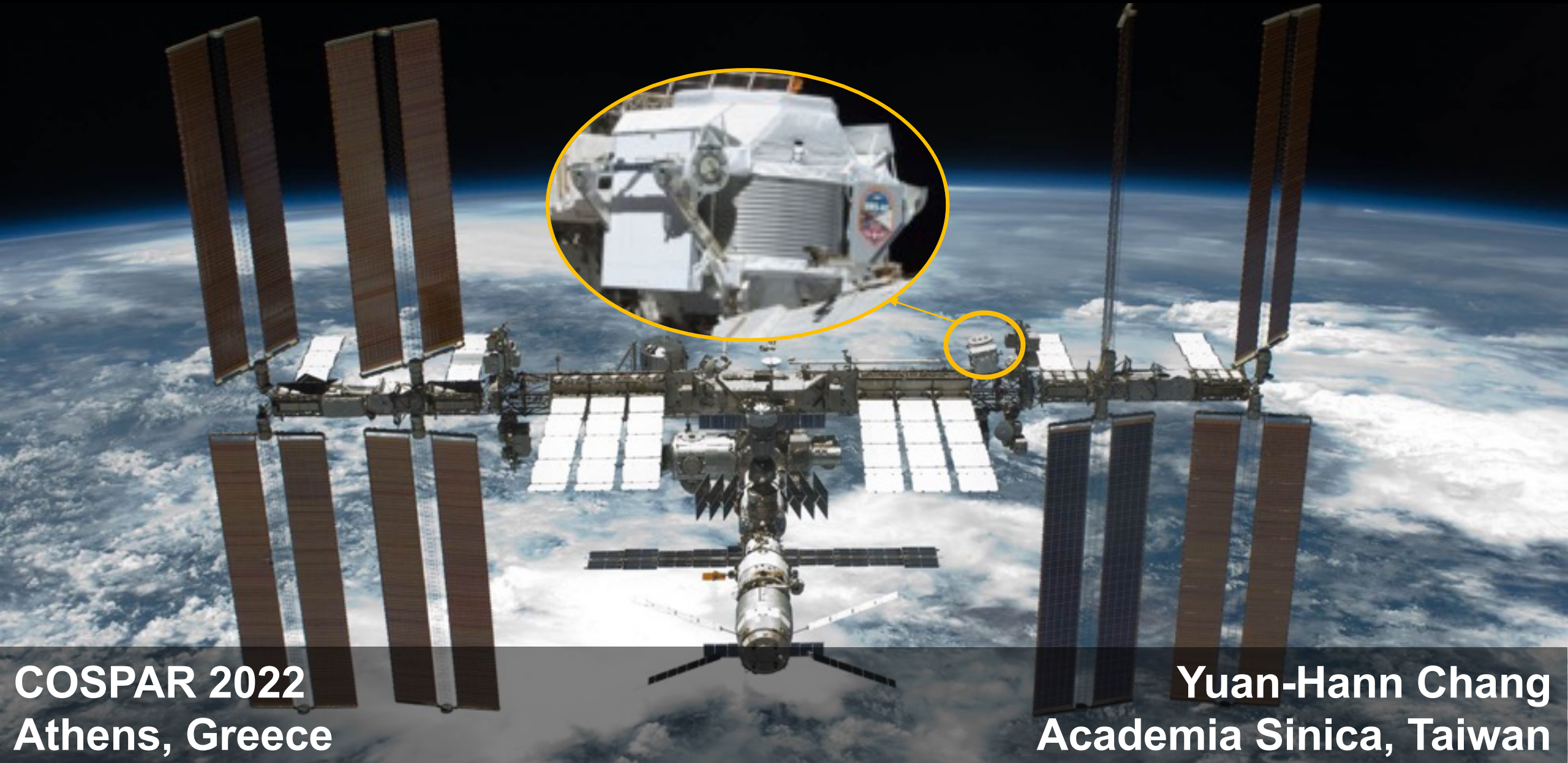


Cosmic Antideuteron

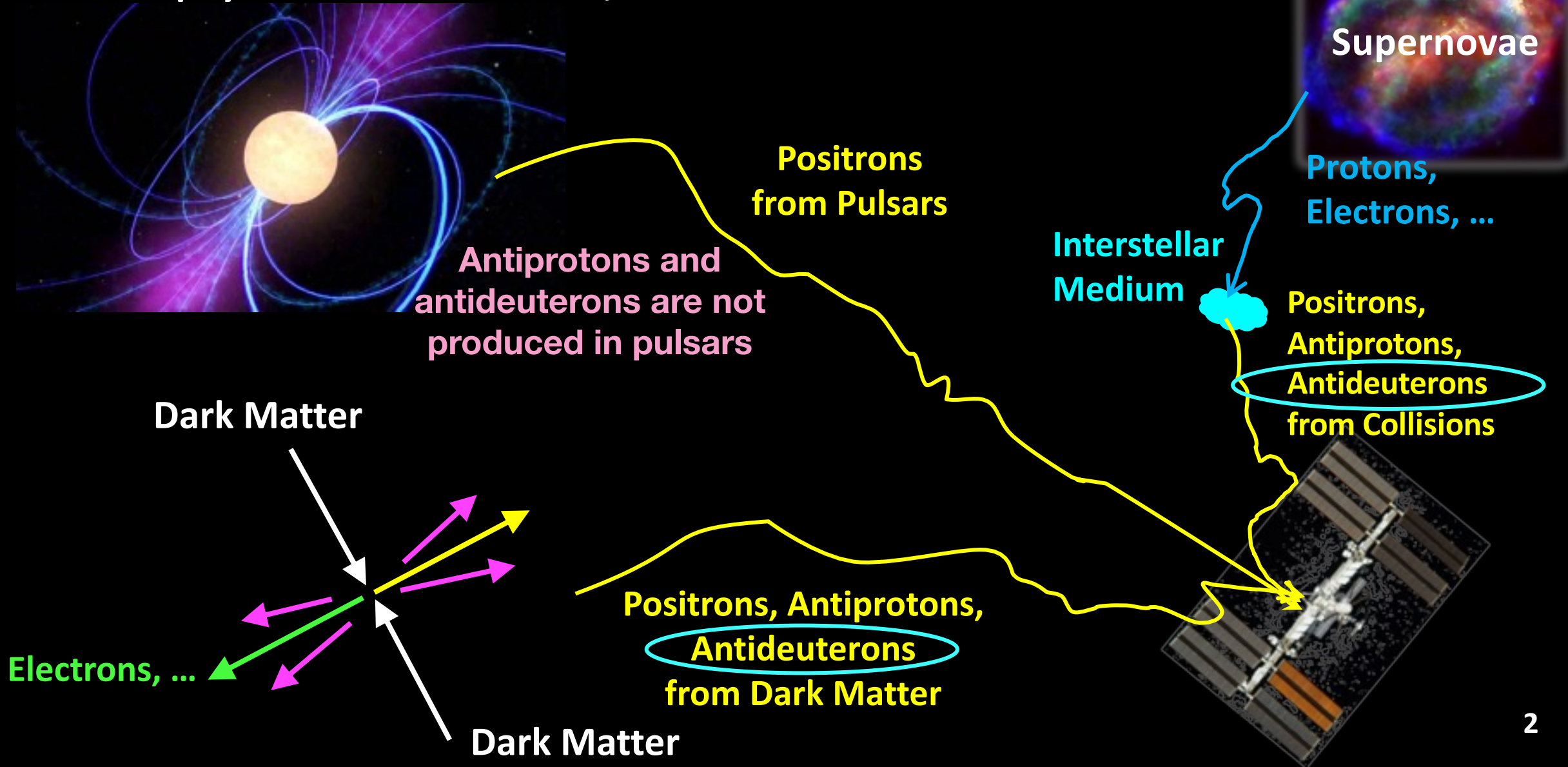


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Athens, Greece

