Antiproton Flux and Properties of Elementary Particle Fluxes in Primary Cosmic Rays Measured with the Alpha Magnetic Spectrometer on the ISS

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on behalf of the AMS Collaboration

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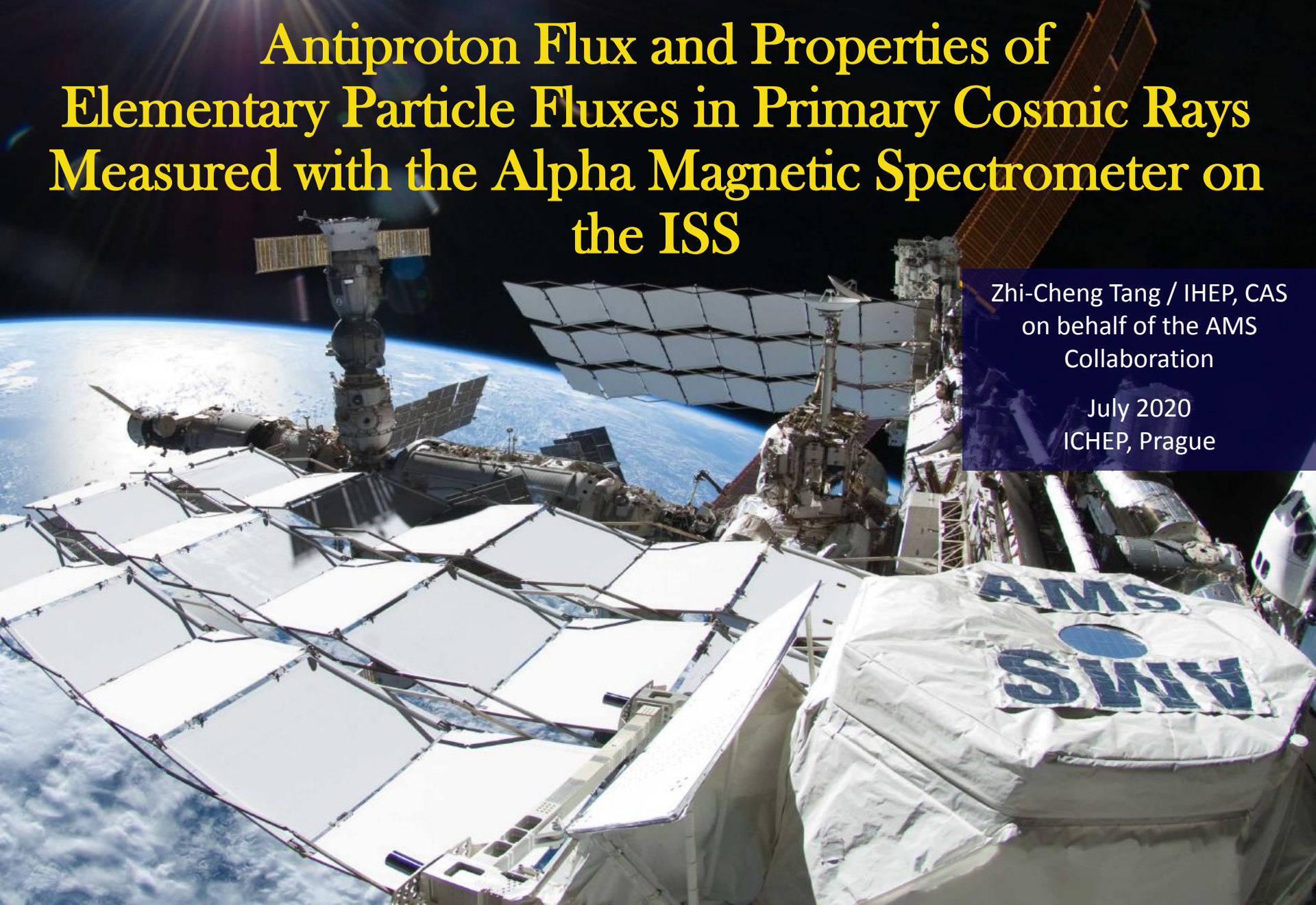
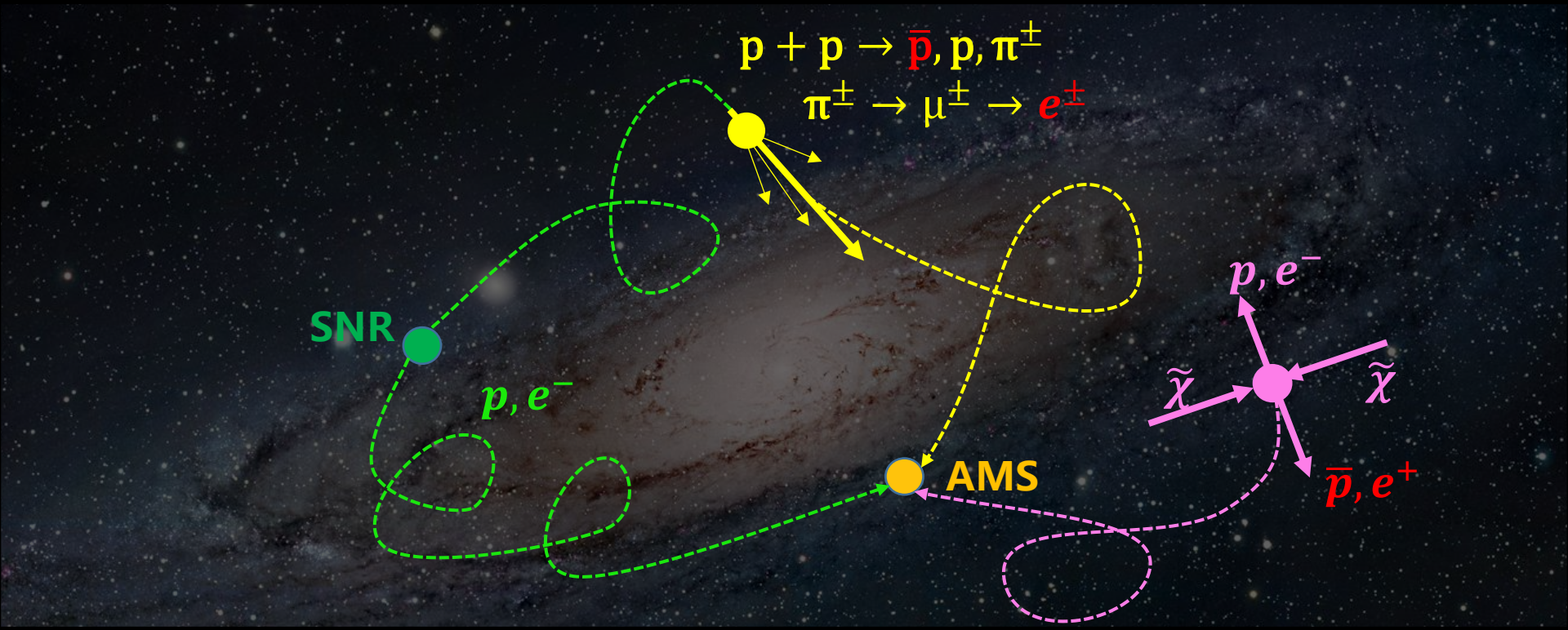
ICHEP, Prague

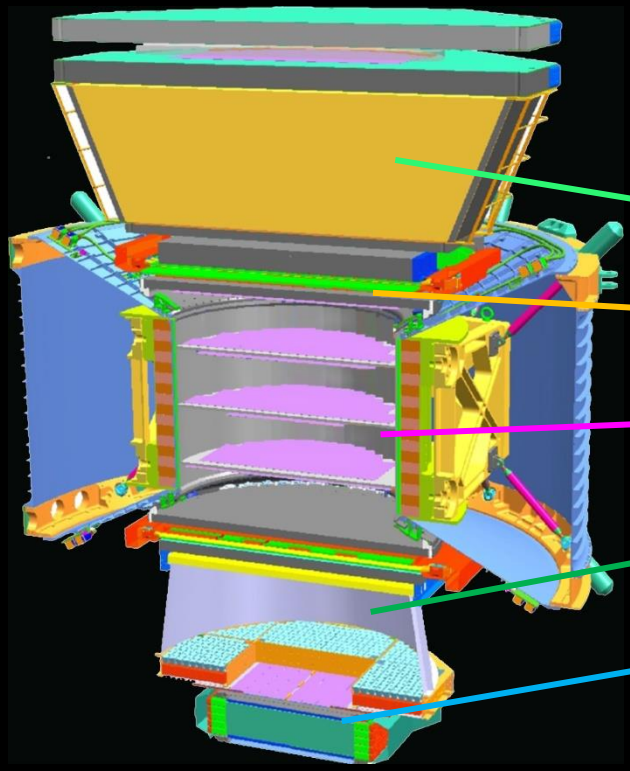


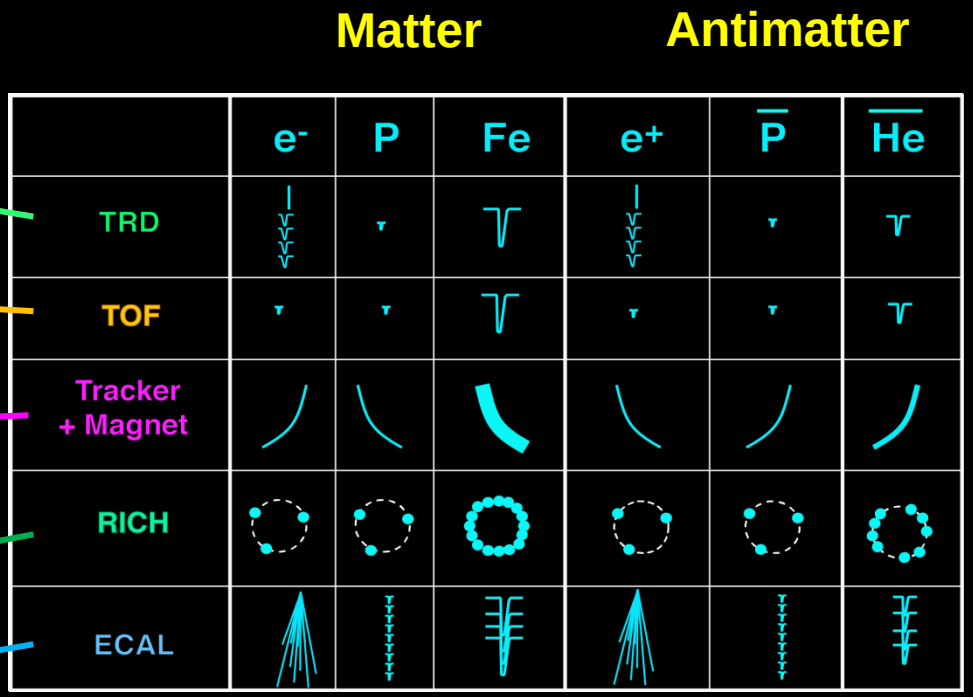
- **The 4 elementary particles: proton, antiproton, positron and electron have infinite live time, they can travel through the galaxy. They carry information of the origin and propagation history of cosmic rays.**
- Protons, Electrons are produced and accelerated in Supernovae Remnants (SNRs) together with other cosmic rays primary components. These particles interact with the interstellar matter and produce secondary components, including anti-particle: positrons, antiprotons
- New sources like dark matter produce particles and antiparticles in equal amount.



