Search for photon line-like signatures from Dark Matter annihilations with HESS

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Christopher van Eldik, Daniil Nekrassov & Peter Eger for the H.E.S.S. Collaboration

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Friedrich-Alexander-Universität Erlangen-Nürnberg

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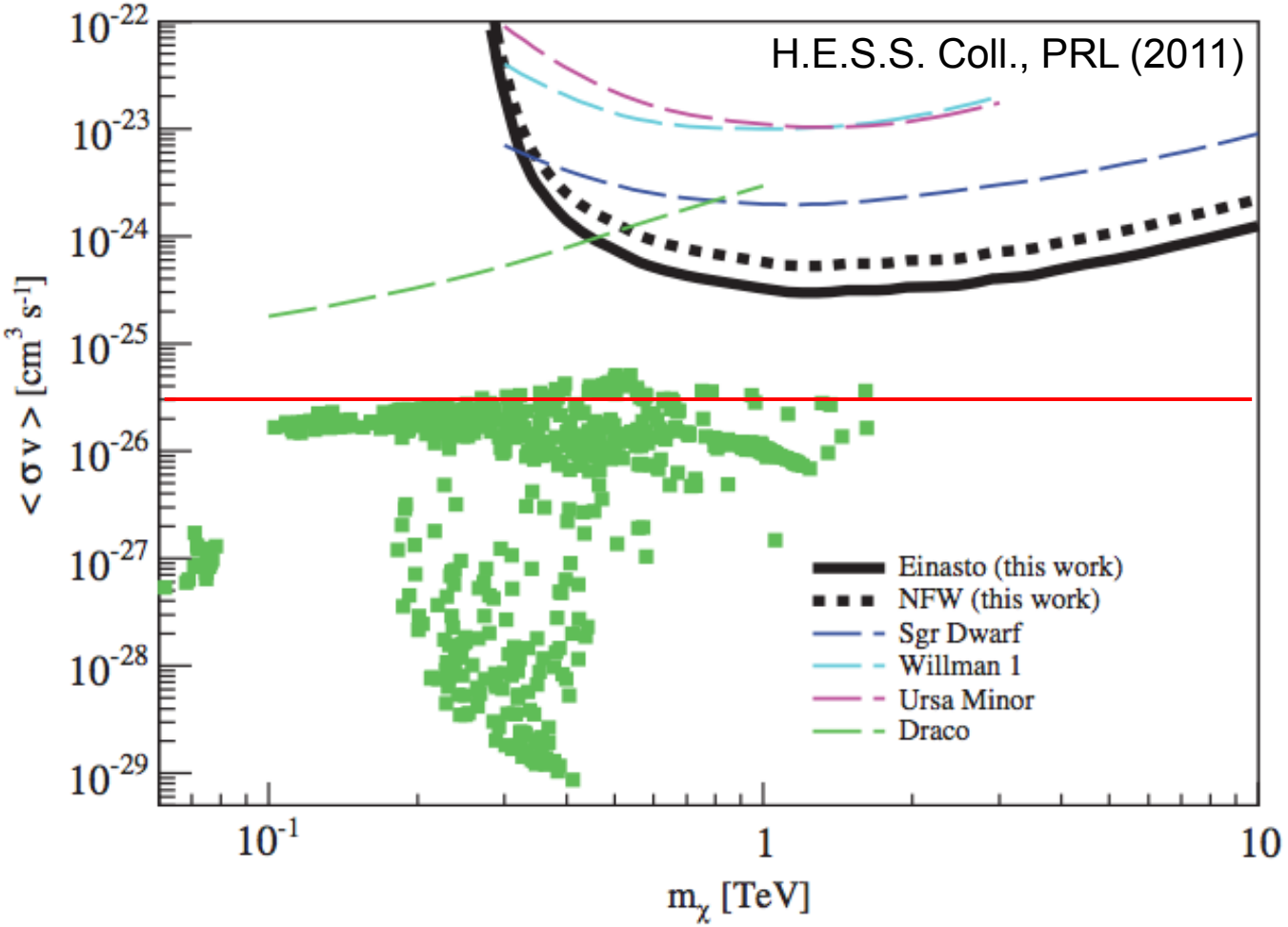
Current <σv> limits for $\chi\chi \rightarrow q\bar{q}$ at TeV energies



- Central Galactic Halo: best limits for ~TeV neutralino masses
- Huge potential for CTA (see talk by S. Funk)

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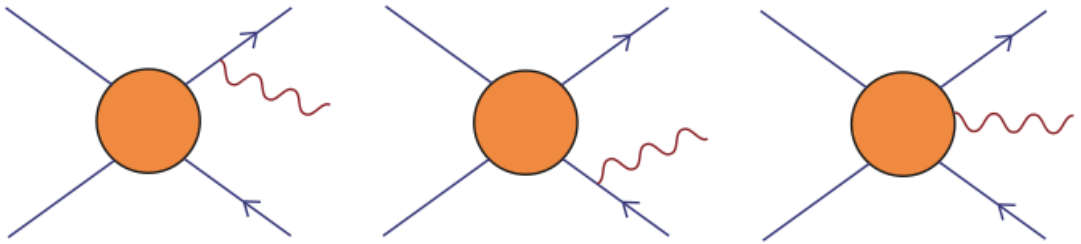
Why search for line-like signatures?

- Smoking gun!
  - Easily distinguishable from particle-accelerating sources
  - Easily identifiable on smooth cosmic ray background spectrum
  - Gun already smoking? (see talk by C. Weniger)



Bringmann et al. (2008)

- Possible production channels
  - $\chi\chi \rightarrow \gamma\gamma$, γZ: line at or close to DM particle mass
  - $\chi\chi \rightarrow \gamma X$: line at ½ DM particle mass
  - $\chi\chi \rightarrow f\bar{f}\,\gamma$, $W^+W^-\,\gamma$, $H^+H^-\,\gamma$: peak close to m_χ due to Internal Bremsstrahlung (VIB + FSR)