Yuan-Hann Chang
Academia Sinica, Taiwan

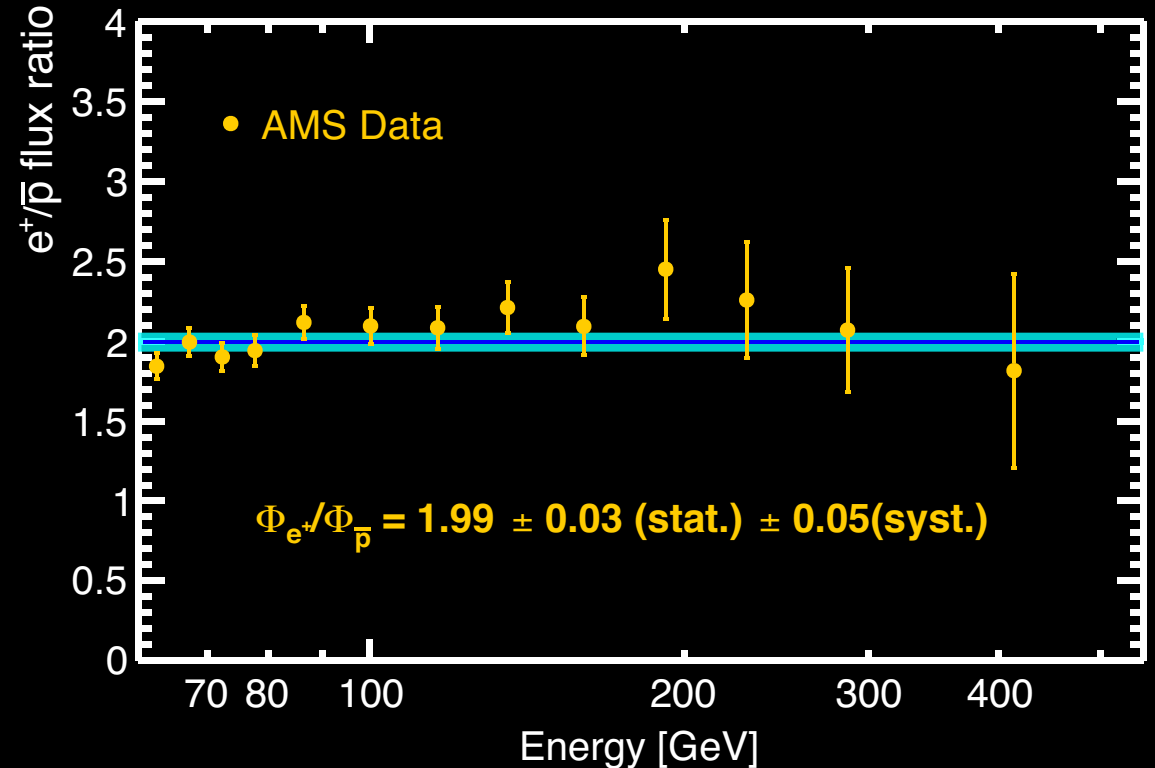
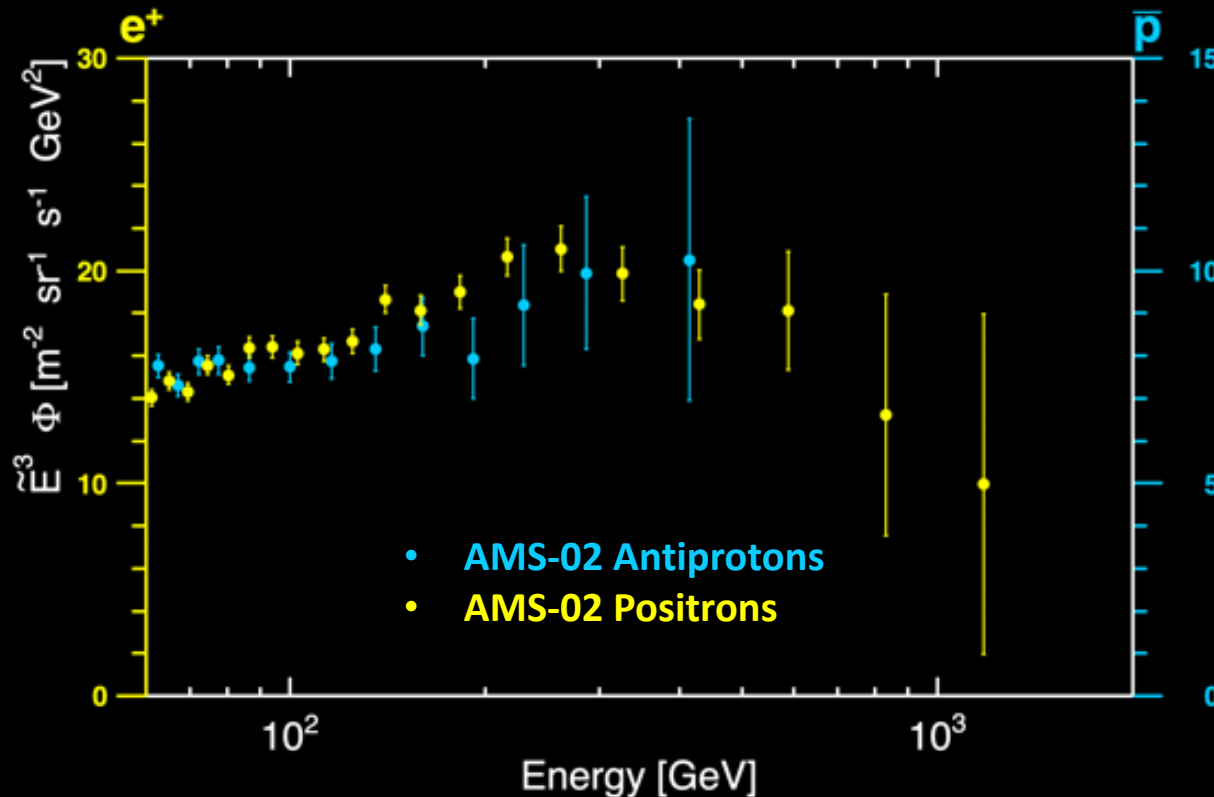
Cosmic Antiparticles as A Probe for New Physics

