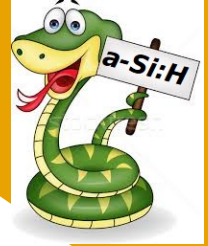
HASPIDE

8th Meeting 2023-02-02/03 (Firenze)

https://https://agenda.infn.it/event/34020/

L. Servoli

HASPIDE STATUS

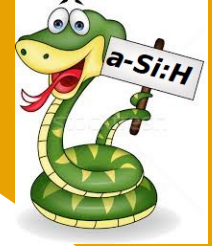


1) Firtst year of project is behind us…

Thanks to 3D-Siam synergies we where able to do quite a lot of experimental work and to tackle some of the questions that needed to be answered.

2) Due to the problem with PostDoc positions some activities could not start with the necessary momentum, hence we have to recover in 2023.

HASPIDE STATUS

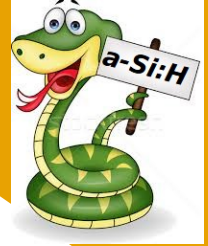


3) We have been financed by INFN CSN5:
   2022: 240 k€ / 515 k€ requested (3 AdR included)
   2023: 257.5 k€ / 358 k€ requested
   (3 AdR included anticipated to 2022)
   Total = 497.5 k€

   We have the means to carry on our research program.

4) Nevertheless we have to keep looking proactively for additional source of money (as we are doing….).

HASPIDE STATUS



5) Manpower situation start to look reasonable:

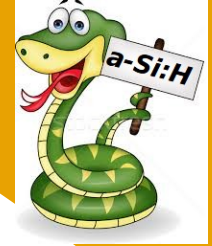
41 researchers + 5 PostDoc starting 2023 = 46

~ 11 FTE + 5.0 (PostDoc) = 16 FTE

FTE/person = 0.34

6) If possible we have to try to attract young people for their Master thesis or PhD programs.

HASPIDE STATUS: WP1



1) Device production (PECVD): Goals:

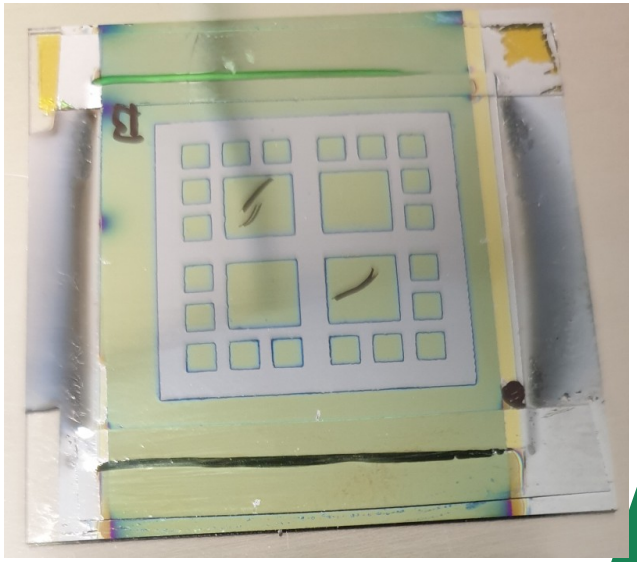
→ deposition on kapton for both p-i-n and CSC devices;
→ optimization of deposition procedures;
→ matrix device production with uniform behaviour

Milestone 30-10-2023: Complete qualification of CSC devices on flexible plastic substrate (PECVD), both single or matrices.

HASPIDE STATUS: WP1

1) Device production (PECVD): Status:

→ first batch of p-i-n structures on kapton has been produced and tested.
(see rest of meeting for results)



→ mechanical recipe for cutting single devices has been found

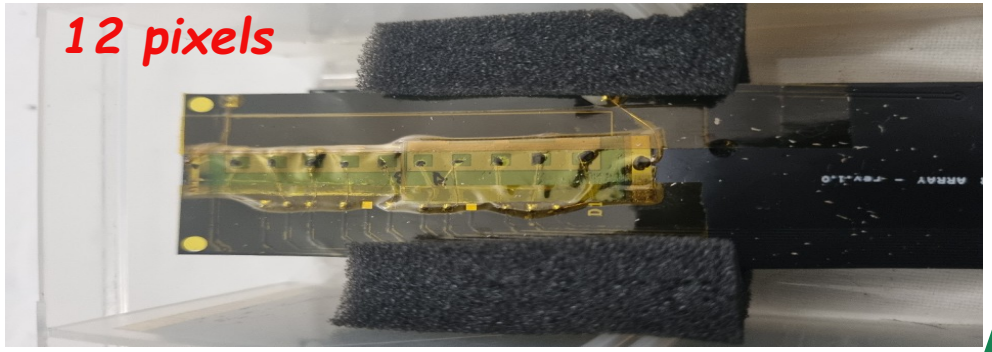
→ studying laser cutting recipe.

