Fermi Gamma-ray Space Telescope

The LAT model of interstellar emission for standard point source analysis.

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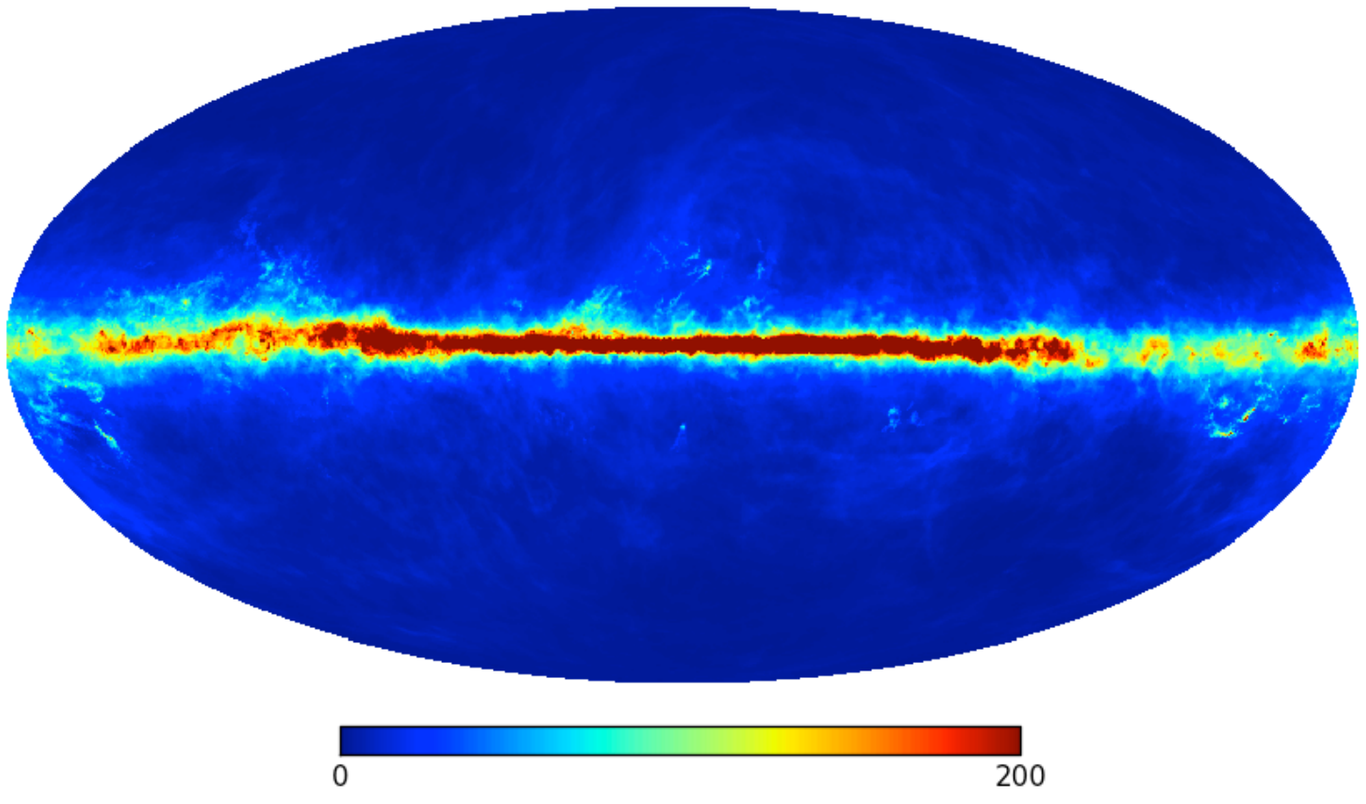
Service d'Astrophysique, CEA Saclay
on behalf of the **Fermi LAT collaboration**

The simplest LAT diffuse counts model

γ *from* π^o *decay and bremsstrahlung* $\propto N(H)$

$$1.3 \times 10^{-20} (N(HI) + 1.8 \times 10^{20} WCO)$$

γ*-ray emissivity per H*

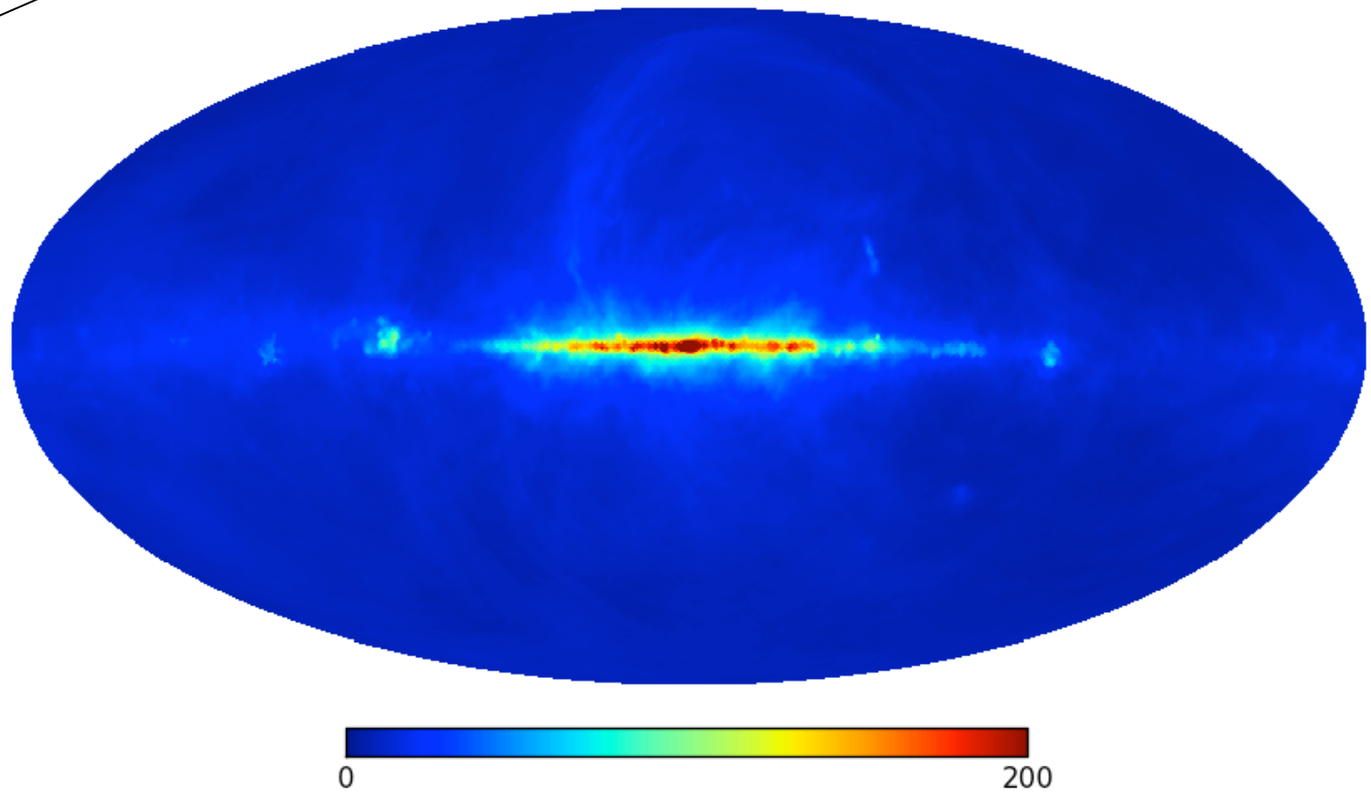


The simplest LAT diffuse counts model

γ *from Inverse Compton* $\propto$ *electron density* $\propto$ *synchrotron map*

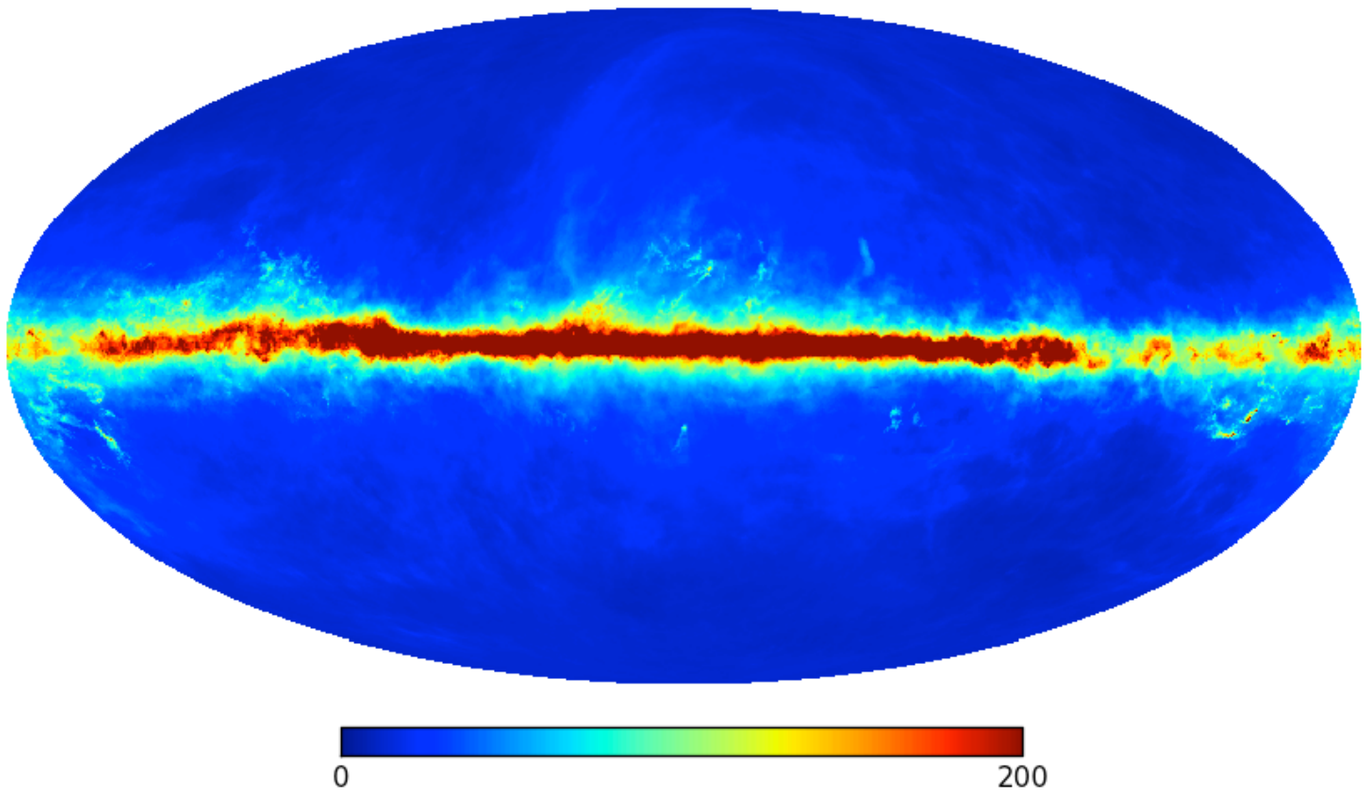
$$0.4 \times I_{408MHz}$$

Normalization factor



The simplest LAT diffuse counts model

$$1.3 \times 10^{-20} \left(N(HI) + 1.8 \times 10^{20} WCO\right) + 0.4 \times I_{408MHz}$$



