

NAIA/AMS-02 Italy Meeting:
Status of Light Ions Analysis
Li, Be, B, C, N & O

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Thursday 30th of November, 2023

Some Information

- **NAIA v1.0.2 ntuples**
 - First 11.5 years of AMS-02 pass8 data, from Bartels 2426 to Bartels 2581.
 - MonteCarlo pass8 B1236 for Lithium to Oxygen.
 - RTI v8.
- **What is new?**
 - Top-of-Instrument (TOI) correction done correctly.
 - Estimation of all systematics error, both for Average and Bartels.

Differential Flux Estimation

Reminder

The isotropic differential flux in the i-th rigidity bin ($R_i; R_i + \Delta R_i$)

$$\Phi_i = \frac{1}{N_i T_i A_i \Delta R_i} N_i$$

Number of events after contamination correction

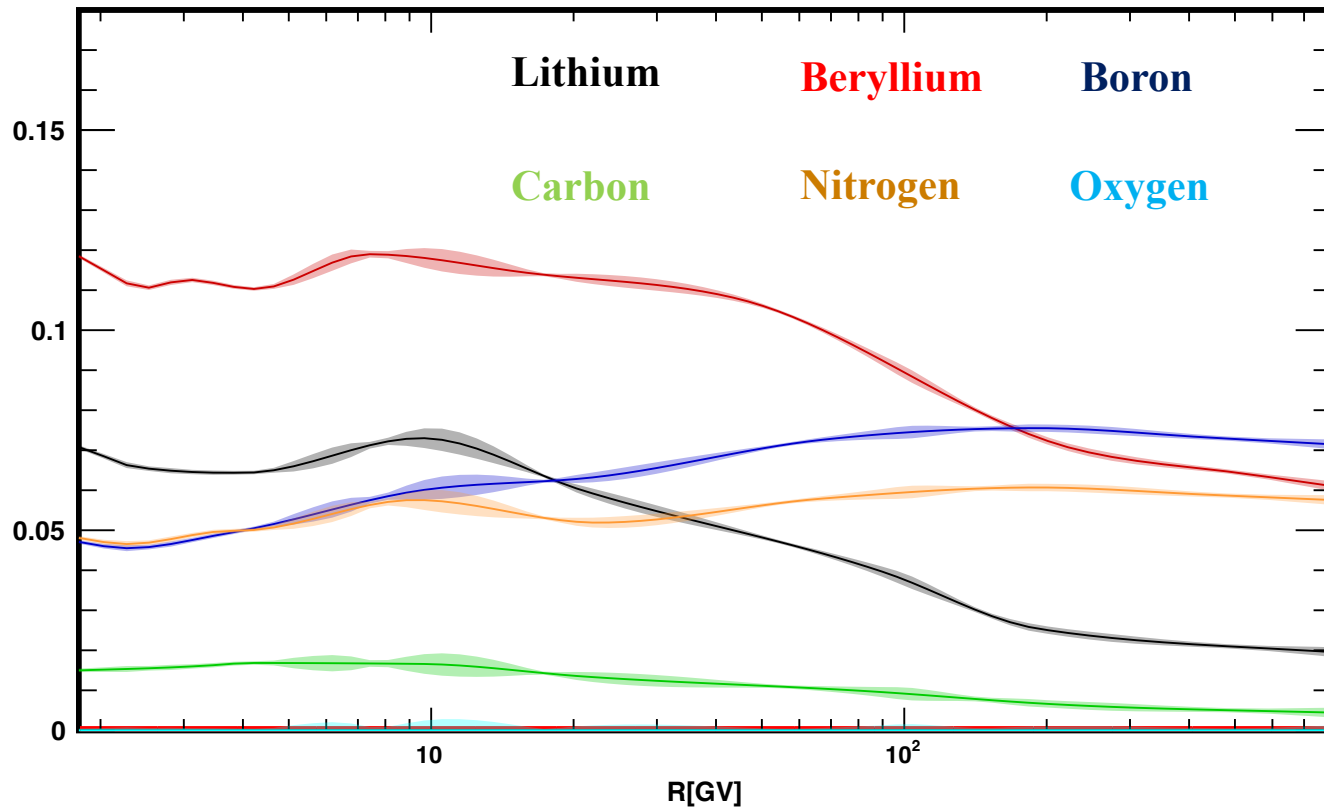
Bin width

Unfolding factor, bin-to-bin migration correction

Exposure time

Effective acceptance

Top-Of-Instrument (TOI) correction (before partial XS)

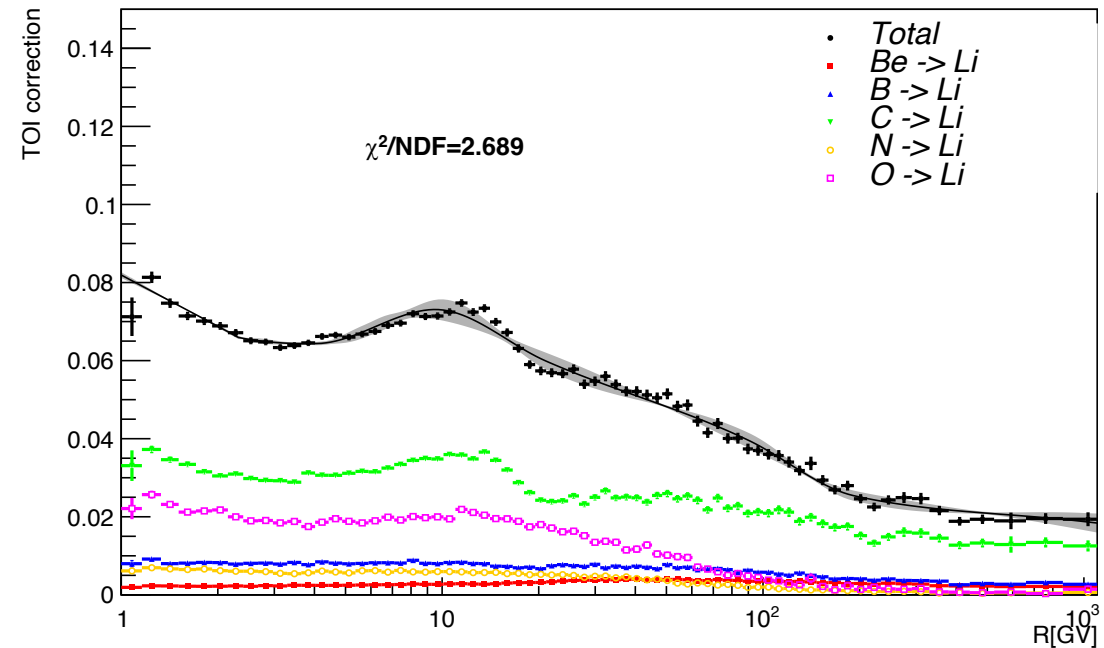


The estimation has been done using Lithium, Beryllium, Boron, Carbon, Nitrogen and Oxygen MonteCarlo.

Fluxes of heavier species (AMS-02 or GALPROP) “folded” acceptance of particles selected as Z_i that with charge-change interaction to Z_i happening before L1.

$$C_i = \frac{\sum_{j>i} \Phi_j A_{j \rightarrow i}}{N_i / \Delta T}$$

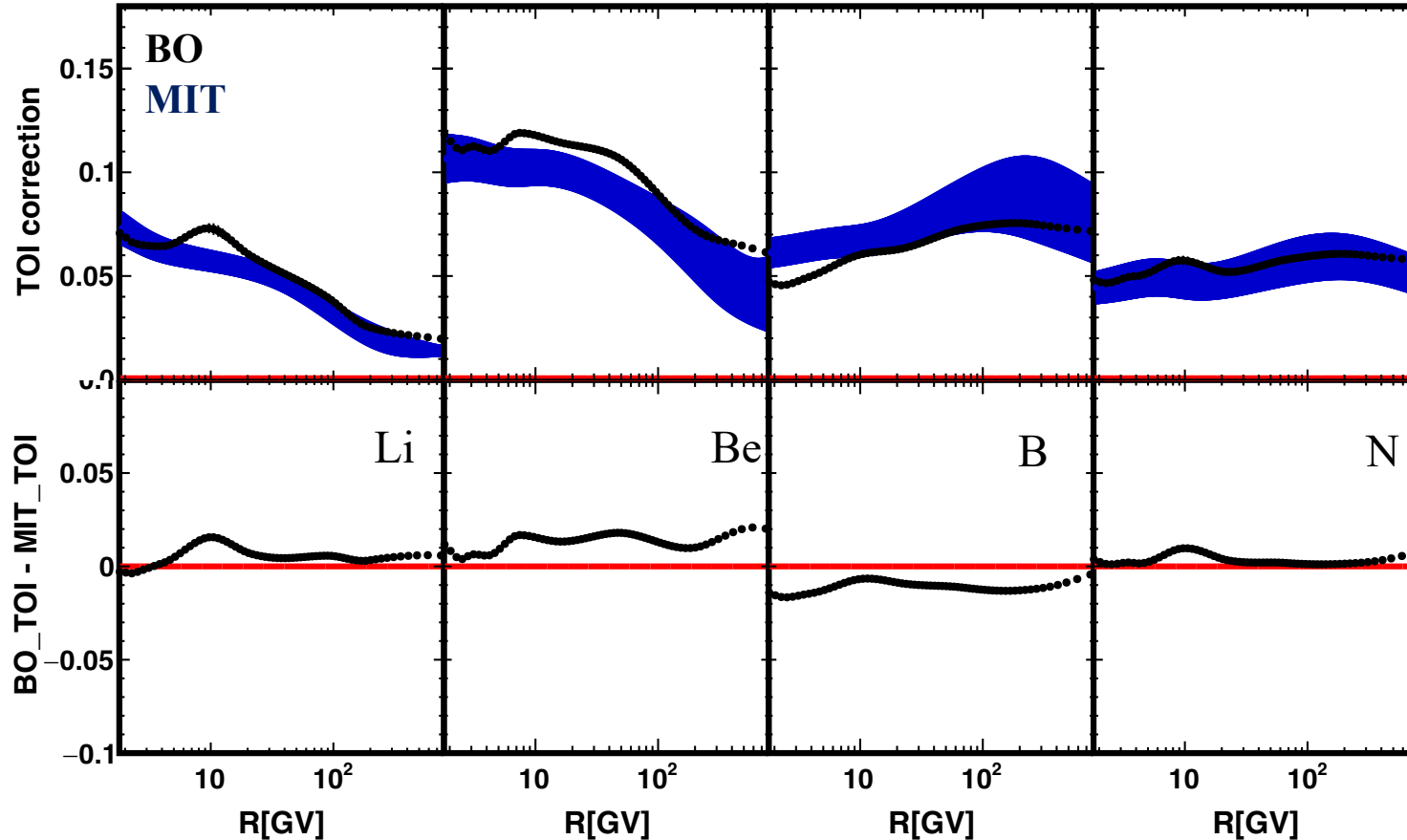
Measured rate of specie Z_i .



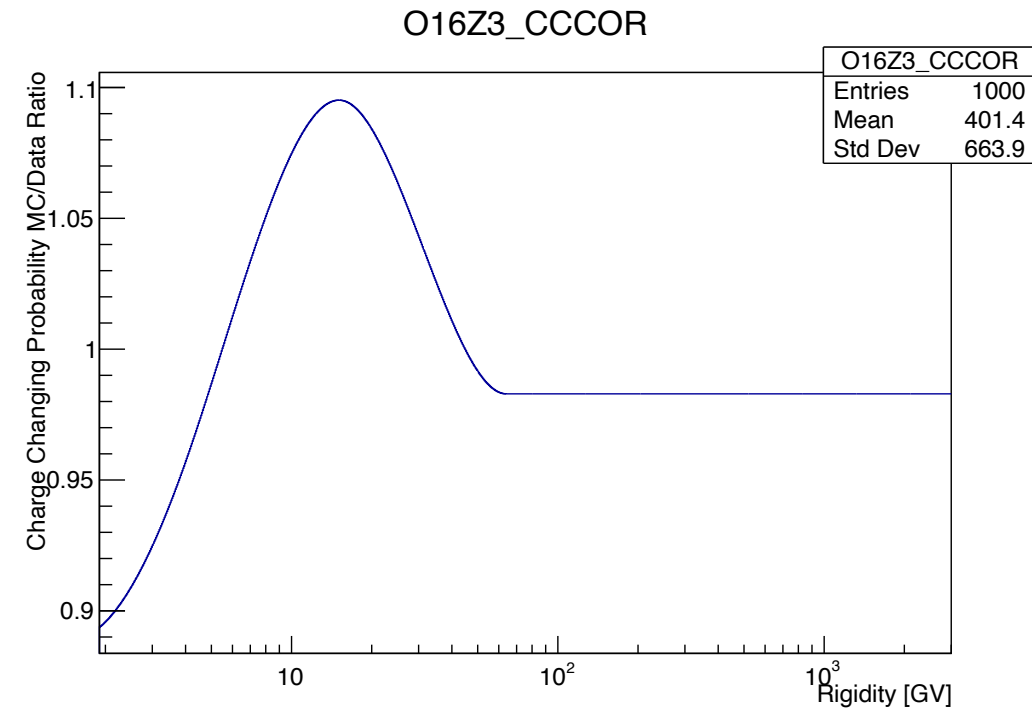
We need to take into account Partial-XS when doing TOI.

Before it was a normalization factor

```
// yao, 01/12/2020
if ( (Zfrom==10)&&(Zto== 9) ) { a = 1+0.103; ea = 0; }
else if ( (Zfrom==12)&&(Zto== 9) ) { a = 1-0.065; ea = 0; }
else if ( (Zfrom==14)&&(Zto== 9) ) { a = 1-0.059; ea = 0; }
else if ( (Zfrom==12)&&(Zto==11) ) { a = 1+0.076; ea = 0; }
else if ( (Zfrom==14)&&(Zto==11) ) { a = 1+0.009; ea = 0; }
else if ( (Zfrom==14)&&(Zto==13) ) { a = 1+0.060; ea = 0; }
```



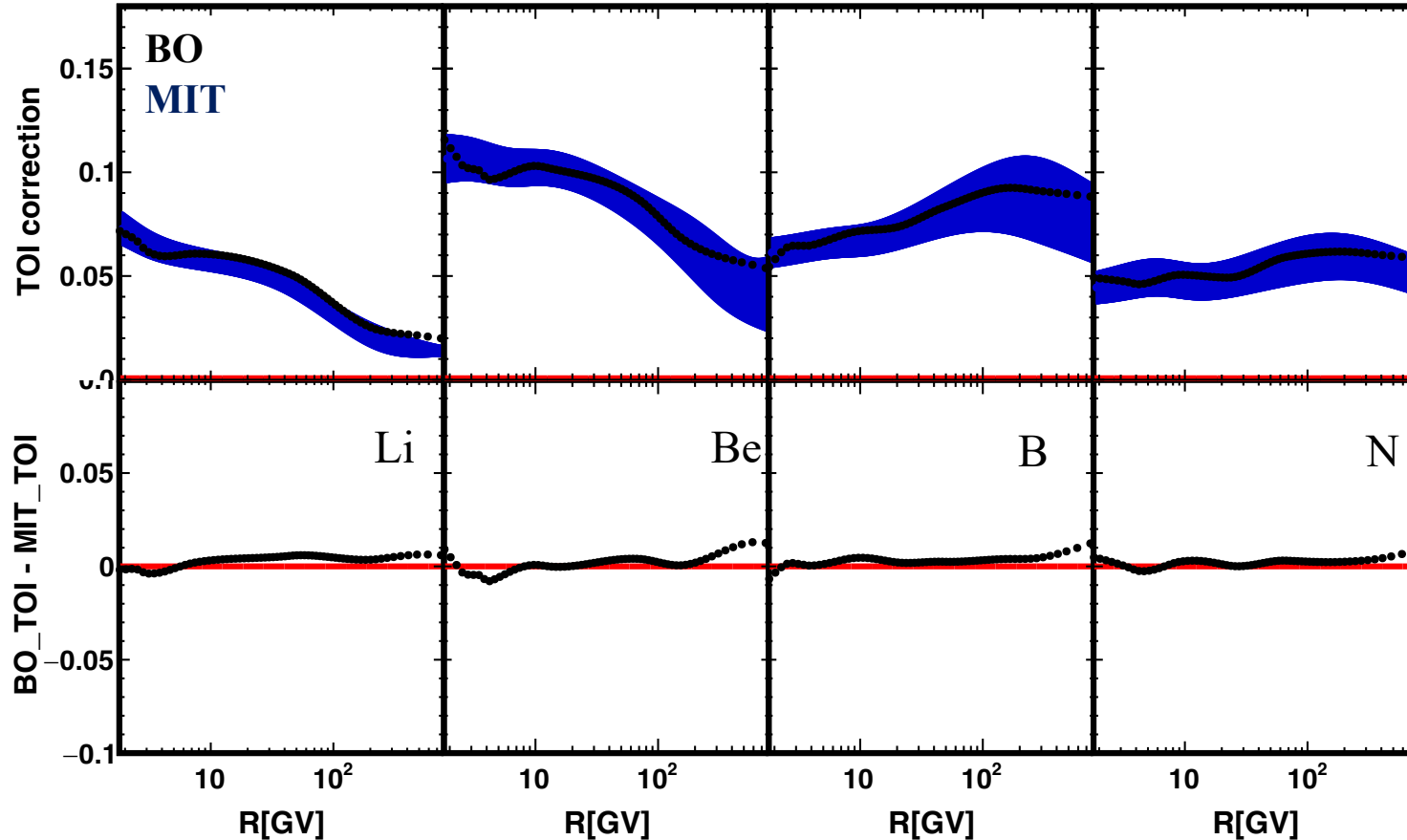
This partial-XS are now dependent on Rigidity, as an example O16 Montecarlo into Lithium



