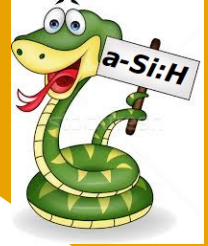
HASPIDE

Meeting con Referee 2023-09-04

L. Servoli

HASPIDE STATUS: AdR



1) Posizioni AdR solo parzialmente assegnate:

- → WP2: (TO) Lorenzo Piccolo (inizio 2022-terminato)
- → WP4: (FI) Deborah Chilà (inizio maggio 2023)
- → WP1: (PG) Luca Tosti (inizio aprile 2023)
- → WP1: (LE) Closed (inizio settembre 2023)
- → WP5: (Urbino) : selezione ribandita
- → WP2: (LNS) : selezione ribandita

2) Richiesta AdR da bandire questo anno per WP2 (MI) per lavoro su versione finale chip CLEOPATRA

Manpower: 49 Ricercatori+Tecnologi; 15.5 FTE

Summary Task, Milestone, Deliverables WP1

• Tasks (50%)

T1.1: *Single Diode PECVD Prototype production and testing*
T1.2: *Single Diode PLD Prototype production and testing*
T1.3: *Small arrays PECVD Prototype production and testing*
T1.4: *Small arrays PLD Prototype production and testing*
T1.5: *Irradiation tests of prototypes*
T1.6: *Production of WP4 detector*
T1.7: *Production of WP5 detector*
T1.8: *Production of WP6 detector*

• Project Milestones (60%)

M1.1: *End of single diode with PECVD qualification tests*
M1.2: *End of single diode with PLD qualification tests*
M1.3: *End of small array with PECVD qualification tests*
M1.4: *End of small array with PLD qualification tests.*
M1.5: *End of irradiation tests.*

• Deliverables (43%)

D1.1: *Single array with PECVD delivered*
D1.2: *Single array with PLD delivered*
D1.3: *Small array with PECVD delivered*
D1.4: *Small array with PLD delivered*
D1.5: *WP4 detector delivered*
D1.6: *WP5 detector delivered*
D1.7: *WP6 detector delivered*

Referee's Milestones for 2024

→ *Qualification of RM1 devices (PECVD)*
→ *EPFL production of devices optimized for Application WPs (WP4, WP5, WP6)*
→ *Complete spectroscopic characterization of devices fabricated in EPFL, LE, RM1.*

Most likely all WP1 2024 milestones will be met by the end of the year

Problems and bottlenecks for WP1: EPFL

1) production of second batch of EPFL HASPIDE sensors; all should arrive within 2024 spring
2) we shall emit a new INFN order to EPFL for the third batch before august. To be defined in autumn.
3) we have to decide before august if we will need a fourth EPFL batch because we have eventually to ask for unblocking INFN money at september CSN5 meeting.
4) no money could be asked for 2025 to produce new EPFL batches. We could only emit the order in december 2024.

EPFL is studying in detail the contact type performances, CSC ws n-i-p

Problems and bottlenecks for WP1

1) In Perugia we have currently just one X-ray tube working.
   One more has been sent to the vendor to be repaired
   One more is being acquired. Foreseen arrival time mid-may.

2) We have extended the AdR of Luca Tosti one more year using other money sources. This should ensure the same level of manpower for device testing.
3) The devices produced in LE with sputtering/PLD technique have to be tested with beams.
4) We have to define a way to produce 2D-arrays, mainly the routing of the signals to the readout.

Summary Task, Milestone, Deliverables WP2

• Tasks (33%)

T2.1: *Design of the front-end chip for clinical dosimetry*
T2.2: *Design and test of the data acquisition board for neutron detection*
T2.3: *Design and test of the data acquisition board for clinical dosimetry*

• Deliverables (0%)

D2.1: *data acquisition board for clinical dosimetry*
D2.2: *data acquisition board for neutron detection*

Referee's Milestones for 2024

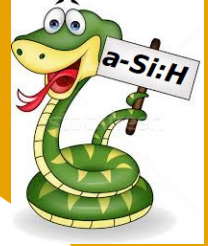
→ Submission of final CLEOPATRA chip
→ Choice of system for pulse mode readout

Most likely all second milestone will be reached, first one possibly.

