CALET Gamma-ray Observations above 1 GeV and Sensitivity Improvements above 100 GeV

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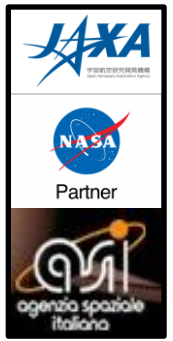
For the CALET Collaboration

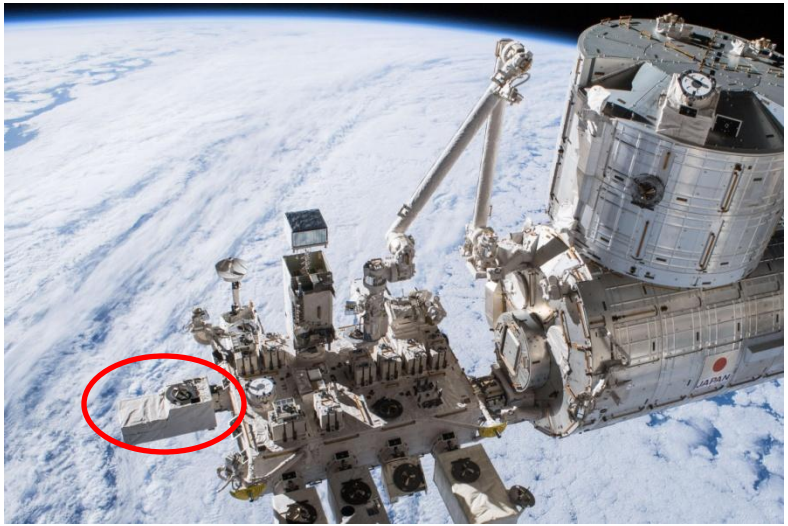
July 23, 2022 – COSPAR (Athina, Greece)



Calorimetric Electron Telescope

CALET is an ISS-borne astroparticle physics observatory, sensitive to

- Electrons from 1 GeV – 20 TeV
- Photons from 1 GeV – 1 TeV
- Hadrons up to 1 PeV total energy



Calorimetric Electron Telescope

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- Electrons from 1 GeV – 20 TeV
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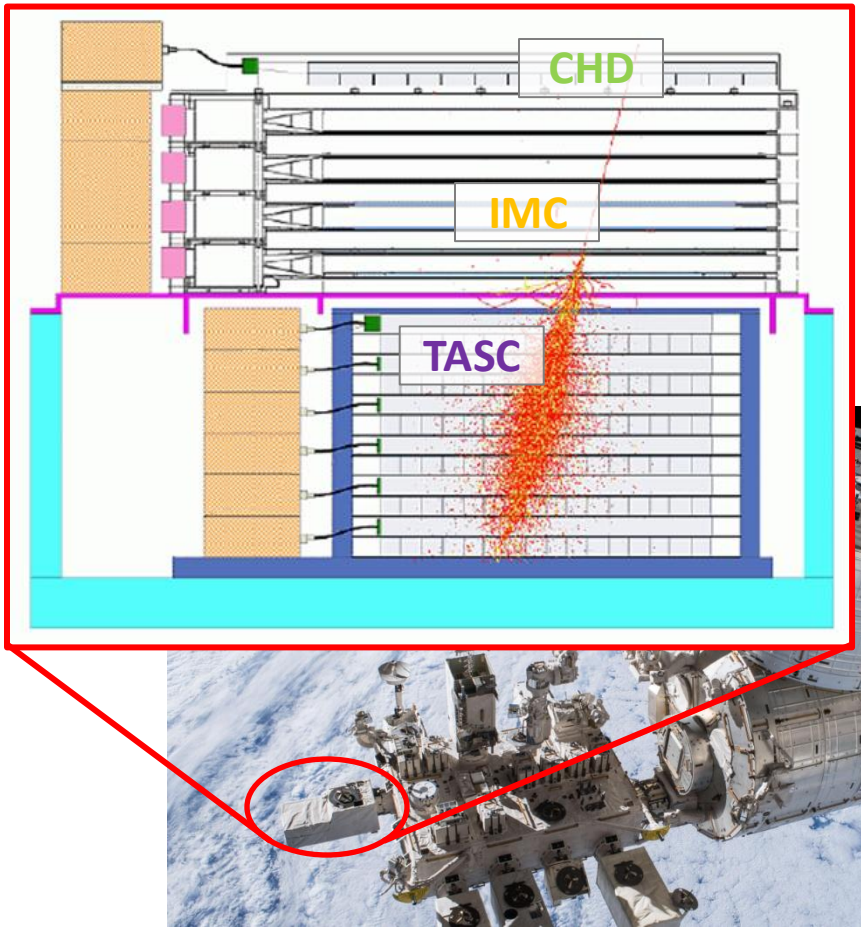
- Hadrons up to 1 PeV total energy

Three detector subsystems:

- **CHD: Charge Detector**
  2x14 plastic scintillating paddles
- **IMC: Imaging Calorimeter**
  2x8x448 plastic scintillating fibers & W sheets
  Shower development and imaging
- **TASC: Total Absorption Calorimeter**
  2x6x16 $PbWO_4$ scintillating logs
  Deep (27 X_0) electromagnetic calorimeter



CALET Gamma-ray Analysis Overview

Observations with high-energy (HE) trigger are always active (E > ~10 GeV)

Observations with low-energy gamma (LEG) trigger are active at low geomagnetic latitudes (E > ~1 GeV)

Trigger of CGBM instrument prompts CALET to temporarily activate LEG mode to search for transient counterparts

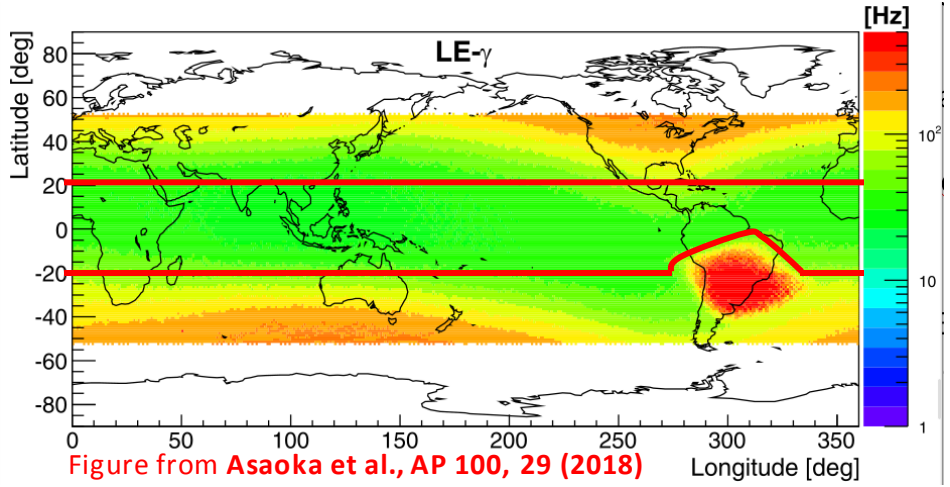
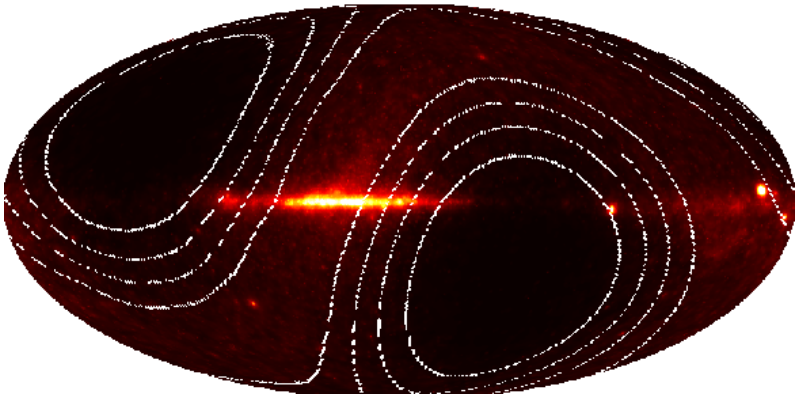


