Measurement of Lithium and Beryllium cosmic-ray abundances by the PAMELA experiment

Nicola Mori
University of Florence & INFN Florence
Elena Vannuccini
INFN Florence
on behalf of the PAMELA collaboration

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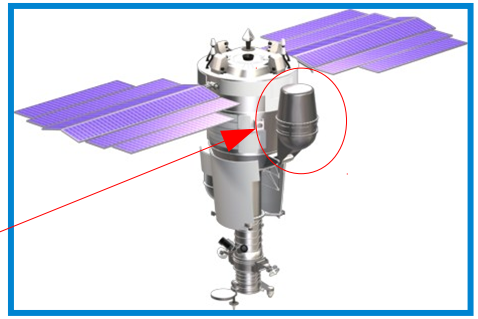
The PAMELA experiment

Resurs DK1 satellite



Satellite-borne experiment

↓

No atmospheric effects

Mission details

Orbit and altitude:

- elliptical, 360 – 600 km (up to 2010)
- circular, 600 km (since 2010)

Orbit inclination: 70°

Planned duration: 3 years

Launch: 15th June 2006

Technical data

Mass ~ 470 kg

Height ~ 1.3 m

Power cons. ~ 355 W

Downlink rate ~ 10 GB/day

Current status

9 years in orbit

Data taking LT ~ 75%

~ 56 TB of raw data

The PAMELA collaboration

Italy

INFN Istituto Nazionale di Fisica Nucleare

Bari

Naples

Florence

Tor Vergata

Rome

Trieste

Russia

Физический Институт

МИФИ

Moscow

Ioffe Physico-Technical Institute

St. Petersburg

Sweden

Kungl Tekniska Högskolan

Stockholm

Germany

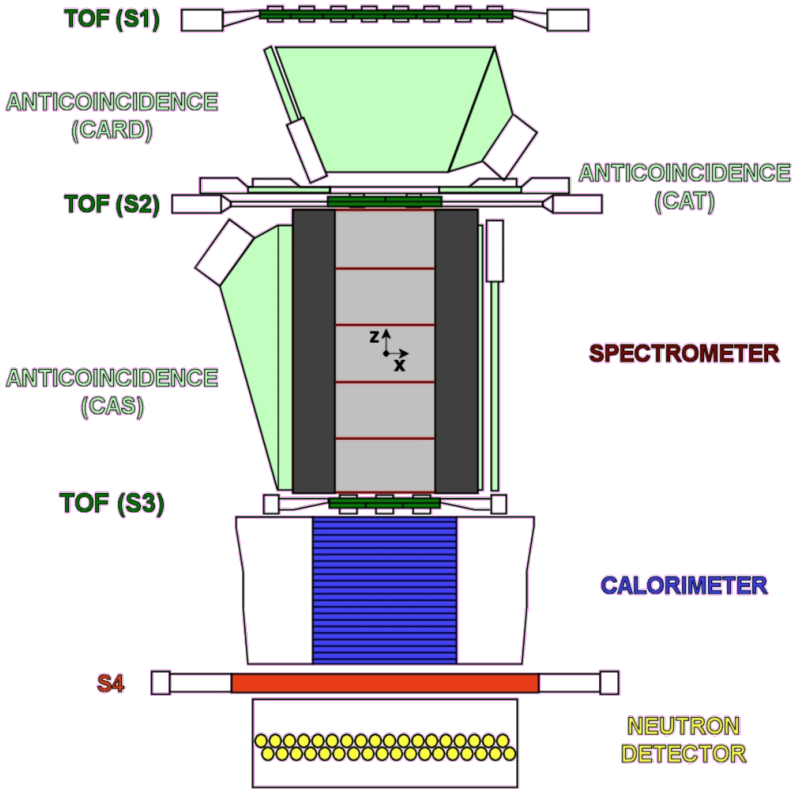
Universität Gesamthochschule Siegen

Siegen

Aimed at light particles (up to oxygen)

Main focus on **antiparticles**

The PAMELA detector



Time-Of-Flight (TOF)
Plastic scintillators + PMT
- Trigger
- Albedo rejection
- Mass identification up to 1 GeV
- Charge identification from dE/dX

