

Gamma-Hadron separation using the temporal distribution of particle cascades at TeV energies in the SWGO experiment

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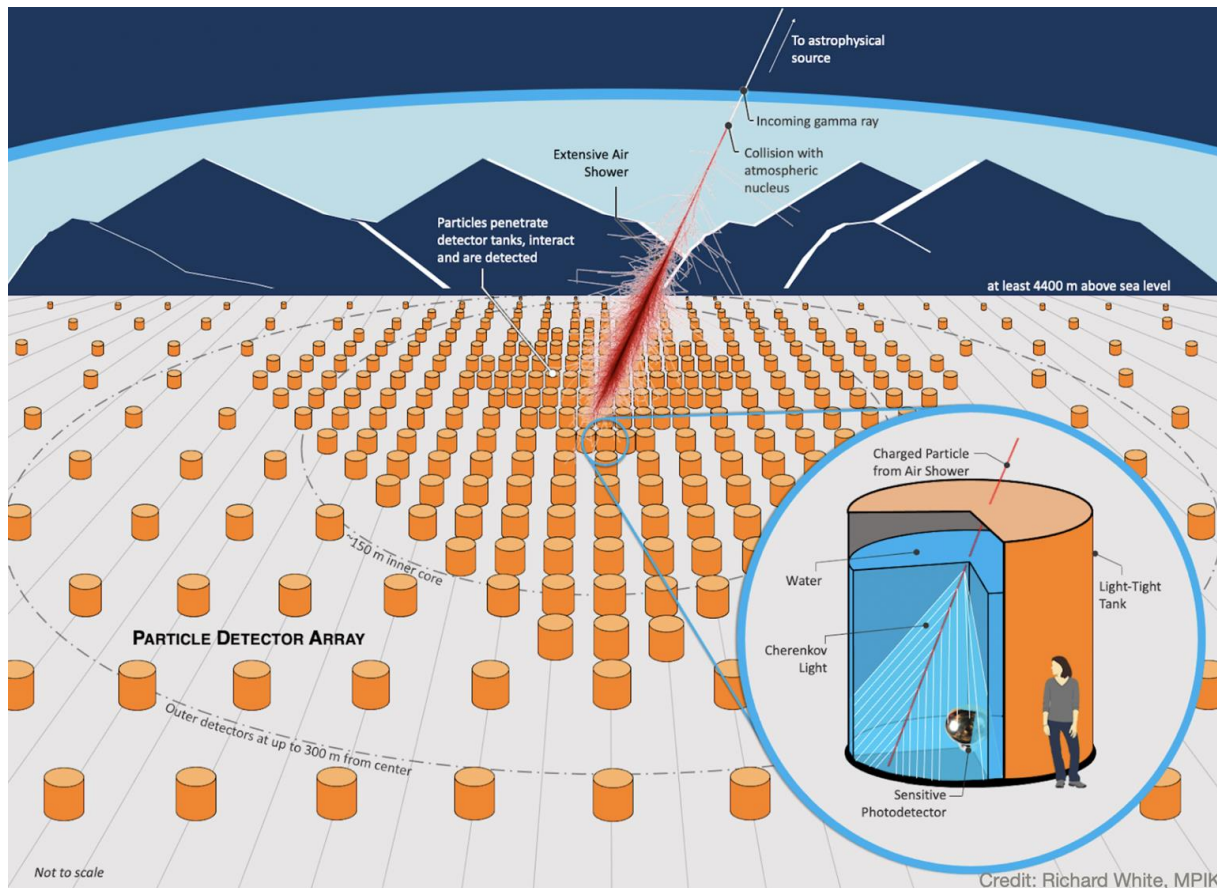
Grupo de Altas Energías