HASPIDE STATUS: WP1

1) Device production (PECVD): Status:

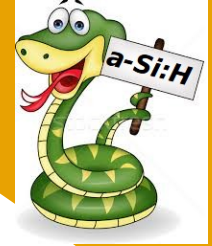
→ single and linear arrays of devices have already been assembled.

→ linear arrays have been developed by EPFL and UOW effort



(M. Large hosted by EPFL during last autumn)

HASPIDE STATUS: WP1



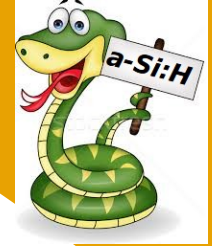
2) Device production: Pulsed Laser Deposition and reactive sputtering. Goals:

→ Investigation of a different deposition techniques to produce HASPIDE devices.

→ Realization of a-Si:H films to be fully characterized with microscopic and electrical techniques.

Milestone 30-10-2023: Evaluation of PLD and reactive sputtering techniques to produce devices for HASPIDE applications.

HASPIDE STATUS: WP1



2) Device production: Pulsed Laser Deposition and reactive sputtering. Means (Lecce site):

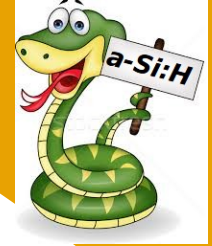
→ acquisition and commissioning of parameter analyzer and DC probes to complete electrical testing equipment;

→ upgrade of film deposition facilities;

→ 1 year PostDoc position starting in 2023;

→ device test at different ionizing radiation facilities;

HASPIDE STATUS: WP1



3) Spectroscopic characterization: Goals

→ Understanding the microscopic properties of the deposition processes

→ Study of the interfaces

→ kapton/metal, metal/a-Si:H, kapton/a-Si:H, a-Si:H / contact layers

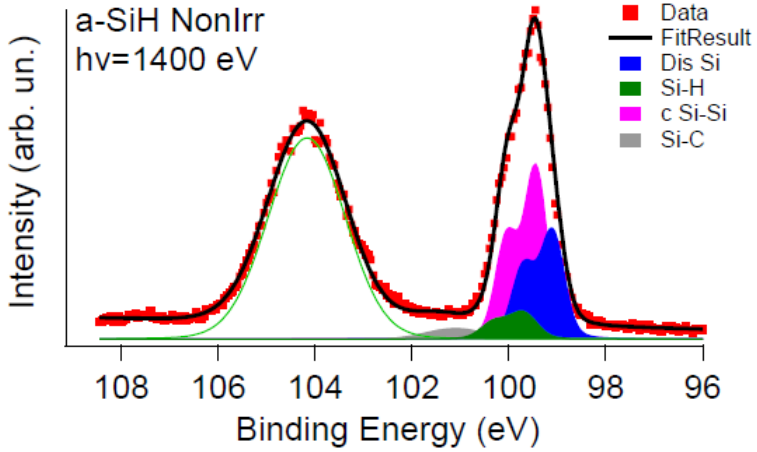
→ Give feedbacks to simulation and production.

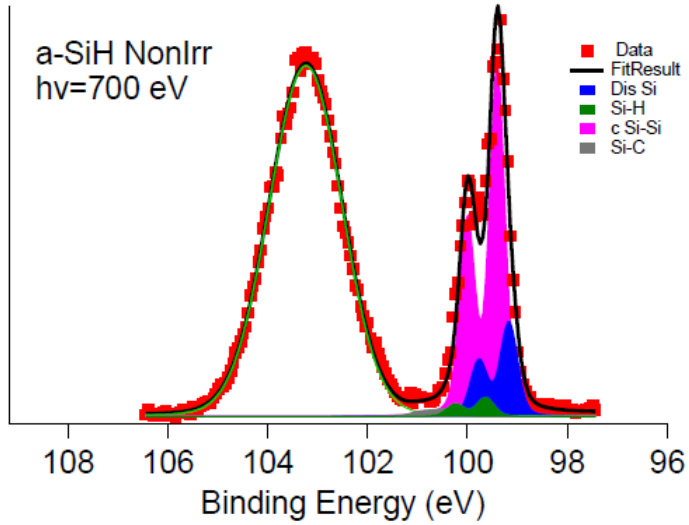
→ Study link of microscopic properties with electrical measurements

