

2384-26

**ICTP Latin-American Advanced Course on FPGA Design for Scientific
Instrumentation**

19 November - 7 December, 2012

Multidisciplinary Laboratory at ICTP

CRESPO Maria Liz
*ICTP Multidisciplinary Laboratory
Via Beirut 31, 34100
Trieste
ITALY*



The Abdus Salam
International Centre
for Theoretical Physics

Multidisciplinary Laboratory at ICTP

Maria Liz Crespo
Research Officer
ICTP MLab



The Abdus Salam
International Centre
for Theoretical Physics

Founded in 1964 by the Nobel
Prize Abdus Salam

Tripartite agreement between
the Italian government, the
International Atomic Energy
Agency (IAEA), and UNESCO

ICTP is

- Advancing scientific expertise in the developing world
- Supporting science in the developing world
- Fostering advanced studies in physics and mathematics
- Develop high-level scientific programmes keeping in mind the needs of developing countries, and provide an international forum of scientific contact for scientists from all countries





The Abdus Salam
International Centre
for Theoretical Physics

Research Programmes



FILTER by date

10/06/2012

FILTER by type

- ☒ Activities in Trieste
- ☒ Activities outside Trieste
- ☒ Seminars
- ☐ Hosted activities

Scientific Calendar

Each year, ICTP organizes more than 60 international conferences, workshops, and numerous seminars and colloquiums.

- Interested in **attending an activity**? Complete an online application form: Events in the calendar that have an "smr" number require an application. Click on the activity and complete the online application form.
- NEW: Call for Proposals** for 2013 activities now online.
- External organizations** can pay for and organize their own high-level scientific and cultural events at ICTP. Details for these "Hosted Activities" are available in the **Logistic Guidelines for Hosted Activities**.
- Travel fellowships** for ICTP conferences and workshops are available.
- PDF versions of the updated scientific calendars are available for download: **2012, 2011, 2010, 2009, 2008, and 2007.**

Pre-PhD Programmes



Postgraduate Diploma Programme

Postgraduate Diploma Programme in General Physics

ICTP/IAEA Sandwich Training Education Programme

Degree Programmes



Joint ICTP/SISSA PhD in Physics or Mathematics

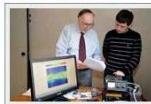
Joint PhD Fluid Mechanics

Joint Laurea

Joint ICTP/Collegio Carlo Alberto

Masters Complex Systems

Career Development



Federation Scheme

Associates Scheme

Laboratory Opportunities



TRIL

ICTP/ELETTRA Users

ICTP Labs

Scientific Outreach



Office of External Activities

ICTP in Brazil

ICTP in Africa

Science Dissemination Unit

African Review of Physics

- International and Regional Training Activities
- Pre-PhD Programmes (Diploma, STEP)
- Degree Programmes (Master and Doctoral degrees)
- Career Development (Federation and Associate Schemes)
- Office of External Activities (OEA)
- Laboratory Opportunities (TRIL)

Research and Training Activities related to MLab Programme

- **ICTP-INFN Microprocessor Laboratory**

R&D of scientific instrumentation, based on modern technologies, for experimental physics

Stimulate synergic cooperation with other research laboratories in the Trieste area as well as at national and international level

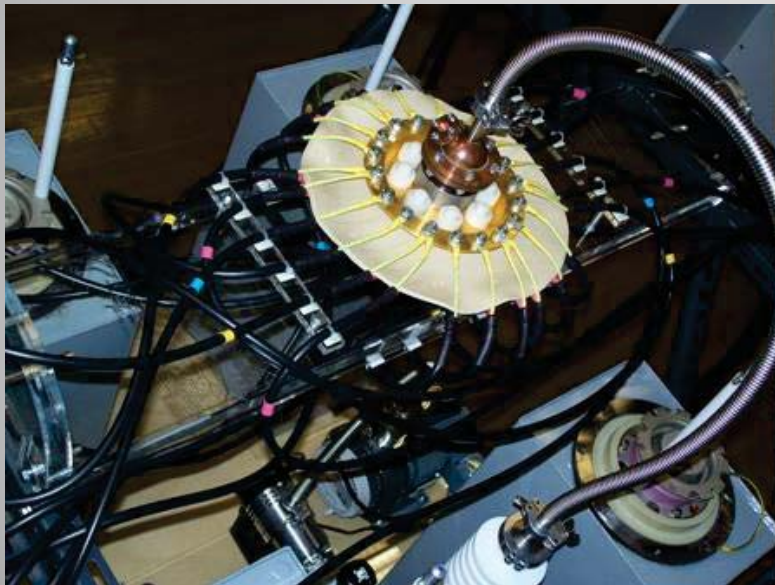
Involve visiting scientists and PhD students from developing countries in hands-on activities. The knowledge and experience gained through experimental training enhances their professional autonomy and at the same time strengthens their ability to conduct interdisciplinary research in cooperation with heterogeneous research teams

