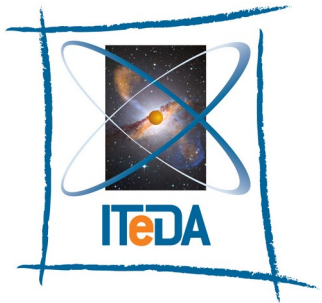


The detectors of AugerPrime

Federico Sánchez

Workshop CUIA

May, 2022



CNEA - CONICET - UNSAM



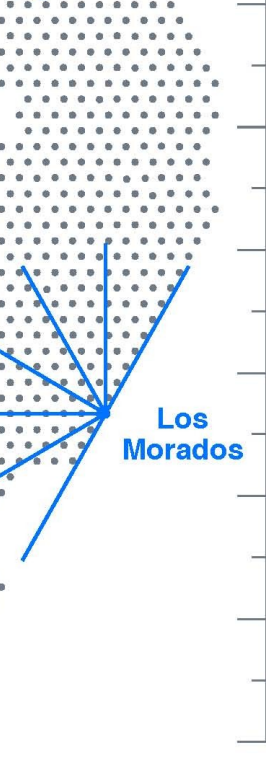
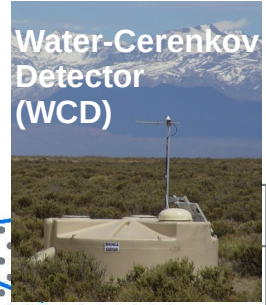
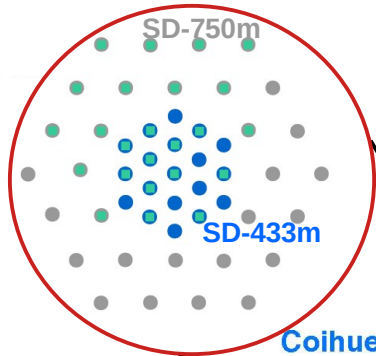
PIERRE
AUGER
OBSERVATORY

The Pierre Auger Observatory: original design + enhancements

Surface detector (SD)

100% duty cycle

SD-1500m	SD-750m	SD-433m
3000 km ²	23.5 km ²	1.9 km ²
1600 WCDs	61 WCDs	19 WCDs
E_{thr}^v 2.5 EeV	E_{thr} 0.1 EeV	E_{thr} 0.03 EeV
E_{thr}^i 4.0 EeV		



Fluorescence detector (FD)

15% duty cycle

4 units x 6 telescopes overlooking SD-1500m
FoV 30° x 30°
Minimum elevation 1.5°



1 units x 3 telescopes (HEAT) overlooking SD-750m
FoV 30° x 30°
Minimum elevation 30°



Bs As city area ~ 203 km²
Torino city area ~ 130 km²

AugerPrime: surface components

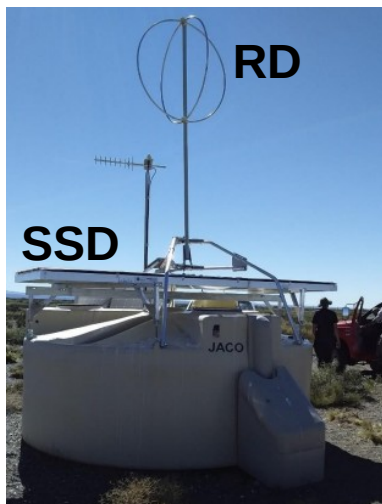
Surface Scintillator detector (SSD) & Radio detector (RD)

