Precision Measurement of the Cosmic Boron-to-Carbon Ratio with AMS

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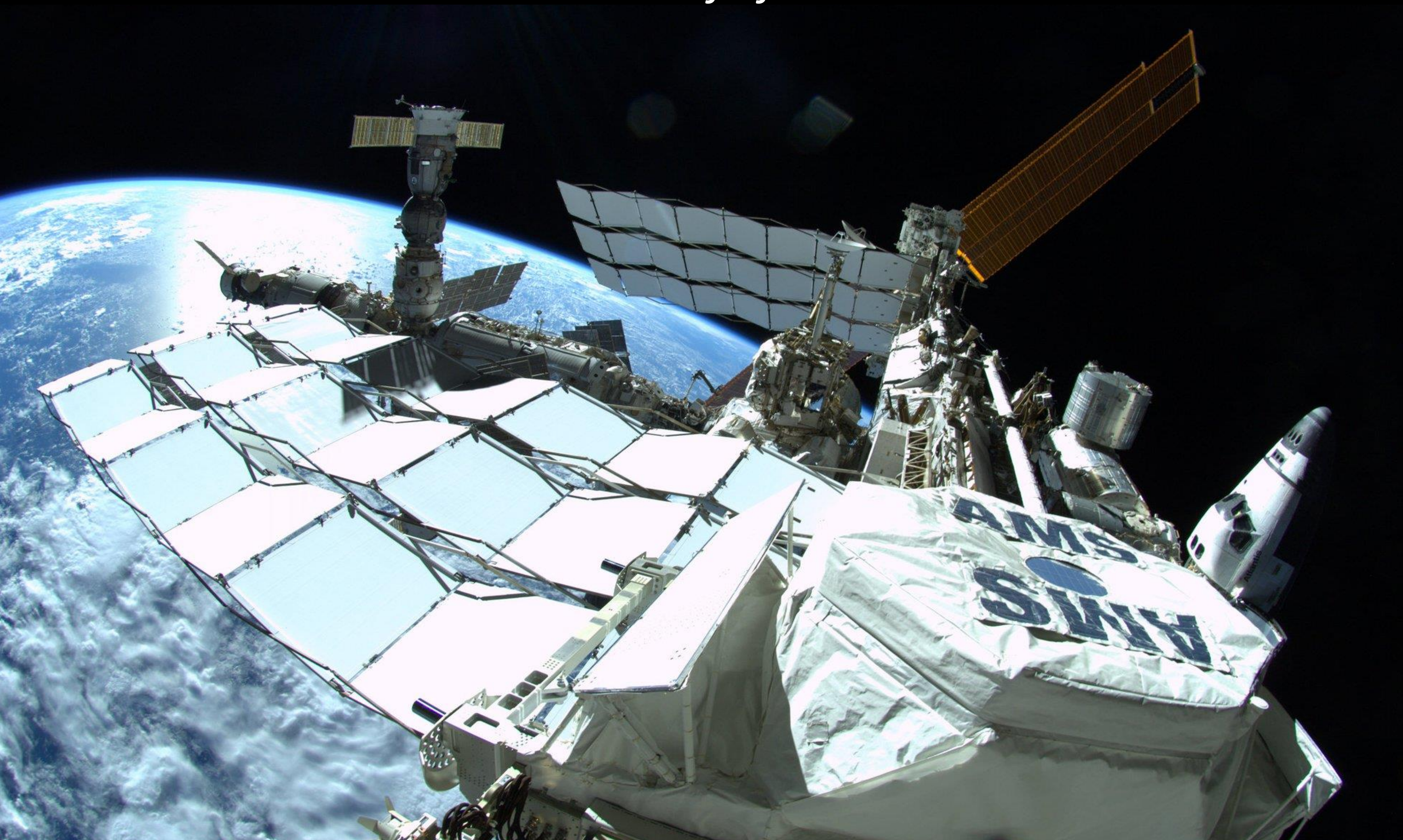
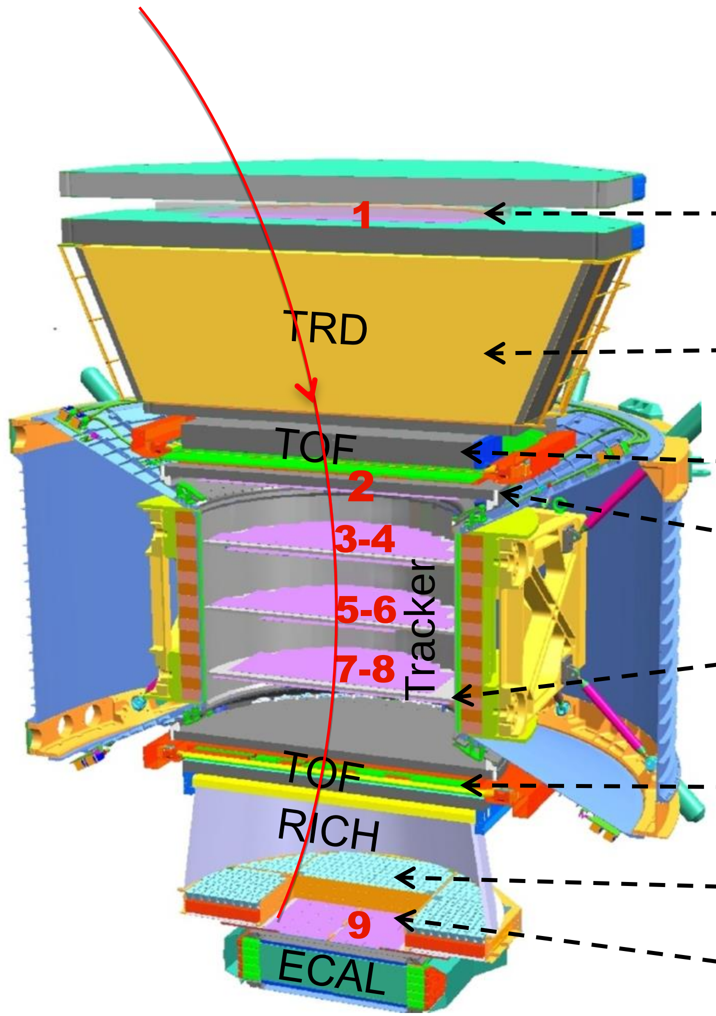
On behalf of the AMS Collaboration



