HERD and γ-ray Astrophysics

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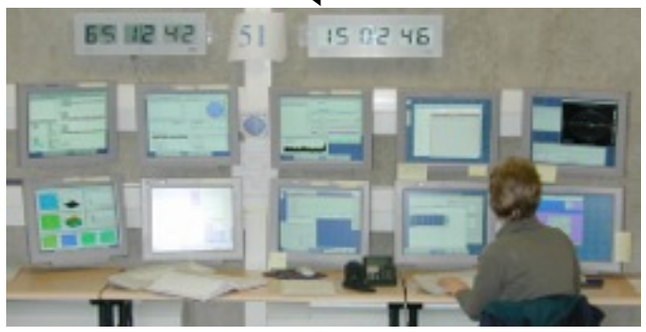
INTEGRAL Science Data Center

INTErnational Gamma-Ray Astrophysics Laboratory Observatory, 20keV-10MeV, launched on Oct 17, 2002

- **Galactic astrophysics:** Compact Objects, Galactic Centre, Nucleosynthesis, Interstellar processes, High-energy transients
- **Extragalactic astrophysics:** Active Galactic Nuclei, Cosmic Background, Clusters, Galaxies



GRB alerts	1/day
FOV GRB	1/month
Circulars	1/week
Data	2TB/year
Science	100 ref. papers/year

The ISDC was created by an international consortium to

- act as i/f between INTEGRAL and the scientific community
- bear the responsibility for the science operations
- provide the critical mass needed to operate many years
- co-locate engineers, operators and scientists
- follow instrument calibrations
- foster science and mission impact

11 years: 2109 papers, 903 circulars, 14061 GRB triggers

Fermi Success at GeV

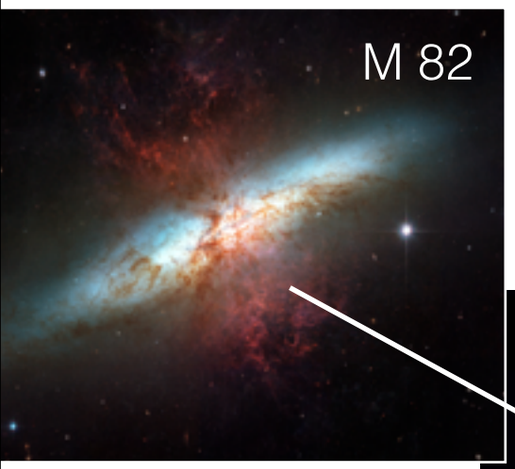
5 years:

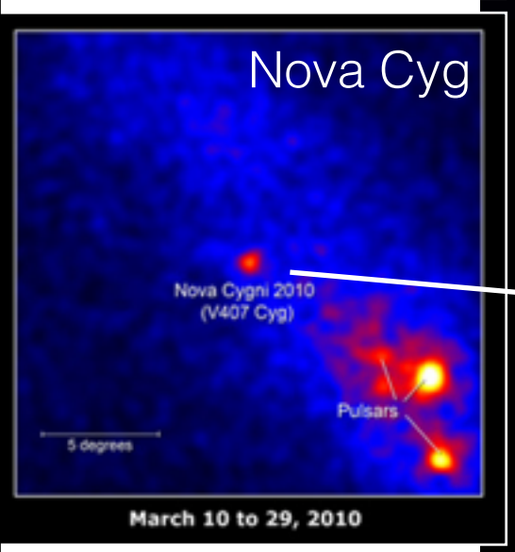
- > 1000 refereed papers
- > 250 refereed papers from the collaboration
- 256 Astronomer's Telegrams
- 63 GRB GCN alerts
- >2500 sources (3FGL - 4 years)

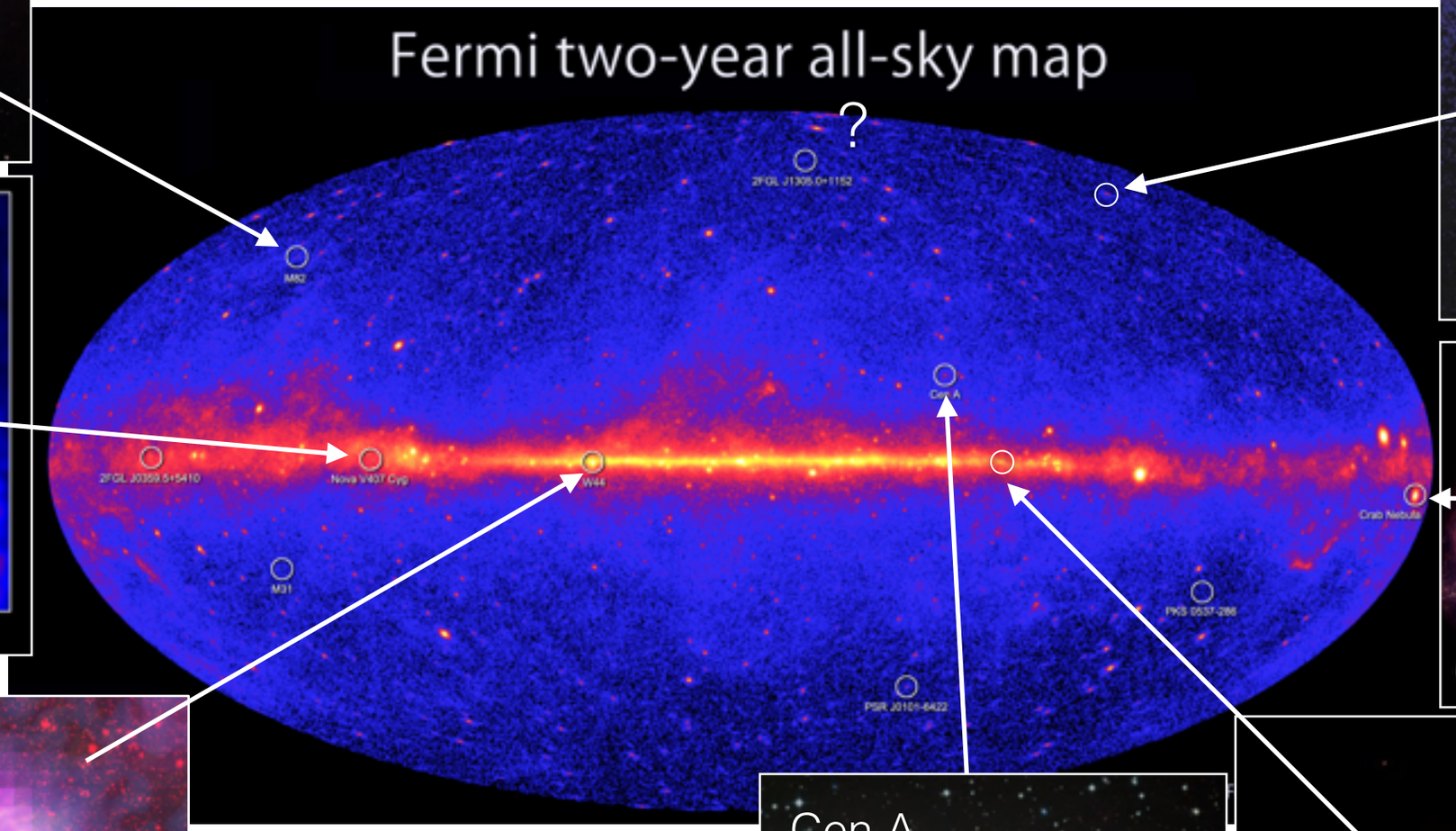
Why ?

