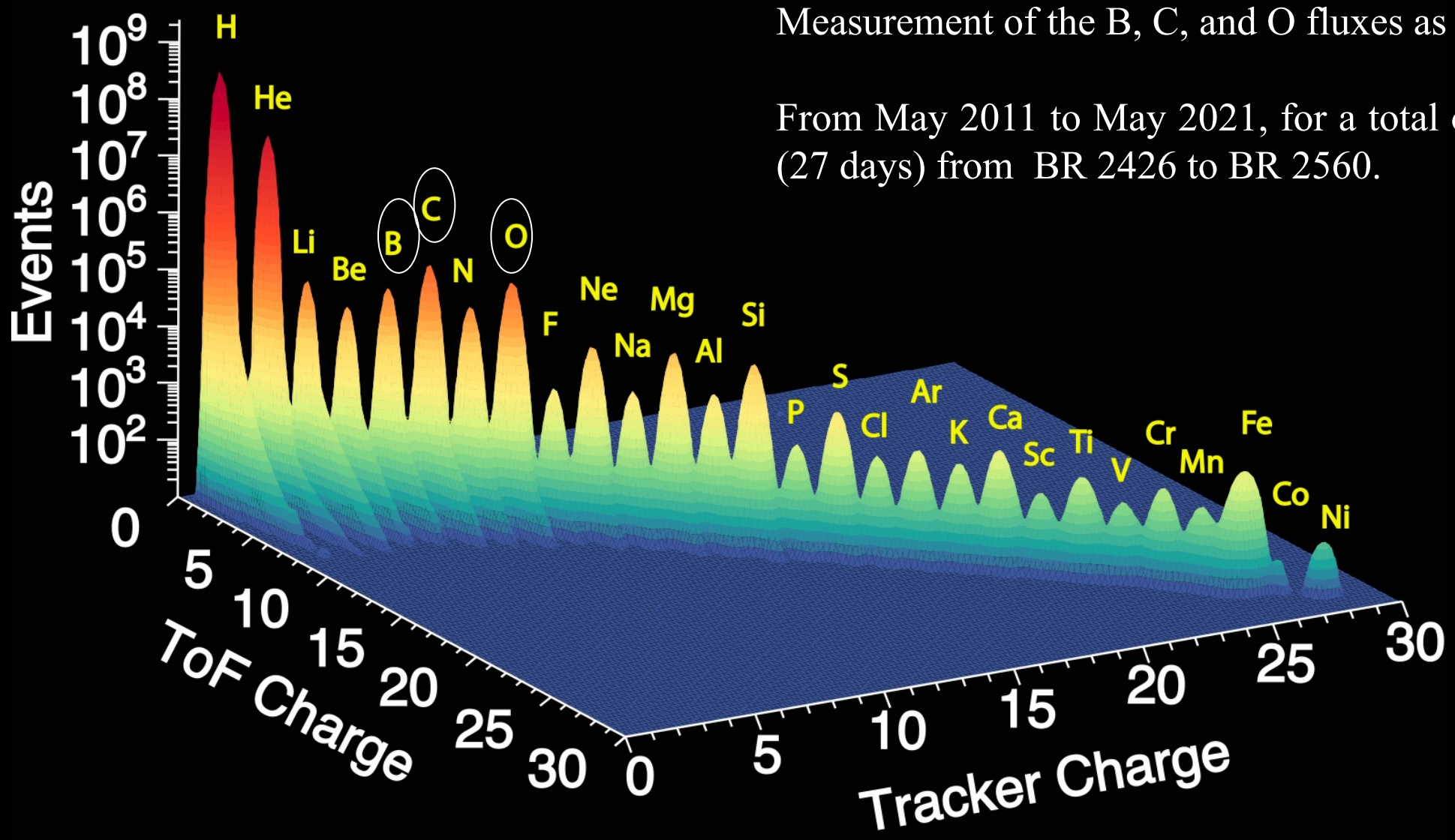
INFN BOLOGNA
Istituto Nazionale di Fisica Nucleare
Sezione di Bologna

AMS-02 Italy Meeting:
Status of Nuclei Analysis

Alejandro Reina Conde, INFN Sezione di Bologna
Alberto Oliva, INFN Sezione di Bologna

Tuesday 20th of December, 2022

Time dependent analysis with pass 7 data (old code & CIEMAT Ntuples)

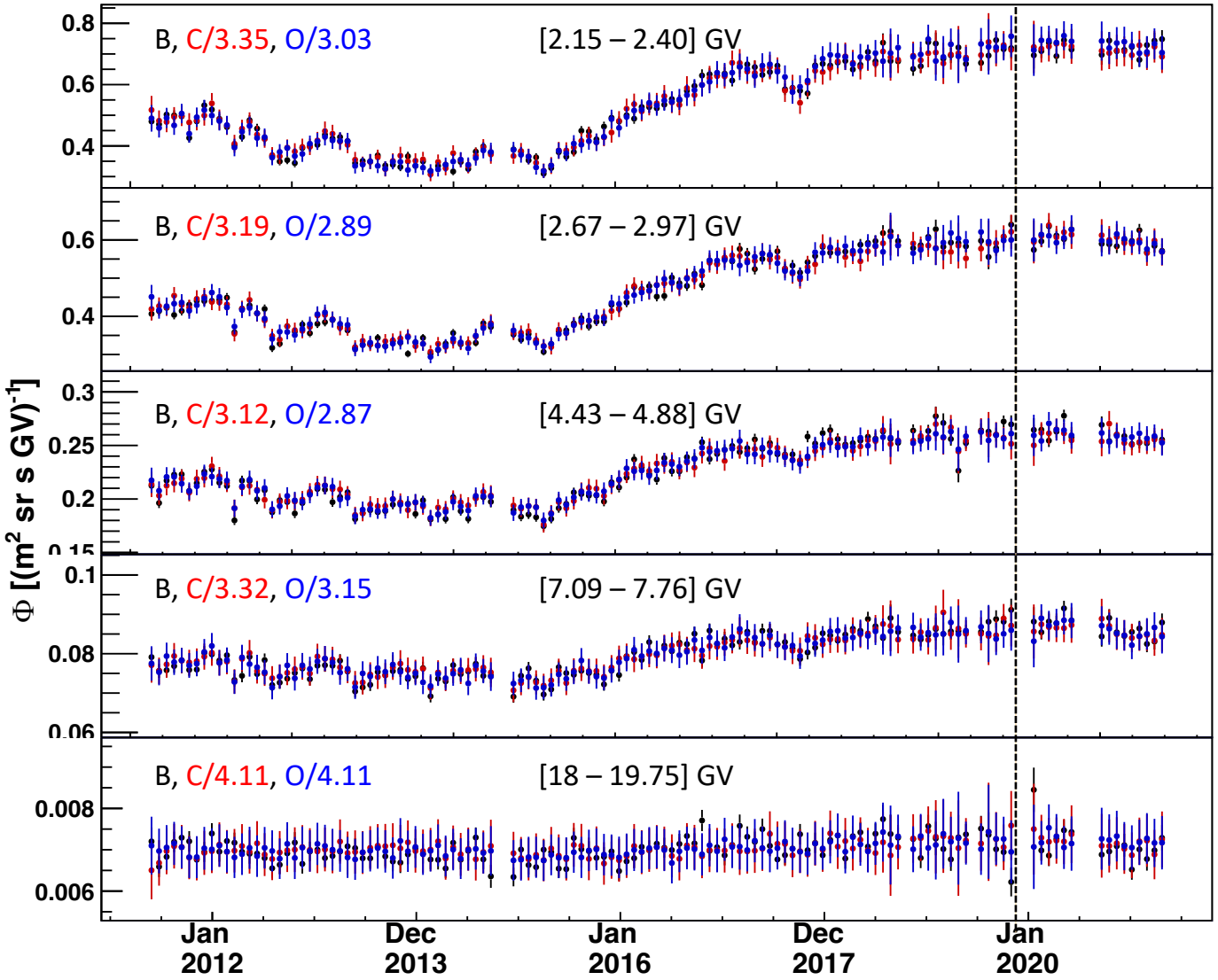


Measurement of the B, C, and O fluxes as function of time.

From May 2011 to May 2021, for a total of 135 Bartels rotations (27 days) from BR 2426 to BR 2560.

B-C-O fluxes vs time: 10 years

extension up to May 2021



At low rigidities the flux is clearly anti-correlated with the solar activity.

↓

Increasing rigidity the effect has a decreasing amplitude.

NAIA and pass8

Pass8:
Implementation of the new v6 alignment, new track reconstruction and GBL fitting algorithm.

NAIA project:
Effort to have a common ntuple production for Italy.

Status:
Data production finished.
MonteCarlo production ongoing.

