

Development of scintillator detector for detection of cosmic ray shower



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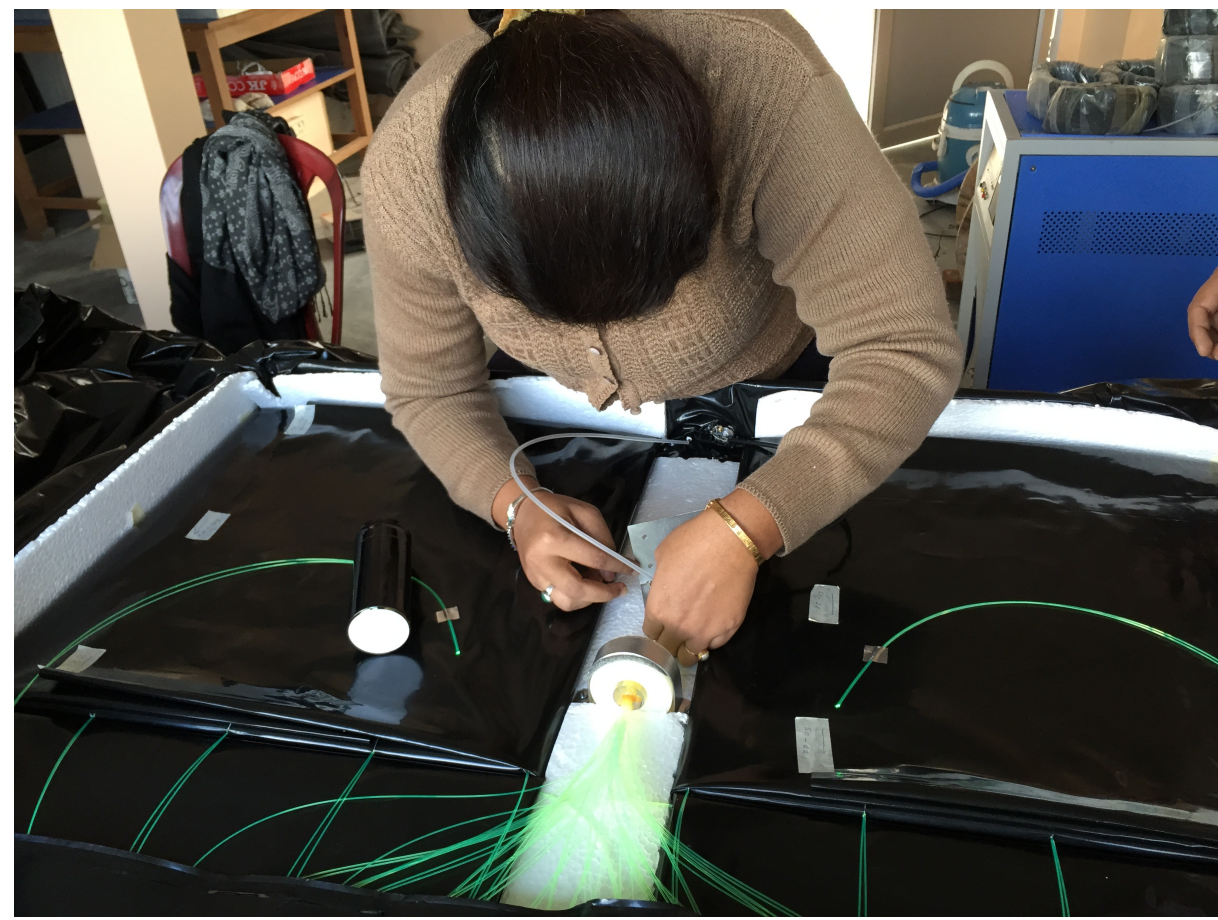
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Introduction

