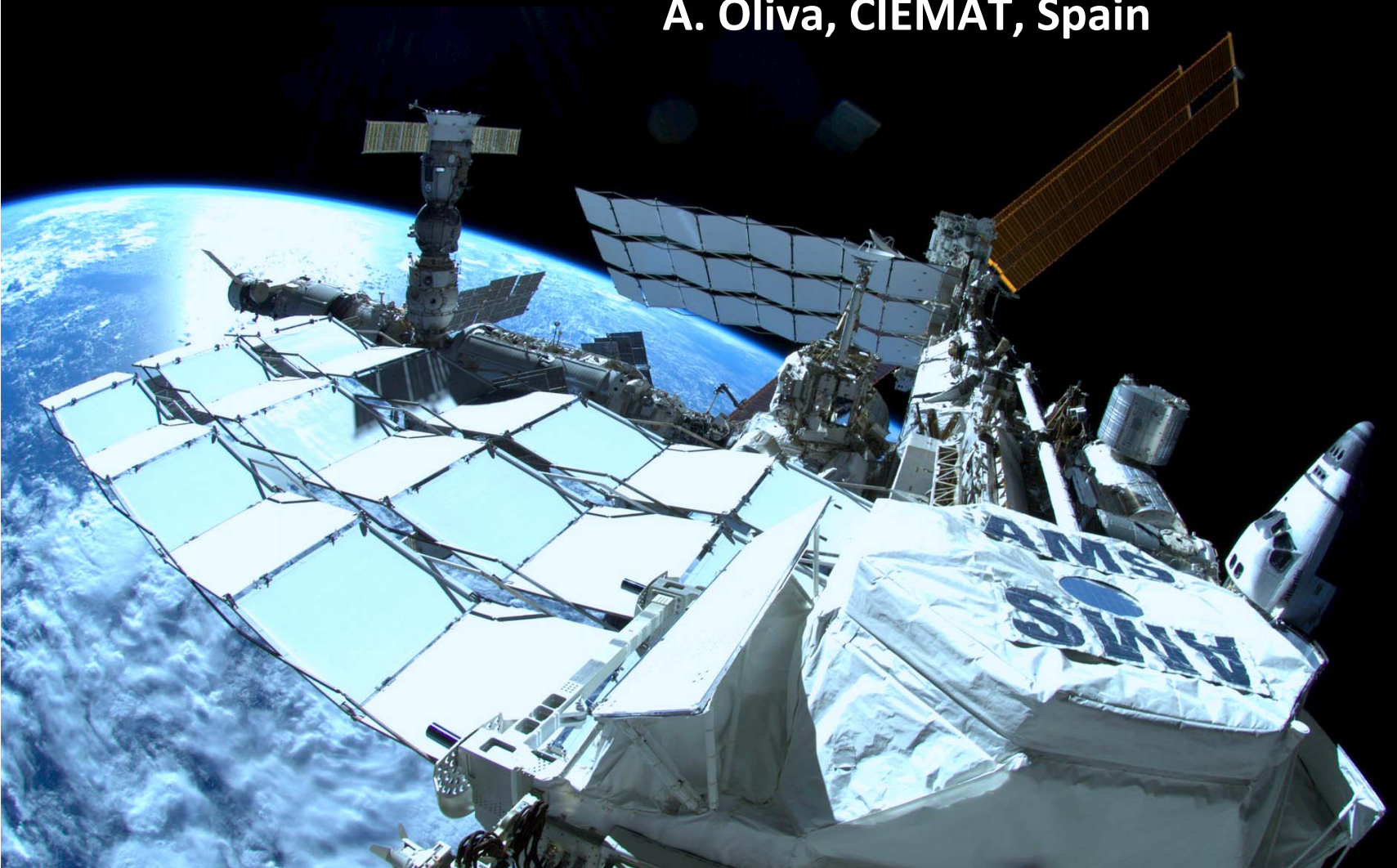
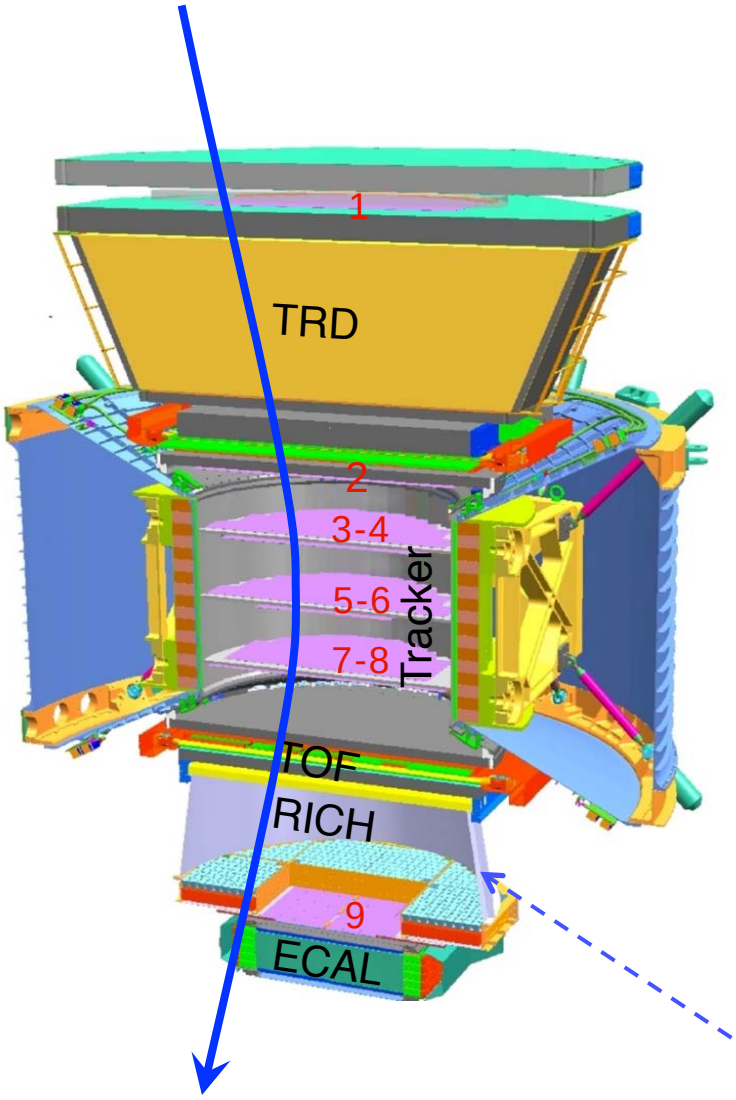
# AMS Results on Light Nuclei: *Measurement of the Cosmic Rays Boron-to-Carbon Ratio with AMS-02*

