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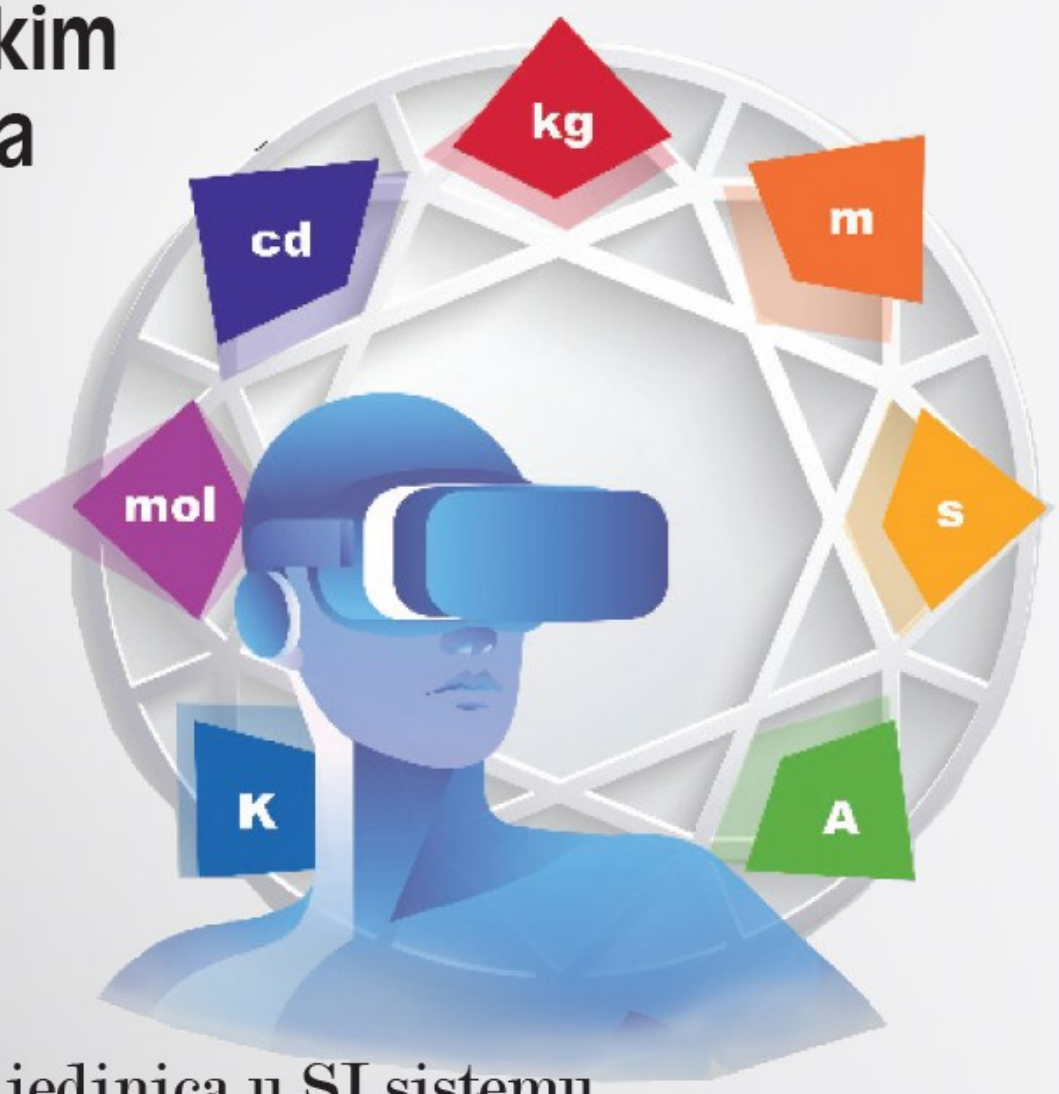
IMBILTEN · GLASNIK INSTITUTA ZA MJERITELJSTVO BOSNE I HERCEGOVINE · IZDANJE IV · MAJ 2019

TEMA BROJA:

Institut u međunarodnim i evropskim istraživačkim projektima



AKTUELNO:

Redefinicije jedinica u SI sistemu

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Glasnik
Instituta za mjeriteljstvo
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Broj IV/2019

Izdanje II, 2020.

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FOREWORD

Drago mi je da vas uputim u ovogodišnje izdanje IM-Biltena, glasnika Instituta za mjeriteljstvo Bosne i Hercegovine, koji je u sklopu obilježavanja Svjetskog dana mjeriteljstva, posvećen rezultatima Instituta na velikom broju evropskih i međunarodnih naučno-istraživačkih projekata. Institut se u projekte istraživanja u mjeriteljstvu, koje finansira Evropska Komisija, uključio 2013. godine. Od tada do danas je ostvario rezultate koji ga u istraživanju svrstavaju među 12 najuspješnijih državnih instituta za mjeriteljstvo u Evropi. Ovim putem vas obavještavamo i o najznačajnijem događaju, koji je kao malo koji događaj u posljednje vrijeme, obilježio svijet nauke – redefiniciji četiri osnovne jedinice Međunarodnog sistema jedinica. Radeći kao institucija u sklopu najreferentnijih evropskih naučnih konzorcija i kroz angažman svojih stručnjaka u međunarodnim timovima, Institut je na desetinama trogodišnjih istraživačkih projekata, na praktičan način dao doprinos u razvoju tehnologija koje su omogućile redefinisanje mjernih jedinica.

Sve veća dostignuća nauke i tehnologije omogućena su primjenom nauke o mjerenju. Prosječan civilizovan građanin nije svjestan da je potreban veliki broj preciznih mjerenja kako bi svakodnevni život bio moguć.

I am pleased to introduce this year's edition of the IM-Bulletin, the gazette of the Institute of Metrology of Bosnia and Herzegovina, which is as the part of the World Metrology Day dedicated to the findings of the Institute on a large number of European and international scientific research projects. In 2013, the Institute involved in the metrology research projects funded by the European Commission. Since then, the Institute has achieved the results of its research among the 12 most successful state metrology institutes in Europe. Hereby, we inform you about the most important event that has, as a bit of the recent events, marked the world of science - redefining the four basic units of the International System of Units. By acting as an institution within the most relevant European scientific consortia and through the involvement of its experts in international teams, the Institute has made dozens of the three-year research projects in a practical way, contributing to the development of the technologies that enabled the redefinition of the measurement units.

The ever-increasing achievements of science and technology are enabled by applying the science of measurement. The average civilized citizen is unaware that a large number of precise measurements are needed to make everyday life possible.

Precizna mjerenja iz oblasti vremena i frekvencije i dužine omogućena su redefinisanjem jedinica - sekunde i metra, na osnovu „fundamentalnih prirodnih konstanti“ (frekvencija oscilovanja atoma cezija – ΔvCs i brzina svjetlosti – c) još 1960. i 1983. godine, respektivno.

Upravo ta težnja za povećanjem preciznosti dovela je do još jednog od najvećih naučnih uspjeha proteklih godina - redefinicije jedinica u Međunarodnom sistemu - SI. U novembru 2018. godine, na Generalnoj konferenciji za tegove i mjere (CGPM) je odobrena nadogradnja Međunarodnog sistema jedinica, odnosno redefinicije u SI sistemu koji predstavlja međunarodno dogovoreni temelj za iskazivanje mjerenja na svim nivoima tačnosti i u svim područjima nauke, tehnike i ljudskog djelovanja. Četiri jedinice koje se koriste za mjerenje mase (kilogram), električne struje (amper), temperature (kelvin) i količine supstance (mol) redefinisane su pomoću „fundamentalnih prirodnih konstanti“ (Plankova konstanta - h, Elementarno naelektrisanje – e, Bolcmanova konstanta - k, Avogadrov broj - N_A).

Konstante koje definišu mjerne jedinice se biraju tako da budu univerzalne (nisu ograničene samo na jedan fizički fenomen), fundamentalne (ne mogu se izraziti u smislu drugih konstanti), i eksperimentalno- pragmatične (treba da budu mjerljive sa najvećom tačnošću).

Nadalje, definicije svih sedam osnovnih SI jedinica će od 20. maja 2019. godine, kada nove definicije stupaju na snagu, biti jedinstveno izražene putem eksplicitnih formulacija konstanti, a uz to će biti uspostavljene specifične *mises en pratique* kako bi objasnili realizaciju definicije svake od osnovnih jedinica u praksi. Revizijom SI sistema uspostavlja se set od sedam fundamentalnih prirodnih

The precise measurements in the area of time and frequency and length are enabled by the redefinition of the units - second and meter, based on the "fundamental physical constants" (frequency of the oscillation of cesium atoms - ΔvCs and speed of the light - c) in 1960 and 1983, respectively.

This tendency to increase the precision has led to one of the greatest scientific achievements in recent years - the redefinition of units in the International System of Units - SI. In November 2018, the General Conference on Weights and Measures (CGPM) approved the upgrading of the International System of Units, i.e. redefinition to the SI system, which represents the internationally agreed basis for expressing the measurement at all levels of accuracy and in all areas of science, technology and human activity. The four units used to measure mass (kilogram), electrical current (ampere), temperature (kelvin) and the amount of substance (mole) are redefined by the "fundamental physical constants" (the Planck constant - h, Elementary charge - e, Boltzmann constant – k, Avogadro number - NA).

The constants that define the units of measurement are chosen so that they are Universal (are not restricted to a single physical phenomenon), Fundamental (cannot be expressed in terms of other constants), Experimental pragmatism (need to be measurable with the highest accuracy).

Furthermore, the definitions of all seven basic SI units will be uniquely expressed through the explicit definitions of constants from May 20, 2019, and specific mises en pratique will be established to explain the realization of the definitions of each of the basic units in practice. Revision of the SI system establishes a set of the seven fundamental natural

konstanti, koje će biti poznate kao „definirajuće konstante SI sistema“.

Definisanjem i izražavanjem mjernih jedinica preko fundamentalnih prirodnih konstanti, one postaju mjerljive i ponovljive na bilo kom mjestu i u bilo kom trenutku, što predstavlja osnovu mjeriteljstva.

Tako je vizija Maks Planka od prije 119 godina postala stvarnost: *Ann.Physik 1, 69-122 (1900) “....uz pomoć fundamentalnih konstanti imamo mogućnost utvrđivanja jedinica dužine, vremena, mase i temperature, koje nužno zadržavaju svoj značaj za sve kulture, pa čak i vanzemaljske i neljudske. “*

constants, which will be known as "defining the constants of the SI system".

By defining and expressing the units of measurement through the fundamental physical constants, they become measurable and repeatable at any place and point of time, which represents the basis of metrology.

The vision of Max Planck, 119 years ago, became true, *Ann.Physik 1, 69-122 (1900) “....with the help of fundamental constants we have the possibility of establishing units of length, time, mass, and temperature, which necessarily retain their significance for all cultures, even unearthly and nonhuman ones.“*

Zijad Džemić

Direktor Instituta za mjeriteljstvo Bosne i Hercegovine

General Director of the Institute of Metrology of Bosnia and Herzegovina

HISTORIJSKA PROMJENA DEFINICIJA U SI SISTEMU

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Abstract

The International System of Units (the SI) provides the basis upon which we measure the world around us, ensuring that measurements made anywhere in the world are comparable. It forms the basis of trade, allowing goods to be valued and exchanged with confidence, and underpins every aspect of scientific research.

On 16 November 2018, at the landmark, 26th General Conference on Weights and Measures (CGPM) in Versailles, France, representatives of 59 members states adopted new definitions of the kilogram, the ampere, the kelvin and the mole. Accurate and precise measurement, as of this day, will no longer rely on the use and comparison with physical objects. The new definitions will modify the foundation of the SI from base units, kilogram, amper, kelvin and mole, to fundamental constants of nature and will ensure stability and consistency of the International System of Units (SI), enabling the development of new quantum technologies.

Fragments from the CGPM open session:

- The French revolution brought us the metric system, with metres as measure of length, and kilogram as measure of mass.

- The Convention du Metre brought us an international agreement about the units.

- On 20th May 2019 (the anniversary of the signing of the 1875 Convention du Metre), we have the biggest revolution in measuring units since the French Revolution.

Međunarodni sistem jedinica (SI) pruža osnovu prema kojoj mjerimo svijet oko nas, te isti osigurava da su mjerenja napravljena bilo gdje u svijetu uporediva. SI sistem predstavlja temelj trgovine, te omogućava da se roba vrednuje i razmjenjuje s povjerenjem i podupire svaki aspekt naučnog istraživanja.

26. Generalna konferencija za tegove i mjere (CGPM), koju je organizovao Međunarodni biro za mjere i tegove (BIPM) održana je od 13. do 16. novembra 2018. u Kongresnoj palati u Versaju, u Francuskoj. Ovoj historijskoj konferenciji su prisustvovali predstavnici država članica i pridruženih članica međunarodnog ugovora Konvencije o metru (*Convention du Mètre*) koji je na snazi od 1875. godine. Na konferenciji je učestvovao i Institut za mjeriteljstvo BiH. Dana 16. novembra 2018. historijskim glasanjem 59 država članica jednoglasno je podržana nadogradnja međunarodnog sistema jedinica, odnosno redefinicije u SI sistemu, koji kao takav datira od 1960. godine i predstavlja međunarodno dogovoreni temelj za iskazivanje mjerenja svih nivoa tačnosti i u svim područjima nauke, tehnike i ljudskog djelovanja. Ovu odluku su pozdravile i 42 pridružene članice CGPM. Taj korak je napravljen poslije višegodišnjeg naučno-istraživačkog rada i nakon većeg boja donesenih međunarodnih rezolucija, kojima se došlo do međunarodnog jednoglasnog dogovora. Tako je četiri godine ranije, na 25. sastanku CGPM u novembru 2014., usvojena Rezolucija o budućoj reviziji Međunarodnog sistema jedinica (Rezolucija 1), koja je zasnovana na rezoluciji iz 2011. godine i prethodnim rezolucijama u kojima je iskazana namjera Međunarodnog komiteta za mjere i utege (CIPM) za revizijom SI i postavljanjem detaljnog putokaza za, sada, već historijske promjene.

U revidiranom SI su navedene nove definicije četiri osnovne jedinice: *kilogram, amper, kelvin i mol,* koje su zasnovane na dosada najpreciznije utvrđenim vrijednostima četiri prirodne konstante: Planckove konstante (*h*), elementarnog naboja (*e*), Boltzmann-ove konstante (*k*) i Avogadrove konstante (N_A), respektivno.

SI sistem jedinica je revidiran nekoliko puta od 1960. godine kada ga je CGPM i formalno usvojio. Međutim, istovremeno redefinisanje četiri osnovne jedinice je do sada nezabilježeno i zahtijeva istovremenu saradnju na globalnom svjetskom nivou iz različitih oblasti mjeriteljstva. Kao i u prošlosti, posebno se vodilo računa da ne dođe do osjetnog uticaja na svakodnevni život, te da mjerenja urađena prema prethodnim definicijama jedinica ostanu validna u okviru njihovih mjernih nesigurnosti. Mali broj korisnika izvan nacionalnih mjeriteljskih laboratorija će primijetiti promjene. Postizanje eksperimentalne tačnosti i ispunjavanje uslova iz CGPM rezolucija predstavlja izvanredan uspjeh koji će osigurati da SI sistem jedinica nastavi da zadovoljava potrebe čak i najzahtjevnijih korisnika.

Kroz historiju, korištene su različite vrste definicija za osnovne jedinice: specifična svojstva artefakta kao što je masa međunarodnog prototipa (IPK) za jedinicu kilogram, specifično fizičko stanje kao što je trojna tačka vode za jedinicu kelvin, idealizirana eksperimentalna pretpostavka kao u slučaju ampera i kandele, ili konstante prirode kao što je brzina svjetlosti za definiciju jedinice metra.

Za bilo koju praktičnu upotrebu ove jedinice, ne samo da moraju biti definisane, već i moraju biti fizički realizirane za diseminaciju. U slučaju artefakta, definicija i realizacija su ekvivalentne - put koji su slijedile napredne drevne civilizacije. Iako je ovo jednostavno i jasno, upotreba artefakta uključuje rizik od gubitka, oštećenja ili promjene.

promjene. Druge vrste definicija jedinica su apstraktnije ili idealizirane. U ovom slučaju su realizacije konceptualno odvojene od definicija tako da se jedinice mogu, principijelno, realizovati nezavisno, na bilo kojem mjestu i u bilo koje vrijeme. Osim toga, nove i napredne realizacije mogu se uvesti, s obzirom da se razvijaju nauka i tehnologija, bez redefinicije jedinice. Ova prednost je očigledno viđena kroz historiju definicije metra od artefakata preko atomskog referentnog prelaza u fiksnu numeričku vrijednost brzine svjetlosti – što je dovelo do odluke da se sve jedinice definišu korištenjem definirajućih konstanti.

Nadalje, definicije svih sedam osnovnih SI jedinica će od 20. maja 2019. godine, kada nove definicije stupaju na snagu za kg, amper, kelvin i mol, biti jedinstveno izražene putem eksplicitnih formulacija konstanti, a uz to će biti uspostavljene specifične *mises en pratique,* tj. objašenjenje realizacije definicije svake od osnovnih jedinica u praksi. Revizijom SI sistema uspostavlja se set od sedam fundamentalnih prirodnih konstanti, koje će biti poznate kao „definirajuće konstante SI sistema".

Rezolucija koja je usvojena u novembru 2018. godine, obuhvatila je sljedeće definirajuće konstante:

- Frekvencija prelaza između dva neperturbovana hiperfina nivoa osnovnog stanja atoma Cezijuma-133 (^{133}Cs) Δv_{Cs} od 9.192.631.770 Hz (hertz),
- Brzina svjetlosti u vakuumu *c* iznosi 299.792.458 m/s (metar u sekundi),
- Planck - ova konstanta *h* iznosi 6,626 070 15 × 10^{-34} Js (džul sekunda),
- Elementarno naelektrisanje *e* iznosi 1,602 176 634 × 10^{-19} C (kulon),
- Boltzmann – ova konstanta *k* iznosi 1,380 649 × 10^{-23} J/K (džul po kelvinu),
- Avogadrova konstanta N_A iznosi 6,022 140 76 × 10^{23} /mol (po molu),
- Svjetlosna efikasnost K_{cd} monohromatskog zračenja frekvencije 540 × 10^{12} Hz iznosi 683 lm/W (lumen po vatu).

gdje su hertz, džul, kulon, lumen i vat, sa simbolima Hz, J, C, lm, i W, respektivno, u izvedene jedinice osnovinih jedinica sekunde, metra, kilograma, ampera, kelvina, mola i kandele, sa simbolima s, m, kg, A, K, mol, and cd, respektivno, prema Hz = s^{-1} , J = kg m^2 s^{-2} , C = As, lm = cd m^2 m^{-2} = cd sr, and W = kg m^2 s^{-3}.

Osnovne jedinice i fundamentalne prirodne konstante na osnovu kojih su definisane [1]

REDEFINICIJA MJERNE JEDINICE ZA MASU (KILOGRAM) U SI SISTEMU

Abstract

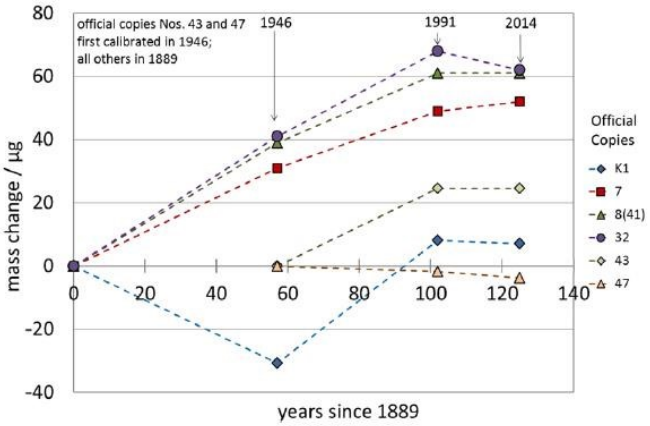
From 20th May 2019, the kilogram will be officially defined in terms of the Planck constant, guaranteeing long-term stability of the SI mass scale. The kilogram can then be realized by any suitable method, (for example the Kibble (Watt) balance or the Avogadro (X-ray crystal density- XRCD) method). Users will be able to obtain traceability to the SI from the same sources used at present. International comparisons will ensure their consistency. The value of the Planck constant was chosen to ensure that there was no change in SI kilogram at the time of redefinition. The gravitational force on an object was comaperd with a magnetic force using a Kibble balance. A kilogram will be therefore defined using the Planck constant, a fixed numerical constant which will not change over time.

New definition: The kilogram, symbol kg, is the SI unit of mass. It is defined by taking the fixed numerical value of the Planck constant h to be 6.626 070 15 × 10^{-34} when expressed in the unit Js, which is equal to kg m^2 s^{-1} , where the metre and the second are defined in terms of speed of light in vacuum (c) and Δv_{Cs}.

Praktična realizacija definicije kilograma

Kilogram je jedina osnovna jedinica koja je do 2018. godine ostala definisana artefaktom i koja nije definisana pomoću nepromjenljivog prirodnog fenomena. Još od kraja 18. vijeka se za praktičnu upotrebu koristio platinasti cilindar od 1 kg (što je odgovaralo masi ove jedinice) koji je proizveden 1799. godine. Međunarodnoj pramjeri (prototipu) je 1889. godine dodijeljena masa $m(K) = 1$ kg, prema definiciji. Međunarodni prototip (*IPK* ili *Le Grand K*) zajedno sa šest etalona "svjedoka" i četiri radna etalona pohranjen je u podrumima Međunarodnog biroa za mjere i tegove (BIPM) u Sèvresu, kod Pariza. Na trećoj Konferenciji BIPM, 1901. godine definisana je jedinica za masu kao: „Kilogram je jedinica za masu, i on je jednak masi međunarodnog prototipa". To je platinsko –iridijski cilindar (90% platine i 10% iridija), kojem su visina i prečnik oko 39 mm, a čija je gustina ≈ 21,5 kg/dm^3. Međutim, u posljednjih 130 godina tokom međunarodnih poređenja IPK sa kopijama u BIPM i nacionalnim prototipovima, koji su distribuirani širom svijeta, zabilježena je promjena mase od 50 mikrograma, što potvrđuje nestabilnost mase i ovakve definicije kilograma u vremenu. Promjena mase je evidentna, ali i nepredvidiva, te se već skoro 20 godina provode istraživanje s ciljem donošenja nove definicije za mjernu jedinicu kilogram koja će obezbijediti pouzdanu i ponovljivu realizaciju. Glavni nedostatak doskorašnje definicije kg je što se ona odnosila na masu artefakta, koji po svojoj prirodi ne može biti apsolutno stabilan i pokazuje odstupanja mase izmjerene u vremenskim intervalima.

Porastom zahtjeva nauke i industrije, javila se potreba za definisanjem kilograma preko neke od fundamentalnih prirodnih konstanti, čime bi se eliminisala potreba za sljedivošću prema fizikalnom artefaktu, poboljšala njegova dugoročna stabilnost i omogućila univerzalna primjenjivost definicije. Istraživanja su vođena na dva projekta: eksperiment sa sferom od elementarnog silicija (Si), kojim se određuje Avogadrov broj (N_A), i eksperiment sa Watt vagom koji definiše i određuje Plankovu konstantu (h).



Promjene mase od prve kalibracije zvaničnih kopija u odnosu na IPK od 1889 [3]

Definisanje kilograma putem fiksne vrijednosti fundamentalne prorodne konstante, kao što je Planckova, predstavlja veliki izazov jer za sobom povlači i redefinisanje mola, ampera i kelvina. Nakon redefinicije, nesigurnosti etalona mase u lancu sljedivosti od Međunarodnog prototipa kilograma su uvećane za mjernu nesigurnost pridruženu IPK. To praktično znači da će masa međunarodnog prototipa kg i dalje biti tačno 1 kg, ali sa pridruženom, nenultom mjernom nesigurnošću, izvedenom iz eksperimenata u kojima je izmjerena Plankova konstanta, na koju će se nova definicija oslanjati.

Kilogram (simbol kg) je mjerna jedinica za masu u SI sistemu. Definiše se na osnovu fiksne brojčane vrijednosti Planckove konstante *h*, koja iznosi 6,626 070 15 × 10^{-34} izražena u jedinici Js, koja je jednaka kgm^{2}s^{-1}, pri čemu su metar i sekunda definisani na osnovu c i Δv_{Cs}

Ova definicija uspostavlja tačan odnos h = 6,626 070 15 × 10^{-34} kg m^2 s^{-1}. Inverzija ovog odnosa daje tačno izraženu jedinicu kilogram u pogledu tri definirajuće konstante h, Δv_{Cs} i c, kako slijedi:

$$1\ \text{kg} = \left(\frac{\text{h}}{6{,}626\ 070\ 15 \cdot 10^{-34}}\right) \text{m}^{-2}\text{s}$$

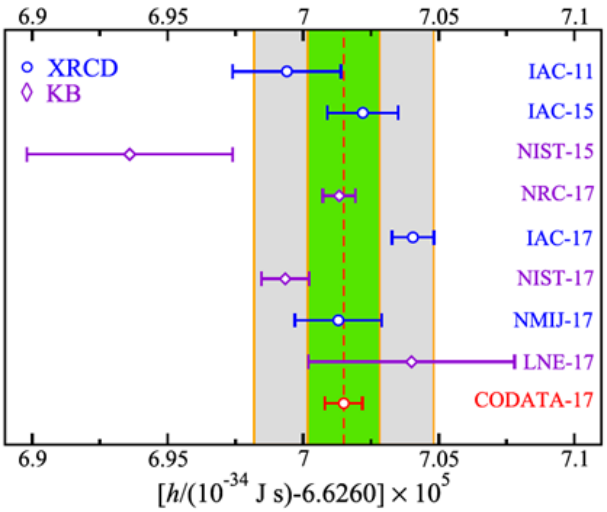
odakle slijedi:

$$1\ \text{kg} = \frac{(299\ 792\ 458)^2}{(6{,}626\ 070\ 15 \cdot 10^{-34})(9\ 192\ 631\ 770)} \frac{h\Delta v_{Cs}}{c^2}$$

$$\approx 1{,}475\ 5214 \bullet 10^{40}\ \frac{h\Delta v_{Cs}}{c^2}$$

Prethodna definicija kilograma fiksirala je vrijednost mase IPK, odnosno m(K) na tačan iznos 1 kg, dok se vrijednost Planckove konstante određivala eksperimentalno. Nova definicija fiksira brojnu vrijednost Planckove konstante, a masa prototipa se određuje eksperimentalnim putem.

Vrijednost odabrana za brojčanu vrijednost Planckove konstante u ovoj definiciji je takva da je vrijednost kilograma jednaka masi međunarodnog prototipa m(K)=1 kg, sa relativnom mjernom nesigurnosti od 1,0 × 10^{-8}, što je standardna nesigurnost kombinirane najbolje procjene vrijednosti Planckove konstante, u vremenu usvajanja definicije.



Grafik CODATA za vrijednosti Planckove konstante [6]

CODATA (Committee on Data of the International Council for Science) je objavio podatke na osnovu kojih je fiksirana

vrijednost Plankove konstante, što je prikazano na grafiku. Na grafiku su prikazane eksperimentalno dobijene vrijednosti Planckove konstante u eksperimentu XRCD (X-ray crystal density metode), odnosno Avogadrov eksperiment i u eksperimentu sa KB – Kibble Balance, što se odnosi na eksperimentalne vrijednosti dobivene sa Kibble vagom. Granice zelenog područija su označene sa ±20 x 10-9, dok su granice sivog područija označene sa ±50 x 10-9. Odabrana fiksna vrijednost Plackove konstante ima relativnu standardnu mjernu nesigurnost od 1,0 x 10-8.

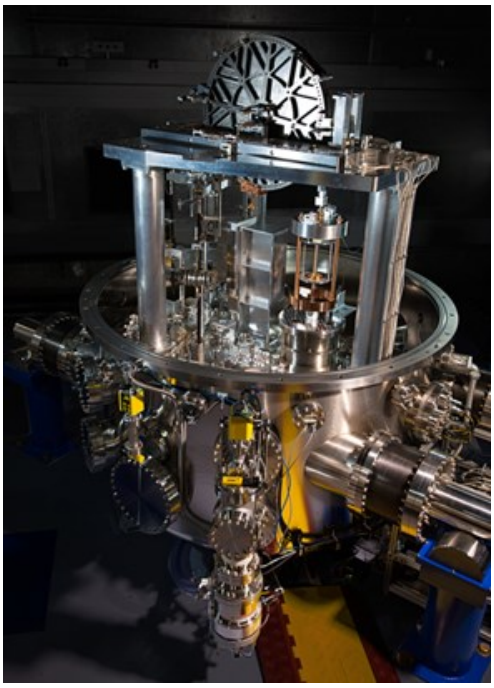
Planckova konstanta je određena na eksperimentu Watt vaga, koji je kasnije preimenovan u Kibble vagu, po Dr. Bryan Kibble koji je 1970-tih radio u NPL-u, nacionalnom mjeriteljskom institutu Velike Britanije, na mjerenjima Planckove konstante.

Dr Bryan Kibble koji je radio u NPL [7]

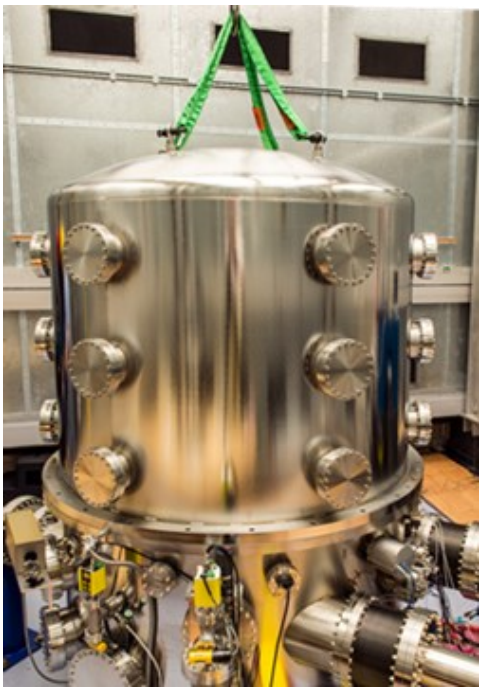
Razvijene su dvije nezavisne primarne metode za realizaciju definicije kilograma, koje se odnose na određivanje mase prema h, bez korištenja bilo kojeg drugog etalona. Druga metoda uspoređuje nepoznatu masu sa masom pojedinačnog atoma određenog izotopa brojanjem atoma u kristalu, gdje je masa atoma poznata i određena preko veličina h, c i $\Delta\nu Cs$.

Realizacija poređenjem mehaničke i električne snage

Precizni instrumenti koji rade na principu izjednačavanja električne i mehaničke snage poznati su kao Watt vage, tj. Kibble vage. Kibble vage mogu imati različitu geometriju.



Kibble vaga u NIST, nacionalni institut u SAD [7]



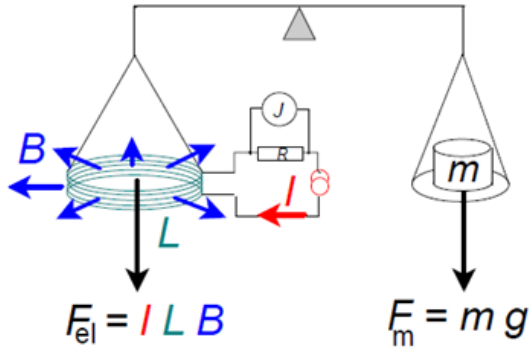
Rad Kibble vage se dešava pri kontrolisanim uvjetima [8]

Određivanje nepoznate mase m artefakta se izvodi u dva moda: modu vaganja i modu kretanja.

vaganja i modu kretanja. Ova dva moda se mogu pojaviti uzastopno ili istovremeno. U modu vaganja, težina artefakta m g je uravnotežena elektromagnetnom silom koju proizvodi kružni namotaj žice dužine L postavljene u radijalno magnetno polje gustoće fluksa B kada struja I teče kroz namotaj. Ova sila je paralelna sa lokalnim gravitacionim ubrzanjem. Gravitaciono ubrzanje koje djeluje na masu i struja I u namotaju se mjere istovremeno tako da je:

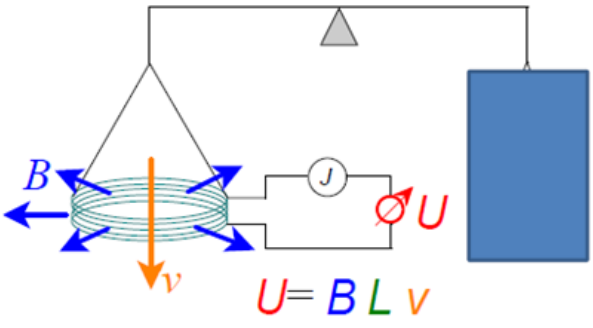
$$mg = IBL$$

Vrijednost struje se mijenja dok gravitaciona sila ne dođe u ravnotežu sa silom iz namotaja u magentnom polju.



Mod vaganja [5]

U modu kretanja, mjeri se inducirani napon tokom kretanja namotaja vertikalno, brzinom *v* kroz magnetno polje iste gustoće magnetnog fluksa *B*.



Mod kretanja [5]

Ako su polje i namotaj konstantni, kombinujući jednačine iz ove dvije faze, uz eliminaciju *B l*, dobija se

$$mgv = IU$$

Struja I se može odrediti putem Ohmovog zakona, mjereći pad napona U kroz terminale stabilnog rezistora vrijednosti R. Napon U se mjeri preko Josephsonove konstante KJ, dok se otpor R se mjeri putem von Klitzingove konstante RK.

Konačna formula za masu je:

$$m=h\left(\frac{b f^2}{4}\right)\frac{1}{gv}$$

Kako je eksperimentalna vrijednost fizikalne konstante $h/m(^{28}Si)$ poznata sa gdje su:

f - eksperimentalna frekvencija,

b - bezdimenzionalna eksperimentalna veličina, obje su povezane sa mjerenjem električne struje i napona.

Realizacija kg putem X-ray crystal density metode (XRCD)

Koncept XRCD zasniva se na ideji da se masa čiste supstance može izraziti preko broja elementarnih čestica u supstanci. Broj elementarnih čestica se može mjeriti putem XRCD metode u kojoj se određuju zapremine jediničnih ćelija i skoro idealnog kristala, tj. mjerenjem parametra rešetke *a* i srednjeg prečnika sferičnog uzorka. Za ovu metodu najčešće se koriste kristali silicija (Si) zbog svoje veličine i mogućnosti pripreme u obliku hemijski super čistog kristala i bez dislokacija u kristalnoj rešetki. Makroskopska zapremina V_s kristala jednaka je srednjoj mikroskopskoj zapremini po atomu u jediničnoj ćeliji pomnoženoj sa brojem atoma u kristalu. Ako se pretpostavi da kristal sadrži izotop ^{28}Si, broj atoma *N* u makroskopskom kristalu je

$$N = \frac{8V_s}{a(^{28}Si)^3}$$

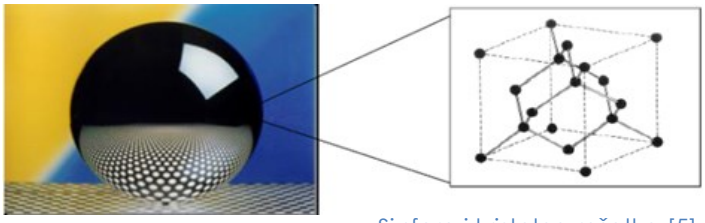
gdje je 8 broj atoma u jediničnoj ćeliji kristalnog silicija, *a* ($28Si)^3$ je zapremina jedinične ćelije oblika kocke, tj. $V_s/a(^{28}Si)$ ^{3}je broj jediničnih ćelija u kristalu. Iz praktičnih razloga, kristal je u oblikovan u sferu mase oko 1 kg. Za realizaciju definicije kilograma, masa sfere m_s je najprije izražena preko mase

pojedinačnog atoma koristeći XRCD metodu:

$$m_s = Nm(^{28}Si)$$

visokom tačnošću, uz fiksnu vrijednost h, prethodna jednačina se može pisati kao:

$$m_s = hN\frac{m(^{28}Si)}{h}$$



Si sfera i kristalna rešetka [5]

REDEFINICIJA MJERNE JEDINICE ZA ELEKTRIČNU STRUJU (AMPER) U SI SISTEMU

Abstract

The ampere has been redefined in terms of the elementary electrical charge (e). The definition of the ampere underwent a major revision – the previous definition, which is difficult to realize with high precision in practice, was replaced by a definition that is more intuitive and easier to realize.

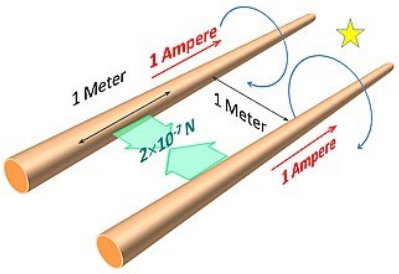
Previous definition: The ampere is that constant current which, if maintained in two straight parallel conductors of infinite length, of negligible circular cross-section, and placed 1 m apart in vacuum, would produce between these conductors a force equal to 2×10^{-7} newton per metre of length.

New definition: The ampere, symbol A, is the SI unit of electric current. It is defined by taking the fixed numerical value of the elementary charge e to be $1.602176634 \times 10^{-19}$ when expressed in the unit C, which is equal to As, where the second is defined in terms of Δv_{Cs}.

Praktična realizacija definicije ampera

Jedinica električne struje, amper, nazvan po francuskom matematičaru i fizičaru André-Marie Ampère (1775 – 1836), koji se smatra ocem elektrodinamike, je jedna od četiri veličine koje su redefinisane u novembru 2018. godine, a nova definicija stupa na snagu na Međunarodni dan mjeriteljstva 20. maja 2019. godine. Prethodna definicija ampera iz 1948. godine je veoma apstraktna.

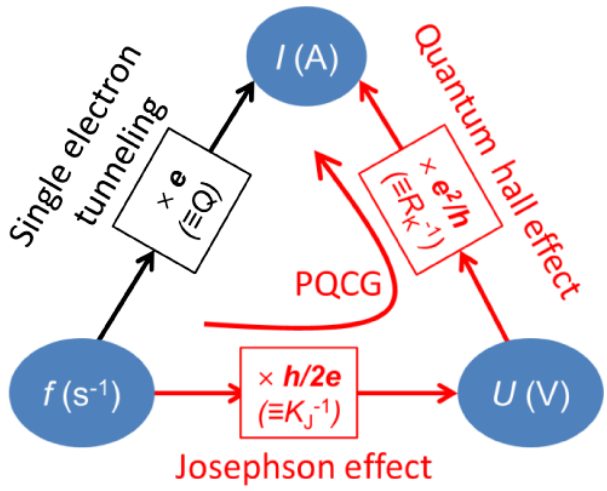
Amper (A) je jačina stalne električne struje koja kada protiče kroz dva paralelna beskonačno duga pravolinijska provodnika zanemarljivog poprečnog preseka u vakuumu, na rastojanju od jednog metra (1m), izaziva između njih silu od 2 x 10-7 njutna po metru dužine (Nm-1).



Definicija ampera iz 1948. godine [13]

Direktna realizacija ampera zasnivala se na složenim elektromehaničkim uređajima nazvanim strujne vage (current balance). Tačnost ovakve realizacije ampera (A) je, dakle, ograničena na nekoliko dijelova u deset miliona (10-7), što je nedovoljno za današnje potrebe nauke i tehnologije.

Napredak u kvantnoj tehnologiji pružio je nove mogućnosti za realizaciju ove veličine. Ovo je dovelo do toga da se 1990-tih, počelo razmišljati o novom načinu definisanja jedinica električnih veličina. 2005. godine BIPM je obavio prve pripreme za redefiniciju SI jedinica, koje će se u potpunosti temeljiti na prirodnim konstantama. Međunarodna istraživanja ostvarila su ove ambiciozne ciljeve kroz zajedničke istraživačke projekte.



Praktična realizacija Ampera na osnovu vrijednosti elementarnog naboja [14]

Nova definicija ampera glasi:

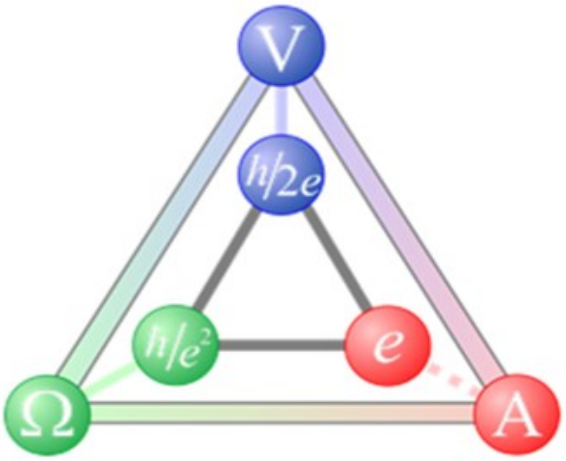
Amper (simbol A) je mjerna jedinica za električnu struju u SI sistemu. Definisan je na osnovu fiksne vrijednosti elementarnog naboja e od 1,602 176 634 x 10^{-19} kada je izražen u kulonima C, što odgovara A s, gdje je sekunda s osnovna SI jedinica i definsana sa Δv_{Cs}:

$$1\ \mathrm{A} = \left(\frac{e}{1{,}602\ 176\ 634 \times 10^{-19}}\right) \times \mathrm{s}^{-1}$$

U praksi amper (A) se moze realizovati na ove načine:

- koristeći Omov zakon, gdje je realizacija jedinice data sa A = V/Ω, koristeći izvedenu jedinicu volt (V) zasnovanu na Josephsonovom efektu ($K_J \cong 2e/h$ = 483 597,848 416 984 GHz/V) i izvedenu jedinicu Om (Ω), zasnovanu na Quantum Hall efektu ($R_K \cong h/e^2$=25 812,807 459 3045 Ω); ili
- koristeći uređaj za transportiranje i brojanje jonizovanih čestica (jednu po jednu) - single electron transport (SET) ili sličan uređaj, gdje je realizacija jedinice data sa A = C/s, koristeći vrijednosti velicine e koja je data u definiciji ampera i osnovne SI jedinice sekunde (s); ili
- koristeći relaciju $I = C \cdot dU/dt$, gdje je realizacija jedinice data sa A = F·V/s, koristeći praktične realizacije izvedenih jedinica volt (V) i farada (F) i osnovne SI jedinice sekunde (s).

Trenutno najbolja tačnost pomenutih metoda, za pojedine vrijednosti struje dostiže vrijednosti od jednog dijela milijarde (10^{-9}).



Veze volta, ampera i oma sa prirodnim konstantama [16]

Definisanje i izražavanje mjernih jedinica električnih veličina, uključujući i amper (A) preko fundamentalnih prirodnih konstanti, one postaju mjerljive i ponovljive na bilo kom mjestu i u bilo kom vremenu i samim tim obezbijeđena je dugoročna stabilnost etalona razvijenih na ovim principima.

REDEFINICIJA JEDINICE TERMODINAMIČKE TEMPERATURE (KELVIN) U SI SISTEMU

Abstract

Since 1954, the kelvin has been defined as "equal to the fraction 1/273.16 of the thermodynamic temperature of the triple point of water—the point at which water, ice and water vapor co-exist in equilibrium. That is a valuable common reference because, for a precise formulation of water at a specific pressure, the triple point always occurs at exactly the same temperature: 273.16 K.

Now, kelvin should be redefined in terms of the Boltzmann constant, which relates the amount of thermodynamic energy in a substance to its temperature.

New definition: The kelvin, symbol K, is the SI unit of thermodynamic temperature. It is defined by taking the fixed numerical value of the Boltzmann constant k to be 1.380 649 × 10^{-23} when expressed in the unit J K^{-1}, which is equal to kg m^2 s^{-2} K^{-1}, where the kilogram, metre and second are defined in terms of h, c and Δv_{Cs}.

Od 1954. godine jedinica termodinamičke temperature, kelvin (K), je definisana kao 1/273,16-ti dio termodinamičke temperature trojne tačke vode – tačke na kojoj led, voda i vodena para istovremeno koegzistiraju u ravnoteži.

Termodinamička temperatura trojne tačke vode je, dakle, 273,16 K. Voda iz ove definicije ima precizno definisan izotopski sastav, i to: 0,00015576 mola ^{2}H po molu ^{1}H, odnosno 0,0003799 mola ^{17}O po molu ^{16}O, i 0,0020052 mola ^{18}O po molu ^{16}O, što je izotopski sastav referentnog materijala vode (VSMOW - Vienna Standard Mean Ocean Water) međunarodne agencije za atomsku energiju (IAEA).

Trojna tačka vode u Institutu za mjeriteljstvo Bosne i Hercegovine

U samoj ovoj definiciji se naziru i osnovne poteškoće vezane za realizaciju ovako definisanog kelvina kao jedinice termodinamičke temperature, te razlozi za njenu promjenu. Voda dakle mora biti u potpunosti bez nečistoća i sa strogo definisanim izotopskim sastavom. Različit izotopski sastav pri realizaciji trojne tačke vode dovodi do razlike u temperaturi. Osim toga, definicija jedinice je na ovaj način vezana za jednu konkretnu temperaturu – temperaturu trojne tačke vode T_{tpw} = 273,16 K.

Osnovni cilj promjene definicije kelvina je da se definicija jedinice temperature generalizuje na način da se uspostavi veza sa nekom univerzalnom konstantom i da u konačnici ne zavisi od bilo kojeg konkretnog materijala ili artefakta, te da bude nezavisna o metodi realizacije i temperaturnom opsegu.

Na ovaj način se osigurava dugoročna vrijednost definicije kao i unaprjeđenje mjerenja temperatura udaljenih od trojne tačke vode, posebno nižih od 20 K i viših od 1300 K.

Rad na novoj definiciji kelvina traje od 2005. godine, kada je Međunarodni komitet za mjere i tegove (CIPM - International Committee for Weights and Measures) odlučio da prihvati prijedloge o redefiniciji kelvina određivanjem vrijednosti Botzmannove konstante.

Boltzmannova konstanta k povezuje temperaturu i energiju i izražava se u džulima po kelvinu. Konstanta je dobila ime po austrijskom naučniku Ludwigu Boltzmannu (1844–1906), pioniru statističke mehanike, naučne discipline koja povezuje kolektivna termodinamička svojstva sistema koji se sastoji od velikog broja čestica sa individualnim energijama tih čestica.

Istovremeno sa prihvatanjem inicijative za promjenu definicije jedinice temperature, određeni su i uslovi koje je je trebalo ispuniti ovim eksperimentalnim određivanjem Boltzmannove konstante prije konačne promjene definicije:

- Konstanta treba biti određena mjerenjem bar jednom metodom sa relativnom standardnom nesigurnošću manjom od 1×10^{-6}.

- Konstanta mora biti određena mjerenjem bar još jednom dodatnom metodom, fundametalno različitom od prve, koja daje podudaran rezultat, sa relativnom standardnom nesigurnošću manjom od 3×10^{-6}.

Sistemi opisani jednačinom stanja koja se može koristiti za direktno mjerenje termodinamičke temperature nazivaju se primarni termometri i korišteni su za eksperimentalno određivanje Boltzmannove konstante.

Niz nacionalnih mjeriteljskih instituta je dugi niz godina radio na ovom zadatku, i nekoliko vodećih svjetskih instituta su do 2017. godine ostvarili mjerenja sa podudarnim rezultatima i zahtjevanim mjernim nesigurnostima. Najbolji rezultati postignuti su akustičnim gasnim termometrom (AGT), koji koristi vezu između brzine zvuka u gasu i temperature gasa. Gasni termometar dielektrične konstante (DCGT), koji koristi fenomen promjene dielektrične konstante sa promjenom temperature, mjerni je uređaj koji se primjenjuje u metodi koja je dovela do rezultata koji su ispunili i drugi post-avljeni uslov. Postoji još nekoliko metoda na kojima rade različiti instituti sa istim ciljem, a jedna od najznačajnijih je svakako Johnson Noise Thermometer (JNT), koji za mjerenje temperature koristi promjenu nivoa električnog šuma koji je rezultat toplotnog kretanja elektrona u provodniku.