HASPIDE STATUS: WP1

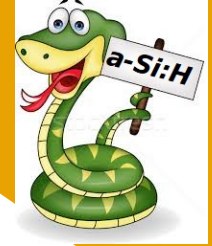
3) Spectroscopic characterization: Status

→ First characterization at ELETTRA beam lines made on a-Si:H film over c-silicon substrate. Paper published





HASPIDE STATUS: WP1



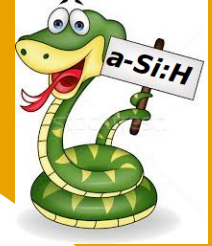
3) Spectroscopic characterization: Means

→ Setup of a measuring station in Perugia for photon energies ~ few eV. (goal: commissioned in summer)

→ Measurement at higher photon energies (Synchrotrons)
We did measurements at ELETTRA in 2022.
In 2023 ELETTRA will not be available, as well as the medical beam line at SOLEIL.

→ We have found a possible solution: laboratory of Quantum Optics (LKO), Nova Gorica (summer).

HASPIDE STATUS: WP1



4) Sensor characterization: Goals

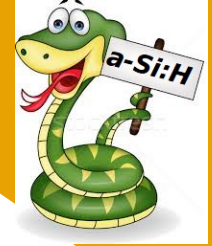
→ study the devices behaviour both in dark condition and in presence of ionizing radiation stimula.

→ give feedback to simulation WP to validate the a-Si:H model.

→ interact with application WPs to optimize design and tests for their specific needs.

Milestone 14-11-2023: completion of studies on resistance to radiation damage for both p-i-n and CSC devices.

HASPIDE STATUS: WP1

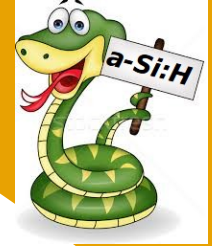


4) Sensor characterization: Status (1)

→ Many sensors have been characterized in 2022, coming from 3D-Siam and the first HASPIDE batch of p-i-n on kapton devices.

Many different combinations have been tested: p-i-n or CSC contacts, pads or strips shape, different thickness, different packaging, different readout systems (Keithley, TetrAmm, UOW system).

HASPIDE STATUS: WP1



4) Sensor characterization: Status (2)

→ low device noise (few pA could be reached)

→ extreme care to the setup and connections with readout is mandatory because the small value of signal (~ nA or less).

→ good linearity wrt dose/rate

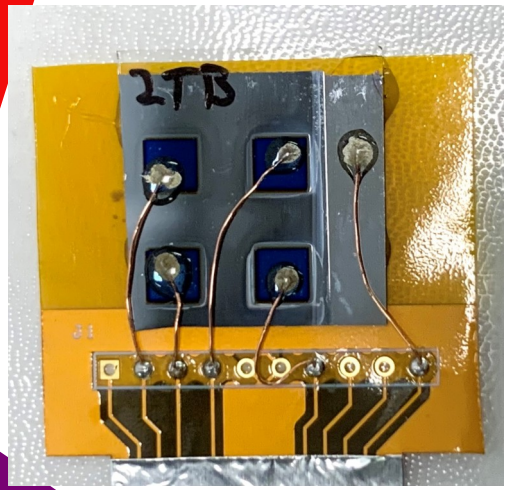
→ linearity remains even changing ionizing radiation type

