TIFPA – Trento Activities

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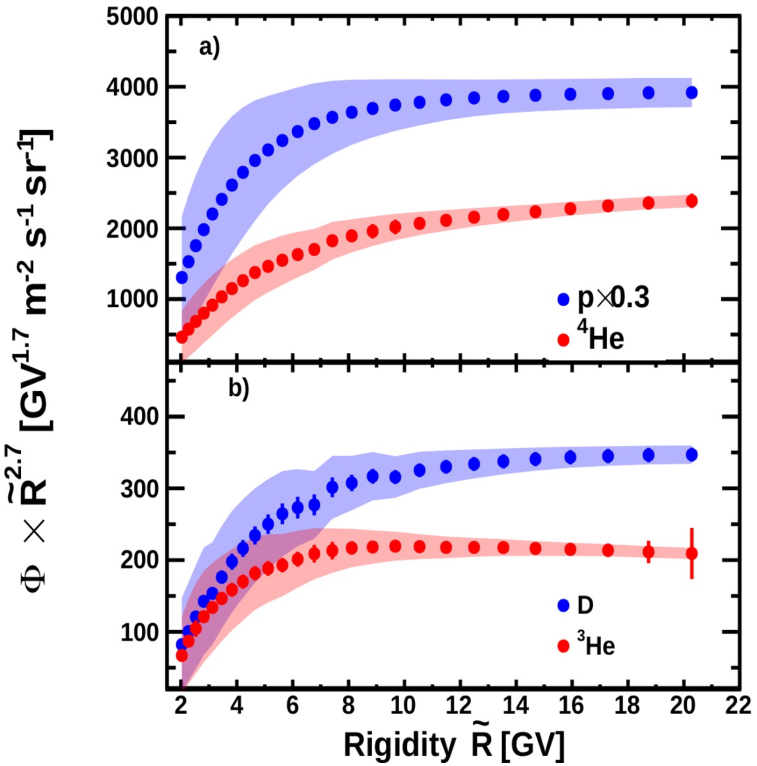
Summary

- 13 rounds of shifts per year at AMS POCC
- Provide ¼ of the AMS Tracker expert
- Data analysis concluded
  - Be Isotopes (A. Dass and F. Dimiccoli)
  - Deterium andHe isotopes (F. Dimiccoli)
- Data Analysis ongoing
  - Search for anti-He in cosmic rays (F. Rossi)

- Future analysis
  - B and N isotopes (F. Dimiccoli)

D and He isotopes results

CIEMAT



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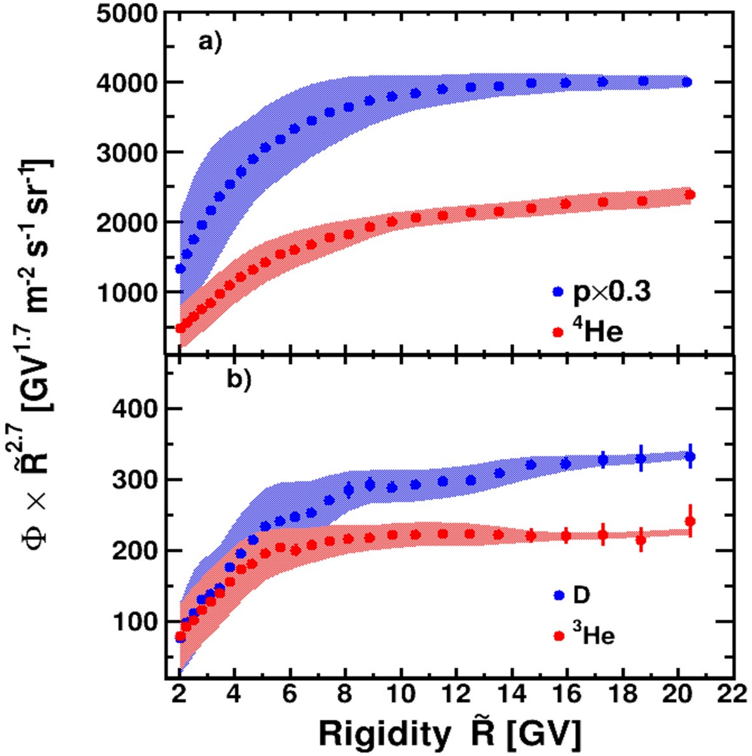

FIG. 1. a) AMS time-averaged ^{4}He (red) and proton (blue) fluxes multiplied by $\tilde{R}^{2.7}$ as functions of rigidity with total errors. For display purposes, proton flux is scaled by a factor 0.3. b) AMS time-averaged ^{3}He (red) and D (blue) fluxes, multiplied by $\tilde{R}^{2.7}$ as functions of rigidity with total errors. The shaded regions show the range of the time variation of the fluxes.

