

PeV Explorer 計画 R & D (5)

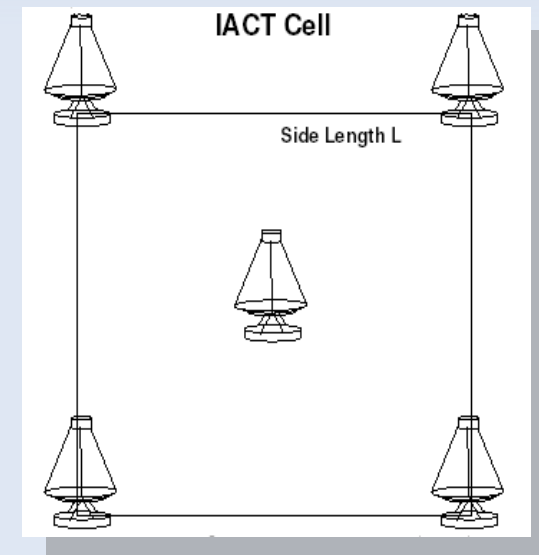
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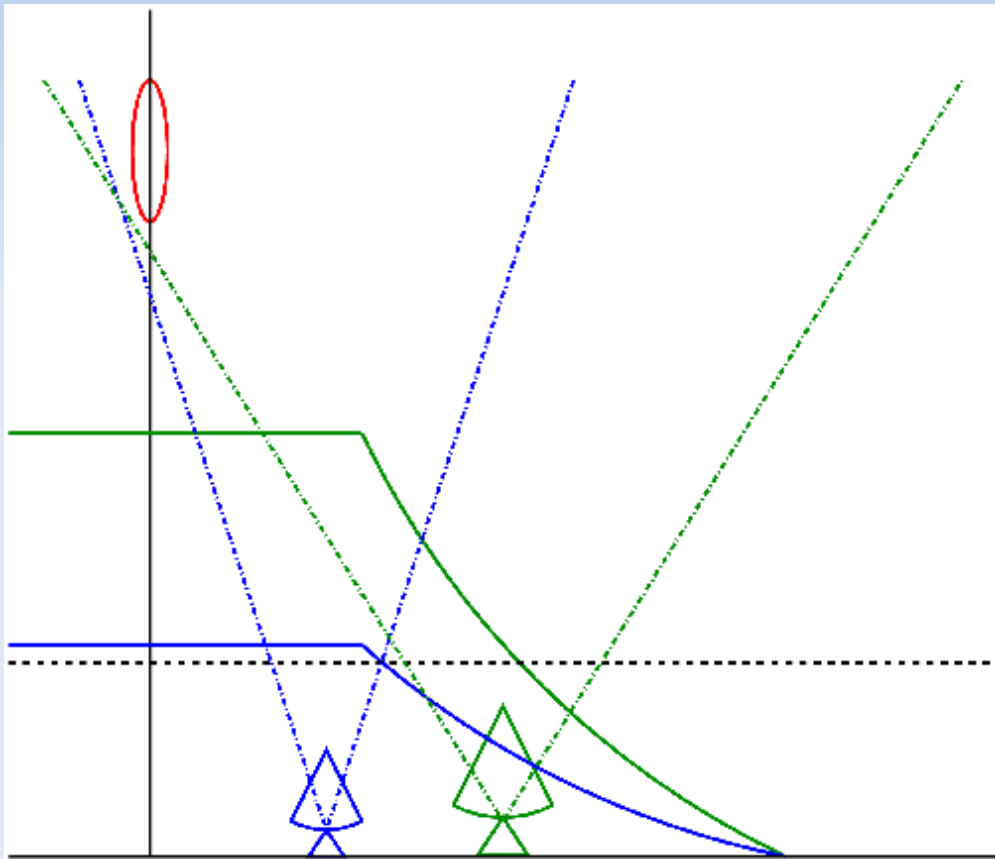
2012年3月24日@日本物理学会第67回年次大会(関学大)

PeV Explorer (PeX)

- TenTen Project
 - Effective area of **10 km²** at energies **> 10 TeV**
 - Stereoscopic array of 30–50 telescopes
- PeX: one cell of TenTen
 - Cost-effective design:
 - Inter-telescope spacing > 300 m
 - Mirror diameter 3–5 m
 - Field of view $\sim 8^\circ$
 - Long exposure (several 100 hr) \rightarrow key science
 - Origin of Galactic cosmic rays up to the “knee”, etc.



