Properties of Neon, Magnesium, and Silicon Primary Cosmic Rays Results from the Alpha Magnetic Spectrometer

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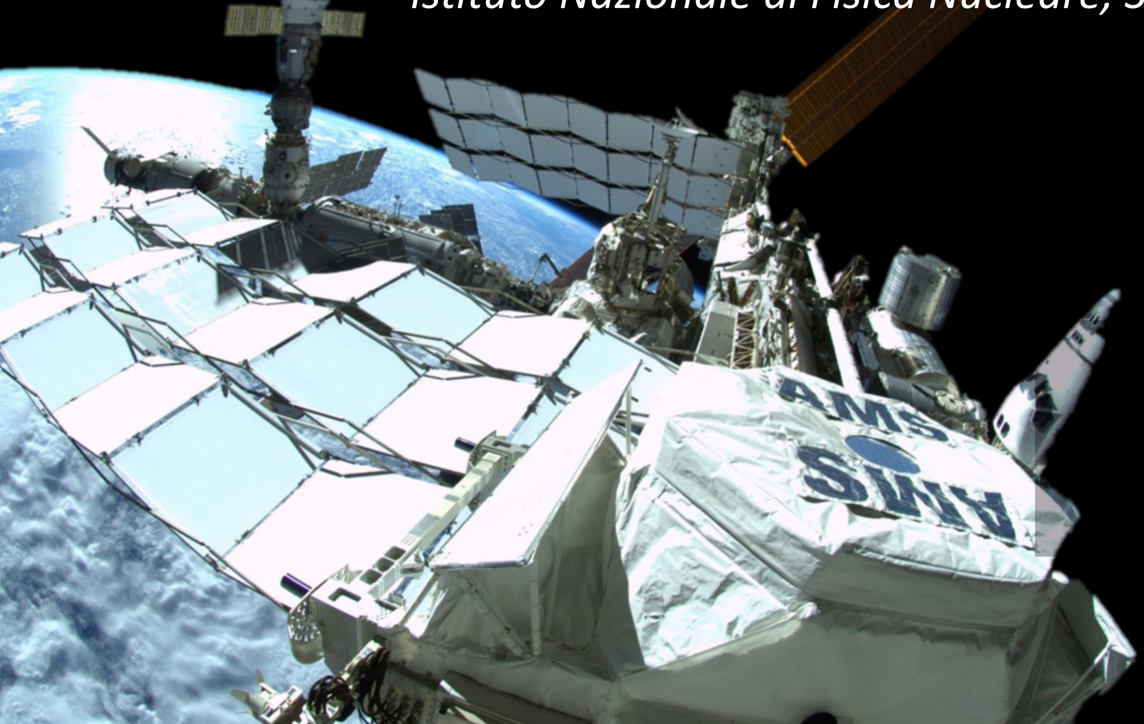

