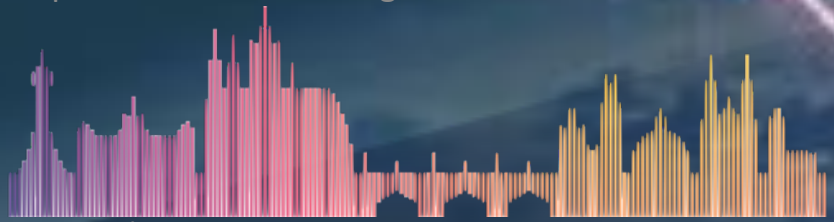
Radio Detection of inclined showers at the Pierre Auger Observatory

Sijbrand de Jong

On behalf of the Auger Collaboration*

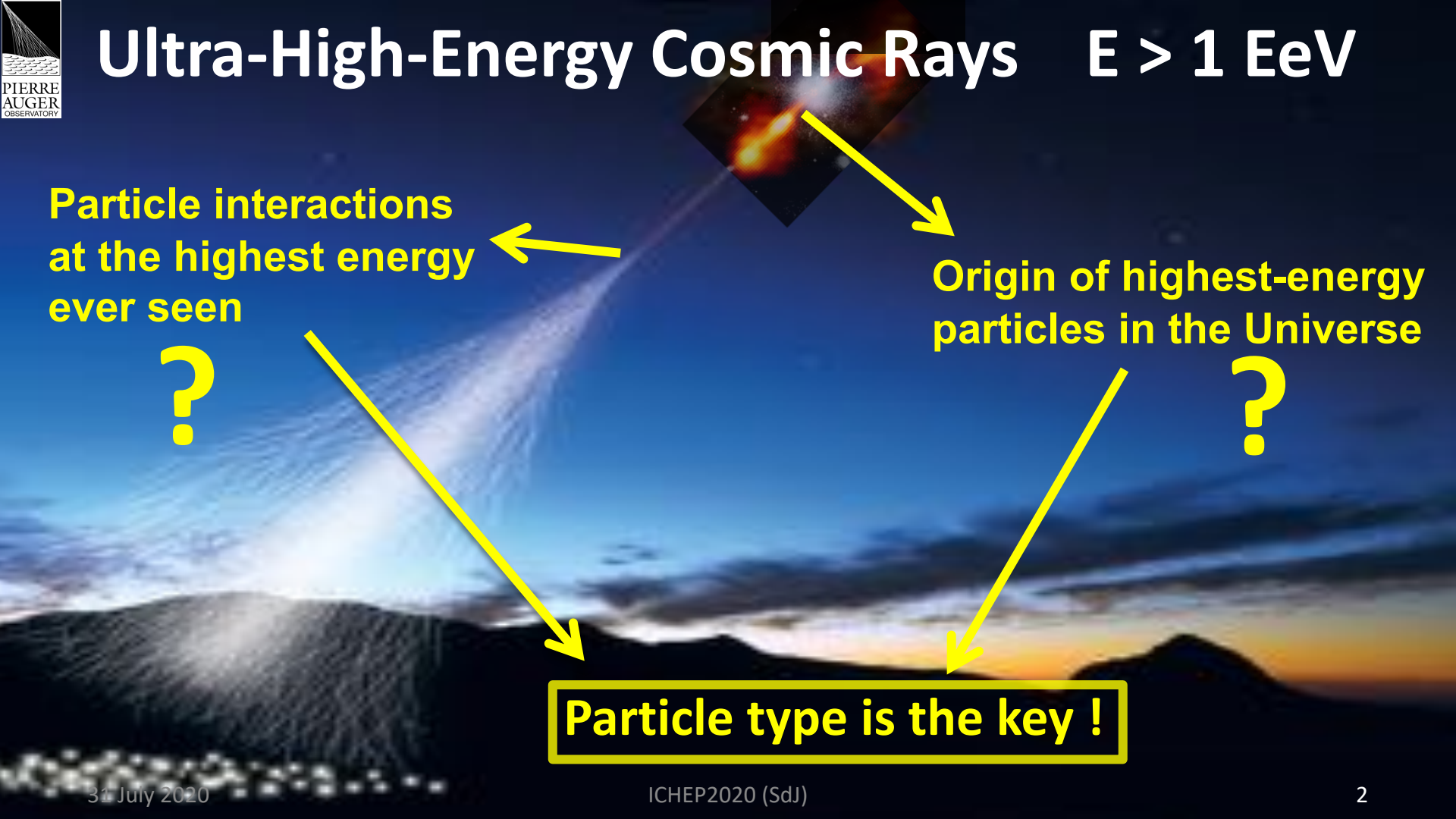
*Many thanks to all Auger members, in particular to all colleagues in AERA



