

Michele Tognò

ARDENT ESR 11 – 2D Ionization Chambers
Array for Clinical Applications



Outline

- Few words about me and my career
- Introduction to ARDENT ESR 11 project
- Work carried out on February/May
- Planned activities for future
- Overview on trainings and conferences



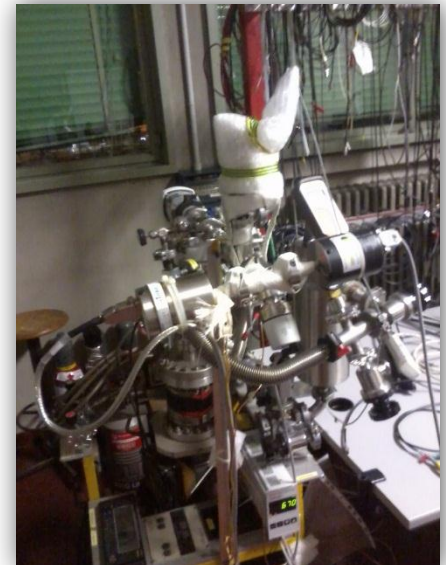
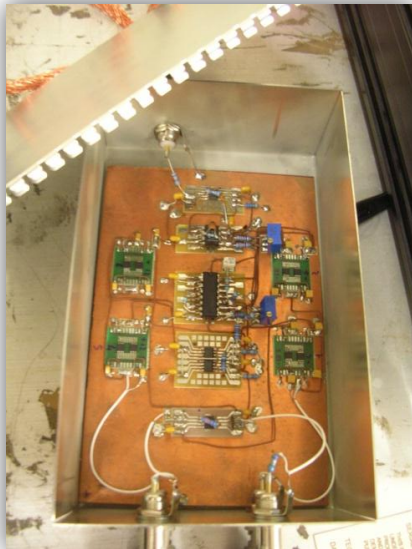
Personal data



I'm 26 and I'm from Italy, precisely from Valtellina. I enjoy hiking and skiing on these mountains!

Education and Previous work

- Bachelor Degree in Physical Engineering (Politecnico di Milano): *“Superconductivity and Isotopic Effect”*
- Master Degree in Nuclear Engineering (Politecnico di Milano): *“Study of a Logarithmic Compression Amplifier for Microdosimetry”*
- Ten months spent at the National Institute of Nuclear Physics in Legnaro (Padova) where I carried out part of my thesis work and I became familiar with gas detectors (especially with TEPC for microdosimetry)



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Hosting organizations



Iba-Dosimetry: The company is located in Schwarzenbruck (Germany) and is a leading manufacturer of quality assurance equipment for radiation therapy and X-ray diagnostics

