

# The Auger Engineering Radio Array

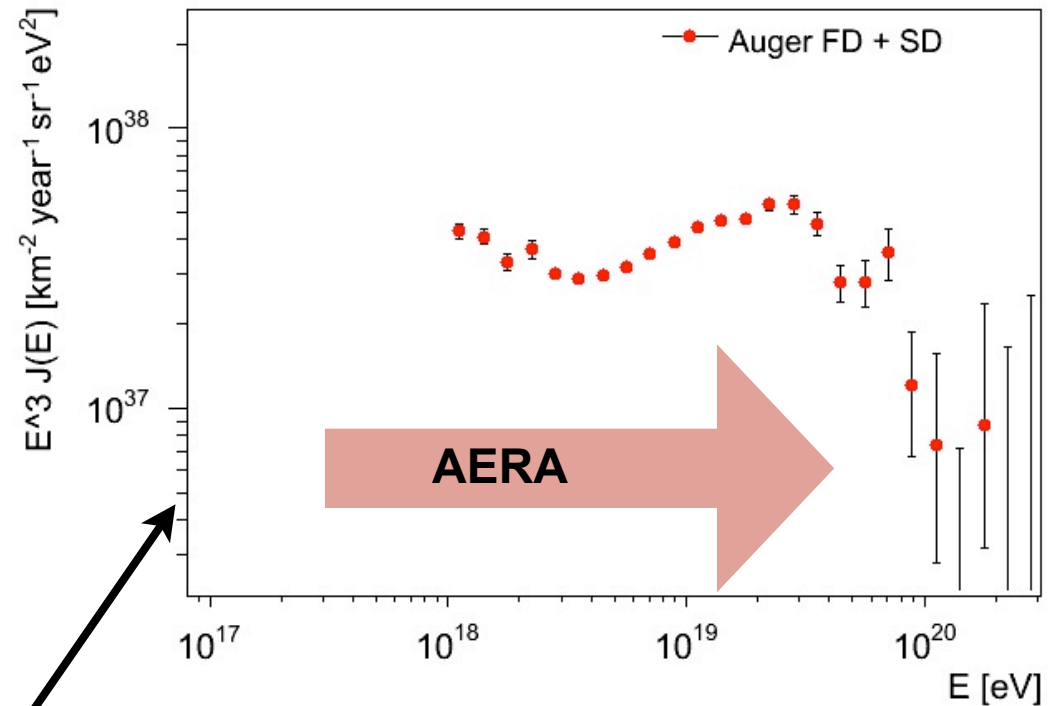
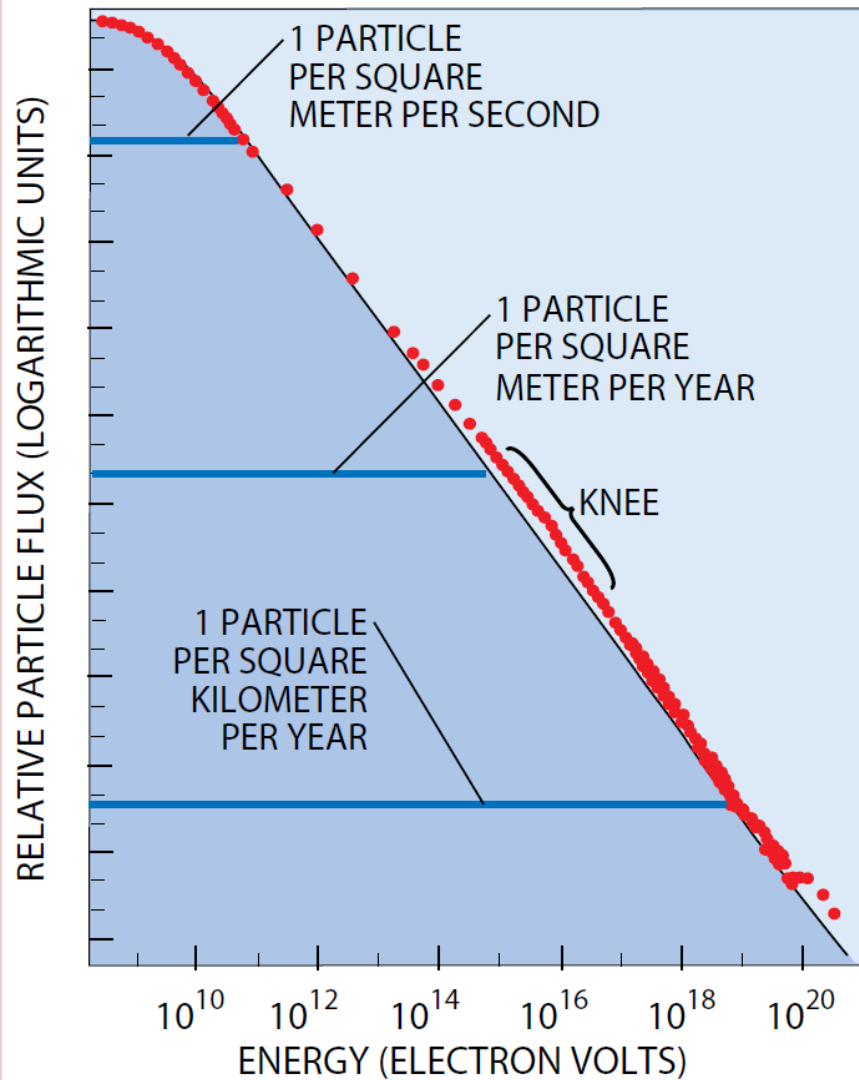


