

The Cherenkov Telescopes Array: fundamental physics and instrumentation



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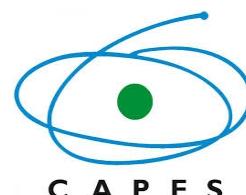


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Astroparticle Physics

The science studying process happening in astrophysical environment through the detection of the highest energetic particles.

Source astrophysics

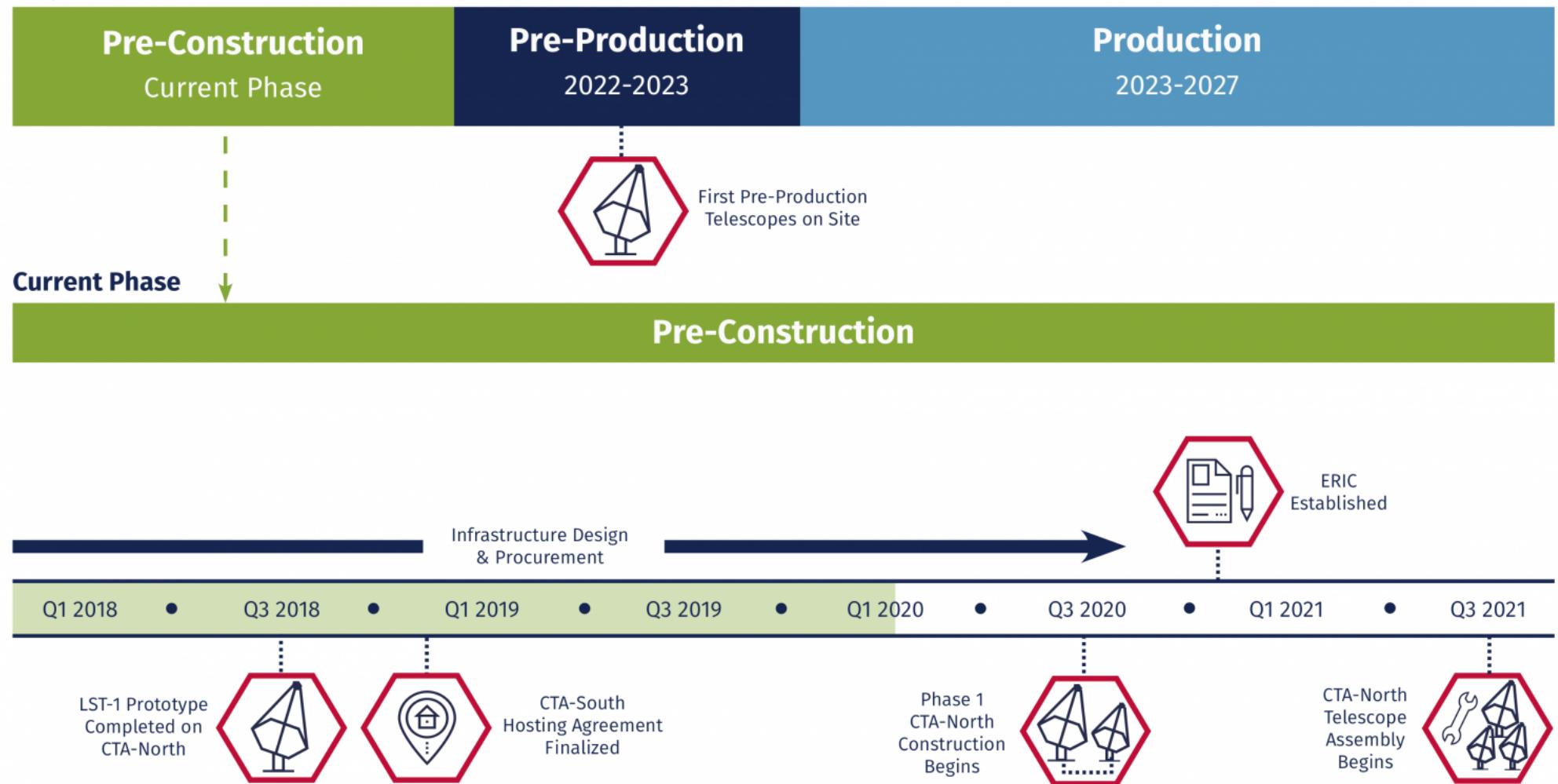
Interaction of particles

Topics of interest – White paper

- Dark Matter
- Lorentz Invariance Violation
- Axion like particles
- Cosmic rays and propagation
- Instrumentation

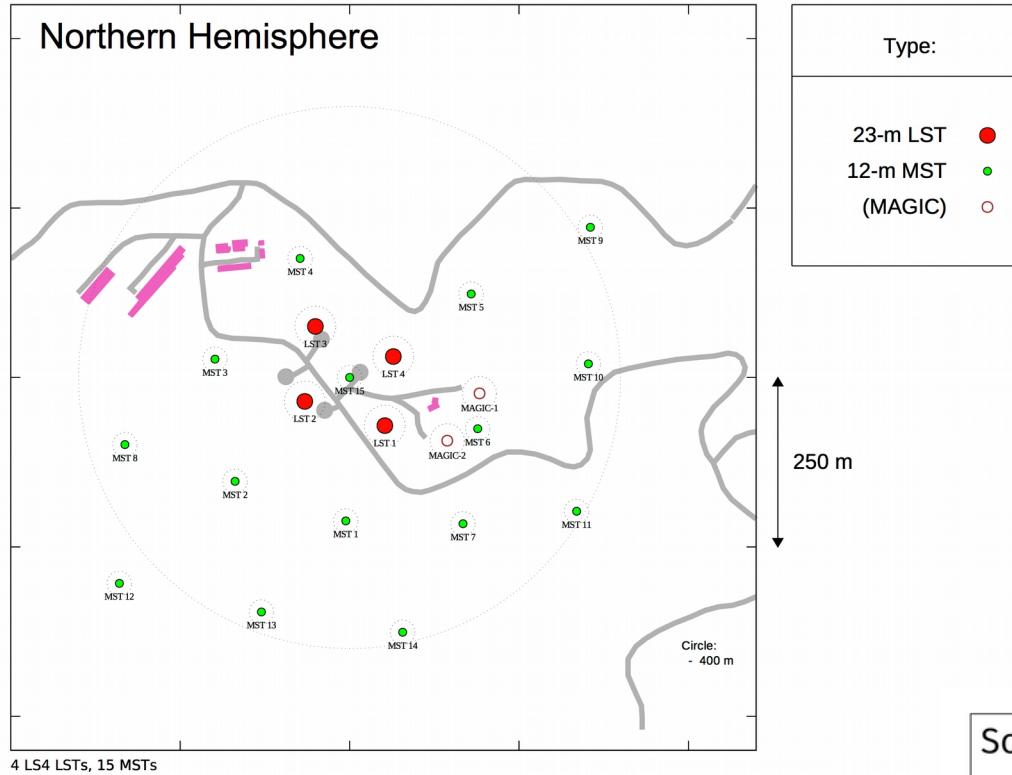
From 15 CTA papers under preparation
3 are lead by authors of this proposal.

