



Fermi

Gamma-ray Space Telescope

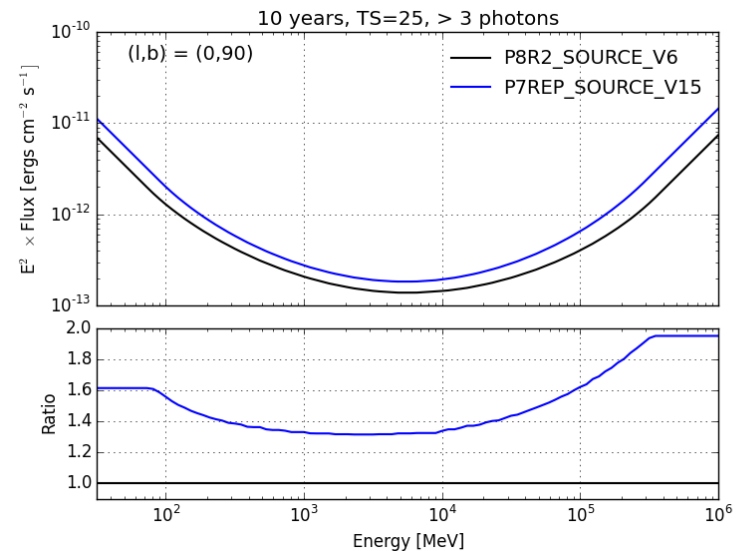
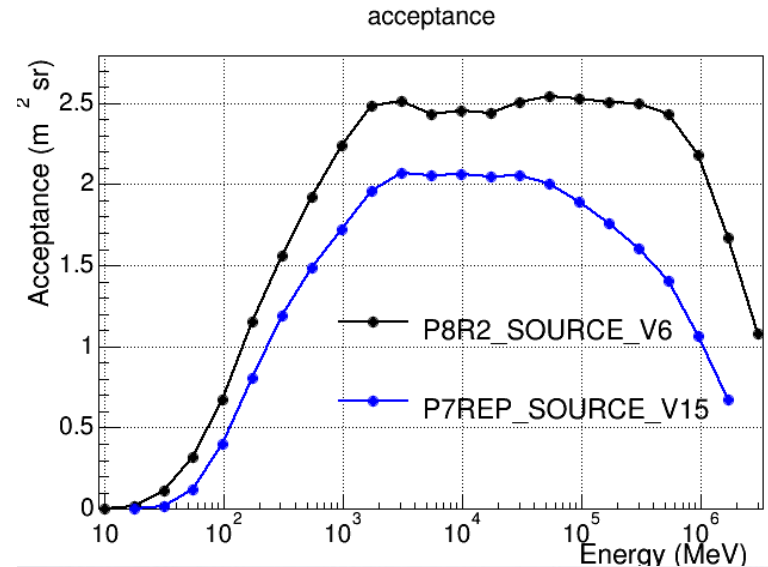