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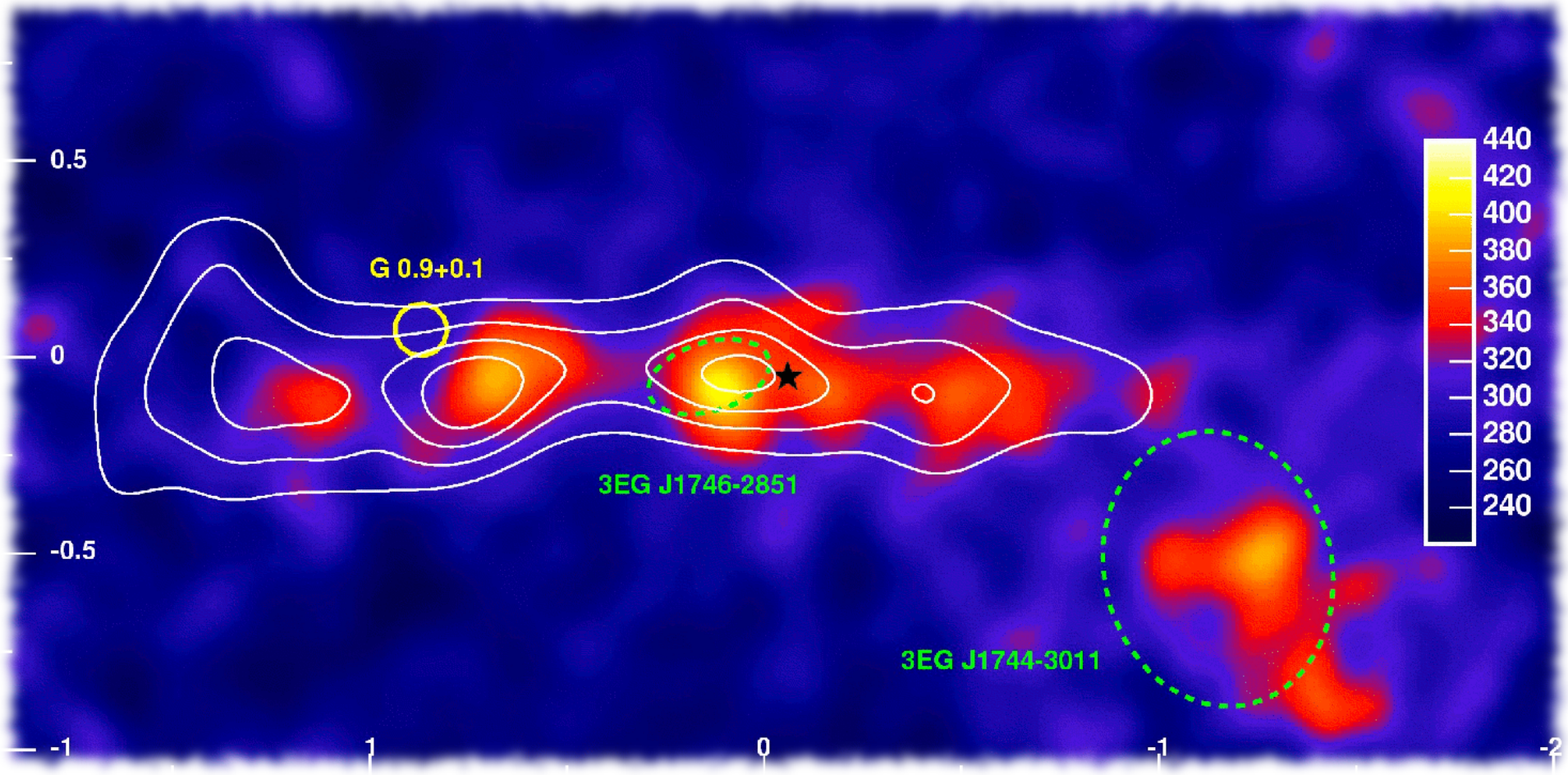
Central Galactic halo: fighting astrophysical background



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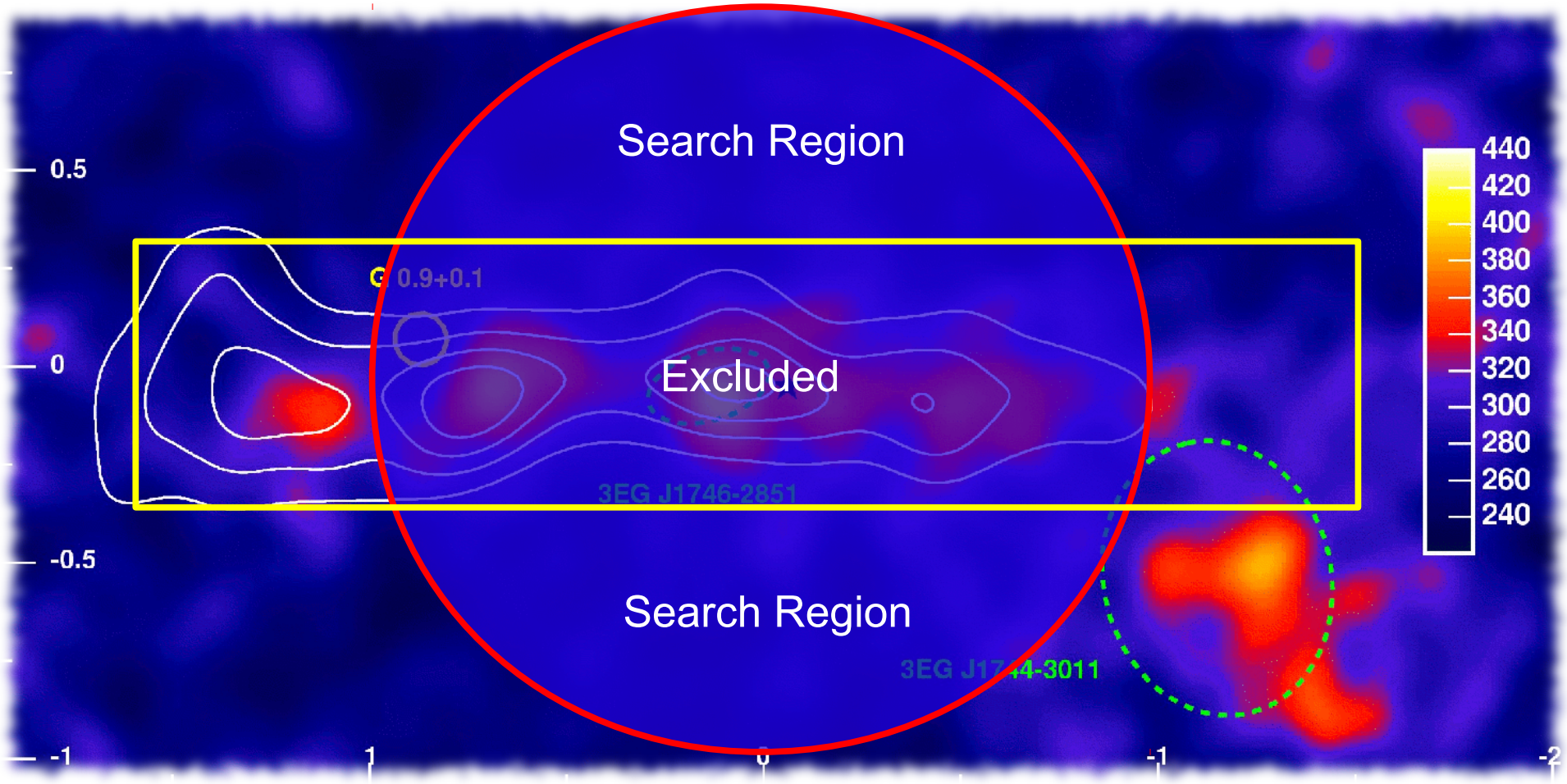
Central Galactic halo: fighting astrophysical background



