POLITECNICO DI MILANO

Overview of the ARDENT European project

Presented by: Alvin Sashala Naik

Venue: Lawrence Berkeley National Laboratory (LBNL)

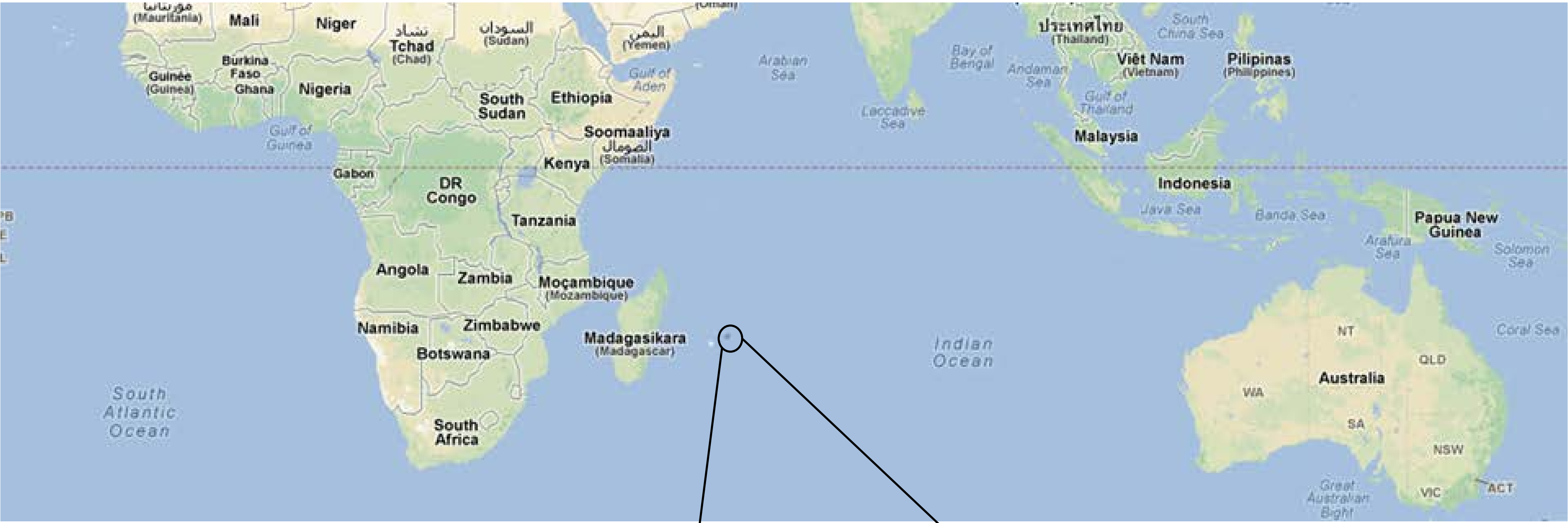
Date: 17th July 2015

This research project has been supported by the Marie Curie Initial Training Network Fellowship of the European Community's Seventh Framework Programme under Grant Agreement PITN-GA-4 2011-289198-ARDENT

Table of contents

- Who am I ?
- The ARDENT European project
- Some cool things we do out there in Europe :
  - Neutron dosimetry and spectrometry
  - Dosimetry in Hadron/ion therapy centers
  - Networking
  - Industrial involvement
- 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 **R**adiation **D**osimetry **E**uropean **N**etwork **T**raining 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

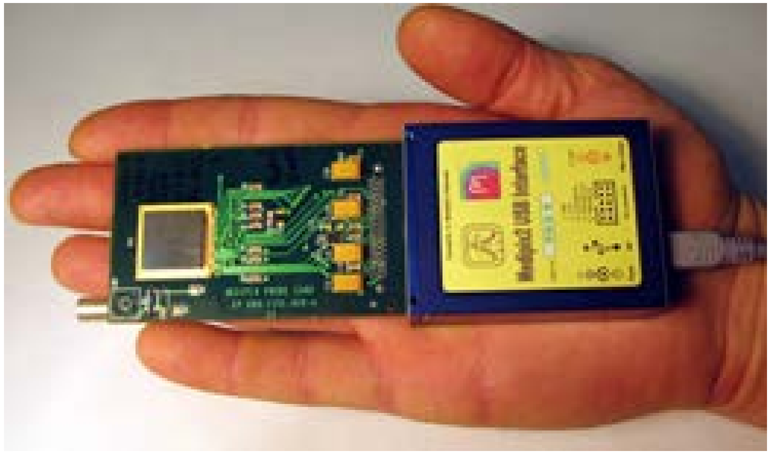
ST Microelectronics, Italy
University of Erlangen, Germany
University of Houston, USA
University of Ontario, Canada
University of Wollongong, Australia
INFN Laboratori Nazionali di Legnaro, Italy

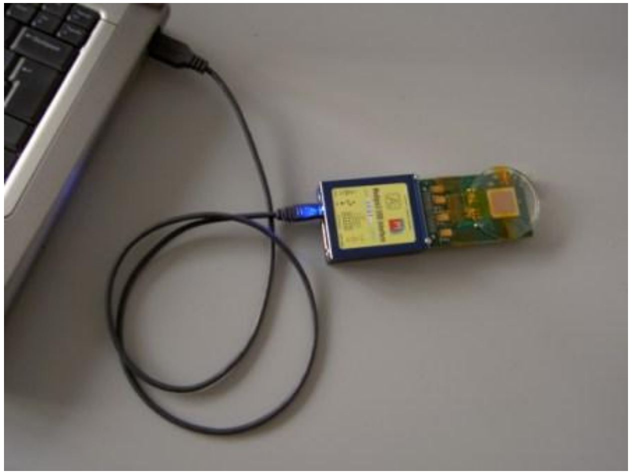
Development of advanced instrumentation for radiation monitoring…