Figure from **Asaoka et al., AP 100, 29 (2018)**



CALET Transient Follow-ups

Trigger of CGBM instrument prompts CALET to temporarily activate LEG mode to search for transient counterparts

Transient analysis pipeline allows for quick follow-up of GRBs or LIGO/Virgo GW triggers

Observations corresponding to triggers in LIGO/Virgo O3 run recently published in **Adriani et al., ApJ 933 85 (2022).**

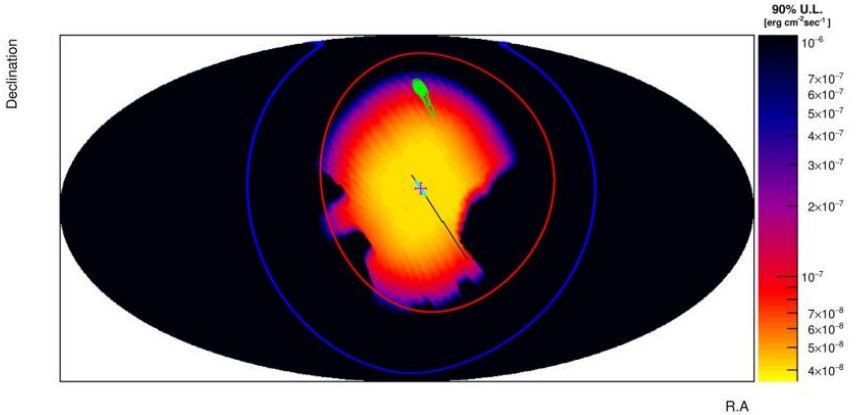


Figure 10. 90% confidence level upper limits observed by CAL in the energy range 1–10 GeV during the interval ±60 s around the time of GW190408an reported by LIGO/Virgo. The intensity scale is given in units of erg cm^{-2} s^{-1}. Red and blue circles are the HXM and SGM fields of view, respectively.

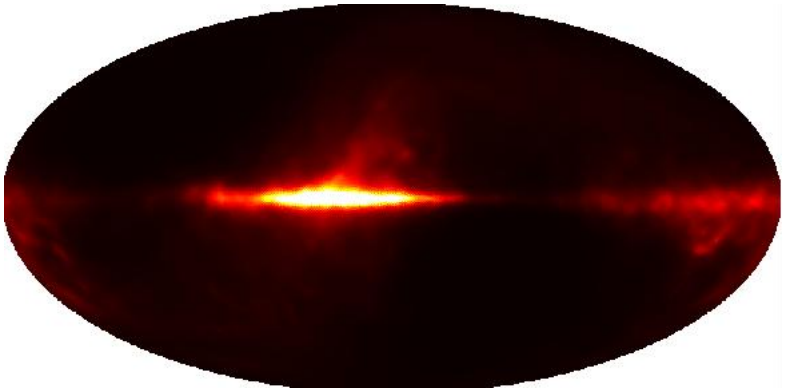
CALET Gamma-ray Skymaps (11/2015 – 02/2022)