Anticoincidence
Plastic scintillators + PMT
- Multi-particle and interacting event rejection

Electromagnetic calorimeter
W/Si sampling (16.3 X_0, 0.6 λ_I)
- e^+/p, $e^-/\bar{p}$ discrimination (shower topology)
- Direct energy measurement for $e^\pm$

Spectrometer
Microstrip silicon tracking system + perm. magnet
- magnetic rigidity R = pc/Ze
  - sign of charge
  - charge value from dE/dx

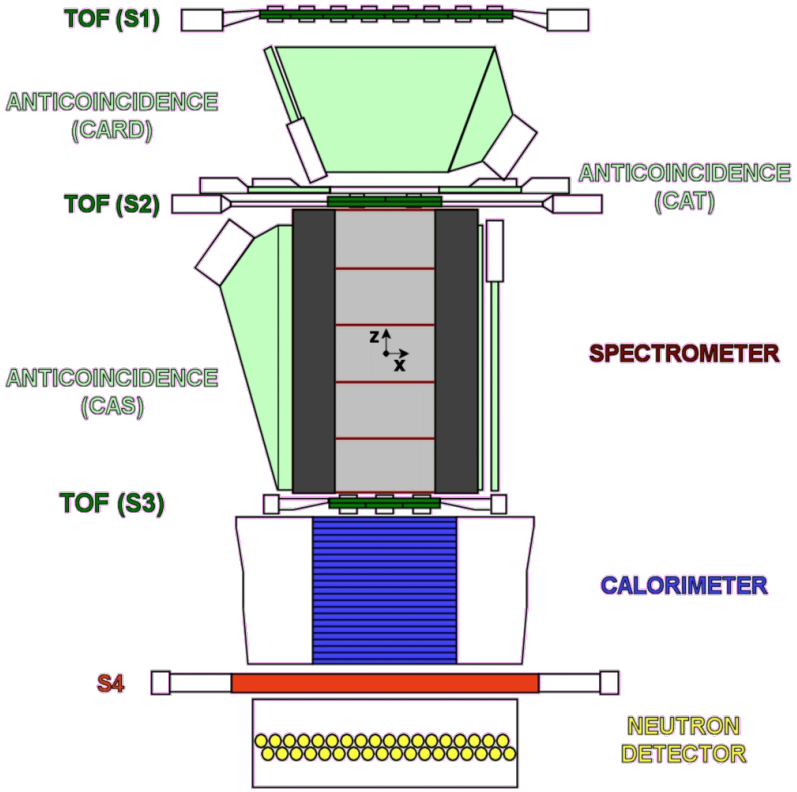
Neutron detector
36 ^{3}He counters
- High-energy e/h discrimination

Optimized for |Z|~1 particles

Tracking performance: σ_x = 3 μm, σ_y = 11 μm, MDR = 1.2 TV

Highlight talk by M. Boezio on 31st July (yesterday)

The PAMELA detector



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Light nuclei measurements

- PAMELA has already published p, He, B, C
- Intermediate masses: Li & Be
- Data anlysis is in an early stage
  - Event quality criteria
  - Charge selection
  - Efficiencies
  - Preliminary results
  - No corrections

Event selection

- Preliminary selection: remove TRK clusters with dE/dx < 5 MIP
  - Removes backscattering from CALO, delta rays, protons and relativistic helium
- Magnetic spectrometer → magnetic rigidity
- Track quality criteria:
  - Single fitted track
  - 4X 3Y LA4
  - Light χ^2 selection
  - Fiducial containment → GF = 19.9 cm^2 sr

