Michigan Technological University

A Survey of TeV emission from Galactic Supernova Remnants with HAWC

Henrike Fleischhack
Michigan Technological University
for the HAWC Collaboration

36th ICRC, July 25, 2019

HAWC
High Altitude Water Cherenkov
Gamma-Ray Observatory

NSF

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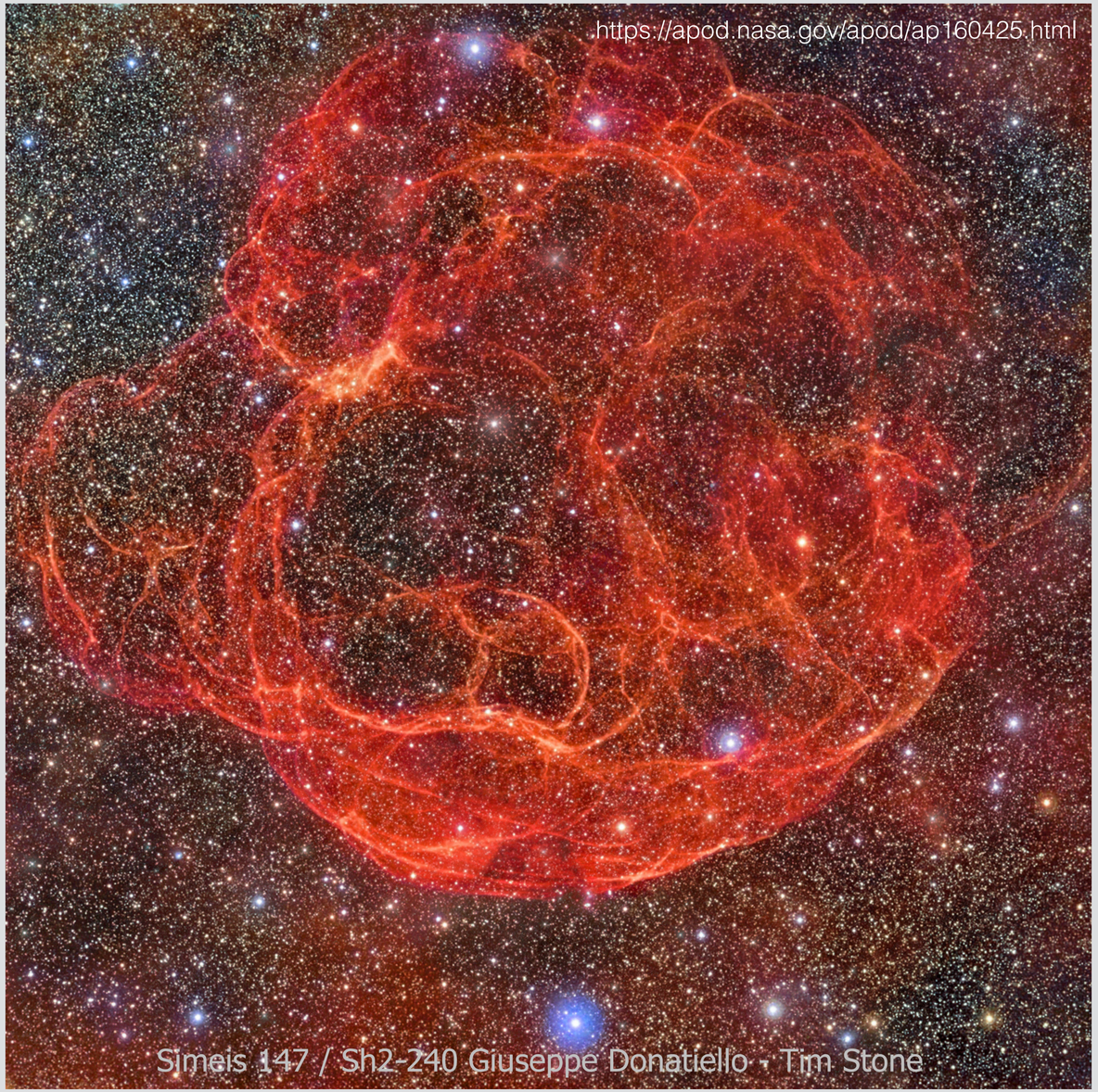
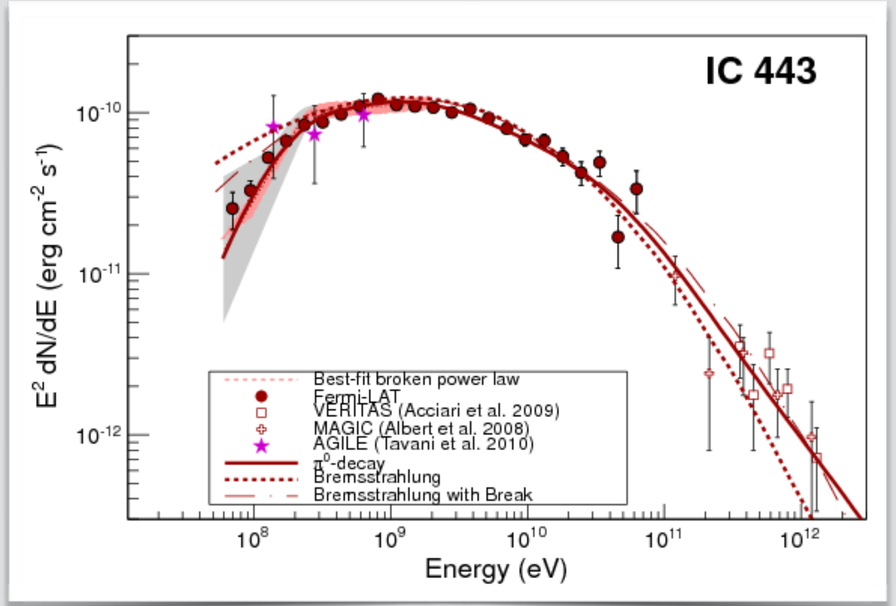
Particle Acceleration in Supernova Remnants

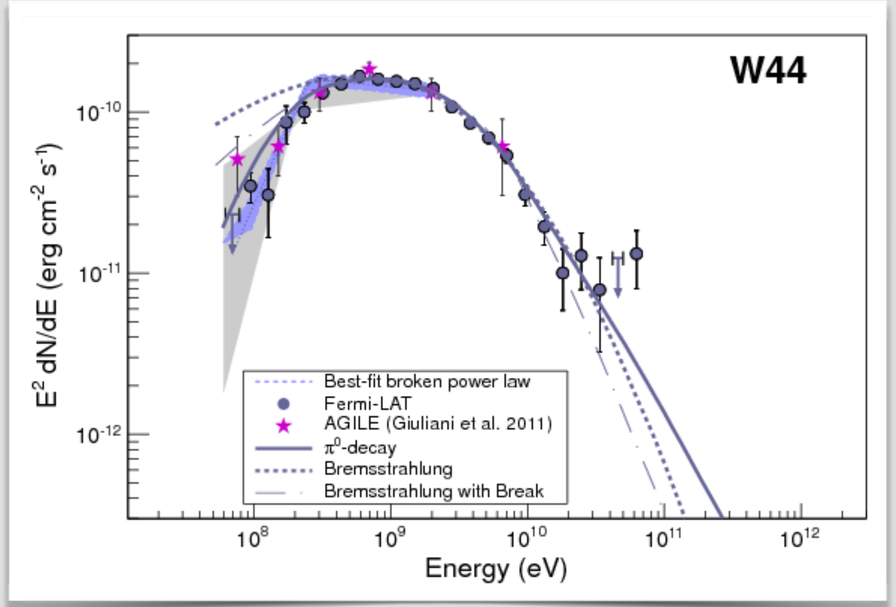
- Shock front as SN ejecta interact with stellar winds and ISM.
- Efficient particle acceleration.
- Sufficient energy budget to produce bulk of Galactic CRs.