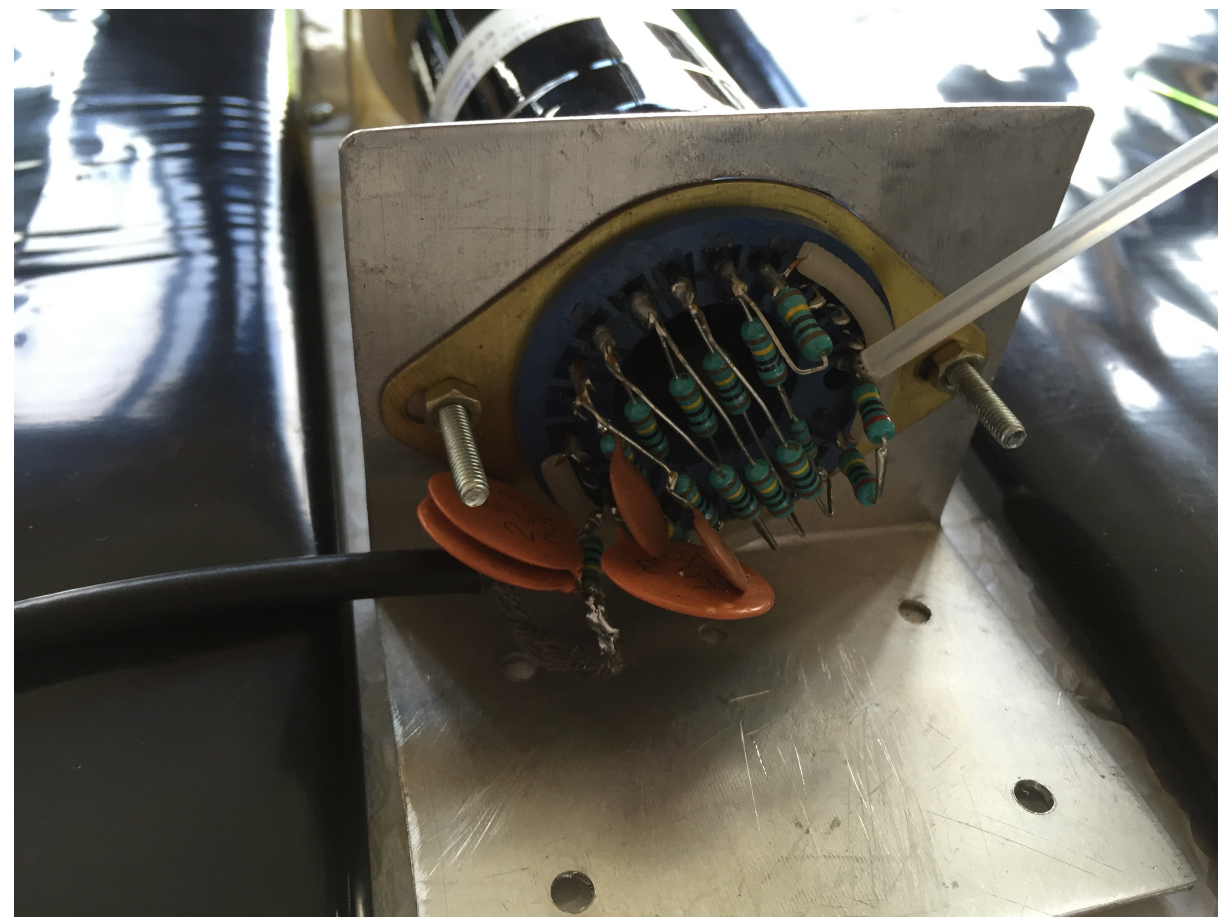
We are building an array of active detectors to detect cosmic ray air showers at an altitude of about 2200 meter above sea level in the Himalayas. Each of the elements of this array is a 1m x 1m plastic scintillator coupled with WLS fibre and photomultiplier tube.

Each 1m x 1m scintillator is made of four 0.5 m x 0.5 m blocks. All four scintillator blocks are connected to a single photomultiplier tube (PMT) by using wavelength shifting (WLS) optical fibres. The PMT is mechanically fixed and connected to the base circuit. The negative high voltage (HV) to the PMTs is applied using MHV cable and the signal is collected by BNC cable. Initially all the PMTs are calibrated and their individual efficiencies are measured using other scintillator blocks of same kind.