Event selection

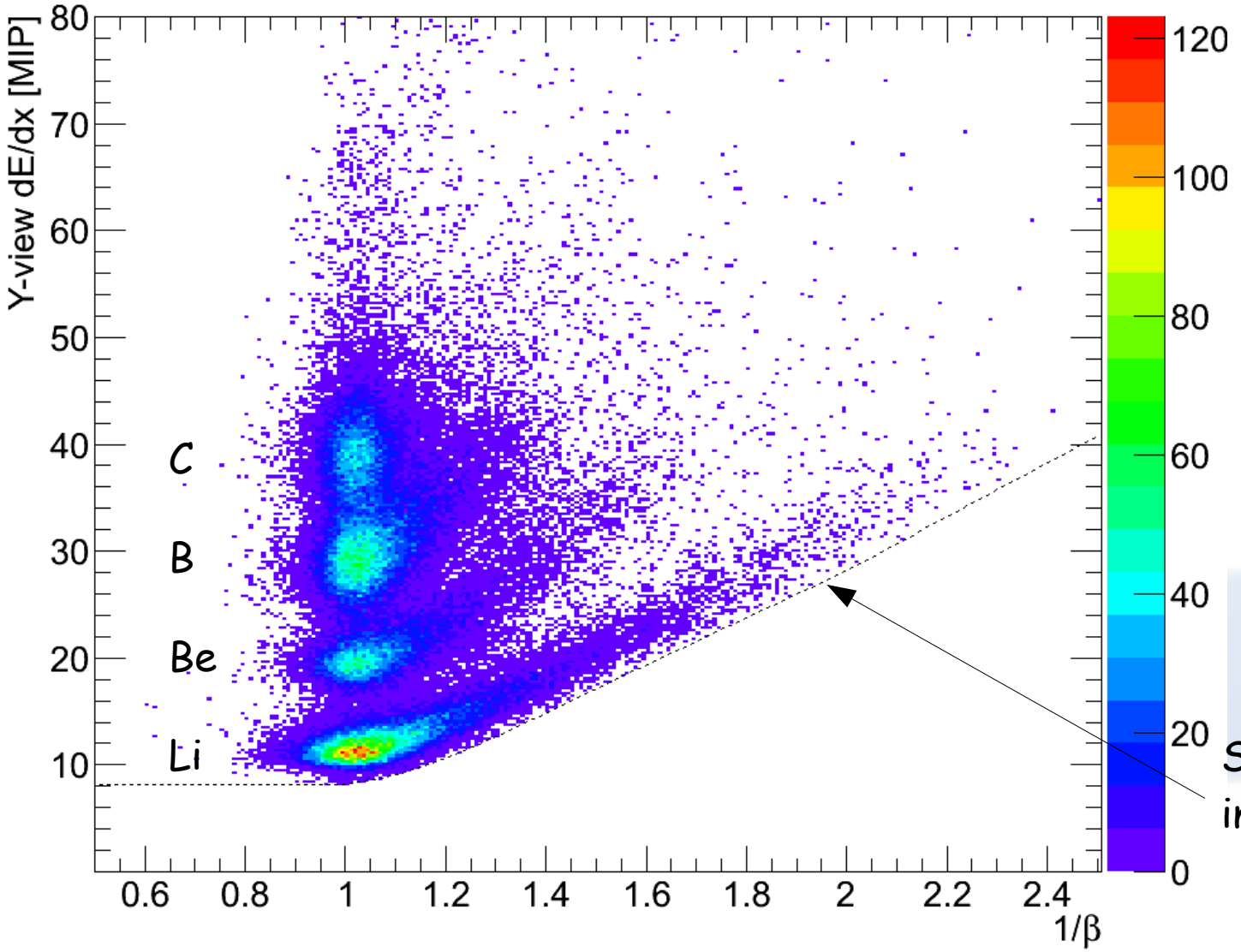
- Charge selection: dE/dX vs 1/β
  - 1/β ~ gaussian
  - No isotopic separation
- Time of flight quality selection
- dE/dX from TRK and ToF:
  - TRK_y vs 1/β
    - Excluding sat. clusters, only relevant for Be
  - ToF S_{12} vs 1/β
  - For Li: additional selection on single TRK clusters to reject He

