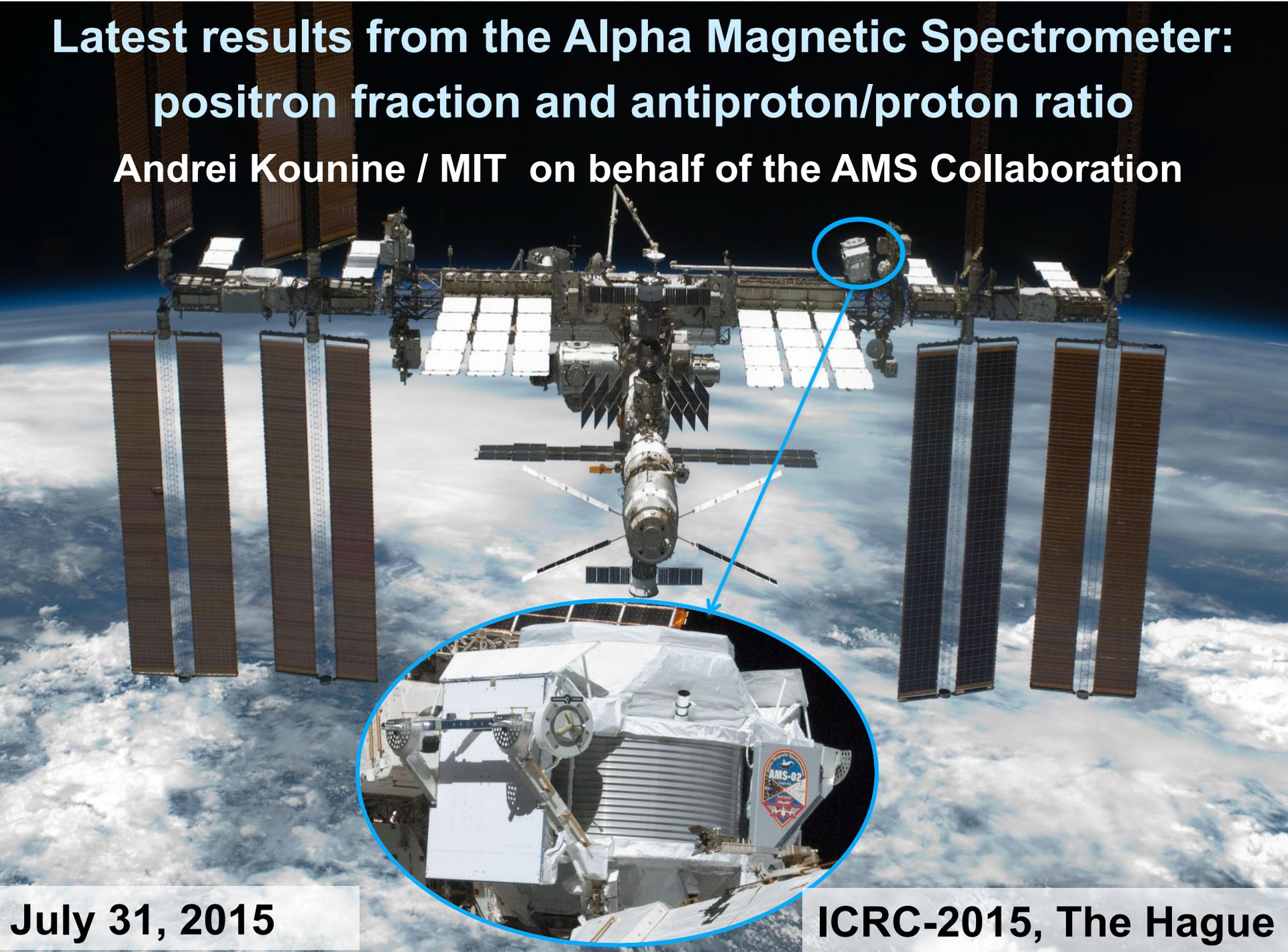


Latest results from the Alpha Magnetic Spectrometer: positron fraction and antiproton/proton ratio

Andrei Kounine / MIT on behalf of the AMS Collaboration



July 31, 2015

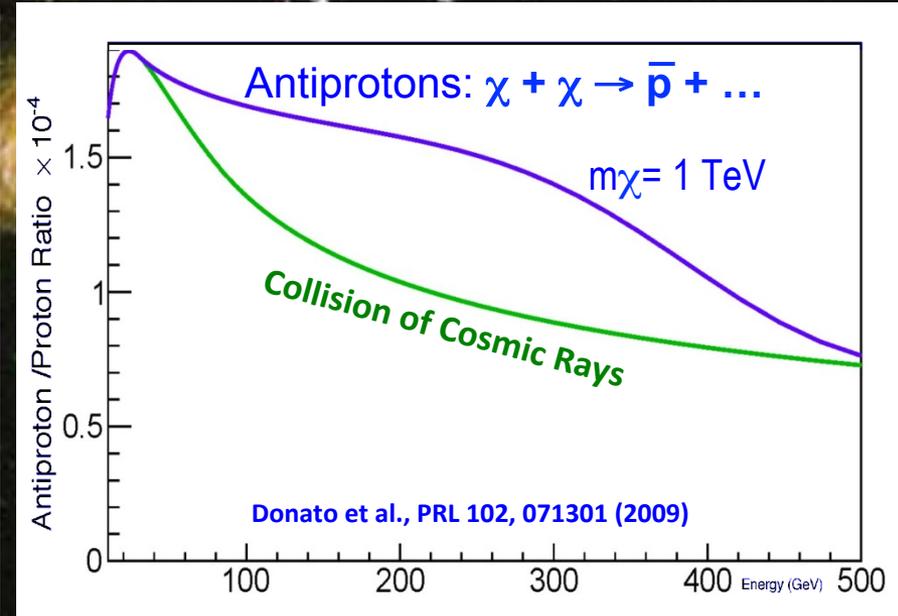
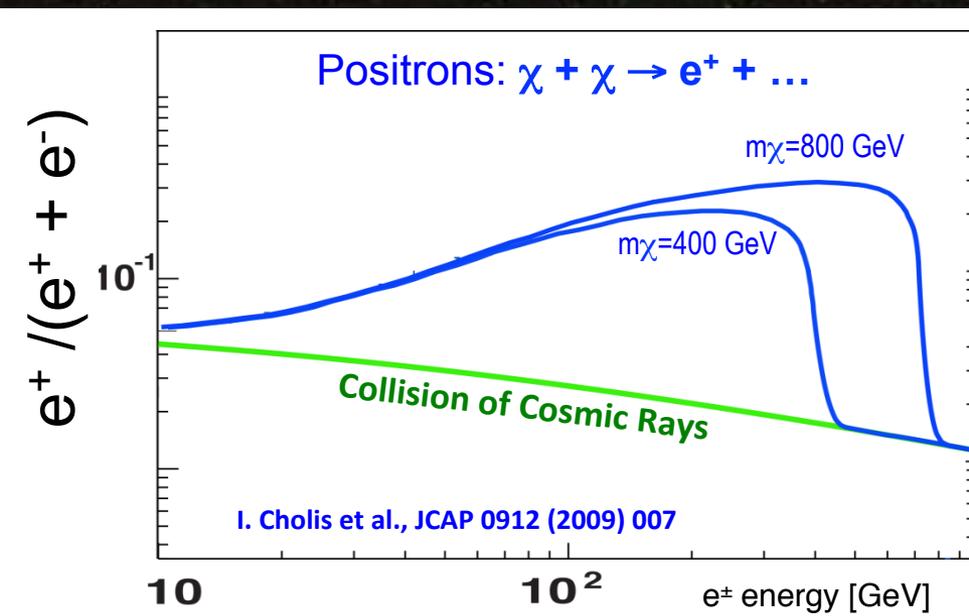
ICRC-2015, The Hague

Dark Matter

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

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

M. Turner and F. Wilczek, Phys. Rev. D42 (1990) 1001

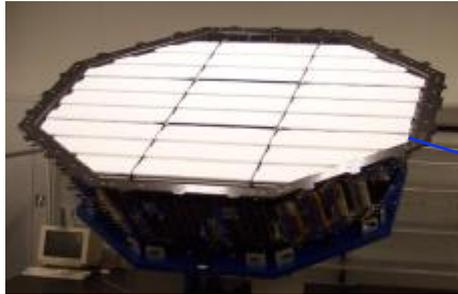


First Result from the AMS on the ISS: Precision Measurement of the Positron Fraction in Primary Cosmic Rays of 0.5-350 GeV, PRL 110 (2013) 141102

