The image shows the AMS-02 detector on the International Space Station. The detector is a large, white, rectangular structure with a grid of solar panels on top. It is mounted on a complex metal structure. The background is the blackness of space. The text is overlaid on the right side of the image.

Latest results from AMS: Positron fraction and antiproton ratio

W. Xu / MIT

On behalf of the AMS Collaboration

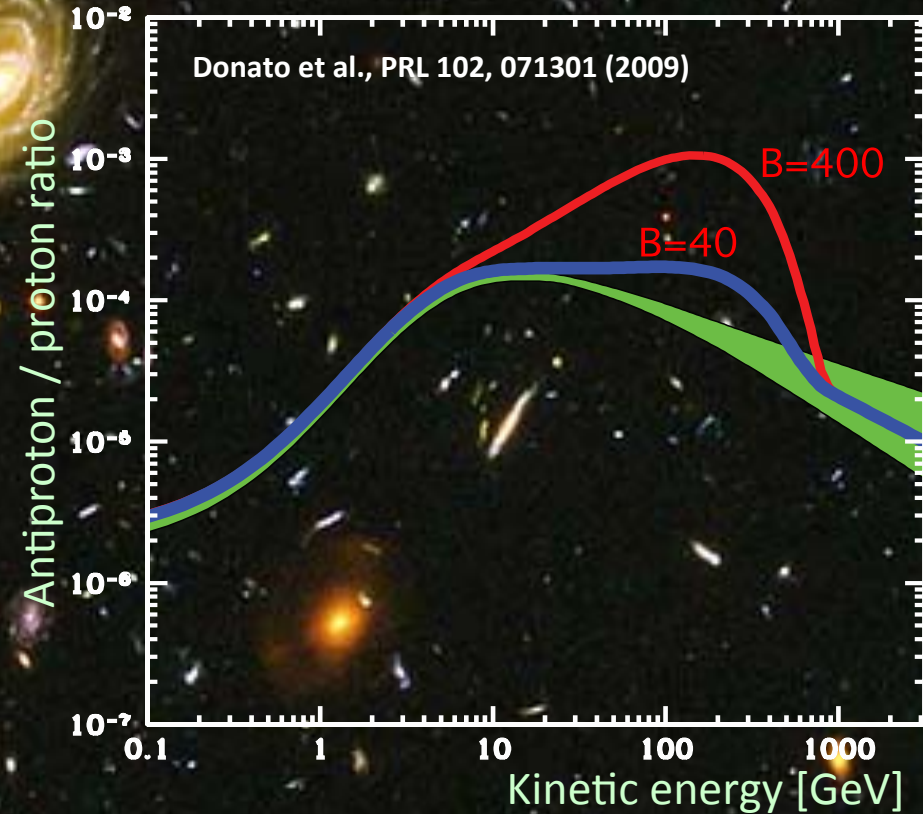
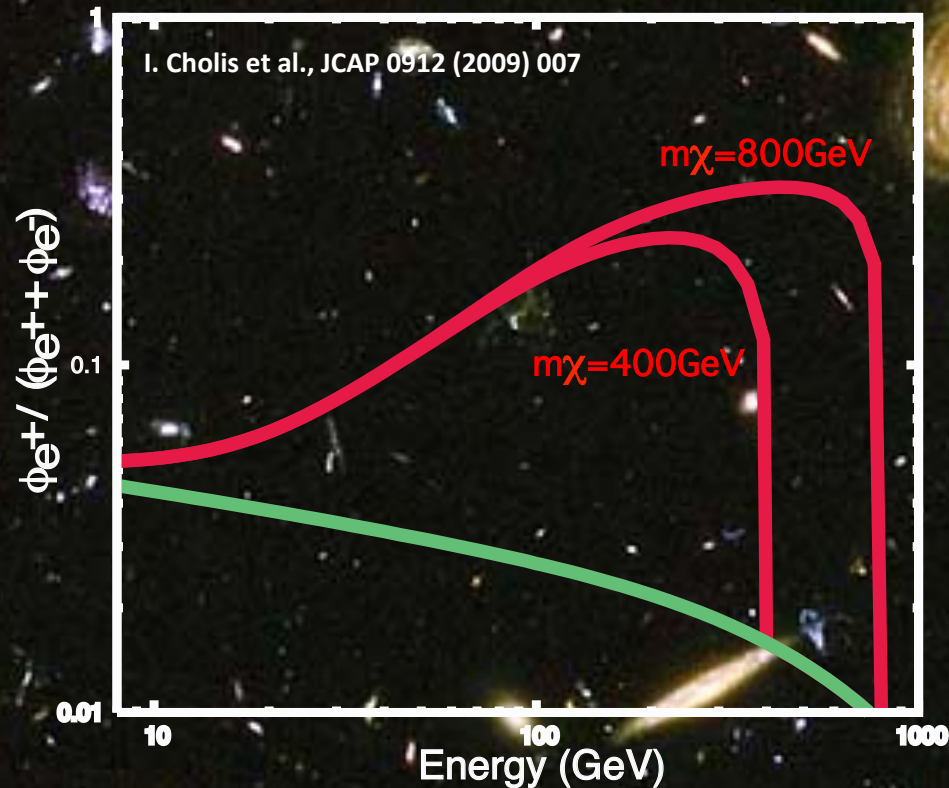
9/9/2015, 14th TAUP, Torino

Dark Matter

~85% of matter in the Universe is not visible and is called dark matter

Collision of “ordinary” Cosmic Rays produce e^+ , \bar{p} ...

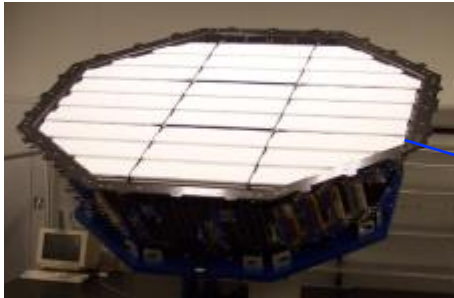
Annihilation of Dark Matter (neutralinos, χ) will produce **additional** e^+ , \bar{p}



To identify the signal of dark matter, we need to measure positrons and antiprotons with high precision to high energy

AMS: A TeV precision, multipurpose spectrometer

Transition Radiation Detector
Identify e^+ , e^-

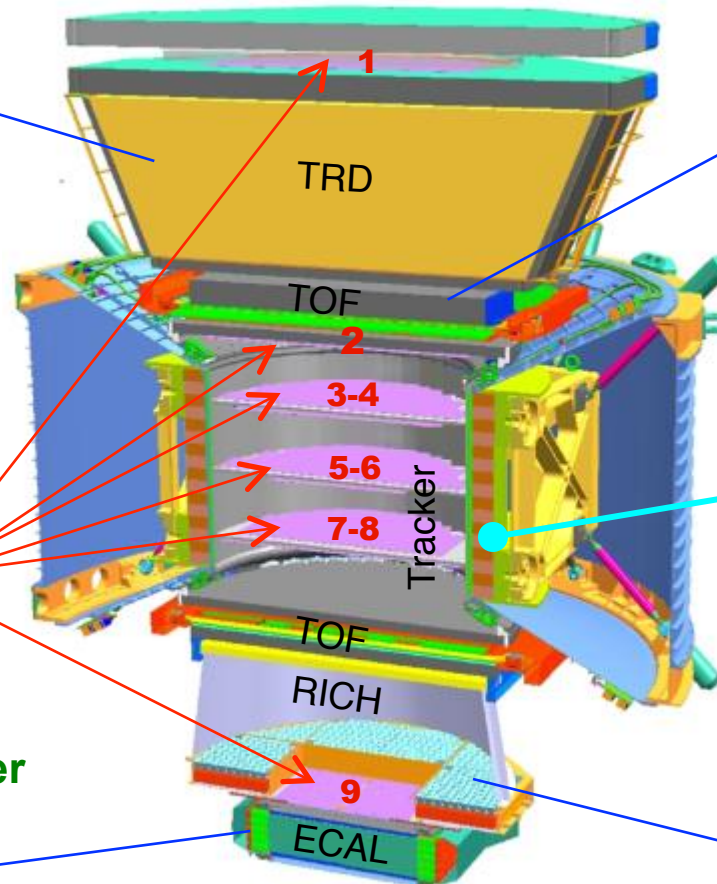


Particles and nuclei are defined by their charge (Z) and energy (E)

