Mapping Science to Instruments

Bill Atwood
atwood@scipp.ucsc.edu

"Workshop to discuss Future MeV Missions"
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Introduction

To be -or- Not to be?

- Making the Science Case for the Next. Gen. Satellite is Critical
- Question: What really worked well for Fermi?
- Design the Mission – not just the Instrument
- The more general (broad based) / the more Community Support

What Worked Well for Fermi?

(*What will we miss the most?*)

- All Sky Scanning
- Fast Data turn-around
- Good PSF
- Large Effective Area
- Exceptional Energy Reach
- Precision Timing
- Sensor Stability

Science Areas

- **Transient Phenomena**
  - Burst Science
    - Short time scales
    - Medium time scales
    - Long time scales
  - Periodic
  - Quasi Periodic
- **Image Resolution Limited**
  - Points Source –or- extended
    - Halos
    - PWN, SNR, etc.
  - Confused Regions
  - Polarization
- **Photon Statistics Limited**
  - Spectral Features
    - Lines
    - Pion Bump
  - Point Source Sensitivity
  - Extended Source Imaging

Instrument Parameters

Effective Area
Field-of-View
PSF
Energy Resolution
Shutter Speed
Frame Advance Timing
Background Rejection

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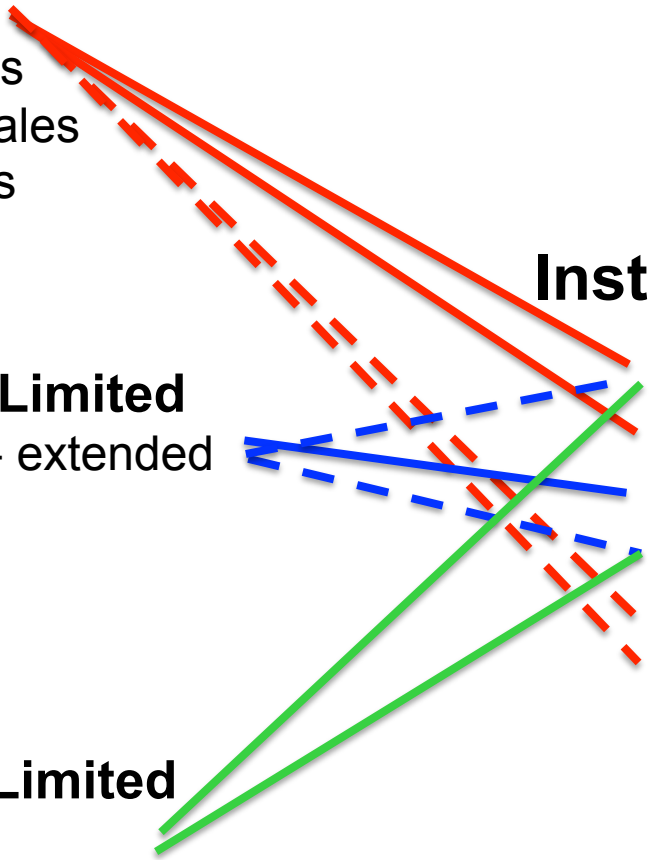

