Electron Spectrum measured by PAMELA

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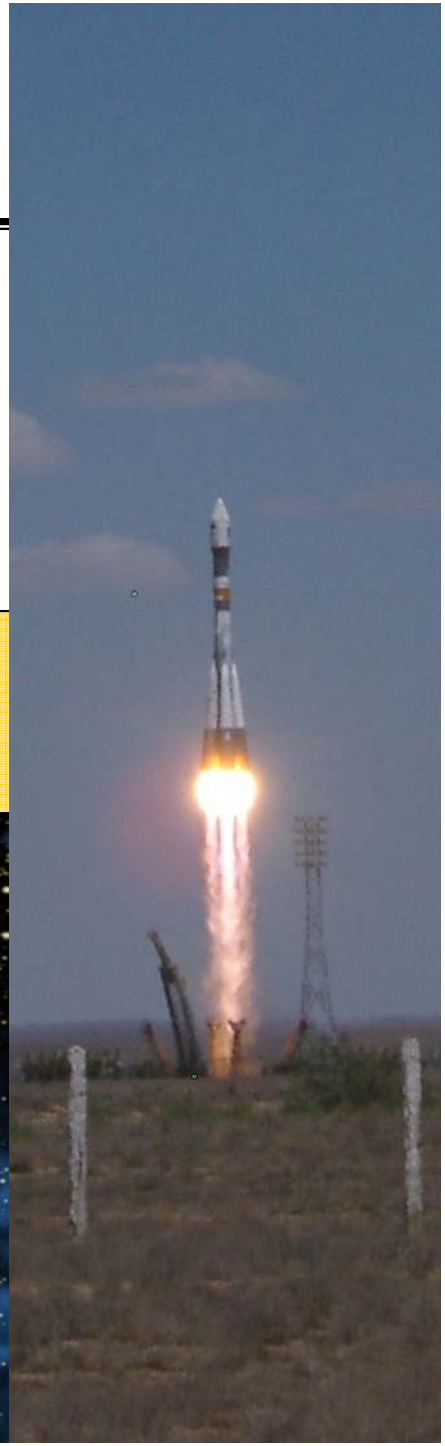
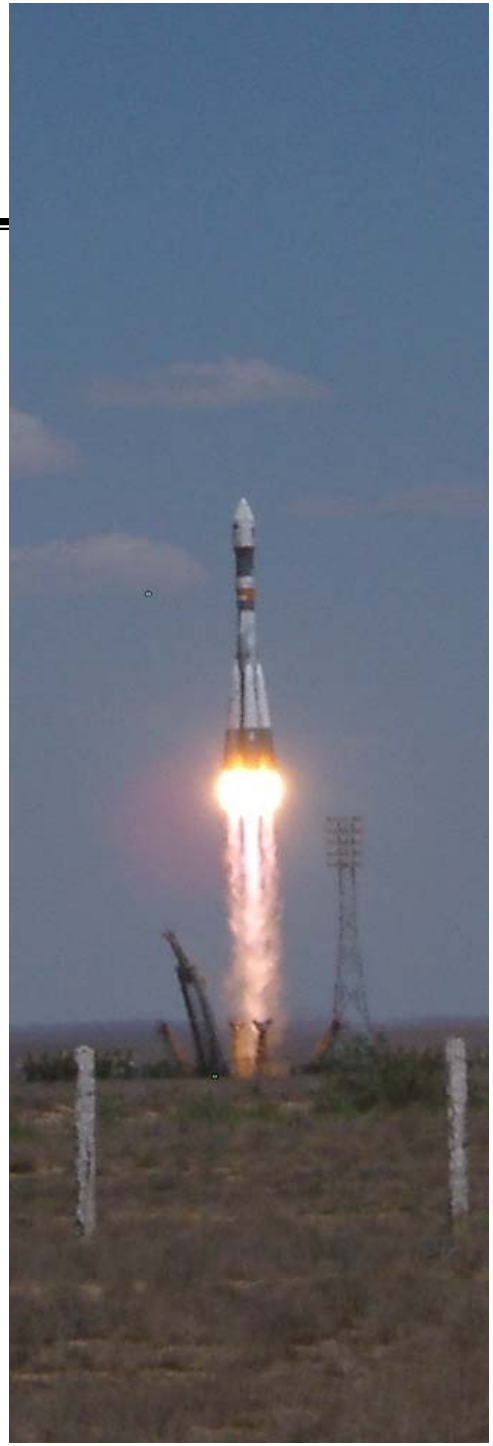
(INFN - Trieste)

on behalf of the PAMELA collaboration



Outline

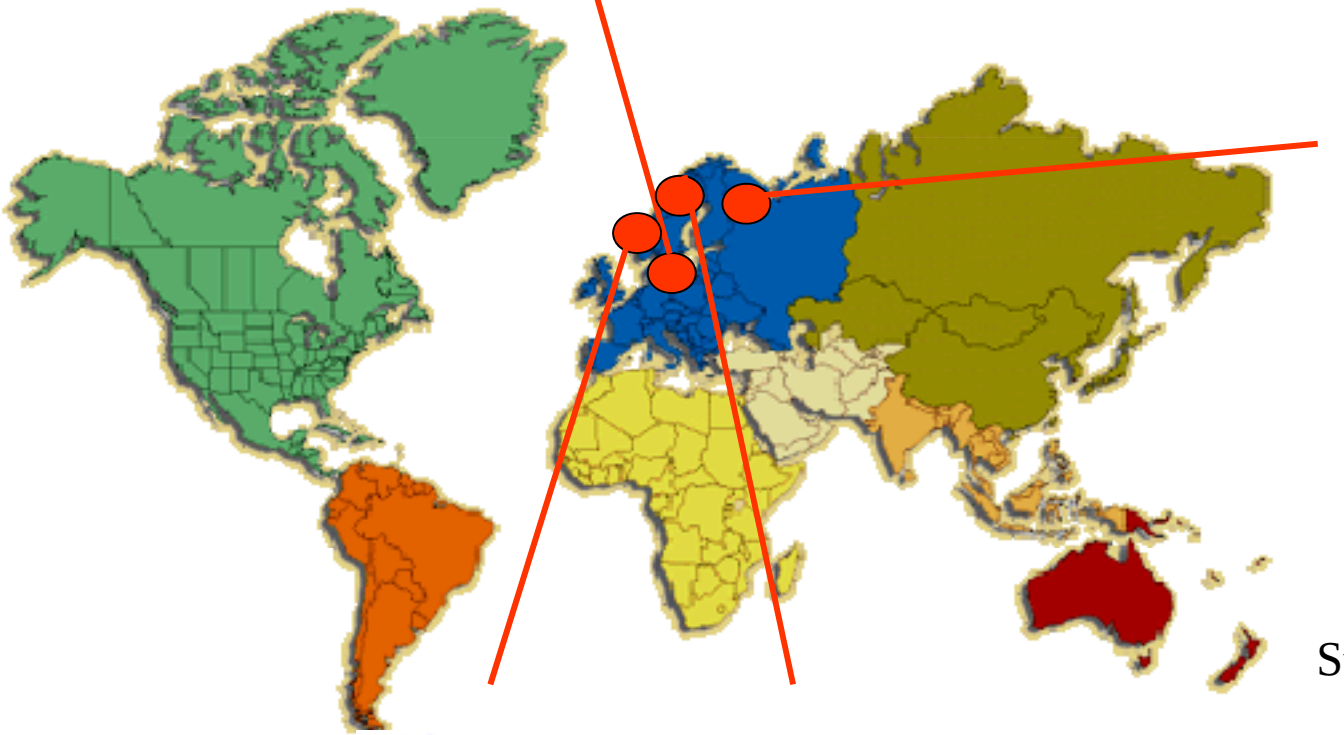
- The PAMELA space experiment
- Electron spectrum measurement
  - Two different approaches
- Conclusions