PUCP

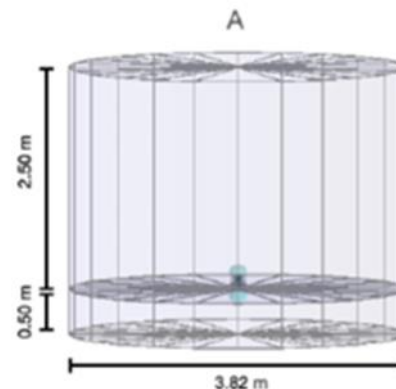
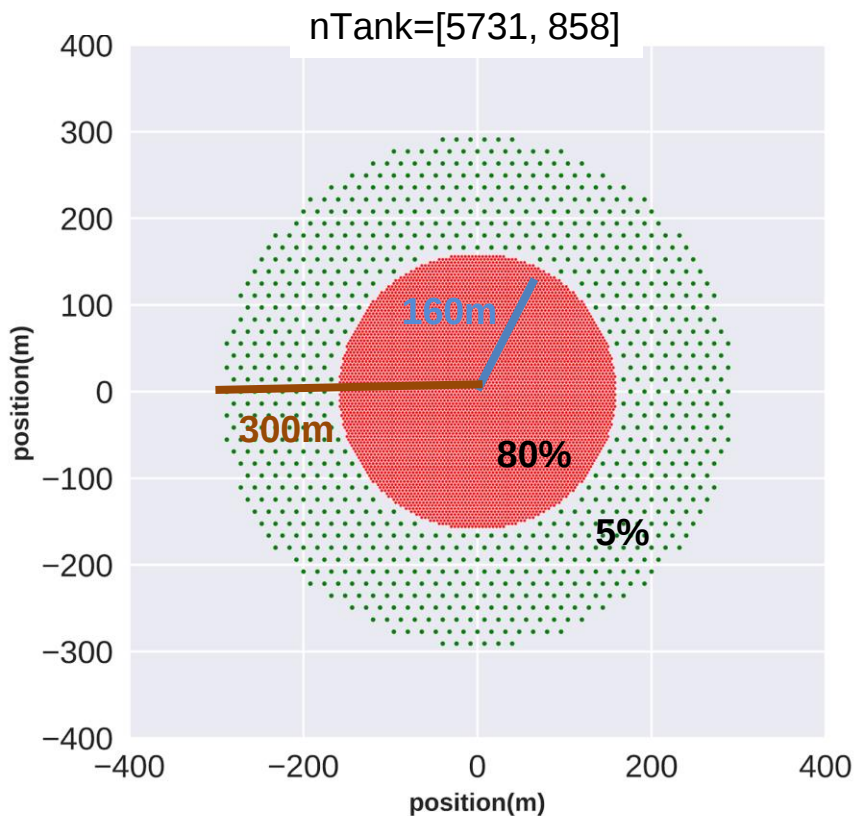


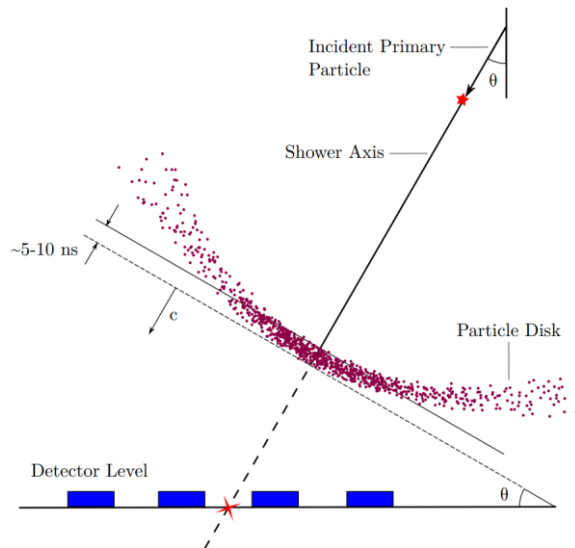
- ① SWGO: The Southern Wide-field Gamma-ray Observatory
- ① Air Shower Reconstruction
- ① Simulations using CORSIKA
- ① Time and space distributions
- ① Search for Gamma/Hadron separator variable and cut value
- ① Conclusions



- **Ground-level particle detection**
- **~100% duty cycle**
- **~sr wide field of view**
- **In: Atacama Astronomical Park, Chile**
- **Altitude: 4770 m.**
- **Energy: 100s GeV - ~PeV**
- **Water Cherenkov detector units.**

Reference design (A1)



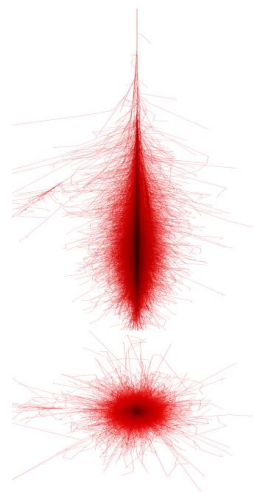


Reconstruction:

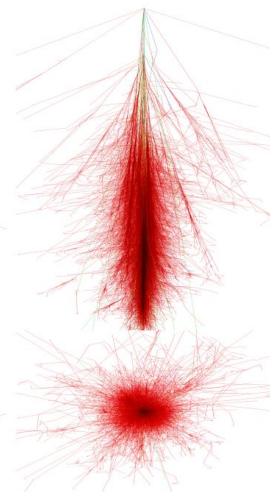
- Core Location
- Direction
- Energy

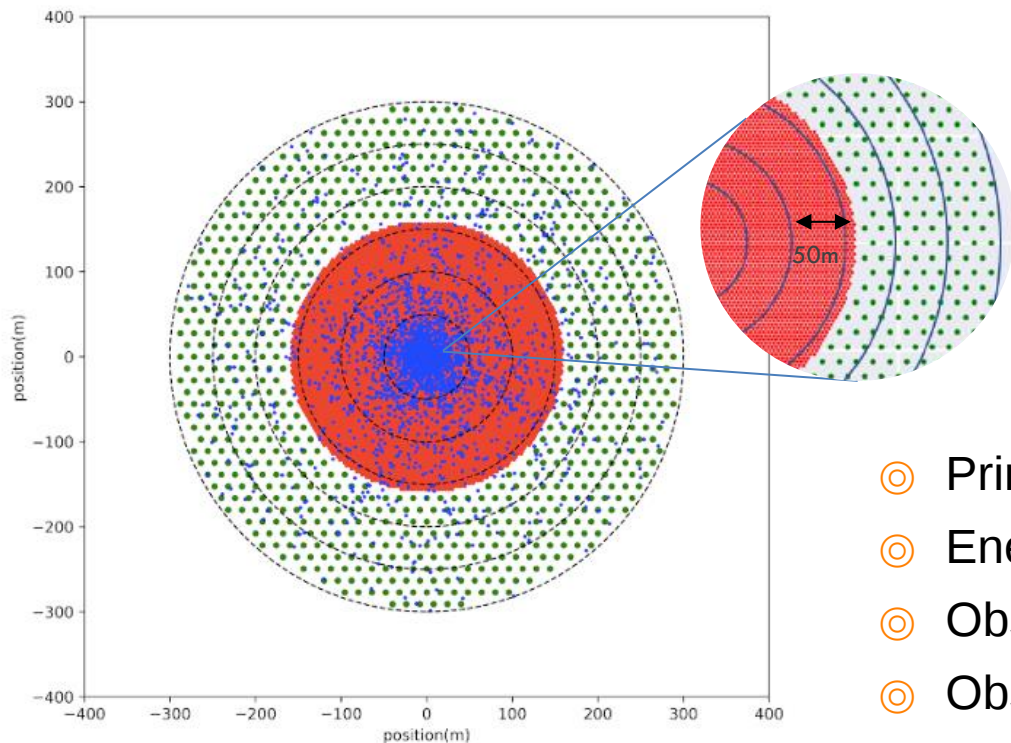
Gamma/Hadron separation

100 TeV
photon



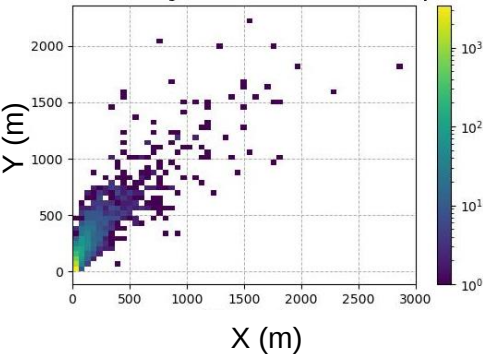
100 TeV
proton



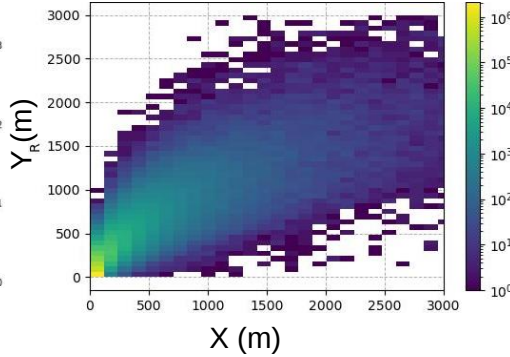


- ⊙ Primary particles: photons, protons
- ⊙ Energy range: 1 - 100 TeV
- ⊙ Observation height: 44500 cm (Imata)
- ⊙ Observation angle: 0° (vertical particles)