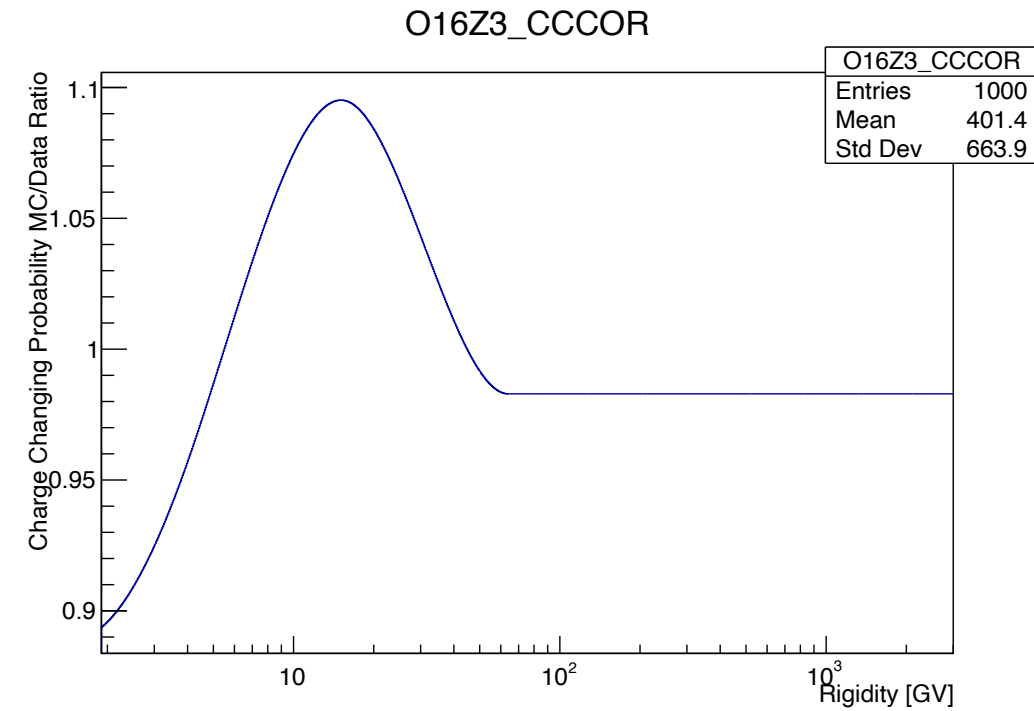
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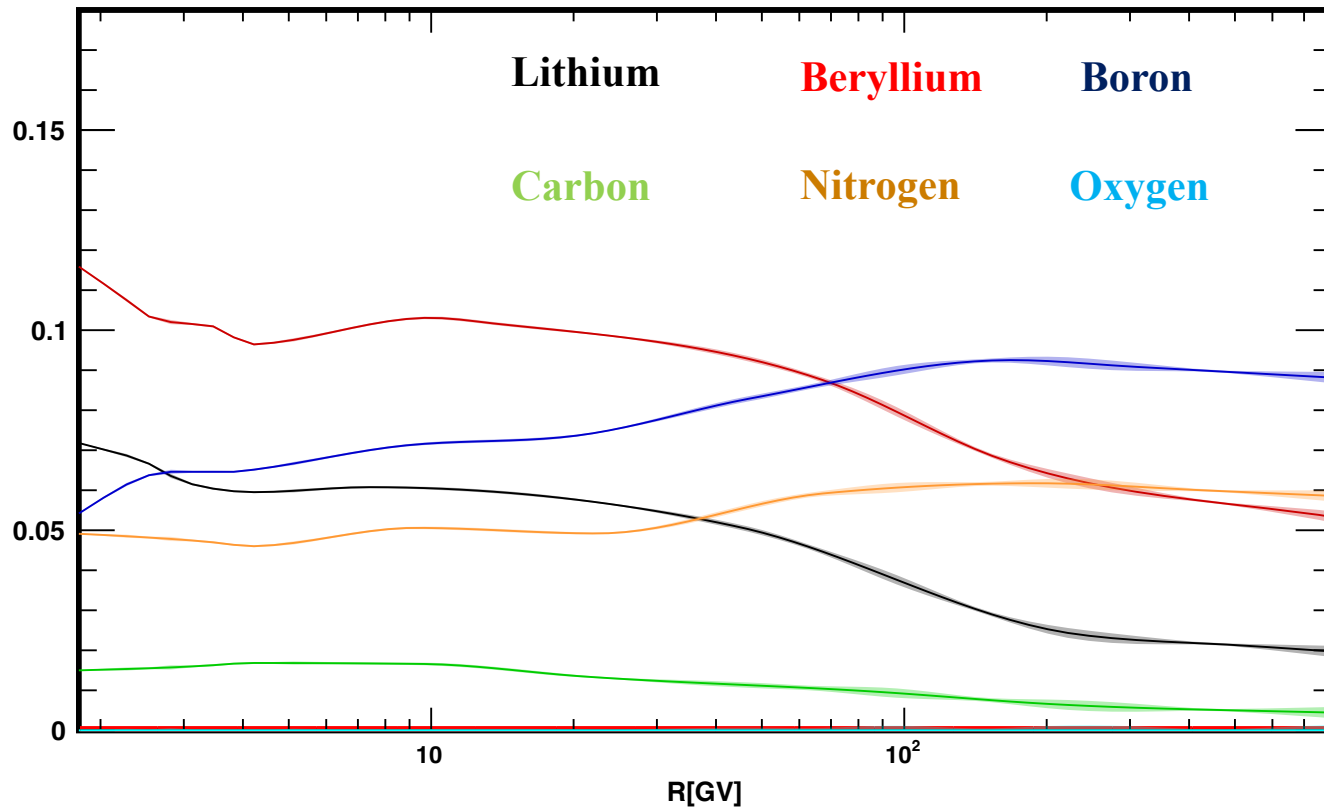
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```



This partial-XS are now dependent on Rigidity, as an example O16 Montecarlo into Lithium



Top-Of-Instrument (TOI) correction (after partial XS)



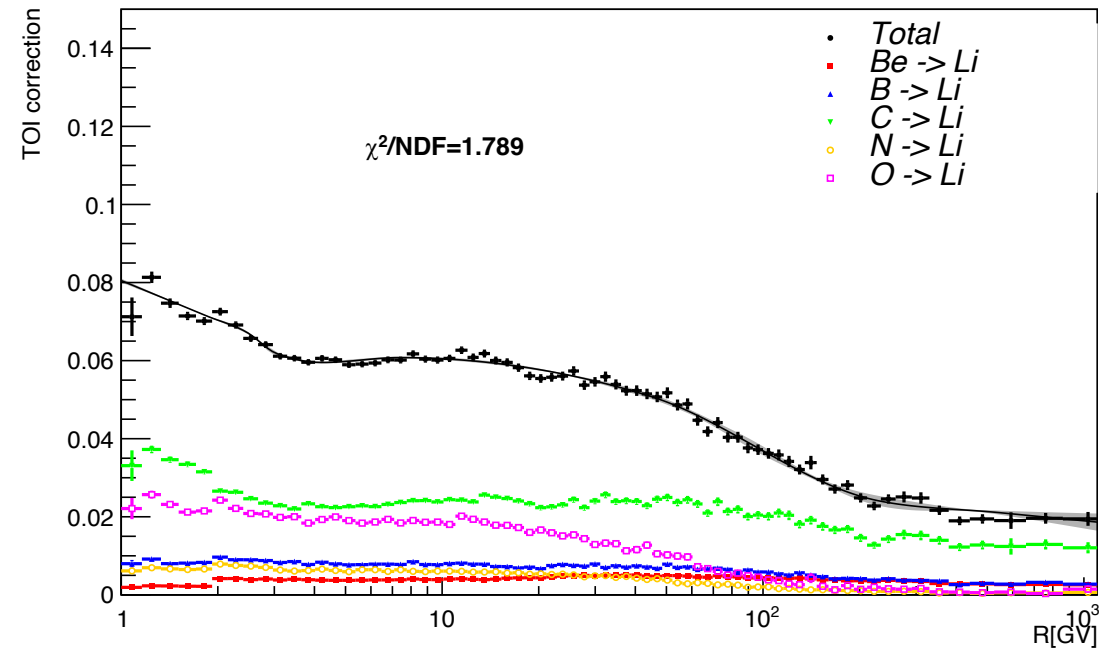
The estimation has been done using Lithium, Beryllium, Boron, Carbon, Nitrogen and Oxygen MonteCarlo.

The differences between TOI w/o partial XS is added as a systematic error.

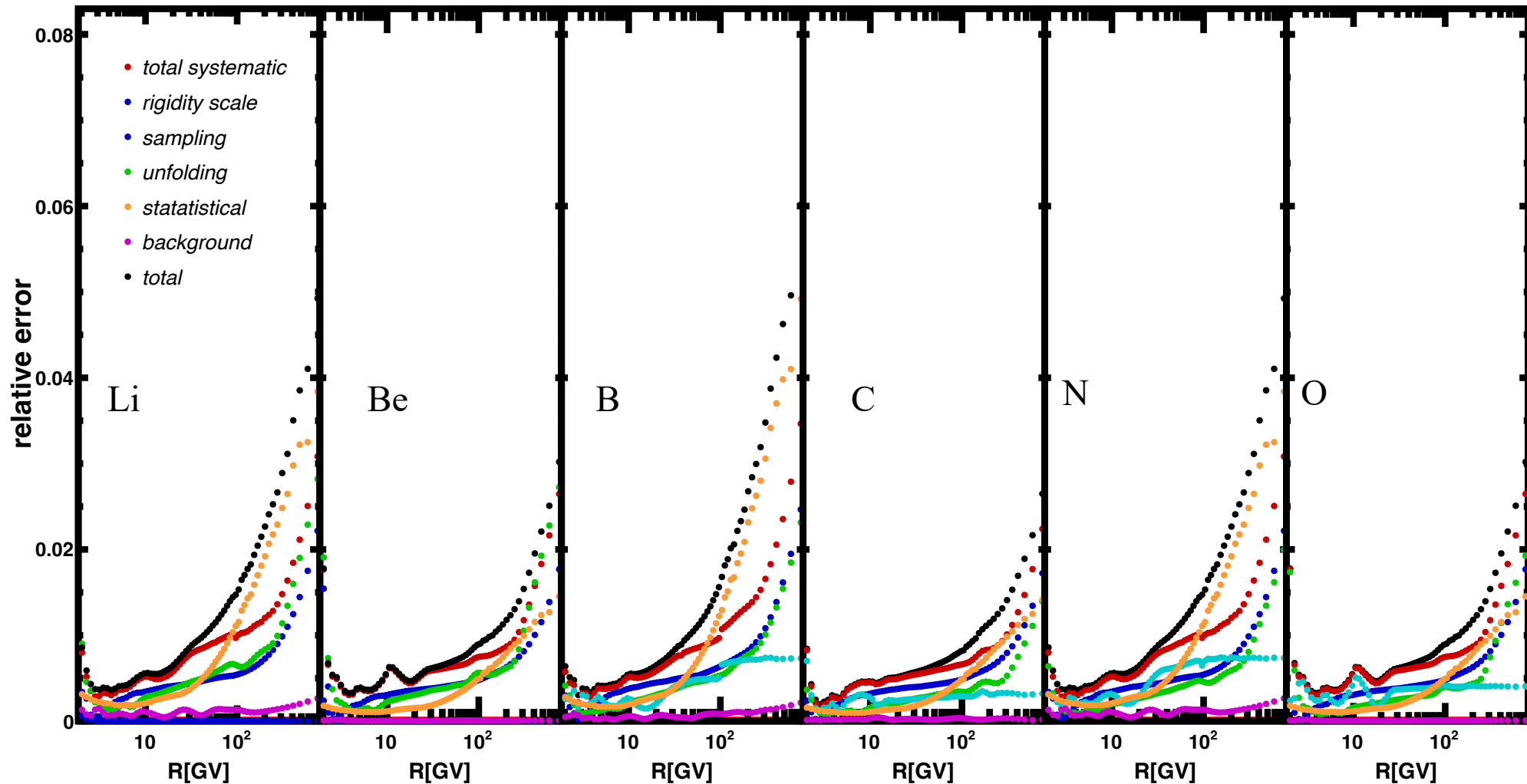
Fluxes of heavier species (AMS-02 or GALPROP) “folded” acceptance of particles selected as Z_i that with charge-change interaction to Z_i happening before L1.

$$C_i = \frac{\sum_{j>i} \Phi_j A_{j \rightarrow i}}{N_i / \Delta T}$$

Measured rate of specie Z_i .



