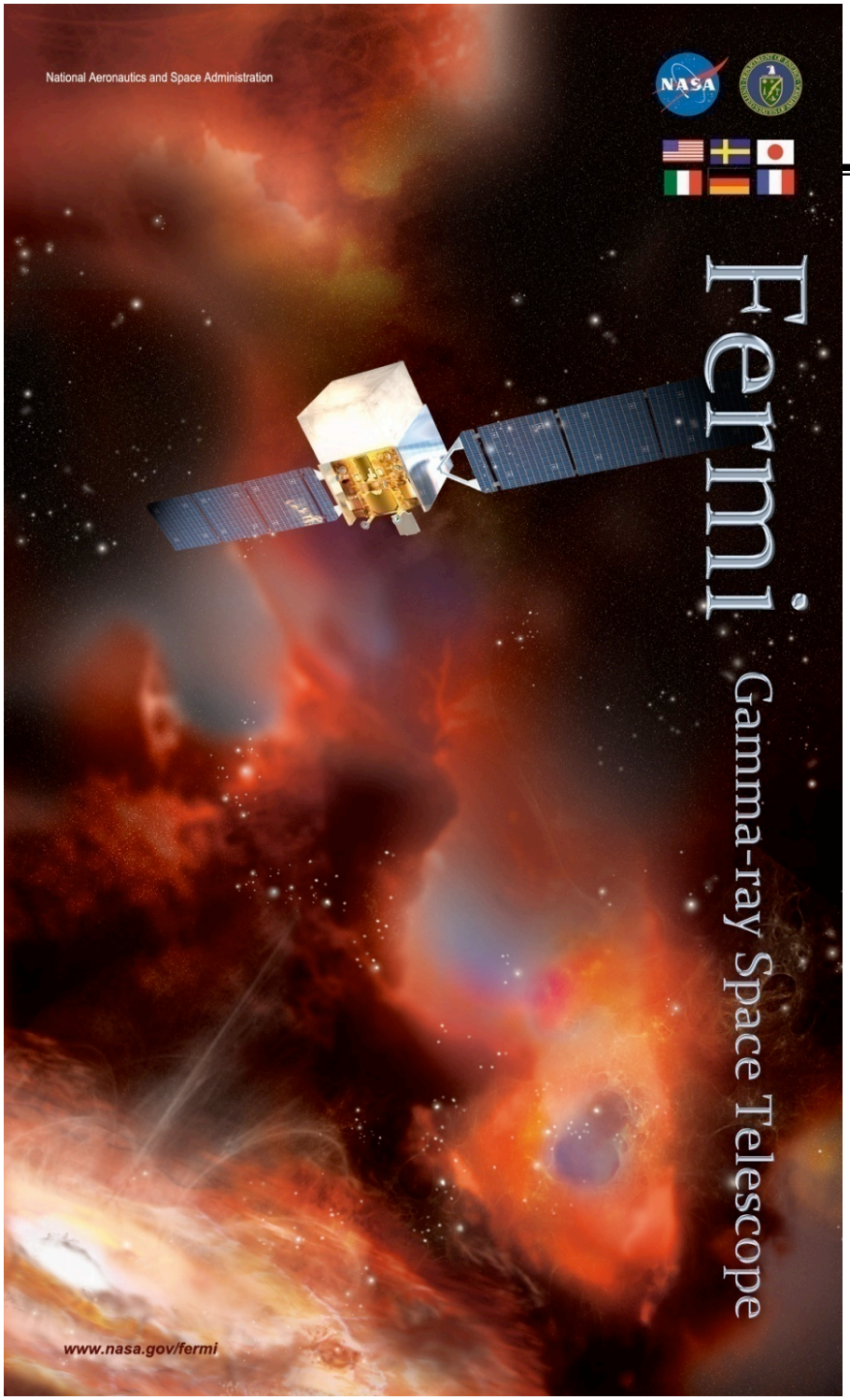


Fermi
Gamma-ray
Space Telescope

Fermi-LAT Observation of the Gamma-Ray Emission from the Sun

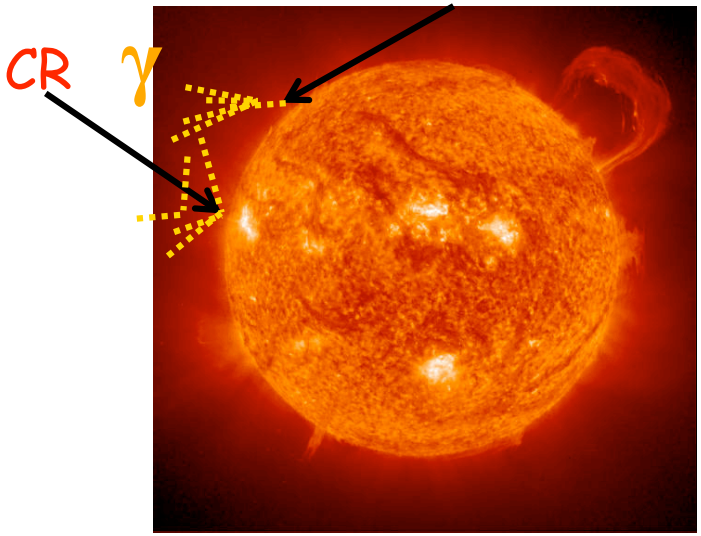
Elena Orlando

(MPE Garching)

