MicroPlus Probe detector

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Outline

- **Memorandum of Understanding with UoW**
- **MicroPlus probe**
- **First preliminary test @CATANA**

Memorandum of Understanding

INFN

UNIVERSITY OF WOLLONGONG AUSTRALIA

Memorandum of Understanding

between

the Laboratori Nazionali del Sud

of the Istituto Nazionale di Fisica Nucleare (LNS-INFN), Italy

and

the Faculty of Engineering and Information Sciences of the University of Wollongong, School of Physics (UoW), Australia

for a scientific and technological collaboration towards future medical applications of the 11B(p,a)2a fusion reaction

Article 2: Purpose

2.1 The purpose of this Memorandum of Understanding (MoU) is to explore a research program whose main aim is to measure and study (both experimentally and with Monte Carlo simulations) the biological effects of the alpha particles generated in the fusion nuclear reaction p+11B → 3a. The possibility to use this reaction (denominated PBCT or Proton

Article 3: Scope of application

The general and specific purposes of this MoU are:

3.1.1. To strengthen the already existing collaboration between the LNS and the UOW in the framework of experimental microdosimetric measures and dosimetric and radiobiological studies of charged particle beams and, in particular, in the investigation of the possibility to use the pB reaction in future radiotherapeutics schemes;

3.1.2. To share the expertise already present at UOW and LNS in various fields connected to the final goal, such as clinical protontherapy, absolute dosimetry, development of detectors for charged particles, microdosimetry and Monte Carlo simulations for the estimation of clinical relevant radiobiological quantities.

3.1.3. For the realization of such goals, different but complementary aspects can be investigated and faced in detail. Schematically these aspects can be divided into the following research topics:

- Development of Microdosimetry for investigation of B11 enhancement and relevant RBE;
- Correlation and interpretation of cell survival studies in field and out of field with microdosimeter response;
- Simulation of the microdosimetric set-up using Geant4;
- Experimental tests performed at proton therapy facilities;

Article 4: Exchange of Students and Scientists

4.1 The Parties will encourage collaboration in research and education in areas of mutual interest, through reciprocal arrangements for students and scientist exchanges.

4.2 Both Parties shall agree in writing or by certified electronic correspondence upon the specific

MicroPlus probe

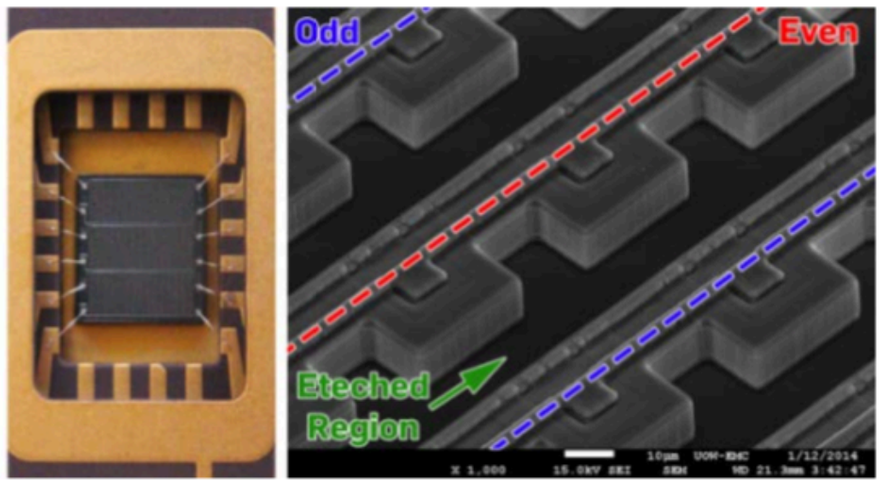

Fig. 1 Segmented CMRP microdosimeter in DIL package (left) and SEM image of the "bridge" microdosimeter 3D sensitive volumes with etched silicon in between (right).

