Precision Measurement of Boron-to-Carbon ratio in Cosmic Rays from 2 GV to 2 TV with the Alpha Magnetic Spectrometer on the International Space Station.

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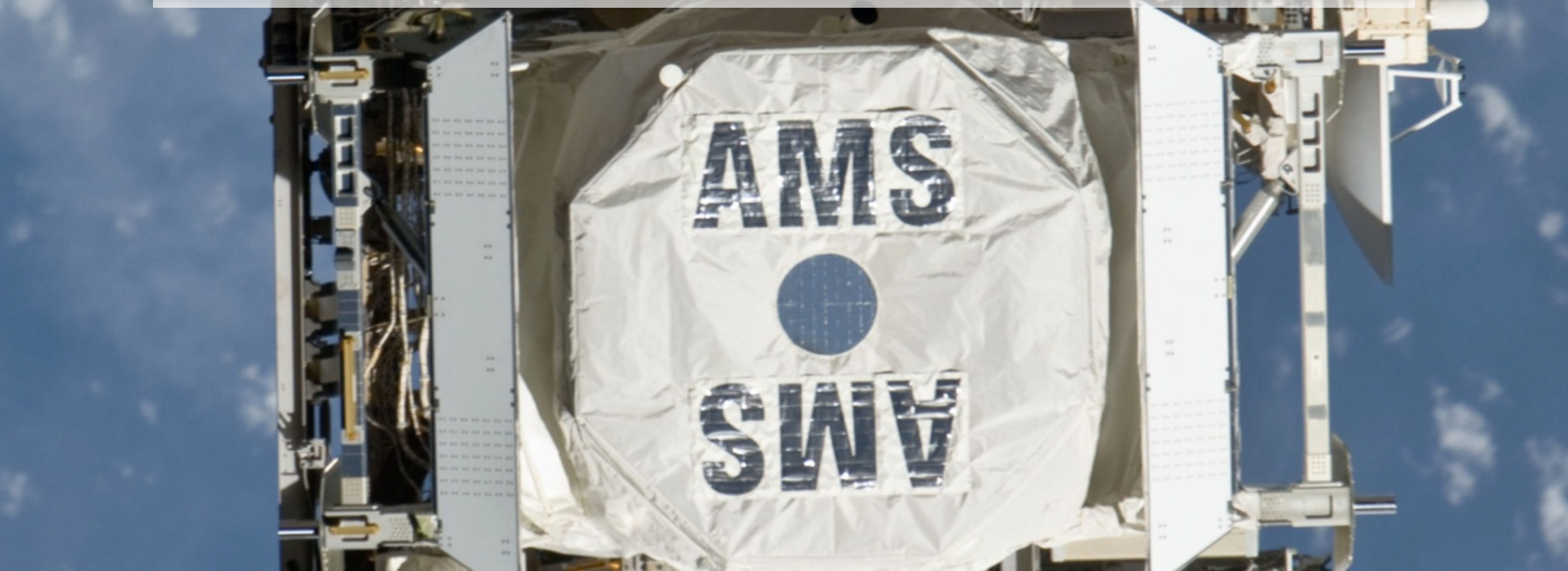
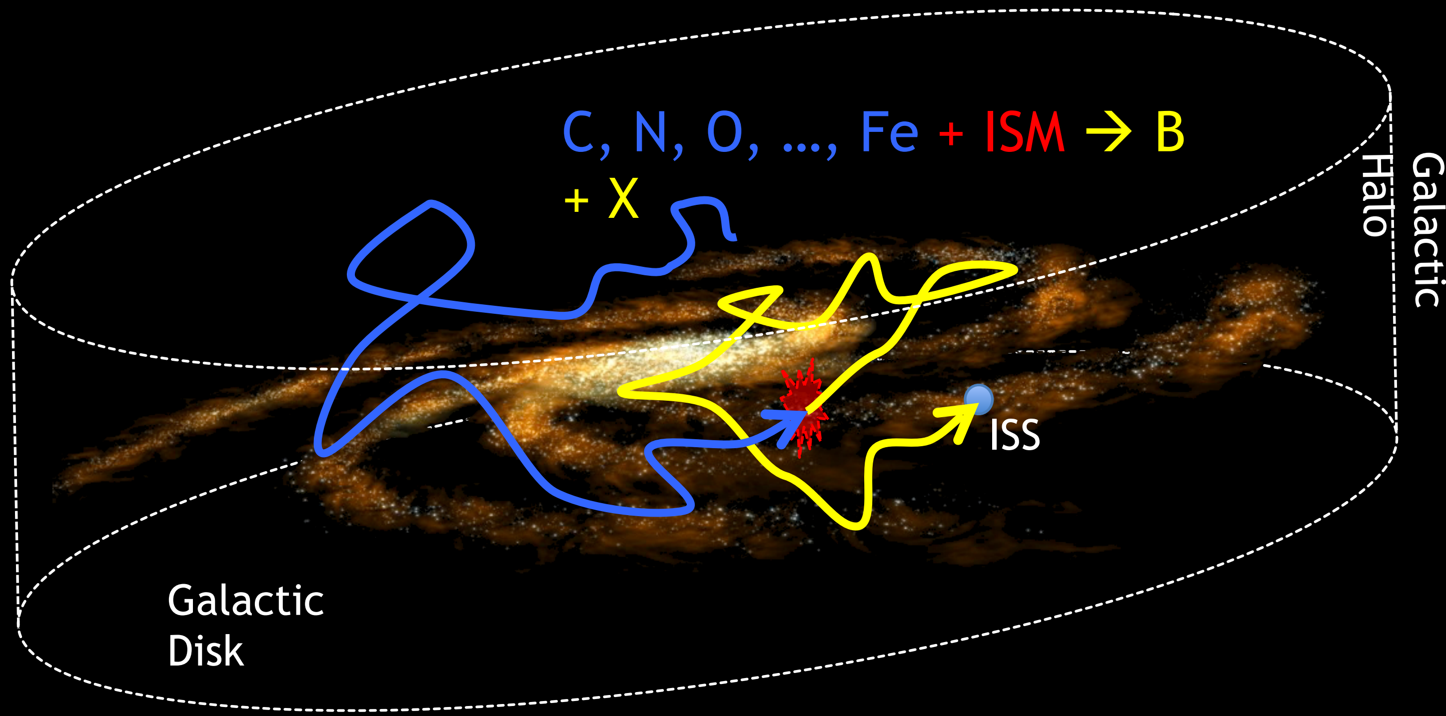
05/09/2016 - ECRS - Torino



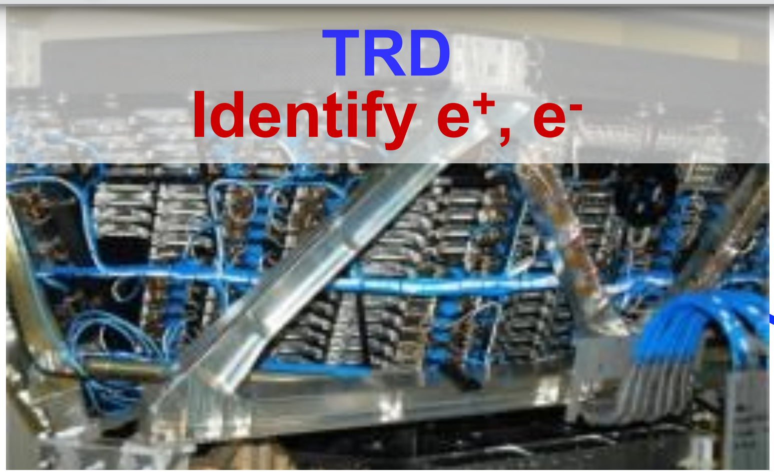
B/C in cosmic rays

The B/C flux ratio is a powerful tool to study the properties of cosmic ray propagation as Boron is assumed to be produced purely from collision of primary cosmic rays, such as Carbon and Oxygen, with the interstellar medium (ISM).