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Effective Area
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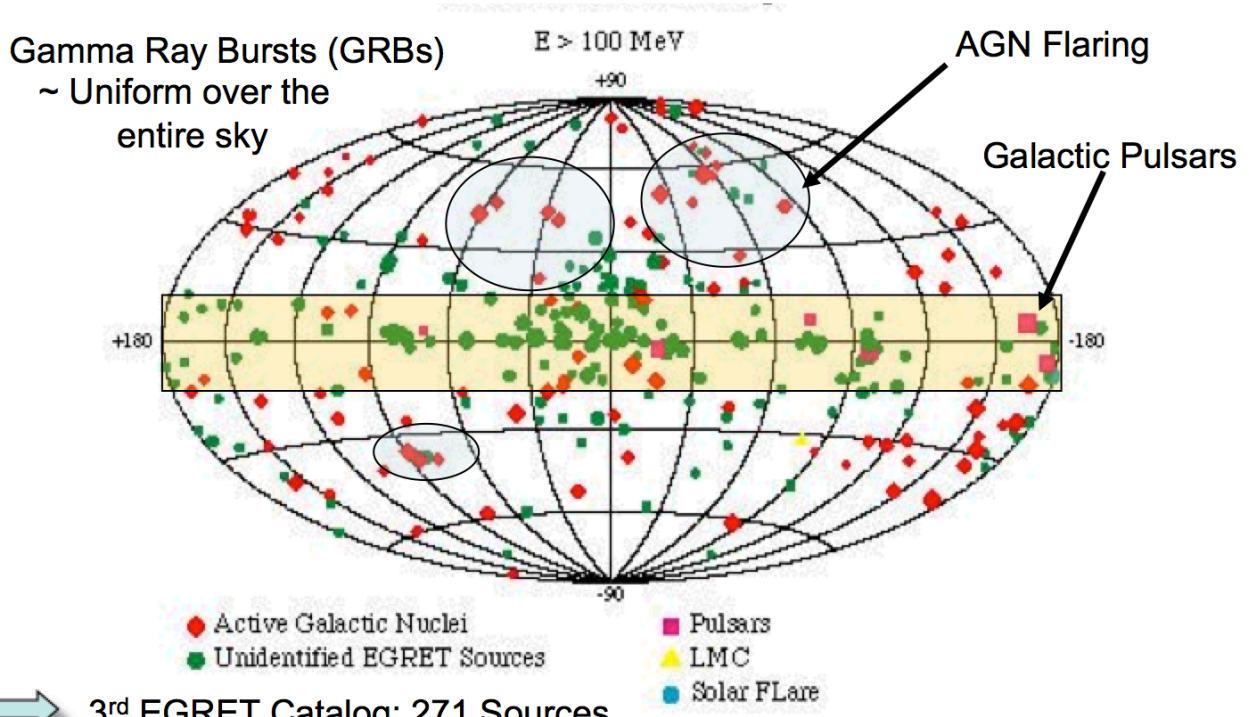
A Chart from before Fermi Launch in 2008

An essential characteristic: VARIABILITY in time!



- 3rd EGRET Catalog: 271 Sources
- Monitoring sky requires wide Field-of-View and large effective area
- In the GLAST Era: daily AGN Flares, hundreds of pulsars, GRB ~ every few days

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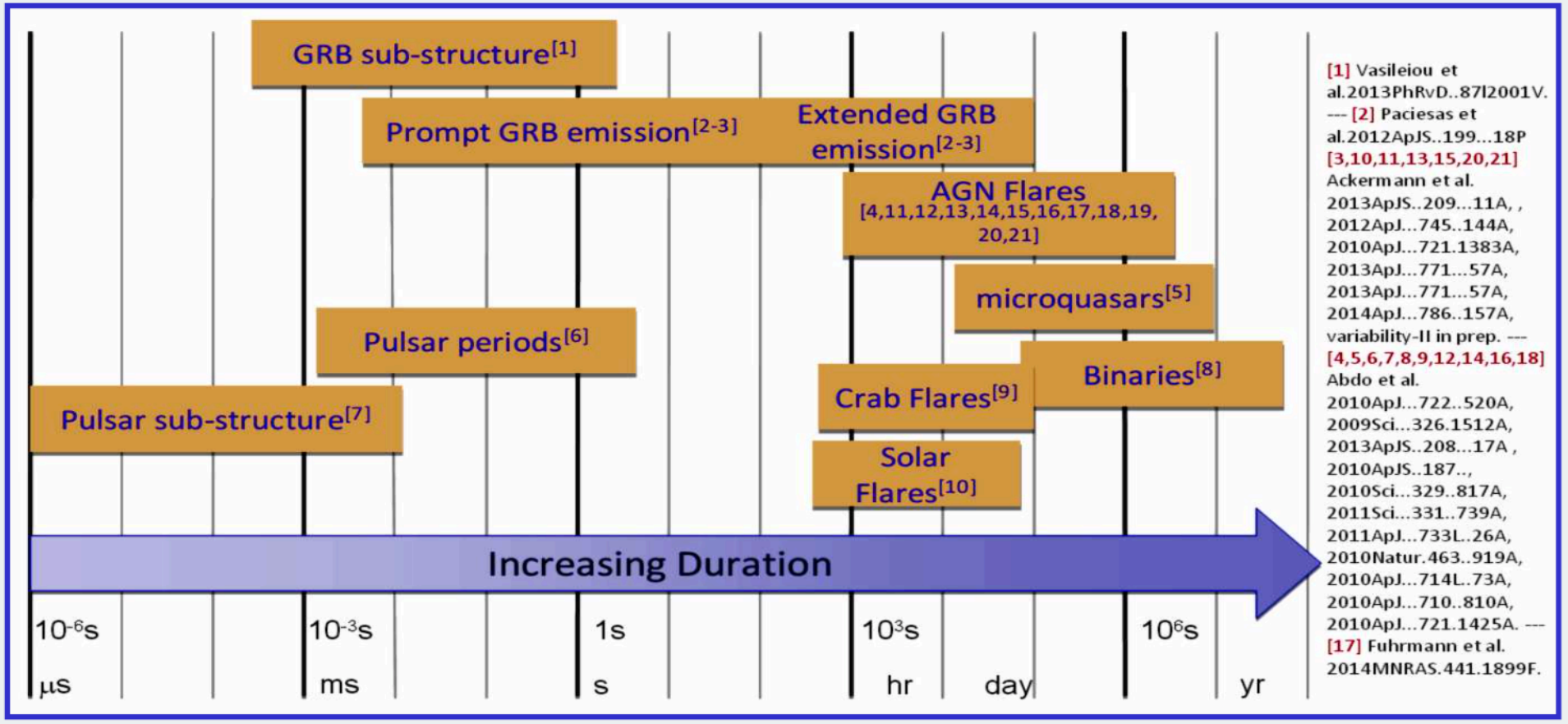
Time Scales for Light Curves



