# Search for gamma-ray counterparts of newly discovered radio astrophysical sources

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PUCP

50 años
CONCYTEC
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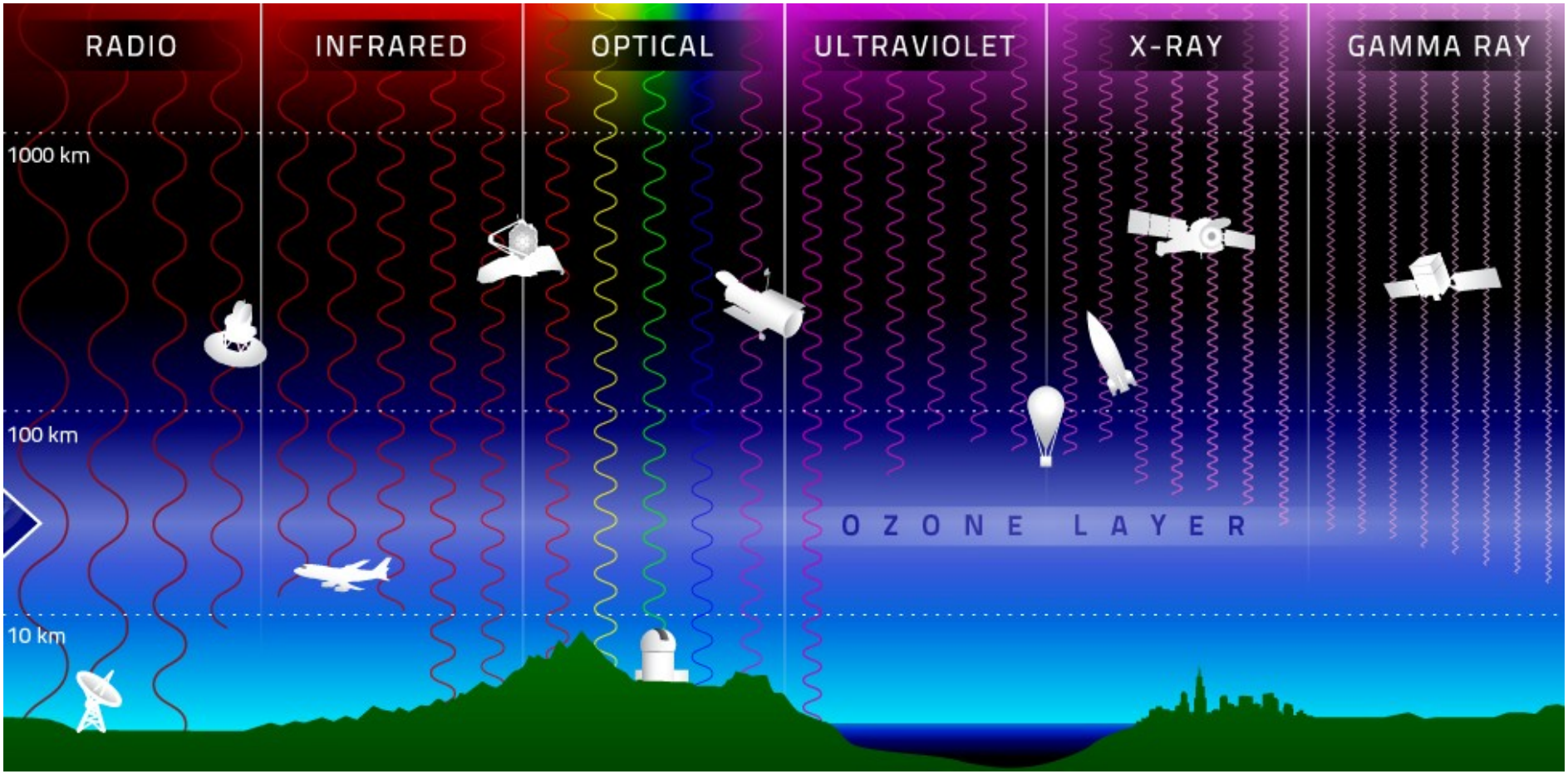
# List of content

- Motivation: We will present two radio sources. FR0s and FRBs.
- Fermi-LAT: The gamma ray detector we get out data from.
- Procedure: Correlation between radio sources with gamma ray data.
- Results: Preliminary results.

# Motivation

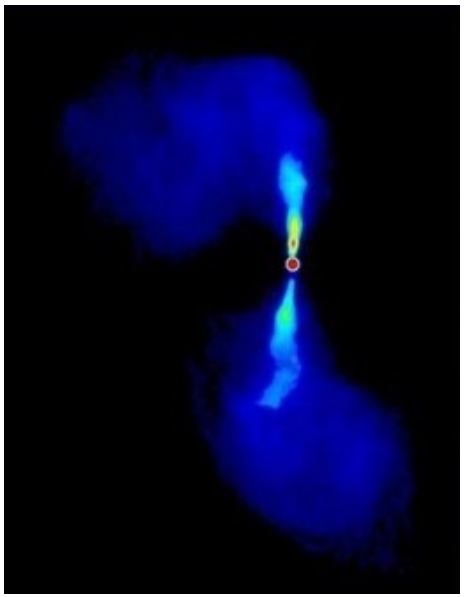


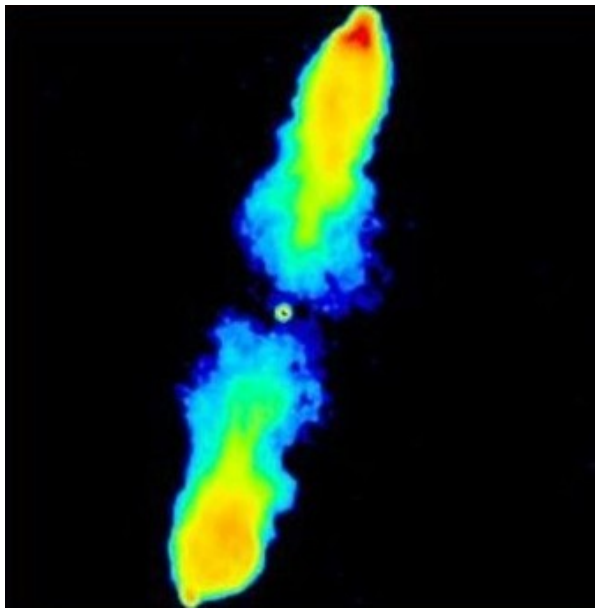

Source: `http://ecuip.lib.uchicago.edu/multiwavelength-astronomy/astrophysics/07.html`

## Fanaroff-Riley Clasification

FR-I: Luminosity decreases as a function of distance to the center. Low Power.

FR-II: Luminosity increases as a function of distance to the center. High Power.

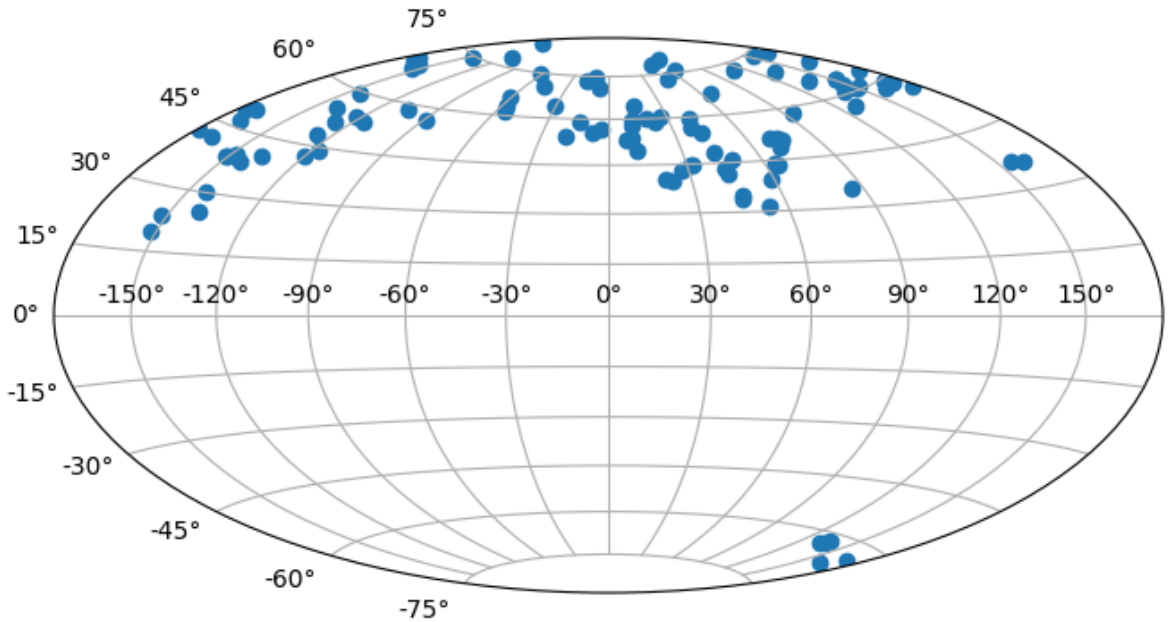




FR-0: Compact (<10kpc), similar to FR-I with no extended structures.

