## PhD Thesis Project Proposal
## INFN and University of Florence

HASPIDE

HAmorphous Silicon Pixel DEtector for ionising radiation

**Title -** ***Medical applications of flexible A:Si detectors***

**Advisor:** Cinzia Talamonti, cinzia.talamonti@unifi.it -
INFN-FI,Dip. SBSC University of Florence

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One of the goals of the **INFN HASPIDE project** (Hydrogenated Amorphous Silicon DEtectors) funded by **INFN CSN 5**, is to explore the possibility to use Hydrogenated Amorphous Silicon (a-Si:H) detectors for **applications in medical physics**. The choice of this material as sensitive layer is driven by its resistance to radiation damage which allows the sensors to operate in very demanding environments like intraoperative radiation therapy (**IORT**) and ultra-high dose rate therapy (**FLASH therapy).**

One of the main challenges in dosimetry and radiation monitoring in radiotherapy is to find sensitive materials featuring at the same time a number of desirable characteristics: 1) a large dynamic range for dose-rates spanning several orders of magnitude; 2) low thickness; 3) radiation resistance; 4) adjustable geometrical shape; 5) possibility to be used in transmission mode; and 6) ability to work both in air and vacuum. The a:Si-H is an excellent detector material candidate in many respects. It has a wide bandgap, wider than crystalline silicon, and its intrinsic non-crystalline nature offers a natural resistance to radiation damage. In addition, being already widely used in medical accelerators and many other application domains, the industrial process to grow a:Si-H in very thin layers and wide surfaces in one go is readily available.

Thin layers of a:Si-H can nowadays be grown on flexible supports, opening new possibilities for the use of this material in medical physics. The supporting layer could be made for example with Polyimide sheets, allowing to produce sensors with a large variety of shapes, light-weighted and easily adaptable in curved configurations like cylinders, ensuring a high solid angle coverage.

The HASPIDE detector is fabricated via PECVD (Plasma Enhanced Chemical Vapor Deposition) or PLD (Pulsed Laser Deposition) with thickness ranging from hundreds of nanometers to tens of micrometers (Figure 1).

*Figure 1 single diode assembled on the kapton pigtail; Pigtail for phantom studies is a 600um thick kapton strip with radiofrequency shielding. The assembling allows a certain degree of mechanical flexibility for optimal positioning of the sensor over irregular surfaces.*

**Research proposals:**

The Ph.D candidates will take part in the HASPIDE research programme covering several aspects of the medical applications of the HASPIDE detectors. In details the candidates will work on:

– **dosimetric characterization of devices**: test and development of different configuration of the dosimeters (1D-2D and matrix configurations) at laboratory and clinical X-ray beams;

–**studies of clinical applications**: *in-vivo measurements* for ***Total Body irradiation***, ***Total skin*** electron beam therapy measurements, ***Skin Dosimetry*** in the Soft Tissue Sarcoma using Helical Tomotherapy.

The PhD project will be developed in collaboration with **INFN-Perugia**, **EPFL** Switzerland and **University of Wollongong**, Australia. By the end of the course, the candidates will have acquired large experience in the development and use of advanced instrumentation for applications in medical physics.

**Cinzia Talamonti** is Professor of Medical Physics at the University of Firenze. She is coordinator of the Haspide "Medical applications" Work-Package. Prof. Talamonti is active at the National Health Service Medical Physics Unit of the Careggi University Hospital of Florence with research interests in conformal, stereotactic, and advanced rotational treatment techniques both from dosimetric and imaging point of view, which are all of paramount importance in the advanced radiotherapy treatments.