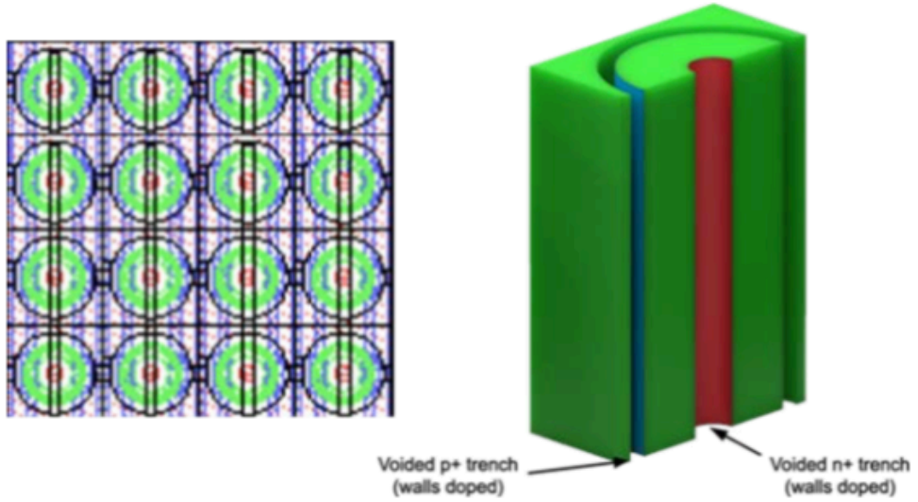

Fig. 2 Array of 3D "mushroom" microdosimeter (left) and sensitive volume geometry (right).

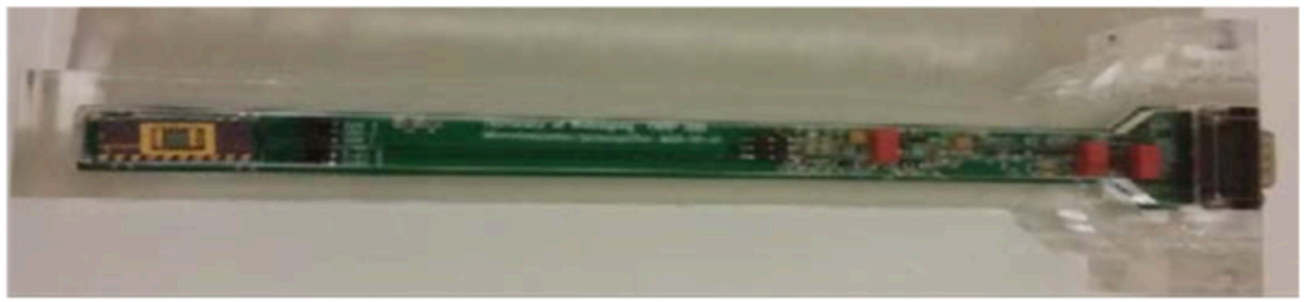

Fig. 3 Micro-plus probe in water-proof sheath.

Silicon Microdosimeter

- ***Bridge microdosimeter:*** The microdosimeter comprised of an array of 4248 3D well defined silicon cells fabricated on 10µm thick silicon-on-insulator substrate and mimicking biological cells. Large sensitive area with a die size of 4.1 x 3.6 mm^2, designed not only for particle radiotherapy but also for use in low dose rate environments such as those in aviation and space.
- ***Mushroom microdosimeter:*** The microdosimeter consists of 3D cylindrical SVs with diameter of 18 µm fabricated on 10µm thick silicon-on-insulator substrate and mimicking biological cells, each surrounded with a trench of air, has been designed to possess low depletion voltage and capacitance, 100% charge collection and physically eliminate the possibility of charge generated outside the SV from being collected.

MicroPlus probe

Istituto Nazionale di Fisica Nucleare

Microdosimetric measurements of a clinical proton beam with micrometer-sized solid-state detector

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Linh T. Tran, Lachlan Chartier, Marco Petasecca, and Michael Lerch
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Dale A. Prokopovich and Mark Reinhard
Institute of Materials Engineering, Australian Nuclear Science and Technology Organisation, Lucas Heights, NSW 2234, Australia

Vladimir L. Perevertaylo
SPA-BIT, Kiev 02232, Ukraine

Microdosimetric applications in proton and heavy ion therapy using silicon microdosimeters

October 2017 · Radiation Protection Dosimetry 180(1-4)
DOI: 10.1093/rpd/ncx226
Project: solid state microdosimetry

Lachlan Chartier

Optimisation of the design of SOI microdosimeters for hadron therapy quality assurance

October 2018 · Physics in Medicine and Biology 63(21)
DOI: 10.1088/1361-6560/aae66b

David Bolst · S. Guatelli · Linh T. Tran · Anatoly B. Rosenfeld

SOI Thin Microdosimeter Detectors for Low Energy Ions and Radiation Damage Studies