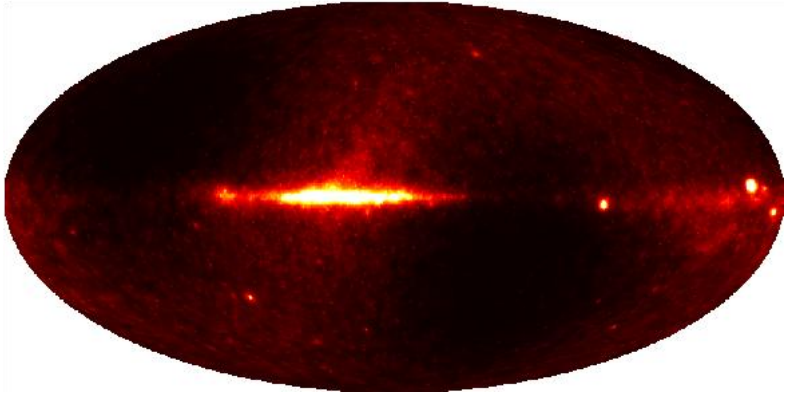
Galactic diffuse model w/ exposure

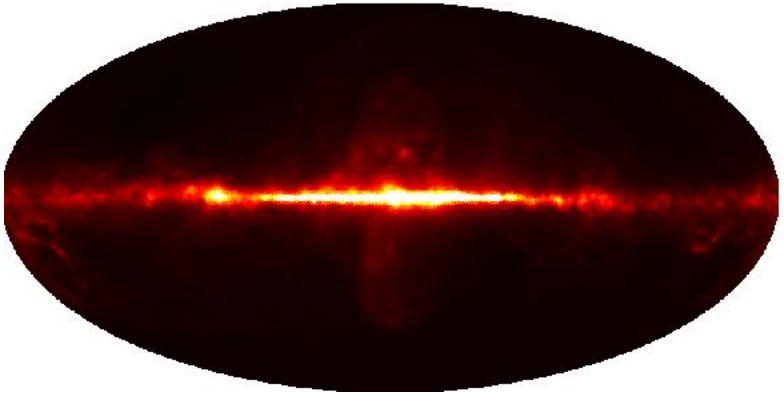
Observations

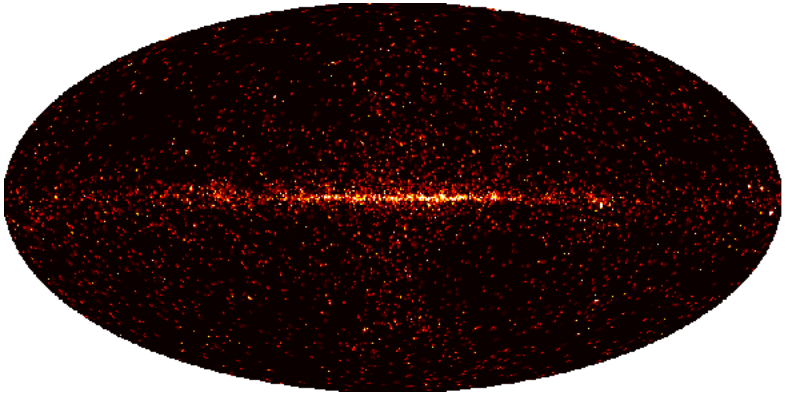
LE-gamma

HE

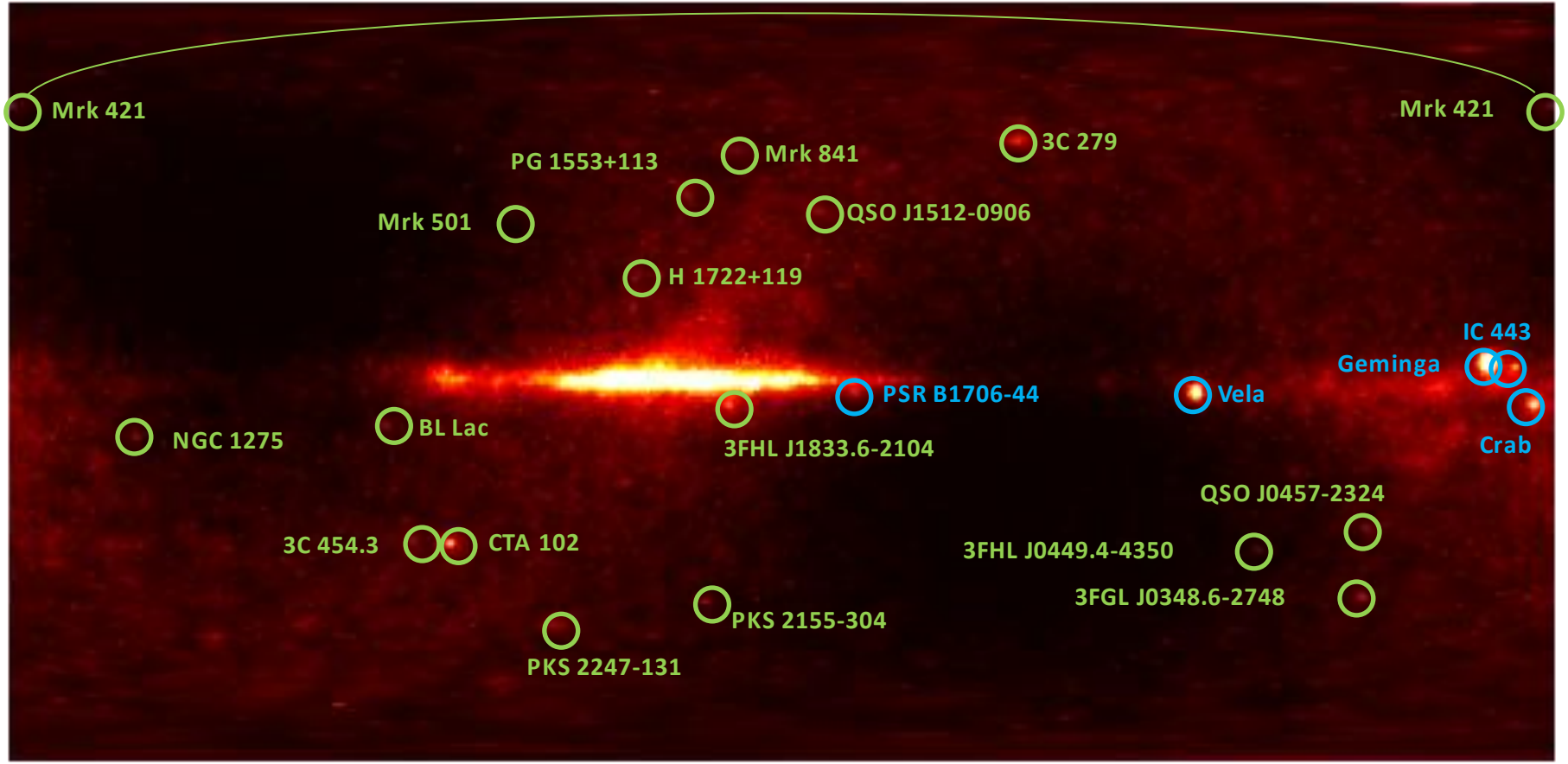








Sources detected >1 GeV (11/2015 – 02/2022)



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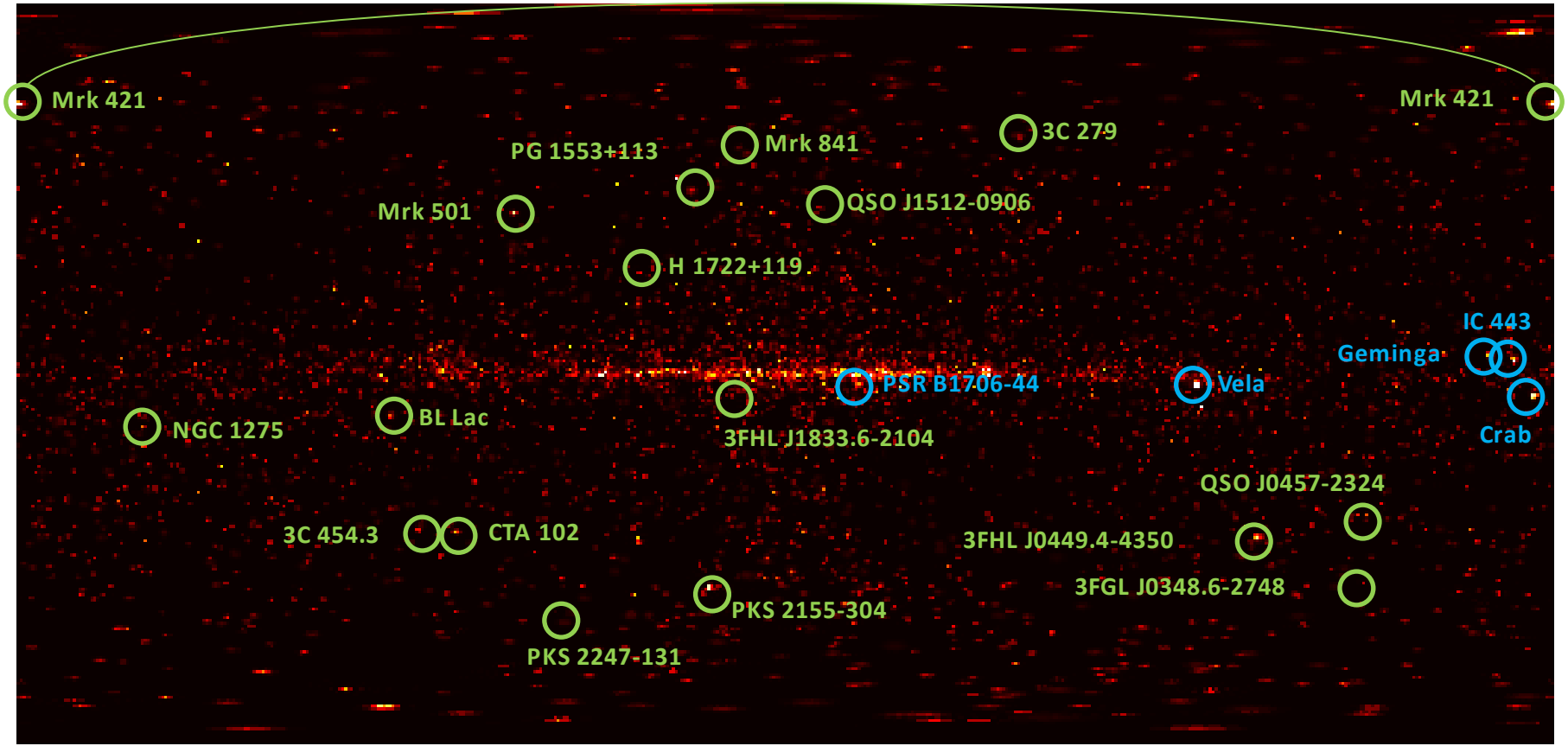
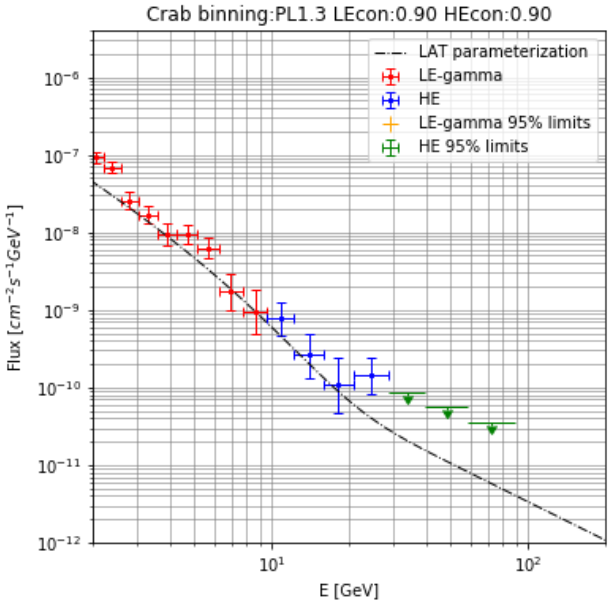
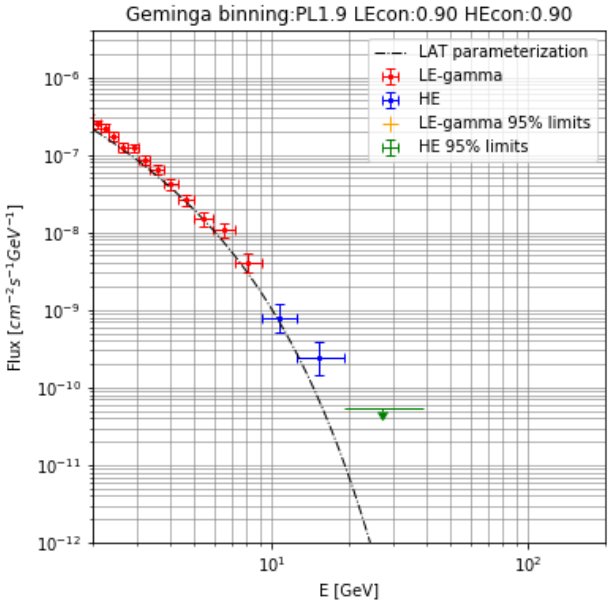
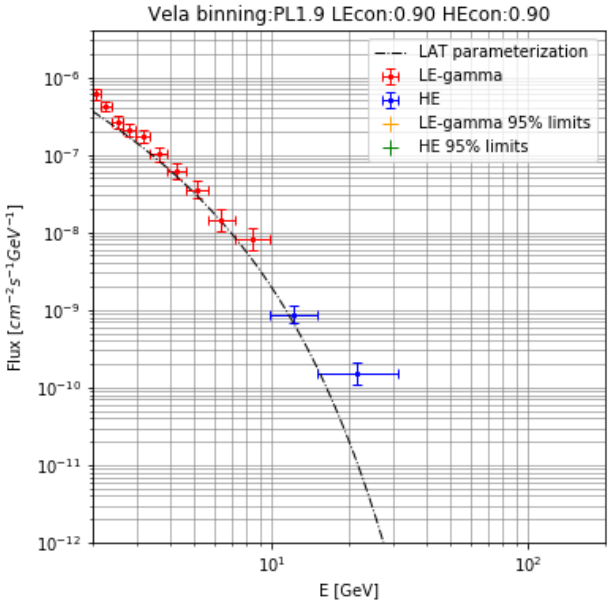