New Astrophysical Sources: Pulsars, ...



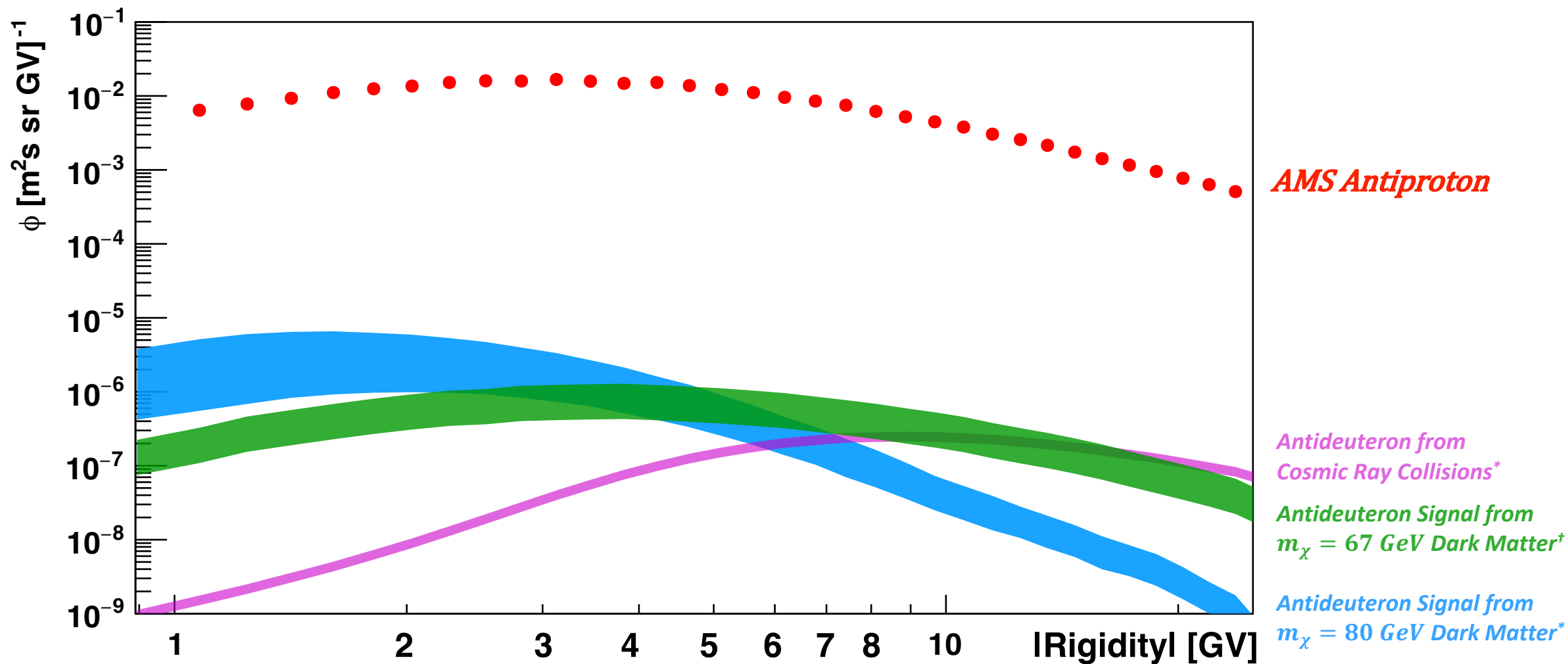
AMS Measurement of Positron and Antiproton

- AMS data shows new and unexpected features from positron and antiproton spectra.
- It is important to extend the study with the antideuteron.