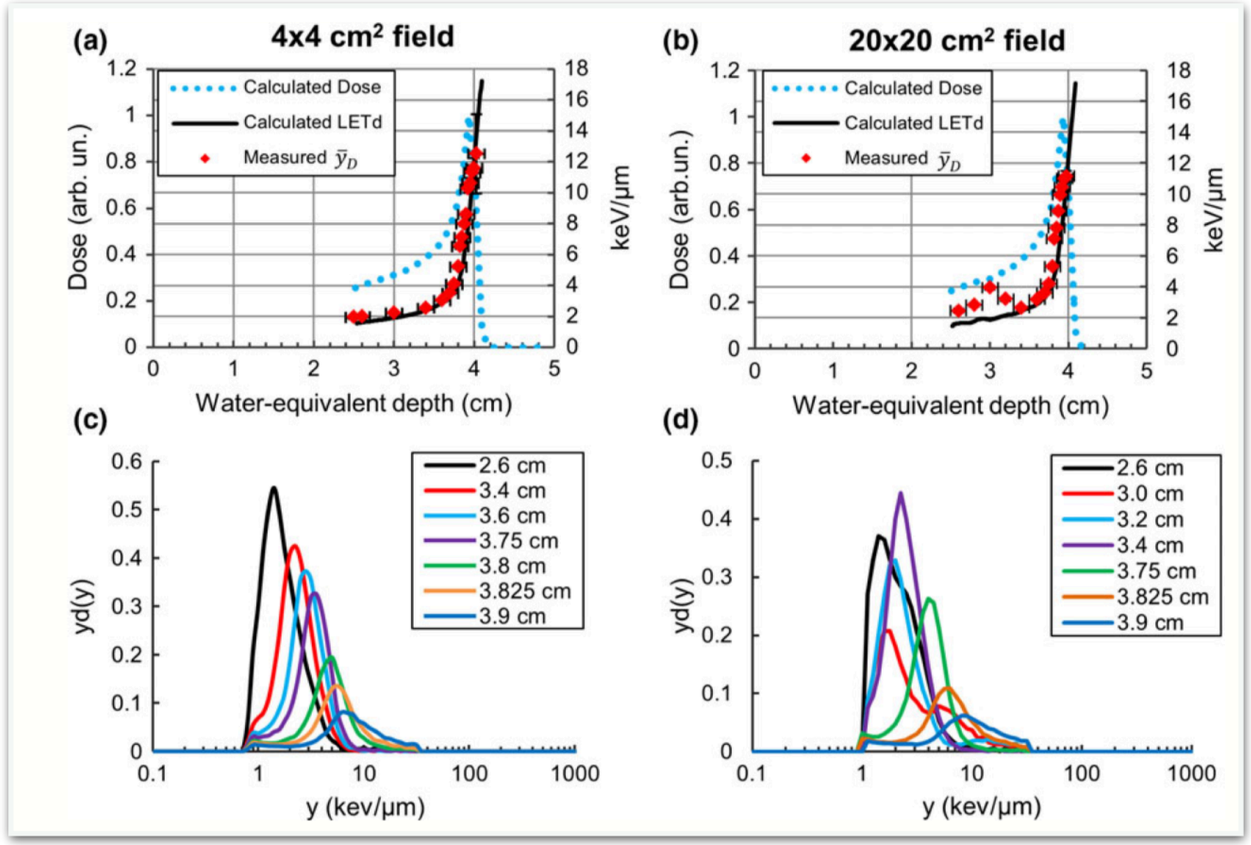
December 2018 · IEEE Transactions on Nuclear Science PP(99):1-1
DOI: 10.1109/TNS.2018.2885996

Benjamin James · Linh T. Tran · James Vohradsky · Show all 19 authors · Anatoly B. Rosenfeld

A new silicon detector for microdosimetry applications in proton therapy

January 1999
DOI: 10.1109/NSSMIC.1999.842503

Anatoly B. Rosenfeld · P. D. Bradley · Iwan Cornelius · Show all 13 authors · Yoshinori Hayakawa



MicroPlus probe

EQUIPMENT SUPPLY AGREEMENT

THIS AGREEMENT IS MADE ON THE MEMORANDUM OF UNDERSTANDING, 2018, and concerning the purchase order number _____,

BETWEEN **UNIVERSITY OF WOLLONGONG (ABN 61 060 567 686)**, a statutory body constituted under the University of Wollongong Act 1989 (NSW) of Northfields Avenue, Wollongong NSW 2522 AUSTRALIA (**"UOW"**)

AND **ISTITUTO NAZIONALE DI FISICA NUCLEARE,** Via S. Sofia 62, 95123 Catania ITALY (**"the Purchaser"**)

RECITALS

A. UOW assembles microdosimetry probe including 3 sensors and 2 sets of readout front end electronics, shaper, PMMA sheath, software and operational manual ("the Equipment").

B. On 12 July 2018, the Parties signed a Memorandum of Understanding for scientific and technological collaboration towards future medical applications of the 11B(p,a)2a fusion reaction.