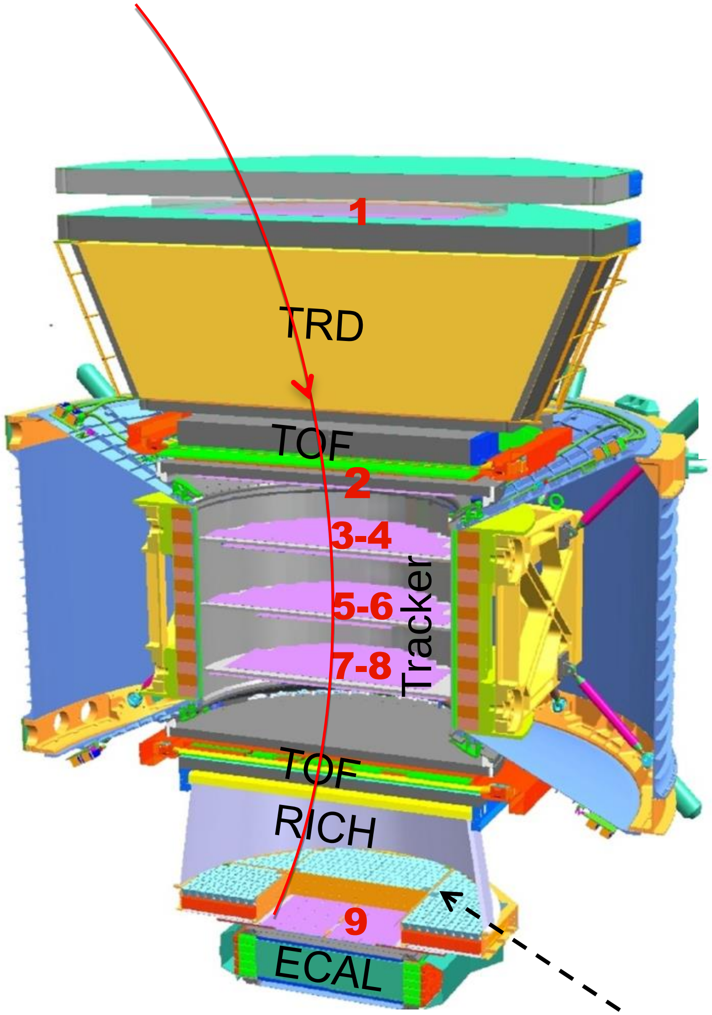
33rd ICRC
8 Jul 2013
Rio de Janeiro

Multiple Measurements of Charge



	Carbon (Z=6) *ΔZ (cu)*
Tracker Plane 1 (L1)	*0.30*
TRD	*0.33*
Upper TOF (1 counter)	*0.16*
Inner Tracker (L2-L8)	*0.12*
Lower TOF (1 counter)	*0.16*
RICH	*0.32*
Tracker Plane 9 (L9)	*0.30*

Multiple Measurements of Energy



Tracker, R = p/Z

MDR (Z=6) ≈ 3TV

TOF, β

Δβ (β=1, Z=6) ≈ 0.01

RICH, β

Δβ (β=1, Z=6) ≈ 5 × 10^{-4}

Flux and Ratio Determination

*B/C is a flux **ratio**. Flux is given by:*

Number of counts

$$\Phi(\overline{K_\mathrm{n}}) = \frac{N(K_\mathrm{n}, K_\mathrm{n} + \Delta K_\mathrm{n})}{A\,\epsilon\,\Delta T\,\Delta K_\mathrm{n}}$$

Acceptance
(m^2 sr)