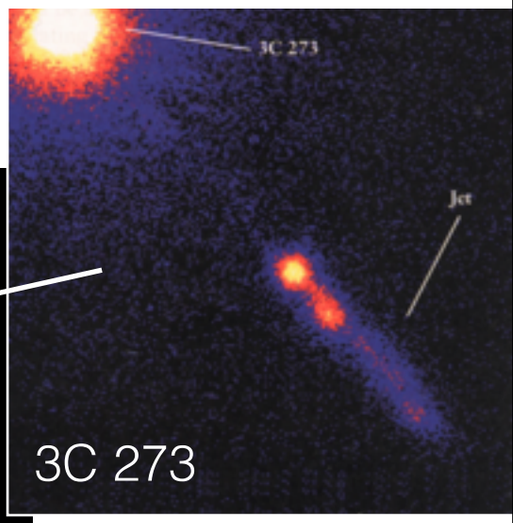
- Smart design (16 tracker planes, 66 cm, 1.8 m^2)
- 400 collaboration members
- 25 people working on simulation and analysis software
- Data becoming public

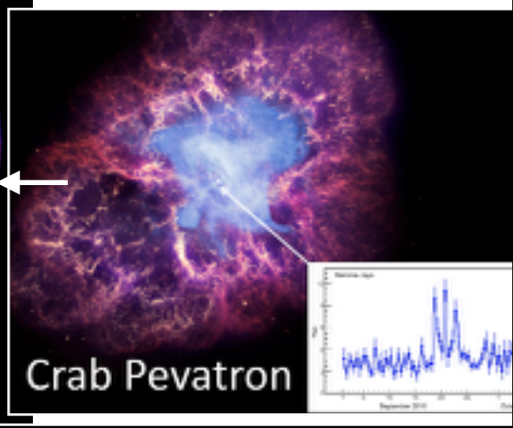
GeV Highlights

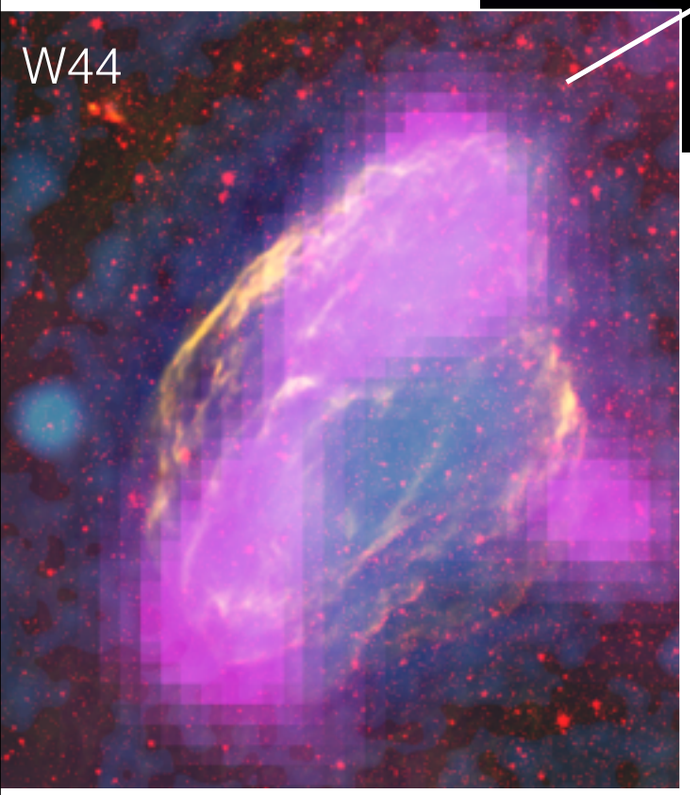


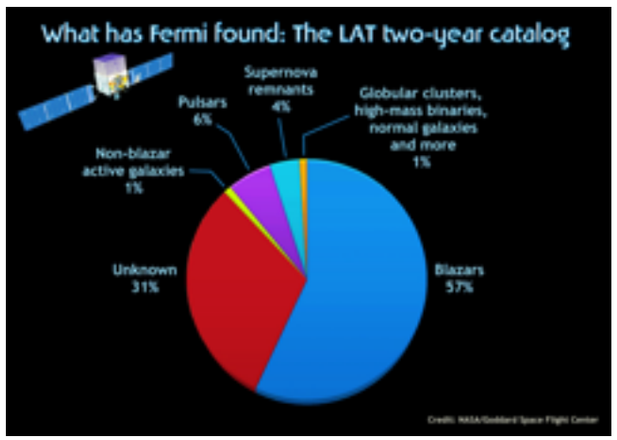