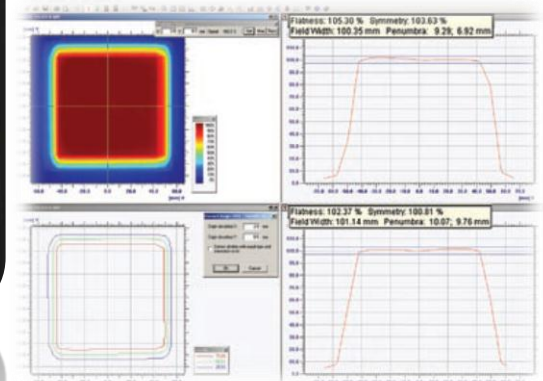
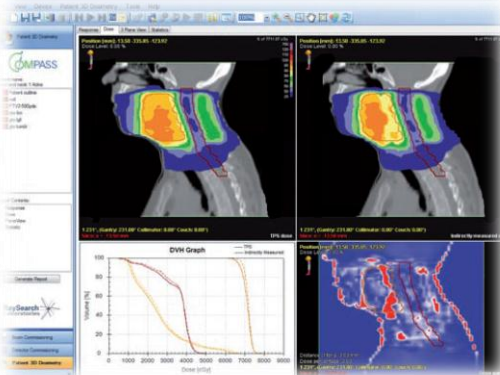
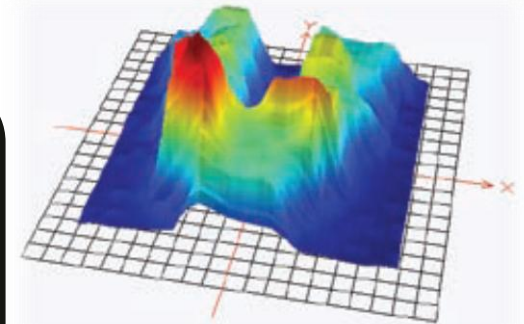
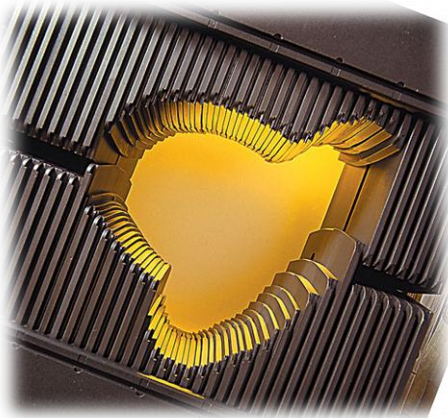
- Acquisition of general dosimetry background
- Main experimental activities are carried out here



Hosting institute for PhD: medical physics unit, department of radiotherapy

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2D Ionizations Chambers Array for Clinical Application



Verification of measured vs planned IMRT treatment cycles

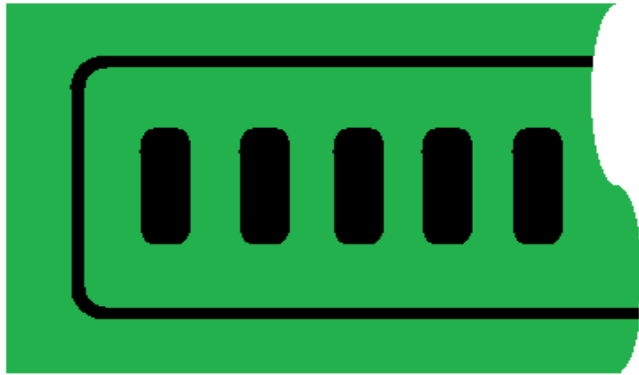
Analysis of critical Linac QA parameters: penumbra, symmetry, flatness and field size

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2D Ionizations Chambers Array for Clinical Application

Concept: development and characterization of a new generation of ionization chambers arrays aimed to radiotherapy applications, particularly for the measurement of absorbed dose from photon, electron and proton radiation.

Start of the activity: experimental characterization of pre-existing 1D array prototype



- Fast and accurate field profiling, suitable to be used within a water phantom
- Test new technical solution in view of a future development of 2D array

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

ARDENT ESR11 - Project

2D Ionizations Chambers Array for Clinical Application

Goals	Benefits
Test new solutions for IC arrays, upgrade of present company array detectors	better future products
Reduce pitch and pixel size	better spatial resolution
Reduce chamber thickness	improved efficiency at high dose rate
Study of materials and geometry	improved stability
Simple assembling, robust design	improved yield, cost, service

2D Ion Chambers Array for Clinical App.