## Improving the Scientific Potential of Pass 8: Status and Plans for a future Pass 8 Release

Matthew Wood  
on behalf of the Fermi-LAT  
Collaboration

6<sup>th</sup> Fermi Symposium  
November 13<sup>th</sup>, 2015

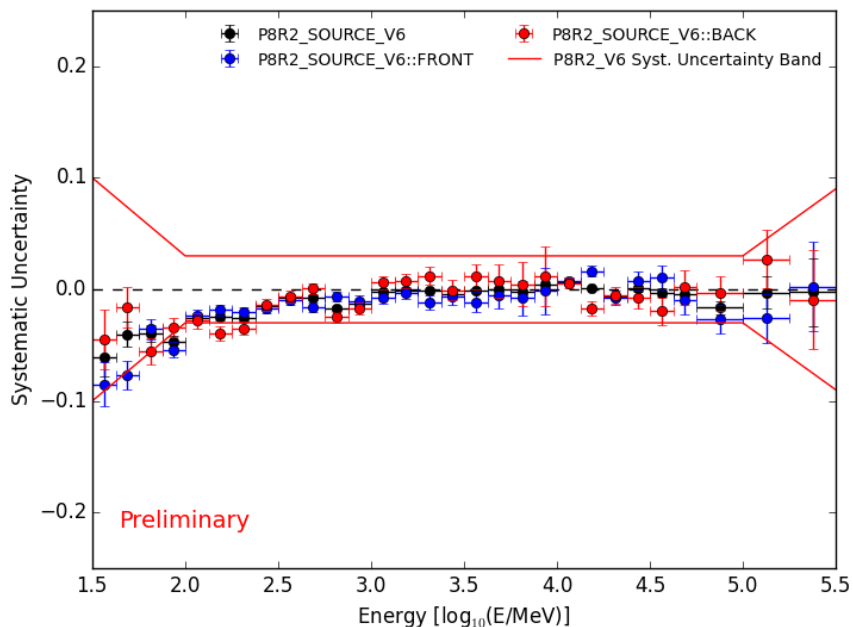
- The first Pass 8 release provided a substantial improvement in the capabilities of the LAT
  - 40% increase in point-source sensitivity
  - Up to 2x gain in acceptance at very low ( $< 100$  MeV) and very high ( $> 100$  GeV) energies
- Upcoming data and software releases will build on the performance gains of Pass 8
  - In-flight IRFs
  - Cal-Only Event Class
  - New Science Tools Features
  - Improved models for residual Earth Limb contamination, CR background, and Galactic Diffuse emission



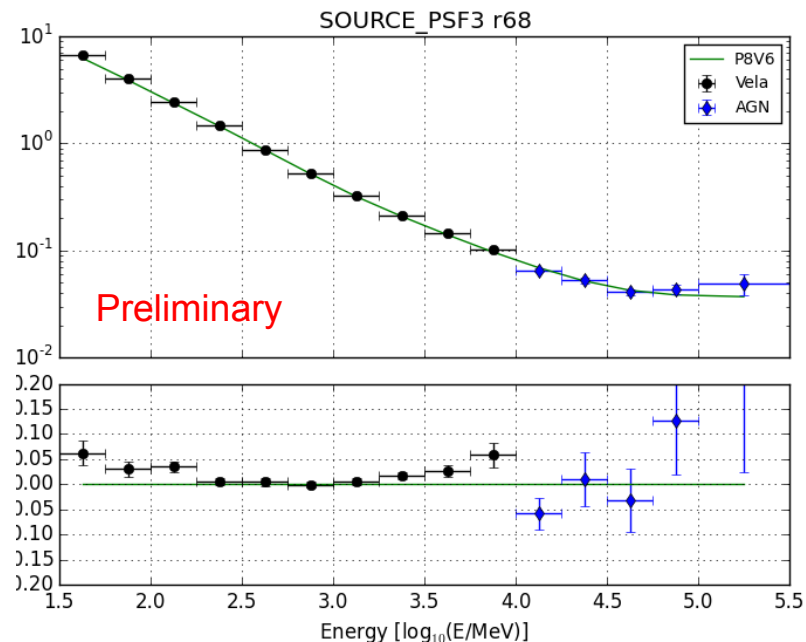
# Pass 8 IRF Systematics

- Improvements to the accuracy of Pass 8 instrument simulation have reduced systematic uncertainties in the IRFs with respect to P7REP
  - Effective area systematics for FRONT/BACK are  $< 3\%$  when enabling correction for energy dispersion (100 MeV – 100 GeV)
  - Systematics in the PSF are  $< 5\%$  (100 MeV – 100 GeV; all event types) with no discrepancy at high energies

