GRAPPA

Gravitation AstroParticle Physics Amsterdam

The search for Dark Matter with the Cherenkov Telescope Array

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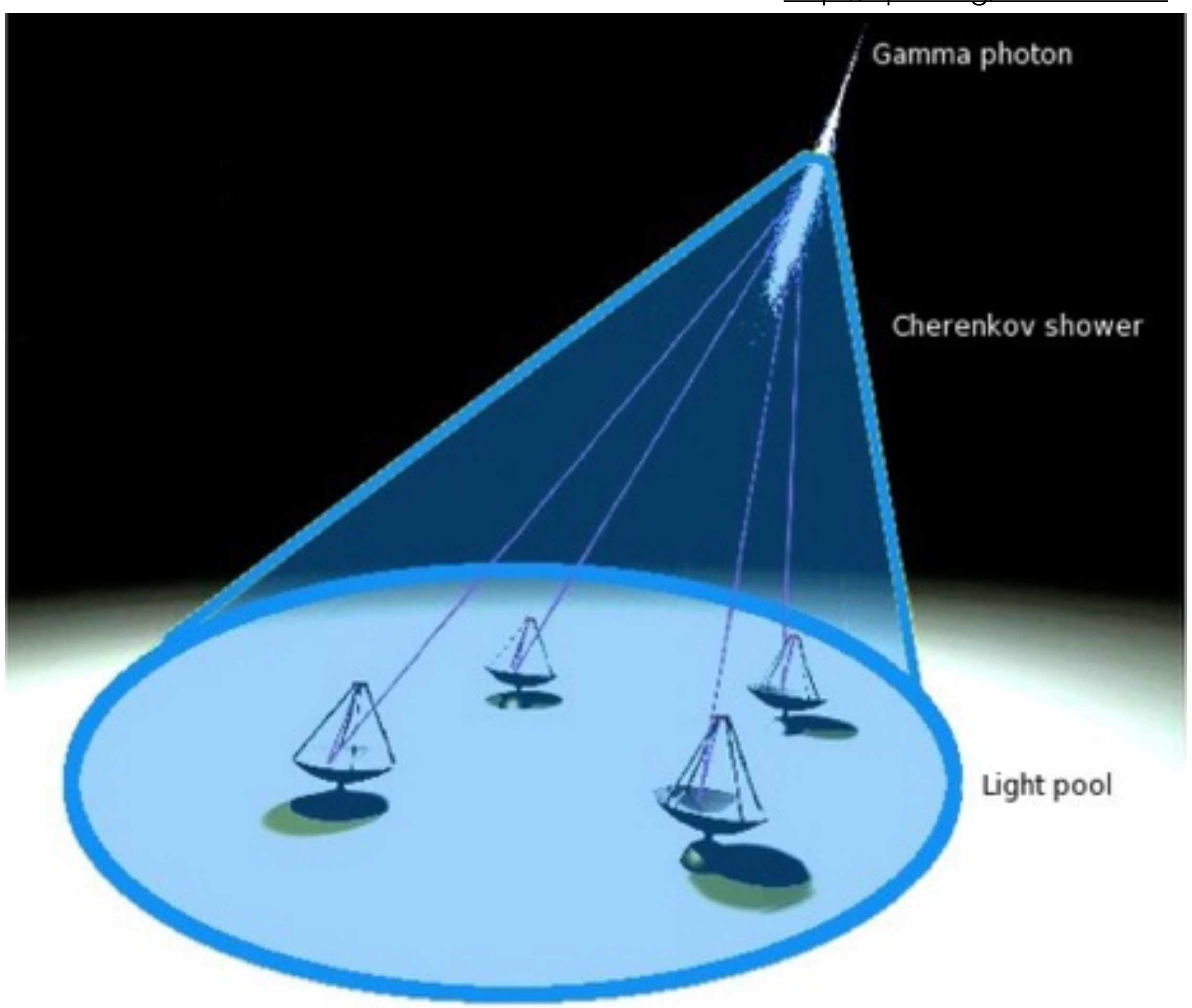
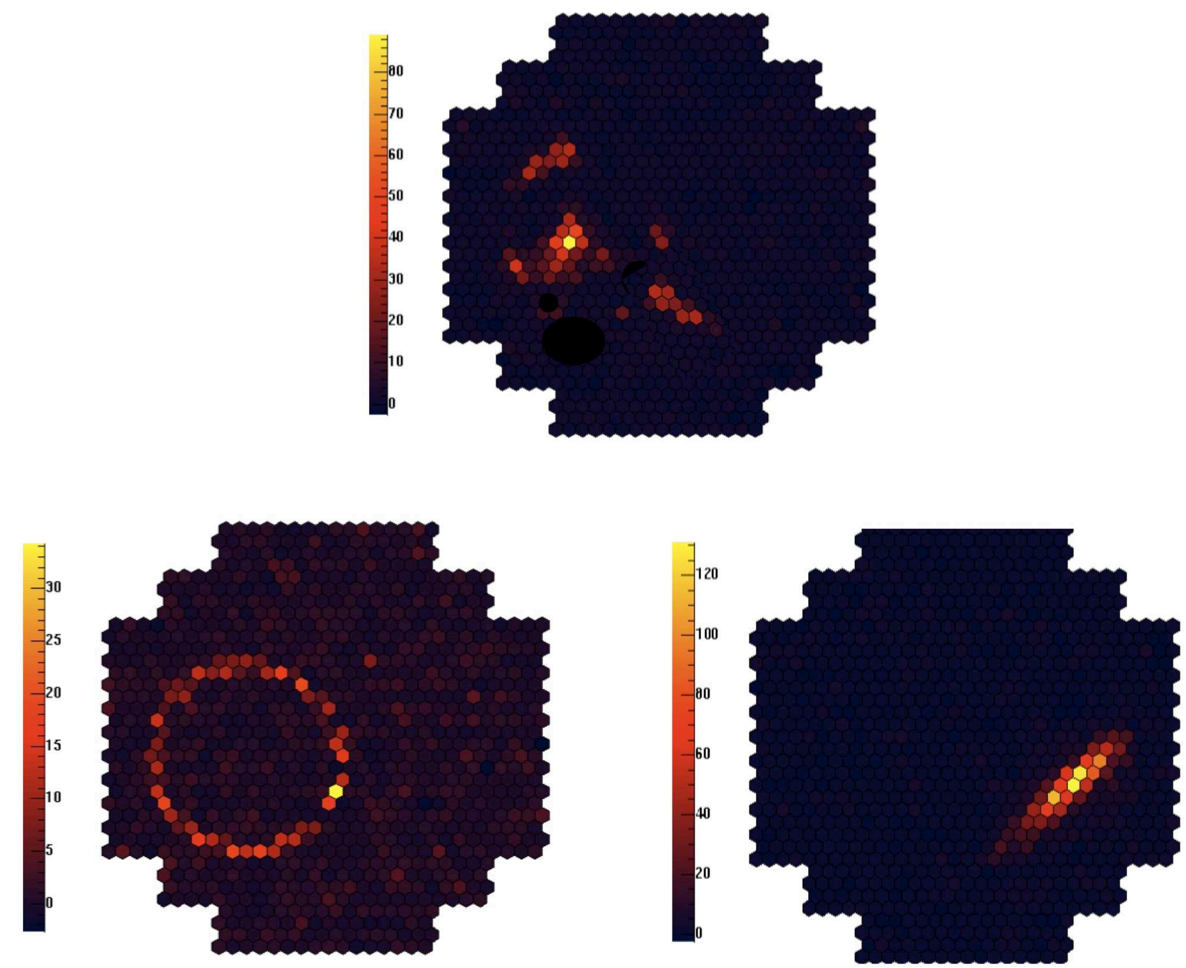
Imaging Cherenkov telescopes