**A. Oliva, CIEMAT, Spain**




AMS Days
17/04/2015
CERN

# Redundant Measurements of Energy

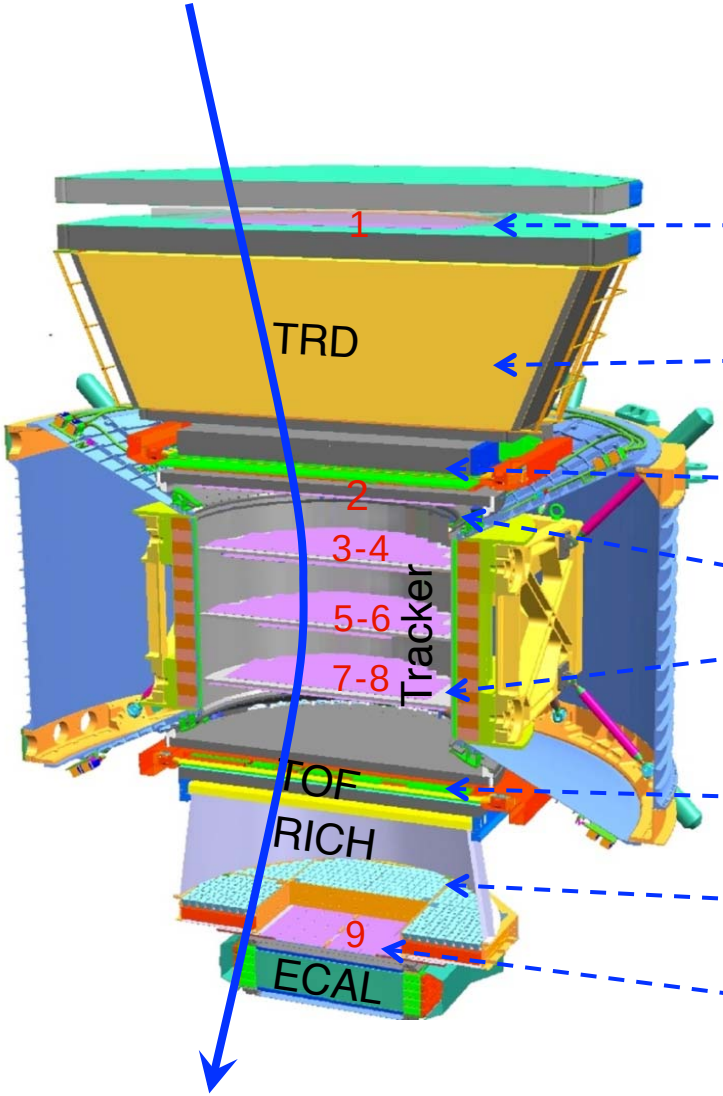



**Tracker, R = p/Z**
Full Span MDR (Z=5,6) ≈ 2.5 TV

**TOF**, β
Δβ (β=1, Z=5,6) ≈ 0.01

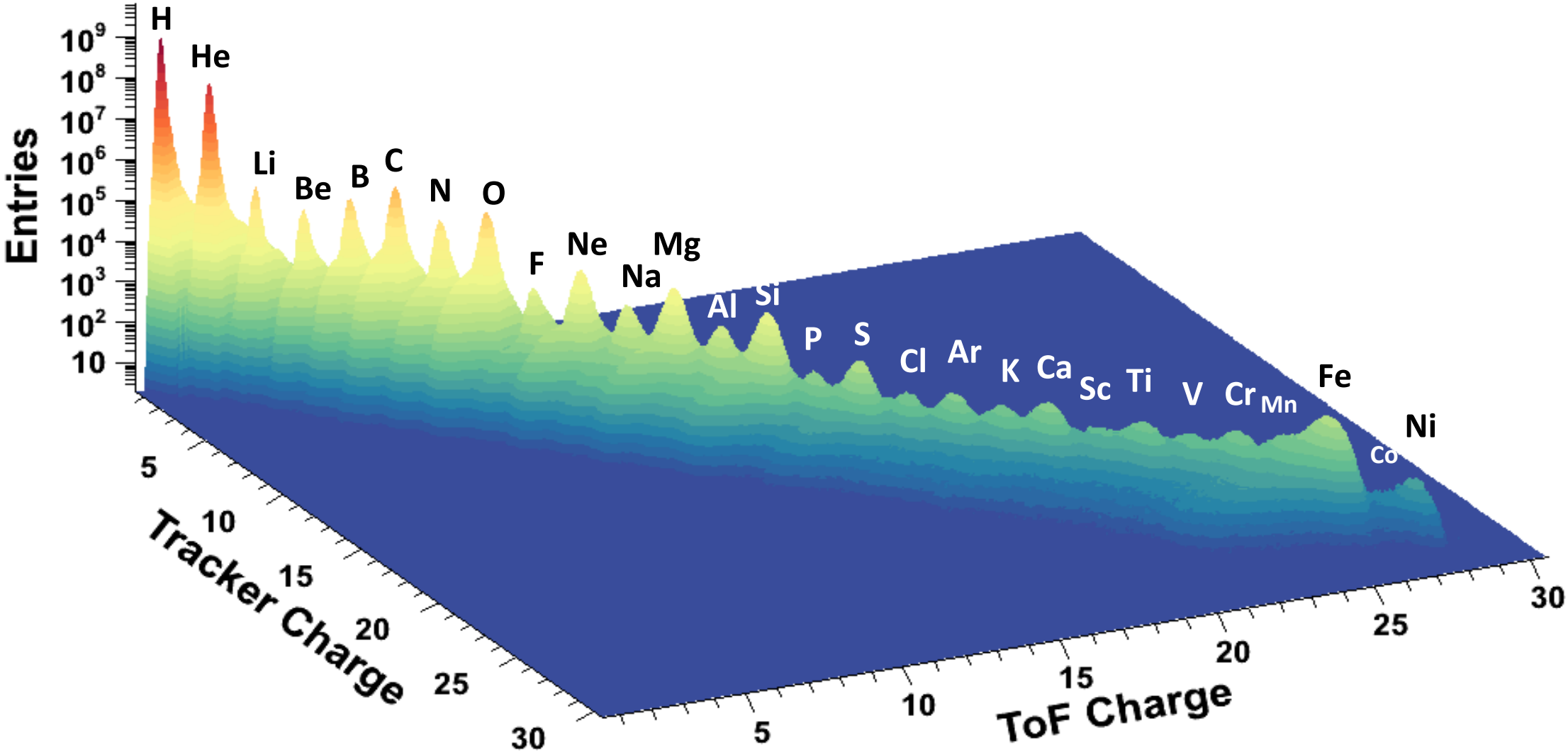
**RICH**, β
Δβ (β=1, Z=5,6) ≈ $5\times10^{-4}$

# Multiple Measurements of Charge




| | Charge Resolution for Z=6 (c.u.) |
|---|---|
| Tracker Plane 1 | **0.30** |
| TRD | **0.33** |
| Upper TOF | **0.16** |
| Tracker Planes 2-8 | **0.12** |
| Lower TOF | **0.16** |
| RICH | **0.32** |
| Tracker Plane 9 | **0.30** |

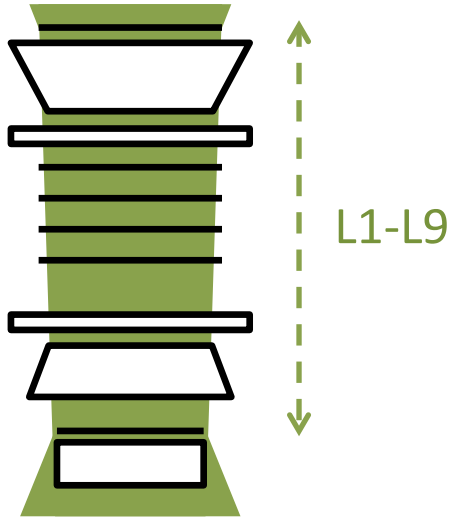
# Cosmic-Rays Composition with AMS



# B/C Event Selection

## Selection

a) Tracker and TOF Charges compatible with Z=5, 6.
b) Track passing through L1 with good charge.
c) Tracks with at least 5 points and a good fit ($\chi^2_Y$ L2-L8 < 10).
d) Rigidity above geomagnetic cutoff (R>1.2 $R_C$).
→ Statistics for 40 months: **7M Carbons and 2M Borons.**

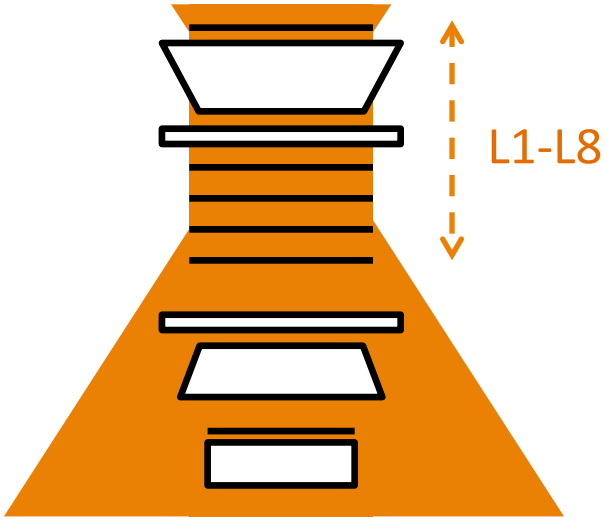



## Long Lever Arm Analysis

a) Tracker Layer 9 Charge compatible with Z=5, 6.
b) Full Span Track with a good fit ($\chi^2_Y$ L1-L9 < 10).
→ Highest possible MDR (about 2.5 TV).

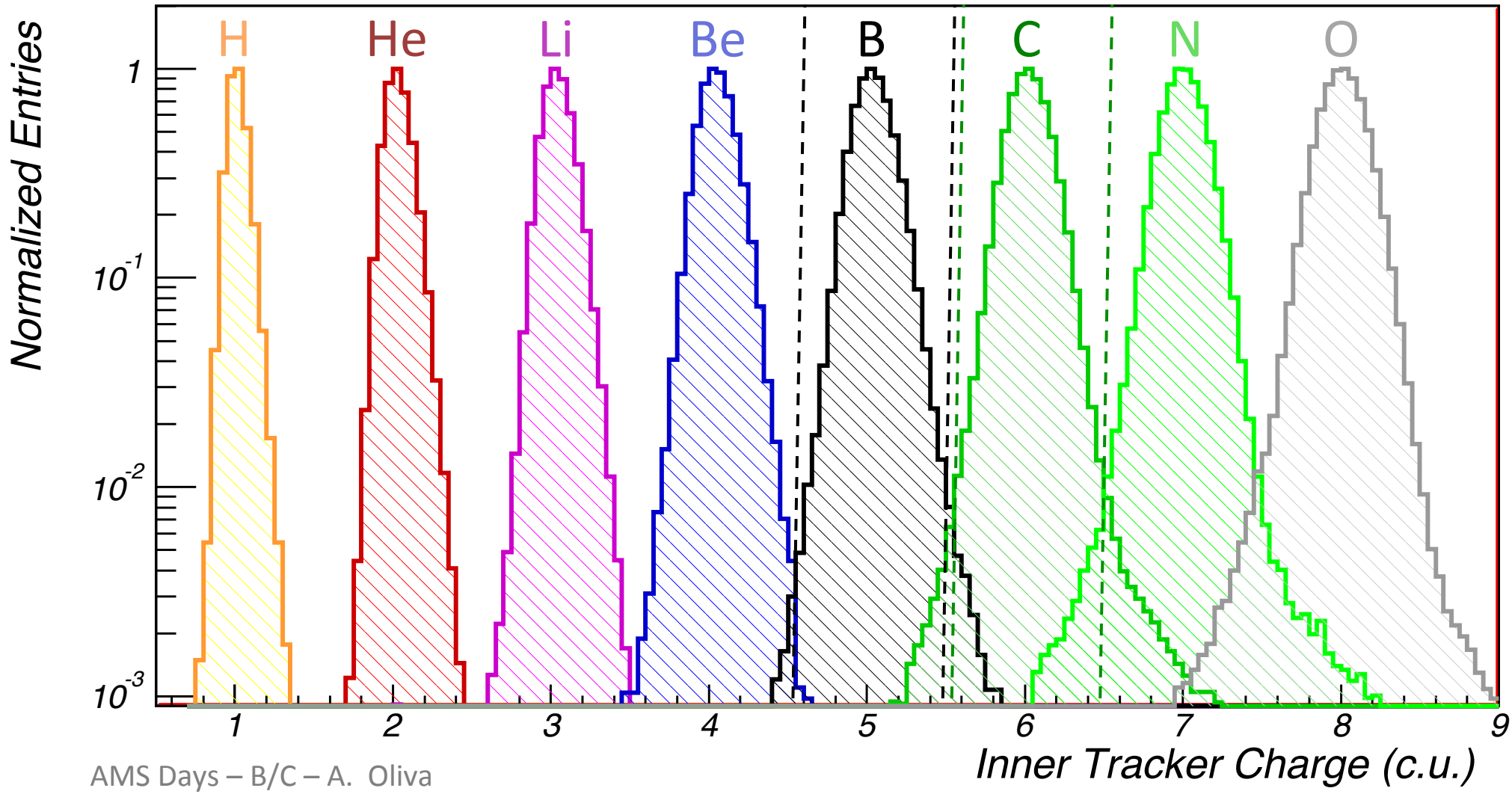
## Large Statistics Analysis

a) No requirement on L9.
b) Track with a good fit ($\chi^2_Y$ L1-L8 <10).
→ Factor 5 more events, and less interacting events.



