2D Ionization Chambers Array for Clinical Applications

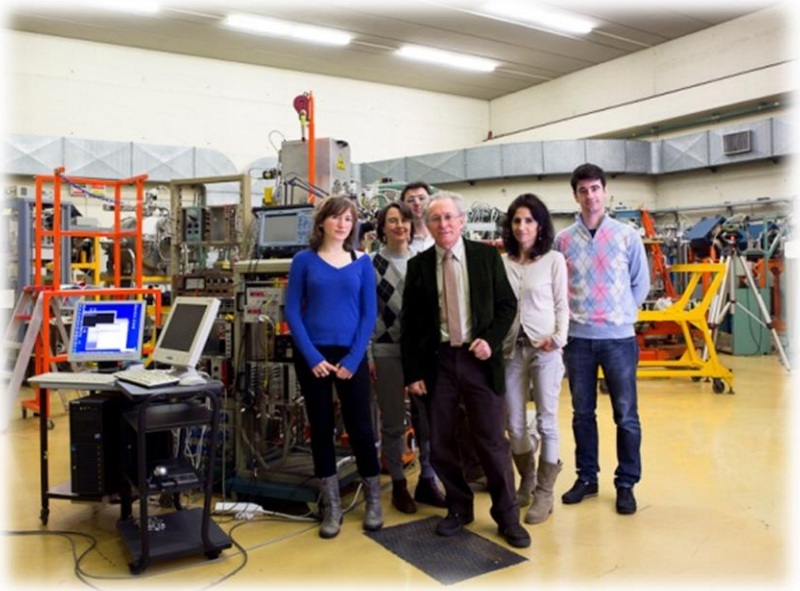
MICHELE TOGNO – ESR11

What about me…

…and my career so far

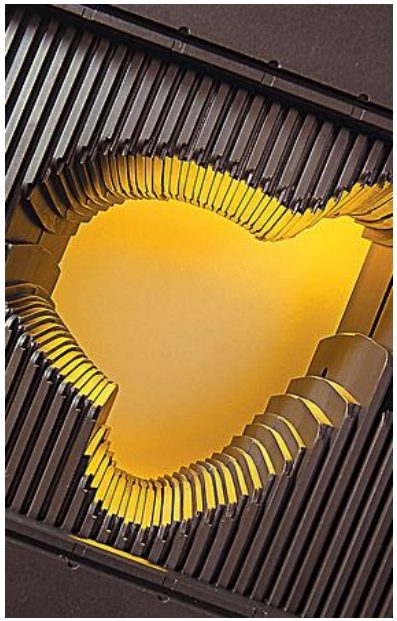
- Bachelor Degree in Physical Engineering (Polytechnic of Milan): "*Superconductivity and Isotopic Effect*"

- Master Degree in Nuclear Engineering (Polytechnic of Milan): "*Study of a Logarithmic Compression Amplifier for Microdosimetry*"



- *National Institute of Nuclear Physics* in Legnaro (Padova): here I carried out part of my thesis work and I became more familiar with gas detectors (especially with TEPC for microdosimetry)