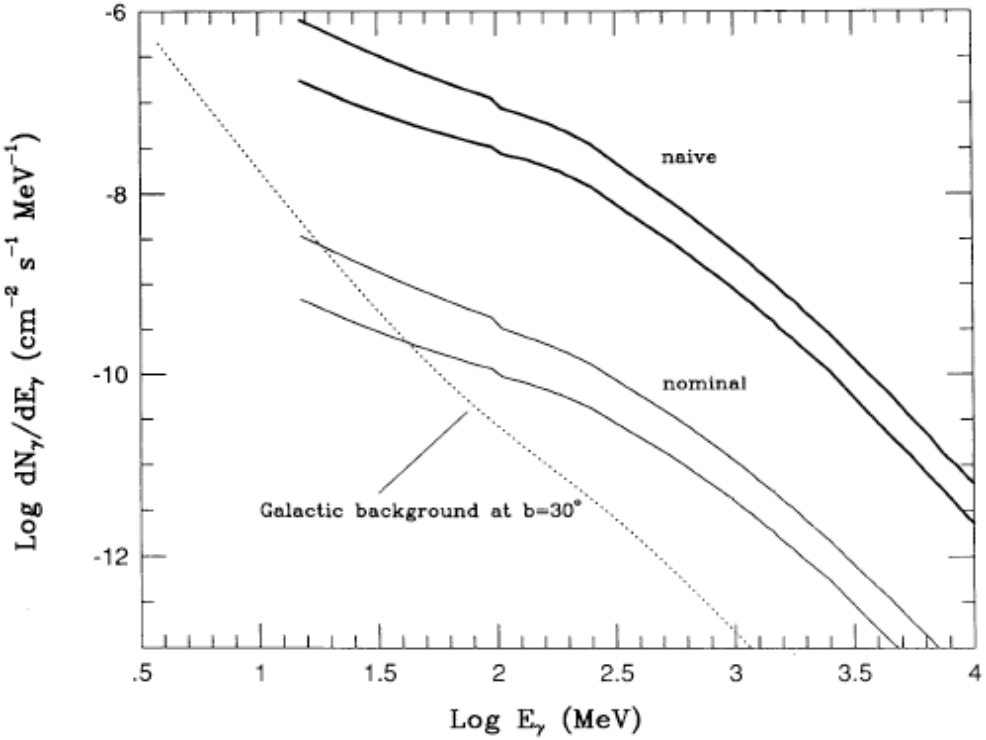
On behalf of the Fermi-LAT Collaboration