100% duty cycle



3 Large-area PMTs

40 MHz sampling
10-bits dynamic range



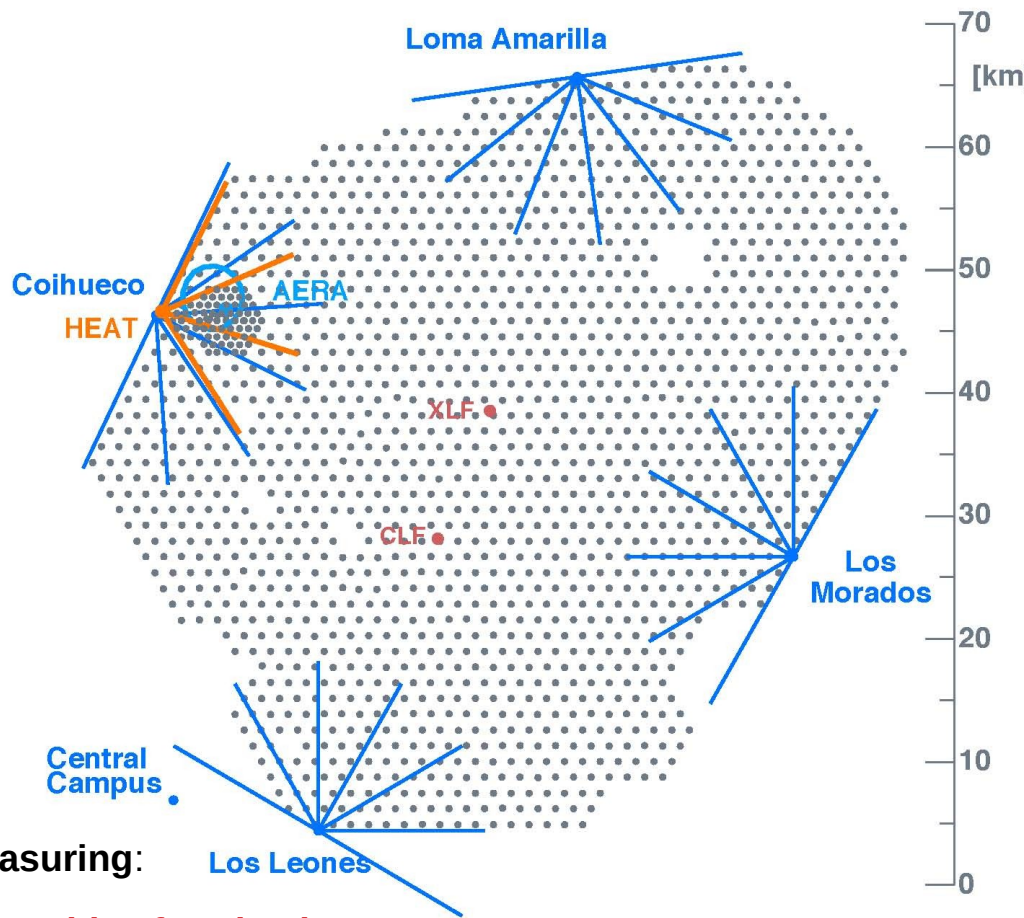
3 Large-area PMTs
1 Small-area PMT

120 MHz sampling
12-bits dynamic range



High improvement in measuring:

- signal size
 - signal timing
- } observables for physics



AugerPrime: underground components (AMIGA)

Underground Muon detector (UMD)

100% duty cycle

UMD-750m

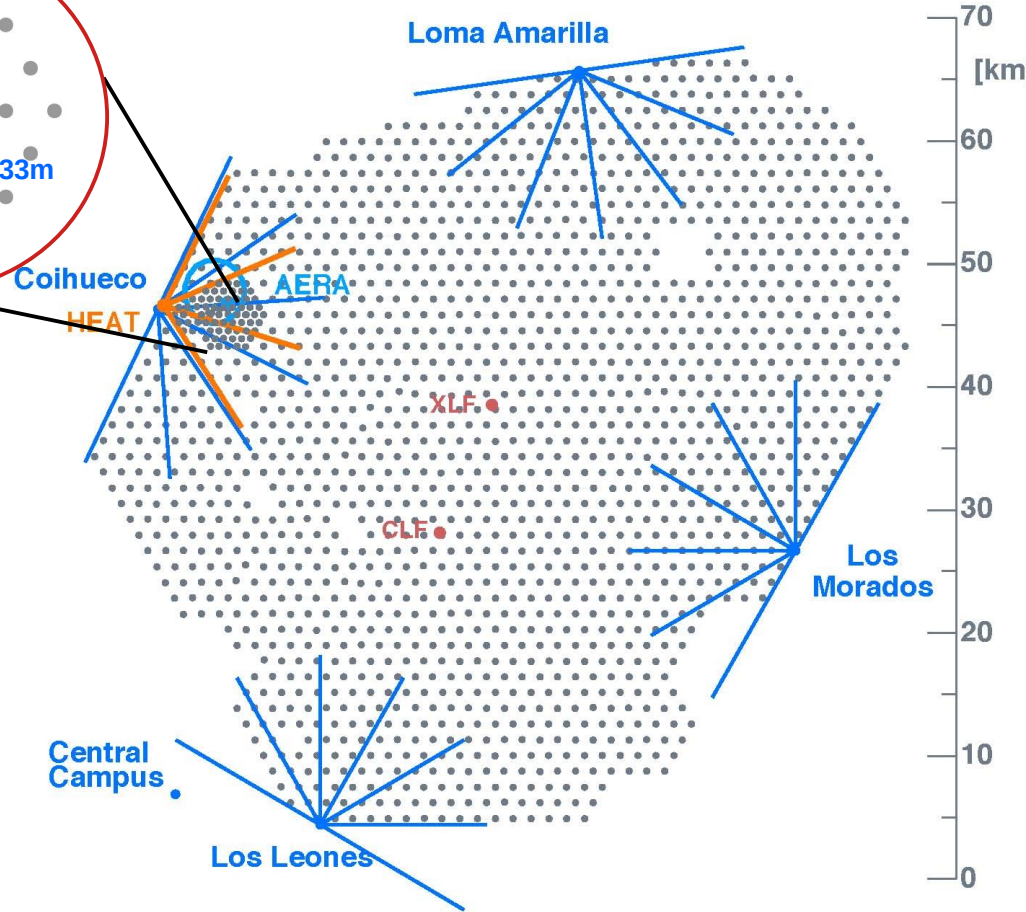
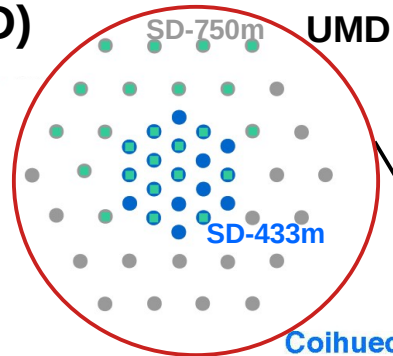
23.5 km²
61 WCDs

