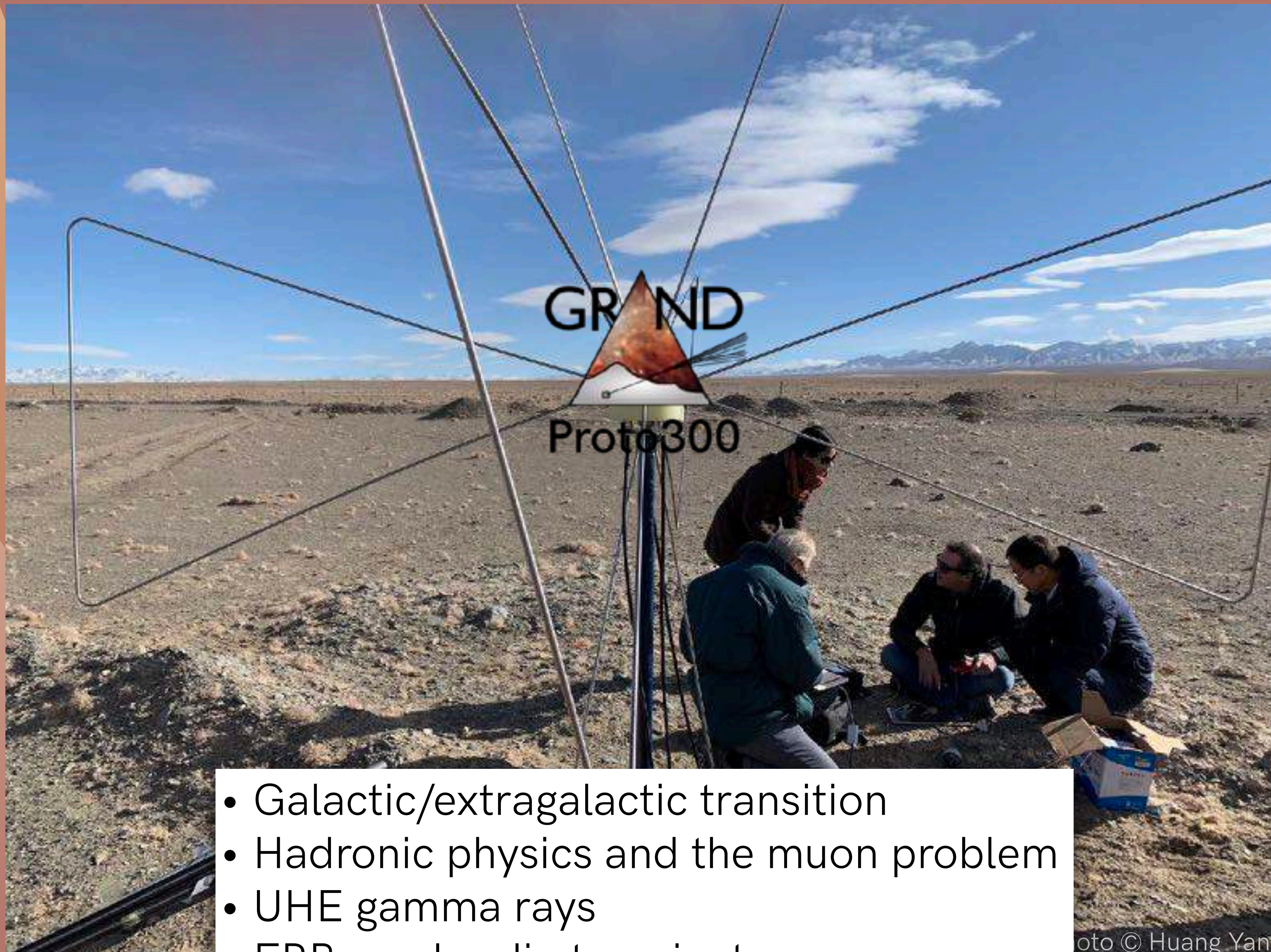
GP300 Science Case Overview

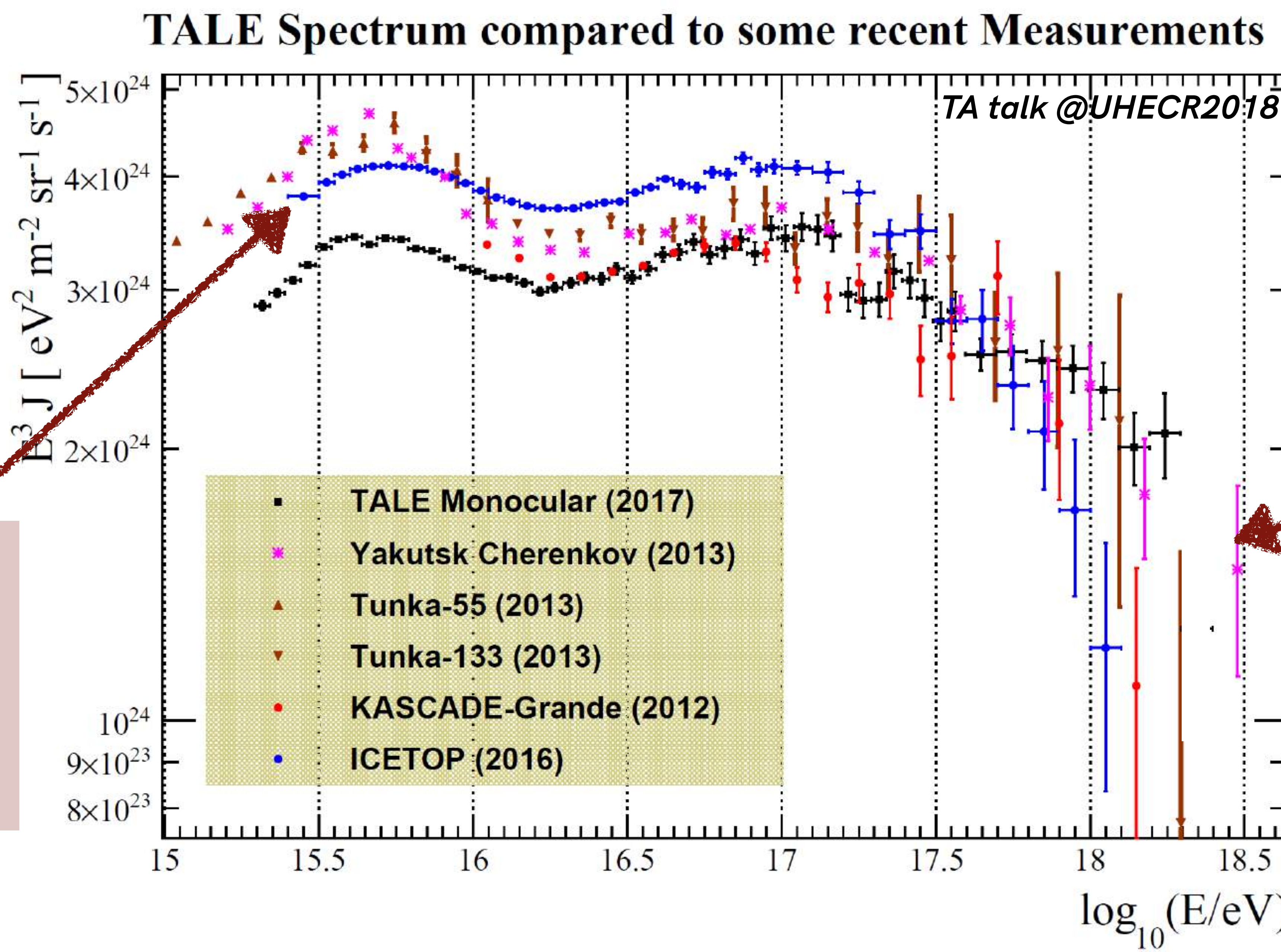


- Galactic/extragalactic transition
- Hadronic physics and the muon problem
- UHE gamma rays
- FRBs and radio transients

Aim of GP300: cosmic rays with $E=10^{16.5-18}$ eV