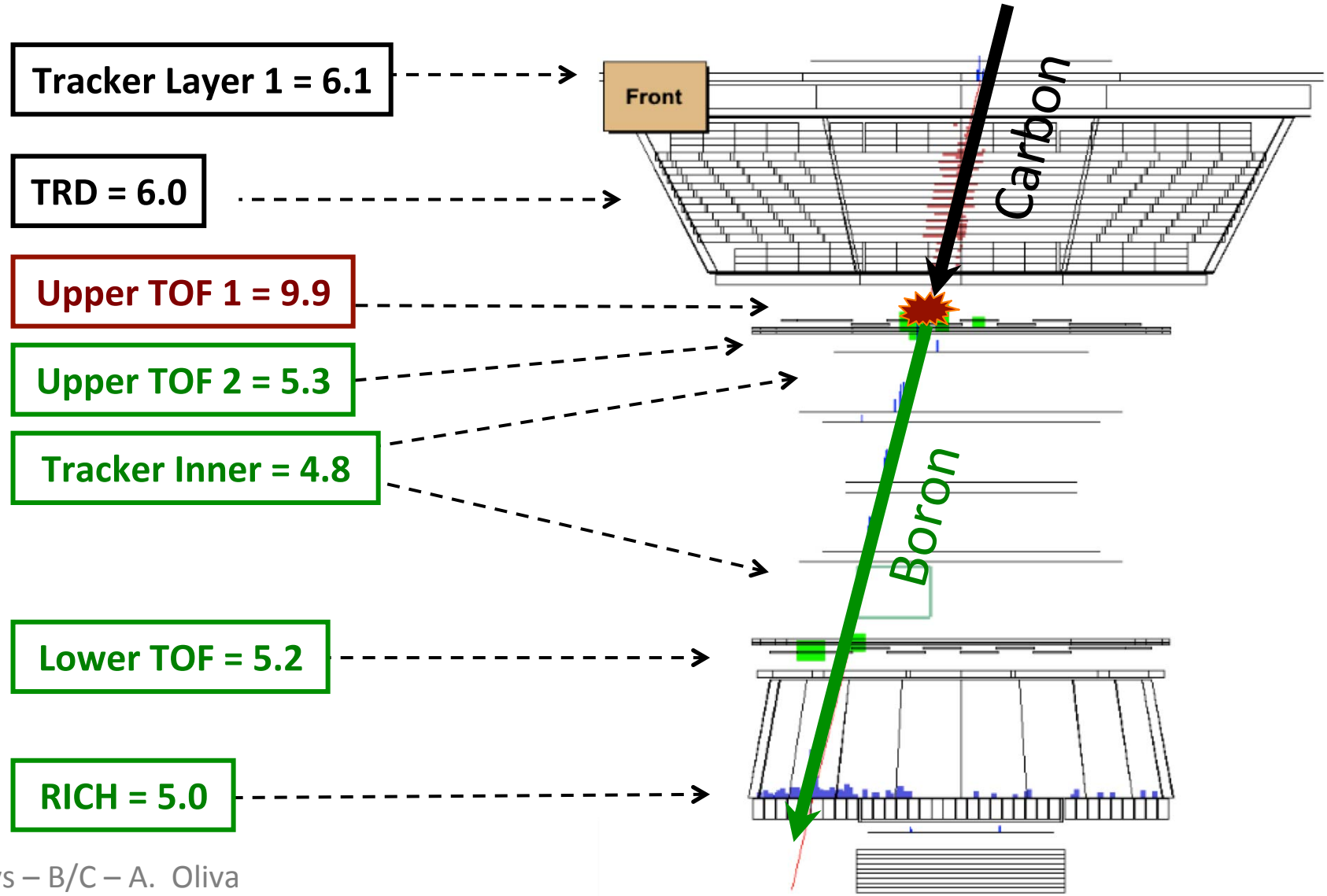
# B/C Event Selection with Inner Tracker

Misidentification from neighboring charges is < $10^{-3}$.
Identification efficiency is > 98%.

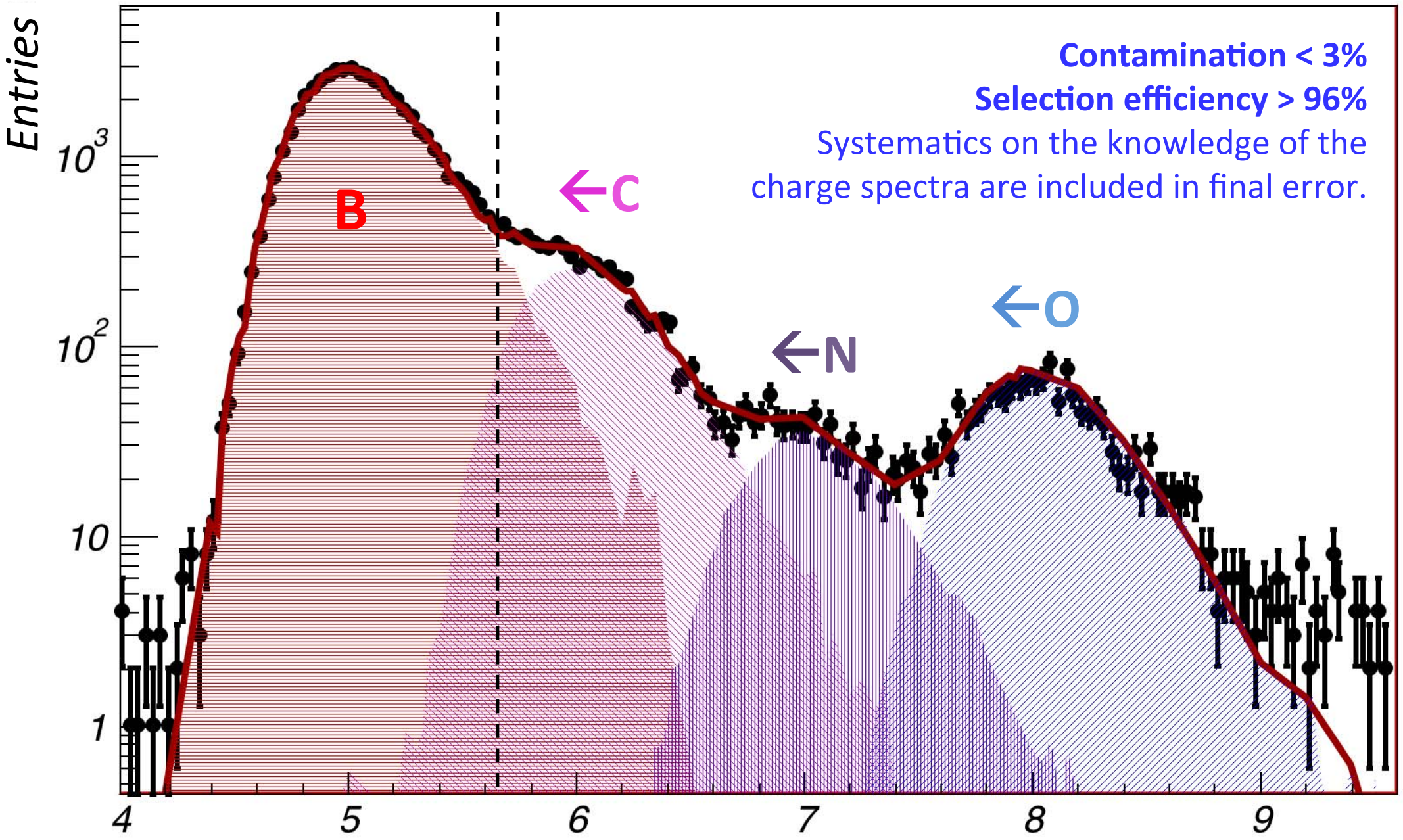


# B/C Sample Purity

The main background of these analyses consists of nuclei fragmenting through hadronic inelastic interaction. These events can be controlled using the AMS upper detectors.