Ova definicija uspostavlja odnos

$$k = 1{,}380\,649 \times 10^{-23} kgm^2s^{-2}K^{-1}$$

Inverzija ovog odnosa izražava kelvin preko definirajućih konstanti h, $\Delta\nu_{Cs}$ and c, kako slijedi:

$$1\ \mathrm{K} = \left(\frac{1{,}380649}{k}\right) \mathrm{x}10^{-23} kgm^2s^{-2}$$

odnosno

$$1\ \mathrm{K} \approx 2{,}266\,6653\ \frac{\Delta\nu_{Cs}\ h}{k}$$

Akustični rezonator u NIST-u [17]

Iz ove definicije takođe proizilazi da je jedan kelvin (K) jednak promjeni termodonamičke temperature koja rezultuje promjenom termalne energije k T za 1,380 649 × 10^{-23} J.

Svakako je važno i pitanje uticaja ove redefinicije jedinice termodinamičke temperature na svakodnevna praktična mjerenja.

Za većinu ljudi ova redefinicija će proći potpuno neprimjetno. U praktičnom dijelu mjerenja temperature u svakodnevnom životu, meteorološkim i industrijskim mjerenjima neće se gotovo ništa promijeniti. Voda će se i dalje mrznuti na 0 °C, certifikati o kalibraciji će i dalje važiti, i temperaturna skala ITS-90 će i dalje biti naša temperaturna skala.

Promjene će biti vidljive u mjerenjima termodinamičkih temperatura bliskih apsolutnoj nuli i temperatura viših od 1300 K, gdje će primjena primarnih termometara omogućiti direktno mjerenje termodinamičke temperature.

Kao rezultat ovih mjerenja konačno je došlo do redefinicije kelvina:

Kelvin, simbol K, je SI jedinica termodinamičke temperature. Definiše se na osnovu fiksne brojne vrijednosti Boltzmannove konstante k koja iznosi 1,380 649 × 10^{-23} izražena u jedinicama J K^{-1} (džul po kelvinu), odnosno kg m^2 s^{-2} K^{-1}, gdje su kilogram, metar i sekunda definisani preko h, c and ΔvCs.

REDEFINICIJA JEDINICE ZA KOLIČINU SUPSTANCE (MOL) U SI SISTEMU

Abstract

Development of measurement methods in chemistry and physics was closely related with the development of metrology - a discipline which focuses on the traceability of measurement results to the reference standards, usually to the International System of Units (SI). The measurement result is necessarily followed by the total estimated budget of uncertainty. Although amount of substance is the sixth on the list of base physical quantities, it takes the first place in chemistry and chemical measurements. Measurement of the amount of a substance is based on the determination of the number of entities (atoms, ions, molecules, etc.), and is traditionally related to the measurement of the mass. However, according to some studies measurements of the amount of the substance are often wrongly identified with the mass. In addition to these studies, a number of other reasons, among which the most important one is long-term instability of Le Grand K, an artefact that defines a kilogram, pointed to the need to redefine all base SI units in a way to be related to the most stable features known to all scientists, i.e. natural physical constants.

The mole, symbol mol, is the SI unit of amount of substance. One mole contains exactly 6.022 140 76 × 10^{23} elementary entities. This number is the fixed numerical value of the Avogadro constant, N_A, when expressed in the unit mol^{-1} and is called the Avogadro number. The amount of substance, symbol n, of a system is a measure of the number of specified elementary entities. An elementary entity may be an atom, a molecule, an ion, an electron, any other particle or specified group of particles.

Praktična realizacija definicije mola

Mol je zvanično uvršten u Internacionalni sistem jedinica (SI) 1971. godine, kada je definisan kao količina supstance (*n*) koja sadrži onoliko elementarnih entiteta koliko ima atoma u 0,012 kg izotopa ugljka ^{12}C. Odmah je bilo jasno da direktna realizacija ove jedinice u bilo kojoj analitičkoj laboratoriji nije moguća, obzirom na nemogućnost pripreme savršeno čistog izotopa ^{12}C i činjenicu da se radi o velikom broju elementarnih jedinki. Upravo je nemogućnost direktne realizacije u laboratoriji uzrokovala konceptualne poteškoće u pogledu sljedivosti hemijskih mjerenja direktno do ove osnovne SI jedinice - mola, pa su i mjerenja količine supstance često pogrešno poistovjećivana sa mjerenjima mase. Prepoznavši potrebu za jasnijim i detaljnijim definsanjem veze između hemijskih mjerenja i odgovarajuće osnovne SI jedinice, BIPM je 1995. godine formirao Konsultativni komitet za količinu tvari (CCQM).

Od 1971. godine, kada je mol definisan kao količina supstance (*n*) koja sadrži onoliko elementarnih entiteta koliko ima atoma u 0,012 kg ugljka ^{12}C pa do danas, učinjeni su veliki napori da se ta definicija koriguje pa je tako u julu 2009.

od strane Konsultativnog komiteta za jedinice (CCU), Međunarodne zajednice za čistu i primijenjenu hemiju – Internacionalnog komiteta za terminologiju, nomenklaturu i simbole (IUPAC-ICTNS), prvi put uvedena Avogadrova konstanta, za čije je određivanje približne vrijednosti Jean Perrin dobio Nobelovu nagradu još 1926. Konstanta svoje ime duguje italijsnkom naučniku Amedeu Avogadru, punog imena Lorenzo Romano Amedeo Carlo Avogadro (1776 – 1856). Od tada se o molu govori kao o broju od 6,02214129 × 10^{23} elementarnih jedinki i taj broj se primjenjuje za sva potrebna hemijska računanja, a određuje se prema relaciji:

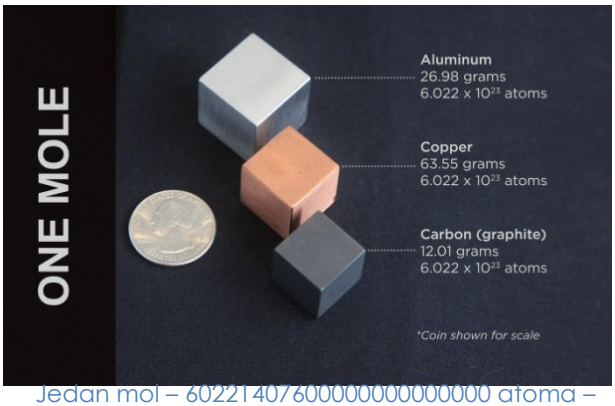
$$N_A = \frac{L^2 M(e^-) c}{2 R_\infty h}$$

$$N_A = 6{,}2214076 \times 10^{23} mol^{-1}$$

Iz prvog pogleda na navedenu jednačinu jasno je da su Planckova konstanta i Avogadrov broj matematički poveazne. Planckovoj konstanti, *h,* koja se računa iz jednačine $m = hv/c^2$, pri čemu se dobije vrijednost 6,626070040 x 10^{-34} J s, je pridružena mjerna nesigurnost koja potiče od nesigurnosti nestabilnog *Le Grand K* artefakta a koja se može pridružiti i Avogadrovom broju jer je sadržan u masi od 0,012 kg ^{12}C.

Kako bi se osnovne SI jedinice svele na fizikalne konstante naučnici su odlučili fiksirati brojčane vrijednosti odgovarajućih fizikalnih konstanti tj. Planckove konstante na vrijednost 6,626070150 x 10^{-34} J s i Avogadrovog broja na vrijednost 6,022 140 76 x 10^{23}, a nakon toga ih potvrditi preciznim mjerenjima. Dakle, kako bi opravdano mogli definisati masu i mol preko fizikalnih konstanti bilo je potrebno što tačnije i preciznije moguće izmjeriti Planckovu konstantu i Avogadrov broj. Konačno, međunarodni tim naučnika je kroz mnoge laboratorijske eksperimente, koristeći obogaćene izotope i sofisticirane instrumente uspješno izmjerio konstante *h* i N_A sa zadovoljavajućom mjernom nesigurnošću. Ovim uspješnim mjerenjima dokazano je da definisanje osnovnih jedinica, u ovom slučaju kilograma i mola, moguće izvršiti bez upotrebe fizičkog artefakta - etalona.

Za precizna mjerenja Planckove konstante korištena je Kibble vaga, a u tzv. Avogadrovom eksperimetu ultra-čista sfera od silicijuma, jedan od najvažnijih mostova koji povezuju atomski i makro svijet, uz naglasak da silicij neće biti biti korišten kao referenca, nego jednačine i brojčani podaci potvrđeni kroz pomenuta mjerenja.



Jedan mol – 602214076000000000000000 atoma – bez problema stane u džep [15]

Na osnovu svih dostupnih i relevantnih eksperimentalnih podataka sakupljenih do jula 2017. CODATA Committee on Data of the International Council for Science je proveo prilagođavanje vrijednosti osnovnih konstanti metodom najmanjeg kvadrata u svrhu određivanja najbolje brojčane vrijednosti nekoliko fizikalnih konstanti *h*, N_A, *e* i *k*. Podešena vrijednost za Planckovu konstantu je *h*= 6,6260701509 (69) x 10^{-34} J s uz relativnu mjernu nesigurnost od 1,0 x 10^{-8} i vrijednost za N_A= 6,022140758(62) x 10^{23} mol^{-1} uz relativnu mjernu nesigurnost od 1.0 x 10^{-8}. Pored Planckove konstante i Avogadrovog broja bitno je pomenuti i Rydbergovu konstantu, R_∞, iz jednačine za računanje N_A koja ima jednu od najmanjih relativnih mjernih nesigurnosti koja se veže za mjerene konstante, a dobija se izjednačavanjem izmjerene frekvencije prijelaza u vodiku (H) i deuteriju (D) s njihovim teorijskim izrazima.

Nova definicija jedinice mol:

Mol (simbol mol) je mjerna jedinica za količinu supstance u SI sistemu. Jedan mol sadrži tačno 6,022 140 76 x 10^{23} elementarnih entiteta. Ovaj broj je fiksna brojčana vrijednost Avogadrove konstante, N_A, koja se u slučaju izražavanja u jedinici

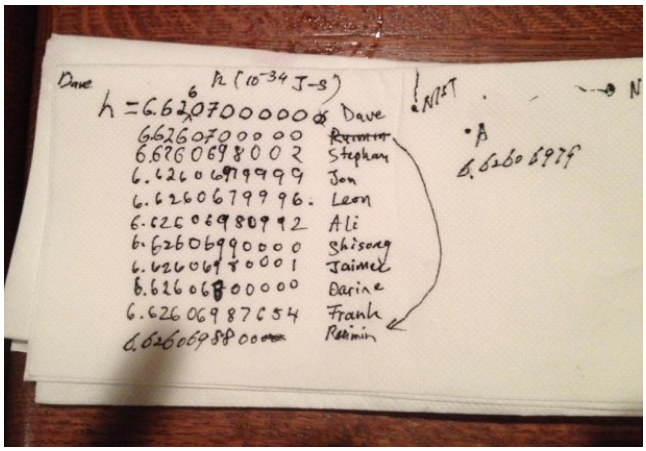
mol^{-1} zove Avogadrova konstanta (N_A ili L).

Količina supstance, sa simbolom *n*, je mjera za broj specifičnih elementarnih entiteta. Pomenuti elementarni entiteti mogu biti atomi, molekule, joni, elektroni i druge čestice ili grupe čestica.

Sama veza između Avogadrovog broja i Avogadrove konstante vidljiva je iz sljedeće jednačine:

$$1\ \text{mol} = \left(\frac{6{,}022140\ 76 \times 10^{23}}{N_A} \right)$$

Da se put do ozbiljnih zaključaka i dogovora u prirodnim naukama često ne razlikuje od dječije igre pokazuje i slika na kojoj se nalazi komad salvete na koju su, u svojevrsnom takmičenju, naučnici uključeni u mjerenje Planckove konstante zapisali svoje pretpostavke vrijednosti koja će biti određena.



Maramica sa pretpostavljenim vrijednostima Plankove konstante [8]

Reference:

[1] https://www.bipm.org/en/measurement-units/rev-si/

[2] BIPM: (Draft of the ninth edition) „The International System of Units (SI)“, 2018. https://www.bipm.org/utils/en/pdf/si-revised-brochure/Draft-SI-Brochure-2019.pdf

[3] Michael Stock, Pauline Barat, Richard S Davis, Alain Picard and Martin J T Milton Calibration campaign against the international prototype of the kilogram in anticipation of the redefinition of the kilogram part I: comparison of the international prototype with its official copies Metrologia 52 (2015) 310–316

[4] https://www.bipm.org/utils/en/pdf/si-mep/MeP-kg-2018.pdf

[5] Milton M.:“On the proposed re-definition of the SI“, Varenna 2016.

[6] D B Newell et al 2018 Metrologia 55 L13: “The CODATA 2017 values of h, e, k, and N A for the revision of the SI“

[7] https://www.nist.gov/si-redefinition/kilogram-kibble-balance

[8] https://www.nist.gov/si-redefinition/kilogram-mass-and-plancks-constant

[9] WGSI Guidelines on implementing the new SI-Francois Piquemal (LNE)

[10] https://www.wikipedia.org/

[11] CCEM Guidelines for Implementationof the „Revised SI“, December 2017

[12] Schlamminger S. „Redefining the Kilogram and Other SI Units Other SI Units, US National Institute of Standards and Technology, Gaithersburg, Maryland, USA (iopscience.iop.org)

[13] https://www.ptb.de/cms/en/ptb/fachabteilungen/abt2/fb-26

[14] J. Brun-Picard, S. Djordjevic, D. Leprat, F. Schopfer, and W. Poirier: „Practical Quantum Realization of the Ampere from the Elementary Charge“, LNE

[15] https://www.nist.gov/si-redefinition/redefining-mole

[16] https://www.researchgate.net

[17] https://www.ptb.de/cms/en/ptb/fachabteilungen/abt2/fb-26

ULOGA EMRP I EMPIR PROGRAMA U RAZVOJU NAUČNOG MJERITELJSTVA U EVROPSKOJ UNIJI

Zijad Džemić

EMRP istraživački program

Evropski nacionalni mjeriteljski instituti ('National Metrology Institutes- NMIs') imaju dugu tradiciju bilateralnih saradnji u sklopu naučnog mjeriteljstva, te su u skladu sa tim 1987. godine osnovali EUROMET, prvu podlogu za evropsku saradnju za mjerne etalone. Članstvo je postepeno raslo, i prešlo 30 zemalja članica uz Centar za istraživanje (Joint Research Centre - JRC) , koji predstavlja IRMM. Pod okriljem petog EU Okvirnog programa ('EU Framework Programme – FP') za istraživanje i tehnički razvoj ('Research and technical development – RTD') (1998-2002), Evropska mjeriteljska zajednica je bila u mogućnosti da iskoristi određene teme kao što su etaloni/standardi, mjerenje i ispitivanje ('Standards, measurement and testing – SMT') za saradnju na projektima za istraživanje i razvoj.

Ovaj program je sufinansirao studiju u sklopu EUROMET-a o mjeriteljstvu za Evropsko istraživačko područje ('Metrology for the European Research Area – MERA') koja je bila završena 2004. godine i koja je uspostavila nove mogućnosti za bolju saradnju između nacionalnih mjeriteljskih instituta u Evropi. Uvođenjem novog instrumenta ERA-NET kooradinacione akcije u FP6 otvorena je mogućnost za implementaciju MERA zaključaka i iMERA je uspostavljena u aprilu 2005. godine. U toku tri godine ERA-NET je uključivala 14 NMI-jeva, JRC/IRMM i neka državna ministarstva. Sveobuvatan cilj bila je priprema za novi istraživački program pod Članom broj 169. Sporazuma o saradnji EU (sada je to Član 185 TFEU), u koji su se NMI-jevi trebali uključivati od 2007. Godine, pa nadalje.

Osnovni rezultat saradnje bila je jedinstvena zakonska struktura (EURAMET e.V.) i nacrt za predloženi Evropski mjeriteljski istraživački program ('European Metrology Research Programme – EMRP'). EMRP je bila jedna od 4 incijative koje su identifikovane u FP7. Kao mjera prelaska na incijativu pod Članom 185, ERA-NET Plus prijedlog ('iMERA Plus') je predat 2007. godine od strane EURAMET-a. Ovaj prijedlog je podržala 21 država članica i JRC/IRMMa, sufinansiran je od strane Evropske Zajednice u iznosu od 21 M€. Rezultat samo jednog javnog EMRP poziva doveo je do toga da je 21 istraživački projekat finansiran 2008. godine, sa ukupnom vrijednošću od 64 miliona eura. Većina ovih projekata je u međuvremenu završena, a iza sebe su ostavili ogroman broj znanstvenih studija.

Priprema predloženog EMRP-a, pod incijativom Člana 185 je također počela 2007. godine, te je nadalje razvijana zajedno sa implementacijom iMERA Plus. U decembru 2008. godine osnivanje EMRP-a usvojeno je od strane Evropske

[1]The Institute for Reference Materials and Measurements (IRMM) is one of the seven institutes of the Joint Research Centre (JRC), a Directorate-General of the European Commission (EC). Its mission is to promote a common and reliable European measurement system in support of EU policies

[2]Treaty of the Functioning of the European Union

[3]EURAMET se koristila kao skraćenica za pravno lice EURAMET e.V. (Evropsko udruženje nacionalnih mjeriteljskih instituta)

Komisije i Odlukom Evropskog Parlamenta i Vijeća, a nakon toga osnivanje je objavljeno i u Službenom Glasniku EU u septembru 2009. godine, te je tačan period za koji je EMRP predviđen tekao od maja 2009. ('početak prvog javnog poziva za pridruživanje istrazivačkim projektima Call for Joint Research Projects') pa sve do kraja 2017. godine. EMRP budžet je planiran tako da bude raspoređen kroz pet godišnjih poziva za pridruživanje istrazivačkim projektima u periodu od 2009. do 2013. Godišnji EMRP pozivi između 2009. - 2013. godine omogućili su finansiranje projekata kroz teme:

- 2009 JRPs Energy (Energija)
- 2010 JRPs Environment and Industry (Okoliš i industrija)
- 2011 JRPs Health - SI broader scope - New Techology (Nove tehnologije-područje SI jedinica)
- 2012 JRPs Industry SI broader scope - Open Excellence (Izvrsnost u nauci-područje SI jedinica)
- 2013 JRPs Energy and Environment (Energija i okoliš)
- 2009-2013 Research projects (Istraživački projekti)

Svaki projekat je trajao tri godine i posljednji finansirani projekti završili su 2017.godine. 400 M€ za finansiranje ovih projekata obezbijeđeno je od 23 EU zemlje učesnice, te od strane EC.

Bosna i Hercegovina postala je 23. država članica EMRP-a u martu 2013. godine. Članstvo podrazumijeva opredijeljenost za sudjelovanje i podršku znanstvenog razvoja mjeriteljskog društva kroz poticanje nacionalnih strateških interesa. Ova obveza uključuje finansijsko sudjelovanje u finansiranju projekata, dio novca koji se daje u gotovini, a ostatak iznosa tzv. *in kind*, odobrava se kroz različite vrste usluga koje NMI-jevi pružaju tokom sudjelovanja u projektu.

Ciljevi:

Odluka br 912/2009 Evropske Komisije i Evropskog Parlamenta i Vijeća na dan 16. septembra 2009. godine o učestvovanju Zajednice u Evropskom mjeriteljskom programu za istraživanje i razvoj koji je pokrenut od strane nekoliko država članica, navodi da:

„*EMRP ima za cilj da podrži naučni razvoj i inovaciju na način da obezbijedi neophodni pravni i organizacioni okvir za evropsku saradnju širokih razmjera između država članica u oblasti mjeriteljskog istraživanja u bilo kojem tehnološkom ili industrijskom polju.*“

Nadalje navodi:

„*Ciljevi EMRP-a su da se ubrza razvoj, validacija i korištenje novih mjernih tehnika, etalona, procesa, instrumenata, referentnih materijala i znanja koji imaju za cilj vođenje inovativnih razvoja u industriji i trzištu, poboljšavajući pri tome kvalitet podataka za nauku, industriju, kreiranje politika, podrzavanje razvoja, te implementacije direktiva i regulativa.*“

Ovi ciljevi su postignuti kroz tri glavne akcije:

- Udruživanje izvrsnosti u mjeriteljskom istraživanju – kreiranjem kompetitivnih istraživačkih projekata, te stvaranjem dovoljne kritične mase iz mreže NMI-jeva i DI-jeva zemalja učesnica koji se bave najvećim mjeriteljskim izazovima aktuelnih na evropskom nivou
- Otvaranjem sistema prema vrhunskoj nauci – povećavajući učestvovanje šire evropske istraživačke zajednice kroz istraživačke grantove
- Proširenje mogućnosti – povećavajući kapacitete evropske mjeriteljske istraživačke zajednice kroz istraživačke mobilne grantove koji su namijenjeni državama članicama EURAMET-a saograničenim istrazivačkim resursima

Aktivnosti

Osnovna i bazna aktivnost EMRP-a jeste finansiranje projekata sa što više partnera i što više različitih istraživačkih institucija koji se bave naučnim istraživanjem, tehnološkim razvojem, pružanjem usluga prijenosa znanja kroz treninge i drugim aktivnostima (EMRP projekti). U pogledu koncentrisanih kapaciteta u mjeriteljstvu, i prirodi nacionalnih prihoda, osnovni dio ovih projekata se koristi od strane NMI-jeva i DI-jeva. EMRP projekti su poznati kao Joint Research Projects (JRPs). Dodatno, kako bi se povećali istraživački kapaciteti u mjeriteljstvu, uspostavljene su tri šeme istraživačkih mobilnih grantova :

- Researcher Excellence Grants (REGs) – koje su omogućavale učestvovanje organizacija iz šire istraživačke zajednice u EU državama članicama i državama povezanim sa FP7. Svaki od ovih grantova je vezan za određeni JRP.
- Researcher Mobility Grants (RMGs) – koje su se odnosile na razvoj pojedinaca u NMI-jevima, DI-jevima, unutar država članica EURAMET-a koje nisu direktno uključenje u EMRP i drugim istraživačima da imaju korist od REG.
- Early-Stage Researcher Mobility Grants (ESRMGs) – koji su trebali da pripreme nove generacije iskusnih mjeritelja u NMI-jevima i DI-jevima država članica za buduće aktivno učešće u projektima.

Predviđeno je da odabir EMRP projekata i REG i RMG grantova bude implementiran kroz proces koji se sastojao od tri faze:

- Faza 1 - Poziv za potencijalne istraživačke teme unutar EMRP projekta
- Faza 2 - Poziv za prijedloge za JRP (sa opcijom za povezani REG)
- Faza 3 - Poziv široj istraživačkoj zajednici da se pridruži EMRP projektima kroz REG i RMG.

Evropski mjeriteljski istraživački program (EMRP) je omogućio evropskim mjeriteljskim institutima, industrijskim organizacijama i akademskoj zajednici da bliže sarađuju na istraživačkim projektima u specifičnim poljima: industrije, energije, okoliša, zdravstva, novih tehnologija i SI jedinica. Njegov sljedbenik – Evropski mjeriteljski program za istraživanje i inovaciju (EMPIR) nastavlja da podržava mjeriteljske istraživačke projekte u istim oblastima kao što je to bio slučaj sa EMRP, ali ovaj put sa dodatnim temama za projekte fundamentalnog mjeriteljstva, projekte normativnog mjeriteljstva, potencijalne istraživačke projekte, te projekte koji su podrška mjeriteljskim mrežama i širenju uticaja postignutih rezultata projekata i drugih vidova saradnje.

EMPIR istraživački program

Evropski mjeriteljski program za istraživanje i inovaciju (European Metrology Programme for Innovation and Research - EMPIR) je razvijen kao integrisani dio strategije Horizon 2020, EU programskog okvira za istraživanje i inovaciju. Horizon 2020 ima za cilj da obnovi i produži izvrsnost EU naučne baze i ujedini evropsko istraživačko područje kako bi napravio istraživački i inovativni sistem kompetitivnijim na globalnom planu. EMPIR pozivi, koji se odvijaju počevši od 2014. godine te će trajati do 2020., raspolažu sa ukupnim budžetom od 600 miliona eura, 300 miliona eura od zemalja učesnica i do 300 miliona eura od EC, primjenom Člana 185 Sporazuma o saradnji EU.

Dva tipa organizacija su pogodna za finansiranje, sa različitim uređenjima sredstava, dok ostali mogu biti nefinansirajući partneri:

- Internal Funded Partners (Interno finansirani partneri): EURAMET nacionalni mjeriteljski instituti (NMIs), te imenovani instituti (Designated Institutes -DIs), koji su u sklopu EMPIR država učesnica koji finansijski podržavaju program (i na taj način mogućnost odgovornost pridruživanja kompltenom

programu), mogu učestvovati u projektu kao „Internal Funded Partners“. Interno finansirani partneri imaju nižu osnovu za indirektne troškove u odnosu na eksterno finansirane partnere što je proizašlo kao posljedica finansiranja kojeg primaju od svojih nacionalnih izvora. Projekat mora biti koordiniran od strane interno finansiranog partnera.

- External Funded Partners (Eksterno finansirani partneri): Sve vrste drugih pravnih osoba koje mogu biti eksterno finansirani partneri ukoliko su uspostavljeni unutar država i teritorija koje su pobrojane u General Annex A Horizon 2020 radnog programa. Internacionalne organizacije od interesa za Evropu bit će u mogućnosti za finansiranje od strane EMPIR-a kao eksterno finansirani partneri.

- Unfunded partners (Nefinansirani partneri): su pravne osobe koje nisu pogodne kao interno finansirani ili eksterno finansirani partneri, ali imaju želju za učestvovanjem na EMPIR projektima. Nefinansirani partneri mogu obavljati rad koji je neophodan za kompletiranje projekta. Potrebno je da predaju procjenu troškova projekta kao dio prijedloga i potpišu sporazum tzv „Grant Agreement“, ali ne primaju nikakva sredstva od strane EURAMET-a. Zakonski entiteti koji imaju mogućnost postati interno ili eksterno finansirani partneri mogu također odabrati da u EMPIR projektu učestvuju kao nefinansirani partner, što će EURAMET smatrati kao posebno odgovarajuće ukoliko bi neki drugi partner iz industrije imao veliku korist od učestvovanja na projektu.

Ciljevi

Unutar EMPIR-a u porastu je fokus na aktivnosti inoviranja u smislu obuhvatanja potreba industrije i ubrzavanja primjene zaključaka i rezultata istrazivanja. Projekti proširenja mogućnosti unutar programa imaju za cilj da premoste jaz izmedju EU zemalja sa ne tako razvijenim mjeriteljskim sistemima i onih koji imaju uveliko razvijene kapacitete.

EMPIR program omogućava evropskim mjeriteljskim institutima, industrijskim i medicinskim organizacijama, te akademskoj zajednici da sarađuju na širokom polju različitih istraživačkih projekata unutar istaknutih tema: industrije, energije, okoliša, zdravstva, SI fundamentalnog sistema jedinica, normativnih projekata, potencijalnih istraživačkih projekata, te kao podrška za mjeriteljske mreže i širenje uticaja.

Aktivnosti

EURAMET trenutno objavljuje pozive za dvije vrste EMPIR projekata:

- Joint Research Projects (JRPs) koji su poznati pod “Research and Innovation Actions" u Horizon 2020,

- Support for Impact Projects (SIPs) koji su poznati pod "Coordination and Support Actions".

JRPs se prijavljuju kao odgovor na listu odabranih istraživačkih tema - Selected Research Topic (SRT) koja je objavljena od strane EURAMET-a, te koja definiše ciljeve istraživanja. SRTs se stvaraju na osnovu informacija dobijenih u ranoj fazi javnog poziva. EMPIR JRP-ovi ovih javnih poziva se uvijek fokusiraju na prioritetna područja istraživanja poznata kao Ciljani Programi (Targeted Programms - TPs), kako bi riješili velike izazove sa kojima se suočava EU u području zdravstva, energije, okoliša i industrije, te u pravcu daljeg razvoja fundametalne nauke o mjerenju.

Zdravstvo

Ciljani program za zdravstvo odnosi se na pouzdanije, usporednije i efikasno korištenje dijagnostičkih i terapeutskih metoda, razvoj novih tehnika za poboljšanje brige o zdravlju, smanjenja troškova, podsticanje kompetitivnosti povezanih evropskih industrija i usluga, te podržavanje regulative.

Energija

Ciljani program za energiju obezbjeđuje unaprjeđenja potrebna za podržavanje stabilnosti energetskih sistema kroz predviđanje varijanti u ponudi i potražnji, smanjujući barijere trgovine i barijere kod uvođenja različitih tipova energije u distribucione sisteme. Također, ovaj program treba da pruži podršku transformaciji gasnih i električnih instalacija u tzv 'smart networks'.

Okoliš

Ciljani program za okoliš treba da se fokusira na istraživanje robusnih i stabilnih mjerenja u svrhu monitoringa klime i istraživanja u svrhu inovativnih novih sistema i tehnologija koje precizno potvrđuju uticaj na okoliš.

Industrija

Ciljani program za industriju ima za cilj razvoj novih instrumenata i metoda u pred -komercijalnoj fazi. Ove inovacije će poboljšati kompetitivnost evropske industrije i dovesti do povećanog ekonomskog obrta.

Fundamentalno mjeriteljstvo

Ciljani program za fundamentalno mjeriteljstvo doprinosi ideji bliske saradnje evropskih mjeriteljskih instituta sa univerzitetima i drugim istraživačkim institucijama da bi nauku o mjeriteljstvu u Evropi podigli na vodeću internacionalnu poziciju.

Standardizacija

Ciljani programi za normativno mjeriteljstvo osiguravaju mjeriteljsko istraživanje u vremenskim okvirima potrebnim za podsticanje kvaliteta i ubrzanje razvoja nacrta evropskih i internacionalnih standarda. Mjeriteljsko istraživanje će pomoći onima koji razvijaju i oslanjaju se na dokumentovane standarde kako bi:

- pojačali industrijsku kompetitivnost,
- omogućili pojačanje mogućnosti razmjene dobara za nove proizvode u razvoju, usluge i tehnologije,
- podržali kvalitet života (klimatske promjene, okolina, briga o zdravlju, zaštita korisnika) kroz naučnu egzaktnost kao podršku regulativi.

Proširenje mogućnosti

Ciljani program za potencijalne istraživačea teme podržava koherentan, efikasan, održiv i integrisan razvoj evropskog mjeriteljskog kapaciteta kroz pridruživanje istrazivačkim projektima, smišljenim na način da proširi mogućnosti istraživača koji dolaze NMI-jeva i DI-jeva koji imaju potrebu za razvojem date oblasti.

Raspodjela

Podrška istraživačkim projektima (SIP) ima za cilj dalje iskoristiti rezultate završenih istraživačkih projekata (JRP). SIP ohrabruje shvatanje rezultata projekta da bi se stvorio uticaj projekta izvan mjeriteljske zajednice, neovisno o tome da li bi se to postiglo kroz doprinos dokumentovanim standardima i regulatornim procesima, ili kroz prijenos znanja ili tehnologiju za komercijalne kompanije koje podržavaju inovacije.

Podrška mjeriteljskim mrežama

EU želi da EMPIR da značajan doprinos ekonomskom rastu Evrope i postavlja ciljeve u smislu povećanog ekonomskog obrta u evropskim državama, ali i interakcije između mjeriteljskih i standardizacijskih zajednica. Dok pojedini JRP podržava ovaj cilj kroz njegovo kompletno trajanje, u drugim područjima postoji potreba za dugoročni dijalog između mjeriteljske zajednice i relevantnih zainteresovanih strana. Taj dijalog treba da podrži korištenje rezultata i zaključaka istraživanja iz mjeriteljske zajednice, ali da u isto vrijeme prikuplja informacije o potrebama industrije kao osnove za buduća istraživanja. Projekti za podršku mrežama (JNPs – Joint Network Projects) će finansirati aktivnosti koje će omogućavati razvoj organizacija koje podržavaju ovaj dijalog. Ovakve aktivnosti mogu uključivati, ali nisu ograničene na sljedeće:

- Predviđanje i zajedničku viziju;
- Razvoj strategijskog istraživačkog plana;
- Razmjena znanja među istraživačima;
- Prijenos znanja na istraživače;
- Planiranje razvoja zajedničkih istraživačkih infrastruktura;
- Uključivanje zainteresovanih strana;
- Širenje i promocija rezultata istrazivanja;
- Povećanje broja učesnika (aktivnosti vezane za proširenje kooperacije sa manje aktivnim EU državama)
- Internacionalizacija (aktivnosti u vezi sa proširenjem kooperacije sa trećim zemljama/ zemaljama koje nisu članice EU)

JNPs uključuje koordinirane aktivnosti i podršku. Istraživanje i razvoj su aktivnosti koje nisu pogodne za finansiranje u okviru JNP, umjesto toga JNP ima jasan fokus na aktivnosti u okviru mreže. Očekuje se da će ovi izazovi biti uspješno riješeni u sklopu vremenskog okvira od 5 godina i sa budžetom od 400 K€. JNP bi trebali biti bazirani na već postojeće organizacije sa dugogodišnjim ciljem za promovisanjem dijaloga (tzv. Evropske mjeriteljske mreže) ili treba planirati osnivanje takvih organizacija. Mjere u prijedlogu da se podrži dugoročna održivost ovakve organizacije bit će ključni aspekt procjene. Osim suočavanja sa velikim izazovima, EMPIR također ima za cilj premoštenje jaza između zemalja sa nerazvijenim mjeriteljskim sistemima i onim koji imaju više razvijene sposobnosti. Jedan način za ostvarenje ovog cilja jesu istraživački mobilni grantovi (RMG).

<u>Reasercher mobility grants</u>

Researcher Mobility Grants (RMGs) ima za cilj da poveća sposobnost evropske istraživačke zajednice u oblasti mjeriteljstva. RMG omogućava finansijsku podršku za istraživače u bilo kojem stadiju njihove karijere, da poduzmu istraživačke aktivnosti relevantne za ciljeve projekta.

RMG istraživači ponekad nemaju iskustvo iz oblasti ili predznanje o EMPIR projektu na koji se prijavljuju. Bez obzira na to, ovaj grant obezbjeđuje platformu za njih da uče i da razviju svoje sposobnosti kao naučnici, ogranizacijama u kojima su zaposleni omogućuju proširenje kapaciteta u oblasti mjeriteljstva, a EMPIR projektu omogućava da proširi svoje ciljeve.

Članovi EMPIR Komiteta su odgovorni za implementaciju EMPIR-a i odabir prijedloga projekata koji će biti finansirani, uzimajući u obzir prijedloge sudija – vanjskih eksperata koji imaju priliku objektivno revidirati prijedloge projekata. EMPIR Chair (predsjedavajući EMPIR komiteta) i njihovi zamjenici su odgovorni za odobravanje odabira sudija i procjenu pregleda procedure. EURAMET Managment Support Unit (MSU) radi prema uputama EMPIR-a.

U periodu od 2013. godine do danas Institut za mjeriteljstvo Bosne i Hercegovine je ostvario učešće u 25 različitih istraživačkih projekta u okviru EMRP i EMPIR programa iz opisanih oblasti. Pored navedenog, osoblje Instituta je iskoristilo RMG alat kroz EMRP i EMPIR program u trajanju od 64 mjeseca. RMG alat je omogućio jačanje mjeriteljskih kapaciteta Instituta što je u konačnici dovelo do aktivnijeg učešća u EMRP i EMPIR programu. U tabeli ispod navedeni su projekti u kojima je Institut učestvovao i koordinirao.

Spisak projekata

Program	Godina	Naziv projekta
EMRP	2014 - 2017	MeteoMet2 Metrology for essential climate variables
EMRP	2014 - 2017	Smart Grid II Measurement tools for Smart Grid stability and quality
EMRP	2014 - 2017	Metrology for biogas
EMRP	2015 - 2018	NNL Sensor development and calibration method for non-Newtonian fluids
EMPIR	2015 - 2018	Traceable calibration of automatic weighing instruments
EMPIR	2015 - 2017	Matrix reference materials for environmental analysis
EMPIR	2015 - 2018	Absorbed dose in water and air
EMPIR	2016 - 2019	Developing traceable capabilities in thermal metrology
EMPIR	2016 - 2019	Research capabilities in humidity measurement
EMPIR	2017 - 2020	Traceability routes for electrical power quality measurements
EMPIR	2017 - 2020	Metrology for biomethane
EMPIR	2018 - 2021	Certified forensic alcohol reference materials
EMPIR	2018 - 2021	Research capabilities for radiation protection dosimeters
EMPIR	2018 - 2021	Establishing traceability for liquid density measurements

Spisak projekata

Program	Godina	Naziv projekta
EMPIR	2018 - 2021	Metrology for the Factory of the Future
EMPIR	2018 - 2021	Advancing measurement uncertainty (comprehensive examples)
EMPIR	2019 - 2022	The European Metrology Cloud
EMPIR	2019 - 2022	Developing an infrastructure for improved and harmonised metrological checks of blood pressure measurements in Europe
EMPIR	2019 - 2022	Improving traceable metrology capabilities for temperature measurements
EMPIR	2019 - 2022	Quantitative MR-based imaging of physical biomarkers
EMPIR	2019 - 2022	Metrology of automated data analysis for cardiac arrhythmia management
EMPIR	2019 - 2022	European metrology network for mathematics and statistics
EMPIR	2019 - 2022	European metrology network for climate
EMPIR	2019 - 2022	European metrology network on smart electricity grids
EMPIR	2019 - 2022	European metrology network for energy gases

Zemlje članice u EMRP/ EMPIR programu

EMRP ENV58 METEOMET 2 - METROLOGY FOR ESSENTIAL CLIMATE VARIABLES

Sažetak

Osnovne klimatske varijable (ECV) su osnovne fizičke, hemijske ili biološke varijable koje utiču na karakterizaciju klime na planeti Zemlji. One uključuju vodenu paru u atmosferi, temperaturu iznad okeana, na površini i dubokom moru, salinitet okeana, temperaturu zraka, padavine i vlagu u tlu. Kako klimatske promjene sve jasnije utiču na sve aspekte ljudskog života, to je mogućnost mjerenja ovih varijabli sve važnije. Samo dugoročno i visokokvalitetno mjerenje ovih varijabli, te naročito mjerenje sljedivo do SI jedinica, može doprinjeti boljem razumjevanju klimatskih promjena.

Ovaj projekat istražuje ponašanje senzora koji se koriste za monitoring klimatskih varijabli i doprinosi ustanovljavanju novih mjernih metoda, tehnika i standarda uključujući i kalibraciju i sjedivost do međunarodnog SI sistema jedinica za meteorološka mjerenja temperature i vlažnosti.

Institut za mjeriteljstvo BiH je svoj doprinos u ovom projektu dao u zadatku 3.2 vezanom za procjenu uticaja pozicioniranja senzora na rezultate mjerenja. Konkretno, istraživan je uticaj blizine asfaltne ceste na rezultate meteoroloških mjerenja.

Project description

An Essential Climate Variable (ECV) is a physical, chemical or biological variable that critically contributes to the characterization of the Earth's climate. ECVs include water vapor in the atmosphere, surface and deep sea temperature, ocean salinity, air temperature, precipitation and soil moisture. They are vital as society becomes increasingly affected by the climate change.

This EMRP ENV58 METEOMET 2 project investigated the performance of sensors used to monitor climate variables under different conditions and produced new measurement methods, techniques and standards, including a significant contribution to the accuracy, calibration, and traceability to the International System of Units of the meteorological measurements of temperature and humidity.

Tekst pripremio:

Semir Čohodarević

Project start date and duration:

October 2014 - September 2017

Coordinator:

Dr. Andrea Merlone, INRIM

Internal Partners:

INRIM, Italy

BEV-PTP, Austria

CEM, Spain

CETIAT, France

CMI, Czech Republic

CNAM, France

CSIC, Spain

DTI, Denmark

IMBiH, Bosnia and Herzegovina

VTT, Finland

NPL, United Kingdom

PTB, Germany

SMD, Belgium

TUBITAK, Turkey

UL, Slovenia

VSL, Netherlands

SHOM, France

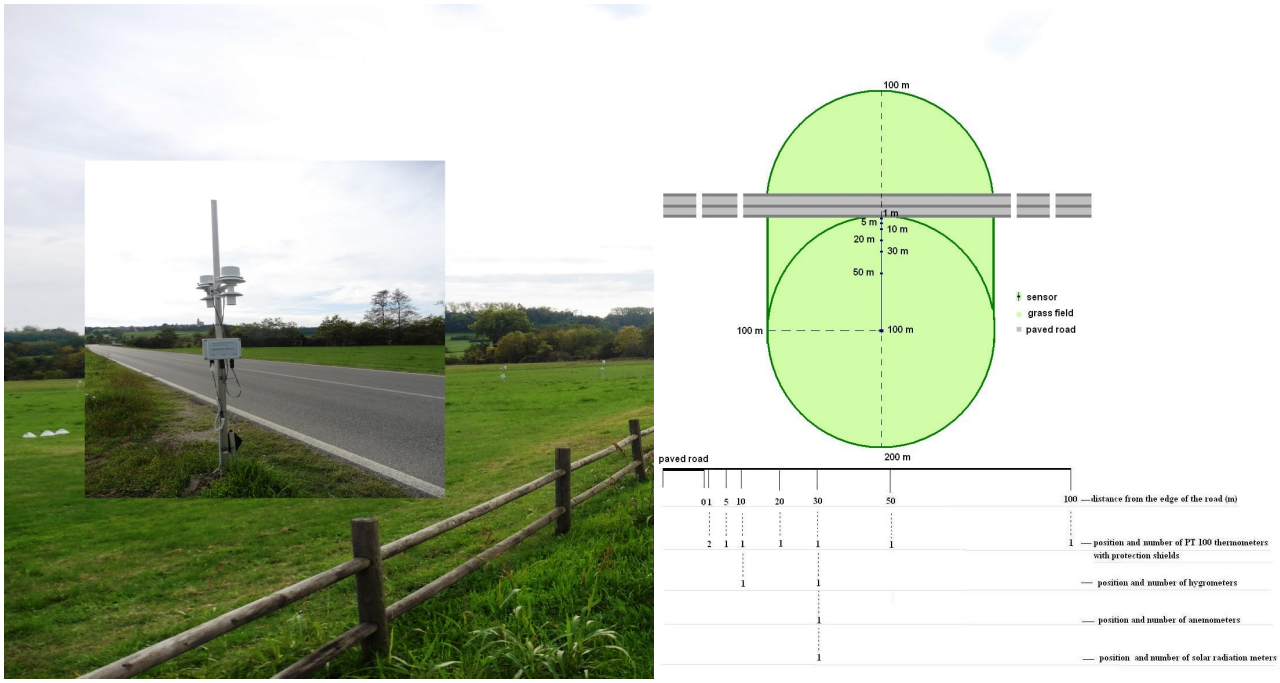
Long-term, high-quality, and uninterrupted observations of the atmosphere, land, and ocean are vital for all countries, as their economies and societies are increasingly affected by the climate variability and change. High quality and comparable observations are possible only if the measurements of the climate variables are traceable to the SI with reliably associated uncertainties.

We set out to solve these problems by investigating the performance of the temperature and humidity sensors in the laboratory and real working conditions. References, test facilities, and on-site experiments were developed. The project realized novel instruments, procedures, and methodologies such as a non-contact thermo-hygrometer and a spectrometer for the measurement of fast transients of temperature and humidity in the air; a facility for determining the temperature and pressure effects on salinometers; a pressure vessel for evaluating the high-pressure effects on deep-sea thermometers. New sensors based on the optical fibers, for the seawater temperature measurements, were developed and tested in real conditions. The influence of albedo, rain, buildings, roads and trees on the air temperature measurements were measured onsite and analyzed. The influence of the solar radiation on air temperature measurements was also numerically investigated. On-site calibrations in high mountains and polar areas were carried out. Thermometers were characterized as regards to dynamics, hysteresis, and repeatability after thermal and mechanical shocks.

IMBIH participated in the task 3.2 – Influence of AWS (Automatic Weather Station) Siting on Air Temperature Measurements – The Road Case, with a goal to evaluate the influence of the asphalt road on the meteorological measurements. It is known that the position of sensors related to obstacles could have a huge influence on the measurement results.

The World Meteorological Organization - Commission for Instruments and Methods of Observations (WMOCIMO) - Guide-8 establishes a classification to determine the small-scale representativeness of the ground based observation sites. This classification associates a discrete uncertainty to the temperature measurements carried out in sites where exposure rules are not fully met.

The project quantified the uncertainty associated with some of the site influences: closeness to trees, buildings, and asphalt roads. The experiments were based on the identical setup and measurement protocols; the temperature was measured close to the obstacles and in seven measuring points up to 100 m of distance in the open field for the 1 year period. It was very challenging to find an adequate measur-



Experimental setup for the evaluation of obstacles on land ground based air temperature measurements

-ing place for this evaluation, and finally measurements were done in Italy. Even more challenging was the evaluation of millions of data produced during the whole year measurement.

The results provided to the WMO CIMO Expert team inputs to revise the prescriptions of the CIMO guide.

ENG 52 SMART GRID II - MEASUREMENT TOOLS FOR SMART GRID STABILITY AND QUALITY

Sažetak

Pametne elektroenergetske mreže predstavljaju moderan koncept mreže, zasnovan na informaciono-komunikacionim tehnologijama, za prikupljanje informacija o snabdjevanju i potrošnji električne energije s ciljem poboljšanja efikasnosti, pouzdanosti, ekonomičnosti i održivosti proizvodnje i distribucije električne energije. Takođe, to je mehanizam koji obezbjeđuje pouzdanu integraciju većeg broja obnovljivih izvora energije u elektroenergetski sistem. U ovakvim okolnostima, mrežnim operaterima su od posebnog značaja alati za mjerenje kvaliteta i stabilnosti snabdjevanja električnom energijom, posebno u dinamičkim uslovima koji preovladavaju u mrežama s visokom penetracijom distribuirane obnovljive energije. Sistemi za mjerenje parametara elektroenergetske mreže u njenom širokom području, zasnovani na GPS sinhronizovanom mjerenju fazora koristeći PMU-ove (eng. Phasor Measurement Units), sve više se posmatraju kao „monitori za održavanje života“ pametnih mreža. Ova nova tehnika mjerenja daje značajne mogućnosti za bolje razumijevanje složenih dinamičkih procesa unutar ovih mreža.

Cilj projekta je da se ova brzo-razvijajuća tehnologija unaprijedi sa stanovišta metrologije, razvijajući kompletan mjeriteljski okvir za implementaciju PMU. Ovaj okvir podrazumjeva, razvoj kalibracione infrastrukture za PMU-ove i pripadajuću opremu (senzore, mjerne transformatore itd.) u mjernom lancu, kada se oni koriste za praćenje stabilnosti elektroenergetskih mreža, sa posebnim osvrtom na distributivne mreže gdje je tačno mjerenje faznih promjena veoma zahtjevno.

Institut za mjeriteljstvo BiH, kao član projektnog konzorcija, dao je zapažen doprinos u realizaciji projektnih ciljeva, razvijajući metodu za mjerenje parametara trofaznih prenosnih visokonaponskih vodova, kao i metodu za daljinsko određivanje grešaka (amplitudskih i faznih) naponskih mjernih transformatora u elektroenergetskoj mreži [1,2,3].

Tekst pripremio:

Vladimir Milojević

Project start date and duration:

June 2014 - June 2017

Coordinator:

Paul Wright, NPL

Internal Partners:

NPL, United Kingdom

BRML, Romania

CMI, Czech Republic

IMBiH, Bosnia and Herzegovina

INRIM, Italy

LNE, France

METAS, Switzerland

MIKES, Finland

SIQ, Slovenia

SMU, Slovakia

SP, Sweden

Trescal, Denmark

VSL, Netherlands

EIM, Greece

STU BA, Slovakia

UniNa2, Italy

External Partners:

EPFL, Switzerland

T-UE, Netherlands

STRAT, Scotland

DPM, Albania

Visit to NPL as a part of the project

Project description

Smart Grids are the mechanism to reliably utilise large amounts of renewable energy and new measurement tools as proposed in this project are essential for their stable operation. The emergence of GPS synchronised measurements has opened up many new measurement opportunities to determine grid parameters and behaviour over a wide geographical area.

The aim of this project was to develop, demonstrate and validate new measurement tools for the management of Smart Grid operational stability and power quality. Results and analysis of on-site measurements were undertaken during the project. The common theme to these tools is the use of multiple digitising instruments placed at geographically remote locations around an electricity grid. These instruments are time-synchronised to form a wide-area measurement system using GPS. The high level objectives of this project where to develop new synchrophasor-based tools and a metrology infrastructure to measure Smart Grid stability and quality.