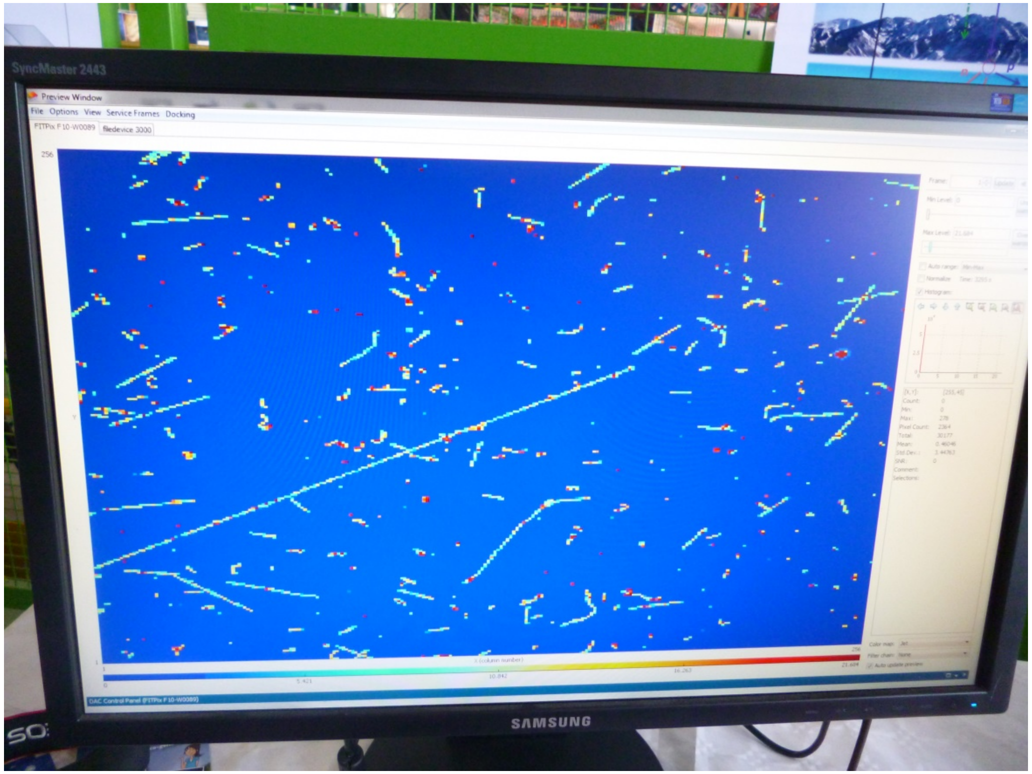
Three main technologies:

- 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



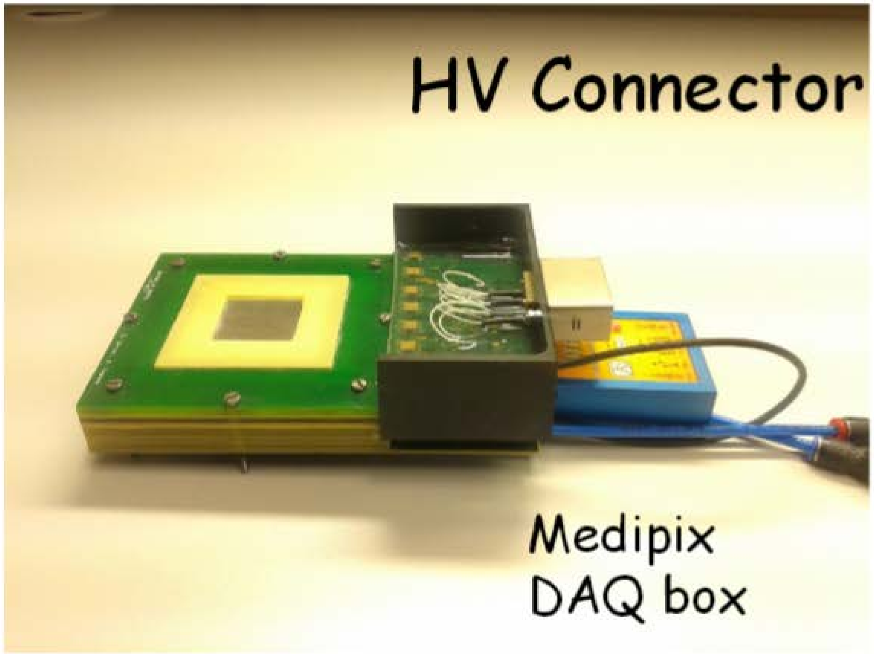


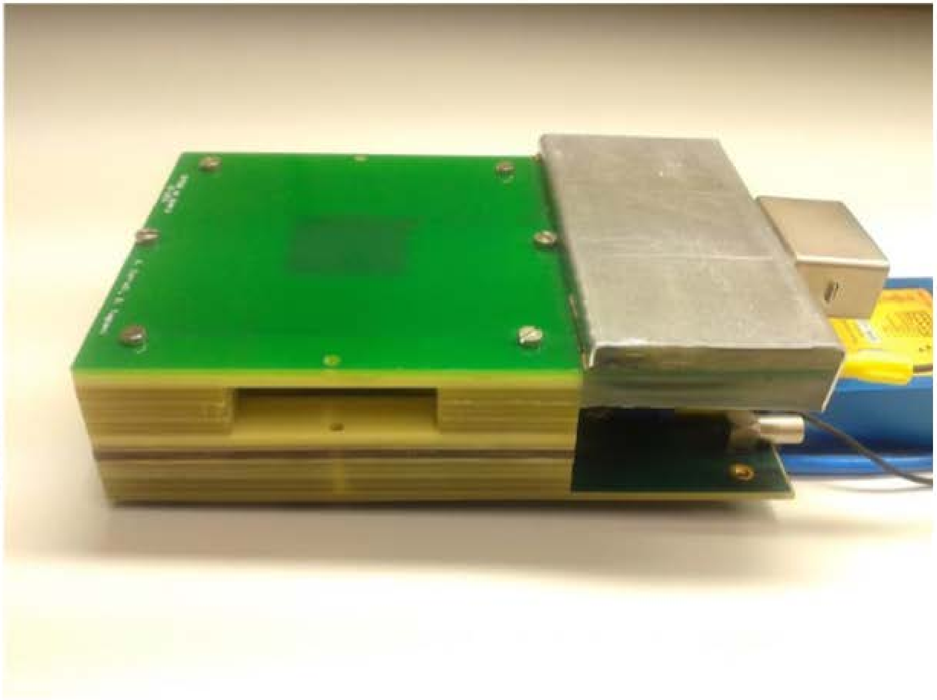


Ref: Medipix collaboration

Gas detectors

- Two prototype of GEMPIX



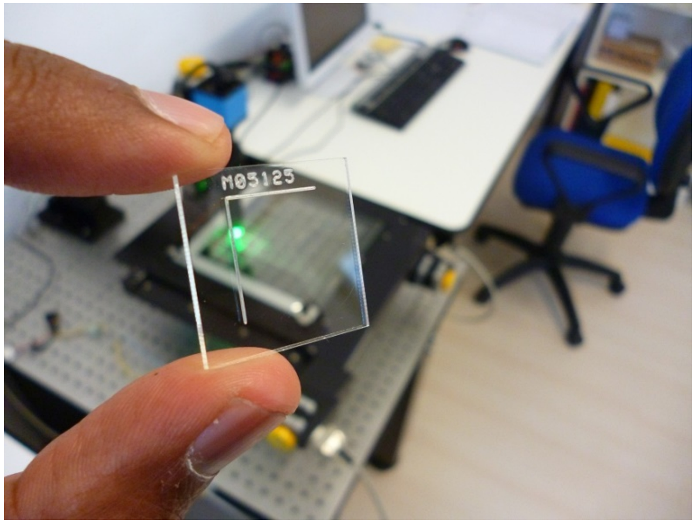


Head-on detector

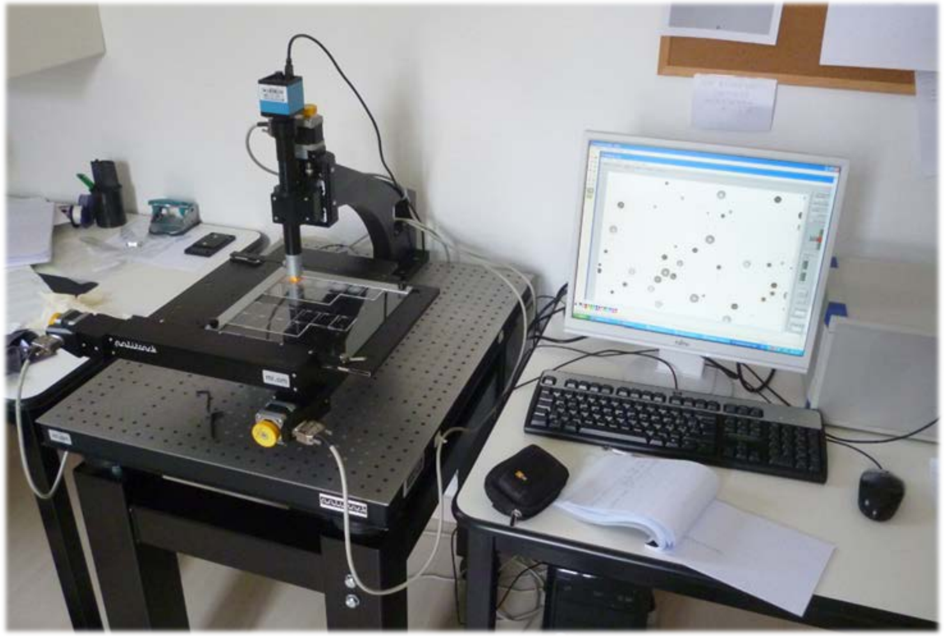
Side-on detector

Ref: Medipix collaboration and INFN