# Boron Sample Purity

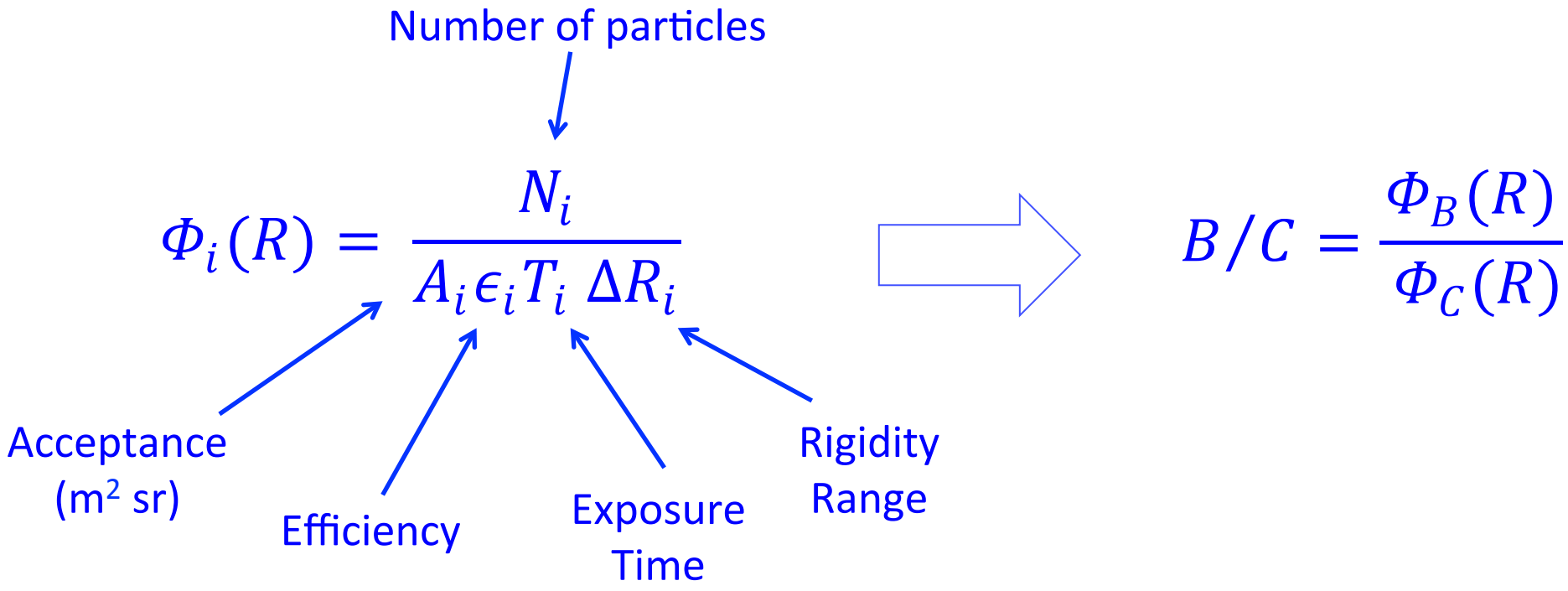



**Contamination < 3%**

**Selection efficiency > 96%**

Systematics on the knowledge of the charge spectra are included in final error.

# B/C Ratio Measurement

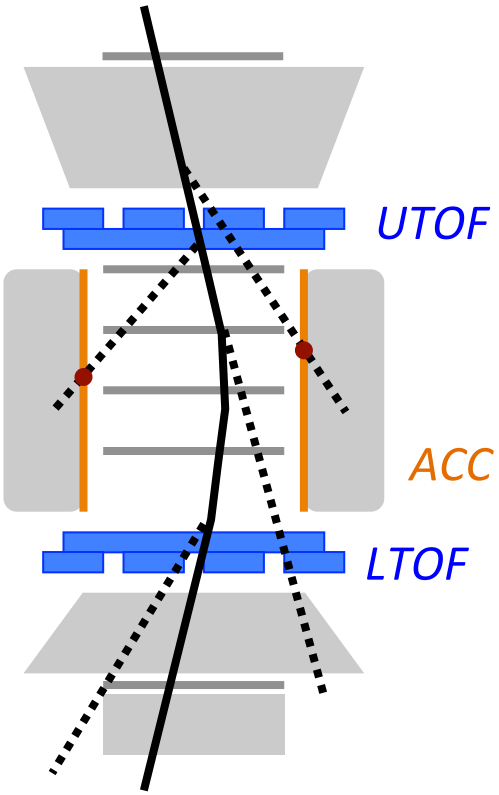


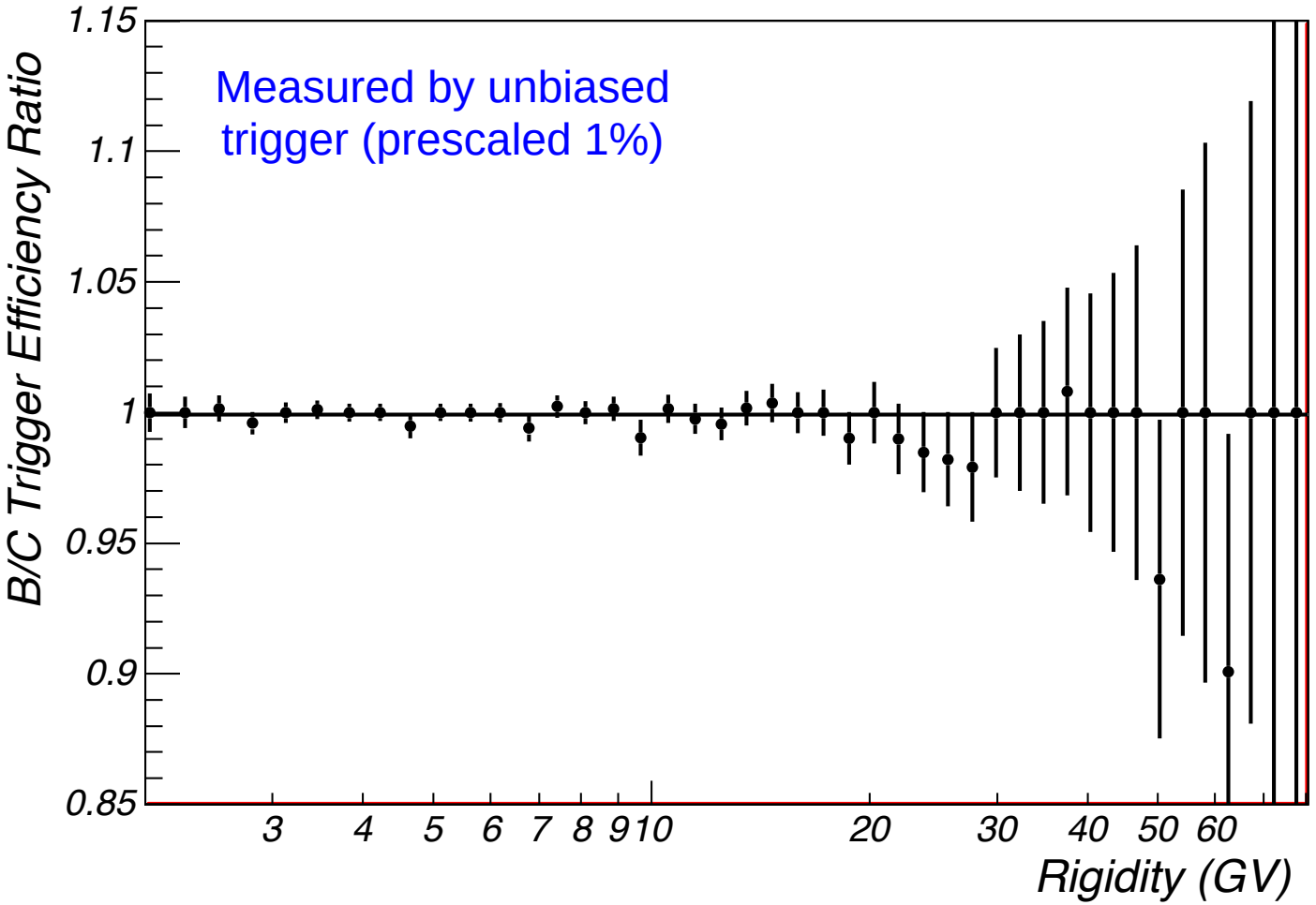

B and C have similar behavior. The small differences in detection efficiency are evaluated directly from data. A global correction of 5% (mostly due to B purity cut) is accounted.

Monte Carlo (MC) is used to derive the geometric term, the resolution matrix for the bin-to-bin migration and the Top-of-the-Instrument corrections.