- optical telescopes located in the light pool of a Cherenkov shower
- background discrimination (1 gamma-ray candidate every 1000 recorded events)

http://spie.org/x48508.xml



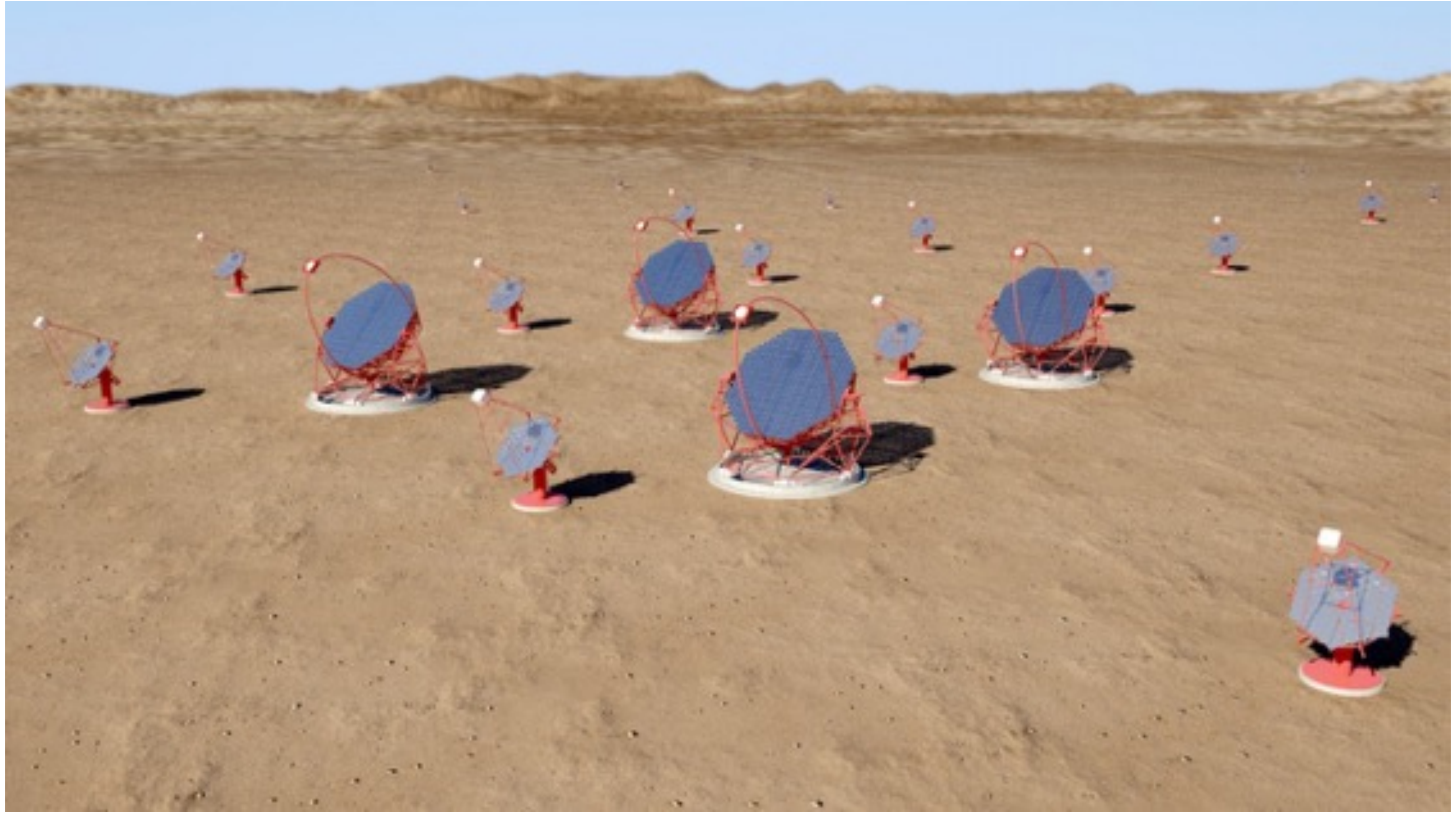


Brun, AIP Conf. Proc. 1446 (2010)

The Cherenkov Telescope Array (CTA)

- up to 100 hundreds telescope of 3 sizes to cover energy range from 20 GeV to 300 TeV
- an open observatory with 2 sites for whole sky coverage
- negotiation has started with candidate host countries: Aar (Namibia) or Cerro Armazones (Chile) for Southern site and La Palma (Spain) or San Pedro Martir (Mexico) for Northern site

http://www.isgtw.org/feature/grand-vision-cherenkov-telescope-array



Searching for Dark Matter (DM) with CTA

$$\frac{d\Phi_\gamma}{dE}(E_\gamma, \Psi) = \frac{(\sigma_{ann} v)}{8\pi m_\chi^2} \int d\lambda \sum_i B_i \frac{dN_\gamma^i}{dE}(E_\gamma(1+z))\, \rho_\chi^2(\lambda(z), \Psi)$$

maximum energy of the
produced gamma rays (cut-off)

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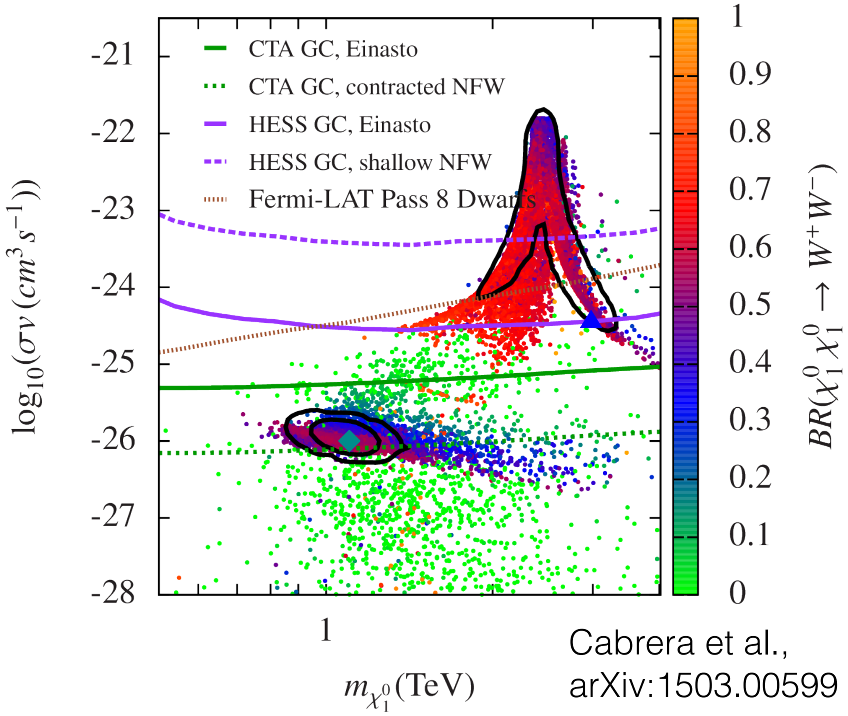
thermal cross-section (3×10^{-26} $cm^2 s^{-1}$) to reproduce Planck DM relic density