Gamma-ray Space Telescope

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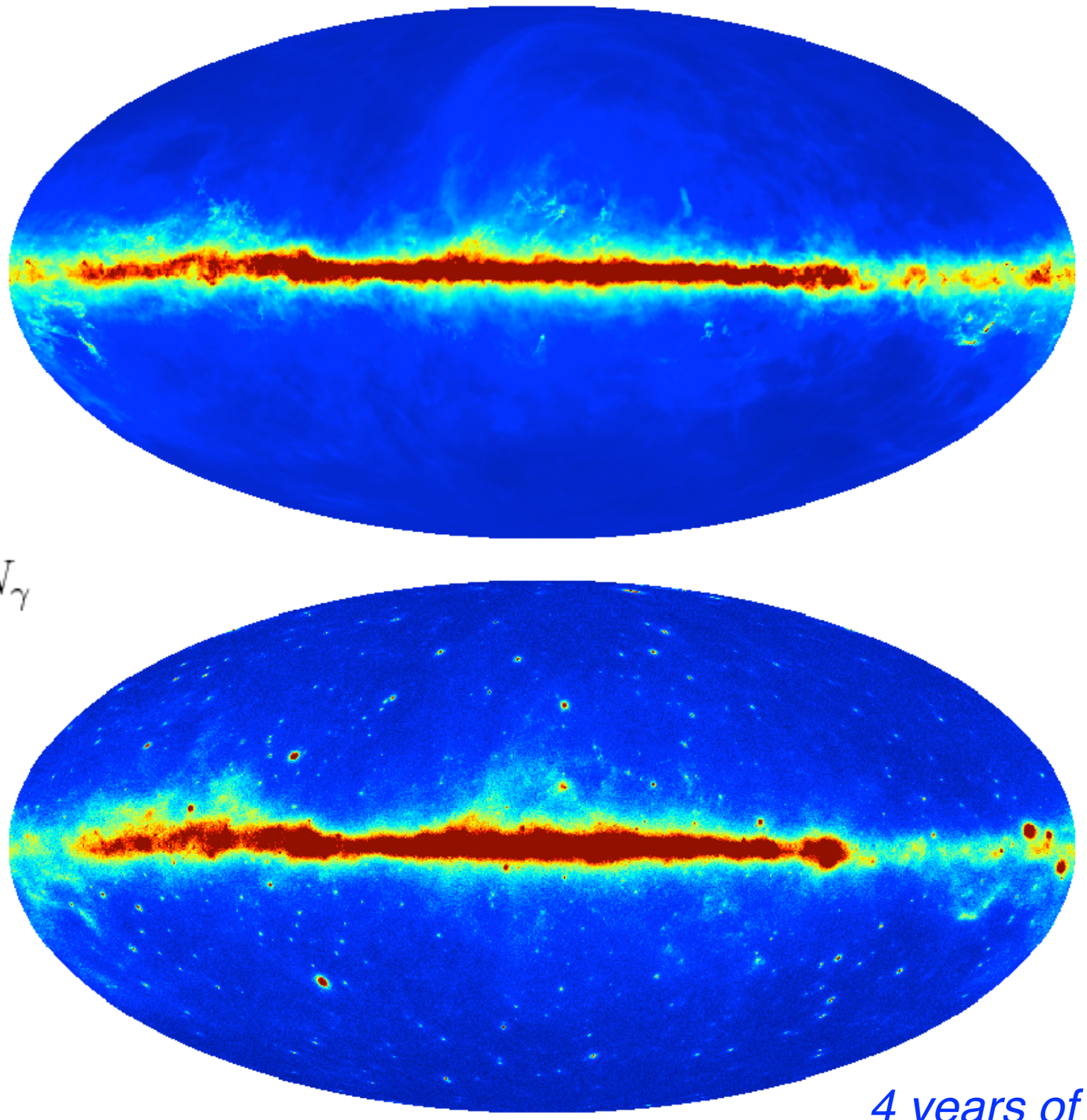
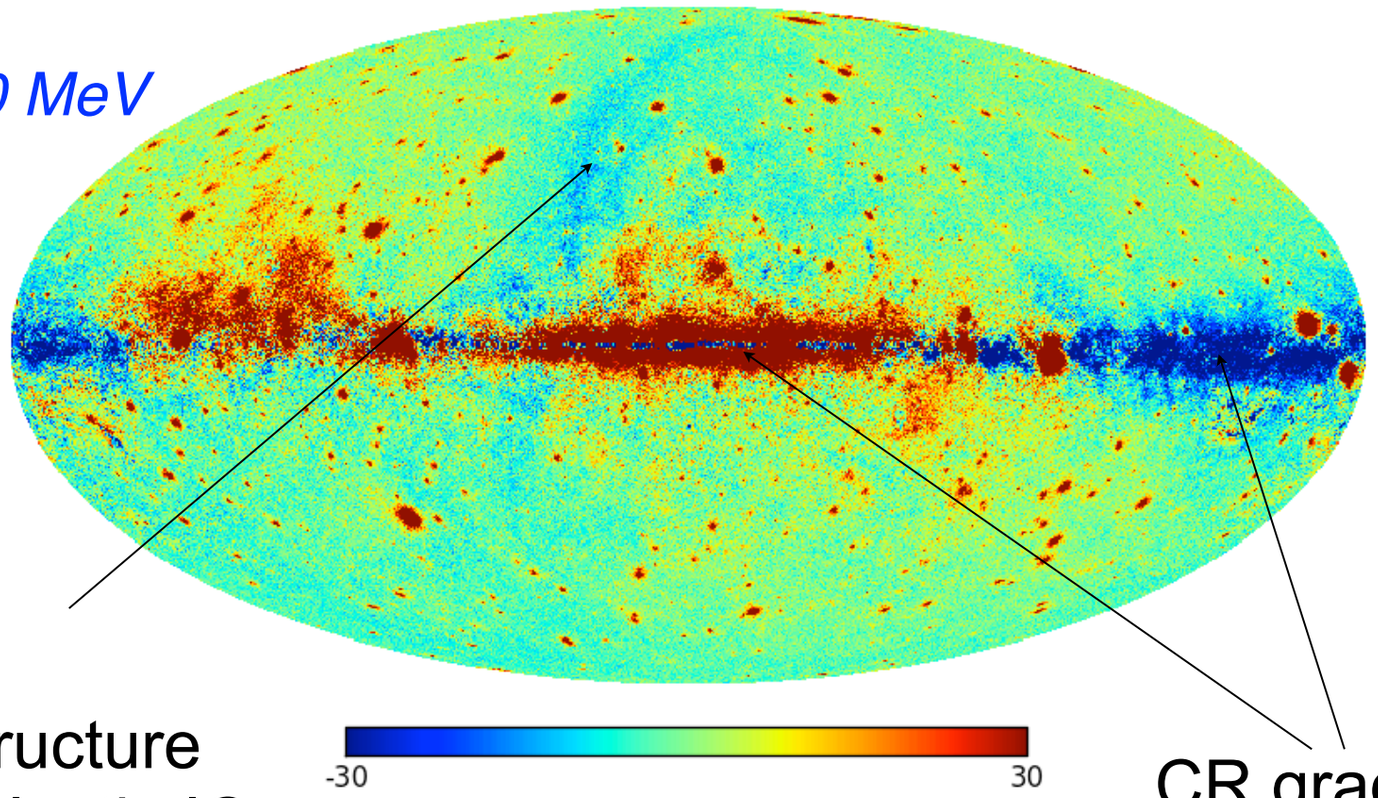


4 years of LAT counts above 220 MeV

The simplest LAT diffuse counts model

$$N_\gamma - 1.3 \times 10^{-20}\ (N(HI) + 1.8 \times 10^{20} WCO) - 0.4 \times I_{408MHz} - 2$$

