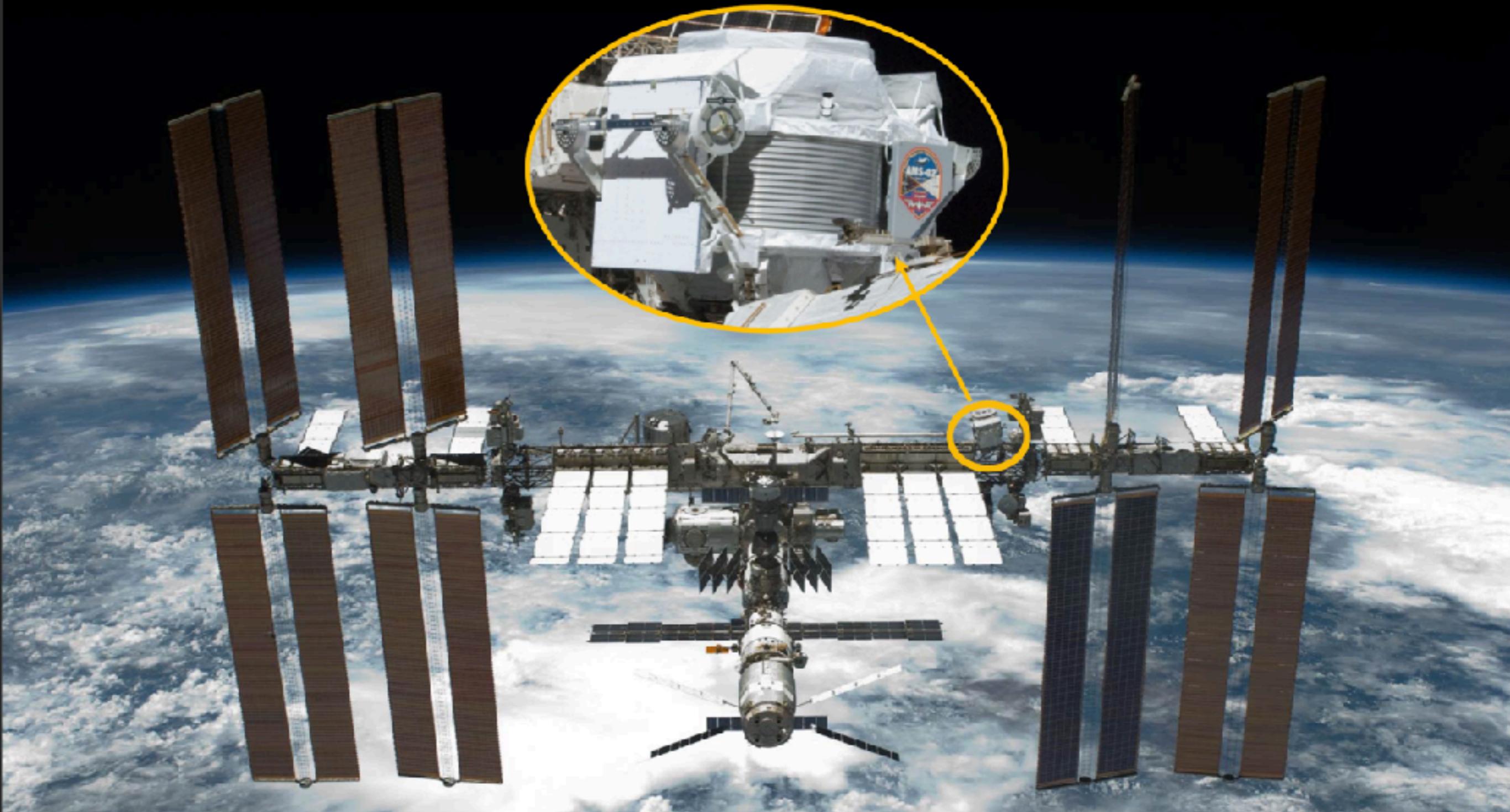


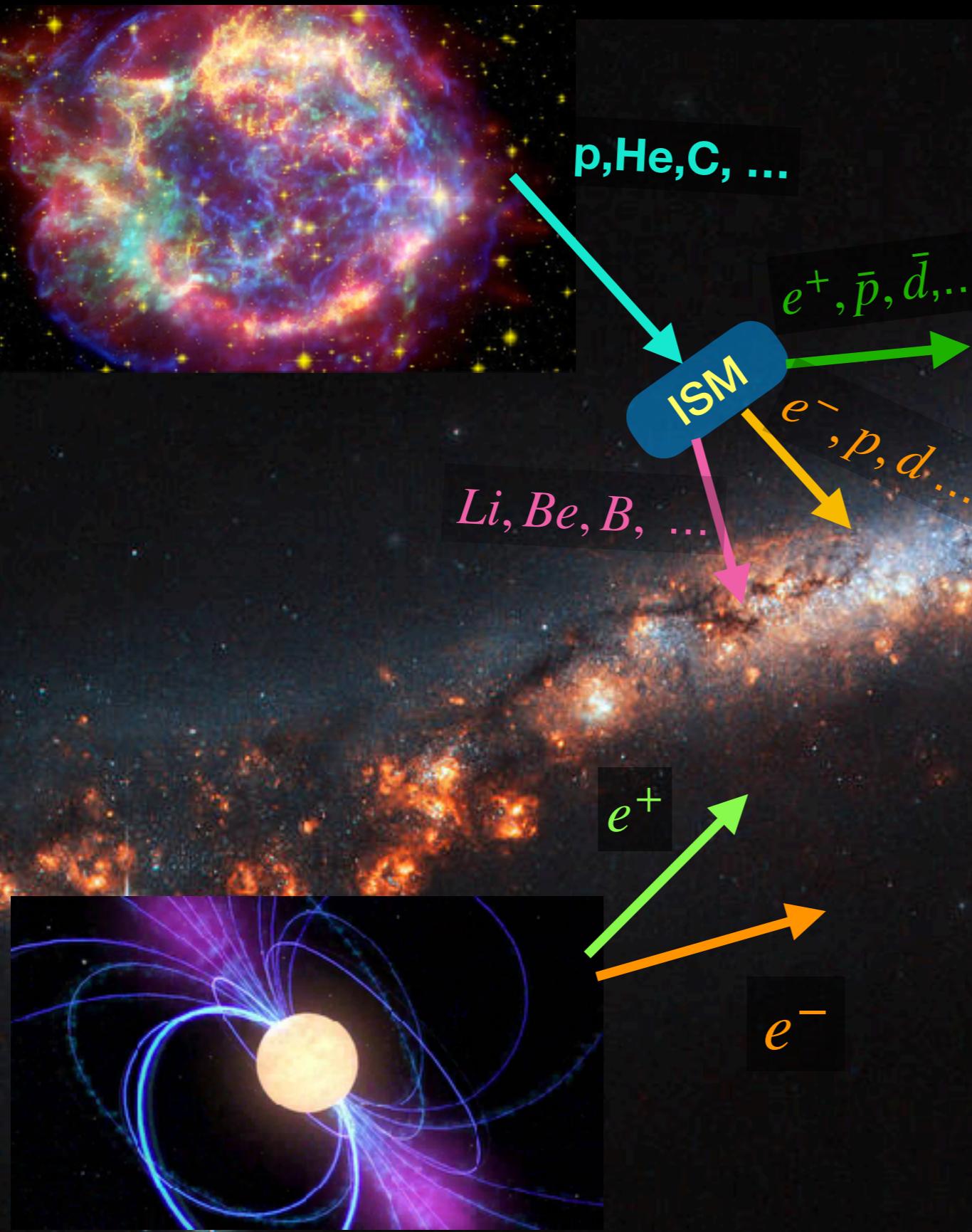
Search of Antideuteron with AMS on the ISS: A data-driven approach



