AMS-02:
13.5 years high-Z cosmic ray fluxes

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DIPARTIMENTO
DI FISICA E GEOLOGIA
DIPARTIMENTO DI ECCELLENZA
MUR 2023/2027

Agenzia Spaziale Italiana

Properties of Heavy Cosmic Nuclei Phosphorus, Chlorine, Argon, Potassium, and Calcium: Results from the Alpha Magnetic Spectrometer
- SUPPLEMENTAL MATERIAL -

(AMS Collaboration)

1. I am working on **silicon (Z=14)**, **phosphorus (Z=15), sulfur (Z=16), argon (Z=18) and calcium (Z=20)** fluxes. **Si, P and S** have been deeply studied between me (Perugia) and Zhen (Rome) with many discussions including Alberto Oliva (Bologna) and Valerio Formato (Rome)

2. Primaries argon and calcium will be presented, but there is more work needed to improve flux components (total correction, **background**, unfolding..)

3. I will show also efficiencies for elements up to Iron (Z=26) to better understand the charge dependence of the efficiencies themselves

Analysis

Flux in the i-th rigidity bin:

$$\phi_i = \frac{N_i}{\Delta R_i \Delta T_i A_i \varepsilon_{L1Q}}$$

- ϕ_i is the flux
- N_i identified counts, after background subtraction and correcting for bin-to-bin migration
- ΔR_i bin width
- ΔT_i exposure time
- A_i acceptance
- ε_{L1Q} L1 charge cut efficiency

- The acceptance is evaluated in Monte Carlo (MC) and is then multiplied by the differences (corrections) of the efficiencies between the data and the MC of the sub-detectors used in the selection
- Since the statistics for phosphorus is very low and contamination is very high, a robust way to obtain the corrections is to **interpolate between silicon and sulfur**
- **Reproduce silicon and sulfur fluxes is mandatory**

Event selection (Inner L1)

Common selections:

Trigger

- Physics trigger

Tof

- $\beta > 0.4$
- UToF charge in «*common*» range

Inner Tracker + L1

- Hit pattern: L2 && (L3 || L4) && (L5 || L6) && (L7 || L8)
- N° of inner tracker Y hits > 4
- Inner tracker and L1 charge in «*common*» ranges
- L1 normalized residuals < 10 $\chi^2_{\mathrm{IL1}} \cdot \mathrm{ndf}_{\mathrm{IL1}} - \chi^2_{\mathrm{INN}} \cdot \mathrm{ndf}_{\mathrm{INN}}$
- L1 charge asymmetry: $(Z_x - Z_y)/(Z_x + Z_y) < 0.2$
- Hit on L1 && with «*good*» status
- Track (IL1) in L1 and inner fiducial volume
- $\chi^2_y < 10$ (both IL1 and INN)

RTI default selection

- Livetime fraction > 0.5, zenith < 40, nTrigger/nEvent > 0.98, nError > 0
- nError/nEvent < 0.1, alignment external layer (0,1) < 35 um and (1,1) < 45 um

Framework:
NAIA italian ntuples v.1.2.0
MC B1315 (Si,P,S), B1236 (Others)
Pass8
FoV 35°
No trigger study runs (TWiki)
No photon trigger period

Utof charge cut

Z=14	Z=15	Z=16	Z=18	Z=20
(13.3, 15.5)	(14.2, 16.5)	(15.2, 17.5)	(17.2,1 9.5)	(19.1, 21.5)

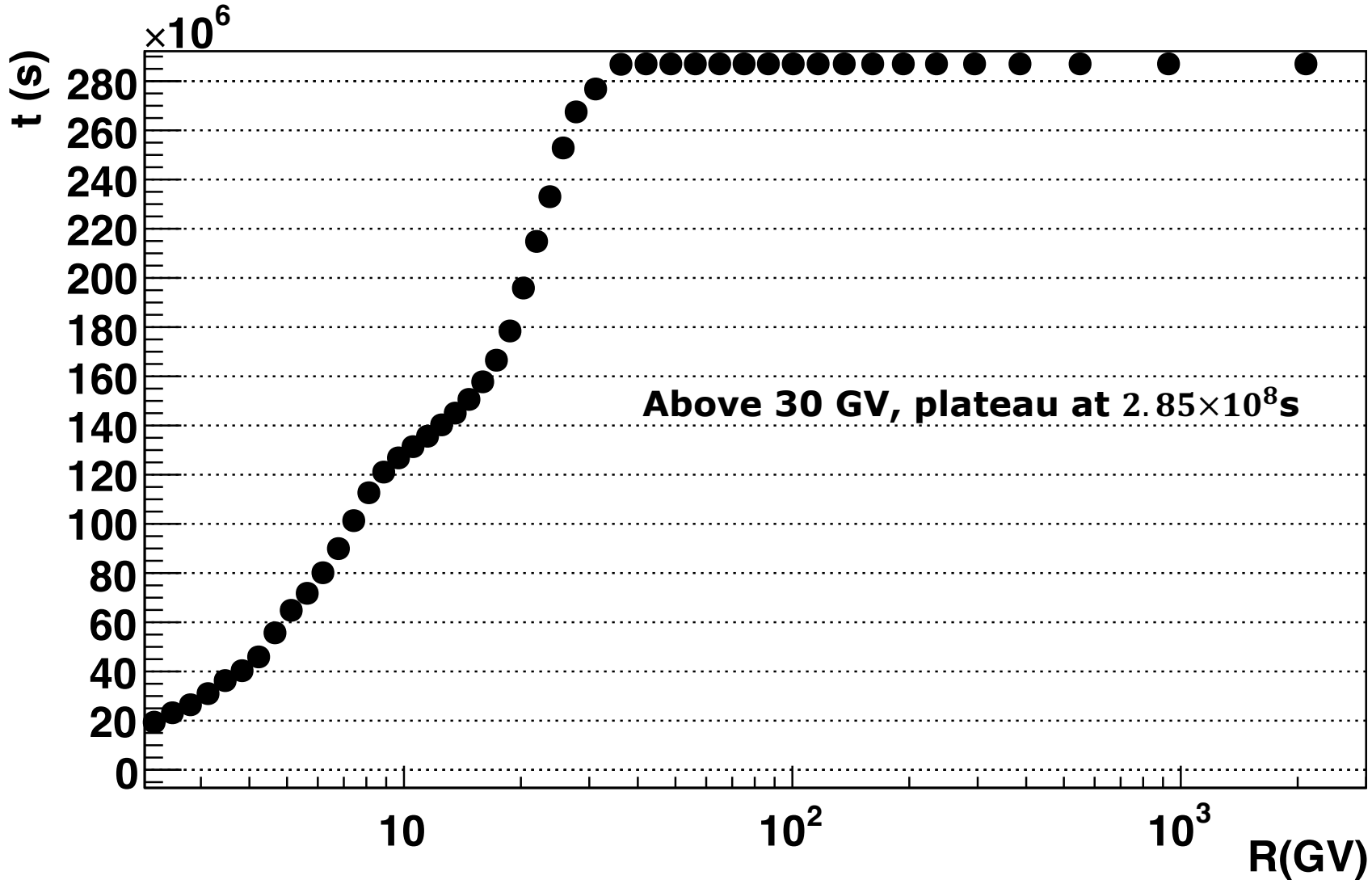
Inner tracker charge cut

Z=14	Z=15	Z=16	Z=18	Z=20
(13.5, 14.5)	(14.5, 15.5)	(15.5, 16.5)	(17.5, 18.5)	(19.5, 20.5)

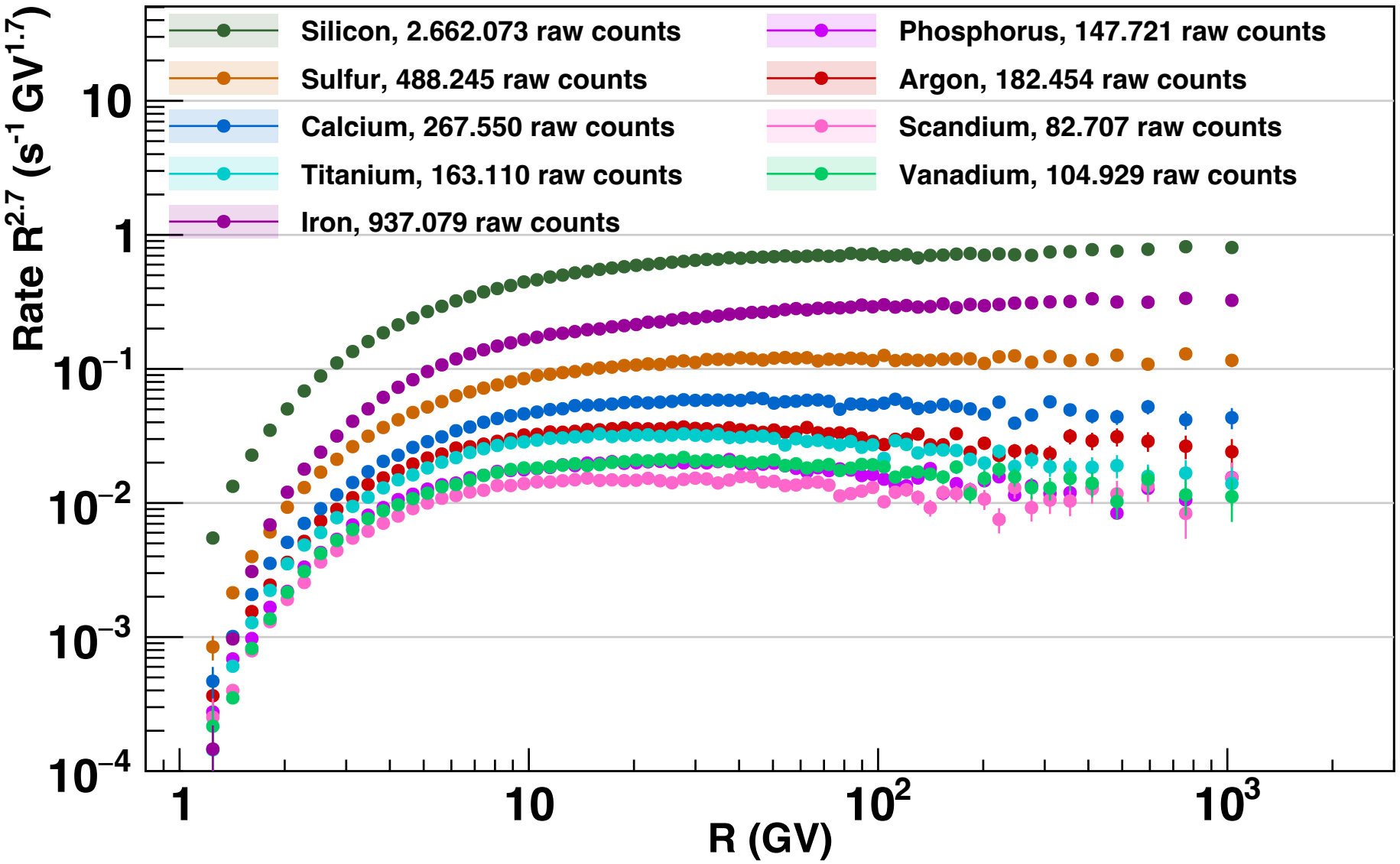
L1 charge cut

Z=14	Z=15	Z=16	Z=18	Z=20
(12.4, 14.9)	(13.3, 15.9)	(14.2, 17.0)	(16.0, 19.1)	(17.8, 21.2)

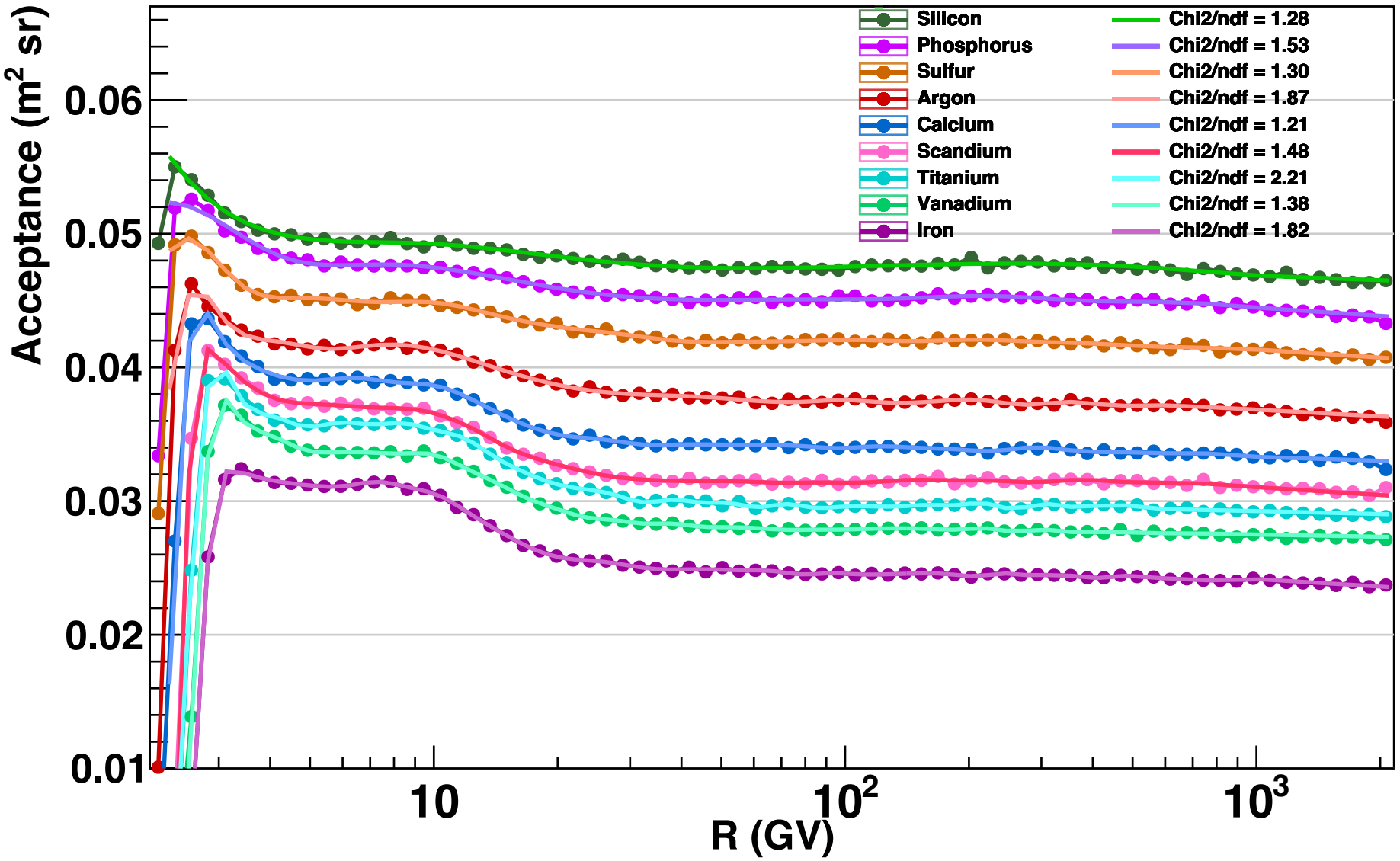
Exposure time (13.5y)



Rate $\left(\frac{N}{\Delta T\, \Delta R}\right)$



Raw acceptance



L1 detection efficiency

Denominator

- Physics trigger
- $\beta > 0.4$
- UToF charge in «common» range
- Hit pattern: L2 && (L3 || L4) && (L5 || L6) && (L7 || L8)
- N° of inner tracker Y hits > 4
- Inner tracker charge in «*common*» range
- $\chi^2_y < 10$ (Inn)
- Track (Inn) in L1 and inner fiducial volume

Numerator

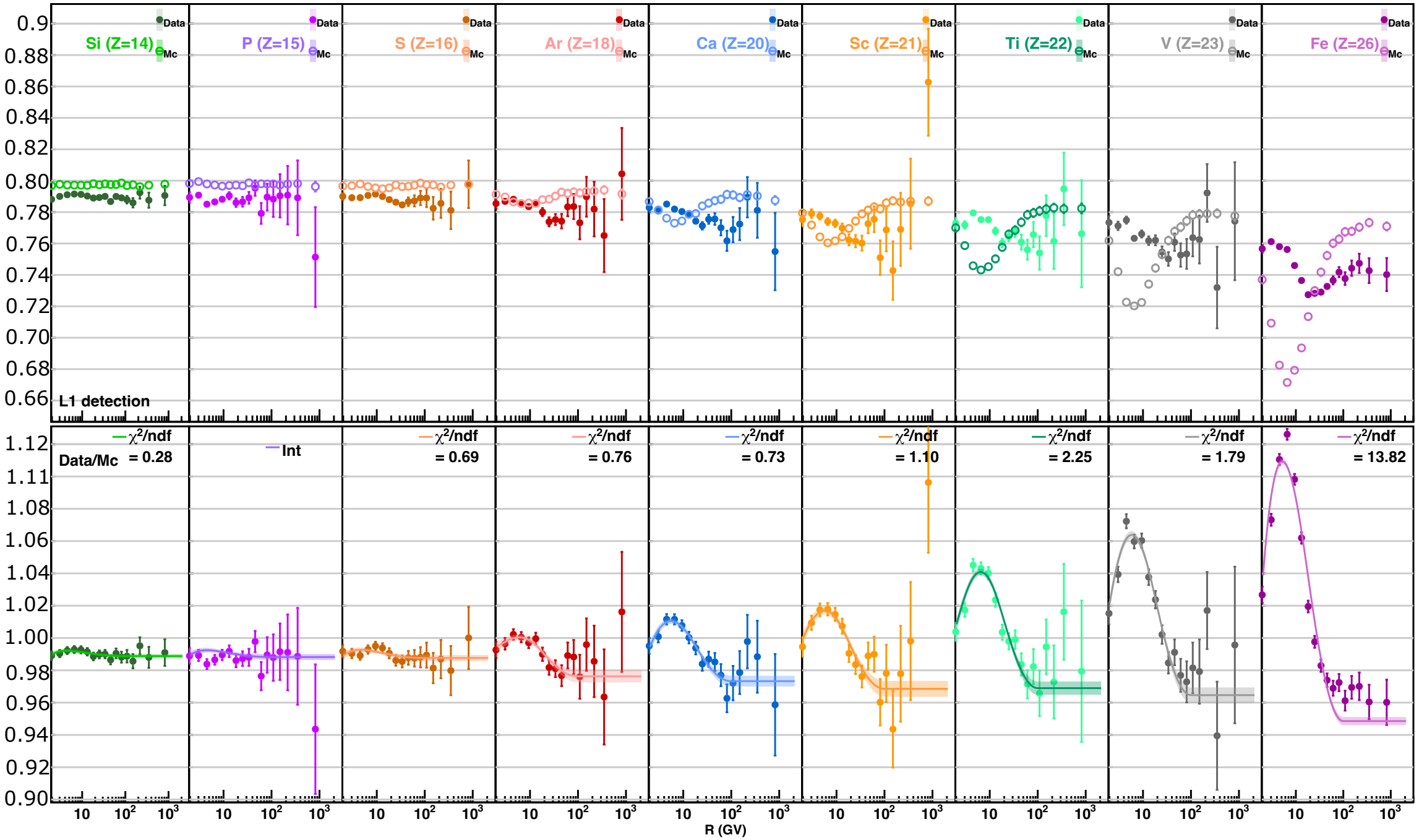
- Denominator
- Unbiased hit on L1 && with «good» status
- Unbiased L1 charge > Z – 2

Utof charge cut

Z=14	Z=15	Z=16	Z=18	Z=20
(13.3, 15.5)	(14.2, 16.5)	(15.2, 17.5)	(17.2,1 9.5)	(19.1, 21.5)

Inner tracker charge cut

Z=14	Z=15	Z=16	Z=18	Z=20
(13.5, 14.5)	(14.5, 15.5)	(15.5, 16.5)	(17.5, 18.5)	(19.5, 20.5)


Si (Z=14)
P (Z=15)
S (Z=16)
Ar (Z=18)
Ca (Z=20)
Sc (Z=21)
Ti (Z=22)
V (Z=23)
Fe (Z=26)
Data
Mc
L1 detection
χ²/ndf
Data/Mc = 0.28
Int
= 0.69
= 0.76
= 0.73
= 1.10
= 2.25
= 1.79
= 13.82
R (GV)

L1 pickup efficiency

Denominator

- Physics trigger
- $\beta > 0.4$
- UToF charge in «common» range
- Hit pattern: L2 && (L3 || L4) && (L5 || L6) && (L7 || L8)
- N° of inner tracker Y hits > 4
- Inner tracker charge in «*common*» range
- $\chi^2_y < 10$ (Inn)
- Track (Inn) in L1 and INN fiducial volume
- Unbiased hit on L1 && with «good» status
- **Unbiased L1 charge in «*common*» ranges -> background reduction**

L1 unbiased charge cut

Z=14	Z=15	Z=16	Z=18	Z=20
(12.4, 14.9)	(13.3, 15.9)	(14.2, 17.0)	(16.0, 19.1)	(17.8, 21.2)

Utof charge cut

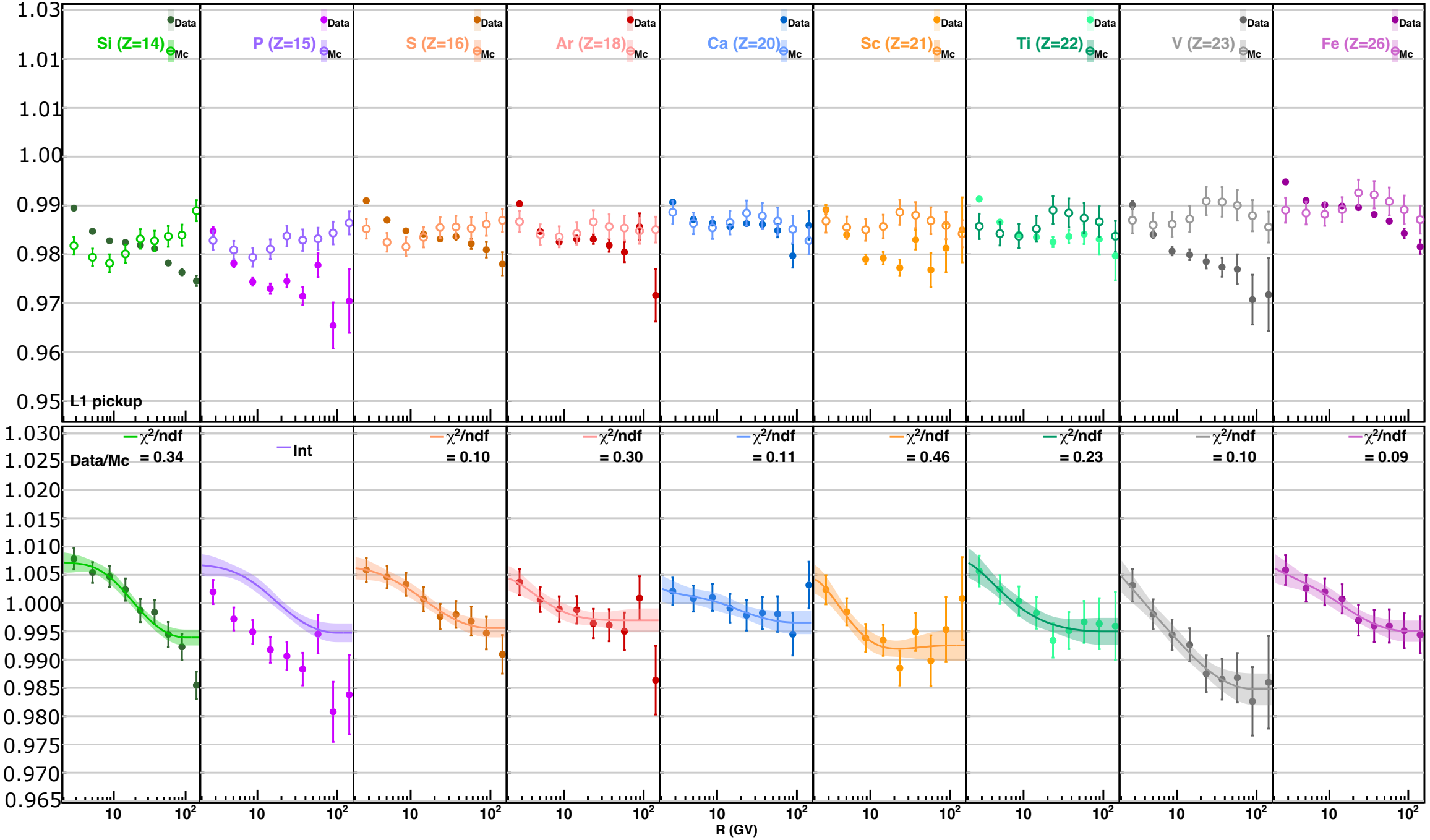
Z=14	Z=15	Z=16	Z=18	Z=20
(13.3, 15.5)	(14.2, 16.5)	(15.2, 17.5)	(17.2,1 9.5)	(19.1, 21.5)

Inner tracker charge cut

Z=14	Z=15	Z=16	Z=18	Z=20
(13.5, 14.5)	(14.5, 15.5)	(15.5, 16.5)	(17.5, 18.5)	(19.5, 20.5)

Numerator

- Denominator
- L1 charge asymmetry $(Z_x - Z_y)/(Z_x + Z_y) < 0.2$
- Hit on L1 && with «*good*» status
- L1 normalized residuals < 10 $\chi^2_{IL1} \cdot ndf_{IL1} - \chi^2_{INN} \cdot ndf_{INN}$
- $\chi^2_y < 10$ (IL1)
- Track (IL1) in L1 and INN fiducial volume


Si (Z=14)
P (Z=15)
S (Z=16)
Ar (Z=18)
Ca (Z=20)
Sc (Z=21)
Ti (Z=22)
V (Z=23)
Fe (Z=26)
Data
Mc
L1 pickup
Data/Mc
Int
χ²/ndf = 0.34
χ²/ndf = 0.10
χ²/ndf = 0.30
χ²/ndf = 0.11
χ²/ndf = 0.46
χ²/ndf = 0.23
χ²/ndf = 0.10
χ²/ndf = 0.09
R (GV)

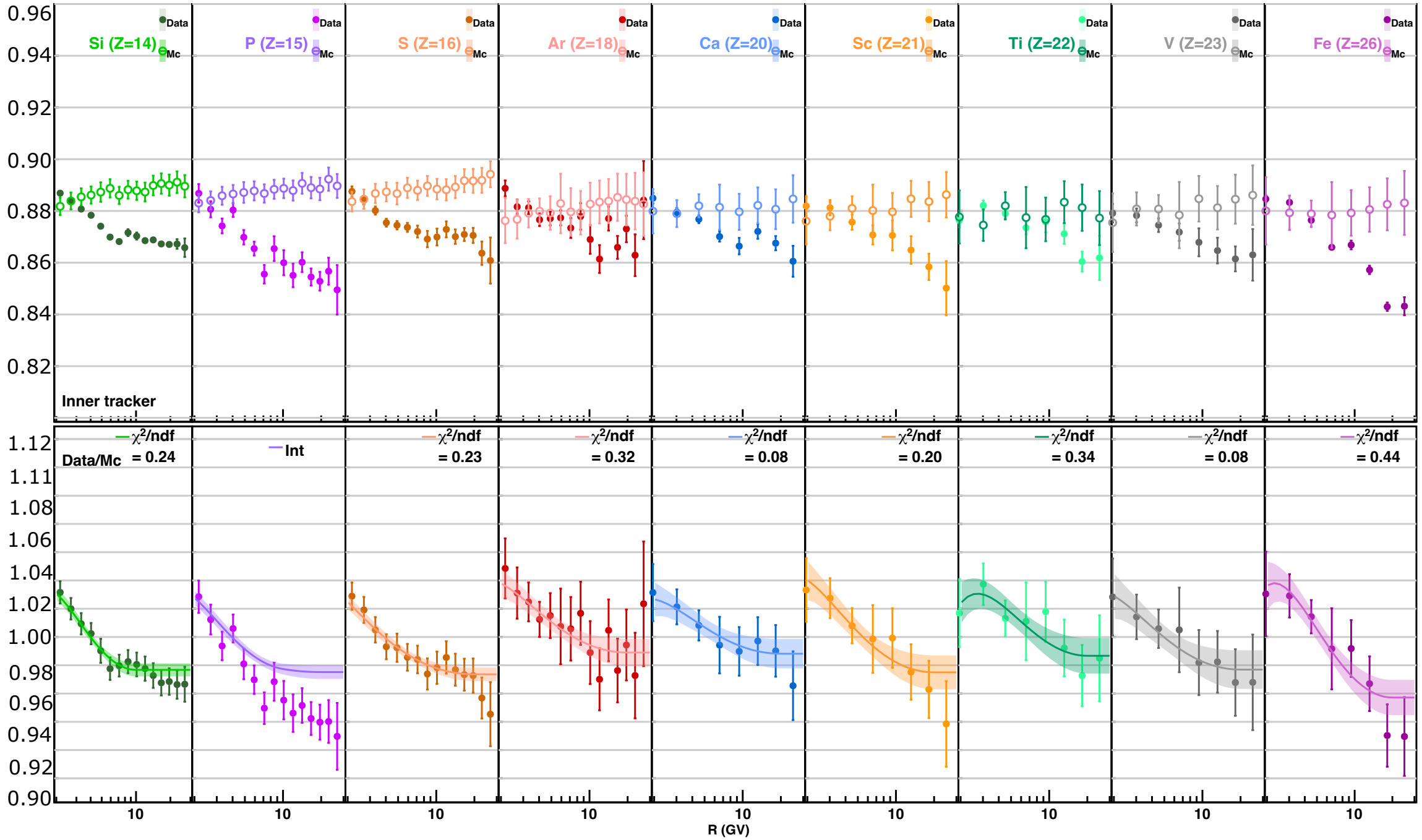
Inner tracker efficiency

Denominator

- Physics trigger
- Unbiased hit on L1 && with «good» status;
- Unbiased L1 charge [Z – 0.4, Z + 0.9]
- Standalone ToF beta > 0.4
- Track (standalone ToF) in L1 and inner fiducial volume
- Standalone ToF χ^2 spatial and temporal < 20
- Upper, lower and total Standalone ToF charge [Z - 0.5, Z + 0.5]

Numerator

- Denominator
- Hit Pattern: L2 && (L3 || L4) && (L5 || L6) && (L7 || L8)
- N° of inner tracker Y hits > 4
- $\chi^2_y < 10$ (Inn)


Si (Z=14)
P (Z=15)
S (Z=16)
Ar (Z=18)
Ca (Z=20)
Sc (Z=21)
Ti (Z=22)
V (Z=23)
Fe (Z=26)
Data
Mc
Inner tracker
Data/Mc
Int
χ²/ndf = 0.24
χ²/ndf = 0.23
χ²/ndf = 0.32
χ²/ndf = 0.08
χ²/ndf = 0.20
χ²/ndf = 0.34
χ²/ndf = 0.08
χ²/ndf = 0.44
R (GV)

Tracker charge efficiency

Denominator

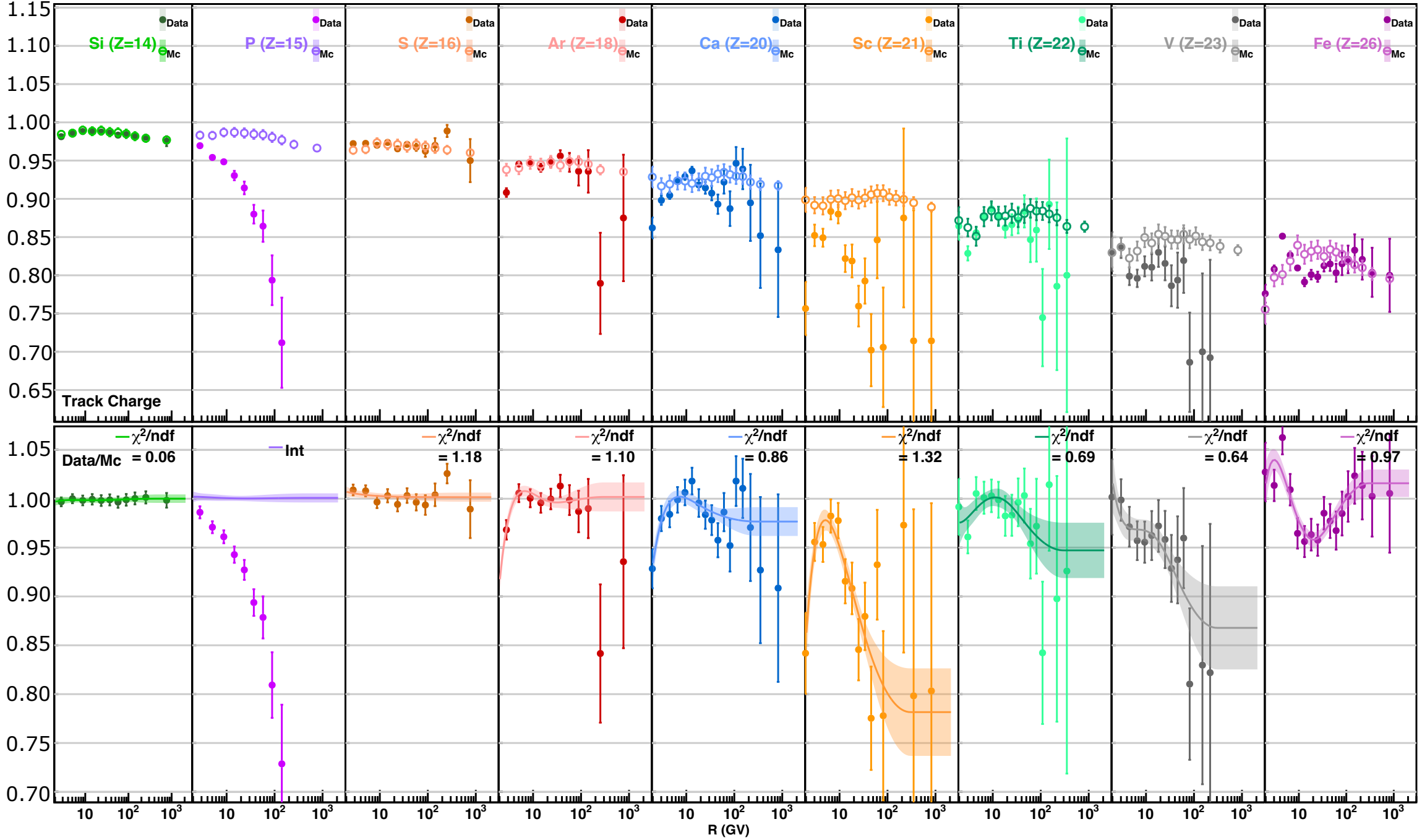
- Physics trigger
- $\beta > 0.4$
- Hit Pattern: L2 && (L3 || L4) && (L5 || L6) && (L7 || L8)
- N° of inner tracker Y hits > 4
- $\chi^2_y < 10$ (Inn)
- Track (IL1) in L1 and inner fiducial volume
- Hit on L1 && with «*good*» status
- L1 charge in «*common*» ranges
- L1 charge asymmetry $(Z_x - Z_y)/(Z_x + Z_y) < 0.2$
- Upper ToF charge [Z - 0.4, Z + 0.4]
- **Lower ToF charge [Z - 0.4, Z + 0.4]**
- **Unbiased L9 charge > Z-0.5**

Numerator

- Denominator
- Inner tracker charge in «*common*» ranges

L1 charge cut

Z=14	Z=15	Z=16	Z=18	Z=20
(12.4, 14.9)	(13.3, 15.9)	(14.2, 17.0)	(16.0, 19.1)	(17.8, 21.2)


Si (Z=14)
P (Z=15)
S (Z=16)
Ar (Z=18)
Ca (Z=20)
Sc (Z=21)
Ti (Z=22)
V (Z=23)
Fe (Z=26)
Data
Mc
Track Charge
Data/Mc = 0.06
Int
χ²/ndf = 1.18
χ²/ndf = 1.10
χ²/ndf = 0.86
χ²/ndf = 1.32
χ²/ndf = 0.69
χ²/ndf = 0.64
χ²/ndf = 0.97
R (GV)

UTof efficiency

Denominator

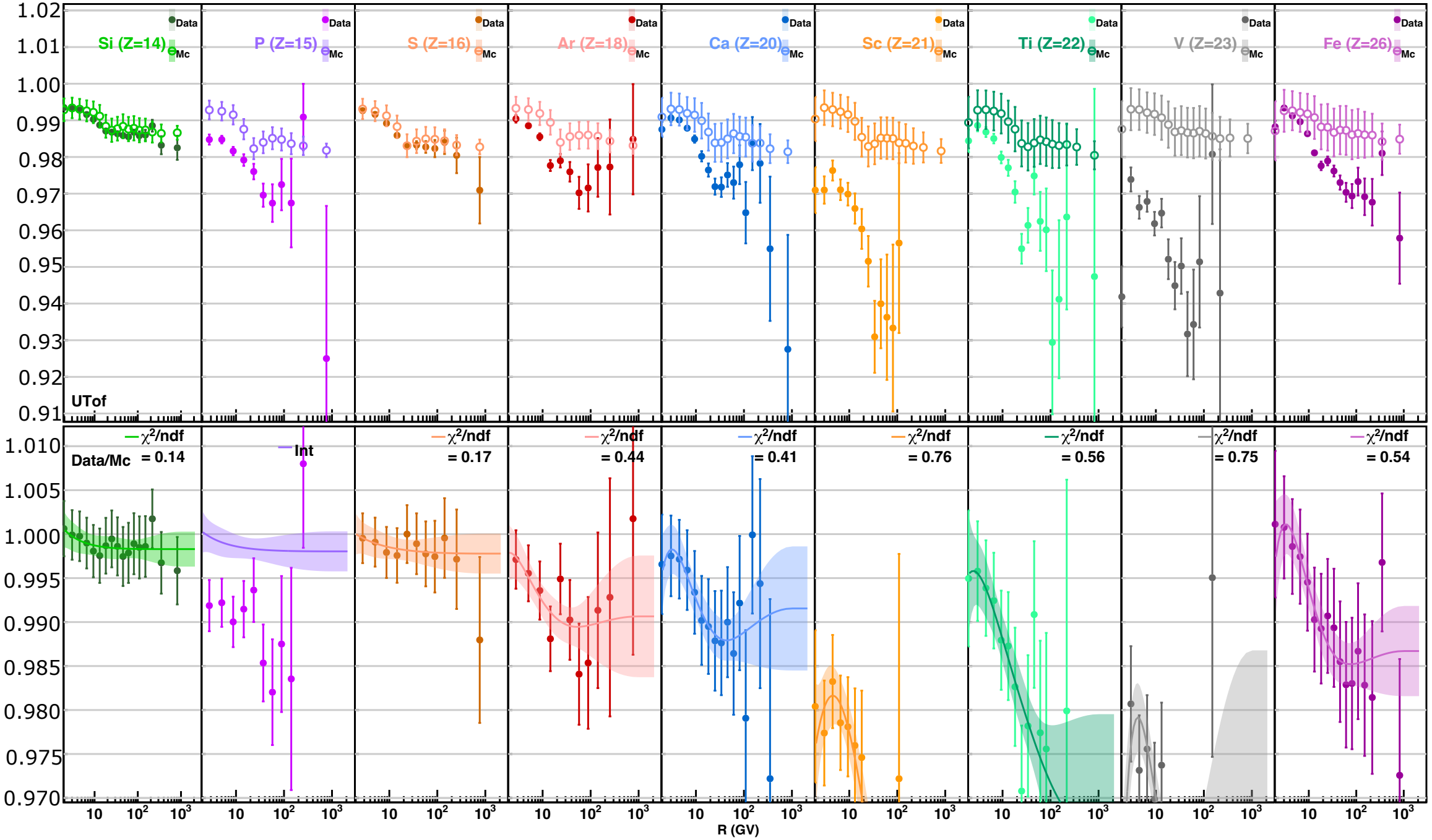
- Physics trigger
- Hit pattern: L2 && (L3 || L4) && (L5 || L6) && (L7 || L8)
- N° of inner tracker Y hits > 4
- Inner tracker and L1 charge in [Z - 0.5, Z + 0.5]
- L1 normalized residuals < 10 $\chi^2_{\mathrm{IL1}} \cdot \mathrm{ndf}_{\mathrm{IL1}} - \chi^2_{\mathrm{INN}} \cdot \mathrm{ndf}_{\mathrm{INN}}$
- L1 charge asymmetry $(Z_x - Z_y)/(Z_x + Z_y) < 0.2$
- Hit on L1 && with «*good*» status
- Track (IL1) in L1 and inner fiducial volume
- $\chi^2_y < 10$ (both IL1 and INN)
- **Lower ToF charge in «common» range**