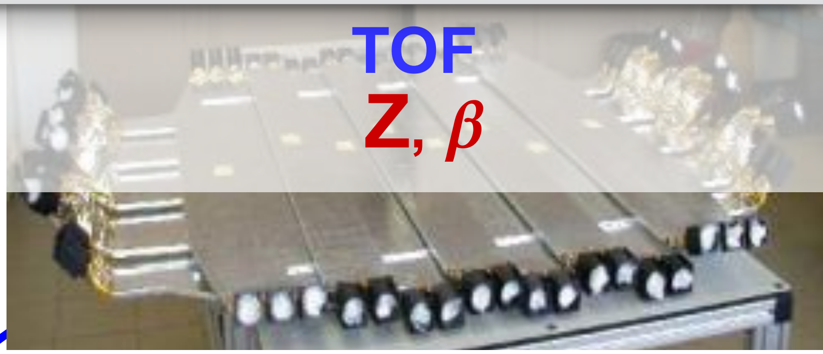


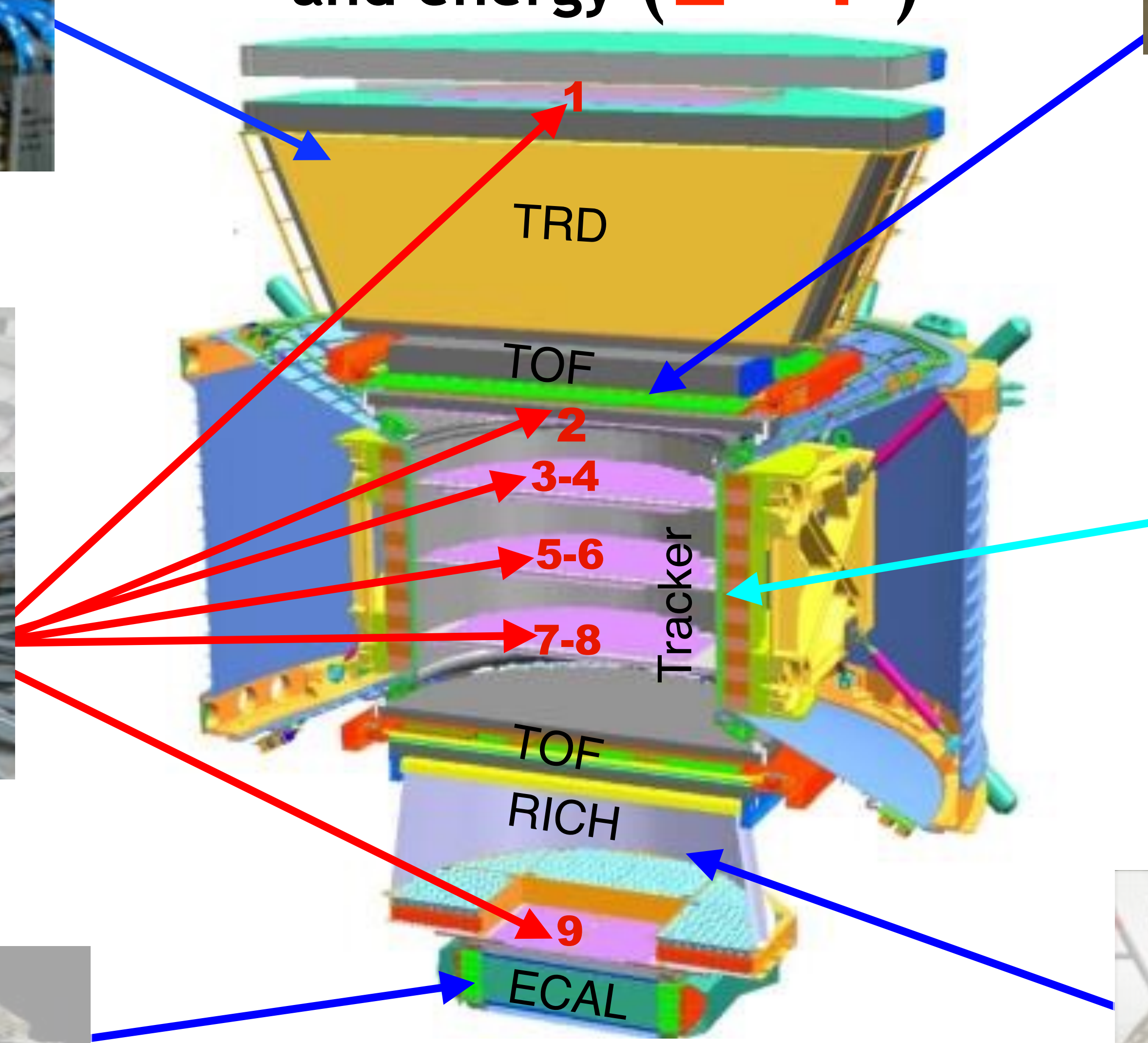
CRs are commonly modelled as a relativistic gas diffusing into a magnetised plasma. Diffusion models based on different assumptions predict different behaviour for $B/C \sim R^{\delta}$. With Kolmogorov interstellar turbulence model a $\delta = -1/3$ is expected, while Kraichnan theory leads to $\delta = -1/2$.

