Current Status and Future Prospects for Space-Based Gamma Ray Astronomy

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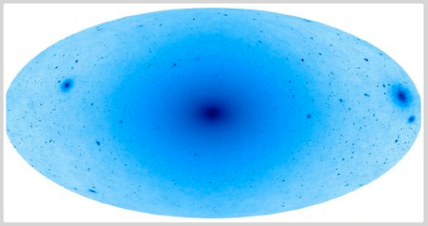
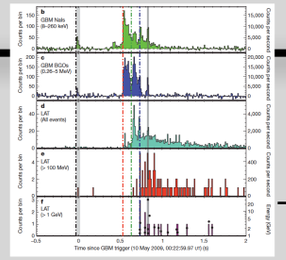
on behalf of the
Gamma-ray Science Interest Group (GammaSIG)
APS - April, 2016

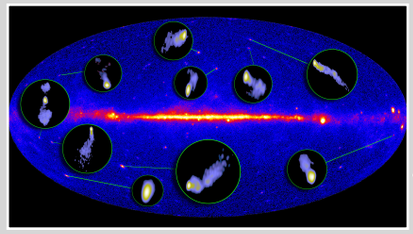
Fermi Highlights and Discoveries

Dark Matter

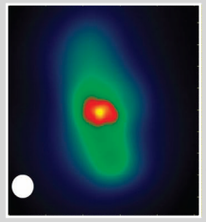




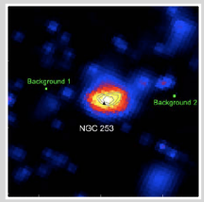
GRBs



Blazars

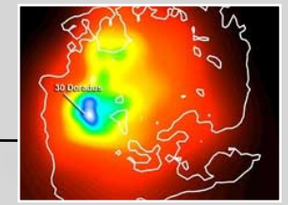


Radio Galaxies

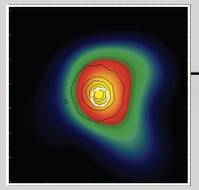


Starburst Galaxies

Extragalactic

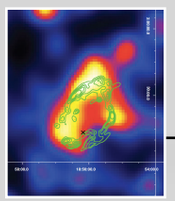


LMC & SMC

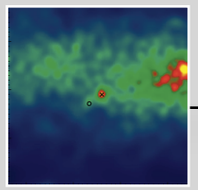


Globular Clusters

Fermi Bubbles

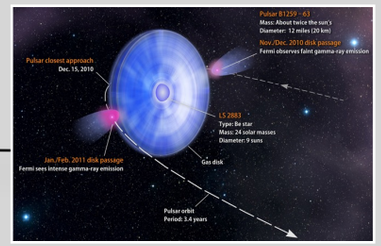


SNRs & PWN

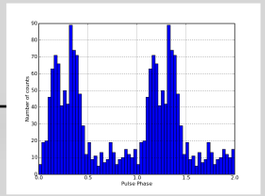


