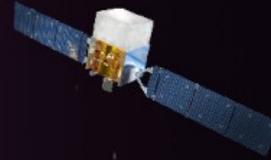


Fermi Large Area Telescope

BARI-PERUGIA-ROMA-TORINO-TRIESTE



8TH FERMI MASTERCLASS

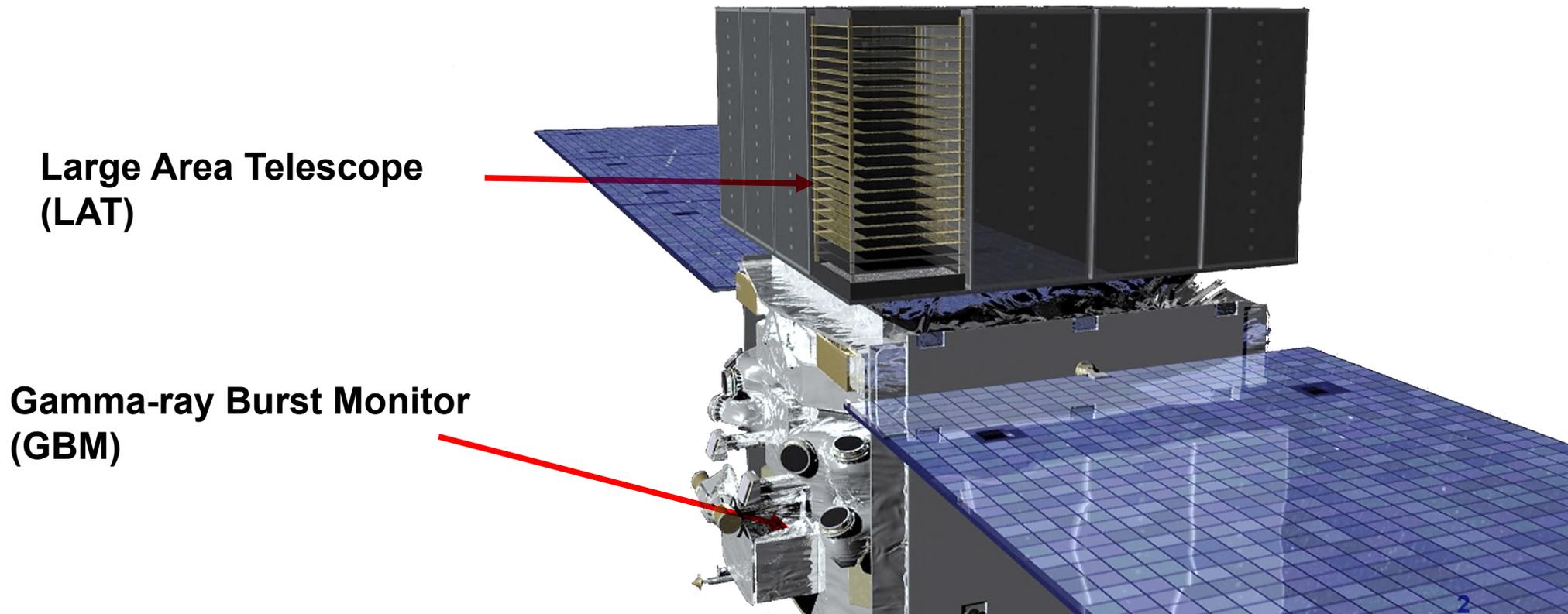
HUNTING FOR GAMMA-RAY BURSTS

S. Maldera
INFN - Torino



Fermi Gamma-Ray space telescope

- Il Fermi Gamma-Ray Space Telescope e' una missione internazionale per l'esplorazione del cielo gamma per mezzo di due strumenti:
 - Gamma-ray Burst Monitor (GBM): 8 keV - 40 MeV
 - Large Area Telescope (LAT): 100 MeV - ~500GeV



Large Area Telescope
(LAT)

Gamma-ray Burst Monitor
(GBM)

Lancio

GLAST (Gamma Large Area Space Telescope), lanciato da un razzo Delta II da Cape Canaveral l'11 Giugno 2008 alle 12:05 EDT.

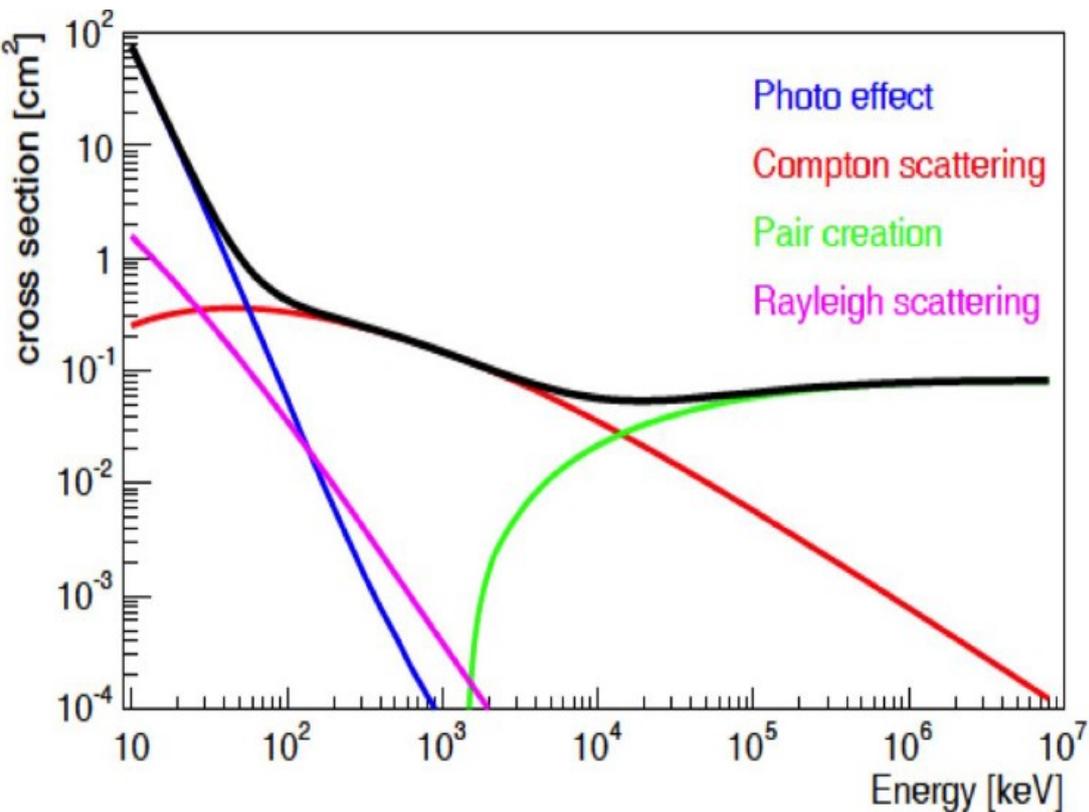
Rinominato in onore di Enrico Fermi dopo il lancio



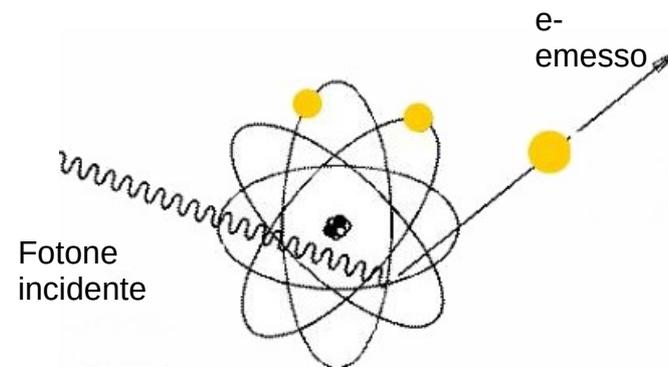
- Orbita quasi circolare
- Altitudine: 565 km
- Inclinazione: 25.6 deg
- Periodo orbitale= ~90 minuti

