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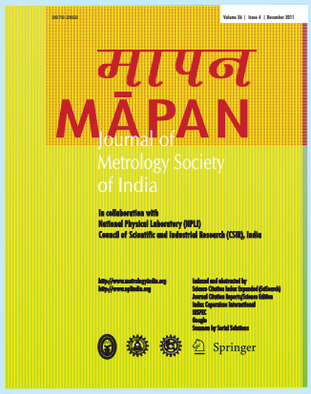
Metrology Society of India
Vol. 2, No. 2, April 2012

Highlights of this issue

Redefining Candela in Terms of Countable Number of Photons
-Dr. H.C. Kandpal



National Conference on Advances in Metrology- AdMet 2012

Mr. Prataprao Pawar, Prof. R.C. Budhani, Ms Rashmi, Mr. Anil Relia and Mr. S.R. Marathe, at the inauguration of AdMet - 2012

Second National Conference on Advances in Metrology, organized jointly by Metrology Society of India, National Physical Laboratory (NPL-CSIR) and Automotive Research Association of India (ARAI) was held during February 6- 8, 2012 at ARAI, Pune. The theme of the AdMet 2012 was **"Precision Measurement and Its Application in Auto Industry"**. The Conference focused on the key areas like advances in metrology, dimensional and surface metrology, mass and force metrology, noise and vibration metrology, thermal and optical metrology, electrical and radiological metrology, role of metrology in quality assurance, uncertainty in measurement and measurement system analysis.

AdMet 2012 was a good platform for industry professionals and research scientists to share their thoughts and innovative ideas concerning advancements in metrology, latest trends in equipment development, etc. Guests and conference delegates had an excellent opportunity to interact with equipment manufacturers and metrological experts in their respective fields.

AdMet 2012 was inaugurated on February 6, 2012 by Shri Prataprao Pawar, Managing Director, Sakal Papers Limited. Important dignitaries, Prof. R.C. Budhani, President, MSI and Director, NPL-CSIR, Shri Anil Relia, Director-NABL and Mr. S.R. Marathe, Director, ARAI graced the occasion. A key-note address on Quantum Metrology was delivered by Prof. R.C. Budhani. A total number of 70 technical papers and 15 keynote papers were presented in 14 technical sessions during AdMet 2012 covering major areas in metrology both on basic research and industrial applications.

Mr. Prataprao Pawar inaugurating the AdMet Expo

An exposition of the

products and the equipment pertaining to industry was organized concurrent to AdMet 2012. The exposition was visited by industry personnel, metrologist and general public. It provided opportunity to share and disseminate information and conduct business.

A Souvenir, containing abstracts of the technical papers, articles, keynote addresses, product information related to metrology and advertisements, was published to commemorate AdMet 2012. The conference proceedings, covering about 84 technical papers including keynotes was also published in the CD form. In its journey towards promoting awareness about metrology, MSI has established Western Chapter at ARAI-Pune as a headquarter. An executive committee has been constituted which includes industry professionals and laboratory experts.

Mr Prataprao Pawar and Shrikant Marathe visiting a stall in Expo

Redefining Candela in Terms of Countable Number of Photons

Photometry is the science of measurement of visible light in terms of its perceived brightness to human vision. It provides the physical base to the physiological phenomena by comprising the measurement of light in such a way that the resulted measurement correlates closely with the visual sensation experienced by a human observer for the same radiation. On the other hand, radiometry encompasses the measurement of energy of electromagnetic radiation, including visible light in an absolute manner.

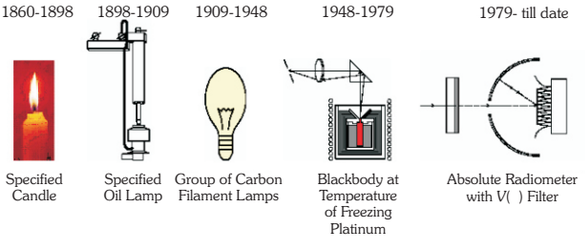
In general, there are two well known ways to realize various radiometric and photometric units, (i) source based radiometry and photometry, and (ii) detector based radiometry and photometry. In the source based radiometry and photometry source of well defined radiation such as a blackbody is used as a standard, while in detector based radiometry and photometry, self calibrating or calibrated detectors such as electrical substitution based radiometers are used as standard.

