High Statistics Measurement of the Positron Fraction in Primary Cosmic Rays with the Alpha Magnetic Spectrometer on the International Space Station

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On behalf of the AMS collaboration

Cosmic rays – the conventional scenario

Production and acceleration	Propagation (diffusion) in our galaxy	Observation

P ~ 90 %
He ~ 10 %
e- ~ 1 %
e+ ~ 0.1 %

- **Supernovae accelerate particles of the interstellar medium (principally hydrogen and helium nuclei)**

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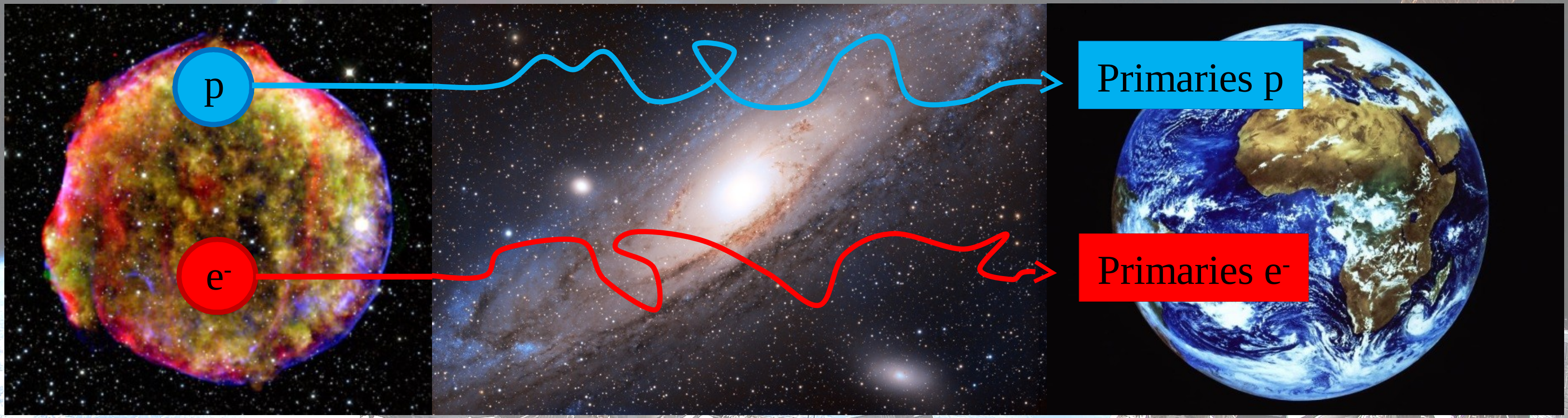

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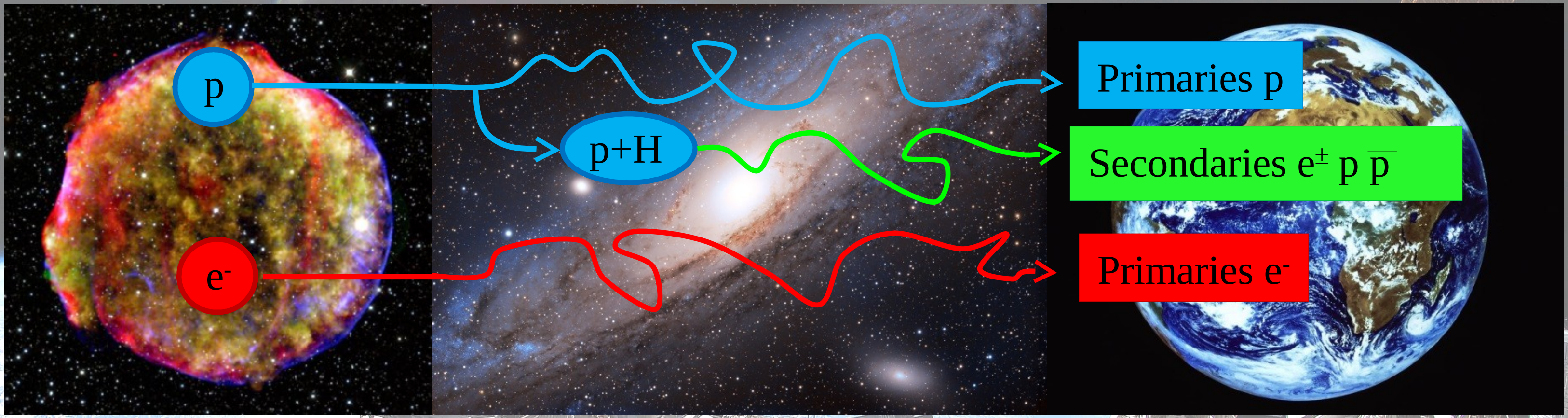

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- **This particles propagate toward the turbulent galactic magnetic field**
- **They can collide with the interstellar medium nuclei and produce secondary particles**