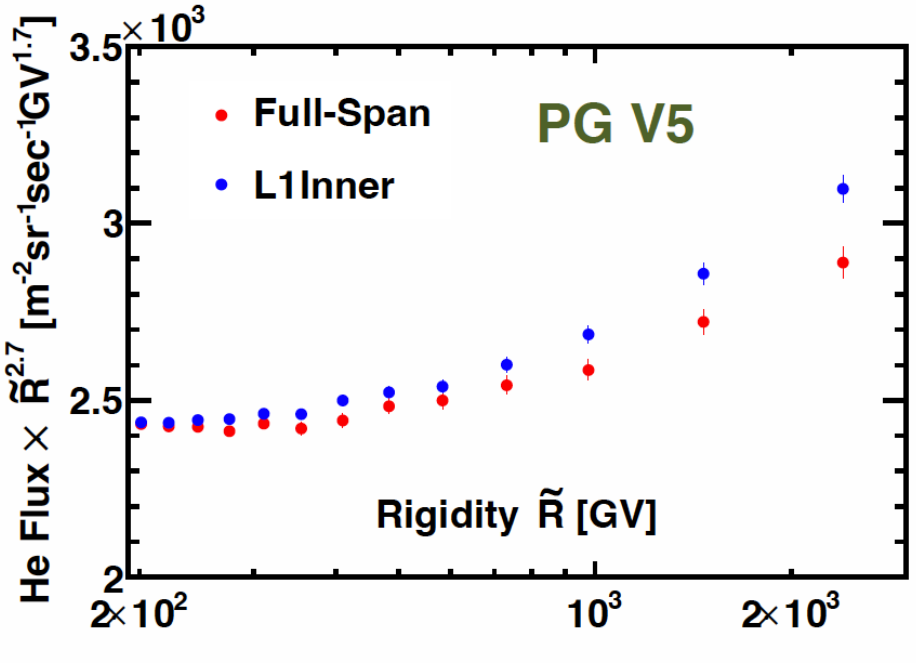
Advantages:

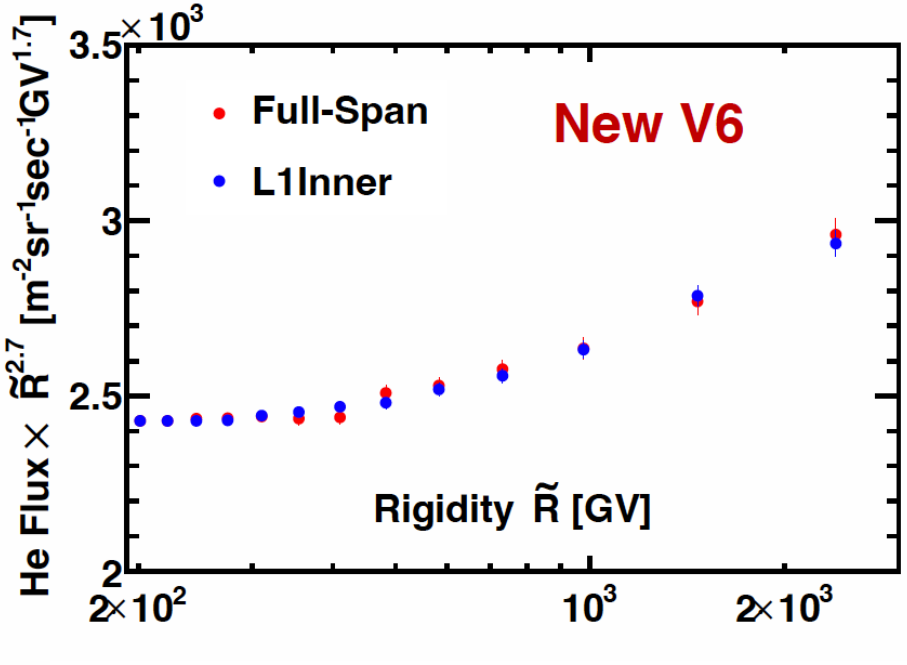
- **Cross-check analysis between groups becomes better, no differences coming from ntuples production (i.e. B-C-O comparison between Bologna, Perugia/Rome2 and Hawai).**
- **Shared effort in the improvement of the analysis. Possibility of cross-group working on the same analysis (i.e. BO-PG-RM2-AntiHeliumAnalysis).**

The Rigidity-Scale Check In Different Geometric Acceptance with Helium Flux

Qi Yan presentation

V6 alignment





The alignment procedure in V6 greatly improved the homogeneity of the detector.

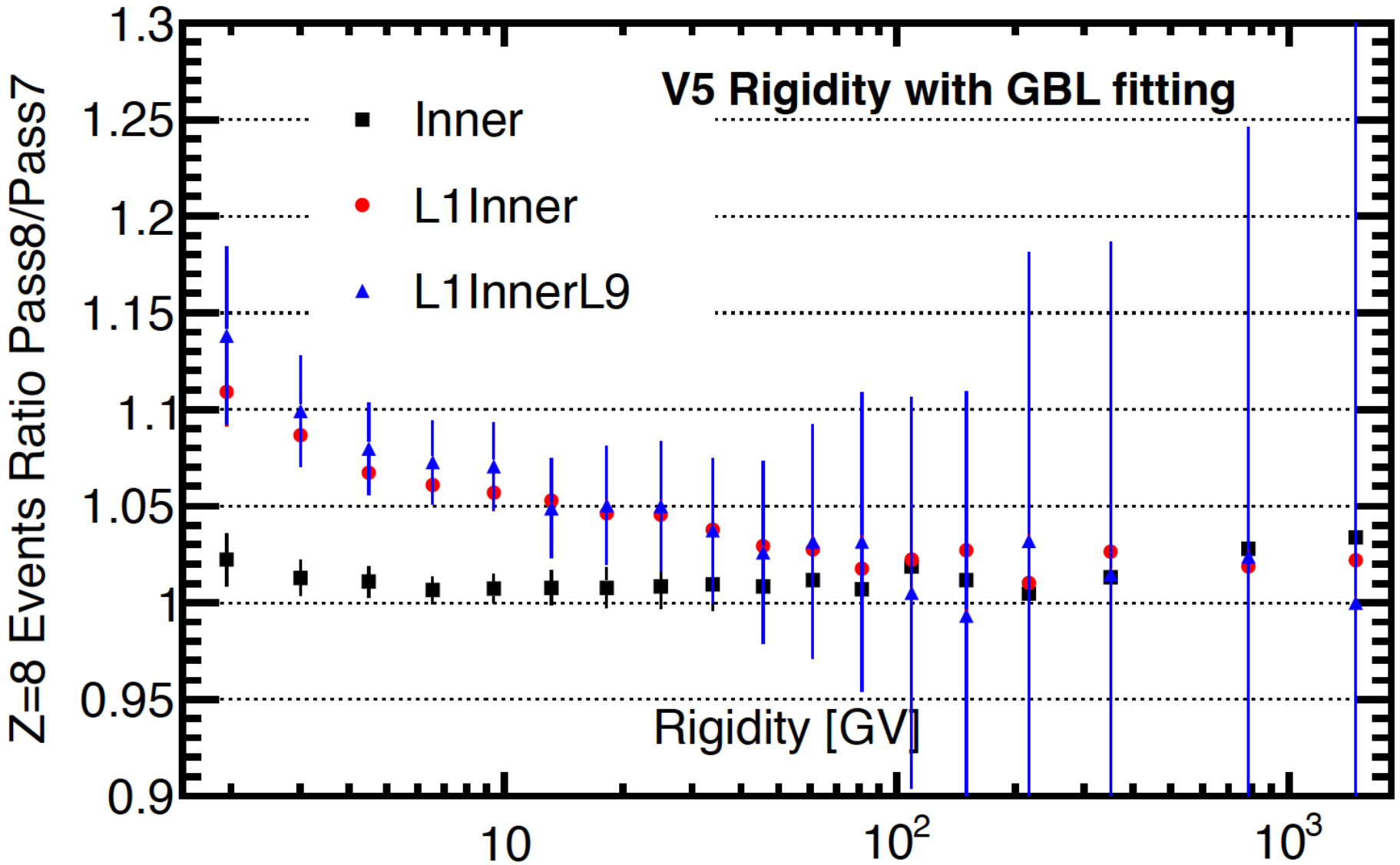
In the new V6, the rigidity-scale difference between Full-Span and L1Inner (L1Inner Geometry) is <1/100 TV^{-1} much smaller than PG-V5 about 1/10 TV^{-1}.

"…In V6, there is no need of any additional external correction neither rigidity-scale time dependent correction nor the rigidity-scale correction for different geometric acceptance. In a word, all the rigidities measured by Inner, L1inner, InnerL9, and L1InnerL9 have no bias in V6." (https://twiki.cern.ch/twiki/bin/viewauth/AMS/AMSNewVersion6)

Oxygen Events Ratio Pass8 (B1235-T4)/Pass7

Qi Yan presentation

pass8 reconstruction



Analysis of AMS-Bologna with NAIA pass8 Ntuples

- **The code has been re-written from scratch.**
- **The goal is the estimation of the B-C-O fluxes vs time and comparison with Perugia/Rome2 analysis. More things after.**
- **Status of Carbon flux in this presentation:**

1. **Inner-L1 geometry**
2. **GBL fitting algorithm**
3. **First 8.5 years of data (ISS.B1236)**
4. **C.B1236 MonteCarlo**

Inner-L1 selection

Orbital Cuts

A good second

Livetime > 0.05

Zenith Angle < 40

Alignment ($|IMD\text{-}PG_{IL1}|<35$ um, $|IMD\text{-}PG_{IL9}|<45$ um)

Not in SAA

$R_{Inner\text{-}L1}>1.2xR_{ctf}$

Selection cuts

Physics trigger

β with ≥ 3 hits

β > 0.3

Inner Tracker Y hits ≥ 5

L2Y&(L3Y|L4Y)&(L5Y|L6Y)&(L7Y|L8Y)

