INFN Istituto Nazionale di Fisica Nucleare

Laboratori Nazionali di Frascati

Strathclyde Collaboration

Calibration of detectors with high energy beams for radiotherapy purpose.

Goal of the experiment

The goal of the experiment was to obtain detectors calibration (Gafchromic EBT2 type film and ionization chamber) commonly used for conventional clinical radiotherapy LINACs with a source of well known properties (electron beam at SPARC).

The objective of the experiment was to calibrate detectors which could reliably being used for dosimetry measurements of very high energy laser-plasma accelerated electron beams (in particularly for ALPHA-X electron beams at the University of Strathclyde).

Requirements: time and LNF staff

1 week and at least 2 LNF staff people every day to run the machine.

Requirements: equipment (Strathclyde)

A water tank to simulate a phantom and a table to hold it;

Detectors that need to be calibrated (Gafchromic EBT2 and ionization chamber) and an IP scanner.

Requirements: electrons (LNF)

Electron bunches with well known properties;

Some distance in air for air propagation of the electron bunches;

Electron beam transversal dimension in the cm scale.

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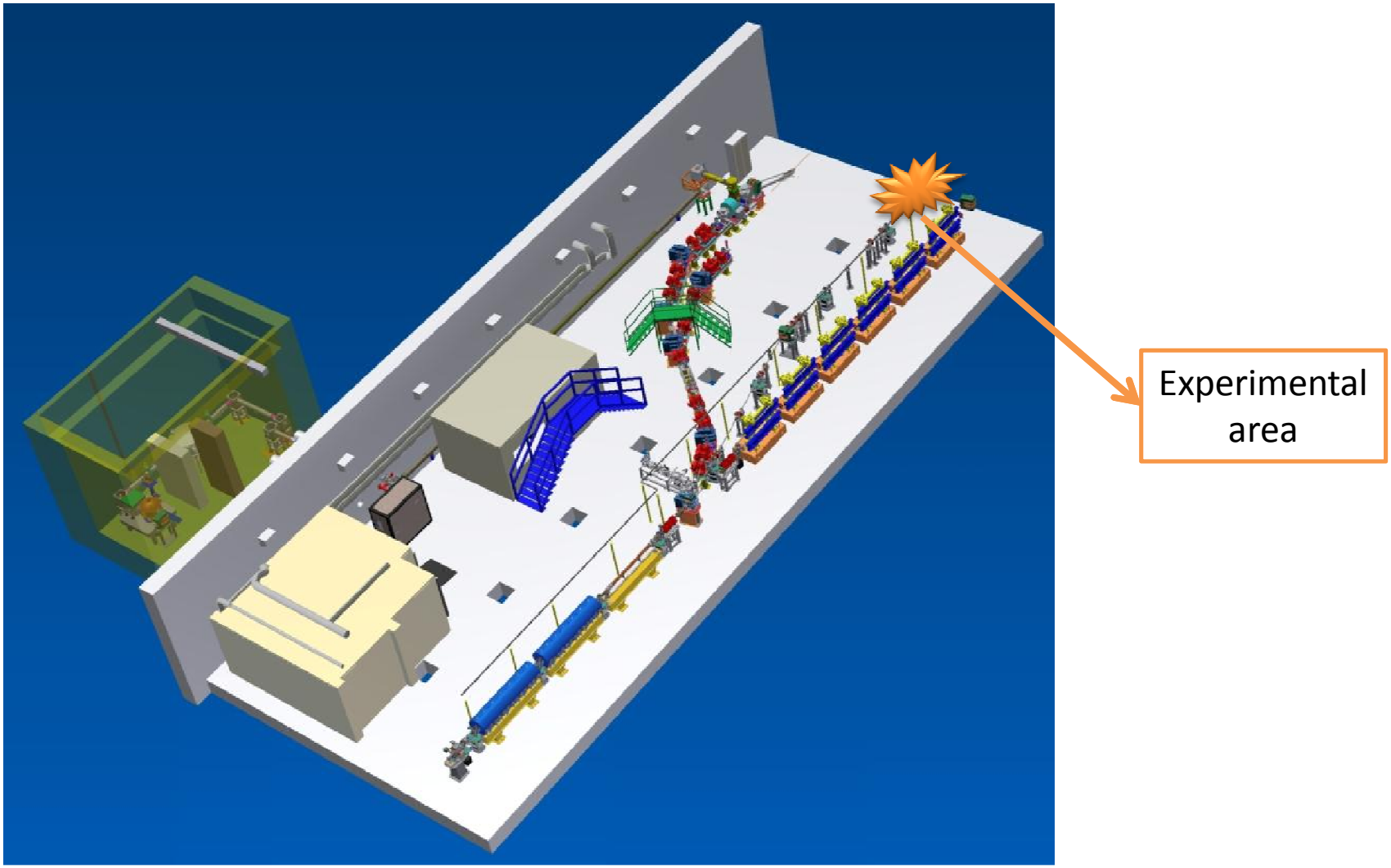
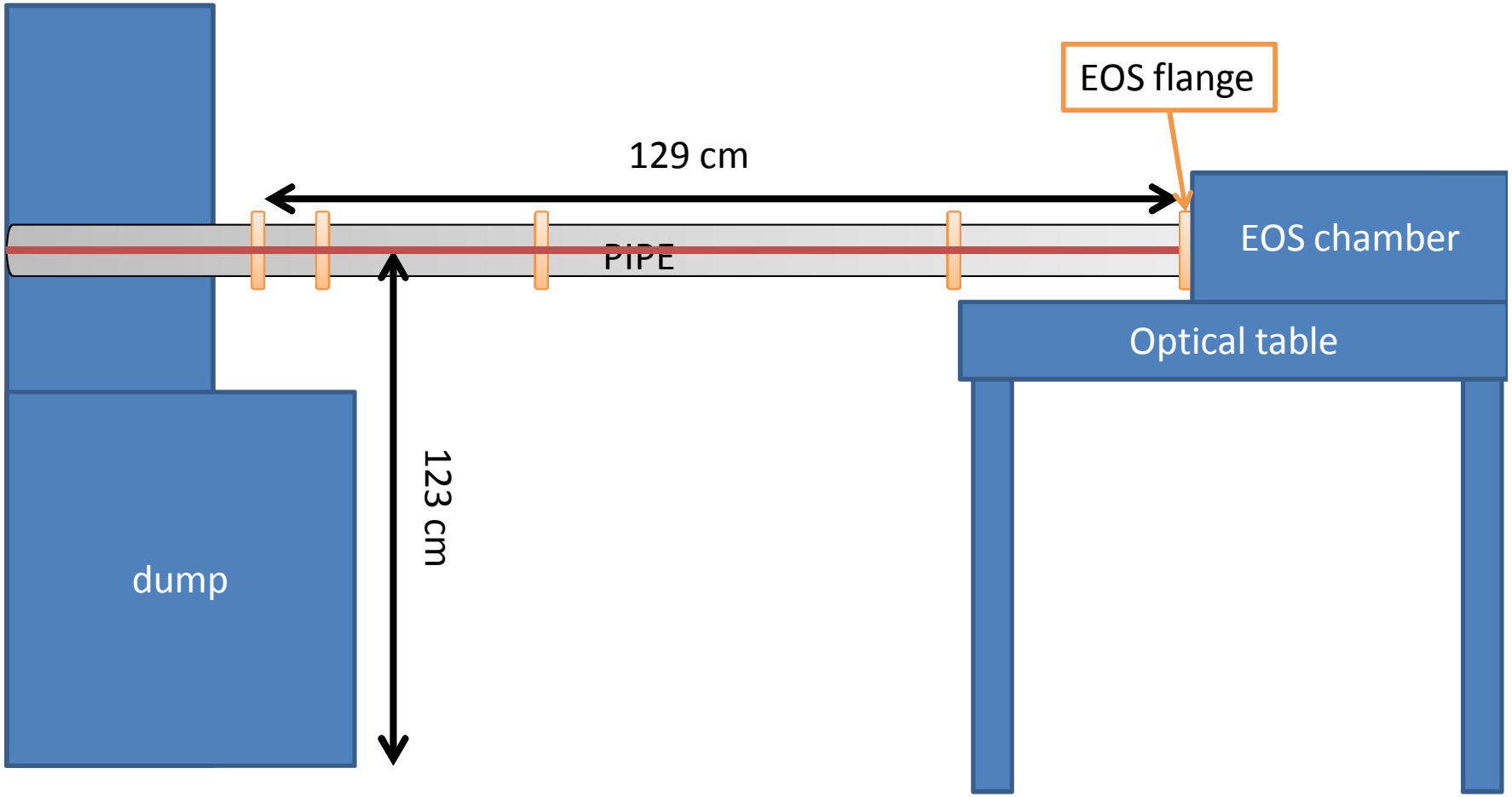
Experimental set-up