Main objectives are:

- To develop and implement wide-area tools to determine the propagation of PQ in a variety of distribution and transmission grids, developing new methods to locate sources of disturbance.

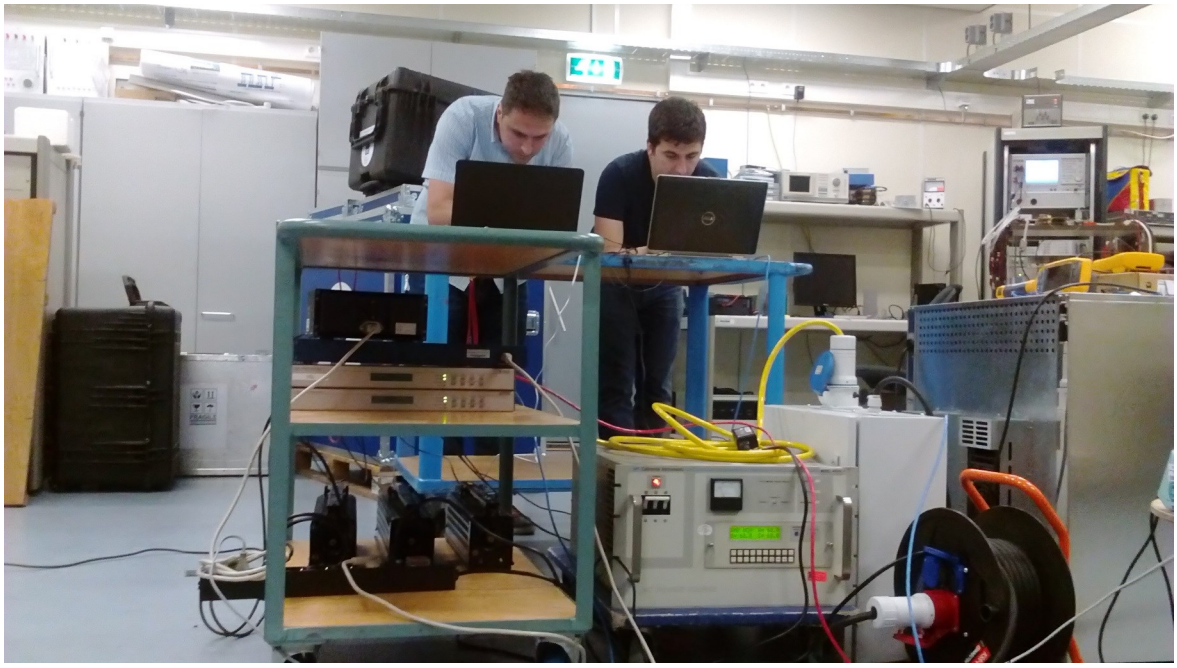
- To develop a metrology framework for PMUs including dynamic calibration, new algorithms to improve resolu-

resolution and immunity to noise and on-site calibration under operational conditions.

- To utilise PMUs in a new tool to measure the impedance of the grid, a parameter essential to the planning, measurement and control of Smart Grid stability and PQ.
- To provide a metrology framework for the PMU/PQ transducers; these devices convert the high voltage and current levels on the grid to measureable low levels, but introduce errors in the process.

The project has led to significant Metrological advancements in relation to Smart Grids operations. Some of the most significant metrological achievements are summarised below:

- A prototype harmonic location method was developed and demonstrated on Bornholm Island Smart Grid (Denmark). Location determinations of predictable cyclic harmonic disturbance has proved plausible and the feasibility of the technique looks highly promising, but will require further development and generalisation for routine use by utilities.
- A new method for the aggregation of harmonic currents which proposes an update of summation coefficients designed for use in the assessment of emission limits of installations. The results of the summation method could revolutionise the way that utilities assess the impact of new renewable connections.
- Three (METAS, EPFL, VSL) fully operational advanced PMU calibrators have been designed and implemented to permit the calibration of PMU designed around the standard C37.118.1 as well for PMUs used in distribution networks for which no standard exists. These calibrators meet the specific requirements of commercially available PMUs ensuring uncertainties of at least 10 times better than the commercial specifications.
- A simulation platform has been developed for testing PMU algorithms. The platform includes tests for the static and dynamic signals that are required by the IEEE Standard C37.118.1-2014 and tests that were considered important by the consortiums stakeholders such as immunity to interference and the ability to measure rapidly changing signals. The platform also allowed the numerical performance of the algorithms to be evaluated.
- PMU algorithms where investigated using simulations and field testing and a comparison guide was published. This will help manufacturers choose the best algorithms for future PMUs and will become a benchmark for new algorithms which are at the core of the process transforming waveform samples into phasors under the exacting PQ conditions and frequency deviations that exist in real networks.
- A new PMU method to remotely determine the errors of VTs connected in energised networks has been developed in the project and could be of significant benefit to the industry providing improved revenue settlement accuracy and PMU measurements.
- Project has made some major steps forward with new algorithms and methods for determination transmission line parameters, demonstrated both in the lab and onsite. This includes new methods for determining in-situ line impedance using two PMUs on either side of the line, with an uncertainty significantly lower (<5%) than for other methods. Extensions to harmonic frequencies were made using a new convolution method making use of the frequencies present during transient disturbances.
- A digital compensation procedure for the real-time correction of the Voltage Transformer frequency response has been developed and implemented. It proved capable of reducing the uncertainties by up to 2 orders of magnitude, even in presence of resonances. This will allow the real time correction of PMUs leading to more accurate results and smaller tolerances on critical grid control decisions.
- A world leading new facility for the calibration of inductive Voltage Transformers has been developed. Its calibration



Measurement in progress at VLS laboratory

uncertainty is two orders of magnitude better than standard limits for Voltage Transformer uncertainties in PQ measurements.

- A new method for optimizing Rogowski Coil temperature coefficient with high frequency response was developed which has resulted in negligible change of coil output voltage vs temperature. A new technique has been proposed for on-site measurement of Voltage Transformers using this technique that would reduce uncertainties by two orders of magnitude improving the measurement to levels accurate enough for some revenue settlement without going to the expense and incontinence of breaking the grid circuit to fit shunts.

- A PMU simulator of actual measurement chains has been developed, which allows estimation of output uncertainties of measured parameters (TVE, ROCOF & THD) by Monte Carlo Methods. This has led to the ability to do a sensitivity analysis of the measurement chain and concentrate on reducing the most important source of uncertainty.

Institute of Metrology of B&H was actively involved in the realization of the project objectives related to utilisation PMUs in a new tool together with VSL and NPL. Some of the IMBIH's significant metrological contributions are summarised below:

- New methods for determining in-situ three phase transmission line parameters using two PMUs on either side of the line, with an uncertainty significantly lower than for other methods was developed by IMBIH and VSL. The method uses a robust regression analysis to improve upon problems related to contamination of the synchrophasor data with unwanted spikes and complex noise which limits the accuracy in the line parameter determination, especially when electricity transmission lines (TL) are short. By using the proposed algorithm, self and mutual parameters of impedance and admittance matrix can be calculated successfully with an uncertainty lower than (<5%) [1,2].

- A new synchrophasor-based method for remote determination the errors of VTs in energised power networks was developed by IMBIH and VSL. The method developed in this project is relatively easy for implementation. Only three well characterised reference VTs and 2 calibrated PMUs are required (reference voltage setup). The proposed method is employed to calculate a set of correction factors (CFs) based on a measurement model and the raw data obtained from PMUs installed on both ends of transmission lines. VTs channel correction is then achieved by multiplying the raw PMU data with the calculated CFs. The advantages of this approach come from the fact that calibration/ verification of VTs can be carried out

remotely in any time as well as VTs errors can be determined with uncertainty value close to uncertainty of reference voltage setup. This lead to opportunity that proposed method could be concept for remote calibration VTs placed in power stations all over the power network [3].

Published papers:

[1] Vladimir Milojević; Srđan Čalija; Gert Rietveld; Miloš V. Ačanski; Daniele Colangelo „Utilization of PMU Measurements for Three-Phase Line Parameter Estimation in Power Systems“, IEEE Transactions on Instrumentation and Measurement,Vol. 67, No. 10 October 2018, doi: 10.1109/TIM.2018.2843098

[2] Vladimir Milojević; Srđan Čalija; Gert Rietveld; Miloš V. Ačanski; Daniele Colangelo „A Robust Synchrophasor-Based Method for Determining Three-Phase Line Impedance“ in Proceedings of the IEEE International Workshop on Applied Measurements for Power Systems (AMPS), Liverpool U.K., Sept. 2017, doi: 10.1109/AMPS.2017.8078340

[3] Vladimir Milojević; Srđan Čalija; Gert Rietveld; Miloš V. Ačanski; „Method for determining 50 Hz instrumentation channel errors in power transmission systems from synchrophasor measurements“ in Proceedings of the 10th Mediterranean Conference on Power Generation, Transmission, Distribution and Energy Conversion (IET MedPower 2016), Belgrade Serbia, Nov. 2016., doi: 10.1049/cp.2016.1097

EMPIR 14RPT04 ABSORB - ABSORBED DOSE IN WATER AND AIR

Sažetak

Laboraotrija za jonizirajuće zračenje Instituta za mjeriteljstvo BiH ili Sekundarna standardna dozimetrijska laboraotrija (SSDL) je po prvi put učestvovala u naučno istraživačkom projektu EMPIR 14RPT ABSORB koji je počeo u junu 2015 godine, a završen je početkom 2018. godine.

Zbog povećanja broja slučajeva raka i starenja stanovništva, trenutno raste potreba za dijagnostičkom i interventnom radiohirurgijom, radiologijom i kardiološkim procedurama. Cilj radioterapije je ubijanje ćelija tumora, uz minimiziranje oštećenja okolnog zdravog tkiva; međutim, promjene doze u vema malim procentima mogu značajno povećati rizik od komplikacija. Zahtjeve u pogledu mjerne nesigurnosti za doze radioterapije i radiohirurgije je teško postići zbog razlike između uslova kalibracije i tretmana.

Ovaj projekat imao je za cilj da razvije poboljšane prakse kalibracije, bolje primarne etalone dozimetara i da smanji mjernu nesigurnosti kalibracije, kao i da omogući učesnicima NMI-a i DI-a da izgrade svoje primarne etalone za apsorbovanu dozu u vodi i zraku i lansiraju nove usluge kalibracije. Mjeriteljske laboratorije koje primijene ove

Project description

The very large number of facilities for radiotherapy, interventional radiology/cardiology and radio diagnostic exams requires proximity to calibration services traceable to the national primary standards. There are four million new cases of cancer per year and subsequently the number of treatments per year is increasing so there is a need for diagnostic radiotherapy. In addition, the number of interventional radiology/cardiology procedures in developed countries is already very high and will only increase in future due to the global ageing of the population. The goal of radiotherapy is to kill the tumor cells and simultaneously achieve a high survival rate of the surrounding healthy tissue. A change in the dose of 5 % can result in a normal tissue complication probability of 20 % - 30 %. However, prior to this project, the standard uncertainty requirement

Tekst pripremila:

Vedrana Makarić

Project start date and duration:

June 2015 - January 2018

Coordinator:

Jean Marc Bordy, LNE-LNHB

Internal Partners:

BEV, Austria

GUM, Poland

IFIN-HH, Romania

IMBiH, Bosnia and Herzegovina

IRB-SSDL,Croatia

IST/LPSR, Portugal

LNE-LNHB, France

SCK-CEN/LNK, Belgium

VINS, Serbia

Kick-off meeting of the project

for the dose to the tumor (2.5 %) is very difficult to achieve due the gap between the calibration and treatment conditions. In order to overcome this problem, there was a need for the improved traceability of measurement devices, known as dosimeters. There was also a need for the leading national metrology laboratories to launch their own calibration services to answer the needs of end users. For diagnostic and interventional radiology/cardiology, the large number of facilities that need to be calibrated and/or controlled requires the development of a network of primary laboratories that is able to transfer the primary reference to calibration laboratories and end users in their own countries. The primary standards used are either cavity or free air ionisation chambers, used for high and low/medium photon radiation energies respectively, or calorimeters used to measure absorbed dose. In addition to these requirements, there was also the need to evaluate the future end user needs for standards for radiotherapy and for diagnostics. The following objectives of the project were to:

- Study the design of water calorimeter primary standards, so that participating NMIs and DIs seeking to establish a the research capability in measuring absorbed dose to water for high energy beams are able to build and operate the primary standards with a harmonised target uncertainty budget of 2.0 % and harmonised calibration procedures.
- Study the design of free air chamber primary standards, so that participating NMIs and DIs seeking to establish a research capability in measuring the air kerma (kinetic energy released per unit mass) for low or medium X-ray energies used in radiation protection and diagnostic (i.e. mammography, short pulse) are able to build and operate the primary standards with a harmonised target uncertainty budget of 0.5 % for continuous beam and 1.0 % for pulsed beams and harmonised calibration procedures.
- Study the design of cavity chamber primary standards, so that participating NMIs and DIs seeking to establish a research capability in measuring

the air kerma for photon energies such as those of Cs-137 used in radiotherapy are able to build and operate the primary standards with a harmonised target uncertainty budget of 0.5 % and harmonised calibration procedures.

- Develop for each participant an individual strategy for the long-term development of their research capability in radiation dosimetry including priorities for collaborations with the research and end users community in their country, the establishment of appropriate quality schemes and accreditation (e.g. participation in key comparisons, the entry of CMCs into the BIPM database, accreditation to ISO/IEC 17025), and a strategy for offering calibration services from the established facilities to their own country and neighboring countries.

The project was focused on capacity-building activities on different technological levels to achieve a balanced and integrated measurement system in the participating states. Knowledge transfer between the partners was the main goal of the project in the field of photon dosimetry primary standards development and construction based on the water calorimeter, free air ionisation chamber and cavity chamber. The main project developments are available to other stakeholders, mainly metrology institutes not participating in the project. NMIs and DIs previously relying on secondary standards now have all the information needed to be able to design, build and operate primary dosimeters based on water calorimeters, cavity ionisation chambers and free air ionisation chambers. Partners harmonised uncertainty budgets need to achieve 0.5 % and 2.0 % for air kerma and absorbed dose to water respectively, calibration procedures and calibration certificates for a better comparison of the capabilities of the laboratories according to the requirements of ISO/IEC 17025.

EMRP ENG54 BIOGAS - METROLOGY FOR BIOGAS

Sažetak

Resursi kao što je prirodni gas postaju deficitarni i EU sve više zavisi od uvoza prirodnog gasa. Diversifikacija opskrbe prirodnim gasom u skladu je sa zahtjevima Direktive o obnovljivoj energiji 2009/28 / EC, a cilj EC je da do 2020. godine 20% potrošnje energije dolazi iz obnovljivih izvora, te da biogoriva čine namanje 10% tečnih goriva koja se koriste za prijevoz (benzin i dizel).

JRP ima za cilj razviti i validirati metode za karakterizaciju biogasa kroz određivanje ključnih nečistoća, vlage, čestične tvari, kalorijske vrijednosti i gustoće. Rezultati ovog JRP će osposobiti nacionalne mjeriteljske institute (NMI) za pružanje usluga industriji radi ostvarenja pouzdanih mjerenja ključnih karakteristika biogasa i biometana. Ove aktivnosti biće predmetom rada CEN TC408 za biogas iz čega će proisteći standardizirane ispitne metode za upotrebu u industrijskim i nezavisnim laboratorijama.

Učešće Instituta za mjeriteljstvo Bosne i Hercegovine na ovom projektu realizuje se u radnim paketima posvećenim uzorkovanju i analizi sadržaja organskih nečistoća. IMBiH je zadužen za razvoj i validaciju metode za ispitvanje ukupnog sadržaja silicija u biogasu.

Project description

As natural gas resources are declining and the EU depends increasingly on imported natural gas, there is a need for diversification of the European natural gas supply. Biogas and biomethane can contribute to this diversification. Furthermore, biogas and biomethane contribute to the implementation of the directive 2009/28/EC on the promotion of the use of energy from renewable sources which require that biofuels should provide at least 10% of transport petrol and diesel consumption by 2020.

To promote the use of biomethane and biogas, the transport of this renewable fuel from the producer to the end user needs to be arranged. The use of the existing transport and transmission infrastructure for natural gas is essential to ensure that the transport of biomethane is

Tekst pripremila:

Katarina Hafner-Vuk

Project start date and duration:

June 2014 - September 2018

Coordinator:

Dr. Adriaan M.H. Van der Veen, VSL

Internal Partners:

VSL, Netherlands

CEM, Spain

CMI, Czech Republic

IMBiH, Bosnia and Herzegovina

LNE, France

MIKES, Finland

BFKH, Hungary

NPL, United Kingdom

PTB, Germany

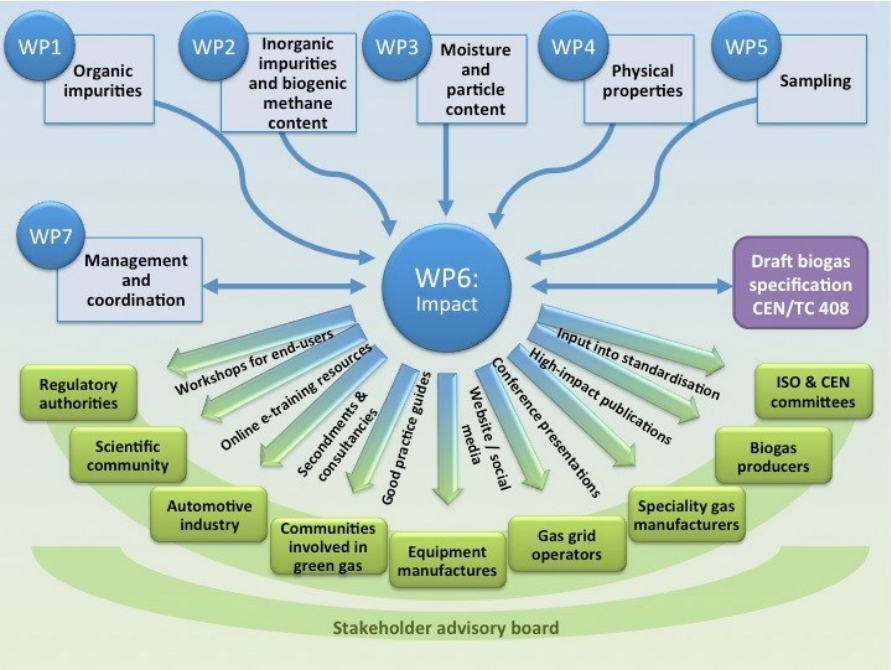
SMU, Slovakia

SP, Sweden

TUBITAK, Turkey

Internal Partners:

HCP, Taiwan



ENG54 Metrology for Biogas project structure

economical, thereby contributing to the competitiveness of the renewable fuel on the natural gas market. Alternative means of transport, such as the liquefaction of biomethane to LBG (Liquefied Biogas), present the similar challenges. To be admitted to such infrastructures, biomethane needs to fulfil firstly the requirements for the quality of natural gas, as laid down in EN 16726. This European standard specifies gas quality characteristics, parameters and their limits, for gases classified as group H that are to be transmitted, injected into and from storages, distributed and utilized. This European standard does not cover gases conveyed on isolated networks.

For biomethane and upgraded biogas, additional requirements are necessary, for the feedstocks used for producing these renewable fuels contains a large diversity of contaminants, some of which may end up in biomethane, even after cleaning of the raw gas. Specifications for biomethane for injection into the natural gas transport and distribution grids and specifications for the use as transport fuels have been developed by CEN/408 under the mandate M/475. These specifications have been laid down in EN 16723 (Natural gas and biomethane for use in transport and biomethane for injection in the natural gas network). The part 1 contains the specifications for biomethane for injection in the natural gas network, whereas the part 2 is the specification for the automotive fuels. Both parts supplement the specification for high-calorific natural gas (H-gas, EN 17626) and a projected specification for low-calorific natural gas (L-gas).

The implementation of these specifications requires that the specifications can be experimentally verified by measurement. Even if the practical implementation of these specifications also foresees other means, such as filters to remove,

METROLOGY for BIOGAS

ENG54 Metrology for Biogas official logo

e.g., water, hydrogen sulphide, carbon dioxide, and particulates, there is still a need to reliably measure the quantities listed in the specification, to enable verifying whether such installations are appropriate and fit for purpose. The quantities specifically addressed in EN 16723 cover a wide range of impurities, the methane number (the part 2 only), the particulate content.

Such measurements can only be reliably performed by competent laboratories, which need the development of such services as certified reference materials and dedicated test and calibration methods. The natural gas area is highly regulated, and the vast majorities of the properties listed in the specifications for natural gas are supported by international standard describing their determination, and the availability of certified reference materials, calibration services for equipment, and, last but not the least, accreditation in accordance with ISO/IEC 17025.

This project aims to develop and validate methods for determining key impurities, moisture, particulates, calorific value, and density in biomethane and biogas:

- Novel traceable methods for the measurement of the contents of key trace-level impurities in biogas and biomethane namely: total silicon and siloxanes, sulphur-containing compounds, aromatic hydrocarbons, halogenated hydrocarbons, ammonia, hydrogen cyanide, hydrogen chloride and carbon monoxide.
- Robust analytical capabilities for the measurement of the particulate content and water content / dew point of biogas and biomethane.
- Methods for the measurement of the calorific value, heat capacity, and density of biogas and biomethane.
- Traceable method for determining the concentration of biomethane in samples of blended biomethane and natural gas.
- Robust methods for sampling biogas and biomethane in the field, and to enable the biogas industry to perform robust and traceable quality assessment measurements.

The results of this project will enable the National Metrology Institutes (NMIs) to provide e.g., calibration, measurement, reference material services that enable the gas industry to reliably measure key properties of biogas and biomethane. For selected parameters, such as the carbon monoxide content and particulates concentration, the project will also deliver the basis for writing a dedicated standard test method.

EMRP ENG59 NNL - METROLOGY FOR NNL

Sažetak

Razne industrije a prvenstveno industrija nafte i gasa iskazuju sve veću potrebu za unapređenjem postojećih mjerila viskoziteta kompleksnih tečnosti koje spadaju u kategoriju ne-njutnovskih fluida. U naftnoj i gasnoj industriji ovo se prvenstveno odnosi na muljnu isplaku koja se koristi tokom bušenja eksploatacionih bušotina nafte i gasa, a koja se često naziva komercijalnim imenom – bentonit. Funkcija bentonita je da obezbijedi stabilnost zidova bušotine, iznošenje nabušenog materija, te "podmazivanje" i hlađenje bušače glave. Imajući u vidu da su bušotine nafte i gasa izuzetno skupi objekti čija se dubina kreće od 2 km do 10 km, jasna je potreba da se o jednom tako bitnom elementu ima što više pouzdanih podataka. Iako je dobro poznato da karakteristike ne-njutnovskih fluida imaju značajan uticaj na mjerenje ne postoje relevantna istraživanja koja se bave problemima kalibracije, uključujući i mjernu nesigurnost mjerila koja su u upotrebi. Pored razmatranja tradiocionalnih metoda mjerenja viskoziteta izvršena je i uporedna analiza naprednih metoda (ultrazvuk, kompjuterska tomografija) u stvarnim uslovima rada.

Institut za mjeriteljstvo je učestvovao na ovom projektu kao podrška za numeričku simulaciju (CFD) toka ne-njutnovskog fluida u u rotacionom reometru a u cilju produbljivanja spoznaja o karakteristikama toka i uticaju na mjerne rezultate.

Project description

Various industries, including the oil and gas industry, have a need for sensors and a metrological standard for the measurement of the viscosity of complex, non-Newtonian fluids. Drilling mud, known as "bentonite", is used for drilling of oil and gas wells as a lubricant and cooling medium of drilling bit, evacuation media of drilled material and it protects borehole walls against collapsing. Since the oil and gas boreholes/wells are extremely expensive structures, whose depths varies between 2 km and 10 km, there is the evident need to have as many as possible reliable information about mud drilling.

Tekst pripremio:

Ernad Borovac

Project start date and duration:

May 2014 - May 2017

Coordinator:

Dr. Alex van der Spek, VSL

Internal Partners:

VSL, Netherlands

CNAM, France

IMBiH, Bosnia and Herzegovina

INRIM, Italy

IPQ, Portugal

METAS, Switzerland

PTB, Germany

Shell, Netherlands

IRIS, Norway

Cenimat, Portugal

Collaborators:

CCMM, Portugal

Anton Paar, Austria

Brookfield, USA

British Petroleum, United Kingdom

IFPen, France

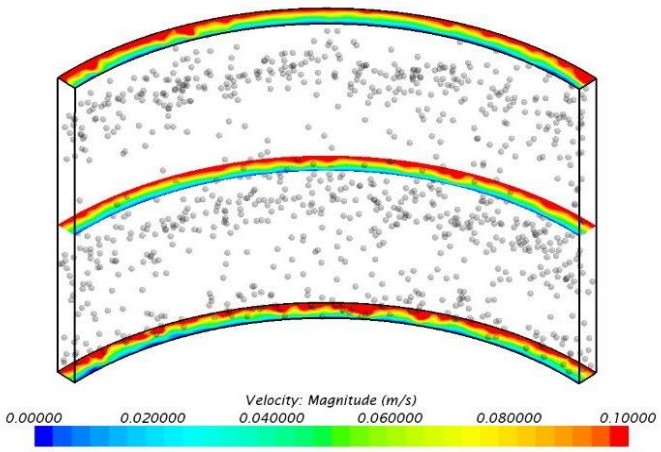
SIK, Sweden

Statoil, Norway

Thermo Fisher, Germany

Endress Hauser, Switzerland

University of Texas - Austin, USA



Lagrangian particles in rheometer gap

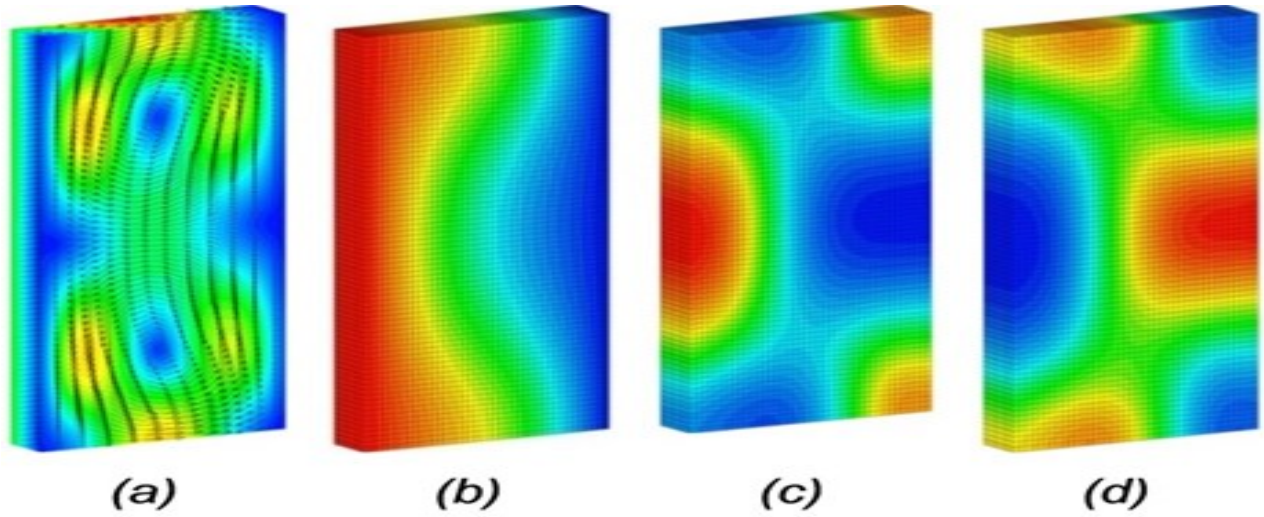
It is known the non-Newtonian physics has significant influence on the measurement of commonly used viscosity meters, but the calibration, resulting uncertainty and inaccuracy has never been evaluated systematically. This project reviewed the physics impacting the viscosity of non-Newtonian liquids used as a drilling mud, and evaluated potential alternative measurement techniques, such as ultrasound and computed tomography. In addition, the typical uses of the upgraded and new viscosity measurement techniques are evaluated outside the laboratory, in harsh, on-site operational conditions. Also, on drilling platforms, the viscosity sensors have to work continuously and reliably what requires development of on-site calibration methods. The ultimate objective of the JRP was to evaluate the various measurement methods in actual field conditions, on the drilling rig test facility.

IMBIH participated in this project as a support for numerical simulation (Computational Fluid Dynamics) of the non-Newtonian fluid flow in the viscometer, i.e. rotational rheometer to closely evaluate flow features and its impact on the measurement results. Two major issues were investigated:

- Influence of the solid particles on rheological behavior of the fluids.
- Analysis of the flow stability in rheometer and appearance of "Taylor" vortices.

Analysis of the influence of solid particle is performed through the simulation of behavior of the liquid (water) filled with solid particles of different sizes in different concentrations. It was shown that the presence of particles does influence the velocity profile, which causes the changes in shear rate and, therefore, influences the viscosity.

Flow stability is ever-present problem in rotational rheometry because the occurrence of instability could be easily misin-



Instability features in rheometer gap: (a) Vortices (b) Velocity (c) Shear Rate (d) Viscosity

-terpreted as characteristic of the material. It was demonstrated that the different formulas developed for Newtonian fluids are not-applicable for non-Newtonians.

In general, it was shown that rheological models obtained from rotational rheometers are not good enough due to assumption of the ideal flow profile in the gap which causes the error in calculated shear rate.

EMPIR 14RPT02 AWICAL - TRACEABLE CALIBRATION OF AUTOMATIC WEIGHING INSTRUMENTS OPERATING IN THE DYNAMIC MODE

Sažetak

S razvojem tehnologije mjerenja, povećao se broj automatskih vaga (AWI), koji obavljaju mjerenja u dinamičkom modu. Dok se neautomatske vage (NAWI) redovno kalibrišu od strane akreditovanih kalibracionih laboratorija prema kalibracionom vodiču EURAMET cg-18, kalibracija AWI nije definisana, jer postoji značajna razlika između mjerenja u statičkom i dinamičkom modu. Također, ne postoje harmonizirane i standardne metode za procjenu mjerne nesigurnosti za kalibraciju AWI, te sljedivost AWI nije osigurana od strane akreditovanih kalibracijonih laboratorija na osnovu usaglašene procedure kalibracije. EMPIR AWICal projekat je primijenjen za automatsku vagu za pojedinačno mjerenje, automatsku gravimetrijsku dozirnu vagu i automatsku vagu za mjerenje drumskih vozila u pokretu. Prve dvije vage se intenzivno koriste u proizvodnji i osiguranju kvaliteta predpakiranih i drugih proizvoda, u kojima se utvrđuje njihov sadržaj ili sastav vaganjem. Cilj ovog projekta je bio razvoj i istraživanje obnovljivih kalibracionih metoda i modela za evaluaciju mjerne nesigurnosti za tri grupe AWI u dinamičkom načinu rada, kao i validacija tih metoda kod proizvođača i krajnjih korisnika. Razvoj kompetencija zemalja članica EURAMET-a za ocjenu usklađenosti s ciljem podrške implementaciji Direktive o mjernim instrumentima i direktiva o predpakiranim proizvodima je podržan ovim projektom. Rezultati projekta su nacrti EURAMET kalibracionih vodiča za tri grupe AWI koji su predati EURAMET-u. IMBIH je učestvovao u nizu aktivnosti na validaciji metoda, te u interkomparacijama koje su organizovane u Sloveniji, Turskoj i Češkoj. Koordinator ispred Instituta je bila lider radnog paketa WP 3, pod nazivom „Razmjena znanja i razvoj dugoročnih strategija za istraživačke sposobnosti u dinamičkom mjerenju mase“.

Project description

Updating the Guidelines on the Calibration of NAWI EURAMET/cg-18 demonstrated the significant impact and knowledge transfer of EURAMET activities in this field to the national accreditation bodies responsible for accreditation of calibration laboratories for NAWI. Previously, there have been no coordinated activities between NMIs in the field of traceability of automatic weighing instruments

Tekst pripremila:

Šejla Ališić

Project start date and duration:

May 2015 - May 2018

Coordinator:

Matej Grum, MGRT (MIRS)

Internal Partners:

MGRT, Slovenia

BEV-PTP, Austria

CMI, Czech Republic

GUM, Poland

IMBiH, Bosnia and Herzegovina

METROSERT, Estonia

MoE, Serbia

PTB, Germany

TUBITAK, Turkey

External Partners:

Mettler Toledo, Germany

Training on AWI- catchweigher in Slovenia, October 2016

(AWI) operating in the dynamic mode, since the NMIs were primarily focused on traceability and research in the field of mass standards with a smaller part of activities related to the NAWI calibration methods. In addition, the weighing instruments legal metrology community has not launched activities on evaluation of measurement uncertainty so far related to the automatic instruments and dynamic measurements. The three groups of AWIs representing the most commonly used instruments were selected and addressed in the project, i.e. automatic catchweighers, automatic instruments for weighing road vehicles in motion and automatic gravimetric filling instruments. The partners with the significant expertise in the field of calibration of AWIs or NAWIs are also authorised by their legislation or governments for the conformity assessment of AWIs (according to OIML R 51; OIML R 134 and OIML R61 respectively). This forms the fundamentals for the research excellence in the field of calibration of dynamically operated automatic weighing instruments. Collaboration between EURAMET NMIs/DIs that are less experienced in the field of testing or calibration of automatic weighing instruments with NMIs/DIs with greater experience developed their metrology research capabilities and especially metrological infrastructure for the traceable dynamic mass measurements. The partners from the emerging EURAMET countries had the training for three groups of AWI in Slovenia, in Czech Republic and in Turkey.

The project developed and validated appropriate measurement methods for the calibration of the selected AWIs. The results obtained using the new methods for calibration of AWIs operating in the dynamic mode were compared with static weighing of objects. The reproducibility of methods developed was confirmed by comparison of dynamic weighing measurements between the partners. Uncertainty budgets for the determination of the measurement uncertainty for the calibration of AWIs and for the determination the uncertainty of a weighing result was developed and validated. Calibration guides based on the methods developed in the project were prepared for the three groups of AWI and in this way the highest metrological and economic benefits are expected for the end users. The draft EURAMET calibration guides are submitted to EURAMET TC-M for further approval by EURAMET. The harmonised calibration guidance will also serve as input information on the measurement uncertainty evaluation for the international organisations such as OIML and WELMEC, which deal with the conformity decision process for AWIs for the legal metrology purposes. The AWICal project comprised the following main objectives:

- To develop and validate appropriate measurement methods for the calibration of selected AWIs. The relevant specific content of a calibration certificate for calibration of an AWI will be defined.

- To develop and validate error models for the dynamic weighing process for these three groups of automatic weighing instruments and to determine the potential sources of measurement uncertainty for these instruments.

- To develop uncertainty budgets for the determination of the uncertainty of measurement for the calibration of AWIs and for the determination the uncertainty of a weighing result.

- To develop 3 draft calibration guides for automatic catchweighers, automatic instruments for weighing road vehicles in motion and automatic gravimetric filling instruments respectively and to submit them to EURAMET for approval, either as three separate EURAMET Calibration Guides or as one combined Guide.

- To develop the individual strategies for each partner (except MT) for the long-term development of their research capability in dynamic mass metrology including priorities for collaborations with the research community in their country, the establishment of appropriate quality schemes and accreditation (including participation in comparisons and submission of CMCs either to the KCDB or an accreditation body as appropriate).

The project partners have closely cooperated with collaborators from industry, which provided access to AWI for the purpose of validation of developed calibration methods. The final versions of EURAMET Calibration Guides for automatic catchweighers, automatic instruments for weighing road vehicles in motion and automatic gravimetric filling instruments were finalised in May 2018. The main stakeholder groups, which directly benefit from the outcomes of the project, are calibration laboratories, accreditation bodies, producers of AWIs and conformity assessment bodies. Harmonised and traceable calibration based on accreditation is a basic requirement for mutual recognition of calibration results, offering a cost saving to the European exporters. The recognised traceability of calibration results will also provide an important contribution to consumer protection.

IMBIH participated in validation activities and performed measurements in Bosnia and Herzegovina. Also, IMBIH participated in interlaboratory comparison organized by MGRT, TUBITAC and ČMI, where the measurements were performed in Slovenia, Turkey and Czech Republic. Partner on the project for validation measurements on catchweigher was company Rolvaga, d.o.o.

IMBiH was also the leader of the Work Package 3: »Exchange of expertise and the development of long-term strategies for research capabilities in dynamic mass metrology«

EMPIR 14RPT03 ENVCRM - MATRIX REFERENCE MATERIALS FOR ENVIRONMENTAL ANALYSIS

Sažetak

Ovaj projekat je bio usmjeren na razvoj kapaciteta za proizvodnju certificiranih referentnih materijala (CRM) za analizu okoliša i to primjenom know how između partnera. Proizvodni proces referentnih materijala je uključivao razvoj novih analitičkih metoda za ispitivanje hemijskih parametara, validaciju metoda, ispitivanje homogenosti, te stabilnosti pripremljenih materijala, kao i njihovu karakterizaciju, sa proračunima za ukupnu mjernu nesigurnost pripremljenih referentnih materijala. U okviru projekta organizirane su dvije ključne komparacije, registrovane u BIPM bazi podataka, kroz čija su učešća potvrđene mjeriteljske sposobnosti pojedinih partnera. Kao krajni rezultat projekta proizvedeni su novi certificirani referentni materijali, dostupni na tržištu, a značaj projekta se ogleda u činjenici da su partneri razvili strategije za dugoročne istraživačke sposobnosti kod proizvodnje referentnih materijala. Učešće Instituta za mjeriteljstvo Bosne i Hercegovine na ovom projektu realizovano je kroz učešće u svim radnim paketima, a najviše kroz koordinaciju radnog paketa posvećenog karakterizaciji organskih i anorganskih analita, te kroz ulogu koordinartora u ključnoj komparaciji iz oblasti anorganske hemije (EURAMET.QM-S11). Značajno je istaknuti da je u navedenoj komparaciji uspješno učešće ostvarila i imenovana laboratorija IMBIH-a (DI – IMBIH) Institut za vode" d.o.o. Bijeljina, te da se objavom završnog izvještaja komparacije očekuje i prvi upis ispitnih sposobnosti (CMC) iz Bosne i Hercegovine u oblasti anorganske hemije u BIPM bazu podataka, što je značajan uspjeh kao na državnom, tako i na međunarodnom nivou.

Project description

The need for the quality assessment of anthropogenic impact on environmental pollution is increasing due to discharge from various industries, the use of chemicals in agriculture, and the consumption of fossil fuels. In order to establish a quality system in the testing of the environmental samples conducted by dedicated laboratories, it is necessary to provide an appropriate quality control materials i.e. matrix CRMs. The term "appropriate" relates to the unique sample matrices representing typical samples in the geomorphological and anthropological sense.

Tekst pripremila:

Aida Jotanović

Project start date and duration:

June 2015 - June 2018

Coordinator:

Alper İşleyen, TUBITAK

Internal Partners:

TUBITAK, Turkey

BAM, Germany

JSI, Slovenia

IMBiH, Bosnia and Herzegovina

DMDM, Serbia

SYKE, Finland

External Partners:

NTUA, Greece

UW, Poland

CRMs prepared within the project

The overall objective of this project was to develop the research capability for the production of environmental reference materials. The specific objectives were:

- Production of CRM Candidates: two inorganic and one organic pollutant candidate CRMs;
- Homogeneity and Stability Tests of CRM Candidates
- Characterization of the CRM Candidates
- Certification of the CRMs
- Long term research capability for environmental CRMs
- Contribution to impact

Additionally, as a direct result of this project new CRMs are available that differ in matrix, analyte(s) and concentration from those on the market prior to the start of the project. Uncertainty values for the analytes are comparable to commercially available. The mix of analytes and the matrix composition of the new CRMs are appropriate to the region in which the partner

NMIs are located. The stability and transportation conditions of the CRMs was analysed as part of the certification process, allowing uptake by industry.

At the end of the project, all the NMIs involved have the capacity to carry out all aspects of CRM development and certification including material sampling, preliminary measurements, production of candidate materials (including spiking/ blending, homogenization, bottling and storage), homogeneity and stability testing, development of reference methods (including methods for homogeneity and stability tests, instrument-based methods and standardized technical methods), sample preparation and characterization, calculation of the results and uncertainties and drafting of certificates. Each partner have benefit from an individual plan for further research and development of CRMs based on stakeholder needs and the results achieved in the project.

Sampling illustration

EMPIR 14RPT05 EURA-THERMAL - DEVELOPING TRACEABLE CAPABILITIES IN THERMAL METROLOGY

Sažetak

Preko 60% industrijskih procesa u Evropi zavisi od tačnog mjerenja temperature ili termo-fizičkih svojstava materijala. Unapređenje mjerenja temperature je zato ključni faktor za povećanje efikasnosti i ekološke prihvatljivosti industrijskih procesa. U evropi postoji nekoliko nacionalnih mjeriteljskih instituta sa specijaliziranom i vrhunskom termometrijom, ali u cilju ubrzanja i ujednjačavanja ekonomskog rasta u Evropi postoji potreba da ova izvrsnost u termometriji bude ravnomjernije raspoređena diljem Evrope. Ovaj projekat imao je za cilj prenos znanja i unapređenje mogućnosti u oblasti kontaktne i bezkontaktne termometrije visokih temperatura i karakterizacije termofizičkih svojstava materijala u manje razvijenim nacionalnim mjeriteljskim institutima. Partneri sa kojima je Institut za mjeriteljstvo Bosne i Hercegovine radio na ovome projektu su LNE (Francuska), CMI (Republika Češka), CNAM (Francuska), FSB (Hrvatska), MKEH (Mađarska), MoE (Srbija), NSAI (Irska), TÜBITAK (Turska), UL (Slovenija) i VINČA (Srbija).

Glavna aktivnost Instituta za mjeriteljstvo Bosne i Hercegovine bila je vezana za dizajn i konstrukciju temperaturnog standarda - fiksne tačke srebra, i uspostavljanje sistema za rad sa otvorenim fiksnim tačkama u IMBIH-u. Kao rezultat, proizveden je prvi primarni standard u IMBIH-u (fiksna tačka srebra), te proširen mjerni opseg na primarnom nivou do 960°C.

Project description

Over 60 % of the processes used in Europe's manufacturing industry depend on the accurate measurement of the thermal properties of materials. Advanced thermal metrology is therefore a key factor for improving the efficiency and environmental impact of industrial processes. Europe has several NMIs specializing in the field of thermal metrology, but in order to accelerate the economic growth across Europe, this expertise needs to be shared more widely. This project increases knowledge transfer and improves the availability of facilities in the field of thermal metrology (i.e. high temperature contact thermometry, non-contact thermometry and thermo-physical properties characterization) to the

Tekst pripremila:

Nedžadeta Hodžić

Project start date and duration:

June 2015 - May 2018

Coordinator:

Dr Jean-Remy Filz, LNE

Internal Partners:

IMBiH, Bosnia and Herzegovina

LNE, France

CMI, Czech Republic

CNAM, France

FSB, Croatia

MKEH, Hungary

MoE, Serbia

NSAI, Ireland

TUBITAK, Turkey

UL, Slovenia

VINČA, Serbia

IMBIH system for open fixed point cells

characterization) to the emerging European NMIs. The enhanced measurement capability provided through the project will help to sustain the economic competitiveness of European states.

The EMPIR 14RPT05 EURA-THERMAL project addresses the following scientific and technical objectives:

- To improve the accuracy of high temperature measurements by contact thermometry (WP1):
- To ensure knowledge transfer in high temperature contact thermometry via establishment of calibration procedures and uncertainty evaluation methods.
- To construct artefacts (Ag fixed point cells) for the use as standards with the objective to disseminate the temperature unit.
- To develop references for radiation thermometry in participating NMIs seeking to establish a research capability in this field (WP2):
- To encourage knowledge transfer in radiation thermometry for the realization of the ITS-90, by organizing training workshop and by establishing the best practice guide.
- To perform an inter-laboratory comparison of radiation thermometer calibration in order to improve calibration technique and to assess the measurement uncertainties.
- To provide assistance to capacity building in radiation thermometry in the framework of technical visits of experts of the consortium.
- To consolidate the traceability and capabilities for the measurement of thermal conductivity by Guarded Hot Plate (GHP) in European emerging NMIs (WP3):
- To transfer the knowledge from experienced laboratories toward the NMIs of the Western Balkans countries, through training courses, tutorials and workshops.
- To implement thermal conductivity measurements by the GHP method in emerging NMIs by participating in an inter-laboratory comparison whose main objectives are to assess the coherency of measurements among involved laboratories.
- To strengthen the development of the central and south-east of Europe metrological capacity in thermal conductivity measurements by GHP, via technical audits and exchanges of guest researchers.

IMBIH silver FP

- To contribute to impact (WP4) via dissemination of research outputs to end-users (conferences, papers, guidelines…)

Main activities of the researchers from IMBiH was related to the design and construction of the open silver fixed point cell (Ag FP) and to the performance of high temperature calibration and development of an uncertainty budget. During this project our researchers, together with colleagues from partner's institutes have investigated various design options for silver fixed point cells. At the end of this process, final design has been chosen and all necessary parts were defined. During the following months, the main challenge was to obtain pure silver with 99,9999% purity, and obtaining other part was challenging too. Finally we constructed the cell and established the system for the open cell calibration in IMBIH, and have done the necessary measurements.

As the main result during this project we have learned how to construct the metal fixed point cell, and together with our partners, we have produced first IMBIH primary standard that was not purchased, but produced in the scope of this project. We are proud that some parts for the open fixed point system are produced in Bosnia and Herzegovina, and few other parts have been produced in neighboring countries.

Over the course of the Eura-Thermal project, 12 training courses and technical visits were organized in various venues around Europe.

EMPIR 15RPT03 HUMEA - EXPANSION OF EUROPEAN RESEARCH CAPABILITIES IN HUMIDITY MEASUREMENT

Sažetak

U EMPIR projektu 15RT03 HUMEA, čiji je cilj razvoj mjernih mogućnosti u oblasti mjerenja vlažnosti, po prvi put Institut za mjeriteljstvo Bosne i Hercegovine je koordinator jednog EMPIR projekta. To je istovremeno i prvi put da koordinator nekog EMPIR projekta nije iz uskog kruga najrazvijenih evropskih instituta, nego dolazi iz manjeg instituta i instituta u razvoju. Projekat je započet 1. juna 2016. godine i trajati će do 31. maja 2019. godine. Osim Instituta za mjeriteljstvo BiH u projekat su uključeni još 9 evropskih instituta (CMI, FSB, INRIM, DMDM, NSAI, TUBITAK, UL, ME-BOM i MER). Dodatno, tokom trajanja projekta uključila su se još 4 saradnika (Collaborators): JV (Norveška), EIM (Grčka), Rotronic (UK) i Alius grupa d.o.o. (Hrvatska). Kroz RMG (Researcher Mobility Grant) prijavu dva istraživača su uključena nekoliko mjeseci na dodatne aktivnosti projekta u dva različita Instituta (CIM i INRIM). Istraživači su uspješno završili svoje aktivnosti i njihovi finalni izvještaj su prihvaćeni od strane EURAMET-a. U mart u 2018. godine se održavao mid-term review (srednjoročni pregled) za EMPIR projekte i cjelokupni projekat je uspješno prošao 18M (18 mjesečnu) kontrolu od strane EURAMET-a. Bitno je napomenuti da su sve aktivnost na projektu do sada izvršene u skladu sa planom i programom projekta.

Tekst pripremila:

Nedžadeta Hodžić

Project start date and duration:

June 2016 - June 2019

Coordinator:

Nedžadeta Hodžić, IMBiH

Internal Partners:

IMBiH, Bosnia and Herzegovina

CMI, Czech Republic

FSB, Croatia

INRIM, Italy

DMDM, Serbia

NSAI, Ireland

TUBITAK, Turkey

UL, Slovenia

External Partners:

ME-BoM, North Macedonia

MER, Montenegro

Project description

Humidity measurement techniques are diverse and each presents different challenges for use and calibration for a range of pressures and gases. Over the past few years, the development of the humidity sensors and apparatus has matured to a level where traceable calibration is beneficial to all industries in which humidity and moisture measurement and control are important.

