

Cosmic-Ray Lithium Isotopes with AMS02

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Light Isotopes in Cosmic Rays

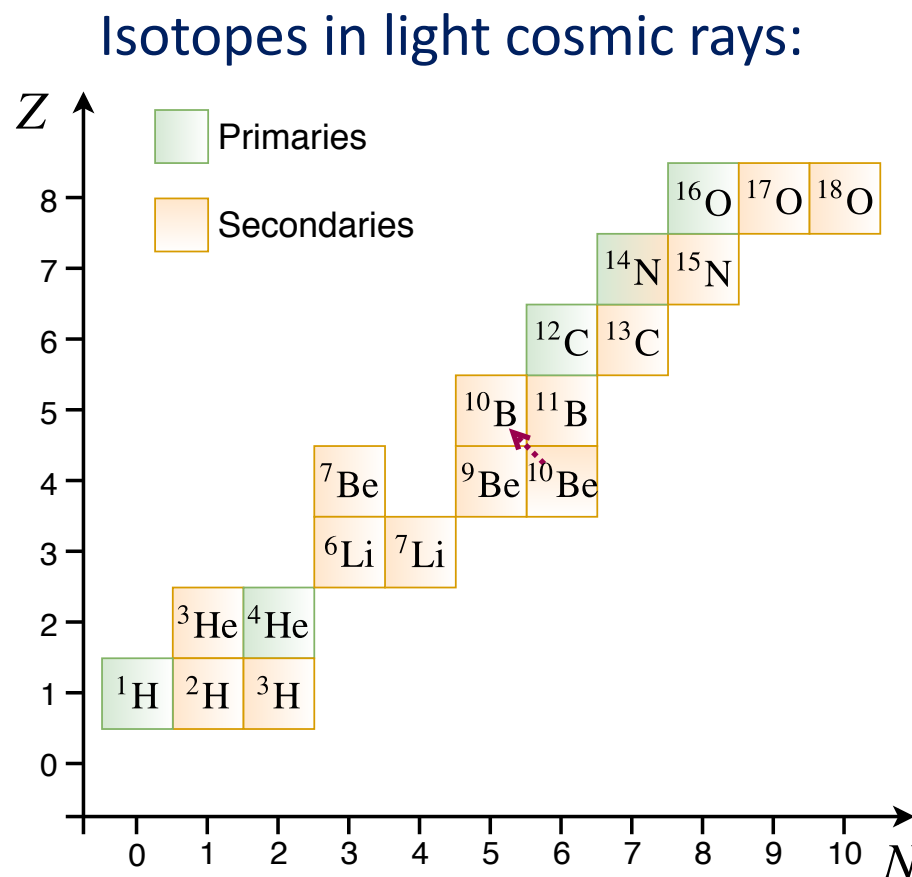
- Precise measurement of the light elemental fluxes by AMS

See A. Oliva Talks (CRD6b) & Q. Yan (CRD7a)

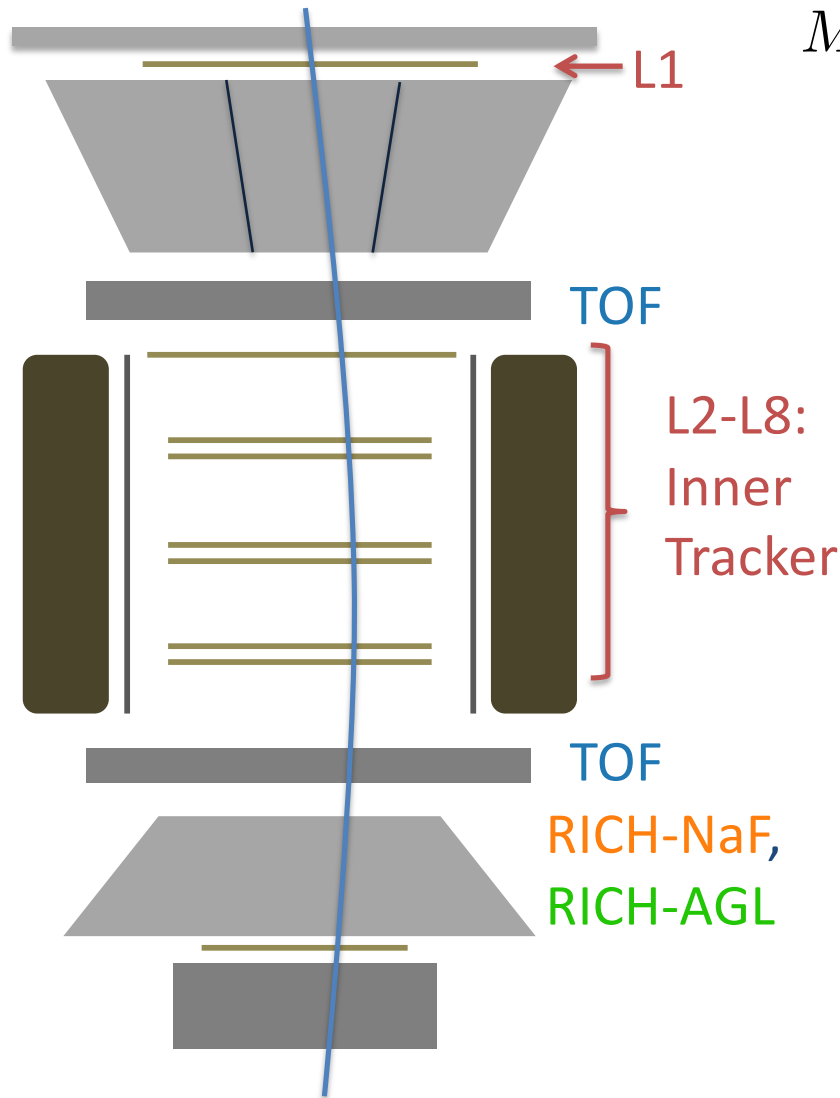
→ Important information to understand the origin and the propagation of Cosmic Rays

- More detailed information from Isotopic composition:
 - Different origins (secondary/primary):
 - $^3\text{He}/^4\text{He}$ *See C. Delgado Talk (CRD6c)*
 - Different propagation history
 - ^{10}Be : $t_{1/2} = 1.4$ My: radioactive clock

- This presentation focused on Lithium isotopes:
 - $^6\text{Li}/^7\text{Li}$ mainly determined by the secondary production cross sections from C, O fragmentation.
 - Develop and test isotopic composition measurement with AMS.