Cabrera et al., arXiv:1503.00599

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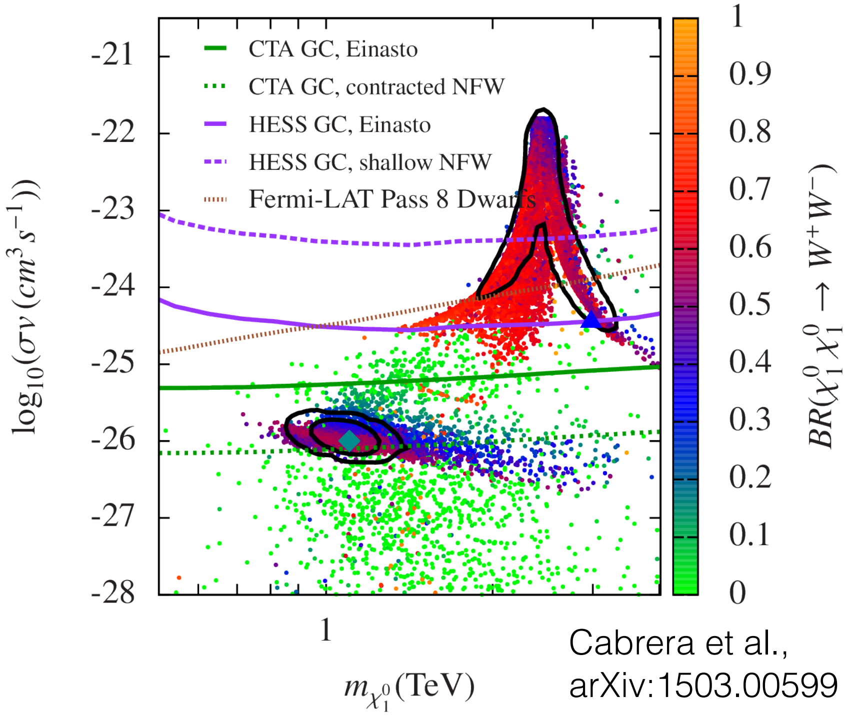

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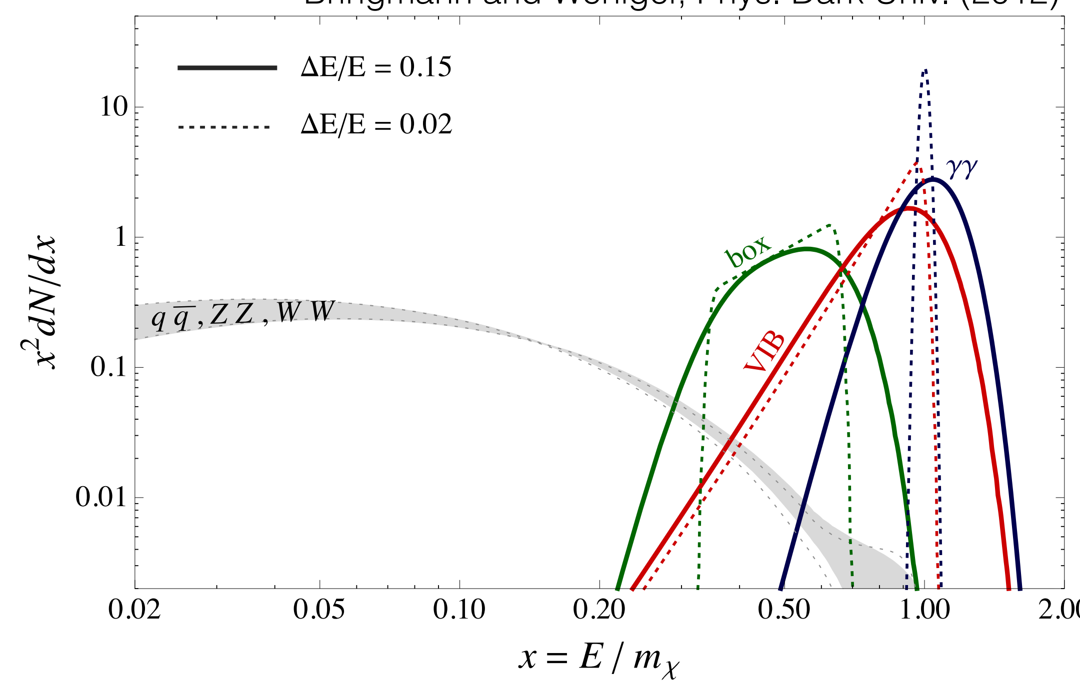
curved continuum with the possibility of features (bumps and lines)

Bringmann and Weniger, Phys. Dark Univ. (2012)



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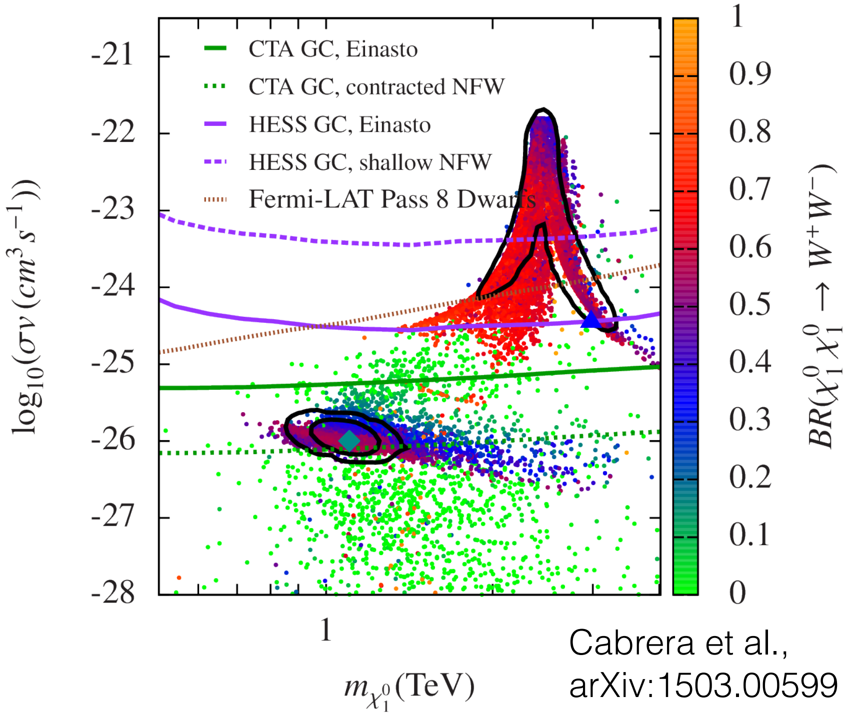

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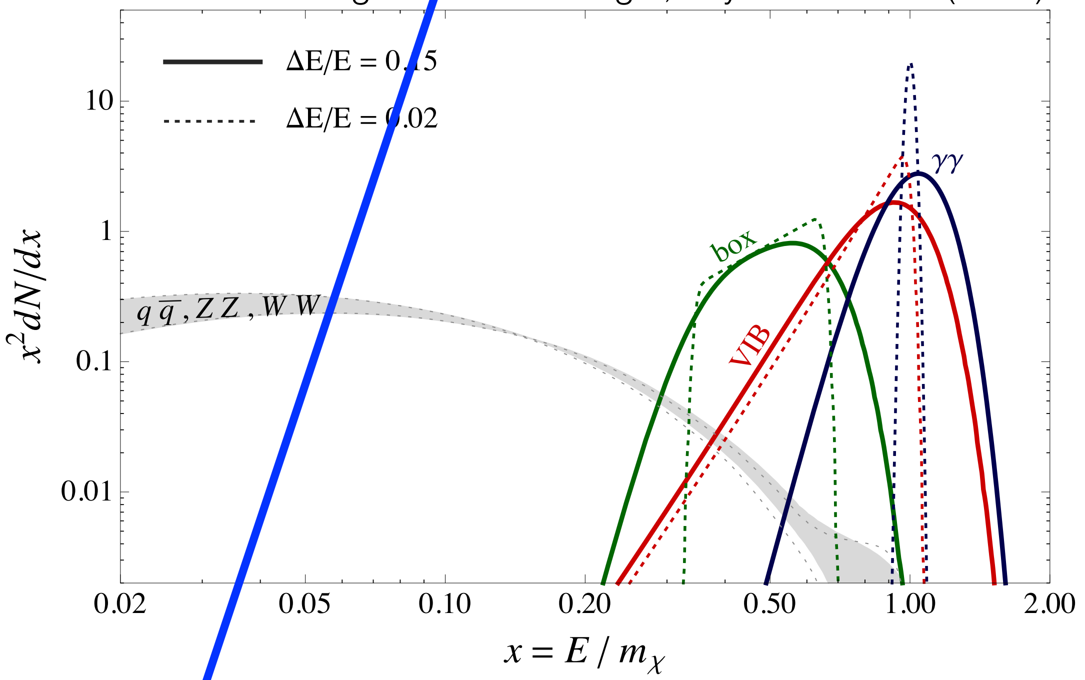