Novae

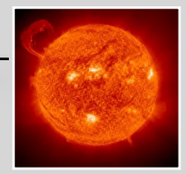
Galactic



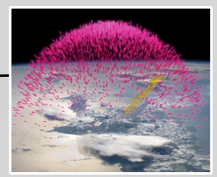
γ-ray Binaries



Pulsars: isolated, binaries, & MSPs



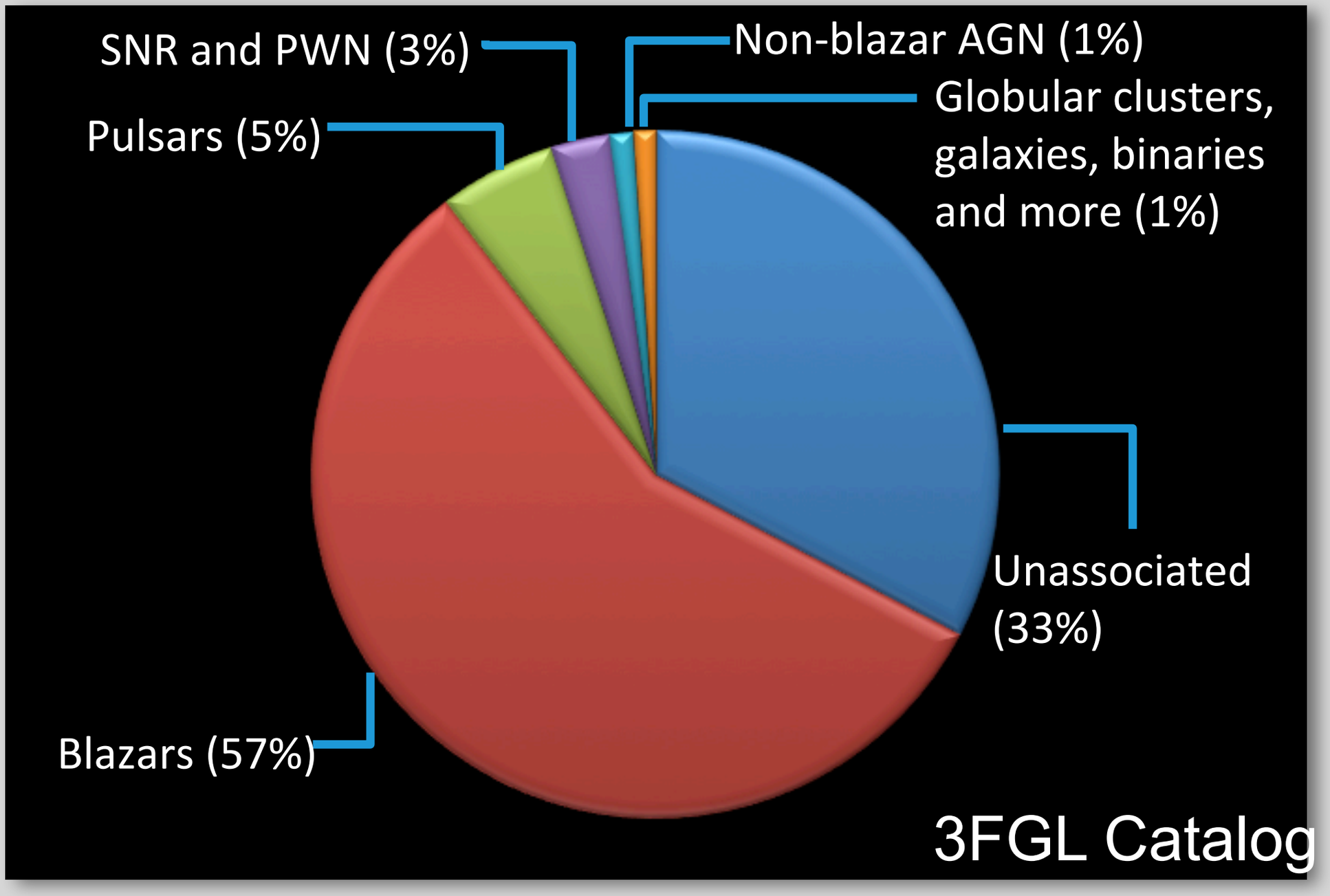
Sun: flares & CR interactions



Terrestrial γ-ray Flashes

What We Don't Know

4 years of data
100 MeV - 300 GeV



What Next?

As we look beyond 2016, what are the next steps for space-based gamma-ray astronomy?

The GammaSIG is organizing a US community effort to develop a roadmap for the future.

Gamma Ray Roadmap

- ✦ Prepare for the 2020 Decadal Review
- ✦ Articulate a common vision for the space-based gamma ray community.
- ✦ The roadmap will…
  - Define the science objectives.
  - Identify a common theme(s).
  - Define the instrument requirements.
  - Summarize possible mission concepts.