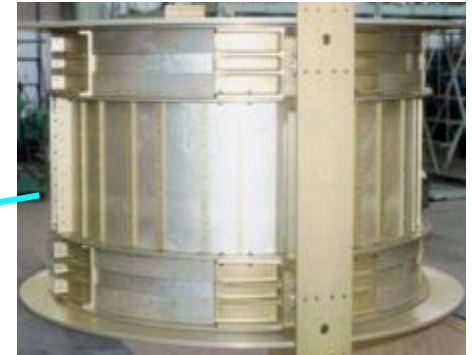
Time of Flight
 Z, E



Silicon Tracker
 Z, P



Magnet
 $\pm Z$



Ring Imaging Cherenkov
 Z, E



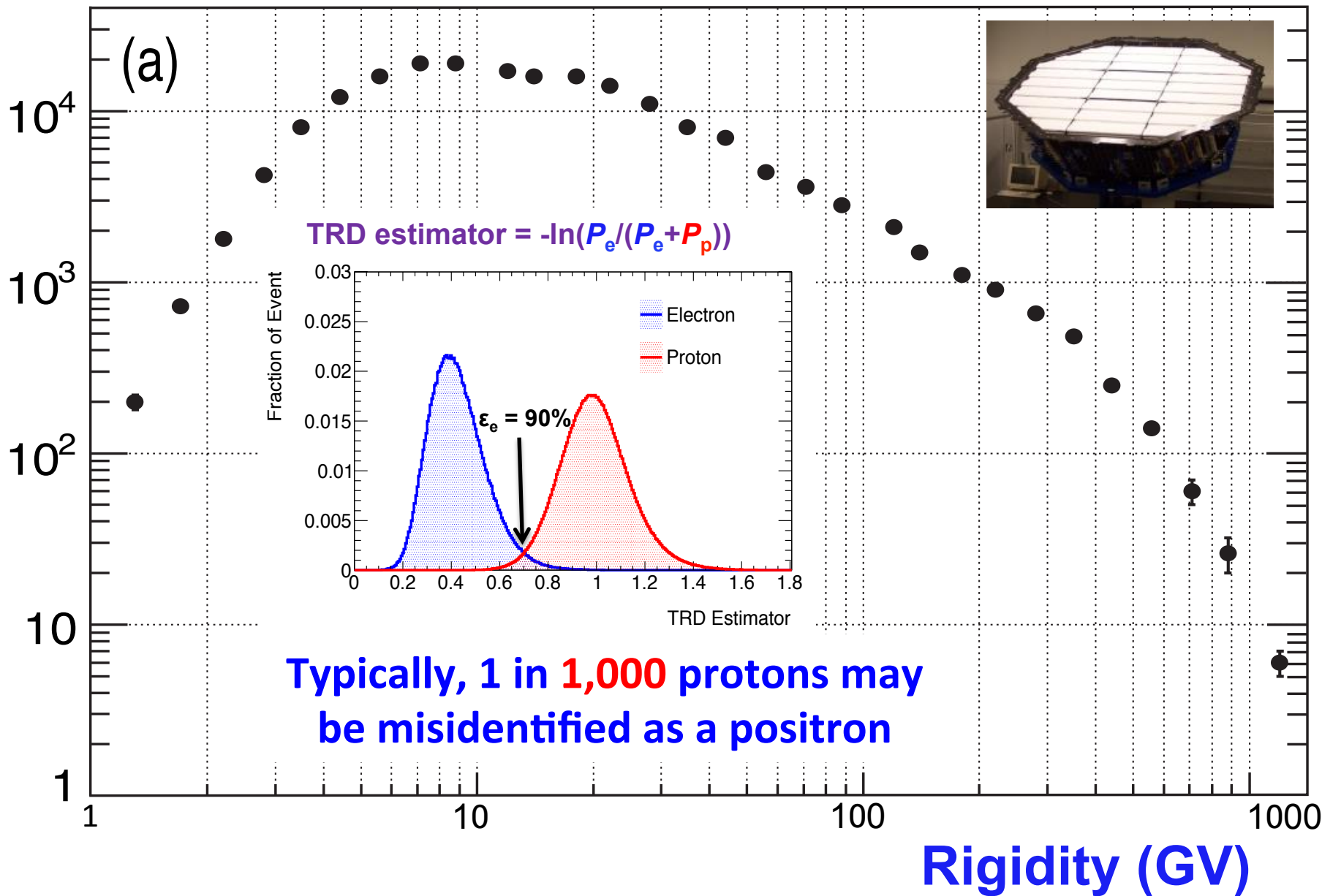
Electromagnetic Calorimeter
 E of e^+ , e^-