## SOURCE FRONT/BACK Effective Area

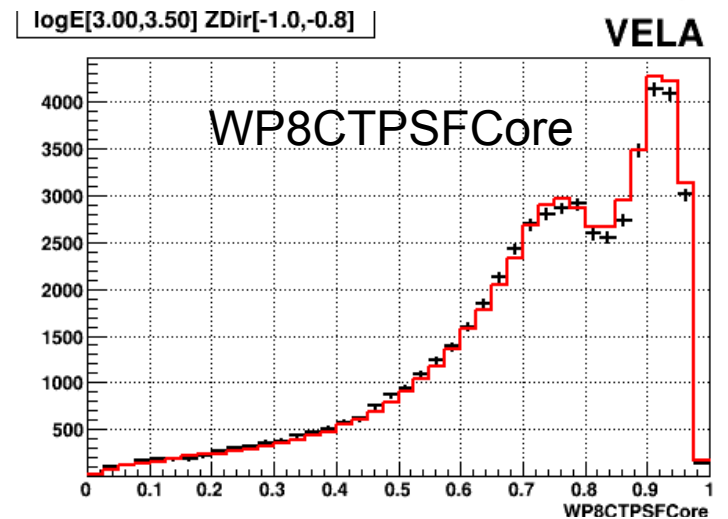
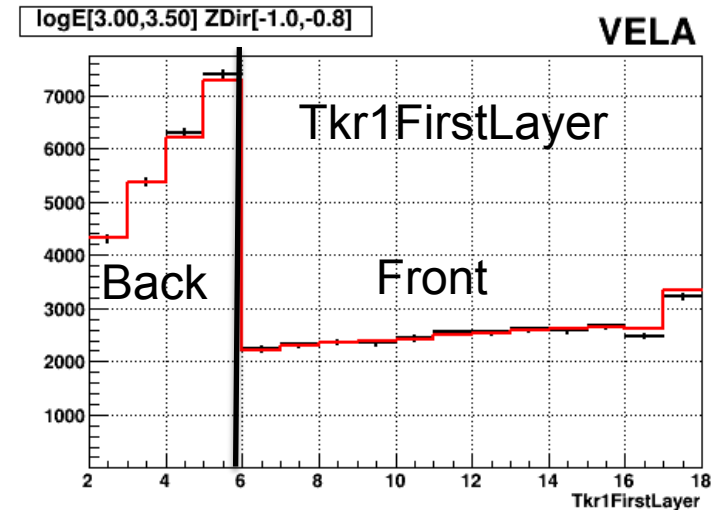
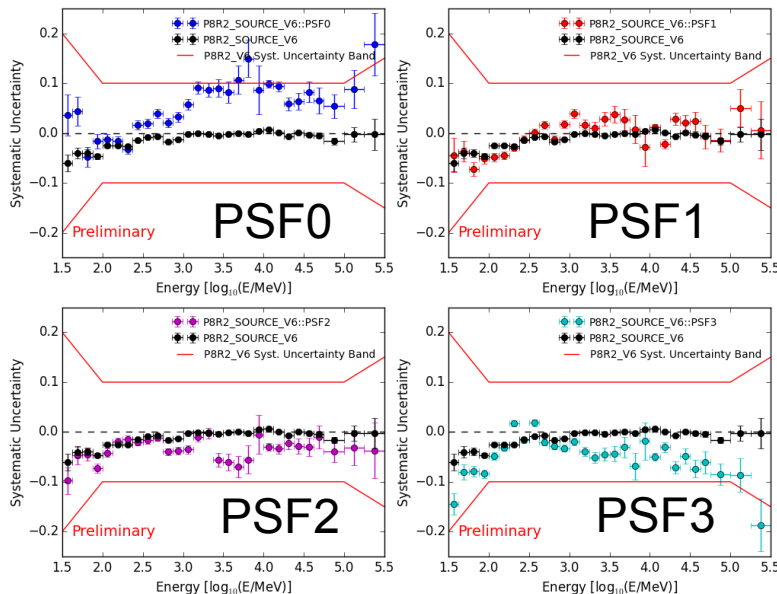


