HAPSPIDE WP6 Application: neutron detection

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CEDAD
Centro di Datazione e Diagnostica

Hydrogenated Amorphous Silicon PIxel DEtectors for ionizing radiation

HASPIDE

UNIVERSITÀ DEL SALENTO

INFN

Dipartimento di Matematica e Fisica "Ennio De Giorgi"

WP6: goal

The main aim of WP6 is the realization of a-Si:H-based neutron detector/dosimeter which take advantages of the properties of the a-Si:H detector.

***Dose monitoring in radiotherapy*.**

Dose monitoring in BNCT (Boron Neutron Capture Therapy).

Space applications.

After the first year of the project, a specific application will be chosen

WP6: the device

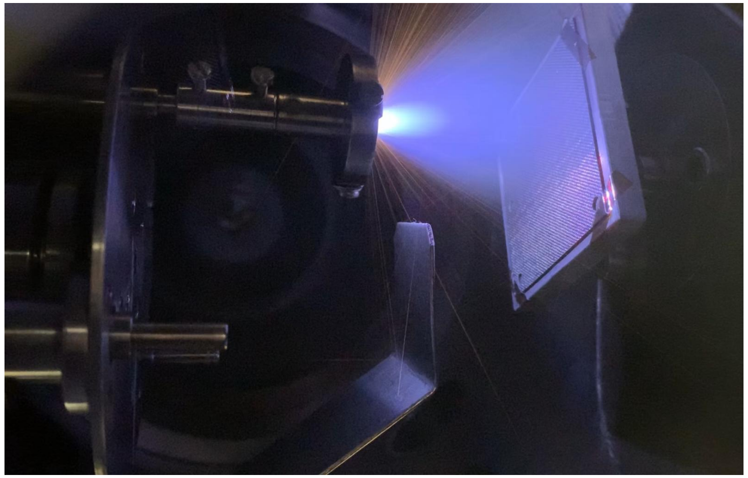
The neutron detector/dosimeter will be realized using at first two a-Si:H single diodes and coupling one of them with a neutron converter element like ^{10}B using the two nuclear n-capture by 10B

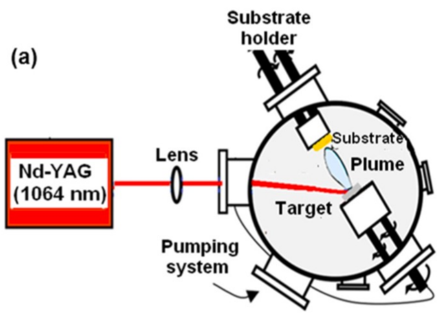
Reaction	Q value (MeV)	Products energy (MeV)	Cross section (b) @0.0253 eV
^{3}He (n, p) ^{3}H	0.764	E_p= 0.573 E_T= 0.191	σ = 5320
^{6}Li (n, α) ^{3}H	4.78	E_α= 2.05 E_T= 2.73	σ = 942
^{10}B (n, α) ^{7}Li	2.792 (6%)	E_α= 1.78 E_{Li}= 1.01	σ = 3842
^{10}B (n, α) $^{7}Li^*$	2.310 (94%)	E_α= 1.47 E_{Li}= 0.84 (E_γ= 0.48)	

The a-Si:H single diode without the neutron converter element is necessary to take into account the gamma contribution which is always associated with neutron production and also with the neutron conversion reaction itself.