Ltof charge cut

Z=14	Z=15	Z=16	Z=18	Z=20
(13.3, 15.5)	(14.2, 16.5)	(15.2, 17.5)	(17.2,1 9.5)	(19.1, 21.5)

Numerator

- Denominator
- $\beta > 0.4$
- UToF charge in «*common*» range

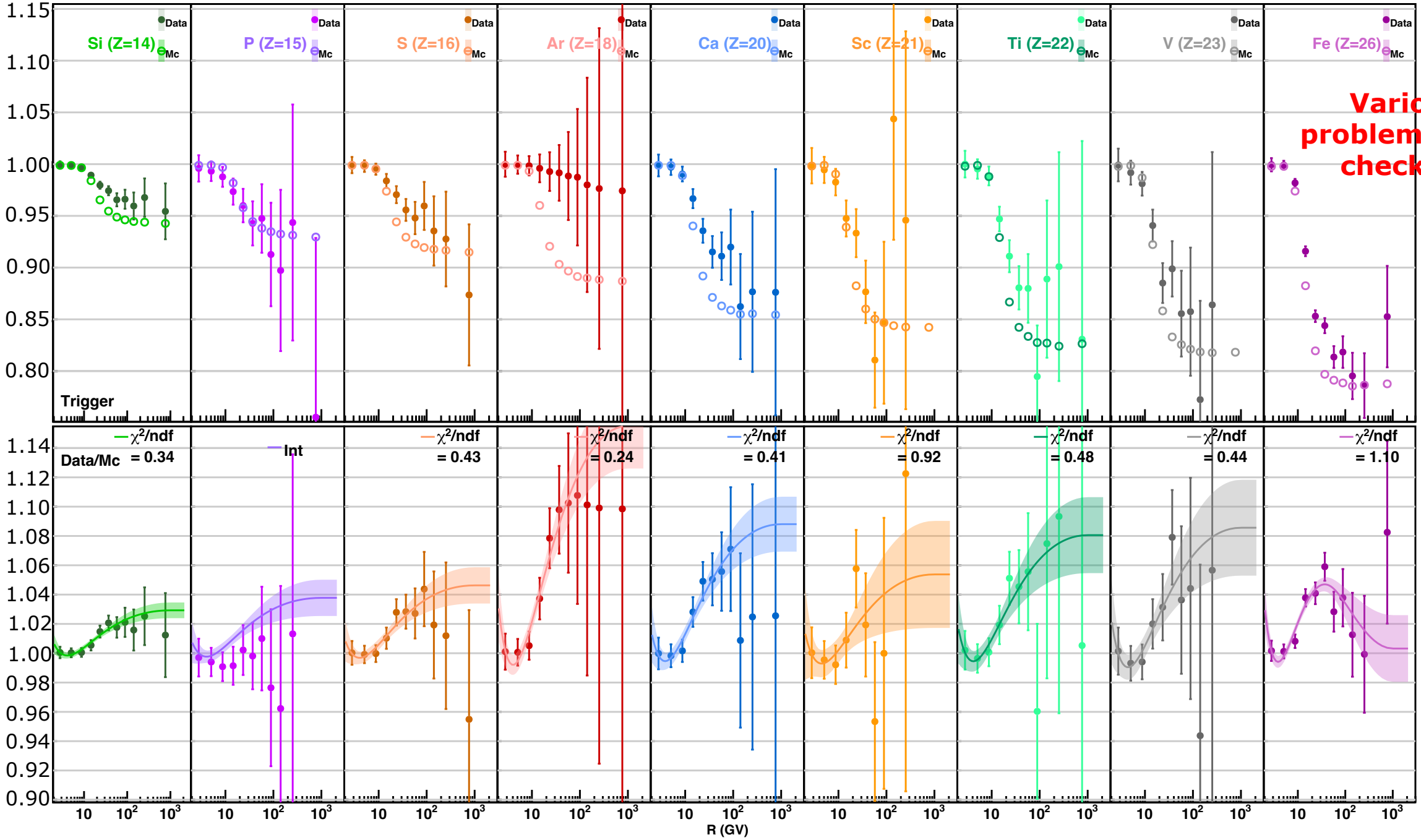

Si (Z=14)
P (Z=15)
S (Z=16)
Ar (Z=18)
Ca (Z=20)
Sc (Z=21)
Ti (Z=22)
V (Z=23)
Fe (Z=26)
Data
Mc
UTof
Data/Mc
Int
χ²/ndf
= 0.14
= 0.17
= 0.44
= 0.41
= 0.76
= 0.56
= 0.75
= 0.54
R (GV)

Trigger and Daq efficiency with emulation

$$\varepsilon_{trig} = \frac{N_p^1 + N_p^2}{N_{acc<5}^1 \frac{N_{acc<8}^2}{N_{acc<5}^2} + N_{acc<8}^2}$$

$$\varepsilon_{Daq} = \frac{N_{<24kB}^1 + N_{<24kB}^2 + N_{24kB}^2}{N_{<24kB}^1 \left(1 + \frac{N_{>24kB}^2}{N_{<24kB}^2}\right) + N_{<24kB}^2 + N_{>24kB}^2}$$

I’m using standard error propagation



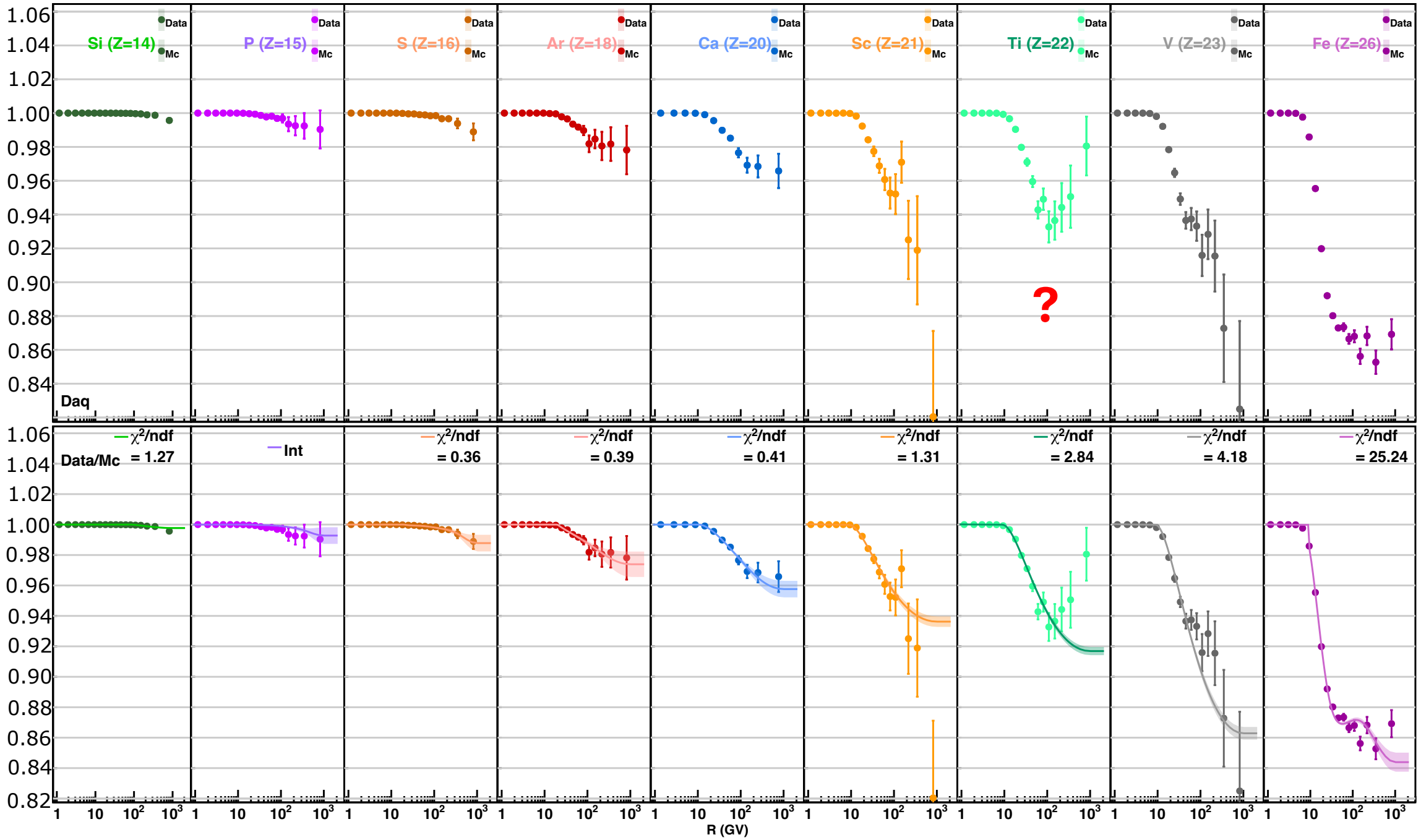
Various problems, still checking

Trigger and Daq efficiency with emulation

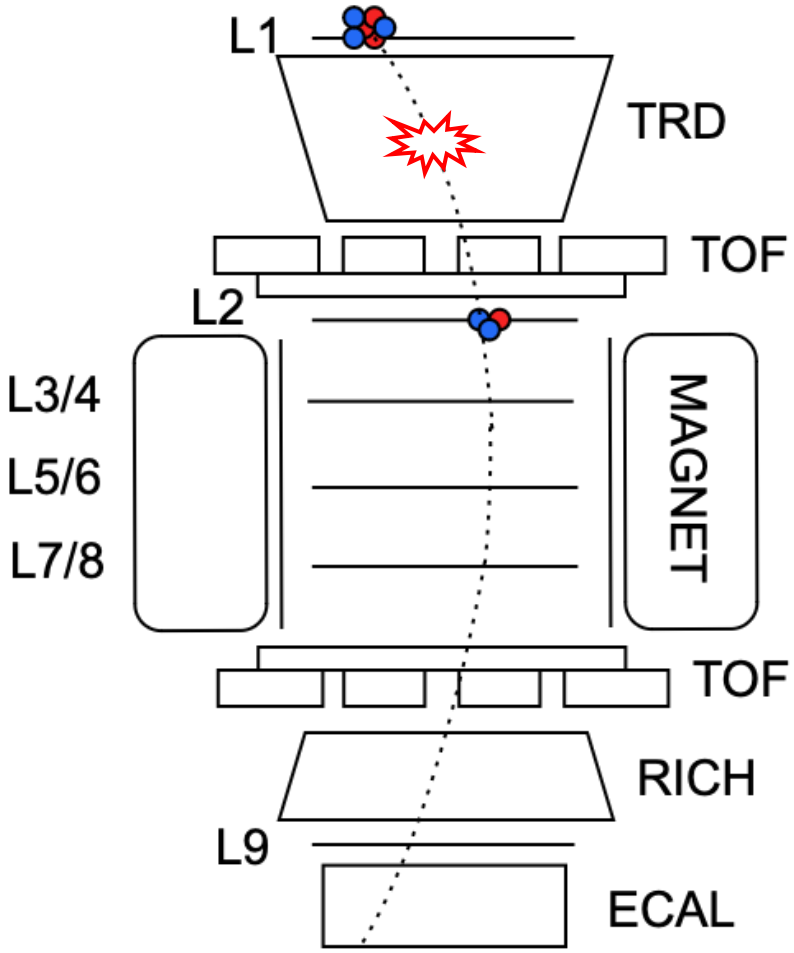
$$\varepsilon_{trig} = \frac{N_p^1 + N_p^2}{N_{acc<5}^1 \frac{N_{acc<8}^2}{N_{acc<5}^2} + N_{acc<8}^2}$$

$$\varepsilon_{Daq} = \frac{N_{<24kB}^1 + N_{<24kB}^2 + N_{24kB}^2}{N_{<24kB}^1 \left(1 + \frac{N_{>24kB}^2}{N_{<24kB}^2}\right) + N_{<24kB}^2 + N_{>24kB}^2}$$

I’m using standard error propagation

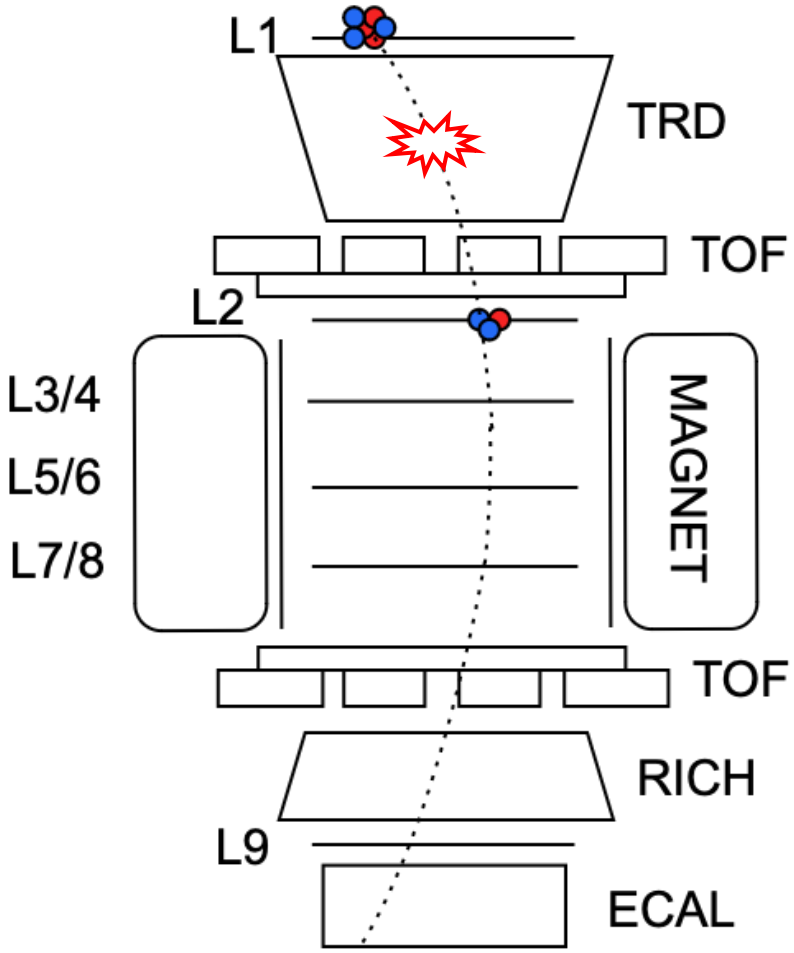

Si (Z=14)
P (Z=15)
S (Z=16)
Ar (Z=18)
Ca (Z=20)
Sc (Z=21)
Ti (Z=22)
V (Z=23)
Fe (Z=26)
Data
Mc
?
Daq
Data/Mc
Int
χ²/ndf
= 1.27
= 0.36
= 0.39
= 0.41
= 1.31
= 2.84
= 4.18
= 25.24
R (GV)

Contamination below the L1



- Below the layer 1 (L1), **nuclei can fragment** in the TRD and in the TOF
- **This fragments** from higher Z nuclei, **can be reconstructed as phosphorus** in the inner tracker
- **Template fit on the L1 charge distribution**, when selecting nucleus under study with the inner tracker and the TOF

Contamination below the L1



To perform the template fit, **the following methodoloy has been applied**

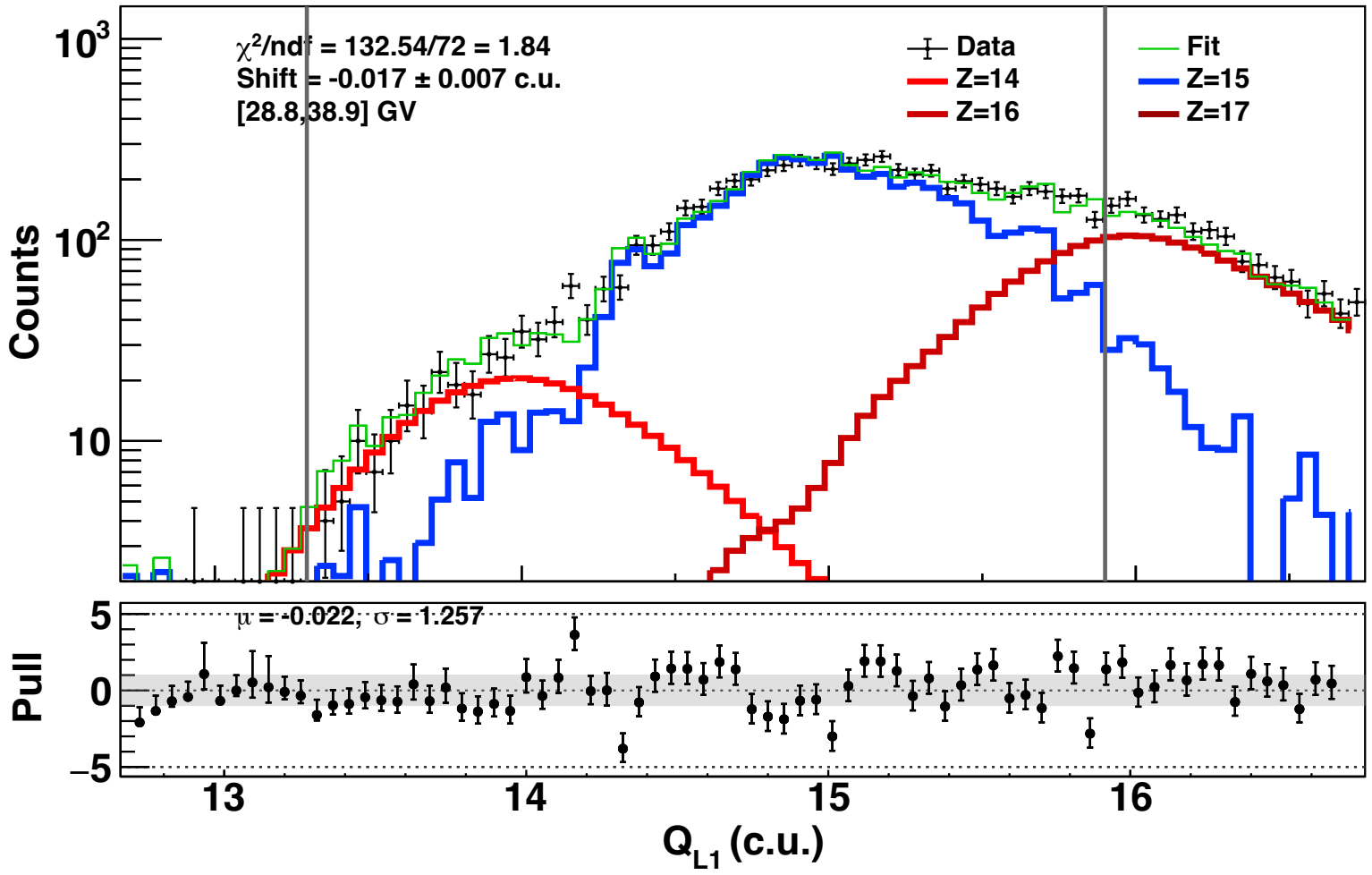
1. The templates for background (Si, S and Cl) have been retrieved from L1, while for the signal (P) from L2

2. To account for the differences between L1 and L2, a **shift procedure has been applied (see next slides)**

3. The L1 charge distribution has been fitted and the purity fraction has been evaluated as:

$$1 - f_i = 1 - \frac{\int (n_{Si} f_{Si} + n_S f_S + n_{Cl} f_{Cl}) dQ}{\int \left(n_p f_p + n_{Si} f_{Si} + n_S f_S + n_{Cl} f_{Cl}\right) dQ}$$

Contamination below the L1
Shifting procedure

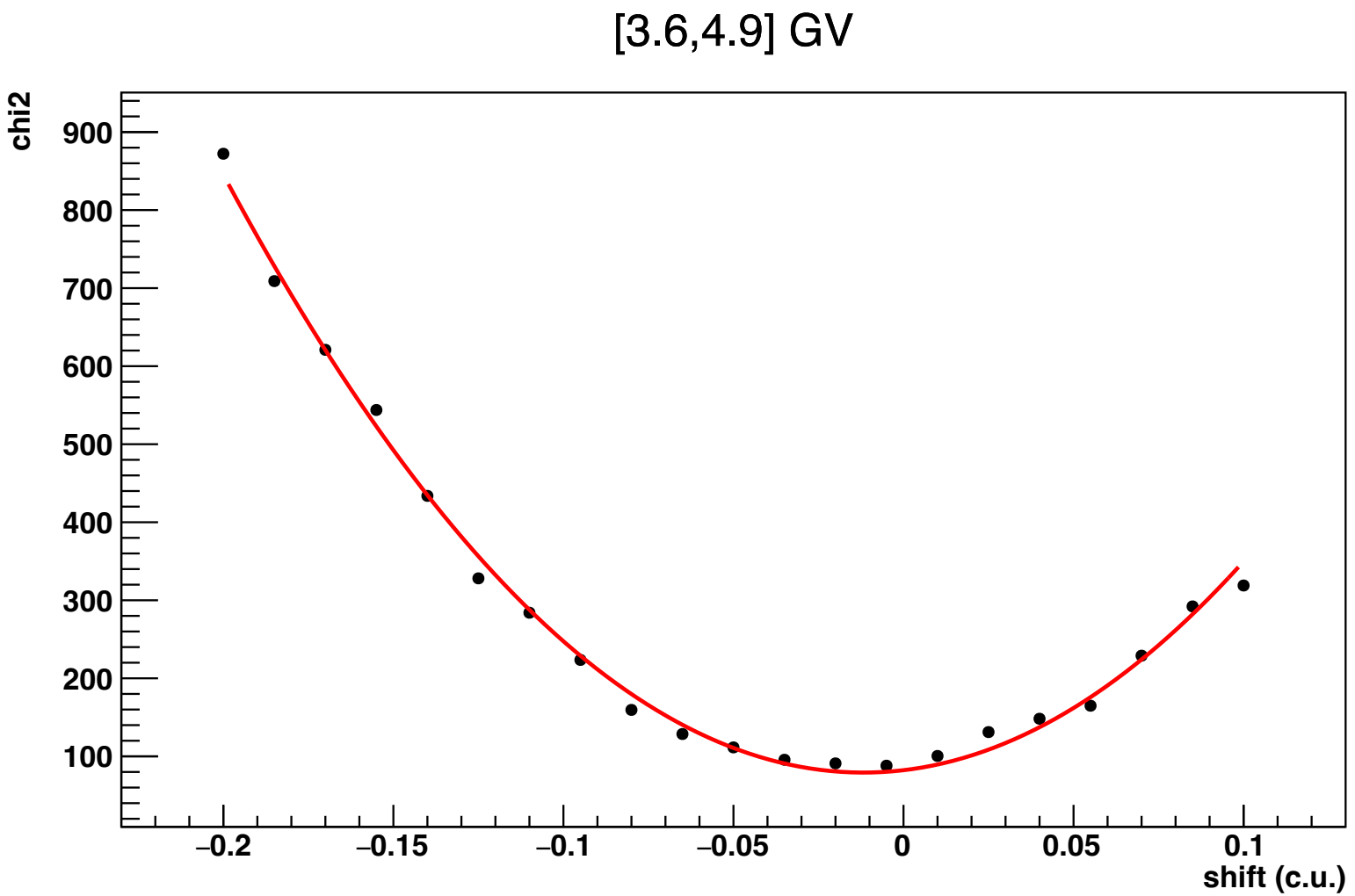


For every rigidity bin:

1. For a given shift value, the L2 template has been shifted and the template fit re-applied to the L1 charge distribution

2. The χ has been evaluated as a function of the shift

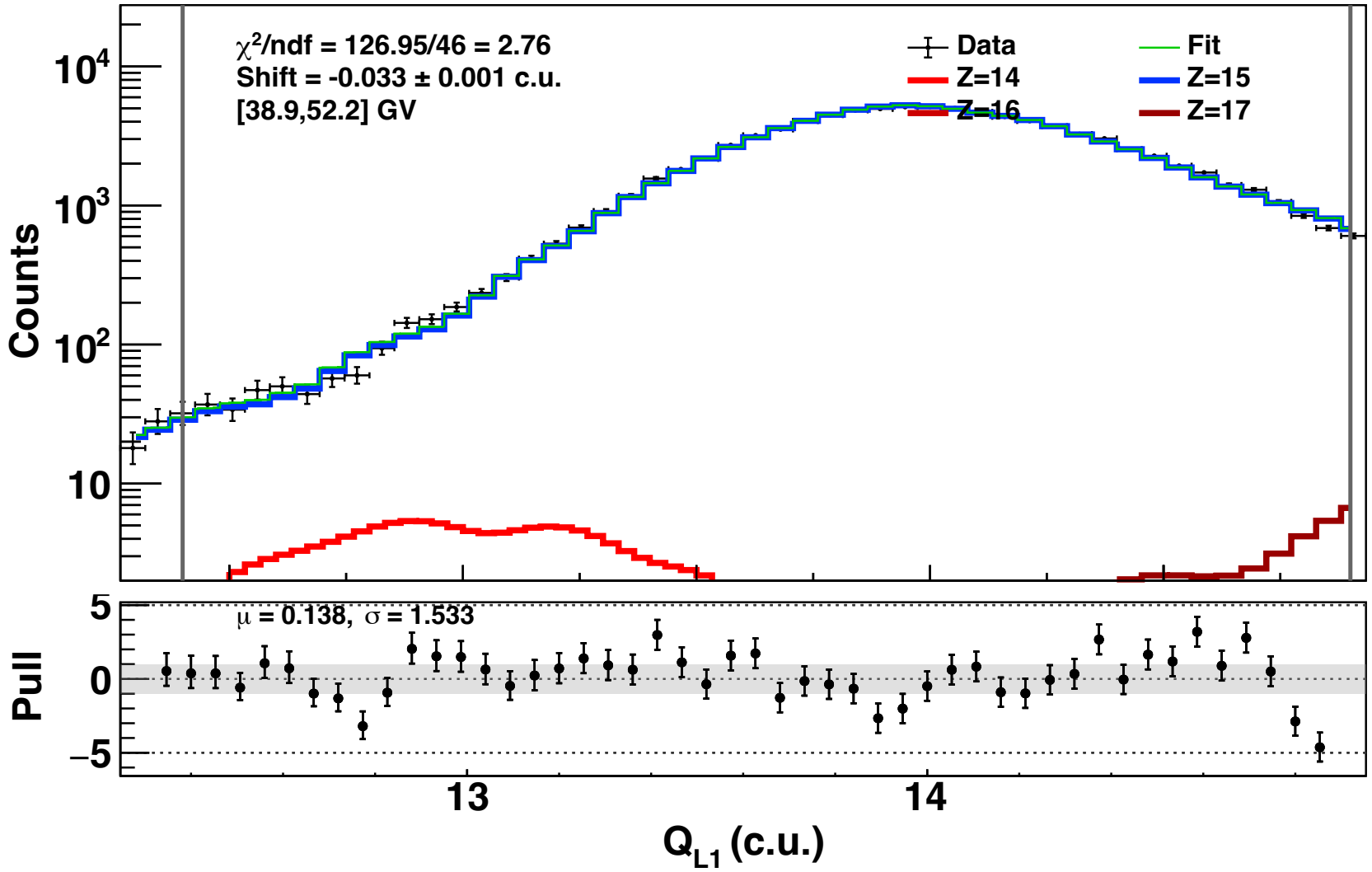
Contamination below the L1
Shifting procedure



For every rigidity bin:

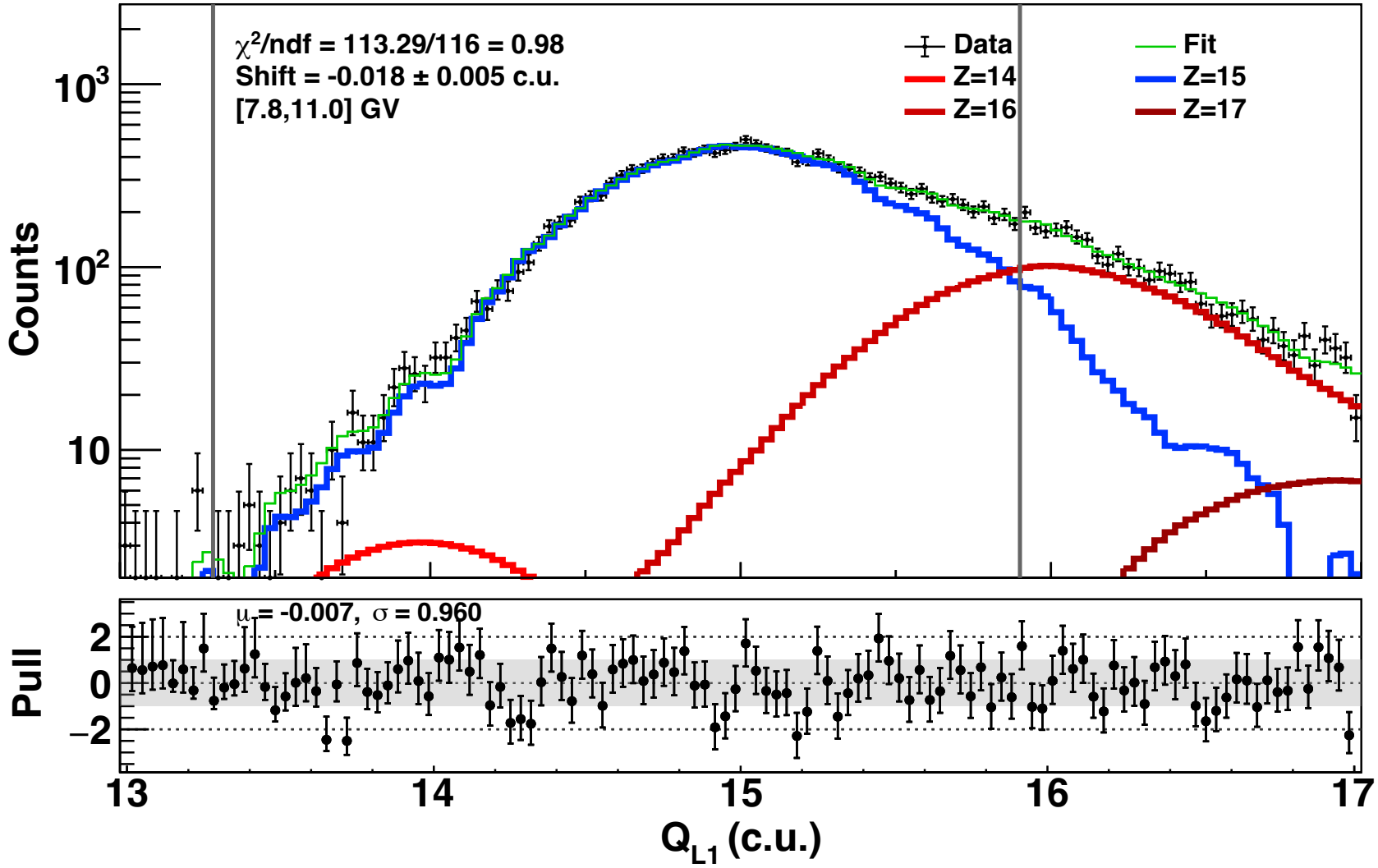
1. For a given shift value, the L2 template has been shifted and the template fit re-applied to the L1 charge distribution
2. The χ has been evaluated as a function of the shift
3. This distribution was fitted with a parabola and the minimum was found
4. The minimum corresponds to the shift utilized in the template fit

Contamination below the L1 (Silicon)

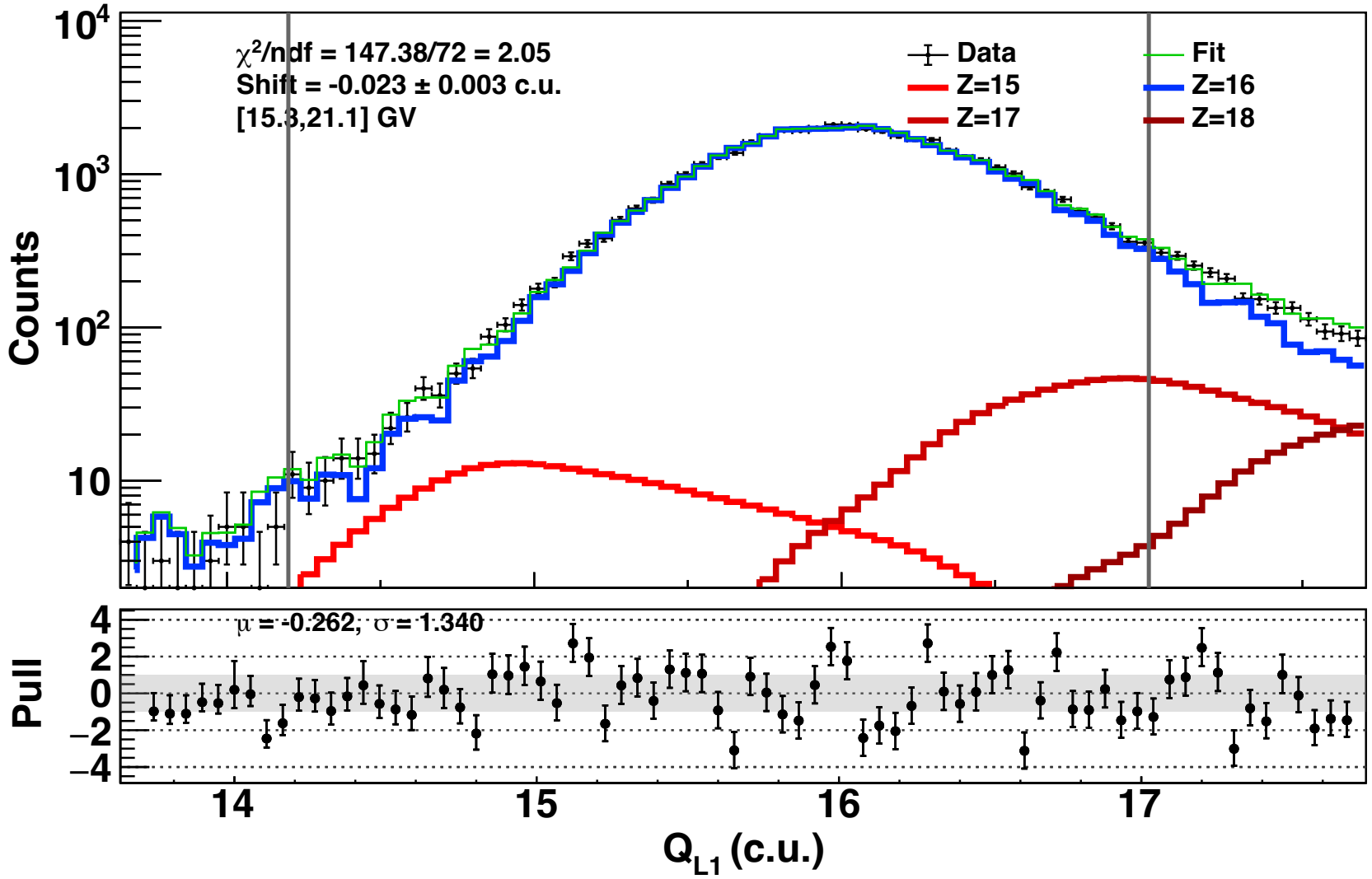


For silicon the contamination below L1 is almost negligible

Contamination below the L1 (Phosphorus)

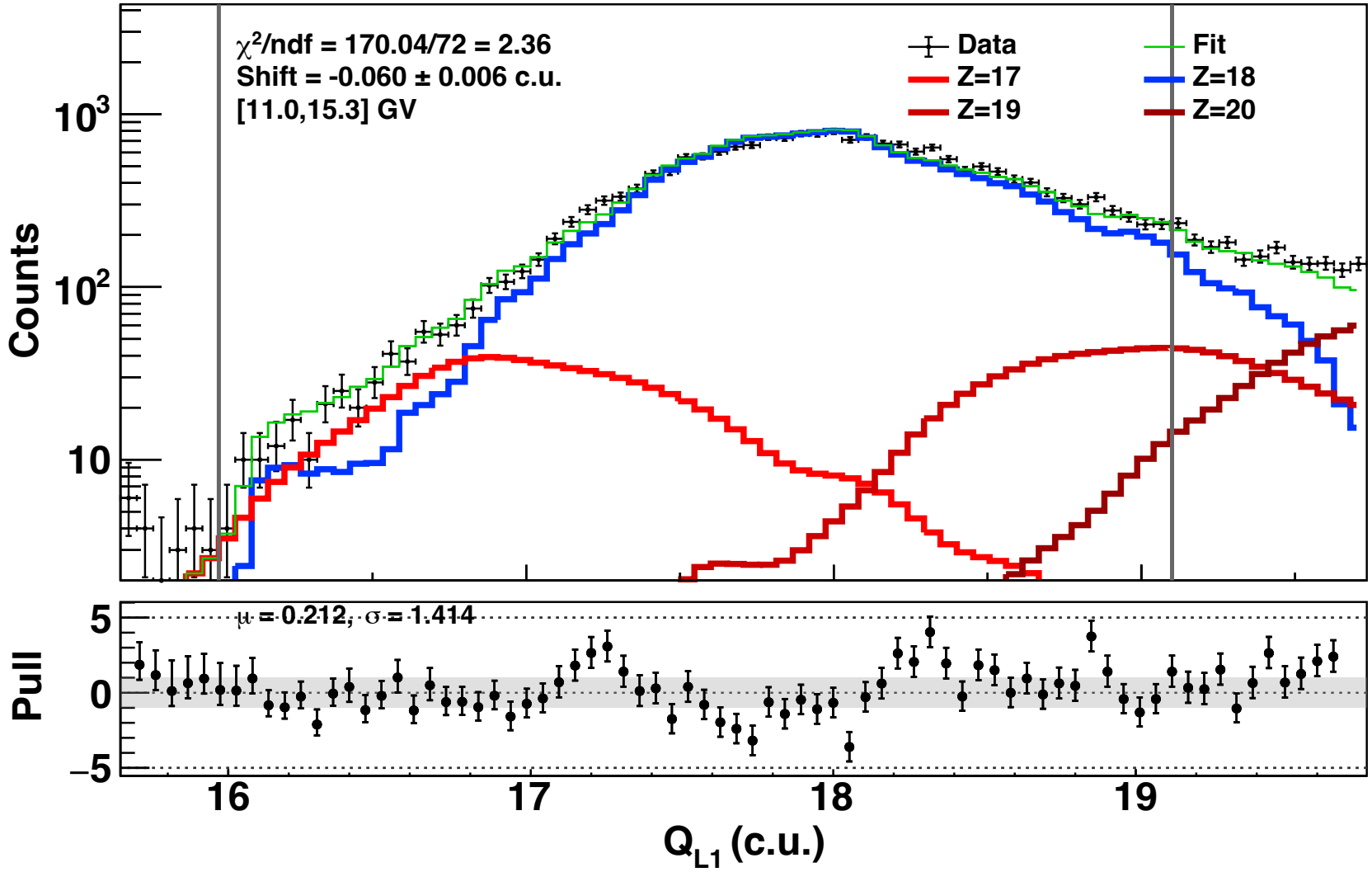


Contamination below the L1 (Sulfur)