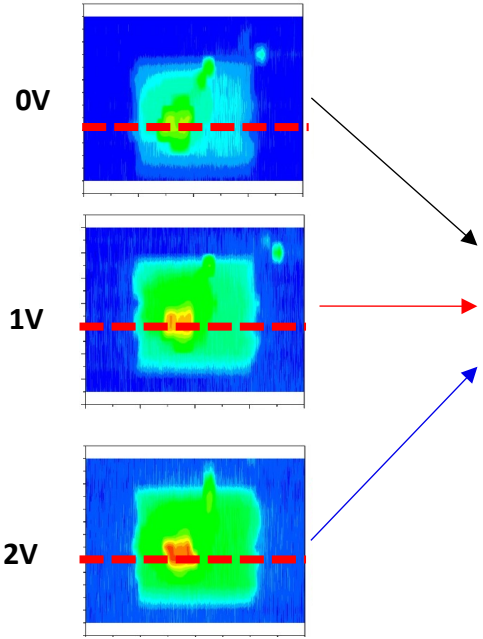
→ NI radiation damage (neutrons) does not change the linearity of response of device, only the sensitivity.

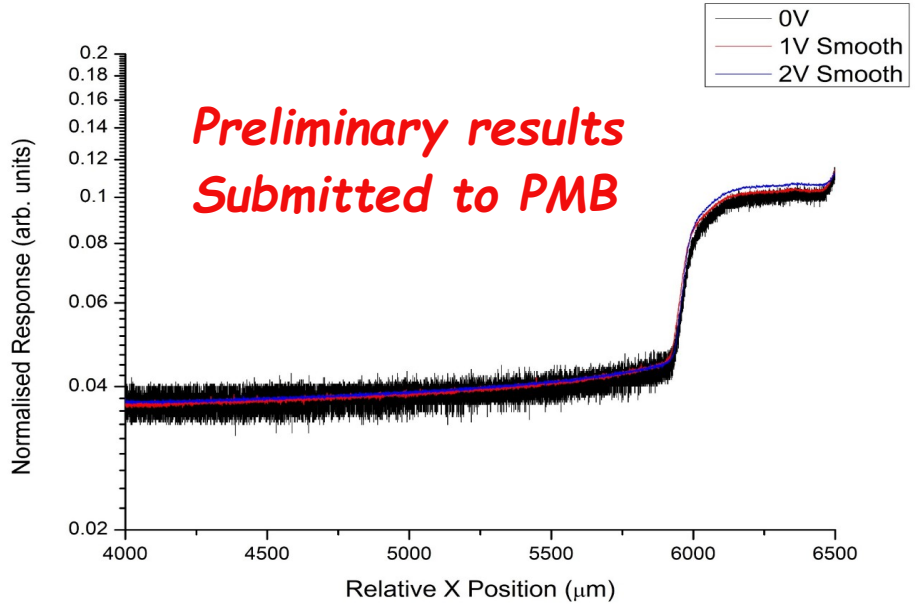
HASPIDE STATUS: WP1

4) Sensor characterization: Status (3)

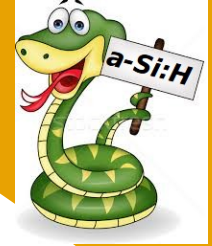
→ charge collection efficiency drops outside the contact (UOW results at Australian synchrotron)







HASPIDE STATUS: WP1



4) Sensor characterization: Points to be addressed:

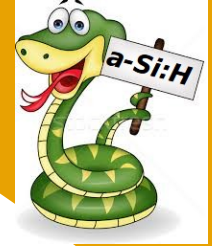
→ **sensitivity:**

- depends on contact type? How?
- depends on surface, volume, thickness, shape?
- depends on bias? And how S/N depends on bias?

→ **stability:**

- how much time to stabilize from biasing?
- priming will make better the device behaviour?

HASPIDE STATUS: WP1



4) Sensor characterization (standard): Means

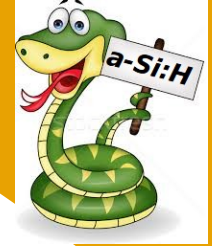
→ Setup of new X-ray tube station in Perugia dedicated to HASPIDE measurements (within february)

→ Setup of infrared microfocused laser (in Perugia) with micropositioning for device surface scanning.

→ I-V tests, response stability in time, temperature dependence, sensitivity, short and long term repeatibility.

→ 1 PostDoc position (PG) and 1 PostDoc (Lecce)

HASPIDE STATUS: WP1



4) Sensor characterization (radiation hardness): Means

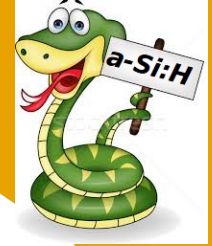
→ Use of CEDAD tandem accelerator (Lecce) for both flux and radiation damage tests with protons (approved).