Experimental set-up



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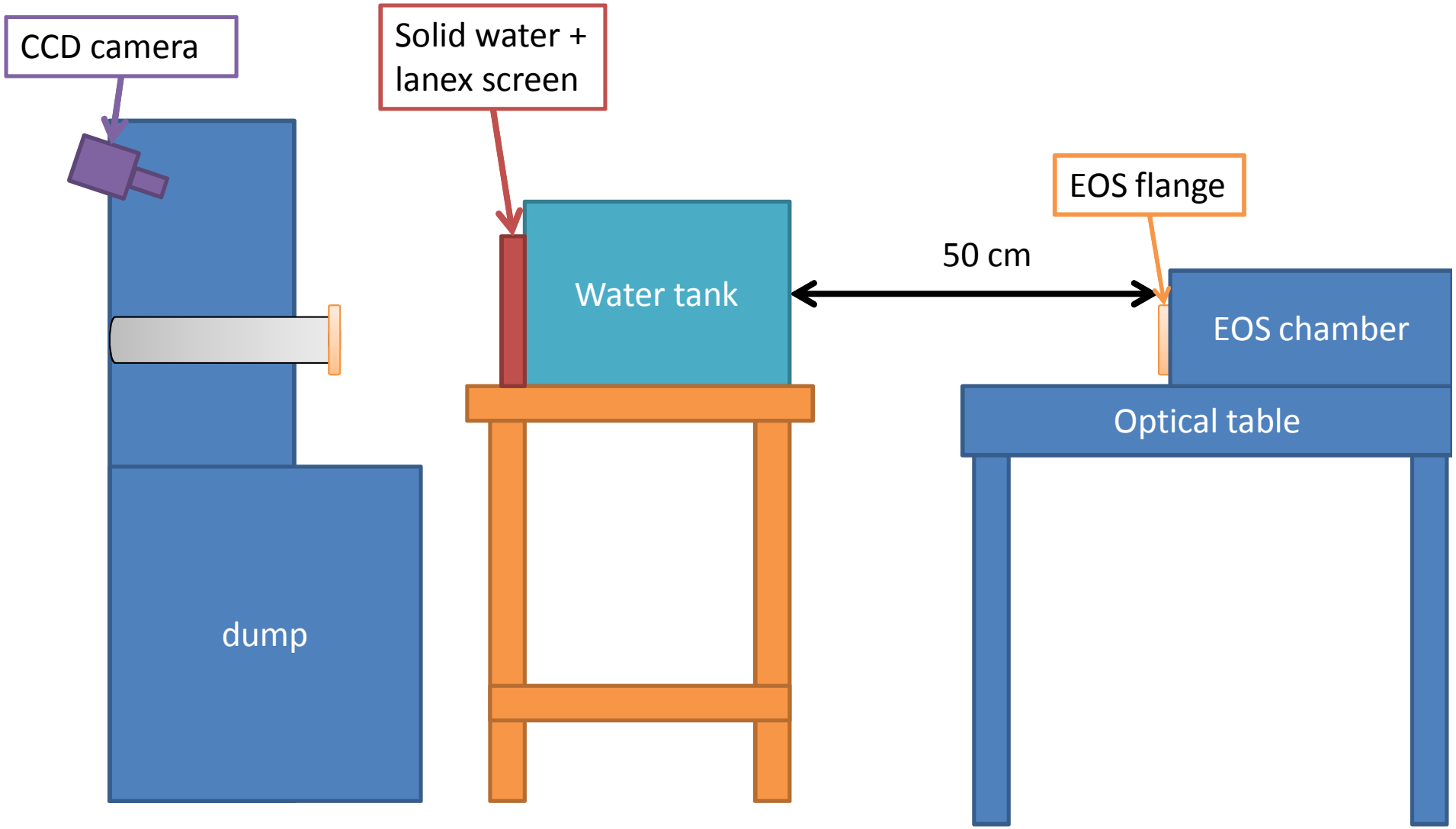

