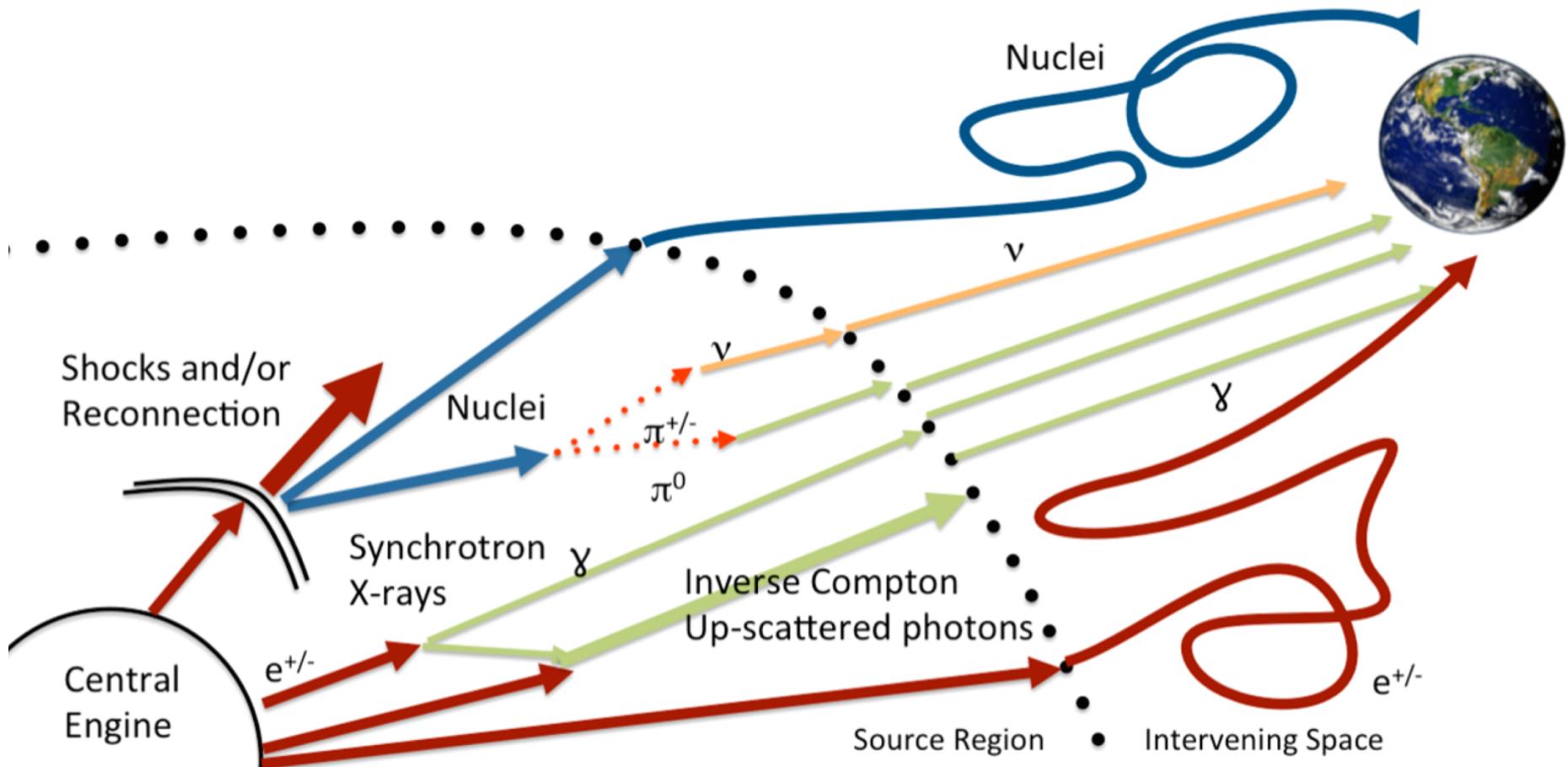


# L'Astrofisica dei Raggi Gamma

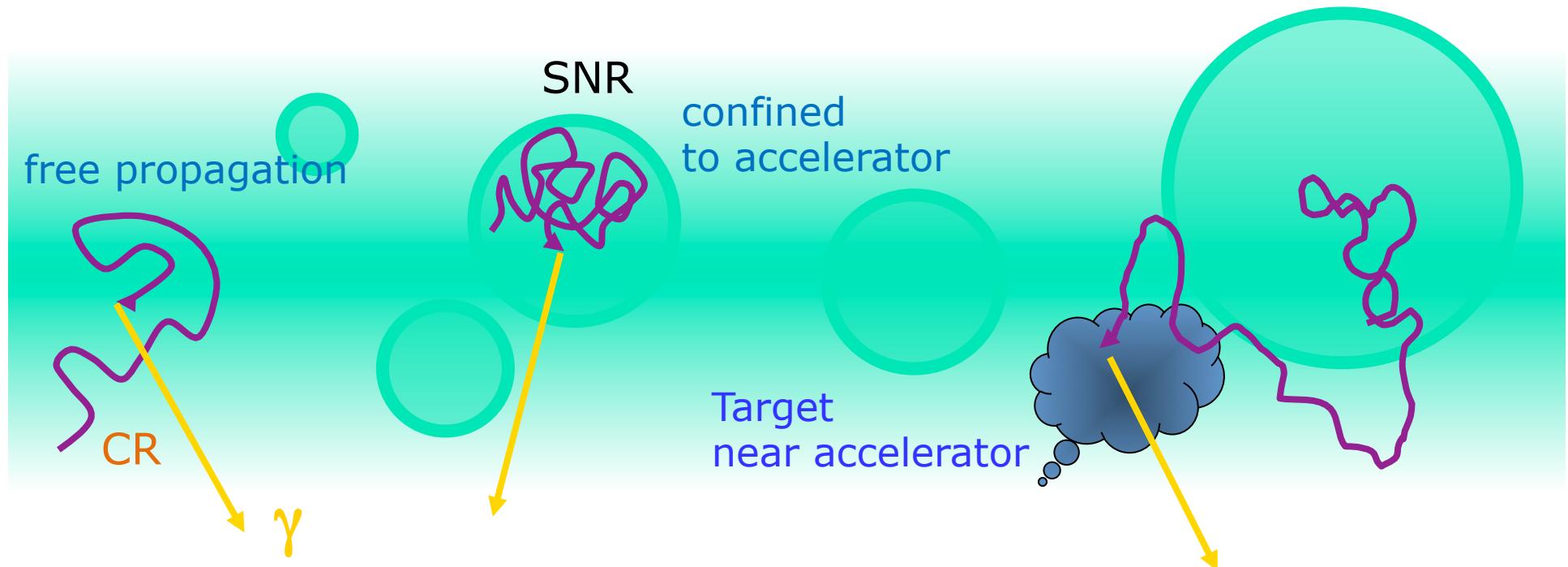
## Connessioni con I Raggi Cosmici

[francesco.longo@ts.infn.it](mailto:francesco.longo@ts.infn.it)

# The Multimessenger sky



# Raggi Cosmici e gamma

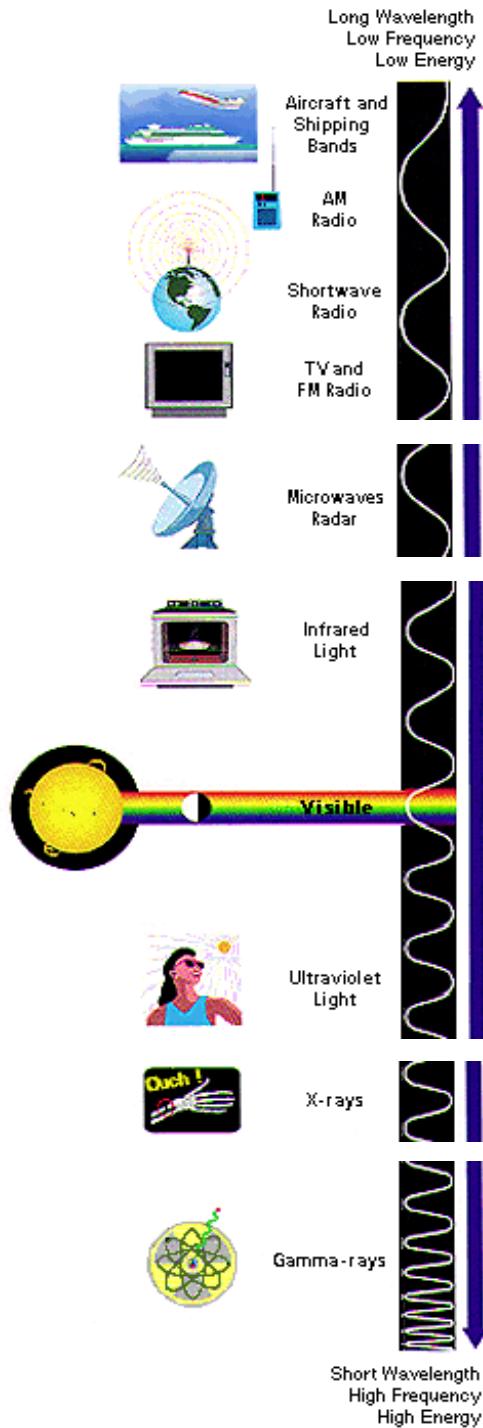


**Gamma rays from secondary interactions:**

p:  $\pi^0$  production and decay

e: Inverse Compton scattering and Bremsstrahlung

**Trace beam density  $\times$  target density**



# Lo spettro elettromagnetico

- insieme di fotoni (particelle senza massa) che si muovono come onde e viaggiano alla velocità della luce
- ogni fotone ha una certa quantità di energia
- l'unica differenza tra le varie radiazioni elettromagnetiche è l'energia dei fotoni