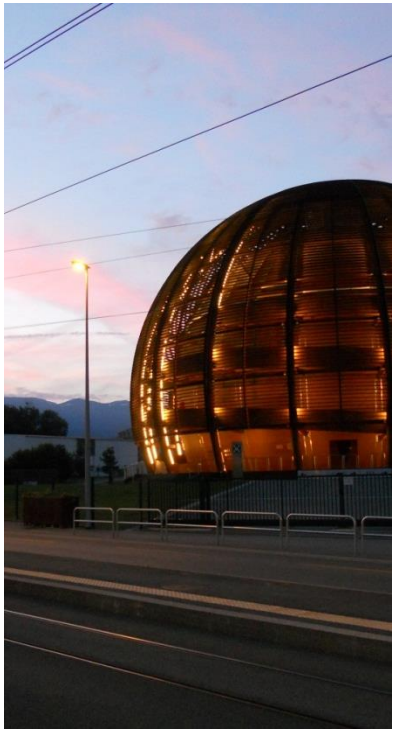
Outline



Overview on the project

Experimental activity

Conferences, trainings…



My ARDENT: overview on the project

Hosting Organization and partner institute

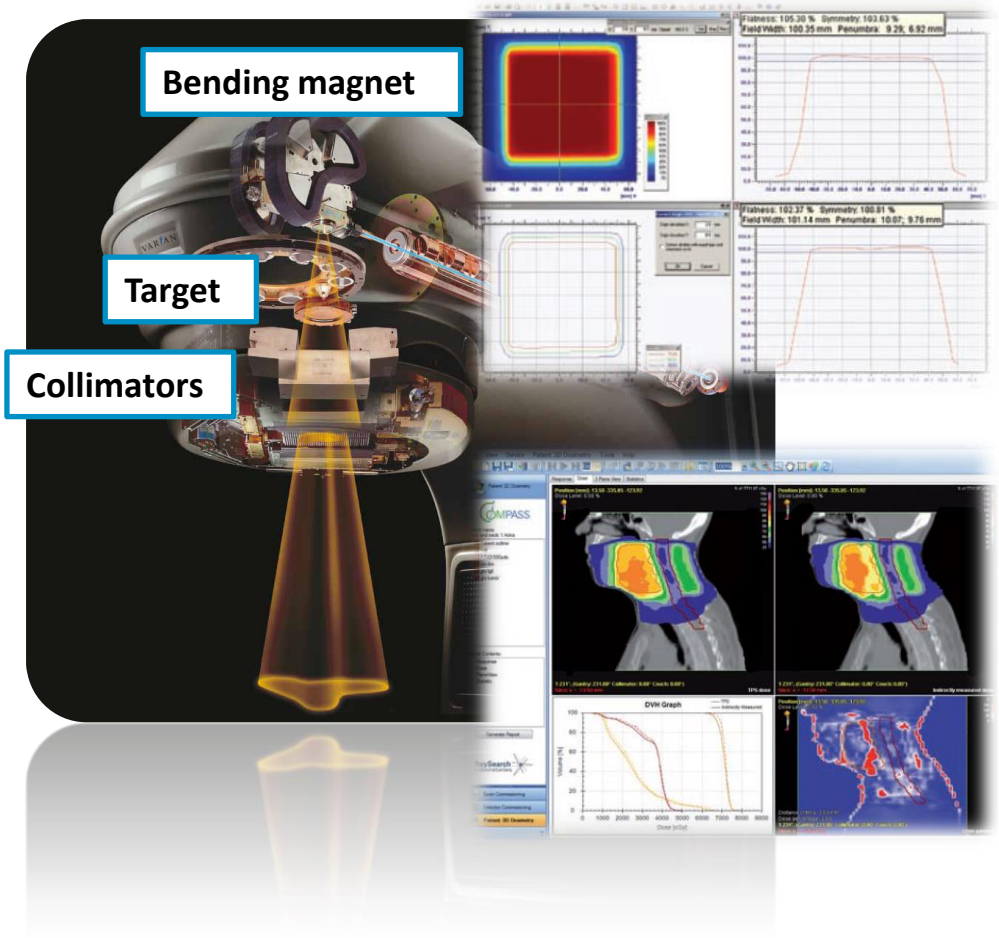
- QA of equipment for radiotherapy and X-ray diagnostic
- SSDL, 5 facilities (^{60}Co, KV X-ray, MV X-ray, mammo) where carry out tests on devices

TECHNISCHE UNIVERSITÄT MÜNCHEN

- Application of detector technology in clinical environment
- Introduction into Medical Physics group scheduled on October, 21th

My ARDENT: overview on the project

Needs in Clinical Application



Before starting daily patient treatments, it is important to perform QA measurements in order to check critical LINAC parameters such as penumbra, symmetry, flatness and field size

Again, do a verification of absorbed dose vs planned dose is essential to validate a radiotherapy treatment

My ARDENT: overview on the project

2D Ionization Chambers Array for Clinical Applications

Project objective: development and characterization of a new generation of high performances ionization chambers arrays for radiotherapy

…we need a detector suitable to perform:

- fast and accurate field profiling
- measurements of absorbed dose in photon, electron and proton beams
- measurements within a water phantom