Rivelazione fotoni gamma

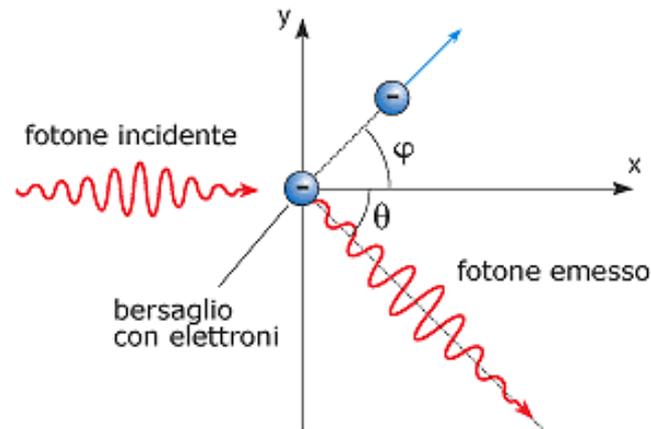
Interazioni fotoni-materia



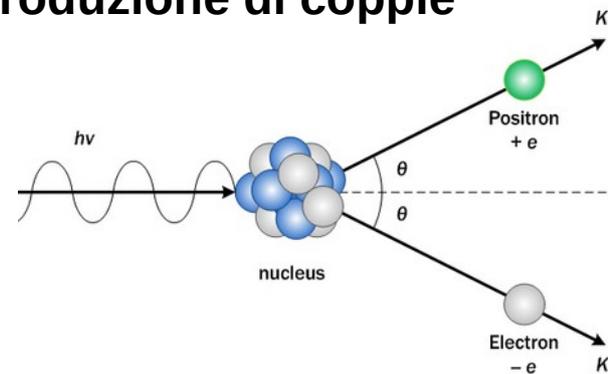
Effetto Fotoelettrico



Scattering Compton

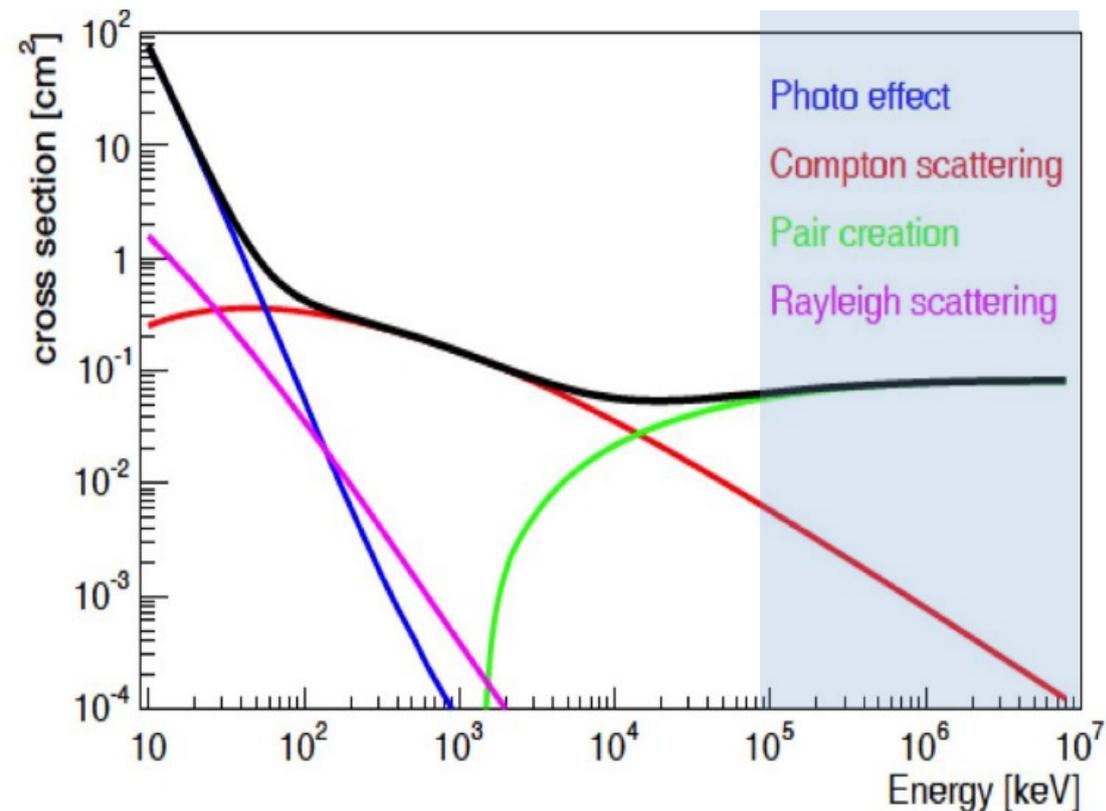


Produzione di coppie



Rivelazione fotoni gamma

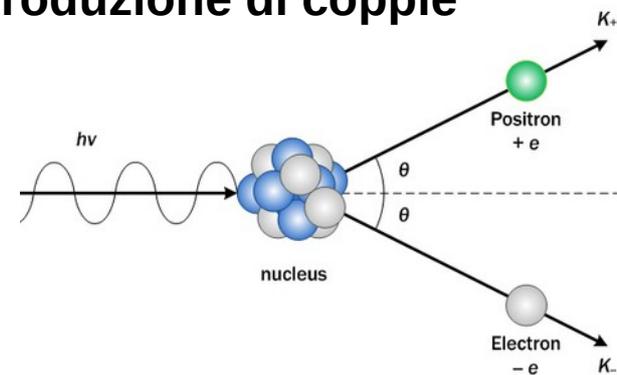
Interazioni fotoni-materia



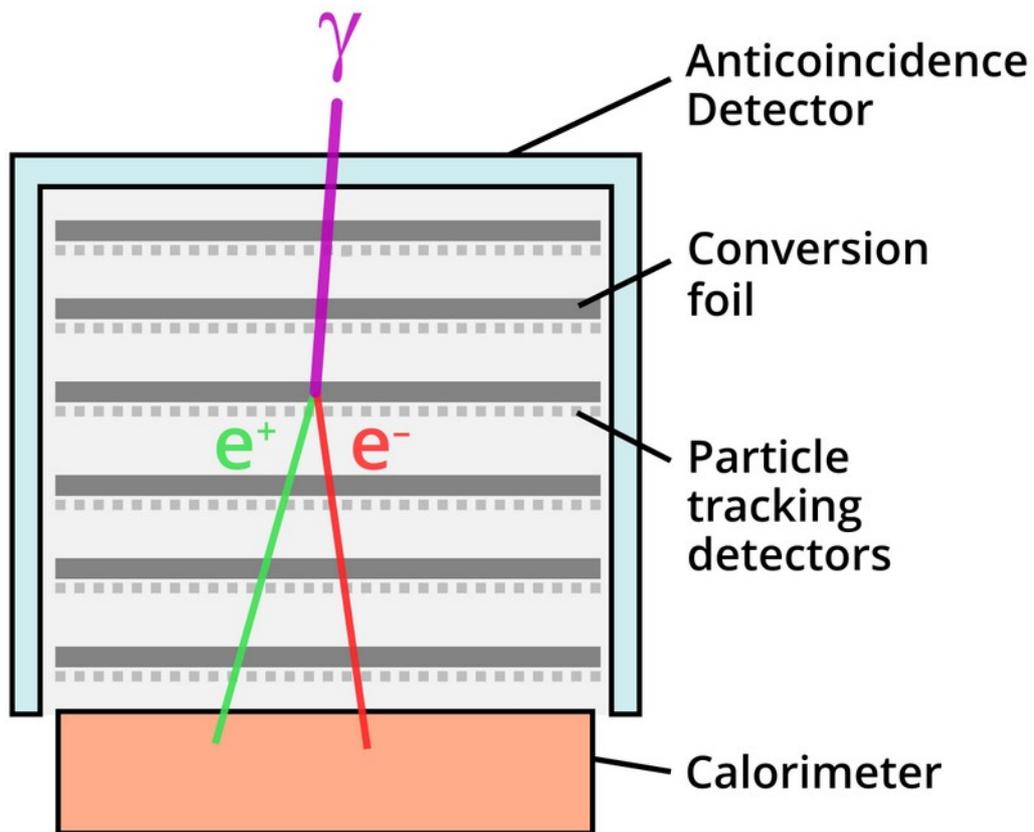
La produzione di coppie e' il processo dominante per fotoni alle energie di interesse del LAT

La coppia e⁺ e⁻ fornisce indicazioni riguardo a energia e direzione di arrivo del fotone

Produzione di coppie



Pair production Telescope



- Convertitore: materiale a alto Z per aumentare la probabilita' di produzione di coppie
- Tracciatore: Rivelatore che traccia il passaggio della coppia e^+e^-
- Calorimetro: Misura l'energia della coppia e^+e^-
- Anticoincidenza: Permette di distinguere le particelle cariche che entrano nel rivelatore

Large Area Telescope

Fermi-LAT

Modular design with 3 subsystems. Calorimeter and Tracker organized in 4 modules

Public Data Release:

All γ -ray data made public within 24 hours (usually less)

Anti-Coincidence Detector:

Charged particle separation

Si-Strip Tracker:

convert $\gamma \rightarrow e^+e^-$
reconstruct g direction
EM v. hadron separation

Hodoscopic CsI Calorimeter:

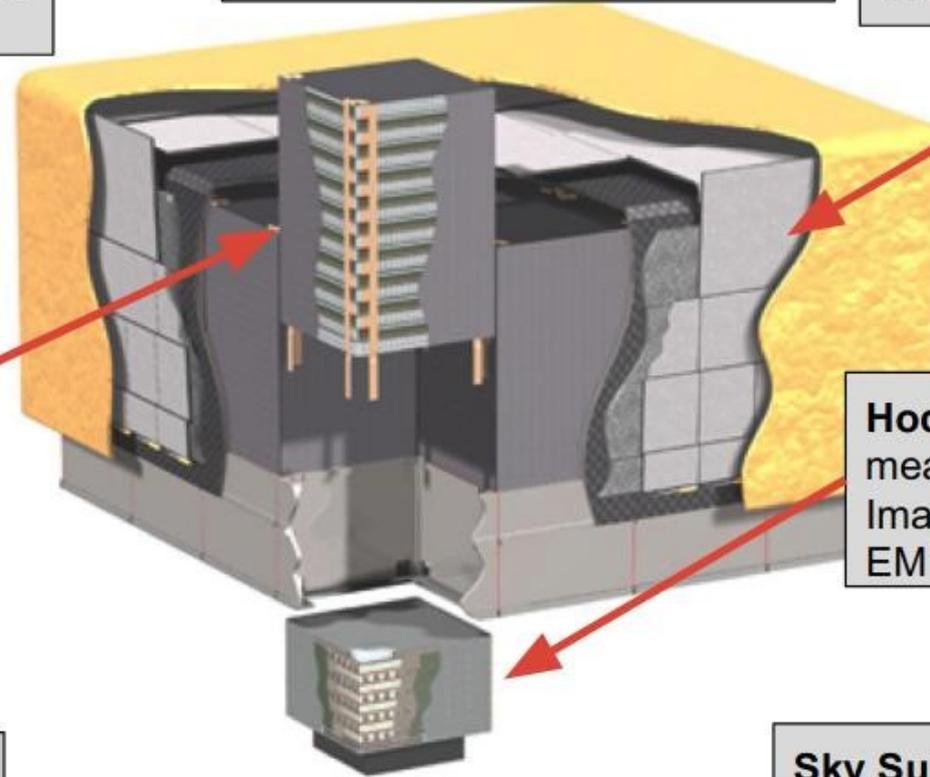
measure γ energy
Image EM shower
EM v. hadron separation