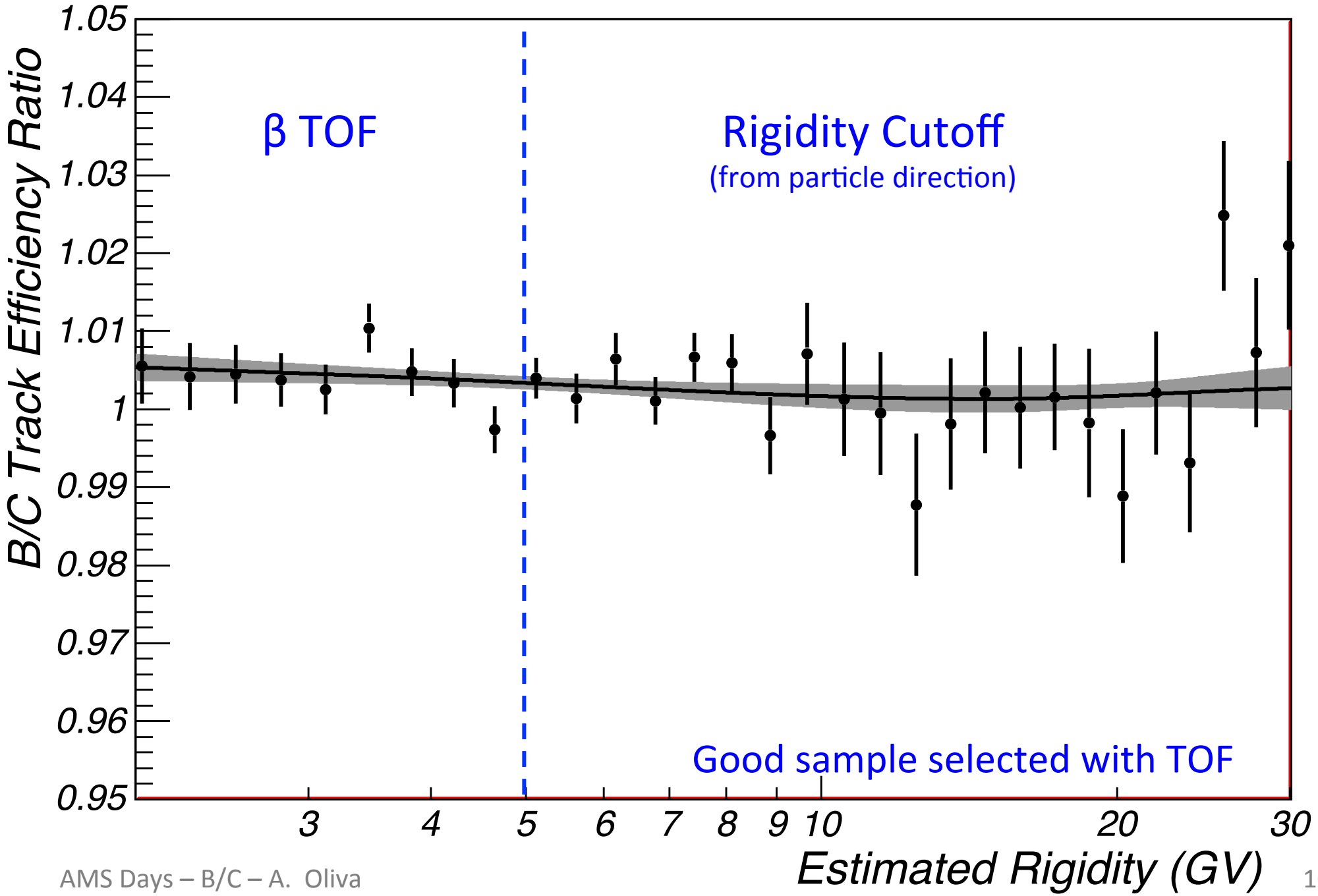
# B/C Trigger Efficiency Ratio

Trigger efficiency for ions is very high (nearly 100%).
Veto counters condition is relaxed when signal in TOF is larger than charge 1.



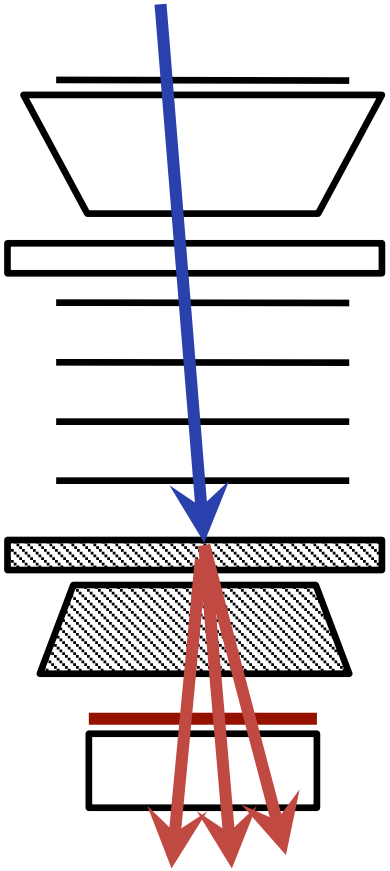



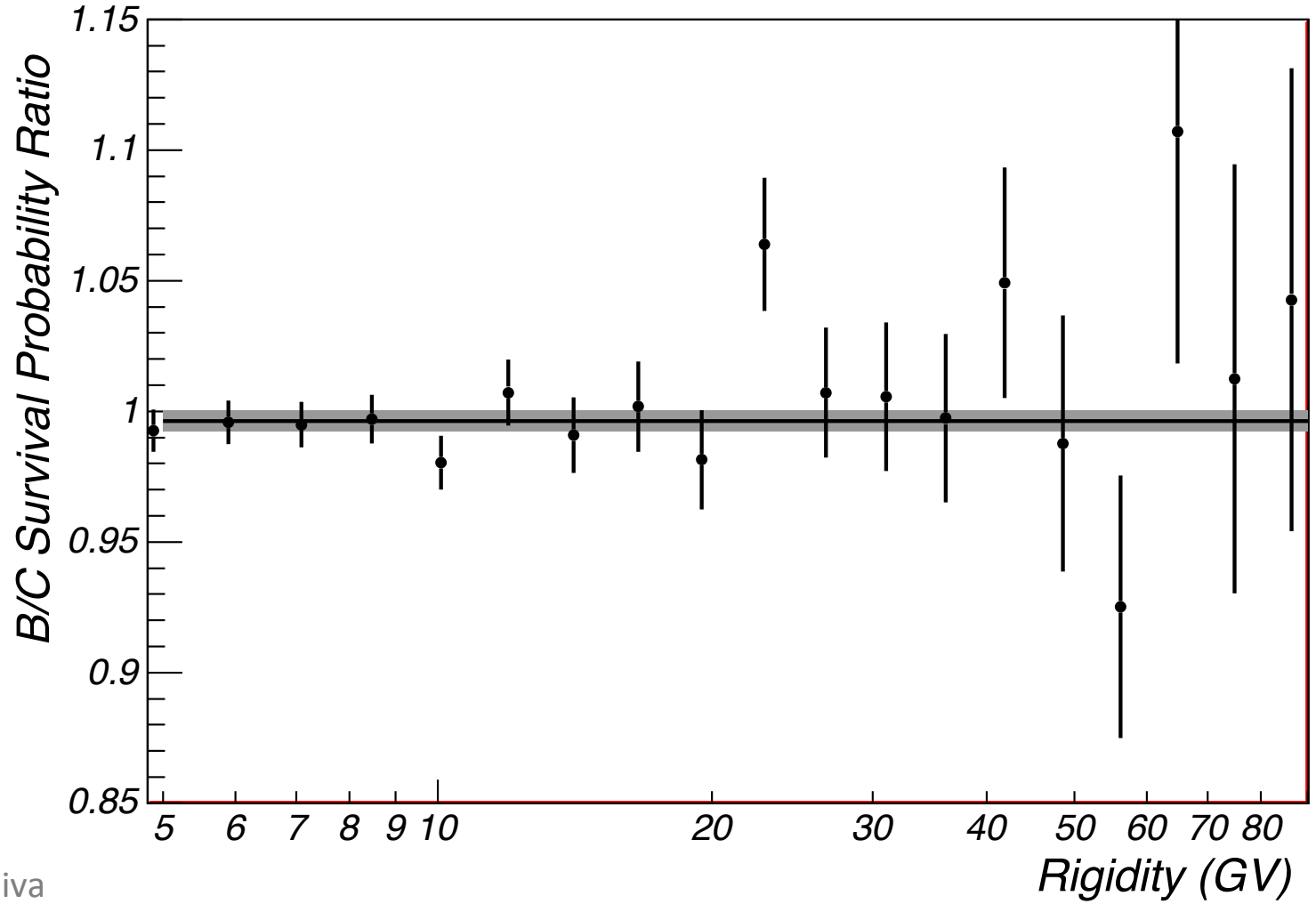
# B/C Track Efficiency Ratio



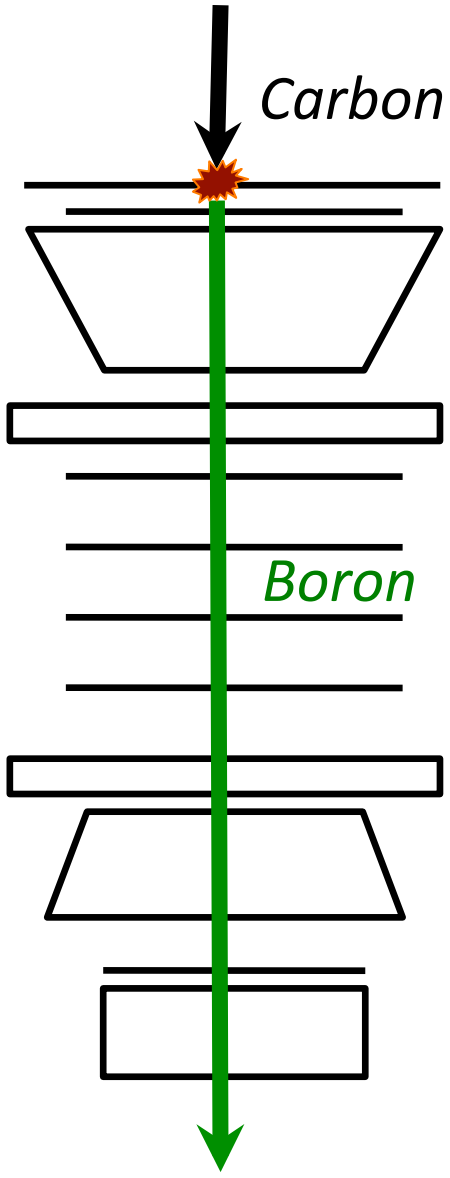
# B/C Survival Probability Ratio

We can estimate the fraction of events interacting in the lower part of AMS (TOF+RICH).
The difference between B and C accounts for the different interaction effect of
the different cross-section in approximately “1/3” of AMS materials.
From the comparison between data and MC an additional systematics of 1% is added.