Event selection

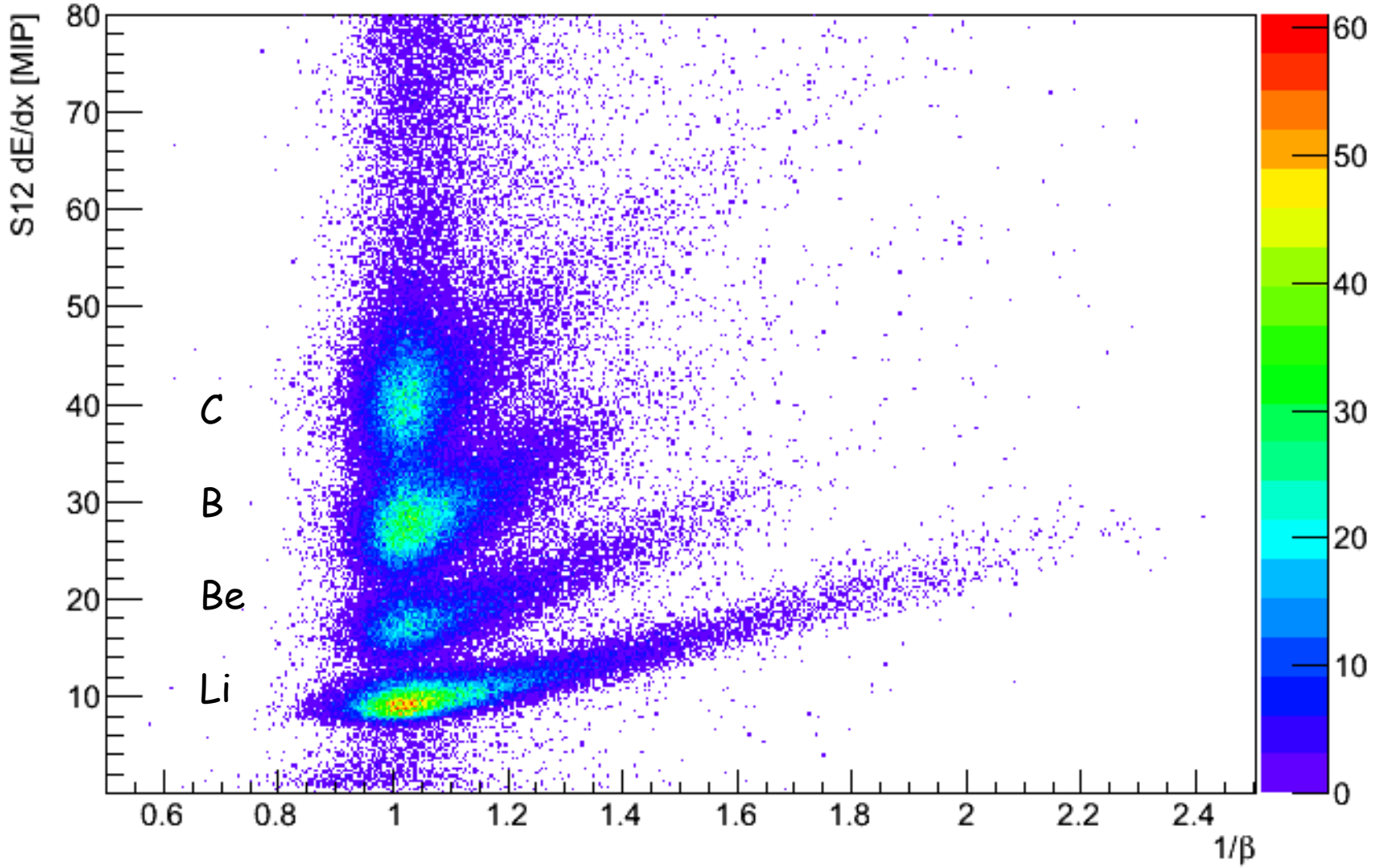
- MDR selection
  - Mitigates the effects of finite rigidity resolution at high energies
    - Full correction by Bayesian unfolding
    - Not done in this analysis