E_{thr} 0.1 EeV

UMD-433m

1.9 km²
19 WCDs

E_{thr} 0.03 EeV

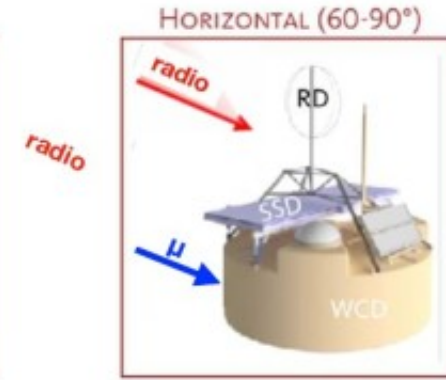
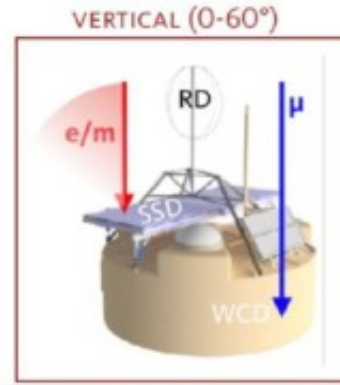


Details in the Gaia's talk

AugerPrime: surface components

Hardware upgrades & enhancements

- Additional scintillators (**SSD**) on top of WCD
- Faster electronics with increased dynamic range (**UUB**)
- Additional small-area PMT (**sPMT**) for WCD
- Additional Radio antennas (**RD**)
- Enhanced duty cycle or FD