WP6: proposed methodology (PLD to deposit neutron converter layers);

The neutron converter layer will be deposited by Pulsed Laser deposition(PLD)



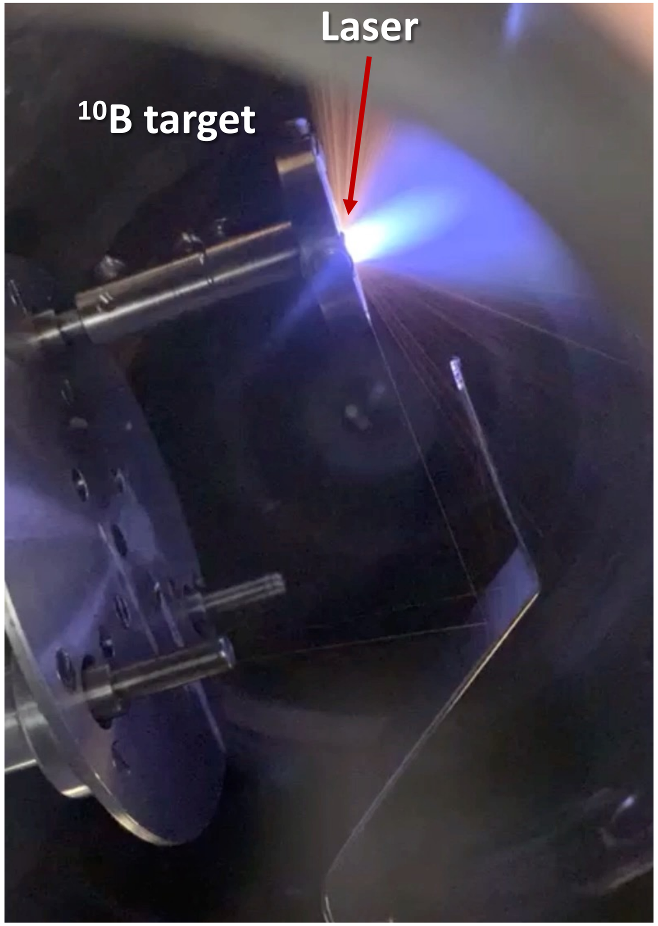


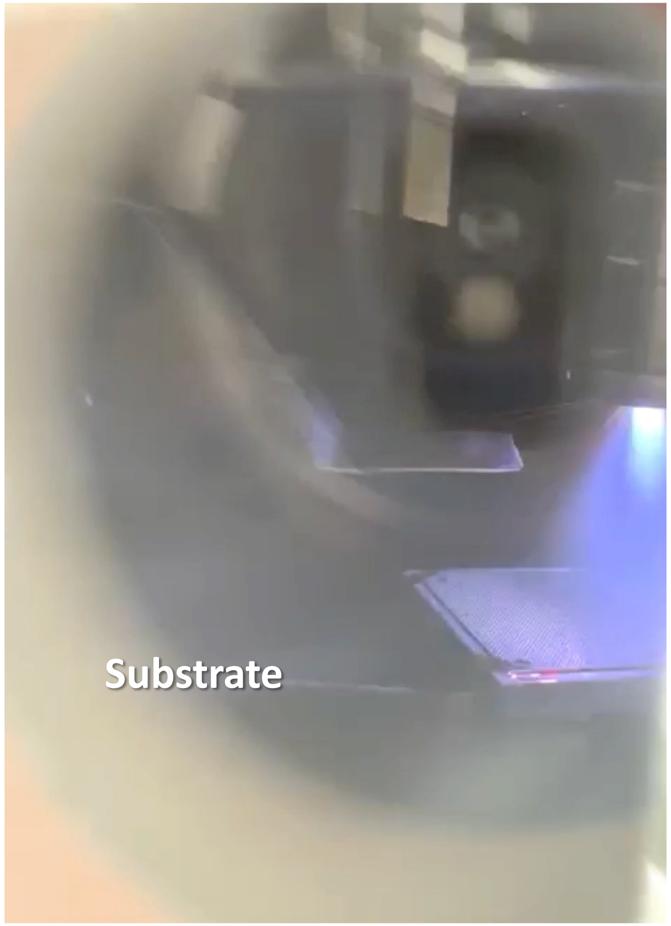
A focused pulsed laser beam interacting with a target (i.e., the source material to be deposited) may induce, under proper fluence (energy delivered per pulse per unit surface) conditions, the generation of a highly forwardly-peaked plasma plume including the species ejected from the target due to the ablation mechanism. The hyperthemal energy distribution of such species enables their transfer from the target to the substrate surface where they deposit and contribute to the film growth.