PAMELA Collaboration

Italy

Bari Florence Frascati Naples Rome Trieste CNR, Florence



Russia

Moscow
St. Petersburg

Germany

Siegen

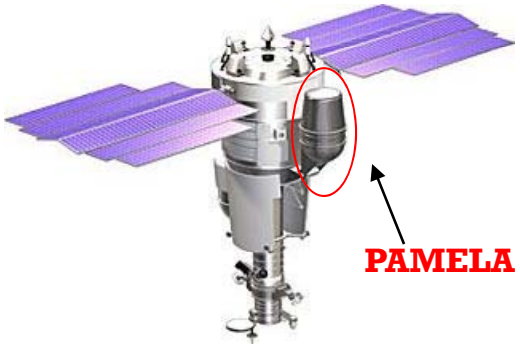
Sweden

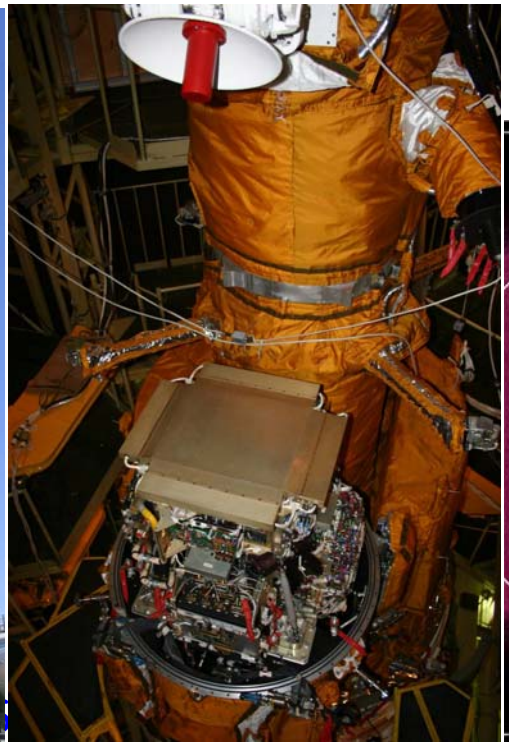
KTH, Stockholm

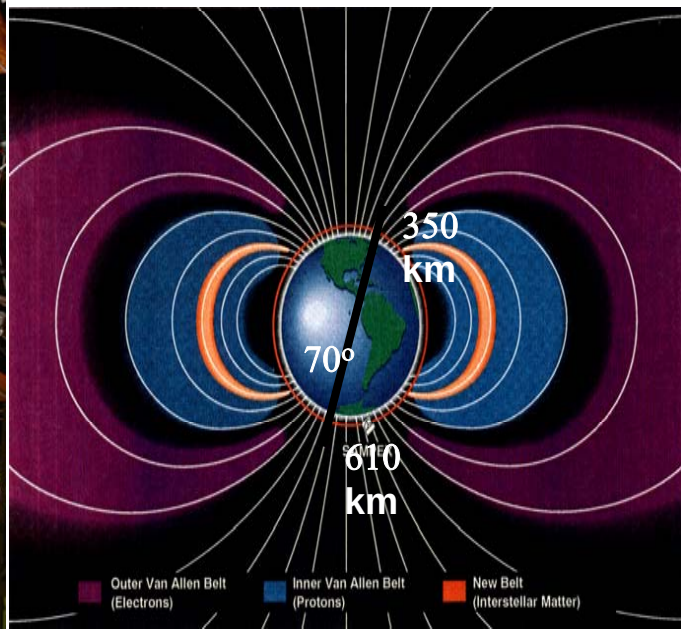
PAMELA experiment

Payload for Antimatter/Matter Exploration and Light-nuclei Astrophysics

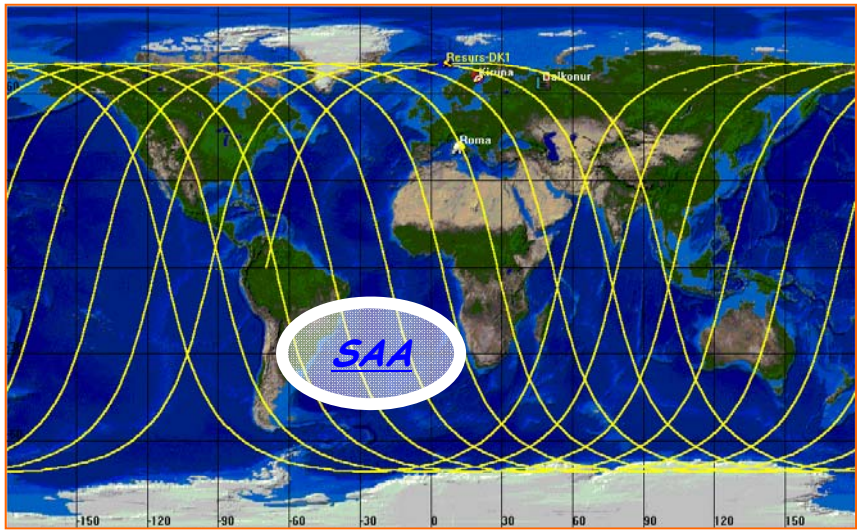
→ Direct detection of CRs in space
→ Main focus on antiparticles component