Measurement of Isotopic composition with AMS02

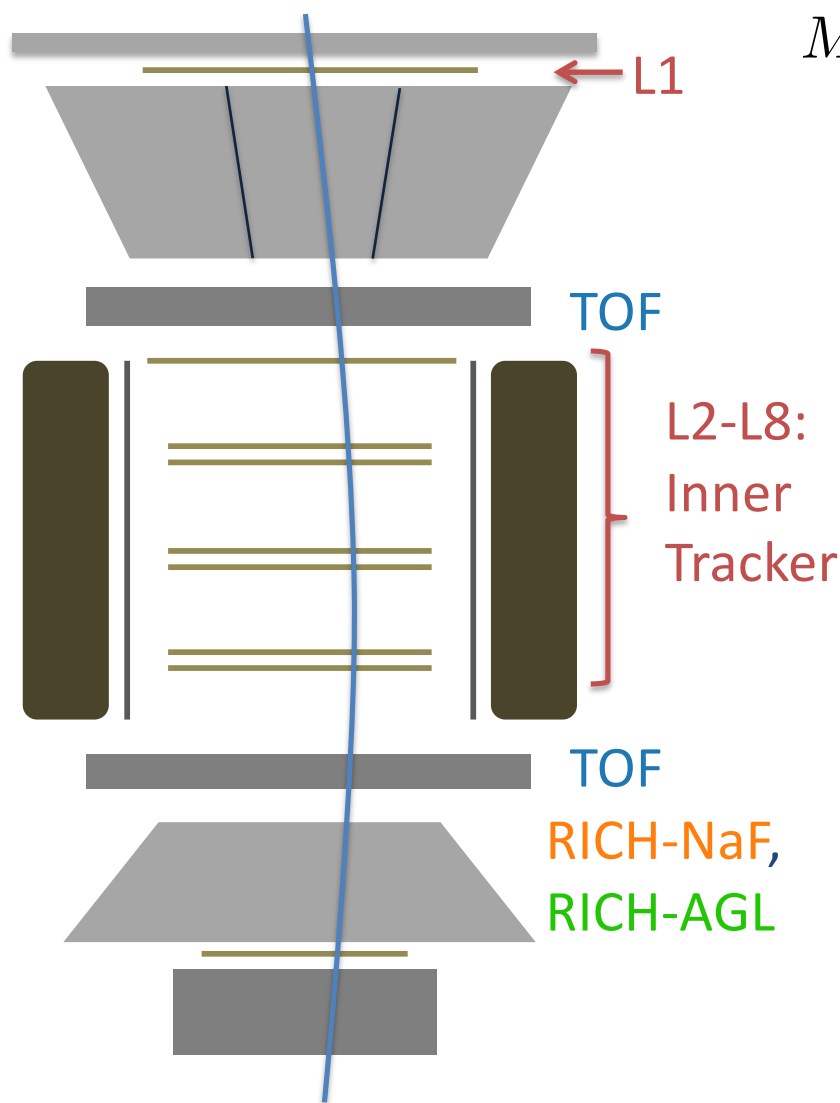


$$M = \frac{RZ}{\gamma\beta} \Rightarrow \frac{\Delta M}{M} = \sqrt{\left(\frac{\Delta R}{R}\right)^2 + \left(\gamma^2 \frac{\Delta\beta}{\beta}\right)^2}$$

- Z measurement :
 - L1 - UTOF - Inner Tracker - LTOF
 - Negligible charge confusion
- R measurement :
 - Tracker (Inner)
- β measurements:
 - TOF (4 layers)
 - $\Delta\beta/\beta(Z=3) \sim 2\%$
 - RICH - NaF ($n_{\text{NaF}} = 1.33$)
 - $\beta > 0.75, \Delta\beta/\beta(Z=3) \sim 0.15\%$
 - RICH - AGL ($n_{\text{AGL}} = 1.05$)
 - $\beta > 0.95, \Delta\beta/\beta(Z=3) \sim 0.05\%$

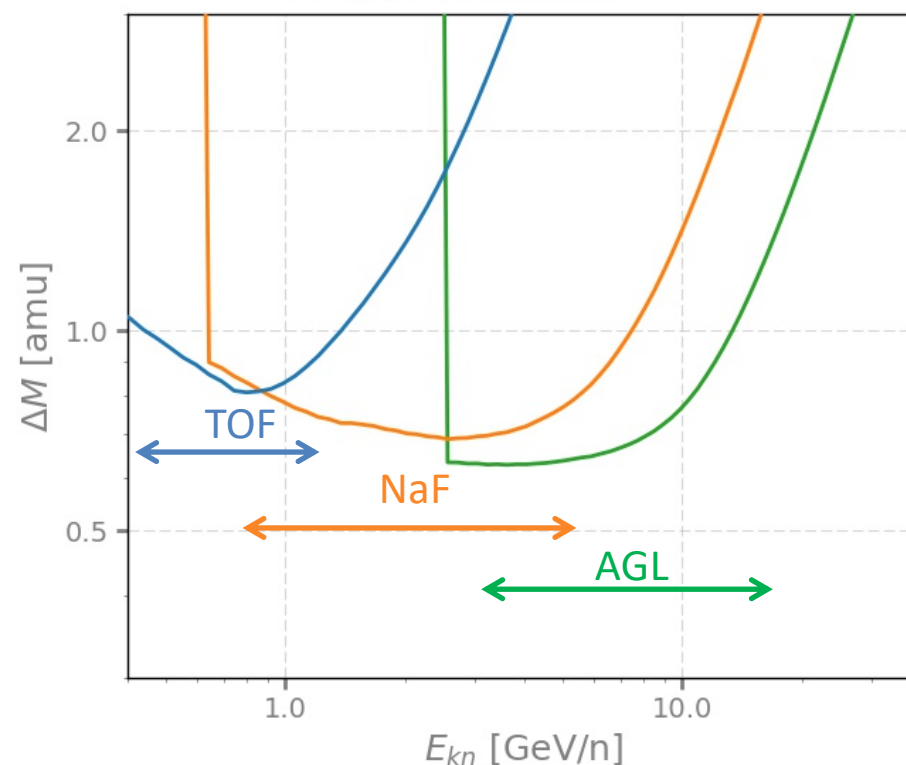
→ 3 analyses which cover different energy ranges