Beyond the conventional scenario

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He ~ 10 %
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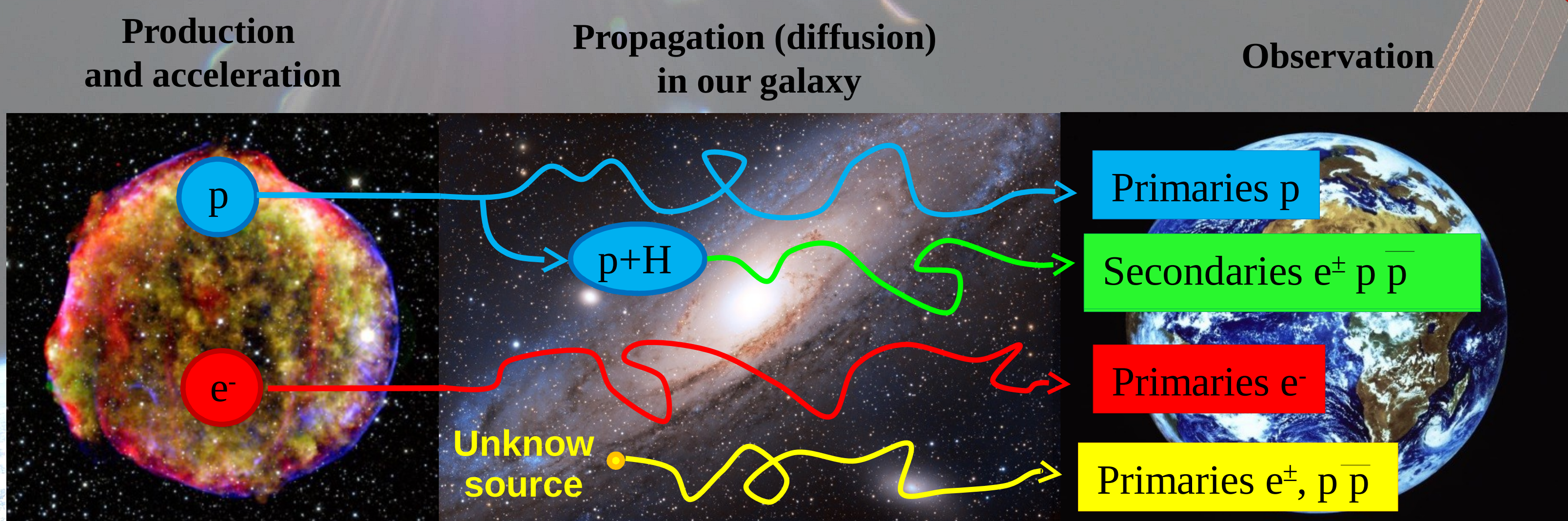
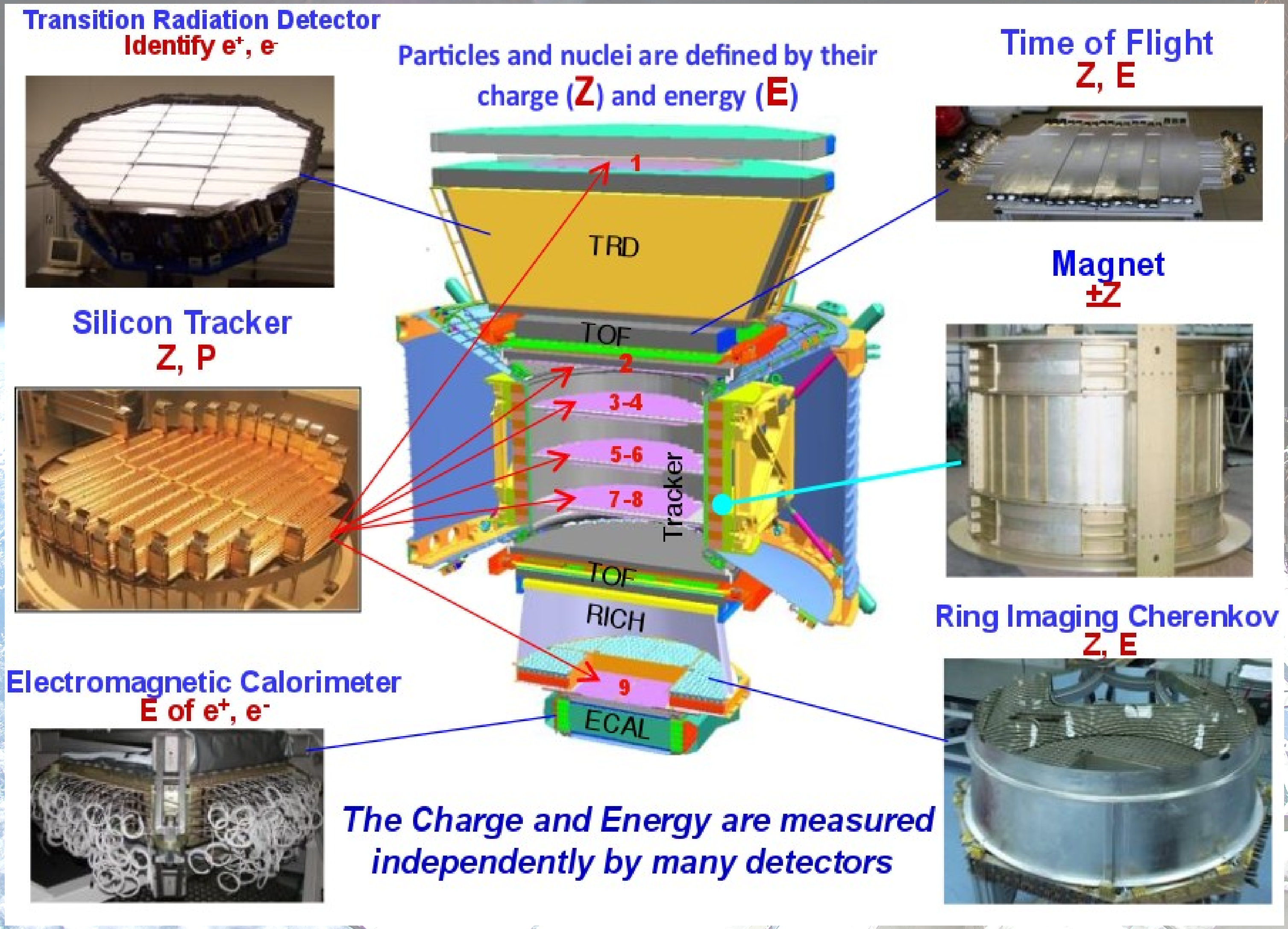
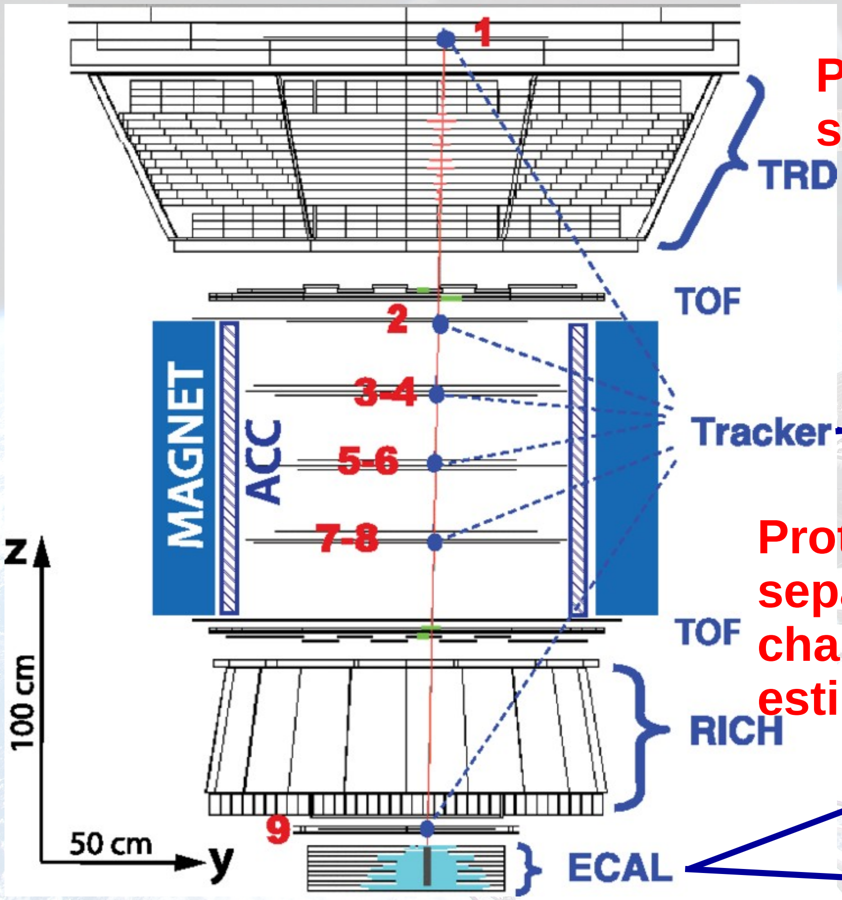


