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New single photon counting ASIC for muography camera based on SiPMs

MUCH (MUography CHerenkov) is a project that aims to carry out non-invasive radiography and tomography of large tectonic and geological structures. This multidisciplinary project is an evolution of the ASTRI (Astrofisica con Specchi a Tecnologia Replicante Italiana) concept and represents an innovative application of modern astronomy technologies, leaded by the Italian National Institute for Astrophysics.
The idea of looking inside the volcano through the Cherenkov light produced by penetrating particles such as muons, namely muography, originated from the presence of the ASTRI-Horn Cherenkov telescope, located in the Fracastoro astrophysical observatory, from where the Etna volcano is visible.
Muons are particles created as a result of the interaction of cosmic rays with the Earth's atmosphere reaching the Earth's surface, losing energy when they go through matter with a reduction in flux that depends on the thickness and density of the material they cross. By measuring the absorption of muons in the massive structure, it is possible to trace the distribution of densities within it, recognizing any internal structures.
The Cherenkov light produced by the muon crossing the target is intercepted by the telescope optics and focused on the focal plane of the camera, where the characteristic Cherenkov ring is formed. The reconstruction of the physical parameters, such as direction of arrival and energy of muon, is simple and is based on the reconstruction of the Cherenkov ring produced on the multipixel SiPM sensors camera. The reconstruction of the Cherenkov ring and the determination of the position on the target allows to measure the density distribution of the interior of the massive structure.
The project presents some aspects of technological innovation; one of the most innovative is the RADIOROC ASIC, a front-end to the SiPM sensors which was designed and manufactured expressly for MUCH by Weeroc microelectronics company. The characteristics of the RADIOROC, capable of operating above 100 MHz in single photon counting, allow the diffuse background of the night sky to be drastically reduced.
In this presentation, we illustrate the advantages deriving from the use of this technique and then move on to the characterization of RADIOROC in the laboratory.

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