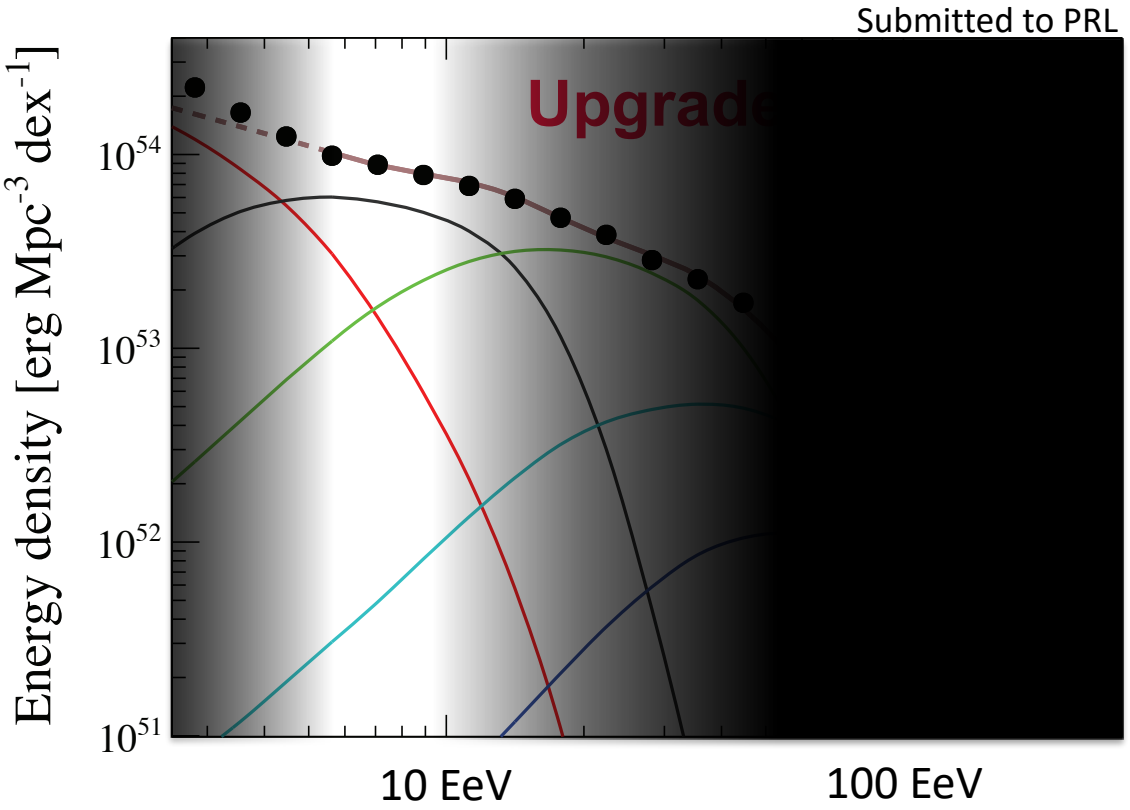
Take home Radio Detection of Cosmic Rays:

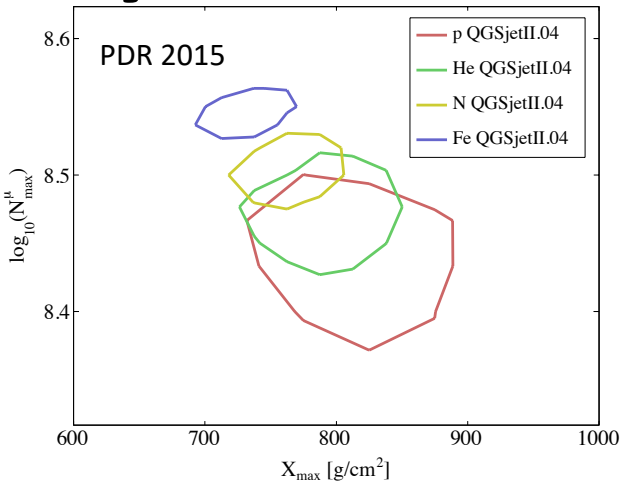
- proven technique
- construct at very large scale (3000 km^2 !)