EMPIR 15RPT03 HUMEA "Expansion of European research capabilities in humidity measurement" is a new European project for establishing the infrastructure for humidity measurements, assuring traceability and providing dissemination as important concept in both developed and emerging NMIs/DIs as well as a precondition to the related research, industrial applications and quality standards as well as support for various services, including the grand challenges (health, environment and energy) and closely associated with quality

of life measures and implementation of the specific EU legislation. The overall objective of the project is to develop measurement and research capabilities in humidity measurements of participating emerging NMI countries, based on the stakeholder's needs. Specific objectives are: identifying existing and future needs, knowledge transfer , developing measurement methods and sharing procedures as best practice, narrowing the gap of the offered calibration services, performing an inter-comparison, building research potential and strengthening the co-operation between the NMIs. The consortium consists of the leading European NMIs/DIs and emerging NMIs in the field of humidity in a complementary metrology structure. The leading NMIs/ DIs of the consortium (INRIM, CMI, TUBITAK, FSB and UL) have a significant experience and excellence in the area of humidity measurements and research. On the other side, the emerging NMIs have the adequate equipment to carry out the project, but limited experience and existing capabilities, particularly in the humidity related research. Collaboration between those partners that are less experienced in the research (IMBiH, MoE, NSAI, ME-BoM and MER) and those that are more experienced will develop metrology capabilities and infrastructure for traceable humidity measurements, which will support their participation in the future research projects. The project is performed within the framework of EURAMET/EMPIR (European Metrology Programme for Innovation and Research) and is divided into five work packages including, three technical and scientific work packages, and two work packages for the impact and management

The EMPIR 15RPT03 HUMEA project addresses the following scientific and technical objectives:

Relative humidity measurements

- To perform a survey of the relative humidity related to the measurement needs of stakeholders in each country with an emerging NMI/DI. The results of the survey will be analysed and used as an input to the strategy for development in the field of humidity measurements in that country.

- To develop an inner chamber for relative humidity calibrations, this will then be characterised by each of the partners.

- To carry out an inter-comparison of the improved measurement capabilities developed by the partners in the field of relative humidity.

Dew point temperature standards

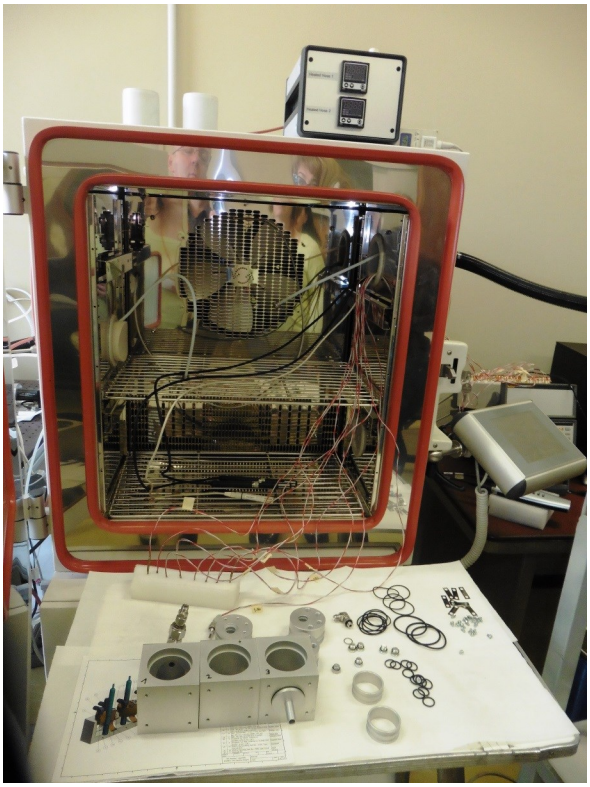
- To obtain information about the dew point measurement related to needs of stakeholders in each country with an emerging NMI/DI.

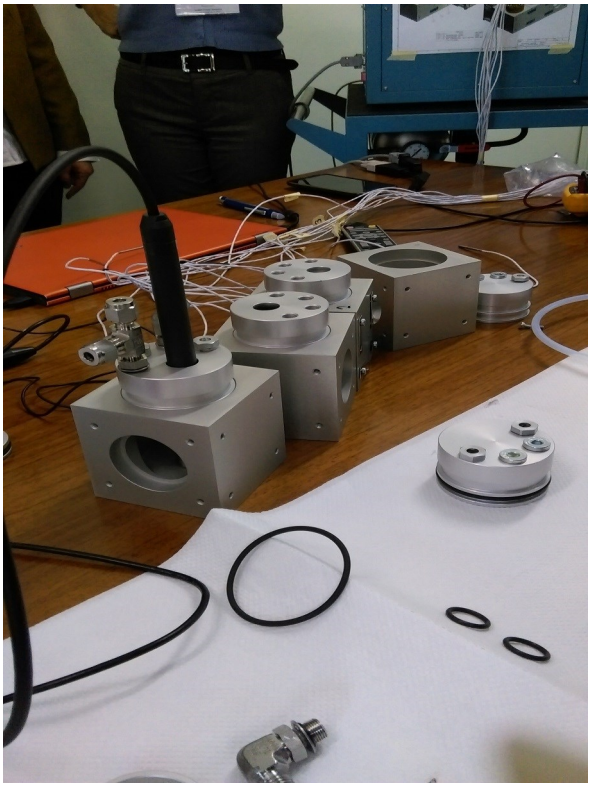
- To obtain information about the existing level of knowledge and capabilities of partners and to identify gaps in the capabilities for dew point temperature measurement of the emerging NMIs/DIs with regard to the stakeholder needs.

- To improve the capabilities to enable emerging NMIs/DIs to perform dew point temperature measurements in the temperature range from -70 °C to 90 °C.

Strategy development

- To ensure that emerging countries engage in further development of humidity metrology infrastructure to support industrial needs, competitiveness and international trade and show commitment to the sustainable growth in the partner's country after the lifetime of the project.





Chamber developed during the EMPIR 15RPT03 HUMEA project

- To ensure that emerging countries engage in future collaboration and co-operation, especially in future joint research and collaborative projects with European NMIs/DIs.

- To identify future trends toward smart specialisation in humidity metrology, based on identified trends and needs for metrology research and services.

Through the development of training courses in humidity measurement, the outcomes of the project, as well as general humidity measurement training will be delivered effectively to industrial stakeholders, thereby improving understanding and skills among industry within the European Union. In the area of relative humidity and dew point measurement knowledge, transfer from experienced NMIs/DIs to those less experienced in how to use new types of humidity instruments and facilities will be very beneficial. It will help to raise the knowledge, measurement and research capabilities and will promote consistency within the humidity metrology. Through highlighting the importance of humidity to processes, and to human comfort levels, this project will lead to a better understanding of humidity among stakeholders and therefore, to the improvement of environment with climate control, as well as humidity or moisture dependant industrial processes. A better understanding of humidity measurement and control will also allow the development of optimal storage conditions for produce, leading to a reduction in waste and spoilage throughout Europe.

HUMEA is the first EMPIR project coordinated by emerging NMIs, and in addition to the development of the research capabilities, there is a clear evidence of improved management experience and capabilities. Institute of Metrology of B&H is actively involved in the realization of the project objectives together with other project partners.

EMPIR 15RPT04 TRACEPQM - TRACEABILITY ROUTES FOR ELECTRICAL POWER QUALITY MEASUREMENTS

Sažetak

Posljednjih decenija sve više se radi na integraciji obnovljivih izvora energije u postojeće elektroenergetske sisteme. Ovaj zadatak je vrlo kompleksan najviše zbog njihove stohastične i intermitentne prirode koja ima uticaj na eksploataciju elektroenergetskog sistema. Takođe nagli razvoj poluprovodničkih komponenti doveo je do razvoja snažnih uređaja energetske elektronike. S obzirom da rade u prekidačkom režimu, ti uređaji su nelinearnog karaktera, što dovodi do pojave harmonijskih izobličenja u signalima napona i struje elektroenergetskog sistema. S obzirom da se broj obnovljivih izvora energije i nelinearnih prekidačkih uređaja sve više integriše u elektroenergetski sistem, sa stanovišta mjeriteljstva, potreba za sljedivim, tačnim i preciznim mjerenjima električne snage i parametara kvalitete električne snage (PQ) je sve prisutnija. Konvencionalne laboratorijske metode mjerenja snage na najvišem mjiteljskom nivo baziraju se na termalnim konvertorima. Međutim, danas je ovaj pristup mjerenja snage ograničen jer daje informaciju samo o efektivnoj vrijednosti amplitude signala, što nije dovoljno u slučaju da se žele odrediti parametri složenih talasnih oblika koji su značajni za procijenu kvaliteta električne snage. Prema tome, potrebno je razviti i primijeniti nove mjerne metode koje koriste tehnike digitalnog uzorkovanja i obrade signala. Trenutno, nekolicina nacionalnih mejriteljskih instituta (NMI) već je razvila svoje mjerne sisteme, koji se međusobno razlikuju kako u mjernoj postavci tako i u primjenjenoj softverskoj aplikaciji. Ovaj projekat ima za cilj da razvije unificiranu modularnu mjernu postavku i softversku platformu za mjerenje električne snage i parametara kvaliteta električne energije upotrebom tehnike digitalnog uzorkovanja. Iskustva sa ovog projekta biće od velike koristi za NMI-ove koji nisu do sada imali razvijene ove mjerne kapacitete. Krajni rezultat projekta biće iskazan u Vodiču koji će biti svima dostupan. Institut za mjeriteljstvo je u fazi uspostave sličnog sistema koji će se bazirati na iskustvima stečenim kroz ovaj projekat i koristiće razvijenu softversku platformu pri realizaciji svoje referentne postavke. IMBIH u ovom projektu ima zadatak da sa kolegama iz Turskog mjeriteljskog instituta TUBITAK UME validira razvijenu softversku aplikaciju i na osnovu novih iskustava pripremi strategiju razvoja ove oblasti u matičnom Institutu.

Tekst pripremila:

Jasna Lončarević

Project start date and duration:

June 2016 - June 2019

Coordinator:

Vera Novakova Zachovalova, CMI

Internal Partners:

CMI, Czech Republic

BIM, Bulgaria

CEM, Spain

FER, Croatia

IMBiH, Bosnia and Herzegovina

INRIM, Italy

JV, Norway

LNE, France

METROSERT, Estonia

NSAI, Ireland

SIQ, Slovenia

SP, Sweden

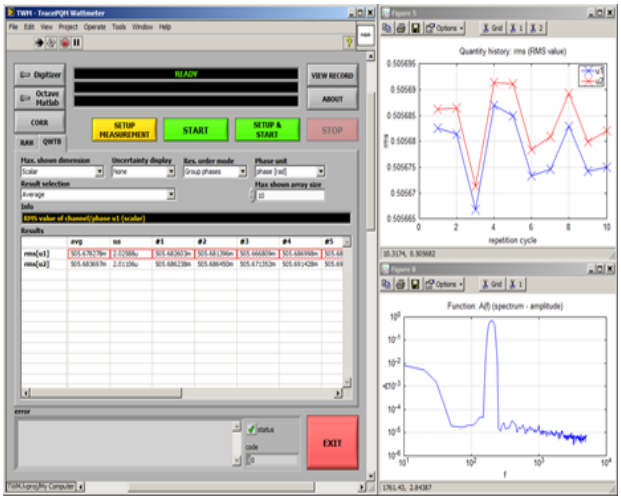
TUBITAK, Turkey

Project description

The project is divided into four technical workpackages dealing with the development of the modular measurement setup of power and PQ parameters accompanied by open SW tool, with the development of good practice guide for sampling power and PQ measurements using the modular measurement setup and with development of the individual strategies for the long-term operation of the developed capacity. One workpackage is focused on creating an impact of the project on wider community and the last workpackage incorporates the coordination and management issues of the project.

The project addresses the following scientific and technical objectives:

- To design, develop and validate a new modular setup for sampling power and PQ measurements based on a review of the best existing setups.
- To develop calibration methods for the most commonly used system components such as current shunts, voltage dividers and wideband digitizers, with the aim of extending the traceability of power and PQ measurements up to 1 MHz.
- To develop an open software tool suitable for handling the high performance and precise state-of-the-art sampling systems (analogue-to-digital converters (ADCs)) identified for power and PQ measurements.
- To develop and provide a practical user's guide for sampling power and PQ measurements using the modular measurement setup and software developed in WP1 and WP2. The good practice guide will encompass both the hardware and software of the modular measurement setup with respect to the different connection schemes and digitizers' configuration inherent to each approach, the traceable calibration of all the components used in the modular measurement setup and automated control and data processing.
- To develop an individual strategy for the long-term operation of the capacity developed, including regulatory support, research collaborations, quality schemes and accreditation. The plan will also include a strategy for offering calibration services from the established facilities to their own country and neighbouring countries.
- To prepare a comparison protocol for for a future supplementary comparison in power and PQ measurement to support the establishment of new CMCs of the participating NMIs/ DIs after the end of the project.
- To ensure that input is sought from the stakeholder community and there is efficient dissemination of information on the project outcomes and to encourage their uptake by the stakeholder community such as developing NMIs, calibration service providers, manufacturers of measuring instruments for electrical power and related quantities, standardisation bodies, energy regulators as well as the power generating and distri-



Version of the TWM tool (from August 2018)

-bution industry. This will be achieved through a range of mechanisms including a stakeholder committee, workshops organised within the project, through the good practice guide, the open software tool and by the wider dissemination of scientific information and outputs though conferences, papers, training material and the website.

Stakeholders within this project will be identified and contacted with a view to forming a stakeholder committee for the project. This will ensure that the project's outcomes are relevant to the community involved with power quality measurements. Contact will be maintained with the relevant technical and standardisation committees.

An on-line platform for efficient transfer of information and data between the partners will be developed. It will also act as the "public face" of the project, providing open access to the technical reports and publications, and to other project outcomes. Ultimately, the web-site will be the access point for resources developed within the project, such as software tools and the good practice guide.

EMPIR 16ENG05 BIOMETHANE - METROLOGY FOR BIOMETHANE

Saţetak

Direktiva o obnovljivim izvorima energije uspostavlja okvir za promociju energije iz obnovljivih izvora, čime se smanjuju emisije CO2 i osigurava opskrba energijom u EU. Trenutno postoji potreba da se značajno poveća količina biometana koji se ubrizgava u mreže prirodnog gasa i koristi u stanicama za punjenje vozila. Da bi se promovisala upotreba biometana u skladu sa zahtjevima 2003/55/EC, potrebno je specificirati svojstva biometana i poboljšanog biogasa. Na osnovu mandata M/475 EC, CEN, Evropska organizacija za standardizaciju, sastavila je takve specifikacije za biometan za ubrizgavanje u transportne i distributivne mreže prirodnog gasa i za upotrebu kao transportna goriva. Ove specifikacije proširuju postojeće specifikacije za prirodni gas, koje su uspostavljene kao rezultat mandata M/400. Pristup mrežama prirodnog gasa je neophodan za promociju biometana i ne smije biti diskriminatoran. U tom smislu, Direktiva o obnovljivim izvorima energije dopunjuje zahtjeve iz Direktive 2003/55 / EC. Bez rezultata rada na ovom projektu, efektivno će se zaustaviti rast upotrebe biometana i poboljšanog biogasa, jer će to biti neekonomično za transport, a ciljevi koji se odnose na diversifikaciju resursa gasa i povećanje upotrebe obnovljivih goriva neće mogu biti ispunjeni.

IMBiH je zadužen za dodatnu optimizaciju i učešće u procesu standardizacije metode za ispitivanje ukupnog sadržaja silicija u biogasu.

Project description

The Renewable Energy Directive establishes a framework for the promotion of energy from renewable sources, thus reducing CO_2 emissions and securing the supply of energy in the European Union. By the end of 2014, there were 17,240 biogas plants in Europe with a total operational capacity of 8293 MWe (megawatts electrical). This represented the 23 % increase compared to 2013 when there were just 367 biogas plants in Europe. There is now an urgent need to significantly increase the amount of biomethane which is injected into natural gas networks and used in vehicle refuelling stations. To promote the use of biomethane as required by 2003/55/EC, the properties of

Tekst pripremila:

Katarina Hafner-Vuk

Project start date and duration:

June 2017 - July 2020

Coordinator:

Dr. Jianrong Li, VSL

Internal Partners:

VSL, Netherlands

IMBiH, Bosnia and Herzegovina

NPL, United Kingdom

PTB, Germany

CEM, Spain

VTT, Finland

External Partners:

ENGIE, France

INERIS, France

ISSI, Italy

WAL, United Kingdom

RUL, Netherlands

NEN, Netherlands

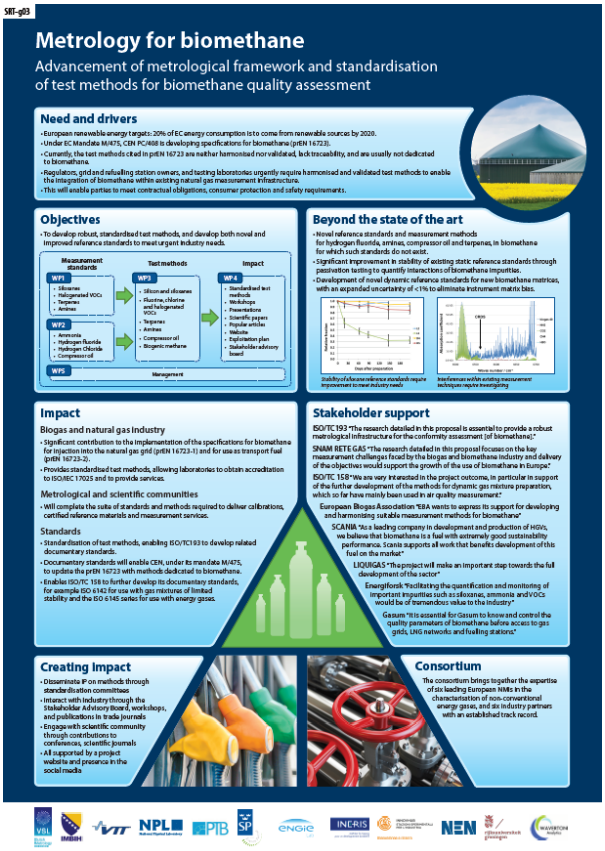
16ENG05 Metrology for Biomethane official logo

of biomethane and upgraded biogas need to be specified. Based on the mandate M/475 of the European Commission, CEN, the European Organization for Standardization, has drawn up such specifications for biomethane for injection into the natural gas transport and distribution grids and for use as transport fuels. These specifications extend the existing specifications for natural gas, which were established as a result of mandate M/400. Access to the natural gas grids is essential for the promotion of biomethane and shall not be discriminatory. In this respect, the Renewable Energy Directive supplements the requirements in the directive 2003/55/EC. Without the results of the work in this project, the growth in the use of biomethane and upgraded biogas will be effectively stopped as it will be uneconomic to transport, and the objectives concerning the diversification of gas resources and the increased use of renewable fuels will not be able to be met.

The feed stocks used for producing biogas differ substantially, as do the processes for producing the biogas and upgrading it to biomethane. The diversity of the feed stocks used to produce biogas means that a larger number of parameters for natural gas have been specified in EN 16723, in particular with respect to critical impurities. The specifications for biomethane for injection into natural gas grids (EN 16723 1) has been published in 2016. The specifications for biomethane as an automotive fuel (prEN16723-2) are close to publication. Therefore, meeting these specifications is crucial for the integrity of piping networks, metering equipment, and of the end users' appliances. However, the specifications refer currently to test methods that have been designed for other matrices (e.g., air) and have not been validated for the conformity assessment of biomethane and upgraded biogas.

For the key critical impurities in biomethane, fit for purpose measurement standards, high accuracy analytical methods and metrological traceability are lacking e.g. for the contents of compressor oil, amines, terpenes and HF. At the same time, some of the measurement standards developed in EMRP JRP ENG54 require further development to be fit for purpose e.g. those for silicon and siloxanes, halogenated VOCs, ammonia, and HCl. In addition, for these groups of components, the short term stability needs to be improved (for siloxanes), the set of components covered needs to be better i.e. to include halogenated VOCs, and the gas mixture preparation needs improvement (for ammonia and HCl). These measurement standards developed by this project will provide the basis for delivering SI traceable calibration and measurement services with state of the art uncertainties for the specifications of biomethane.

Another important prerequisite for the implementation of the specifications EN 16723 [7,8] for biomethane and upgraded biogas is the availability of robust, reliable, and SI traceable standardized test methods for these parameters e.g. contents of siloxanes, halogenated VOCs, ammonia, hydrogen chloride, compressor oil, amines, hydrogen fluoride, and



16ENG05 Metrology for Biomethane poster

and terpenes dedicated to biomethane. The project will deliver dedicated methods for measuring the above mentioned impurities and odorants, to replace the methods currently cited in the specifications [7,8], which have been developed for air quality, and some of which are outdated, or not harmonised. With these standardized test methods, the conformity assessment of biomethane and upgraded biogas can be undertaken in an effective, unambiguous way.

Jointly this project and JRPs ENG01 and ENG54 will provide a comprehensive package of up to date and tailored methods and measurement standards to support the required growth in production and use of biogas and biomethane. In doing so, they support the transition towards a sustainable energy supply for Europe, which has been stimulated by the Directive 2009/73/EC [9], "Common rules for the internal market in natural gas and repealing the Directive 2003/55/EC".

The commitment to avoiding technical barriers to the use of energy from renewable sources is further emphasised by the "Promotion of the use of energy from renewable sources the Directive" 2009/28/EC, which states (para 45):

"regulations and rules relating for example to levels of quality, testing methods or conditions of use, should not create barriers to trade in renewable energy equipment and systems"

The priority of the requirements addressed by this project, which are agreed at EU level and concern interchangeability of gaseous fuels between transporters and producers in different countries provides a compelling case for the funding of the necessary metrology infrastructure at the EU level though EMPIR.

This project is performed under EURAMET's EMPIR framework. The EMPIR is jointly funded by the EMPIR participating countries within EURAMET and the European Union.

EMPIR 16RPT02 ALCOREF - CERTIFIED FORENSIC ALCOHOL REFERENCE MATERIALS

Sažetak

Testiranje vozača na prisustvo alkohola u organizmu prilikom vožnje smatra se ključnom mjerom u smanjenju broja smrtnih slučajeva na cestama koji su uzrokovani konzumiranjem alkohola. Za testiranje vozača policija koristi etilometre koji omogućavaju mjerenje koncentracije alkohola u krvi putem izdaha. Prije upotrebe etilometri se moraju kalibrisati/verifikovati u zakonski propisanim vremenskim intervalima i u tu svrhu se mogu koristiti certificirani referentni rastvori etanola u vodi. Trenutno samo dva državna mjeriteljska instituta (NMI) u Evropi proizvode takve certificirane refrentne materijale. Projektom je planirano osposobljavanje i ostalih zainteresovanih NMI-a za proizvodnju certificiranog referentnog materijala etanola u vodi i to kroz uspostavljanje novih analitičkih metoda te razmjenu znanja i iskustava između NMIs/Dis. Lakši i brži pristup certifikovanim referentnim materijalima iste kvalitete obezbjedit će provođenje kontrole etilometara u skladu sa definisanim zahtjevima iz Preporuke R126 OIML (Organizacije za zakonsko mjeriteljstvo). Sveukupno mjerenja će biti pouzdanija i tačnija što će doprinjeti većoj sigurnosti u saobraćaju širom Evrope.

Project description

This project addresses the need by building up long term capacities for the production and certification of the forensic alcohol reference materials suitable for calibration/verification of evidential breath alcohol analysers as defined by recommendation R 126 of the International Organization of Legal Metrology (OIML). Certification includes characterisation of the materials, assessment of homogeneity, stability and uncertainty. Ethanol concentrations will meet regional legal limits for alcohol control. Within the project, partner institutes will agree on the individual strategies for the long-term exploitation of the newly established capabilities. After conclusion of the project the reference materials developed at NMIs/DIs will be available to the laboratories for verification and type approval in county as well as to the breath analyser producers, calibration laboratories, police etc.

Tekst pripremila:

Azra Ibrahimagić

Project start date and duration:

September 2017 - August 2020

Coordinator:

Rosmarie Philipp, BAM

Internal Partners:

BAM, Germany

CEM, Spain

IMBiH, Bosnia and Herzegovina

BRML, Romania

GUM, Poland

LNE, France

MoE, Serbia

TUBITAK, Turkey

External Partners:

HMF, Greece

FTMC, Lithuania

UW, Poland

An interlaboratory comparison will be conducted within the EURAMET Technical Committee Metrology in Chemistry (TC-MC) to test the materials and capabilities developed. Positive results of the intercomparisons will enable entering CMC in the BIPM database.

This will lead to an improvement in the European infrastructure beyond the lifetime of the project. Law enforcement of drinking/driving regulations will benefit from traceable calibrated/verified instruments.

The ALCOREF project comprises the following main objectives:

- To develop traceable measurement and production capabilities for certified ethanol in water reference materials at NMIs/DIs. Materials should be eligible for the calibration of breath analysers as defined by OIML R 126.

- To enable NMIs/DIs to produce forensic alcohol reference materials following an appropriate quality system according to ISO Guides 30 to 35. This includes assessment of homogeneity, short and long term stability, and uncertainty, as well as appropriate documentation, drafting of certificates and certification reports. Certified values should be traceable to the SI. Measurement capabilities and reference materials developed should be at the metrological level high enough for entries into the BIPM CMC database.

- To conduct EURAMET TC-MC intercomparison to test the reference materials and measurement capabilities developed within the project.

- For each emerging NMI/DI (BRML, CEM, GUM, IMBiH, MoE, TUBITAK, FTMC, IAPR), to develop a country specific strategy for the long-term development of their measurement and production capabilities by specifying the collaborations with regional stakeholders such as calibration authorities, reference materials producers, standardisation and accreditation bodies, and manufacturers of breath analysers.

The project will impact on industrial and other user communities. The main stakeholder groups, which will directly benefit from the outcome of the project, are the end-users of the certified materials to be developed - manufacturers and service providers of breath analysers, the national calibration/verification authorities and calibration laboratories, and the national police. This project will enable higher accuracy reference materials to be available to the community, allowing higher accuracy calibration and verification of breath alcohol analysers to be made with greater confidence.

Several partners already have close links to such stakeholders in their countries; others will establish these links in the course of the project. The ongoing interaction with stakeholders will also be achieved through the stakeholder committee. The partners will systematically engage with the target user communities via ad-hoc meetings, the website, the final workshop organised at the end of the project, and international technical working group meetings as well as presenting the project's results at metrology conferences and in practitioner journals. Furthermore, new CMC claims and the registered new reference materials in international databases such as COMAR will raise the awareness of the project results and consequently will promote uptake by end users.

Several NMIs/DIs will directly benefit from the project by their newly established production and measurement capabilities. The certified materials themselves will also be achievements for

CRMs prepared within the project

Sampling illustration

Kick-off meeting + training16th to 18th October 2017, BAM, Berlin

for the partners, since they will enable them to provide new services. The materials together with a wet gas simulator ("bubble train") operated at each NMIs/ DIs will represent the national measurement standards for breath alcohol analysis. Therefore, the project will help to maintain comparable and equivalent national measurement standards in the field Europe-wide. The intercomparisons organised within the project will be opened to other European and CCQM OAWG NMIs/ DIs. This will allow them to compare their available or new measurement capabilities and reference materials with the ones developed in the project. The project will actively support knowledge transfer with the key international and European metrology and legal committees such as CCQM OAWG, EURAMET TC-MC Subcommittee for Organic Analysis and CEN/TC 367 Project Committee – Breath alcohol testers. The link to legal metrology is particularly important since the OIML recommendation R 126 is currently under review.

Furthermore, the partners who are members of the relevant national technical committees or organisations will inform them about the results of this project and will seek feedback.

Institute of Metrology of BiH (IMBiH) is actively involved in the realization of the project objectives together with other project partners. Participation in this project will enable production of traceable certified alcohol reference materials at IMBiH.

After conclusion of the project, the reference materials developed at IMBiH will be available to the laboratories for verification and type approval in our county, allowing higher accuracy calibration and verification of breath alcohol analysers to be made with greater confidence.

EMPIR 17RPT01 DOSETRACE - RESEARCH CAPABILITIES FOR RADIATION PROTECTION DOSIMETERS

Sažetak

Trogodišnji projekat koji je započeo u junu 2018. godine koordinira IMBiH, Laboratorija za jonizirajuće zračenje koja predstavlja sekundarnu standardnu dozimetrijsku laboratoriju (SSDL) u Bosni i Hercegovini. Pored koordinaranja projekta, IMBiH SSDL je uključen u skoro sve aktivnost ovog projekta. Ostalih 13 učesnika na projektu takođe su primarne ili sekundarne dozimetrijske laboratorije iz 13 Evropskih zemalja.

Opšti cilj projekta 17RPT01 DOSEtrace je poboljšanje mjerenja SI operativnih mjernih velčina koje se koriste u zaštiti od zračenja u nacionalnim mjeriteljskim institutima (NMI) iz zemalja u razvoju. Za zakonska mjerenja prema DIREKTIVI SAVJETA EU 2013/59 / EURATOM potrebna su sljediva mjerenja. Ovaj projekat će osigurati da svi učesnici u projektu imaju adekvatnu opremu i procedure potrebnu za mjerenje i procjenu izloženosti ljudi i radioaktivne kontaminacije okoliša. Osnovni cilj ovog projekta je da se uspostave i usklade procedure za kalibraciju dozimetara za zaštitu od zračenja u različitim poljima zračenja sa posebnim fokusom na postizanje mjerne nesigurnosti od 5% (k = 2) ili manje. Istraživački dio ovog projekta će se fokusrati na operativnu veličinu Hp(3) koja se odnosi na dozimetriju očnog sočiva te izradu sekundarnog etalona za direktno mjerenje ove veličine. Pored ovih glavnih ciljeva, nacionalni mjeriteljski instituti koji učestvuju će pripremiti pojedinačne strategije za razvoj mjeriteljstva u oblasti zaštite od zračenja koje će biti odobrene od strane EURAMET zajednice kako bi se osigurao koordiniran i optimiziran pristup.

Project description

EU COUNCIL DIRECTIVE 2013/59/EURATOM (laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation) requires to have the adequate equipment and procedures for measuring and assessing exposure of persons and radioactive contamination of environment, assure effectiveness of measurements and ensure regular calibration of measuring equipment. Establishing new or improving current calibration services in terms of

Tekst pripremila:

Amra Šabeta

Project start date and duration:

June 2018 - June 2021

Coordinator:

Amra Šabeta, IMBiH

Internal Partners:

IMBiH, Bosnia and Herzegovina

GUM, Poland

IRB, Croatia

IST, Portugal

PTB, Germany

SCK-CEN, Belgium

SMU, Slovakia

TAEK, Turkey

VINS, Serbia

External Partners:

EEAE, Greece

INM, Moldova

NSC-IM, Ukraine

USC, Spain

Unfunded Partners:

IJS, Slovenia

operational radiation protection quantities will make it easier for technical services to also fulfil the requirements of regulatory authorities for calibrations of radiation monitoring equipment. Radiation protection dosimeters are used to assess human exposure and environmental contamination due to ionizing radiation in a variety of settings, including hospitals and industry. To meet regulatory requirements, technical services across Europe need to be established or improved for the calibration of radiation monitoring equipment. By having facilities with trained staff, emerging National Measurement Institutes could deliver the traceable measurements needed and participate in the research activity. The International Commission on Radiation Units and Measurements (ICRU) has defined three operational quantities for external monitoring, in terms of area monitoring: *Ambient dose equivalent H*(d)* and *Directional dose equivalent H'(d)),* and in terms of individual monitoring: *Personal dose equivalent Hp(d)*. For the assessment of effective dose, a depth *d* = 10 mm is recommended, and for assessing equivalent dose to the skin, and to the hands and feet, a depth *d* = 0.07 mm. For the eye-lens dosimetry, a depth of 3 mm is recommended.

Control of patients' exposure to ionizing radiation, as well as of the exposure of personnel working with ionizing radiation in science, medicine or industry has been recognised as the most important need. The obligation of legal metrology and the dissemination of the standards obtained certainly leads to better radiation protection.

To address the stated needs, the following specific objectives are:

- To develop traceable measurement capabilities for operational radiation protection quantities, including the full characterisation of a measurement setup conversion procedure from air kerma (kinetic energy released per unit mass) to (H_p(0.07), H_p(3), H_p (10), H'(0.07), H'(3), H^*(10) operational quantities with an uncertainty of 5 % (k=2) or less. The applicable photon energy range and dose rate range are 5 keV - 7000 keV and 0.05 µSv/h to 100 Sv/h respectively.

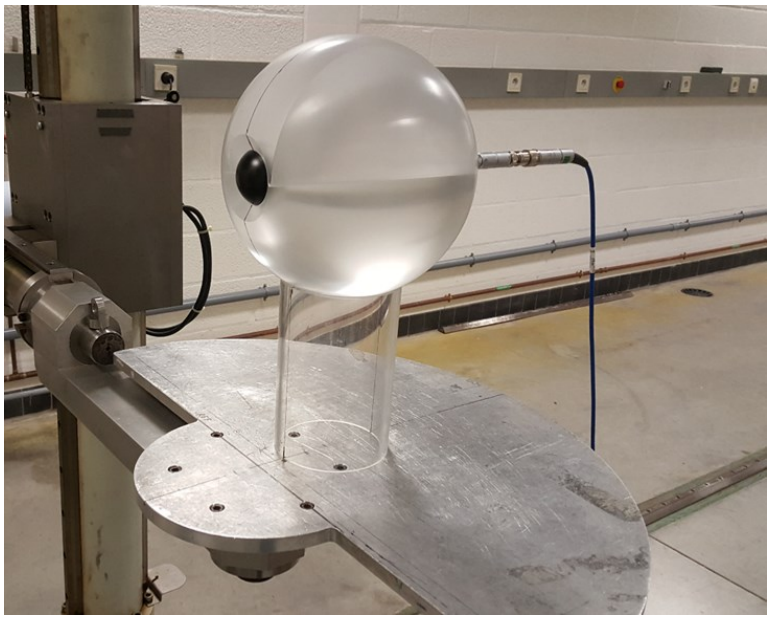
- To validate the developed measurement capabilities for the operational radiation protection quantities, to ensure that within an applicable energy range, from 5 keV to 7 MeV and dose rates, 0.05 µSv/h to 100 Sv/h, the accuracy of the dose measurement under well-defined calibration conditions has to be at least 5 % (k=2), by organising and undertaking a intercomparison in dosimetry, including activities related to travelling standards, technical protocols, logistical provisions, and the evaluation of intercomparison results.

Kick-off meeting

- To develop and submit the draft CMCs for the traceable calibration of dosimeters, thus proving the international equivalence of their measurement standards and the calibration and certificates that they issue.

- For the each partner, to develop an individual strategy for the long-term operation of the capacity developed, including possible regulatory support, research collaborations, quality control, the quality management system and accreditation. They should also develop a strategy for offering calibration services from the established facilities to their own country and neighbouring countries. The individual strategies should be discussed within the consortium and with other EURAMET NMIs/Dis.

The final outcome will be to set up measurement capabilities and a unified code of practice on the procedures for the measurement and secondary realisation of the operational radiation protection quantities, as this will enable harmonisation in the field, so that the services provided are comparable across Europe. Within this project, a methodology for the design of an *H*p(3) secondary standard ionization chamber is being developed, with the focus on measurements at the radiology departments. For the *H*p(3) secondary standard (ionization chamber) that will be calibrated in one reference beam quality, spectrometric measurements will not be necessary and thus no conversion coefficients from air kerma will be needed. Commercially available ionization chambers can be modified by adding a PMMA (polymethylmethacrylate) phantom around it, to account for the scattering effects, so that the chamber has a relatively constant response in terms of *H*p (3). Alternatively, extra scattering material introduced inside the ionization chamber can be used to compensate for the energy dependence of the *Hp(3)* operational quantity. This will enable the direct calibration of eye lens dosimeters in terms of *H*p(3). An extensive intercomparison exercise is organised, and laboratories will be able to prove and compare their measurement capabilities for the operational quantities that are most needed by all participants. A target uncertainty of 5 %, or less, and harmonised calibration procedures among participating laboratories will increase confidence in the measurements performed in the calibration laboratories. The knowledge gained will lead to improved measurement capabilities at the calibration laboratories and this will, in



Laboratory

turn, enable improvements to be made in radiation safety and in the health protection of workers exposed to ionizing radiation, as well as members of the public. The individual strategies, for the long term operation of the developed capacities, will lead to the provision of calibration services from the established facilities and this will ensure the sustainability of the activities undertaken. The partners with less developed laboratories will increase their research activities and will establish standards and methods for the calibration of radiation protection dosimeters at an acceptable international level. This project will benefit the industrial community, such as manufacturers of the secondary standard ionization chambers for eye lens dosimetry, as well as for the scientific community. It will also improve the accuracy of the measurements made by radiation protection dosimeters at the NMIs/DIs and this will have a direct impact on end users. Impact will be created for the partners as they will learn, through the research, how to design a *Hp*(3) secondary standard ionization chamber especially for use in the measurement of occupational exposure in medical applications of ionizing radiation. In particular, an improved secondary standard for eye lens dosimetry will be developed that is more suitable for use in the radiology departments of hospitals. T The design of the modified dosimeters will take into account the actual use in real practice.

EMPIR 17RPT02 RHOLIQ - ESTABLISHING TRACEABILITY FOR LIQUID DENSITY MEASUREMENTS

Sažetak

Projekat obuhvata realizaciju sljedivosti gustine tekućine. Cilj ovog projekta je uspostaviti sljedivost mjerenja gustine tekućine u nacionalnim mjeriteljskim institutima (NMIs), te razvoj ekspertize za primarnu realizaciju mjerne jedinice za gustinu tekućine na fundamentalnom instrumentu HID - Hidrostatički instrument za mjerenje gustine tekućina (opsega od 600 kg/m^3 do 1800 kg/m^3). Također, projekat obuhvata i uspostavljanje i potvrđivanje mjerne sposobnosti za određivanje gustine tekućine na sekundarnom nivou, koristeći metodu oscilirajuće U-cijevi, na ambijentalnoj temperaturi i visokom pritisku. Laboratorija za masu i srodne veličine Instituta za mjeriteljstvo BIH (LM IMBIH) ostvaruje učešće u interkomparacijama u okviru projekta na primarnom i sekundardnom nivou, koje će omogućiti potvrdu stepena ekvivalencije za mjerenje gustine tekućine. U konačnici, biće omogućeno priznavanje i demonstracija kompetencija kalibracionih i mjeriteljskih sposobnosti (CMC) u skladu sa CIPM MRA na primarnom i sekundarnom nivou. Projekat ima za cilj i pripremu prijedloga kalibracionih procedura, kao i prijedloga EURAMET vodiča za kalibraciju gustine tekućine. Putem projekta će se razviti pružanje usluga kalibracije i izvođenje mjerenja na najvišem nivou, te proizvodnja referentnih materijala za gustinu za potrebe klijenata iz prehrambene, kemijske, farmaceutske i naftne industrije. Ovaj projekat će olakšati usklađivanje s relevantnom EU direktivom 2007/45/EZ (utvrđivanje pravila o nominalnim količinama za pretpakirane proizvode), te će dodatno ojačati konkurentnost proizvodnih industrija u državama učesnicama.

Project description

The aim of this project is to support the build-up of the metrological capabilities in liquids density measurements of the emerging NMIs, enabling them to provide the high-level calibration and measuring services, as well density reference materials, to national and international stakeholders, with the lowest measurement uncertainty possible to achieve, when using the state-of-the-art density measuring systems. This will lead to the

Tekst pripremio:

Azmir Alić

Project start date and duration:

May 2018 - May 2021

Coordinator:

Andreia Furtado, IPQ

Internal Partners:

IPQ, Portugal

BEV-PTP, Austria

BRML, Romania

CMI, Czech Republic

DMDM, Serbia

GUM, Poland

IMBiH, Bosnia and Herzegovina

JV, Norway

PTB, Germany

TUBITAK, Turkey

External Partners:

INM, Moldova

Unfunded Partners:

Anton Paar, Austria

Kick-off-meeting of EMPIR rhoLiq project, PTB, May 2018

the international recognition of their density measurement capabilities, to the reinforcement of mutual confidence and cooperation at the regional and international level. The overall objective of this project is to develop the national metrological capacity in liquid density metrology for the less experienced partners, with the target of achieving the lowest measurement uncertainty possible when using state of the art density measuring systems and coverage of the quantities that influence the measurement of density, i.e. temperature and pressure, and viscosity. This will also include a review and upgrade of the existing capabilities and needs, validation of the existing systems and, if required, the development of new systems, with the support of the more experienced NMIs, for the density, temperature and pressure intervals that are relevant for scientific and industrial needs.

The rhoLiq project comprises the following main objectives:

- To develop the first-level liquid density measurement capabilities using the hydrostatic weighing method for the less experienced partners, at the atmospheric pressure, and in the temperature interval from 5 °C to 60 °C, with an uncertainty from 0.002 kg/m^3 to 0.005 kg/m^3.
- To develop the second-level liquid density measurement capabilities using oscillation-type density meters for the less experienced partners, for liquids with a dynamic viscosity of at least up to 2 000 mPa s (ideally up to 10 000 mPa s), in the temperature interval from 5 °C to 60 °C, at the atmospheric pressure, with an uncertainty from 0.01 kg/m^3 to 0.05 kg/m^3, and for pressures up to 600 bar, with an uncertainty from 0.1 kg/ m^3 to 0.5 kg/m^3.
- To establish the degree of equivalence of the density measurements performed by the emerging NMIs via comparisons of the first and second-level measuring systems that will be developed.
- To study the robustness of the first-level, i.e. hydrostatic weighing method, and the second-level, i.e. oscillation-type density meter, liquid density measurement methods regarding the influence of the liquid's physical properties: viscosity (from 1 mPa s to 10 000 mPa s); surface tension from 20 mN/m to 72 mN/m and viscoelasticity (behaviours other than Newtonian, such as yield point); and of independent properties (temperature (from 5 °C to 60 °C) and pressure (from atmospheric

Hydrostatic weighing instrument for primary realization of liquid density in LM IMBIH

pressure up to 600 bar).

- To develop the new guidance documents for the first and second-level liquid density measurement methods and for the production of certified reference liquids for use in density measurements, such as EURAMET guides and a good practice guide, for the metrological and industrial communities. To provide an input for the revision of relevant reference documents (ISO 15212, OIML Guide 14 and WELMEC Guide 6.4).

- To develop the emerging NMIs' individual strategies for the long-term operation of the capacity development, including: new/ upgraded measurement and calibration services; the production of certified reference liquids; the provision of training to disseminate the best practices in liquid density metrology; the provision of national metrological infrastructures and proficiency testing schemes to support accreditation bodies and field laboratories.

The early impact of this project on the metrological community is related to the opportunity for the less experienced/ emerging NMIs to establish/improve their liquid density measurement capabilities, for both the highest-level (hydrostatic weighing), as well for the secondary (oscillation-type density meters) methods. By the end of this project these less experienced NMIs will be able to establish a complete national density measurement traceability chain at the level needed by each participating country .These NMIs will have the opportunity to establish their degree of equivalence for the liquid density measurements by participating in the inter-laboratory comparisons, organised in the scope of this project, leading to their recognition and demonstration of competence in accordance with the CIPM MRA. This will increase the number of European CMCs that are available in the BIPM database regarding liquid density measurements by first and second-level methods, as well as fulfilling the paucity of CMCs for liquid CRMs for density. Building of measurement capabilities will empower the emerging NMIs to offer new/improved calibration services and CRMs, fulfilling the needs of national industries and services. Accredited bodies and calibration and measurement laboratories will benefit immediately from this by having access to the new national accreditation schemes. From the legal metrology point of view, these NMIs will be able to fulfil community obligations regarding the metrological control of the prepacked liquid products using their own density

traceability chain. The resulting impact of boosting liquid density metrology will lead to an increase in the protection of European citizens and the market, in terms of the legal metrological control of the quantity of commercial prepacked liquids, to support the European protection of products and enterprises against defrauders, and therefore this will have secondary effects such as boosting industrial competitiveness. At the end of this project, the scientific community will be able to enhance the coherence of liquid density measurements thanks to the improved traceability chains. This will be through a larger involvement of the participating NMIs in the BIPM working group on Density and Viscosity and in the EURAMET TC-M Subcommittee Density and Viscosity. This Committee will be updated on the outputs of the project and draft EURAMET guides.

Laboratory for Mass and Related Quantities of Institute of Metrology (LM IMBIH) is participating in inter-laboratory comparisons, organised within the scope of this project, as well as in all other project activities. This will lead to its recognition and demonstration of the laboratory competences in accordance with the CIPM MRA. LM IMBIH is going to realise the primary realisation of density unit in liquid density and to develop the calibration services on primary and secondary levels. LM IMBIH is in charge for maintanance of project website. Throughout this project, LM IMBIH will put in operation the HID (Hydrostatic weighing instrument) which was provided by IPA 2007.

EMPIR 17IND12 MET4FOF - METROLOGY FOR THE FACTORY OF THE FUTURE

Sažetak

Factory of the Future (FoF) je naziv za proizvodno okruženje gdje autonomni tok informacija i donošenja odluka stvara digitalnu transformaciju klasične proizvodnje kako bi se unaprijedila efikasnost i konkurentnost iste. Transparentnost, mogućnost poređenja i održiv kvalitet zahtijevaju pouzdane mjerne podatke, metode i rezultate. Ovaj projekat ima za cilj uspostavljanje mjeriteljskih okvira za kompletan životni ciklus mjernih podataka u industrijskoj primjeni: od kalibracionih mogućnosti za individualne senzore sa digitalnim unaprijed obrađenim izlazom, pa sve do procjene mjerne nesigurnosti popraćene "machine learning" u mrežama senzora. Osim toga, u projektu će biti urađena praktična primjena, što će biti osnova za daljnji razvoj u industriji. Sljedivost rezultata mjerenja, harmoniziran pristup mjernoj nesigurnosti i industrijski etaloni, standardi i vodiči su najveće komponente sveobuhvatne mjeriteljske infrastrukture koja je omogućava globaliziranu proizvodnju i trgovinu. Digitalizacija i obrada podataka sve brže mijenjaju sve aspekte ovakve proizvodnje. Primjeri za to bi bili pametni senzori koji se javljaju u industriji kao i mreže senzora koje se koriste zajedno sa "machine learning" algoritmima kako bi ostvarili automatizovanu proizvodnju i upravljanje proizvodnim procesom. Kombinacija ovih tehničkih elemenata upravo čini FoF, i doprinosi razvoju Industrije 4.0.

Project description

The "Factory of the Future" (FoF) as an inter-connected production environment with an autonomous flow of information and decision-making constitutes the digital transformation of manufacturing to improve efficiency and competitiveness. Transparency, comparability and sustainable quality, all require reliable measured data, processing methods and results. This project will establish a metrological framework for the complete lifecycle of measured data in industrial applications: from calibration capabilities for individual sensors with digital pre-processed output to uncertainty quantification associated with machine learning (ML) in industrial sensor networks. Implementation in realistic testbeds will also demonstrate the practical applicability and provide the templates for

Tekst pripremio:

Alen Bošnjaković

Project start date and duration:

June 2018 - June 2020

Coordinator:

Sascha Eichstadt, PTB

Internal Partners:

PTB, Germany

CEM, Spain

IMBiH, Bosnia and Herzegovina

INRIM, Italy

IPQ, Portugal

LNE, France

NPL, United Kingdom

TUBITAK, Turkey

VSL, Netherlands

External Partners:

SPEA, Italy

STRATH, United Kingdom

TU-IL, Germany

UCAM, United Kingdom

ZEMA, Germany

Unfunded Partners:

ITRI, Taiwan

future up-take by industry. Traceable measurement results, harmonised treatment of measurement uncertainties, and industrial standards and guidelines, are the major components of a comprehensive metrological infrastructure that has enabled globalised manufacturing and international trade. Digitalisation and data science are rapidly changing almost all aspects of this landscape: e.g. sensors are becoming smart, large networks of sensors are being used together with ML algorithms to make automated decisions and manage production processes.

The Met4FoF project comprises the following main objectives:

- To develop calibration methods for industrial sensors of dynamic measurements such as acceleration, force and pressure with digital data output (data streams) and internal digital pre-processing, including the extrapolation of the measurement uncertainty from individually calibrated sensors to other individuals of the same type by means of co-calibration and statistical modelling.