Ruoyu Liu & Ke Fang

Galactic to extragalactic transition



knee
Galactic
SNR
origin

> 8 EeV
extragalactic
origin

dipole measurement
Auger Coll. 2018

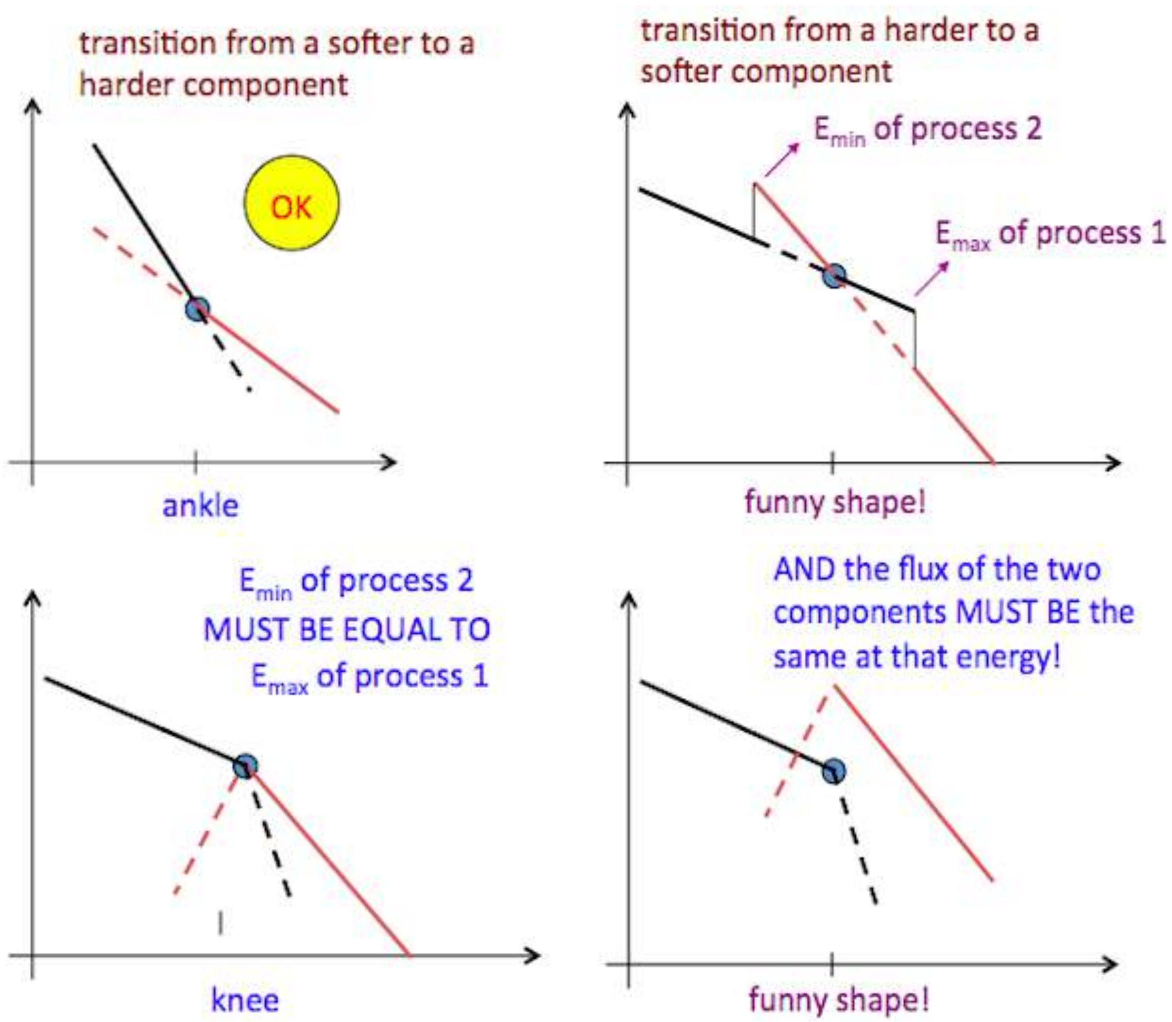
virtue of this transition region

- relatively important particle flux (few 100 cm^{-2} sr^{-1} s^{-1} GeV^2)

