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The capability of water Cherenkov detectors arrays of the LAGO project to detect Gamma-Ray Burst and High-Energy Steady Gamma sources

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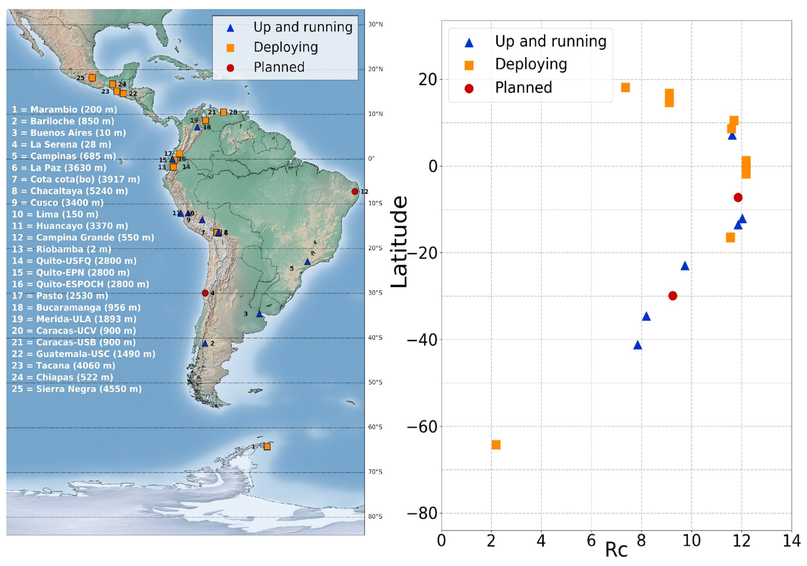
1. LAGO Network



The Latin American Giant Observatory (LAGO) constitute a **Water Cherenkov Detector (WCD) network** through Latin America, with large variation of altitudes and rigidity cut offs and **different detector geometries.**

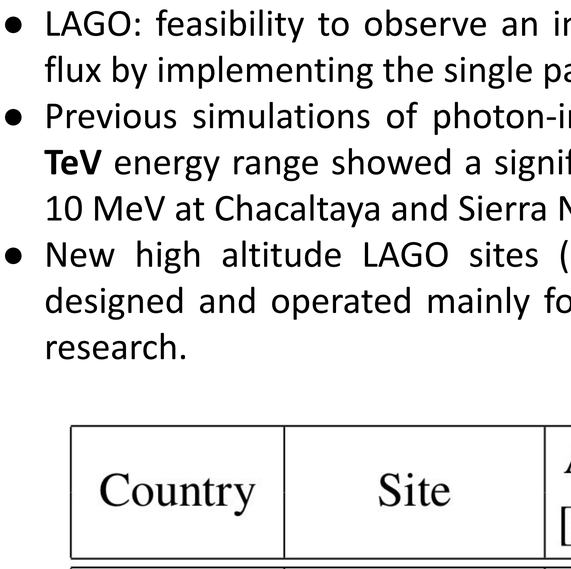
Two of the currently deployed high altitude small arrays of LAGO: **Chacaltaya (left, Bolivia, 5400 m a.s.l.)** and **Sierra Negra (right, México, 4600 m a.s.l.)**.

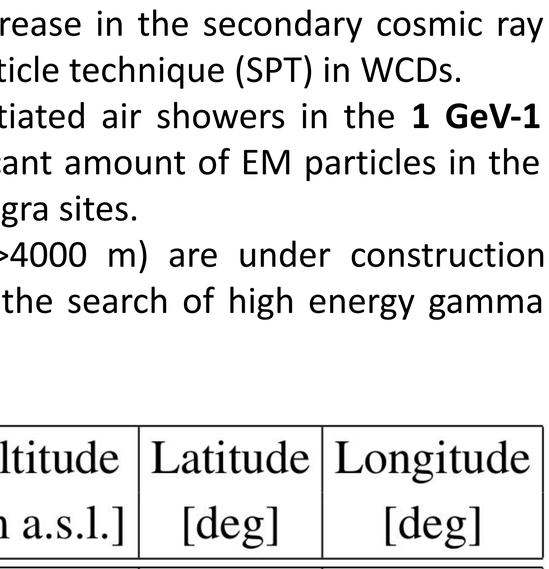
2. Motivation and previous studies

- MAGIC: First unambiguous detection of **GRB from ground level at energies 0.2-1 TeV (GRB 190114C)**.
- LAGO: feasibility to observe an increase in the secondary cosmic ray flux by implementing the single particle technique (SPT) in WCDs.
- Previous simulations of photon-initiated air showers in the **1 GeV-1 TeV** energy range showed a significant amount of EM particles in the 10 MeV at Chacaltaya and Sierra Negra sites.
- New high altitude LAGO sites (h>4000 m) are under construction designed and operated mainly for the search of high energy gamma research.