Quiet Sun: First emission mechanism

Hadronic interactions of cosmic rays with the solar atmosphere

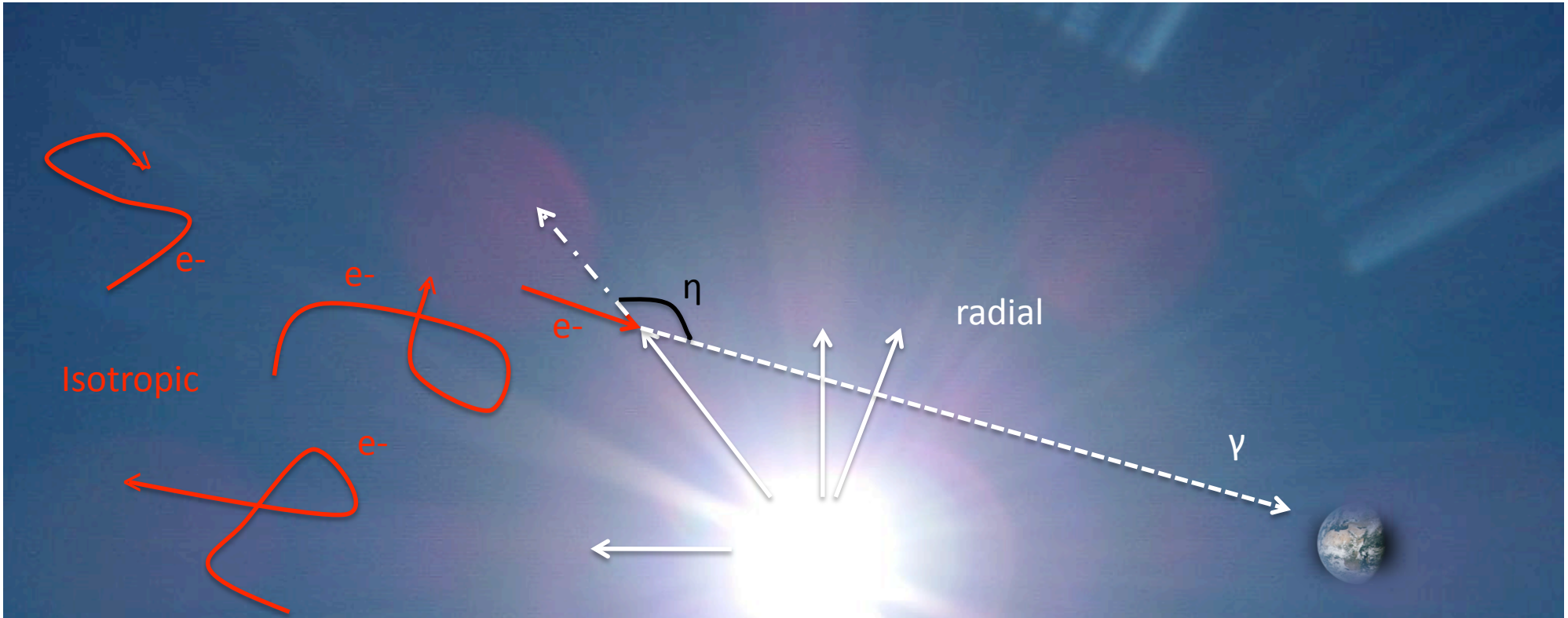


Disc emission: Seckel et al., 1991



Gamma-ray flux ➔ cosmic-ray flux ➔ solar activity

Quiet Sun: Another mechanism: Inverse Compton emission



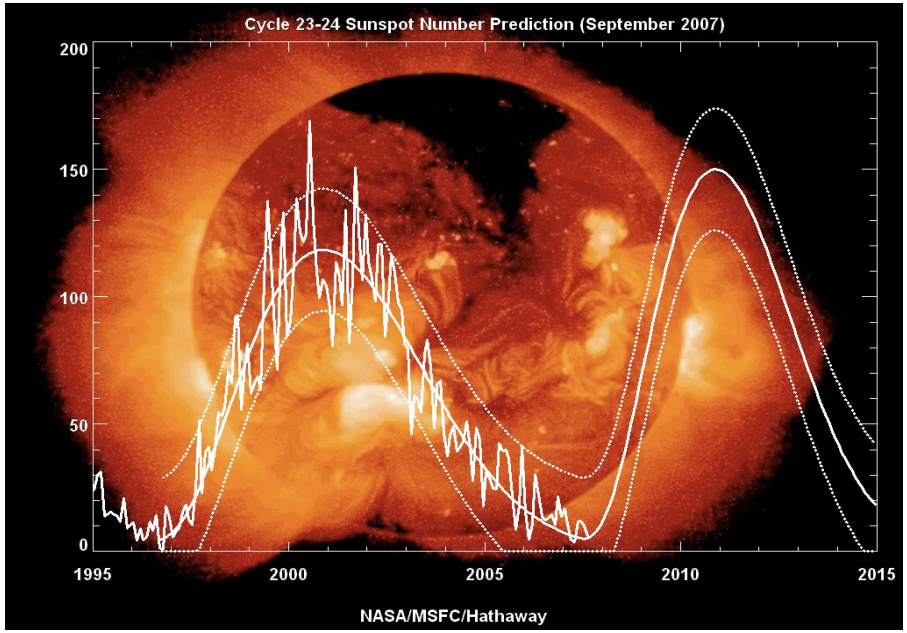
✓ Solar black-body distribution (T=5777 K)

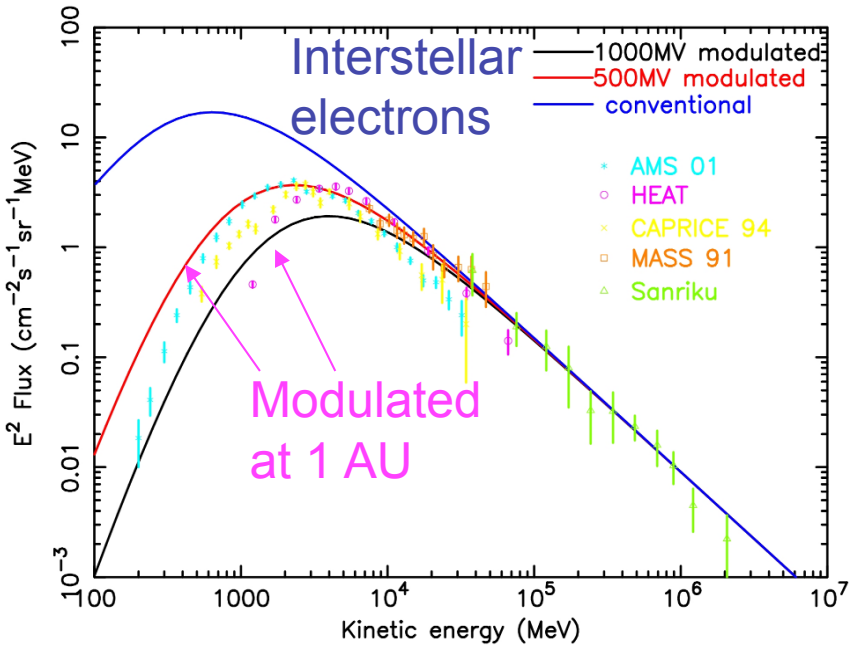
✓ Modulated CRe$^-$ spectrum

Moskalenko et al.+'06, Orlando&Strong'07

Cosmic-ray modulation

Max solar activity -> min cosmic-ray flux
Min solar activity -> max cosmic-ray flux