# Top-of-the-Instrument (TOI) Correction



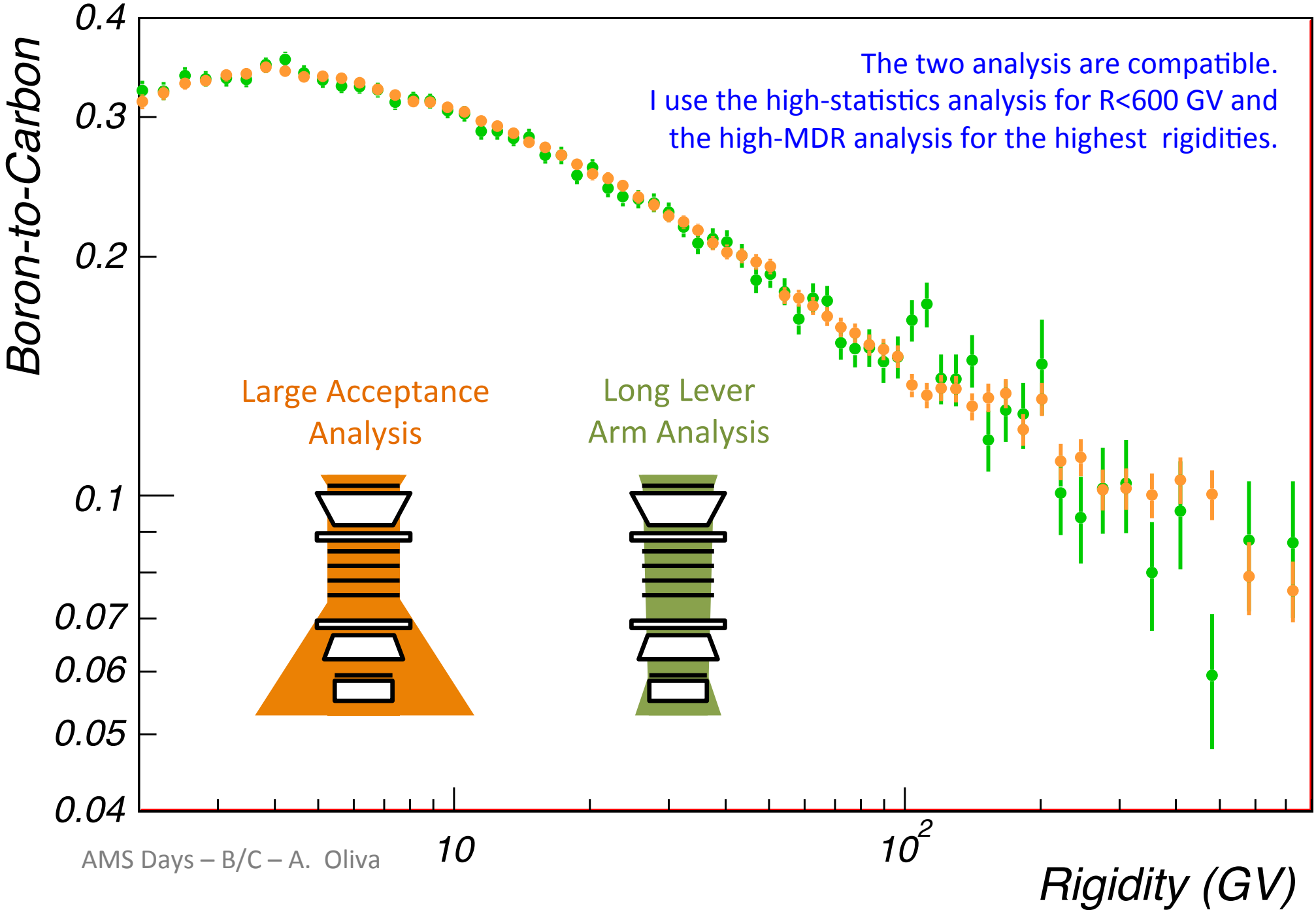

Fragmentation of nuclei before L1 is accounted.

Correction is derived from a MC tuned to reproduce the survival probabilities observed in the data.

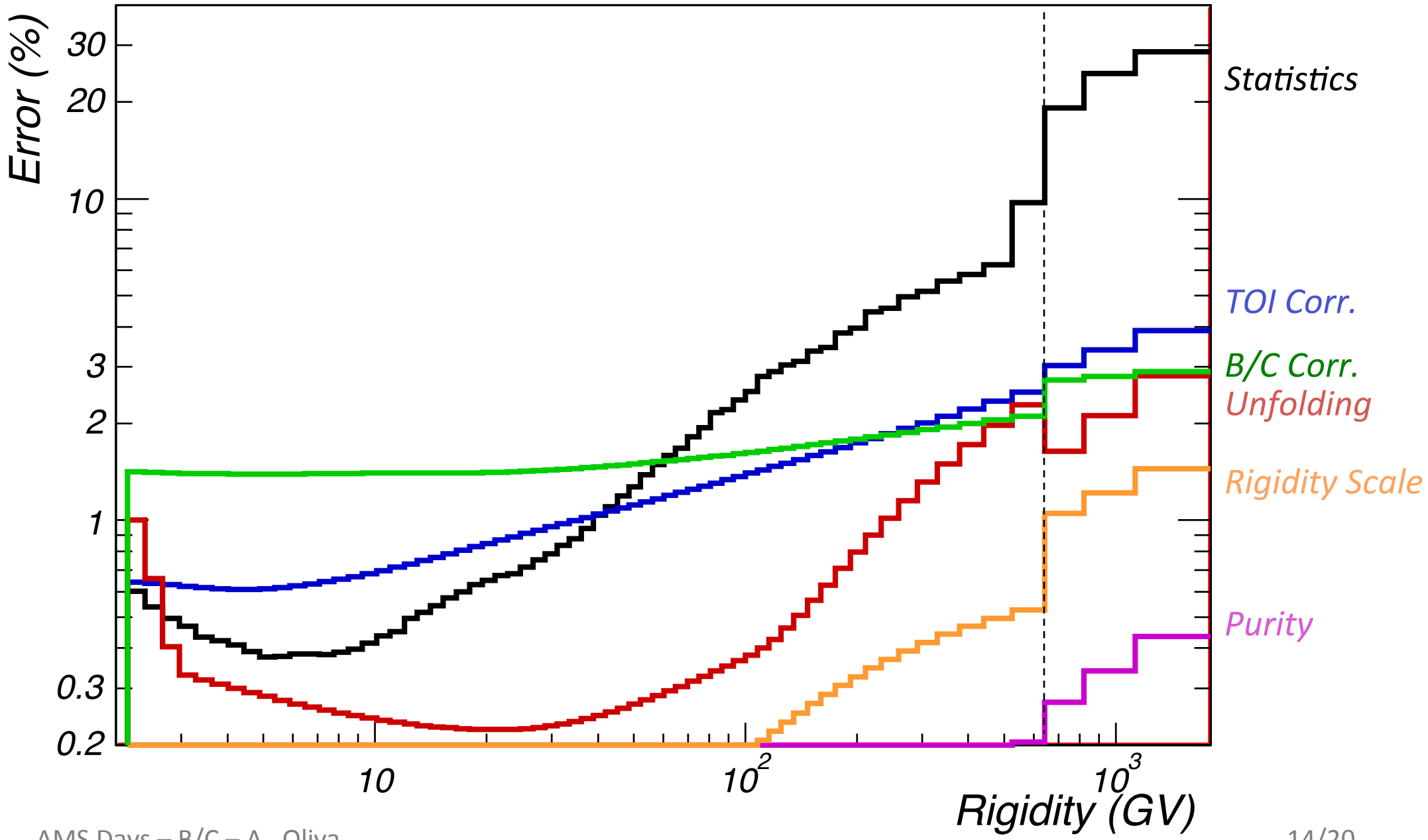
Most important channels are:

$$P(B|C) = (4.5 \pm 1.0) \times 10^{-3}$$
$$P(B|O) = (1.4 \pm 1.0) \times 10^{-3}$$