Selected by APS as a Highlight of the Year 2013 and cited >400 times

AMS: A TeV precision, multipurpose spectrometer

Transition Radiation Detector
Identify e^+ , e^-

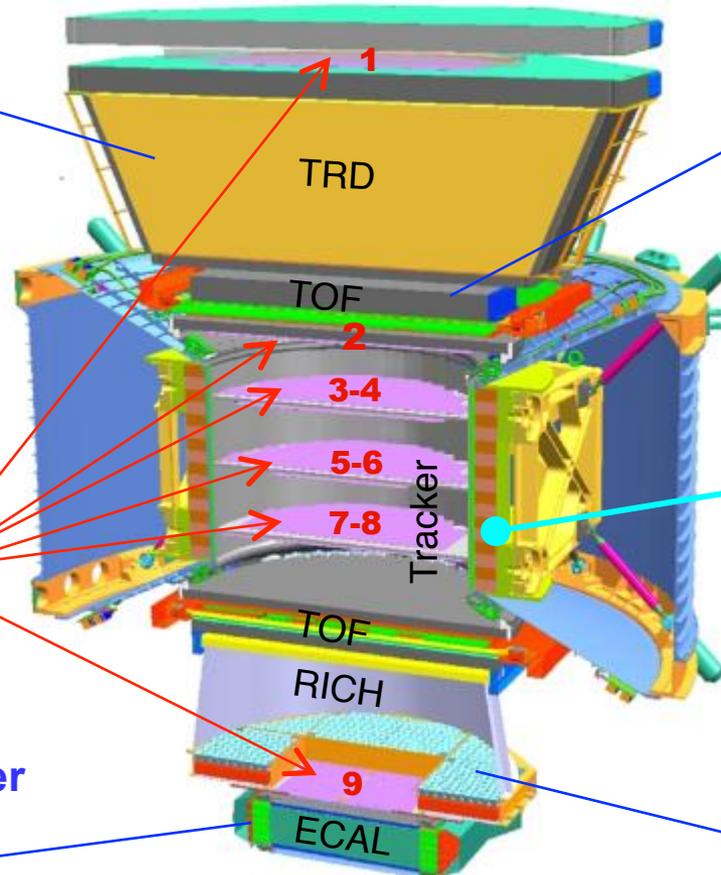


Particles and nuclei are defined by their charge (Z) and energy (E)

