Overview of the ARDENT European project

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Venue: Lawrence Berkeley National Laboratory (LBNL)

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• My contribution to Berkeley labs during this 5 weeks secondment
Who am I?

Rep. of Mauritius
The ARDENT project

ARDENT
February 2012 – January 2016

Advanced Radiation Dosimetry European Network Training initiative

Marie Curie Initial Training Network under EU FP7 – 4 M€
8 Full Partners and 6 Associate Partners
Coordinator: CERN, Scientist-in-Charge: Dr. M. Silari

CERN (coordinator), Switzerland
AIT Vienna, Austria
SL Siebersdorf, Austria
CTU- IAEP Prague, Czech Republic
IBA Dosimetry, Schwarzenbruck, Germany
Jablotron, Prague, Czech Republic
MI.AM, Milano, Italy
Politecnico of Milano, Italy

ST Microelectronics, Italy
University of Erlangen, Germany
University of Houston, USA
University of Ontario, Canada
University of Wollongong, Australia
INFN Laboratori Nazionali di Legnaro, Italy
Development of advanced instrumentation for radiation monitoring...

Three main technologies:

• Solid state detectors [e.g. Medipix, Timepix, silicon micro-dosimeters]

• Gas detectors [e.g. gas electron multipliers (GEM), tissue equivalent proportional counters (TEPC), etc.]

• Track detector techniques [e.g. CR-39, nano-dosimeters]
Medipix detector – pixelated silicon detector

Ref: Medipix collaboration
Gas detectors

- Two prototype of GEMPIX

Head-on detector

Side-on detector

Ref: Medipix collaboration and INFN
Track detectors

CR-39® track detector

Politrack® instrument
Etching: making the tracks visible

The tracks can be made visible under a microscope, by etching in:

NaOH at 98°C for 90 minutes.

The opening of the track is then of about 5-20 µm depending on the type and energy of the ions.
Politrack® instrument

A few examples of frames on a CR-39 detector

Totally saturated detector
CR-39 detector analysis with Politrack®

- Automatic counting and geometrical analysis of the tracks by Politrack® (a)
- Track filtering (account for dust particles or surface defects) (b)
- $V_t$ and $LET_{nc}$ and impinging angle determination (c)
- $LET_{nc}$ distribution (d)

**Dose Calculation**

$$H = \frac{1}{\rho.A} \cdot 1.602 \cdot 10^{-6} \cdot \sum_{i=1}^{n} \frac{LET_i}{\cos \theta_i} \cdot Q\left(\frac{LET_i}{\rho.A}\right)$$
Some cool nuclear facilities in Europe

The CERN organisation

Compact Muon Solenoid (CMS) detector

An American at the LHC experiment

CERF irradiation facility for detector characterisation
Some cool nuclear facilities in Europe: Hadron Therapy

CNAO Oncology center: Pavia, Italy

Beam delivered to treatment room for patient cancer treatment

Synchrotron designed to accelerate:
- Protons up to 250 MeV
- Carbon ions up to 400 MeV/nucleon
LET spectrometry and dosimetry for beam diagnostics
LET spectrometry and dosimetry for beam diagnostics

Proton beam
• Gaussian
• 10 mm FWHM
• $E = 183.7$ MeV
2D current density reconstruction along the beam path

Detector 1

Detector 2

Detector 3

Detector 4

Detector 5

Detector 6

In-beam LET spectrometry and dosimetry in Proton beam
Industrial involvement within ARDENT: MI.AM Srl

Autodesk Inventor

3D printing of designed prototype

CAM3D Srl
Applications of CR-39 track detectors in UC Berkeley

\[ d + d \rightarrow ^3\text{He} + n \ (2.45 \text{ MeV}) \]

Ref: Karl van Bibber & Lee Bernstein, High energy density nuclear physics at UC Berkeley, LLNL, and LBNL.

High Flux Neutron Generator (HFNG), UC Berkeley & Lawrence Berkeley National lab
Thank you for your attention!!

The ARDENT team!!