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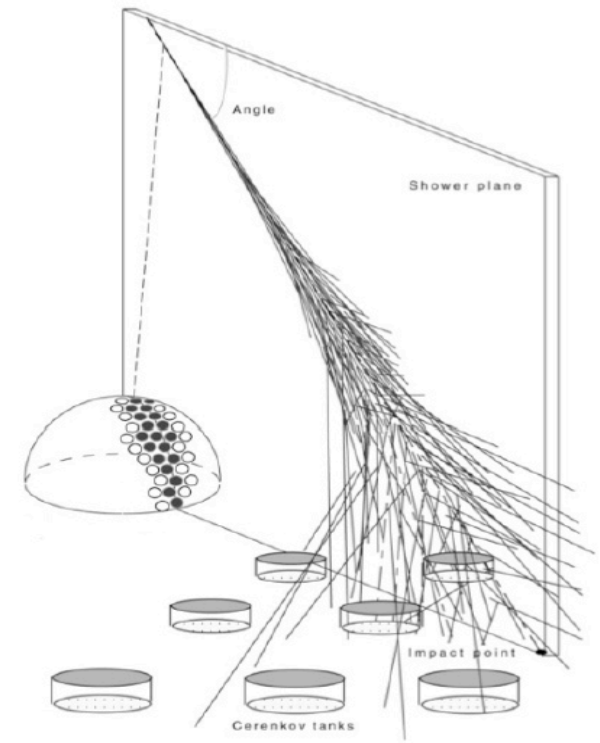
# Cosmic Rays



- sources of particles still unknown
- nature of particles not known at these energies