# Onde Radio, raggi di sole, foton Gamma

## Cosa sono e come si rivelano?



# Radio Telescopes



# Optical Telescopes



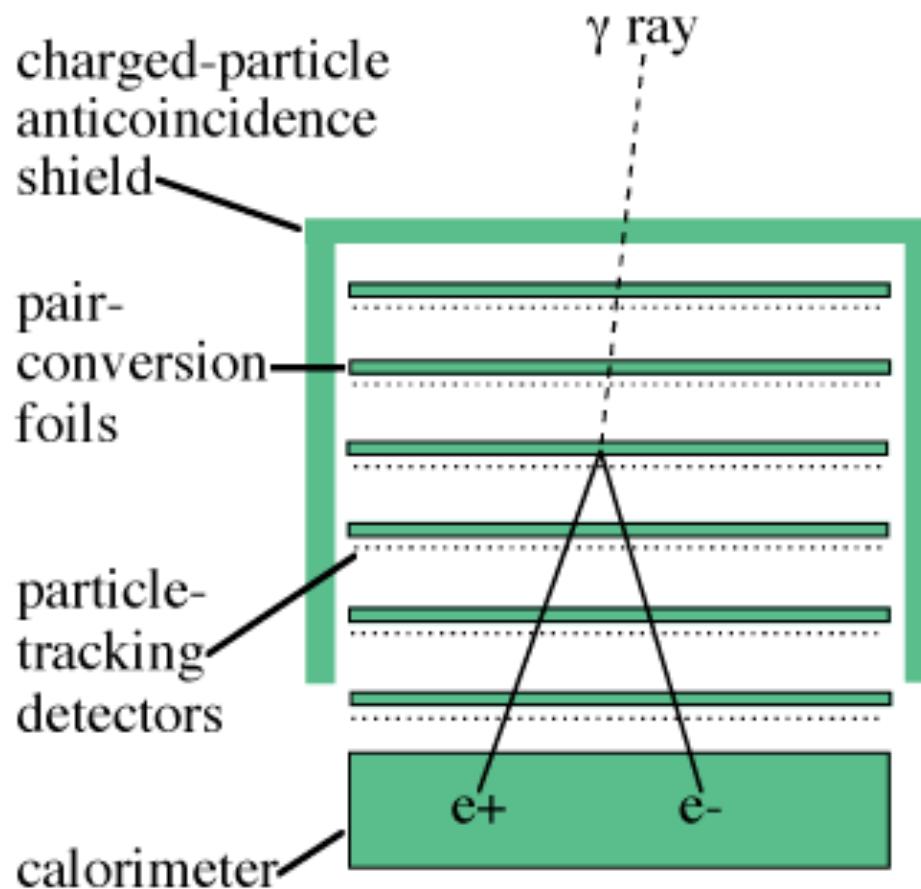
# X-ray telescopes



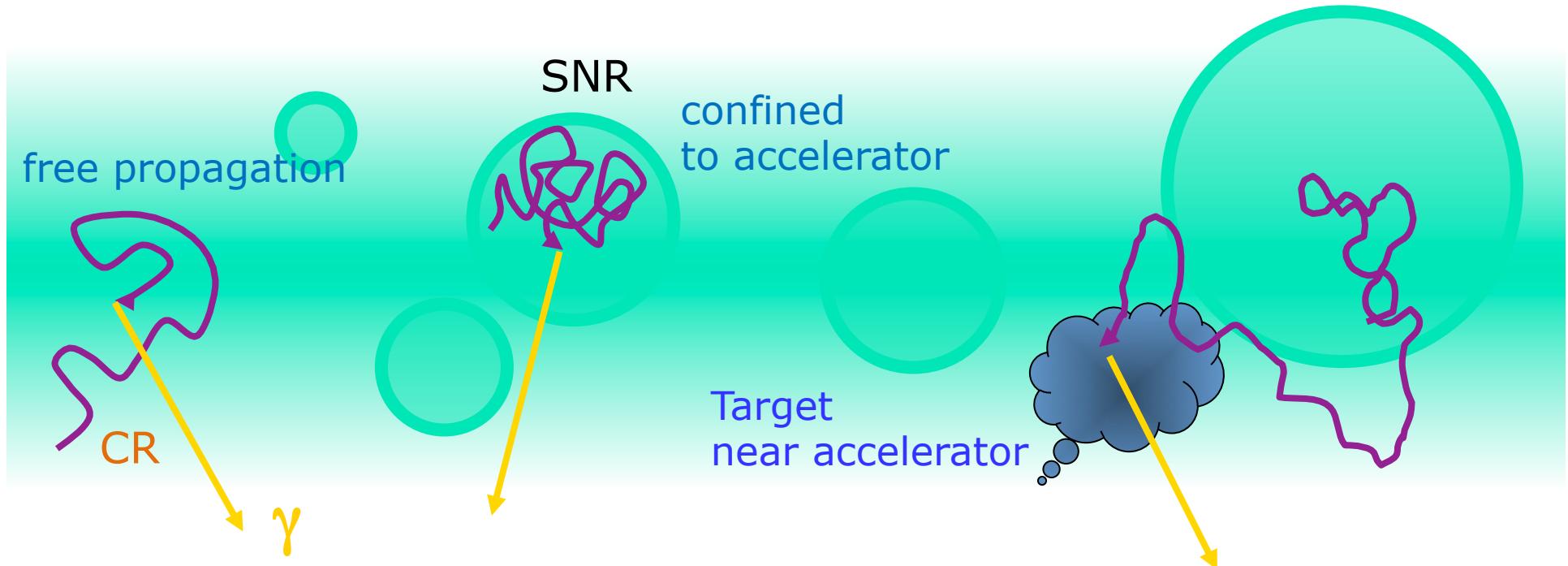
# Gamma-ray Telescopes



# La tecnica di rivelazione



# CR origin and propagation



**Gamma rays from secondary interactions:**

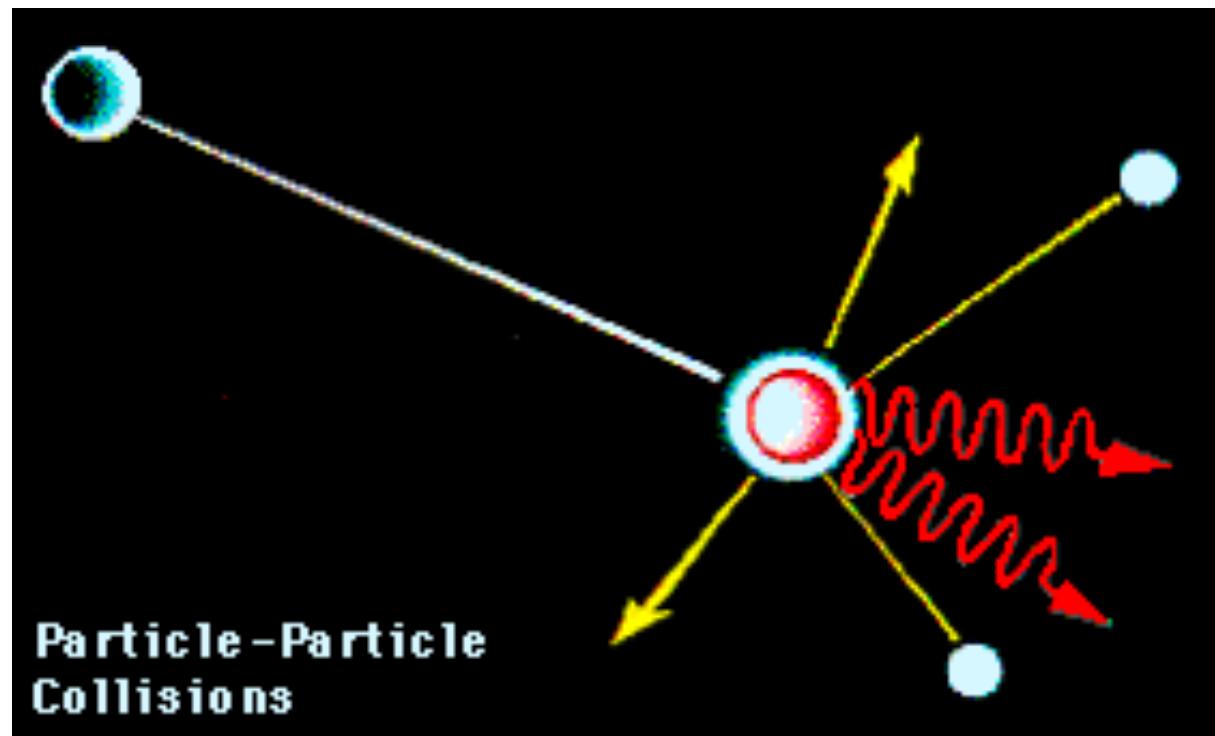
p:  $\pi^0$  production and decay

e: Inverse Compton scattering and Bremsstrahlung

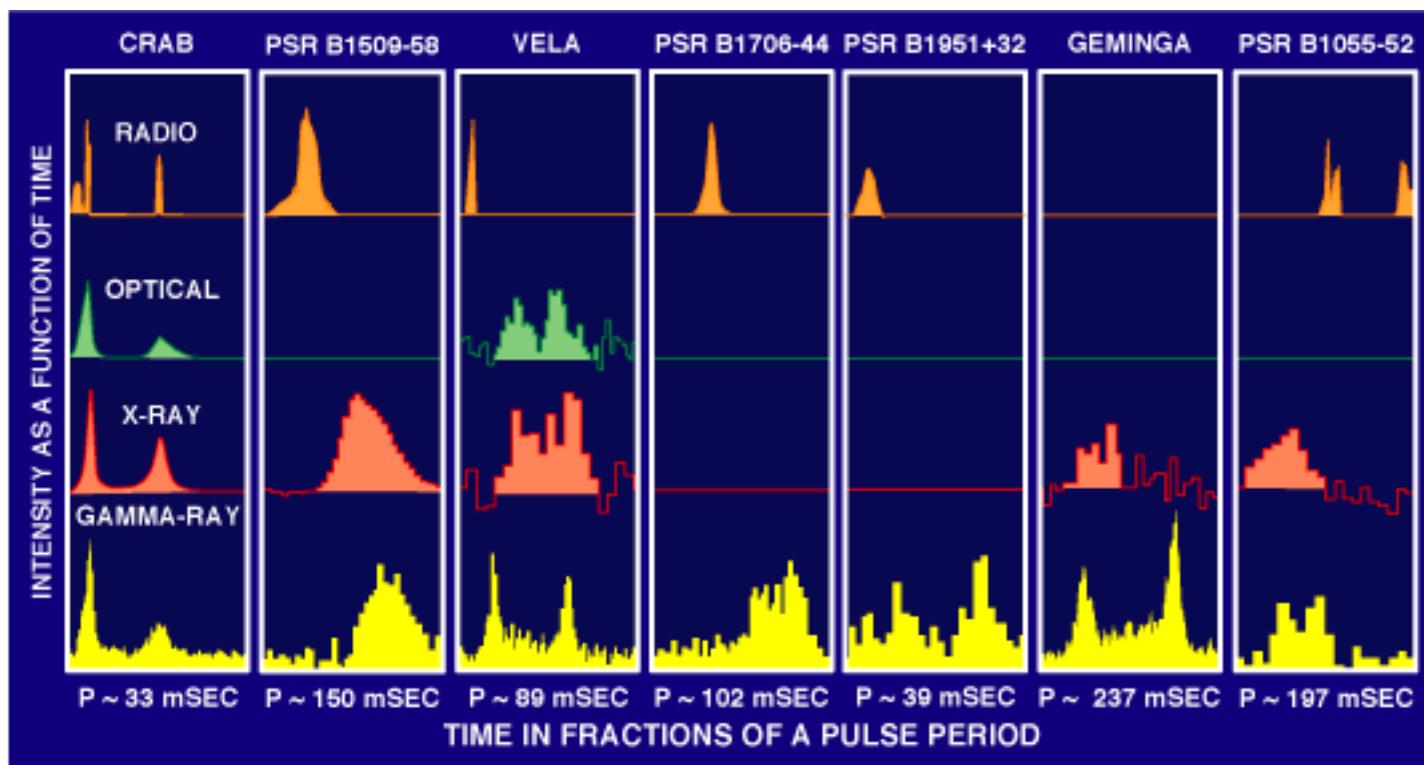
**Trace beam density  $\times$  target density**