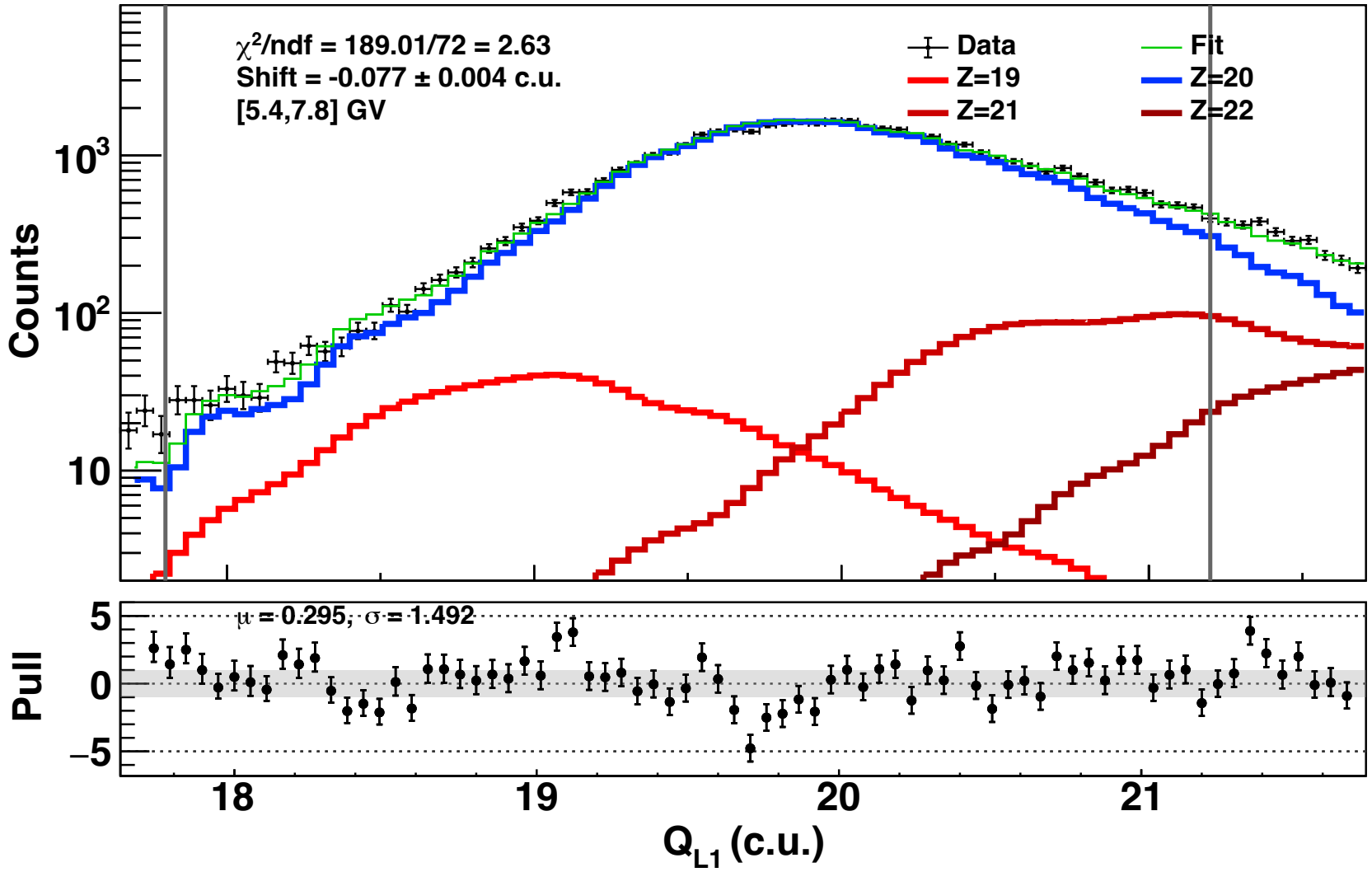
For sulfur the contamination below L1 is almost negligible

Contamination below the L1 (Argon)



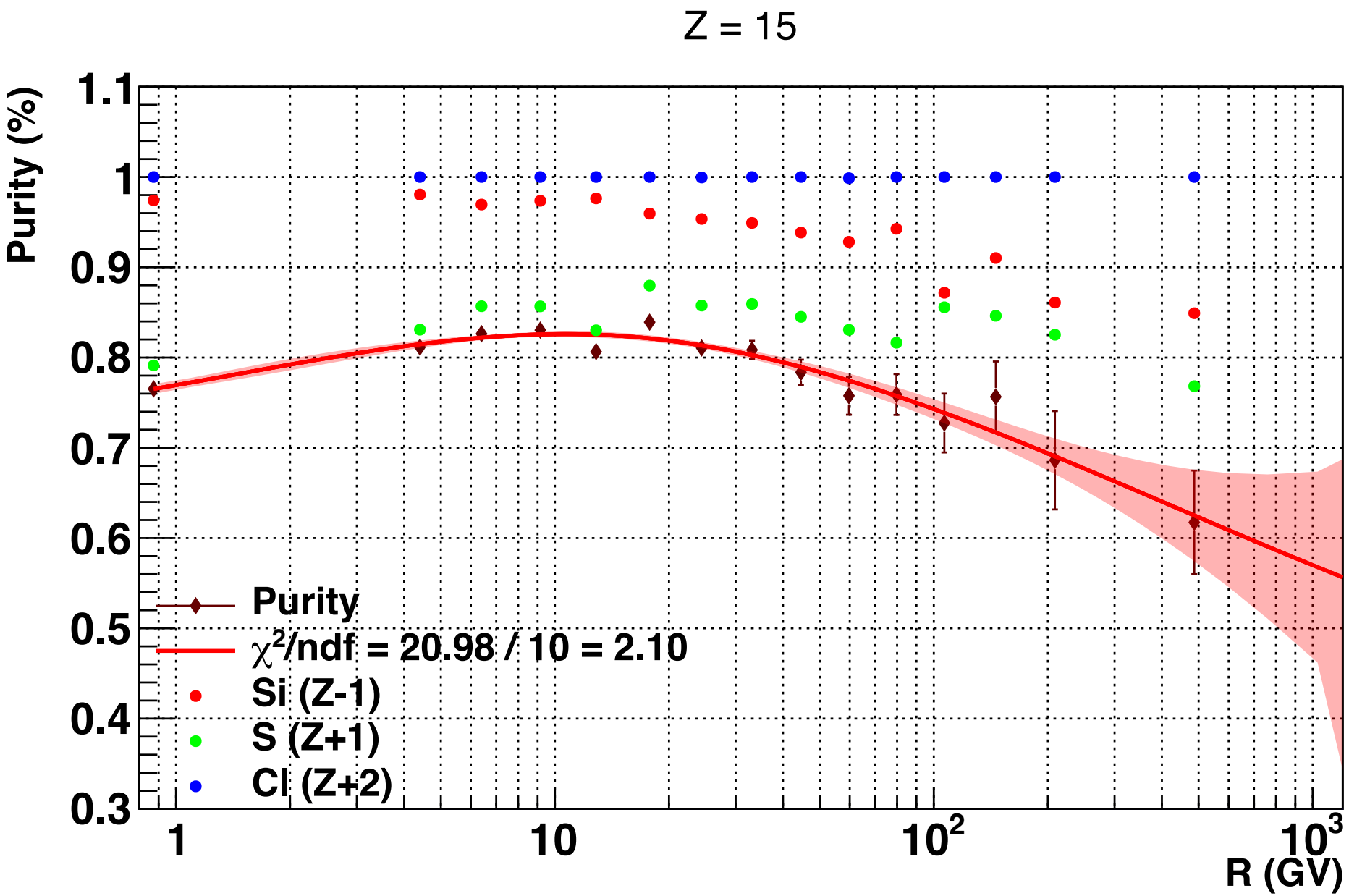
For argon, the templates are taken from L2

Contamination below the L1 (Calcium)



For calcium, the templates are taken from L2

Contamination below the L1

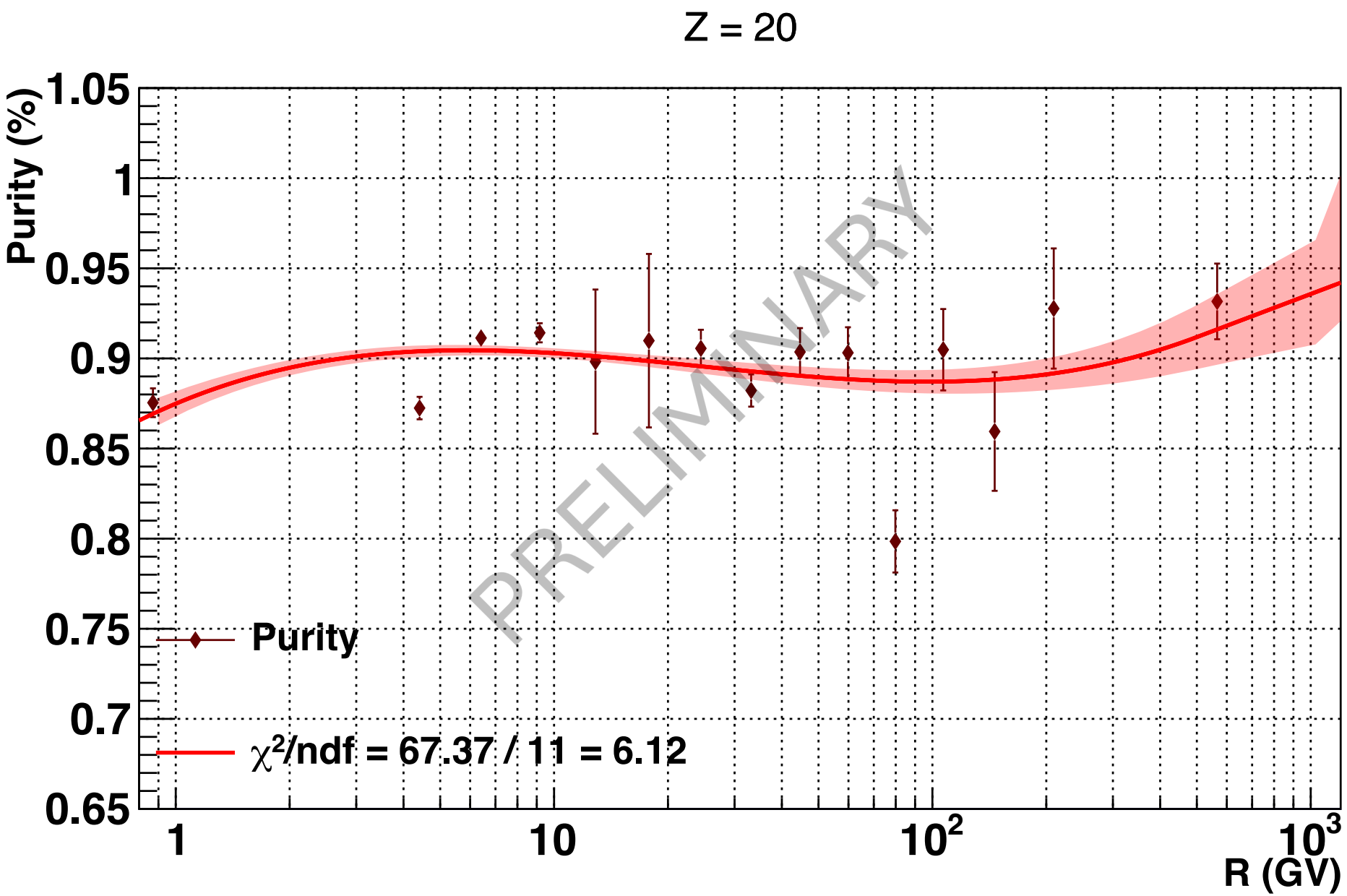


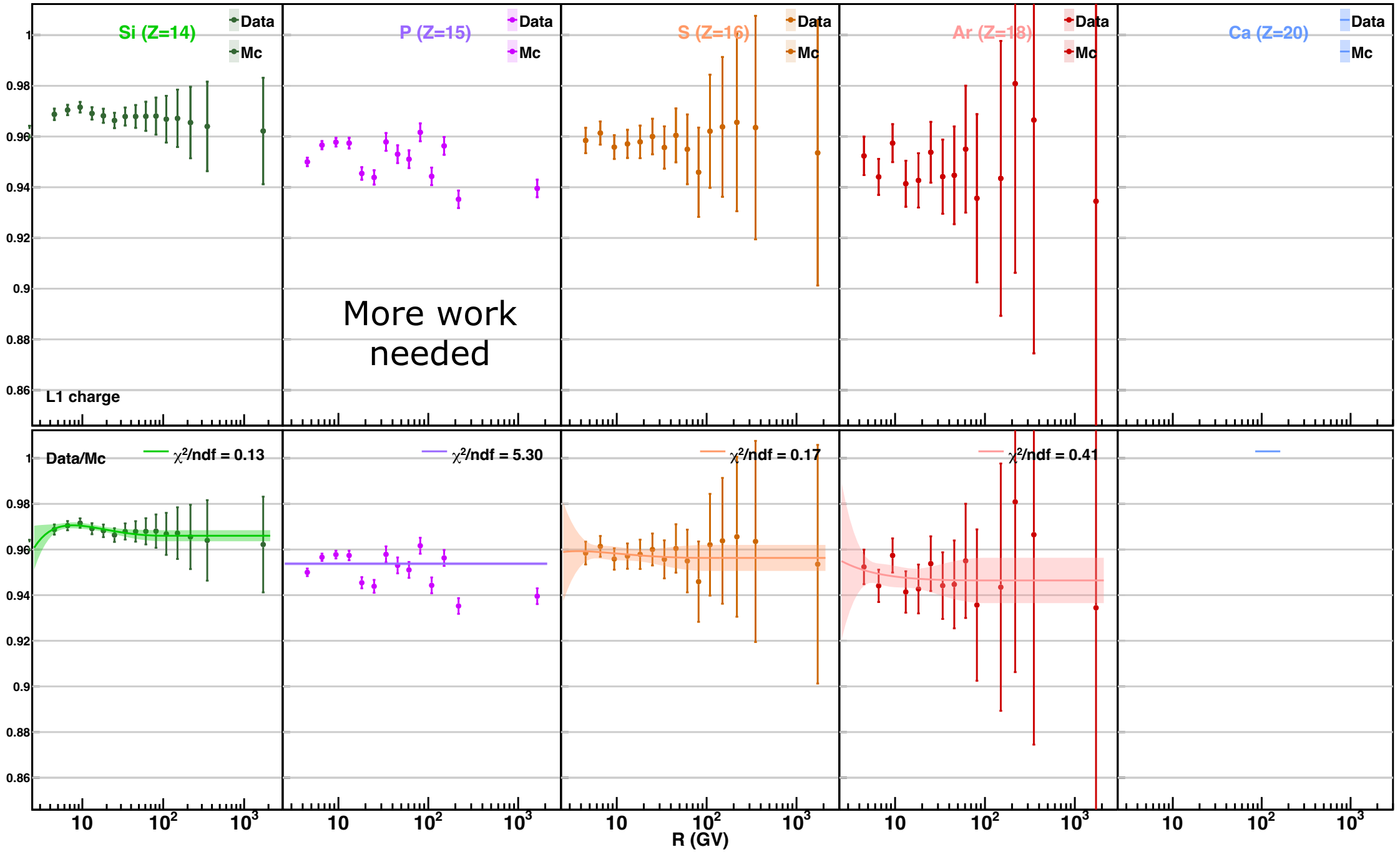
Contamination below the L1

Argon

More work needed

Contamination below the L1




Si (Z=14)
P (Z=15)
S (Z=16)
Ar (Z=18)
Ca (Z=20)
Data
Mc
More work needed
L1 charge
Data/Mc
χ²/ndf = 0.13
χ²/ndf = 5.30
χ²/ndf = 0.17
χ²/ndf = 0.41
R (GV)

Top of the instrument (TOI) correction, $f(R)$

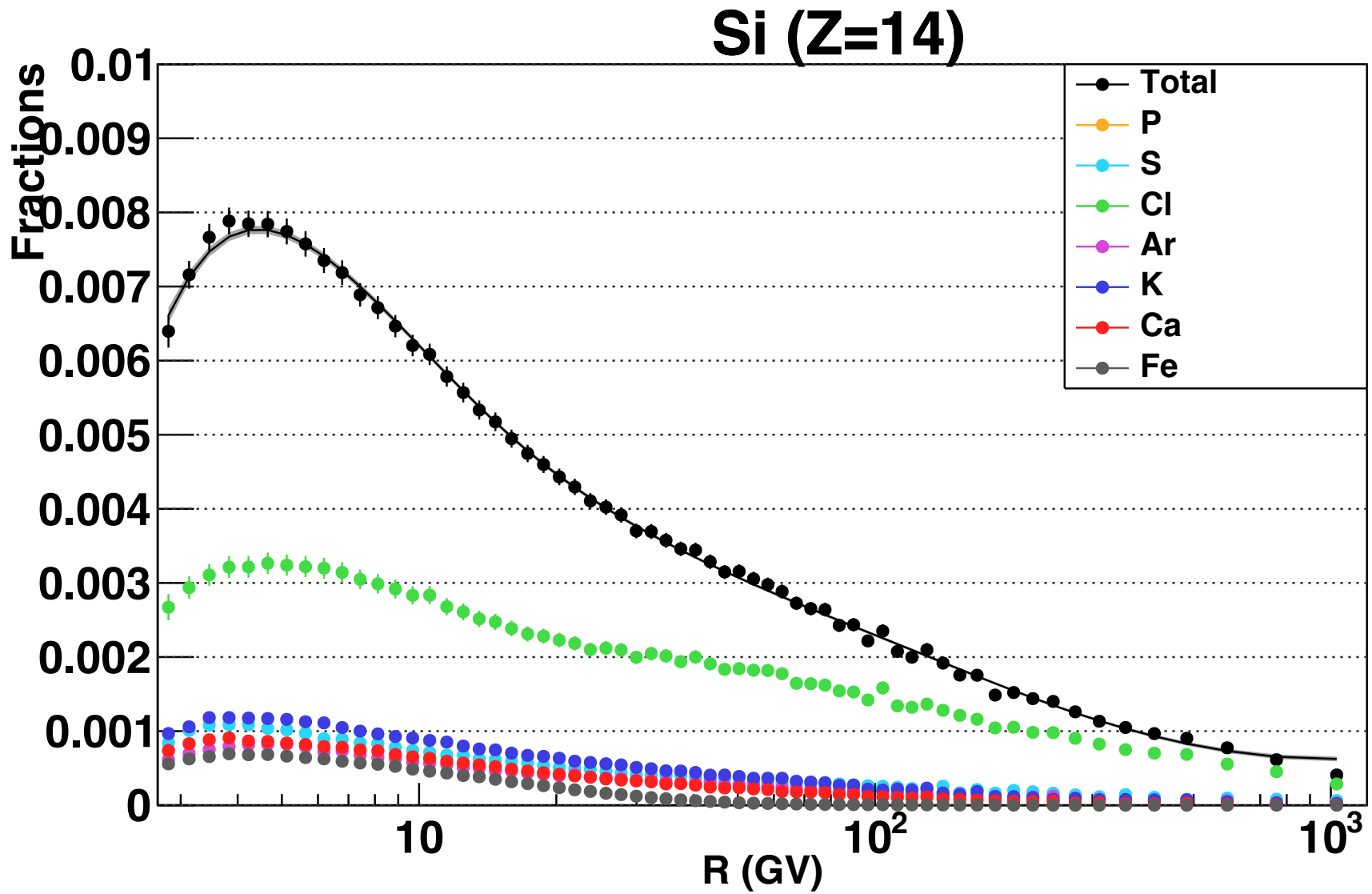
- Nucleus under study can present **contamination** given by fragmentation of other nuclei (with higher Z) **above the L1**
- Since there is no detector above the L1 to estimate this background, one way to go is to use MC:

$$N_{i\to j}(R) = \phi_i(R)T(R)\Delta R\, A(R)_{i\to j}$$

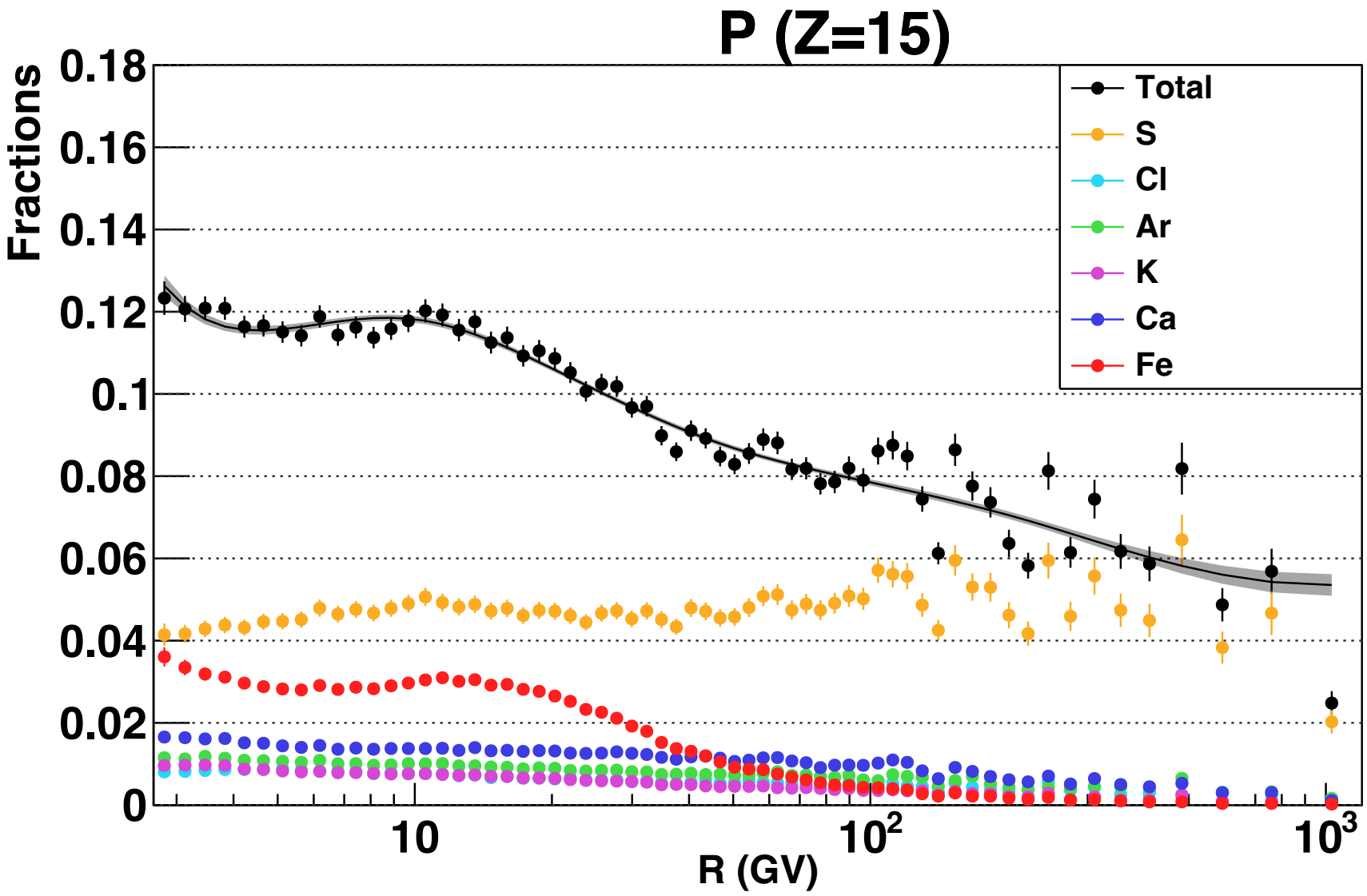
- $N_{i\to j}(R)$ is the number of contaminants from species i to nucles under study j, **that fragment above the L1**
- ϕ_i is the flux of contaminant i (**Qi Yan and for SubFe elements mine**)
- $T(R)$ is the exposure time, ΔR is the bin width
- $A_{i\to j}$ is the MC acceptance of contaminant i to satisfy the selection for nucleus under study j, **in the reconstructed space**

$$f(R) = \frac{\sum_{z_i>z_j} N_i(R)}{N_i(R)}$$

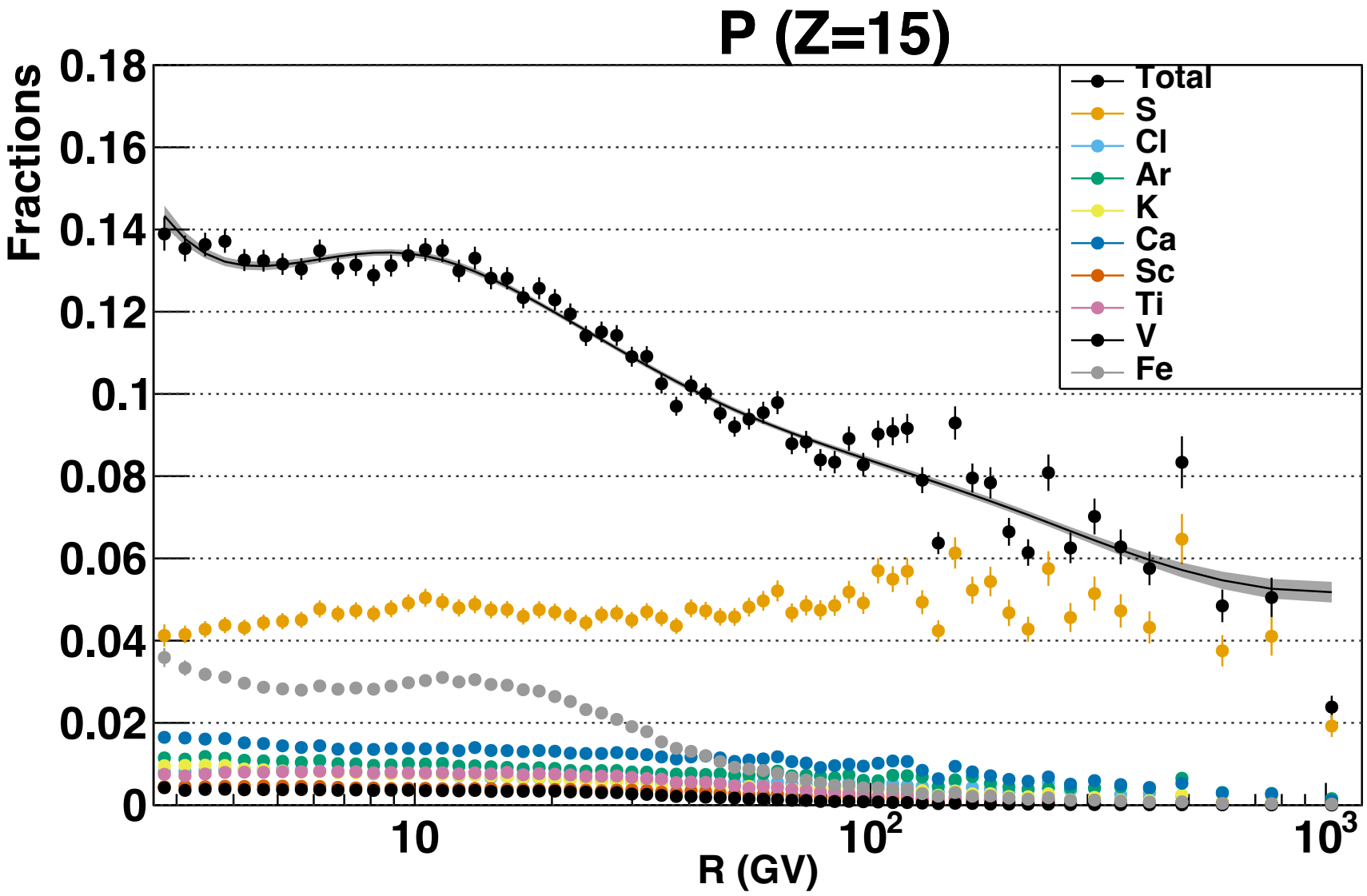
Top of the instrument (TOI) correction



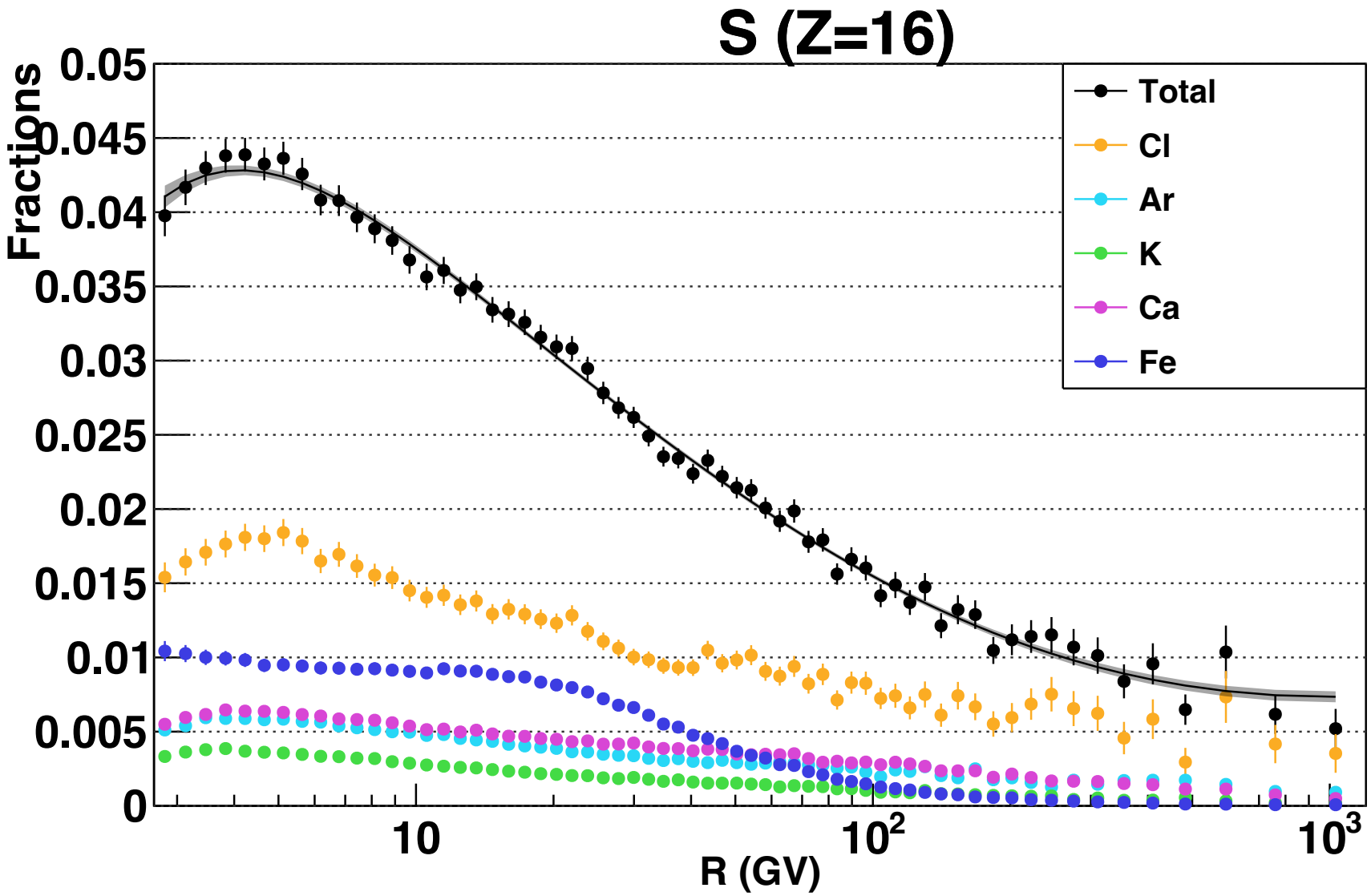
Top of the instrument (TOI) correction (No SubFe)



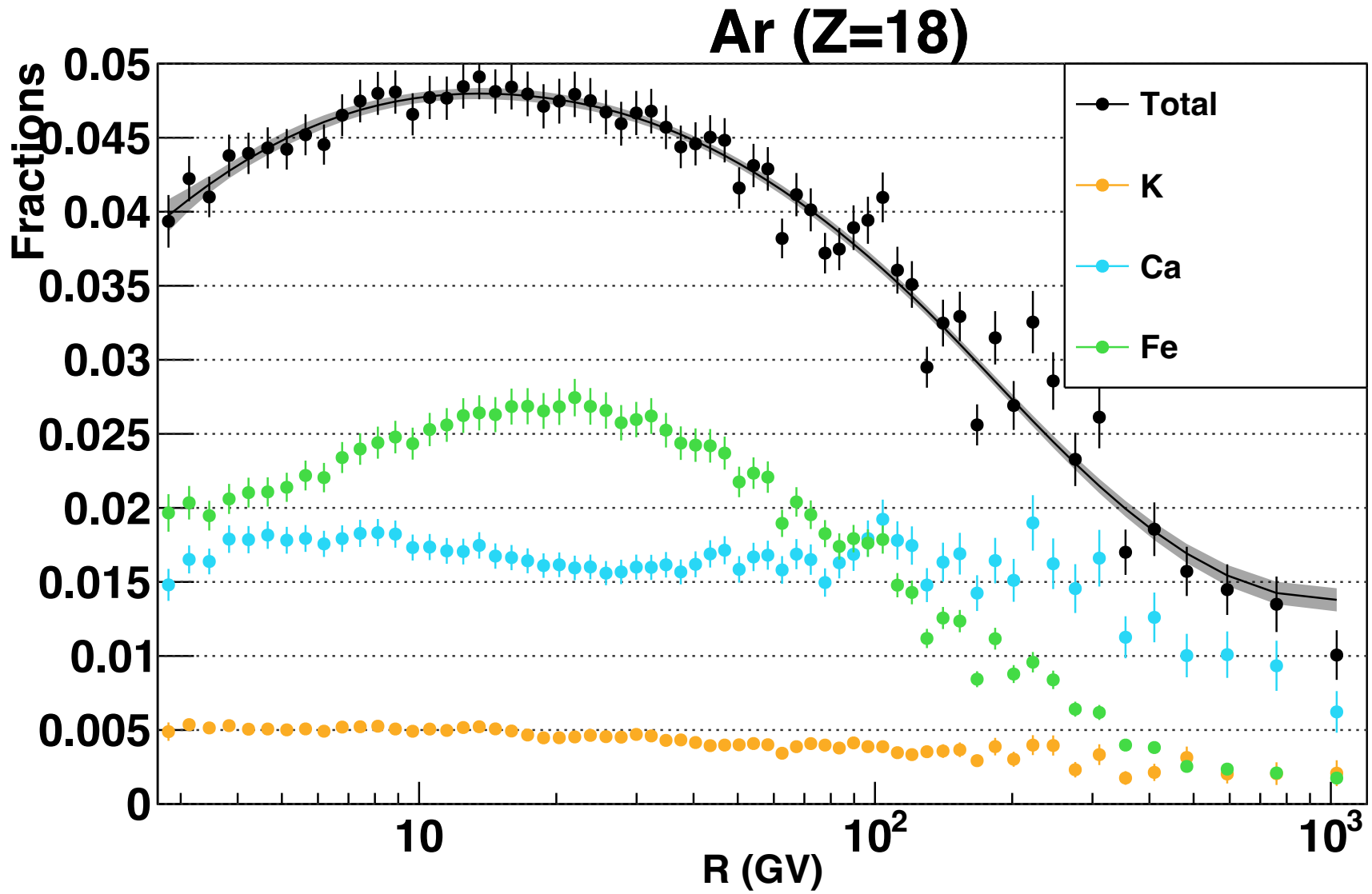
Top of the instrument (TOI) correction (Yes SubFe)



