TAXI

a Transportable Array for eXtremely large area Instrumentation studies

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DESY - Zeuthen

HAP Workshop
Mainz, 1 – 2 February 2016

HELMHOLTZ ASSOCIATION
Alliance for Astroparticle Physics

KIT
Karlsruhe Institute of Technology

DESY

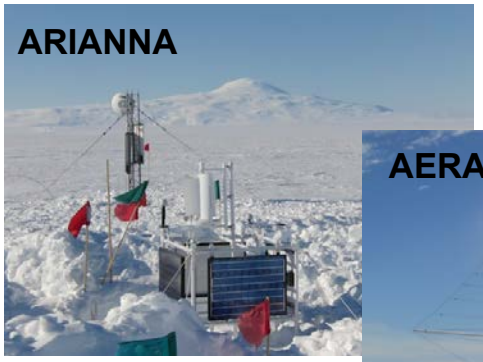
Concept

- Common “feature” of many astro-particle projects at the highest energies:
  (UHECR, neutrinos, (non-imaging) gamma astronomy)
  - Small signal fluxes:

    Large detection areas required
  - Very similar infrastructure:

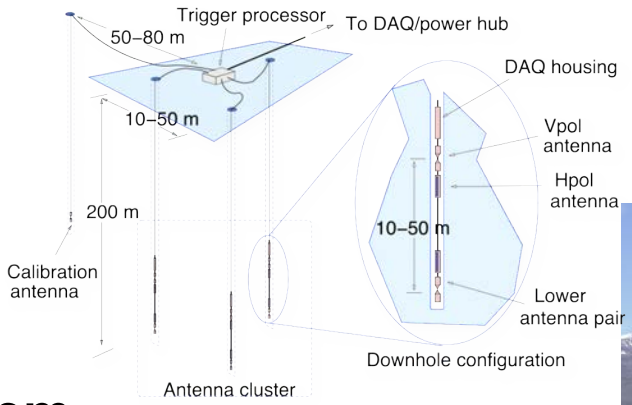
    capture of an analogue signal
    trigger for distributed stations
    communications
    power distribution
    clock distribution

ARIANNA

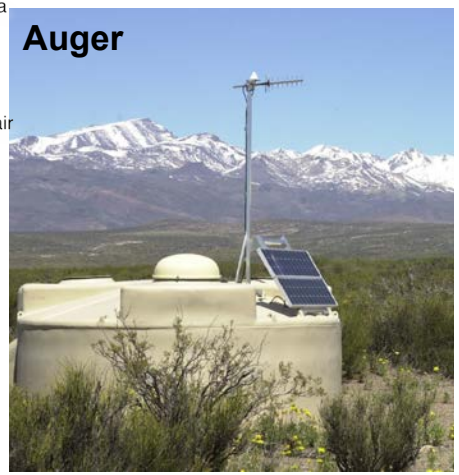


AERA

ARA



Auger



- **Development of a R&D system for testing different aspects of large area detectors**

Different Experiments – Similar Requirements

- Air shower surface detector with PMTs (scintillators or water-Cherenkov)
  - (unipolar) PMT pulse (order of 10 ns)
- Radio air shower detection
  - Waveform ≤ 100 MHz
- Microwave air shower detection
  - (unipolar) pulse (order of 10 ns) after power detector
- Radio neutrino detection
  - (unipolar) pulse (order of 10 ns) after power detector
- Non-imaging Cherenkov telescopes
  - (unipolar) PMT pulse (order of 10 ns)
- Acoustic neutrino detection
  - Waveform ≤ 1 MHz

- **Very similar requirements:**
  single R&D station for different projects possible

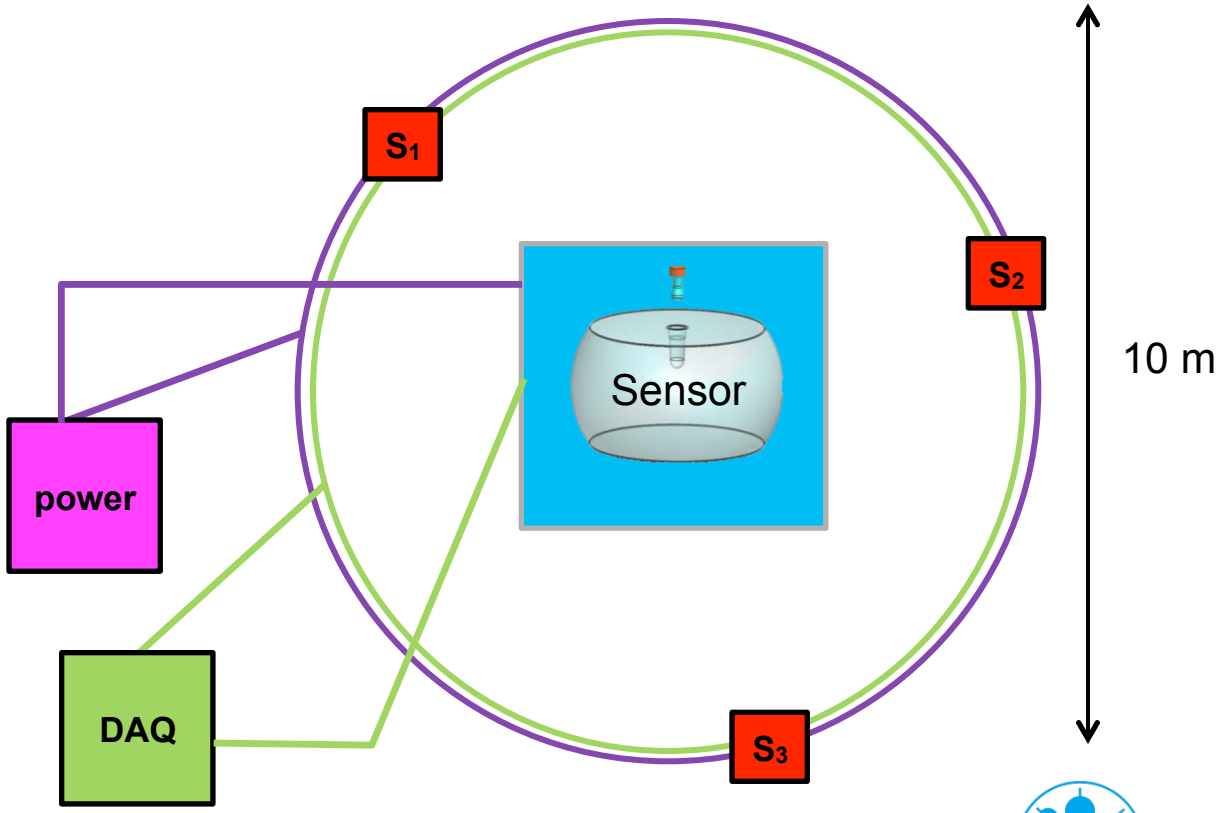
TAXI

Autonomous Station(wind, solar & comms)