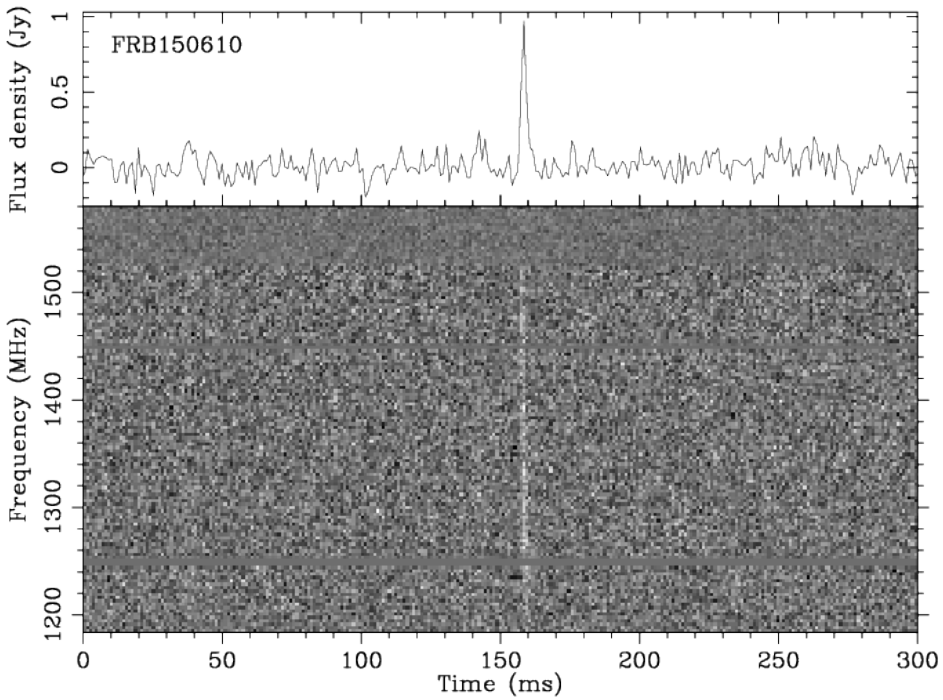
Source: Active Galactic Nuclei with Fermi-LAT, Elisabetta Cavazzuti

# FR0 Map
# (100+ Sources)



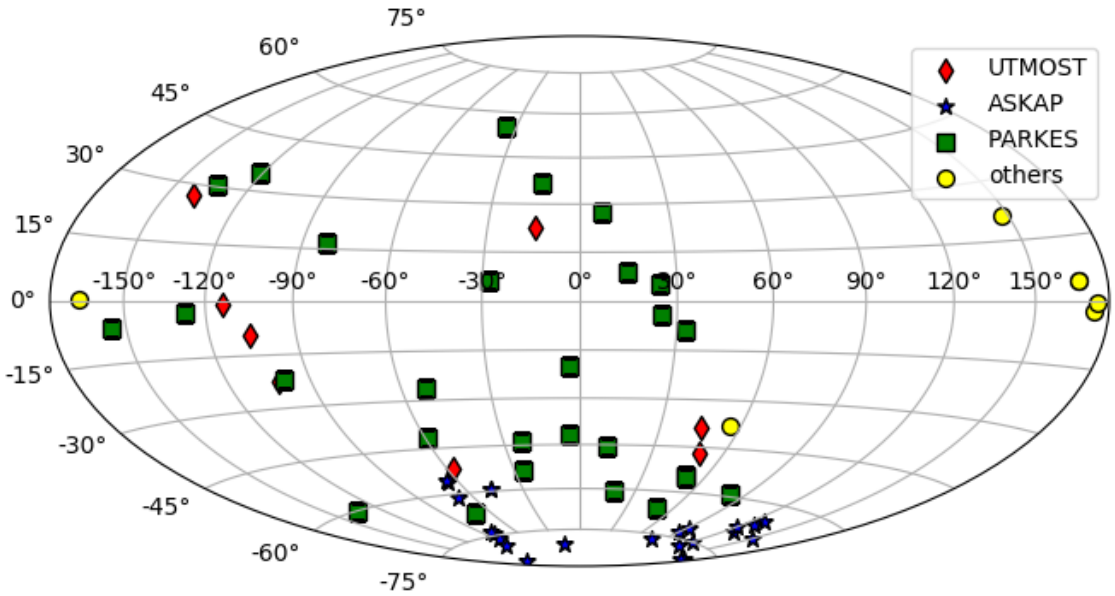

Coordinates from FR0-Cat: `https://arxiv.org/abs/1709.00015`

# Fast Radio Burst



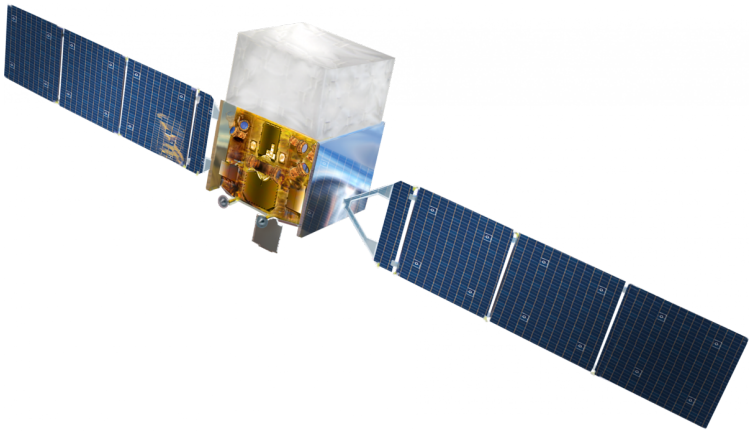

- Short in time (miliseconds)
- Ranges from 1000 to 1500 MHz.
- Unknown origin, although most probably extragalactic due to spatial distribution.