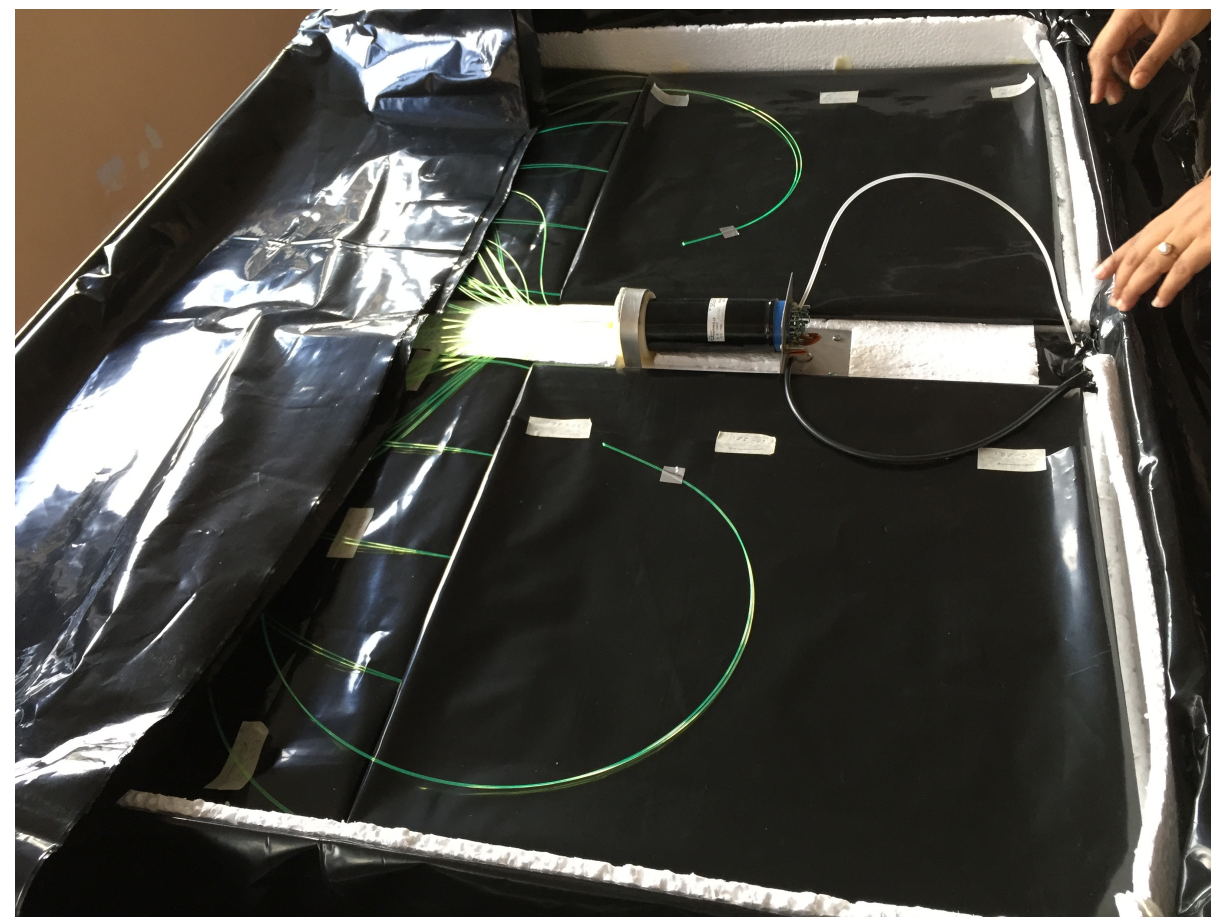
Some steps of detector fabrication



WLS fibre insertion



Voltage divider network



HV cable connected in proper position