Trigger and Filter:

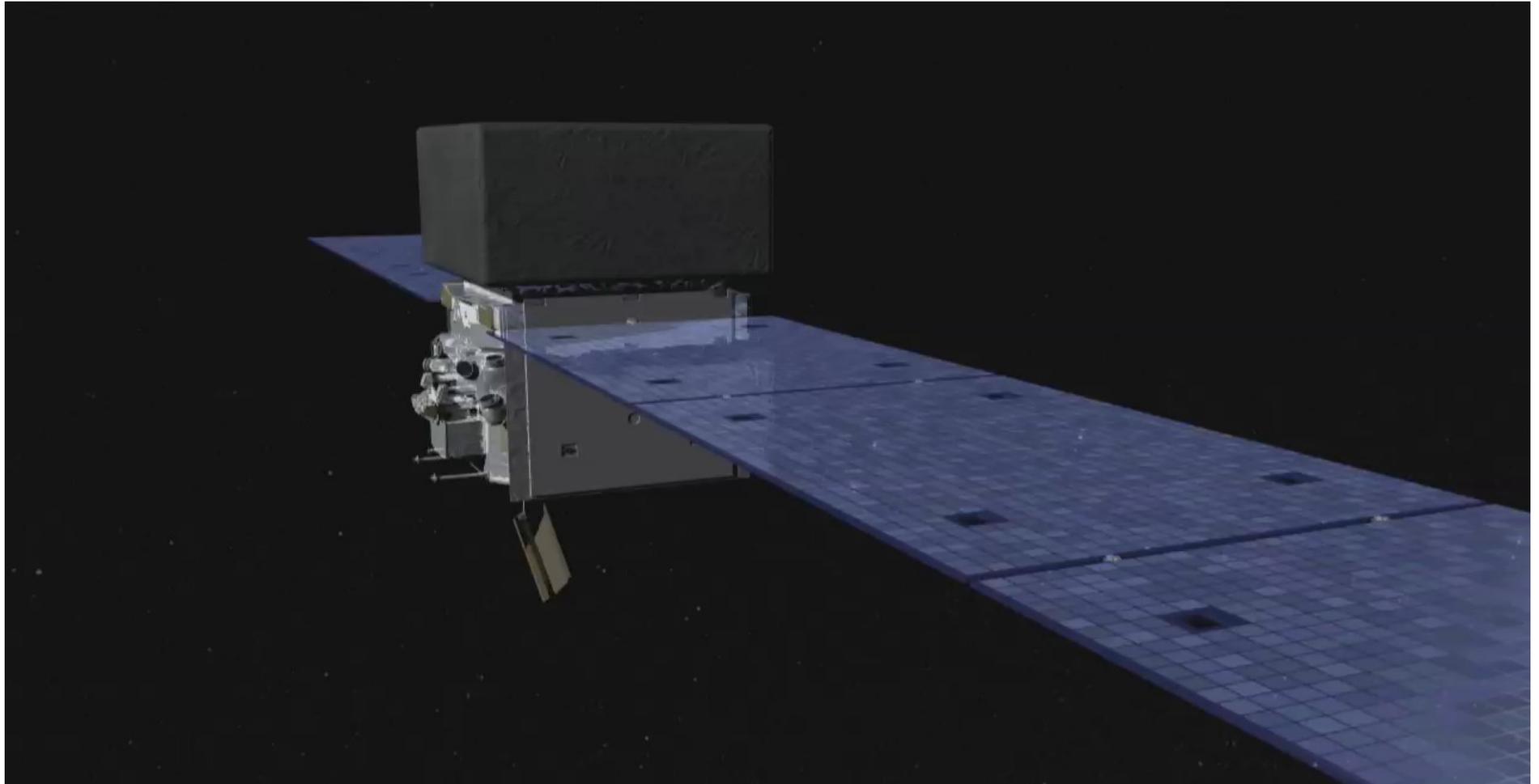
Reduce data rate from
 $\sim 10\text{kHz}$ to 300 - 500 Hz

Sky Survey:

With 2.5 sr Field-of-View LAT
sees the sky every 3 hours



Large Area Telescope



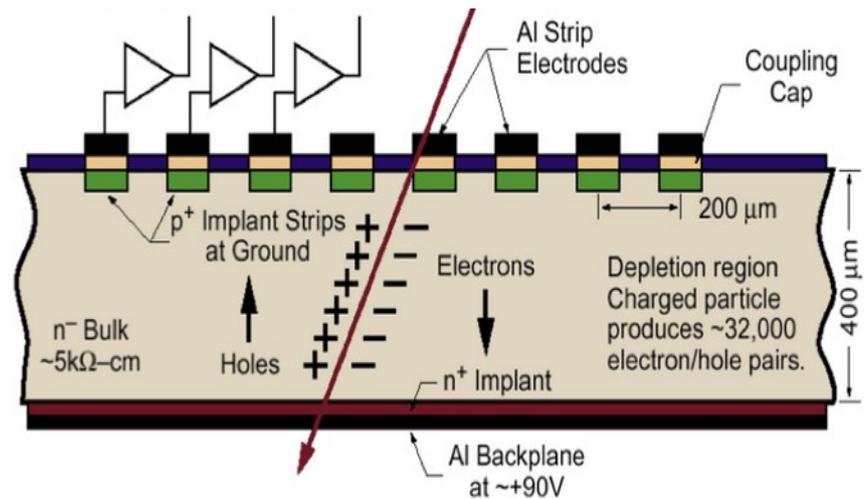
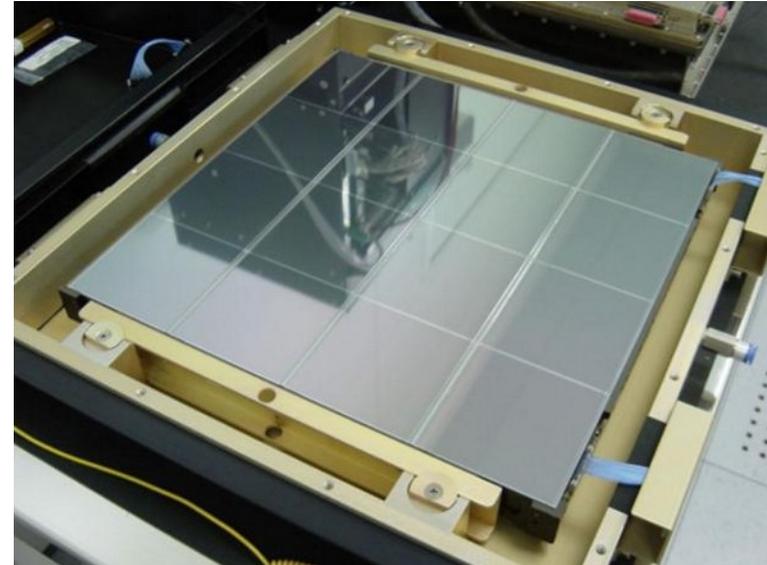
LAT Tracker



18 bi-layers di silicon strip detector
(piani x,y)

Intervallati 14 da fogli di tungsteno

spaziatura $256 \mu\text{m}$

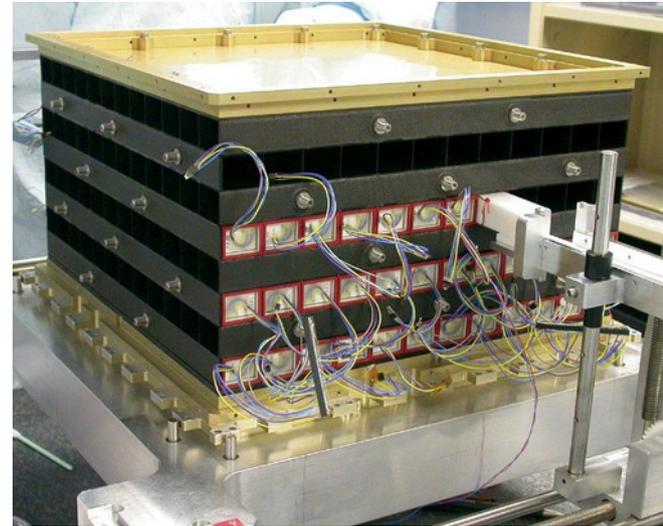


GLAST has 884736 channels. Total Tracker Power = 160 Watts!