Human eye response relates the radiometric quantities (Q_e) with the photometric quantities (Q_v) through an equation:

$$Q_v \quad K_m \quad Q_e \quad V \quad d \ , \qquad (1)$$

$$0$$

where $V(\ )$ is termed as the spectral luminous efficiency function, which describes the relative spectral responsivity of the average human eye for photopic vision (light adopted). K_m is a constant giving the number of photometric units corresponding to 1 radiometric unit at 555 nm, peak wavelength of $V(\ )$ curve and is termed as maximum luminous efficacy function and its value is 683 lm/W.



Historical development of luminous intensity standards

The role of National Metrology Institutes (NMIs) in respective countries is to establish, maintain and upgrade national standards. Candela, which is one of the seven SI base units, is also established, realized and is upgraded accordingly. Historical development of luminous intensity scale (candela) is shown in above mentioned figure.

Dr. H.C. Kandpal, Head, Quantum Phenomena and Applications, NPL

In 1979, the 16th CGPM (1979) adopted a new definition of the candela, in which candela was expressed in terms of derived unit "Watt".

The candela is the luminous intensity, in a given direction, of a source that emits monochromatic radiation of frequency 540 10^{12} Hz and that has a radiant intensity in that direction of 1/683 watt per steradian.

In parallel to the advancements of various technologies, metrology has also to be modernized taking advantage of photon counting techniques. As photons are the quantum optical entities, the advanced photon counting technology provides new dimensions to upgrade optical metrology in a very straight way.

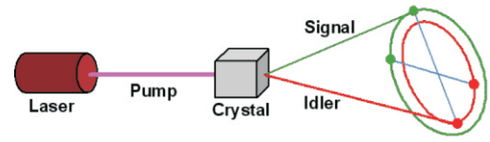
The fast progress in the area of absolute photon source and its absolute detection technologies make it timely to redefine the base unit of photometry 'candela' in terms of the countable number of photons. If the value of the quantity $Q_eV(\ )d$ in the right hand side of the eqn. (1), which is also radiant intensity is 1/683 W/sr i.e. $Q_eV(\ )d$ =1/683 W/sr, then the luminous intensity is 1 lm/sr, i.e. 1 cd. If this value of radiant power 1/683 W/sr is expressed in terms of number of photons at frequency 540 10^{12} Hz, a simple relation $P=nh$, where n is the number of photons, h is Planck constant and is the photon frequency, would give the number of photons corresponding to the luminous intensity 1 cd. The value of Planck constant is 6.626 0693(11)10^{-34} Js with relative standard uncertainty of 7 10^{-7}, value in the parenthesis is the numerical value of standard uncertainty. These values of P, ν and h give the number of photons n=4.091 9429(7) 10^{15} with relative standard uncertainty of 7 10^{-7}. Considering the actual value of n is equal

to 4.092 10^{15} s^{-1}, the candela can be redefined as: "The candela is the luminous intensity, in a given direction of source that emits photons of frequency 540 10^{12} Hz at a rate of 4.092 10^{15} photons per second per steradian in that direction".

This definition will be referred as quantum candela (quCandela). The uncertainty in the value of candela depends on the value of the Planck constant and realization of second. As second is realized with extremely less uncertainty, its contribution in uncertainty is insignificant. Although, current technologies are not capable to count photons at more than 10^{10} s^{-1} rate, however, the definition can be realized by considering a rate reduced by a fraction. Realization of candela in terms of number of photons will be of practical use, provided the uncertainty in the measurement should be equal to or less than 0.02%, which is presently achieved uncertainty in the realization of candela using cryogenic radiometry. Most of the NMIs realize candela using cryogenic radiometer. NPL India is presently establishing the facility of cryogenic radiometer for reducing the uncertainties in measurements. Large mismatch in the present operational power levels in the cryogenic radiometry (~mW) and photon counting systems (~pW) is a major limitation in the realization of the proposed definition.

Internationally, efforts are being made to develop a cryogenic radiometer working at few microwatt power levels by using a 4 K mechanical cooling engine to cool a helium pot to reduce the noise levels. In the radiometer, the test detectors are mounted under vacuum, but gate valves allow them to be interchanged while system is cold, thereby reducing measurement time. In the design, the control of the temperature stability of the reference block is optimized by using the low noise AC bridges electronics. Present challenge is to develop a photon flux cryogenic radiometer working at nanowatt power levels with uncertainty in the picowatt levels. Photon flux can be generated by three different ways, surface acoustic waves (SAWs), spontaneous parametric down conversion (SPDC) based absolute photon source and attenuated laser beam. Among above SPDC appears more prospective for realization of absolute photon source.