(In Situ) Characterization of Detection Units

Surface Veto Array

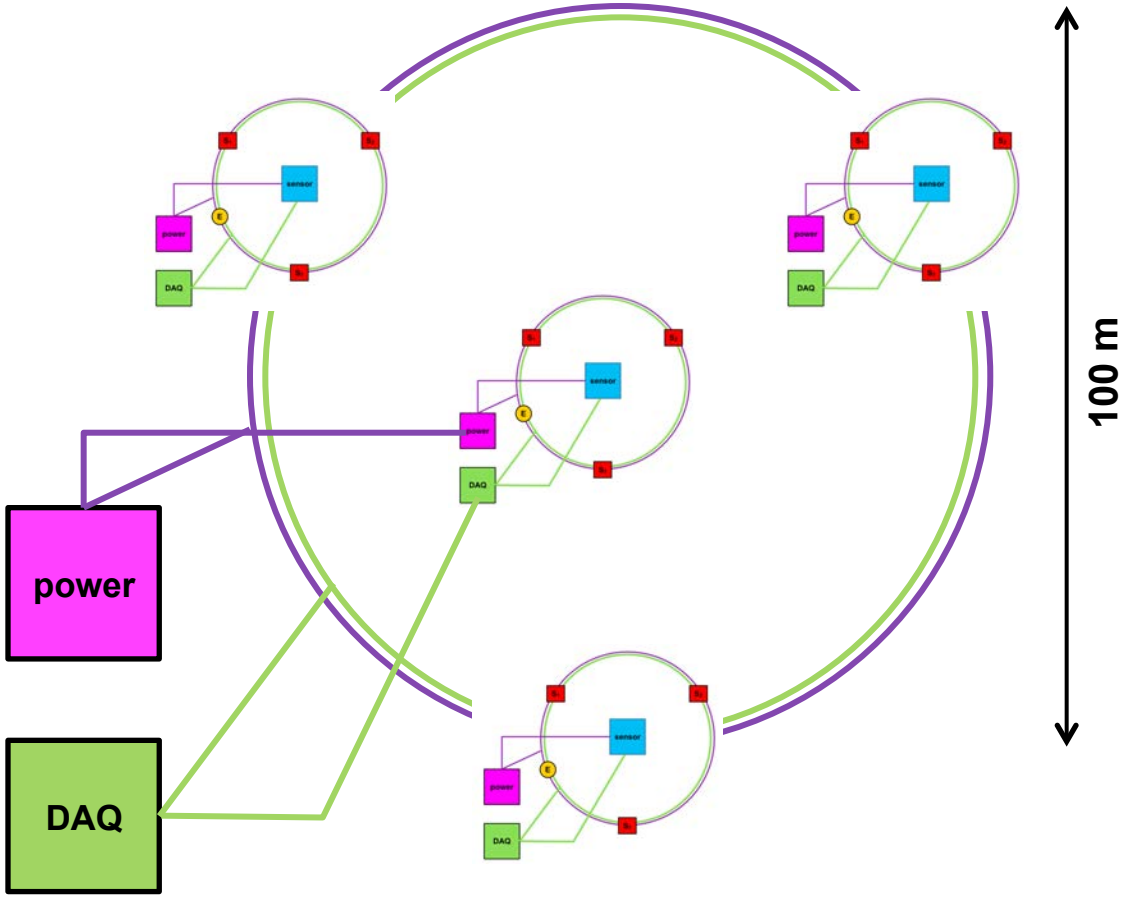
- Modular
- Transportable
- Scalable



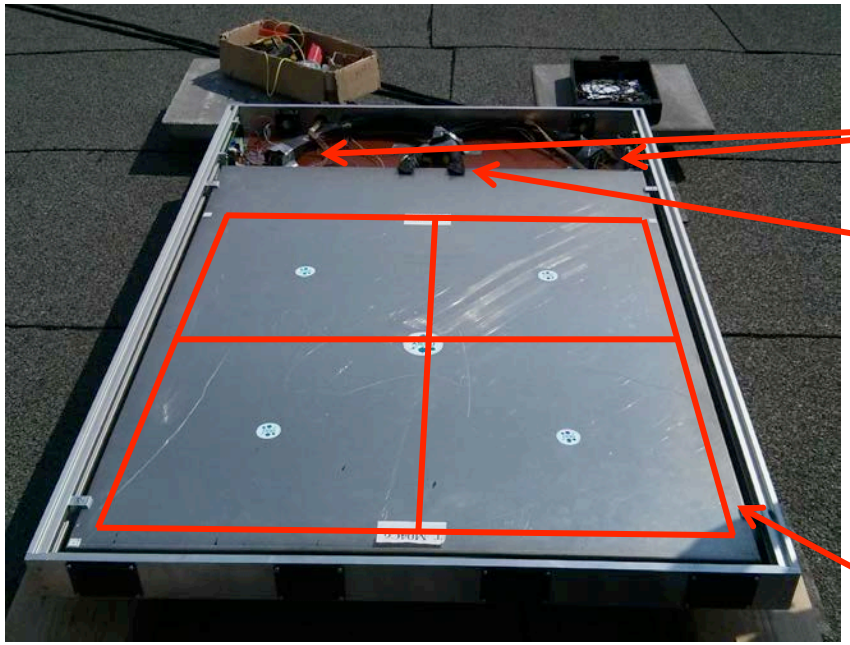
Reference detectors allow triggering and reconstruction of air showers!