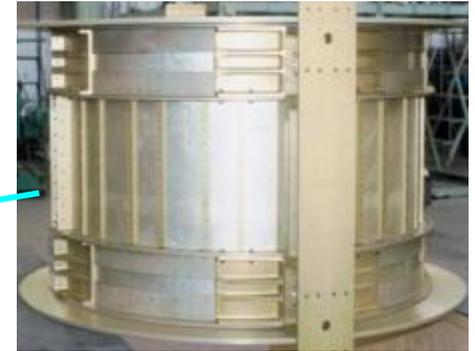
Time of Flight
 Z, E



Silicon Tracker
 Z, P



Magnet
 $\pm Z$



Ring Imaging Cherenkov
 Z, E

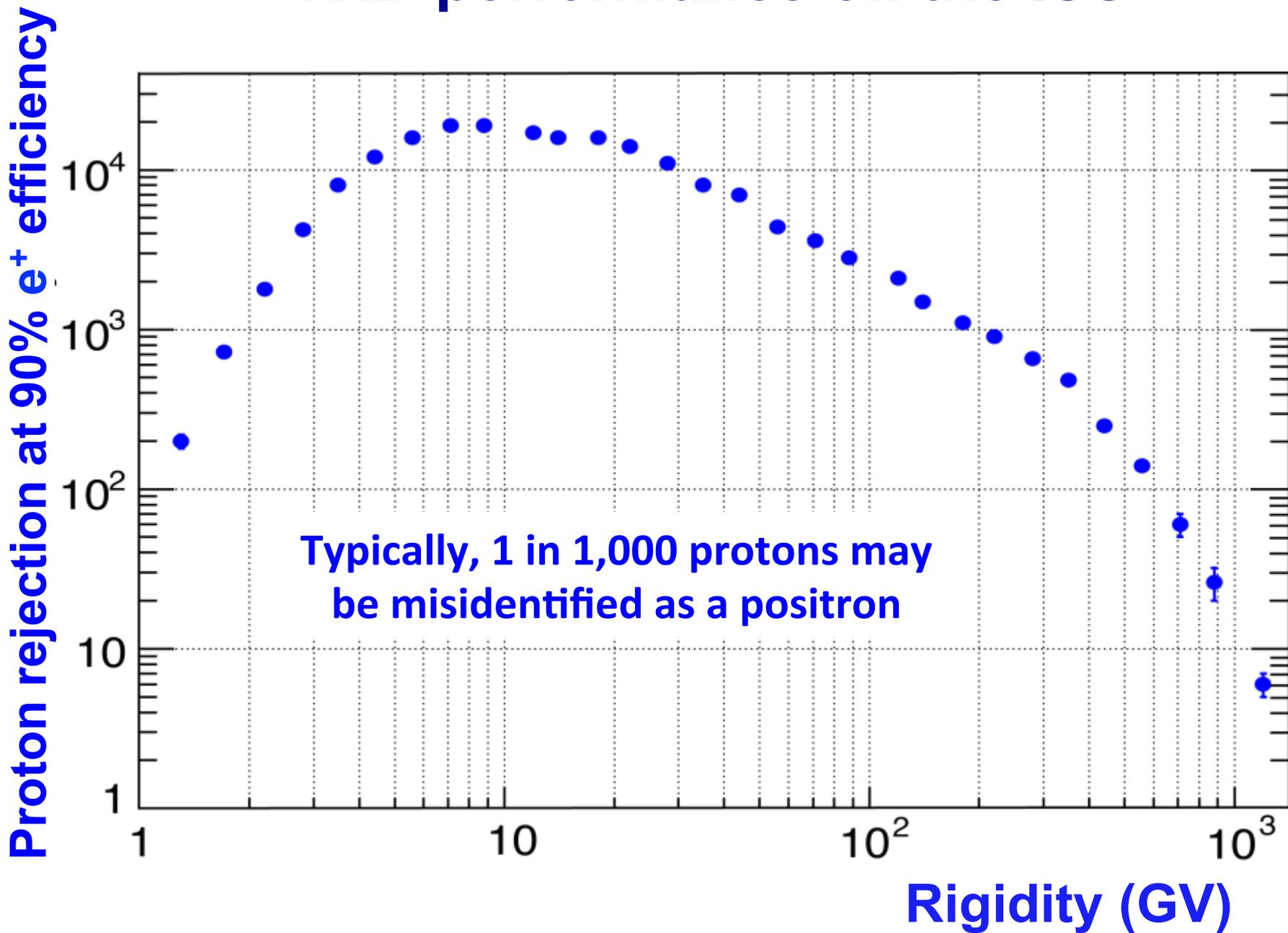


Electromagnetic Calorimeter
 E of e^+ , e^-



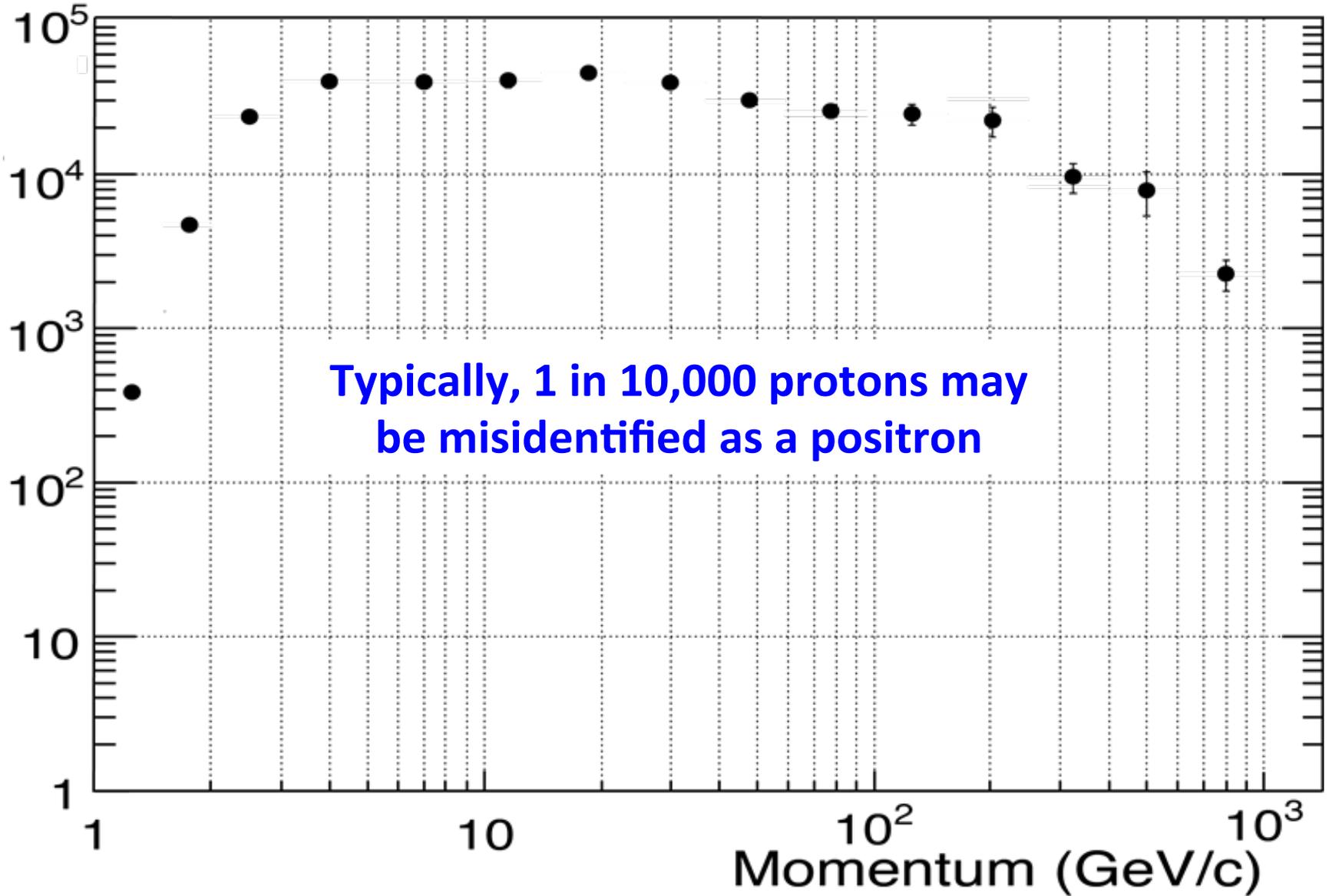
The Charge and Energy are measured independently by many detectors

TRD performance on the ISS



ECAL Performance on the ISS

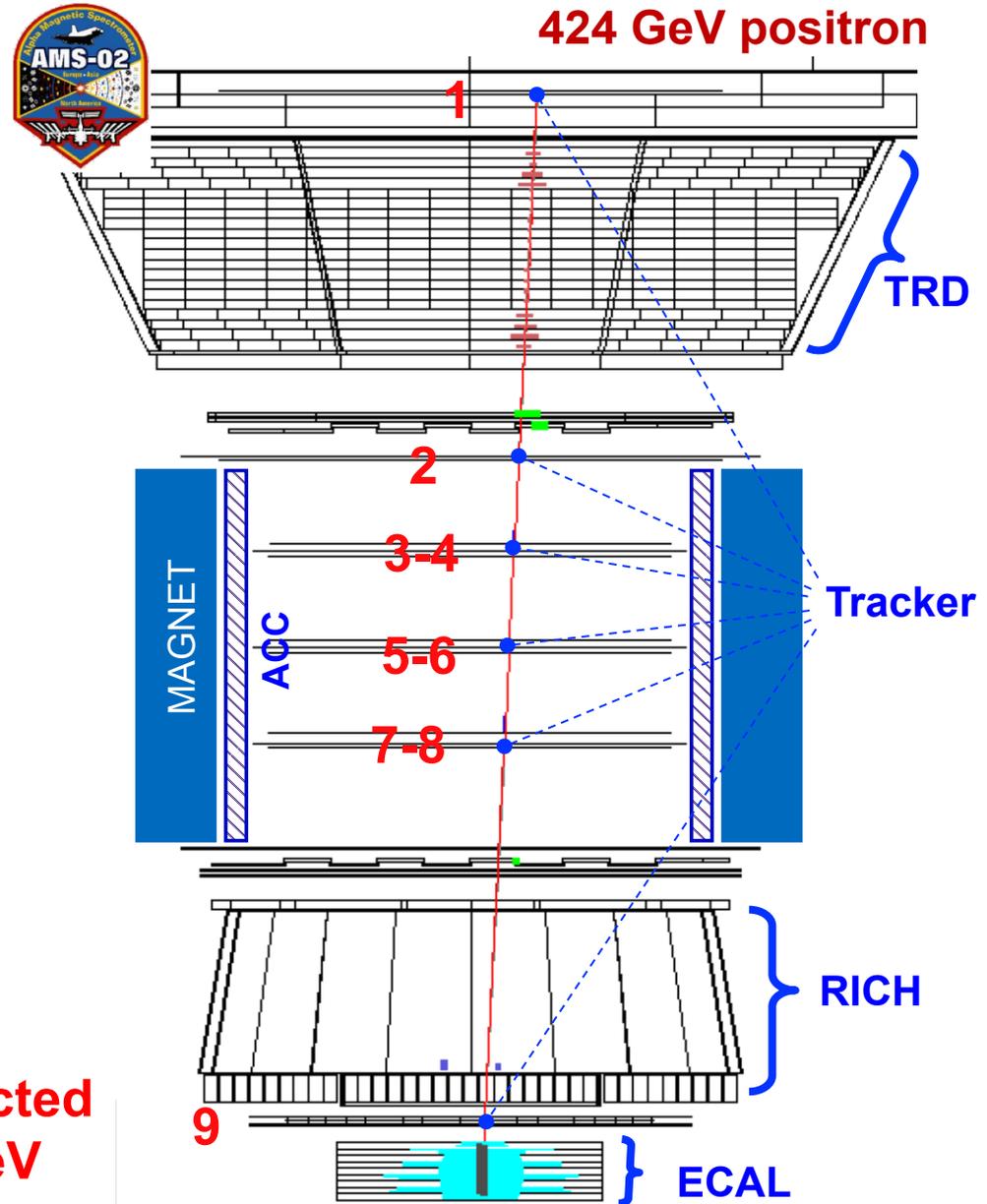
Proton rejection at 90% e^+ efficiency



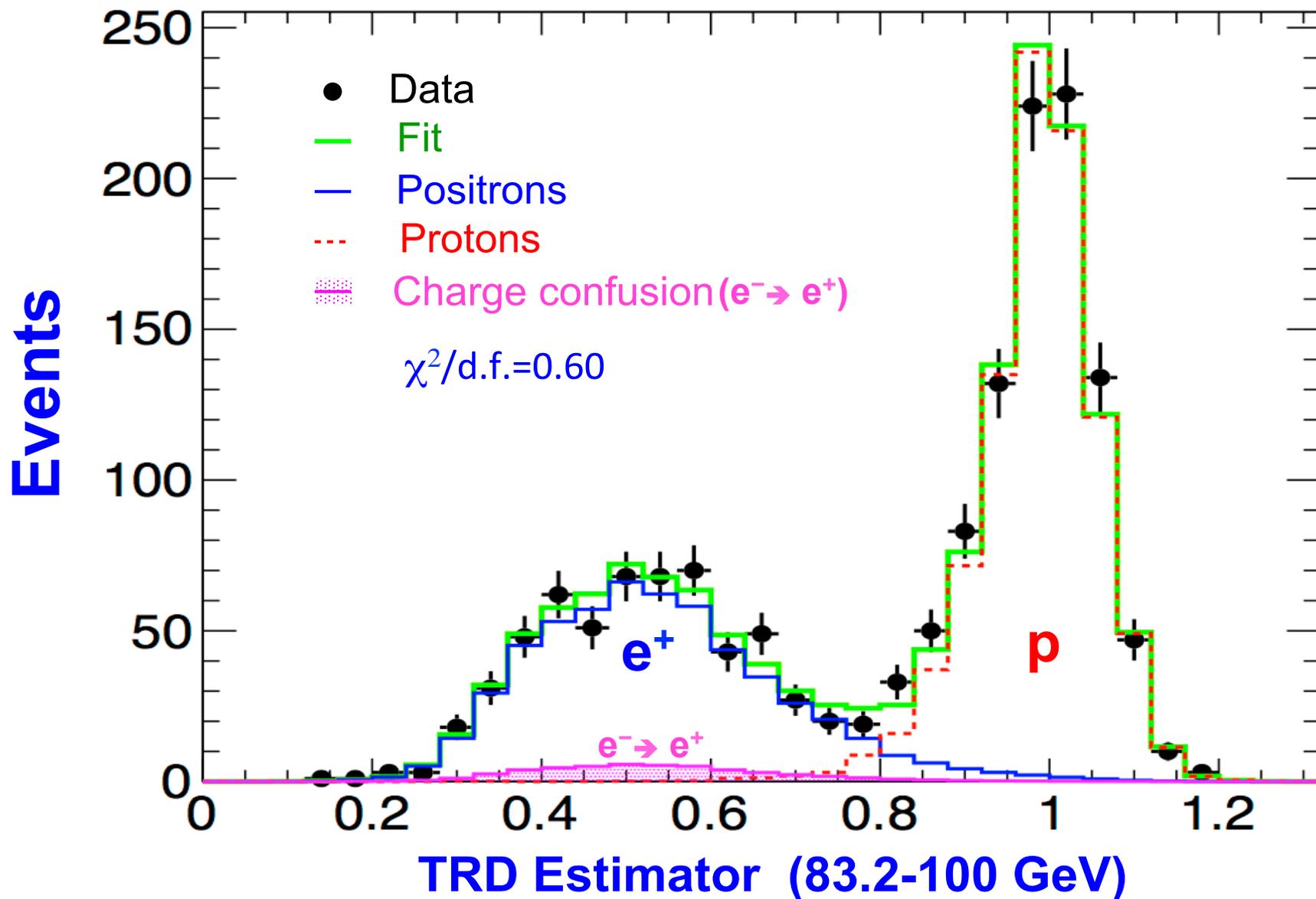
Event selection for the positron fraction analysis

