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UNIVERSITÀ
DEGLI STUDI
DI PADOVA

**PhD course of National Interest in Technologies for
Fundamental Research in Physics and Astrophysics**

Annual report

Name and surname: Federico Cittadini
Cycle and a.a.: XL cycle, 2024/25
Supervisor: Leonello Servoli

- Research activity carried out during the year**

The aim of the INFN HASPIDE project is the development of an hydrogenated amorphous silicon-based detector as dosimeter both for conventional and FLASH radiotherapy. This necessity arises from the fact that traditional dosimeters saturate when irradiated with a FLASH clinical beam, preventing their application with this technique. For this reason, the HASPIDE (*Hydrogenated Amorphous Silicon Pixel DEtector*) group is developing sensors based on this material deposited on thin flexible substrates (kapton), which make them a tissue-equivalent device and are also characterized by high radiation hardness and flexibility.

Within this framework, the research activity carried out during my first year of the PhD is organized as follows:

first of all, a not-negligible amount of time was spent to study, learn and understand better the context and details of the experiment, the techniques for the characterization of devices and the use of ROOT for data analysis.

After that, a relevant part of my activity is the characterization in laboratory (both in terms of iv-curves of dark current and X-rays sensitivity evaluated by means of an X-ray tube) of the sensors coming from EPFL Institute (Switzerland), which is the production center. This takes a lot of time, but it is fundamental in order to check the quality and performance of the detectors and to choose the best ones to bring with us when we have beam time in some facility.

Another huge activity is represented by the analysis of data taken in Torino at the beginning of the year, under a modified LINAC accelerator which delivers a FLASH electron beam, with a sensor characterized previously in laboratory. The results of this analysis will be presented in two conferences, IPRD25 at Siena and SIF at Palermo, and for the first one the proceeding will be published in Journal of Instrumentation (JINST).



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This analysis took a lot of time, since it is very detailed, but it was very important in order to see the behavior of the sensor under a FLASH beam, in particular by performing a scan of the applied bias voltage. The results are very good and seems to show that a-Si:H devices are promising candidate for FLASH dosimeters.

The remaining part of the activity is represented by several sessions of measurements, in particular in Florence, at the hospital Careggi, where tests with photons and electrons were performed (but in this case, using conventional beams), and also in Lubiana (Slovenia), at the JSI institute, to see the performance of a sensor after radiation damage induced by neutrons in nuclear reactor and the subsequent effect of the annealing procedure, which seems to restore the initial conditions of the sensor. For a matter of time and priorities, these data are still to be better analyzed and it will be done after the aforementioned conferences.

Currently, I am beginning to work on the test and comparison of different readout electronics (with and without the sensor) and to learn how to use a pulse simulator (new CAEN object) which will enable us to compare these various electronics with the same detector signal.



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- **List of attended courses and passed exams**

Photodetection: Scintillators and Silicon Photomultiplier (2 cfu) - **passed**

Detectors for ionizing radiation (1 cfu, UniPg course) – **passed**

Spectroscopic fine characterization of Nanosystems and advanced materials (1 cfu, UniPg course) – **passed**

Solid State Detectors (2 cfu) - **attended**

- **List of attended conferences, workshops and schools, with mention of the presented talks**

Attendance and oral presentation at IPRD25, Siena (15-19 September 2025)

Attendance and oral presentation at SIF, Palermo (22-26 September 2025)

Seminar presentation at UniCam, Camerino (22 May 2025)

Attendance of TECH-FPA PhD Retreat at LNGS (17-21 February 2025)

Submission to attend EDIT School at CERN (3-13 March 2026)

- **List of published papers/proceedings**

Conference proceeding (IPRD25), to be published in JINST

Article published on Sensors, title “Hydrogenated Amorphous Silicon Charge-Selective Contact Devices on a Polyimide Flexible Substrate for Dosimetry and Beam Flux Measurements”, 19 February 2025

- **Thesis title (even temporary)**

Study of a-Si:H detectors for clinical ionizing radiation characterization



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Date, 11/9/2025 Perugia

Signature

Federico Cittadini

Seen, the supervisor

Enrico L...