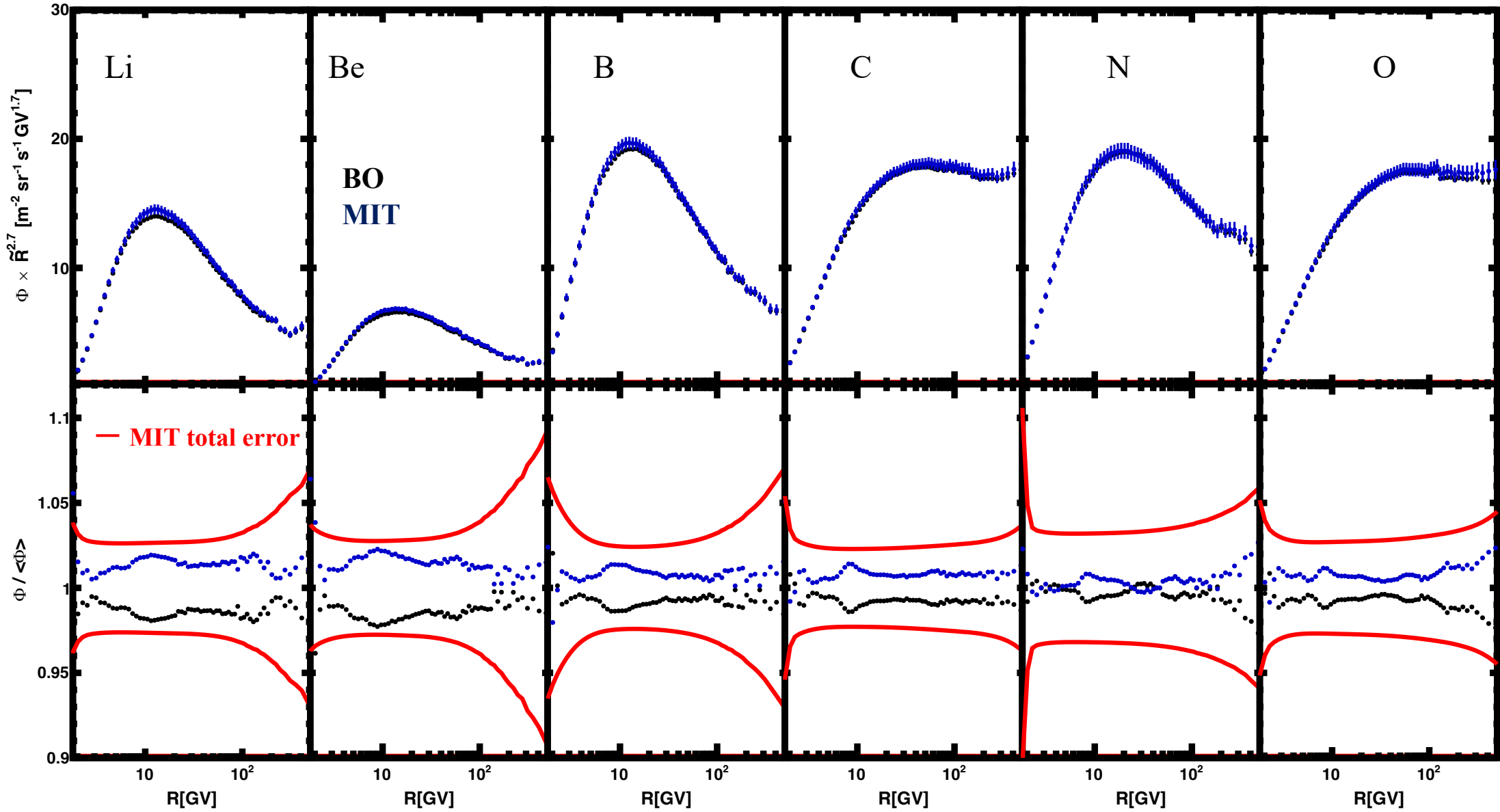
Error breakdown



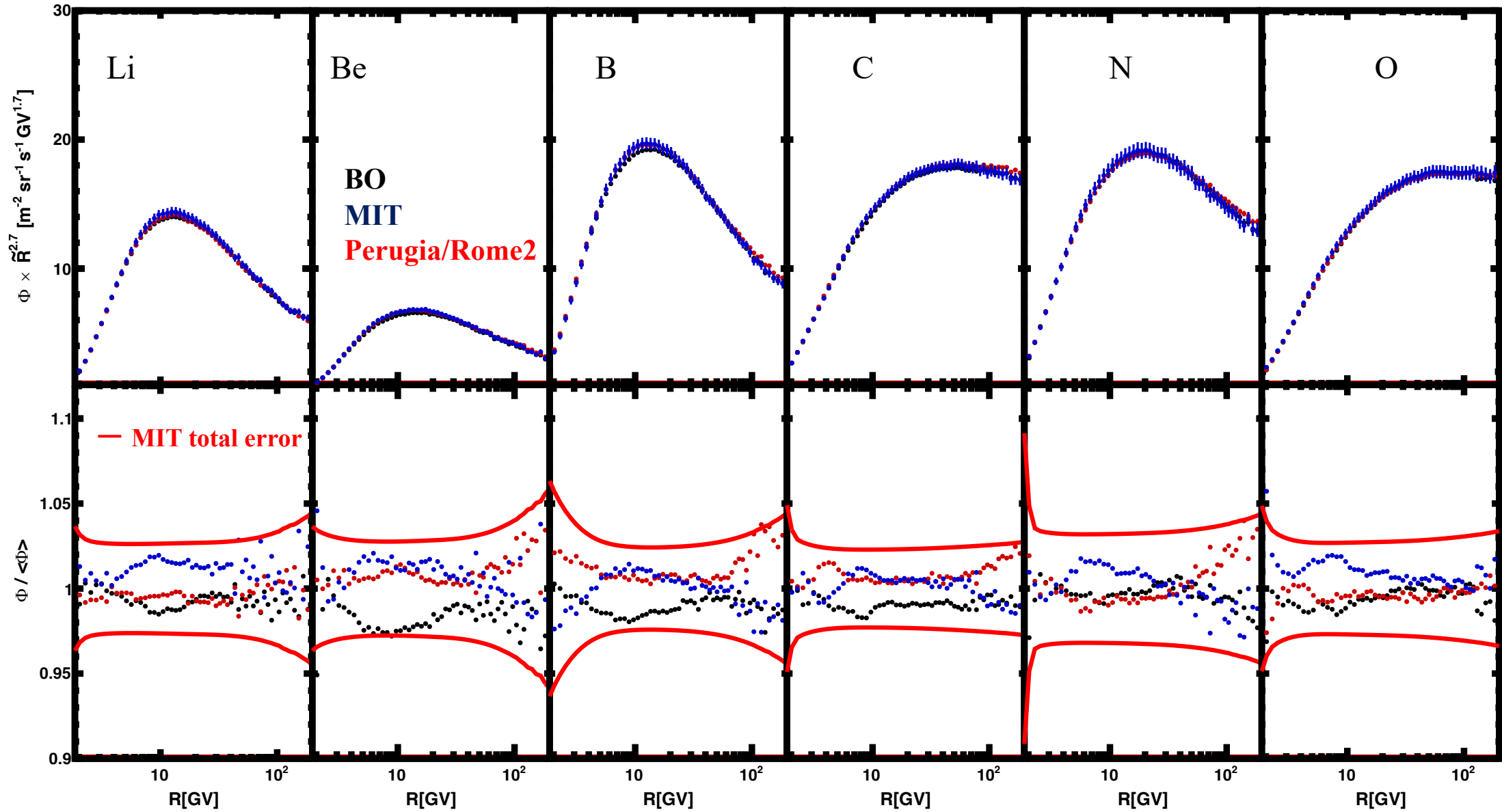
Two systematic error sources are not considered here:

- Cross section (XS) error, which is around 2-3% extra "flat" in rigidity.
- Partial cross sections TOI correction error, estimated before.

Average vs MIT



Average vs MIT vs PG/Rome2

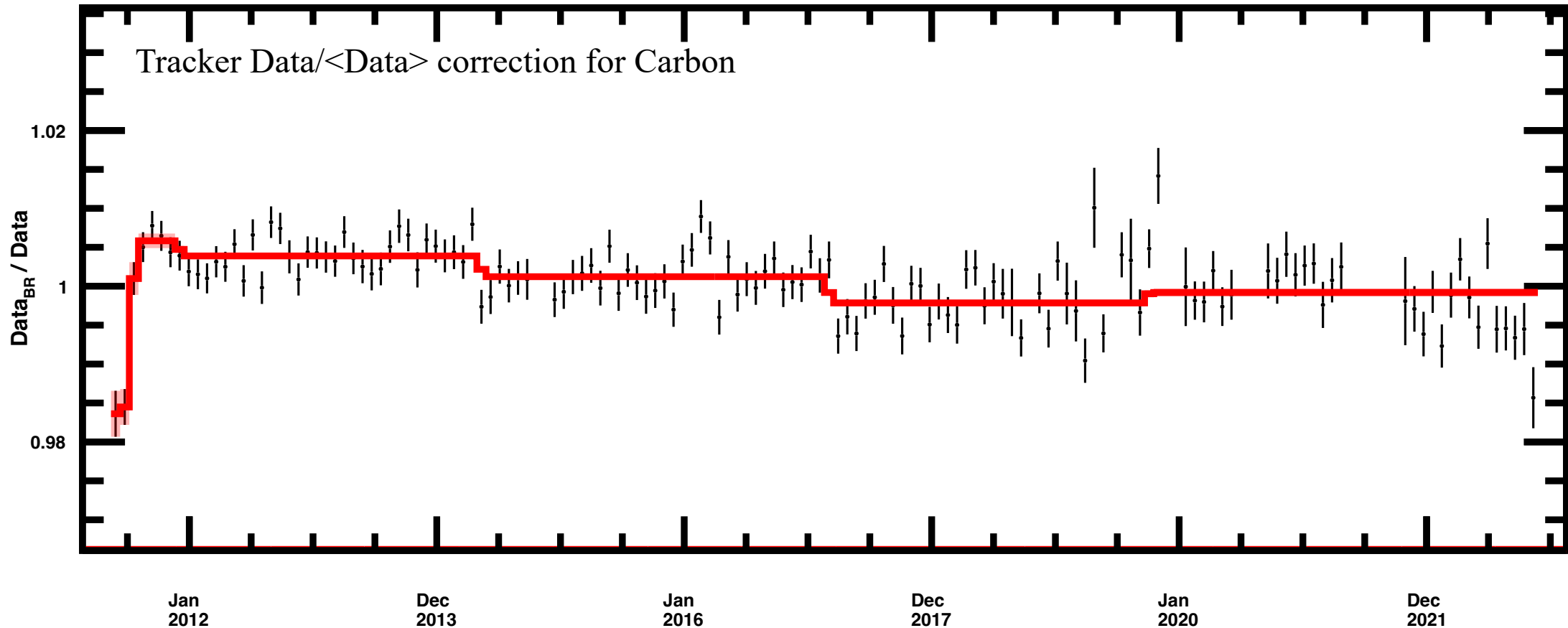


Data/<Data> Corrections

Reminder

- Correct the average acceptance by all the Data/Data corrections.

$$A_i^{BR} = A_i^{11y} \prod_j \frac{\epsilon_i^{Data, BR}}{\epsilon_i^{Data, 11y}} \Big|_j$$

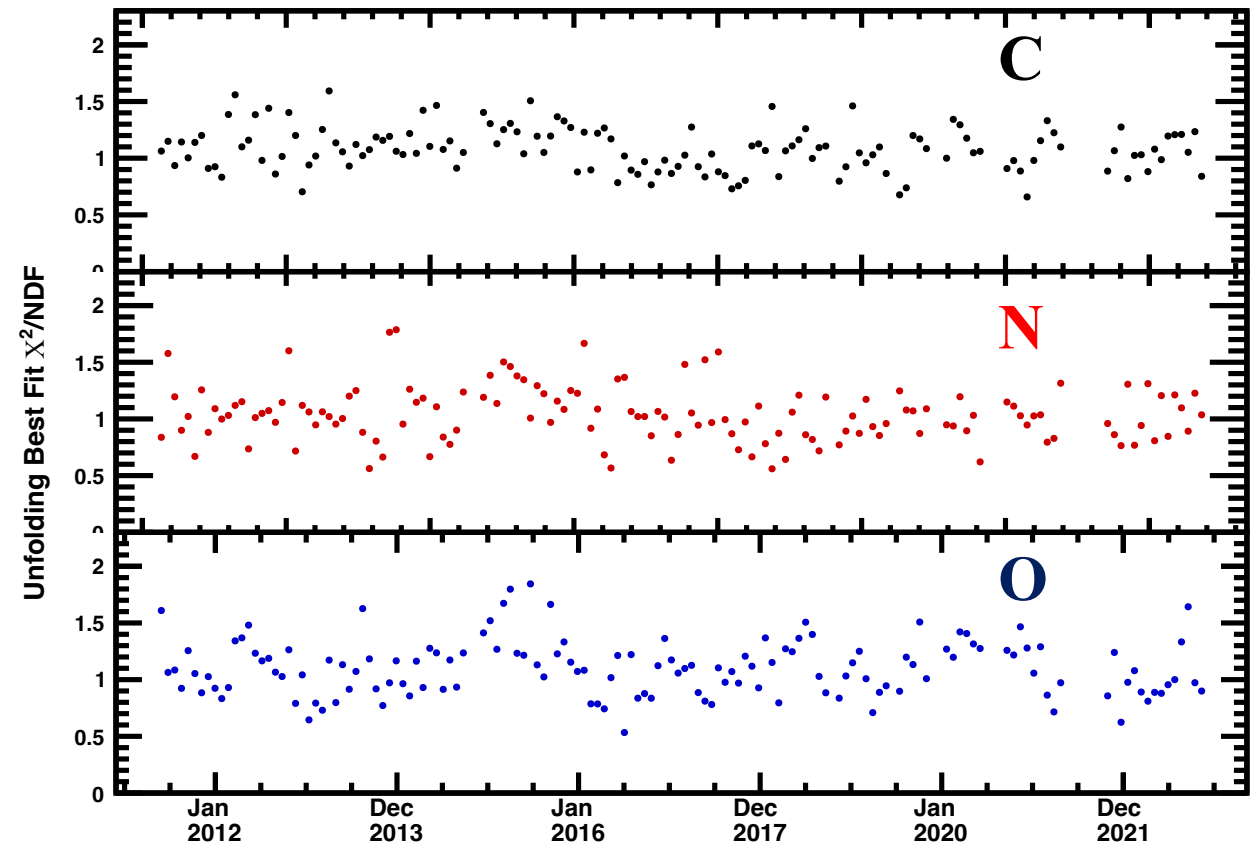
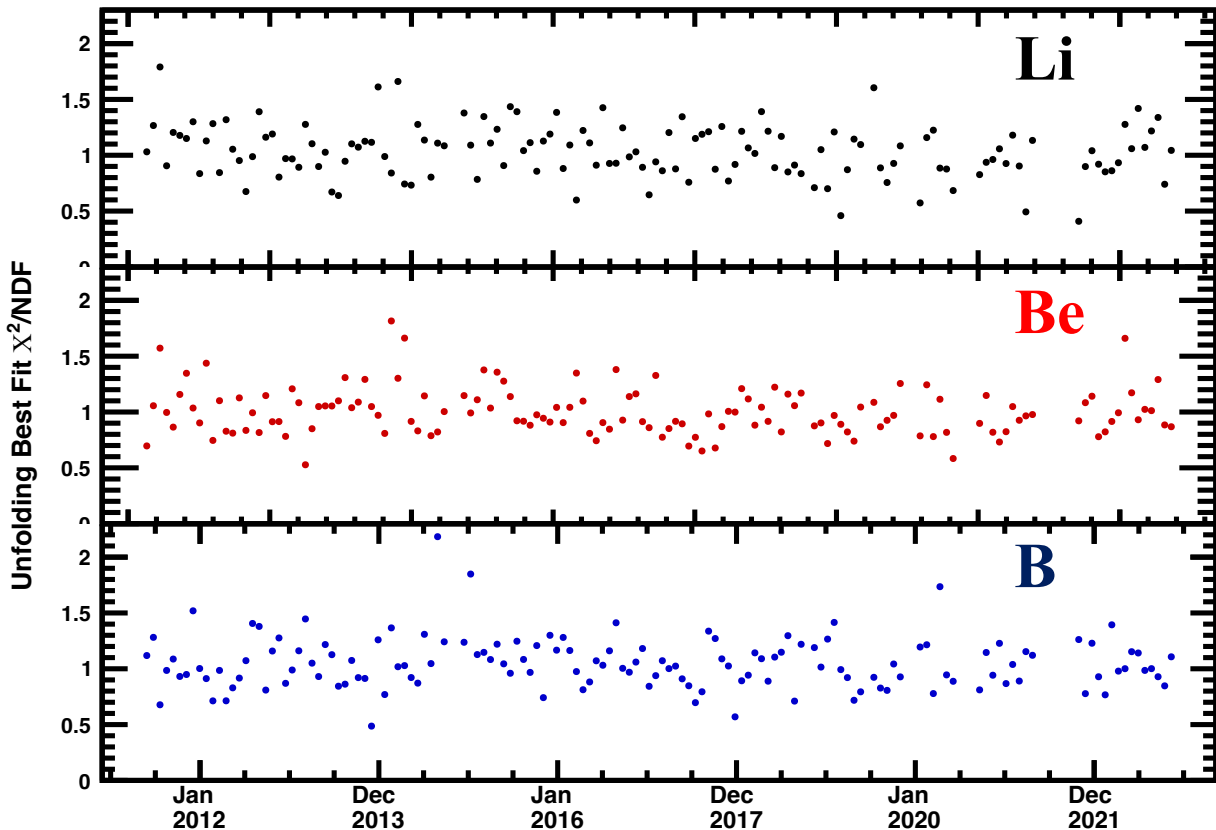