• Project Milestones (22%)

M2.1: *design of the first miniAsic (M8)*
M2.2: *test board for the first miniAsic (M12)*
M2.3: *characterization of the first miniAsic (M15)*
M2.4: *design of the second miniAsic (M18) Removed*
M2.5: *test board for the second miniAsic (M22) Removed*
M2.6: *characterization of the second miniAsic (M25) Removed*
M2.7: *design of the front-end chip for clinical dosimetry (M30)*
M2.8: *design and fabrication of the data acquisition board for neutron detection (M24)*
M2.9: *firmware for data acquisition on the FPGA board (M26)*
M2.10: *characterization of the data acquisition board for neutron detection (M29)*
M2.11: *design and fabrication of the data acquisition board for clinical dosimetry (M32)*
M2.12: *characterization of the data acquisition board for clinical dosimetry (M36)*

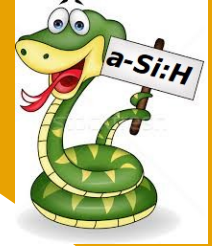
Problems and bottlenecks for WP2:



1) Manpower: the AdR position will be called out before june (Italian rules deadline) by Milano Group. This should ensure the needed manpower for designing and testing the final version of CLEOPATRA chip.
2) There have been some problems in the production of the custom DAQ and sensor board, linked to producers availability. This year INFN modified purchasing procedures could delay further the arrival of custom boards.

→ As soon as possible place orders.

Problems and bottlenecks for WP2:



3) Pulse mode readout:

the choice will be done among readout system under development in LNS based on existing TERA chips and TOAST chip developed by Torino group for PANDA experiment.

We need to test deviced connected to sensors on ion beams or highly ionizing particles.
Likely places: CNAO with carbon ion beams, other facilities with low energy ions or protons, pulsed laser facility.

We need to submit requests for beam time.
This is an activity that could require some extension in 2025.

Summary Task, Milestone, Deliverables WP3

• Tasks (50%)

T3.1 *Modeling development/validation.*
T3.2 *Geant4 simulations.*
T3.3 *TCAD simulations: DC, (AC), transient analysis (CCE).*
T3.4 *Optimization of a-Si:H devices: layout/geometries, operating conditions.*
T3.5 *Radiation tolerance analysis. (do we need this?)*

• Project Milestones (22%)

M3.1 *TCAD modeling of a-Si:H.*
M3.2 *Combined Geant4 + TCAD simulation environment set-up.*
M3.3 *Comparison between simulations and measurements.*

• Deliverables (40%)

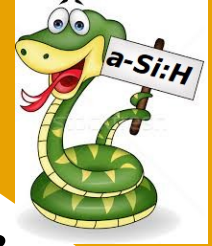
D3.1 *a-Si:H TCAD material model with embedded physical models (e.g. carrier mobility) - M6.*
D3.2 *Report on layout/geometry of dosimetric flux sensor - M12.*
D3.3 *Report on layout/geometry of single particle sensor – M18. (next year?)*

Referee's Milestones for 2024

→ time variant TCAD simulation for charge efficiency collection studies

Most likely the milestone will be reached.

Problems and bottlenecks for WP3:



1) Choice of appropriate energy deposition models for each type of ionizing radiation and relative parametrization of radiation sources.
2) Accurate description of specific devices to be simulated.
3) Validation with data from measured devices exposed to different sources.

4) Decide if the GEANT4 simulation is needed for our goals, and find manpower and competence to perform it.