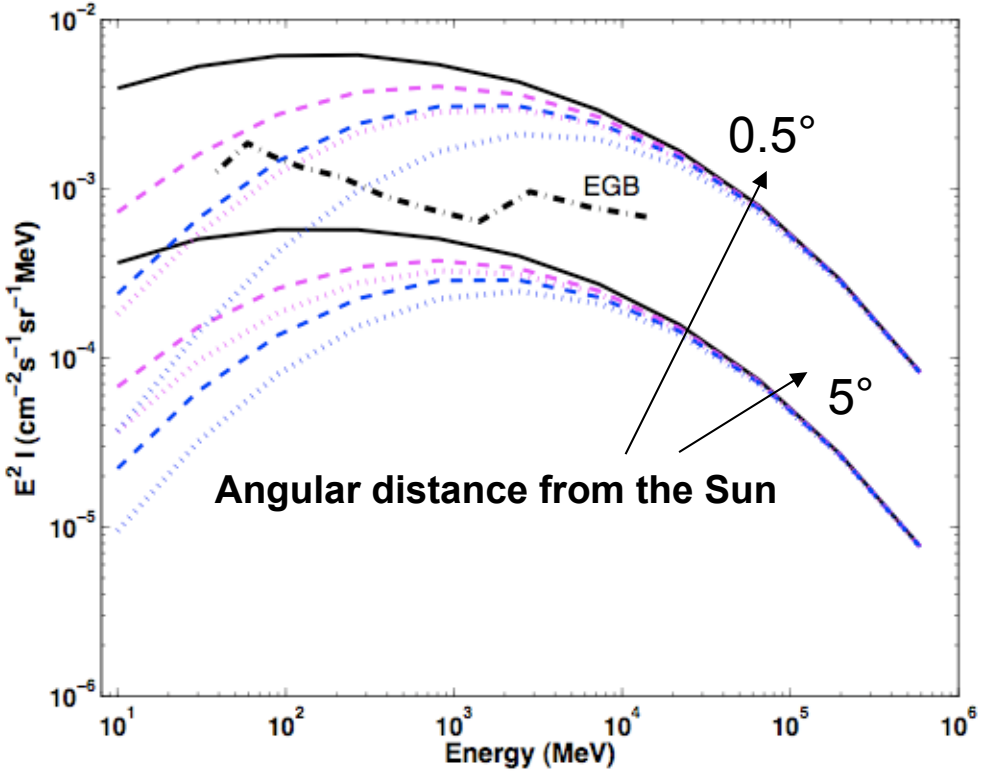


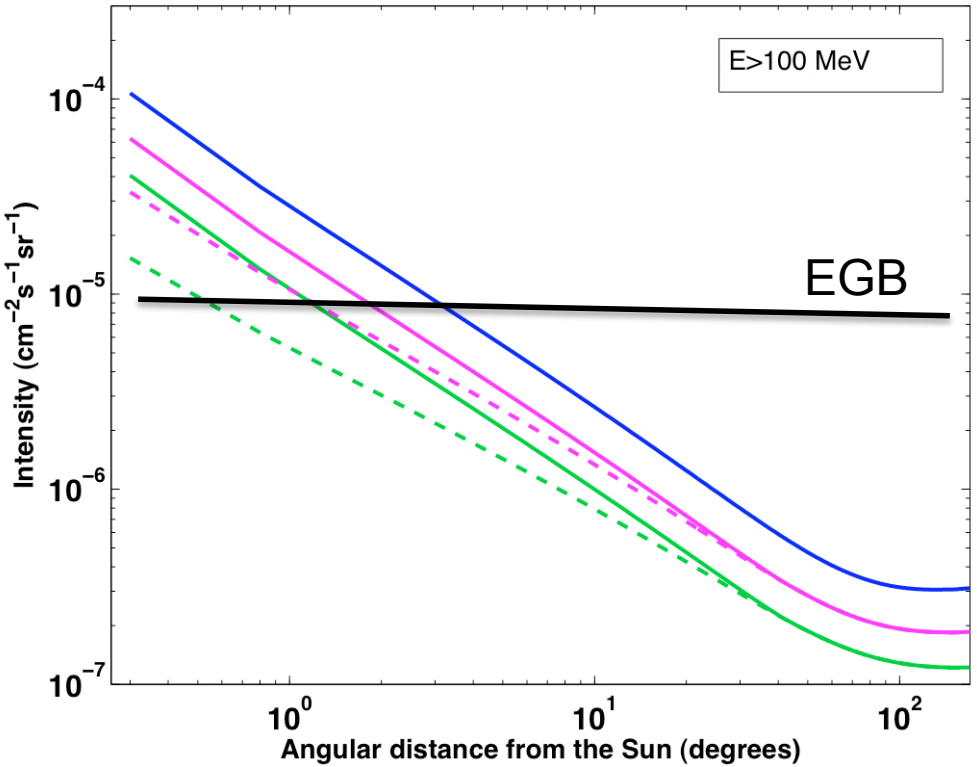


- **Solar Activity is now at its minimum**
- **Fermi operates for nearly the entire duration of solar cycle 24**

Models of IC solar emission

Inverse Compton emission: Moskalenko et al. 2006, Orlando&Strong 2007
First detection with EGRET: Orlando&Strong, 2008





Solar gamma rays -> info on the cosmic-ray spectra and modulation close to the Sun

