



Fermi

Gamma-ray Space Telescope



Fermi-LAT Update

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Fermi User Group (FUG) meeting,
July 30, 2018

Overall Message

The LAT Collaboration is actively improving *improving* and *increasing interactions* between the science groups and public LAT data users to get the most out of the mission

**LAT Collaboration
Meeting and Status**

**LAT Collaboration
Response to March
16 event**

**Recent Science
Highlights**

Looking Forward

Collaboration Meeting: Pisa, Italy



12-16 March 2018: 103 registrants!

5 days: mix of plenary/splinter sessions
Plans for 10 year celebrations/symposium

Junior Lunch: ~20 attendees

Lots of good recommendations to
improve communication

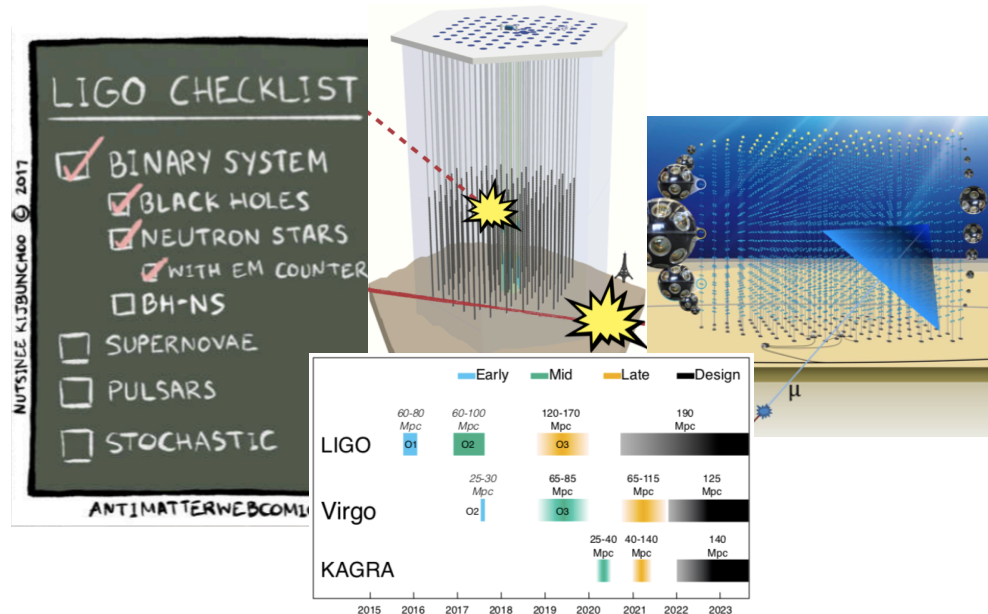
Continued tradition:

Open session (see next slide)

Next CM@GW before
Fermi Symposium

Open Session

- Talks from Collaborators:
 - IceCube, Km3NET, Virgo, GBM, GRAWITA, CTA, highlights on Novae, Open Universe, AGILE, Theory... and more
 - Theme: All the messengers! LAT is a key player



- Highlights from LAT Collaboration:
 - LAT Science, Building the collaboration and instruments, reflections on 10 years of the mission and 10 year celebration activities



Fermi-LAT Status

- The LAT continues to operate well with no degradations in science performance
 - photon database: 1,140,815,240 photons, collected between 2008-08-04 15:43:36 UTC and 2018-07-27 13:39:09 UTC
 - event database: 301,9314,260 events, collected between 2008-08-04 15:43:36 UTC and 2018-07-27 13:39:09 UTC
- The LAT Collaboration continues to provide excellent coverage for all LAT instrument operations and data processing/analysis needs
 - good coverage in all areas due to multitasking by many collaboration members
 - collaboration actively engaged in data quality monitoring;
 - key commitments from partners for extended operations remain firm

LAT Collaboration response to 16 March Event

The Calibration and Analysis group led the validation effort:

On April 9 we had an important C&A meeting with reports from TKR, CAL, ACD, DQM experts and with analyses on Vela and 3C279.

