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Proton-range verification in proton radiation therapy using PET

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I will report first performance results for a prototype PET system designed for proton rage verification in proton therapy. This prototype will later be evaluated with phantoms and animals at the proton therapy center of MD Anderson Cancer Centre in Houston, Texas, USA.

The PET system consists of two detector module assemblies in the shape of angular sections of a cylinder with an inner diameter of 325 mm and axial length 105 mm. The two angular sections cover 99 degrees each. Because of the partial angular coverage, optimization the time resolution is essential in this application. Each PET detector module consists of an 8x8 LYSO array with 3x3x15 mm3 pixels in one-to-one coupling to one Hamamatsu MPPC array S14161-3050HS-08 with 3x3 mm2 pixels. The readout electronics is developed by PETsys Electronics and is based on the PETsys TOFPET2 ASIC. The complete PET system will has 96 detector modules and 6144 electronic readout channels. The interface to the DAQ computer is based on a DAQ module using the PXI express bus, and receiving data from the front-end part through two optical links at 6 Gbit/s.

A Clock&Trigger module located near the detectors will distribute clock signals and allow selecting system wide coincidence events selection in the front end firmware. The complete readout can be divided in a configurable number of trigger regions, and events without a coincidence partner in a different trigger region will not be transmitted to the DAQ computer. This will reduce the data rate to the computer by about one order of magnitude.

We will also report the results of a study of radiation damage to the detectors in this application. The study is based on Geant4 simulation.

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