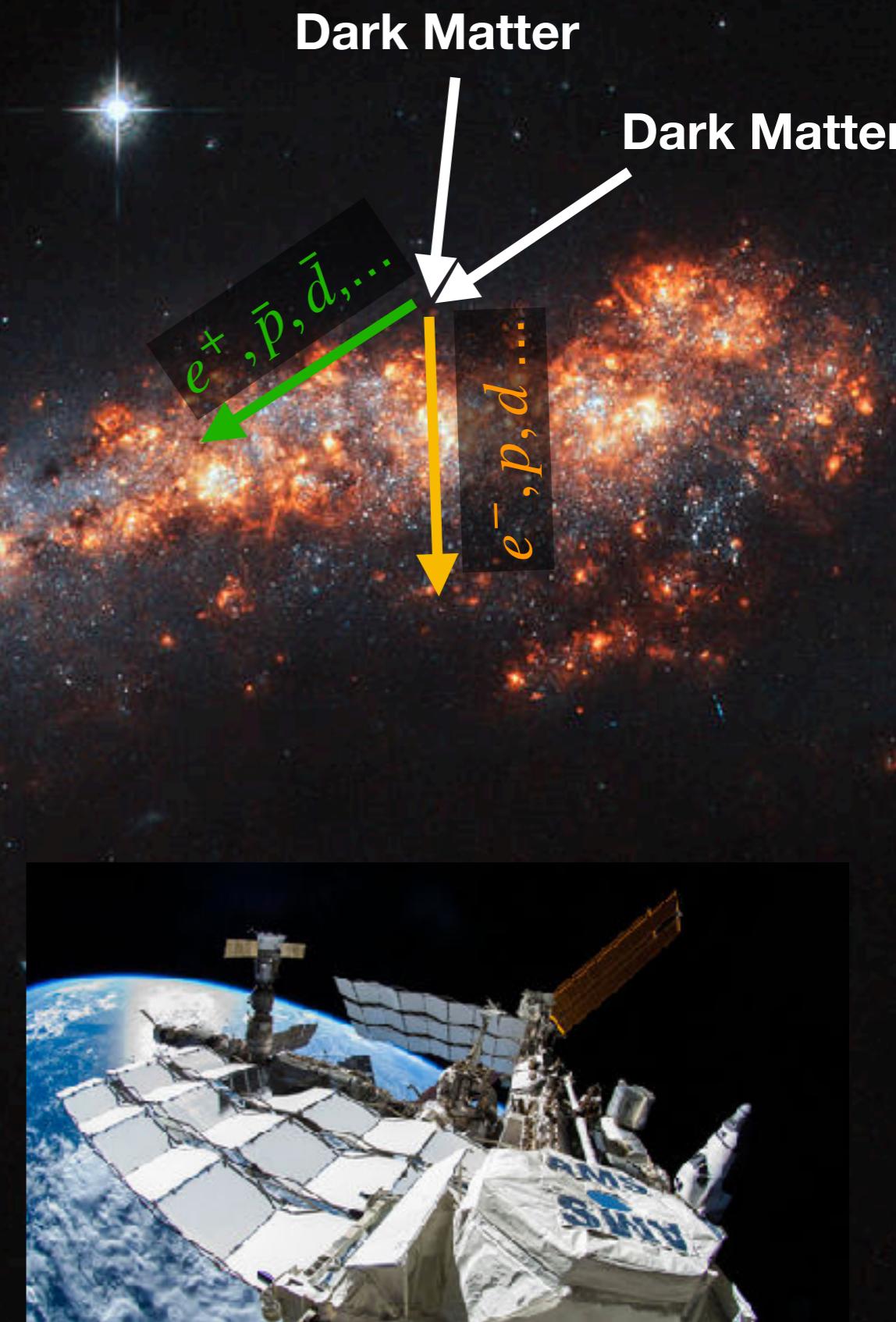
Senquan Lu / Academia Sinica
2019-Oct-15
Lorentz Center, Leiden

On the Origin of Cosmic Rays

Supernovae

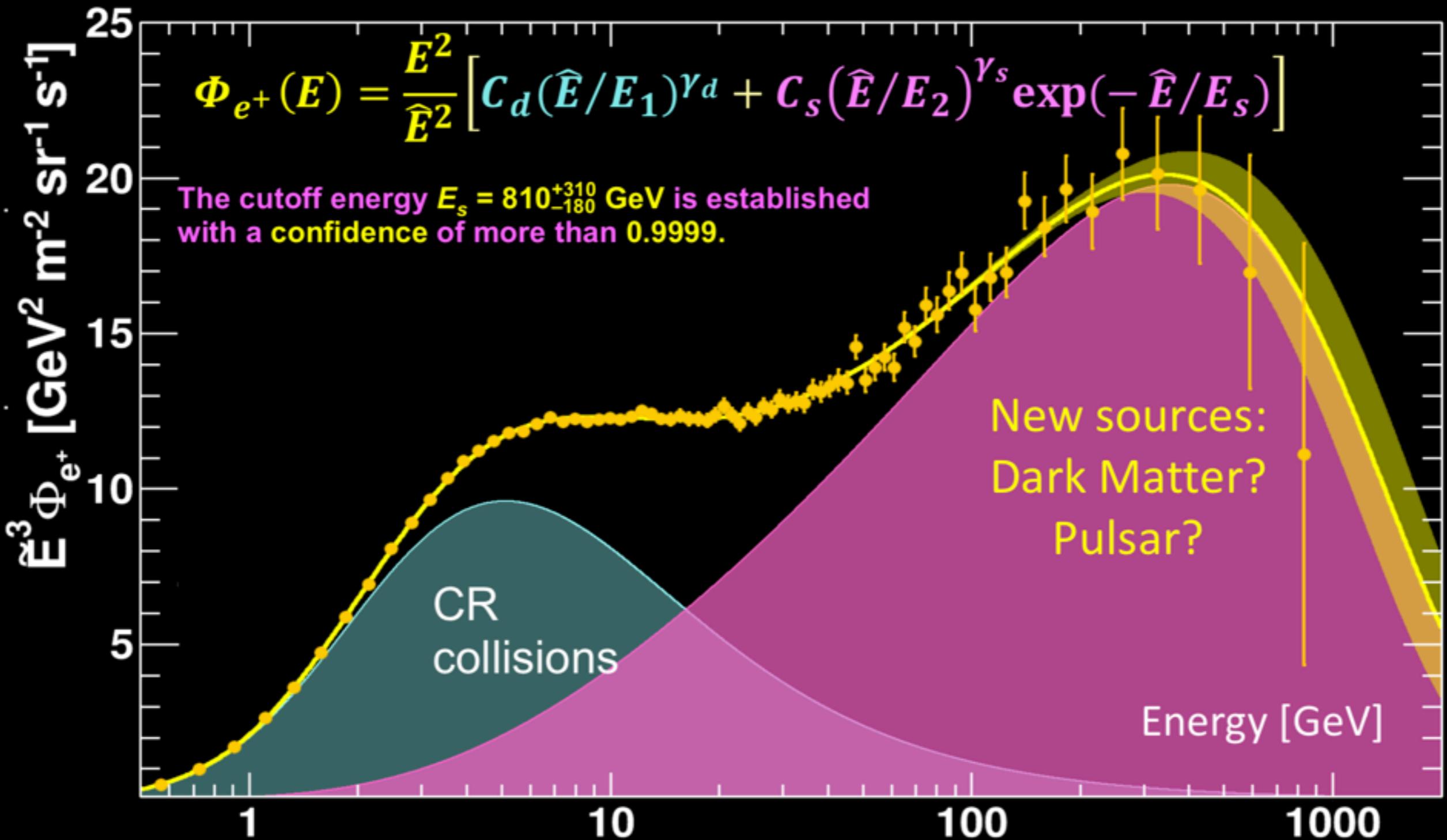


Dark Matter

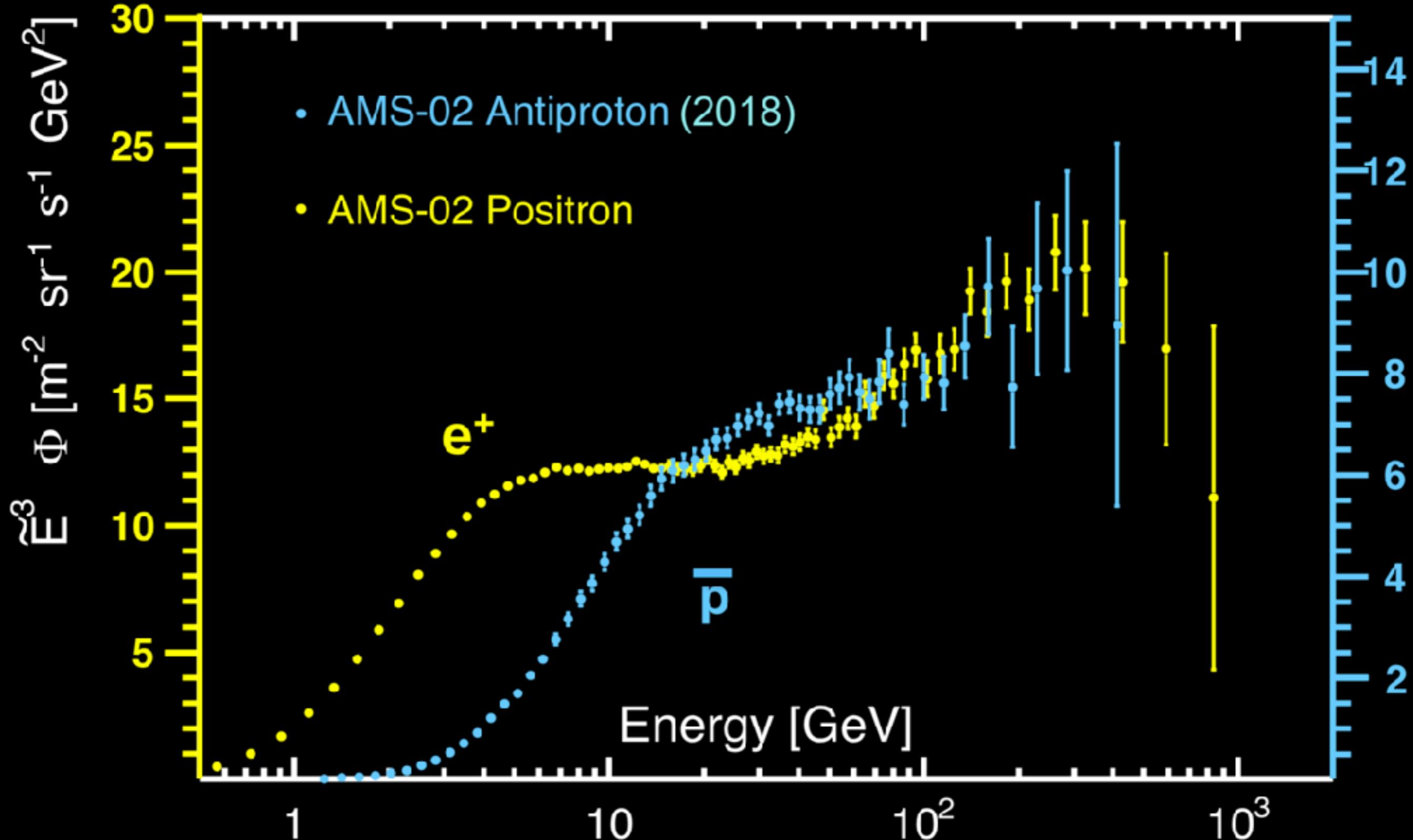


New Astrophysical Sources: Pulsars, ...