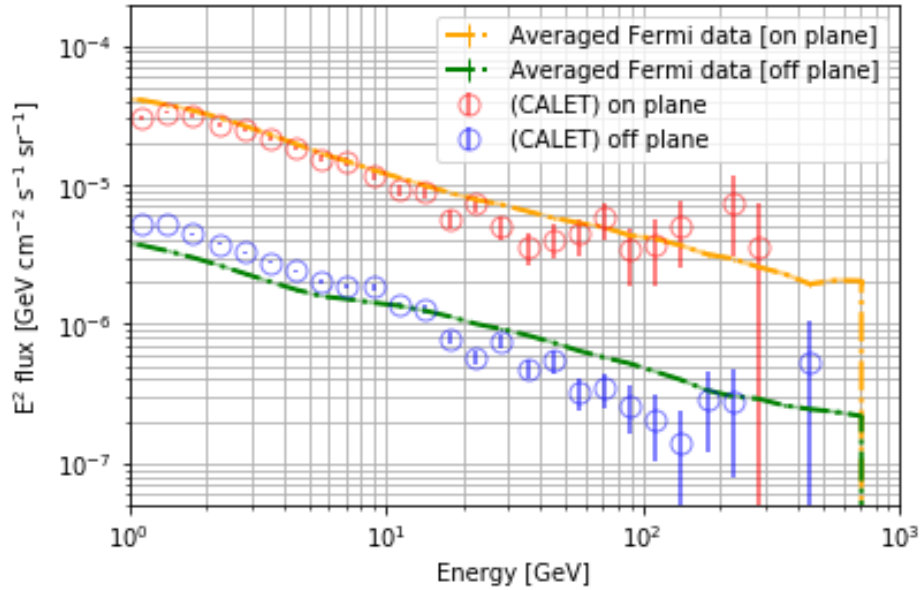
Energy spectra for bright point sources (11/2015 – 02/2022)





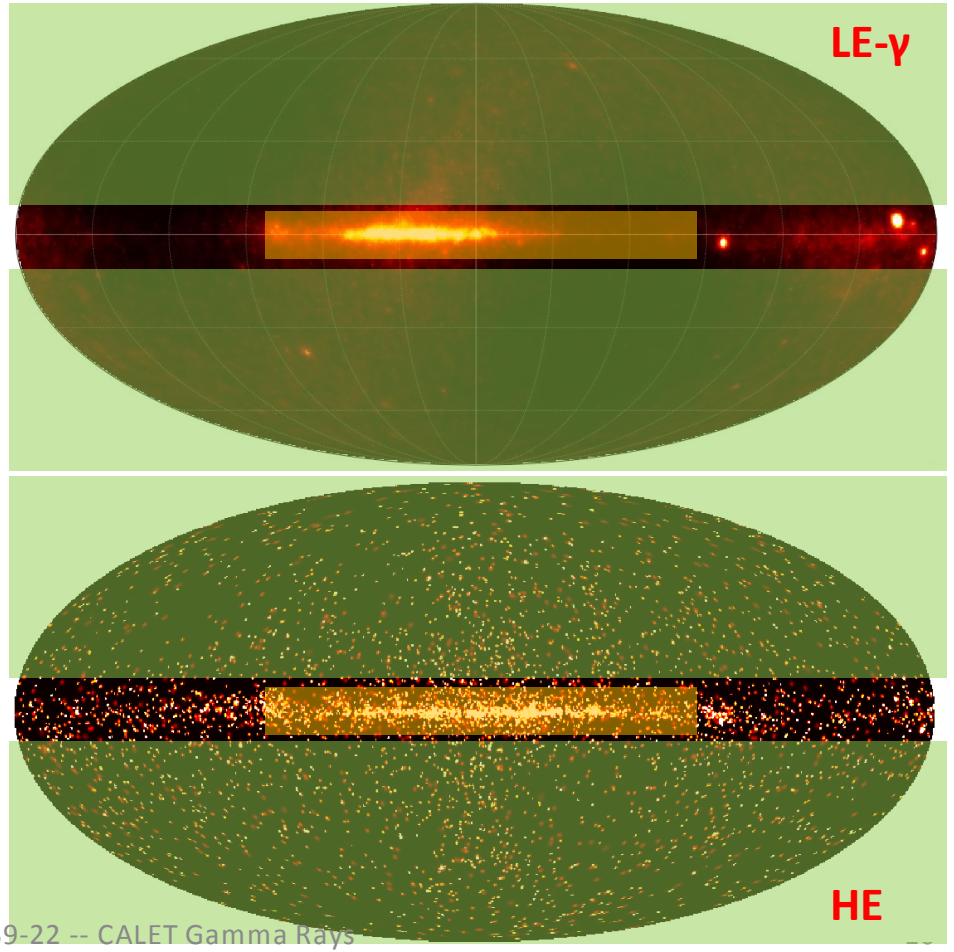


Diffuse emission – on-plane and off-plane (11/2015 – 02/2022)