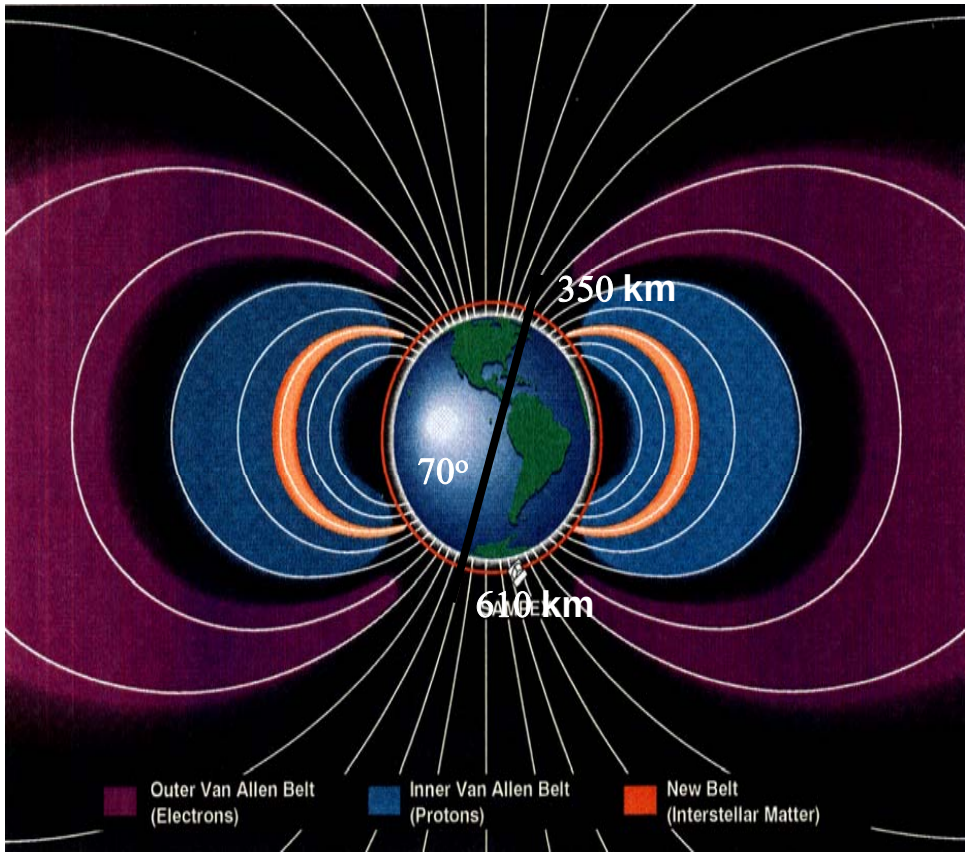






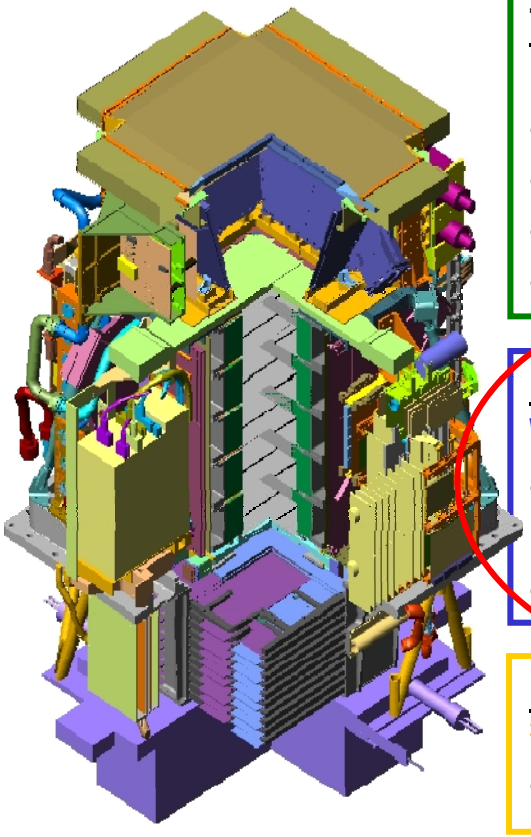
Orbit characteristics





- Low-earth elliptical orbit
- 350 – 610 km
- Quasi-polar (70° inclination)
- SAA crossed
- 16 Gigabytes trasmitted daily to Ground-NTsOMZ Moscow

PAMELA apparatus



Time-Of-Flight

plastic scintillators + PMT:

- Trigger
- Albedo rejection;
- Mass identification up to 1 GeV;
- Charge identification from dE/dX

Electromagnetic calorimeter

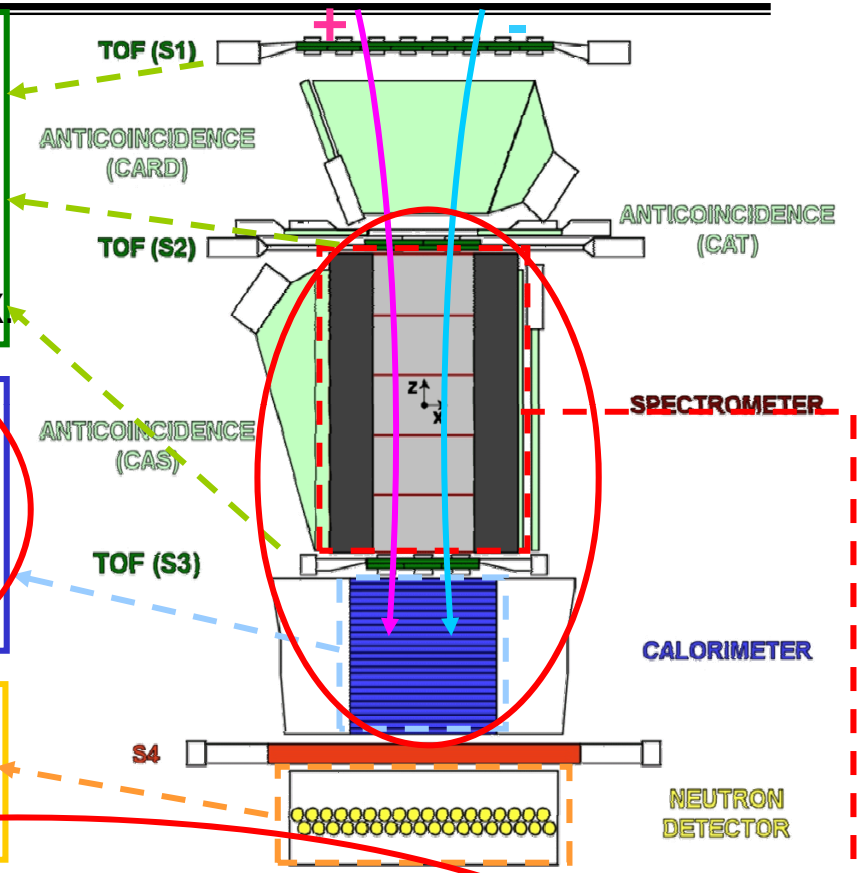
W/Si sampling (16.3 X_0, 0.6 λ_I)

- Discrimination e+ / p, anti-p / e^- (shower topology)
- Direct E measurement for e^-

Neutron detector

^{3}He tubes + polyethylene moderator:

- High-energy e/h discrimination



GF: 21.5 cm^2 sr
Mass: 470 kg
Size: 130x70x70 cm^3
Power Budget: 360W

Magnetic Spectrometer

microstrip silicon tracking system + permanent magnet

It provides:

- Magnetic rigidity → R = pc/Ze
- Charge sign
- Charge value from dE/dx

Electron spectrum measurement

Electron identification

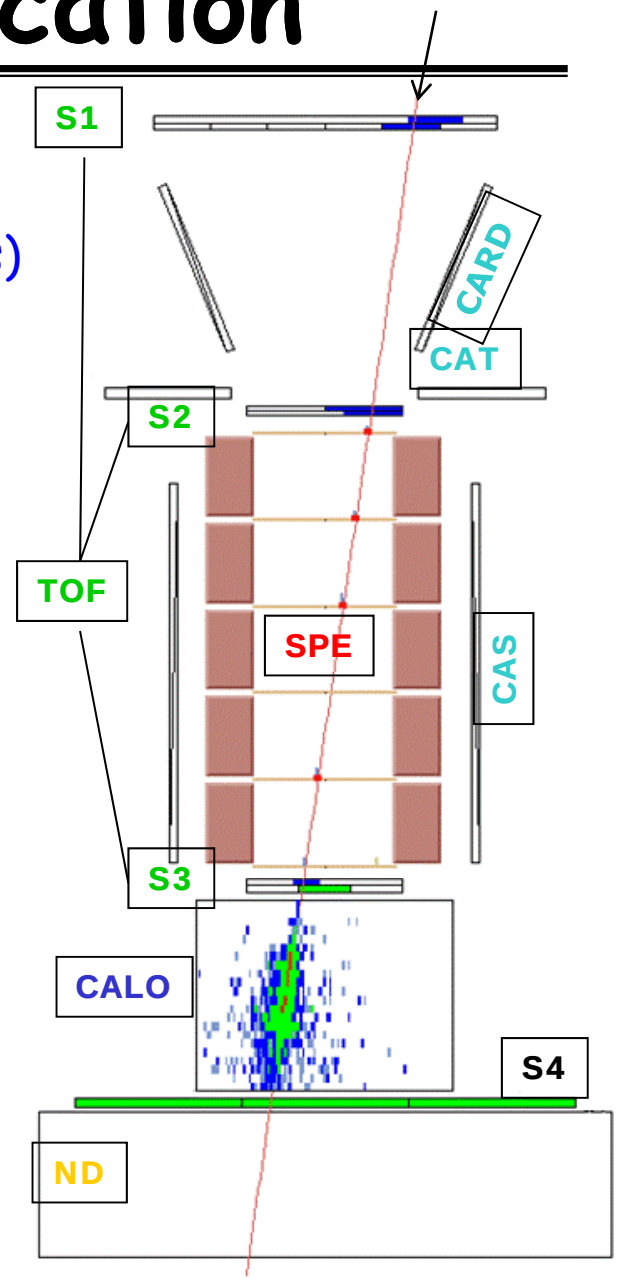
Statistics:

- Analyzed data July 2006 – January 2010 (~1130 days)
- Collected triggers $>10^9$
- Identified ~ 6 10^5 electrons between 1 and 200 GeV

Electron identification:

- $|Z|=1$ (dE/dx=MIP) → SPE&ToF
- $\beta=1$ → ToF
- rigidity (R) → SPE
- *charge sign separation → SPE*
- *e-/p-bar separation → CALO*

- ***~ no background, issues:***
  - spillover protons at high energy
  - spectrometer resolution
  - selection efficiencies

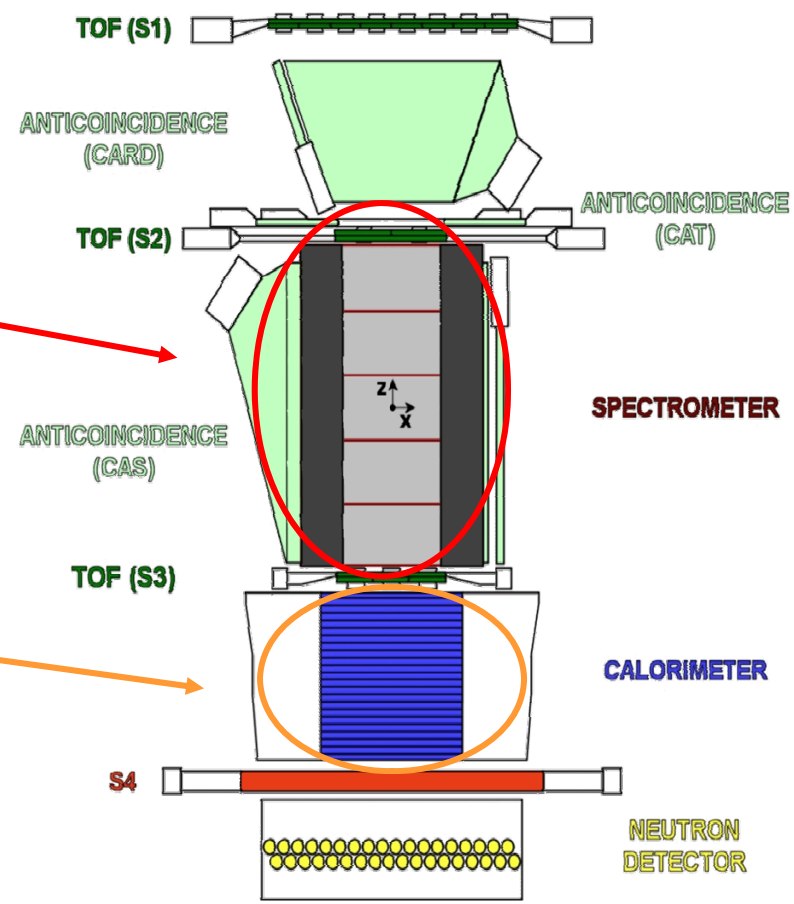


Electron spectrum, methods

Two independent energy measurements:

Rigidity from Tracker

Energy from Calorimeter



→ possibility to cross-check the energy measurement

Electron spectrum, methods

Two different approaches:

1) Tracker-based selection

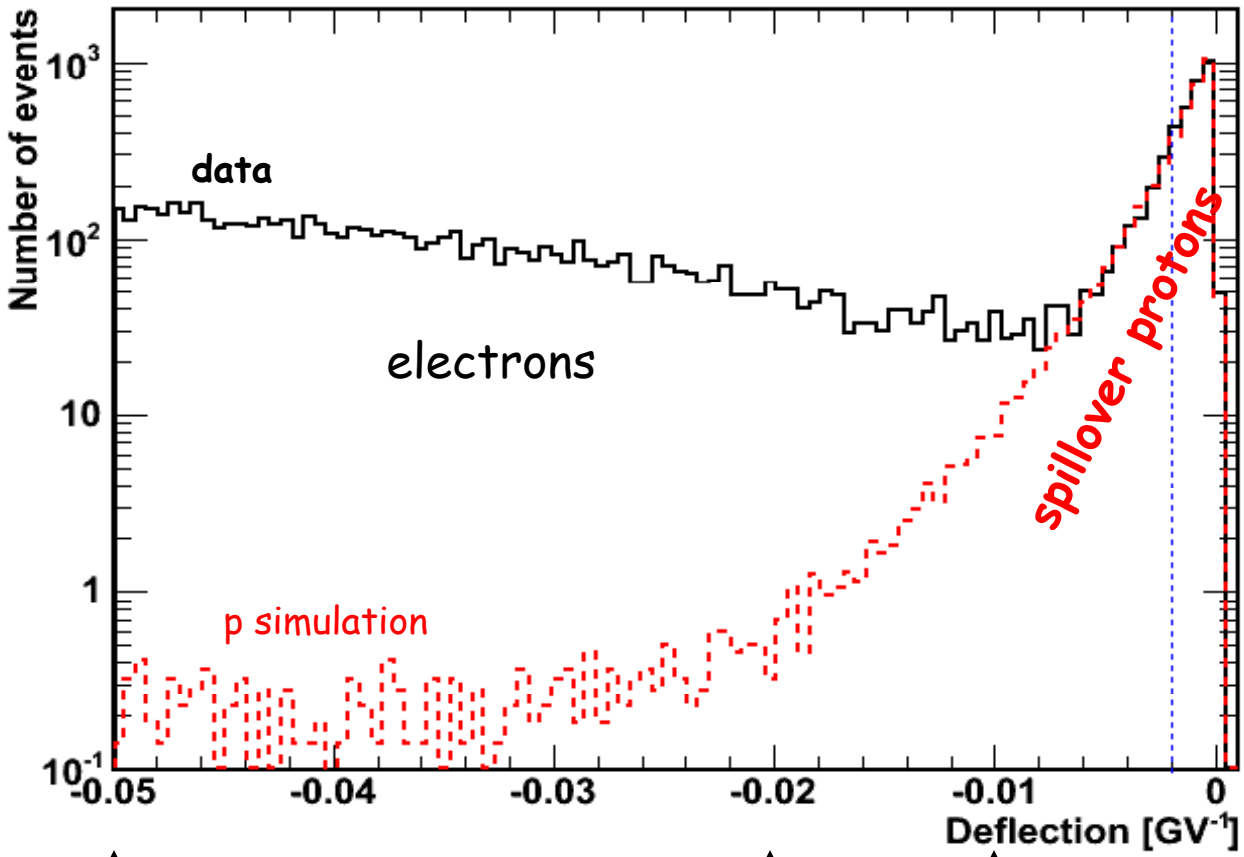
- strong track quality requirements
- loose calorimeter selection
- energy measured by the tracker

