A Mini-Imaging Air Cherenkov Telescope

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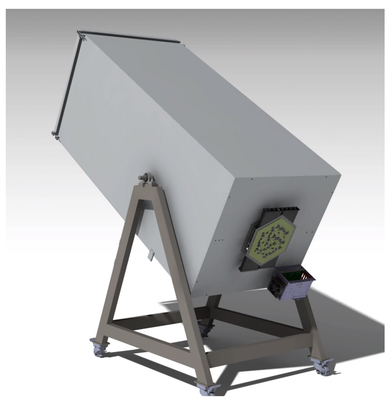
ABSTRACT

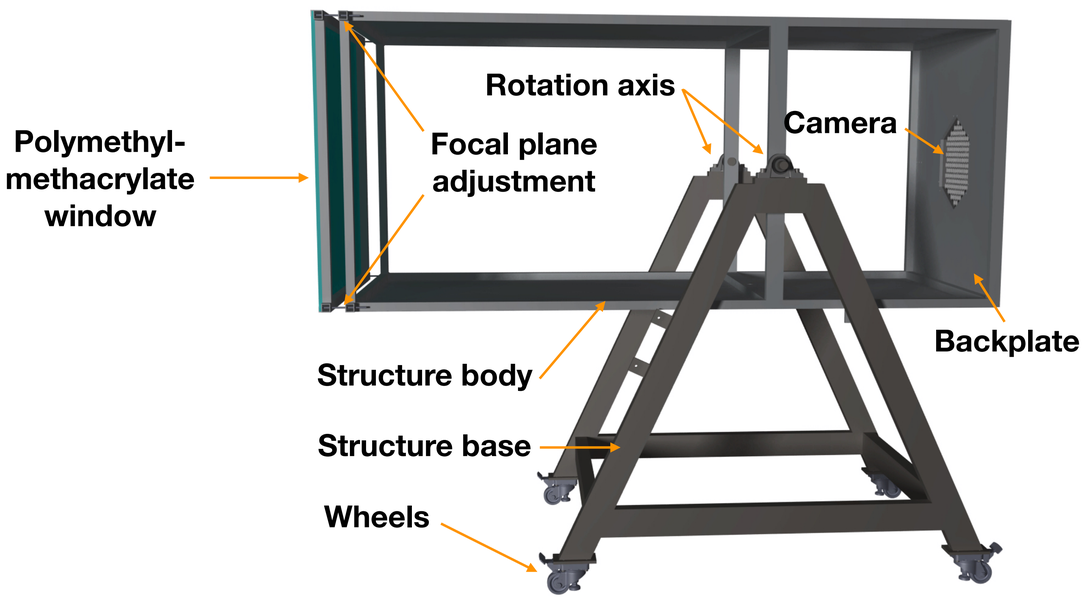
A mini-telescope for the detection of cosmic rays and gamma-rays has been developed at the University of Geneva [1].
The development of this mini-telescope is born as an outreach project for public events but turned out to be as well a very effective and interesting way to illustrate to amateur and students the cosmic and gamma rays detection from ground as it is done in real telescopes.
It is as well a perfect instrument for training students on astrophysics instrumentation, as photosensor (SiPM) and the associated electronics (a dedicated ASIC - CITIROC), but on acquisition software, data taking and data analysis. The results of the measurements done at the Saint-Luc Observatory, presented here, demonstrate the ability of the telescope to observe cosmic rays with energy above about 100 TeV.
Therefore, such a mini-telescope can be a real instrument which can be a cost-effective solution for an out-trigger array that can surround other gamma-ray telescopes or extended air showers detector arrays.