C. The Purchaser wishes to purchase the Equipment.

D. UOW has agreed to sell the Equipment to the Purchaser on the terms and conditions of this Agreement.

Verrà acquistato entro il 2018

30 k€

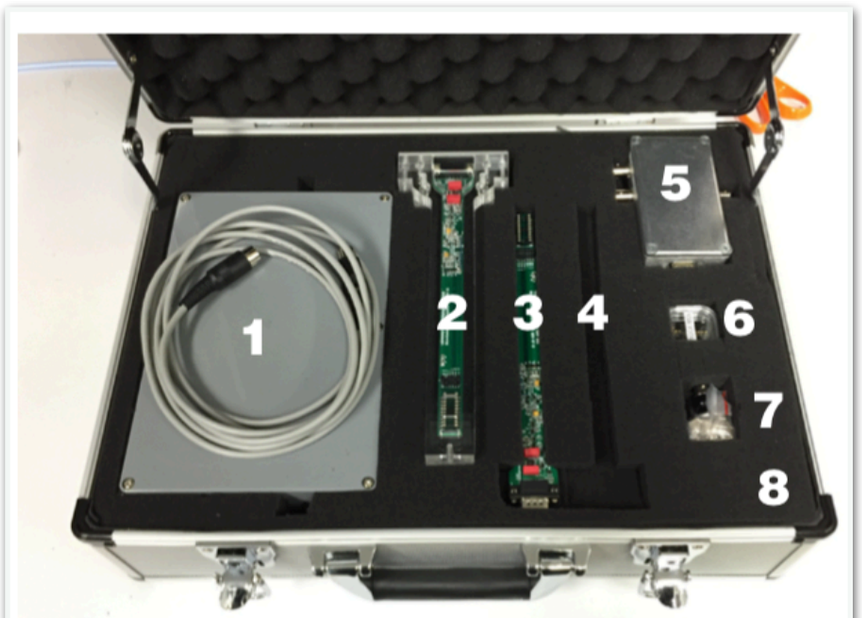
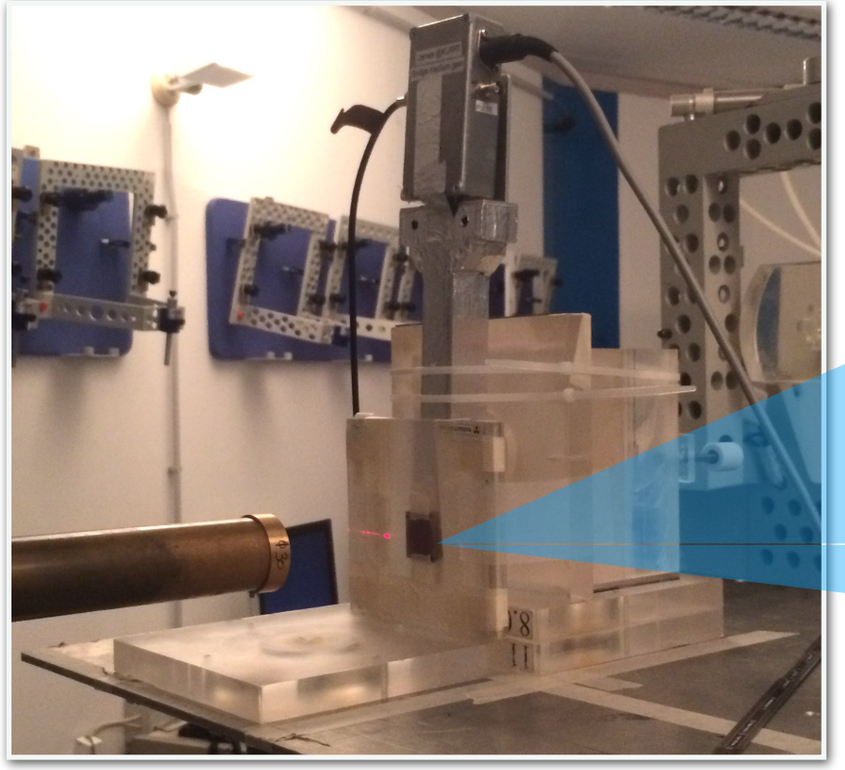


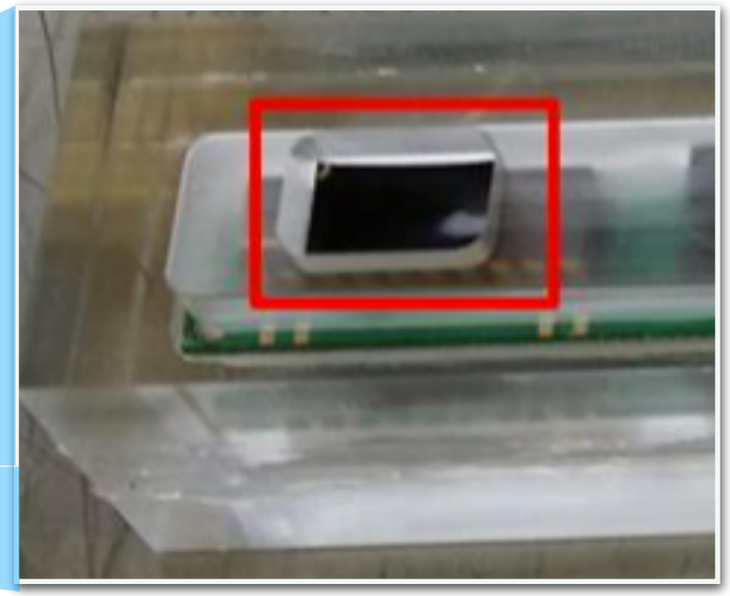
Figure 1 - Suit case containing MicroPlus Probe and accessories