Antideuteron Signals from Dark Matter

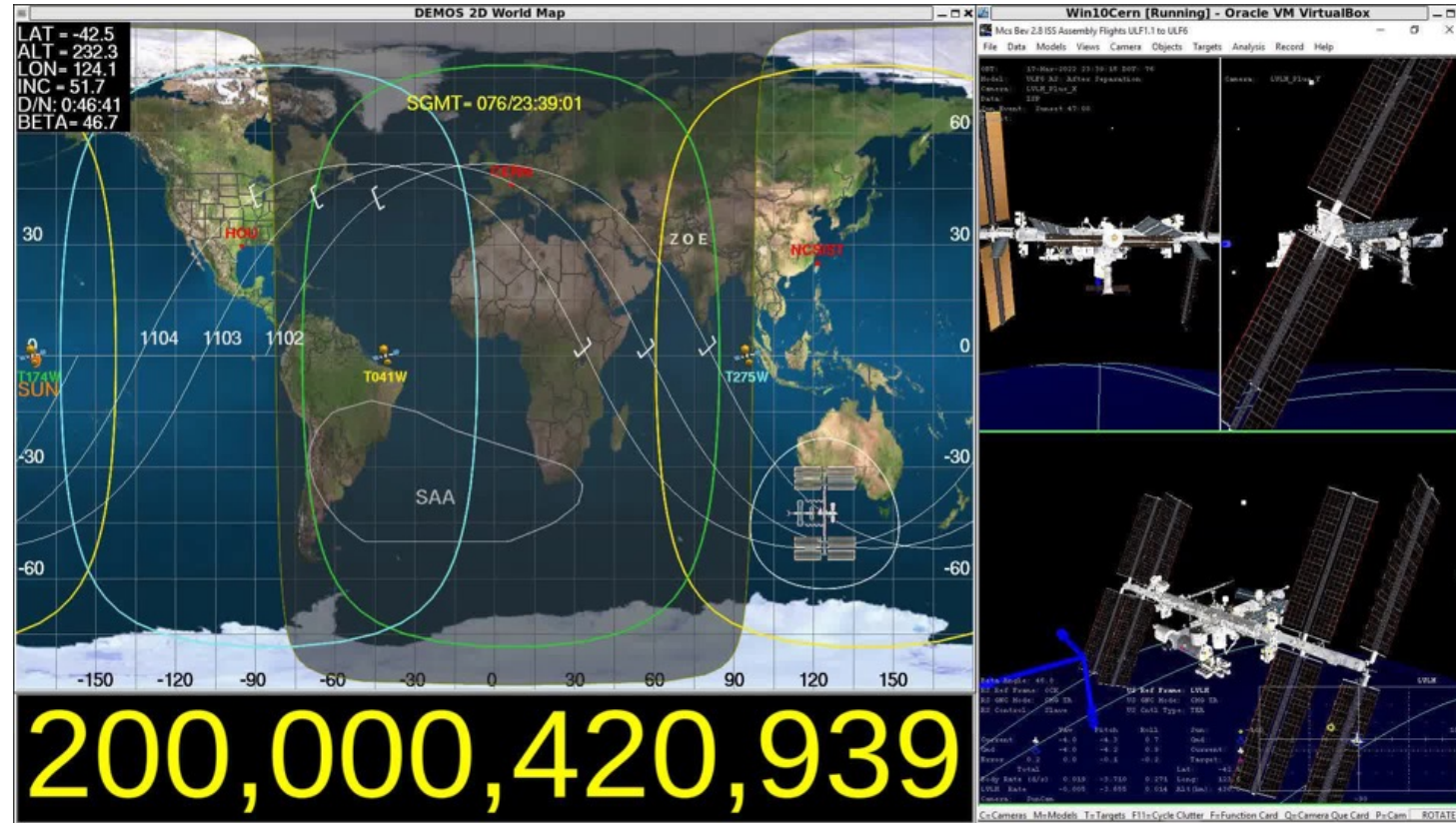
- Antideuteron Flux is $<10^{-4}$ of the Antiproton Flux
- High Signal-to-Background Ratio at low energy



* M. Korsmeier et al., Phys.Rev.D 97 (2018) 10, 103011

† I. Cholis et al., Phys.Rev.D 102 (2020) 10, 103019

Antideuteron have never been observed in Cosmic Rays.



00:39:01 CET 18 March 2022

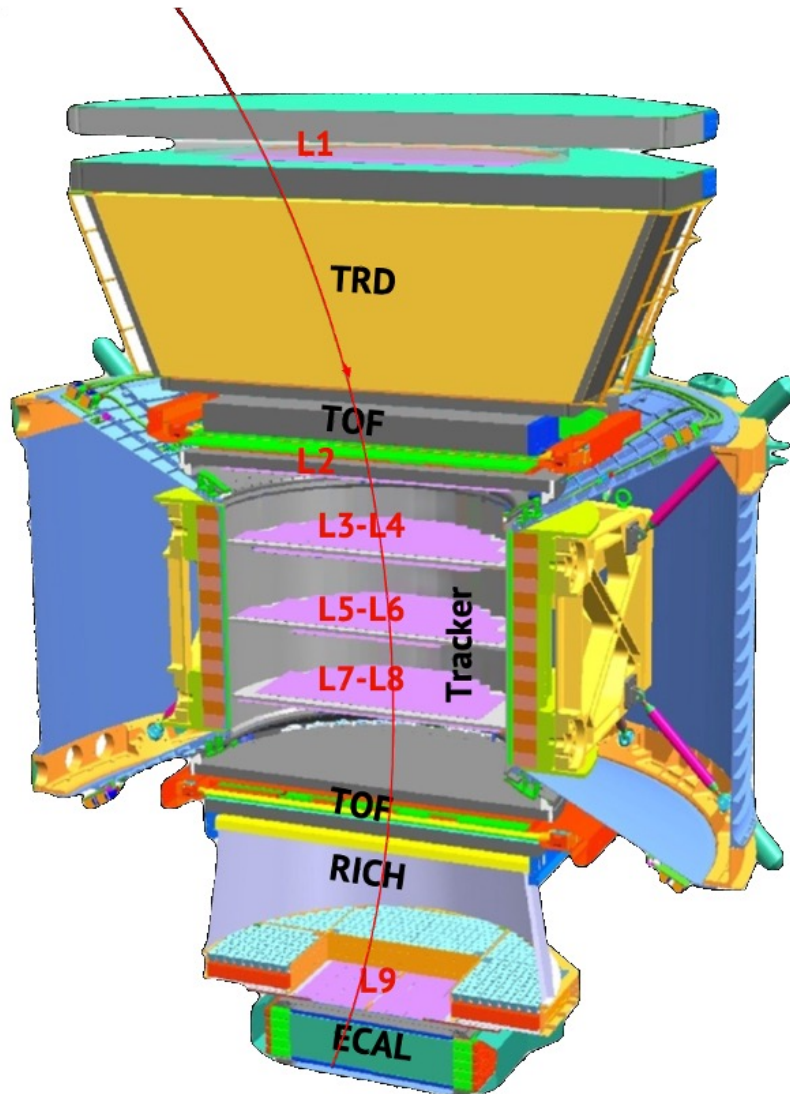
With 10 Years of data taking,
AMS has collected more than 200 billion of events.

A high signal efficiency and low background analysis is required due to their extreme low rate. 5

AMS Measurement of $|Z| = 1$ Particle to Identify Antideuteron

$e^\pm$ can be rejected by the TRD

The only way to distinguish $p^\pm, d^\pm$ is measuring the mass $M = RZ/\beta\gamma$



TRD, Tracker, TOF, RICH

Charge Magnitude

Along Particle Trajectory

$\Delta Z (Z=1) \approx 0.05-0.1$

Tracker + Magnet

Rigidity (R) and Charge Sign

$R \cdot \Delta(1/R) \approx 10\%$ at 10GV

TOF

Velocity and Direction by ΔT

$\Delta\beta/\beta^2 \approx 4\%$ ($Z=1$)

