Exploring the 10-100MeV range with *Fermi*-LAT and GALPROP

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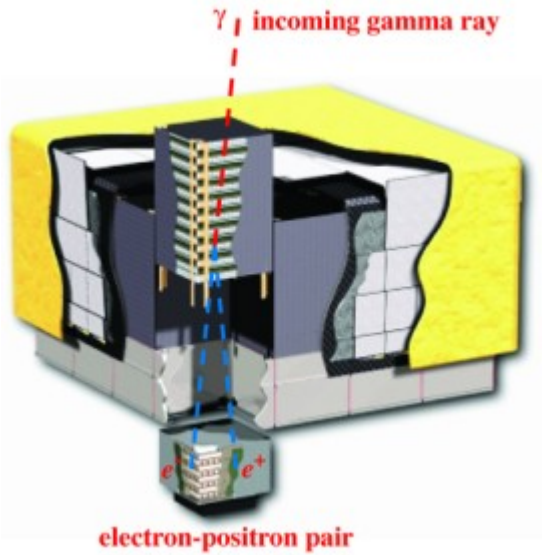
– The challenges of the 10-100 MeV band with Fermi-LAT –

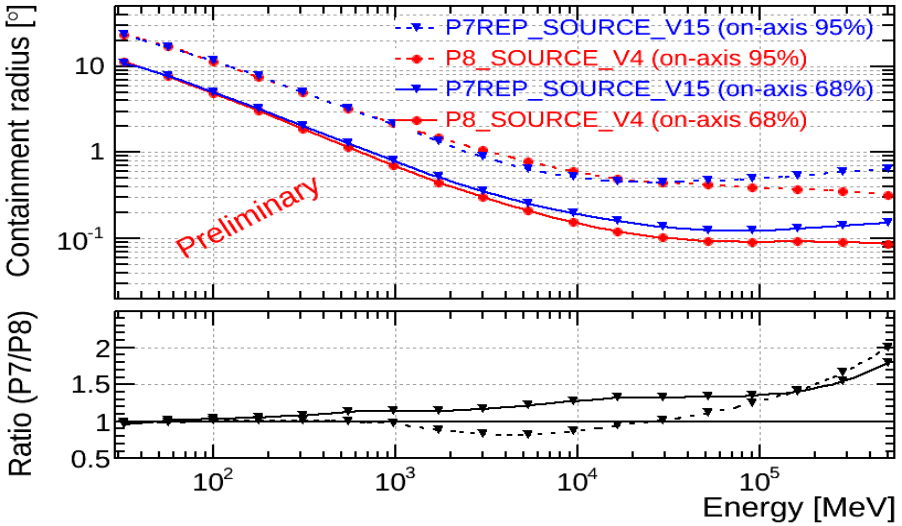
The Fermi-LAT instrument:

→ Pair conversion telescope
→ Launch in 2008
→ standard analysis start above 100 MeV



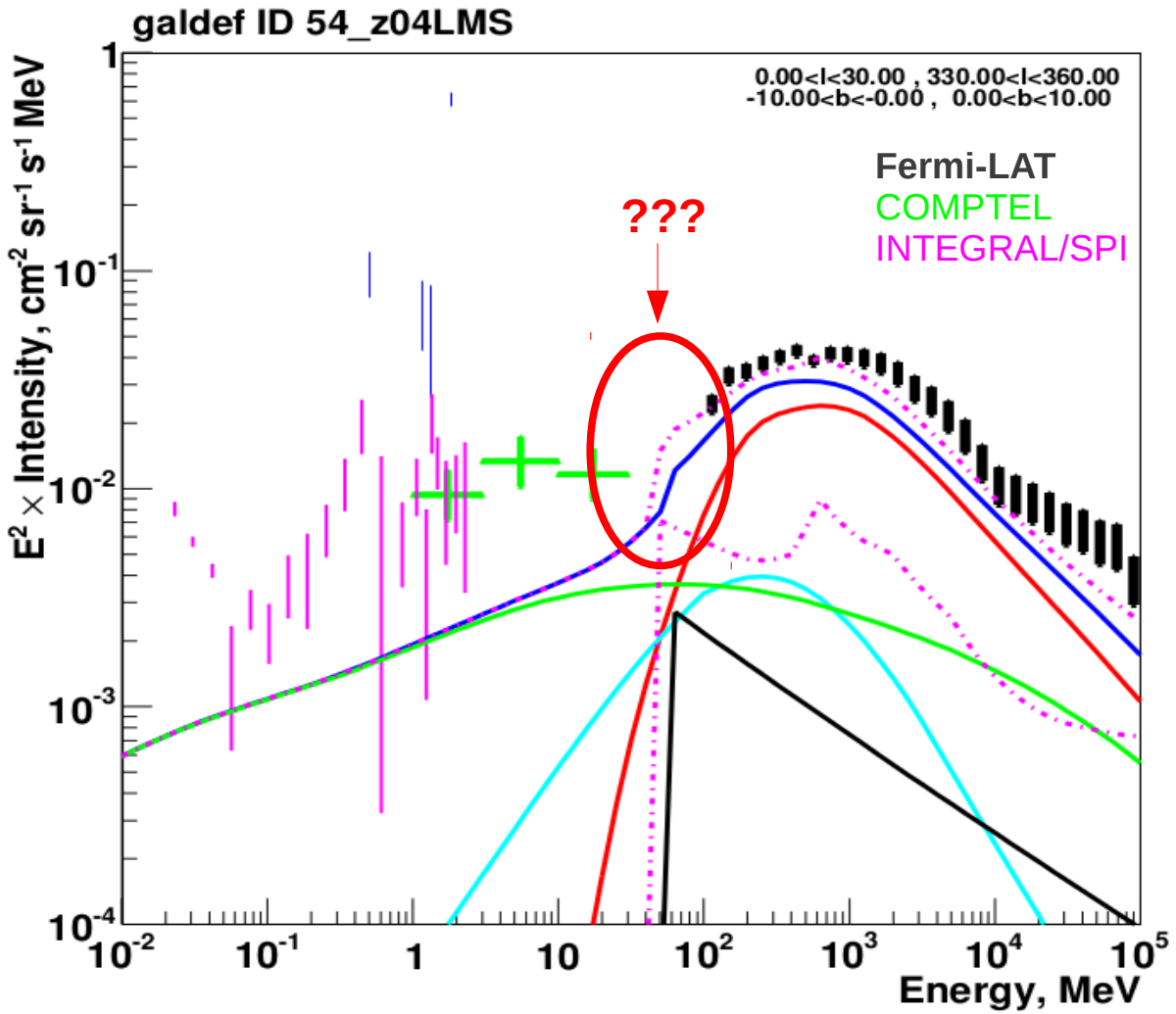
Main problems at low energy:

→ Electron scattering at low E => limit the PSF performances.
→ Tracks don't reach the calorimeter => limits energy resolution.
+ make Pass 7 track reconstruction easier



PSF 68% and 95% containments.
One can clearly see a strong increase as we go down in energy.