- **ICTP Multidisciplinary Laboratory**

- Dense Plasma-Focus Device for Applications in Material, Medical, and Plasma Sciences
- X-Ray Imaging and Analysis for Culture Heritage Conservation

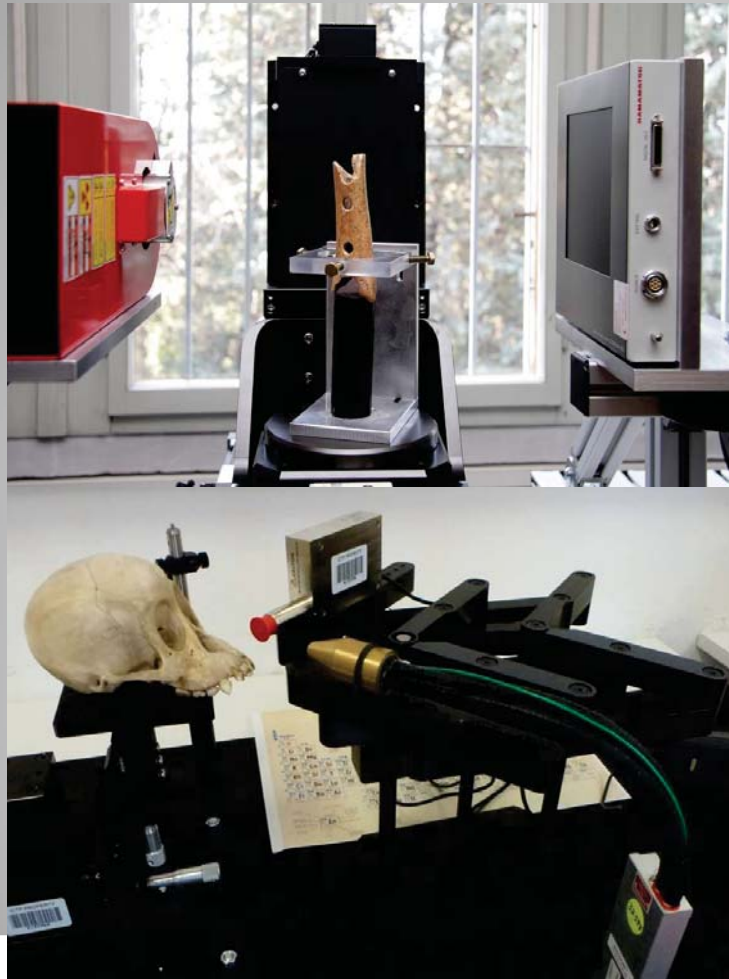
Dense Plasma-Focus Device for Applications in Material, Medical, and Plasma Sciences

Compact and non-radioactive source of X-Rays and Neutrons for applications, high education and basic research



- IAEA Research Agreement: *"Use of the ICTP based repetitive Dense Plasma Focus device for applications in radiation material sciences as well as in nuclear medicine and for training of young researchers"*
- Workshops on *Dense Magnetized Plasma as a Source of Ionizing Radiations, their Diagnostics and Applications* (2010 and 2012)

X-Ray Portable System for Non-Destructive Analysis of Archeological, Paleontological and Artistic Materials



- Three-phase project funded by RFVG
- Micro-computed tomography (microCT)
- X-ray fluorescence (xrf), X-ray diffraction (xrd) and radiography
- Workshop on *Portable X-ray Analytical Instruments for Cultural Heritage* (2013)