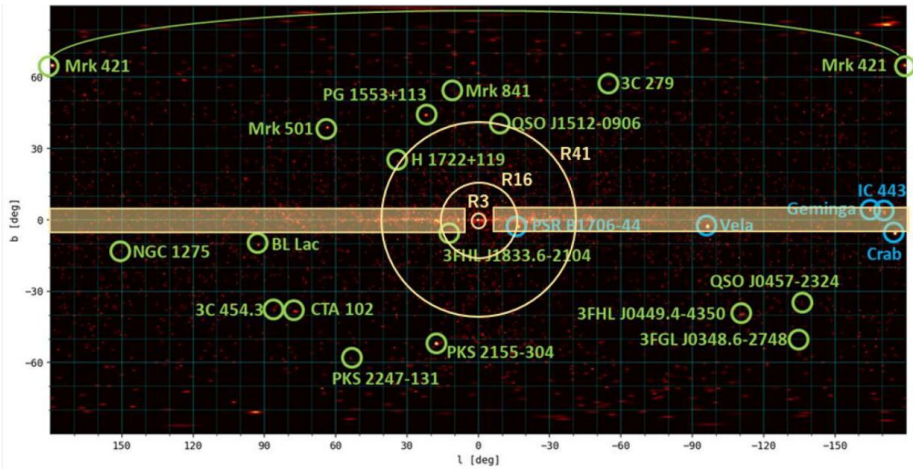


On-plane: |b| < 8° & |l| < 80°

Off-plane: |b| > 10°



Diffuse emission – DM line flux limits



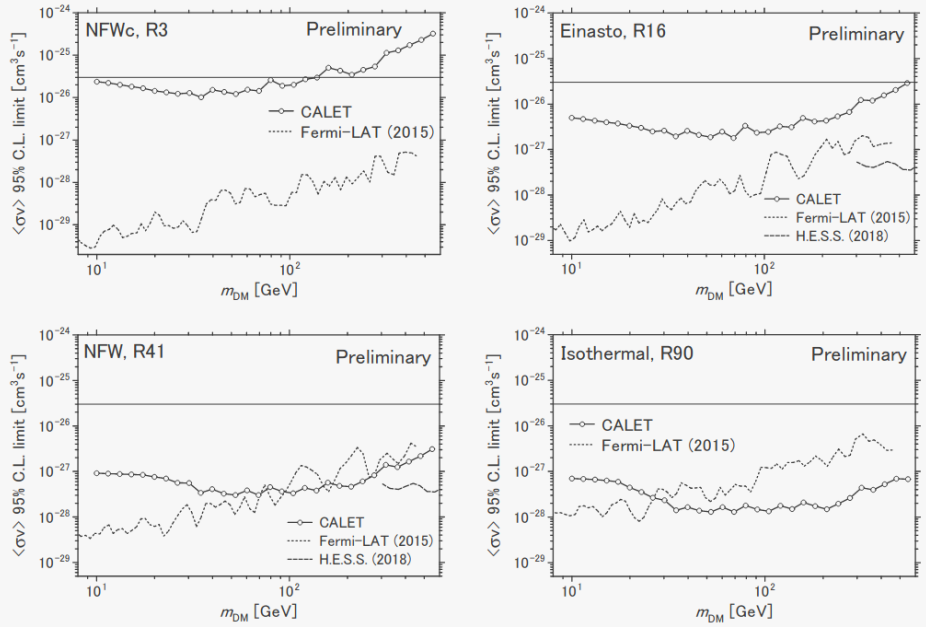


Figure 5: Upper limits on DM velocity-averaged annihilation cross section as a function of the DM mass for each ROI. Also shown are those given by Fermi-LAT [11] and H.E.S.S. [15] for comparison. Horizontal thin lines show the canonical thermal relic cross section of 3×10^{-26} cm^3 s^{-1}.

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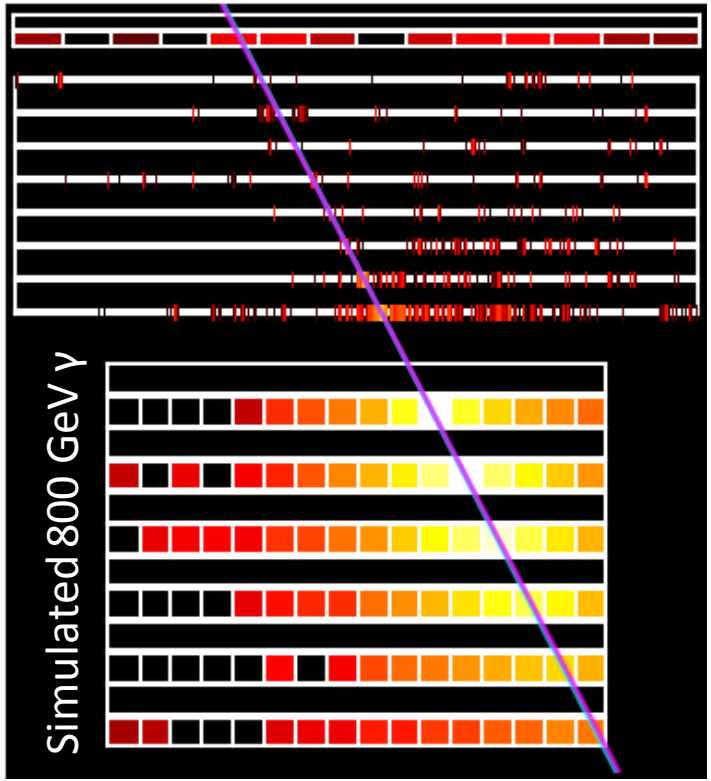
M. Mori for the CALET Collaboration

Improvements to HE sensitivity

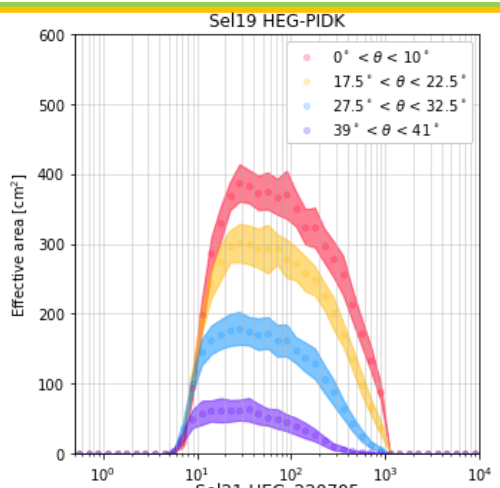
At higher energies, charge selection with CHD becomes contaminated with backscattered secondary particles.

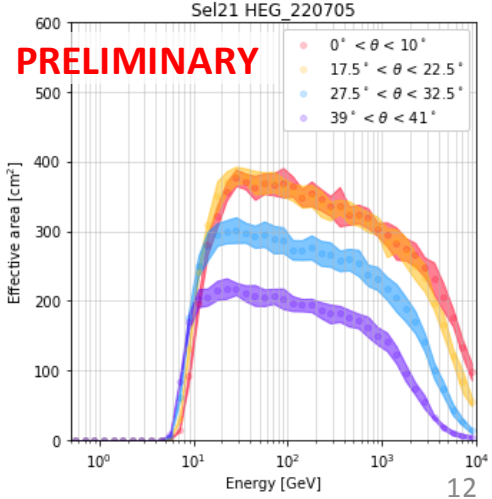


New selection defined to use looser cuts in CHD and incorporating first two layers of IMC for charged primary rejection

Preliminary results show significant increase in effective area E > 100 GeV

Testing of selection and contamination being finalized for implementation in all analyses soon!