A major tool to look for new physics in space is to measure and compare the properties of the fluxes of these particles

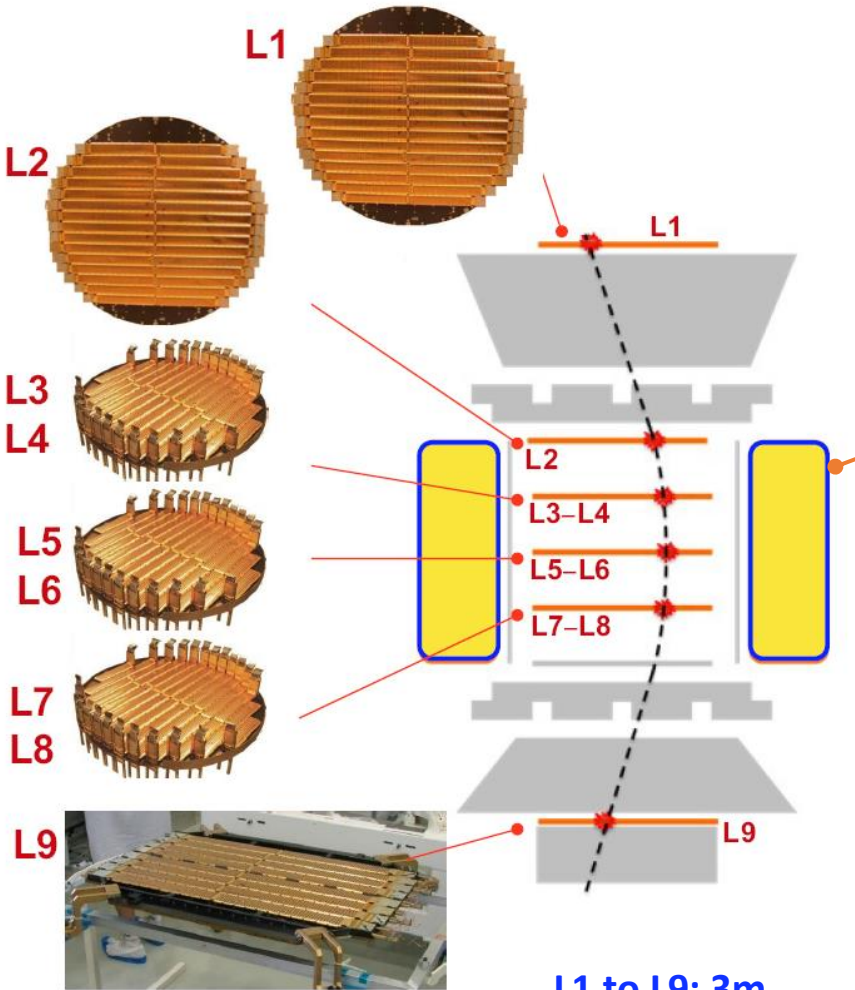
AMS is a Unique Magnetic Spectrometer in Space





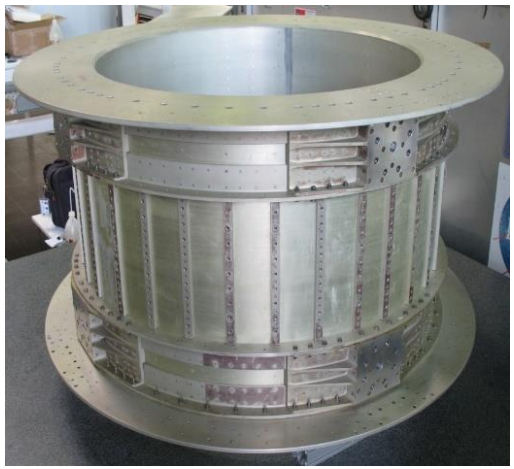
Cosmic rays are measured up to TeV range simultaneously in the same detector: Unprecedented data sample to study the properties of elementary particles in cosmic ray.

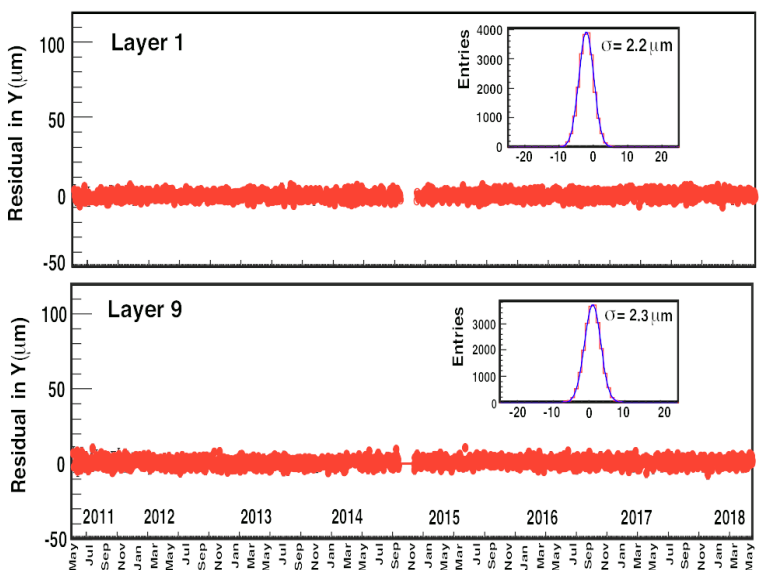
Silicon Tracker and Magnet



L1 to L9: 3m

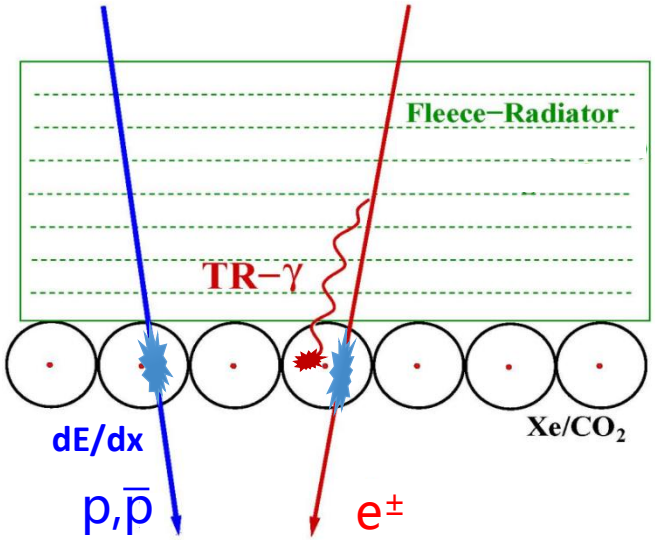
1.4 kG



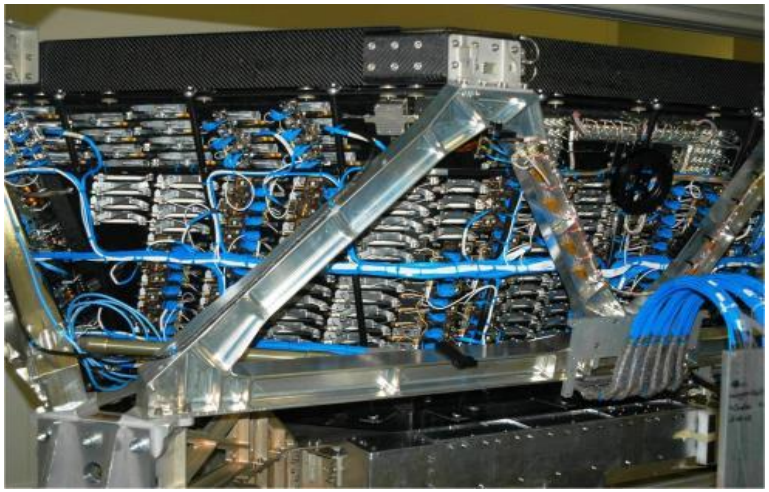


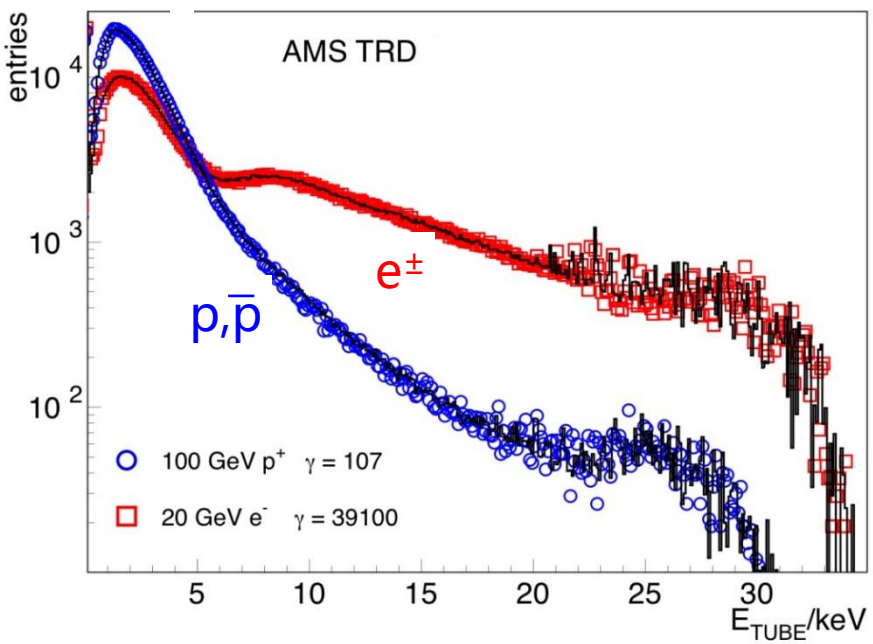
single point resolution: 10 μm, Stable with time, MDR: 2TV

Transition Radiation Detector (TRD)