## P8R2\_SOURCE::PSF3



# Pass 8 IRF Systematics: PSF/EDISP Types

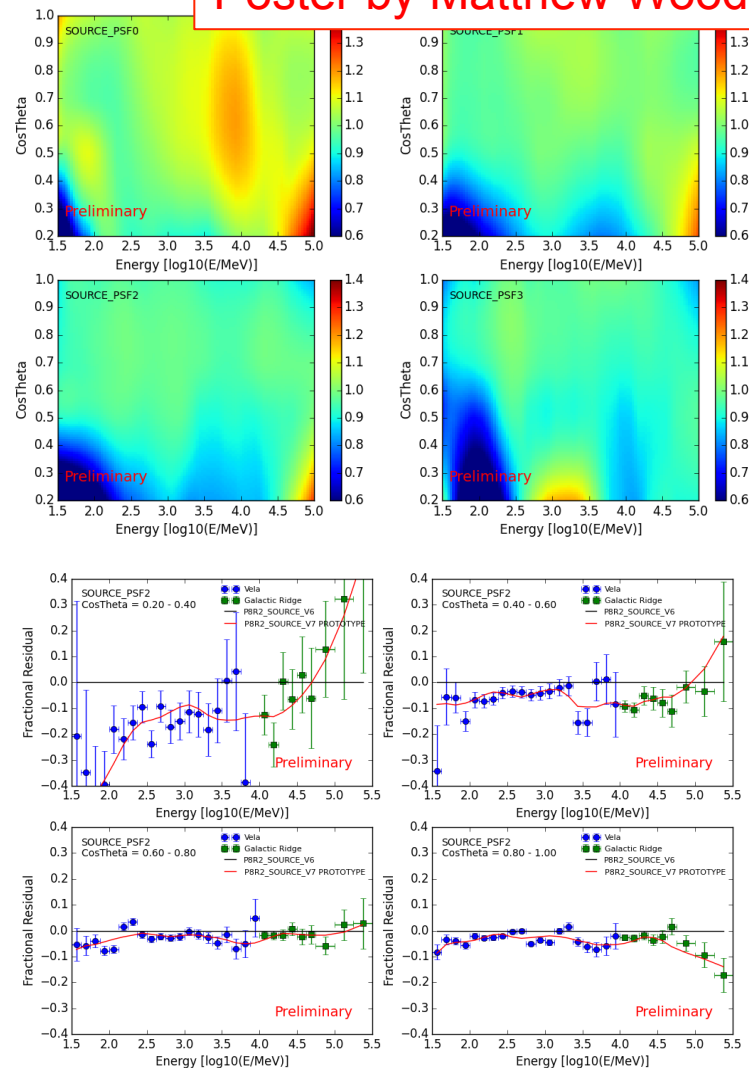
- PSF and EDISP selections depend on CT variables that have poorer Data/MC agreement than the first conversion layer (used for FRONT/BACK selection)
- This is responsible for 5-10% systematic errors in the efficiency of each type with respect to the full class selection



# In-Flight IRFs for Pass 8

- Next Pass 8 IRF release (P8R2\_V7) will include in-flight corrections that will address the inconsistencies in the PSF/EDISP event type effective areas
- Correction is applied to the MC-based effective area (P8R2\_V6) as a function of energy and incidence angle
- In-flight corrections will reduce systematic uncertainties for analyses using a single PSF or EDISP event type

Poster by Matthew Wood

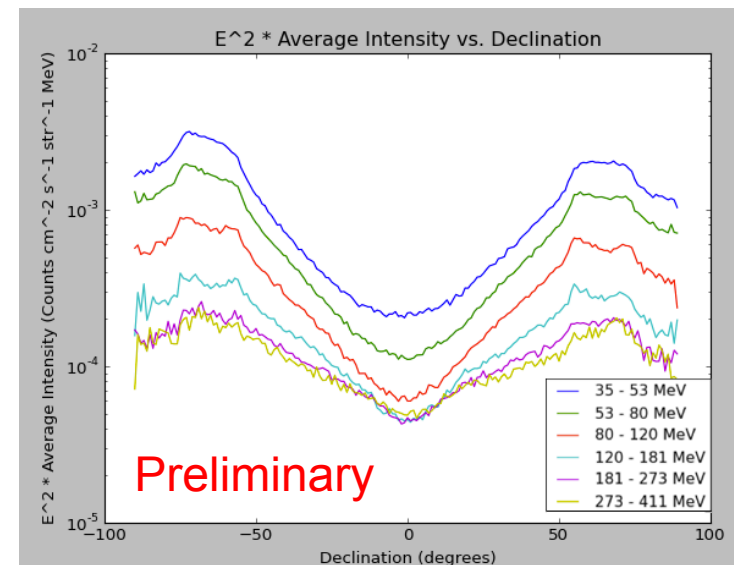
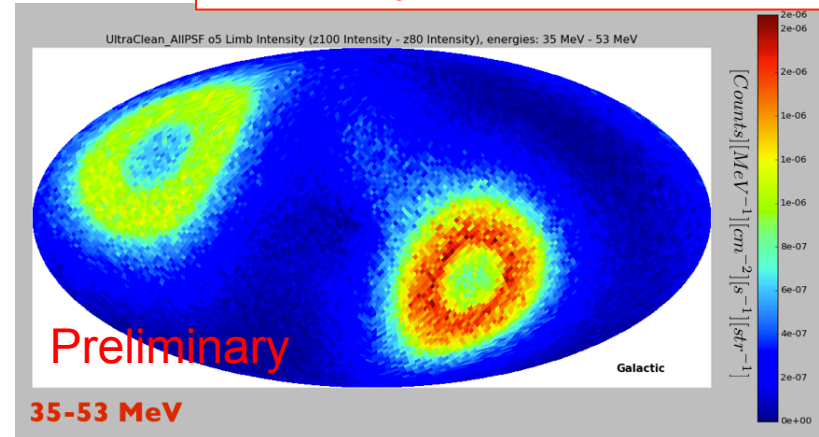