Because of these low energy problems the 10-100 MeV range is not study yet.

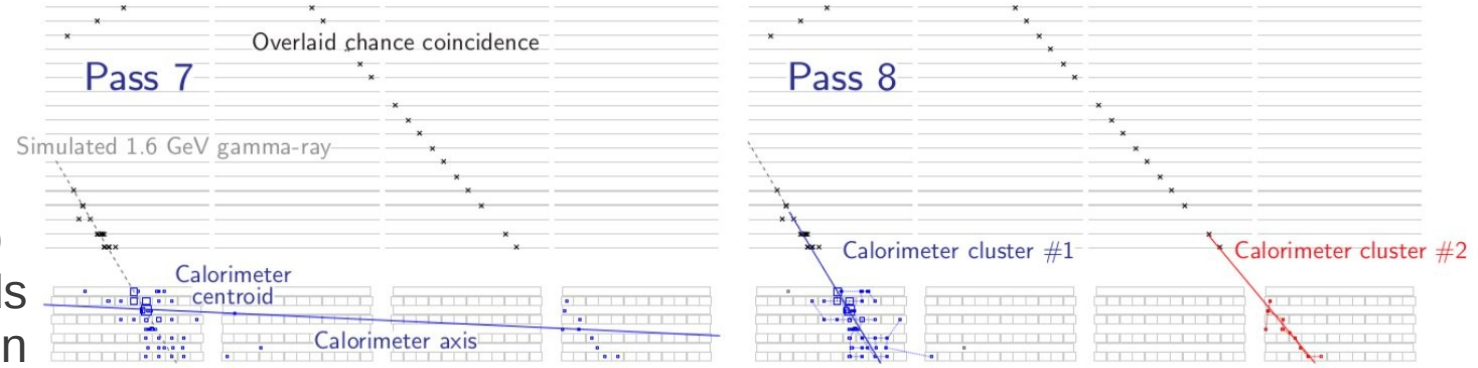


Spectrum of inner Galaxy
(330° < l < 30° , |b| < 10°)
A.Strong
arXiv:1101.1381v1[astro-ph.HE] 7 Jan 2007

– The reasons to think we can do something there –

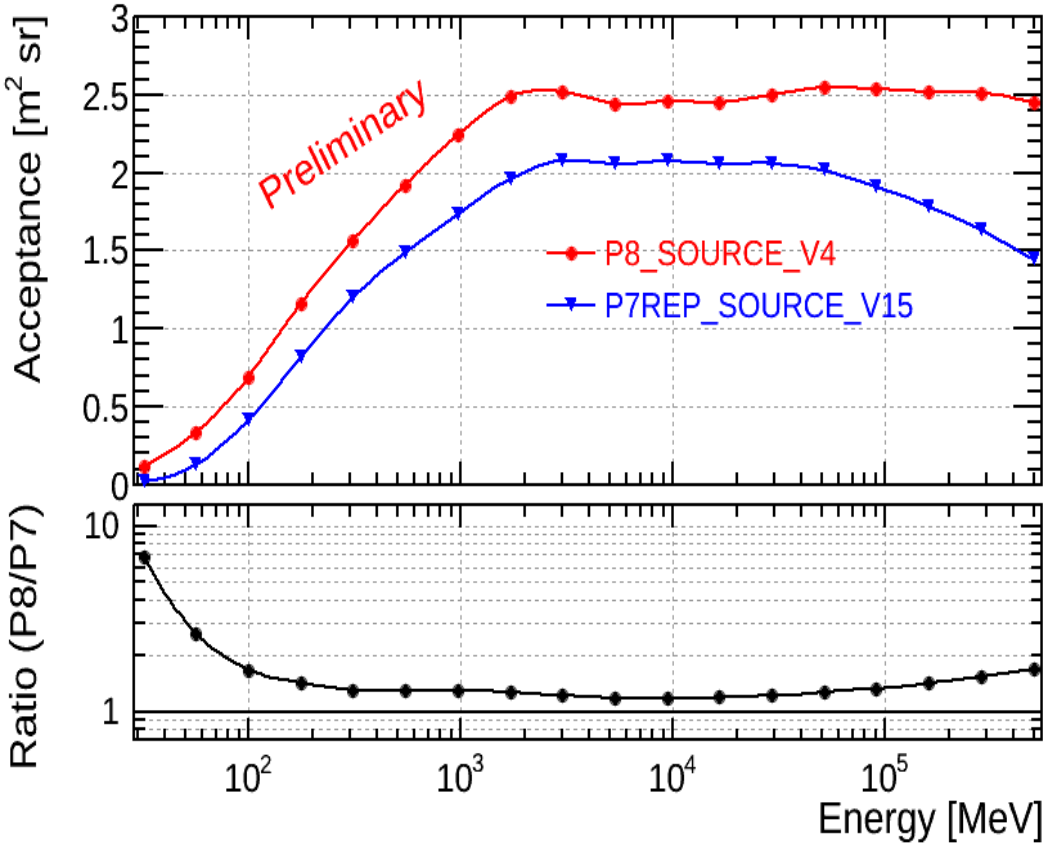
Pass 8:

→ New event reco
→ Doesn't depends on CAL direction

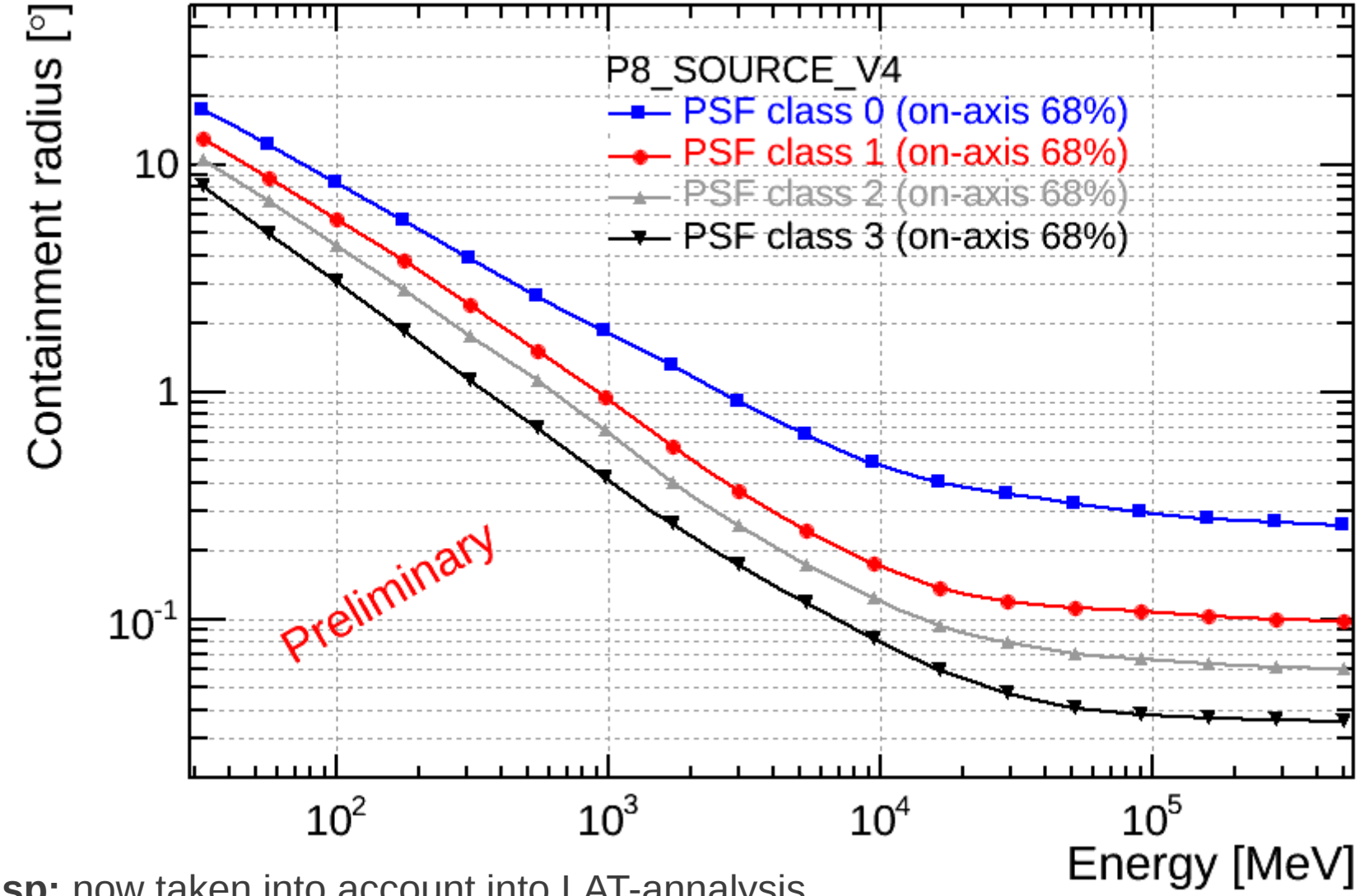


As a consequence
Strong increase of effective area at low energy
(3-5 times bigger)

We now have more events at low energy to work with



Pass 8: Also comes with new event types that optimize PSF or edisp (here is an example for psf types)

