A compact Time of Flight detector for radiation measurements in a space habitat: LIDAL-ALTEA

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The LIDAL - ALTEA detector is developed to measure the radiation flux inside the International Space Station. It is composed by two subsystems: i) - a portion of the ALTEA system [1], that already measured the radiation onboard of the ISS in the 2006-2012 period, providing also the dose to astronauts, and ii) LIDAL[2] which is under development and will enhance the ALTEA performances both, expanding the energy acceptance window for light nuclei, and in terms of particle identification.

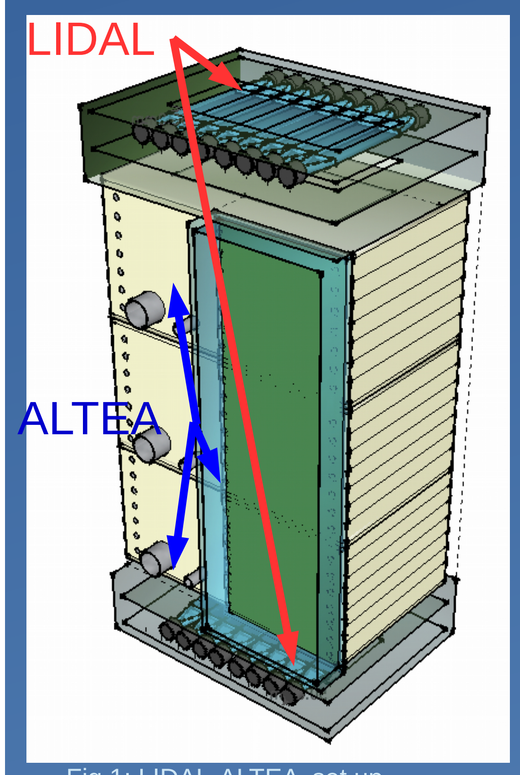


Fig.1: LIDAL-ALTEA set up

LIDAL is composed by two arrays of plastic scintillators (EJ-230) 0.4 cm thick, read by PMTs (Hamamatsu RS9880-U110), positioned at a distance of 49 cm with custom electronics. They are expected to measure the particle TOF with a resolution better than 120ps, (σ) and to provide trigger for the light and fast particles to the whole system. Three ALTEA modules, each composed by 6 silicon striped planes, 380 μm thick, will be inserted between the two scintillators arrays to measure the energy release and to track the particles (Fig.1). The whole system will detect all ions passing through at least one ALTEA modulus. Particle identification will be achieved by combining TOF and LET measurements.

We are performing simulations (FLUKA code [3]) and measurements in a proton test beam. The simulation has been used to opti-mize the scin-tillator dimensions and the electronics (Fig.2,3). The first test beam measurements have been perfor-med with the sa-me scintillator material and an electronic chain with the same major components of the flight model. The simulation has been also used and validated to study the ALTEA detector system exposed to a mono-energetic proton beam (Fig. 4,5).

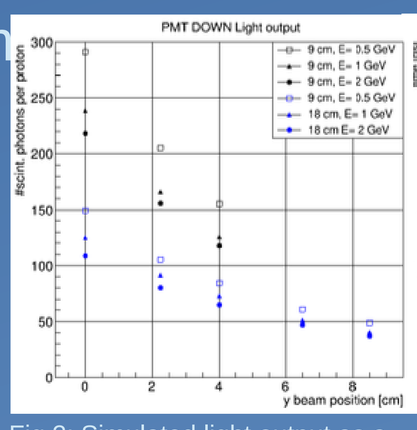


Fig.2: Simulated light output as a function of Proton beam energy, crystal thikness, and impact point

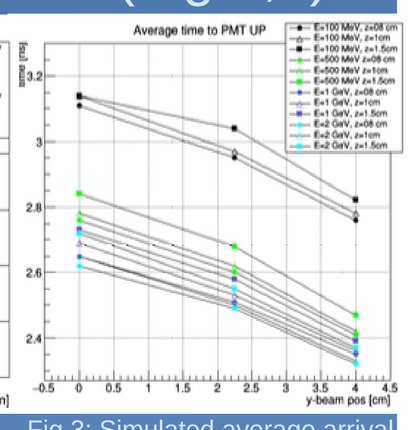


Fig 3: Simulated average arrival time to PMT for the optical Photons as a function of beam position, scintillator thickness