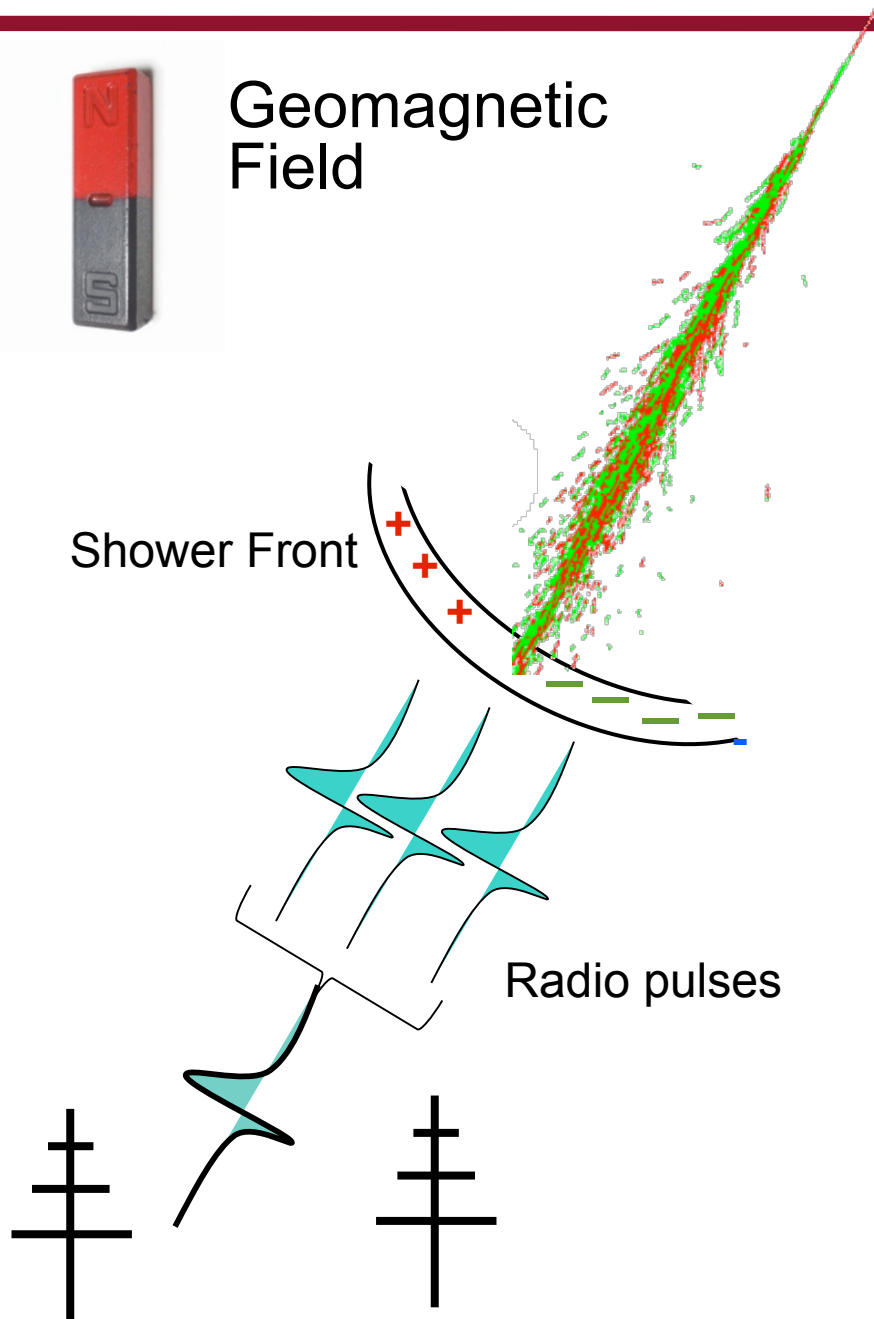
Cronin, Gaisser, Swordy 1997

# Pierre Auger Observatory



- province of Mendoza, Argentina, 3500 km<sup>2</sup>
- 5 Fluorescence Detectors (FD)
  - fluorescent light from nitrogen molecules (~10% duty cycle)
- 1600 Surface Detector Stations (SD)
  - particle content of shower at ground level (~100% duty cycle)

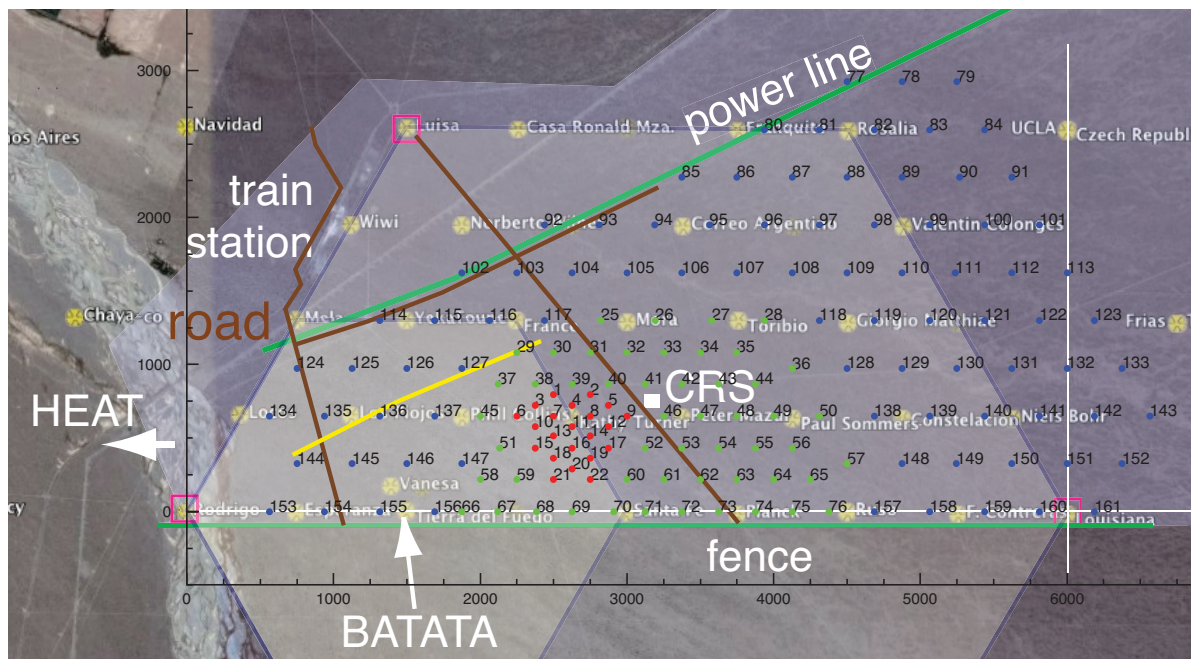
# Radio Detection of Cosmic Rays



- electrons and positrons in shower emit coherent radiation
- geomagnetic synchrotron
- charge variation
- ...
- frequencies in MHz range
- enables to observe the shower development
- new method to study composition of air showers
- about >90% duty cycle

# AERA

- Collaboration of Groups from:
  - **France, Germany and the Netherlands**
- Colocation with Auger low energy extensions:
  - **HEAT (FD), AMIGA (SD)**
- Three stages:
  - Stage 1
    - 24 antennas
  - Stage 2
    - + 52 antennas
  - Stage 3
    - + 85 antennas



# AERA stations



**Logarithmic-Periodic Dipole Antenna  
Bandwidth 30 - 80 MHz  
with Low Noise Amplifier and Filter**

**GPS Antenna**

**Solar Panels**

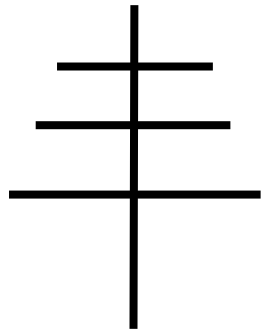
**Fiber Connection  
to Central Station**