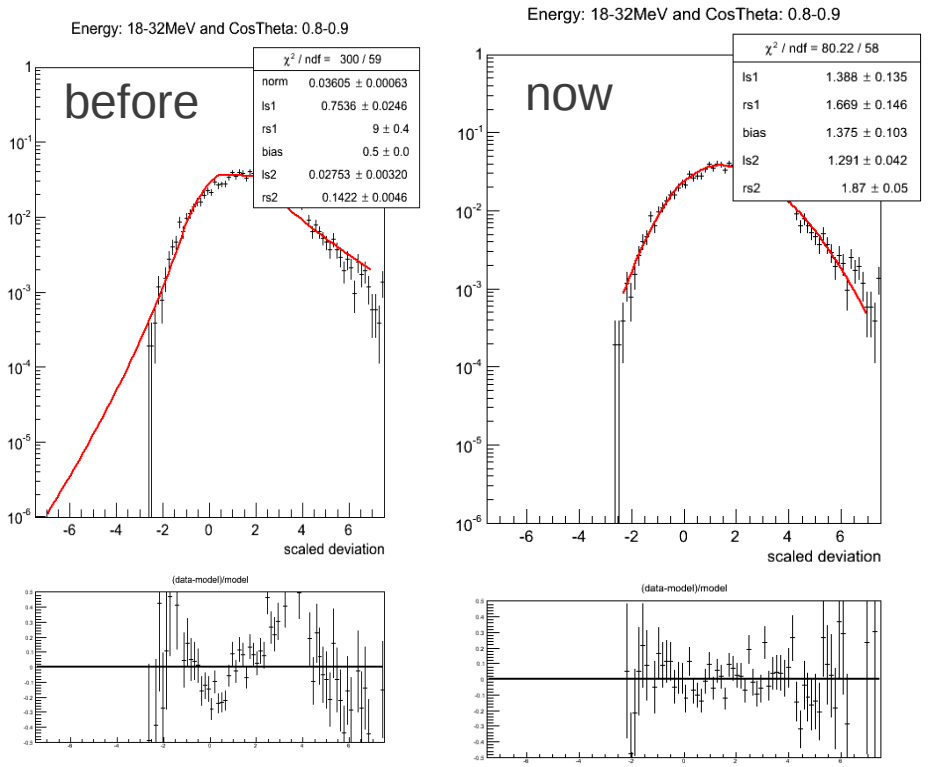


Edisp: now taken into account into LAT-annalysis

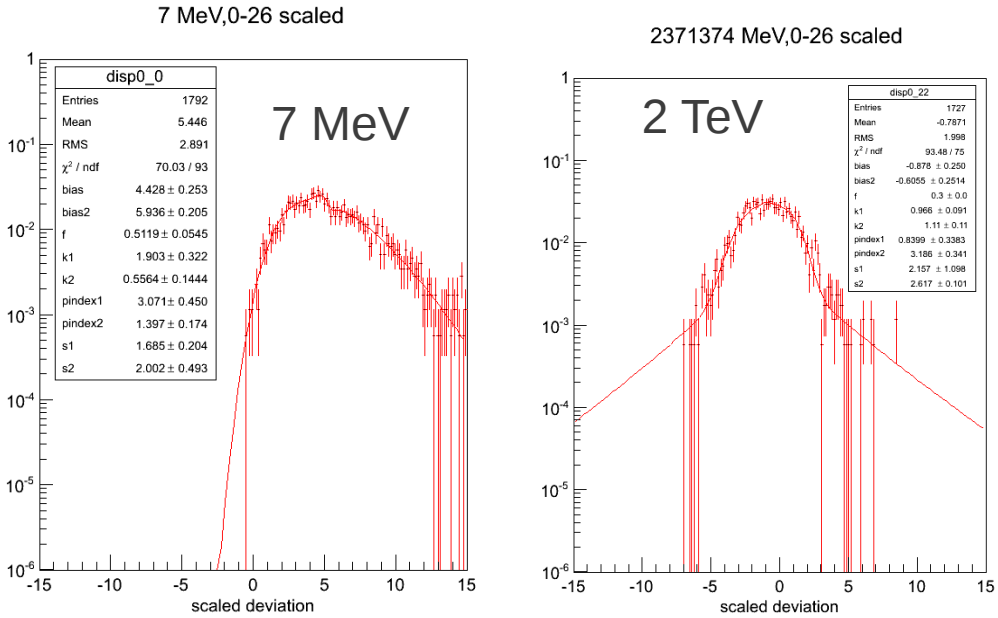
The new edisp parametrization

- Need new energy dispersion parametrization for Pass 8.
- The new parametrization I developed was approved by the collaboration.
- It was implemented in the Science-Tools
- It is used in the latest IRFs (P8V5)

The new parametrization provided a better fit of the energy dispersion distribution (generated from MC) at low (E < ~100 MeV) and high (E > ~100 GeV) energies.



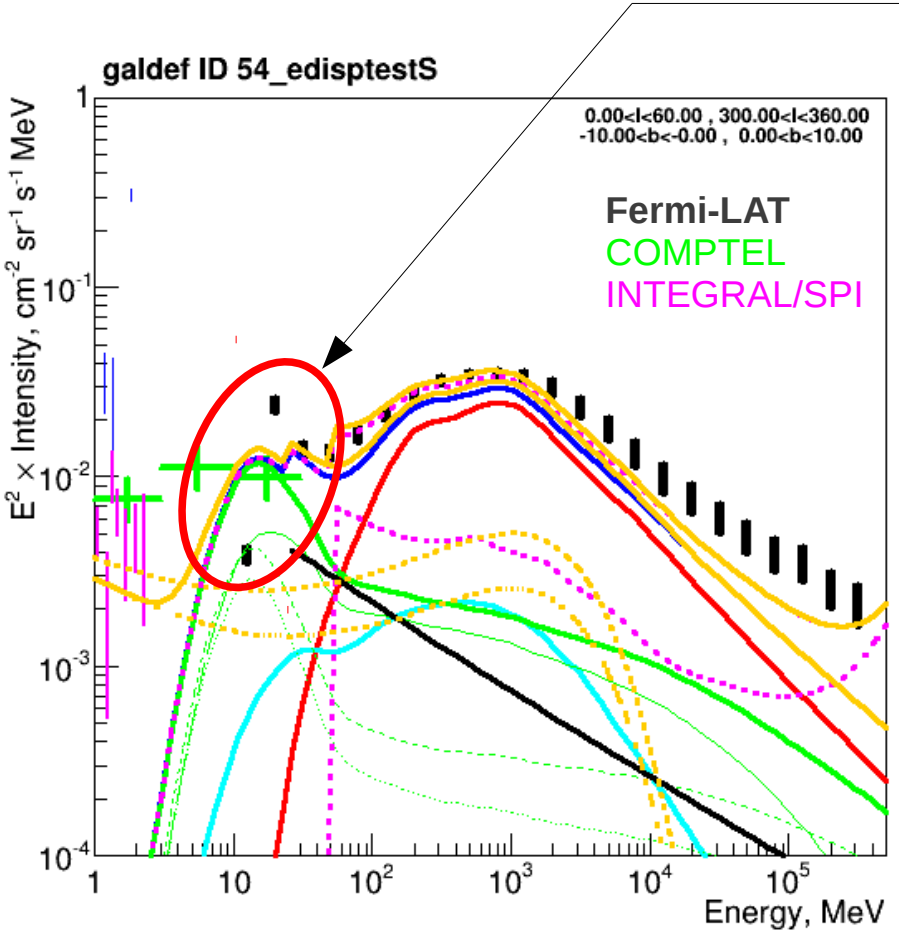
Parametrization now able to go from 7MeV to 2TeV



Implementing the new edisp in GALPOT

- GALPLOT is a tool that convolve and fit data to GALPROP models
- Andrew Strong and I implemented the new edisp in the code.

First results:



Current problem:
At very low energy strange behavior
Certainely due to LAT effective area not taken into account in edisp correction

The code disperse photon that the LAT would not able to detect.

Need to correct this

In the mean time we can use other tools with edisp properly taken into account:

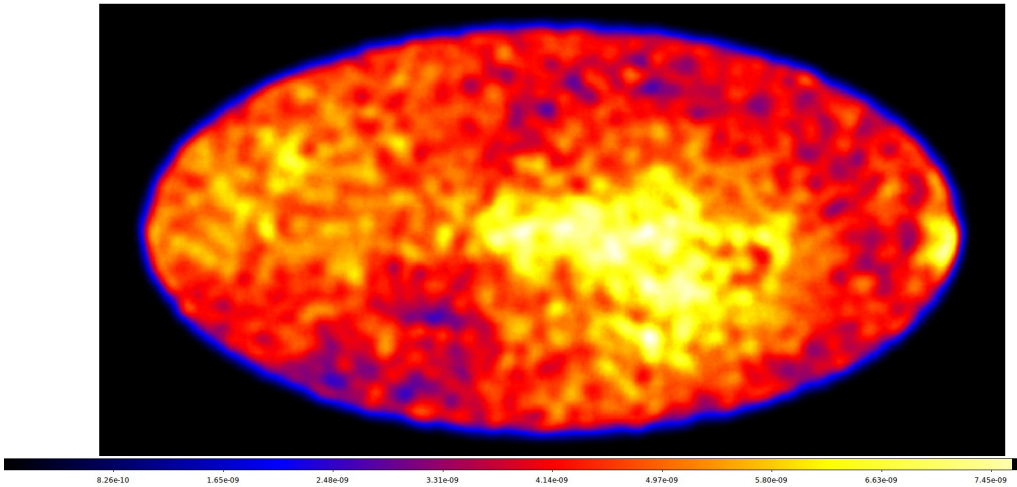
- **GaRDiAn**
- **Pylikelihood**

– First analysis –

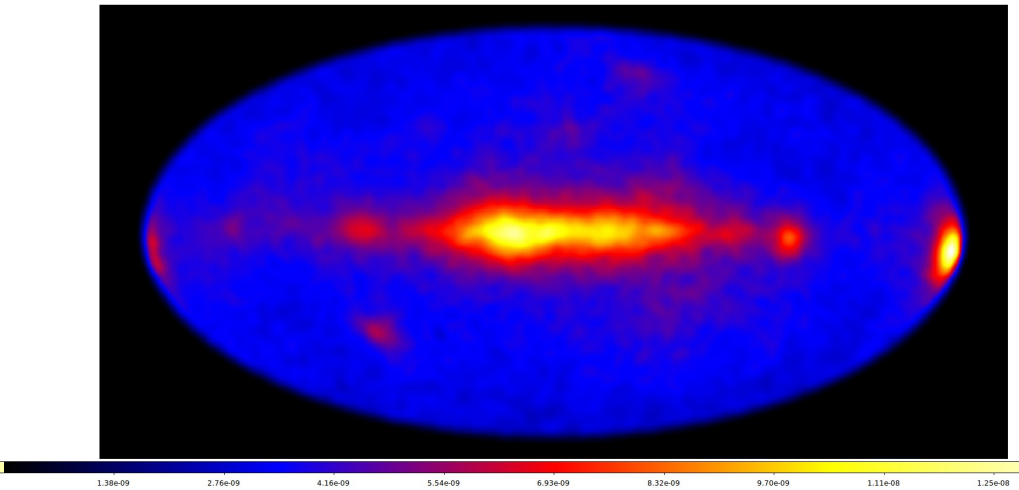
Low energy sky see by *Fermi*-LAT:

5 years of SOURCE::PSF3 (best psf) data with zmax=70 cut (remove earthlimb)
Maps are **counts/exposure** smoothed to 1/3 of psf 68% containment.

