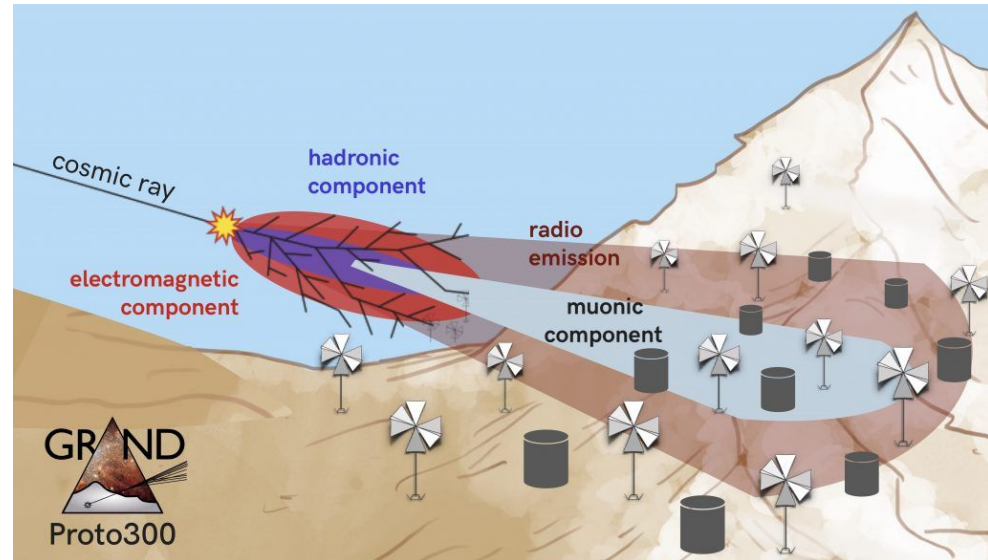
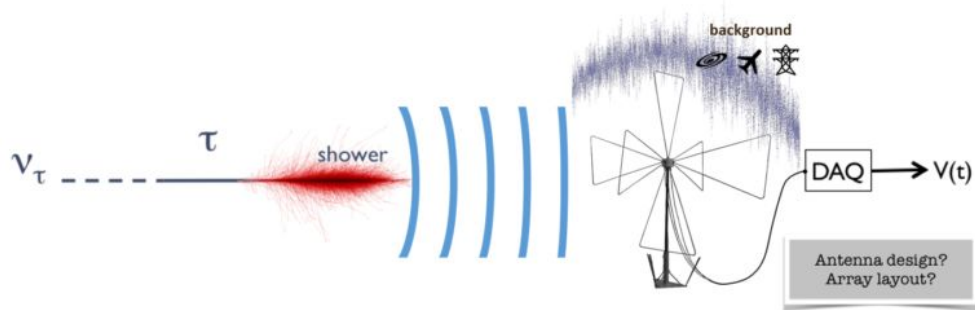


GRANDProto300 will be an array of 300 antennas deployed over 200 km². It will operate in the 50-200 MHz band and will trigger, from radio data alone, on nearly horizontal air showers.

The preliminary layout of GRANDProto300 covers 200 km² with ~200 detection units to enable large statistics at EeV energies, complemented with two denser levels of infills. This density hierarchy enables to reach good accuracy and large statistics from energies as low as $10^{16.5}$ up to $10^{18.5}$ eV, with a single system.