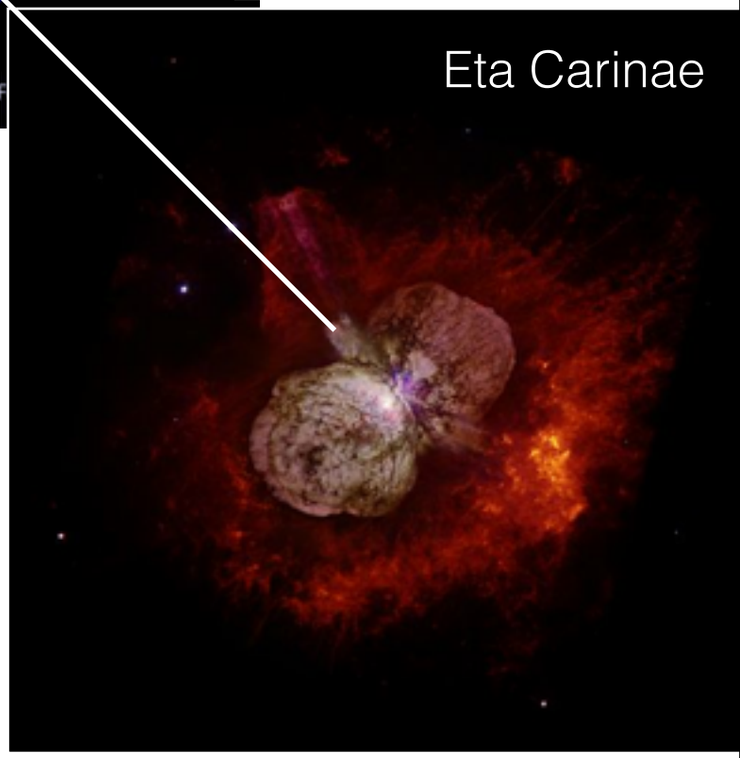




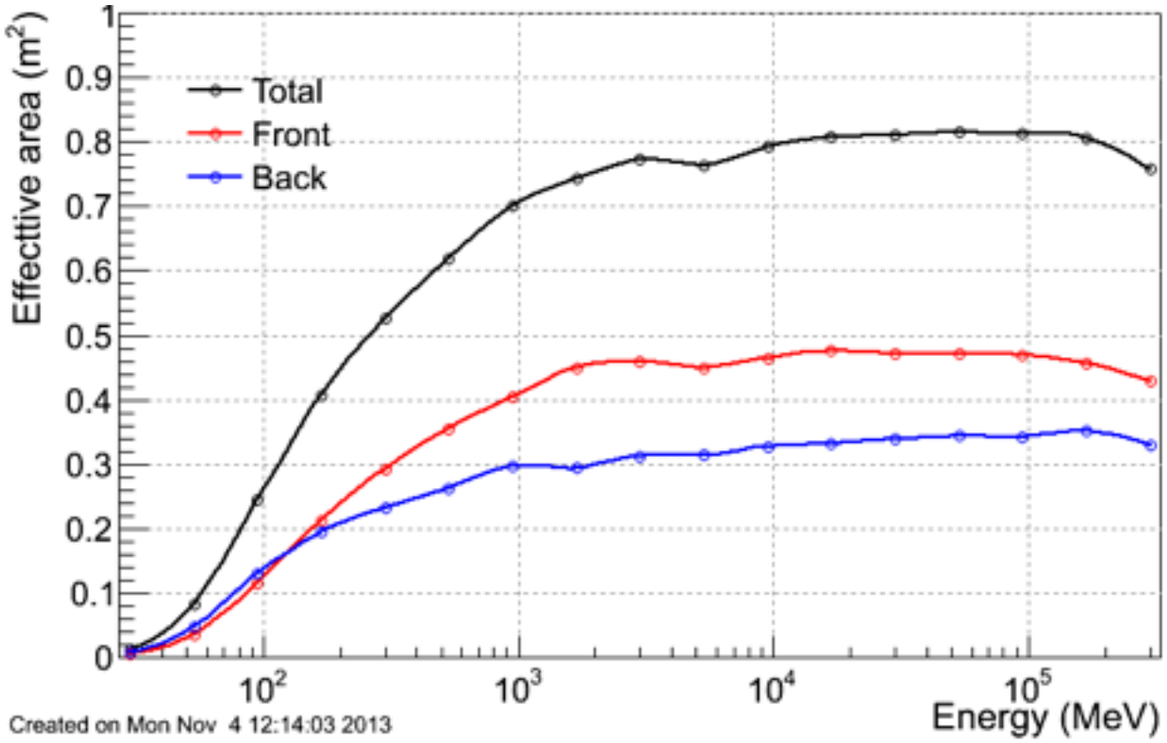


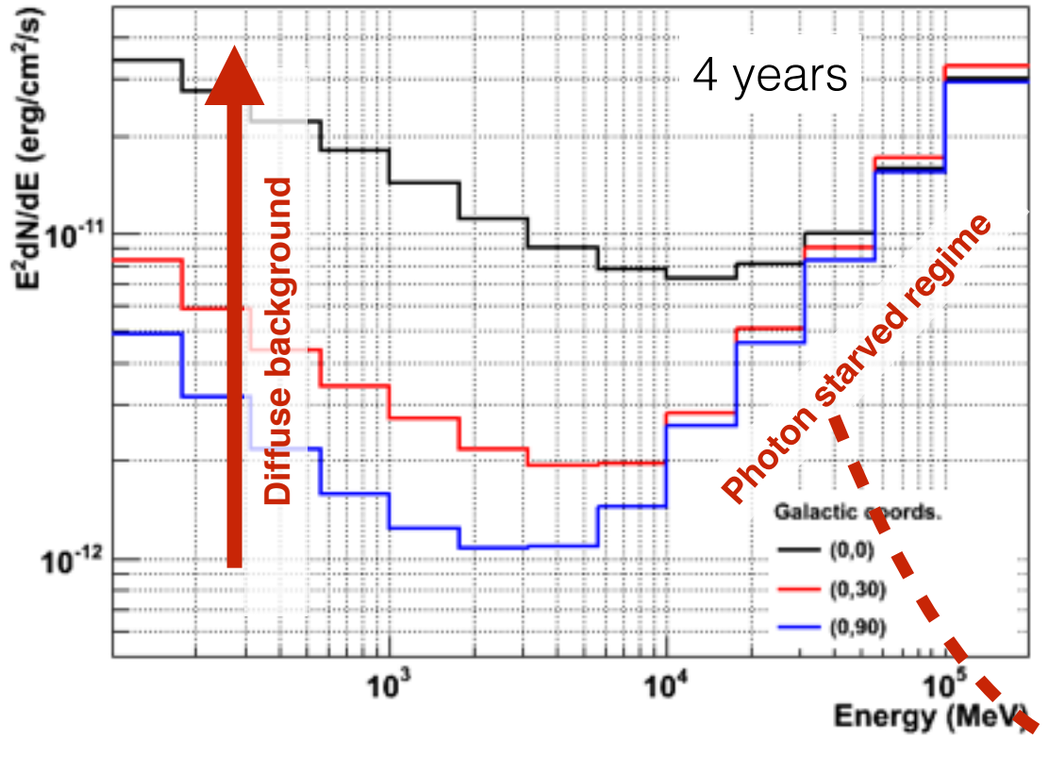


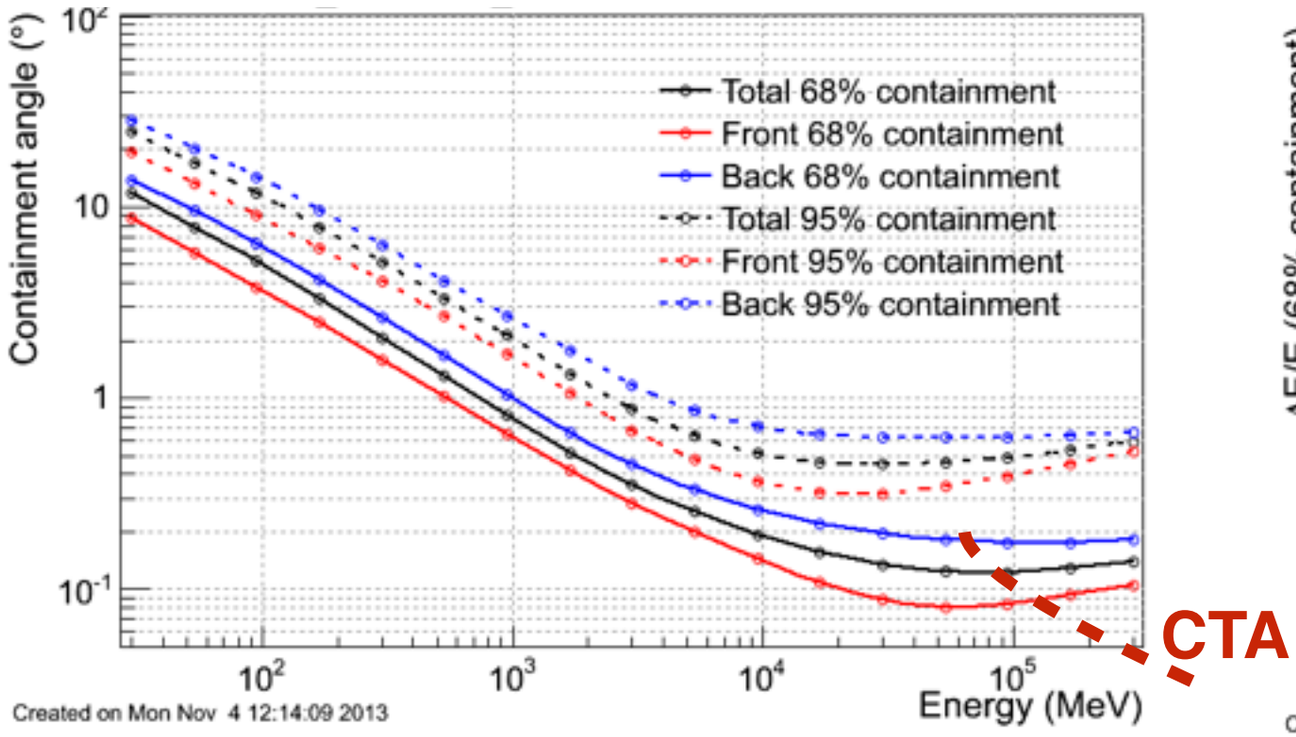


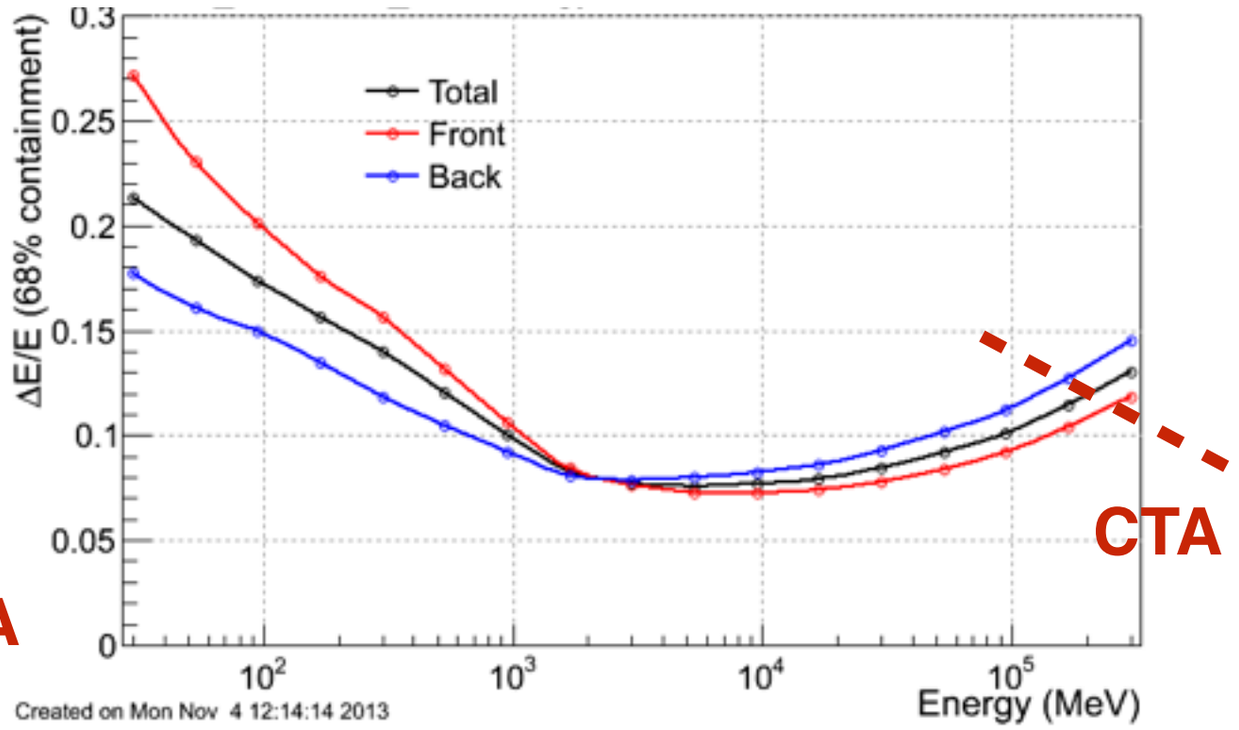


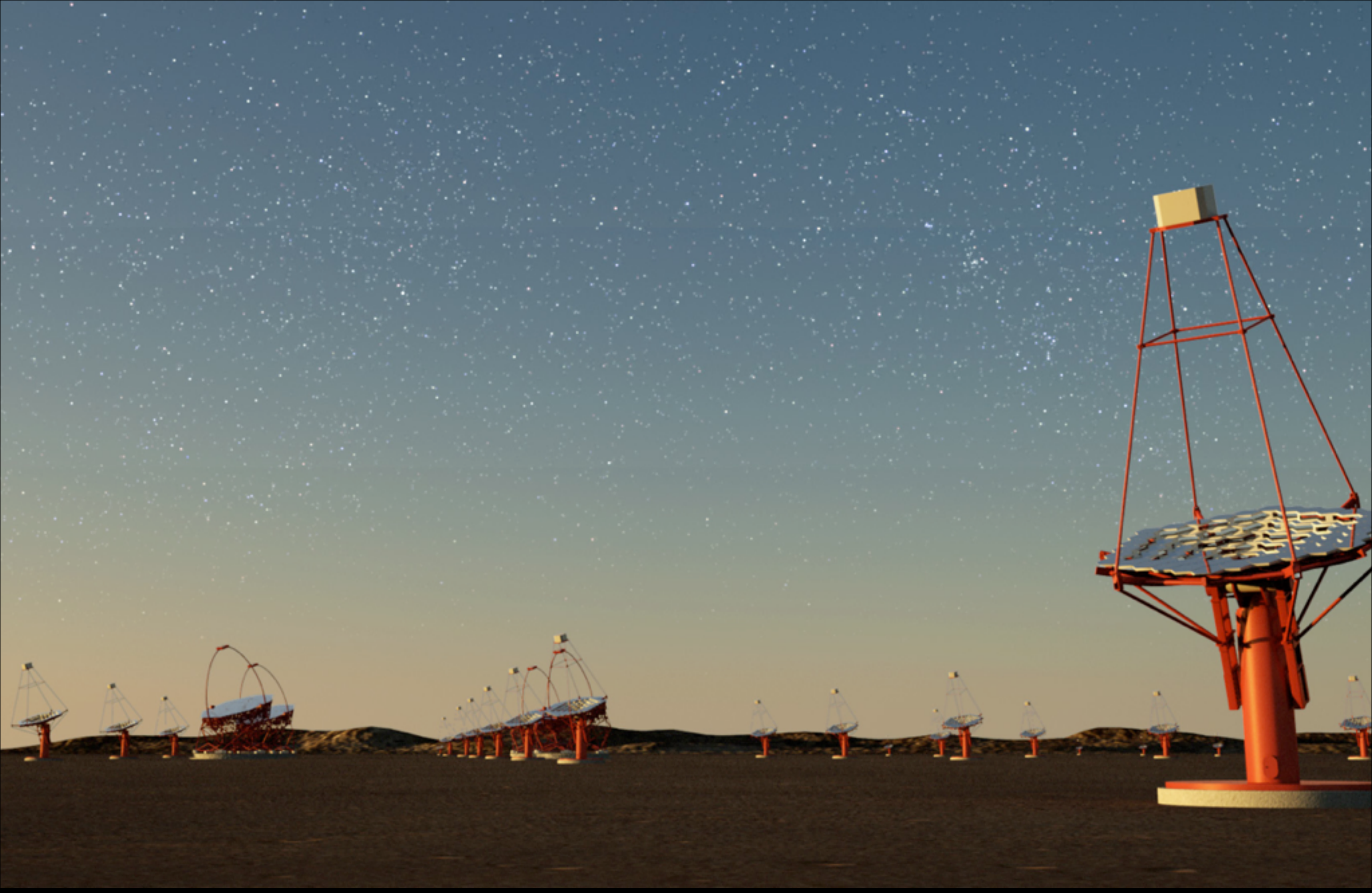
Fermi Performance









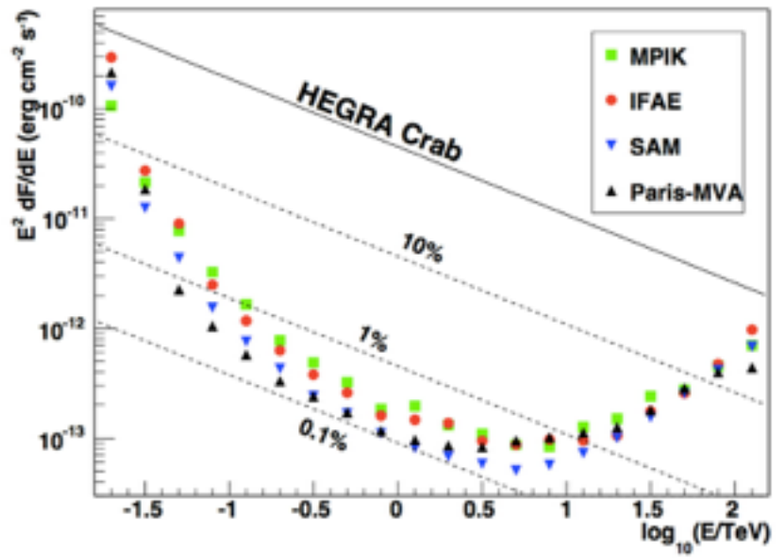