Normalize Inner $\chi^2_Y<10$

L1XY hit on track with good status

Normalized Inner-L1 $\chi^2_Y < 10$

Charge cuts on L1, UTOF, and Inner Tracker:

- $Q_{L1}–Z > –0.16(Z–3)–0.46$
- $–0.6< Q_{UTOF}–Z <1.5$
- $|Q_{Inner}–Z| < 0.45$

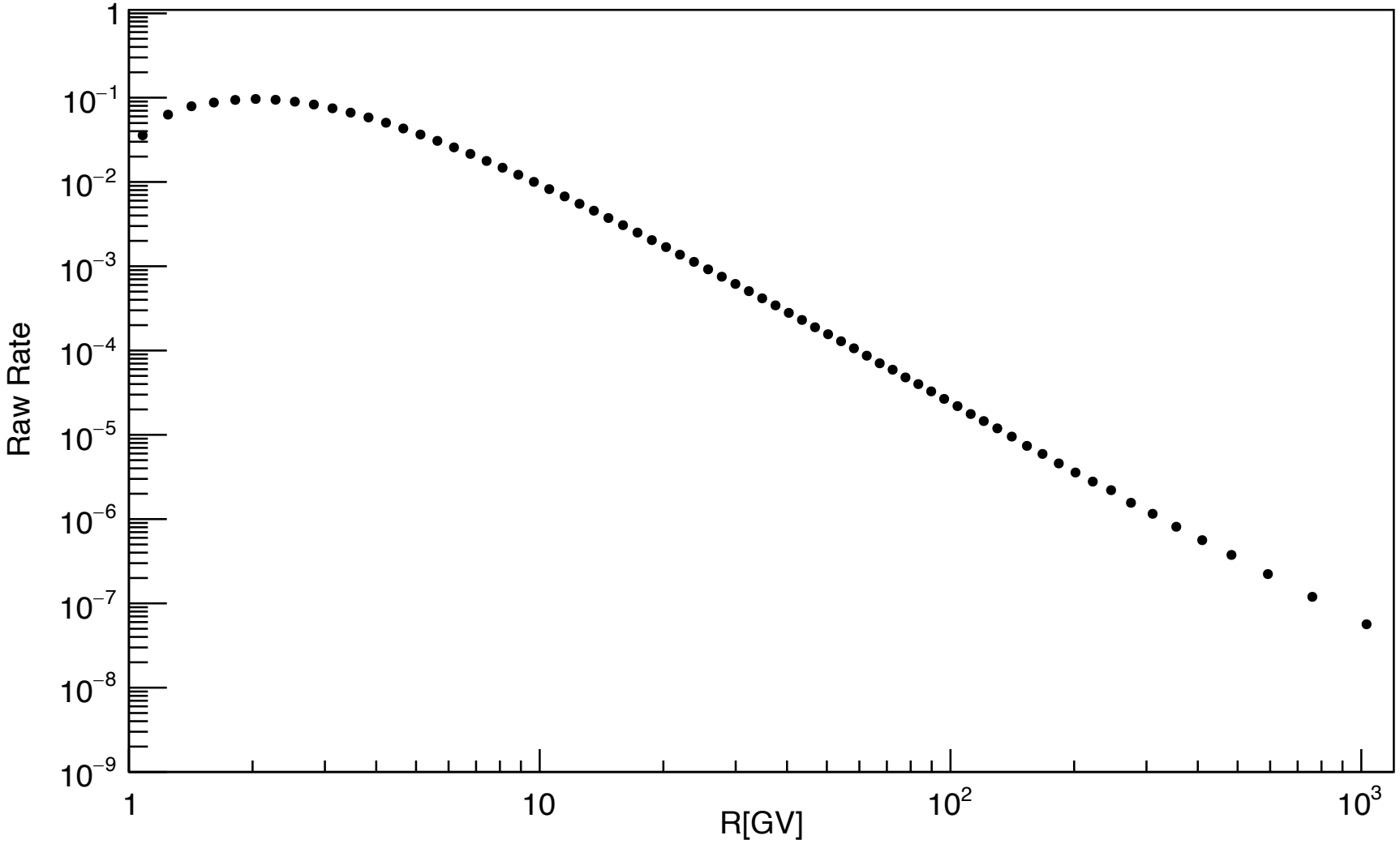
Additional L1 charge cut (purity cut):

- $Q_{L1}–Z < 0.65+0.03(Z–5)$

Raw Rate

Carbons before background subtraction

NAIA-pass8: 27.97 M **CIEMAT-pass7: 19.77 M**



Beta Efficiency Selection

Denominator

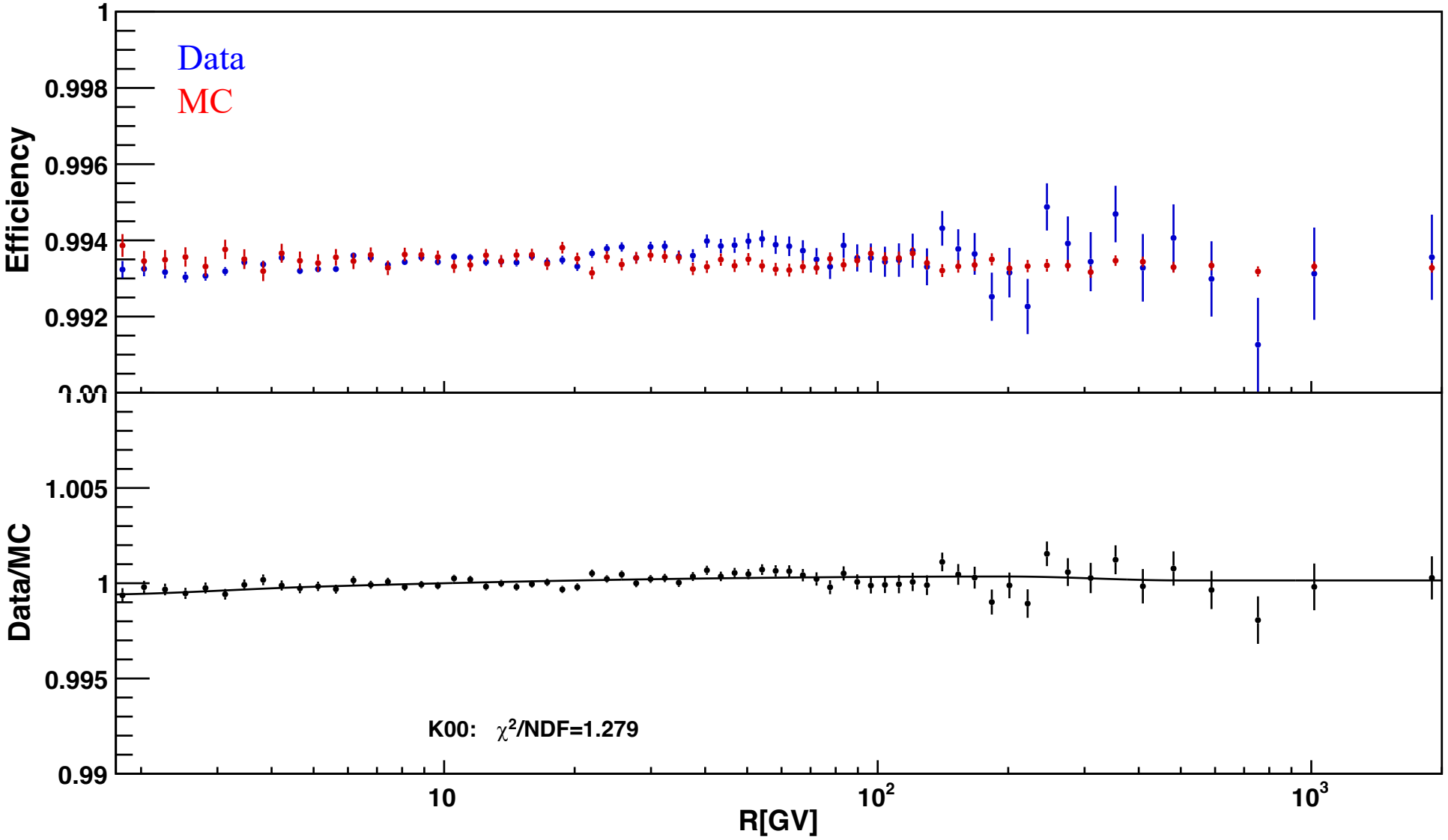
- Standard selection for Inner-L1 with no UTOF and LTOF related cuts.
- Track in fiducial L1+Inner volume.
- Tighter cuts on standalone charges (no beta correction).