GRANDProto300



Topography along track
CC & NC ν_τ interactions
 τ energy losses
 τ decay

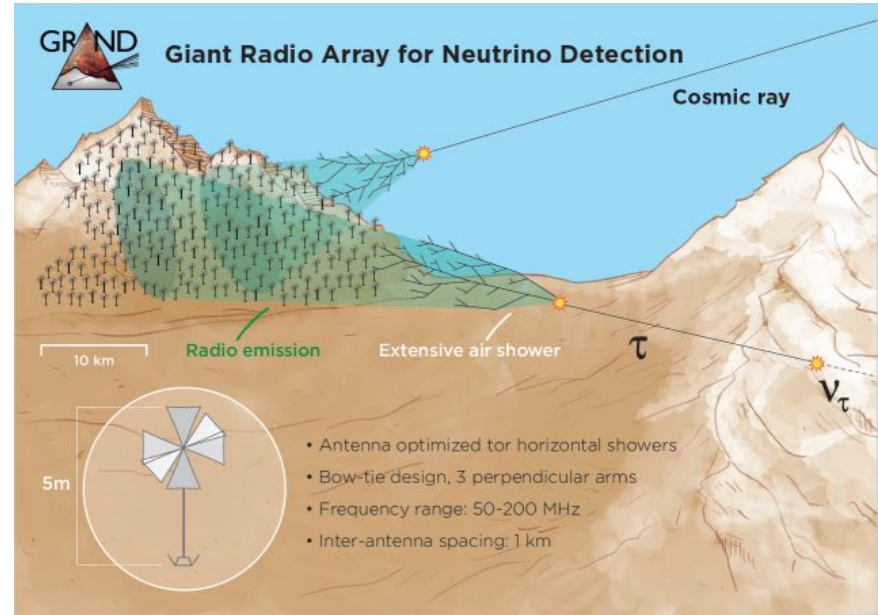
DANTON

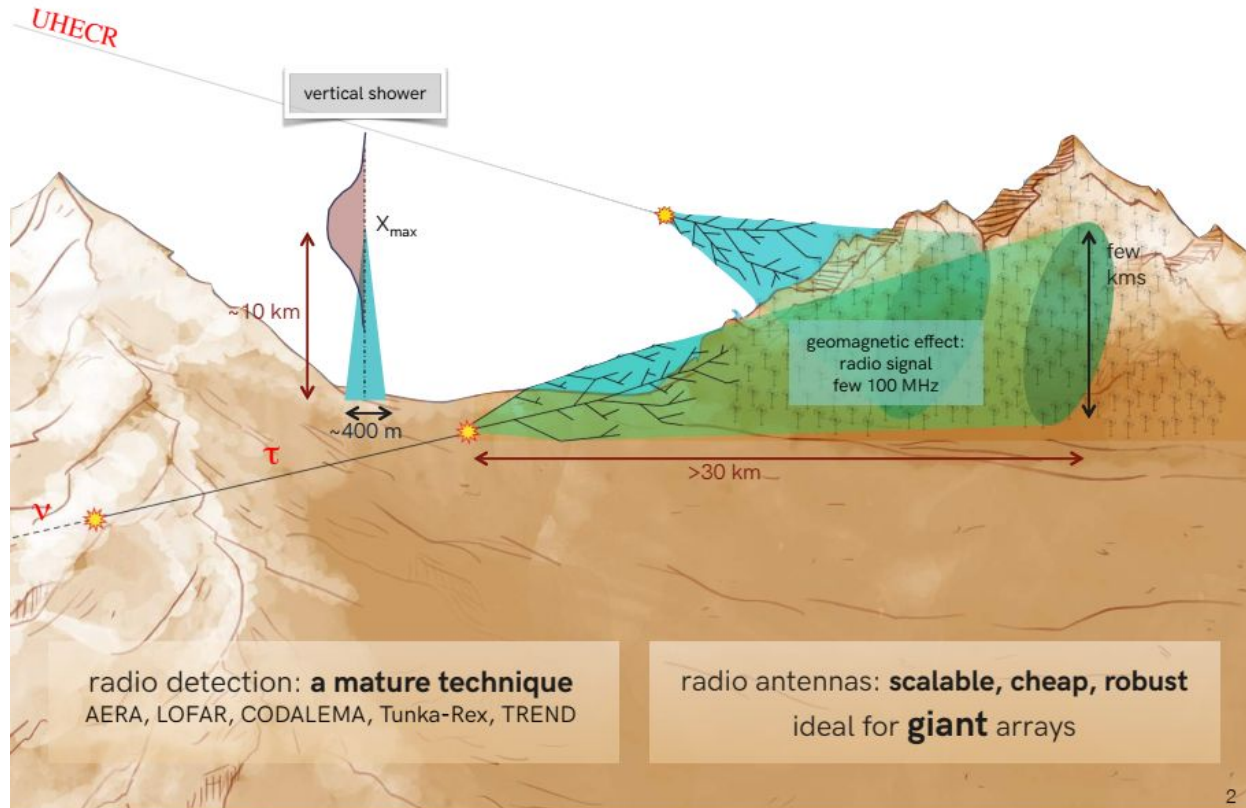