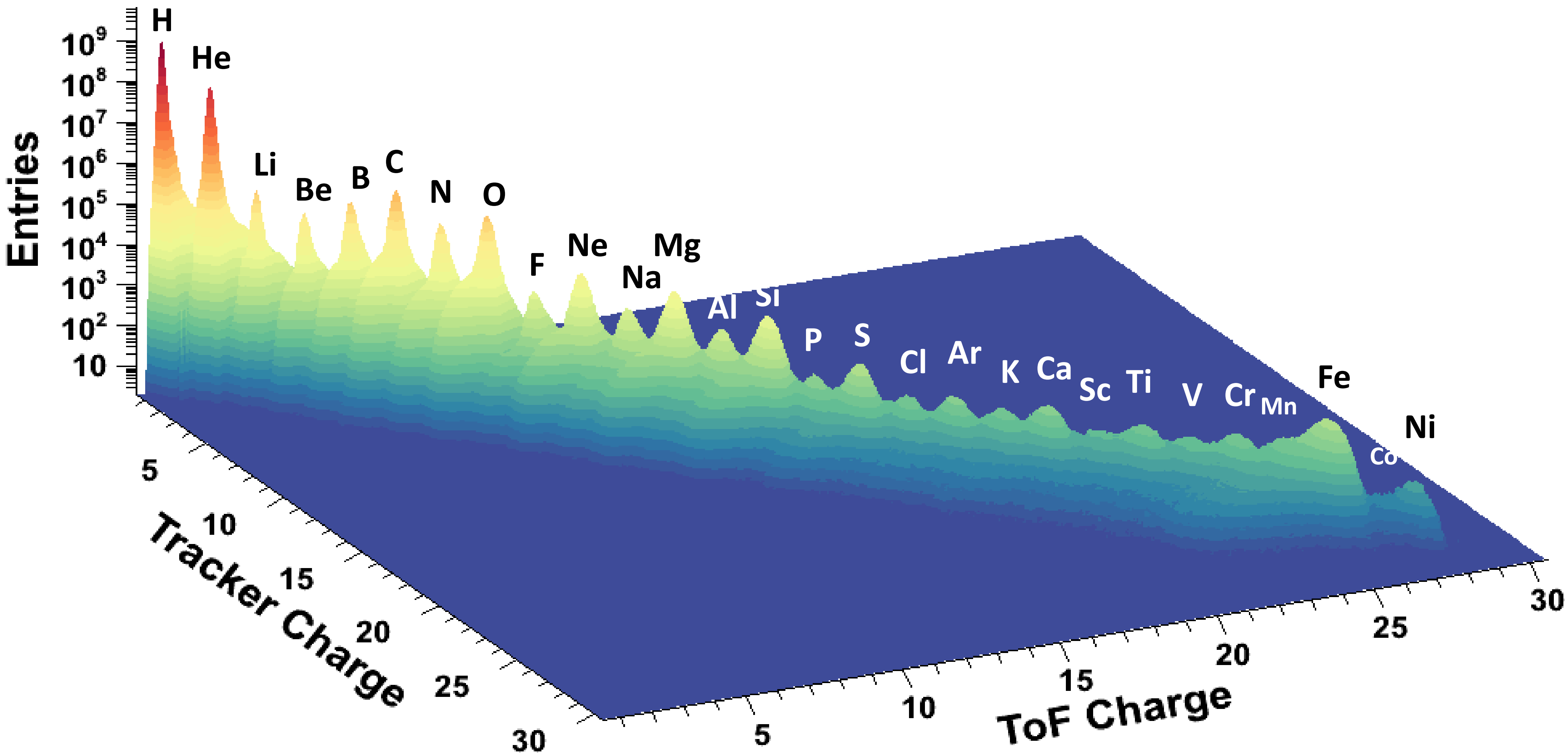
Efficiency

Exposure Time

Bin Width

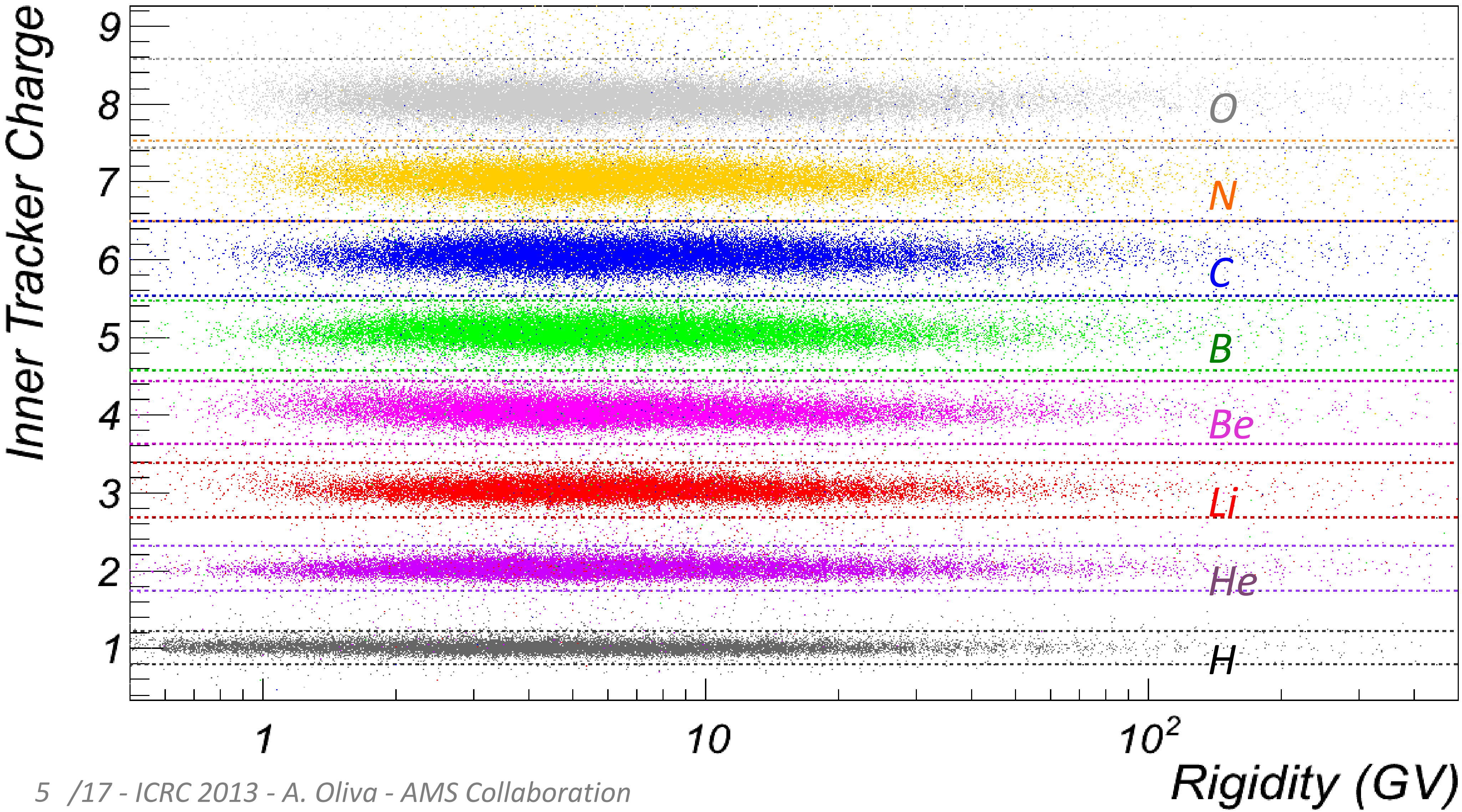
*K_n is the **kinetic energy per nucleon,***
is measured from TOF and RICH (beta)
or from Tracker (rigidity)

Nuclei Identification in AMS

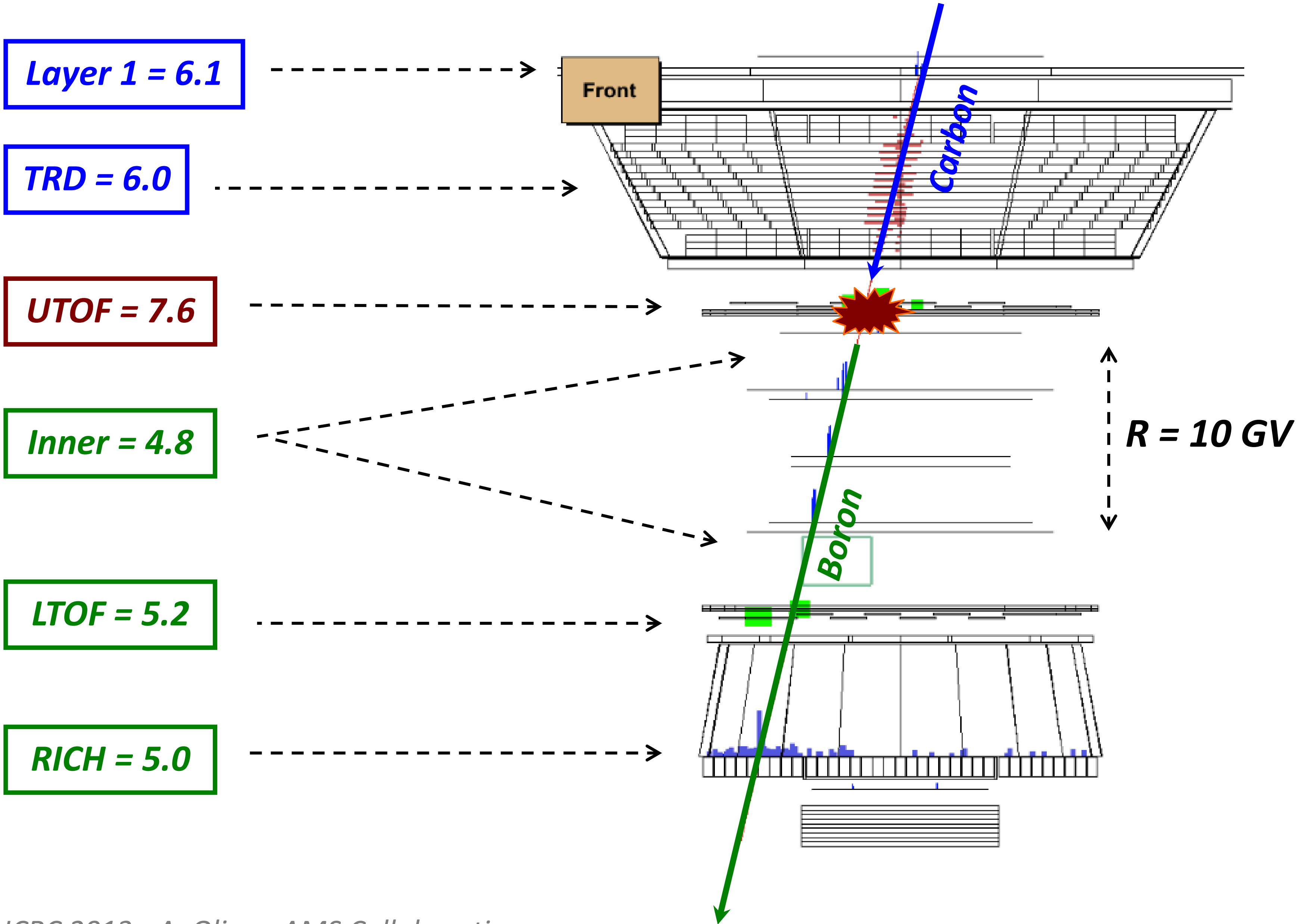


Nuclei Identification with Inner Tracker

Contamination from neightboring charges < 10^{-4}, identification efficiency is > 98%.