Numerator

- Denominator
- β calculated with ≥ 3 hits
- $\beta > 0.3$

UTOF and LTOF charge cuts are done separately

Beta Data/MC Correction



Beta Charge Efficiency Selection

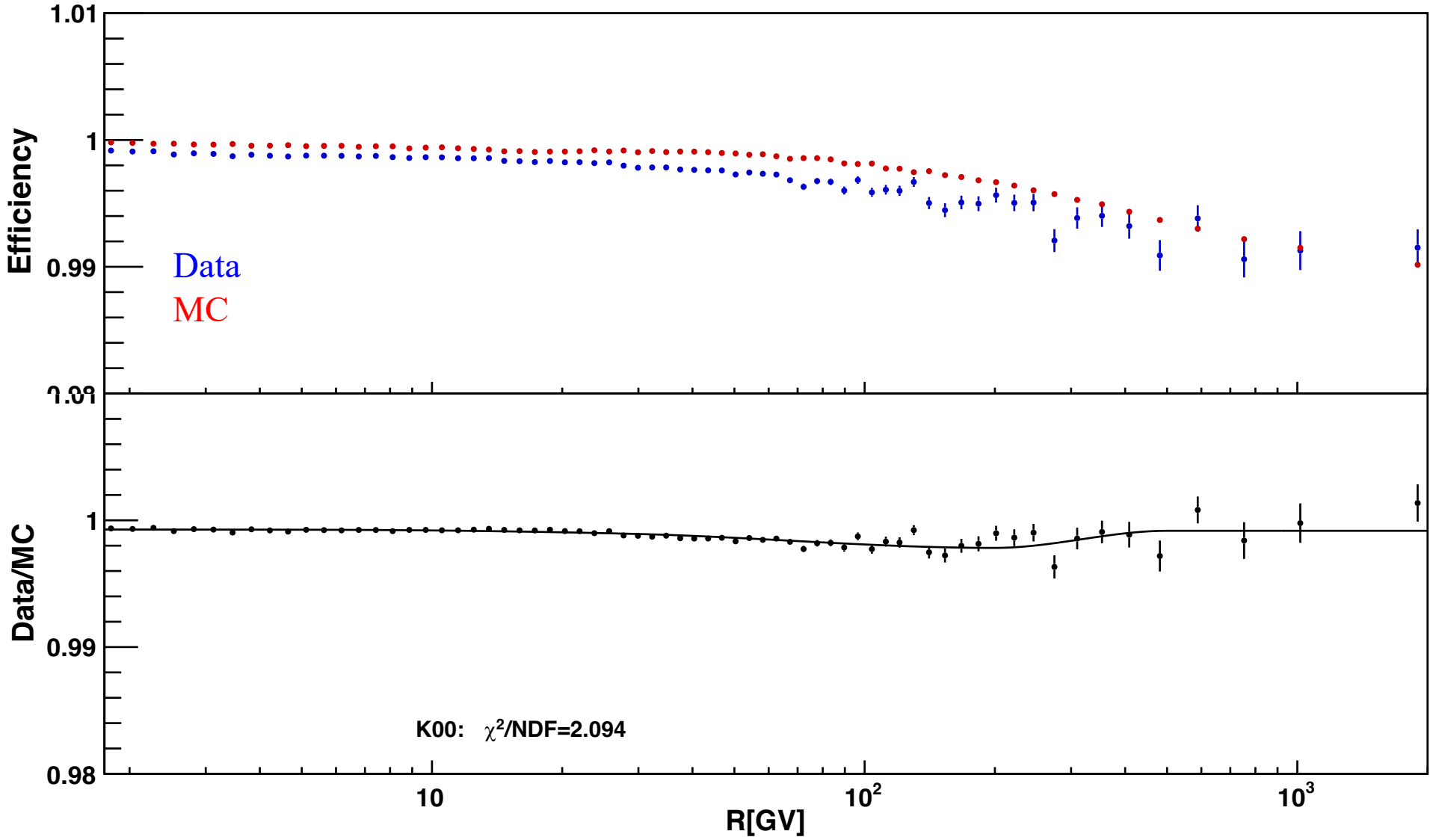
Denominator

- Standard selection for Inner-L1, without cuts on UTOF and LTOF charges.
- R_{sec} <= 0.5 GV (no high-R positive second track)

Numerator

- Denominator
- UTOF standard charge cut

Beta Charge Data/MC Correction



Tracker Efficiency Selection

Denominator

- Physics trigger
- β calculated with ≥ 3 hits
- $\beta > 0.3$
- $\beta > \beta(1.2 \times R_{ctf})$
- An unbiased XY hit on L1 with position inside L1 fiducial volume
- TOF in inner Tracker fiducial volume with margin of 4.5 cm
- Unbiased hit on L1 < 9 cm from TOF extrapolation to L1
- Tighter cuts on UTOF, LTOF and UnbiasedL1 charges.