The Charge and Energy are measured independently by many detectors

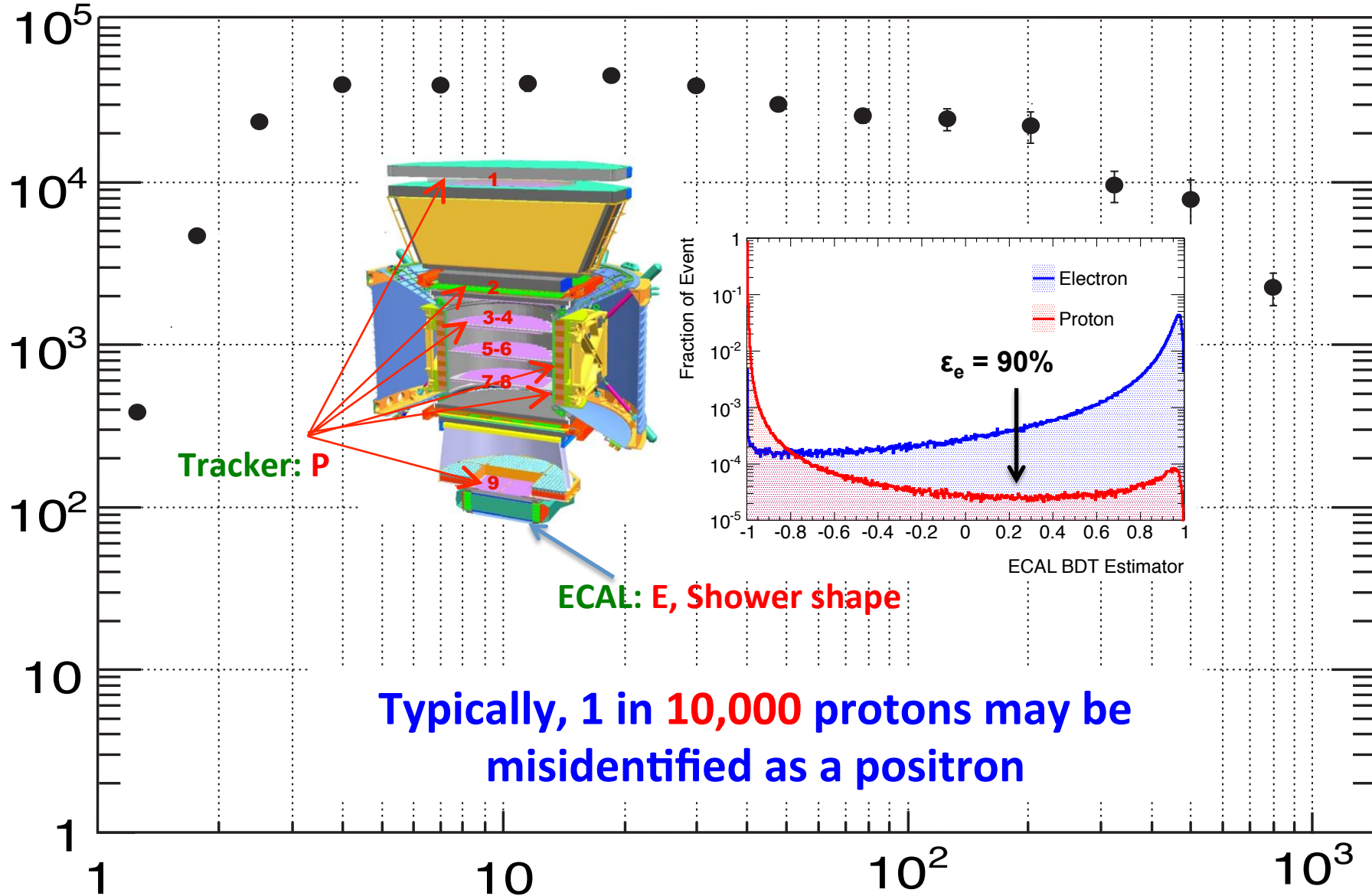
TRD performance on the ISS

Proton rejection at 90% e⁺ efficiency



ECAL Performance on the ISS

Proton rejection at 90% e^+ efficiency



Typically, 1 in 10,000 protons may be misidentified as a positron

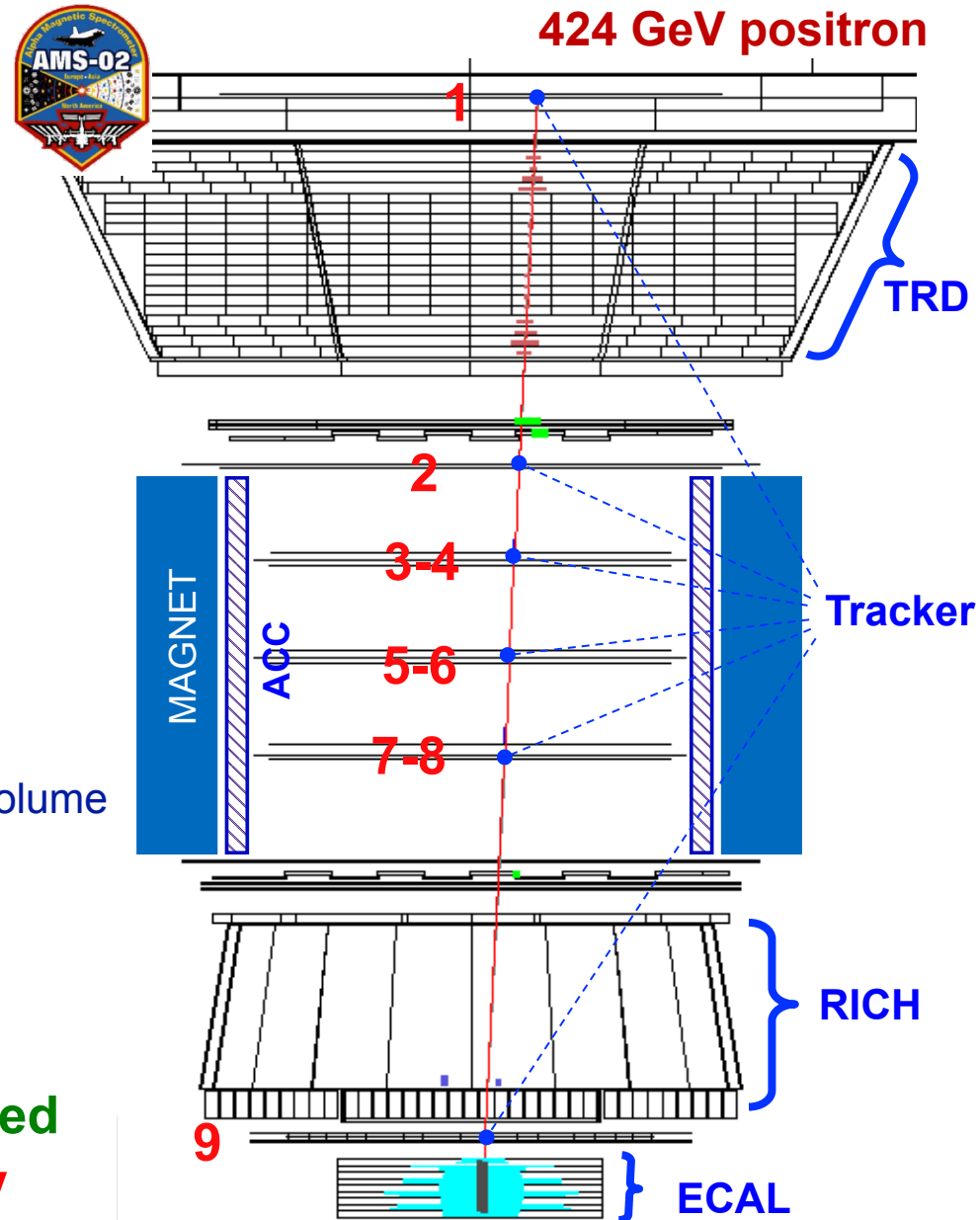
Rigidity (GV)

Event selection for the positron fraction analysis

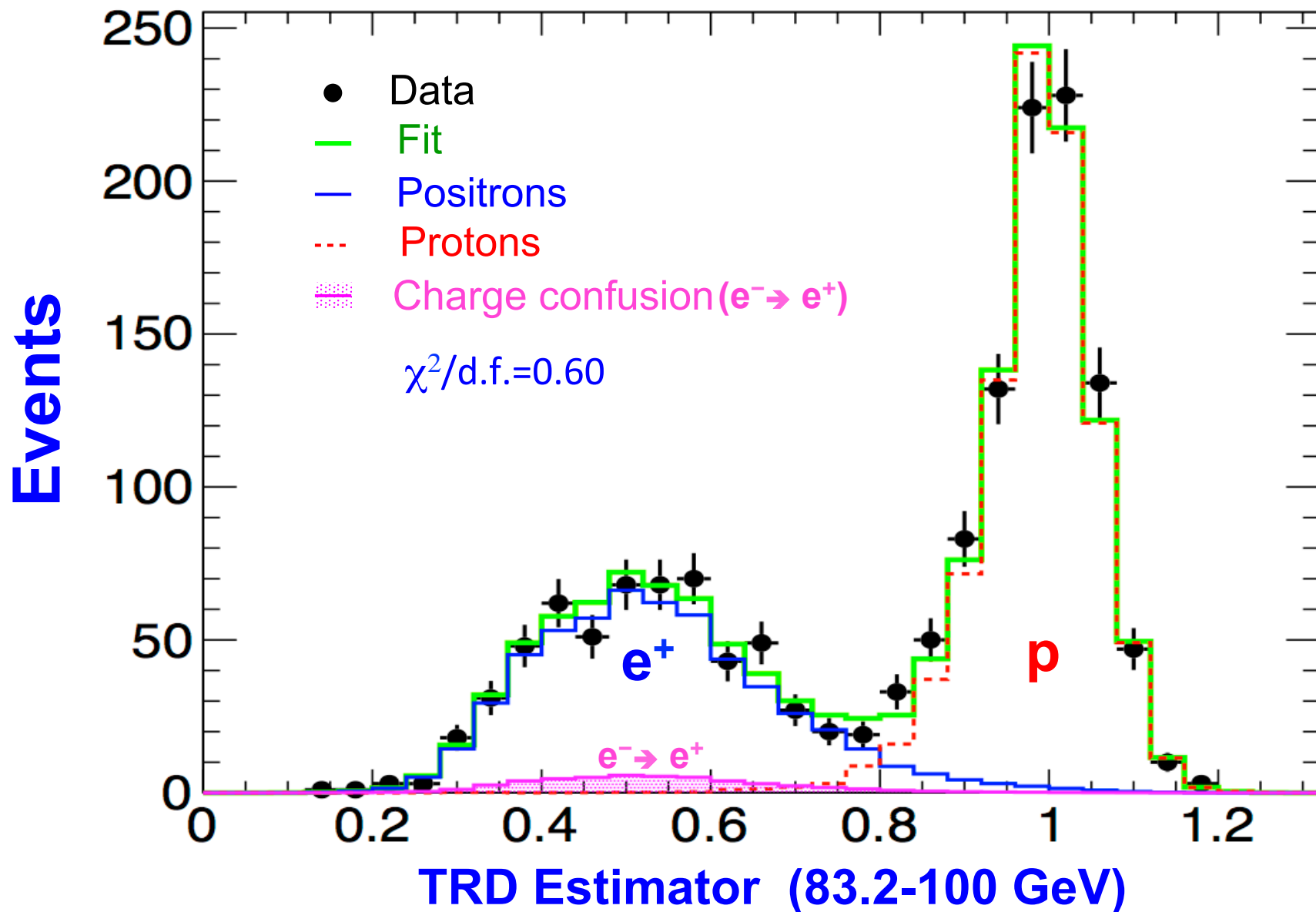
- **Primary cosmic ray particle:**
 - $E > 1.2 \cdot \text{max cutoff}$
- **TRACKER:**
 - Track quality
 - Geometrical match with ECAL shower
 - $0.8 < |Z| < 1.4$
- **TRD:**
 - At least 15 hits
- **TOF:**
 - Down-going particle,
 - $\beta > 0.8$
- **ECAL:**
 - Shower axis within the ECAL fiducial volume
 - Electromagnetic shower shape

Data sample:

10.9 million of e^\pm events are selected
in the energy range **0.5–500 GeV**



TRD Estimator shows clear separation between **protons** and **positrons** with a small **charge confusion** background