- To develop and demonstrate methods enabling digital sensors to provide uncertainty and/or data quality information together with the measurement data.

- To develop a cost-efficient in-situ calibration framework for MEMS sensors measuring ambient temperature for their integration into an industrial sensor network with the metrological quality infrastructure.

- To develop and assess data aggregation methods for industrial sensor networks based on machine learning and efficient software architectures, addressing synchronisation of measurements, making use of redundancies of measurements, taking into account uncertainty of calibration and network communication issues, including strategies for balancing cost versus uncertainty and explore methods to identify the measurement coverage and accuracy required for process output targets.

- To improve existing industry-like testbeds for sensor networks in manufacturing environments towards the implementation of a metrological quality infrastructure and to facilitate the take-up of the project outputs by the stakeholders, especially the manufacturing industry.

This project will impact all industries that apply sensor networks, with an early impact in particular for industries using digital sensors for monitoring mechanical quantities such as acceleration, force and pressure. The examples are monitoring of vibration, temperature and hydraulic pressure in the

Project Kick-off meeting

forming of materials or in precision positioning for high-value manufacturing. In the future, calibration of smart sensors will contain a "calibration" (possibly in the sense of validation) of the sensor's internal data pre-processing. The development of sensor concepts with built-in "Smart Traceability" in this project will lay the foundation for a new understanding of data analysis in the application of sensors. Existing standards for calibration of sensors, like the ISO 16063 series for the calibration of vibration and shock sensors, need to be revised and amended in order to account for digital output data streams. New requirements must be defined, the terminology has to be adapted and new approaches have to be established to deal with digitally pre-processed output data. Therefore, the consortium of this project will promote the results of the metrological framework for digital sensors within the standardisation community and provide input to the respective standardisation groups like ISO/TC 108 dealing with acceleration, force and pressure. This project will foster the development of the metrological infrastructure for the digital age by providing ready-to-use templates for dynamic calibration of digital sensors and validated data analysis procedures for the industrial IoT. Moreover, sensor networks subject to problems addressed in this project are widely used in weather prediction and for monitoring environmental conditions such as air pollution and water quality. In the medium term, the methods developed in this project will be disseminated to these sectors. Institute of Metrology of B&H is actively involved in the realization of the project objectives together with other project partners. Also, it will provide its expertise through the statistical data analysis, establishing traceability route for the digital sensors and establishing the measurement uncertainty budget for the sensor networks. These networks include the sensors with different measurement characteristics. During the project, Institute of Metrology of B&H will closely cooperate with the Faculty of Mechanical Engineering, Sarajevo, which is also a member of the project steering committee.

EMPIR 17NRM05 EMUE - ADVANCING MEASUREMENT UNCERTAINTY - COMPREHENSIVE EXAMPLES FOR KEY INTERNATIONAL STANDARDS

Sažetak

Advancing measurement uncertainty comprehensive examples for key international standards/Examples of Measurement Uncertainty Evaluation (EMUE) je naziv projekta koji ima za cilj dodati nove primjere u postupku proračuna mjerne nesigurnosti, naročito u oblastima koje nisu bile dovoljno pokrivene postojećim materijalima vezanim za proračun. Potreba za ovim projektom se, između ostalog, javila jer su postojale nejasnoće u interpretaciji i primjeni pravila za proračun mjerne nesigurnosti prema trenutnim GUM dokumentima. Uzimanje u obzir realno stanje kod nekog od primjera za proračun mjerne nesigurnosti prilikom izbora odgovarajuće metode uključuje sve češći odabir Monte-Carlo i Bayesian metoda, što je također jedan od razloga za ovaj projekat. Očekuje se da će rezultati ovog projekta uključivati više povjerljive vrijednosti mjerne nesigurnosti (ekonomsko poboljšanje u nekim oblastima), ispravnije vrijednosti doza nekih lijekova u medicini, harmoniziraniji pristup u postupku ispitivanja vremenskih promjena, unapređenje dokumenata standardizacijskih tijela, tehničkih komiteta i akreditacijskih tijela, te dobru povezanost s EU direktivama. Sumarno, očekuje se da će rezultati ovog projekta biti relevantni u smislu normativnih dokumenata u dužem predstojećem periodu.

Project description

This project provides a comprehensive set of worked examples illustrating the manner in which measurement uncertainty evaluation supports normative and related practices. It promotes the harmonized evaluation of measurement uncertainty according to the internationally recognized standards and guides across broad disciplines of measurement. It will provide new or improved examples to the Joint Committee for Guides in Metrology (JCGM), standards committees, and other bodies and end users, and so improve their use of accepted uncertainty principles. Reliable statements of uncertainty are needed in diverse areas of measurement such as environment, energy and quality of life. ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*, states that it should be ensured 'that the form of reporting of the result does not give a wrong impression of the uncertainty'. Thus, practitioners should pay appropri-

Tekst pripremio:

Vedran Karahodžić

Project start date and duration:

June 2018 - June 2022

Coordinator:

Maurice Cox, NPL

Internal Partners:

NPL, United Kingdom

BAM, Germany

IMBiH, Bosnia and Herzegovina

INRIM, Italy

IPQ, Portugal

LGC, United Kingdom

LNE, France

NEL, United Kingdom

PTB, Germany

SMD, Belgium

VSL, Netherlands

External Partners:

ACCREDIA, Italy

LNEC, Portugal

UKAS, United Kingdom

Unfunded Partners:

AIST, Japan

RR, United Kingdom

WADA, Switzerlands

-ate attention to evaluating and reporting uncertainty. Since many end users "learn by example", a diverse set of practical examples, ranging in complexity from the simple to the sophisticated, is required. International bodies that have stated their need for representative uncertainty examples are the JCGM and various ISO Technical Committees. In addition, a major European accreditation body, UKAS (United Kingdom Accreditation Service) and Eurachem (a network of European organisations having the objective of establishing a system for the international traceability of chemical measurements and the promotion of good quality practices) have requested examples to support their guidance documents and activities. Support for end users directly and via these bodies is urgently required to improve the quality of stated uncertainties, and thereby being positioned to take informed decisions based on measurement results. Industrial need includes uncertainty evaluation problems that cannot directly be tackled by applying the existing guidance given in the *Guide to the expression of uncertainty in measurement* (GUM), but need to be supported by methods of numerical simulation. Societal need includes ways in which uncertainty statements are made concerning cancer therapy and doping control, for instance.

The overall objective is to provide a comprehensive set of examples to illustrate the uncertainty evaluation according to the GUM and related suite of documents. The examples will be offered to the JCGM and its member organizations (BIPM, IEC, IFCC, ILAC, ISO, IUPAC, IUPAP and OIML) for use in the developing examples document JCGM 110, which will illustrate the application of the GUM suite of documents.

The EMUE project comprises the following main objectives

- To develop examples of the measurement uncertainty evaluations capable of acting as template solutions that end users can use for related problems. Examples will include measurement model construction, application of uncertainty evaluation principles for addressing industrial conformity assessments, and taking correlations into account as requested by ISO/REMCO, the ISO committee concerned with reference materials.

- To derive worked examples of uncertainty analyses using the GUM and other methods to assist users to make informed choices on an appropriate uncertainty evaluation method to use. Examples will include an examination of the extent to which the GUM is appropriate for certain applications or whether the Monte Carlo methods of GUM Supplements 1 and 2, or Bayesian methods, have greater efficacy.

- To collaborate with JCGM/WG1 (the chief stakeholder), and the standardization, regulatory and accreditation communities (ISO, IEC, OIML, and ILAC) to ensure that the outputs of the project are aligned with their needs,

communicated quickly, and in a form that can readily be incorporated into the JCGM Guides and other documents.

Accordingly, this project brings together NMIs and DIs, accreditation bodies and other organizations with excellent access to end-users' requirements. The project outputs constitute examples range from simple to sophisticated cases, which will be taken up by the JCGM for document JCGM 110 and in turn by JCGM member organizations (BIPM, IEC, IFCC, ILAC, ISO, IUPAC, IUPAP and OIML). International standards committees will implement examples in their standards in the near-term, with some supporting standards by uncertainty statements for the first time. Although this project will have the greatest impact on the relevant international standards and guides, attention is also paid to industrial and societal needs by involving a major European industrialist and an international regulator. A contribution on linking CIPM and RMO key comparisons would be made to JCGM document JCGM 109 and would be well received by CIPM Consultative Committees. The JCGM and its member organizations will benefit from the work, which will particularly lead to an enrichment of the examples document JCGM 110, the conformity document JCGM 106 and the interlaboratory comparison document JCGM 109. The project consortium is configured so that there will be specific influence on UKAS, Eurachem and ten ISO and CEN committees, which have made statements of need for improved examples. In relation to the further development of the GUM and related documents, the Secretariat of the ISO Technical Management Board (TMB) made a recommendation in September 2017, that a separate part in the series of JCGM uncertainty documents contain "detailed informative examples".

Application of the GUM's uncertainty principles is not uniform across disciplines and remains daunting to many end users.

Poster presentation of the EMUE project

The Institute of Metrology of B&H is actively involved in the realization of the project objectives together with other project partners. IMBIH brings in expertise on uncertainty evaluation, using statistical methods, such as Monte Carlo method and the Bayesian approach, and will be included in activities that refer to different types of calibration, measurement models involving additive and multiplicative corrections, example in the area of electrical power, evaluation of uncertainty for hardness testing methods. Also, IMBiH, with assistance from LNE, NPL and VSL, will organize a training course for the Western Balkan Countries with a special focus on selected examples elaborated during the project. The emphasis will be on the uncertainty evaluation methods appropriate in various disciplines and the manner in which the examples can be adapted to other applications. The relationship to relevant guides and standards will be emphasized. During the project, the Institute of Metrology of B&H will closely cooperate with the Institute for Standardization of B&H, which is also a member of the project steering committee.

THE EUROPEAN METROLOGY CLOUD

Saţetak

"The European Metrology Cloud" (EMC) je jedan od tri strateška projekta koji su predloženi u okviru Evropskog programa za istraživanje i inovacije u području mjeriteljstva (EMPIR) iz oblasti digitalizacije u mjeriteljstvu, a koji su koordinirani od strane Instituta za mjeriteljstvo Njemačke (PTB). Jedan od primarnih ciljeva projekta će biti prelazak iz analogne infrastrukture kvaliteta u digitalnu, čime će biti povećano povjerenje korisnika u procese zakonskog mjeriteljstva. Jedinstveno digitalno tržište u Evropi može donijeti veliku ekonomsku korist, pa je Evropska komisija objavila digitalnu strategiju "Digital Single Market Strategy" za EU kako bi ubrzala procese vezane za digitalizaciju, kao što su: Cloud Computing, Big Data Analyses, Open Science Cloud, itd. Putem projekta kreirat će se pouzdana mjeriteljska platforma s namjerom da olakša regulatorne procese objedinjavajući postojeće infrastrukture, kao i baze podataka, tako da će svi podaci biti dostupni na jednom mjestu. Pristup platformi će imati sve strane koje učestvuju u realizaciji infrastrukture kvaliteta čime će se znatno olakšati implementacija principa zakonskog mjeriteljstva, i dodatno osnažiti njegova pozicija kod krajnjih korisnika. Prvi rezultati projekta poslužit će kao osnova za zasebne državne platforme koje će imati za cilj da uključe sve zainteresovane strane iz oblasti zakonskog mjeriteljstva u njihovoj zemlji, te da omoguće korištenje digitalnih usluga. Ove nacionalne platforme kasnije će biti kombinovane sa prethodno uspostavljenom platformom koja će biti koordinirana od strane upravljačkog odbora članica projekta.

Project description

Today, measuring instrument sensors are often fully developed within the scope of the required measurement accuracy. New business and service models will therefore address the individual customer requirements which are based on user data and data collected in the field. Consequently, the need to offer data-based services and business models – for example, based on big data processing schemes – will increase. Unfortunately, it is felt by the European manufacturers' associations that the implemented processes within the quality infrastructure hamper the use of technological breakthroughs providing new

Tekst pripremila:

Merima Čaušević

Project start date and duration:

June 2018 - June 2022

Coordinator:

Florian Thiel, PTB

Internal Partners:

PTB, Germany

LNE, France

NPL, United Kingdom

METAS, Switzerland

RISE, Sweden

BEV, Austria

CEM, Spain

IMBiH, Bosnia and Herzegovina

CMI, Czech Republic

IPQ, Portugal

External Partners:

NSAI, Ireland

TU Berlin, Germany

AQUA, EU

CECIP, Belgium

CECOD, EU

FARECOGAZ, Germany

VDMA, Germany

Sartorius AG, Germany

Diehl Metering, Germany

Bizerba, Germany

Espera-Werke GmbH, Germany

Itron, USA

Gilbarco Veeder-Root - Europe

hamper the use of technological breakthroughs providing new products, to exploit the technological potential to streamline the processes, and to develop new data based business models. Exemplarily, the manufacturers' associations envision marketing concepts based on innovations which are driven by technologies that have matured significantly over the past ten years. Hence, the transition from an instrument with locally concentrated parts towards a distributed hardware and cloud-located stored data, data based services and virtualized processing software. To foster the digital transformation in legal metrology, Germany's National Metrology Institute (PTB) has initiated the development of a coordinated European digital quality infrastructure for innovative products and services, called the "European Metrology Cloud". Its foundation lies in a trustworthy metrological core platform in each Member State, designed to support and streamline regulatory processes by joining the existing infrastructures and databases and to provide a single point of contact for all stakeholders. Within this digital quality infrastructure, reference architectures, i.e. innovative measuring instruments, as well as technology- and data-driven digital services for legal metrology will be provided. The early outcomes of this initiative will be the demonstrators to serve as blueprints for the individual national platform to attract further stakeholders and services to be integrated. These first results could be used to support or even initiate processes to "future-proof" national and European legislation. These national platforms can later be combined via coordinating platform established and maintained by the board of Member States' representatives, authorities and industrial stakeholders.

The EMC project comprises the following main objectives:

- To develop the trustworthy metrology "core" platform (TMC-platform) for the EMC. This platform will serve to implement the digital concepts for the coordination, concentration, simplification, harmonization and quality assurance of metrological services for the Member States and all parties involved.

- To provide and distribute knowledge via broadly applicable general reference architectures specifically for the new and complex technologies fitting the needs of all stakeholders. The reference architectures will undergo an adequate risk assessment as required by the Directives (2014/32/EU) and (2014/31/EU).

- To develop a digital representation of the measuring instrument. The digital representation is a hierarchical database hierarchical database which should contain administrative data, information about processes, collects data, evaluates data, disseminates data and initiates actions if certain conditions are fulfilled.

Metrology Cloud Kick-off Workshop

- To develop data-based services for legal metrology, a theoretical approach is taking advantage of the available data sources created by all stakeholders.

The reference architectures, which will be developed within the course of the initiative, will offer the European Notified Bodies the solutions, which are in line with the legal framework, and provide market surveillance with easy verification methods to support their tasks without the need of in-depth expertise in the method. Secondly, market surveillance and verification authorities will also gain improved services from the platform, which will avoid high costs, and downtime associated with the verification and in-service control of the instruments abroad. The industrial project partners or collaborators are the most direct and immediate uptakers. They will incorporate the outcome in their current and future work, spreading it to their customers and users. The initiative is designed so that the relevant standardization committees for software in legal metrology (WELMEC WG 7 Software and OIML TC 5/SC 2 Software) will be informed about its progress. Furthermore, this project actively promotes the circulation of the following fundamental European and international guidance documents for software and ICT: WELMEC 7.2:2015 Software Guide and OIML D 31:2008 General requirements for software controlled measuring instruments.

Institute of Metrology of Bosnia and Herzegovina as part of the European Metrology Network Digitalization (EMN-MD4) will support and contribute to development of overall metrology digitalization infrastructure across the Europe. In this way, IMBiH will support the objectives of EMC and realization of the metrological platform, but at the same time it is the individual national platform.

EMPIR 18RPT02 ADOSSIG - DEVELOPING AN INFRASTRUCTURE FOR IMPROVED AND HARMONISED METROLOGICAL CHECKS OF BLOOD PRESSURE MEASUREMENTS IN EUROPE

Sažetak

Hipertenzija (povišeni krvni pritisak) uzrok je jednog od osam smrtnih slučajeva u svijetu, a u mnogim evropskim državama pogađa skoro polovinu stanovništva. Tretman hipertenzije je moguće vršiti samo ukoliko je postavljena tačna dijagnoza. Važeći standardi i preporuke koje definišu uslove ispravnog rada i ispitne metode za mjerila krvnog pritiska (sfigmomanometre) utemljeni na statičkom pritisku uredno karakterišu mjerila sa mehaničkim principom rada. Za automatizirane uređaje ispitne i kalibracijske metode definisane ovim dokumentima služe samo za provjeru zadovoljavajućeg rada senzora pritiska, jer se statički pritisak znatno razlikuje od stvarnog dinamičkog krvnog pritiska kojem su uređaji izloženi tokom upotrebe. Prema tome, ispitne metode zasnovane na statičkom pritisku ne daju pravu sliku o ispravnosti očitanja krvnog pritiska. Projekat „Developing an infrastructure for improved and harmonised metrological checks of blood-pressure measurements in Europe“ (adOSSIG) usmjeren je na povećanje pouzdanosti i tačnosti mjerenja krvnog pritiska razvijanjem naprednog generatora signala krvnog pritiska i uspostavljanjem novih kalibracionih metoda i usluga u oblasti mjerenja krvnog pritiska. U cilju bolje zdravstvene zaštite stanovništva evropskih država, projekat teži ka uspostavljanju evropskog centra /mreže u oblasti medicine u mjeriteljstvu.

Project description

A common factor in Central and South-Eastern Europe is that national laws require periodic metrological checks for measuring medical devices, and many of the national and designated metrology institutes (NMIs/DIs) in these countries lack either the resources, or the research know-how, or both, to cope with the new technical developments in the field of measuring medical devices in general and blood pressure measurements in particular. Also, professional medical communities recommend such periodic controls. The overall aim of the project is to progress beyond the current state of the art in blood pressure (BP) metrology and develop new advanced BP oscillometric signal generator (aOSG) - a device capable of accurately reproducing pre-recorded real-life oscillometric data, to

Tekst pripremila:

Šejla Ališić

Project start date and duration:

June 2019 - June 2022

Coordinator:

Václav Sedlák, CMI

Internal Partners:

CMI, Czech Republic

BEV-PTP, Austria

GUM, Poland

IMBiH, Bosnia and Herzegovina

IPQ, Portugal

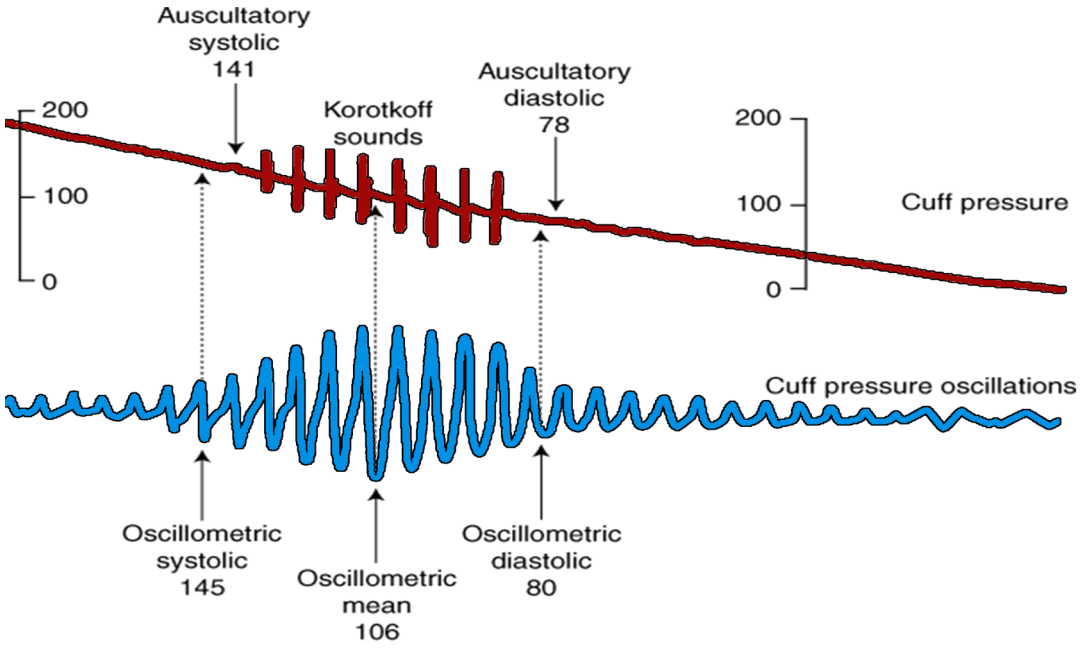
NSAI, Ireland

PTB, Germany

SMU, Slovakia

External Partners:

UL, Slovenia



Range for oscillometric signals

develop tool and methods for calibration of this and similar devices in order to make the BP measurements more accurate and reliable.

Unlike its commercially available counterparts, the aOSG will not replay the same signal (or set of signals) again for every tested device, but will rather create unique signal for each tested sphygmomanometer taking into account the dynamic variables like deflation rate, cuff size etc. The development of aOSG will be accompanied by development of the test procedures for sphygmomanometer testing and dynamic pressure calibrations with the aOSG.

Parallel to the development of the aOSG, there will be substantial part of the project focused on development and implementation of smart specialisation concept for traceable oscillometric BP measurement and research in Europe. The smart specialisation concept will create a network of NMIs/DIs and universities, that will be able to support and advice BP metrology in Europe at all levels of the system, from manufactures, through test offices and laboratories, market surveillance bodies to end-user, the medical community and patients. In addition with the unified approach to the BP metrology among the members of the consortium and established contact to stakeholders, this network can be incorporated into emerging European centre for medicinal metrology.

Project objectives:

- To develop an aOSG, including a recording unit, with the capability of accurately reproducing pre-recorded real-life oscillometric BP pulses.
- To define the necessary requirements and test procedures for such an aOSG to be acceptable as a reference standard and hence as a means to establish the traceability for the automated sphygmomanometers.
- To develop a procedure for the periodic recalibrations of such aOSG at the NMI level, including defining acceptable uncertainty limits which should be ±1.5 mmHg or better.
- To engage closely with regional and European stakeholders, including regulatory and governmental bodies, medical experts, professional medical societies, standards developing organisations, metrological committees and device manufacturers to ensure that all medical, legal and metrological requirements are met.

- To develop and implement a concept for smart specialisation in the field of traceable BP measurements and to integrate this concept with similar ones for other medical devices. The smart specialisation should aim at the establishment of a single joint research capacity.
- To develop a strategy for the perpetuation and sustainability of this new capability and a strategy for offering calibration and research services to national or international customers including NMIs/DIs.

The manufacturers and distributors of sphygmomanometers will deal with a homogeneously developed market which is ready to absorb the newest trends. A well-developed metrological infrastructure provides them with clear guidance, and hence legal certainty, on how the requirements can be met,

Physicians, medical staff and their organisations will be able to rely on a clear compliance, a correct traceability chain, correct measurement results and validated methods. Patients in clinics and practitioner offices, but also increasingly in home-care settings, will have more confidence in the displayed BP values, because the improved infrastructure will allow the surveillance bodies and other legal entities to ensure adequate quality on the market.

The required accuracy of automated sphygmomanometer in a clinical trial is ±5 mmHg, but a consistent over- or underestimation of measured BP values by 5 mmHg would alter the number of diagnosed patients by 30% in either direction. At the end of the project, an advanced aOSG will exist with uncertainty of better than ±1.5 mmHg and a dynamic traceability chain to serve all BP simulators will be established. It can thus be ascertained that the initial ±5 mmHg uncertainty of sphygmomanometers can be maintained without deterioration over the whole production and lifetime cycle of the device; a guarantee which cannot possibly be given today.

Cautiously assuming that for only 1% of the patients a hypertension misdiagnosis can be avoided in the future by traceable, dynamic recalibrations utilizing certified simulators, the direct benefits of the project can be quantified as:

- 2 million EU citizens who will be spared a false positive or false negative diagnosis,
- 370 M € per year which will be saved for the EU healthcare systems by avoiding the costs for unnecessary medication of healthy subjects and the even higher costs for undetected and untreated hypertension (estimated from 196 B €/a total costs for cardiovascular diseases in the EU in 2009, 53% of which are treatment costs, and a 36% share for hypertension treatment).

Through this project, the Institute of Metrology of B&H will work on the investigation of the dynamic properties of the aOSG and its recording unit, formulation of the model uncertainty and definition of limits for maximum permissible errors of aOSG and recording unit calibration. IMBIH is in charge to lead the preparation of the deliverable document: Uncertainty model for the aOSG and recording unit calibration. Participation in the following project gives us an opportunity for further improvement and development of the knowledge that is applicable in both pressure metrology and medical devices with measuring function.

EMPIR 18RPT03 METFORTC - TRACEABLE MEASUREMENT CAPABILITIES FOR MONITORING THERMOCOUPLE PERFORMANNCE

Sažetak

Novi EMPIR projekat u oblasti mjerenja temperature će početi 1. juna 2019. godine i trajati će do 31. maja 2022. godine. Koordinator ovog projekta je turski mjeriteljski institut TUBITAK UME, a osim Instituta za mjeriteljstvo BiH u projekat su uključeni još 8 evropskih instituta (BFKH, BIM, BRML, CMI, FSB, JV, INM i MER). Opšti cilj ovog projekta je razviti nove naučne i tehničke mogućnosti koje omogućavaju diseminaciju međunarodne temperaturne skale iz 1990. (ITS-90), na osnovu merenja sa termoparovim, koji je najčešće korišten instrument za merenje temperature u industriji. Ovaj cilj će biti postignut razvojem novih praktičnih metoda i uređaja (kao što su npr. dvostruki termometri) za provjeru drifta termoparova u mjestu ugradnje i jednostavnih za upotrebu minijaturnih ćelija za određivanje nehomogenosti termoparova za primarne i sekundarne kalibracione laboratorije. IMBiH je u ovom projektu vođa radnog paketa za IMPACT. IMBiH će kroz WP Impact biti odgovaran za aktivnosti vezane za: izradu webstranice projekta, blagovremeno izvršavanje planiranih obuka, radionica, predstavljanje aktivnosti projekta na različitim konferencija i pisanje naučnih radova u ovoj oblasti.

Project description

EMPIR 18RPT03 MetForTC "Traceable Measurement Capabilities for Monitoring Thermocouple Performance" is a new EMPIR project that will start in June 2018. The general aim of this project is to develop novel scientific and technical capabilities providing both the dissemination of the International Temperature Scale of 1990 (ITS-90), which is an important concept in both developed and emerging NMIs/DIs, and the accurate low uncertainty temperature measurements by thermocouple, which is the most frequently used temperature sensing instrument. This objective will be achieved by developing novel practical methods and devices (such as dual-type thermometers and heater arrays) for checking thermocouple drift performance in-situ and easy-to-use integrated miniature cells to determine the inhomogeneity of thermocouples for primary and secondary calibration laboratories.

Tekst pripremio:

Semir Čohodarević

Project start date and duration:

June 2019 - May 2022

Coordinator:

Narcisa Arifovic, TUBITAK

Internal Partners:

TUBITAK, Turkey

BFKH, Hungary

BIM, Bulgaria

BRML, Romania

CMI, Czech Republic

FSB, Croatia

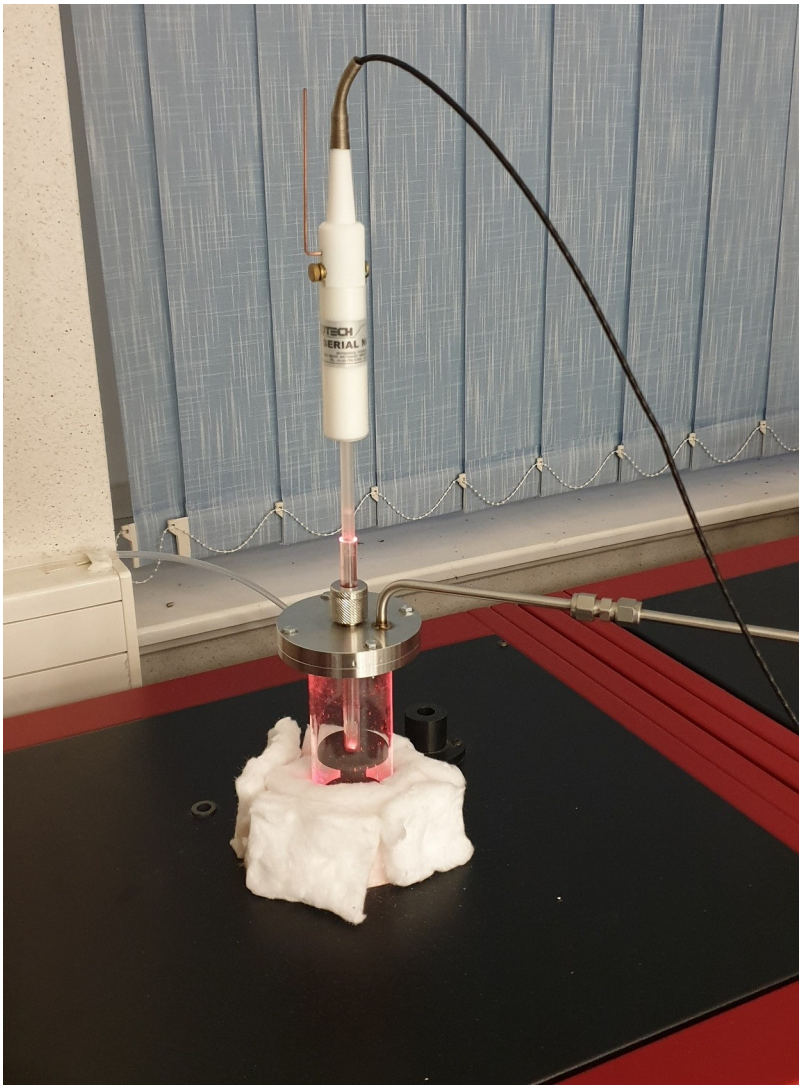
IMBiH, Bosnia and Herzegovina

JV, Norway

External Partners:

INM, Moldova

MER, Montenegro



Work with fixed point cells

The industry need in this field lies in assuring and improving the quality of products, maximising process efficiency and optimising energy management for processes operating in the range from 232 ° C to 1100 °C. Thermocouple performance is critically dependent upon the uniformity of the physical and chemical properties along the length of the thermo element. With the use, thermocouples lose homogeneity through heat, chemical exposure, or mechanical damage, causing the measured voltage to differ at the same temperature, resulting in error and severely reducing the temperature measurement accuracy. For the high precision calibration, primary and secondary calibration laboratories are required to determine the inhomogeneity of thermocouples while performing their calibrations. Unfortunately, standardised, easy-to-use methods and devices are not currently available for the task. At the level of primary laboratories, new and extended traceable measurement methods and devices that will provide confidence in the verification the thermocouple performance are needed. Knowledge of the lifetime and drift of the thermocouples in industrial applications are not very well known, and usually thermocouples are replaced periodically to ensure the continuity in maintaining process control at an optimal level. However, it can often be very difficult for the user to detect the inadequate thermocouple performance. There are no standardised traceable measurement capabilities for the verification of the performance of the thermocouples in-situ. The stability, homogeneity, and drift of the thermocouples

have been addressed in several EMRP and EMPIR projects: 14RPT05 Eura-Thermal, 14IND04 EMPRESS, SIB10 NOTED, etc. However, more comprehensive work on this topic is still required. This project will develop novel methods and techniques, traceable to the ITS-90 that will significantly improve knowledge on drift and homogeneity, as well as confidence in the verification of the thermocouple performance for primary and secondary calibration laboratories. Eventually, it will lead to a decrease in the uncertainty of the measurement of temperature by the thermocouple and, as a result, the efficiency of industrial processes will be increased. The objective of the research is to develop novel methods and techniques that will significantly improve knowledge and facilities for the verification of the thermocouple performance for primary and secondary calibration laboratories. Special attention will be paid to the methodology on drift and homogeneity tests.

Project objectives are:

- To develop and test novel methods and devices for the monitoring of thermocouple drift in-situ in the temperature range up to 1100 °C. These methods will be suitable for implementation in the critical industrial processes in order to assist the users in maintenance and replacement decisions.

- To develop and test easy-to-operate methods and instruments for the assessment of inhomogeneities of the thermocouples for secondary calibration laboratories in the temperature range from 230 °C to 1100 °C.

- To design and construct novel measurement facilities that can provide confidence in the verification of the thermocouple performance and to identify and quantify the range of drift of the thermocouples. The new facilities, targeting primary calibration laboratories, should have the ability to measure the physical changes and behaviour of the thermocouples under the typical conditions of production and distribution processes with a target uncertainty of less than 1.5 °C.

- For each participant, to develop an individual strategy for the long-term operation of the capacity developed, including regulatory support, research collaborations, quality schemes and accreditation. They will also develop a strategy for offering calibration services from the established facilities to their own country and neighbouring countries.

The consortium consists of leading European NMIs/DIs and emerging NMIs/DIs in the field of temperature in a complementary metrology structure. The leading NMIs/DIs of the consortium (TUBITAK, FSB, BKHF, CMI and JV) have the significant experience and excellence in the area of temperature measurements and research. On the other side, the emerging NMIs/DIs have adequate equipment to carry out the project, but limited experience and existing capabilities, particularly in temperature related research. Collaboration between those partners that are less experienced in research (IMBiH, INM, BRML, BIM and MER) and those that are more experienced and developed will develop the former's metrology capabilities and infrastructure for the traceable temperature measurements, which will support their participation in the future research projects. Another important characteristic of this project is to develop scientific and technical capabilities in thermal measurement in a number of European countries that currently have limited metrology capacity (beneficiary partner countries). The partners will work together developing and thus homogenising their competence and capacity. TUBITAK, FSB, BFKH, CMI and JV will share their existing knowledge and expertise among consortium members and will work in strong linkage together with IMBiH, INM, BRML, BIM and MER on the development, construction and characterisation of platinum based thermocouples and miniature fixed points that will provide reliable calibration capabili-

-ties for the thermocouple calibrations. IMBiH's main research activities are oriented to the new fields of fundamental metrology, especially to the contact thermometry and hygrometry. The Institute has taken part in various EMRP and EMPIR projects related to the temperature and humidity research and coordinates the 15RPT03 HUMEA. In this project, IMBiH will improve its capabilities for traceable thermocouple measurements and determination of homogeneity of thermocouples. IMBiH will lead the impact WP, drawing on its experience of coordinating the 15RPT03 HUMEA.

EMPIR 18HLT05 QUIERO - QUANTITATIVE MR-BASED IMAGING OF PHYSICAL BIOMARKERS

Sažetak

Snimanje magnetnom rezonancom (eng. Magnetic Resonance Imaging - MRI) predstavlja jedan od najvažnih tomografskih alata u kliničkoj praksi. U državama članicama EURAMET-a se izvrši preko 30 miliona MRI snimaka godišnje. Rezultati dobiveni MRI tehnologijom su većinom kvalitativne prirode (tj. prikazuju kontrast između obuhvaćenih tkiva) i analiziraju se vizuelno, što ograničava objektivnost u interpretaciji i mogućnost njihove komparacije. Projektom se nastoji evaluirati upotreba dvije komplementarne tehnike zasnovane na MRI tehnologiji – Electric property Tomography (EPT) i Magnetic Resonance Fingerprinting (MRF) uz mjeriteljsku karakterizaciju njihovih performansi. Nedostatak informacija o nesigurnosti rezultata dobivenih ovim metodama značajno umanjuje njihovu pouzdanost kao dijagnostičkih alata. Stoga, da bi se medicinskoj zajednici obezbijedio nivo povjerenja pridružen rezultatima EPT i MRF metoda, potrebno je izvršiti sistematičnu i progresivnu mjeriteljsku analizu, uključujući preciznost, ponovljivost, reproducinilnost i uticaj buke. Povezivanje svakog piksela slike sa rezultatima mjerenja (uključujući nesigurnost) jednog ili više parametara tkiva predstavlja kvantitativnu revoluciju MRI tehnologije.

Project description

Due to the interest towards the subject, a number of implementations of both EPT and MRF algorithms appeared in the scientific literature of the last few years. However, in most cases the authors of the computational codes that perform the EPT/MRF reconstruction have the full ownership and exclusive use of them; in particular, no software for EPT results is publicly available at present, neither as a freeware, nor under a commercial license. For these reasons, the consortium will select and implement its own codes, which will be fully under control. This will allow to compare the performances of different EPT/MRF approaches exactly in the same conditions and, thanks to suitable virtual experiments, to characterize such approaches against a completely known ground truth. The project aims at overcoming the specific technical challenges of these methods, producing: 1) MRF procedures designed to face the presence of the heart

Tekst pripremila:

Ehlimana Jugo

Project start date and duration:

June 2019 - June 2022

Coordinator:

Luca Zilberti, INRIM

Internal Partners:

INRIM, Italy

IMBiH, Bosnia and Herzegovina

LGC, United Kingdom

LNE, France

PTB, Germany

TUBITAK, Turkey

External Partners:

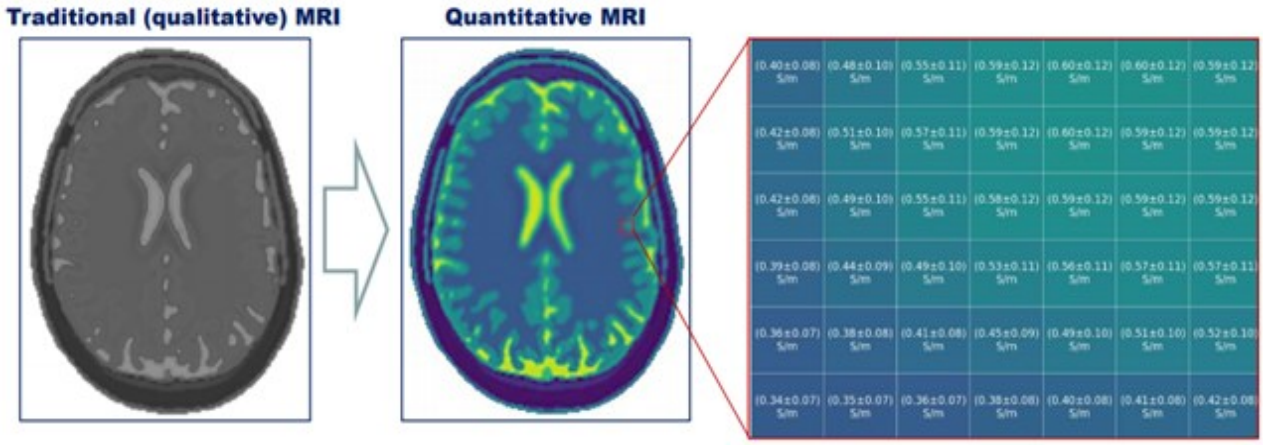
CHARITE, Germany

SM, Italy

TUD, Germany

UL, Slovenia

UNITO, Italy



Example of electrical conductivity mapping

motion and novel dictionary-free MRF approaches that do not show any heart-rate dependency; 2) more efficient EPT implementations, where the (typically limited) information about the phase of the RF magnetic field is properly managed. In addition, the project will explore the possibility to "hybridize" the two techniques, for instance using MRF as a fast method to measure the magnetic field distribution required to perform EPT. During the project lifetime, specific attention will be devoted to tissue mimicking materials (TMM) preparation techniques that allow mimicking realistic tissue properties (including the presence of a pathology within a healthy background), as well as to the realization of anthropomorphic phantoms through the 3D printing technology. In addition, the possibility to exploit the artificial intelligence (AI) to interpret automatically the values and distribution of each biomarker (or a combination of them) in the scanned slice will be deeply explored.

Project objectives:

- To develop, improve and implement numerical algorithms for use in EPT and MRF and to characterize their performances. For EPT, both local relationships and global inversion methods will be considered and compared; for MRF, statistical template-free methods will be evaluated as an alternative to traditional dictionary-based techniques.
- To make EPT and MRF suitable for practical use in the analysis of "high impact" clinical conditions. Basic EPT techniques will be improved to handle the partial knowledge of the phase of the magnetic field and mainly applied to the analysis of diseases that cause significant changes in dielectric properties (e.g. cerebral ischemia). The application of MRF will be extended to the heart region through methods able to suppress artefacts caused by physiological motion and moving fluids.
- To evaluate the accuracy of EPT and MRF procedures in magnetic resonance experiments under controlled conditions. Heterogeneous phantoms, composed of soft semi solid materials mimicking the properties of human tissues (e.g. conductivity, relative permittivity, longitudinal and transverse relaxation times), will be specifically developed and used for this purpose. The target uncertainties required are 20 % for EPT and 10 % for MRF.
- To fully characterise EPT and MRF as diagnostic tools under real-world conditions, including determining, for a selection of pathologies, the frequency of occurrence of false positives/negatives. The variability of tissue properties will be taken into account and advanced statistical techniques and in vivo assessments

will be applied. The synergistic use of EPT and MRF should be explored to optimise diagnosis and specific computer-aided diagnostics approaches should be developed.

- To facilitate the take up of the technology and measurement infrastructure developed in the project by the measurement supply chain (accredited laboratories, MRI manufacturers), the relevant technical committees and end users (e.g. hospitals and health centres).

The medical community will receive a quantification of the reliability of EPT and MRF, becoming aware of their actual suitability as diagnostic tools. MR-based quantitative imaging will boost early disease detection, which is considered a fundamental element to increase survival rates, as emphasised, for example, by the European Code Against Cancer. Besides their intrinsic value for the detection and monitoring of pathologies, fast and quantitative MRI methods will also cut down the use of (unnecessary) invasive procedures, like biopsies, reducing patients' stress (as well as the corresponding cost for the healthcare system).

For the researchers working on the development of the new EPT and MRF approaches, the project will provide a comprehensive and systematic example of characterization of these techniques, from the intrinsic accuracy of the algorithms to their sensitivity and specificity. Most participant NMIs belong to MATHMET, the European Centre for Mathematics and Statistics in Metrology, for which the project will represent an opportunity to cooperate on hot topics, like the analysis of uncertainty propagation through very complex and multivariate processes (in particular, through Bayesian approaches) and the adoption of artificial intelligence to manage critical decision-making situations and big data. The contribution given by the NMIs to the development of quantitative MRI will pave the way towards new calibration services, fundamental to guarantee the traceability of the measurements associated with the imaging process. Considering that the total annual cost of the MRI investigations for the European healthcare system is in excess of 3 billion €, each percentage point of avoided scans will allow saving more than 30 million € every year. The transformation of MRI into a quantitative instrument, together with the availability of characterized phantoms, will allow assessing the stability of the performances of the scanners, with possible extension of their working life, which represents an advantage from both the economic and environmental viewpoints.

This project will improve IMBiH's knowledge and experience in the fields of modelling, data analysis, uncertainty quantification with specific reference to competences in metrology for the sector of health. IMBiH will participate in identification of the most accurate, precise and robust EPT algorithms and assessment of the input parameters obtained from the MRF approaches. These parameters will be verified in terms of required accuracy and precision. Also, an analysis of repeatability and reproducibility of the MRF experiments will be performed.

EMPIR 18HLT07 MEDALCARE - METAROLOGY OF AUTOMATED DATA ANALYSIS FOR CARDIAC ARRHYTHMIA

Sažetak

Kardiovaskularne bolesti su najrelevantnije i epidemološki najznačajnije neprenosive bolesti u Evropi. American Heart Association (AHA) je uspostavila listu od 83 kardiovaskularne abnormalnosti za koje je potrebna adekvatna stručnost. Aritmije su jedan od glavnih uzroka srčanog i moždanog udara, sa rastućim brojem pacijenata u svijetu, posebno u Evropi. Za ispravnu dijagnozu takvih stanja, ECG (elektrokardiografija) je ključan. ECG predstavlja neinvazivno i isplativo sredstvo za inicijalni pregled i nadzor pacijenata. ESC (Guidelines of the European Society of Cardiology) naglašava važnost nadzora uz pomoć ECG-a za atrijalnu fibrilaciju. Alati za automatsku analizu su potrebni za detekciju i klasifikaciju epizoda ishemije i aritmije. Buduća telemedicina i kućni nadzorni system će povećati potrebu za automatskom i validiranom ECG analizom.

Ovaj projekat će početi u julu 2019, u sklopu Evropskog mjeriteljskog programa za inovaciju i istraživanje (EMPIR), i trajat će 36 mjeseci. Cilj ovog projekta je da se razviju nove strategije validacije algoritama za klasifikaciju srčane aritmije zasnovane na više- parametarskoj analizi podataka kroz mjeriteljsko istraživanje. Nova sintetička referentna baza podataka će biti razvijena, koja će omogućiti istraživanje nesigurnosti modernih pristupa analizi podataka, kao što je machine learning u medicini, i također će doprinijeti standardizovanju metoda machine learninga za primjene u zdravstvu, posebno uspostavljanjem nove mjeriteljske platforme za validaciju takvih algoritama koji predstavljaju digitalni lanac sljedivosti.

Project description

Cardiovascular disease (CVD) is the most relevant and epidemiologically significant non-communicable disease in Europe. The American Heart Association (AHA) has established a categorical list of 83 cardiovascular abnormalities requiring an adequate expertise. Arrhythmias remain one of the major causes of sudden cardiac death and stroke with the rising number of patients worldwide and especially in Europe. For diagnosis of such conditions, electrocardiography (ECG) is essential. It is a non-invasive and cost-effective tool for the initial examination and

Tekst pripremila:

Esma Musić

Project start date and duration:

July 2019 - July 2022

Coordinator:

Tobias Schaeffter, PTB

Internal Partners:

PTB, Germany

IMBiH, Bosnia and Herzegovina

LNE, France

NPL, United Kingdom

External Partners:

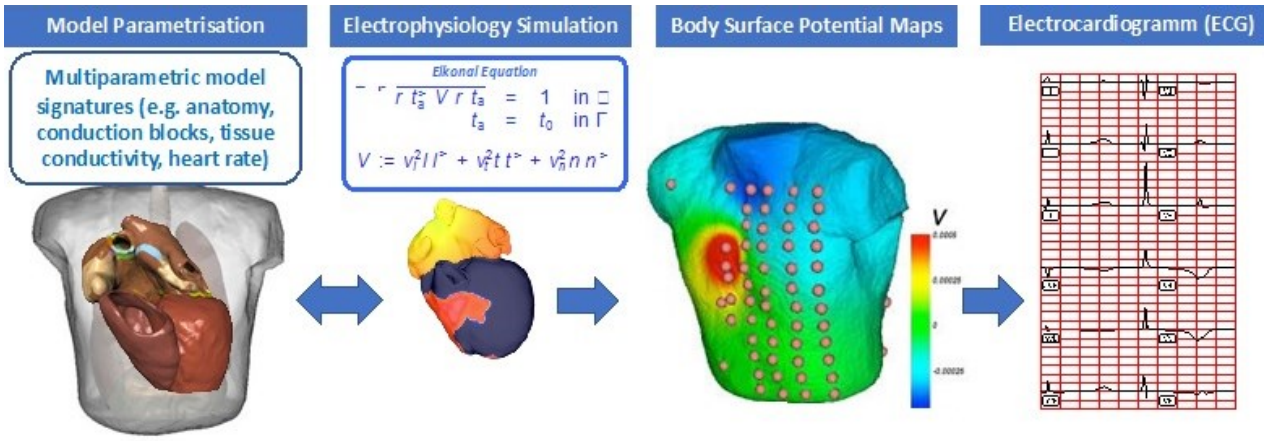
AA, United Kingdom

KCL, United Kingdom

KIT, Germany

MUG, Austria

TUB, Germany



Block scheme of the approach for the research

monitoring of patients. The importance of ECG-monitoring for atrial fibrillation, a cardiac arrhythmia with high prevalence, is stressed by the Guidelines of the European Society of Cardiology (ESC). Automated analysis tools are required for the detection and classification of episodes of ischemia and arrhythmia. Future telemedicine and home monitoring systems will even boost the need for automated and validated ECG analysis.