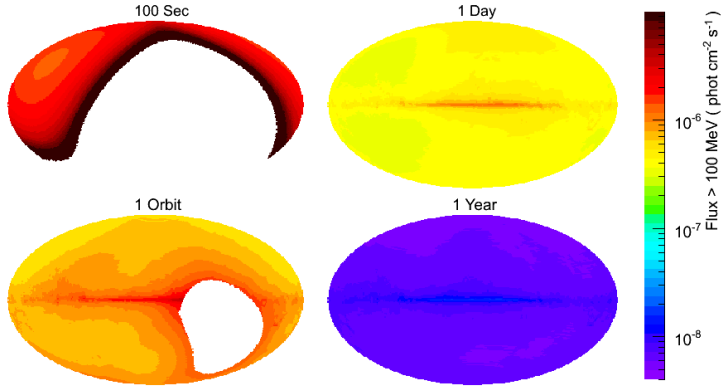
# FRB Map




Coordinates from FRBCat: `http://adsabs.harvard.edu/abs/2016PASA...33...45P`

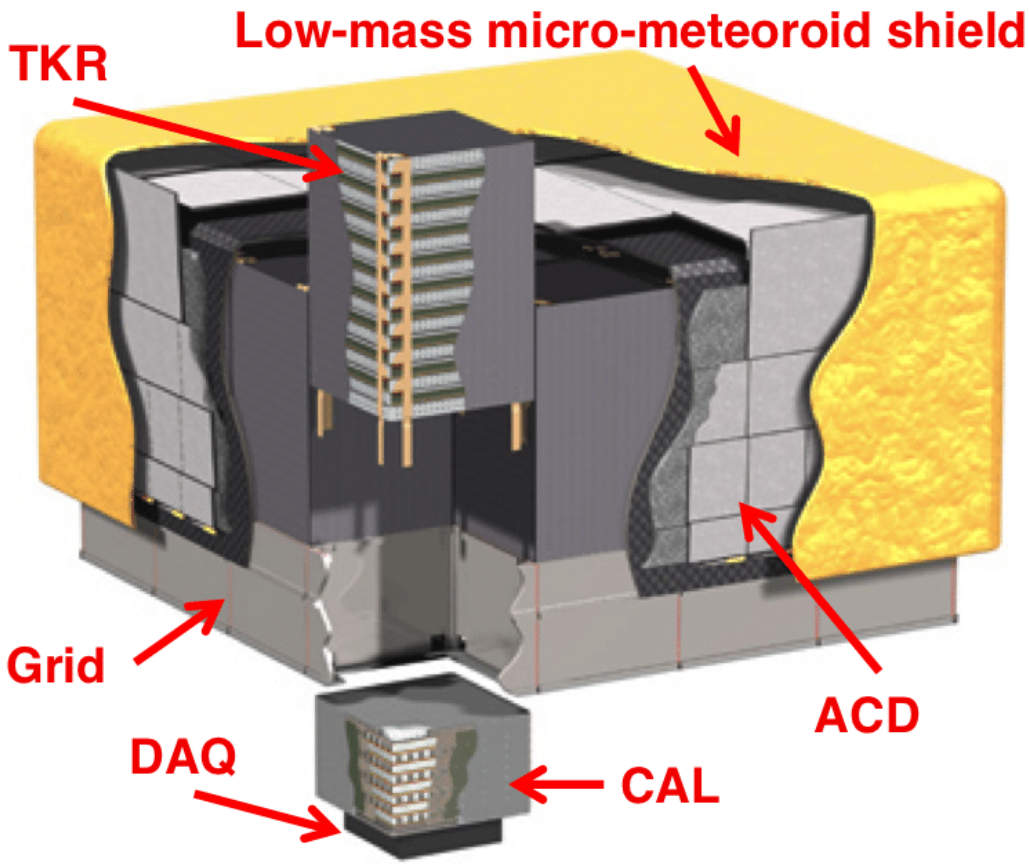
# Fermi-LAT





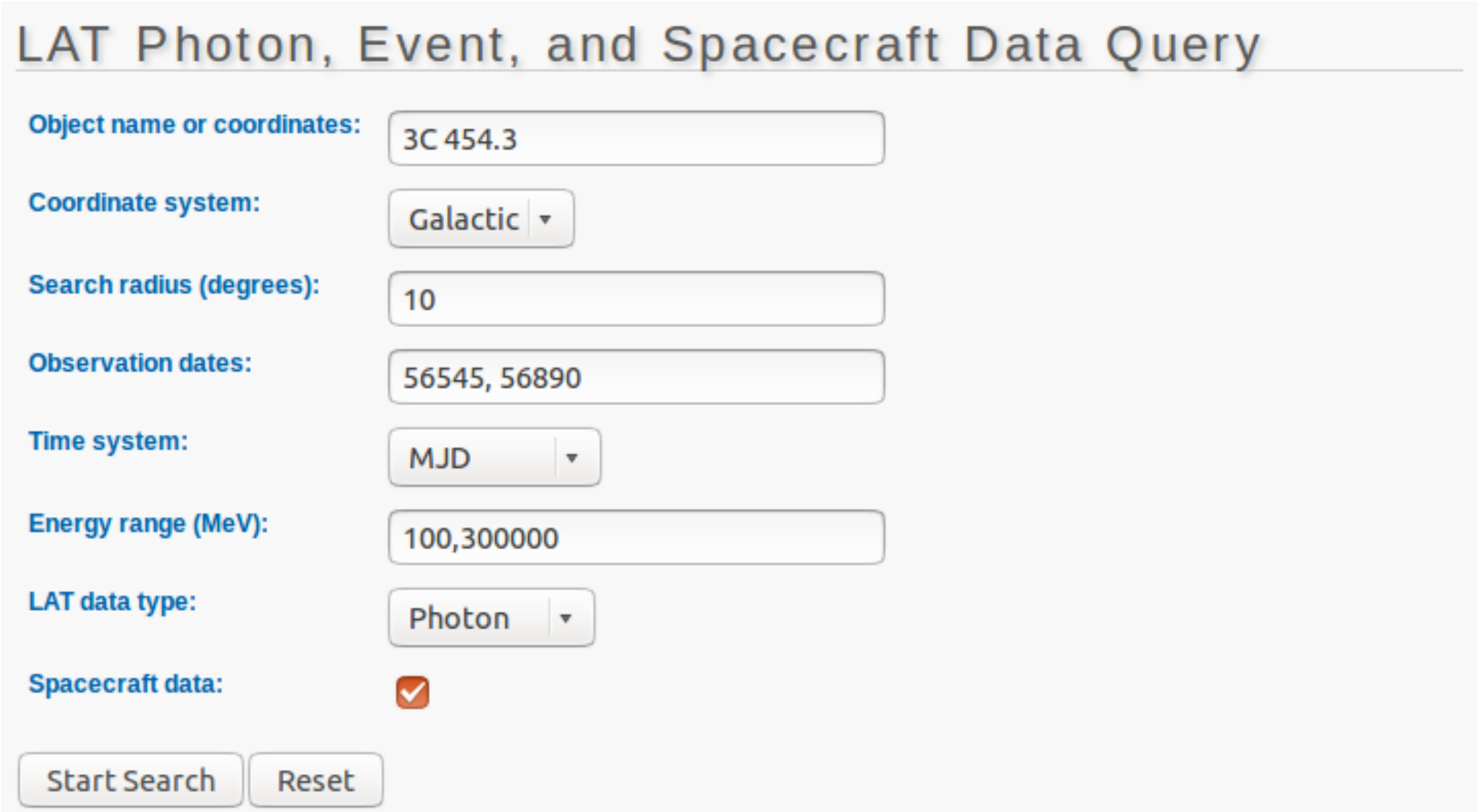

- Area: 2.4 Sr $\approx$ 20%
- Detection: Gamma rays
- Energy Range: 30 MeV - 300 GeV
- Resolution: $\sim$ 1 arcminute