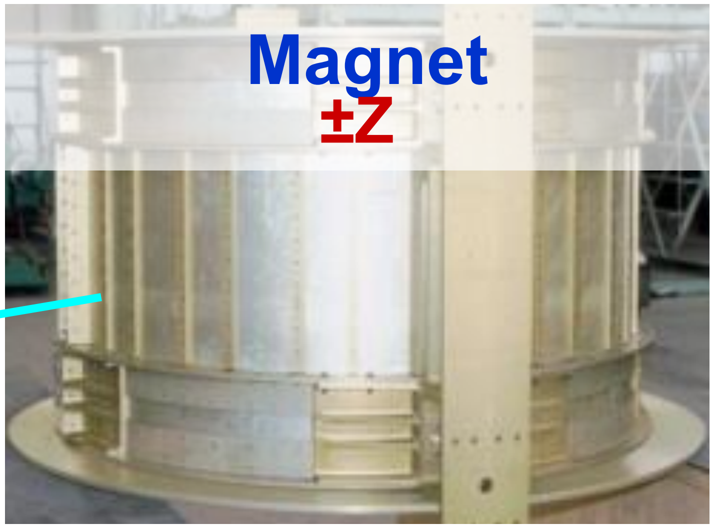
AMS in a nutshell

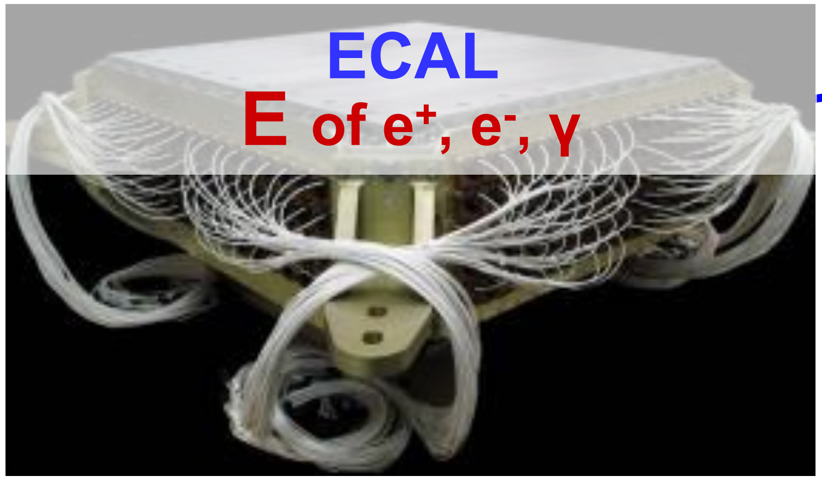


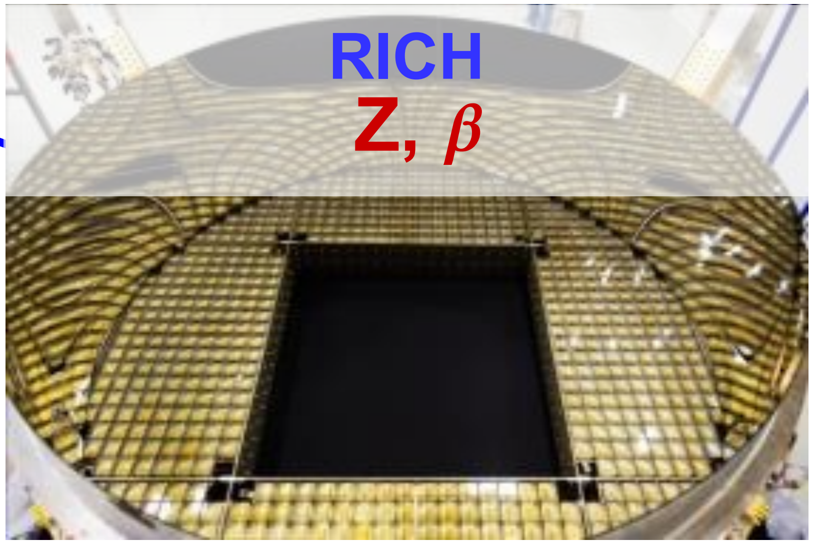
Particles and nuclei are defined by their charge (Z) and energy (E ~ P)