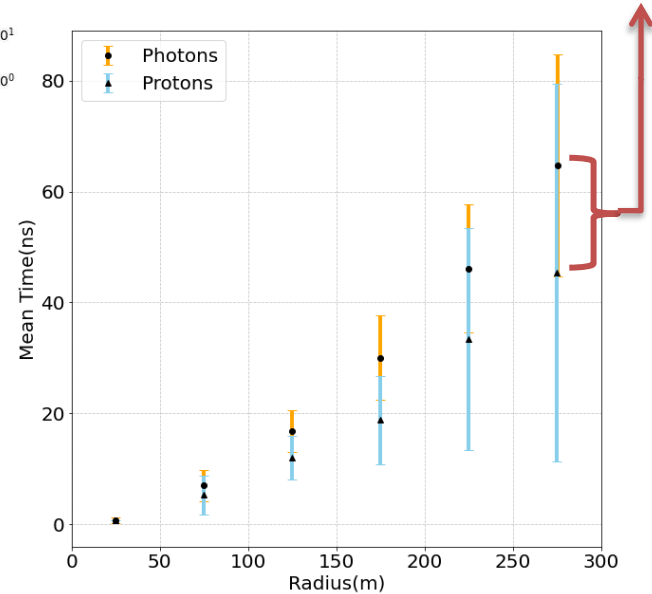
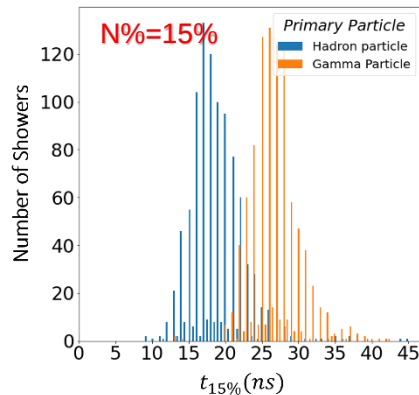
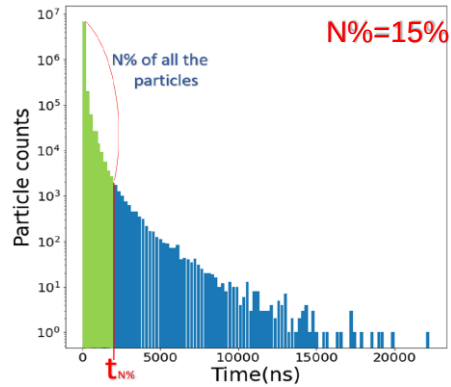
Gamma