PeX Concept



Plyasheshnikov et al. (2000)

- Cherenkov plateau
 - Radius ~ 150 m
- Cherenkov tail observable with larger aperture (or at high E)
 - Expand effective area
- Wider FoV necessary
- Effective area is a function of:
 - Aperture, span, FoV

Expansion Plan

- “Mobile Telescope Array”
 - Reduce the risk in array optimization
 - Telescopes independent of power line needed

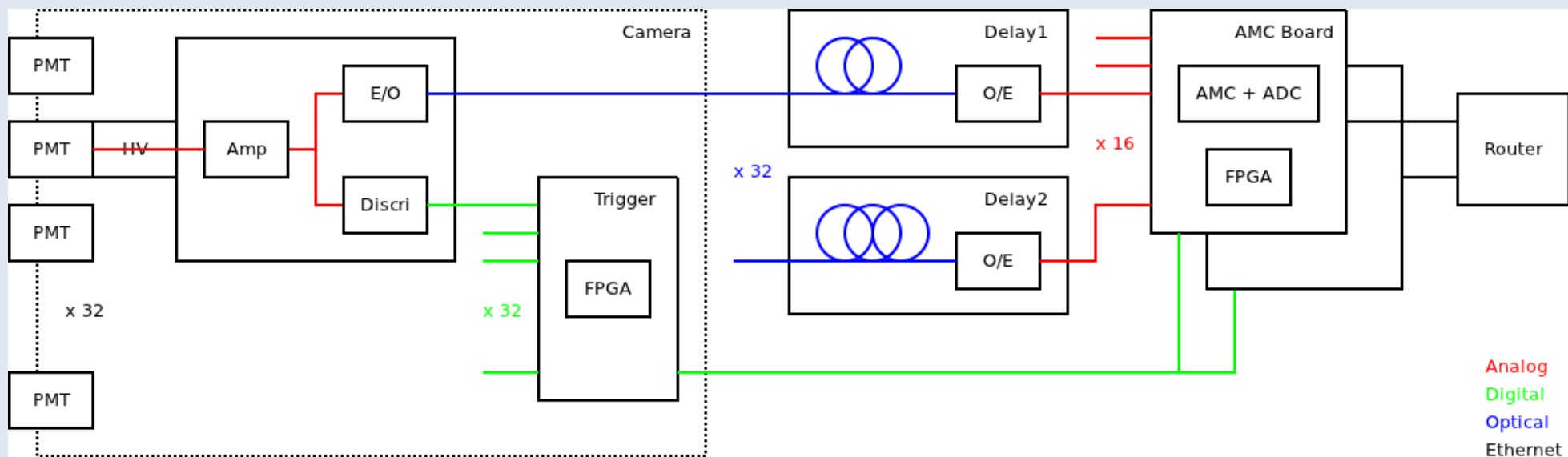


R & D

- Low power consumption system & high capacity battery
 - Make telescopes independent of the power line
 - Analog Memory Cell (AMC) ASIC
 - Compact analog delays
- Simulation study
 - Cherenkov image time gradient, etc.
- Test observations at Akeno
 - Reuse a secondhand Cherenkov telescope