Summary Task, Milestone, Deliverables WP4

- **Tasks (75%)**

T4.1 *Survey of the facilities accessible by the Project's collaborators.*

T4.2 *Definition of the priority of the clinical applications, planning for accelerators availability, data taking and data analysis.*

T4.3 *Preliminary test on small non-optimized prototype.*

T4.4 *Design of the geometries and structures (In collaboration with WP1) for the fabrication of the first batch of devices.*

T4.5 *Design of the phantoms for the single pixels to be used with photon beams (HASPIDE-1D).*

T4.6 *Definition of the tests to be carried out at the facilities.*

T4.7 *Test with available prototypes.*

T4.8 *In collaboration with WP1, definition of the second batch of fabrication of pixelated devices*

T4.9 *Design of the phantoms for the pixelated detectors to be used with stereotactic photon beams (HASPIDE-SBRT). Definition of tests to be performed in available facilities.*

T4.10 *In collaboration with WP1, definition of a third device to be used with proton beams (HASPIDE-p+). Definition of tests to be performed in available facilities.*

T4.11 *HASPIDE-1D test on standard photon beams and data analysis*

T4.12 *HASPIDE-SBRT test on small photon beams and data analysis*

T4.13 *HASPIDE-p+ test on proton beams and data analysis*

Summary Task, Milestone,Deliverables WP4

• Project Milestones (66%)

M4.1 *Defining of clinical application (first year of the project) (M12)*
M4.2 *Development of the devices designed for each clinical application (second year of the project)* **(M24)**
M4.3 *Test on beams of the devices (third year of the project) (M36)*

• Deliverables (80%)

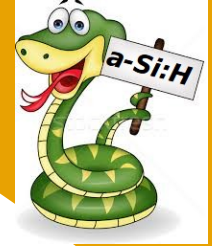
D4.1 *Description of the clinical applications of HASPIDE detector (end of the first year) (M12)*
D4.2 *Description of the HASPIDE devices (end of the second year) (sistemi per test ready) (M24)*
D4.3 *Characterization of the HASPIDE devices (end of the third year) (M36)*

Referee's Milestones for 2024

→ small field dosimetry with HASPIDE devices and comparison with standard dosimetry

→ in-vivo dosimetry using antropomorphic phantom

Most likely the milestones will be reached.



Problems and bottlenecks for WP4:

1) Refinement of phantoms for each type of measurement.

2) Manpower for data analysis.

3) Availability of beam time for non clinical characterization and tests.

4) Decide eventual partecipation to calls for technological transfer with or without firms.

Summary Task, Milestone, Deliverables WP5

• Tasks (40%)

T5.1 *Modeling solar energetic particle (SEP) flux evolution at 1 AU.*

T5.2 *FLUKA+LEI simulations*

T5.3 *Test of the available prototypes*

T5.4 *Optimization of a-Si:H devices for space weather applications: geometry, surrounding material and spacecraft positioning.*

T5.5 *Optimization of a-Si:H devices for human dose monitoring is space: geometry and spacecraft positioning.*

T5.6 *Test on final prototypes and evaluation of possible implementation in space.*

• Deliverables (40%)

D5.1 *Database of the evolution of SEP fluxes at 1 AU in energy, space and time – M12*

D5.2 *Outcomes of Monte Carlo simulations of a-Si:H devices for space weather applications and* ***critical comparison with other instruments in space – M24***

D5.3 *Outcomes of Monte Carlo simulations of a-Si:H devices for dose absorption in space and critical* ***comparison with other instruments in space – M36***

• Project Milestones (45%)

M5.1 *Parametrization of the evolution of different intensity SEP events in energy, space and time.*

M5.2 *Monte Carlo simulations of a-Si:H device performance for space weather applications and possible implementation.*

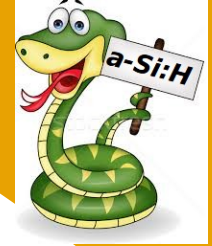
M5.3 *Monte Carlo simulations of a-Si:H device performance for dose measurements in space and possible implementation.*

Referee's Milestones for 2024

→ design of demonstrator to measure SEPs in space

Most likely a first version of the demonstrator design will be ready.