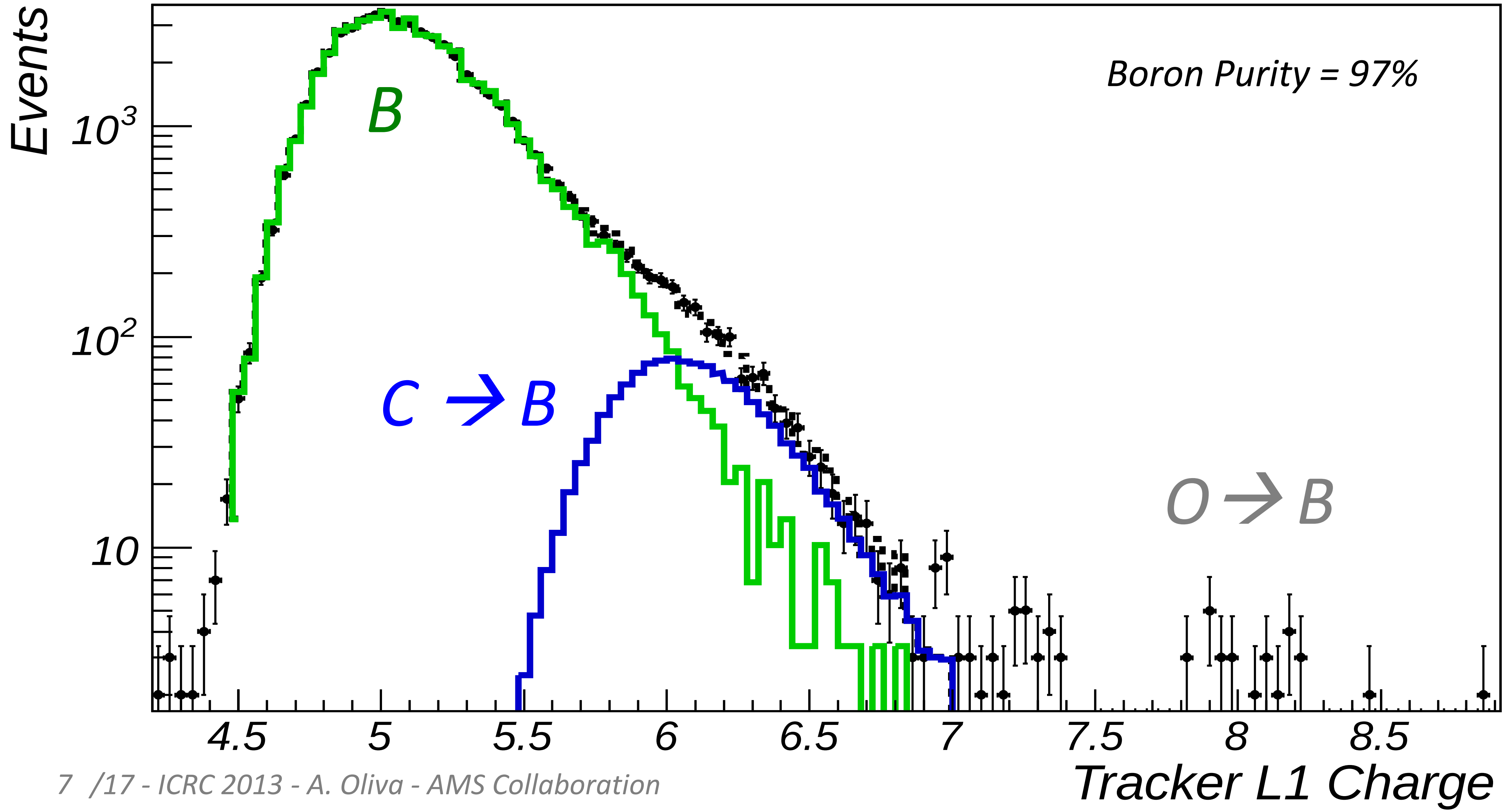


Identification of Fragmentation Events



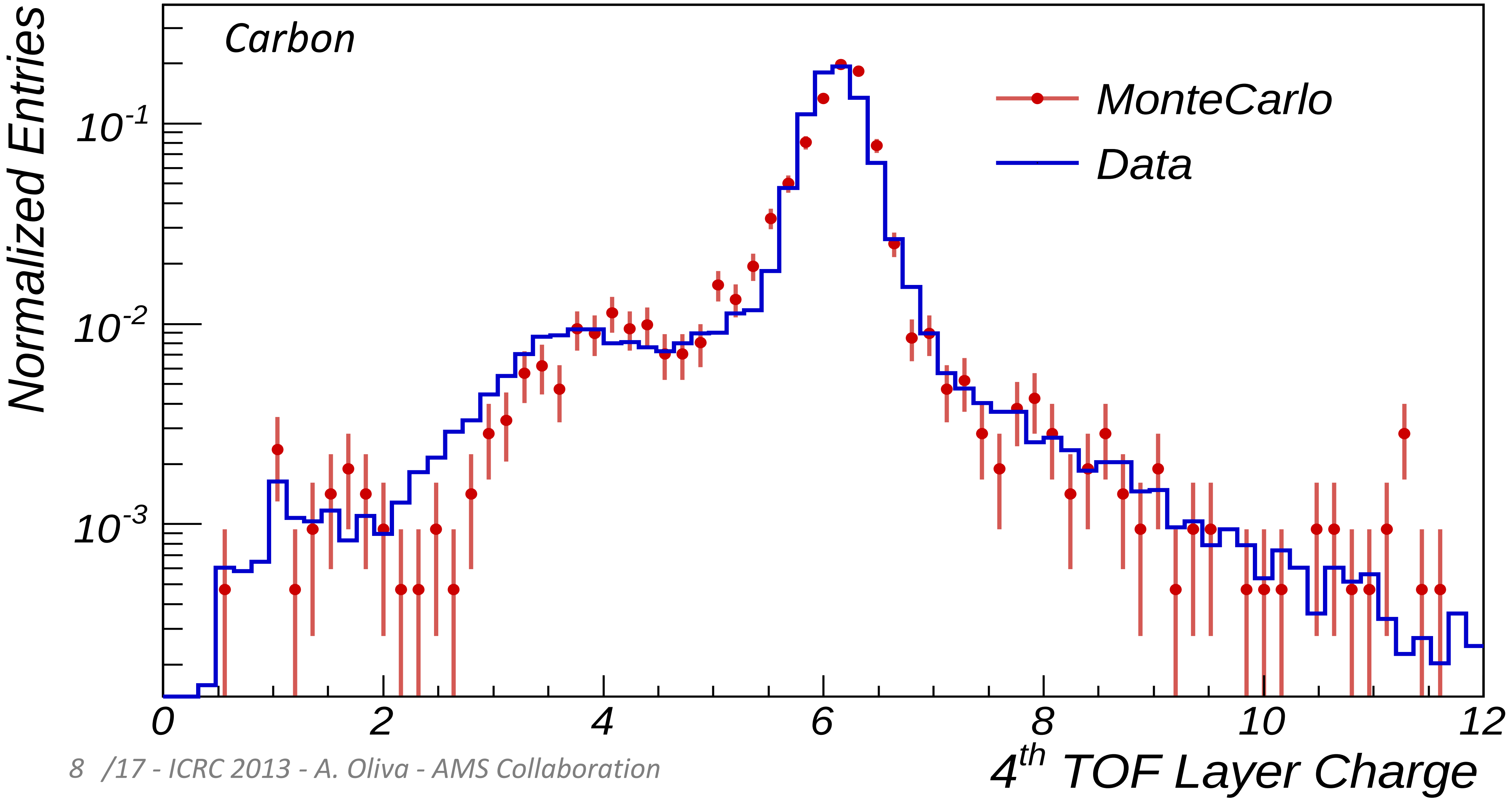
Purity Estimation

Selection efficiency is >70% for both Boron and Carbon, ratio is ≈ 1.
Boron selected with Inner Tracker and TOF.
Background estimated down to accuracy of 0.1%.