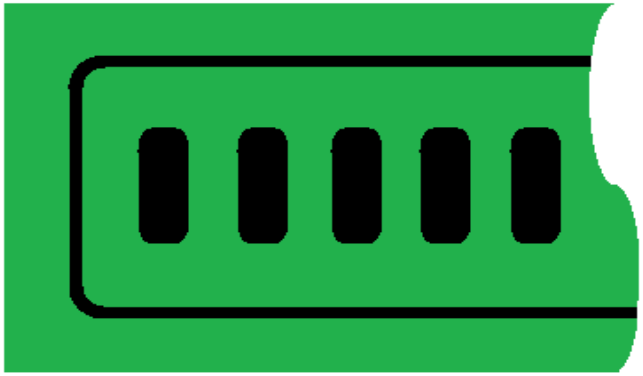
Starting point: IBA experience (MatriXX detector family, developed in collaboration with *INFN Turin*)

My ARDENT: overview on the project

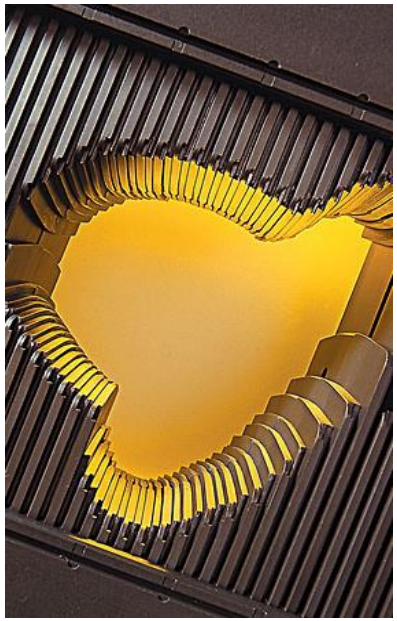
2D Ionization Chambers Array for Clinical Applications

Physics specifications: outperform existing devices in terms of

- improved stability of the detector
- better spatial resolution
- high charge collection efficiency at high dose rates (X-ray and p^+)
- lower production cost, better yield and less security concerns



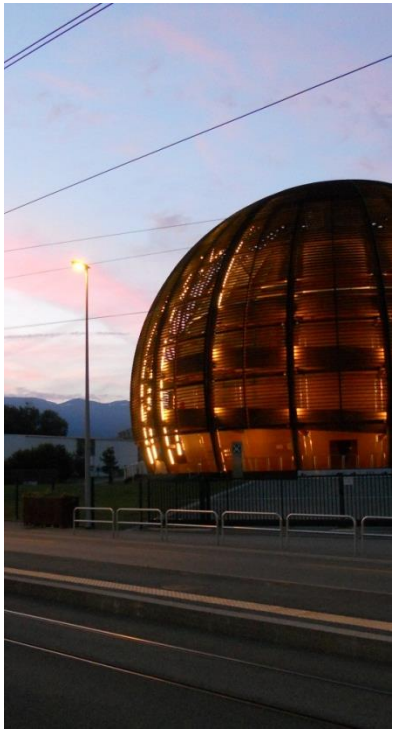
Design, geometry and materials represent a strategic know-how for the company, in future this technology will be protected by a patent



Overview on the project

Experimental activity

Conferences, trainings…



Experimental activity

Measurements at IBA facilities

Characterization of prototype I (developed at IBA before the beginning of this project), which includes several arrays with different shapes and geometries

Two type of investigation:

- dynamic response of individual pixel
- measurement of 1D dose distribution

Main problem to be solved

small chamber volume and reduced sensitivity:

- read-out electronics noise
- high sensitivity to parasitic signals

Experimental activity

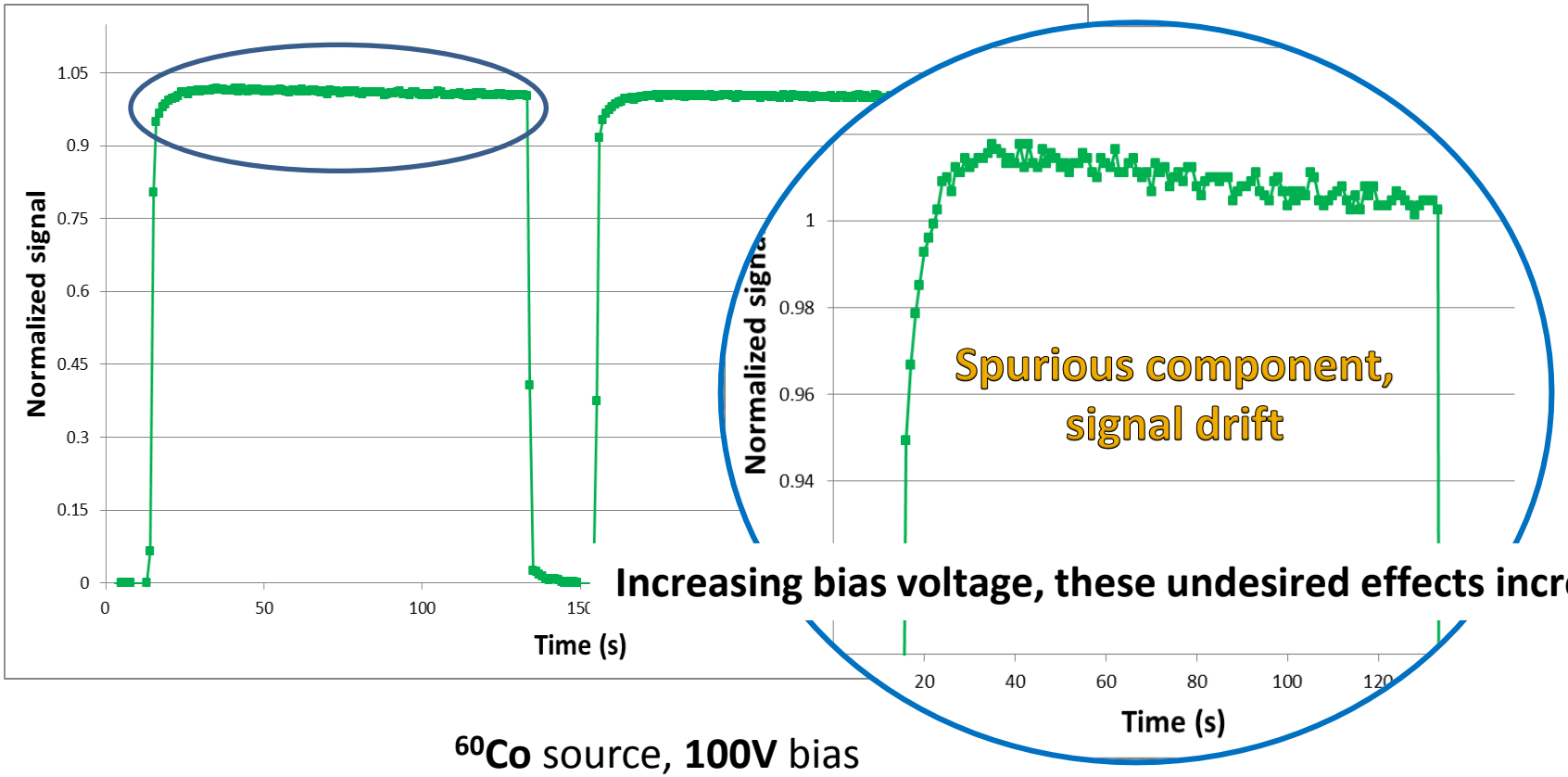
First results/1

First results in ^{60}**Co** beam profiling was very satisfactory

Comparison between reference amorphous Silicon Flat Panel and IC array shows a good agreement