TAXI Array

4 Stations



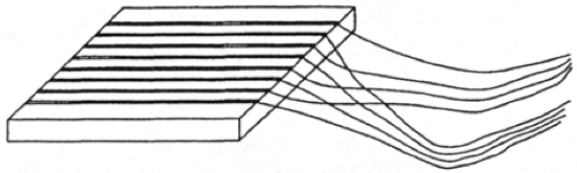
Scintillation Detector



Hamamatsu R 5900-3-M4
2 × 2 multi-anode PMT

optical fibers
each tile read out by 2 sets of fibers

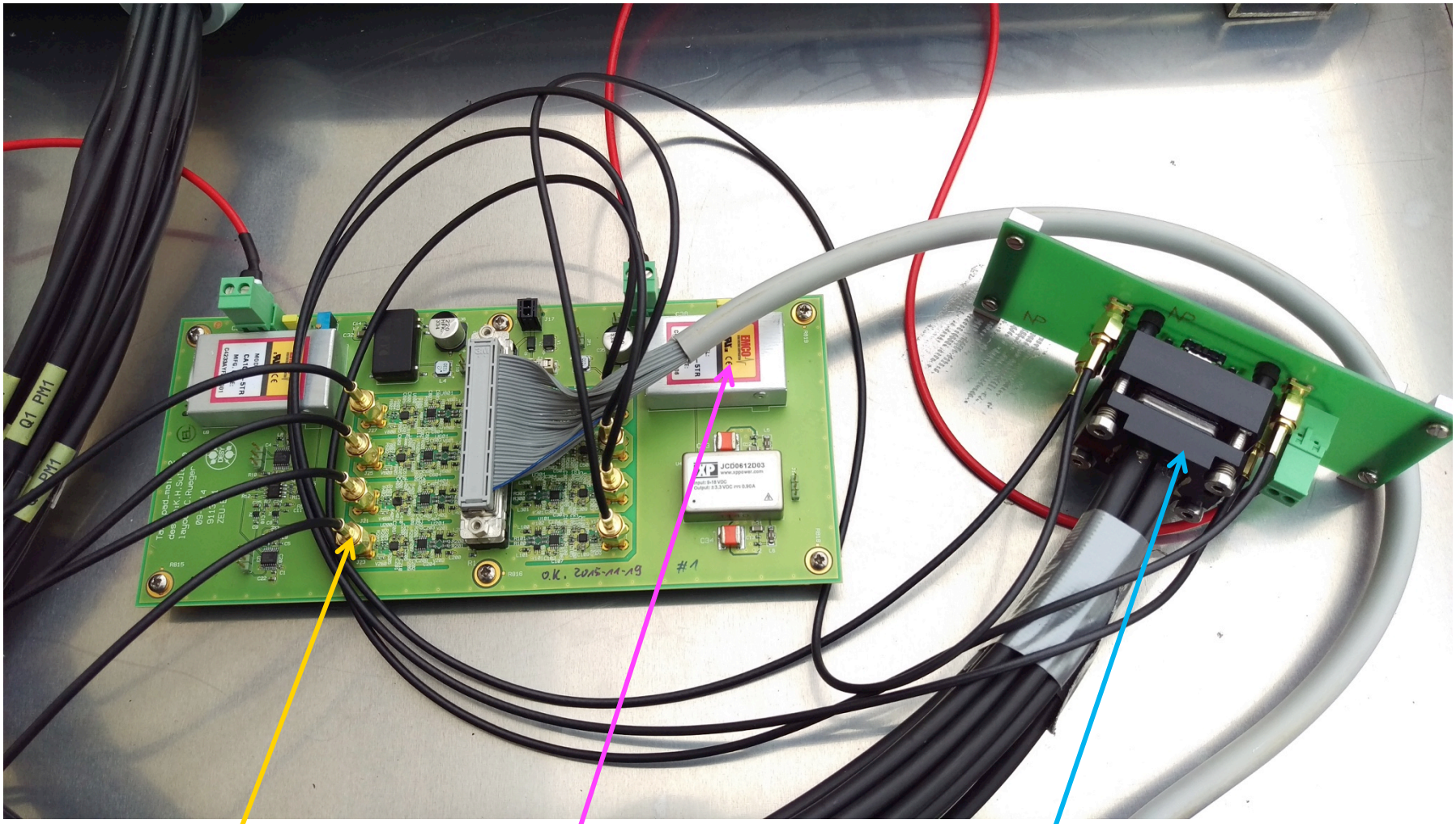
1 m^2 tiled plastic scintillator
16 tiles, 25 × 25 cm each



combined to 4 segments
of 50 × 50 cm for readout

- Input: ± 12 V
- Output: differential,
  analog PMT signal (8 channels)

PMT BASE (Control Via TAXI Main Board .. i2c)



