HASPIDE

APPROVED!!!

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Hydrogenated Amorphous Silicon PIxel DEtectors for ionizing radiation

L. Servoli on behalf of HASPIDE Collaboration

General Communications

1) we have now an Indico page to manage meetings
   Both general than WP ones.

2) An experiment's mailing list will be defined.

3) Beginning of january it will be possible to insert in INFN Experiment Database the names and Full Time Equivalent (FTE) commitment of people for year 2022.
   → It is very important to perform this task to allow INFN referees to check the manpower available to the HASPIDE experiment

General Communications

4) There is an interest in the experiment from ASI researcher. (V. Vagelli). Mainly WP5 and WP6. He has started to check the possibility to apply within the framework of INFN/ASI agreement to obtain specific funding on some aspect of the HASPIDE project.

5) There is an interest of two firms on some project's related activities/goals. Both belong to WP4:
→ IBA (Support letter attached to HASPIDE proposal)
→ Accuray (Contact after a Conference presentation)

General Communications

6) *Meetings:*

I propose to have general meetings on a monthly basis to have Reports on the whole project activities from WPs and to discuss general matters.

This will leave space for WPs meetings called by the respective Coordinators.

7) *Next general meeting should take place between 10 and 20 January 2022 and one of the topic will be the publication policy.*

Financial requests for 2022: 461 k€→ 198.5

Total Requests: 893 k€ of which 264 k€ = 11 years PostDoc)

Institutions:

Perugia:	L. Servoli	63.0 k€
Firenze:	C. Talamonti	17.0 k€
Lecce:	A.G. Monteduro	57.5 k€
LNS:	G. Cuttone	21.0 k€
Milano:	V. Liberali	15.0 k€
Torino:	G. Mazza	25.0 k€ → 1.0 + 24 (1 year PostDoc)

Total: 198.5 k€ Approved

N.B.

if we had inserted 3 PostDoc positions for 2022 these would have been approved

HASPIDE Collaboration (~40 researchers)

HASPIDE Project (L. Servoli)	WP1 M. Menichelli Device Fabrication and Optimization	WP2 V. Liberali Front-end Electronic and DAQ	WP3 D. Passeri Simulation	WP4 C. Talamonti Beam monitoring	WP5 C. Grimani Spatial Applications (SEPs detection)	WP6 G. Quarta Neutron detection	RU Total FTE
FI (C. Talamonti)				0.5	1.0		1.5
LE (AG. Monteduro)	0.7					0.9	1.6
LNS (G. Cuttone)		0.2		0.8			1.0
MI (V. Liberali)		1.0					1.0
PG (L. Servoli)	0.9	0.2	0.5	0.8			2.4
TO (G. Mazza)		1.0					1.0
Total INFN	1.6	2.4	0.5	2.1	1.0	0.9	8.5
EPFL (N. Wyrsch)	0.3						0.3
UoW (M. Petasecca)			0.3	0.3			0.6
ASI interest (V. Vagelli)					X	X	X
Total FTE	1.9	2.4	0.8	2.4	> 1.0	> 0.9	> 9.4

HASPIDE Goals

Deposition of thin a-Si:H layers (1- 10 μm) on thin substrates to allow the production of devices for:

→ beam monitoring of clinical and non-clinical accelerators;

→ detection of some types of cosmic radiation;

→ neutron detection with the deposition of ^{10}B on a-Si:H layers to convert neutrons to alfa.

Milestones Concordate

Data	Descrizione	Completamento
30-06-2022	Simulazione TCAD del materiale a:SiH nel layout del rivelatore	WP3
31-08-2022	Design miniAsic	WP2
31-12-2022	Qualificazione dei dispositivi PQCVD single diode + array	WP1
31-12-2022	Realizzazione e test miniAsic	WP2
31-12-2022	Validazione della simulazione TCAD da confronto con misure di qualificazione dei dispositivi	WP3 WP1
31-12-2022	Definizione dell'applicazione clinica da portare avanti	WP4

R&D on deposition and contacts is needed

State of the art: much research done on thin layers (~ 100 nm) for solar cell application. However…..