- Supernovae accelerate particles of the interstellar medium (principally hydrogen and helium nuclei)
- This particles propagate toward the turbulent galactic magnetic field
- They can collide with the interstellar medium nuclei and produce secondary particles
- According to this scenario, antimatter are secondary particles, an excess of antimatter with respect to the secondary production can be a sign of a new source of cosmic ray.

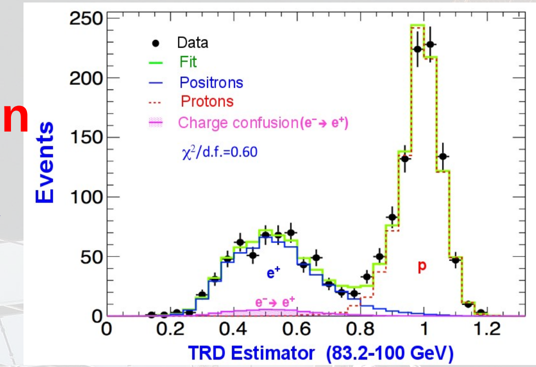
AMS-02 detector



Analysis principle

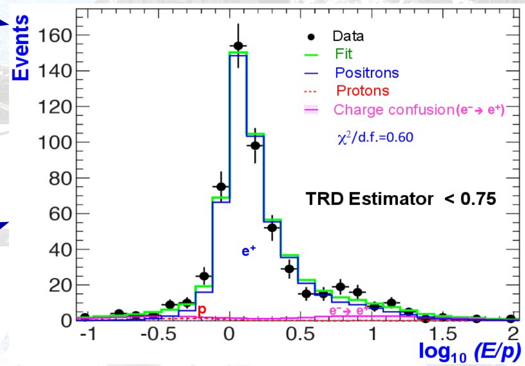


Proton/electron separation



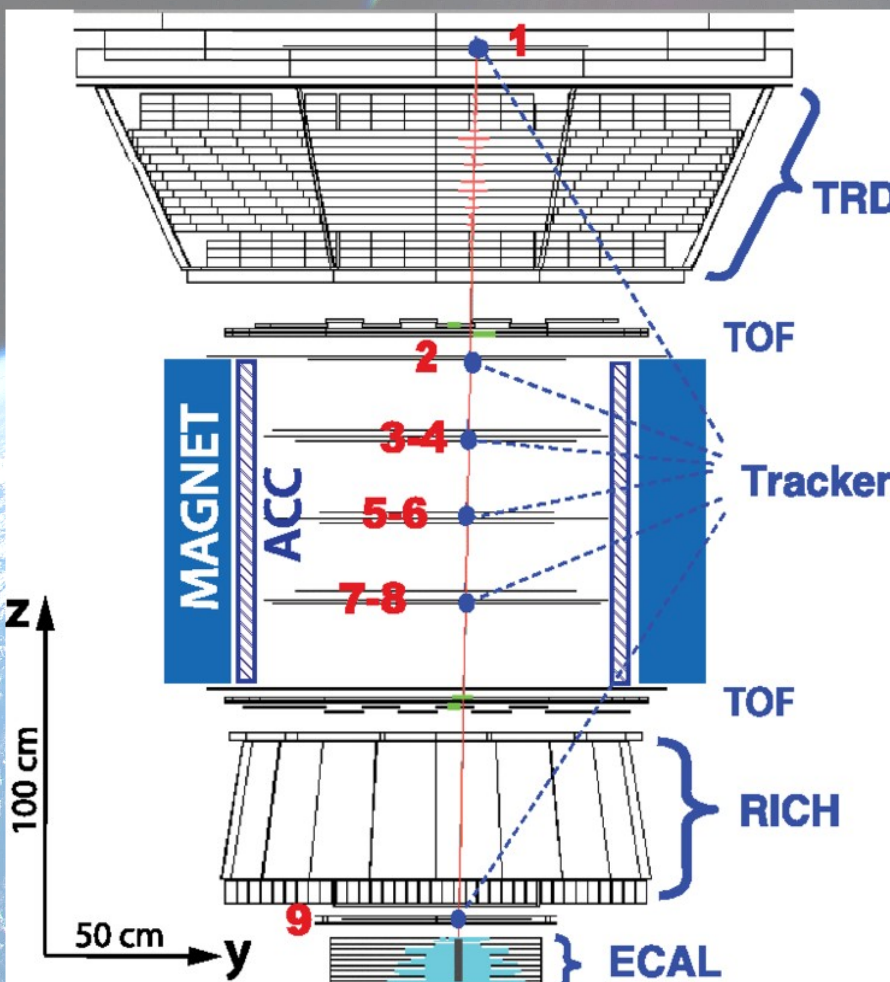
Rigidity sign measurement

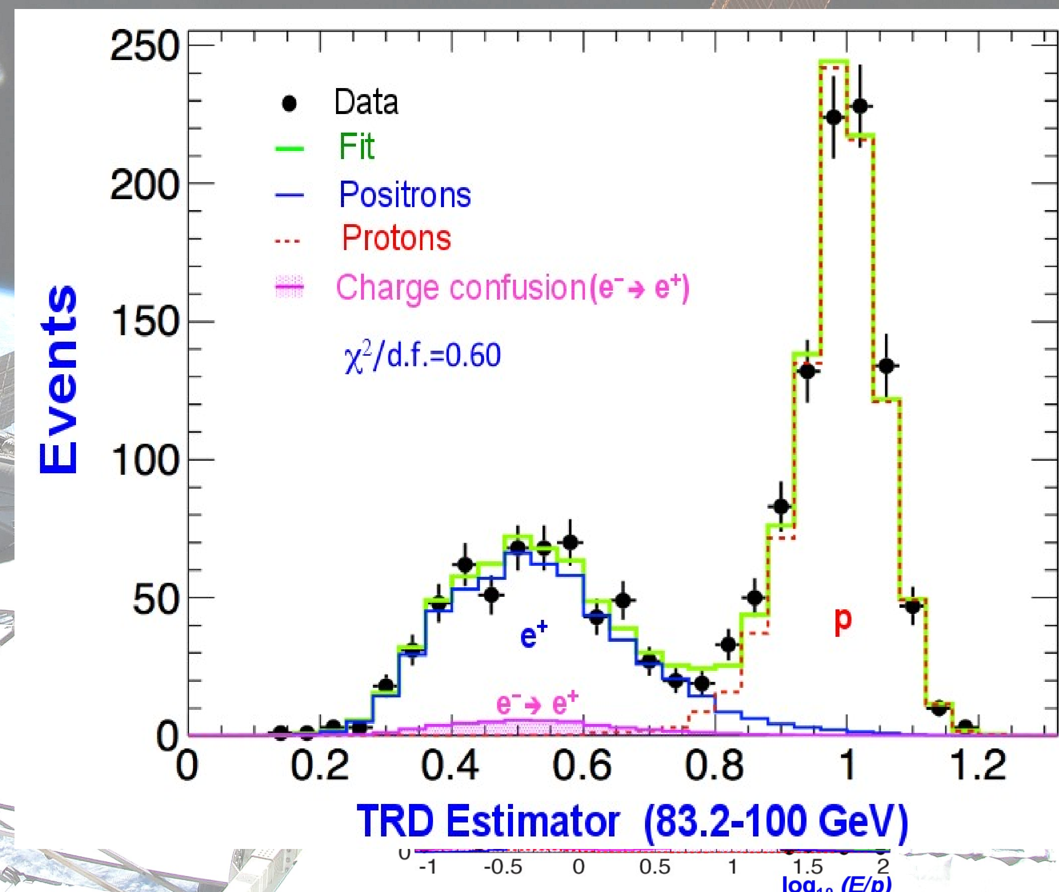
Proton/electron separation and charge confusion estimation