**Electronics Box  
Read-Out Electronics  
Communication  
Batteries**

# AERA Data taking

## On station level:

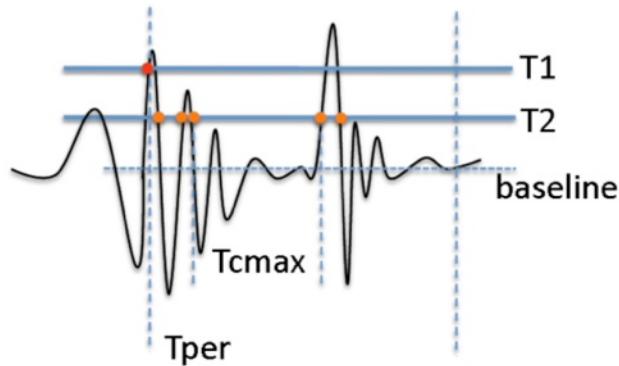
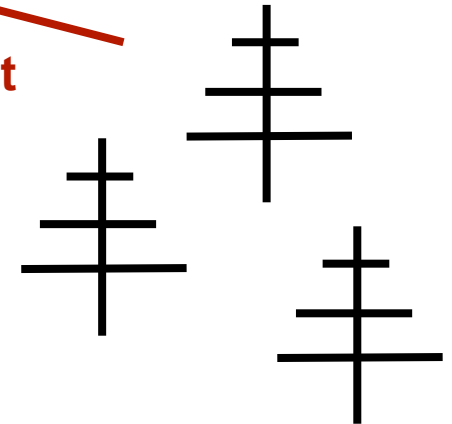
## DAQ in Central Radio Station



Trigger to  
DAQ



Read-Out  
request



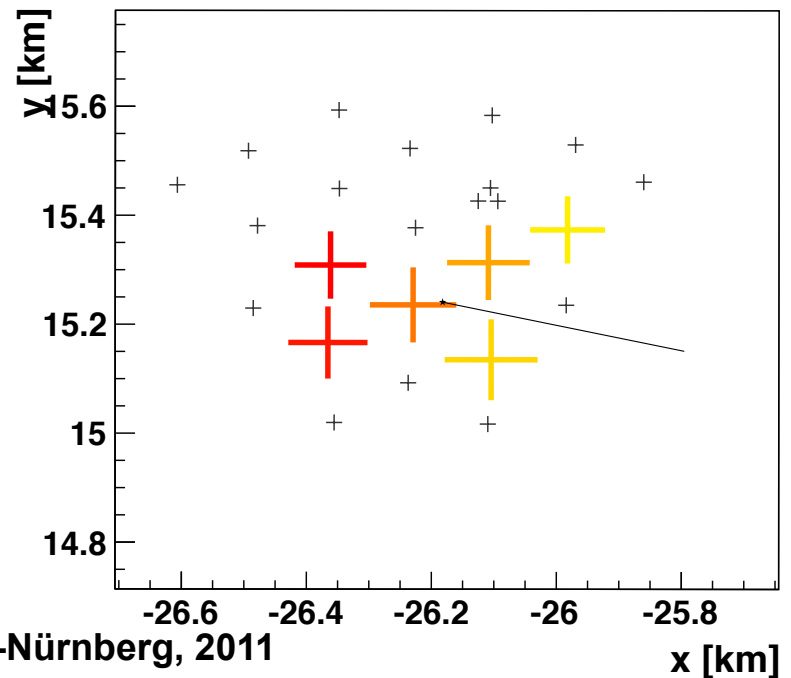
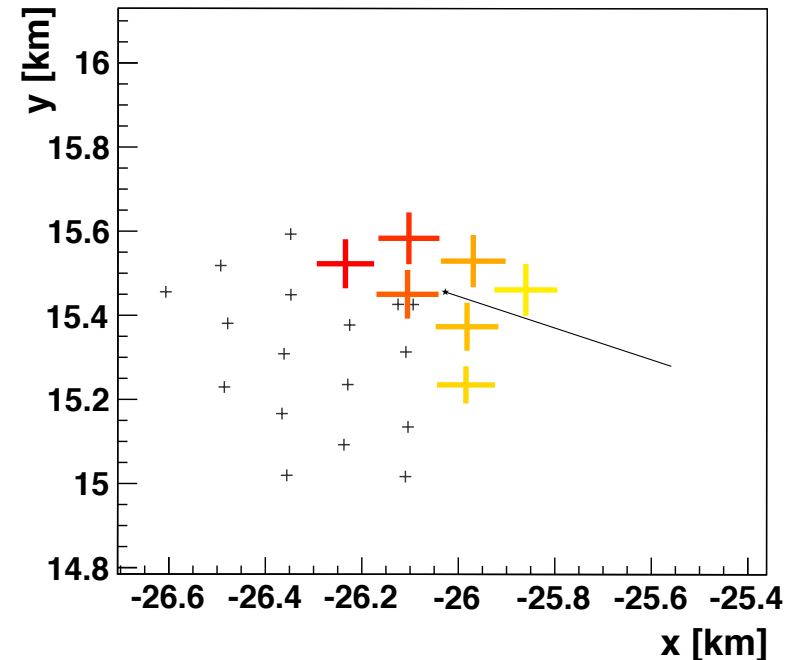
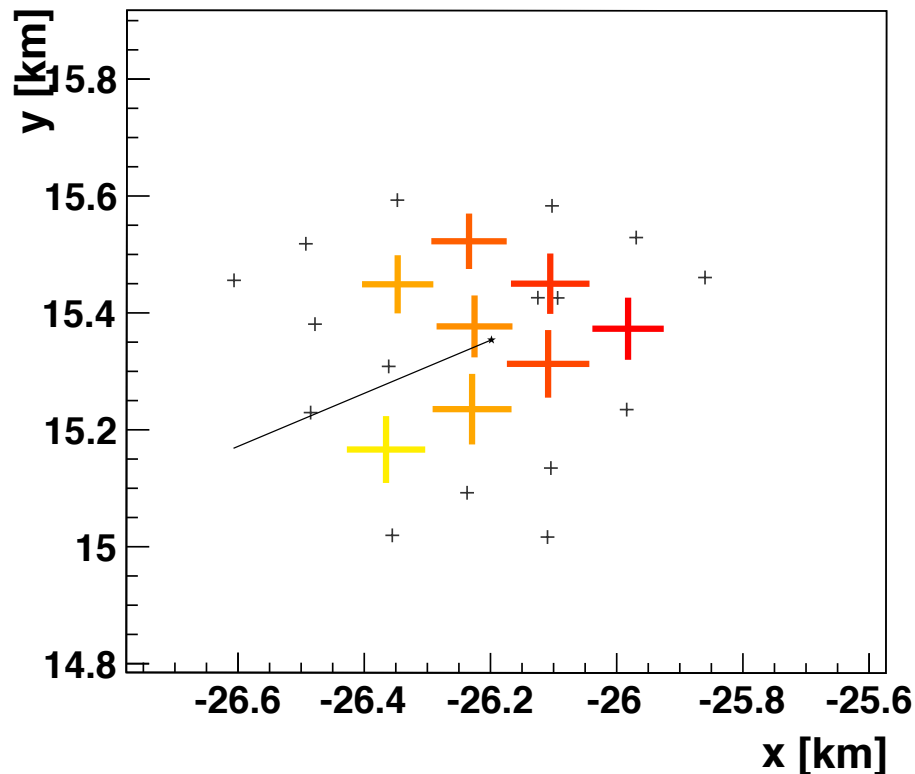
- checking for  
coincidences in time  
in **> 1 station**