# Working Principle



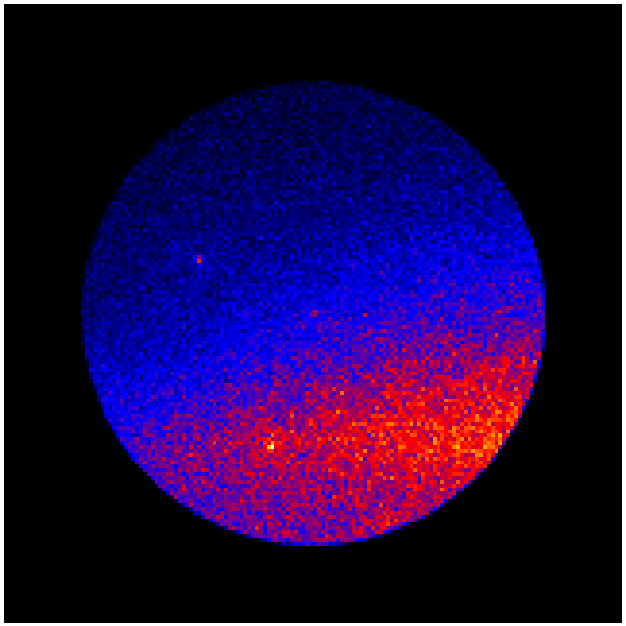

- VOLUME: 1.8x1.8x0.72m
- PROCESS: $\gamma \rightarrow e^+e^-$

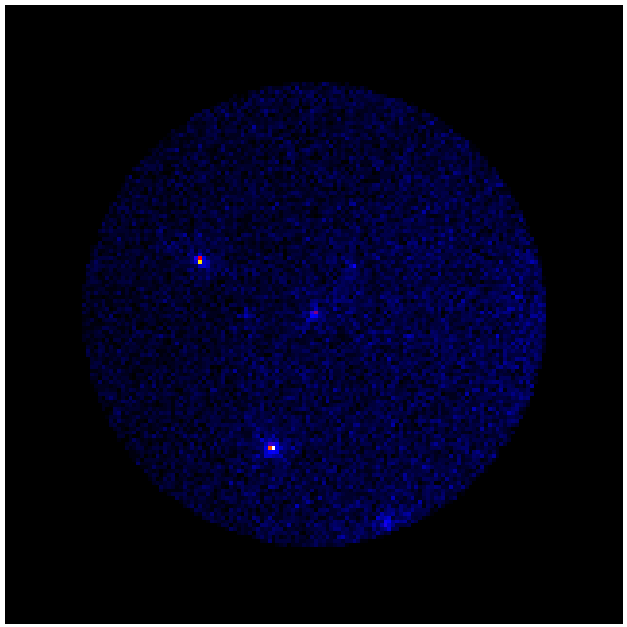
# Procedure



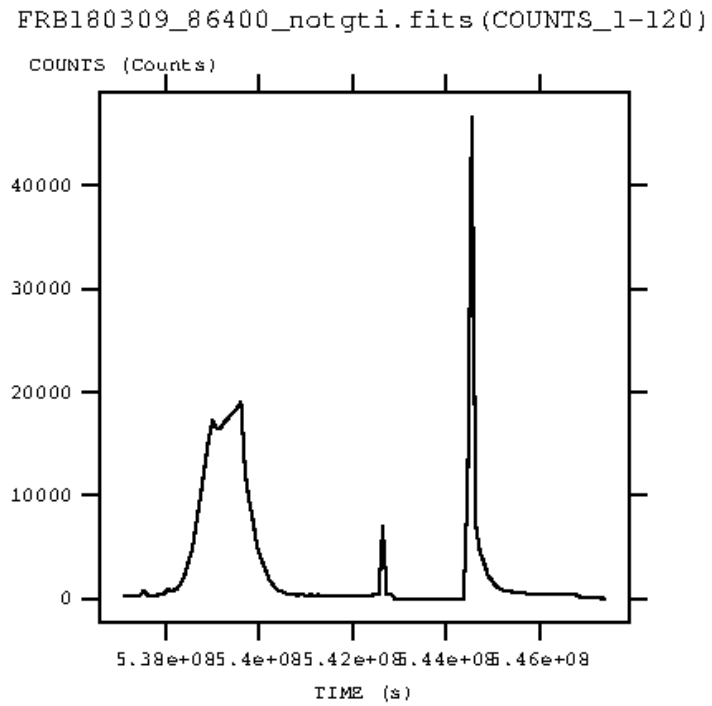

https://fermi.gsfc.nasa.gov/cgi-bin/ssc/LAT/LATDataQuery.cgi

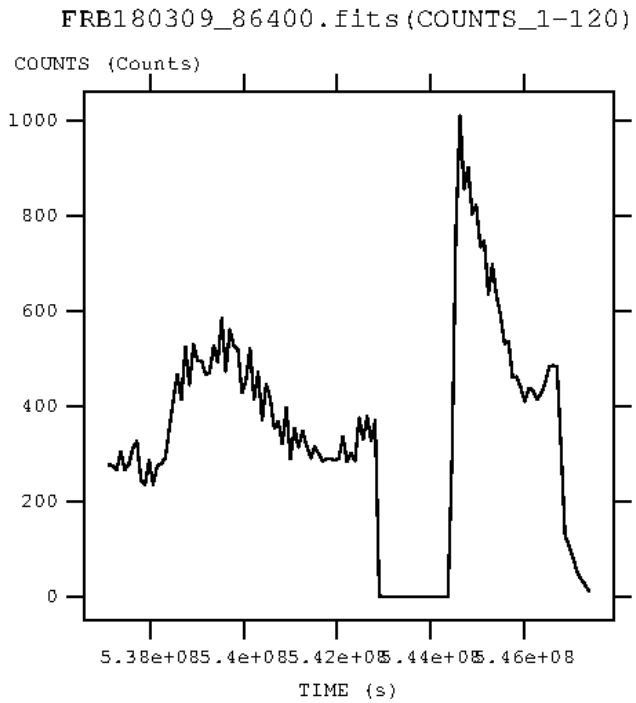
Filtering Background from Earth. Count maps.





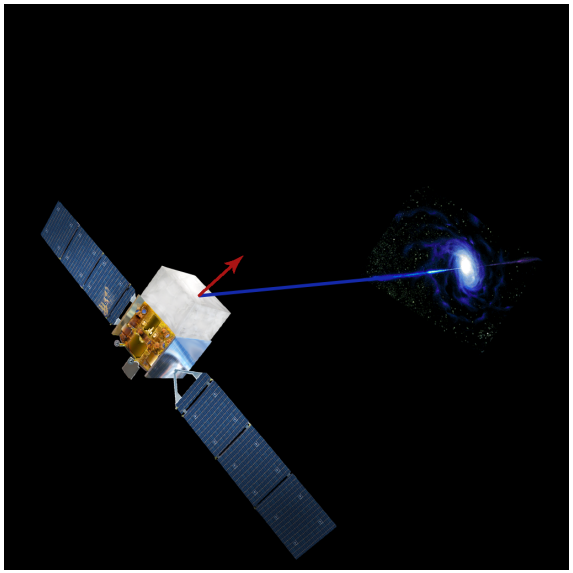
# Filtering Background from Earth. Lightcurves.

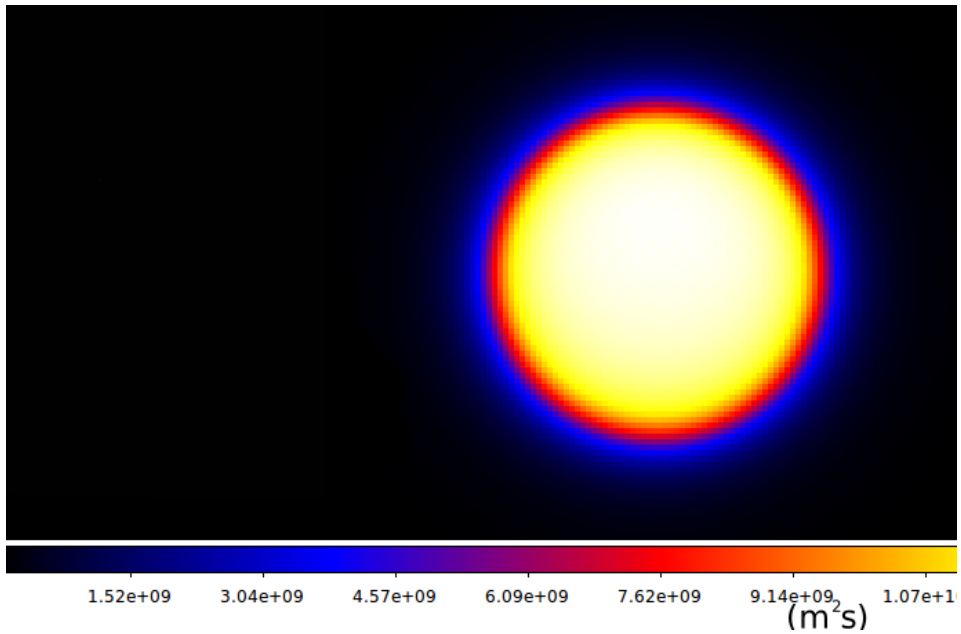


## Livetime Cube and Exposure Map

Satellite's response due to the inclination angle and time of exposure.





Many models were used (e.g.: Power Law, Log Parabola) in order to substract from the original.

Power Law

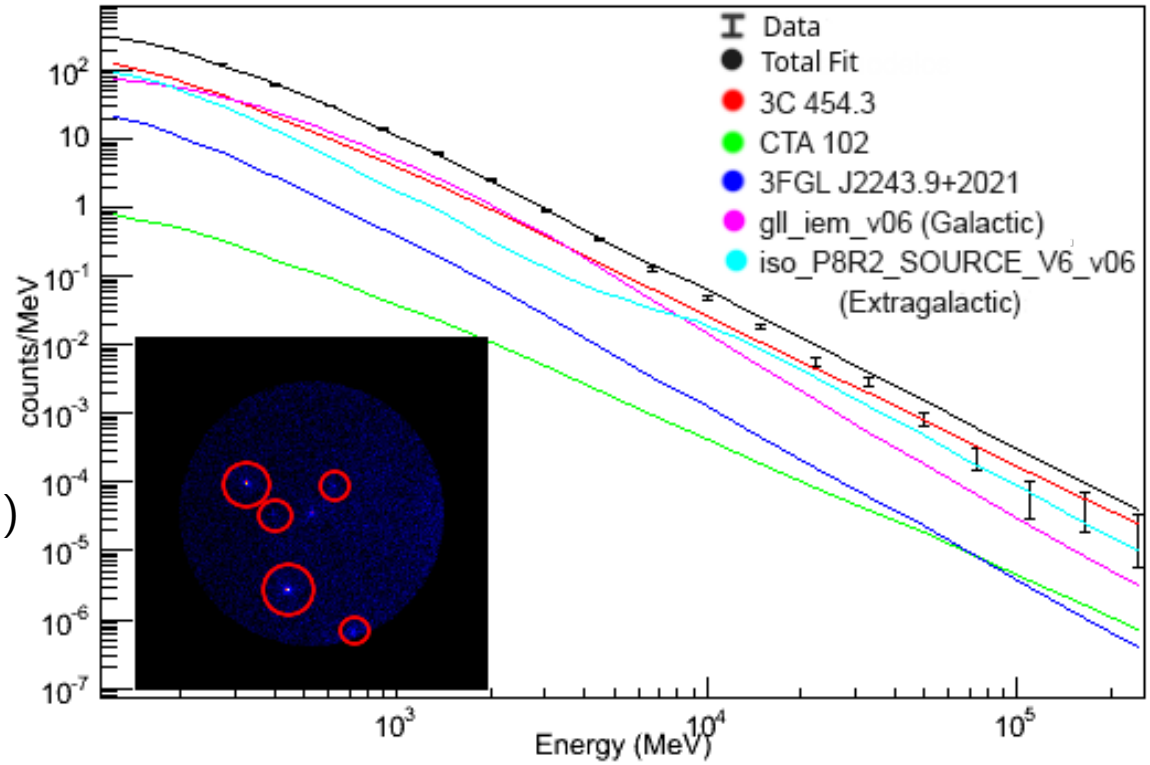
$$\frac{dN}{dE} = N_0 (\frac{E}{E_0})^{\gamma}$$