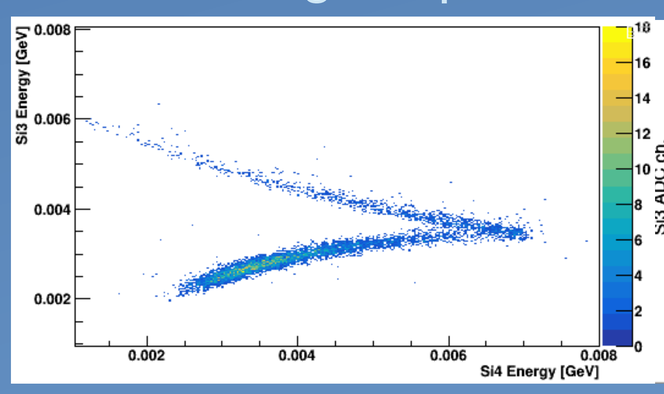


Fig.4: Simulated energy released by 70 MeV priotons in two consecutive ALTEA planes.

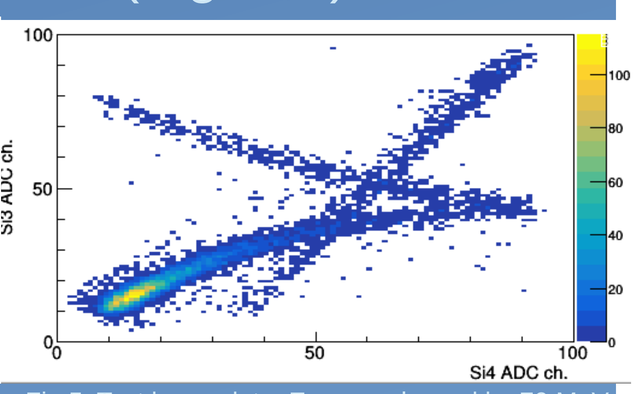
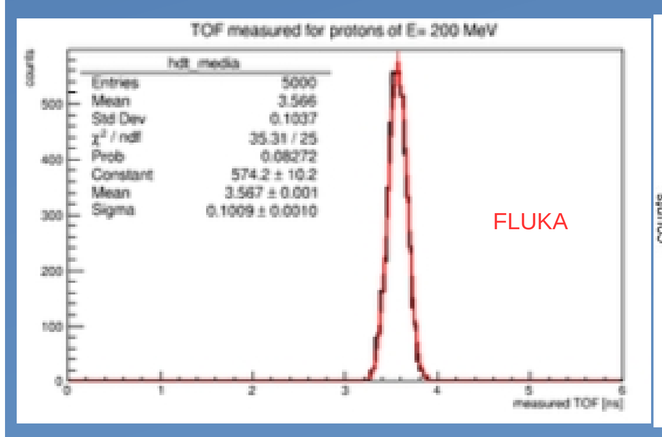


Fig.5: Test beam data: Energy released by 70 MeV prioton beam in two consecutive ALTEA planes.



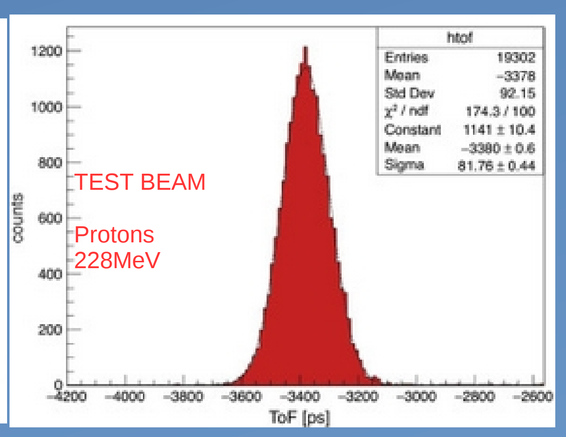


Fig.6: Simulated and measured time resolution.

The LIDAL prototype was exposed to a test proton beam at the Proton Therapy Center TIFPA-Trento. For a proton energy of 228 MeV, a time resolution of 92 ps (σ) has been measured.

[1]: V.Zaconte et al.High Energy radiation fluences at ISS-USLab: ion discrimination and particle abundances, Rad. Meas. 45 (2010
[2]: A.Rizzo et al. A Compact Time of Flight detector for space applications:The LIDAL system Nuc.Inst.Meth. Phys. Res. A 898(2018) 98
[3]: A.Ferrari et al. FLUKA: A multiparticle transport code, no.004.4:539.1, CERN-2005-010; INFN-TC-2005-11;SLAC-R-77,2005