Problems and bottlenecks for WP5:



1) Refinement of phantoms for each type of measurement.

2) Manpower for data analysis.

3) Availability of beam time for non clinical characterization and tests.

4) Decide eventual partecipation to calls for technological transfer with or without firms.

Summary Task, Milestone, Deliverables WP6

• Tasks (50%)

T6.1 Determinations of optimal conditions of the PLD system for ^{10}B deposition (Month 1-12).

T6.2 Deposition of ^{10}B films on both flexible substrates and a-Si:H-based detectors (Month 12-24).

T6.3 Tests of the devices exposed to thermal neutron fields (Month 18-36)

• Project Milestones (45%)

***M6.1**-Month 12. Deposition of pure and thick 10B film on flexible substrates and on sample mimiking the devices.*

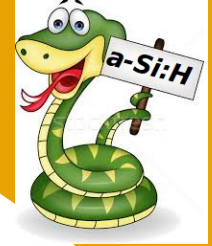
***M6.2**-Month 24. Deposition of ^{10}B converters on a-Si:H devices and substrates*

***M6.3**-Month 36. Test of the devices for thermal neutron detection.*

Referee's Milestones for 2024

→ test of devices for thermal neutron detection

Most likely the milestone will be reached.



Problems and bottlenecks for WP6:

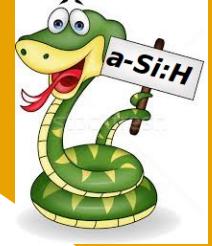
1) Availability of neutron sources.

2) Optimization of ^{10}B deposition thickness and uniformity.

3) Availability of substrates to deposit ^{10}B.

4) Measurement of neutron detection efficiency as a function of different device parameters.

Other business:

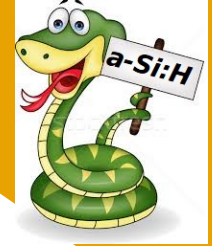


1) ASI Call outcome: The proposal has not been selected.

Soon the detailed evaluation of the project should be avaible to Presenters (Mauro and Catia).

2) An accelerator for FLASH electron beams will be based in Perugia for 1 year. We are in the process of defining the Collaboration with the medical staff to test HASPIDE devices as dosimetry.

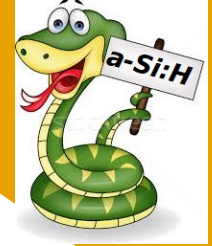
Other business:



3) *Presented a proposal to a PNRR call with Cinzia as PI.*
   The proposal is focused on testing a-Si:H devices as possible dosimeters for FLASH electron therapy.
   The institution proposing the project is Careggi Hospital.
   INFN could not partecipate due to formal incompatibility.

4) *Conference financing: we have to define the conferences to which submit abstract and the amount of money needed, in order to ask CSN5 for the necessary money.*

HASPIDE STATUS: WP1



Caratterizzazione sensori: questioni da affrontare

→ **sensitività:**

- dipende dal tipo di contatti? Come?
- dipende da area, volume, spessore, forma?
- dipende dal bias? Il S/N come dipende dal bias?

→ **stabilità:**

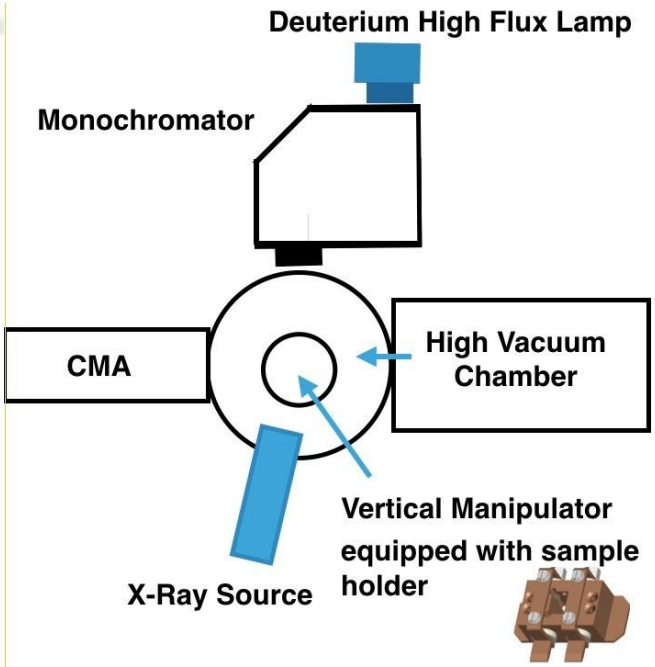
- quanto tempo per stabilizzare il sensore dopo polarizzazione?
- serve un priming e di che tipo per migliorare la risposta?