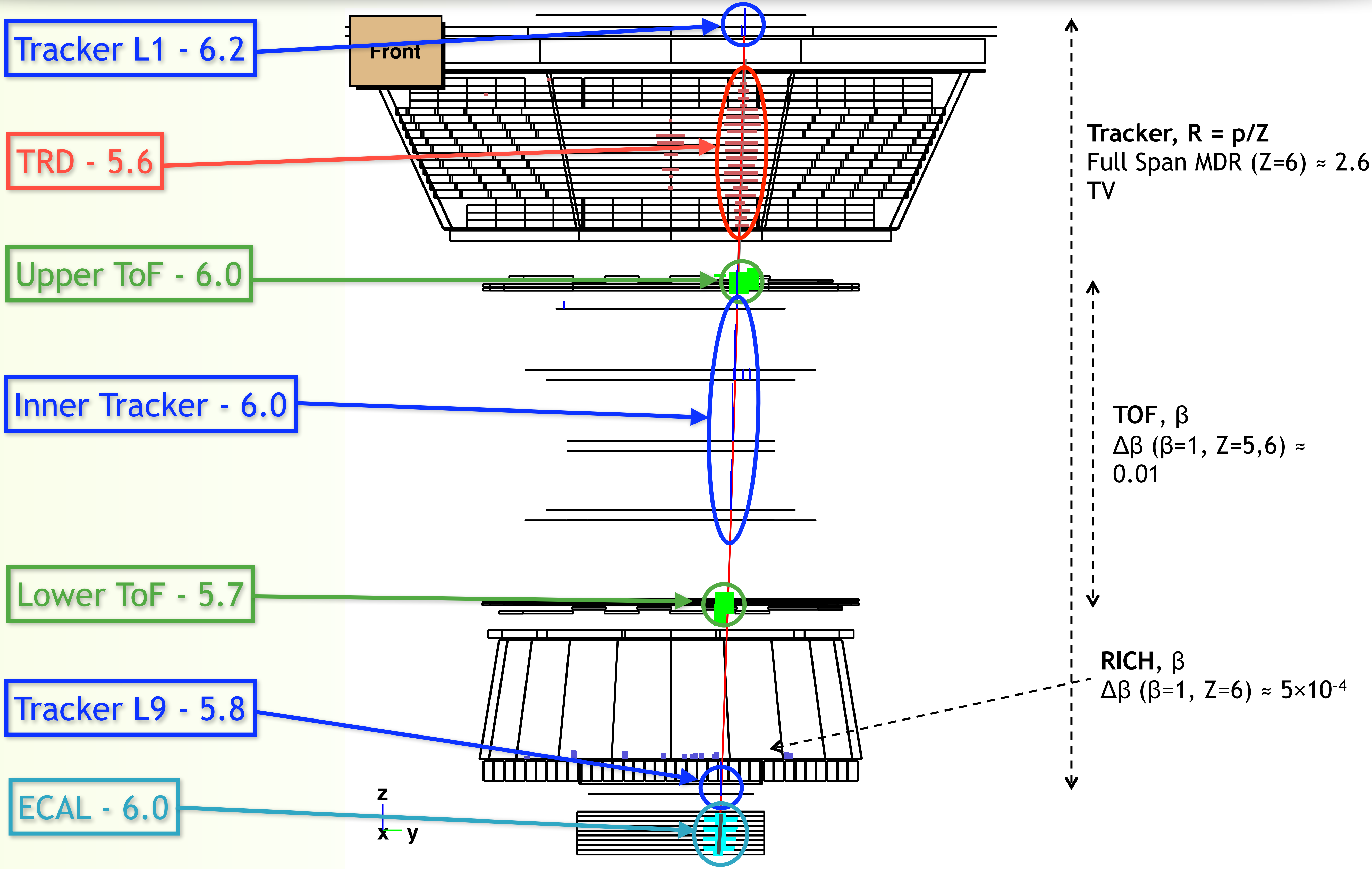




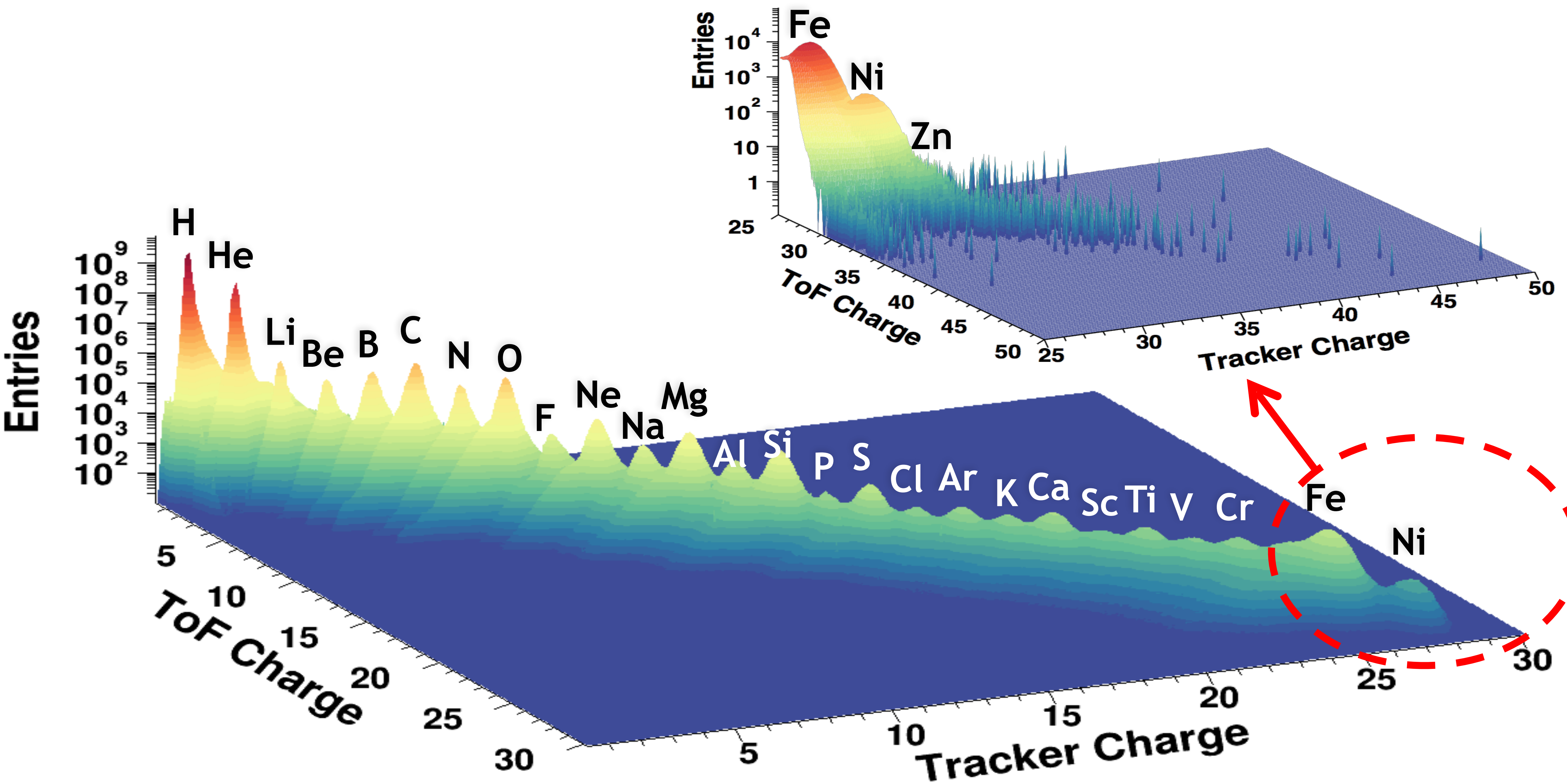


***Z, P** are measured independently by the Tracker, RICH, TOF and ECAL*

Charge measurements in AMS



Nuclei identification in AMS

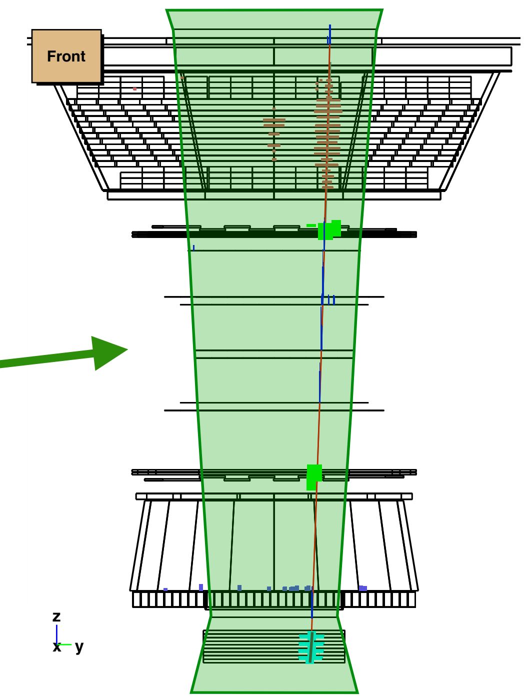


B/C Event selection

Selection

- Tracker and TOF Charges compatible with Z=5, 6.
- Track passing through L1 with good charge.
- Tracks with at least 5 points and a good fit (χ^2_Y L2-L8 < 10).
- Rigidity above geomagnetic cutoff (R>1.2 R_C).

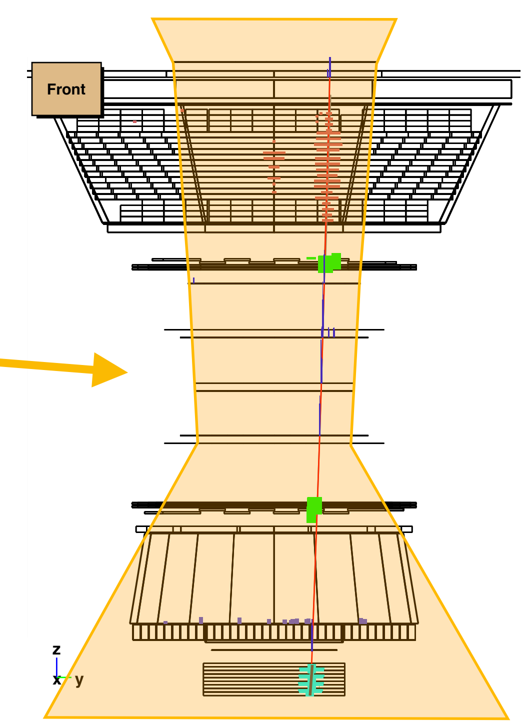
→ *Statistics for 60 months: **8.3M Carbon and 2.3M Boron.***



Long Lever Arm Analysis

- Tracker Layer 9 Charge compatible with Z=5, 6.
- Full Span Track with a good fit (χ^2_Y L1-L9 < 10).

→ *Highest possible MDR (2.6 TV for C, 3.0 TV for B).*



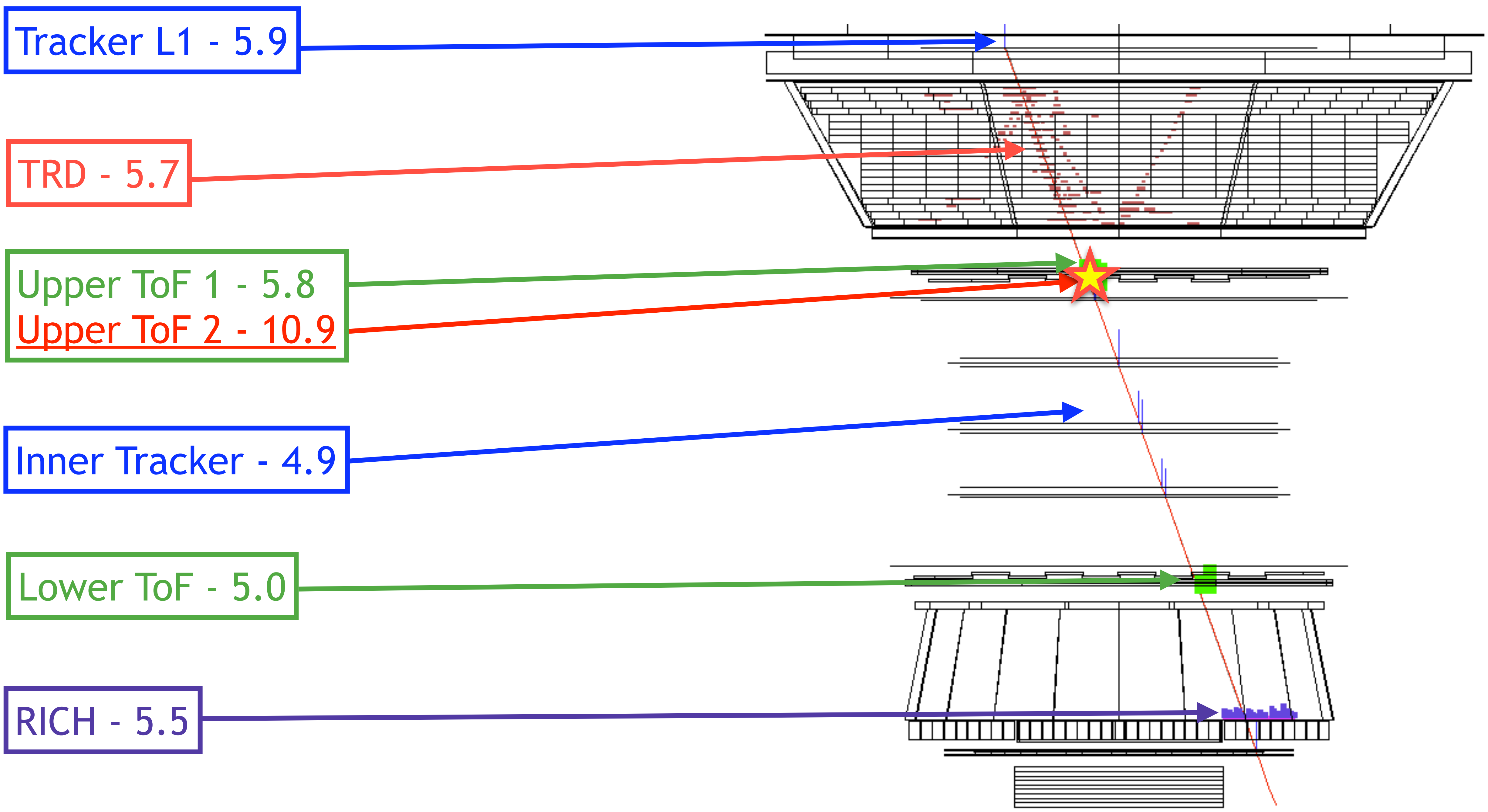
Large Statistics Analysis

- No requirement on L9.
- Track with a good fit (χ^2_Y L1-L8 <10).