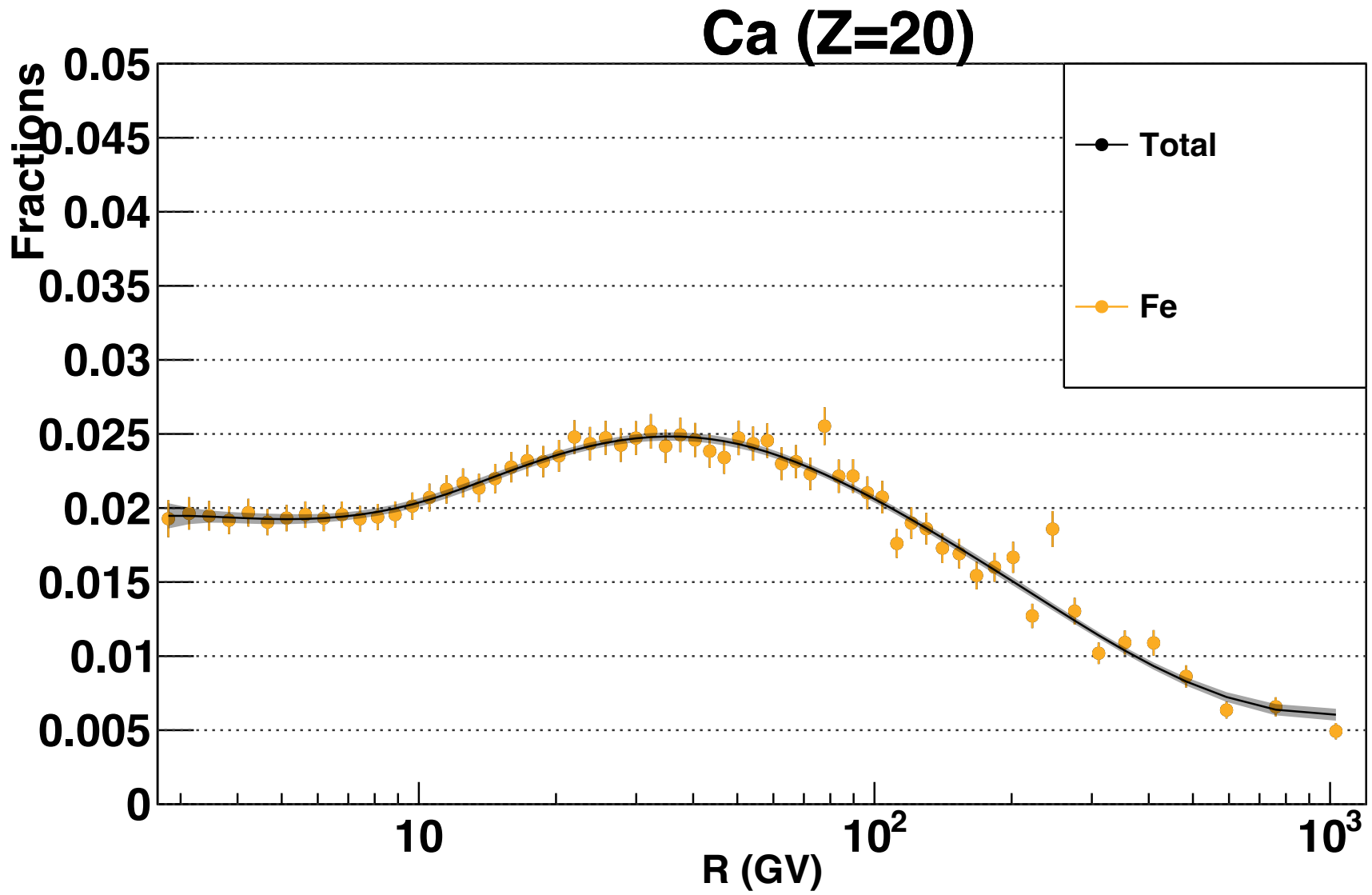
Top of the instrument (TOI) correction



Top of the instrument (TOI) correction

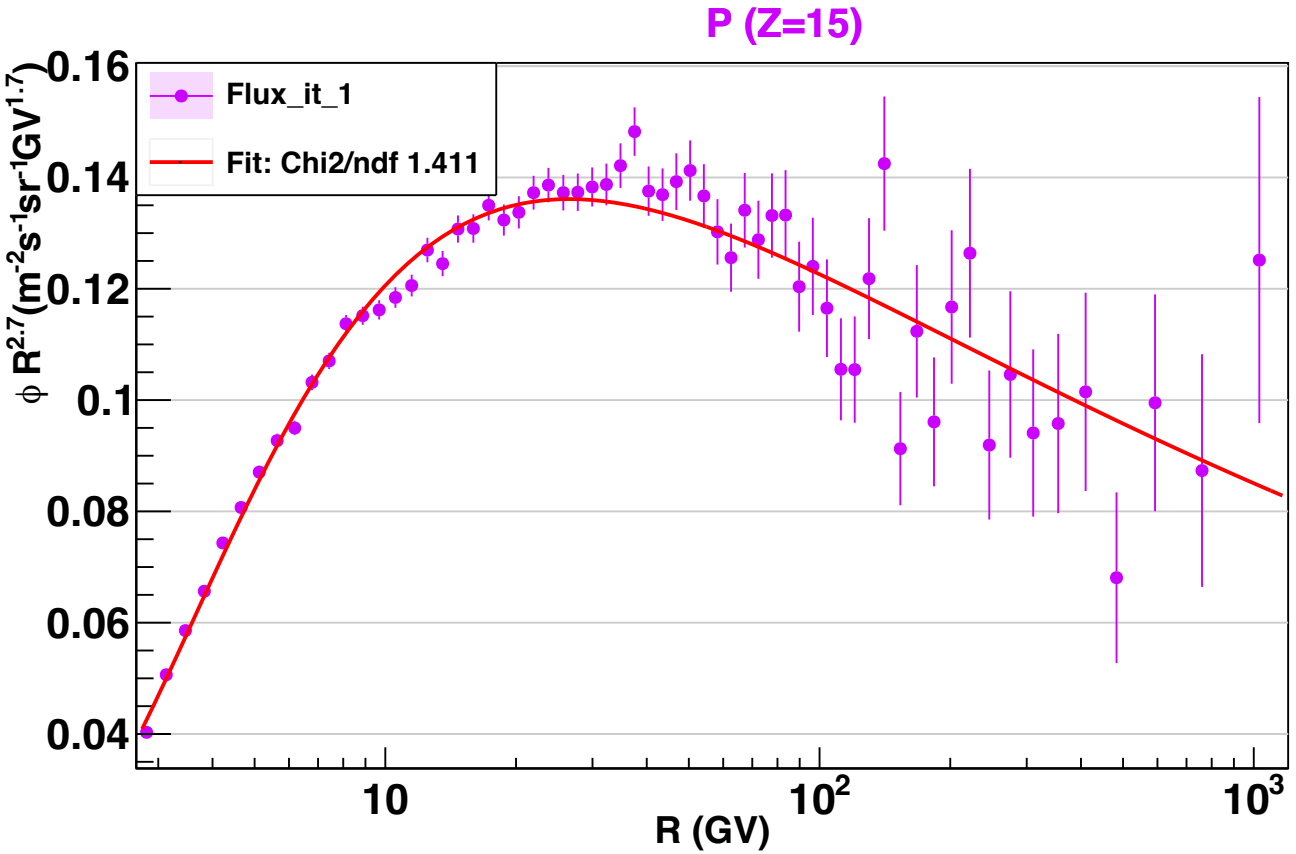


Top of the instrument (TOI) correction



Unfolding

- I'm currently using the **folded acceptance method**
- Iteratively, I weigh the MC acceptance by using, at first iteration, **Qi Yan flux** fitted with a **force field function:**



$$\Phi = \boldsymbol{N}\left(\frac{R}{Z}\right)^{\boldsymbol{\gamma}}\left(\frac{E_{tot}^2 - m^2}{(E_{tot} + \phi)^2 - m^2}\right)$$

- N normalization factor
- γ exponent
- ϕ modulation potential

Unfolding

- The weight is given by:

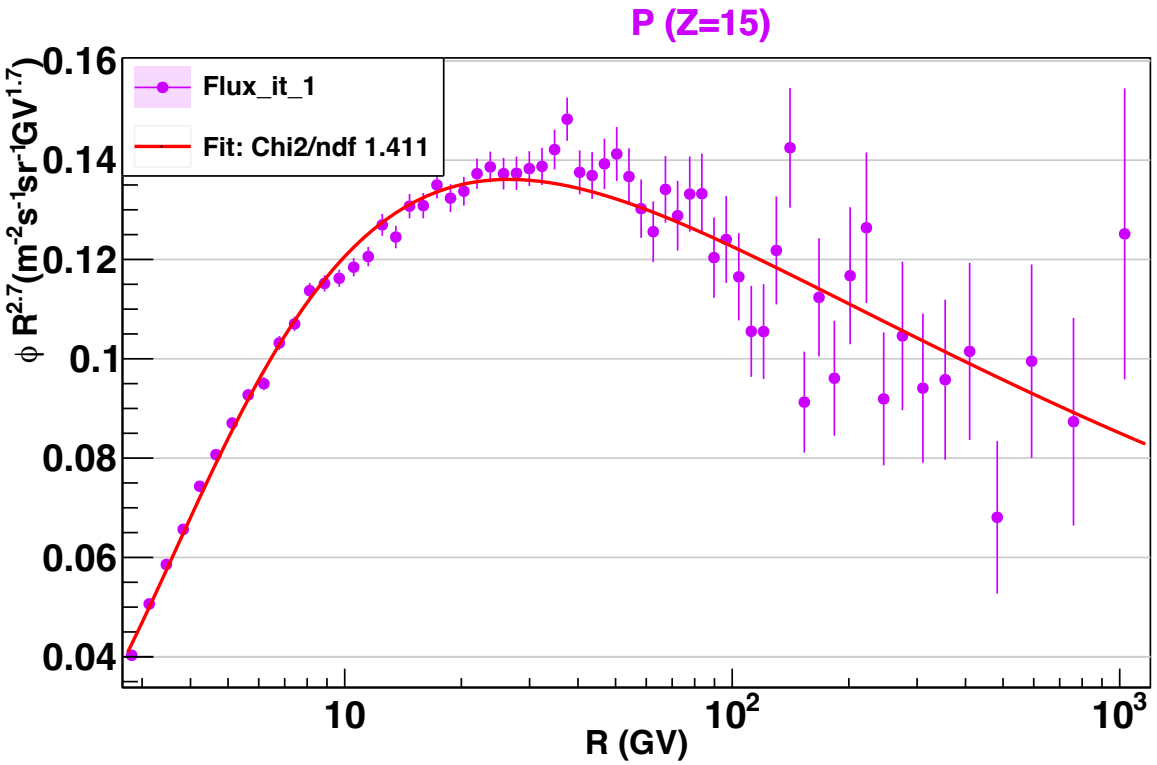
$$w = \frac{\phi_{fit}(R_{gen})R_{gen}}{N}\log\left(\frac{R_{prod,max}}{R_{prod,min}}\right)$$

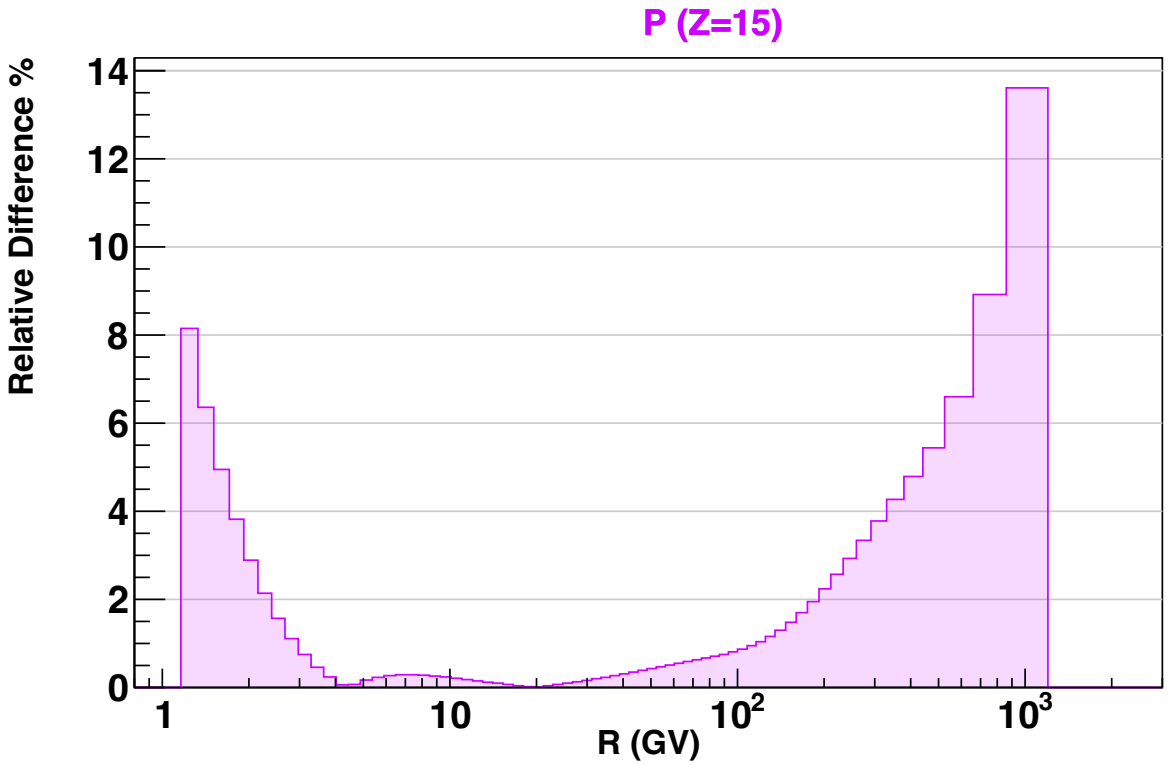
$$R_{prod,min} = 1\ \text{GV}$$
$$R_{prod,max} = 2000\ \text{GV}$$

$$N = \int_{R_{prod,max}}^{R_{prod,min}} \phi_{fit}(R)dR$$

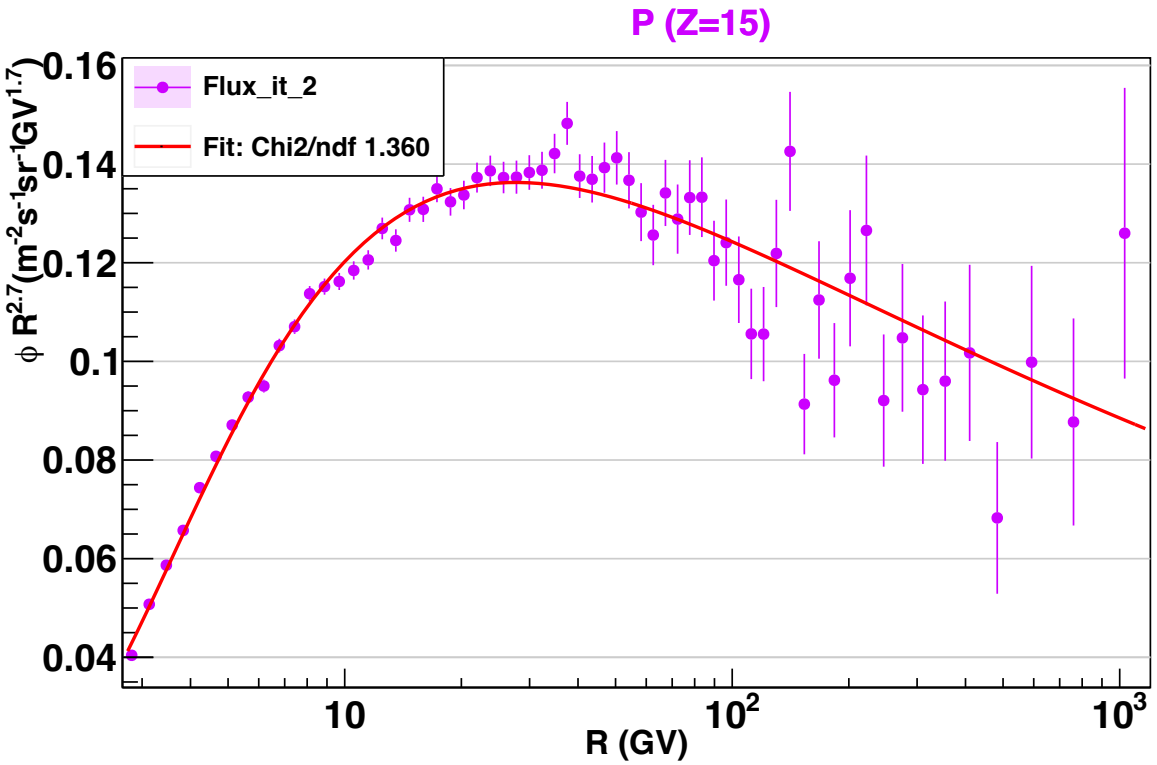
- Then i build the new weighted flux and I fit it with the force field function, **as model for the next iteration**
- **Convergence criterion**: for every rigidity bin, I evaluate the relative difference between two flux iterations. If the **maximum relative difference** among all the rigidity bin is < 0.01%, I stop the procedure