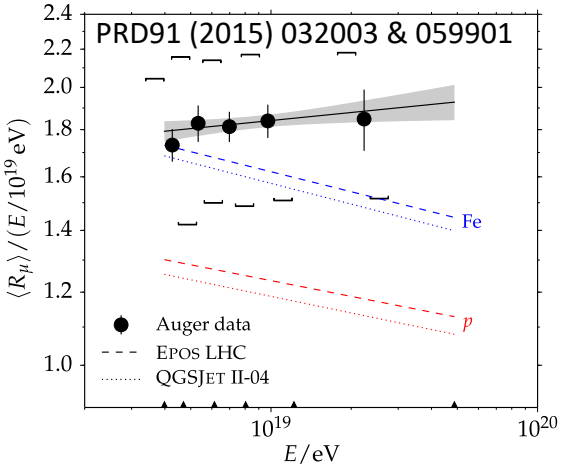
Ultra-High-Energy Cosmic Rays E > 1 EeV



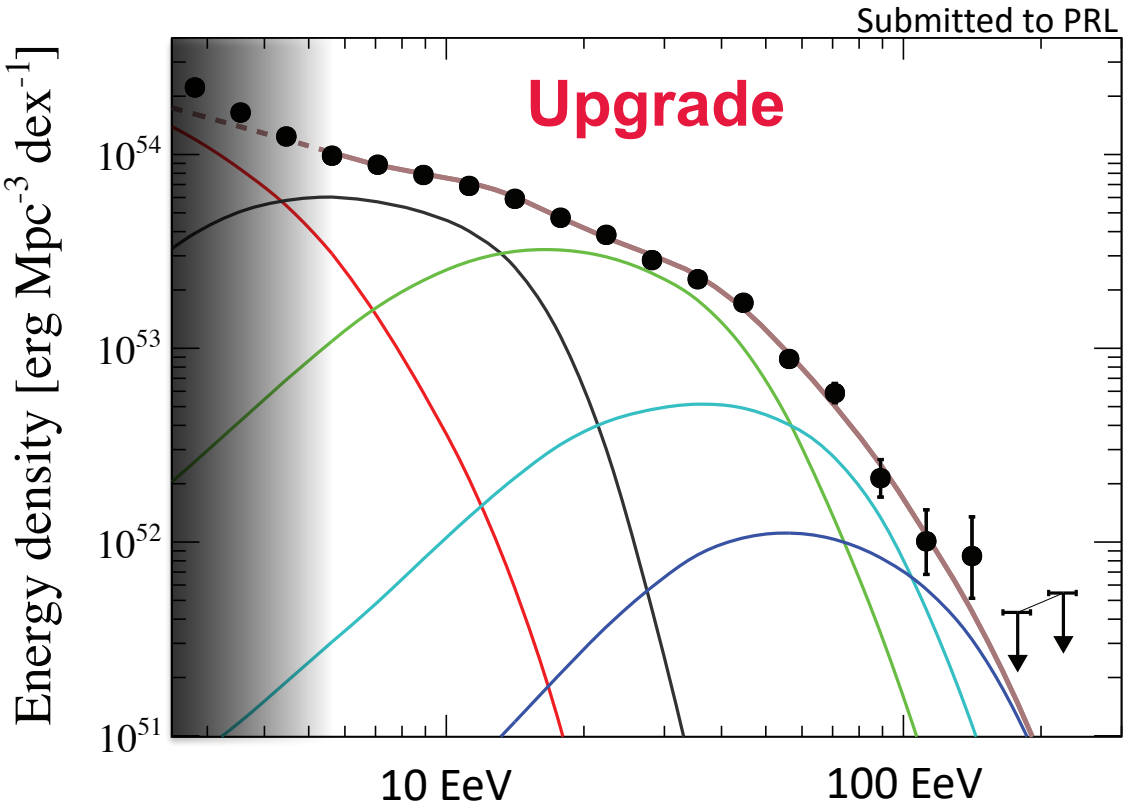
Pierre Auger Observatory results

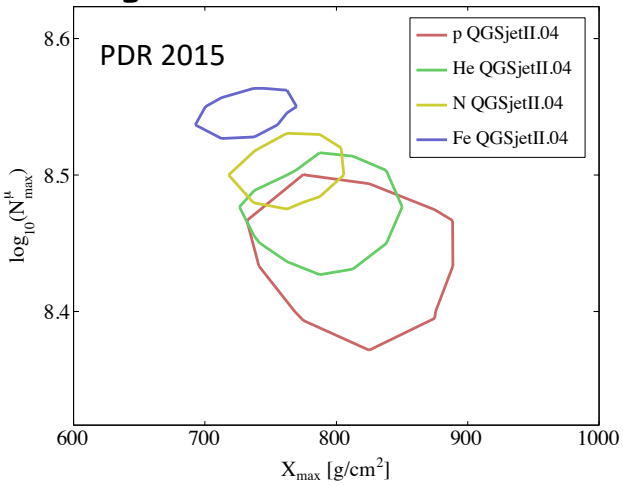


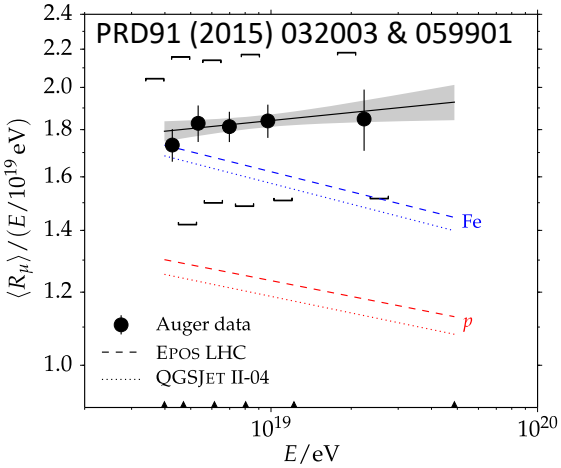




Pierre Auger Observatory results

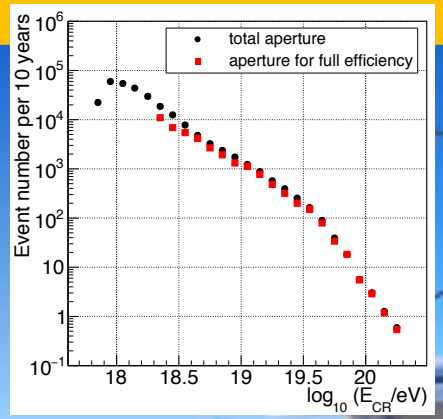