SNRs as Sources of Cosmic Rays

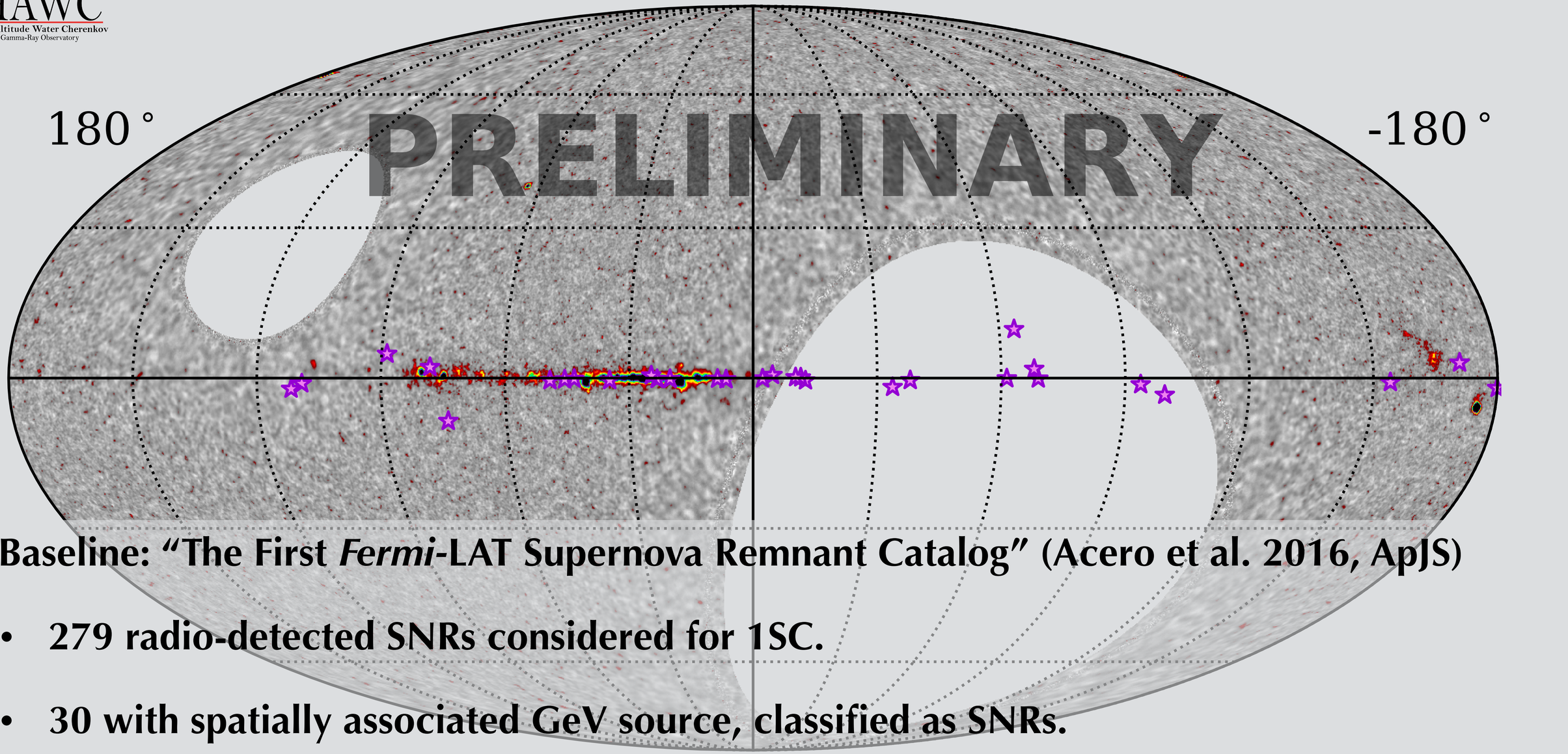
- So far, two SNRs are known to emit gamma rays dominantly produced by hadronic processes.
- Do all SNRs accelerate protons/nuclei? How efficiently?
- Maximum acceleration energy?
- Need spectral coverage from ~100 MeV to ~10 TeV or more.





Ackermann et al., Science 339 (2013) 807

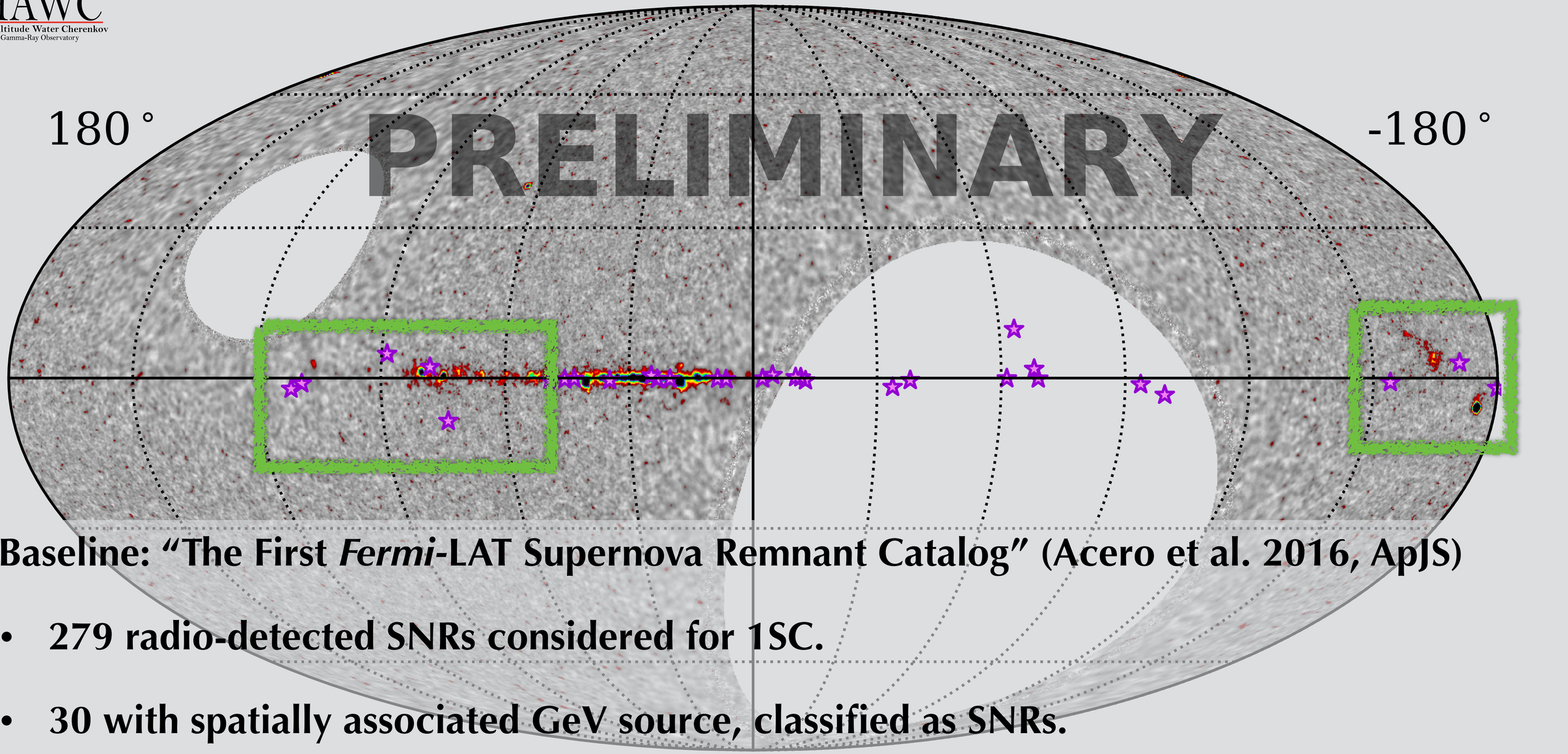
GeV-detected SNRs



Baseline: "The First *Fermi*-LAT Supernova Remnant Catalog" (Acero et al. 2016, ApJS)