AMS Measurement of Positron

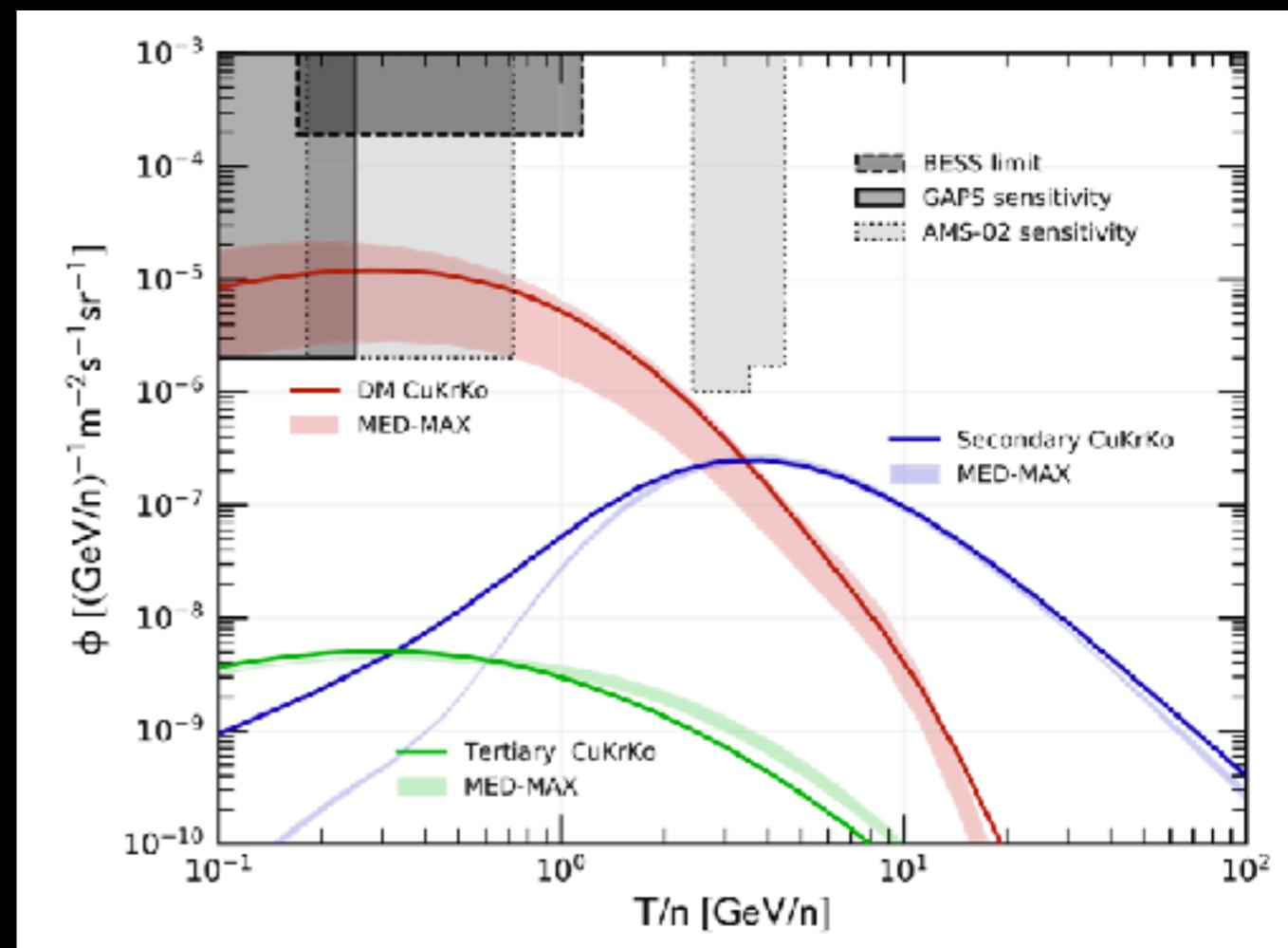
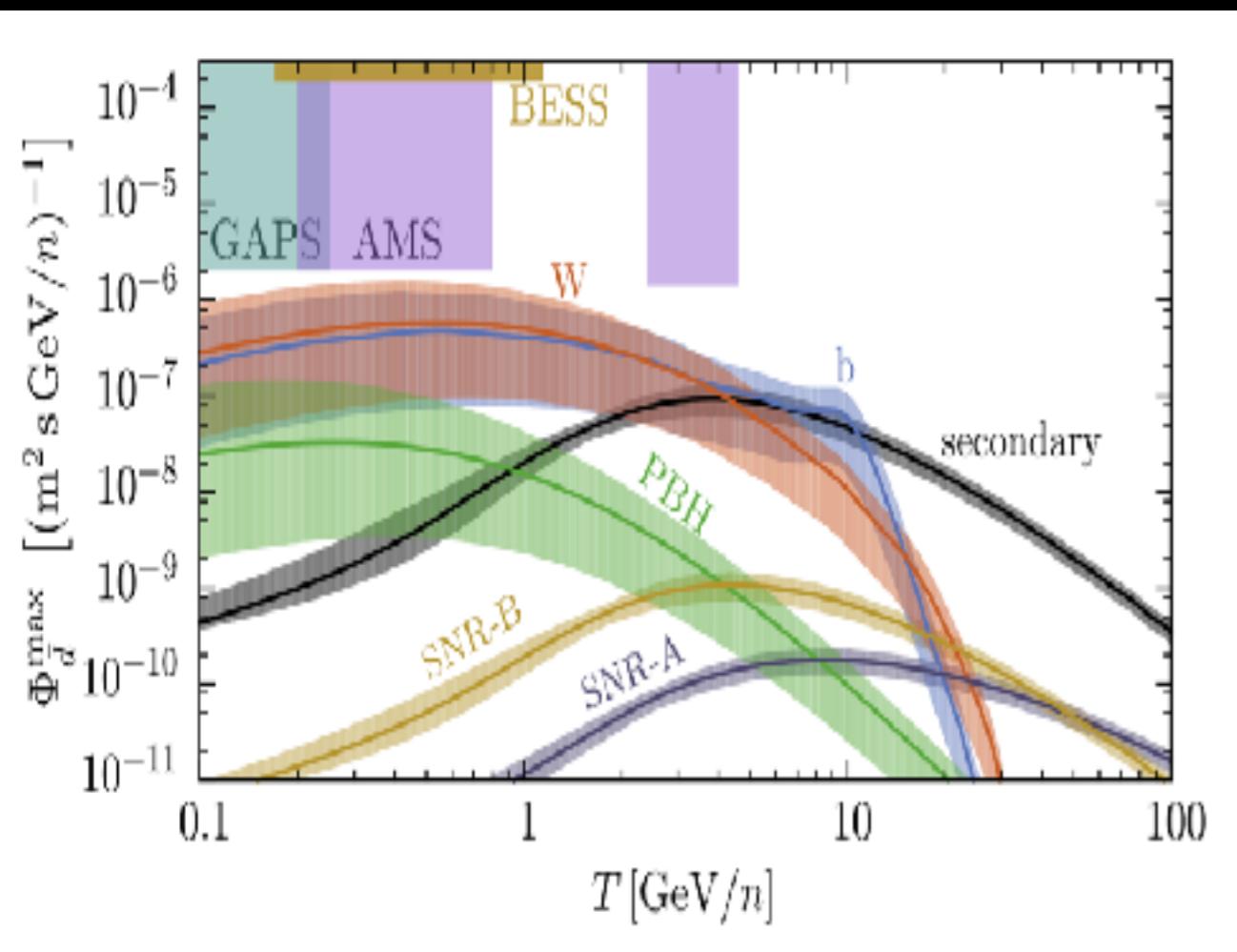