# Fenomeni Emissivi

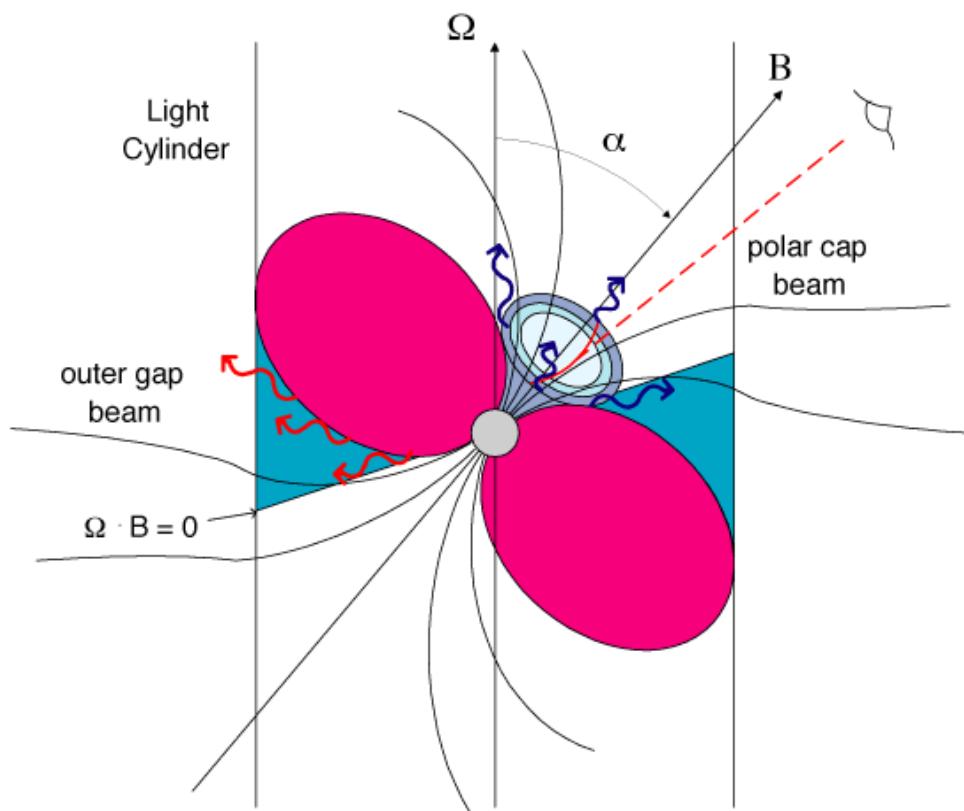
Decadimento del pione neutro



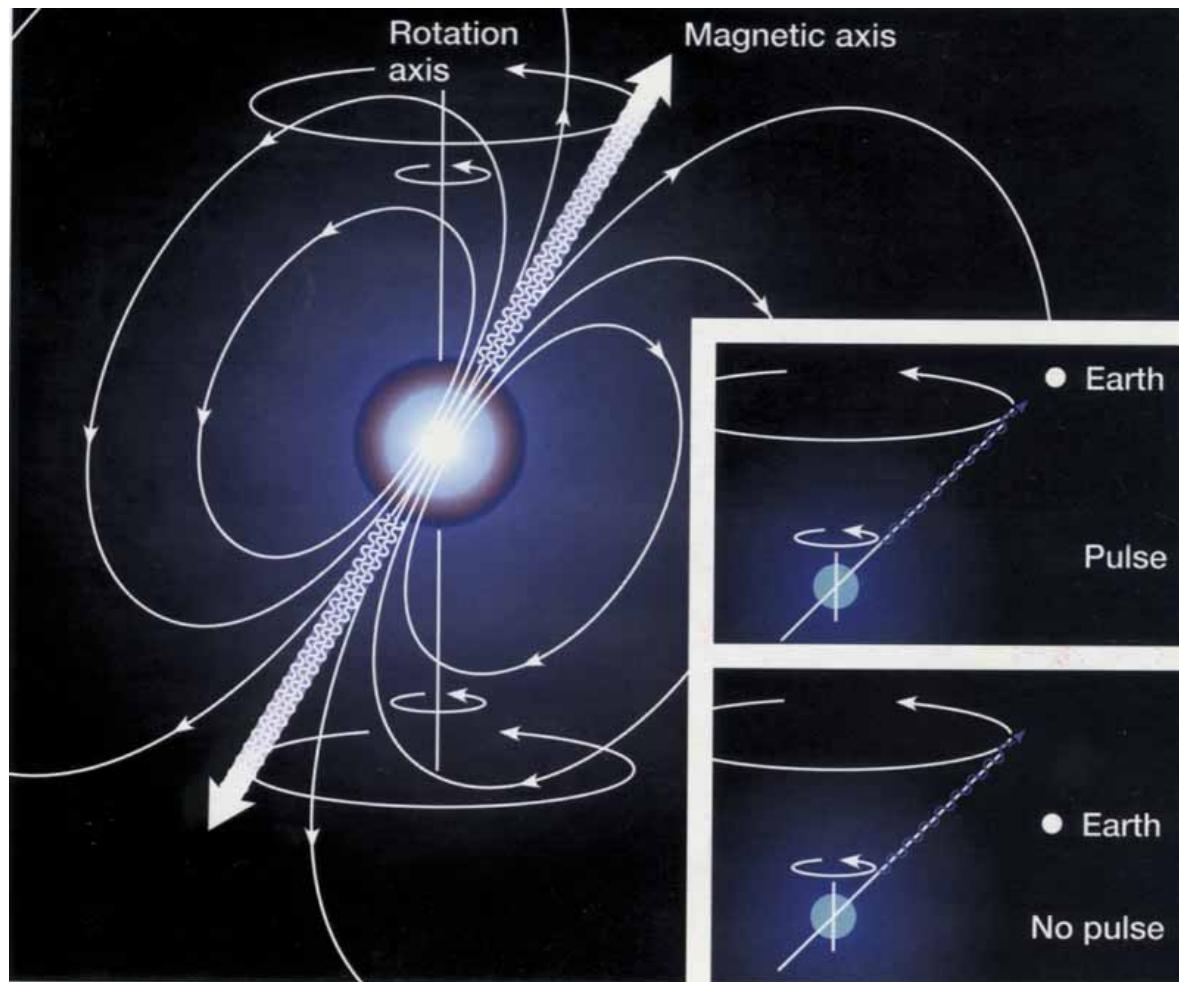
# Pulsar



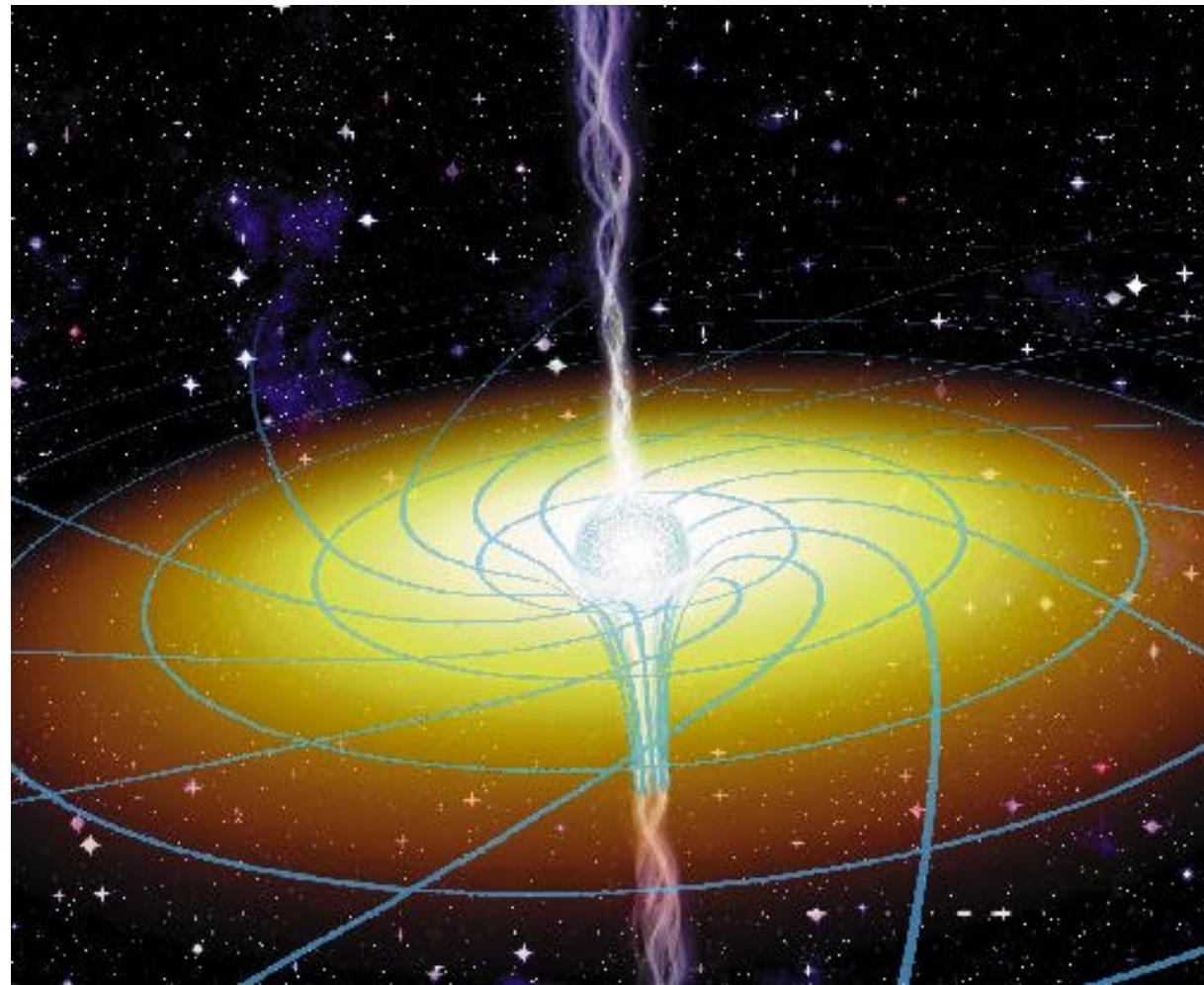
# Emissione gamma dalle Pulsar



# Le Pulsar



# I Nuclei Galattici Attivi

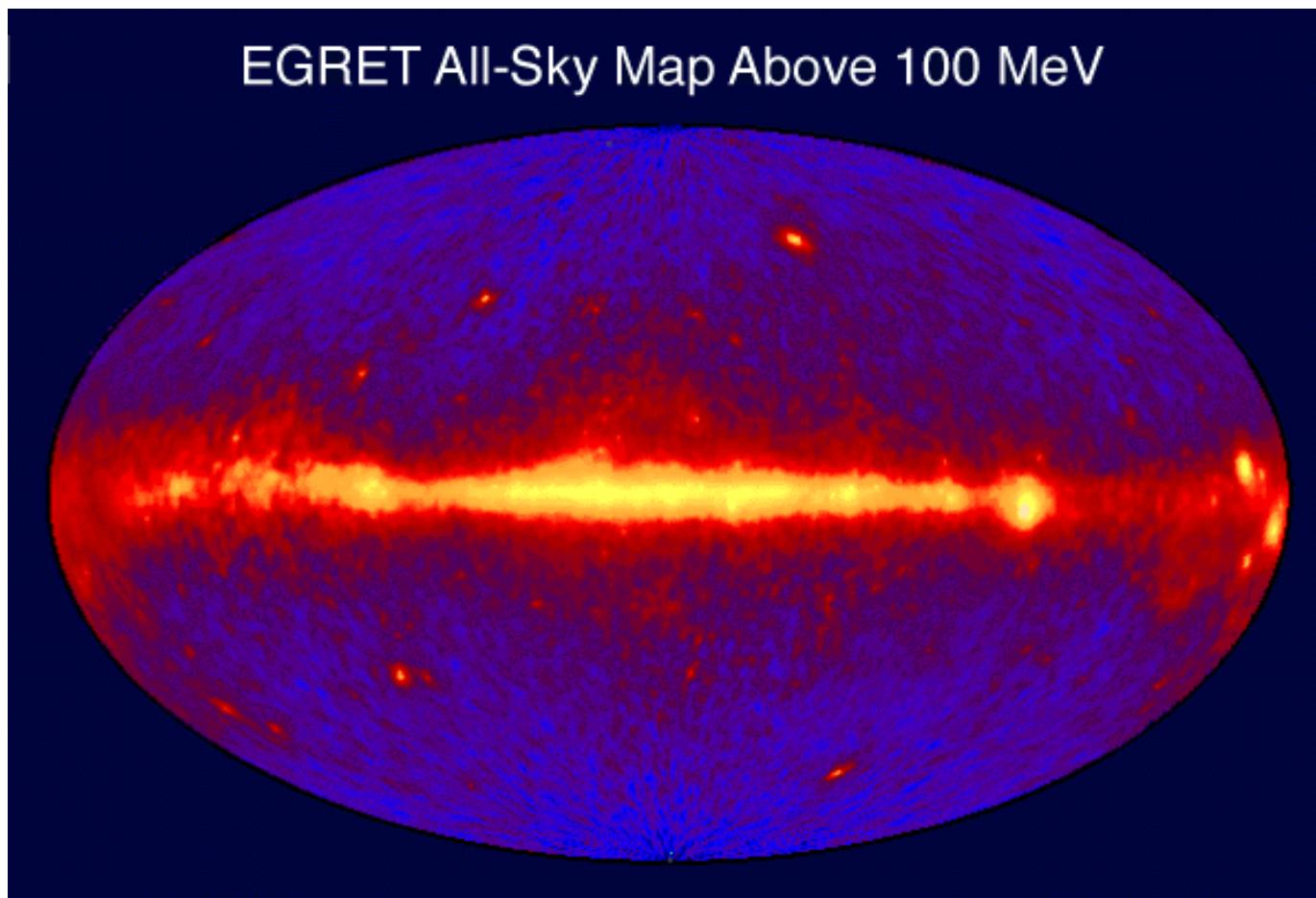


# EGRET



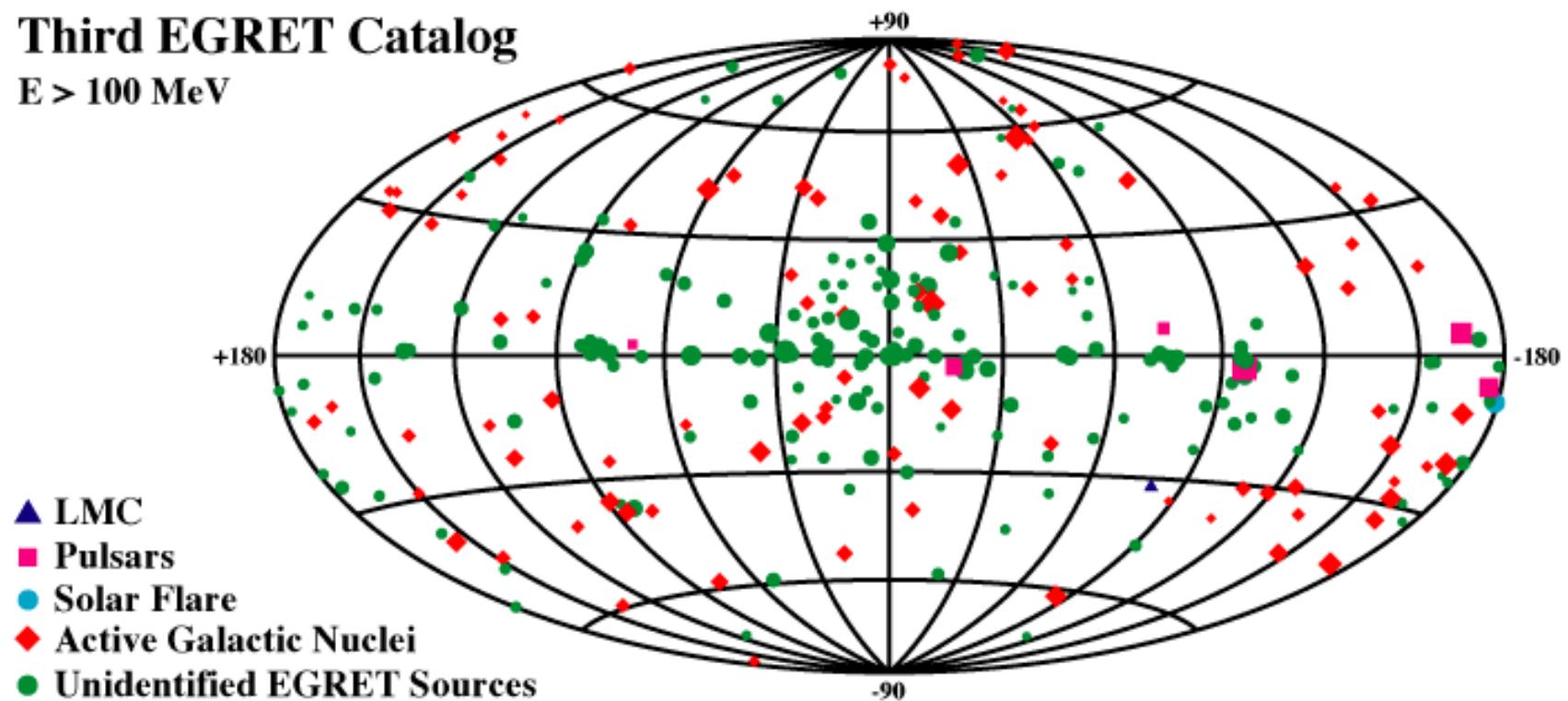
CGRO satellite (1991-2000)