SMA Connection

HV Power Supply

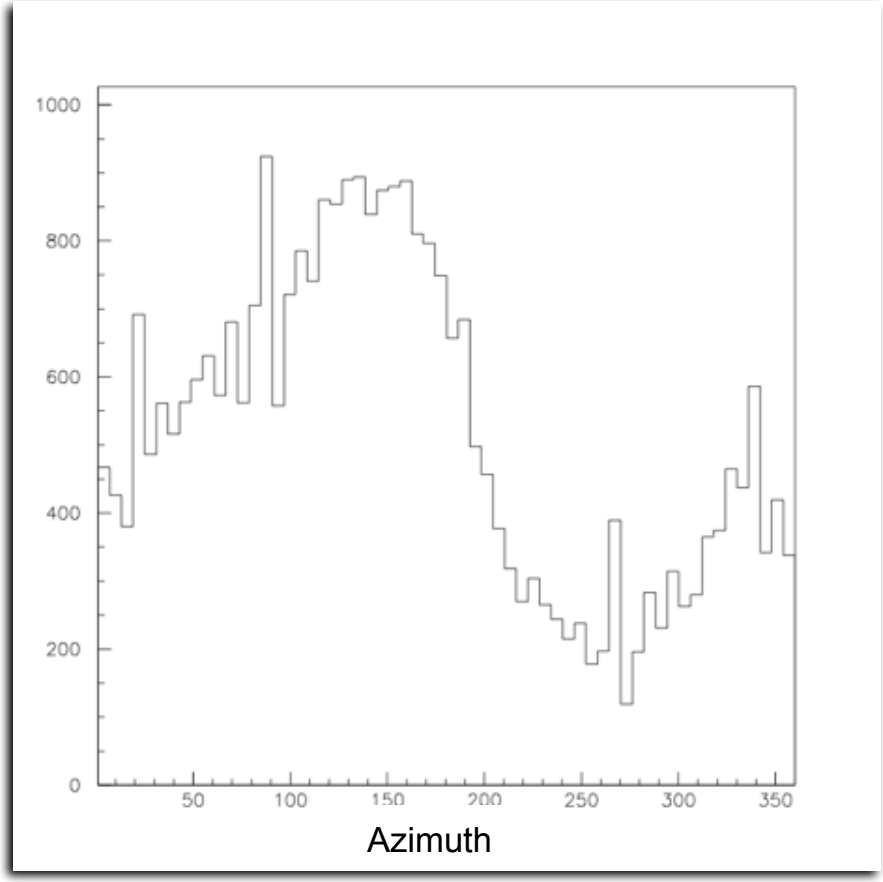
PMT

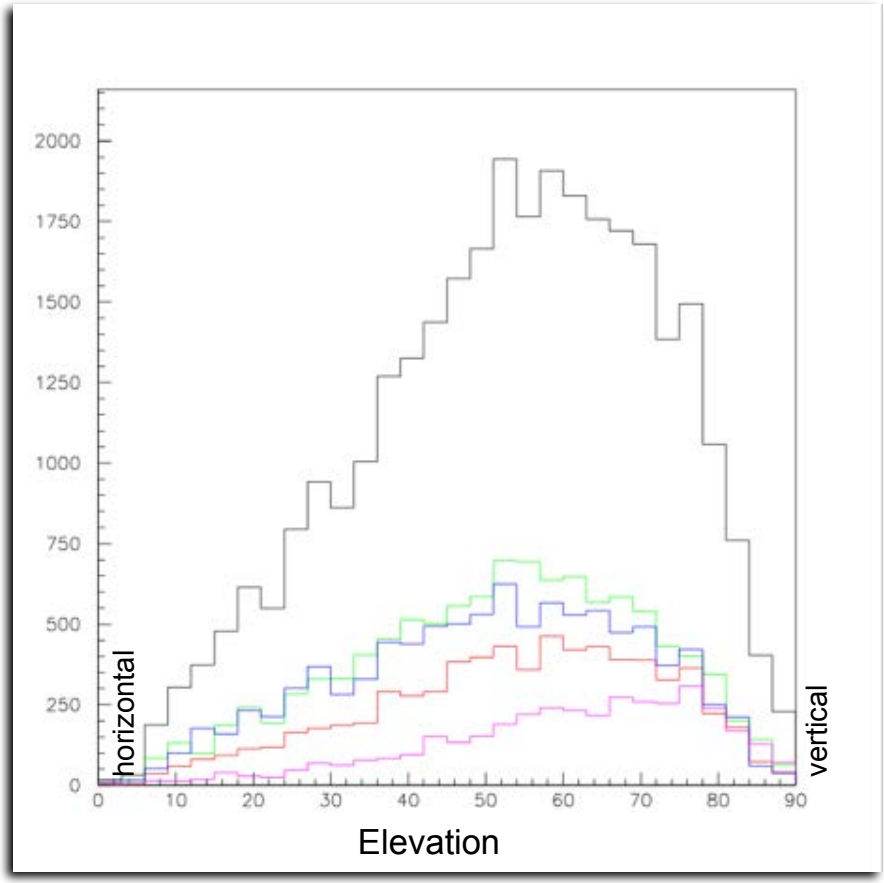
TAXI Station 1 Operational @ DESY since 2013

DESY
Zeuthen, Mechanical Workshop

Reconstructed Directions

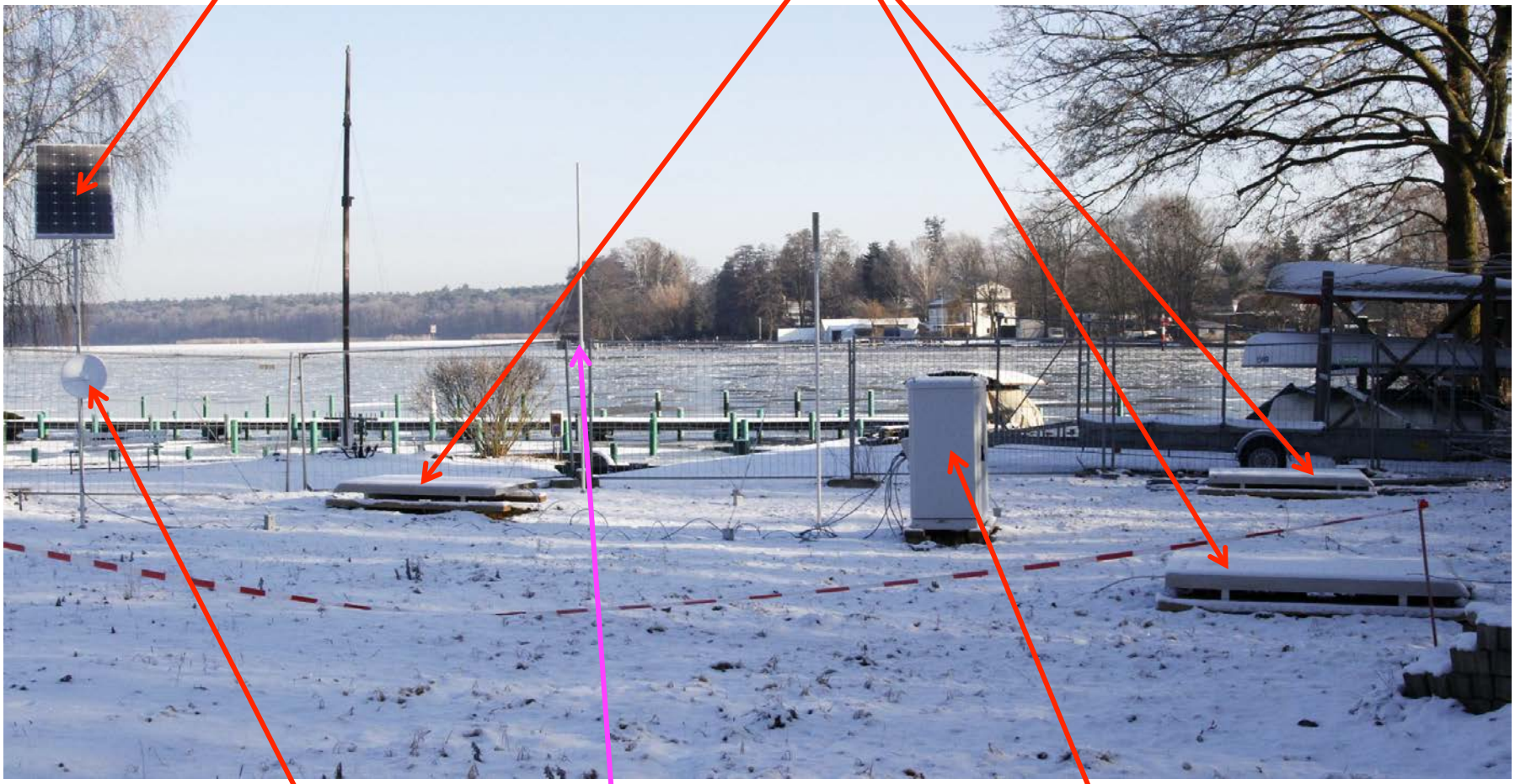
Direction of air shower reconstructed from arrival time differences





