Multi-Gap Ionization Chamber for High Flux Pulsed Charged Particle Beams

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Purpose: Nowadays new compact accelerators for charged particles beam therapy have been proposed where high beam intensities occur in short pulses. An innovative multi-gap ionization chamber is proposed which will allow to measure on-line high flux charged particle beams.

Methods: The device includes three parallel ionization chambers with independent anodes and cathodes separated by gaps of different thicknesses filled with air. The charge produced in the gas by an ionizing particle is proportional to the gap width. Deviations from proportionality are expected with high flux beams because of inefficiencies due to charge recombination. The deviation from proportionality can be used to determine the collection efficiency and correct for it.
The electronics read-out of each chamber is based on the 64-channel ASIC chip, designed in CMOS 0.35µm technology which features for each channel an independent current-to-frequency converter followed by a synchronous counter.
The data acquisition system is based on NI FlexRIO FPGA module and LabView software.

The monitor was preliminarily characterized with pulsed beam of photons produced by a 6 MeV Linac and with continuous beam of carbon ions at fixed energy of 120 MeV/u provided by a synchrotron. Later, it was tested with beam at much higher intensity, up to 100 nA, provided by a 18 MeV cyclotron.

Results: The results with photons, protons and carbon ions beam show that the efficiency of the chamber is well described by Boag's theory. As expected, the efficiency increases with the voltage between the electrodes. The ionization density is derived from the efficiency by applying the Boag's theory and, in the case of photons, it is found to increase as the chamber is moved closer to the gamma source.

Conclusions: The Multi-Gap Ionization Chamber to measure high flux charged particle beams was built. The design and preliminary characterization will be presented.