Country	Site	Altitude [m a.s.l.]	Latitude [deg]	Longitude [deg]
Argentina	SAC	4500	24.23 S	66.32 W
Chile	Atacama	5100	23 S	67.76 W
Ecuador	Chimborazo	5000	1.47 S	78.82 W
Perú	Imata	4600	15.84 S	71.10 W

3. High Energy Sources Model

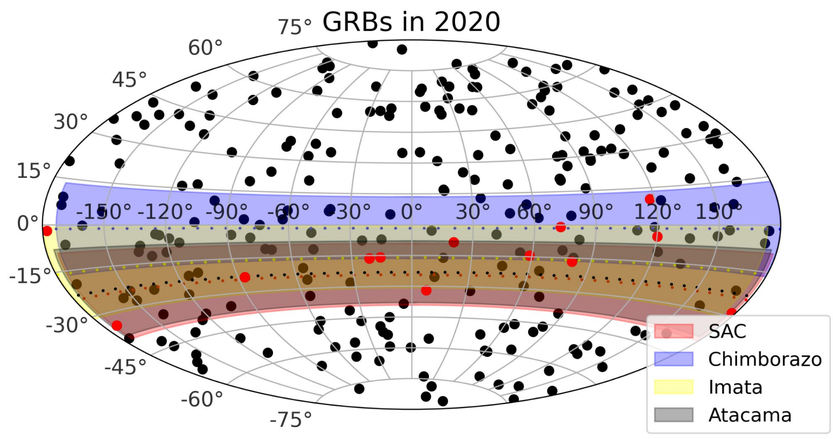




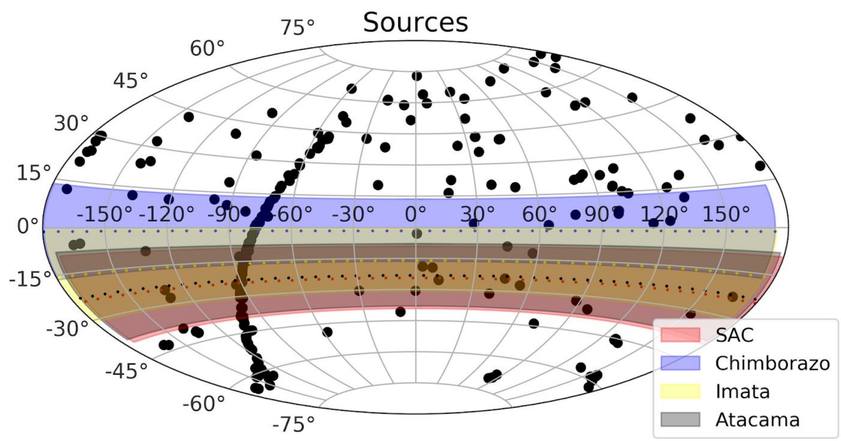
- High energy component of GRBs emission could reach up to E_γ~1TeV.
- For each energy interval, we performed 50,000 simulations using the corresponding spectral index, and computed the flux of secondaries arriving at ground level and the average weighted by the contribution of each high-energy component.
- Primary injection (left) and flux of secondaries at ground level (right) for three different possible spectral indices. The black line is the total secondary radiation background.

4. LAGO sites field of view (FOV)

- The FOV band considering a 15° aperture is projected as the colored bands for each of the new altitude sites.