SPDC is a $\chi^{(2)}$ nonlinear optical process, in which inside a nonlinear optical crystal, a pump laser beam (frequency, ω_0) is converted into sequence of highly correlated down converted photons (frequencies, ω_1 and ω_2). In this process, the energy and momentum (k) remain conserved, i.e. $\omega_0=\omega_1+\omega_2$ and $k_0=k_1+k_2$.



Schematic diagram of setup for spontaneous parametric down conversion (SPDC)

According to momentum and energy conservation laws, the direction and the energy of the detected photon can be used to predict not only the existence, but the direction and the energy of the other photon of the pair also. The process of SPDC can be degenerate and nondegenerate as well, i.e. both the daughter photons can have same frequency or different frequencies. This process can therefore be arranged to allow one visible photon to indicate the existence of a second IR photon, forming the basis of an extremely useful IR measurement technique. In addition, two photons created simultaneously with entangled quantum states are essential tools for investigating the foundation of quantum mechanics, especially quantum interference, bell inequalities and quantum information processing. Recently, two particle entanglement has received much attention for their equally surprising and useful applications in the field of optical metrology, more specifically for measuring the absolute quantum efficiency of the detector. A new absolute photon source can be realized by exploiting the constraints of simultaneity and energy-momentum conservation on part on pairs of photons produced by down conversion of pump beam photons in a nonlinear crystal to specify not only the direction and wavelength of an output photon, but its emission time also, simply by recording its partner in a detector.

A facility for absolute quantum efficiency measurement of photo-detectors using SPDC is established at NPL India. The technique of correlated photon pair can also be exploited to measure the spectral radiance R_0 of the photon beam at frequency ω_2 by overlapping it with the crystal along with the direction of output beam at frequency ω_2. In this case, both the output beams at frequencies ω_1 and ω_2 are enhanced due to additional input beam R_0. By measuring the signal with an uncalibrated detector in a convenient visible region (ω_1), the absolute radiance of R_0 in the more difficult region ω_2 can be obtained simply from the ratio of the visible detector signal with R_0 on and off. The spectral radiance $R_0(\omega_2)$ in this case can be written as: $R_0(\omega_2)=(\eta_1(\omega_2)|_{on}/\eta_1(\omega_2)|_{off})-1$, where η_1 is the quantum efficiency of test detector.

In conclusion, low power cryogenic radiometry, with enhanced photon detection capability of detectors and also determination of absolute quantum efficiency of detectors may provide a solid ground for realization of candela in terms of countable number of photons.

NABL Activities

National Accreditation Board for Testing and Calibration Laboratories (NABL)

Co-operation to SAARC Nations

NABL has been regularly supporting the SAARC nations in capacity building to establish the accreditation services in their own countries. NABL has been conducting various training courses in the countries like Sri Lanka, Nepal and Bangladesh. In view of this, NABL had organized a five day residential 'ISO/IEC 17025:2005 NABL Lead Assessor training course' at Nepal Bureau of Standards

and Metrology, Kathmandu from December 26-30, 2011. Further extending its support to its neighbors, NABL has signed a memorandum of understanding with Bhutan Standards Body (BSB), Bhutan on January 10, 2012. The purpose of this memorandum of understanding is to provide NABL accreditation services to laboratories in Bhutan and also to establish National Accreditation Focal Point (NAFP) in BSB, Bhutan with technical cooperation and assistance from NABL, India. Recently NABL had organized a 'Training programme on laboratory accreditation' for the SAARC nations during February 13-24, 2012 at Indian National Science Academy (INSA), New Delhi. The training programme was attended by participants from Afghanistan and Bhutan. NABL had actively participated in the 'Conformity assessment Workshop for Asian developing Economies' at Dhaka organized by Bangladesh Accreditation Board (BAB), Bangladesh Standards and Testing Institute (BSTI) and United Nation Industrial development Organization (UNIDO) and worked on the specific actions required to develop the road map for establishing conformity assessment services in the developing nations based on their existing infrastructure.