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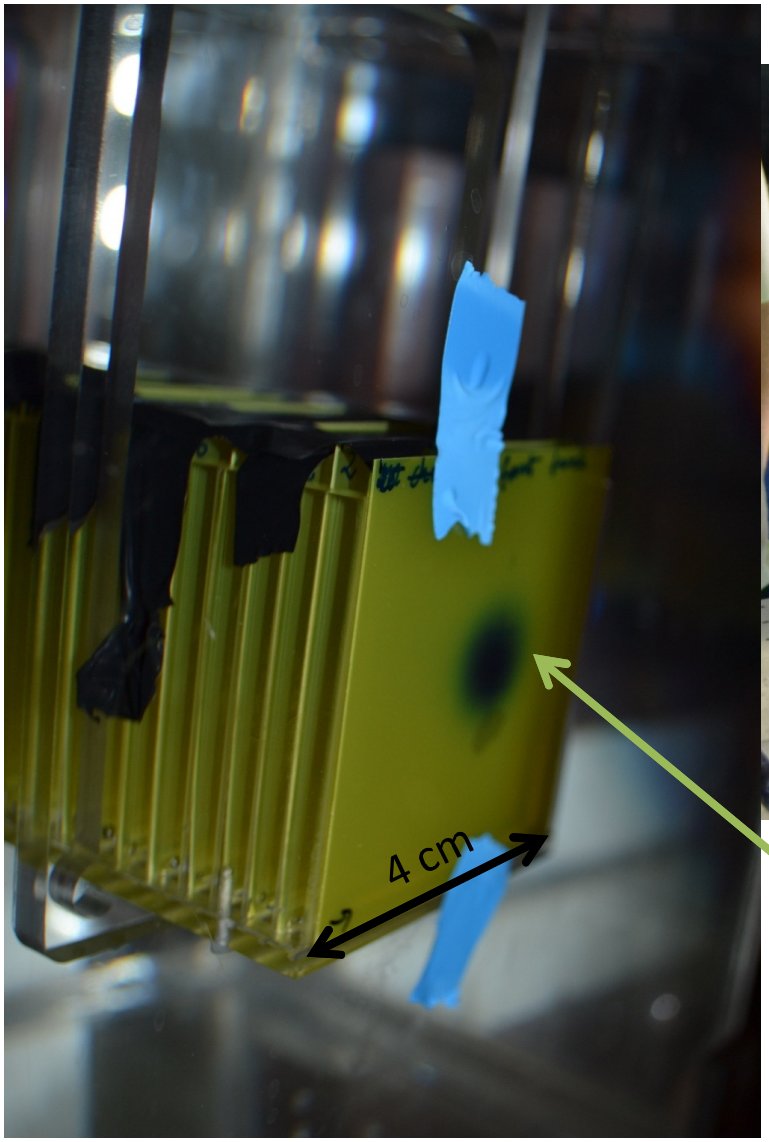
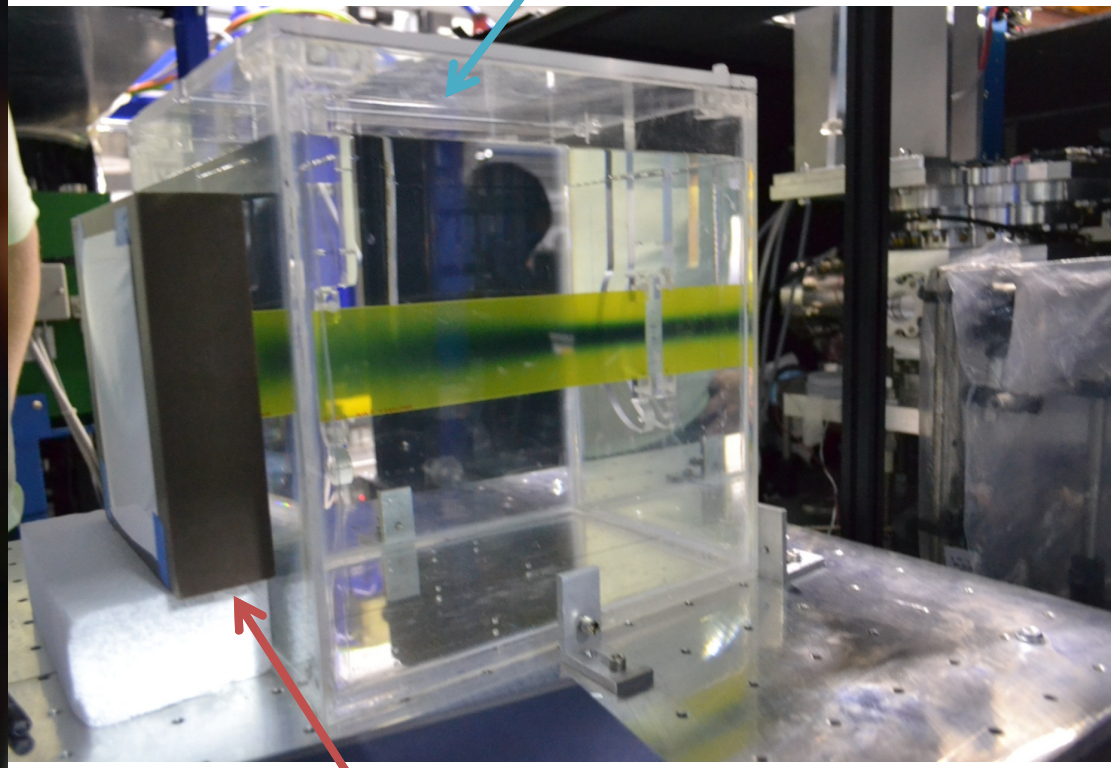




Transver profile of the first electron bunch imaged on the Gafcromic film after 50 cm of propagation in air.