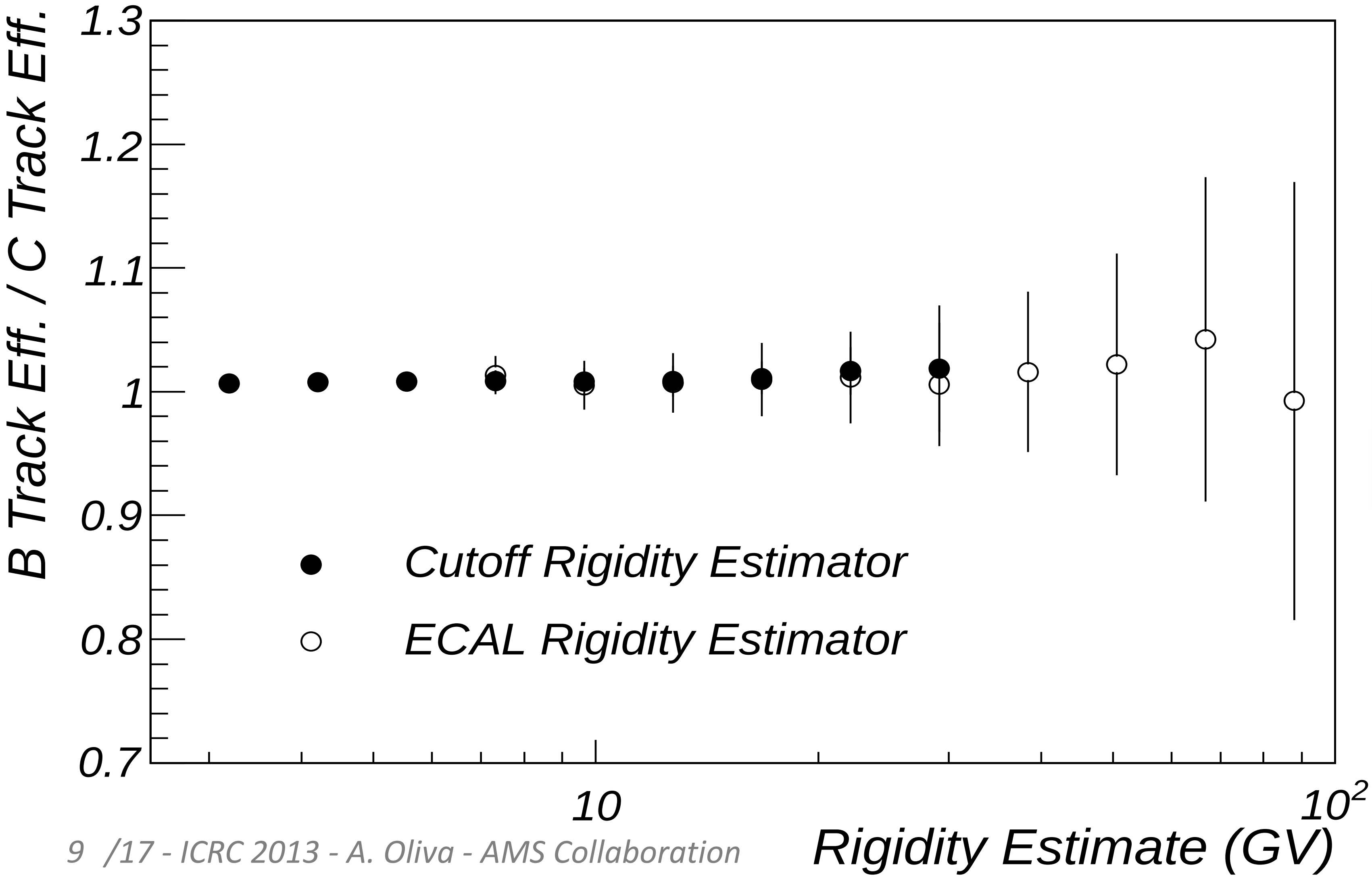
Estimation of Fragmentation

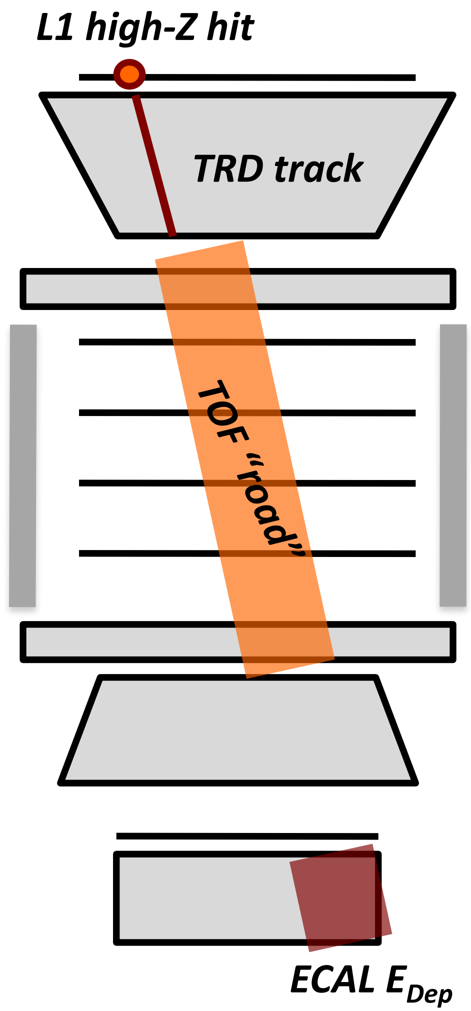
Acceptance is convolution of geometry and fragmentation effects.
Carbon selected with L1 and UTOF. Fragmentation distribution evaluated with LTOF.
Data and MC agreement evaluated being at 2% level.