- **279 radio-detected SNRs considered for 1SC.**
- **30 with spatially associated GeV source, classified as SNRs.**

GeV-detected SNRs



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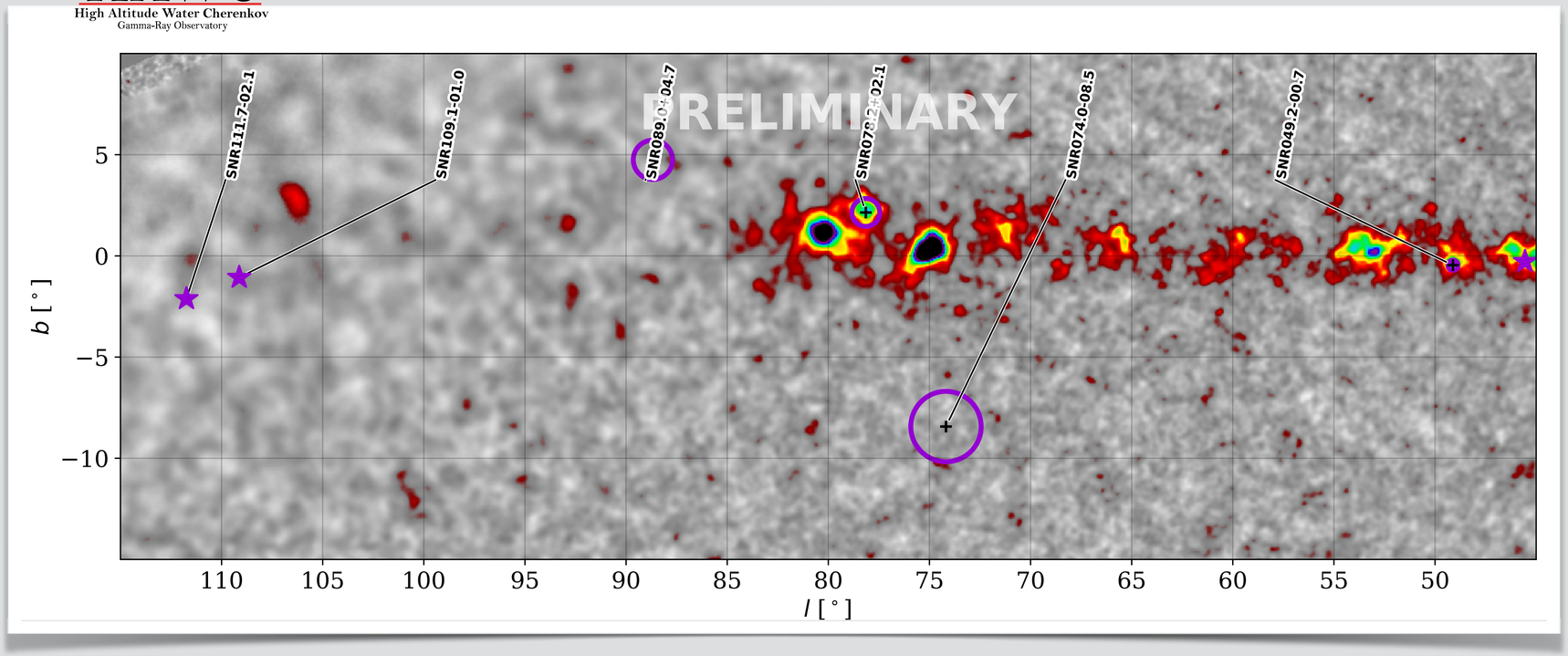
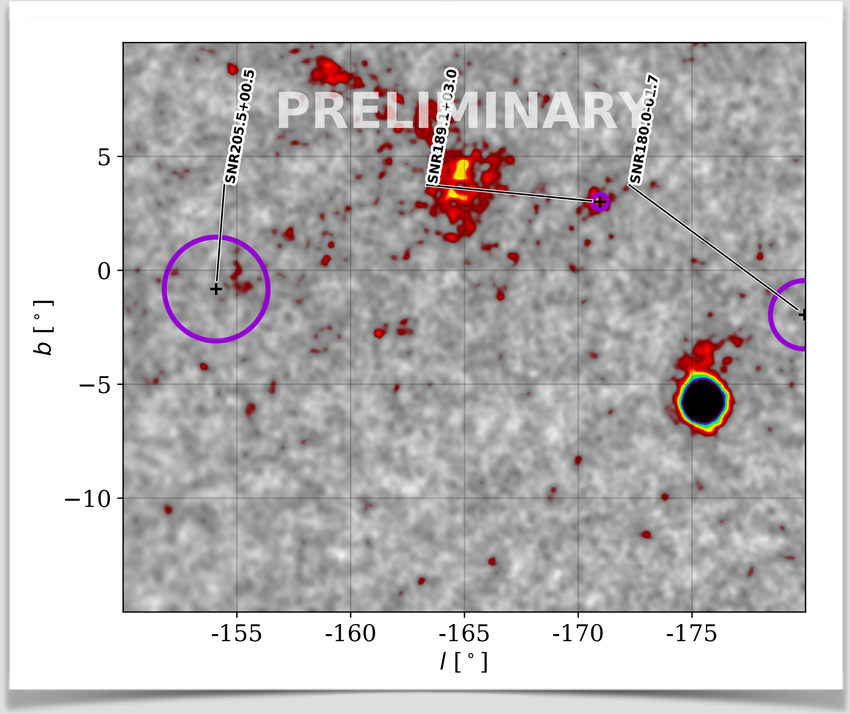
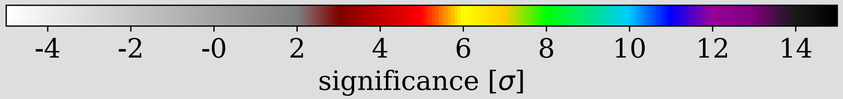
Source Selection







Baseline: "The First *Fermi*-LAT Supernova Remnant Catalog" (Acero et al. 2016, ApJS)

- **17 SNRs in HAWC's field of view.**
- **9 in (relatively) isolated regions.**

Results

Name	GeV Radius	TeV association (TeVCat)	isolated	HAWC detection
SNR049.2-00.7	0.25°	W51 C	yes	
SNR074.0-08.5	1.74°		yes	
SNR078.2+02.1	0.69°	γ Cygni	no*	
SNR089.0+04.7	0.97°		yes	
SNR109.1-01.0	—		yes	
SNR111.7-02.1	—	TeV J2323+588 (Cas A)	yes	
SNR180.0-01.7	1.5°		yes	
SNR189.1+03.0	0.33°	IC 443	yes	
SNR205.5+00.5	2.28°		no*	