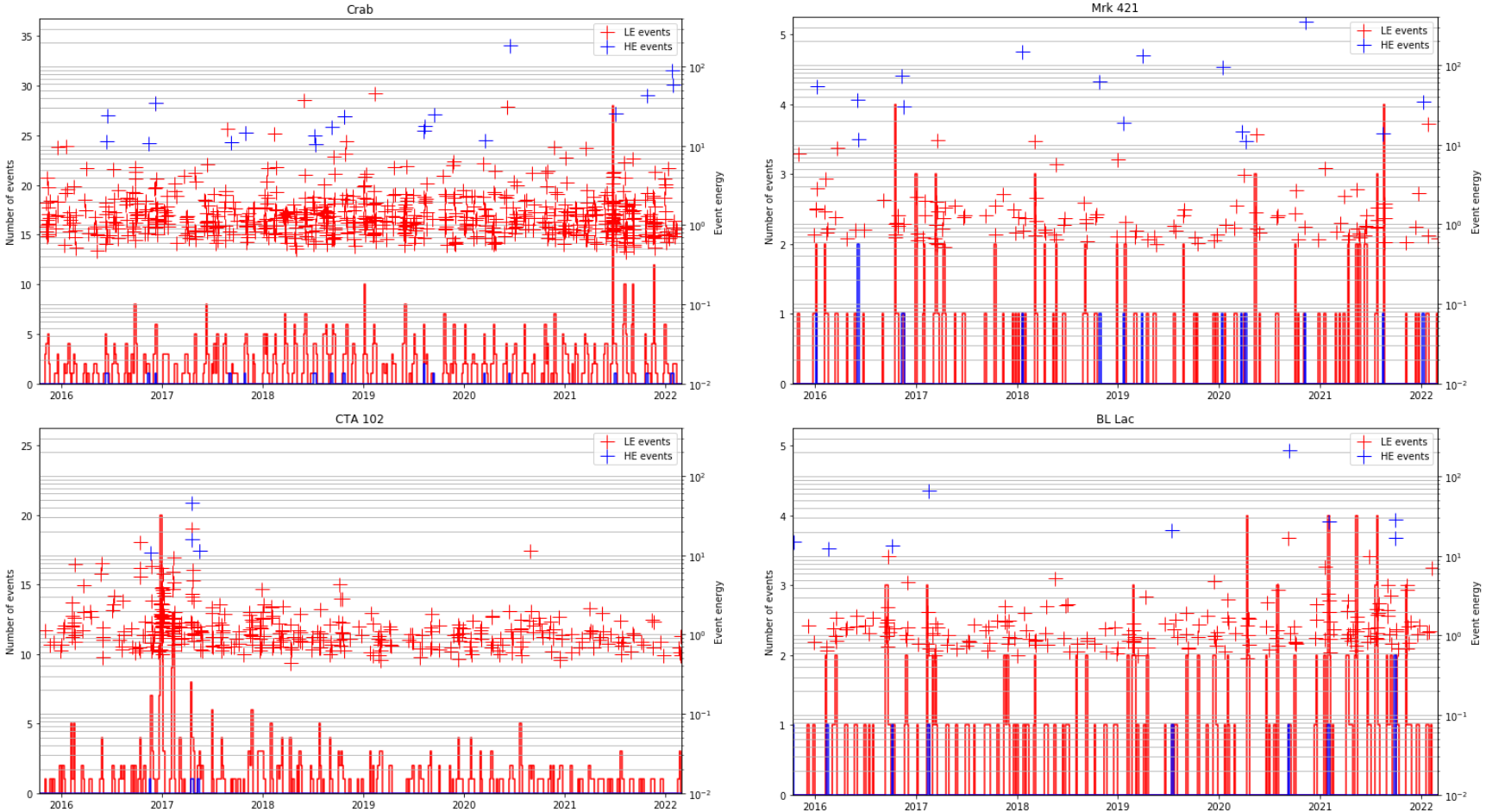


Summary

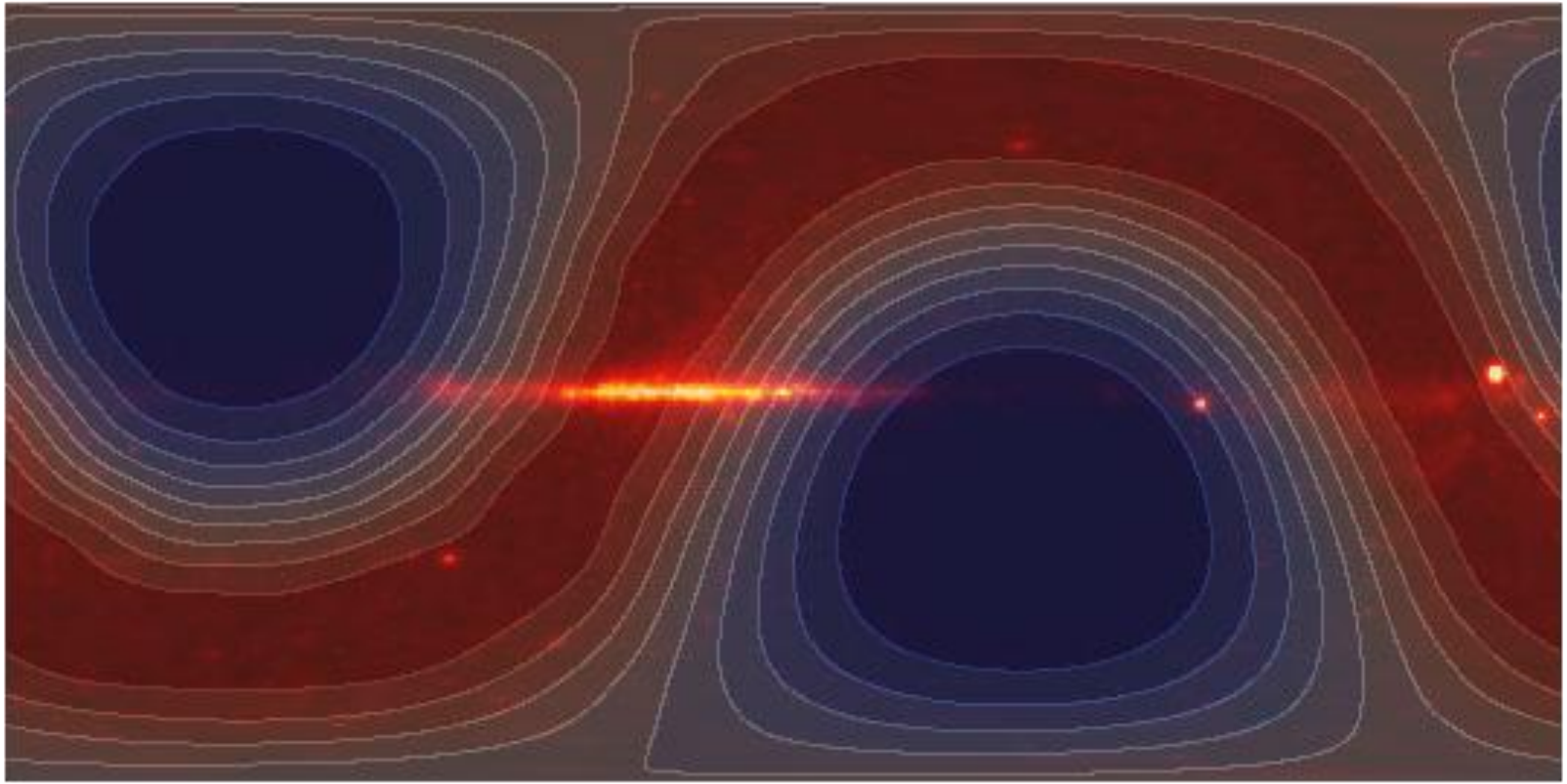
- CALET has been taking data for 6.5 years on the ISS and is in good health
  - Operations approved until end of 2024, are possible for even longer
- CALET gamma-ray data is being used for analysis of:
  - Transients: results recently published for LVC O3 counterpart search
  - Galactic and extra-galactic point sources
  - Galactic diffuse emission and dark matter line searches
  - Solar and space weather phenomena (not discussed here)
- Improvement to the photon selection is being implemented
  - Especially at high energies, IMC being used more extensively to keep photons
  - Revised geometrical acceptance allows for HE sensitivity at larger zenith angles
  - Preliminary results indicate >3x increase in effective area at 500 GeV for normal incidence, much larger for larger zenith angles