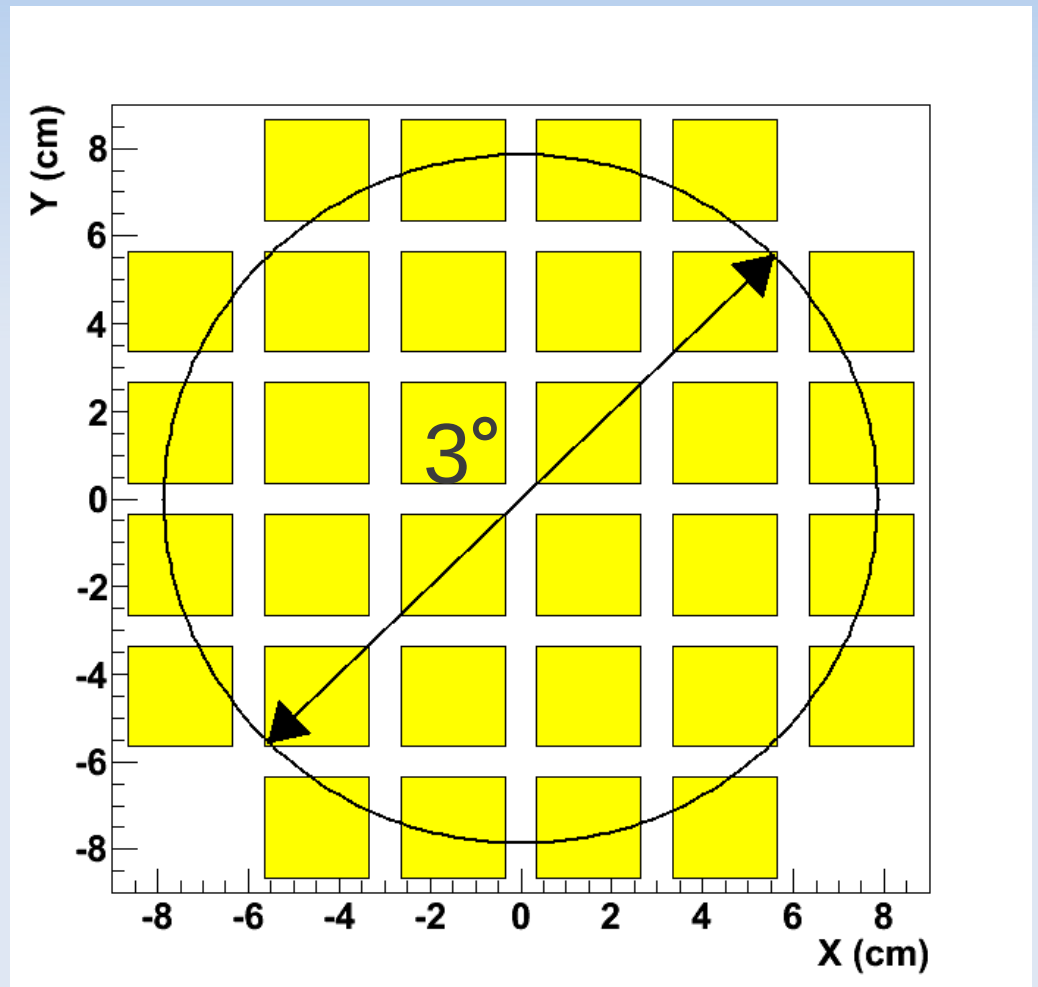
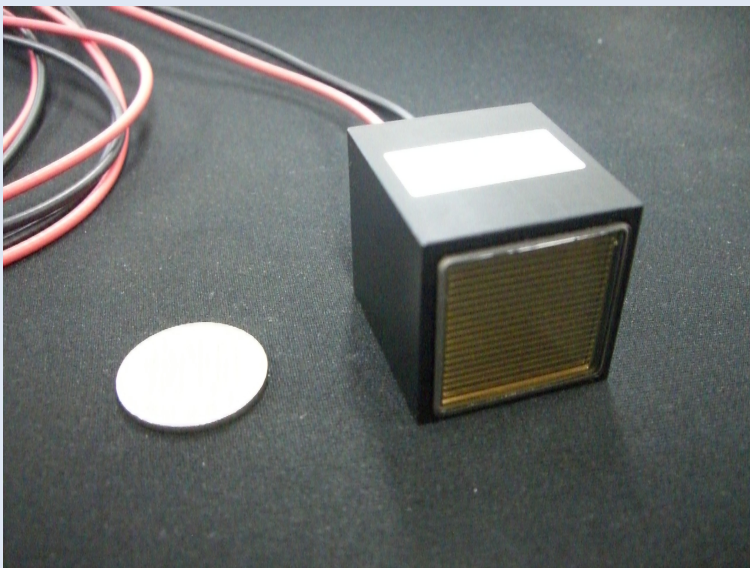
System Plan

- AMC ASIC with Wilkinson ADCs incorporated (OpenIt)
 - 1 GS/s, analog bandwidth > 200 MHz
 - Minimize sampling depth / pixel (64 ns)
 - Utilize differential optical delays
- FPGA trigger board just behind the camera
 - Simple trigger logic (adjacent 2)