D and He isotopes results

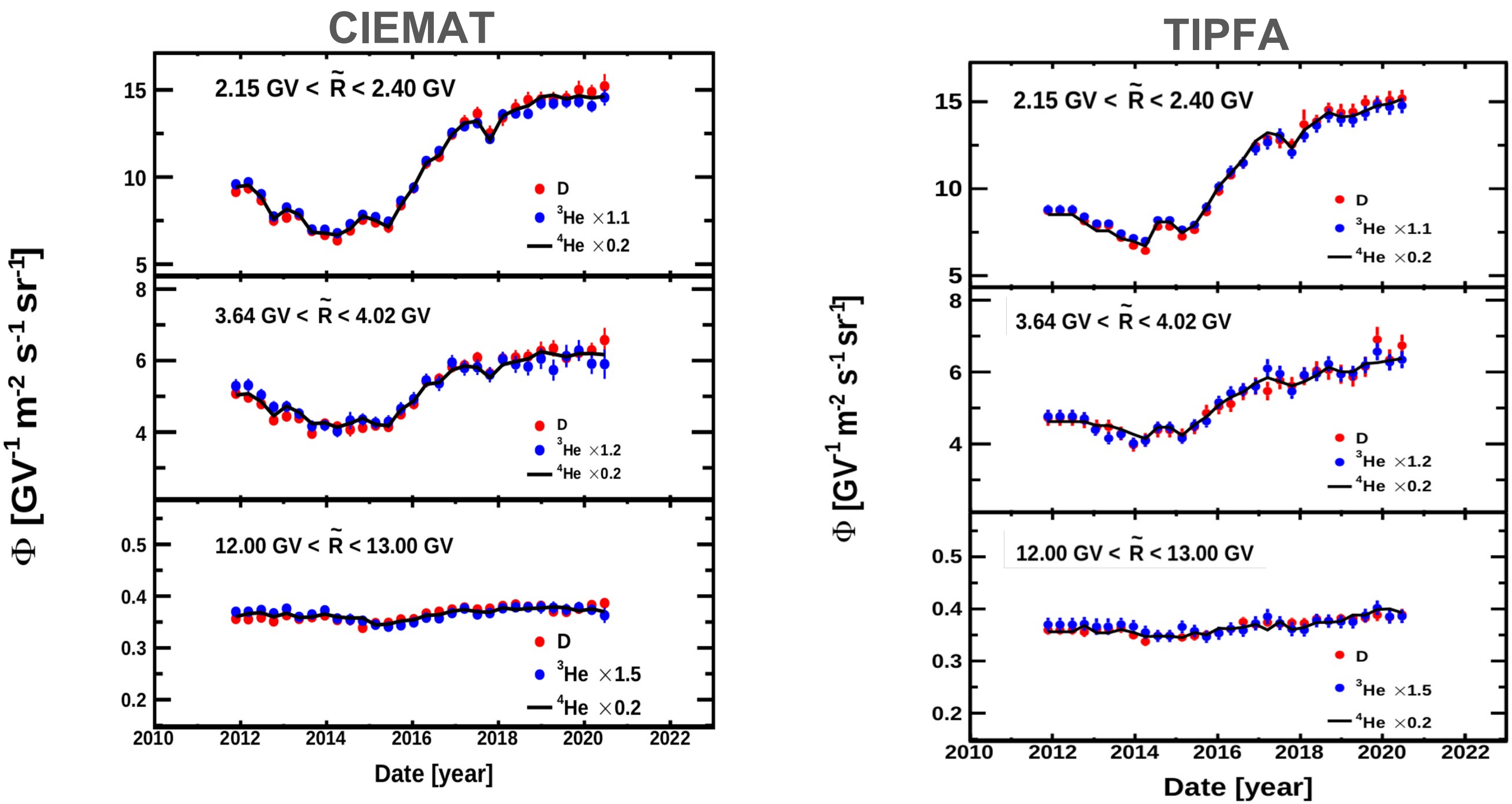

FIG. 2. The AMS D (red points), ^{3}He (blue points), and ^{4}He (black curves) fluxes as functions of time for three rigidity bins. The ^{3}He and ^{4}He fluxes have been scaled to obtain the same time-averaged flux as D in each rigidity bin. The errors are the quadratic sum of the statistical and time-dependent systematic errors. In each rigidity bin the three fluxes show a nearly identical time behavior.

D and He isotopes results

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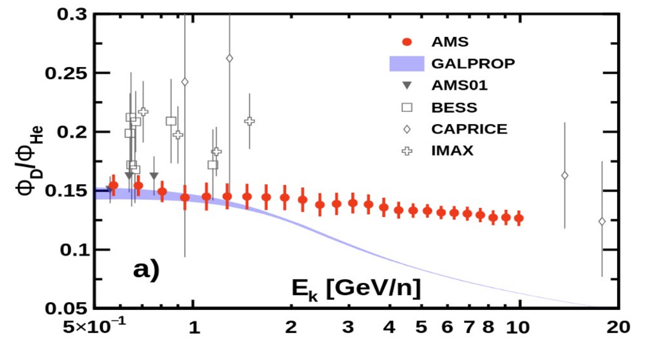

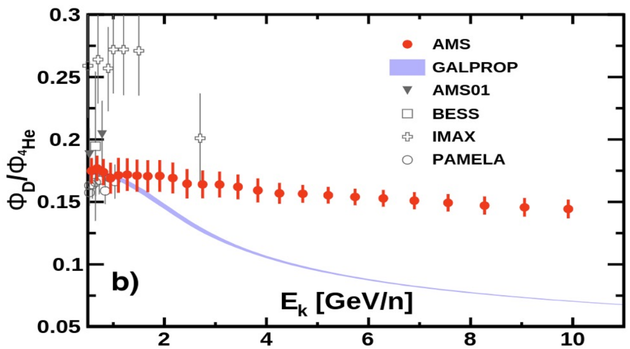

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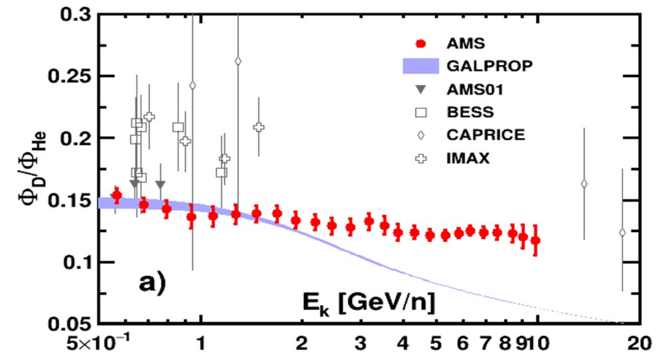


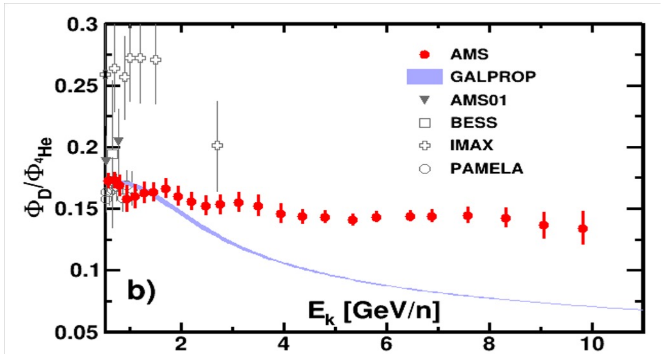


FIG. 3. The AMS a) D/(^{3}He +^{4}He),b) D/^{4}He, and ^{3}He/^{4}He flux ratios as functions of kinetic energy per nucleon with total error, together with previous measurements [12–16] and the cosmic ray latest propagation model GALPROP [35] predictions (shaded areas). The areas show the uncertainty of GALPROP prediction due to different solar modulation during the time period of the AMS observations.

Isotopes flux ratios

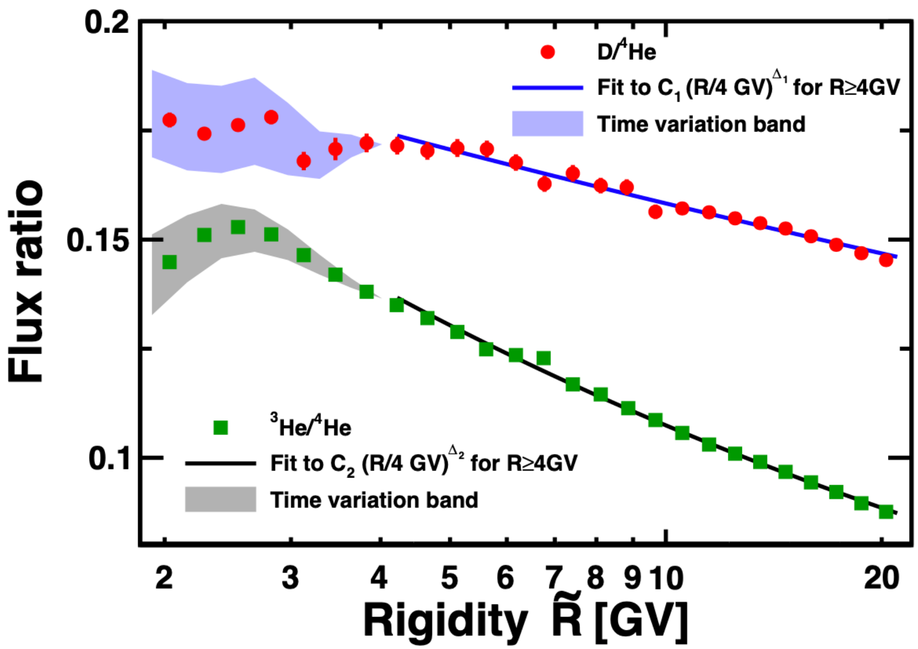


FIG. 4. AMS time-averaged D/^{4}He (red circles) and ^{3}He/^{4}He (green squares) flux ratios as functions of rigidity with statistical and uncorrelated systematic errors added in quadrature. Solid blue and black curves show power law fits $C\,(R/4\mathrm{GV})^{\Delta}$ for R > 4 GV to the D/^{4}He and ^{3}He/^{4}He flux ratios respectively. Shaded areas show their time variation. For D/^{4}He flux ratio the fit yields: $\Delta_1 = -0.108 \pm 0.003$ and $C_1 = 0.175 \pm 0.004$ with $\chi^2/d.o.f.$ of 11/17. For ^{3}He/^{4}He flux ratio the fit yields: $\Delta_2 = -0.290 \pm 0.002$ and $C_2 = 0.140 \pm 0.003$ with $\chi^2/d.o.f.$ of 21/17.