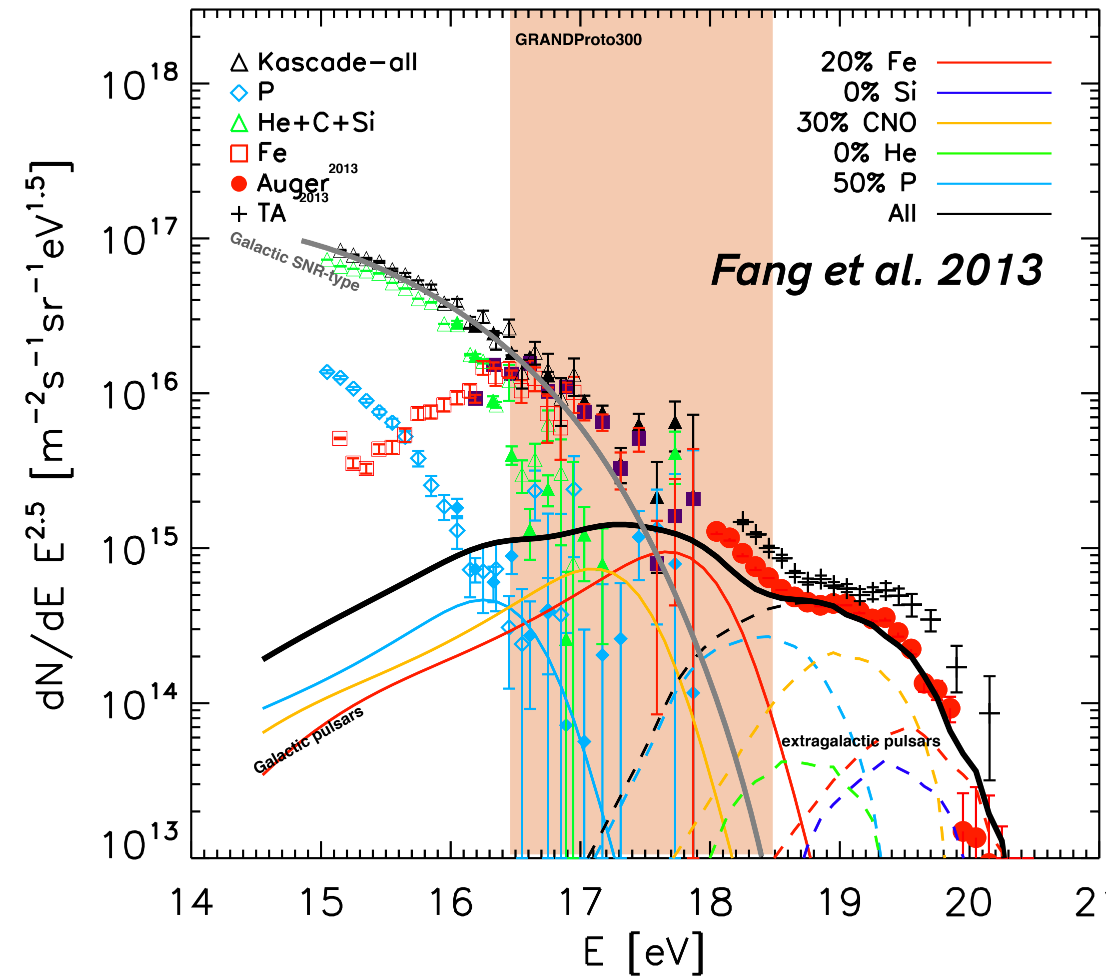
—> accumulate reasonable statistics with mid-sized detectors

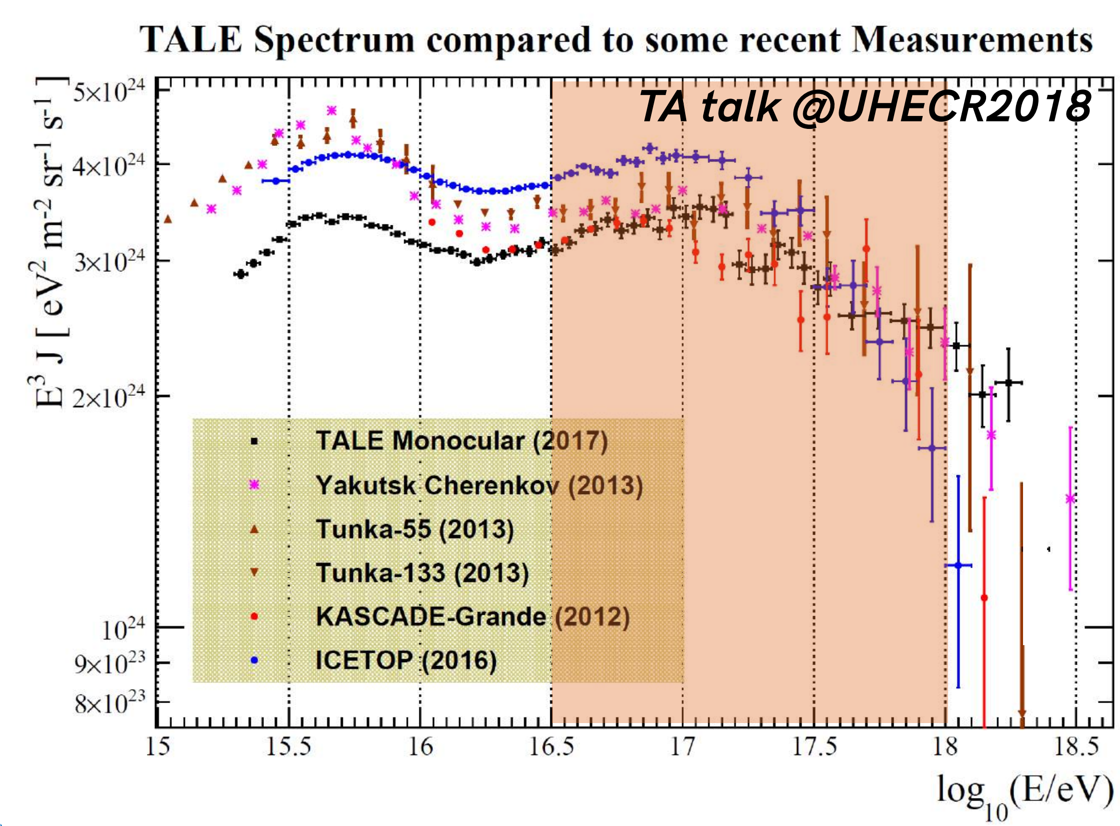
- overlaps with energy range experimentally probed by LHC