- need to be constrained with other observations
- *N*-body simulations can also help

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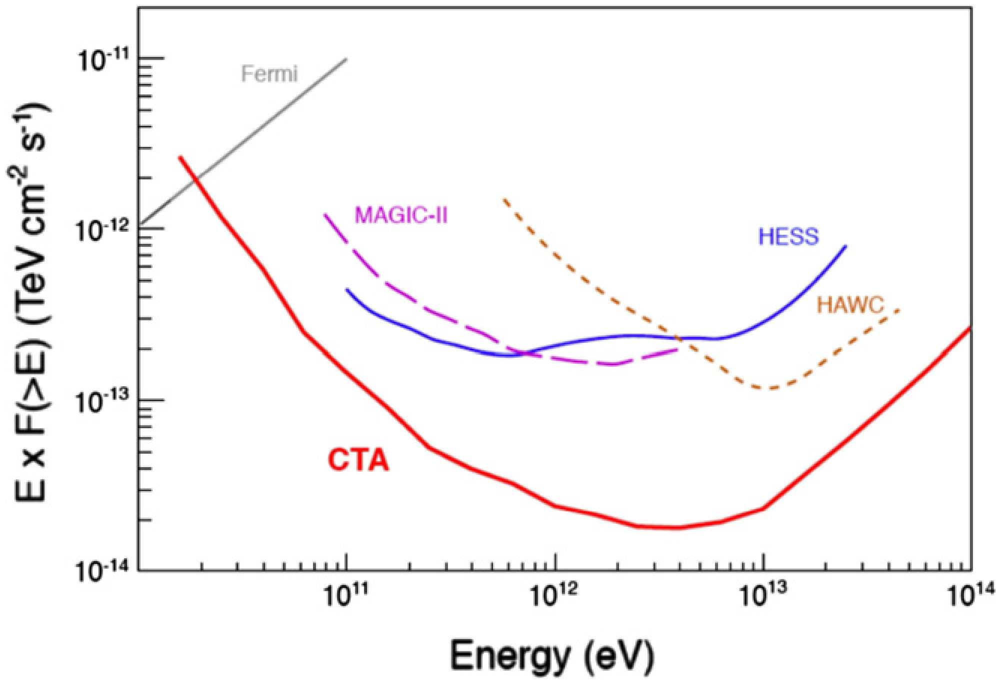

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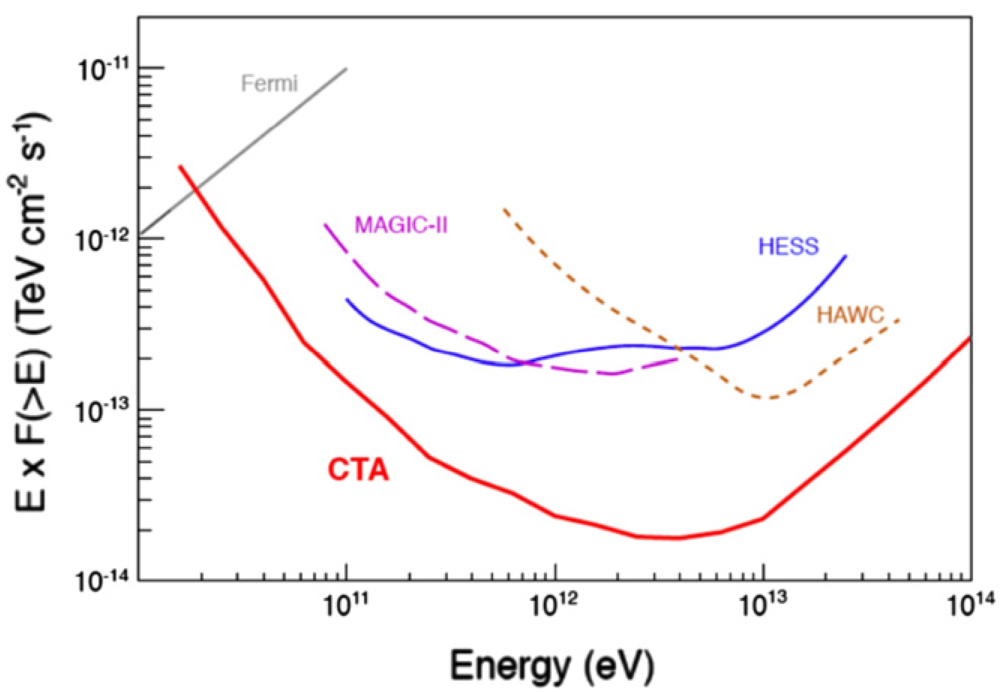