Project Phases

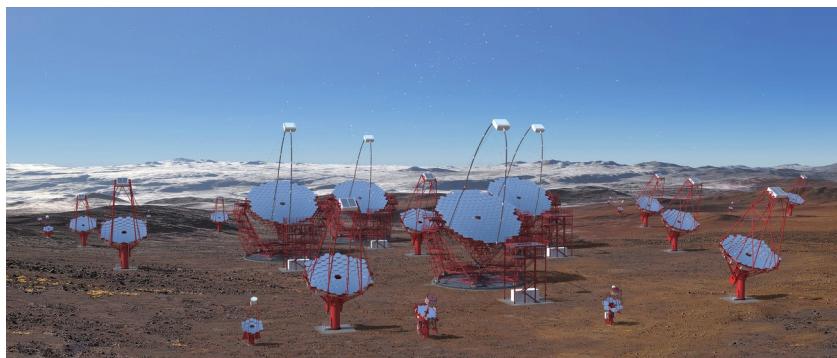
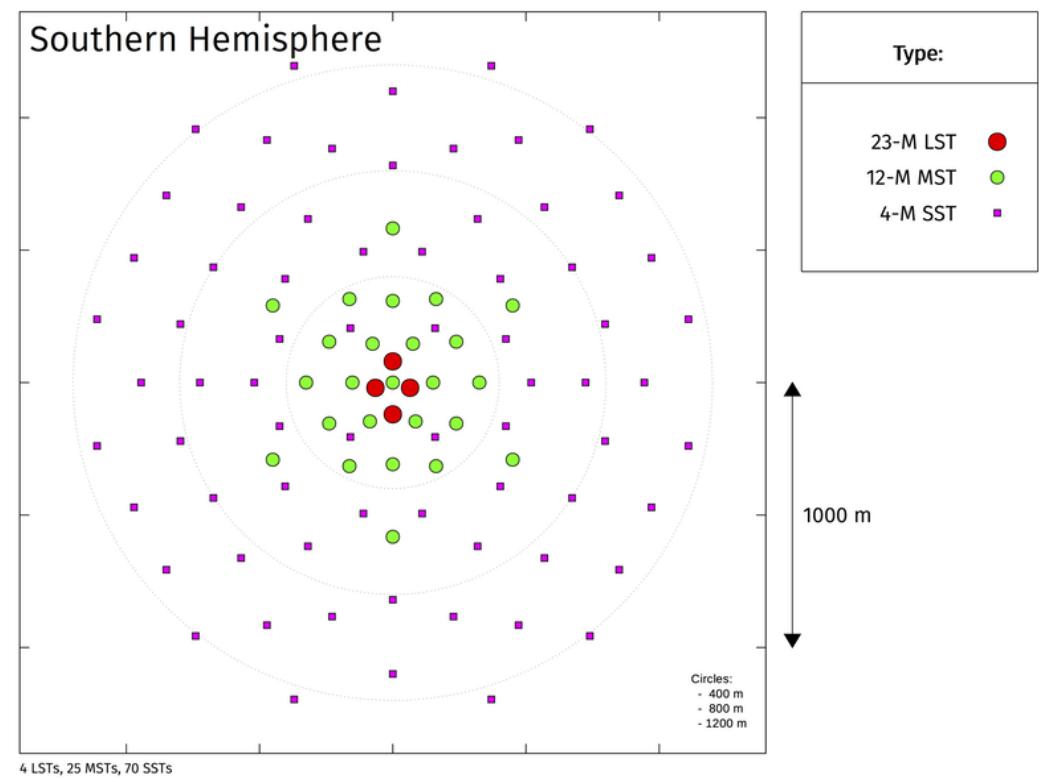


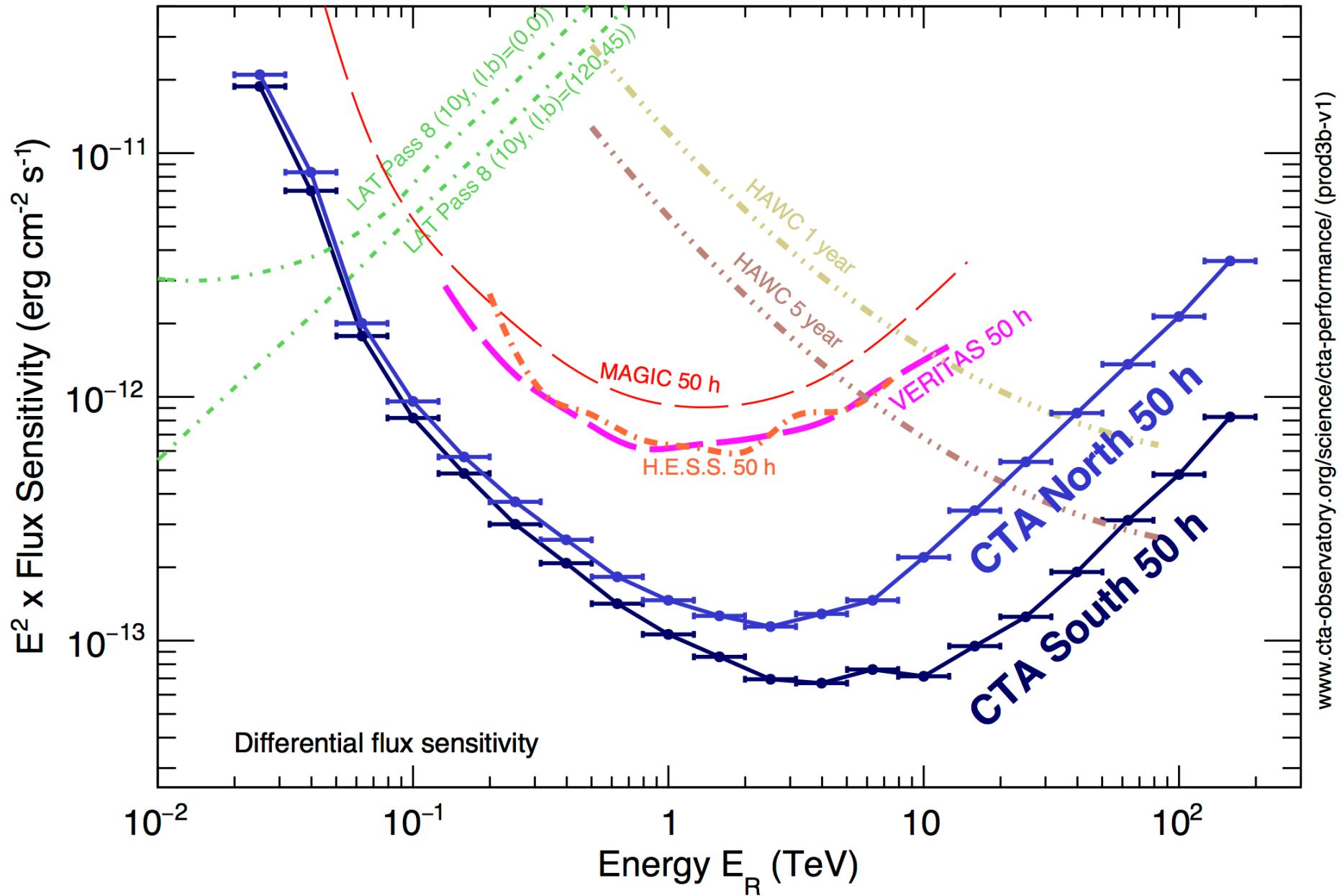
<https://www.cta-observatory.org/project/status/>