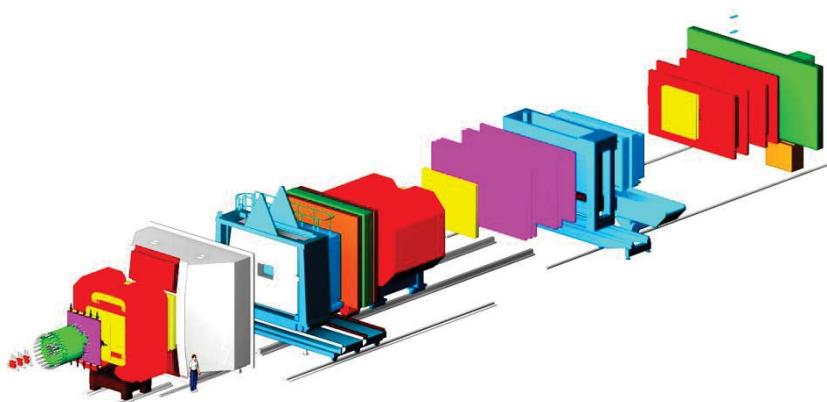
ICTP-INFN Microprocessor Laboratory

COMPASS Experiment at CERN

"COMmon Muon and Proton Apparatus for Structure and Spectroscopy" at SPS of CERN.

Study of hadron structure and hadron spectroscopy with high-rate muon and hadron beams.

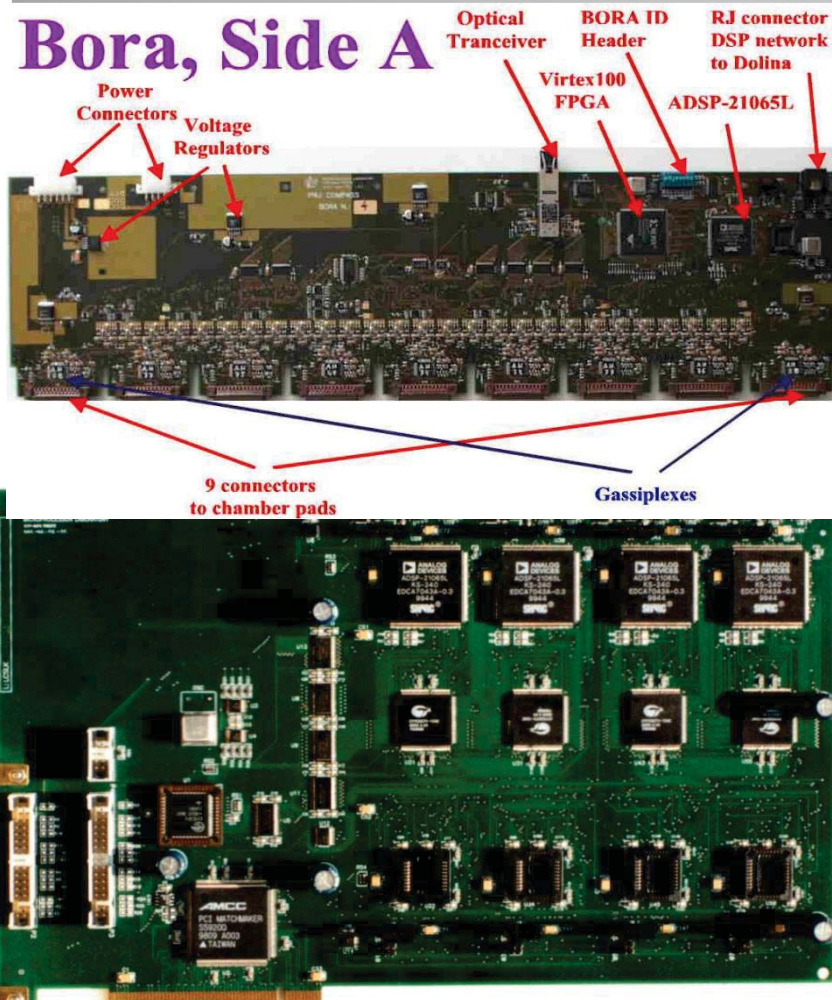
COMPASS Spectrometer:



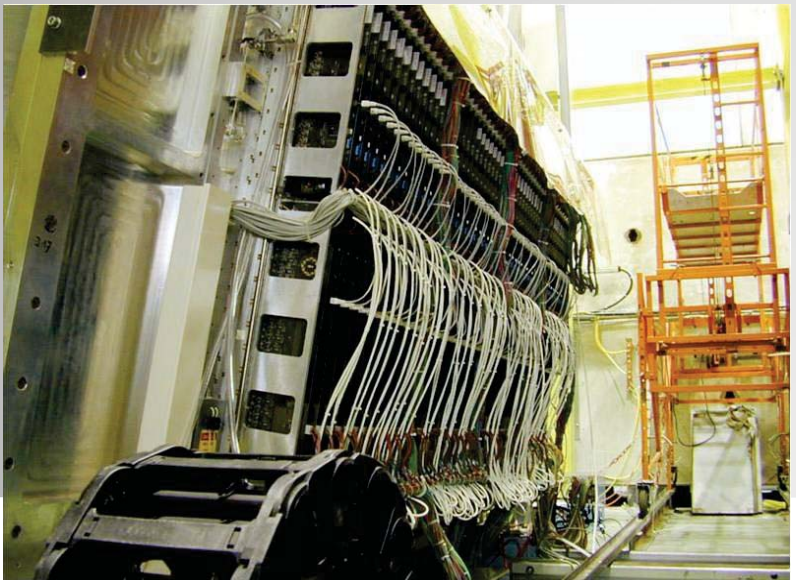
- Reconfigurable Read-Out System for the 83000-channel *Ring Imaging Cherenkov* (RICH) Detector.
- Data taking since 2002.
- Recently approved COMPASS-II proposal.
- PhD Thesis: *"Data acquisition and Processing System for the RICH-1 of COMPASS Experiment"*.

ICTP-INFN Microprocessor Laboratory

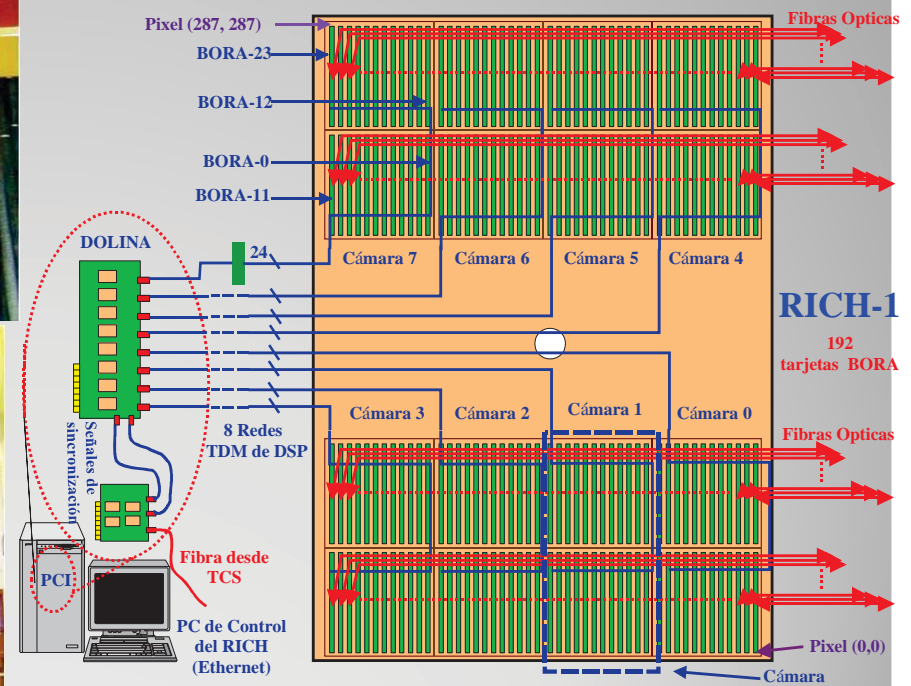
Data acquisition and Processing System for the COMPASS RICH



- Challenging requirements:
 - Reconfigurability
 - Peak trigger rate of 800 kHz
 - Acquired data rate up to 80 GB/s
 - Transmitted data rate up to 8 GB/s
- Innovative architecture:
 - DSP network
 - FPGA as co-processor of DSP
 - FPGA-DSP board (Bora) for acquisition, processing and transmission of 432 channels.
 - 1 Multi-DSP board (Dolina)



Global Architecture



ICTP-INFN Microprocessor Laboratory

Hands-On Training Activities

International and Regional Training Activities, with hands-on experimental sessions, on DSP and FPGA Design for Scientific Instrumentation and Reconfigurable Computing (Peru 2002, Ghana 2005, Trieste 2006, Colombia 2007, Malaysia 2008, Trieste 2009, Argentina 2010, Mexico 2010, Bangladesh 2011)

