



Design and Operation of a Field Telescope for Cosmic Ray Geophysical Tomography

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The muons density tomography of geological structures relies on the measurement of the cosmic ray muons flux attenuation due to the presence of the rock crossed by the particles.

A muons telescope is presented with, based on scintillator strips readout by photomultiplier(s) (either multichannel pixelized PM or silicon PM), auto-triggerable front-end electronics and Ethernet-based data acquisition system with embedded processors.

A detailed picture of the telescope architecture is given, hardware and software and the features of the main elements are discussed. In particular the choice of photosensors is a key issue with an unavoidable compromise between photon detection efficiency and noise rates. While the standard photomultipliers exhibit a limited quantum efficiency they offer a low noise level and a remarkable stability in terms of gains and pedestals levels. The opposite conclusions stand for the silicon photomultipliers whose performances depend furthermore strongly with temperature, which is a concern in open air field conditions.

The modularity of the readout system is naturally obtained due to the design based on Ethernet-capable smart sensor electronics. Each plane of a telescope are seen as standard nodes on the network and the initial design of a telescope may be extended according to the needs.

The telescope performances are described not only in terms of detection efficiency, acceptance, spatial/angular resolution and lifetime but also with respect to the harsh field conditions, far from road and power lines, where the weight and the consumption have to be taken into account.

Designed on the concept of the smart unmanned sensor our telescope has been built and deployed in 2010 on volcanoes (Guadeloupe, Etna) and in underground facility (Mont-Terri) and provide continuous data sets of interest for the systematic studies of the relevant density profiles. First results obtained are also presented and briefly discussed.