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Advances in electronics for a Compton camera

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Compton cameras can determine the origin distribution of emitted photons by exploiting Compton scattering kinematics and electronic collimation. The detectors operate in time coincidence and thus, good timing resolution is essential to reduce the amount of random coincidences by applying narrow coincidence windows. Backscattering constitutes an important source of image degradation, in particular for energies below 1 MeV. A timing resolution in the range of 100-200 ps would allow the interactions in the detectors to be correctly ordered, improving image quality. In the context of hadron therapy, in which Compton cameras are investigated as a promising tool for treatment monitoring, good timing resolution is crucial to reduce the background of undesired particles produced through the interaction of the proton beams with the patient.

The IRIS group of IFIC (Valencia) is developing a Compton camera for medical imaging and hadron therapy treatment monitoring. The system is composed of three planes of monolithic LaBr3 crystals coupled to SiPM arrays. Accurate timing resolution is challenging due to the large variety of signal amplitudes detected per channel for two different reasons: the different energies deposited in the crystal in each event through the Compton interactions and the spread of the light in the monolithic crystal.

The first MACACO prototype was developed employing the ASIC VATA64HDR16 from Ideas. With the aim of improving timing resolution, an alternative system, MACACOp, has been developed employing TOFPET2 ASIC from PETsys. This system, made of two detector planes, has been tested and characterized in the laboratory with different radioactive sources and at CNA (Sevilla) with 4.4 MeV photons. In addition to a significantly improved timing resolution, the system has wider dynamic range, achieving promising results for hadron therapy treatment monitoring. The ASIC HRFlexToT developed at the University of Barcelona is also being evaluated.

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