Inverse Compton model: using electrons measured by Fermi

LAT data selection

- **1 year data**

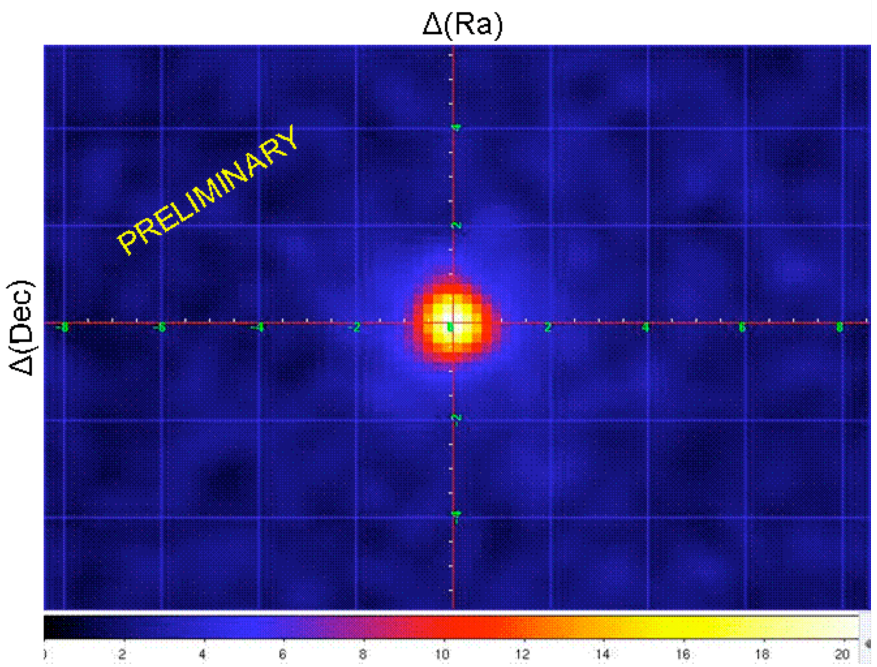
- **Analysis in Sun-centered system**

- **Zenith angle < 105° (to avoid the Earth's emission)**

- **Galactic Plane Cut (|b|>30°) (to reduce the background)**

- **Moon-Sun angular separation >20°**

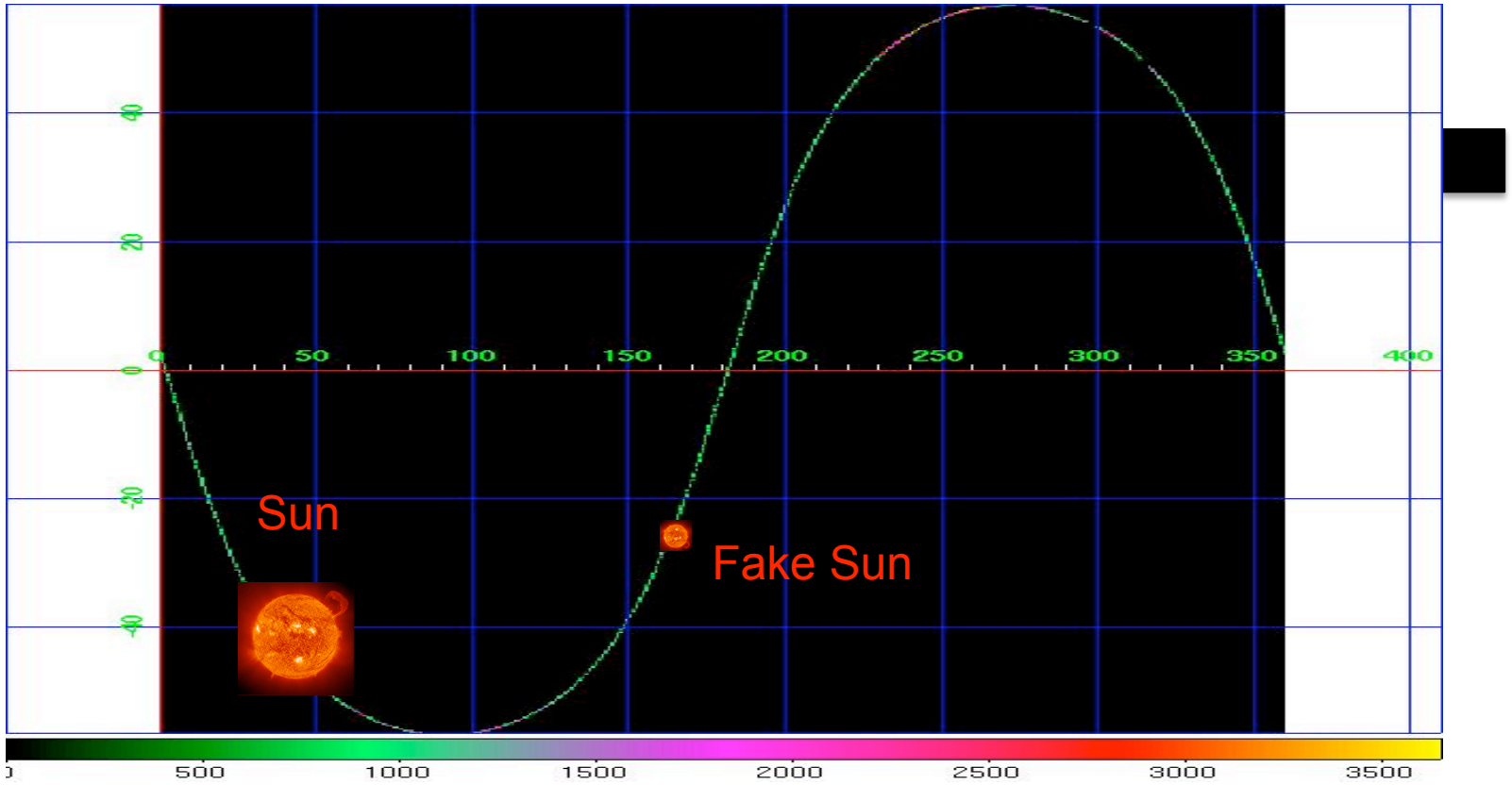
- **Avoided the brightest sources (Flux(>100 MeV) above 5e-7 $cm^{-2}s^{-1}$)**