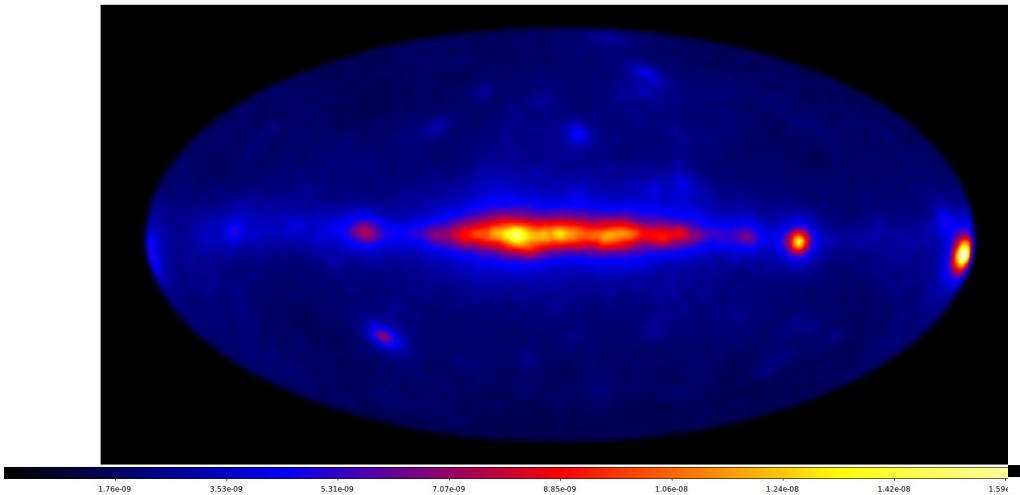
10-18 MeV



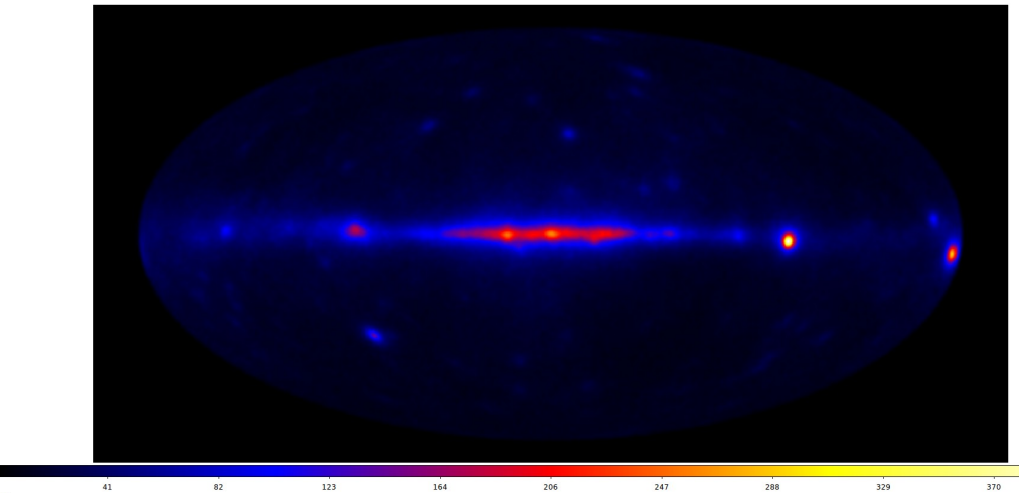
18-32 MeV



32-56 MeV

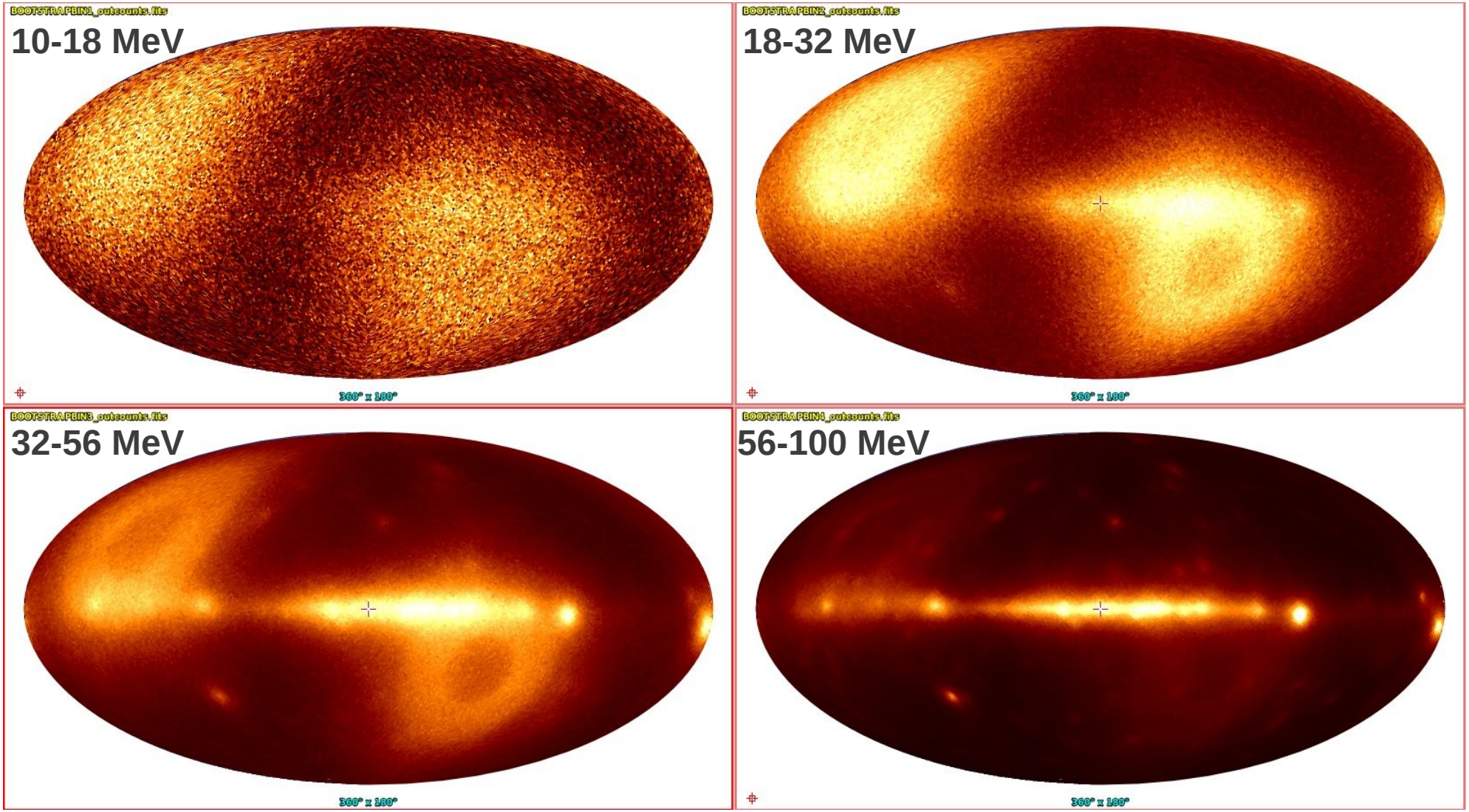


56-100 MeV



Low energy sky see by *Fermi*-LAT:

Counts maps : 5 years of Pass 8 SOURCE zmax=100, no smoothing



GaRDiAn analysis:

- GaRDiAn allows **full sky** annalysis (healpix framework)
  → good for low energy where psf is high.

- Model extended to low energy (down to 10 MeV)
  → basic (rescale lowest template available),
  need norm to be refit in each bins.
  → model for: galactic diffuse, earth limb, extagalactic.
  → sources modeled via a fixed index -2 PL (norm fitted in each bins)
  → All 3FGL fitted this way (100 sources at a time)
  → energy dispersion correction turned ON

- Get SED down to 10 MeV for: Vela, Crab and 3C454.3

Pylikelihood analysis:

- Work on 10 deg radius ROI (bin size 0.2 deg) all source in 20 deg fixed in the model.

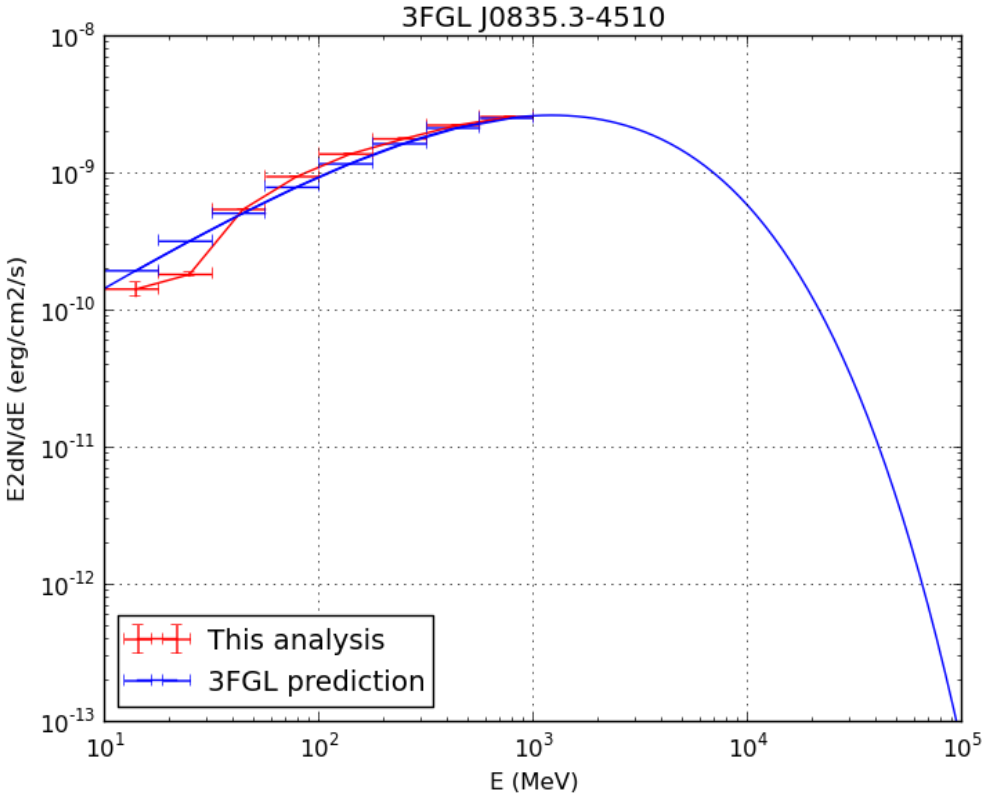
- Similar model and method that with GaRDiAn

- Compare GaRDiAn / Pylikelyhood.

