

# Interstellar gamma-rays: first large-scale results from Fermi-LAT

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*on behalf of Fermi-LAT collaboration*

ICRC Lodz 7-15 July 2009  
OG2.1 ID 0390

SCOPE:

*preliminary* evaluation of Fermi-LAT data

comparing with models of diffuse interstellar emission

What are the first lessons we have learned ?

# Fermi results on diffuse gamma-rays at this ICRC:

Julie McEnery

Fermi overview highlight talk

Troy Porter:

Intermediate latitudes, EGRET comparison POSTER

This session:

Luigi Tibaldi :

2<sup>nd</sup> Galactic quadrant

Akira Okumura:

Orion clouds

Markus Ackermann:

Extragalactic background

Troy Porter:

Large Magellanic Cloud

also in progress:

Tsufune Mizuno

HI emissivity analysis

Jean-Marc Cassandjian

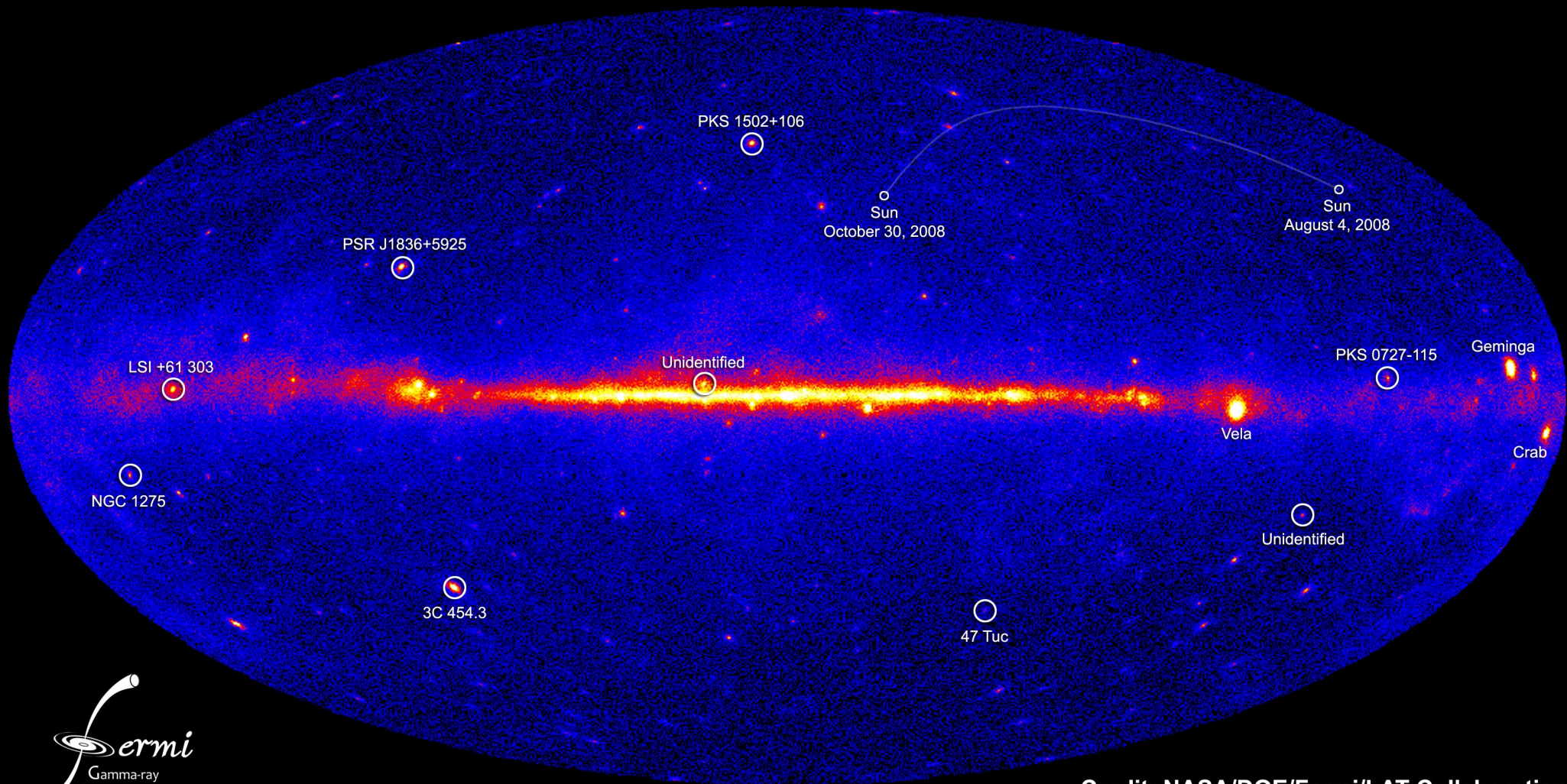
Galactic Rings analysis

ALL ONGOING WORK

see also synchrotron for the same model, Orlando et al. this ICRC

# Fermi 3 month skymap

**NASA's Fermi telescope reveals best-ever view of the gamma-ray sky**

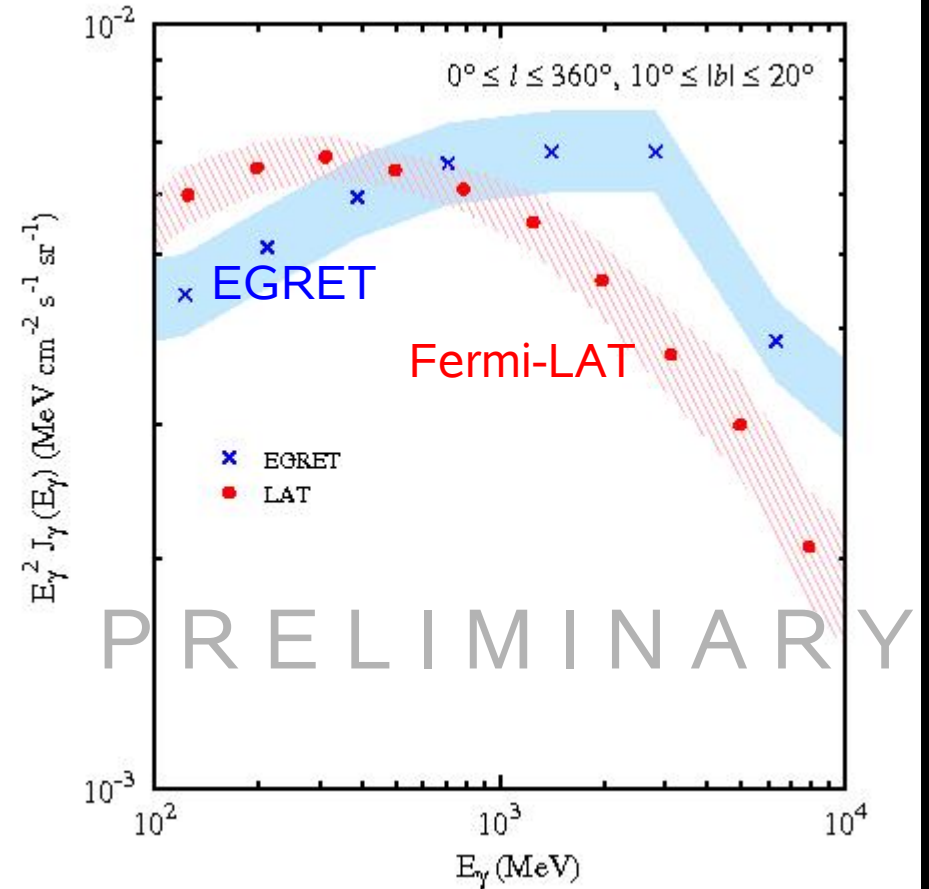
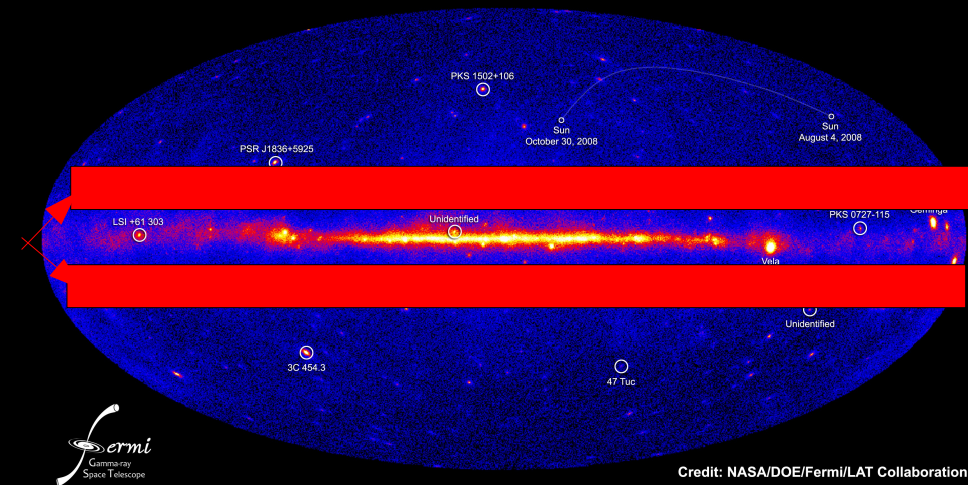