# L'astrofisica gamma



# Le sorgenti gamma

Third EGRET Catalog  
 $E > 100$  MeV



# Le sorgenti non identificate

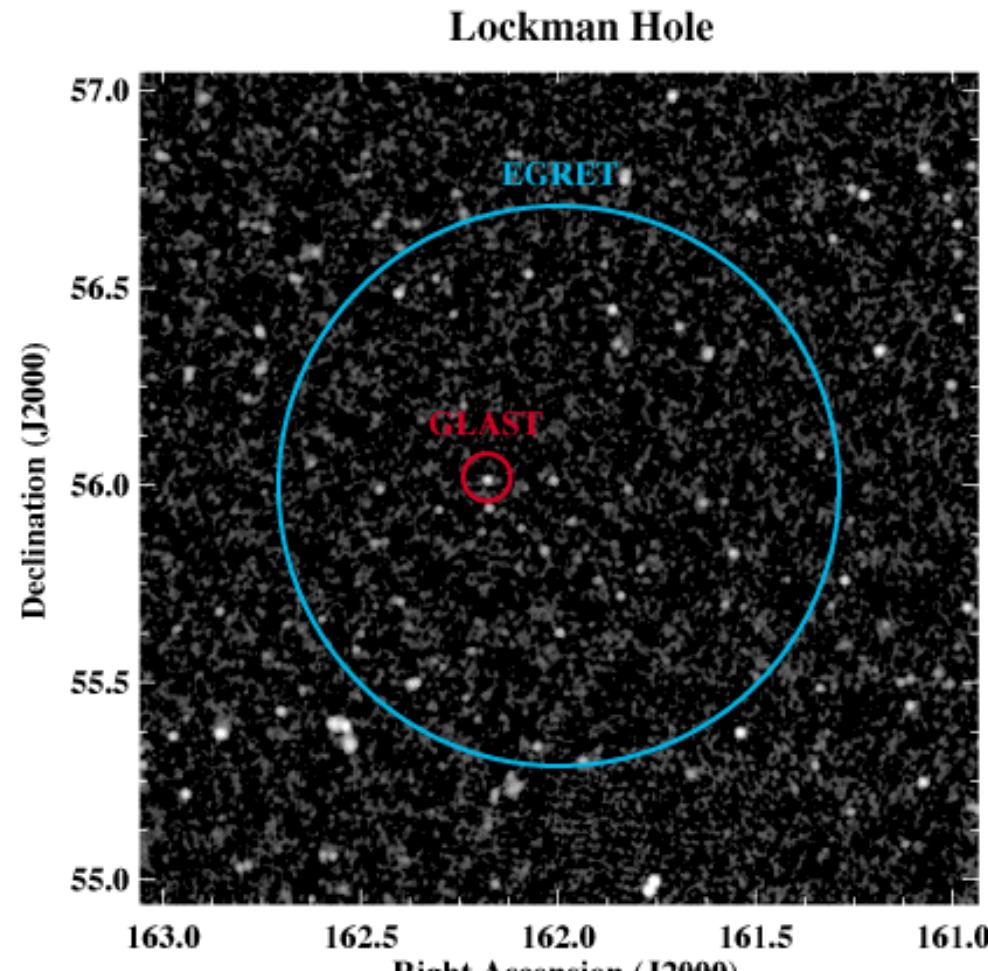


Image from NVSS 1.4 GHz survey, Condon et al. (1998)