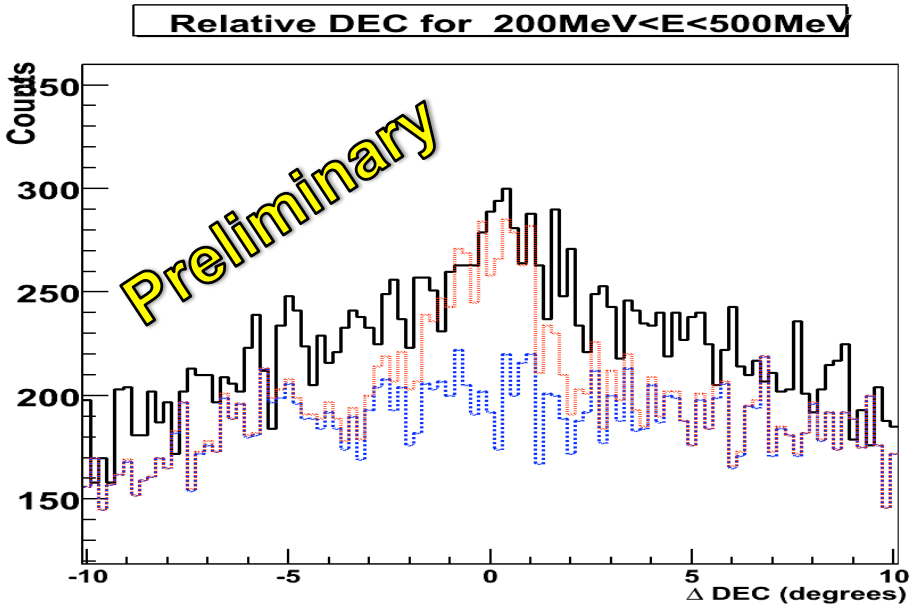
Counts map >100 MeV

Background estimation

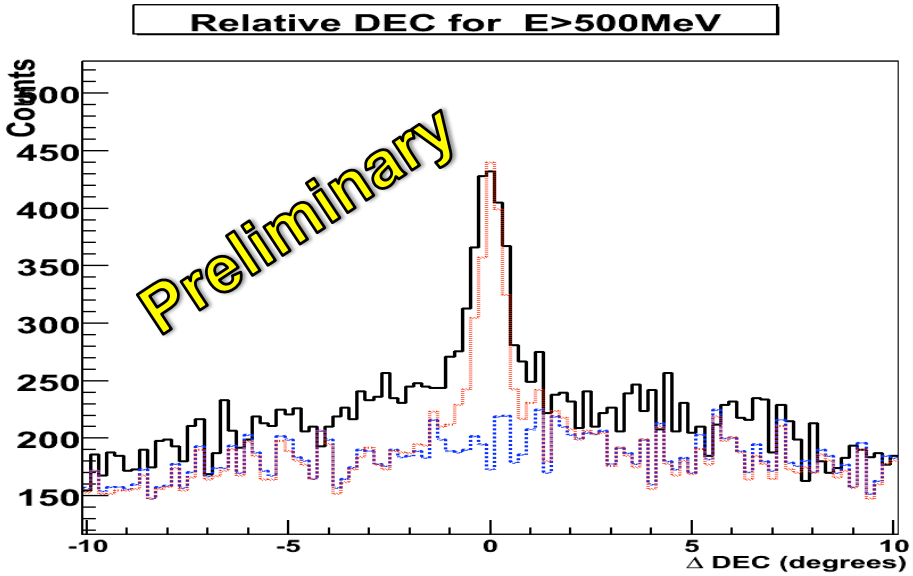
- **The "fake" source method: A fake source follows the path of the real source but 30 degrees away (it passes through the same areas on the sky but at different times)**



