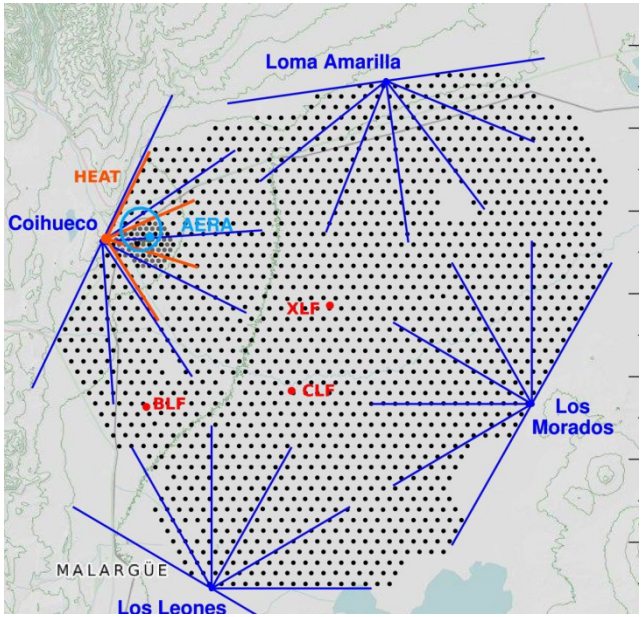
New electronics for the surface detectors of the Auger Observatory



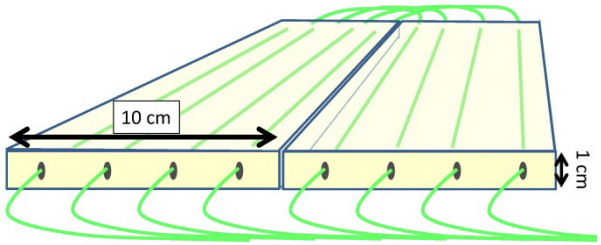
Layout of the Observatory

Pierre Auger Observatory and motivation

- measure cosmic rays above 10^{17}eV
- 1660 water Cherenkov detectors (WCD) and 27 fluorescence telescopes
- energy spectra, composition and asymmetry measured and published
- need detectors for air shower composition

→ upgrade of WCD with scintillators modules

→ upgrade of electronics with new functions

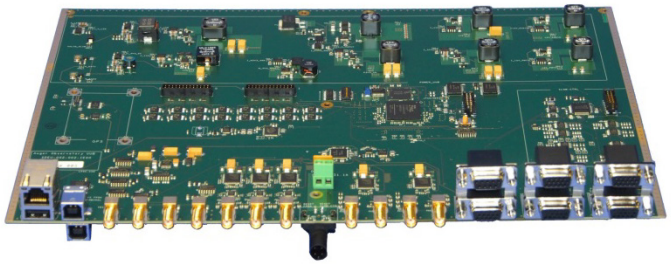


Sketch of scintillator module

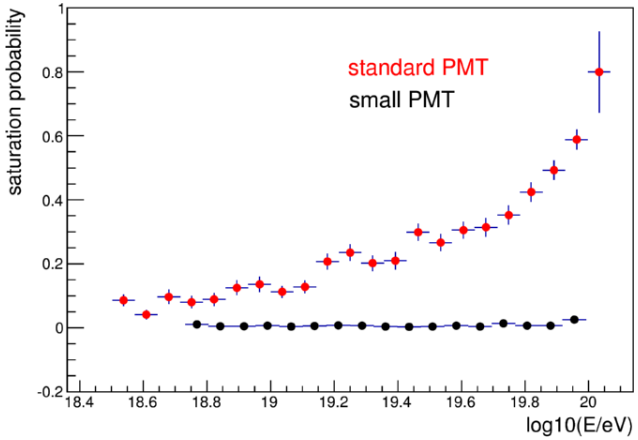
Scintillator surface detector (SSD):

- 4 m^2 modules of extruded scintillators
- bars are 1.6 m long, 5 cm wide and 1 cm thick
- 1 mm wavelength-shifting fibers for readout
- coupled to 8-stage PMT (Hamamatsu R9420)
- prototypes in operation since 2014

Design of the new electronics for the surface detectors (UUB):



New UUB electronics:



Fraction of saturated events vs. energy
→ need extra PMT

- replacement with present-day technology for higher performance and integration of SSD
- keep 10W consumption and 150 byte/s comms link
- split in high-gain and low-gain channel for 17 bit extended dynamic range
- 12-bit 120 MHz FADC sampling for 10 channels
- GPS synchronization with 2 ns accuracy
- Xilinx Zynq FPGA with 2 embedded ARM A9
  → much higher processing power
  → improved and additional trigger algorithm
- MSP430 µ-controller for slow control functions

- WCD equipped with additional extra small PMT
  → expected to reduce # of saturated events
  → extend dynamic range 600 → > 20000 VEM
- 5 UUB prototypes are currently tested in labs