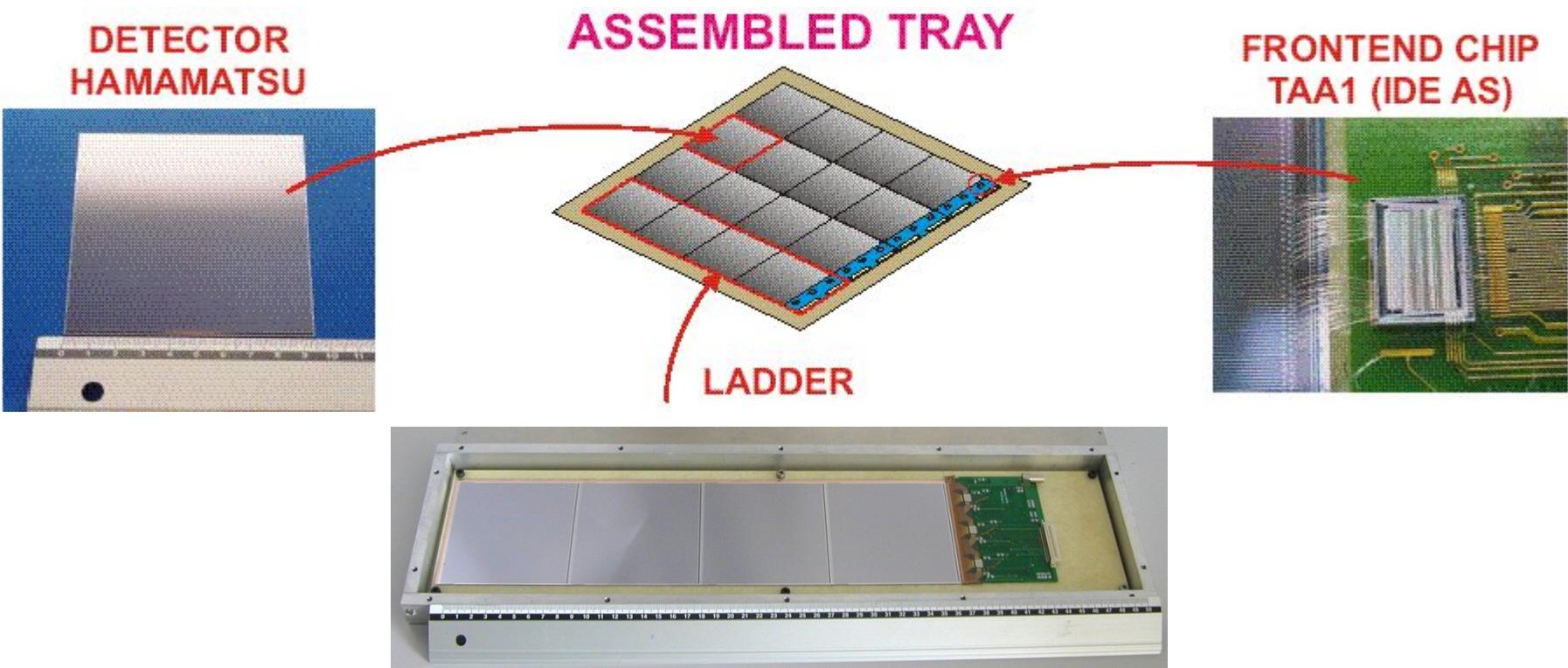
# High Energy Gamma-ray Astrophysics



# AGILE

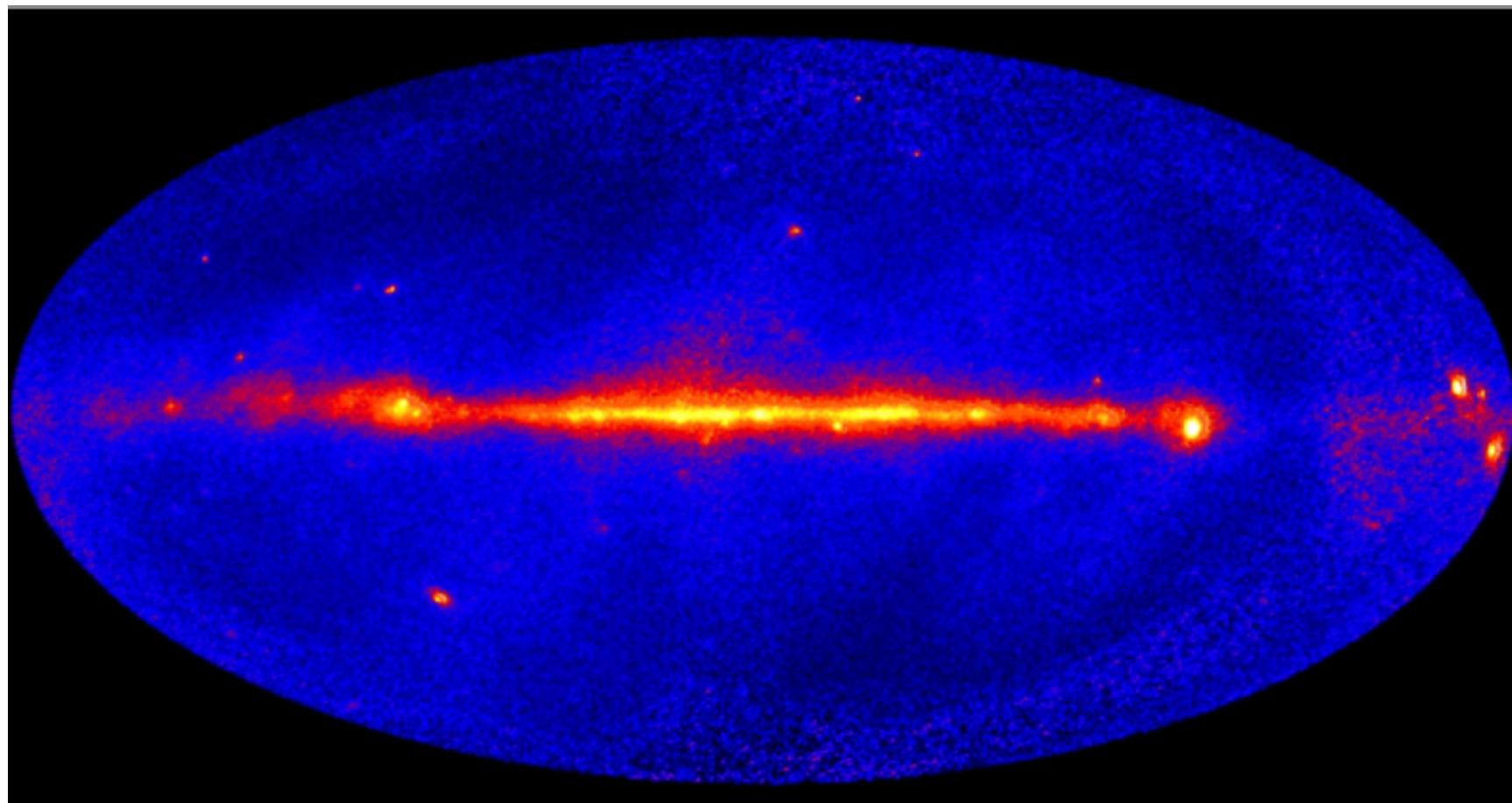


# Silicon Detectors

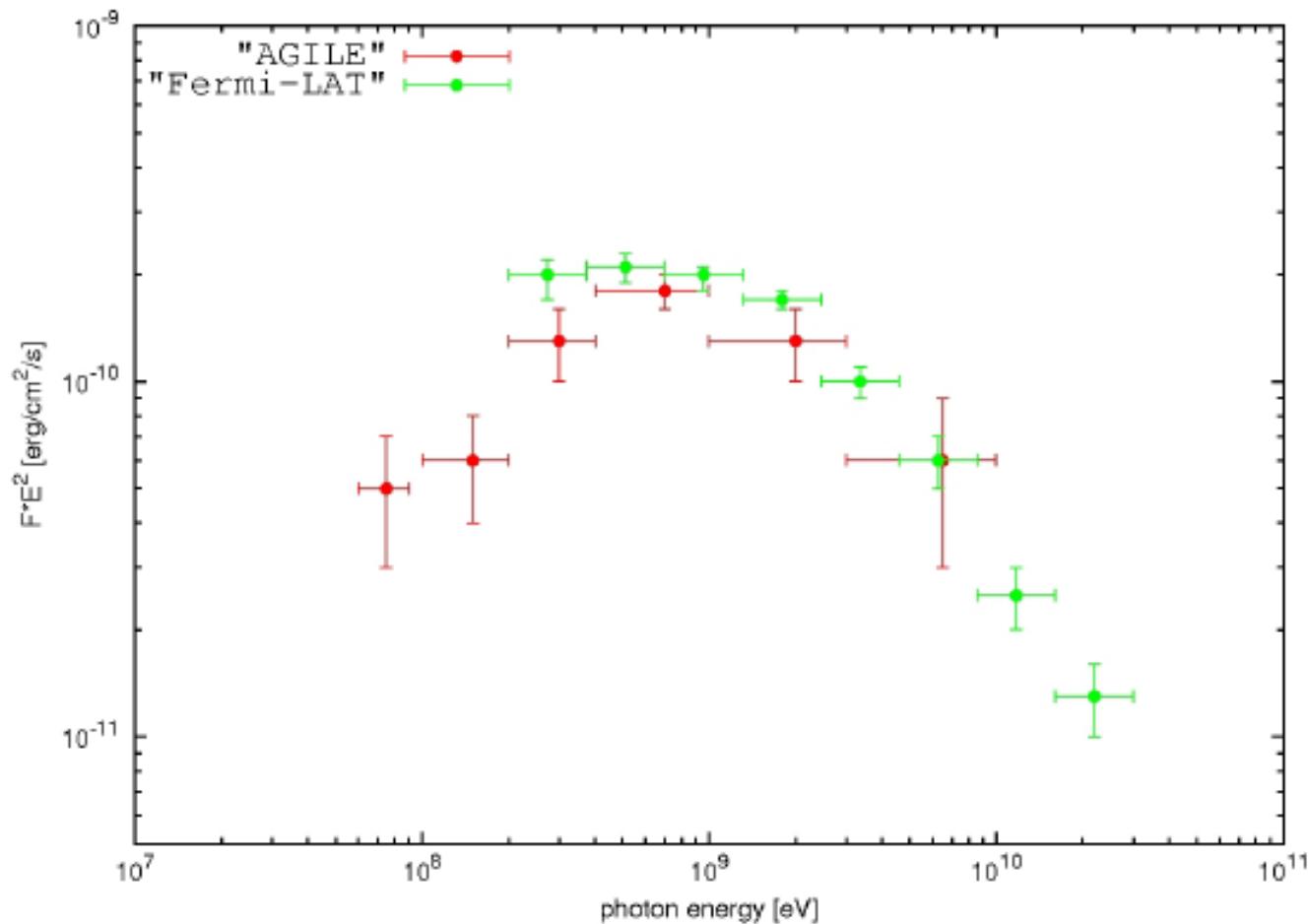


AGILE silicon tracker

# Il cielo di AGILE

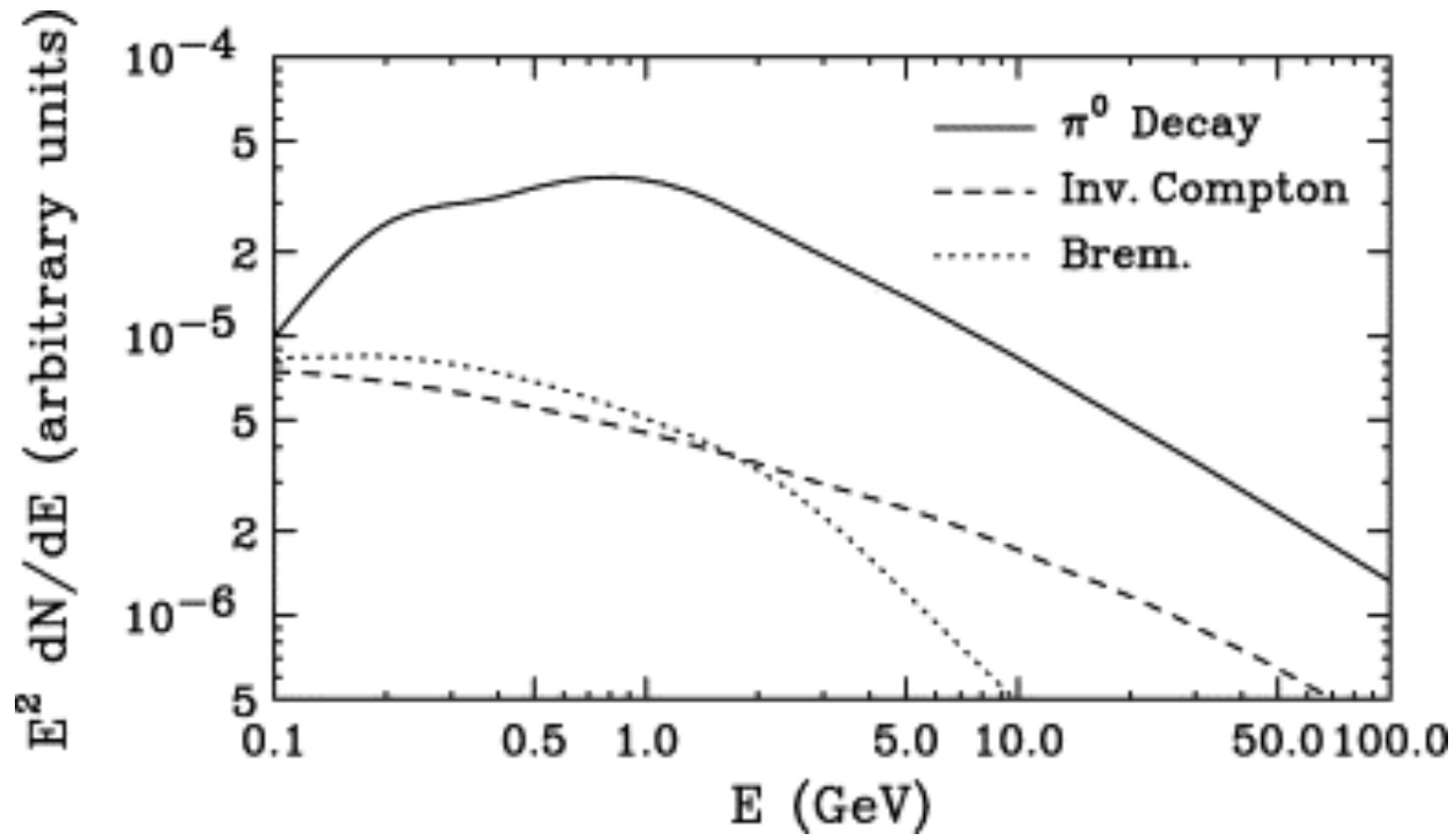


# The SNR W44

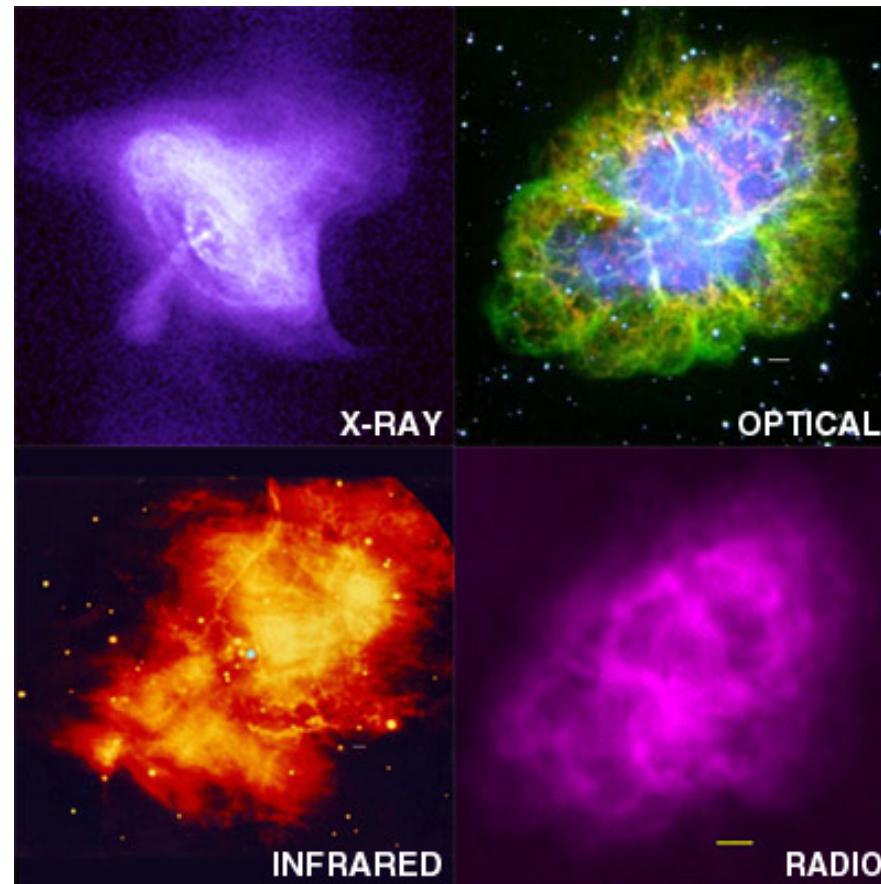


Giuliani et al. 2011

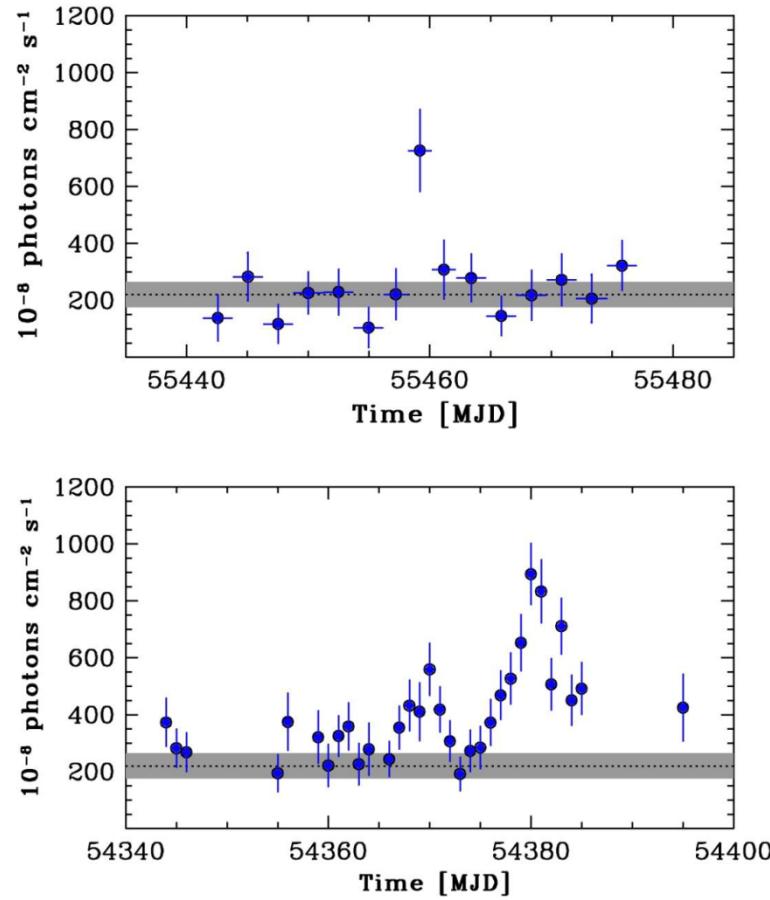
# Protoni e resti di SNe



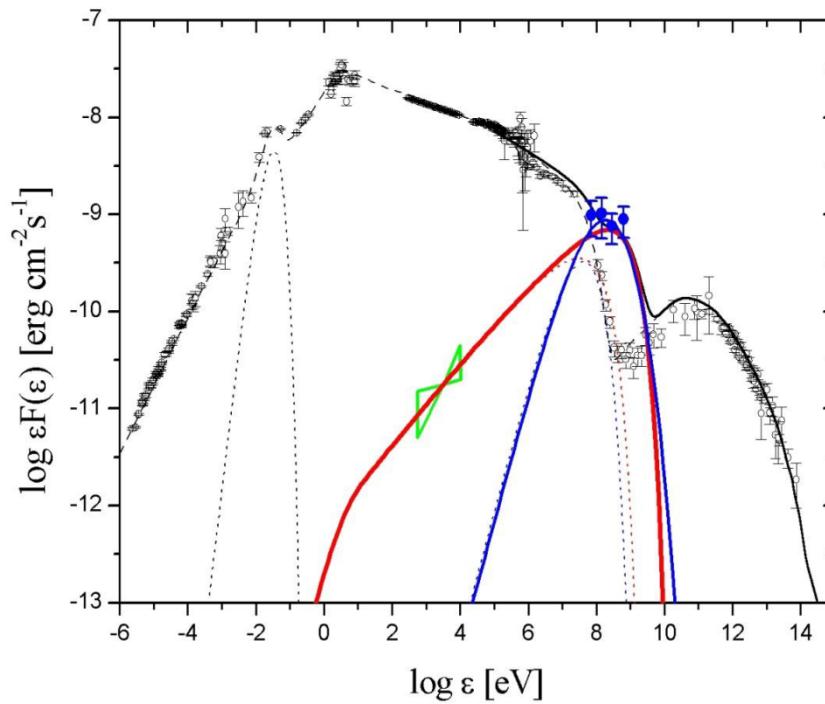