# Modeling the Earth Limb

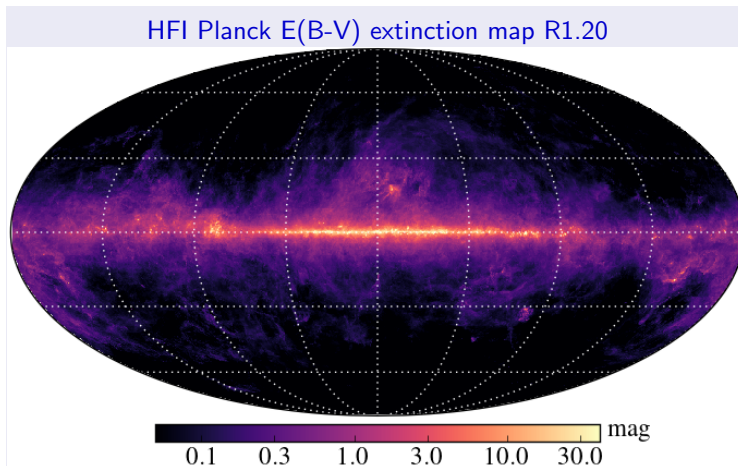
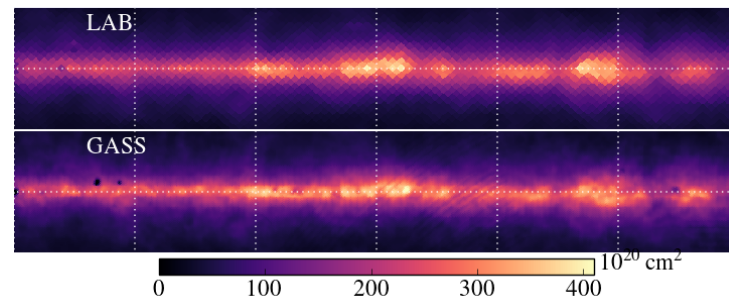
Poster by Elliott Bloom et al.

- Residual Earth Limb contamination is a major challenge for analyses using data below 100 MeV
- A model for the residual Earth Limb is needed to fully take advantage of the improvement in Pass 8 acceptance below 100 MeV
- A Limb tool is currently in development
  - ST application that builds an Earth Limb template for a given time selection and zmax cut
  - Input is a Phenomenological Earth Limb model derived in Earth-centered coordinates



## Pass 8 Galactic Diffuse Model

- Current Pass 8 Galactic IEM (gll\_iem\_v06) is based on the P7REP model with a small energy-dependent correction to account for differences in energy dispersion in P7REP and Pass 8
- A new Galactic IEM based entirely on Pass 8 data is currently under development
  - New surveys (Planck) and higher resolution gas maps
  - Inclusion of energy dispersion effect at fit level
  - Extension of the model to lower and higher energies ( $\sim 30$  MeV and  $\sim 1$  TeV)