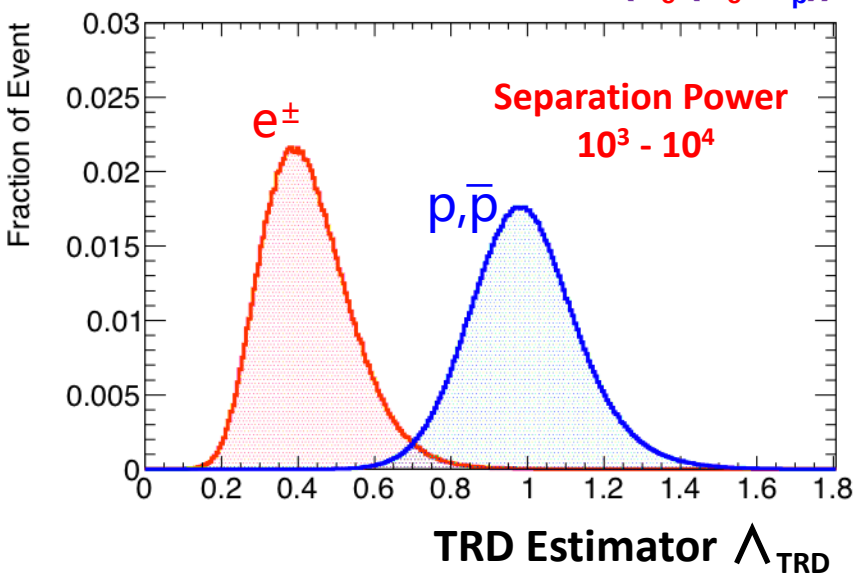


One of
20 layers



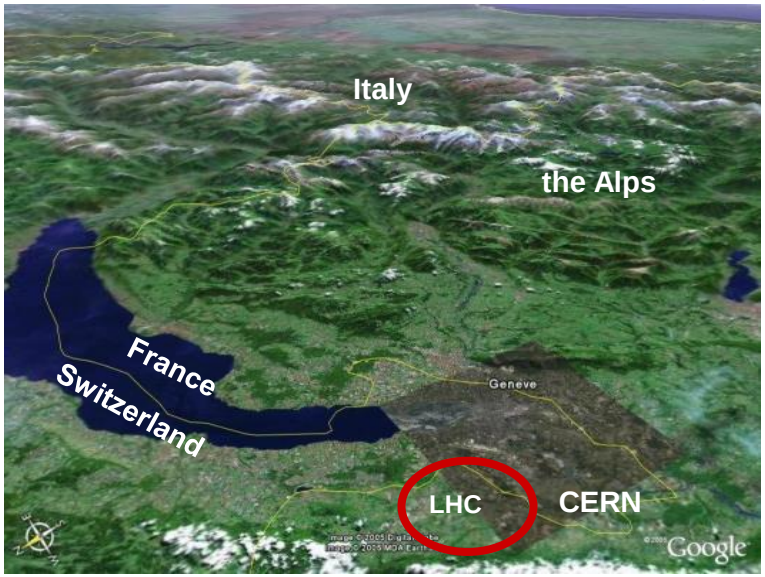


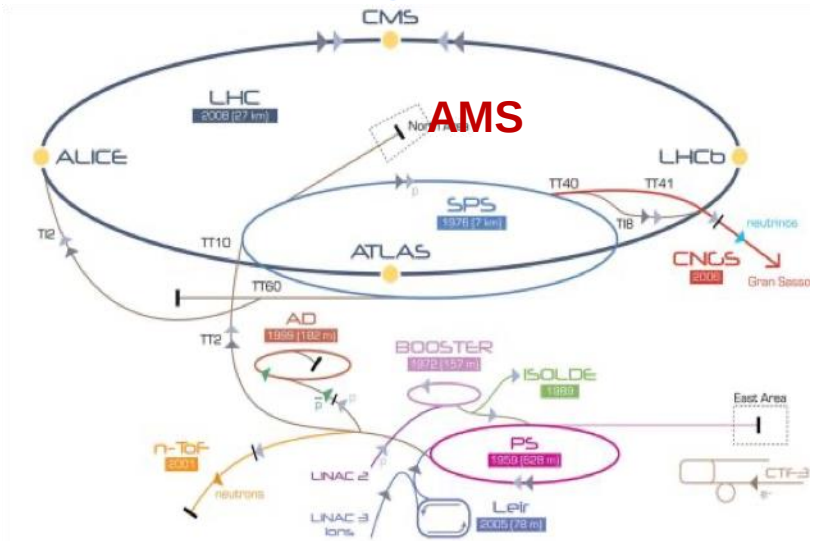
TRD estimator = $-\ln(P_e/(P_e+P_p))$

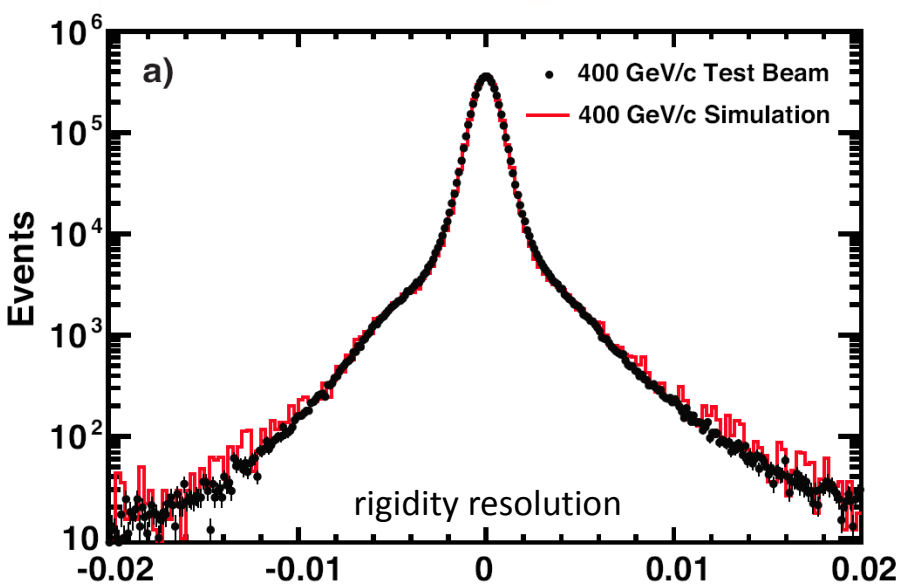


Calibration at CERN

with different particles at different energies



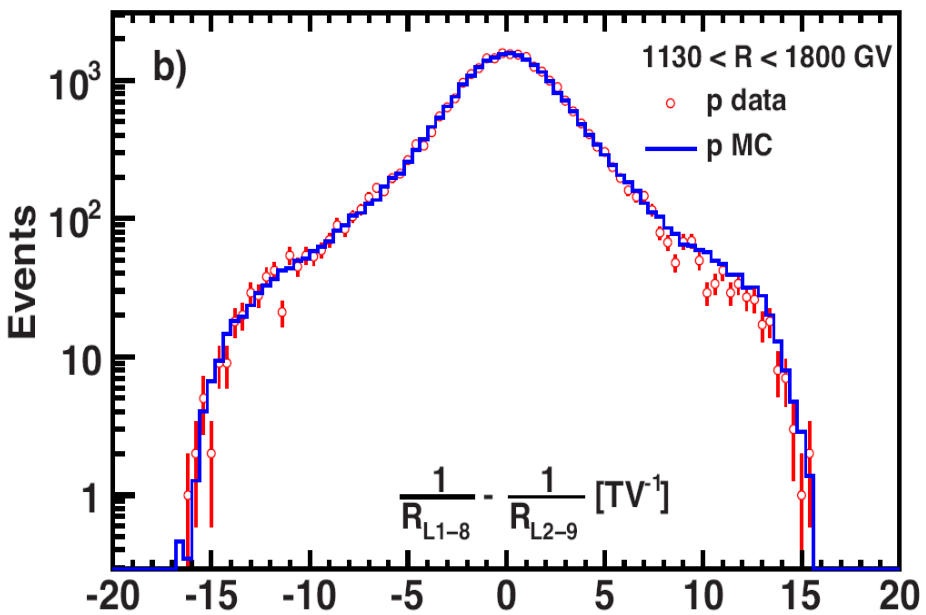




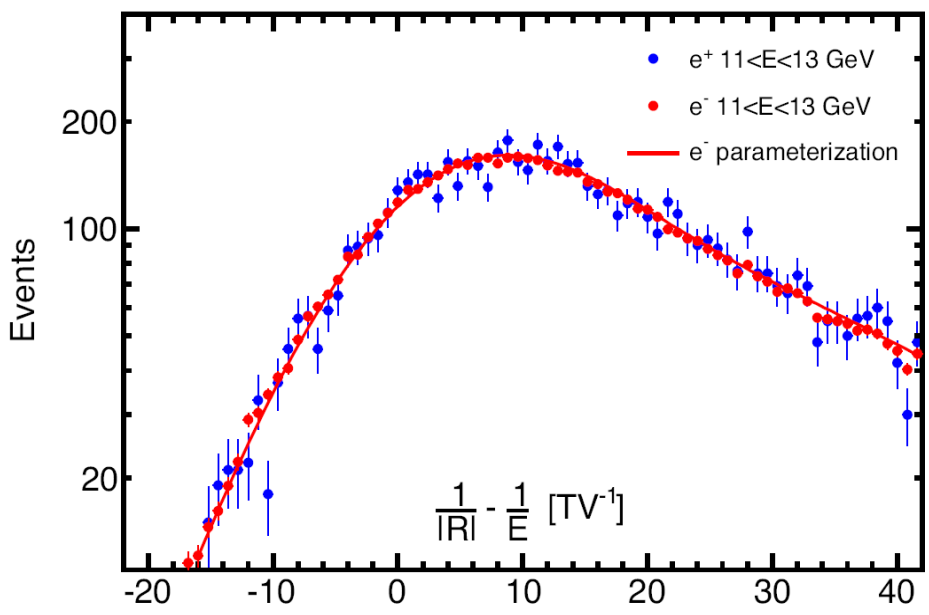
Unique Properties of AMS

Calibrate the detector in space, beyond test beam energy

Measurements above test beam energy

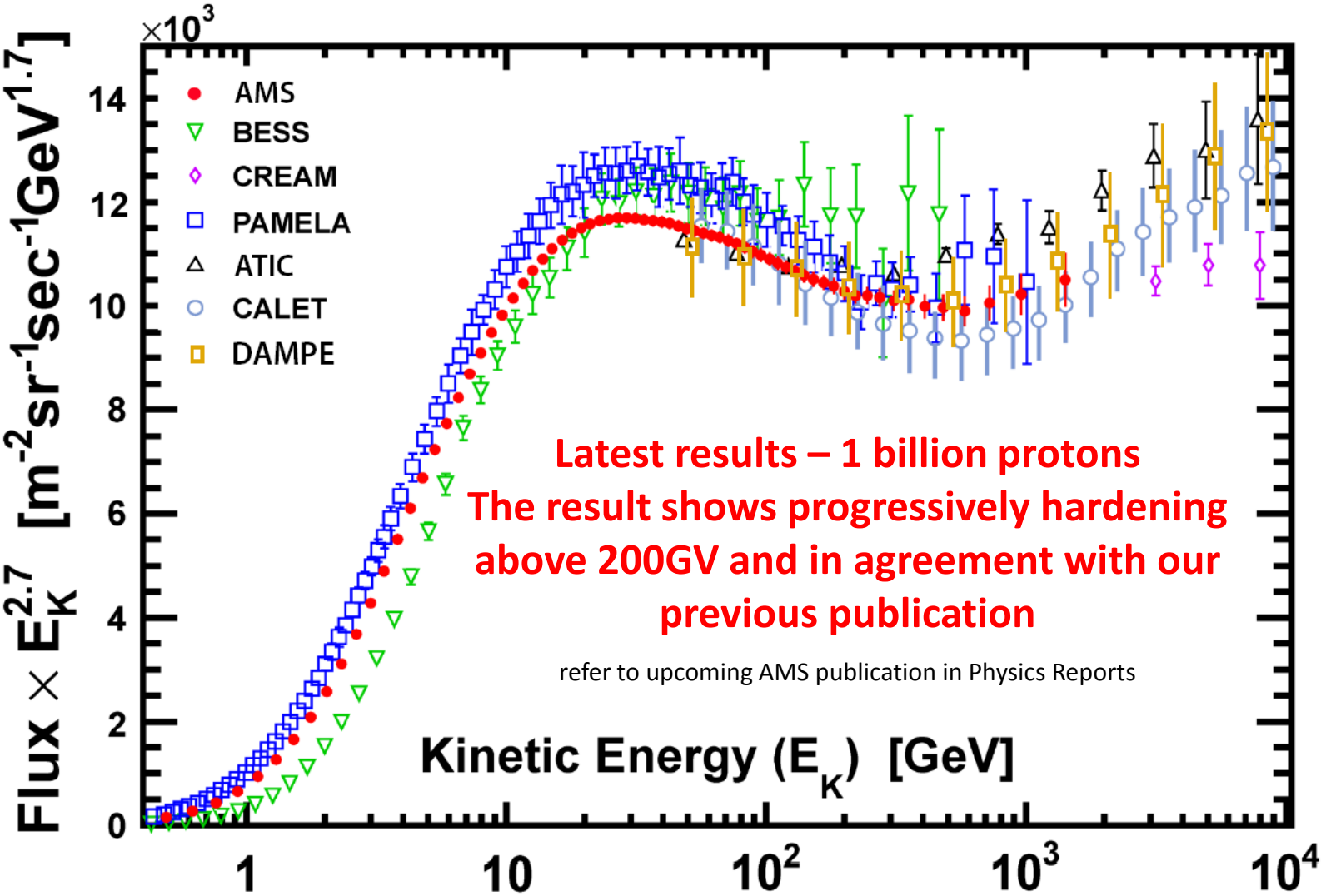


Accuracy of the rigidity scale



The accuracy of the rigidity scale is found to be ±0.033 TV^{-1}, constant with time, limited only by available positron statistics