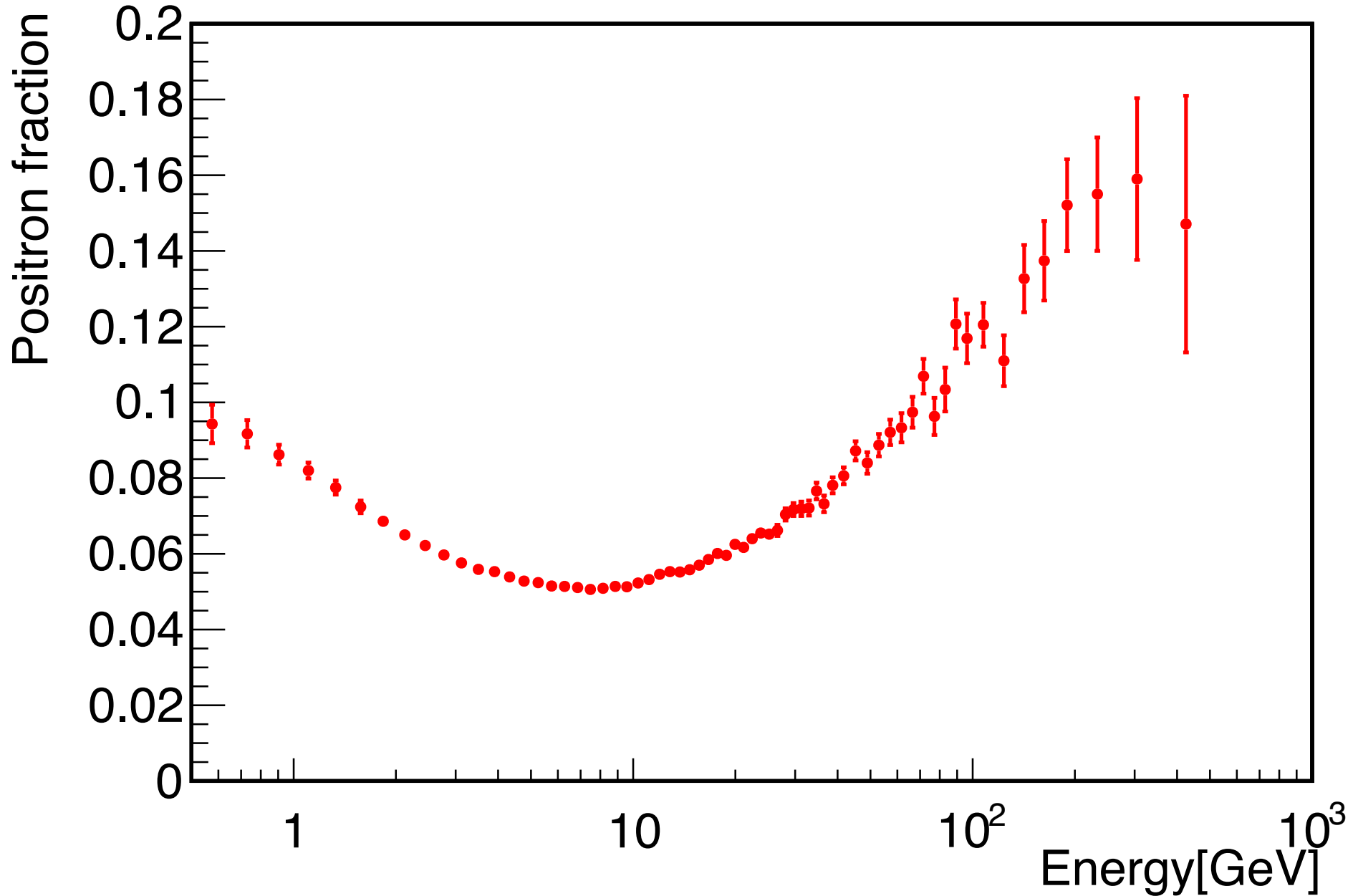
Systematic errors on the positron fraction

$$\text{Ne}^+ / (\text{Ne}^+ + \text{Ne}^-)$$

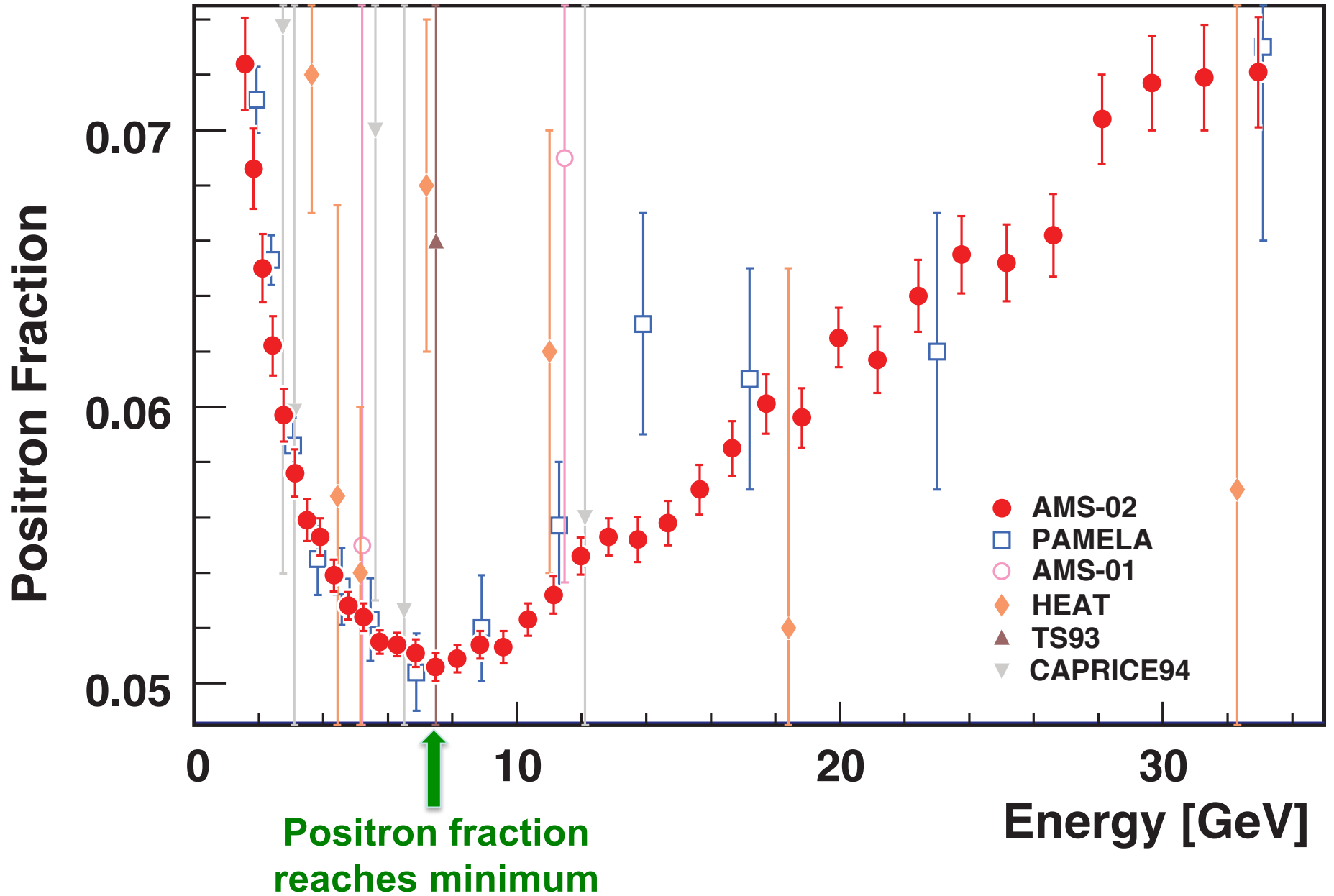
1. Acceptance asymmetry
2. Selection dependence
3. Absolute energy scale and bin-to-bin migration
4. Reference spectra uncertainties
5. Charge confusion

Energy [GeV]	N_{e^+}	Fraction	σ_{stat}	σ_{acc}	σ_{sel}	σ_{mig}	σ_{ref}	$\sigma_{\text{c.c.}}$	σ_{syst}
74.30–80.00	450	0.0963	0.0047	0.0002	0.0010	0.0007	0.0002	0.0006	0.0014
80.00–86.00	381	0.1034	0.0056	0.0002	0.0011	0.0007	0.0002	0.0007	0.0015
86.00–92.50	398	0.1207	0.0063	0.0002	0.0011	0.0007	0.0003	0.0009	0.0016
92.50–100.0	358	0.1169	0.0063	4.5%	0.0013	0.0007	0.0003	0.0010	1.5%
100.0–115.1	524	0.1205	0.0054	0.0002	0.0014	0.0007	0.0004	0.0013	0.0021
115.1–132.1	365	0.1110	0.0062	0.0002	0.0017	0.0007	0.0005	0.0018	0.0026
132.1–151.5	271	0.1327	0.0083	0.0002	0.0020	0.0007	0.0006	0.0024	0.0032
151.5–173.5	228	0.1374	0.0097	0.0002	0.0023	0.0007	0.0007	0.0031	0.0040
173.5–206.0	225	0.1521	0.0109	0.0002	0.0027	0.0007	0.0008	0.0044	0.0053
206.0–260.0	178	0.1550	0.0124	0.0003	0.0034	0.0007	0.0011	0.0076	0.0084
260.0–350.0	135	0.1590	0.0168	19%	0.0045	0.0007	0.0015	0.0123	13%
350.0–500.0	72	0.1471	0.0278	0.0003	0.0064	0.0007	0.0022	0.0182	0.0194