residual above 220 MeV



local structure with Galactic IC

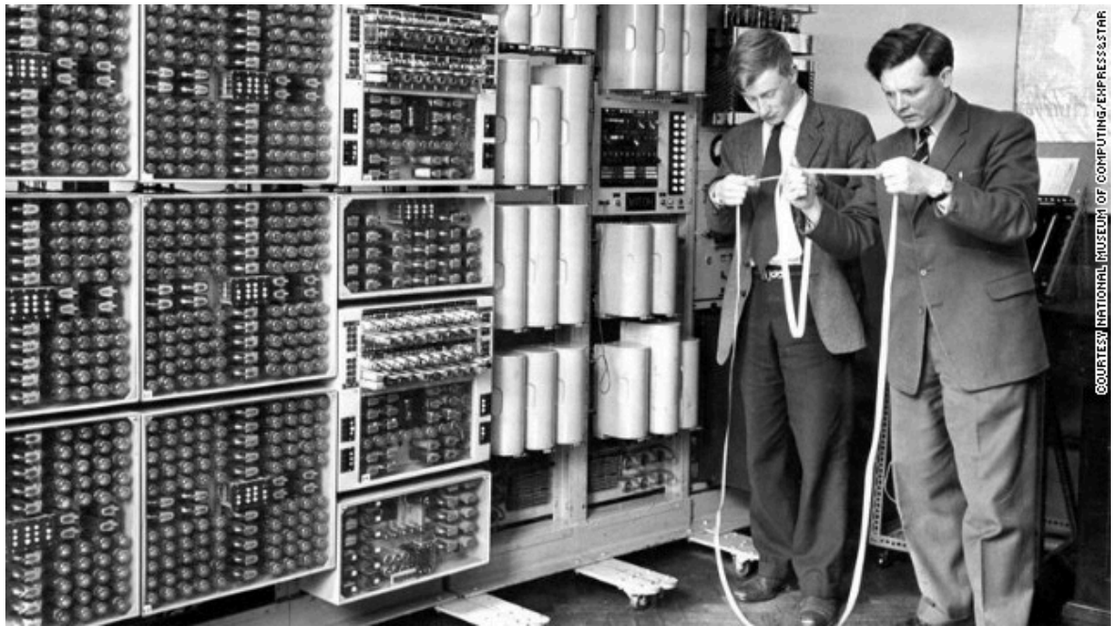
CR gradient

Galactic IC from Galprop prediction, fit normalization

+

partition H map in annuli, fit each emissivity

Fitting the preliminary template model: 1 slide for 99% of the work



data

56,562,718 counts (4 years)
Pass 7 reprocessed
CLEAN class
14 energy bands

method

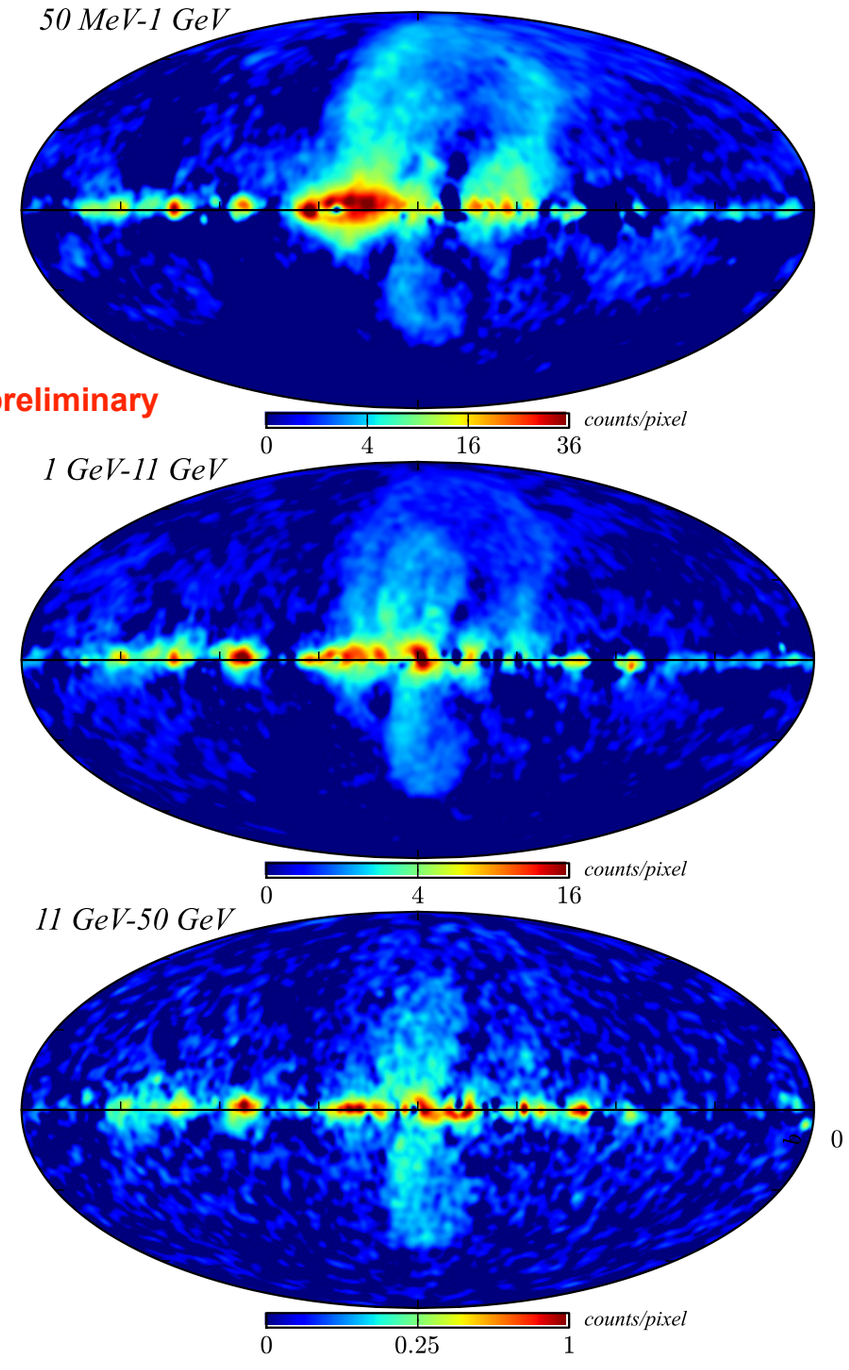
Binned likelihood
Iterative procedure
Optimized ROI
Patches of uniform intensity

model

~20 maps templates with free emissivities or normalization factors
21 extended sources
2179 point sources
Sun, Moon, Earth templates

→ *Preliminary template model*

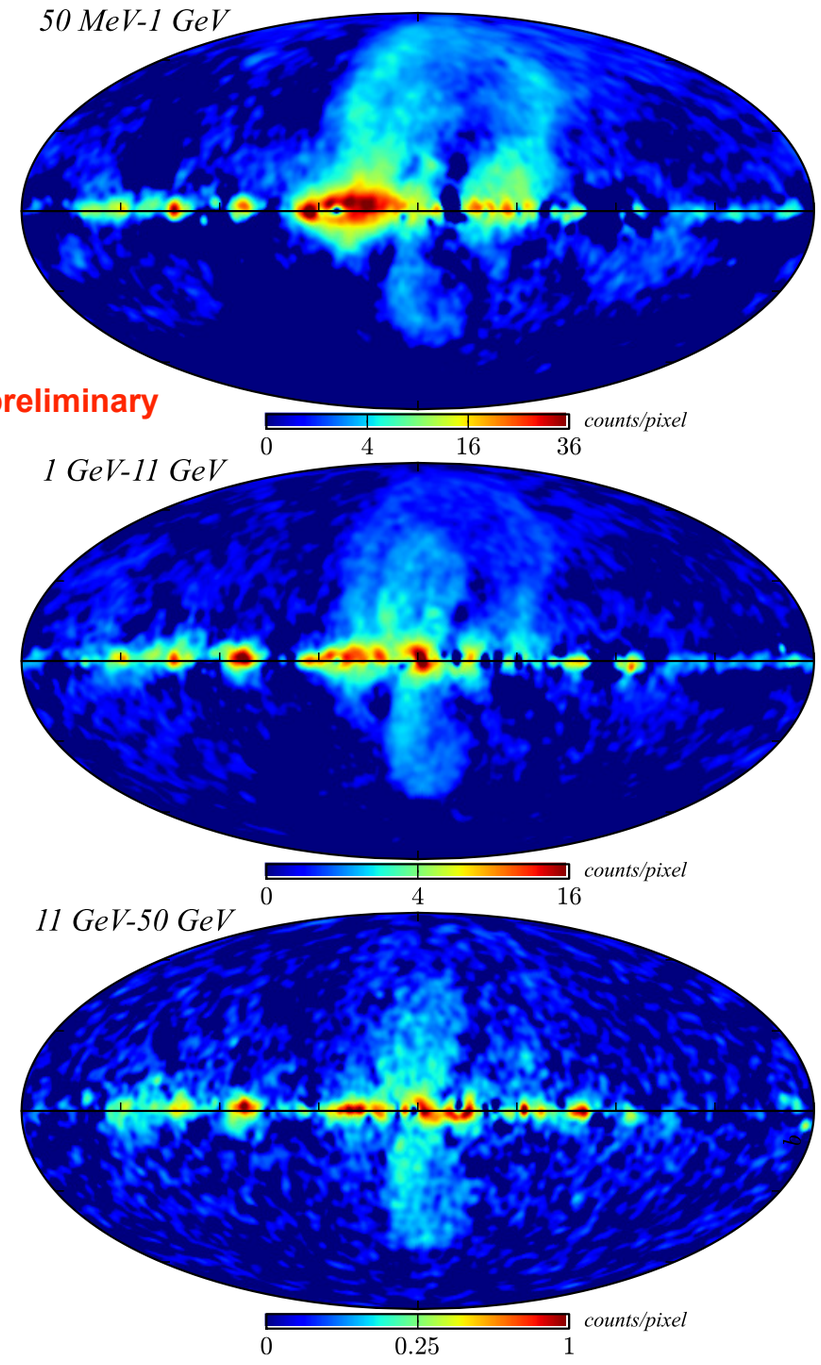
The preliminary model residuals



preliminary

Large scale structures are missing in this preliminary template model.