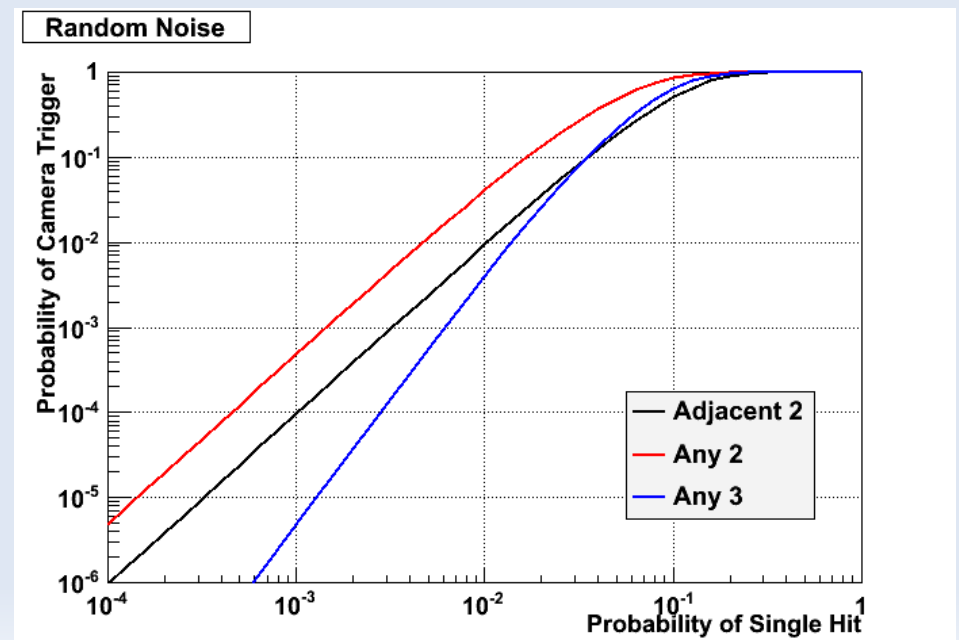
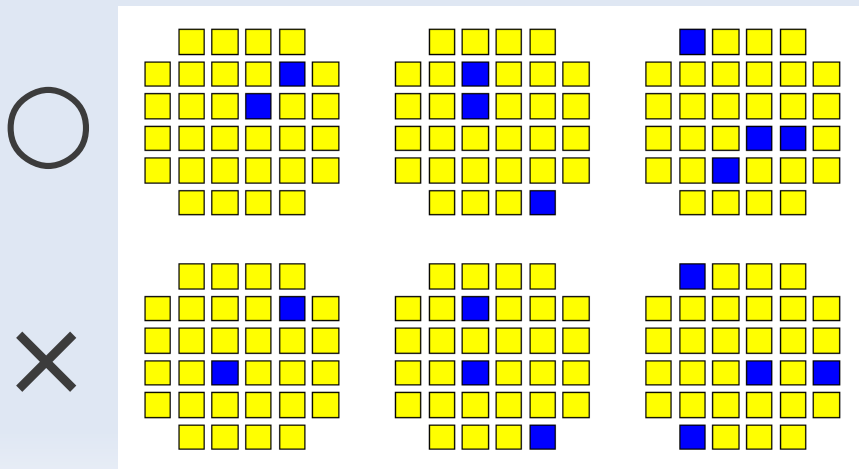
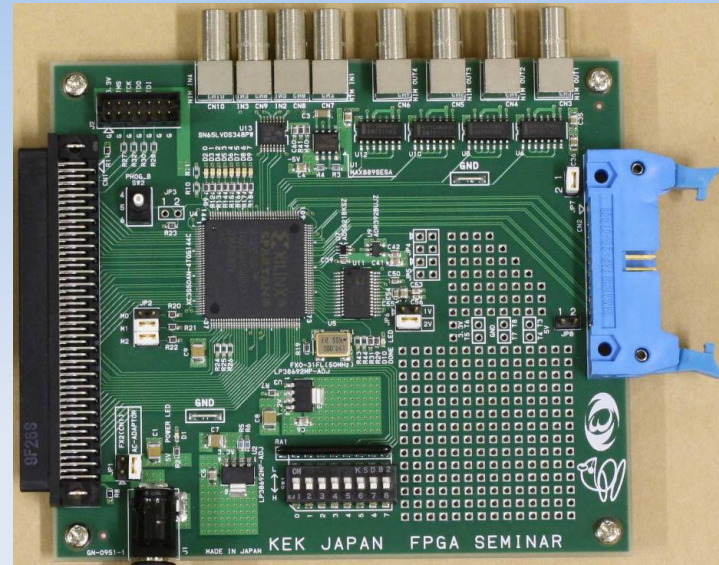
PMT Camera