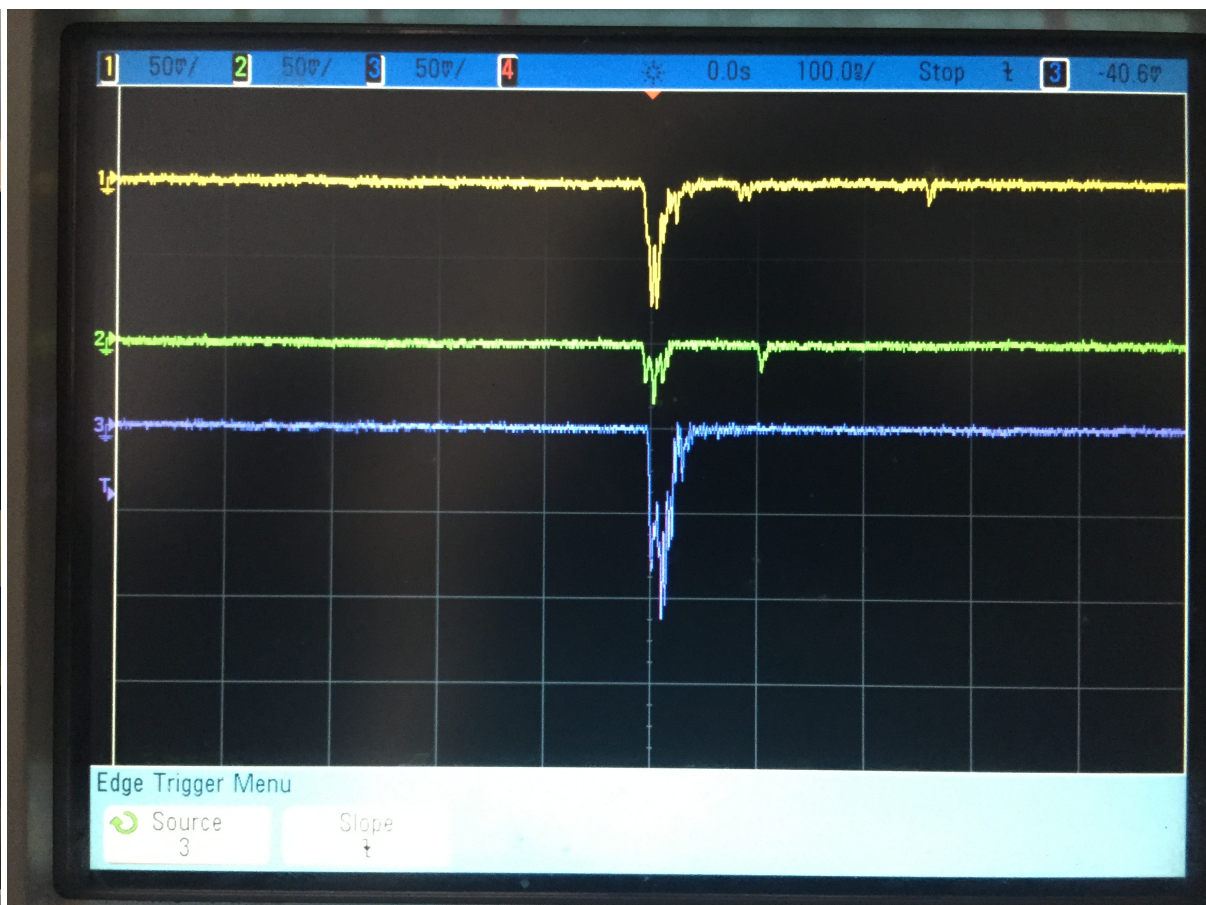
Closing the box

Experimental technique

Dimension of each scintillator block: 0.5 m x 0.5 m
One detector consists of 4 such blocks