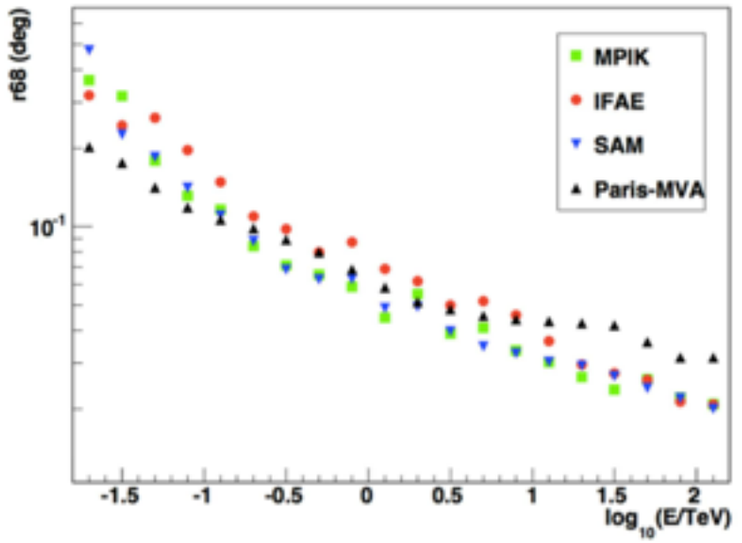
cta
cherenkov telescope array

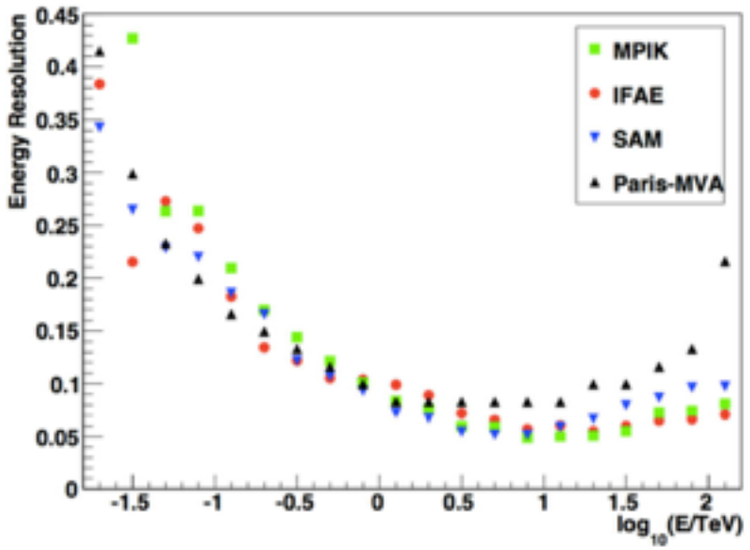
http://www.cta-observatory.org

CHOICE LOCATIONS

The competition for a Cherenkov Telescope Array site in each hemisphere pits candidates in South America against southern Africa, and the United States against Europe.







Where to improve ?