AMS Measurement of the Proton Flux



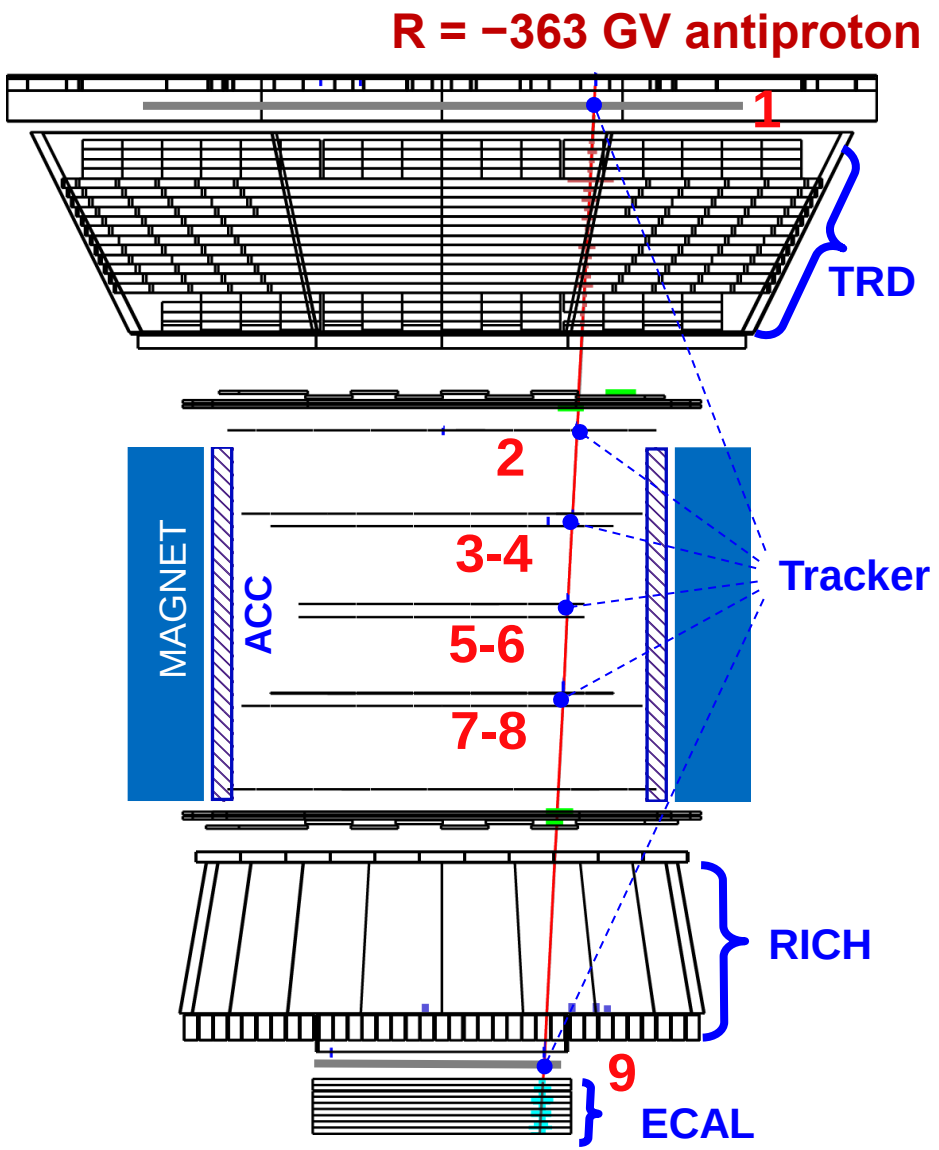
See M. Paniccia's talk for details

Antiproton Analysis

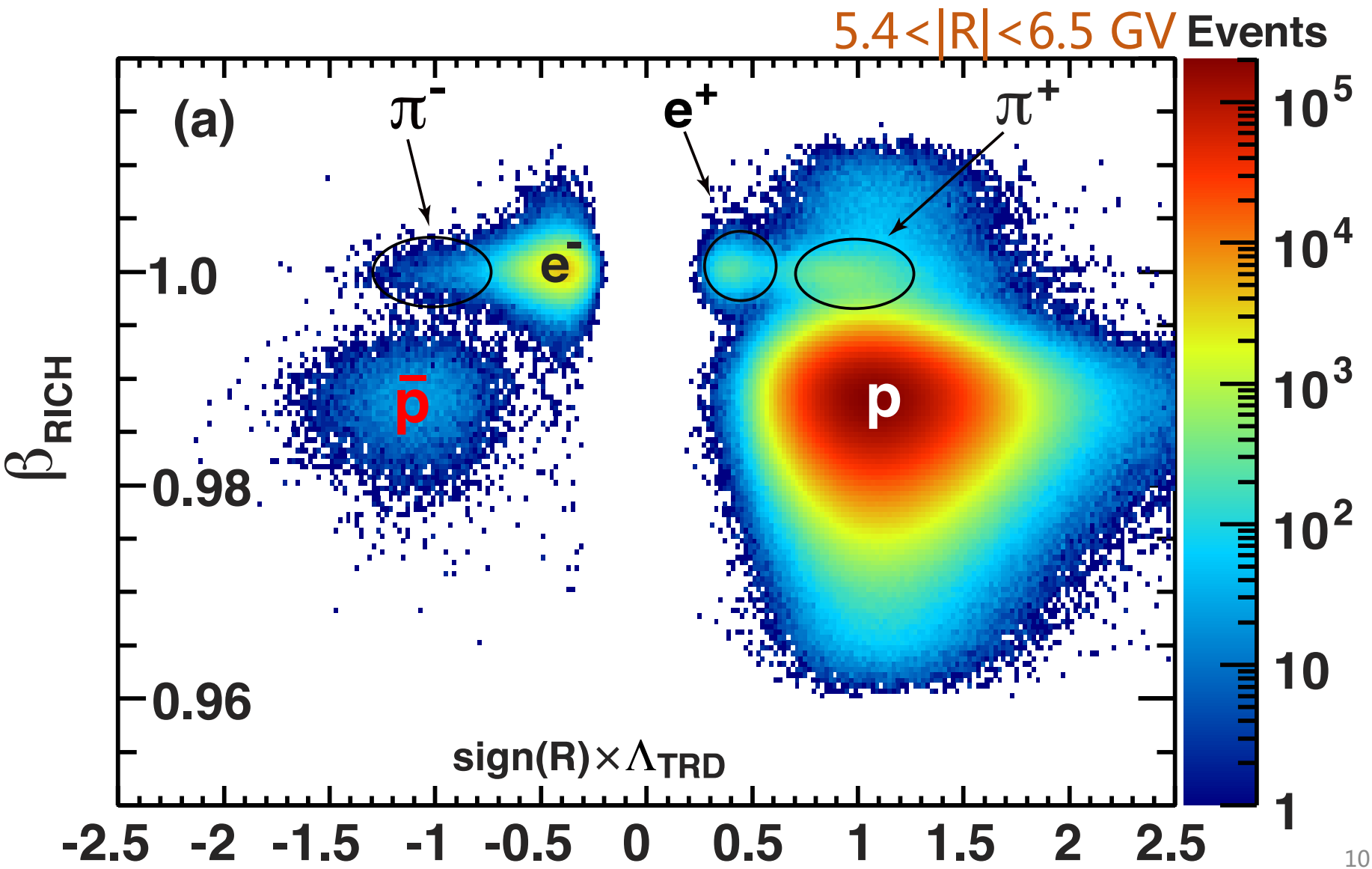
The Antiproton Flux is ~10^{-4} of the Proton Flux.
A percent precision experiment requires background rejection close to 1 in a million

- **TOF & RICH:** select down going particle and measure velocity
- **TRD & ECAL:** reject electron background
- **Tracker:** Measure rigidity and reject misidentified proton

More than 0.56M antiproton selected in the analysis between 1 and 525 GV



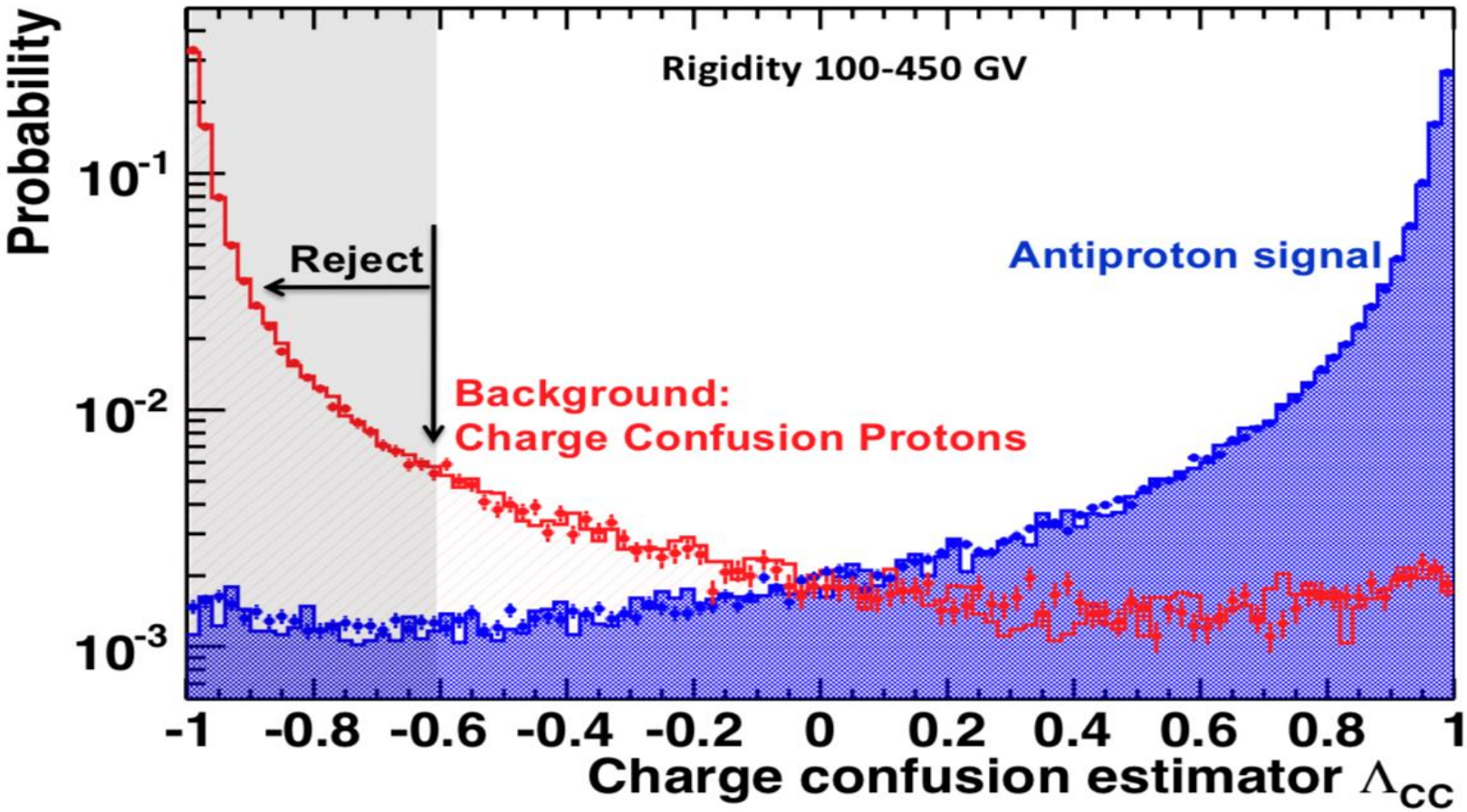
Antiproton Identification in AMS



Separation of Positive and Negative Charges

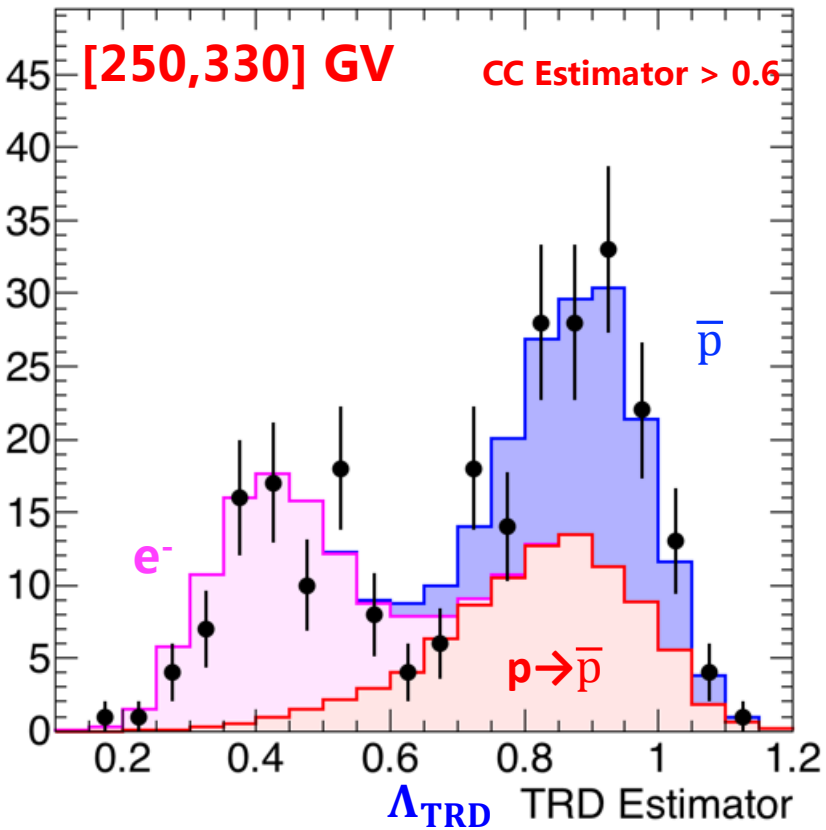
At high rigidities it is particularly important to ensure that the charge sign of antiproton is correctly identified in the tracker.