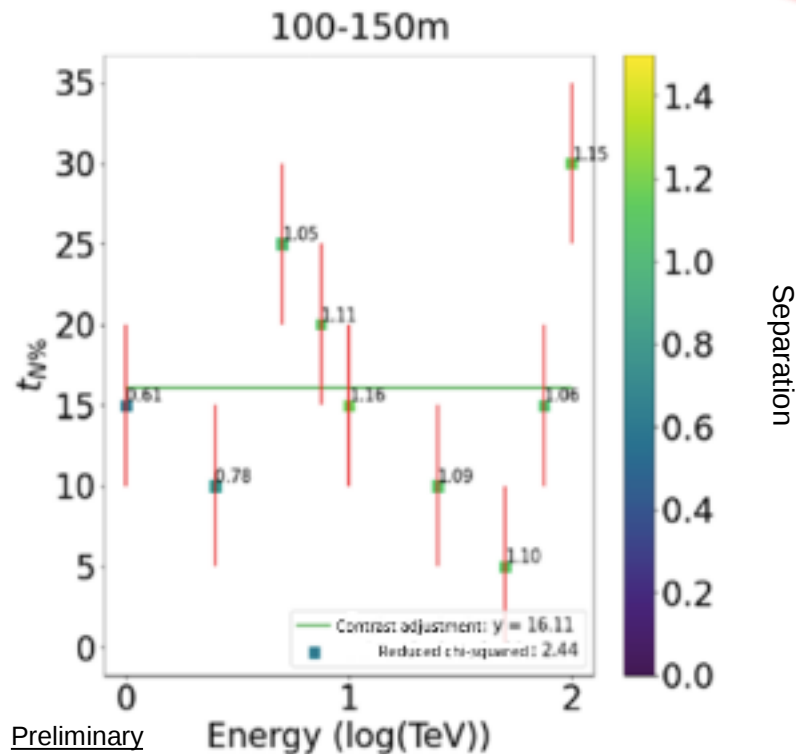
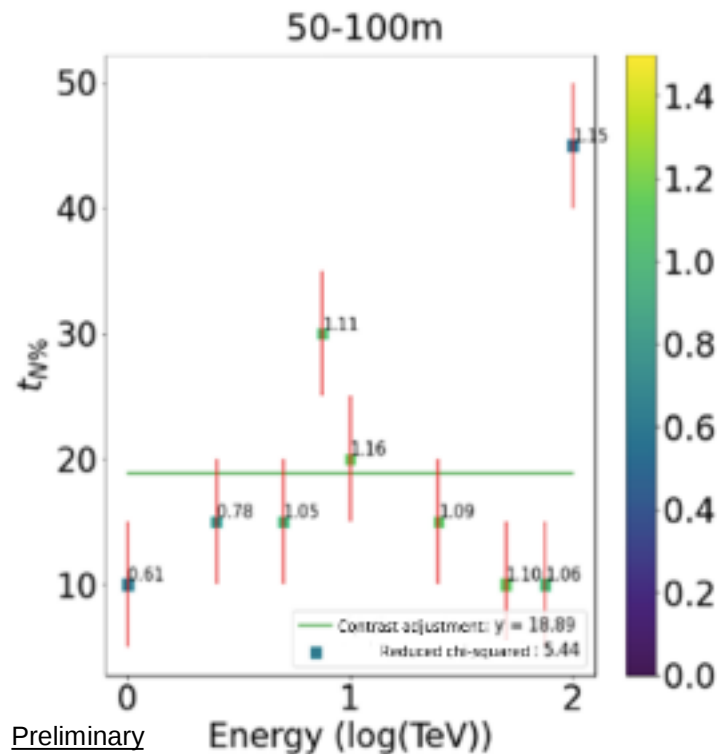


Hadron



$$\sigma_{G/H}(E, r, N\%) = \frac{|\overline{t_{hadron}} - \overline{t_{\gamma}}|}{\sqrt{\sigma_{hadron}^2 + \sigma_{\gamma}^2}}$$