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SNR189.1+03.0	**0.33°**	**IC 443**	**yes**	**yes**
SNR205.5+00.5	2.28°		no*	no

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SNR205.5+00.5	2.28°		no*	no

MW modeling

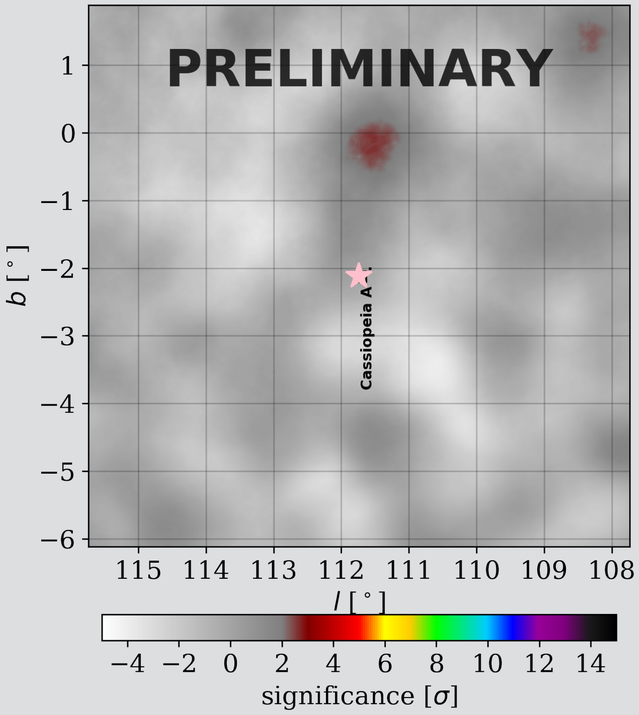
constraining upper limits

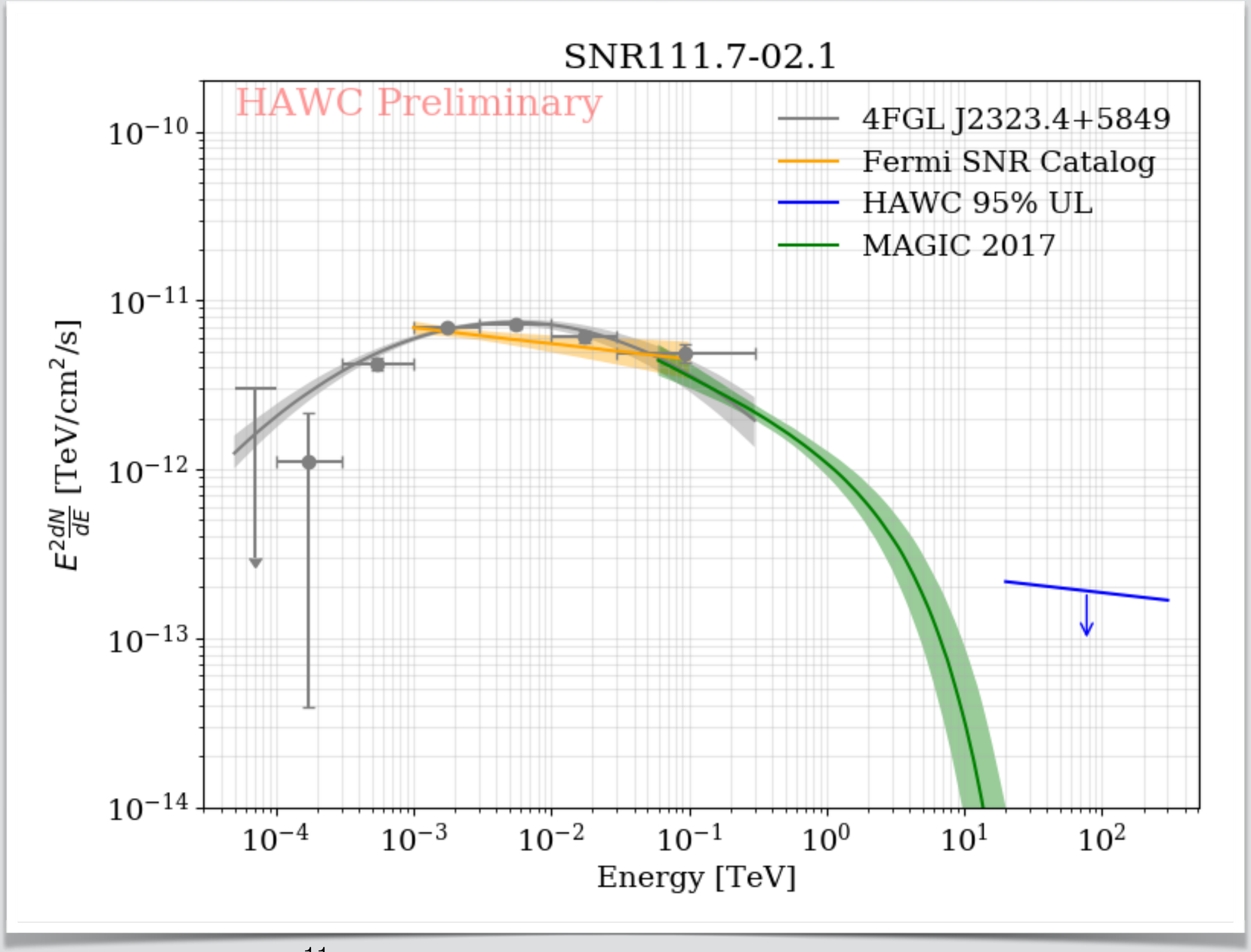
SNR 111.7-02.1 (Cas A)

Age: ~340 yr

Distance: ~3.4 kpc

GeV index: -2.09±0.07





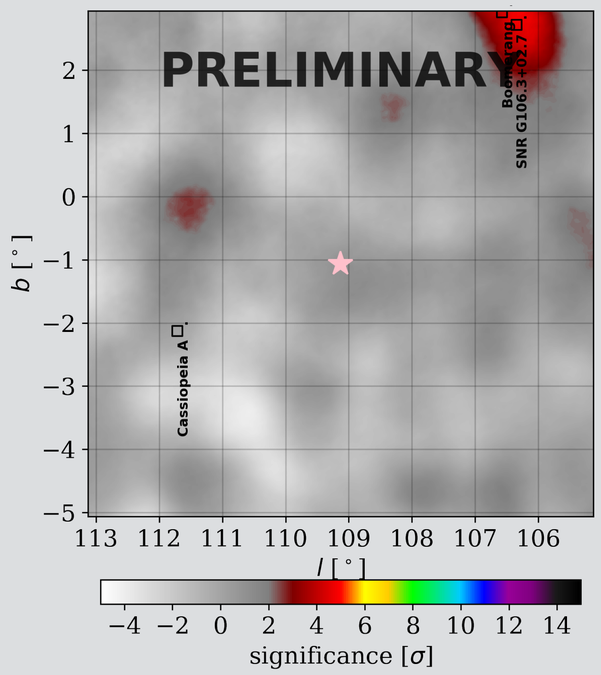
http://www.physics.umanitoba.ca/snr/SNRcat/SNRrecord.php?id=G111.7m02.1