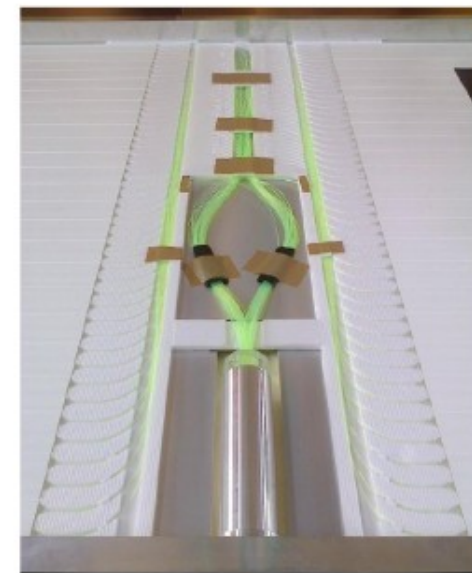
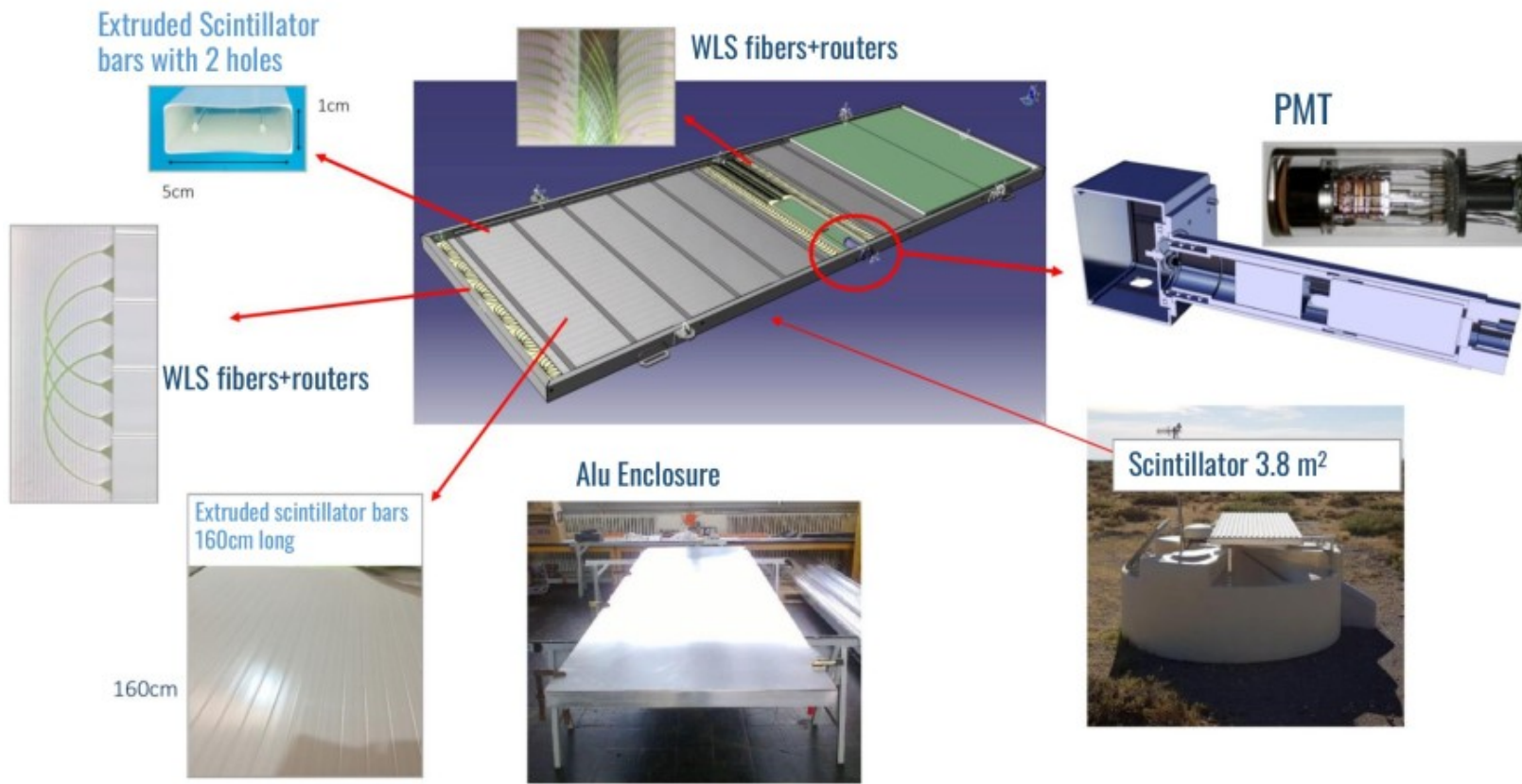


(AugerPrime design report 1604.03637)