- dynamic thresholds
- noise thresholds
- trigger on either polarization

- study for optimal time-window
- reduction of data

- Event building
- storage of raw data for analysis

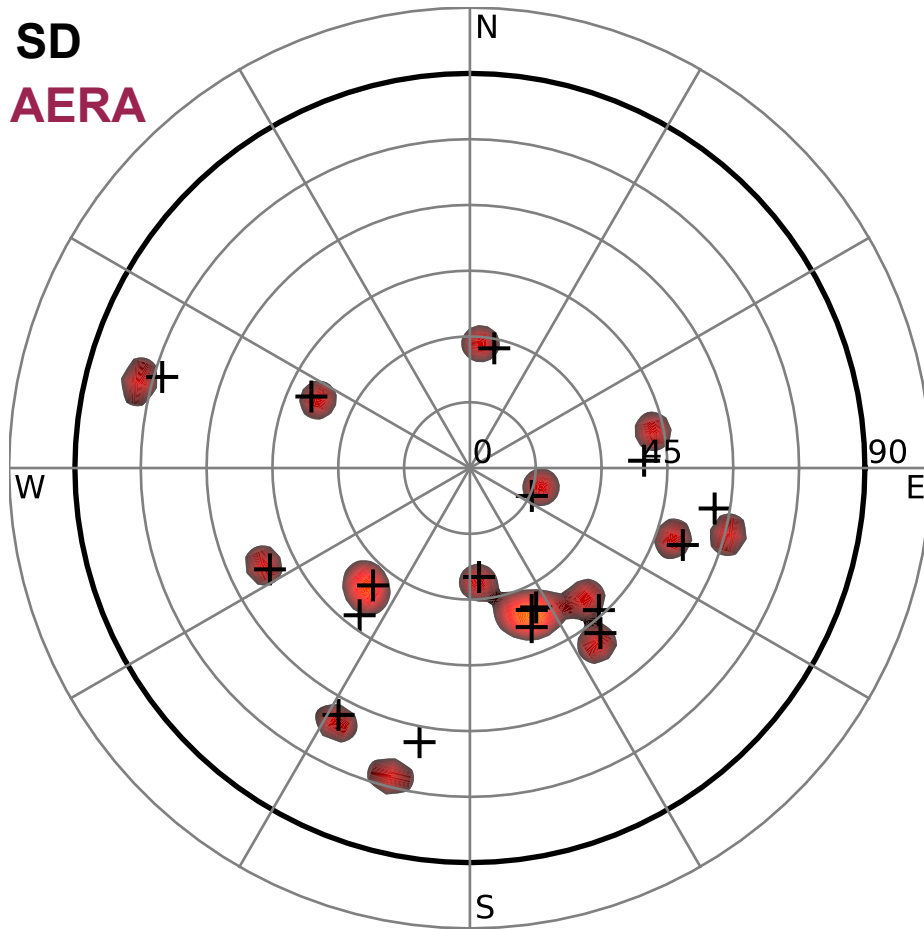
# Cosmic Ray Events



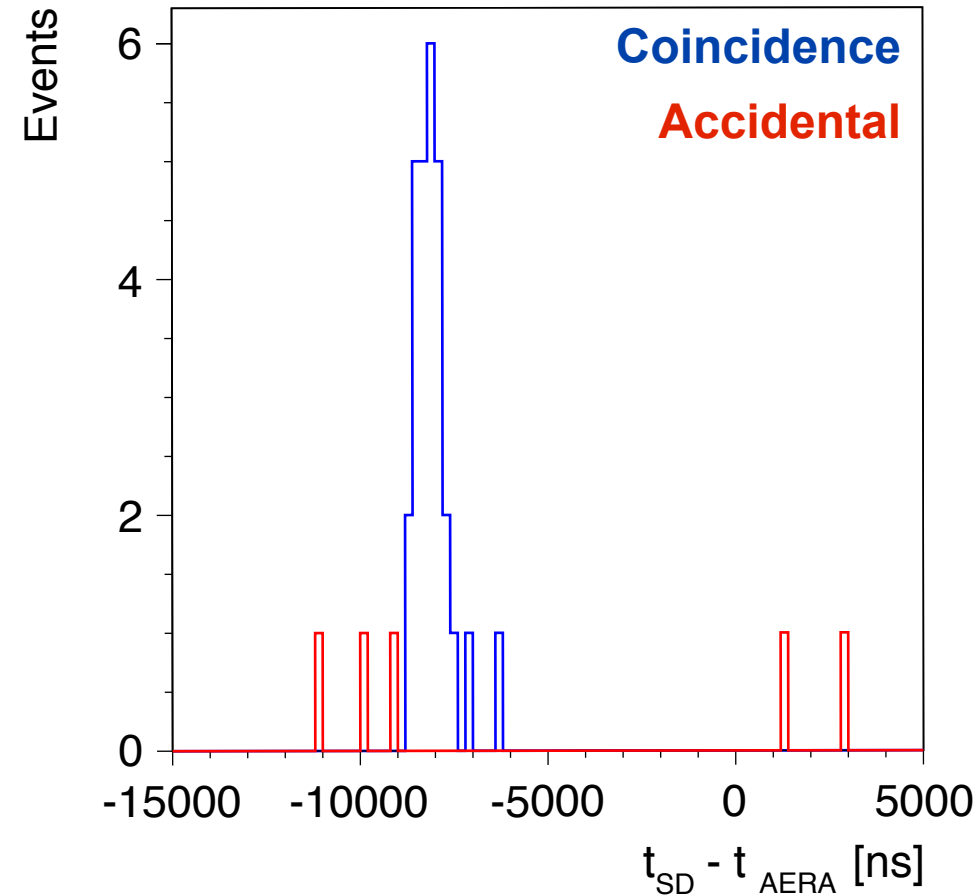
- Since April 15th:
  - self-triggered cosmic ray events in coincidence with SD
  - 37 events of which 18 at least 3-fold, one with FD



