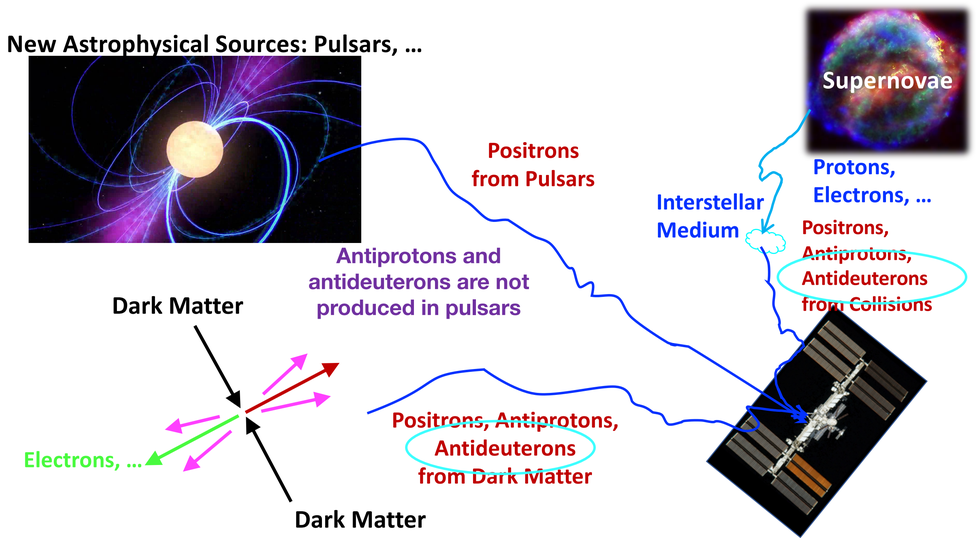
SEARCH OF ANTIDEUTERON WITH AMS

S.Q. Lu / Academia Sinica

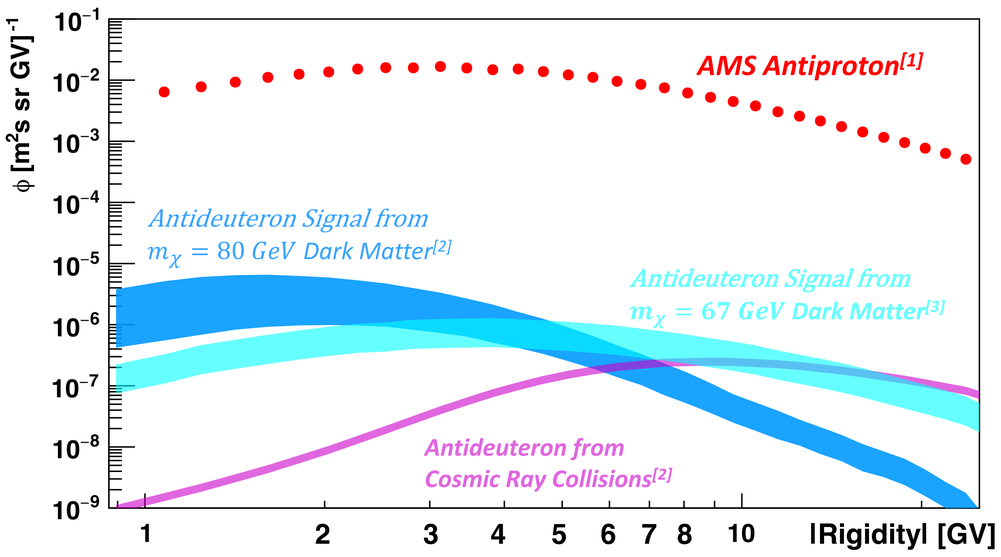
on behalf of the AMS Collaboration

INTRODUCTION

Light cosmic ray antiparticles, including $e^+, \bar{p}, \bar{d}$, are crucial for the understanding of new phenomena in the cosmos, since the yield of them from cosmic ray collisions is small.

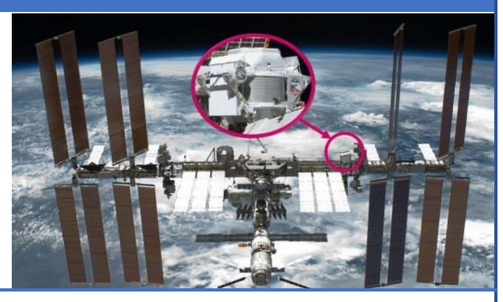


Antideuteron has the advantage of high signal-to-background ratio at low energy, compared to antiproton, although the rate is about 10^{-4} lower.