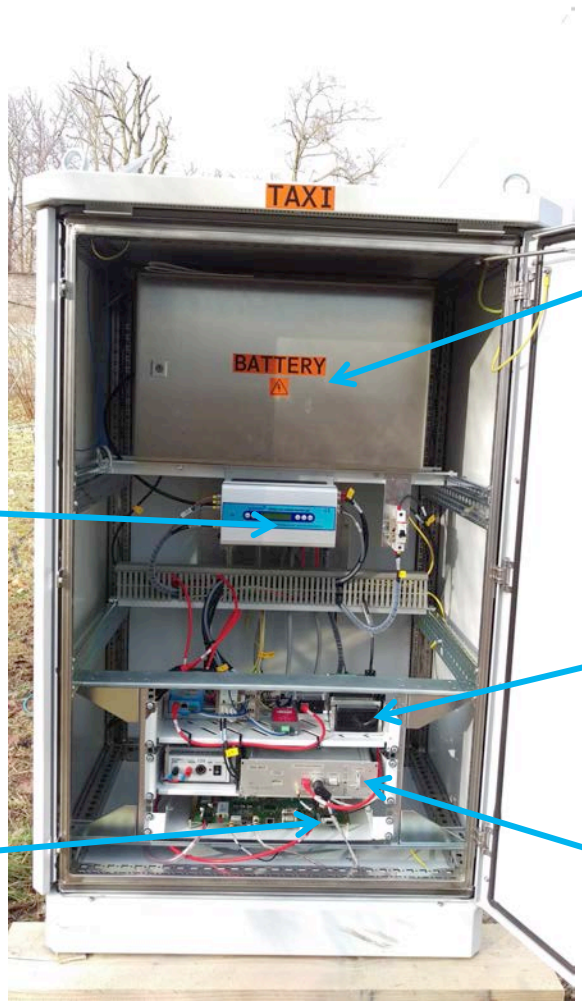
(35 days of data)

November 2015; Deployment of TAXI Station 2



DAQ Box

Can be made smaller!!



Battery

Hybrid Charge Controller

Ethernet, POE..

TAXI DAQ

AERA

Power Considerations

TAXI Station (Incl. PMT, GPS) ~ 25 W
AERA Board ~ 10 W

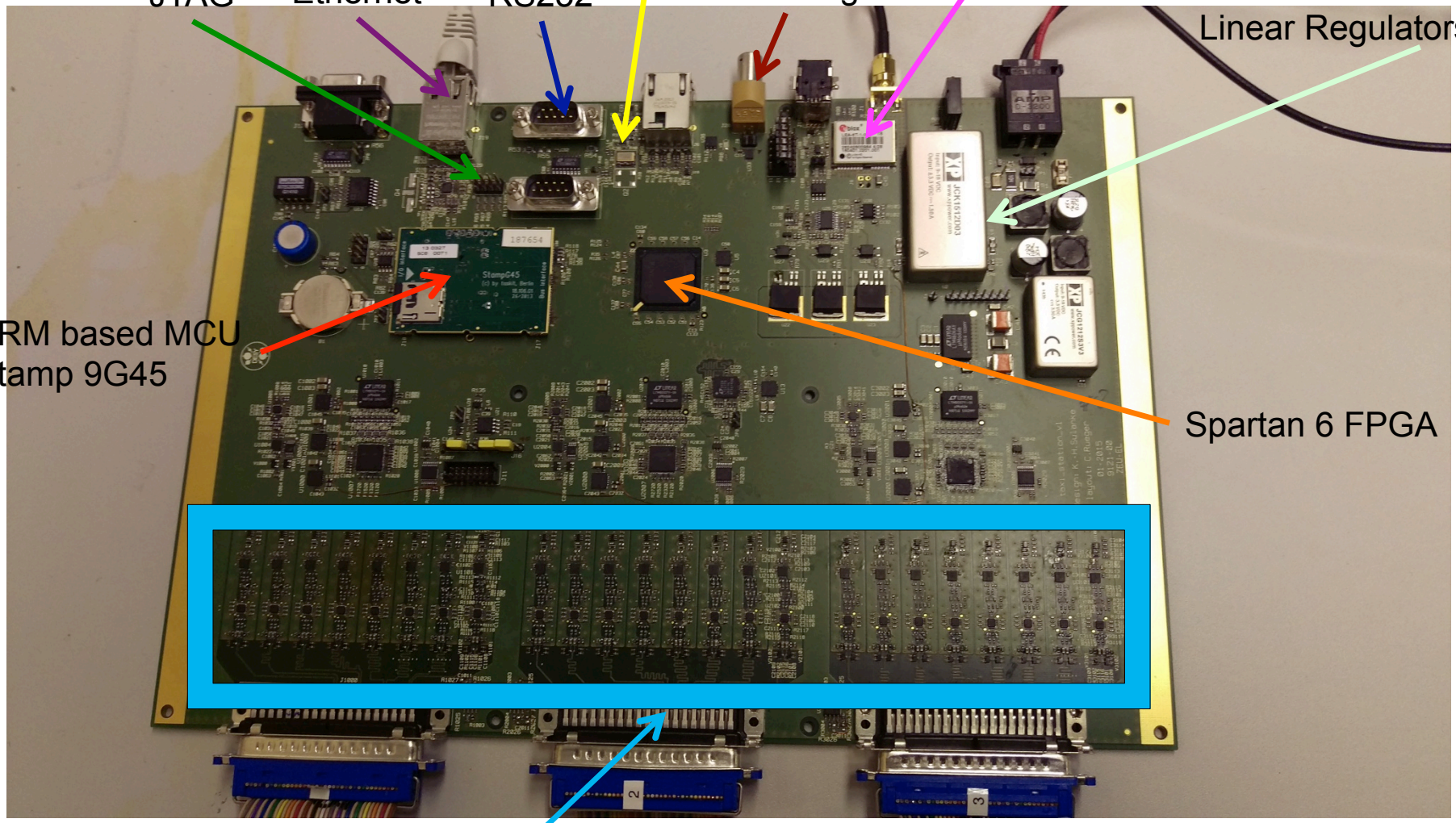
Need to optimize power consumption!!!