Experimental activity

First results/2



Increasing bias voltage, these undesired effects increase

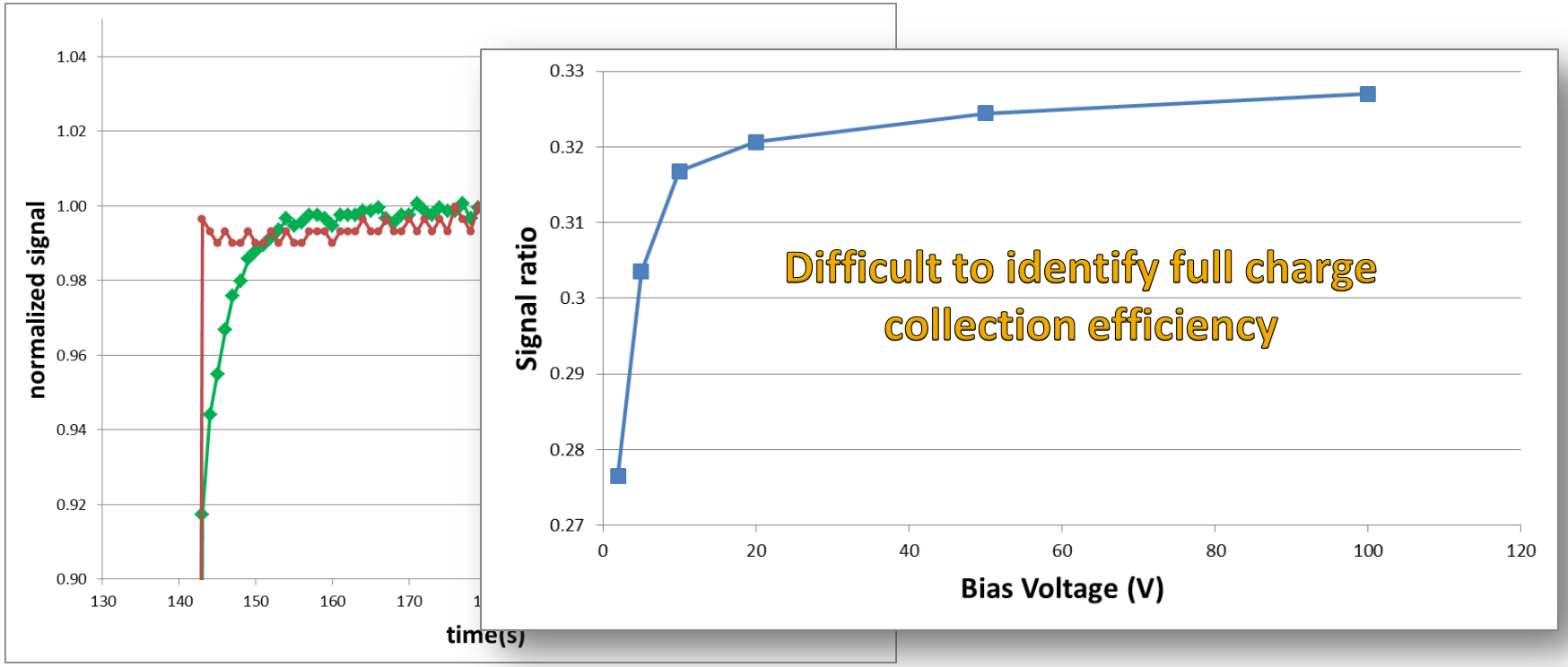
^{60}**Co** source, **100V** bias

Single chamber readout with reference class electrometer (KETHLEY)