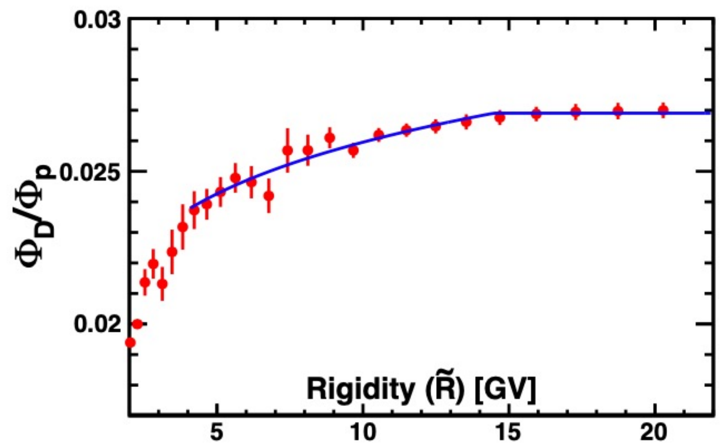


FIG. S7. The AMS D/p flux ratio as a function of rigidity with total errors. The blue curve shows the fit result of $C\,(R/R_0)^{\Delta}$ for 4GV < R < R_0; C for R ≥ R_0. The fit yields $C = 0.027 \pm 0.001$, $\Delta = 0.09 \pm 0.01$ and $R_0 = 14 \pm 1$ with a $\chi^2/d.o.f.$ of 8.6/16. As seen, above $R_0 \simeq$ 14GV the D/p flux ratio is compatible with a constant.

D and He isotopes results

Low energy time dependence

$$\frac{\Phi^i_{(\mathrm{D},^3\mathrm{He})}/\Phi^i_{^4\mathrm{He}}}{\langle\Phi^i_{(\mathrm{D},^3\mathrm{He})}/\Phi^i_{^4\mathrm{He}}\rangle} - 1 = k^i_{(\mathrm{D},^3\mathrm{He})} \cdot \left(\frac{\Phi^i_{^4\mathrm{He}}}{\langle\Phi^i_{^4\mathrm{He}}\rangle} - 1\right)$$

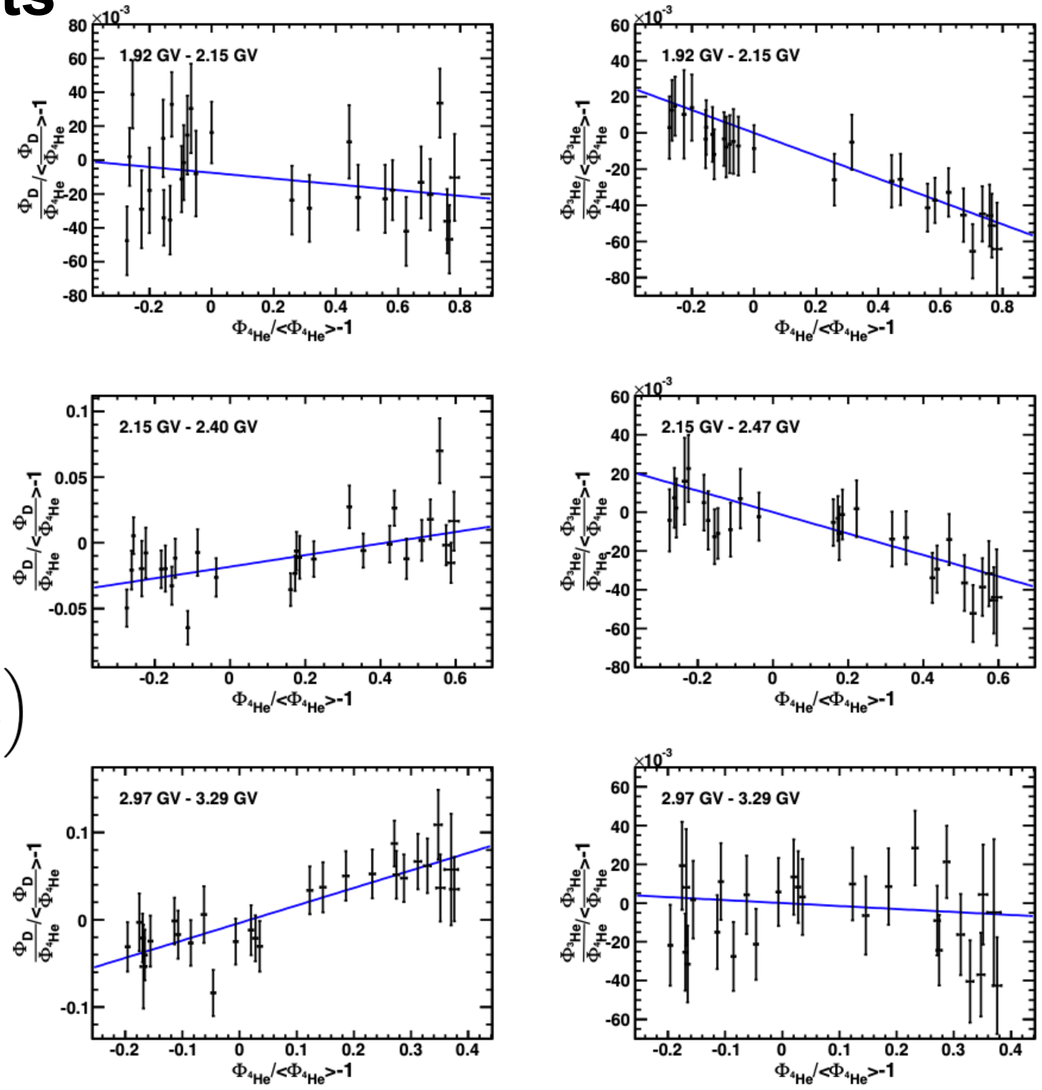
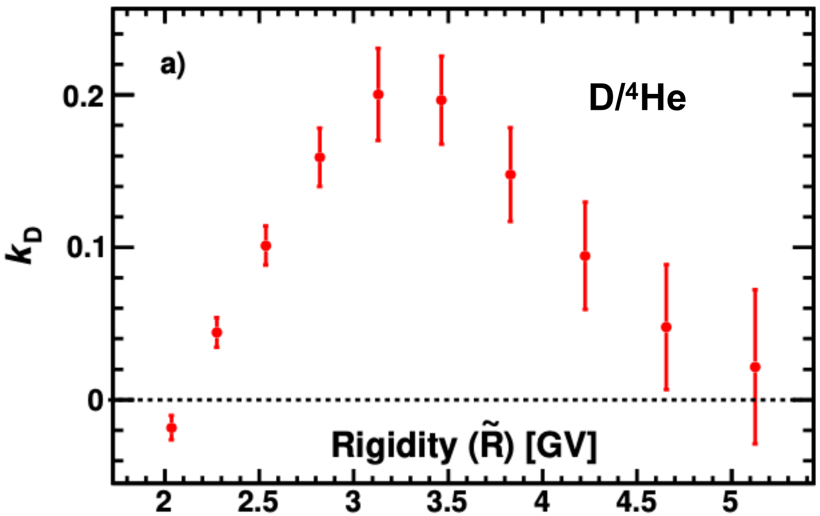


FIG. S5. The AMS D/^{4}He and ^{3}He/^{4}He flux ratios as function of ^{4}He flux for three characteristic rigidity bins. The blue lines show the fit with Eq. (3) result.