The Mini-Telescope design

	mini-telescope	SST-1M
Optics	Fresnel lens	Davies-Cotton
Collection area [m^2]	0.8	6.5
Focal length [m]	2.4	5.6
Field of View [°]	6.6	8.6
Linear pixel size [m]	0.234	0.234
Angular pixel size [°]	0.55	0.24
Number of pixels	144	1296
Electronics coupling	AC	DC
Readout	Peak sensing	Full waveform

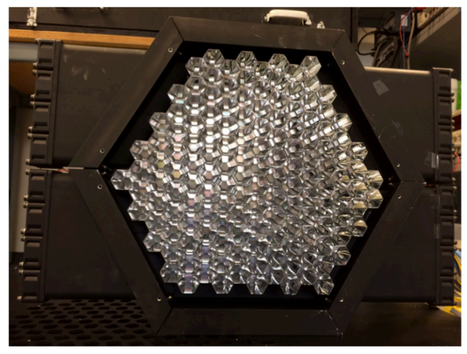


- **Using prototype Fresnel-lens developed for Jem-EUSO [2] (2 mm thick PMMA) with 2.4 m focal length**
- **Manual pointing direction**
- **Moveable structure**



The Mini-Camera

- **The camera features 144 pixels from the SST-1M camera [3]**
- **The pixel are connected to a Baby-Mind acquisition board [4] which feature the CITIROC ASIC for the charge and time extraction**



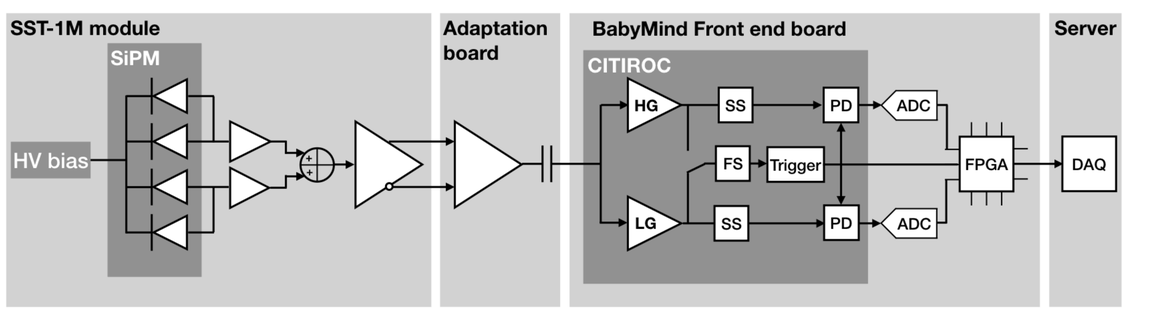


Fig. 1: Acquisition chain based on the SST-1M front-end electronics and the Baby-Mind readout. For any triggered event, the timing, charge from high gain and low gain channels can be extracted, processed and sent out by an FPGA.

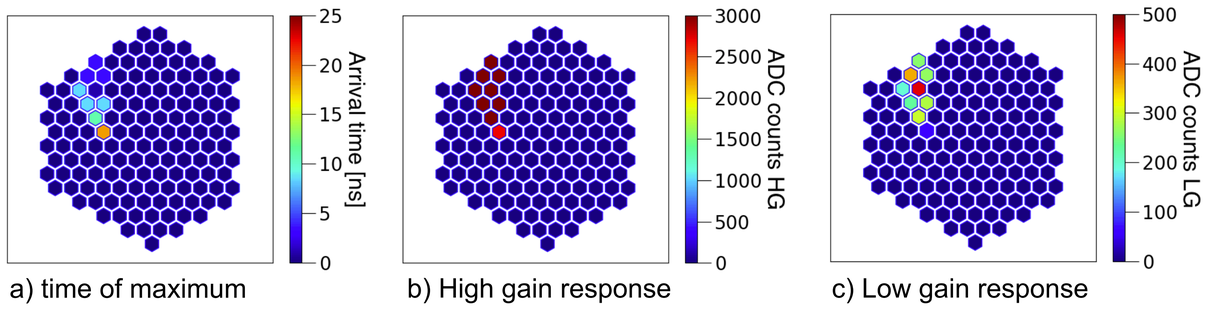


Fig. 2: Shower event candidate observed with the Mini-Telescope during an observation nigh in St-Luc. The time development of the shower combined to the charge information allow to discriminate between cosmic ray candidates and background induced trigger