# La nebulosa del Granchio



# Galactic Transients: The Flaring Crab



Tavani et al. 2011

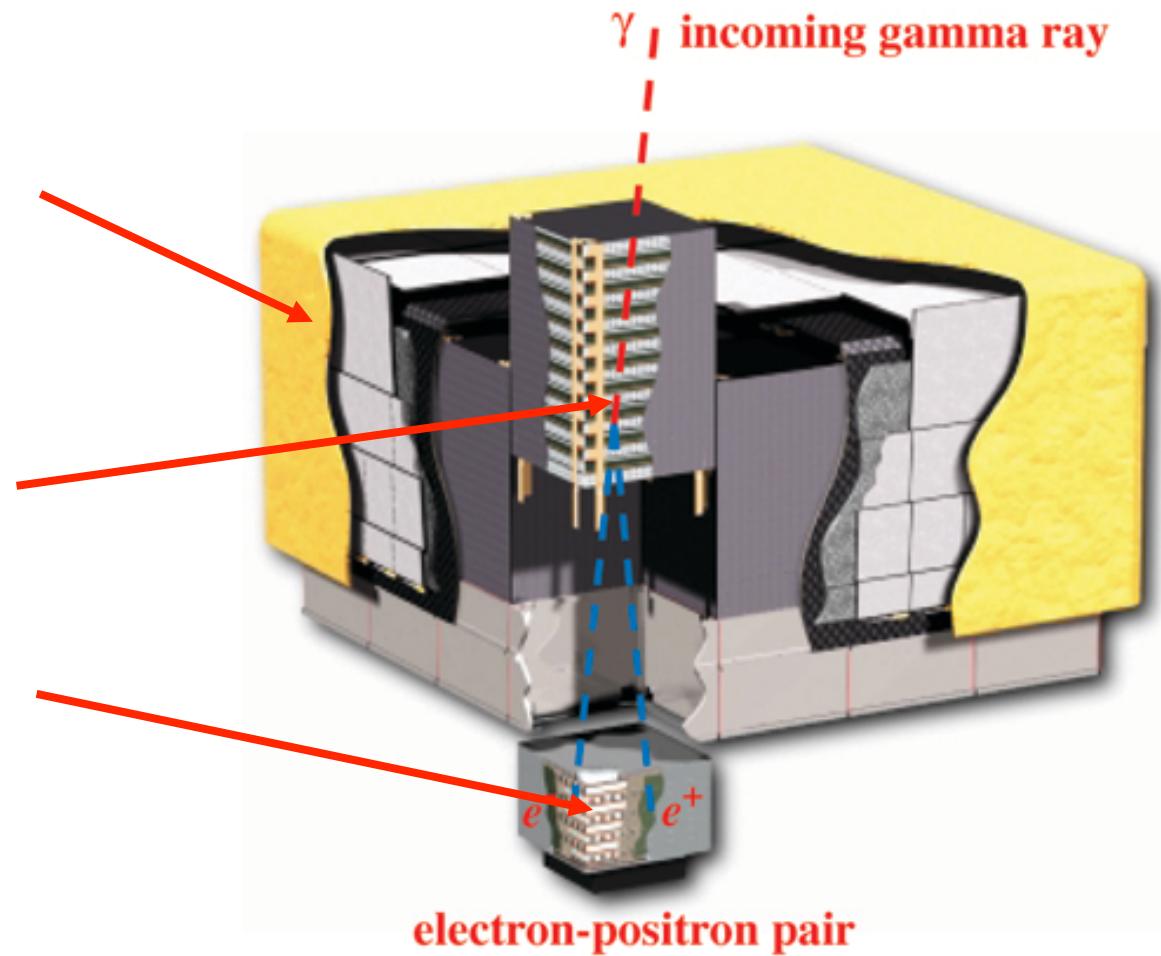


# High Energy Gamma-ray Astrophysics

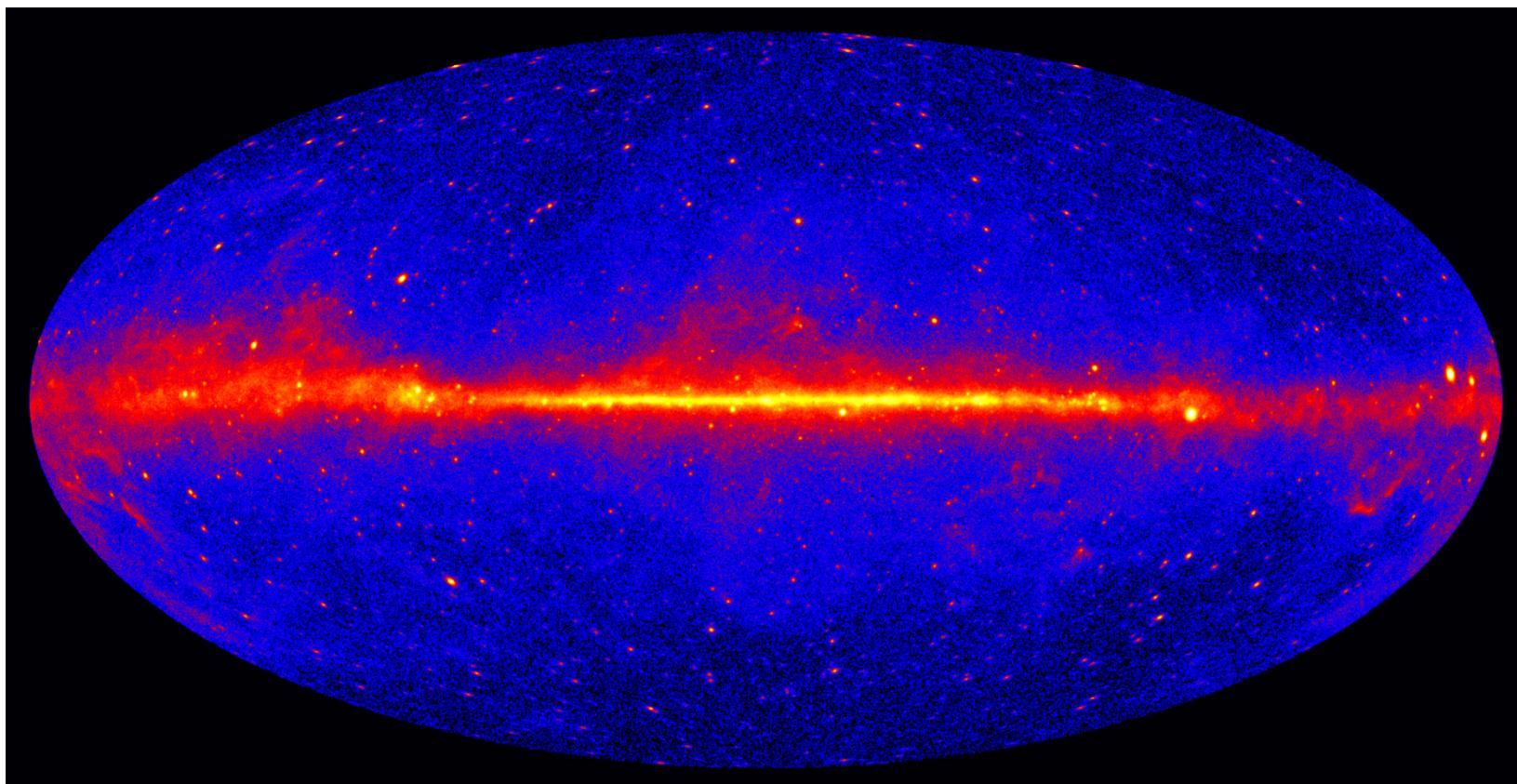


# LAT Schematic

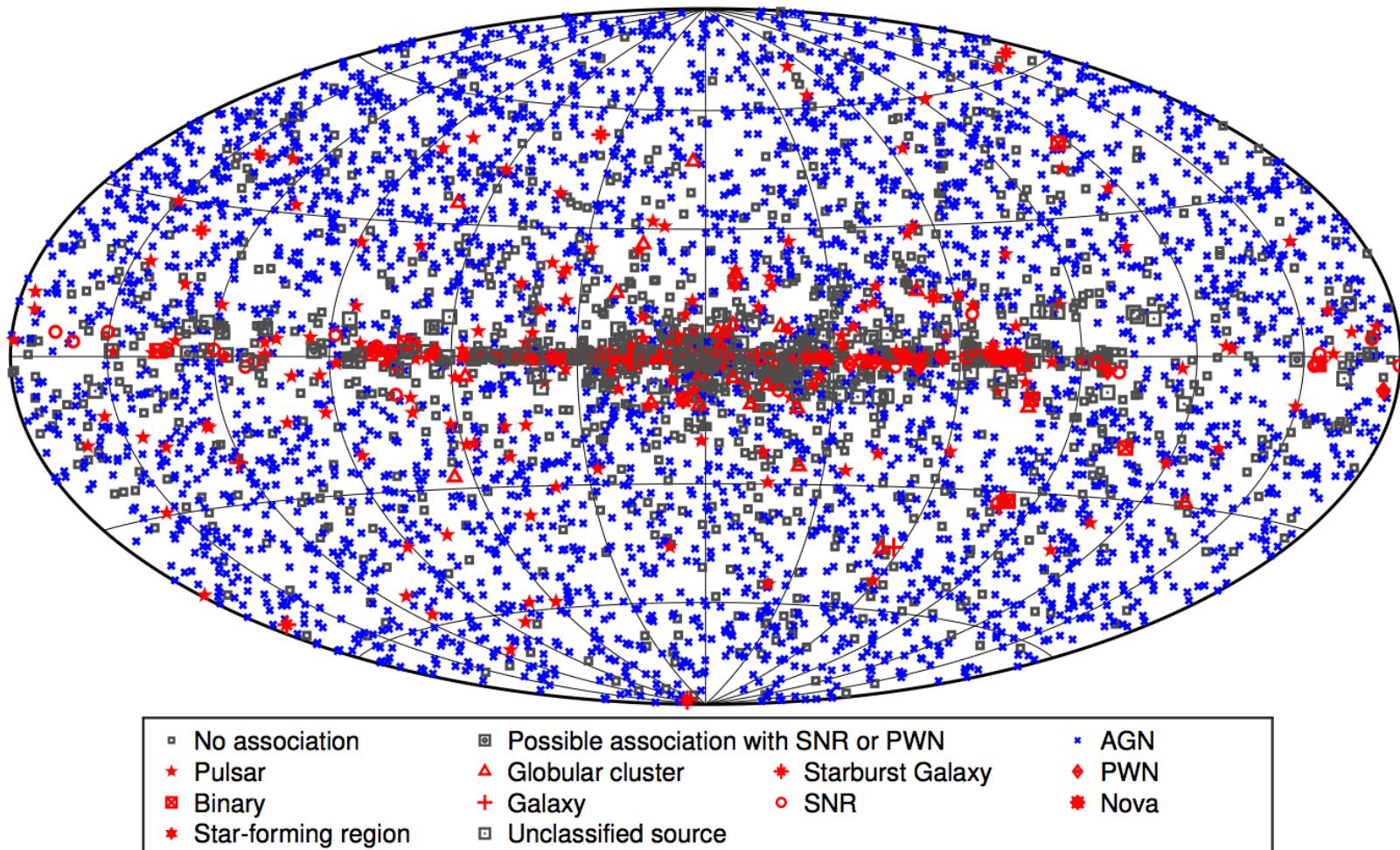
- Tiled Anticoincidence Detectors
- Silicon strip detectors interleaved with Tungsten converter
- Cesium Iodide hodoscopic calorimeter