ICRC 2021
THE ASTROPARTICLE PHYSICS CONFERENCE
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Cosmic Ray Conference
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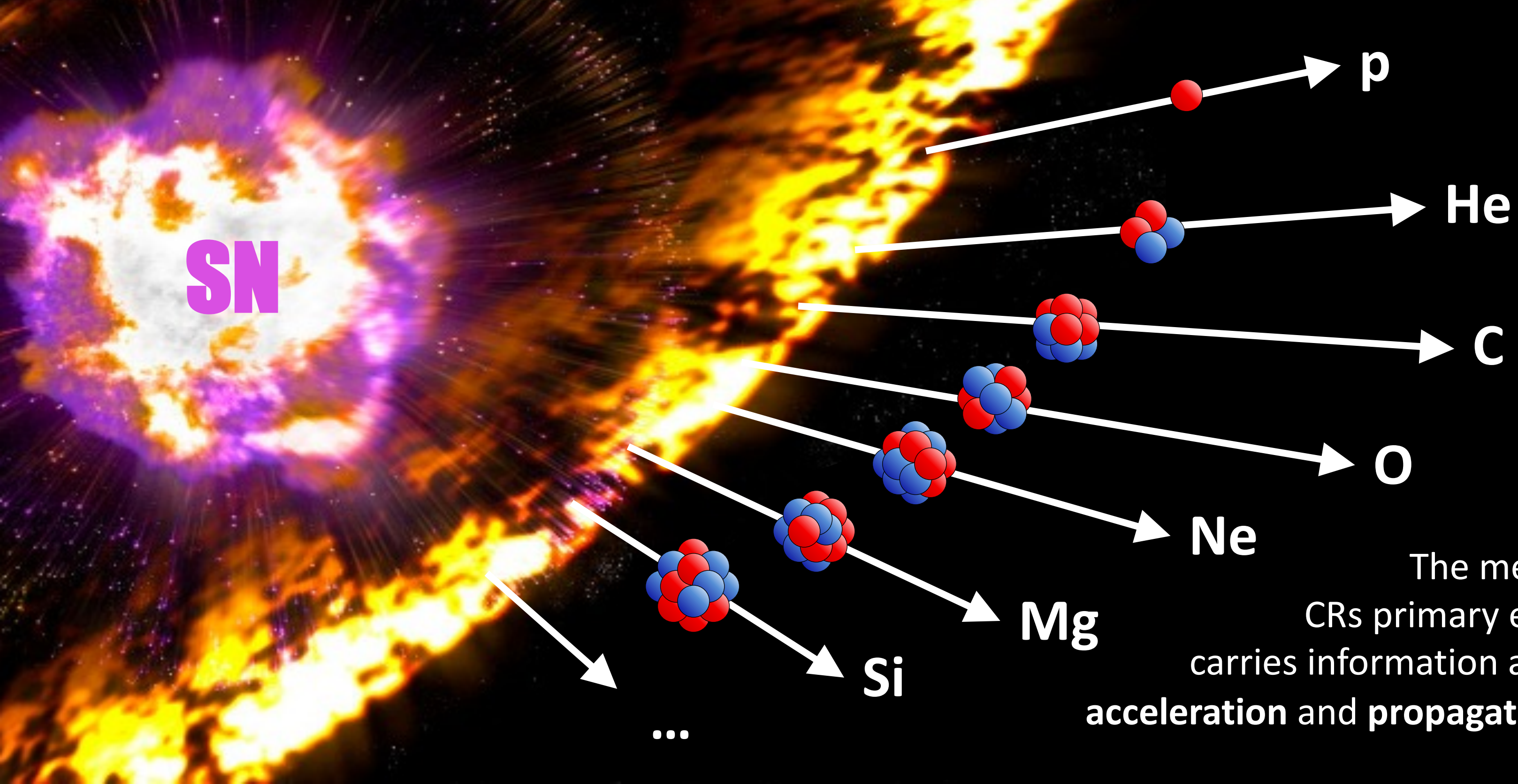
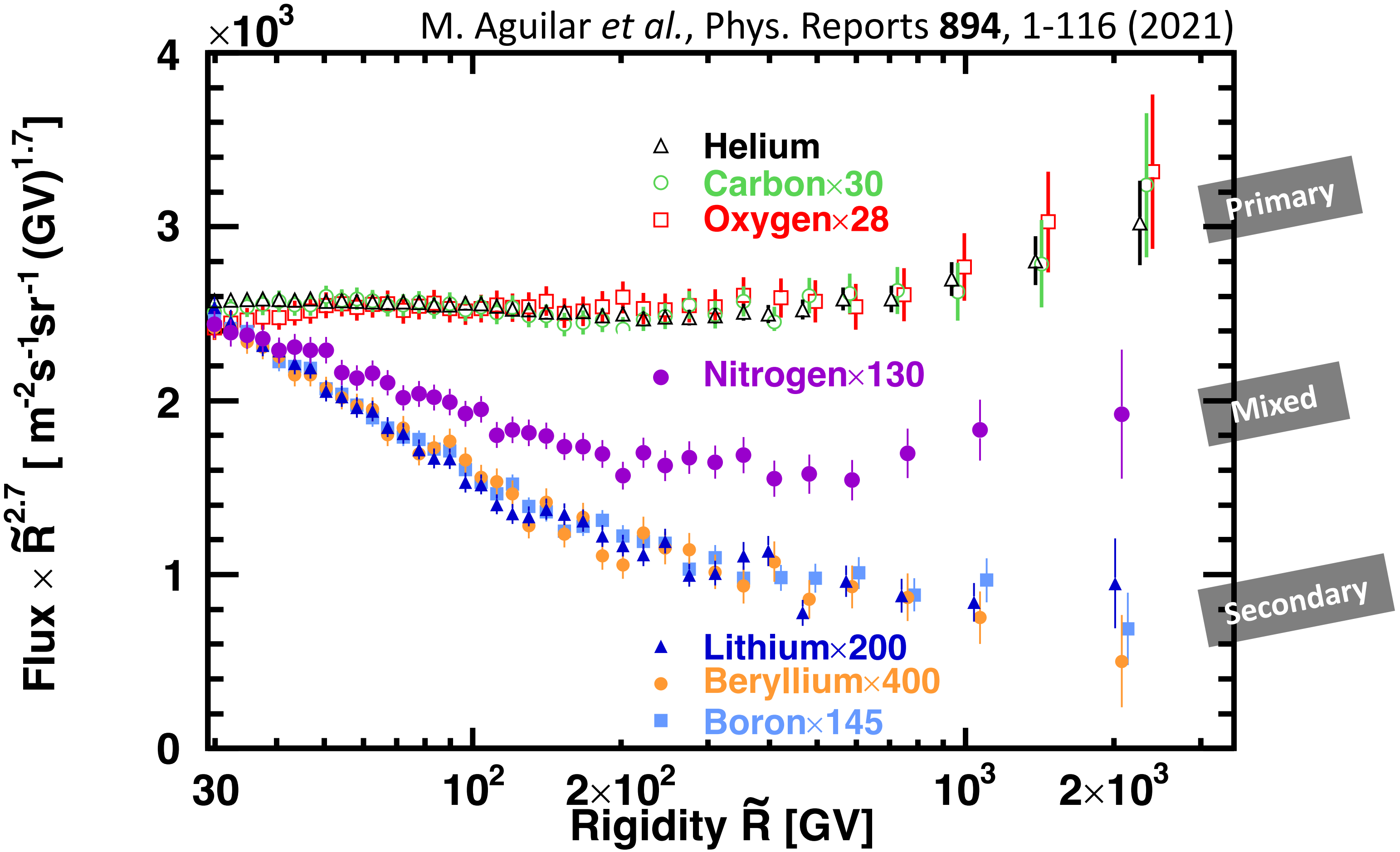
Primary Cosmic Rays

Primary CRs (p, He, C, O, Ne, Mg, Si, ..., Fe) are thought to be mostly produced during the lifetime of stars and accelerated in supernovae shocks in our Galaxy.