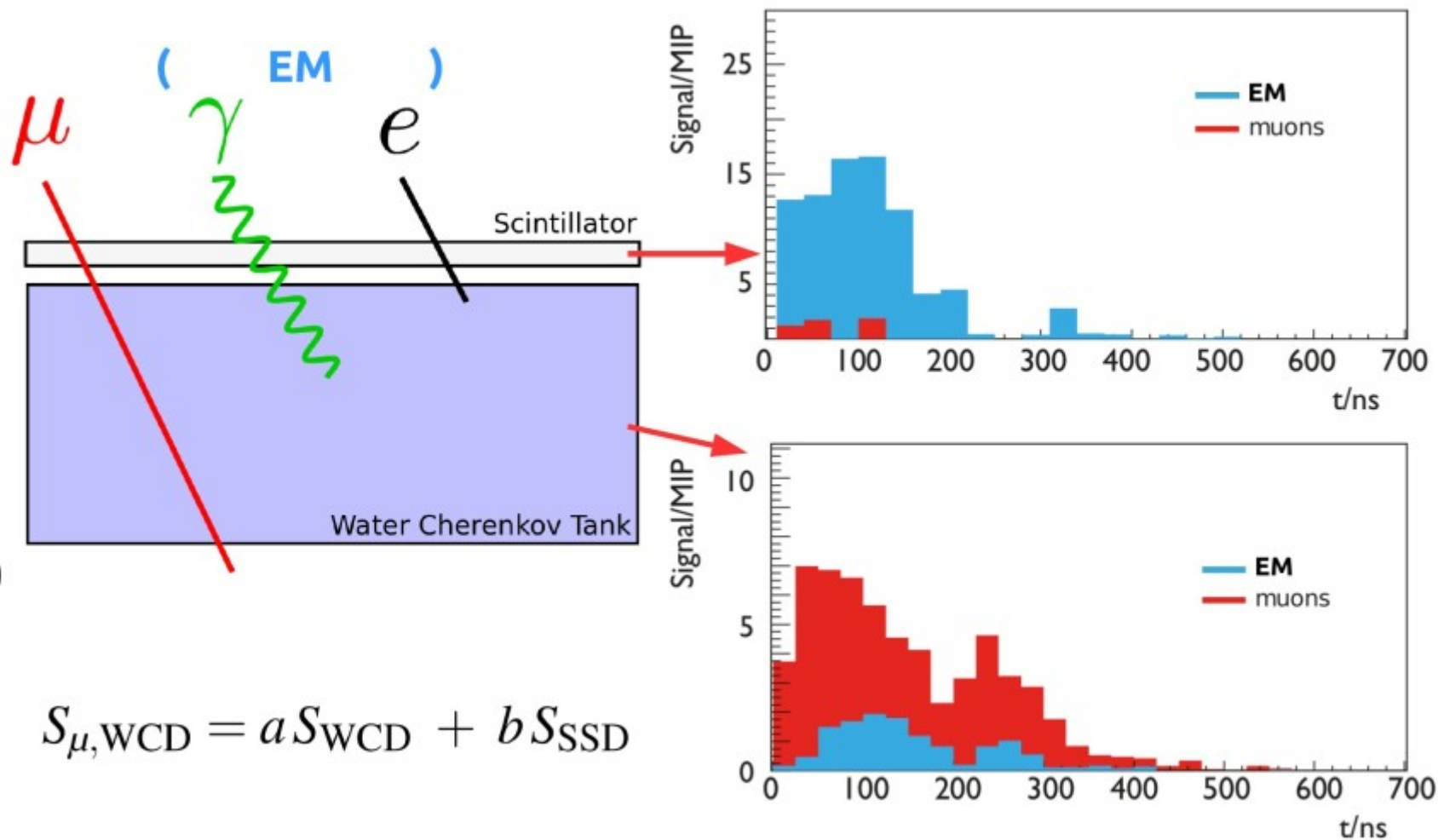
AugerPrime: Surface Scintillator Detector