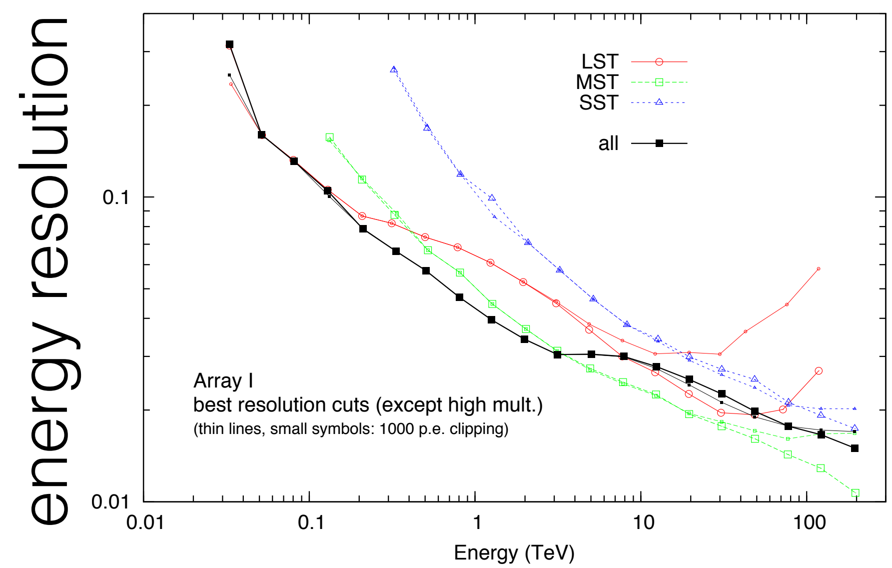

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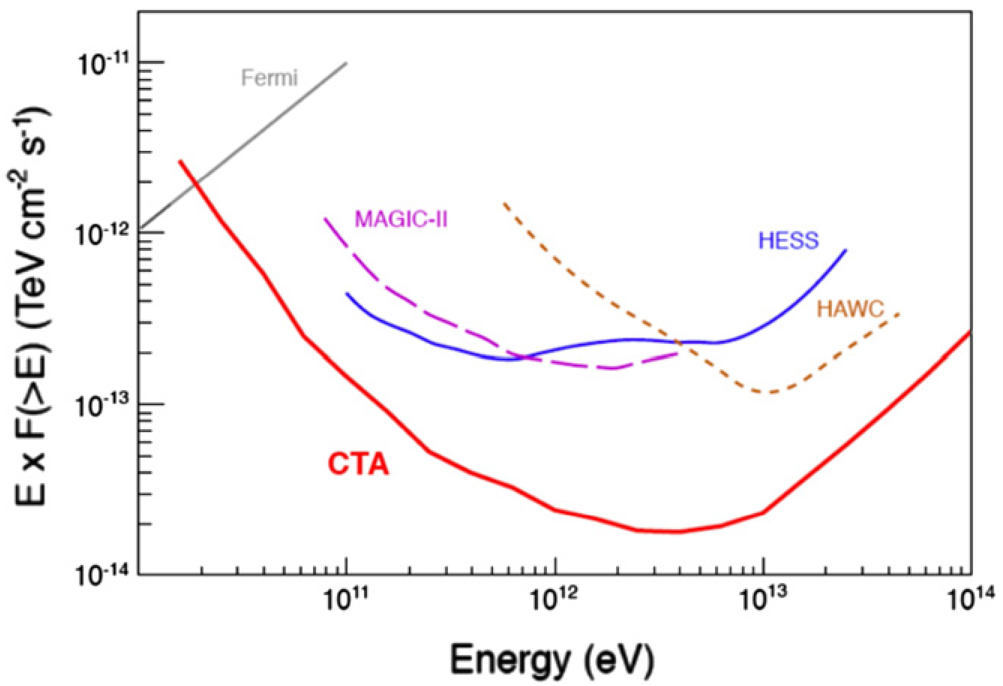
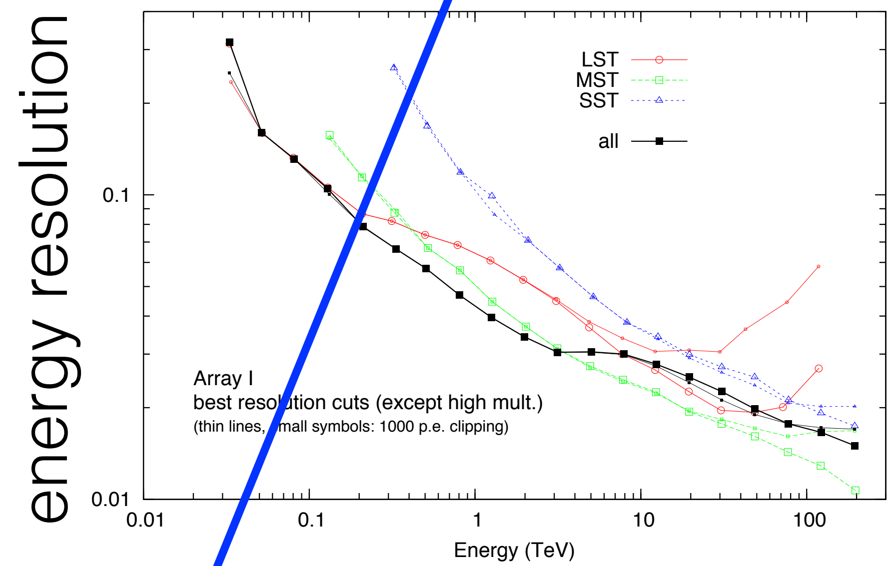
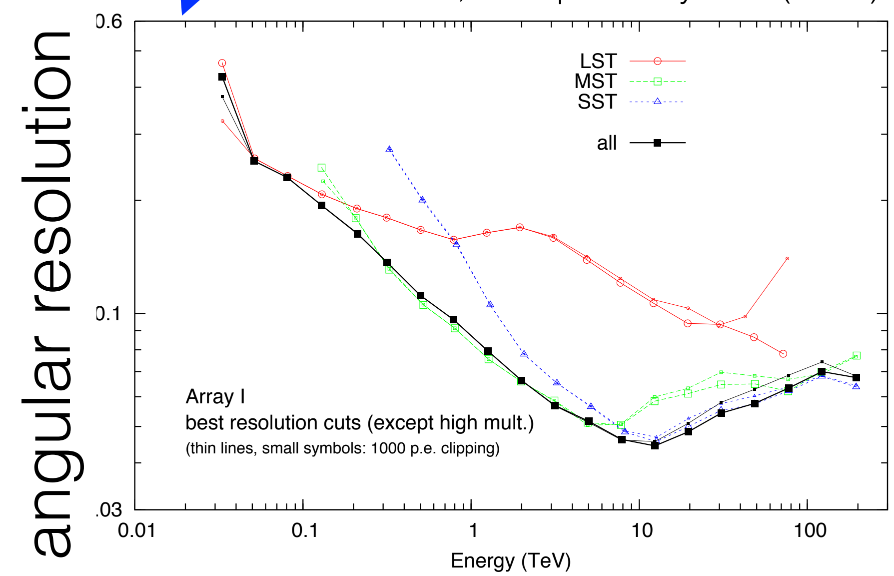
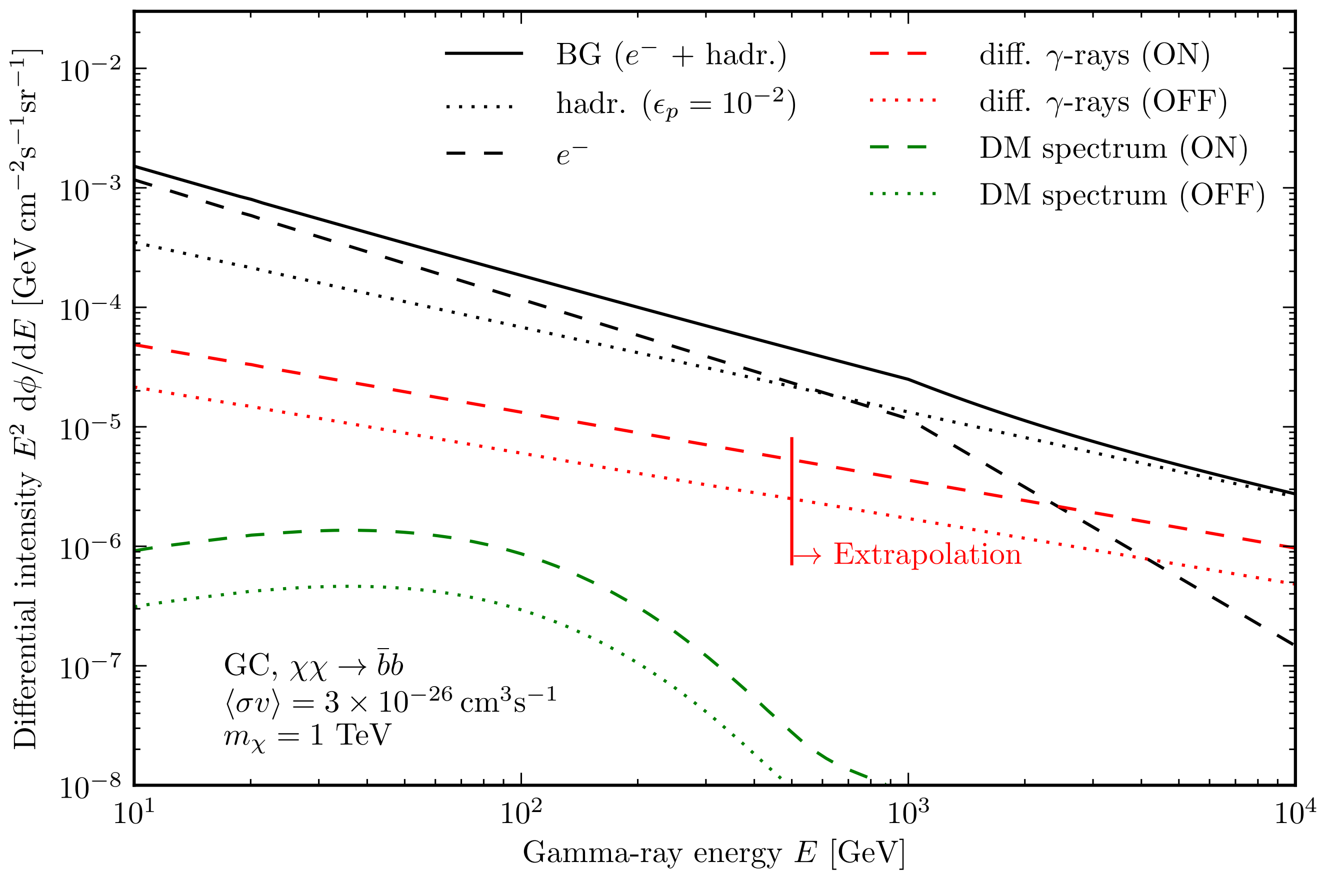