Latest Results on Antiproton



Anti-D for Dark Matter Searches

High Signal-to-Background Ratio



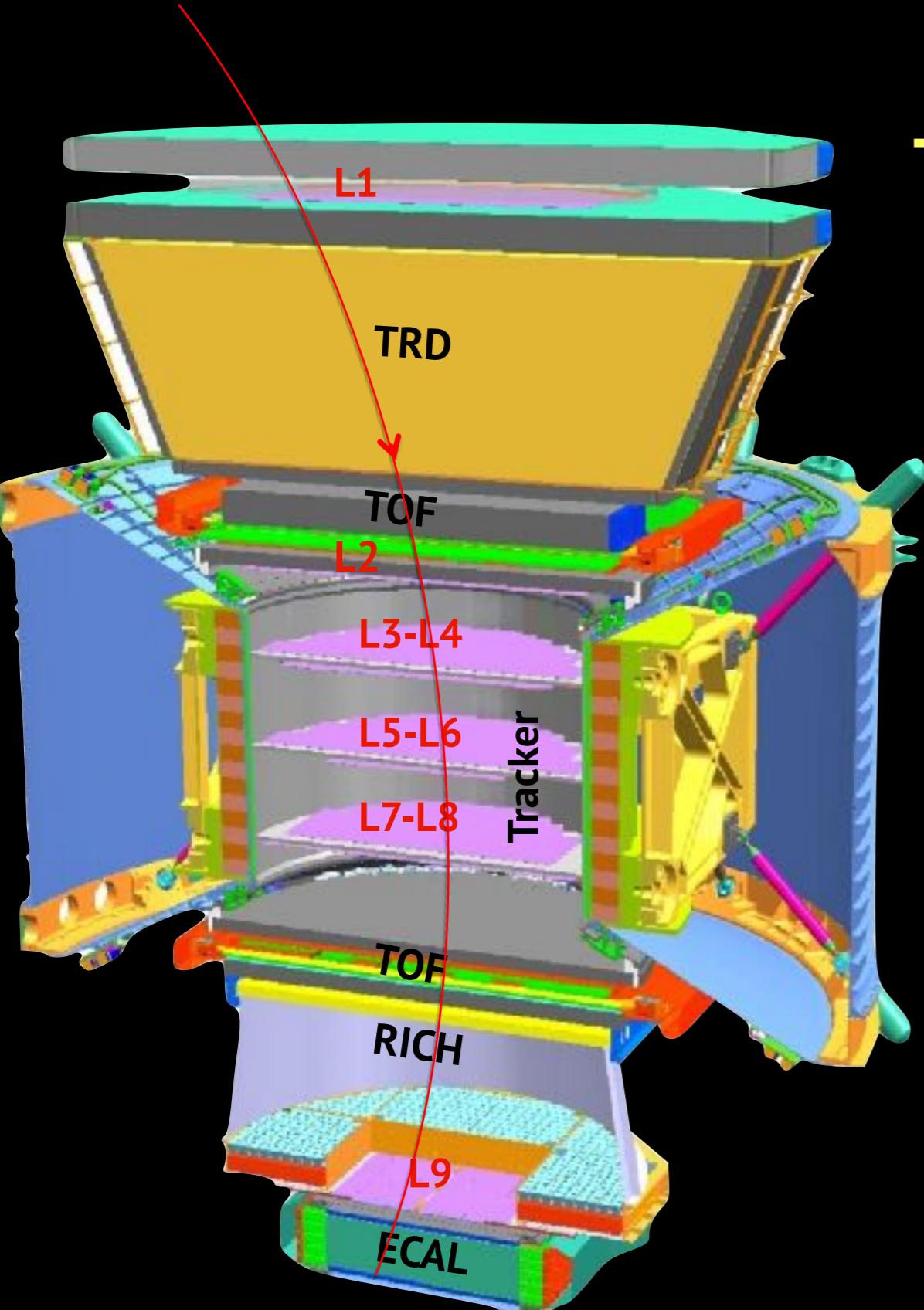
J. Herms, A. Ibarra, A. Vittino and S. Wild,
JCAP02(2017)018

M. Korsmeier, F. Donato, and N. Fornengo,
Phys. Rev. D 97, 103011. (2018)

AMS has collected more than 100 million cosmic ray deuterons.

Analysis of Antideuteron is on-going by two independent working groups in AMS

Mass Measurement by AMS



Tracker + Magnet

Rigidity (R) and Charge Sign
 $R^* \Delta(1/R) \approx 10\% \text{ at } 10\text{GV}$

TOF

Velocity and Direction by ΔT
 $\Delta\beta/\beta^2 \approx 4\% \text{ (Z=1)}$

RICH

Velocity by Cherenkov light
 $\Delta\beta/\beta \approx 0.1 - 0.4\% \text{ (Z=1)}$

TRD, Tracker, TOF, RICH

Charge Magnitude
Along Particle Trajectory

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

$$M = \frac{RZ}{\beta\gamma}$$

Analysis Method: Mass Quality Estimator

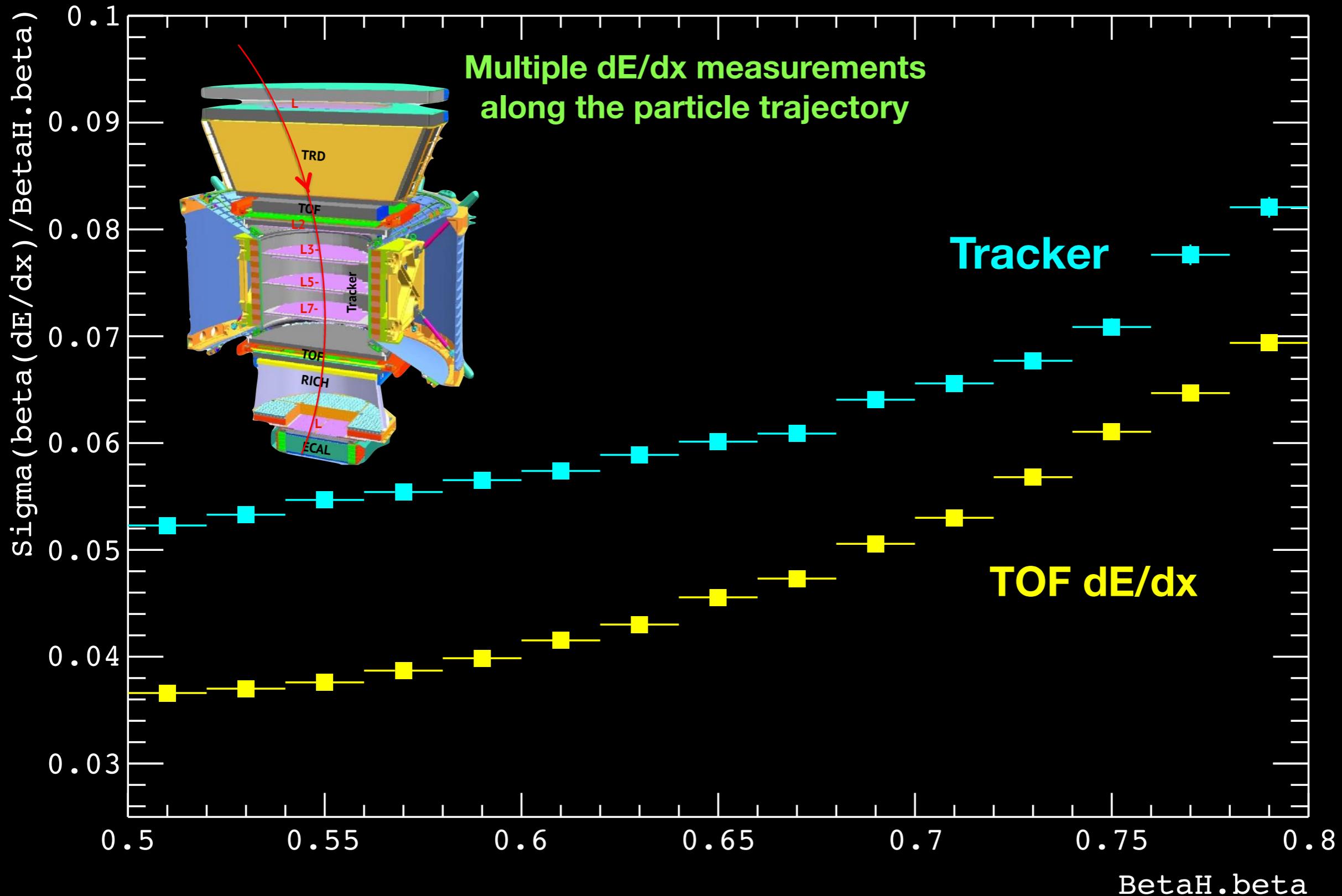
A single value that evaluate the reconstruction quality of the mass by combining the informations from different sub-detectors.