Forward Unfolding vs Time

Reminder

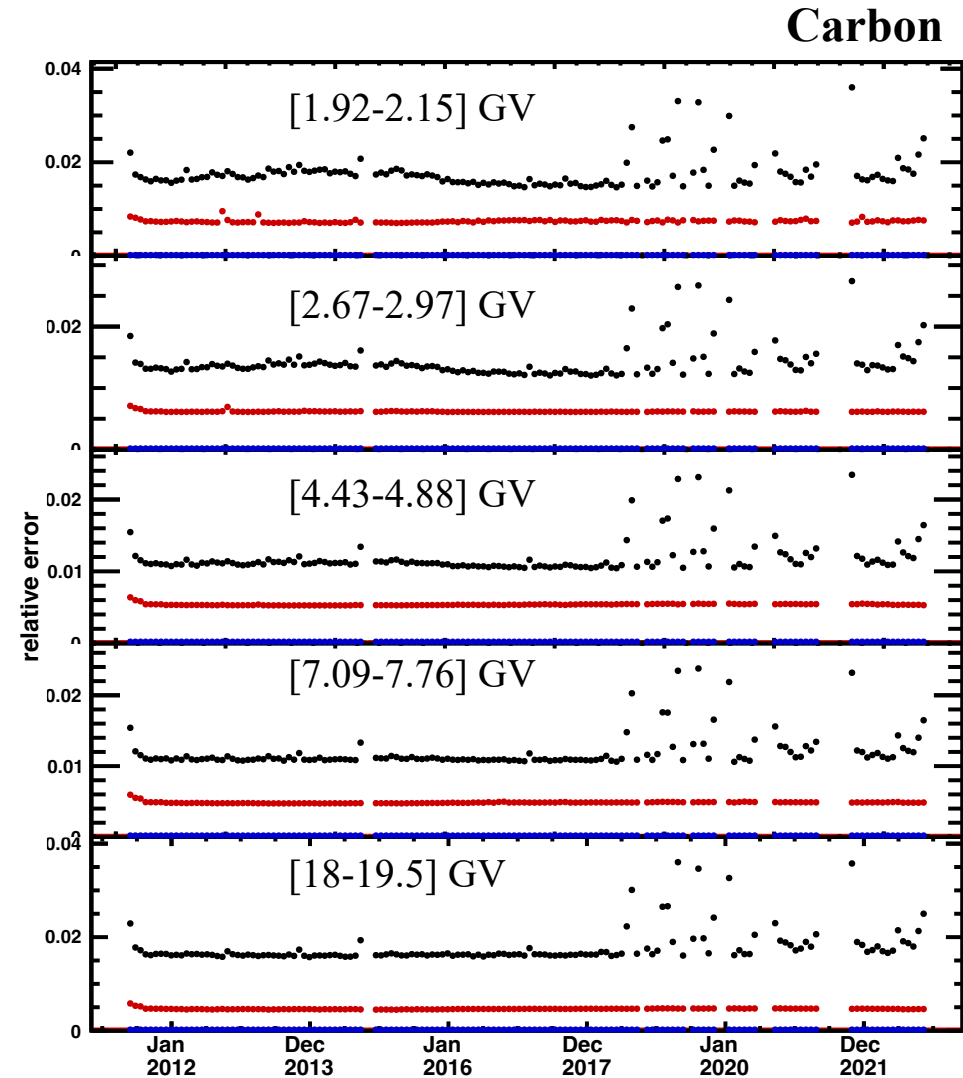
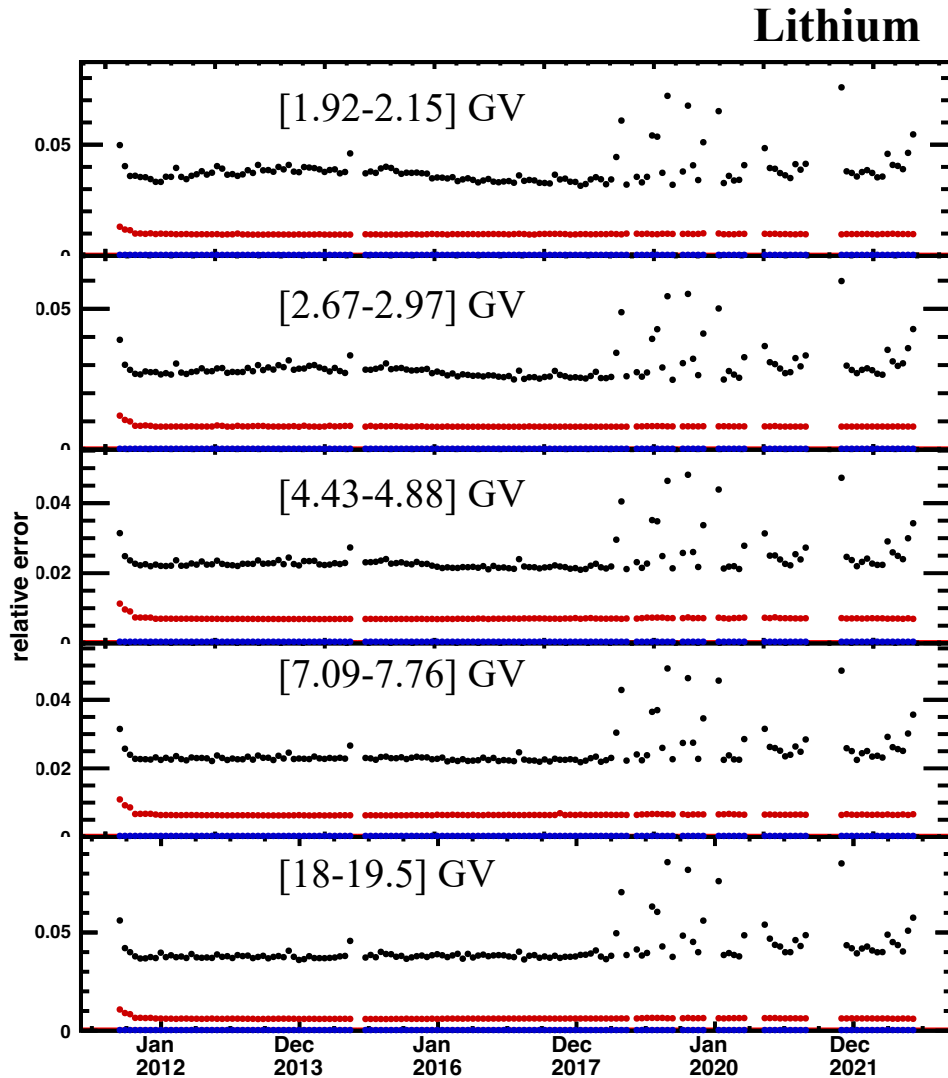
The flux model for each Bartels is given by the best-fit flux model obtained from the average flux forward unfolding method multiplied by a parametrization of the $\Phi^{\text{BR}}/\Phi^{\text{AVG}}$ ratio by a spline allowed to fluctuate only at low rigidities.

This effectively allows to study the solar modulation effects on the unfolding.



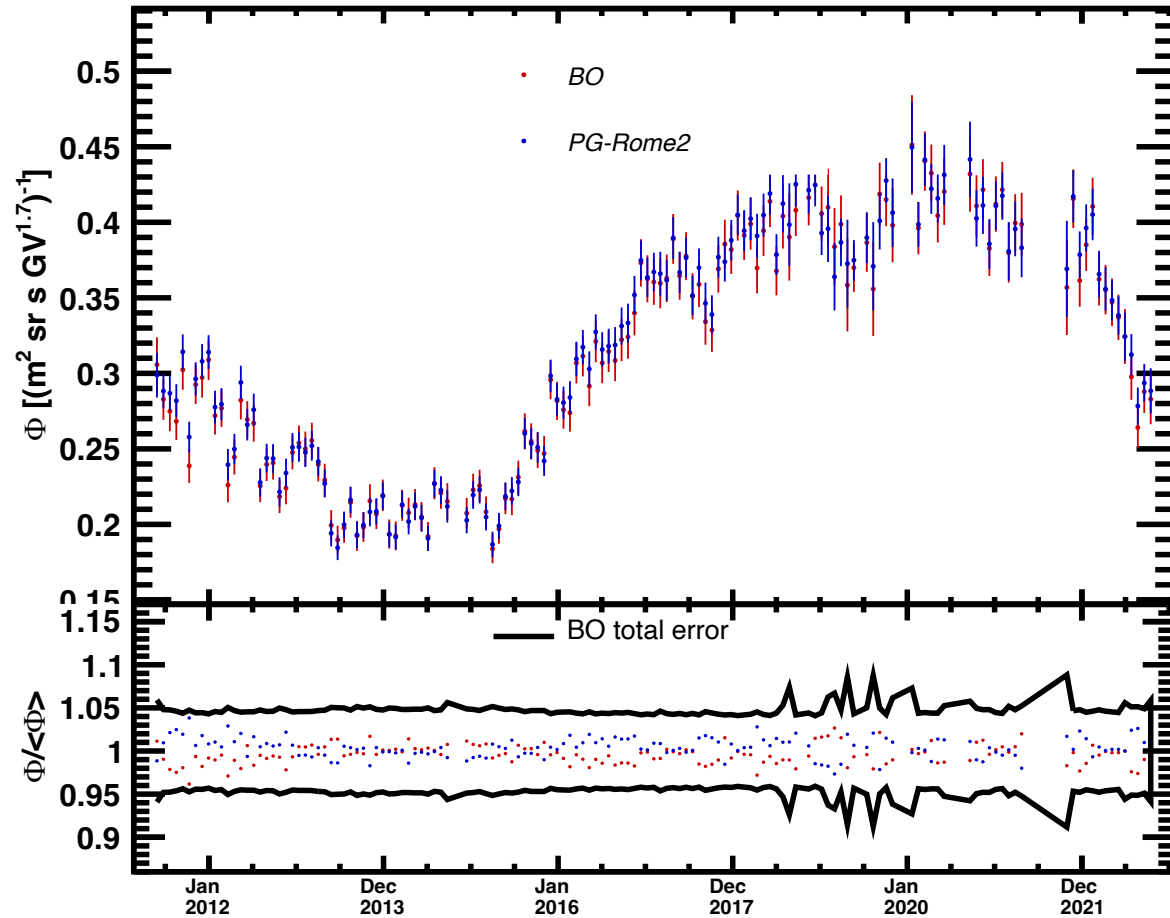
- **Statistical Error** (it is time dependent too)
- **Systematics Time dependent error** (data/data + unfolding sampling + matrix resolution + rigidity scale)
- **Systematics Time independent error** (raw acceptance + data/MC + background)

XS and partial XS TOI errors were not added to the systematics time independent.