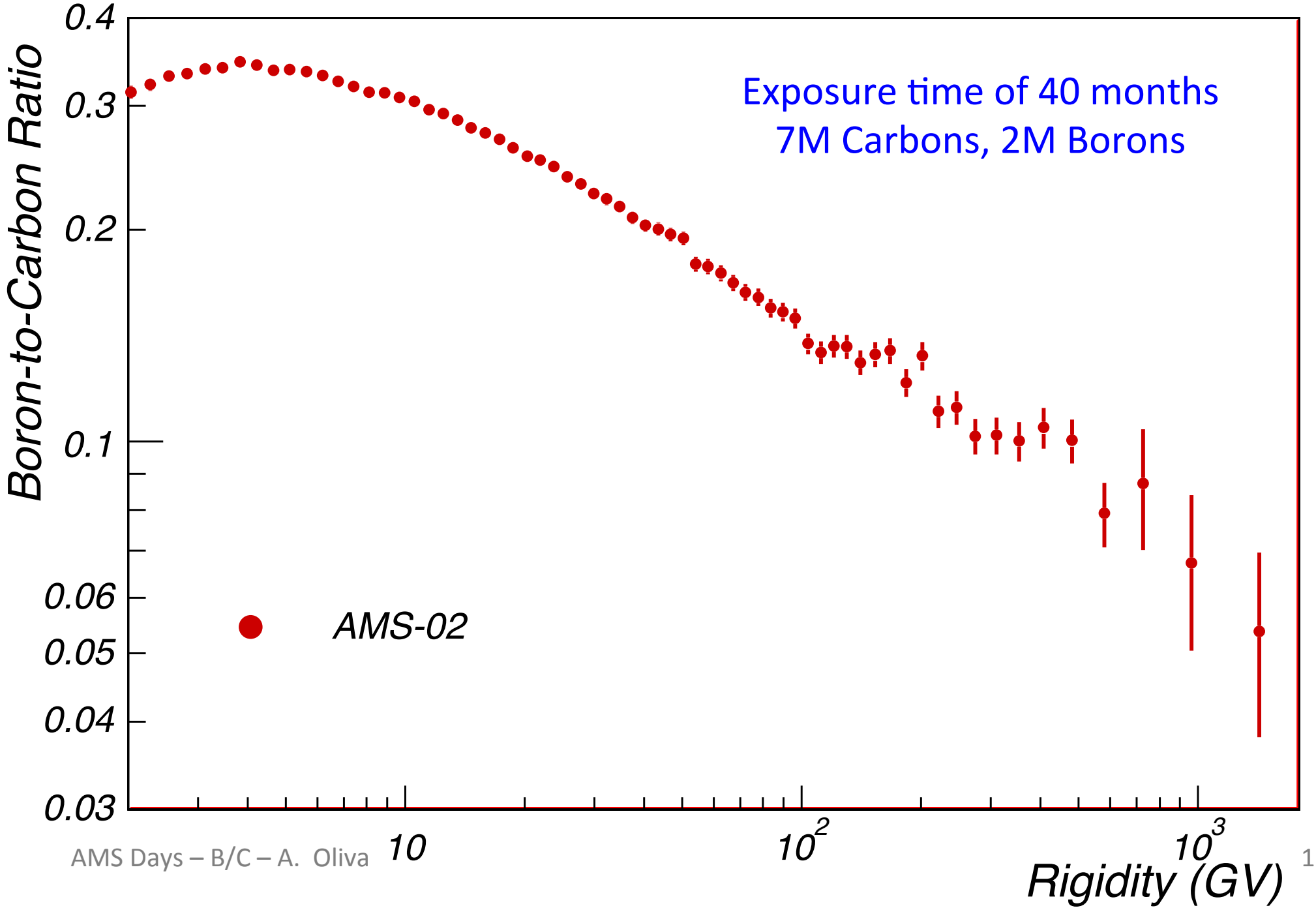
# Verification of Unfolding and Acceptance



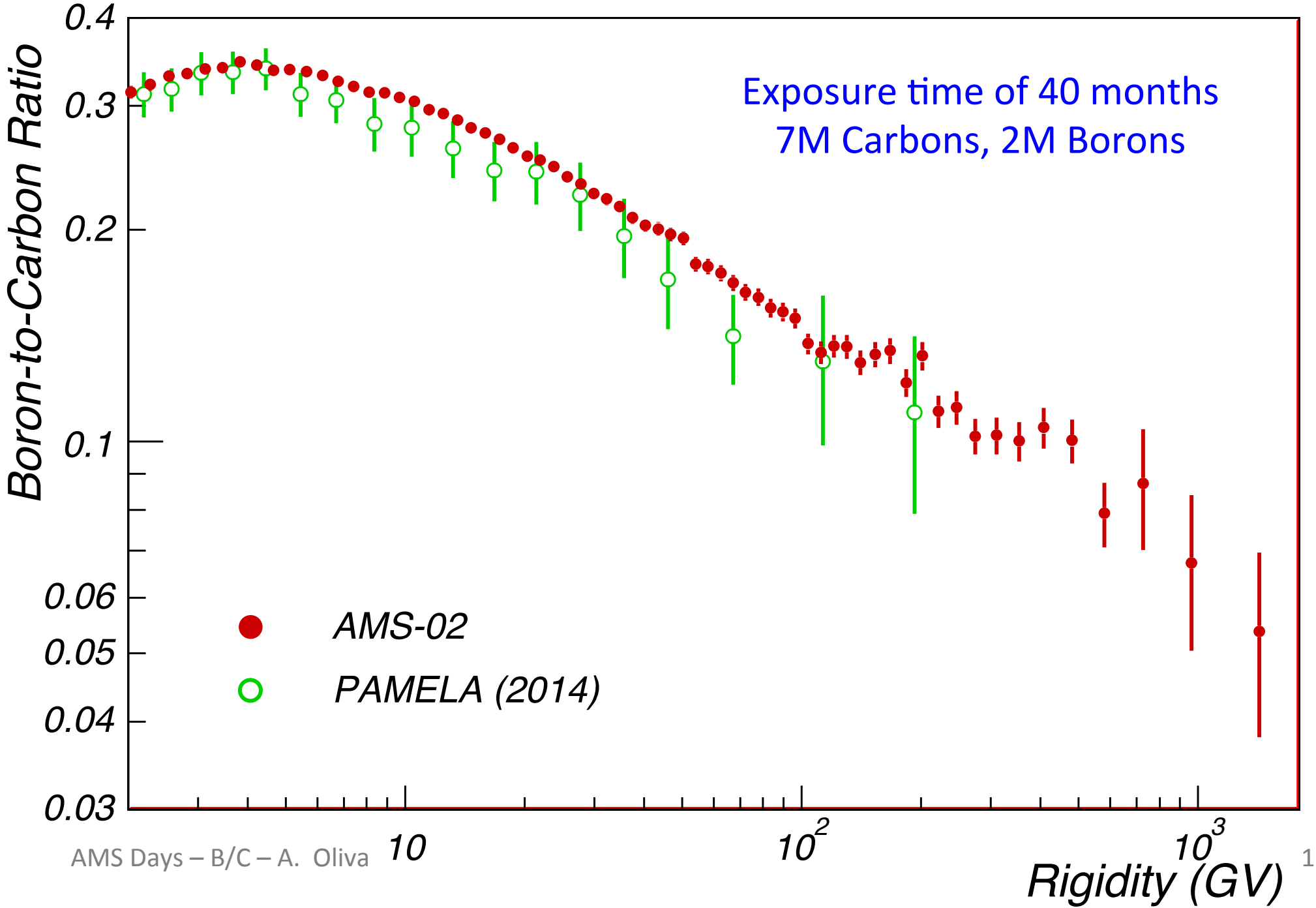
# B/C Error Breakdown



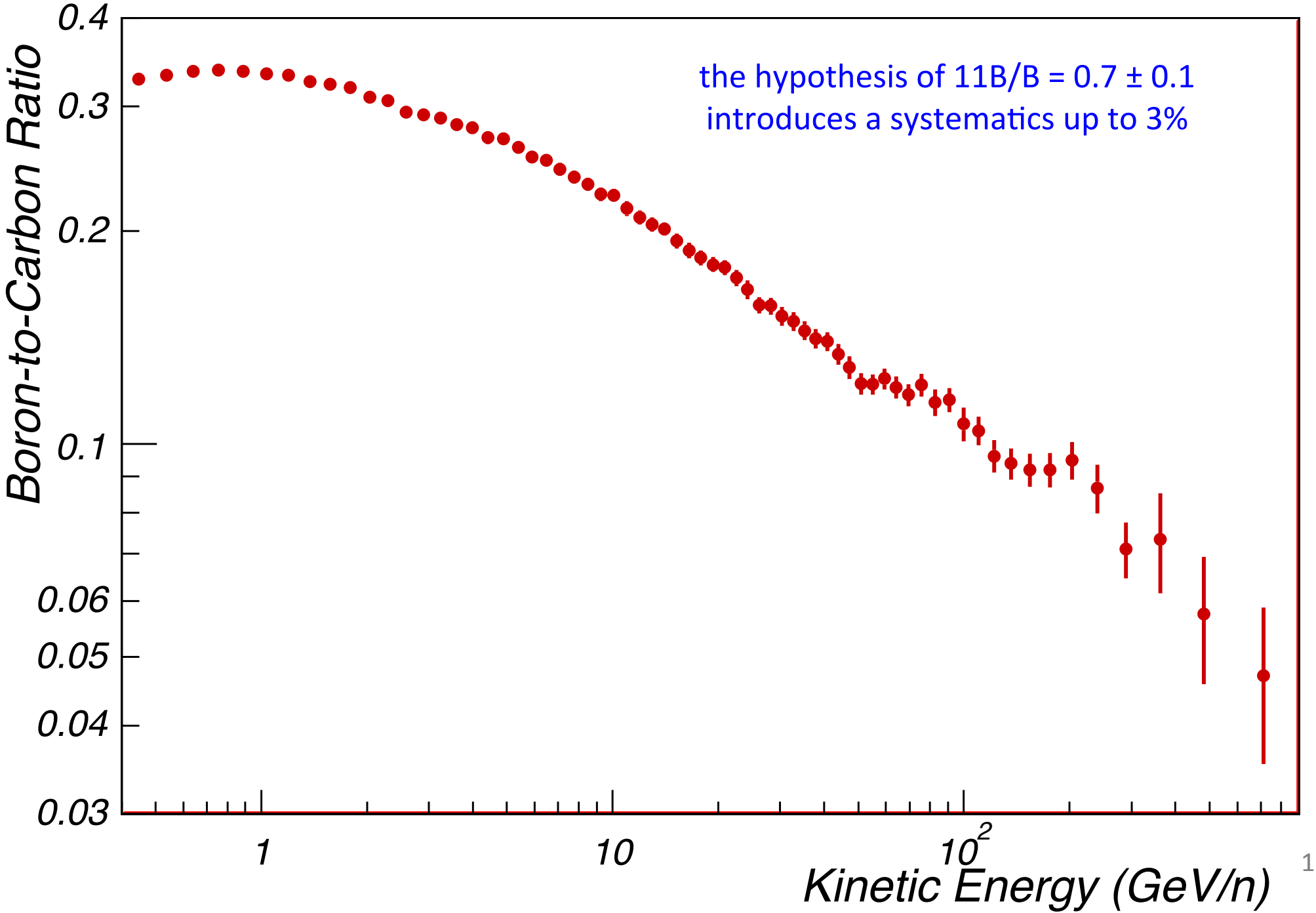
# B/C Ratio


Exposure time of 40 months
7M Carbons, 2M Borons
AMS-02
Boron-to-Carbon Ratio
0.4
0.3
0.2
0.1
0.06
0.05
0.04
0.03
10
$10^2$
$10^3$
Rigidity (GV)