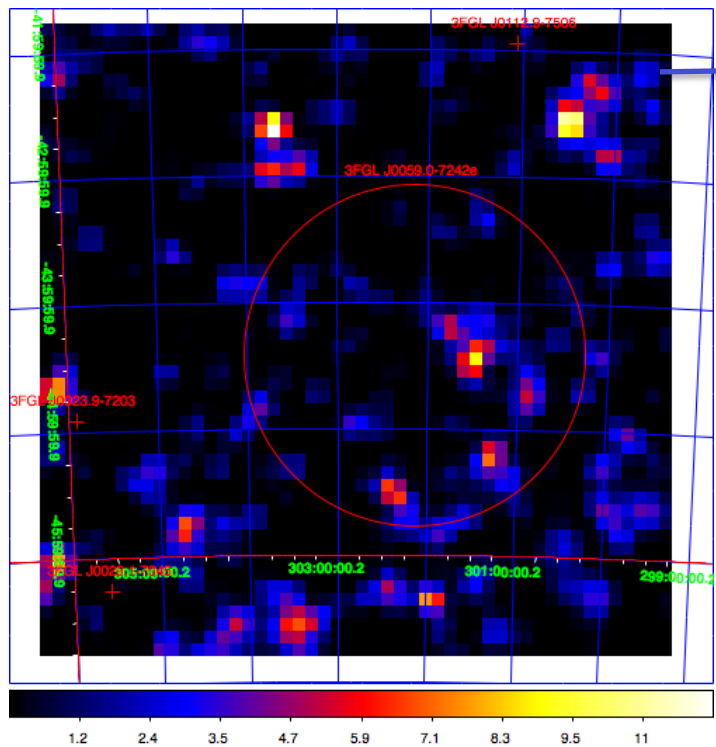
See Talk by Gulli Johannesson

# New ST Features: Test Statistic Cube (gttscube)

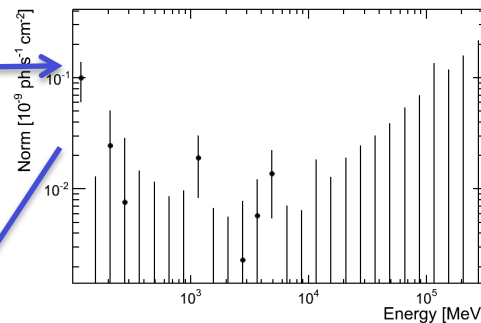
See Talk by Eric Charles

- **gttscube** will be a new ST application that enables fast computation of TS maps ( $\sim 100x$  faster than gttsmap)
- Also stores at every location a likelihood profile vs. flux at each energy (the cube)

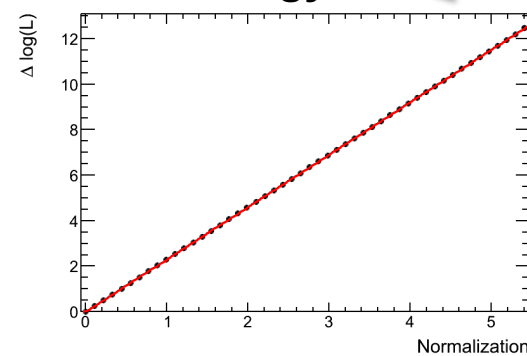
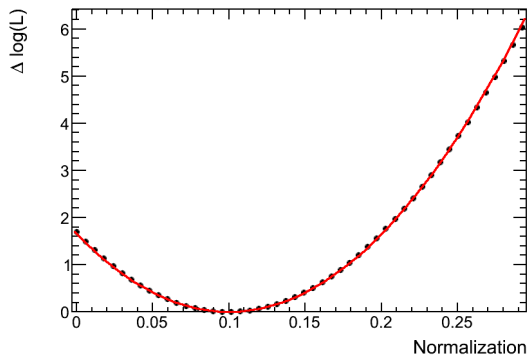
TS Map of  $5^\circ \times 5^\circ$  Region