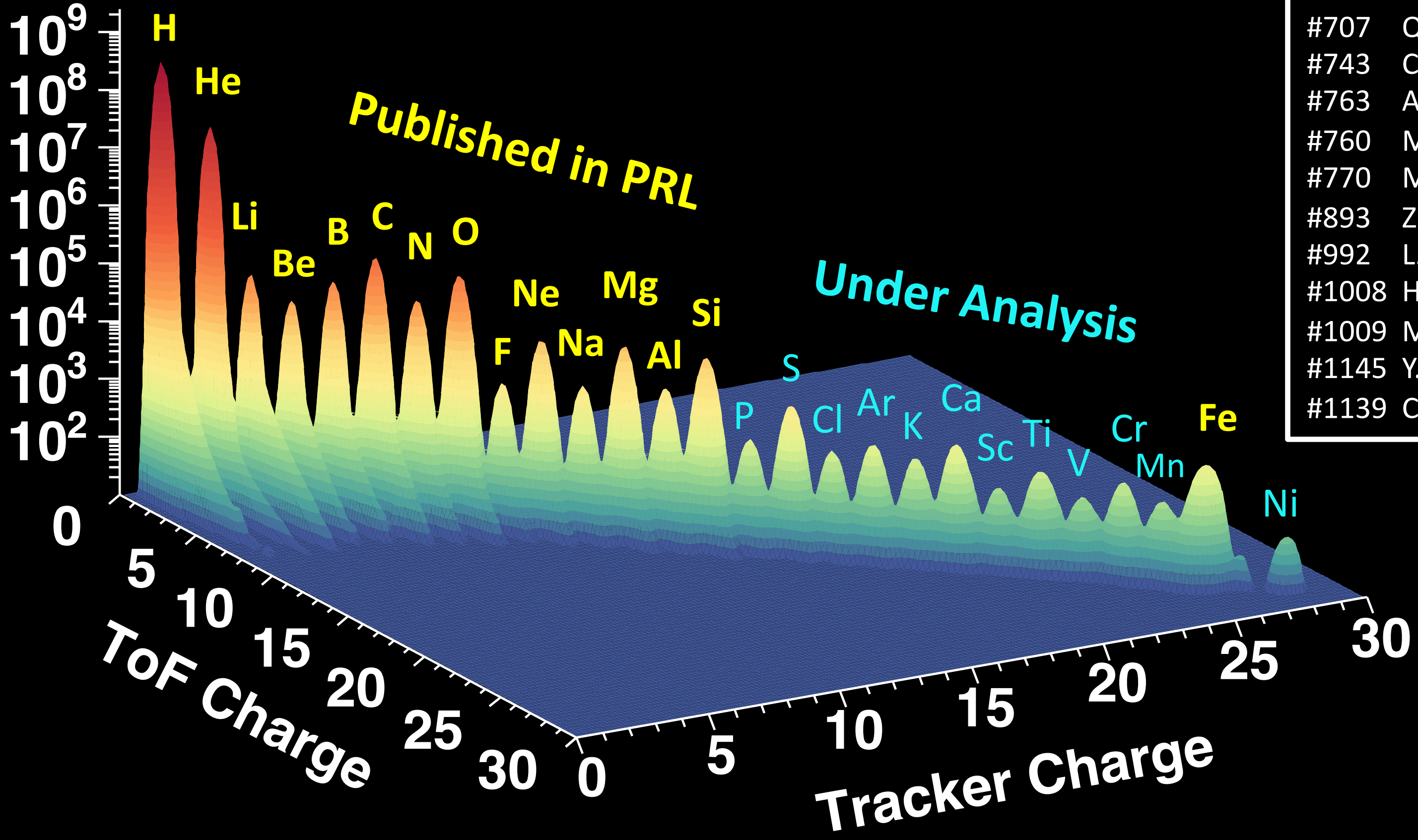


The measurement of CRs primary energy spectra carries information about **sources**, **acceleration** and **propagation** processes.

Properties of Light Nuclei Cosmic Rays with AMS



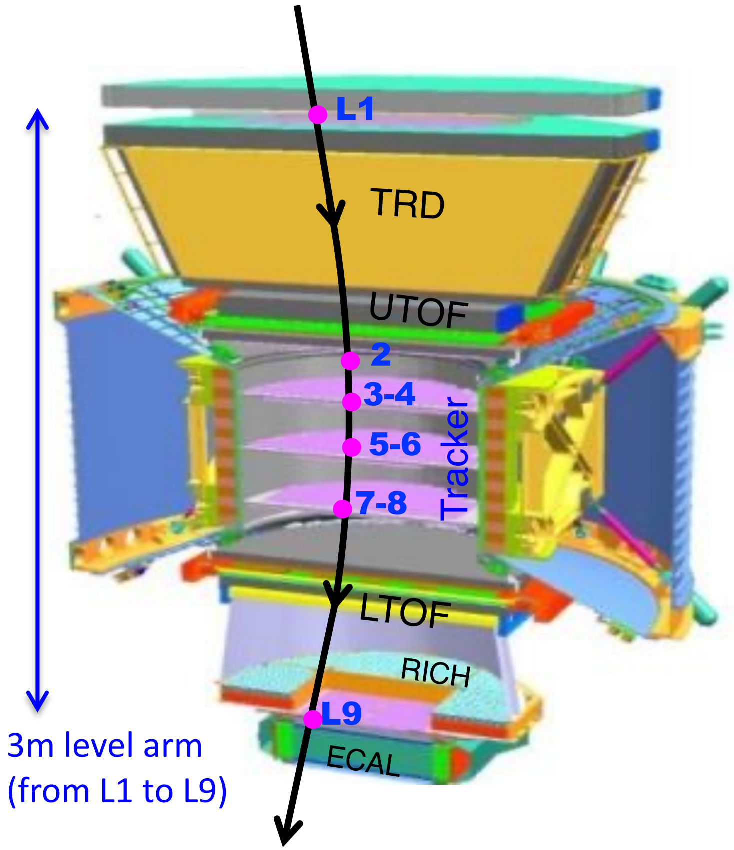
CRs Chemical Composition with AMS



#320	F. Giovacchini	**He** isotopes
#707	Q. Yan	**F**
#743	C. Zhang	**Na**
#763	A. Oliva	**Ne**, **Mg**, and **Si**
#760	M. Valencia	**Z>2** trapped
#770	M. Velasco	**pHeCO** anisotropy
#893	Z. Liu	**Al**
#992	L. Y. Derome	**Li** and **Be** isotopes
#1008	H. Gast	**HeCO and LiBeB**
#1009	M. Palermo	Monthly **pHeCO**
#1145	Y. Chen	**Fe**
#1139	C. Consolandi	Daily **He**

