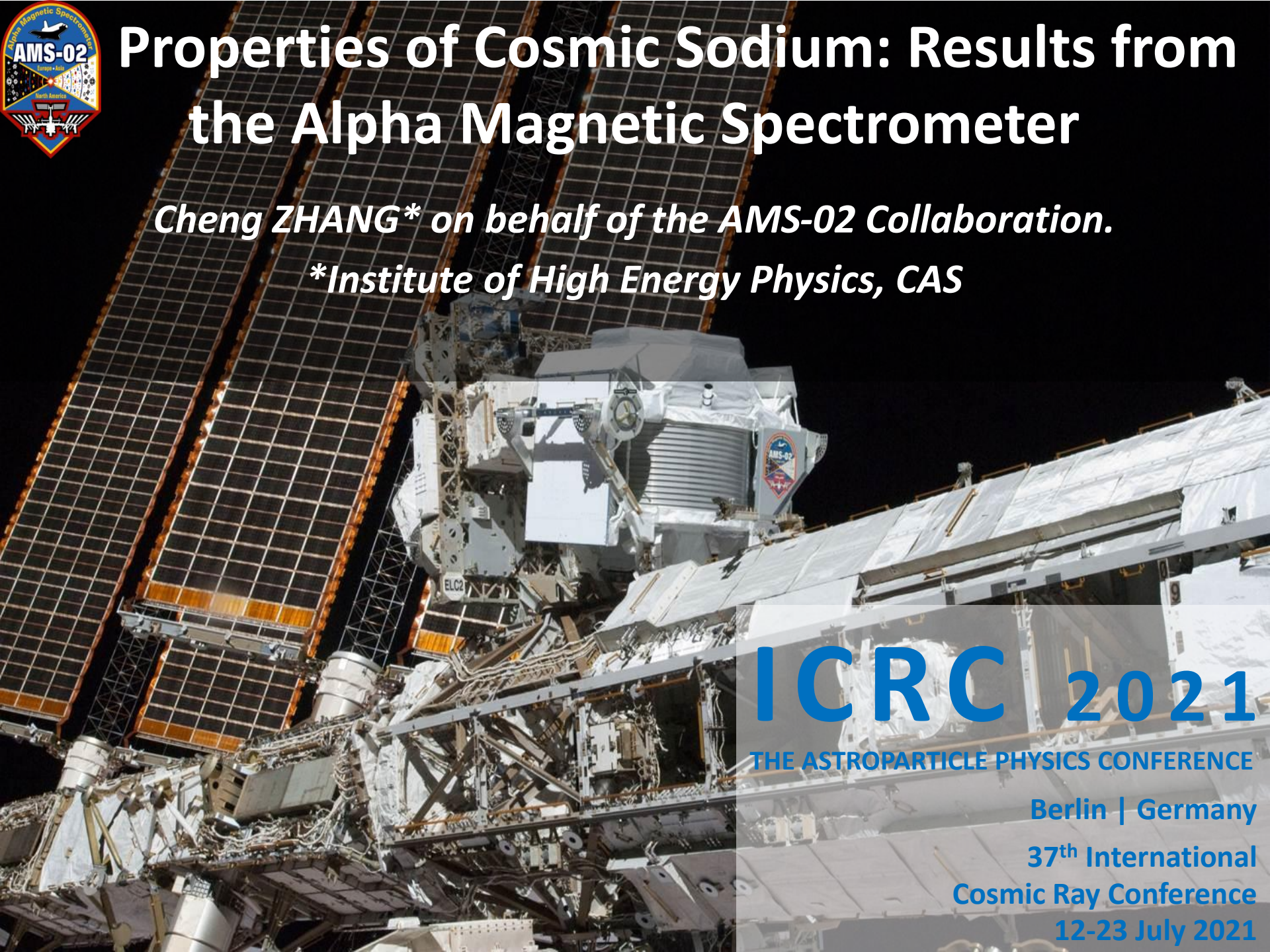
Properties of Cosmic Sodium: Results from the Alpha Magnetic Spectrometer