Experimental activity

First results/3

The same behavior was found for device response under **MV X-ray beam**



Single chamber readout

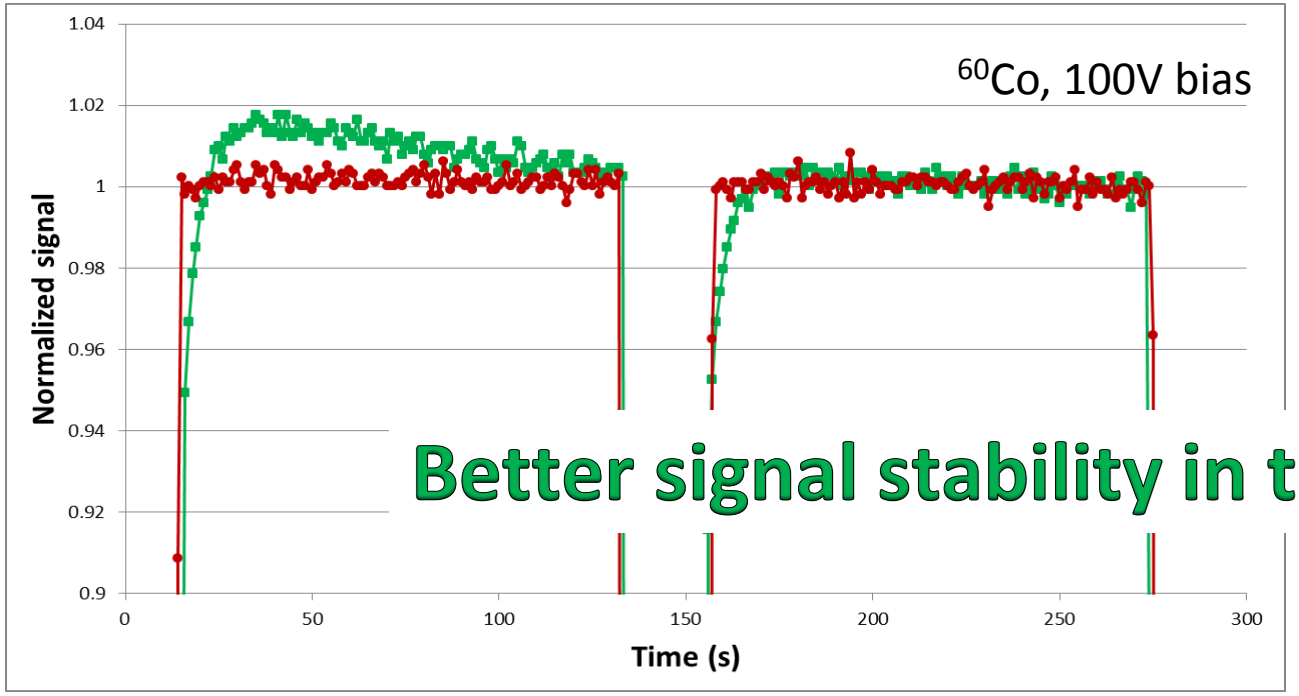
Comparison between reference ionization chamber and IC array

Experimental activity

First results/4

After improvement in:

- guarding of device
- signal routing



Development of prototype II

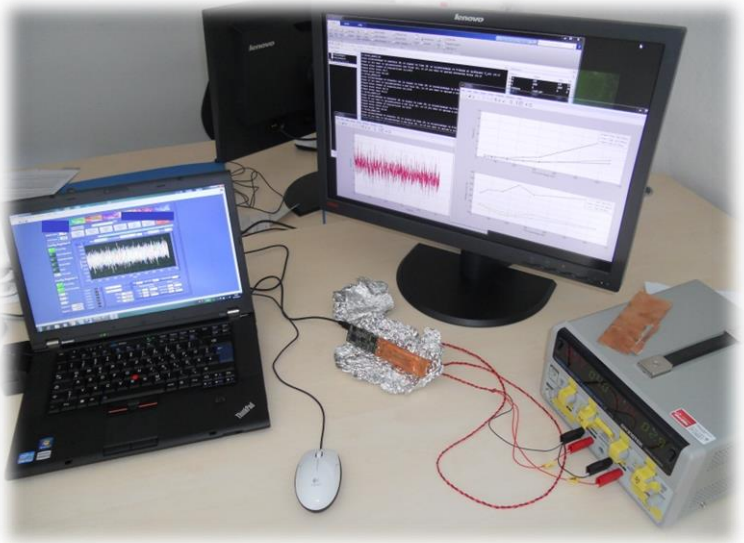
Upgraded detector: prototype II

Designed according to lessons learned with Prototype I

Other goals:

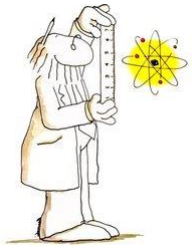
- reach a high signal stability
- consolidate results obtained with Prototype I
- produce a device suitable for independent tests at clinics

+ introduction of a new multi-channel / low noise / front-end electronics



Prototype II is now ready for the first tests!