# Fermi does *not* confirm GeV excess seen by EGRET

## see paper 0554 (Troy Porter)

NASA's Fermi telescope reveals best-ever view of the gamma-ray sky



The two experiments have different instrumental backgrounds, so this comparison is not exact, but *the difference is not mainly attributable to this.*

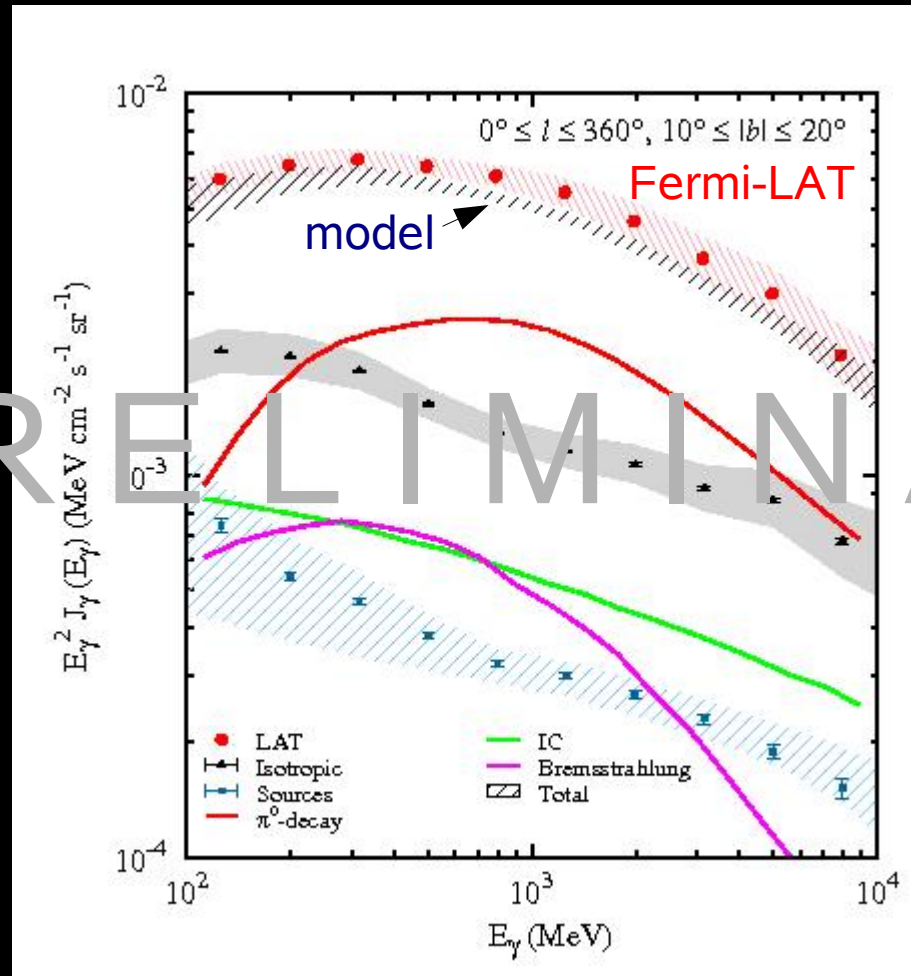
*Abdo et al. in preparation for the Fermi-LAT Collaboration*

model based on *local* cosmic-ray spectra  
(but *pre-Fermi* electrons) .....

agrees with Fermi !

see paper  
0554  
(Troy Porter)

INTERMEDIATE  
GALACTIC  
LATITUDES  
 $10^\circ < b < 20^\circ$



Intermediate latitudes: mainly emission within 1 kpc -> local cosmic rays  
Small, uniform excess can be due to uncertainties in  
cosmic rays, gas surveys, unresolved sources, etc.

Abdo et al. in preparation  
for the Fermi-LAT Collaboration

# Modelling the gamma-ray sky

## main ingredients:

cosmic-ray spectra  $p$  ,  $He$  ,  $e^-$  ,  $e^+$  (including secondaries)  
(NB here using *Fermi-measured* electrons)  
cosmic-ray source distribution follows SNR/pulsars

B/C etc for propagation parameters  
halo height = 4 kpc (from radioactive nuclei)