Observation in St LUC observatory

Results of one Moon-less observation night

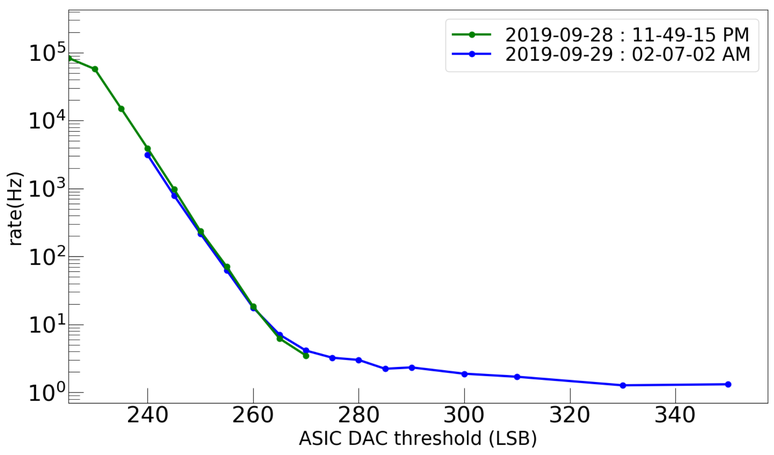


Fig. 3: Result trigger rate scan using the low-gain for the trigger path. The steep slope corresponds to the NSB induced trigger while the plateau is mostly populated by cosmic ray showers and muon tracks

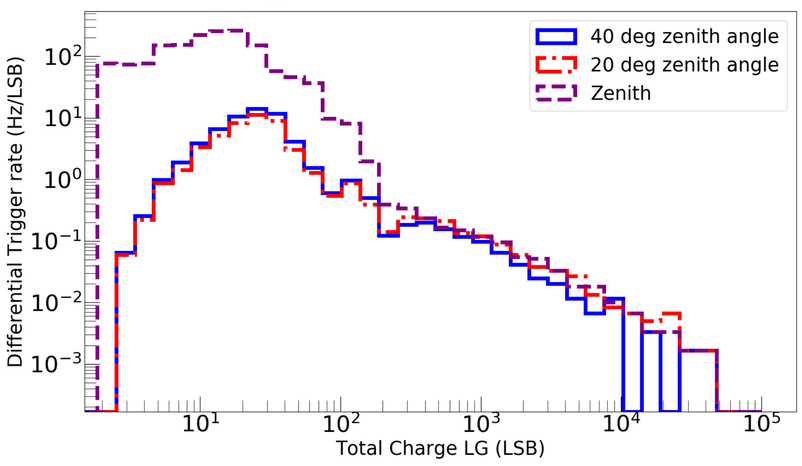


Fig. 4: Differential trigger rate as function of the total charge for different zenith angle. The energy scale is derived from the integrated cosmic ray rate above ~200 LSB which gives an energy threshold of 6 TeV.

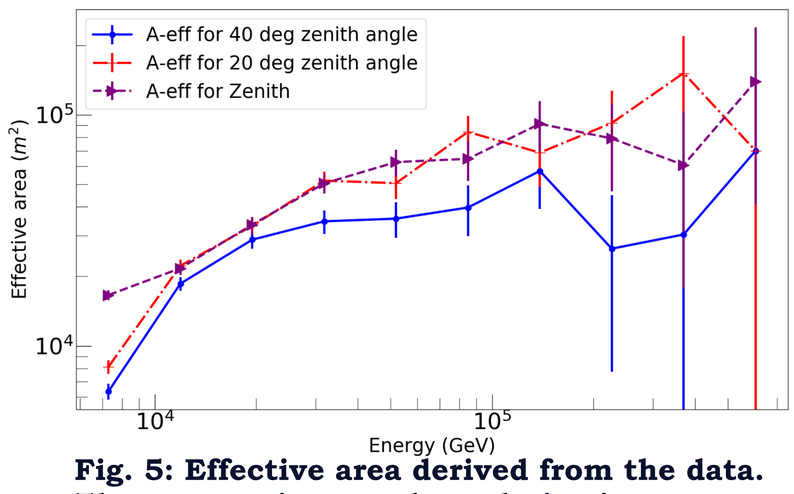


Fig. 5: Effective area derived from the data. The assumptions made to derive it are described in [1]

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