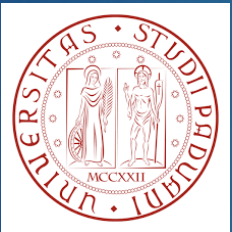


Presentation for admission to the 2° year

PhD program of National interest

'Technology for Fundamental Research in Physics and Astrophysics'
(Curriculum Detectors)



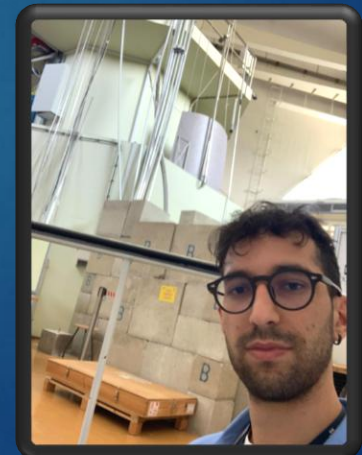
Dr. Federico Cittadini

PhD TFPA, XL cycle, A.Y. 2024/25

federico.cittadini@phd.unipd.it

INFN Sec. Perugia

federico.cittadini@pg.infn.it



Outline

2

- ❑ Research topic
- ❑ Objectives and Performed research activity
- ❑ Future activities and Overall planning
- ❑ Courses, exams, training activities and academic achievements

Research topic

3

Research and development of a solid-state sensor acting as dosimeter for radiotherapy application, both for conventional and FLASH clinical beams.

Conventional radiotherapy technique

- ❑ Dose delivered in **many sessions**
- ❑ Session time ≈ 10 min
- ❑ Dose rate ≈ 6 Gy/min
- ❑ **Damaging of healthy tissues**

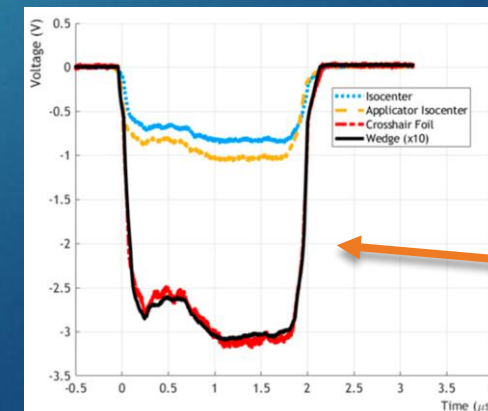
PROBLEM: conventional dosimeters **saturate** under a FLASH clinical beam...



(POSSIBLE) SOLUTION: HASPIDE dosimeter !

FLASH radiotherapy

- ❑ Same dose delivered in **only one pulse !**
- ❑ Session time $\approx$ tenths of a second
- ❑ **Dose per pulse $\approx 20 - 40$ Gy**
- ❑ **Duration of a pulse $\approx \mu\text{s}$**
- ❑ **Less side-effects (FLASH EFFECT)**



**TIME and
INTENSITY
are
fundamental**

HASPIDE experiment



4

The **INFN HASPIDE** project aims to use thin layers of a-Si:H (*Hydrogenated Amorphous Silicon*) material as ionizing radiation detector.

- ❑ Disordered semiconductor ➡ **high radiation hardness**
- ❑ $E_{\text{gap}} \approx 1,75 \text{ eV}$ ➡ **low dark current**
- ❑ Well-developed deposition technology (used for photovoltaic panels)
- ❑ Hydrogen introduced for defects passivation (*dangling bonds*)
- ❑ Thin layers of intrinsic a-Si:H ($\approx 1 - 20 \mu\text{m}$) deposited on **polymide thin flexible substrates** ➡ suitable for dosimetric measurements



Objective

5

- Prove, through measurements and data analysis, that a-Si:H sensors are good candidate as dosimeters under FLASH beams

How to do it: ← **Activities**

❑ Characterization (of different kind of sensors)

iv - curves

X-rays sensitivity

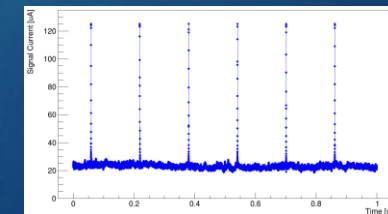
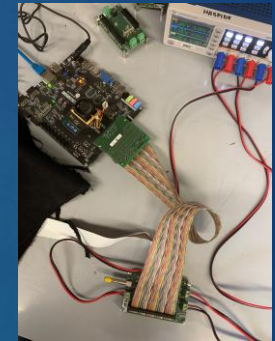
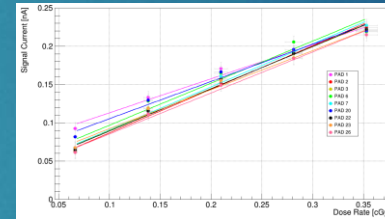
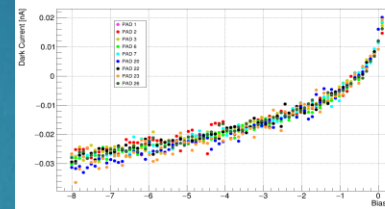
Test of different (new) readout electronics

❑ Beam tests

Perform measurements in FLASH/quasi-FLASH accelerators (e.g., Torino, Pisa, Foligno) and standard clinical beams (Careggi)

❑ Data analysis

Performance study of the sensor (ROOT)



Planned research activity (2° Year)

6

- Characterization of **new kind of sensors and comparison** (EPFL vs Sapienza)

- Comparison bewtween **different electronics** (Keithley vs TetrAmm vs Cleopatra)



- **Beam tests** (Torino, Trento, Pisa)

- Learn how to use a **pulse simulator** (new CAEN object) **to test different electronics with the same detector signal.**

Overall Planning

7

1° YEAR

Sensors characterization

Beam test

Data analysis

2° YEAR

Sensors characterization

Beam test

Data analysis

Readout electronics analysis

3° YEAR

Comparison among sensors

Comparison among
electronics

Results

Thesis

Training Activities

8

➤ Courses

1. Photodetection: Scintillators and Silicon Photomultiplier (2 cfu) - passed
2. Detectors for ionizing radiation (1 cfu, UniPg course) – passed
3. Spectroscopic fine characterization of Nanosystems and advanced materials (1 cfu, UniPg course) – passed
4. Solid State Detectors (2 cfu) - attended

➤ Schools

1. Attendance of TECH-FPA PhD Retreat 2025 (17-21 February, LNGS)
2. Submission to attend EDIT School at CERN (3-13 March 2026)

➤ Others Training Activities

1. Tutoring in Physics for pharmacy degree course
2. Presentation of a seminar at UniCam, Camerino, for bachelor degree students in Physics

➤ Conferences

1. Oral presentation at IPRD25, Siena (15-19 September 2025)
2. Oral presentation at SIF, Palermo (22-26 September 2025)

➤ Publications

1. “Hydrogenated Amorphous Silicon Charge-Selective Contact Devices on a Polyimide Flexible Substrate for Dosimetry and Beam Flux Measurements”, Sensors, 19 February 2025
2. Conference proceeding (IPRD25), to be published in JINST



THANKS FOR THE ATTENTION