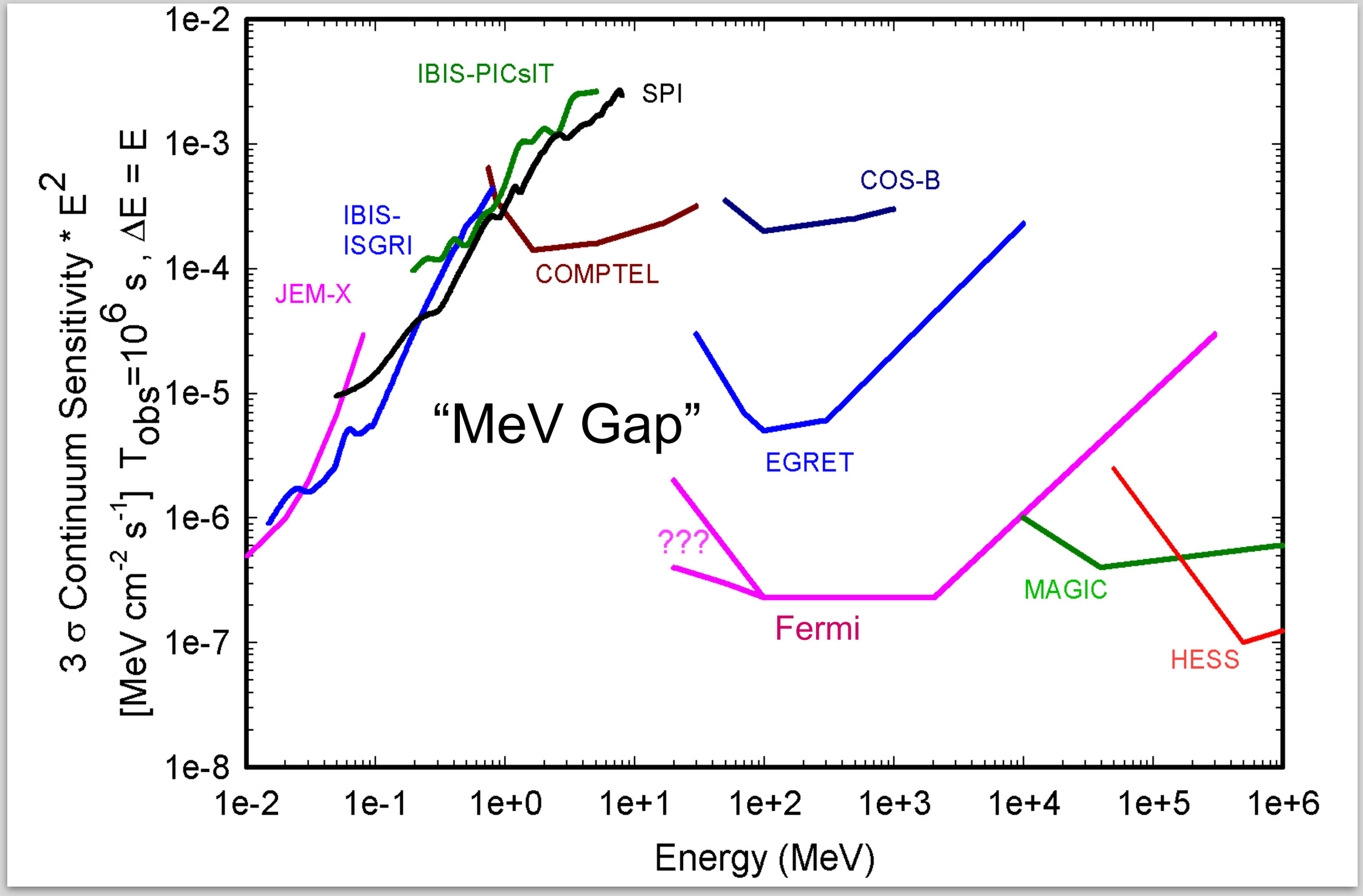
Science

- X-Ray Binaries
- Pulsars / Magnetars
- SNR / PWNe
- Classical Novae
- Supernovae
- Active Galactic Nuclei
- Diffuse Galactic Emission
- Cosmic Diffuse Emission
- Gamma Ray Bursts
- Dark Matter
- Solar Physics
- Terrestrial Gamma Flashes

Numerous science topics linked by common theme.

- Chemical Evolution in the Universe
- Particle Acceleration in the Cosmos
- ???