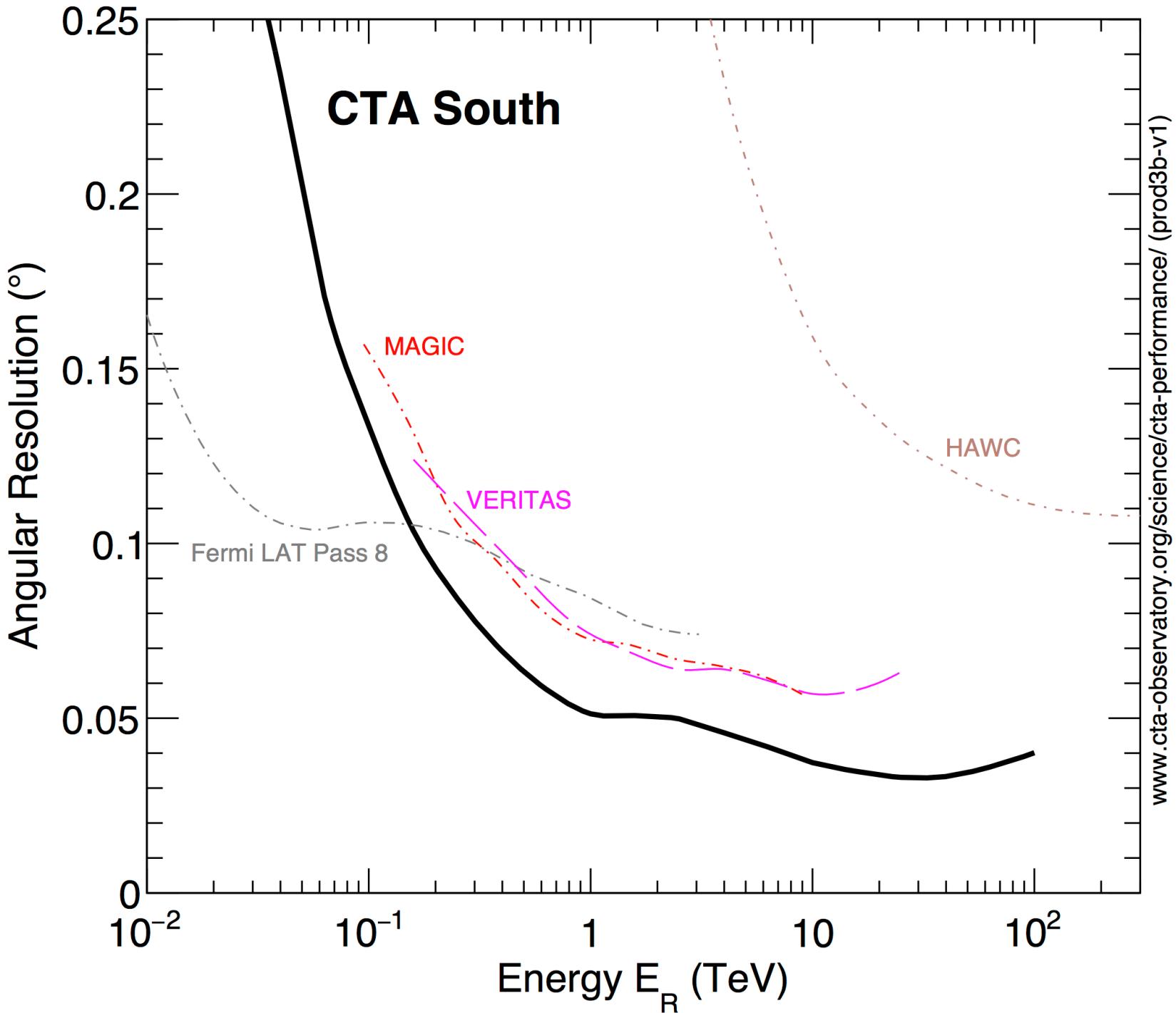
Northern Hemisphere



Southern Hemisphere

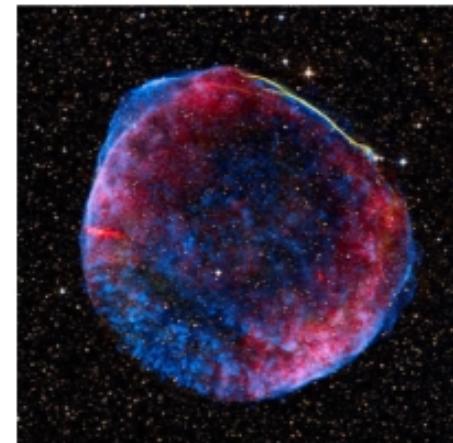






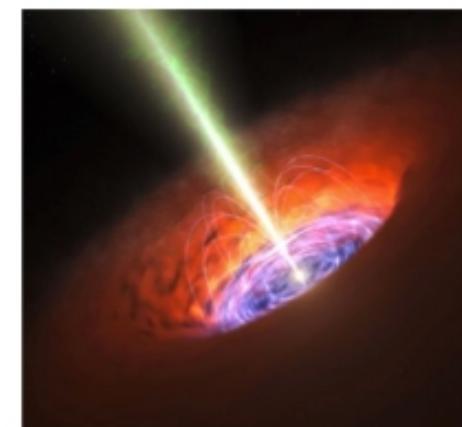
COSMIC PARTICLE ACCELERATION

- How and where are particles accelerated?
- How do they propagate?
- What is their impact on the environment?