Main issues

1. Counting the number of shots irradiating the ionization chamber;

2. Evaluate and reduce the dark current contribute;

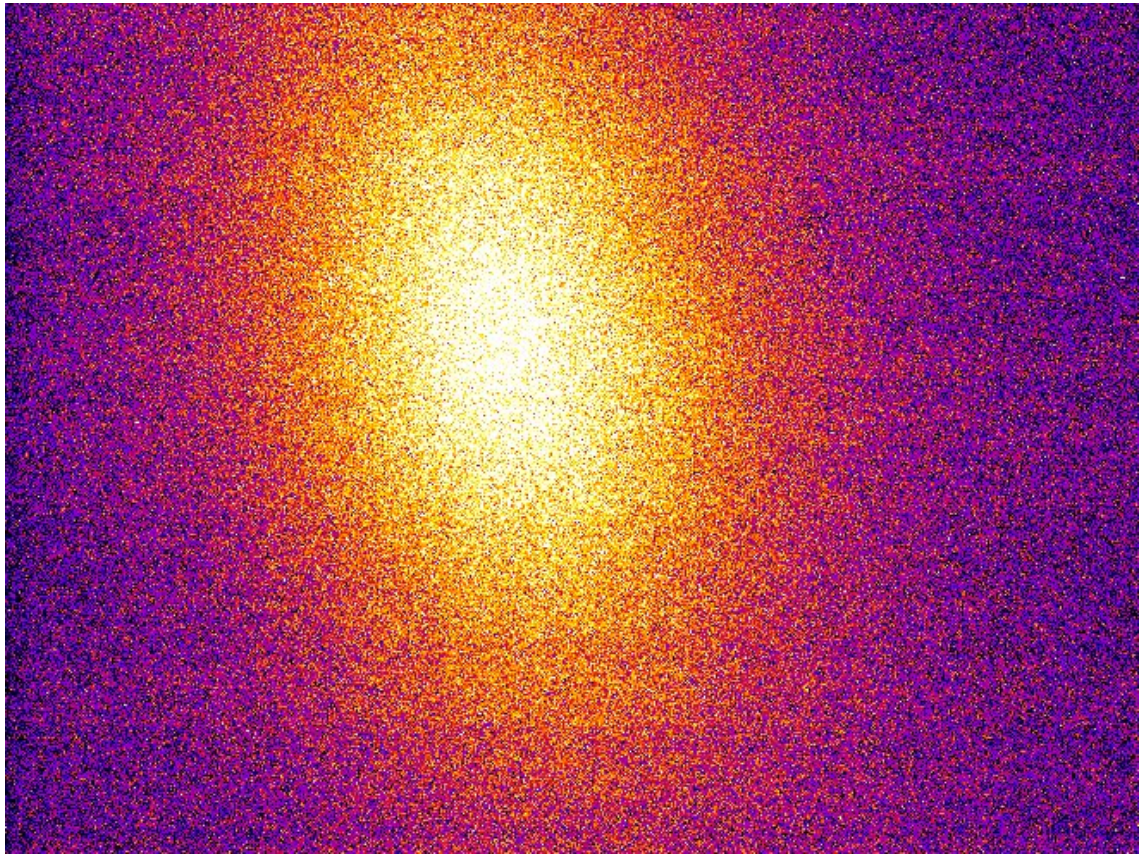
3. Obtain a cm transversal dimension of the electron beam with high uniformity.

BUT MOREOVER

Go inside the bunker a thousand of times to replace the detectors!

Main issues

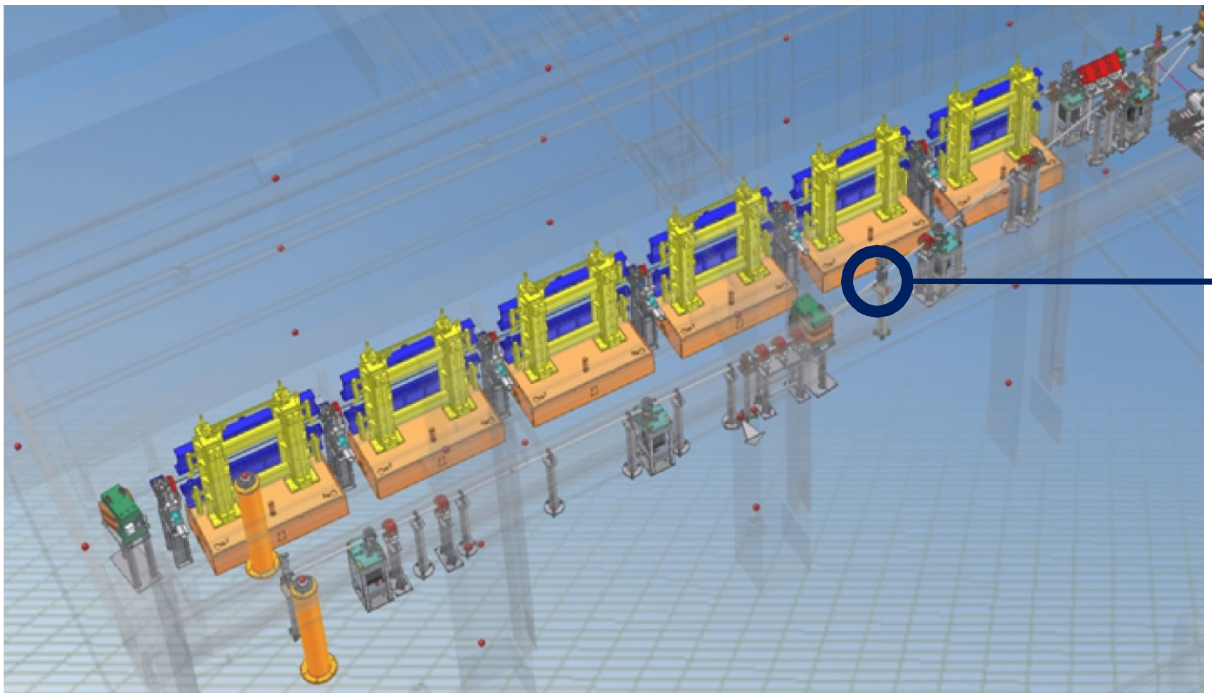
1. Counting the number of shots irradiating the ionization chamber;



Contrast of the image enhanced for purpose.