National Seminars/ Conferences

NABL being a stakeholder participated in Indo-German Technical cooperation on 'Metrology in Chemistry-Planning Workshop Phase II' organized by NPL and PTB Germany on February 29, 2012 to strengthen the national network for quality in environment analytics as well as strengthening the metrological traceability through reference materials and proficiency schemes. Director, NABL addressed the participants about accreditation of laboratories and the significance of Reference standards for enhancing confidence in analytical methods in Chemistry. NABL officers had attended the 2nd National conference on 'Advances in Metrology' during February 6-8, 2012 jointly organized by Automotive Research Association of India, Metrology Society of India and CSIR-National Physical Laboratory, India. Director, NABL as a Guest of Honour briefed about the importance of metrology in the area of accreditation.

Training Programmes

NABL regularly organizes various training programmes for upgrading the knowledge of its officers. In lieu of this, a five days residential 'ISO/IEC 17025:2005 NABL Lead Assessor training course' on March 19-23, 2012 has been organized for NABL Officers. Also, a three day training course was organized by NABL in collaboration with Central Pollution Control Board (CPCB), New Delhi on 'Environmental Testing, Pollution Control Acts and Rules' from February 27-29, 2012 for NABL officers dealing with the environment testing laboratories. The officers were briefed about the environments acts on the establishment of environment testing laboratories and the rules to be followed on the disposal of waste. A four days training course on 'Accreditation of laboratories' under Department of Science and Technology's plan scheme "National Programme of Training of Scientists & Technologists working in Governement Sector' was conducted during March 26-29, 2012. The objective of the course was to familiarize the participants with the Accreditation procedure and the requirements of ISO/IEC 17025:2005.

Awareness Programme on Accreditation

NABL regularly conducts awareness programmes in various regions of India to familiarize the Applicant/ Accredited Testing and Calibration Laboratories with the prerequisite to apply for accreditation and the accreditation procedure. Laboratories are also briefed about the benefits of accreditation. A short glimpse of the requirements of the relevant standard (ISO/IEC 17025 or ISO 15189) is also provided to the laboratories. Also, the queries of accredited laboratories related to the accreditation are also addressed. NABL had conducted an awareness programme in collaboration with Confederation of Indian Industries (CII) for the Testing and Calibration Laboratories on January 24, 2012 at Vizag for guidance in ISO/IEC 17025:2005 requirements and familiarizing with accreditation benefits and procedures. NABL has also planned an Awareness programme in collaboration with Christian Medical Association of India (CMAI) on March 16, 2012 at Surat for familiarizing the Medical testing laboratories with the requirements of ISO 15189:2007 and accreditation benefits and procedures.

APLAC Evaluations

NABL plays an important role in the APLAC evaluation of the peer accreditation bodies. Many NABL officers are trained APLAC evaluators. In the month of December 2011, an NABL officer has participated as a Lead Evaluator for the APLAC evaluation of IA, Japan. Another NABL officer has participated as an APLAC team member for the evaluation of MNAS, Mangolia in the month of January 2012.

News and Views

Certificate of Membership

Based on the resolution of the 22nd Annual General Body meeting of the Society held on September 29, 2011, the membership committee prepared the certificates and will be distributed to the members shortly. All regional branches are requested to collect the certificates from the MSI secretariat in the NPL campus, New Delhi. A copy of the certificate is displayed for reference.


Metrology Society of India

(Registered under registration of the Society Act XXI of 1860 vide registration No. S-15149/1984)

National Physical Laboratory
Dr. K.S. Krishnan Marg, New Delhi - 110 012, India

Certificate of Membership

By approval of the Executive Council

M/s Bagson Calibration Lab Pvt Ltd

has been enrolled as Corporate Member of Metrology Society of India.