→ **filtro per la luce visibile:**

- come mascherare il sensore senza degradare le prestazioni?

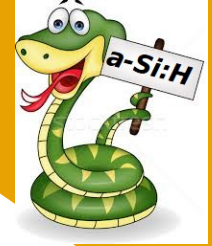
→ **curvatura:** come dipendono le prestazioni dalla curvatura?

HASPIDE STATUS: WP1 spettroscopia



Strumento montato: CNR con contributo INFN (monocromatore finanziato nel progetto HASPIDE). Commissioning quasi finito. Prime misure in ottobre.

HASPIDE STATUS: WP3



Poster presentato a E-MRS 2023 Spring Symposium.

Articolo sottomesso in luglio a Materials Science in Semiconductor Processing (IF=4.64)

In attesa di risposta.

Se accettato richiesta a CSN5 per Open access.

2024: Licenza TCAD,
HD esterno per backup

TCAD modelling of a-Si:H devices for particle detection applications

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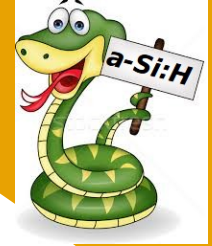
ARTICLE INFO

Keywords:
TCAD
Amorphous Silicon
Particle Detectors

ABSTRACT

Hydrogenated amorphous silicon (a-Si:H) has been proposed as a suitable material for particle detection applications thanks to its property to be deposited over a large area and above a variety of different substrates, including flexible materials. Moreover, the low cost and intrinsic radiation tolerance made this material appealing in applications where high fluences are expected, e.g. in high energy physics experiments. In order to optimize the device geometry and to evaluate its electrical behaviour in different operating conditions, a suitable Technology CAD (TCAD) design methodology can be applied. In this work, carried out in the framework of the HASPIDE INFN project, we propose an innovative approach to the study of charge transport within the material, using the state-of-the-art Synopsys Advanced TCAD Suite.

HASPIDE STATUS: WP4 fasci clinici



Abbiamo effettuato molti test presso:

→ *l'Ospedale di Careggi*

→ *il Centro di Adroterapia di Trento;*

→ *facilities in Australia, sia ospedaliere che presso il Sincrotrone Australiano.*

I sensori testati sono di vari tipi:

→ *a-Si:H depositato su vetro, su substrato di c-Si o + su kapton (primo batch HASPIDE),*

→ *di varia forma e spessore, e con contatti p-i-n e CSC*

HASPIDE STATUS: WP4 fasci clinici

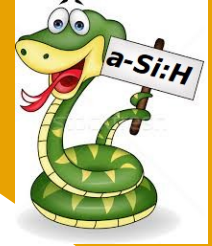
I risultati ottenuti sono:

→ Set completo di misure di dosimetria (Careggi) su fascio di radioterapia usando un array di pixel depositati su kapton. Presentato a ESTRO 2023 e in sottomissione a Physics and Imagning in Radiation Oncology.

→ Primo set di misure su sincrotrone pubblicato su Physics in Medicine and Biology. doi: 10.1088/1361-6560/acdb43

→ Set completo di misure presso Ospedale in Australia, articolo in sottomissione su Medical Physics.

