# WP4: *Fermi*-LAT DATA ANALYSIS

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News Scientific Board
Meeting
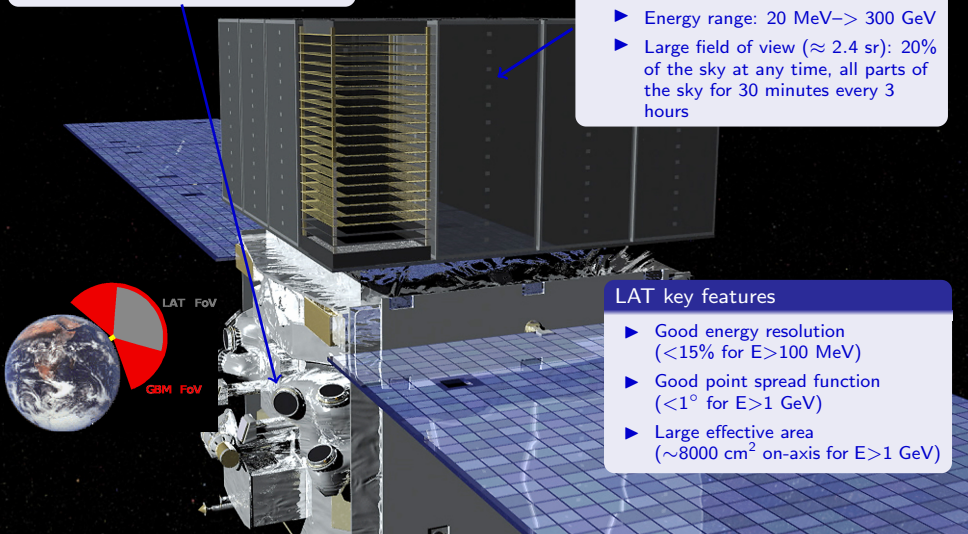
# THE *Fermi* SPACE TELESCOPE



**Gamma-ray Burst Monitor (GBM)**

- ▶ 12 NaI and 2 BGO detectors
- ▶ Energy range: 8 keV–40 MeV
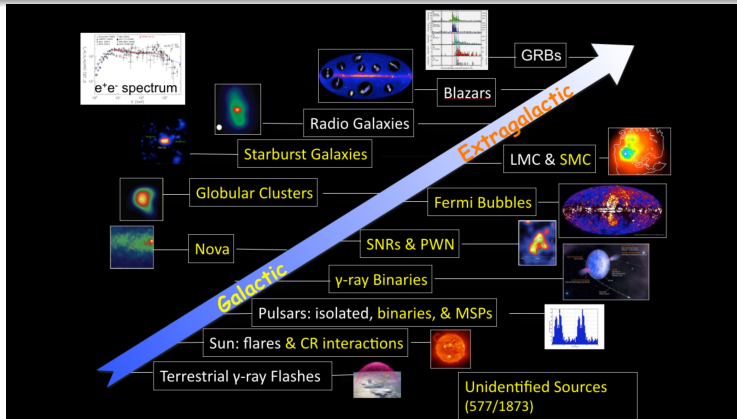
**The Large Area Telescope (LAT)**

- ▶ Pair conversion telescope
- ▶ Energy range: 20 MeV–> 300 GeV
- ▶ Large field of view ($\approx$ 2.4 sr): 20% of the sky at any time, all parts of the sky for 30 minutes every 3 hours

**LAT key features**

- ▶ Good energy resolution (<15% for E>100 MeV)
- ▶ Good point spread function (<1° for E>1 GeV)
- ▶ Large effective area (~8000 cm$^2$ on-axis for E>1 GeV)

WP4: Focus on four topics

- ▶ *Fermi*-LAT source catalog (4FGL)
- ▶ WIMP dark matter searches
- ▶ Cosmic-Ray Electron science
- ▶ Electromagnetic counterparts to gravitational wave events

# The 4th Fermi Gamma-ray Catalog

- The 4th Fermi Gamma-ray Catalog (4FGL) is close to complete
  - Goal is to release the catalog by the end of the year
- The 4FGL will comprise about 5500 sources
  - With a ~66% association rate