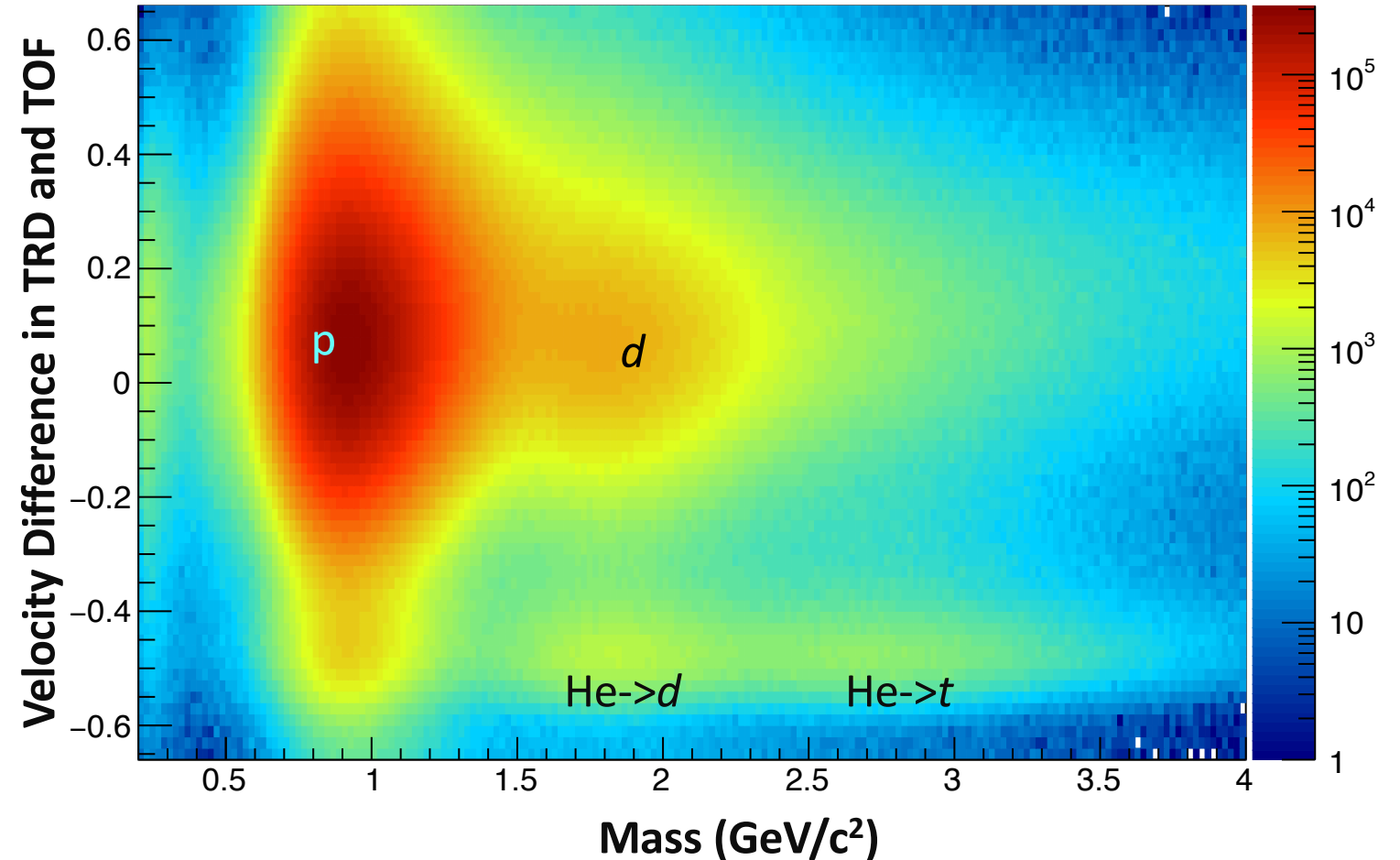
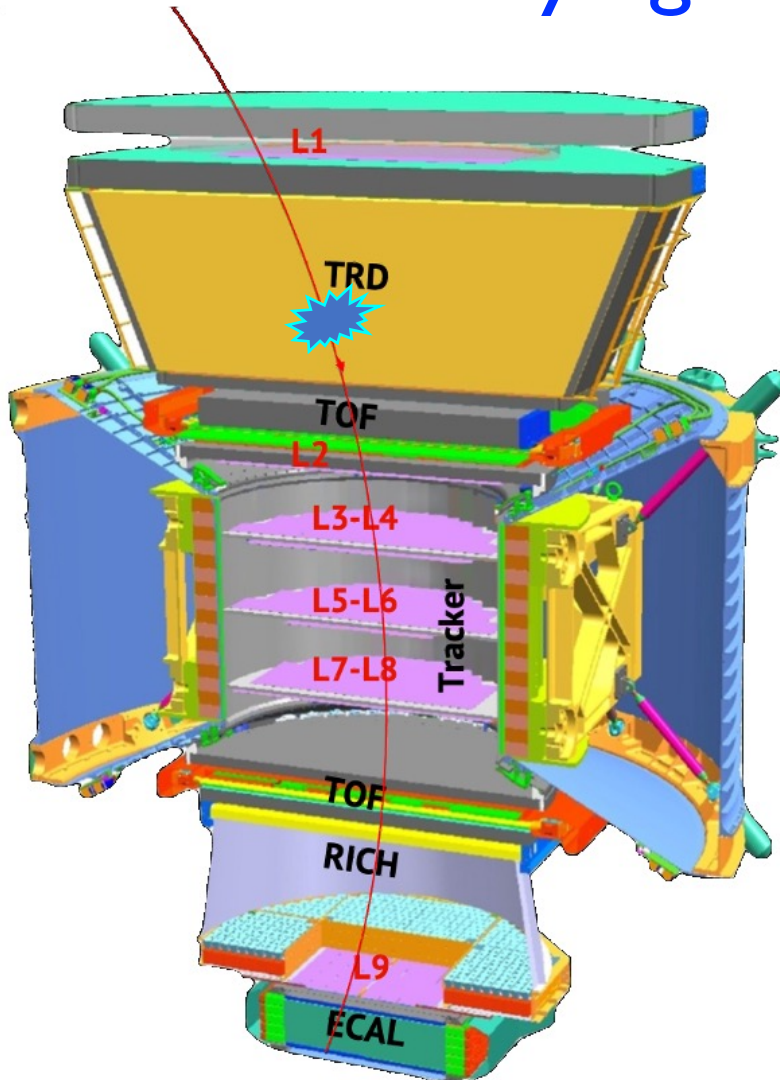
RICH

Velocity by Cherenkov light

$\Delta\beta/\beta \approx 0.1 - 0.4\%$ ($Z=1$)

Unique Property of AMS:

Classifying Events with Redundant measurements

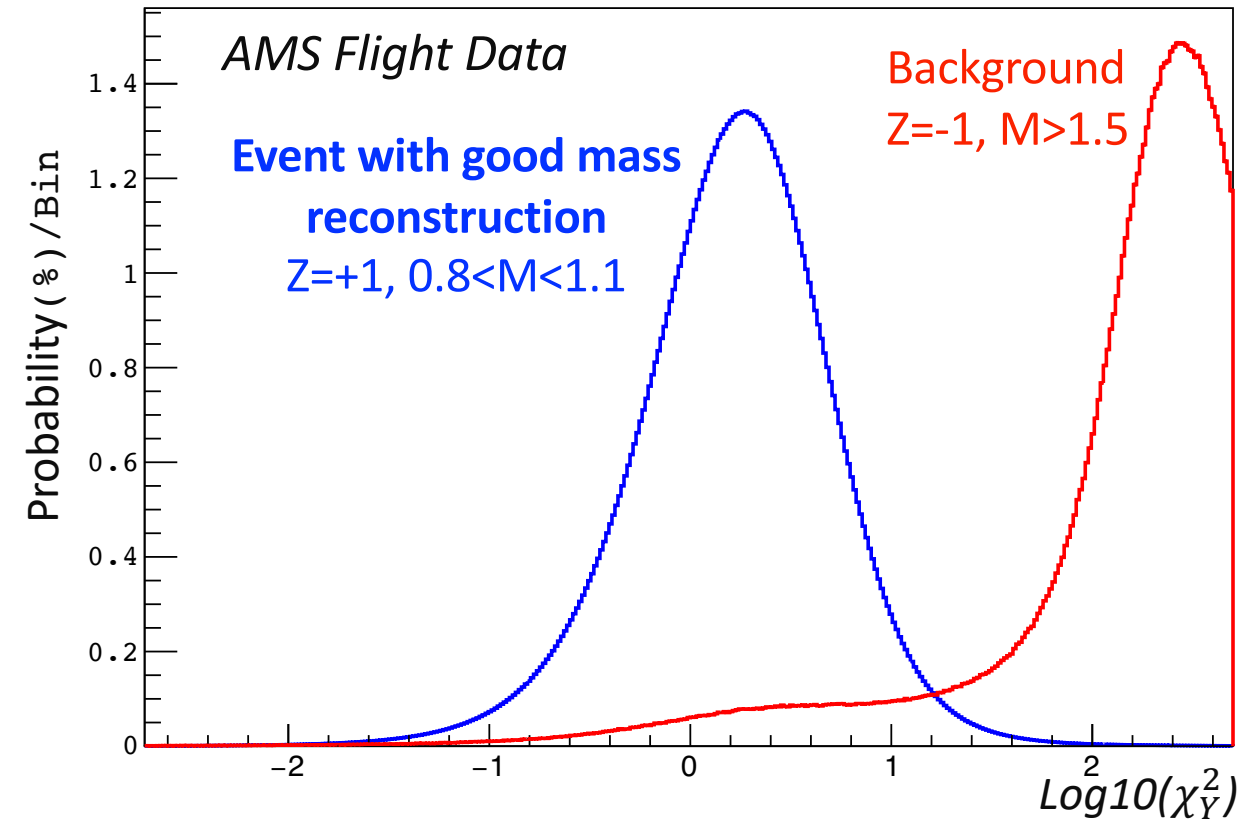


Background rejection: Track quality variables

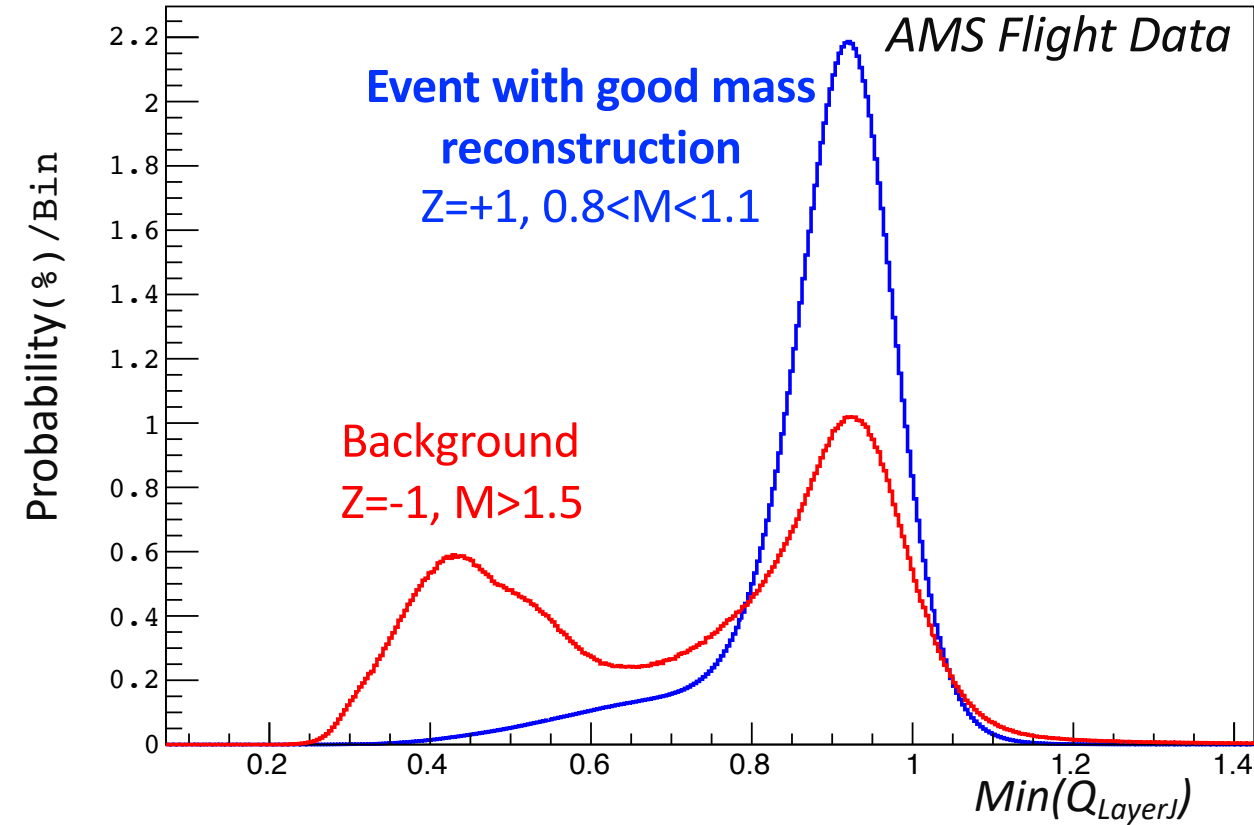
Examples:

- Tracks with large scatterings: removed by Track Fitting χ^2
- Event with noise hit: removed by Minimum Charge of Tracker Hits.