D and He isotopes results

Low energy time dependence



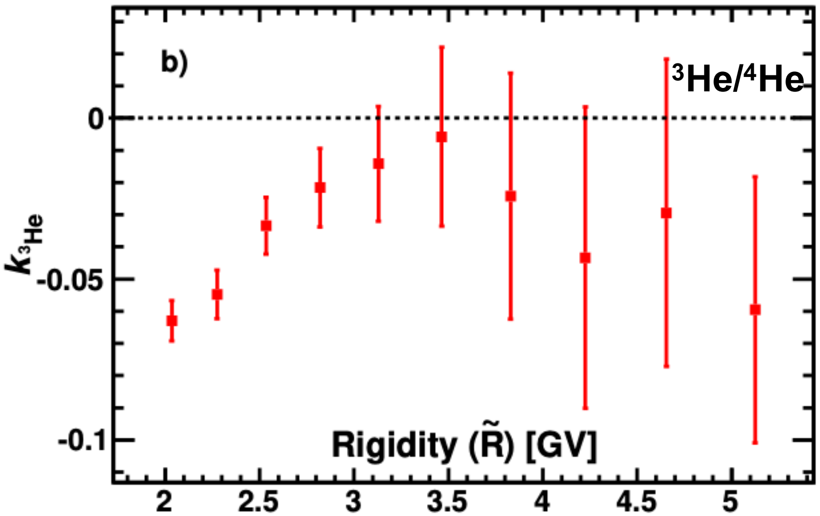
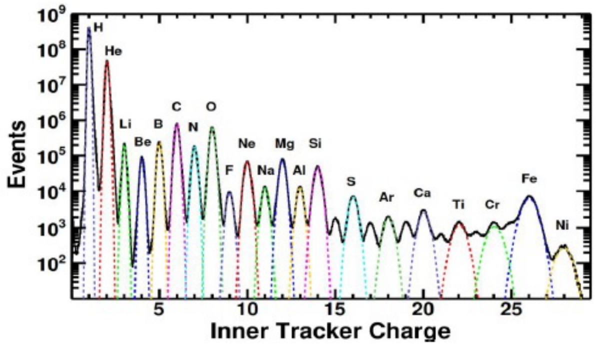


FIG. S6. Eq 3 k_i fitted values for a) D/^{4}He and b) ^{3}He/^{4}He flux ratios as function of rigidity.

$$\frac{\Phi^i_{(\mathrm{D},^3\mathrm{He})}/\Phi^i_{^4\mathrm{He}}}{\langle\Phi^i_{(\mathrm{D},^3\mathrm{He})}/\Phi^i_{^4\mathrm{He}}\rangle} - 1 = k^i_{(\mathrm{D},^3\mathrm{He})} \cdot \left(\frac{\Phi^i_{^4\mathrm{He}}}{\langle\Phi^i_{^4\mathrm{He}}\rangle} - 1\right)$$

Be Isotopes

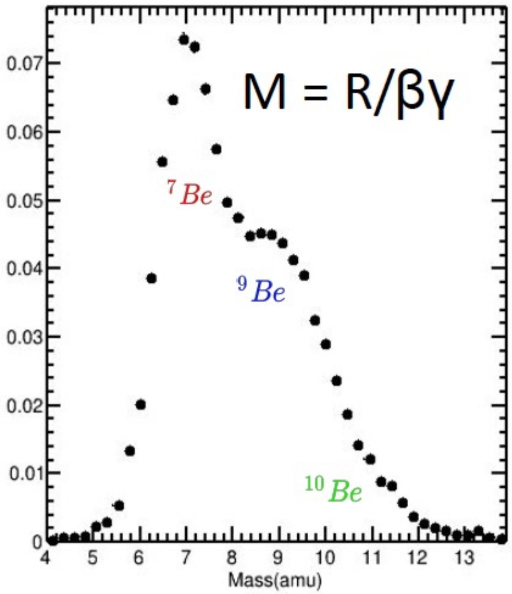
Measuring Be isotope ratios



1) Good charge resolution:
Selection of Beryllium

2) **Distinction of isotopes**

- Mass from Rigidity (R) and β
- Rigidity from Inner + L1
- β from different sub-detectors



	ToF	NaF	AgI
Δβ/β	1%	0.4%	0.1%
Ekin Energy range	0.51-1.55 GeV/n	1.55-3.61 GeV/n	3.61-12.18 GeV/n

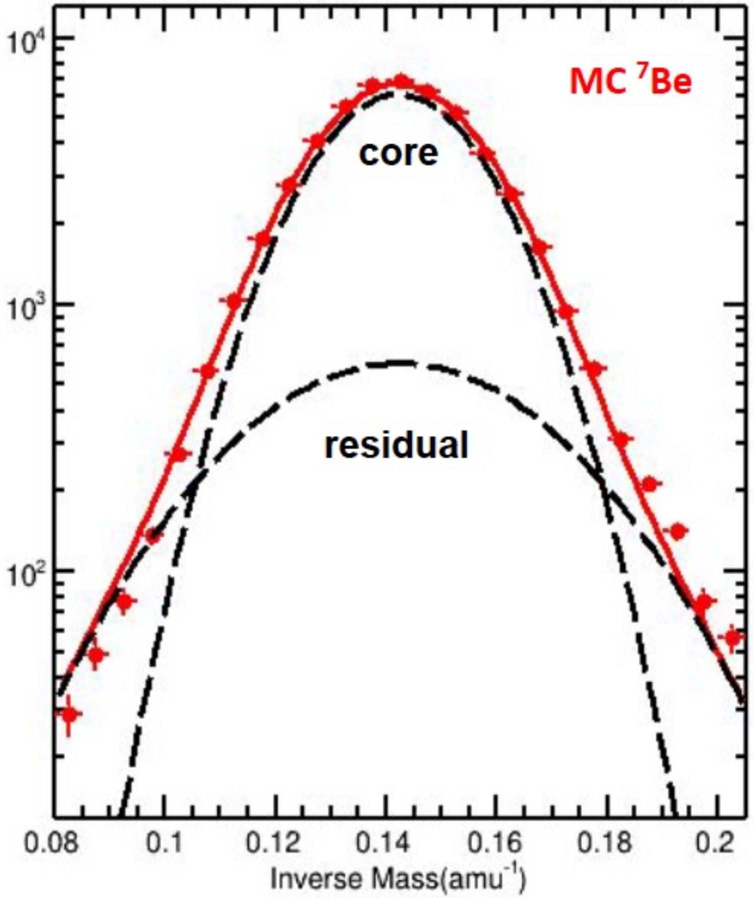
Beryllium Data Sets

- **General Selections**
  - $\beta_{TOF} > 0.3$
  - ISS is not in SAA
  - Inner Trk: at least one hit each plane
  - $\chi^2_y < 10$
  - L1+Inner fiducial volume
- **Charge Selections (Identify Be and remove fragmentations)**
  - 3.38 < Ly1 Trk< 4.65
  - 3.55 < Inner Trk < 4.45
  - 3.4 < Upper ToF < 5.5
  - RMS(Q) <0.55
- **ToF Quality**
  - $\chi^2_{coo} < 5,\ \chi^2_T < 10$
- **RICH Quality**
  - N_pmt>2 (NaF: 10)
  - N_pe(ring)/N_pe(total)>0.4
  - $|\beta_{TOF} - \beta_{\rightarrow RICH}| < 0.06\beta_{RICH}$
  - Remove bad tiles
  - Geometric selections