The main Advantages of the technique to deposit thin films are:

- possibility to change many independent parameters;
- high energy of the ablated/ejected particles;
- deposition on thermolabile substrates;
- good adhesion on many kind of substrates without the need of particular substrate treatment;

Deposition of ^{10}B thin films on different substrates

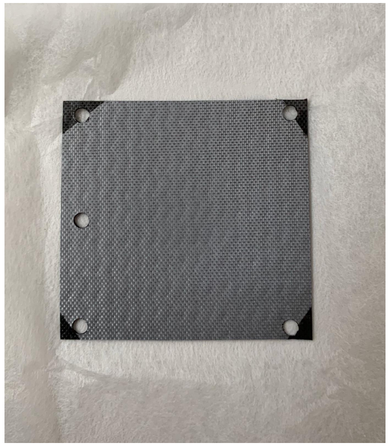


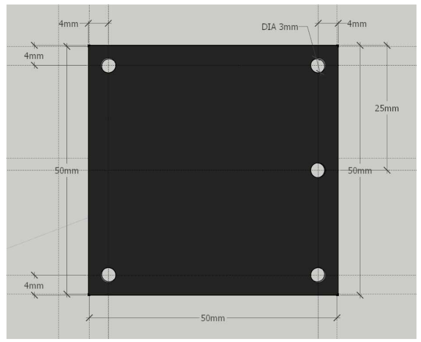


WP6 activity: proposed methodology (PLD to deposit neutron converter layers);

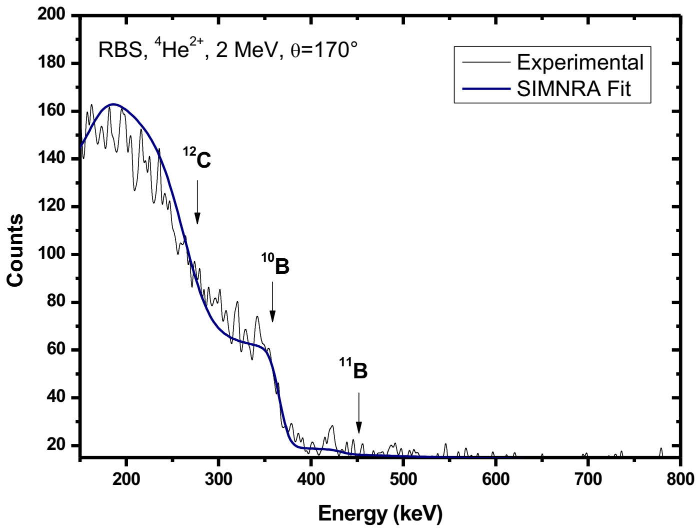
The Lecce Unit has a consolidated experience in the deposition of ^{10}B conversion layers. In a recent paper the authors have demonstrated the potentialities of PLD technique in depositing free of contaminants µm-thick enriched ^{10}B films (95% of enrichment) on Al and carbon fiber substrates with a thickness uniformity of 10% over a circular area of 3 cm in diameter. The film, coupled with a Si detector, presented promising conversion properties.

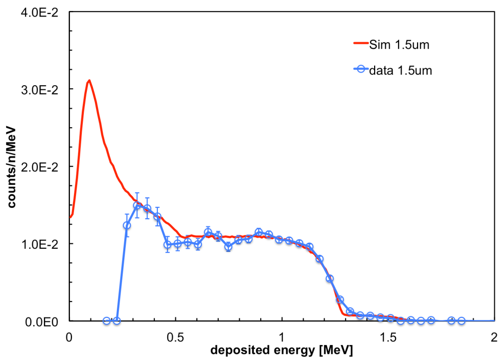
Deposition of a ^{10}B conversion layer on a carbon fiber sheet





WP6 activity: proposed methodology (PLD to deposit neutron converter layers);





Very pure films

Film Density: 2.24 g/cm3 which is in agreement with what expected for a ^{10}B-enriched boron film.