Lepton energy measurement

Analysis principle





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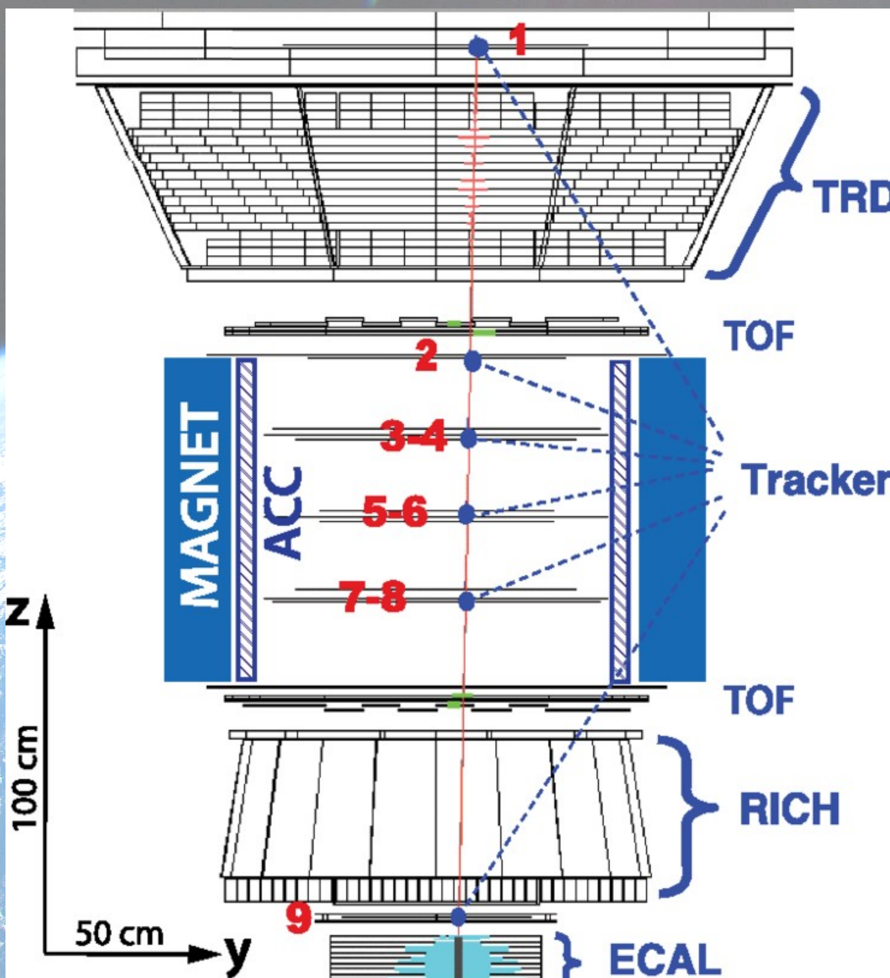
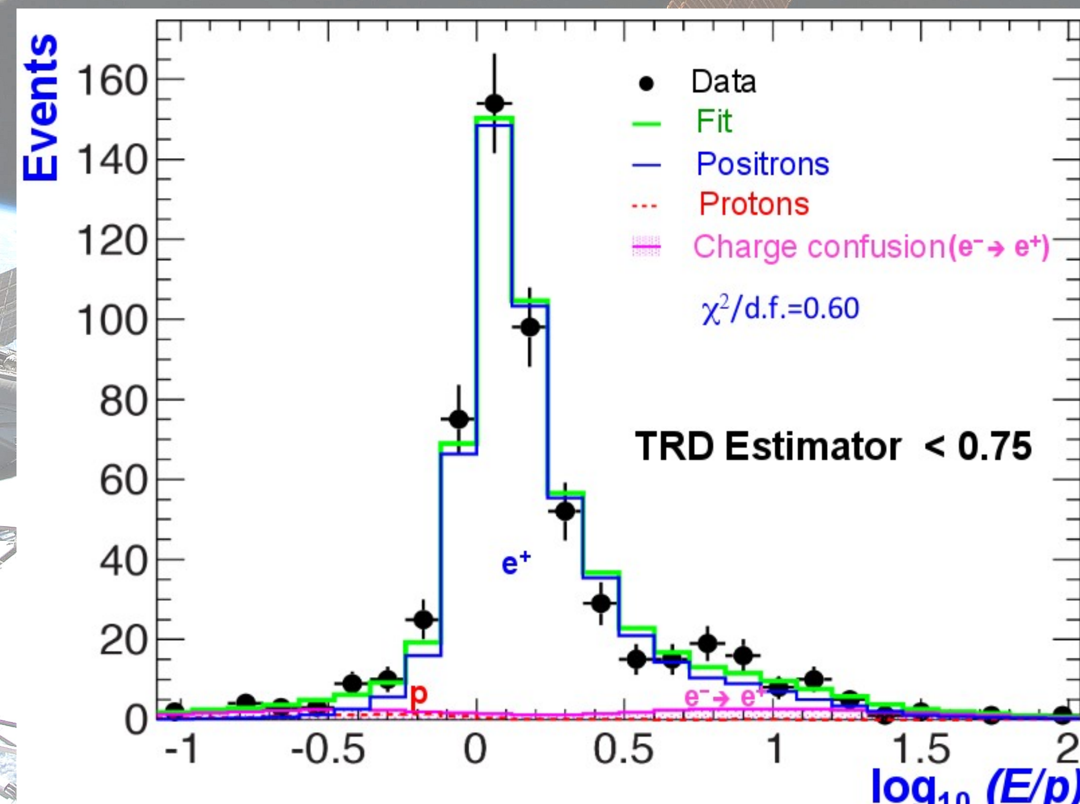