Track Fitting χ_Y^2

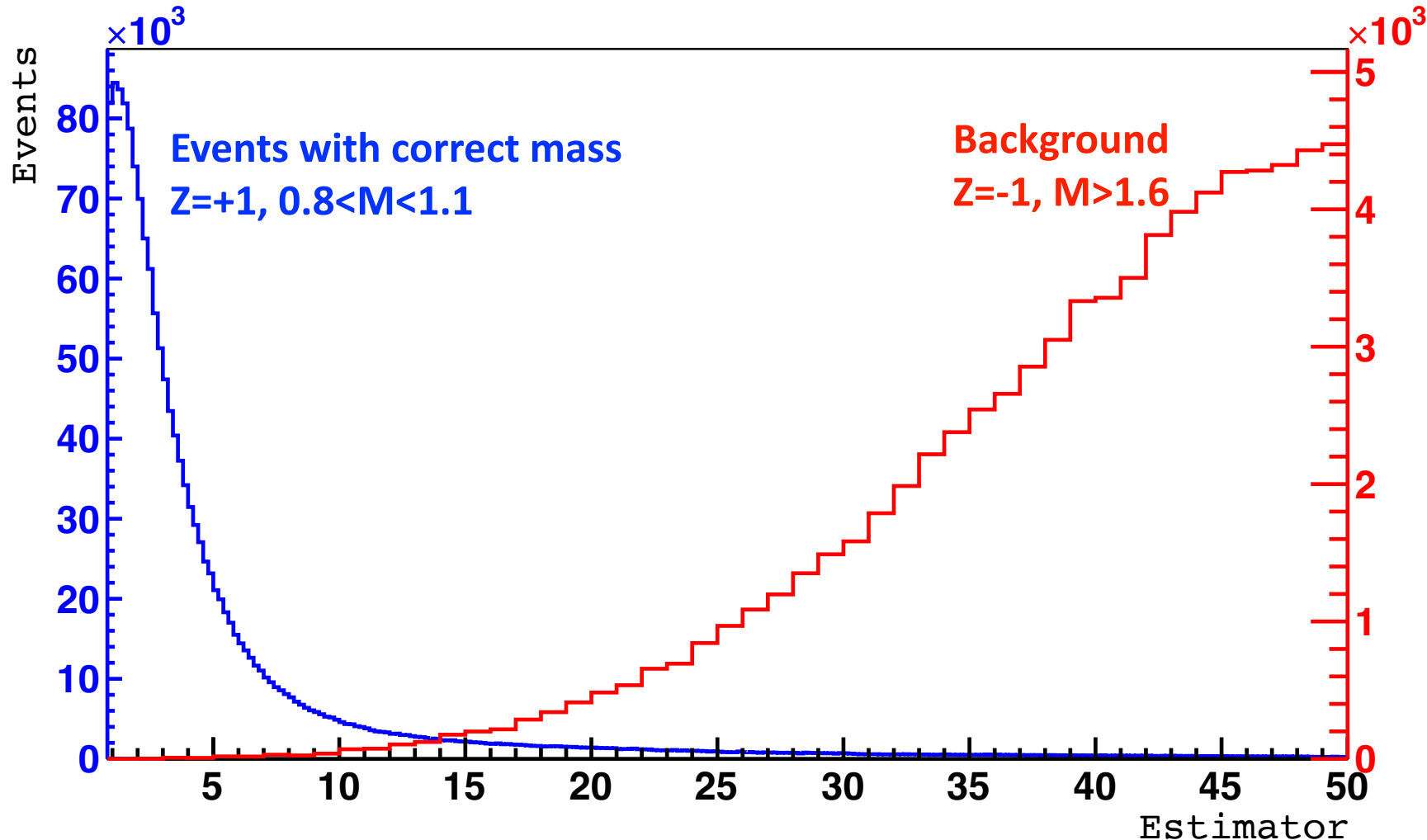


Minimum Charge of Tracker Hits



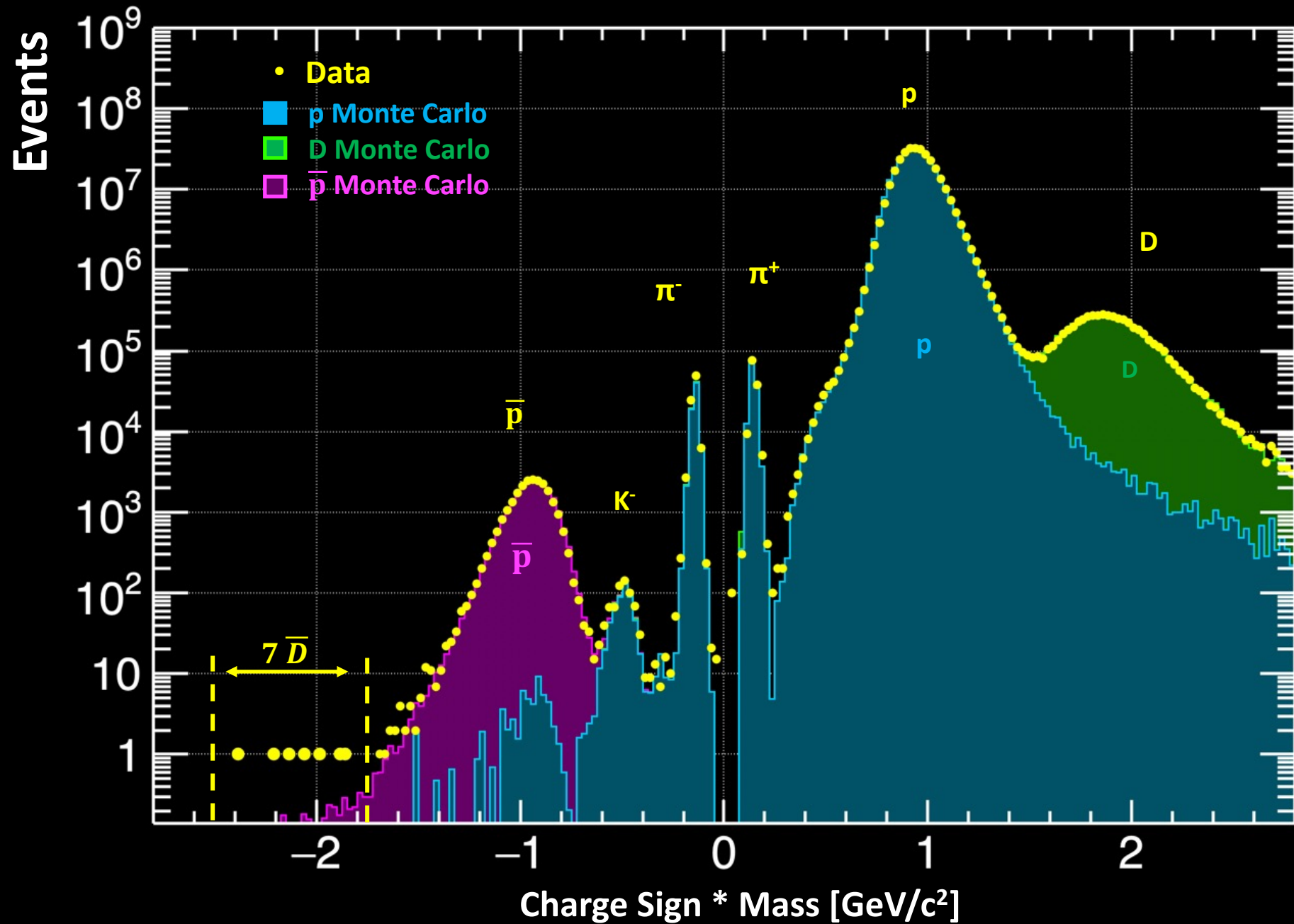
Data-Driven Method: Mass Quality Estimator