- **Primary cosmic ray particle:**
 - $E > 1.2 \cdot \text{max cutoff}$
- **TRACKER:**
 - Track quality
 - geometrical match with ECAL shower
- **TRD:**
 - at least 15 hits
- **TOF:**
 - downgoing particle,
 - $\beta > 0.8$, $0.8 < Z < 1.4$
- **ECAL:**
 - shower axis within the fiducial ECAL 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

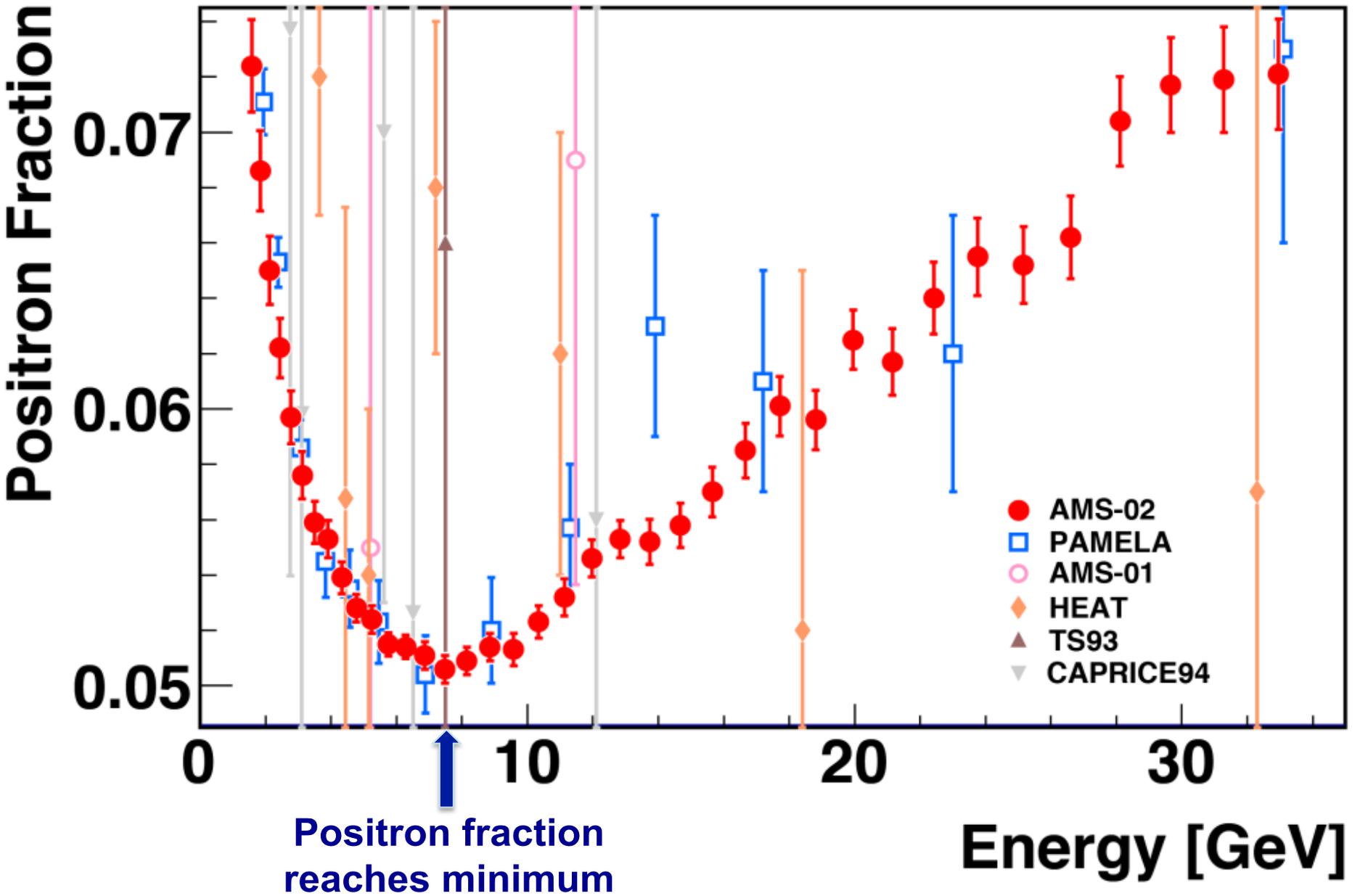


Systematic errors on the positron fraction, $Ne^+ / (Ne^+ + Ne^-)$:

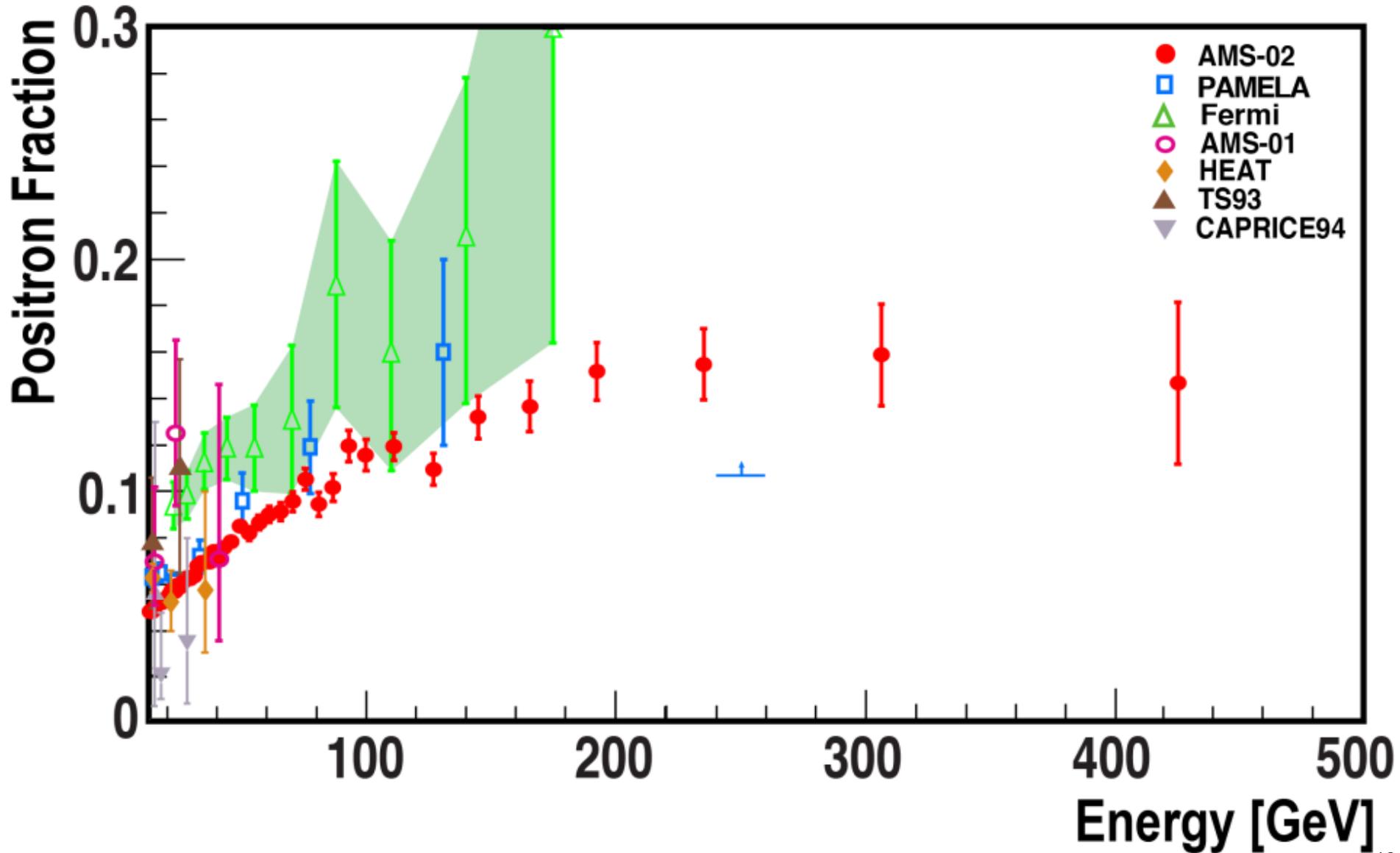
1. Acceptance asymmetry
2. Selection dependence
3. Absolute energy scale and bin-to-bin migration
4. Reference spectra uncertainties
5. Charge confusion