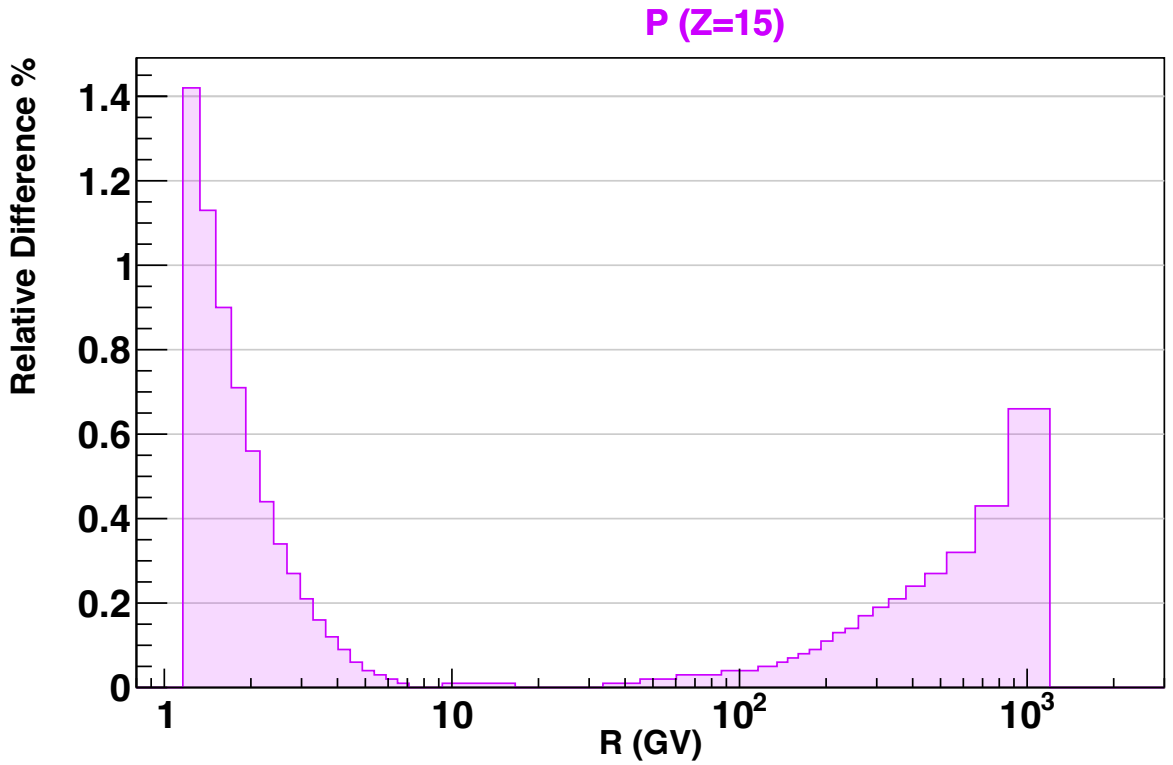
Unfolding – iteration 1



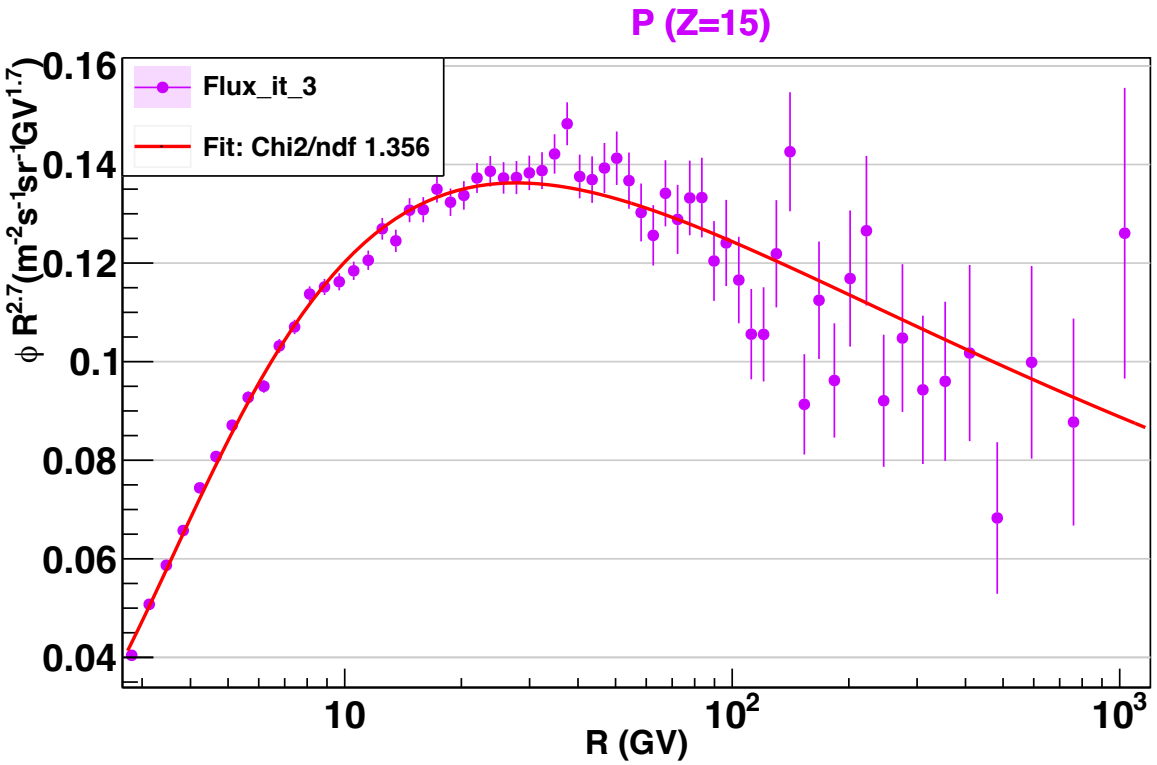


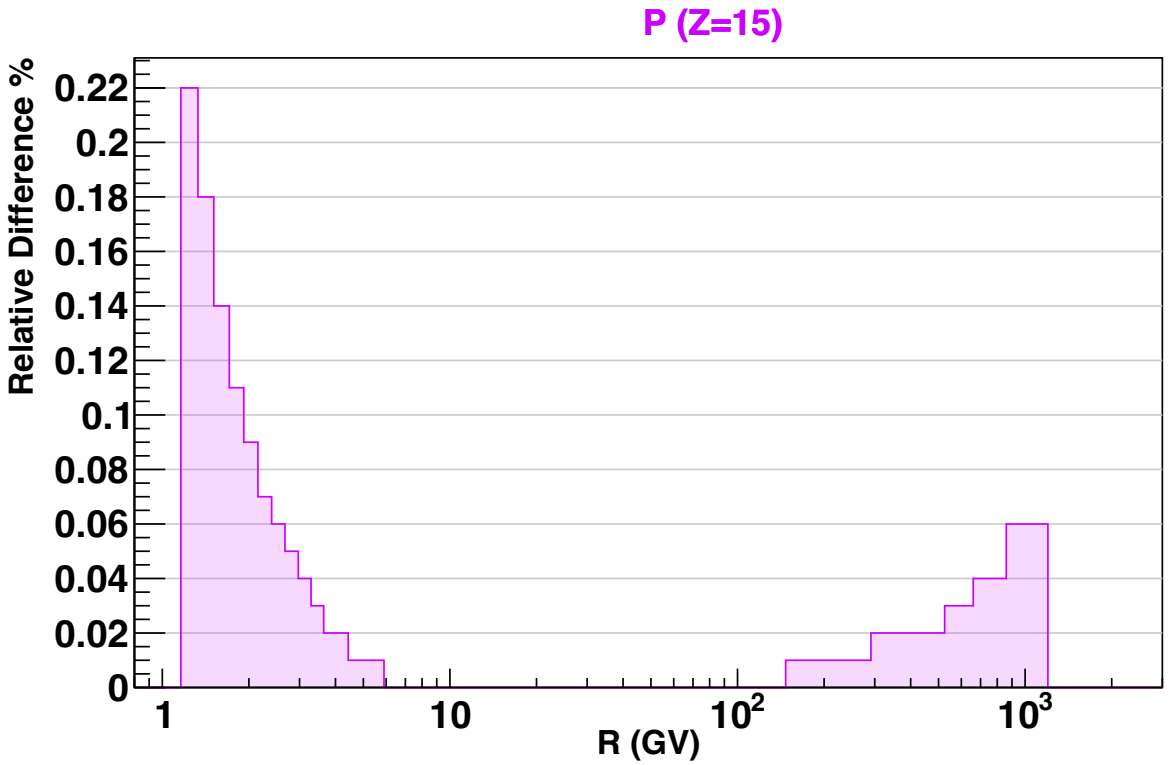
Unfolding – iteration 2



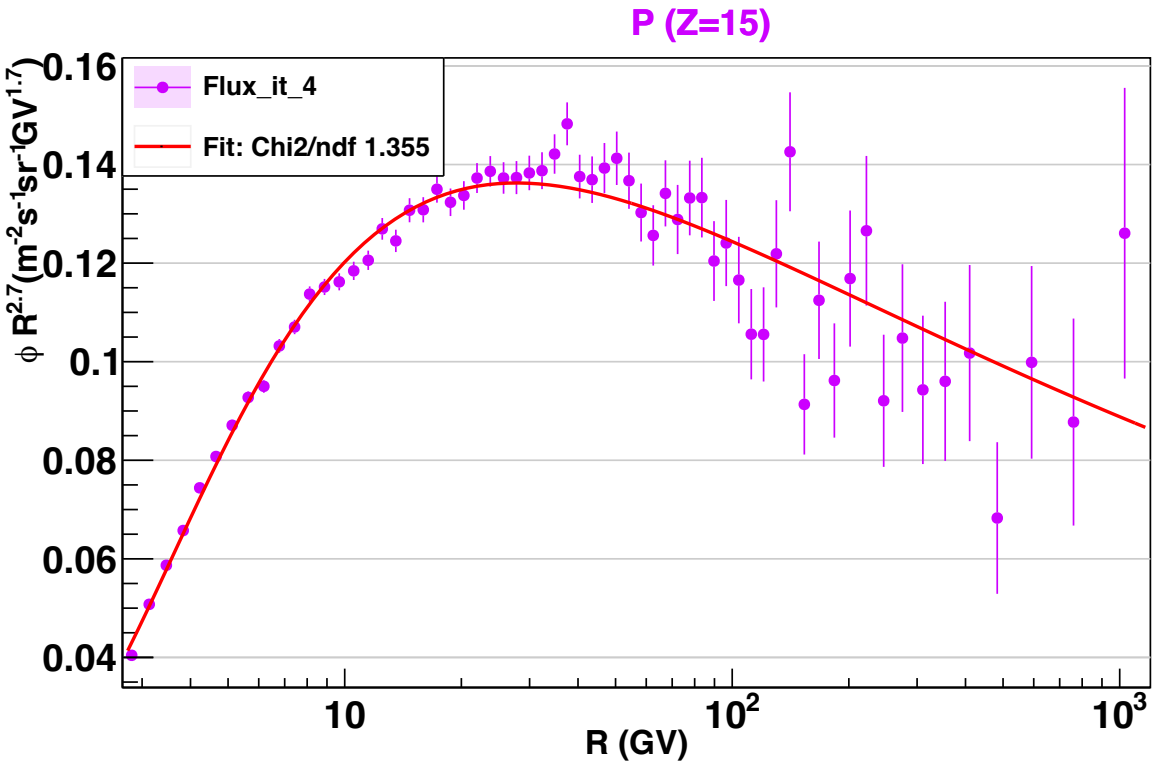


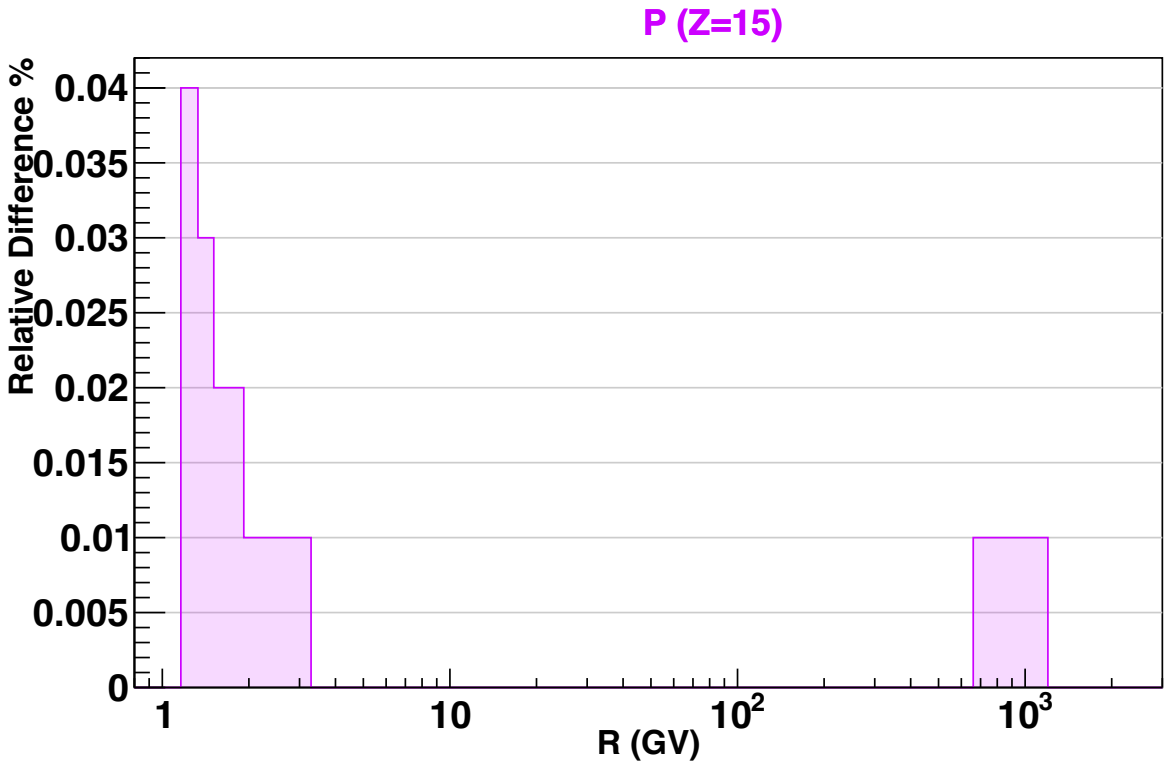
Unfolding – iteration 3



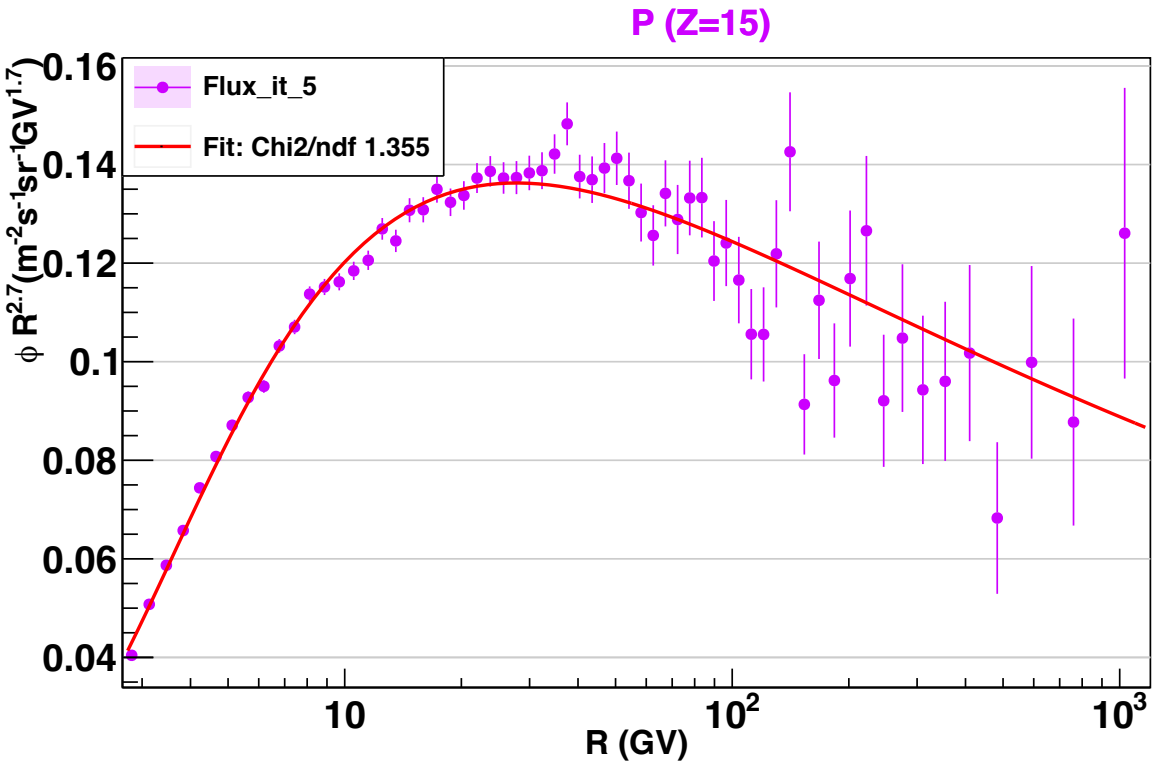


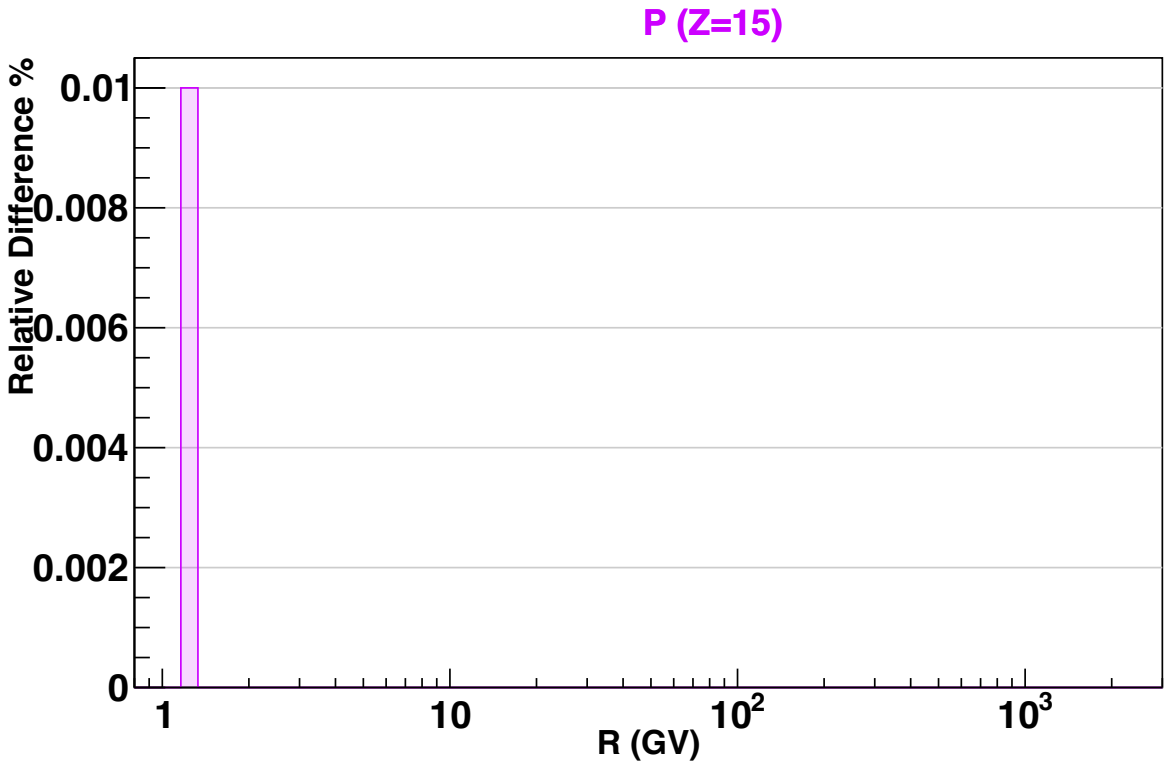
Unfolding – iteration 4



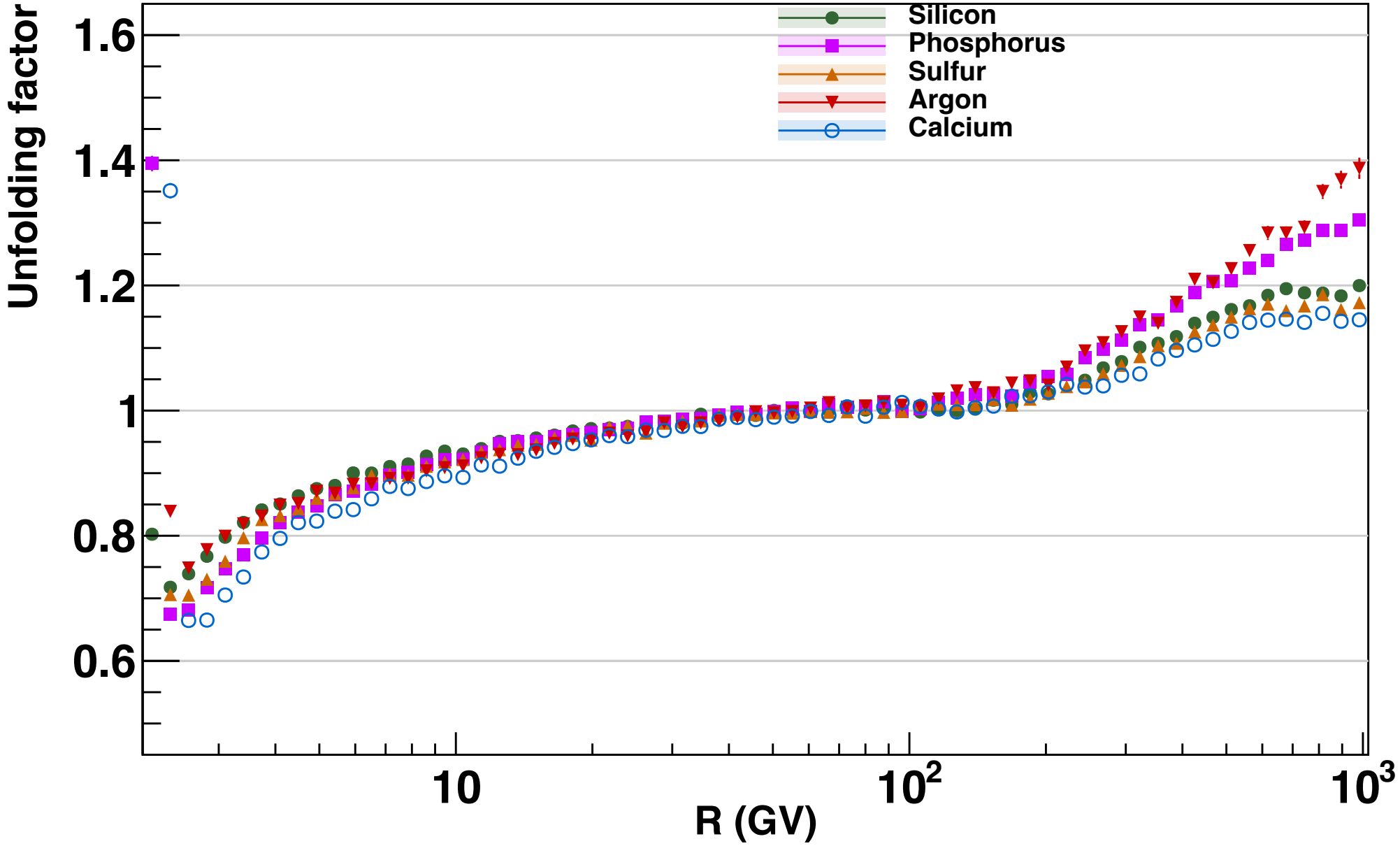


Unfolding – iteration 5

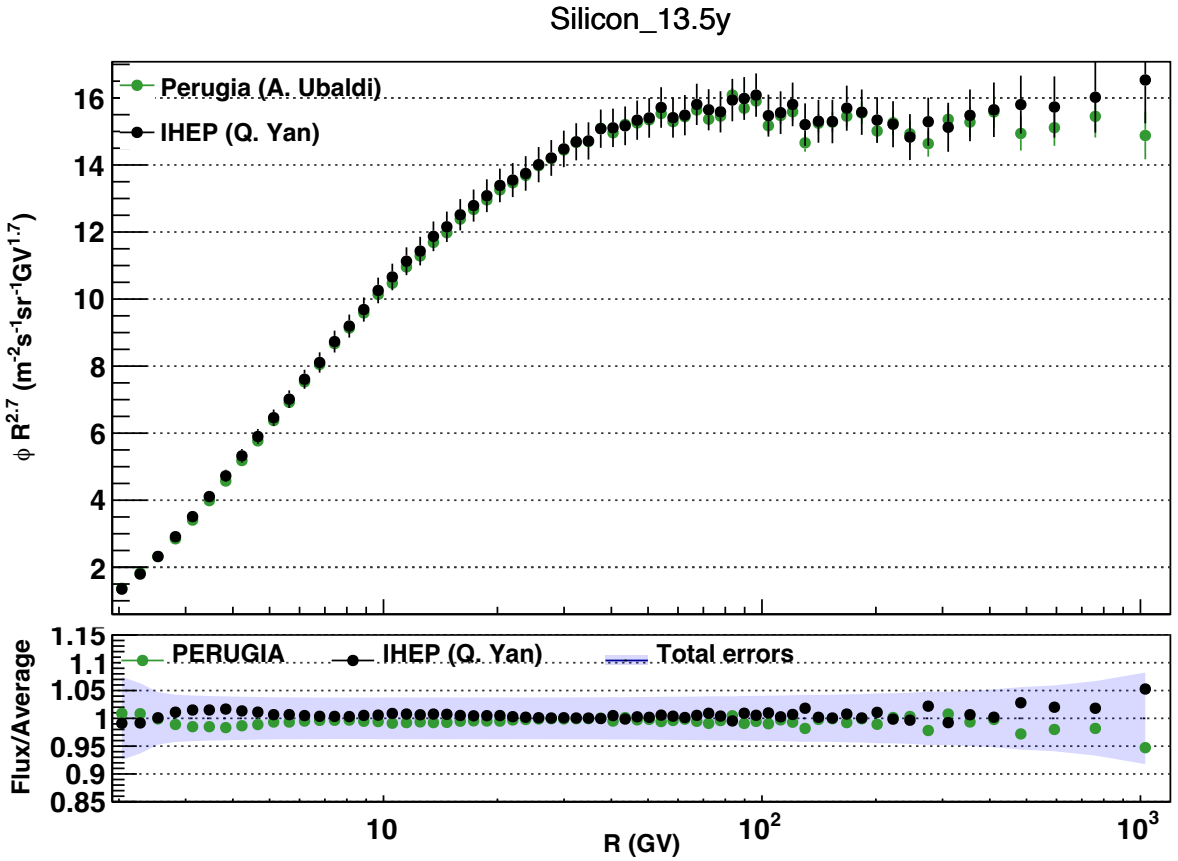


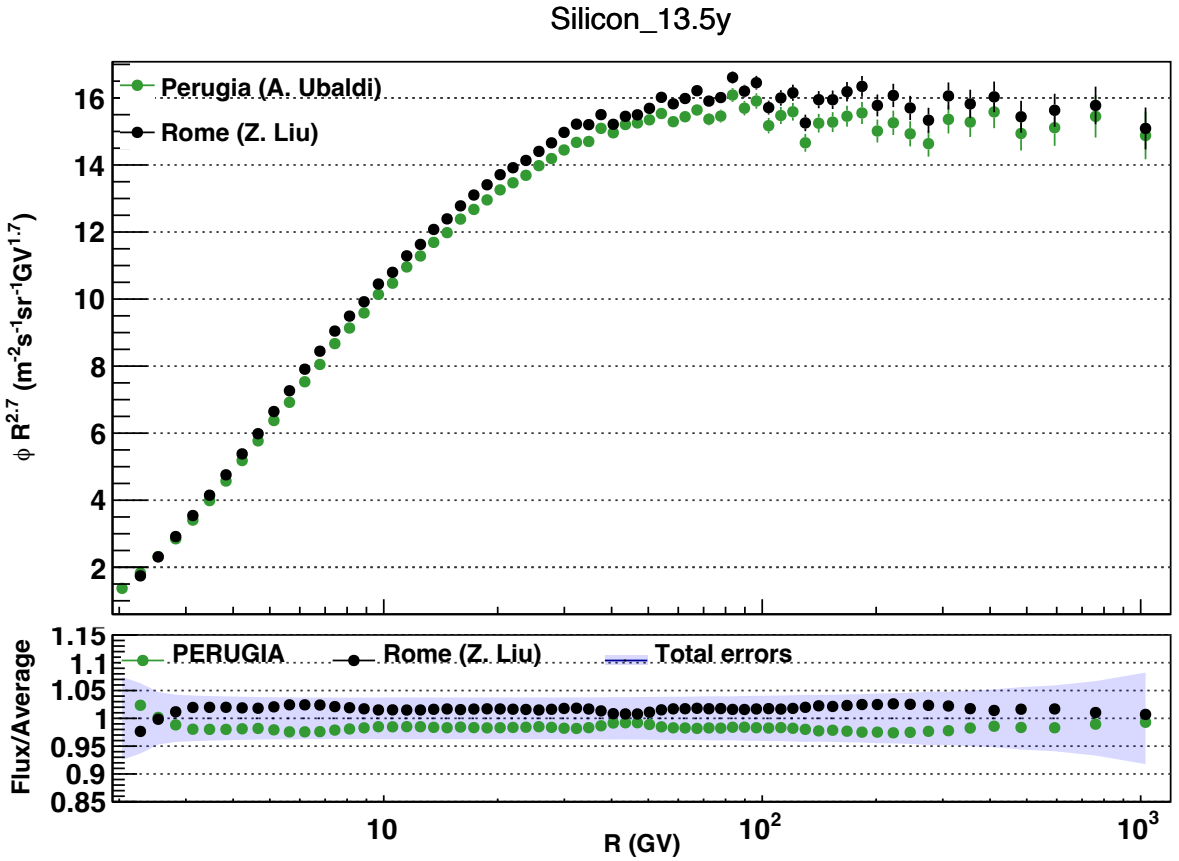


Unfolding factors

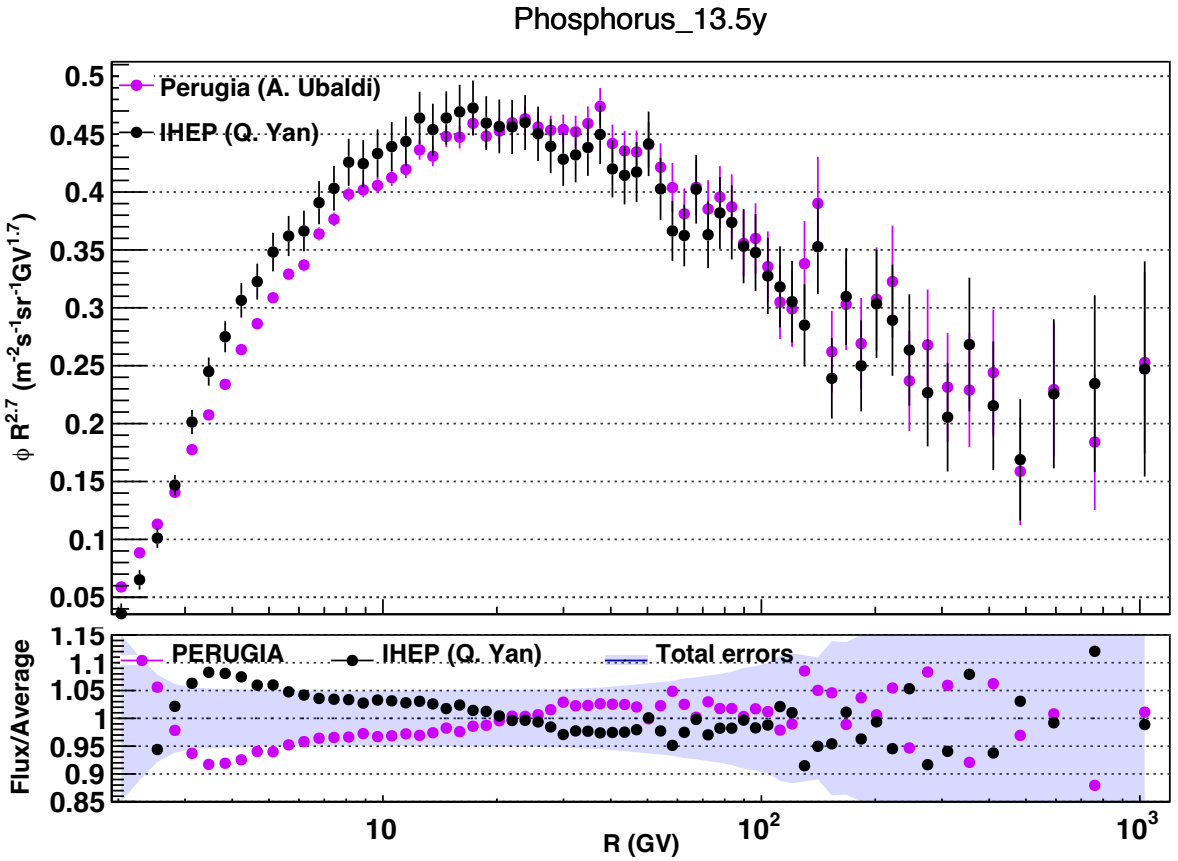


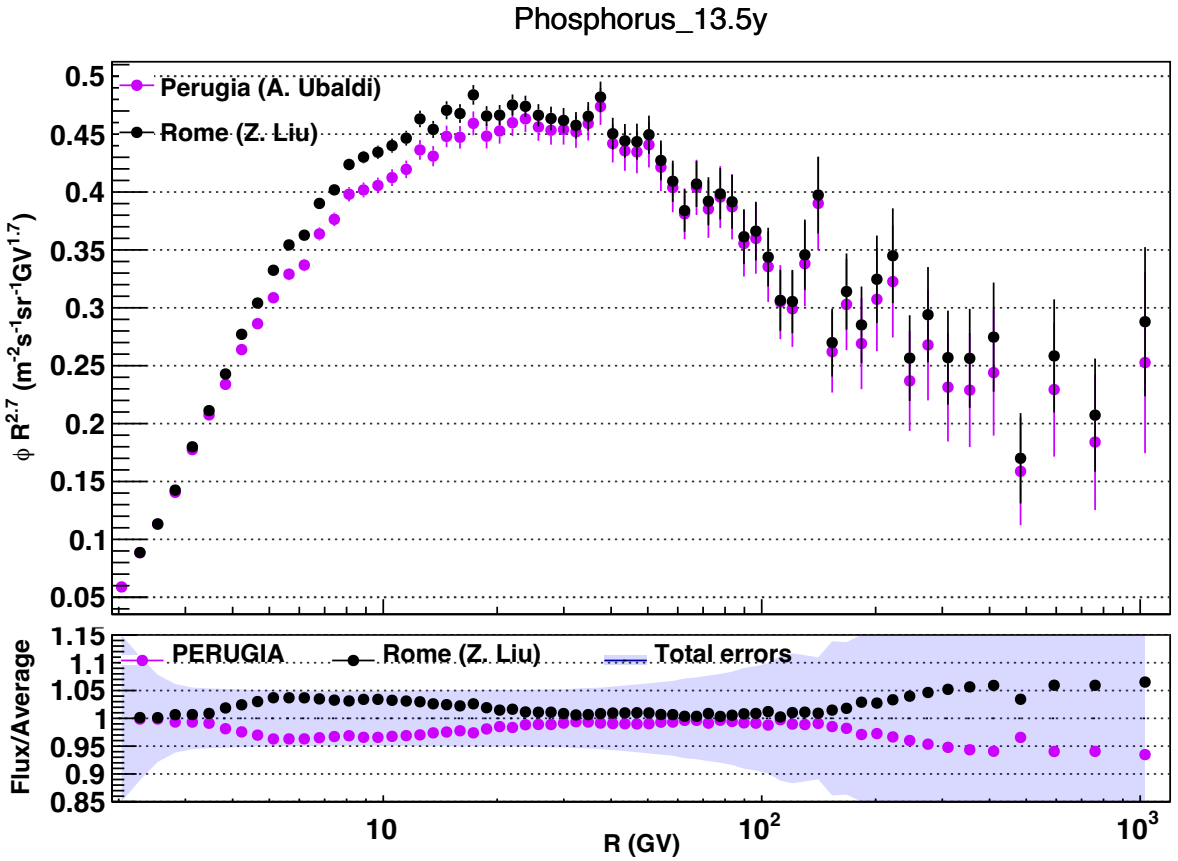
Fluxes
Silicon (Z=14)



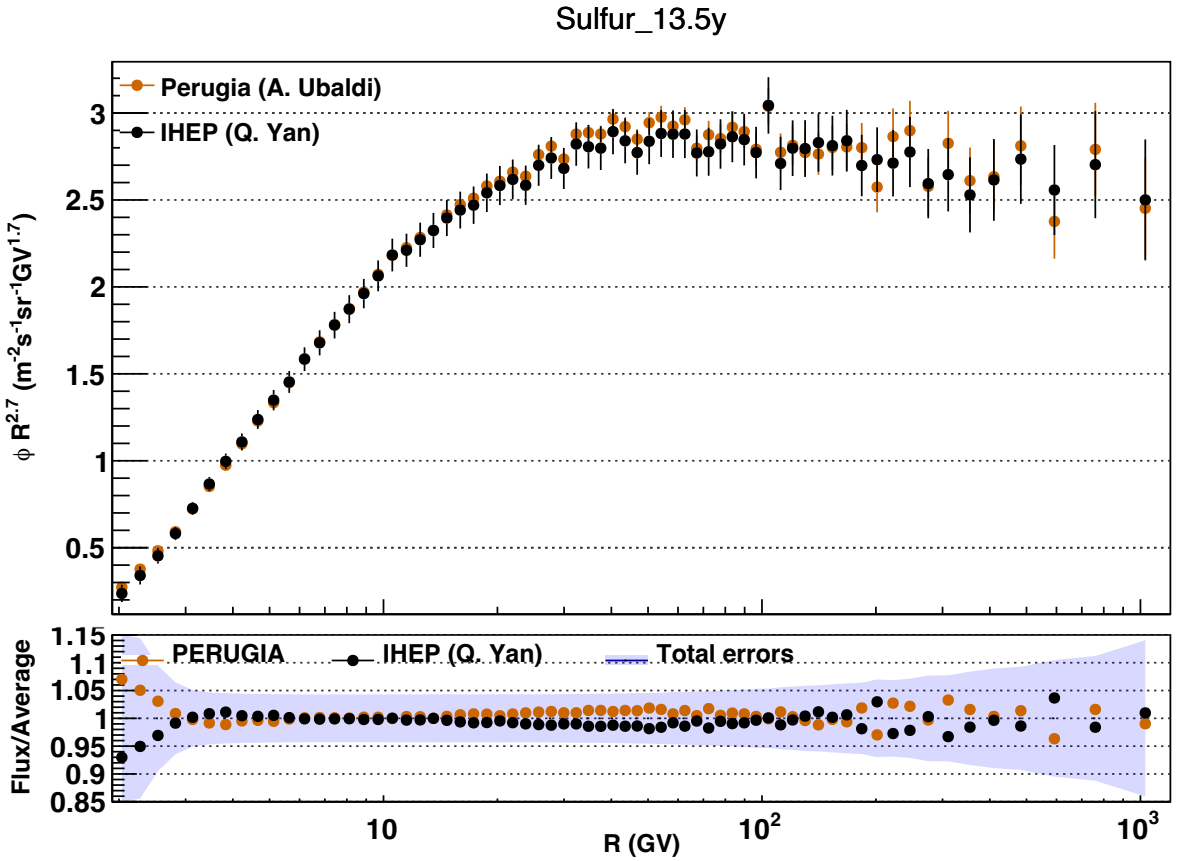


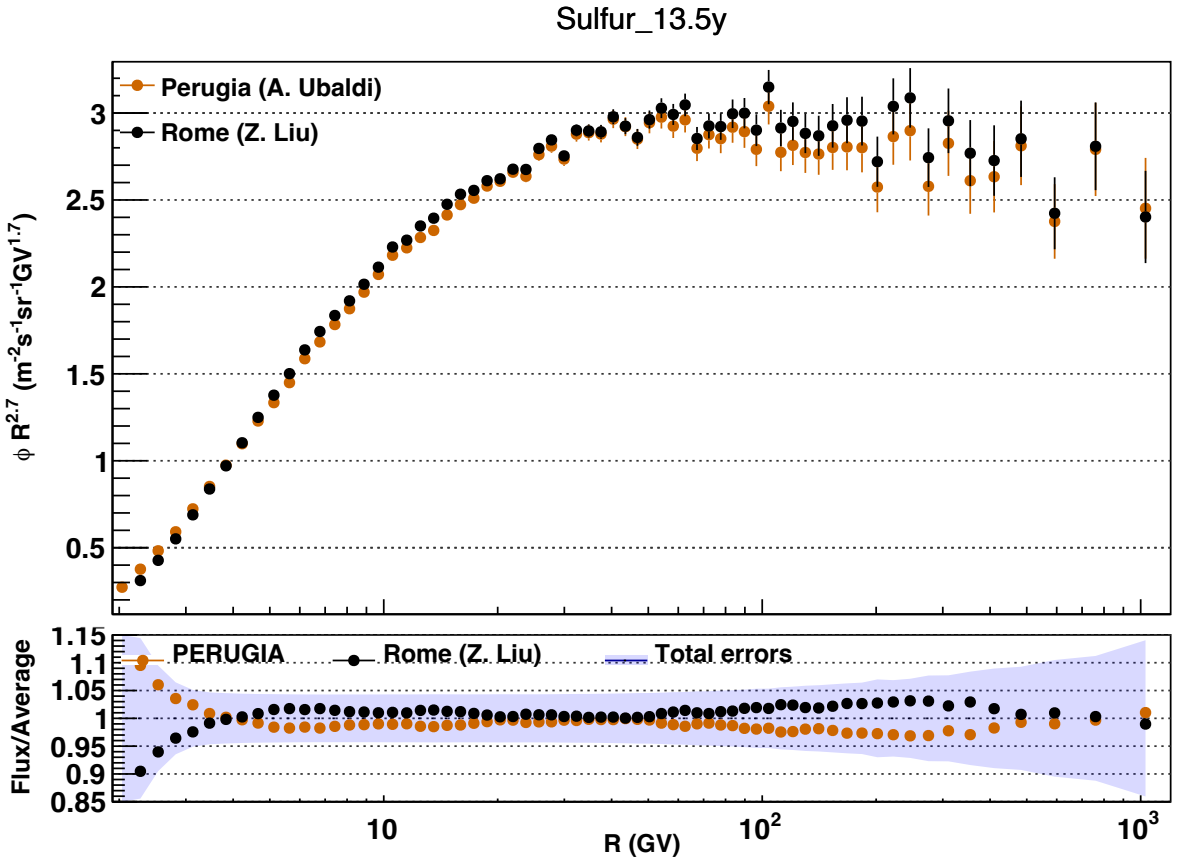
Fluxes
Phosphorus (Z=15)



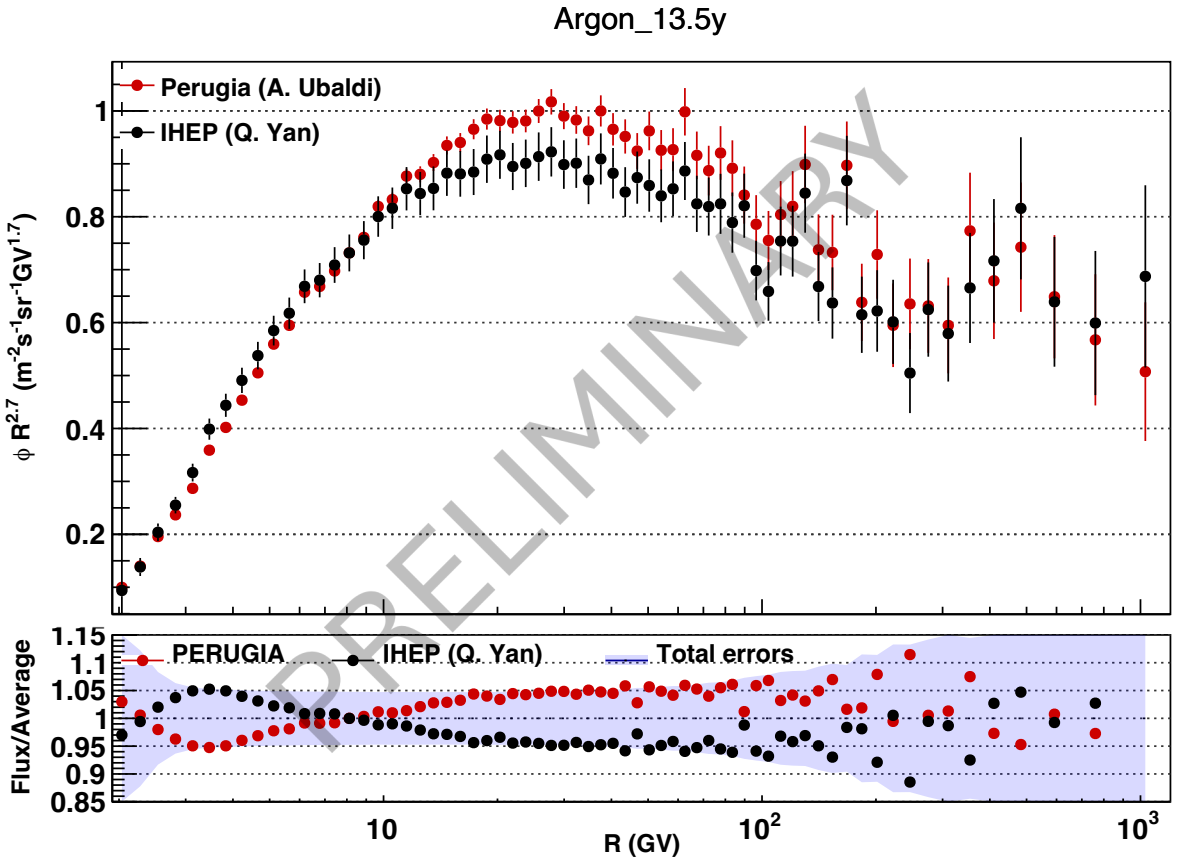


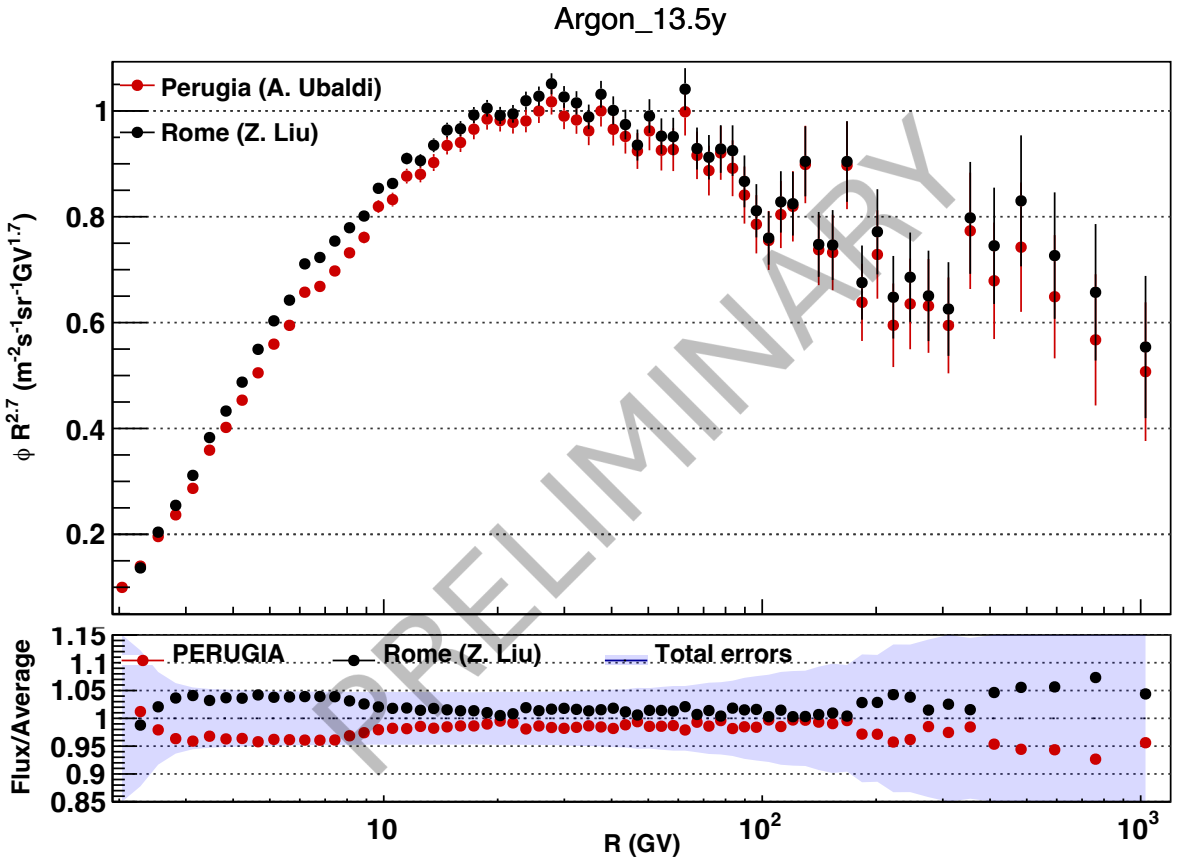
Fluxes
Sulfur (Z=16)



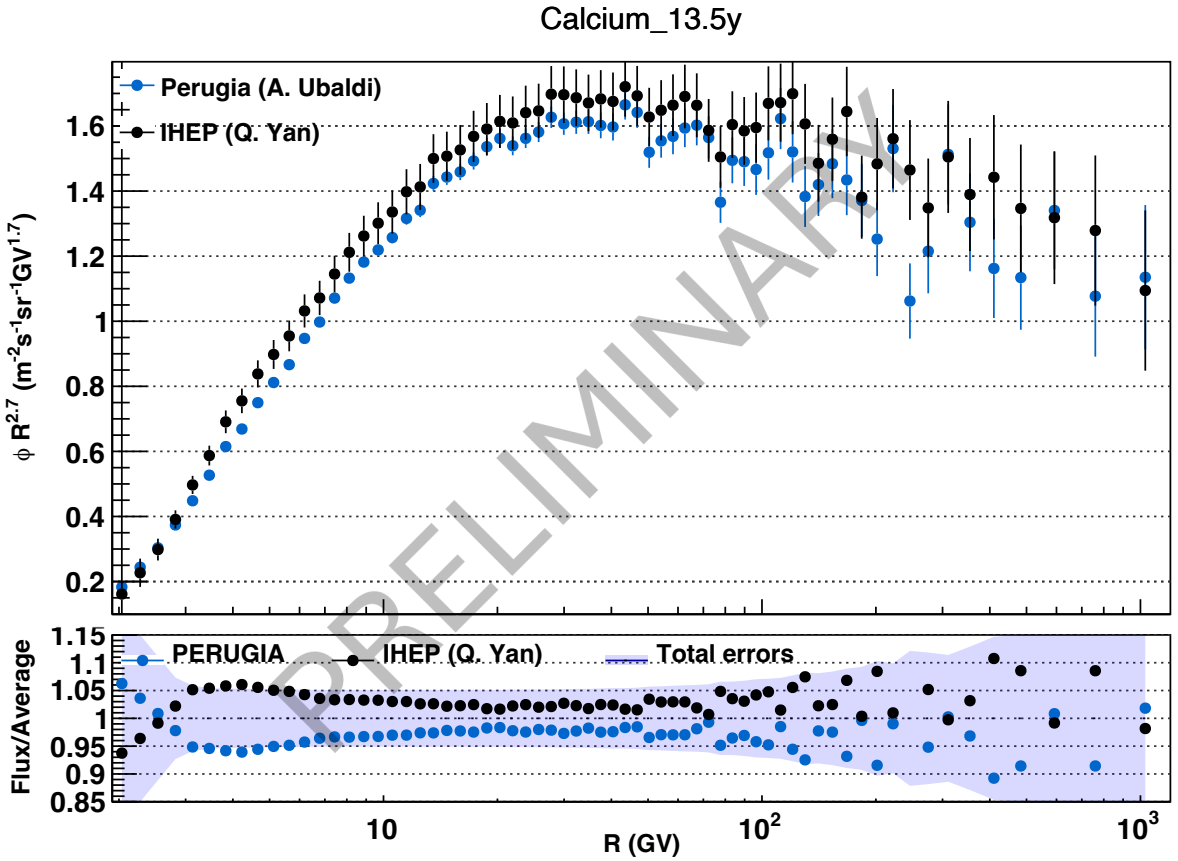


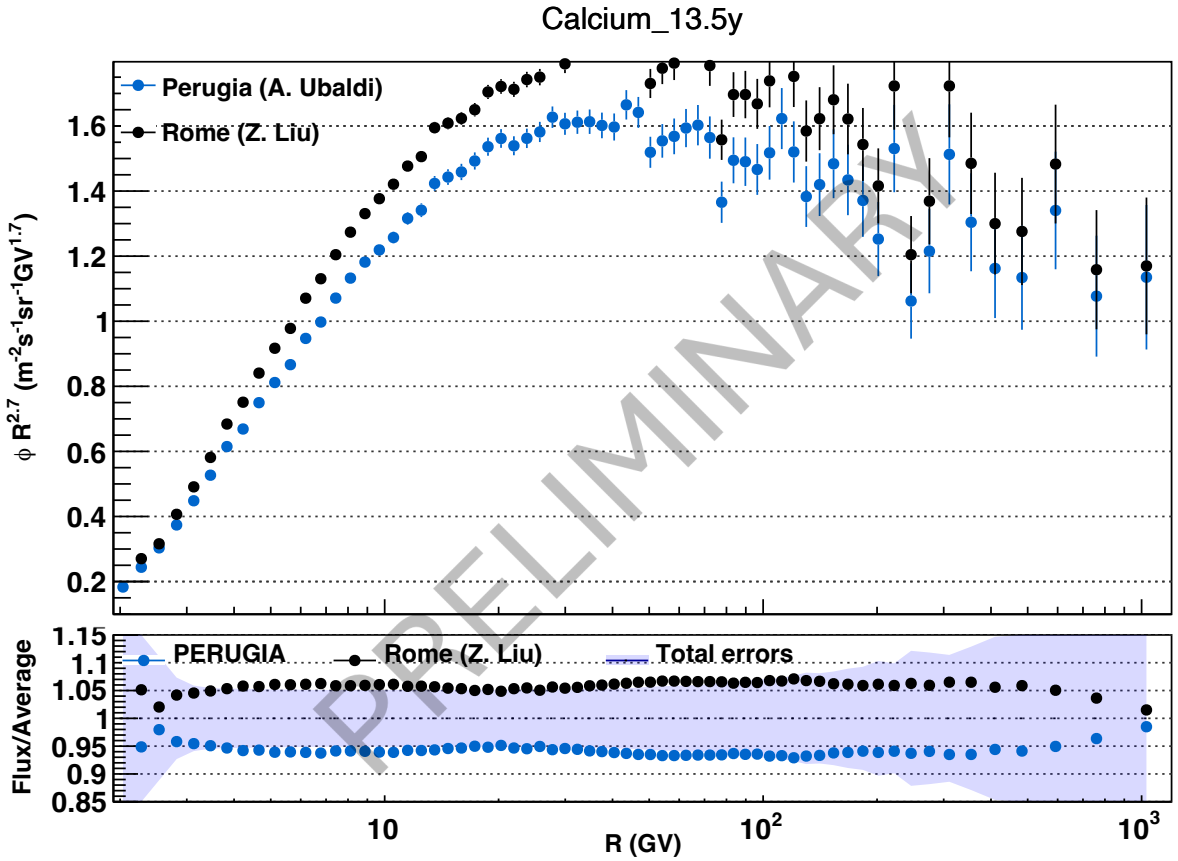
Fluxes
Argon (Z=18)





Fluxes
Calcium (Z=20)





Backup

L1 detection efficiency

Denominator

- Physics trigger
- $\beta > 0.4$
- UToF charge in «common» range
- Hit pattern: L2 && (L3 || L4) && (L5 || L6) && (L7 || L8)
- N° of inner tracker Y hits > 4
- Inner tracker charge in «*common*» range
- $\chi^2_y < 10$ (Inn)
- Track (Inn) in L1 and inner fiducial volume -> den
- Lower Tof charge [Z - 0.4, Z + 0.4] -> den+ltof
- Unbiased L9 charge [Z - 0.5,) -> den+ltof+UnbL9
- Unbiased L9 charge [Z - 0. ,) -> den+ltof+UnbL9>

Utof charge cut

Z=14	Z=15	Z=16	Z=18	Z=20
(13.3, 15.5)	(14.2, 16.5)	(15.2, 17.5)	(17.2,1 9.5)	(19.1, 21.5)

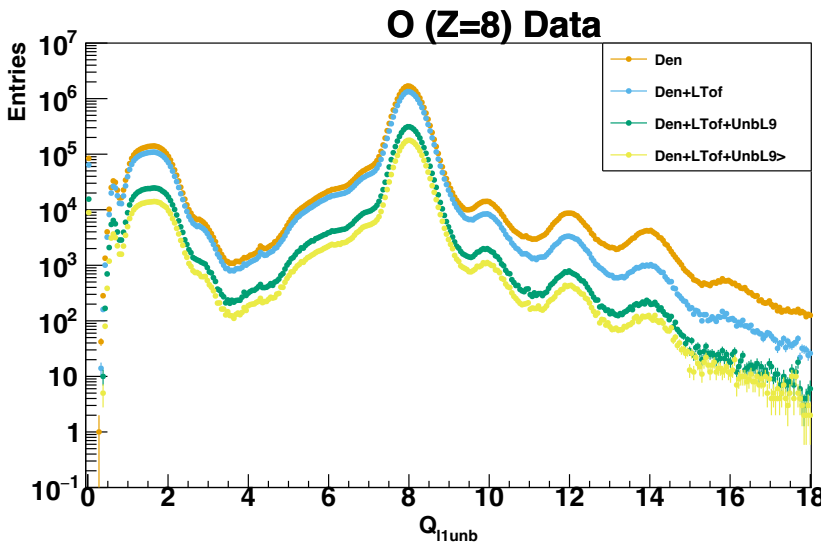
Inner tracker charge cut

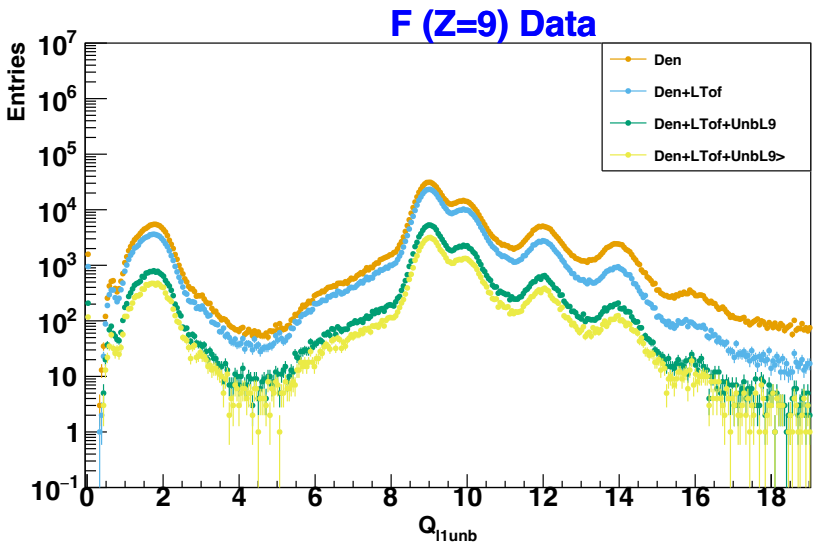
Z=14	Z=15	Z=16	Z=18	Z=20
(13.5, 14.5)	(14.5, 15.5)	(15.5, 16.5)	(17.5, 18.5)	(19.5, 20.5)

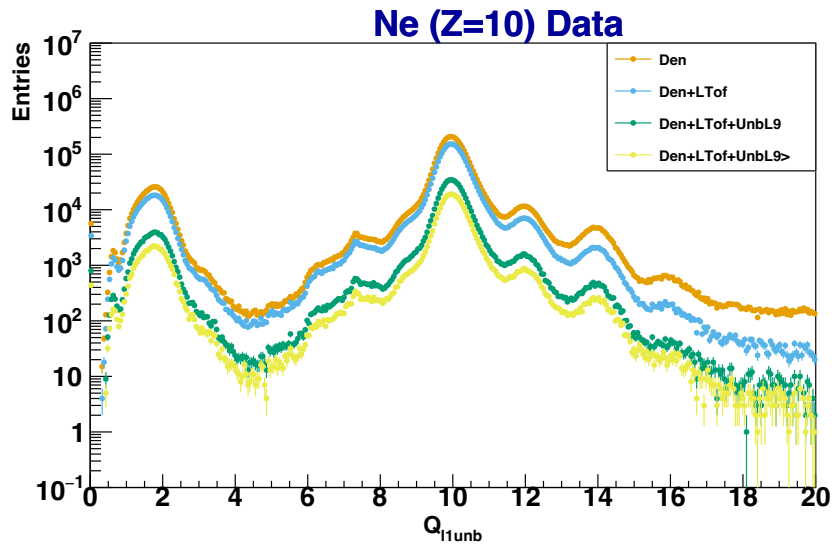
Numerator

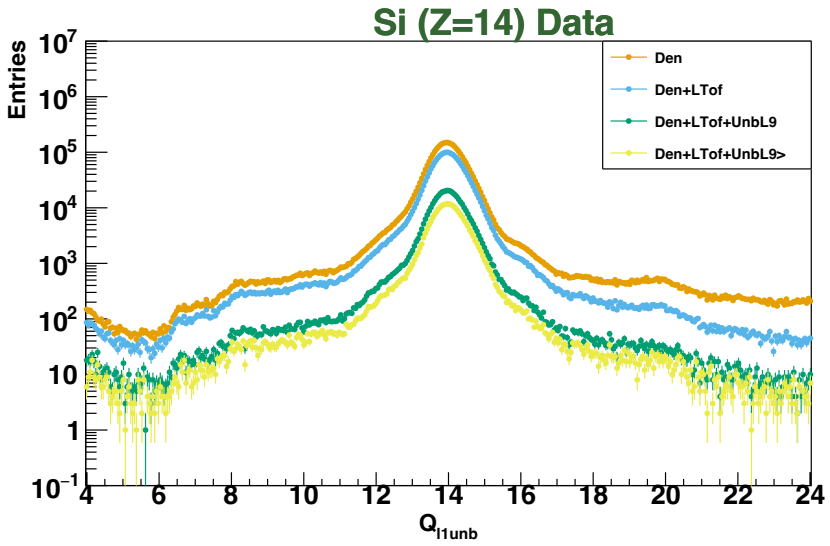
- Denominator
- Unbiased hit on L1 && with «good» status
- Unbiased L1 charge > Z – 2