Total statistics:

- ISS (V7_pass7) ~7.5 years data
- MC (B1220): ^{7}Be, ^{9}Be, ^{10}Be

Mass Template Modelling (1)

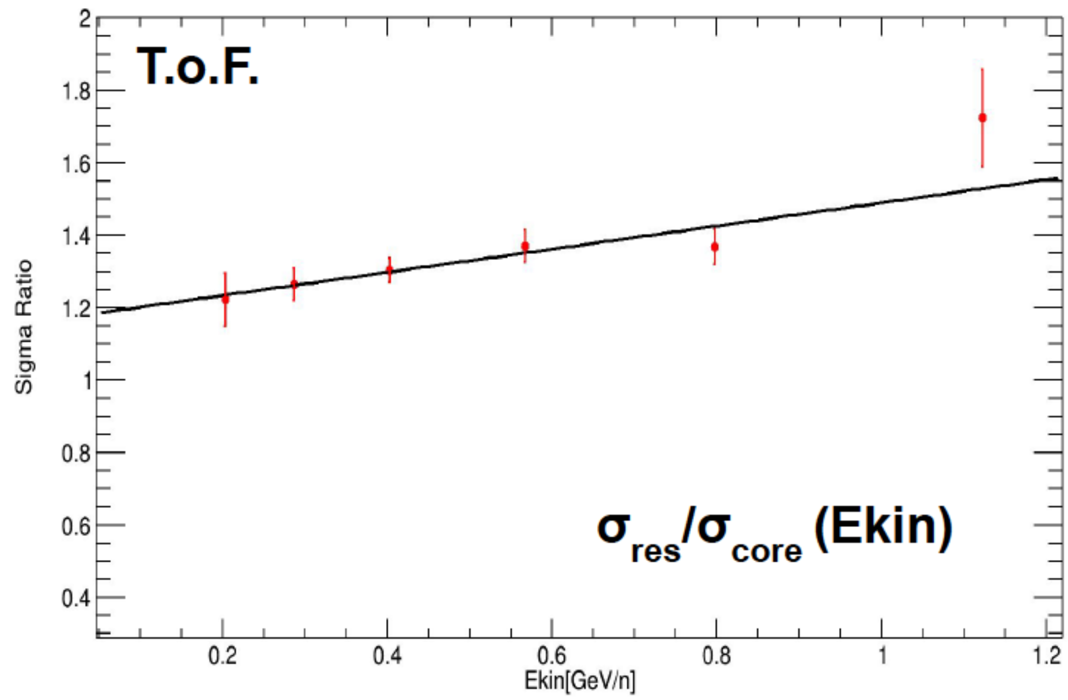


Model of Inverse mass from MC

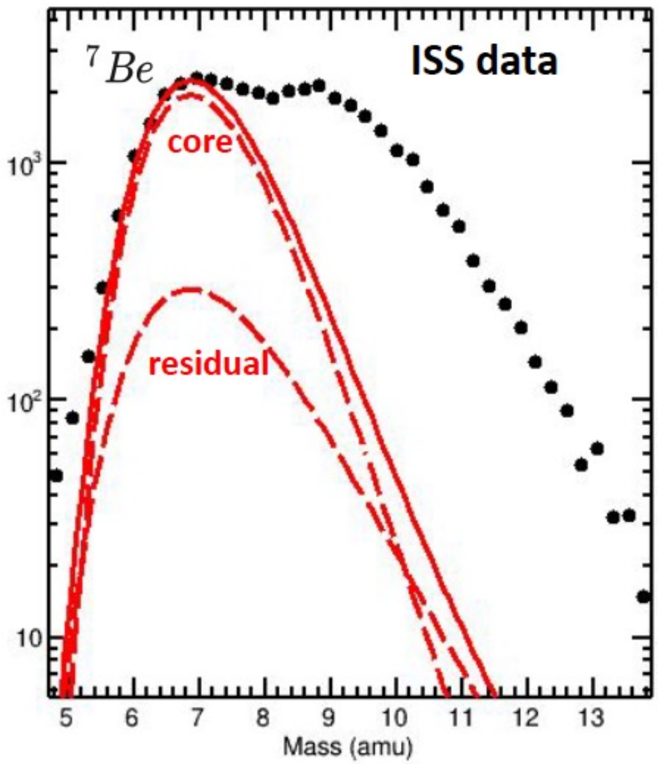
- **Double-gaussian:** Core and residual
- From MC Inverse mass distribution
- Parametrization:
  - A_{core}: Height of core gaussian
  - μ: same for core and residual
  - σ: dev. St. of core
  - A_{res}/A_{core}: residual/core ratio
  - $\sigma_{res}/\sigma_{core}$: dev. st. of residual by core

Mass Template Modelling (2)

- Energy dependent parametrization for every parameter
- Simple linear models for parameter evolution
- Independent parametrizations for ToF, NaF and Agl



Mass distribution fit (1)

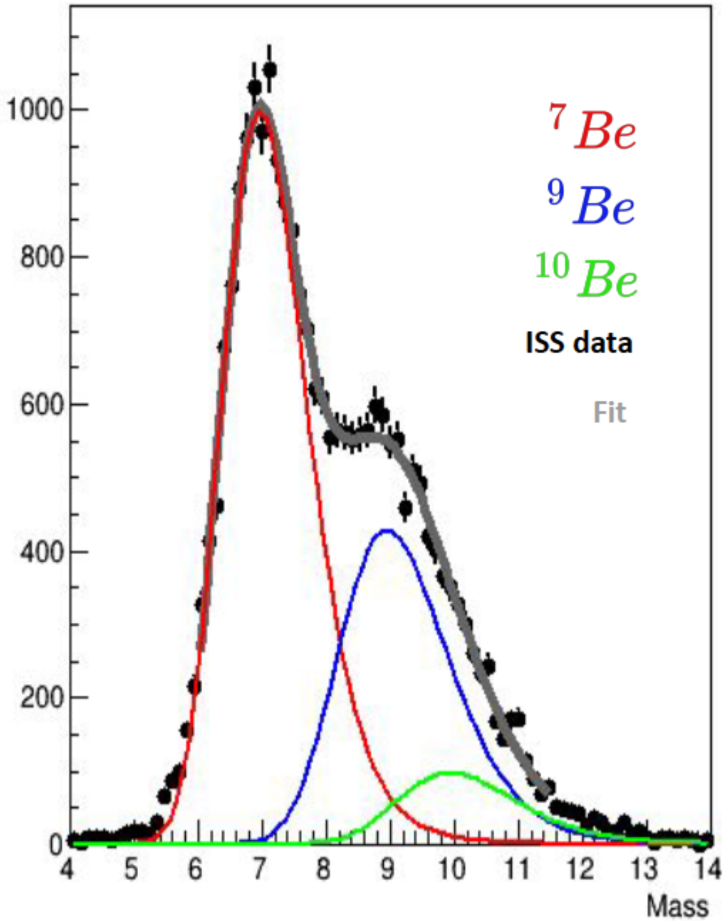


1. We adapt the templates to describe mass distribution

2. We obtain templates for all the isotopes rescaling ^{7}Be

   - $\mu_x \rightarrow$ **(x/7)** μ_7
   - $\sigma_x \rightarrow$ **(x/7)** σ_7

Mass distribution fit (2)