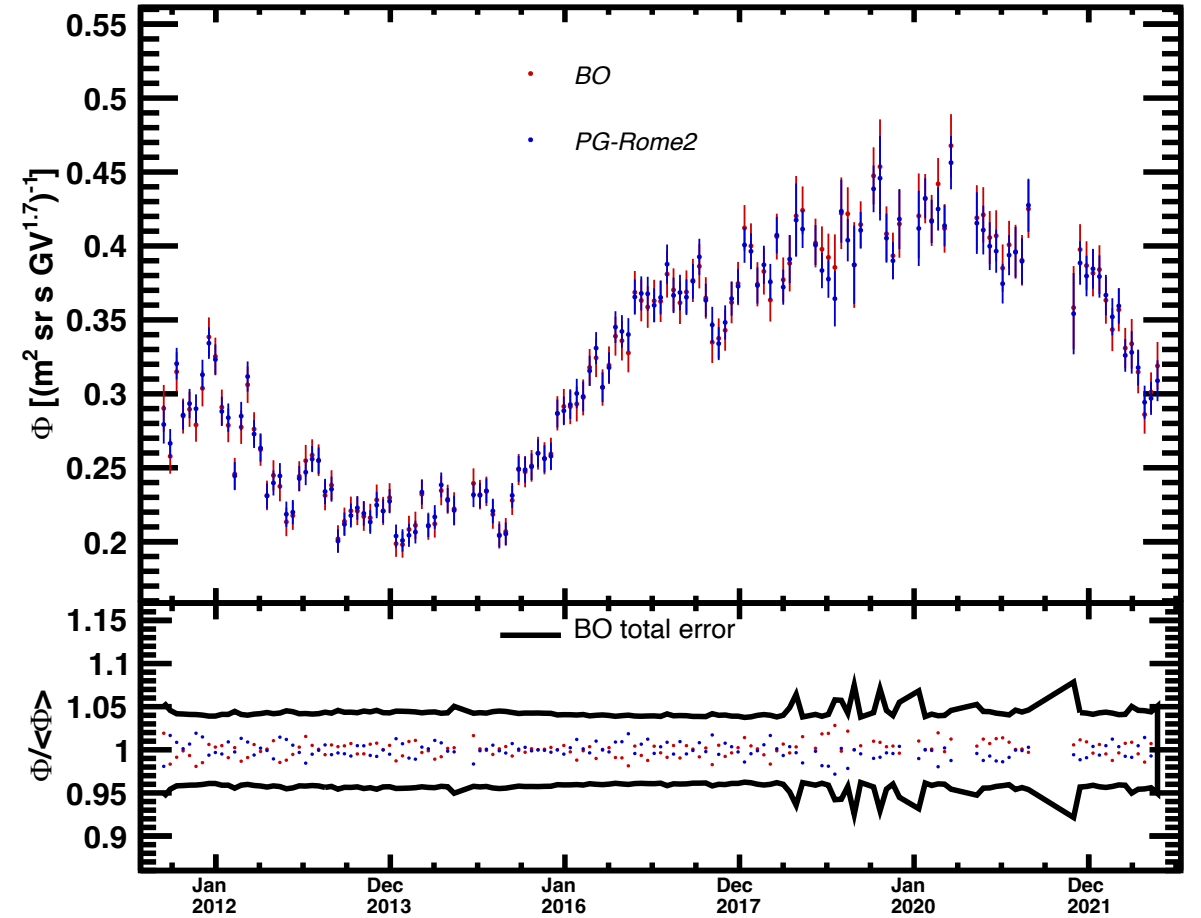


Bartels Comparison: Lithium

[1.92 - 2.15] GV

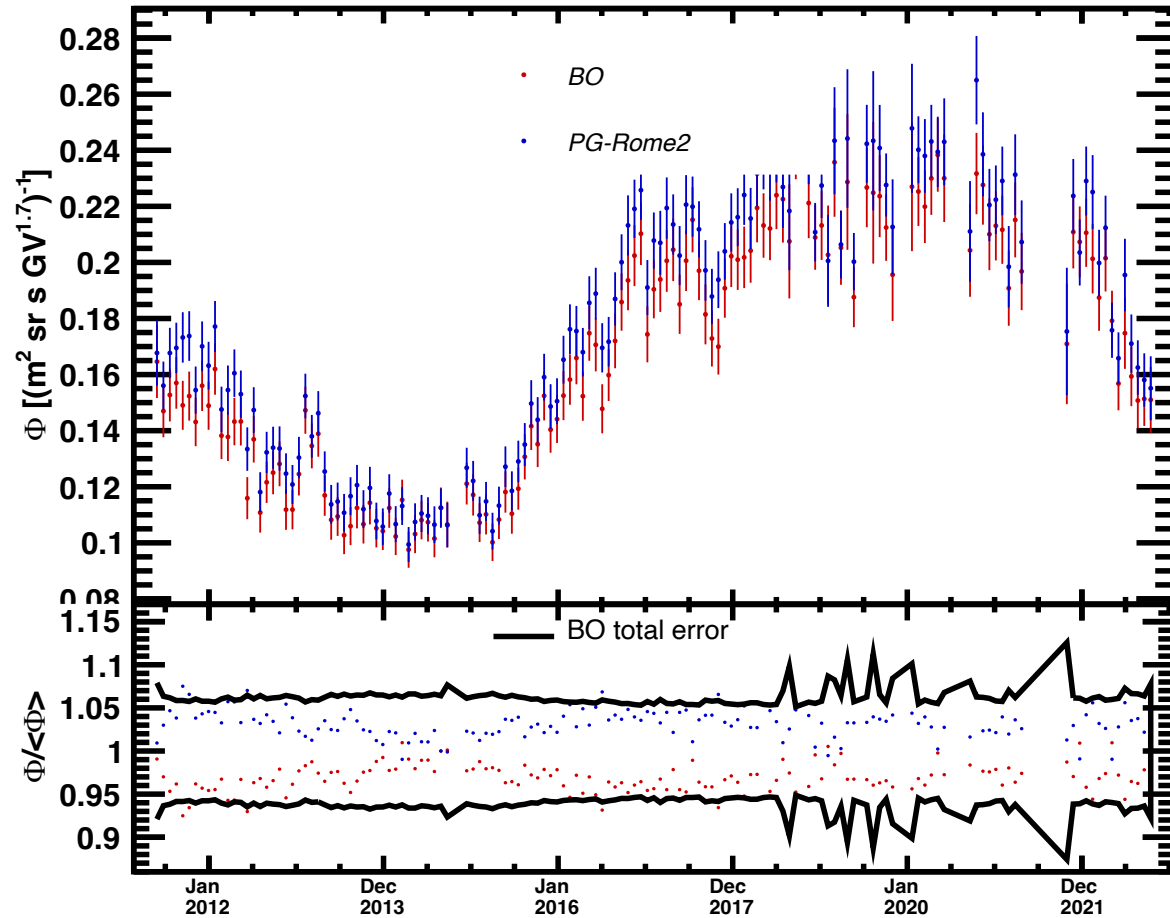


[2.15 - 2.40] GV

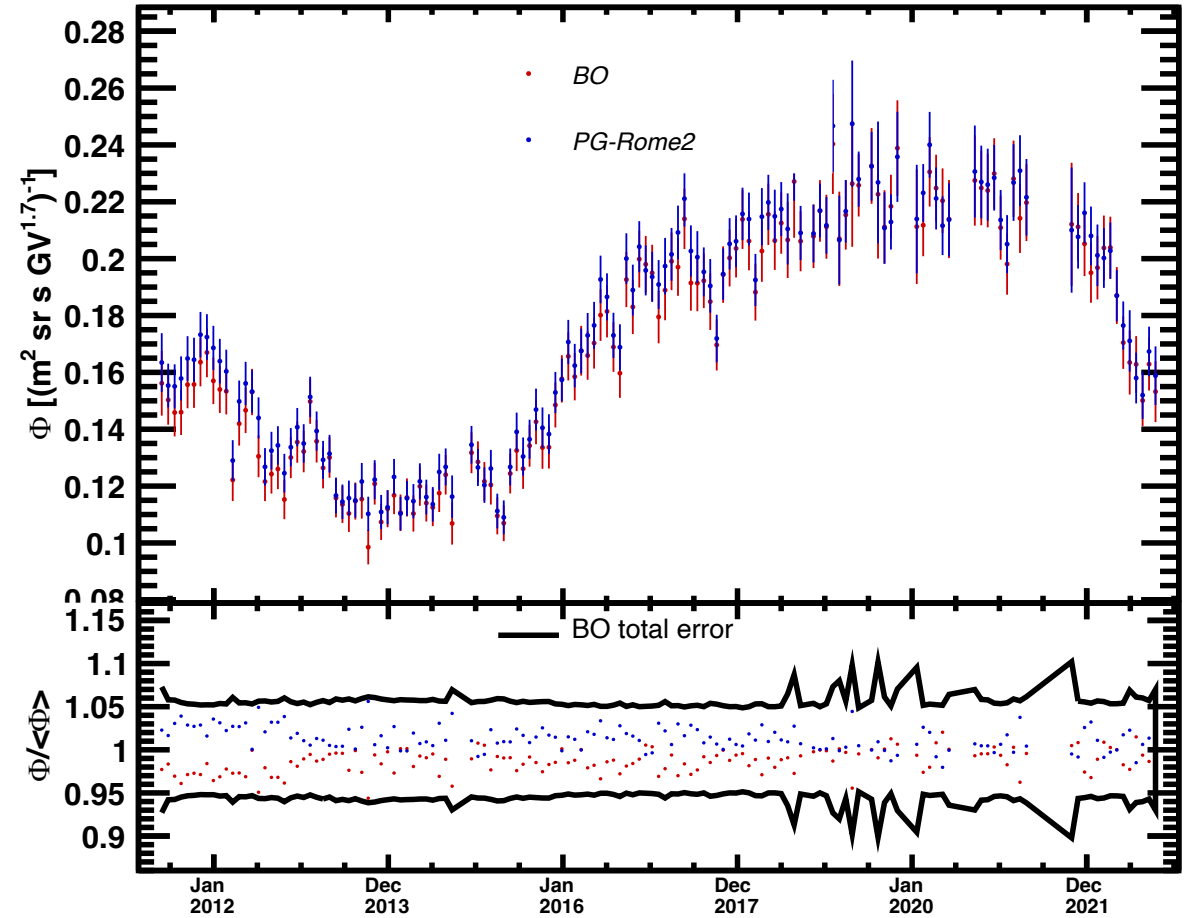


Bartels Comparison: Beryllium

[1.92 - 2.15] GV

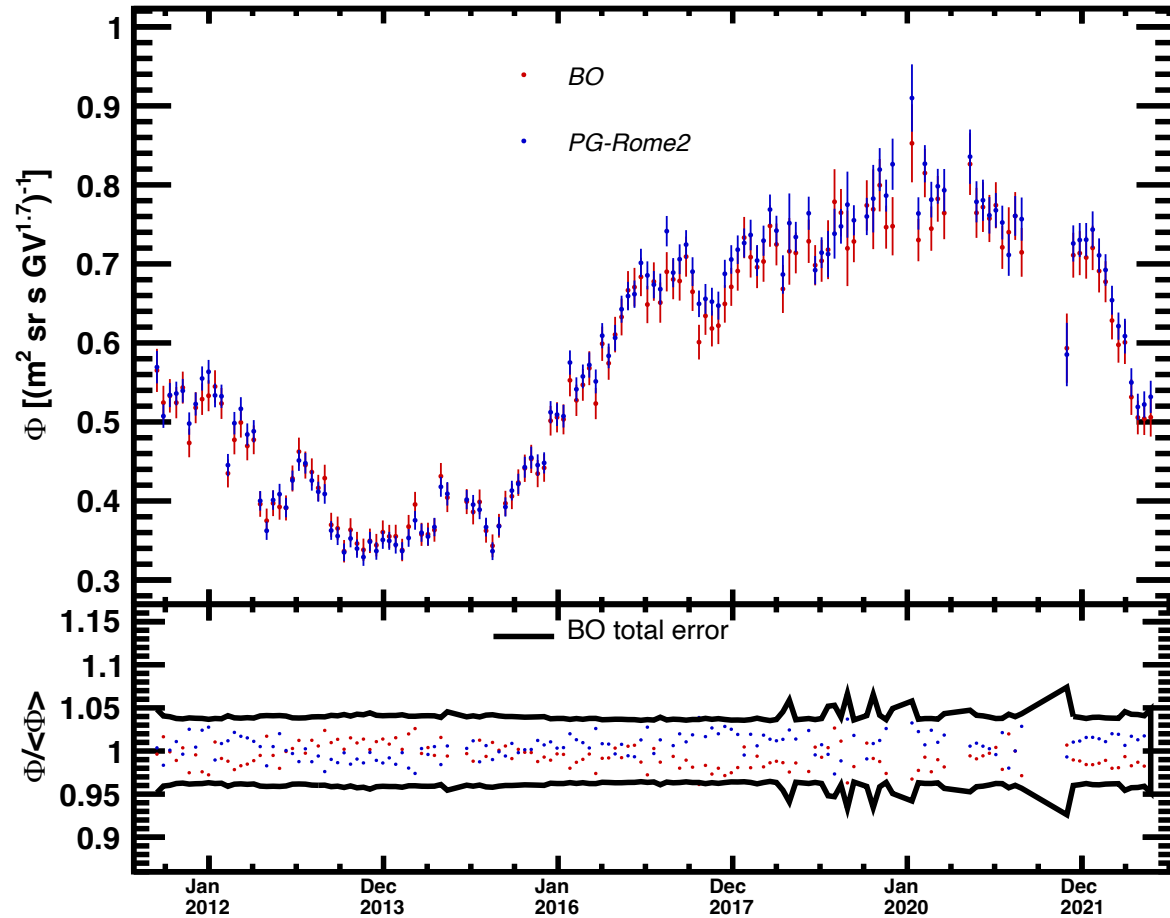


[2.15 - 2.40] GV

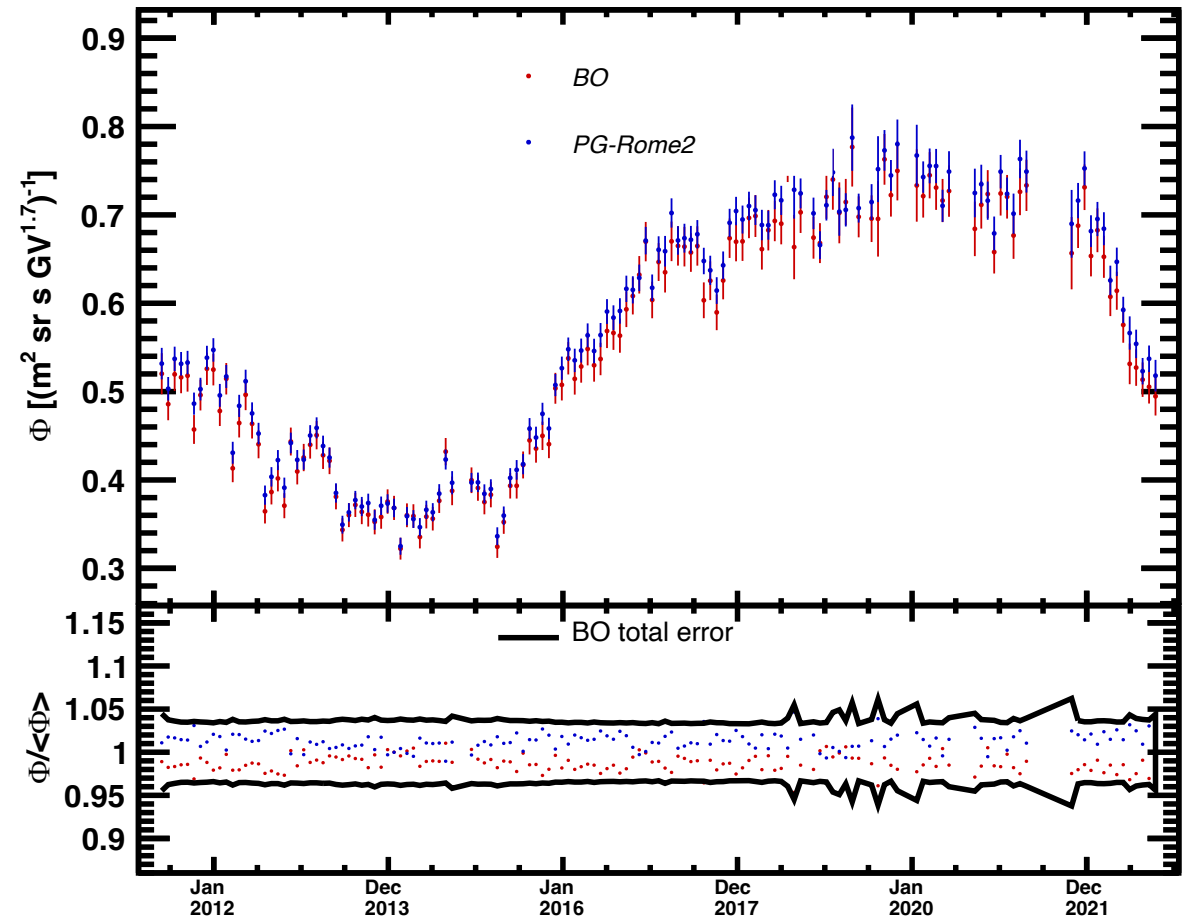


Bartels Comparison: Boron

[1.92 - 2.15] GV

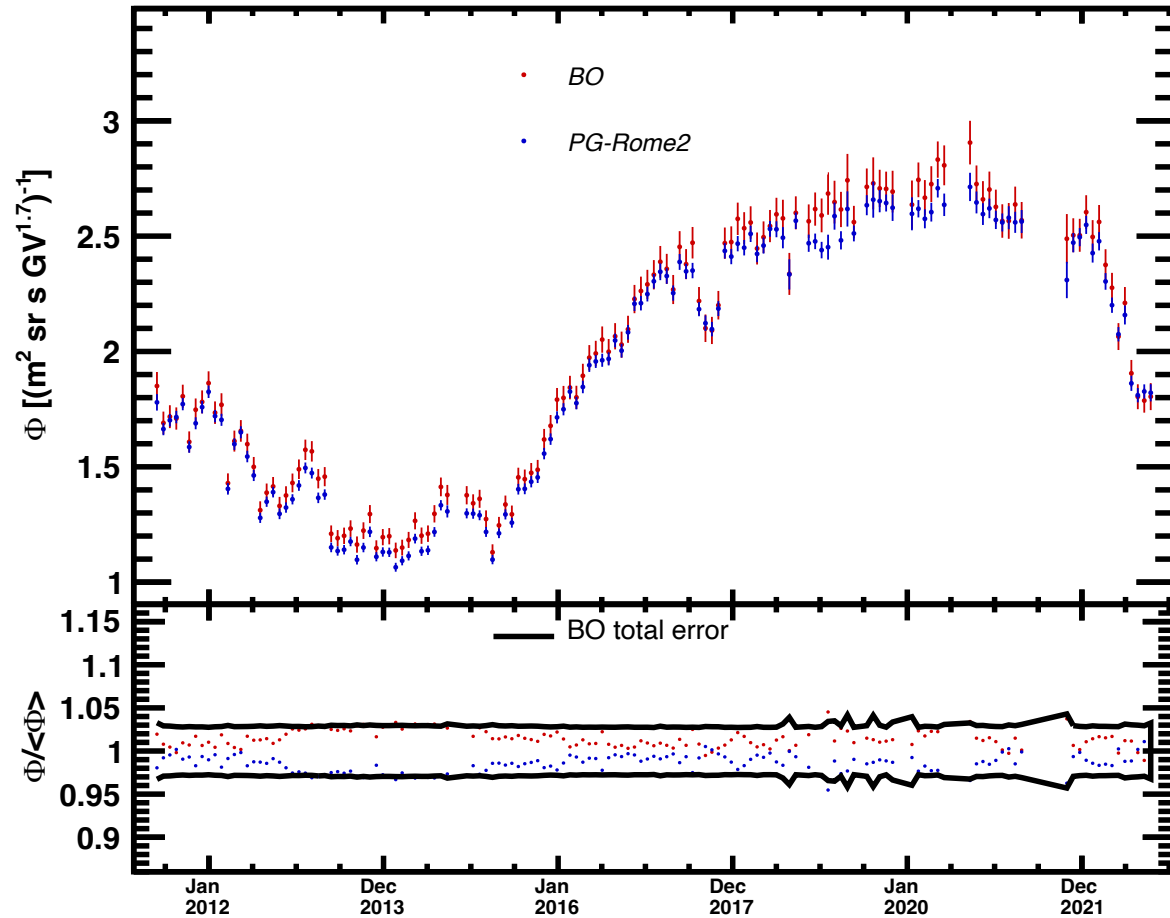


[2.15 - 2.40] GV

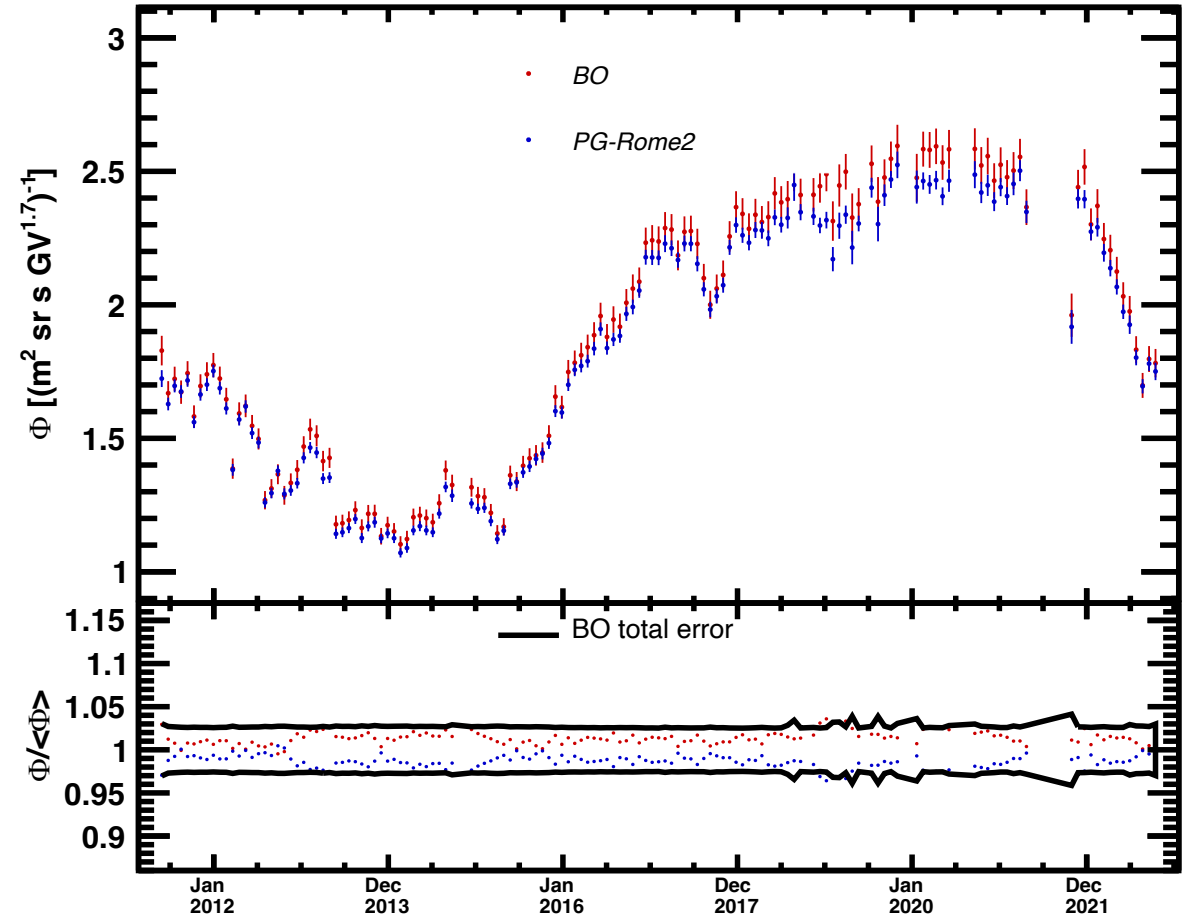


Bartels Comparison: Carbon