- 32 pixels
 - FoV $\sim 3^\circ$
- Hamamatsu R11265-100
 - 1 inch square
 - SBA photocathode
- Mass production completed



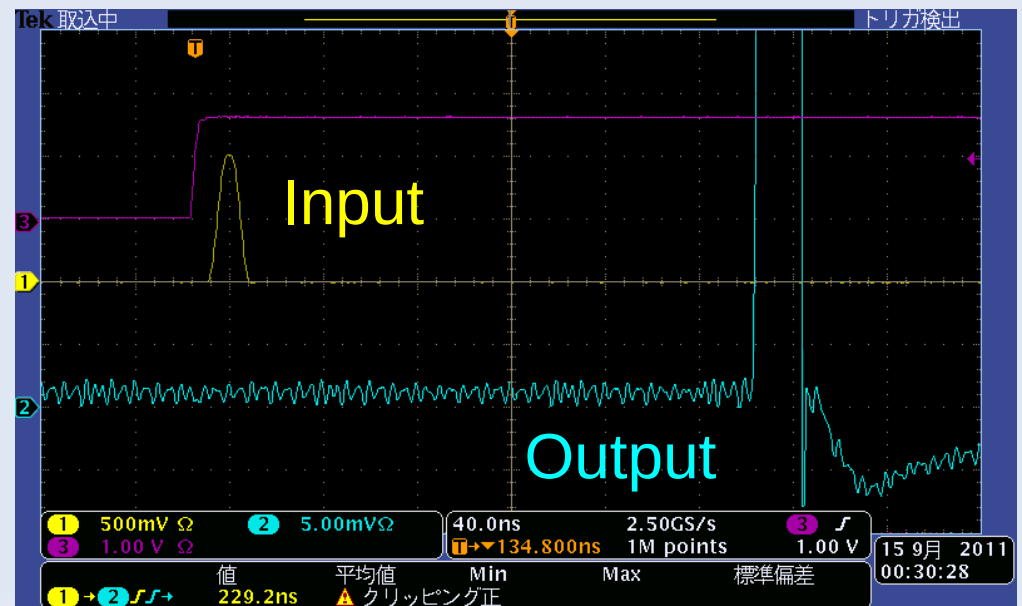
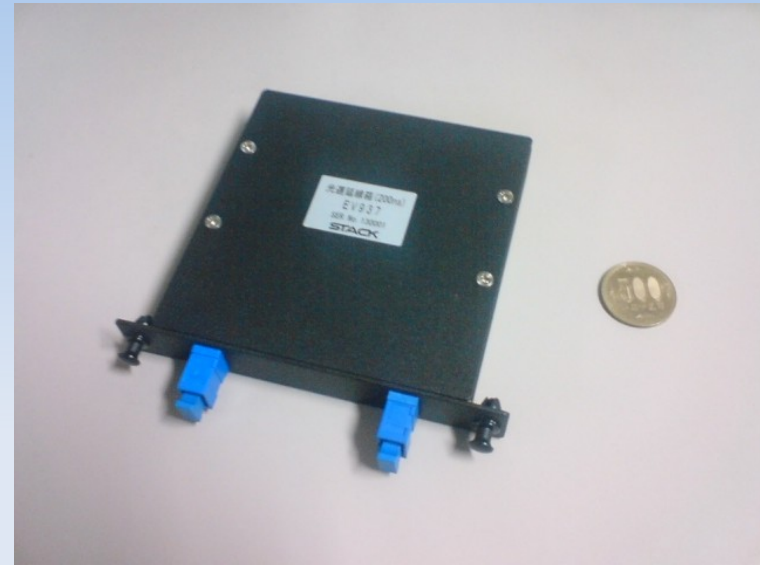
Trigger Board

- FPGA for a pattern trigger
 - Developed by KEK (OpenIt)
 - Based on a XILINX FPGA
 - XC3S50AN-4TQG144C
 - 40 inputs
- Adjacent 2 (or 2NN) logic
 - ~ 5 times better accidental (NSB) rate than the any 2 logic