Cheng ZHANG on behalf of the AMS-02 Collaboration.*

**Institute of High Energy Physics, CAS*



ICRC 2021

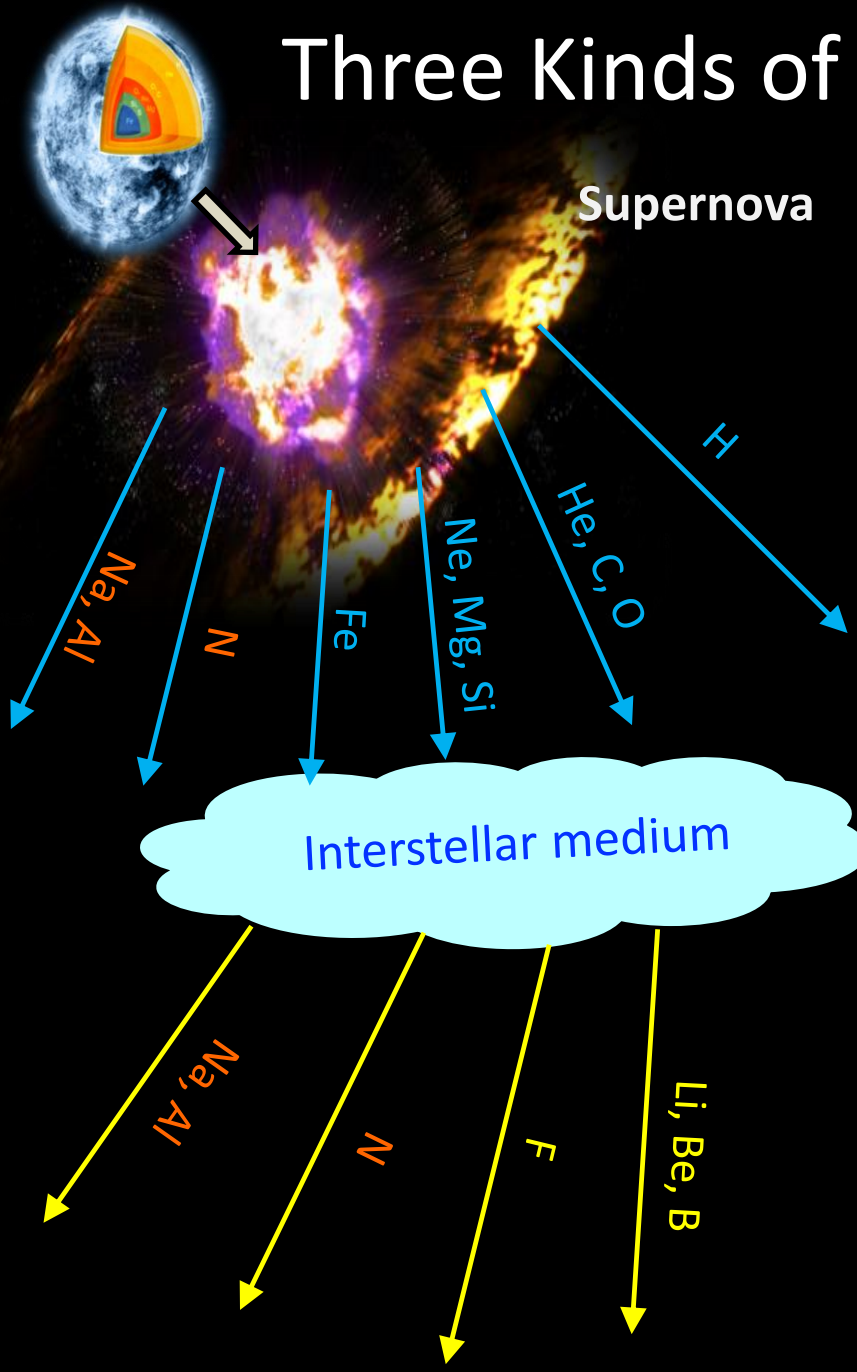
THE ASTROPARTICLE PHYSICS CONFERENCE

Berlin | Germany

37th International Cosmic Ray Conference

12-23 July 2021

Three Kinds of Charged Cosmic Rays

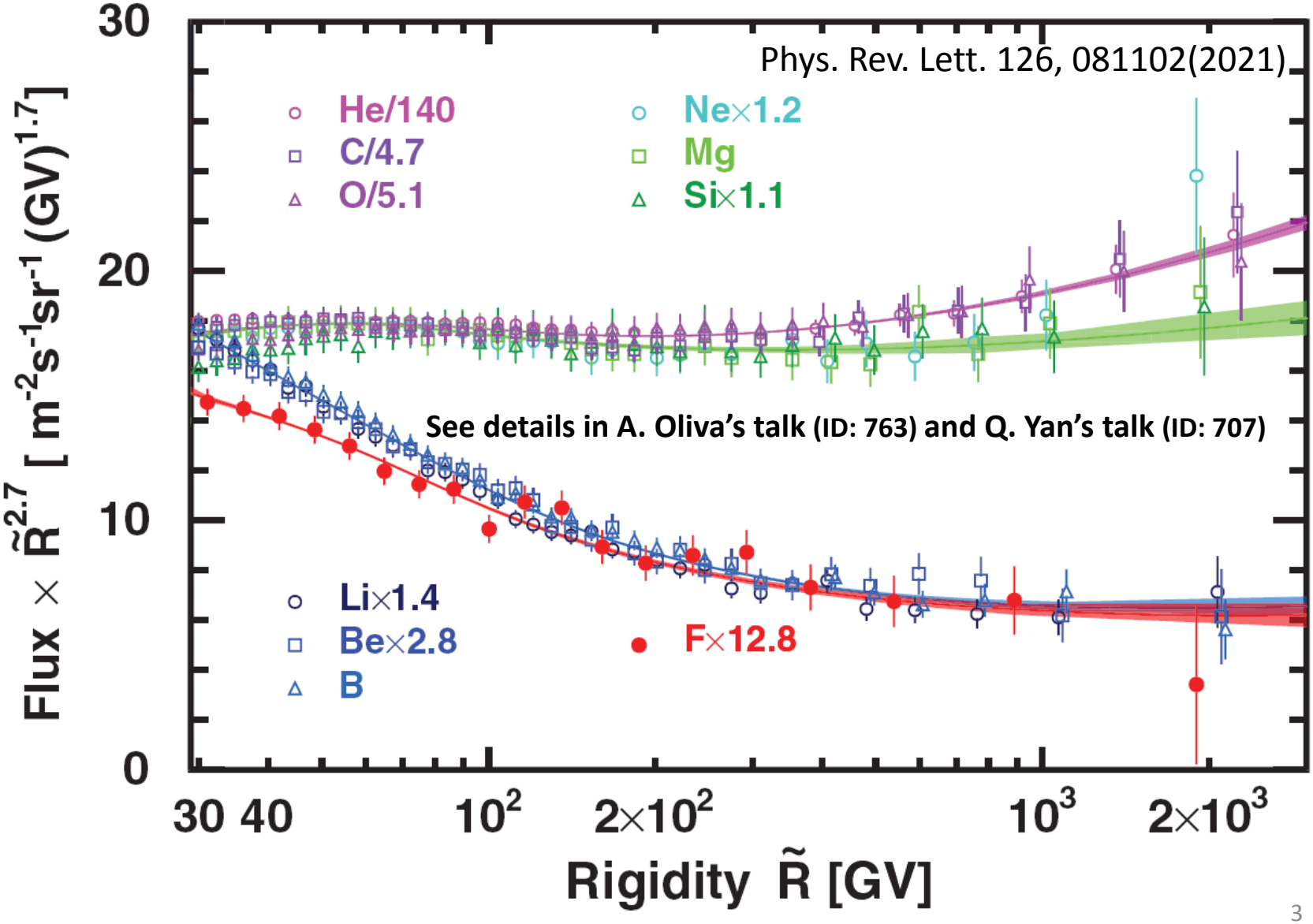


Primary cosmic rays (p, He, C, O, Ne, Mg, Si ..., Fe) are mostly produced during the lifetime of stars and are accelerated in supernovae shocks, whose explosion rate is about 2-3 per century in our Galaxy.