Experimental work at IBA

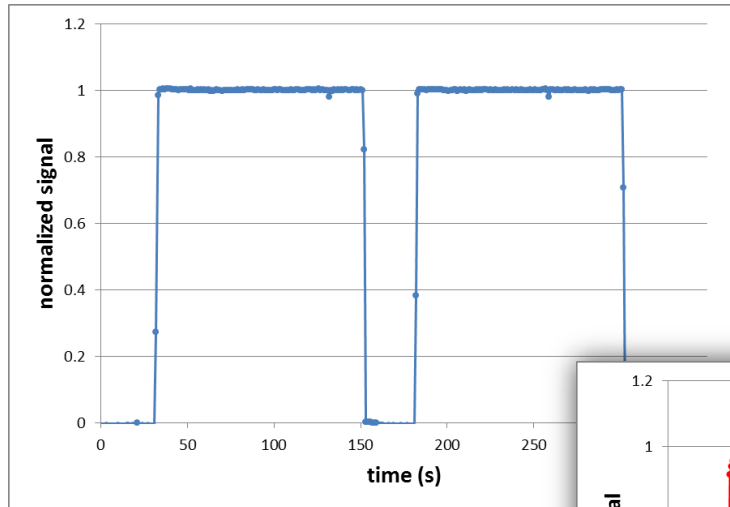


- First prototypes: several small arrays on a multi-layer PCB
 - Different shapes and geometries
 - Possibility to readout only one pixel or the whole array
 - Due to small chamber volume, at a dose rate of 1Gy/min the ionization current is in the order of few pA
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- Actually, the signal outcoming from chambers can be read by a commercial KEITHLEY electrometer or by a multi-channel electrometer developed at IBA but not dedicated to this application

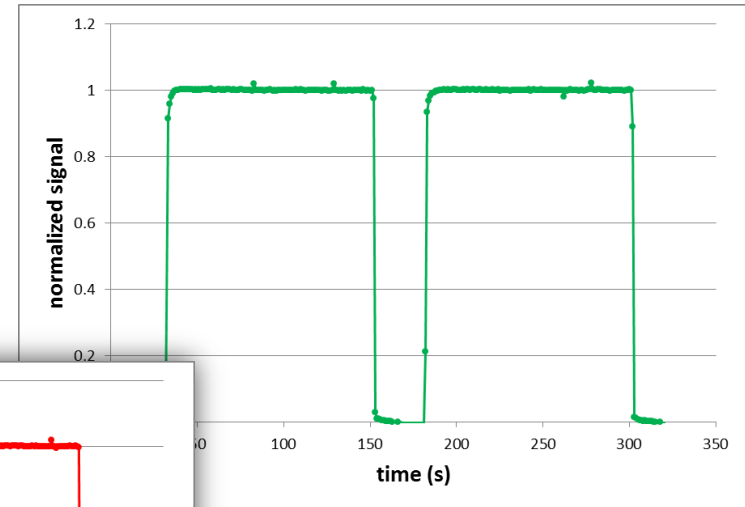
2D Ion Chambers Array for Clinical App.

Experimental work at IBA

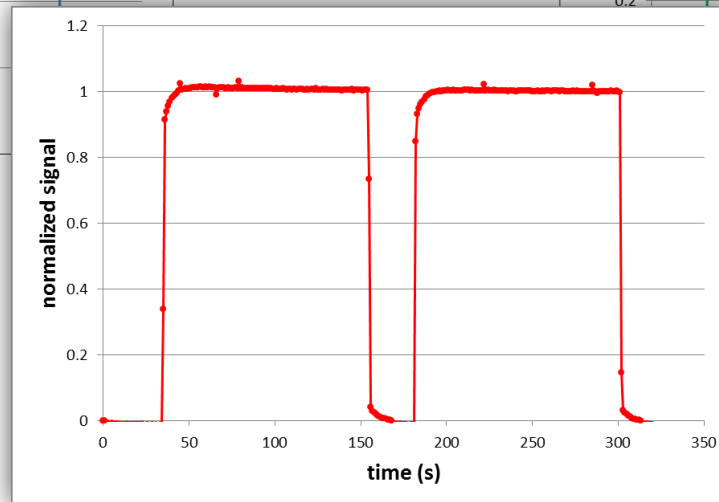
- Preliminary results: sensitivity is not stable with the time. This is probably due to the presence of spurious components