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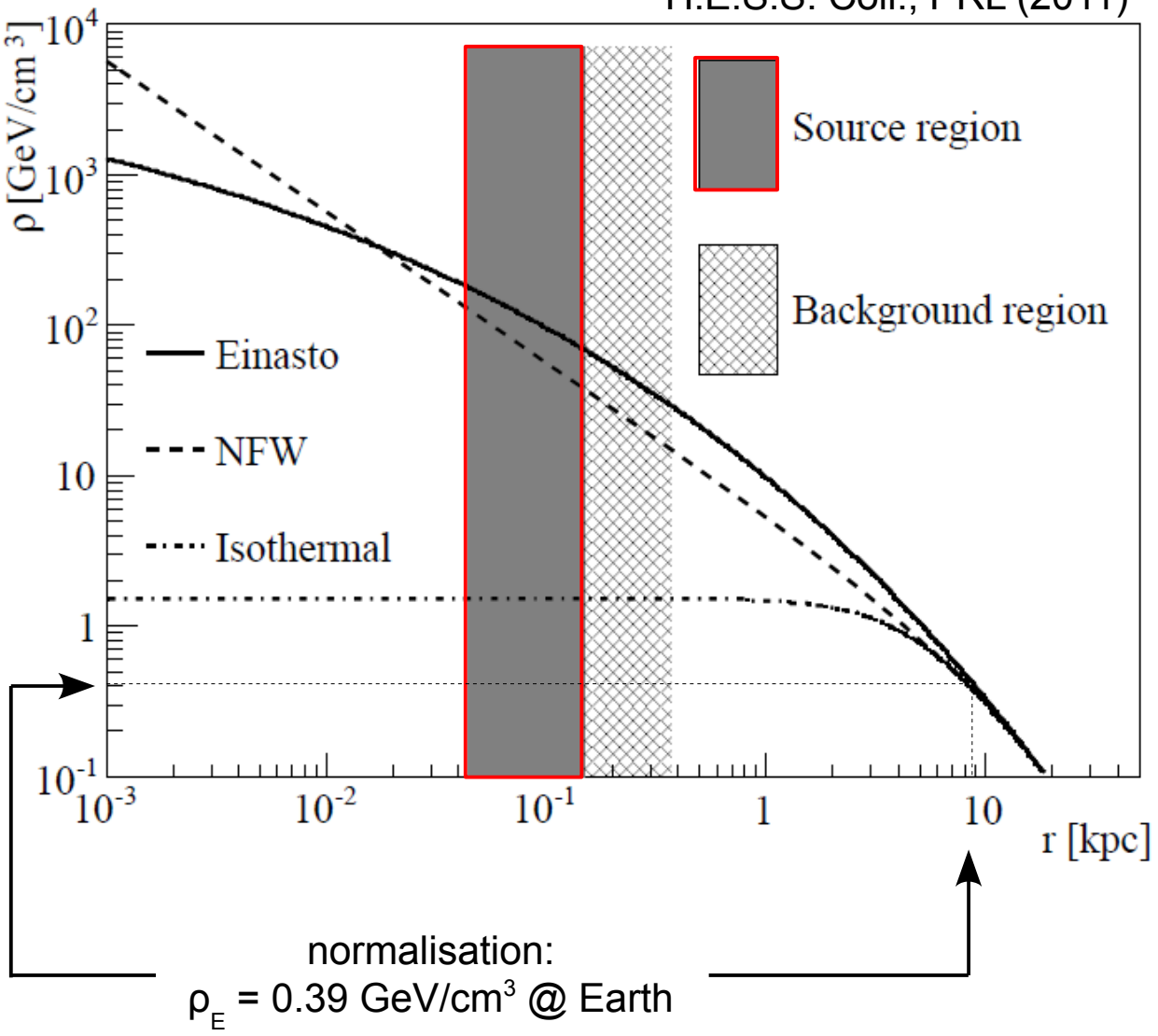
The role of the Dark Matter halo

H.E.S.S. Coll., PRL (2011)