2) Calorimeter-based selection

- loose track quality requirements
- negative charged particle
- strong calorimeter selection
- energy measured by the calorimeter

Electron spectrum - tracker-based

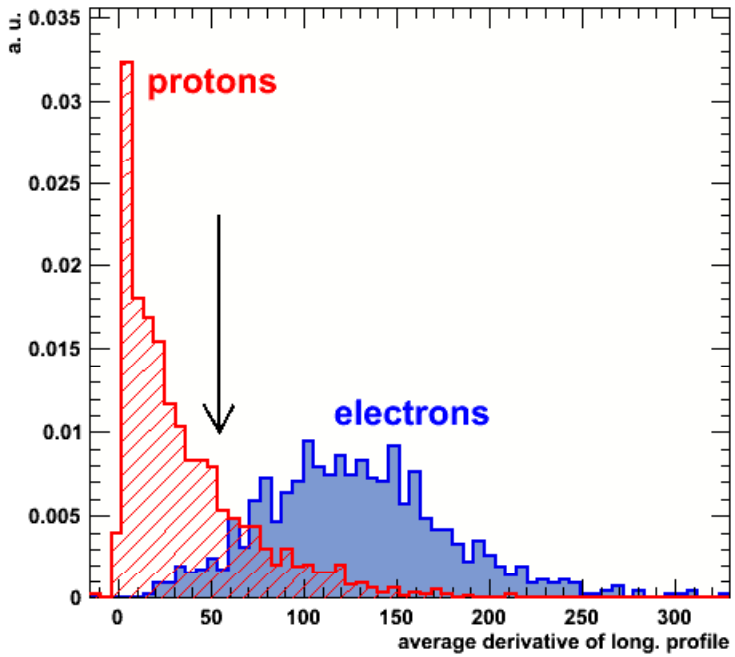
Negatives tracks with E>20GeV



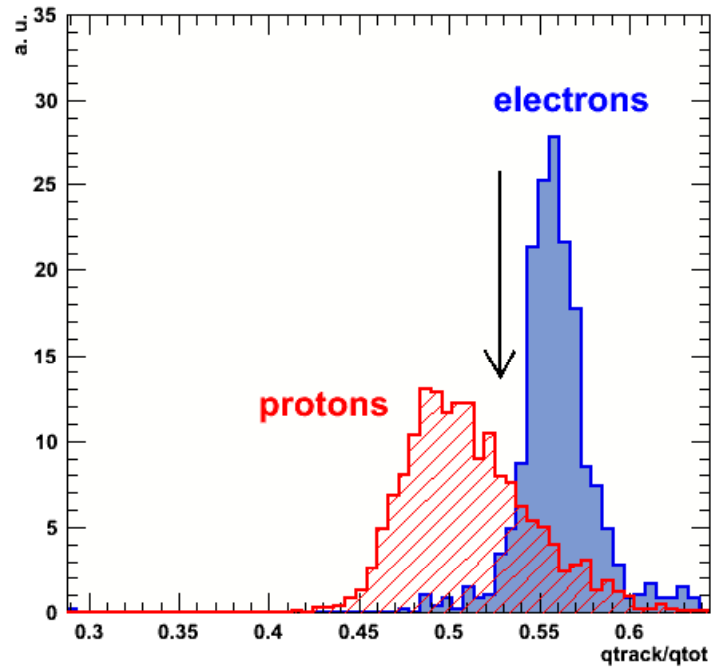
20 GeV 50 GeV 100 GeV

Electron spectrum - tracker-based

- Event selection : topology of the shower



Longitudinal profile topological variable

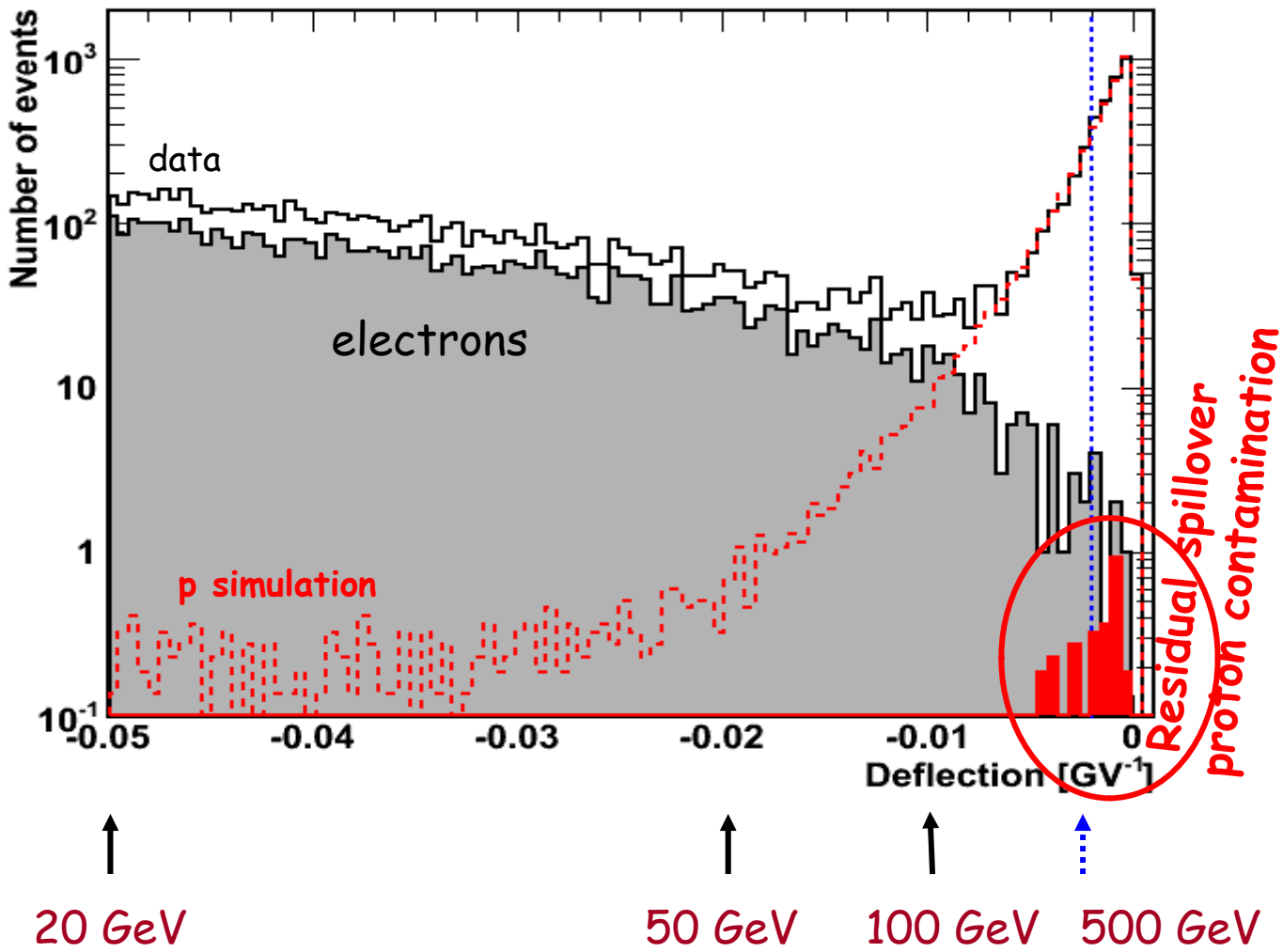