Measurement of Isotopic composition with AMS02



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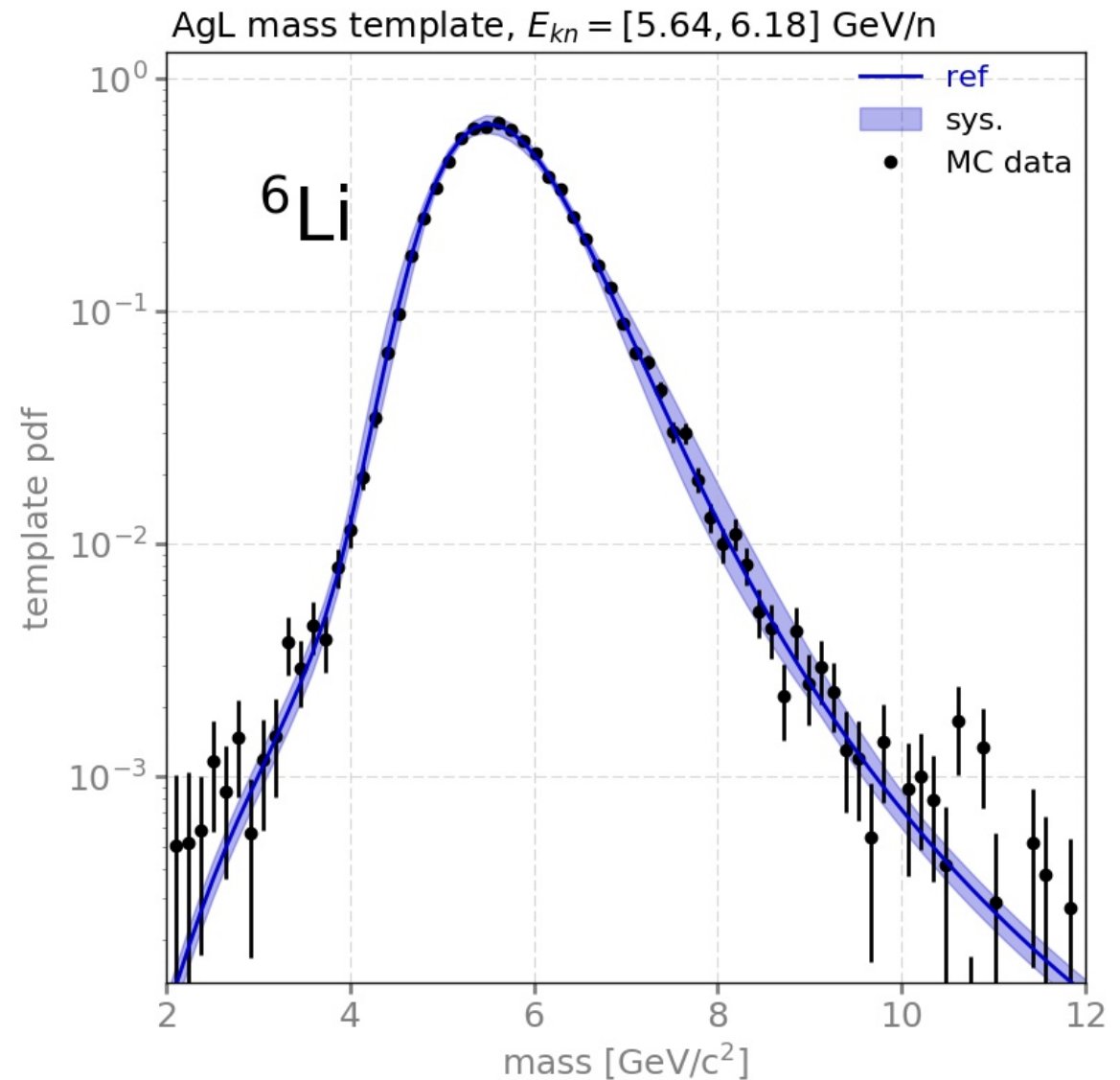
${}^6\text{Li}$ mass resolution



- $\Delta M \sim 1 \text{ amu} \rightarrow$ Event by Event isotopic identification not reachable.
 \rightarrow Isotopic abundances from the shape of the mass distribution.

