Self-trigger radio prototype array for GRAND

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GRAND

The Giant Radio Array for Neutrino Detection (GRAND)[1] will use a huge number of antennas to detect radio emission generated by extensive air showers (EAS) that are initiated by ultra high energy (UHE) particles in the atmosphere. GRAND will consist of roughly 20 separate, independent sub-arrays of approximately 10000 radio antennas each, totaling a combined area of 200000 km^2 .

GP300

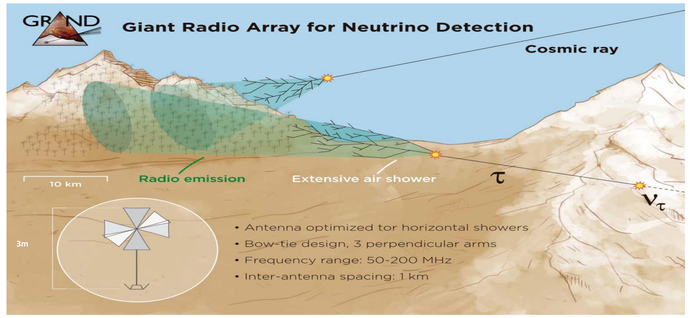
The GRANDProto300 (GP300) experiment is the 300-antenna pathfinder stage of GRAND.

- GP300 will validate GRAND as a standalone radio detection array and optimize the self-trigger techniques [2].
- GP300 will be an ideal test bench to improve the reconstruction algorithm for near-horizontal showers.
- GP300 will measure the SED, anisotropy and mass composition for CRs from 30 PeV to 1 EeV.

Deployment site

For two sites we are now evaluating the ease of access, infrastructure, support by local authorities, and possible extension to the GRAND10k stage.

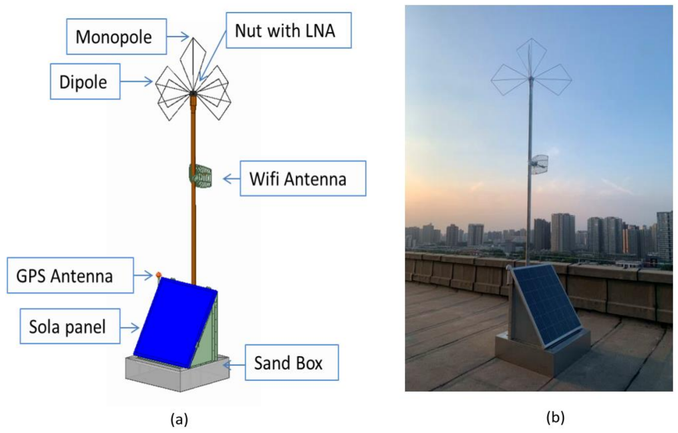
One candidate site close to the town of Lenghu in Qinghai Province was selected in July 2019. Another candidate is in a natural preservation zone near DunHuang in Gansu Province.



GRAND detection principle.

Antennas

The GP300 use a kind of Horizontal Antenna. The height of the antennas is set to 3 m above ground to decrease the diffraction effect of radio waves off the ground. The antenna unit is composed of 5 radiation arms. The detector is operated at frequencies in the range of 50-200 MHz.



(a) Schematic view of the GP300 antenna unit. (b) Picture of a prototype.

Trigger

Three consecutive levels have been designed to progressively reduce the background:

- The T0 is generated for one antenna channel when the amplitude of a radio signal after filtering exceeds a threshold (5σ).
- The T1 performs a pulse shape rejecting 95% of the background events.
- The T2 acts on the time-stamps sent by the T1 triggers and searches for time coincidences among a minimum of five detection neighboring antennas.

Science cases

- Air shower physics: test hadronic interaction models based on measurements on electromagnetic component and muon component.
- Galactic/extra-galactic transition and Large scale anisotropy : GP300 can detect about 100k cosmic ray events in the energy range of 30 PeV-1EeV after one-year operation, and measure the SED, anisotropy and mass composition of CR more precisely[14].
- Ultra-high-energy gamma rays: GP300 will have high gamma/hadron separation ability for shower with zenith angles between 65° and 85° above 10^9 GeV.
- Radio Astronomy : The GP300 sensitivity reaches 750 Jy in the band of 100-200 MHz. The large field of view and high duty-cycle allow GP300 to monitor the full sky for Fast Radio Burst(FRBs) and Giant Pulses.

Acknowledgements

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References

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[2] D. Charrier, et al., Astroparticle Physics 110, 15 (2019),