SED for test source a specific pixel



Likelihood v. Flux for each energy bin



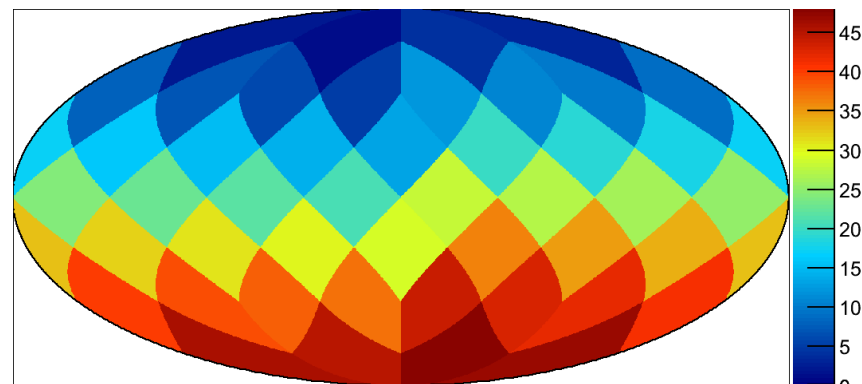


## New ST Features: HEALPix-Based Likelihood Analysis

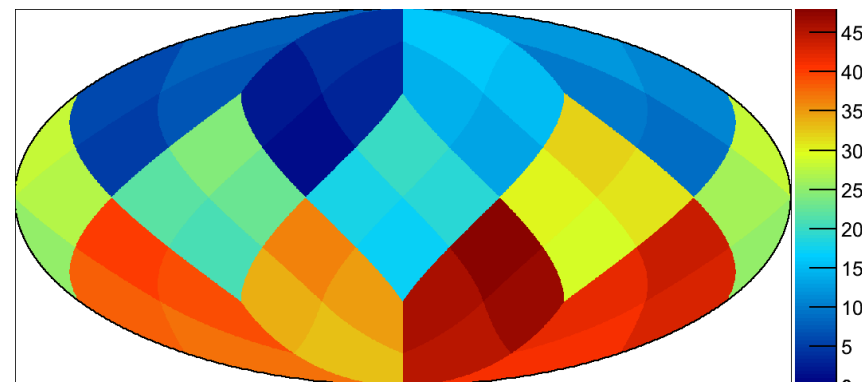
See Talk by Eric Charles

- Fermi STs currently only support binned likelihood analysis on local cartesian projections
- New functionality will allow binned likelihood fits to use HEALPix maps
  - Existing ST apps and tools will handle HEALPix maps transparently
  - Support for all- or partial-sky maps
  - PSF convolution handled efficiently with spherical harmonics
- HEALPix support should make it easier to perform large-scale diffuse analysis with the STs

