Innovative thin silicon detectors for beam monitoring in particle therapy

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Purpose. For beam monitoring in particle therapy, silicon detectors
could overcome the limitations of ionization chambers. In particular,
silicon sensors with internal gain (Ultra Fast Silicon Detectors,
UFSDs) provide high signal-to-noise ratio and fast collection times
(_1 ns in 50 lm thickness).
A segmented sensor could allow discriminating and counting single
protons up to high fluxes of therapeutic beams. Moreover, the
excellent time resolution suggests using time-of-flight techniques
for measuring the proton beam energy.

Materials and Methods. Several 50 lm thick UFSD prototypes, both
single pads or segmented in strips, doped with Boron or Gallium, and
with different doping concentrations were fully characterized at the
Turin university laboratory and tested on the clinical proton beam of
the CNAO particle therapy facility, up to fluxes of 109 p/s.
Signal-to-noise ratio, pileup probability, internal gain and gain
degradation with beam fluence were determined from the offline
analysis of the collected waveforms and compared, whenever possible,
to the laboratory measurements.

Conclusions. UFSDs are found to be a viable option for improving
the qualification and the monitoring of a therapeutic proton beams.
However, a careful design is necessary to avoid large pileup inefficiencies
and early performance degradation