Log Parabola

$$\frac{dN}{dE} = N_0 (\frac{E}{E_b})^{-(\alpha+\beta log(\frac{E}{E_b}))}$$

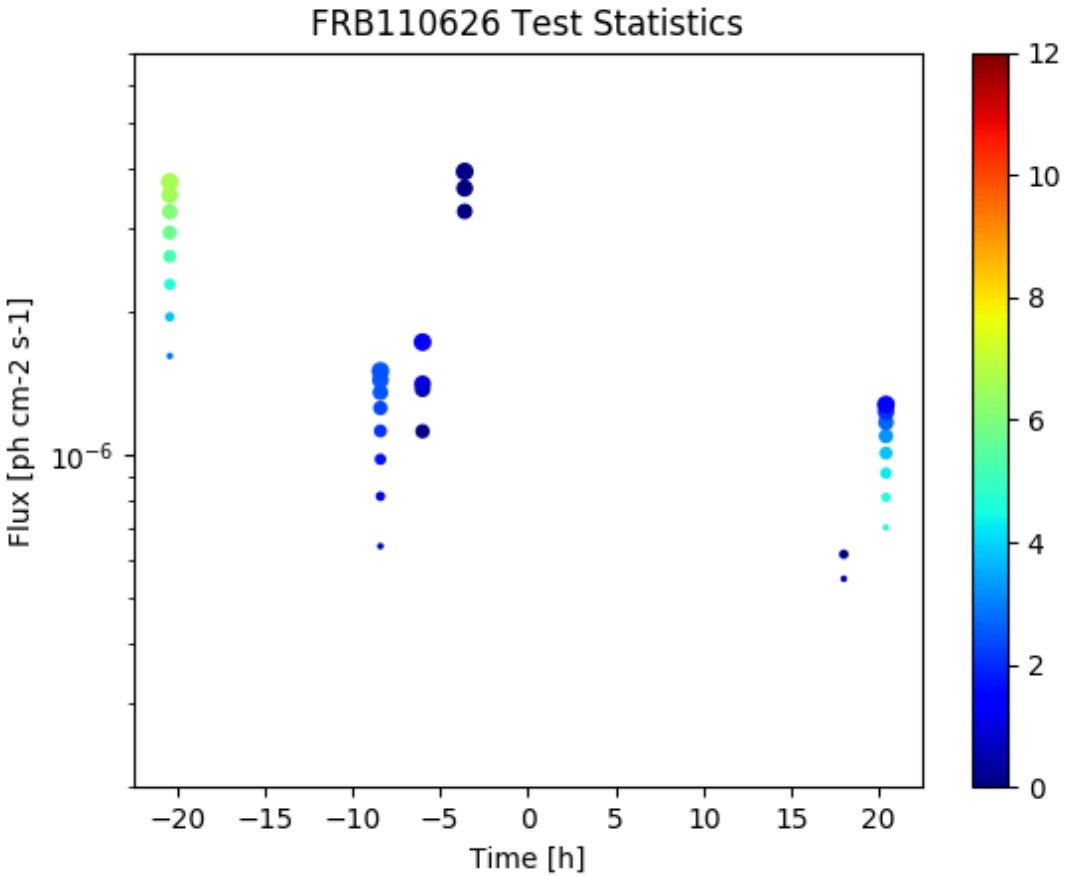
Exponential Cutoff

$$\frac{dN}{dE} = N_0 (\frac{E}{E_0})^{\gamma_1} exp(-(\frac{E}{E_c})^{\gamma_2})$$



# Results

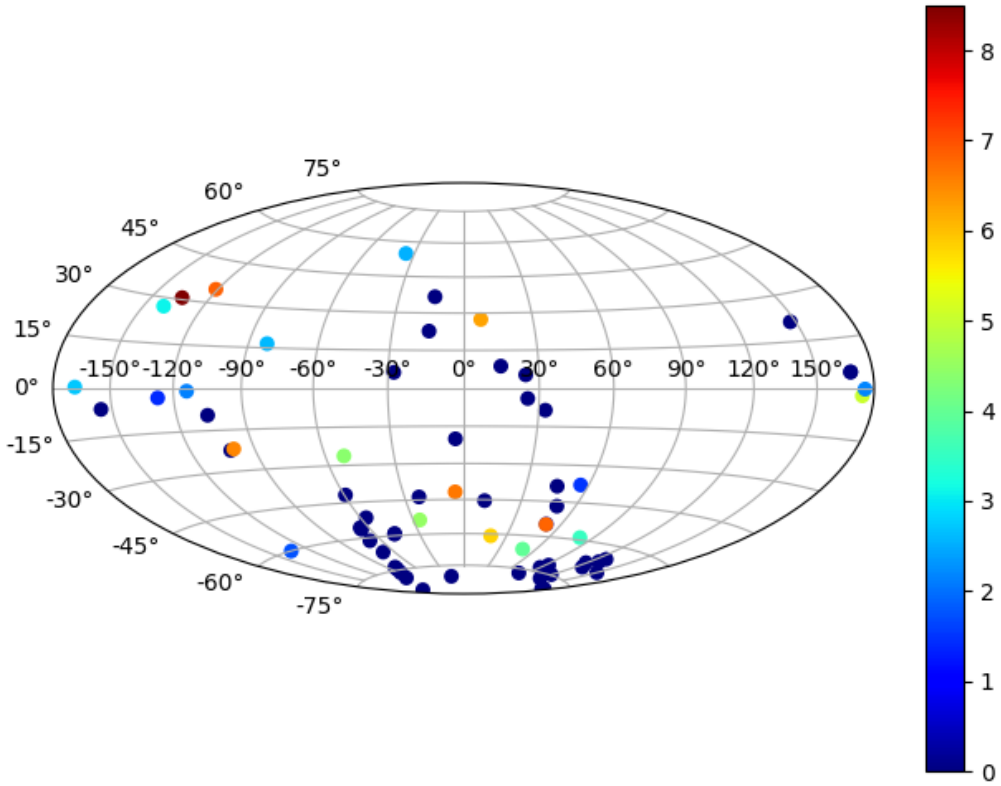
# Preliminary plot.




$$TS = -2log(\frac{L|\theta_0}{L|\theta_{ML}})$$

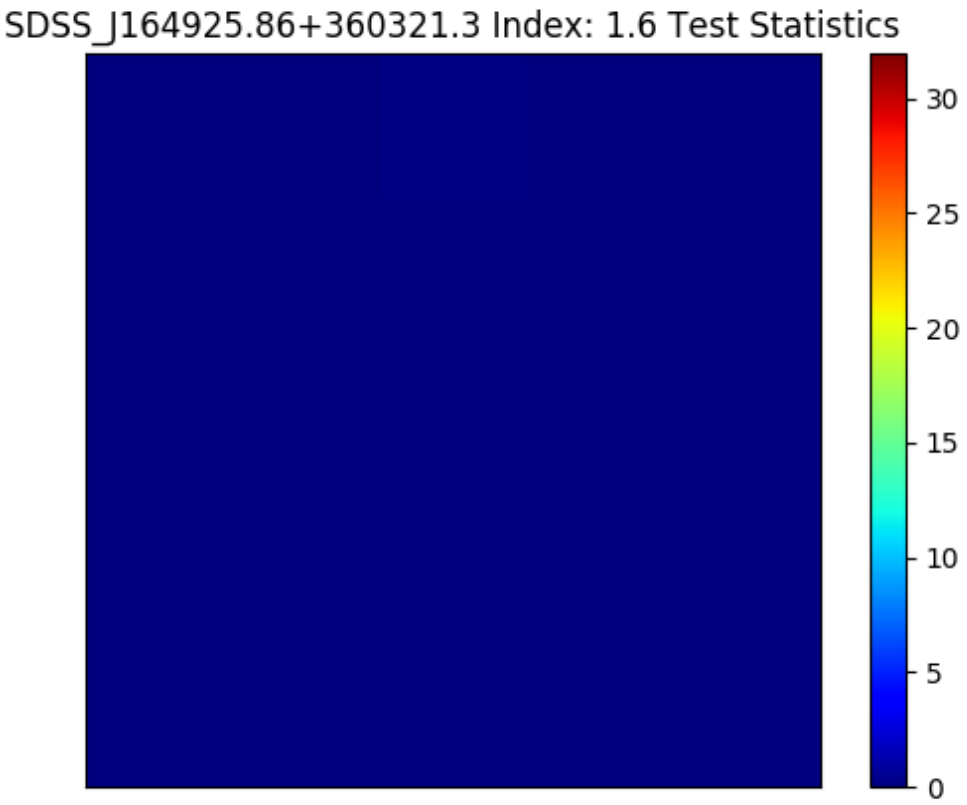
# Test Statistics FRB Map

Preliminary plot.