$E = -\sum \log P(v_i)$ for variables (v_i) from TOF, Tracker, RICH:

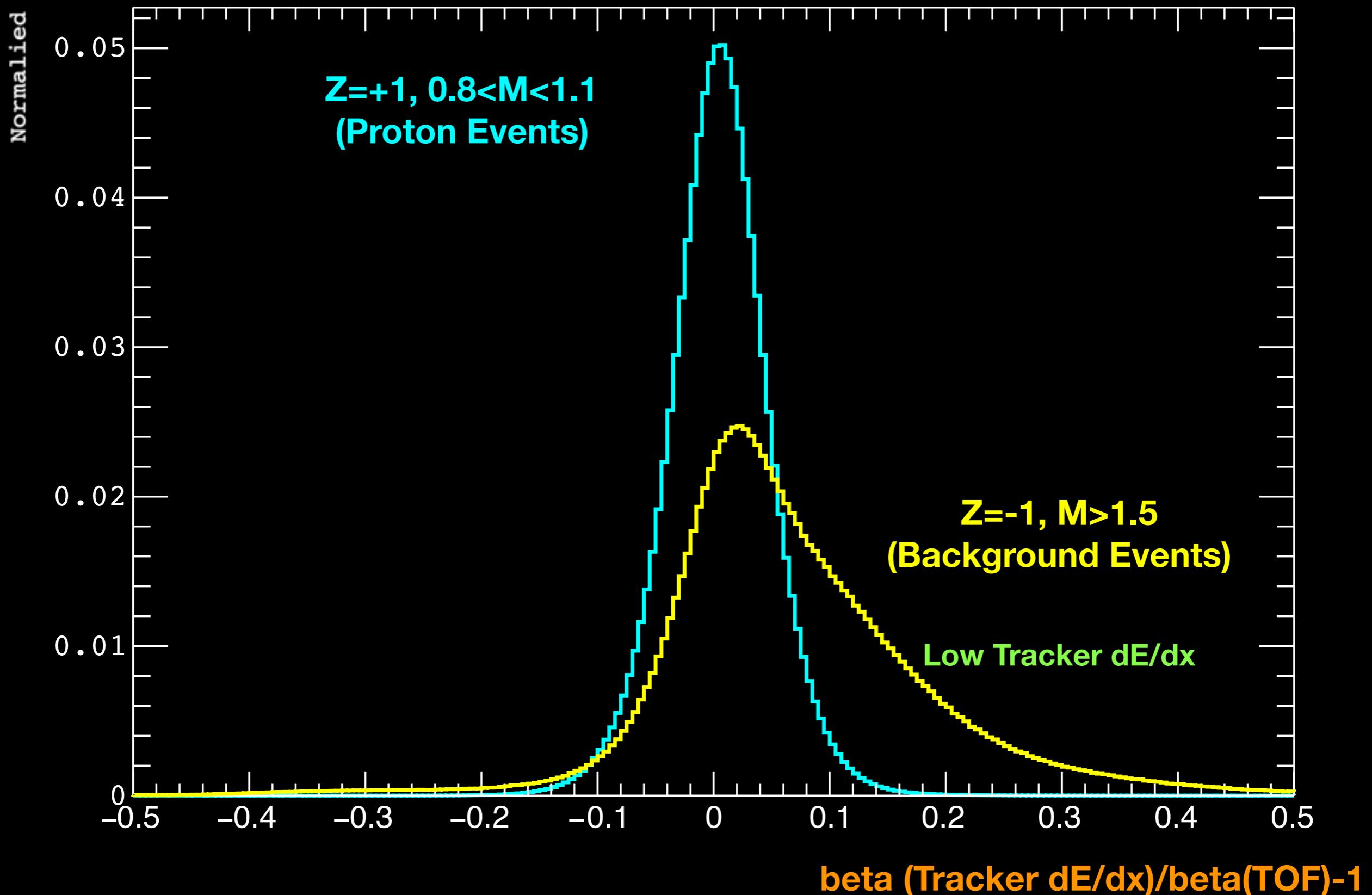
- TOF Fitting Quality: $\chi^2_{Coord.}, \chi^2_{Time}$;
- TOF Charge Measurement $Q_{Upper}/Q_{Lower}, \text{Prob}(Z=1)$;
- Tracker Fitting Quality in the bending direction: $\chi^2_{Y,Algorithm(1,2)}$
- Tracker Fitting Quality in the non-bending direction: $\chi^2_{X,Algorithm(1,2)}$
- Tracker Charge Measurement: $\text{Min}(Q_{Layer})$
- RICH: Number of Cherenkov photons
- RICH: Distance of Particle Trajectory to Radiator Border
- Beta(Tracker, TRD, TOF dE/dx) vs Beta(TOF, RICH)
- ...