SilentWind

↓

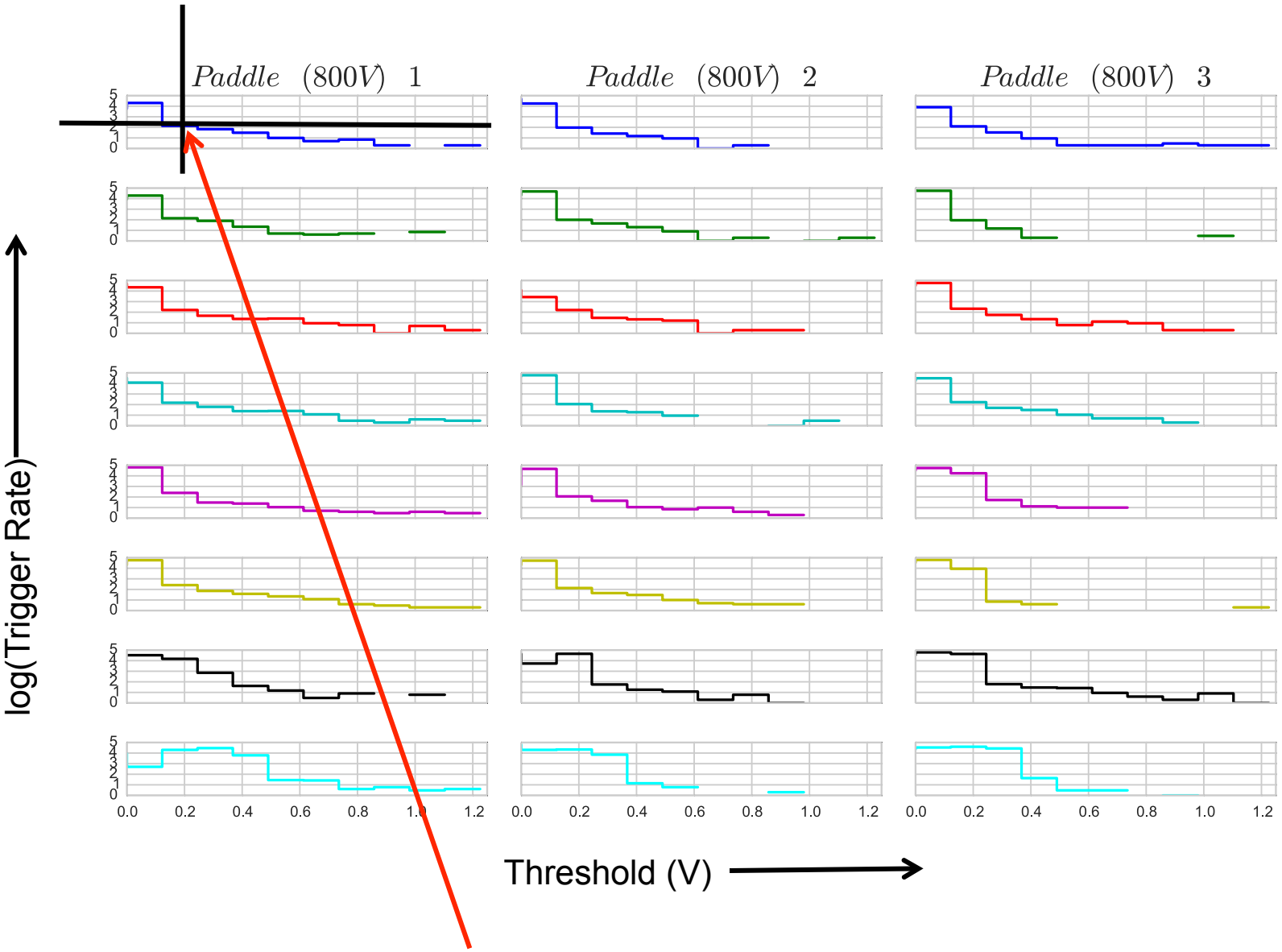
Aero6gen?
Forgen?
AIR 40?