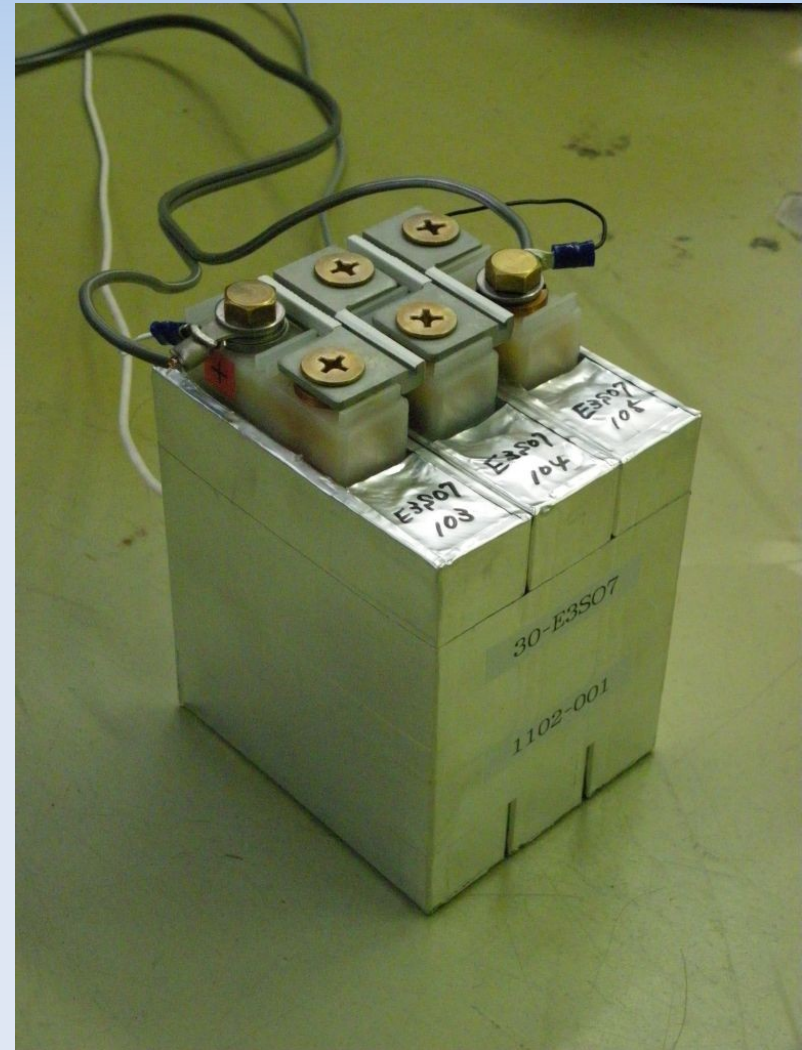
Compact Analog Delay

- Optical fiber
 - 200 ns delay prototype
 - Size reduced by removing the cable jacket
- No cross talk
 - Tested with 1 V input pulses