→ *Factor 5 more events, and less interacting events.*

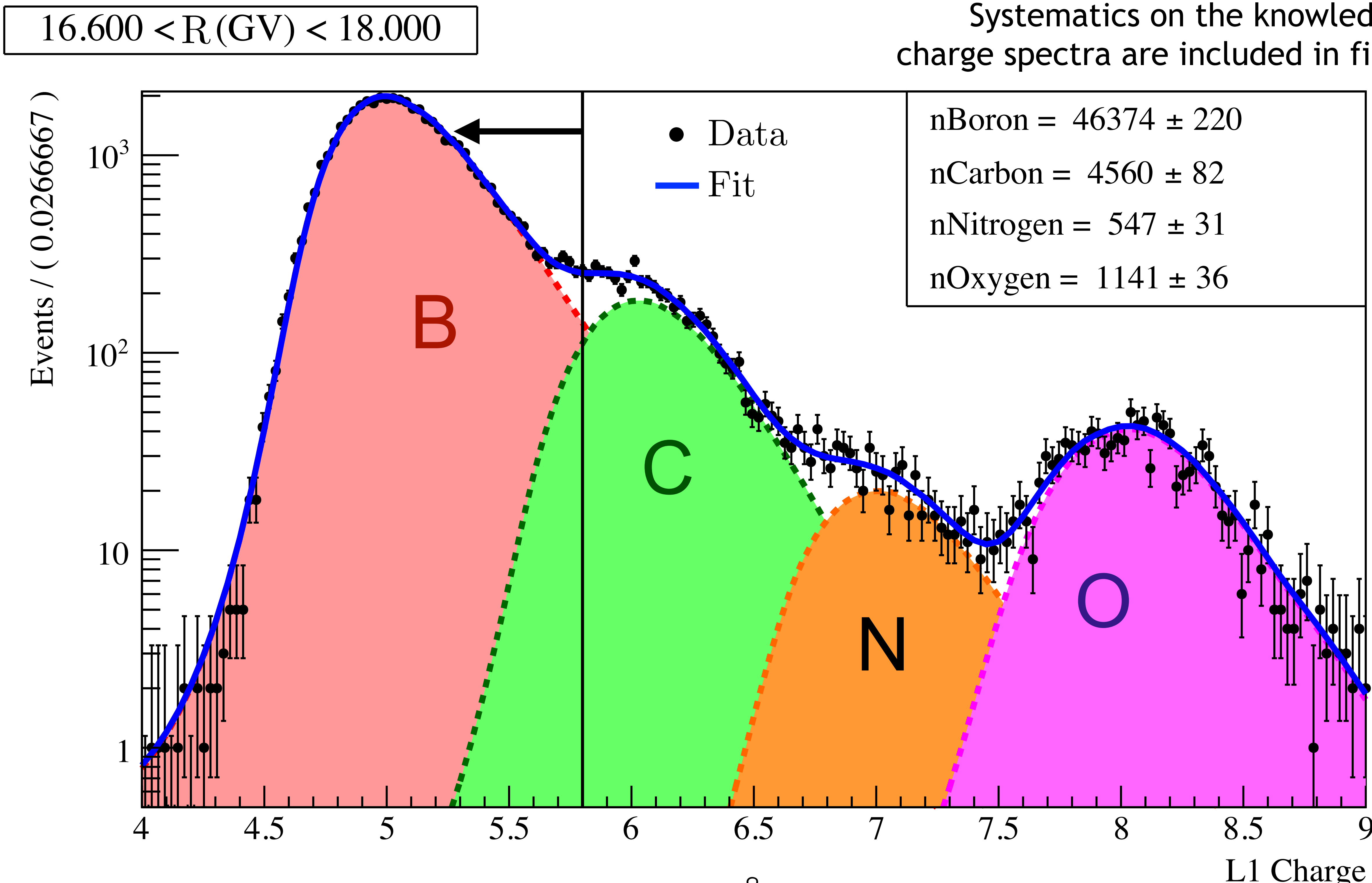
Boron sample purity

The high redundancy in charge measurements allows to spot and identify nuclei fragmenting through hadronic inelastic interactions.



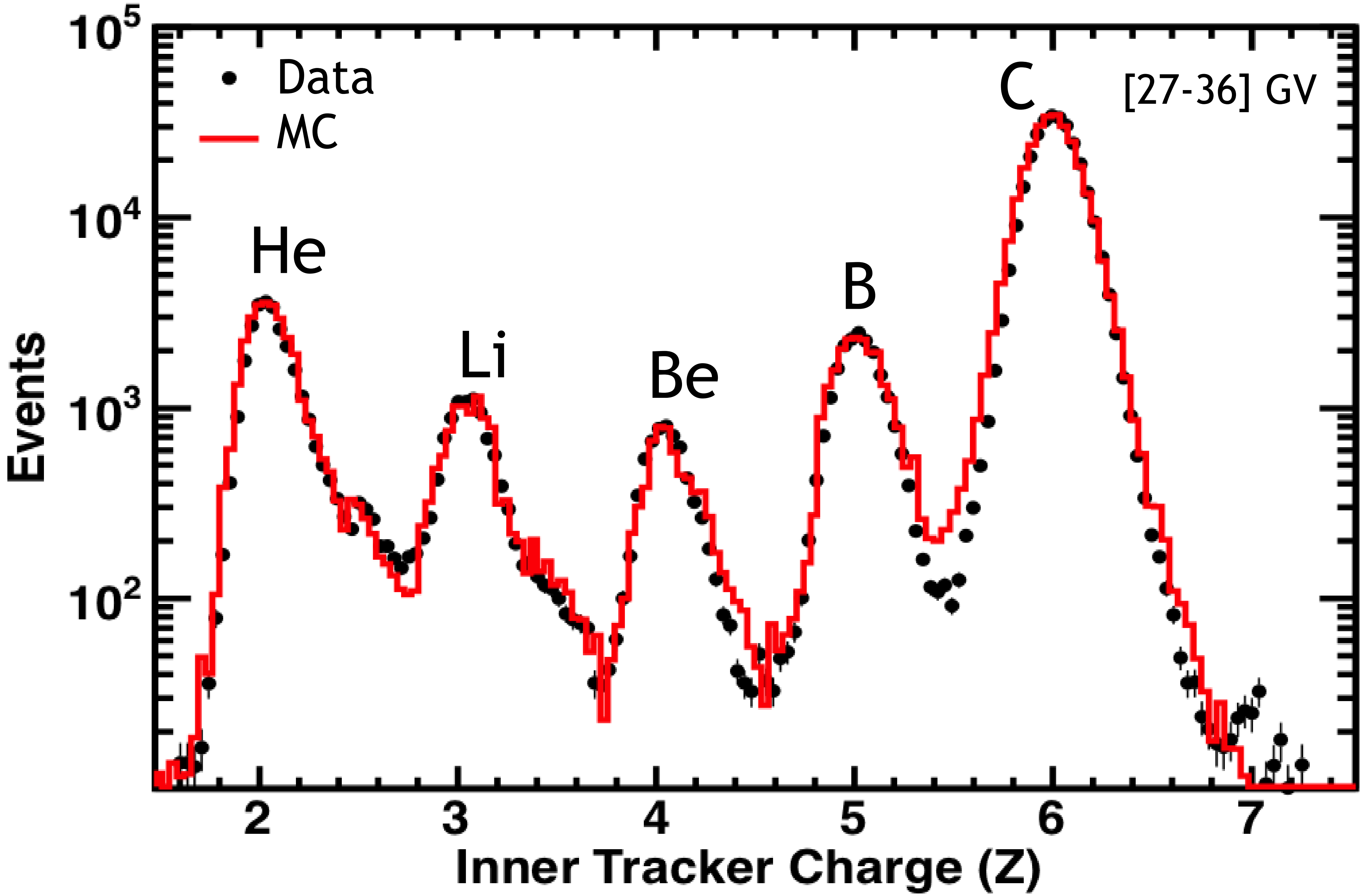
Boron sample purity

Contamination < 3%
Selection efficiency > 96%
Systematics on the knowledge of the charge spectra are included in final error.