Energy [GeV]	N_{e^+}	Fraction	σ_{stat}	σ_{acc}	σ_{sel}	σ_{mig}	σ_{ref}	$\sigma_{c.c.}$	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%	0.0002	0.0013	0.0007	0.0003	0.0010	0.0018
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%	0.0003	0.0045	0.0007	0.0015	0.0123	0.0132
350.0–500.0	72	0.1471	0.0278	0.0003	0.0064	0.0007	0.0022	0.0182	0.0194	

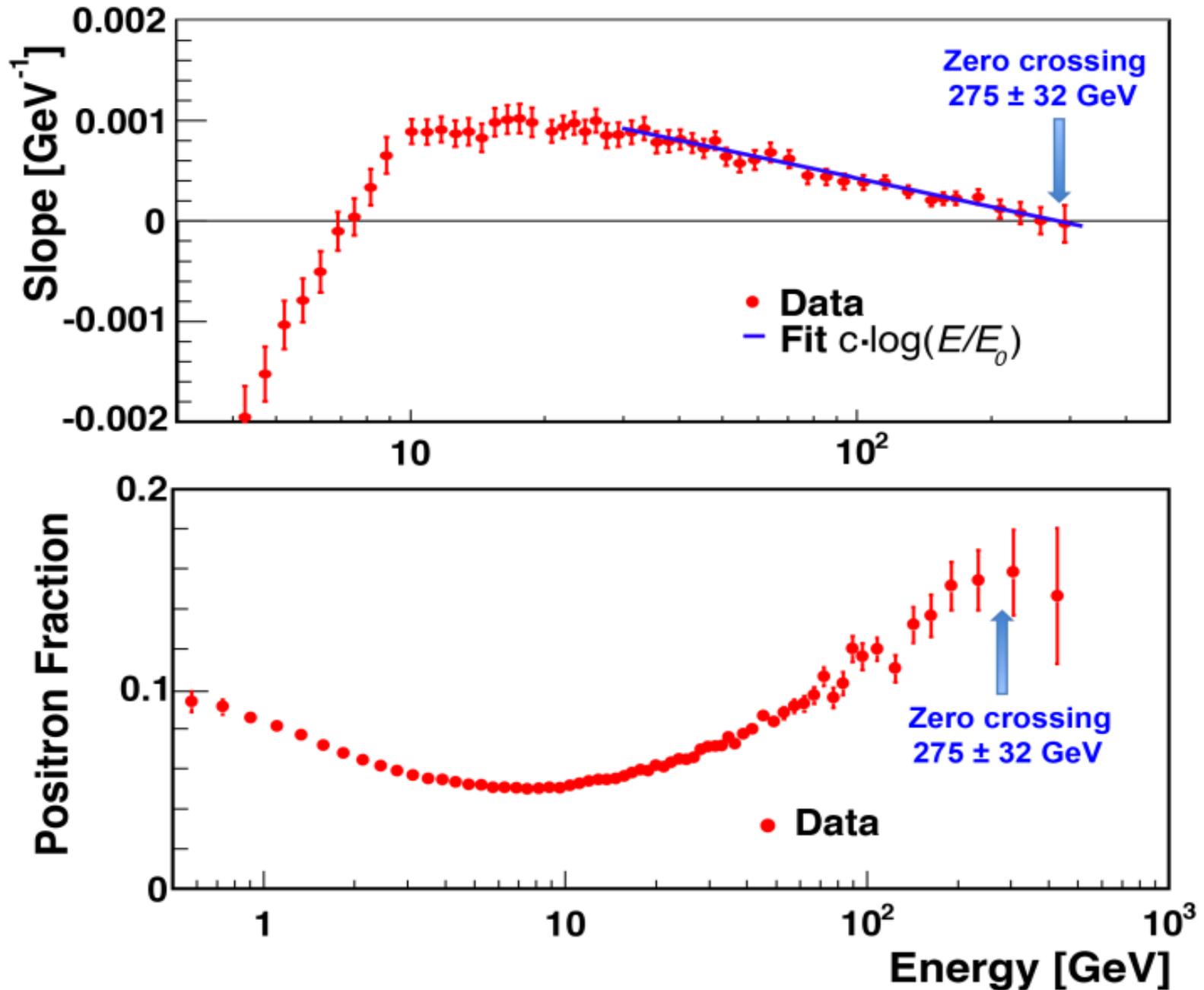
The energy at which positron fraction begins to increase



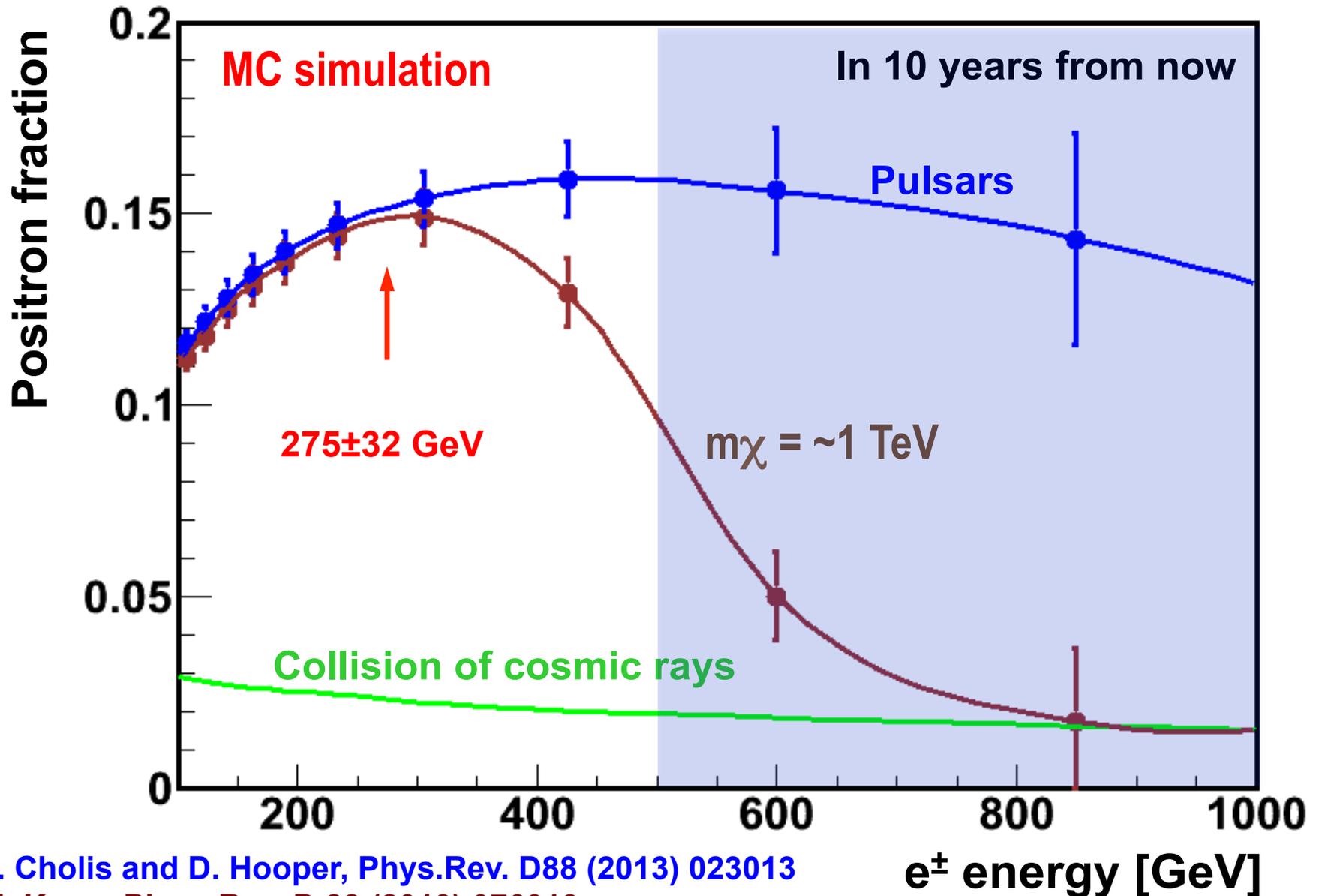
The rate of increase with energy.
The **non**-existence of sharp structures.