Monte Carlo simulations

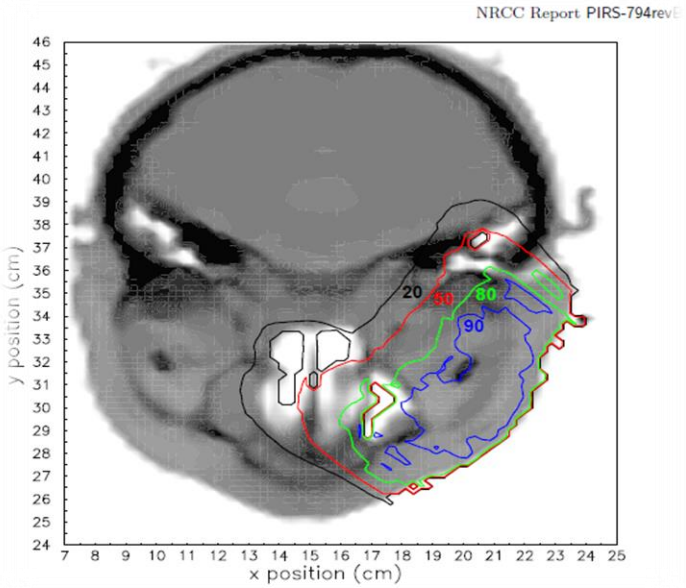


Upgrading detector: Monte Carlo simulations

Simulations of the array has been started using Monte Carlo code **EGSnrc**, specifically suited to model the transport of photons and electrons through matter

Goals:

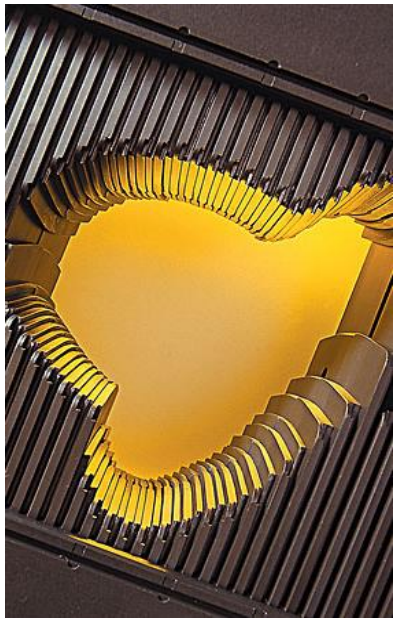
- understand the physics of chambers
- Support the improvement of design and material choice



Work in progress

and planned activities

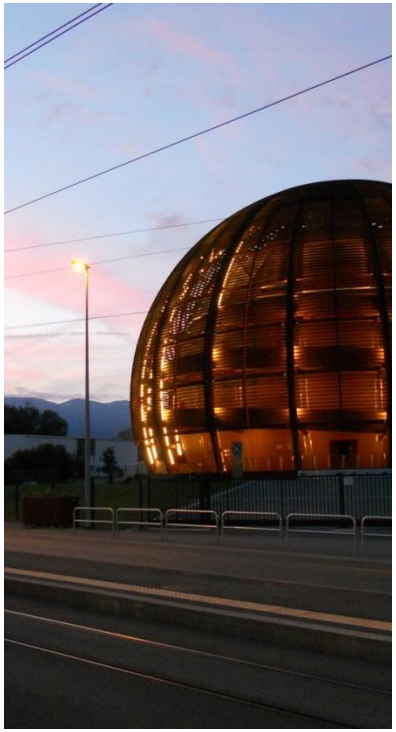
- Experimental characterization of Prototype II
- Going ahead with Monte Carlo simulations:
  - comparison with experimental results obtained with tests on Prototype II
  - possibility to strengthen the collaboration with Medical Physics Department of S.Bortolo Hospital
- Starting activities at TUM (next week), drawing a plan for secondments activities
- Other secondments to be evaluated…