More details are reported at the following confluence pages:

- TKR: <https://confluence.slac.stanford.edu/pages/viewpage.action?pagelId=233313436>
- CAL: <https://confluence.slac.stanford.edu/pages/viewpage.action?pagelId=233313441>
- ACD: <https://confluence.slac.stanford.edu/pages/viewpage.action?pagelId=233313444>
- DQM: <https://confluence.slac.stanford.edu/pages/viewpage.action?pagelId=233313453>
- Analyses of Vela: <https://confluence.slac.stanford.edu/display/SCIGRPS/2018/04/09/Vela+after+LAT+reactivation>
- Analysis of 3C279: <https://confluence.slac.stanford.edu/display/SCIGRPS/2018/04/09/3C+279+after+LAT+reactivation>
- Comparison of a few variables: <https://confluence.slac.stanford.edu/pages/viewpage.action?pagelId=233314230>

Summary

A great work has been done by the LAT restart team to make checks on the different subsystems:

The safemod lasted 17 days and 8 hours.

The TKR, CAL, ACD are working at nominal values.

The DQM confirms this.

The Science cases for Vela flux and timing and 3C279 also confirm the LAT performance has not changed

We are therefore ready to make again exciting science with the LAT.



April 9

Science Highlights

Publications from LAT Team

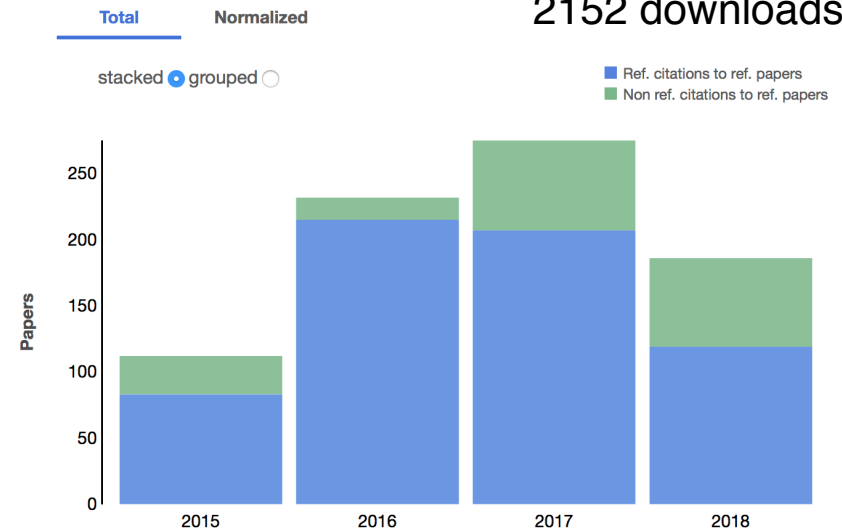
Summary of Fermi LAT science publications

27 July 2018

Category I and II papers in refereed journals

Journal	Published	In press	Total
Advances in Space Research	0+1=1	-	1
Astronomy and Astrophysics	8+69=77	0+6=6	83
Astroparticle Physics	2+6=8	-	8
Astrophysical Journal	102+125=227	0+5=5	232
Astrophysical Journal Letters	33+36=69	-	69
Astrophysical Journal Supplement	14+6=20	-	20
Astrophysics and Space Science	0+1=1	-	1
Journal of Cosmology and Astroparticle Physics	4+8=12	-	12
Journal of Geophysical Reserch	0+1=1	-	1
Monthly Notices of the RAS: Letters	0+2=2	-	2
Monthly Notices of the Royal Astronomical Society	0+55=55	0+1=1	56
Nature	2+1=3	-	3
Nature Physics	0+2=2	-	2
Nuclear Instruments and Methods	0+1=1	-	1
Physical Review D	11+8=19	-	19
Physical Review Letters	11+1=12	-	12
Physics Reports	0+1=1	-	1
Publ.Astron.Soc.Austral.	0+1=1	-	1
Publications of The Korean Astronomical Society	0+1=1	-	1
Publications of the ASJ	0+2=2	-	2
Science	21+0=21	1+0=1	22
Total	208+328=536	1+12=13	549