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

e[±] energy [GeV]

**Many models proposed to explain
the physics origin of the observed behavior**

- 1) Particle origin: Dark Matter**
- 2) Astrophysics origin: Pulsars, SNRs**
- 3) Secondaries: peculiarities of propagation**

**Models based on very different assumptions
describe observed trends in the data.**

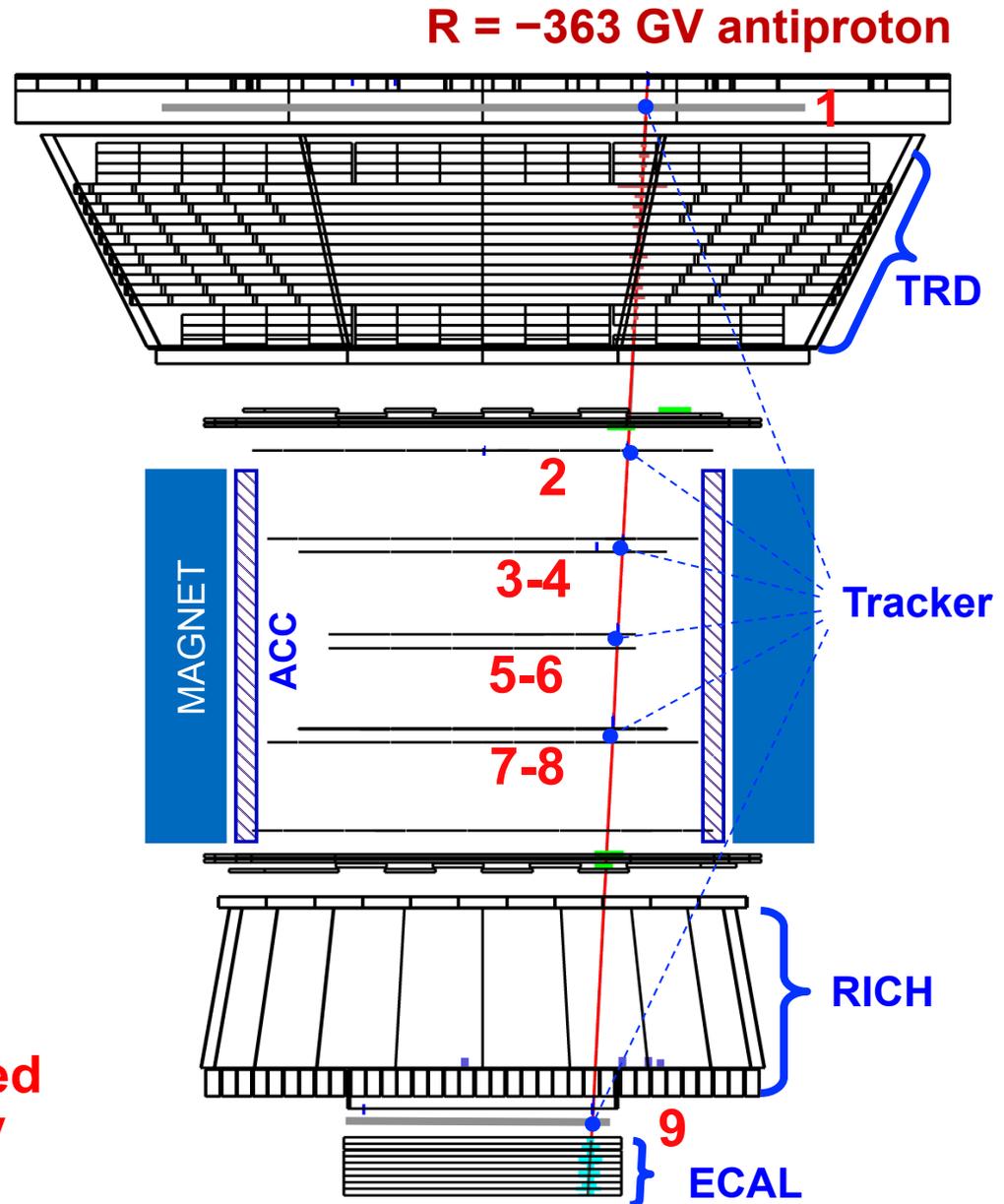
**New precision AMS measurements and model
predictions with matching accuracy will uncover
the underlying physics**

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

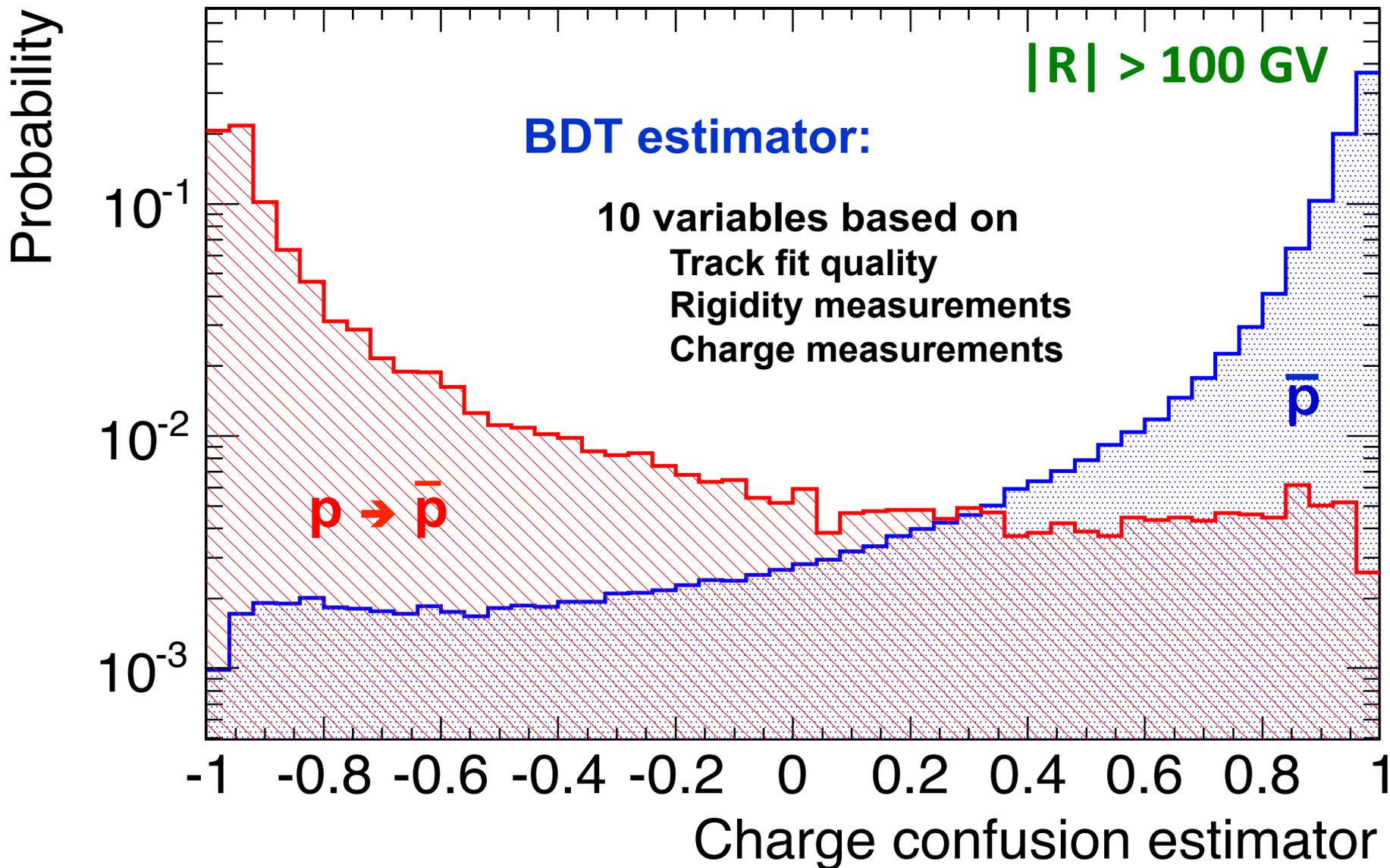
- **Primary cosmic ray particle:**
 - $|R| > 1.2 \cdot \text{max cutoff}$
- **TOF:**
 - downgoing particle
 - $\beta > 0.3$
- **TRD:**
 - at least 12 hits
- **TRACKER:**
 - Track quality
 - $0.8 < |Q| < 1.2$
- **ECAL:**
 - Hadron shower shape