The preliminary model residuals



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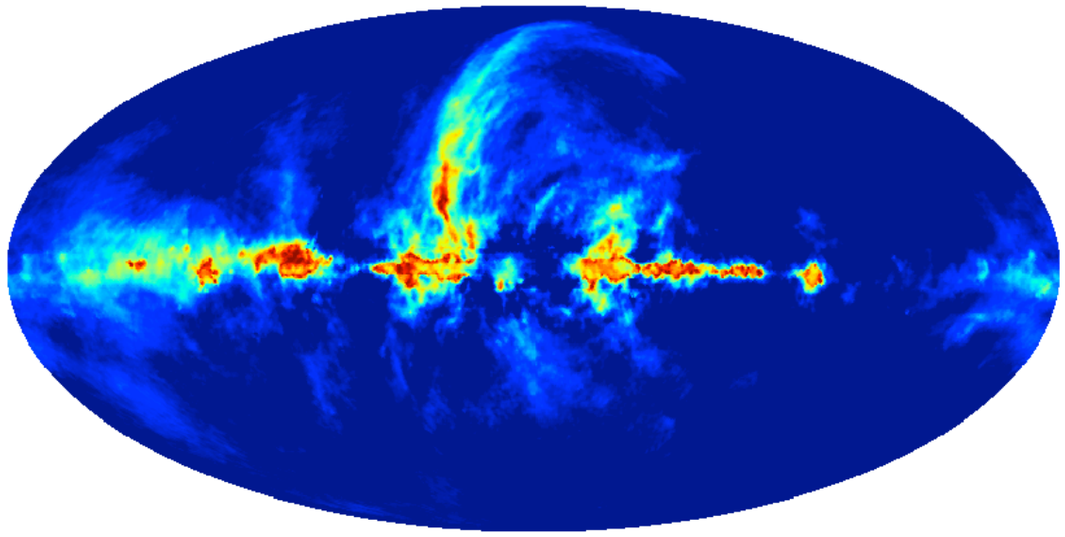
$$I_{408MHz} - I_{Galprop_{408MHz}}$$

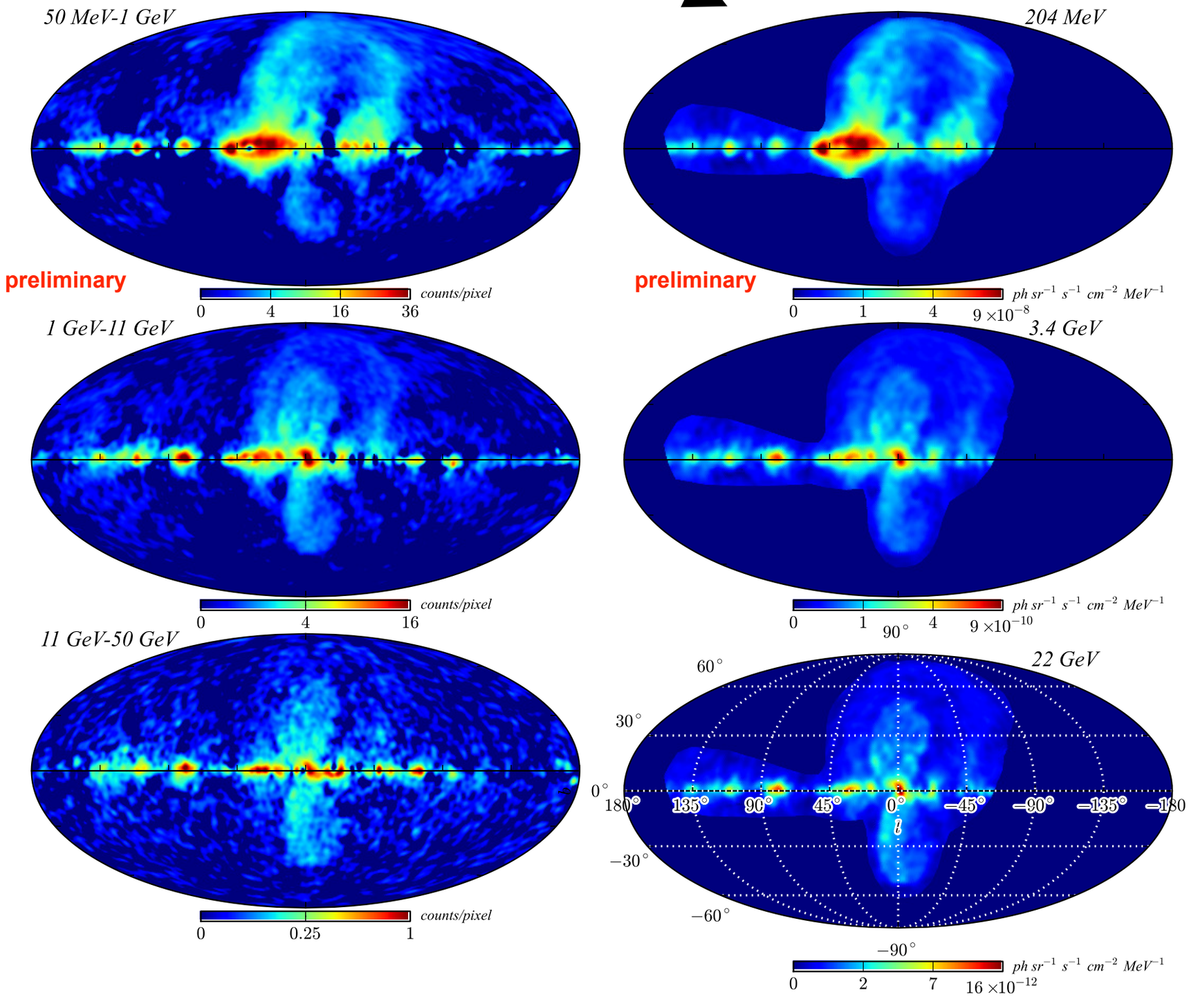


The electrons in excess to Galprop synchrotron prediction may produce IC radiation detected by the LAT.

The preliminary model residuals

fit assuming an IC origin

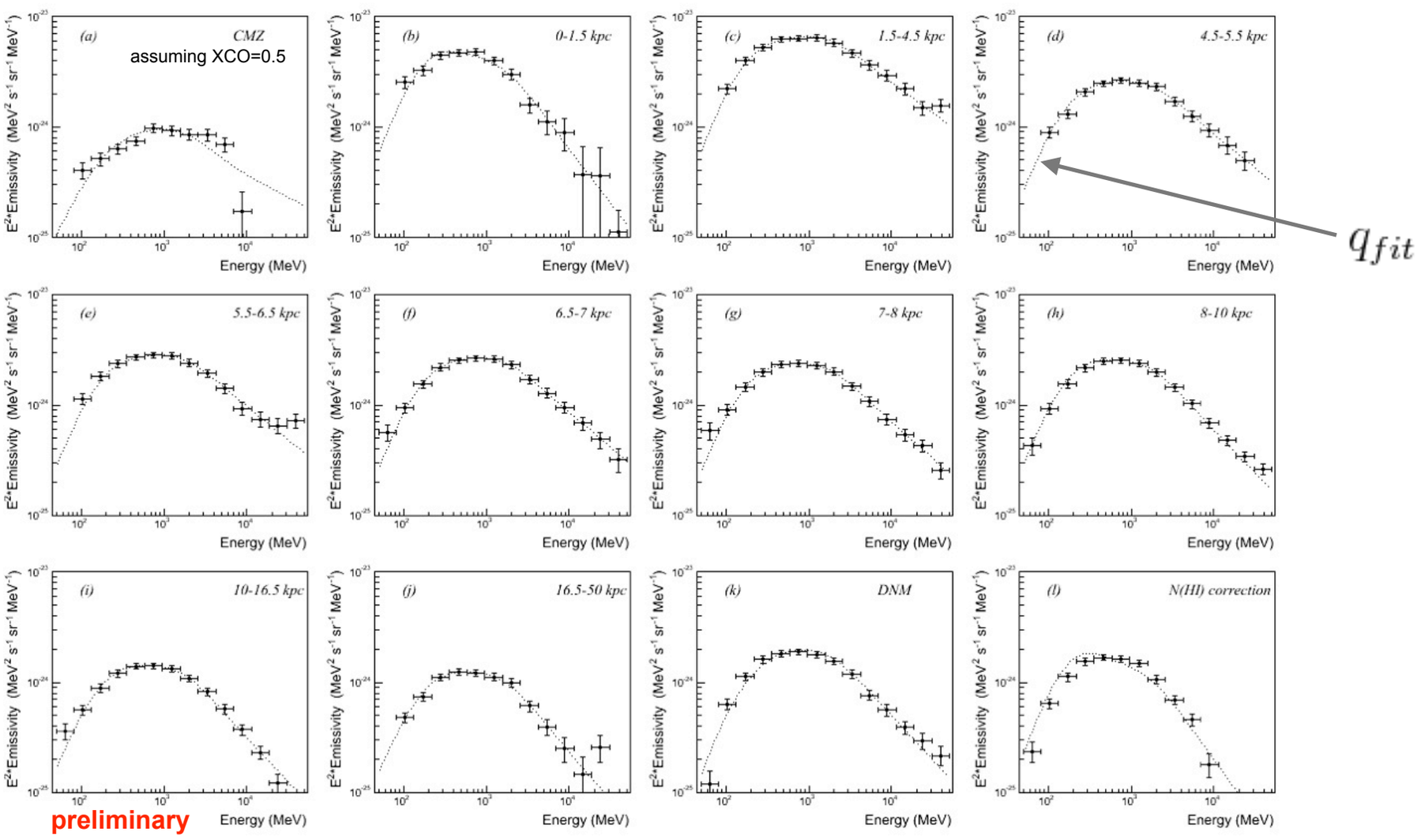
$I_{LargeScale}$



Large scale intensity is modeled assuming an IC origin.
Structures smaller then 2 degrees are filtered from the map

The LAT final 4-years interstellar model

$$I(E,l,b) = \sum_{i=HI,H_2,DNM} \frac{dq_{fit_i}}{dE}(E)\, N(H)_i(l,b) + \hat{N}_{IC}(E) I_{IC_{Galprop}}(E,l,b) + I_{Large\ Scale}(E,l,b)$$



preliminary

some of the points are outside of the range of the plot and not shown

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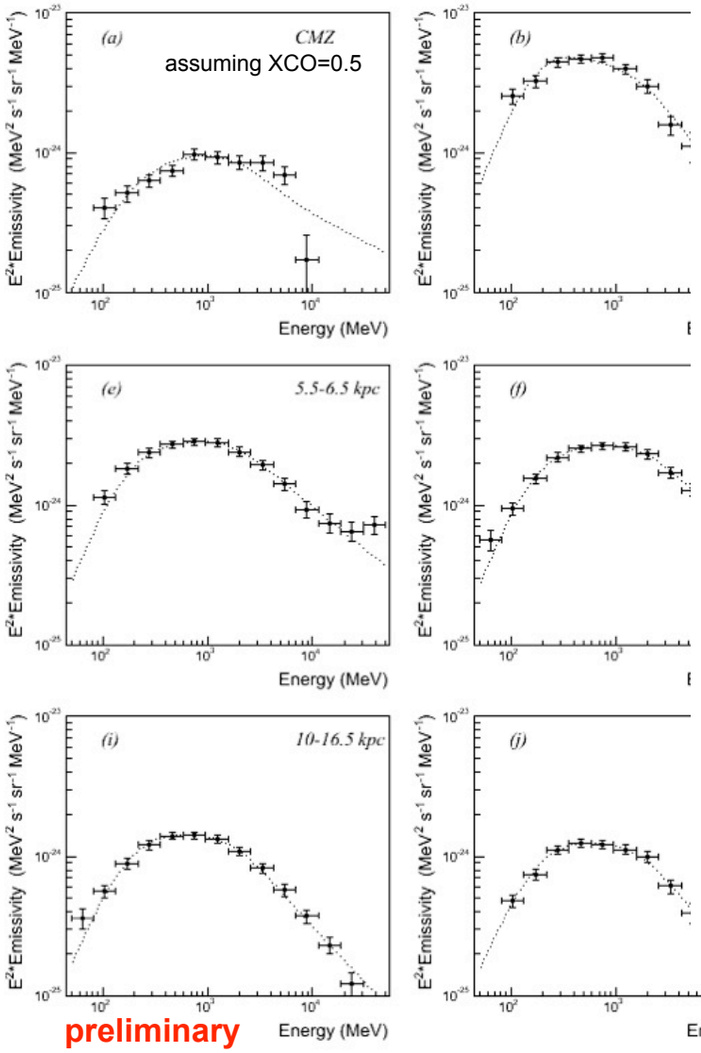