HASPIDE STATUS: WP4 fasci clinici

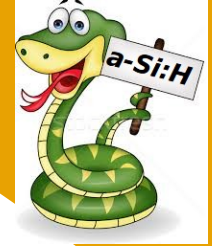


→ Siamo convinti che i sensori a-Si:H depositati su kapton siano *eccellenti dal punto di vista del paragone con la dosimetria di riferimento* e possano essere usati con successo in applicazioni soprattutto per misurare fasci in trasmissione.

→ Riteniamo che possa anche essere esplorata la possibilità di uso per dosimetria di fasci in modalità FLASH.

In autunno effettueremo un primo test con il gruppo di Pisa sulla macchina a fasci di elettroni FLASH.

HASPIDE STATUS: WP4 fasci clinici



Richieste per 2024:

→ Sistema di DAQ a 128 canali per lettura contemporanea di matrici almeno 10 x 10 di sensori per misura bidimensionale dei fasci. Vedi WP2.

Se viene finanziata nel 2023 la richiesta del 2024 cade.

→ Set di lastre di acqua solida per effettuare misure con minimizzazione di effetti sistematici (FI) 20 k€

→ Dosimetro di riferimento (assegnato nel 2023, FI 3.5 k€)

Richiesta replicata nel 2024, in caso finanziamento DAQ 128 canali nel 2023 assorba i 3.5 k€ del 2023.

HASPIDE STATUS: WP4 fasci non clinici

Test effettuati presso:

→ **il Centro di Adroterapia di Trento**

→ **il fascio di protoni presso il CEDAD di Lecce.**

→ **Stiamo pianificando una esposizione ai fasci presso l'infrastruttura ELI e ad un fascio di ioni**

Analisi dati in corso. Parte dei risultati saranno usati nell'articolo sulla sensitivity (vedi WP1)

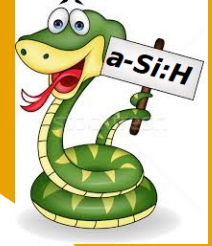
HASPIDE STATUS: WP4 Milestone

Milestone 31-12-2023: Validation of prototypes performance, with respect to reference dosimetry, when exposed to both photon or electron clinical beams

Con la prossima pubblicazione degli articoli sottomessi riteniamo di soddisfare la milestone.

In autunno effettueremo anche test su fasci clinici di elettroni (LINAC, IORT, FLASH)

HASPIDE STATUS: WP5 Space Weather



Abbiamo presentato l'idea di misura e alcuni aspetti delle attività svolte finora nel WP5:

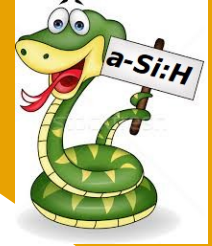
→ 1 talk di C. Grimani al ESA SPACEMON Conference (Norwjik)

- A Hydrogenated amorphous silicon detector for Space Weather Applications.

→ 2 talk alla conferenza ASAPP 2023 (Perugia)

- C. Grimani: HASPIDE-SPACE for solar, magnetar and gamma-ray burst monitoring
- L. Servoli: a-Si:H as active material for the detection of different radiations observed during the evolution of Solar Energetic Particle events

HASPIDE STATUS: WP5 Space Weather



È stato sottomesso e accettato per la pubblicazione un articolo su questa proposta.

"A Hydrogenated amorphous silicon detector for Space Weather Applications" , su "Astrophysics and Space Science".