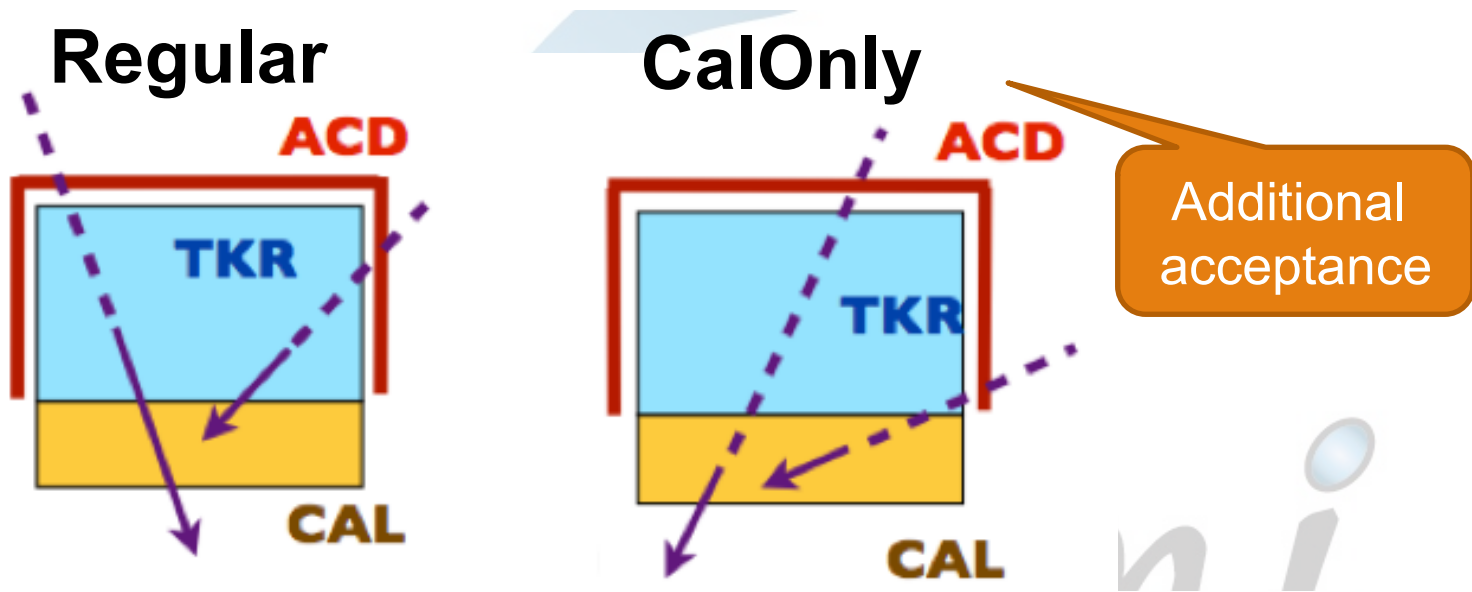
Pixel Index: RING scheme, nside=2



Pixel Index: NESTED scheme, nside=2



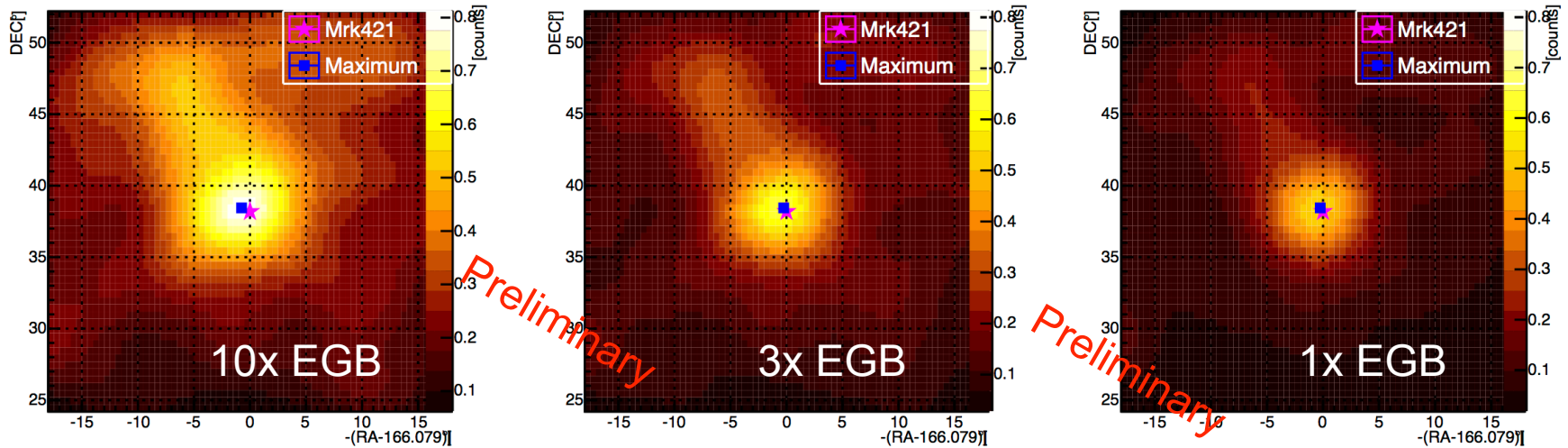
## Cal-Only Event Class



- The CalOnly analysis can recover valuable gamma-ray events that are not converted in the TKR, *i.e.* side-entering or TKR-passing events
  - Provides an increase in acceptance above a few tens of GeV, where sensitivity is limited by photon statistics
  - CalOnly events are expected to have somewhat worse angular resolution ( $R_{68} = 2\text{-}3$  deg) and signal/bkg separation

# Cal-Only Class Performance: Mkn 421

Smoothed count map in 56.2-562GeV



CalOnly	CalOnly 10xEGB	CalOnly 3xEGB	CalOnly 1xEGB
<b>Counts within <math>1.5\sigma</math> PSF</b>	150	120	95
<b>Expected background</b>	57.4	34.3	19.4
<b>Regular</b>	<b>TRANSIENT</b>	<b>SOURCE</b>	
<b>Counts within <math>1.5\sigma</math> PSF</b>	190	178	
<b>Expected background</b>	0.41	0.03	

# Summary and Plans

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- Upcoming developments are focused on realizing the full potential of Pass 8
  - Reducing IRF systematics
  - Improving models for diffuse emission
  - Enabling analysis at very low energy ( $< 100$  MeV)
  - Opening new capabilities at the highest energies (Cal-Only event class)
- Release Schedule
  - **Early-Mid 2016:** New IRFs and some ST Features
  - **Mid-2016 and later:** Earth Limb tool, Cal-Only Event Class, P8 Galactic Diffuse Model, Full HEALPix support in the STs