Ciprini et al, 5th Fermi Symposium, 2014

Field-of-View and Aeff

LAT had a large FoV due to compact design

Limited by Tracker Conversions

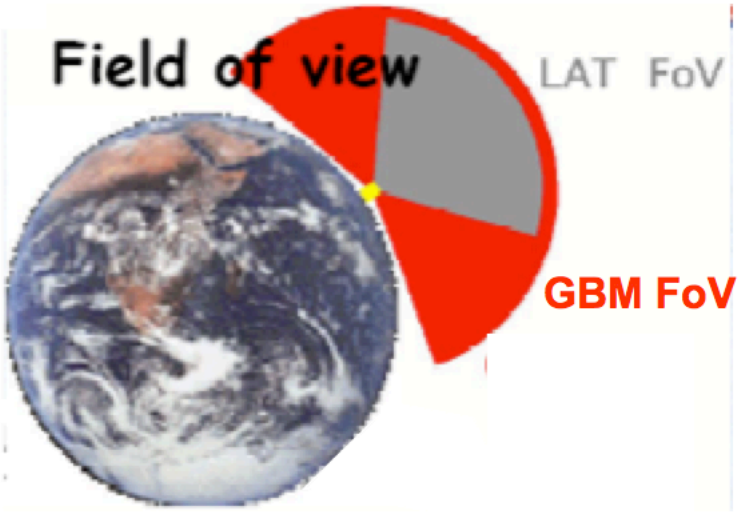
Planar geometry – $A_{eff} \sim \cos(\theta)$

Increase the FoV significantly

need Omni-Directional Detector

Increase A_{eff} Significantly

need several Rad. Lens.