Charge selection: TRK

Only non-saturated clusters



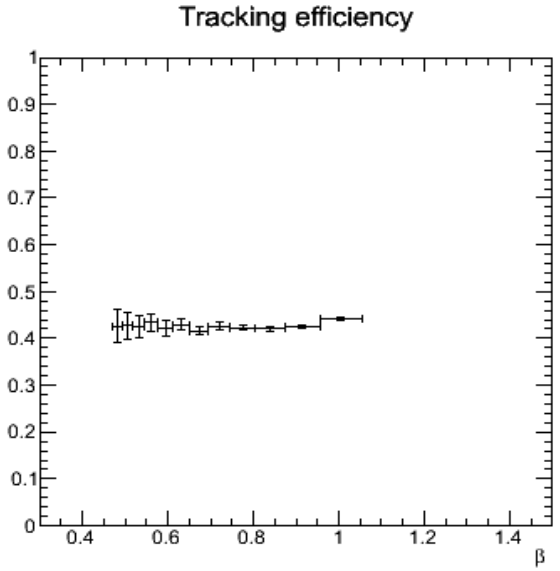
Charge selection: TOF_{S12}

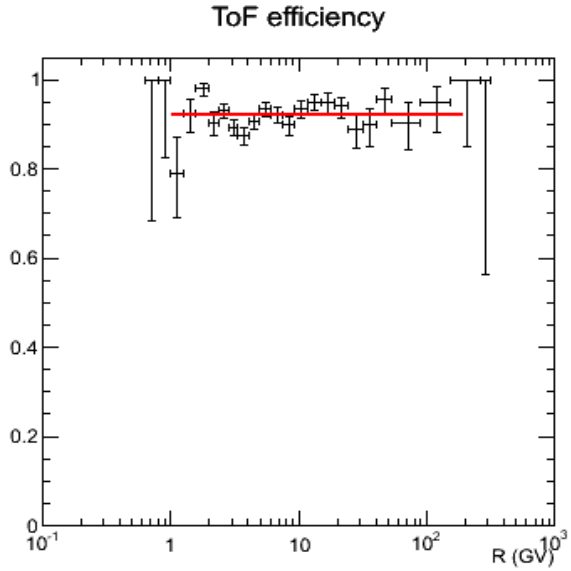


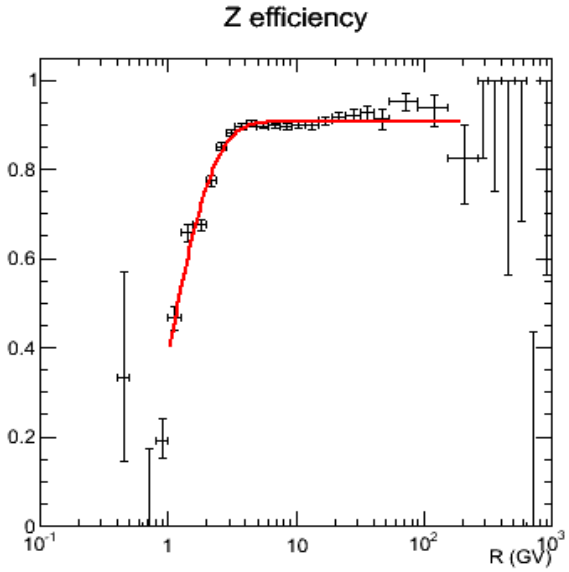
Selection efficiencies

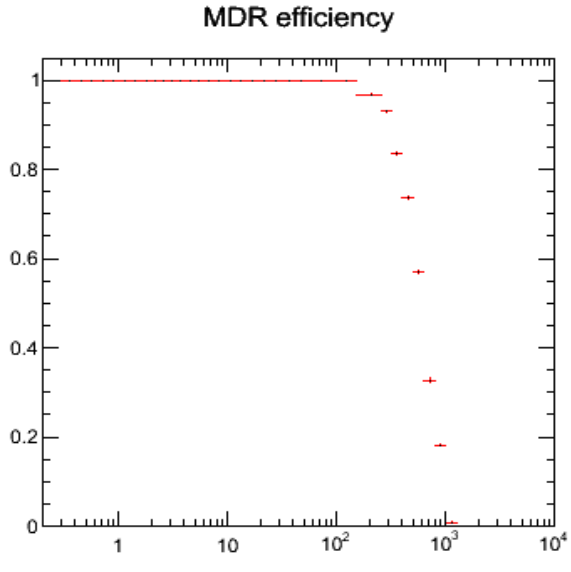
- Measured from flight data
  - Thanks to detector redundancy
- Tracking efficiency:
  - Pre-select Li and Be events with ToF and CALO-0
- Charge selection efficiency:
  - Pre-select with S11, <S2> and CALO-0 (vs. 1/β)
- TBD: Monte Carlo corrections & cross checks