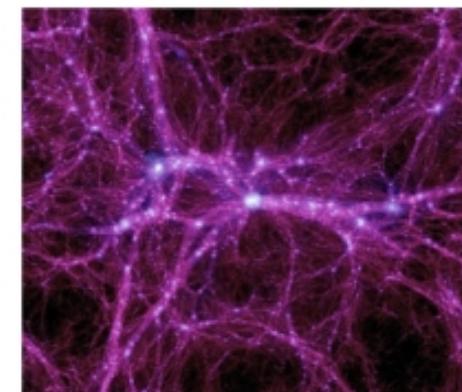
PROBING EXTREME ENVIRONMENTS

- Close to neutron stars and black holes
- Relativistic jets, winds and explosions
- Cosmic voids



PHYSICS FRONTIERS

- What is the nature of Dark Matter?
- Is the speed of light a constant?
- Do axion-like particles exist?





Science with the CTA:

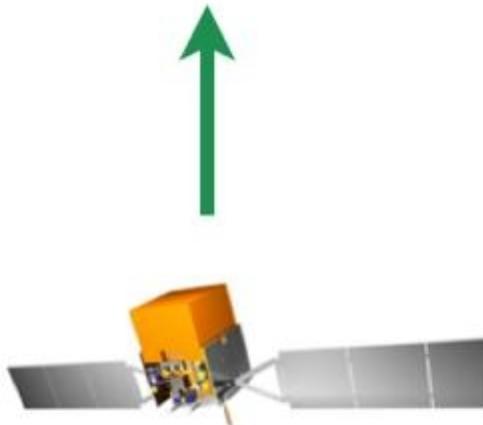
[https://arxiv.org/abs/
1709.07997](https://arxiv.org/abs/1709.07997)

CTA is an open observatory with 40% of its time reserved for Key Science Projects.

Dark Matter

Gamma-Ray Flux
(signal in data)

$$\frac{d\Phi}{dE}(E, \phi, \theta)$$



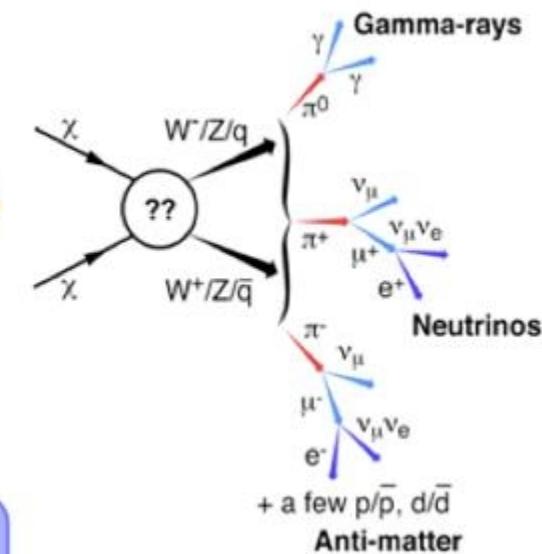
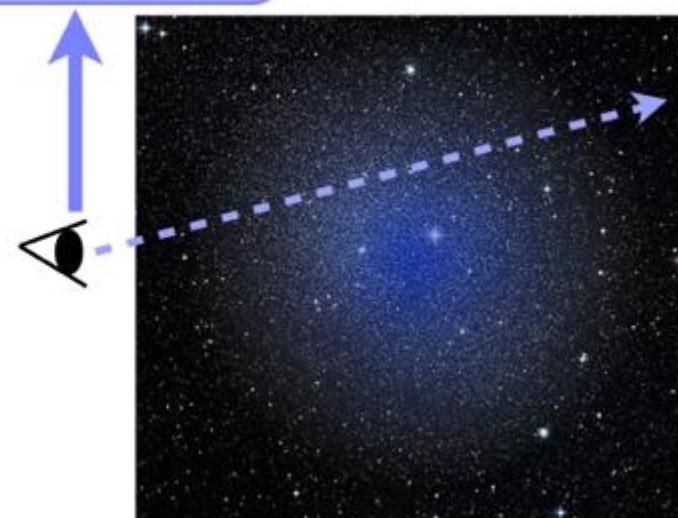
Particle Physics
(particles per annihilation)

$$= \frac{1}{4\pi} \frac{\langle \sigma_{ann} v \rangle}{2m_{DM}^2} \sum_f \frac{dN^f}{dE} B_f$$