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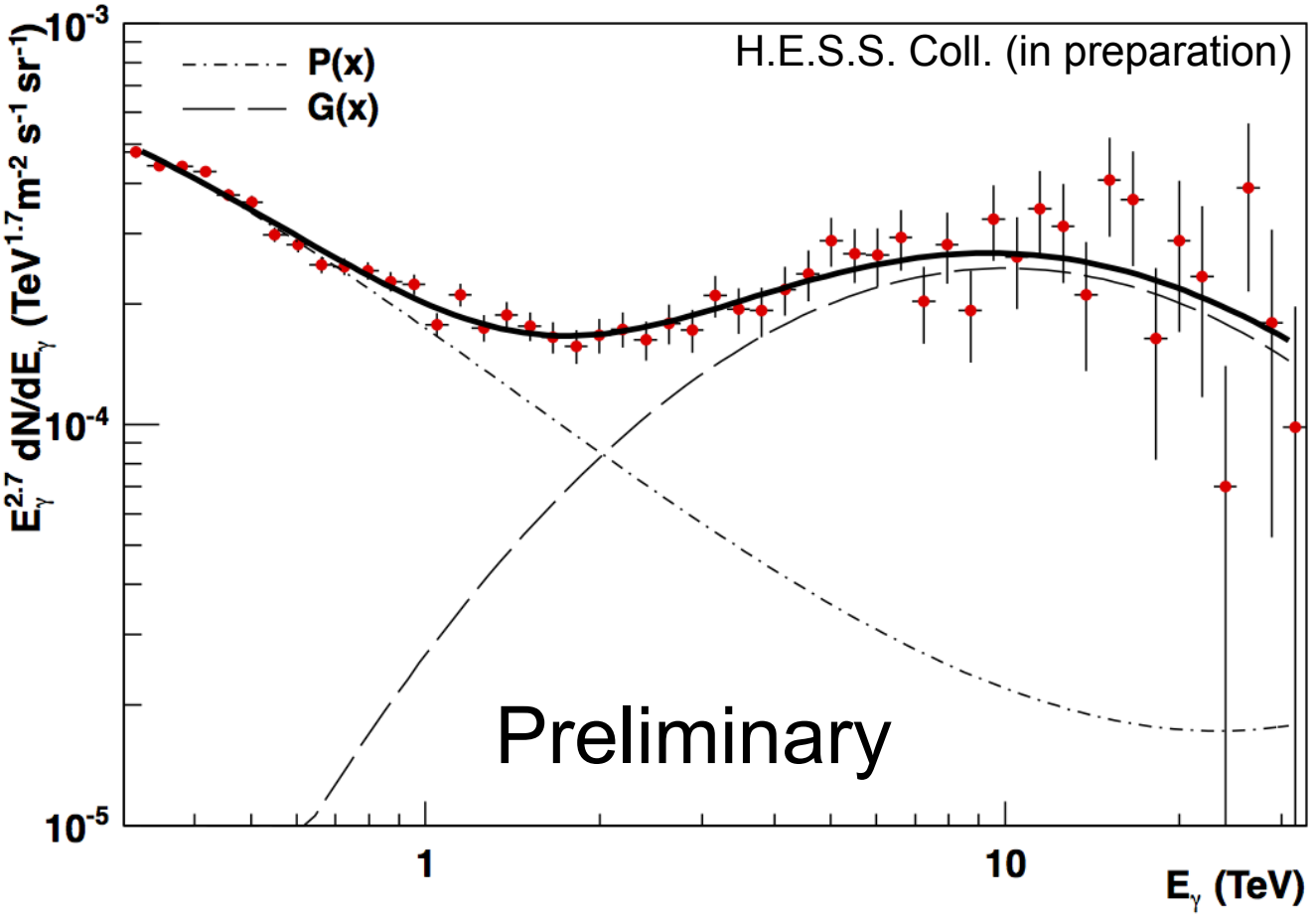
Galactic halo: gamma-ray candidate flux spectrum



- 112 h live time, standard Hillas analysis
- 4 telescope events only
  → improved energy resolution and line sensitivity
- Mostly misidentified cosmic ray events, empirical parameterization

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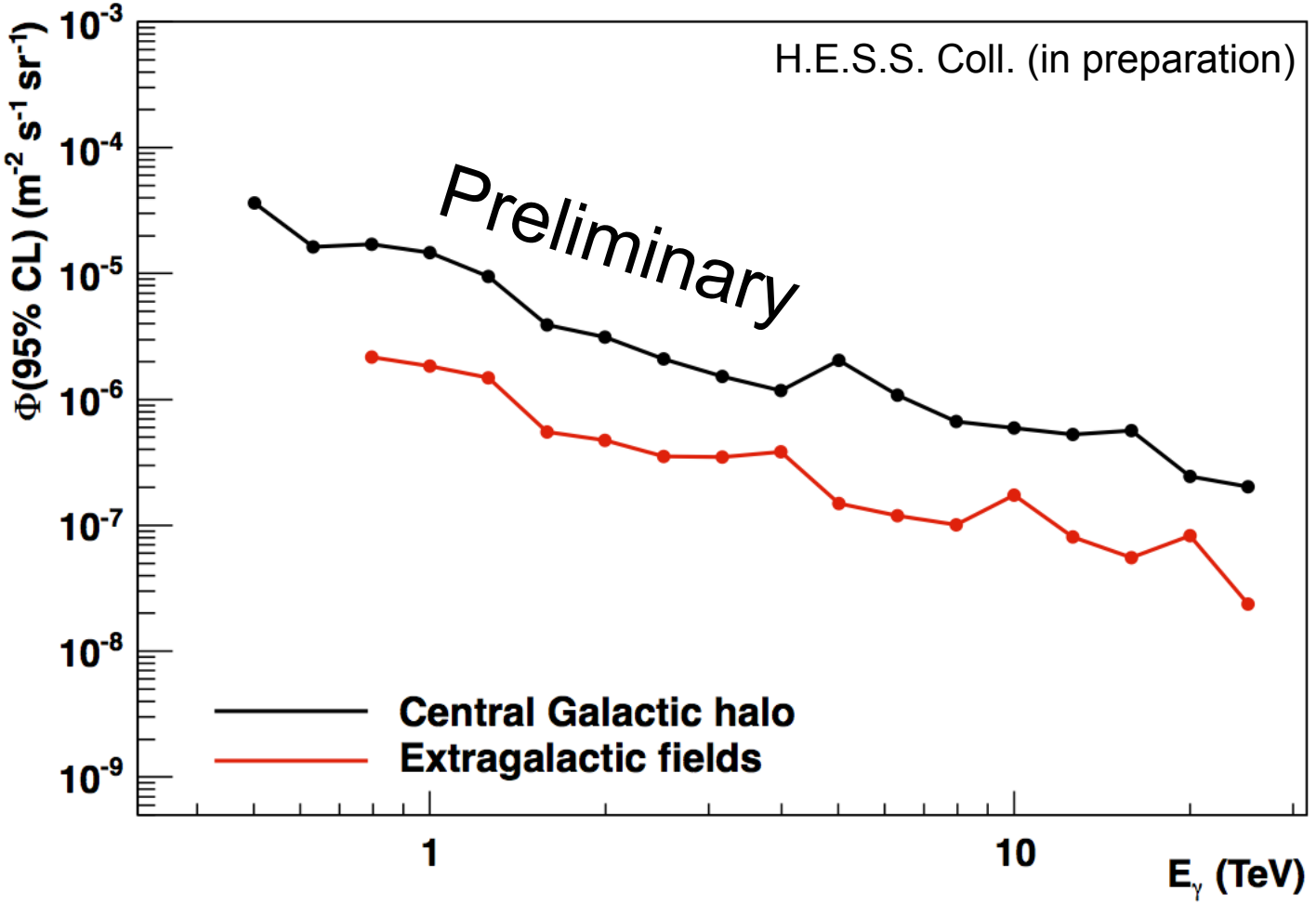
Flux limits for line emission



