

Commission A report for the year 2006-2008

*(Chair: Dr. S. Politt: from October 2005 to January 2007 (resigned).
Vice Chair: Dr. P. Banerjee from October 2005 and Acting Chair
since January 2007)*

In the triennium 2006-2008, Commission A has been active through the following events. Unexpectedly Dr. Stuart Politt, Commission Chair, resigned in January 2007. Since then Vice Chairman Dr. P. Banerjee took over as the acting Chair of the Commission A.

Terms of reference of Commission A has been modified in the last GA 2005. These may further be evolved in due course of time keeping space with the rapid advancement in radio science and communication and the related technologies.

In the report of Long Range Planning Committee (LRPC) the following aspects have been emphasized for Commission A.

It is apparent that significant opportunities exist in the establishment of time standards, for example with the emergence of atomic clocks that may have stabilities of 1 in 10^{15} . Another topic of interest is Nano metrology, for which a special Tutorial session has been scheduled for the upcoming General Assembly. Opportunities also exist in the area of characterization of electromagnetic properties of materials, especially with the preponderance of metamaterials with unprecedented properties. In the area of realization and dissemination on time and frequency standards, new technologies of navigation and time, based on combined usage of atomic clocks and GPS timing must constitute new opportunities. Precise time transfer techniques via GPS and two-way-satellite time/frequency transfer and antenna measurement techniques (jointly with Commission B) are also seen as emerging opportunities.

The preparation of the session of the 2008 General Assembly in Chicago was the major activity on which most attention was given since early 2007. Dr. Banerjee with the help of very enthusiastic session conveners of the technical programme, the

overall technical programme of Commission A of the Chicago general assembly took a nice shape.

The some emerging topics have been focused in the technical session of the General Assembly. Few speakers who are eminent in respective field could be consented to give invited talks. A tutorial talk on very special emerging topic of “Nanometrology” would be given by Dr. Janssen (change of speakers). Some joint Commissions could be arranged and a good response from the delegates with contributed papers was received.

Few sessions on the emerging areas have been organized. Some of them are

- a. Primary Frequency Standards in which area very interesting developments have been reported,
- b. Characterization of EM Materials which are currently the area of major emphasis,
- c. Measurements to Support Advanced Communications Systems and
- d. Antenna Characterization which has become more and more important for smart antenna design.

Other sessions are also related to the current issues. Responses from the researchers in the respective field are quite encouraging.

The issue related to the continuation of “Leap Second” has been an important international debate. International Telecommunication Union (ITU) is supposed to decide on this based on Recommendations ITU_R_TF.460-6.

Radio Science Bulletin

One paper of Commission A is supposed to be published in June 08 issue of RSB “P. Banerjee” GPS: a powerful tool for time transfer” .

Some contacts have been developed and some of them may persuaded to submit papers for the publication in RSB

Report of China

1 Structure of EM Metrology Commission in URSI China CIE

Chairman: Prof. WANG Nanguang, China Academy of Space Technology (CAST).

Vice-Chairman: Prof. WANG Yiqiu, Peking University (PU).

Secretary: Mr. LI Zizhong, Beijing Institute of Radio Metrology and Measurement (BIMM).

There are 10 members who come from institutes, universities and academies of the country

2. Overview

In this triennium, the papers published at the conferences showed that some progresses have been made in Electromagnetic Metrology in China.

In time and frequency metrology field, the National Institute of Metrology (NIM) completed the first cesium cold atom fountain frequency standard at the end of 2003. Recently the set-up is reconstructed for further improving the magnetic shielding to eliminate the Majorana transition. NIM now has constructed the second fountain standard with minor size with physical package of 0.6m×0.8m×1.8m and better performance, it can be transportable with rollers. Recent evaluation of the frequency uncertainty of the set-up is less than 3×10^{-15} .