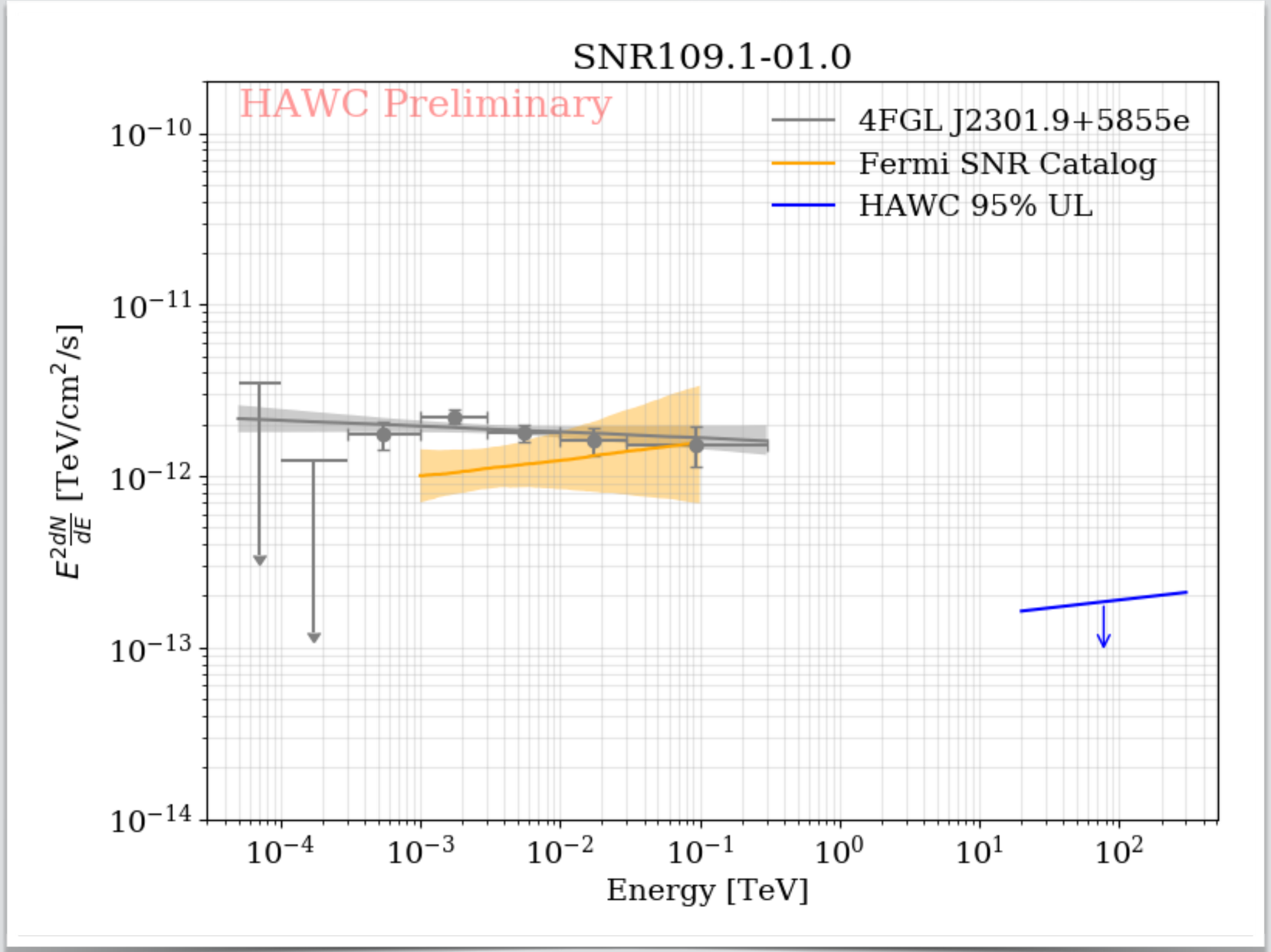
SNR 109.1-01.0

Age: ~10 kyr

Distance: ~3 kpc

GeV index: 1.91±0.21





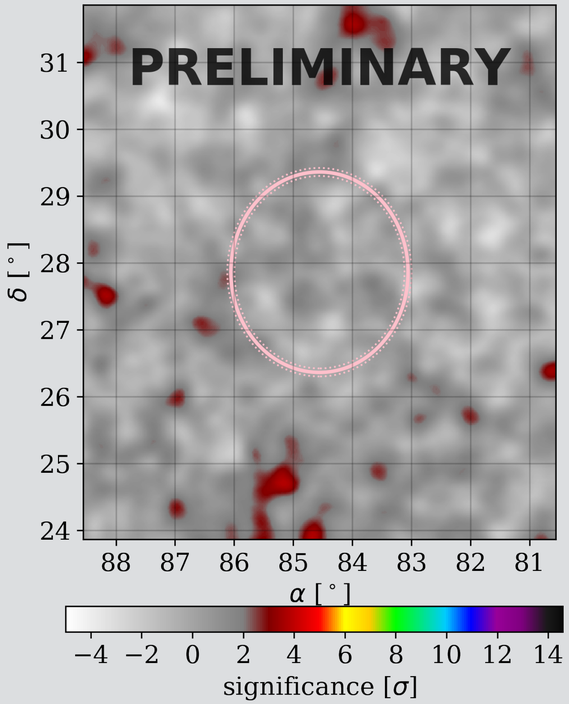
http://www.physics.umanitoba.ca/snr/SNRcat/SNRrecord.php?id=G109.1m01.0