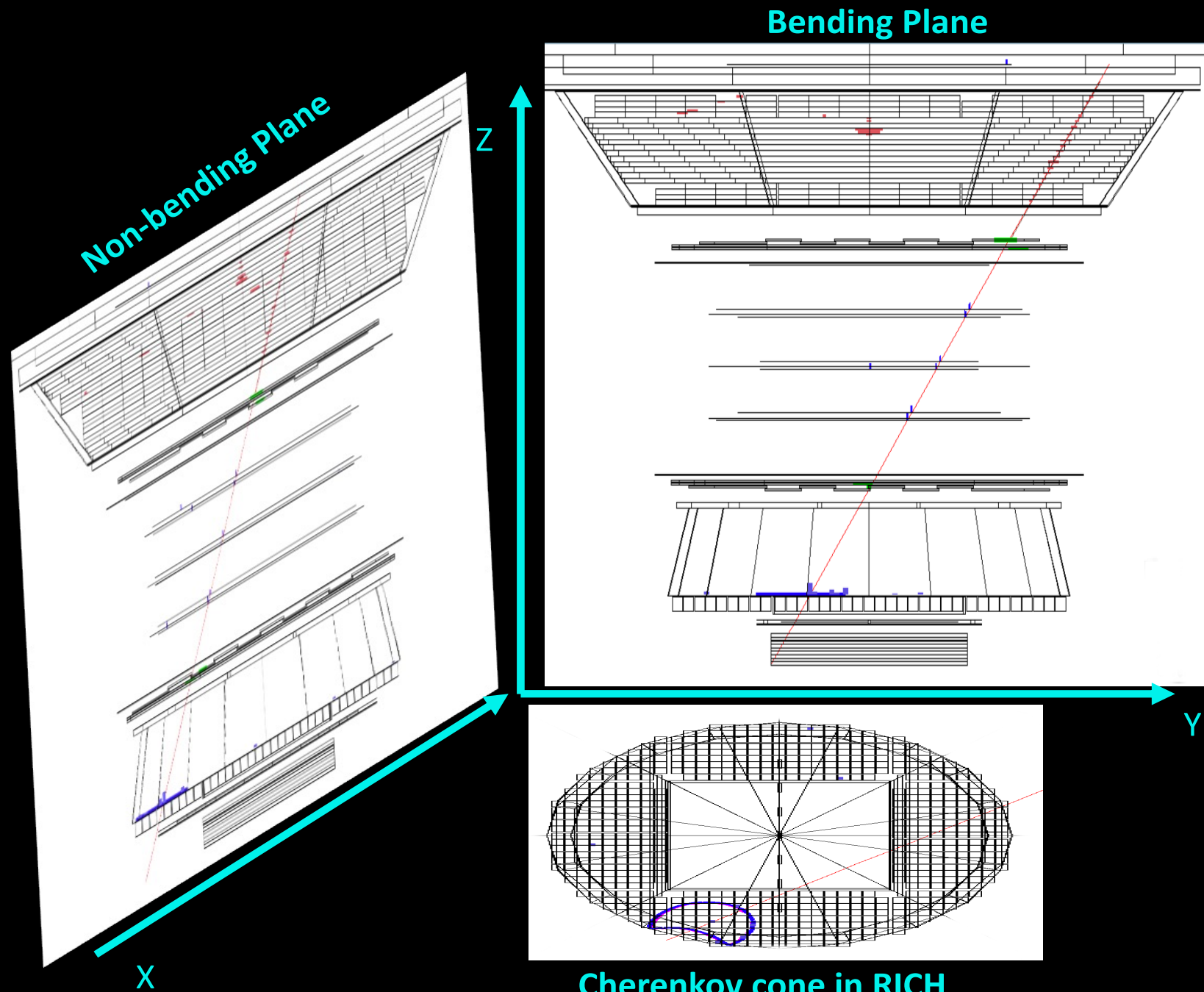
Use the sum of log-likelihood $E = -\sum \log P(v_i)$ for variables (v_i) from **TOF, Tracker, RICH, TRD** to build the Mass Quality Estimator (MQE)



MQE is built with only AMS data collected in space

Current AMS Anti-Deuteron Status





Anti-deuteron Candidate
Charge = -1.02 ± 0.05
Mass = $1.9 \pm 0.1 \text{ GeV}/c^2$

Deuteron
Charge = $+1$
Mass = $1.88 \text{ GeV}/c^2$

Conclusion

- *AMS has collected more than 200 billion events during the first 10 years of data taking.*
- *A few antideuteron candidates were selected with the Mass Quality Estimator. Extensive study of the Monte Carlo simulation is on-going to understand the detector effects.*
- *With continuous data taking through the lifetime of the Space Station, AMS will be able to ultimately probe the existence of primary sources of antideuteron in the cosmos.*