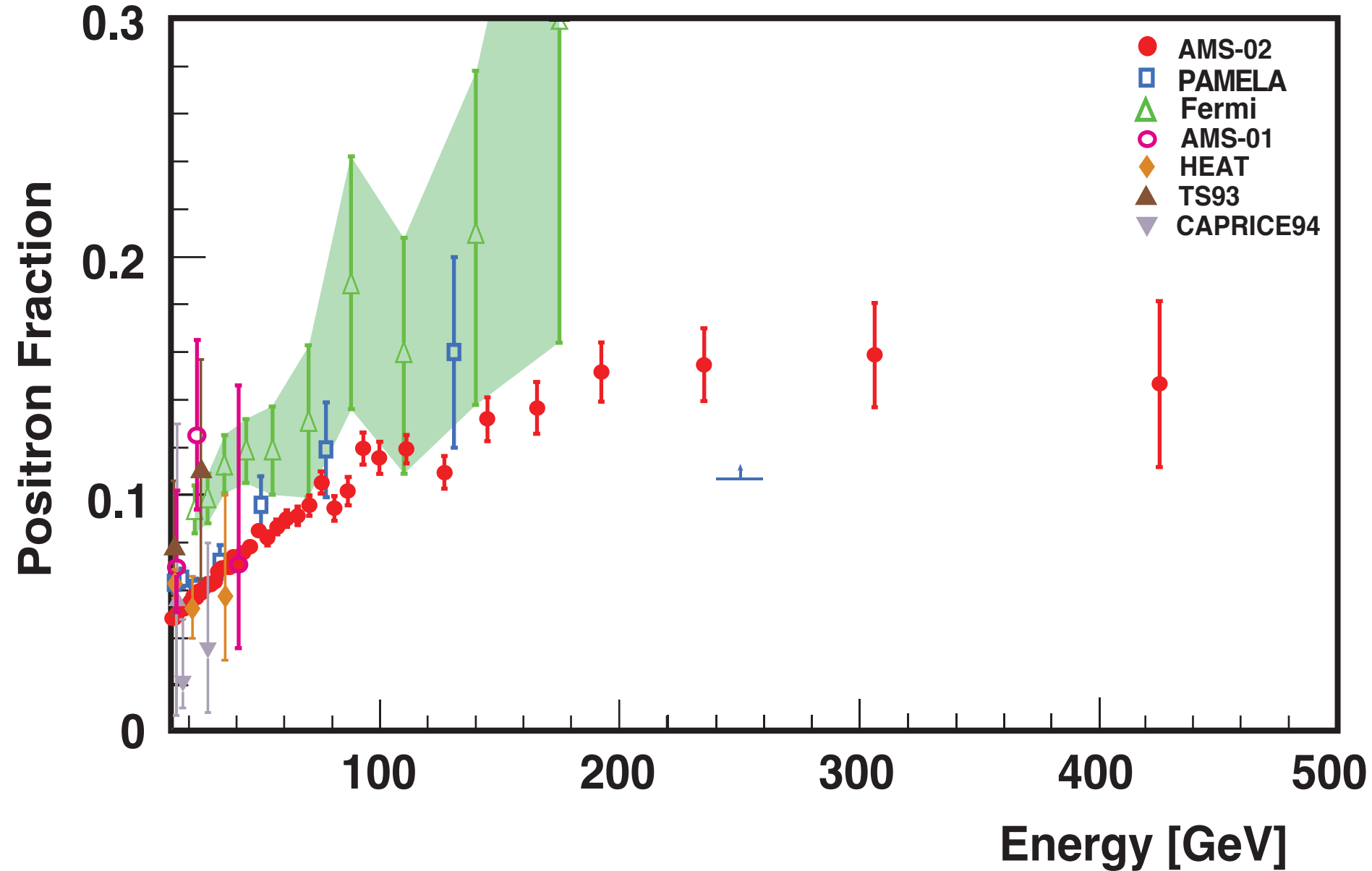
Positron fraction based on 10.9 million events



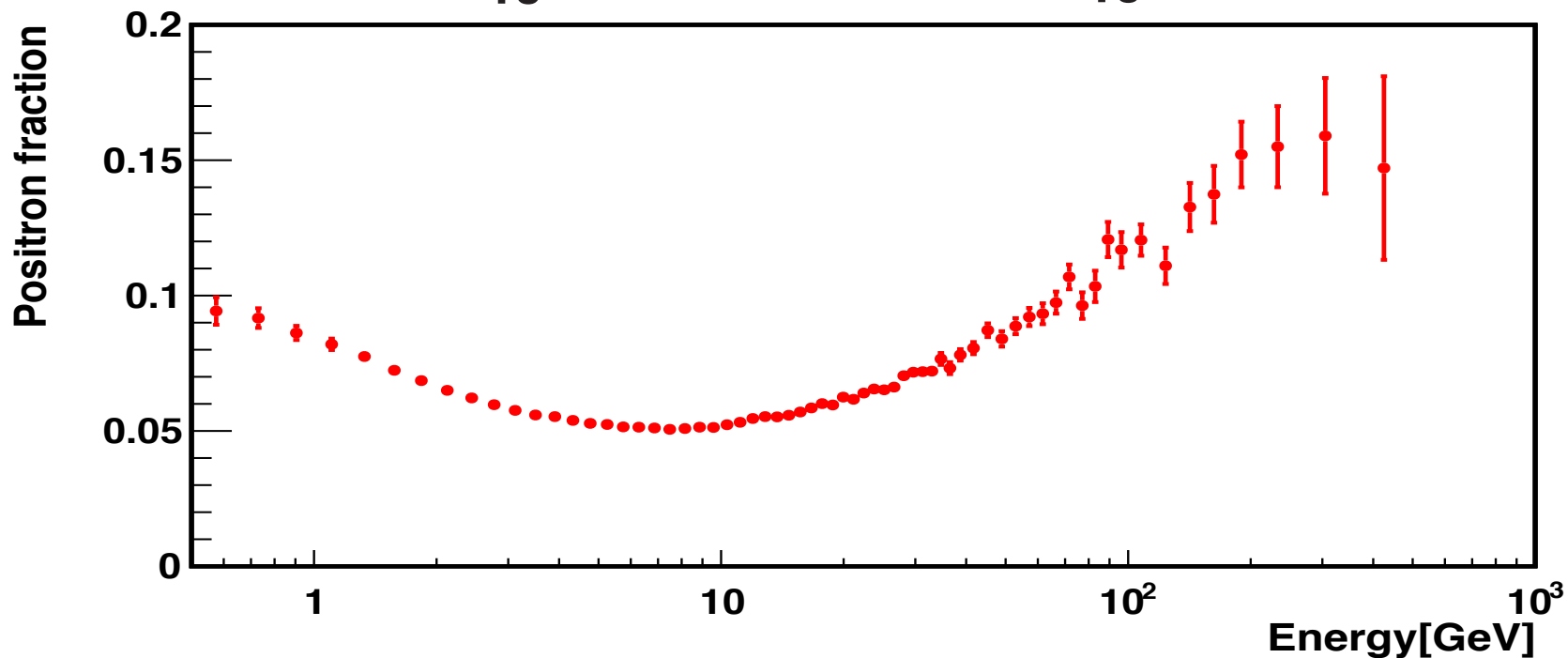
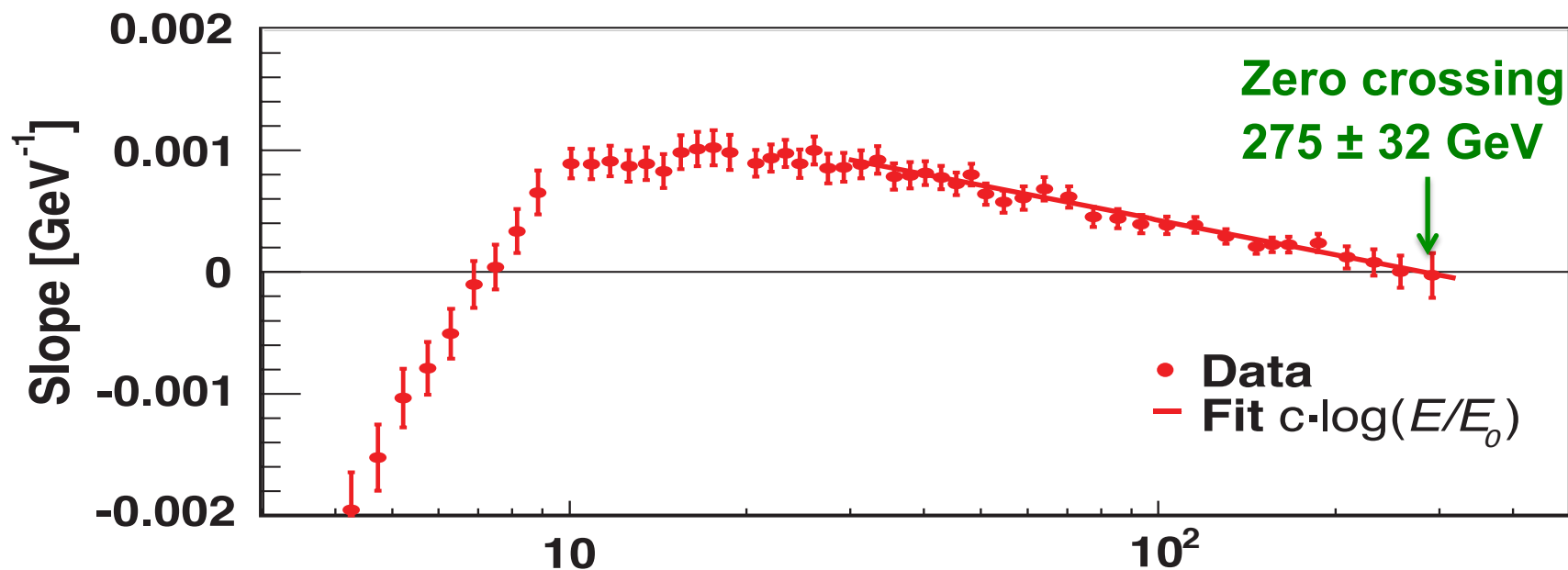
The energy at which positron fraction begins to increase