- Extragalactic fields: 1153 h live time, 2º radius field of view
- First flux limits on line emission at TeV energies

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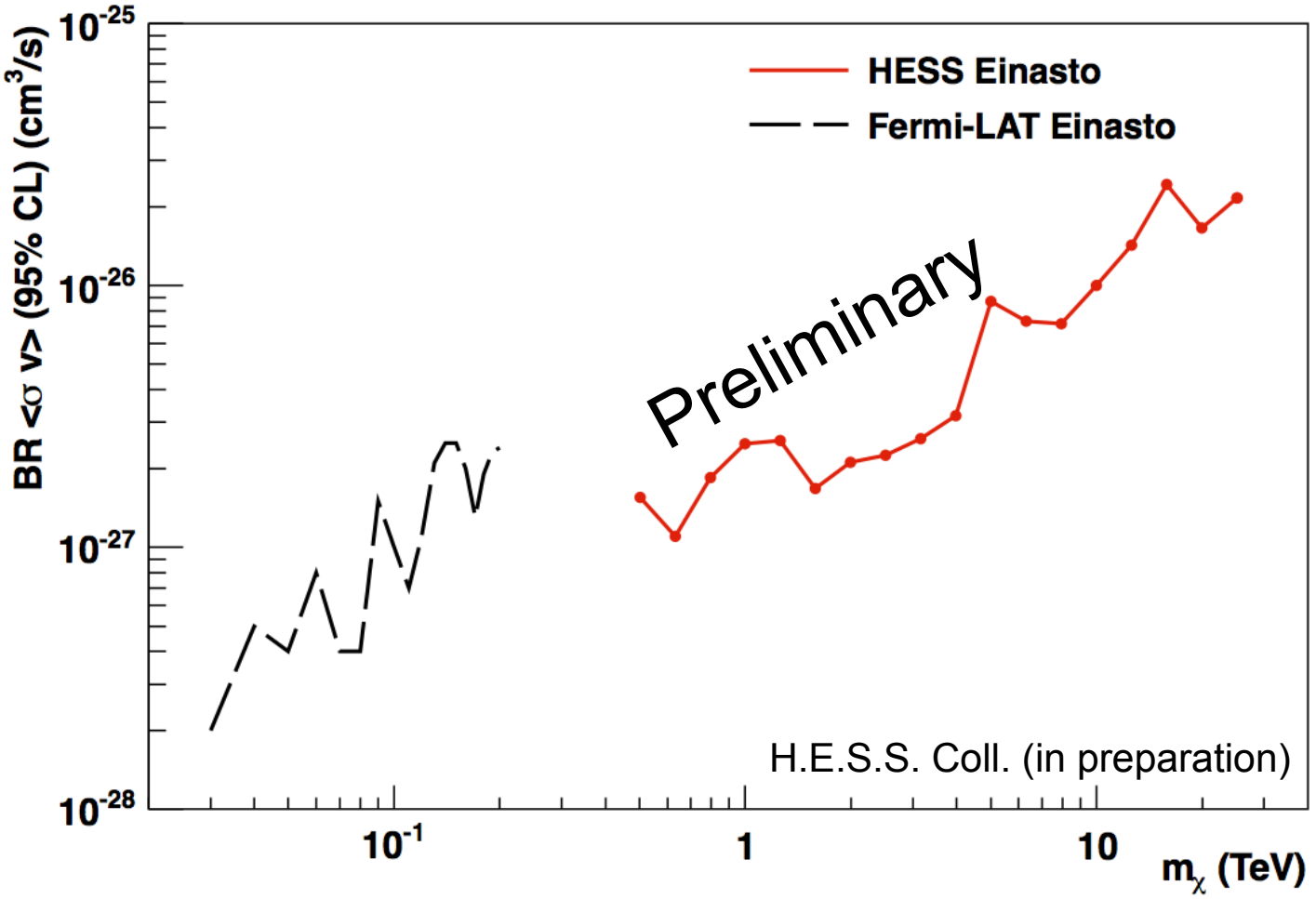
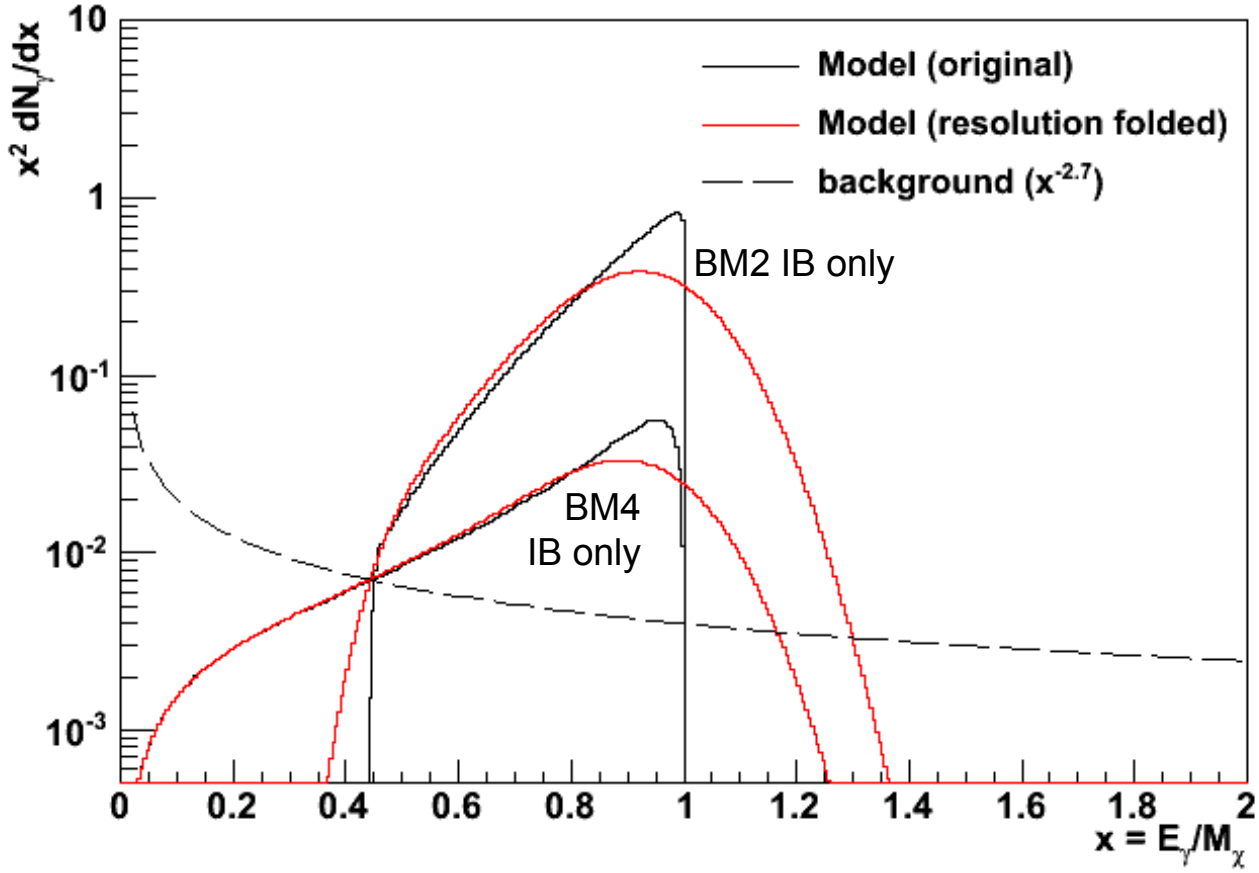
Central Galactic Halo: <σv> limits for χχ→γγ



