

From MACACO to MACACO II: a Compton telescope for hadron therapy treatment monitoring.

Gabriela Llosá, John Barrio, Ane Etxebeste, Carlos Lacasta, Enrique Muñoz, Josep F. Oliver, Ana Ros, Carles Solaz.

Instituto de Física Corpuscular (CSIC-UV), Valencia, Spain.

Compton Cameras are promising devices for hadron therapy monitoring, to detect the gamma rays emitted by the irradiated tissue, which are correlated to the dose deposition. The IRIS group of IFIC-Valencia has developed and fully characterized a first version of MACACO (Medical Applications CompAct COMpton camera), a three-layer Compton telescope based on LaBr_3 crystals coupled to SiPMs. Laboratory and beam tests have shown very promising results. In addition, Monte Carlo simulations have been developed which perfectly reproduce the laboratory tests, assessing the behaviour of the prototype in different geometrical configurations. Beam tests carried out in experimental conditions and at energies closer to the final application have allowed us to demonstrate the possibility of imaging the target in different positions. Tests have been performed both with protons impinging a PMMA target at KVI-CART, Groningen and with 4.4 MeV photons at HZDR, Dresden. The system limitations have also been identified, being energy resolution a critical parameter in Compton cameras. While values close to 6% FWHM at 511 keV have been achieved with these detectors, in long-term operation the system warming up leads to a resolution around 8% FWHM.

A second version of the telescope has been assembled and is being tested, with the main objective of enhancing the energy resolution. To this end, new photodetectors, the TSV S13361-3050AE-08 model from Hamamatsu, have been employed. As in the first version of the prototype, the readout is carried out employing the VATA64HDR16 ASIC from IDEAS. The first tests performed show a preliminary energy resolution of 6.5% FWHM at 511 keV in long-term operation. The characterization and optimization of the detector performance is being completed. The first coincidence tests with two and three layers in the laboratory have been carried out. In addition to imaging point-like sources, a Na-22 array of point sources has been successfully imaged with the two-layer version of the prototype. Tests with PETsys ASIC are also being performed, and beam tests are also foreseen in the beginning of May 2017 at CNA, Sevilla. The final results of MACACO and the first results obtained with MACACO II will be presented.