LAT Calorimeter

Misura l'energia della coppia $e^- e^+$

- Ogni modulo e' formato da 8 strati di 12 cristalli CsI ortogonali tra loro
- Particelle cariche relativistiche producono una luce di scintillazione, raccolta alle estremità tramite 2 fotodiodi

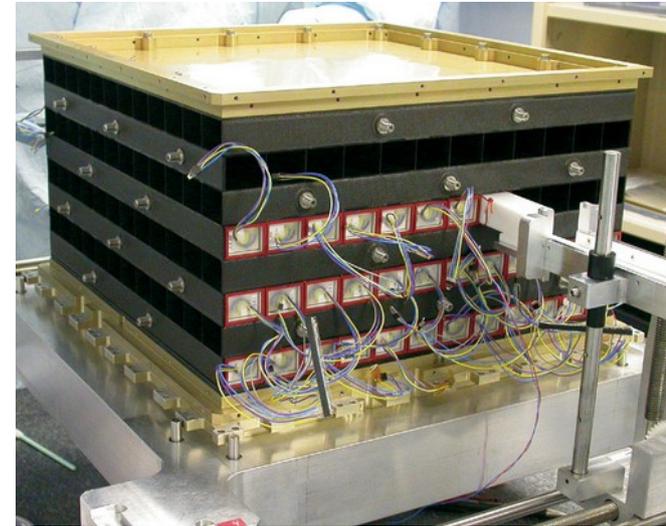
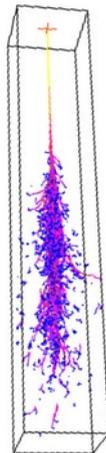
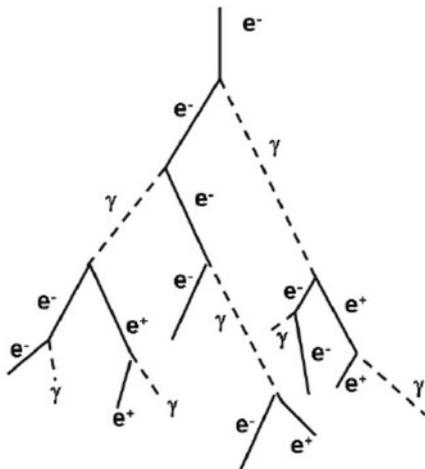


LAT Calorimeter

Misura l'energia della coppia $e^- e^+$

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Elettroni (e positroni) generano uno sciame elettromagnetico nel calorimetro

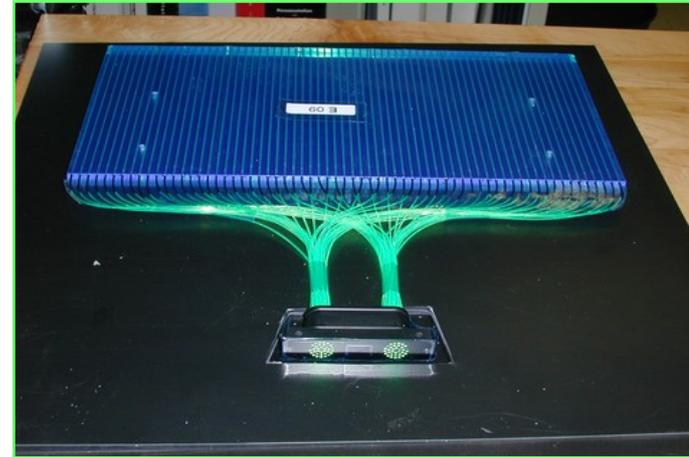


La segmentazione del calorimetro permette di misurare avere un'immagine dello sciame e.m.

LAT Anticoincidence Detector (ACD)

Identifica particelle cariche che entrano nel rivelatore

- Le 16 torri (tracker+cal) sono circondate da 89 piastrelle di scintillatore plastico
- Luce raccolta tramite fibre ottiche e portata a 2 fotomoltiplicatori



Segmentazione riduce il self-veto (backsplash dal calorimetro)

Alta efficienza (~99.97%)



Fermi pronto per il lancio...

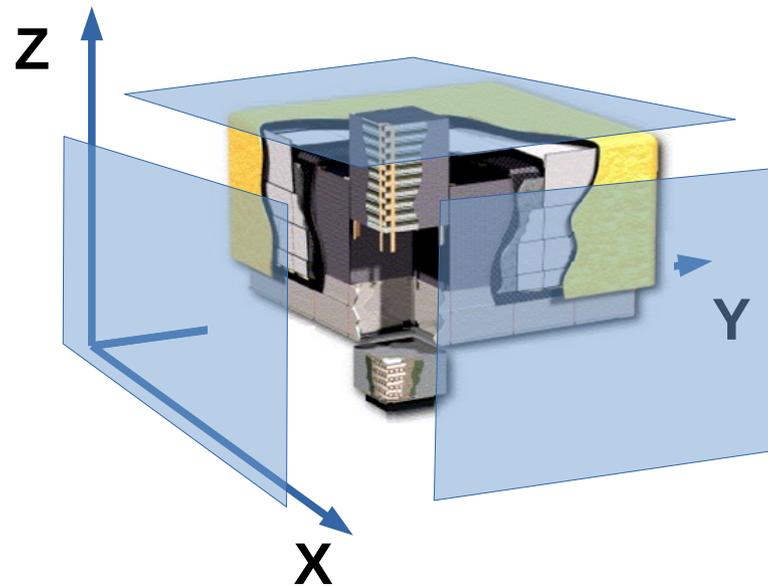
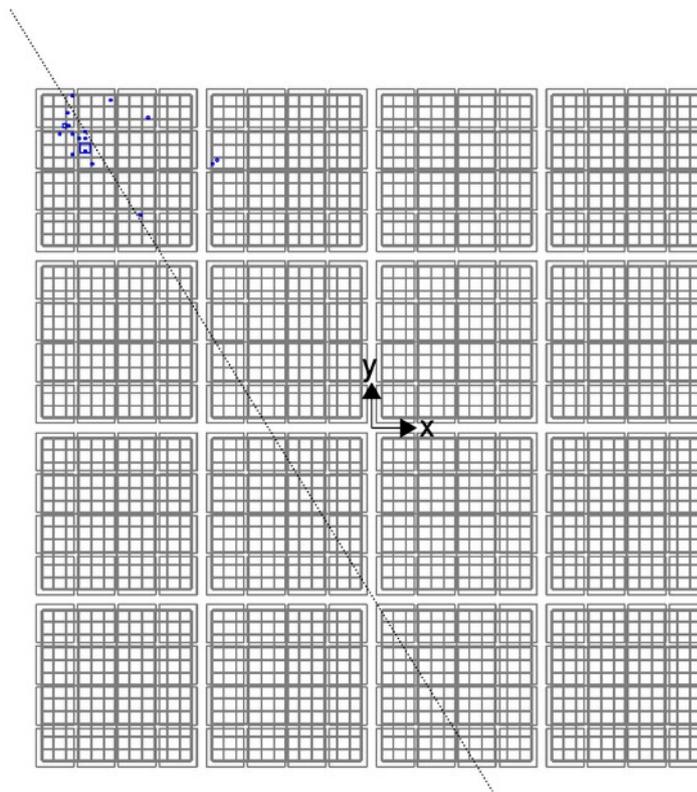
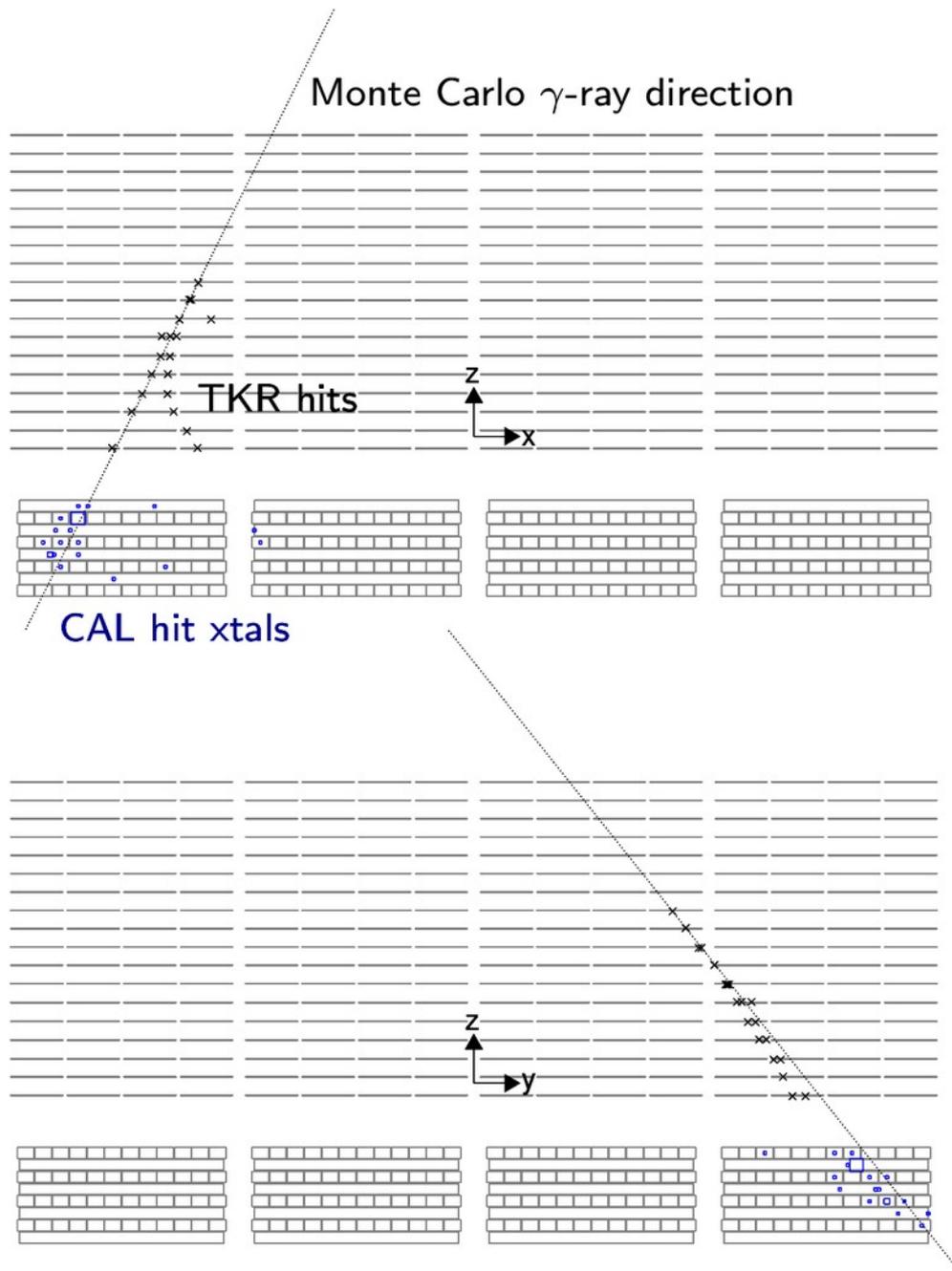