Interstellar radiation field

HI, CO surveys

CO-to-H<sub>2</sub> conversion a function of position in Galaxy

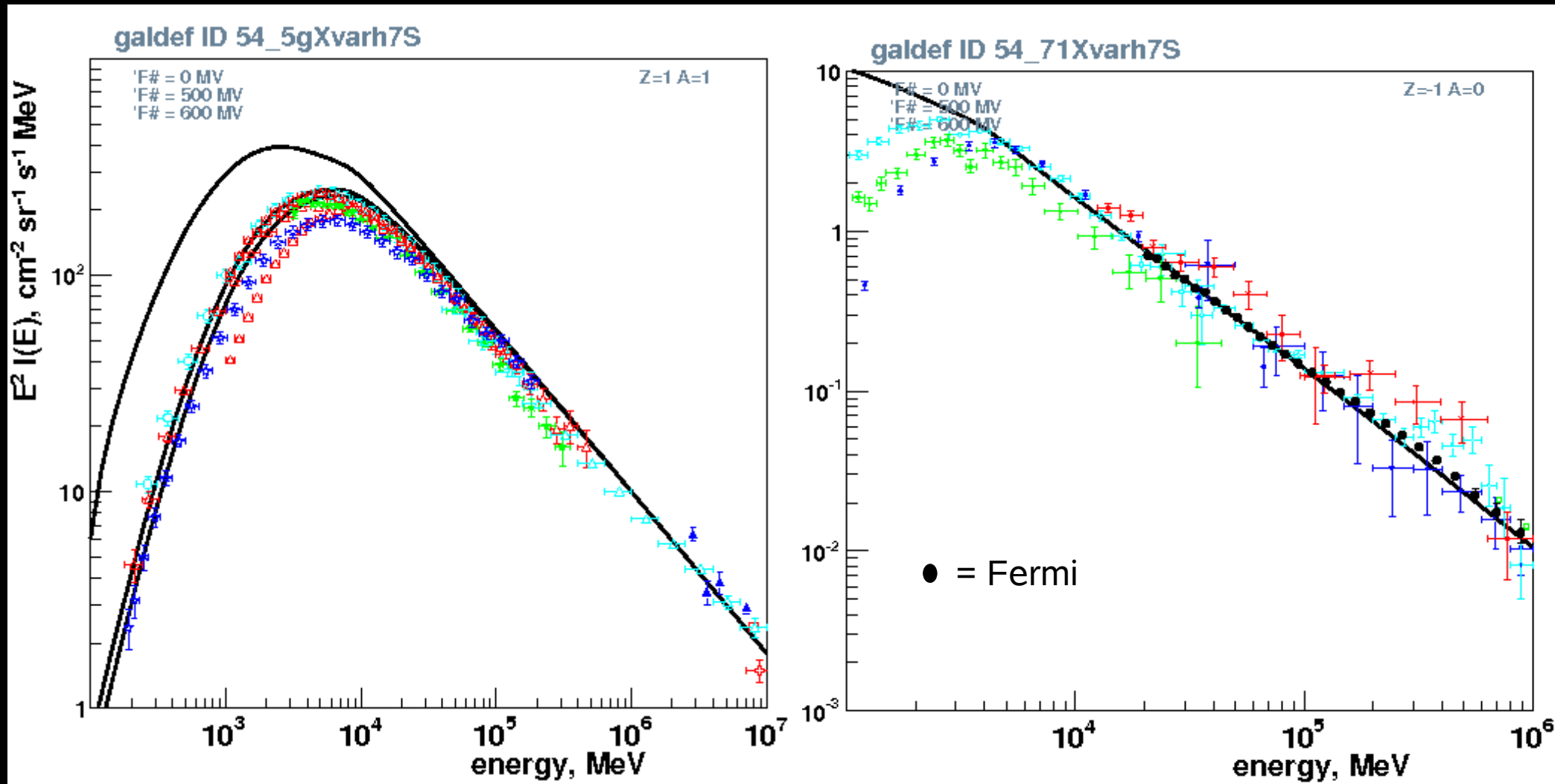
Fermi bright source list

Uses *GALPROP* latest version: this ICRC, ID 0902

First use a model based on locally-measured cosmic rays

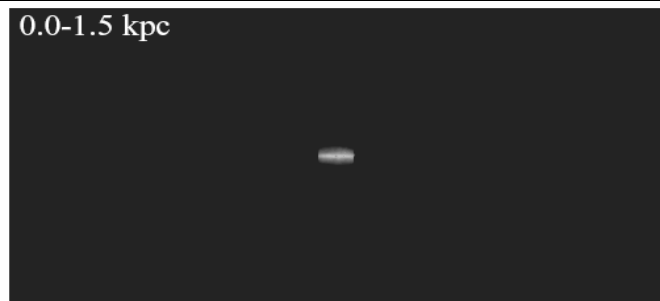
## PROTONS

## ELECTRONS

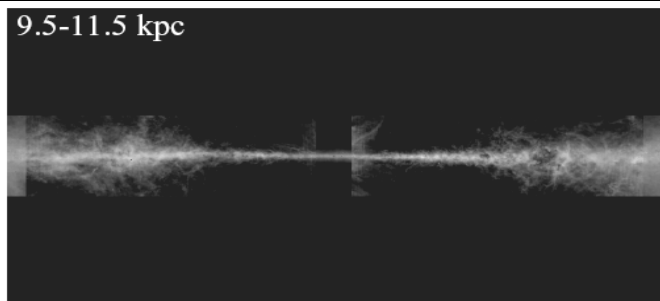




0.0-1.5 kpc



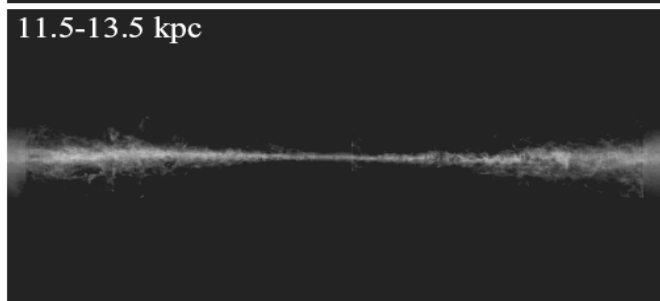
9.5-11.5 kpc



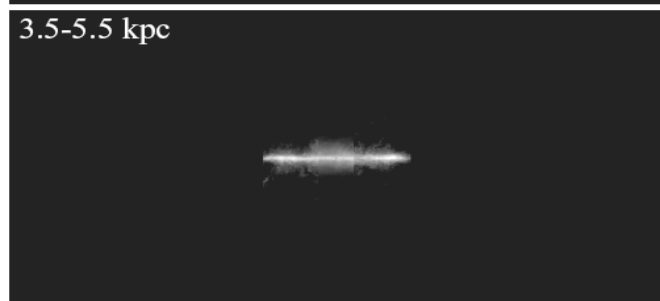
1.5-3.5 kpc