Shower development
Radio emission

Radio-morphing

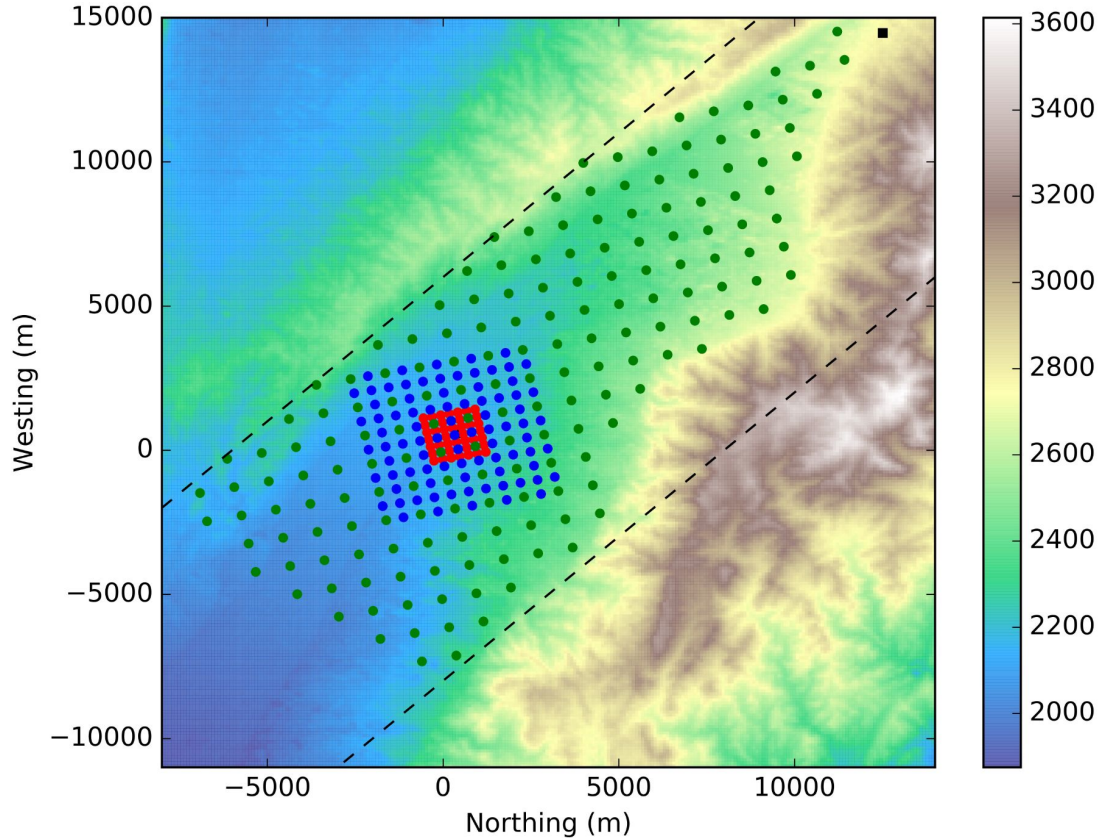
Antenna response
Antenna trigger
(background noise sim)