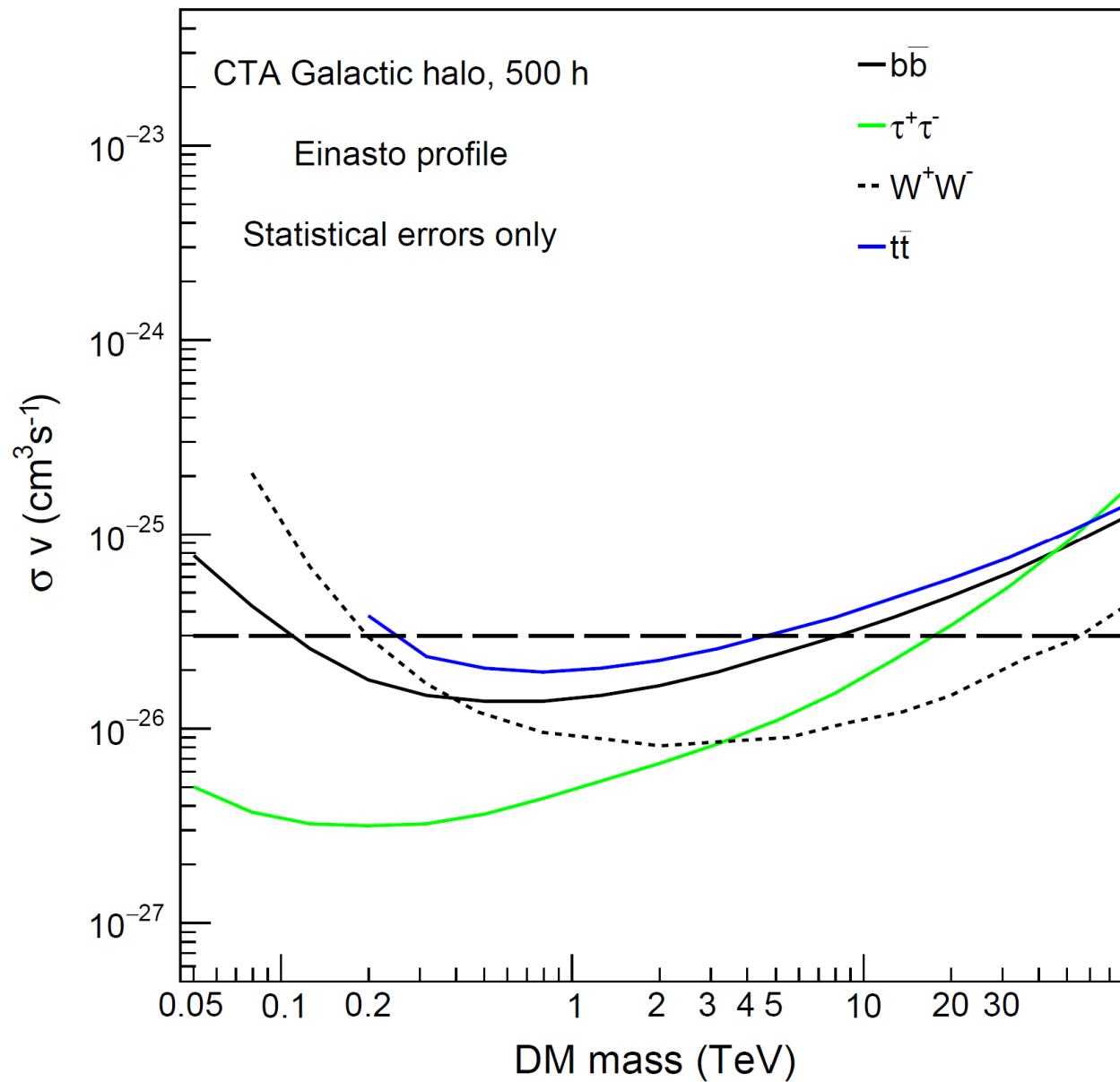
×

$$\int_{\Delta\Omega(\phi, \theta)} d\Omega' \int_{los} \rho^2(r(l, \phi')) dl(r, \phi')$$

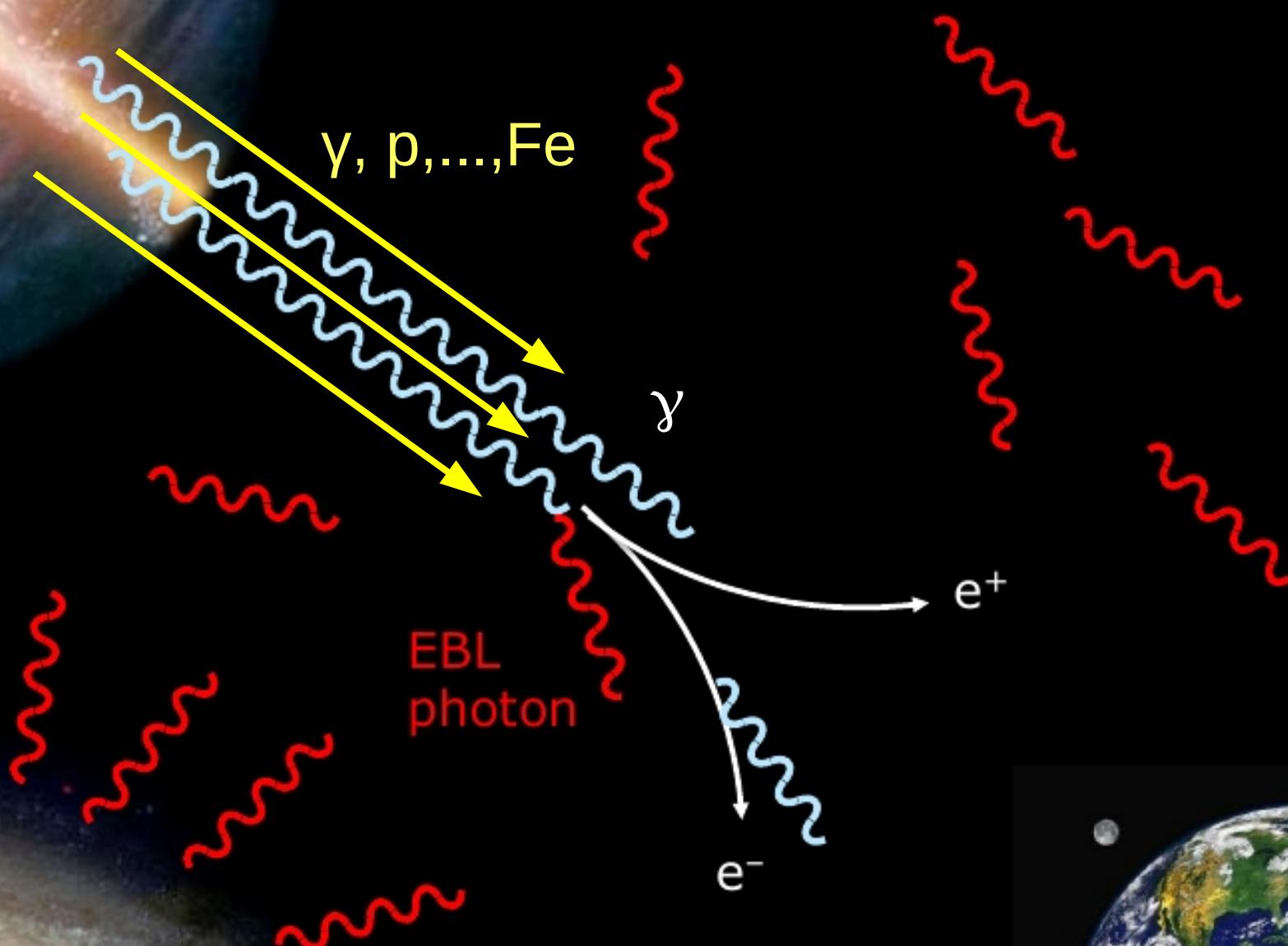
**Dark Matter
Distribution**
(line-of-sight integral)