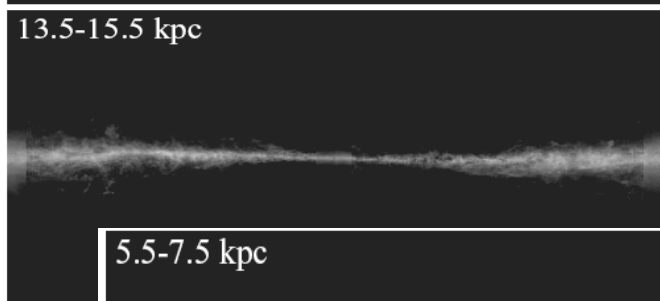
11.5-13.5 kpc



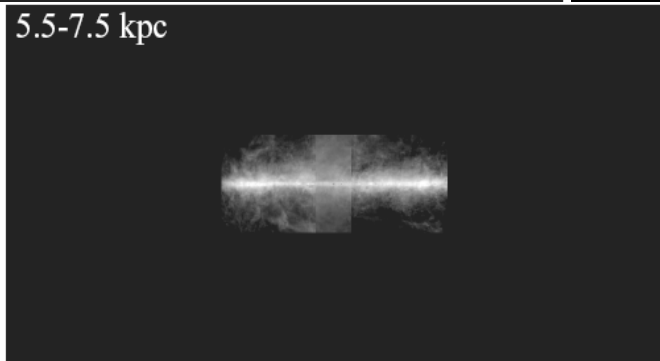
3.5-5.5 kpc



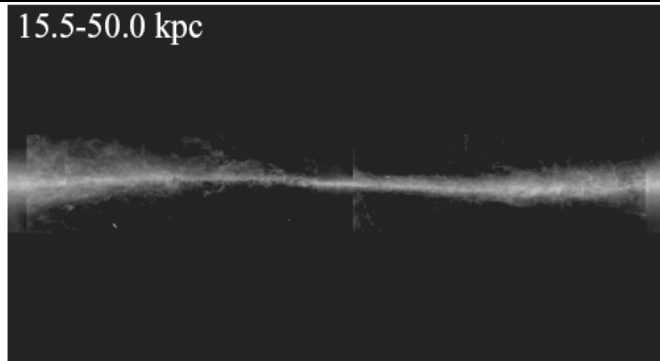
13.5-15.5 kpc



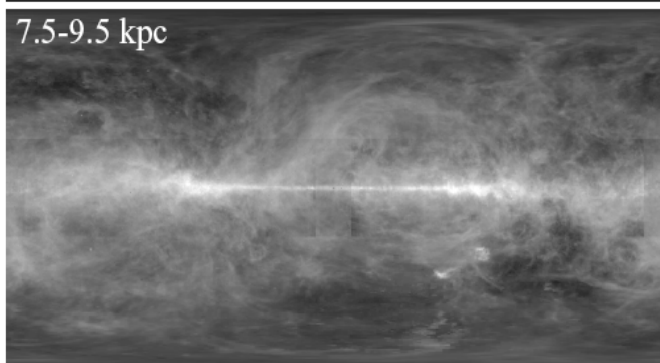
5.5-7.5 kpc



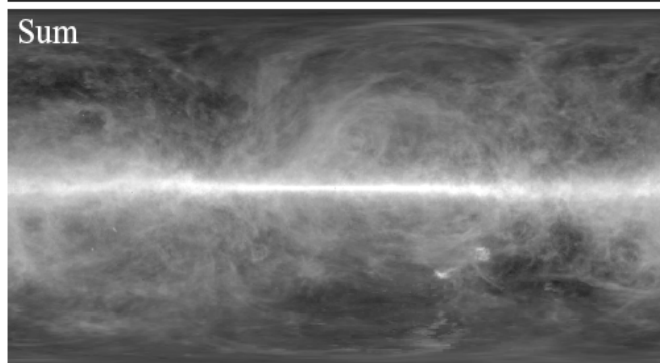
15.5-50.0 kpc



7.5-9.5 kpc



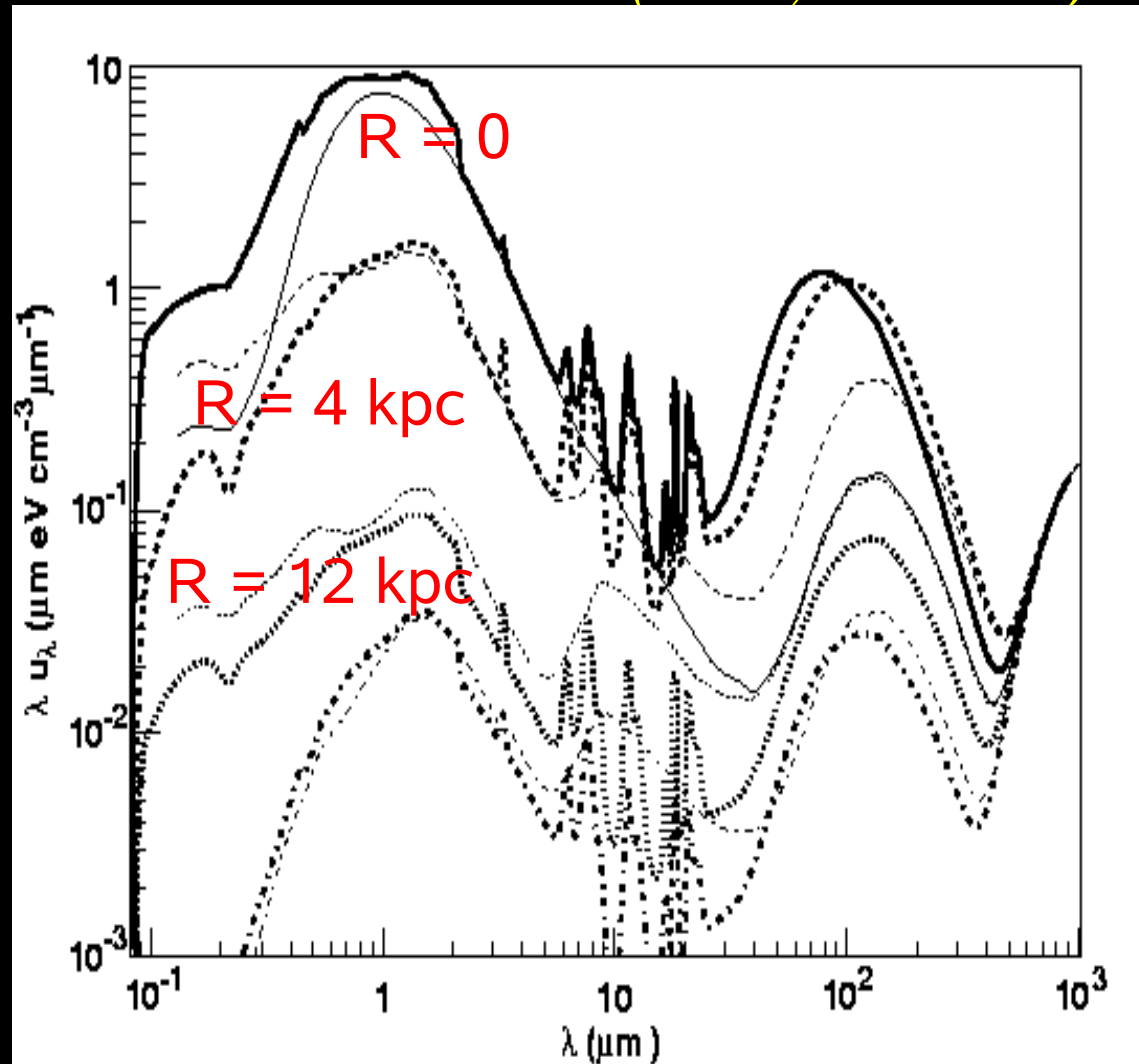
Sum



Gas Rings: HI  
Inner &  
Outer Galaxy

Gas Rings: HI  
Local Galaxy

Interstellar Radiation Field  
(for electron dE/dt, inverse Compton  $\gamma$ -rays):  
new model (*Troy Porter*)