[1.92 - 2.15] GV

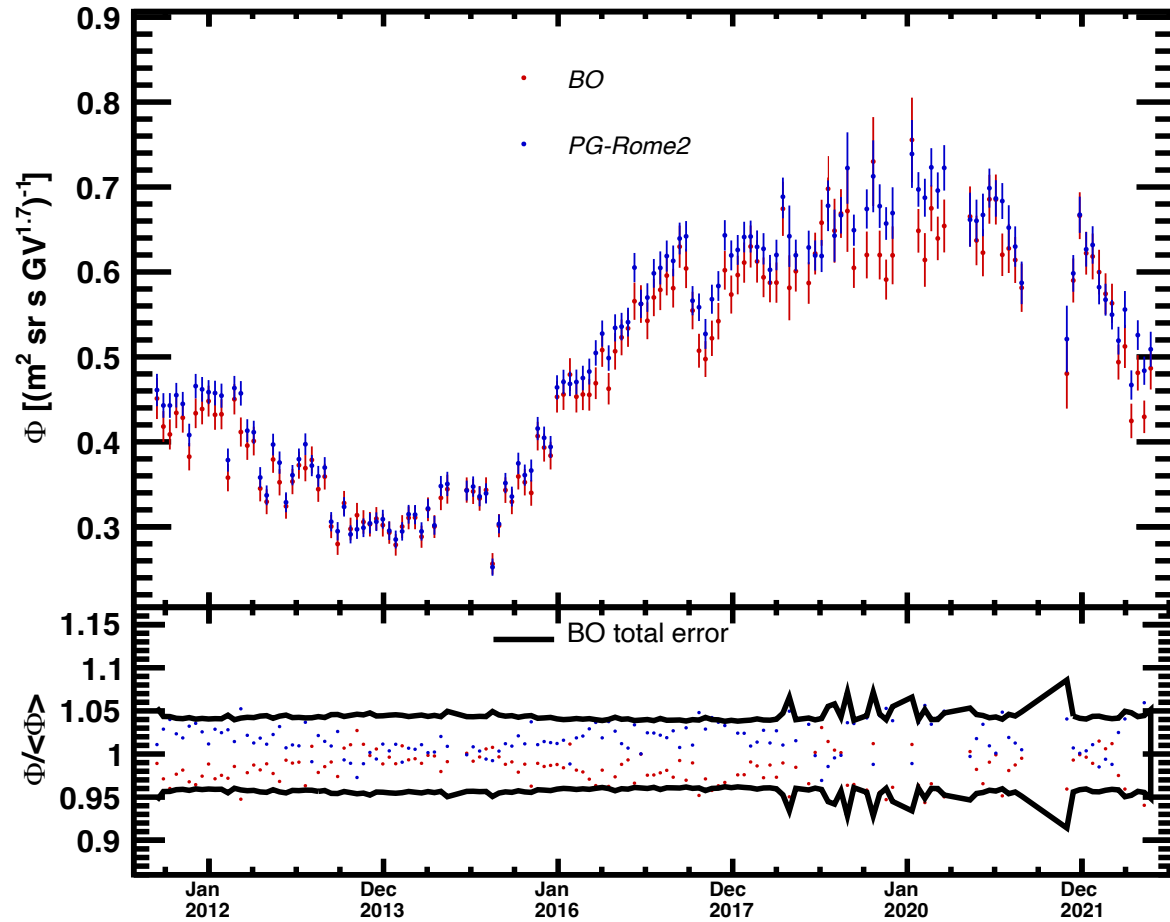


[2.15 - 2.40] GV

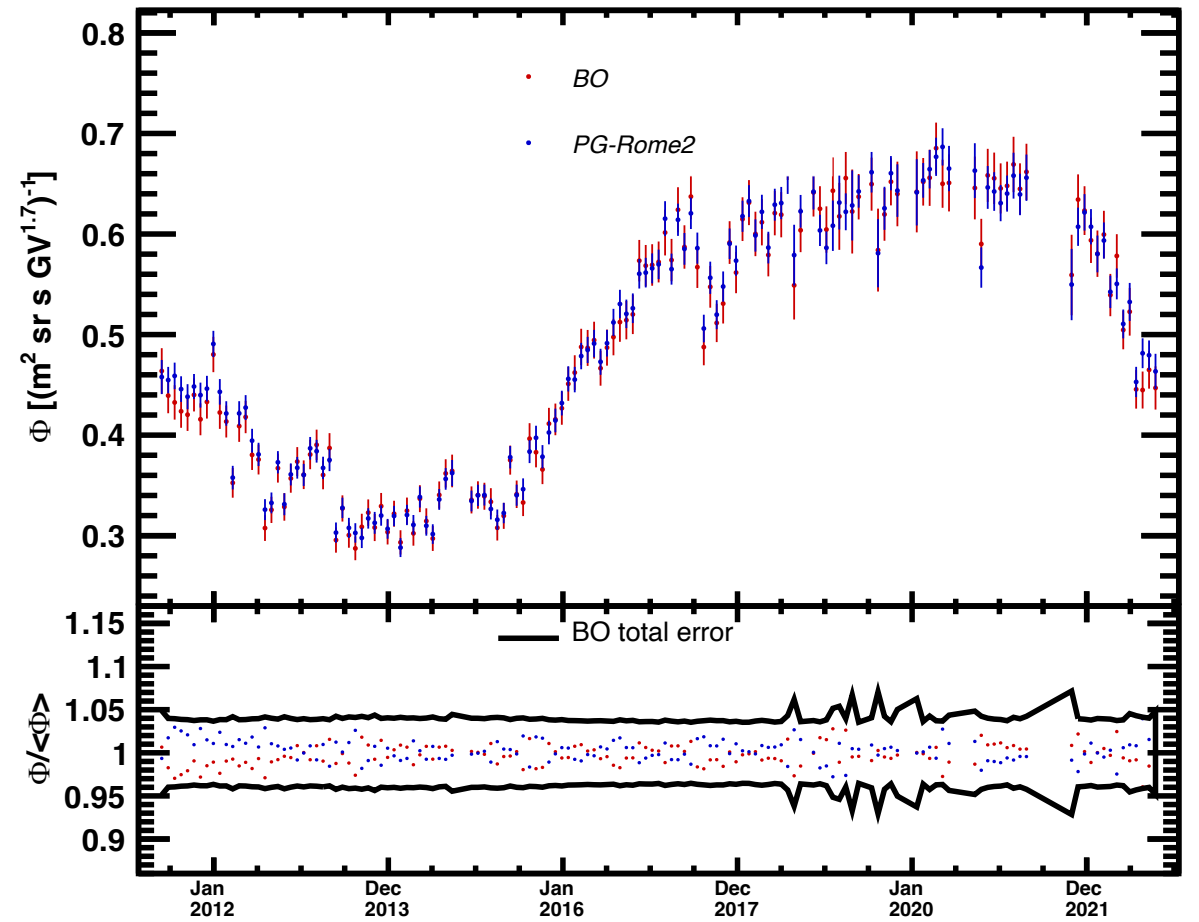


Bartels Comparison: Nitrogen

[1.92 - 2.15] GV

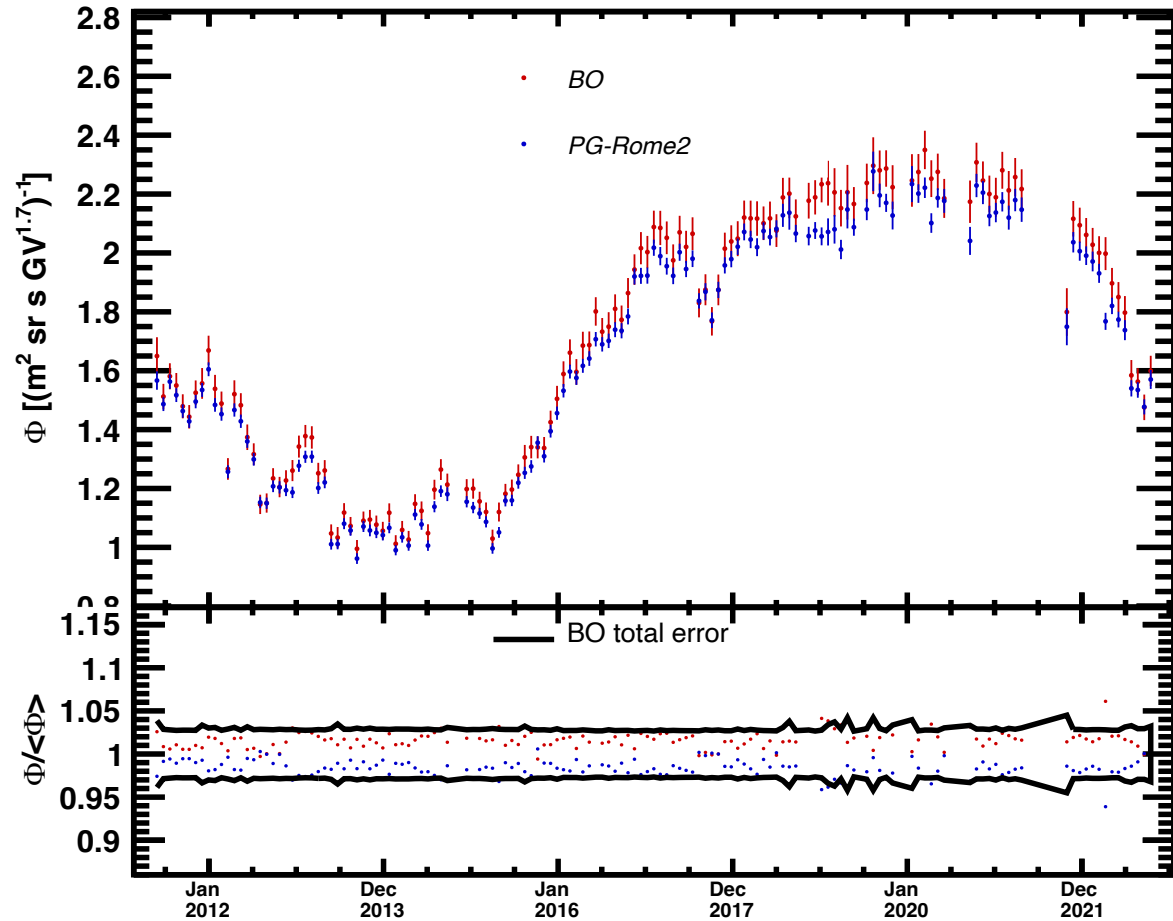


[2.15 - 2.40] GV

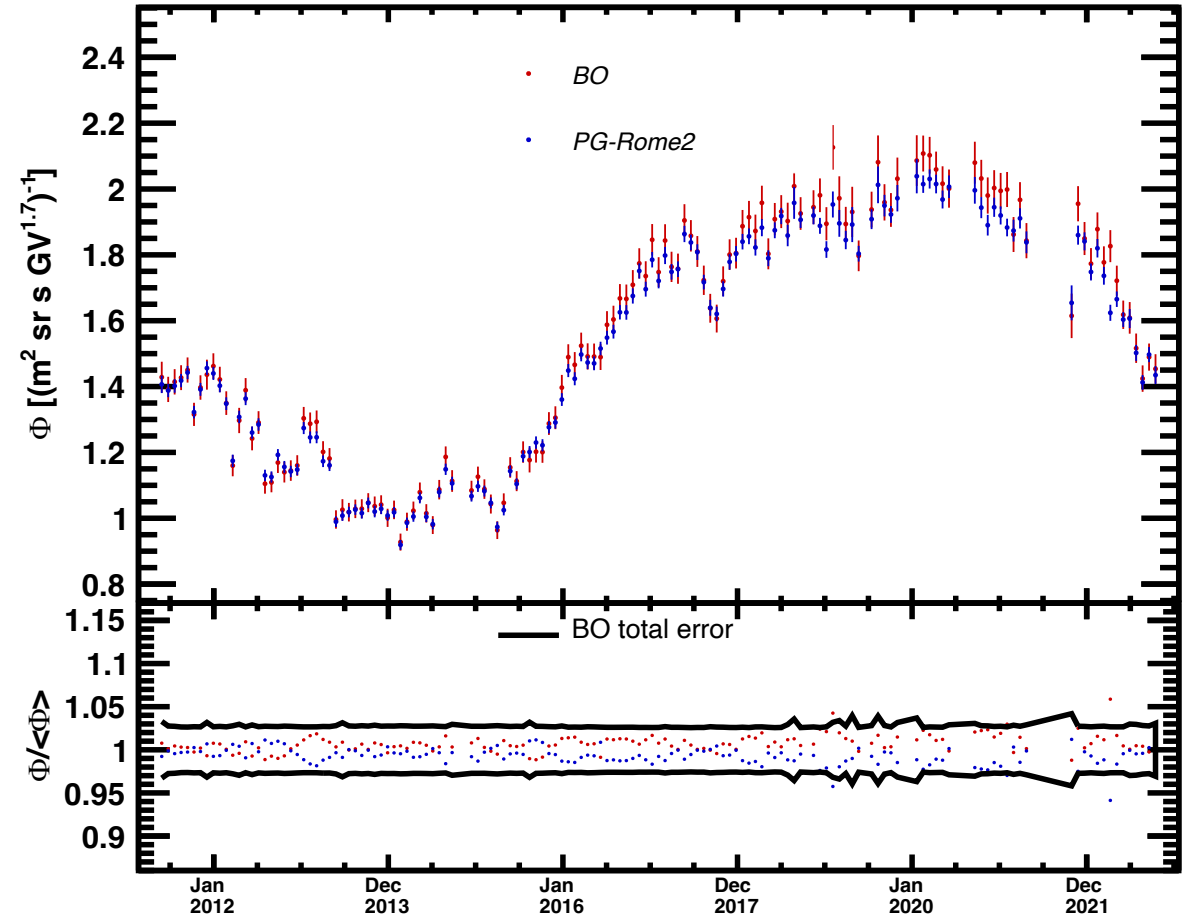


Bartels Comparison: Oxygen

[2.15 - 2.40] GV



[2.40 - 2.67] GV

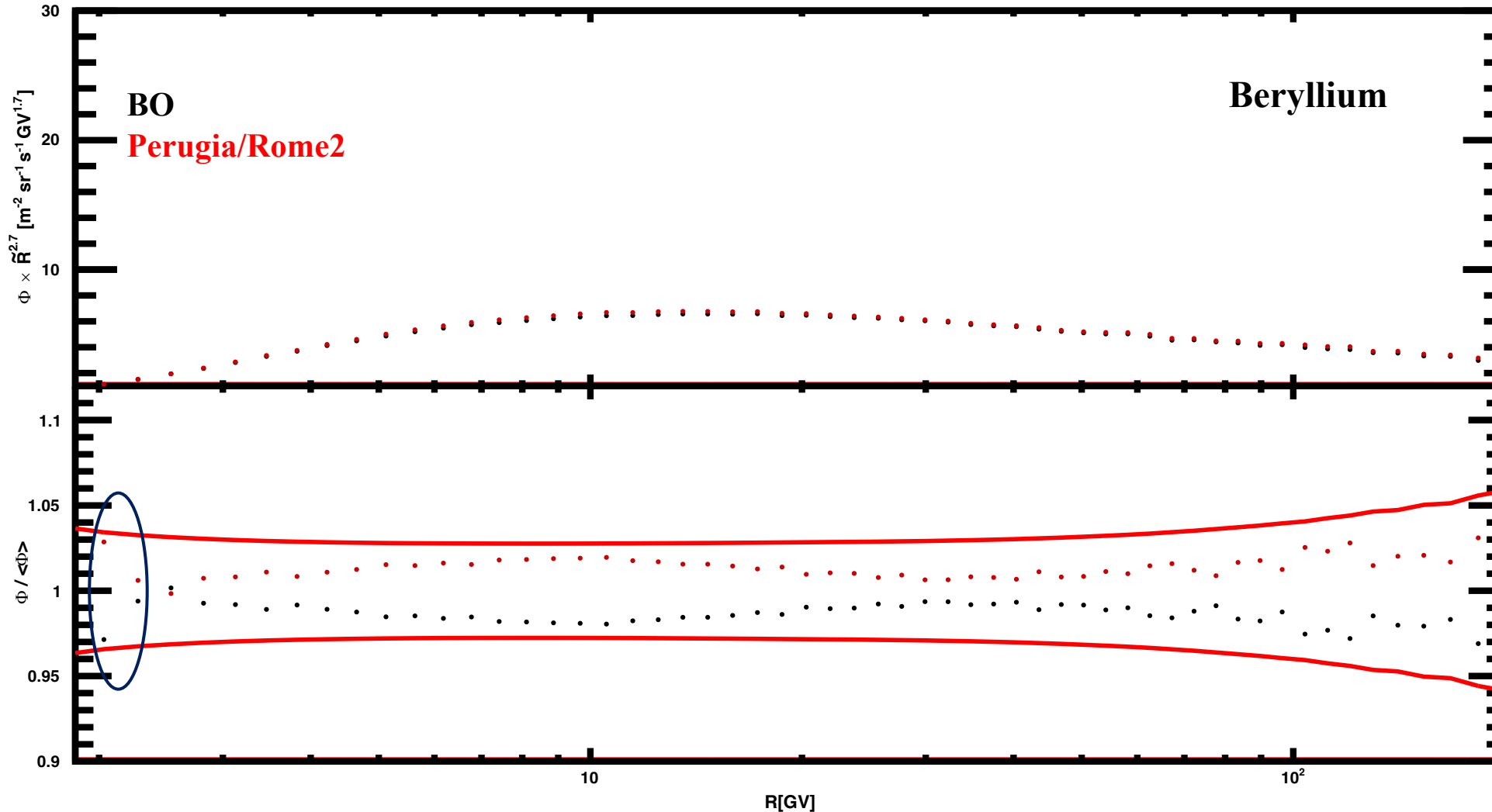


Bartels differences between groups

- Difference is coming from Average → Normalize
- Difference is coming from Bartels → Data/Data or/and Unfolding