Sensitivity Coverage



Technical Challenge

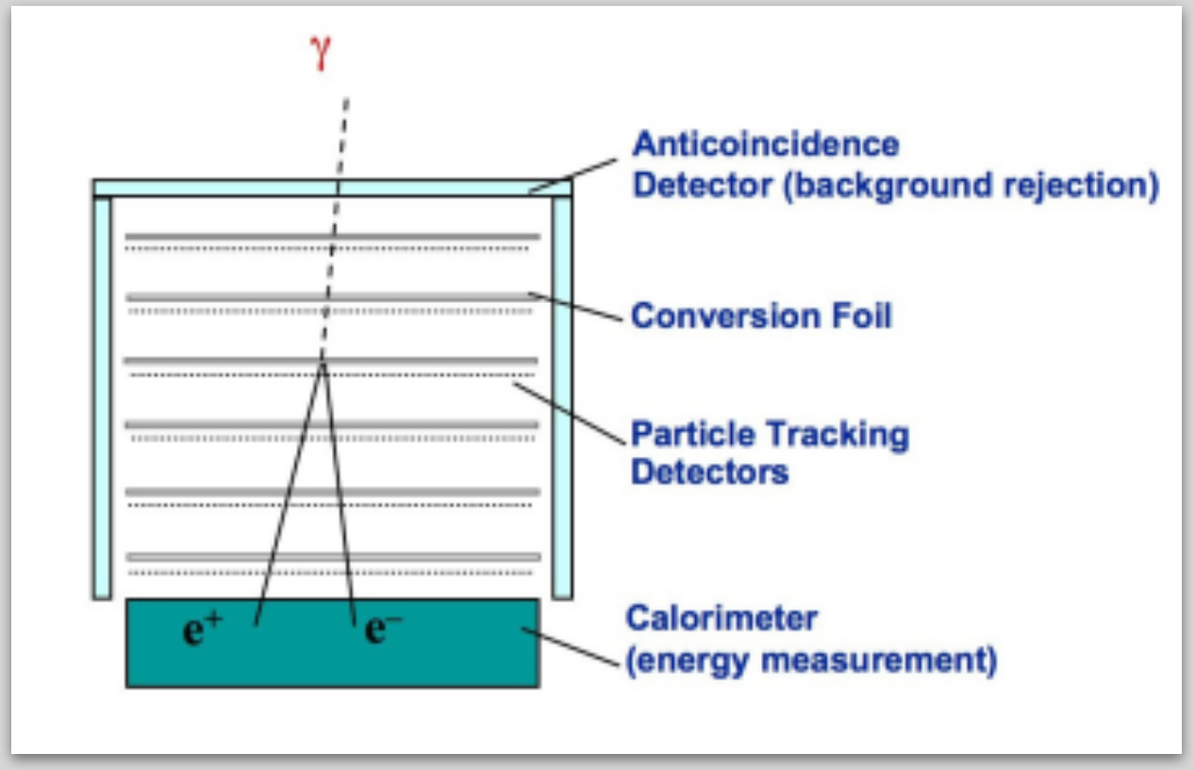
How to cover a broad energy range that extends from ~100 keV to > 100 GeV.