TAXI Main Board



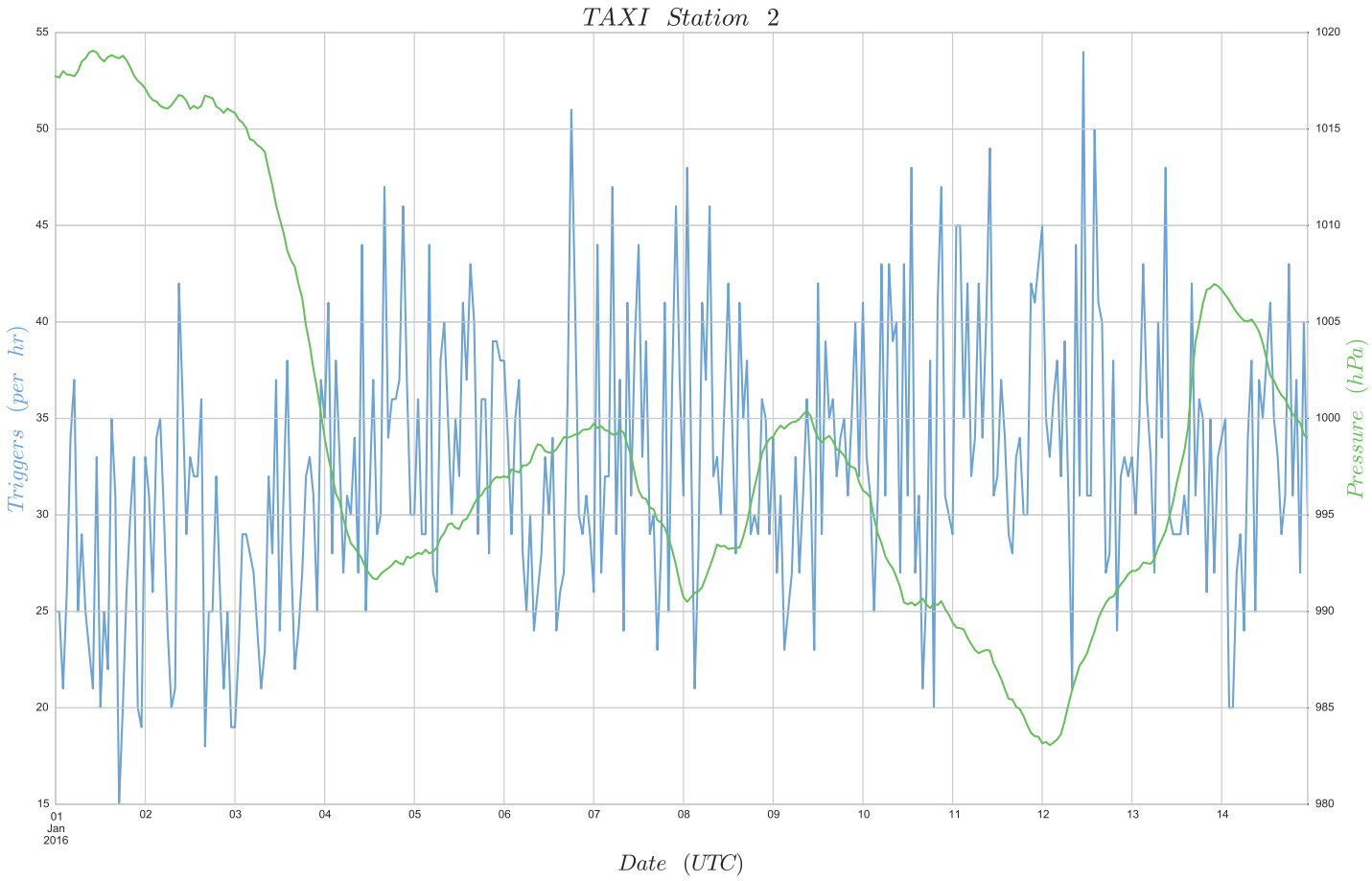
3 Scintillators X 8 discriminators per Scintillator = **24 channels**

Discriminator Threshold

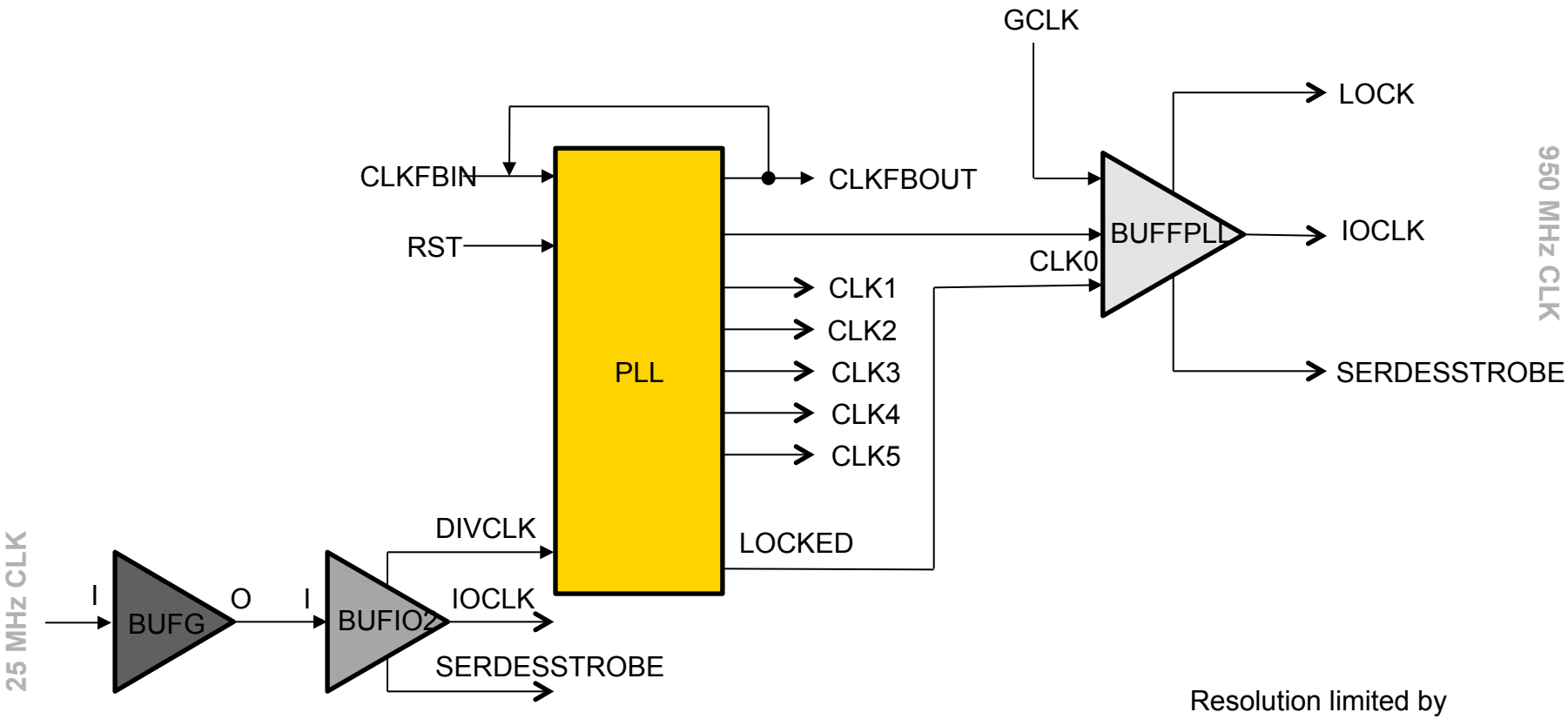


Set discriminator threshold via pre determined channel trigger rate

Trigger Rates (Jan 1st to 15th , 2016)