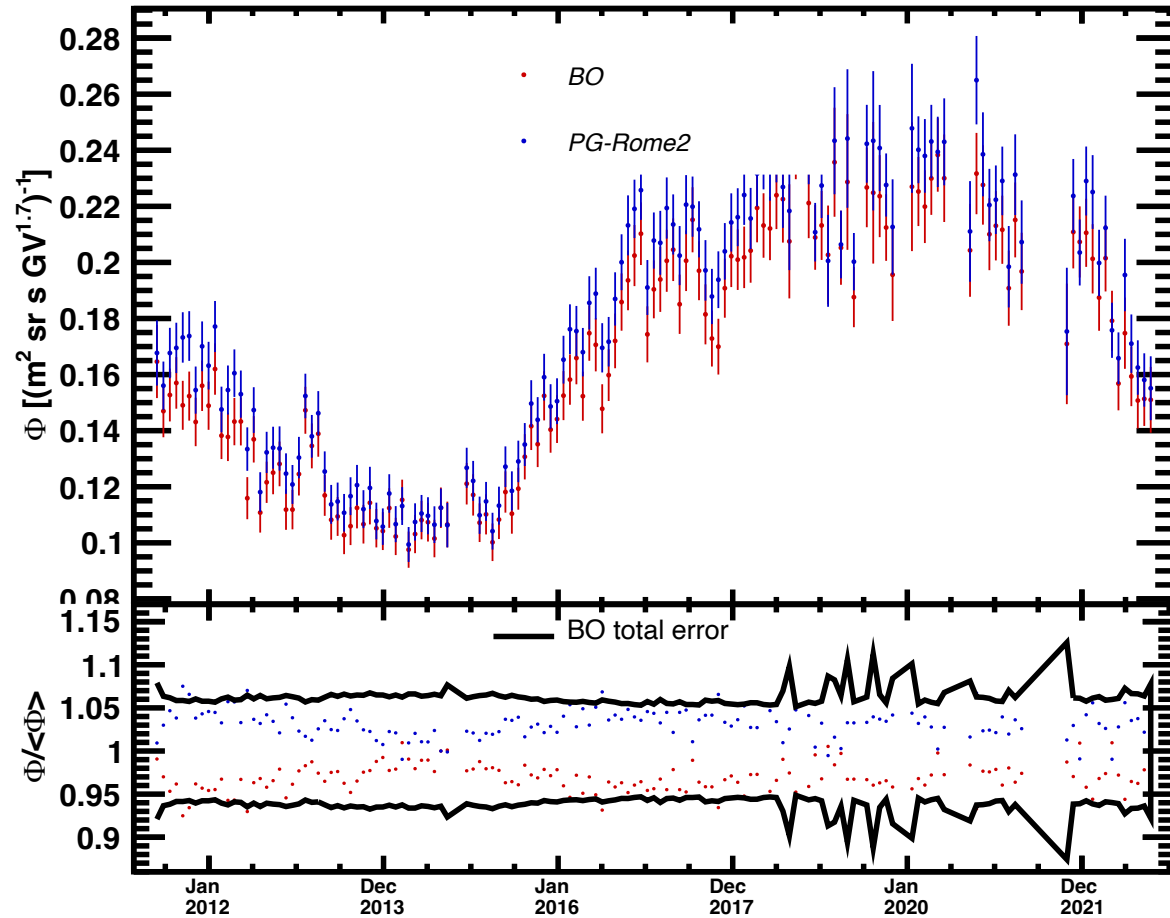
Bartels differences between groups

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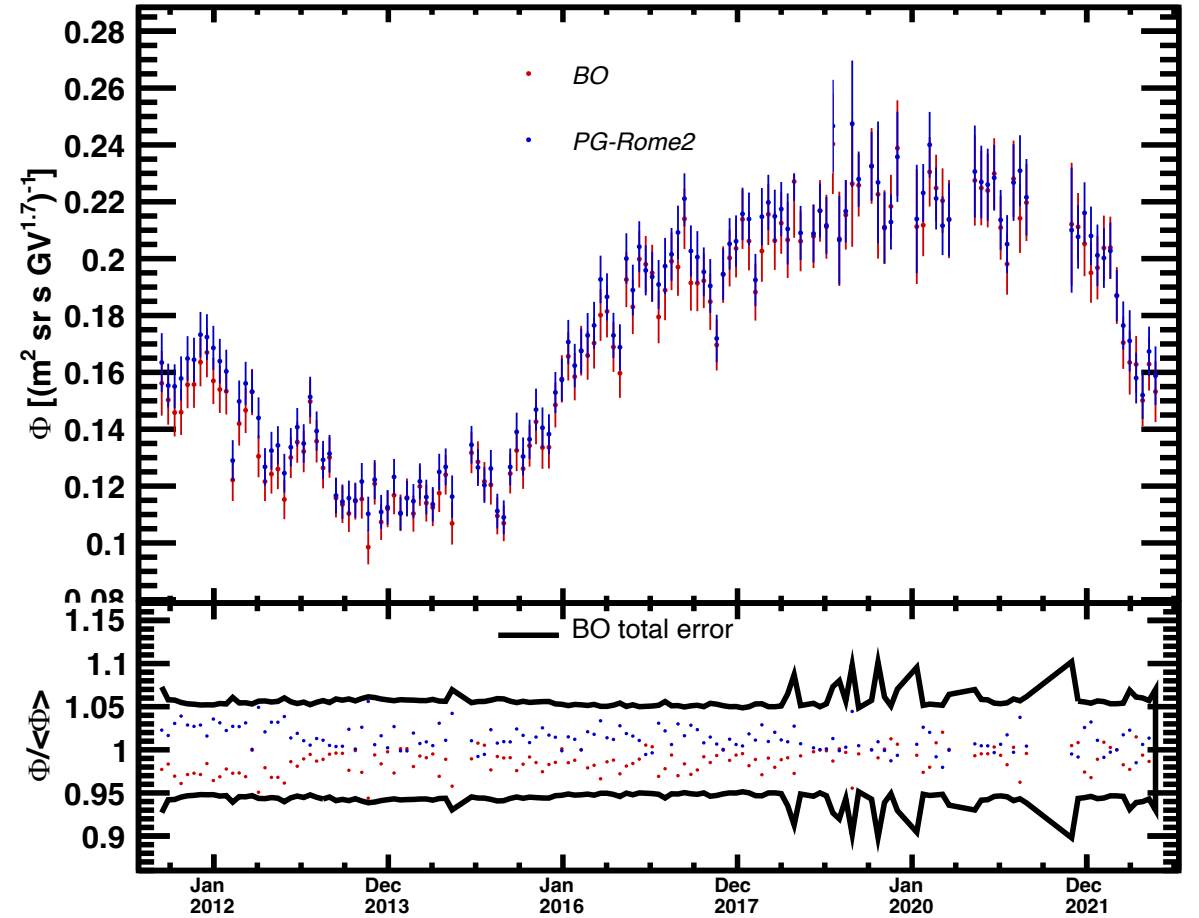