Bernlohr et al., Astropart. Phys. 43 (2013)



Silverwood, Weniger and Bertone, JCAP 1503 (2015)



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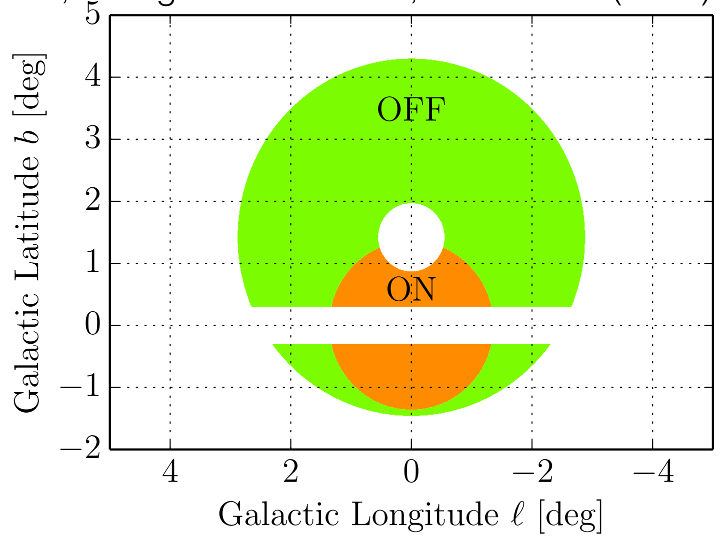
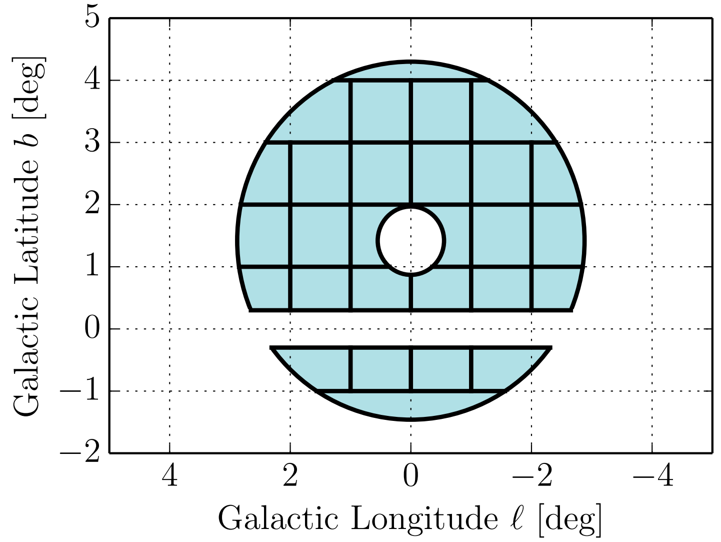


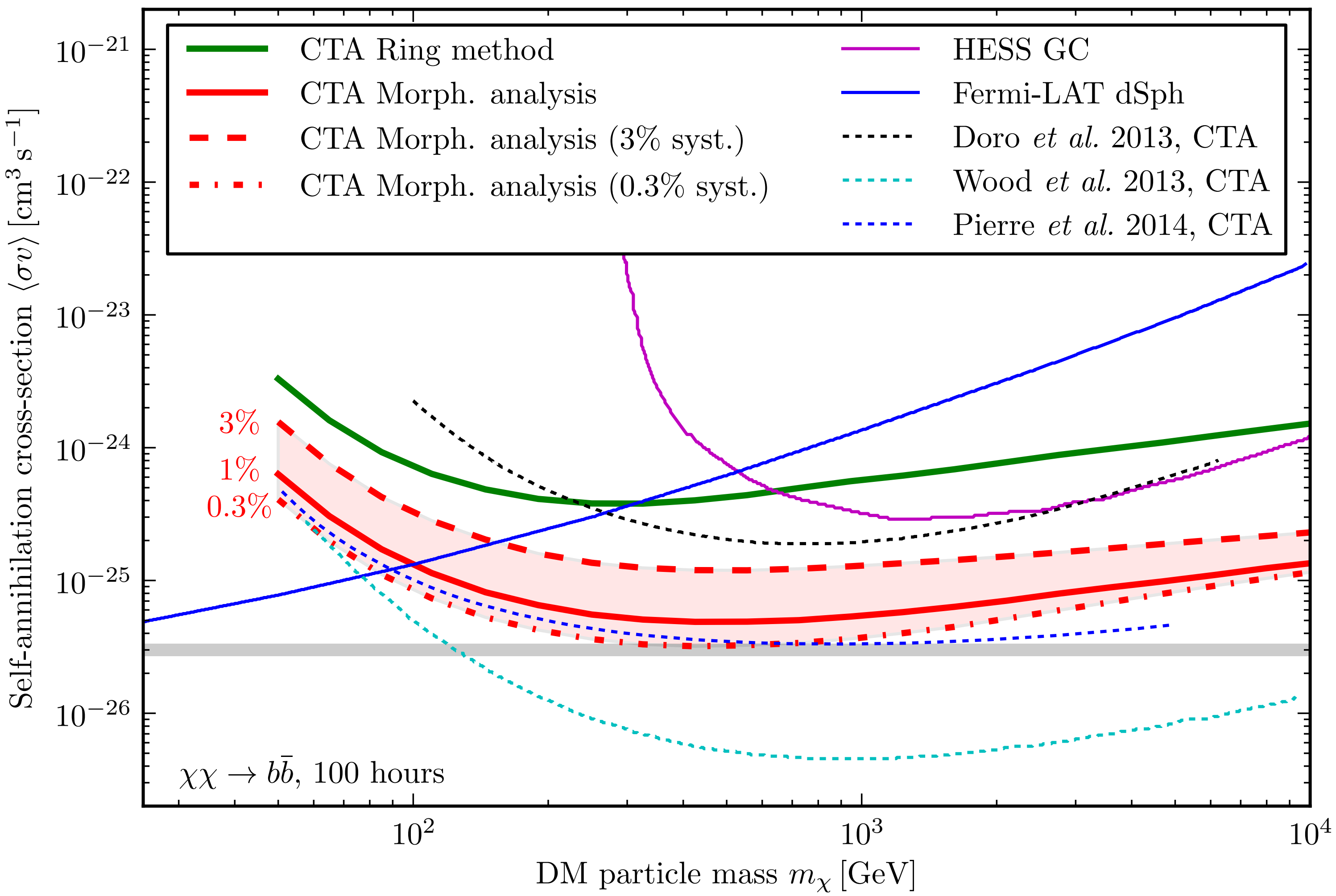


- N_{ON}, N_{OFF}: “experimental” data
- N_γ^S, N_γ^B, β: model and systematic uncertainty
- Poissonian statistics