AMS@ICRC2021
on nuclei with Z>1

AMS Nuclei Measurement



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

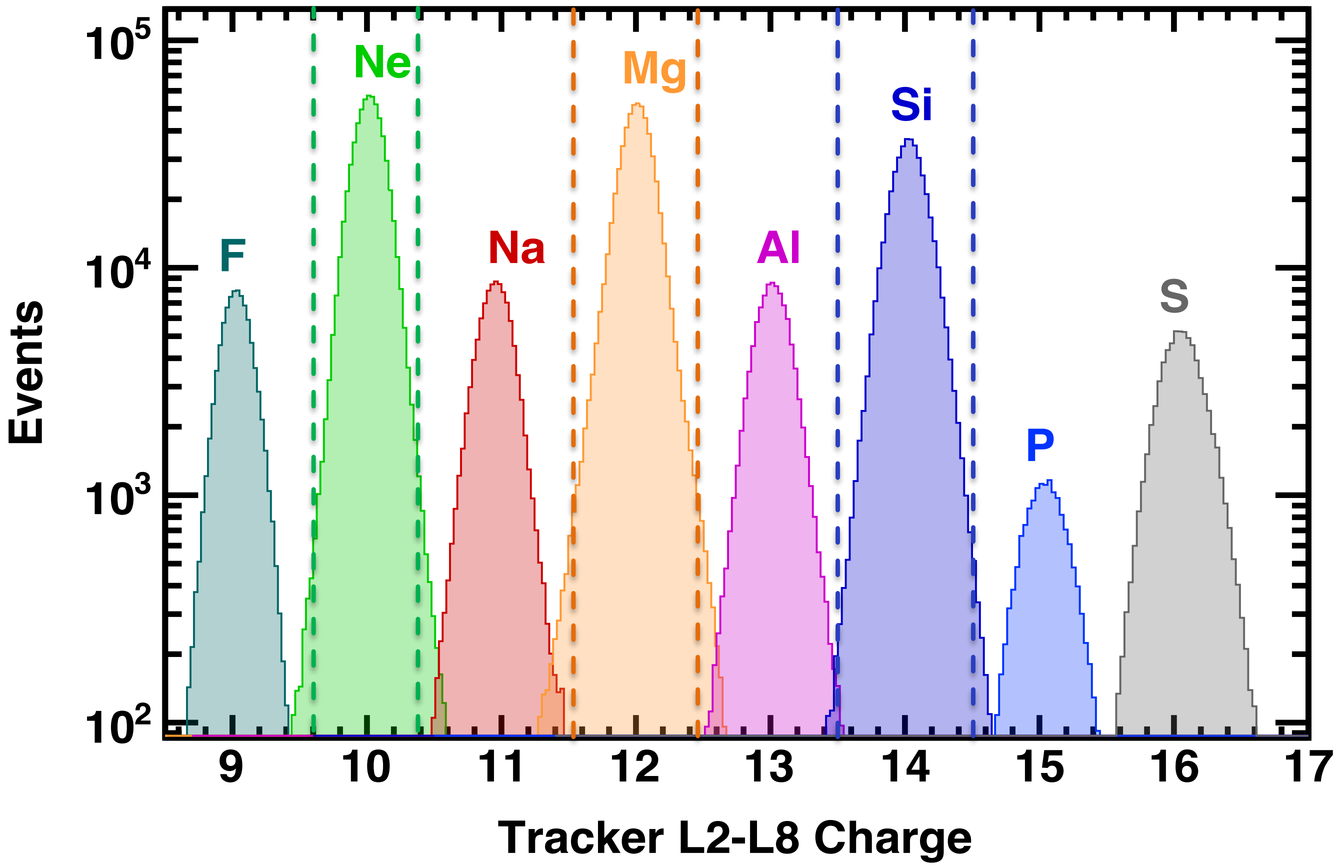
	Coordinate Resolution	MDR
Z =1	10 μm	2 TV
$2 \leq Z \leq 8$	5-7 μm	3.2-3.7 TV
$9 \leq Z \leq 14$	6-8 μm	3-3.5 TV

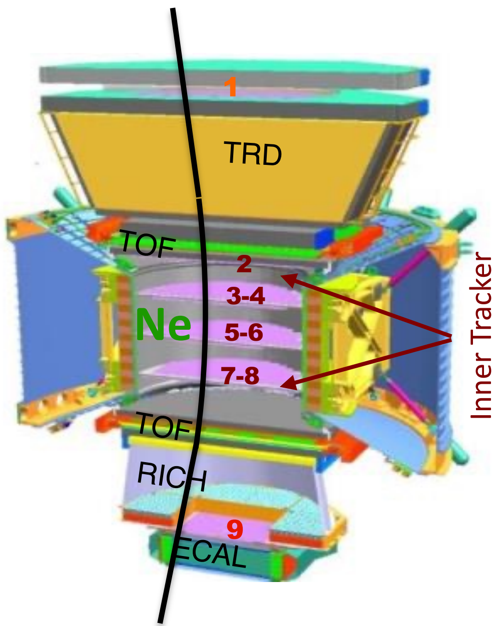
Particle is identified using charge from L1, UTOF, Inner Tracker (L2-L8), LTOF and L9. As an example:

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

Ne, Mg, and Si Event Selection

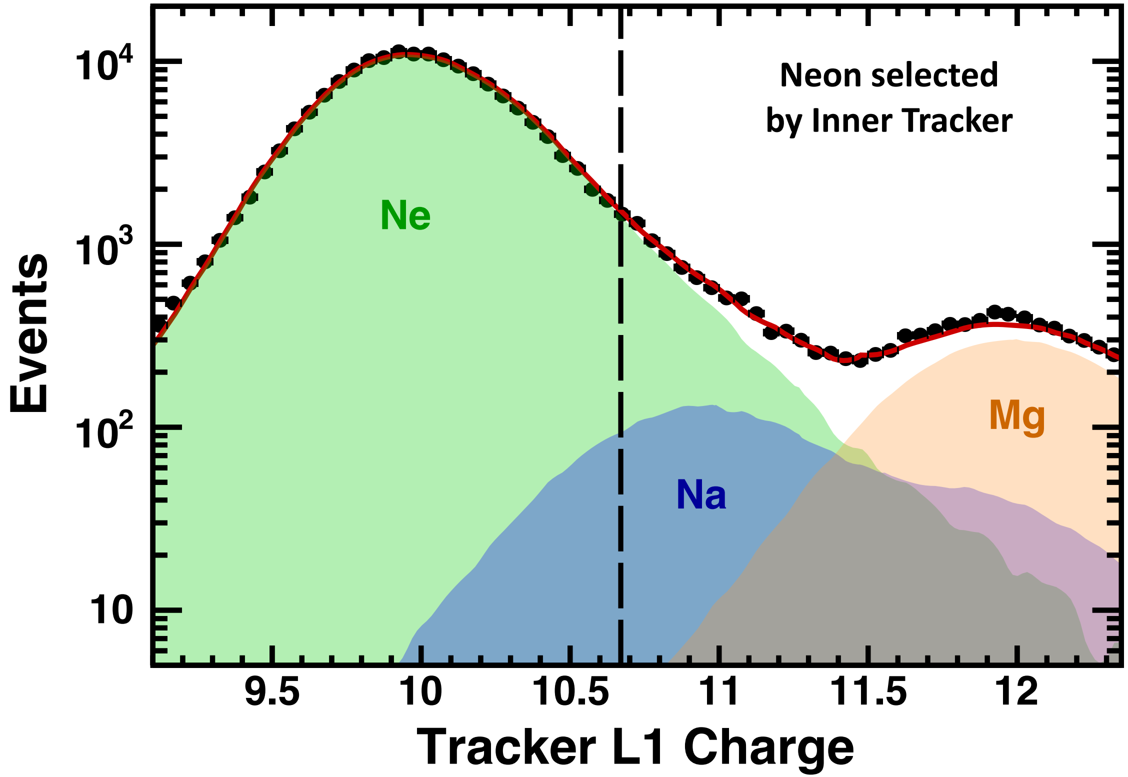
Charge distribution in the inner tracker (L2-L8).