Bartels Comparison: Beryllium

[1.92 - 2.15] GV

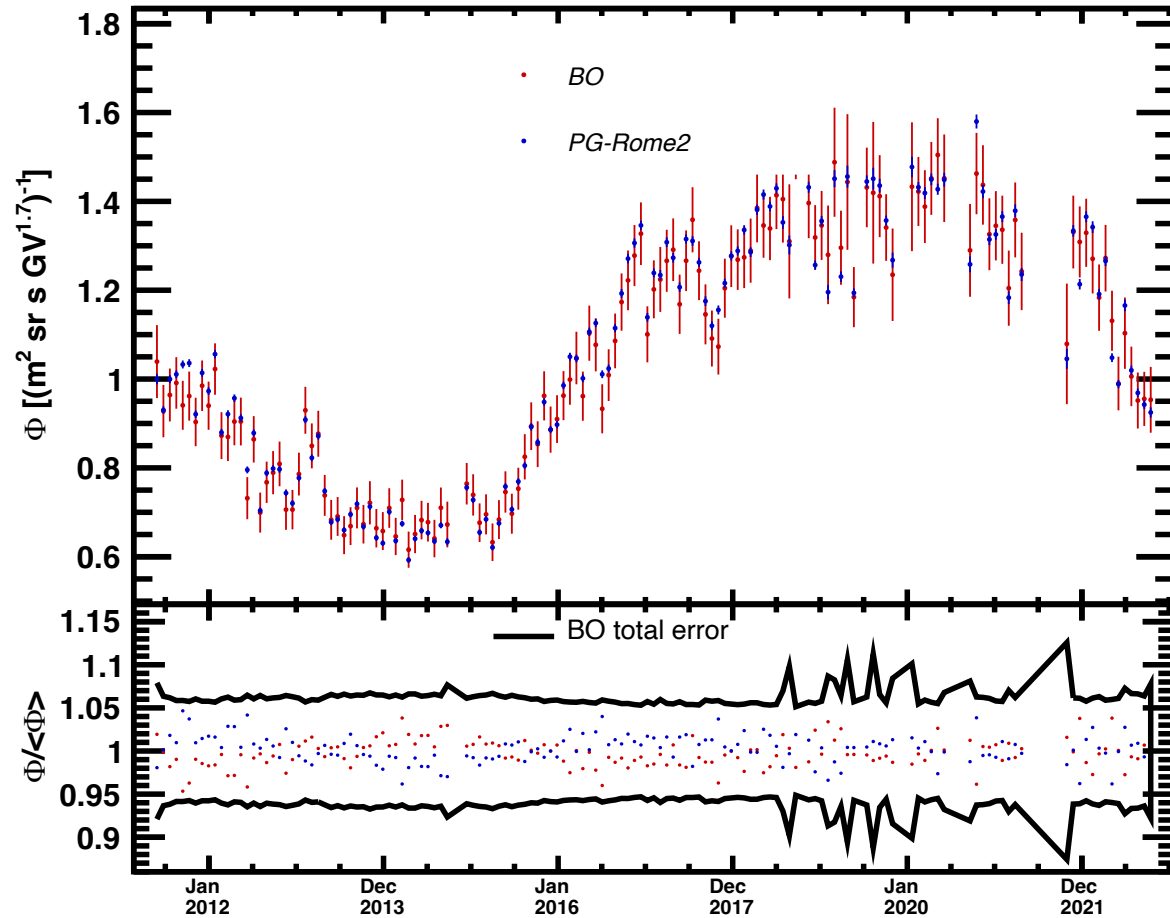


[2.15 - 2.40] GV

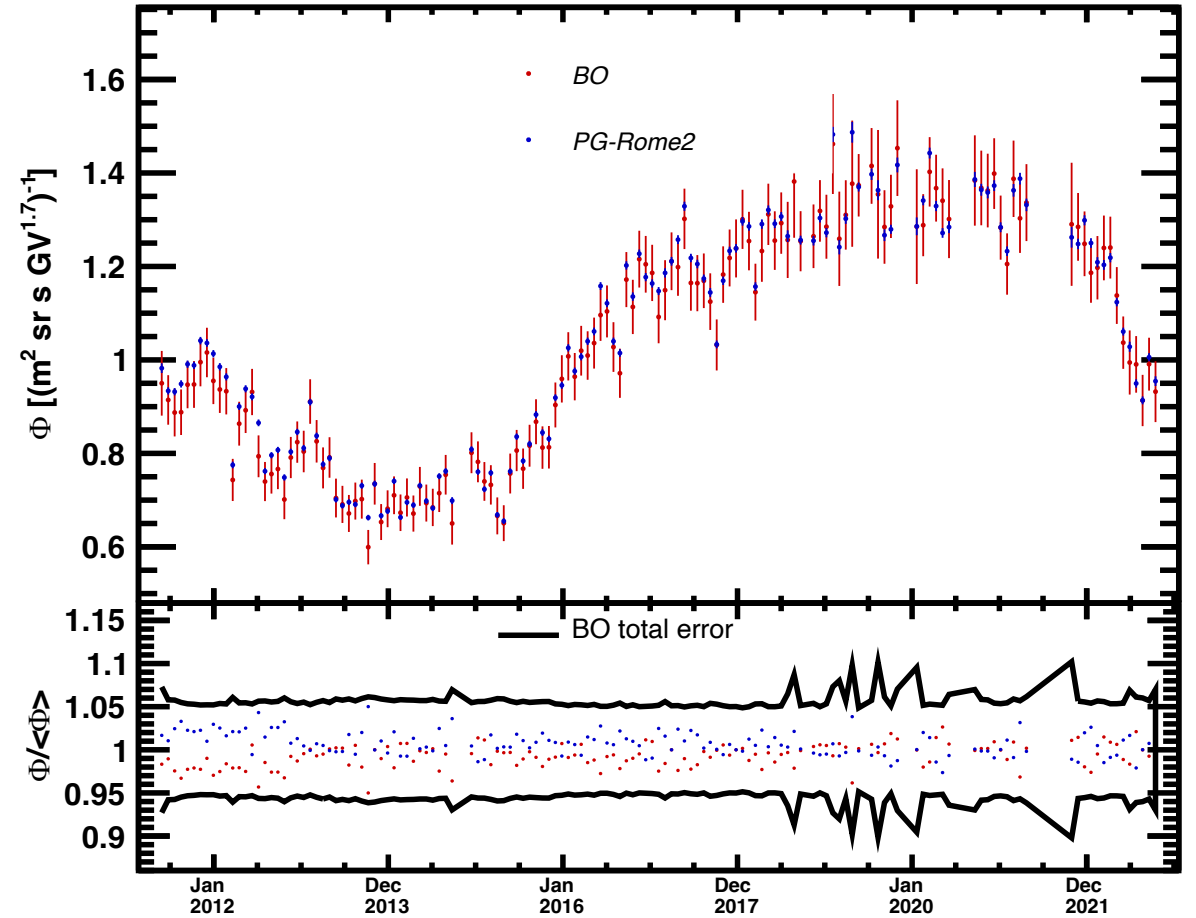


Bartels Comparison: Beryllium Normalized to Average

[1.92 - 2.15] GV



[2.15 - 2.40] GV

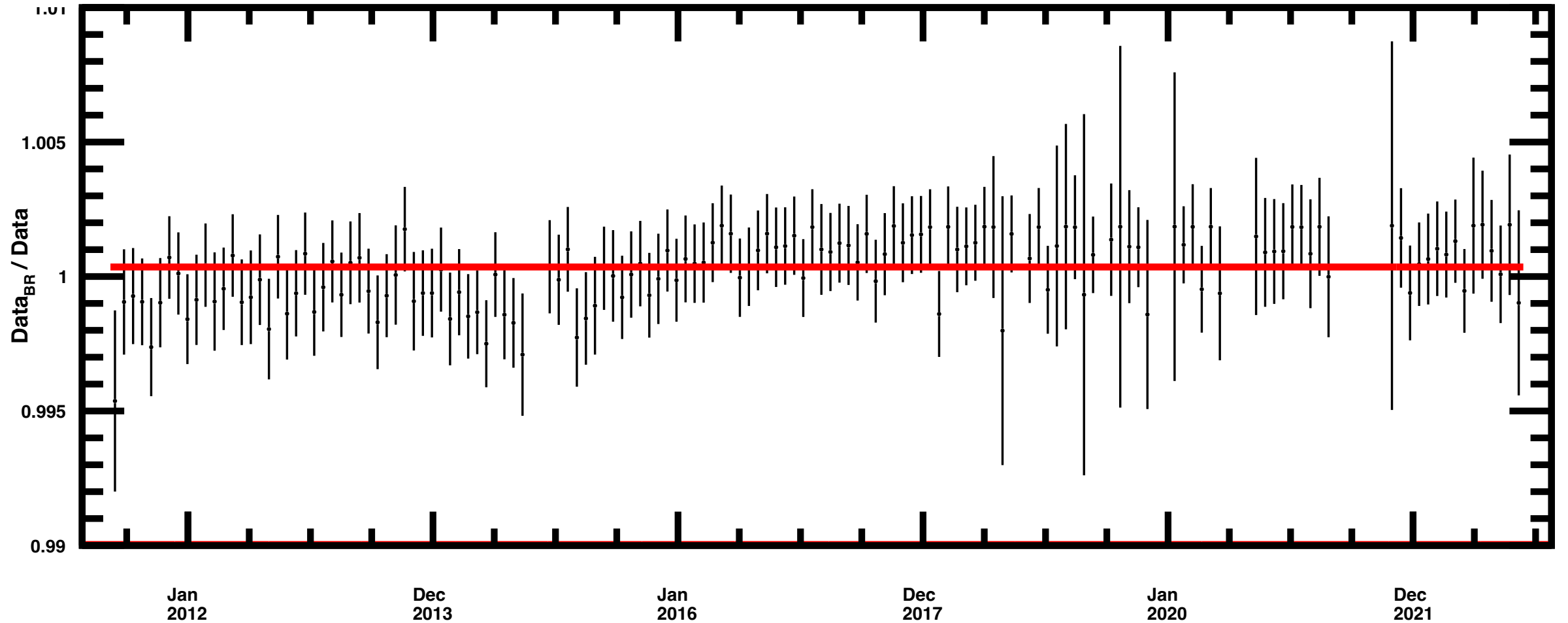


Conclusions

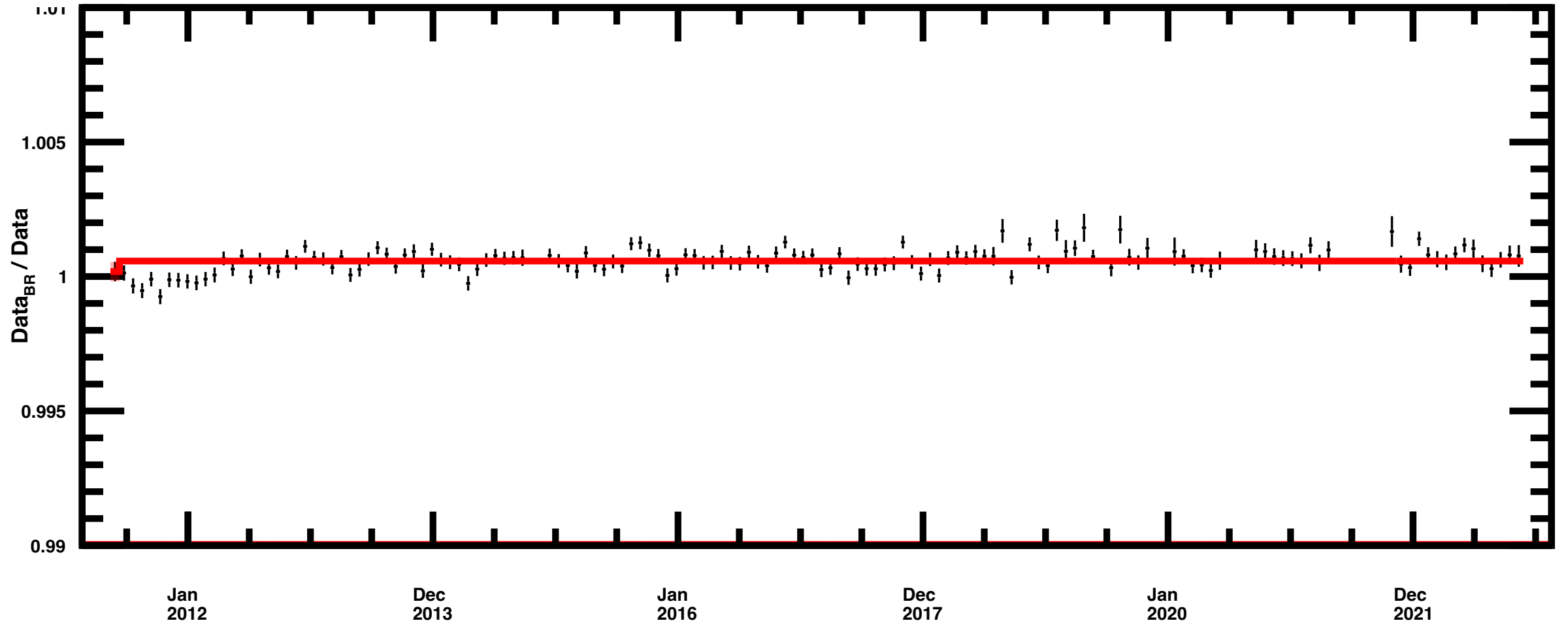
- **The Bartels fluxes for Lithium to Oxygen for the first 11.5 years of AMS data taking, from Bartels 2426 to Bartels 2581, have been present.**
- **The agreement between the two groups is good enough for a publication. Anyway, a few more checks will be done:**
 - **Compare Unfolding vs Time**
 - **Compare Data/Data corrections**
- **All the systematics, time dependent and time independent, have been estimated.**
- **The Photon-Trigger period (6 months) is being studied to include it.**
- **The goal is to have everything prepare for the General Meeting in January, and present something solid to publish.**

Back Up

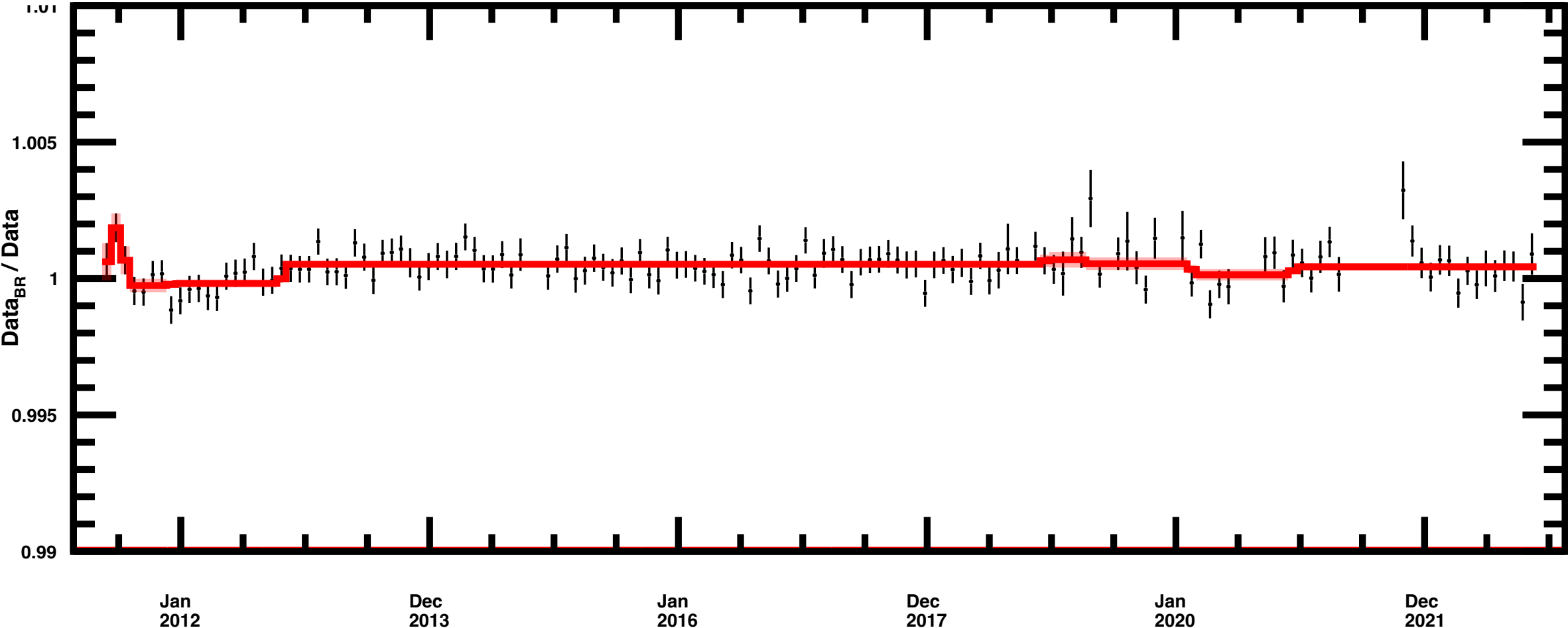
Carbon Trigger Data/ \langle Data \rangle correction



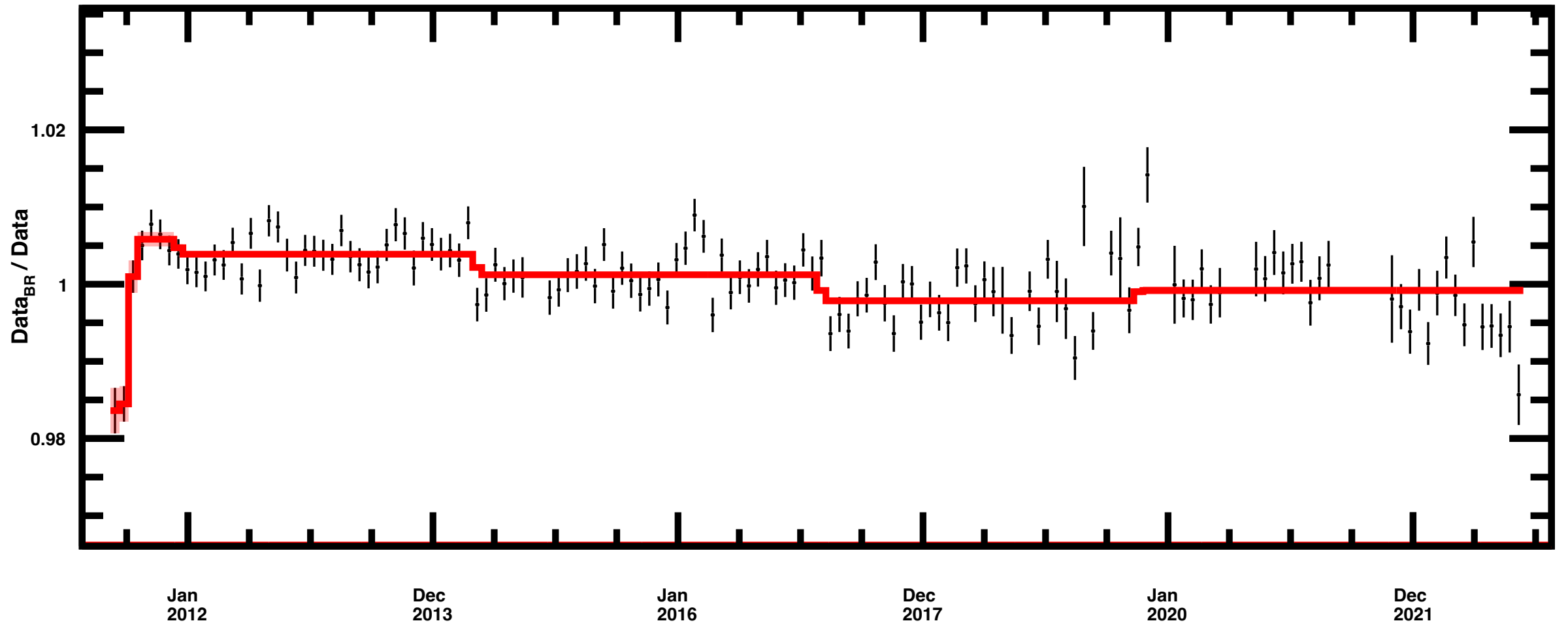
Carbon TOF Data/ \langle Data \rangle correction



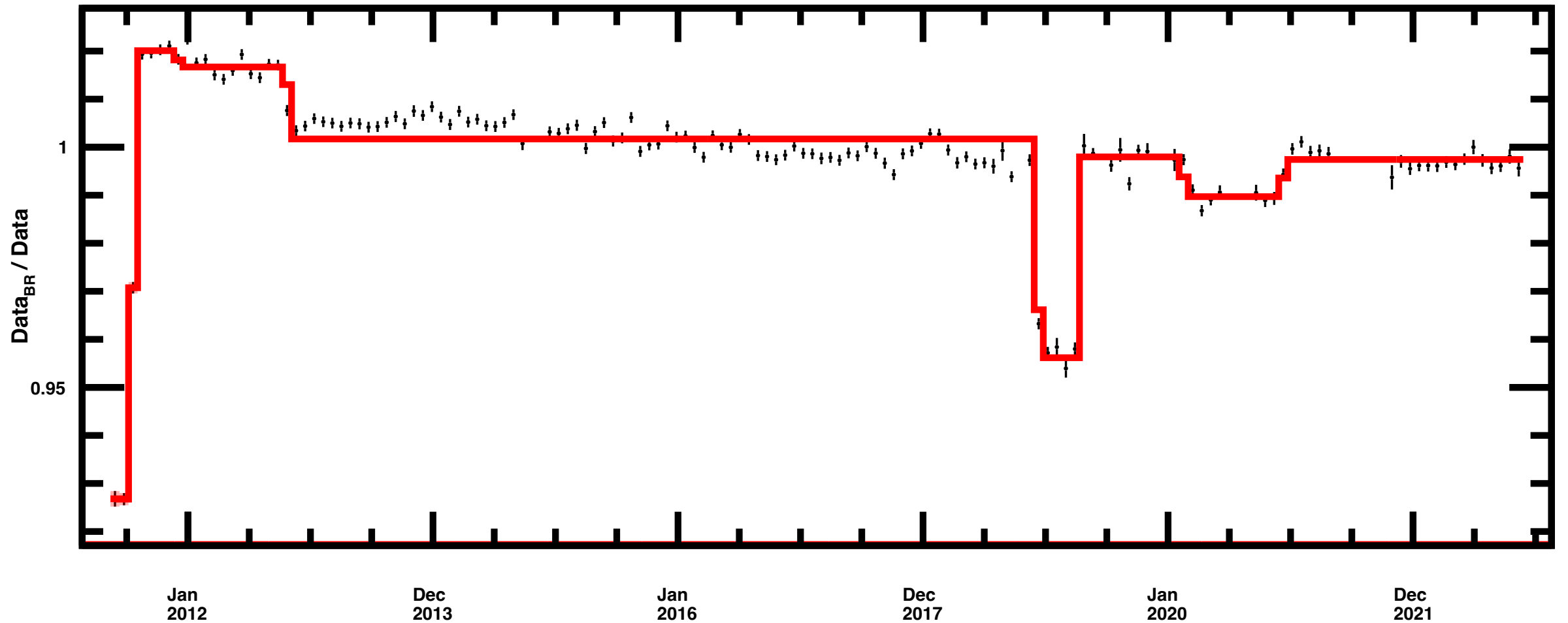
Carbon L1-HitAssociation Data/<Data> correction



Carbon Tracker Data/ \langle Data \rangle correction

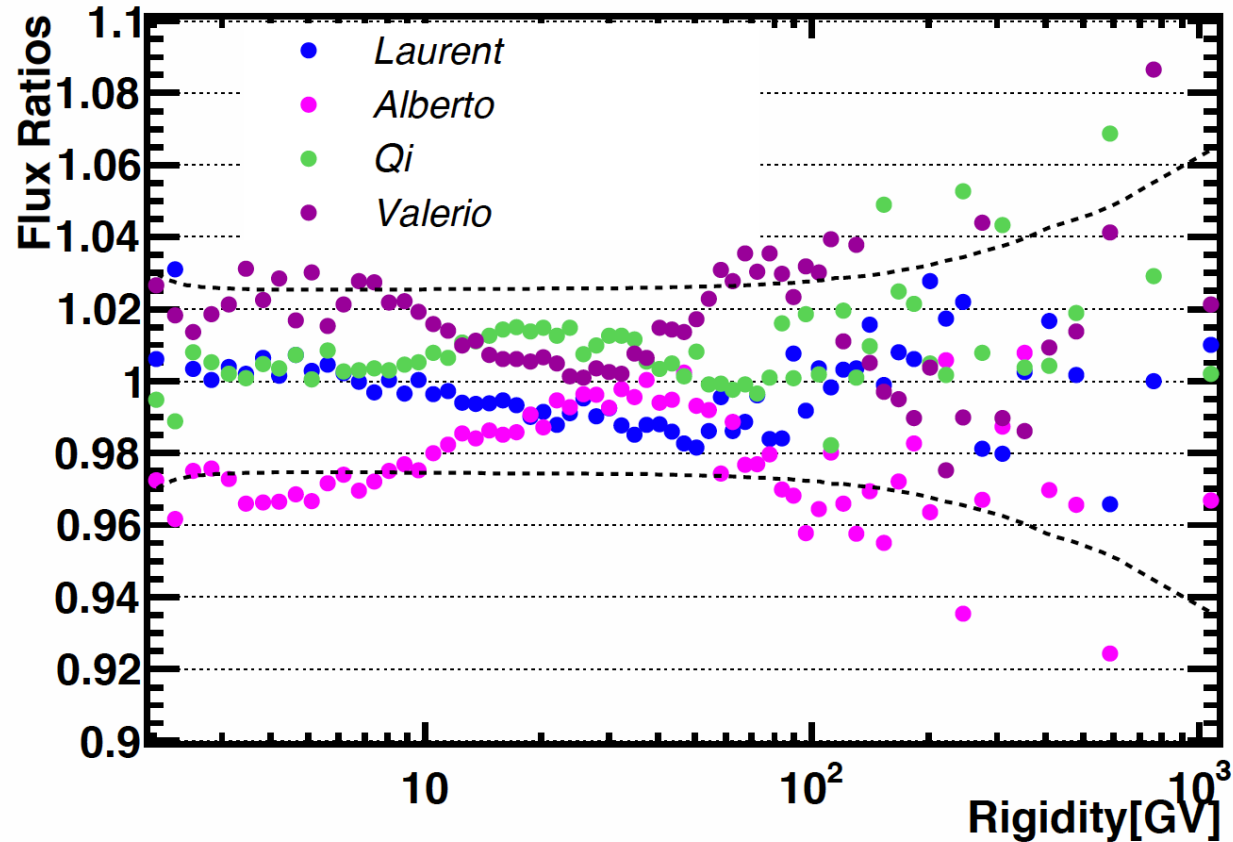


Carbon L1-UnbiasedHit Data/ \langle Data \rangle correction



Lithium AMS comparison in 2017

L1I Flux Comparison



Last comparison made for Lithium in detail.

This was the status before publication.