3FGL: 805 citations
4948 reads
2152 downloads



<http://fermi.gsfc.nasa.gov/ssc/library/pubs/>

R. <http://www-glast.stanford.edu/cgi-bin/pubpub>

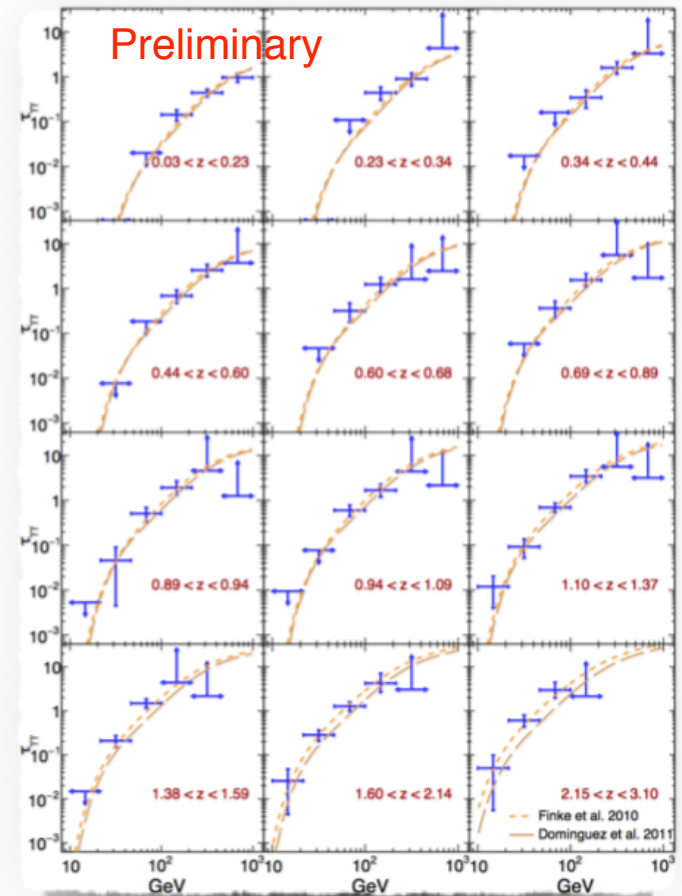
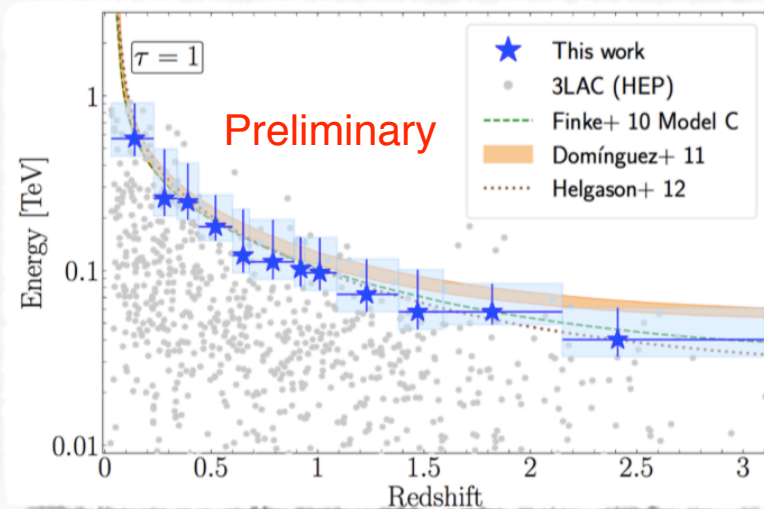
Published Specialized LAT Catalogs

- Specialized catalogs produced by LAT Team (past 2 years)
 - High-Latitude Extended Sources (FHES), ApJ, 2018
 - Novae Catalog, A&A, 2018
 - 3FHL, ApJS, 2017
 - 2FAV Catalog of flaring Sources, ApJ, 2017
 - Galactic Plane Extended Sources (FGES), ApJ, 2017