10V bias



50V bias

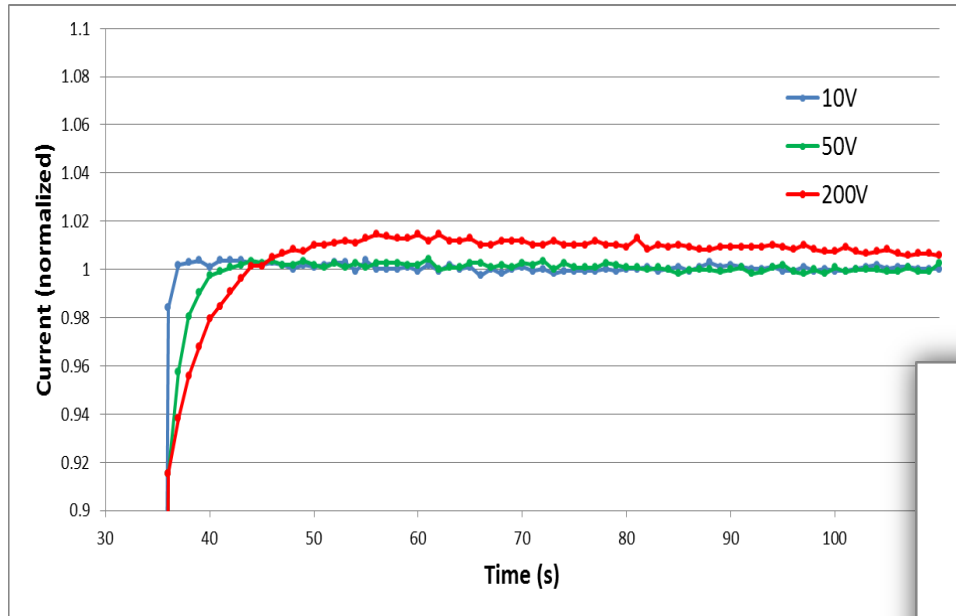


200V bias

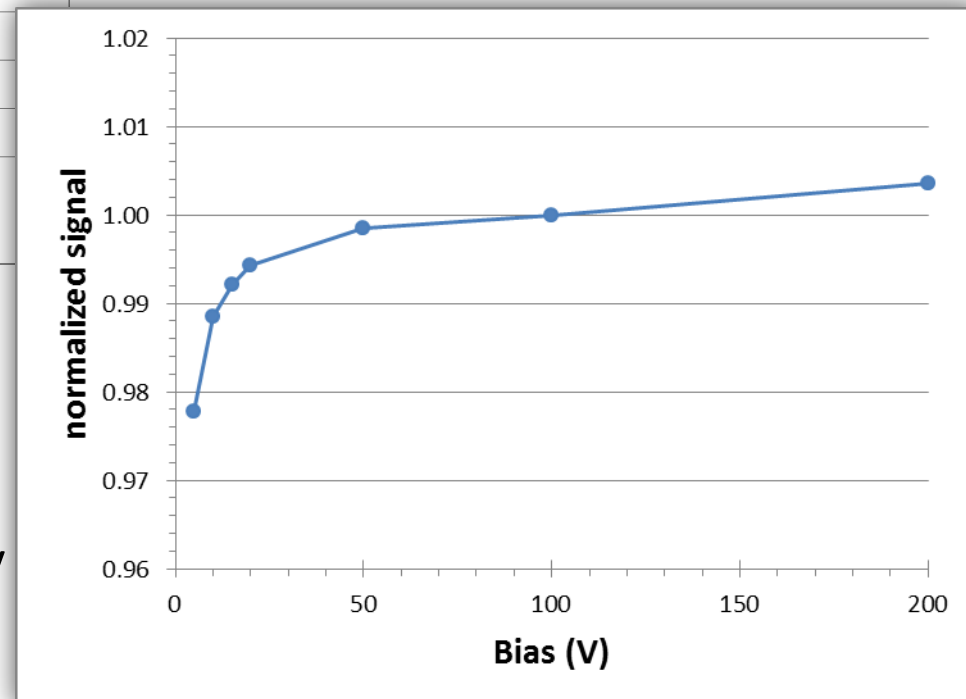
Series of pulses, time profile

2D Ion Chambers Array for Clinical App.