Ricostruzione degli eventi

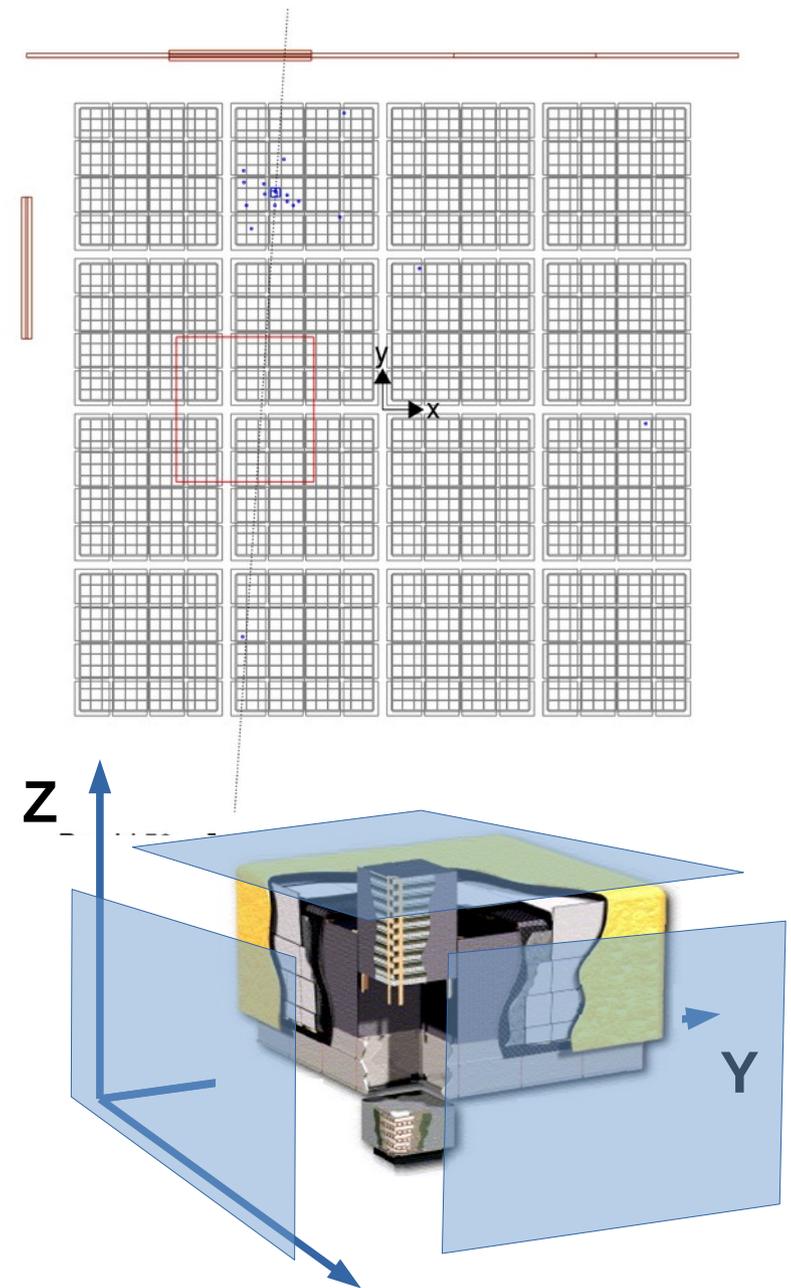
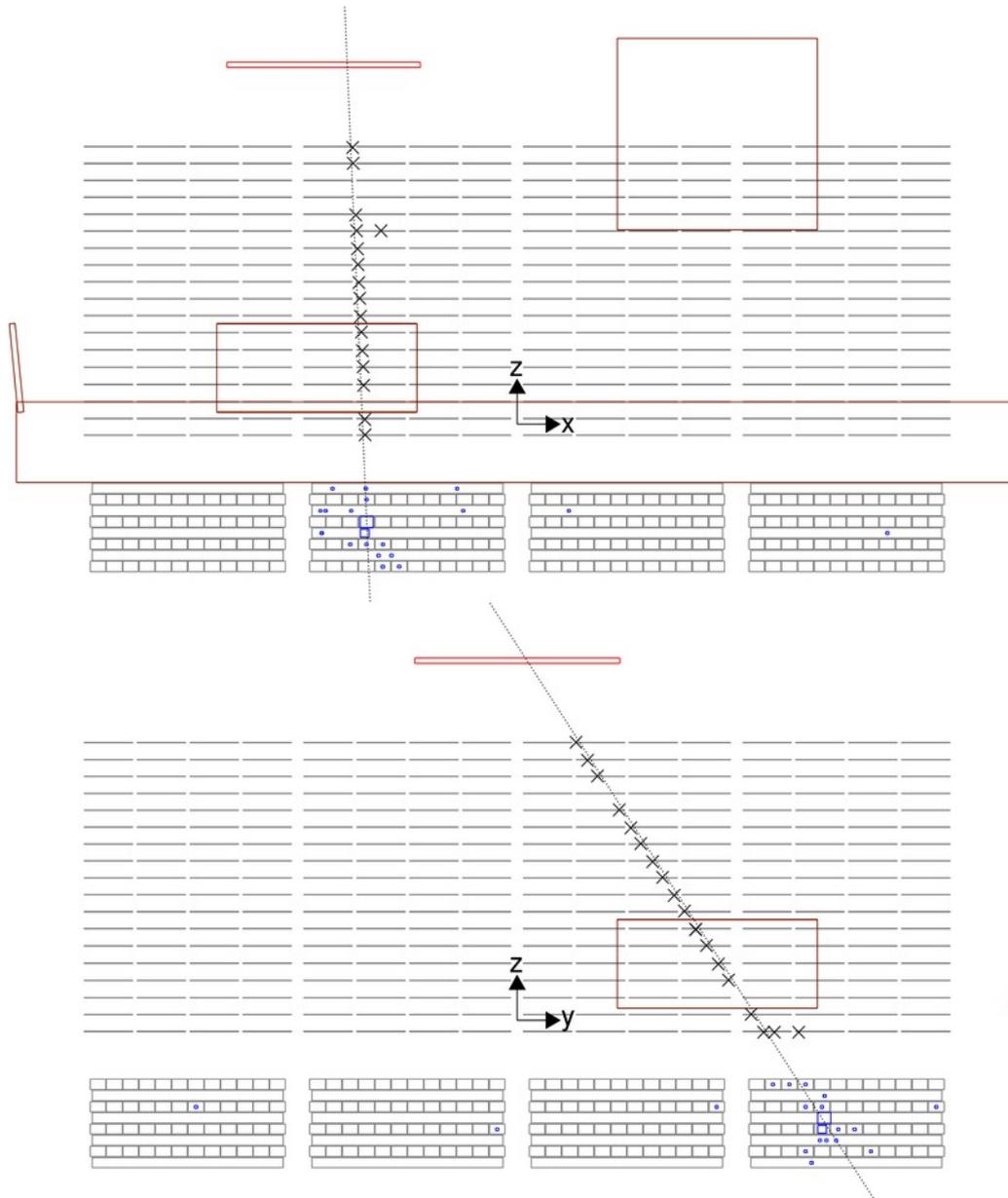
A partire dai segnali nei rivelatori vogliamo:

- eliminare (o studiare) le particelle cariche (background)
- ricostruire la direzione di arrivo
- ricostruire l'energia