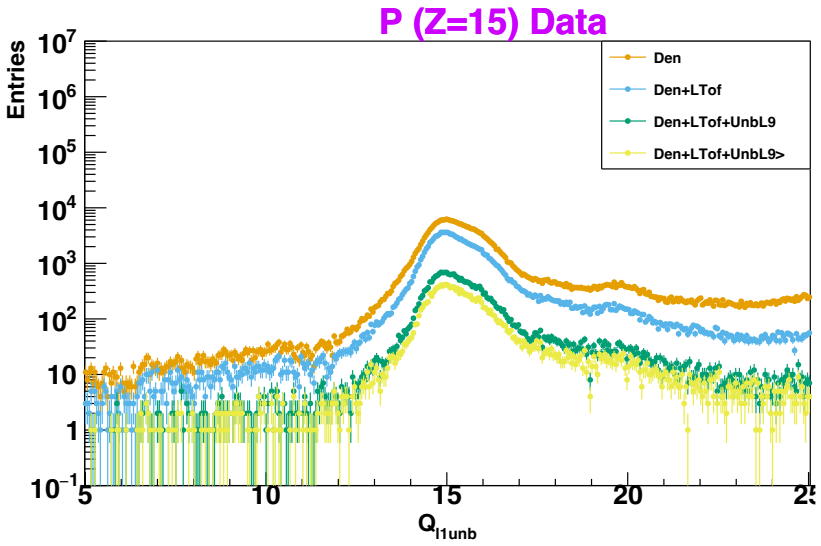
L1 detection efficiency

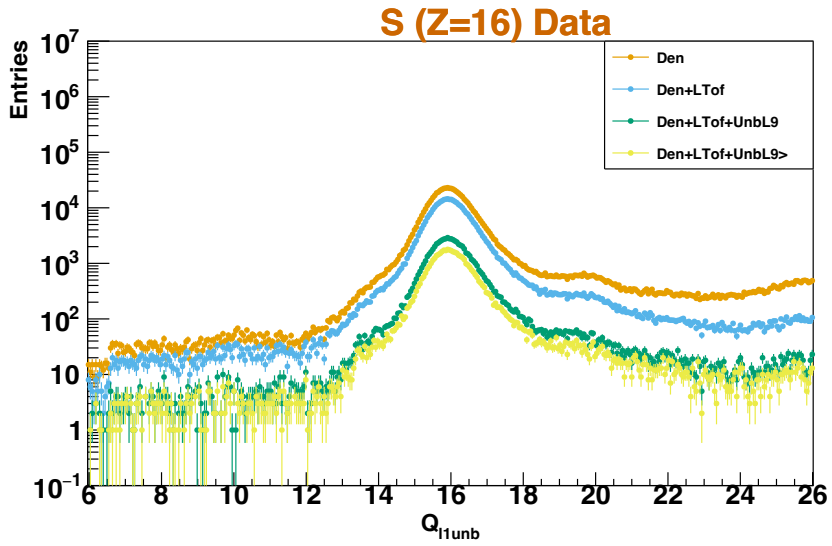




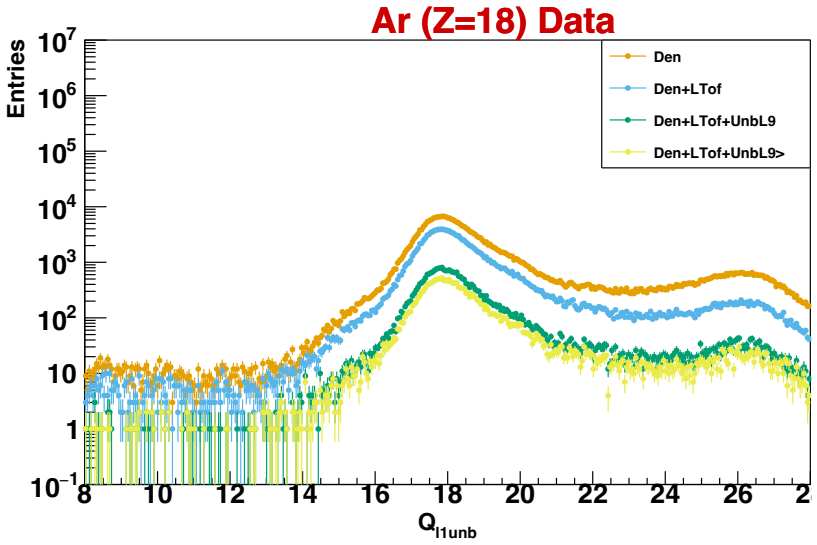


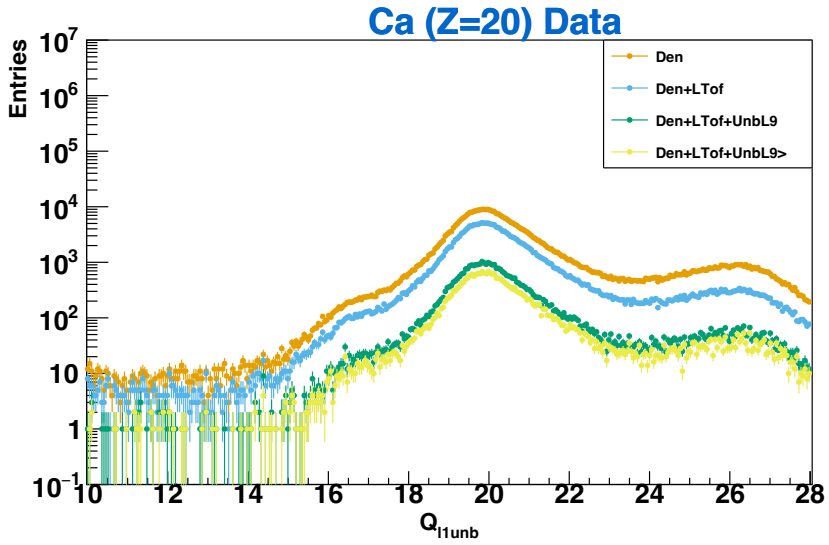


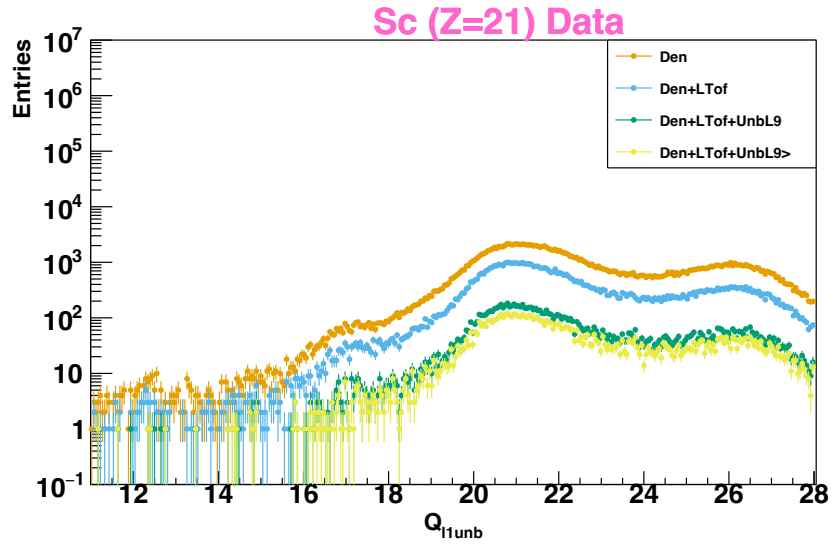


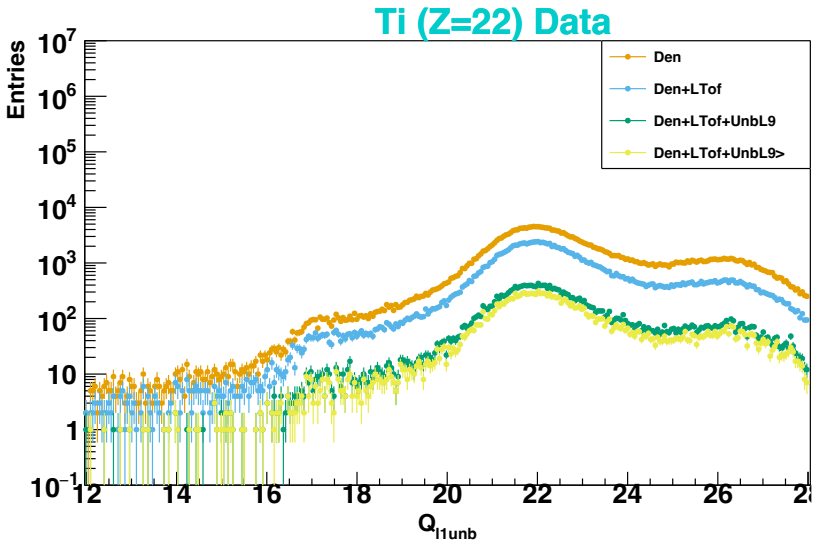


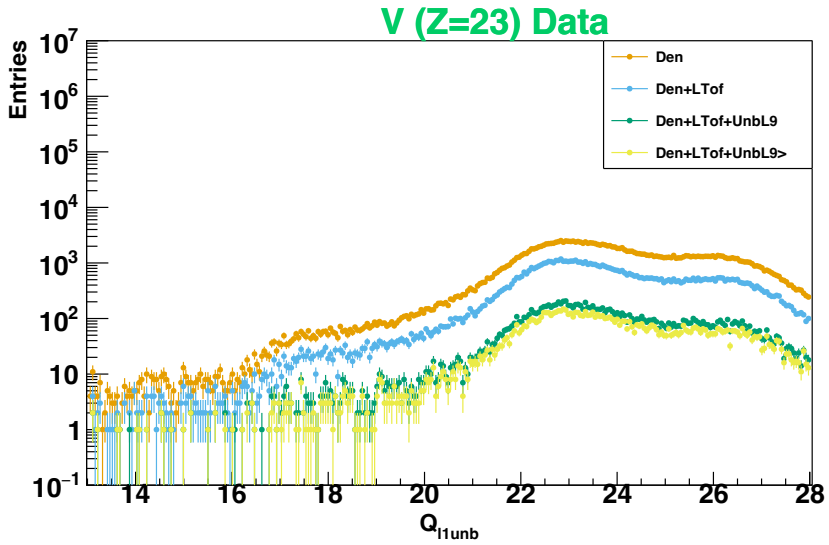
L1 detection efficiency

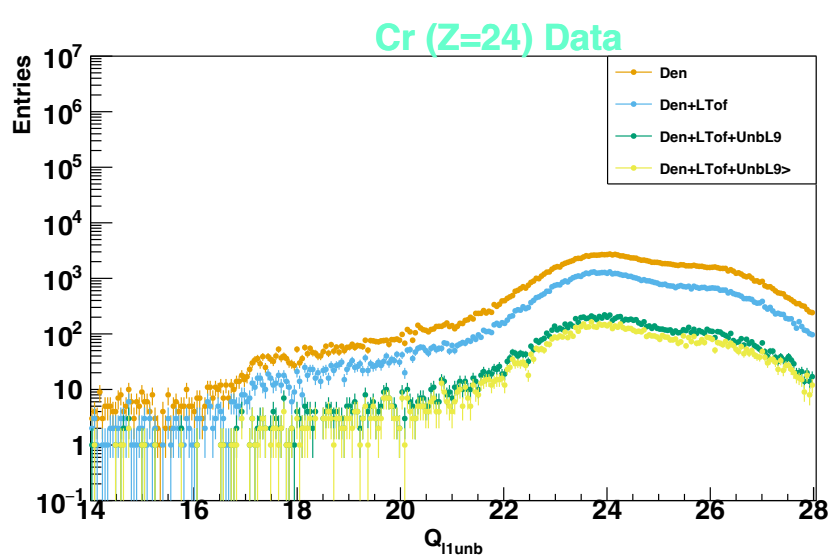




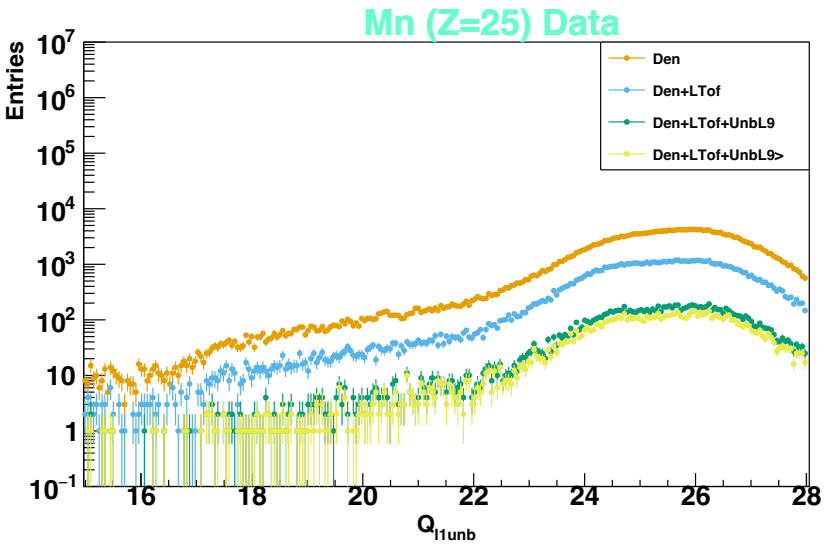


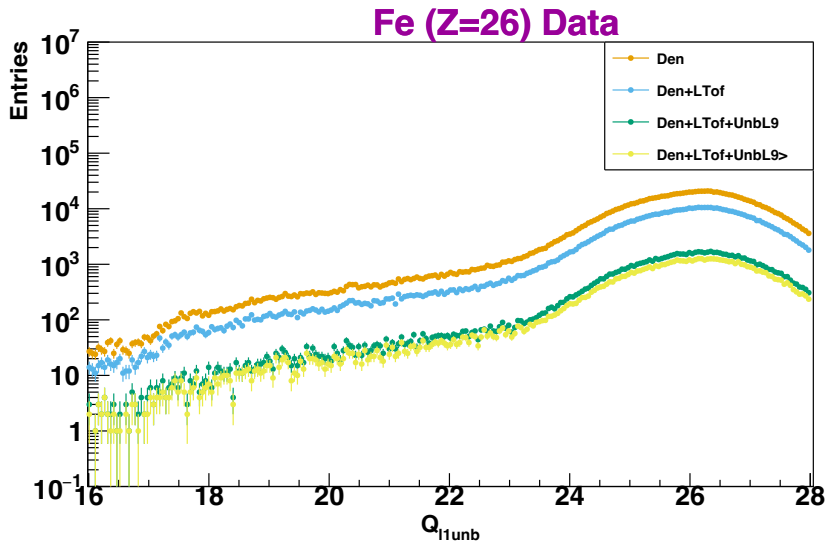






L1 detection efficiency





L1 pickup efficiency

Denominator

- Physics trigger
- $\beta > 0.4$
- UToF charge in «common» range
- Hit pattern: L2 && (L3 || L4) && (L5 || L6) && (L7 || L8)
- N° of inner tracker Y hits > 4
- Inner tracker charge in «*common*» range
- $\chi^2_y < 10$ (Inn)
- Track (Inn) in L1 and INN fiducial volume
- Unbiased hit on L1 && with «good» status
- **Unbiased L1 charge in «*common*» ranges -> background reduction**

L1 unbiased charge cut

Z=14	Z=15	Z=16	Z=18	Z=20
(12.4, 14.9)	(13.3, 15.9)	(14.2, 17.0)	(16.0, 19.0)	(17.8, 21.1)

Utof charge cut

Z=14	Z=15	Z=16	Z=18	Z=20
(13.3, 15.5)	(14.2, 16.5)	(15.2, 17.5)	(17.2,1 9.5)	(19.1, 21.5)

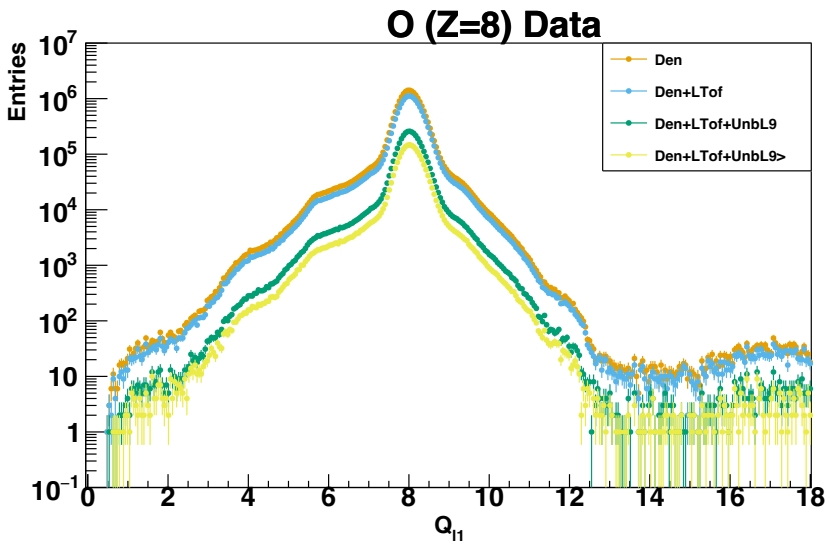
Inner tracker charge cut

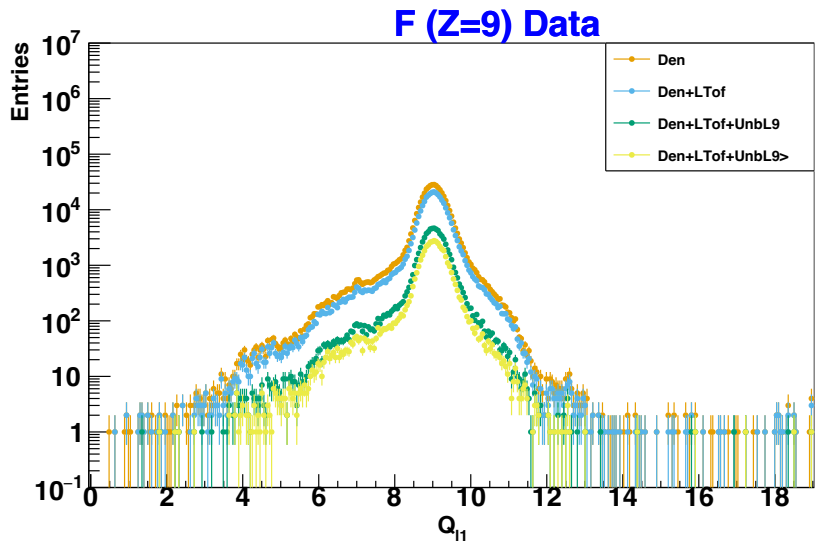
Z=14	Z=15	Z=16	Z=18	Z=20
(13.5, 14.5)	(14.5, 15.5)	(15.5, 16.5)	(17.5, 18.5)	(19.5, 20.5)

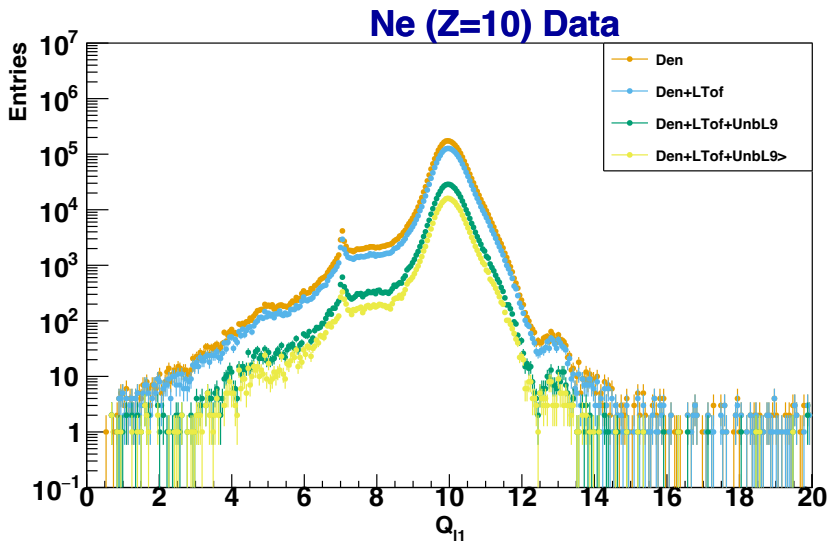
Numerator

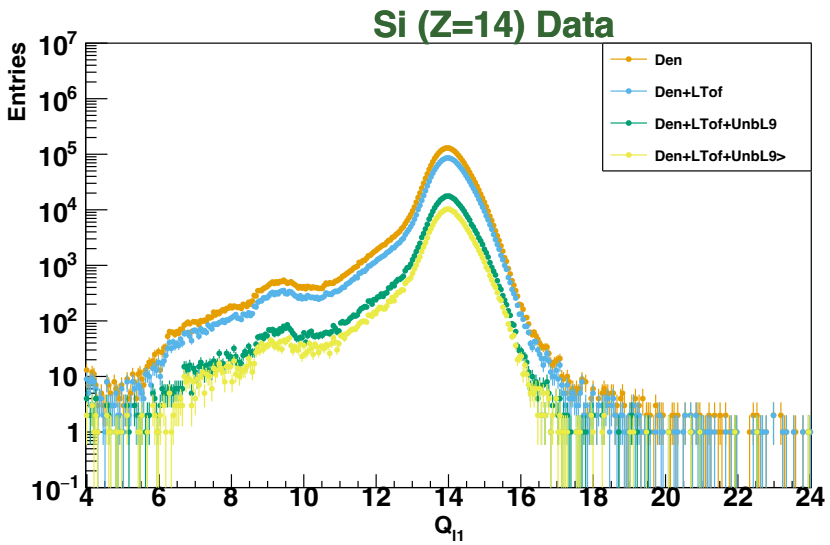
- Denominator
- L1 charge in «*common*» ranges
- L1 charge asymmetry $(Z_x - Z_y)/(Z_x + Z_y) < 0.2$
- Hit on L1 && with «*good*» status
- L1 normalized residuals < 10 $\chi^2_{IL1} \cdot ndf_{IL1} - \chi^2_{INN} \cdot ndf_{INN}$
- $\chi^2_y < 10$ (IL1)
- Track (IL1) in L1 and INN fiducial volume

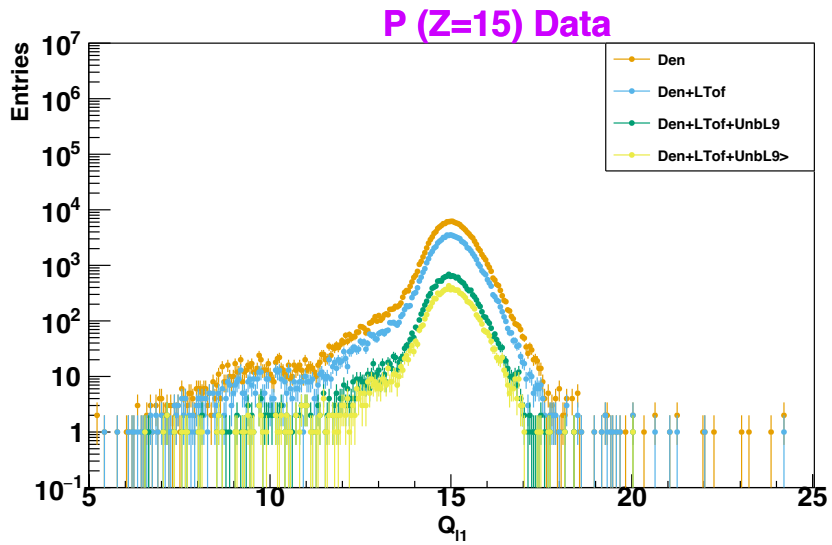
L1 pickup efficiency

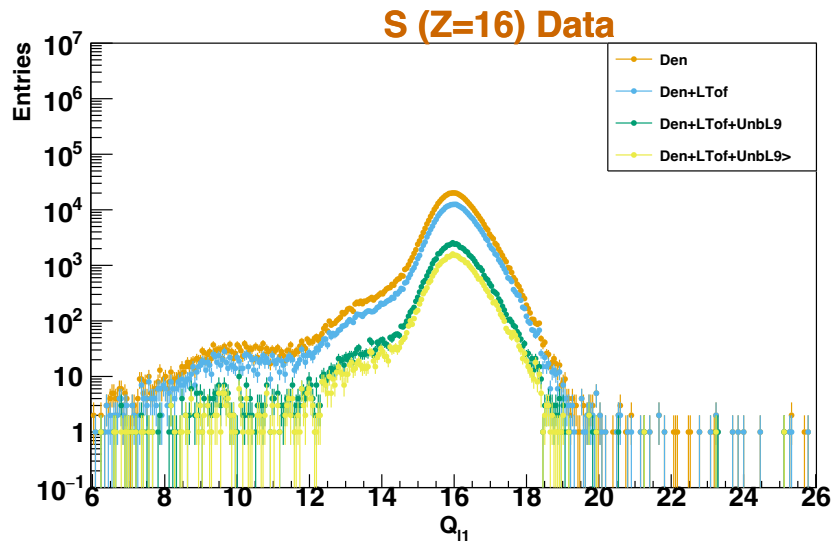




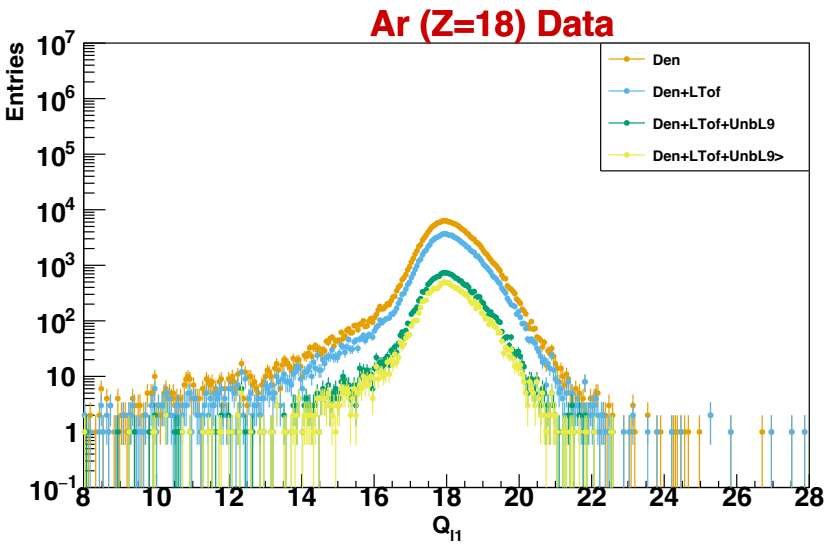


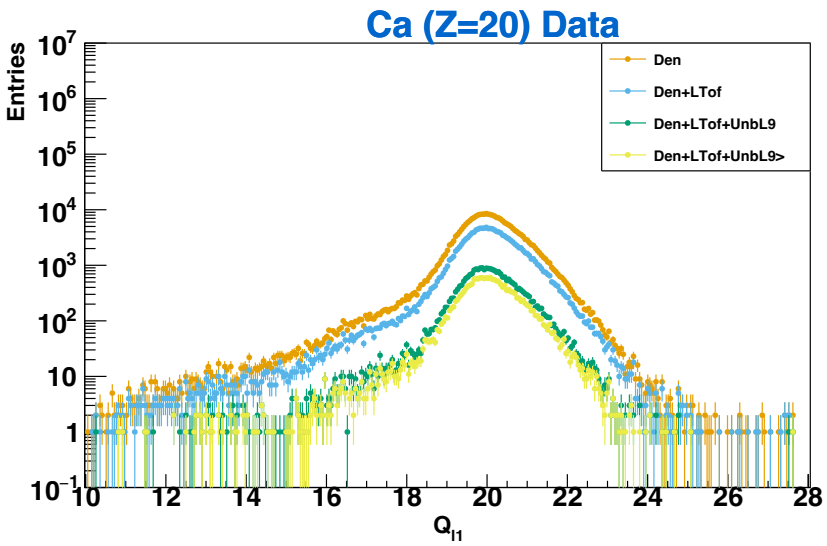


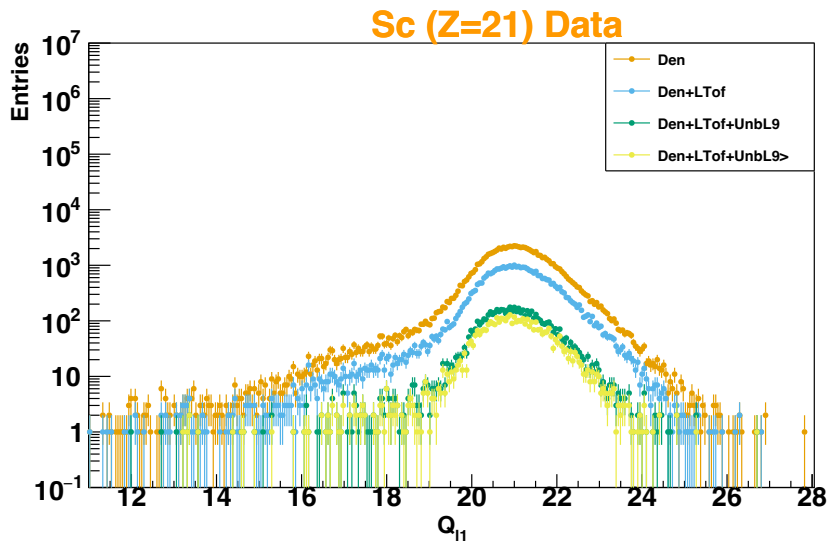


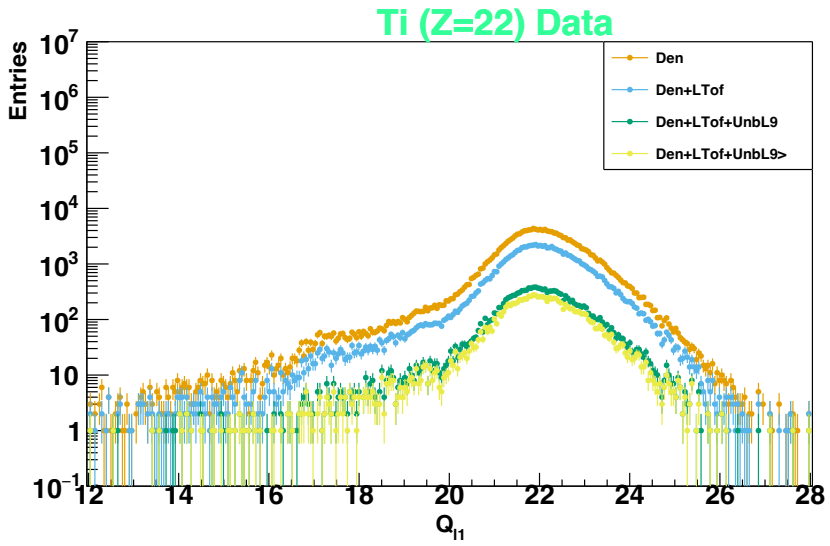


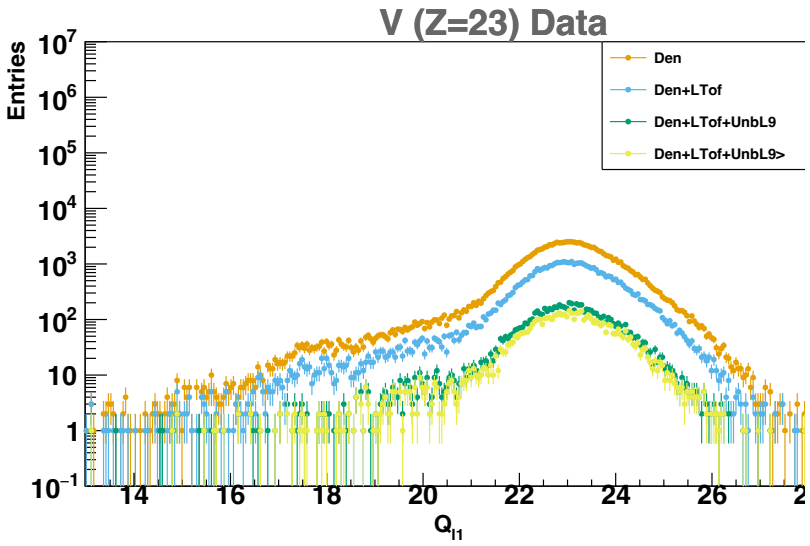
L1 pickup efficiency

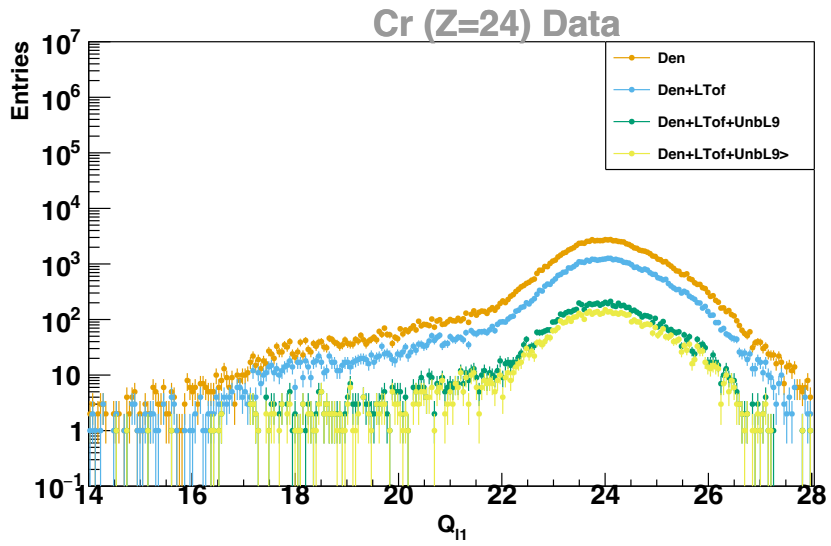




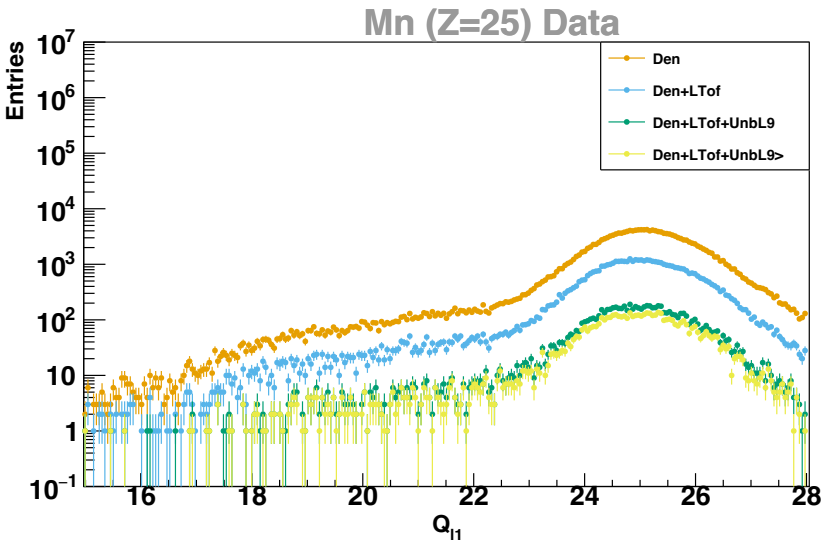


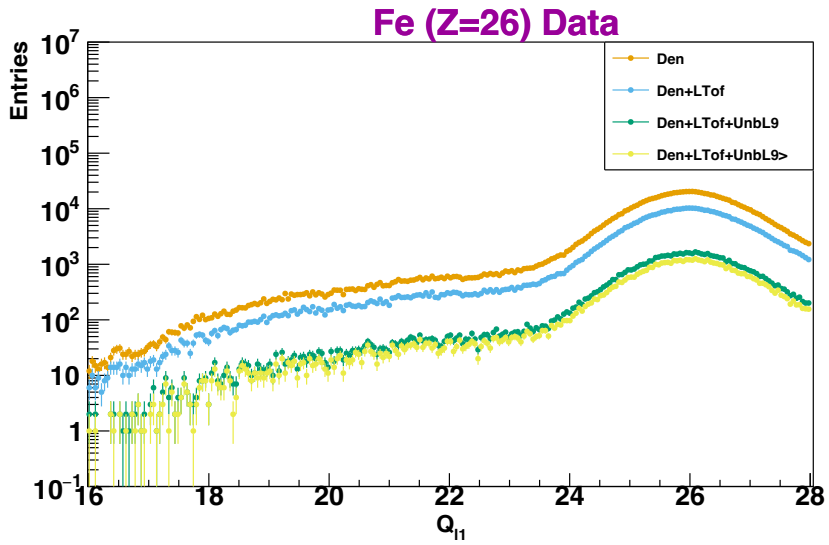






L1 pickup efficiency





Tracker charge efficiency

Denominator

- Physics trigger
- $\beta > 0.4$
- Hit Pattern: L2 && (L3 || L4) && (L5 || L6) && (L7 || L8)
- N° of inner tracker Y hits > 4
- $\chi^2_y < 10$ (Inn)
- Track (IL1) in L1 and inner fiducial volume
- Hit on L1 && with «*good*» status
- L1 charge in «*common*» ranges
- L1 charge asymmetry $(Z_x - Z_y)/(Z_x + Z_y) < 0.2$
- Upper ToF charge [Z - 0.4, Z + 0.4]
- **Lower ToF charge [Z - 0.4, Z + 0.4]**
- **Unbiased L9 charge > Z-0.5**

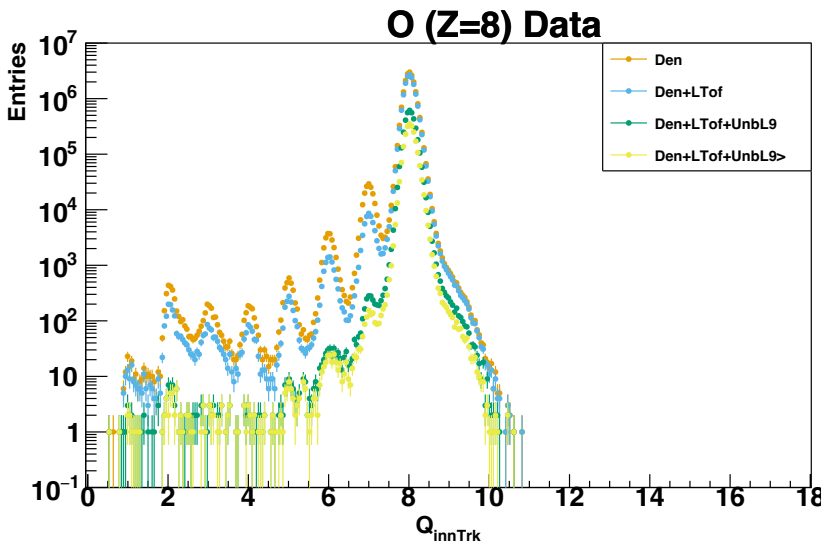
Numerator

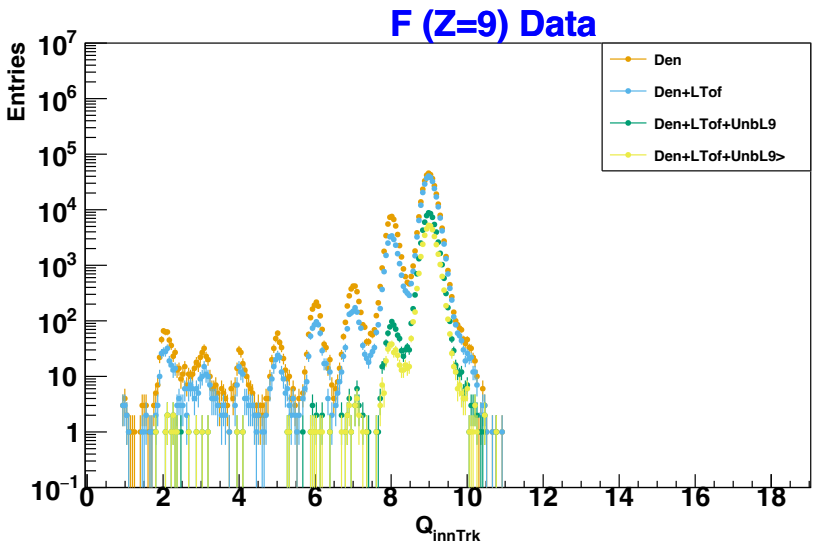
- Denominator
- Inner tracker charge in «*common*» ranges