NEC



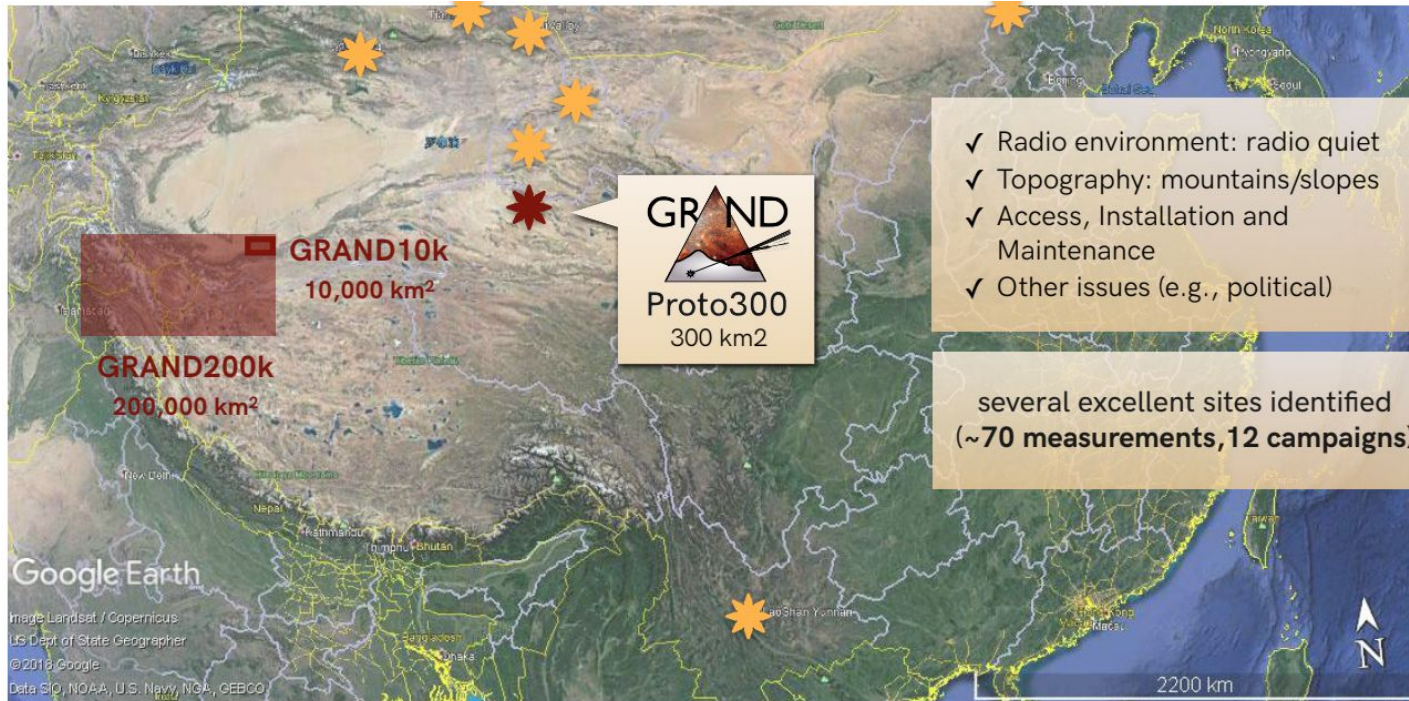
 Radio detection of ultra-high-energy air-showers


GRANDProto300



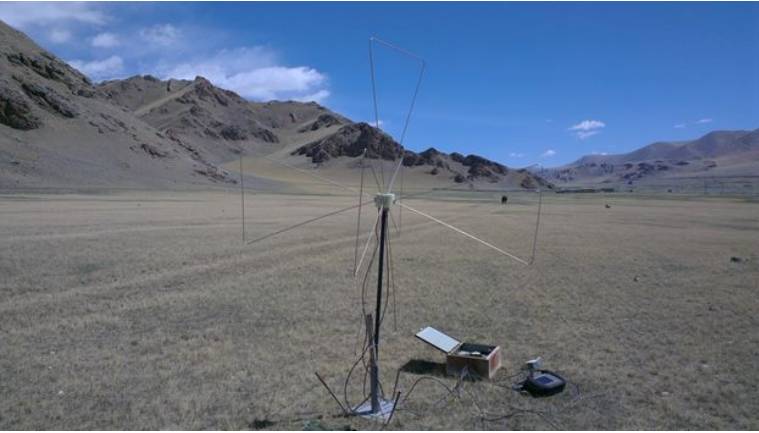
An ideal setup, as in GRANDProto300, is thus a hybrid array of radio antennas and muon detector, to have a handle on both the electromagnetic and muonic contents of the shower. For inclined showers as will be observed in GRANDProto300, the electrons are absorbed in the atmosphere, leaving only muons on the ground. Autonomous radio detection allows to measure the shower energy mostly independently from hadronic models.

GRANDProto300



Deployment site and political support in China. A dozen of site surveys have been conducted in the past 2 years in mountainous and deserts areas in China and an excellent 300 km² site with clean radio background properties and good accessibility has been selected in the Qinghai Province, on the verge of the Tibetan plateau. The project has strong political support at local and Province level, and deployment is planned for 2021.