Observational status: spectra



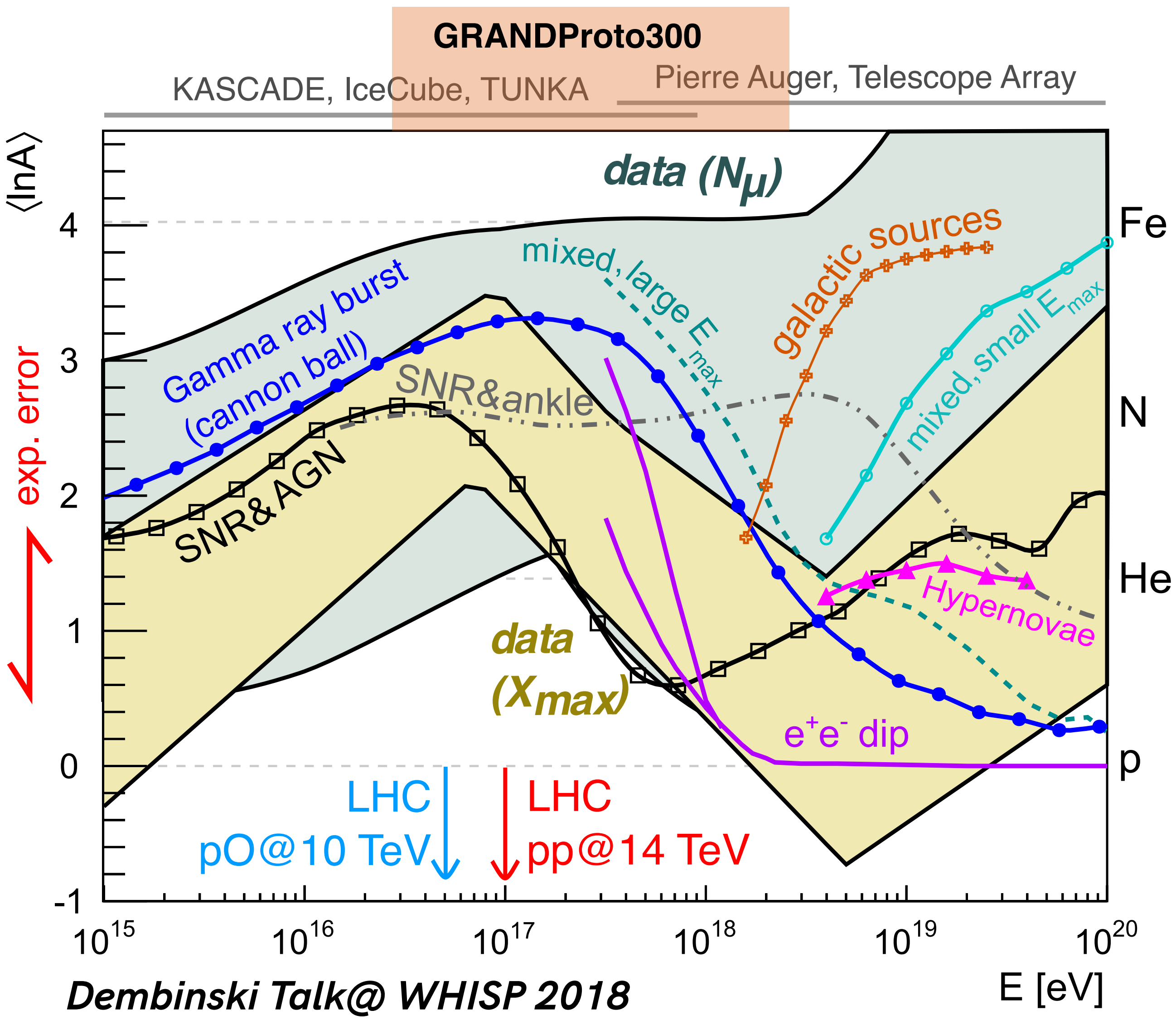
Parizot 2014



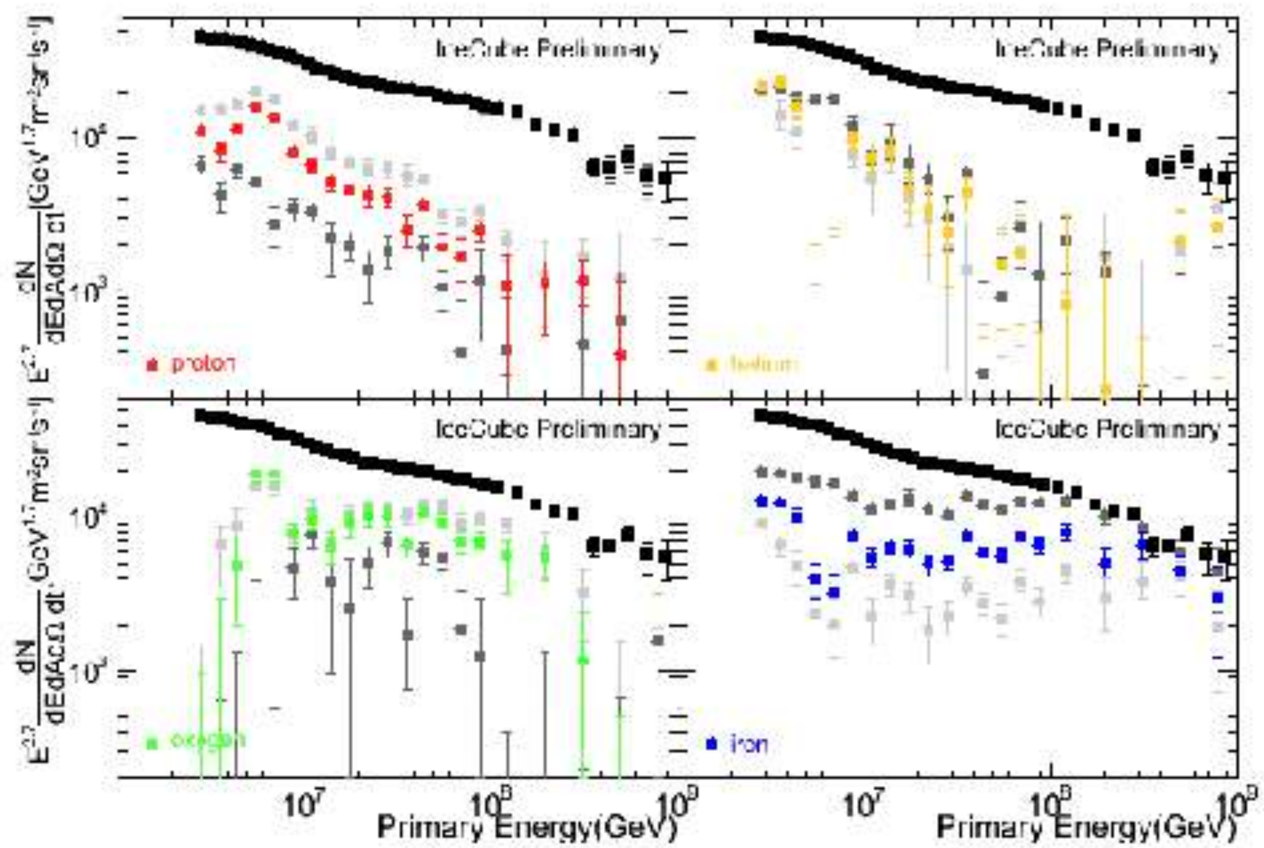


- bumpy spectrum
- emerging and vanishing mass elements?
- most theory models fit because of systematic uncertainties
- experimental gap around 10^{17}eV

Observational status: mass



Dembinski Talk@ WHISP 2018
from Kampert & Unger (2012)



IceCube ICRC 2015

- not precise enough for constraints on models
- muon data —> large uncertainties