Transversal profile topological variable

100 – 200 GeV, simulations

Electron spectrum - tracker-based

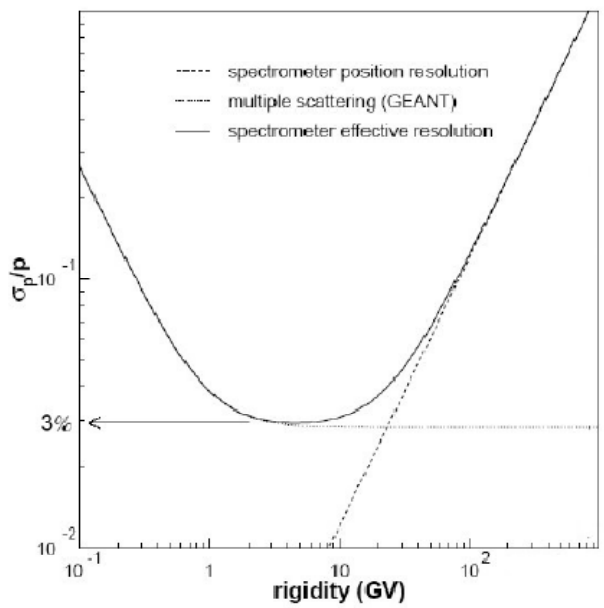
Negatives tracks with E>20GeV + electron selection

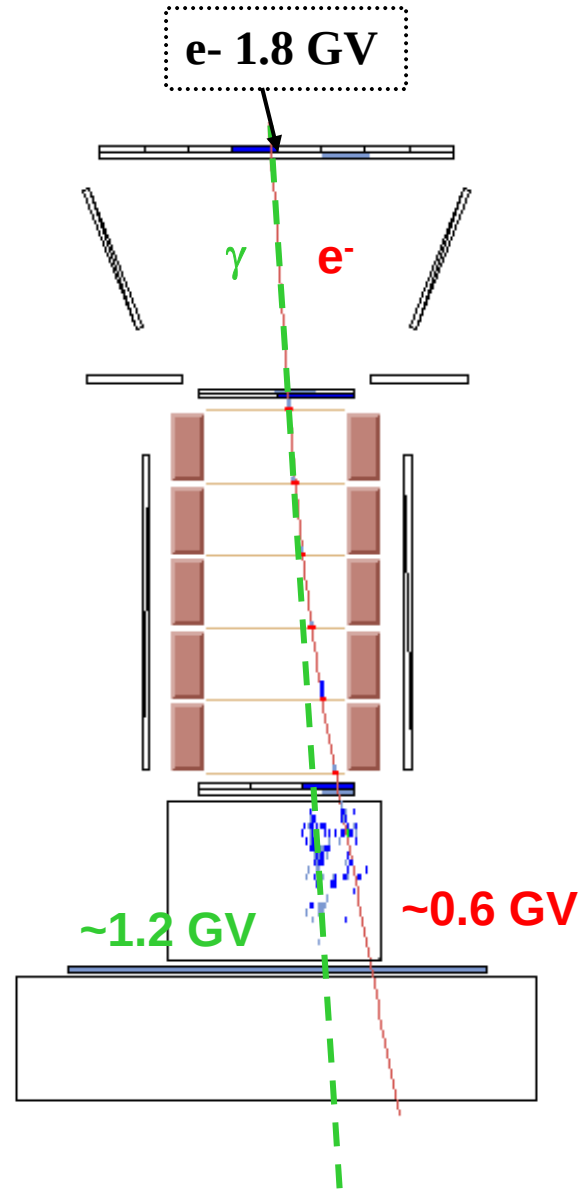


Energy measurement by the tracker

Rigidity from Tracker

- bremsstrahlung above tracker
- decreasing energy resolution





Unfolding (or deconvolution)

Real energy particle spectrum

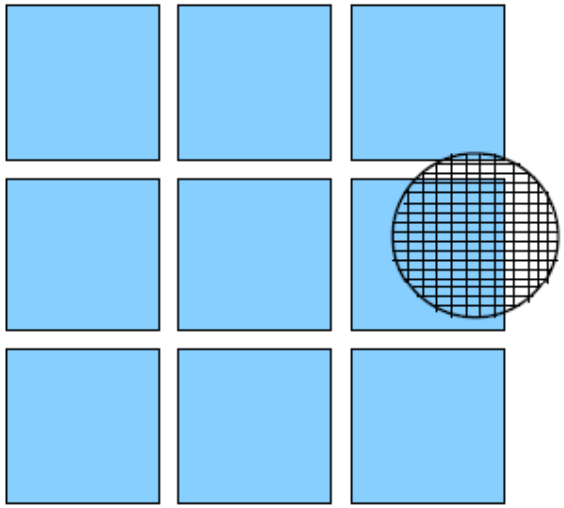
Instrumental effect
(energy loss, energy resolution, …)