# Il cielo di Fermi

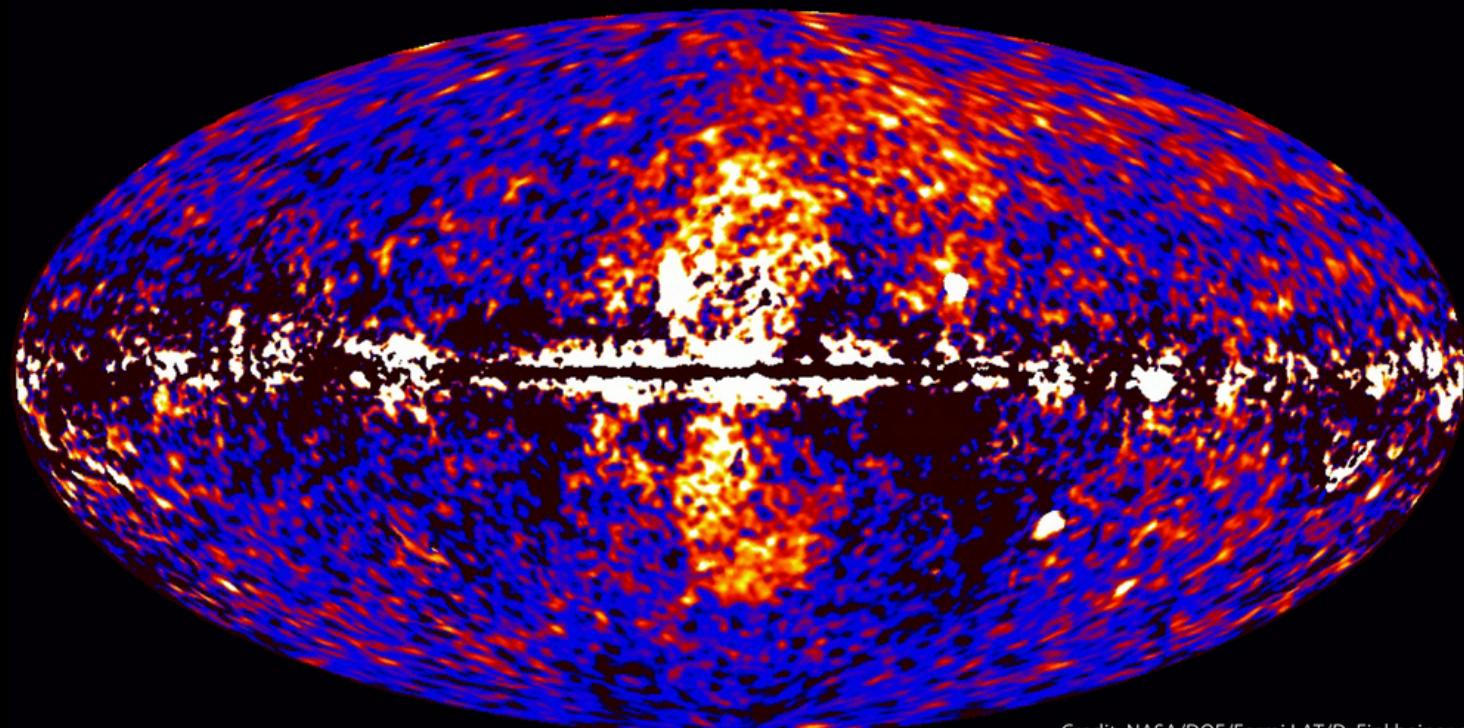


# 4FGL catalog – 8 anni di dati



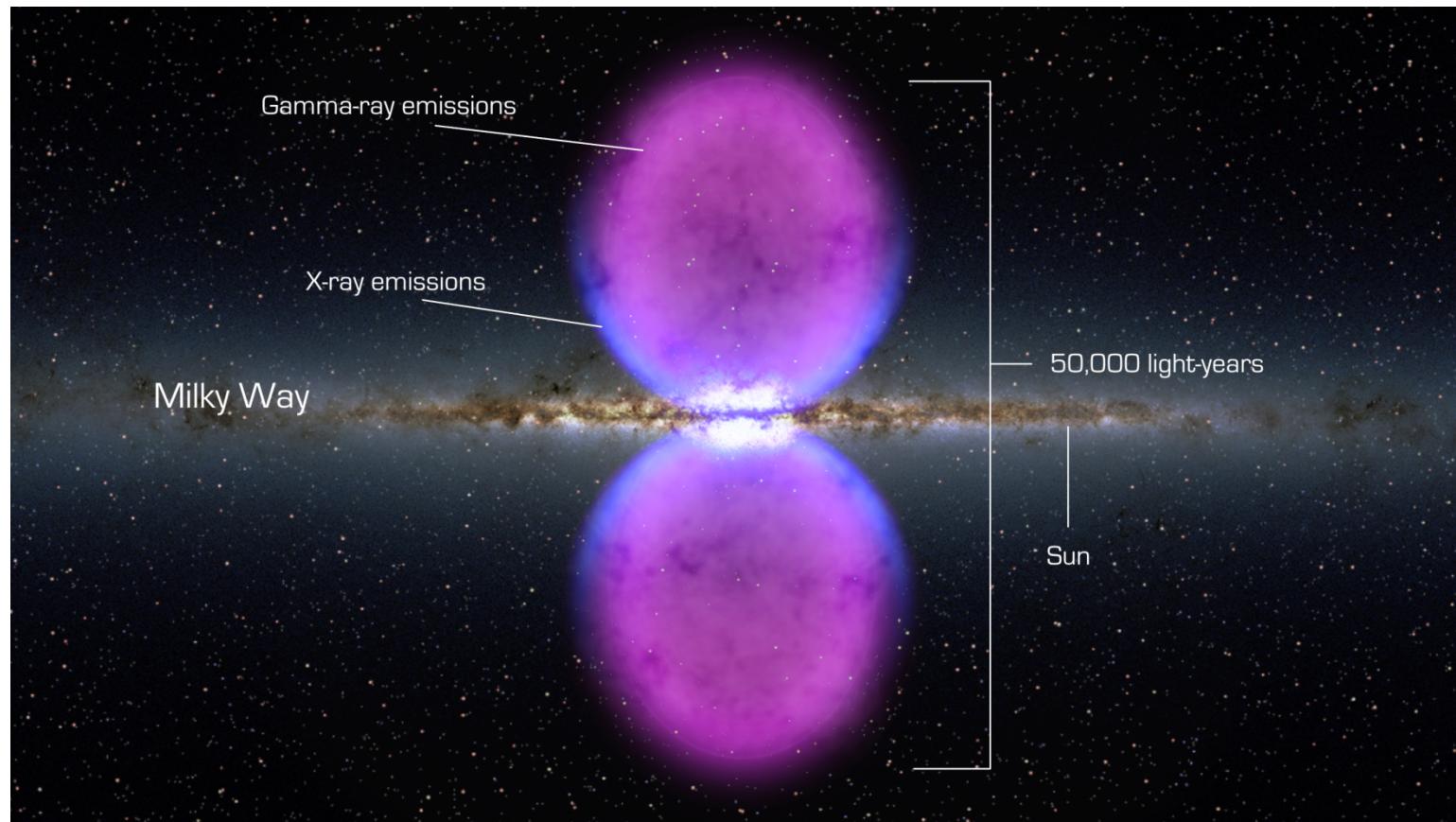
# Le Fermi Bubbles

Fermi data reveal giant gamma-ray bubbles

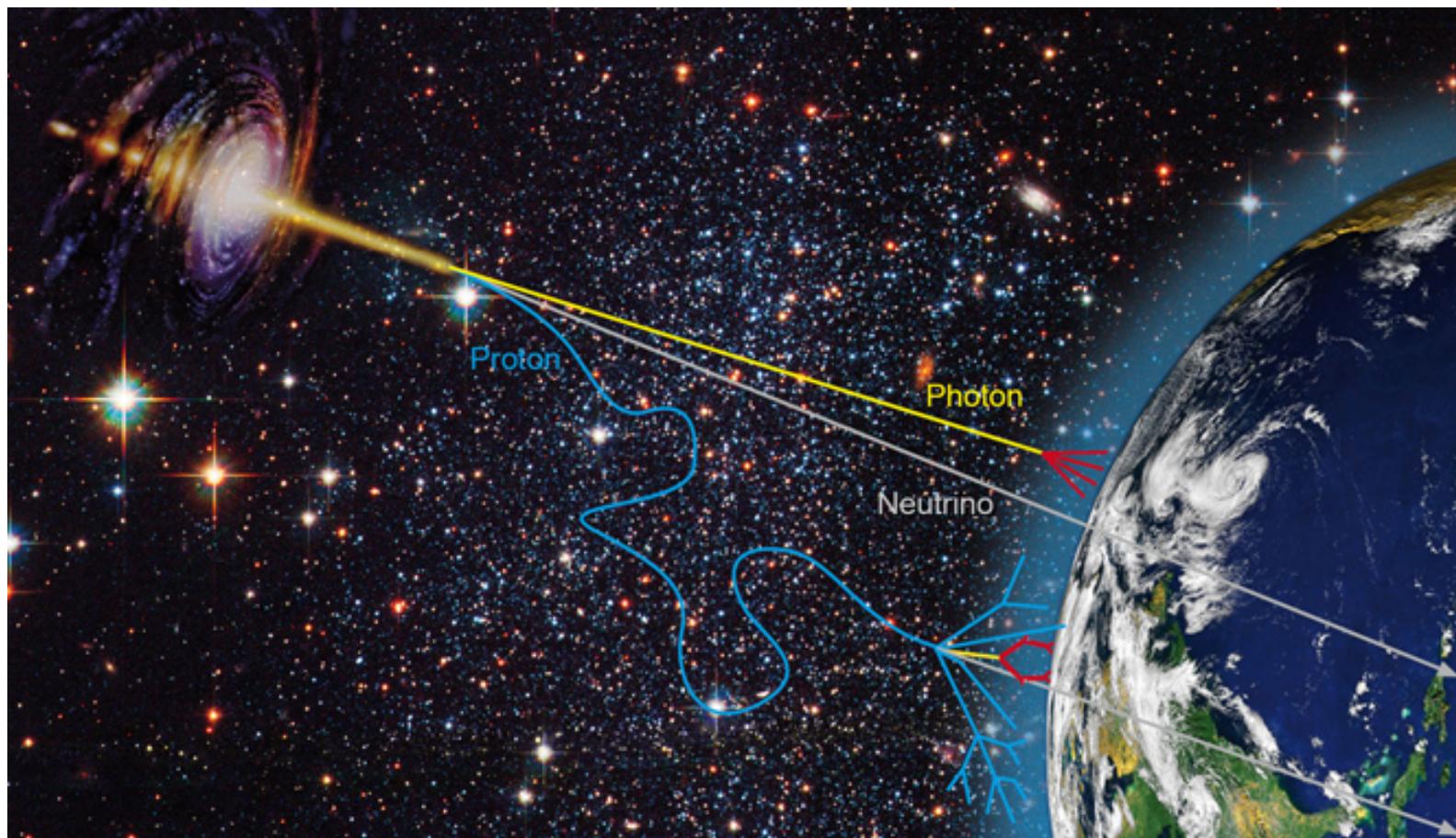


Credit: NASA/DOE/Fermi LAT/D. Finkbeiner et al.

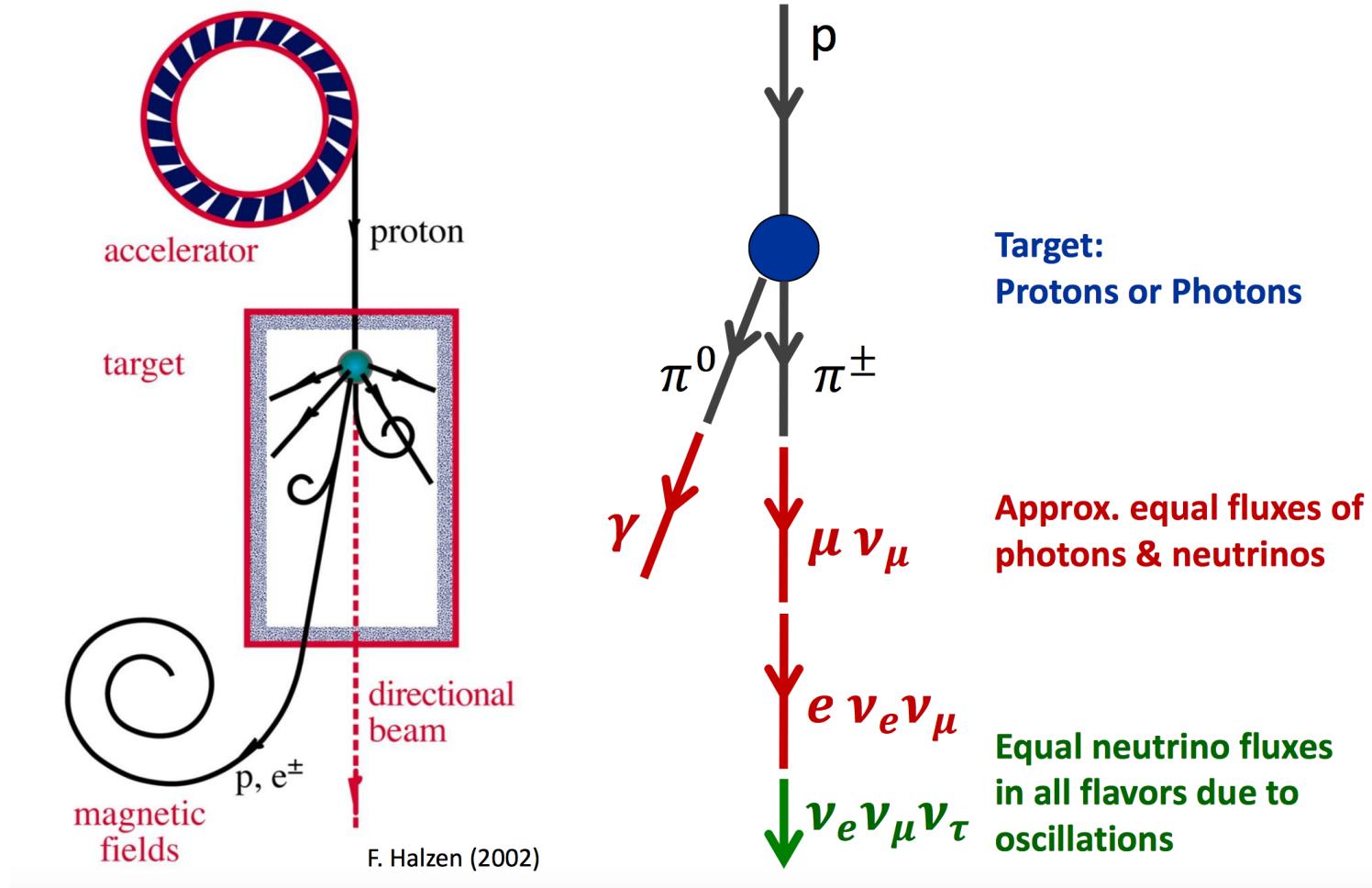
# Le Fermi “Bubbles”