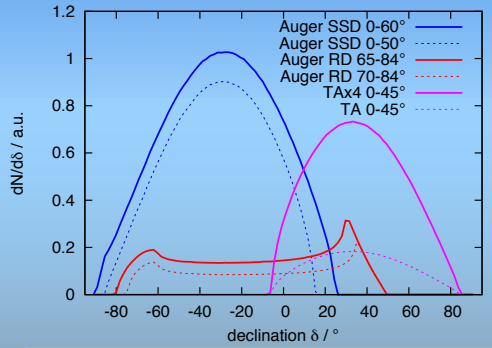
Measure particle type at highest energies

total # e



combination gives
e and μ separately

e+μ in
shower tail



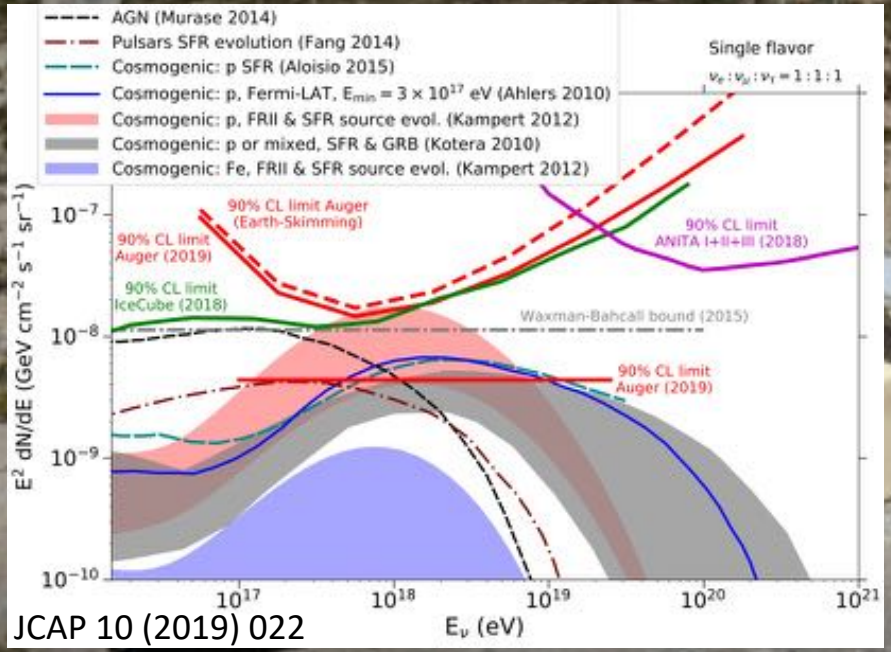
μ in
shower
tail

*a*e+*b*μ
in shower tail

Auger RD

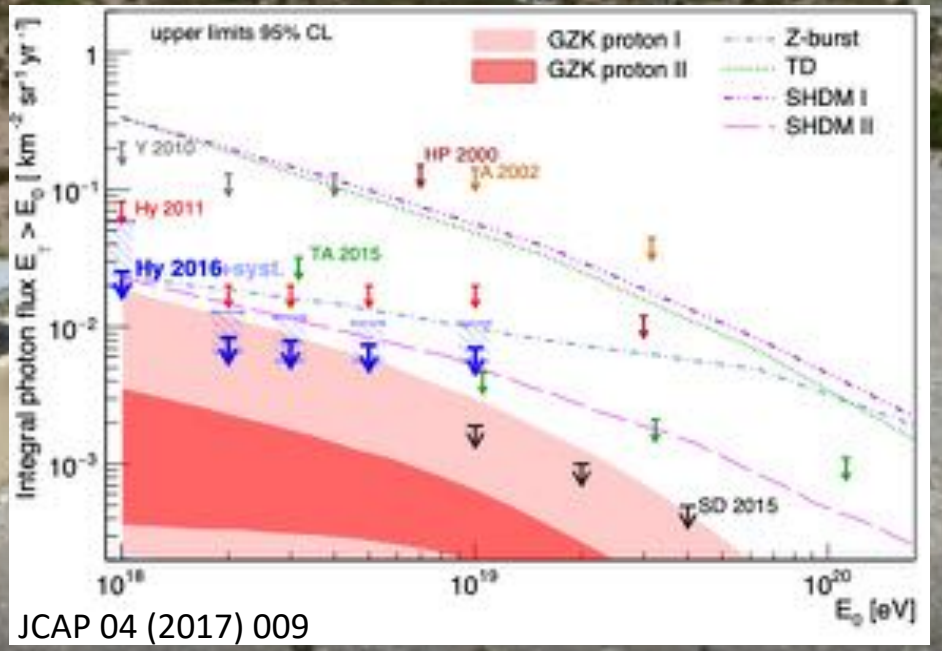
Looking for ultra-high-energy neutrals in inclined showers