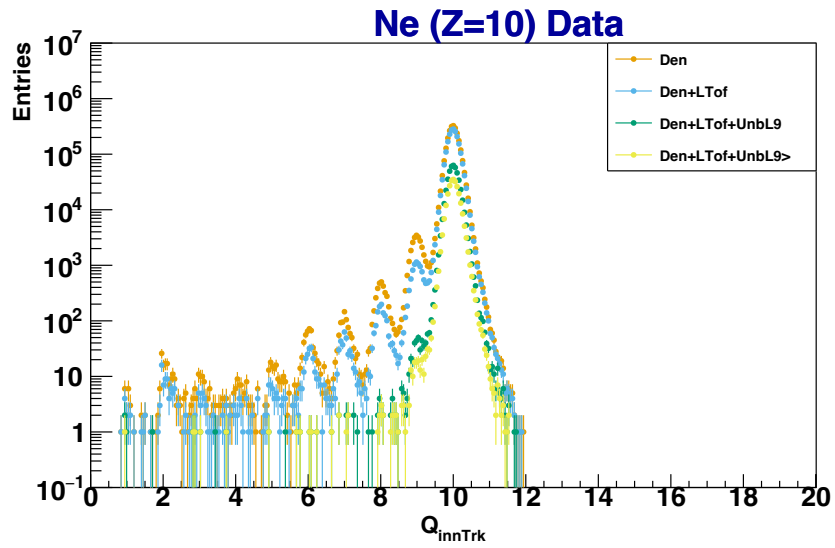
L1 charge cut

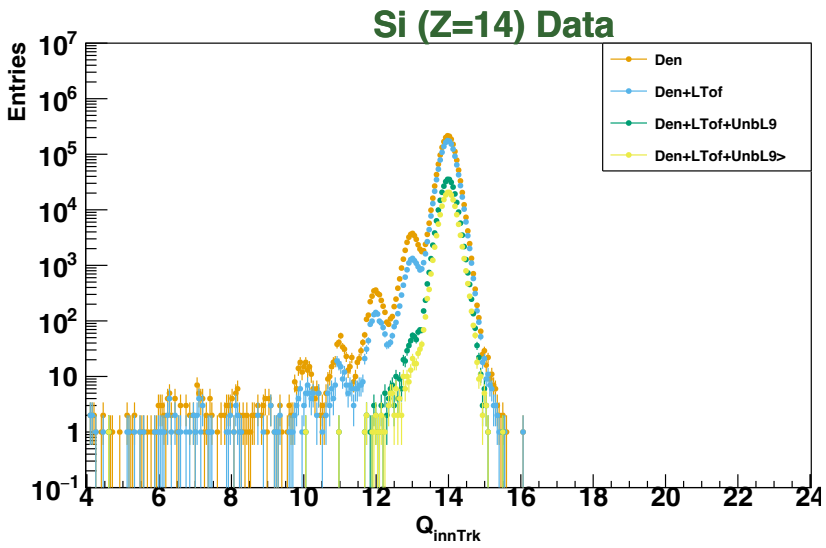
Z=14	Z=15	Z=16	Z=18	Z=20
(12.4, 14.9)	(13.3, 15.9)	(14.2, 17.0)	(16.0, 19.1)	(17.8, 21.2)

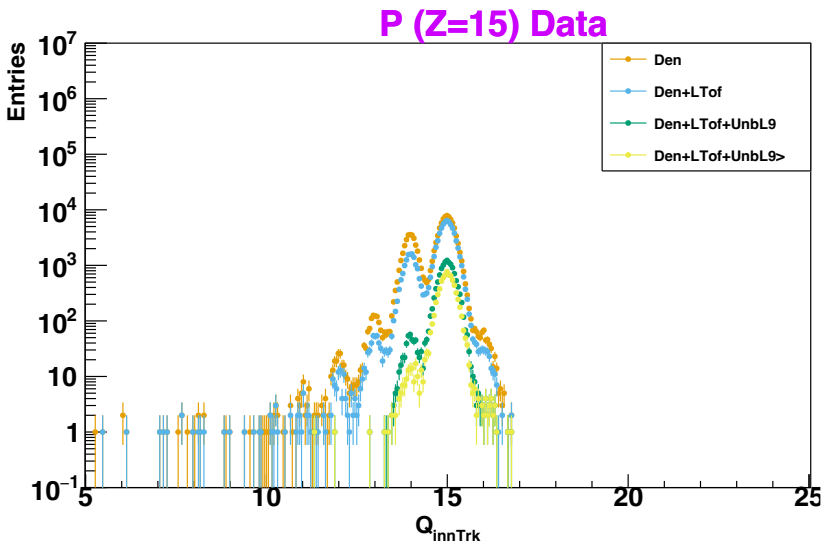
Tracker charge efficiency

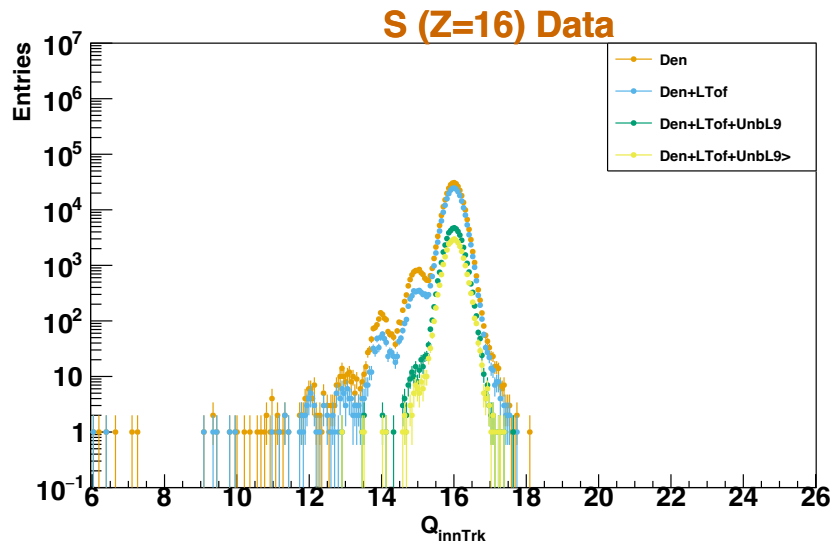




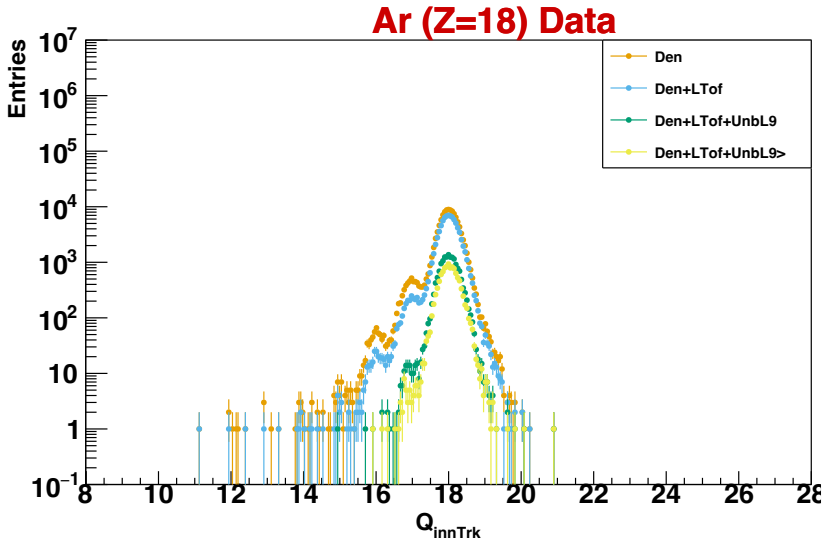


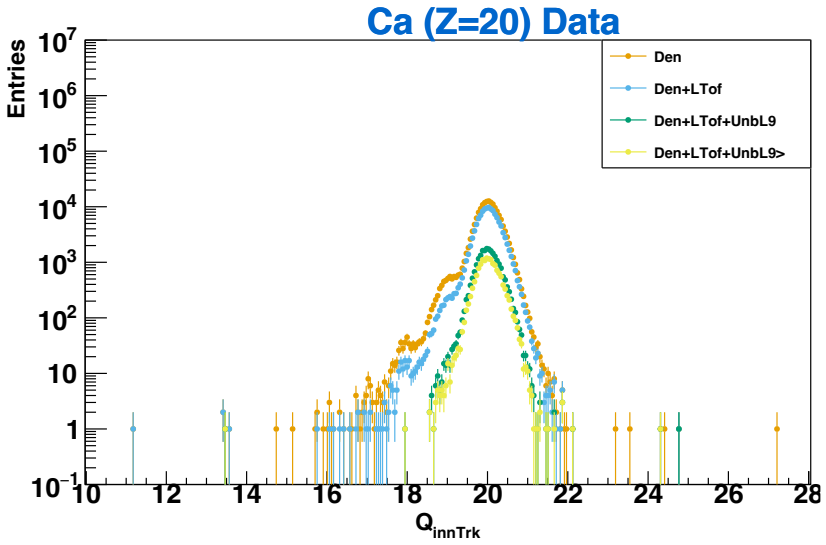


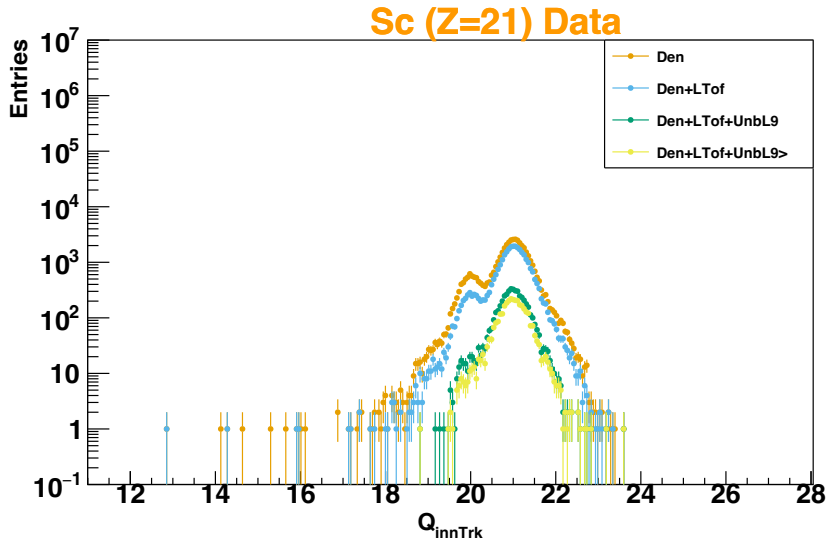


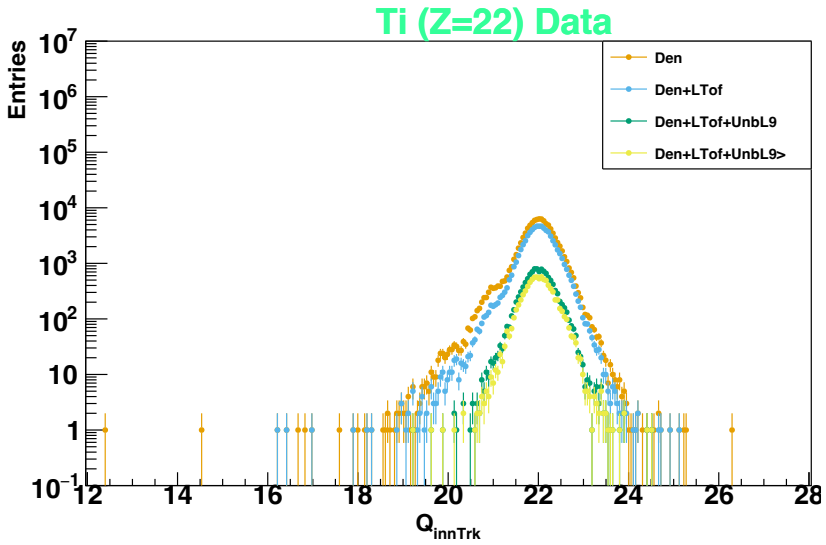


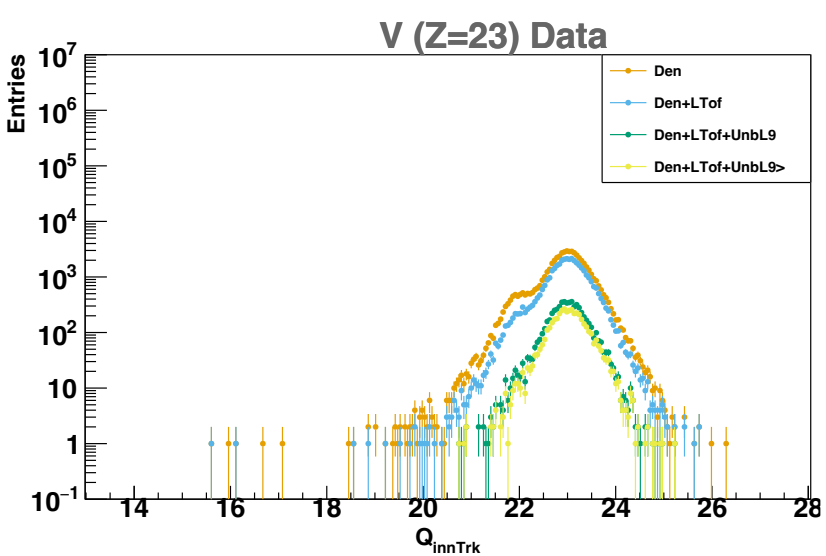
Tracker charge efficiency

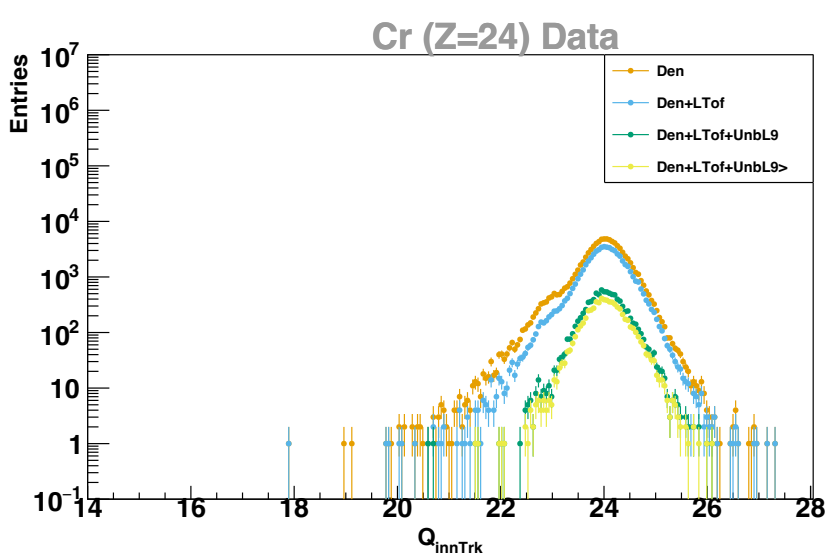




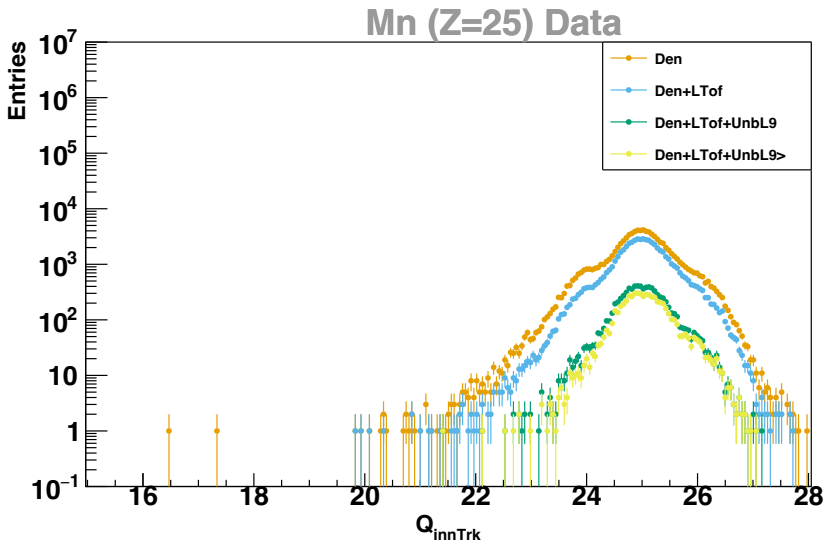


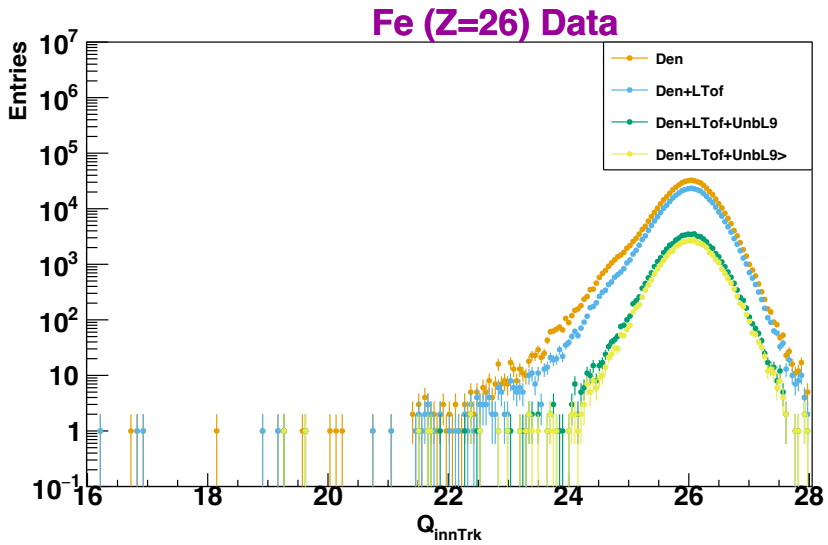






Tracker charge efficiency





UTof efficiency

Denominator

- Physics trigger
- Hit pattern: L2 && (L3 || L4) && (L5 || L6) && (L7 || L8)
- N° of inner tracker Y hits > 4
- Inner tracker and L1 charge in [Z - 0.5, Z + 0.5]
- L1 normalized residuals < 10 $\chi^2_{\mathrm{IL1}} \cdot \mathrm{ndf}_{\mathrm{IL1}} - \chi^2_{\mathrm{INN}} \cdot \mathrm{ndf}_{\mathrm{INN}}$
- L1 charge asymmetry $(\mathrm{Z_x} - \mathrm{Z_y})/(\mathrm{Z_x} + \mathrm{Z_y}) < 0.2$
- Hit on L1 && with «*good*» status
- Track (IL1) in L1 and inner fiducial volume
- $\chi^2_{\mathrm{y}} < 10$ (both IL1 and INN)
- **Lower ToF charge in «common» range**

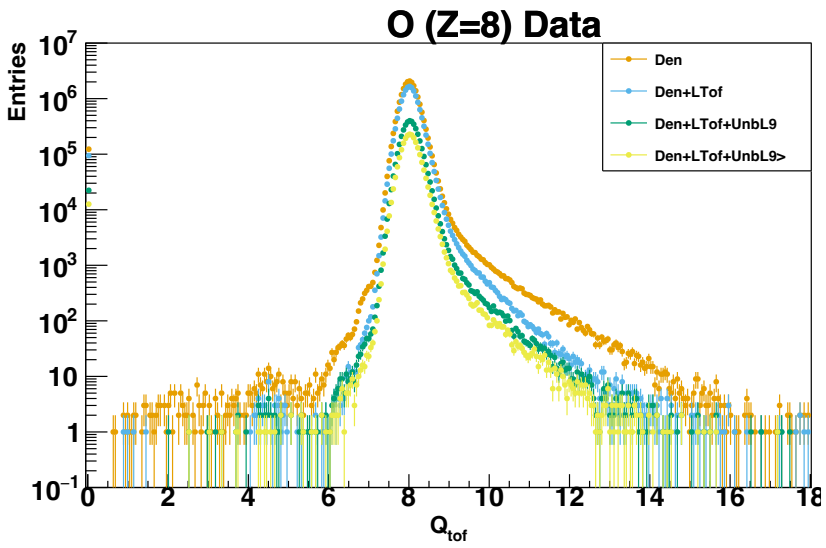
Ltof charge cut

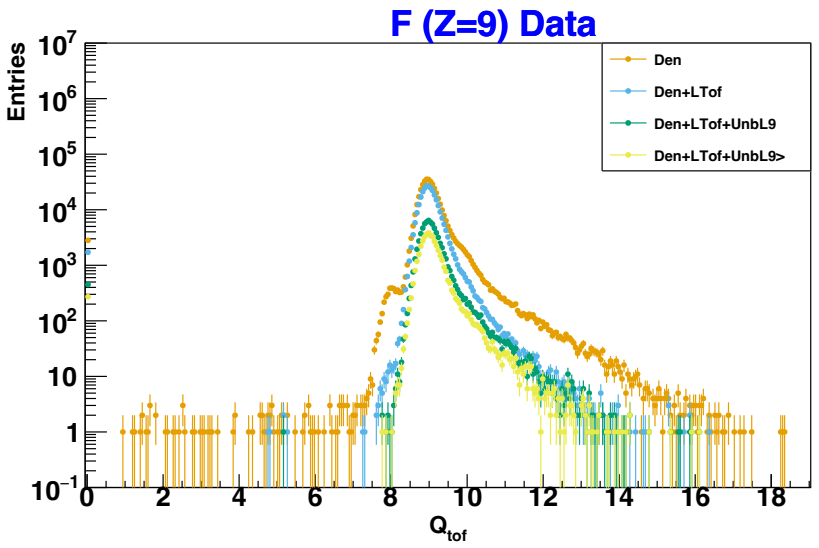
Z=14	Z=15	Z=16	Z=18	Z=20
> 13.3	> 14.2	> 15.2	> 17.2	> 19.1

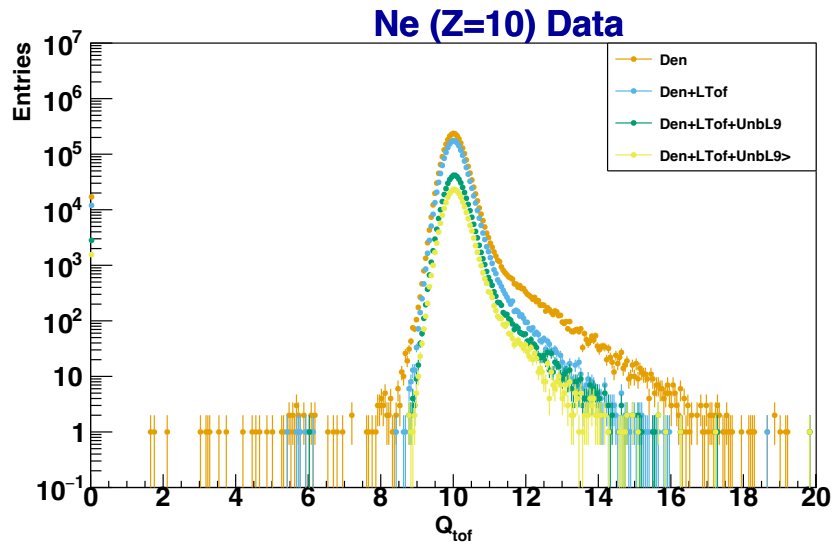
Numerator

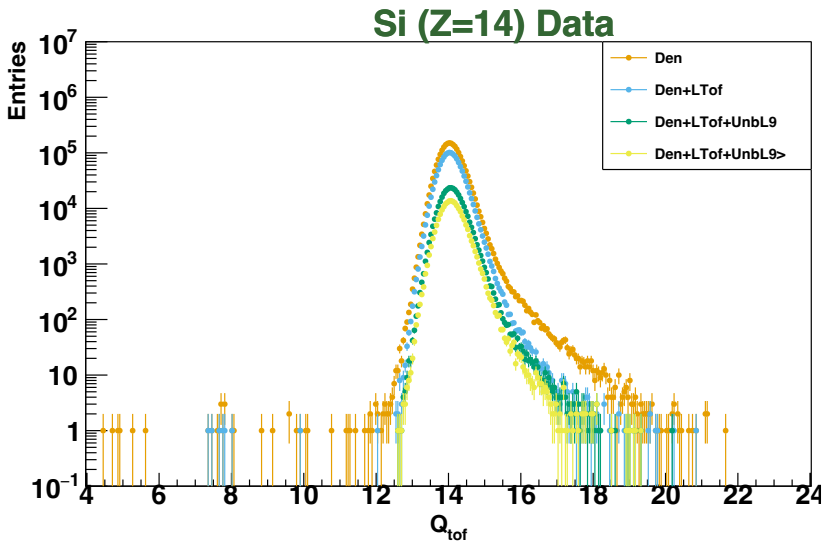
- Denominator
- $\beta > 0.4$
- UToF charge in «*common*» range