Experimental work at IBA



Signal fluctuation depends on Vbias.



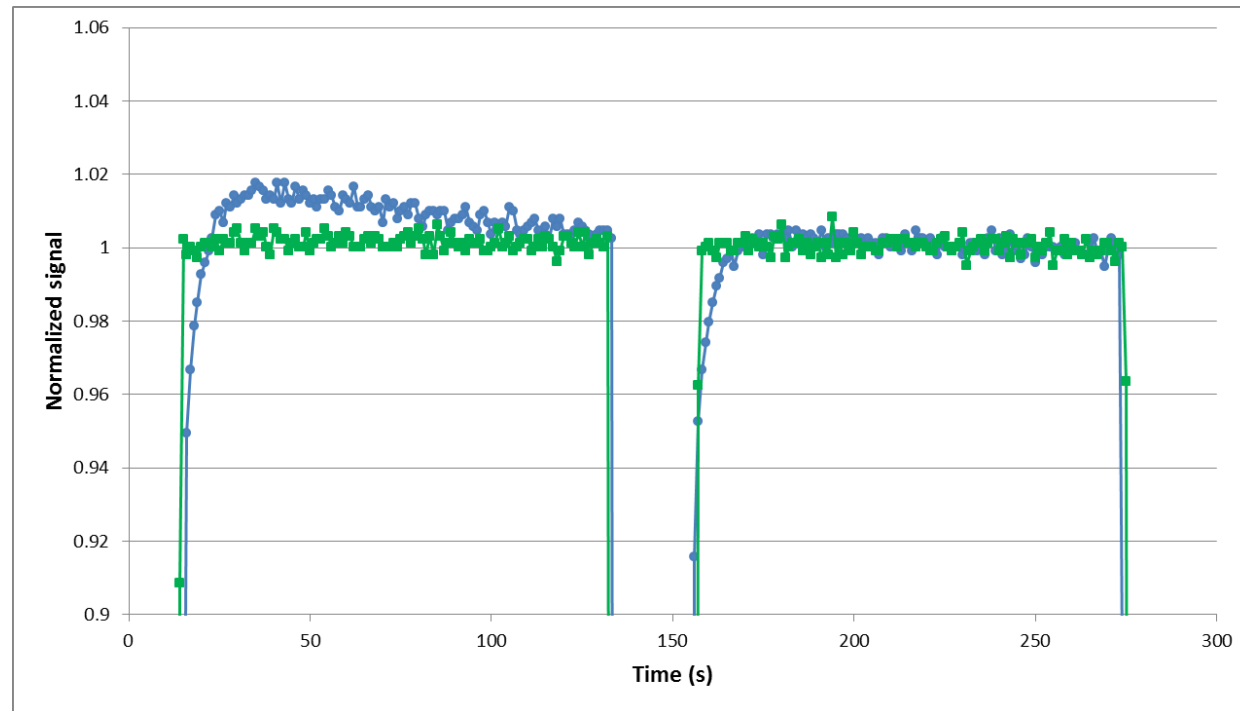
Chamber saturation region is not clearly defined as well

2D Ion Chambers Array for Clinical App.

Experimental work at IBA

- Where these spurious effects take source?
 - Ionization of materials outside of chamber volume?