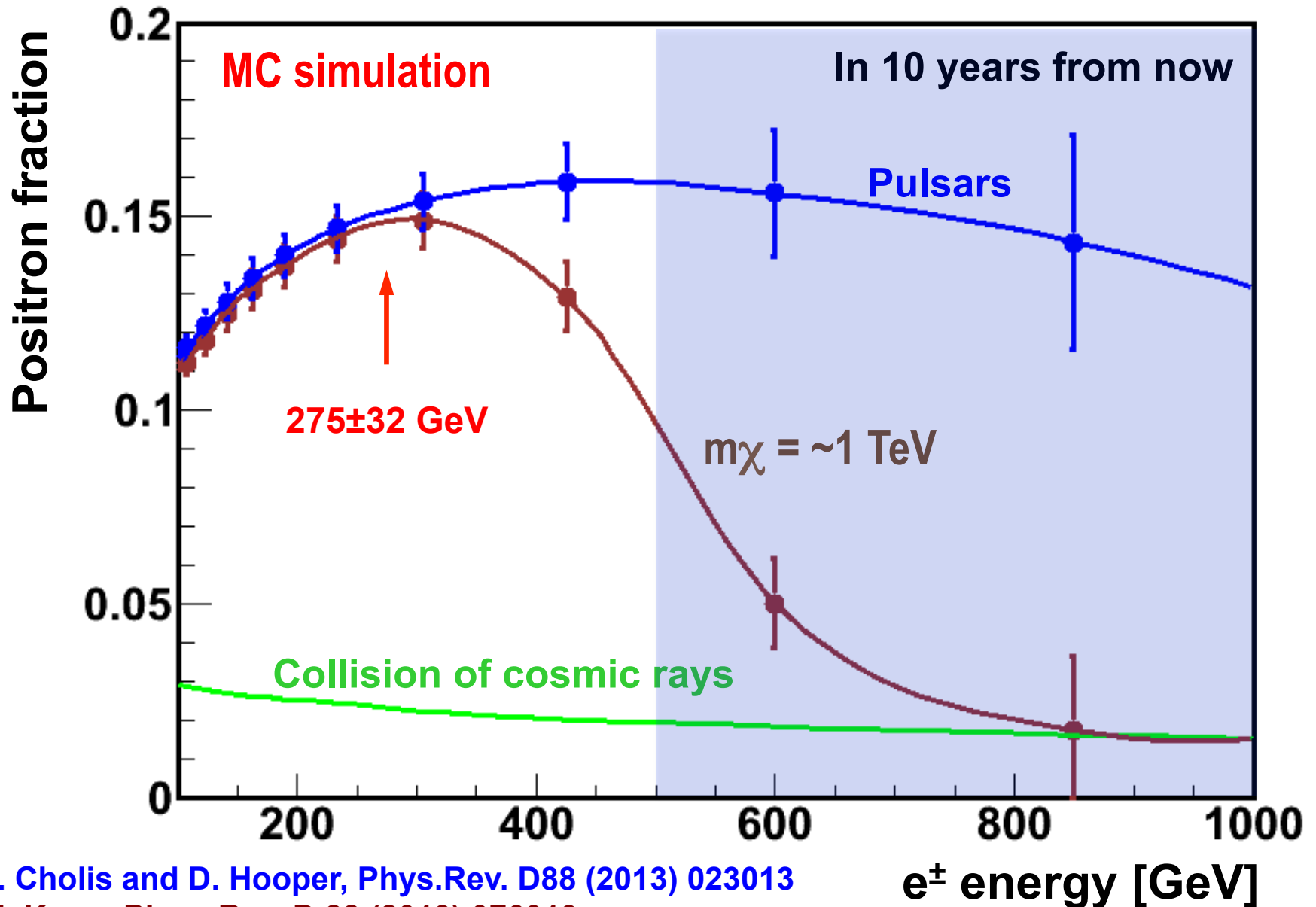
The rate of increase with energy.
The **non**-existence of sharp structures.



The energy beyond which it ceases to increase.



The expected rate at which it falls beyond the turning point.



