Interdisciplinary Physics with Small Accelerators at LNL

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INFN Laboratori Nazionali di Legnaro
28 years ago

Proceedings
International Symposium on
THREE-DAY IN DEPTH REVIEW ON THE NUCLEAR ACCELERATOR IMPACT IN THE INTERDISCIPLINARY FIELD

Edited by
P. MAZZOLI and G. MOSCHINI

Laboratori Nazionali di Legnaro (Padova), Italy
May 30th - June 1st, 1984

FOREWORD

Over the past few years there has been an increasing interest in the study and application of nuclear accelerators in the interdisciplinary field. The Symposium covered recent and novel developments in the use of nuclear accelerators, including Tandem accelerators, particularly from a basic point of view, in cross-disciplinary fields such as Astrophysics, Geophysics, Medicine, Solid State Physics, Material Science, Surface Science, Hyperfine Interactions, Environment Pollution, Dosimetry and Radiation Biology.

The Symposium consisted of papers by invited speakers, each giving both a review of a major topic and new ideas for further development. The introduction of each topic was followed by shorter contributed papers.

Invited talks were given by the following speakers:

J.A. Davies - Chalk River,
C. Cohen - Ecole Normale Paris,
G. Amsel - Ecole Normale Paris,
N. Hertel - University of Aarhus,
J.P. Sierak - Hahn-Meitner Institut Berlin,
R.A. Ricci - University of Padova,
J. Goldring - Weizmann Institute Rehovot,
G.W. Arnold - Sandia Laboratory New Mexico,
J.P. Thomas - Institute de Physique Nucléaire Villeurbanne,
G. Turiz - University of Trieste,
E. Daini - Weizmann Institute Rehovot,
G. Dearnaley - Harwell Laboratory Didcot,
H.J. Matske - J.E.C. Karlsruhe,
O. Meyer - Kernforschungszentrum Karlsruhe,
D.E. Watt - University of St.Andrews.

A round table on "State of the art, prospects and needs in Megavolt accelerator building technology" has been organized with G. Amsel, F. Chemar (Ionex Corporation), G. Dearnaley, M. Lesournel (Strasbourg), J.H. Larson (DNL, Lenano), R.E. Ryder (Oxford).

The Symposium was attended by about one hundred participants with approximately 60% from Italy.

New developments in nuclear techniques were also featured. The success of this Meeting suggests the utility of this kind of organizations for stimulating contacts and discussions between researchers in this developing area.
ION BEAMS 12
Multidisciplinary Applications of Nuclear Physics with Ion Beams
Legnaro (PADOVA), Italy
6th - 8th June 2012

TOPICS
Radiation Interaction and Damage
Surface Modification
Materials Science
Nuclear Data Acquisition and Analysis
Ion Beam Analysis and Channeling
Environmental Sciences
Art and Archaeology
Dosimetry, Microdosimetry, Nanodosimetry
Radiation Biophysics and Medicine.

LIST OF INVITED SPEAKERS
Preliminary list of invited speakers
D.K. Avasthi (IUAC, New Delhi, India)
L.C. Feldman (Institute for Advanced Materials, Devices and Nanotechnology, Rutgers University, USA)
M. Hill (CRUK/MRC, Gray Inst. for Radiation Oncology and Biology, Oxford, UK)
W. Möller (Helmholtz-Zentrum Dresden-Rossendorf, Germany)
C. Pacheco (C2RMF-Centre de recherche et de restauration des musées de France, Paris, France)
H. Rabus (Physikalisch-Technische Bundesanstalt, Braunschweig, Germany)
M. Touloumonde (CIMAP Laboratory, Caen, and GANIL, France)
R. Webb (Surrey Ion Beam Centre, University of Surrey, Guildford, UK)
A. Zucchiatti (Centro de Microanalisis de Materiales, Universidad Autónoma de Madrid, Spain)

Scientific Committee
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M. Campoleoni, INFN, Pisa, Italy
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Conference Secretariat
Conference Coordinator, INFN, Pavia, Italy
A. A. Zucchiatti, INFN, Pisa, Italy
Conference Manager, INFN, Pisa, Italy

Source: INFN-LNL 2012
Accelerators used for interdisciplinary studies today

- TANDEM- XTU - ALPI
- CN Van de Graaff
- AN2000 Van de Graaff

Source: INFN-LNL 2012
Accelerators used for interdisciplinary studies today

- **CN Van de Graaff**
- **AN2000 Van de Graaff**
- **Oxford micro-beam**
- **TANDEM- XTU - ALPI**
- **SIRAD -IEEM**

**Single ion microbeam in air**

Source: INFN-LNL 2012
V. RIGATO

Snapshot of the AN2000 and CN accelerators for interdisciplinary research

**CN (oper. since 1961)**

7 beam lines (1-6MV pulsed/cont, $^1$H, $^2$H, $^3$He, $^4$He, $^{14}$N, $^{15}$N)