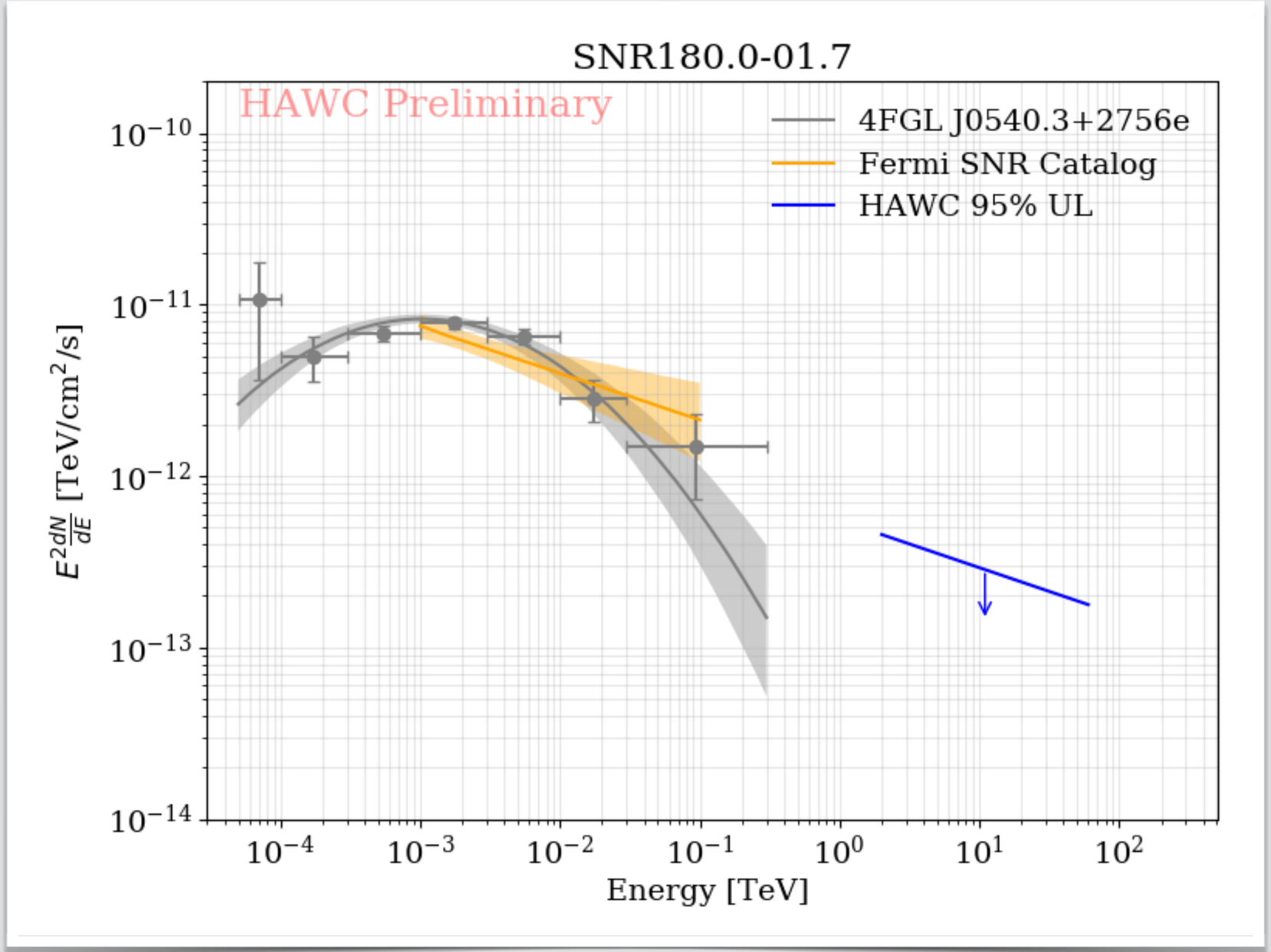
SNR 180.0-01.7

Age: ~30 kyr

Distance: ~1.3 kpc

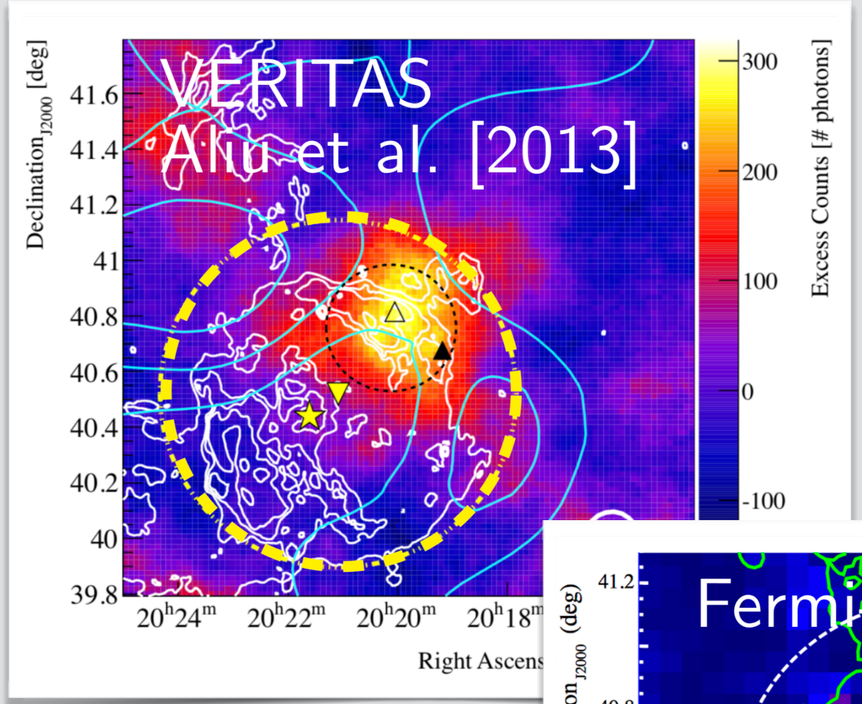
GeV index: 2.28±0.13

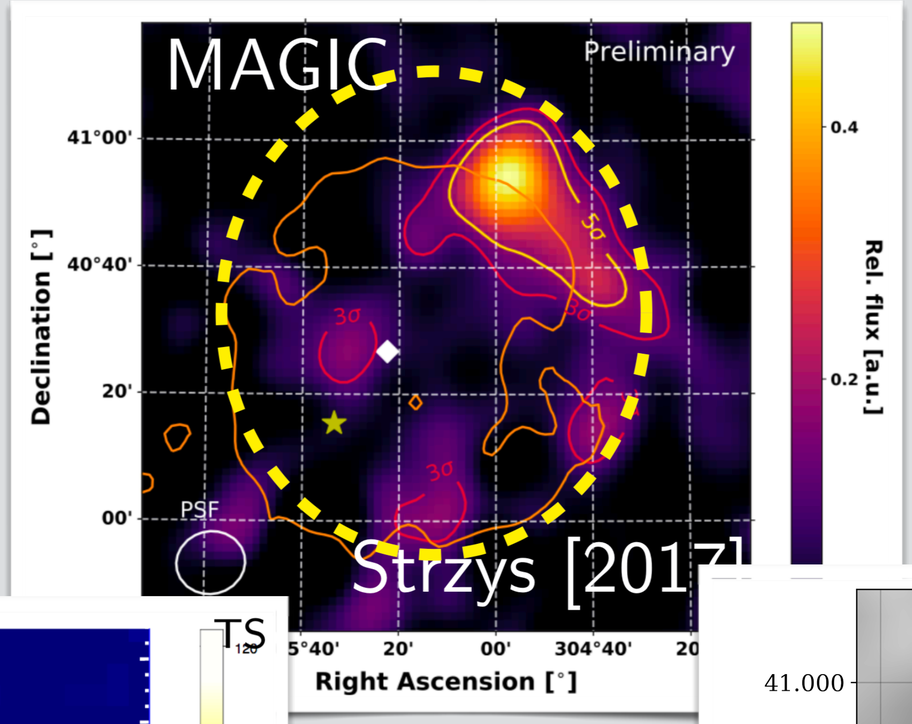


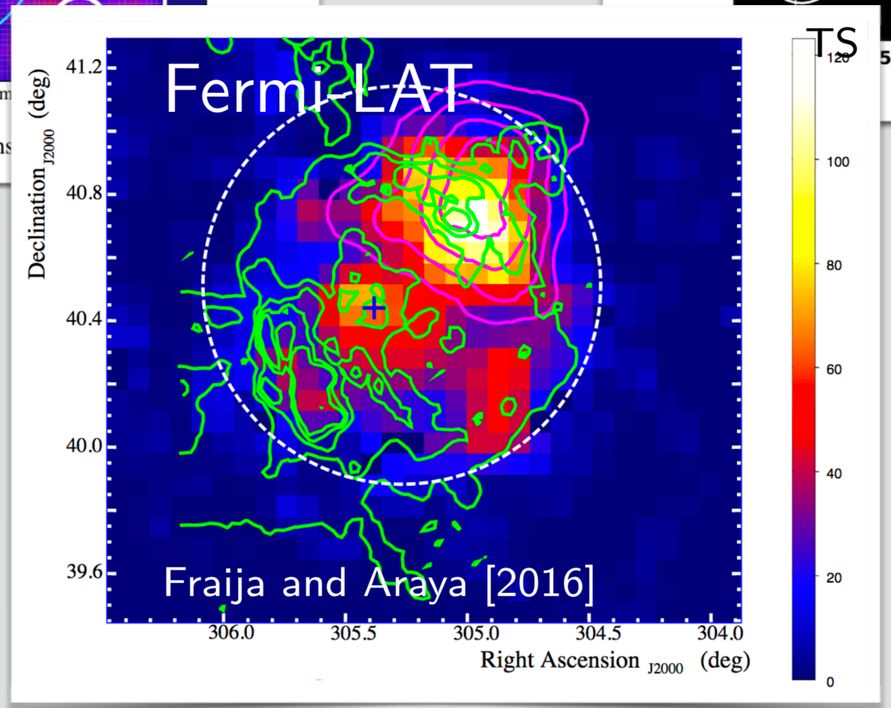


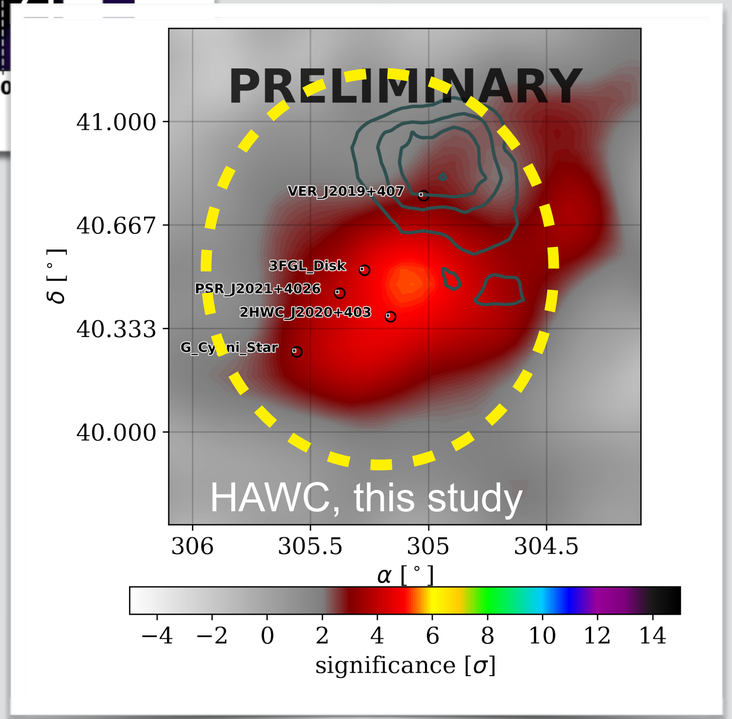
http://www.physics.umanitoba.ca/snr/SNRcat/SNRrecord.php?id=G180.0m01.7