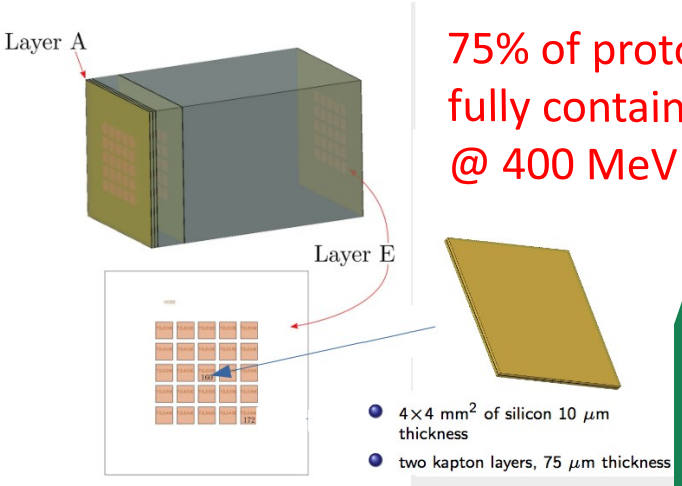
Chiedamo alla CSN5 di finanziare la sua pubblicazione come articolo Open Access. 2.5 k€ su PG

HASPIDE STATUS: WP5 Space Weather

→ Abbiamo effettuato una prima campagna di test presso il Centro di Adroterapia di Trento per verificare la risposta a bassi flussi di protoni di varie energie.

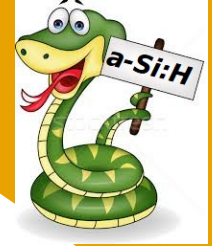
→ Primi test con sorgente di ^{90}Sr in laboratorio dimostrano la sensitivity dei sensori anche per bassi flussi di elettroni con spettro di energia < 2 MeV.

→ Inizio di implementazione di modelli di sensore in GEANT4 per verificare la configurazione di un dimostratore.



75% of protons fully contained @ 400 MeV

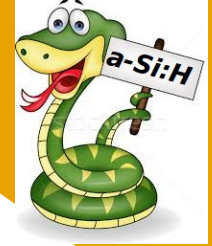
HASPIDE STATUS: WP5 Space Weather



→ chiediamo per il 2024 l'acquisto del tungsteno necessario per implementare il dimostratore e verificare il principio di misura dello spettro dei protoni (3 k€ PG).

→ chiediamo la possibilità di effettuare una sessione di test presso un centro di taratura SIT per verificare la risposta di un sensore ad un fascio X con spettro simile a quello di un evento SEP (1 k€ PG).

HASPIDE STATUS: WP5 Milestone

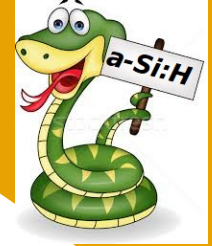


Milestone 14-12-2023: Simulation of prototype instrument, with a-Si:H sensitive volume, for Space Weather applications.

La non disponibilità del AdR previsto per questa attività ha rallentato il lavoro.

Riteniamo comunque che alla data proposta avremo una prima versione non definitiva dello strumento.

HASPIDE STATUS: WP6 neutron detection

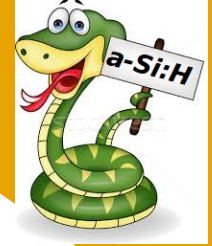


I substrati per la deposizione di ^{10}B sono arrivati a Lecce. Primi tentativi di deposizione a settembre.

Milestone 31-12-2023: ^{10}B thin films deposition on flexible substrate and on a-Si:H sensors and their characterization.

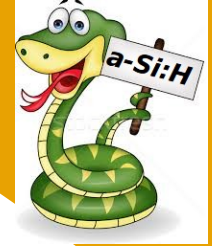
Riteniamo che la milestone proposta verrà rispettata.