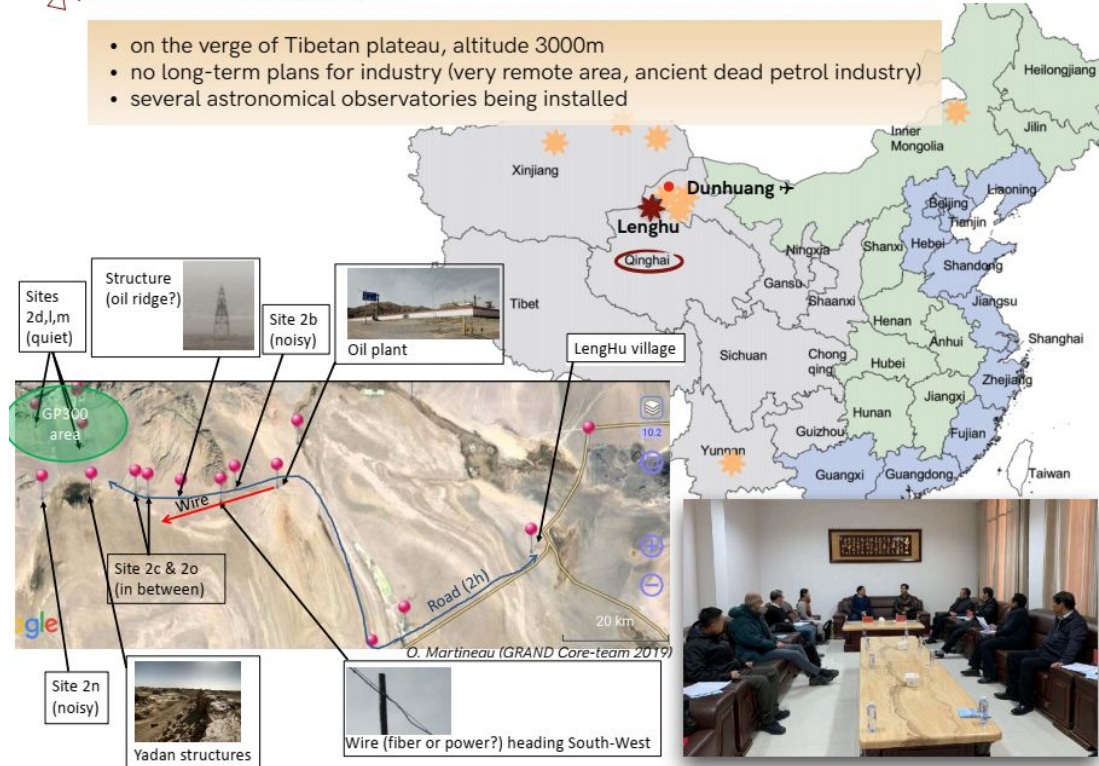
GRANDProto300



A GRANDproto35 three-dimensional antenna at the testing site, XinJiang Province, China.

✦ GRANDProto300 site

- on the verge of Tibetan plateau, altitude 3000m
- no long-term plans for industry (very remote area, ancient dead petrol industry)
- several astronomical observatories being installed



GRANDProto300

 GRAND Today

~80 collaborators from 11 countries

GRAND Workshop,
Dunhuang, April 2019



Particle detectors
Penn State U.

Science case
IAP
Nanjing U.
NBI
PMO
Penn State U.

Electronics prototyping
Nikhef/Radboud U.
NAOC
PMO

Fast Radio Bursts
PMO
Obs. Paris/Nançay

Simulations/data analysis
IAP
KIT
LPNHE
Nanjing U.
PMO
UF Rio de Janeiro
VU Brussels

Software
Warsaw U.
IAP/LPNHE
LPC Clermont
UF Rio Janeiro

Antenna prototyping
Nikhef/Radboud U.
Xidian U.

Unit production
NAOC
PMO
Xidian U.

Site management
PMO
NAOC

GRANDProto300

GRANDProto300

GRANDProto35

GRAND10k

GRAND200k

2018

2020

2025

203X

Goals

standalone radio array: test efficiency & background rejection

standalone radio array of very inclined showers ($\theta_z > 70^\circ$) from cosmic rays ($> 10^{18}$ eV)
+ ground array to do UHECR astro/hadronic physics

first GRAND subarray, sensitivity comparable to ARA/ARIANNA on similar time scale, allowing discovery of EeV neutrinos for optimistic fluxes

first neutrino detection at 10^{18} eV and/or neutrino astronomy!

Setup

35 radio antennas
21 scintillators



- 300 HorizonAntennas over 300 km²
- Fast DAQ (AERA+ GRANDproto35 analog stage)
- Solar panels (day use) + WiFi data transfer
- Ground array (à la HAWC/Auger)

DAQ with discrete elements, but mature design for trigger, data transfer, consumption

200,000 antennas over 200,000 km², ~ 20 hotspots of 10k antennas, possibly in different continents

Budget & stage

160k€, fully funded by NAOC+IHEP, deployment ongoing @ Ulstai

1.3 M€ to be deployed in 2020

1500€ / detection unit



ASIC
Cost ~ 10M€ → few 10€/board
Consumption < 1W
Reliability

Industrial scale allows to cut down costs: 500€/unit
→ 200M€ in total