→ Thicker devices (1 - 10 μm) and their contacts are a new game.

→ Detection of ionizing radiation fluxes needs extended R&D.

Deposition techniques to be used:

→ Plasma Enhanced Chemical Vapor Deposition (PECVD) (baseline)

→ Pulsed Laser Deposition (PLD)

Contacts type to be explored:

→ p-doped and n-doped layers

→ charge selective contacts

WP2: DAQ and readout chips

DAQ should provide two separate reading modes:

→ current mode (for intense beams)

→ pulse-by-pulse mode (for low radiation fluxes)

→ A new version of an existing current-to-frequency circuit will be developed on a more radiation resistant technology (28 nm).

→ An existing prototype chip developed for PANDA experiment is a good candidate for the pulse-by-pulse mode.
It will be evaluated as soon as possible.

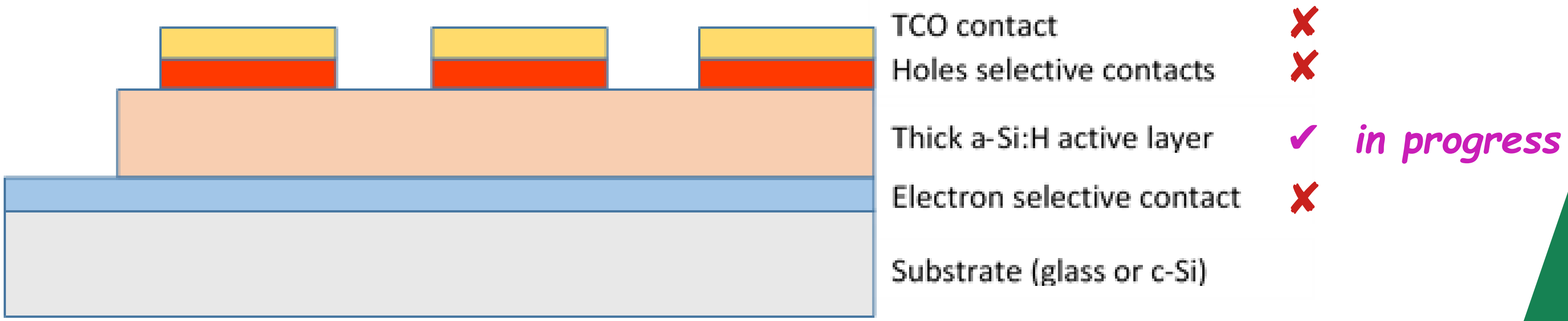
→ Existing solution will be explored in the first 1-2 years.

WP3: TCAD simulation challenges

a-Si:H not included in TCAD material library

R&D: strategy to include a-Si:H in TCAD material library (3D-Siam)

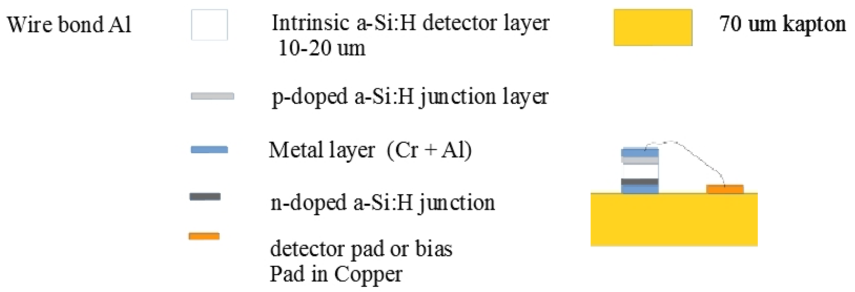
→ Semiconductor (~ uniform domain macro properties) – band gap engineering (via defects parametrization).