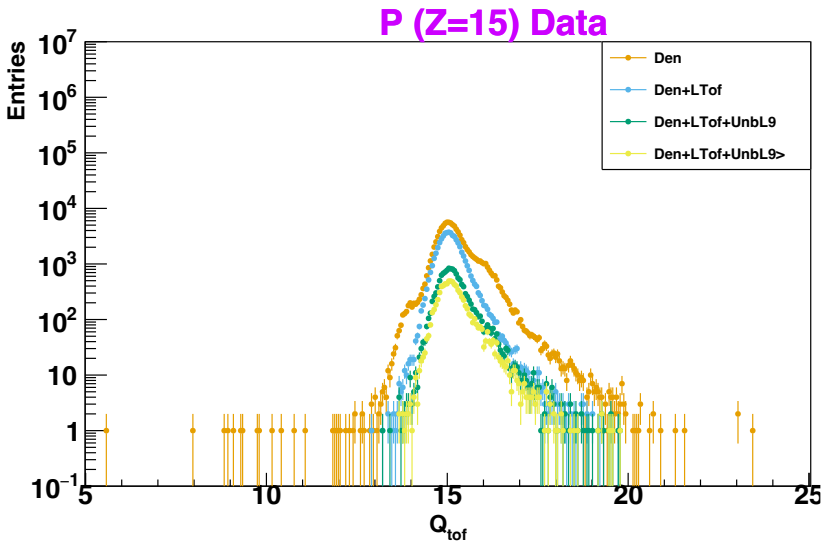
UTof efficiency

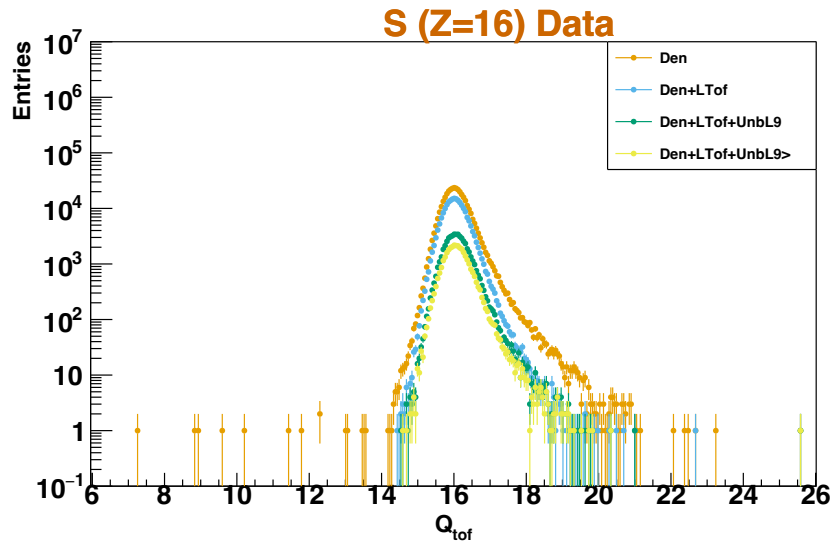




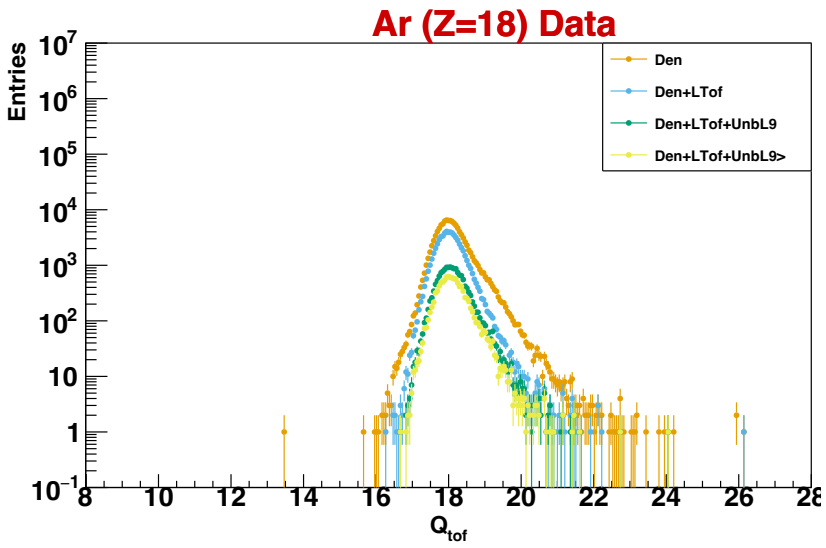


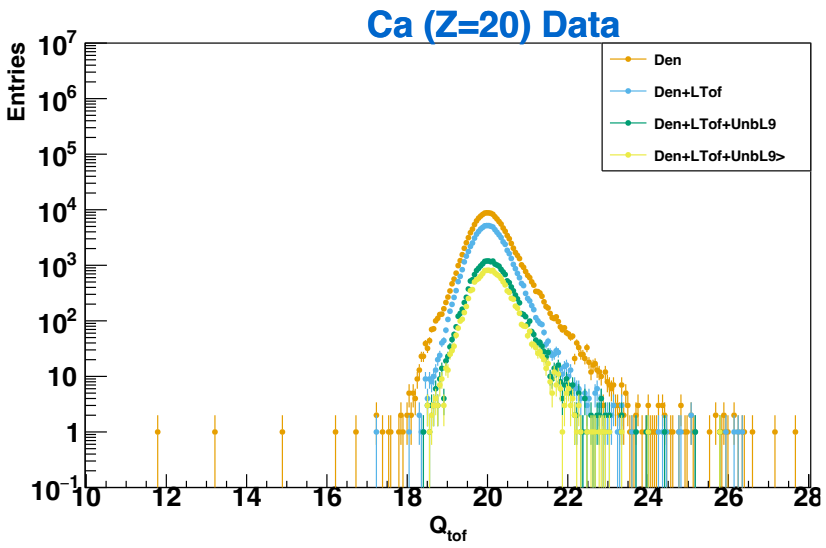


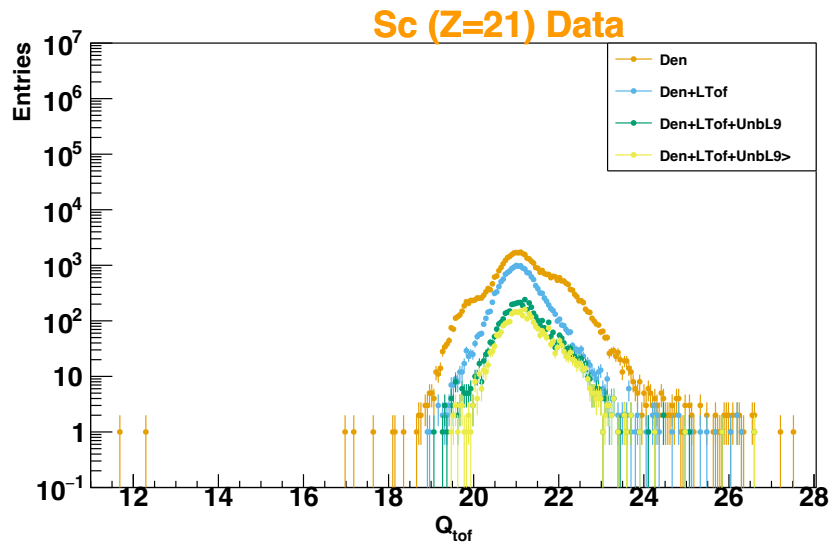


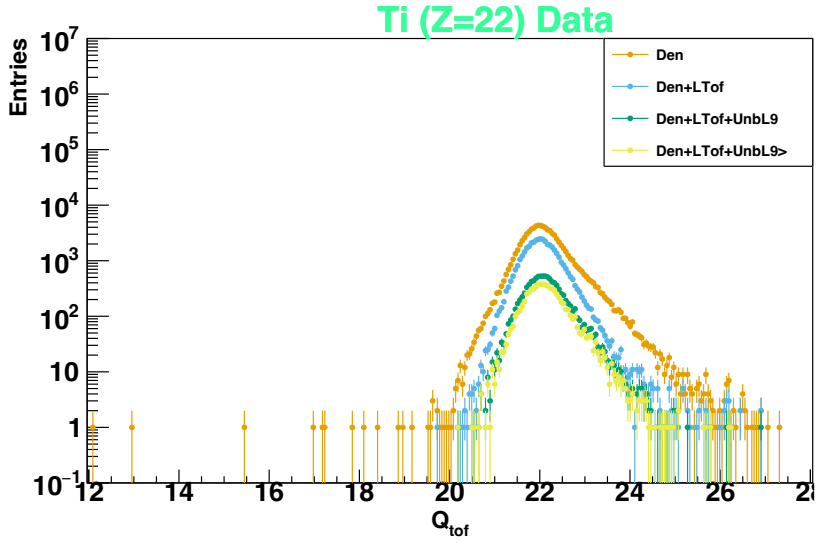


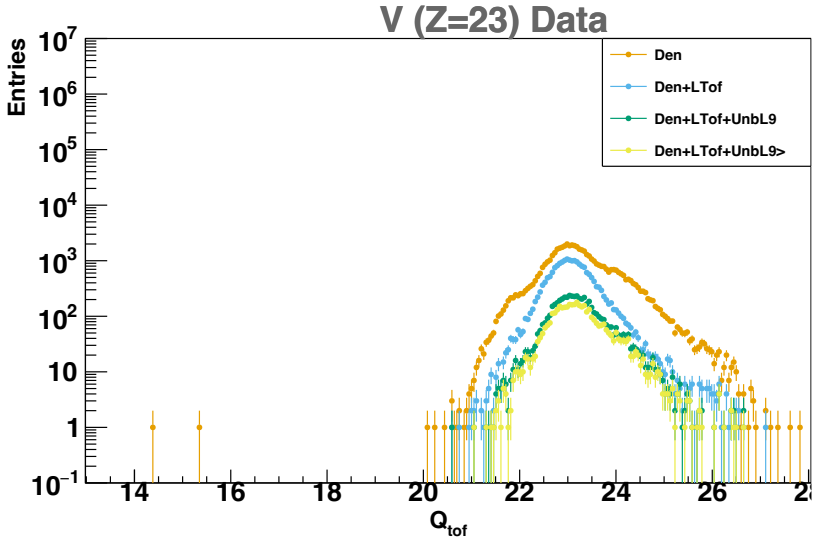
UTof efficiency

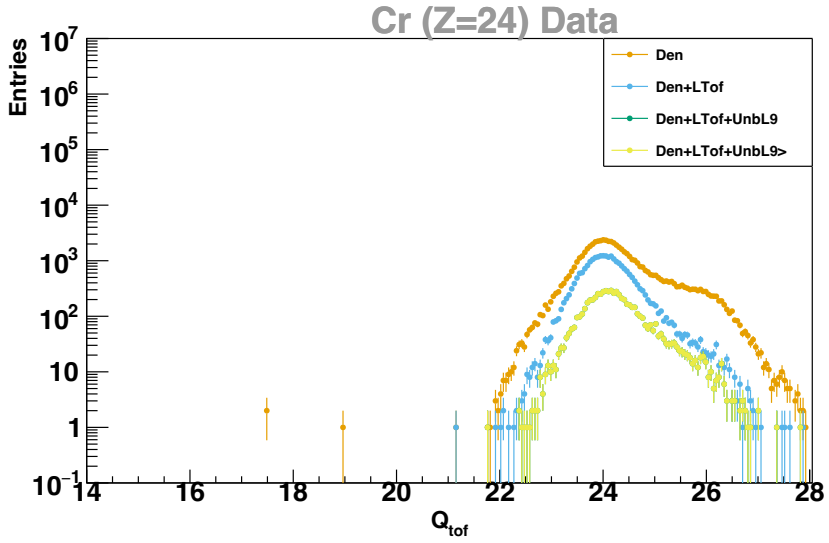




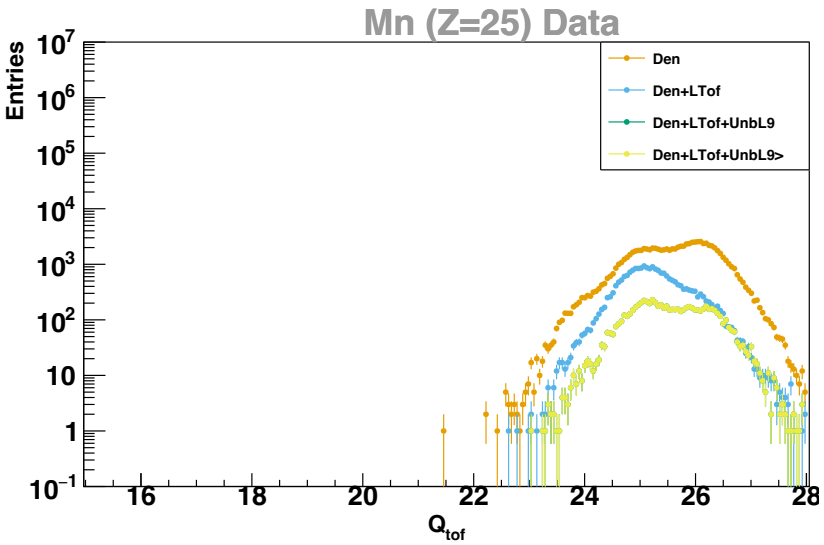


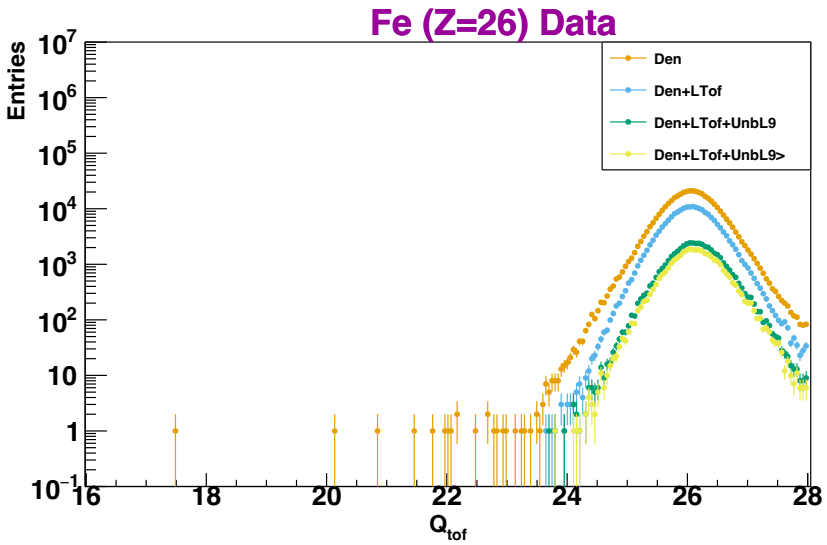




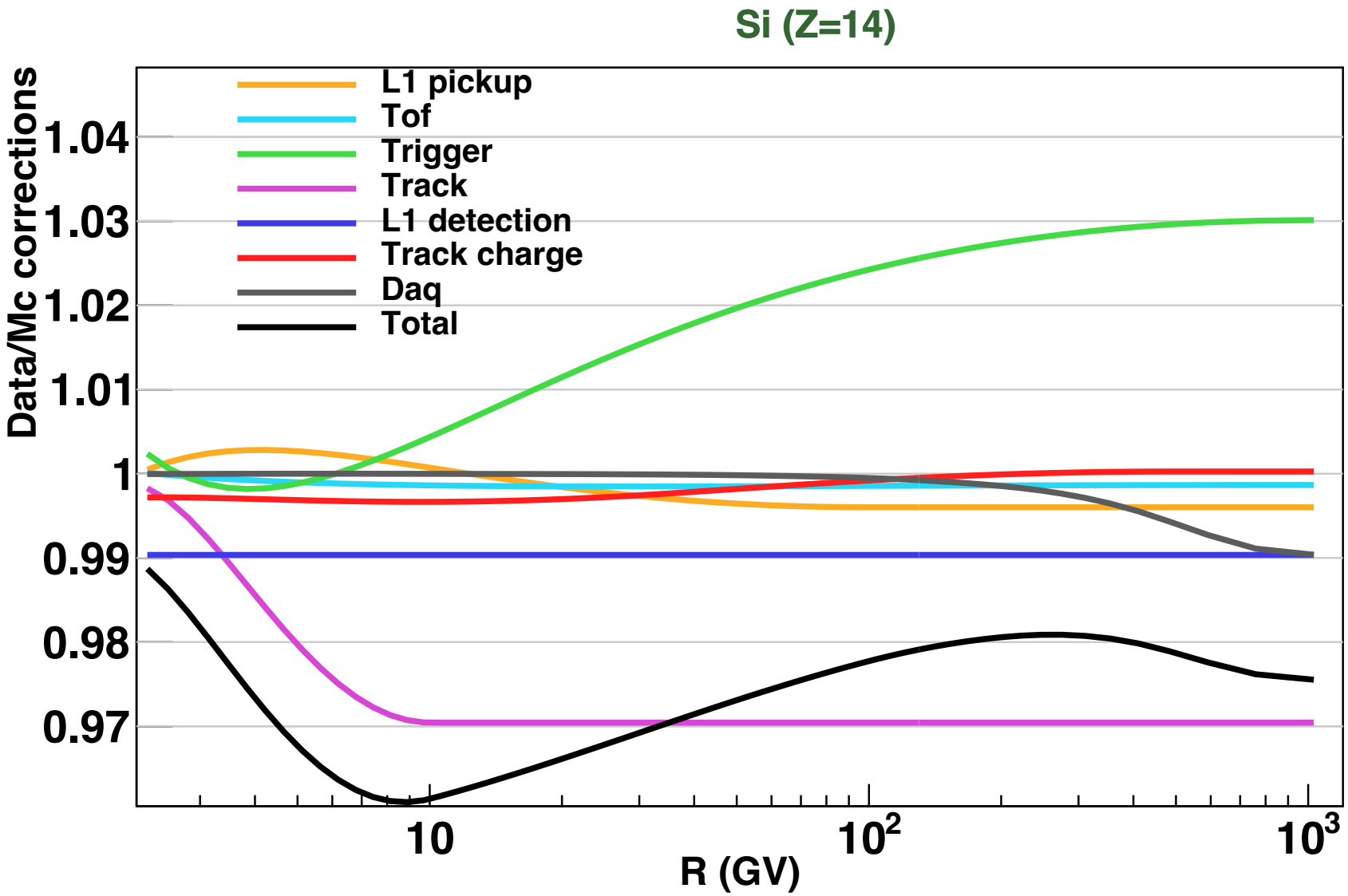


UTof efficiency

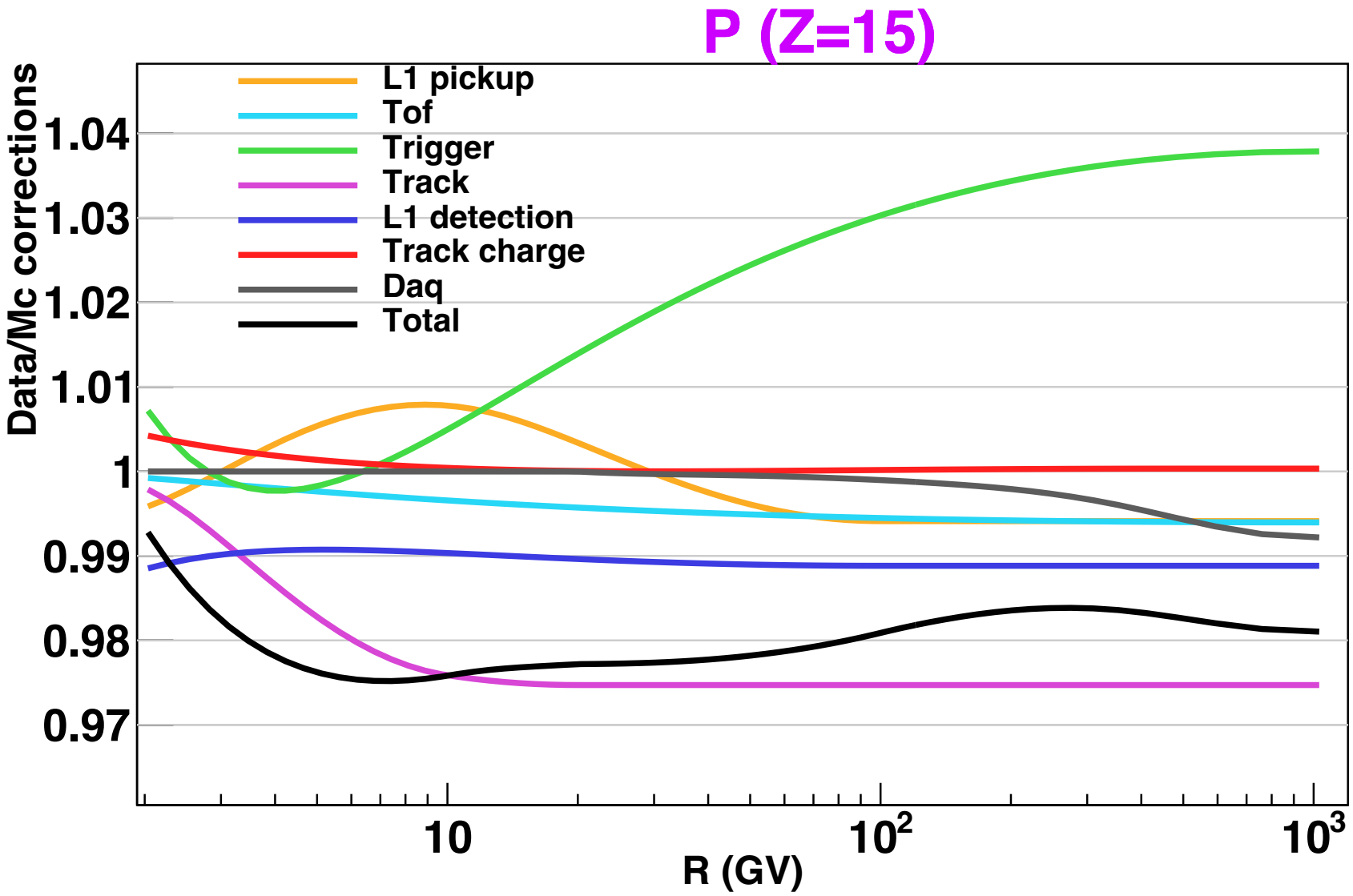




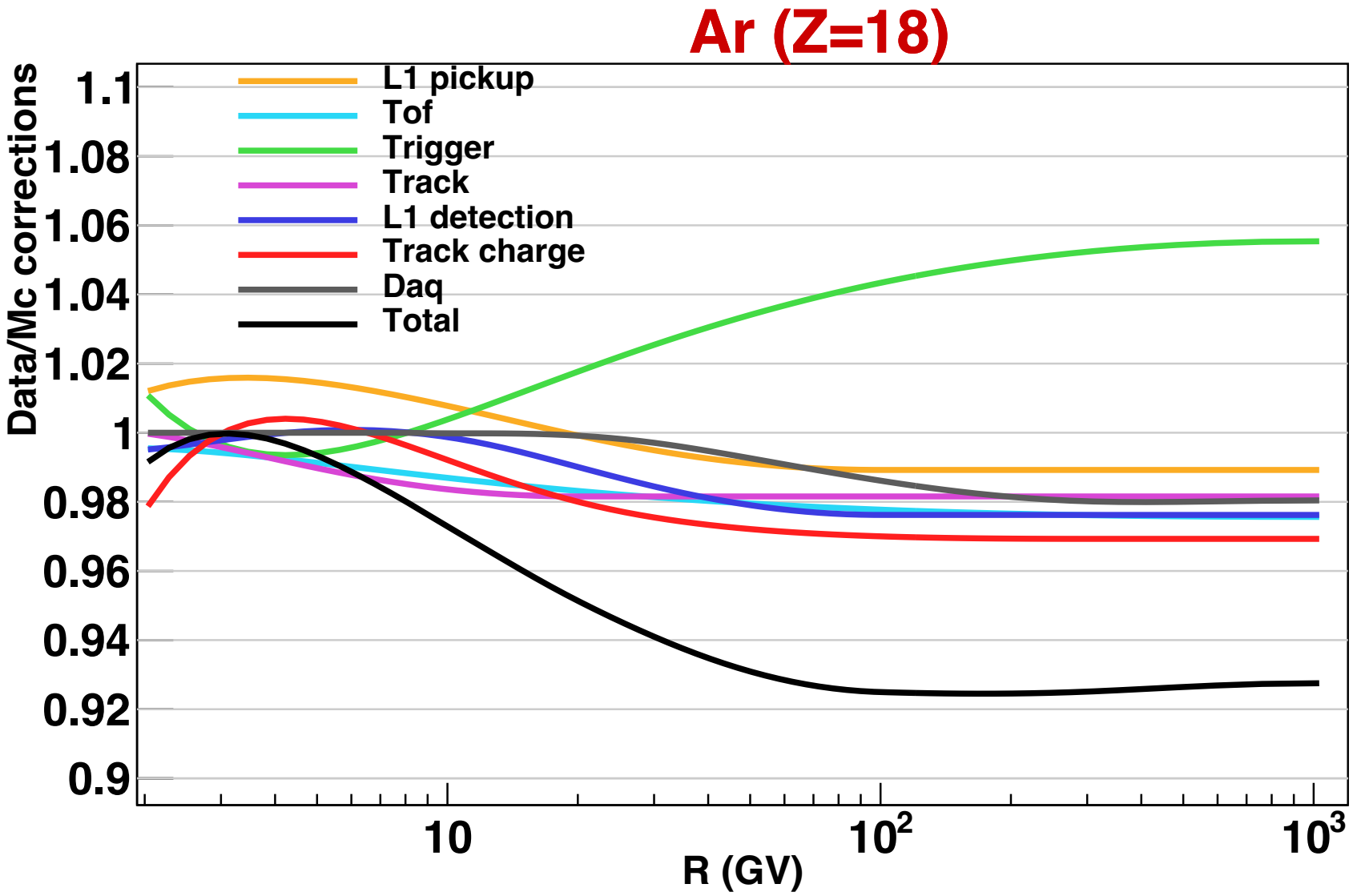
Total correction



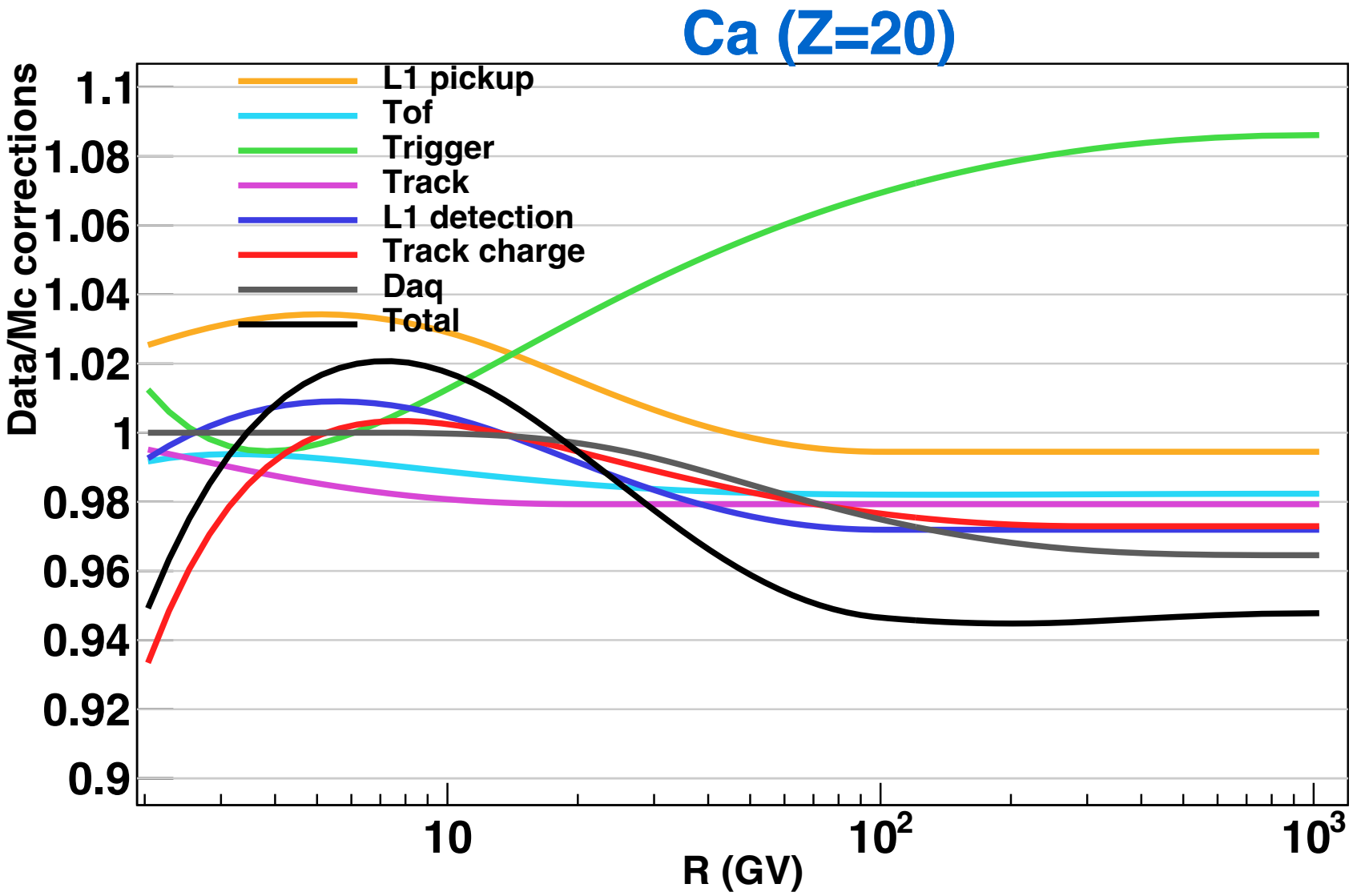
Total correction



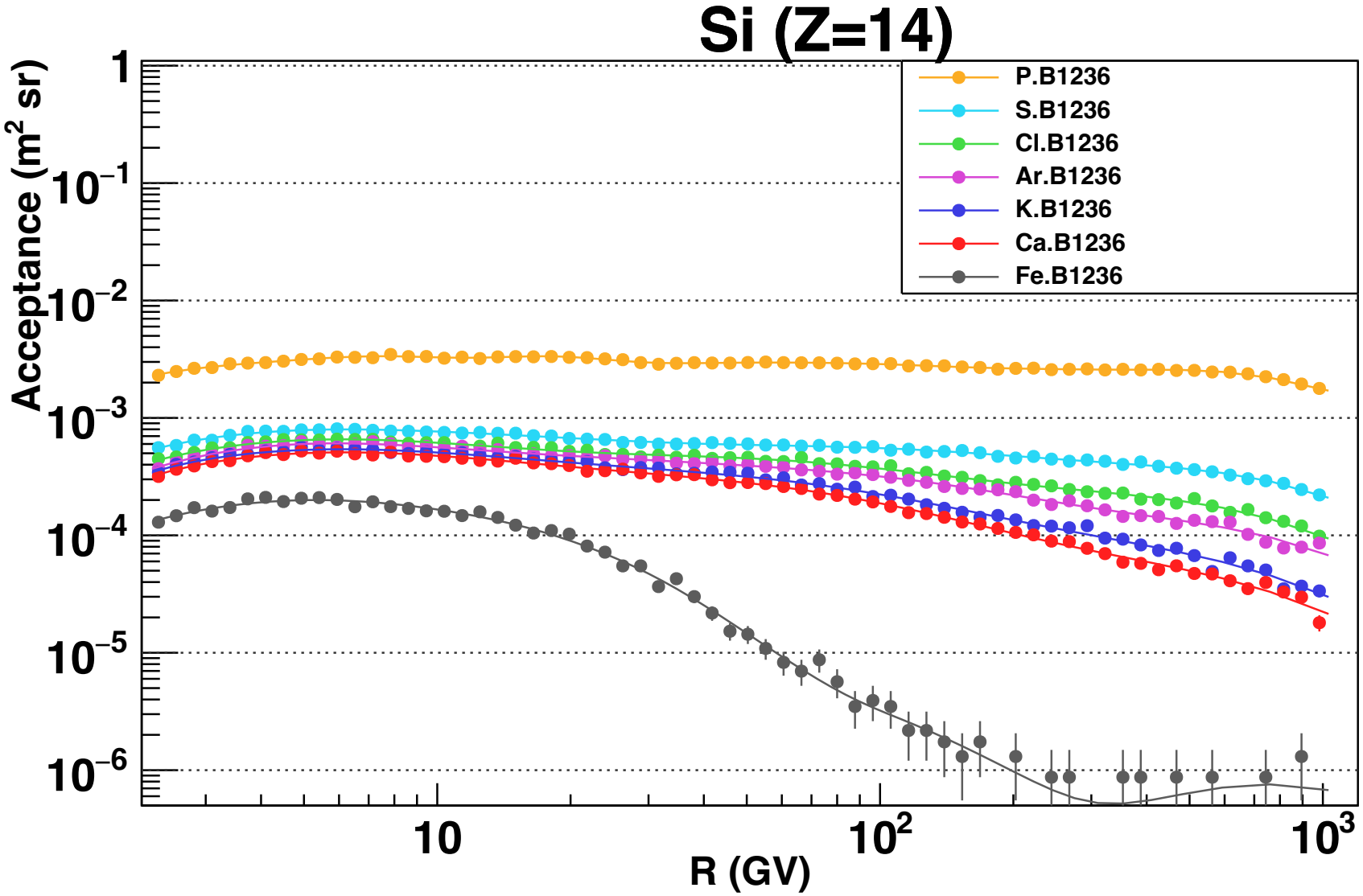
Total correction



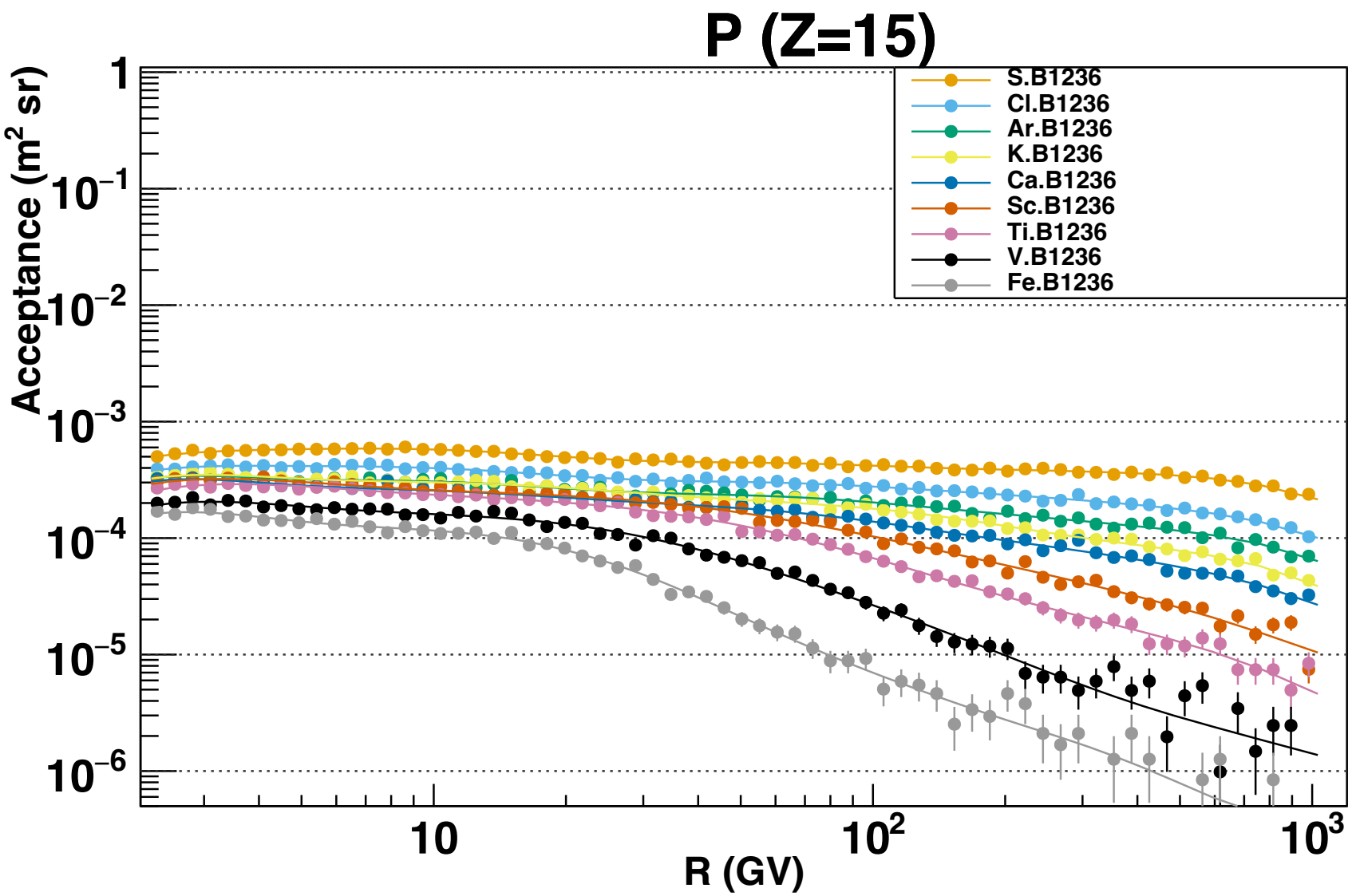
Total correction



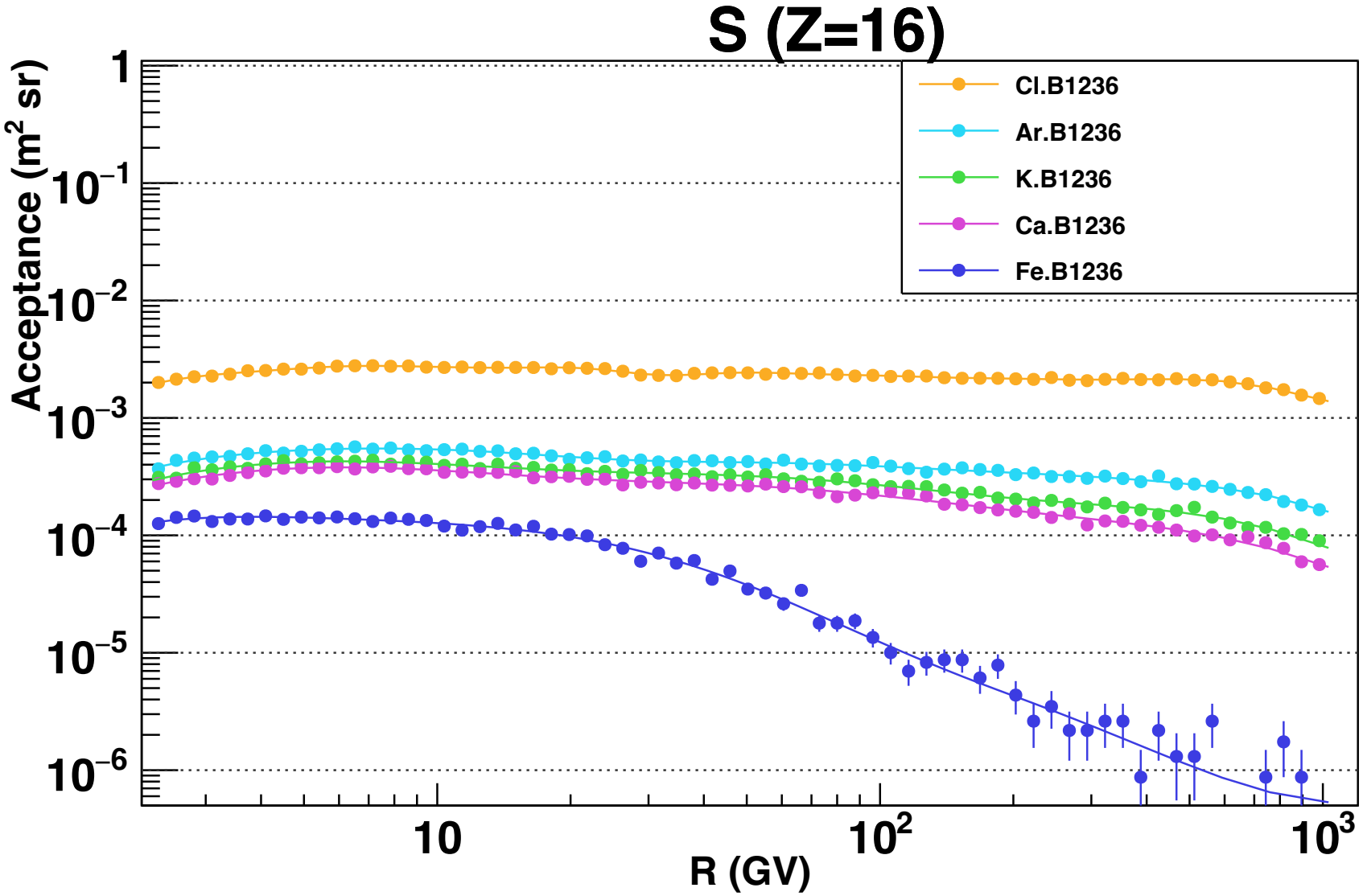
TOI Acceptance



TOI Acceptance



TOI Acceptance



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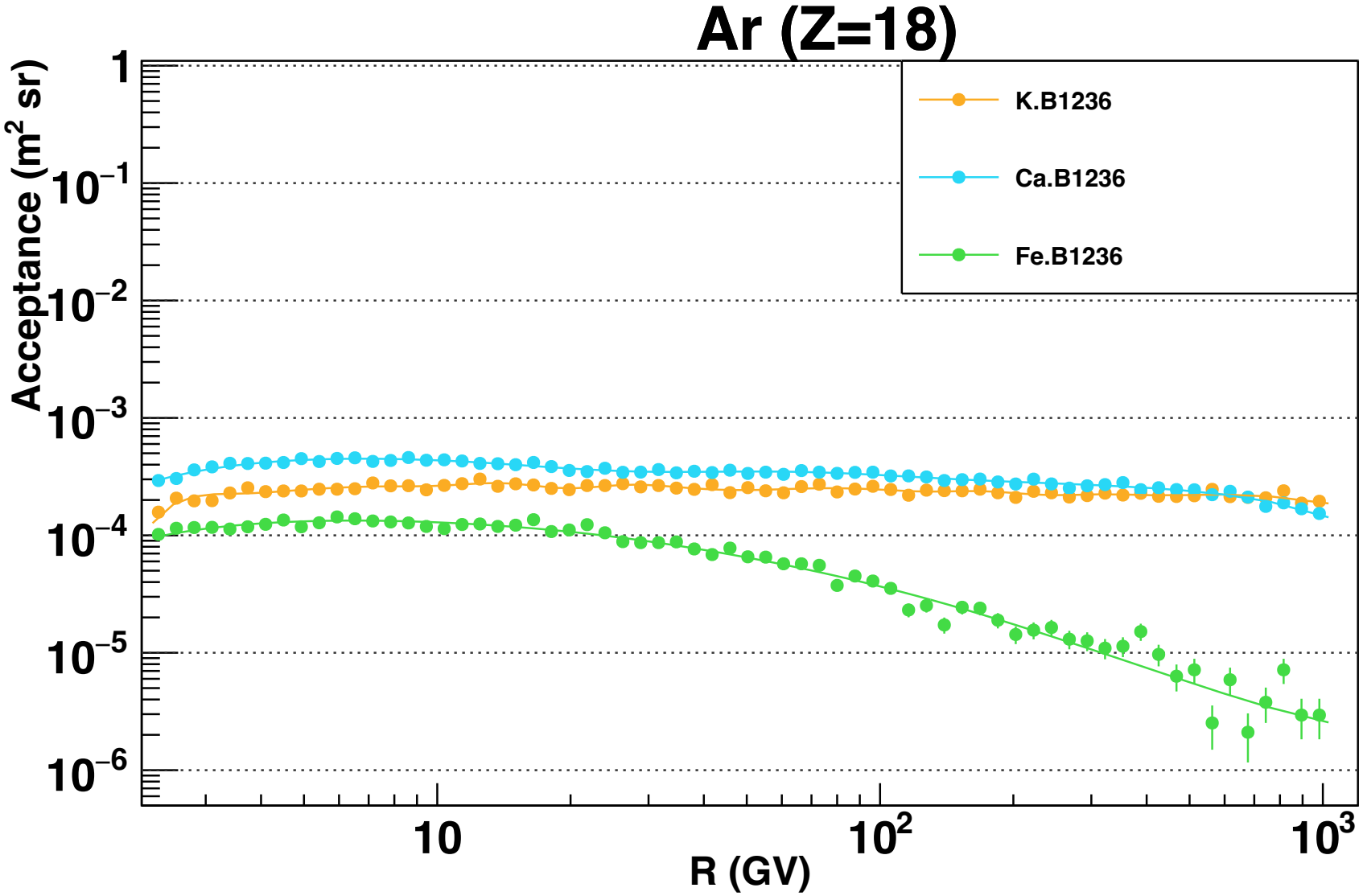

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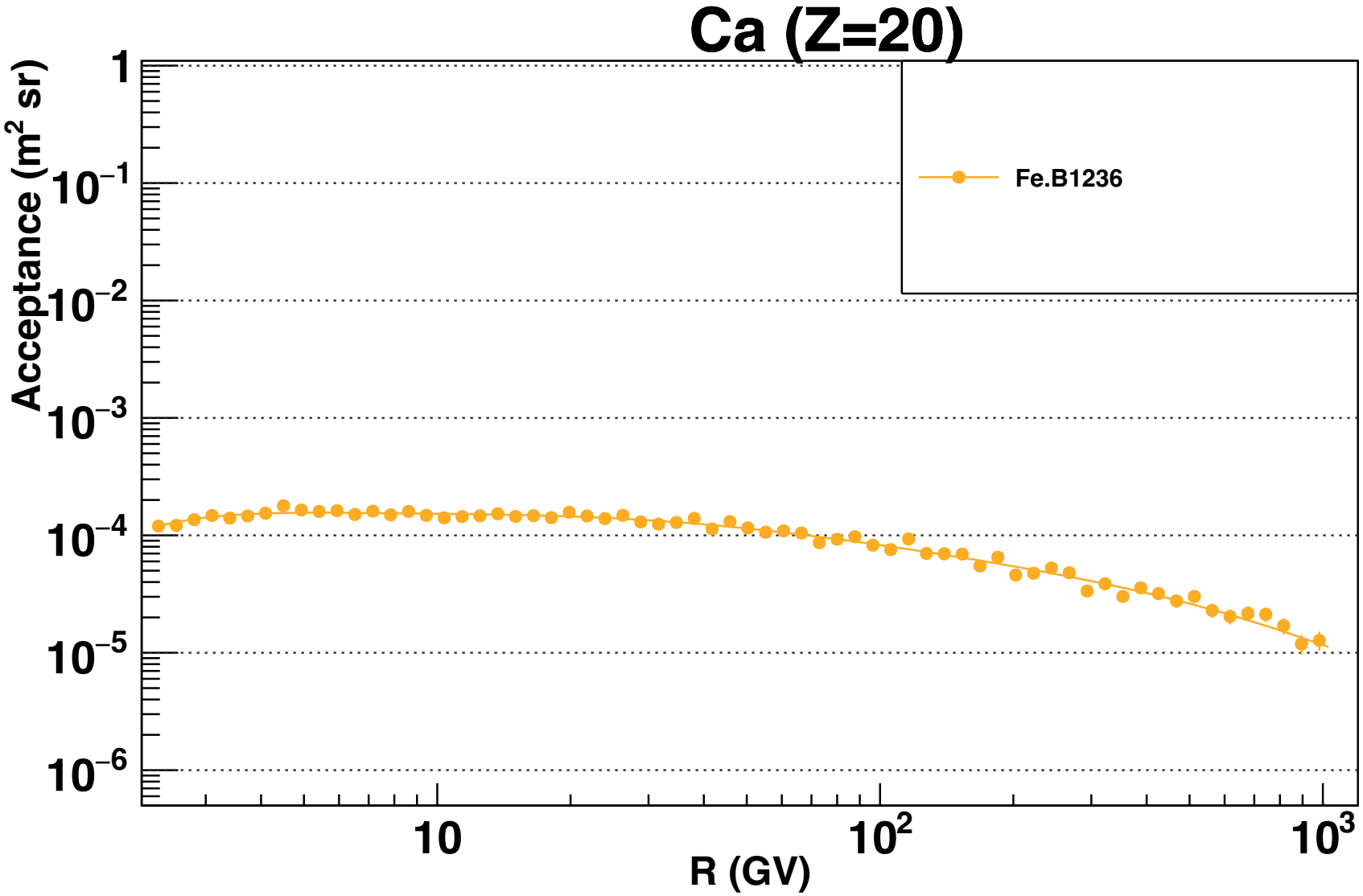
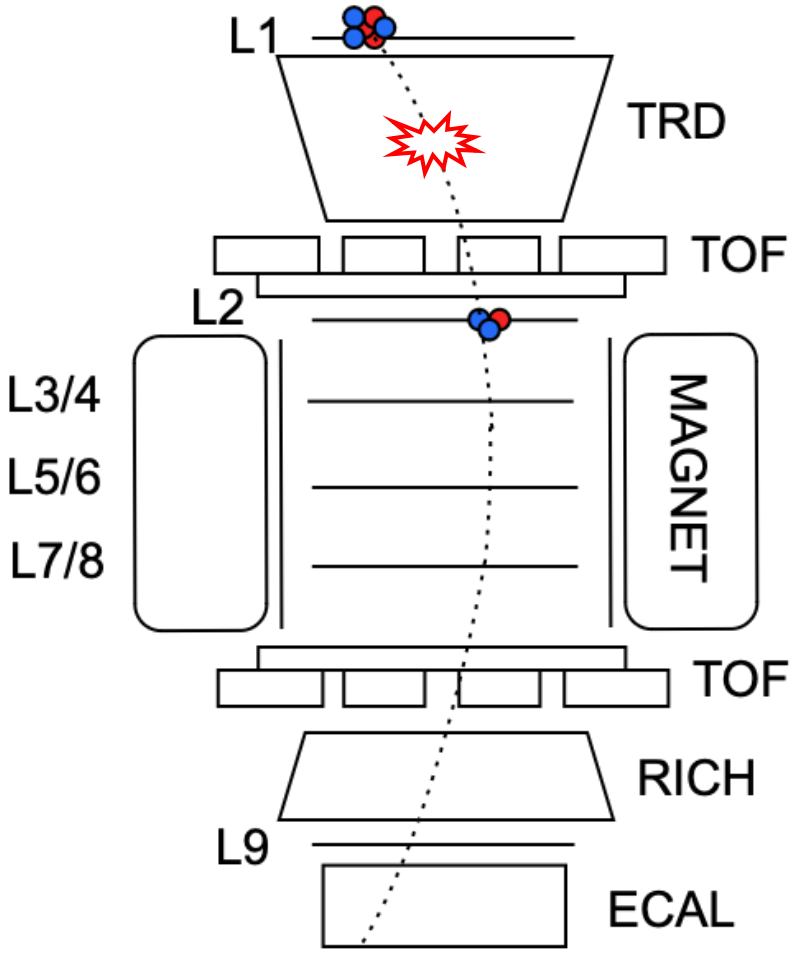


Contamination below the L1



Template selections

Layer 1

- Hit pattern side X
  L2 && (L3 || L4) && (L5 || L6) && (L7 || L8)
- U&LTof charge [Z - 0.5, Z + 0.5]
- Hit on layer 1
- Inner tracker charge [Z – 0.3, Z + 0.3]

Layer 2

- Hit pattern side X
  L2 && (L3 || L4) && (L5 || L6) && (L7 || L8)
- U&LTof charge [Z - 0.5, Z + 0.5]
- Inner tracker charge [Z – 0.3, Z + 0.3]
- L1 charge [Z – 0.3, Z + 0.5]

Contamination below the L1

- For Silicon and Sulfur the background given by the fragmentation below the L1 is almost negligible