Hard to beat Fermi studying constant sources unless:

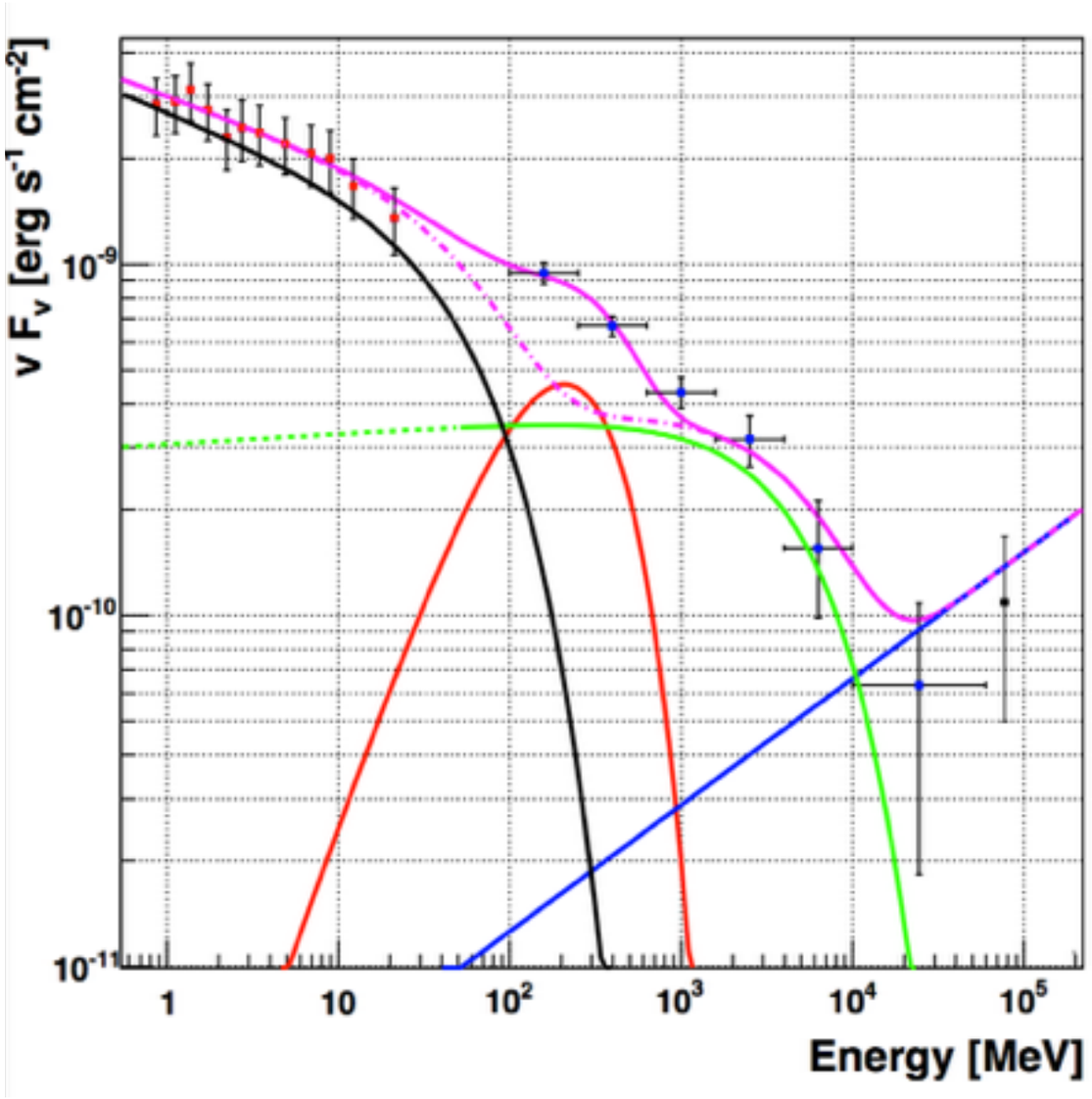
- optimize for low energies/spatial resolution (front tracker)
- optimize for high-energies (side tracker)
- optimize for polarisation (front tracker, calorimeter?)

Variability and contemporaneous observations with CTA and many others (HXMT, AstroSAT, e-Rosita, Mirax, LOFT)

- blazars & GRB: low energies (front tracker)
- galactic sources: spatial resolution is an issue (front tracker)

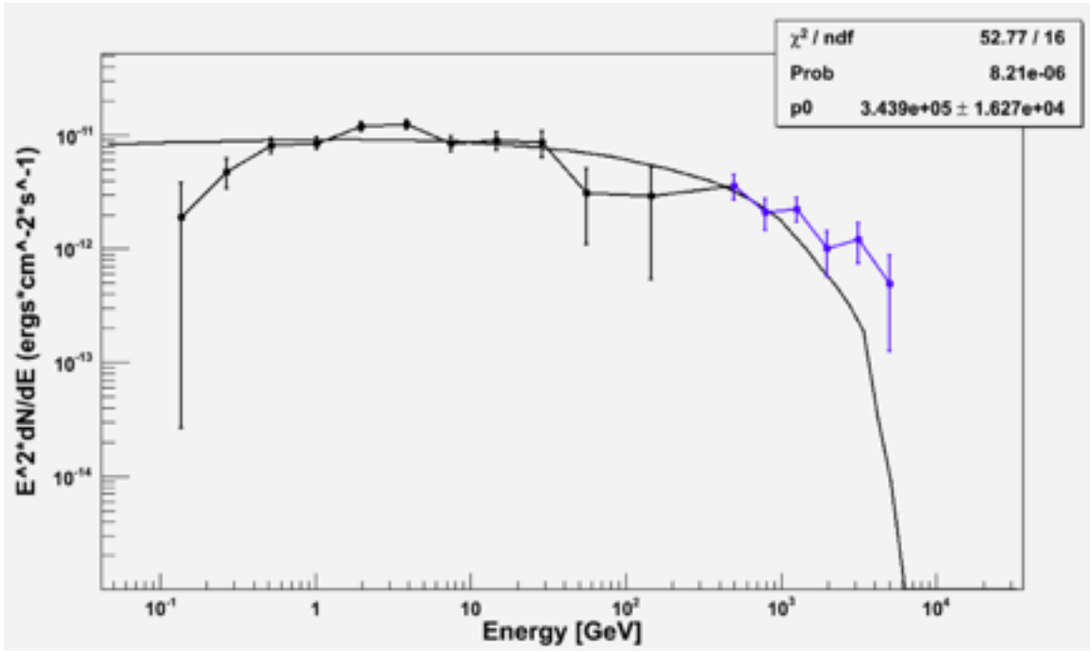
Relevant source types

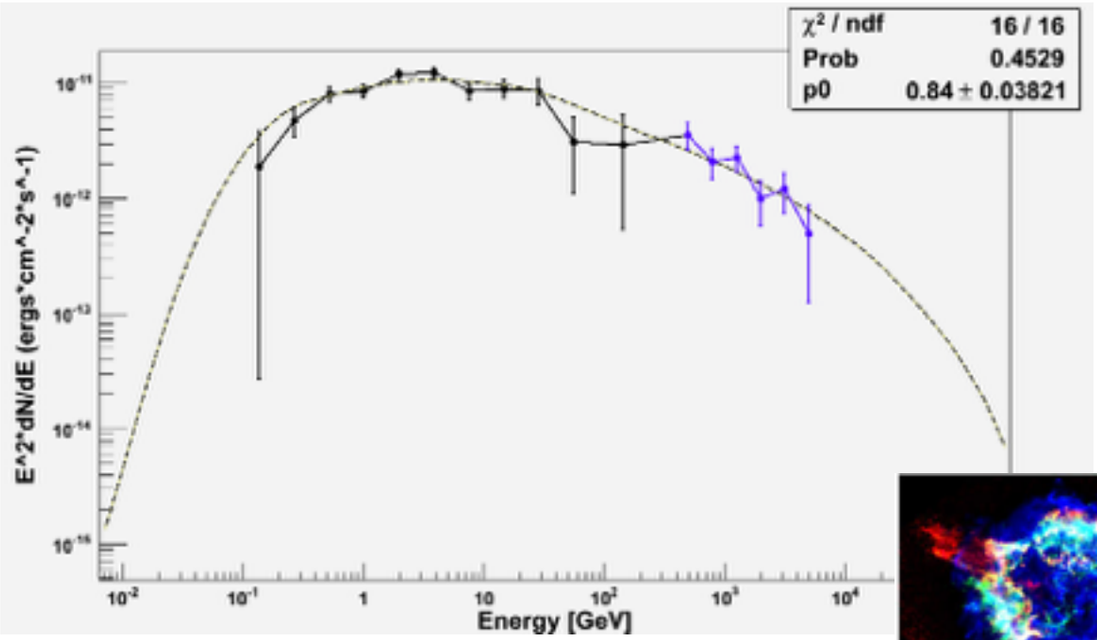
Pulsar Wind Nebula (Crab)

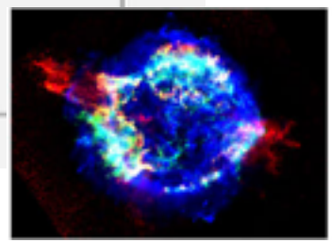


Balbo et al, 2011

SNR (Cas-A)