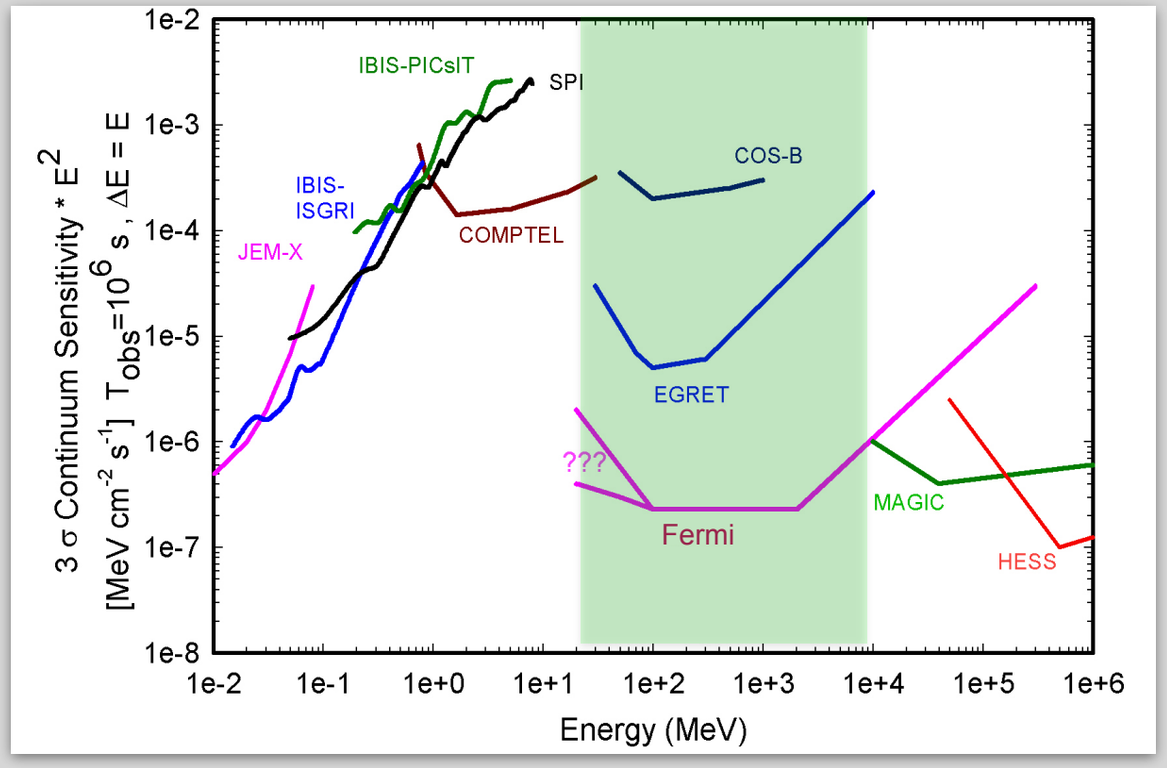
It is difficult to achieve with one instrument.

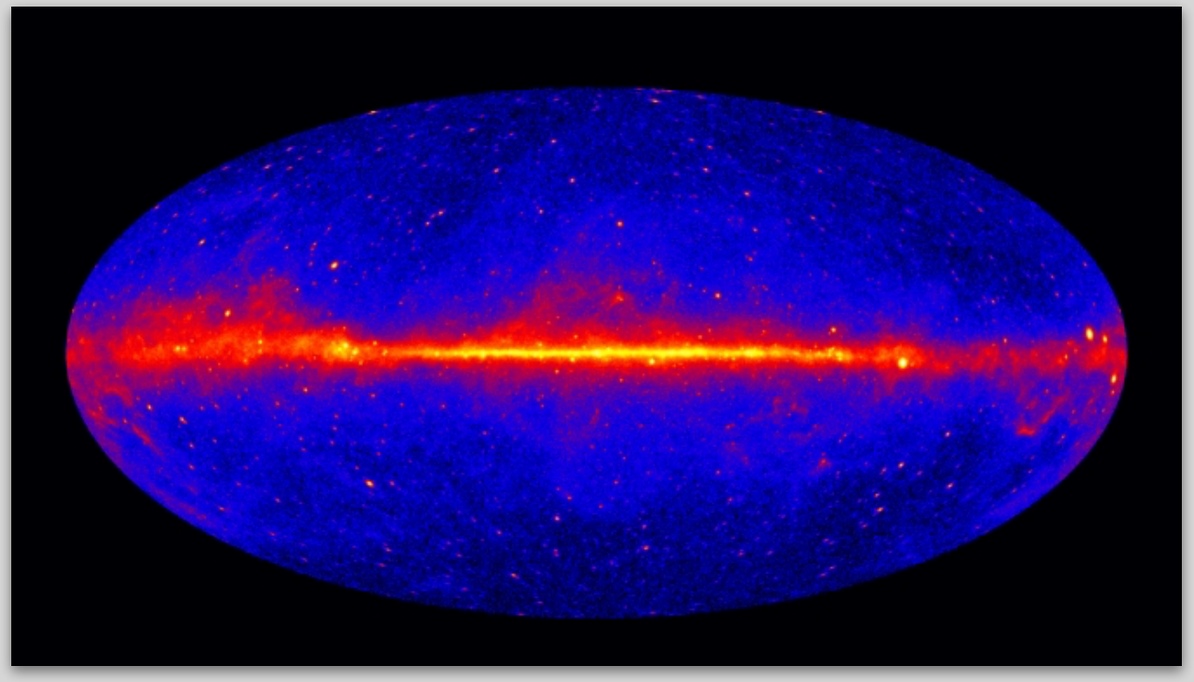
The roadmap may define a limited number of missions that would be required to fulfill the next generation of science objectives.