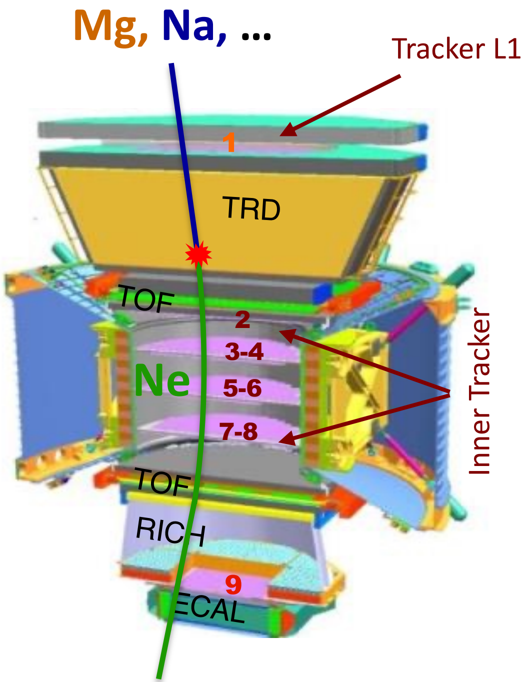




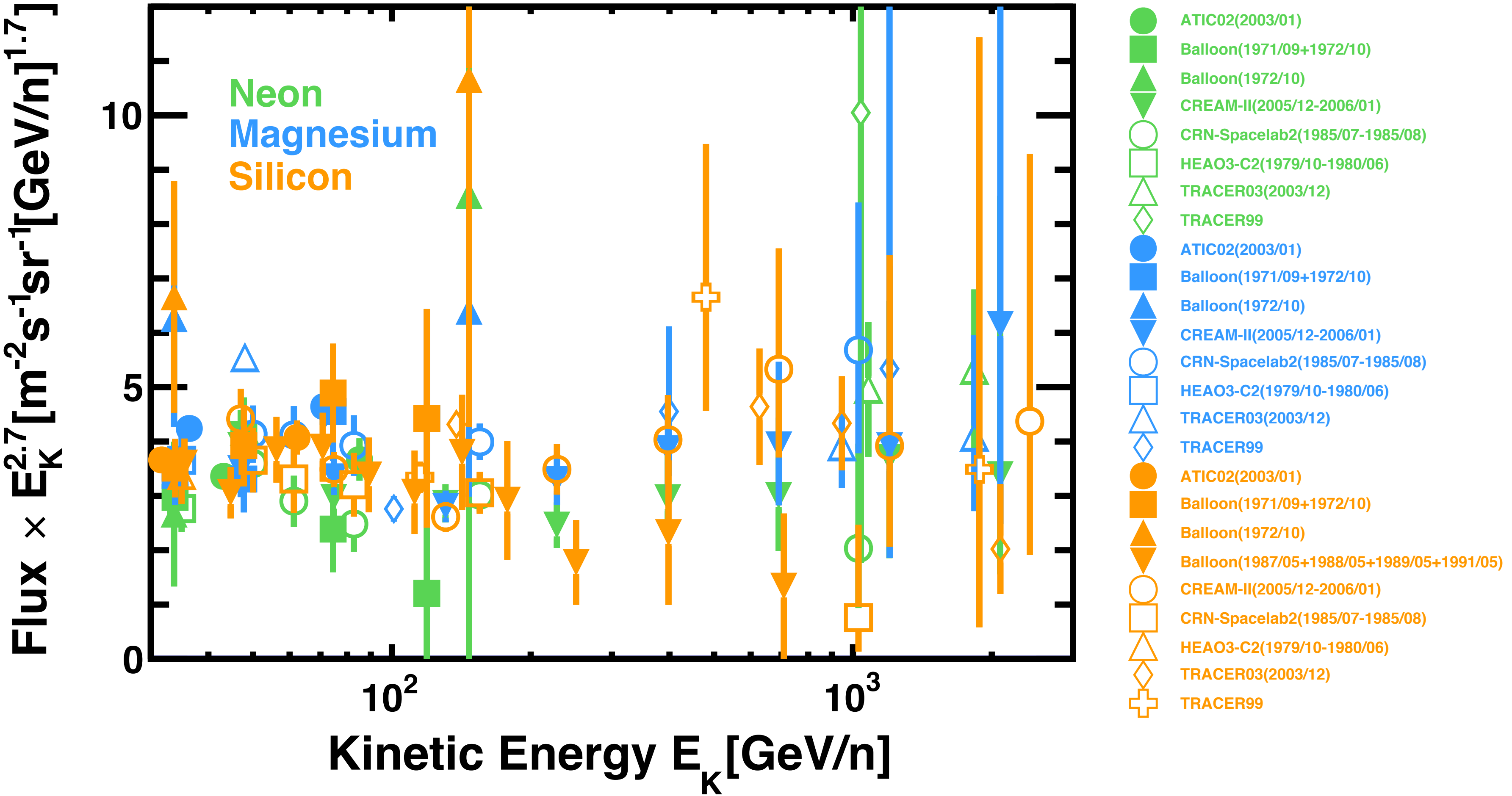
Residual Background Subtraction

The background resulting from heavier nuclei which interact between L1 and L2 (as Mg, Na, … + C, Al → Ne) can be subtracted with a fit procedure. After subtraction we have, in 7 years, **1.8M Ne, 2.2M Mg and 1.6M Si nuclei**. The systematics on background subtraction is **<0.5%** in the entire rigidity range.





Measurements of Ne, Mg and Si CRs before AMS

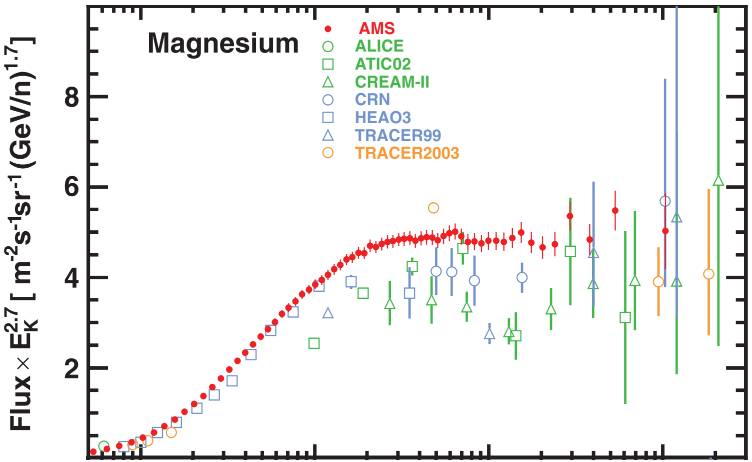


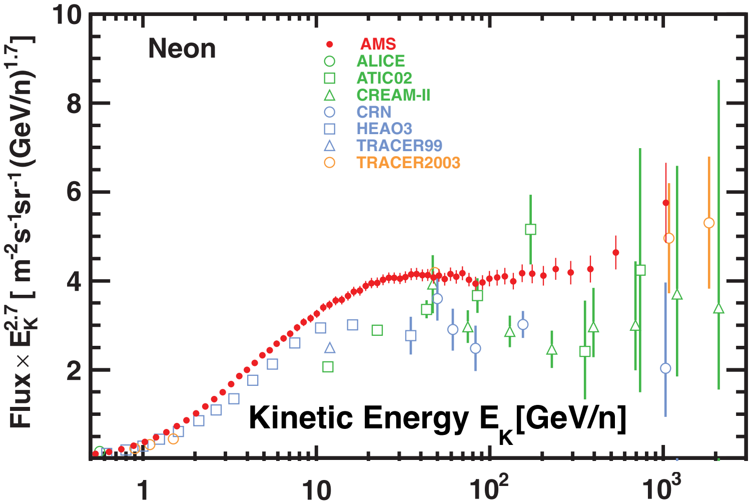
AMS Neon, Magnesium and Silicon CRs Fluxes

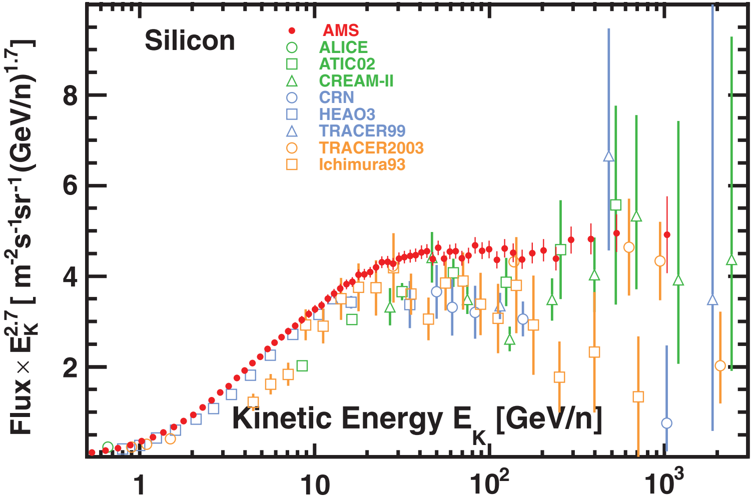
M. Aguilar *et al.*, PRL **124**, 21102 (2020)

The publication has full description of analysis procedure and systematic error evaluation.

For comparison purposes our results are here converted from rigidity to kinetic energy per nucleon.