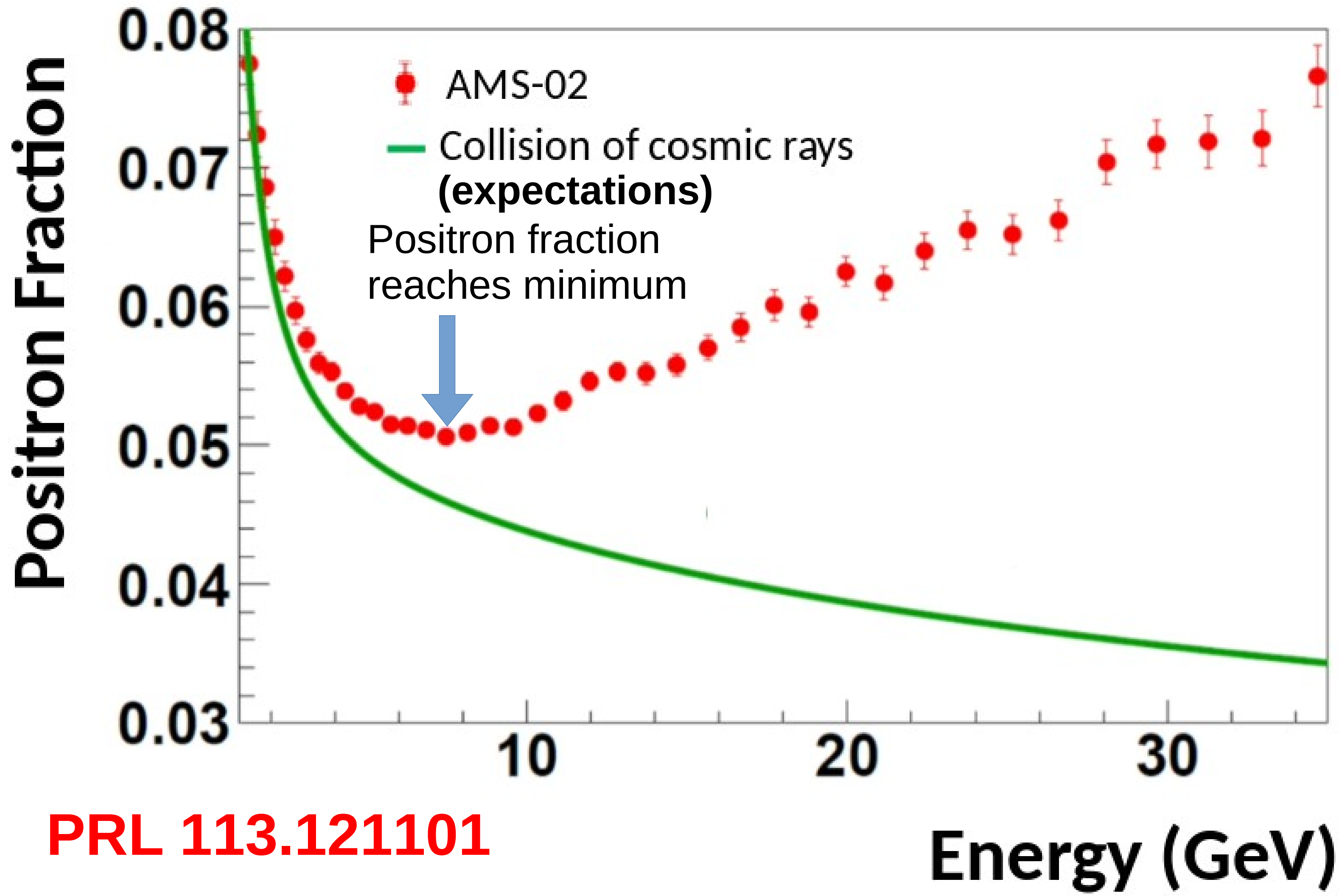


Uncertainties

- Acceptance asymmetry
- Selection dependence
- Absolute energy scale and bin-to-bin migration
- Reference spectra
- Charge confusion