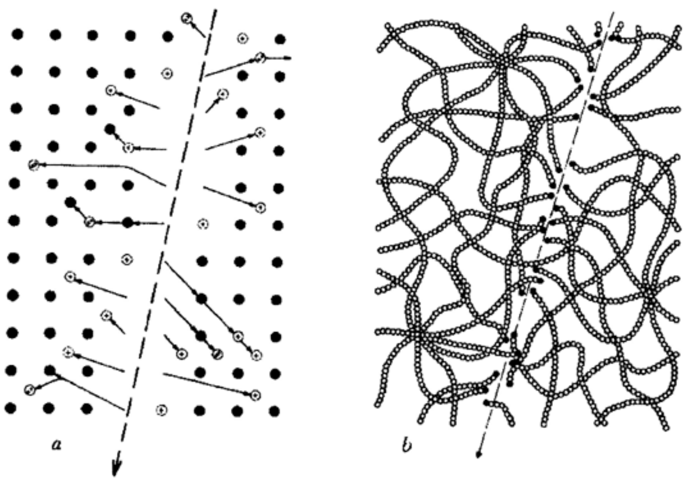
Track detectors

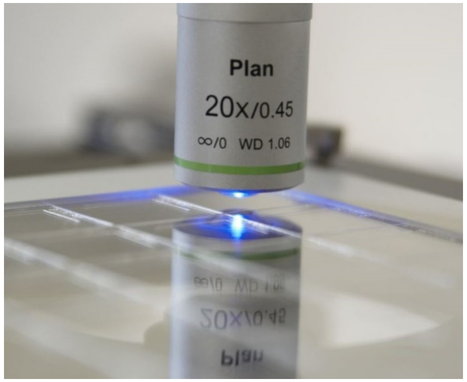


CR-39® track detector



Politrack® instrument



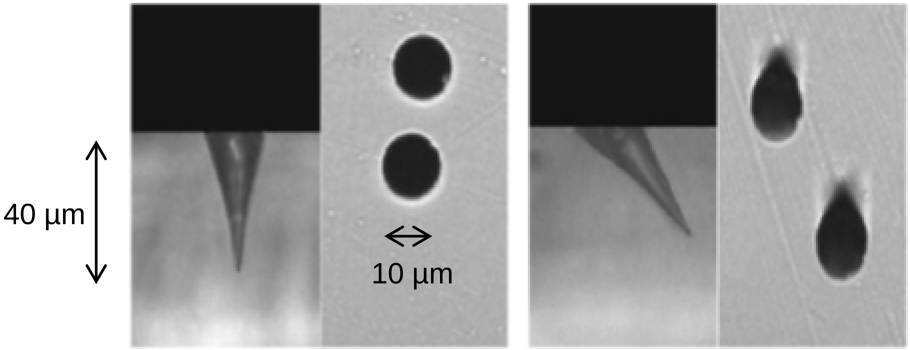


Etching: making the tracks visible

The tracks can be made visible under a microscope, by <u>etching</u> in:

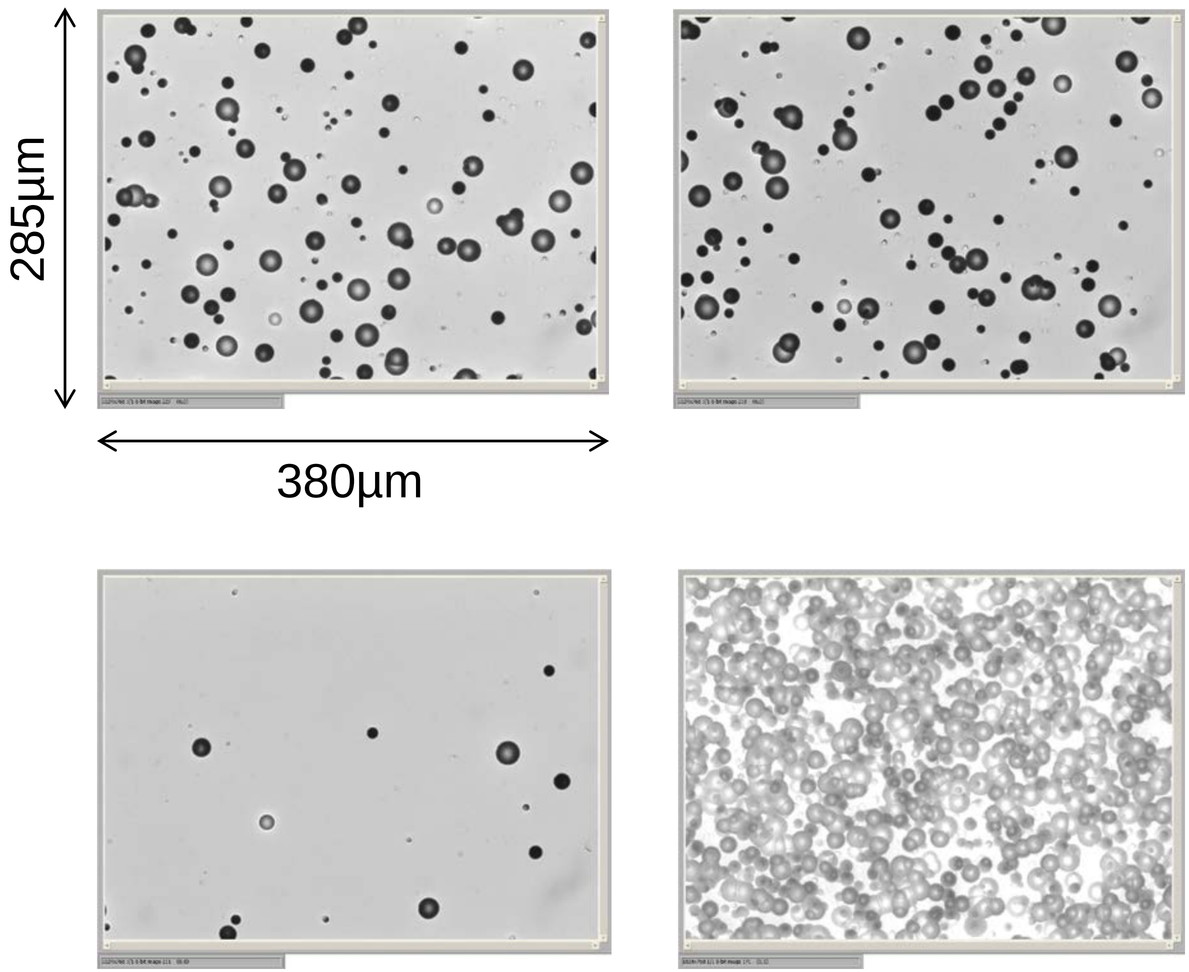
NaOH at 98°C for 90 minutes.