This project will start in July 2019 within European Metrology Programme for Innovation and Research (EMPIR), and will last for 36 months. The aim of this project is to develop a novel validation strategy of cardiac arrhythmia classification algorithms based on multiparametric data analysis of ECG data through metrological research. A novel synthetic reference database will be developed to enable the investigation of the uncertainty of modern data analysis approaches, such as machine learning in medicine and to contribute to standardizing machine learning methods in health applications, specifically by establishing a novel metrological validation platform of such algorithms manifesting a digital traceability chain. Limited number of analysis algorithms with the focus on uncertainty quantification will be investigated. Uncertainty of techniques will be assessed by using both real ECG signals and synthetic ECG signals. A two-step and traceable validation approach will be established: from synthetic external ECG to synthetic internal electrogram and then to the underlying parameter. Furthermore, the influence of the data uncertainty on the results analysis approaches will be assessed. Since the machine learning based approaches rely on the "correctness" of training data, any wrongly labeled training data can result in wrong predictions. This will be investigated by artificial mislabeling and applying different noise types to the training data. Potential bias that a machine learning algorithm might have due to the selection of the training data set will also be analyzed. A "leave one subject out" method will be employed to achieve realistic means for assessing algorithmic out-of-sample performance.

Current developments in machine learning show a tremendous potential in the field of health data. However, the understanding of the uncertainty propagation through such modern data analysis algorithms has not kept pace with the fast development of machine learning for healthcare applications and the related industry. This projects provides an excellent opportunity to show the impact of metrologically sound approaches in data science. Also, new approaches for the validation of machine learning like back propagation as investigated in this project will also strengthen the data science capabilities in metrology. The proposed synthetic database will enable the comparisons between different methods and algorithms using traceable digital reference values. Overall, the project will start a new metrological research area to expand the position of European metrology in the growing field of digital health.

EUROPEAN METROLOGY NETWORK FOR MATHEMATICS AND STATISTICS

Sažetak

Prethodnik Europske mjeriteljske mreže za matematiku i statistiku (EMN MATHMET) vuče korijene još od 2014. godine kada je kao rezultat EMRP projekta NEW04 *Novel mathematical and statistical approaches to uncertainty evaluation* osnovan MATHMET. MATHMET je tada osnovan od strane sedam različitih europskih zemalja, te je njegova osnovna aktivnost bila organizacija niza seminara kako bi pripremili i olakšali sprovođenje EMPIR projekata, sa naglaskom na matematičke i statističke metode koje se koriste u mjeriteljstvu. Na zasjedanju EURAMET Generalne Skupštine u maju 2018. godine dogovorena je uspostava Europske mjeriteljske mreže za matematiku i statistiku-MATHMET.

Osnovni cilj projekta 18NET05 MATHMET jeste pružanje podrške EMN MATHMET kroz kreiranje dokumenta strategijskog istraživačkog plana, uspostave mreže zainteresovanih partija za pružanje podrške, te stvaranje sistema upravljanja kvalitetom. Dodatne aktivnosti ovog projekta maksimizirat će i ubrzati uticaj EMN MATHMET. Ovaj projekat će biti dodatna pomoć mreži da definiše jasno potrebe industrije, standardizacijskih i akreditacijskih tijela kada su u pitanju problemi iz oblasti matematike i statistike. Što je najvažnije od svega, dokumenti u vidu vodiča, priručnika, softveri i slično koji budu izašli kao proizvod ovog projekta, bit će dostupni svima, čime će značajno unaprijediti mjeriteljsku praksu.

Project description

The objective of this network project is to support the associated European Metrology Network (EMN) for Mathematics and Statistics (EMN MATHMET). This will be achieved by creating a Strategic Research Agenda (SRA), a stakeholder network and a Quality Management System (QMS). These additional activities will significantly maximise and accelerate the impact of the EMN MATHMET. This project will bring the associated EMN MATHMET to a position where it defines a point of reference for mathematics and statistics for metrology that includes input from stakeholders from industry, standardisation bodies and academia. Through this project, the associated EMN MATHMET will be enabled to promote the best practice in mathematics

Tekst pripremio:

Alen Bošnjaković

Project start date and duration:

June 2019 - June 2025

Coordinator:

Sebastian Heidenreich, PTB

Internal Partners:

PTB, Germany

BAM, Germany

IMBiH, Bosnia and Herzegovina

INRIM, Italy

IPQ, Portugal

LGC, United Kingdom

LNE, France

NPL, United Kingdom

VSL, Netherlands

CECIP, Belgium

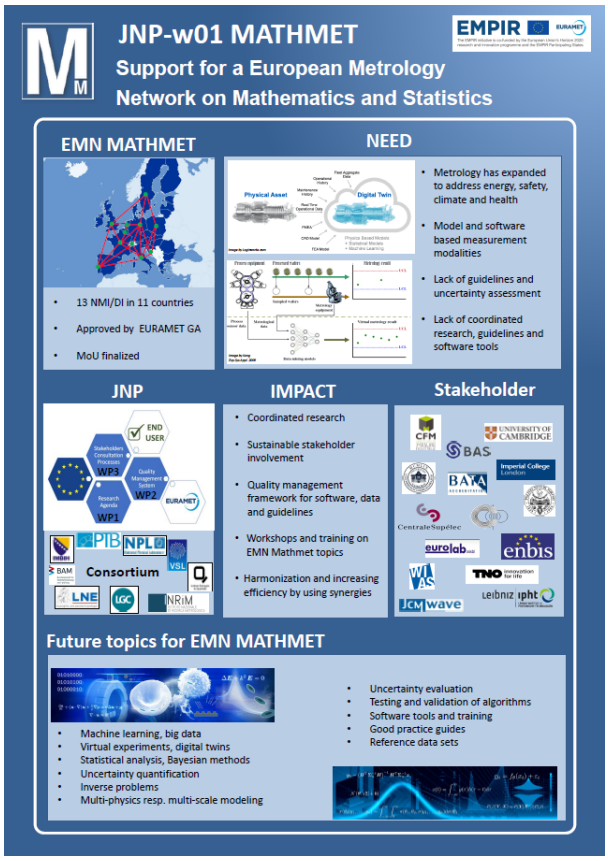
and statistics for metrology through providing guidelines, software and dedicated projects.

The precursor of the EMN MATHMET is the current European Centre for Mathematics and Statistics in Metrology (MATHMET) which was established in 2014 as an outcome from the EMRP project NEW04 *Novel mathematical and statistical approaches to uncertainty evaluation*. Members from seven different EU countries have joined this center, whose main activity has been to hold a regular series of workshops and to prepare and facilitate EMPIR projects with a strong emphasis on mathematical and statistical methods. Approval for the present MATHMET center becoming an EMN was agreed by the EURAMET General Assembly in May 2018. The MATHMET project comprises the following main objectives:

- To develop a strategic research agenda (SRA) for the EMN MATHMET that supports EU and EURAMET priorities by addressing the grand challenges in mathematics and statistics in metrology (e.g. large-scale and multivariate data analysis, new data analytics including machine learning, mathematical modelling, uncertainty quantification for large-scale metrology, virtual experiments and multi-physics and simulations).

- To develop the stakeholder consultation processes for the EMN MATHMET to enable it to identify the most urgent guidelines, software tools, virtual training and reference data in line with the SRA.

- To create and implement a quality management system (QMS) that includes criteria and procedures for the assessment of advanced metrology software and guidance documents which ensures that the EMN MATHMET recommendations meet the highest quality levels and achieve wide use and substantial impact.



EMN MATHMET poster presentation

The network infrastructure developed in this project will support the successful start of the associated EMN MATHMET, providing it with the important basic tools for promoting the best practice in mathematics and statistics for metrology. With support of this project, EMN MATHMET will provide a unique reference point for mathematical and statistical activities needed to tackle the grand challenges and emerging fields in metrology. The EMN MATHMET will have substantial long-term impact on the relevant stakeholder organizations and policy-makers, therefore the input form this project at an early stage within the EMN will help to focus and identify the most important stakeholder needs, and hence the resultant impact.

This project will involve such stakeholders in an extensive consultation to identify the most urgent needs for software tools, guidelines, virtual trainings and reference data in line with the research agenda. This output from this consultation will enable the EMN MATHMET to disseminate best practice and give support for industry and standardisation organisations and their technical committees for widespread applications of mathematical and statistical tools in metrology, in par-

and statistical tools in metrology, in particular in the field of uncertainty evaluation.

The expected outcome of the QMS developed in this project is that the recommendations of the associated EMN MATHMET will be based on the highest quality levels and should achieve wide stakeholder use and hence substantial impact. Publication of the documentation of the QMS will also make the associated EMN MATHMET recommendations available to other institutions so that they can make use of them for improving the quality of their own work. The project's SRA and QMS will both help to define and address the research questions in the field of mathematics and statistics in metrology in terms of the highest societal needs and the highest impact on an improvement of the environment.

A wider impact of this project will also be created by the input from this project to the future research projects within the associated EMN MATHMET. The EMN has the ability to tackle the grand research challenges of modern metrology in areas such as healthcare & medical diagnostics, industrial production & quality assessment, energy & sustainability, safety and environmental monitoring. The associated EMN MATHMET, with input from this project, will also give support to the development of capabilities for NMIs and stakeholders in the field of mathematics and statistics in metrology, thus leading to an improved European metrology research landscape.

Institute of Metrology of B&H will actively participate in the project with an aim of creating the good environment for solving as more as possible number of problems related to mathematics and statistics in metrology.

EUROPEAN METROLOGY NETWORK FOR CLIMATE AND OCEAN OBSERVATION

Abstract

Earth's climate is changing. The potential for societal catastrophe is second to none. Trustable global data providing evidence for policy makers to make timely decisions on mitigation and investments for adaptation is needed. This requires decadal observations of the Earth system to extract the small signals from noisy backgrounds - a metrology grand challenge. The observables are complex and require multi-disciplinary metrology from the coordinated efforts of the worlds NMIs, to achieve laboratory quality uncertainties from space, deserts & oceans. The European Union's current Integrated Maritime Policy (IMP) focuses on "Blue Growth" - harnessing the untapped potential of Europe's oceans, seas and coasts to stimulate long-term economic development and job creation. Observing the Oceans is not only necessary for climate purposes but also to provide knowledge that can promote European Growth. EURAMET intends to establish a collaborative network of climate and ocean observing tailored metrology expertise encompassing all technical domains as a single focal point for stakeholders to prioritize research and access services. This EMN has been launched in December 2018.

Tekst pripremila:

Aida Jotanović

EMN Champion:

Dr. Emma Woolliams, NPL

Opis mreže

Observacija klime i oceana je europska mjeriteljska mreža (EMN) s ciljem stvaranja održive strukture za potporu promatranju klime i oceana koja je područje od strateškog značaja za budućnost europskog mjeriteljstva i uključuje: stvaranje i širenje znanja, sticanje međunarodnog vodstva i priznanja, izgradnja koordinirane infrastrukture, uključivanje zainteresovanih strana.

Najvažniji elementi u uspostavljanju EMN-a za observaciju klime i okeana biće opisani u strateškom programu i planu implementacije. Plan rada će se uspostaviti i redovno ažurirati kako bi se precizirale obaveze pojedinih članica i partnera. EMN za observaciju klime i okeana podijeljena je u tri sekcije: posmatranje atmosfere, posmatranje okeana i posmatranje zemljišta / zemlje, koje u velikoj mjeri odgovaraju podjelama bitnih klimatskih varijabli

globalnog klimatskog sistema (GCOS) i glavnih tehnika opažanja (npr. tzv.: „remote sensing Earth Observation“).

Strateški program, plan implementacije i plan rada će biti podijeljeni na teme koje se odnose na navedene sekcije i također će obuhvatiti preglede kako bi se ti dijelovi spojili u formu prikladnu za interesne strane u okviru EMN. EMN za observaciju klime i okeana će raditi sa drugim nacionalnim, evropskim i međunarodnim organizacijama posvećenim posmatranju klime i okeana i gradiće se na vezama koje postoje između NMI-a, akademske zajednice i industrije.

EMN za klimu i posmatranje okeana će:

- koristiti sinergije uključenih članova i partnera,
- povećati vidljivost i prihvaćanje mjeriteljstva u istraživačkoj zajednici koja je aktivna u mjerenju i korištenju podataka observacije klime i oceana,
- podržavati naučnu saradnju između članova i partnera EMN i trećih strana,
- omogućiće formiranje jedinstvene referentne tačke za informacije, saradnju i učešće evropske mjeriteljske zajednice u organizacijama koje su aktivne u posmatranju klime i okeana i kreatorima politika,
- podići ukupni nivo mjeriteljskih sposobnosti i kvaliteta usluga,
- poboljšati efikasnost savjetovanja o politici,
- podupirati regulativu i standardizaciju putem istraživanja, prijenosa znanja i usluga,
- uspostaviti sveobuhvatnu, dugoročnu evropsku mjeriteljsku infrastrukturu kako bi se odgovorilo na potrebe sudionika,
- aktivno promovisati najbolje prakse u mjeriteljskim mjerenjima ECV-a i EOV-a za zajednice zainteresiranih strana,
- stimulisati razmjene između akademske zajednice, vladinih organizacija, industrije i mjeriteljske zajednice.

EMN za posmatranje klime i okeana će aktivno promovisati transfer znanja između svojih članova i partnera i trećih strana kroz tematske radionice i publikacije.

Članstvo u EMN-u za posmatranje klime i okeana je otvoreno za članove i saradnike EURAMET-a koji imaju aktivan istraživački program i / ili pružaju mjeriteljske usluge u okviru područkka koja pokrivaju EMN sekcije i mogu se obavezati da podrže ciljeve strateškog istraživačkog programa EMN-a i prisustvuje Generalnim sastancima EMN-a.

EUROPEAN METROLOGY NETWORK ON SMART ELECTRICITY GRIDS

Tekst pripremio:

Srđan Čalija

EMN Champion:

Gert Rietveld, VSL

Abstract

The European Energy Union strategy puts high priority on renewable energy, smart energy systems, and energy efficiency in order to 'build a low-carbon, climate resilient future' via 'secure, clean and efficient energy'. This strategy has a profound impact on our electricity grids – the backbone of our modern society. At present there is no recognisable entity that represents the metrology community in discussions on measurement issues related to the future of the electric grid. Therefore, EURAMET created the European Metrology Network (EMN) on Smart Electricity Grids (SEG).

The EMN aims to provide a single point of contact for stakeholders and stakeholder organisations, to realise a coherent NMI response to their measurement challenges, and to maximise the impact of metrology R&D activities in the field of Smart Electricity Grids.

Opis mreže

Evropska mjeriteljska mreža za pametne elektroenergetske mreže (eng. EMN on Smart Electricity Grids - EMN SEG) je struktura sastavljena od nacionalnih mjeriteljskih instituta (NMI) koja uz koordinisan rad sa proizvođačima mjerila, elektroenergetskim kompanijma, univerzitetima itd., ima za cilj da pruži ključnu podršku u rješavanju mjeriteljskih izazova s kojima se suočavaju elektroenergetske mreže pri njohovoj tranziciji na korištenje obnovljivih izvora energije.

Pored toga cilj je i uspostaviti jedinstvenu kontaktnu tačku za sve stejkholdere, kako bi se postigao napredak u istraživanjima i razvoju na terenu. Ambicija EMN SEG je da EURAMET postane vodeći svjetski akter za mjeriteljstvo u oblasti pametnih električnih mreža.

Snaga EMN za pametne elektroenergetske mreže se ogleda u pokrivanju cijelog spektra mjeriteljskih izazova koji se tiču elektroeneregetskih mreža, kao što su mjerenje potrošnje električne energije, pametna mjerila (PMU, pametna mjerila električne energije itd), kvalitet električne

energije, nadzor i upravljanje mrežom, visokonaponsko testiranje, mjerenje gubitaka u mreži, efikasnost mreže, digitalna instrumentacija (prema IEC-61850), mjerni transformatori, itd.

EMN SEG poster presentation

Koordinisan rad svih NMI-a u okviru ove mreže usmjeren je na četiri glavna cilja:

- Uspostavljanje zajedničke platforme NMI-a i zainteresovanih strana (industrija, akademske zajednice, elektroprivreda, proizvođači mjerila itd.) kako bi se identifikovale strateške potrebe za uslugama mjerenja i istraživanjima, kao i da se podstakne prenos znanja i razvoj tehnologije. Ovako organizovana mjeriteljska zajednica može odgovoriti na ove izazove samo tako što će se unaprijed sa svim relevantnim zainteresiranim stranama dogovoriti o tome što je mjeriteljstvu potrebno i u kojem trenutku, te pažljivim usklađivanjem nacionalnih programa u okviru zajedničkog evropskog istraživačkog programa.

- Stvaranje zajedničke održive evropske mjeriteljske infrastrukture za pametne elektroenergetske mreže, podsticanjem razvoja mjeriteljske infrastrukture evropskih NMI-a s ciljem da se iskoriste postojeći resursi, te da se razviju novi a da se pri tome izbjegne nepotrebno dupliranje.

- Stvaranje prepoznatljivog identiteta evropske mjeriteljske asocijacije za pametne elektroenergetske mreže, kao i uspostavljanje jedinstvene kontaktne tačke za sve buduće zainteresovane strane. Dosadašnji kontakti sa zainteresovanim stranama su uglavnom bili pojedinačni od strane svakog NMI-a, ili prilikom zajedničkih projekata, te nijedan NMI nije imao mandat da govori u ime drugih. Također, sve zainteresovane strane biće u mogućnosti putem jednostavne i sveobuhvatne platforme pristupiti prošlim, postojećim i budućim (JRP EMRP i EMPIR) istraživačkim projekatima i njihovim rezultatima, te dobiti informacije i odgovore na sva relevantna pitanja iz navedene oblasti, što do sada nije bio slučaj.

- Uspostavljanje strateških veza sa relevantnim evropskim i svjetskim organizacijama kao što su ENTSO-E, CENELEC, WELMEC, CIGRE, EURELECTRIC, TD Europe, ESMIG, IEC, OIML, te sa Evropskim JRC, kao i sa akademskom zajednicom, industrijom itd.

Institut za mjeriteljstvo BiH (IMBIH) je od samog uspostavljanja EMN-a za pametne elektroenergetske mreže postao njen član i aktivno učestvuje u njenom razvoju zajedno sa još 17 evropskih nacionalnih mjeriteljskih instituta (NMI). Institut će kroz svoje djelovanje u ovoj asocijaciji (mreži) doprinijeti razvoju elektroenergestkog sektora u Bosni i Hercegovini na način širenja novih znanja i promovisanja važnosti mjeriteljstva i postojeće nacionalne i Evropske mjeriteljske infrastrukture potrebne za tranziciju današnjih elektroenergetskih mreža na nivo pametnih mreža.

Također, IMBIH će biti na usluzi svim stranama iz Bosne i Hercegovine (proizvođačima opreme, elektroprivrednim preduzećima, akademskoj zajednici itd.) koje su na neki način zainteresovane za rezultate i informacije o radu ovog tijela. Ovo prije svega podrazumjeva zajedničku saradnju na budućim istraživačkim projektima, informisanje o trenutnim i budućim istraživačkim projektima u okviru EMN SEG, postojećim mjeriteljskim resursima u IMBIH-u i drugim Evropskim NMI, kao i upoznavanje sa IMBIH-im znanjem stečenim na različitim nacionanim i internacionalnim projektima.

Podršku formiranju ove mreže iz BiH, kao i učešće Institutu za mjeriteljstvo BiH u njenom radu pružili su Bosanskohercegovački komitet za elektrotehniku (BAKE), Elektrotehnički fakultet iz Istočnog Sarajeva, Elektrotehnički fakultet iz Sarajeva, Mikroelektronika a.d. Banja Luka, IskraEmeco Sarajevo.

EUROPEAN METROLOGY NETWORK FOR ENERGY GASES

Tekst pripremila:

Katarina Hafner-Vuk

EMN Champion:

Dr. Annarita Baldan, VSL

Abstract

Human life depends on energy. To prosper, while tackling climate change, society needs to provide more energy than ever for a growing global population, while finding ways to reduce CO2 emissions. Therefore, the energy sector is facing a transition. Driven by the EU legislation on renewable energy and by the ratification of the Paris Agreement aimed at a zero-carbon economy, renewable energy gas sources are being explored and entering the market.

EURAMET intends to establish a collaborative network aimed at identifying and jointly addressing the diversity of metrological needs with respect to quality, efficiency, safety and trade aspects of this energy transition and thereby setting the basis for a harmonized and sustainable European measurement infrastructure to catalyze the process.

Opis mreže

EMN ima za cilj da pruži podršku društvenim potrebama vezanim za energetsku tranziciju ka obnovljivim izvorima gasovitih goriva. To će olakšati rješavanje mjeriteljskih aspekata vezanih za održivu i transparentno snabdijevanje energijom iz konvencionalnog (prirodnog gasa, ukapljenog prirodnog gasa) i obnovljivih izvora energije kao što je biogas / biometan, vodik i dr. Glavni pokretači na evropskom nivou u pravcu diversifikaciji energije i ka upotrebi više izvora održivih i obnovljivih energetskih gasova su evropske direktive o obnovljivoj energiji (2009/28 / EC), ograničenje snabdijevanja gasom i ratifikacija Pariškog sporazuma (COP21). Što se tiče visokog značaja transporta i distribucije energetskih gasova na panevropskom nivou, EC je objavila Uredbu EU 703/2015, postavljajući zahtjeve za usklađene pristupe za merenje energije kojom se trguje širom Evrope.

Osnovane su nacionalne i evropske platforme zainteresovanih strana za energetske plinove i one rade na tome da se temeljni izazovi, kao što su postavljanje fizičkih i hemijskih specifikacija potrebnih za obnovljive gasove kako bi postali dio postojeće mreže prirodnog plina, procjenjujući

zahtjeve kvalitete i sigurnosti za korištenje vodika kao goriva, za transport na velike udaljenosti ili identifikovanje najučinkovitijih metoda za omogućavanje konverzije snage u gas. Robusnost mjerenja u

EMN Energy Gases kick-off meeting

ovim područjima često je ugrožena na najvišem nivou zbog nedostatka sledljivosti mjernih standarda i na razini krajnjeg korisnika odsustvom odgovarajuće kontrole kvalitete i standardizovanih procedura uzorkovanja i rutinskih mjerenja. Aktivnosti potrebne za njihovo rješavanje imaju za cilj premostiti jaz između mjeriteljstva i zajednice krajnjih korisnika izvan tekućih aktivnosti koje se provode u tehničkim odborima EURAMET-a i CIPM-a. Ove aktivnosti bi zahtijevale fleksibilniji pristup i, posebno, sposobnost da se mnogo više radi s krajnjim korisnicima da osiguraju pravilno širenje mjeriteljske sljedivosti i najbolje prakse u rutinskim merenjima na terenu ili u fabrikama I+i laboratorijama. EMN za energetske gasove ima zadatak da odgovori na ove zahtjeve i postane jezgro za pokrivanje svih mjernih potreba u vezi sa mjeriteljstvom, standardizacijom I pitanjima akreditacije. EMN će također obuhvatiti slične izazove standardizacije koji se pojavljuju u oblastima kao što su protočne karakteristike vodika ili prirodnog gasa obogaćenog vodikom, analiza čistoće vodika ili biogas / biometan, itd. (npr. ISO / TC 158 Analiza gasa, ISO / TC 193 prirodni gas (uključujući biometana) i ISO / TC 197 vodonik) koji trenutno nisu dio koherentnog pristupa.

CCQM i CCM su razvili strateške dokumente koji potvrđuju nove energetske gasove kao jednu od ključnih sektora koji će zahtijevati produkciju samo sljedivih rezultata mjerenja i demonstraciju međunarodne ekvivalentnosi. Programi EMRP i EMPIR podržali su i još uvijek podržavaju zajedničko istraživanje na velikom broju finaliziranih I tekućih projekata, od kojih su neki: ENG01 GAS, ENG54 Biogas, 16ENG05 Biometan, ENG03 LNG, ENG60 LNG II, 16ENG09 LNG III, 15NRM03 vodonik, 16ENG01 MetroHyVe, 14SIP06 siloksani (za biometan) u okviru kojih se radi na razvoju novih metoda mjerenja i mjerni standardi za specifične potrebe energetske tranzicije. Ovi istraživački programi na kojima prvenstveno učestvuju NMI/DI su se blisko povezali sa ciljnim akterima i identifikovali njihove specifične potrebe. Na primjer, odgovor na potrebu za procjenom kvaliteta biopgasa koji ulazi u mreže prirodnog gasa, te mjerni standardi za određivanje sadržaja specifičnih nečistoća u biogasu razvijeni su u EMRP JRP ENG54 BIOGAS. Međutim, ovi projekti nisu dovoljni da zadovolje buduće potrebe industrije gasa i samog društva, a tek nekolicina NMI /DI je uključena u ove projekte. Navedene mjeriteljske potrebe i izazovi su od panevropske važnosti jer energetska tranzicija zahtijeva harmonizaciju i implementaciju na cijelom prostoru Evrope.

METROLOGY FOR LONG DISTANCE SURVEYING - SIB60

Sažetak

Klizišta, vrtače i druge tektonske aktivnosti mogu ugroziti čitave populacije ljudi, zgrade ili industrijske objekte u rudarskim područjima, planinskim područjima i oko nuklearnih elektrana. Stoga se radi kontinuirano praćenje ovakvih područja u svrhu sprječavanja nesagledivih posljedica za društvo od strane mjeritelja (geodeta) koji se suočavaju sa mjerenjem udaljenosti od nekoliko stotina metara do nekoliko kilometra sa mjernom nesigurnošću reda veličine jednog milimetra. U okviru Evropskog mjeriteljskog programa za inovacije i istraživanje (EMPIR) započet je projekt za mjerenje velikih udaljenosti (Metrology for long distance surveying). Projekt je započet 2013. godine, i završen je uspješno krajem 2016. godine. (IMBiH) je uzeo učešće na projektu u trajanju od šest mjeseci u 2014. godini kroz EMPIR alat za mobilnost mladih istraživača na projektima (RMG). Zadatak RMG (IMBiH) je bio razvoj novog primarnog etalona za kalibraciju geodetskih baza uz saradnju sa Institutom za mjeriteljstvo Njemačke (PTB) u kojoj su ujedno provedena i istraživanja za projekt.

Project description

Rockslides, sinkholes and other tectonic activities can endanger the entire population of people, buildings or industrial facilities in mining areas, mountainous areas, and around nuclear power plants. That is why the continuous monitoring of these areas is carried out in order to prevent the immeasurable consequences for the society, by the surveyors (geodesist), who are faced with a distance measurement from several hundred meters to several kilometers with the one-millimeter size measurement uncertainty. A project for long distance measuring (Metrology for long distance surveying) had started within the European Metrology Program for Innovation and Research (EMPIR). The project started in 2013 and was completed successfully in late 2016. IMBiH took part in the project for a period of six months in 2014 through EMPIR Research Mobility Grant (RMG). The task of RMG (IMBiH) was the development of a new primary standard for calibration of geodetic bases in cooperation with the National Institute of Metrology of Germany (PTB), where project research

Tekst pripremio:

Alen Bošnjaković

Project start date and duration:

July 2013 - July 2016

Coordinator:

Dr. Florian Pollinger, PTB

Internal Partners:

PTB, Germany

CNAM, France

NLS, Finland

IPQ, Portugal

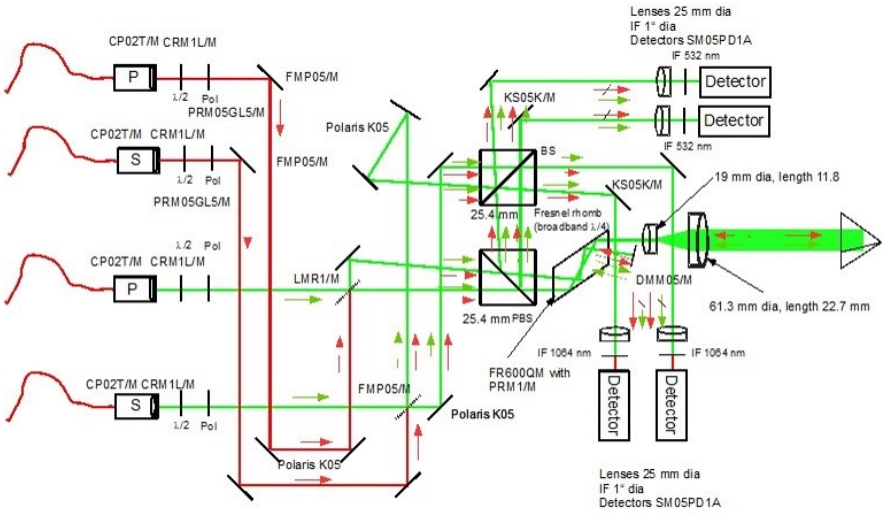
VTT, Finland

RISE, Sweden

VSL, Netherlands

NSC-IM, Ukraine

INRIM, Italy



Scheme of interferometric head for long distance measurements

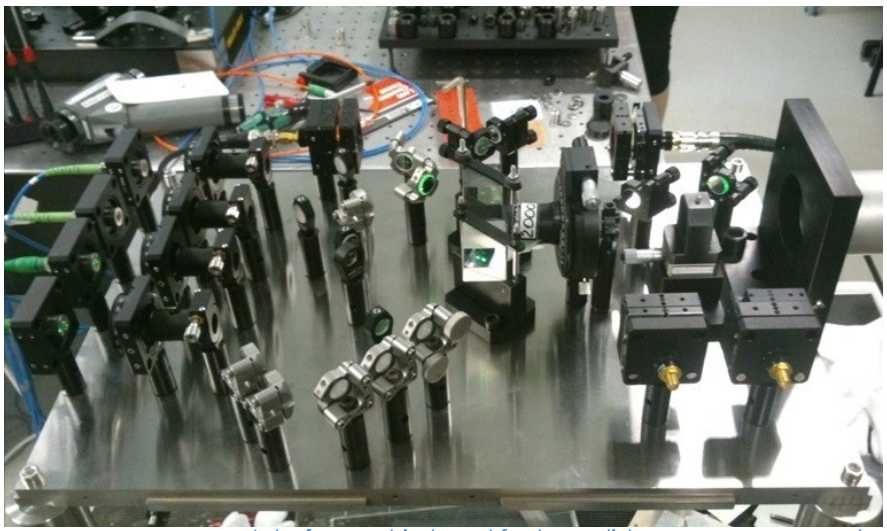
was also carried out.

The novel primary standard for the calibration of geodetic baselines, the "Tele-YAG" interferometer was developed within Joint Research Project EMRP SIB60 "Metrology for long distance surveying". The optical distance measurement is realized as an absolute measuring heterodyne interferometer with a targeted measuring range of 1 km and an accuracy of 0.1 mm or better. To achieve such a measurement uncertainty outside laboratory, the index of refraction must be determined with an uncertainty of 0.1 ppm. Hence, the interferometer has to compensate for the influence of the index refraction in-situ by implementation of the dispersion based two-color measurement method. In addition, particular focus was on the mechanical stability of the measurement head.

The refractivity compensated distance meter has been developed in an effort to improve the traceability chain in surveying. It is supposed to be capable of measuring distances up to 1 kilometer in air with a relative uncertainty of 10^{-7}. To achieve this, an absolute distance interferometer based on six synthetic wavelengths with in -situ dispersion-based refractivity compensation was developed. Specific emphasis was put on stability in the mechanical design.

Acknowledgments:

This project was performed within the joint research project SIB60 "Metrology for long distance surveying" of the European Metrology Research Program (EMRP). The EMRP is jointly funded by the EMRP participating countries within EURAMET and the European Union.



Interferometric head for long distance measurements

METROLGOY FOR THE FACTORY OF THE FUTURE - 17IND12 MET4FOF

Sažetak

Pored aktivnog učešća u vidu jednog od partnera, Institut za mjeriteljstvo Bosne i Hercegovine (IMBiH) je u 2019. godini uzeo tromjesečno učešće na projektu "Metrology for the Factory of the Future" (17IND12 MetFoF) godini i kroz EMPIR alat za mobilnost mladih istraživača na projektima (RMG). Cilj RMG-a jeste usvajanje znanja i razvijanje postojećih i novih sposobnosti kroz rad u institutima – učesnicima na projektu, a što će predstavljati dodatni doprinos projektnim aktivnostima. Zadatak RMG-a (IMBiH) je proučavanje i primjena Monte Carlo metode za evaluaciju mjerne nesigurnosti skupina podataka u mrežama senzora koje će se generisati kroz projekat "Metrology for the Factory of the Future" (17IND12 MetFoF). Realizacija zadatka će se odvijati u Institutu za mjeriteljstvo Njemačke (PTB). Zahvaljujući dostupnosti i bibliotekama prilagođenim za upotrebu u oblasti *Data Science*, u programskom jeziku Python biće izvršene Monte Carlo simulacije u skladu sa GUM (Guide to the Expression of Uncertainty in Measurement) vodičem. Rezultati rada će biti prezentirani kroz naučne konferencije, te će poslužiti za izradu web tutorijala u cilju primjene naprednih statističkih alata i programiranja za obradu rezultata mjerenja.

Project description

The parent project 17IND12 MetFoF aims to develop calibration frameworks for industrial and distributed network sensors where measurement uncertainty from individually calibrated sensors is extrapolated to other individual sensors of the same type. In FoF environments, sensors will provide digital-only time-dependent output and will have internal signal processing capabilities. This makes phase calibration challenging, because the internal time keeping of the sensor is no longer managed by the calibration system, making new concepts for the calibration of such sensors necessary. The project will develop the required basic concepts, terminology and specifications as well as a proof of concept by calibration of a selected group of digital interface sensors. The scope of the project is focused on sensors for pressure, force and acceleration which are often operating in dynamic conditions, requiring dynamic calibration frameworks.

Tekst pripremila:

Ehlimana Jugo

Project start date and duration:

June 2018 - June 2021

Coordinator:

Sascha Eichstädt, PTB

Internal Partners:

PTB, Germany

CEM, Spain

IMBiH, Bosnia and Herzegovina

INRIM, Italy

IPQ, Portugal

LNE, France

NPL, United Kingdom

TUBITAK, Turkey

VSL, Netherlands

External Partners:

SPEA, Italy

STRATH, United Kingdom

TU-IL, Germany

UCAM, United Kingdom

ZEMA, Germany

Unfunded Partners:

ITRI, Taiwan

MEMS pressure sensor with integrated temperature sensor (TE Connectivity)

Currently, uncertainty evaluation of measurands is covered by the GUM and its Supplements. The original GUM referred only to the models with negligible linearization errors and uncertainty evaluation of univariate measurement models with single scalar output quantity. Two supplements to GUM were also published to address an arising need for dynamic measurements with time-dependent and development of models with more than one quantity:

- Supplement 1 – involves Monte Carlo method application and propagation of probability distributions in order to evaluate measurement uncertainty of univariate measurement models.

- Supplement 2 – intended for Monte Carlo method application and propagation of probability distributions in order to evaluate measurement uncertainty of multivariate measurement models.

This RMG will study the implementation of Monte Carlo method for uncertainty evaluation of selected aggregated (one measurement value and its associated uncertainty collected from number of measurements) and distributed data sets (spatial and temporal distribution of specific quantities) in sensor networks through computer programming environment. These data sets will be generated within the parent project 17IND12 MetFoF. In advance, the case studies and current state of the art in relation to the applicable statistical methods with measurement uncertainty evaluation will be analyzed. Project partners and the RMG researcher will share the obtained knowledge during the process of development and improvement of mathematical and statistical models and their alignment with metrological needs. This research will bring new expertise in dynamic measurements and digitalization in metrology from the perspective of applying the novel computational methods in the process of quantification of measurement uncertainty.

The additional impact of the project will be made through workshop for students in Bosnia and Herzegovina interested in Python programming and Machine Learning concept.

Acknowledgments:

This research is performed within the joint research project "Metrology for the Factory of the Future" (17IND12 MetFoF) of the European Metrology Programme for Innovation and Research (EMRP). The EMPIR is jointly funded by the EMPIR participating countries within EURAMET and the European Union.

METROLGOY FOR THE FACTORY OF THE FUTURE - 17IND12 MET4FOF

Saţetak

Pored aktivnog učešća na projektu "Metrology for the Factory of the Future" (17IND12 MetFoF) kao jednog od partnera, Institut za mjeriteljstvo Bosne i Hercegovine (IMBiH) će u 2019. godini imati učesnika na RMG-u u sklopu istog projekta. RMG (Researcher Mobility Grant) je EMPIR alat za mobilnost mladih istraživača na projektima. Cilj RMG-a jeste usvajanje znanja i razvijanje postojećih i novih sposobnosti kroz rad u institutima što u konačnici, osim razvoja učesnika, doprinosi i razvoju matičnih instituta. Zadatak u sklopu ovog RMG-a je proučavanje i primjena različitih metoda za analizu podataka koji će se generisati kroz projekat "Metrology for the Factory of the Future" (17IND12 MetFoF). Realizacija zadatka će se odvijati u Institutu za mjeriteljstvo Njemačke (PTB), a analiza podataka će se vršiti korištenjem "machine learning" metoda iz postojećih biblioteka i to korištenjem programskog jezika Python™. Također, jedan od primarnih zadataka je i kreiranje tutoriala za početnike u korištenju ovih metoda u oblasti „data science". Rezultati rada će biti prezentirani kroz naučne konferencije, a učesnik će napisati finalni izvještaj za ovaj RMG u kojem će sumirati postignuća i uticaj provedenog istraživanja.

Project description

Traceable calibrations, harmonized treatment of measurement uncertainties, and industrial standards and guidelines are the significant components of a comprehensive metrological infrastructure that has enabled globalized manufacturing and international trade. All mentioned above are well known in traditional metrology but with modernization and introducing digitalization in metrology world, it is necessary to establish new metrological infrastructure. It supports the transition from conventional metrology to modern metrology by applying novel techniques. The overall aim of the parent JRP 17IND12 MetFoF is to improve the instrumentation and digitalization of manufacturing facilities as well as their efficiency from the metrology perspectives. This can be achieved by applying machine learning methods in metrology. Early work in the parent JRP requires some of the partners to provide datasets from their test beds with additional information

Tekst pripremio:

Haris Lulić

Project start date and duration:

June 2018 - June 2021

Coordinator:

Sascha Eichstädt, PTB

Internal Partners:

PTB, Germany

CEM, Spain

IMBiH, Bosnia and Herzegovina

INRIM, Italy

IPQ, Portugal

LNE, France

NPL, United Kingdom

TUBITAK, Turkey

VSL, Netherlands

External Partners:

SPEA, Italy

STRATH, United Kingdom

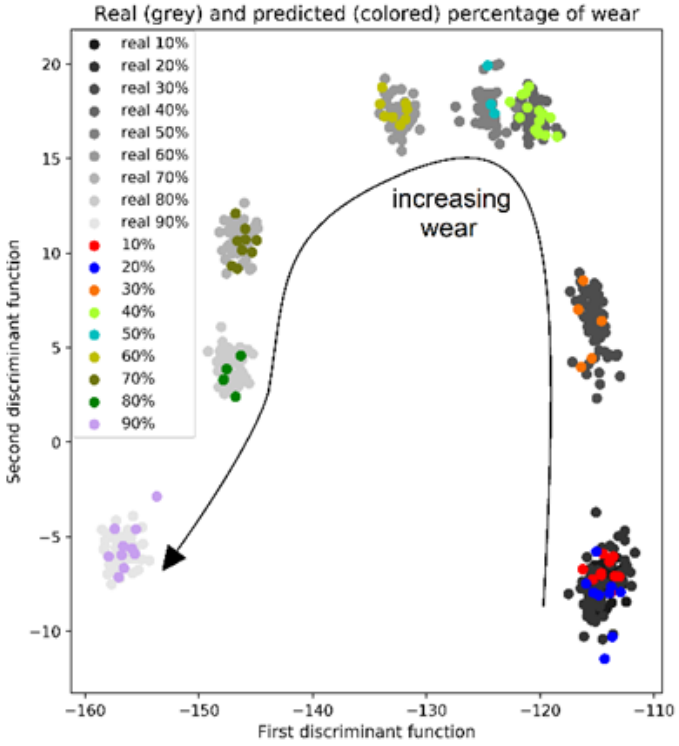
TU-IL, Germany

UCAM, United Kingdom

ZEMA, Germany

Unfunded Partners:

ITRI, Taiwan



Example of result from applied machine learning methods for lifetime prognoses of the electro-mechanical cylinders (EMC)

and metadata. The aim of the RMG task is to select a handful of methods from existing libraries, such as scikit.learn in Python, and apply these to the data sets made available by the JRP partners. At least two methods (classification, regression) will be used and compared by each other on the same data sets. The aim is primarily to develop first web-based tutorials oriented at beginners in data science. Later these tutorials are going to be extended by uncertainty evaluation methods. The RMG researcher will collaborate with JRP partners where necessary, receiving advice and support in the form of consultation and information in order to achieve the RMG technical objectives. Also, the activities and outputs of the RMG will contribute to the improvement and further development of laboratories within the Institute of Metrology of Bosnia and Herzegovina and strengthening of its metrological infrastructure.

Acknowledgments:

This research will be performed within the joint research project "Metrology for the Factory of the Future" (17IND12 MetFoF) of the European Metrology Programme for Innovation and Research Program (EMPIR). The EMPIR is jointly funded by the EMPIR participating countries within EURAMET and the European Union.

DEVELOPING PRACTICAL MEANS OF DISSEMINATING THE NEW KILOGRAM - SIB05 NEWKILO

Saţetak

U junu 2012. godine u okviru EMRP-a (Evropski mjeriteljsko istraživački program) započeo je projekat iz oblasti mjerenja mase sa kodifikacijom SIB05 NewKILO i koji nosi naziv „Razvijanje praktičnog načina diseminacije novog kilograma“.

Projekat je trajao tri godine i završen je 31.maja 2015. godine. Jedinica mase (kilogram) je zadnja od sedam osnovnih jedinica međunarodnog sistema jedinica (SI) koja je definisana preko materijalnog artefakta, što znači da nije vezana za neku nepromjenjivu prirodnu konstantu. Napredak je postignut prema redefiniciji kilograma u pogledu Plankove konstante (h) realizirane preko Kibble vage i Avogadrovog eksperimenta.

Projekat je koncipiran kao zajedničko-istraživački projekat u kojem je učestvovalo 14 partnera (13 partnera iz Evrope i jedan partner iz Kanade). Sam projekat se sastojao iz sedam radnih paketa. Svoj istraživački rad predstavnik Instituta za mjeriteljstvo BiH obavio je u laboratorijama NPL-a (Velika Britanija) sa posebnim fokusom na čišćenje tegova i njihovu stabilnost u periodu nakon čišćenja primjenom metoda UV/Ozon i korištenjem plazme niskog pritiska uz primjenu vodika.

Project description

The project aimed to develop and provide the practical infrastructure, procedures and technologies necessary to fix the Planck constant with relation to the current definition (IPK – International Prototype Kilogram) and to disseminate the mass unit following redefinition. This was addressed by the following objectives;

- Develop and evaluate artefacts suitable for the determination of the Planck and the Avogadro constants to provide traceability to the IPK and to maintain and disseminate of a redefined kilogram
- Provide appropriate procedures and apparatus for the mass transfer between in-vacuum experiments

Tekst pripremio:

Haris Memić

Project start date and duration:

June 2012 - May 2015

Coordinator:

Dr. Stuart Davidson, NPL

Internal Partners:

NPL, United Kingdom

CMI, Czech Republic

CNAM, France

DFM, Denmark

METAS, Switzerland

LNE, France

MGRT, Slovenia

MIKES, Finland

PTB, Germany

SMU, Slovakia

TUBITAK, Turkey

INRIM, Italy

NRC, Canada

Testing of material surface of weight standard- ellipsometry

(Kibble balance apparatus and vacuum mass comparators) and to in-air experiments (comparison with the IPK and dissemination of the unit to end-users)

- Develop and adapt surface analysis techniques (e.g. X-Ray Photoelectron Spectroscopy, (XPS), Ellipsometry, Contact Angle Spectrometry, (CAS)) and overlayer models for the accretion of contamination on mass standards (including silicon spheres), including the use of complimentary surface analysis techniques to evaluate transfer, storage and cleaning techniques Evaluate the mass stability of suitably stored mass artefacts and develop the metrological infrastructure for the (medium term) maintenance of the mass unit and its dissemination based on different realisations (via a pool of artefacts which may be held at a number of NMIs and key comparisons)

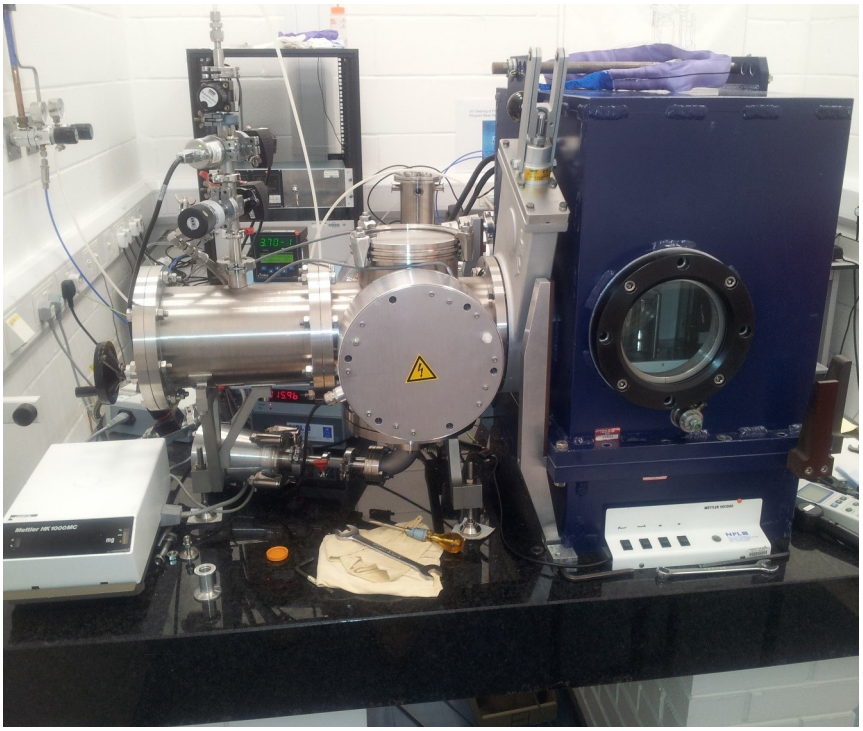
- Develop and validate methods to allow reproducible cleaning (to less than 5 µg) of primary mass artefacts, including optimisation and comparison of non-contact cleaning techniques (such as the use of UV activated ozone and gas plasma) with traditional solvent and nettoyage-lavage method

- Identify and evaluate the uncertainty components inherent in the mise-en-pratique and their propagation through the dissemination chain for the kilogram and its multiples and sub-multiple.

IMBiH participated in the application of new cleaning methods on measurement standards, by application of two different noncontact methods applied in NPL.

The current practice of cleaning used in BIPM, which dates back to 1882, is based on "nettoyage-lavage" technique, which proved to be highly dependent on the user's ability, as it has been shown on a number of occasions, which led to the change of mass of tens of micrograms.

IMBiH representative performed cleaning on mass standard using UV/O3 cleaning method by removing carbon contamination from mass standard surfaces using UV light in combination with gaseous ozone,



Cleaning of weights with plasma technique

and another method using low pressure hydrogen (H2-plasma). The subject of the study at the NPL was to investigate long-term weight stability (gravimetrically) after applying the above-mentioned cleaning methods as newly developed cleaning techniques that can provide better reproducibility and repeatability than with BIPM method used so far. IMBiH has also come up with the additional research of contaminated surface of the weights. As a subject of research, 1 cm diameter stainless steel plates (material from which commercial batches are made) and silicone plates (material as a silicone sphere used at kilogram realization). In order to establish the thickness of the contaminated layer, an ellipsometer was used. As ellipsometry indicates the thickness of the surface layer, but not the surface contamination composition, additional studies were carried out with XPS (photoelectron spectroscopy x-ray) apparatus.

Acknowledgments:

This project is performed within the joint research project SIB05 Developing a practical means of disseminating the new kilogram (EMRP). The EMRP is jointly funded by the EMRP participating countries within EURAMET and the European Union.

CHARACTERIZATION OF ENERGY GASES - EMRP ENG01

Sažetak

Resursi prirodnog gasa u Evropi opadaju, stoga se razvijaju i koriste neke nove procedure za "ozelenjavanje" i obogaćivanje prirodnog gasa. Neki od pristupa poboljšanja prirodnog gasa uključuju dodavanje biogasa, prirodnog gasa obogaćenog vodikom, te metana iz uglja i rudnika uglja u postojeće gasne mreže. Potrebno je razviti metrološku osnovu i infrastrukturu za mjerenje parametara od interesa za ove nove proizvode kako bi se pratile sve moguće prednosti i nedostaci i usporedili ovi gasovi s konvencionalnim gasovitim gorivima.