Star formation history of the Universe using EBL measurements

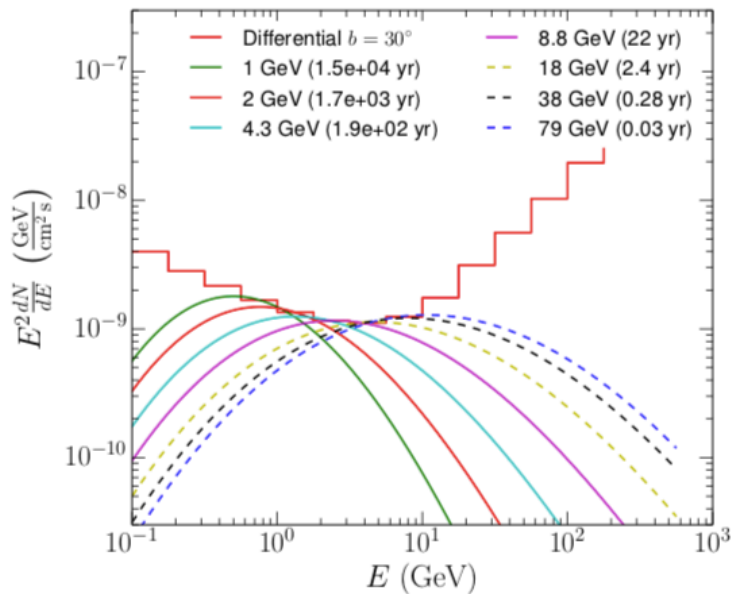
- Measure the attenuation due to the EBL as a function of energy at 12 redshifts
- Translate the attenuation measurement into measurements of the EBL and cosmic emissivity
- Derive the star-formation history of the Universe
- Place an upper limit to the cut-off luminosity of the galaxy UV luminosity function

Cosmic gamma-ray horizon

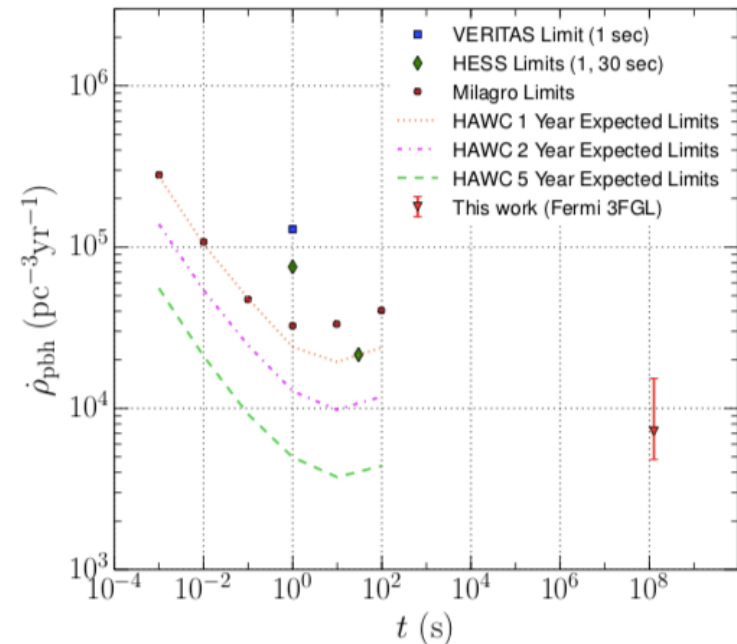


First reviews back from Science

Search for Gamma-ray Emission from Local Primordial Black Holes with the Fermi Large Area Telescope



PBH spectra (Hawking radiation) compared with 3FGL sensitivity - Dashed lines, shorter than Fermi mission time