AMS Neon, Magnesium and Silicon CRs Fluxes

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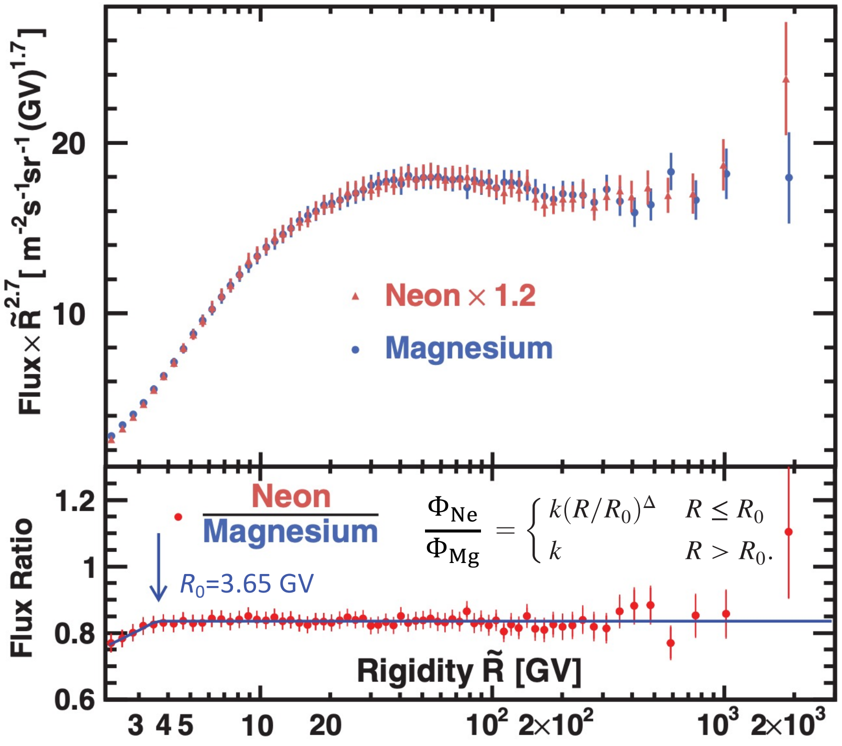
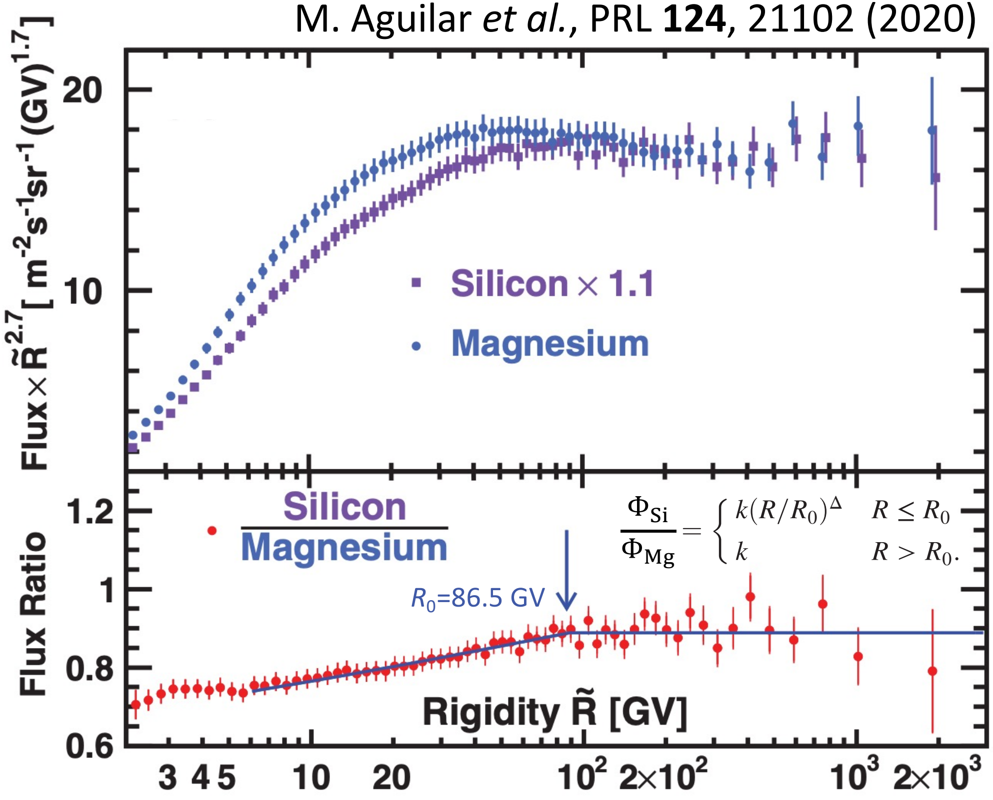
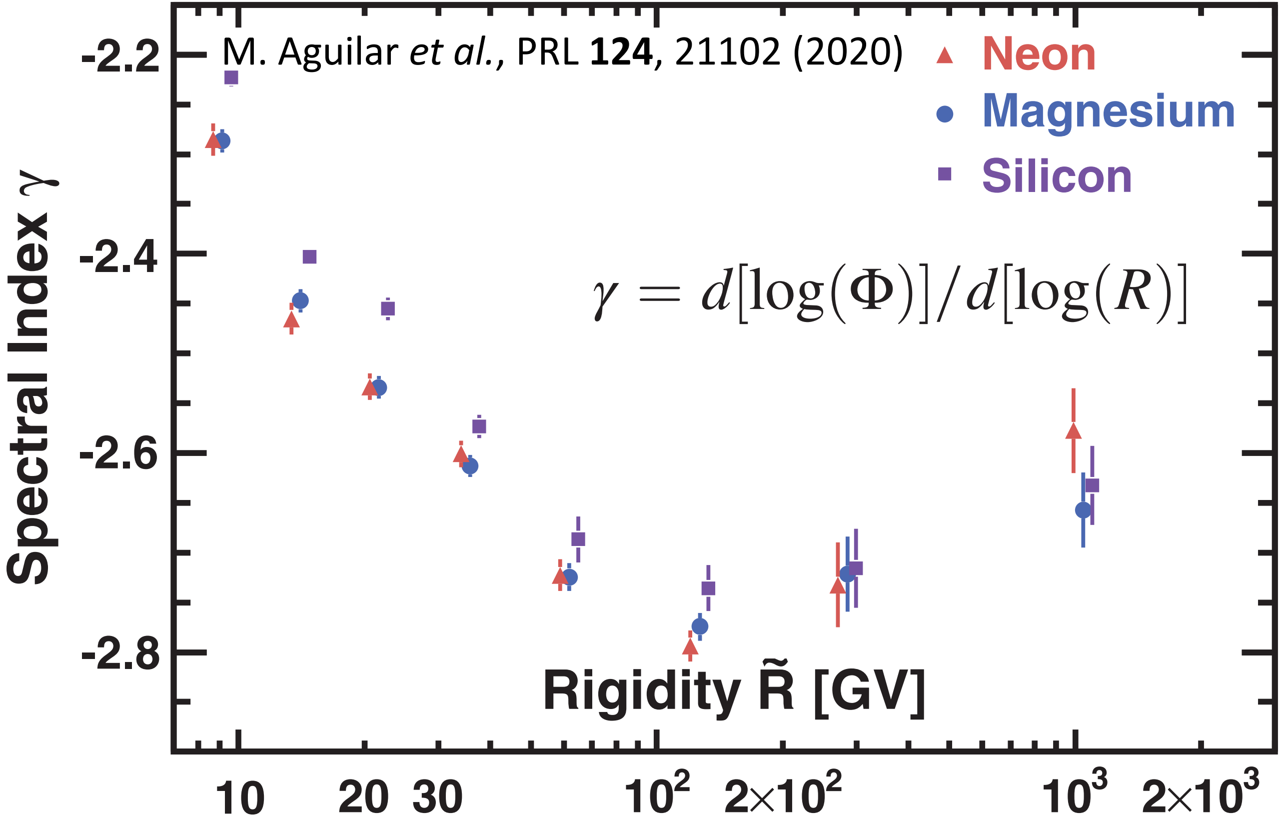