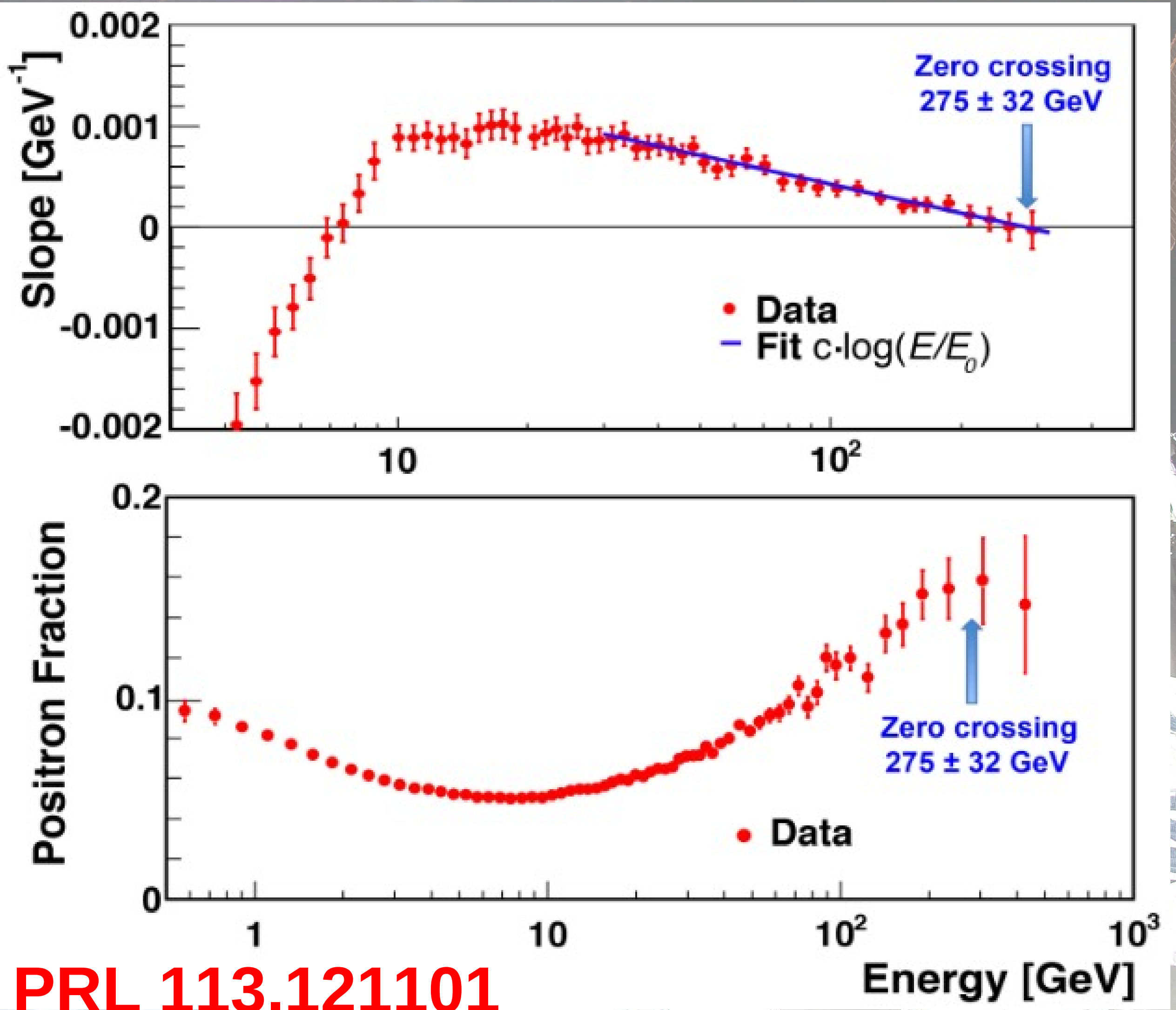
Energy [GeV]	N_{e^+}	Fraction	σ_{stat}	σ_{acc}	σ_{sel}	σ_{mig}	σ_{ref}	$\sigma_{c.c.}$	σ_{syst}
74.30–80.00	450	0.0963	0.0047	0.0002	0.0010	0.0007	0.0002	0.0006	0.0014
80.00–86.00	381	0.1034	0.0056	0.0002	0.0011	0.0007	0.0002	0.0007	0.0015
86.00–92.50	398	0.1207	0.0063	0.0002	0.0011	0.0007	0.0003	0.0009	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 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%	0.0003	0.0045	0.0007	0.0015	0.0123	0.0132 13%
350.0–500.0	72	0.1471	0.0278	0.0003	0.0064	0.0007	0.0022	0.0182	0.0194

Positron fraction – the turning point



PRL 113.121101

Positron fraction – high energy trend



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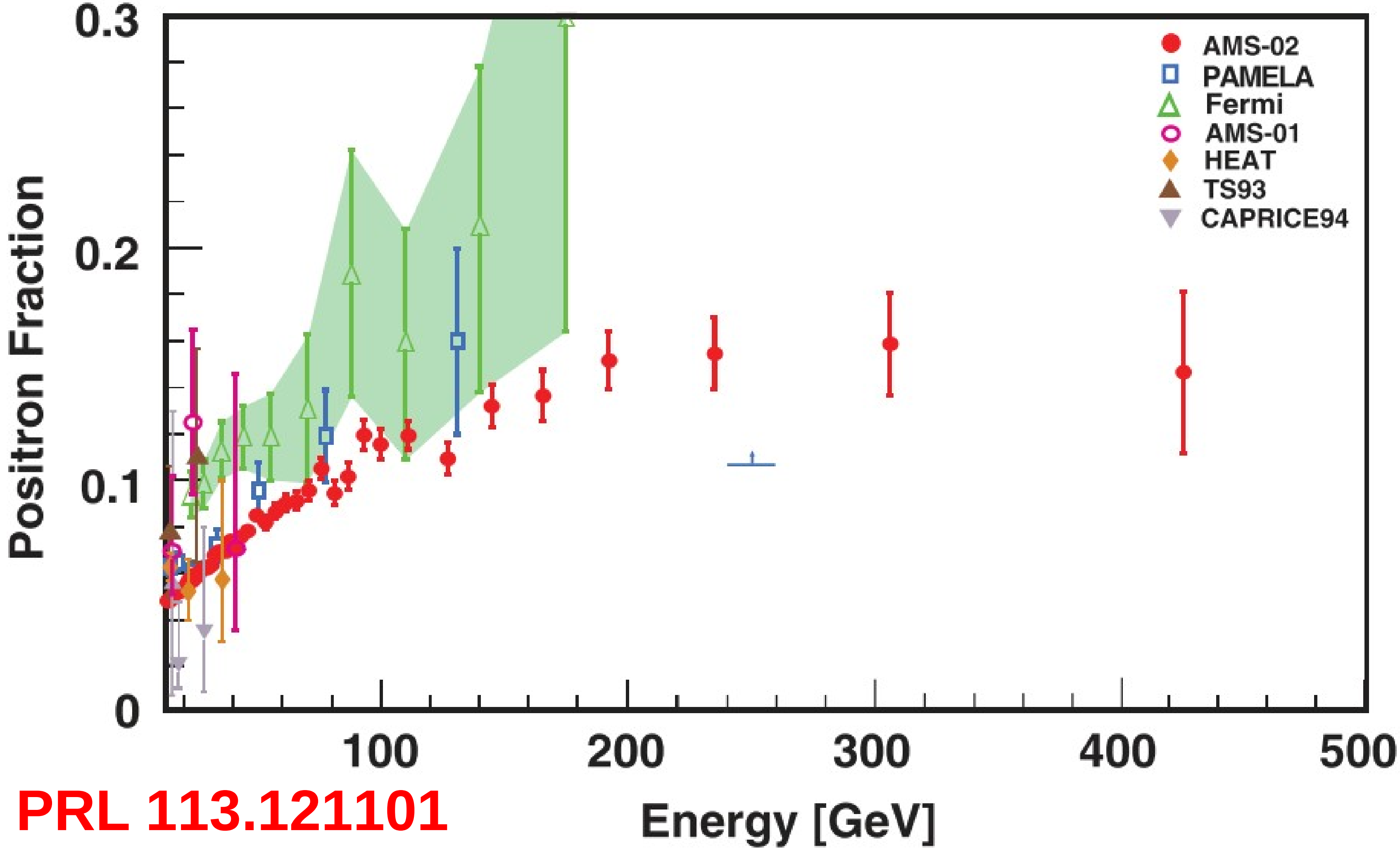
Positron fraction – Comparison