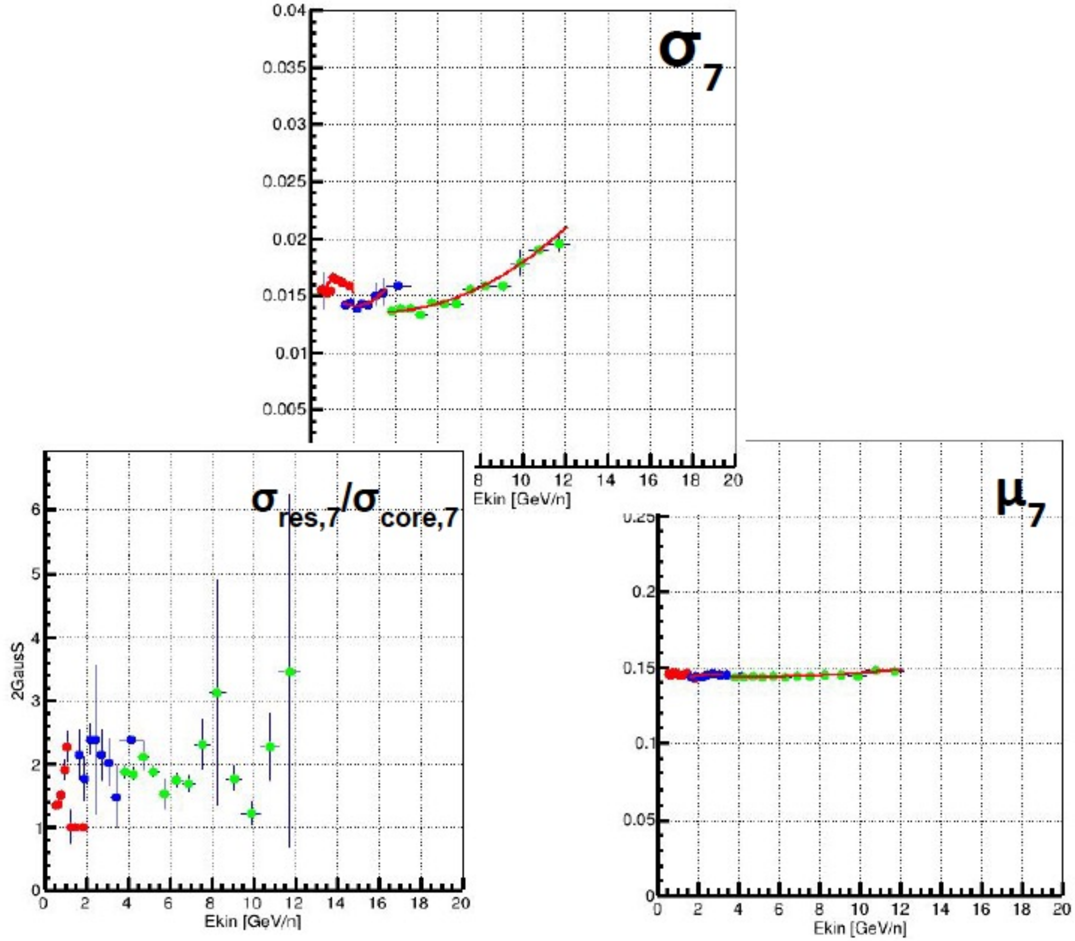
"Free" parameters of the Full Be Model:

- A_7: Height of ^{7}Be
- A_9/A_7: height of ^{9}Be w.r.t ^{7}Be
- A_{10}/A_7: height of ^{10}Be w.r.t ^{7}Be
- σ_7: dev. st. of ^{7}Be core gaussian
- μ_7: Mean of ^{7}Be at peak

"Shape" Parameters (studied from MC)

- $A_{res,7}/A_{core,7}$
- $\sigma_{res,7}/\sigma_{core,7}$

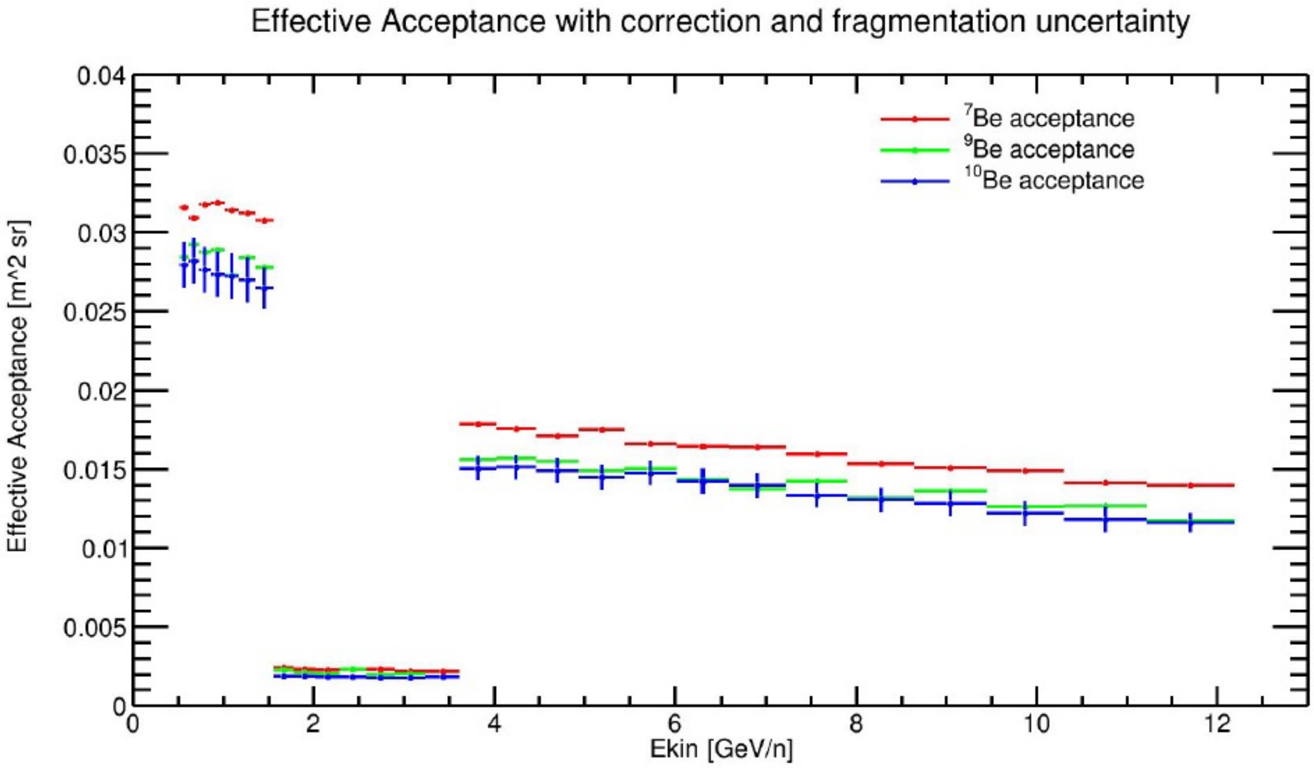
Energy dependent fit procedure (Two fits)



1. **First fit:**
   a. Free parameters loosely constrained
   b. "Shape" parameters constrained around MC parametrized values
2. **Regularization:** Polynomial fit of free parameter trends
3. **Final fit:**
   a. MC parametrizations and polynomials as starting points
   b. ~10% level freedom for param. fit

Effective Acceptance

- L1 correction
- Tracking correction
- Against Interaction
- Beta ToF correction
- Beta NaF correction
- Beta Agl correction
- Trigger eff correction: to be implemented