Track Efficiency

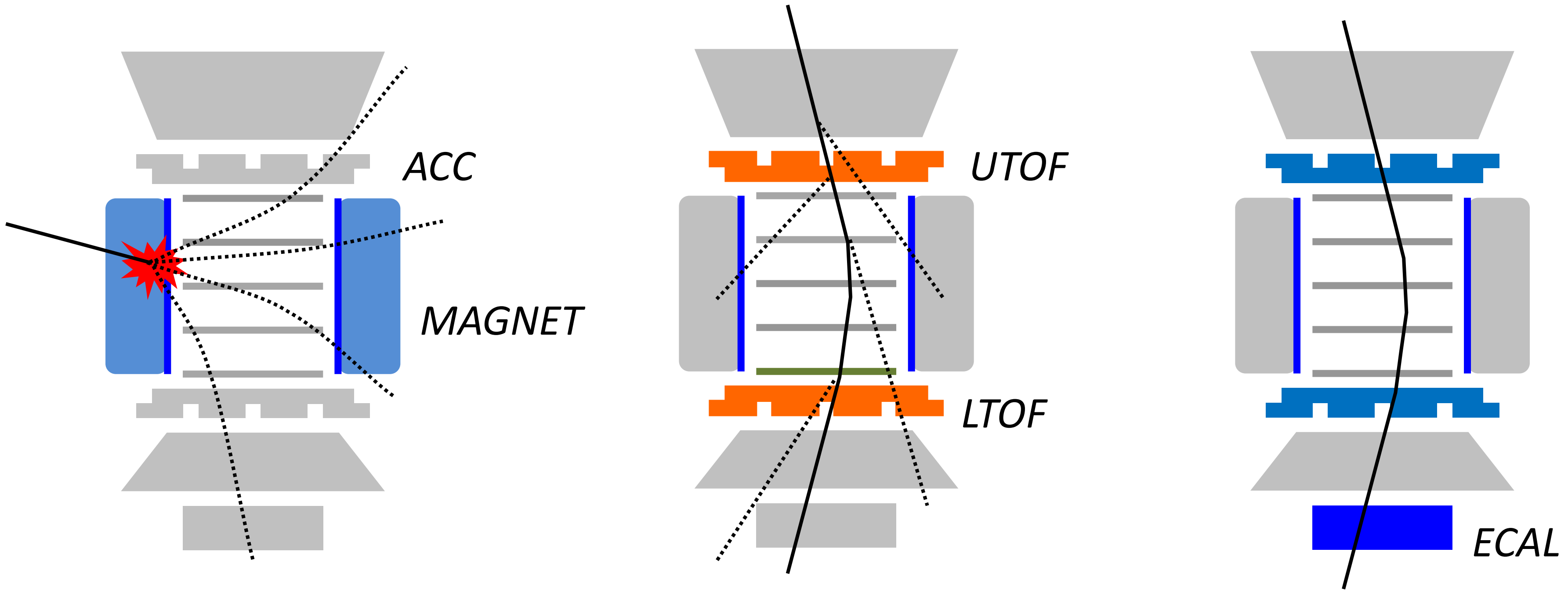
The ratio of Boron and Carbon track efficiencies is calculated and cross-checked with MC up to 100 GV. Is about 2% correction.





Trigger Efficiency

Trigger efficiency is estimated with an unbiased trigger sample.
Efficiency is > 95%, no apparent difference between B and C.



Horizontal Particle	High-Z particle	TOF + ECAL Trigger
Rejected	**Accepted**	**Accepted**

Top-of-the-Instrument Correction

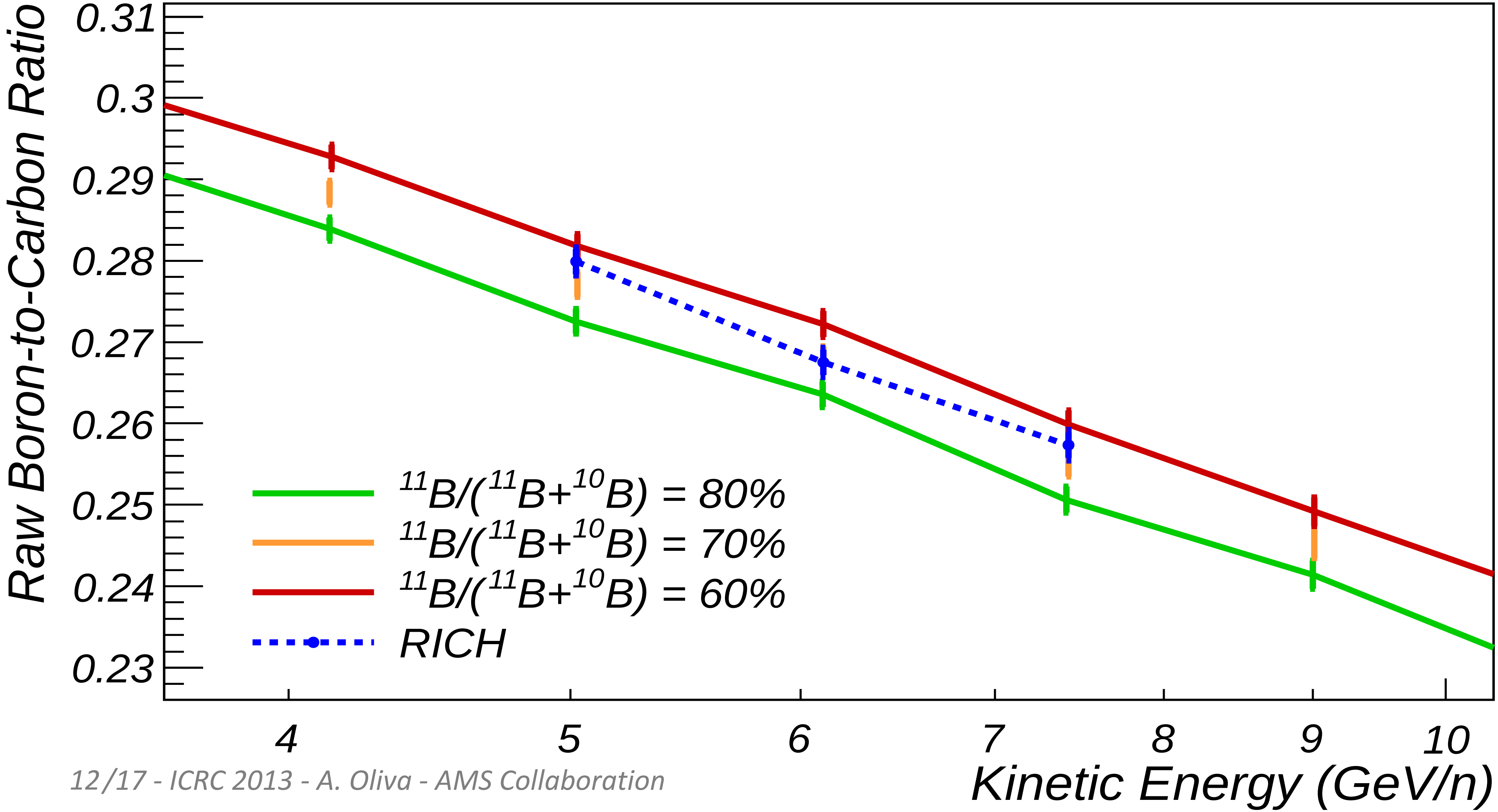
Carbon to Boron conversion on materials above L1.

$$\left(\frac{B}{C}\right)_{L1} = \frac{B + C \cdot \epsilon_{C\rightarrow B}}{C} = \left(\frac{B}{C}\right)_{TOI} + \epsilon_{C\rightarrow B}$$

Correction to the ratio has been estimated with MC: $e_{C\rightarrow B} = 0.005 \pm 0.002$.