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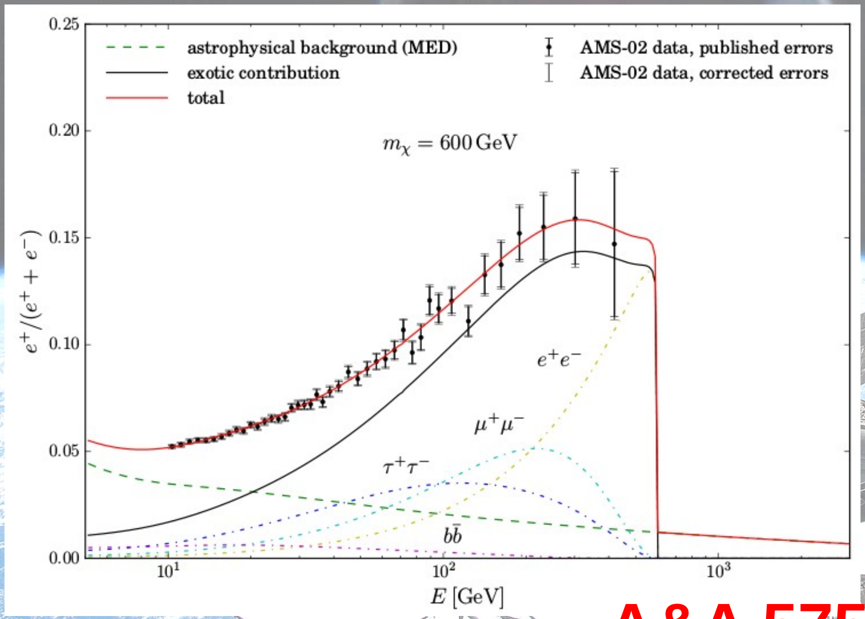
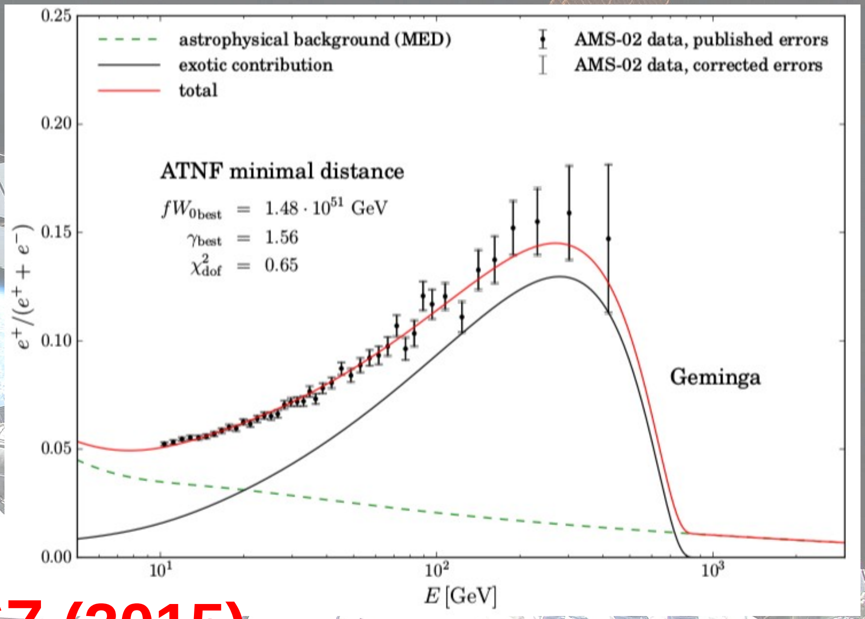
Positron fraction – Interpretation

Dark matter annihilation $e^+ e^-$ pair production



Pulsar $e^+ e^-$ pair production



A&A 575, A67 (2015)

- Models based on very different assumptions can describe observed trends in the data.
- The understanding of the positron excess still needs more precise data and better model prediction accuracy

Positron fraction – Interpretation

Diffusion understanding :
B/C cf Valerio Formato talk

Solar modulation understanding :
Cf Stephano Della Torre talk

Lepton Anisotropies measurement :
Cf Giuseppe La Vacca talk

Lepton flux measurement :
Maura Graziani and Manuela Vecchi

- Models based on very different assumptions can describe observed trends in the data.
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Conclusions

- With **10.9 million** of electrons and positrons in the **0.5-500 GeV** range, AMS-02 have produced a precision measurement of the positron fraction.
- A **steady increase** is observed between **10 and 250 GeV**.
- The **positron fraction maximum** is measured at **275 ± 32 GeV**.
- **Since the dominant uncertainty is the statistical one, the measurement of the positron fraction with more statistics is useful and will help to understand the underlying physics.**