Want FoV like the GBM

PSF: Precision Imaging

Multiple Scattering

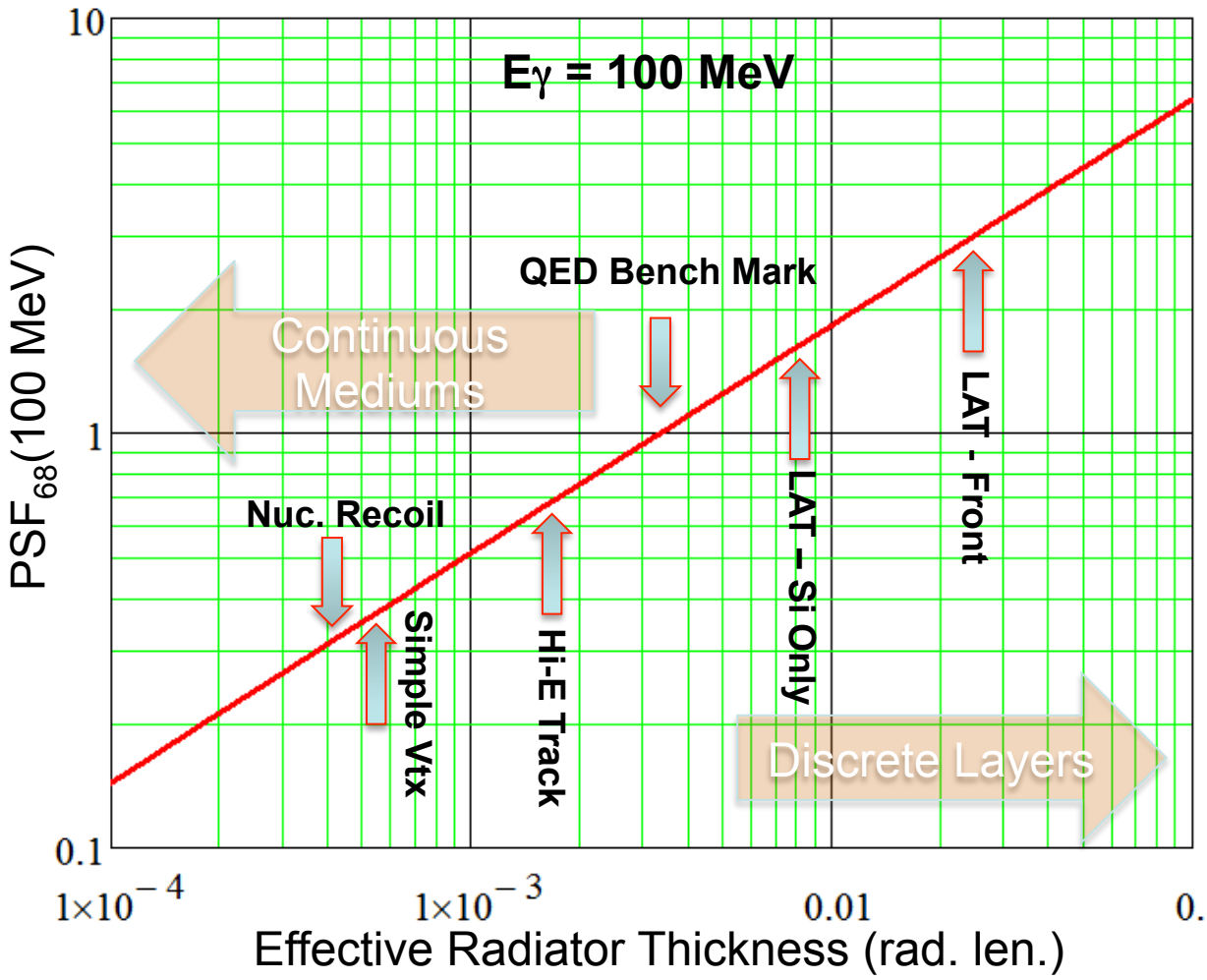
Dominates PSF for most designs – it's the 800 lbs. Gorilla!

$$\Theta(E,X) := \frac{13.6\cdot\sqrt{X}(1. + .038\ln(X))\cdot\sqrt{2}\cdot 57.295}{.5\cdot E}$$

Ave Single Tkr Energy

Space Angle

Multiple Scattering for 100 MeV Gamma Ray vs Radiator Thickness



Wish List for Next Generation Fermi

All Sky Monitoring

- Large Etendue
  - LAT: Aeff ~ 1 m^2 ; FoV ~ 2.4 str.; Etendue ~ 2.5 m^2-str
  - Increase FoV to 2π str.
  - Increase Aeff to ~ $2m^2$
  - Goal: NGF Etendue > 10 m^2-str. (> 4x LAT)
- Imaging: Good enough to provide Fast Alerts