Main issues

2. Evaluate and reduce the dark current contribute;

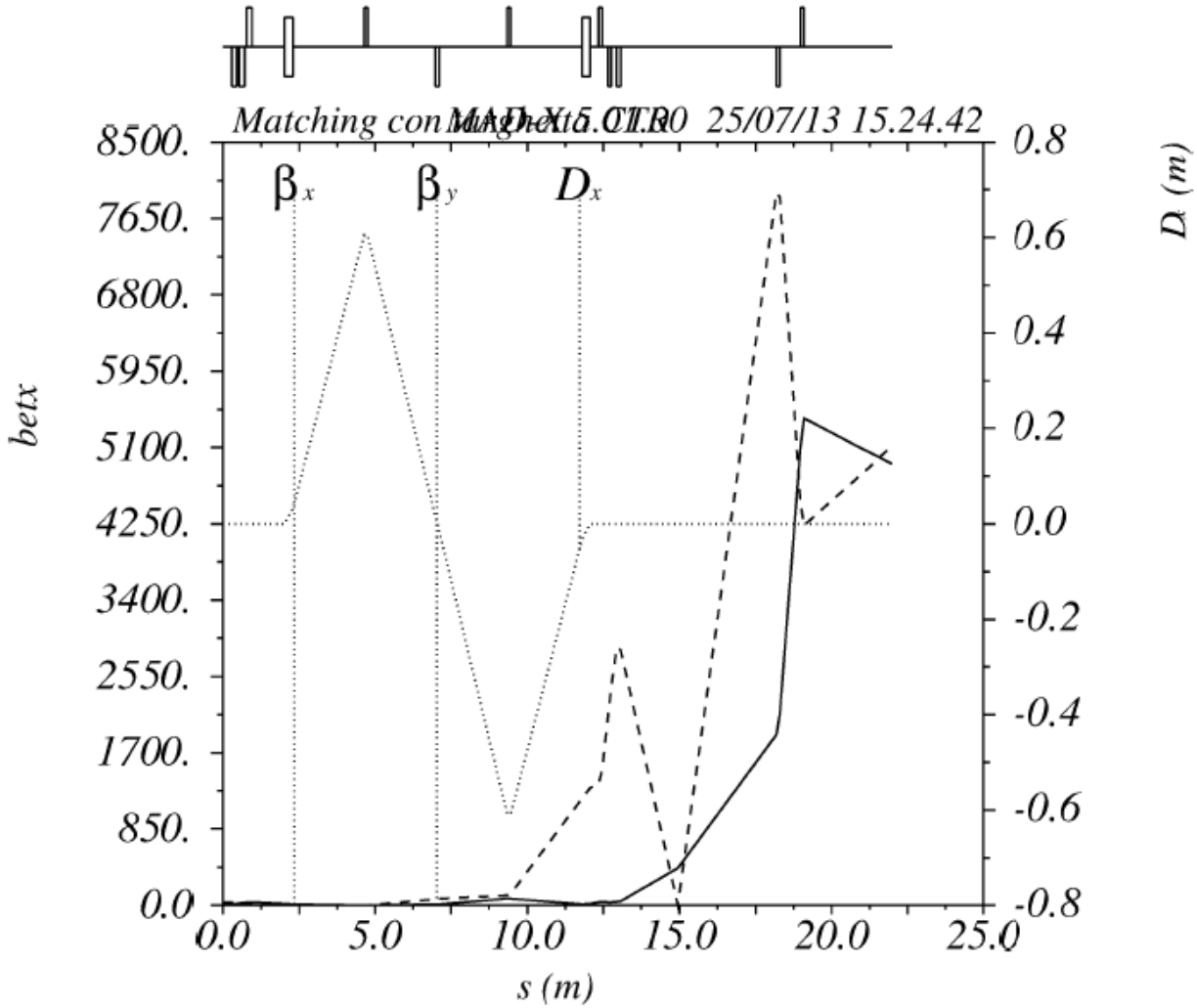


Control of dark current has been done using the last valve of the oblique part of the dogleg.

The contribution of the dark current on the measurement have been evaluated by irradiating the detectors with different time windows to change the dose deposition. Dark current effects has been eventually treated as background.

Main issues

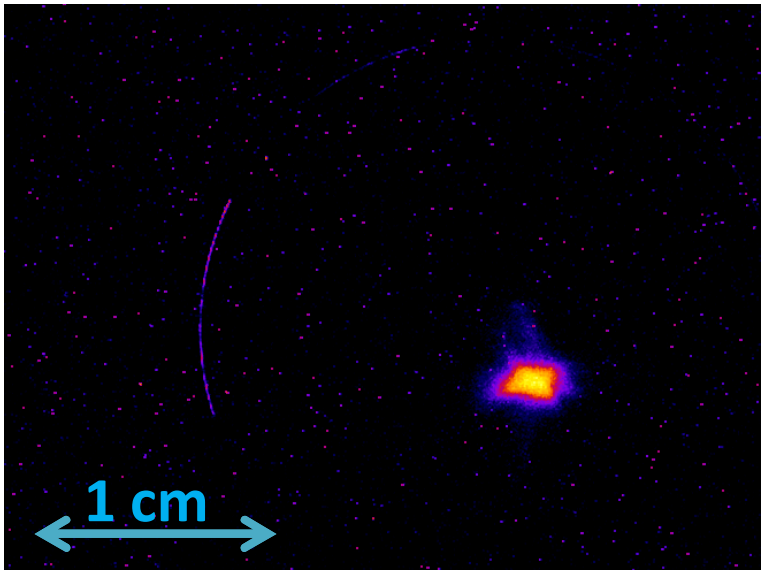
3. Obtain a cm transversal dimension of the electron beam with high uniformity.

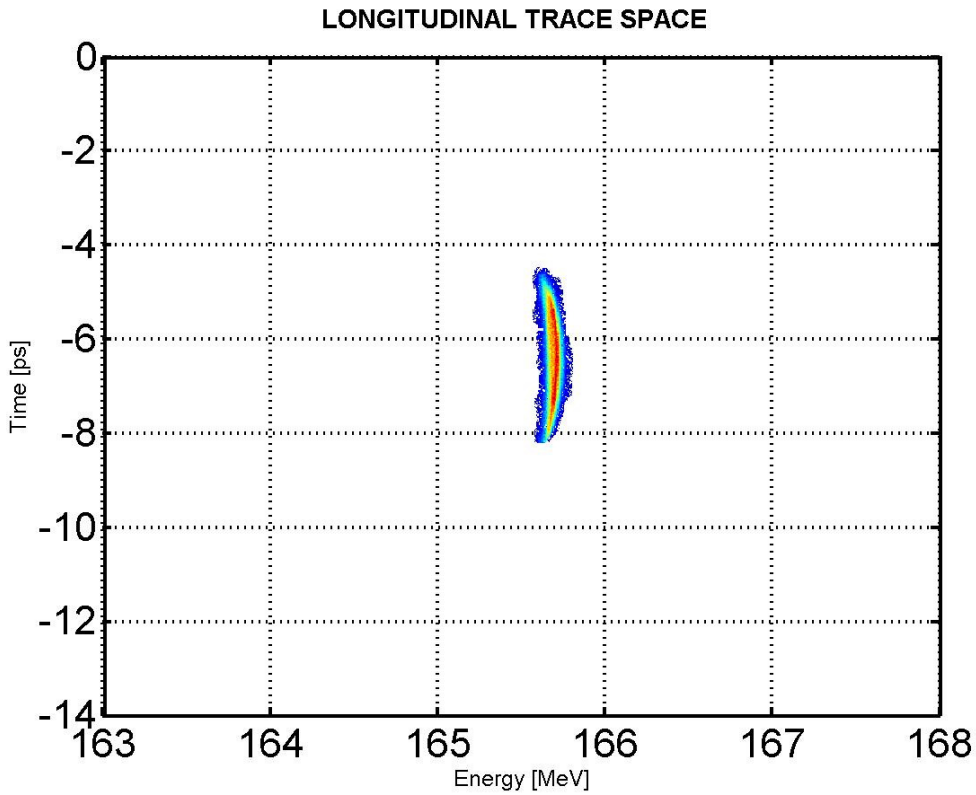


Electron beam properties

Single bunch with the following parameters:

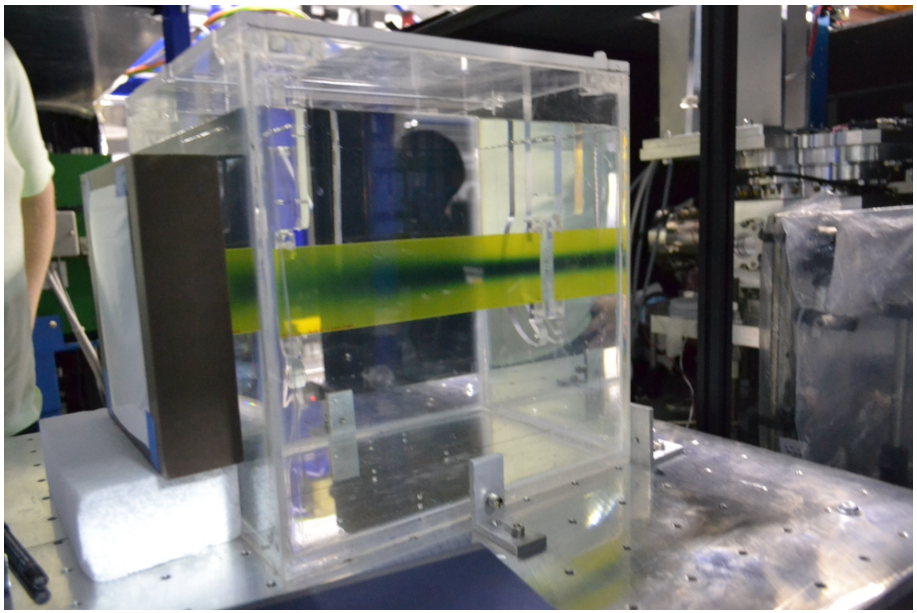
Energy: 165.7 (± 0.11) MeV;
Energy Spread: 0.0698 (± 0.003) MeV
Charge: 50 pC;
Duration: 0.87 (± 0.031) ps;

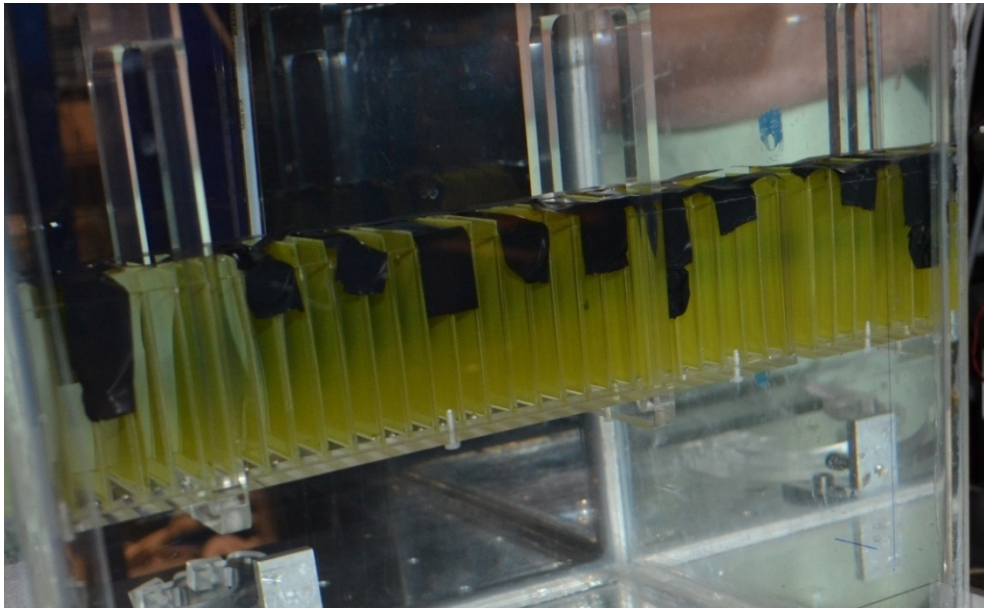




Results of the measurements

Longitudinal profile of deposition



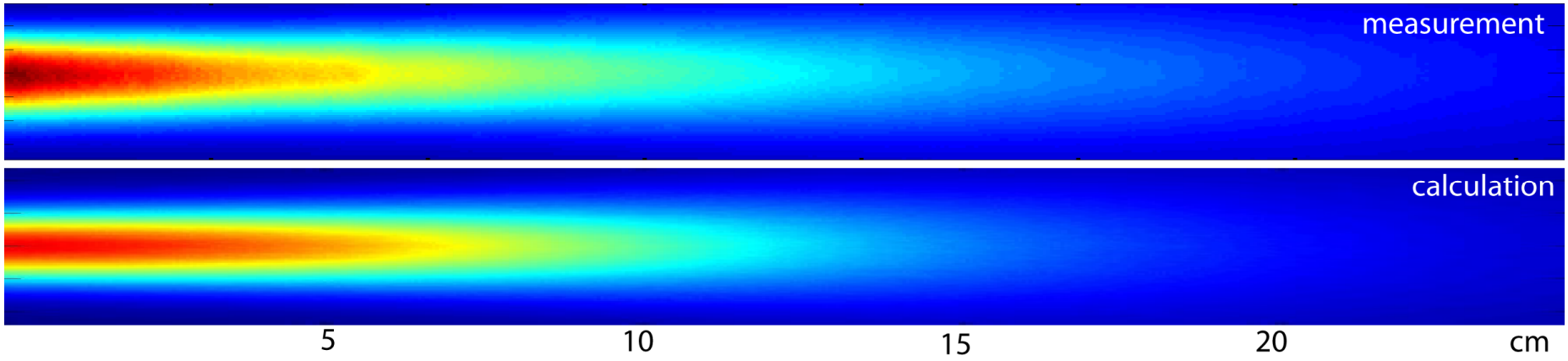


Transverse profile of deposition

Results of the measurements:

LONGITUDINAL PROFILE

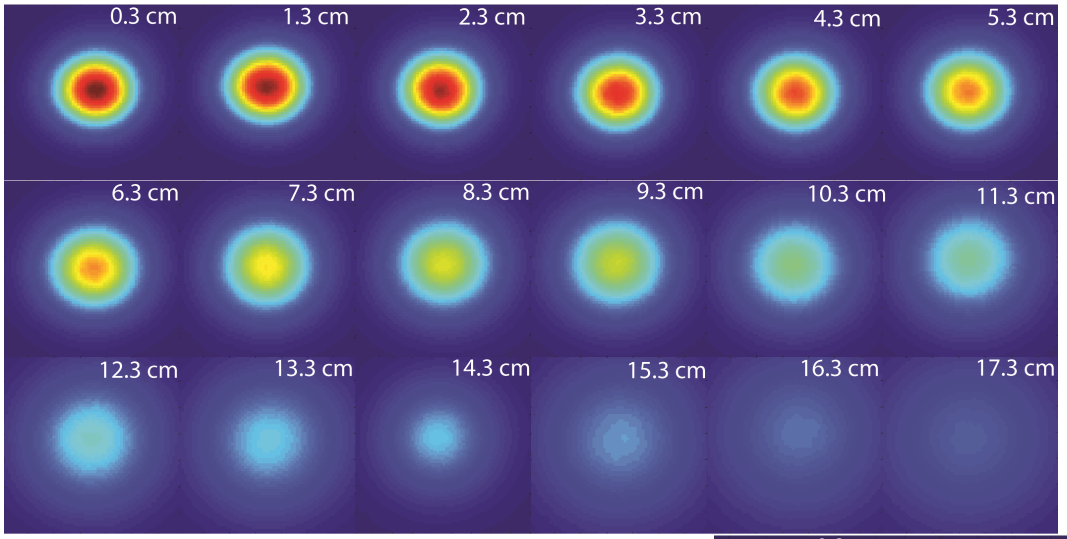
Calculation done with FLUKA (Monte Carlo code).