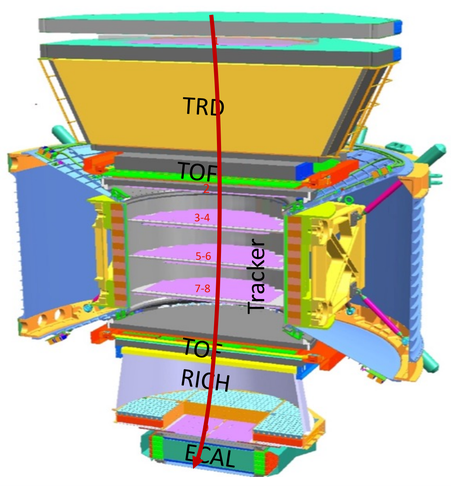


AMS DETECTOR

AMS[1] is mounted on the **International Space Station** since 2011 and to date has collected more than **200 billion** events.



To identify antideuteron with AMS, the **Transition Radiation Detector** (TRD) is used to reject electrons and positrons. **Tracker** and the **Magnet** measuring the rigidity, **Time-of-Flight** (TOF) and **Ring Imaging Cherenkov** (RICH) detector measuring the velocity, are used to reconstruct the mass of the incoming particles.



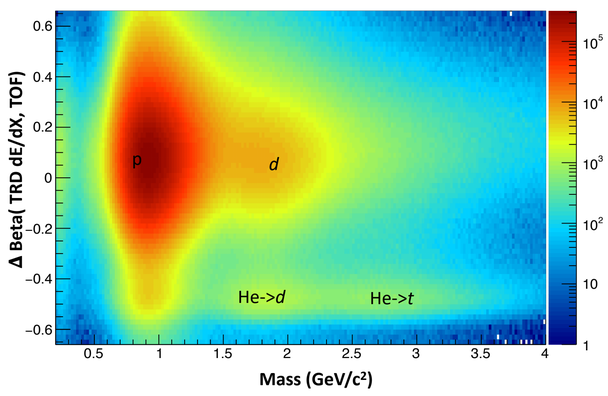
Tracker + Magnet
Rigidity (R) and Charge Sign
R*Δ(1/R) ≈ 10% at 10GV

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

RICH
Velocity by Cherenkov light
$\Delta\beta/\beta \approx 0.1 - 0.4\%$ ($|Z|=1$)

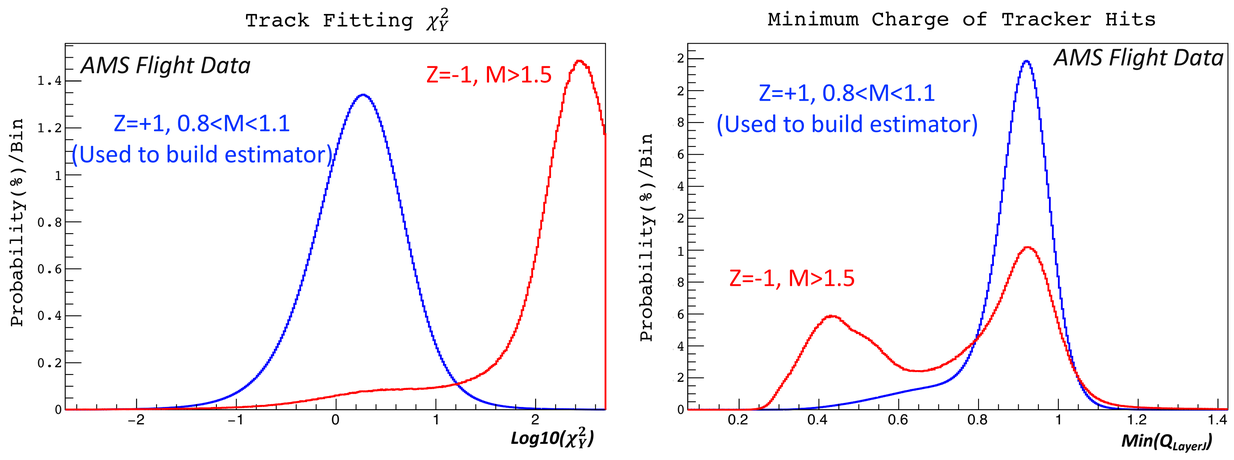
TRD, Tracker, TOF, RICH
Charge Magnitude
Along Particle Trajectory
ΔZ ($|Z|=1$) ≈ 0.05-0.1

One of the unique properties of AMS in space is that events can be classified with different sub-detectors. For example, secondary particles produced by interactions inside TRD can be identify with the velocity differences in TRD and TOF and the mass reconstructed with TOF and Tracker.