Additional scintillators (SSD) on top of WCD



AugerPrime: Surface Scintillator Detector

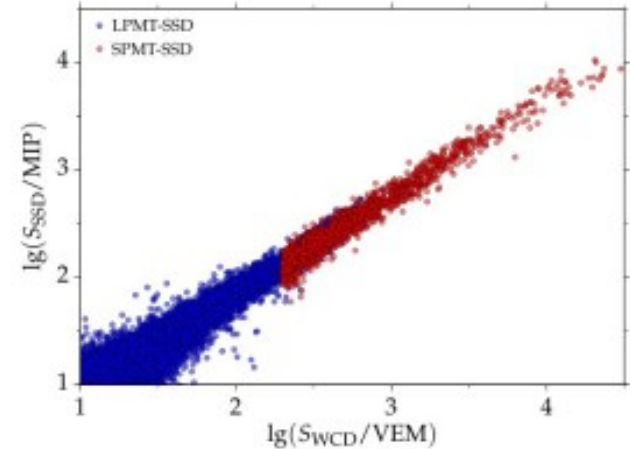
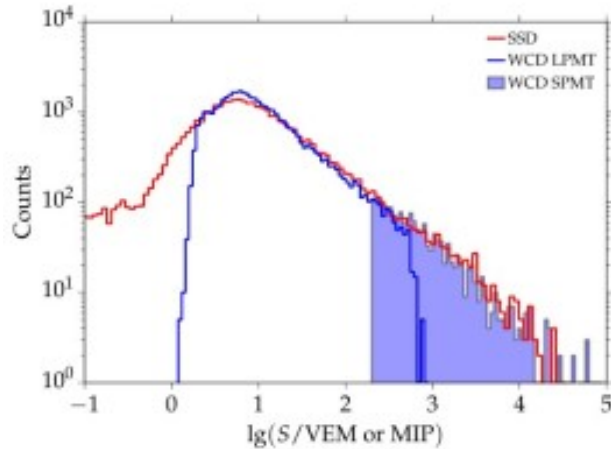
Additional scintillators (**SSD**) on top of WCD



AugerPrime: small Photomultiplier Tube (sPMT)

Additional small-area PMT (sPMT) for WCD

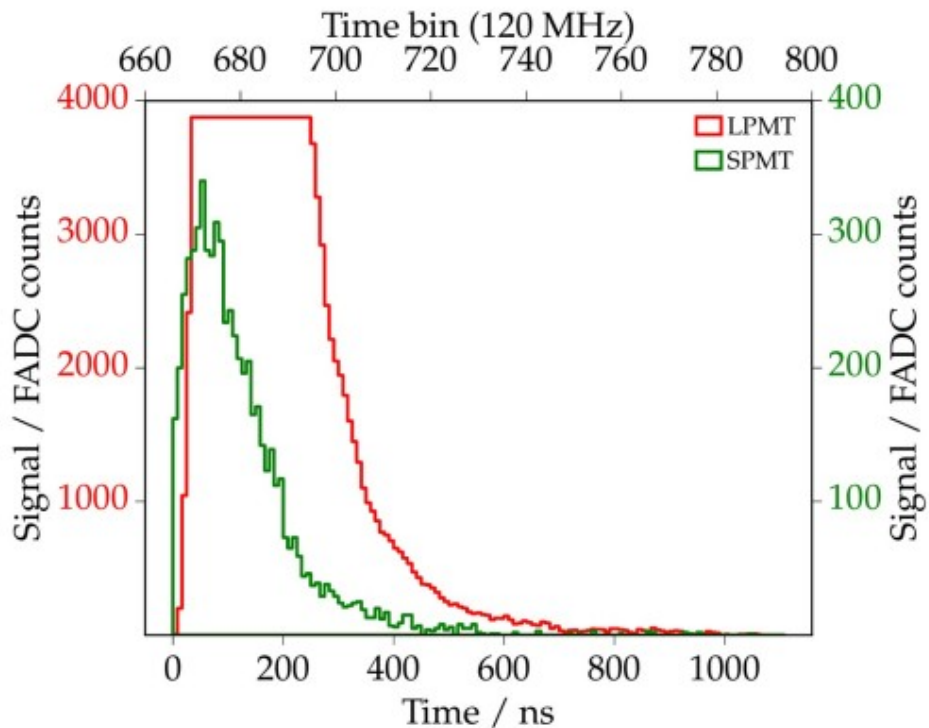
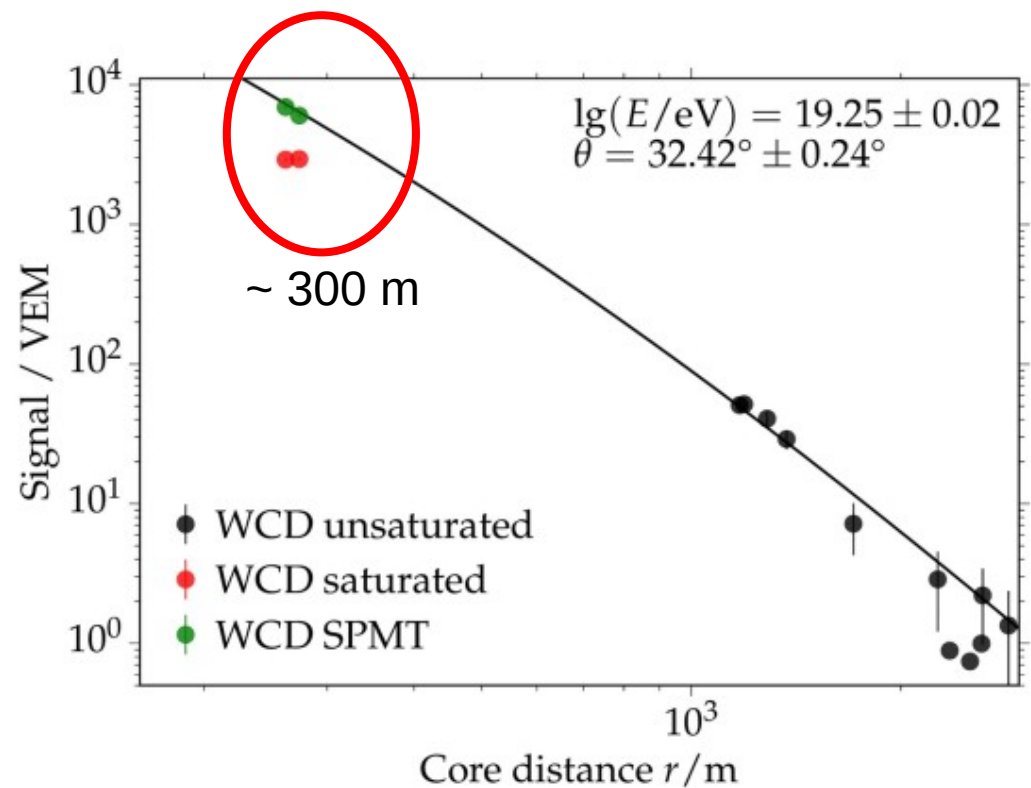
- Extend the dynamic range of current WCD
- Calibrated in the overlap region
- Linear and unsaturated measurements of signals close to the shower core