Backup slides

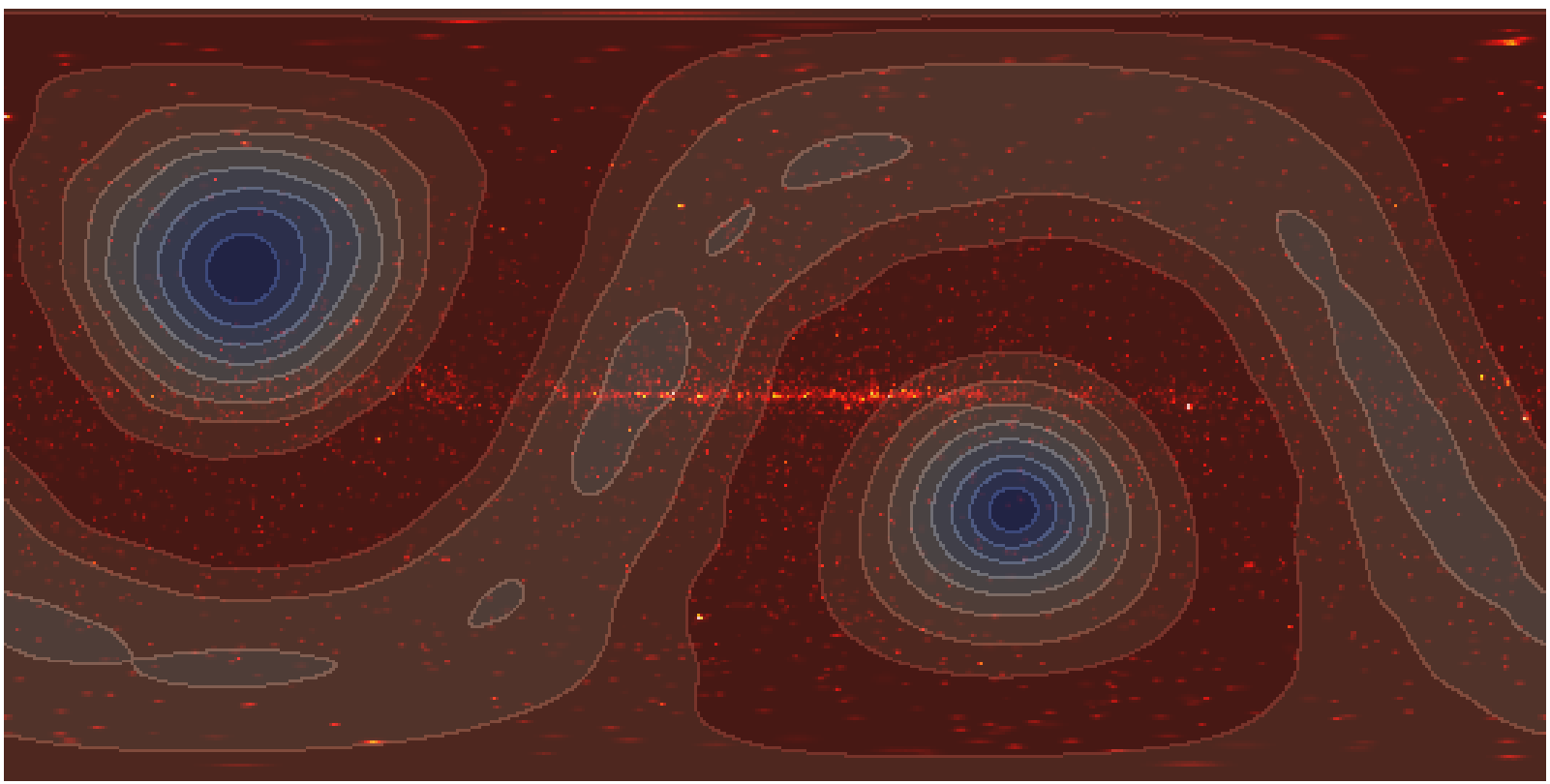
5-day lightcurves



LE skymap with exposure contours



HE skymap with exposure contours



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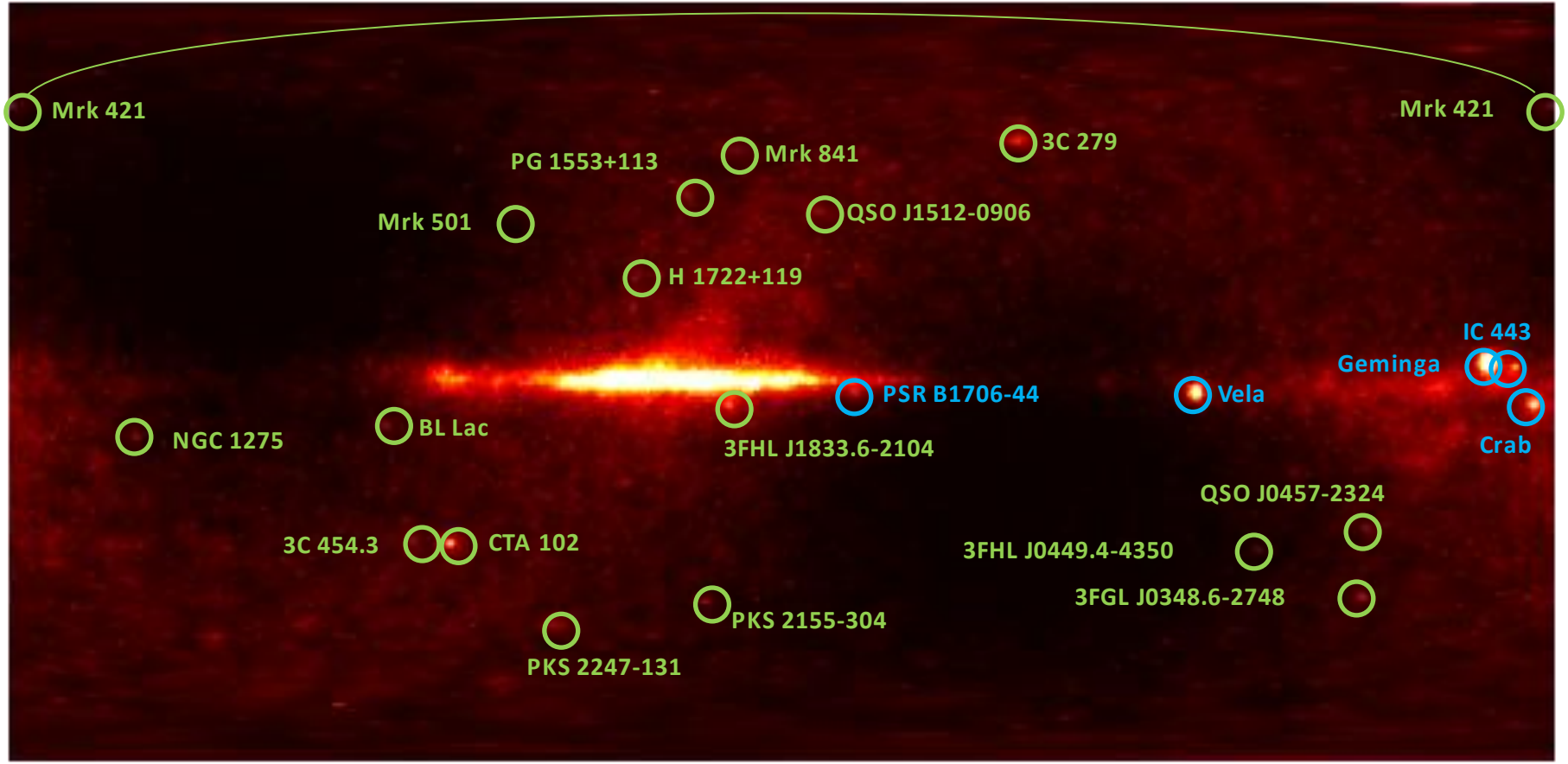