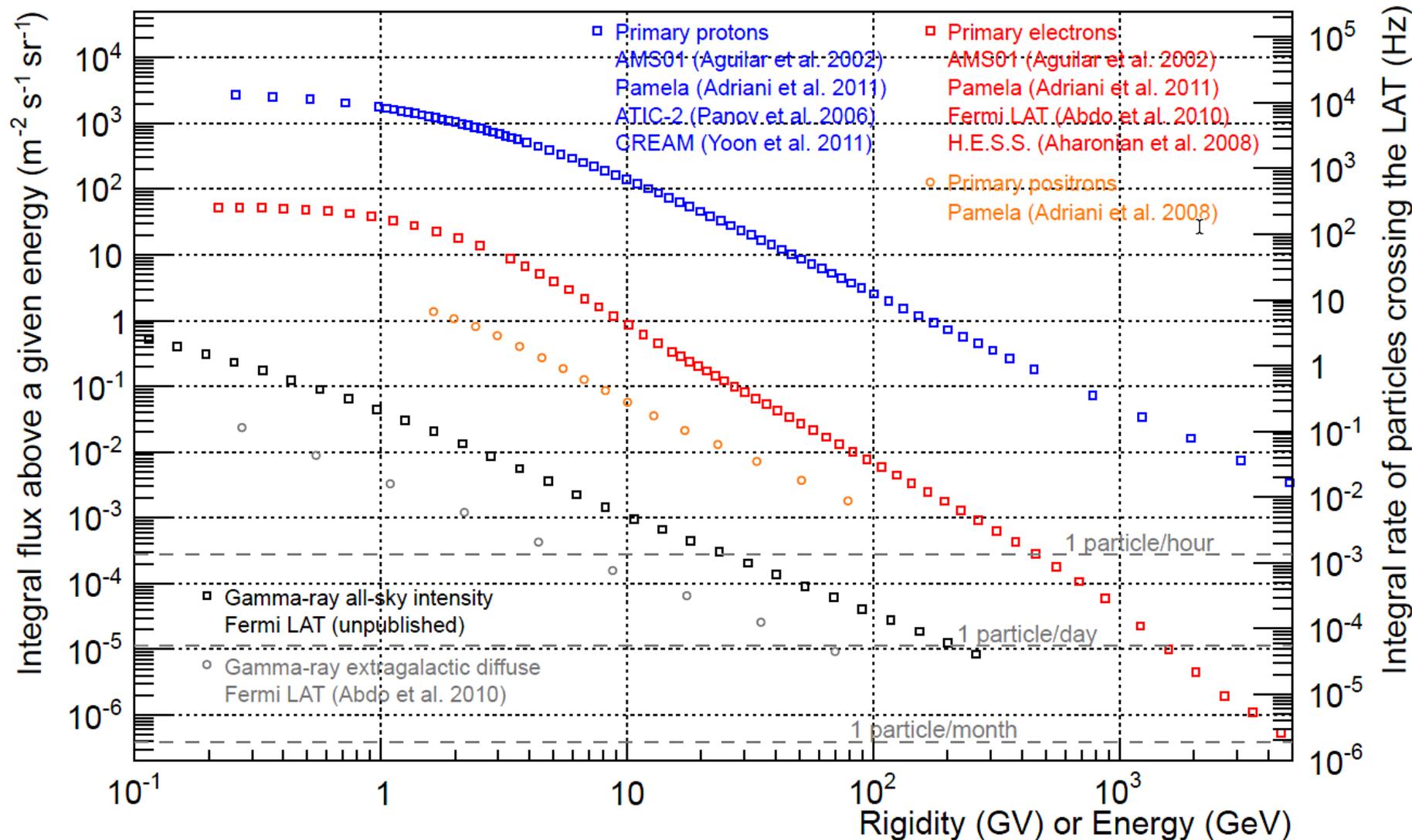
Fotone gamma nel LAT



Evento background nel LAT (protone ~1GeV)



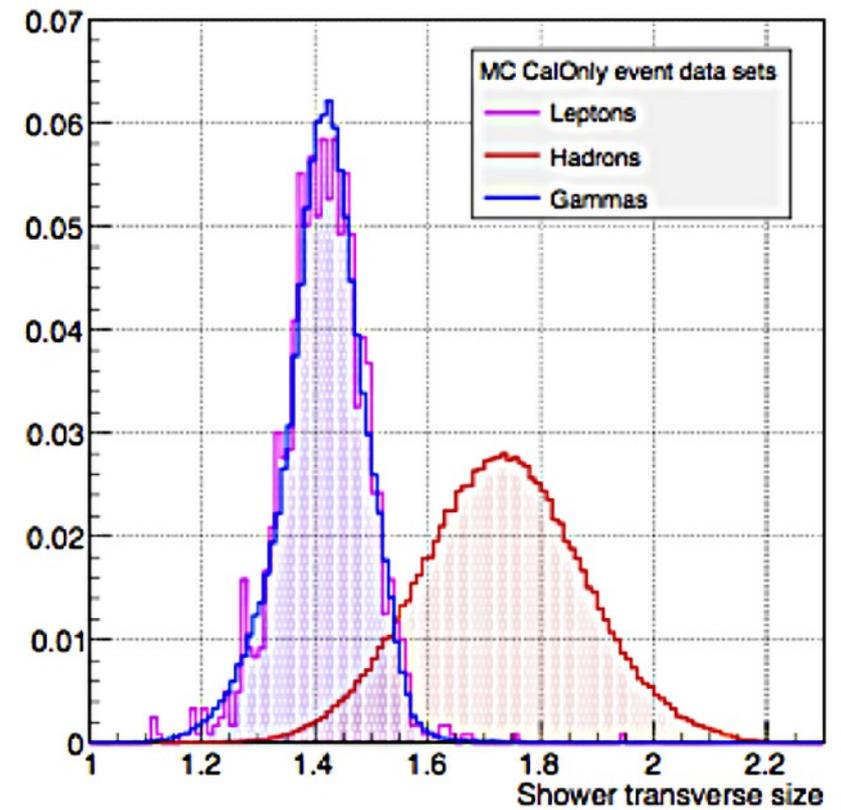
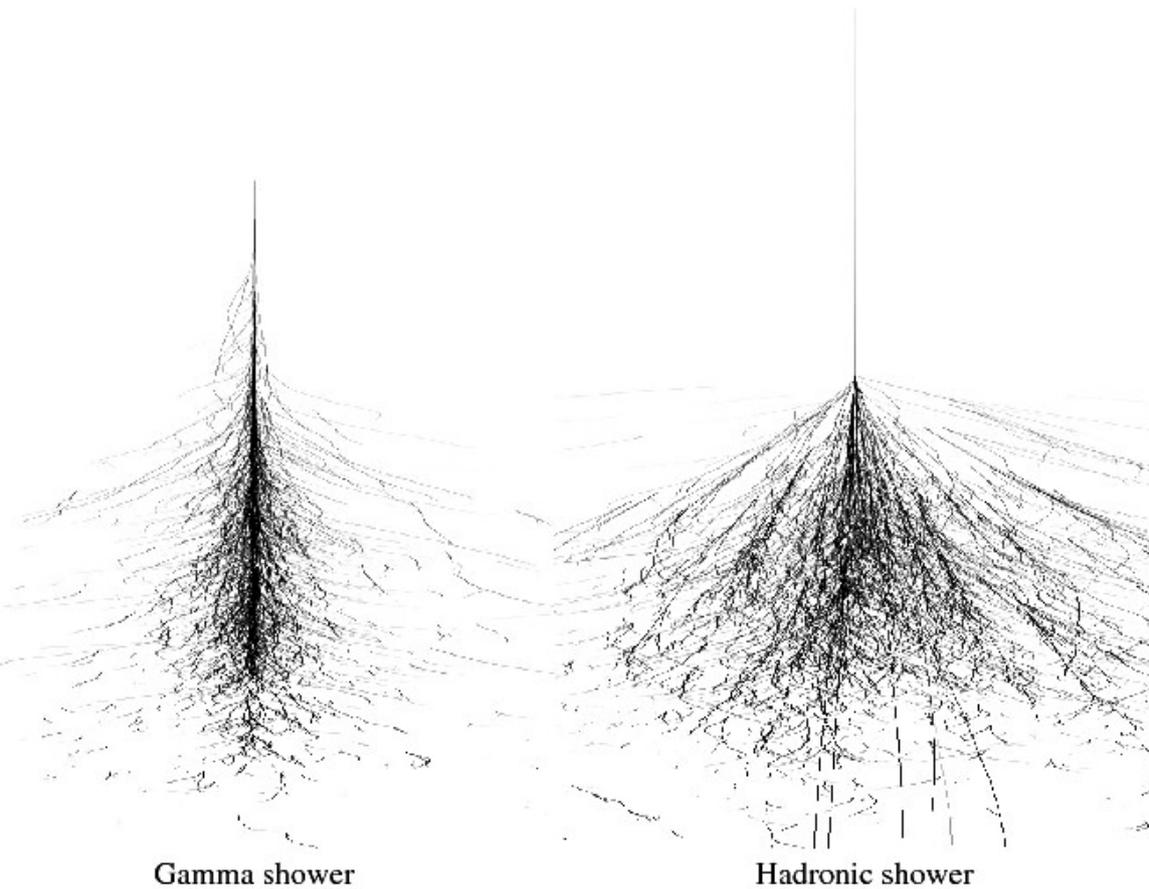
Flussi all'orbita di Fermi