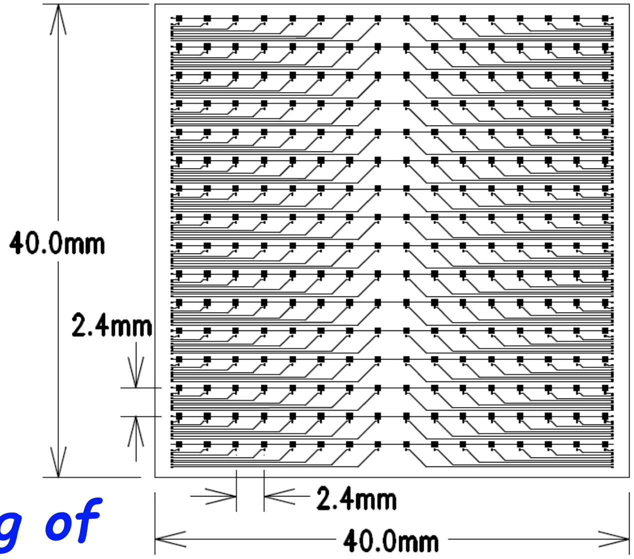


WP4: Radiation Beam Monitoring

Main goal is to produce a device capable of real-time measurement of shape and dose of radiation beam.

→ *transmission device* → *thin device AND support.*





→ *Pending INFN patent request for active exit flange for accelerators (M. Menichelli, L. Servoli,..)*

→ *Transmission device for real time monitoring of dose administered to patients during treatments*

WP5: Spatial Applications

Use case: detection of Solar Energetic Particles (SEPs)

Year	Interval of fluence (protons/cm^2)	Number of events minimum	average	maximum
2019	10^6-10^7	0.00	0.26	0.64
	10^7-10^8	0.00	0.099	0.25
	10^8-10^9	0.00	0.036	0.090
	10^9-10^{10}	0.00	7.58×10^{-3}	0.019
	10^{10}-10^{11}	0.00	8.93×10^{-5}	2.23×10^{-4}

Interest from ASI researchers

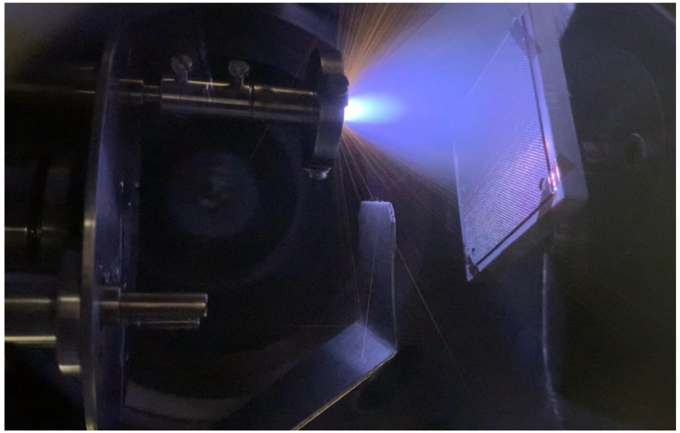
Detection most of the particles are protons (> 90%)

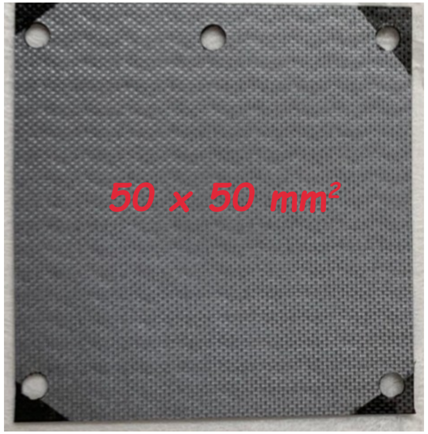
Requirements: mandatory energy detection < 50 MeV
desirable also detection up to 200 MeV
both pulse-by-pulse and current mode DAQ.

Other Requirements: reasonable cost, small volume,
versatile form factor, reliable,
radiation resistant.

WP6: Neutron Detection

Deposition of ^{10}B on the a-Si:H substrate to have a converting layer for neutrons to produce an α that could be detected due to its high signal, and a blind detector to γ.





Example of Pulsed Laser Deposition (PLD) technique using ^{10}B on carbon substrate.

If principle will work then:

Applications: Dose monitoring in radiotherapy;
Dose monitoring in BNCT;
Space crew exposure; ← Interest from ASI researchers