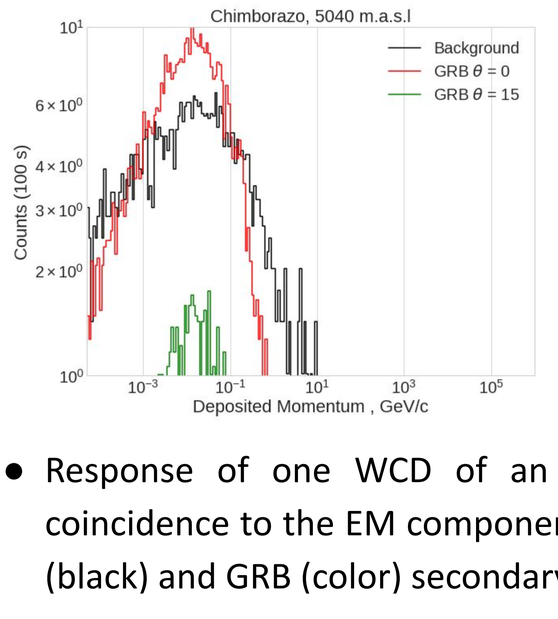


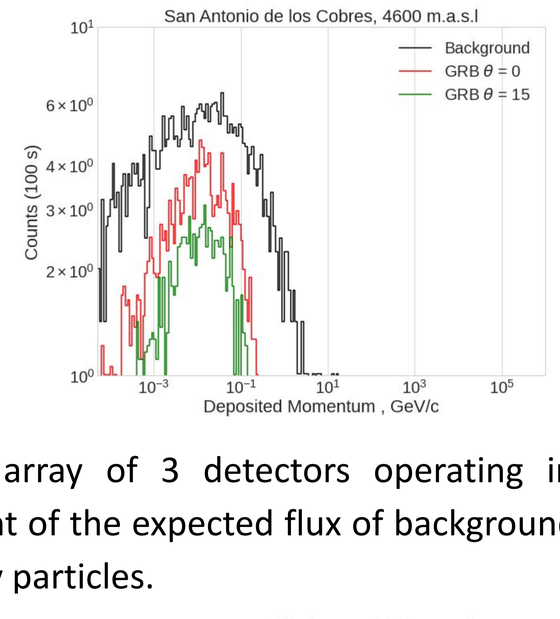
- GRBs are detected from all directions in the sky with a detection rate of ~240 GRBs per year by GBM at FERMI.
- We present the bursts o**bserved by GBM in the years 2019 and 2020.**
- In **red circles,** the high energy GRBs in the **FOV of the new LAGO** high altitude sites (>4000 m.a.s.l.).



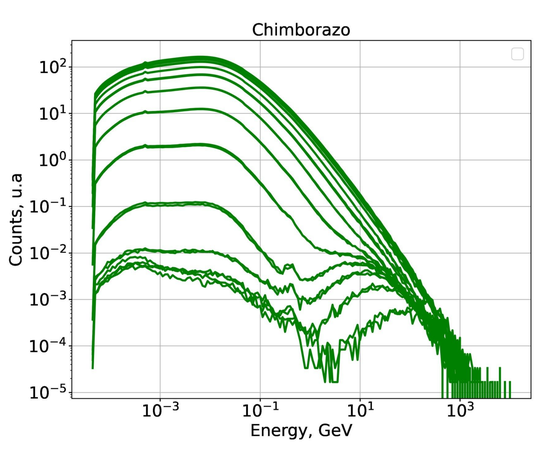
- **TeV steady gamma sources detected by 2022** (black dots) reported in the TeVCat catalogue and high altitude LAGO sites FOV.

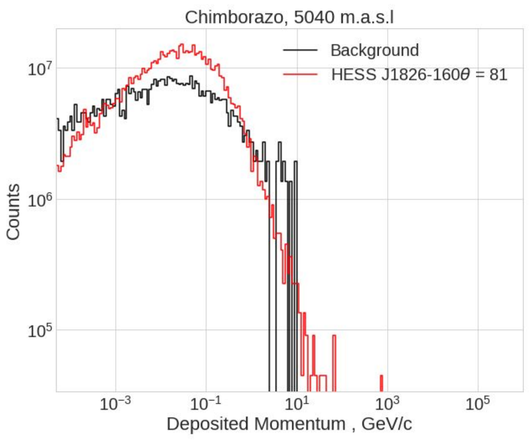
5. Simulations





- Response of one WCD of an array of 3 detectors operating in coincidence to the EM component of the expected flux of background (black) and GRB (color) secondary particles.





- Secondary flux for different elevations (left) and response of one WCD of an array of 3 detectors operating in coincidence (right) to the simulated expected flux of the HESS J1826-160 gamma source

5. Conclusions

- Expected secondary fluxes generated by GRB and energetic gamma sources exceeds the expected background at high altitude sites.
- The daily observations of the sources enhance the LAGO detection capabilities over local backgrounds. The final response to steady gamma source is currently under development.
- Our large FOV makes LAGO a gripping facility for GRBs detection and long term steady gamma source observation.