Be Isotopes fluxes

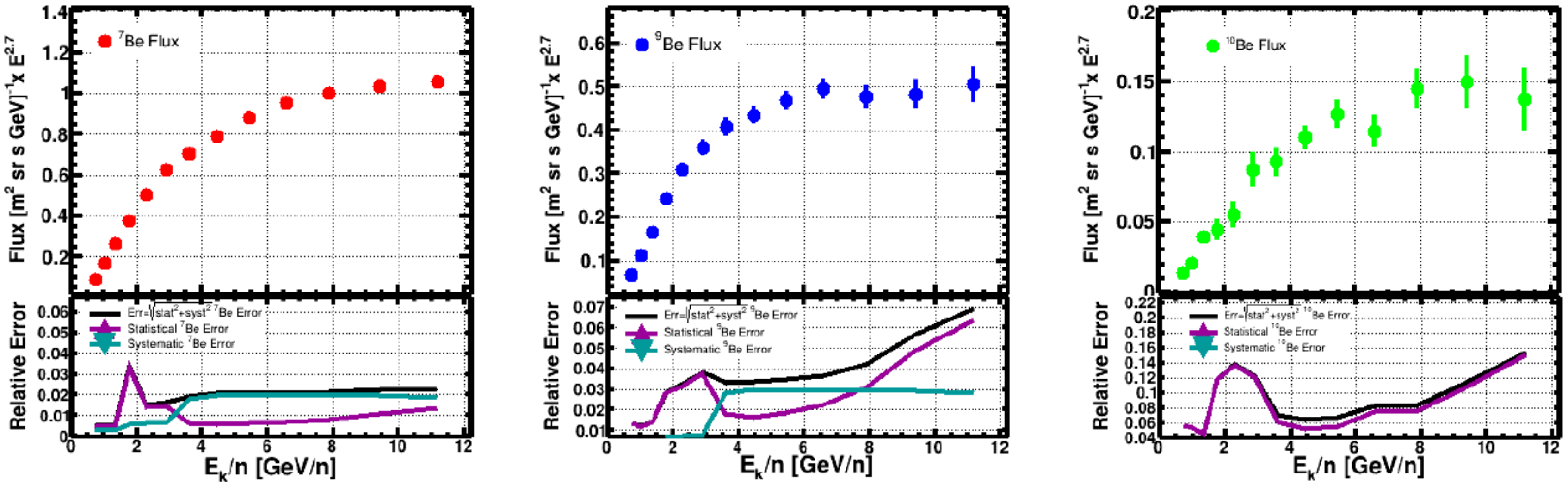
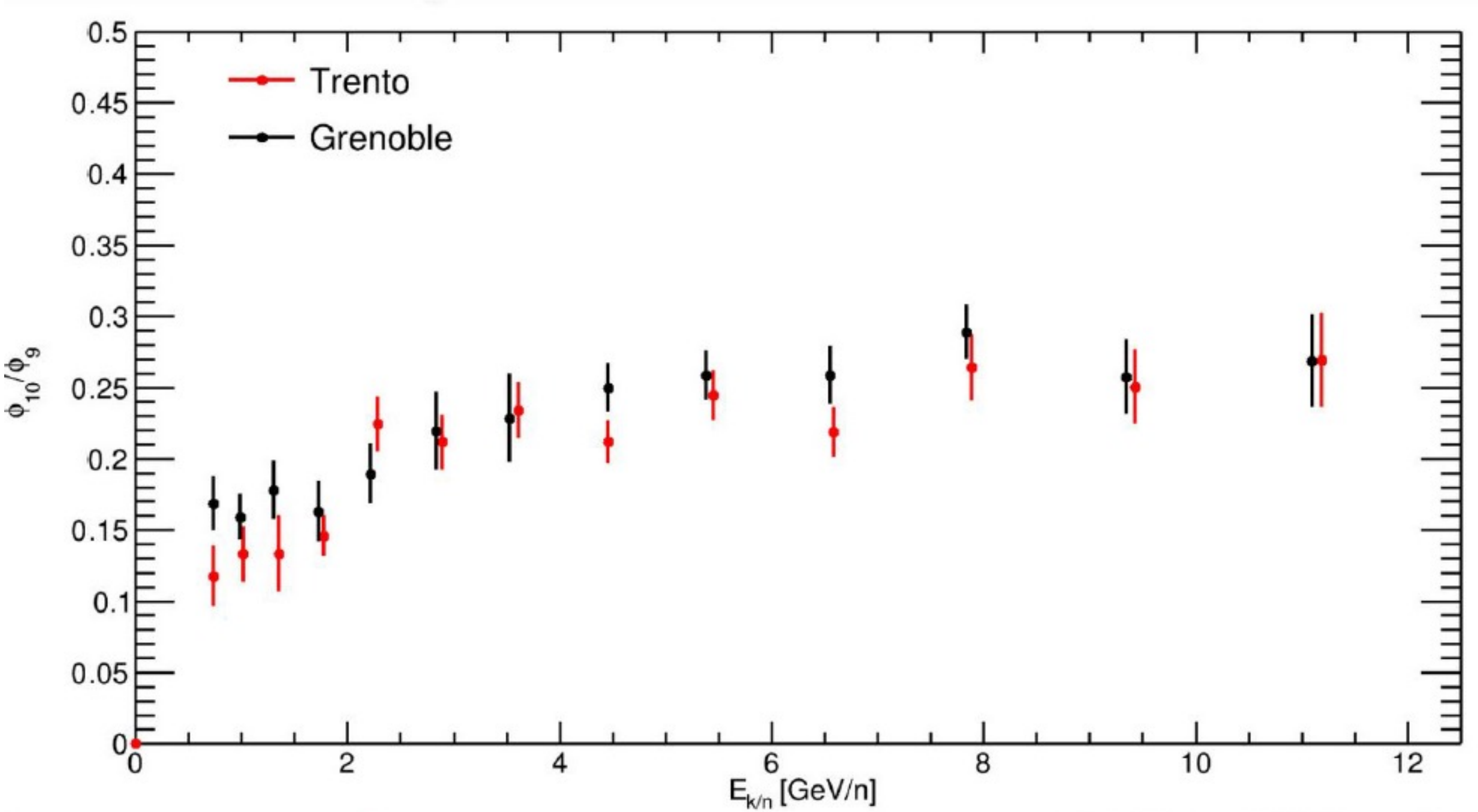