A charge confusion estimator was build with information from tracker and TOF, to reject misidentified protons

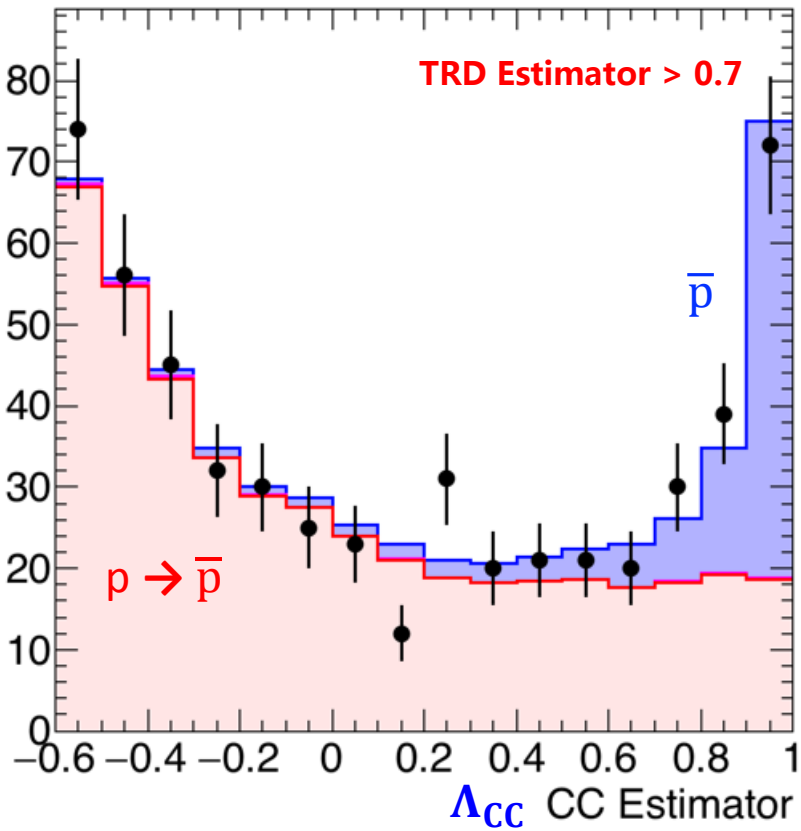


Antiproton Identification at High Energy

TRD Estimator Projection



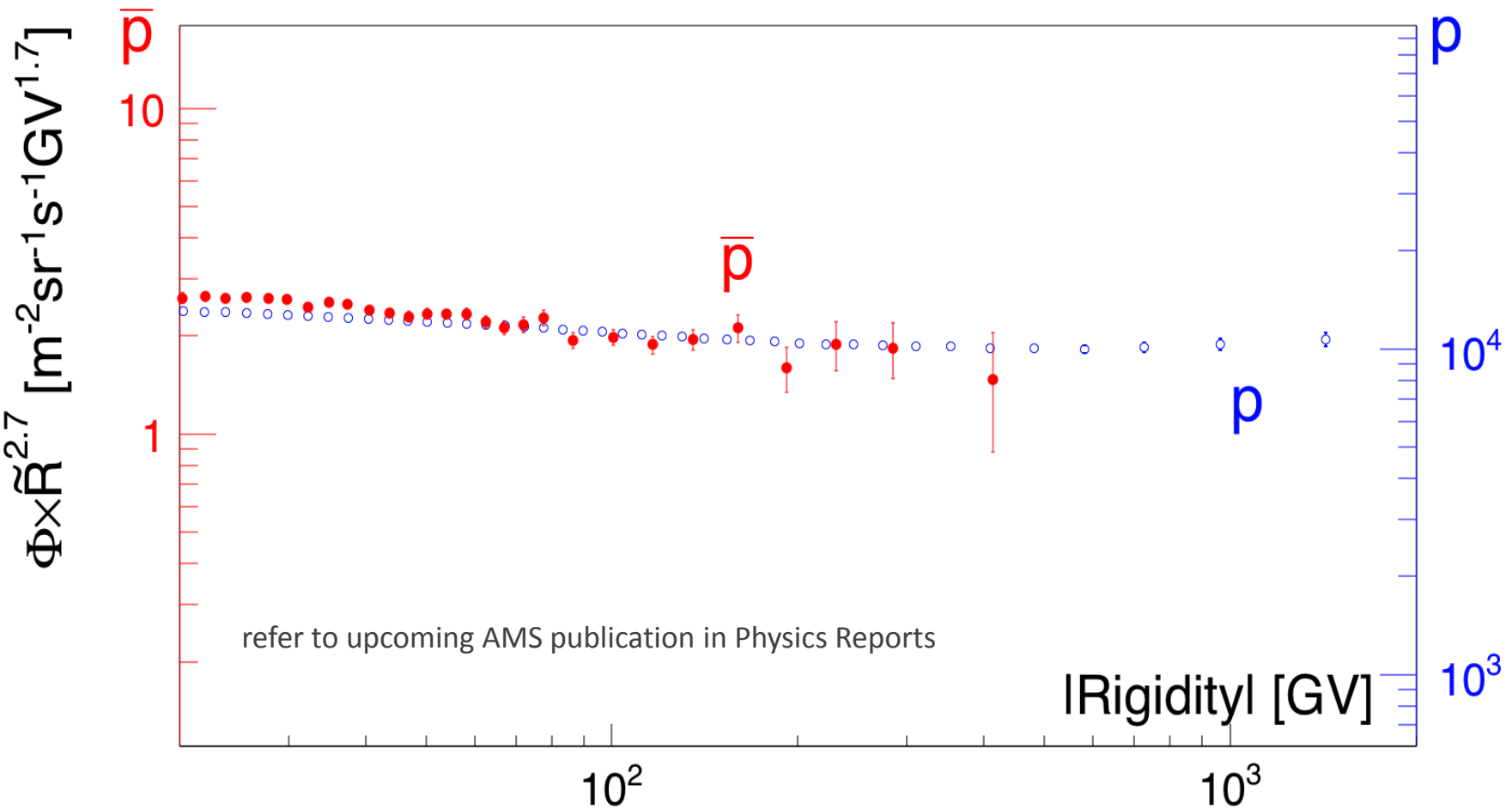
Charge Confusion (CC) Estimator Projection



more than 3500 antiprotons above 100GV
extensive systematic study been performed

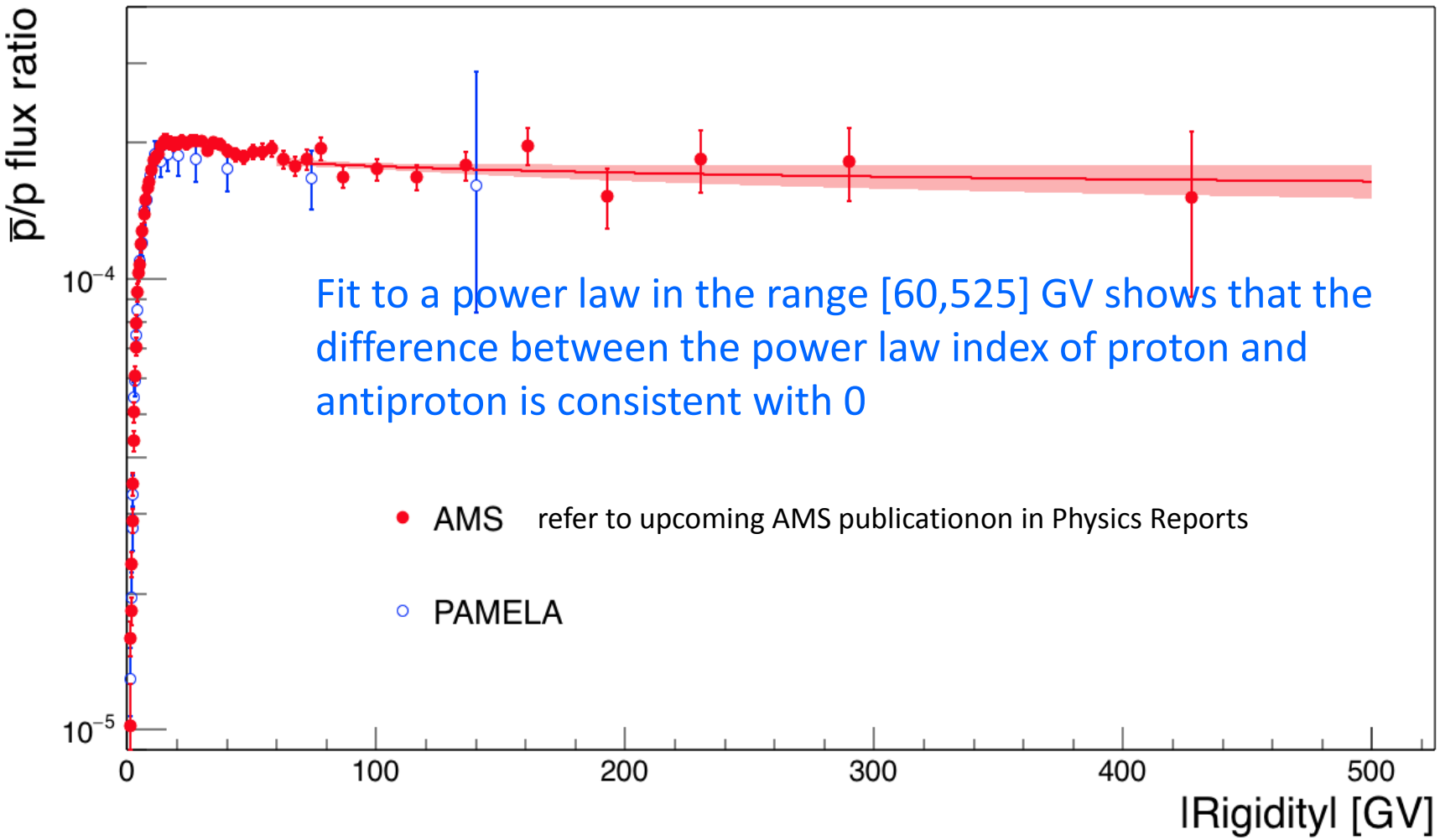
The Spectra of Antiprotons and Protons

AMS observed for the first time that above 60 GeV, p and $\bar{p}$ have identical behavior



Antiproton-to-Proton Flux Ratio

Show no rigidity dependence above 60GV

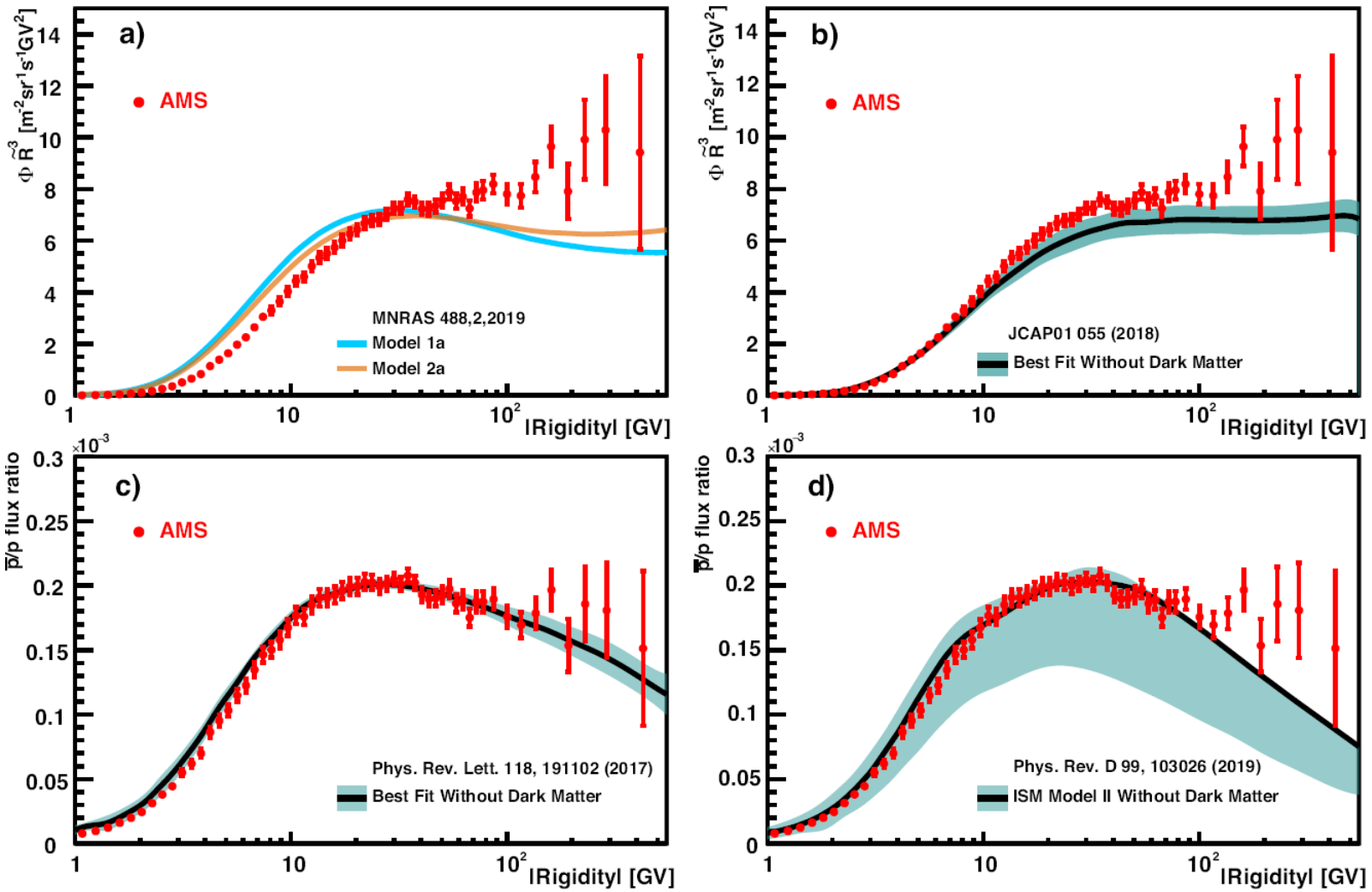


Fit to a power law in the range [60,525] GV shows that the difference between the power law index of proton and antiproton is consistent with 0