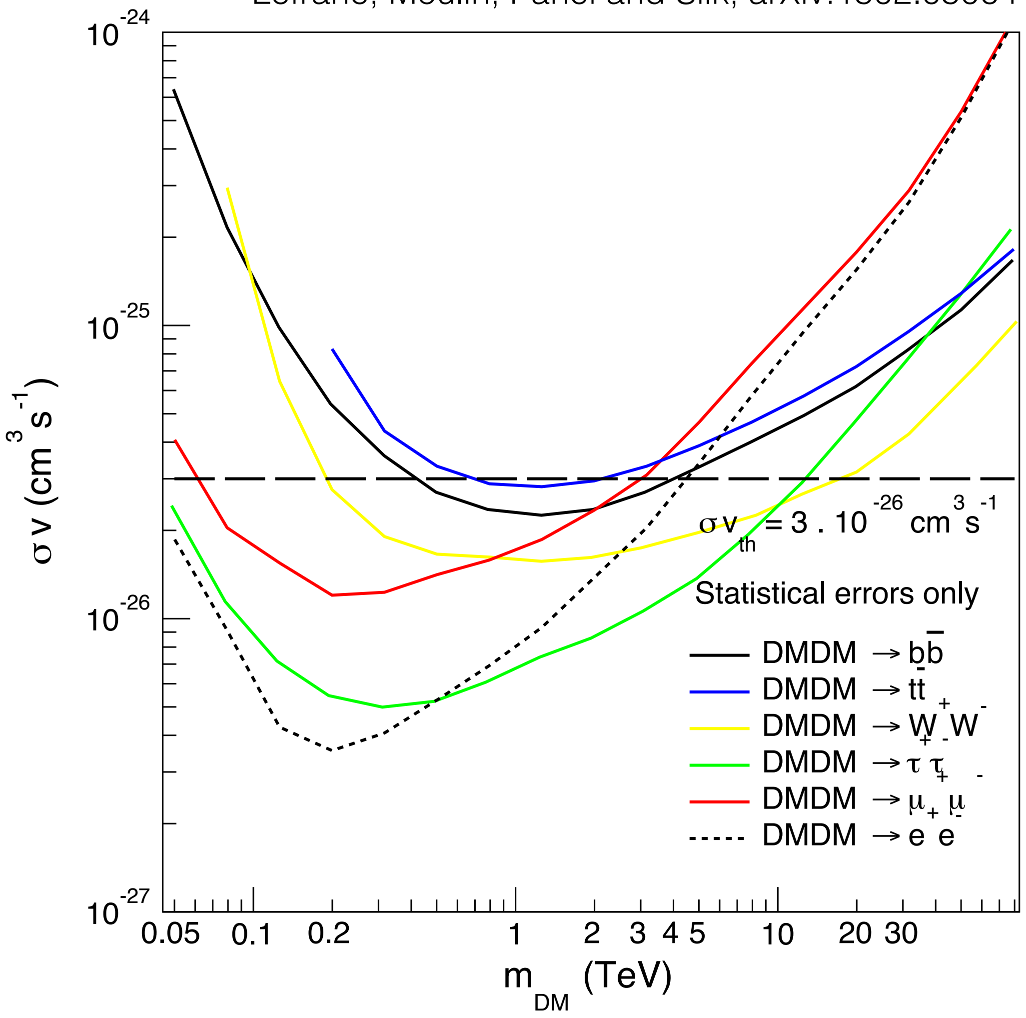
$$\mathcal{L}_{ij}(N_\gamma^S, N_\gamma^B, \beta | N_{ON}, N_{OFF}) = \frac{e^{-\frac{(1-\beta_{ij})^2}{2\sigma_{ij}^2}}}{\sqrt{2\pi}\sigma_{ij}} \frac{\beta_{ij}^{N_{ON,ij}} (N_{\gamma,ij}^S + N_{\gamma,ij}^B)^{N_{ON,ij}}}{N_{ON,ij}!} e^{-\beta_{ij}(N_{\gamma,ij}^S + N_{\gamma,ij}^B)} \frac{(N_{\gamma,ij}^B/\alpha_i)^{N_{OFF,ij}}}{N_{OFF,ij}!} e^{-N_{\gamma,ij}^B/\alpha_i}$$

Sensitivity from the MW inner halo

Silverwood, Weniger and Bertone, JCAP 1503 (2015)



Lefranc, Moulin, Panci and Silk, arXiv:1502.05064

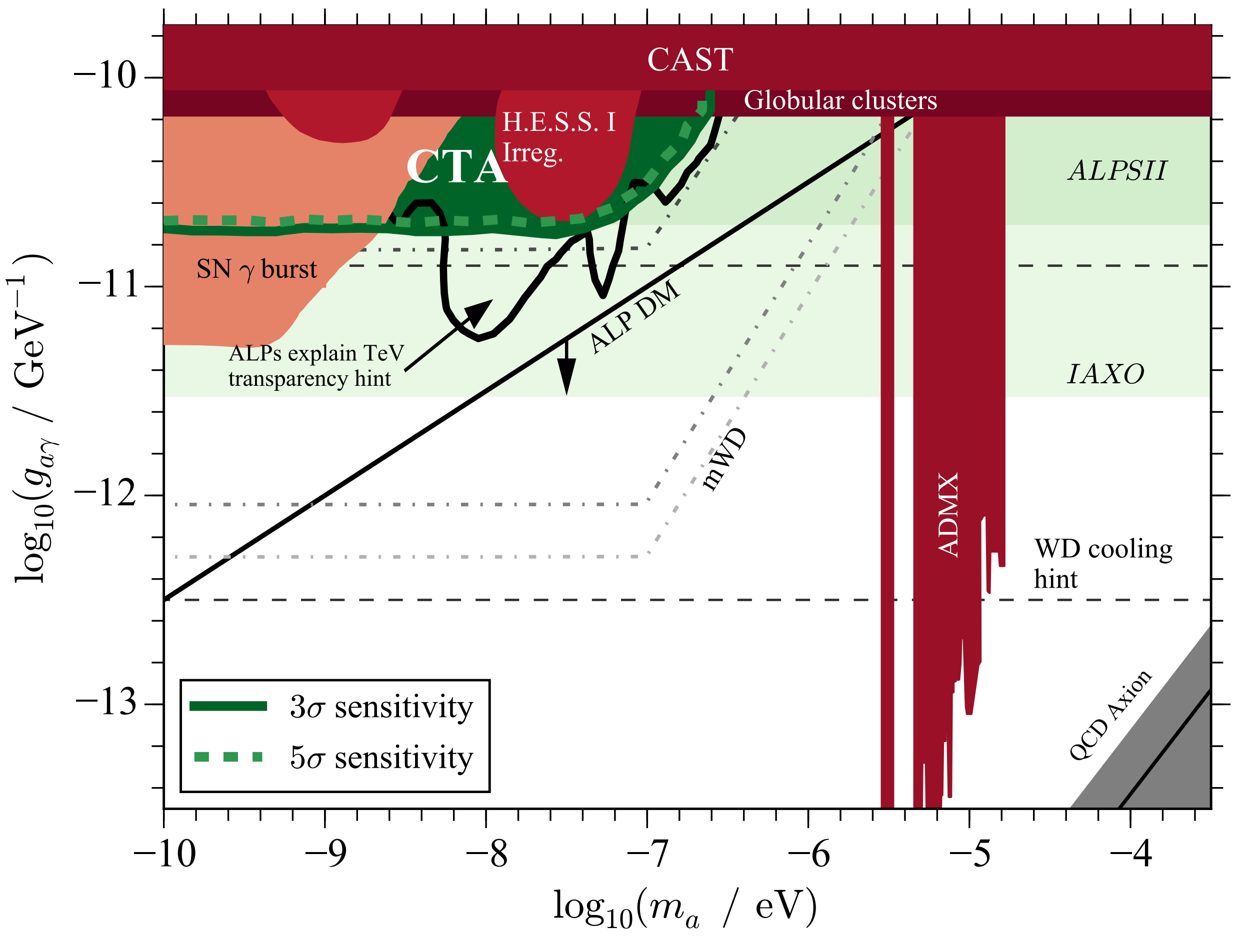


- improvement in the “morphological” analysis compared to the “Ring” method
- effect of systematic uncertainties

Search for axion-like particles (ALPs)

- mixing of ALPs with photons in the presence of magnetic fields
- excess of photons in the "optical thick" regime due to reconversion of from ALPs to gamma rays

Meyer and Conrad, JCAP 1412 (2014)