→ Test at Trento hadrontherapy center with proton beams, various energy and fluxes (approved).

→ Test at Australian Synchrotron with high dose-rate high-energy photon fluxes for TID (approved)

→ Test at Berne Cyclotron with high-fluxes proton beam (approved).

HASPIDE STATUS: WP2



1) MiniASIC development: Goals

→ produce a news chip for current mode readout.

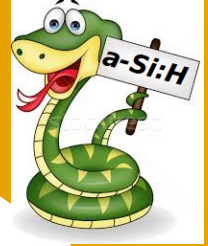
→ implement a readout system to functionally test it

→ test the ASIC chip attached to a sensor.

We have a name for the chip: CLEOPATRA.

Milestone 29-09-2023: First miniASIC characterization

HASPIDE STATUS: WP2



1) MiniASIC development: Means

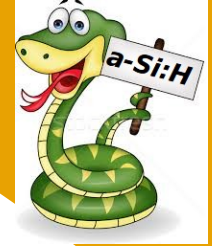
→ use of 28 nm technological node for design and submission.

→ design and implementation of miniASIC test board;

→ design and implementation of sensor board

→ 1 year PostDoc position from june 2022.

HASPIDE STATUS: WP2

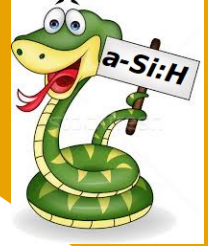


2) Implementation of multichannel DAQ systems: Goals

→ make available to the collaboration DAQ systems for sensor readout while waiting for the release of a full scale functional CLEOPATRA chip.

→ evaluate the performance for the different application WPs.

HASPIDE STATUS: WP2



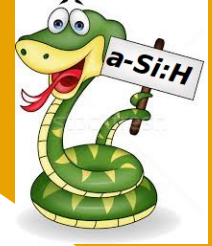
2) Implementation of multichannel DAQ systems: Means

→ Already available UOW system, developed for clinical use-cases. To be evaluated for all application WPs.

→ Construction of a system based on TERA8 chip. Financed in 2022 for parts and in 2023 for PostDoc position (LNS).

→ Cooperation with WPs to define sensor interfaces.

HASPIDE STATUS: WP3



1) A-Si:H simulation in CAD: Goals

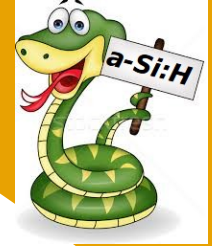
→ refine simulation model for TCAD and validate it with experimental data;

→ optimization studies for sensor design for specific applications;

Milestone 31-12-2022 already achieved.

a-Si:H model introduced as new material in TCAD.

HASPIDE STATUS: WP3



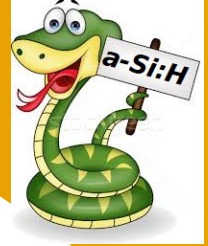
1) A-Si:H simulation in CAD: Means

→ dedicated workstation for simulation (acquired and working in PG).

→ interaction with WP1 for definition of measurements to be compared with simulations results.

→ simulation of DAQ circuitry connected to the sensor.

HASPIDE STATUS: WP4

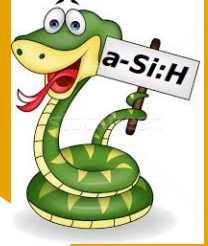


1) Clinical applications: Goals

→ demonstrate that a-Si:H sensor could be used for clinical dosimetry with results compared with reference dosimetry.

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

HASPIDE STATUS: WP4

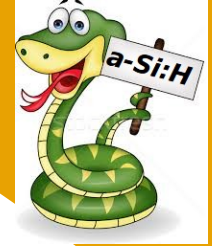


1) Clinical applications: Status

→ Several tests have been carried out using first 3D-Siam prototypes and later in autumn the first devices on kapton produced specifically for HASPIDE project.

Tests done at Careggi Hospital, Berne Cyclotron, Australian facilities: electron and photon beams.

HASPIDE STATUS: WP4



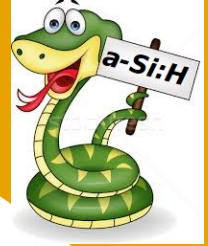
1) Clinical applications: Status

→ Many interesting results obtained, some reached publication submission or conference presentation.