Preliminary test @CATANA

- Two converters: natural boron carbide (B4C) and ^{10}B4C
- The density of boron carbide was 2.52 g/cm3
- The boron was deposited on Al foils (50um and 18um thickness of Al)
- Exact coating thicknesses are: 1.1 um, 2.2 um and 3.4 um

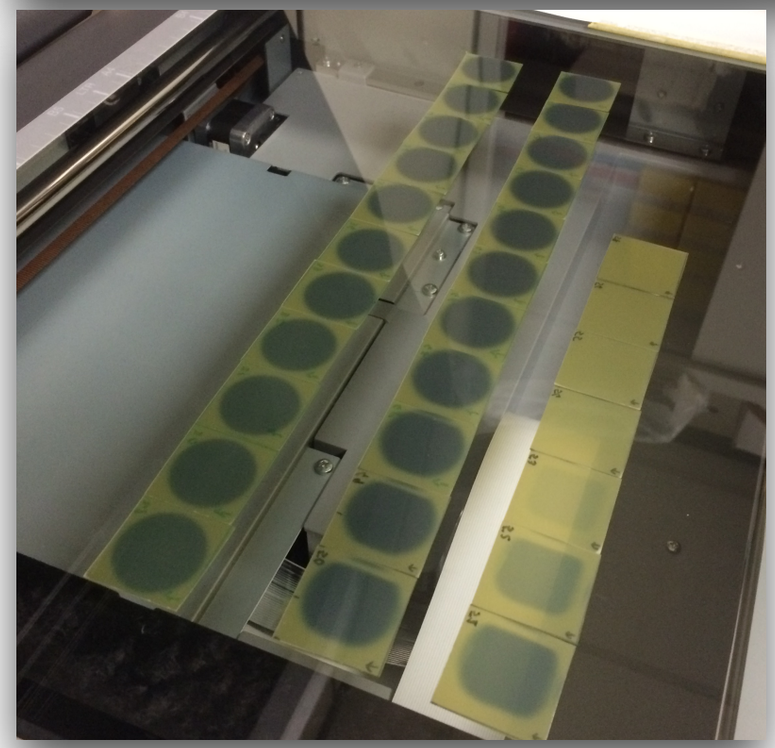


Adopted experimental setup

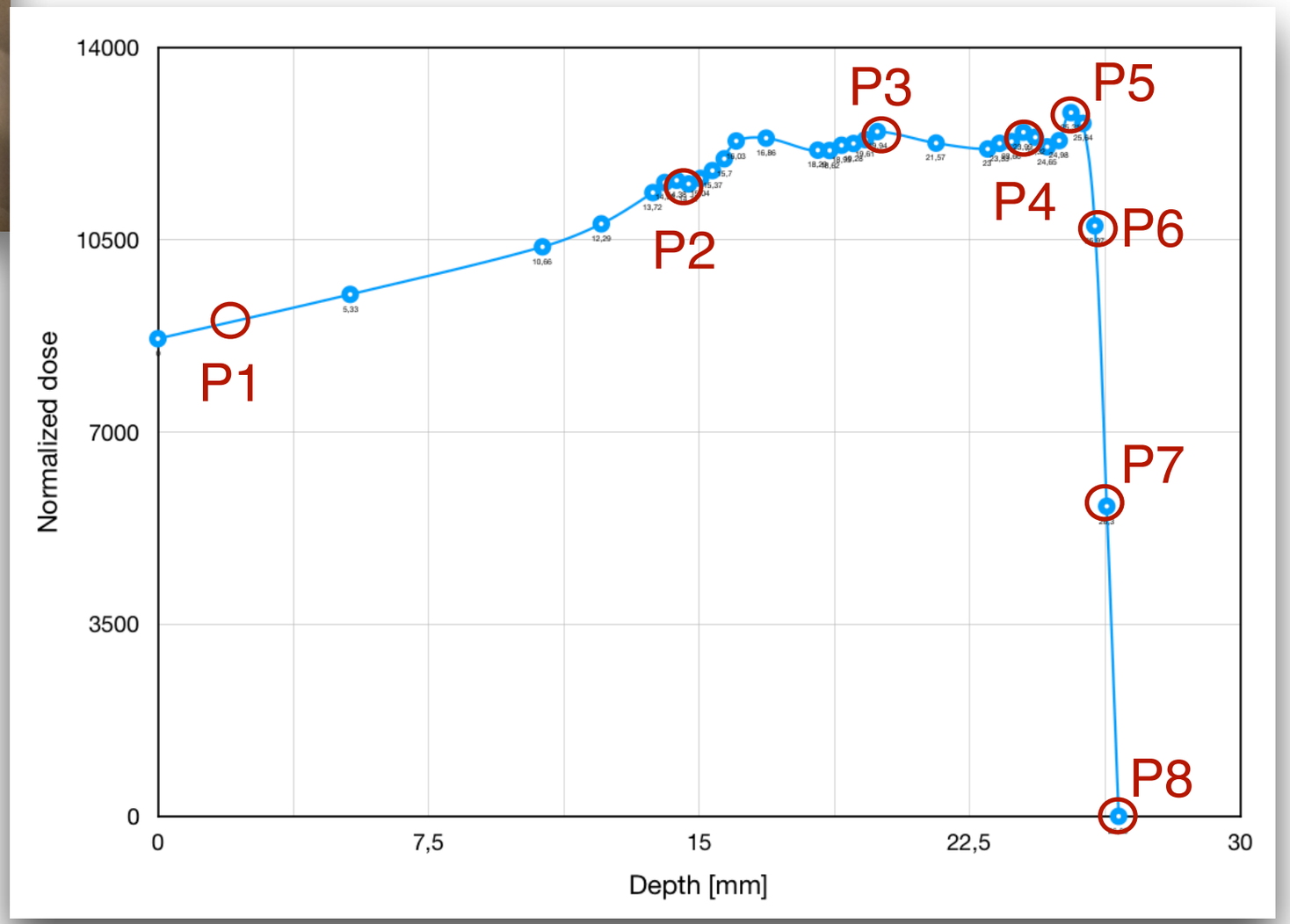


Boron Converter

Preliminary test @CATANA