Dark Matter



ABSORPTION & CASCADES



EBL determination

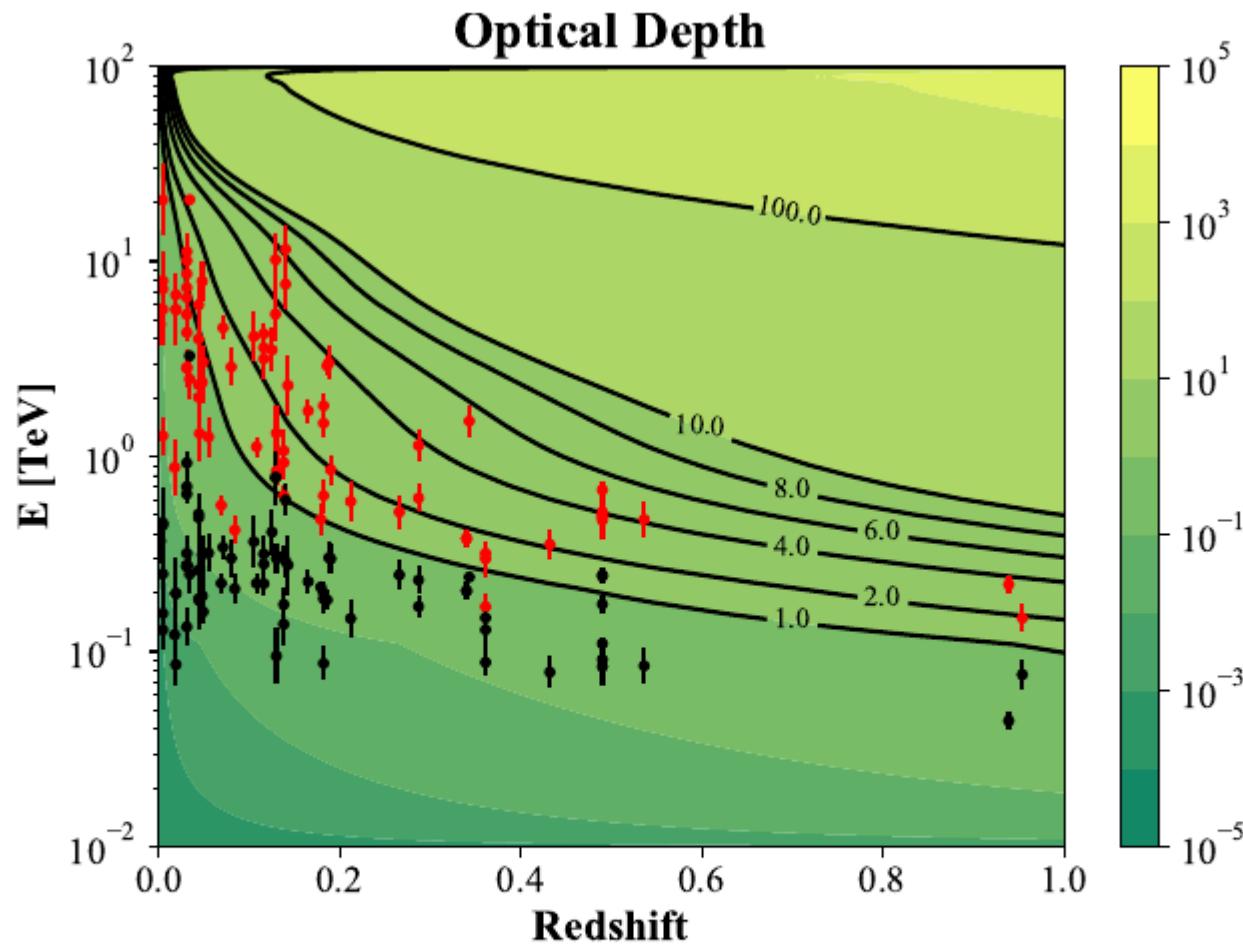
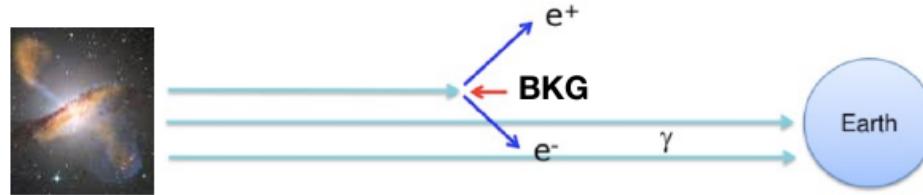


Figure 10. Heat map showing the optical depth to gamma-rays according to Finke et al. model in the $E_\gamma \times z$ parameter space. The lowest (black) and highest (red) energy bins for each observation shown in tables 6 and 7 are superimposed to the plot. Black curves at specific values of τ are shown. The curve corresponding to $\tau = 1$ is defined as the cosmic gamma-ray horizon (CGRH).