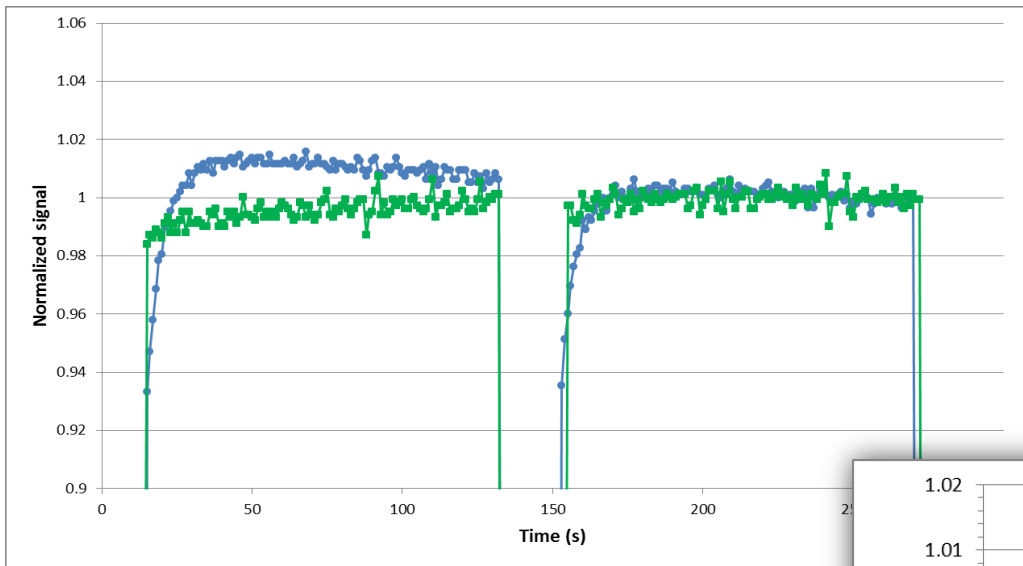
We improved guarding, in order to minimize radiation induced leakage currents



Time profile,
100V bias

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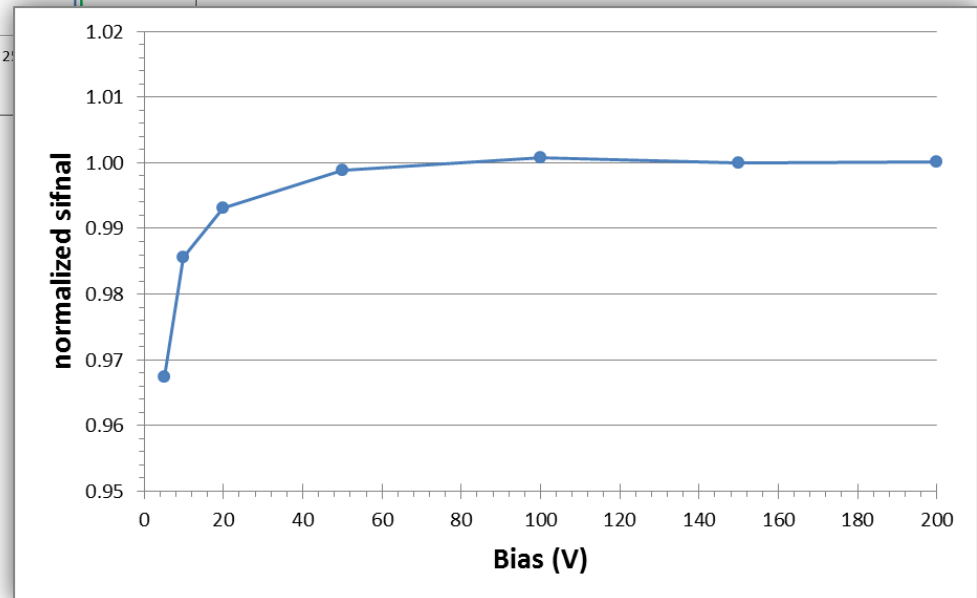
Experimental work at IBA