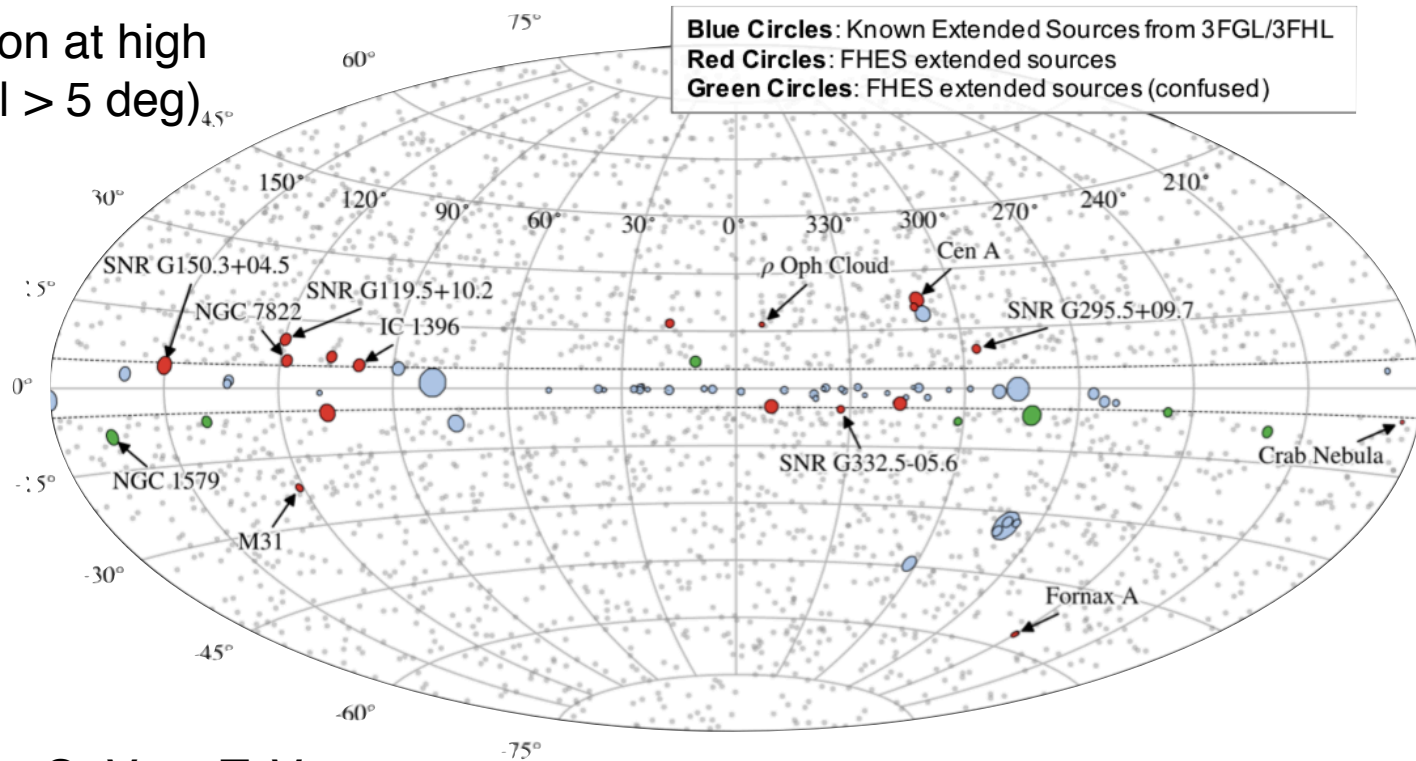


Limits on PBH evaporation rate in a new part of parameter space

Published ApJ

Fermi High Latitude Extended Source Catalog

FHES: search for sources with angular extension at high Galactic Latitude ($|b| > 5$ deg)