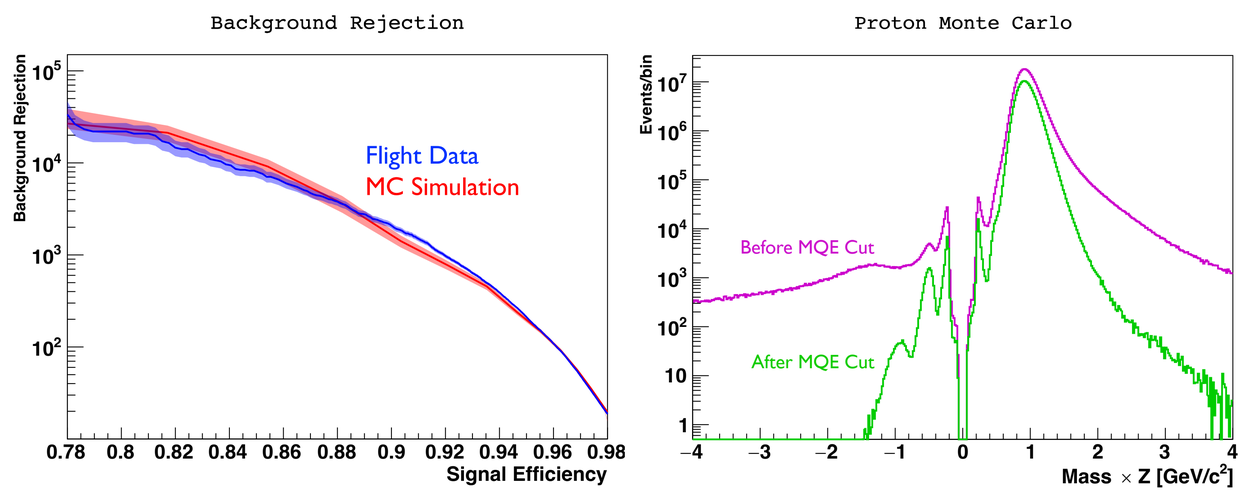


MASS QUALITY ESTIMATOR

To obtain the best signal extraction efficiency, we build a likelihood estimator using variables from all sub-detectors, to evaluate the quality of mass reconstruction, based only on the data collected by AMS in space, without the dependence of Monte Carlo (MC) simulations. Examples of variables used are shown below.



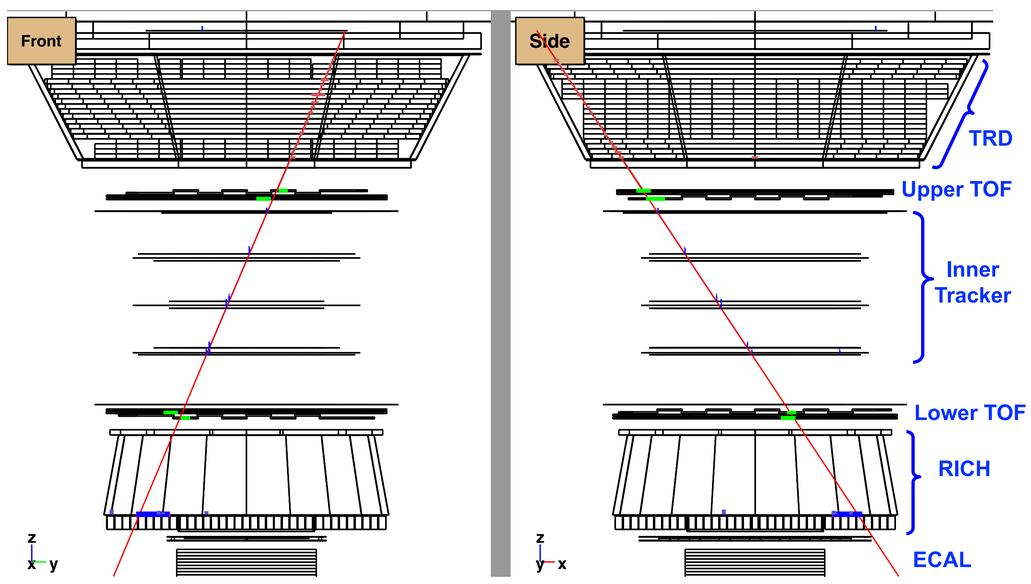
With the Mass Quality Estimator (MQE), we reach a background rejection of > 10^4 at 80% signal efficiency. Study of Proton MC shows that background events are efficiently removed.



RESULTS

During the first 10 years of data taking, AMS has collected more than 100 million deuteron events. A few antideuteron candidates were selected with the Mass Quality Estimator. Extensive study of the Monte Carlo simulation is on-going to understand the possibility of detector effects. With continuous data taking and improved analysis, AMS will be able to probe the existence of primary sources of antideuteron in the cosmos.

AMS Event Display of an Antideuteron Candidate



REFERENCES

[1] M. Aguilar et al., *Phys.Rept.* 894 (2021) 1-116

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

[3] I. Cholis et al., *Phys.Rev.D* 102 (2020) 10, 103019