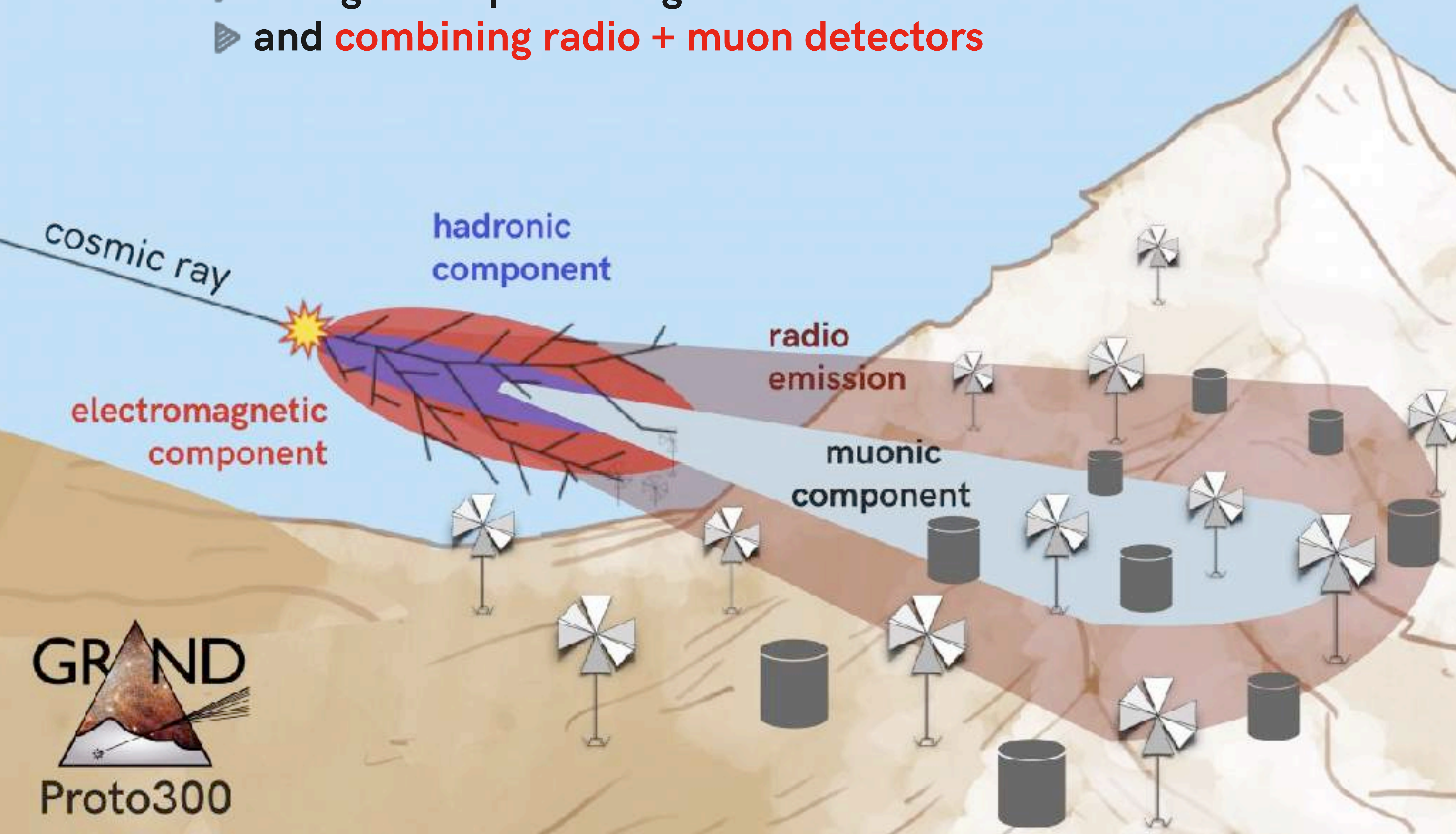
Observational status: anisotropy

- No measurement in this band!

the Rio/San Paolo group (Marcio Mueller, João Torres de Mello Neto, Bruno Lago, Rogerio Menezes de Almeida)

How GP300 will help

- experimental gap around 10^{17}eV
- **a single setup covering $10^{16.5-18}$ eV**
- **and combining radio + muon detectors**



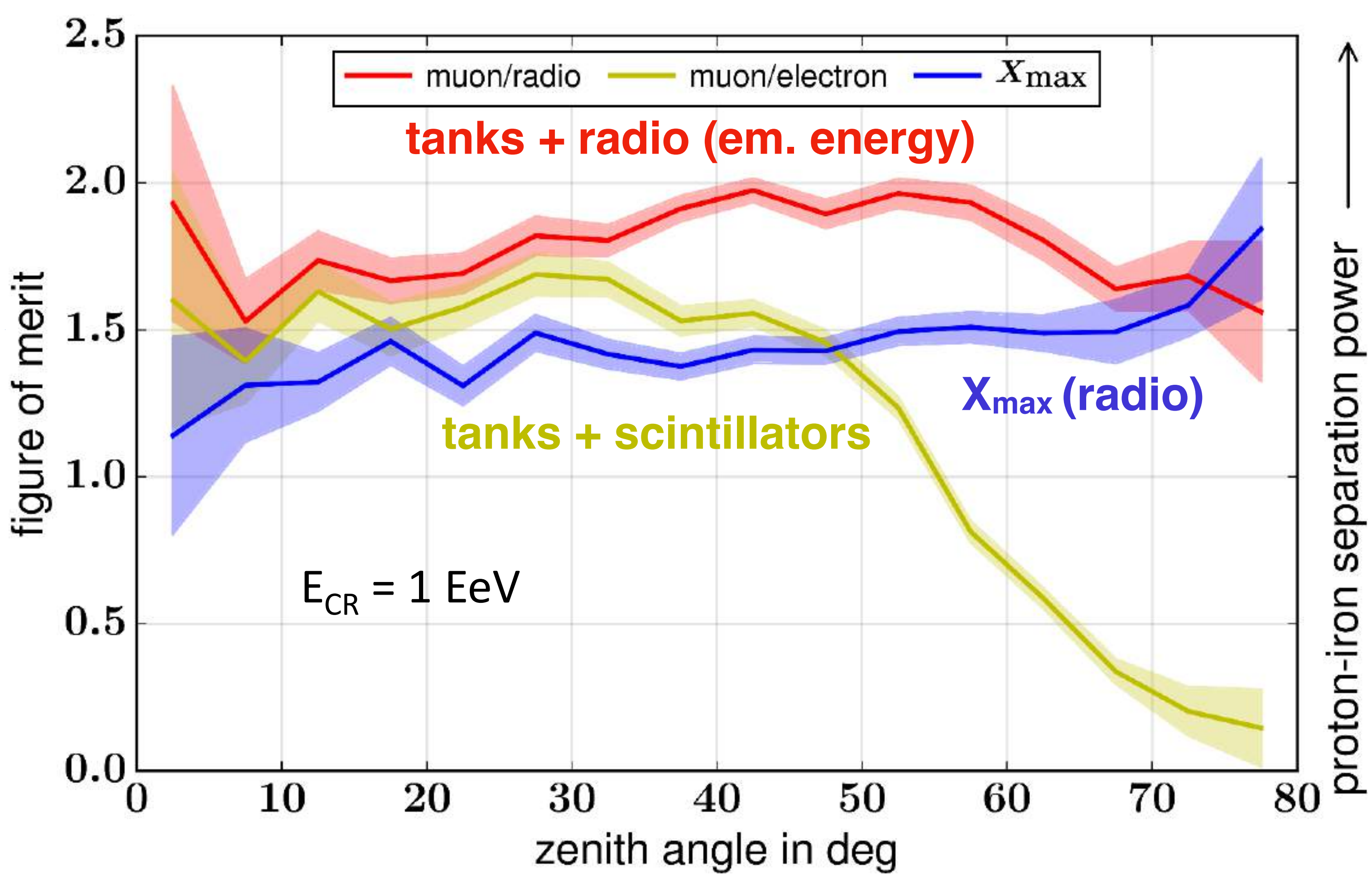
GRAND Proto300

How to reach an exquisite accuracy on mass composition?