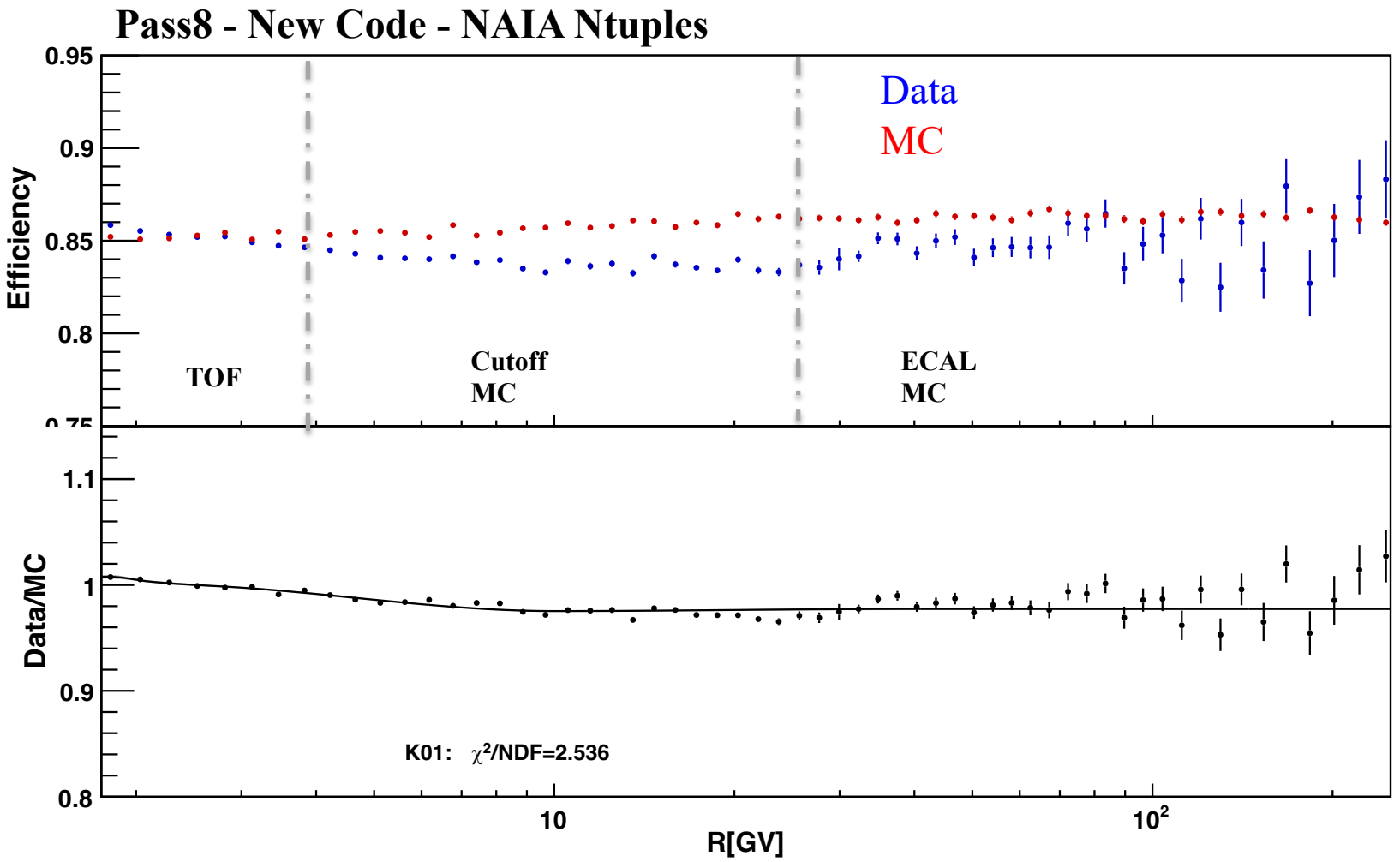
Numerator

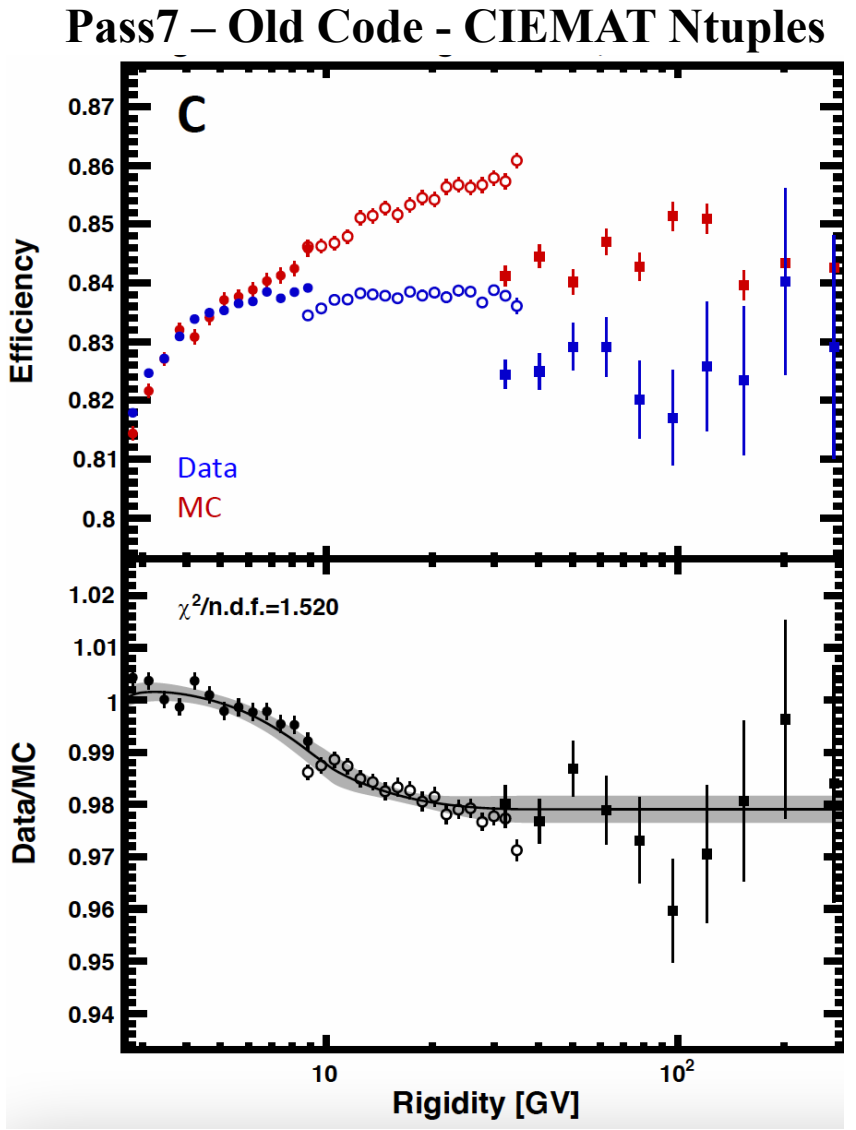
- Denominator
- Inner Tracker Y hits ≥ 5
- L2Y&(L3Y|L4Y)&(L5Y|L6Y)&(L7Y|L8Y)
- Track in fiducial Inner-L1 volume
- Norm. χ^2_Y Inner < 10
- $Q_{Inner} > Z - 2.5$

Inner Tracker Charge cut is done separately

Tracker Data/MC Correction

A clear improvement of track reconstruction at low R can be seen.





Tracker Charge Efficiency Selection

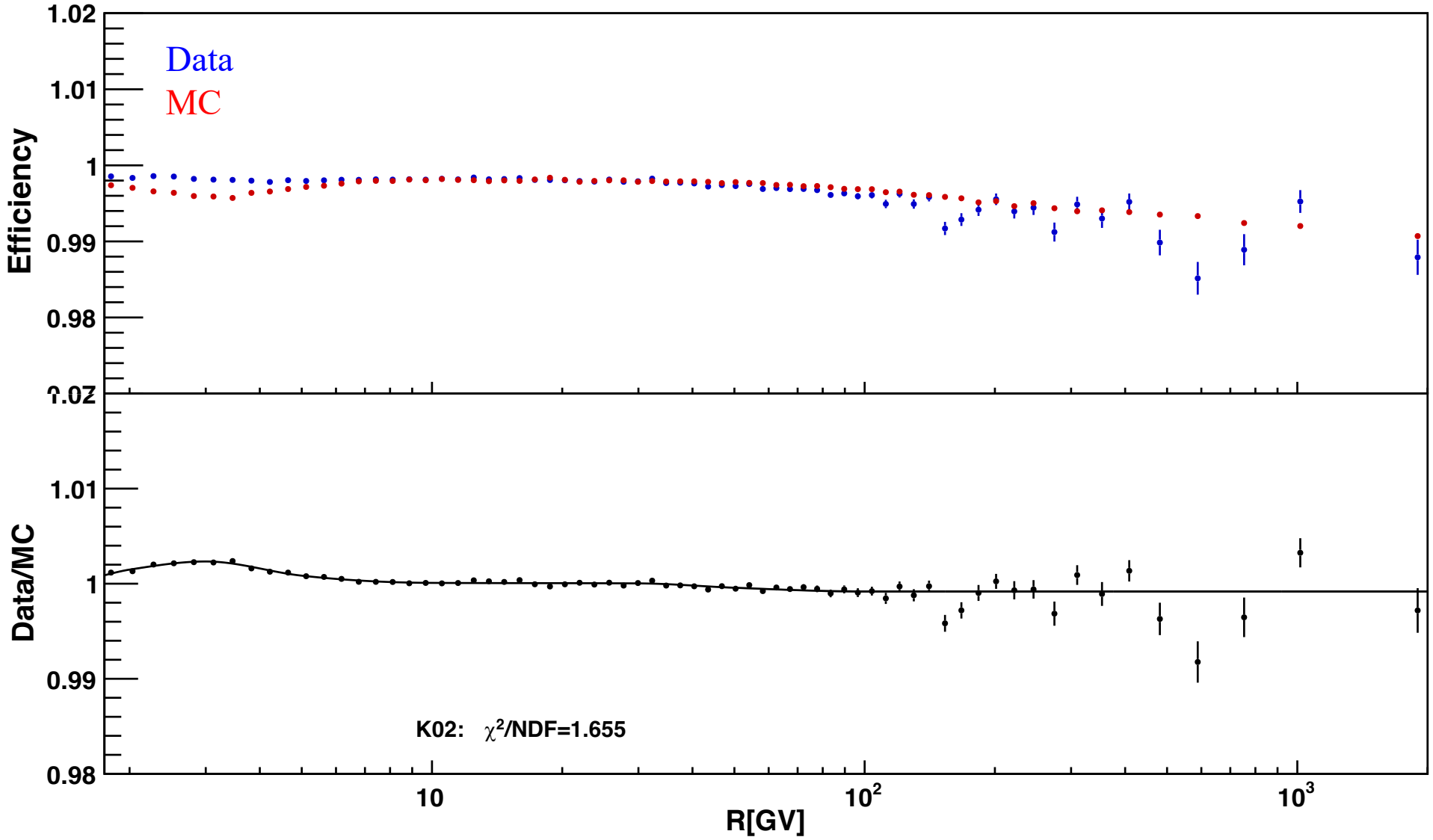
Denominator

- Standard selection without QInner cut
- Tighter cuts on UTOF, LTOF and UnbiasedL1 charges.
- $Q_{Inner} - Z > 2.5$

Numerator

- Denominator
- Q_{Inner} standard charge cut

Inner Tracker Charge Data/MC Correction



L1 Unbiased Hit Efficiency Selection

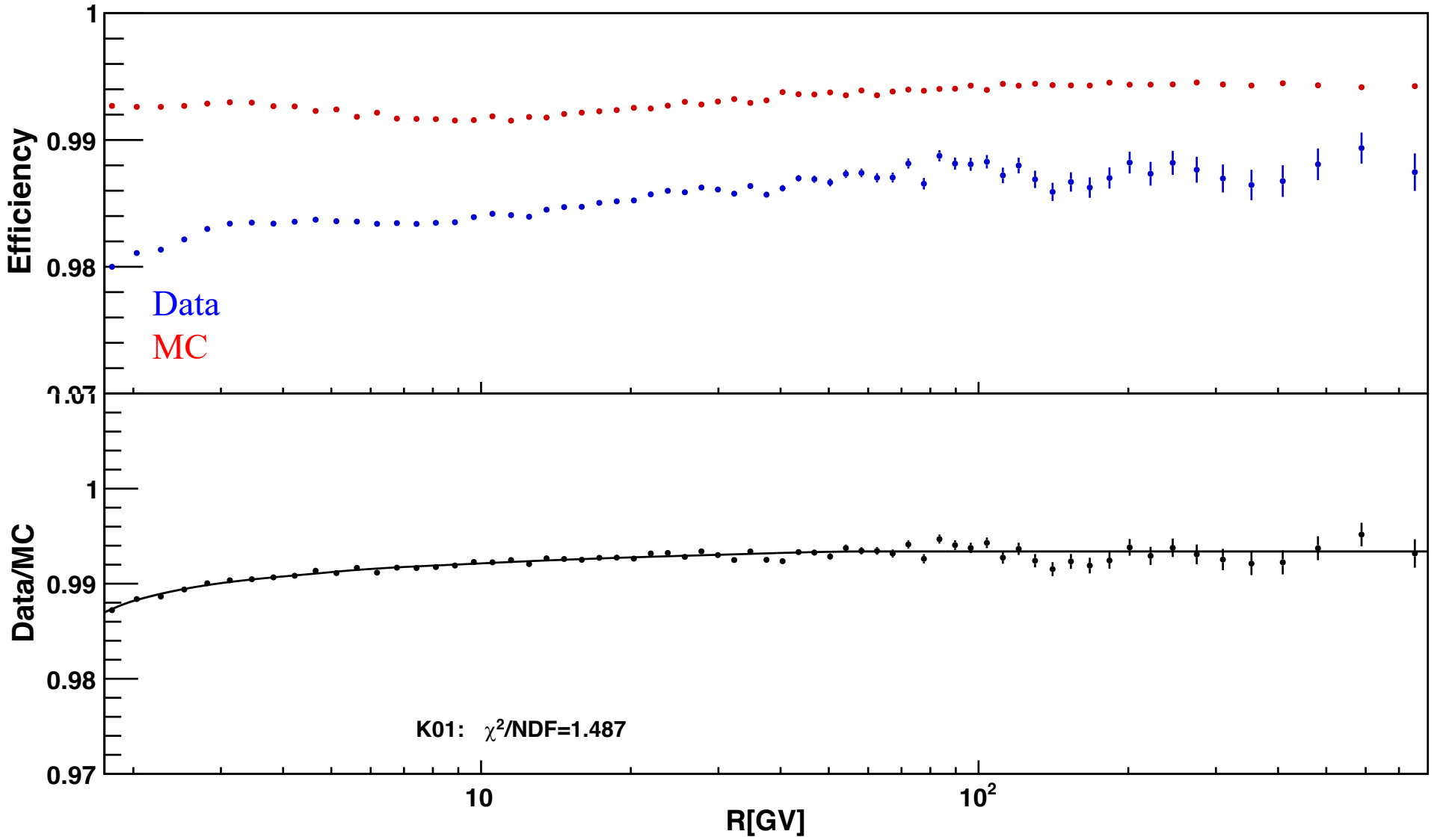
Denominator

- Standard selection excluding L1 related cuts
- Tighter cuts on Q_{UTOF}, Q_{Inner} charges.