- Radio-Biology (broad beam in air, single ion microbeam in air – resolution: 5$\mu$m)
- Neutron dosimetry (monoenergetic $^7$Li(p,n))
- Neutron Spectrometry (Be(p,n))
- Radiation Damage
- Ion Beam Analysis (NRA, EBS, IBIL, PIXE)
- Nuclear experiments / target activation / nuclear astrophysics

**AN2000 (oper. 1971)**

5 beam-lines (0.25-2.2MV $^1$H, $^3$He, $^4$He)

- Micro-beam (resolution: 1 $\mu$m)
  - MicroPIXE, microIBICC, microIBIL
  - Ion Beam Writing
  - Ultra rarefied beam / single event
- Ion Beam Analysis
  - NRA, RBS, ERD, IBIL
  - Ion Channelling
- PIXE
  - Archaeology
  - Environmental
## 2011 summary

### Research groups and institutions involved in the interdisciplinary activities at LNL (AN2000 and CN)

<table>
<thead>
<tr>
<th>CN YEAR 2011</th>
<th>AN2000 YEAR 2011</th>
</tr>
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<tbody>
<tr>
<td>EXPERIMENTS/YEAR</td>
<td>27</td>
</tr>
<tr>
<td>External Institutions</td>
<td>12</td>
</tr>
</tbody>
</table>

Univ. Firenze, Modena e Reggio, Pisa, Padova, Roma3, Trento, Torino; CNR-Pd, CNR-Trieste, INAF-IASF Bologna, Politecnico Milano e Torino

<table>
<thead>
<tr>
<th>CN Beam-time distribution 2011. 27 experiments: total 1104 hours</th>
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<tbody>
<tr>
<td>0% (2010)</td>
</tr>
<tr>
<td>5%</td>
</tr>
<tr>
<td>13%</td>
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<tr>
<td>40%</td>
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</tbody>
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- **Ion Beam Analysis (EBS, NRA, IBIL)** - Thin Films
- **Radio-Biology** (single-ion microbeam in air, broad beam in air)
- **Neutrons** (dosimetry, detectors, materials)
- **Nuclear Cross Section measurements /nuclear target activation**
- **Devices Radiation Damage**

<table>
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<tr>
<th>AN2000 Beam-time distribution 2011. 26 experiments: total 1948 hours</th>
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<tbody>
<tr>
<td>30% (2010)</td>
</tr>
<tr>
<td>16% (2010)</td>
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- **Ion Beam Analysis (EBS, NRA, ERD, IBIL)** - Thin Films
- **Ion Channelling**
- **PIXE (Environmental, Archaeology)**
- **Micro-beam (microPIXE: geology, archaeology; single event IBIL, IBIC, Ion Beam Writing)**

Source: INFN-LNL 2012
The laboratory activity is supported by INFN National Commissions (CNS5 and CNS3) and by external projects.

**The LNL Detector Materials Laboratory**

**Laboratory mission:**
- Develop new materials for novel radiation detectors
- Support materials development in new particle accelerating devices
- Complex nuclear targets preparation

**Laboratory know how:**
- Ion–surface interaction processes
  - (ion beam analysis, ion implantation, ion assisted film growth, irradiation)
- Thin films synthesis
  - PVD and hybrid CVD-PVD technologies
  - Sol-gel and liquid phase deposition
- Ion plasma diagnostics
- Electron and atomic force microscopy
- Electrical mechanical properties of coatings
- Structural properties of coatings

Source: INFN-LNL 2012
The Detector Materials Laboratory

- Advanced materials process development and synthesis
  - Reactive Plasma Sputtering Deposition
  - CVD and Glow Discharge
  - Liquid phase/ sol-gel deposition
  - Ion Implantation
- Soft X-ray multilayers
- Optical multilayers
- High Performance Plastics
- Passivating layers (HPGe…)
- Scintillator materials
- Low Friction, High Hardness Nanoscaled Materials and Multilayers

Source: INFN-LNL 2012
Characterization of materials with advanced methods
1) Composition, stoichiometry, microstructure, morphology, surface topography
2) Electrical, optical, mechanical properties

The Detector Materials Laboratory

Characterization of Physical Properties

- Composition / depth profile / structure
  - Ion Beam Analysis (RBS, NRA, ERD, PIXE)
  - Micro-PIXE 2-D trace element analysis
  - Micro-EBS, micro IBIL, IBICC
  - FT-IR, XRD
  - Porosity

- Other physical properties
  - Nano-Hardness, Elastic modulus
  - Adhesion (Micro-Scratch)
  - Residual Stress
  - Atomic Force Microscopy & SEM

Source: INFN-LNL 2012
SUMMARY

- The Laboratori Nazionali of Legnaro provide MeV ion beams to internal INFN projects and to many external institutions involved in cross disciplinary fields since many decades.

- Ion beams methods are of great importance for the development of new nuclear materials, devices and technologies.

Announcement

14th International Conference on Nuclear Microprobe Technology & Applications

Will be held in Padova in 2014