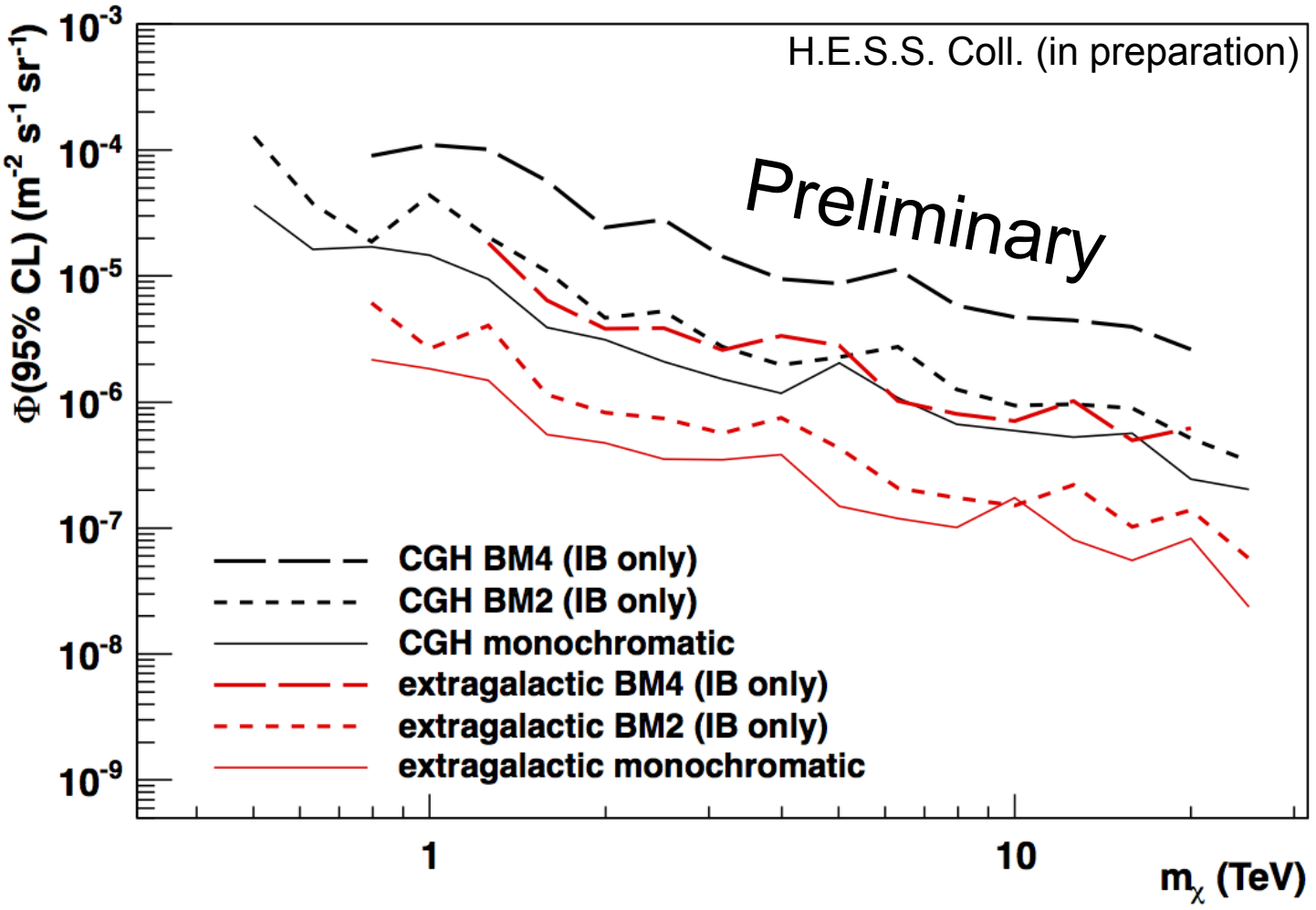
- Assume Einasto profile normalized to 0.39 GeV/cm^3 @ Earth
- Limits competitive to Fermi-LAT halo search

Sensitivity for IB-like features



- Spectrum models BM2/BM4 from Bringmann et al. (2008)
  note: valid for distinct sets of MSSM parameters only
  → only used as templates to estimate sensitivity for broader features
- Secondary gamma-ray production hidden by cosmic ray background
  → fit only IB part of model