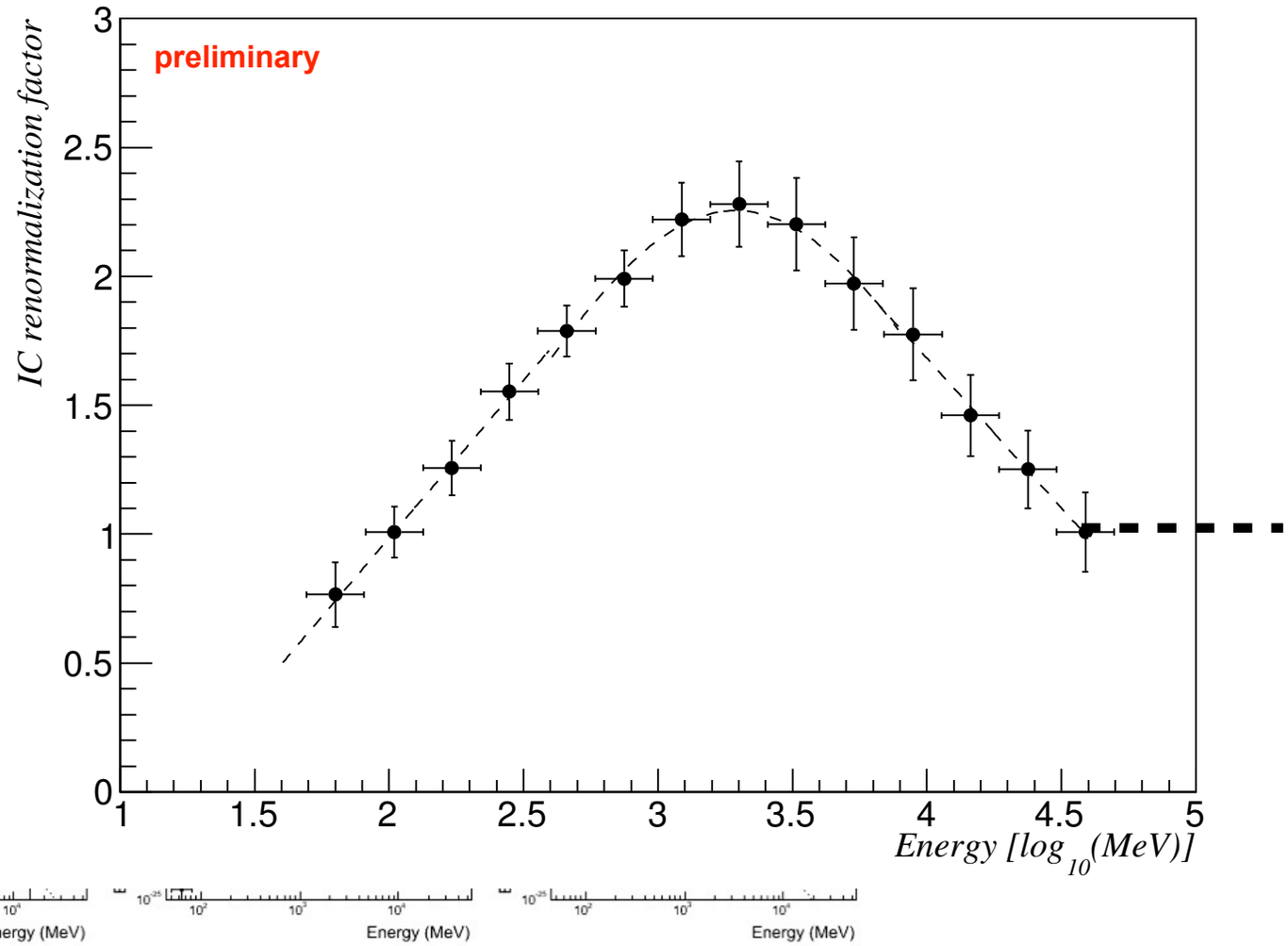

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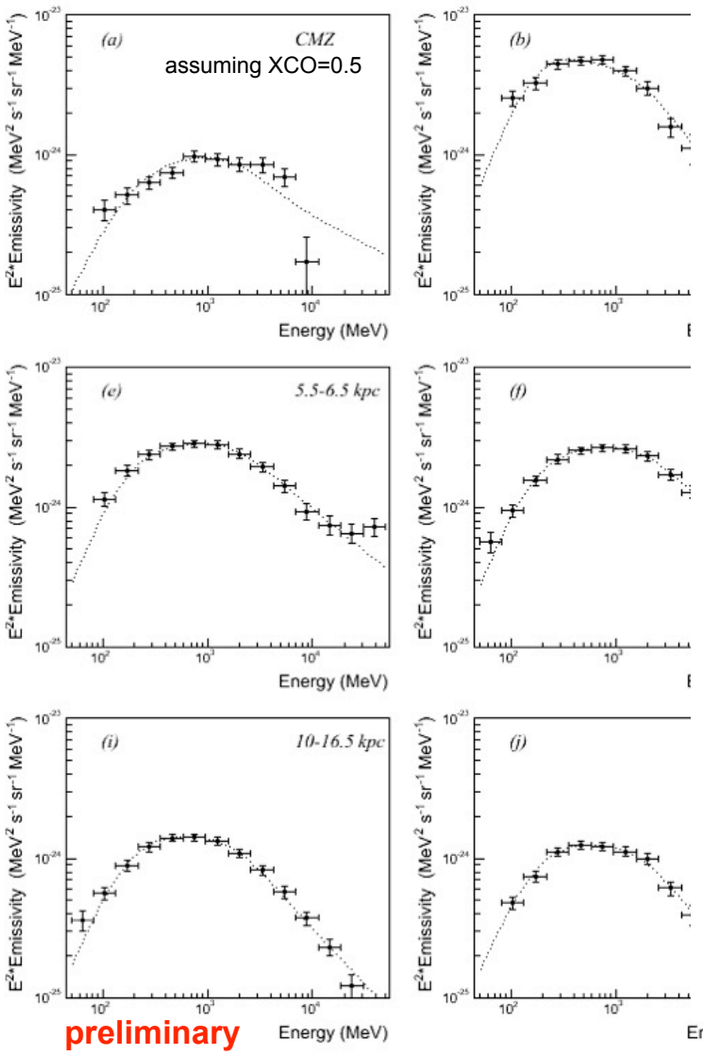

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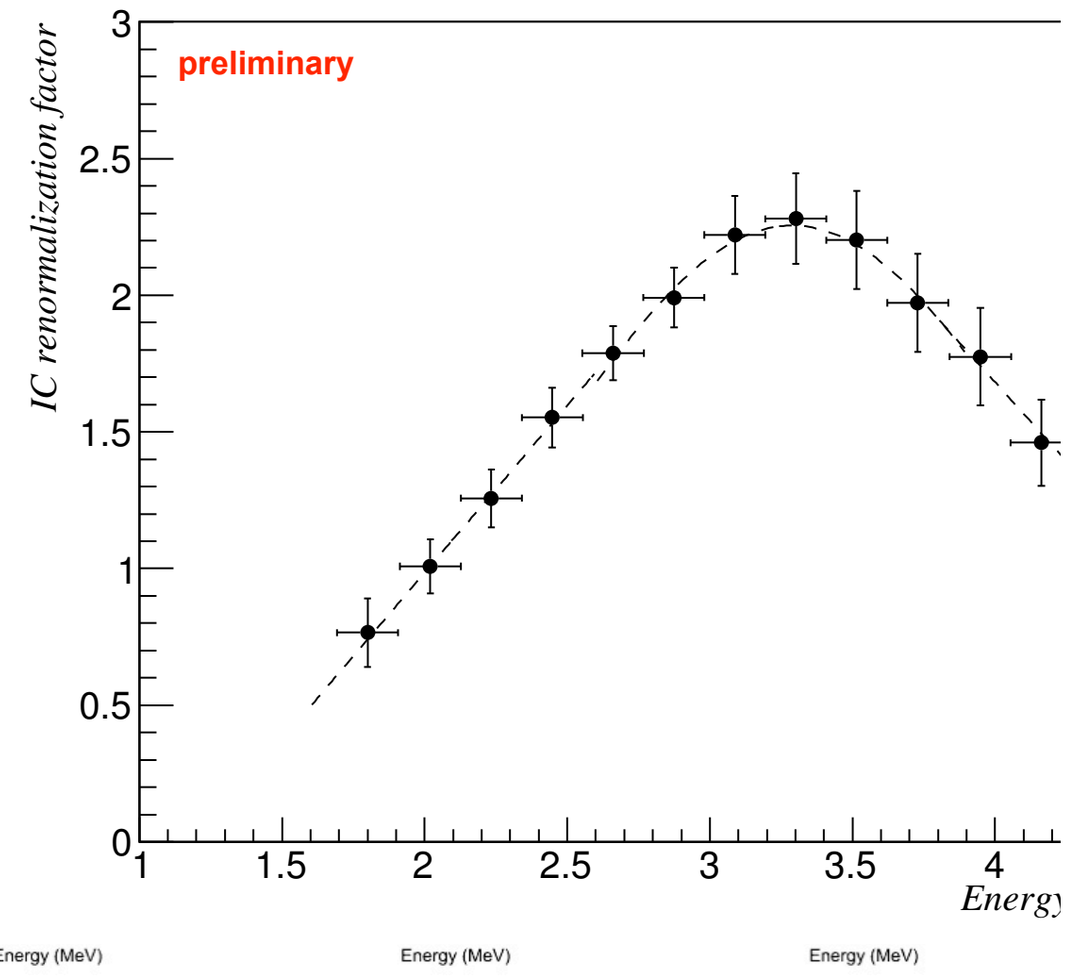