Pair Production Telescopes

30 MeV - 300 GeV







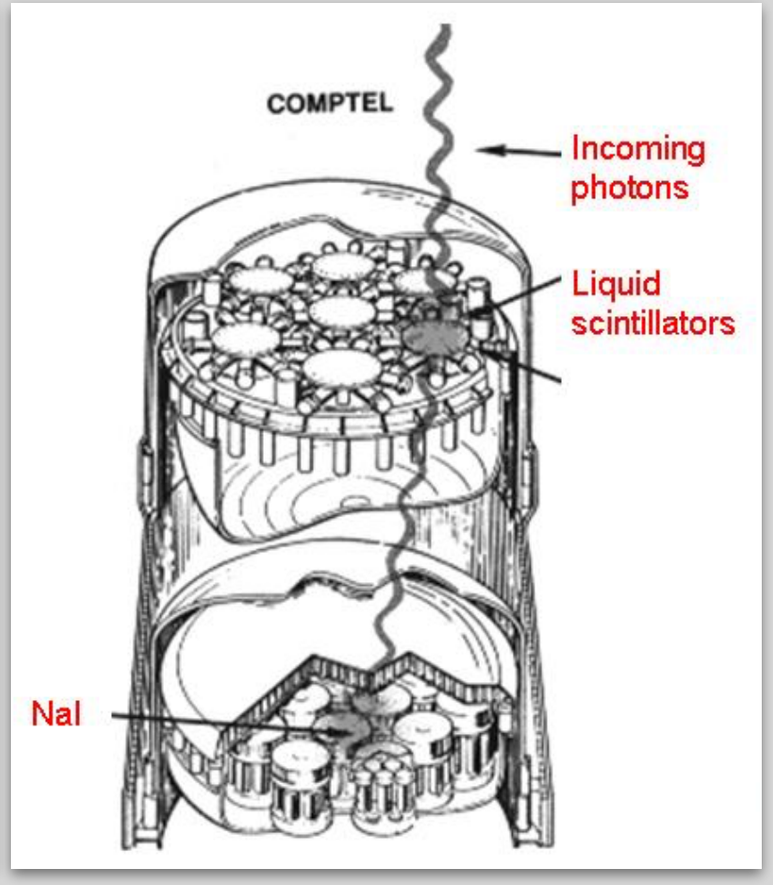
SAS-II (1972-1973) / COS-B (1975-1982)
25 sources

