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Fermilab, LAL, INGV-Osservatorio Vesuviano, University of Tokyo

MU-RAY: a telescope for muon radiography of geological structures

ABSTRACT

Cosmic-ray muon radiography is a technique for imaging the variation of density inside the top few hundred meters of a volcanic cone. With resolutions up to tens of meters in optimal detection conditions, muon radiography can provide images of the top region of a volcano edifice with a resolution that is considerably better than that typically achieved with conventional methods. Such precise measurements are expected to provide us with information on anomalies in the rock density distribution, like those expected from dense lava conduits or low density magma supply paths.
The MU-RAY project [1] aims at the **construction** of muon telescopes and the development of new **analysis tools** for muon radiography. The telescopes are required to be able to work in harsh environment and to have low power consumption, good angular and time resolutions, large active area and modularity. The telescope consists of two/three X-Y planes up to 2x2 square meters area made by plastic scintillator strips of triangular shape. A fast WLS fibre coupled to a silicon photomultiplier reads each strip. The readout electronics is based on the SPIROC chip and a custom board [3].

TECHNOLOGY STAGE

- First prototype (1 square meter): design completed and modules under construction
- Analysis tools developed using real data from a scintillator-photomultiplier detector mounted at Monte Vesuvius.

POSSIBLE APPLICATIONS

- Radiography of massive structure using cosmic muons.

EXISTING APPLICATIONS

- Muon radiography is performed by H.K.M. Tanaka group in Japan [2].

SPECIFICATIONS

- Scintillator bars of triangular shape with TiO_2 coating.
- Scintillator light collected by fast WLS fibers.
- Custom 32 channels optical connector
- Custom 32 channels Silicon photomultiplier board.
- ~3 mm spatial resolution (~3 mrad angular resolution).
- ~1 ns time resolution.

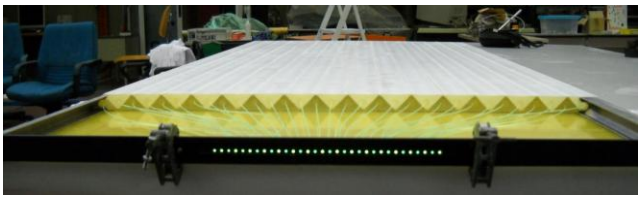

Figure 1: 32 channels module.

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ADVANTAGES

- Light and mechanically robust modules for large area detector assembling in situ.
- Low power consumption.
- Good spatial and time resolution.
- Low background.
- Low cost.

LIMITATIONS

- Silicon Photomultiplier temperature controlled by Peltier cells.

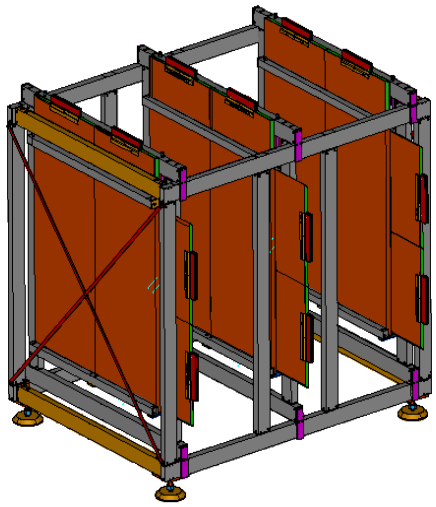

Figure 2: 1 square meter area telescope with three X-Y planes and 12 modules.

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