PDF is defined from flight ($Z=+1$) data, e.g., free from Monte Carlo

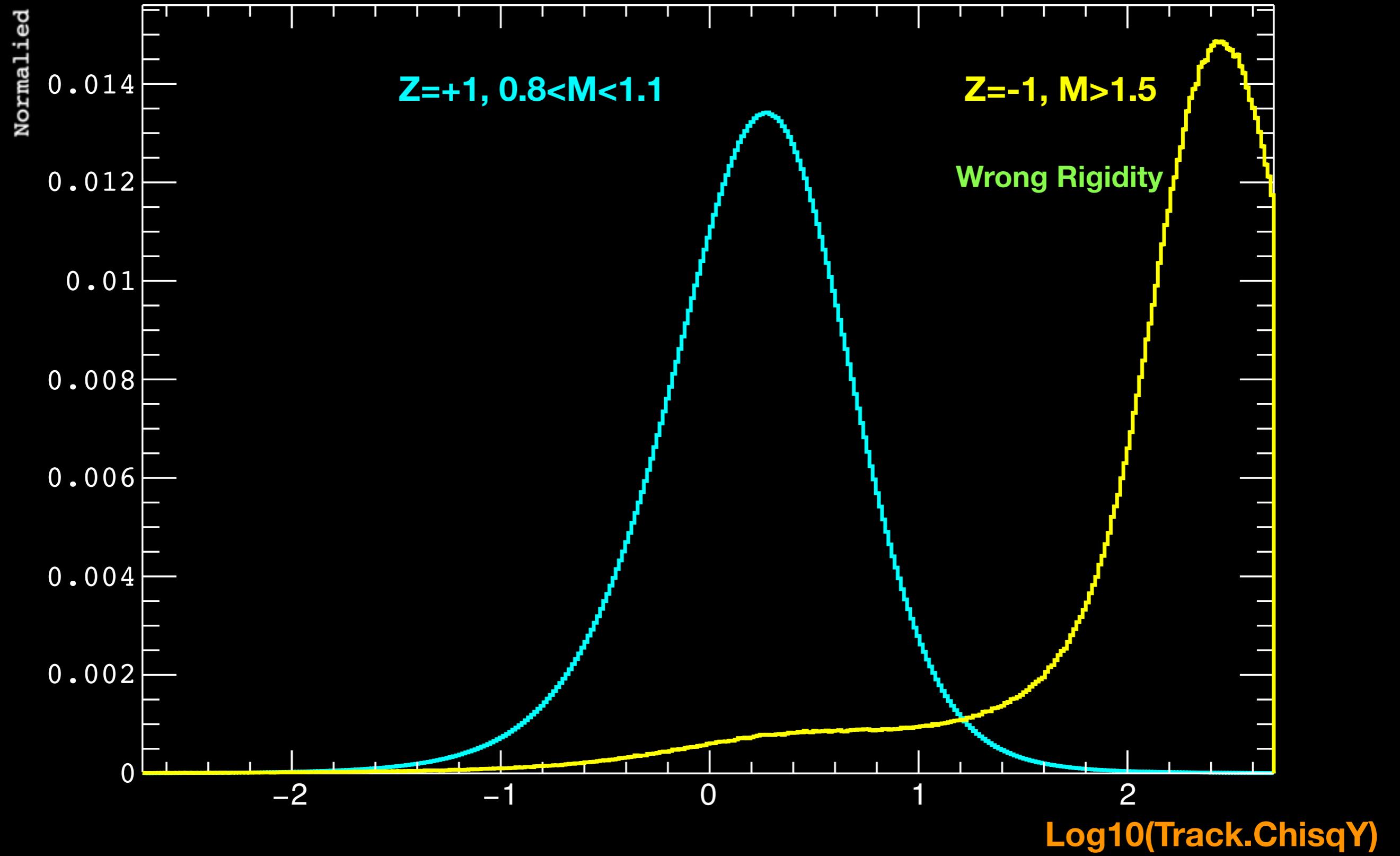
Redundant Velocity Measurement by dE/dx



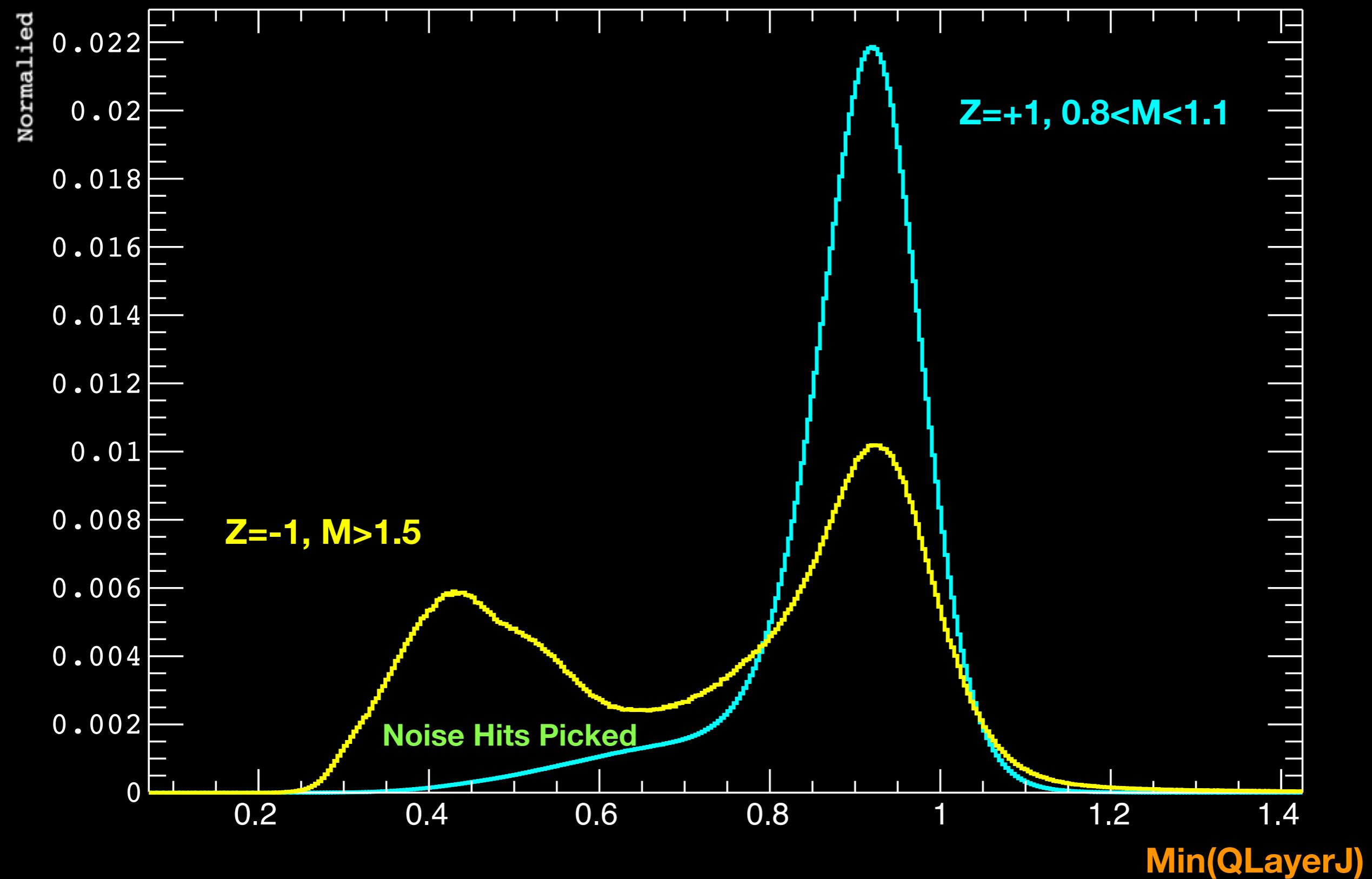
Beta (Tracker dE/dx) / Beta(TOF)



Track Fitting χ^2_Y

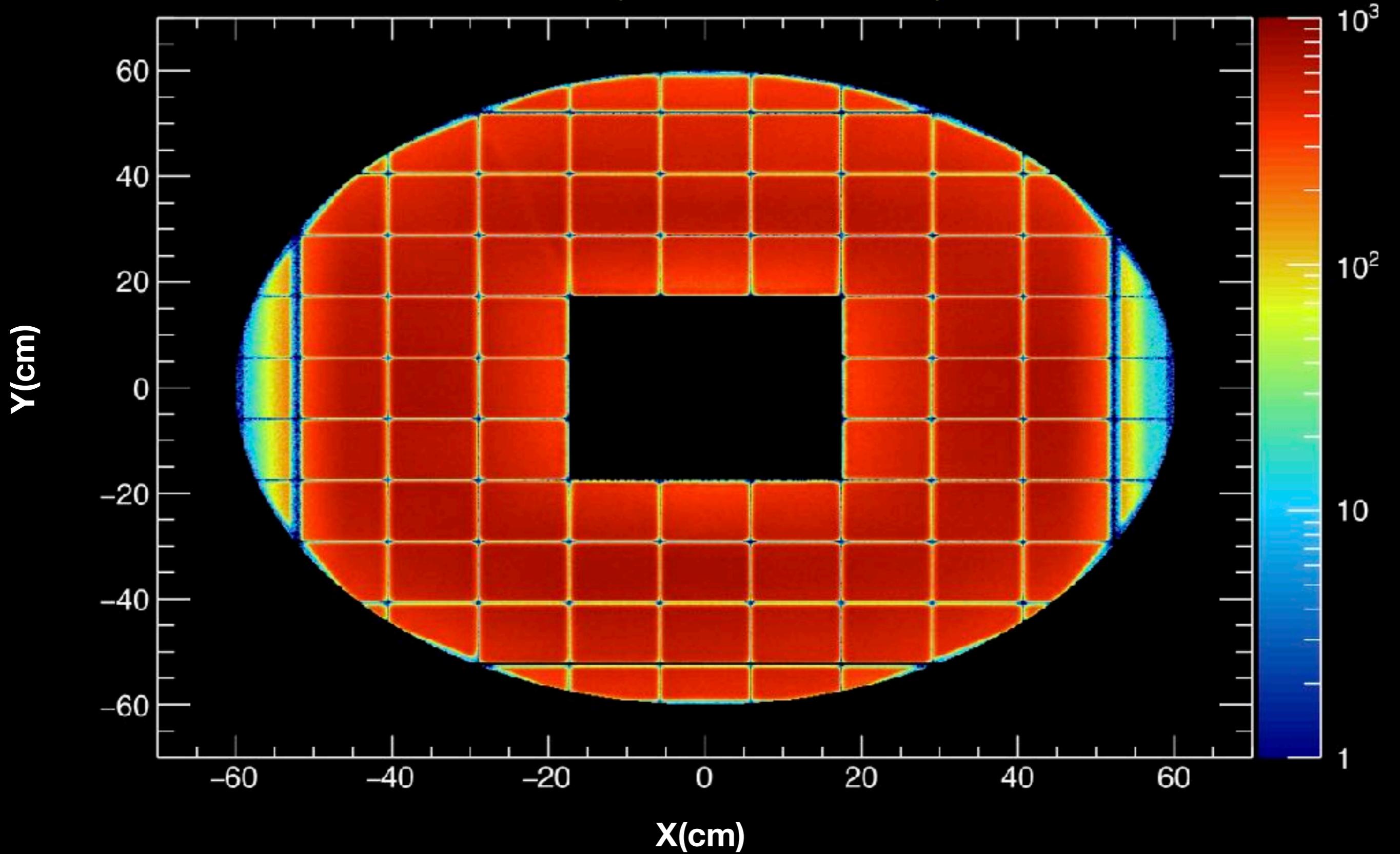


Minimum Charge of Tracker Hit



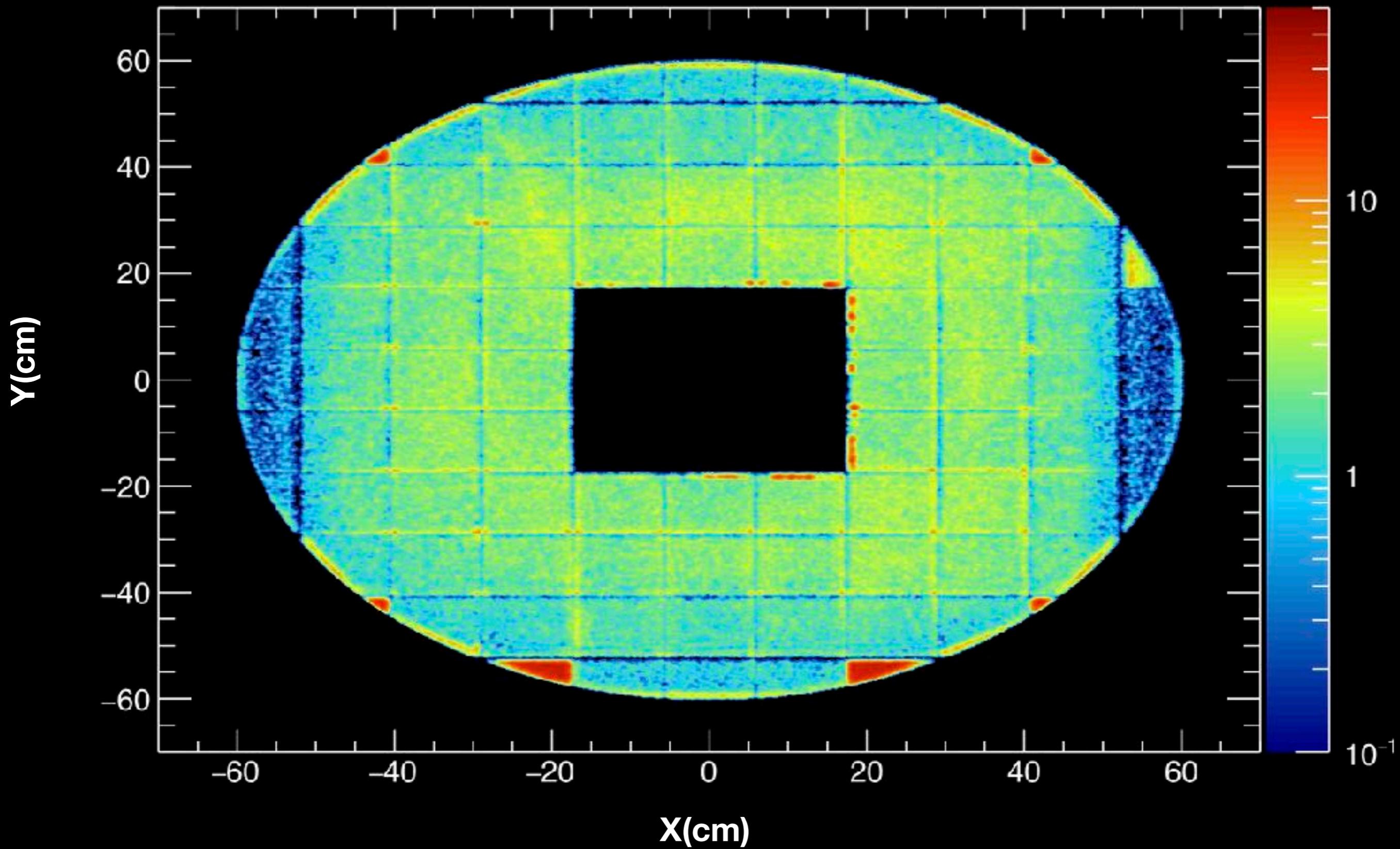
Particle Trajectory Positions on the RICH radiator