Efficiencies for Li

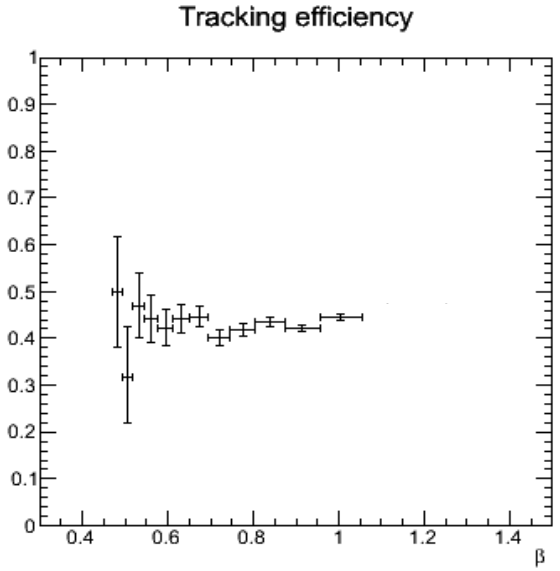


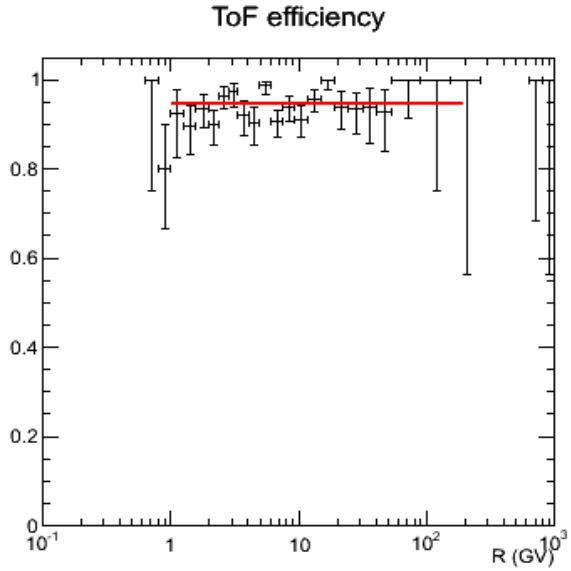


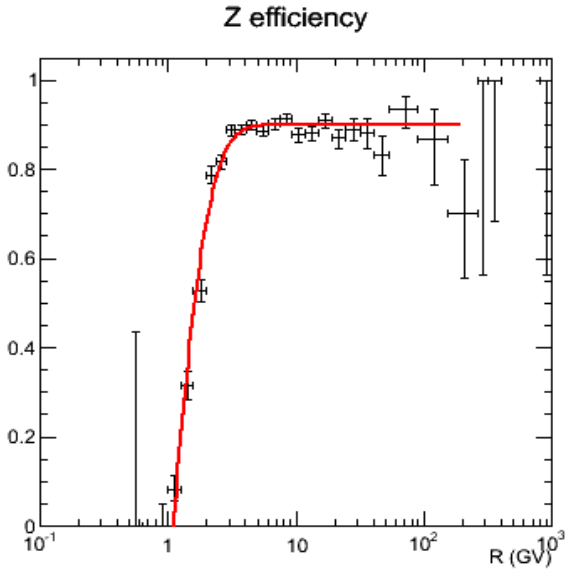


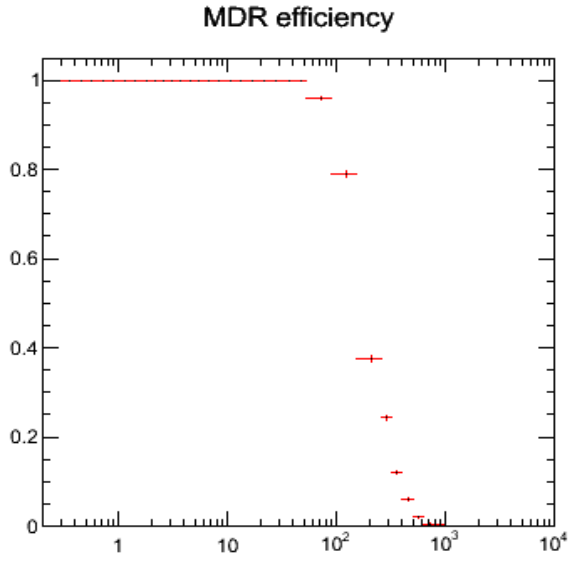


Efficiencies for Be



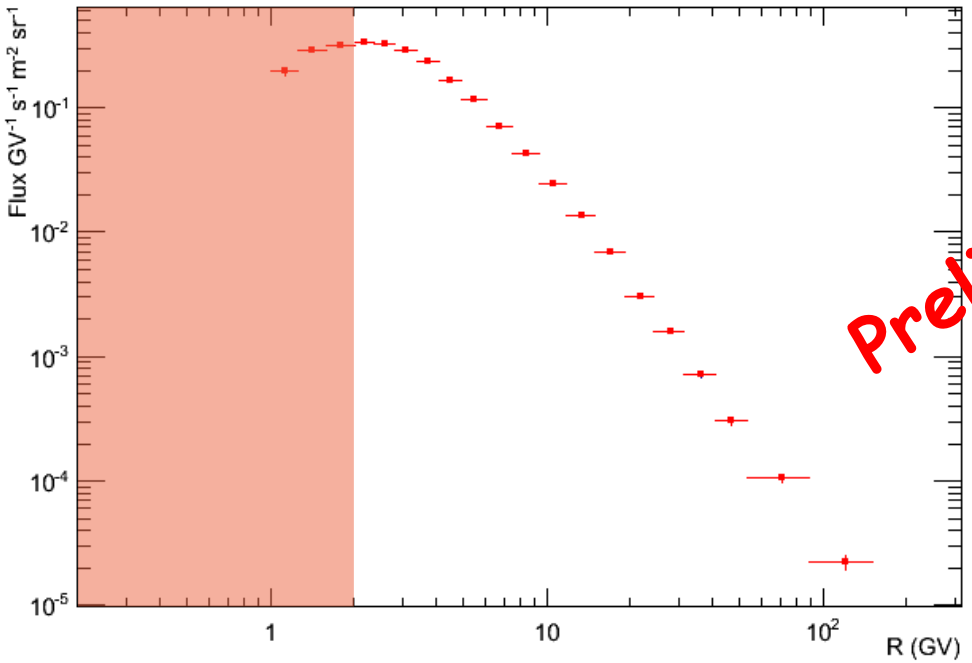




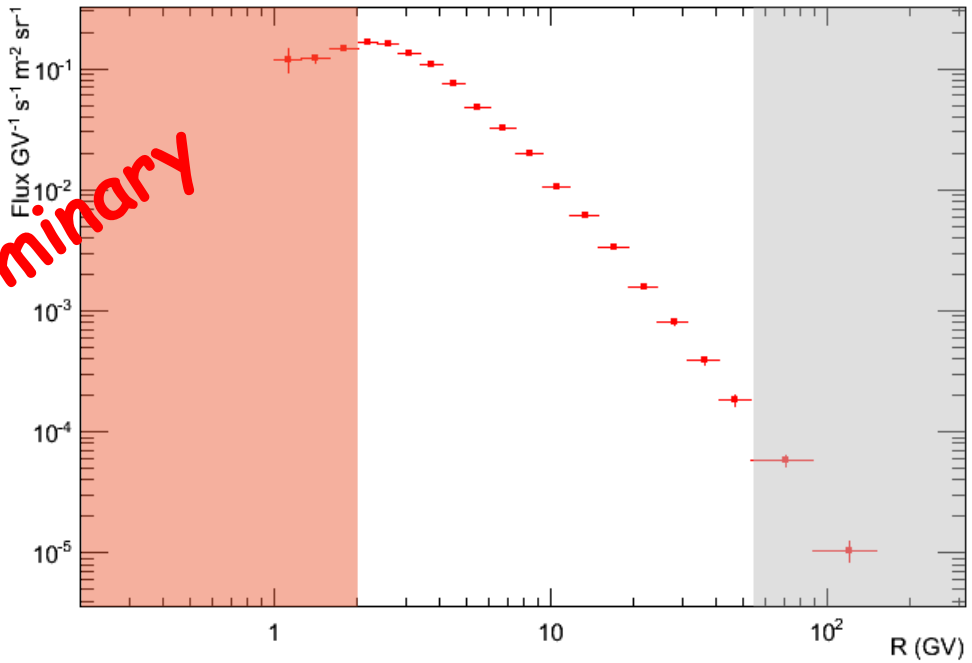


Fluxes

Li



Be