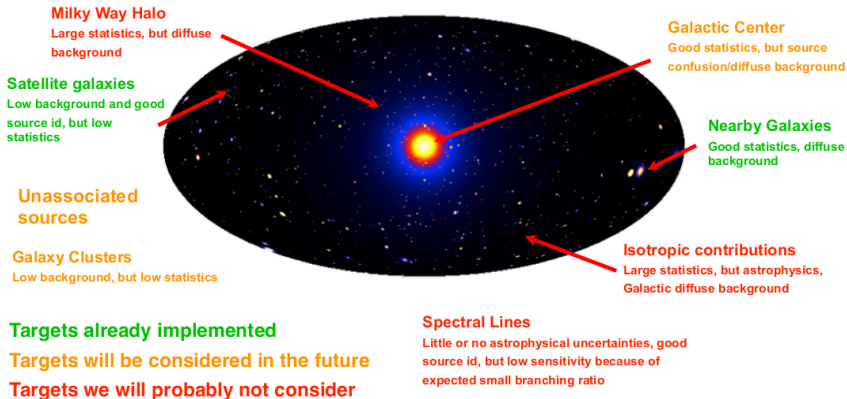| Catalog | Energy Range (GeV) | Data Interval (m) | Sources | Unasso-ciated | Event Selection | Release Date |
|---------|--------------------|-------------------|---------|---------------|-----------------|--------------|
| **0FGL** | 0.2-100 | 3 | 205 | 37 (18%) | P6V1 DIFFUSE | Feb. 2009 |
| **1FGL** | 0.1-100 | 11 | 1451 | 630 (43%) | P6V3 DIFFUSE | Feb. 2010 |
| **2FGL** | 0.1-100 | 24 | 1873 | 649 (35%) | P7V6 SOURCE | Aug. 2011 |
| **3FGL** | 0.1-300 | 48 | 3033 | 992 (33%) | P7V15 SOURCE | Jan. 2015 |
| **4FGL** | 0.05-1000 | 96 | ~5500 | ~1800(33%) | P8 SOURCE | End of 2018 |
| **1FHL** | 10-500 | 36 | 511 | 65 (13%) | P7V6 CLEAN | Jun. 2013 |
| **2FHL** | 50-2000 | 80 | 360 | 48 (14%) | P8 SOURCE | Aug. 2015 |
| **3FHL** | 10-2000 | 84 | 1556 | 176 (11%) | P8 SOURCE | Mar. 2017 |
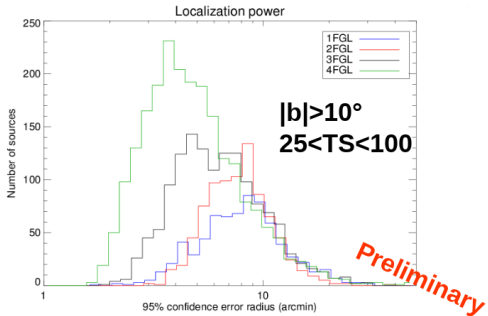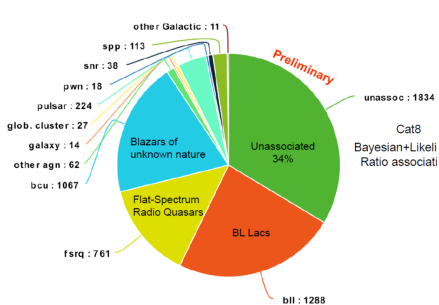
WP4 team has actively participated in the catalog effort

- Improvements in the diffuse emission model
- New Pass8 selection
  - Description of new selection in paper on archive
    https://arxiv.org/abs/1810.11394
- Energy dispersion effects taken into account
- Higher energy reach: 1 TeV vs 300 GeV

- **DMcat project**: perform a combined search for Dark Matter (DM) from multiple targets.
- We plan to release the results in a format that can be used by the community to perform their own DM searches.



**Milky Way Halo**
Large statistics, but diffuse background

**Galactic Center**
Good statistics, but source confusion/diffuse background

**Satellite galaxies**
Low background and good source id, but low statistics

**Nearby Galaxies**
Good statistics, diffuse background

**Unassociated sources**

**Galaxy Clusters**
Low background, but low statistics

**Isotropic contributions**
Large statistics, but astrophysics, Galactic diffuse background

**Spectral Lines**
Little or no astrophysical uncertainties, good source id, but low sensitivity because of expected small branching ratio

**Targets already implemented**
**Targets will be considered in the future**
**Targets we will probably not consider**

WP4 team has contributed to the dark matter pipeline effort:

- ▸ Almost ten years of Fermi-LAT data has been analyzed and combined searches for DM from the LMC, SMC, M31, M33 and dSphs have been performed
  - ▸ No significant emission from DM has been found
- ▸ Future steps of the analysis
  - ▸ add to the target list clusters and the Galactic center
- ▸ Plan to publish a paper with the analysis, including likelihood profiles for individual targets and for the combined searches
- ▸ Results can be used by the community to test their particular DM models
- ▸ Results presented at the 8$^{th}$ International Fermi Symposium
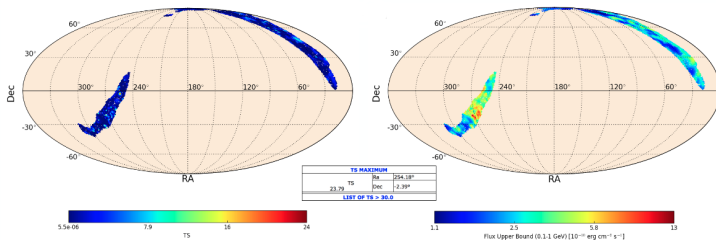
- ▶ WP4 team actively contributes to the EM follow-up to gravitational wave events
- ▶ This summer we used 1 month of secondments to work at SLAC
- ▶ Dedicated to the study of the sensitivity of our pipeline
  - ▶ Estimate the number of trials from MC simulations
  - ▶ Studies of the flux upper limits
- ▶ Getting ready for O3

SPARE SLIDES