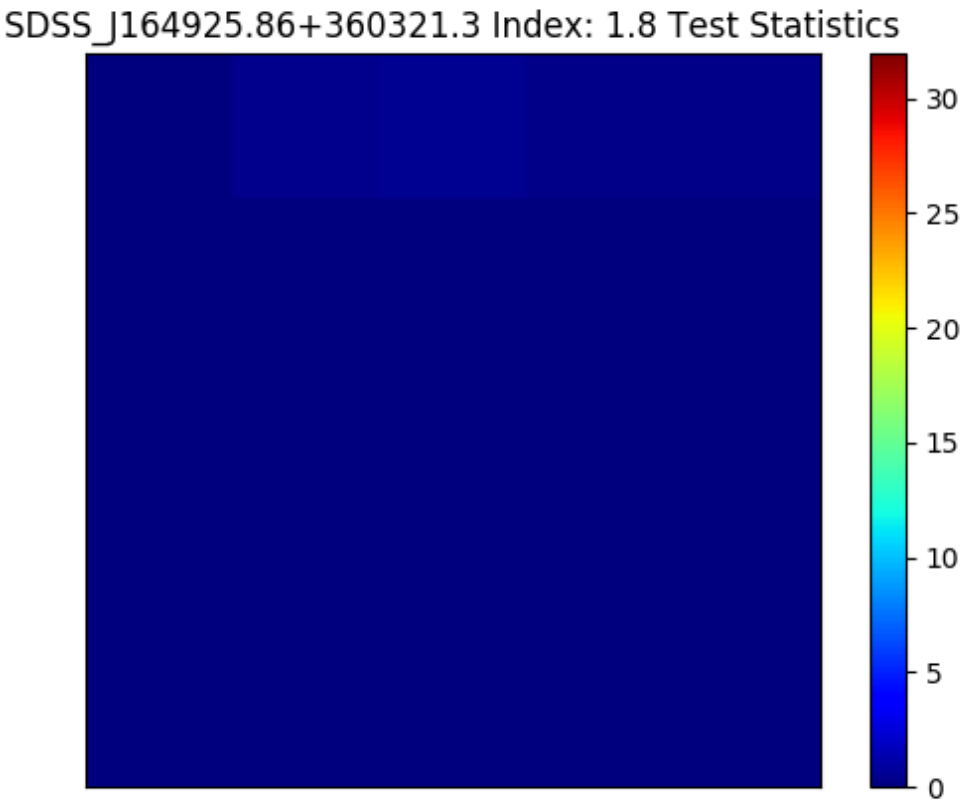



$$TS = -2log(\frac{L|\theta_0}{L|\theta_{ML}})$$

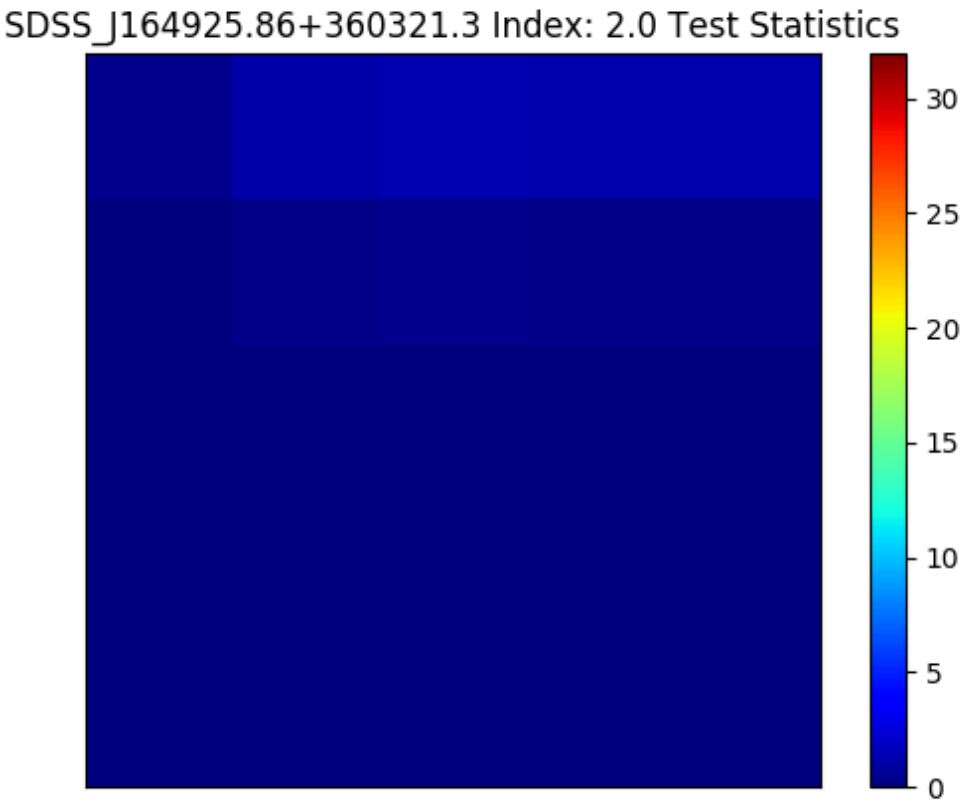
Preliminary plot.



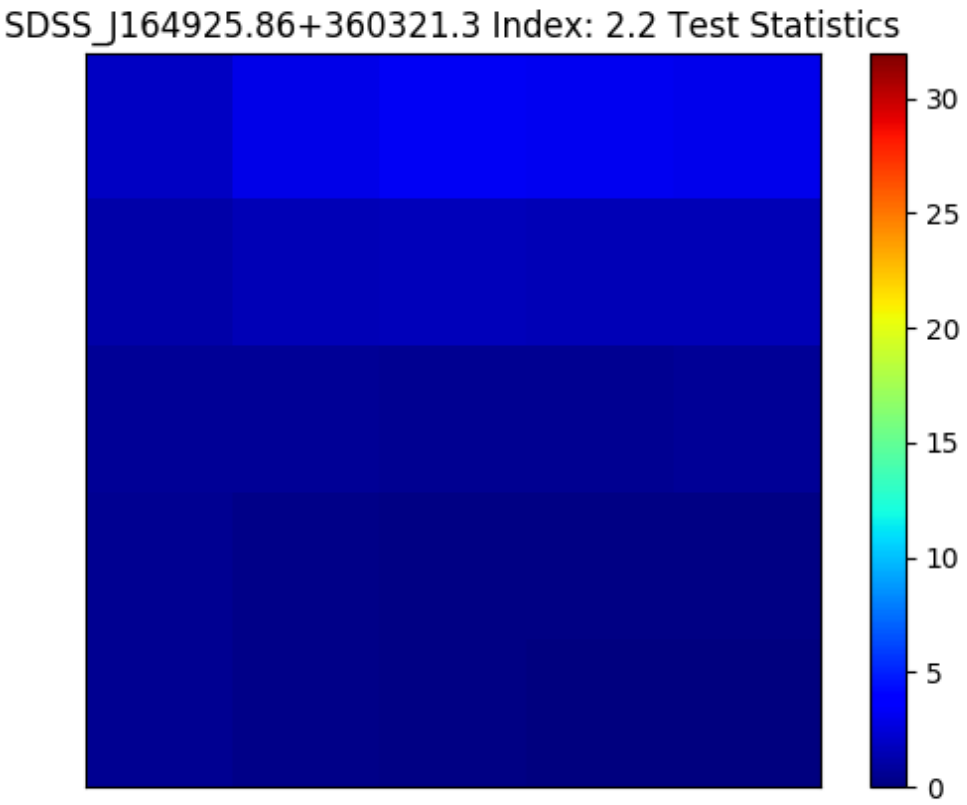
Preliminary plot.