Secondary cosmic nuclei (Li, Be, B, F, …) are produced by the collisions of primary cosmic rays and interstellar medium.

AMS found that
the third group of cosmic nuclei with the linear combination of Primary and Secondary components (N, Na, Al,…).

AMS Measurement of Primary and Secondary Cosmic Rays



AMS Cosmic Rays Chemical Composition

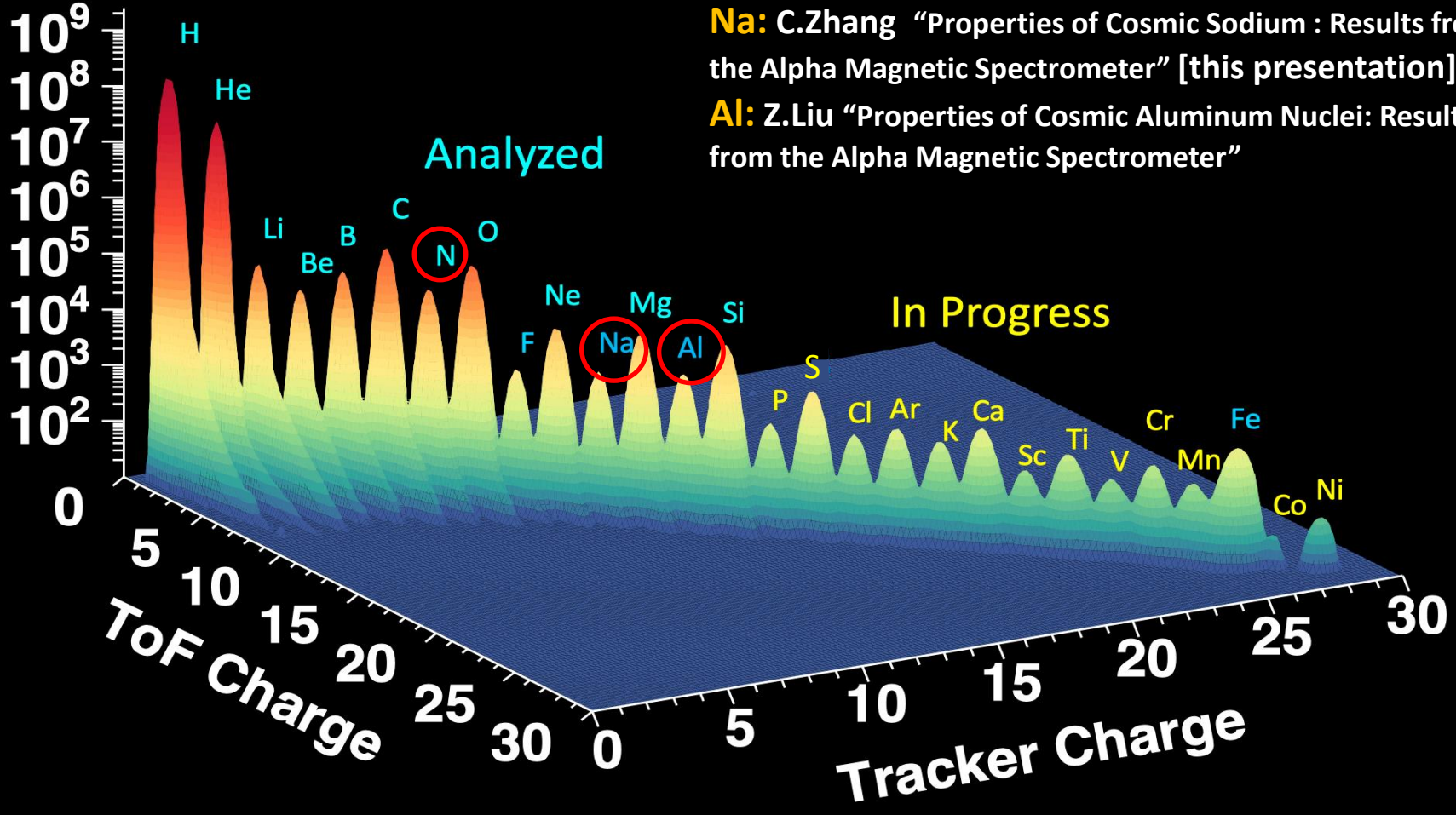
N: Phys. Rev. Lett. 121, 051103 (2018).
"Precision Measurement of Cosmic-Ray Nitrogen and its Primary and Secondary Components with the Alpha Magnetic Spectrometer on the International Space Station"

Na,Al: Phys. Rev. Lett. in press.
"Properties of Cosmic Sodium and Aluminum and their Primary and Secondary Components, Results from the Alpha Magnetic Spectrometer"