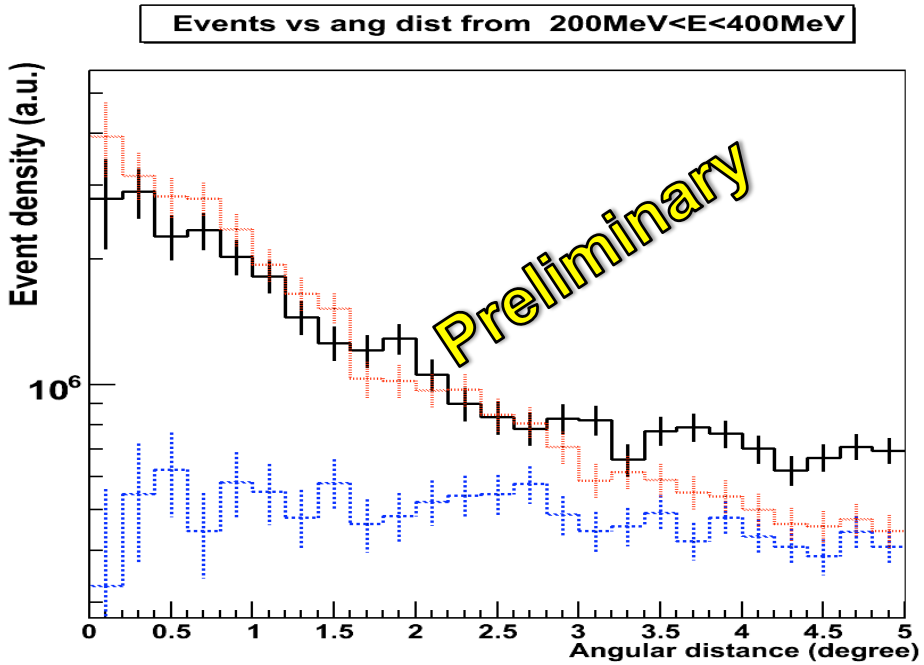
Angular profiles

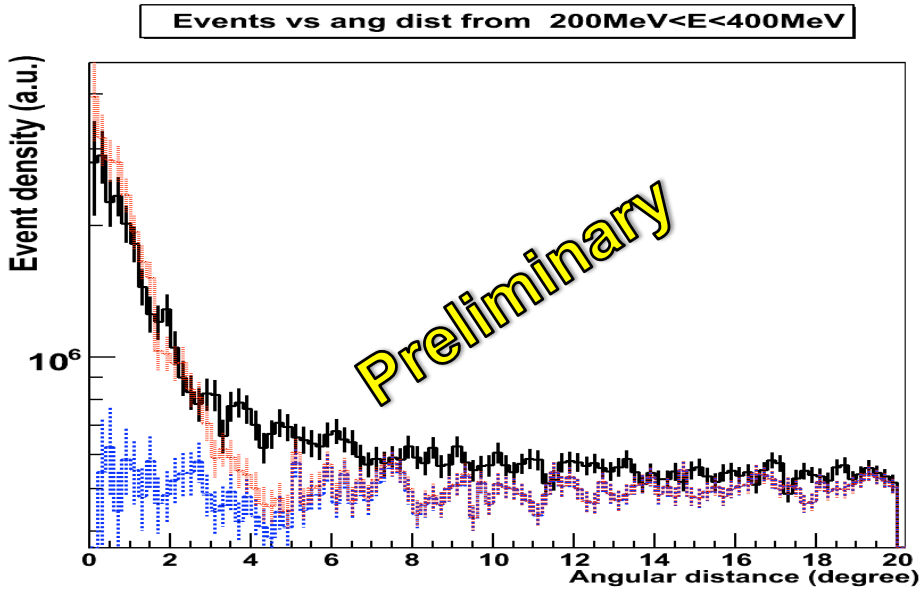


- BKG
- BKG+point source
- Data



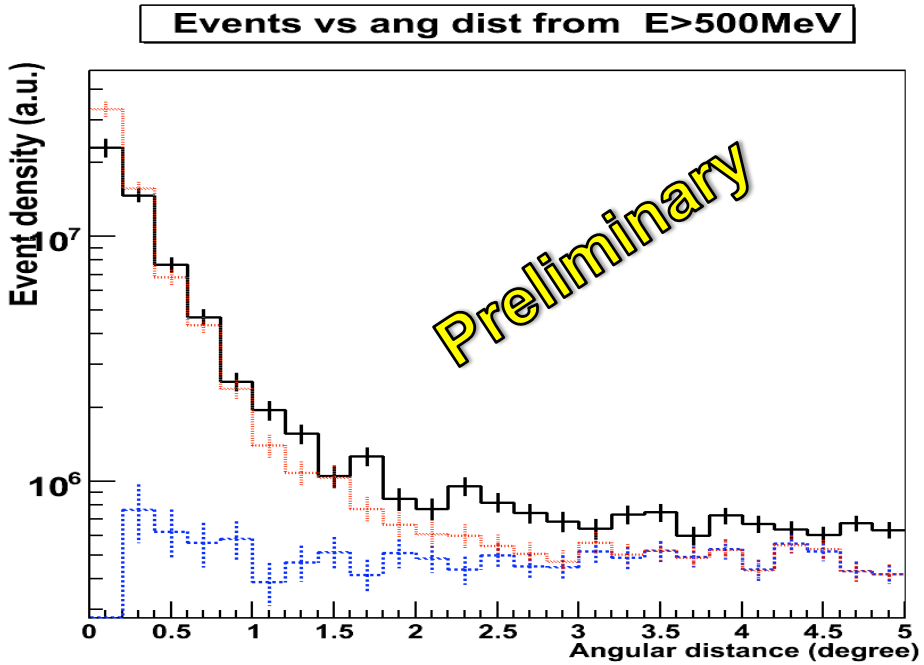
Angular profiles

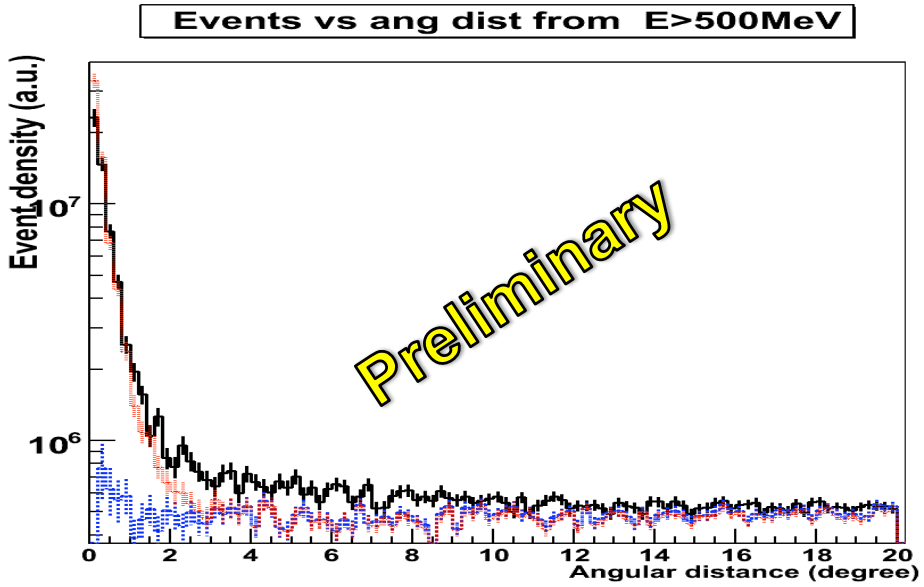




- BKG
- BKG+point source
- Data

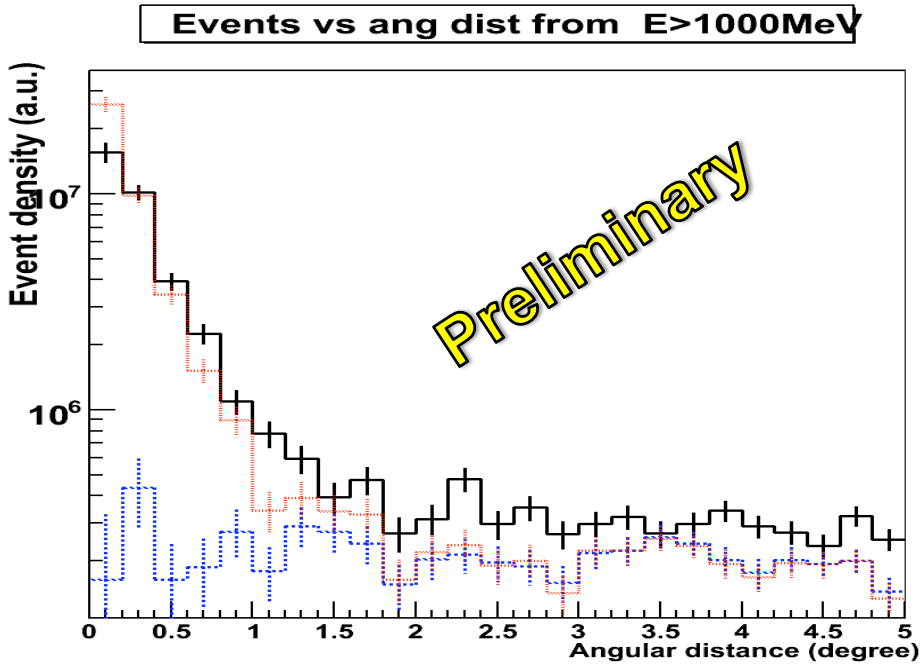
Angular profiles

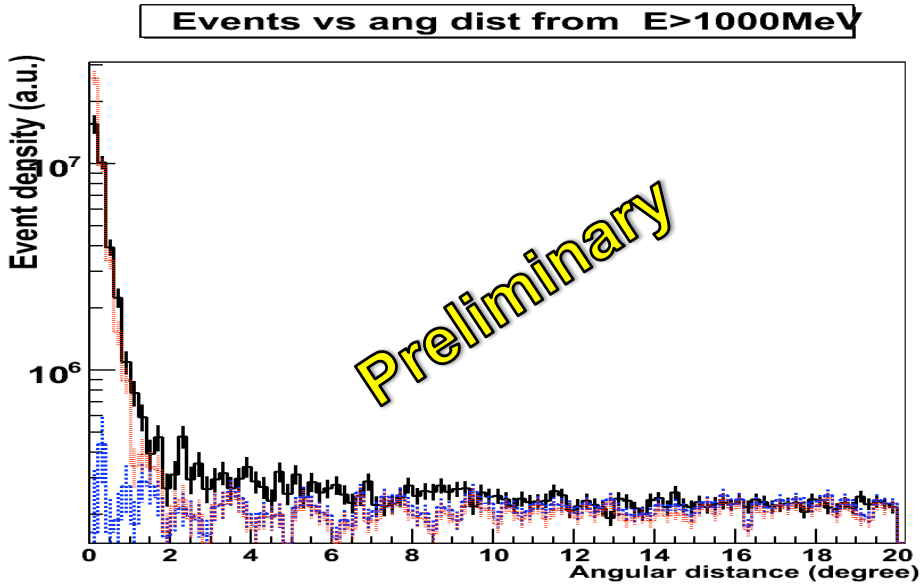




- BKG
- BKG+point source
- Data

Angular profiles





- BKG
- BKG+point source
- Data

Maximum likelihood fitting results

100 MeV - 1 GeV, disc sp. index = -1.4

flux ($cm^{-2}s^{-1}$) within 15° radius

IC flux	disc flux
9.39e-7	2.02e-7

100 MeV - 1 GeV, disc sp. index = -2

flux ($cm^{-2}s^{-1}$) within 15° radius

IC flux	disc flux
8.77e-7	3.0e-7

> 1 GeV, disc sp. index = -2

flux ($cm^{-2}s^{-1}$) within 15° radius

IC flux	disc flux
8.57e-8	2.5e-8

> 1 GeV, disc sp. index = -3

flux ($cm^{-2}s^{-1}$) within 15° radius

IC flux	disc flux
6.57e-8	3.36e-8

Disc and IC spectrum depends on solar modulation, that is not exactly known

detection>40σ

* The values of the fluxes still vary with the disc spectral index assumed. The different values give the systematic errors.

IC Flux(>100 MeV, 15deg) = (11±3.5) 10^{-7} $cm^{-2}s^{-1}$
Disc Flux(>100MeV)=(3.0±1.5) 10^{-7} $cm^{-2}s^{-1}$

with systematics

Still uncertain by a factor of 2, since model dependent

Summary

- ✓ Quiet solar emission detected and two components clearly separated for the first time
- ✓ Fluxes obtained in agreement with models

BUT …

- ➢ Inverse Compton flux is model dependent ➔ still some uncertainties

FINAL RESULTS EXPECTED SOON!