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



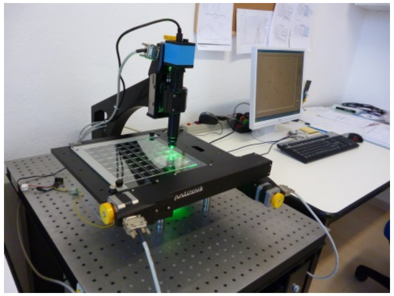
B. Dorschel et al. / Radiation Measurements 37 (2003) 563 – 571

Politrack® instrument



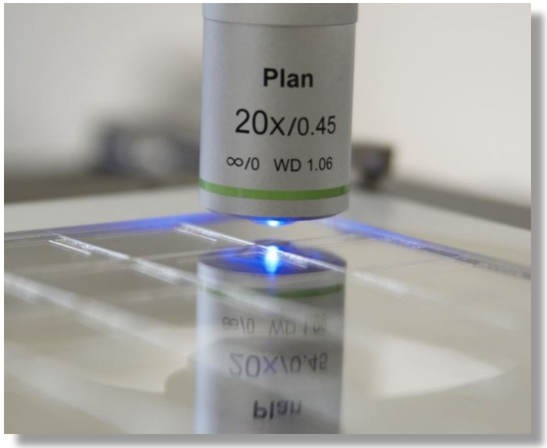
Totally saturated detector

A few examples of frames on a CR-39 detector

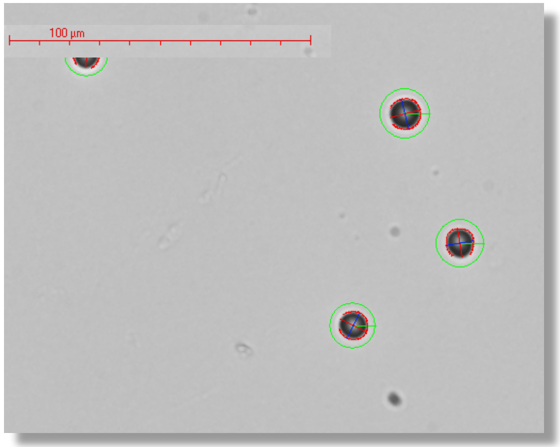


CR-39 detector analysis with Politrack®

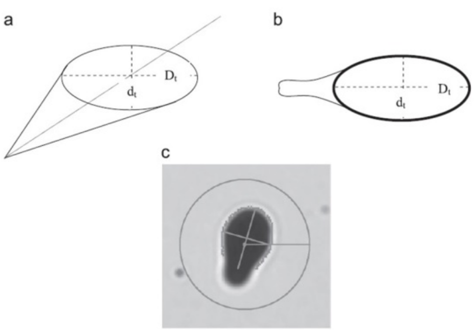
- Automatic counting and geometrical analysis of the tracks by Politrack® (a)
- Track filtering (account for dust particles or surface defects) (b)
- V_t and LET_{nc} and impinging angle determination (c)
- LET_{nc} distribution (d)



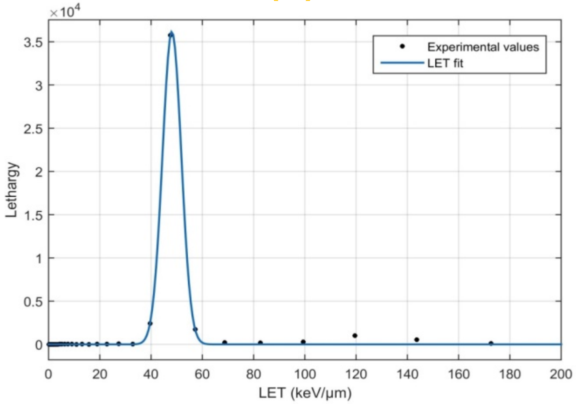
(a)



(b)



(c)



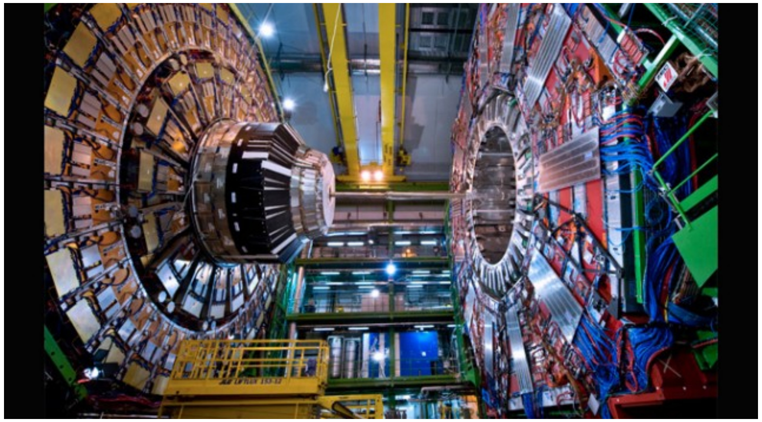
(d)