Flux limits for IB-like features



- Sensitivity typically factor 2-10 worse compared to lines
- Similar limits for signatures of comparable shape

Summary

- For the first time:
  flux limits on line emission @ TeV energies
- Energy range of search ~ 500 GeV – 25 TeV
- Limits @ 1 TeV ~ 2×10^{-9} ph/cm^2/s/sr (Central Galactic halo)
  ~ 2×10^{-10} ph/cm^2/s/sr (extragalactic fields)

- Neutralino annihilation into photons ($\chi\chi \rightarrow \gamma\gamma$):
  BR$\langle\sigma v\rangle$ limits reach 10^{-27} cm^3/s for Einasto profile

- Flux sensitivity for IB-like signatures
  typically factor 2-10 worse

GEFÖRDERT VOM
Bundesministerium für Bildung und Forschung
HELMHOLTZ ASSOCIATION
Alliance for Astroparticle Physics
EMERGING FIELDS INITIATIVE
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Backup

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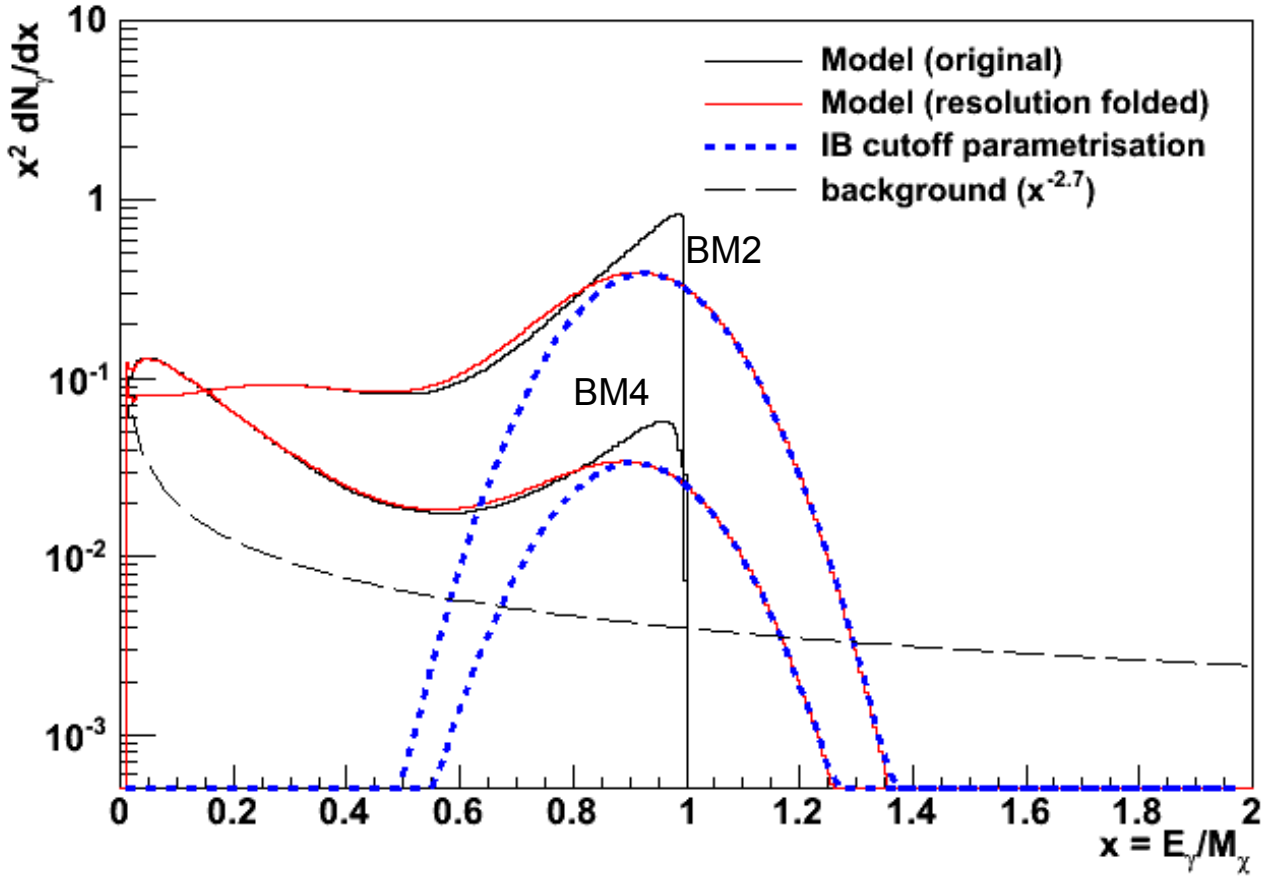
IB-like feature limits – full IB spectrum

- Cutoff smeared out due to energy resolution (here: σ_E=11% @ E=10 TeV)
- Generally: low energy part mostly hidden by background
  → concentrate on detection of IB cutoff at x=1