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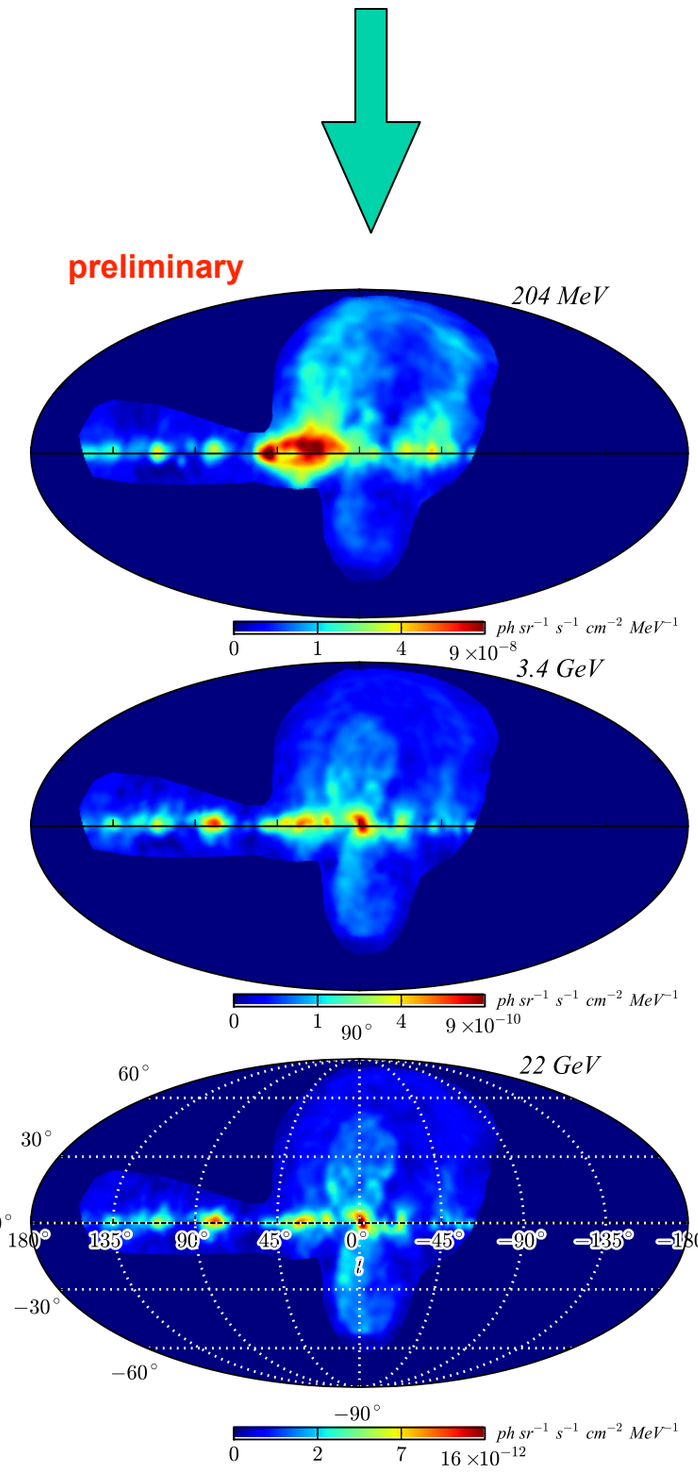

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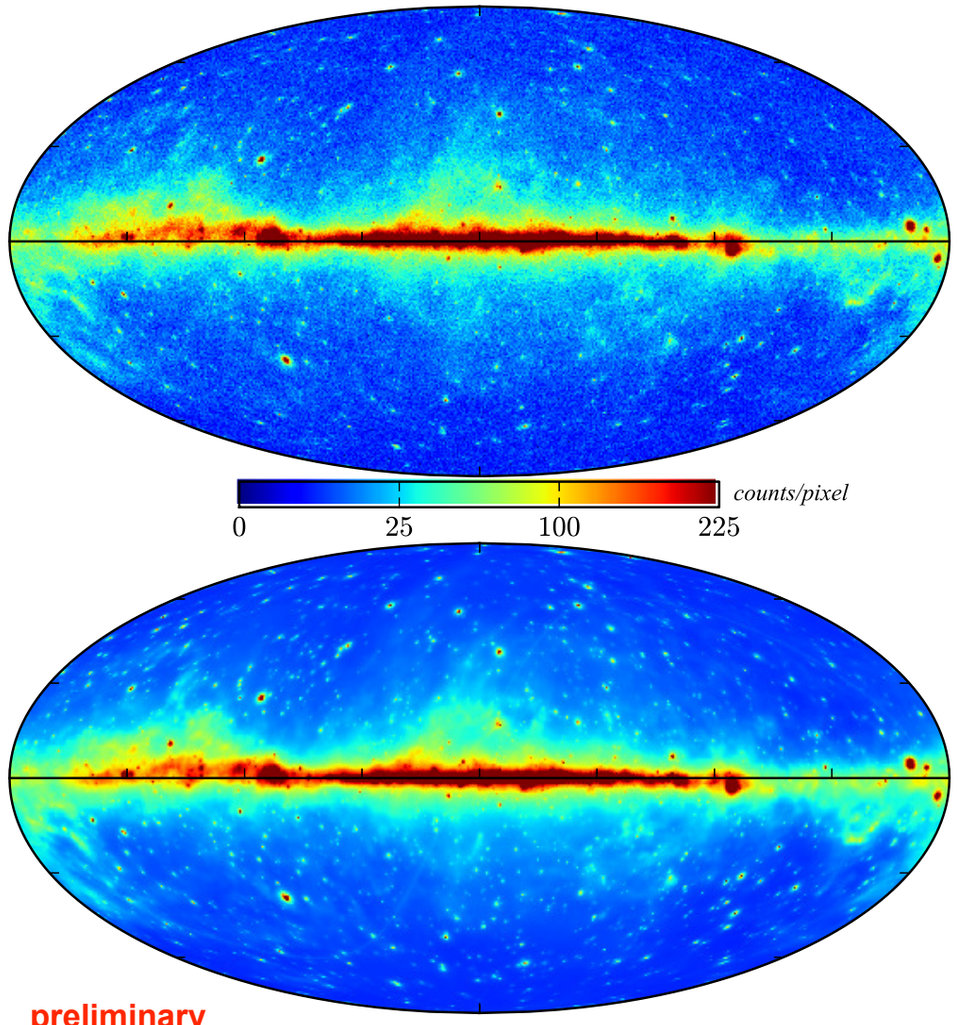
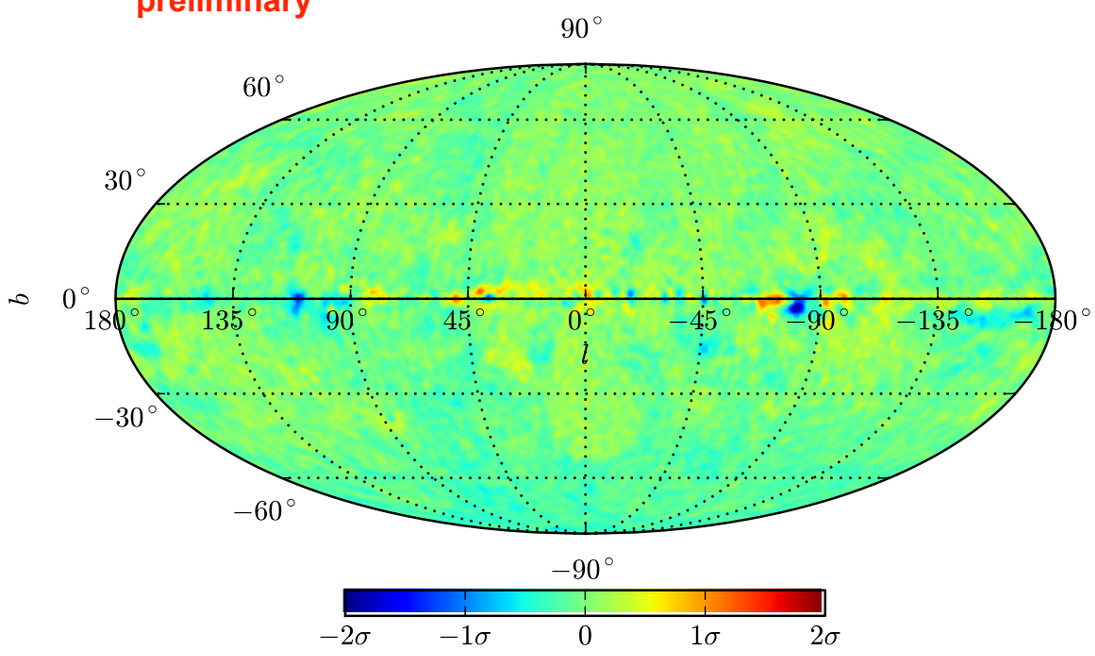