- Dose Calculation => $H = \frac{1}{\rho.A} \cdot 1.602 \cdot 10^{-6} \cdot \sum_{i=1}^{n} \frac{\overline{LET}_i}{\cos\vartheta_i} \cdot Q\left(\overline{LET}_i\right)$

Some cool nuclear facilities in Europe

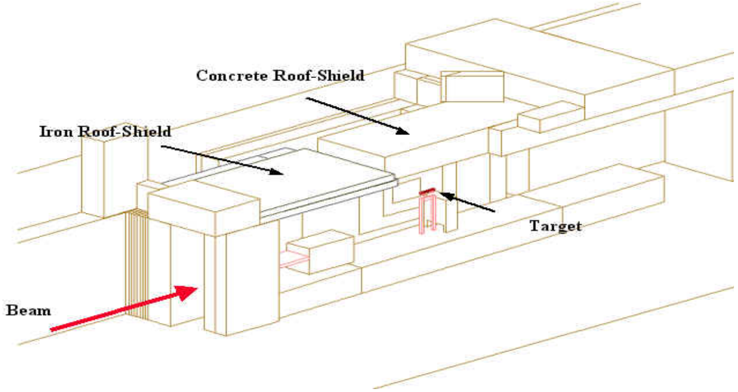
The CERN organisation

Compact Muon Solenoid (CMS) detector

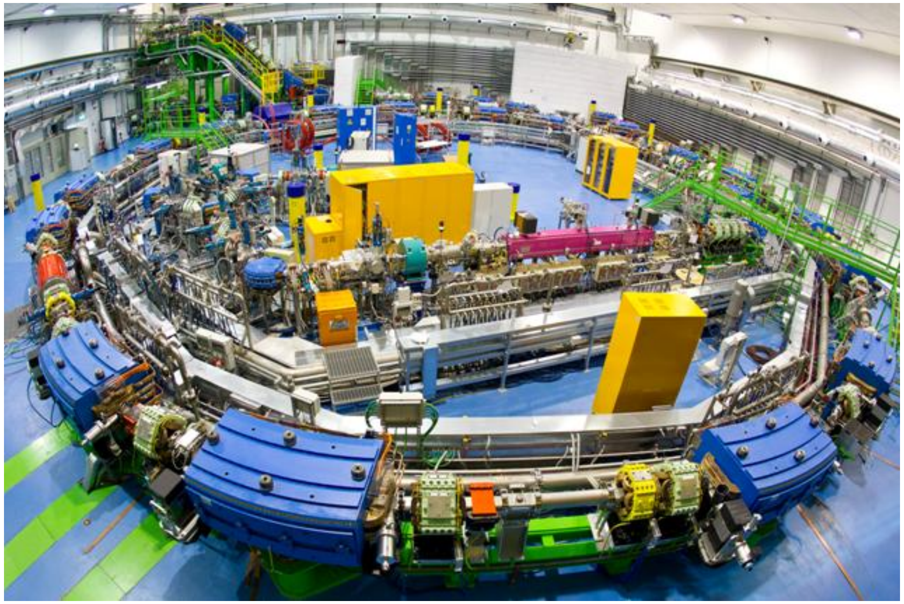


An American at the LHC experiment

CERF irradiation facility for detector characterisation



Some cool nuclear facilities in Europe: Hadron Therapy



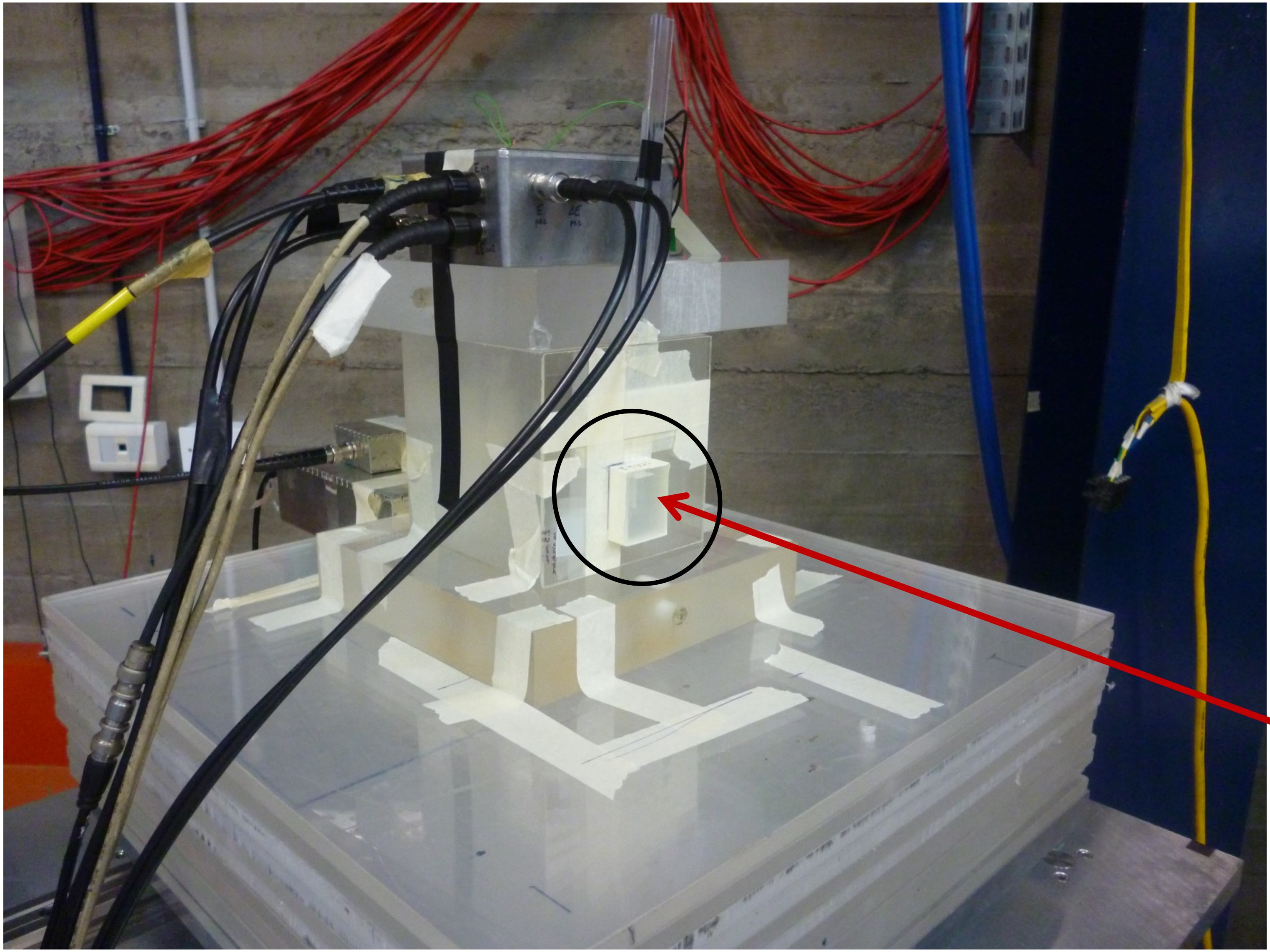
CNAO Oncology center: Pavia, Italy

Synchrotron designed to accelerate :