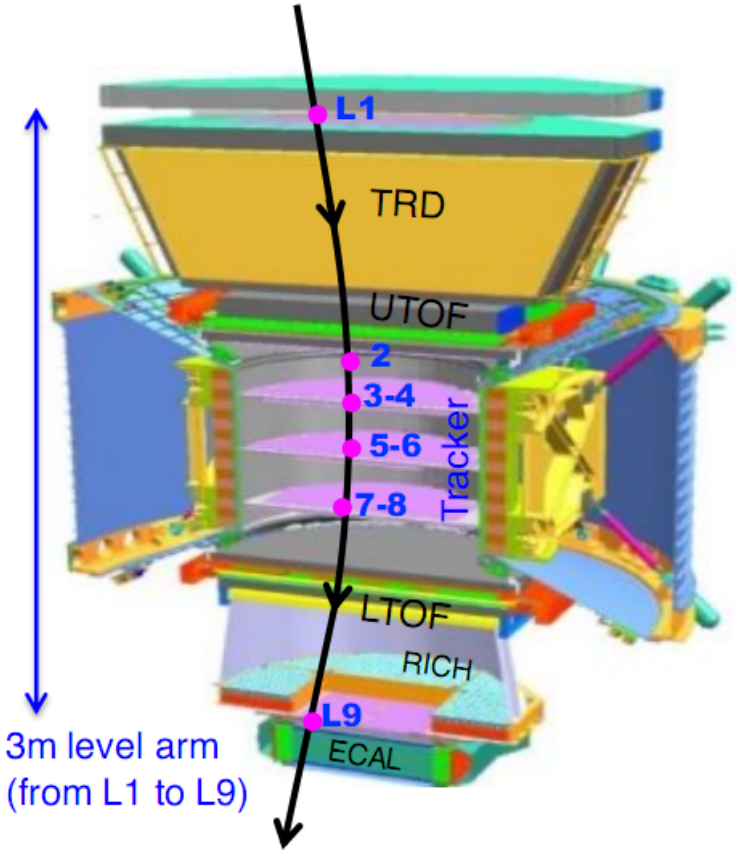
In ICRC 2021:

Na: C.Zhang "Properties of Cosmic Sodium : Results from the Alpha Magnetic Spectrometer" [this presentation]

Al: Z.Liu "Properties of Cosmic Aluminum Nuclei: Results from the Alpha Magnetic Spectrometer"



AMS Ions Measurement



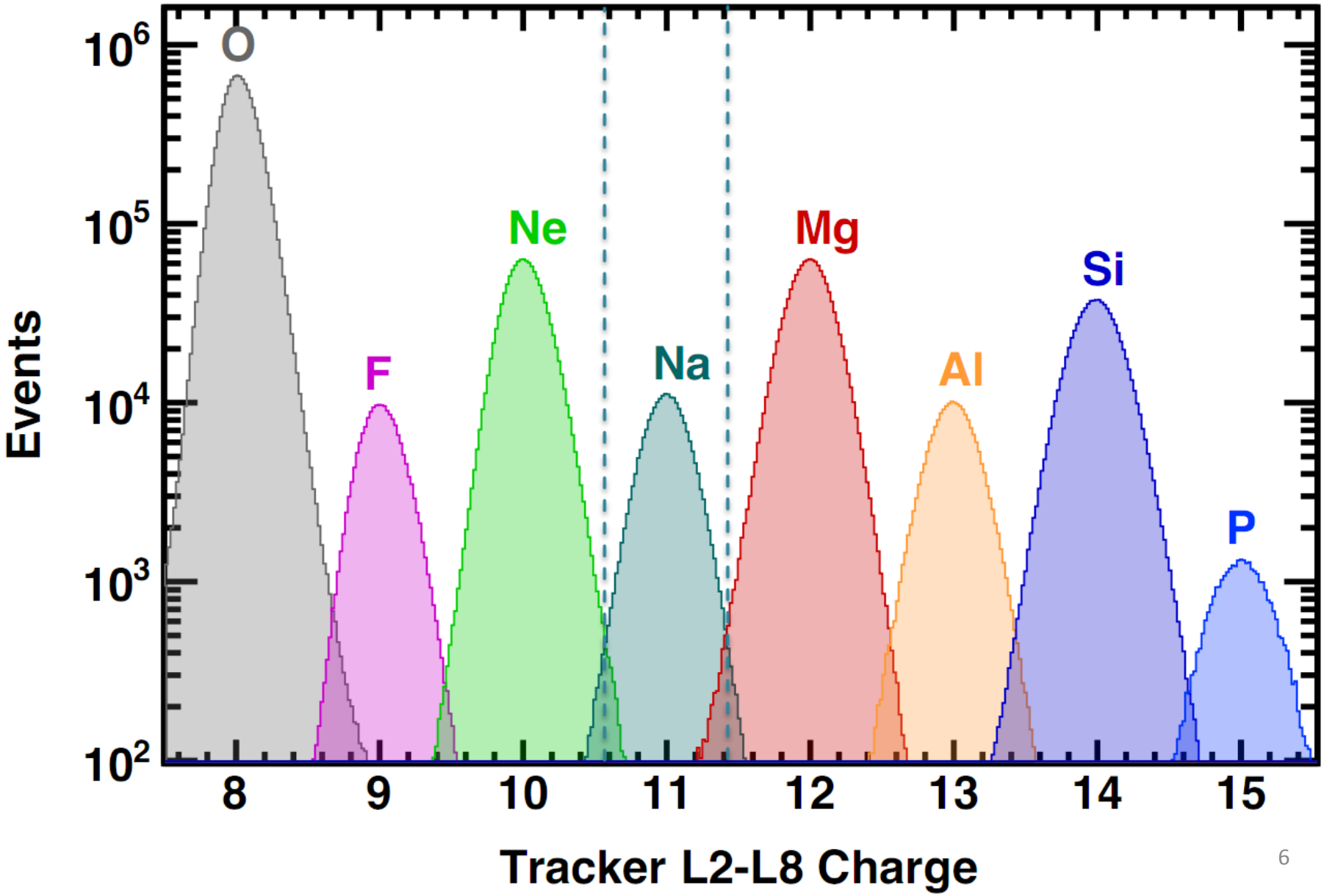
Particle Rigidity (momentum/charge) is measured combining Tracker (9 Layers) + Magnet

	Coordinate Resolution	MDR
Z =1	10 μm	2 TV
$2 \leq Z \leq 8$	5-7 μm	3.2-3.7 TV
$9 \leq Z \leq 14$	6-8 μm	3-3.5 TV

Particle is identified using charge from L1, UTOF, Inner Tracker (L2-L8), LTOF and L9. As an example:

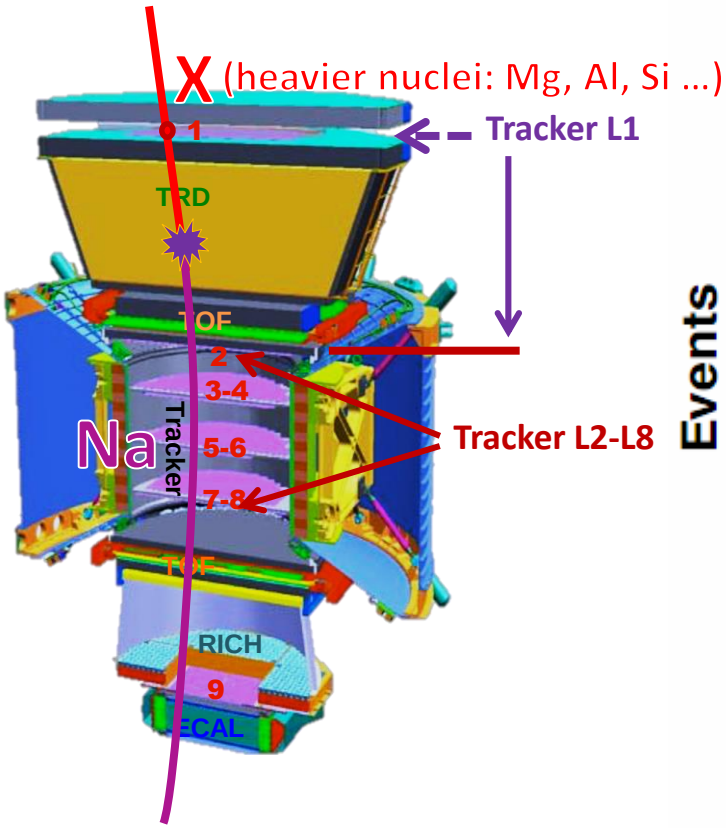
	Tracker L2-L8 Charge Resolution (c.u.)
$1 \leq Z \leq 8$	$\Delta Z \approx 0.05\text{-}0.12$
$9 \leq Z \leq 14$	$\Delta Z \approx 0.13\text{-}0.17$

