



# **The Abdus Salam ICTP – Boston College partnership for training in GNSS Science and Technology,**

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Head,

Aeronomy and Radiopropagation Laboratory

**United Nations/Azerbaijan/United States of America/European Space Agency  
Workshop on the Applications of Global Navigation Satellite Systems  
Baku, Azerbaijan, 11 – 15 May 2009**

# ICTP and BC



- ❑ The ICTP promotes Advanced Scientific Research in developing countries through schools, colleges, workshops and other training activities both at ICTP and in countries where such programs are needed. In particular the **Aeronomy and Radiopropagation Laboratory** has been concerned with ionospheric research of interest to the European Navigation Satellite programs and GNSS ionospheric related science and applications for a number of years, involving scientists from developing countries particularly from South America and Africa.
- ❑ Boston College through the **Institute for Scientific Research** has been involved in research using GNSS for ionospheric and space weather research. It provides ionospheric expertise in relation with navigation systems developed by the Federal Aviation Administration of the USA. It has also been involved in international programs related to GNSS studies. These studies have included scientists from developing countries from South America, Asia and recently from Africa.

# Partnership genesis



- ❑ Participation of both the **BC Institute for Scientific Research** and the **ICTP Aeronomy and Radiopropagation Laboratory** in the meetings of the International SBAS – IONO Group organized mainly by the USA FAA and ESA (first meeting in 1999).
- ❑ P. Doherty (BC) and S. M. Radicella (ICTP) directed the **Workshop on the Future of Ionospheric Research for Satellite Navigation and Positioning: its Relevance for Developing Countries** held at the ICTP in Trieste, Italy, 4-15 December 2006.
- ❑ At the Workshop a partnership between both Institutions towards the development of GNSS science and technology activities in developing countries with particular emphasis on Africa was discussed.



# Present partnership



- ❑ Cooperation between **ICTP** and **BC** for the promotion of GNSS Science and Technology teaching, training, research, projects and professional activities in developing countries with particular emphasis on Africa.
- ❑ The types of cooperation include:
  - ✓ Conducting training workshops for university lecturers/professors and students from African countries in the area of GNSS science and applications to create a knowledgeable workforce in that continent.
  - ✓ Providing African universities with equipment and training elements to carry out research and capacity building for GNSS applications and science.
  - ✓ Providing follow-up activities and periodic evaluation of the progress made in the participating universities.
  - ✓ Providing opportunities for north-south and south-south international scientific collaboration in the field of GNSS applications in space physics.

# First step: Satellite Navigation Science and Technology

## Trieste, 23 March- 9 April 2009



The Abdus Salam  
International Centre for Theoretical Physics

### Satellite Navigation Science and Technology for Africa

23 March to 9 April 2009  
Miramare, Trieste, Italy

The Abdus Salam International Centre for Theoretical Physics, in co-operation with the Boston College of the United States, is organizing a **Workshop on Satellite Navigation Science and Technology for Africa** from 23 March to 9 April 2009. It will be directed by Professors P. H. Doherty (Boston College, USA) and S. M. Radicella (ICTP, Trieste, Italy).

Local Organiser: Prof. S. M. Radicella (ICTP, Trieste)

#### WORKSHOP PURPOSE AND TOPICS:

Global Navigation Satellite Systems provide an enabling technology that can make major contributions to economic growth and societal betterment worldwide. International organizations have recognized this fact and have initiated the deployment of infrastructure to allow Africa to exploit this technology. Unfortunately, these developments have been slow due to limited funding and a short supply of educated workers to support GNSS activities in Africa. The educational programme of our workshop is directed to prepare a future knowledgeable GNSS African workforce that is necessary for the sustainability of this revolutionizing science and technology.

The workshop will include formal lectures and hands-on practice in GNSS architecture and signal structure, hardware, state of the art applications and scientific exploration using GNSS. Some of the applications that will be demonstrated include remote sensing, precision agriculture, mapping and surveying, air, land and sea navigation, and emergency location systems. In addition, lectures and demonstrations of using GNSS for scientific exploration will also be addressed. In particular, space weather and ionospheric research activities will be described in an effort to initiate space science research programs in African universities.

The workshops will be taught by worldwide experts in GNSS science and technology.

**PARTICIPATION:** The Workshop calls for the participation of a number of lecturers/professors of African universities and research centres to promote the establishment of GNSS programmes and research at the university level in the region. The selected participants will be entitled to propose the participation in the Workshop of up to three students from their university or research centre. Although the main purpose of the Centre is to help researchers from Africa, through a programme of training activities within a framework of international co-operation, scientists from developed countries are also welcome to apply at their own expense. As the activity will be conducted in English, participants should have an adequate working knowledge of this language.

As a rule, travel and subsistence expenses of the participants should be borne by the home institution. Every effort should be made by candidates to secure support for their fare (or at least half-fare). However, limited funds are available for some participants, who are nationals of, and working in, an African country. Such support is available only for those who attend the entire activity. There is no registration fee.

#### HOW TO APPLY FOR PARTICIPATION

The application form can be accessed at the activity website  
<http://agenda.ictp.it/view.php?22025>

Once in the website, comprehensive instructions will guide you step-by-step, on how to fill out and submit the application form.