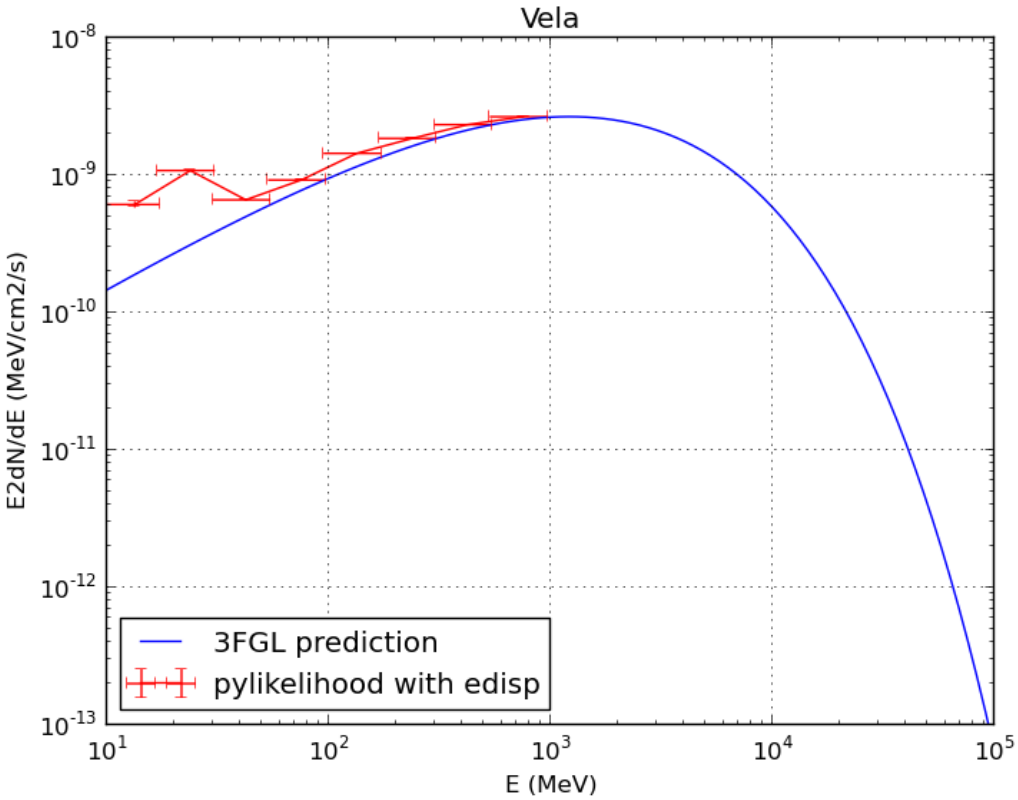
Results:

Vela

GaRDiAn



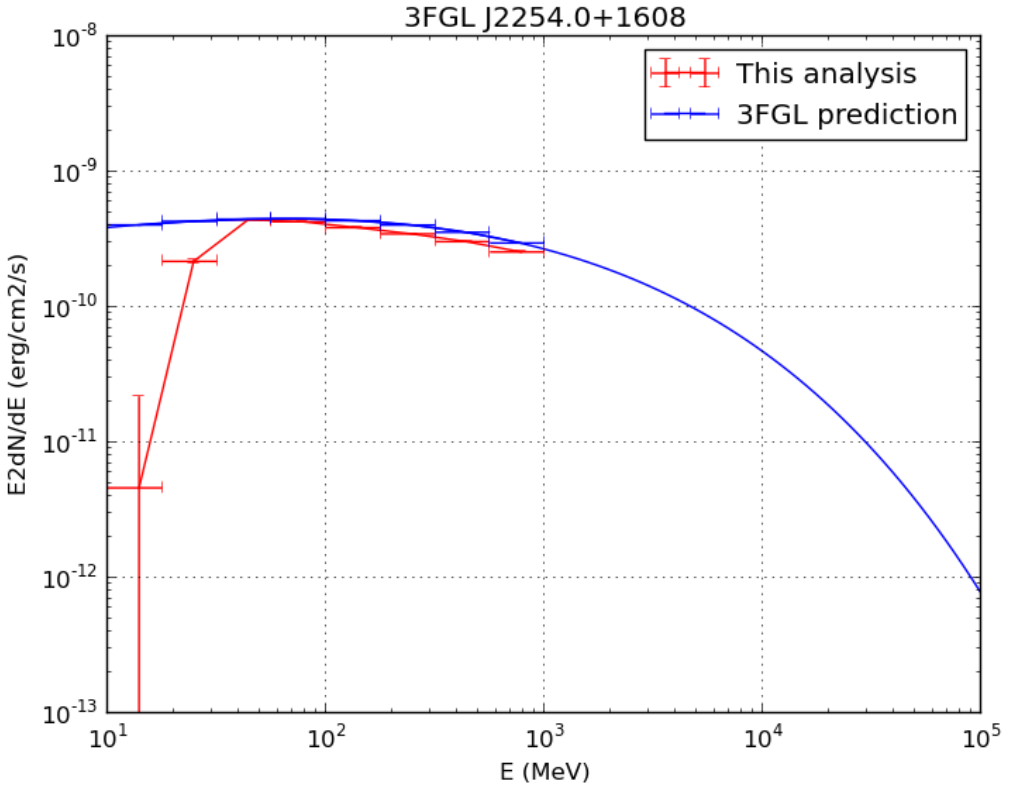
Pylikelihood



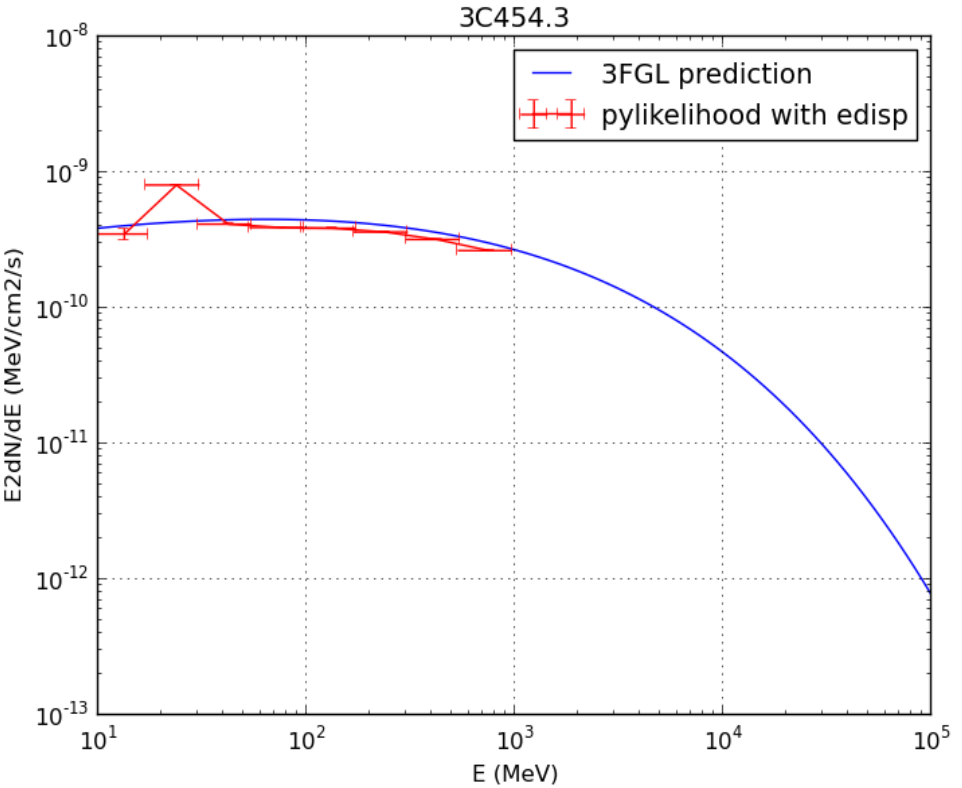
Results:

3C454.3

GaRDiAn



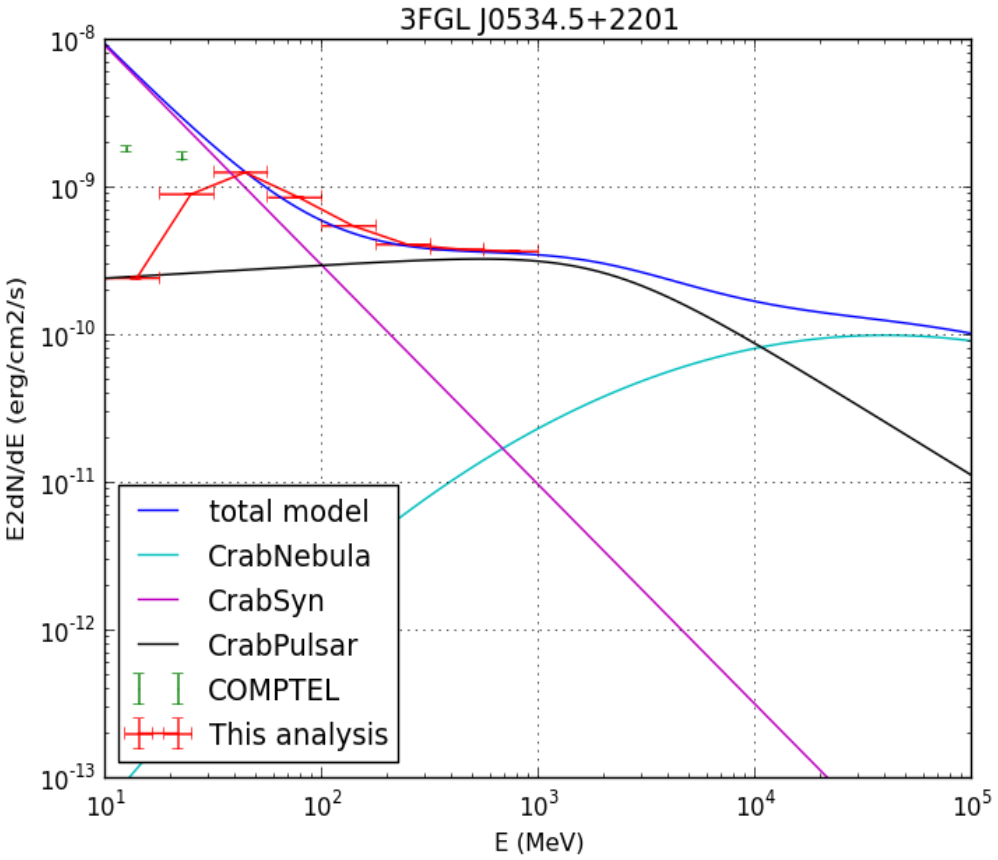
Pylikelihood



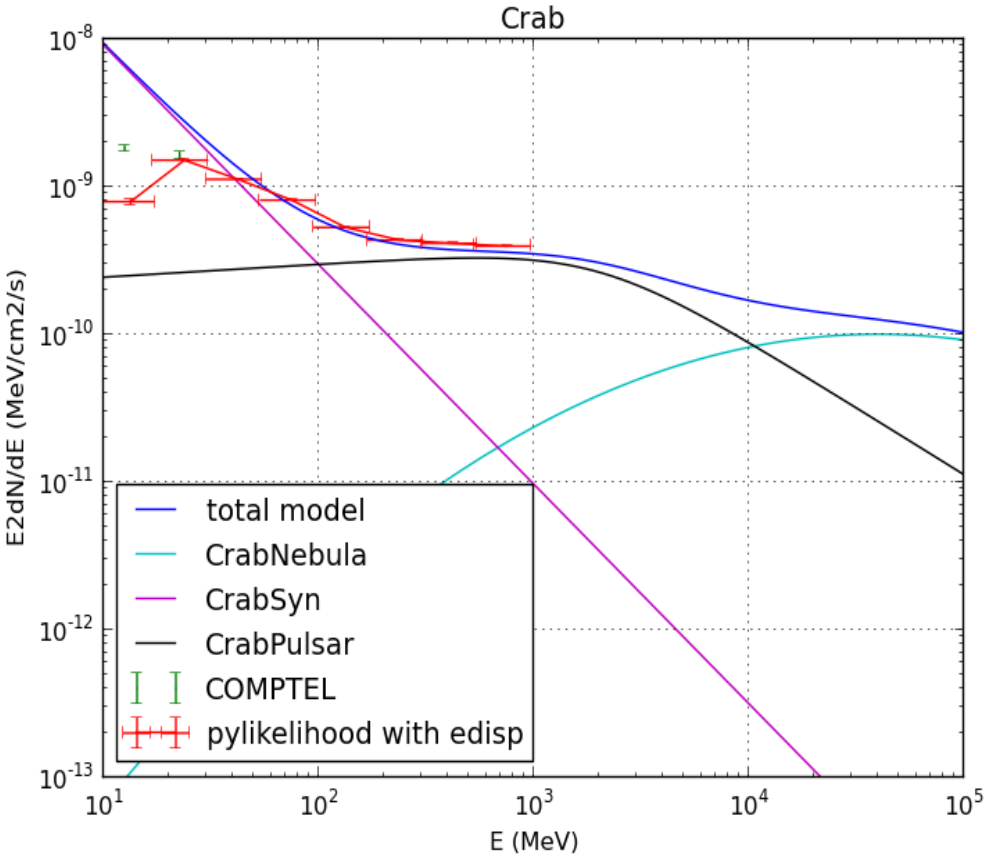
Results:

Crab

GaRDiAn



Pylikelihood



– Conclusions –

Fermi data analysis below 100 MeV is not straightforward.

→ Bad PSF / edisp

→ No official Fermi model (below 58 MeV)

But, there are reasons to hope:

→ Pass 8 (more aeff at low E, new event classes with improved PSF)

→ Edisp taken into account in STs

→ New edisp parametrisation

First studies shows interesting results:

→ Method allows agreements with 3FGL prediction down to ~30 MeV

→ GaRDiAn and Pylikelihood give similar results down to ~30 MeV

Still some work to do:

→ Need to understand what happens below 30 MeV (gtobssim study)

→ Try with physical models down to 10 MeV

→ What are the systematics down there ?

→ Finish technical work on GALPLOT.