a single setup covering $10^{16.5-18}$ eV
combining radio + muon detectors

- best for inclined showers (>60°)
- **add also standalone radio measurement of X_{max} for exquisite accuracy!**

radio self trigger —> no dependency on the primary nature for trigger efficiency (ex : light primaries inducing muon-poor showers)



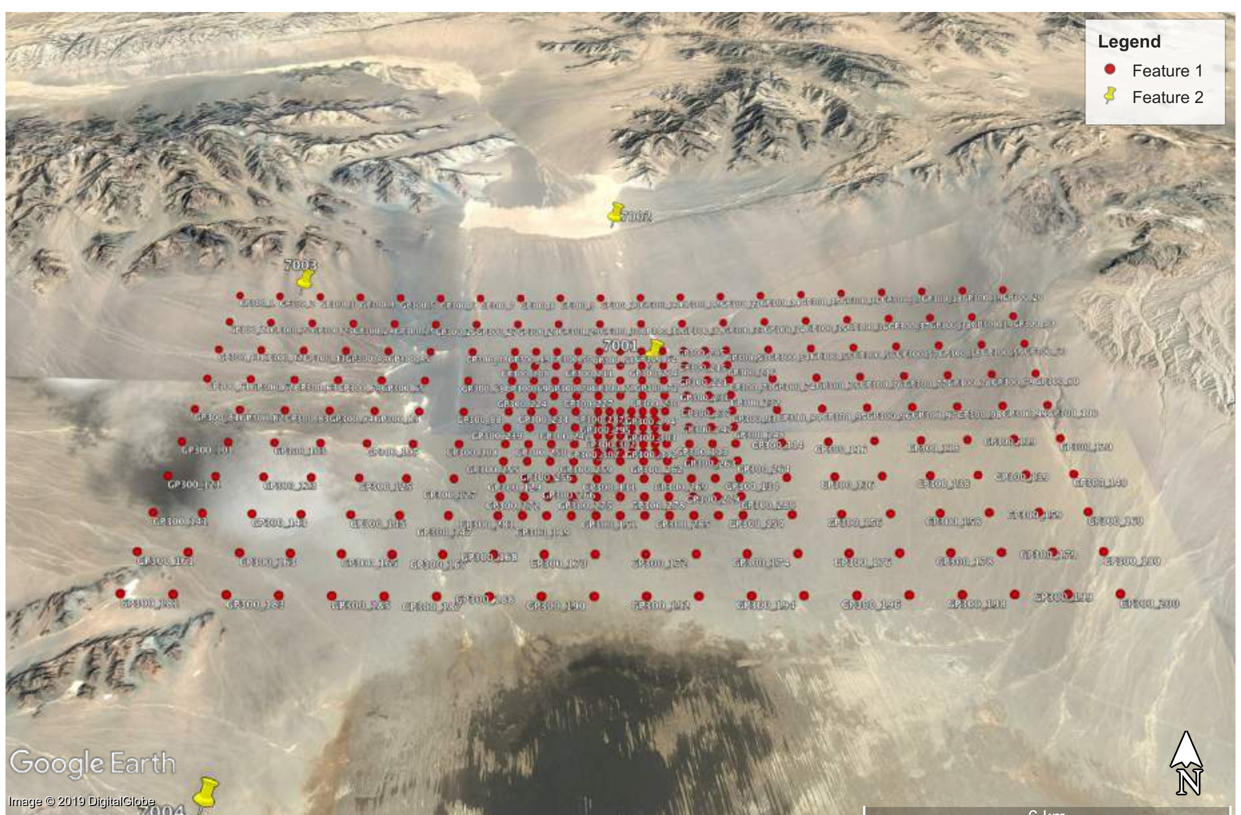
Ewa Holt PhD thesis

GRANDProto300

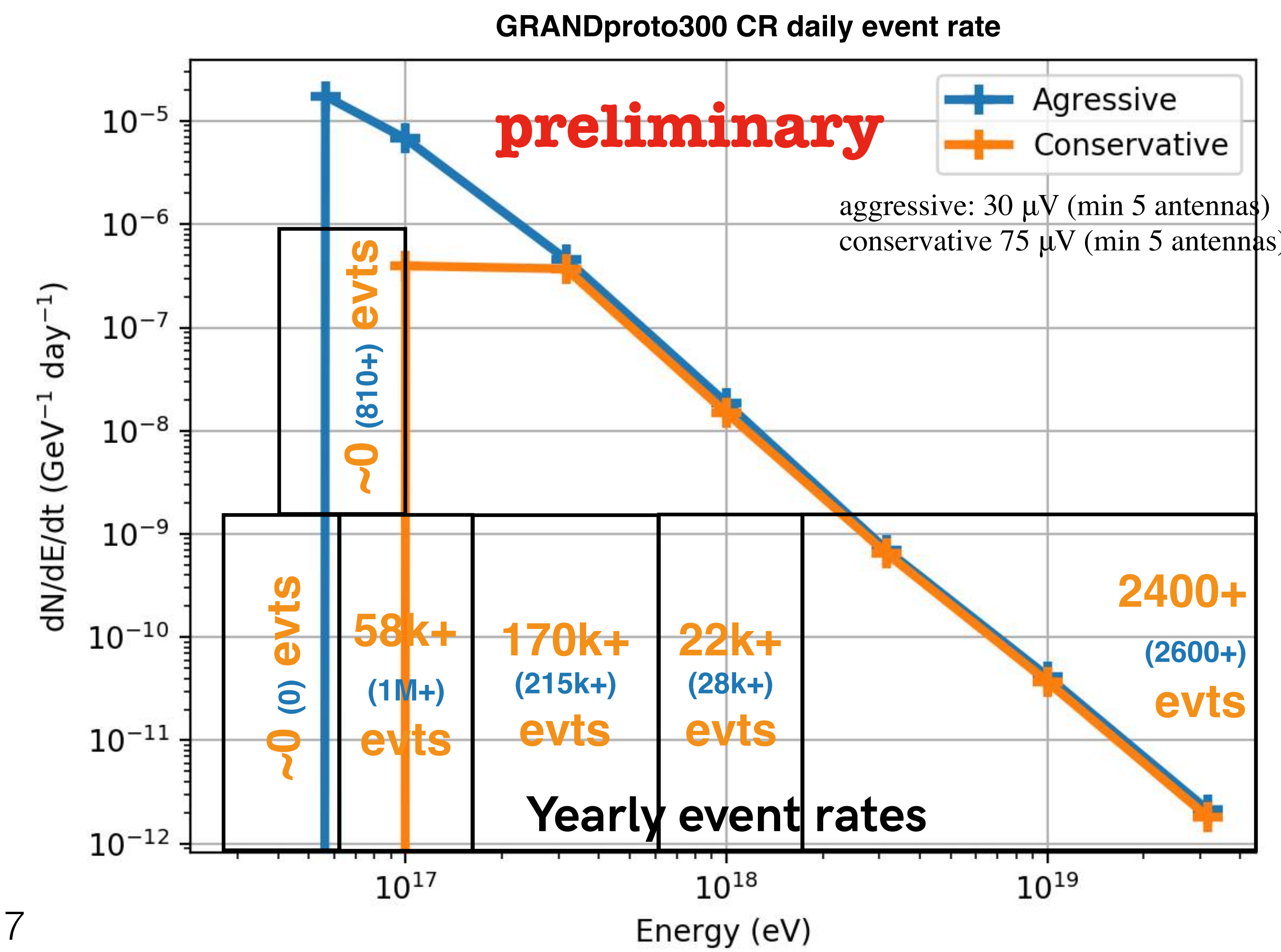
- an autonomous radio array
- for inclined air-showers
- with denser infill to reach low energies and cover $10^{16.5\text{-}18}$ eV
- a hybrid ground array for muon detection