- Protons up to 250 MeV
- Carbon ions up to 400 MeV/nucleon

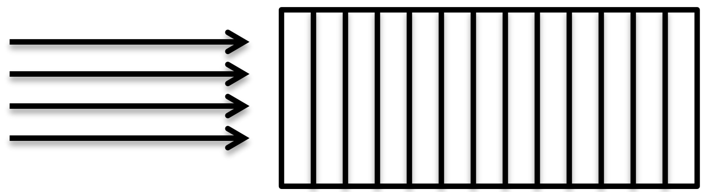
Beam delivered to treatment room for patient cancer treatment

LET spectrometry and dosimetry for beam diagnostics

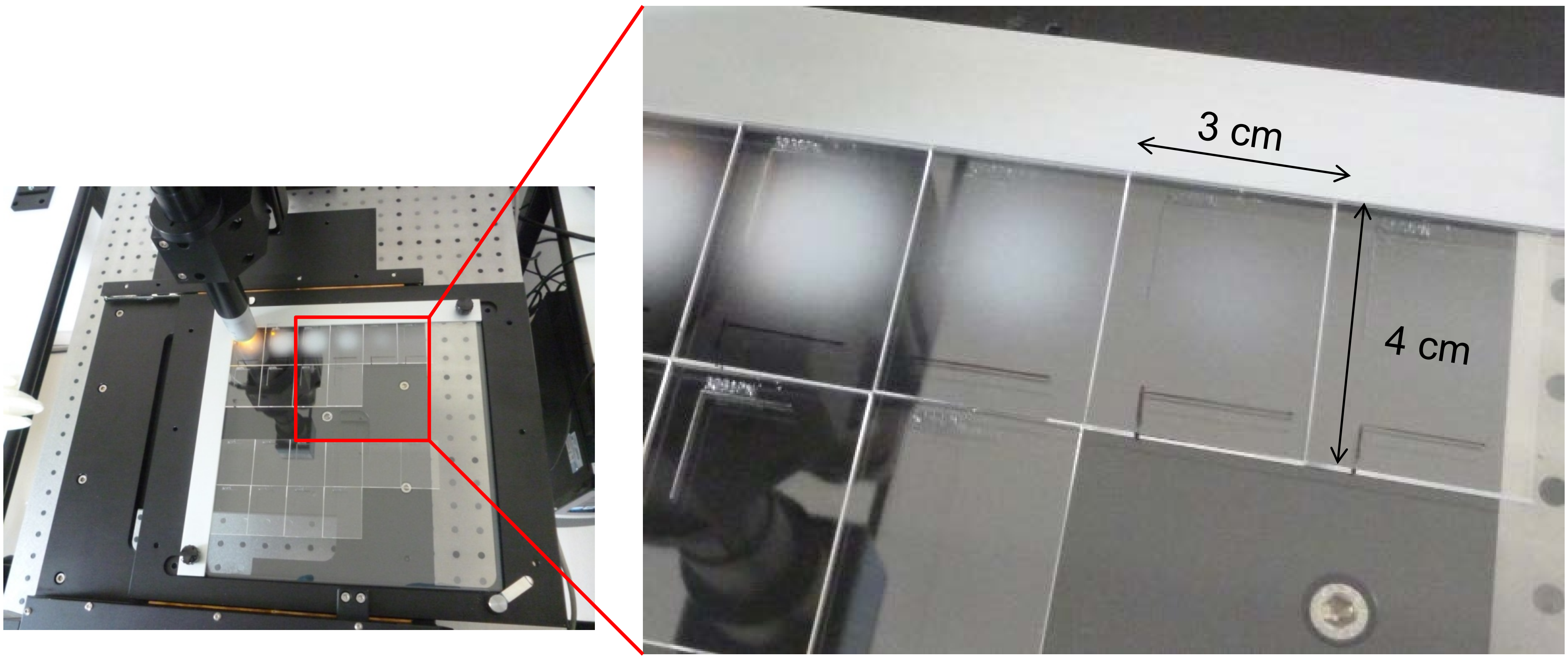


Ion beam

LET spectrometry and dosimetry for beam diagnostics

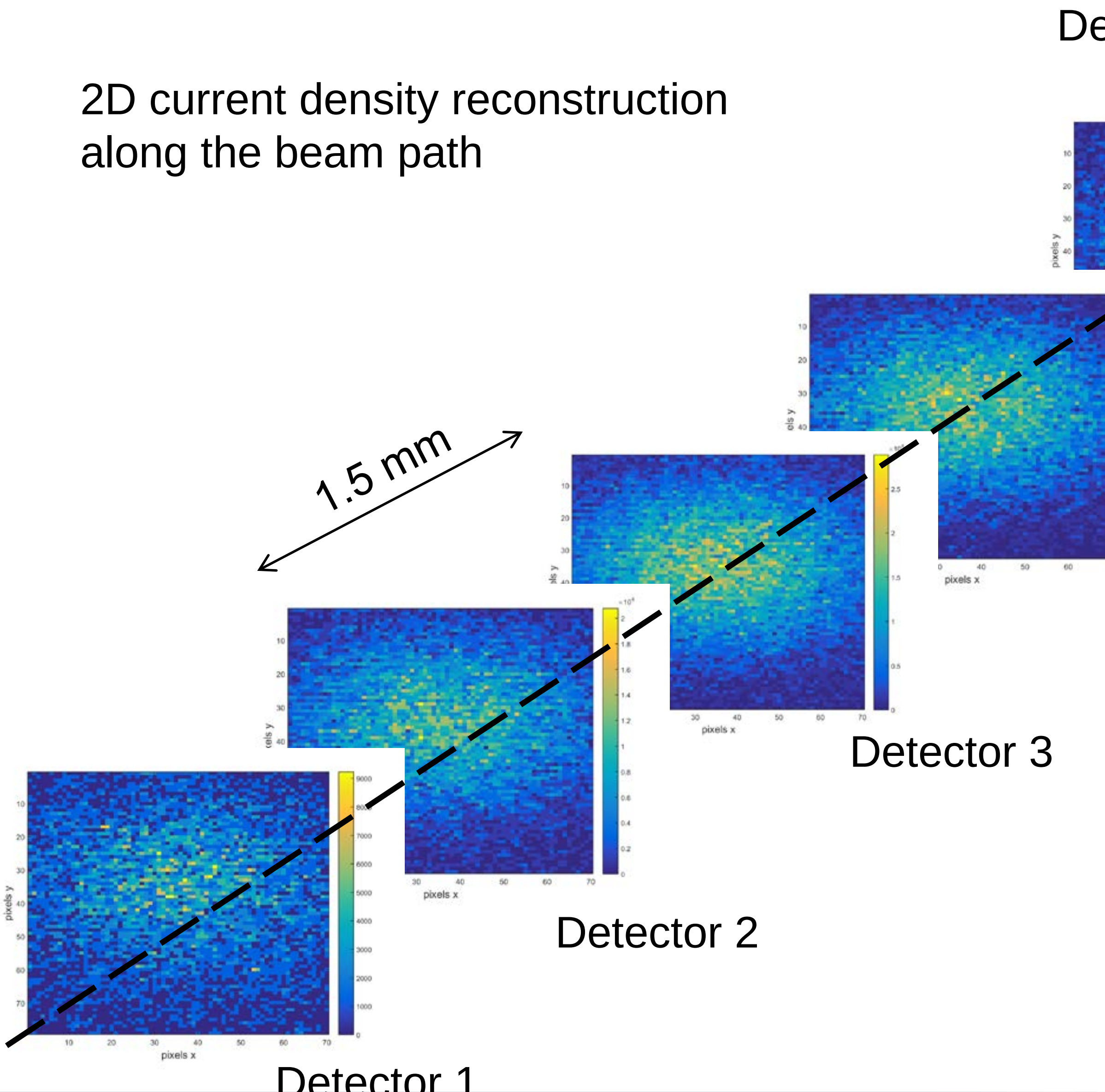


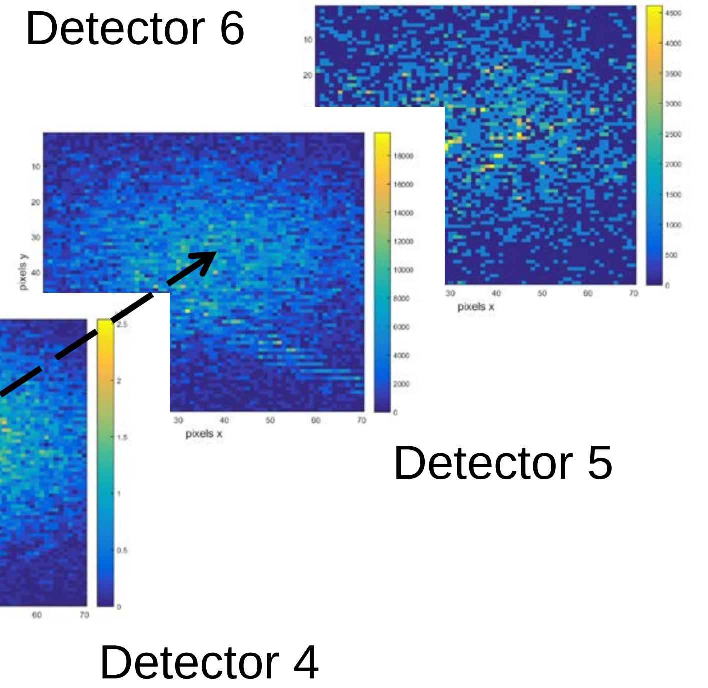
Proton beam
- Gaussian
- 10 mm FWHM
- E = 183.7 MeV

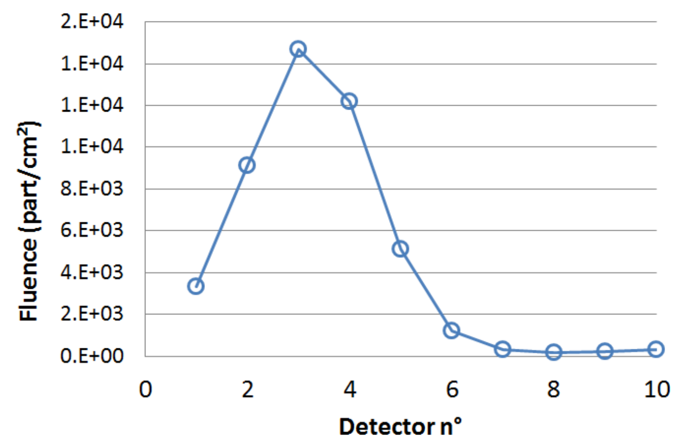


In-beam LET spectrometry and dosimetry in Proton beam

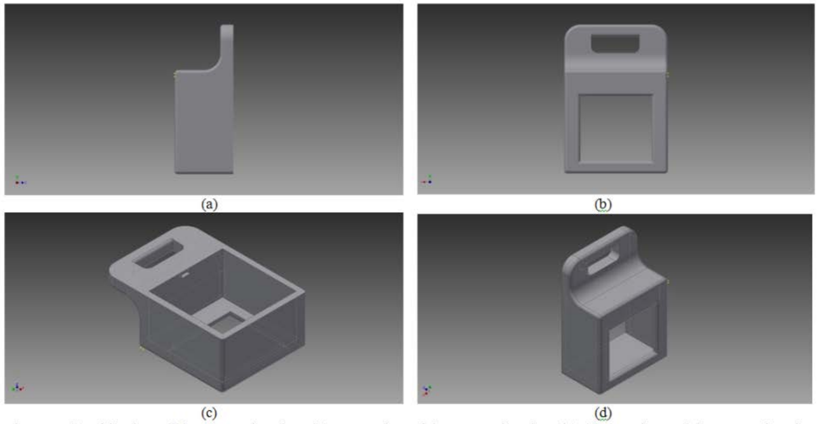
2D current density reconstruction along the beam path