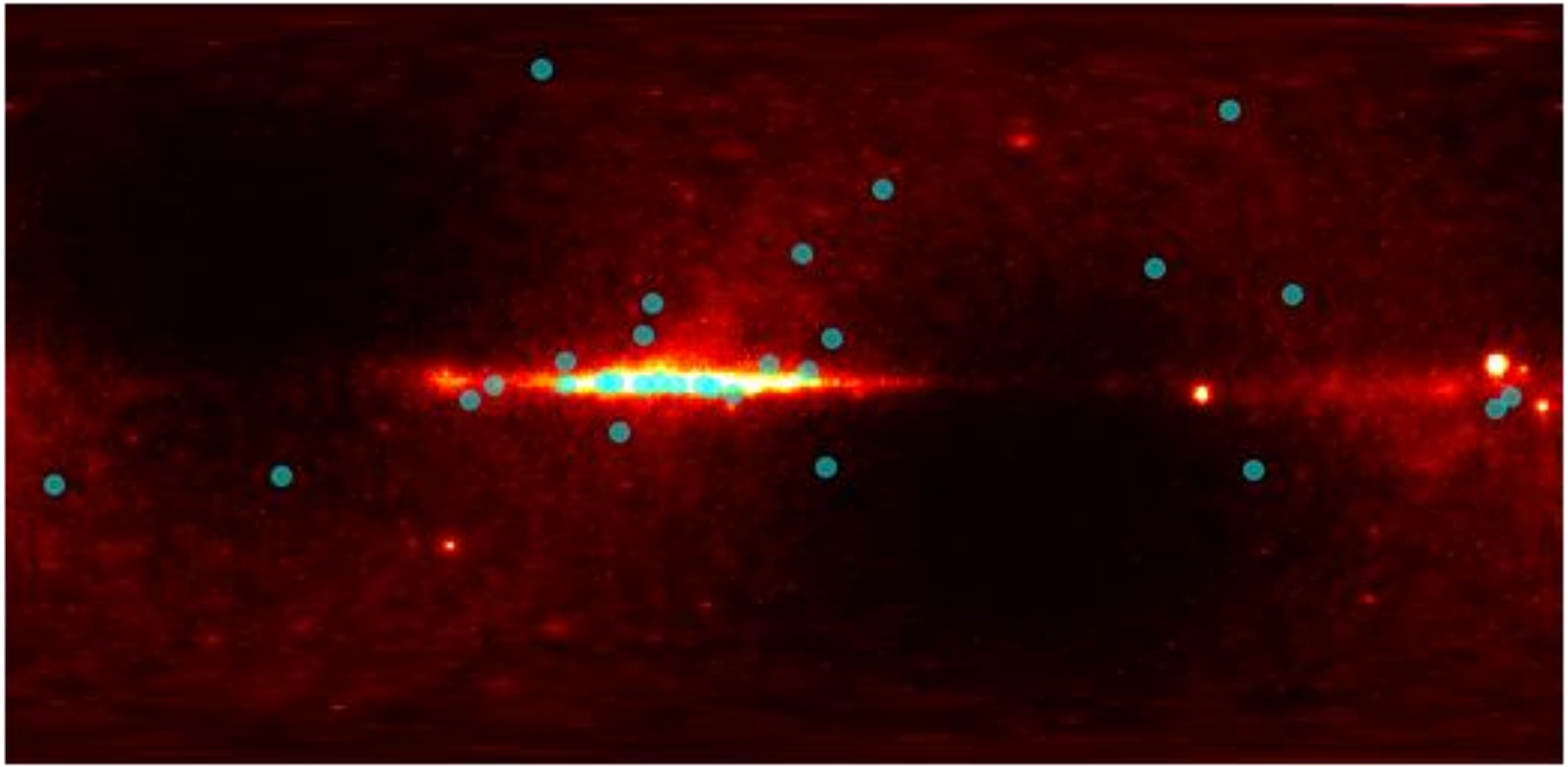
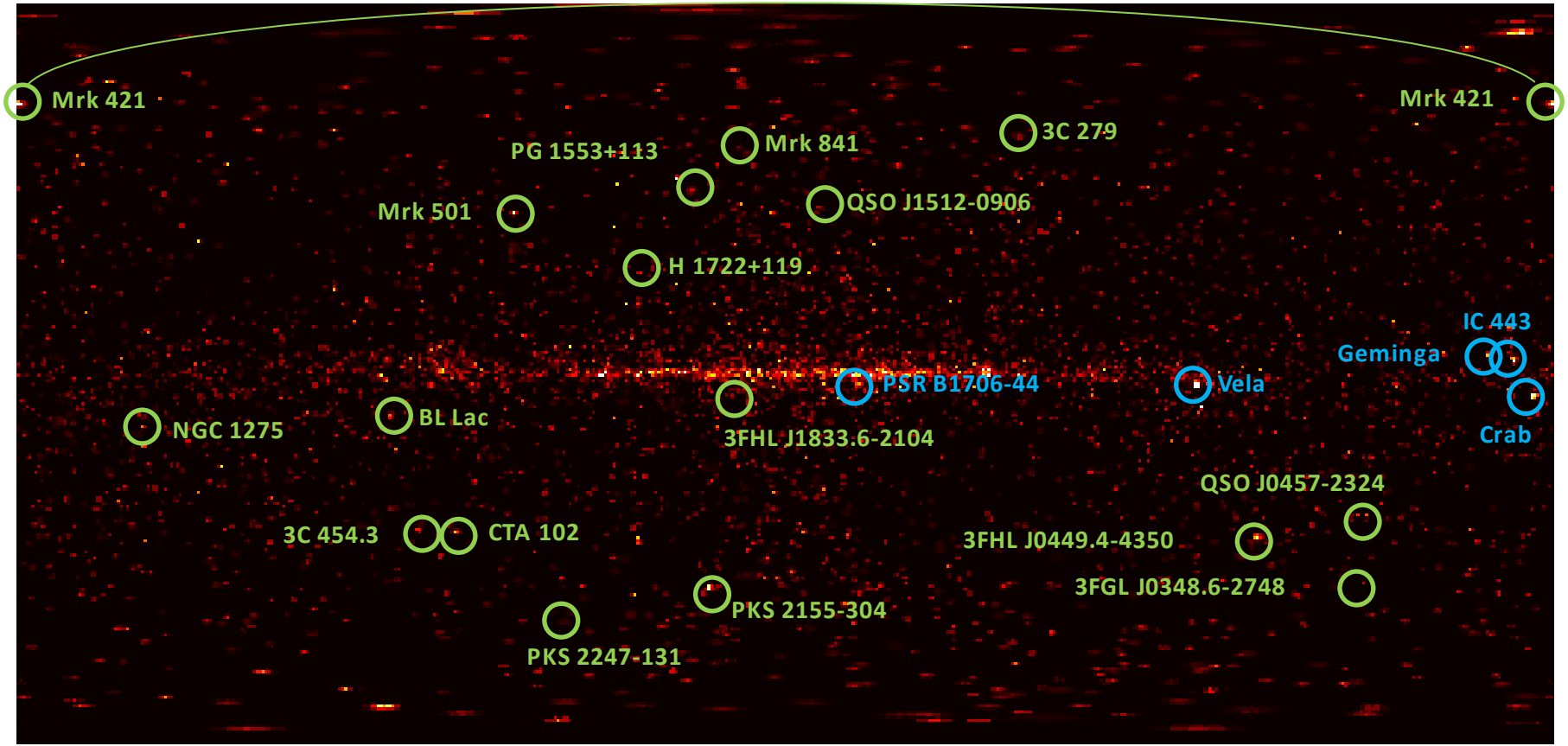


Photons detected >100 GeV (LE-gamma)



Sources detected >1 GeV



Photons detected >100 GeV (HE)