Optical depth + LIV



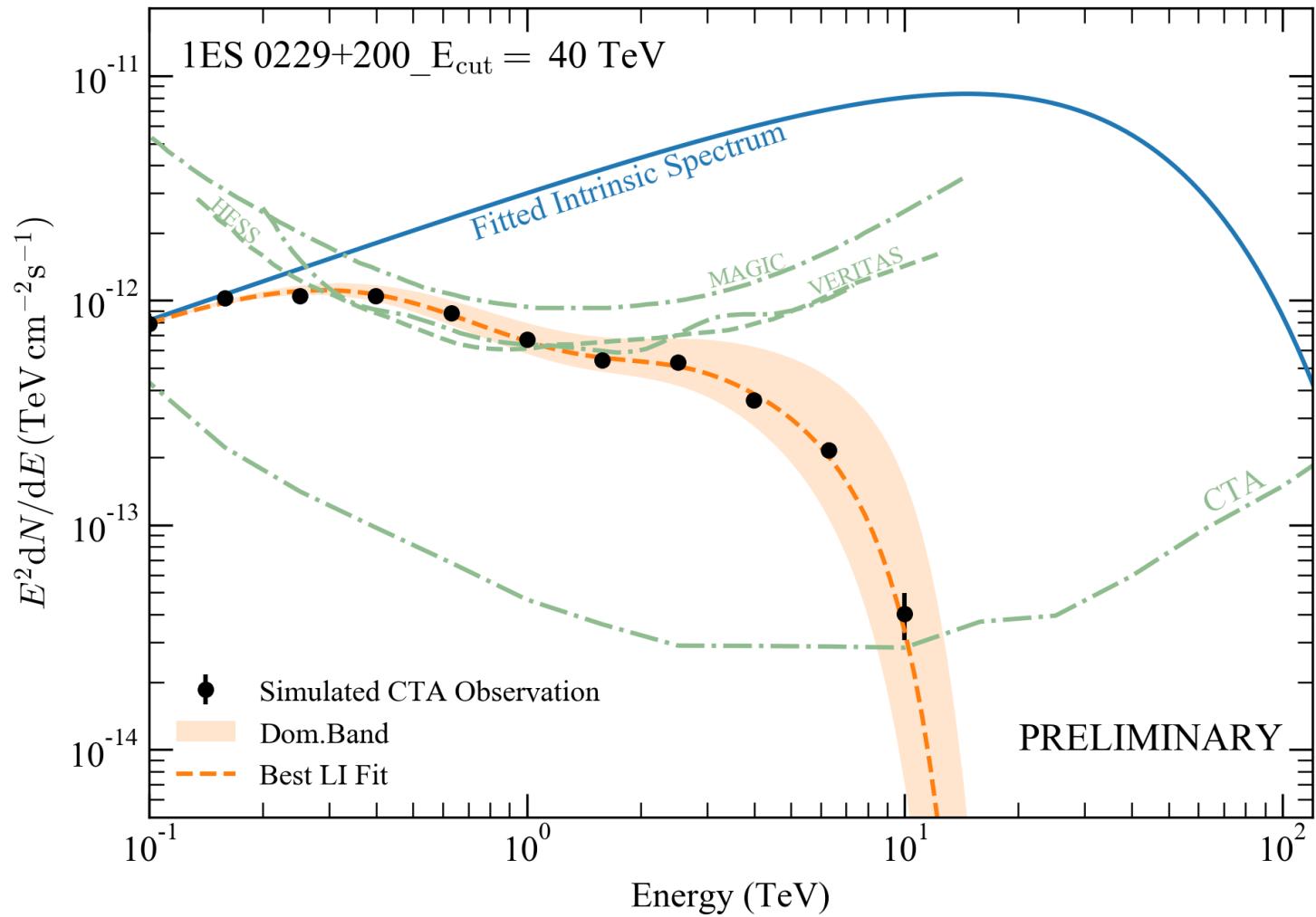
$$\tau_\gamma(E_\gamma, z, n, E_{LIV}^{(n)}) = \int_0^z dz \frac{c}{H_0(1+z)\sqrt{\Omega_\Lambda + \Omega_M(1+z)^3}}$$

$$\times \int_{\epsilon_{th}^{LIV}}^{\infty} d\epsilon n_\gamma(\epsilon, z) \quad \times \int_{-1}^1 d(\cos \theta) \frac{1 - \cos \theta}{2} \sigma(E_\gamma, \epsilon, z, \cos \theta)$$

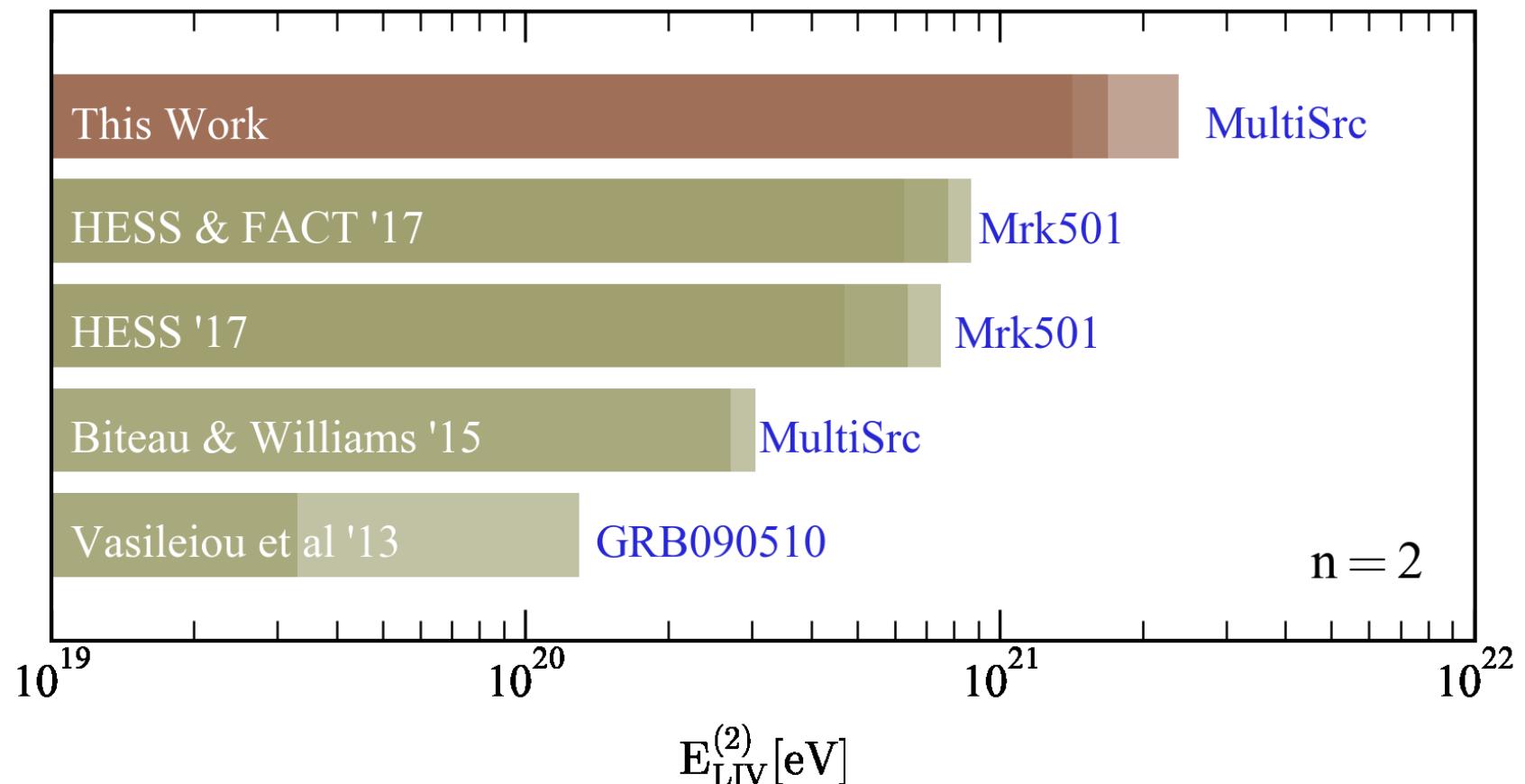
LIV

$$\epsilon_{th}^{LIV} = \frac{m_e^2}{4E_\gamma K(1-K)} - \frac{\delta_{\gamma,n} E_\gamma^{n+1}}{4}$$