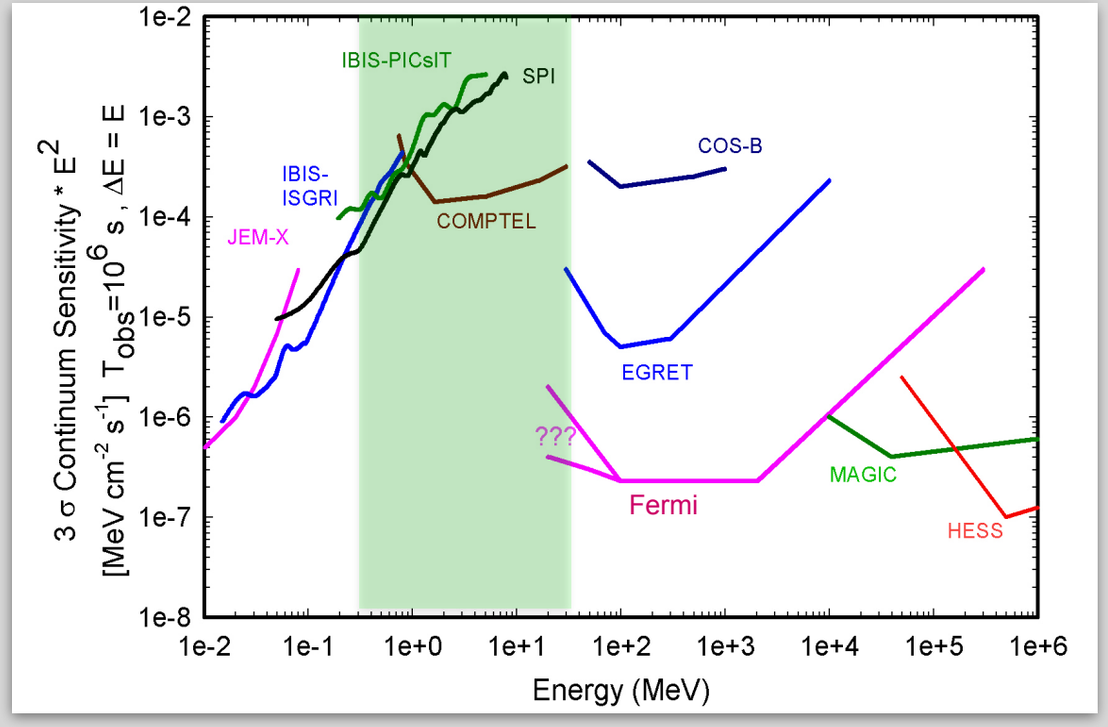
CGRO/EGRET (1991-2000)
271 sources

Agile (2007-present) / Fermi (2008-present)
3033 sources

Compton Telescopes

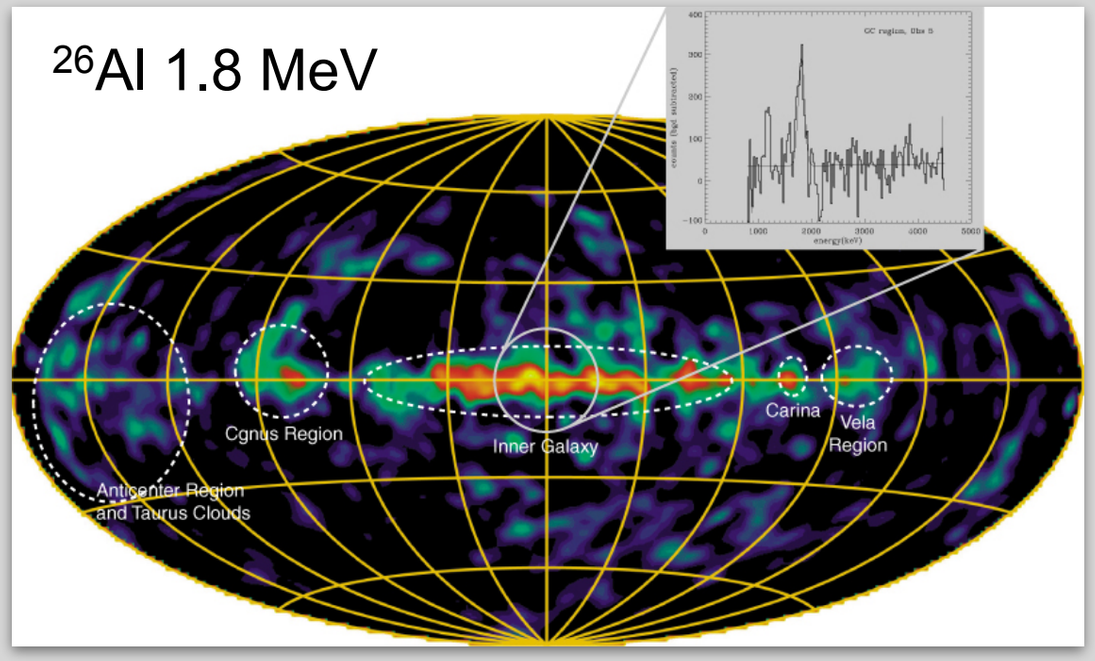
0.2 - 30 MeV





CGRO/COMPTEL (1991-2000)
25 sources

To date, COMPTEL is the only Compton telescope that has flown in space.



The Gamma-Ray Surveyor

The next major gamma-ray mission could well be a Probe-class mission, incorporating several possible designs.