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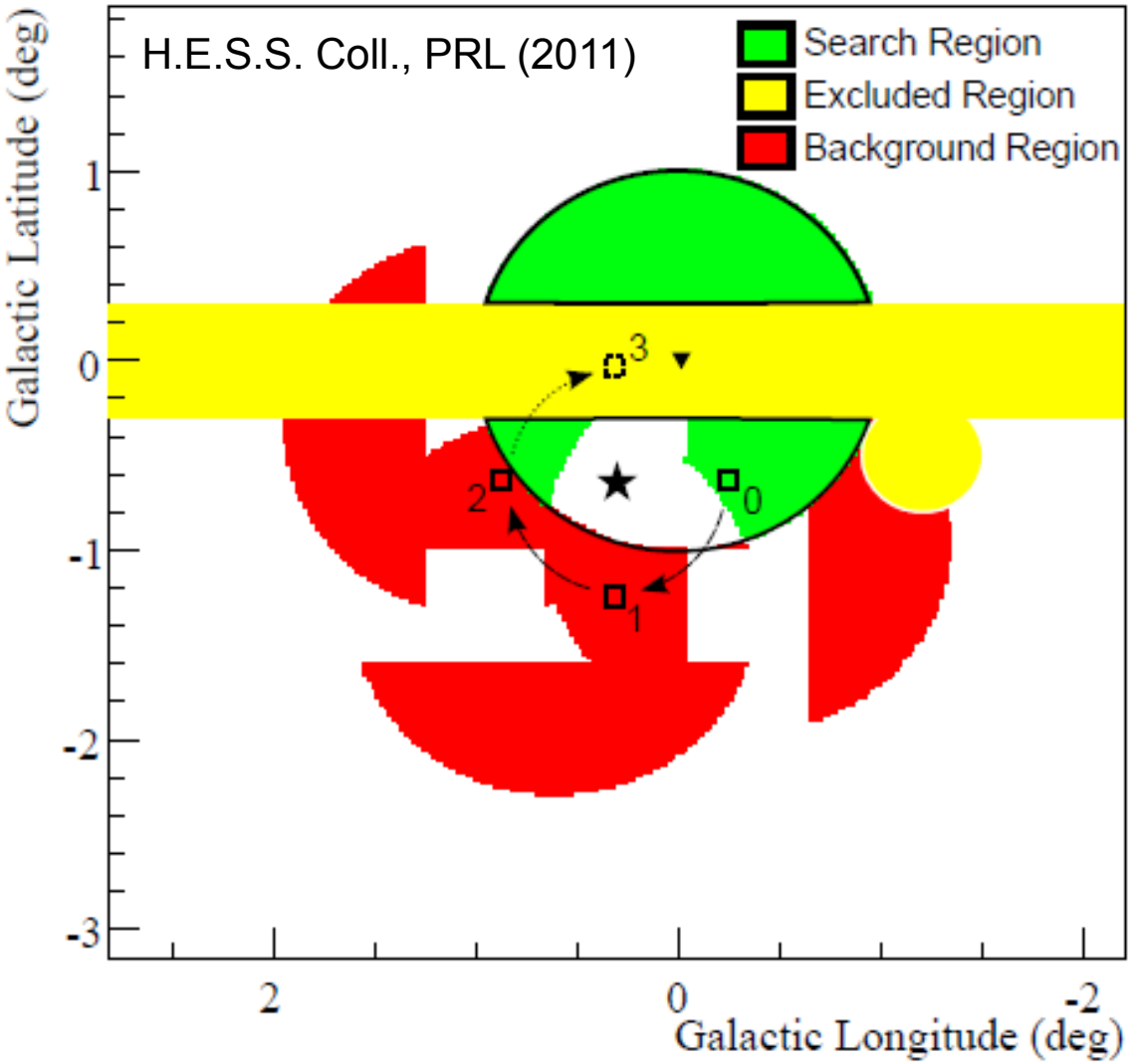

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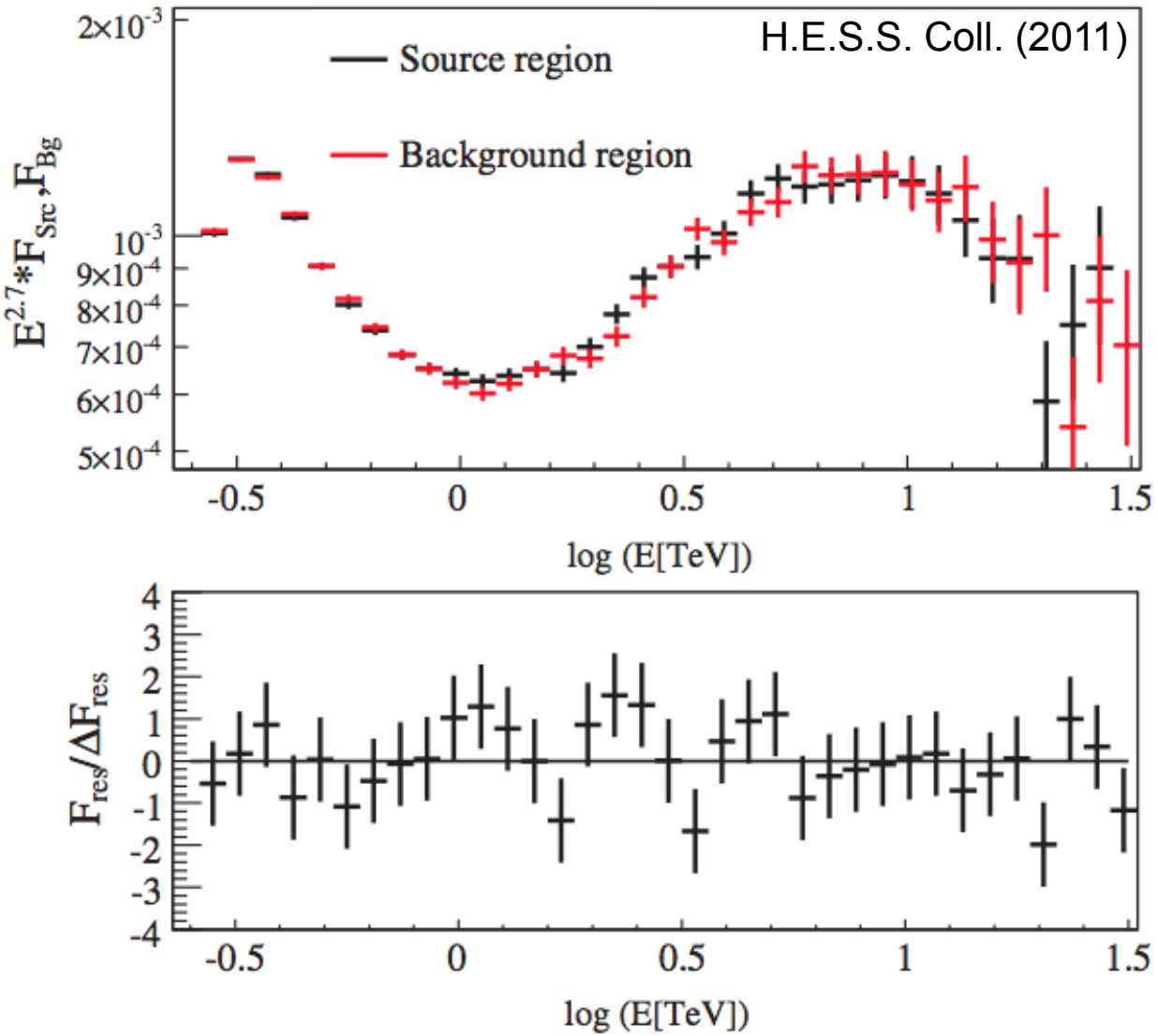

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