Perpex slabs and Gaf Chromic films used to check the positions



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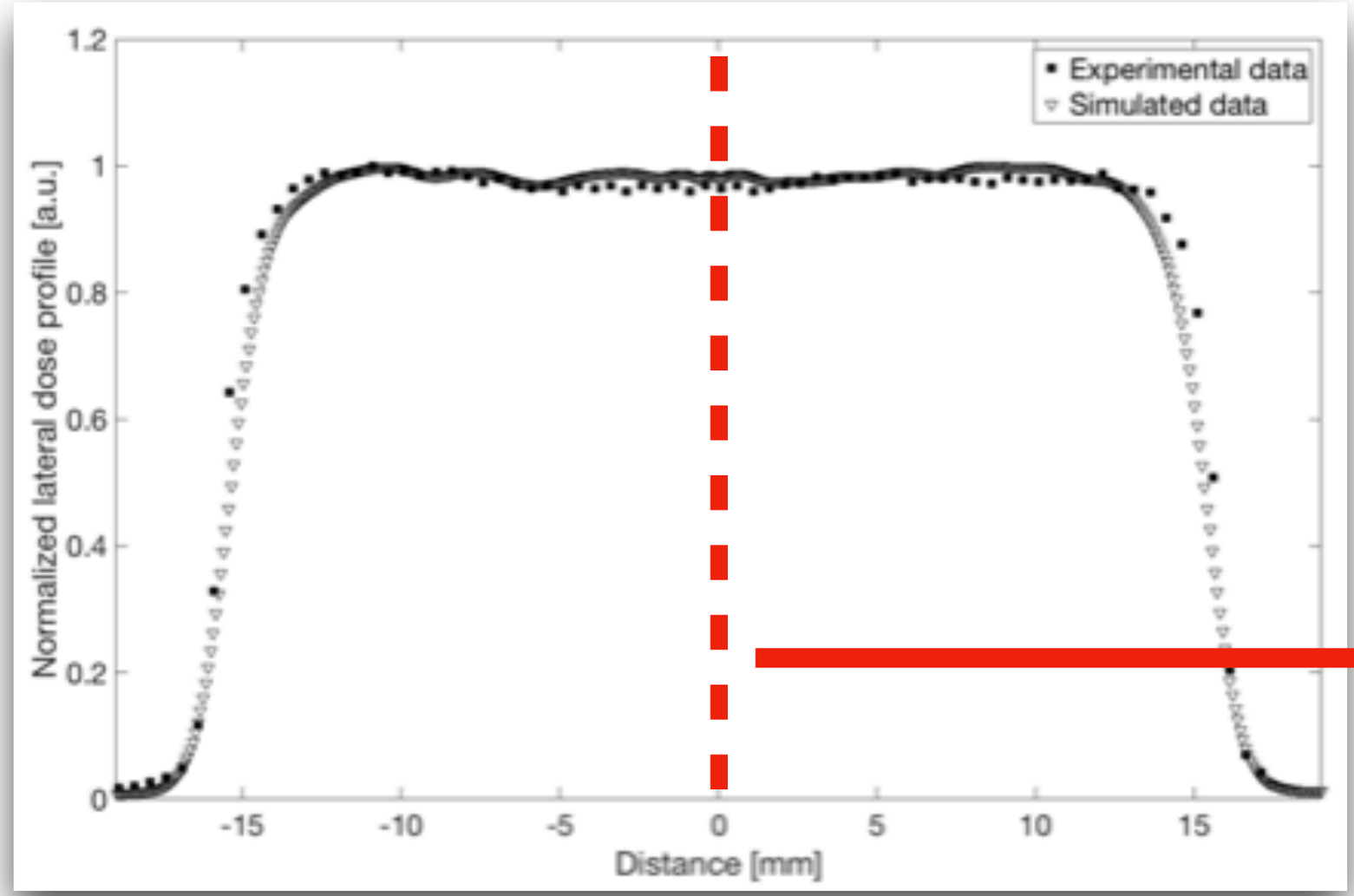
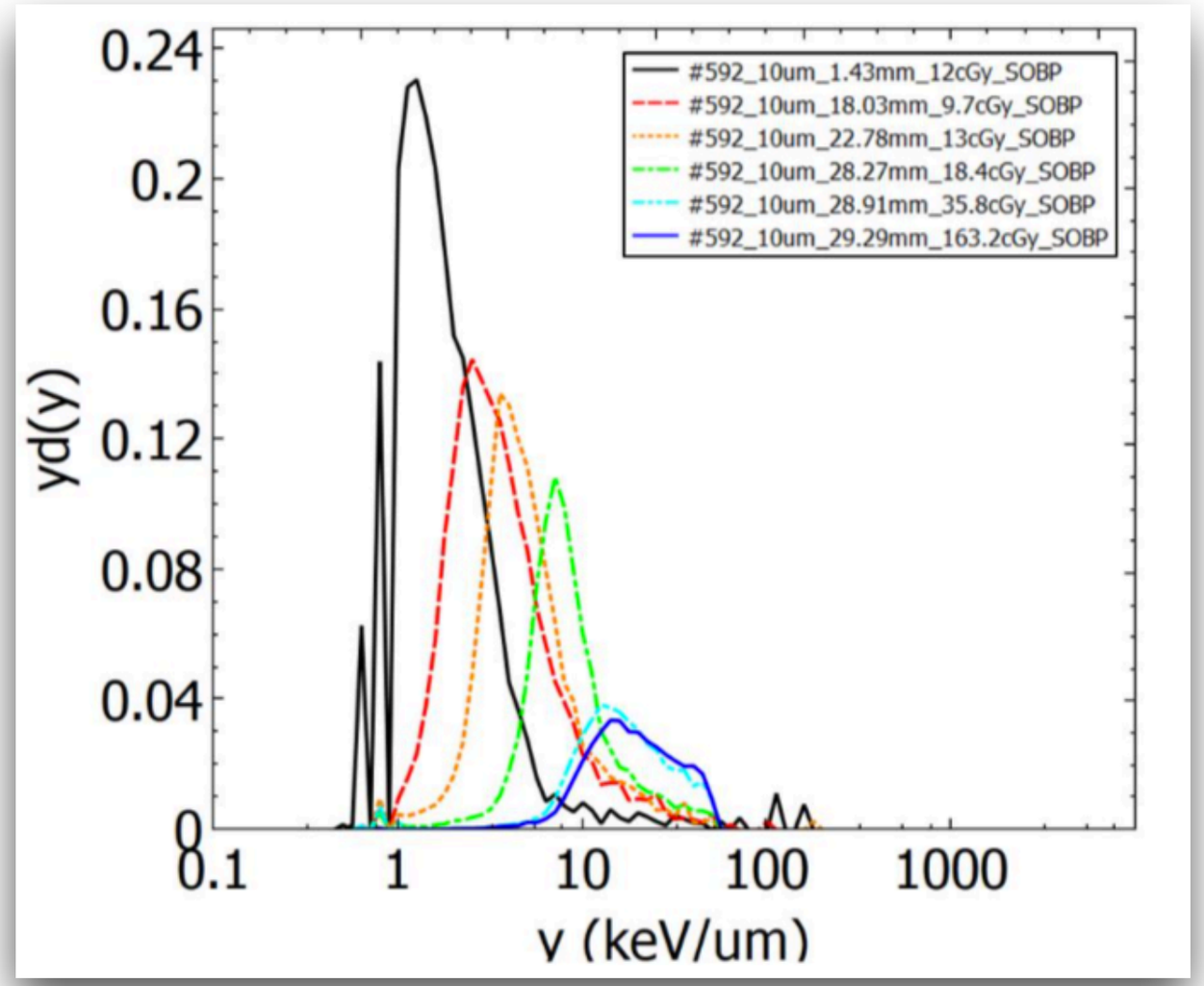