WP6 activity: proposed methodology (PLD to deposit neutron converter layers);

In the framework of the Haspide project ^{10}B neutron conversion layers will be at first deposited directly on the a-Si:H-based diode. The effect of the deposition on the a-Si:H-based diode properties will be evaluated. In case of damages induced by the deposition, the conversion layer will be coupled with the a-Si:H-based diode simply placing the ^{10}B layer on the top of the diode.

WP6: test

The dosimeter/detector will be tested in;

- BNCT centers;
- E-LIBANS facility (To)

  A Linac Elekta SL18 MV coupled to a gamma-n based cavity produces neutrons with an evaporation peak which is moderated until Thermal or epithermal energies. The thermal fluence rate is 2 x 10 ^ 6 cm-2s-1, the epithermal one 10 ^ 5 cm-2s-1The cavity is 200 x 200 x 200 mm3 and the uniformity of the field inside is> 90%;

  - ……….

Persons

Name	Position	FTE-WP6
Gianluca QUARTA	Associate Professor	0.2
Anna Grazia Monteduro	Assistant Professor	0.1
Anna Paola Caricato	Associate Professor	0.1
Giuseppe Maruccio	Full Professor	0.1
Silvia Rizzato	Assistant Professor	0.2
Maurizio Martino	Associate Professor	0.2
Lucio Calcagnile	Full Professor	0.2
	TOTAL	1.1

CEDAD
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THE 3 MV TANDETRON ACCELERATOR

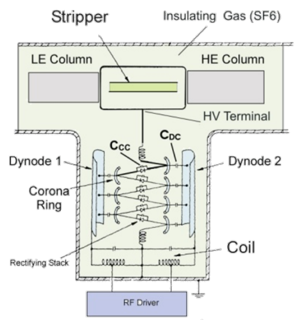
Type: ***Linear electrostatic accelerator***

HV Generator: ***Cockroft Walton***

Maximum voltage: ***3 MV***

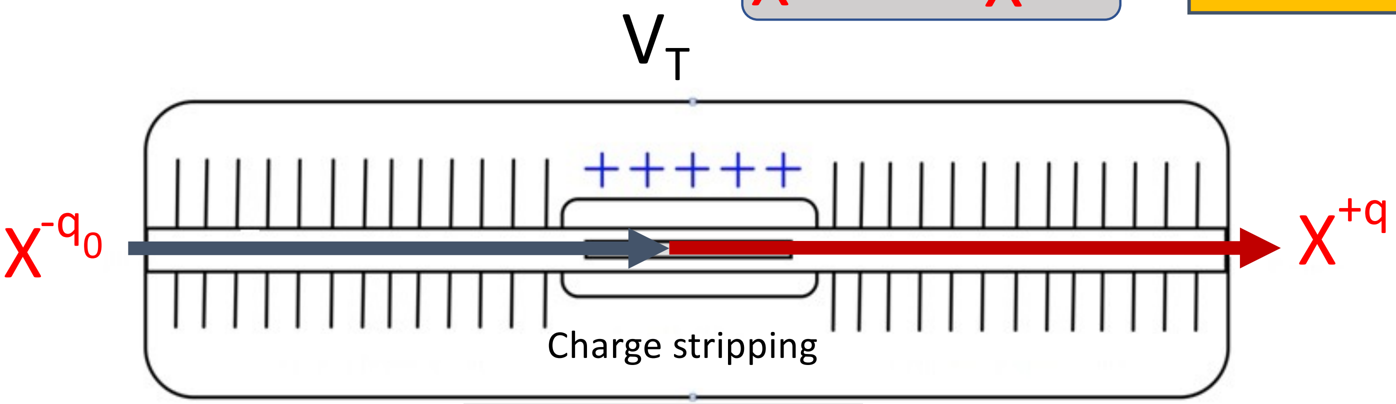
Stripper: ***A gas Argon con ricircolo***