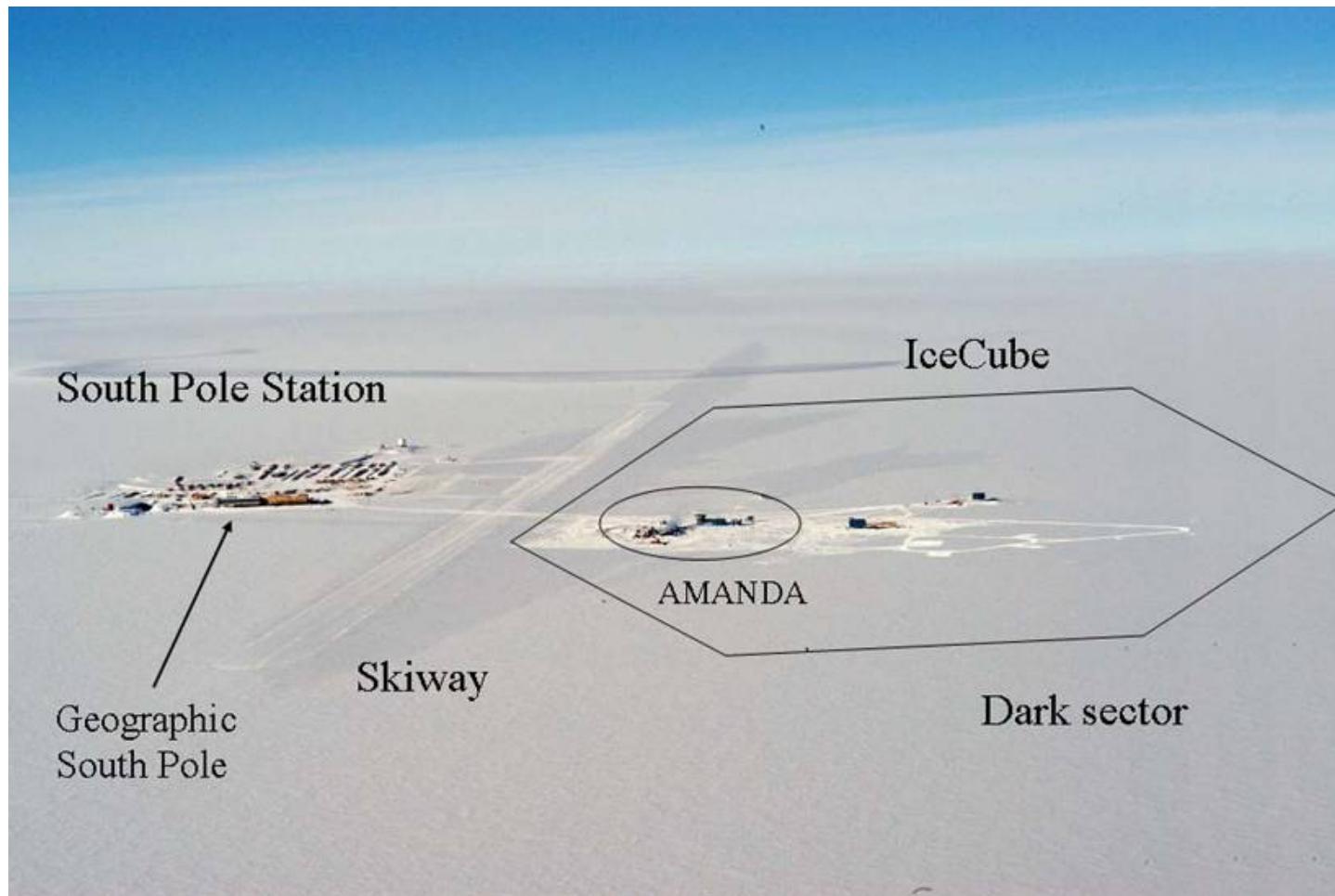
# I neutrini astrofisici



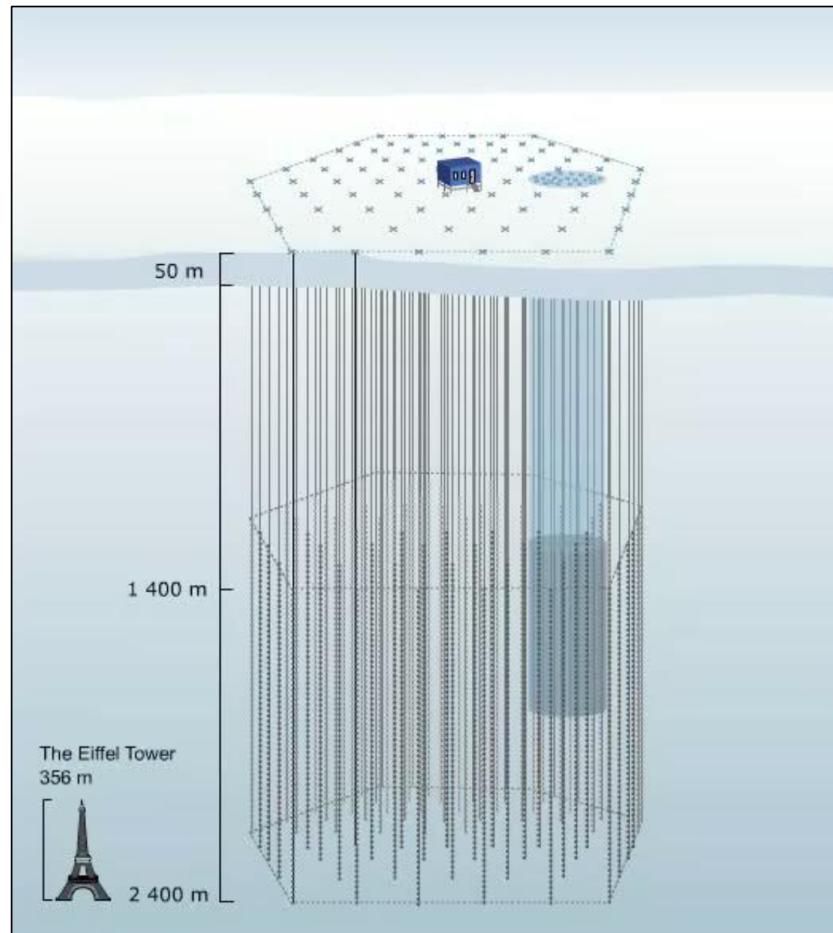
# I neutrini astrofisici



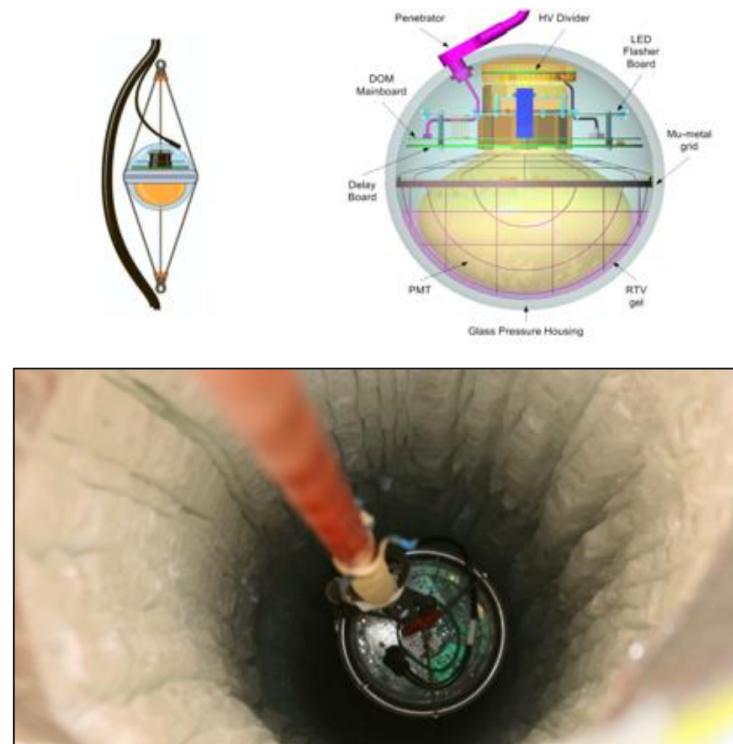
# Icecube



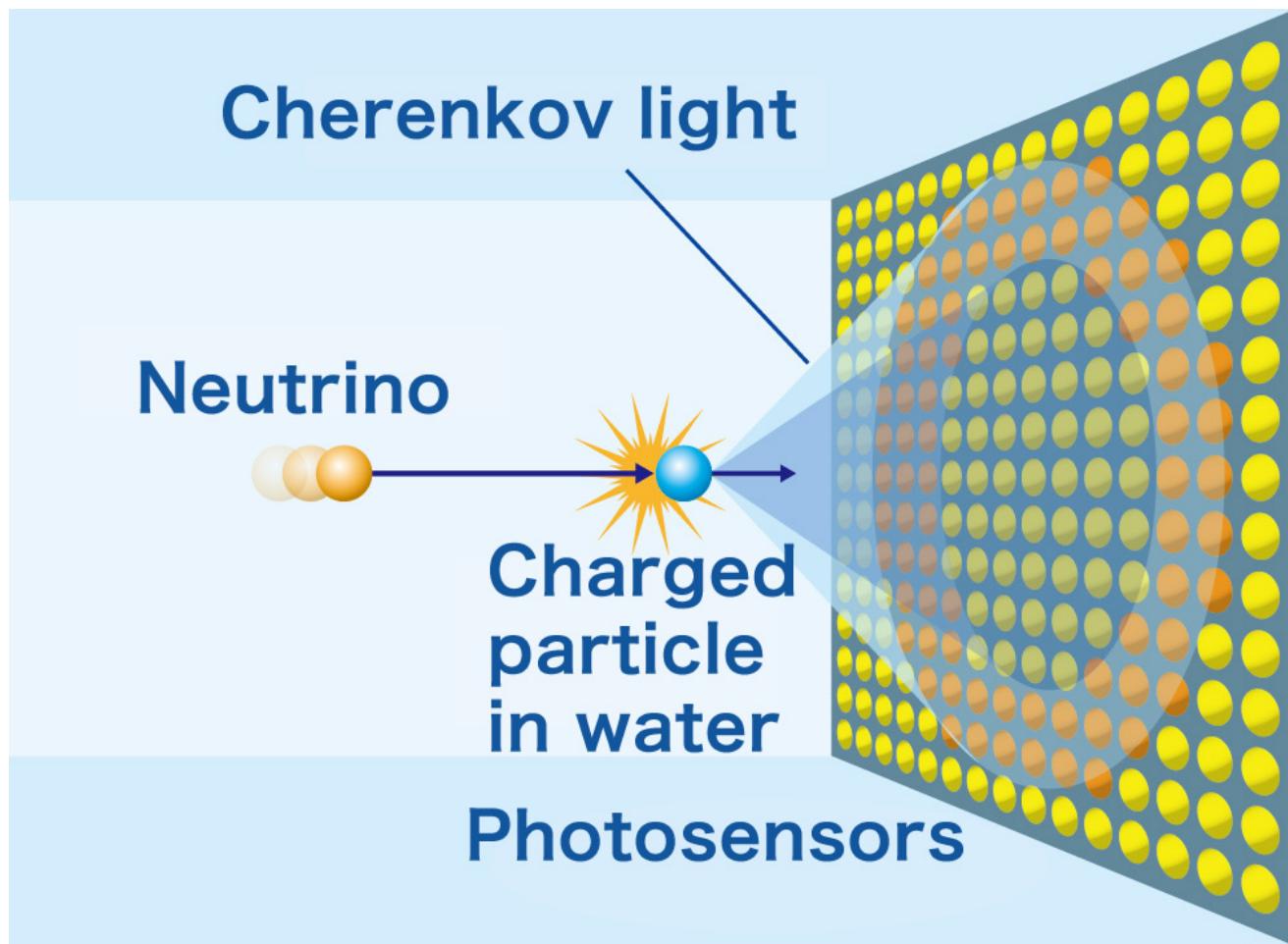
# Icecube



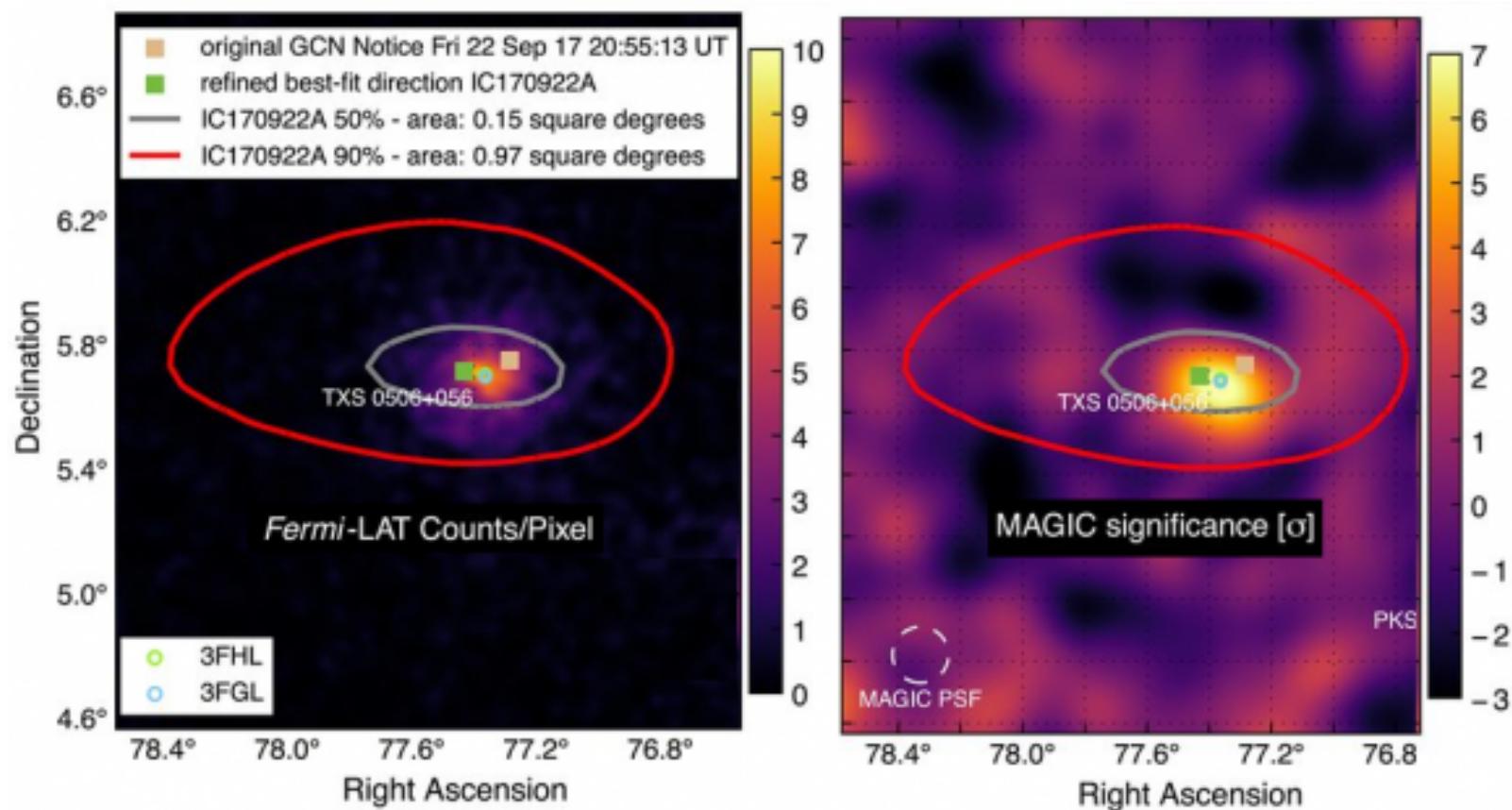
**Instrumentation of 1 km<sup>3</sup> antarctic ice with ~ 5000 photo multipliers completed December 2010**



# La rivelazione dei neutrini



# TXS 0506+056



# Future VHE Gamma-ray projects