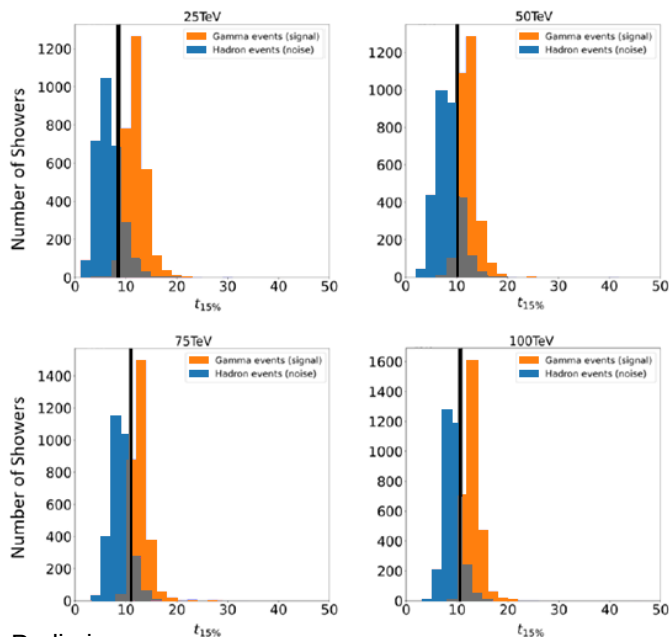


Best: $t_{15\%}(100-150 \text{ m})$

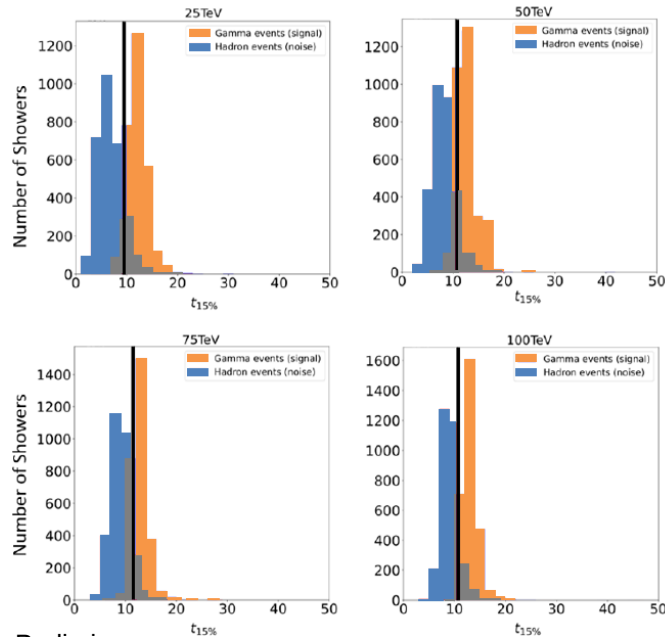
Cut value search

Cut 1: $t_{15\% \gamma_{\min}} = \langle t_{15\% \gamma} \rangle - \sigma_{\gamma}$

Cut 2: $t_{15\% p_{\max}} = \langle t_{15\% p} \rangle + \sigma_p$



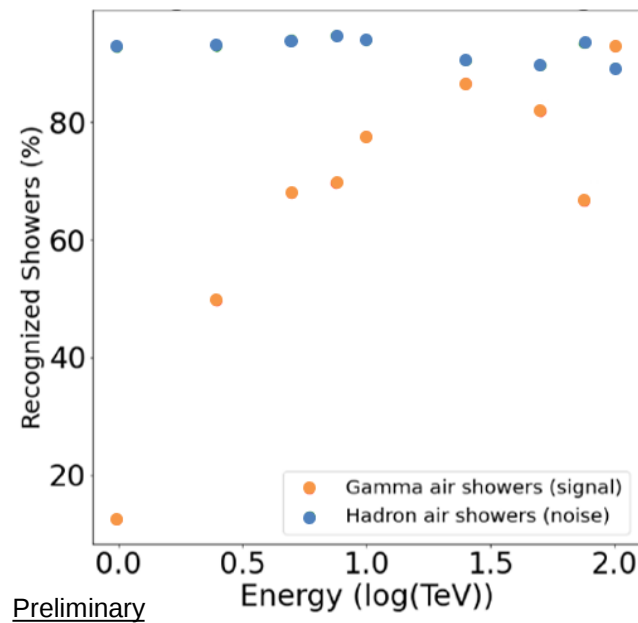
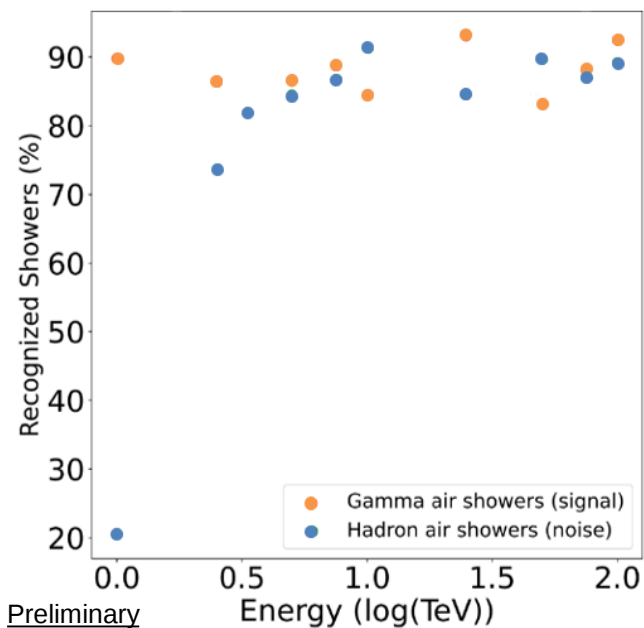
Preliminary



Preliminary

$$t_{15\% \gamma \min} = \langle t_{15\% \gamma} \rangle - \sigma_{\gamma}$$

$$t_{15\% p \max} = \langle t_{15\% p} \rangle + \sigma_p$$



- ⊙ Results from CORSIKA valid for single energies in 1-100 TeV range, for vertical showers, Imata site (*), A1 configuration, limited statistics without improved training.
- ⊙ Best G/H variable: 15% time percentile in 100-150 m ring
- ⊙ Best time cut: $\langle t_{15\% \gamma} \rangle - \sigma_{\gamma}$ from photon distribution
- ⊙ Signal and background efficiency: $\sim 90\%$
- ⊙ Doto: zenith angle range, power law energies, different core positions, use IRF.