Model: ***4130 HC-HVEE***



$X^{-q_0} \longrightarrow X^{+q}$

$E_f=(q_0+q)V_T$



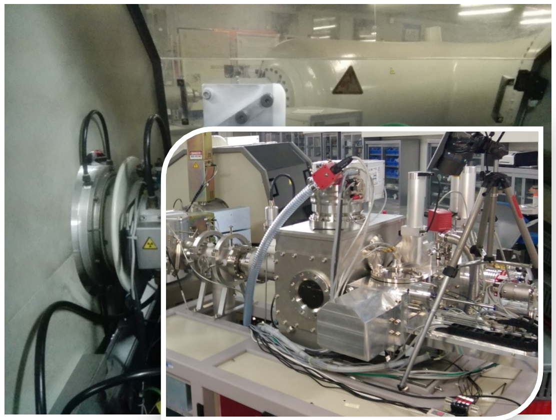
$E_1= \quad q_0V_t$

ION SOURCE AND BEAMS

Four different ion sources are available

Duoplasmatron Ion source → ^{4}He, ^{1}H

Sputtering source 860 → H, B, C, Si, Ge, Fe, Ni, Au, Ag, Cu ….



Multicathode sputtering source 846 → C, Be, Al, I …..

Hybrid (solid-gas) ion source → C, CO_2

EXPERIMENTAL BEAMLINES

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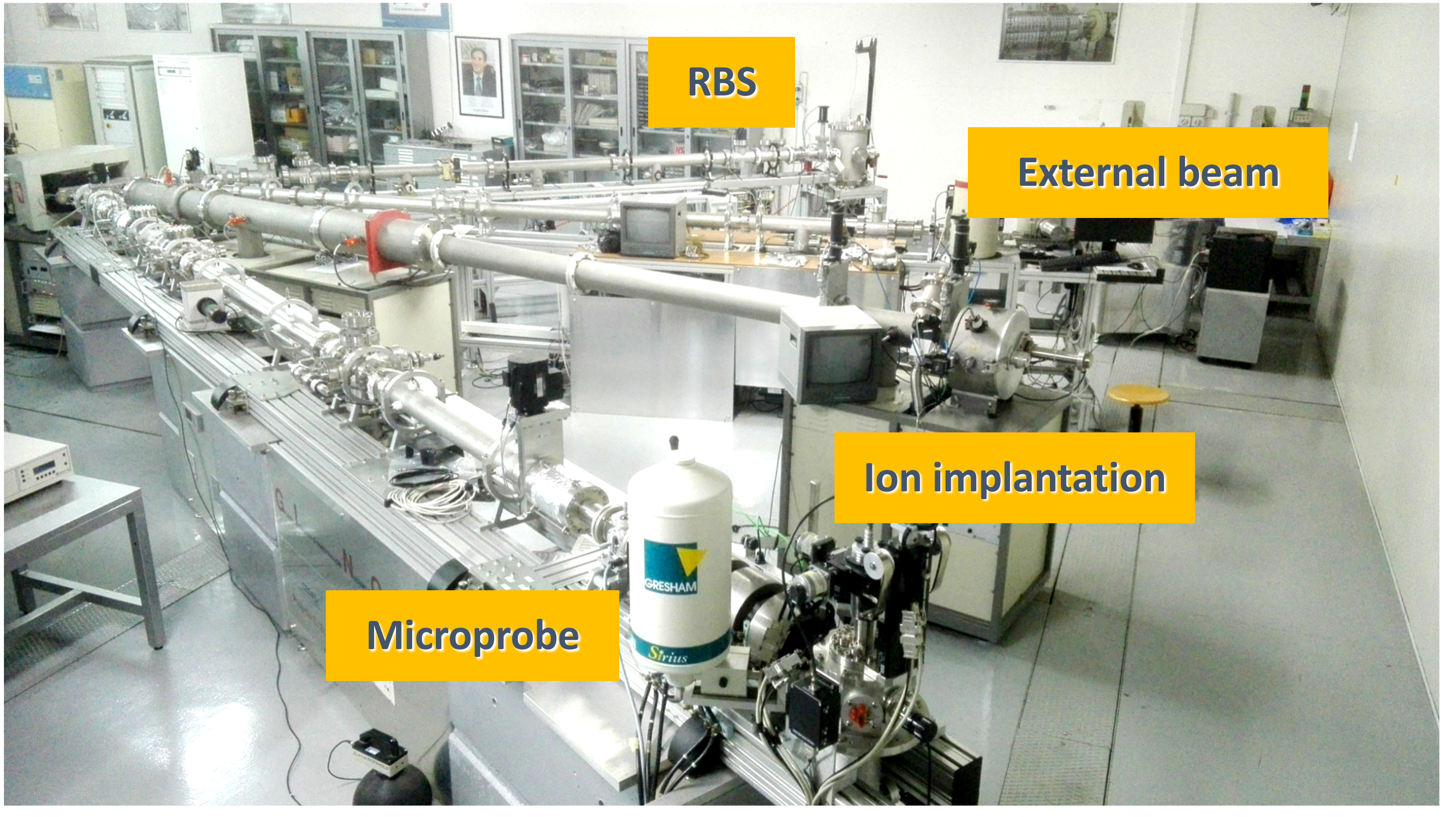
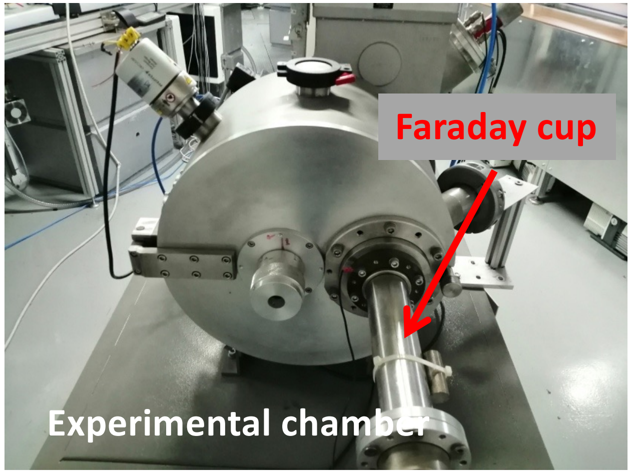
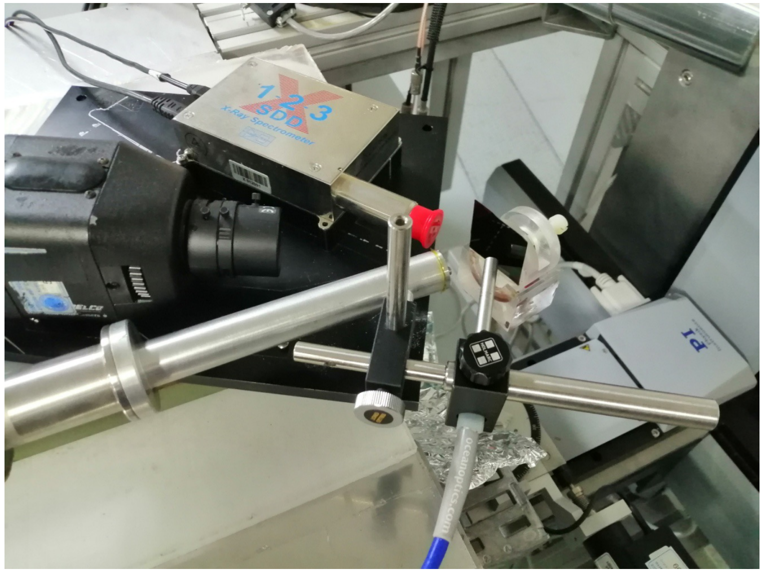




IN AIR IRRADIATION WITH PROTONS



Thank you!

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