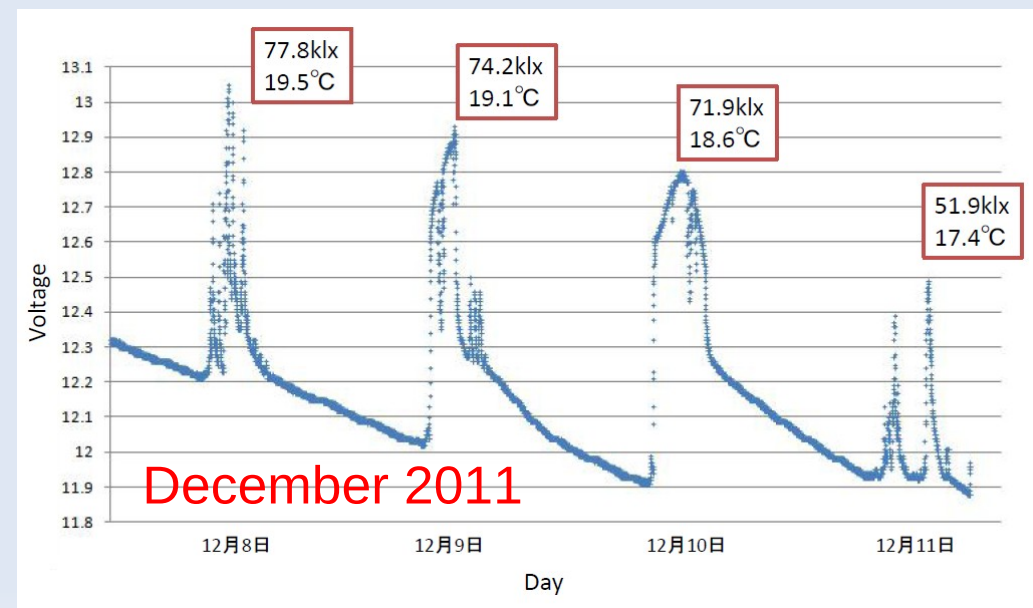
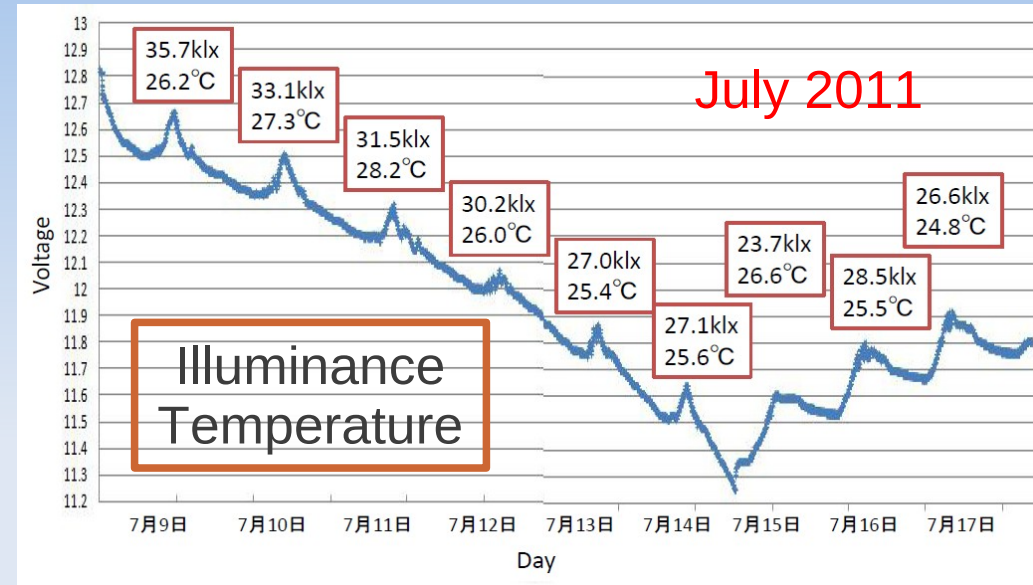
High Capacity Battery

- Lithium-ion battery
 - Litcel 30-E3SH7
 - Developed for automobile use
 - 30 Ah / cell
 - $\sim 3.5 \text{ V} \rightarrow \sim 100 \text{ Wh}$
- Test measurements ongoing at Ritsumeikan
 - Temperature characteristics, etc.



Examples of Test Measurements

- System of a solar panel & a battery
 - **Lead battery** used for comparison
 - Load: 90 W bulb
- Long time monitoring
 - Temperature dependence, etc. seen in the output voltages