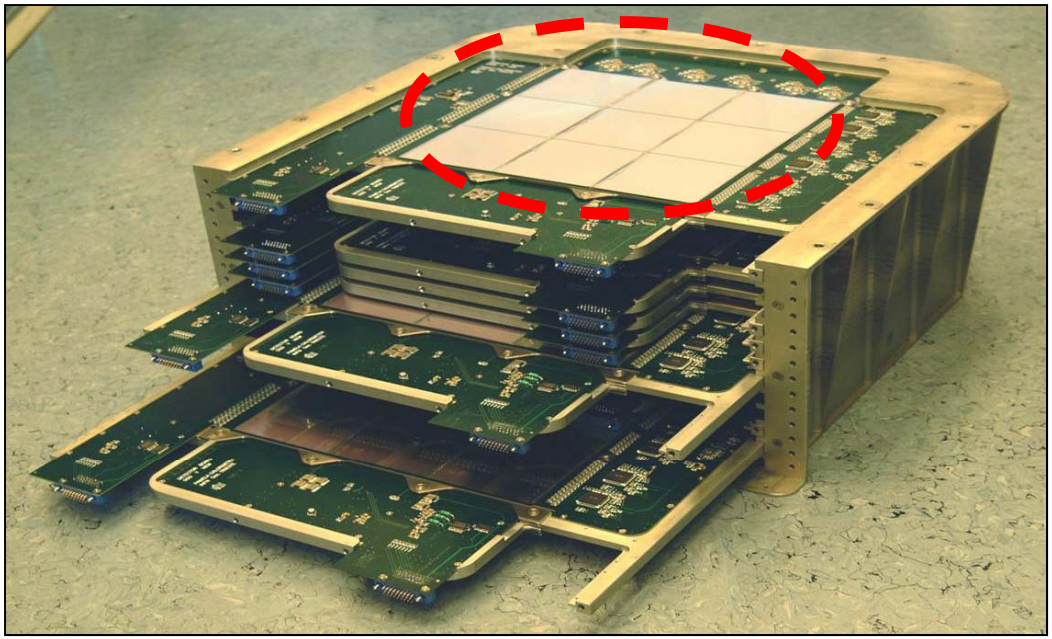
Measured energy particle spectrum

Bayesian Unfolding Procedure

D'Agostini, G., (1995). *"A Multidimensional unfolding method based on Bayes' theorem".*
Nucl Instrum Meth A362 487–498.

Energy measurement





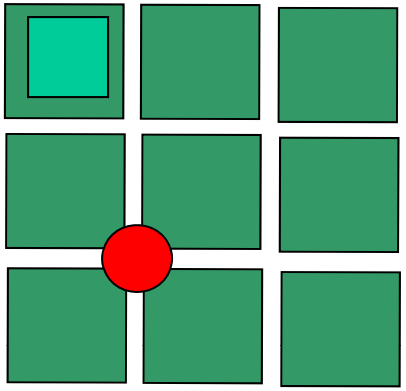
Energy from Calorimeter

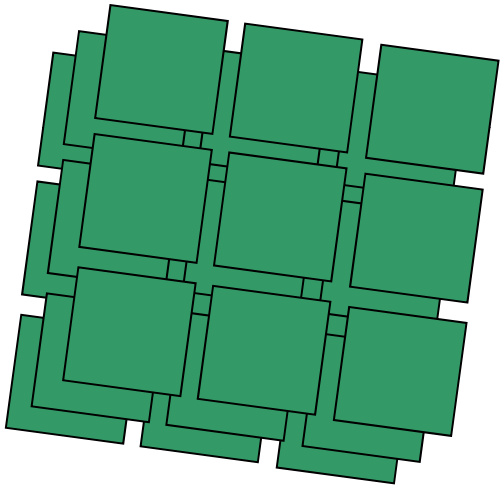
- sampling calorimeter + dead areas
- increasing energy resolution

Electron flux - calorimeter-based

Transversal and dead areas leakage:

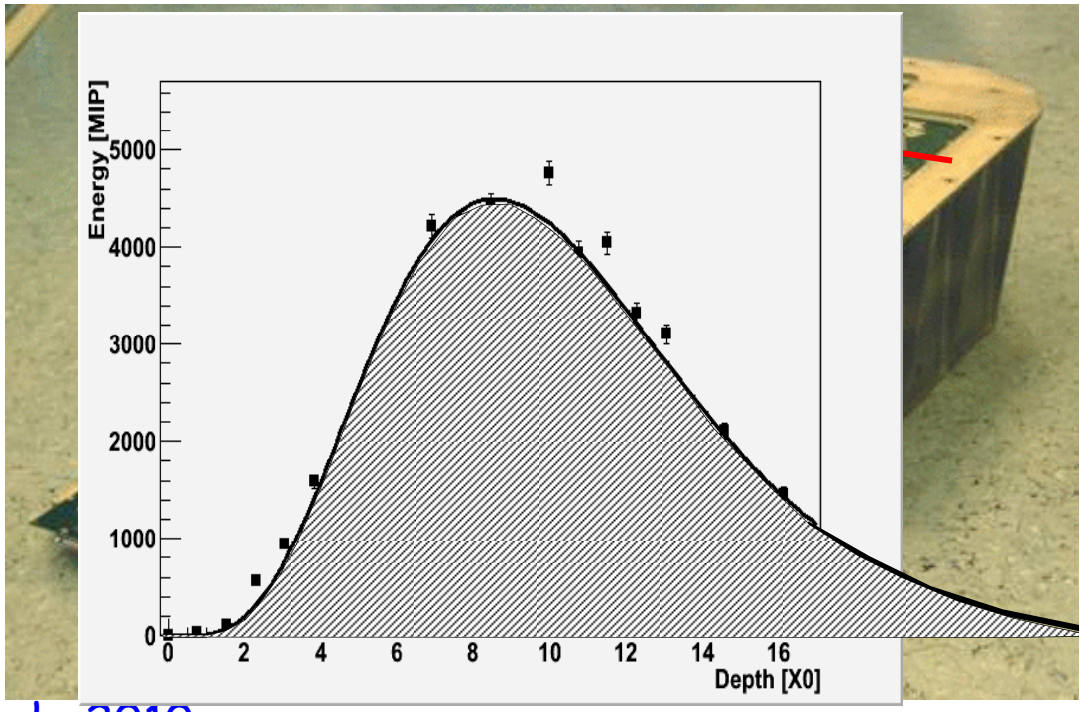
strong containment conditions



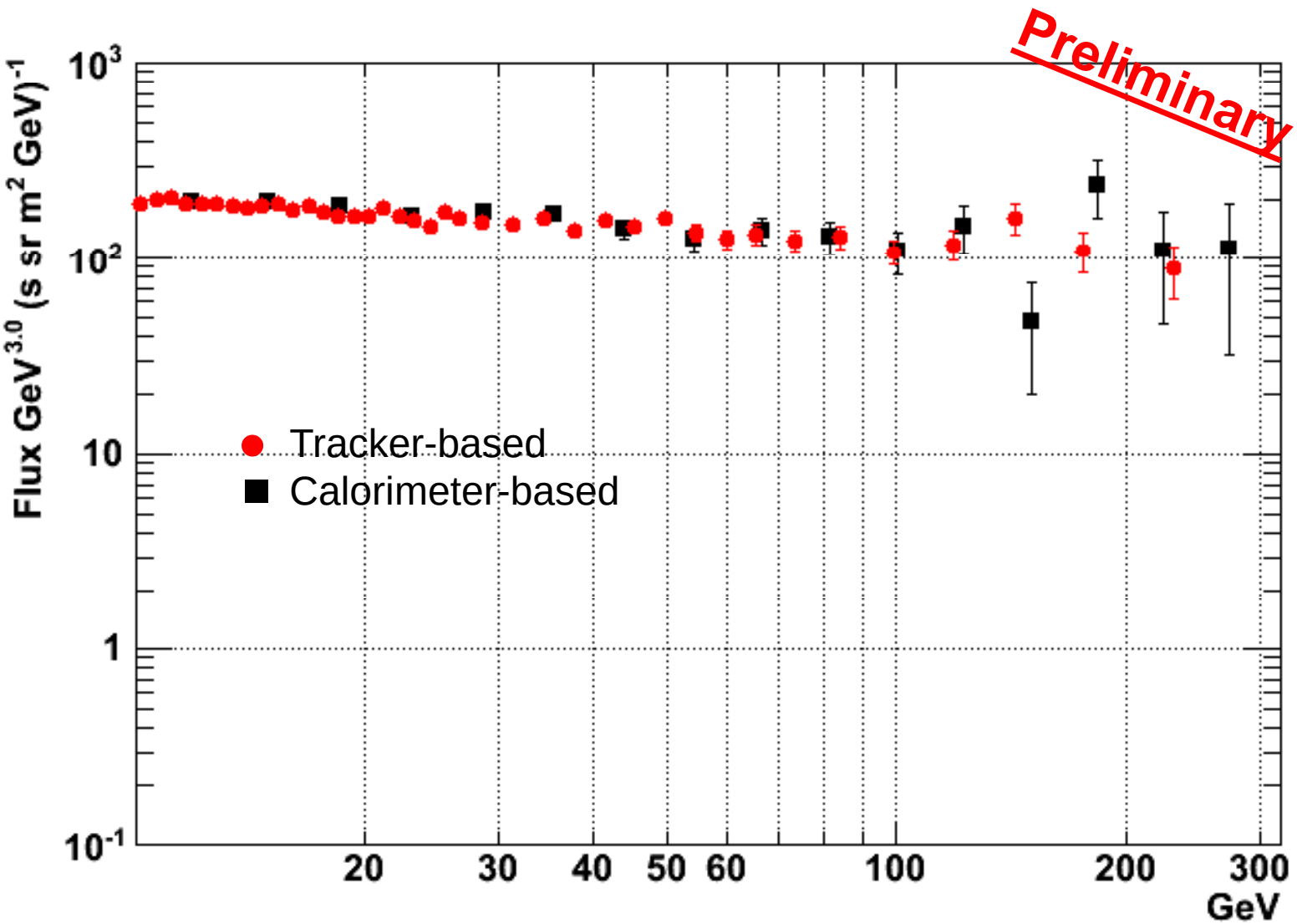


Longitudinal leakage:

Integrate a longitudinal fit of the shower

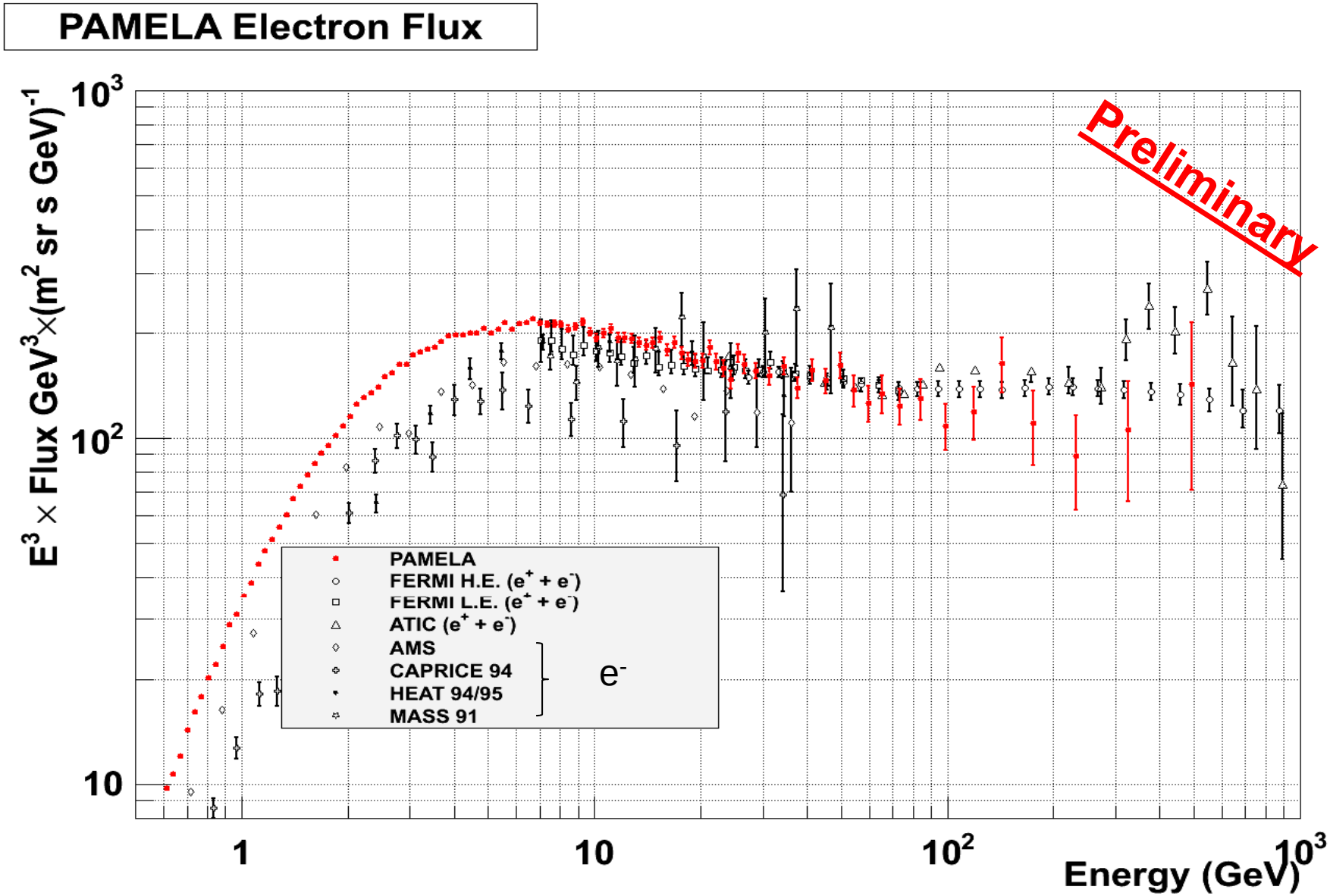


Electron spectrum



Giovan

Negative Electron spectrum



Conclusions

PAMELA has been in orbit and studying cosmic rays for ~1500 days. >10^9 triggers registered, and >20 TB of data has been down-linked.

We present the electron spectrum measured by Pamela in the energy range 0.5 - 500 GeV.

Electron spectrum analyses based on different approaches with different systematics are in agreement

Analysis ongoing to finalize the electron spectrum.

Thank you

http://pamela.roma2.infn.it/index.php