Possible preliminary layout

- 200 km² with 196 detection units
- 25 km² infill of 85 antennas with 500-m spacing
- 2 km² infill with 26 antennas with 250-m spacing
- + ground array - configuration to be studied



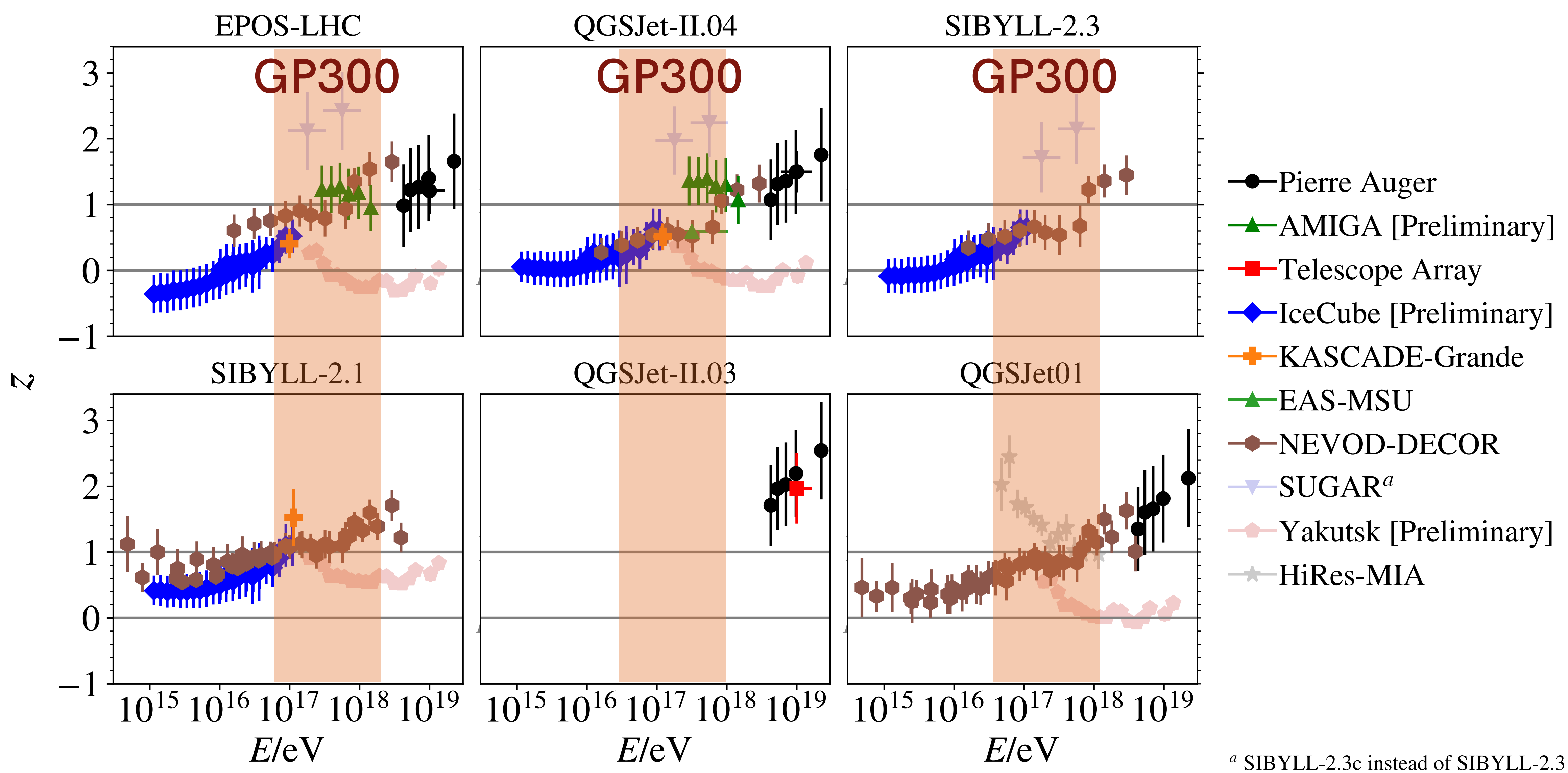
enough statistics for good accuracy on anisotropy+spectrum



Step 1: Convert all measurements to z-scale $z = \dfrac{\ln N_{\mu}^{\mathrm{det}} - \ln N_{\mu,p}^{\mathrm{det}}}{\ln N_{\mu,\mathrm{Fe}}^{\mathrm{det}} - \ln N_{\mu,p}^{\mathrm{det}}}$

corrects simple biases;
$z_p = 0$ and $z_{Fe} = 1$

Potential divergence from differences in: **energy scale offsets**, zenith angles, lateral distances, muon energy thresholds