Numerator

- Denominator
- Q_{UL1} standard charge cut

L1 Unbiased Hit Data/MC Correction



L1 Hit Association to Track Efficiency Selection

Denominator

- Standard selection excluding L1 related cuts
- $-0.16(Z-3)-0.46 < Q_{UL1}-Z < 0.65+0.03(Z-5)$
- Tighter cuts on UTOF, InnerTrack charges.
- $R_{sec} < 0.5$ GV (no high-R second track)

Numerator

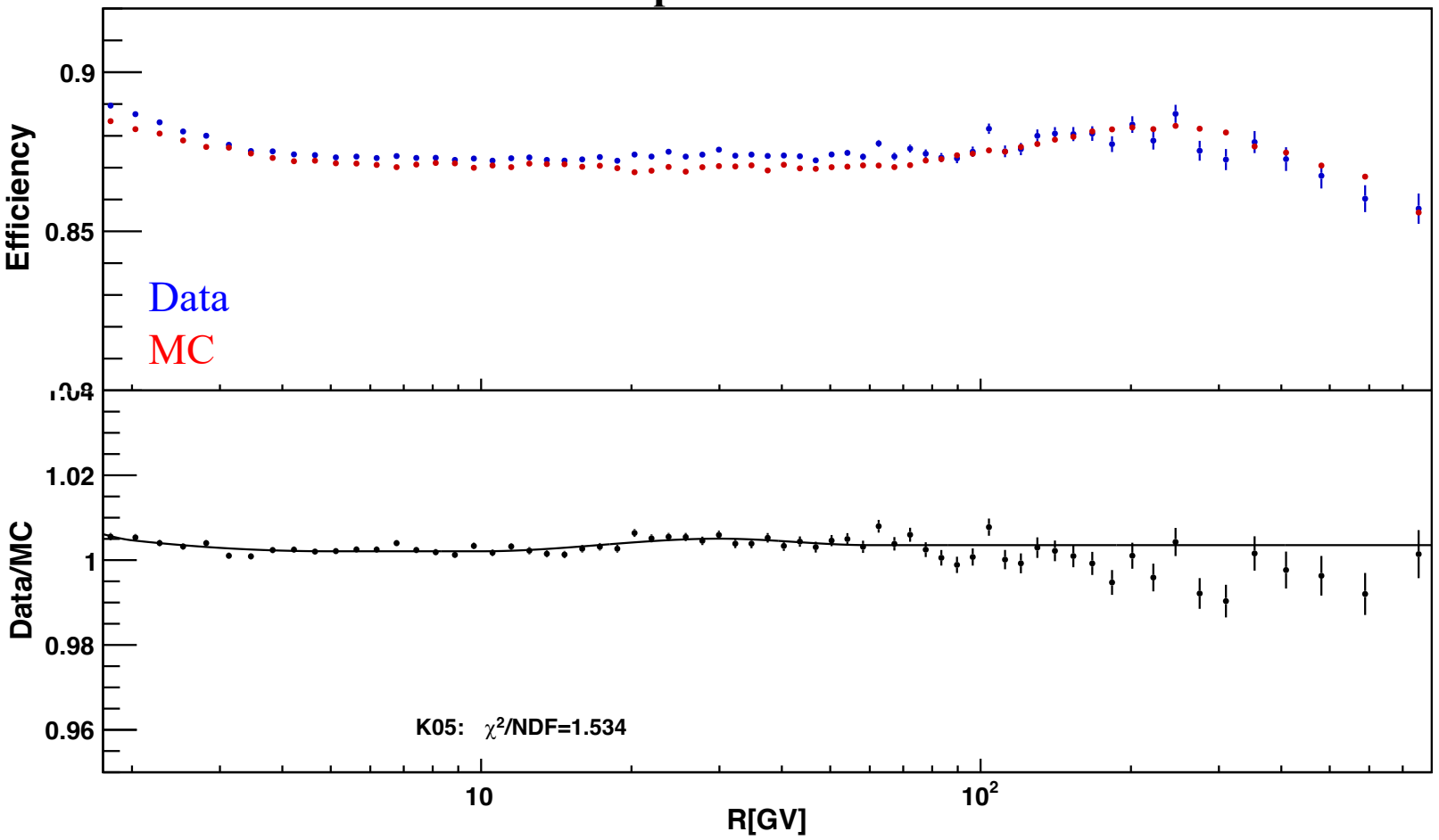
- Denominator
- L1XY hit on track with good status
- Normalized L1-Inner $\chi^2_Y < 10$
- Normalized L1 $\chi^2_Y < 10$
- Standard L1 charge cuts

MIT people are studying this efficiency. Maybe it would be better to apply a different cut instead of the normalized χ^2.

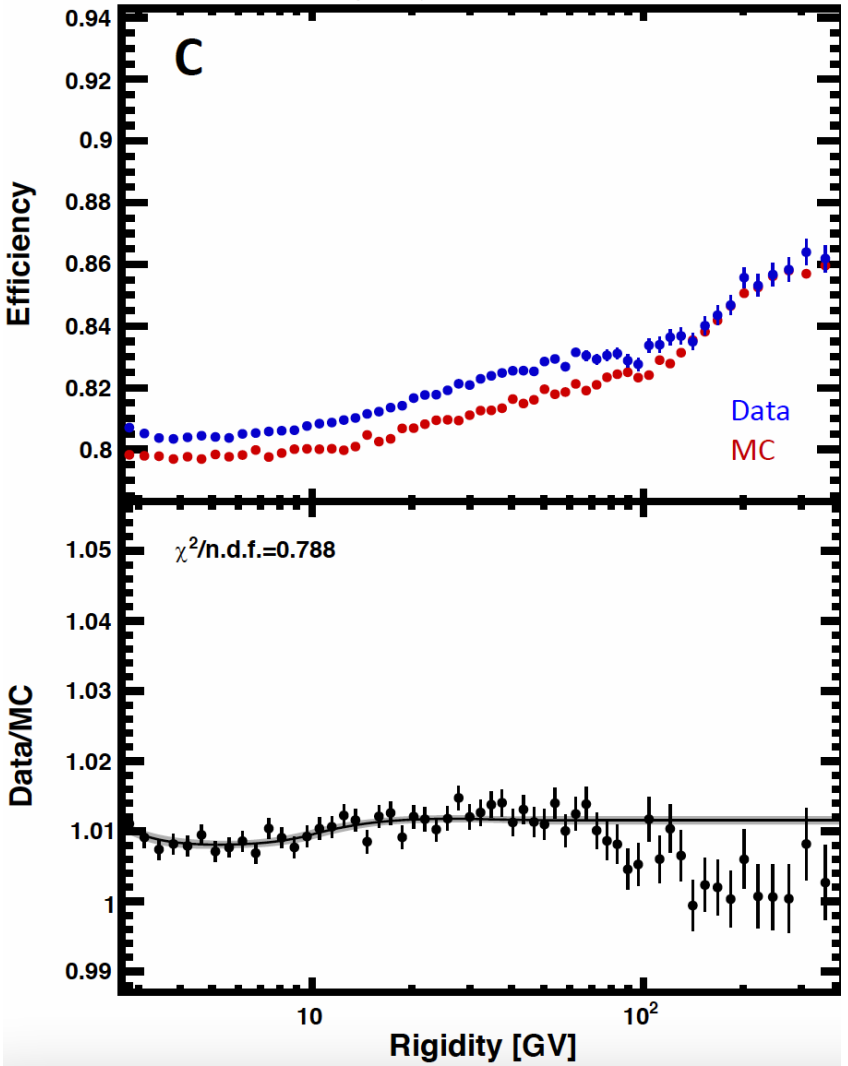
L1 Hit Association to Track Data/MC Correction

From pass7 to pass8 reconstruction, the position matching windows for external layer hits have been increased by a factor of 5.