Deadline for requesting participation: **1 December 2008**

#### ACTIVITY SECRETARIAT:

Telephone: +39-040-2240576    Telefax: +39-040-2240585  
E-mail: [sm2025@ictp.it](mailto:sm2025@ictp.it)    ICTP Home Page: <http://www.ictp.it/>

Trieste, October 2008



International Committee on  
Global Navigation Satellite Systems

#### CO-SPONSORS:

Boston College, USA  
Institute of Navigation, USA  
Federal Aviation Administration, USA

#### Directors

P. Doherty Boston College, USA  
S. Radicella ARPL-ICTP, Italy

#### Invited Lecturers

B. Arbesser-Rastburg ESA-ESTEC, The Netherlands  
S. Basu Boston College, USA  
A. Coster MIT Haystack Lab, USA  
P. Ege Stanford University, USA  
D. Grejner-Brzezinska Ohio State University, USA  
K. Groves AFRL, USA  
C. Hergarty MITRE Corporation, USA  
M. Hernandez-Pajares Technical Univ. of Catalonia, Spain  
W. Kleczynski US Naval Observatory, USA  
M. Miller AFRL, USA  
B. Nava ARPL-ICTP, Italy  
L. Cirraolo IFAC, Florence, Italy  
S. Skene Univ. of Calgary, Canada  
C. Valladares Boston College, USA  
T. Walter Stanford College, USA  
P. Ward Navward GPS, USA

#### DEADLINE

for requesting participation

**1 December 2008**

The sponsors

[http://cdsagenda5.ictp.trieste.it/full\\_display.php?smr=0&ida=a08148](http://cdsagenda5.ictp.trieste.it/full_display.php?smr=0&ida=a08148)

# Lectures and hand-on training



*A number of experts from USA, Europe and Africa gave lectures and hand-on training to the participants.*

## □ The main topics

### ▪ First Week:

- ✓ GPS Space and Control Segments
- ✓ GPS Measurements and Error Sources
- ✓ Precise Positioning
- ✓ High Accuracy GPS
- ✓ GPS Receiver Design

### ▪ Second Week:

#### ✓ Applications:

- Autonomous GPS
- Mapping and surveying
- Precision agriculture
- Air navigation
- Atmospheric monitoring and mitigation

### ▪ Third Week:

#### ✓ Science:

- Ionospheric effects on GNSS operations
- Ionospheric TEC modelling
- Ionospheric scintillations

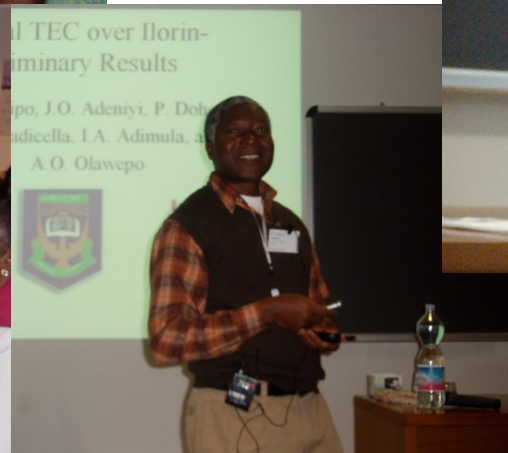


# Participants

15 Professors from different universities of 9 countries in Africa each accompanied by a team of 2-3 graduate students or junior scientists.



# Lectures





# Hands-on activities



# The first day of the Activity



The first day of the Workshop, 23 March 2009, was dedicated to illustrate and discuss about the development of Satellite Navigation Science and Technology in Africa and about the uses of these technologies in different areas of social and economic relevance.

Representatives of the following international and national organizations and institutions interested in satellite navigation related activities took part to the event of the first day of the workshop:

- ✓ Bureau of Development of Telecommunications, International Telecommunication Union
- ✓ ICG Secretariat, Office for Outer Space Affairs, United Nations Office at Vienna
- ✓ Human Resources Science & Technology Department, African Union Commission
- ✓ European Space Agency
- ✓ US Institute of Navigation
- ✓ US Federal Aviation Administration
- ✓ Italian Space Agency

# Support to African teams



- ❑ A number of computers was donated by ICTP to several African research teams present at the training activity to facilitate scientific work in collaboration with ICTP and BC.
- ❑ A number of GPS dual frequencies receivers are going to be made available with support from the USA to the African research teams to start ionospheric research work in collaboration with BC and ICTP.

# Planned Follow-up actions



In the framework of the BC-ICTP partnership a series of follow-up actions are planned:

- ❑ Possible coordinated and collaborative research projects on GNSS Science will be discussed at the IHY Africa 2009 meeting in Livingstone, Zambia, 7-12 June 2009 by P. Doherty (BC) and S. M. Radicella (ICTP)
- ❑ Taking into account the large number of teams from Nigeria trained at the Trieste activity, a Follow-up Workshop on GNSS Science Applications is being organized in Abuja to be carried out in November 2009 including:
  - ✓ Awareness sessions for local decision makers from different organizations
  - ✓ Updating of scientific topics
  - ✓ Discussion on specific scientific projects to be done in Nigeria using GNSS and including collaboration with BC and ICTP
- ❑ At request of the Egyptian participants a Workshop on GNSS Science will be organized in Cairo in December 2009 or January 2010 that should include also Awareness sessions.



Thank you for your attention