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Dr. David Menichelli: Dosimetry with silicon pixel detectors

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Dosimetry with silicon pixel detectors

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Silicon sensors are widely adopted in clinical dosimetry due to small size and reliable manufacture technology, and many detectors have been developed based on either single diodes or arrays. The goal of this training course is to present physics and technology of silicon dosimeters for radiotherapy, with special regard to arrays aimed to the characterization of external photon beams.

An introduction to silicon dosimeters is given in the first part of the talk, starting from motivations to use silicon diodes in clinical applications and detector operating principle, which is based on diffusion of excess carriers (diode are typically used in photovoltaic mode). Performances parameters which depend on chip details (sensitivity dependence on dose, dose rate and temperature, quantum noise) and overall detector design (energy dependence and angular dependence) are presented. Influence on radiation induced traps and recombination centers on these parameters are discussed in detail, together with the technical solutions which can be used to improve chip radiation hardness.

The second part is dedicated to the discussion of diode arrays. Solutions available on the market (all based on arrays of single dies) are reviewed, including detectors developed for a variety of applications such as LINAC commissioning, quality assurance and patient plan verification. Then research prototypes developed by several institutions during last ten year are presented. Their common feature is a decrease of pixel size and pitch beyond the specifications of commercial devices, toward the ultimate values which would be useful for clinical applications (respectively $\sim 0.1\text{mm}^2$ active area and $\sim 1\text{mm}$ pixel pitch). In contrast with commercial devices, most of research projects adopt monolithic sensors, in which diodes are not cut from the wafer.

Finally, the various design solutions (both at sensor and system level) which have been presented are critically analyzed and discussed, and compared with present clinical needs.

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