Isotopic Fraction Evaluation

RICH evaluates the isotopic composition of Boron.
This fraction is used for the Tracker rigidity → kinetic energy conversion.
$^{11}B/(^{11}B + ^{10}B) = 0.7 \pm 0.1 \rightarrow \sim 1\%$ systematic error on ratio



Systematics

(a) 2% from MC and data comparison of interactions.

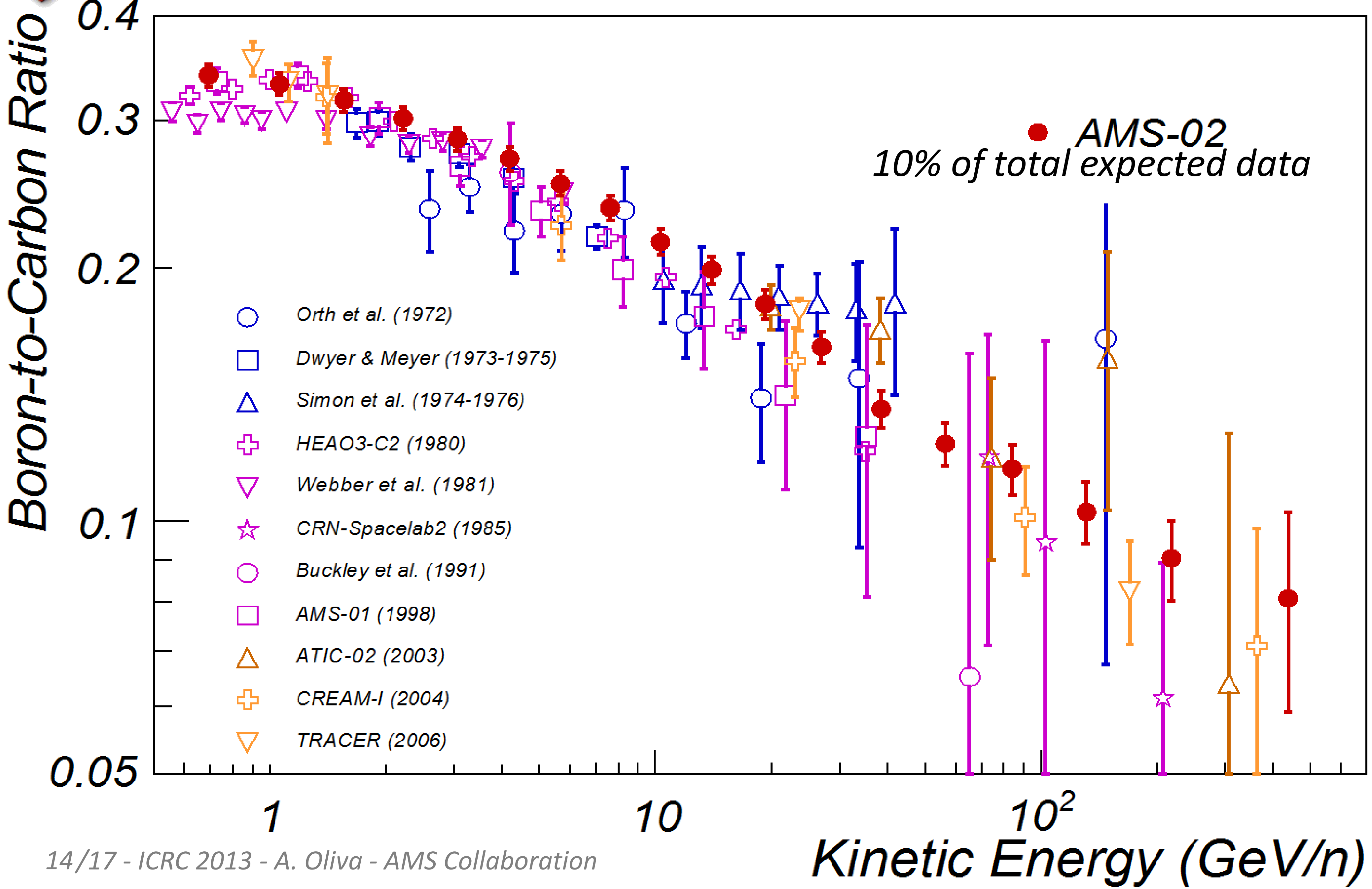
(b) 1% from isotopic composition evaluation.

(c) <2% from TOI correction.

(d) bin-to-bin migration error is <1% up to 200 GeV/n, and 2% above.