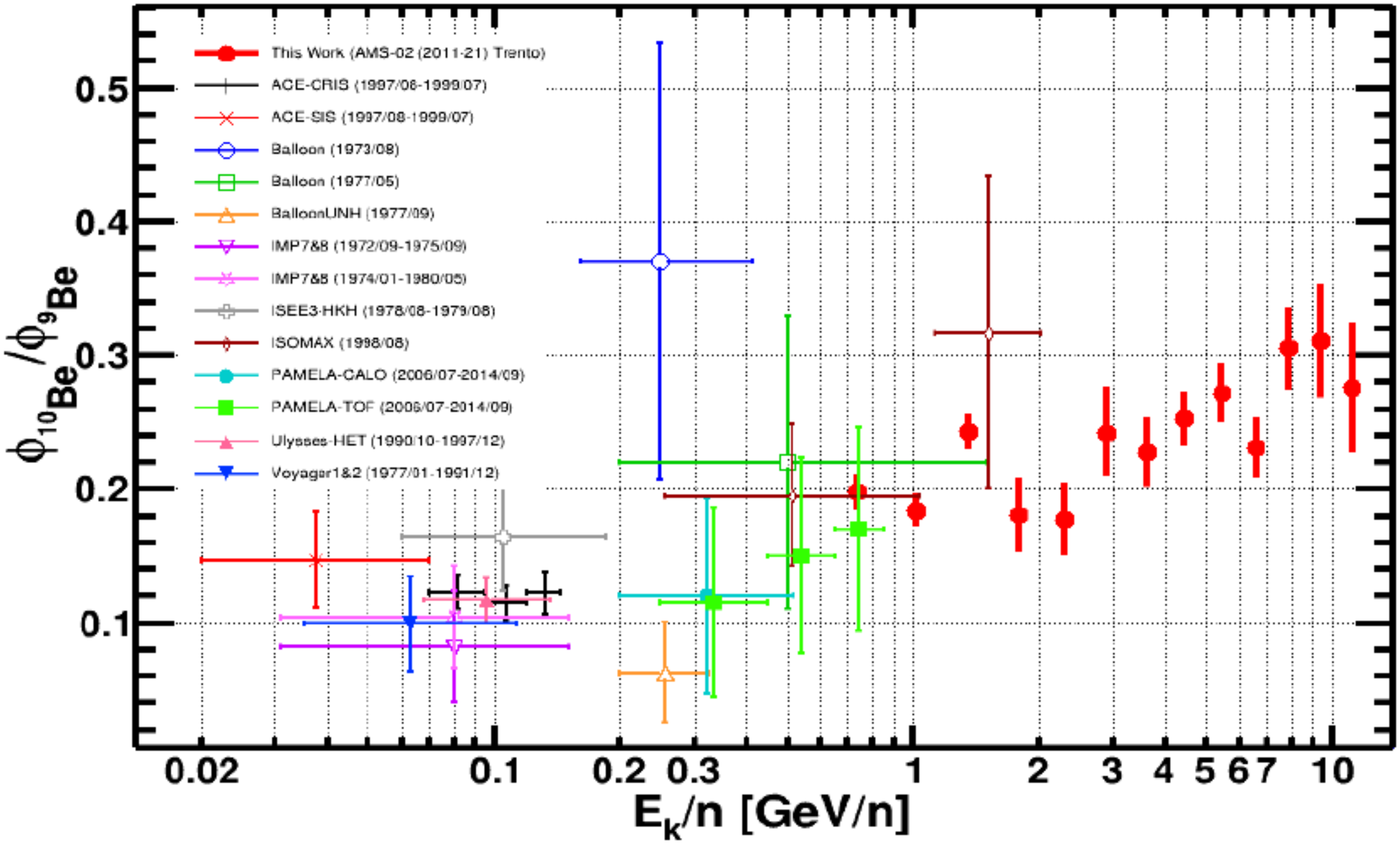
Figure 5.10: The fluxes for the isotopes ^{7}Be, ^{9}Be, and ^{10}Be with their relative error in the bottom panel. The Statistical errors are shown in magenta, Systematic errors in cyan, and Total errors in black.

Be10/Be9 Flux Comparison



P.S: Grenoble points shifted for comparison

AMS $^{10}Be/^{9}Be$ compared to existing data

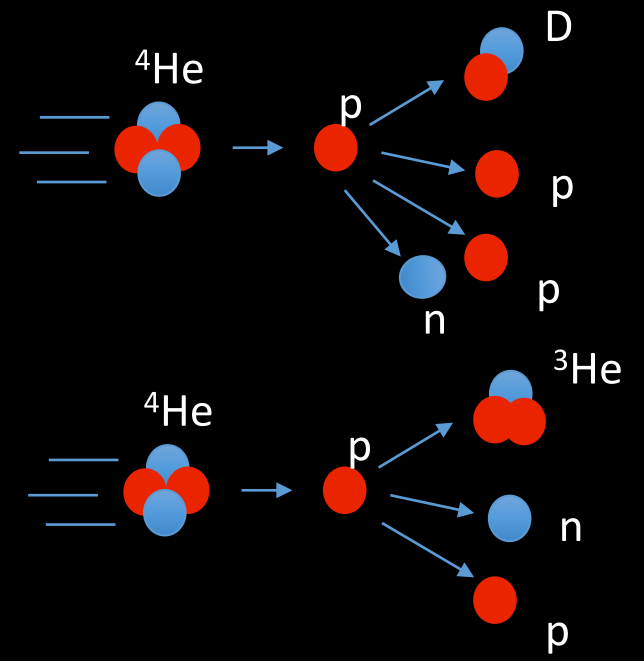


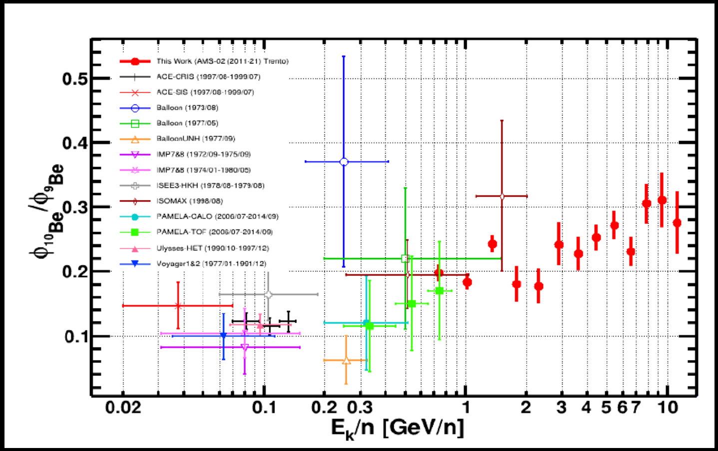
Summary

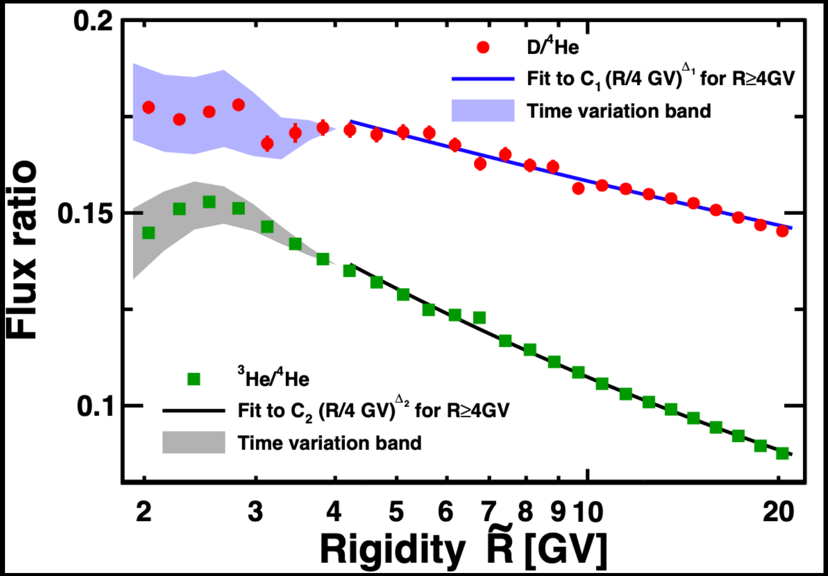
- TIFPA played a forefront role in publishing the AMS-02 measured the ^{3}He and D fluxes using 10 years of data in the rigidity range from 2GV to 20 GV.

- TIFPA completed a competitive analysis on Be isotope fluxes

- TIFPA is working on anti-He antimatter analysis
- TIFPA will be involved on the B and N isotopes analysis







Thanks for your attention