Proton ($Z=1$, $0.8 < M < 1.1$)

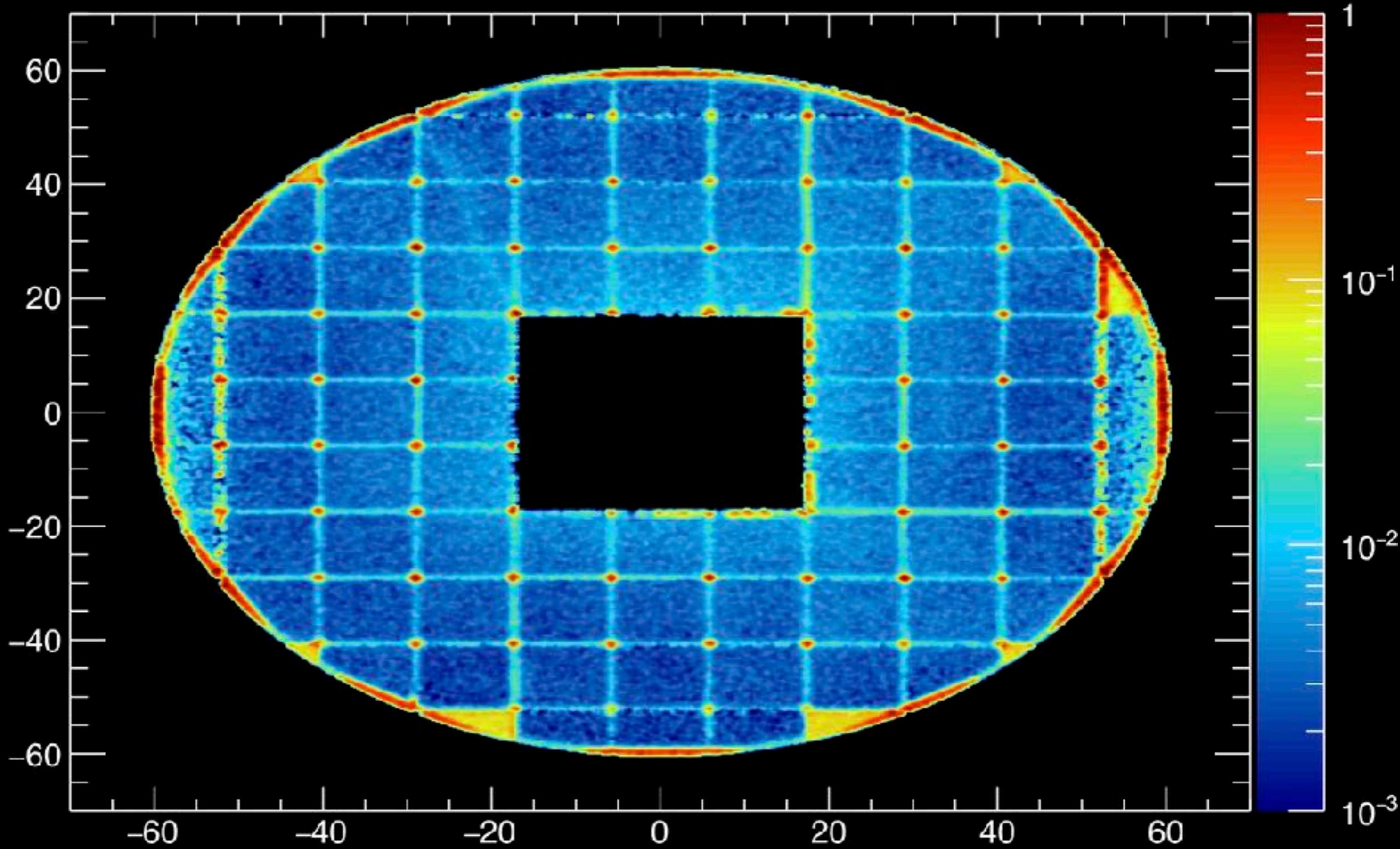


Particle Trajectory Positions on the RICH radiator

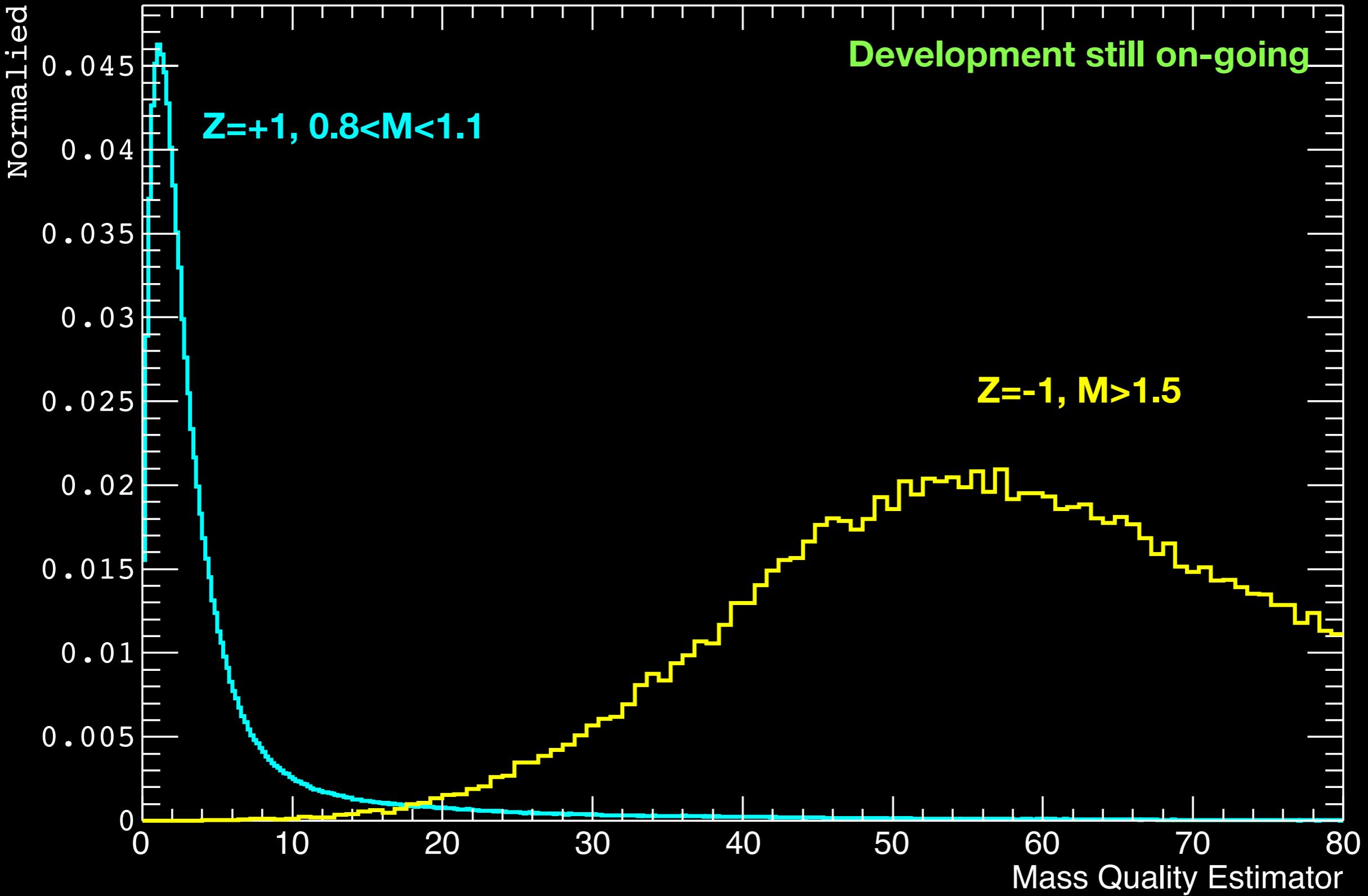
Background ($Z=-1$, $M>1.5$)