Industrial involvement within ARDENT: MI.AM Srl

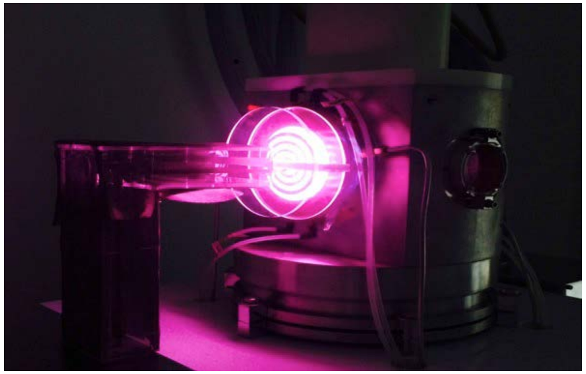


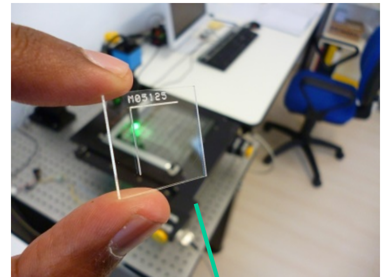
Autodesk Inventor

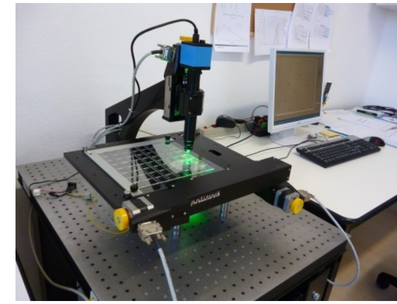
3D printing of
designed prototype


CAM3D Srl

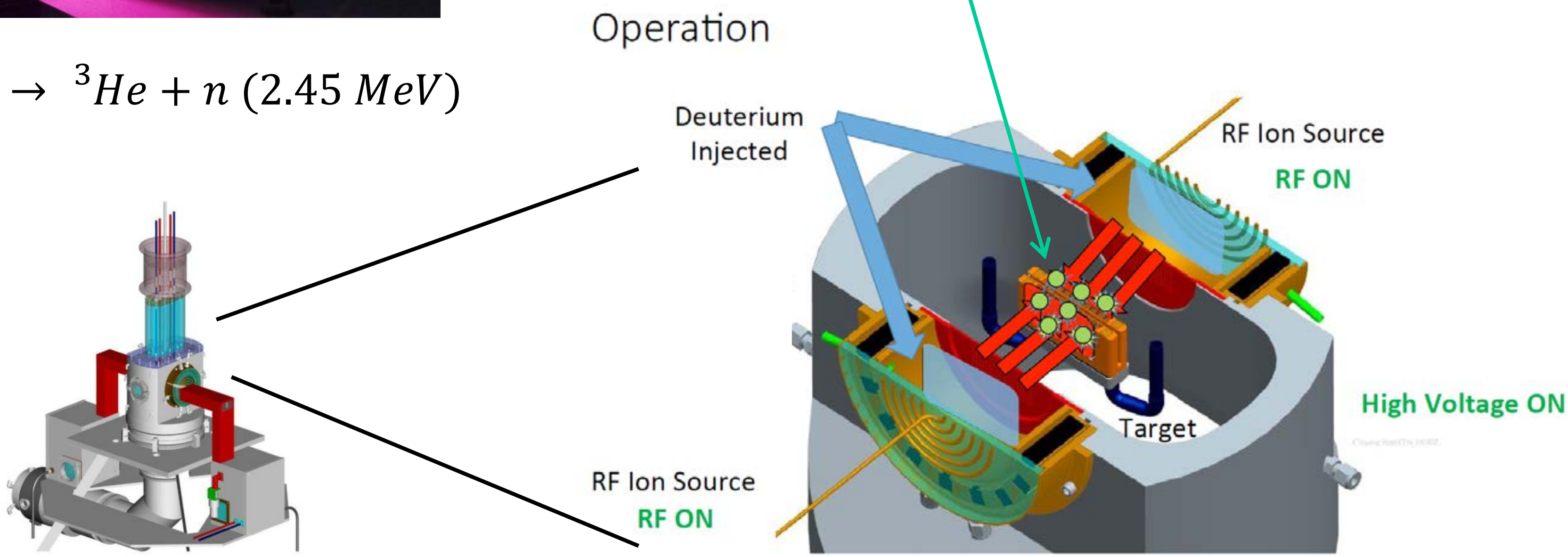
Applications of CR-39 track detectors in UC Berkeley







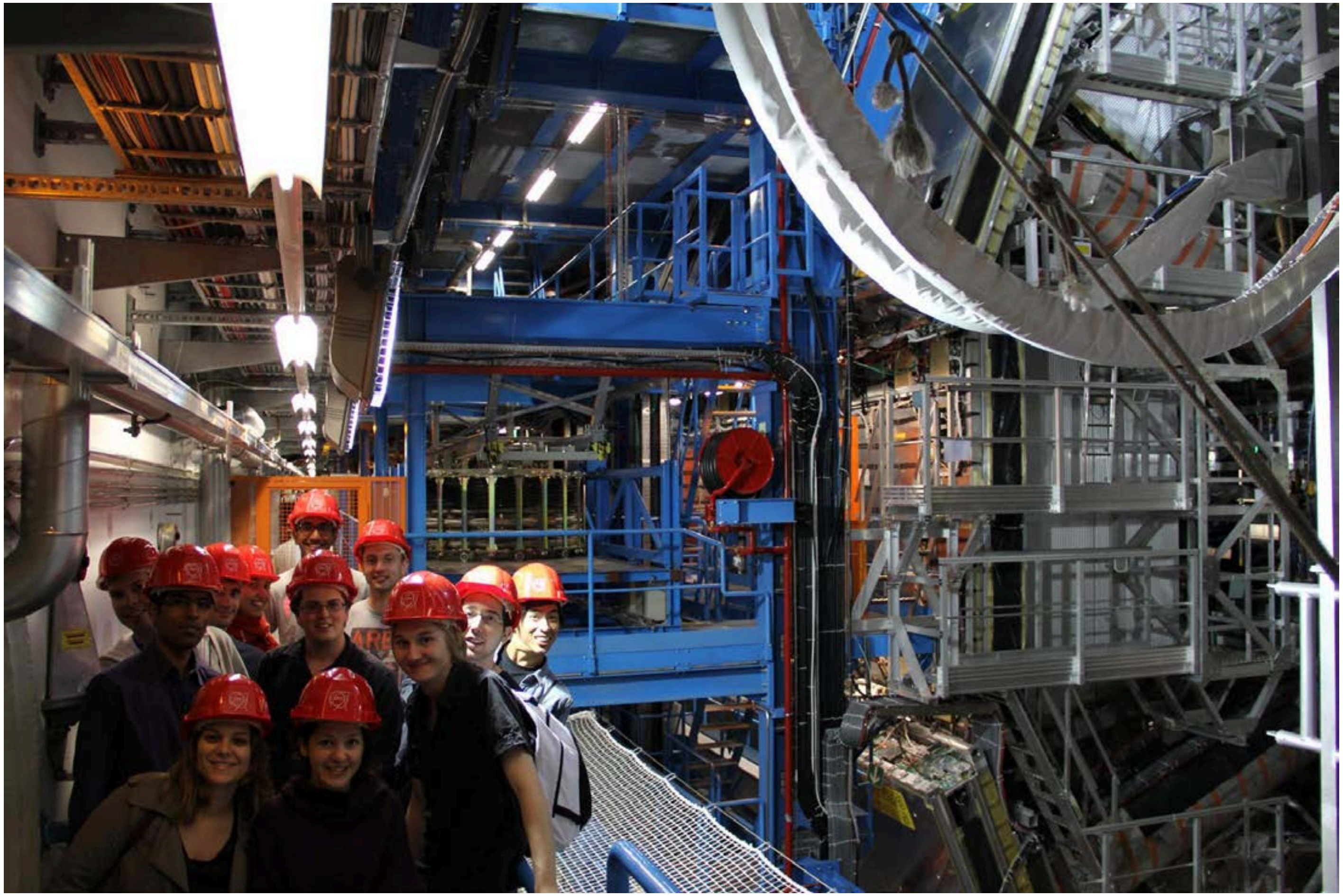
$$\mathrm{d} + \mathrm{d} \rightarrow \ {}^{3}He + n \ (2.45\ MeV)$$



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 !!