U okviru Evropskog mjeriteljskog istraživačkog programa (EMRP) finaliziran je projekt za karakterizaciju energetskih gasova (Metrology for long distance surveying). Projekt je započet 2010. godine, i završen je uspješno sredinom 2013. godine. (IMBiH) je uzeo učešće na projektu u trajanju od četiri mjeseca u 2012 godini kroz EMRP alat za mobilnost mladih istraživača na projektima (RMG). Zadatak RMG (IMBiH) je bio sprovede fizička i hemijska merenja vještačkih i realnih uzoraka novih oblika gasnih goriva kako bi se razvile nove primenljive referentne metode za analizu sastava gasa. To je ralizovano određivanjem ukupnog sastava, te nivoa nečistoća (siloksana, HCl i amonijaka) gasnohromatografskim tehnikama sa različitim detektorima (FID, FPD, MS, AED) i optičkim laserskim metodama (Cavity enhanced absorption spectroscopy – CEAS).

Project description

The Directive establishing the EU ETS (2003/87/EC) states in Annex IV that: "activity specific emission factors are acceptable for all fuels". Hence, there is a requirement for accurate and validated measurement methods for use in the estimation of such factors for high-value energy gases of variable composition, which are traded within the ETS. This project addresses those EU level requirements for the inter-changeability of gaseous fuels between transporters and producers in different countries. The project has put in place the metrology requirements for the safe and efficient trade and transportation of energy gases in the gas pipeline system within Europe.

Tekst pripremila:

Katarina Hafner-Vuk

Project start date and duration:

June 2010 - July 2013

Coordinator:

Dr. Dai Jones, NPL

Internal Partners:

NPL, United Kingdom

BAM, Germany

BRML INM, Romania

CEM, Spain

CMI, Czech Republic

INRIM, Italy

INTA, Spain

LNE, France

MIKES, Finland

MKEH, Hungary

PTB, Germany

SMU, Slovakia

SP, Sweden

TUBITAK, Turkey

VSL, Netherlands

Unfunded Partners:

BEV/E+E, Austria

TUBITAK MAM, Turkey

Gas Chroamtograph with FID and TCD detectors for the analysis of the components of natural gas mixtures

In summary, the scientific and technical objectives of this project, required to meet the interchangeability objective, were:

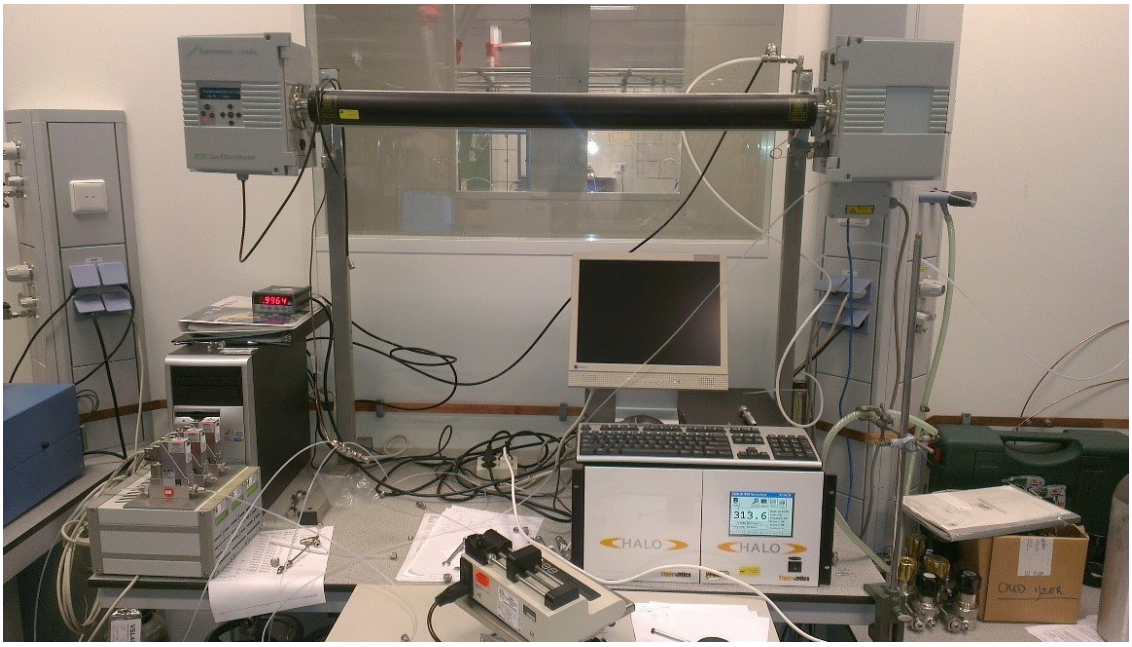
For the required non-conventional gases composition determinations:

- To develop and validate new highly accurate measurement methods to achieve the uncertainty required by the European industry for the physical properties of gases injected into the network and certified reference materials for the composition of non-conventional and renewable gaseous fuels (e.g. biogas, coal bed methane, coal mine methane and hydrogen enriched natural gas) and refinery gases (e.g. 'syngas').

- To develop highly accurate measurement methods for odorants in non-conventional and renewable gaseous fuels, matching where possible the current 1.0 % uncertainty of sulphur species in methane. Odorants are deliberately added to energy gases to ensure that potentially dangerous leaks can be detected.

For the calorimetric measurements:

- To validate the results of a new primary calorimeter able to produce very low uncertainty (0.2 %) on energy



Gas IR spectrometer for the analysis of HCl content in syngas and similar gas matrices (VSL chemistry department)

measurement of these gases in accordance with the principles of the "Guide to the Expression of Uncertainty in Measurement" (GUM).

- To develop and validate a range of field calorimeters for the measurement of the calorific value of non-conventional gases.

For primary and reference humidity facilities:

- To develop a new primary dew point standard for high pressure and a new water vapor amount fraction standard at low pressure to cover conditions typical of gas distribution across Europe.
- To improve the measurement validity in sampling and in conversions between humidity quantities by producing data on the effect of interactions between water and other gas molecules and developing new calculation methods.

For evaluation of existing and novel humidity sensors:

- To develop measurement systems for 1) studying experimentally the effect of interactions between water and other gas molecules and 2) sensitivity of humidity sensors to variations in gas composition and measurement conditions.
- To develop and validate new methods for comparing humidity standards with humidity sensors used in industrial gas monitoring conditions.

Acknowledgments:

This project is performed within the joint research project ENG01 Characterization of energy gases (EMRP). The EMRP is jointly funded by the EMRP participating countries within EURAMET and the European Union.

ADVANCING MEASUREMENT UNCERTAINTY - COMPREHENSIVE EXAMPLES FOR KEY INTERNATIONAL STANDARDS - 17NRM05 EMUE

Saţetak

U današnje vrijeme u različitim sferama ljudske svakodnevnice veliki broj odluka koje se donose oslanja se na podatke dobijene mjerenjem.

Pravilna procjena pridružene mjerne nesigurnosti i poznavanje njenog uticaja na sam kvalitet procesa koji zahtijevaju mjerenje uveliko doprinosti smanjenju nezgoda, rizika i troškova. Da bi se pomoglo industriji da pravilno pristupi procjeni mjerne nesigurnosti, Joint Committee for Guides in Metrology (JCGM) je objavio vodič pod nazivom Guide to the expression of uncertainty in measurement (GUM), koji daje detaljna uputstva, procedure i ilustrativne primjere za procjenu mjerne nesigurnosti. Međutim, činjenica da je GUM ponekad nepraktičan za krajnje korisnike, kao i ta da su neki od primjera koji se nalaze u njemu stari preko četrdeset godina doveli su do potrebe da se GUM unaprijedi i poboljša.

U tu svrhu pod okriljem Europske mjeriteljske organizacije i Europskog mjeriteljskog programa za istraživanje i razvoj, započet je istraživački projekat pod nazivom "Advancing measurement uncertainty comprehensive examples for key international standards". Sveobuhvatan cilj ovog projekta jeste da razvije što je moguće više novih primjera za procjenu mjerne nesigurnosti u skladu sa GUMom.. Osim što je jedan od internih partnera na projektu, IMBiH će na projektu učestvovati i kroz šemu tzv. „Reasercher Mobility Grant". Ova šema omogućava istraživačima iz nacionalnih mjeriteljskih instituta, da provedu određeno vrijeme radeći na projektu u nekoj od institucija koje su i same dio projekta.

Ovaj RMG će trajati 3 mjeseca i odvijat će se u nacionalnom mjeriteljskom institutu Ujedinjenog Kraljevstva - NPLu. U toku projekta, istraživač treba da razvije dodatne primjere za procjenu mjerne nesigurnosti koristeći različite metode za procjenu.

Tekst pripremila:

Merima Čaušević

Project start date and duration:

June 2018 - June 2021

Coordinator:

Dr. Maurice Cox, NPL

Internal Partners:

NPL, United Kingdom

BAM, Germany

IMBiH, Bosnia and Herzegovina

INRIM, Italy

IPQ, Portugal

LGC, United Kingdom

LNE, France

NEL, United Kingdom

PTB, Germany

SMD, Belgium

VSL, Netherlands

External Partners:

ACCREDIA, Italy

LNEC, Portugal

UKAS, United Kingdom

Unfunded Partners:

AIST, Japan

RR, United Kingdom

WADA, Switzerland

Project description

From manufacturing to medical diagnosis, organisations routinely make decisions based on measurement data. Awareness of the associated uncertainty and its impacts on quality can therefore mitigate failures, risks and increased operating costs.

To help industries accurately assess uncertainties, the Joint Committee for Guides in Metrology (JCGM) publish the Guide to the expression of uncertainty in measurement (GUM) which provides instructions, procedures and illustrative examples. Application of the GUM is still difficult for end-users and it should be revised and updated accordingly.

Within Regional Metrology Organisation (EURAMET) under European Metrology Program for Innovation and Research (EMPIR), a research project 17NRM05 EMUE named "Advancing measurement uncertainty comprehensive examples for key international standards" was awarded for funding. The project has started in year 2018 and will last until 2021.

Poster presentation

The overall aim of this project is to create comprehensive set of new or improved examples for uncertainty evaluation methods in accordance with the GUM.

IMBIH takes part in the project as an Internal Funded Partner as well as through Researcher Mobility Grant scheme with duration of three months in 2019, at the premises of the National Physical Laboratory (NPL), UK. The aim of this RMG is to develop additional examples for evaluation of measurement uncertainty by using methods different from those used in relevant documents for specific metrological fields.

Besides the impact at European level, these examples will have a great impact on the work done by national accreditation bodies and their calibration laboratories in Bosnia and Herzegovina by providing them with new developed examples. That will ensure improvement of their metrological capabilities.

Acknowledgments:

This RMG will be part of 17NRM05 EMUE of the European Metrology Program for Innovation and Research (EMPIR). The RMG will be located in UK's National Metrology Institute (NPL), which is at the coordinator of the project.

METROLOGY FOR AIR POLLUTANT EMISSIONS - 16ENV08 IMPRESS2

Sažetak

Europske direktive, koje se sve više primjenjuju postavljaju izuzetno visoke dozvoljene vrijednosti emisija za ključne zagađivače zraka kako bi smanjile globalno zagađenje. Jedan od najvećih uzročnika zagađenja zraka su emisije iz industrijskih postrojenja, gdje se javlja problem mjeriteljske prirode, odnosno jako nepraktičnih metoda koje bi trebalo da omoguće provođenje zahtjeva postavljenih u direktivama. Pod okriljem Europske mjeriteljske organizacije (EURAMET) i Europskog mjeriteljskog programa za istraživanje i razvoj (EMPIR), finansiran je istraživački projekat pod nazivom "Metrology for air pollutant emissions- IMPRESS 2". Sveobuhvatan cilj ovog projekta jeste da omogući unaprijeđen mjeriteljski pristup i metode za provedbu direktiva koje se tiču mjerenja emisija zagađujućih čestica u vazduh.

IMBIH je učestvovao u ovom projektu kroz RMG alat koji omogućava istraživačima iz nacionalnih mjeriteljskih instituta da provedu određeno vrijeme radeći na projektu u nekoj od institucija koje su i same dio projekta. Ovaj RMG je trajao 3 mjeseca i odvijao se u nacionalnom mjeriteljskom institutu Ujedinjenog Kraljevstva- NPLu. U toku projekta, istraživač je pružio pomoć u analizi zahtjeva koji se postavljaju ispred država, a tiču se izvještavanja o vrijednostima emisija u vazduh. Važno je bilo istražiti kako drugačiji pristupi u različitim dokumentima utiču na samo izvještavanje o emisijama čestica i koliko to utiče na implementaciju direktiva.

Aktivnosti u toku projekta doprinijet će unaprijeđenju i budućem razvoju IMBiHa, a ujedno i jačanju kompletne mjeriteljske infrastrukture u Bosni i Hercegovini.

Project description

European Directives coming into force are setting increasingly stringent Emission Limit Values for key air pollutants to mitigate pollution. However, the emissions industry faces an issue as a metrologically robust framework of standardised measurement methods to enforce these directives is not fully in place. Within Regional Metrology Organisation

Tekst pripremila:

Merima Čaušević

Project start date and duration:

June 2017 - June 2020

Coordinator:

Rod Robinson, NPL

Internal Partners:

NPL, United Kingdom

CEM, Spain

CMI, Czech Republic

PTB, Germany

RISE, Sweden

VSL, Netherlands

VTT, Finland

External Partners:

CNR, Italy

DTI, Denmark

DTU, Denmark

ENEA, Italy

INERIS, France

ISSI, Italy

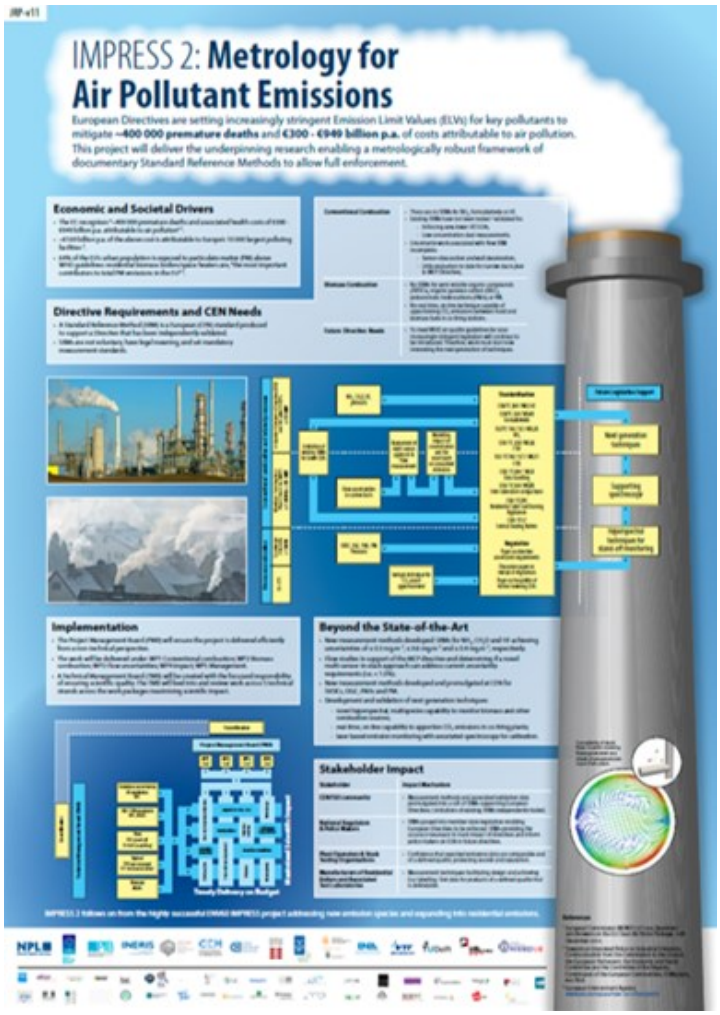
TU Delft, Netherlands

UC3M, Spain

(EURAMET) under European Metrology Program for Innovation and Research (EMPIR), a research project 16ENV08 named "Metrology for air pollutant emissions- IMPRESS 2" was awarded for funding. The project has started in year 2017 and will last until 2020. The overall aim of this project is to provide metrology to enable the enforcement of the Industrial Emissions, Medium Combustion Plant and Ecodesign Directives, and the EU's Emissions Trading Scheme.

IMBIH took part in the project through RMG scheme during three months in 2019 at the premises of the National Physical Laboratory (NPL), UK. The aim of this RMG was to investigate regulatory requirements for mass emissions and flow measurement in emission ducts from the perspective of different implementation of these regulations across Europe, including uncertainties arising from the different flow calibration scenarios allowed in European standards.

This RMG contributed to addressing the lack of uncertainty characterisation in flow measurement in emission ducts and harmonisation of uncertainty reporting. The IMBIH researcher also contributed to drafting a paper on a metrological investigation of the uncertainties in emission monitoring in



Poster presentation

industrial processes across the Europe. The main goal was to discover how the different approaches to emission reporting effect the ability to enforce existing and introduce new, stringent future legislation.

Activities and outputs of the RMG will contribute to the improvement and further development of IMBiH and help to strengthen its metrological infrastructure.

Acknowledgments:

Researcher Mobility Grants enable researchers employed by EURAMET NMIs and DIs to spend between one and eighteen months working alongside a Joint Research Project (JRP) in a different country to their employer.

This RMG was part of 16ENV08 IMPRESS 2 of the European Metrology Program for Innovation and Research (EMPIR). The RMG was located in UK's National Metrology Institute (NPL), which was also the coordinator of the project.

NOVEL TECHNIQUES FOR TRACEABLE TEMPERATURE DISSEMINATION - SIB10 NOTED

Sažetak

Međunarodna temperaturna skala (International Temperature Scale) ITS-90 iz 1990. g. predstavlja najbolju aproksimaciju termodinamičke (apsolutne) temperaturne skale, koja se periodično poboljšava. BIPM u definiciji skale ITS-90 propisuje temperaturne fiksne tačke u području od 0,65K do 1358K (-272,5°C do 1085°C), a čije su temperature izmjerene najtačnijim termodinamičkim metodama, te skalu dijeli u nekoliko područja za koje propisuje interpolacijska sredstva i matematički model za interpolaciju između fiksnih tačaka. Temperature između fiksnih tačaka definiraju se pomoću interpolacijskog termometra kalibrisanog u fiksnim tačkama. Mjerenja u pojedinim područjima ITS-90 skale imaju veće mjerne nesigurnosti od drugih. Smanjenje ovih nesigurnosti će osigurati da ITS-90 skala može učinkovitije zadovoljiti potrebe korisnika. U okviru Evropskog mjeriteljskog programa za istraživanje (EMRP) započet je projekt „Nove tehnike za sljedivo mjerenja temperature“ (SIB10 NOTED, Novel techniques for traceable temperature dissemination). Projekt je započet 2012. godine, i završen je uspješno krajem 2015. godine. IMBiH je uzeo učešće na projektu tokom 2013. i 2014. godine u trajanju od devet mjeseci kroz EMRP alat za mobilnost mladih istraživača na projektima (ESRMG/RMG). Osnovni zadatak ESRMG (IMBiH) je bio konstrukcija i karakterizacija četiri termopara od plemenitih metala tipa Au/Pt u Turskom institutu za mjeriteljstvo (TUBITAK UME). Zatim upoređivanje rezultata mjerenja novih Au/Pt termoparova sa termoparovima koji su u upotrebi u TUBITAK UME i IMBiH-u. Mjerenja se izvršena na fiksnim tačkama i metodom poređenja u opsegu od trojne tačke vode(WTP) do fiksne tačke srebra (AgFP).

Project description

Accurate and consistent temperature measurement underpins manufacturing, health and safety as well as the development of new science and technology. Temperature measurement devices are calibrated using well-defined ‘fixed points’ (specific temperatures at which certain substances freeze or melt) on the International Temperature Scale of 1990 (ITS-90). However, measurements in some regions of the ITS-90 scale have larger uncertainties

Tekst pripremila:

Nedžadeta Hodžić

Project start date and duration:

June 2012 - June 2015

Coordinator:

Dolores del Campo, CEM

Internal Partners:

CEM, Spain

CMI, Czech Republic

INRIM, Italy

IPQ, Portugal

LNE, France

MKEH, Hungary

NPL, United Kingdom

PTB, Germany

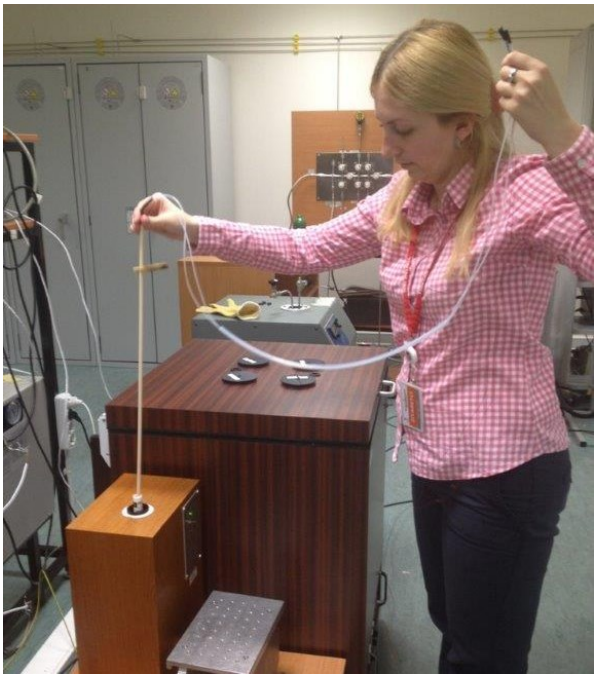
SMD, Belgium

TUBITAK, Turkey

UL, Slovenia

VSL, Netherlands

UC, Spain



Work with constructed Au/Pt thermocouples at TUBITAK UME, calibration on FP

Work with constructed Au/Pt thermocouples at TUBITAK UME, annealinig of Au/Pt

than others. Reducing these uncertainties will ensure that the ITS-90 can more effectively meet user needs, whilst new and emerging temperature measurement methods offer the potential for direct thermodynamic temperature measurements without using a defined temperature scale. The EMRP project "Novel techniques for traceable temperature dissemination" (NOTED) improved the accuracy of some regions in the ITS-90 scale, and developed direct temperature measurement methods to provide a link to thermodynamic temperature, so removing reliance on the ITS-90. High Temperature Standard Platinum Resistance Thermometers (HT-SPRTs) are defined as the standard interpolating instrument of the ITS-90 in the temperature range between 660.323 °C (freezing point of Al) and 961.78 °C (freezing point of silver). SPRTs are therefore widely used for the calibration of other instruments at high temperatures. Unfortunately they are prone to changes in their characteristics. Their susceptibility to contamination, lack of stability and poor repeatability are well known problems and even small mechanical shocks can significantly change their characteristics. These issues highlight the need for new more stable instruments for calibration at higher temperatures and in addition there is a need to develop instruments which can ensure high quality traceability and have low production costs. Research in various laboratories has shown that Au/Pt thermocouples can be successfully used as primary thermometers instead of SPRTs.

IMBiH took part in the project for a period of nine months in 2013 and 2014 through EMRP Early-Stage Researcher Mobility Grant (ESRMG). The main objective of the research was to design and construct 4 Au/Pt thermocouples with improved homogeneity, and then to determine their characteristics by repeated calibration at defined points of ITS-90. The scientific and technical objectives were:

- To develop and construct 4 Au/Pt thermocouples using a two different construction procedure.
- To characterise each of the new Au/Pt thermocouples in the fixed points of Ga, In, Sn, Zn, Al and Ag, determining the relationship between temperature and EMF at each of the fixed points. The target expanded uncertainty was 1 µV.

- To compare the characterisation results of the new Au/Pt thermocouples with the results from used Au/Pt thermocouples provided by TUBITAK and one commercially provided by IMBiH.

ESRMG(IMBiH) contributed to the assessment in JRP NOTED Task 5.1 of the suitability of Au/Pt thermocouples as a more robust replacement for HT-SPRTs, which are defined as the standard interpolating instrument of the ITS-90 in the temperature range between 660.323 °C (freezing point of Al) and 961.78 °C (freezing point of silver). The results of the research are used in a paper on "Thermoelectric properties of currently available Au/Pt thermocouples related to the valid reference function" and "a recommendation to the CCT Comparison of the performance of Au/Pt thermocouples and HTSPRTs, over the range 660.323 °C and 961.78.

Acknowledgments:

The work is being developed within the joint research project SIB10 "Novel techniques for traceable temperature dissemination" of the European Metrology Research Program (EMRP). The EMRP is jointly funded by the EMRP participating countries within EURAMET and the European Union.

METROLOGY FOR PRESSURE, TEMPERATURE, HUMIDITY AND AIRSPEED IN THE ATMOSPHERE - ENV07 METEOMET

Sažetak

U okviru Evropskog mjeriteljskog programa za istraživanje (EMRP) započet je projekt „MeteoMET - Mjeriteljstvo za pritisak, temperaturu, vlažnost i brzinu vjetra u atmosferi ". Projekt je započet 2011. godine, i završen je uspješno krajem 2014. godine. IMBiH je uzeo učešće na projektu tokom 2013. i 2014. godine u trajanju od šest mjeseci kroz EMRP alat za mobilnost mladih istraživača na projektima (RMG). Istraživanje je trajalo šest mjeseci, a provedeno je u Italijanskom institutu za mjeriteljstvo (INRIM) i bilo je vezano za karakterizaciju komore za ispitivanje automatskih vremenskih stanica. Mogućnost karakterizacije kompletne vremenske stanice bez demontaže senzora značajno ubrzava kalibraciju i doprinosi povećavanju povjerenja u mjerne rezultate i obezbjeđuje sljedivost mjerenja. Rad na ovom projektu omogućio je da IMBiH postane partner u znatno većem projektu ENV58 MeteoMet2 "Mjeriteljstvo za osnovne klimatske varijable".

Project description

The EMRP MeteoMet project is focused on the traceability of measurements involved in climate change: surface and upper air measurements of temperature, pressure, humidity, wind speed and direction, solar irradiance and reciprocal influences between measured. The project responds to the need for new stable and comparable measurement standards, protocols, sensors and calibration procedures, data-fusion and uncertainty evaluation methods, to enhance data reliability and to reduce uncertainties in climate models.

The JRP (Joint research project) structure reflects two key aspects: scientific innovation and practical traceability for end users. It includes development and testing of novel instruments as well as improved calibration procedures and facilities for ground based observations, in-situ practical calibrations and best practice dissemination. The development of novel instruments for the measurement of water vapour, the most important gas in the atmosphere and a key player in climate change, is a scientifically and technically relevant part of the project.

Tekst pripremila:

Nedžadeta Hodžić

Project start date and duration:

October 2011 - September 2014

Coordinator:

Andrea Merlone, INRIM

Internal Partners:

INRIM, Italy

CEM, Spain

CETITAT, France

CMI, Czech Republic

CNAM, France

DTI, Denmark

INTA, Spain

INTiBS, Poland

MIKES, Finland

NPL, United Kingdom

PTB, Germany

SMD, Belgium

SMU, Slovakia

SP, Sweden

TUBITAK, Turkey

UL, Slovenia

Unfunded Partners:

AU, Denmark

Chalmers, Sweden

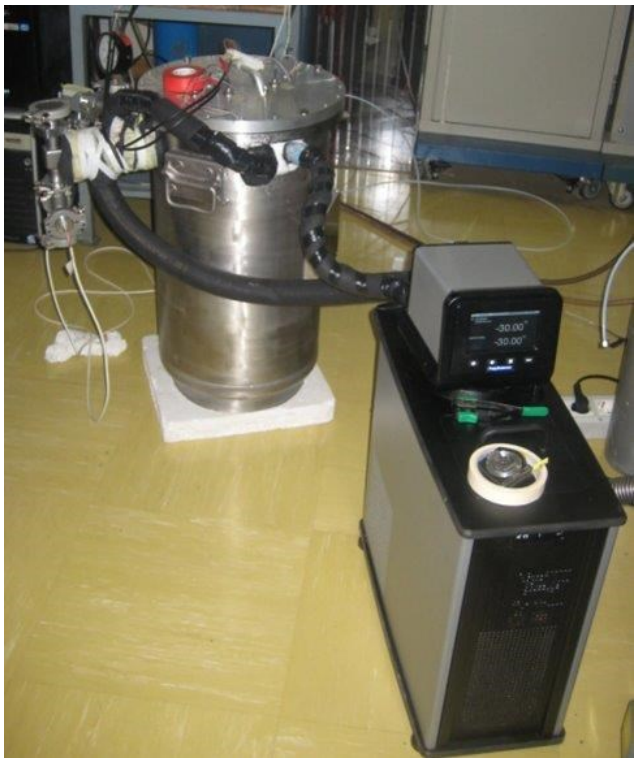
UWr, Poland

IMBiH took part in the project for a period of six months in 2013 and 2014 through EMRP Researcher Mobility Grant (RMG). The RMG(IMBiH) contributed to

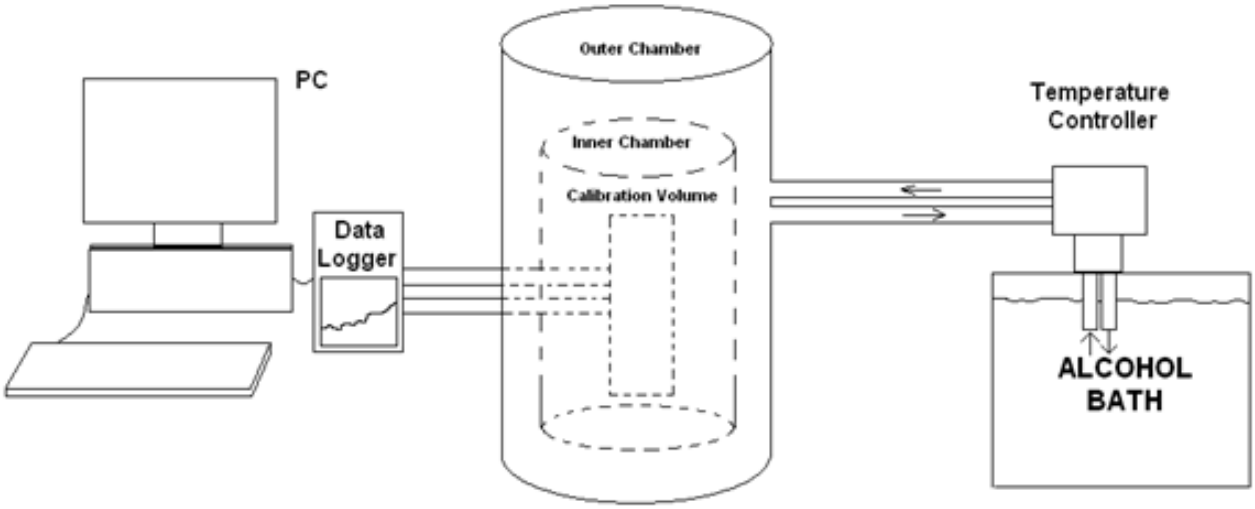
Work package 3 (WP3) of the project related to "Traceable measurement methods and protocols for ground based meteorological observations". The improvement of calibration procedures and facilities for meteorological instruments used in ground-based observations carried out within JRP ENV07 MeteoMet will lead to more robust and reliable measurements. RMG(IMBiH) evaluated the procedures developed in JRP ENV07 MeteoMet Task 3.4 for the calibration of the humidity/temperature sensors in climatic chambers. The scientific and technical objectives of RMG(IMBiH) were:

- An evaluation of procedures for the calibration of humidity/temperature sensors developed for and used in weather stations - in climatic chambers.
- An investigation of air temperature measurements and the associated influence factors during a calibration in climatic chambers.
- A comparative evaluation of guidelines and procedures used in the characterisation of climatic chambers, as available in the technical literature, for example EURAMET Guide cg-20.

Calibration methods and protocols for weather stations



Experimental equipment - chamber



Experimental equipment - connection

used in ground-based observations are diverse and often highly specific for each weather station. RMG(IMBiH) went beyond state of the art by making a comparative evaluation of such procedures in order to highlight the potential differences amongst them in terms of calibration results and calibration uncertainty estimation both for relative humidity and air temperature. Supported by INRIM, RMG researcher selected, evaluated and validated an appropriate uncertainty model for characterisation of climatic chambers, based on the results of temperature characterisation. As final activities, with support of INRIM, the results were used for writing a scientific paper on JRP tasks and for a presentation during the final JRP meeting. A workshop was organized at IMBiH in co-operation with INRIM in the frame of the project „MeteoMet and RMG activities. During this workshop Andrea Merlone, JRP Coordinator of the project presented the main activities of the project METEOMET and the next project METEOMET2. The RMG presented his activities in project METEOMET.

Acknowledgments:

This work is being developed within the frame of the European Metrology Research Program (EMRP) joint research project "METEOMET". The EMRP is jointly funded by the EMRP participating countries within EURAMET and the European Union.

INTERNATIONAL TIMESCALES WITH OPTICAL CLOCKS - SIB55

Sažetak

SI sekunda je trenutno definisana kao frekvencija mikrotalasnog prijelaza između dva osnovna stanja hiperfinog nivoa atoma cezijuma-133. Međutim, najnapredniji optički atomski satovi sada su dostigli nivoe stabilnosti i tačnosti koji značajno nadmašuju performanse primarnih standarda na bazi cezijuma, za koje su nabolji prijavljeni rezultati: stabilnost $1.4\times10^{-14}\ t^{-1/2}$ (gdje je t vrijeme usrednjavanja) i tačnost 2.1×10^{-16}. Upravo iz tog razloga, međunarodna mjeriteljska zajednica razmatra mogućnost redefinicije sekunde koristeći optičke tranzicijske frekvencije različitih hemijskih elemenata kao što su Yb, Sr, Hg itd. Predstavnik Instituta za mjeriteljstvo Bosne i Hercegovine (IMBIH) je učestvovao u okviru ovoog projekta kao kolaborator/secondee u periodu od 4 mjeseca na Institutu za mjeriteljstvo Velike Britanije (NPL).

Project description

The main aim of this secondment is to transfer general knowledge regarding time and frequency transfer, generating national time scale and strengthen the links and interactions between the two projects "Operation of the national timescale at NPL" and "International timescales with optical clocks (ITOC)". The defined deliverables of the secondment were:

- Providing IMBIH with access to expertise that will help in the development of a national laboratory for time and frequency in Bosnia and Herzegovina.
- Design of thermally controlled enclosures for the NPL hydrogen masers to improve their frequency stability.
- A report analysing how the improved maser stability will improve the stability of the NPL timescale and the benefit this would bring to optical clock frequency measurement and comparison experiments by reducing dead time uncertainties inherent in these measurements.

Tekst pripremio:

Osman Šibonjić

Project start date and duration:

May 2013 - May 2016

Coordinator:

Dr. Helen Margolis, NPL

Internal Partners:

NPL, United Kingdom

CMI, Czech Republic

INRIM, Italy

LNE, France

MIKES, Finland

OBSPARIS, France

PTB, Germany

Collaborators:

Laboratorie Souterrain de Modane, France

IMBiH, Bosnia and Herzegovina

DIALTI-POLITO, Italy

Observatoire Royal de Belgique, Belgium

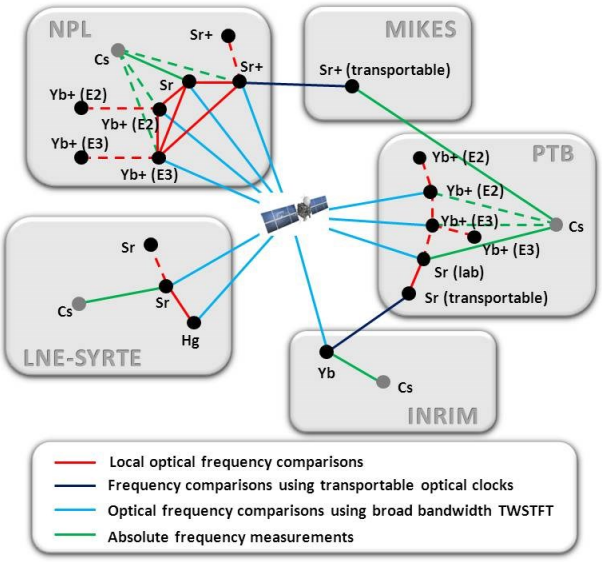
TimeTech GmbH, Germany

NICT, Japan

NIST, USA

- During this secondment NPL provided knowledge transfer related to: Technical infrastructure for time and frequency transfer, generating and steering national time scale i.e. different GNSS receivers, high resolution offset generators, hydrogen masers etc.

With increased role of masers in time scales and as references for primary frequency standards since they offer fractional frequency stabilities below $1x10^{-15}$ at time intervals on the order of hours to days. In most laboratories the only frequency source with short term stability compared to that of a maser is another maser. Therefore, it is necessary to know if there any common – mode frequency fluctuations which would not be visible in a comparison between masers. Since common mode fluctuations generally come from environmental sensitivities and these sensitivities must be known. In order to control environmental parameters temperature and humidity design and specification of the electronic components of the thermal enclosure for hydrogen masers had been made. Technical characteristics of the thermal enclosure are: temperature stability ± 0.1◦C and relative humidity stability ± 5%. The main parts of mentioned enclosure are Peltier devices. Although the principle has long been known, only state-of-the-art semiconductor materials enabled the breakthrough of Peltier technology. The strengths of Peltier technology lie in the scalability of the cooling elements, their location independence, reliability and precision control. The primary advantage over conventional compressor cooling units is elimination of flammable or environmentally harmful refrigerants. The basic idea is improving frequency stability of the hydrogen maser which is



Network topology of optical clocks between European Metrology Institutes and the methods of their comparisons

the source of UTC (NPL) using specifically designed thermal enclosure that is used for controlling environmental conditions.

Acknowledgements:

The work is being developed within the joint research project JRP SIB55 "International timescales with optical clocks" of the European Metrology Research Program (EMRP). The EMRP is jointly funded by the EMRP participating countries within EURAMET and the European Union. The secondment was made possible by means of "Exchange of Letters" signed by IMBiH and NPL.

CERTIFIED FORENSIC ALCOHOL REFERENCE MATERIALS - 16RPT02 ALCOREF

Sažetak

Prilikom rutinske kontrole vozača u saobraćaju policija koristi odobrene, verifikovane i kalibrisane instrumente za određivanje koncentracije etanola u krvi putem izdaha. U svrhu verifikacije/kalibracije tih uređaja koristi se certificirani referentni materijal (CRM) etanola u vodi.Laboratorije ovlaštene za verifikaciju ovih uređaja u BiH koriste certificirani referentni materijal etanola u vodi i trenutno ga kupuju u zemljama EU.

Institut za mjeriteljstvo Bosne i Hercegovine (IMBiH) planira proširiti svoje aktivnosti u oblasti proizvodnje certificiranog referentnog materijala, etanola u vodi.

Ukupni cilj ovog istraživanja je povećati razumijevanje cjelokupnog procesa proizvodnje certificiranih referentnih materijala. Učesnik RMG-a ispred Instituta za mjeriteljstvo BiH će kroz praktičan rad na Federalnom zavodu za istraživanje i ispitivanje materijala (BAM, Njemačka) steći potrebna dodatna znanja iz ove oblasti. Bitno je napomenuti da BAM proizvodi cetificirani referentini materijal etanola u vodi još od 2001. i da je akreditovran u ovoj oblasti u skladu sa zahtjevima ISO 17034.

Učesnik RMG-a će provoditi aktivnosti vezane za sljedivu proizvodnju certificiranog referentnog materijala (etanol u vodi), što podrazumijeva primjenu stečenih znanja iz oblasti zahtjeva ISO vodiča 31, 33, 35 i standarda ISO 17034. Učesnik RMG-a će provesti validaciju analitičke metode za kvantifikaciju etanola u vodi, test dugoročne i kratkoročne stabilnosti pripremljenih certificiranih referentnih materijala.

Project description

The overall objective of the project is to develop/establish regional research and metrological capacity for the development of certified forensic alcohol reference materials at NMIs/DIs which will be used for breath analyser type approval and calibration. By the end of the project, new production capabilities for ethanol in water reference materials will be available at NMIs/DIs. State of the art analytical

Tekst pripremila:

Rialda Kurtić

Project start date and duration:

September 2017 - August 2020

Coordinator:

Dr. Rosemarie Philipp, BAM

Internal Partners:

BAM, Germany

CEM, Spain

IMBiH, Bosnia and Herzegovina

BRML, Romania

GUM, Poland

LNE, France

MoE, Serbia

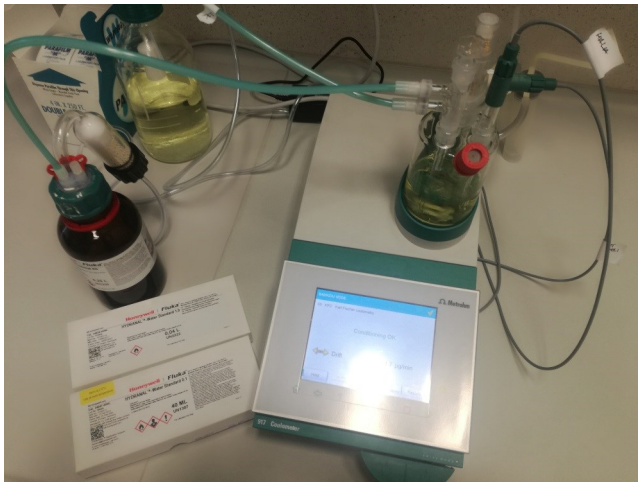
TUBITAK, Turkey

External Partners:

HMF, Greece

FTMC, Lithuania

UW, Poland



Fischer coulometer used for purity assessment of ethanol

Calibration of alcotesters by referent material prepared at IMBiH

methods for purity assessment of ethanol and for the accurate quantification of ethanol in aqueous media will be implemented at Institutes that had no access to these methods before. The project partners will maintain newly established or improved quality assurance systems according to ISO Guides 30 to 35 and standard ISO 17034, which will allow the reproducible production of the certified materials. Standard operating procedures (SOPs), draft certificates and certification reports will be further important outcomes of the project.

Certified values will be traceable to the SI and will be reported with an uncertainty budget to fulfil the requirements of the OIML (International Organisation of Legal Metrology). The project will actively support knowledge exchange with key international and European metrology and legal committees and corresponding working groups such as CCQM OAWG, EURAMET TC-MC Subcommittee for Organic Analysis and CEN/TC 367 Project Committee – Breath alcohol testers. The link to legal metrology is particularly important since the OIML recommendation R 126 is currently under review. The project will actively exchange information with OIML TC17/SC7 Breath testers and provide input to the revised recommendation if appropriate.

Furthermore, new CMC claims and the registered new reference materials in international databases such as COMAR will raise the awareness of the project results and consequently will promote uptake by end-users. Production of CRM, ethanol in water is under development activities at the Institute of metrology of Bosnia and Herzegovina (IMBIH). Within two months RMG researcher will be trained for the production of traceable CRM of the ethanol in water at Federal Institute for Materials Research and Testing in Germany (BAM). Further, RMG researcher will gain additional knowledge on verification and calibration of breath alcohol analysers at the Physikalisch-Technische Bundesanstalt (PTB, Germany). Through this research, RMG researcher will gain additional theoretical and practical knowledge which will enable further development of IMBIH capacities in the field of traceable CRM production in organic chemistry and verification of the breath alcohol analysers.

Acknowledgement:

The work is being developed within the joint research project 16RPT02 ALCOREF: Research in certification of ethanol/water CRM of the European Metrology Programme for Innovation and Research (EMPIR). The EMPIR is jointly funded by the EMPIR participating countries within EURAMET and the European Union.

WHITE RABBIT FOR INDUSTRIAL TIMING ENHANCEMENT - 17IND14 WRITE

Sažetak

White Rabbit Precision Time Protocol (PTP-WR) je danas jedna od najpreciznijih tehnika za transfer vremena, sa mogućnošću sigurne distribucije vremena sljedivog do univerzalnog koordinisanog vremena (UTC) tačnosti bolje od 200 ps, koristeći postojeću telekomunikacionu optičku infrastrukturu, te omogućavajući široku primjenu UTC vremena u industriji i istraživanju.

Project description

There is an increasing demand for synchronisation networks that provide precise time and frequency: e.g. 5G mobile communication networks, smart grids, the financial sector, and scientific users. Currently, time and frequency dissemination for most industrial applications is realised through the Global Navigation Satellite System (GNSS). However, GNSS suffers from integrity and resilience weaknesses, spoofing, hacking and disturbance due to space weather. PTP-WR can strongly outperform the commonly used techniques. It is a technique suited for dissemination of UTC(k) time scales and frequency using ordinary IT fiber-optic infrastructures.

The specific objectives of the project:

- To develop improved calibration techniques for PTP-WR fibre links that are applicable to existing telecommunication configurations.
- To develop validated techniques that meet the recommendations for the timing characteristics of primary reference clocks in Telecommunications Networks
- To improve performance of PTP-WR devices that interface better with Smart Grids.
- To demonstrate the use of PTP-WR to deliver UTC(k) time scales and frequency from NMIs to industrial users.

Tekst pripremio:

Sani Šarčević

Project start date and duration:

June 2018 - July 2021

Coordinator:

Dr. Davide Calonico, INRIM

Internal Partners:

INRIM, Italy

NPL, United Kingdom

OBSPARIS, France

RISE, Sweden

VSL, Netherlands

VTT, Finland

External Partners:

LEONARDO, Italy

NWO-I, Netherlands

OPNT, Netherlands

Sevensols, Spain

Thales AVS, France

White Rabbit link establishing and performance evaluation

This project will offer new time dissemination solution addressing the needs of industrial manufacturers, internet and telecommunication service providers and financial sector. The project's outputs will facilitate the more accurate and efficient dissemination of the SI second. The collection of data for the realisation of TAI and UTC would also benefit since PTP-WR will offer an outstanding method for clock comparisons. The project's outputs will be relevant to the development of the IEEE1588 standard, Recommendation ITU-T G.8271/Y.1366, as well as to activities of BIPM Working Group for the Advanced Time and Frequency Transfer Techniques.

Institute of Metrology of B&H actively participate in WRITE trough linked RMG project, which is realizing in National Metrology Institute of Italy - Istituto Nazionale di Ricerca Metrologica (INRIM). The main aim is to establish a PTP-WR link for the dissemination of UTC(IT) between INRIM and industrial user LEONARDO which produces passive H-masers for the Galileo (Europe's GNSS System) space segment and today uses active hydrogen masers to characterize production clocks. The fibre haul link will be 230 km long, realized in a hybrid architecture: most of the link will use dark fibre, while for the last few kilometres a DWDM channels will be utilized. The end-to-end link is mastered at INRIM in Turin disseminating UTC(IT) and terminates with at the LEONARDO premises in Novara.

IMBIH's staff will be involved in in-field link deployment and establishment, characterisation of the time dissemination, performance evaluation (stability and accuracy) and stress tests. Based on the project results and the knowledge gained, design of the optimal solution for WR-PTP time dissemination to be used by industrial users in Bosnia and Herzegovina will be developed.

Acknowledgments:

This research work has been carried out within the framework of White Rabbit for Industrial Timing Enhancement (WRITE) project. RMG was supported and organized by EURAMET.

METROLOGY FOR SMART ELECTRICAL GRIDS - ENG04 SMART GRID

Sažetak

Transformacija postojećih elektroenergetskih mreža u "pametne mreže" je ključna za uspješnu integraciju obnovljivih izvora energije u elektroenergetsku mrežu. Jedinice za merenje fazora (eng. Phasor Measurement Units - PMU) su prepoznate kao idealno riješenje za poboljšanje praćenja statičkih i dinamičkih električnih parametara unutar velikih prenosnih elektroenergetskih mreža. U budućnosti PMU-i će imati važnu ulogu u pametnim elektroenergetskim mrežama srednjeg i niskog napona za nadzor i kontrolu njihove stabilnosti. Primjetne razlike u mjernim performansama pojedinih PMU-ova su prepoznat problem, koji narušava korisnost ovih uređaja u šemama nadzora i kontrole stabilnosti elektroenergetskih mreža. Da bi se premostio jaz između potrebe za ovom vrstom mjerenja i trenutnog nedostatka mjeriteljske infrastrukture u Evropi, nekoliko evropskih nacionalnih mjeriteljskih instituta i univerziteta kroz EMRP ENG04 projekat, uložili su zajednički napor za razvoj metrološke infrastrukture potrebne za testiranje PMU-a. Jedan od glavnih ciljeva ovog projekta bio je uspostava referentnog sistema za kalibraciju PMU-a. IMBIH je učestvovao u ovom istraživanju, angažujući svog uposlenika u nacionalnom mjeriteljskom institutu Holandije (VSL), kroz ESRMG (eng. Early Stage Research Mobility Grant) projektni grant, u trajanju od šest mjeseci u 2013. godini. Dio aktivnosti istraživačkog rada u VSL-u je bio razvoj standardizovanih metoda za testiranje i kalibraciju komercijalnih PMU-a, sa fokusom na metrološku karakterizaciju postojećeg VSL-ovog referentnog sistema za kalibraciju PMU-a.