UV optical

IR

FIR

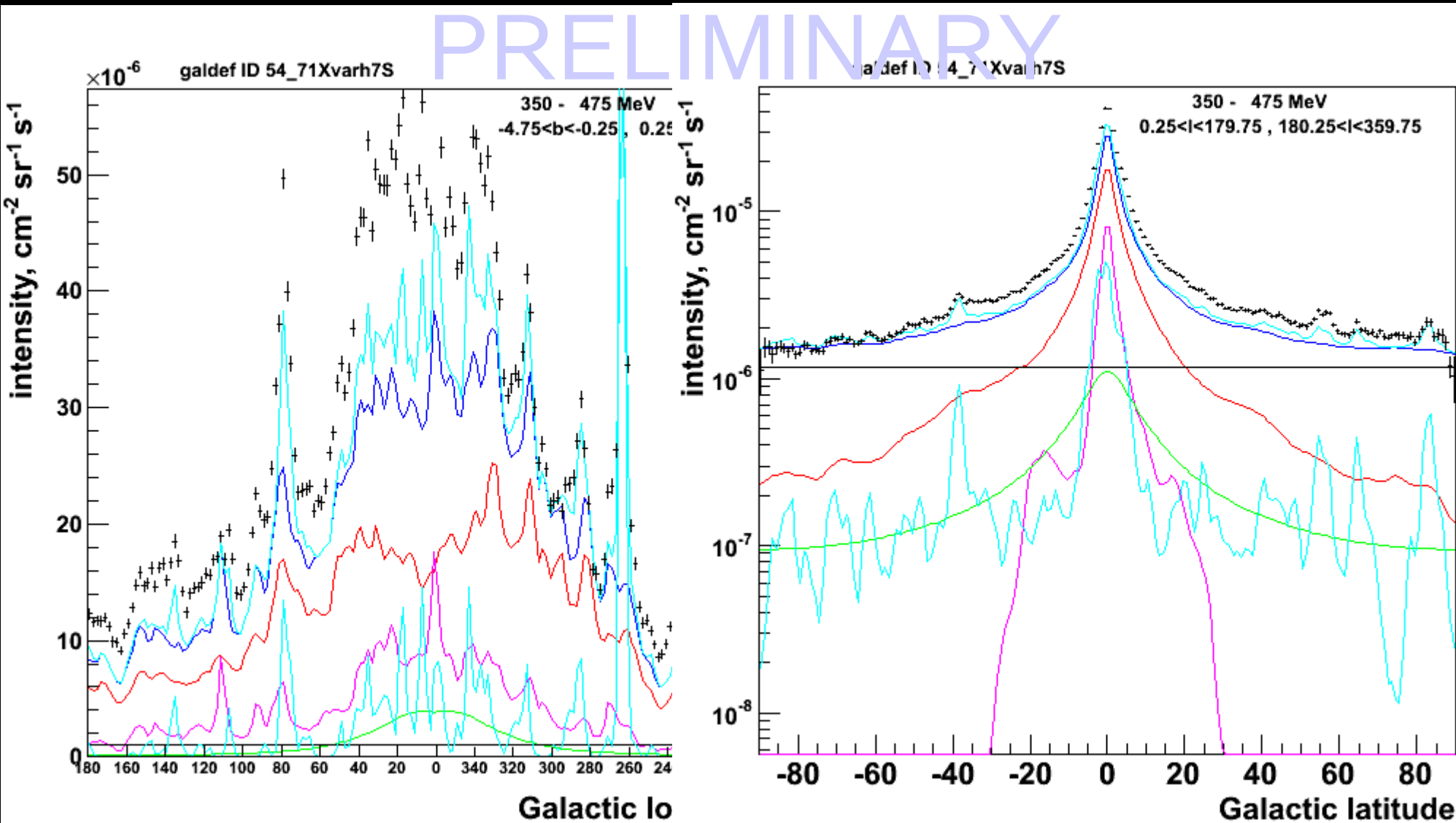
CMB



# *a priori* model with Fermi electron spectrum

LONGITUDE PROFILE

LATITUDE PROFILE



*generally too low*



not bad for an *a priori* model prediction

but generally too low

this means either more CR electrons and/or protons

model fitting guides us to a better model:

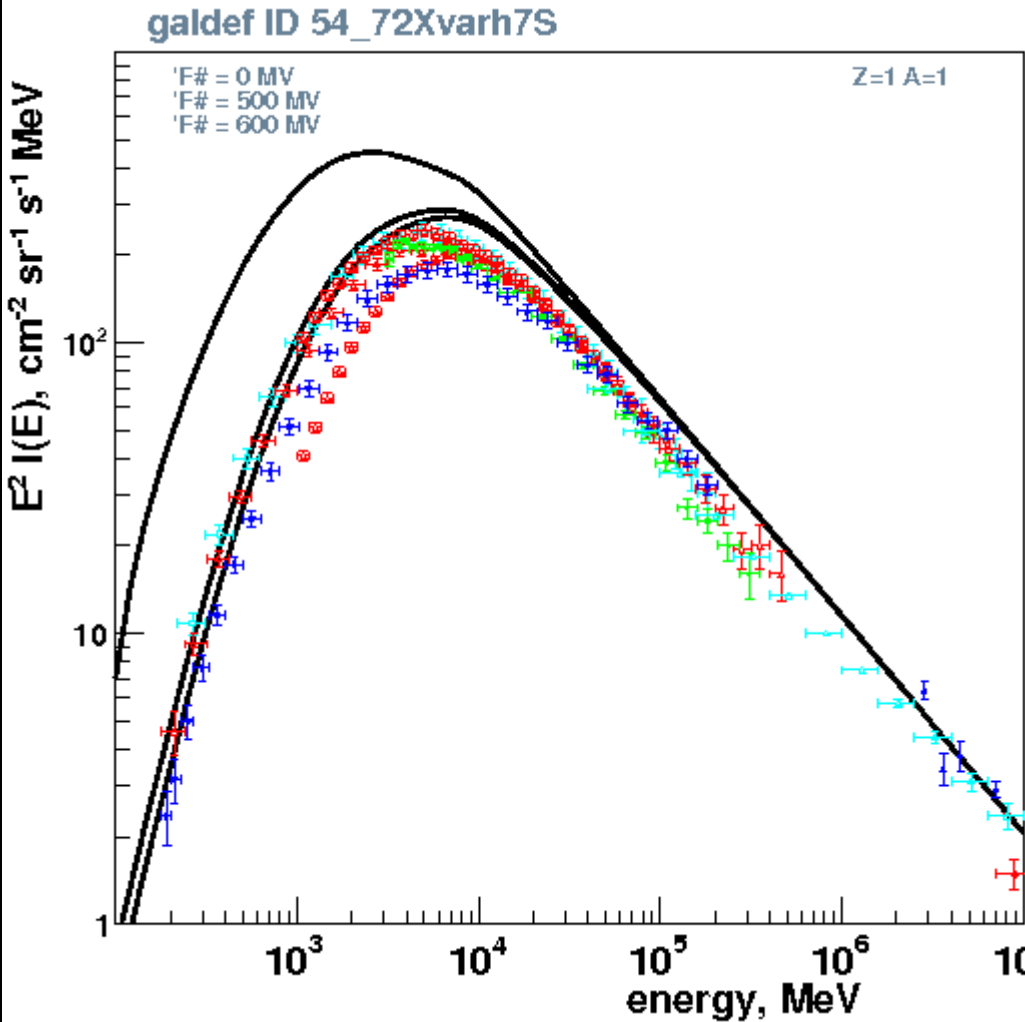
**electrons increased by factor ~2**

**protons increased by ~15%**

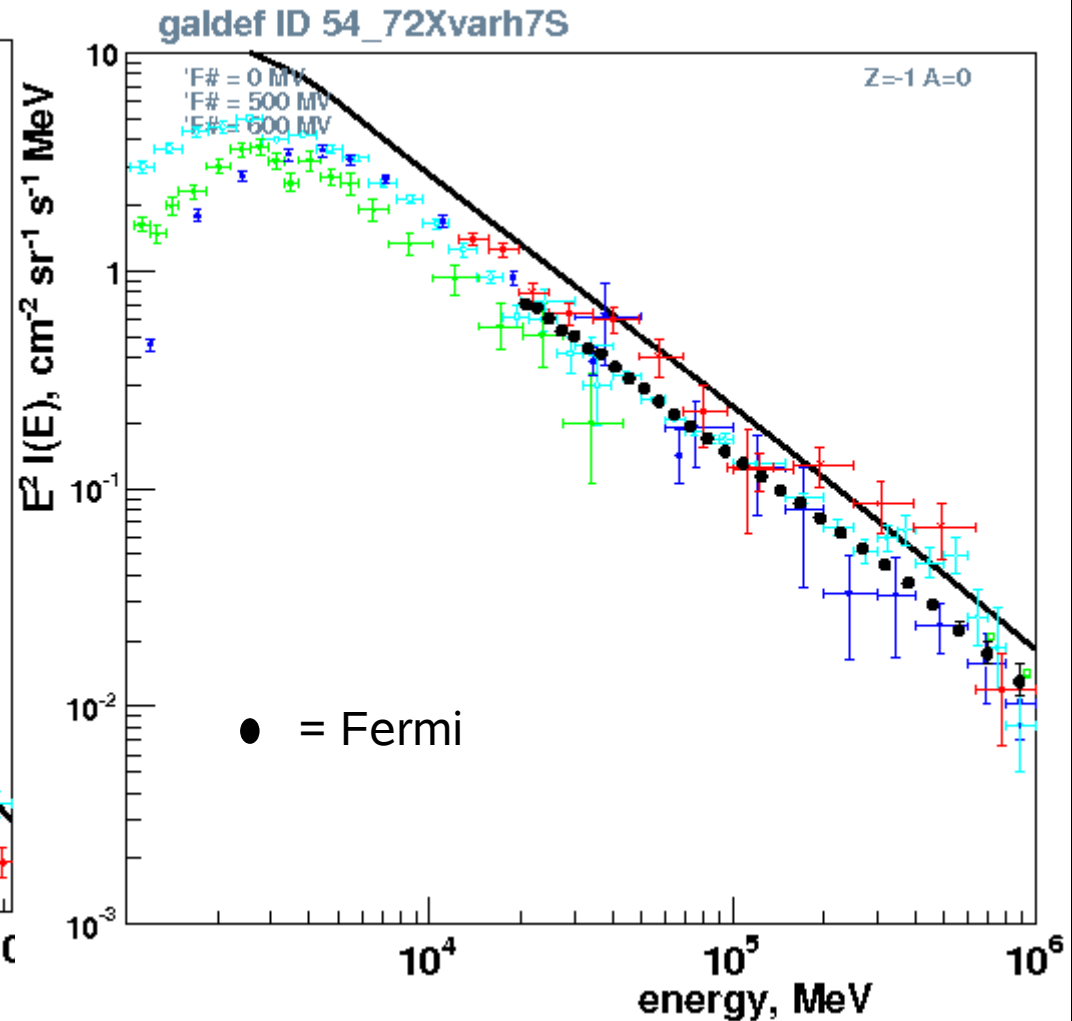


# Improving the model with increased CR

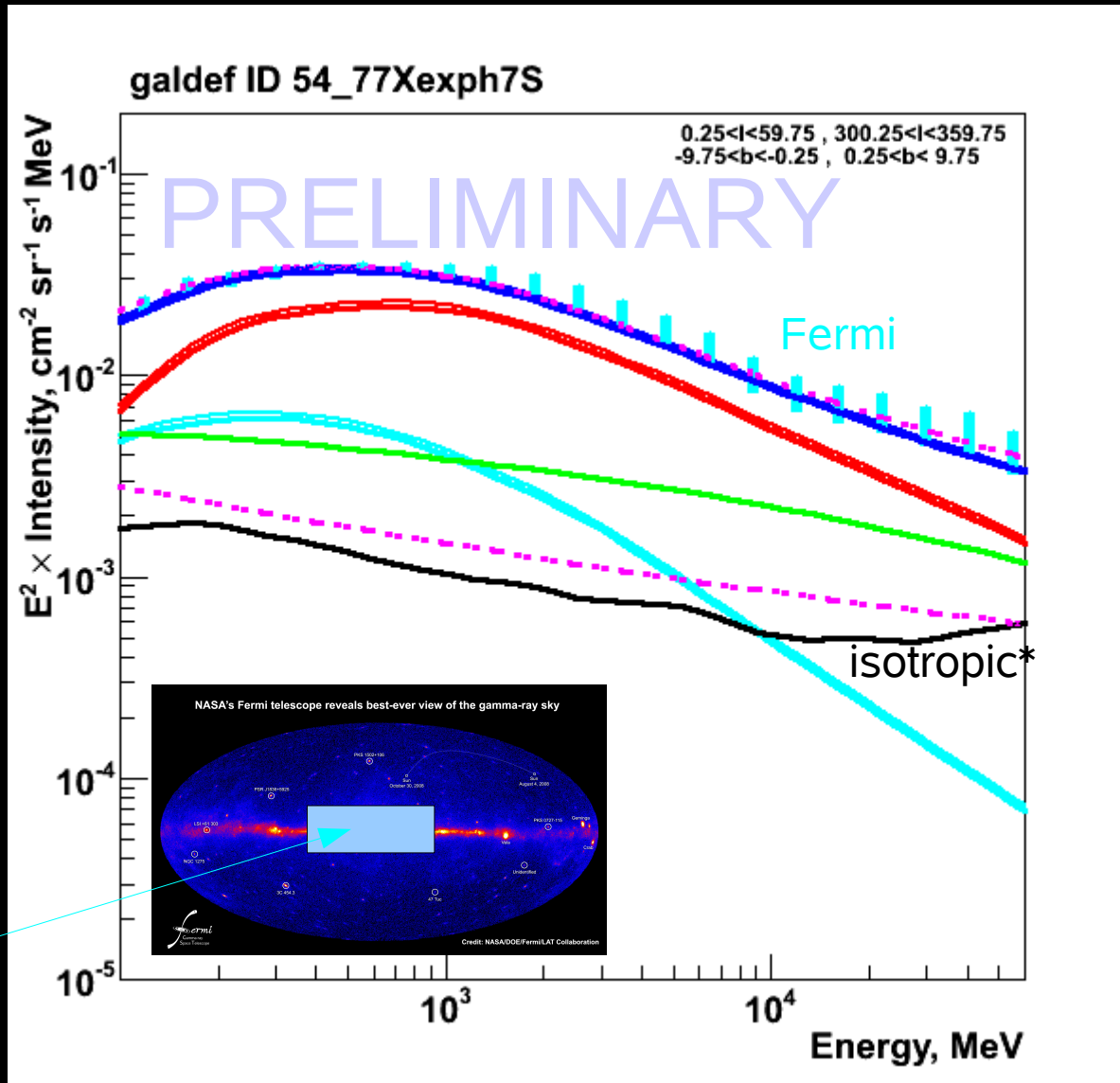
## PROTONS



## ELECTRONS



# model adjusted to Fermi INNER GALAXY



statistical +systematic  