Data sample

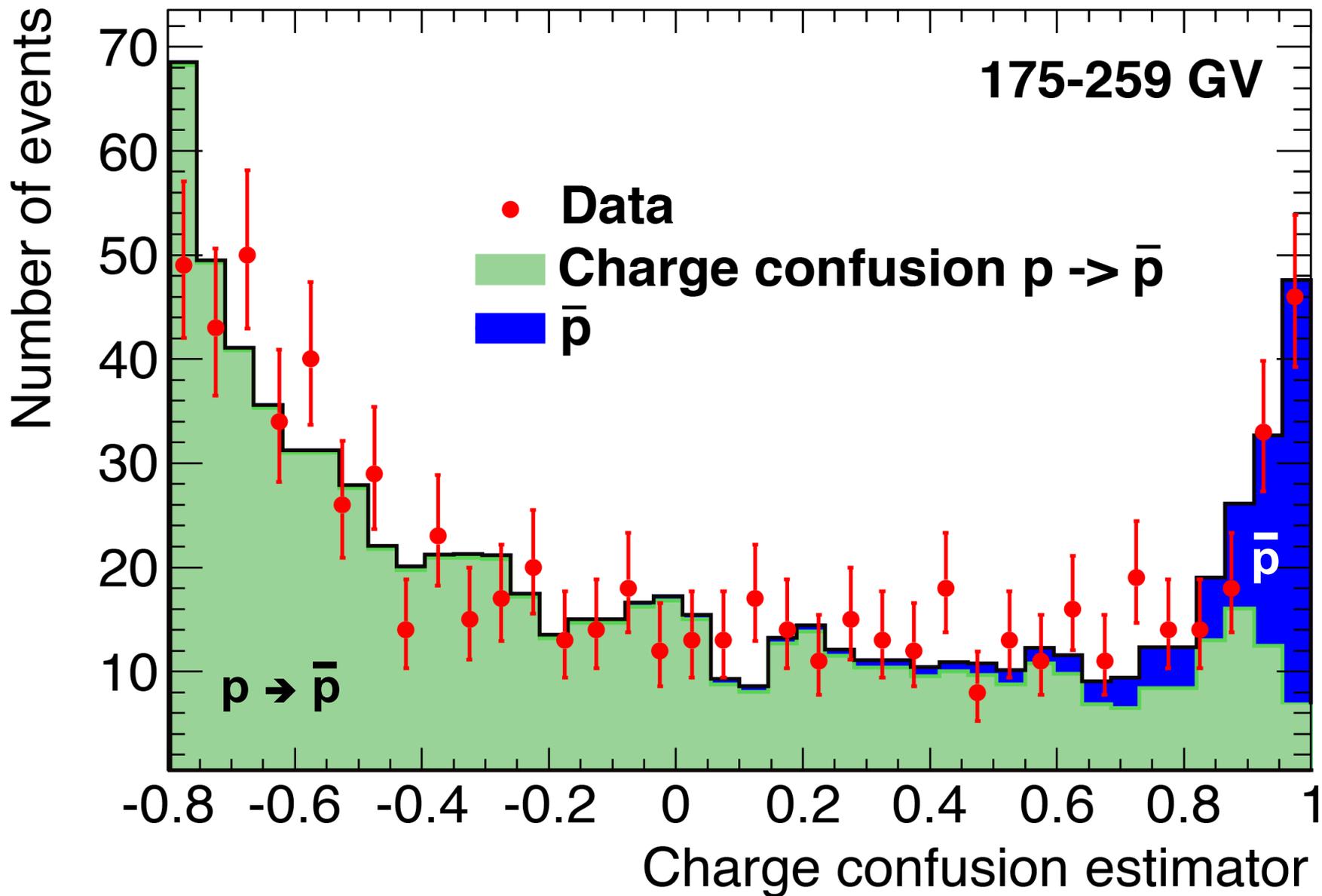
290,000 antiprotons are selected
in the rigidity range 1–450 GV