Pass8 - New Code - NAIA Ntuples

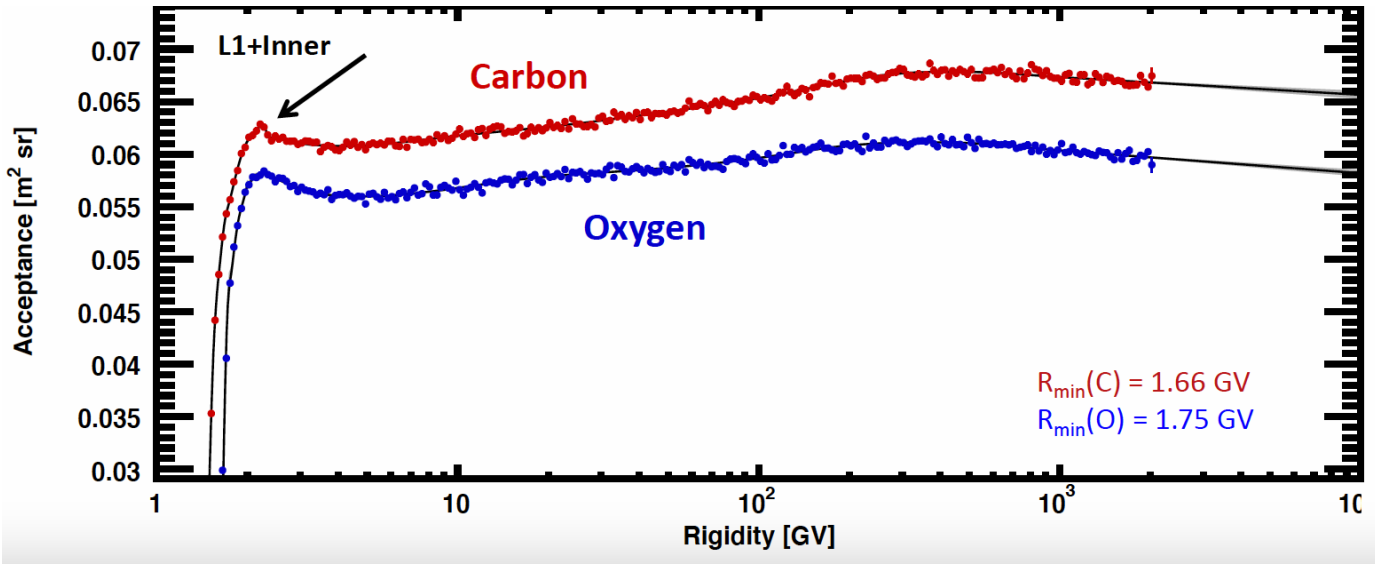


Pass7 – Old Code - CIEMAT Ntuples

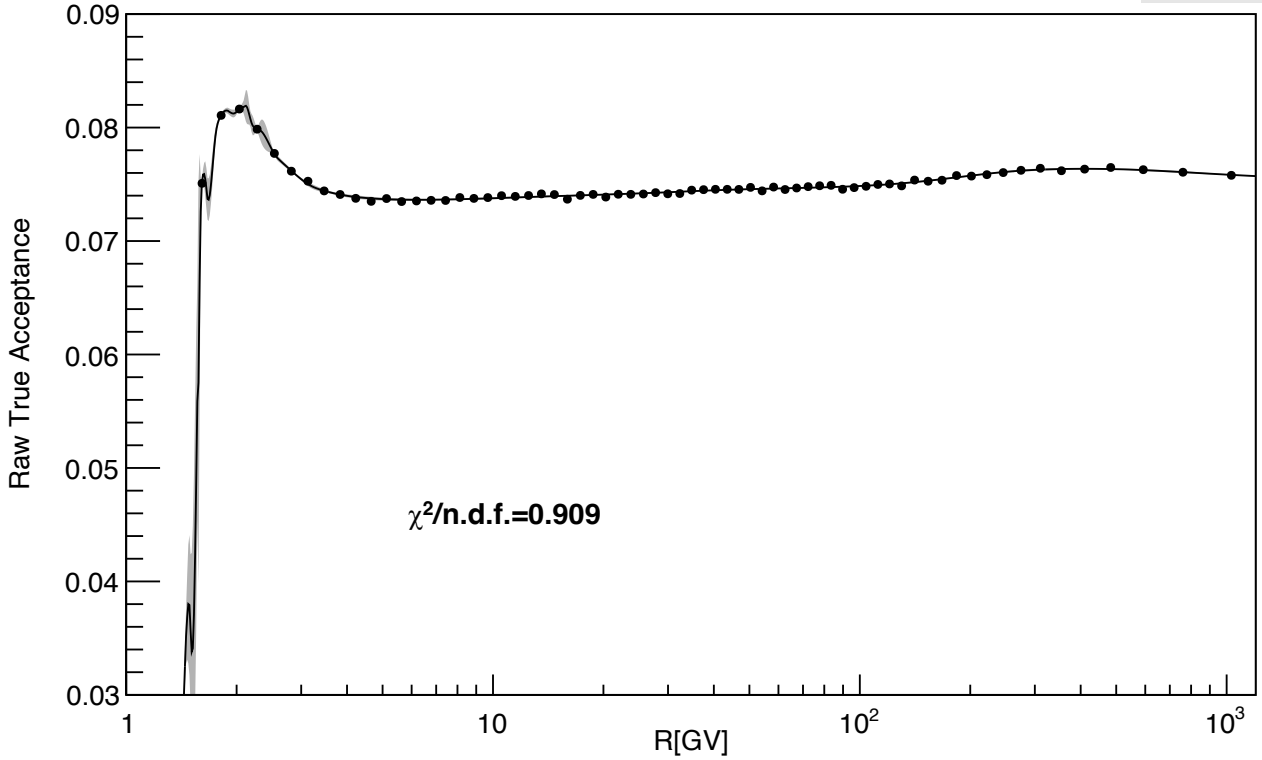


Raw True Acceptance

Pass7 – Old Code - CIEMAT Ntuples



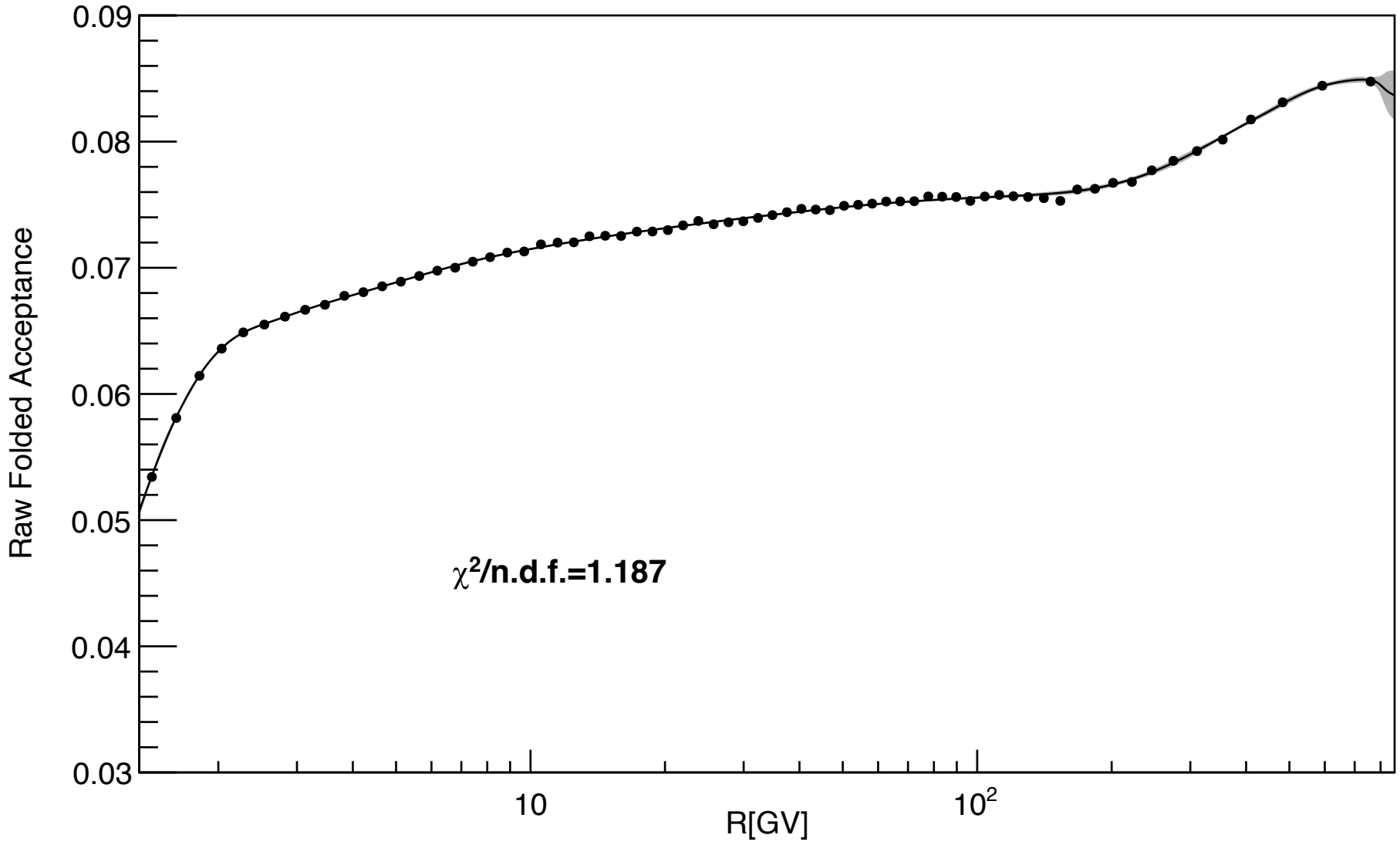
Pass8 - New Code - NAIA Ntuples



Following the reconstruction improvement in pass8, it results in a higher acceptance.