errors

pion-decay

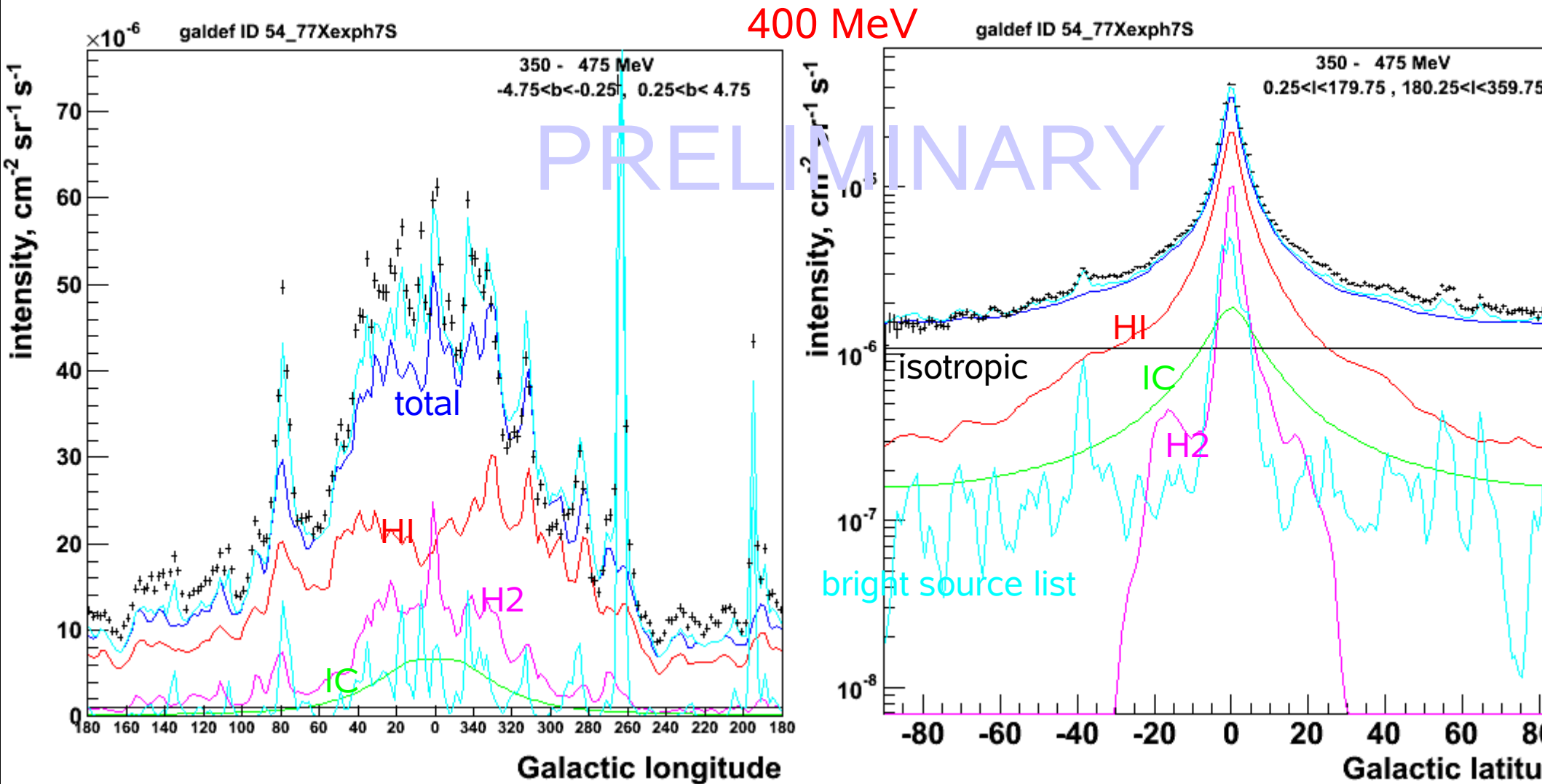
inverse Compton

LAT bright source list

bremsstrahlung

\* isotropic = instrumental plus astrophysical backgrounds

# Model adjusted to Fermi

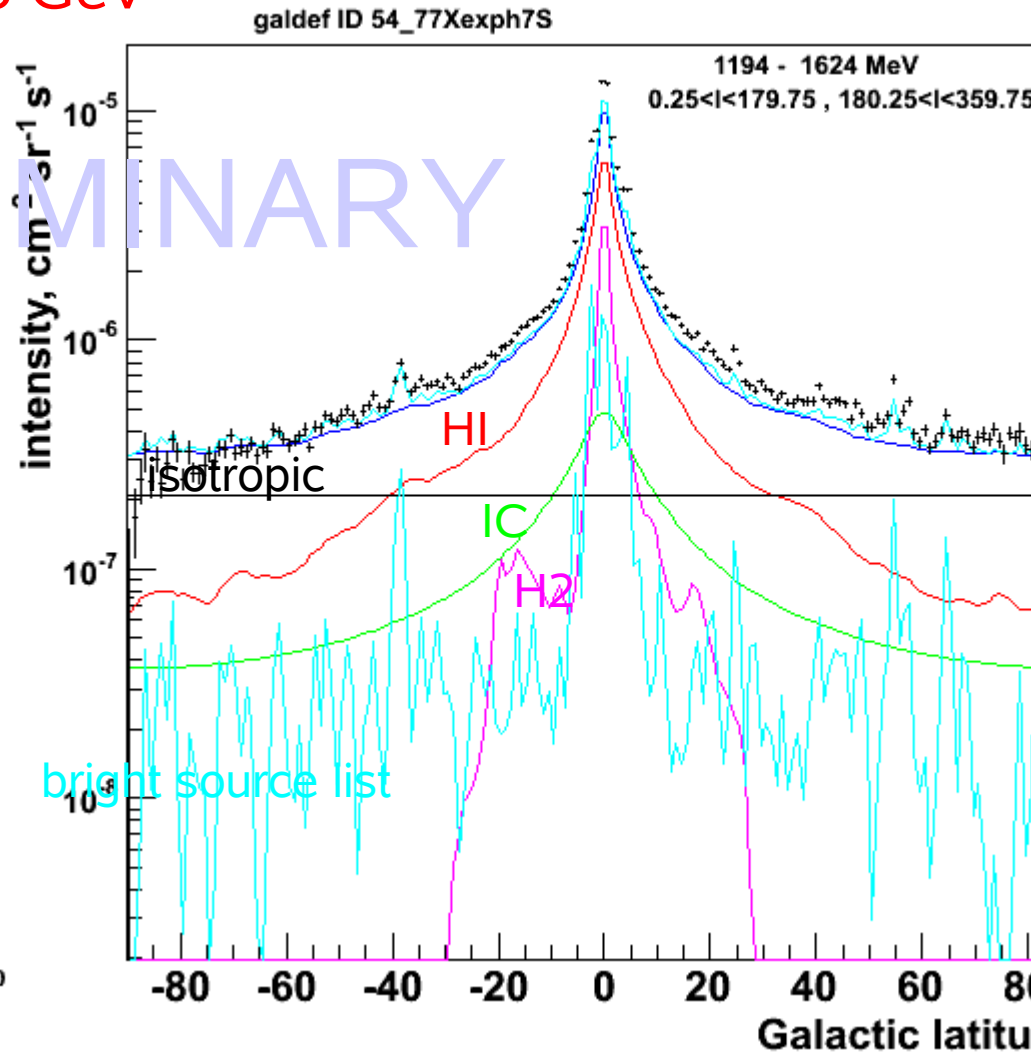
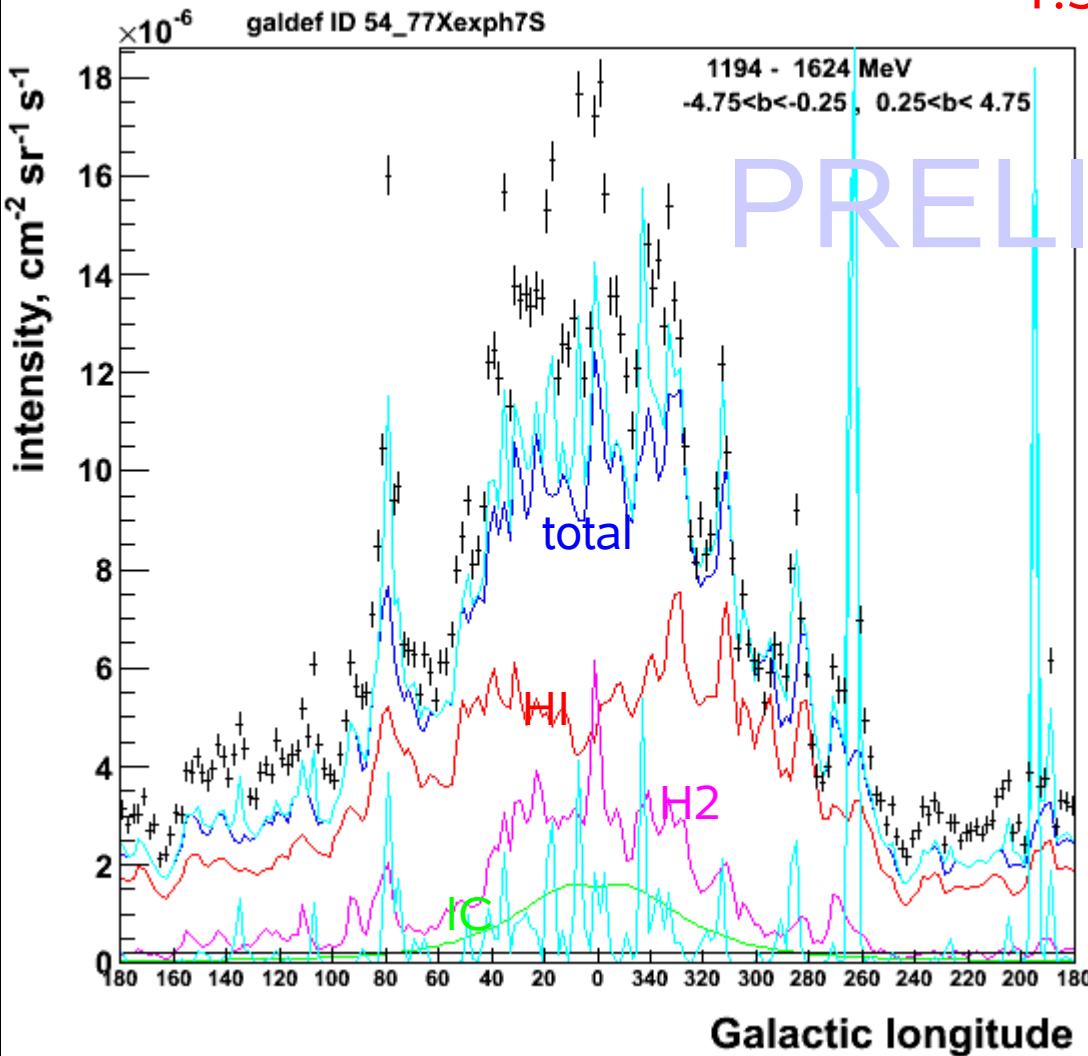