For hydrogen maser frequency standard, Shanghai Astronomical Observatory (SO) has completed the prototype of small size passive hydrogen maser standard and started to manufacture this type of standard in 1998. Now they are struggling for further reducing the size of the standard and improving the performance by using some new technique of cavity, magnetron cavity. And BIMM are now working on the development of hydrogen maser frequency standards in both active and passive modes. Their maser is particular in using the sapphire cavity to reduce the volume of physical package.

For the Rubidium optical pumped gas cell frequency standards, Wuhan Institute of Physics and Mathematics (WIPM) recently has made a miniaturized cavity-cell assembly and tested the frequency shift

characteristics. The results seem very promising. In collaboration with PU, WIPM, and BIMM, CAST is working on the compact rubidium gas cell standards, mainly for onboard use.

The cold atoms are very promising for new generation of frequency standard. Groups at PU and Shanghai Institute of Optic and Fine Mechanics (SIOM) have made some proposals in this field. Included are the laser decelerated continuous atomic beam fountain, a new space atomic frequency standards for working on the micro-gravity environment and a novel compact and transportable cold atom fountain clock. The experimental work on small rubidium fountain clock has been carried out at SIOM.

In the recent few years the optical frequency standards have shown a revolutionary progress due to the breakthrough of the optical synthesis technique by use of the frequency comb produced from a fs pulse laser. Now there are several groups in China have initiated the work in this direction, included NIM, Institute of Physics, PU, WIPM, Shanghai East-China Normal University, etc. At PU, a device for observing the optical Ramsey pattern of Ca atomic beam has been constructed, and the Ramsey signal has been obtained recently. Shanghai East-China Normal University has already realized an optical frequency chain covering from microwave to optical frequencies. The international comparison of four fs laser frequency synthesizers, namely East-China Normal University (ECNU-C1), BIPM-C2, NIST-BB1 and BB2 showed surprisingly high level of uncertainty approaching 10^{-19} .

In quantum metrology field, a proposed program for SI base units such as kilogram, ampere to fundamental and atomic constants is under consideration. The Quantum Hall Resistance Standard at NIM has got excellent result in BIMP key comparisons, shown that the standard has the top performance in the world. And new reference standards, the Josephson Voltage Standard and Quantum Hall Resistance Standard were established at Beijing Orient Institute of Measurement and Test (BOIMT) recently.

In DC and LF Metrology field, BOIMT realized the digital simulation impedance standard. And the national patent right was got for the new concept of the Digital Simulate Impedance. A DC zero magnetic field standard was set up in 2007 at BIOMT. And an alternating weak magnetic field standard was established at Yichang Institute of Testing Technology, ranging from $1 \times 10^{-11} \text{T}$ to $3 \times 10^{-6} \text{T}$ with uncertainty $2 \times 10^{-3} \text{T}$ to $7 \times 10^{-3} \text{T}$ at frequencies 10Hz to 10kHz.

In RF and microwave metrology field, the measurement technique for emissivity of microwave blackbody, a high accuracy frequency and phase measuring technique, a new noise source calibration method, calibration technique for Compact Range CR), an optimizing design on electromagnetic characteristic of microwave band blackbody calibration target, the experiment of the frequency-stirred technique for the reverberation chamber, time-domain transmission coefficients of skeletal bi-conical antennas in test sites,....., the papers reported recent years by BIMM scientists showed that the measurement standards and calibration techniques in RF , microwave and mm band have made much progress and improvements at BIMM.

Conference Organized by China

1. The Internal Conference of Metrology and Measurement 2005 (ICMM 2005) was held in Xining City, Qinghai Province, China, Sep. 2005.
2. The Internal Conference of Metrology and Measurement 2006 (ICMM 2006) held in Nanchang City, Jiangxi Province, China., Sep. 2006.
3. The International Conference of Metrology and Measurement 2007 (ICMM 2007) was held in Xiangshan Park Hotel, Beijing, China, in Sep., 2007.

URSI China CIE (Beijing) is applying that Beijing is a candidate of the Venue of the next URSI General Assembly - URSI GA 2011.