refer to upcoming AMS publicationon in Physics Reports

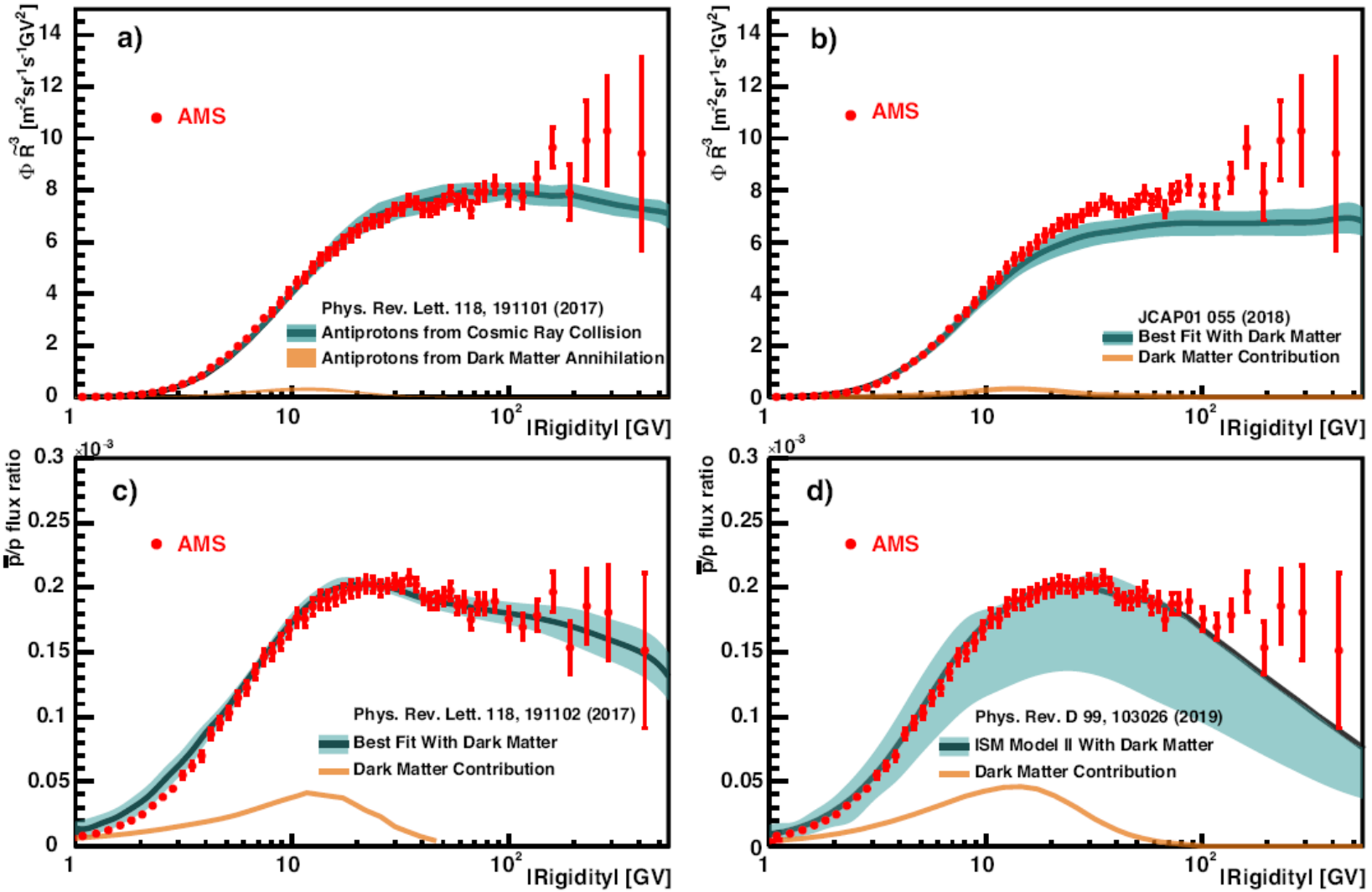
Antiprotons and Theoretical Models

Recent models including only secondary production of antiprotons
Comparing with AMS antiproton measurement