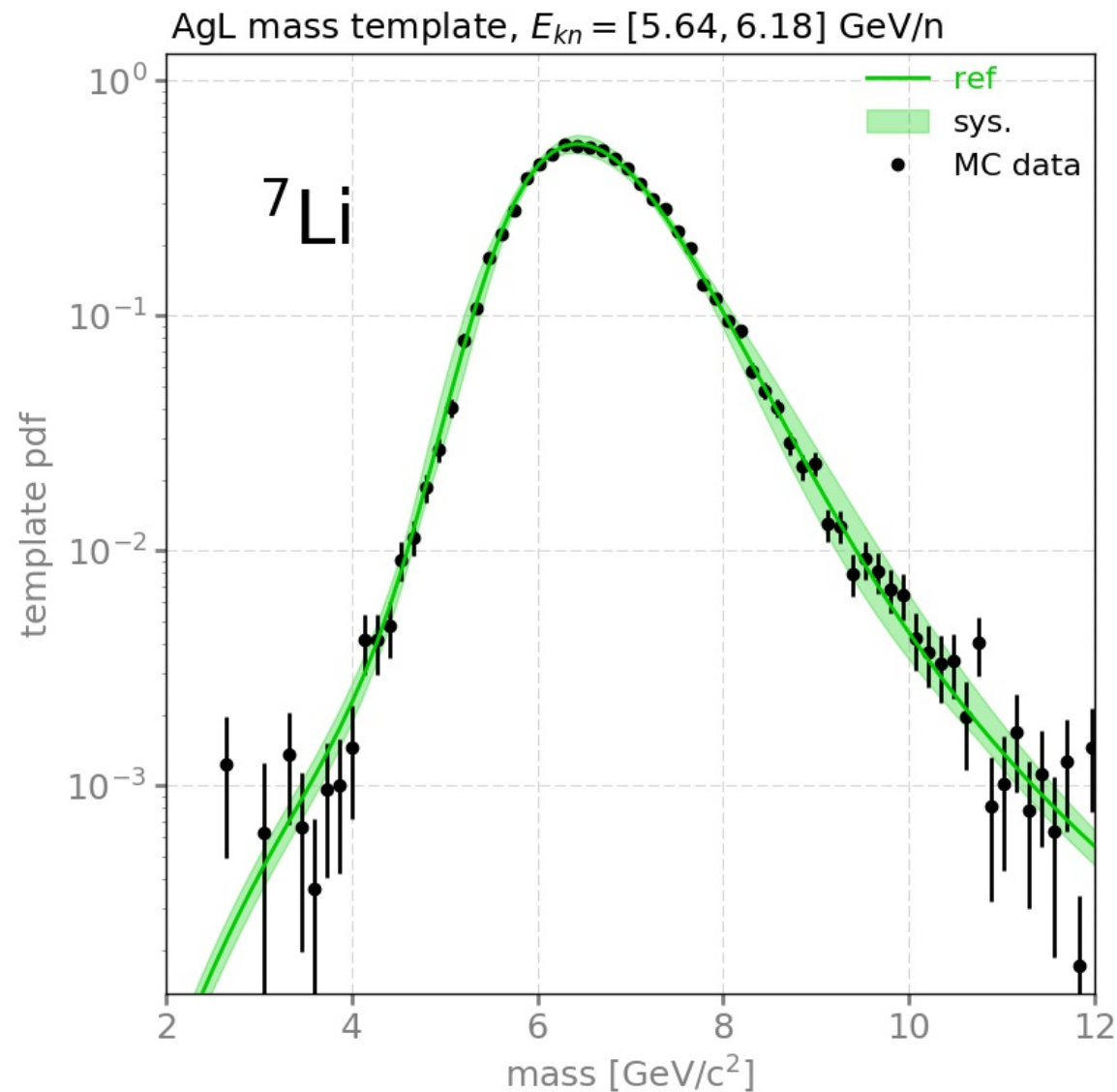
Mass Templates

- Mass templates reconstructed from the β resolution and R resolution models obtained from MC simulation.
- Systematic in the mass template shapes are implemented by varying the β resolution and R resolution models with nuisance parameters (shift, width and tails).
- 1 template for each isotope, each energy bin, each analysis.



Mass Templates

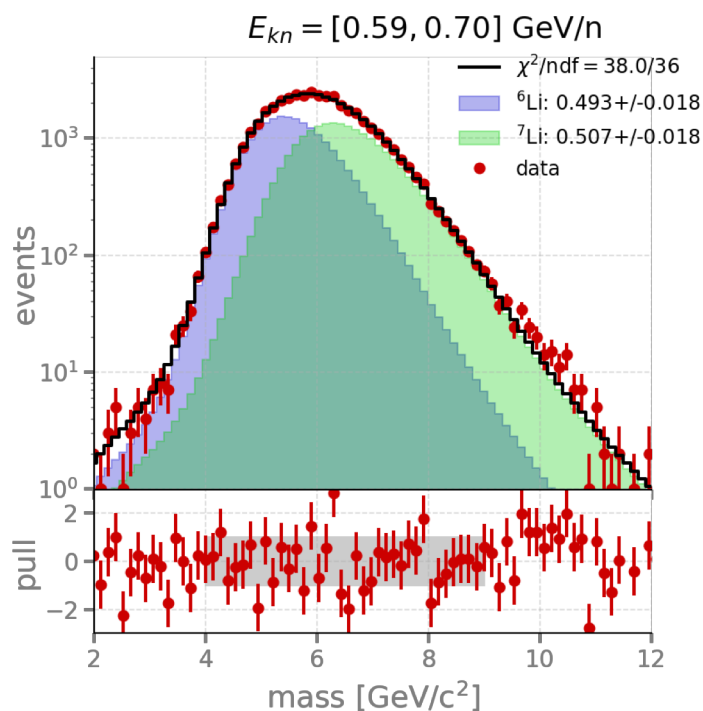
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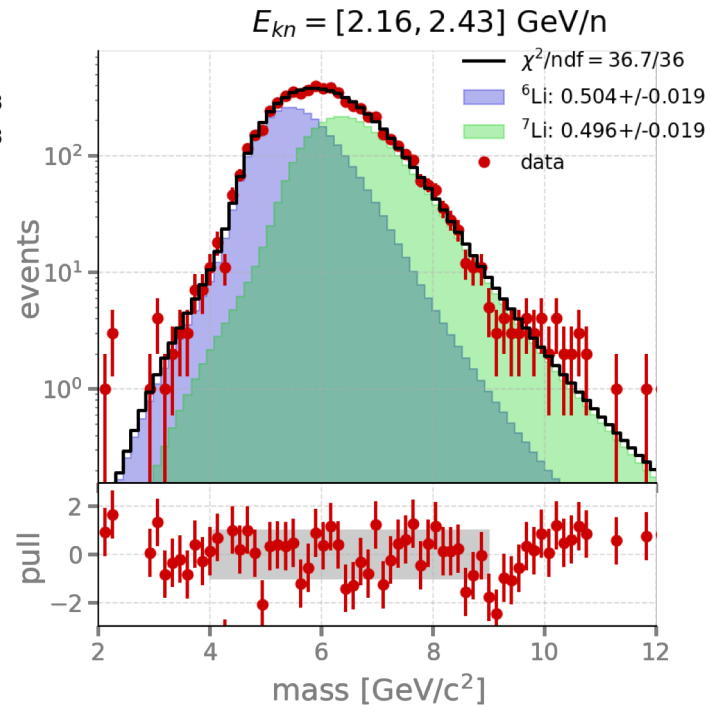
${}^6\text{Li}/{}^7\text{Li}$ abundances

- ${}^6\text{Li}$ and ${}^7\text{Li}$ abundances fitted on the mass distribution for $Z=3$ data by weighting ${}^6\text{Li}$ and ${}^7\text{Li}$ templates with their abundances:

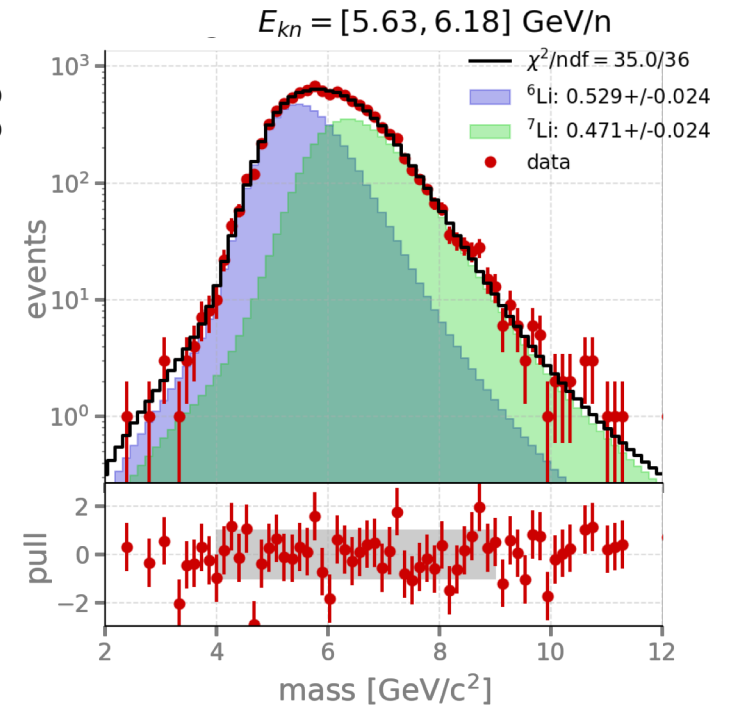
TOF



NaF



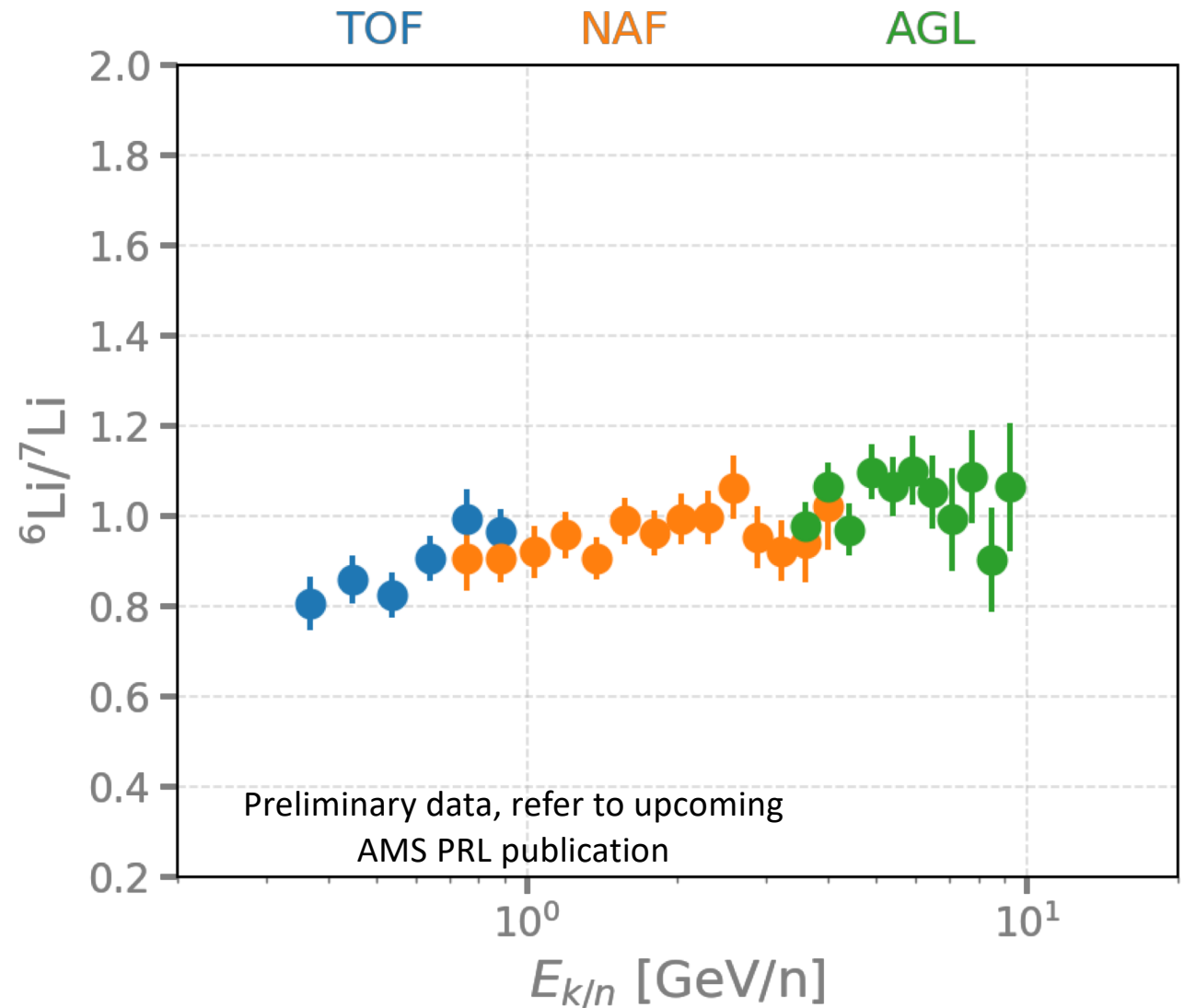
AGL



- Errors on abundances include statistical error and systematic error from the mass template shapes.

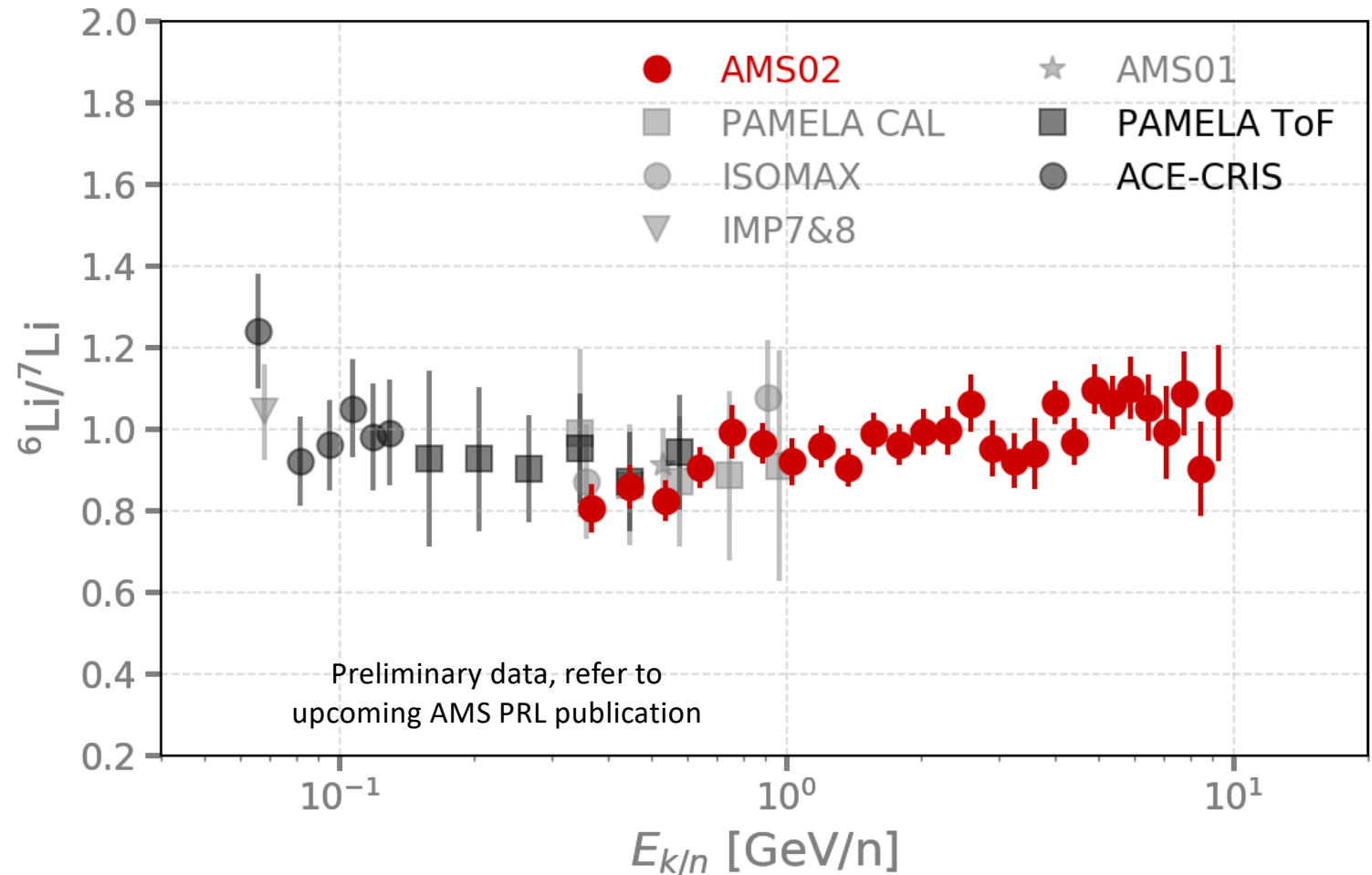
$^6\text{Li}/^7\text{Li}$ ratio vs Kinetic Energy per nucleon