I. Cholis and D. Hooper, Phys.Rev. D88 (2013) 023013

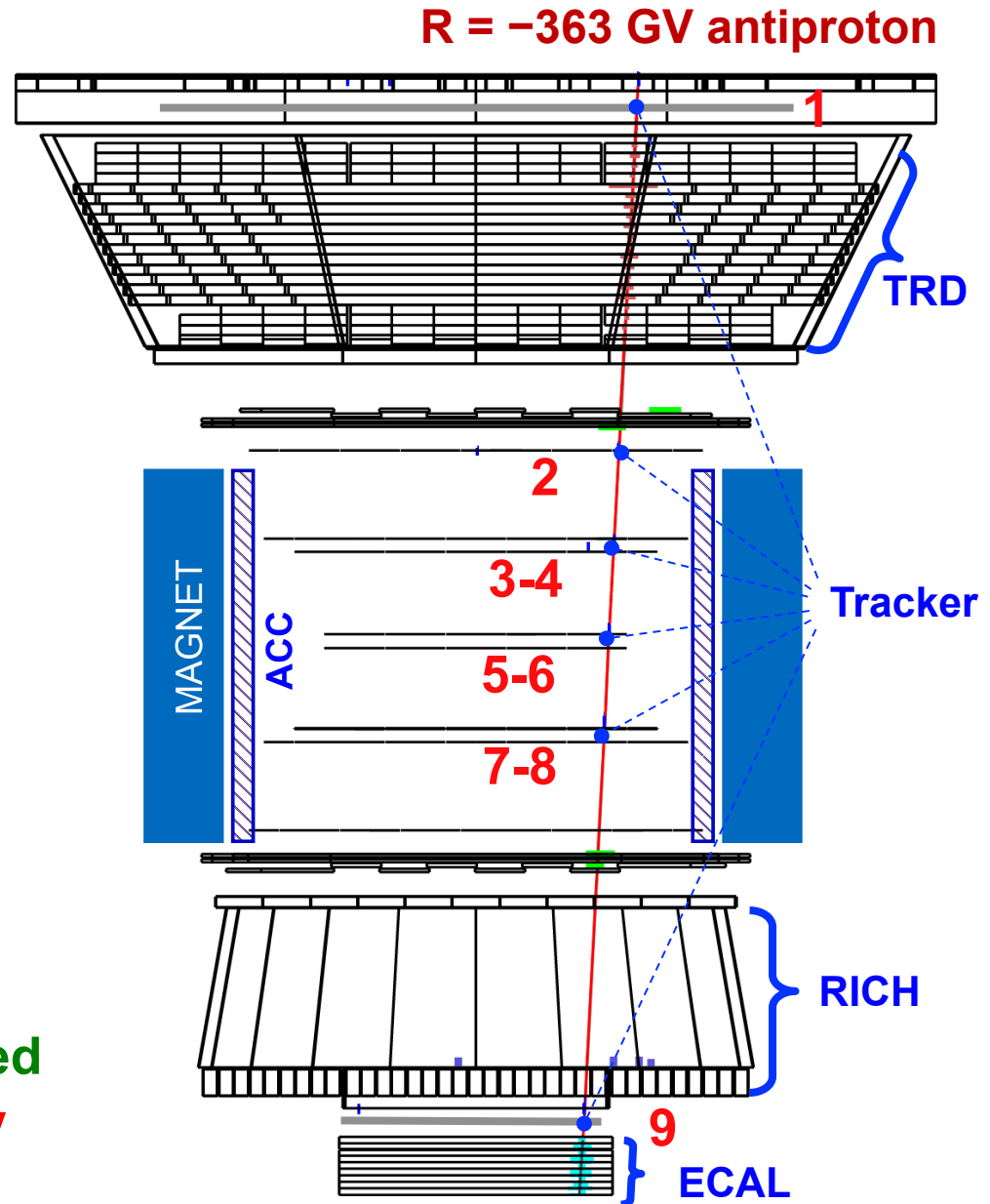
J. Kopp, Phys. Rev. D 88 (2013) 076013

Event selection for the \bar{p}/p analysis

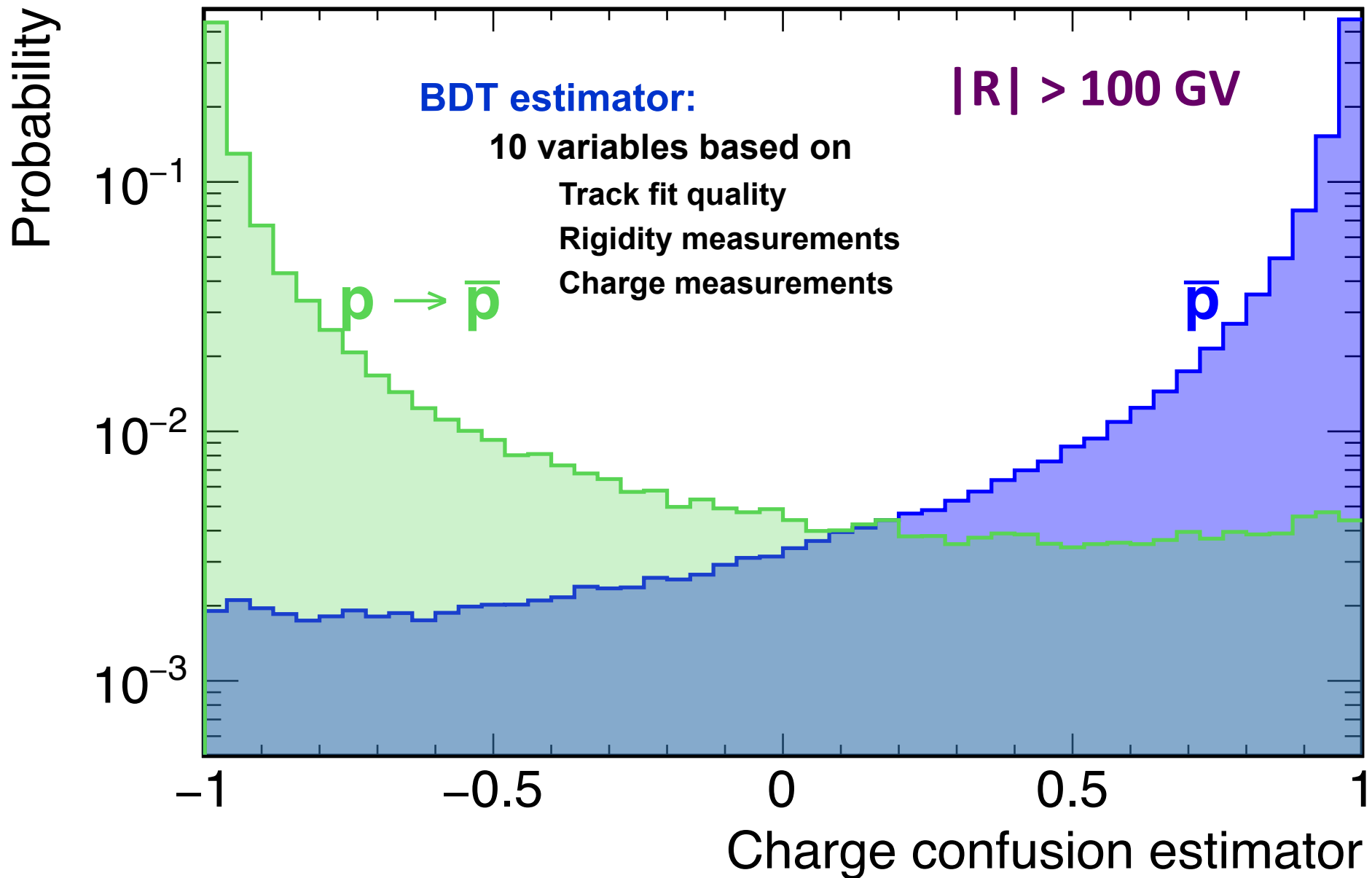
- Primary cosmic ray particle:
 - $|R| > 1.2 \cdot \text{max cutoff}$
- TOF:
 - Down-going particle
 - $\beta > 0.3$
- TRD:
 - at least 12 hits
- TRACKER:
 - Track quality
 - $0.8 < |Q| < 1.2$
- ECAL:
 - Hadron shower shape

Data sample

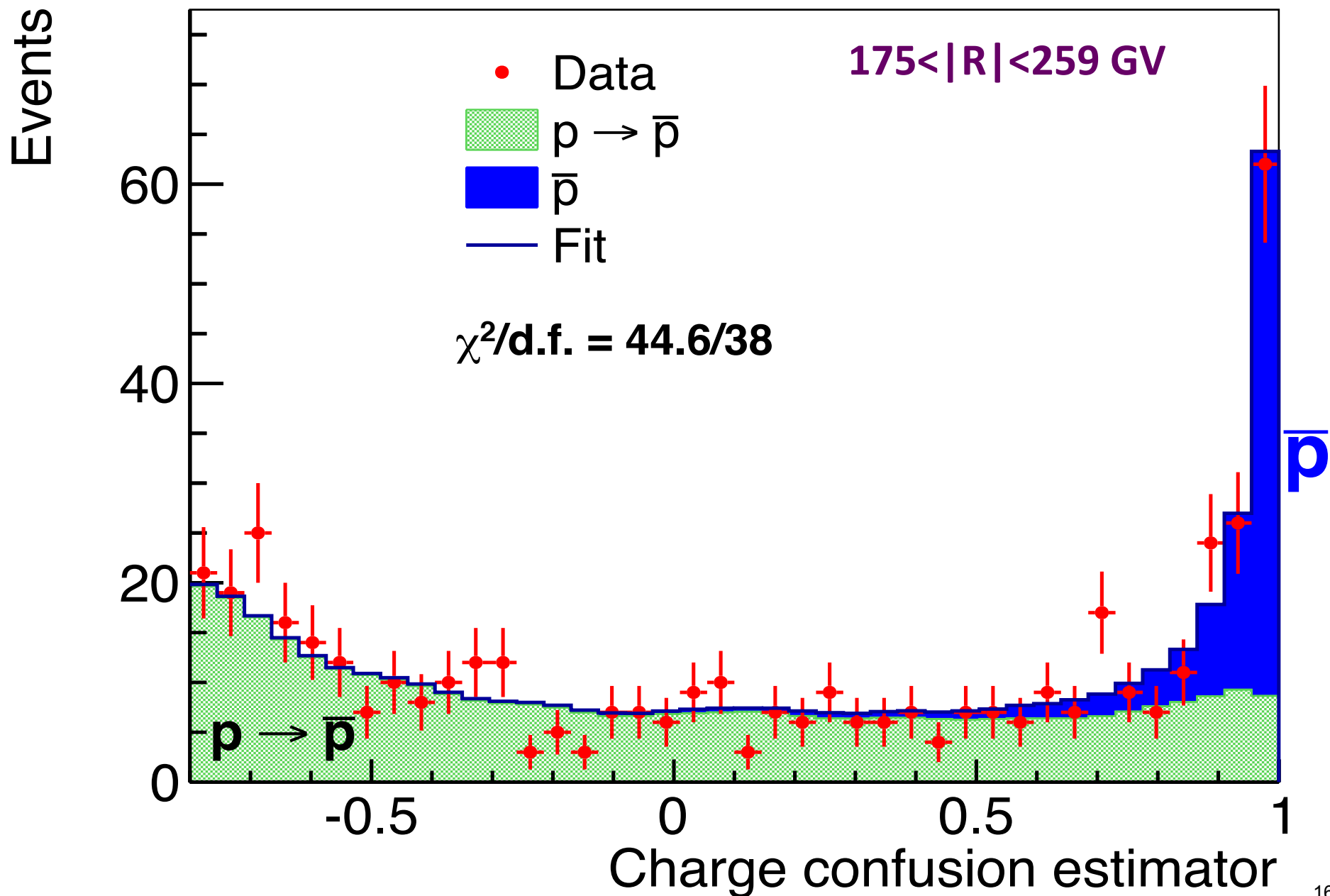
290,000 antiprotons are selected
in the rigidity range 1–450 GV