C M No. : 004

Vice President

President

Need to Assess the Economic Impact of Metrology Services in India

Metrology is enabling factor behind any new technology. Many countries have made studies on economic & social impact of metrology services but such studies are not readily available in India. Many organization, involved in metrology services in India, complaint that they find it difficult to convince the funding agencies about the importance of their service & need for development of metrology infrastructure further. Funding agencies, be it from Government, Private or Public sector wish to know the figures in terms of impact factor. Due to lack of availability of an impact factor for metrology, it sometimes does not get its due & this lowers the rate of growth of metrology infrastructure in the country. But in reality, this poor condition of our existence is because we are not able to create awareness for the importance of our services. We are not able to explain properly that our services are under constant threat from the products of other countries. In the era of globalization of economy, the products are moving towards our demand-oriented markets where the demand is so high that multinational manufacturers of these products are pushing the commodities in the market without proper calibration or test certificates. Unfortunately, there is not much community awareness and as a result, customers do not demand calibration and certification. Now the question is shall we sit idle? Why not we discuss the problem through this News Letter? This problem has been discussed in many other business meetings. It is a suggestion why not we use the MSI forum? Would MSI be useful to develop a common approach to awareness raising activities in the field of emerging technology? Since it is a vast problem, it is not possible to get the task done by an individual or organization. It is possible only when all our members use the 'Principle of Net Working'. If we are successful, we should first identify the Program. Next is the identification of the like minded organizations and willingness of the participation in the program, that information available by each organization as on date vis-à-vis information available at the national level. Next would be the analysis – 'Identification of areas for capacity building' – resources and increase in the confidence level, participation and sharing of the Information. We have already mentioned that we have very little provision for resources and trained man power. As a result, regular meeting and information sharing are non existent at this stage. Therefore, we should discus among ourselves for removal of bottle necks, so that resource/knowledge sharing and periodic review of the progress are possible. We should formulate a Road Map - like the formation of Task Force/Core group. For example, at this stage MSI has not taken the initiative for PT provider. But if we take this initiative, we can take the advantage and our enormous expenditure of ILC may be reduced. This is an example of co-operation but any step in this direction would enhance a time targeted overall action plan and programs through the identification of the activities and Institutions and signing of MOU.

Dr. A.K. Bandyopadhyay,
Vice President, MSI

Participation in an International Training Program on Metrology

A training program on Metrology entitled "The Third Country Training Programme on Strengthening of Measurement Standards Institutes of Asia Pacific Countries" was held in Thailand from the January 16 to February 24, 2012 organized by National Institute of Metrology (Thailand), sponsored by Japan International Cooperation Agency (JICA) and Thailand International Development Cooperation Agency (TICA).

Five fields of metrology namely Angle, Photometry, Radiation Thermometry, RF and Torque Standard were covered in this training program. Dr. Bharat Kumar Yadav and Mr. Vinod Kumar were selected from Apex Level Standards and Industrial Metrology, NPL (CSIR), New Delhi, India for Photometry standard and Angle standards respectively.

Technical Training Program on Quality System – Laboratory Management, Need for Calibration / Accreditation as per IS/ ISO/ IEC – 17025

A Technical training program on Quality System – Laboratory Management, Need for Calibration / Accreditation as per IS/ ISO/ IEC – 17025 was organized by CSIR-National Physical Laboratory in collaboration with Director-Legal Metrology, Department of Consumer Affairs, Krishi Bhavan, New Delhi during January 30 to February 1, 2012 at CSIR-NPL. The training program was attended by 45 Legal Metrology Officers of various States, Union Territories, Indian Institute of Legal Metrology (IILM) and Regional Reference Standard Laboratories (RRSL). The participants were trained on various topics namely the requirement of quality management system, process of implementation and

A group photo of the trainees and faculty members

Elements of IS/ISO/ IEC – 17025:2005 -Technical Requirements by Dr. R.K. Garg and Mr. A.K. Saxena, NPL; Status of the Legal Metrology Law by Shri B.N. Dixit, Director, Legal Metrology; NABL Accreditation Process by Mr. Anil Relia, Director, NABL; Estimation & Expression of Uncertainty in Measurements by Dr. A.K. Bandyopadhyay, NPL and PT Programme by Dr. K.P. Chaudhary, NPL. There were discussions on exercises in the afternoon session.

Training Programme for Legal Metrology Officials

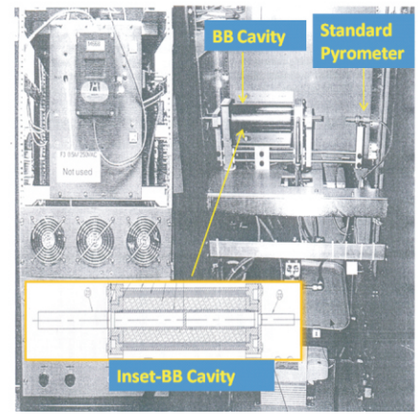
CSIR-NPL arranged a training program on March 6, 2012 with Apex Level Standards and Industrial Metrology Division (ALSIM). Officials from IILM, Ranchi participated in the training programme. The training was inaugurated by Dr. A.K. Bandyopadhyay, Head, ALSIM, NPL. Talks were delivered by Mr. Anil Kumar, Head, Mass Standards, Dr. K.P. Chaudhary, Head, Standards of Dimension and Dr. Sanjay Yadav, Pressure Standards. After the talks a visit was arranged to the following specific areas of interest: demonstration on national prototypes, exhibitions on hierarchy of standards, mass measurement, volume measurement and length measurement .