# Cosmic Ray Events



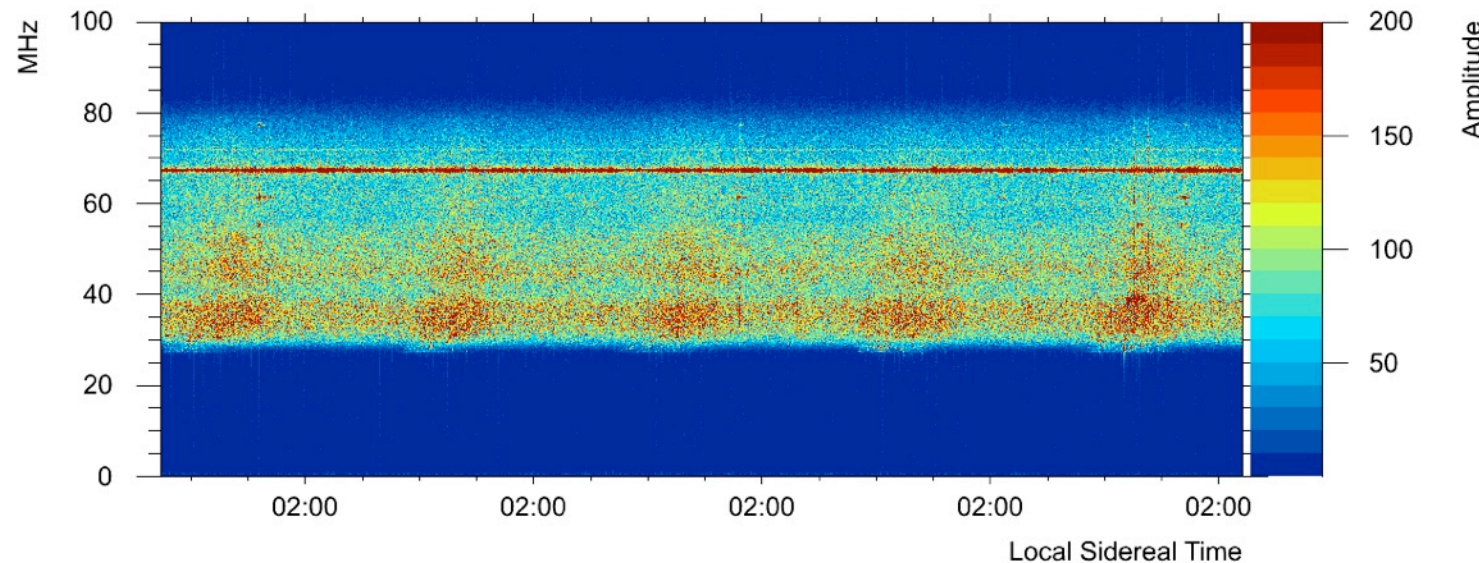
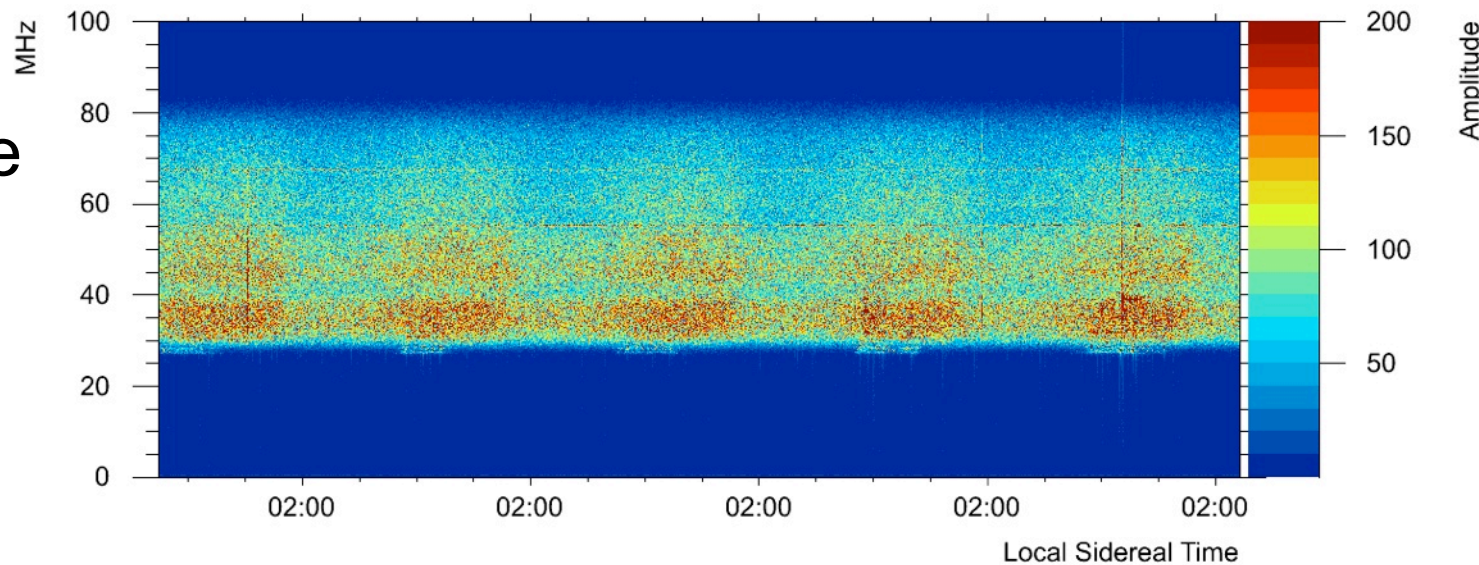
Agreement of directions to within 3 degrees space angle