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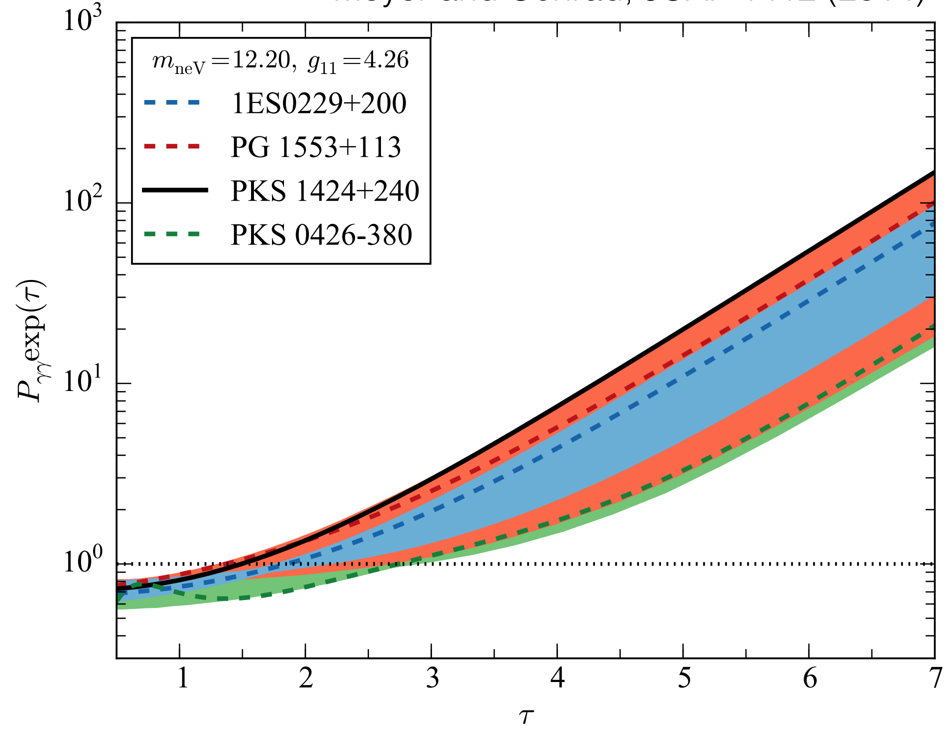

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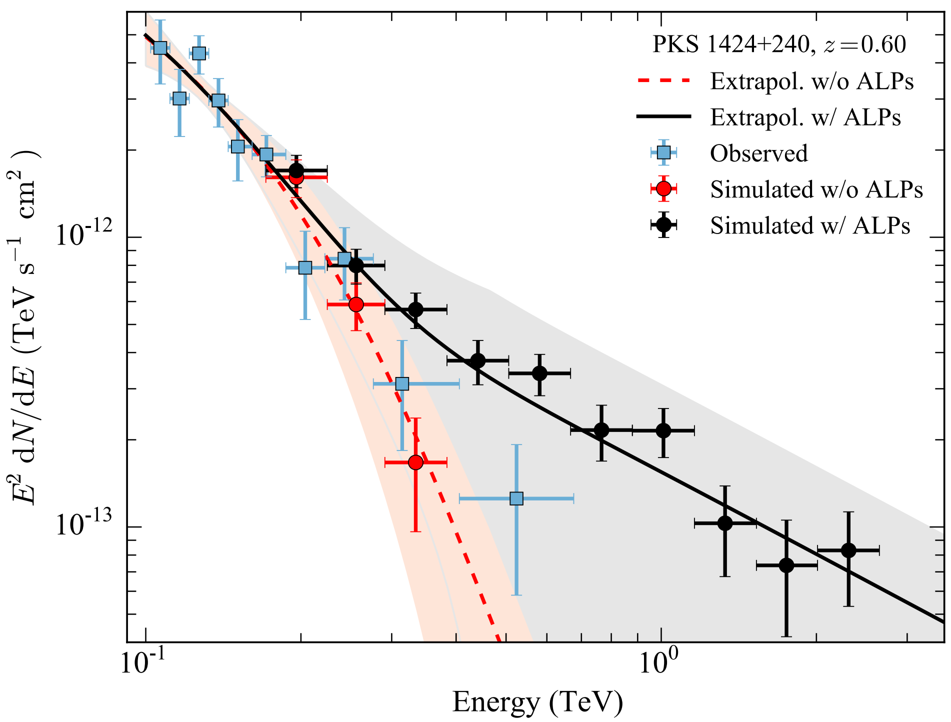
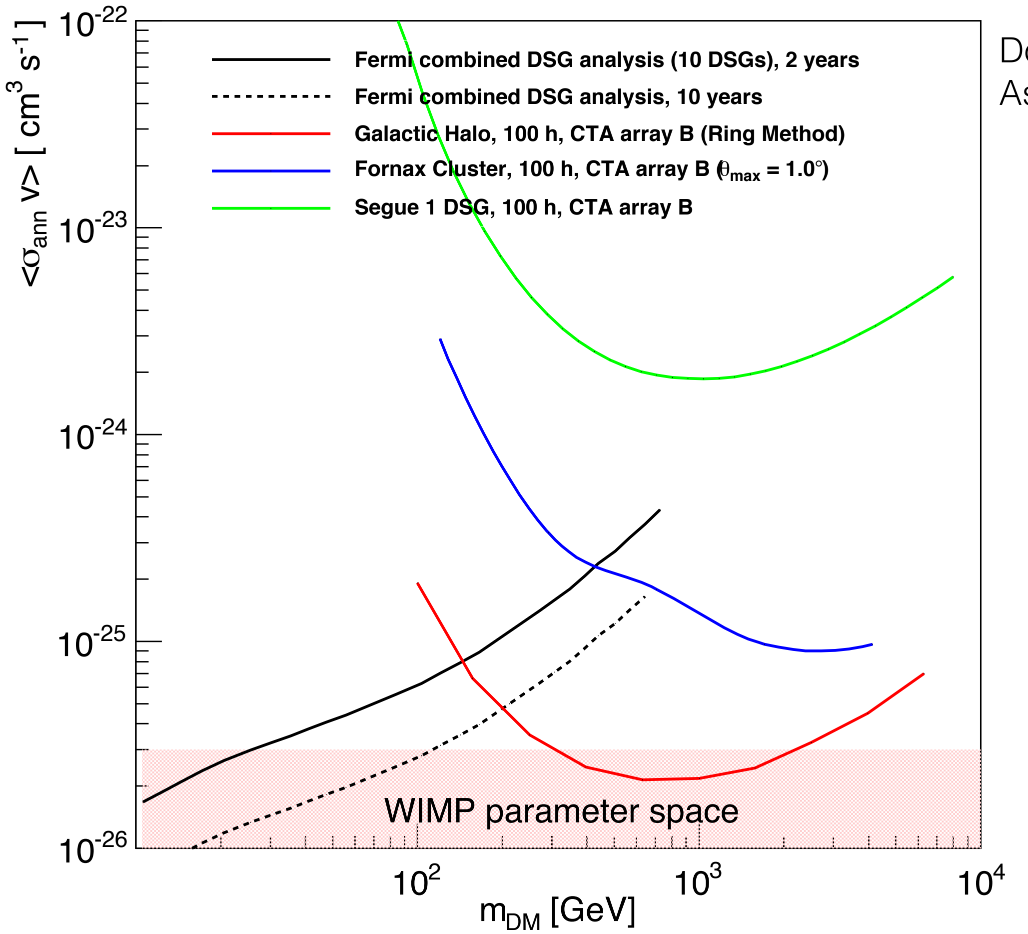


Conclusions

- CTA will have the best sensitivity to search for DM in the near future (especially for heavy candidates)
- sensitivity reaches thermal cross-section for WIMPs
- complementarity with other detection strategies (collider and direct detection)



Doro et al.,
Astropart. Phys. 43 (2013)