quite good, latitude fits from plane to poles over 2 decades dynamic range  
 importance of inverse Compton at high latitudes : gamma-ray halo !  
 unresolved sources may contribute and make up difference, not included !



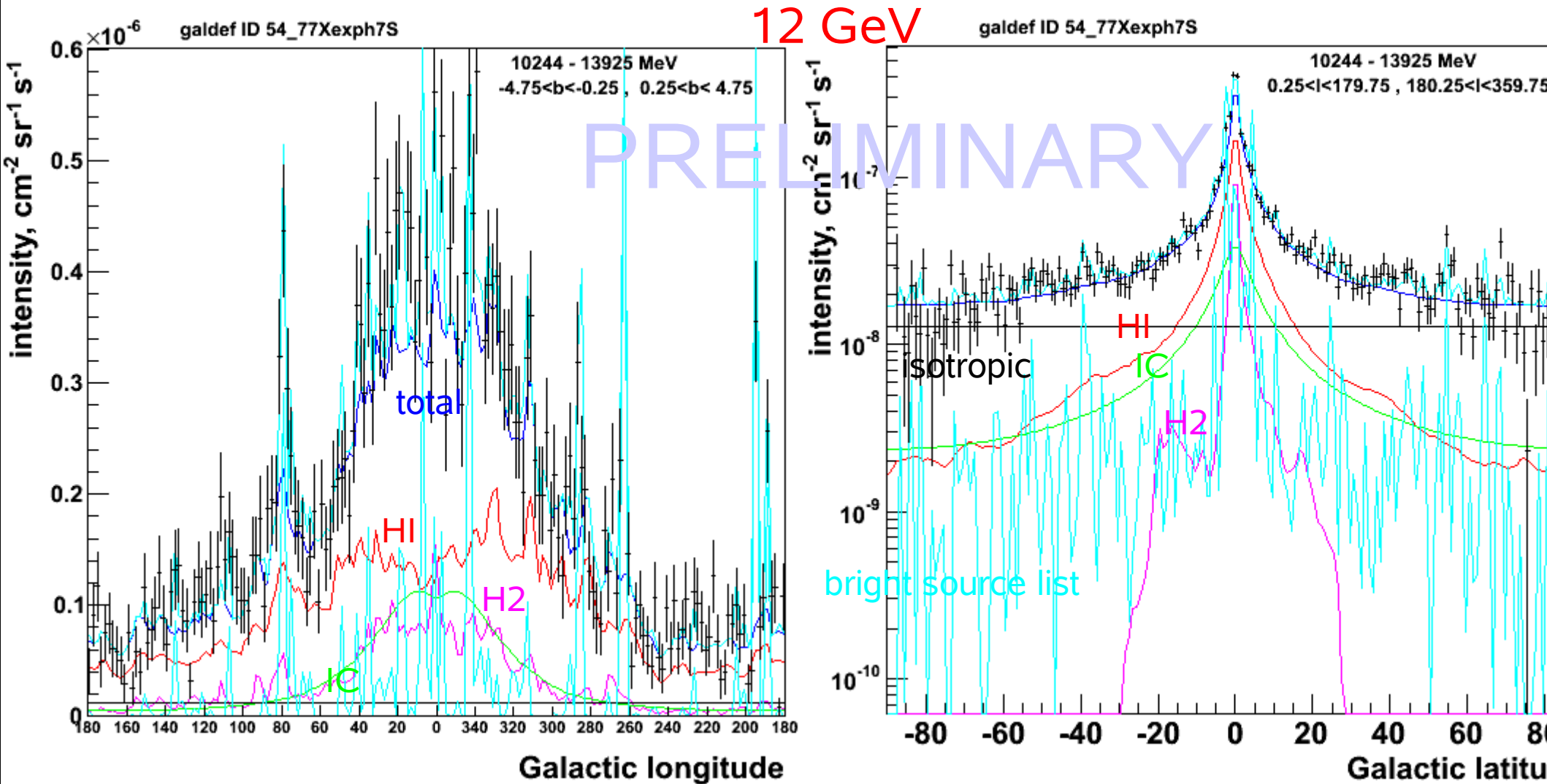
# Model adjusted to Fermi

1.3 GeV



quite good, latitude fits from plane to poles over 2 decades dynamic range  
importance of inverse Compton at high latitudes : gamma-ray halo !

# Model adjusted to Fermi



quite good, latitude fits from plane to poles over 2 decades dynamic range  
importance of inverse Compton at high latitudes : gamma-ray halo !

## CONCLUSIONS

Fermi does *not* confirm EGRET GeV excess

*a priori* model: agrees with Fermi at **intermediate latitudes**

has correct spectral shape but is rather low in the **inner Galaxy**

generally reasonable fit with **simple scaling** of CR protons, electrons  
over the sky and wide energy range

increased protons consistent with local CR data

increased electrons *inconsistent* with local CR data (including Fermi-measured)

increased inverse Compton : more electrons OR more ISRF or ..... ?

inverse Compton component at high latitudes : CR halo !

evidence for 'Dark gas' not traced by HI, CO

THESE RESULTS ARE PRELIMINARY - ONGOING WORK !

END