Interactions above L1

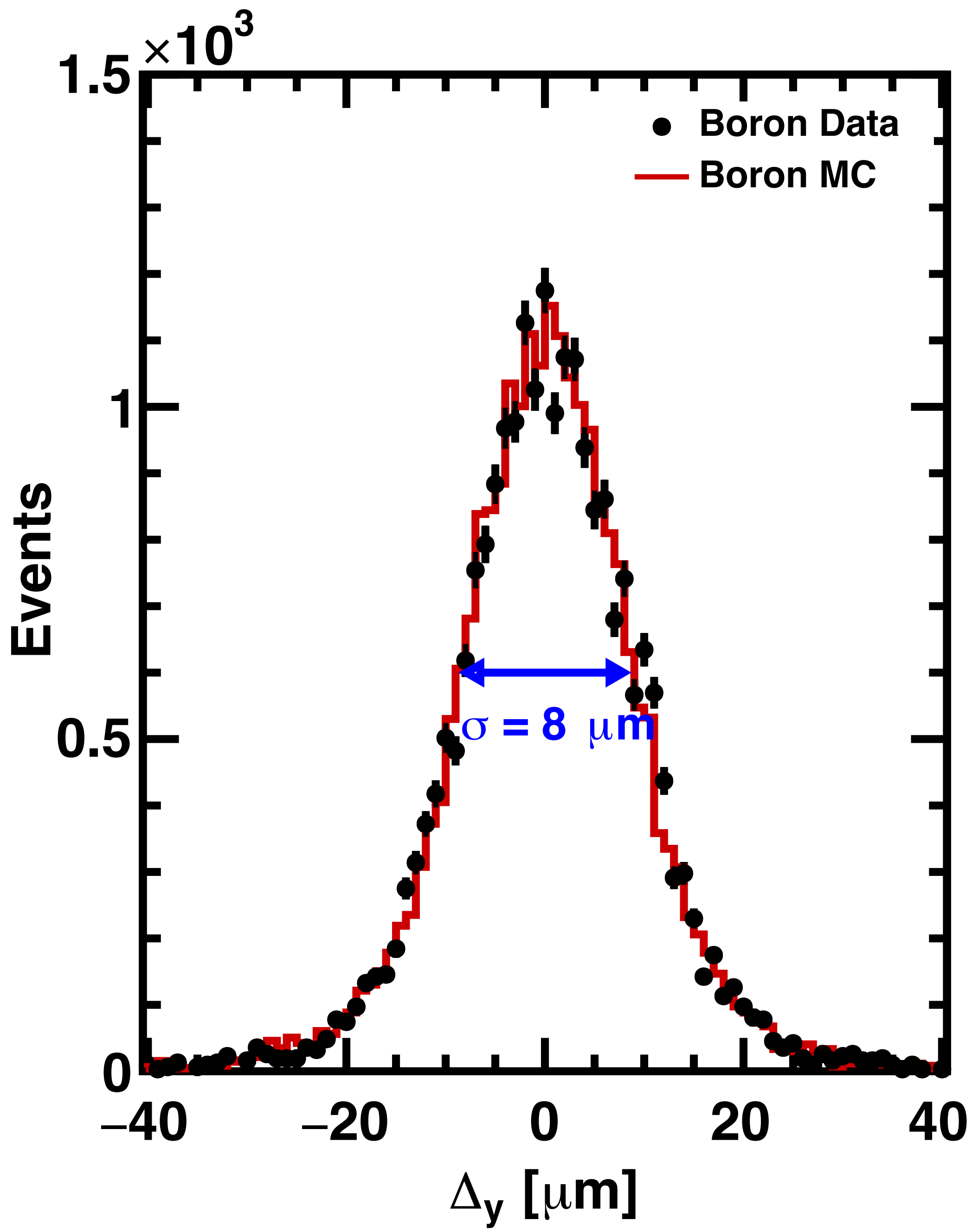
Background generated above L1 is calculated using MC and light nuclei fluxes measured by AMS.
MC interaction channels (ex. C + C, Al → B + X) have been verified with data (see below).
Background is up to 9% for B, associated systematic error is below 1%.

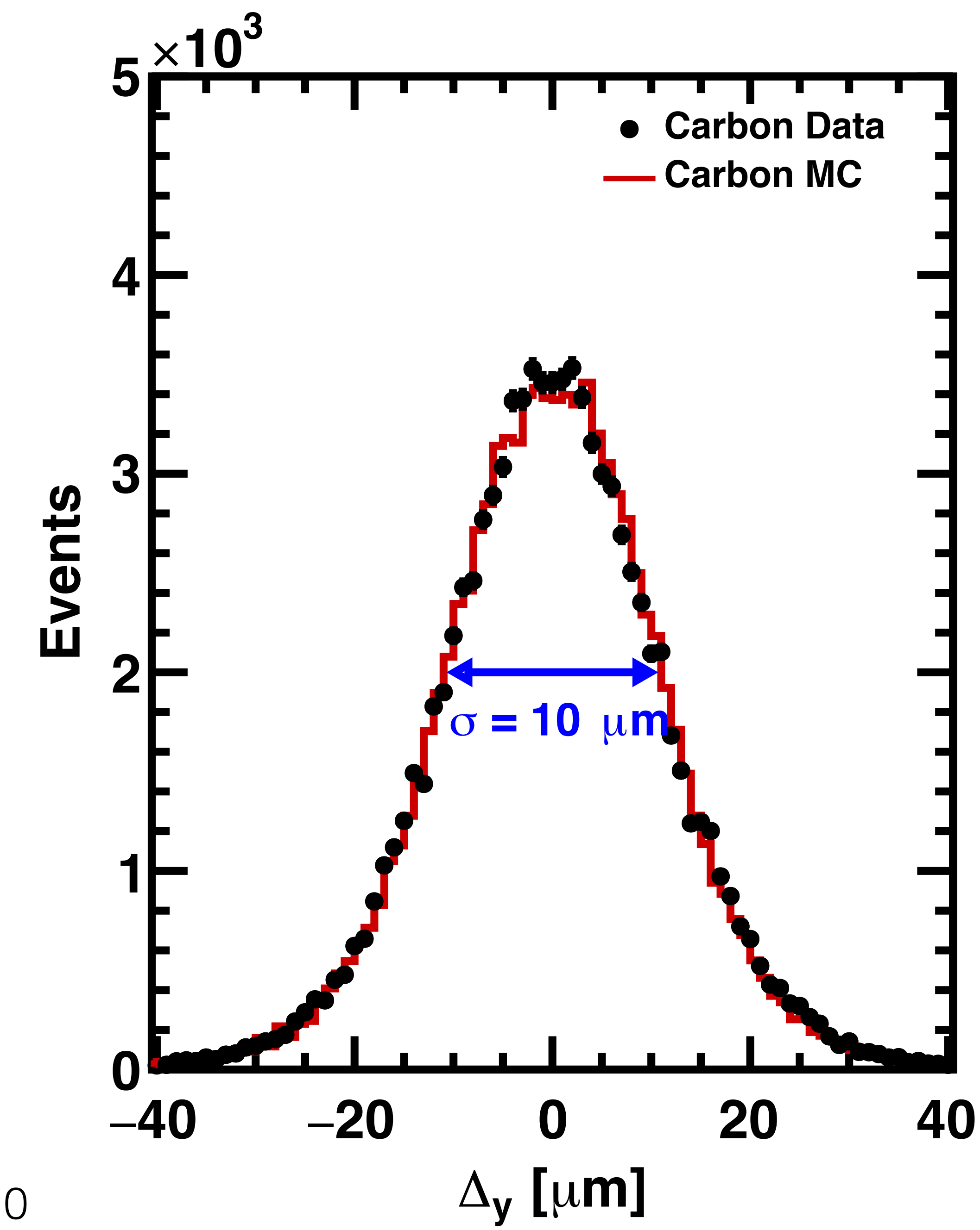


Systematics on Rigidity Resolution

The MC rigidity resolution functions were verified with the ISS data in multiple ways. One of the comparison is the validation of the spatial resolution of the inner tracker.