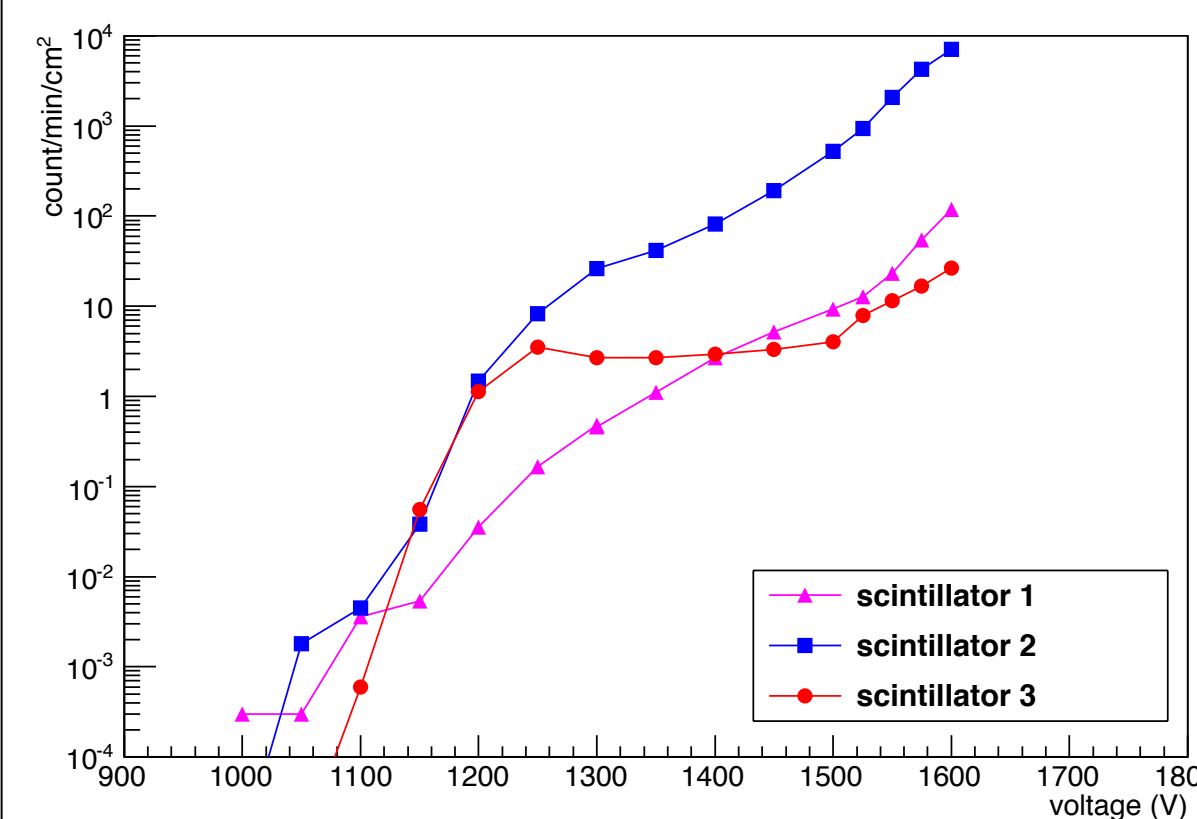
Experimental set-up



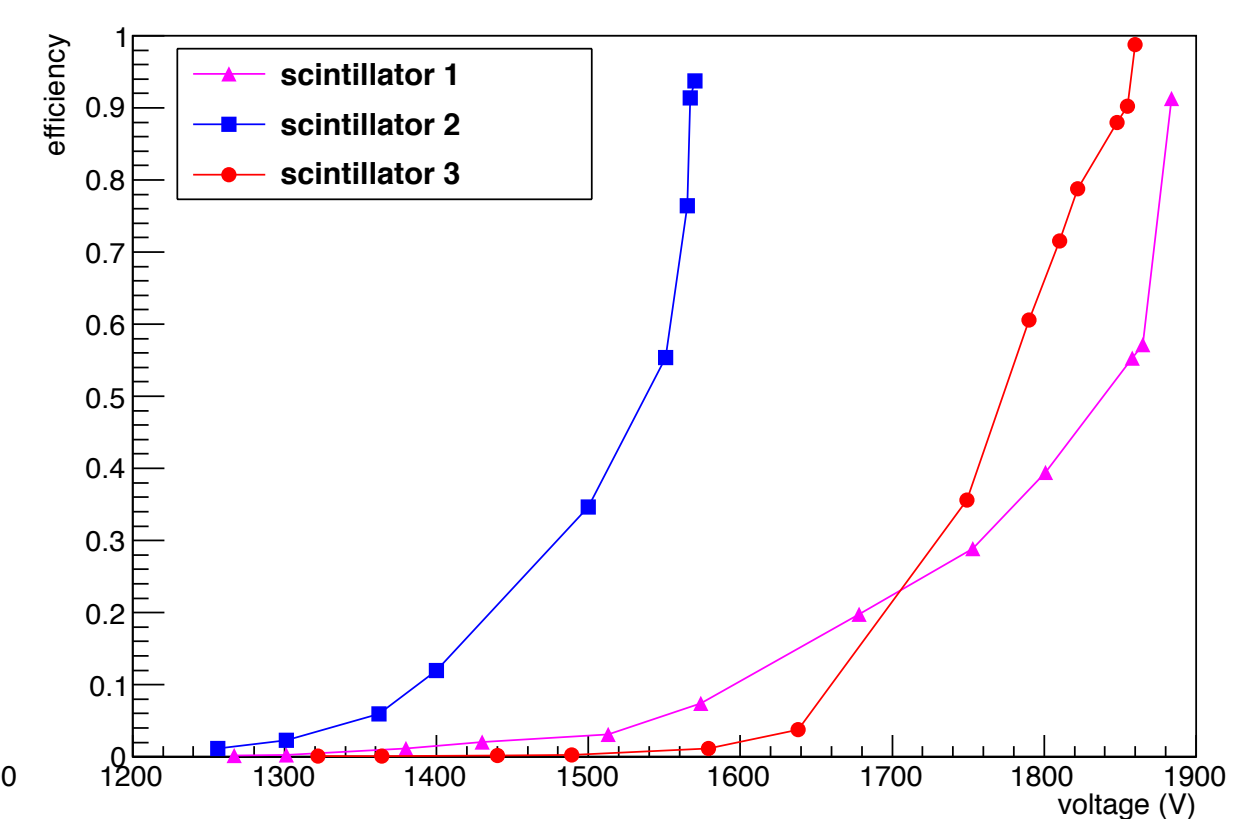
Coincidence signals

- In the present program, seven 1m x 1m plastic scintillator detectors are planned to be built for detection of cosmic ray air showers at an altitude of about 2200 meters at Centre for Astroparticle Physics & Space Sciences, Darjeeling campus of Bose Institute.
- Three such scintillator detectors are completed and tested.
- The detectors are named as scintillator 1, scintillator 2 and scintillator 3.
- Each detector is tested varying the applied negative HV and measuring the singles count rate per unit area.
- The scintillators are kept in a vertical stack to detect the coincidence signal of cosmic ray muons.
- From the detector stack the efficiency of each scintillator detector is measured using the trigger taken from the two fold coincidence of other two scintillators.
- The efficiency is defined as the three-fold coincidence/two fold coincidence trigger.
- To detect the cosmic ray shower (as a proof of principle) three scintillator detectors are placed horizontally. The centres of the scintillator detector made a triangle of sides 1.9m, 3 m and 3.5 m respectively. -1525 V is applied to all three and threshold to the leading edge discriminator module is set -40 mV for all three.
- The three-fold coincidence from this horizontal stack of three detectors, which determines a cosmic ray shower, is measured for about 1 month period.