Others will be presented in this meeting.

→ General feeling is that some of these clinical applications could be tackled by the a-Si:H solution in a competitive way compared to state of the art.

HASPIDE STATUS: WP4



1) Clinical applications: Means

→ Phantom development for clinical validation

→ access to clinical beams (approved at Careggi)

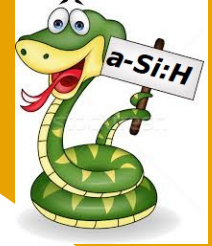
→ access to clinical beams (approved at Trento)

→ access to clinical beams (requested at UOW)

→ access to clinical beams (approved at Berne)

→ 1 year PostDoc position at FI

HASPIDE STATUS: WP4



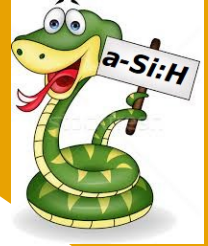
2) Non-Clinical applications: Goals

→ Verify the a-Si:H sensors could be used for beam monitoring in case of non-clinical beams.

→ Study the threshold to operate an a-Si:H sensor in current mode for low radiation flux.

→ Evaluate possibility to use pulse mode readout.

HASPIDE STATUS: WP4



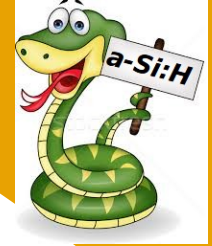
2) Non-Clinical applications: Means

→ Test at Trento protontherapy center to measure low flux proton beams at various energy (synergic with WP1 and WP5).

→ Test at ELIBEAM facilities.

→ Test at ion beam facilities.

HASPIDE STATUS: WP5

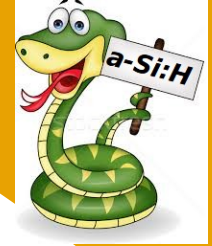


1) Space Weather application: Goals

→ Demonstrate the feasibility of a-Si:H devices for measurements in space for Space Weather application

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

HASPIDE STATUS: WP5



1) Space Weather application: Means

→ Identify a use-case: Solar Energetic Particle events (SEPs)

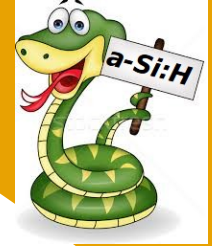
→ Design and simulate a demonstrator for the specific use-case.

→ Measure sensitivity, noise and response to different radiation fluxes (photons, electrons, protons)

→ test over beams similar to the SEPs'.

→ WS dedicated to HASPIDE + 1 year PostDoc (Urbino)

HASPIDE STATUS: WP6

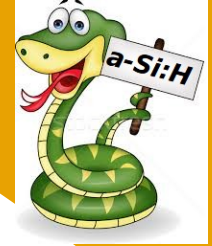


1) Neutron detection with a-Si:H devices: Goals

→ **Demonstrate that a-Si:H devices, if sputtered with ^{10}B, could detect a neutron flux.**

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

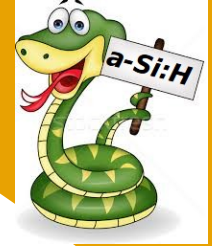
Other projects linked to HASPIDE



1) *Nicholas Wyrsch (EPFL) obtained a Swiss Government grant to study the Charge Selective Contacts technology* applied to Amorphous Silicon devices, both planar and 3D. (440 kCHF)

2) *Marco Petasecca's request to access ANSTO Australian Synchrotron beamline has been accepted.*
3 full days, inkind value ~ 98 kAUD.
Beam Time will be dedicated to undestand a-Si:H sensor behaviour for photon FLASH beams.

Other projects linked to HASPIDE

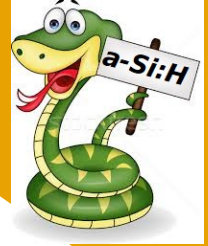


3) *A PRIN proposal has been submitted (INFN, UNIFI).*
Title: DEFLADOS (Detectors for photon FLASH therapy Dosimetry).
PI L. Servoli, deputy PI C. Talamonti
Project aims to use 3D diamond and a-Si:H devices as possible dosimeters for photon beams in FLASH mode.
Requested ~ 300 k€ .
a-Si:H devices from HASPIDE project, some of the prototypes available to be used.