Overview on the project

Experimental activity

Conferences, trainings…



Trainings & conferences

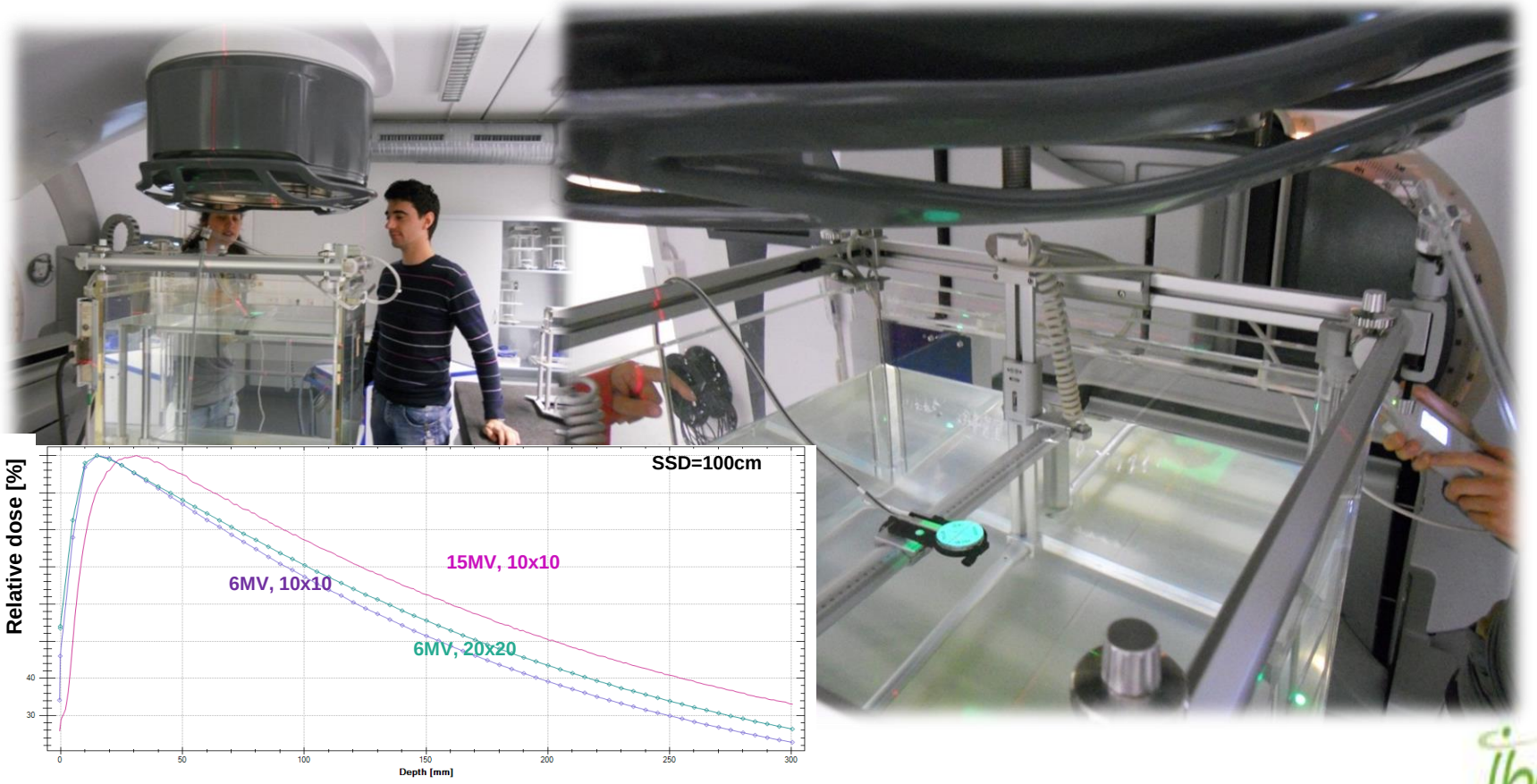
Trainings in using radiation facilities

- ^{60}Co sources:
  - Terabalt: 249.1TBq
  - Gammatron: 85.5TBq
- Linac, MV X-ray

Trainings & conferences

Relative and absolute dosimetry

- measurement with LINAC facility: how to measure a PDD profile, beam profile and output factors of a medical linear accelerator, perform a beam calibration



Trainings & conferences

- Monte Carlo EGSnrc:
  - First training @ IBA
  - Second training: Paolo Francescon, ***Department of Medical Physics***, *S.Bortolo Hospital*, Vicenza

- "*V National School in Detector and Electronics for High Energy Physics, Astrophysics, Space Applications and Medical Physics, INFN Padova (Italy)*":
  - radiation damage in detectors
  - front-end electronics
  - medical application of radiation

- German language course

- Trainings delivered by company : *introduction to working safety, introduction to QM system, radiation safety, company data protection*

Trainings & conferences

- *ARDENT* Mid-Term Review Meeting, CERN

- Confirmed attendance at *IEEE*, *NSS-MIC*, Seoul
- Under evaluation: attendance to *AIFM* (Turin), *ICTR-PHE* (Geneva)


Thank you!