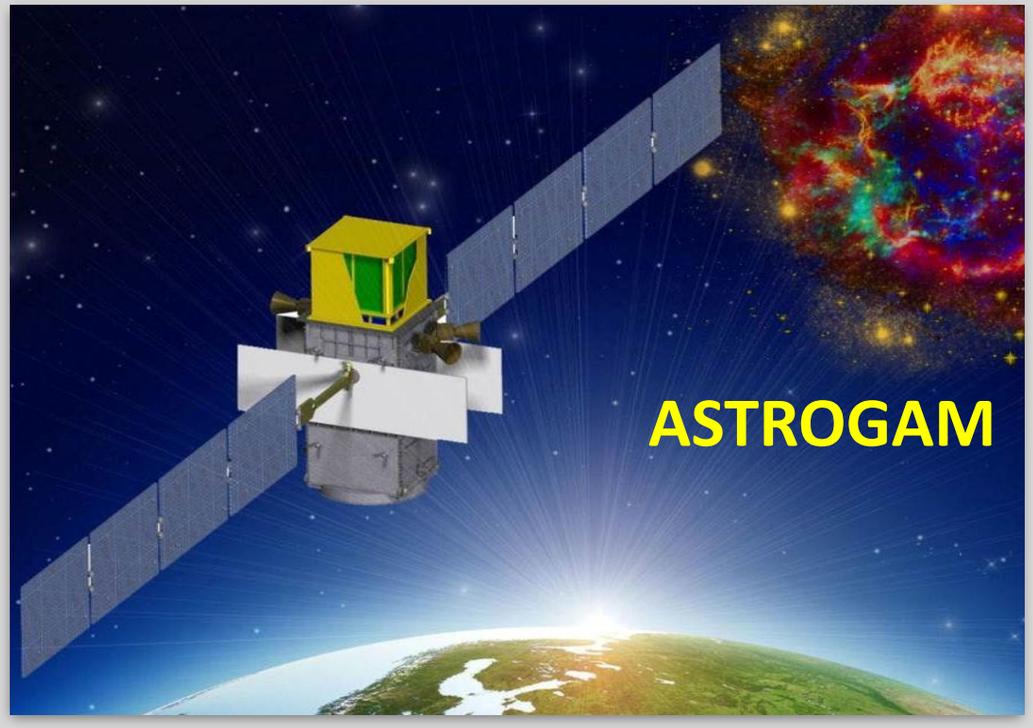
- There is a lot of new science that could be accomplished with a probe-class mission.
- Several Probe-class mission concepts have been discussed.

Fermi spacecraft

The Gamma-Ray Surveyor

Much of the discussion to date focuses on the 1-100 MeV energy band.

- A Compton telescope could study the nuclear line regime.
- Properly designed pair telescope could better probe below 100 MeV.



(e-ASTROGAM to be proposed as an ESA M5 mission)

One mission or two (or three?).

Recent GammaSIG Events

Future Space-Based Gamma-Ray Observatories
February 2015 workshop @ NASA/GSFC

Mini-Symposium on Future Gamma-Ray Missions
April 2015 APS Meeting @ Baltimore

Special AAS-HEAD Meeting
High Energy Large and Medium-class Space Missions in the 2020s
June 2015 @ Chicago

Fermi Workshop
November 2015 @ Washington, DC

Future Space-Based Gamma-Ray Observatories
March 2016 workshop @ NASA/GSFC

AAS-HEAD Meeting
April 2016 @ Naples, FL

Timeline for Gamma Ray Roadmap

- *June 1 - Science Topics Input*
  Each topical working group provide 2-3 summary of science questions to be addressed and the instrument requirements needed to address them.

- *July 1 - Mission Concepts Input*
  Each mission concept representative provide a concept summary (no more than 5 pages).

- *Sep 1 - First Draft*
  The roadmap committee will distribute the first draft of the roadmap for community comment.

- *Nov 1 - Second Draft*
  Second draft distributed to community for final input.

- *Dec 1 - Final Version*

Gamma Ray Science Interest Group

GammaSIG Website
(http://pcos.gsfc.nasa.gov/sags/gammasag.php)
many past presentations can be found here

Mailing List
(http://pcos.gsfc.nasa.gov/sags/gammasag/gammasag-maillist.php)