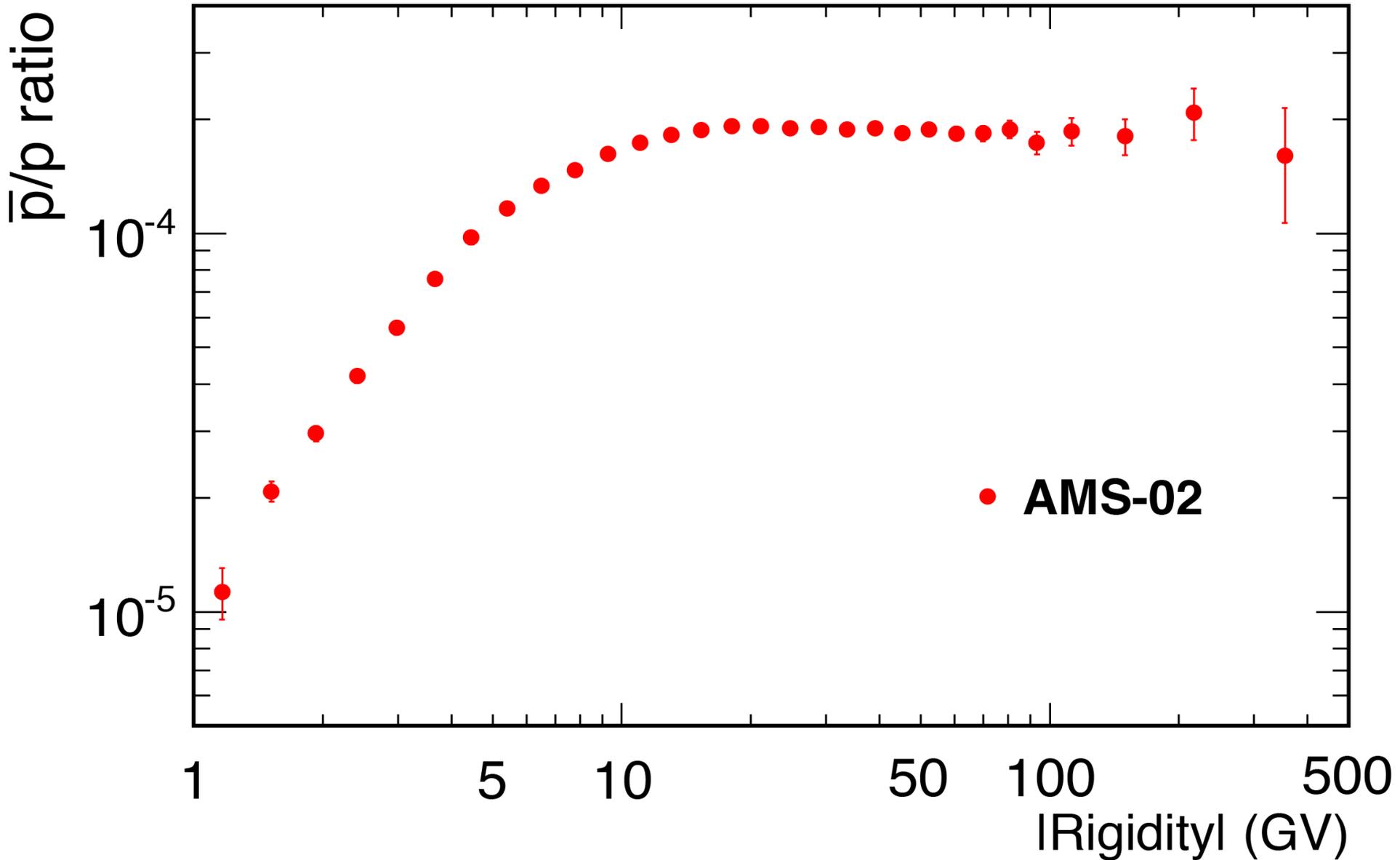
Charge confusion estimator



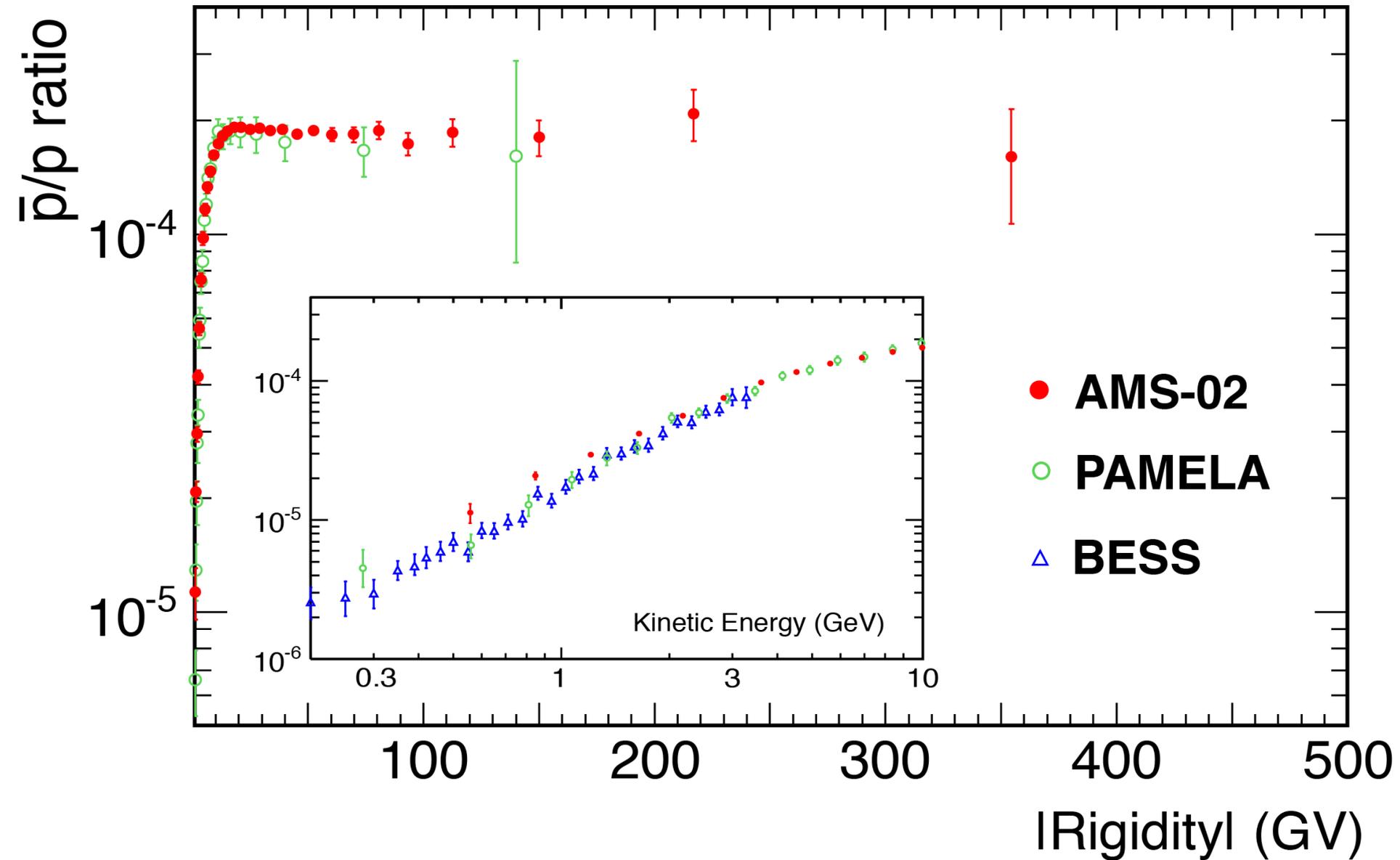
Anti-proton identification



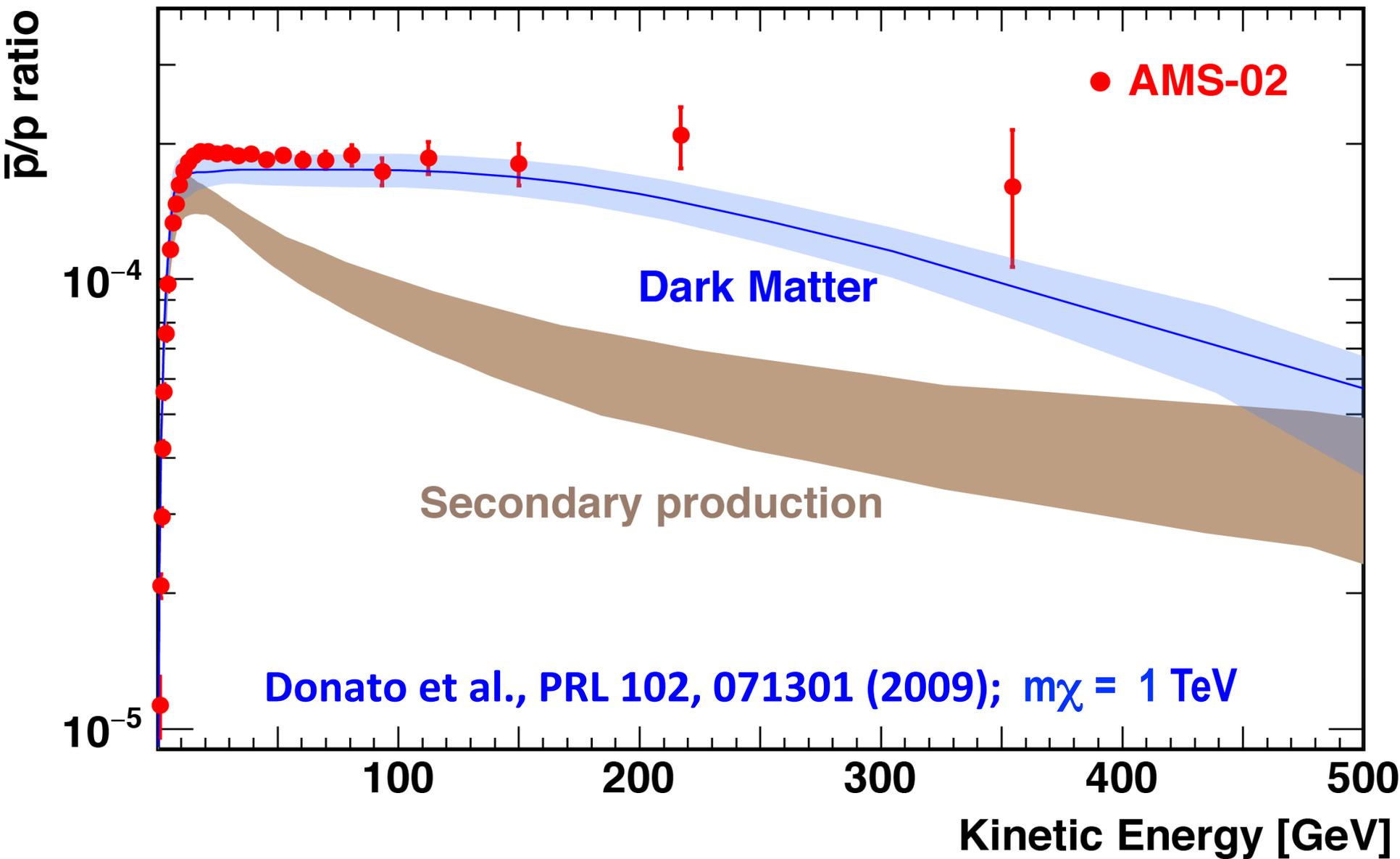
AMS \bar{p}/p results



AMS \bar{p}/p results



AMS \bar{p}/p results and modeling



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
 - \bar{p}/p ratio is flat above 100 GV