7.5 years, P8 data, 1 GeV - 1 TeV

24 extended sources: 5 known vs 19 new

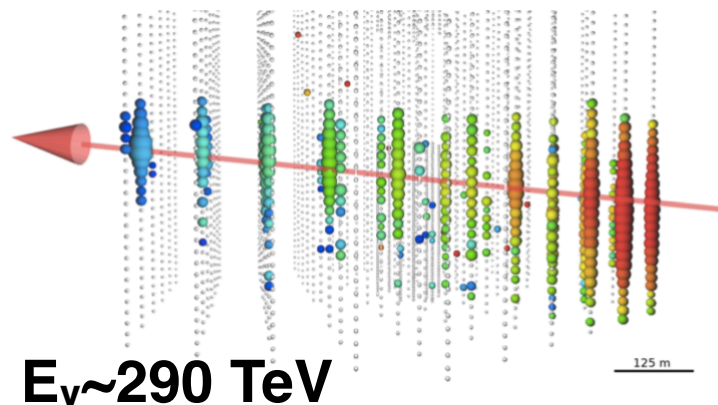
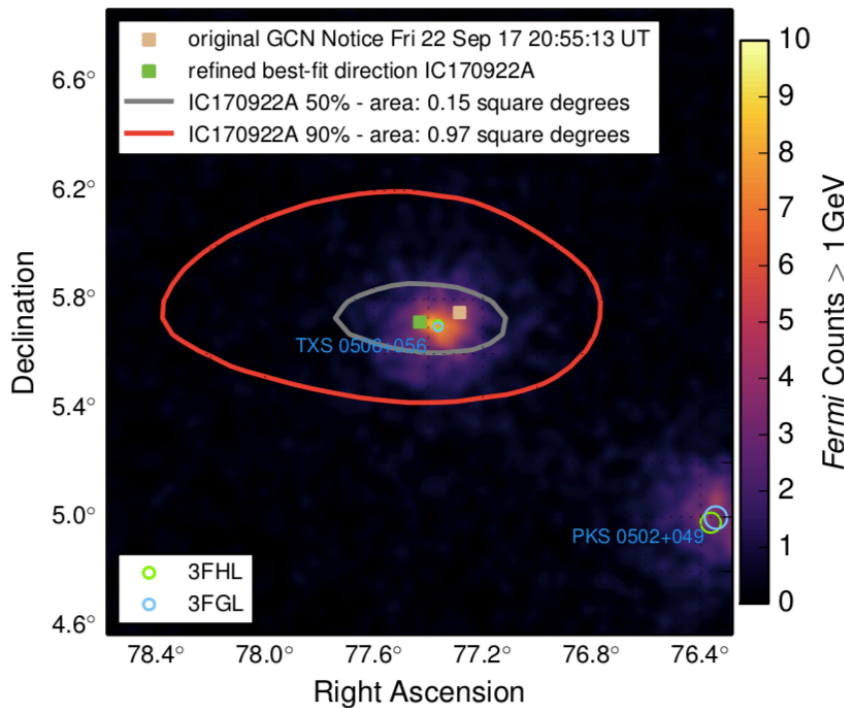
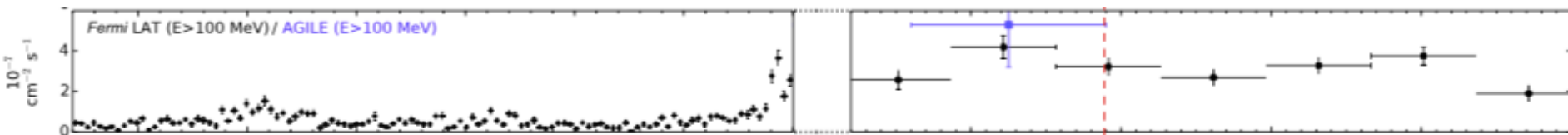
19 new sources:

8 associated, 4 unassociated, 7 confused

Accepted by ApJ

A Gamma-ray Blazar Candidate Origin of a Cosmic Neutrino

A flaring γ -ray blazar TXS 0506+056 and IC-170922A



Published in Science
Lots of press activity

Looking Forward

Plans For the Fermi Symposium

Catalogs in the pipeline:

4FGL, 4LAC, GRB, Solar Flare, Transient,
3rd Pulsar

Selected Analyses:

Instrument performance after 10 years

Gamma-ray polarization

Flare Properties of bright FSRQs, Misaligned AGNs

Joint Fermi/MAGIC/Veritas on 2HWC Sources

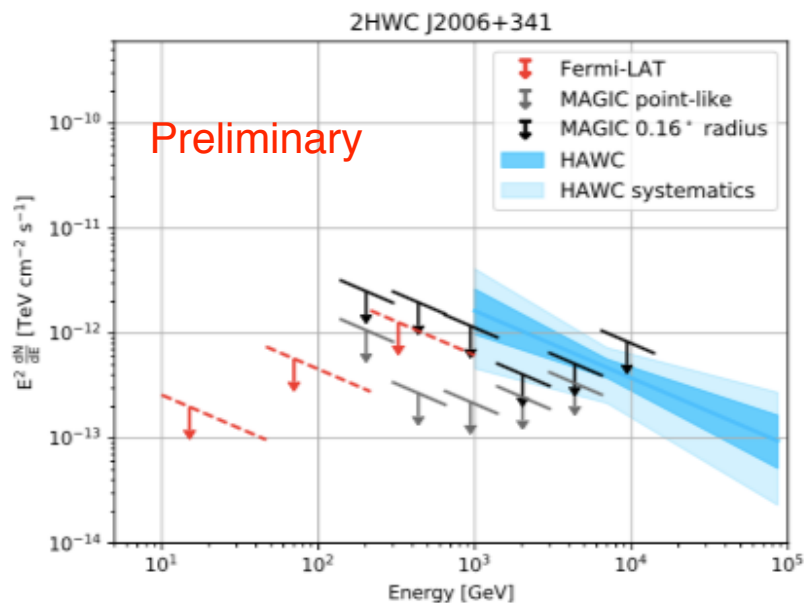
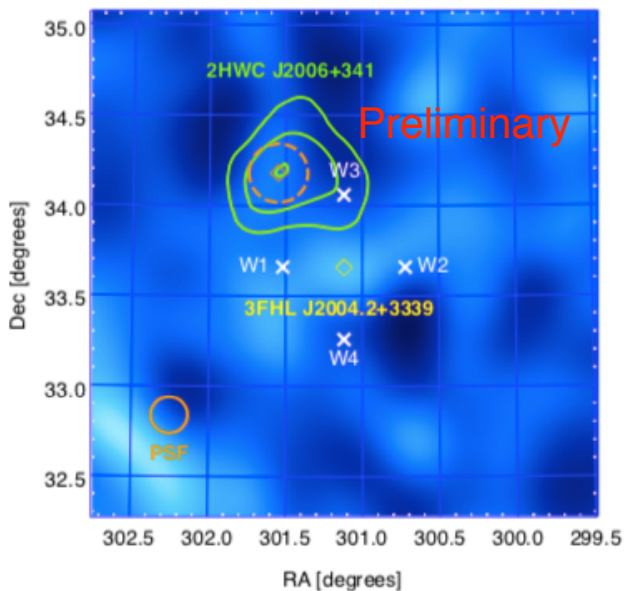
Pass 8 Interstellar Emission, All sky Fermi/Planck
comparison IEM in the Galactic plane