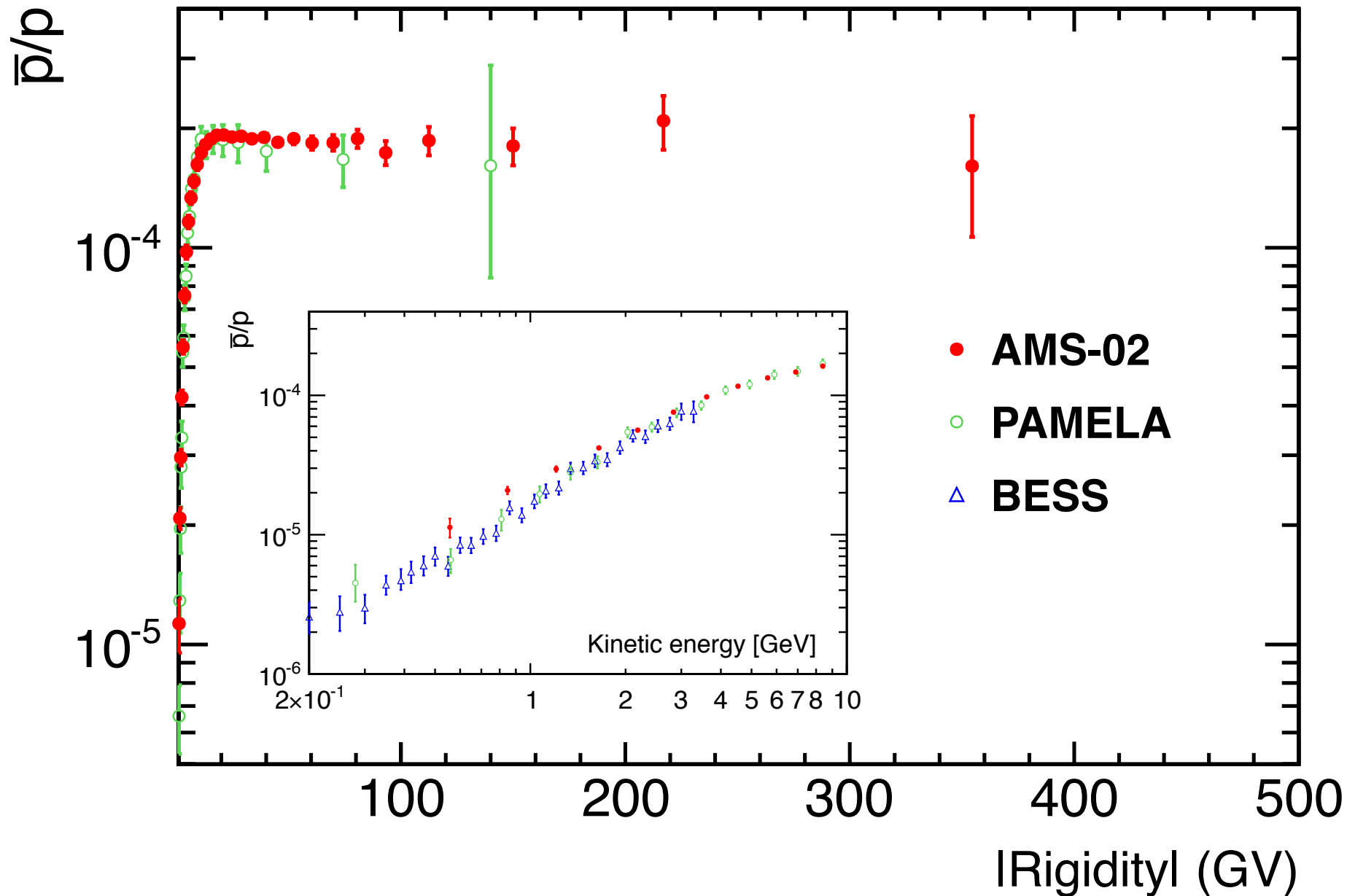
Charge confusion estimator



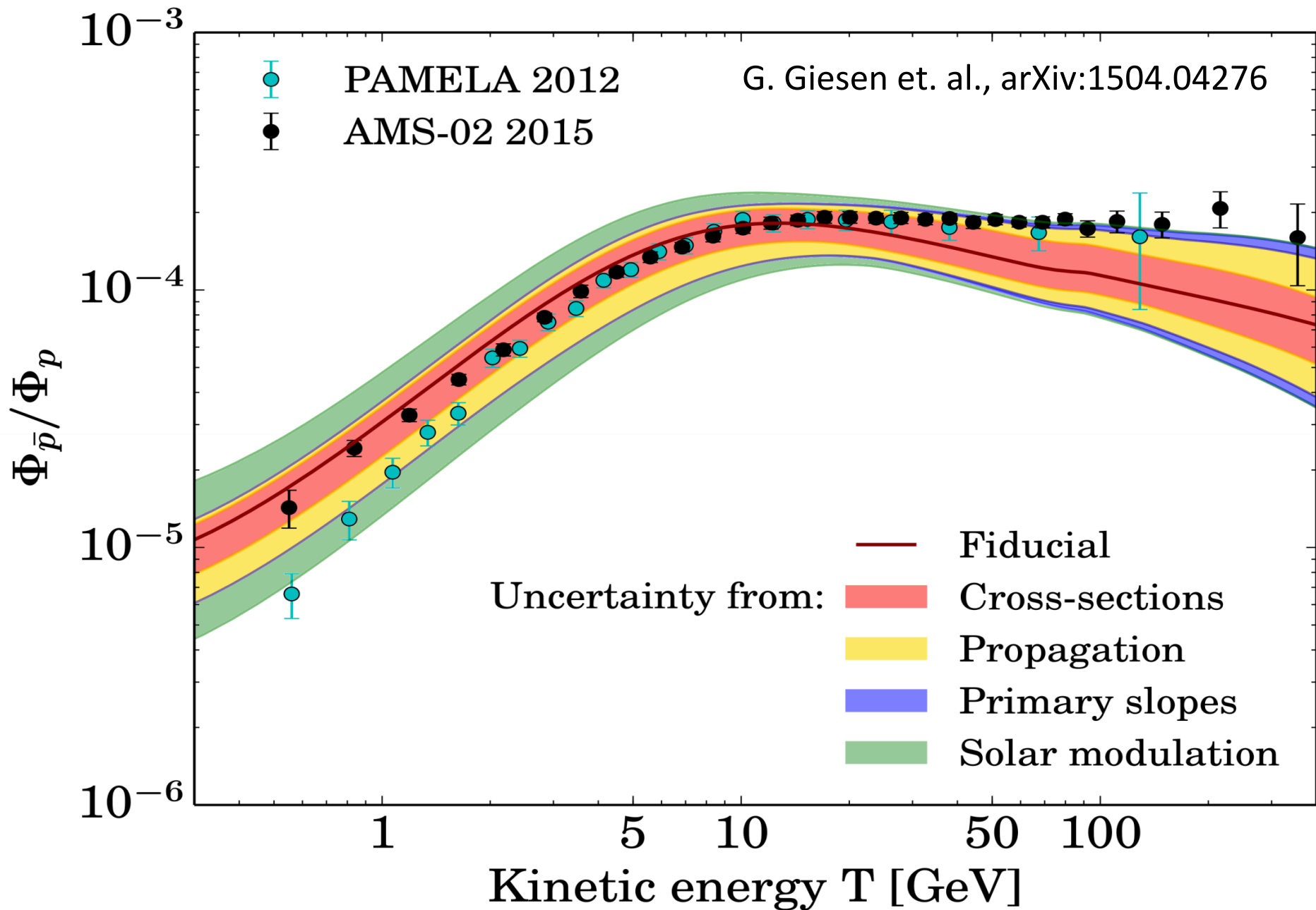
Antiproton identification



AMS \bar{p}/p results



AMS p/p results and the theoretic models



Conclusions

- 1. Positron fraction is measured from 0.5 to 500 GeV:**
 - Steadily increases from 10 to ~250 GeV;
 - At 275 ± 32 GeV the fraction reaches its maximum;
 - Exact behavior of the positron fraction at high energies requires more statistics;
- 2. Antiproton analysis status is presented:**
 - Rigidity range explored: 1–450 GV

New precision AMS measurements and model predictions with matching accuracy will uncover the underlying physics