Ratio between Background map and Proton map

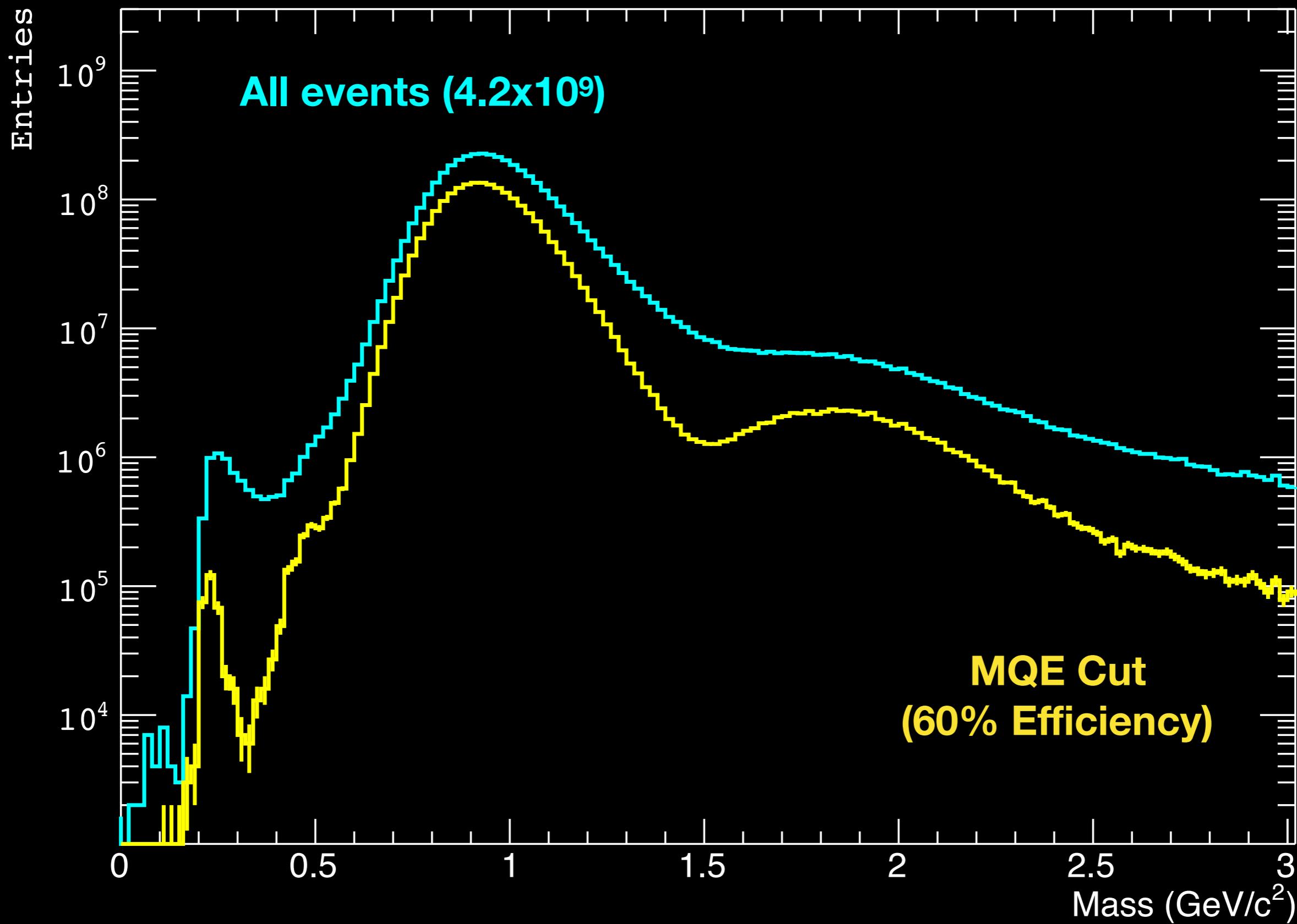


Mass Quality Estimator (MQE)



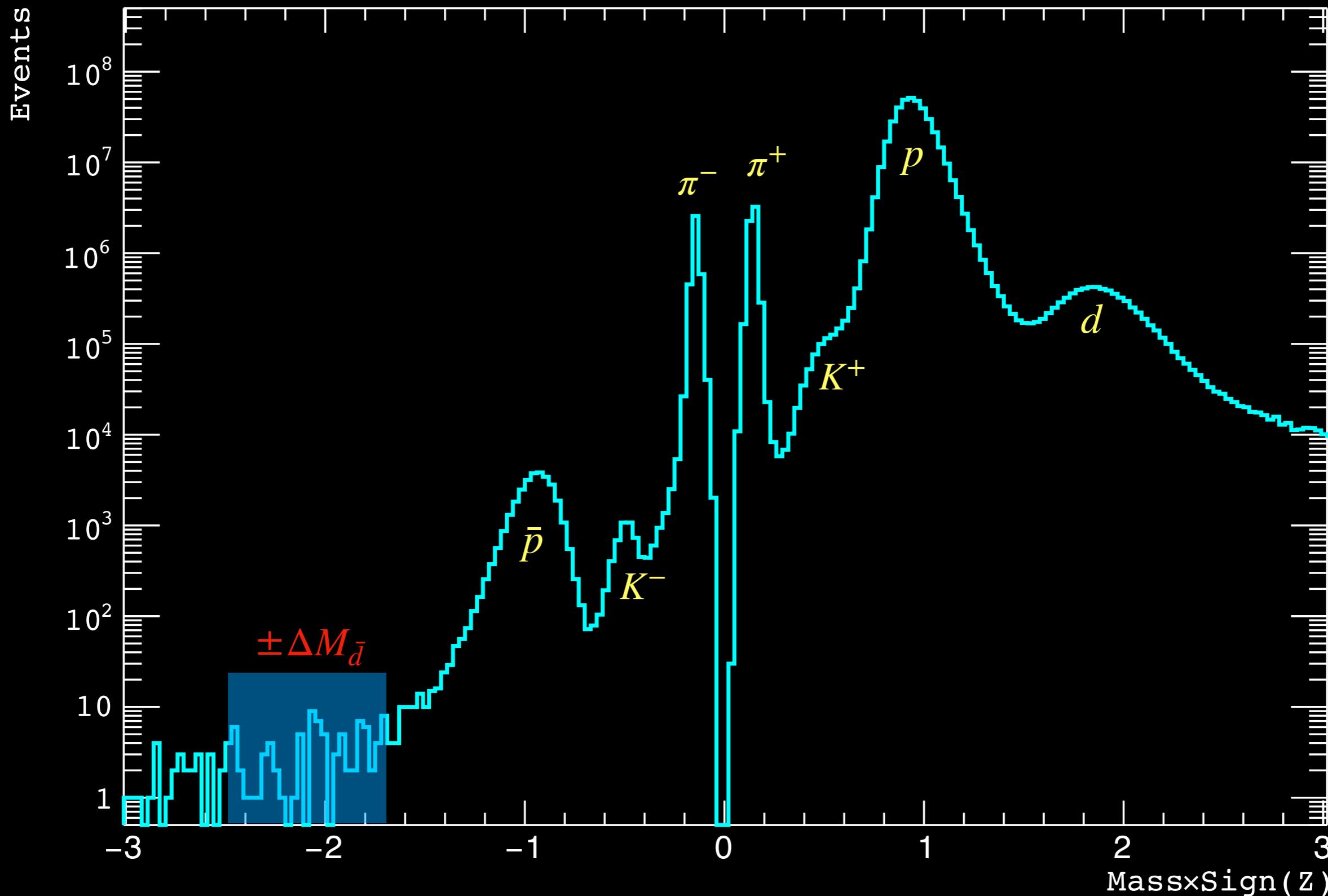
Testing the performance of on Deuteron/Proton Separation

Data Sample (May/2011–Jan./2019)
TOF ($0.5 < \beta < 0.8$)



Development is still on-going to improve the Background Rejection

Data Sample (May/2011 – Jan./2019)
 2.7×10^9 events with RICH Ring ($0.95 < \beta < 0.98$)



Summary

- AMS has collected more than 100 million deuteron during the first 7.5 years of data taking.
- A data-driven analysis method is established and under development for Antideuteron search.
- With continuous data taking and analyzing, AMS will be able to probe the existence of Antideuteron in the Cosmic Rays.