counts above 360 MeV

model with sources and isotropic above 360 MeV

preliminary

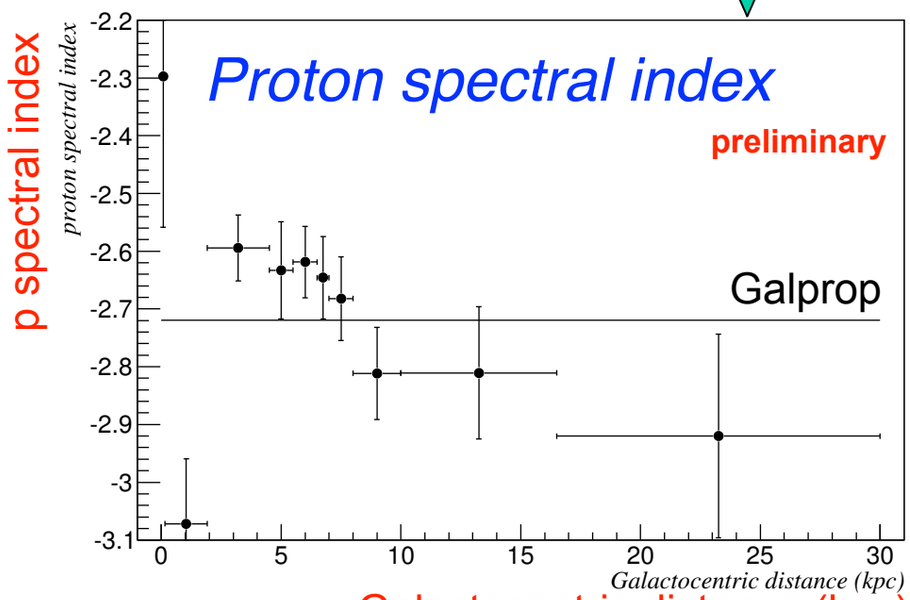


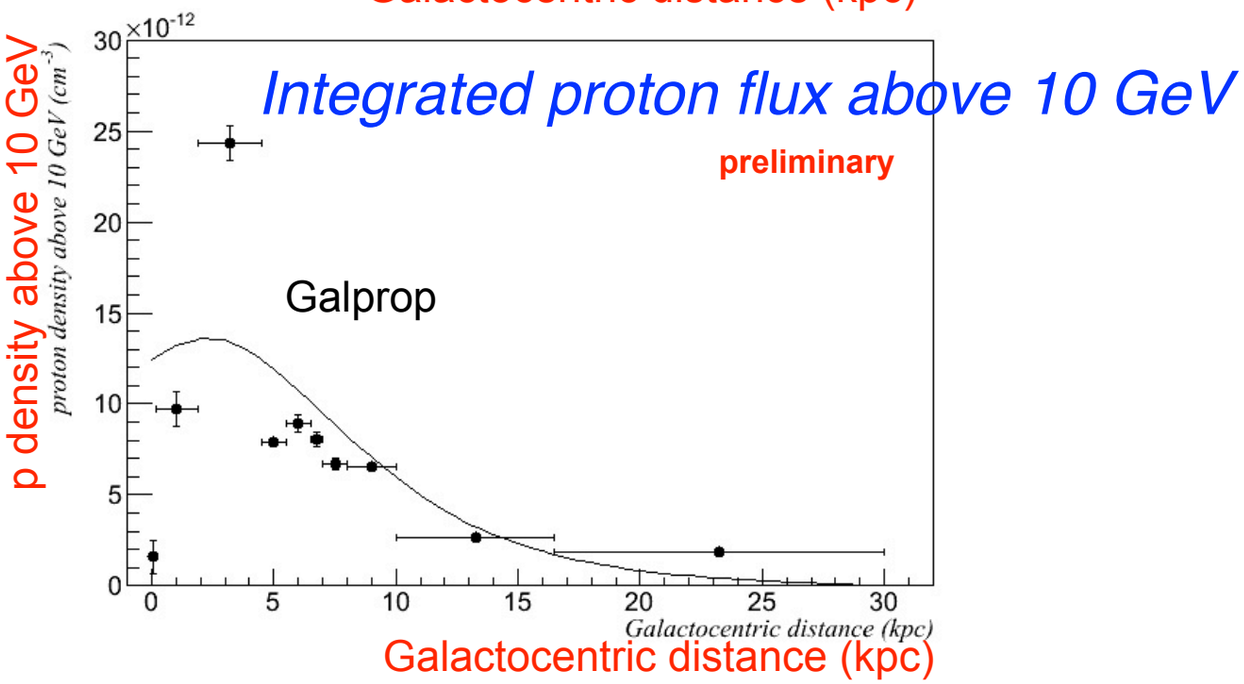
residuals

What did we learn ?

$$I(E,l,b) = \sum_{i=HI,H_2,DNM} \frac{dq_{fit_i}}{dE}(E)\, N(H)_i(l,b) + \hat{N}_{IC}(E) I_{IC_{Galprop}}(E,l,b) + I_{Large\ Scale}(E,l,b)$$

Systematics are not included in the error bars





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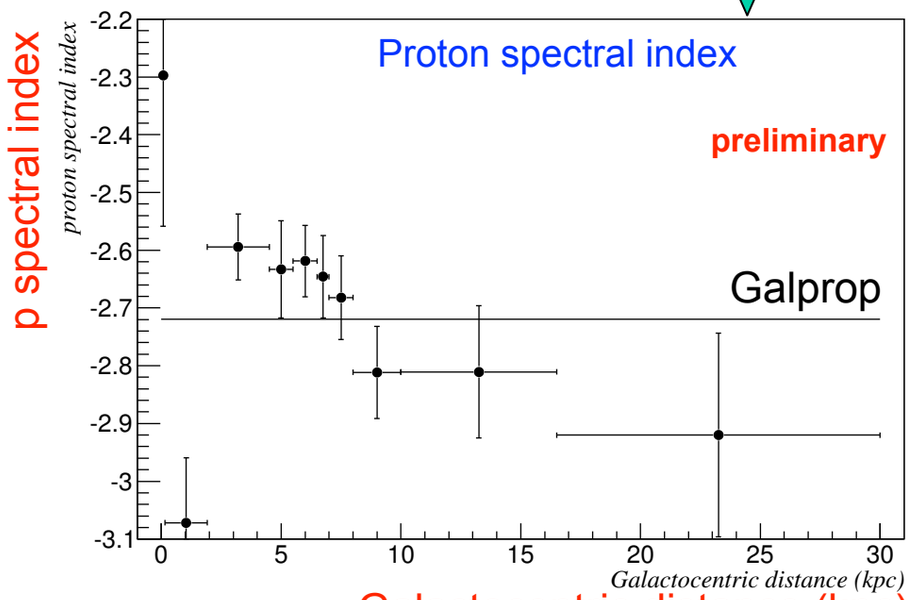
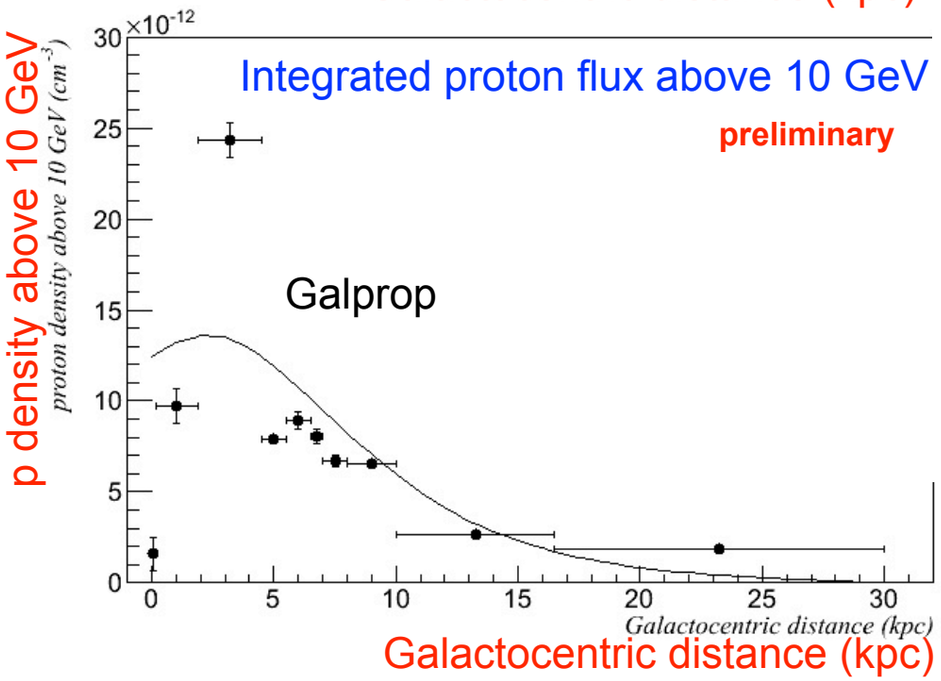
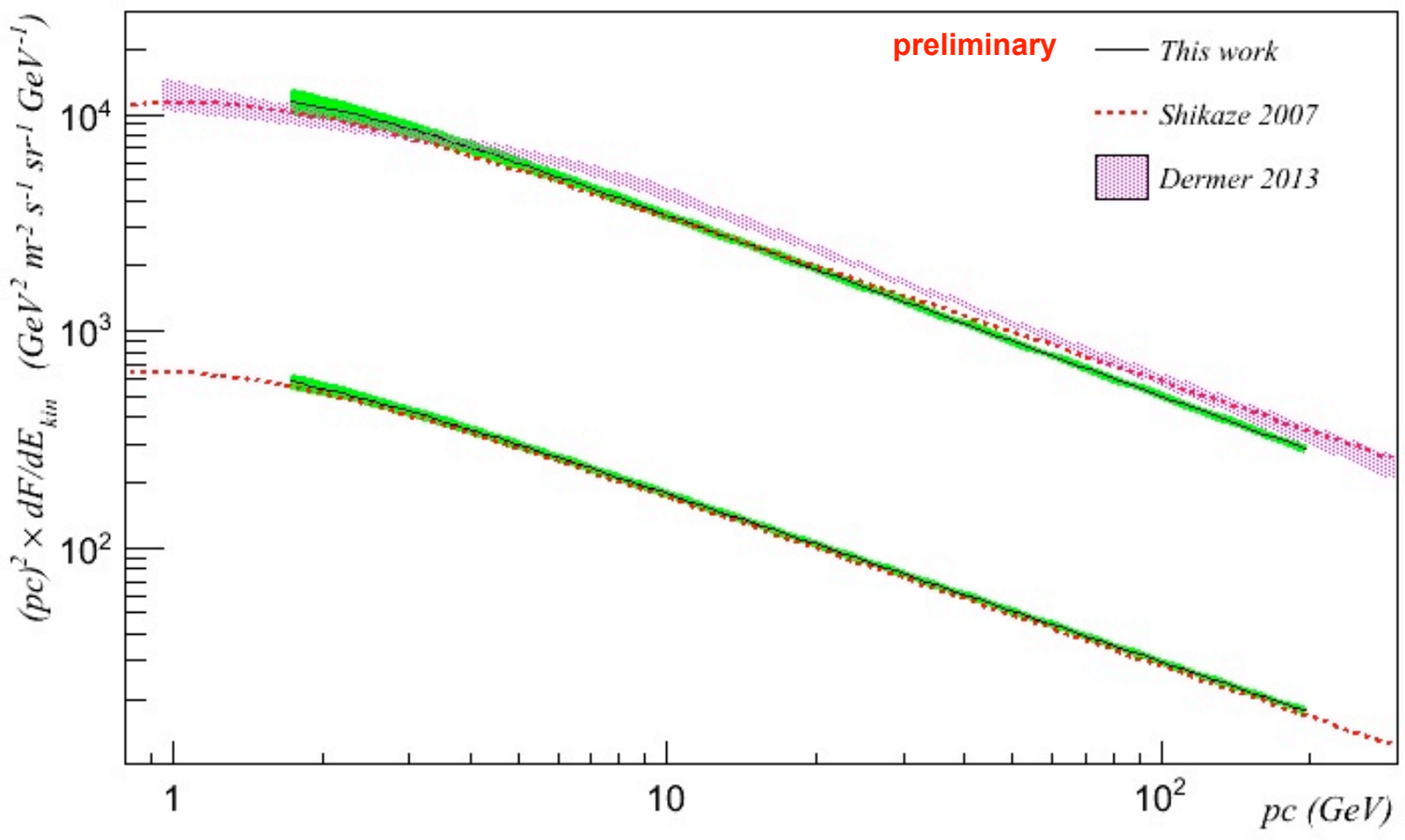