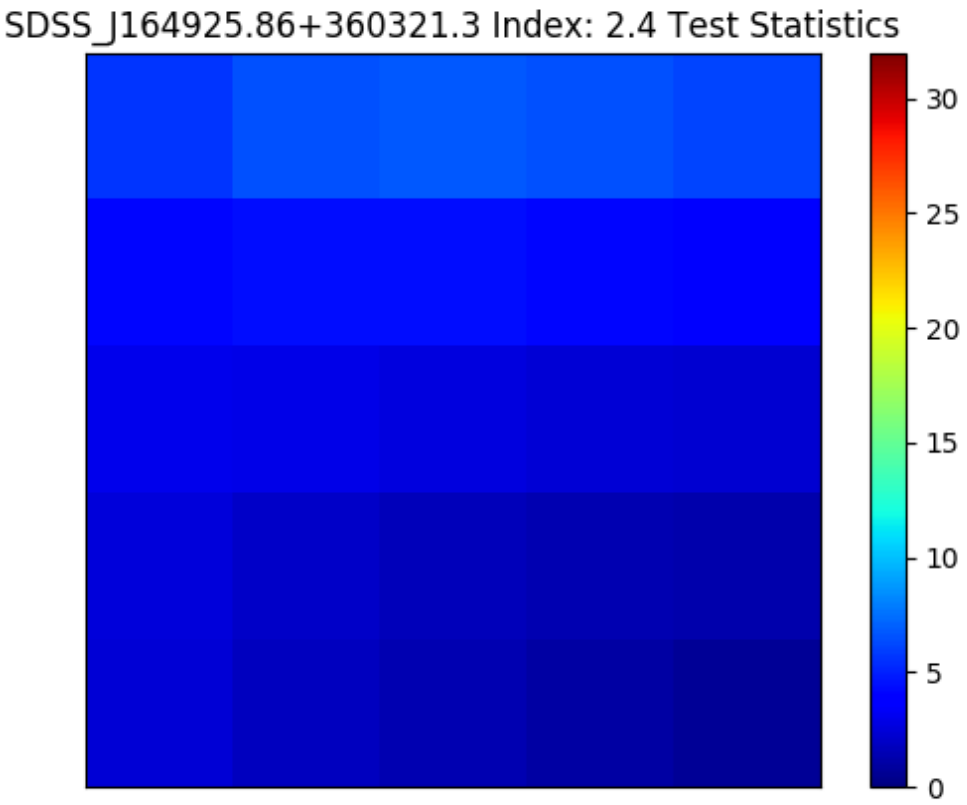
Preliminary plot.



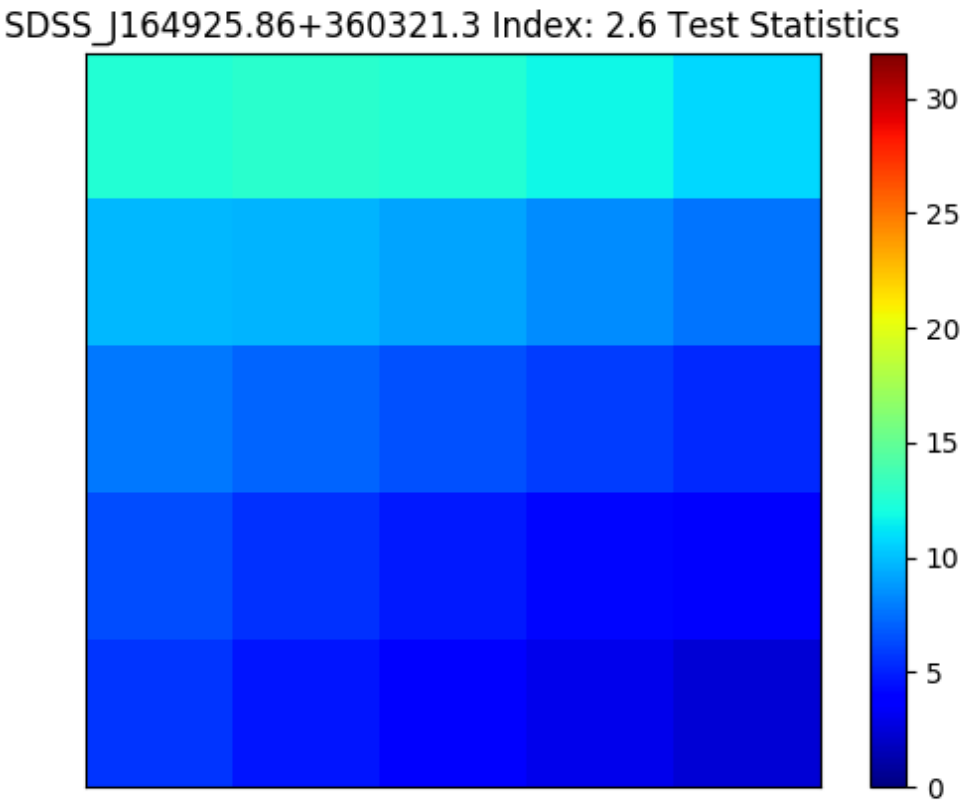
Preliminary plot.



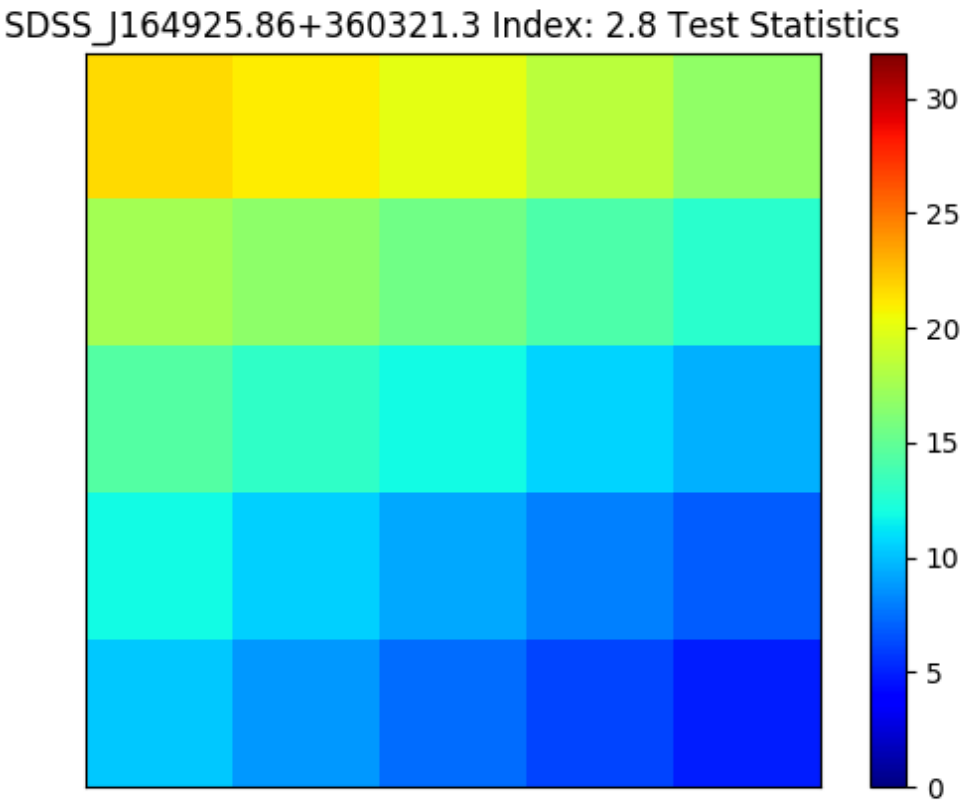
Preliminary plot.