Precision Imaging

- Not possible over entire FoV?
- Good enough to do Polarization

Compton Sensitive

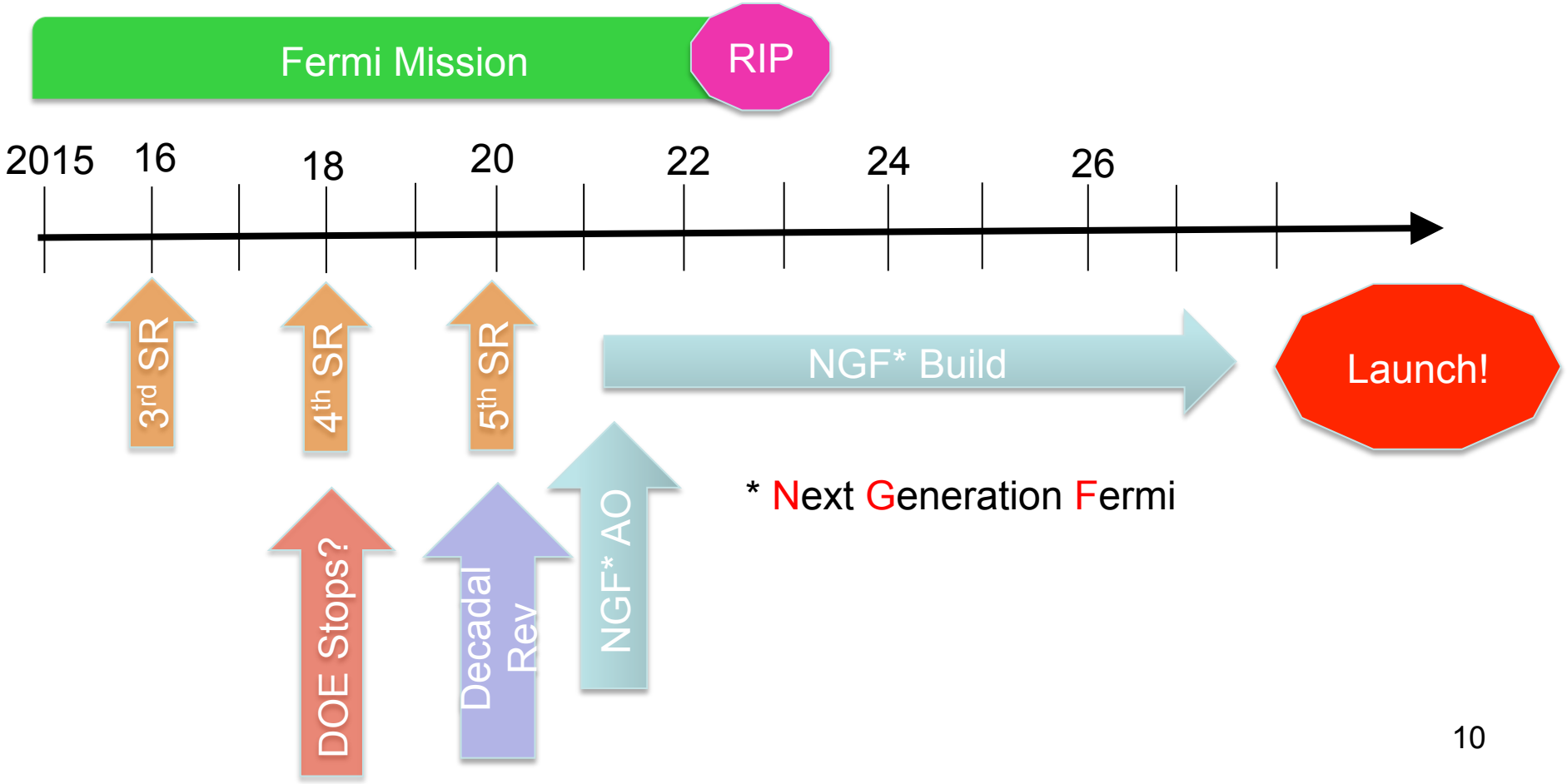
- Precision Imager + 1st layer of Calorimeter?

Robust Technologies

- Maximize Mission Lifetime
- Minimize Calibration maintenance

Time Line

- Senior Reviews every 2 years
- DOE ends support 2018?
- Decadal Rev. Critical
- Fermi Mission will END



Summary

- Where is this all headed?
- 100 KeV – 100 MeV: AstroMeV?
- Science Case for 2020 Decadal Review
- Instrument Concepts which enable the Science
- Flagship Mission in the 2020's?