p and He flux from a fit to emissivities and PAMELA



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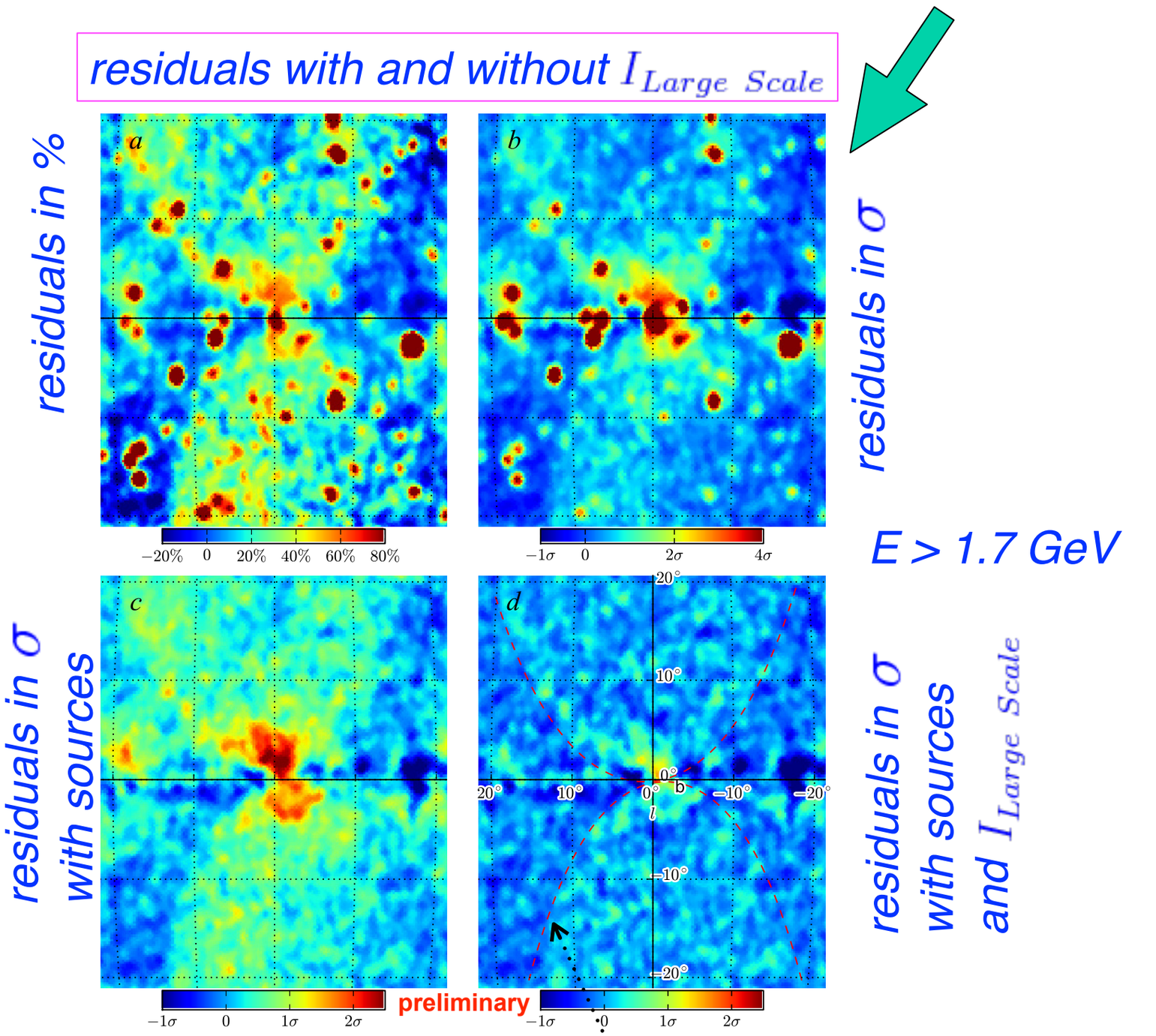
The Fermi bubbles seem to have a catenary shape approximately pointing toward the GC

An enhanced emission within few degrees to the GC, possibly linked to the bubbles, is observed

The shape of the structures within 10º of the GC depends on inner gas emissivity within 1.5 kpc of the center and on the model for the intensity.



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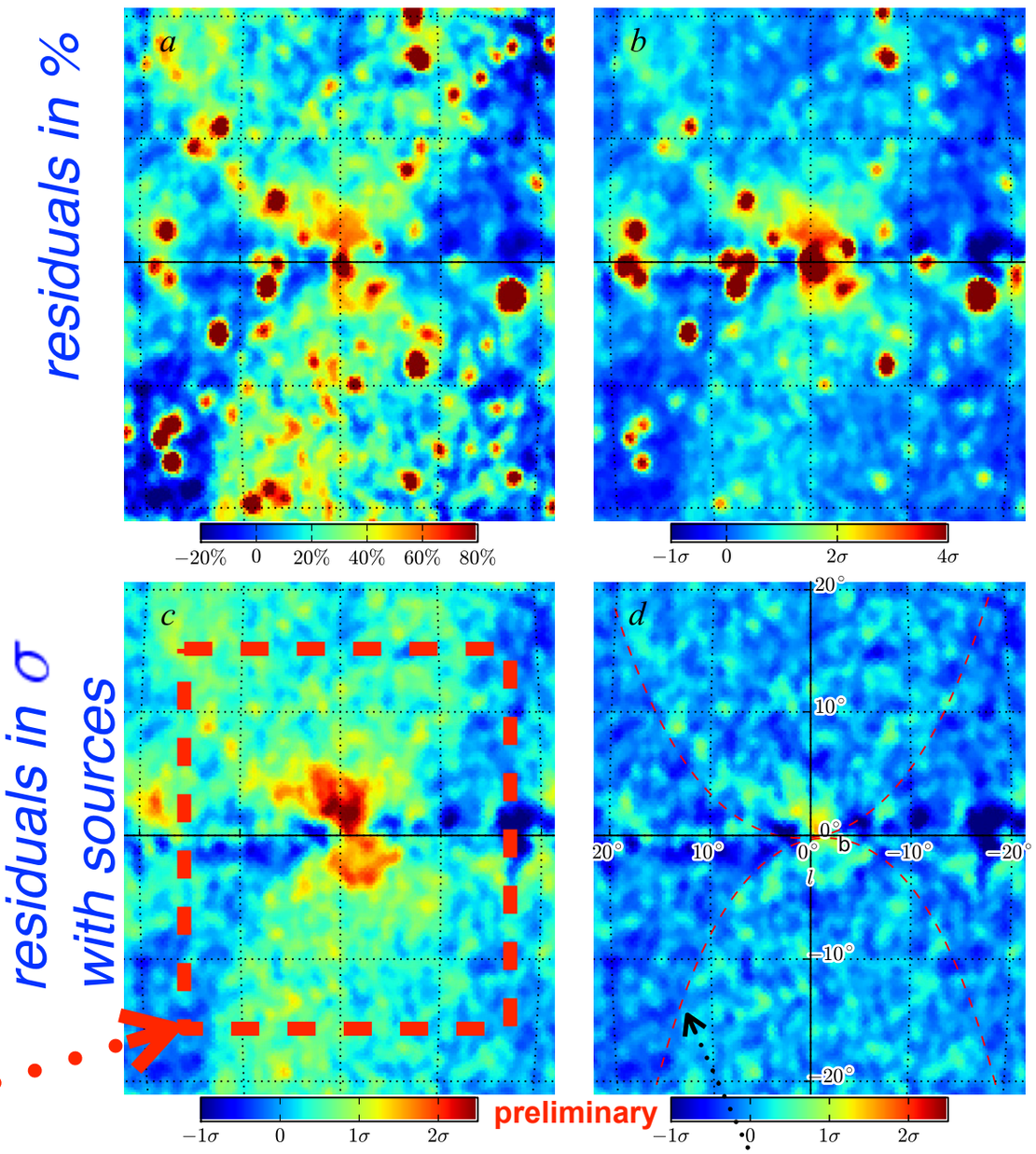
In the next talk, Simona Murgia will show the results of a dedicated study of the diffuse emission in the inner 15 x 15 deg of the Milky Way. This study had some different degrees of freedom in the models considered.

residuals with and without $I_{Large\ Scale}$



Catenary shape :

$-8.7 \times (cosh((l+1.7)/8.7) - 1)$ *(South)*

$10.5 \times (cosh((l-1)/10.5) - 1)$ *(North)*

The model

The 4-years interstellar model is built using a template approach.

It is based on radio, millimeter and IR survey as well as Galprop predictions fitted to Pass7 reprocessed LAT observations.

It is available at: http://fermi.gsfc.nasa.gov/ssc

We resampled all the maps to an 0.125° grid. The FITS file comprises 30 logarithmically-spaced energies between 50 MeV and 600 GeV.

The model is then intended for use with the instrument response functions versions P7REP_SOURCE_V15, P7REP_CLEAN_V15, and P7REP_ULTRACLEAN_V15.

Over much of the sky, any sources larger than about 2° are incorporated in the diffuse emission model

Any ideas on how to improve the interstellar model ? Contact us !