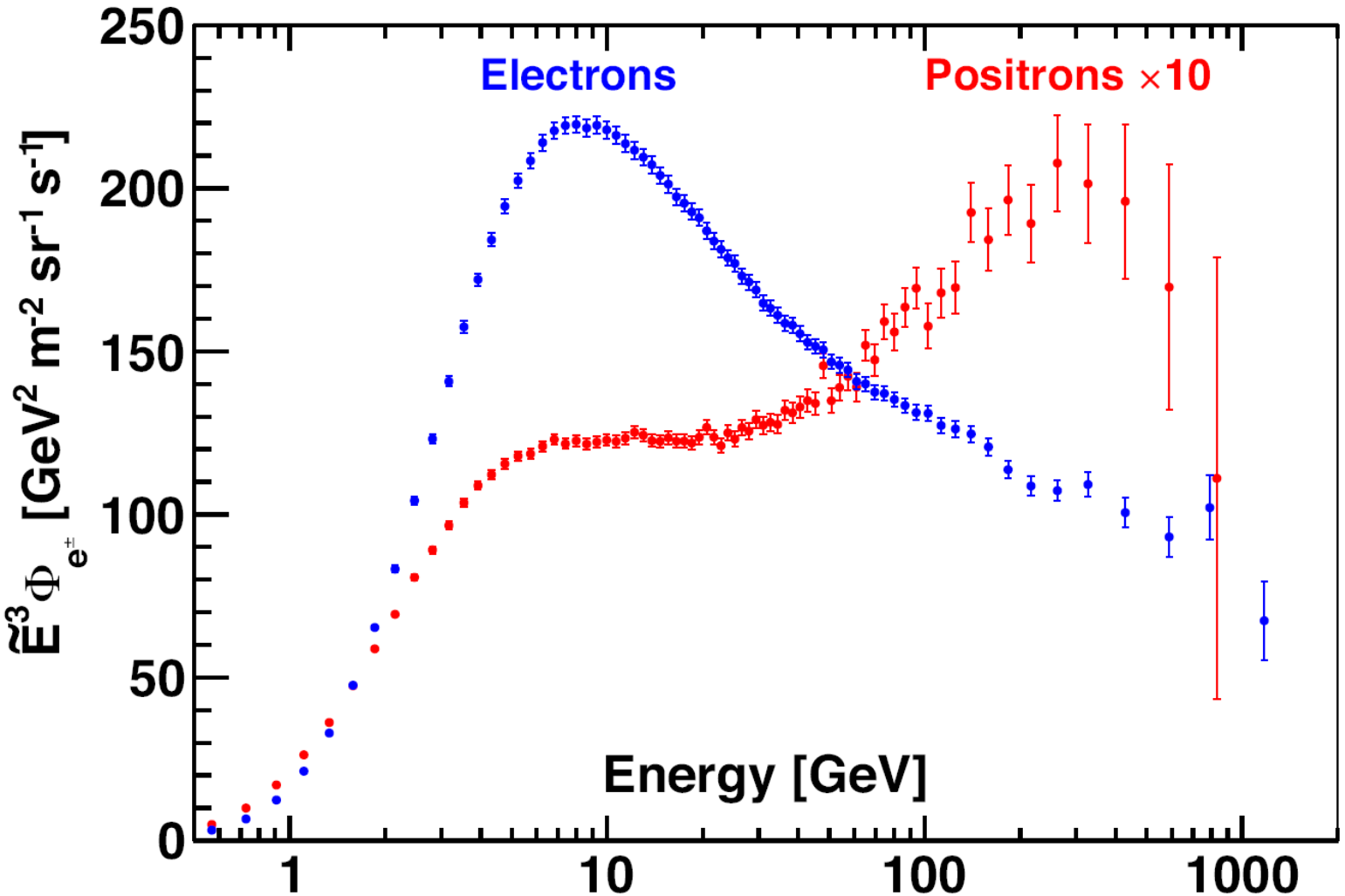
Antiproton and Theoretical Models

Recent models including also contribution from dark matter



Electron and Positron Fluxes

Latest results – 28M electron and ~2 M positrons

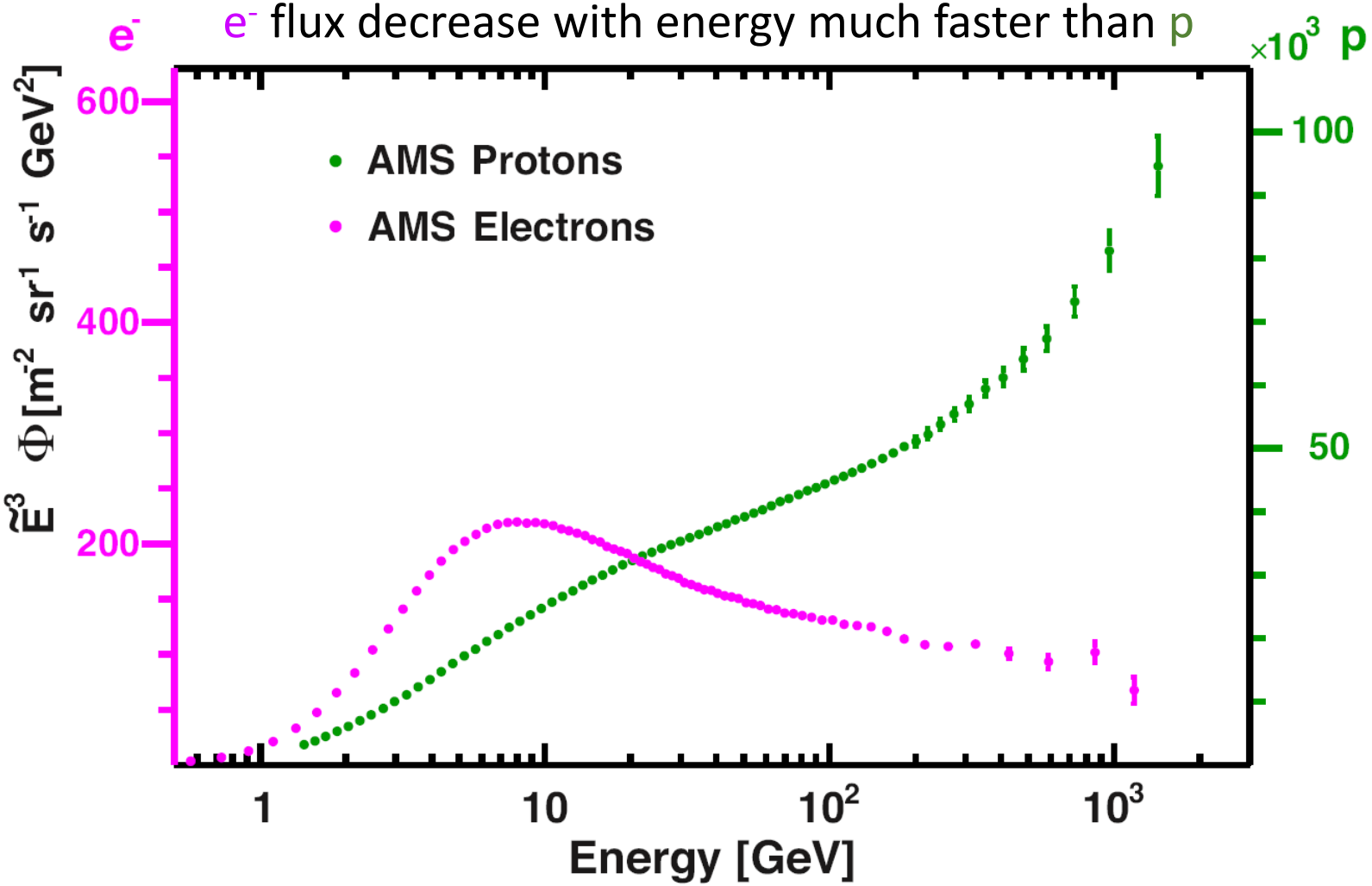


See Z. Weng's talk for details

Spectra of Electrons and Protons

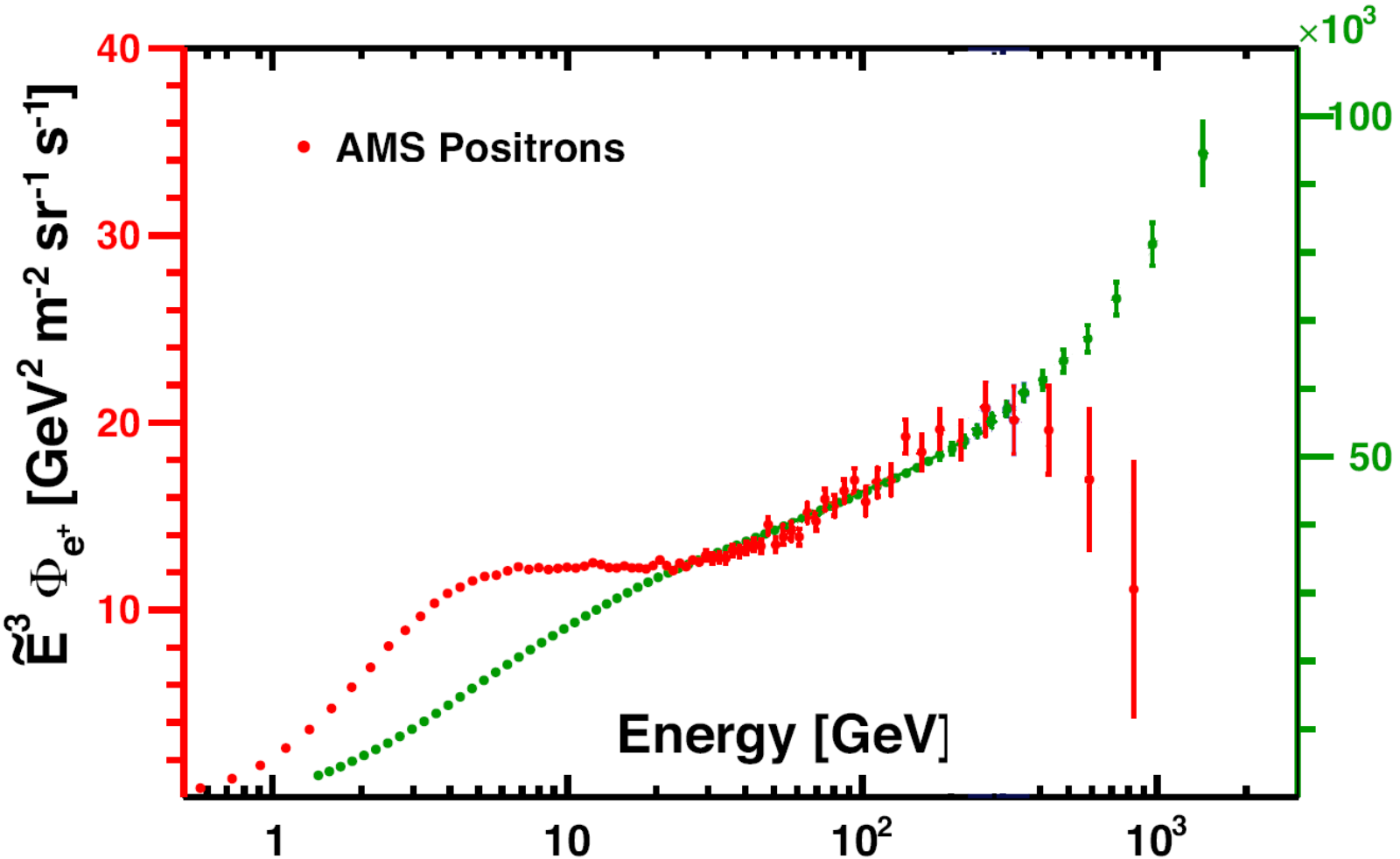
Distinguishly different behavior

e^- flux decrease with energy much faster than p



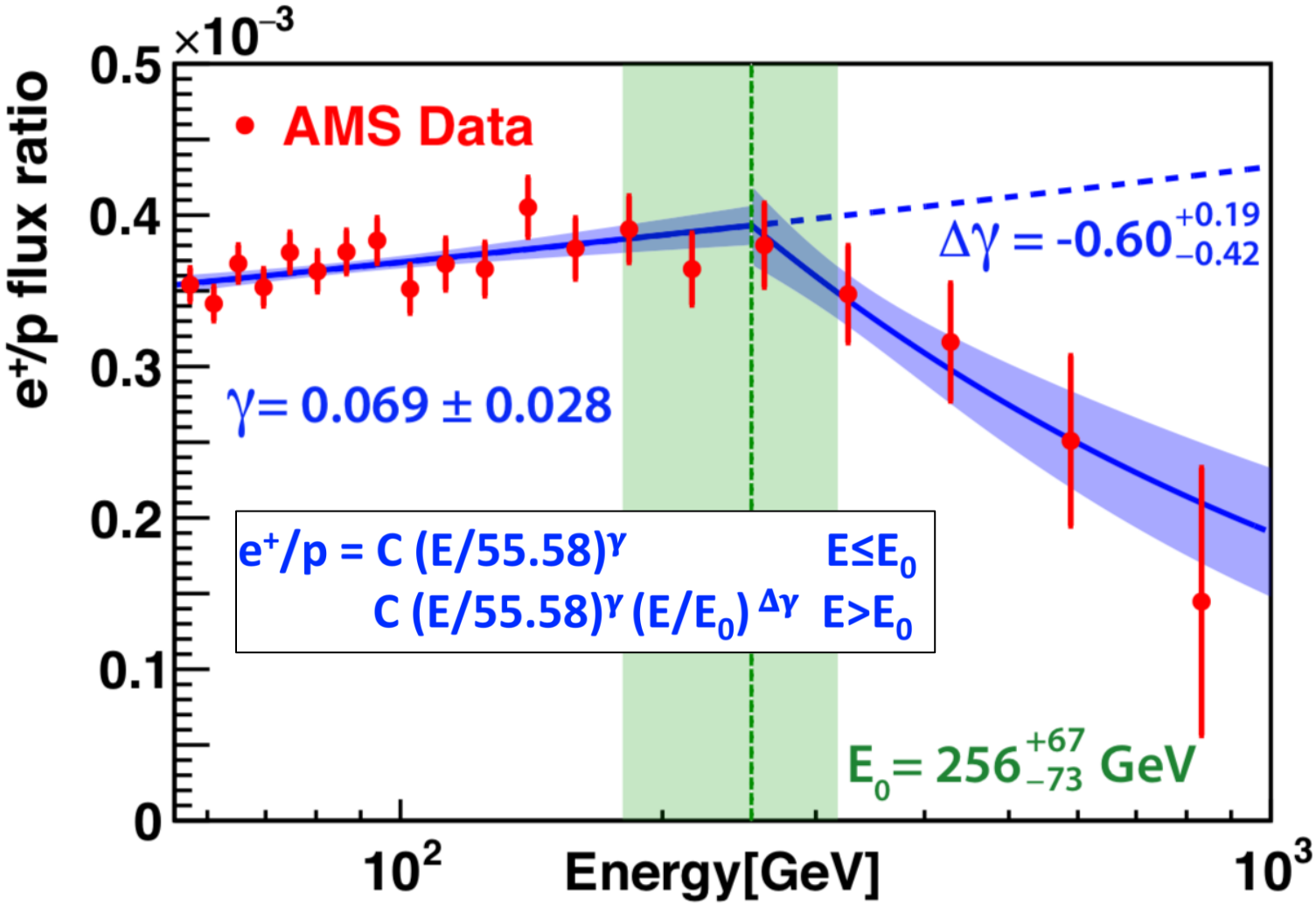
Spectra of Positrons and Protons

Spectrum of positrons and protons fluxes are surprising very similar from 60 to ~300 GV. from 300GV above, positron decrease faster in contrast with proton.



Positron-to-Proton Flux Ratio

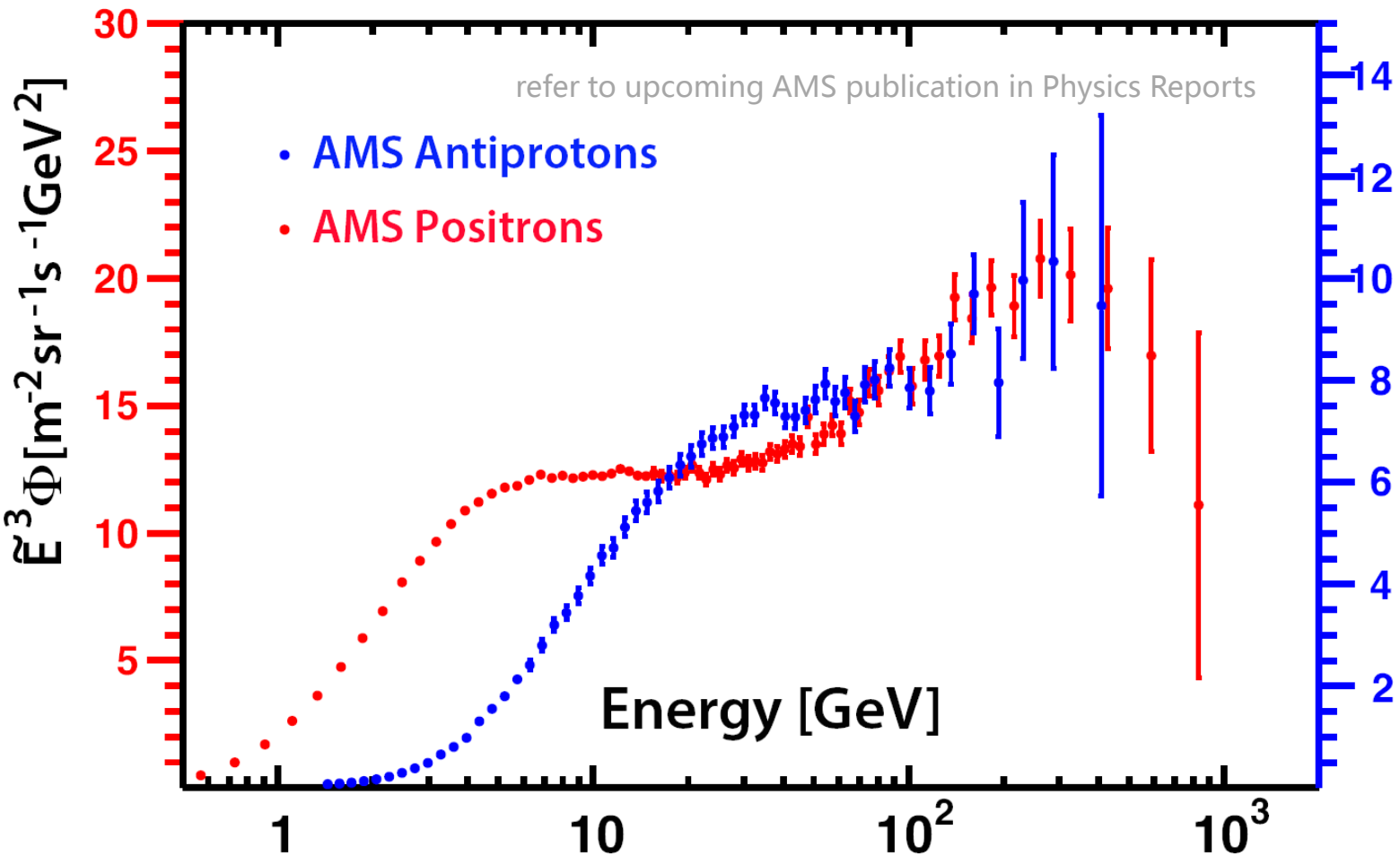
Another surprising observation is that the positron spectrum is harder than the proton spectrum from 60-260GeV