- Isotopic abundances from the fit of each mass distribution, corrected with $^6\text{Li}/^7\text{Li}$ acceptance and exposure time.



${}^6\text{Li}/{}^7\text{Li}$ ratio vs kinetic energy per nucleon

Comparison with previous experiments:

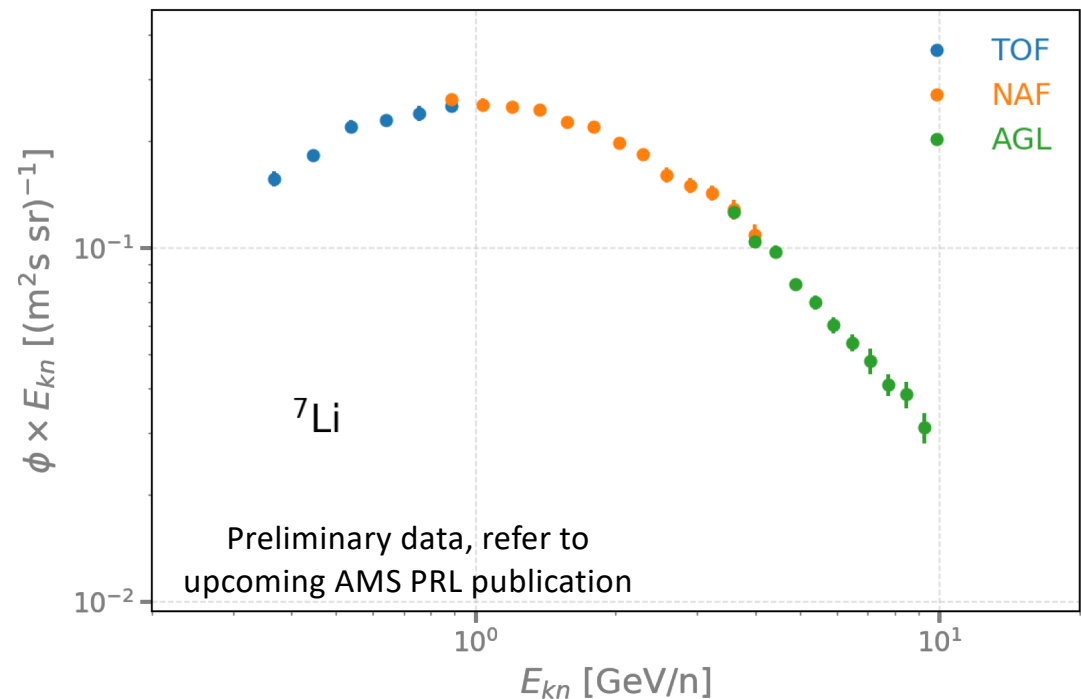
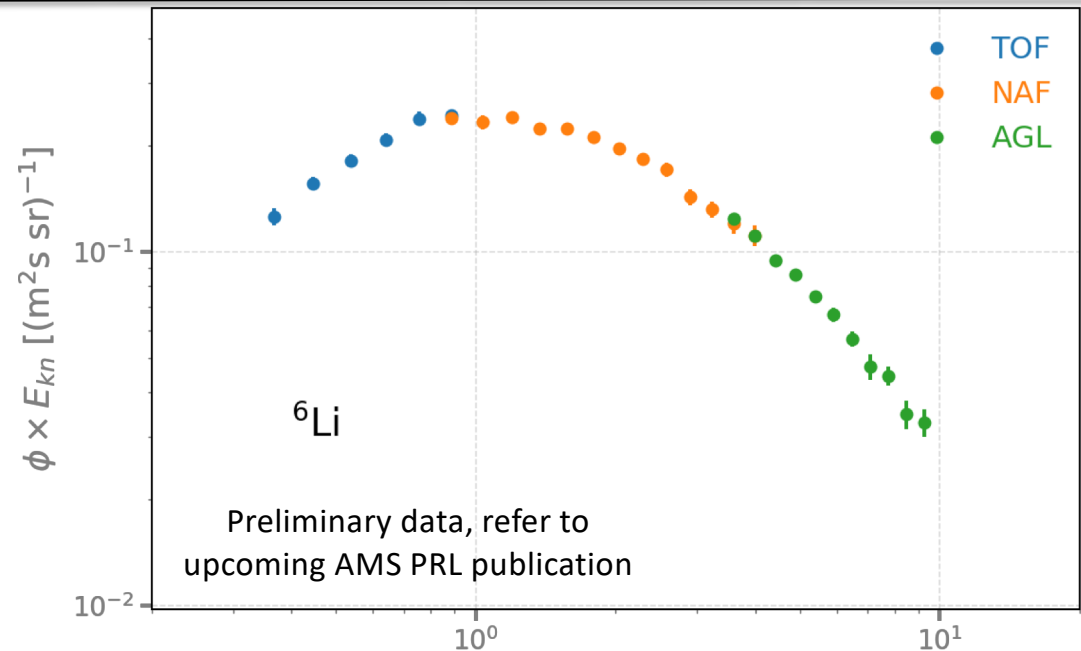


→ Extends ${}^6\text{Li}/{}^7\text{Li}$ ratio measurement above 1 GeV/n up to 10 GeV/n