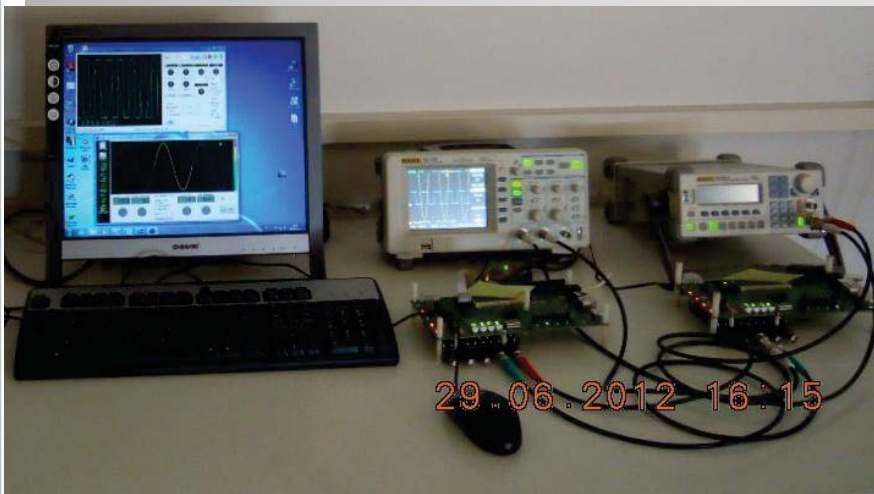
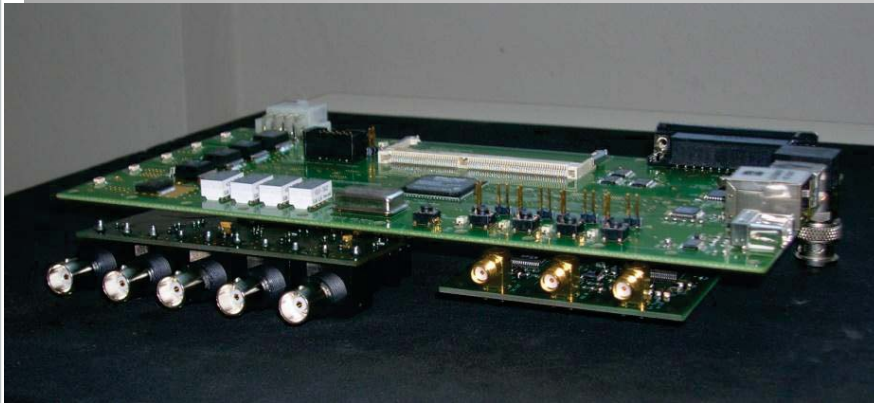
- Industrial partner: Actel Corp. (USA)



- Advanced Course on FPGA Design for Scientific Instrumentation (Cuba, 2012)
- International Training Course on FPGA Design for Scientific Instrumentation and Computing
- Workshop on State-of-the-Art Open Source Hardware and Software for Instrumentation for Physicists (Trieste, 2013)

ICTP-INFN Microprocessor Laboratory

Reconfigurable Virtual Instrumentation based on FPGA and open source intellectual property



- Low-cost powerful reusable hardware/software platform for the emulation of multiple instrumentation systems
 - Hardware & Software modularity
 - Common standardized global architecture
 - Open Source & Open Hardware
- Sharing the design efforts and results among a large community of users and contributors from different fields of expertise and backgrounds

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Reconfigurable Virtual Instrumentation based on FPGA and open source intellectual property

- MLab Hardware Loan Programme
Academic partners in Colombia, Cuba, Mexico, Argentina, Ukraine, Peru, India, Malaysia, Ghana, Panama, Costa Rica, etc.

- FORGE (gforge.ictp.it)
Project-1: RVI based on FPGA

Project-2: FPGA Open Hardware Platform for Science

Open-Survey ICTP Open Hardware Initiative - New FPGA platform to implement reconfigurable instruments for research and higher education, with emphasis on maximizing performance at the lowest possible cost.

ICTP-INFN Microprocessor Laboratory

Other Collaborations

- Trieste University, Italy
DSP Laboratory with FPGA.
- INFN Trieste, Italy
Novel SDD detectors for X-ray detection and spectroscopy.
Read-out systems and algorithms to improve SDD spectral and timing resolution.
- Rockefeller University, USA
Open-Hardware Neuroscience Project.
Data acquisition and processing system to handle simultaneously 128 bioelectric signals.
- University of Castilla, La Mancha, Spain
Reconfigurable hardware in cloud computing to accelerate compute-intensive applications (Image processing)

Thank You