AugerPrime: small Photomultiplier Tube (sPMT)

Additional small-area PMT (sPMT) for WCD

Measurements close to the core at the highest energies!



AugerPrime: Radio detector (RD)

Additional Radio antennas (RD)

Fully integrated in existing infrastructure

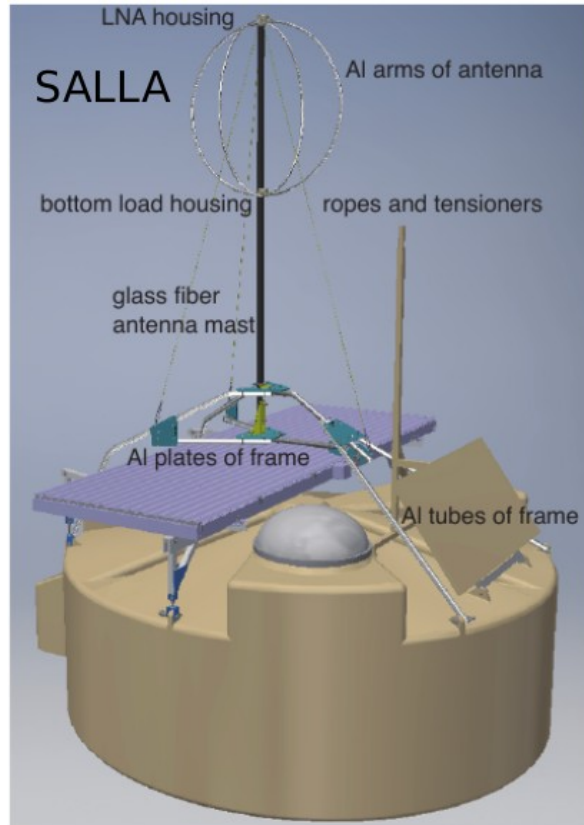
- Triggering and DAQ from SD

Short Aperiodic Loaded Loop antennas (SALLAs)

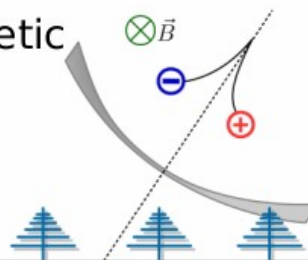
- Di-polarized signals in 30-80 MHz, sampled with 250 MHz
- Refined design for higher sensitivity

Energy and band-width budget:

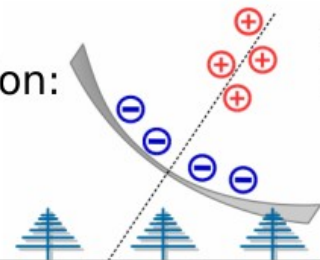
- Solar powered: budget < 3W
- 20+ year-old wire-less COMMS