A group photo of the trainees and faculty members

Establishment of High Temperature Blackbody Radiation Source for the Calibration of IR Total Radiation Pyrometers up to 3000 °C

The new High Temperature Blackbody radiation source facility has been established in the temperature metrology activity in the range of 600 °C to 3000 °C for the calibration of total radiation thermometers/pyrometers, thermal imagers and blackbody radiation sources at the National Physical Laboratory, New Delhi. The blackbody source is MIKRON USA make (Model: M390-C2) having an emissivity of 0.997. The total Radiation Pyrometers calibration facility in the range from 50 °C to 1300 °C has already been established, where a spherical blackbody source of emissivity 0.998 is used with in-house traceability through thermocouples. In the new variable temperature blackbody radiation source the graphite cavity of 25 mm aperture is self heated by a direct current to work in the temperature range from 600 °C to 3000 °C. A standard pyrometer is used to focus the rear surface of the graphite cavity from where the radiation fall over the detector to measure and control the temperature of blackbody. The shutter with six variable aperture sizes is provided in front of the radiating source to choose size-of-source from 25.4 mm to 4.2 mm, as required by the pyrometer

under calibration. The overall uncertainty of measurement associated with blackbody source is ±1.5 °C to ±7.8 °C for the range from 660 °C to 2700 °C. Total Radiation Infrared Pyrometer (IR-TRP) is an important tool to measure the temperature in non-contact way from – 50 °C to over 3000 °C. We have calibrated infrared radiation pyrometer, MINOLTA/LAND Cyclops 152, with spectral response the wavelength range 0.8 μm to 1.1 μm on the above blackbody radiation source in the temperature range from 660 °C to 2700 °C with the estimated uncertainties of ±1.8 °C to ±7.9 °C. The facility will be useful for comparison calibration of IR-total radiation pyrometers in the above mentioned range to the accredited laboratories, user industries and temperature metrology community in the country.



High Temperature Blackbody radiation source (MIKRON USA make Model: M390-C2) and IR-Total Radiation Pyrometer Calibration Set-up

Peer Review of Quality System and Calibration Measurement Capabilities (CMCs) claims for various areas of NPL-CSIR

As a member signatory of CIPM mutual recognition arrangement, NPL-CSIR's CMCs have already been published for many areas of electrical, electronics and physico-mechanical measurements in Appendix C of MRA, available on www.bipm.fr These entries are made in Appendix C after a through review of the capabilities. First step of such review is a peer review by international experts at the concerned laboratory. To expand the recognition of CMCs in area of Magnetic standards, Ozone Standards and Chemical Metrology, Peer review of these facilities was carried out recently.

During January 17–18, 2012 Magnetic Standards of NPLI, was reviewed by Dr. Po Gyu Park, KRISS, Korea, Technical expert along with the quality expert, Mr. S.K. Kimothi, Ex. Director, ERTL/STQC. Based on the review results of NPLI's Quality System and CMCs claimed under Magnetic Standards, the reviewers recommended that, the Magnetic Standards of NPLI has demonstrated, (i) the establishment of Quality System satisfying ISO/IEC 17025:2005 standard, and (ii) demonstrated the technical competence to provide calibration and measurement services in 10 CMCs. A report has been sent to APMP for the onward transmission to BIPM/Paris.

Prof. R.C. Budhani, Director, NPL with Dr. Po Gyu Park, Mr. S.K. Kimothi and NPLI officers

Prof. R.C. Budhani, Director, NPL with Mr. James Edward Norris, Mr. S.K. Kimothi and NPLI officers

Peer Review of the Quality System and the CMC claims for Ozone Standards of NPLI, was carried out during January 11 – 12, 2012, by review comprising of a Technical expert, Mr. James Edward Norris, NIST, USA and a Quality expert, Mr. S. K. Kimothi, Ex. Director, ERTL/STQC. Based on the review results of NPLI's Quality System and CMCs claimed under Ozone Standards, the reviewers recommended that, the Ozone Standards of NPLI has demonstrated the Quality System. This is the first CMCs under Metrology in Chemistry activities.