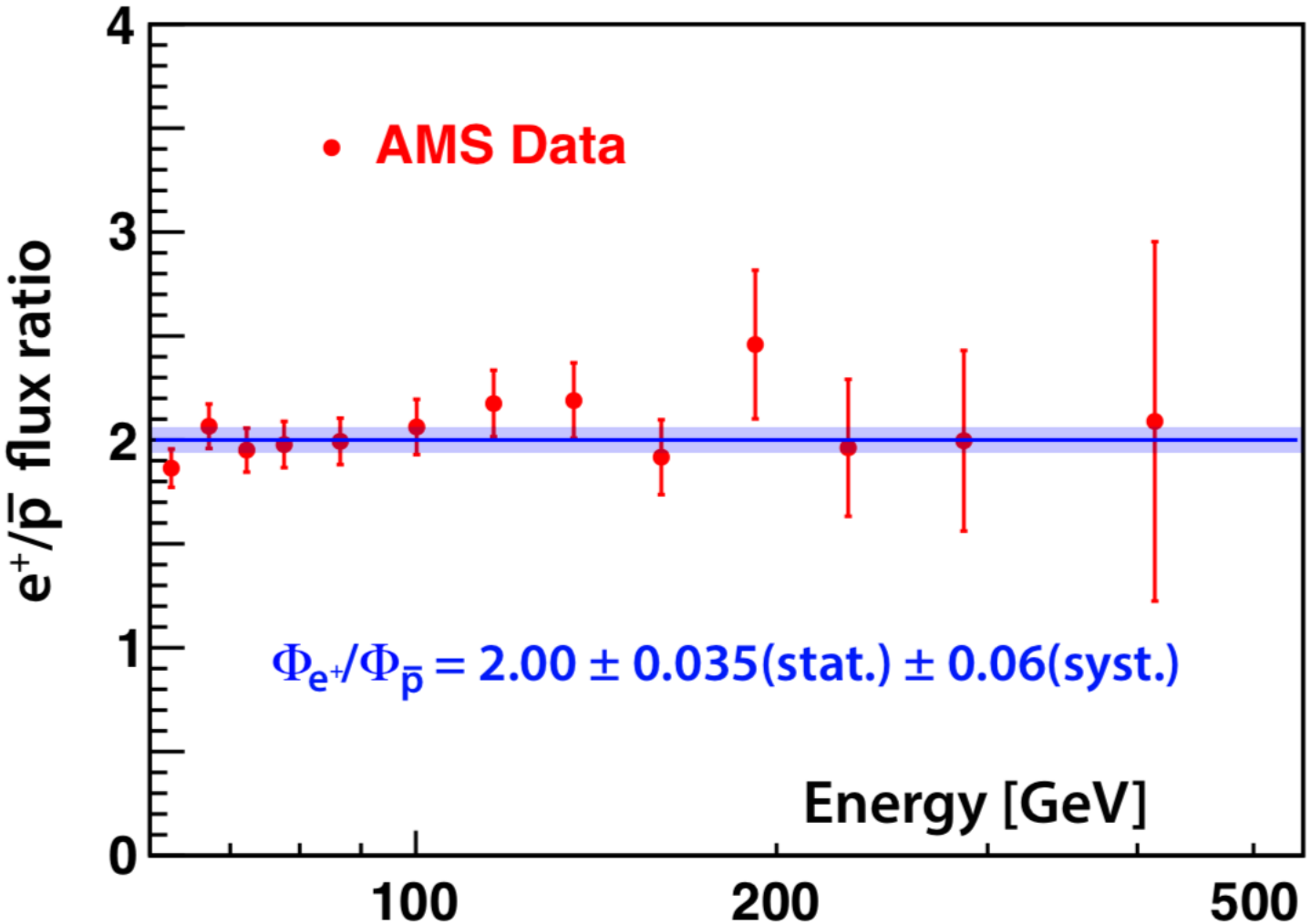
Spectra of Antiprotons and Positrons

At high energy Antiprotons have very similar trends with Positron

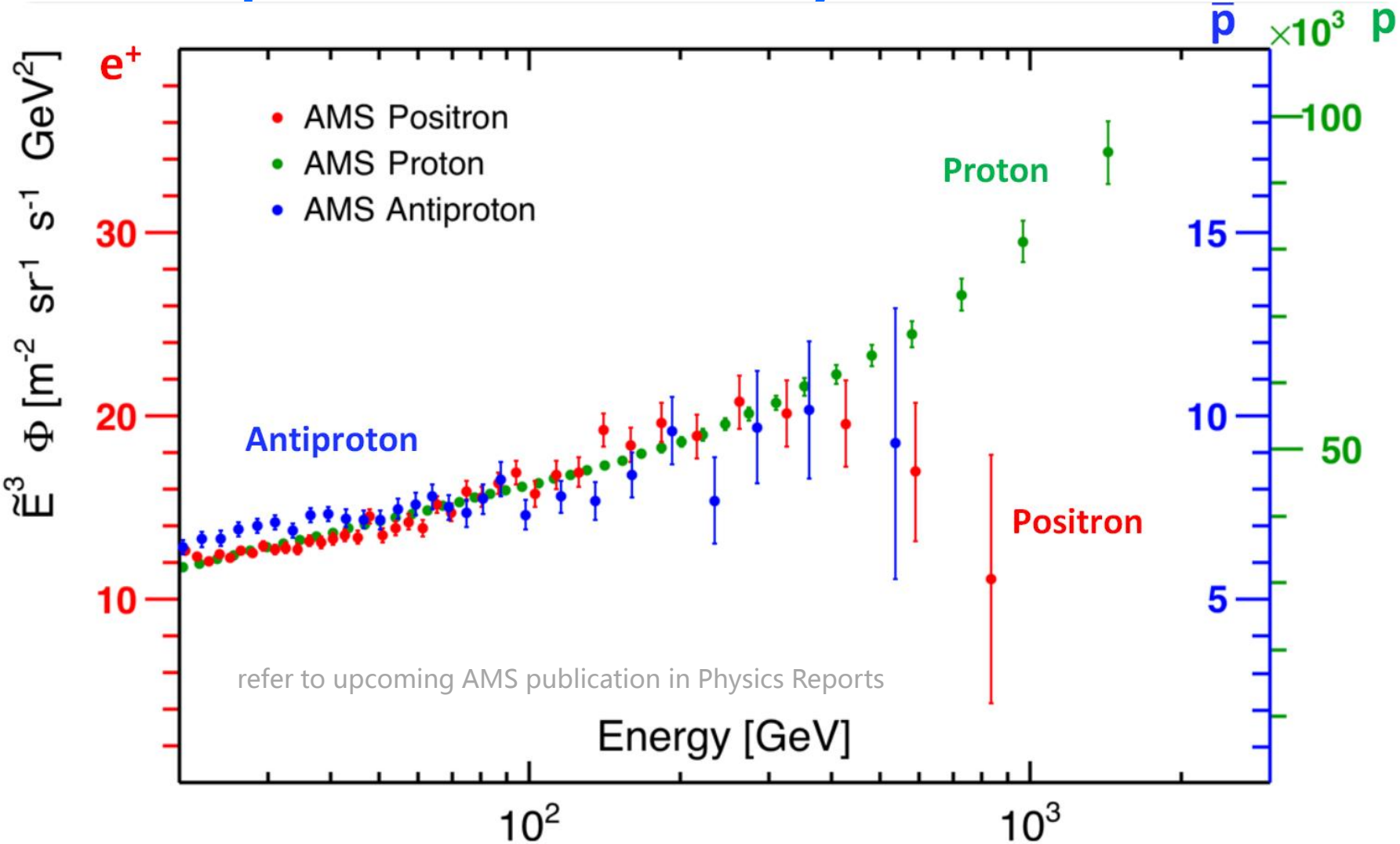
Antiprotons can not come from pulsar



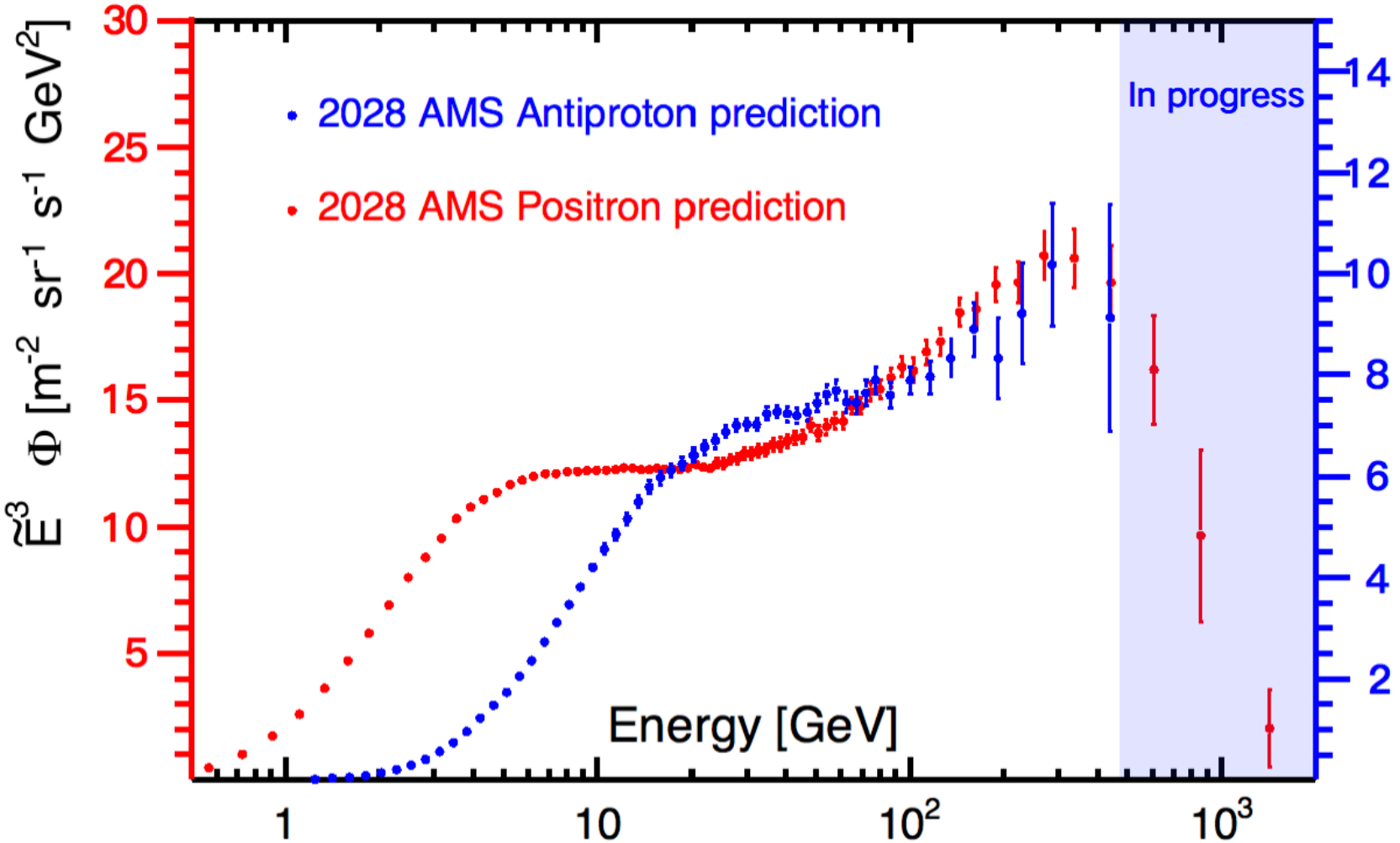
Positron-to-Antiproton Flux Ratio



Properties of Elementary Particle Fluxes



AMS is exploring fundamental physics in space with many different types of cosmic rays. Many new and exciting phenomena are observed.



By collecting data through the lifetime of ISS, AMS will greatly improve the accuracy of these measurements and will reach higher energy.