Neutrino: RD signal + many muons



JCAP 10 (2019) 022

Photon: RD signal + few muons



JCAP 04 (2017) 009

Triggering as slave of SD tank, but investigating using RD in local station trigger

The Auger Engineering Radio Array (AERA)

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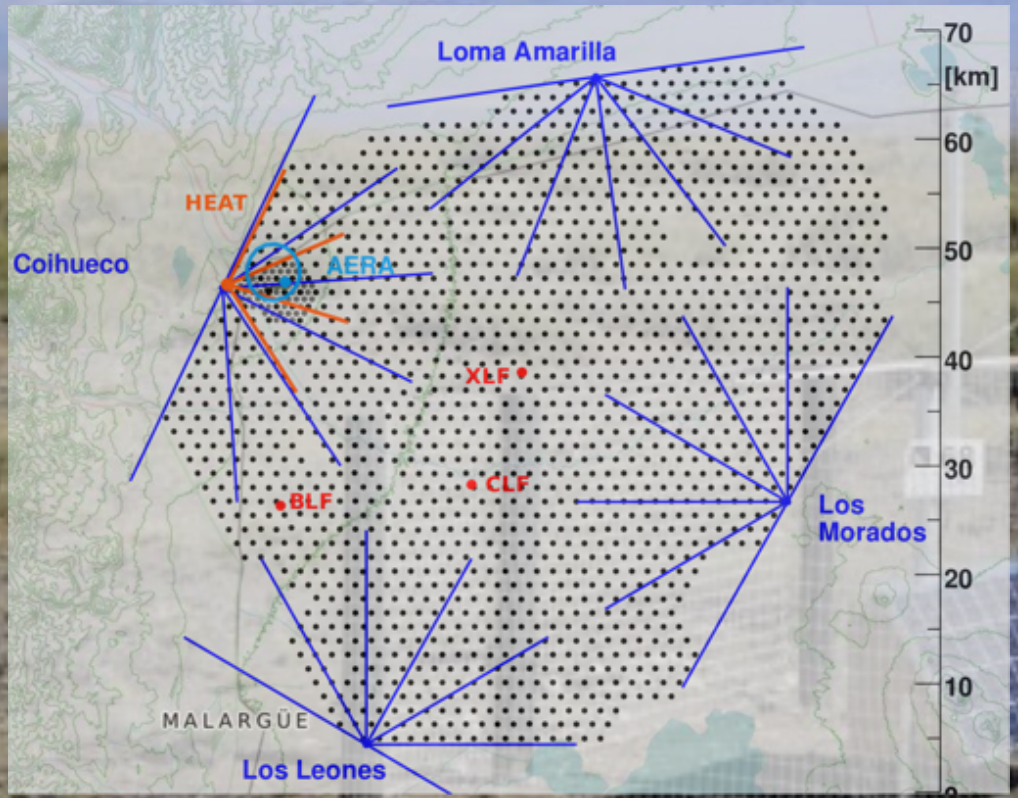
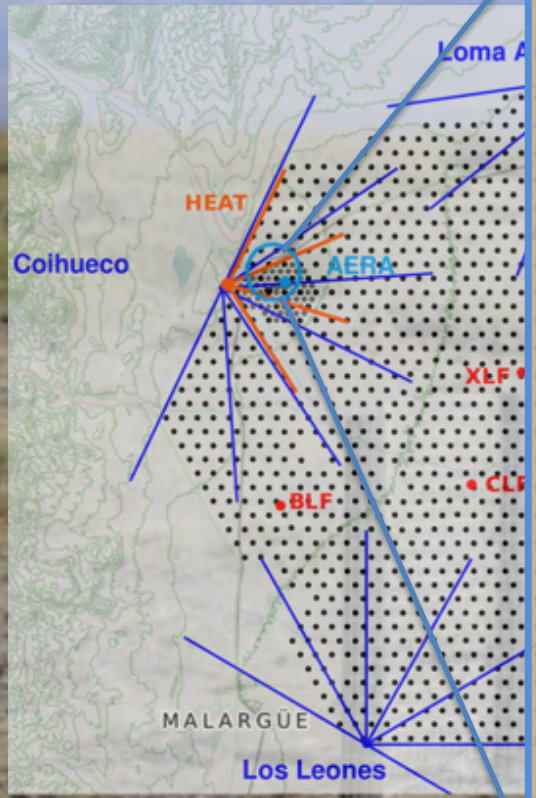
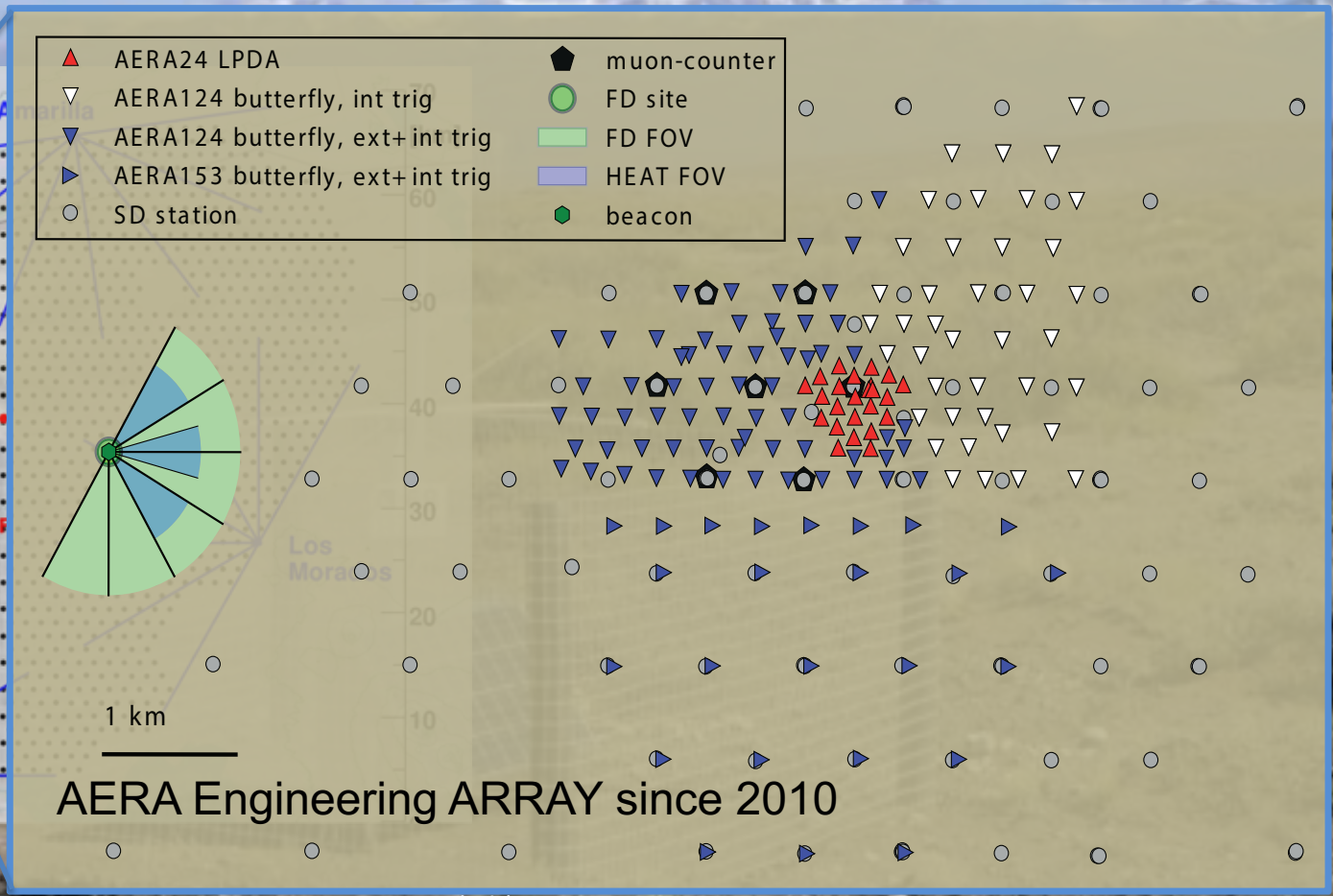
RD full array



The Auger Engineering Radio Array (AERA)