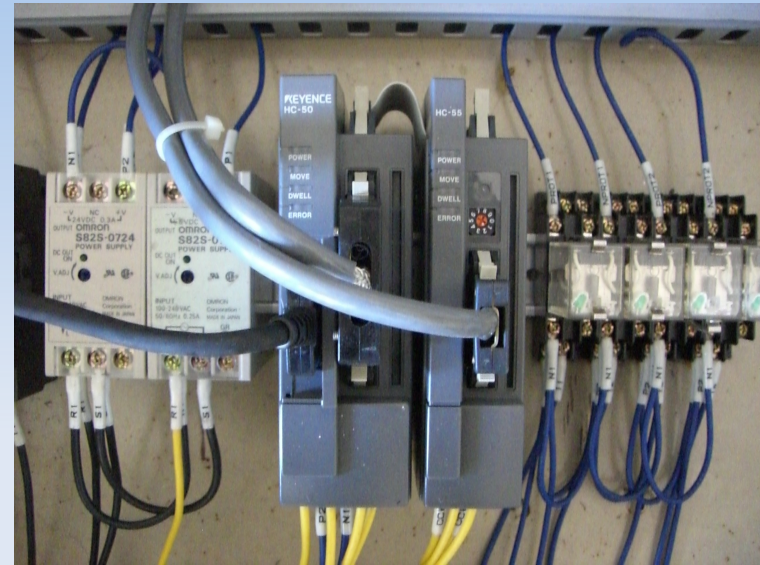
Akeno Atmospheric Cherenkov Telescope

- Test bench of Cherenkov telescope systems
 - Only Cherenkov telescope in Japan
- Davies-Cotton optics
 - 3 m aperture, $f/d = 1$
- Altazimuth mount
- Re-installation done at the Akeno Observatory
 - Mirror recoating ongoing (Ohishi-san's talk)



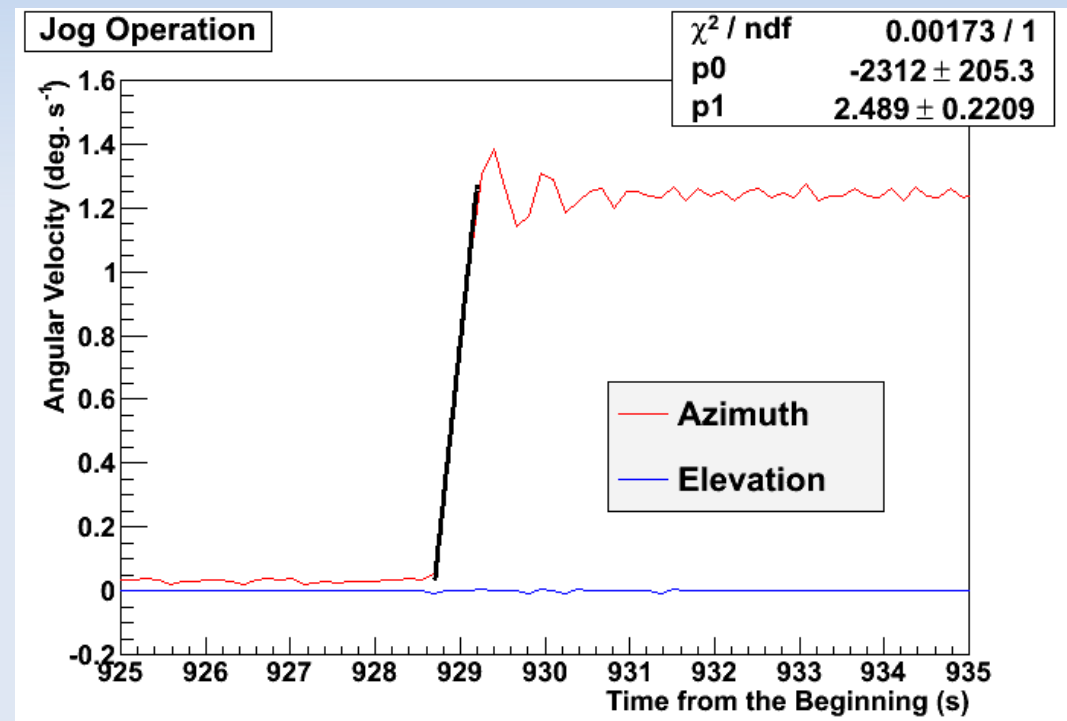
Telescope Control

- Ready to operate manually
 - Using a teaching panel
- AC servomotor: Sanyo Denki P60B13150HXS
 - Positioner: **Keyence HC-50/55**
- Encoder: Heidenhain ROD456
 - Counter: **Heidenhain ND920**
- Tracking system will be developed with a PC
 - Reuse the program for CANGAROO-III



Test Operation (Manual)

- Encoder readout OK
 - Serial connection (RS-232C)
- Jog operation
 - High speed: $\sim 1.2^\circ/\text{s}$
 - Low speed: $\sim 0.03^\circ/\text{s}$
 - Max. acceleration: $\sim 2.5^\circ/\text{s}^2$
- Positioner control under investigation



Summary

- PeV Explorer (PeX) aims to explore:
 - Origin of Galactic cosmic rays up to the “knee”
 - Astrophysics at energies > 10 TeV
- R & D for PeX
 - Development of the system ongoing
 - First battery-powered IACT system (?)
- Akeno atmospheric Cherenkov telescope
 - Usable for various R & D
 - Test observations with the developed system