Morphology: γ Cygni SNR



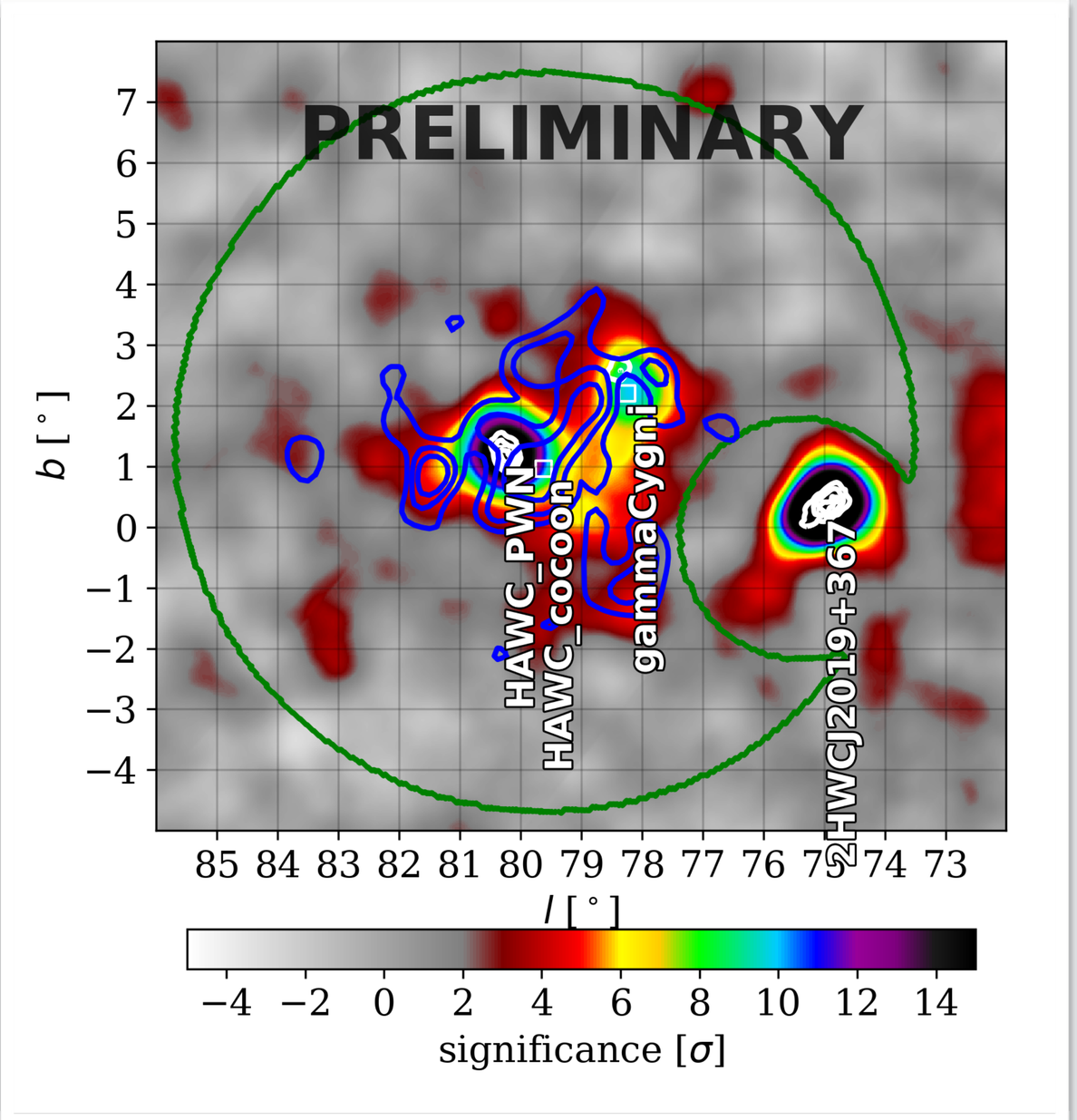




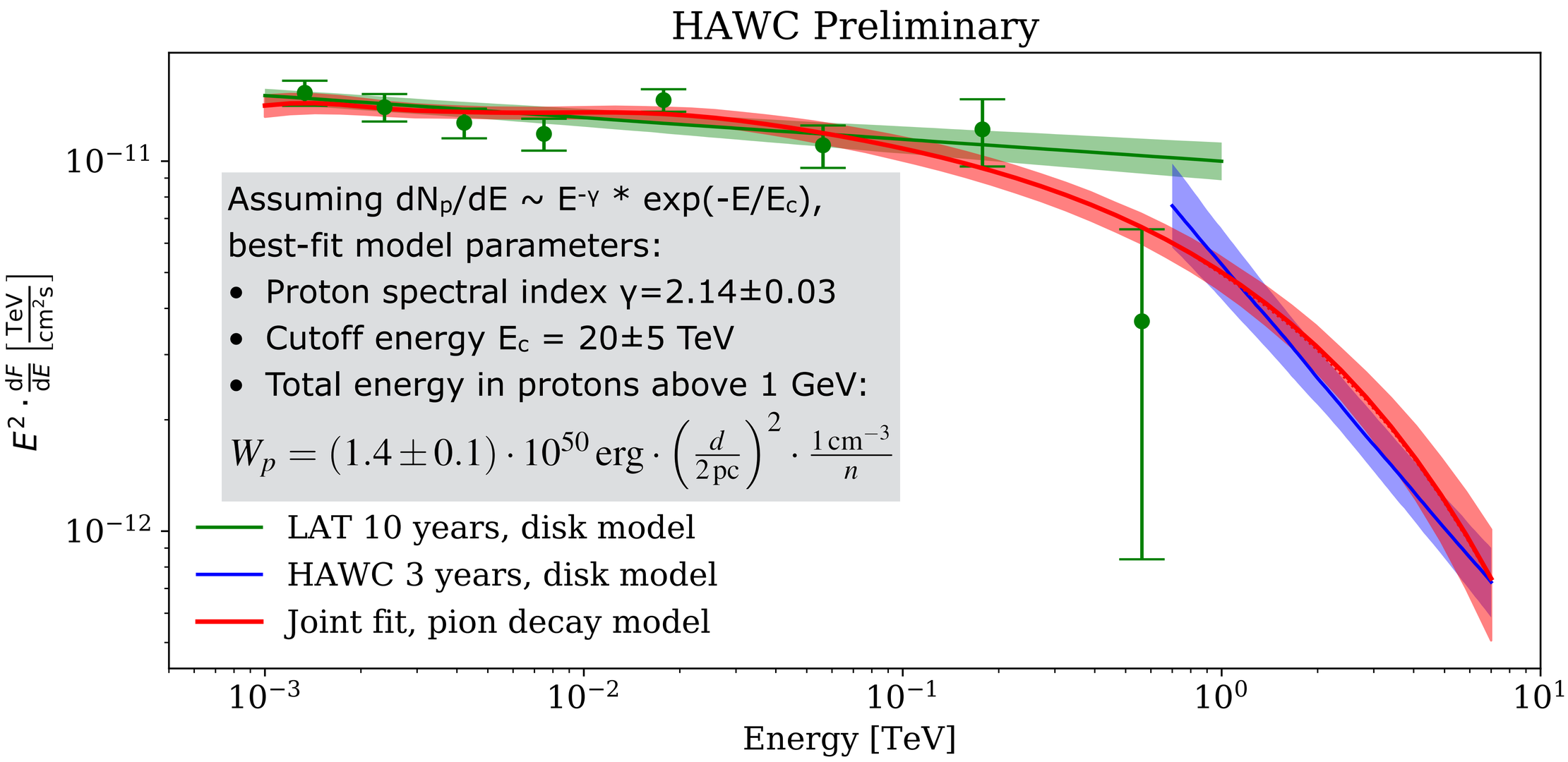


HAWC Analysis: γ Cygni SNR

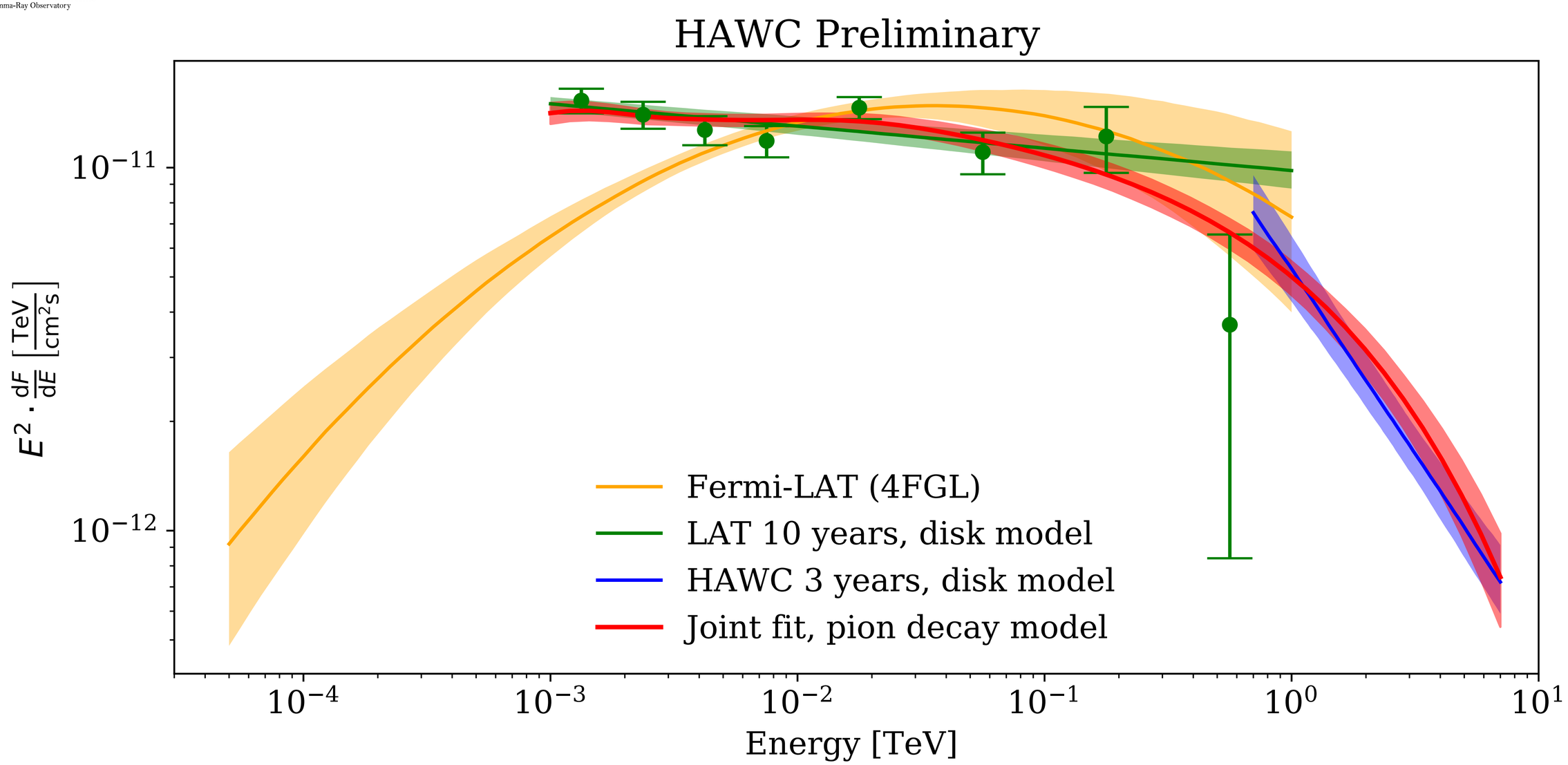
- Cygnus Cocoon region.
- Multiple overlapping sources.
- More details on multi-source analysis:
  - B. Hona, GA-I 7d (7/29, 5:15 PM, here)
  - H. Fleischhack, PS1-64 (Tripp Commons, 2nd floor).



Hadronic Modeling: γ Cygni SNR



Update with 4FGL…



Conclusions

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- Searched for TeV gamma-ray emission from GeV-detected SNRs.
- Detected three SNRs, upper limits placed for the remaining six.
- For three detected and three non-detected SNRs, HAWC measurements or upper limits imply break or cutoff in the gamma-ray spectrum.
- More detailed studies and modeling ongoing.

proceedings

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