RD full array





AERA Engineering ARRAY since 2010

Radio Detection of (Ultra-)High-Energy Cosmic Rays

Geomagnetic

Charge separation

Cherenkov interference

Signal $A \sim E^2$

B

current

current

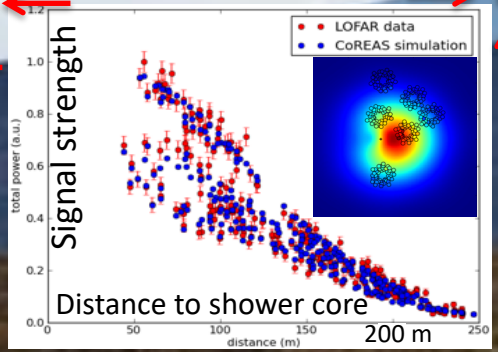
c

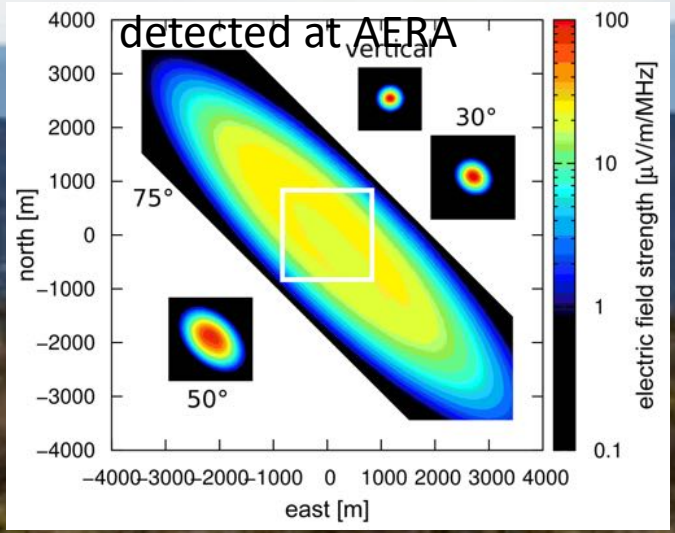
c/n

c/n

Polarisation:

>500 inclined showers detected at AERA





Project in $\vec{v} \times \vec{B}$ and $\vec{v} \times \vec{v} \times \vec{B}$ plane

Radio Detection of (Ultra-)High-Energy Cosmic Rays

Geomagnetic

Charge separation

Cherenkov interference

B

Signal $A \sim E^2$

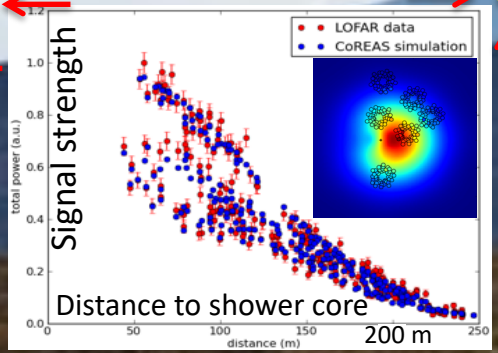
current

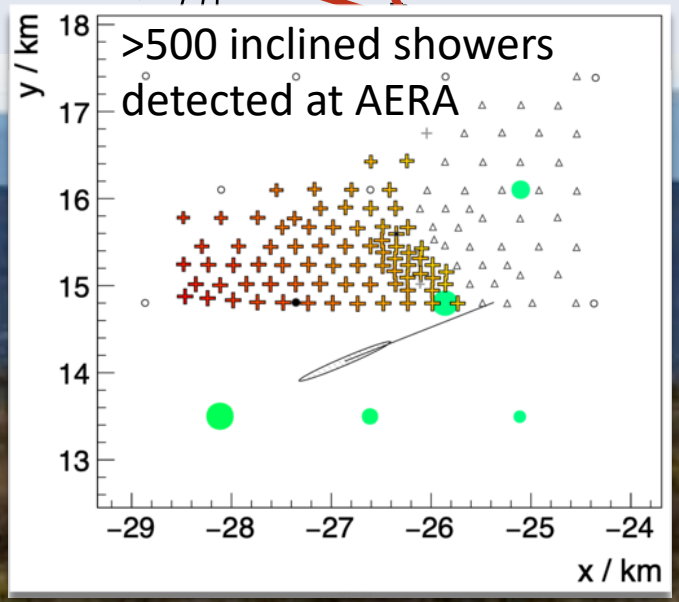
current

c

c/n

Polarisation:





Project in $\vec{v} \times \vec{B}$ and $\vec{v} \times \vec{v} \times \vec{B}$ plane

Radio Detection of (Ultra-)High-Energy Cosmic Rays

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Signal $A \sim E^2$

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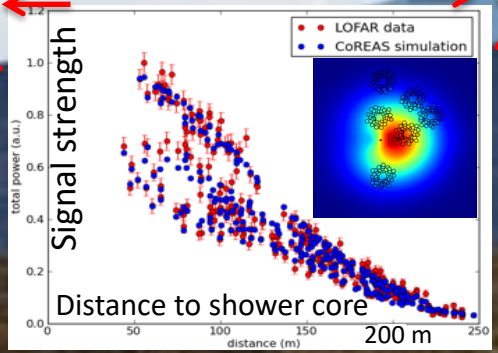