Flux reconstruction

Isotopic fluxes:

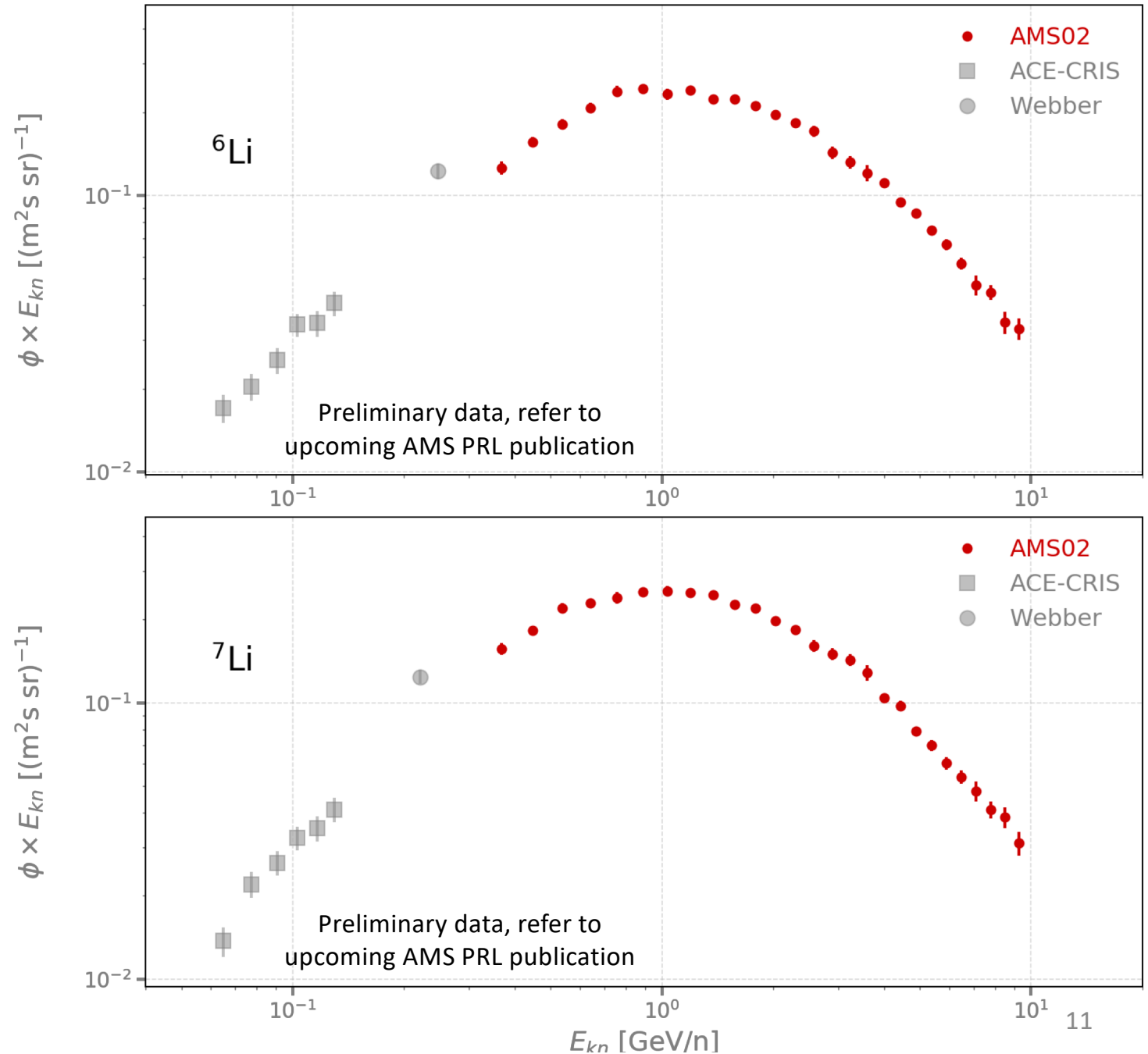
- computed from abundances, effective acceptances and exposure time.
- Corrected for contamination from fragmentation of heavier nuclei.
- Unfolded to correct energy migration due to finite β resolution.



^6Li and ^7Li fluxes vs kinetic energy per nucleon

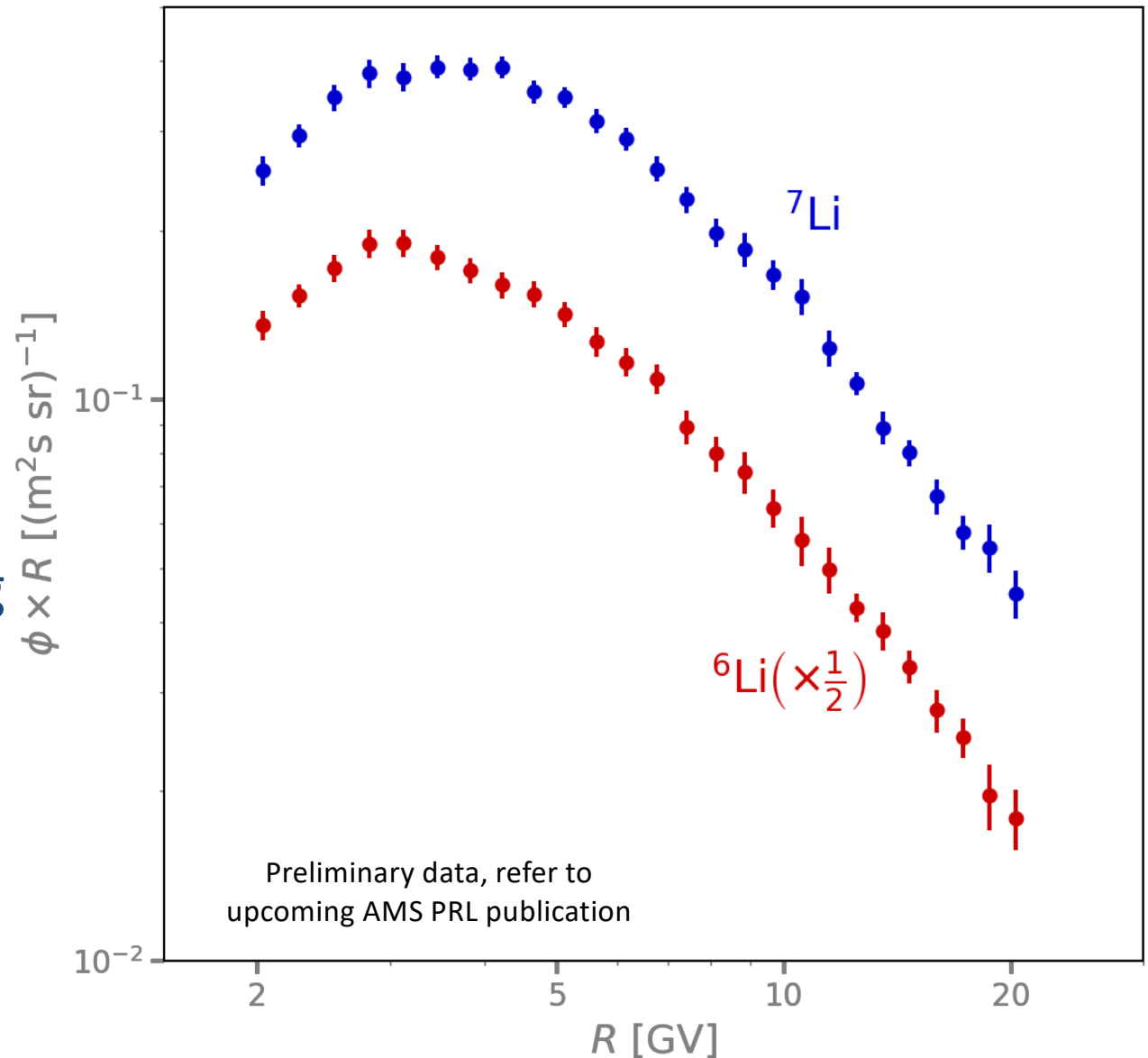
Comparison with previous experiments:

→ First measurement of ^6Li and ^7Li fluxes above 0.3 GeV/n.



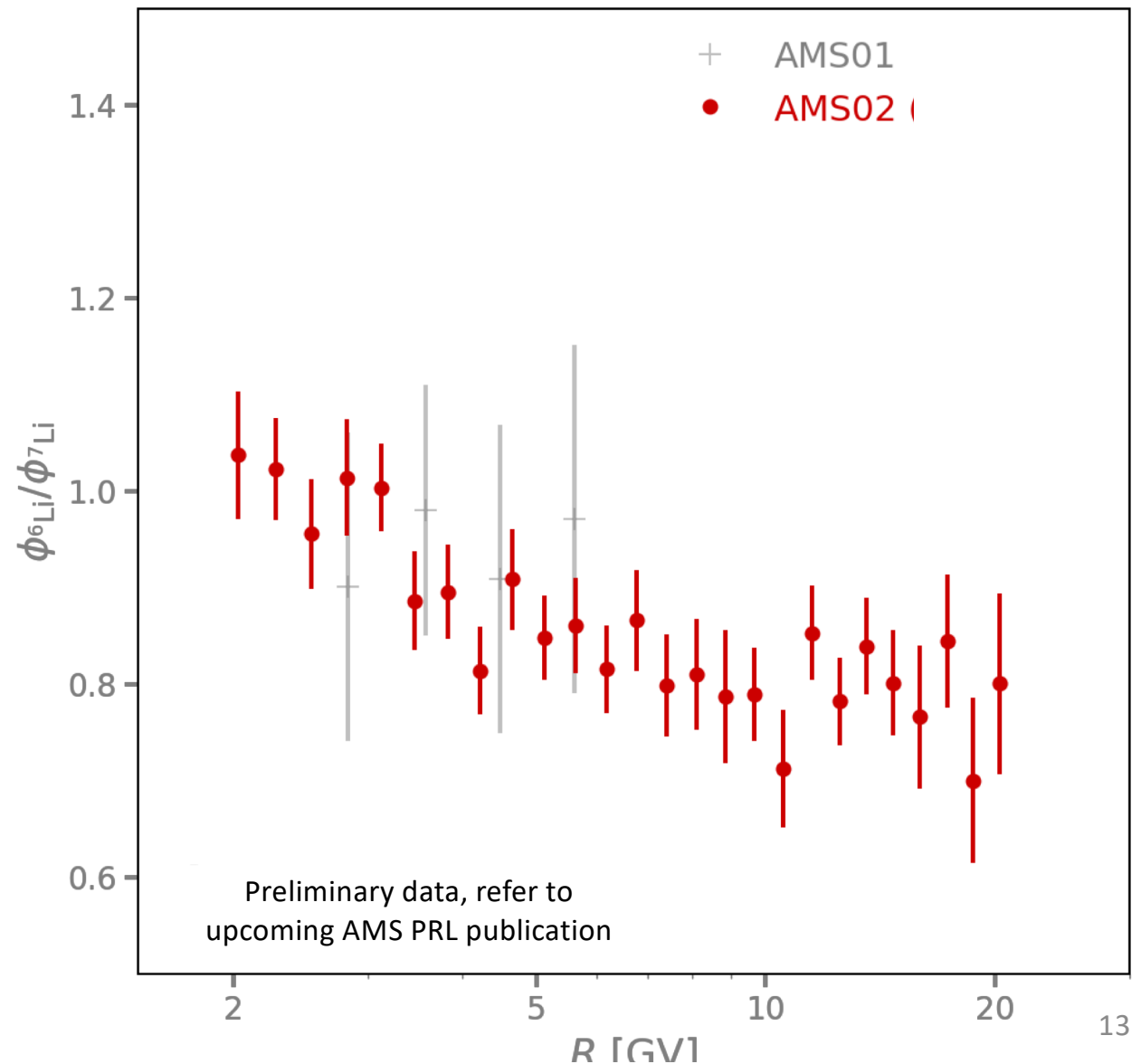
^6Li and ^7Li fluxes vs rigidity

- Use of different binning vs $E_{k/n}$ for ^6Li and ^7Li to get the same rigidity bins
- Full isotopic analysis done for the two binning
- $E_{k/n} \rightarrow R$ conversion for each Isotope.



$^6\text{Li}/^7\text{Li}$ flux ratio vs rigidity

- Use of different binning vs $E_{k/n}$ for ^6Li and ^7Li to get the same rigidity bins
- Full isotopic analysis done for the two binning
- $E_{k/n} \rightarrow R$ conversion for each Isotope.



Conclusion

- Isotopic composition of light nuclei in cosmic rays is a key measurement to understand cosmic rays origin and propagation.
- Dedicated method based on template fit of the mass distributions presented here.
- First measurement of ${}^6\text{Li}/{}^7\text{Li}$ ratio above 1 GeV/n.
- First measurement of ${}^6\text{Li}$ and ${}^7\text{Li}$ fluxes above 0.3 GeV/n.
- Measurement vs rigidity from 2 to 20 GV.
- Work ongoing to analyze heavier isotopes.