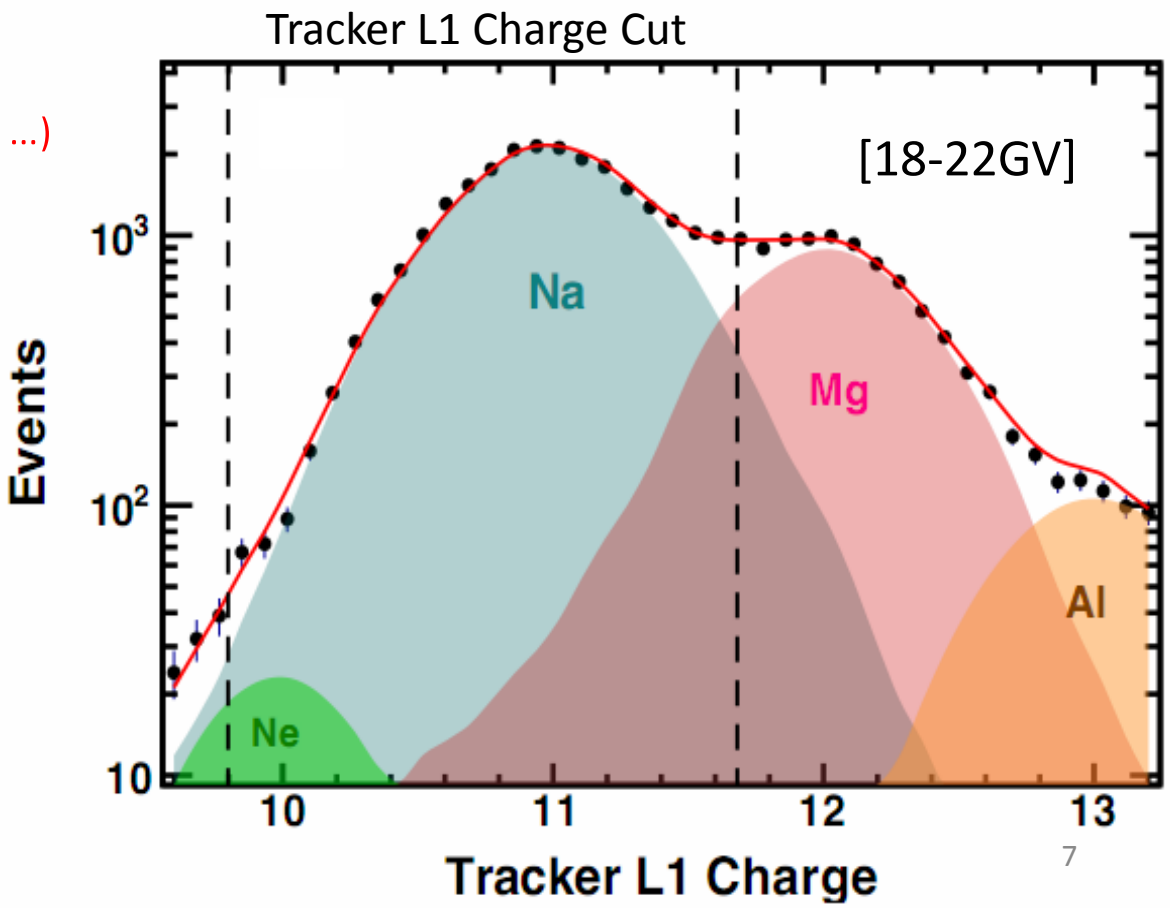
Na Event Selection



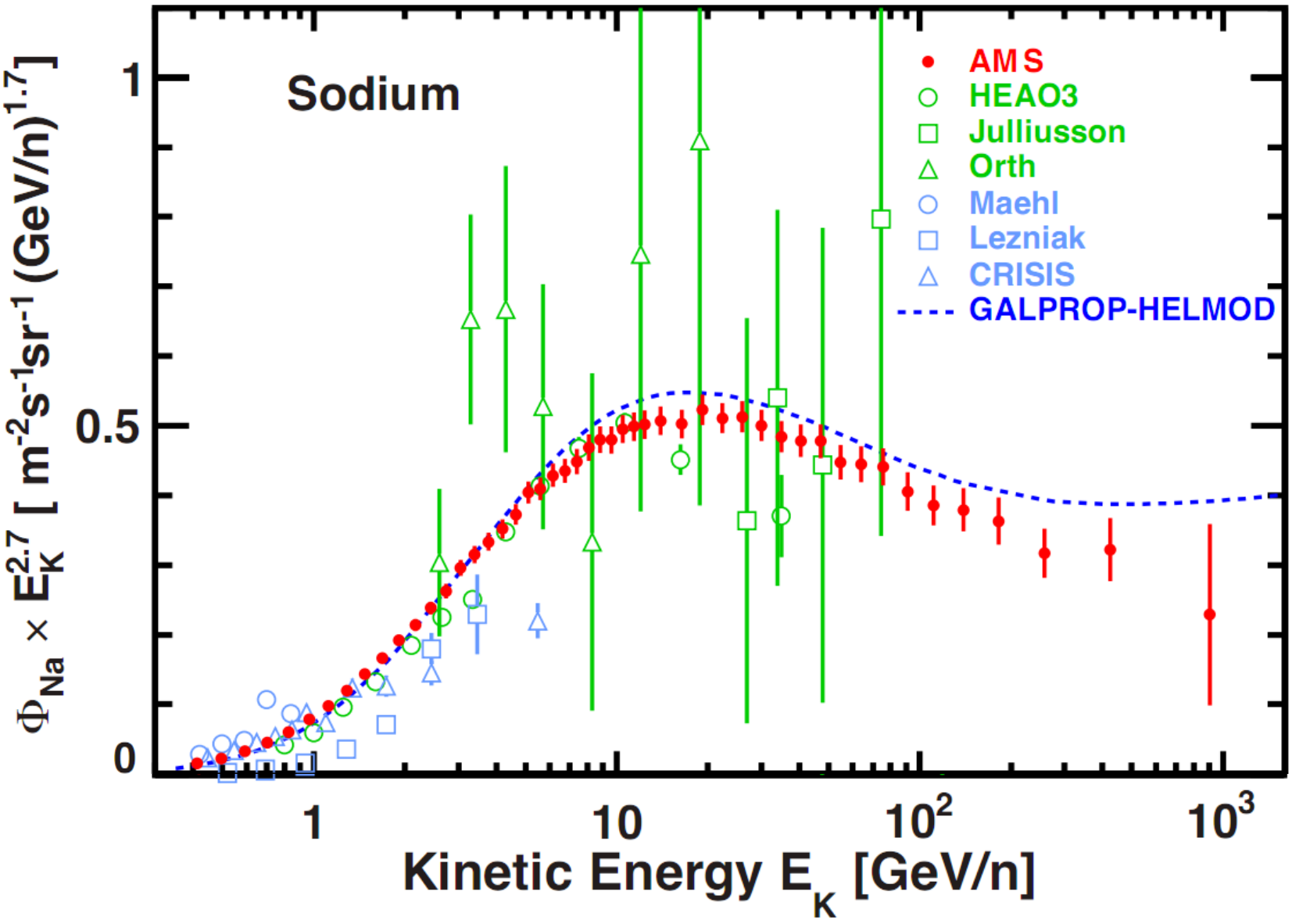
Sodium Background

The Na background resulting from heavier nuclei interactions between Tracker L1 and L2 (materials of TRD and UTOF) is evaluated by charge distribution template fit of Tracker L1.