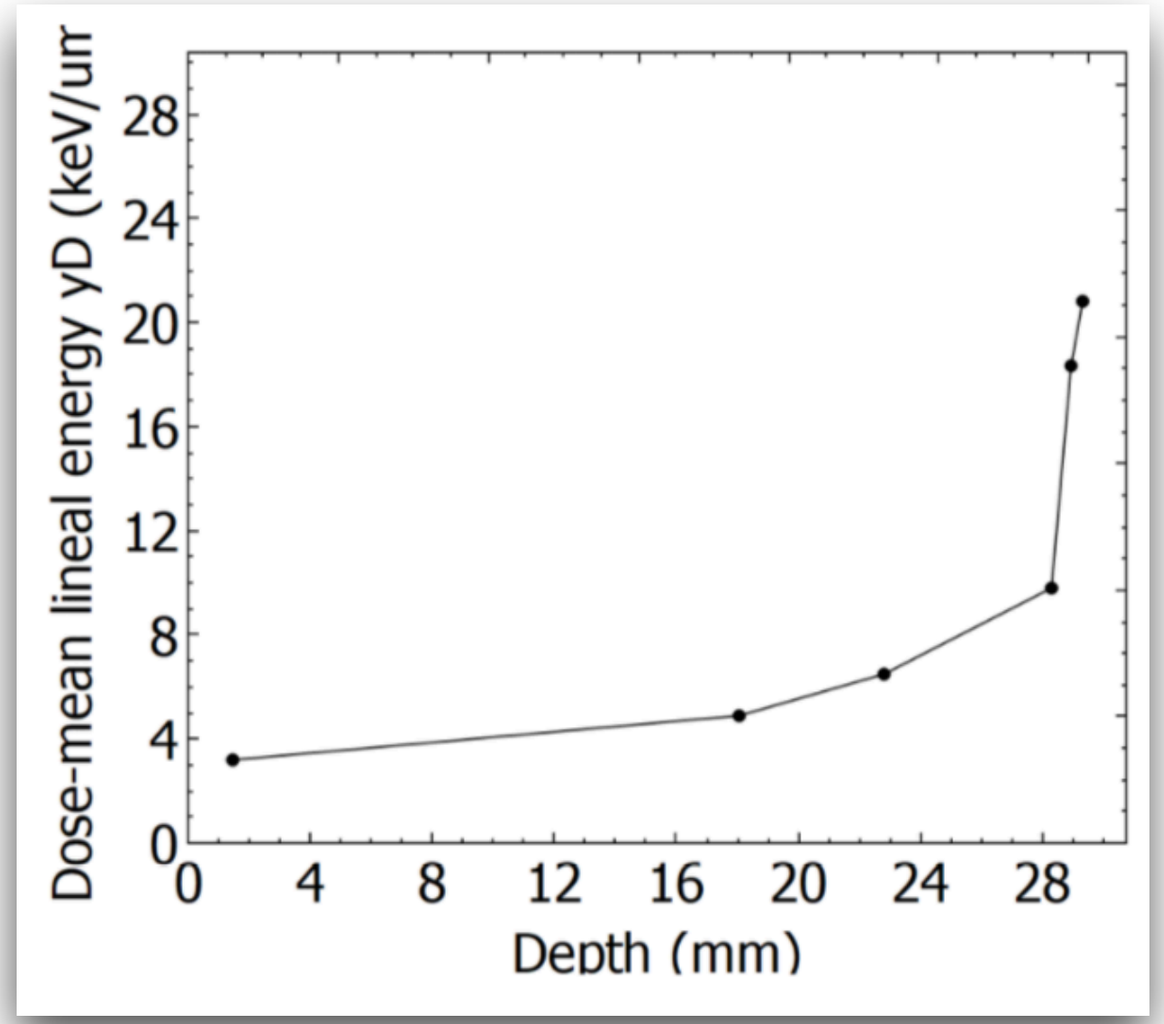
Preliminary results

w/o boron

Microdosimetric spectra for different WET depth



Yd distribution vs WET [mm]



Grazie a tutti