Time profile, 200V bias

Slow spurious component still persist at high bias

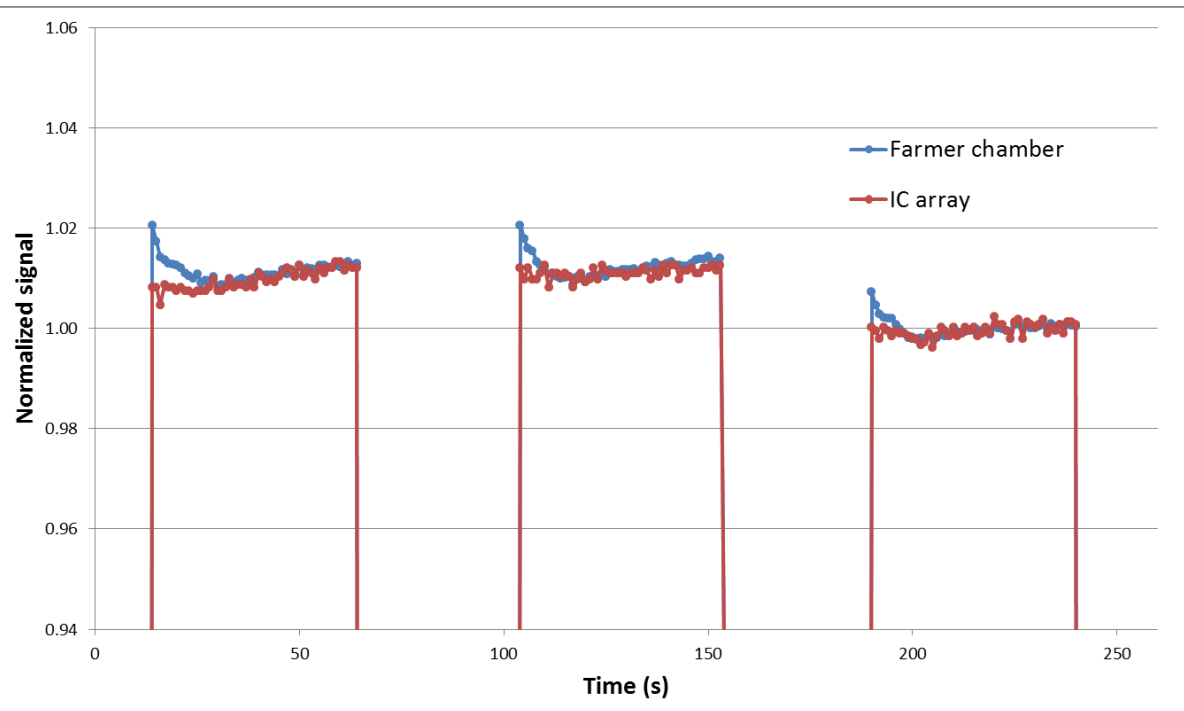
Saturation curve shows a better behavior, plateau is reached between 50 and 100 Volts



2D Ion Chambers Array for Clinical App.

Experimental work at IBA

Test under pulsed X-rays beam (LINAC facility)



- 6MV beam quality, dose rate 400 MU
- Time profile 100V bias, comparison with a reference Farmer chamber

2D Ion Chambers Array for Clinical App.



Work in progress and planned activities

- **Complete the debug** of first prototype
- Design and implementation of a **new improved prototype**, which will take into account the results of carried out measurements
- Implementation of a **new multi channel readout electronics**
- **Monte Carlo simulation of ion chambers**, useful to better understand the physics and to correctly choose materials and geometries

ARDENT Project

Trainings received and schools/conferences attendance

- EGSnrc Monte Carlo code training, photons and electrons simulation
- Relative and absolute dose measurement with LINAC facility



ARDENT Project

Trainings received and schools/conferences attendance

- Practice with TERABALT and GAMMATRON irradiation facilities (^{60}Co)
- Company delivered trainings:
 - Introduction to working safety
 - Introduction to QM system
 - Radiation safety
- German language course
- *“V National School in Detector and Electronics for High Energy Physics, Astrophysics, Space Applications and Medical Physics, INFN Padova (Italy)”*, which was focused on radiation damage in detectors, front-end electronics and medical application of radiation.
- Planned attendance at IEEE, NSS-MIC, Seoul

A photograph of a person in winter gear climbing a snowy mountain peak. The person is wearing a dark blue jacket, dark pants, and a red backpack. They are using ice axes and are positioned on a steep, snow-covered slope. The background is a vast, snowy landscape under a clear sky.

Thank you