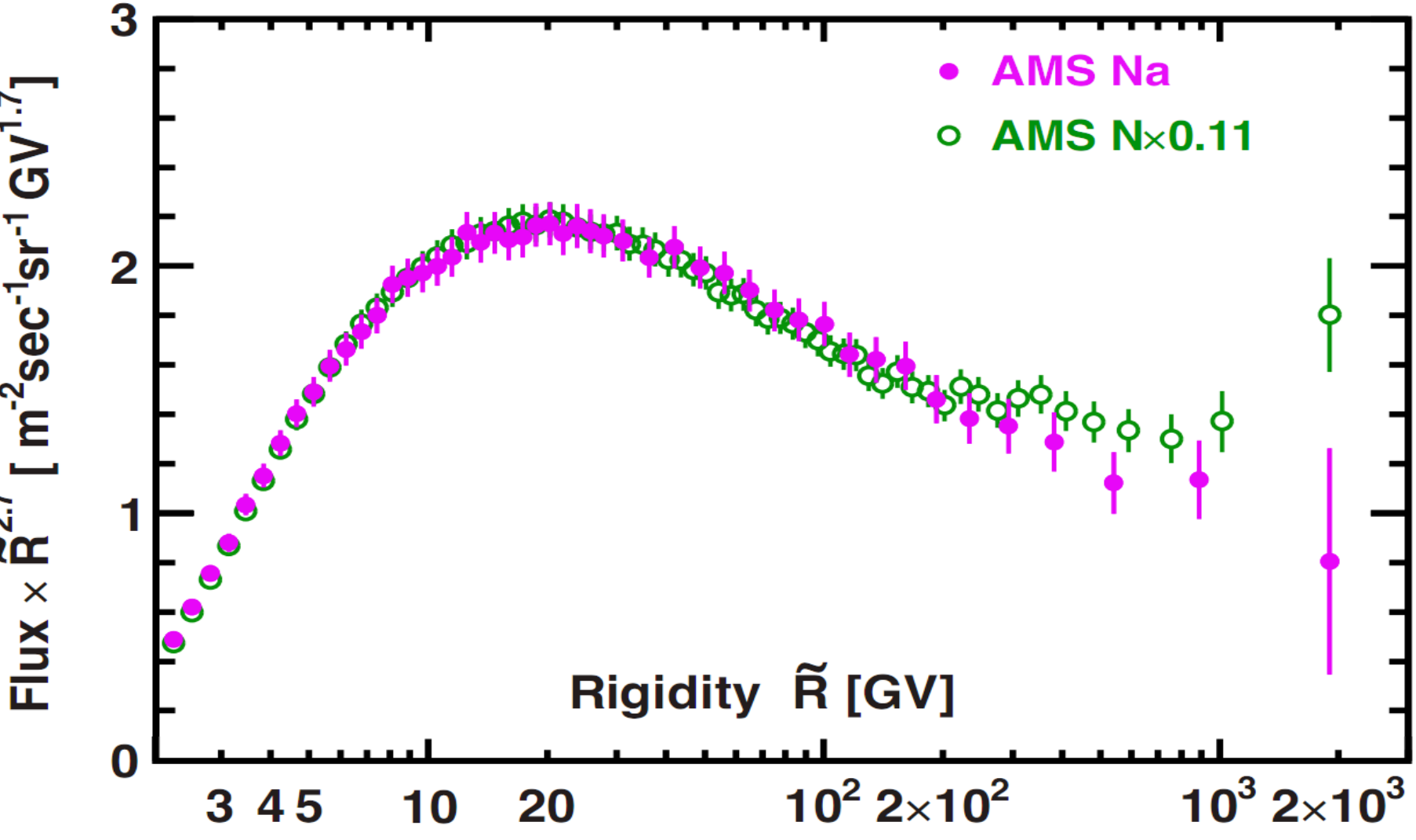




AMS Sodium Flux Compared with Other Experiments

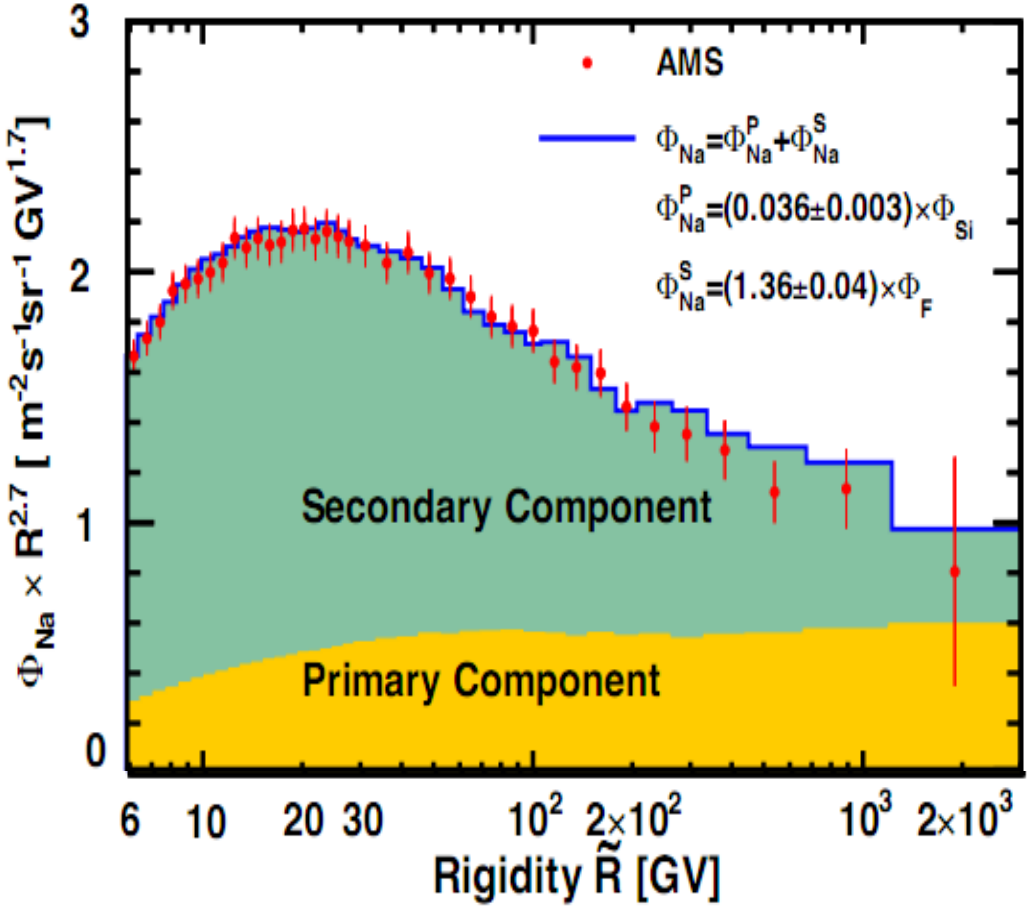


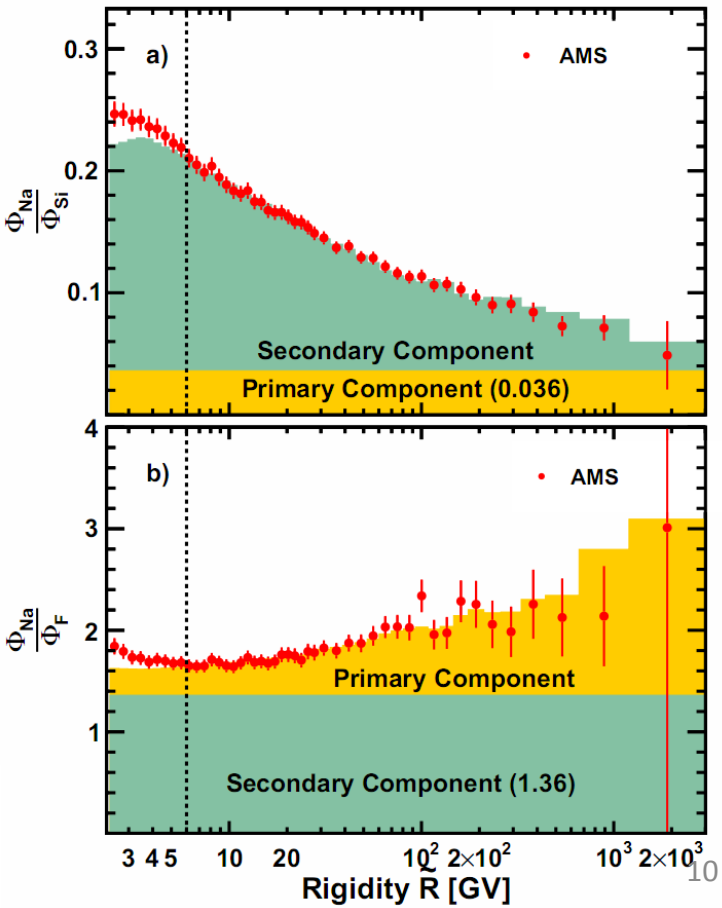
Sodium Flux Compare with Nitrogen Flux



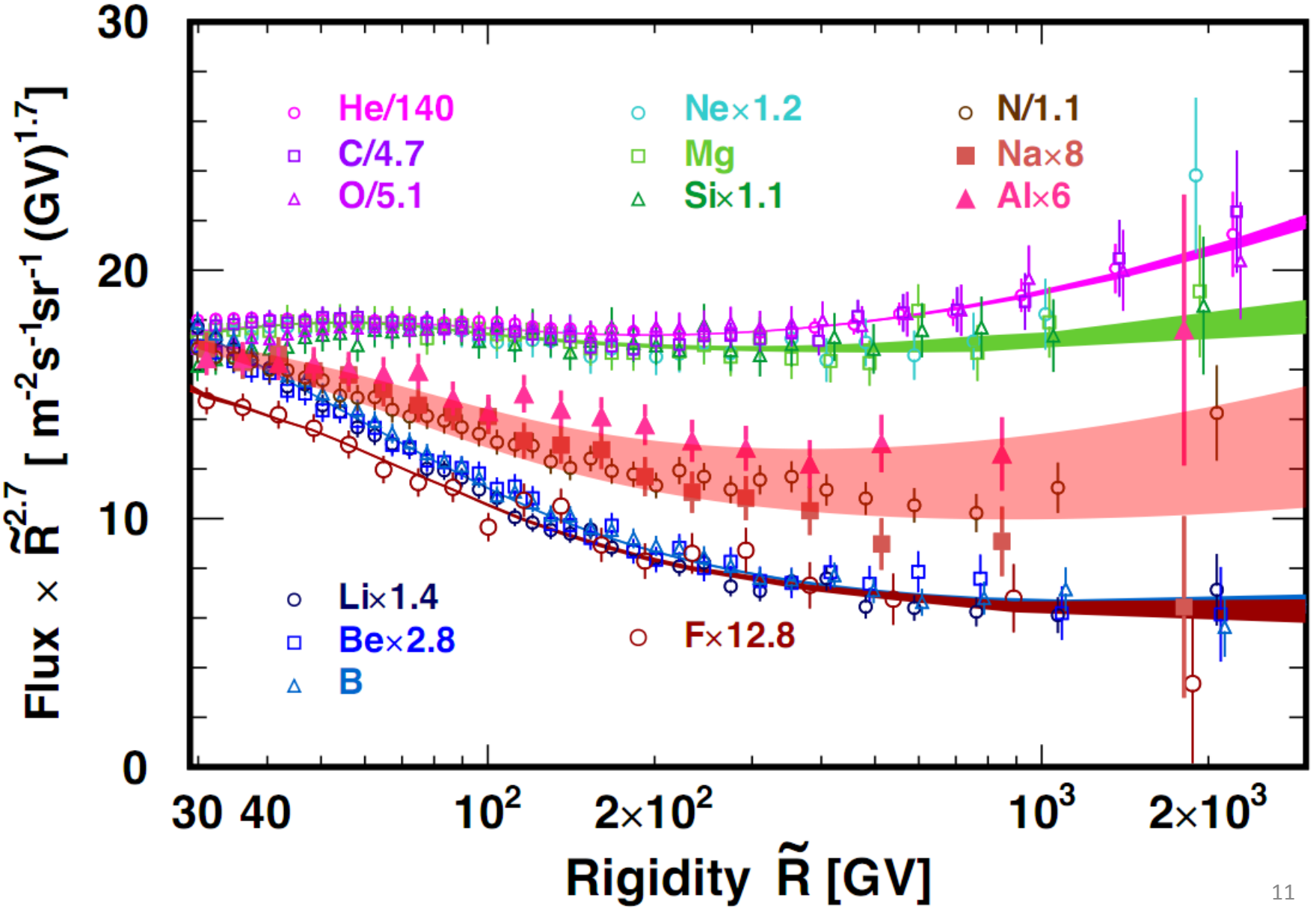
The Primary and Secondary Components of Sodium Flux

- Na flux can be fit above 6 GV as the linear combination of primary (Si) and secondary (F) fluxes. The fraction of the primary component increases with rigidity and becomes dominant at the highest rigidities.
- The Na/Si abundance ratio (0.036 $\pm$0.003) at the source is determined independent of cosmic ray propagation.





The Fluxes of Cosmic Nuclei Measured by AMS (He-Si)



Summary

Precision measurement of sodium (Na) cosmic ray flux from 2.15 GV to 3.0 TV based on 0.46 million AMS data (8.5 years) has been presented.

Na and N belong to a distinct cosmic ray group and are the combinations of primary and secondary cosmic rays. The fraction of the primary component increases with rigidity for N and Na fluxes and becomes dominant at the highest rigidities.

The Na/Si abundance ratio (0.036 $\pm$0.003) at the source (primary component) is determined independent of cosmic ray propagation.