DM from UNID sources, Quiet Sun... many many more

4FGL and Interstellar Emission Model Status

- The Takeaway: Switching to higher resolution data sets was more challenging than previously expected. We're now at a level that we were at with previous IEM
- We're aware that this is overdue... many people focusing on this task
- Updates/Challenges
 - Improved DNM from Planck (has been completely redone)
 - Planck: 2 maps for the column density estimate, radiance and extinction.
 - Both estimates provide a non-linear estimate of the column density map.
 - The methods for determining extinction have been updated from the SFD map and the non-linear relations have thus changed.
 - Getting the DNM right requires iterations between dust and gamma-ray modeling and is therefore a very time consuming task.
 - HI4PI (All sky database of galactic HI) also more time consuming
 - Lower energies included (down to 50 MeV)
 - Many more point sources (>6000)
 - Analysis split in regions to break degeneracies between diffuse components
 - Coordination with many experts
 - Handling of energy dispersion is explicit
- 4FGL is ready to start running once this is complete

Joint Fermi/MAGIC/Veritas on 2HWC Sources



One example: 2HWC 2006+341

Detected by HAWC @ $\sim 6\sigma$, spectral parameters taken from 2HWC
 closest Fermi-LAT source is 3FHL J2004.2+3339 (searched for
 pulsations (Clark et al. 2017), none found), area observed by MAGIC

Analysis Tools

Fermipy - an open-source python framework that facilitates analysis of data collected by the Fermi Large Area Telescope (LAT)

- built on the Fermi Science Tools
- Supported by a team within the LAT collaboration (questions submitted via git)
- high-level interface for analyzing LAT data in a simple and reproducible way.
- Methods include:
 - extracting spectral energy distributions and lightcurves, generating test statistic maps, finding new source candidates, and fitting source position and extension...

The LAT team is working to a **new event selection which efficiently removes residual CR background:**

- heavy ion and ribbon cuts remove the non-isotropic bkg above 100 MeV
- This cleaner event class should replace the current SOURCE class
- Makes SOURCE class as clean as ULTRACLEAN VETO

Fermi@10: Fermi-LAT in the next 10 years

The Future is transients (multi-messenger/wavelength sky)

Fermi-LAT has a key role in MM/MW observations, supporting:

- IceCube, LIGO/Virgo, JWST, CTA, SKA, LSST, ...

Flare advocate and Burst/GW advocate are critical to our success in the time domain era

- We've always been in the transient business

Many new exciting results for the Fermi Symposium in October (Baltimore)

- Next Collaboration meeting right before the symposium

Summary

- The collaboration continues to release quality products to the community
 - Expect new products coming out from the LAT team and released via the FSSC including new catalogs, new software, and new alerts
 - New data selection to the community
- Fermi-LAT has a critical role in the future of MM/MW astrophysics