Predmet istraživanja je takođe bila analiza mjernih performansi komercijalno dostupnih PMU-a u realnim uslovima na visokonaponskim i srednjenaponskim elektroenergetskim prenosnim mrežama (u Švedskoj i Holandiji), te njihova primjena u određivanju parametara prenosnih vodova. Rezultati ove analize, provedene od strane IMBIH-a, VSL-a i SP-a, pokazali su mogućnost primjene PMU-ova za određivanje parametara prenosnih vodova (impedanse i admitanse), kao i za kalibraciju naponskih mjernih transformatora u mreži. Sveobuhvatni rezultati dobijeni u okviru ovog istraživanja podstakli su istraživački angažaman IMBIH-a u narednim EMRP-a projektima.

Tekst pripremio:

Vladimir Milojević

Project start date and duration:

September 2010 - August 2013

Coordinator:

Dr. Ir. Gert Rietveld, VSL

Internal Partners:

BRML, Romania

CEM, Spain

CMI, Czech Republic

EJPD, Switzerland

FFII, Spain

INRIM, Italy

LNE, France

MIKES, Finland

NPL, United Kingdom

PTB, Germany

PTB, Germany

SIQ, Slovenia

SMD, Belgium

SMU, Slovakia

SP, Sweden

Trescal, Denmark

TUBITAK, Turkey

EIM, Greece

TUBS, Germany

TUC, Germany

AUTH, Greece

STRAT, United Kingdom

External Partners:

AUTH, Greece

STRAT, United Kingdom

IMBiH, Bosnia and Herzegovina

Project description

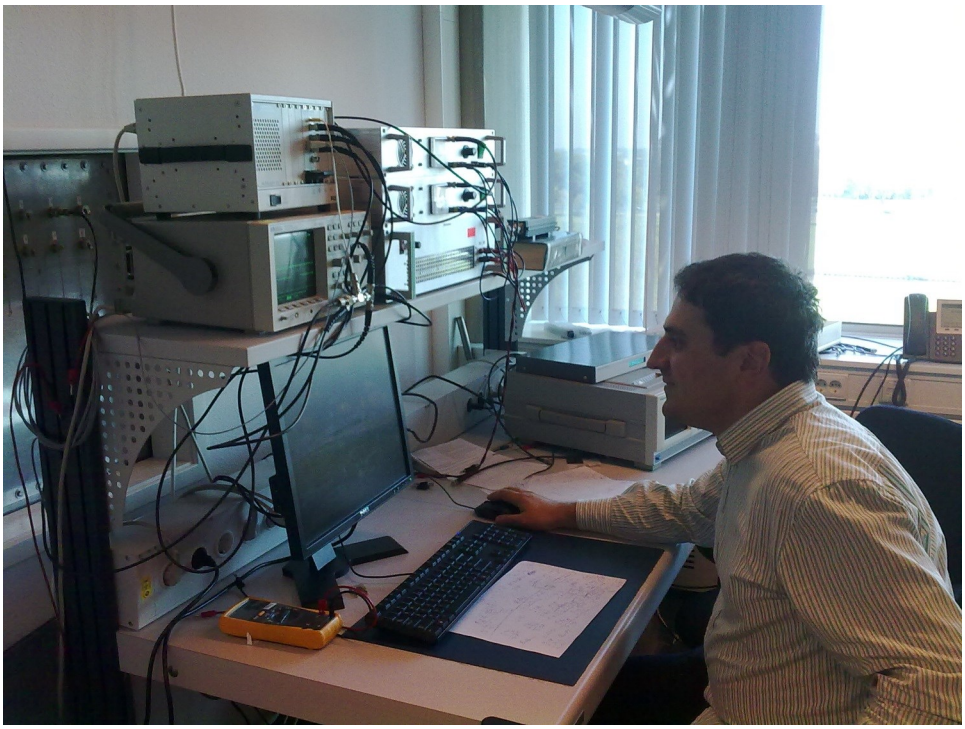
The transformation of our present electricity grids into "smart grids" is crucial for the successful uptake of renewable energy sources in the grid. Phasor Measurement Units (PMUs) are ideally suited to improve the monitoring of the static state estimation as well as the dynamic behavior of large transmission networks. In the future, PMUs will be essential for the monitoring and control of the stability of medium and low voltage Smart Grids. Differences between individual PMU performances are currently a recognized problem that undermines the usefulness of these devices in grid stability monitoring and control schemes.

To bridge the gap between the need for traceable PMU measurements and the current lack of metrology related infrastructure within Europe, a combined effort of a few European national metrology institutes and universities through EMRP ENG04 project, have been focused to development metrology infrastructure for testing PMUs.

One of project objectives was development reference setups for calibration of PMUs. The Van Sweden Laboratory (Netherlands' national metrology institute) is one of the institutes which has actively worked on the development of a reference setup. IMBIH took part in the project for a period of six months in 2013. through Early Stage Research Mobility Grant (ESRMG).

Development of standardized test methods for testing and calibration of commercial PMUs, focusing on metrological characterization of the present preliminary test setup at the guest working organization (VSL) for calibration of PMUs, has

Project logo



Laboratory work at VSL

been part of ESRMG researcher's activities carried out in VSL.

Further technical objectives were focused on examination of commercially available PMUs and their applications in High and Medium Power Networks. The series of on-site measurements were performed in Sweden and the Netherland by a team of project partners. In a collaborative effort by IMBIH, VSL and SP, the acquired PMU phasor data was subsequently analyzed. Given the results of this analysis, PMUs appear to be ideally suited for both accurate determinations of grid line parameters (impedances and admittances) as well as provide a method for calibrating voltage transformers in the grid.

Comprehensive results obtained within this research have given the research incentive to IMBIH in further EMRP projects. Similar research activities were continued in the next EMRP project (ENG 52 Smart Grid 2), where IMBIH achieved remarkable research work.

Acknowledgments:

This project is performed within the joint research project ENG04-Smart Grid "Metrology for Smart Electrical Grids" of the European Metrology Research Program (EMRP). The EMRP is jointly funded by the EMRP participating countries within EURAMET and the European Union.

ABSORBED DOSE IN WATER AND AIR - 14RPT04 ABSORB

Saţetak

Koncept upotrebe fizičke veličine *apsorbovana doza u vodi u tački* D_w (absorbed dose to water at a point) za dozimetrijske reference koje se koriste u oblasti *radioterapije malih polja* zahtjeva korišćenje relevantnih faktora korekcije koji ne zavise samo od kvaliteta zračenja, već i od tipa detektora. U zavisnosti od vrste detektora, svaki pojedinačni detektor može drastično povećati mjernu nesigurnost konačnog rezultata mjerenja, a samim tim imati znatan uticaj na vrijednost doze koja se u konačnici isporučuje pacijentu. Obzirom da je proračun navedenih korekcionih faktora teško izvodljiv, da bi se prevazišla ova poteškoća sprovedena su adekvatna naučna istraživanja bazirana na proširenju upotrebe nove dozimetrijske veličine DAP (Dose-Area Product), koja je našla široku primjenu u oblasti dijagnostičke radiologije, i na oblast radioterapije. U okviru Evropskog mjeriteljskog programa za inovacije i istraživanje (EMPIR) započet je projekt Absorb 14RPT04: „Absorbed dose in water and air". Projekt je započet 2015. godine i uspješno je završen početkom 2018. godine. U okviru projekta IMBiH je uzeo učešće na naučno-istraživačkom radu u trajanju od tri mjeseca u 2017. godini, a kroz EMPIR alat za mobilnost mladih istraživača na projektima (RMG). Zadatak RMG (IMBiH) je bio karakterizacija, utvrđivanje i razvoj protokola konverzije za pretvaranje DAP u D_w u radioterapiji malih polja uz saradnju sa Komisijom za atomsku energiju i alternativne energije (CEA). Cijelokupna analiza i tehničke aktivnosti ovoga rada su sprovedene u francuskoj Nacionalnoj laboratoriji Henri Bekerel (CEA/LNE/LNHB) u Saclay-u, Francuska, od strane istaknutih stručnjaka ispred CEA i istraživača ispred IMBiH-a.

Project description

For small beam in radiotherapy, the concept of absorbed dose at a point for the dosimetric references leads to the use of correction factors which are difficult to determine and depend not only on the radiation quality but on the detector type and may be within the detector type with each single detector itself increasing drastically the uncertainty on the dose to the patient. To overcome this difficulty CEA has proposed to extend the dose area product (DAP) concept used in radio diagnosis to radiotherapy.

Tekst pripremila:

Vedrana Makarić

Project start date and duration:

June 2015 - March 2018

Coordinator:

Dr. Jean-marc Bordy, CEA

Internal Partners:

CEA, France

BEV-PTP, Austria

CMI, Czech Republic

IFIN HH, Romania

IMBiH, Bosnia and Herzegovina

IRB, Croatia

IST, Portugal

MG, Poland

SCK-CEN, Belgium

VINCA, Serbia

Profile measurements and techniques used to map dose distributions and measure dose rates

The first part of this research work consisted of measuring dose distribution with small volume point dosimeters in order to select the most accurate and feasible techniques to determine the conversion factor to calculate D_w from DAP. The second part corresponds to interpretation and analysis of the obtained data (in terms of uncertainty budget) in order to develop and validate a conversion protocol. All measurements were realized in the beams of the "Saturne 43" medical LINAC in a water cubic phantom of 30 cm edge length and three radiation qualities of 6 MV, 12 MV and 20 MV photon beams were used. For each selected dosimeters profile measurements were performed in a 10x10 cm^2, 4x4 cm^2 and 2 cm diameter beams. In line with the goals of this research work (use of the DAP concept in small beam radiotherapy), the main focus was on the profile measurements made in the 2 cm diameter field. In order to completely cover the field surface it was necessary to split the measurements into four different squares. The profile measurements were made over four axes: horizontal, vertical, diagonal 1 and diagonal 2, respectively. After all the measurements were completed the processing of the obtained data was undertaken and maps of the 2D dose distribution were prepared. Mean profile was fitted using 4 degree polynomial from the 95% profile region to allow analytical calculation of the correction factor k_{prof}. A large deviation is observed between the detectors, in particular in the out of the field region. From 2.26 cm to 4 cm the PTW 60019 detector gives a value of 11% to 30% more than the PTW 31014 detector. This was expected because the doses are too small, so the variation of the measurements is large. Also, the presence of such a large deviation can be explained by the fact that the PTW 60019 detector has a smaller sensitive volume compared to another detector. It has a sensitive volume of 0.004 mm^3, so it is more accurate than the PTW 31014 ionization chamber with a sensitive volume of 0.015 cm^3.

Summarising the final results obtained with point dosimeters it was obvious that quite large deviations are observed between the detectors. Taking into account their sensitive volumes, as the main conclusion, an ionizing radiation detector will show better behaviour depending on its volume. However, the correction factor could significantly increase for larger user dosimeters. This is very important for determining maximum allowed detector sizes at certain distances and uncertainties due to field inhomogeneity. Therefore each type of detector will require the evaluation of conversion factors and the introduction of a new conversion table, such as those already existing in IAEA protocols. More precisely, each facility will be able to determine the conversion factors for its own detectors. Further investigations should be carried out in order to derive the conversion factors relative to other detectors.

Acknowledgments:

This research work has been carried out within the framework of 14RPT04-RMG1 contract as a part of 14RPT04 Absorb Project :"Absorbed dose in water and air". RMG was supported and organized by EURAMET.

APPLICATION OF ISOTOPE DILUTION MASS SPECTROMERTY TECHNIQUES FOR DETERMINATION OF THE HG CONTENT IN FISH SAMPLES

Tekst pripremila:

Aida Jotanović

Location of study visit:

PTB, Germany

Sažetak

U okviru EURAMET projekta ENV-51 – „Traceability for mercury measurements“ održana je obuka u trajanju od mjesec dana u laboratorijama njemačkog mjeriteljskog instituta (Physikalisch-Technische Bundesanstalt PTB) koji je u navedenom projektu imao značajnu ulogu voditelja radnog paketa za specijaciju žive. Pored teoretskog dijela i predavanja, obuka se pretežno bazirala na praktičnom radu u laboratoriji.

Cjelokupan proces obuke određivanja sadržaja žive primjenom metode Isotope Dilution Mass Spectrometry - IDMS, na instrumentu MC-ICP-MS obuhvatao je pripremu uzorka primjenom mikrovalne digestije, pripremu referentnih rastvora primjenom gravimetrijskog principa, podešavanje instrumenta, priprema za mjerenja, izvođenje mjerenja na instrumentu, kao i evaluacija podataka te proračun ukupne mjerne nesigurnosti.

Ovom studijskom posjetom značajno je unaprijeđeno praktično iskustvo te znanje iz oblasti anorganske hemije u okviru razvoja i validacije novih metoda za određivane sadržaja metala u okolišu.

Description

Project ENV-51 – „Traceability for mercury measurements“ has established the metrological infrastructure for mercury measurements and one of the tasks was to develop primary measurement procedures for mercury speciation (separates and measures the different forms / species of mercury) in water and biota in order to improve mercury monitoring. In order to develop and validate measurement procedures for Hg species in fish different methods to quantify Hg were developed and compared. One of these methods were based on isotope dilution mass spectrometry techniques developed by PTB that provides a training course within mentioned task.

A training course entitled “Application of isotope dilution mass spectrometry techniques for determination of the Hg content in fish samples”, organized by Inorganic Analysis

Laboratory work during study visit

Working Group was held from 01th August to 28th August.

The training aimed to combine theory lecture, on site practical work as well as data evaluation. The essential outcomes of the workshop have been gaining knowledge in following topics:

- Theory of IDMS based on single IDMS and double IDMS, exact matching
- Gravimetric preparation of standard solutions, BrCl stabilizer technique based on EPA 1631 method;
- Laboratory work that includes fish sample preparation using microwave digestion;
- Basic principles of ICP-MS using multicolector, mass calibration of the instrument, cup alignment, tuning, sequences, etc.
- Theory of MC-ICP-MS and isotope ratios
- Theory of Cold vapor technique
- Measurement uncertainty (basic theories based on GUM principles); Measurement uncertainty of IDMS
- Laboratory work: IDMS measurements that includes all theory lectures above mentioned
- Data evaluation + uncertainty estimation

Acknowledgments:

This study visit was realized through German-Bosnian Technical Cooperation project: "Strengthening Metrology and Quality Infrastructure in Bosnia and Herzegovina" (2015-2017).

CALIBRATION OF DOSIMETERS USED IN THE FIELD OF RADIATION PROTECTION AND DIAGNOSTIC RADIOLOGY

Tekst pripremila:

Amra Šabeta

Location of study visit:

GAEK, Greece

Saţetak

Dozimetri koji se koriste za mjerenje jonizujućeg zračenja u laboratorijama, medicinskim ustanovama, industriji i drugim relevantnim oblastima moraju biti kalibrisani prema nacionalnom standardu kako bi se osiguralo da su rezultati mjerenja u skladu sa Međunarodnim sistemom jedinica (SI). Preciznost dozimetrije zračenja se zahtjeva u zavisnosti od aplikacije primjene i ona je od suštinskog značaja kada je riječ o radijacionoj terapiji pacijenata oboljelih od tumora. Takođe, ista je potrebna i u mnogim drugim oblastima, kao što su optimizacija zračenja u oblasti dijagnostičke radiologije i nuklearne medicine, kao i za zaštitu od zračenja osoblja, pacijenata i javnosti. Stoga, precizna dozimetrija zračenja postiže se samo upotrebom kalibrisanih dozimetara.

S ciljem postizanja sto većeg nivoa preciznosti u pruzanju usluga kalibracije, ali i pridruživanja IAEA/WHO SSDL mreži zemalja članica, pokrenuta je inicijativa za realizaciju relevantnog trening kursa za osoblje Sekundarne Standardne Dozimetrijske Laboratorije IMBIH-a. U periodu od 12. septembra do 13. oktobra 2017. godine, u Greek Atomic Energy Commission (GAEK) u Atini, obavljena je edukacija na temu: „Kalibracija dozimetara koji se koriste u zaštiti od zračenja i dijagnostičkoj radiologiji“ u sklopu prijave za Fellowship NTC BOH6015 Projekta: "Establishment of the national diagnostic reference levels", podržane i organizovane od strane International Atomic Energy Agency (IAEA). Edukacija je predvođena i realizovana od strane predstavnika i istaknutih stručnjaka iz EEAE zaduženih za oblast sekundarne standardne dozimetrijske laboratorije, te dva predstavnika ispred IMBIH-a.

Description

Dosimeters used to measure radiation at laboratories, hospitals, industry and other relevant areas must be calibrated according to the national standard to ensure that the measurement results are consistent with the International System of Units (SI). Accurate radiation dosimetry is required for different applications and it is essential in the radiation therapy of cancer patients. It is also needed in many other areas, such as the optimization of radiation

Calibration of dosimeters used in the field of Radiation Protection and Diagnostic Radiology at GAEK

imaging for diagnostic radiology and nuclear medicine, and the radiation protection of staff, patients and public. In order to achieve the highest level of precision in providing calibration services, as well as joining the IAEA / WHO SSDL Network, an initiative for implementation of the relevant training course for IMBiH SSDL staff through the support of IAEA has been started. The major elements of the training programme were set up to meet the most important needs of the IMBiH Dosimetry Laboratory. Given that the recent infrastructure of the laboratory allows only radiation protection calibrations for Cs-137 gamma beams, the main focus of the training was placed on this type of calibrations. The major elements of the training framework consisted of the technical and analytical aspects on the topic: Relevant International guidelines;

- Dosimetry formalism for "Air-kerma free in air" and "Absorbed dose to water";
- Practical training on the protection level calibrations and reference irradiations for Cs-137 gamma beams/ On-the-job training for the calibration of various types of area survey meters and EPD's;
- Reference irradiation of TLD's, finger and wrist dosimeters - including blind tests;.
- Establishing X-ray radiation qualities used in the radiation protection field (N qualities);
- Calibration of the dosimetry equipment and testing the energy dependence of the area survey meters;
- Measurement uncertainty estimation and
- Quality Management System for an SSDL.

During this training course, IMBIH's representatives actively participated in the realization of all activities and successfully fulfilled the tasks assigned by the lecturers. This training enabled the laboratory staff to establish the calibration service in terms of Air-kerma and radiation protection operational quantities in Bosnia and Herzegovina, thereby supporting the economic and industrial development.

Acknowledgments:

This cooperation has been carried out within the framework of the NTC BOH6015 Project: "Establishment of the national diagnostic reference levels". The training course was supported and organized by IAEA.

METROLOGY FOR SAFE FOOS AND FEED IN DEVELOPING ECONOMIES

Tekst pripremila:

Dijana Ćorić

Location of study visit:

NIM, China

Saţetak

Pitanja vezana za sigurnost hrane glavna su briga zemalja koje razvijaju mjeriteljstvo i sisteme osiguranja kvaliteta. Shodno tome posljednjih je godina baš ta tema glavni fokus međunarodnih i nacionalnih akcija. Mikrobiološke i hemijske opasnosti, kao i onečišćenje hrane i hrane za životinje mikotoksinima (toksični metaboliti gljiva) su i više nego zabrinjavajuće.

Više od 100 zemalja implementiralo je specifična regulatorna ograničenja vezana za mikotoksine u prehrambenim proizvodima i hrani za životinje koja moraju biti podržana dobrom mjernom infrastrukturom za analizu mikotoksina u cilju provedbe i provjere proizvoda, zaštite populacija i izbjegavanja tehničkih prepreka prilikom trgovine hranom.

Ovaj projekt osmišljen je kako bi se omogućilo nacionalnim mjeriteljskim institutima da zajedno rade na jačanju infrastrukture mjeriteljstva u kontroli hrane, kako bi se osigurao prijenos znanja znanstvenicima koji razvijaju sposobnosti u ovom području, te da bi se osigurali materijali za kalibraciju i referentni materijali kojima bi se podržale laboratorije za ispitivanje kvaliteta hrane.

Predstavnici Instituta za mjeriteljstvo Bosne i Hercegovine su u sklopu ovog projekta, krajem 2018. godine, učestvovali u radionici na temu „Sigurnost hrane – mjerenja i tehnologije“, koja je održana u kineskom Nacionalnom mjeriteljskom institutu (NMI).

Description

The issue of food safety and trade is a major concern for countries developing the metrology and quality assurance systems. Ensuring the food safety has been a major focus of the international and national actions over the last years. Both microbiological and chemical hazards are of concern, including the contamination of food and feed by mycotoxins (toxic metabolites of fungi), which are significant sources of food-borne illnesses. The knowledge that mycotoxins can have serious effects on humans and

Participants of the workshop

animals has led many countries to establish the regulations on mycotoxins in food and feed in the last decades to safeguard the health of humans, as well as the economic interests of producers and traders. Over 100 countries have implemented the specific regulatory limits for mycotoxins in foodstuffs and feedstuffs, and these need to be supported by the sound measurement infrastructure for mycotoxin analysis in order to enforce and verify products, protect populations and avoid technical barriers to trade in foodstuffs. This project is designed to allow NMIs to work together to strengthen the mycotoxin metrology infrastructure; to provide the knowledge transfer to the scientists developing capabilities in this area, including periods as visiting scientists at the BIPM; and enable NMIs to provide the mycotoxin calibrant and matrix reference materials and proficiency test materials to support the mycotoxin testing laboratories within their countries.

A workshop "Food Safety Measurement Standard and Technology" was held within the Euro-Asian Cooperation of the National Metrological Institutions (COOMET) in the period from October 21st to November 9th, 2018 as part of the mentioned project. The topic of the workshop, which was organized by the Chinese National Institute of Metrology (NIM) and sponsored by the Ministry of Science and Technology (MOST) of the People's Republic of China, was Food Safety. The Chinese National Institute of Metrology continuously participates in various activities related to the metrology in chemistry and the field of food safety. The workshop "Food Safety Measurement Standard and Technology" was organized with the purpose of promoting this project, knowledge transfer and technical experience in this field.

Two representatives from the Laboratory for Chemistry represented the Institute of Metrology of Bosnia and Herzegovina at the workshop.

Acknowledgments:

Many current issues were covered in the lectures including metrological concept required for food safety, demonstrating measurement traceability, demonstrating Calibration and Measurement Capabilities (CMCs) of the laboratory, requirements according to ISO 17034 standard for reference materials producers, reference methods for analyzing inorganic and organic parameters in food, and many more. Furthermore, practical work in the laboratories was organized as well as official visits to some of the leading Chinese food producers and manufacturers of measuring equipment.

STRENGTHENING OF IMBIH CAPACITIES WITH DEVELOPMENT OF A POWER AND POWER QUALITY CALIBRATION SYSTEM

Tekst pripremila:

Esma Musić

Location of study visit:

TUBITAK, Turkey

Sažetak

BIPM (Ured za mjere i tegove) i TÜBİTAK UME (Turski mjeriteljski institut) su drugu godinu zaredom organizovali program „2019 BIPM - TÜBİTAK UME Project Placement“, u kojem je Institut za mjeriteljstvo Bosne i Hercegovine učestvovao kao pridruženi član BIPM-a. Ovaj program je za cilj imao da okupi mlade i relativno neiskusne mjeritelje iz cijelog svijeta, i odvio se u okviru CBKT (Capacity Building and Knowledge Transfer) programa BIPM-a. Program je bio individualno prilagođen svakom od učesnika. IMBiH je učestvovao sa projektom iz oblasti snage i kvalitete električne energije, koji je rađen u laboratoriji za snagu i energiju. Trajanje ovog projekta je bilo 12 sedmica, od marta do maja 2019. godine.

Projekat je osmišljen tako da učesnika obezbijedi sa svim informacijama, znanjem i potrebnim iskustvom da učesnik može uspostaviti rađenu oblast na svom matičnom institutu. Obrađeni su svi aspekti i dijelovi uspostave DSWM (Digital Sampling Wattmeter), koji predstavlja primarnu realizaciju etalona za električnu snagu, kao i kvalitet električne energije.

Također, održan je i seminar na temu CIPM MRA, koji je za cilj imao upoznavanje učesnika sa mehanizmima kojima se osigurava ekvivalencija i uporedivost nacionalnih etalona, kao i međunarodno priznanje kalibracionih certifikata. Predavanja u sklopu seminara je održalo visoko kvalificirano osoblje TÜBİTAK UME i BIPMa.

Description

The “BIPM – TÜBİTAK UME Project Placements” is TÜBİTAK UME’s contribution to the Capacity Building and Knowledge Transfer (CBKT) Programme implemented by the BIPM, which aims to increase the visibility and participation of emerging metrology systems in the world-wide metrology community. TÜBİTAK UME offers ten selected metrologists from countries that have either newly signed the CIPM MRA or have the prospect of doing so in the near term the opportunity to perform research in TÜBİTAK UME laboratories for periods ranging from one month to three months.

Measurement setup at TUBITAK

Institute of Metrology of Bosnia and Herzegovina took part in this project placement with duration of twelve weeks, beginning in March 2019 in the field of power and power quality.

Theoretical part of this project covered the basic principles of DSWM (Digital Sampling Wattmeter), from characterization of all elements, to basics of sampling using Fast Fourier Transform. Special focus was put on characterization of transducers used in this setup – current shunts and resistive voltage dividers.

Practical part of the project covered calibration using DSWM, as well as the calculation of measurement uncertainty budget. Tests which are performed on DSWM to ensure its functionality were also done.

In addition to developing the setup itself, review and work was done with TWM (Traceable Wattmeter) software which has been developed within EMPIR project TracePQM. It is aim to use this software for control and data acquisition from DSWM in IMBiH laboratory.

As a result of this project placement, expertise needed to establish the system for calibration of power and power quality meters was obtained. This will expedite the development of such a system at IMBIH, which will greatly increase laboratory capacities and also provide the existing industry with a much needed infrastructure. In the future, this can also mean further development of the industry since their needs will be met by IMBIH. It is planned to continue research on this system, as there is much which can be contributed within the field of power and power quality measurements.

Acknowledgments:

The project was performed within the 2018 BIPM - TÜBİTAK UME Project Placement. The initiative was aimed particularly at young and relatively inexperienced scientific and technical staff from BIPM Member States or Associates that have emerging metrology systems.

STUDY VISIT TO THE NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY, USA

Tekst pripremila:

Katarina Hafner-Vuk

Location of study visit:

NIST, USA

Sažetak

U okviru saradnje sa nacionalnim mjeriteljskim institutom NIST, 2014. godine ostvarena je tromjesečna studijska posjeta gasnoj laboratoriji i statističkom odjeljenju u okviru koje je rađen praktični dio pripreme smjesa, analize, te statističke obrade podataka uz primjenu konvencionalnih i alternativnih statističkih modela.

Praktični rad podijeljen je na dvije osnovne djelatnosti. Jedan dio odvija se u laboratoriji za analizu i pripremu gasnih smjesa gdje je provođena certifikacija smjese 3 ppm mol/mol propana u zraku (NIST SRM1665b). Drugi dio je vezan za programiranje, tj. pisanje koda u programskom jeziku „R“ za procjenu homogenosti, analizu outliera, te certificiranje vrijednosti uz proračun mjerne nesigurnosti.

Description

Gas chromatography with a flame ionizing detector (GC/FID) was used to test the homogeneity of the mixture (22 cylinders) propane in the synthetic air. The surfaces below the propane response peaks from the above mentioned concentrations and the reference concentrations of the approximate concentration are compared and a series of data representing the relationship of these surfaces were formed. This data is processed in written code using "R", where, with the help of bootstrap, a large number of "similar" random data were generated in order to evaluate the homogeneity of the mixture using the distribution and histogram graphics. In the case of a uniform dispersion of surface volumes (with uncertainty, i.e. reproducibility less than 0.2%), it is considered that the entire sequence of cylinders is homogeneous and is approaching certification of a unique value for the whole lot. In case of a deviation from the nominal value to a greater percentage, the approach is to certify the concentration of the analyte in individual cylinders, either separately or divided into several lots, depending on the layout of the distribution function obtained.

The two cylinders are randomly selected for analysis. In this case, the mixture of propane in the air implies the pres-

NIST
National Institute of Standards and Technology
U.S. Department of Commerce

NIST logo

-ence of CO_2, moisture / water, argon and total hydrocarbons other than propane. Since the synthetic air was used to fill the cylinders, CO_2 is usually added to the concentration present in the air on the northern hemisphere (in this case), which is about 380 ppm mol/mol. This value is not required to be certified since it is considered an impurity, thus not reported with the specified uncertainty. CO_2 analysis was also performed on GC/FID using methanizer. The methanizer is a chamber located just in front of the detector on the instrument. In this chamber there CO_2 is reduced to CH_4 in the presence of hydrogen and a catalyst. The methanization reaction has a negative Gibbs energy, i.e. the process is spontaneous in the presence of hydrogen but is kinetically limited. In the presence of metal, in this case nickel, the process takes place very quickly with 100% efficiency. The CO_2 Estimate Standard is the reference air mixture above collected Rocky Mountains, USA. This mixture was subjected to key comparison in BIPM and has a certified CO_2 value (~ 393.6 ppm). The moisture/water concentration in the gas mixtures can be investigated by means of several instrumental techniques. The most commonly used are FTIR (Fourier transform infrared) and CRDS (Cavity ring down spectrometry). Water has many spectral lines in the infrared red spectrum. CRDS is one of the most sensitive techniques since it provides a light-path of several kilometers. Moisture concentration is not required to be certified in this case. It is necessary to establish that the total water concentration is less than 1 ppm (mol/mol).

The analysis of total hydrocarbons other than propane is performed on GC/FID and confirmed using a mass spectrometer (GC/MS). Mass spectrometry allows qualitative and quantitative analysis. Qualitative analysis is carried out in so-called. "full scan" mode, i.e., analyzing all the present compounds in the sample using the appropriate capillary column (in this case HP -1MS) and the temperature program. After the identification of the total chromatogram and mass spectrum of the sample, quantitative analysis using reference materials follows. In the case of propane mixtures in the air, the concentration of other hydrocarbons expressed as propane is less than 50 ppb. The argon is analyzed using a micro GC with a thermal conductivity detector (TCD) for the analysis of permanent gases that allows the separation of oxygen and argon at Molsieve Column 5A. After confirmation of the homogeneity of the mixture and the permissible concentrations of the admixture, access to the certification of the analyte, in this case propane. The analysis is performed on GC/FID with a large number of repeats and changes in the order of cylinders in the sequence.

Acknowledgments:

This study visit was performed under the merit of National Institute of Standards and Technology, Department of Commerce, 100 Bureau Drive Gaithersburg, MD 20899; 301-975-2000.

IMPROVEMENT OF SKILLS AND KNOWLEDGE TRANSFER IN THE FIELD OF FLUID MECHANICS

Tekst pripremila:

Merima Čaušević

Location of study visit:

TUBITAK, Turkey

Sažetak

Kao pridruženi član BIPMa (Ured za mjere i tegove) Institut za mjeriteljstvo Bosne i Hercegovine učestvovao je u „2018 BIPM - TÜBİTAK UME Project Placement“, koji je organizovan pod okriljem BIPMovog programa za proširivanje mogućnosti i prenosa znanja. Cilj ovog programa bio je da se mladim i relativno iskusnim mjeriteljima pruži mogućnost za sticanje znanja i iskustva putem istraživačkog projekta kreiranog tako da odgovara iskustvu i ekspertizi učesnika. Projekat sa kojim je IMBIH učestvovao bio je u oblasti mehanike fluida, te se odvijao u laboratoriji za mehaniku fluida Turskog mjeriteljskog instituta (TÜBİTAK UME). Sveukupno trajanje projekta bilo je 6 sedmica počevši u Aprilu 2018. godine.

Projekat je osmišljen tako da se sastoji iz teoretskog i praktičnog intenzivnog treninga u pomenutoj oblasti. U toku projekta obuhvaćena su tri dijela Laboratorije za mehaniku fluida- mjerenje protoka vode, gasa i brzine vazduha, s tim da je naglasak bio na mjerenju protoka vode u skladu sa potrebama IMBIHa za razvitkom i napretkom u ovoj oblasti.

U toku trajanja projekta svi učesnici imali su mogućnost rada i prisustvovanju predavanjima od strane visoko kalificiranog osoblja TÜBİTAK UME i BIPMa.

Description

The „2018 BIPM - TÜBİTAK UME Project Placement“ was initiative between BIPM and TÜBİTAK UME under the BIPM Capacity Building & Knowledge Transfer Programme and the aim was to provide young metrologists to gain the in-depth knowledge and experience by conducting research on a subject of their choosing for a period of 1 to 3 months in TÜBİTAK UME's laboratories. The training programme was designed individually for each participant, taking into account the participant's research area and the laboratory capabilities at TÜBİTAK UME.

Institute of Metrology of Bosnia and Herzegovina took part in this project placement with duration of six weeks, begin-

Promotion of the Certificates of achievements

-ning in April 2018 and the research was conducted in the field of Fluid Mechanics. This project work provided the comprehensive and intense training on fluid flow measurements. All three parts of Fluid Mechanics Laboratory (Water Flow, Gas Flow and Air Speed) within TÜBİTAK UME were included in this training, while the emphasis was placed on the activities of the Water Flow Measurements Laboratory.

Theoretical part of this project included the research on functioning of different kinds of flow meters used in the industry or other applications and studying of the associated laboratory procedures and standards.

Practical part of the project included different kinds of calibrations that were performed, together with the calculation of their measurement uncertainty budgets.

New measurement techniques such as LDA (Laser Doppler Anemometry) and PIV (Particle Image Velocimetry), which are also used in large body of research, were shown, with the aim of gaining knowledge for the future work.

The project has certainly contributed to broadening the knowledge of IMBIH's personnel in the area of fluid flow measurements and calibrations. The knowledge and skills gained will assist in the development of the existing flow laboratories through the deployment of new methods for calibration and new measurement uncertainty budgets.

Acknowledgments:

The project was performed within the 2018 BIPM - TÜBİTAK UME Project Placement. The initiative was aimed particularly at young and relatively inexperienced scientific and technical staff from BIPM Member States or Associates that have emerging metrology systems.

BIPM 2016 “LEADERS OF TOMORROW” COURSE

Tekst pripremila:

Nedžadeta Hodžić

Location of study visit:

BIPM, France

Sažetak

U periodu od 7. do 18. novembra 2016. godine održana je obuka pod nazivom 2016 "Leaders of Tomorrow" u Međunardnom birou za mjere i utege (BIPM) u Parizu. "Leaders of Tomorrow" obuka je bila namjenjena novim i potencijalnim predsjedavajućim Tehničkih komiteta (TC) i Radnih grupa (WG) u okviru regionalnih mjeriteljskih organizacija (RMO). Cjelokupnu obuku je finansirao NIST (Nationale Institute of Standards and Technology) iz Sjedinjenih Američkih država. Prijava učesnika bila je omogućena mjeriteljskim organizacijama iz cijelog svijeta. Iz cijelog svijeta i svih regionalnih mjeriteljskih organizacija izabrano je ukupno osamnaest učesnika: SIM: 7 učesnika, AFRIMETS: 6 učesnika, COOMET: 2 učesnika, GULFMET: 1 učesnik, APMP: 1 učesnik i EURAMET: 1 učesnik.

Kao jedini učesnik iz EURAMET-a je izabrana Nedžadeta Hodžić, tehnički rukovodilac Laboratorije za temperaturu IMBIH-a. Važno je napomenuti da je ovo prva vrsta ovakvog treninga koju je organizovao BIPM na svjetskom nivou sa dužinom trajanja od četrnaest dana. Trening je omogućio učesnicima bolje razumijevanje međunarodne najbolje prakse iz oblasti mjeriteljstva.

Description

Eighteen participants, designated by their RMOs as the future leaders in the global metrology system, recently completed the two-week "Leaders of Tomorrow" training course as part of the BIPM Capacity Building and Knowledge Transfer (CB&KT) program. The course was fully sponsored by the National Institute of Standards and Technology (NIST), USA. This new course was held for the first time from 7-18 November, 2016 at the BIPM, and brought together highly respected professional experts in measurements and quality systems from leading NMIs, representatives of international organizations (OIML, ISO, ILAC), and staff of the BIPM, to teach the participants their personal perspectives on conducting measurement comparisons, reviewing the calibration and measurement capabilities and supporting the national quality infrastructure. The "Leaders of Tomorrow" course was aimed at new and potential RMO Technical Committee Chairs and RMO Work-

BIPM 2016 "Leaders of Tomorrow" course participants

-ing Group Conveners. The training provided participants with the understanding of the Global Quality Infrastructure and international best practice in metrology. By combining the theoretical and practical perspectives, participants gained a truly comprehensive overview of the internationally accepted Consultative Committees' guidelines on metrology. Participants gained practical experience through the group working sessions on the CMC review and lectures that illustrated common challenges and mistakes made in practice. A very popular part of the course was the multi-day module on laboratory priority setting and project management.

The only participant selected from EURAMET was Nedžadeta Hodžić, technical manager of the IMBIH's Temperature Laboratory. It is important to note that this is the first type of training that was organized by BIPM on the world level with duration of fourteen days. The training provided participants with a better understanding of the international best practice in the field of metrology.

Lecturers gave comprehensive talks that explained procedures and processes, but more importantly, gave their personal the perspective on the context and drivers related to their specific areas. Topics included: the CIPM MRA mechanisms and outcomes; specific guideline documents from the Consultative Committees on comparisons and CMCs; Consultative Committee strategies and structure; specific requirements of different RMOs on quality assurance; use of the KCDB; the CMC review process; and the role of international organizations - BIPM, ISO, OIML, ILAC - in the Global Quality Infrastructure.

At the group working sessions, participants evaluated real CMCs in order to demonstrate the understanding of the concepts. Groups also examined the global quality infrastructure within their countries. In the "Hitting the target" session, groups were engaged in priority setting and used the structured "log-frame" tools to plan the projects that could be implemented in their countries. This session introduced a method that can be applied to help define national needs and set priorities in metrology.

Acknowledgments:

Course was organized by BIPM as a part of their Capacity Building and Knowledge Transfer (CBKT) program, and was dully sponsored by National Institute of Standards and Technology USA (NIST).

CALIBRATION OF DOSIMETRY EQUIPMENT IN X-RAY FIELDS

Tekst pripremila:

Vedrana Makarić

Location of study visit:

VINČA, Serbia

Saţetak

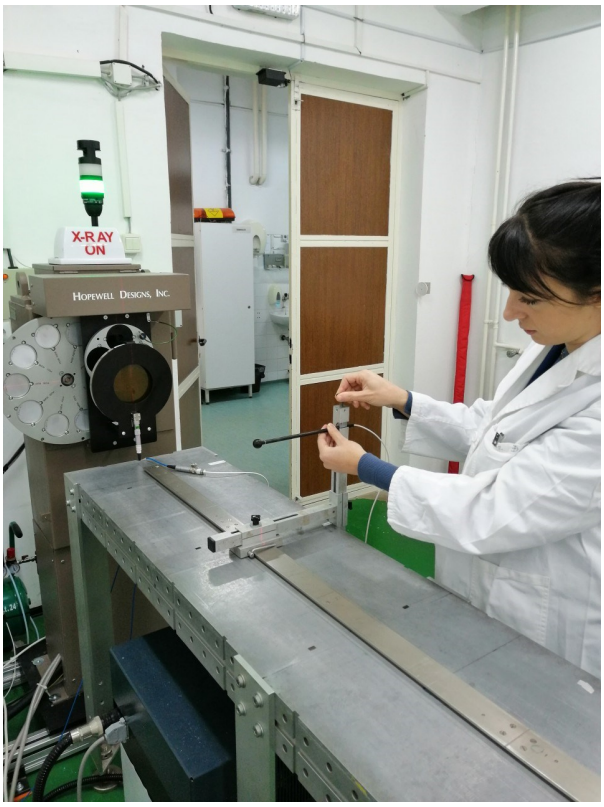
Dozimetrija je oblast od sve većeg značaja u dijagnostičkoj radiologiji. Formulacija i mjerne procedure za dijagnostičku radiološku dozimetriju su standardizovani kroz međunarodni kodeks prakse koji opisuje potrebne metologije koje se koriste u dijagnostičkoj radiologiji. Zajedničko za sve dozimetrijske metodologije je mjerenje operativne velicine *kerme u vazduhu* u polju X zracenja pod jasno definisanim uslovima. Da bi se osigurala ispravnost dozimetrijske determinacije, potrebno je da se takva mjerenja vrše sa adekvatnom opremom koja je sljediva do standardizovanih laboratorija.

S ciljem postizanja što većeg nivoa preciznosti u pružanju usluga kalibracije dozimetrijske opreme u polju X zračenja, IMBIH SSDL postaje učesnik nacionalnog IAEA projekta BOH9009: "Sustaining an Integrated Management System and Capabilities in the Regulatory Body and Strengthening Capabilities of the Dosimetry Laboratory˝ koji je počeo u 2018 g., a ima za cilj da obezbjedi potrebnu opemu za kalibracije u rendgenskim N-kvalitetima i usavrašavanje ekspertize osoblja.

U periodu od 05. novembra do 30. novembra 2018. godine, u Institutu za nuklearne nauke VINČA u Srbiji, obavljena je edukacija na temu: „Kalibracija dozimetrijske opreme u poljima X zračenja“ u sklopu prijave za Fellowship NTC BOH9009 projekta. Edukacija je predvođena i realizovana od strane predstavnika i istaknutih stručnjaka iz Instituta VINČA zaduženih za oblast sekundarne standardne dozimetrijske laboratorije, te predstavnika ispred IMBIH-a.

Description

Dosimetry is an area of increasing importance in diagnostic radiology. The formulation and measurement procedures for diagnostic radiology dosimetry have been standardized through the international code of practice that describes the necessary methodologies used in diagnostic radiology. Common to all dosimetry methodologies is the measurement of the *air kerma* in the X-ray field under defined conditions. To ensure the correctness of the dosimet-



Calibration of a 3.6 cm3 Exradin A3 ionization chamber in X-Ray fields of VINCA Dosimetry Laboratory

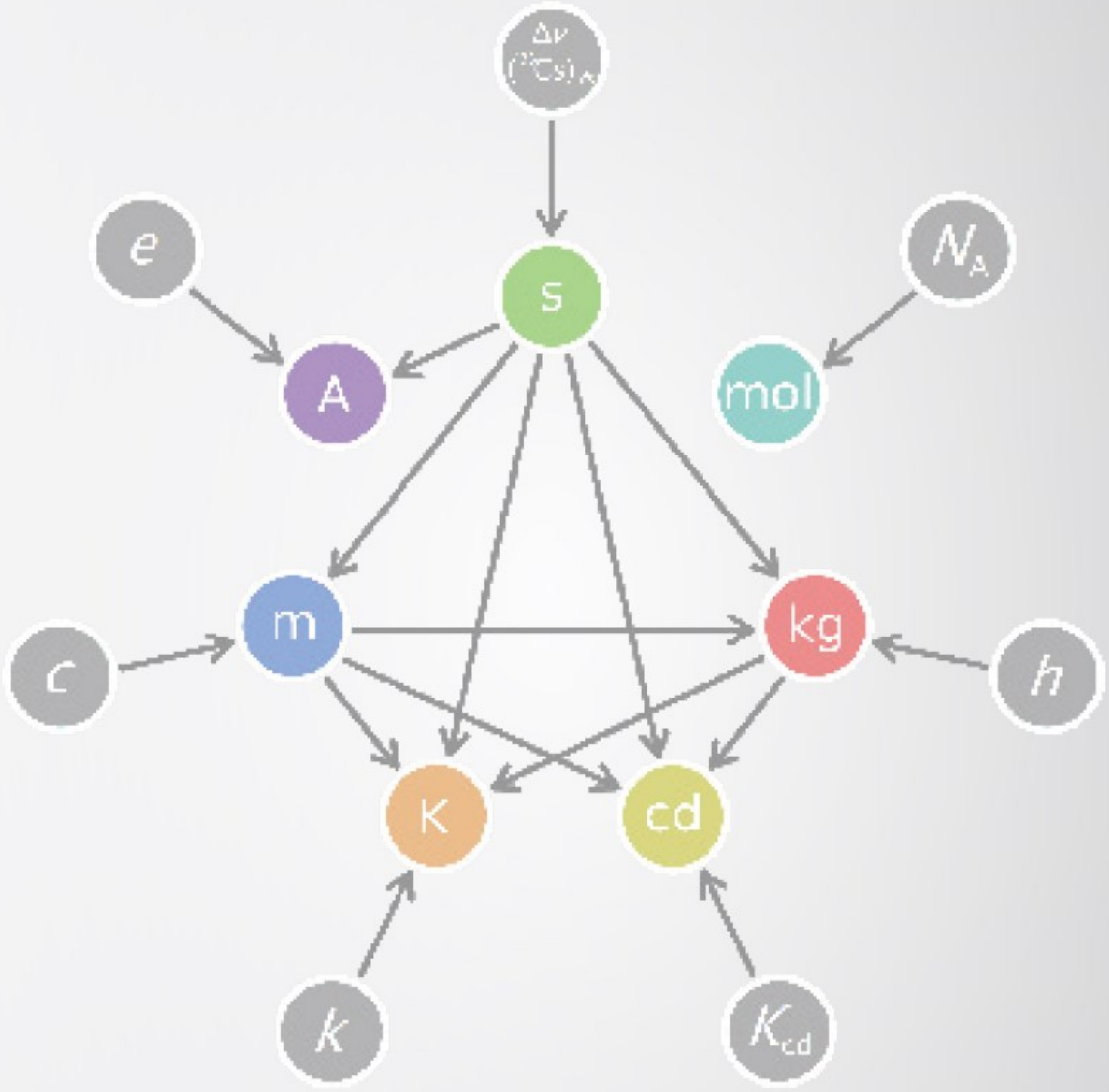
-ric determination, such measurements should be made with suitable equipment that has the calibration that is traceable to a standard laboratory.

Dosimetric methods are used in radiology departments for a variety of purposes including the determination of patient dose levels to allow the examinations to be optimized and to assist in the decisions on the justification of examination choices. Patient dosimetry is important for special cases such as X-ray examinations of children and pregnant patients and it is one of the key components of the quality control of the X-ray equipment and procedures. The basic safety standards of Bosnia and Herzegovina are prescribed in the Regulations on Radiation Protection of Workers and the General Population, but the implementation is very difficult, since there is no accredited calibration/ verification laboratory in the country.

Accordingly, the IAEA organized the relevant training course for IMBIH staff in order to enhance the ability of IMBIH staff in providing calibration services for X-ray radiation protection and diagnostic radiology dosimeters, at the highest level. The training was partly extended to the field of the research work. In fact, this research work was focused on the study and determination of the correction factor for non-uniformity and size of the radiation field using two different types of dosimeters: 3.6 cm^3 Exradin A3 spherical ionization chamber and radiochromic film dosimeter. The preliminary results of the study show the deviations in the measurements obtained with these two detectors (the field size determined by the ionization chamber is (for about 1 cm) smaller than the field size determined by the film dosimeter). The completion of this activity depends on the final conclusion that will be made on the basis of the results obtained from this research work, as some deeper analysis is still needed. The deeper analysis of the results may include another irradiation of the films, in order to confirm the initial results. However, this training enabled IMBIH staff to establish the calibration service in X-ray fields in Bosnia and Herzegovina, thereby supporting the economic and industrial development.

Acknowledgments:

This fellowship has been carried out within the framework of NTC BOH9009 Project: "Sustaining an Integrated Management System and Capabilities in the Regulatory Body and Strengthening Capabilities of the Dosimetry Laboratory". The training course was supported and organized by IAEA.



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