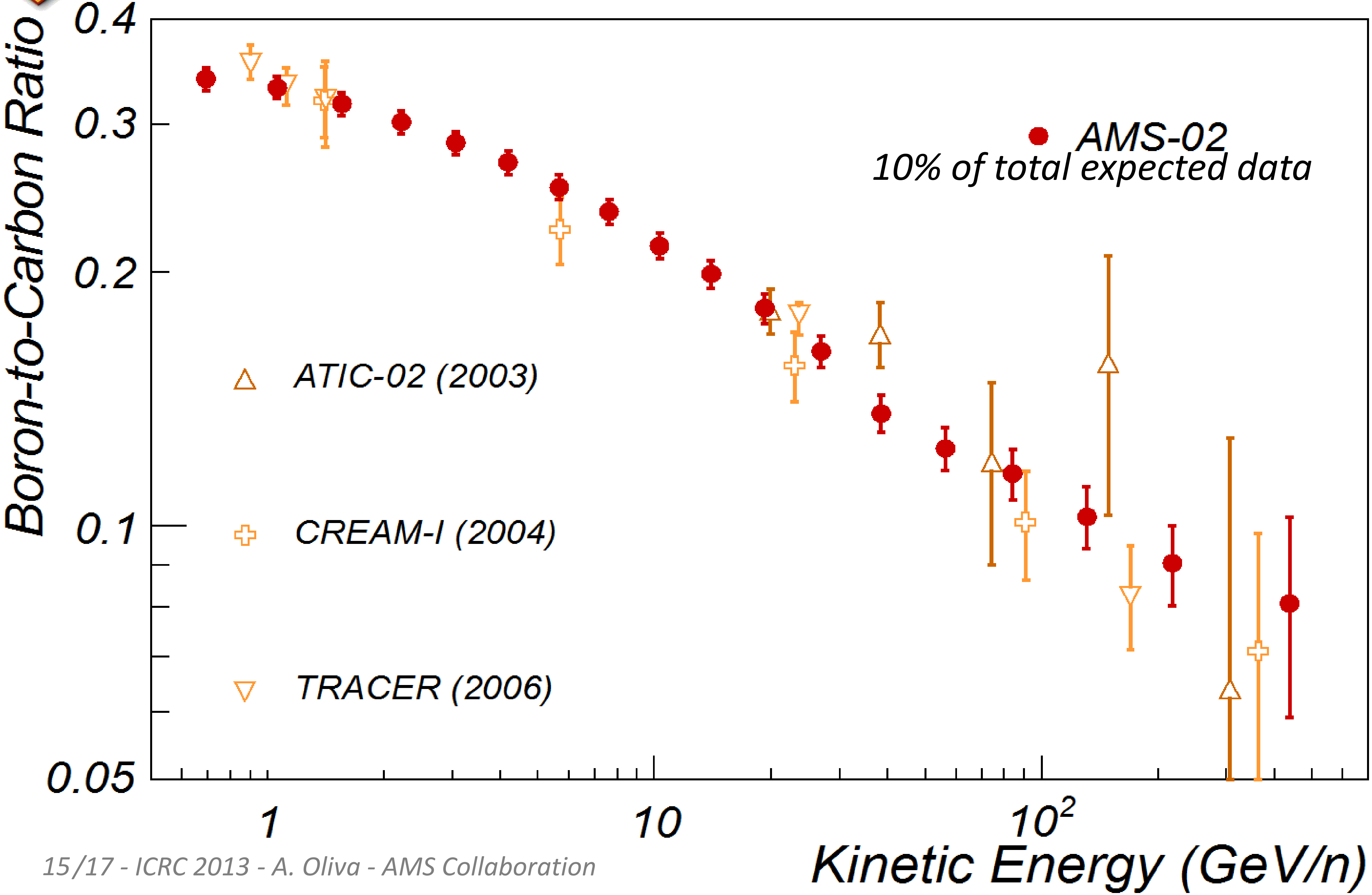
Systematic error will be reduced with more data.

B/C Ratio

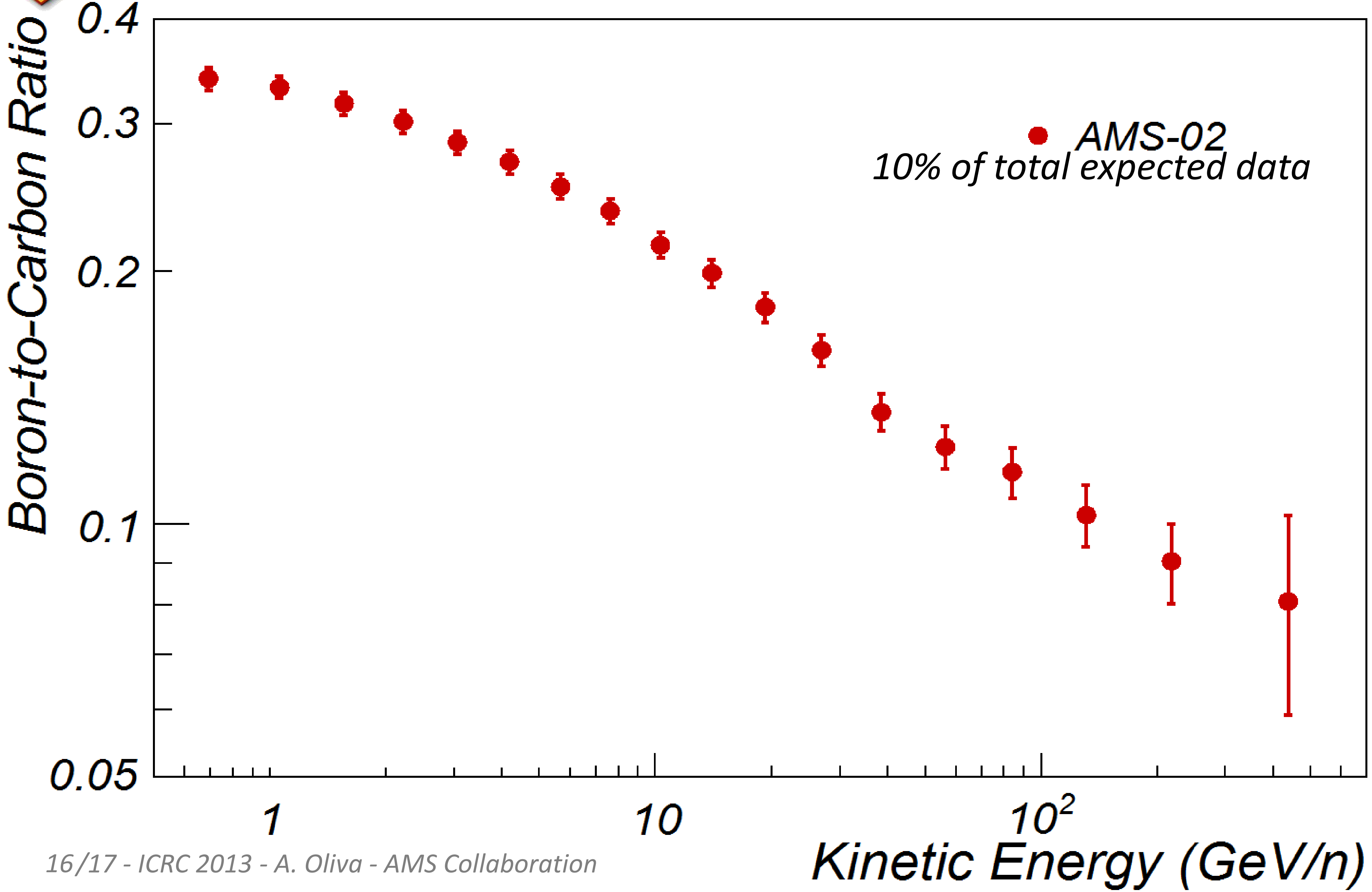


Boron-to-Carbon Ratio
0.4
0.3
0.2
0.1
0.05
1
10
10^2
Kinetic Energy (GeV/n)
AMS-02
10% of total expected data
Orth et al. (1972)
Dwyer & Meyer (1973-1975)
Simon et al. (1974-1976)
HEAO3-C2 (1980)
Webber et al. (1981)
CRN-Spacelab2 (1985)
Buckley et al. (1991)
AMS-01 (1998)
ATIC-02 (2003)
CREAM-I (2004)
TRACER (2006)

B/C Ratio (year > 2000)



AMS B/C Ratio



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AMS-02
10% of total expected data
1
10
10^2
Kinetic Energy (GeV/n)

Conclusions

Measurement of the B/C between 0.5 to 670 GeV/n with AMS has been presented.

Sources of differences between Boron and Carbon counting were investigated and corrections applied when needed.

Main limitation for the ratio measurement and systematics error evaluation at high energy is the statistics.

AMS has collected 10% of the expected statistics.

The B/C behavior at high energy will be become more clear with more data.