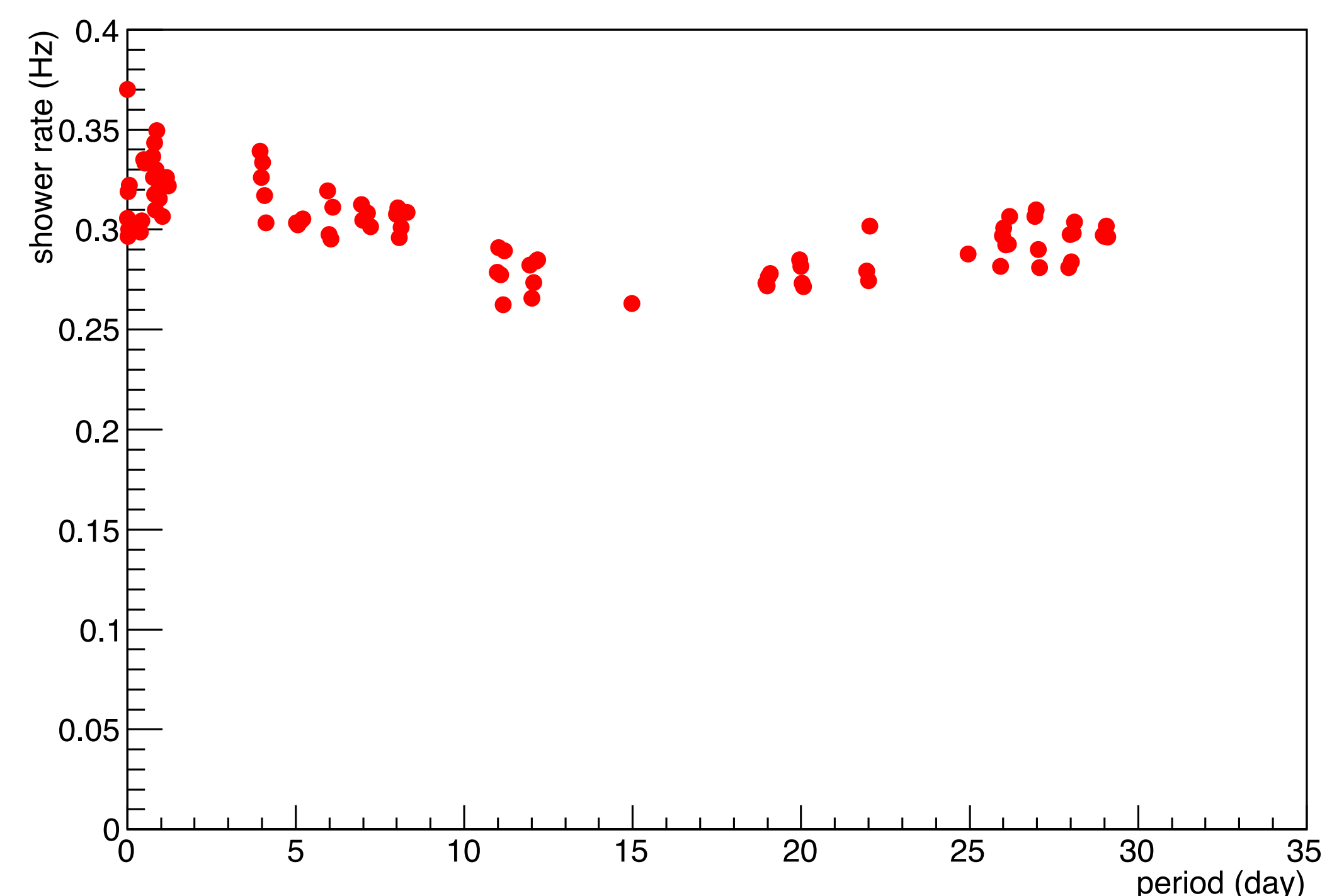
Results



Count rate per unit area as a function of applied voltage



Efficiency as a function of applied voltage



Shower rate vs. time during mid November - mid December, 2016

Summary and outlooks

The three-fold coincidence from a stack of three detectors placed on a horizontal plane is measured for about 1 month period. This mimics a cosmic ray air shower. It is found that the shower rate varies with time between ~ 0.25-0.35 Hz. Further measurement of the cosmic ray shower more precisely with all 7 detectors are in progress.

Acknowledgements

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