Hand Book 2012- Metrology Society of India

The updated Hand Book 2012 containing the membership list of all members are in the process of completion. It will be distributed shortly.

Letter to the Editor

Dear Dr. Bandyopadhyay,

The Committee on Data for Science and Technology of the International Council for Science CODATA has announced the 2010 version of values of physical constants. It will be a good idea to issue the values of important physical constants as a news item in the MSI News Bulletin. I have prepared a table for values of important physical constants as declared in 2010 along with the corresponding values of 2002. For the purpose of comparison, the values of relative standard uncertainties in 2002 and 2010 are also given for each physical constant.

Quantity	Symbol	Value 2002	Value 2010	unit	u_r 2002	u_r 2010
Speed of light in vacuum	c	299 792 458	299 792 458	ms^{-1}	exact	exact
Magnetic constant	μ_0	4 10^{-7}	4 10^{-7}	NA^{-2}	exact	exact
Electric constant	ε_0	8.854 187 817... 10^{-12}	8.854 187 817... 10^{-12}	Fm^{-1}	exact	exact
Gravitation constant	G	6.674 28 10^{-11}	6.673 64 10^{-11}	$m^3kg^{-1}s^{-2}$	1.5 10^{-4}	1.2 10^{-4}
Planck constant	h	6.626 068 96	6.626 069 57	Js	5	4.4
Elementary charge	e	1.602 176 487	1.602 176 565	C	2.5	2.2
Electron mass	m_e	9.109 382 15	9.109 382 91	kg	5	4.4
Proton mass	m_p	1.672 621 637	1.672 621 777	kg	5	4.4
Fine structure constant	α	7.297 352 537	7.279 352 5698	—	6.8	3.2
Rydberg constant	R	1.097 373 156 8527	1.097 373 156 8539	m^{-1}	6.6	5.0
Avogadro constant	N_A	6.022 141 79	6.022 141 29	mol^{-1}	5.0	4.4
Molar gas constant	R	8.314 472	8.314 462 1	$Jmol^{-1}K^{-1}$	1.7	9.1
Boltzmann constant	k	1.380 6504	1.380 6488	JK	1.7	9.1
Electron volt	eV	1.602 176 487	1.602 176 565	J	2.5	2.2
Atomic mass unit	u	1.660 538 782	1.660 538 921	kg	5.0	4.4

u_r means relative standard uncertainty.

Here we observe that there is an improvement in uncertainty in all the physical constants. The improvement in uncertainty in the fine structure constant is worth noting. The uncertainty was $6.8x10^{-10}$ in 2002 while now it is less than half i.e. $3.2x10^{-10}$. Similar situation is in the measurement of Molar gas constant and Boltzman constant. As the Planck's Constant (h) appears in fairly large number of physical constants even a small decrease in uncertainty in the value of Planck's constant (h) is meaningful.

Please accept my sincere regards

Dr. S.V. Gupta
Ex. Scientist

First Announcement of 8th International conference on Advances in Metrology (AdMet 2013)

The 8th International conference on Advances in Metrology (AdMet 2013), being organized jointly by National Physical Laboratory, New Delhi (www.nplindia.org) and Metrology Society of India (MSI) (www.metrologyindia.org), will be held at National Physical Laboratory, New Delhi during February 20-23, 2013. The emphasis of AdMet 2013 will be on advances in quantum metrology with particular emphasis on time and frequency standards, electrical variables like voltage, resistance and current, development of quantum candela, precision measurements of nanoscale forces, dimensions, magnetic moments and photon flux. Special sessions will be organized on chemical and industrial metrology. National and international experts in metrology from various NMI's, laboratories and institutions will participate and share their knowledge and present their works. The organizing committee invites all the concerned researchers, metrologists, academicians, policy makers and exhibitors to submit their research work for presentation and proposals for other conference related activities. The AdMet Expo 2013, an exhibition of state-of-the-art instruments, measurement systems and related accessories will be conducted concurrently. This expo offers excellent opportunity to the manufacturers and service providers to show-case their products and services to target customers. For details please contact:

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