Systematic errors arising from the understanding of the resolution matrix and the bin-to-bin migration unfolding procedures account for 1% below 200GV and 3% at 2.5 TV.

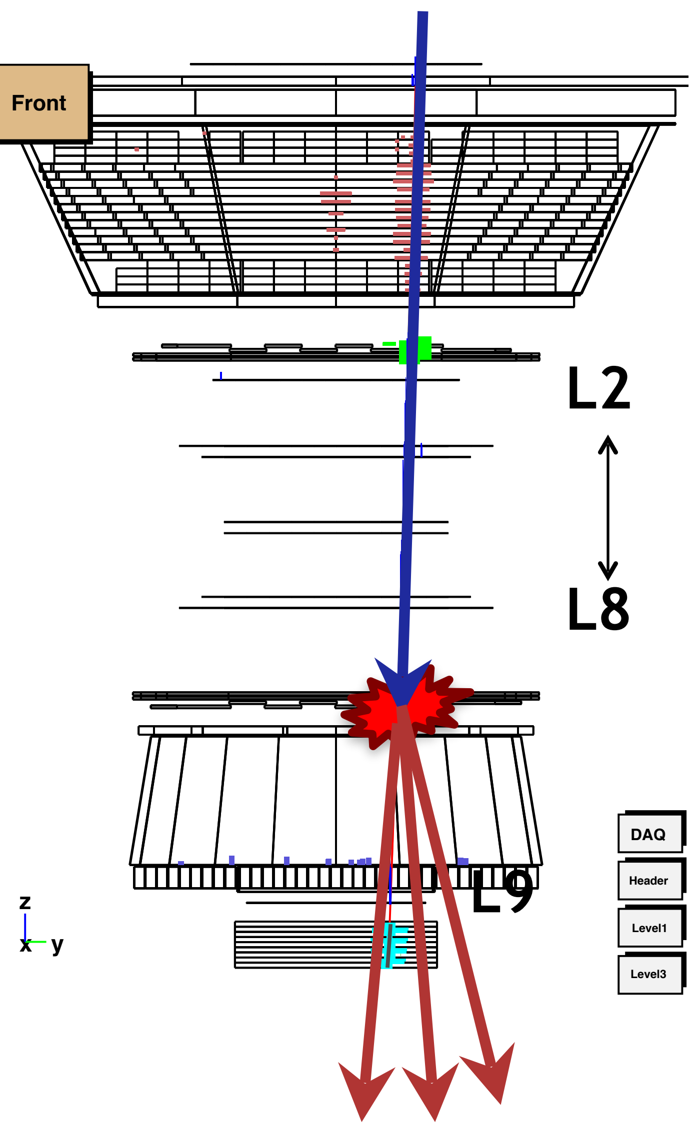


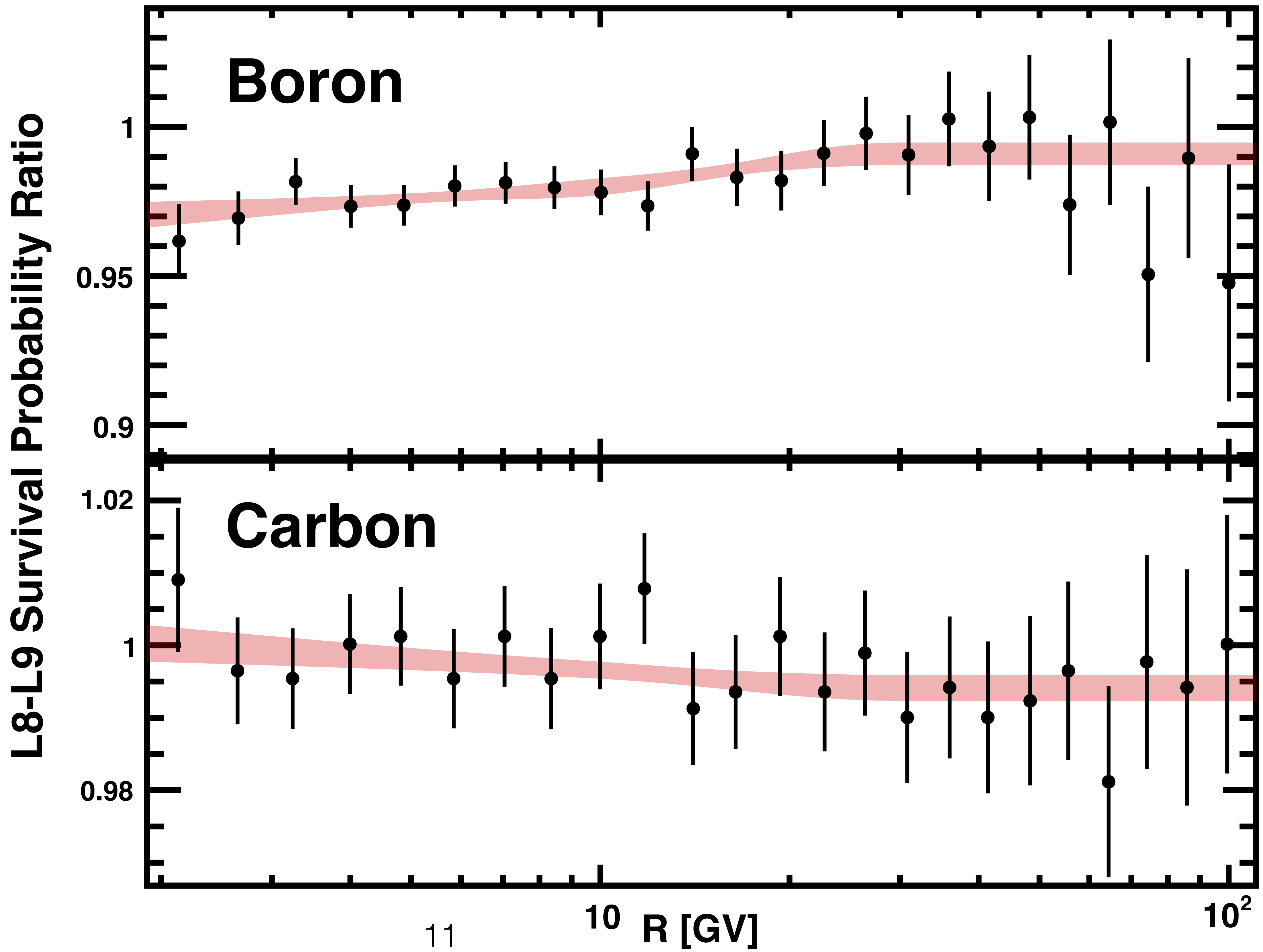


Systematics on Acceptance

Probability of detecting an hit on L9 depends on the **inelastic interactions** in the materials between L8 and L9 (“1/3” of the AMS material), allowing the control of flux normalisation.