Very clearly defined timing offset due to trigger conditions

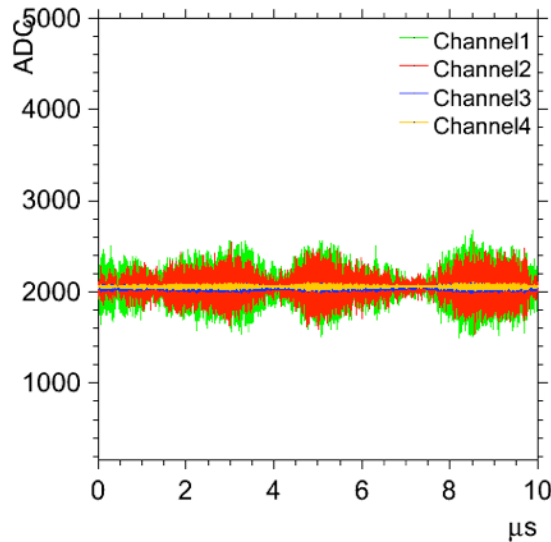
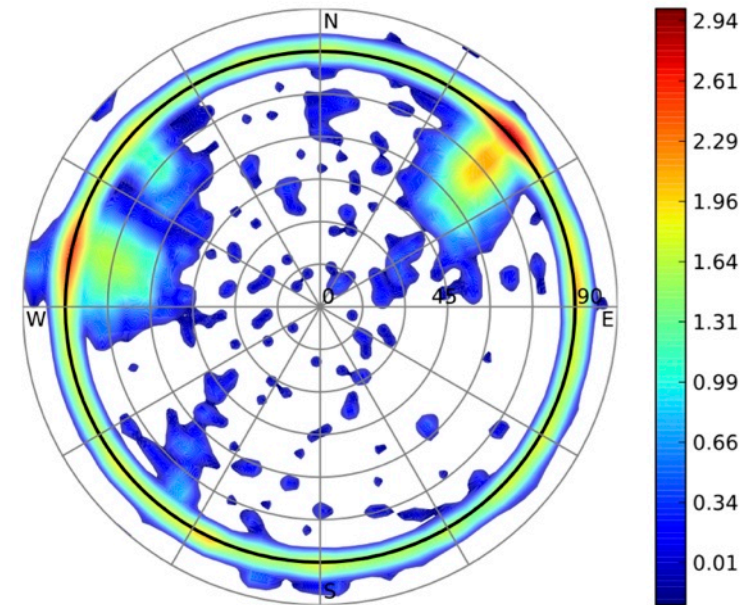
# Longterm-Performance

- every 10 s a background trace is recorded
- stations are running stable
- very little narrow-band RFI
- electronics very quiet
- background spectrum dominated by galactic noise

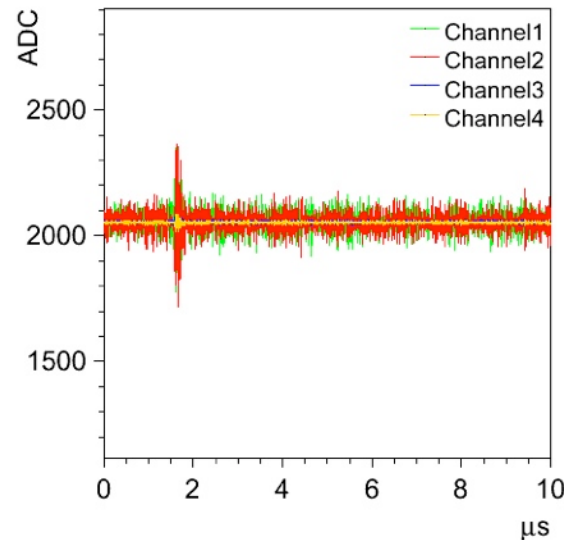


# Noise and Transients

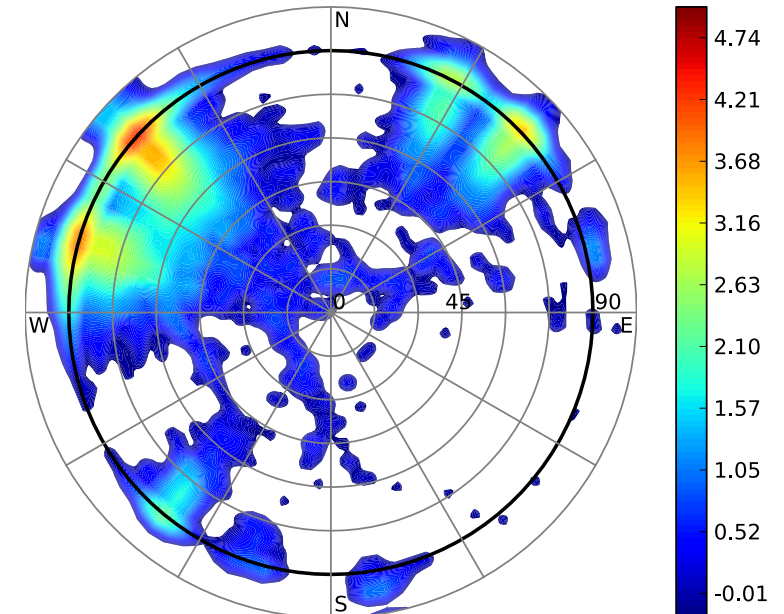
- non-negligible amount of radio interference
  - five primary sources
  - probably human made
  - at large zenith angles less interference



will be vetoed



will trigger



# Summary and Outlook

- 21 Stations deployed in Argentina
- Stations are operating within Engineering parameters
- Ongoing effort on suppression of interference and background monitoring
- Coincidences of radio self-triggered events with SD observed → first air-showers detected