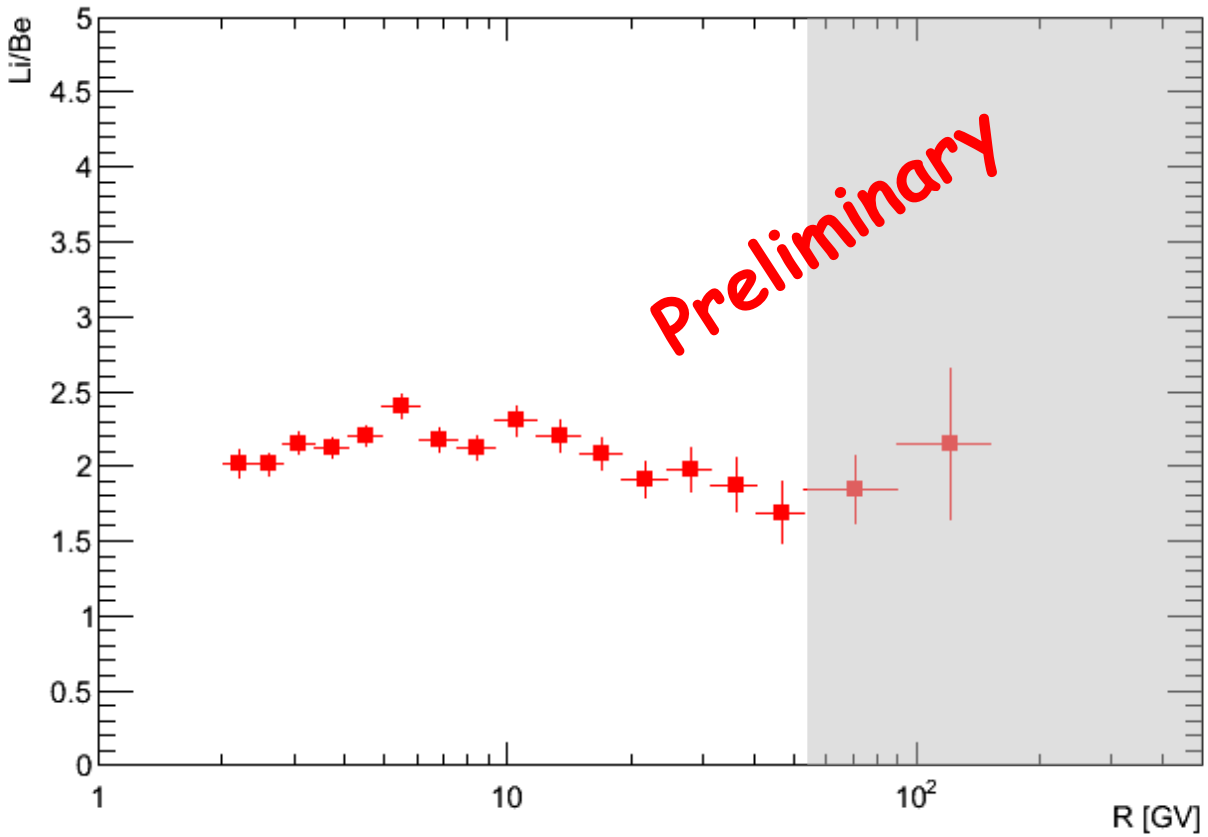
Preliminary

- Shaded red area: particle slow-down effects
  - Still to be corrected

- No MC corrections
- Not unfolded
- Only statistical errors

- Shaded grey area: relevant MDR effects for Be (due to saturated clusters)
  - Still to be corrected

Ratio



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Summary

- The measurement of the Li and Be fluxes with PAMELA is ongoing
  - Complementary work on isotopes (talk by W. Menn in this session)
- Up to now, work has been focused on flight data (data selection and efficiencies)
- Work on MC data (for corrections, unfolding etc.) is starting