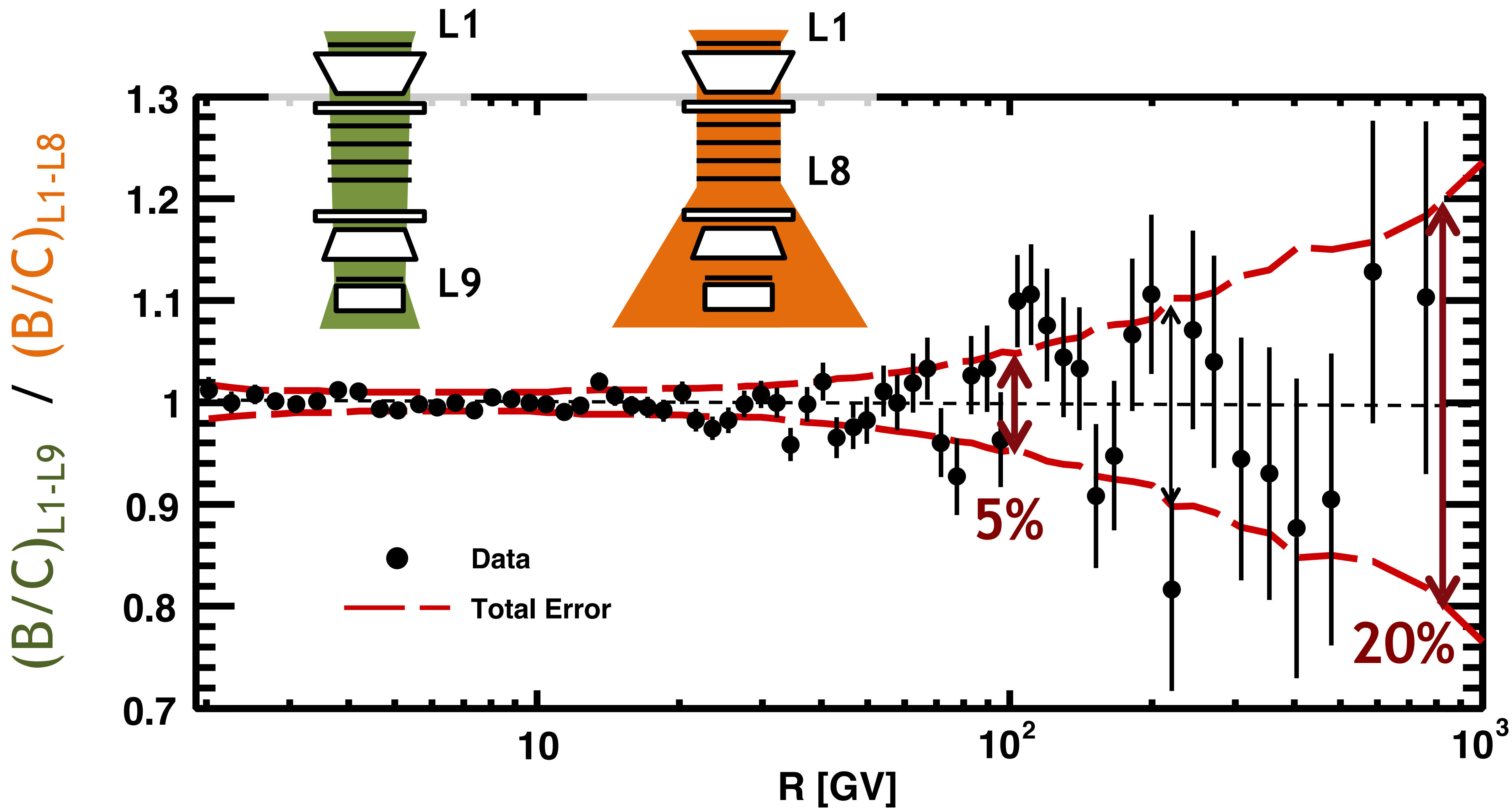
Total systematic error including all AMS materials is about 2%.



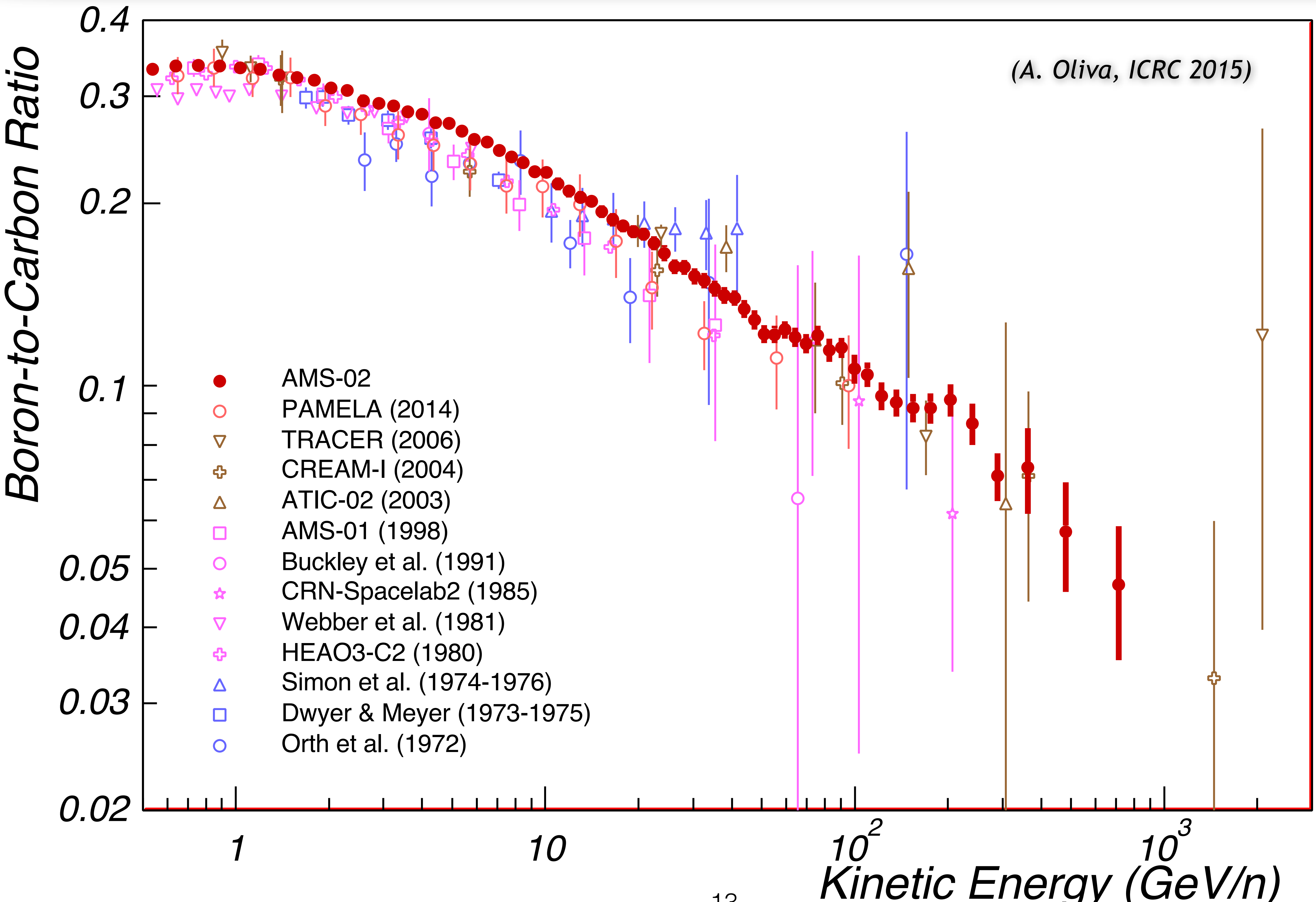


Measurement verification

B/C measured using events passing through L1-L9
divided by the one measured using events passing through L1-L8.
The observed agreement verifies:
(i) **acceptance**: the amount of material traversed is different
(ii) **unfolding**: bin-to-bin migration is different due to different resolution



B/C current result



Conclusions

- The B/C is an important measurement for the understanding of the propagation of the CRs.
- AMS measures B/C from 1.9 GV to 2.6 TV, with 2.3 million boron and 8.3 million boron nuclei with a typical accuracy of 3% at 100 GV.
- AMS B/C is able to reject a class of models explaining the positron fraction as an effect of secondary production.
- The accuracy of the B/C will be significantly improved, in particular at the highest rigidities, during the lifetime of the ISS.