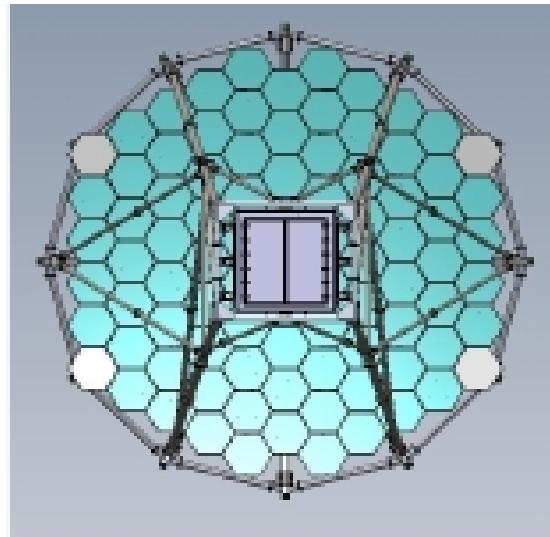
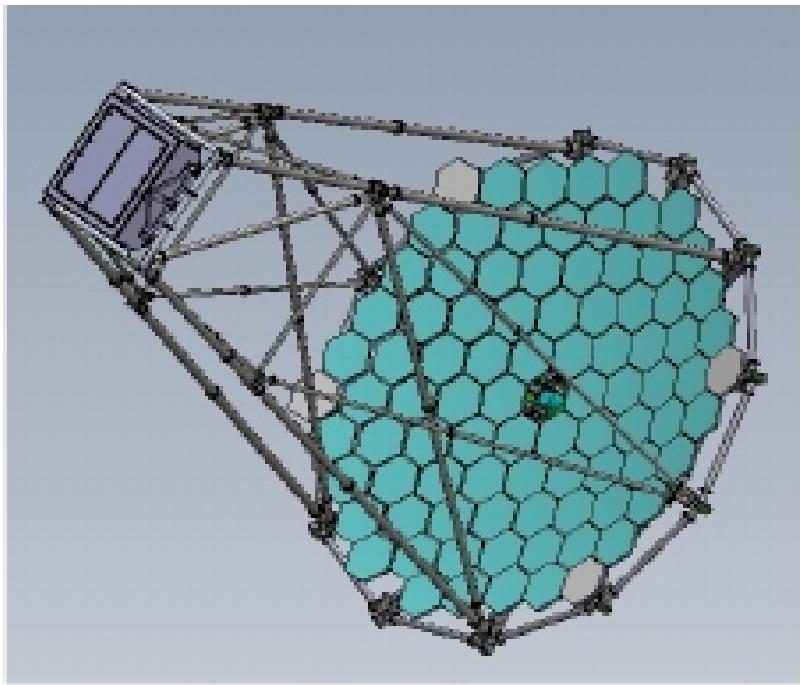
TeV γ -rays & LIV



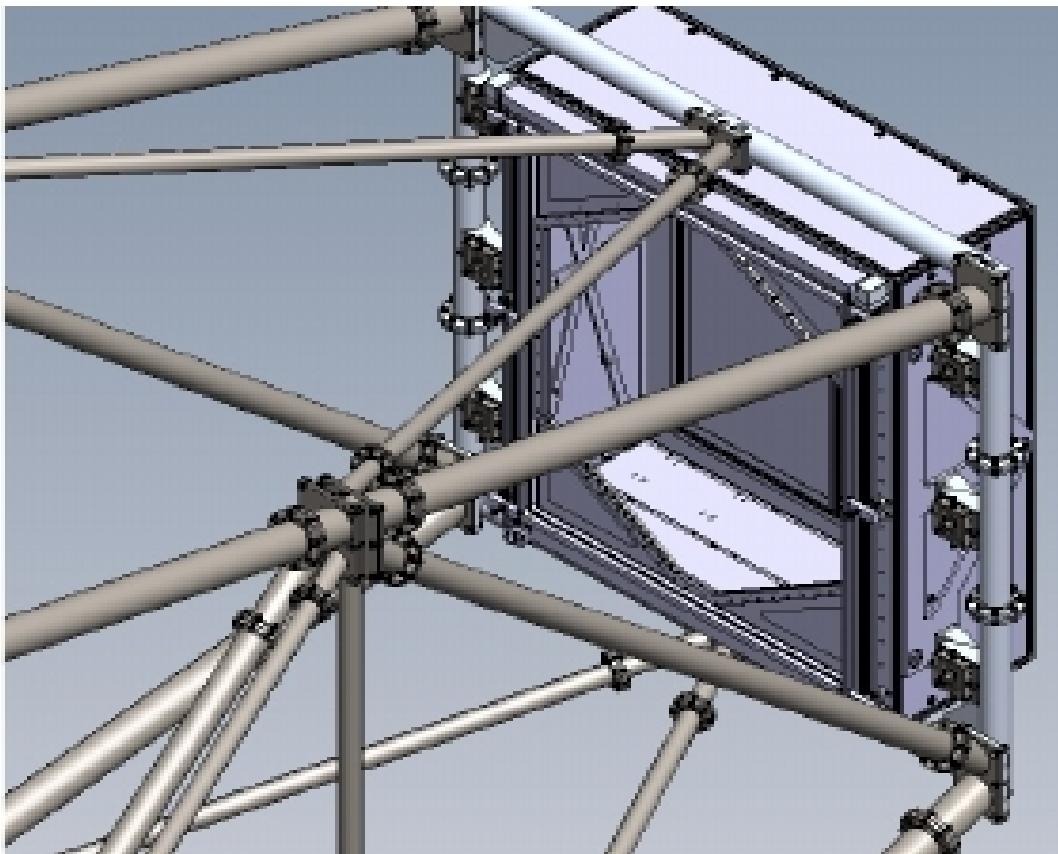
LIV Coefficient Limits



Telescope Construction



Adjustment Device



Move tons with
milimiter precision

Brazilian technology
for CTA

Patent deposited



IFSC UNIVERSITY
OF SÃO PAULO
São Carlos Institute of Physics



Brazilian Technology Built-in