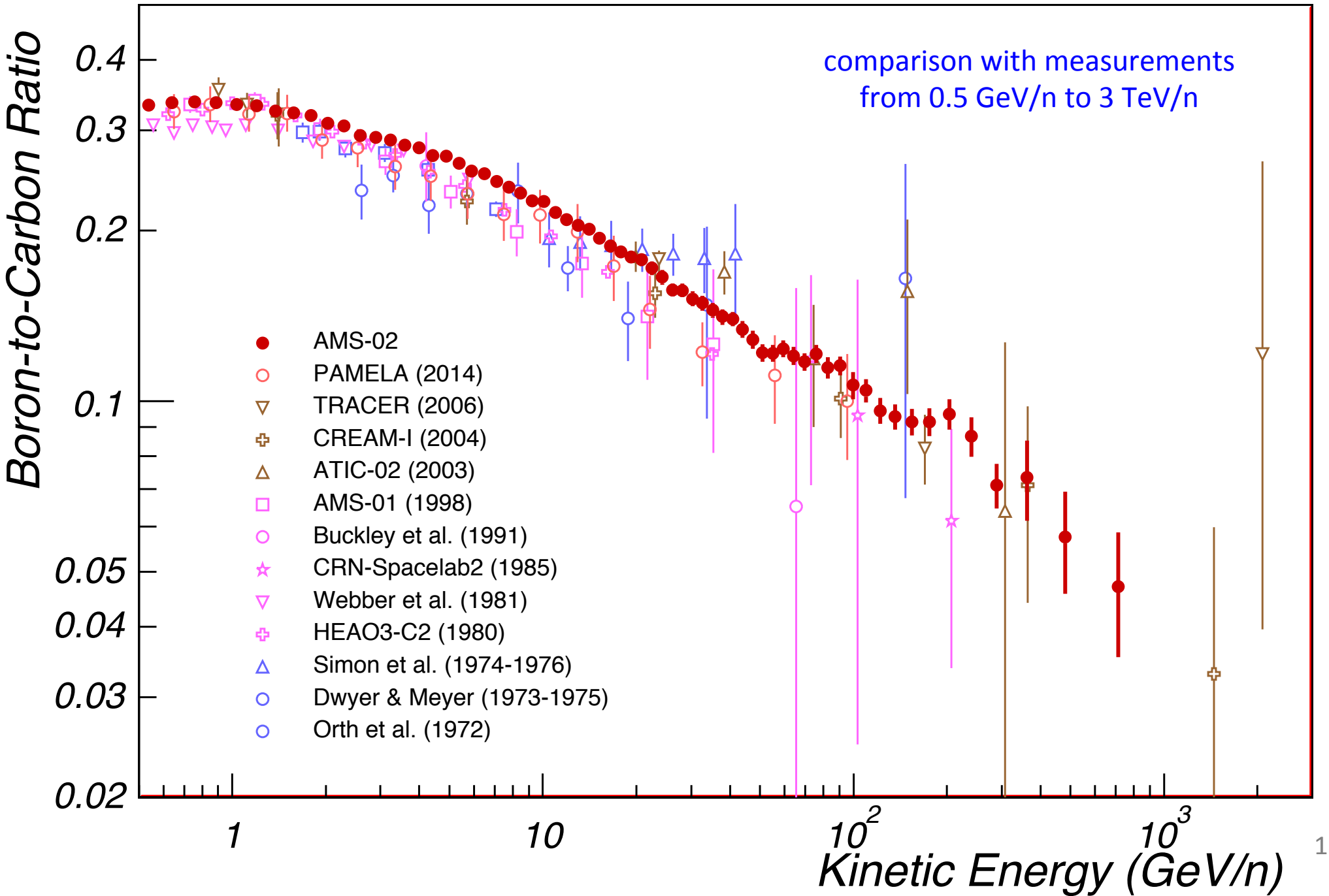
# B/C Ratio


Boron-to-Carbon Ratio
0.4
0.3
0.2
0.1
0.06
0.05
0.04
0.03
Exposure time of 40 months
7M Carbons, 2M Borons
AMS-02
PAMELA (2014)
10
$10^2$
$10^3$
Rigidity (GV)

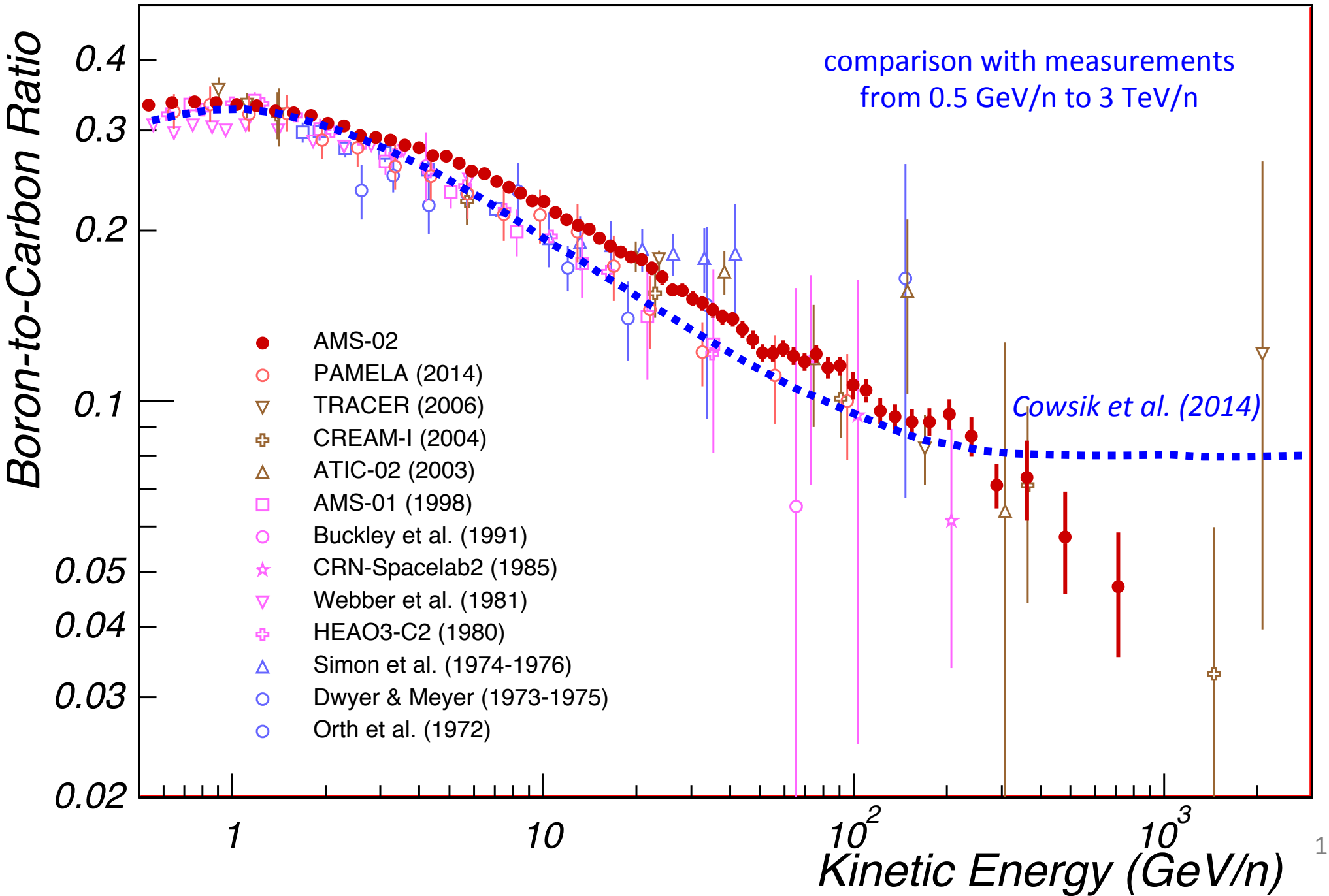
# B/C Ratio converted in Kinetic Energy



# B/C Ratio converted in Kinetic Energy



# B/C Ratio converted in Kinetic Energy



# Conclusions

- The B/C flux ratio, based on an exposure time of 40 months of AMS-02, 7M Carbon and 2M Borons has been shown between 2 GV and 1.8 TV rigidity.

- Sources of differences between Boron and Carbon counts were investigated and systematics included in the error.

- The high accuracy of AMS-02 B/C measurement gives possibility to distinguish between current models and reveals new details about the cosmic-rays propagation.