Other projects linked to HASPIDE

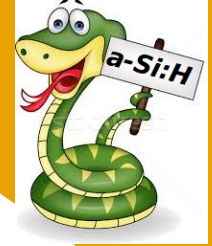
4) *ASI call for innovative detectors and measurement strategies should be published again in the next weeks.*
Mauro Menichelli will be the PI of the proposal.
Previous call was structured as a two-stage call:
Money asked: 25 k€ for the first step, to be used to work on full proposal definition (6 months).
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).

Other projects linked to HASPIDE



5) *I'm now in the e-mail list of INFN-E project (E. Nappi project manager). It's a project dealing with energy applications, including nuclear sites monitoring.*

The aim of the partecipation is to understand if there are applications, collaborations or synergies with HASPIDE

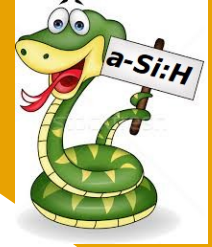


Publications:

1) *Paper on spectroscopy measurements has been published by NanoMaterial. Open Access.*

High-Resolution Photoemission Study of Neutron-Induced Defects in Amorphous Hydrogenated Silicon Devices. Nanomaterials 2(19),3466 (2022) doi:10.3390/nano12193466

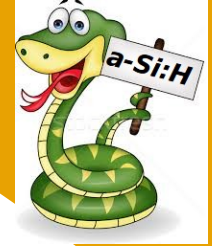
Publications:



2) *Paper on Charge Selective Contact device, published by Journal of Instrumentation. Open Access*

Testing of planar hydrogenated amorphous silicon sensors with charge selective contacts for the construction of 3D-detectors.

Journal of Instrumentation, Volume 17, Issue 31 (2022) doi:10.1088/1748-0221/17/03/C03033



Publications submitted:

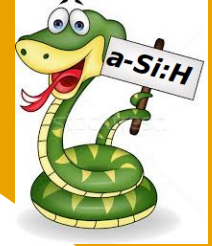
3) *Paper on proposal for measurement instrument for Space Weather applications.*

A Hydrogenated amorphous silicon detector for Space Weather Applications.

Submitted to Experimental Astronomy

Also present in arXiv:

http://arxiv.org/abs/2302.00339



Publications submitted:

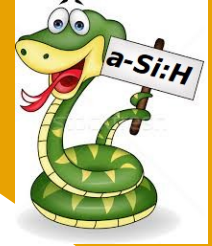
4) *Paper on precision measurements at Australian Synchrotron for sensor characterization.*

Hydrogenated Amorphous Silicon High Flux X-ray Detectors for Synchrotron Beam Monitoring Applications.

Submitted to: Physics in Medicine and Biology

PMB-114633

Publications submitted:

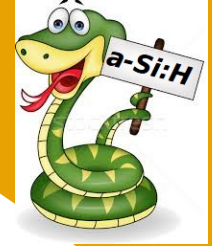


5) *Resistance to neutron radiation damage of both + p-i-n and CSC devices.*

Displacement damage in Hydrogenated Amorphous Silicon p-i-n diodes and charge selective contacts detectors.

Submitted to: Nuclear Instruments and Methods B

Also on TechrXiv: articles/preprint # 19555042



Publications submitted:

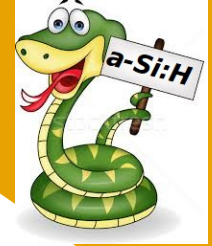
6) *Proceedings of presentation at IEEE NSS/MIC conference on a-Si:H detectors on a flexible substrate.*

Development of thin hydrogenated amorphous silicon detectors on a flexible substrate.

Submitted to: Proceedings of IEEE NSS/RTST/MIC 2022

Also on arXiv: doi: 10.48550/arXiv.2211.17114

Conferences and Workshops:



1) 2 Talks at 108° SIF Congress in Milano
→ C. Talamonti, → L. Servoli

2) Talk at RADECS 2022 (Venezia) → M. Large

3) Talk at 2022 IEEE NSS/RTST/MIC, Milano
→ M. Menichelli

Poster at 2022 IEEE NSS/RTST/MIC, Milano
→ F. Peverini

4) ASI Workshop (virtual) → L. Servoli , C. Grimani