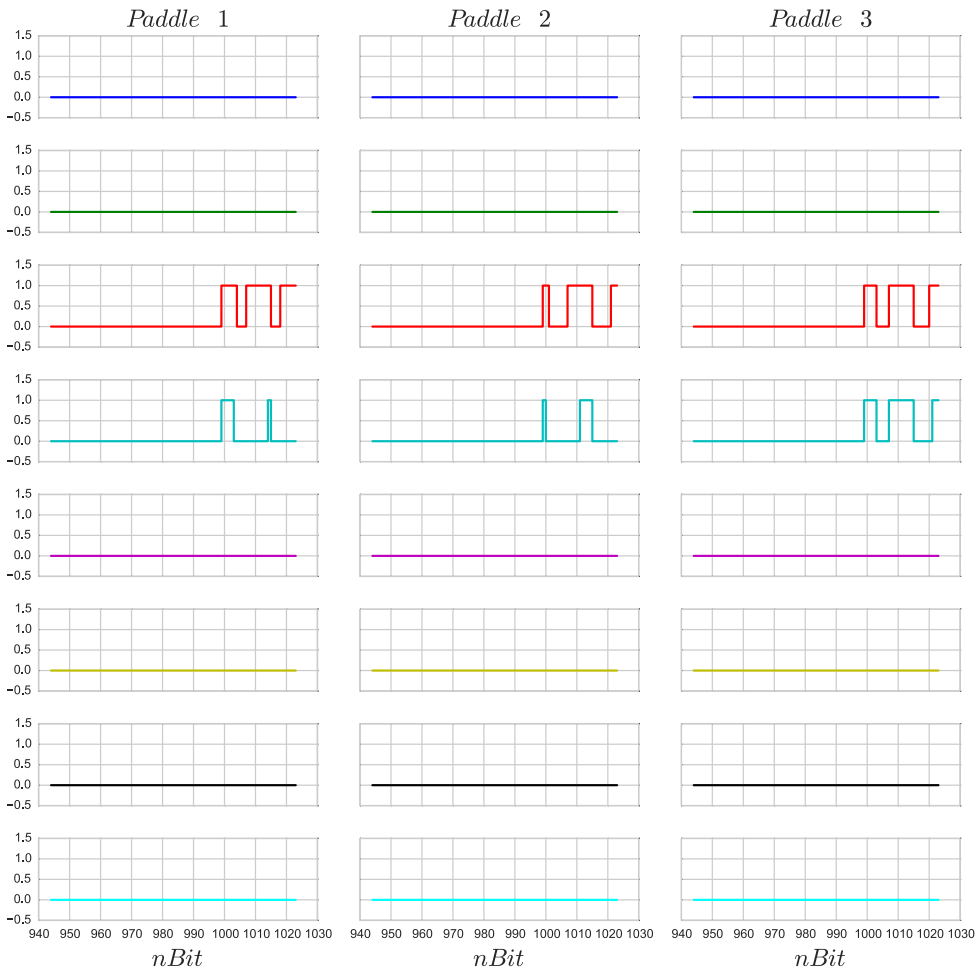
Timing (nano-second resolution…)



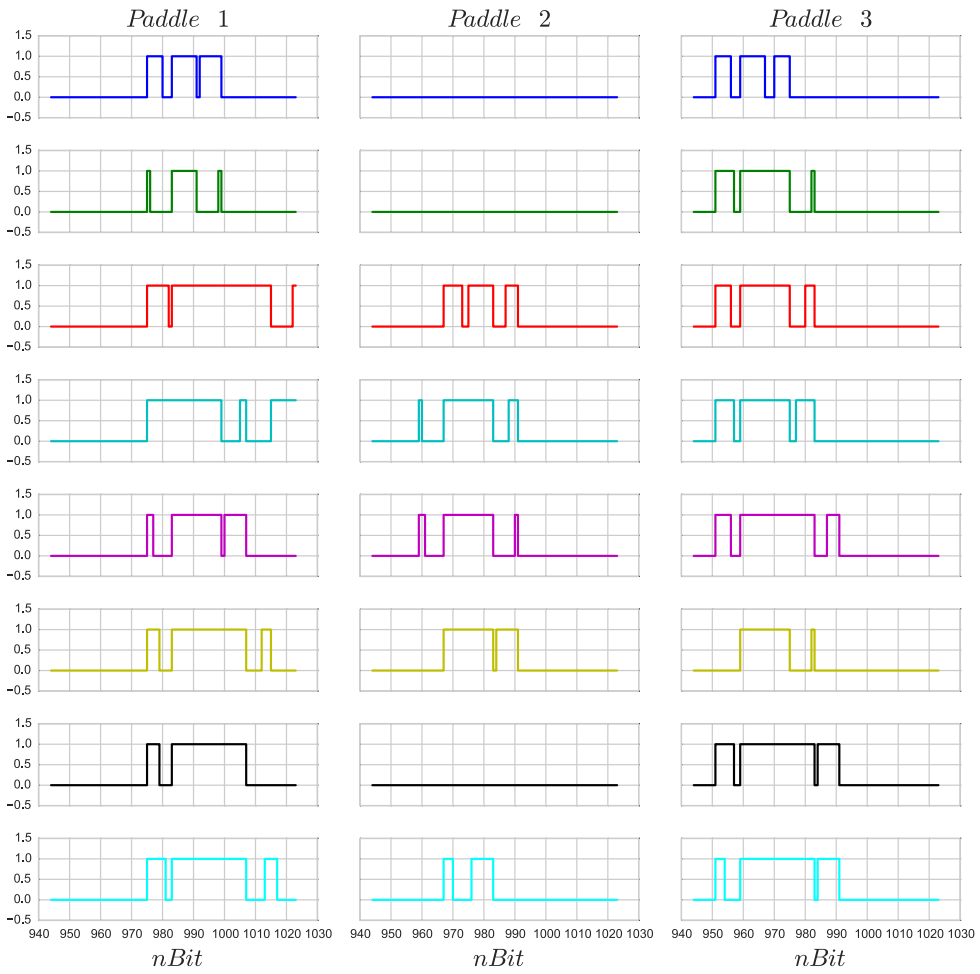
Resolution limited by the fpga. Can be improved with a different model.

24 discriminator outputs are connected to an INPUT SERDES
Sample serial data at 950 MHZ and get slower parallel output (1/8th input rate)

Through Going Muon Event (Stacked Paddles)



Air Shower Event



3. 2. 1.

Summary and Outlook

- TAXI is an Autonomous R&D detector capable of stand alone air shower measurements.
- Test, characterize & calibrate sensors/detectors (e.g. IceBag)
- Serve as a Surface Veto Array.
- Anticipated Timeline

November 2015 : Deployed first autonomous station at DESY Zeuthen

March 2016 : Deploy four stations at DESY Zeuthen

- Run Autonomously
- Configuration Testing
- Test other sensors (e.g Icebag)
- Electronics Testing (e.g. tech transfer for mDOMS or others)