Conferenze e Workshop: fatti



1) WP4: Poster at ESTRO Conference in Vienna → C. Talamonti (altri)
2) WP3: Poster at E-MRS Conference (Strasbourg) → D. Passeri (altri)
3) WP5: Talk at workshop SPACEMON ESA/ESTEC Noordwijk → C. Grimani (altri)
4) WP1: Talk at IWASI 2023 (Monopoli) → M. Menichelli (CSN5)
5) WP4: Talk at ASAPP conference (Perugia) → L. Servoli (CSN5)
6) WP4: Talk at ASAPP conference (Perugia) → C. Grimani (CSN5)
7) WP1: Talk at IWORID conference (Oslo) → F. Peverini (phD+CSN5)
8) HASPIDE: Talk at X-ray precision measurement workshop (LNF)
   → K. Kanxheri (Premio per miglior presentazione) (altri)

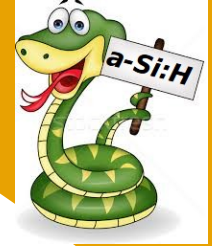
Conferenze e Workshop: Accettati



9) WP1: Poster at FISMAT 2023 (Milano) → F. Peverini (PhD)
10) WP1: Talk at 109° SIF (Salerno) → B. Gianfelici (CSN5)
11) WP4: invited talk at 20th International Conference on Solid State Dosimetry → M. Petasecca (altri fondi)
12) HASPIDE: talk at IPRD Conference (Siena) → L. Tosti (CSN5)

Richiesta finanziamento missioni PG:
2.5 k€: 0.5 IWORID, 1.0 SIF, 1.0 IPRD (3 talk)

Per il 2024: Sulla base delle 6 conferenze del 2022 e delle 12 del 2023 stimiamo in circa 12 quelle che saranno accettate. (~ 2/WP)



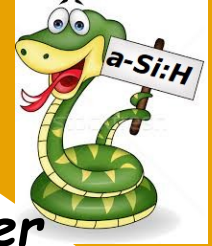
Articoli pubblicati

1) Hydrogenated Amorphous Silicon High Flux X-ray Detectors for Synchrotron Beam Monitoring Applications. Phys. in Med. and Bio. 68, (2023) 135010, doi: 10.1088/1361-6560/acdb43 OA [UOW]

2) Neutron irradiation of Hydrogenated Amorphous Silicon p-i-n diodes and charge selective contacts detectors. NIMA 1052 (2023) 168308 doi: 10.1016/j.nima.2023.168308

3) X-ray qualification of hydrogenated amorphous silicon sensors on flexible substrate. Proceedings IWASI 2023, (2023) 190-193, doi: 10.1109/IWASI58316.2023.1016461.

Articoli accettati e sottomessi



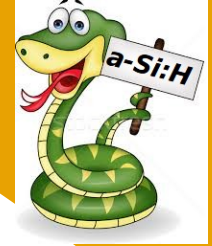
4) A Hydrogenated amorphous silicon detector for Space Weather Applications. *Astrophysics and Space Science.* *Open Access [CSN5]*

5) TCAD modelling of a-Si:H devices for particle detection applications. *Sottomesso a Materials Science in Semiconductor Processing.* *Open Access [CSN5]*

6) Characterization of a flexible thick-film a-Si:H detector for dosimetry in therapeutic X-ray beams. *Sottomesso a Medical Physics*.

7) First dosimetric characterization of an a-Si:H dosimeter on flexible support. *Sottomesso a Physics and Imaging in Radiation Oncology*.

Projects linked to HASPIDE (1)



→ *Submitted proposal for ASI call for innovative detectors and measurement strategies.*

Mauro Menichelli is the PI of the proposal.

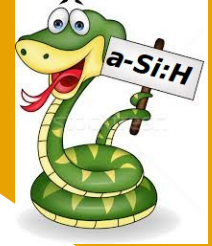
It is a two-stage call:

Money asked: 25 k€ for the first step, to be used to work on full proposal definition (6 months).

Only 4 projects will be selected for the second stage.

Requests passing to the second stage will have 275 k€ more for preparing a demonstrator (2 years).

Projects linked to HASPIDE (2)



→ *A PRIN proposal has been submitted (INFN, UNIFI).*
Title: DEFLADOS (Detectors for photon FLASH therapy Dosimetry).
PI L. Servoli, deputy PI C. Talamonti

Rejected.

Project aims to use 3D diamond and a-Si:H devices as possible dosimeters for photon beams in FLASH mode.
Requested ~ 300 k€ .