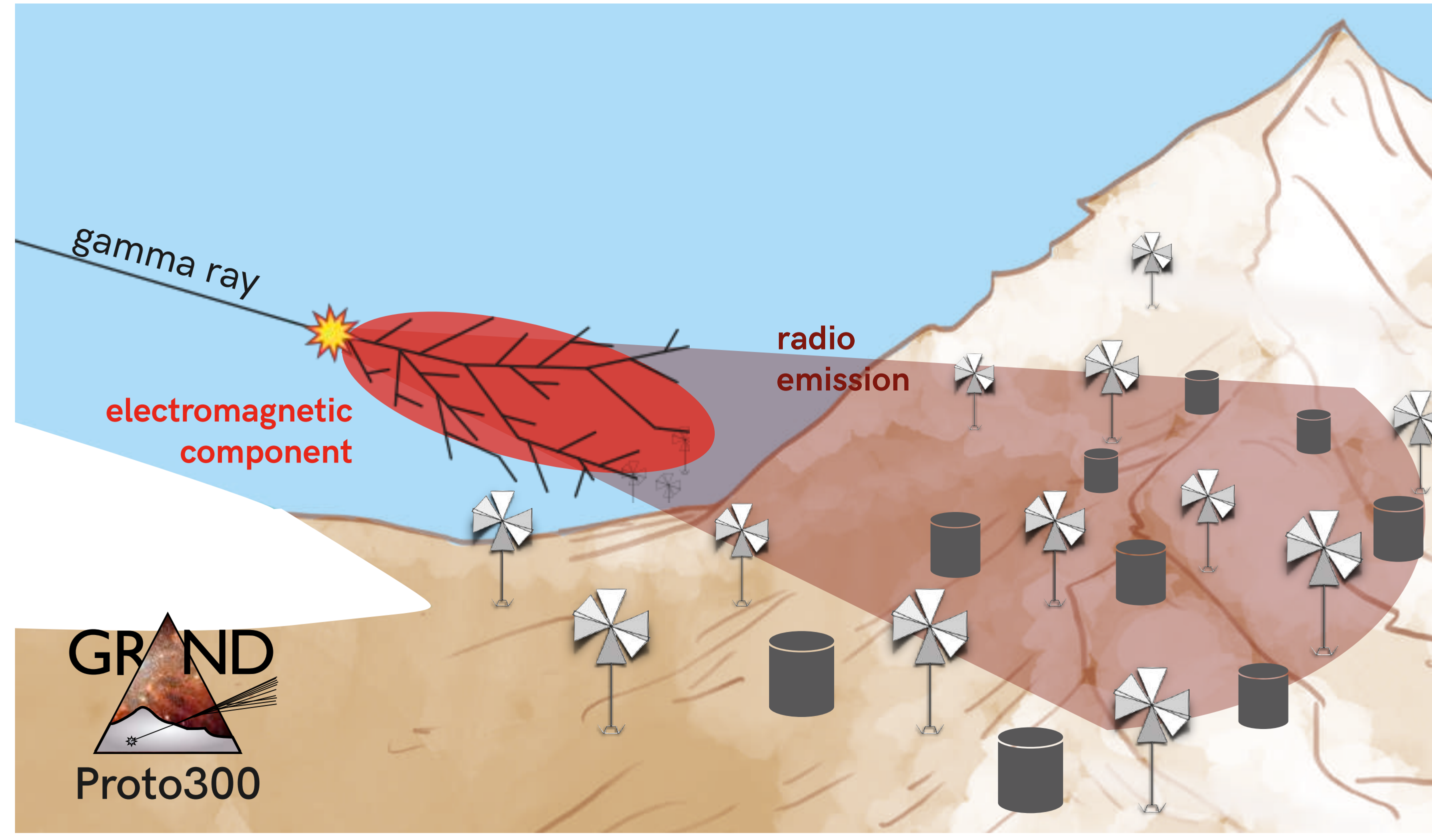
H. Dembinski WHISP 2018

UHE gamma-rays with GP300

Kohta Murase

- veto to search air-showers initiated by UHE gamma-rays

gamma-ray air showers with $\theta_z \geq 65^\circ$
—> electromagnetic component dominant
—> fully absorbed by atmosphere before reaching the ground
—> no muons

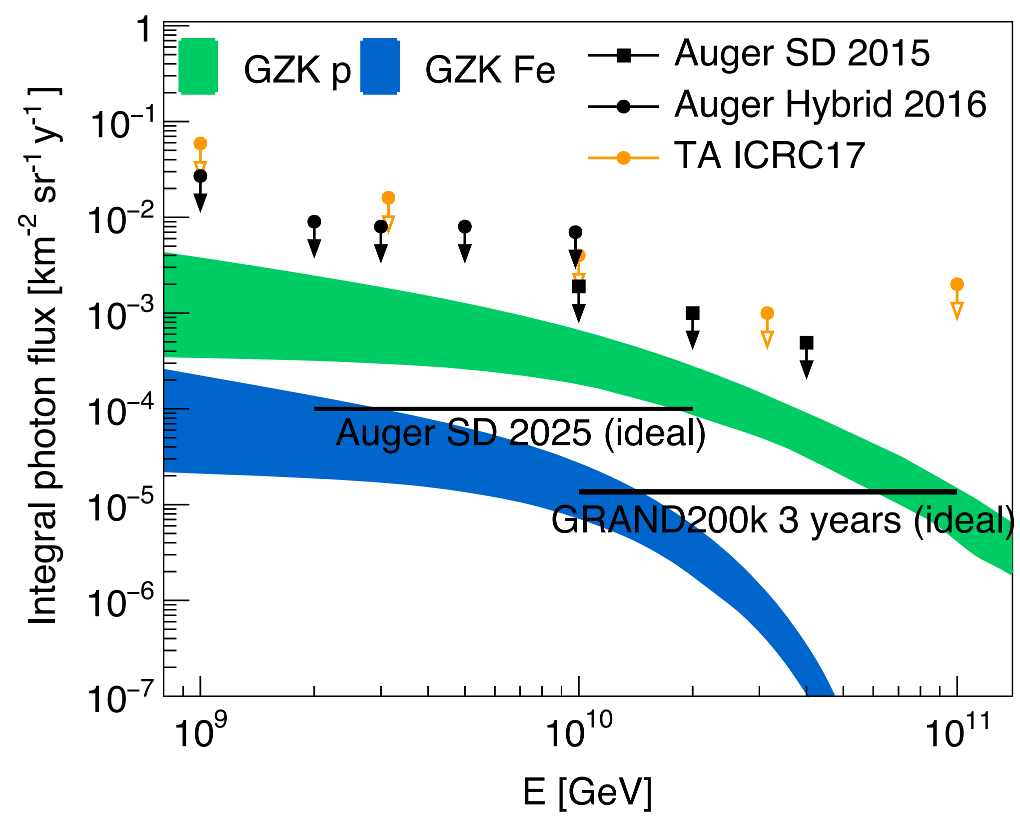


- preliminary simulations:

separation ~100% for $65^\circ \leq \theta_z \leq 85^\circ$ at E>10^9 GeV

- if no gamma-ray events identified in a sample of 10 000 showers at E>10^9 GeV, collected in 2 years

—> 95% C.L. limit on fraction of gamma ray-initiated showers **~0.03%**
(current best limit by Auger 0.1%).



FRBs, GRPs and other radio transients

Valentin Decoene
(with NenuFAR & GRAND)

- radio transient events (ms impulsions, broad frequency band)
- simple downscaling from GRAND: 750 Jy sensitivity for GP300

—> good for Giant Radio Pulses (Crab and other pulsars)

—> other serendipitous radio transient discovery? half sky coverage

- learning FRB observations from NenuFAR

- what happens in the low frequency band for FRBs? (observation of specific repeater FRBs detected by CHIME with "beam-forming")

- blind search performances