Differences between measurements and calculations due a misalignment: the Gafchormic films were not well aligned with the central axis of the electron beam.

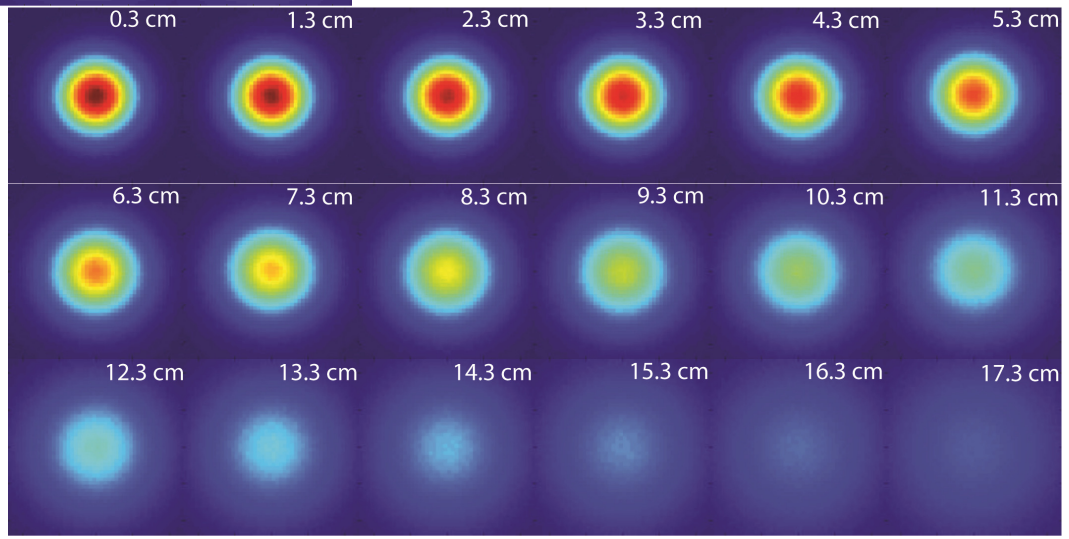
Results of the measurements:

TRANSVERSE PROFILE



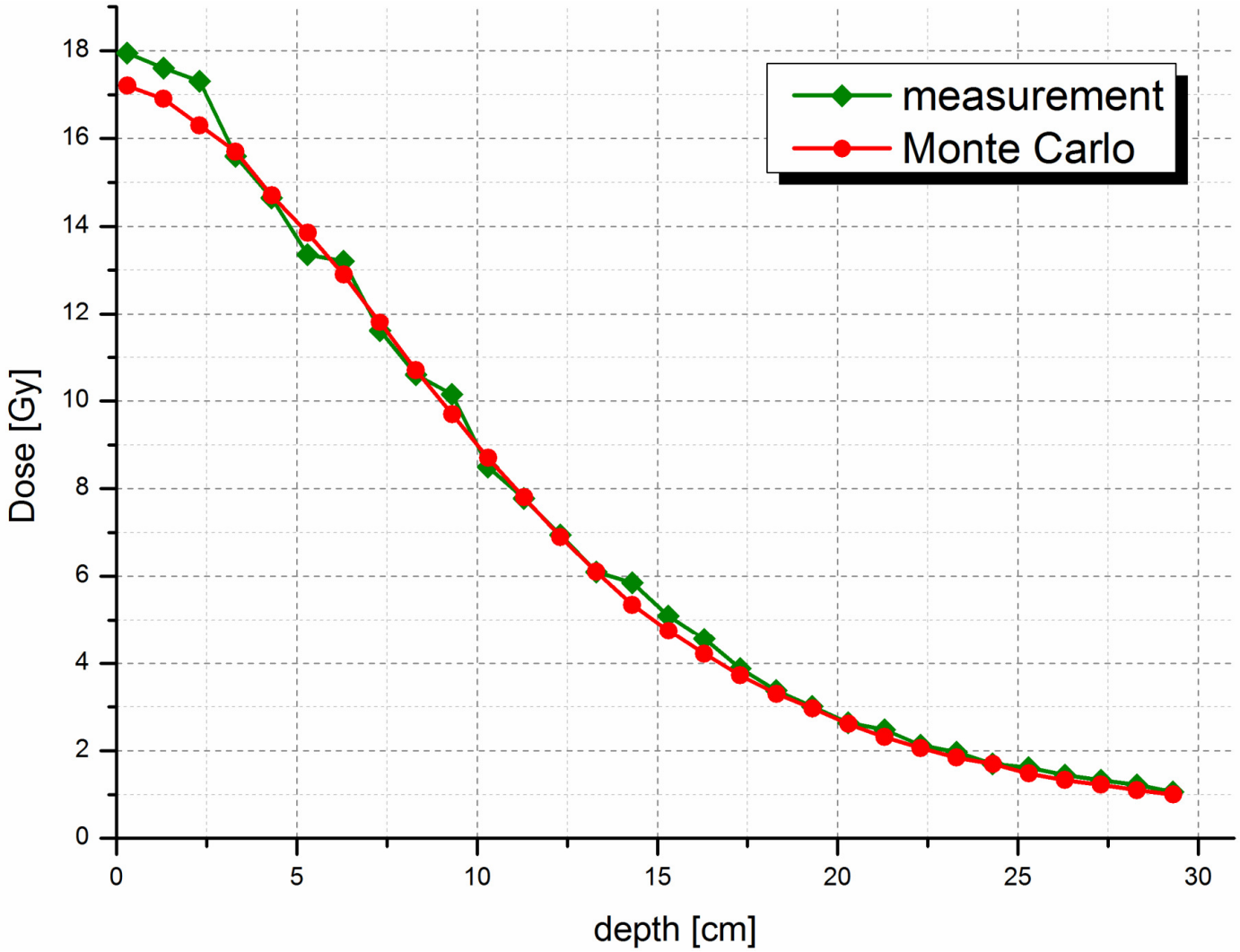
MEASUREMENTS

CALCULATED with FLUKA



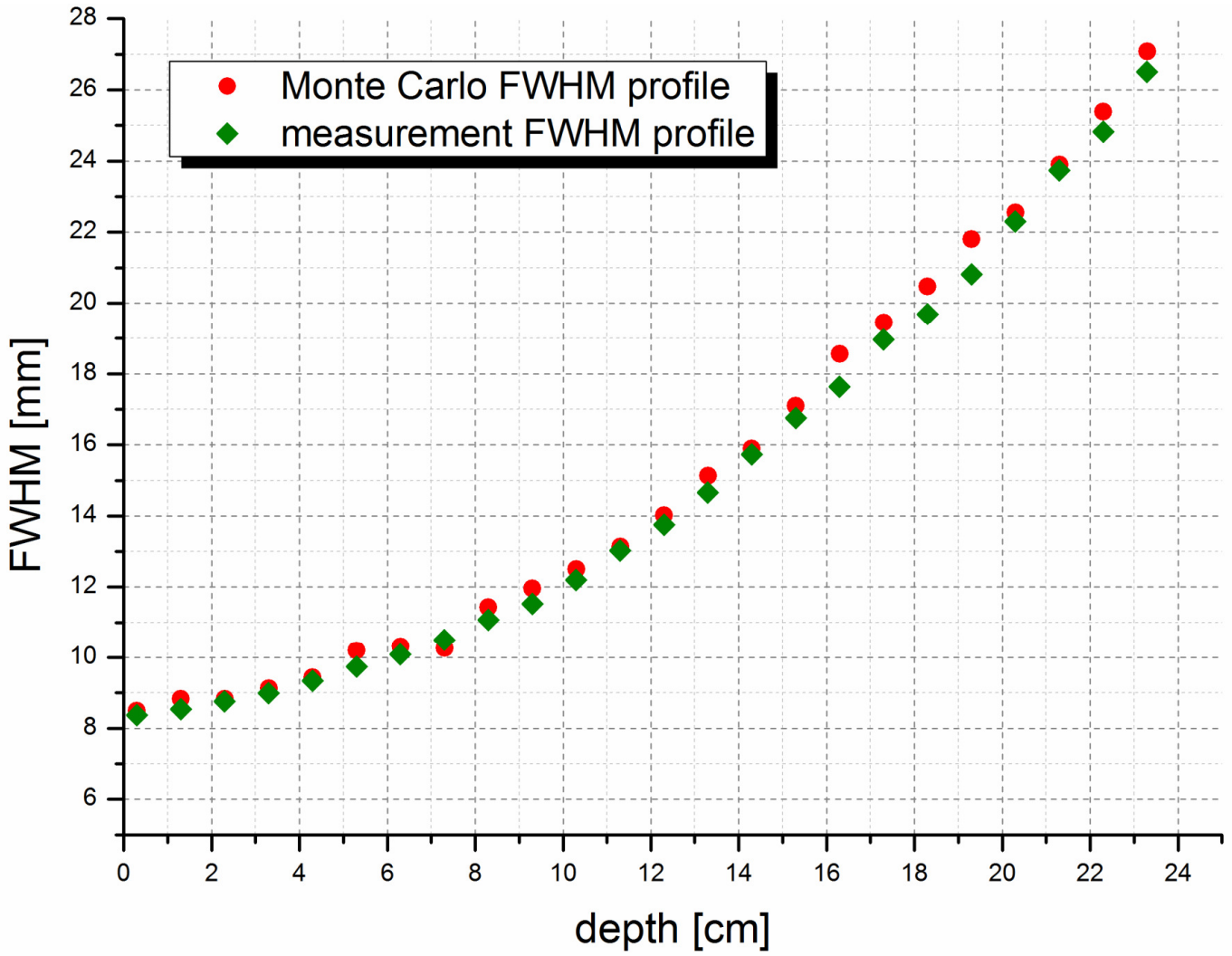
Results of the measurements:

LONGITUDINAL PPD curve



Results of the measurements:

Evolution of FWHM transverse size during propagation in water.

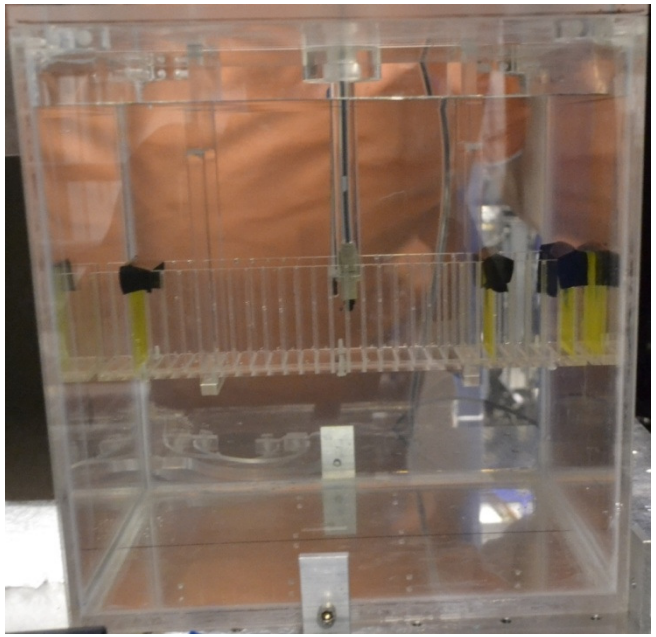


Results of the measurements:

ALPHA-X experiment di **mariapia.anania** del 2013-07-27 20:42:47	**Entry:** 9058 **Visite:** 11
Dear the SPARC team, We would like to say how grateful and thankful we are to each and every one of the team here, at Frascati. This extends from allowing us to perform our experiment on SPARC, to the planning of the experiment, setup of equipment and most importantly the aquisition of our data. Of course, with such a complex facility there were problems but luckily your team solved these in time. I hope that we can use this experience to stimulate a frutiful collabotation in the future (and also continue the experiments we began this week). Once again a big thank you from Gregor and Anna and the ALPHA-X team at the University of Strathclyde.	

Future development

Repeat the some experiment with different electron beam properties (especially energy and bunch duration).



Ionization chamber experiment: ion chambers are well-established detectors for conventional radiotherapy beams (where field size is of the order of 5-10 cm, energy up to 25 MeV, ms bunch duration and kHz repetition rate) but their response at higher energy and shorter beams is still unknown.

The few data on ionization chamber taken in July show that there might be some interesting behaviours which need to be further investigated.

Thank you!