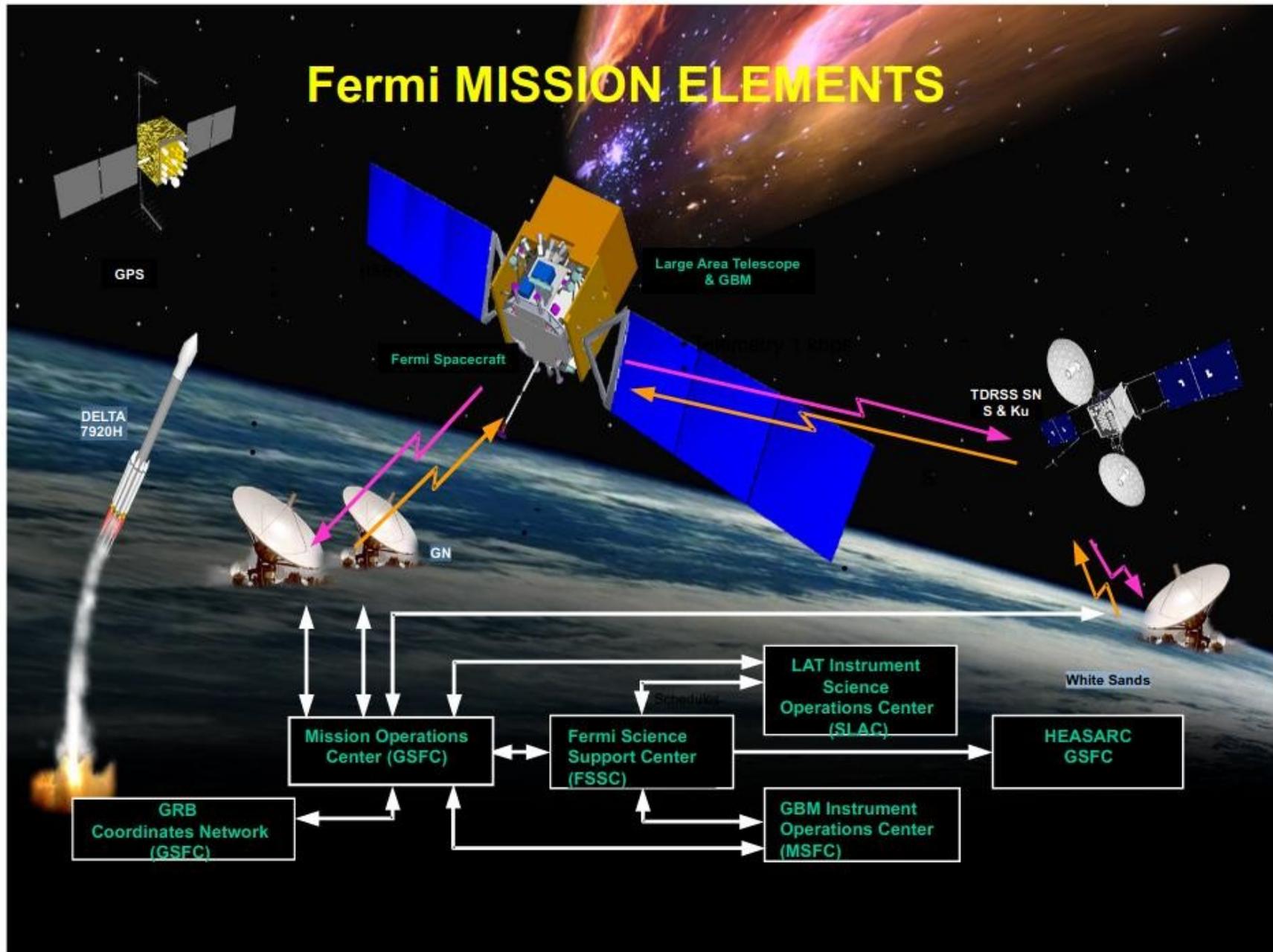
necessaria una riduzione del background di un fattore $\sim 10^6$

ACD + "forma" dello sciame nel calorimetro

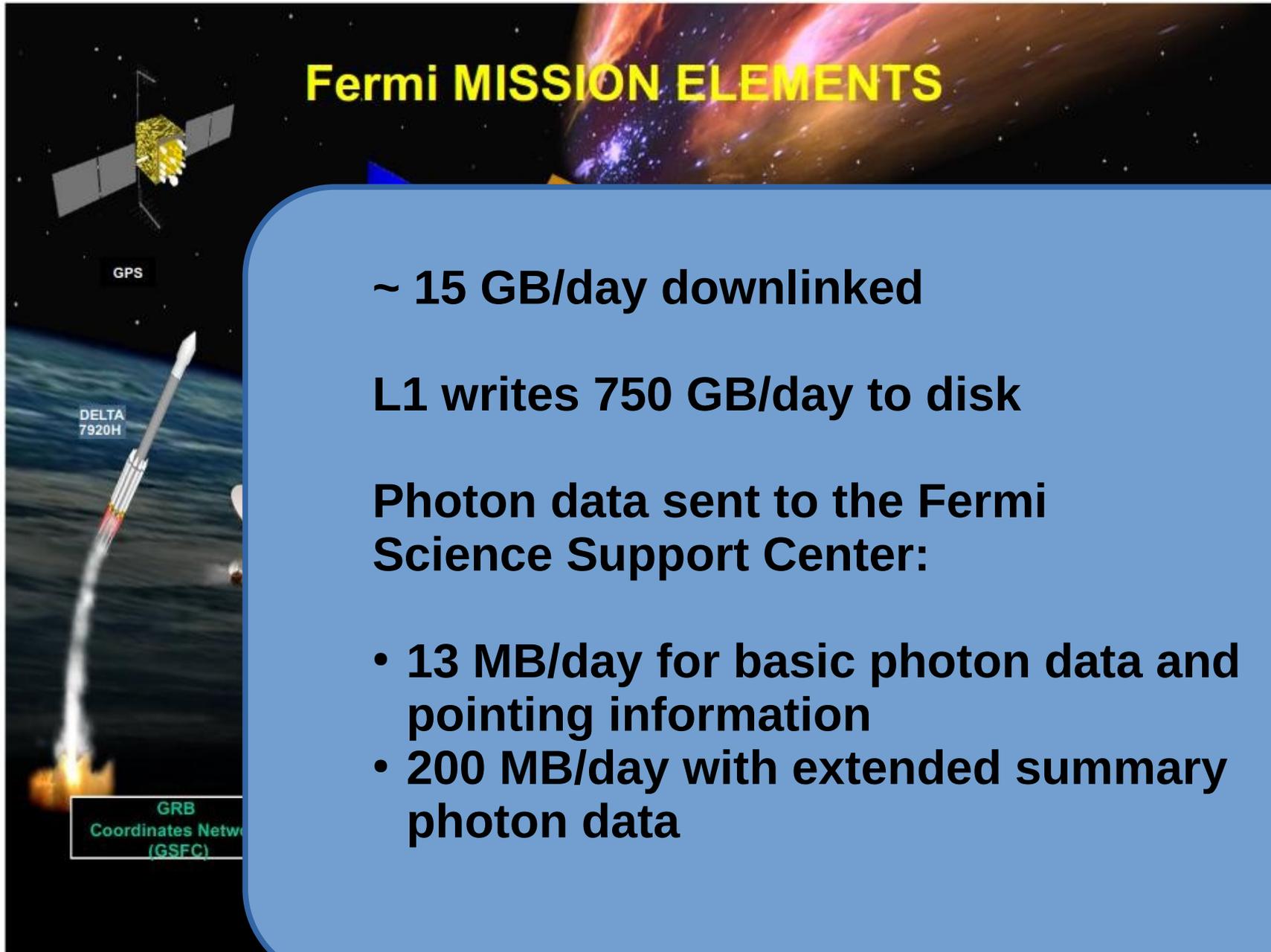
Sciame elettromagnetico vs sciame 'adronico'



Data processing



Data processing

A composite image titled "Fermi MISSION ELEMENTS" in yellow text. The background is a colorful nebula. On the left, a satellite is labeled "GPS". Below it, a rocket is labeled "DELTA 7920H". At the bottom left, a box contains the text "GRB Coordinates Network (GSFC)".

Fermi MISSION ELEMENTS

~ 15 GB/day downlinked

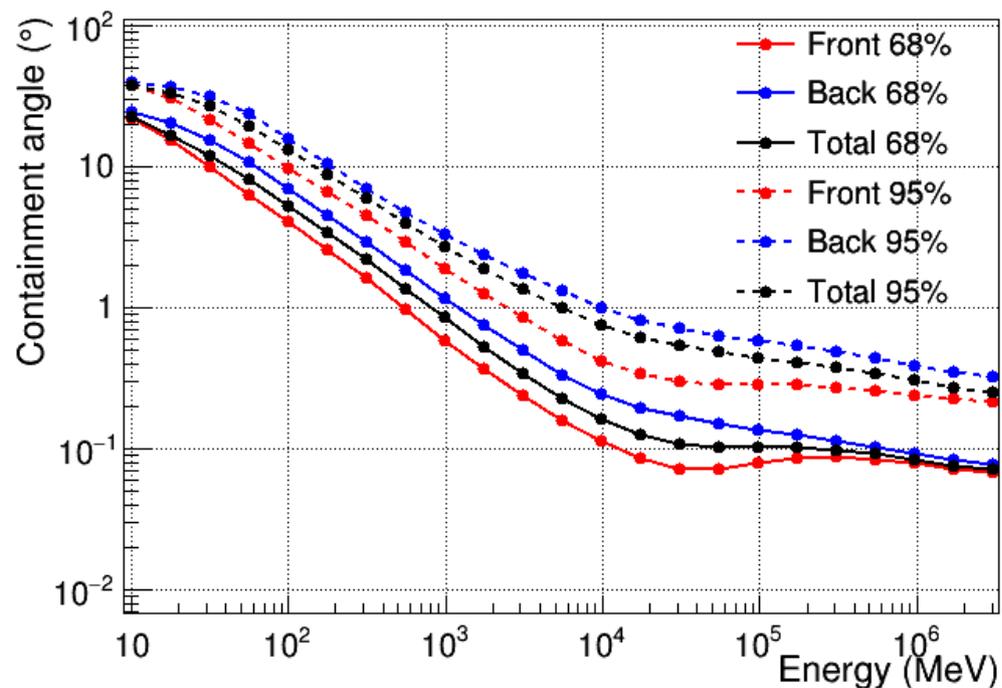
L1 writes 750 GB/day to disk

Photon data sent to the Fermi Science Support Center:

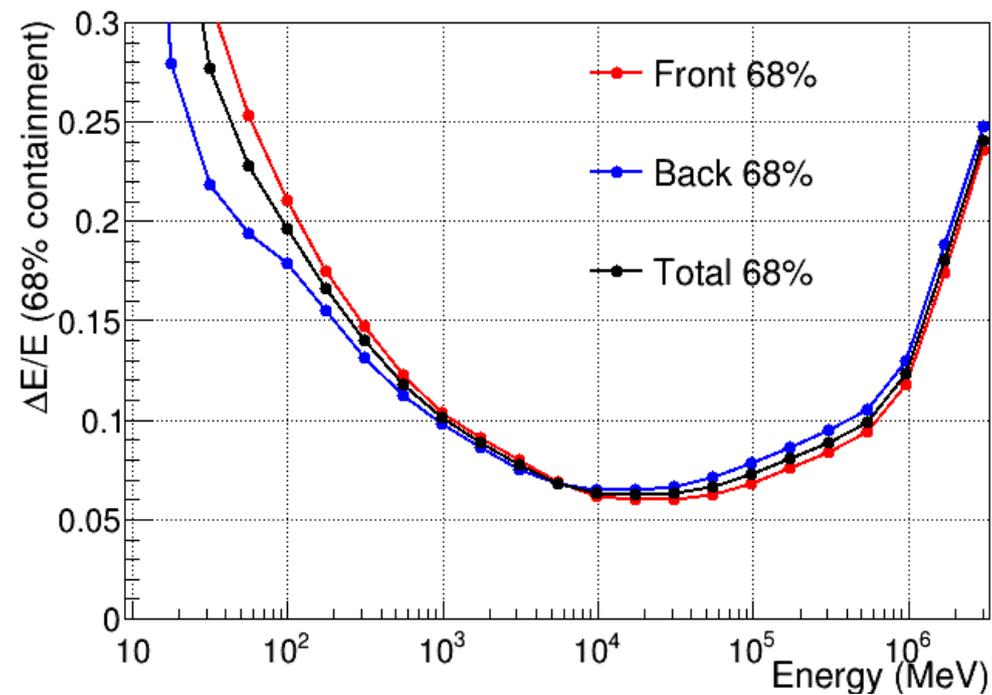
- 13 MB/day for basic photon data and pointing information
- 200 MB/day with extended summary photon data

LAT Performances

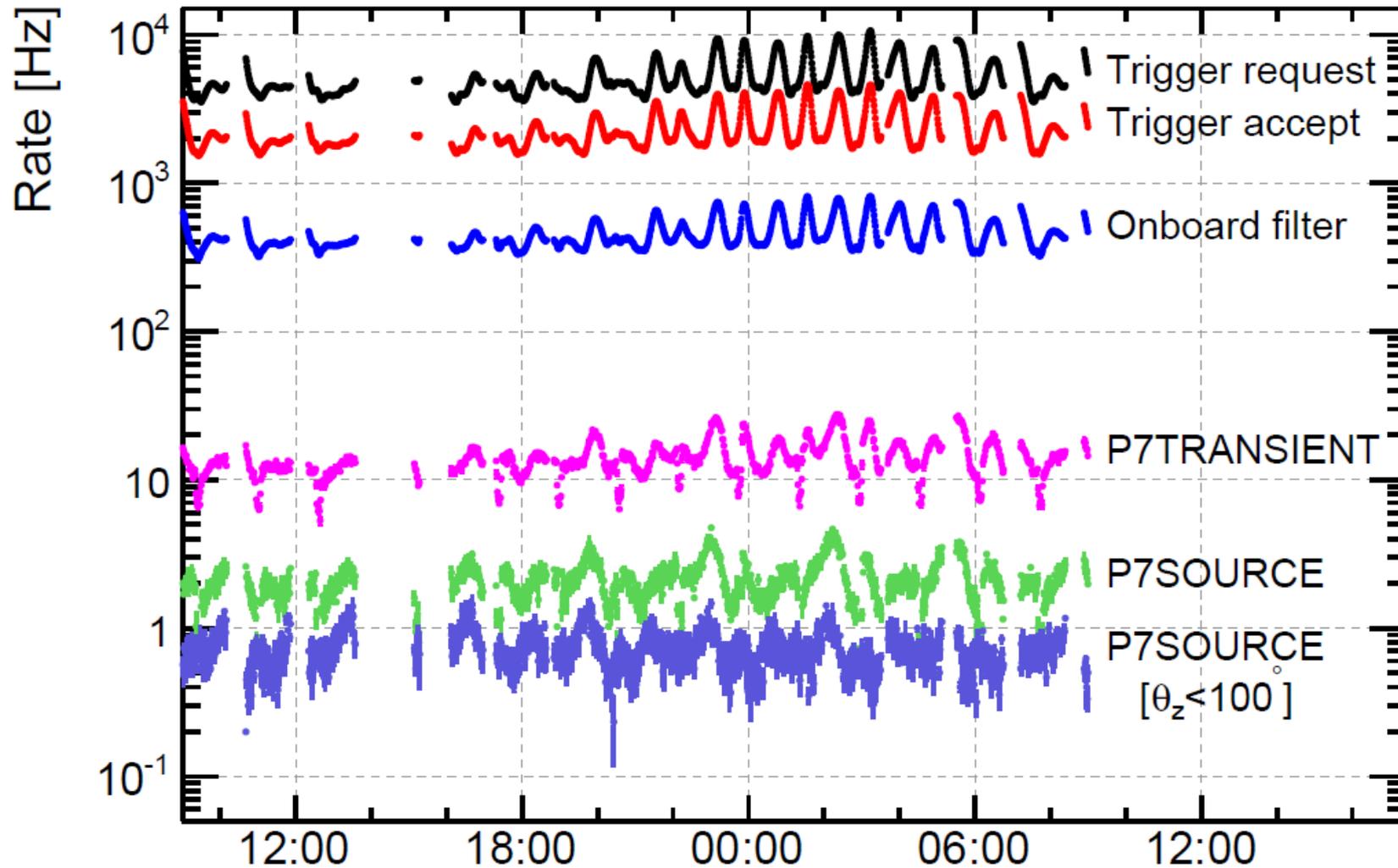
P8R3_SOURCE_V2 acc. weighted PSF

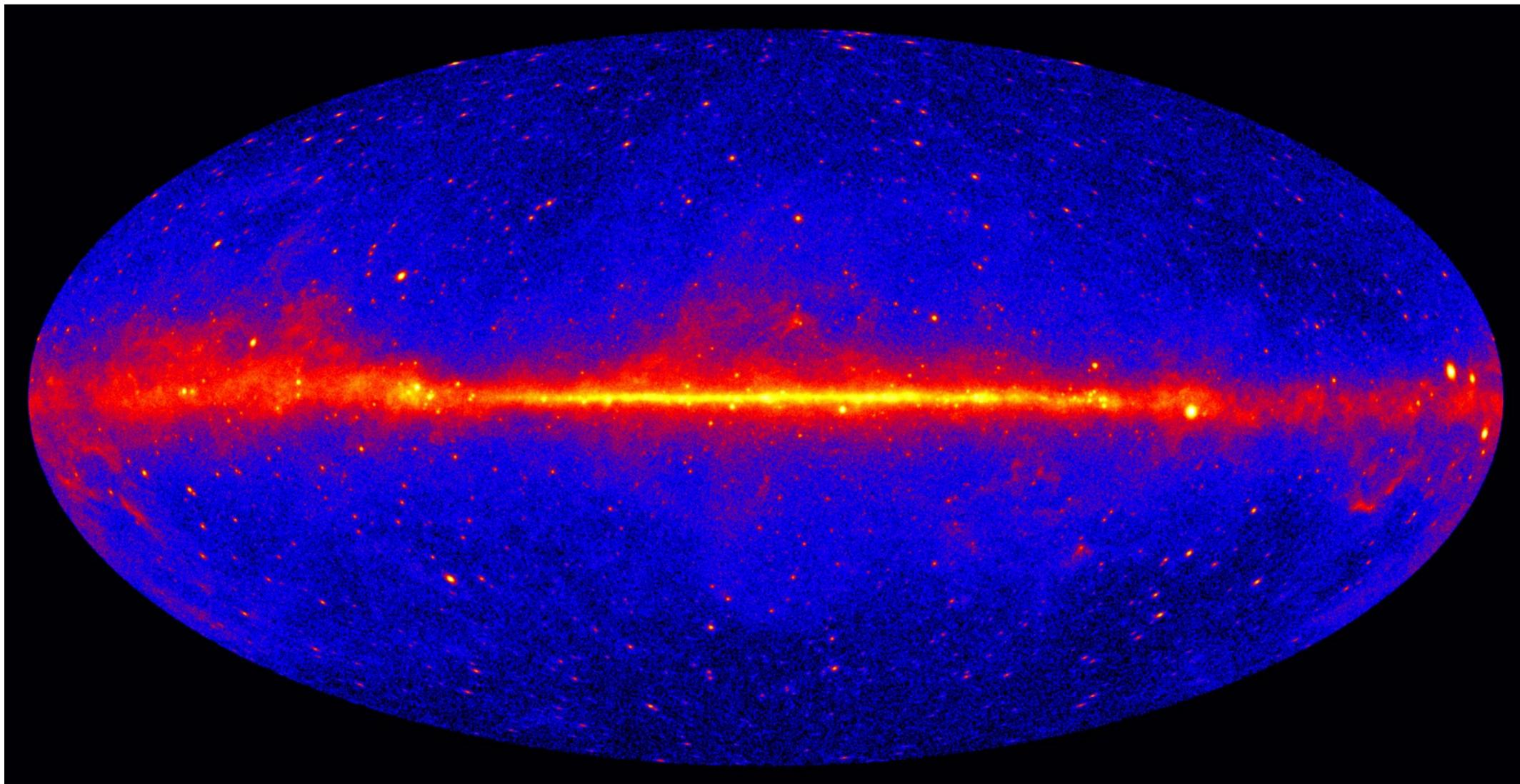


P8R3_SOURCE_V2 acc. weighted energy resolution



Eventi gamma







Kahoot!

Game PIN

Enter