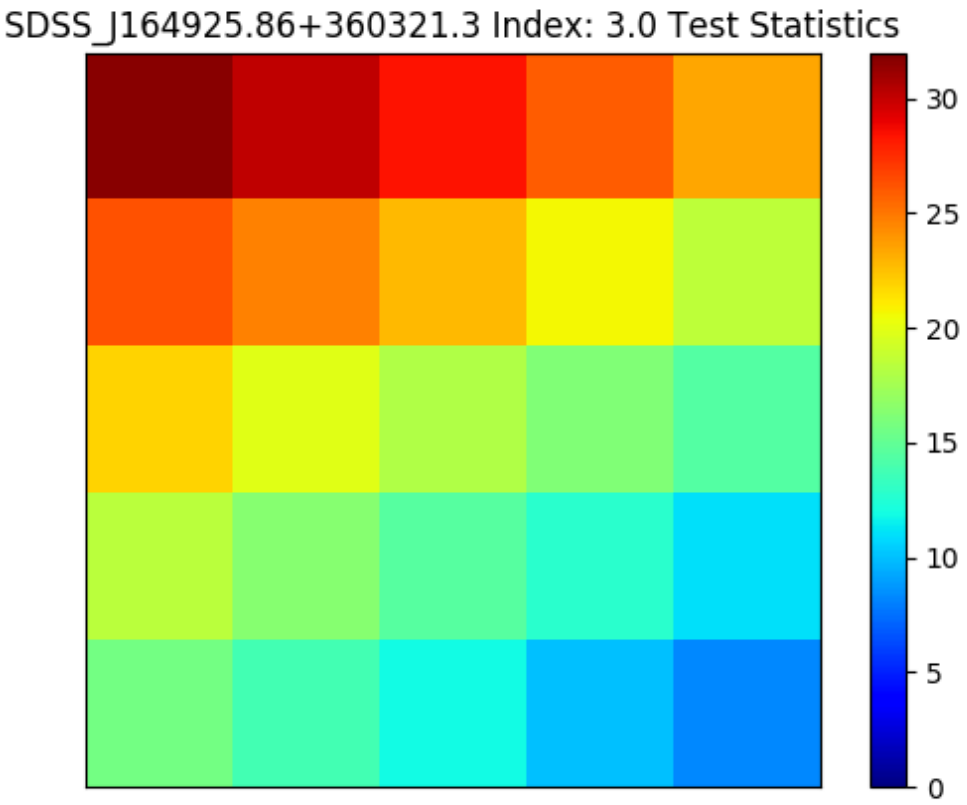
Preliminary plot.



Preliminary plot.

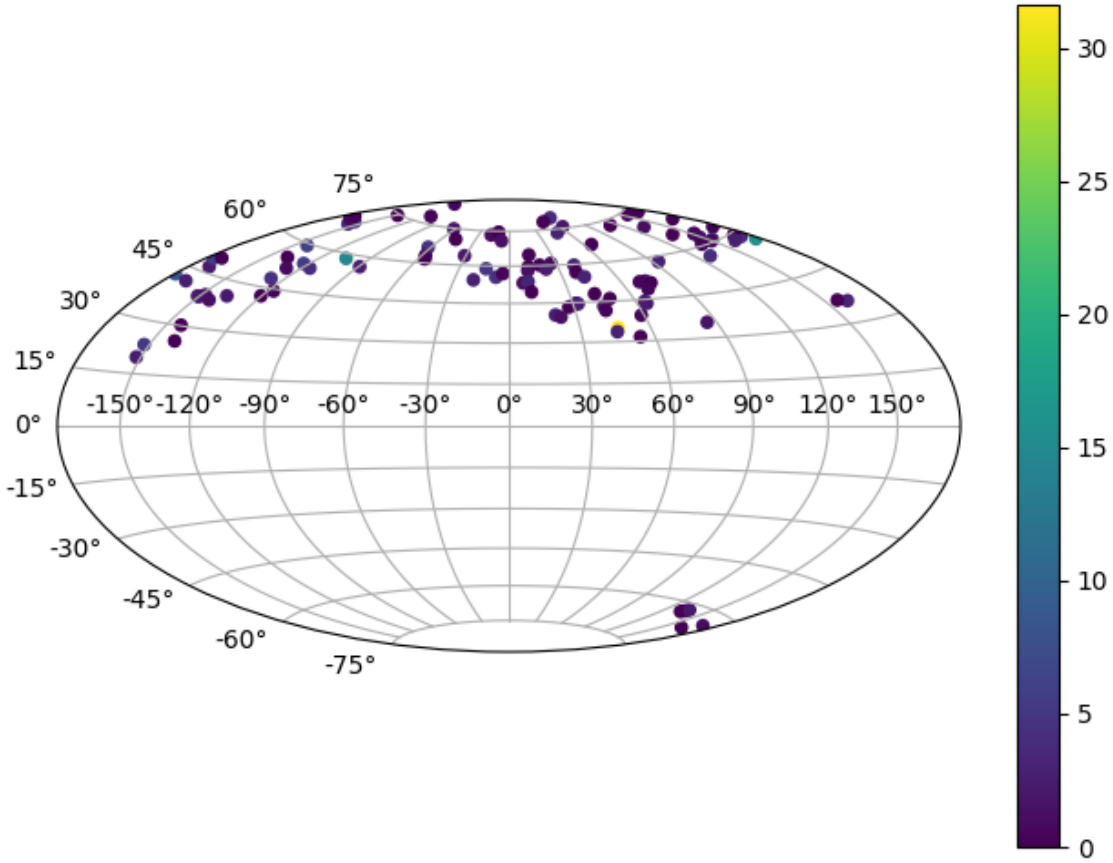


Preliminary plot.



# Test Statistics FR0 Map

Preliminary plot.




$$TS = -2log(\frac{L|\theta_0}{L|\theta_{ML}})$$

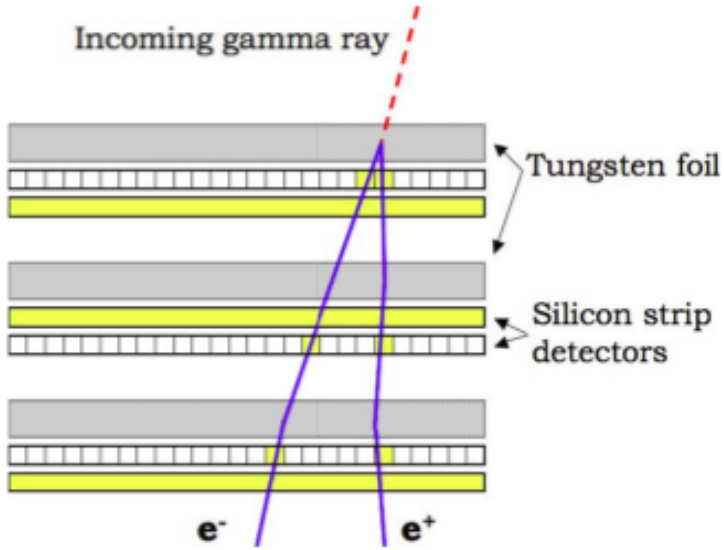
# Thank You

# Bibliography

[1] The Large Area Telescope on the Fermi Gamma-ray Space Telescope Mission, Atwood et al.,*arxiv.org/abs/*0902.1089
[2] Petroff et al., 2016. frbcat.org [3] Active Galaxies: Unified Model, Bradley M Peterson, Belinda J Wilkes,
*http* : *//www.astro.caltech.edu/ george/ay*21*/eaa/eaa* − *agnunif .pdf*
[4] *https* : *//fermi.gsfc.nasa.gov/cgi* − *bin/ssc/LAT/LATDataQuery.cgi*
[5] Josefa Becerra, *https* :
*//fermi.gsfc.nasa.gov/ssc/data/analysis/scitools/likelihood*$_t$*utorial.html*

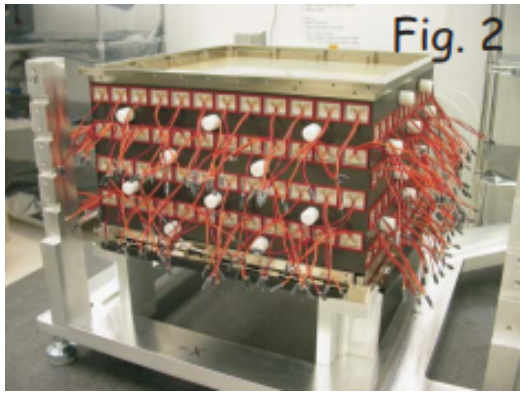
# Backup Slides

## Tracker



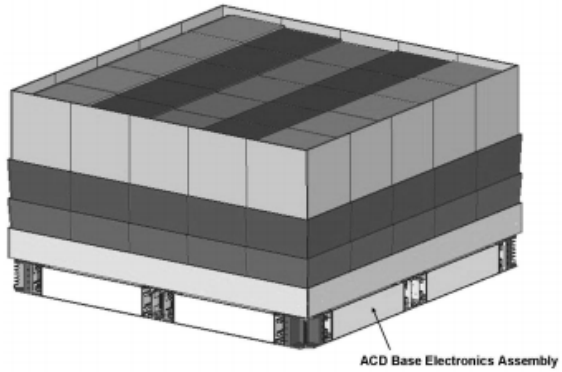

- FUNCTION: Detects direction of incident photon.
- COMPOSITION: Tungsten due to its high atomic number (74). Silicon microstrip detectors.

## Calorimeter




- FUNCTION: Photon's initial energy.
- COMPOSITION: Made of scintillators.

## Anticoincidences Detector




- FUNCTION: Filter cosmic rays.
- COMPOSITION: Also uses scintillators.