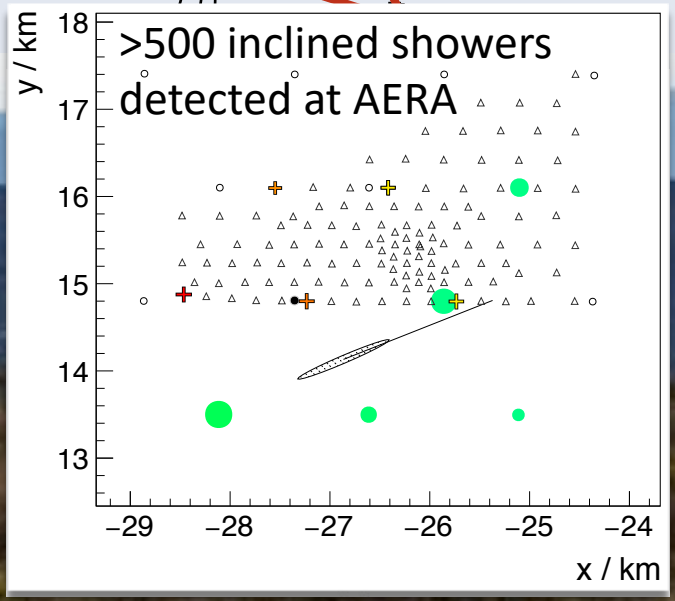

Project in $\vec{v} \times \vec{B}$ and $\vec{v} \times \vec{v} \times \vec{B}$ plane

Auger RD Status

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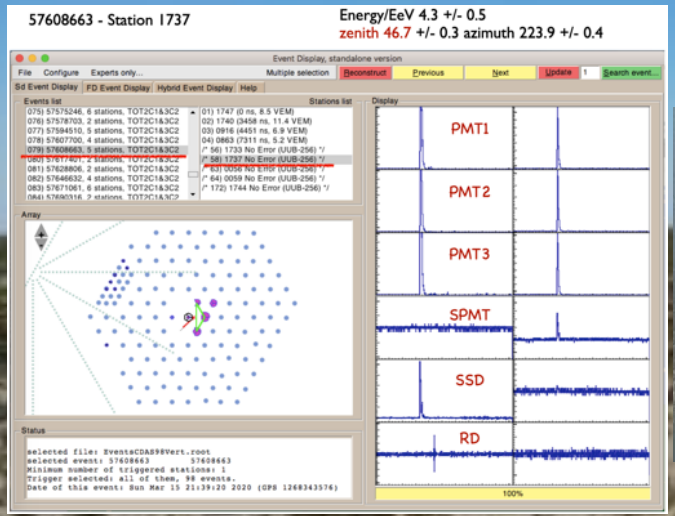

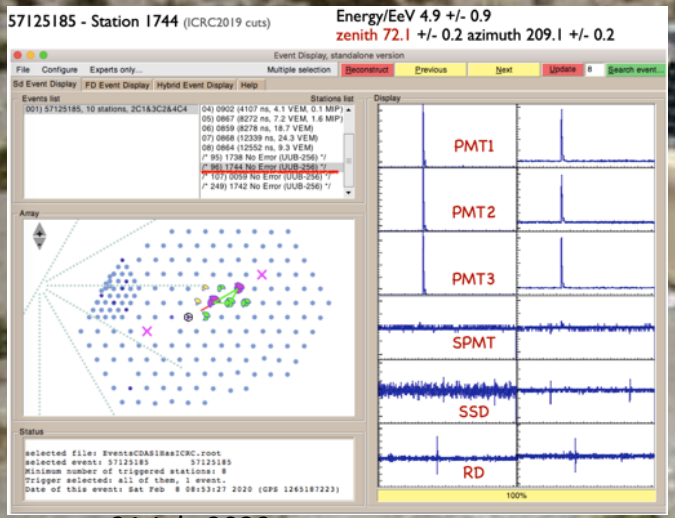

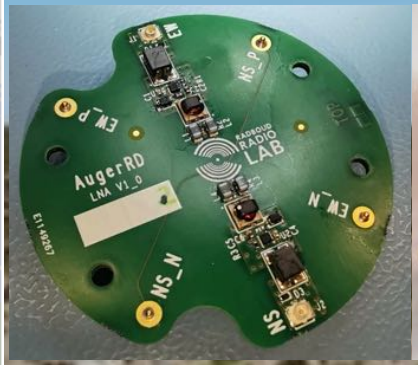

- Mechanical design complete and tested
- Electronics design nearly complete, optimising gain and noise performance on galactic background
- 10 prototypes in the field,
  7 in engineering array taking data since 8 months
- Start production end this year
- Deployment in 2021
- Measuring until 2030 (and beyond)