Geomagnetic emission:



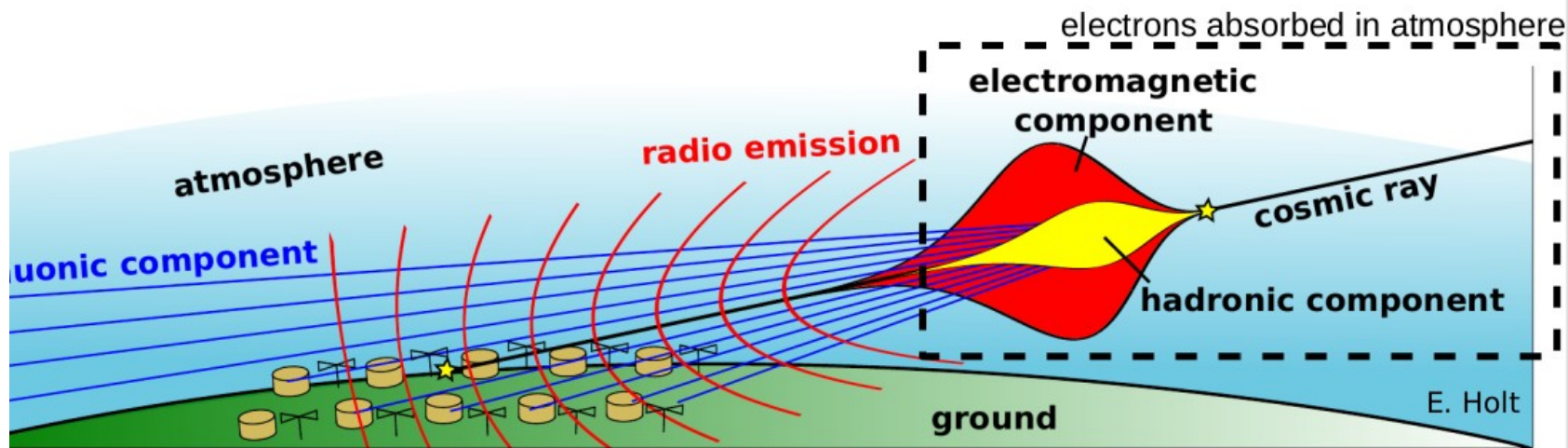
Neg. charge-excess emission:



AugerPrime: Radio detector (RD)

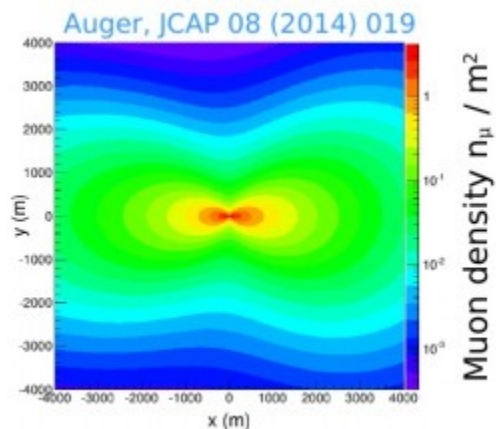
Goal: Disentangle **muonic** and **electromagnetic** shower components

Mass sensitive measurement with large exposure & sky-coverage

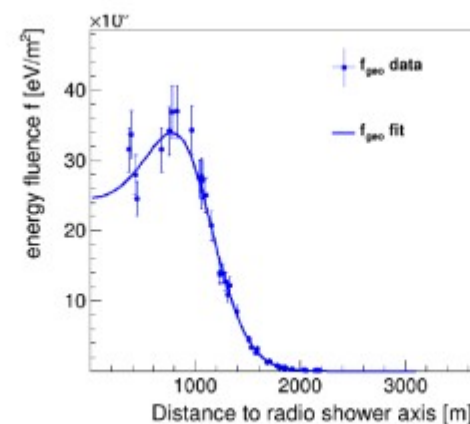


Muonic component via water-Cherenkov tanks

■ Electromagnetic component via radio antennas



+



AugerPrime: a multi-hybrid detector

- Multi-hybrid measurements will allow a unprecedented resolution for composition analysis
- Even-by-Event composition might open the door to charged-particle Astronomy
- New insights to hadronic interactions