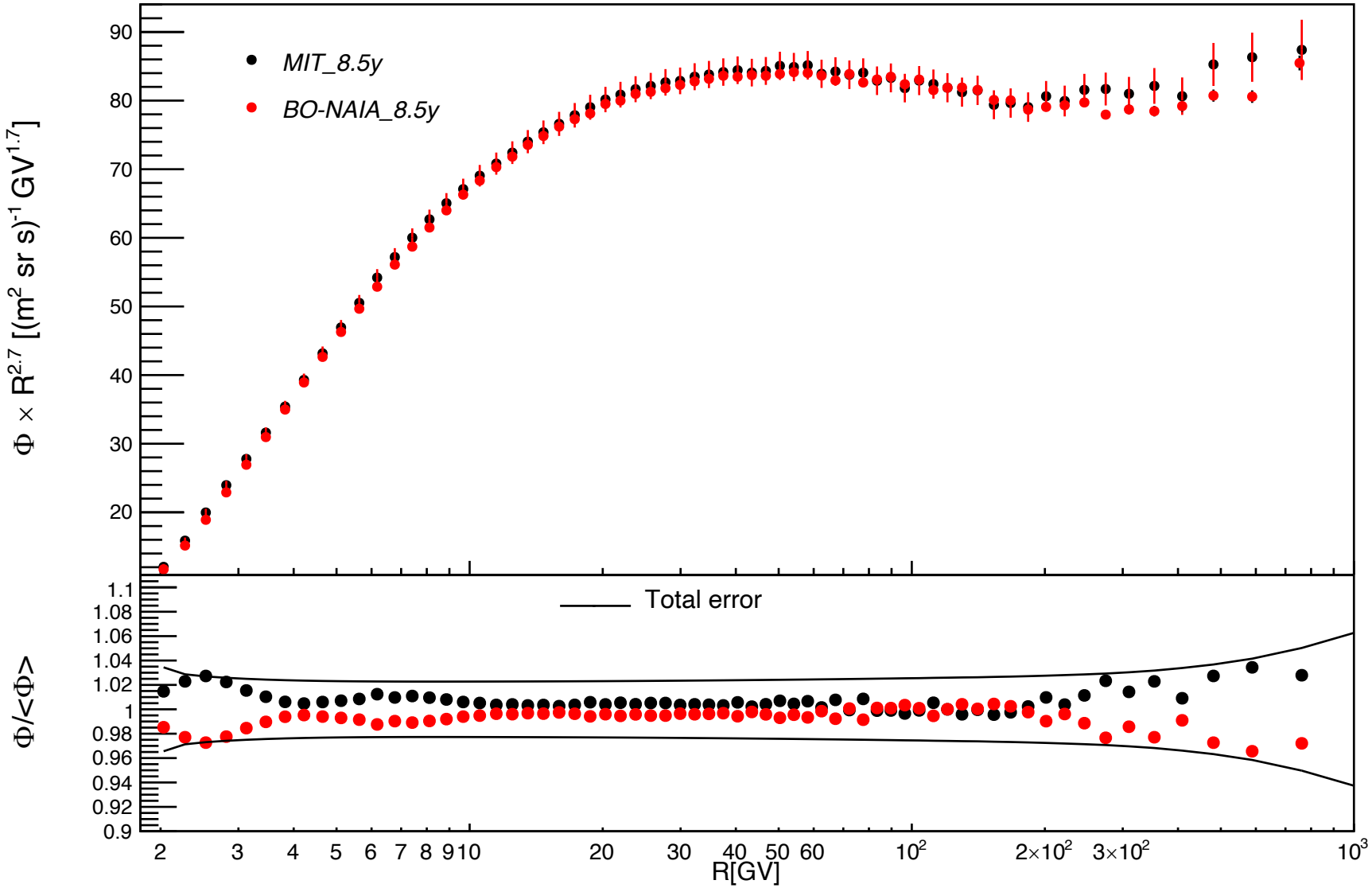
Raw Folded Acceptance

Weighting the MonteCarlo with a combination of MIT 10 years fluxes and Galprop, we can obtain a folded acceptance.



First Flux Estimation

By the combination of the Raw Rate, all the Data/MC corrections and the raw folded acceptance, we can estimate a flux.



Conclusion

- A completely new analysis code has been implemented using NAIA. A lot of work has been done, but it is still to be finished. We got, however, some comforting preliminary result.

- The new code in NAIA will improve the comparison with results from Federico D., since we can exchange detailed information. Ultimately this should solve the persistent discrepancy we got in the past.

- We are using NAIA production processing from both CNAF and LXPLUS (via XROOTD). We are experiencing some difficulties in the processing. Would be useful to have some discussion on data production strategies (maybe tomorrow at NAIA meeting).

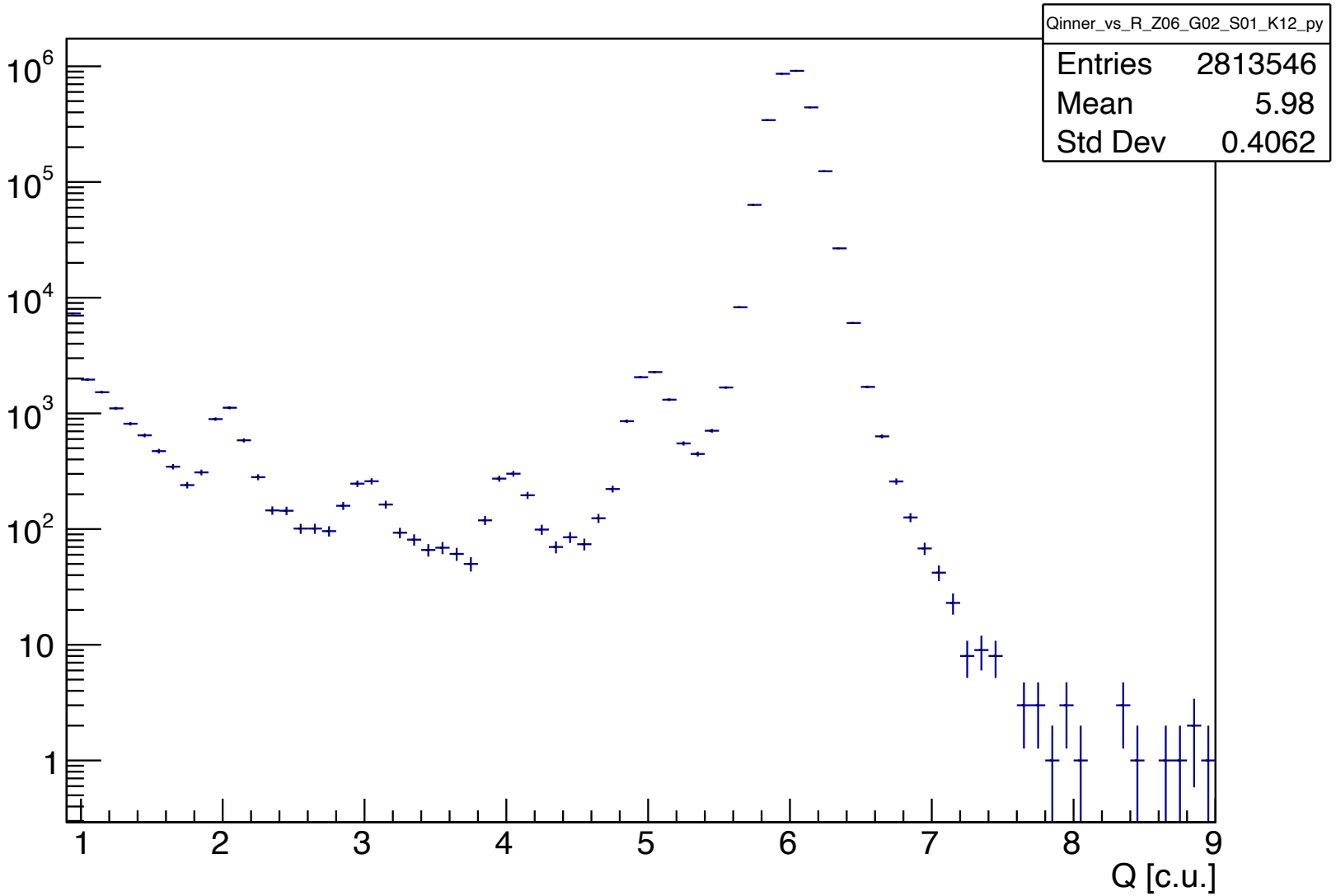
Back Up Slides

Pass8 updates from Qi Yan presentation

Not only that, the pass8 reconstruction (V6) is using more advanced track finding algorithm than pass7. Here lists a number of other updates:

a) Better tracker Cluster (Hits) reconstruction:
   fix missing Clusters (Hits) issue existing in all previous pass: <=pass7
b) More powerful inner track candidate builder together with more robust quality estimator
c) More efficient noisy Hit filter
d) New missing Hit refinding algorithm
e) Higher external hit (tracker L1 or L9) picking-up efficiency
f) Including all latest track fitting algorithms: Choutko (with bugs fixed), Kalman, GBL, …
   and all alignments: V5 (Inner/PG, external layers/PG+CIEMAT), V6 (Inner, external layers)
g) New algorithm of tagging primary track (particle)

Qinner charge distribution



Loose cut on Charge is needed.

Vertical tracks producing gamma rays most probably.

It is a tracker inefficiency, not a tracker charge one, that is why we put it in the tracker numerator.

Trigger Data/MC Correction

Standard selection with trigger as a last cut.