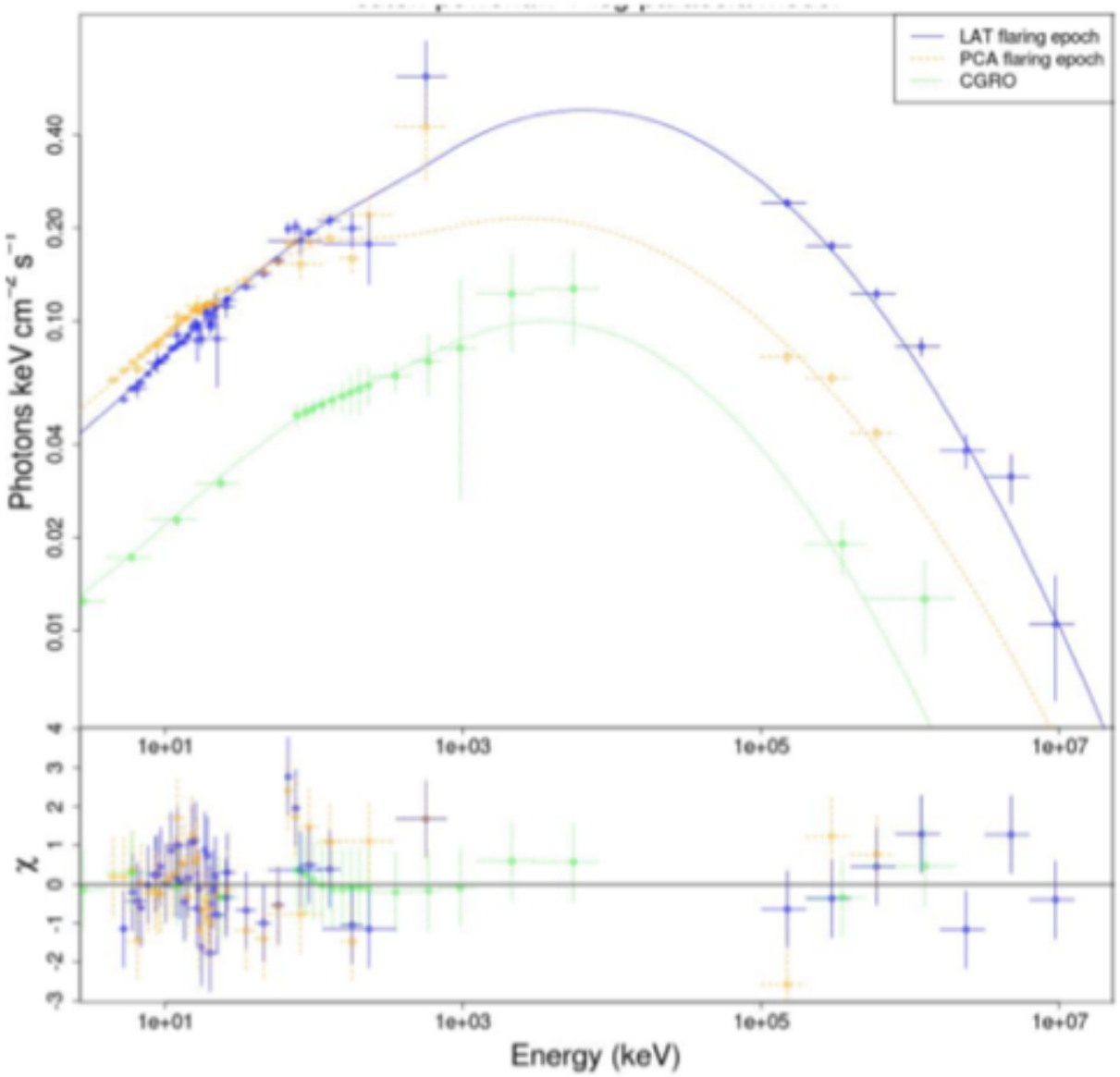


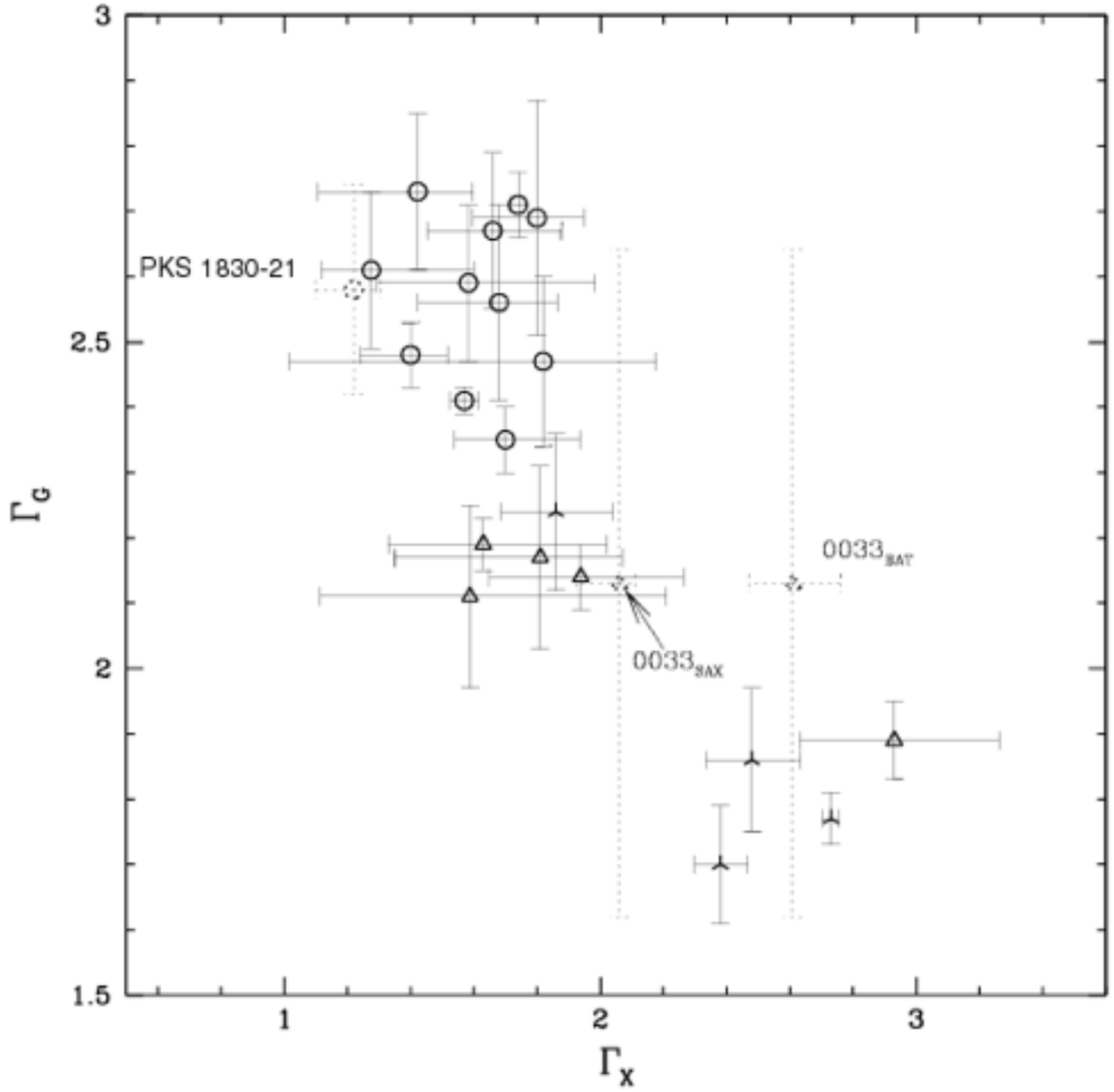


Florez report, 2012

Relevant source types

Quasars, MeV Blazars

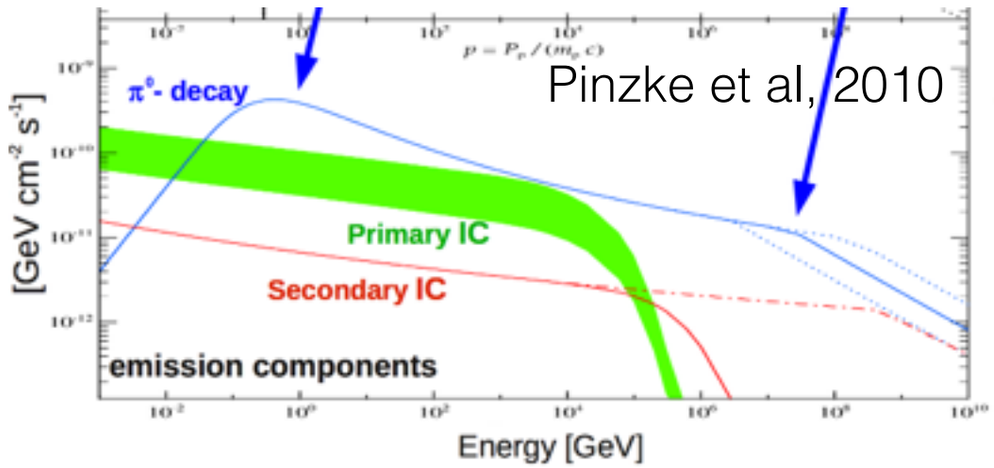




Esposito et al, 2014

Relevant source types

Galaxy clusters



Stacking technique:

F_γ < few 10^{-11} ph/s/cm^2

CR/thermal energy < 5%

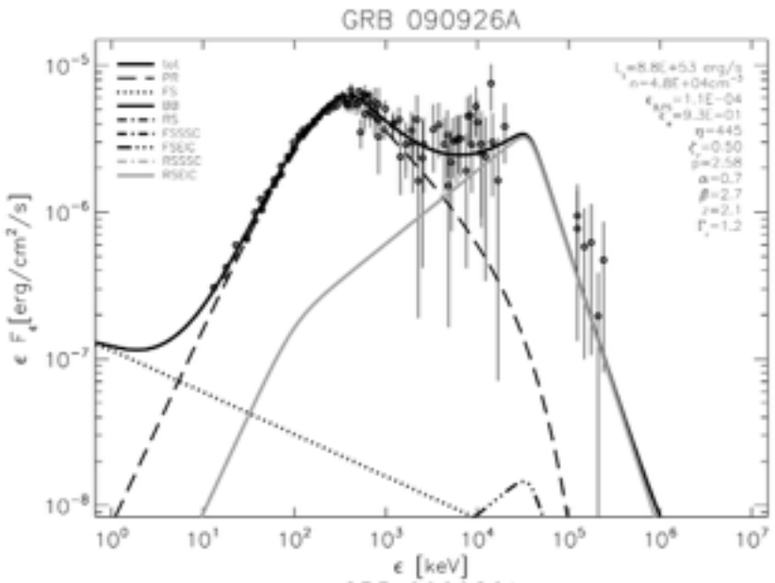
Anti baryon/baryon < few 10^{-9}

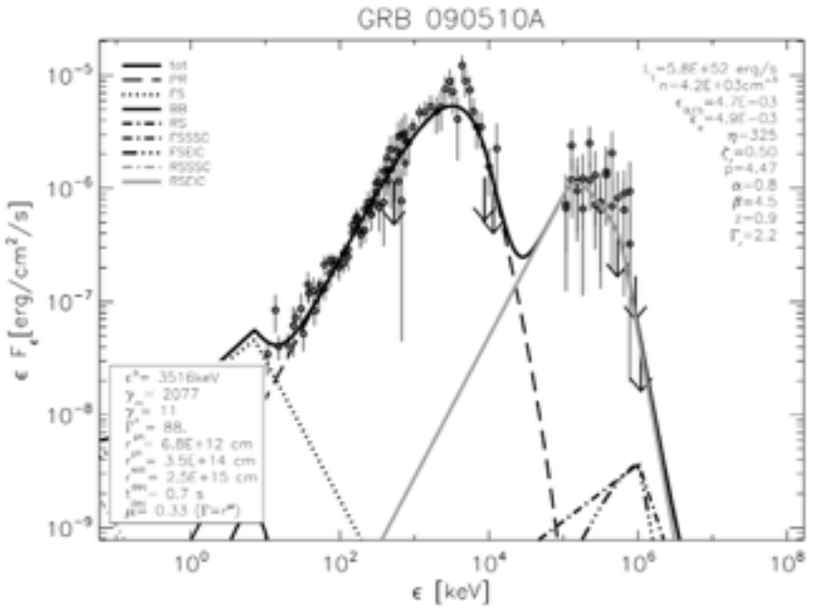
Anti matter domain > tens of Mpc

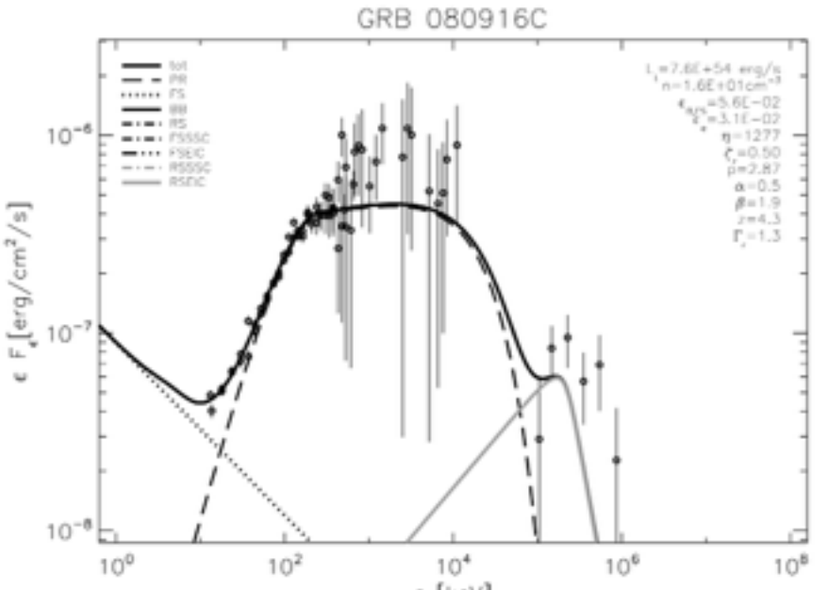
Huber et al, 2013

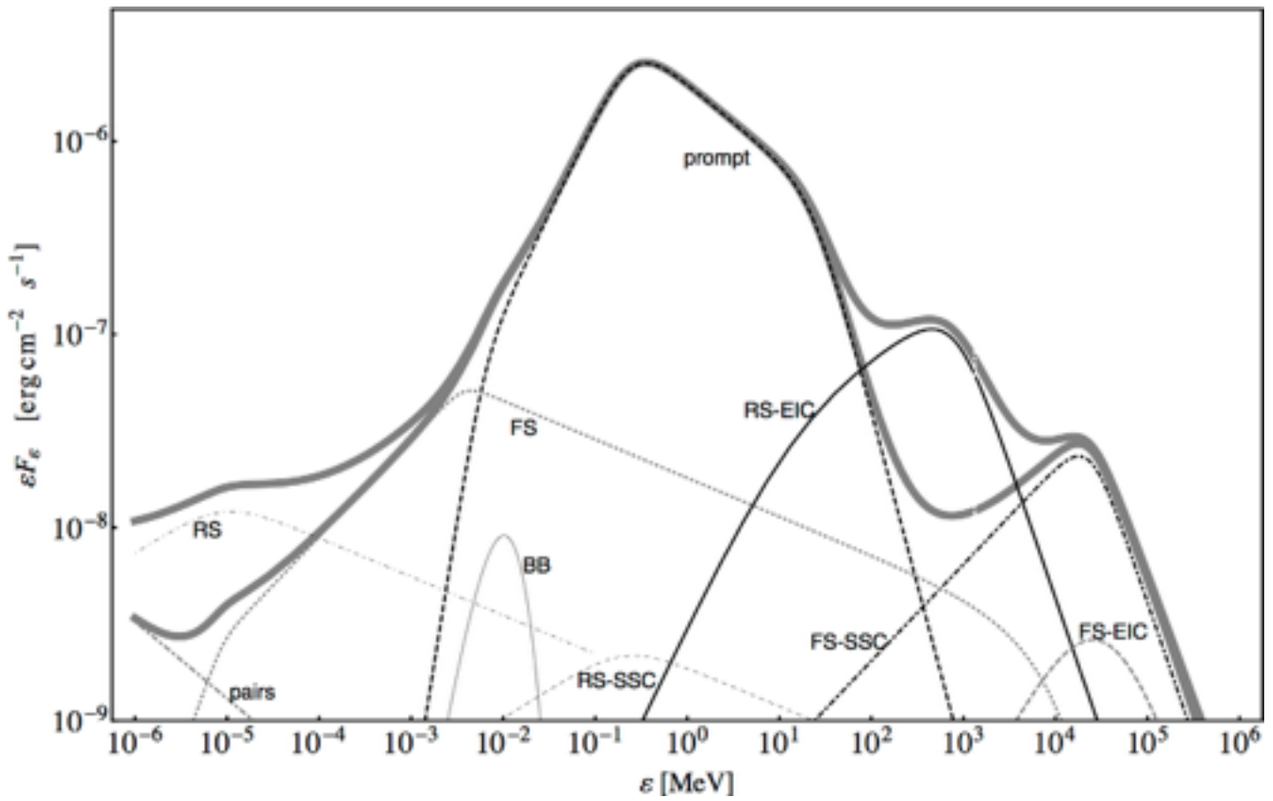
Relevant source types

Gamma-Ray Bursts





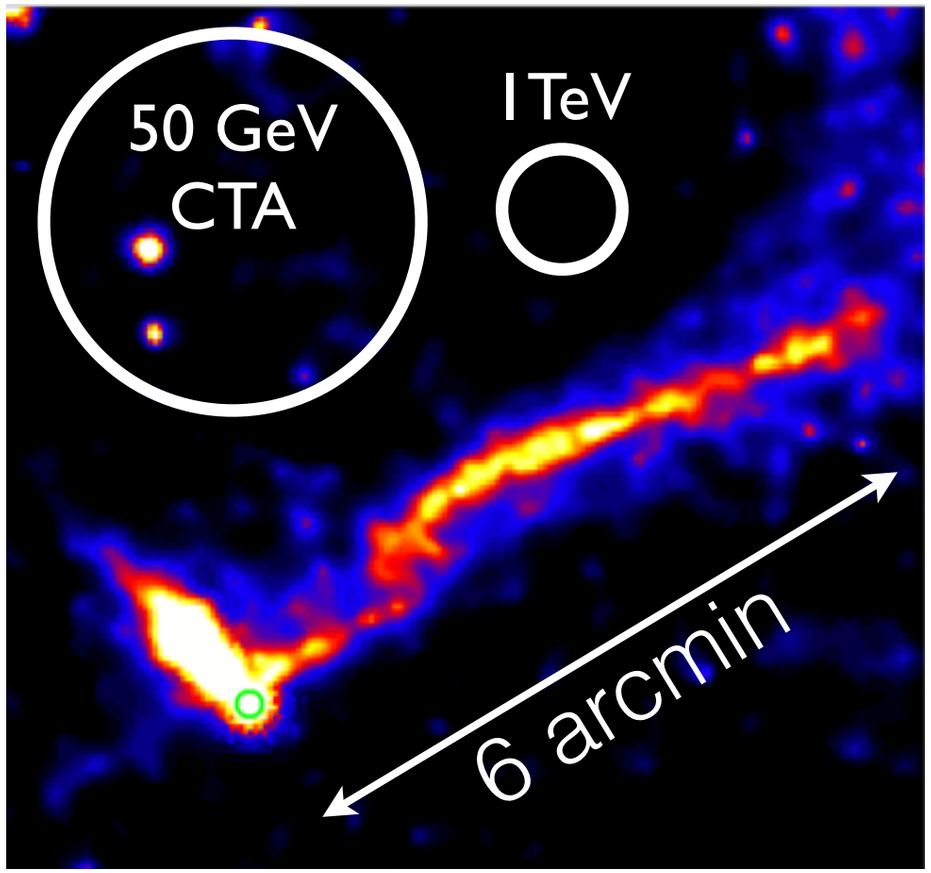




Veres et al, 2013

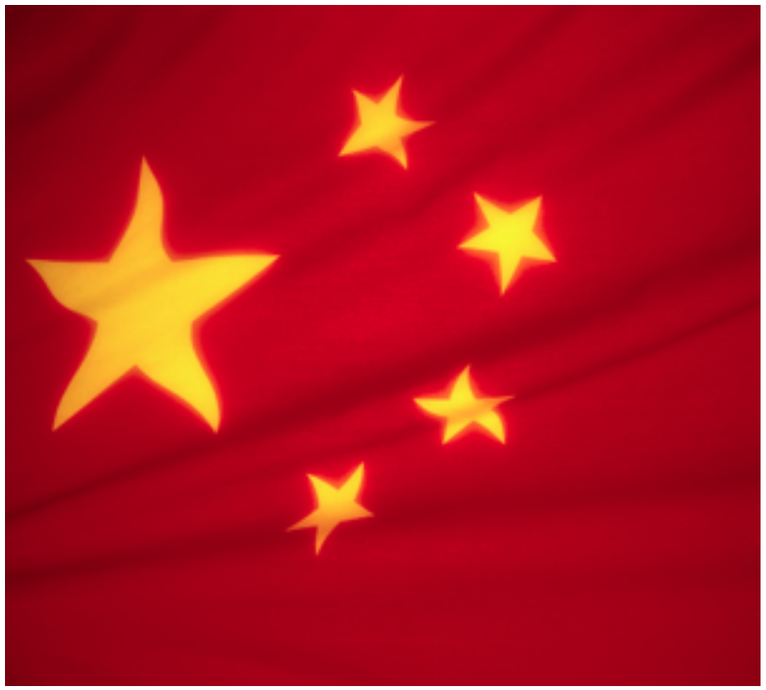
Relevant source types

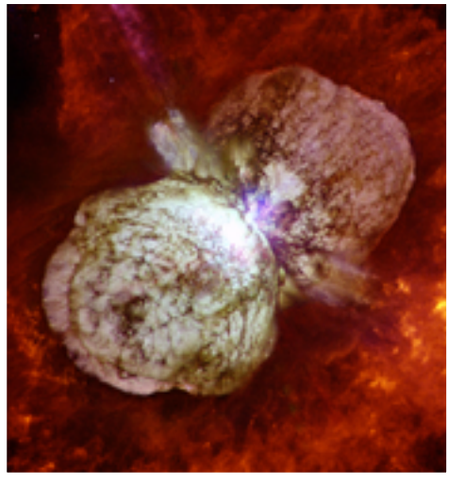
Galactic Jet



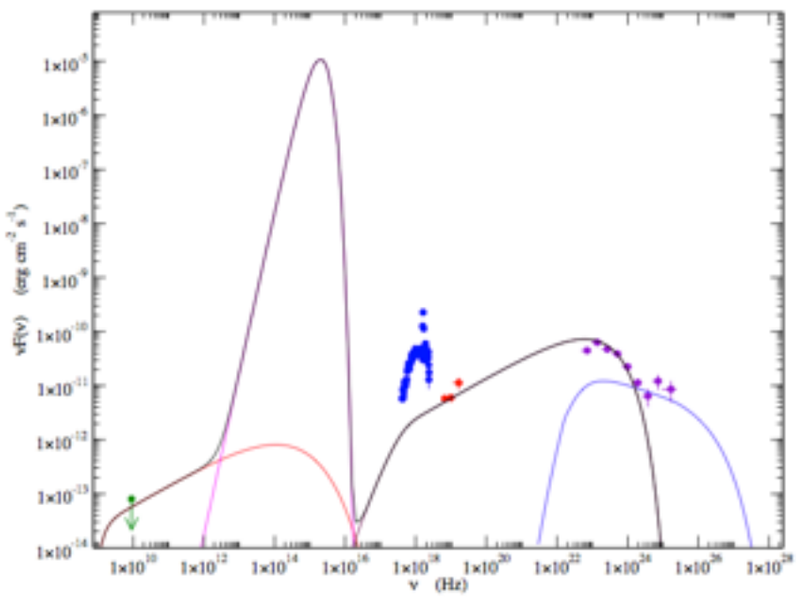
Pavan et al, 2013

