Fast Silicon Detectors for beam monitoring in proton therapy: preliminary results.

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The MoVeIT project of the Italian Institute for Nuclear Physics (INFN) aims at studying, modeling and verifying the biological impact on charged particle therapy of some complex physical and biological effects, so far neglected by treatment planning systems (TPS) currently used. The preclinical testing of biologically optimized TPS requires dedicated devices for its validation, able to analyze beam particle fluences and beam energy at the same time. Unlike the legacy gas ionization chambers, solid state detectors offer large granularity and sensitivity to single protons and would ideally be suited for beam monitoring in therapy applications. However, signal pileup, radiation damage and the readout complexity prevented their use so far on therapeutic beams.

The work-package 4 of the MoVeIT project is investigating the use of innovative silicon low-gain avalanche detectors (LGAD) optimized for time resolution (Ultra Fast Silicon Detectors - UFSDs) in particle therapy.

Two prototype devices are being developed, one to directly count individual protons at high rates (hundreds of MHz/cm2), the second to measure beam energy with time-of-flight techniques. This requires the design of custom UFSD sensors as well VLSI readout electronics. From simulations' results and first beam tests with UFSD pads, strip detectors were produced by the Fondazione Bruno Kessler (FBK) in Trento (Italy), varying geometries and doping modalities to study the dependence of detector performances on these parameters. Particular effort is being focused on radiation damage, which represents the main issue to be investigated, together with pileup effects. In parallel, prototypes of a new TERA10 readout chip have been produced and are ready to be tested. The aim of this contribution is to review the advancement of the project, and to report on the preliminary results of the test of UFSD strip sensors for counting and of a telescope of UFSD sensors for the energy measurement with the therapeutic proton beam of the Italian National Centre of Oncological Hadrontherapy (CNAO, Pavia).