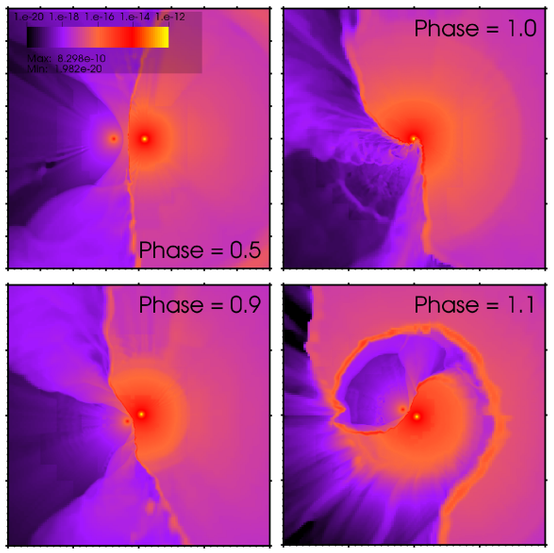
Massive star clusters





Next periastrons:
2014 & 2020





Walter et al, 2011

Polarisation

- Pulsar: phase and location dependent curvature radiation
- PWN: synchrotron radiation (Crab flares)
- Blazars: proton synchrotron or IC
- GRBs: cf POLAR

Pair detectors very good, in principle
badly affected by multiple scattering

Significance for HERD

γ-ray energies:

> 10 GeV: CTA will be hard to beat

1-10 GeV: Fermi is hard to beat

0.1-1 Gev: An opportunity for HERD ? → INTERNATIONAL SPACE SCIENCE INSTITUTE - BEIJING

γ-ray polarisation:

any opportunity ? → Bill Atwood & Fermi team