Ne and Mg fluxes have an identical rigidity dependence above 3.65 GV.

Ne, Mg and Si have identical rigidity dependence above 86.5 GV.

AMS Ne, Mg and Si CRs Flux Spectral Indices

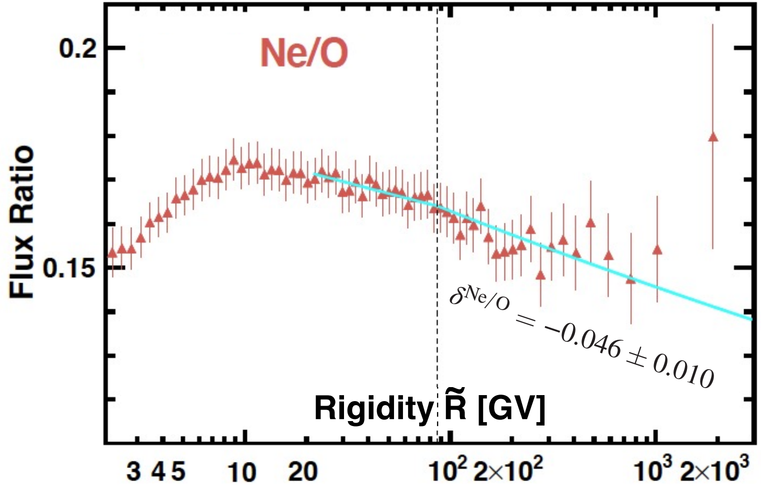


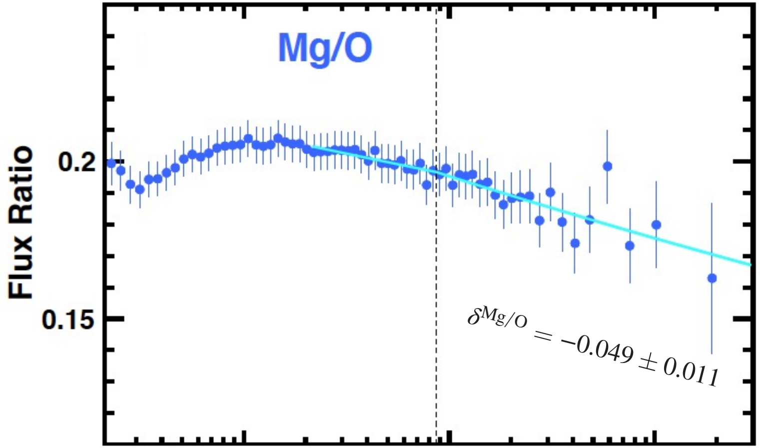
The Ne, Mg, and Si spectra have identical rigidity dependence above 86.5 GV, deviate from a single power law above 200 GV and harden in an identical way.

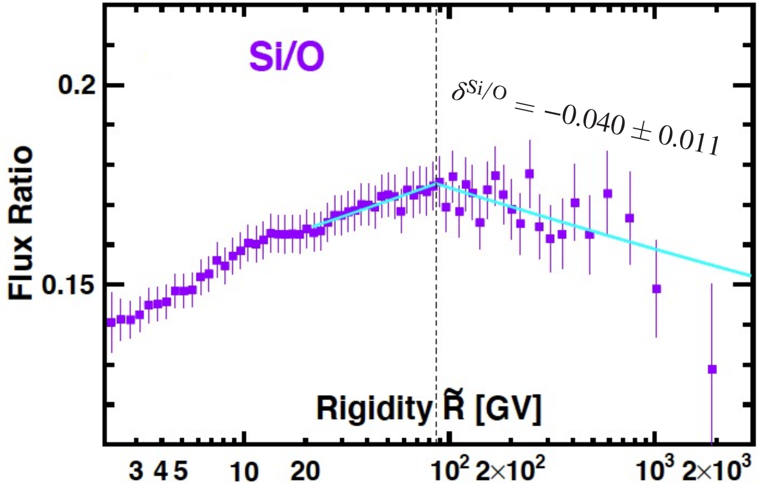
Neon, Magnesium and Silicon Ratios to Oxygen

To examine the rigidity dependence difference between He, C, and O and Ne, Mg and Si, Ne/O, Mg/O, and Si/O flux ratios were fitted to:

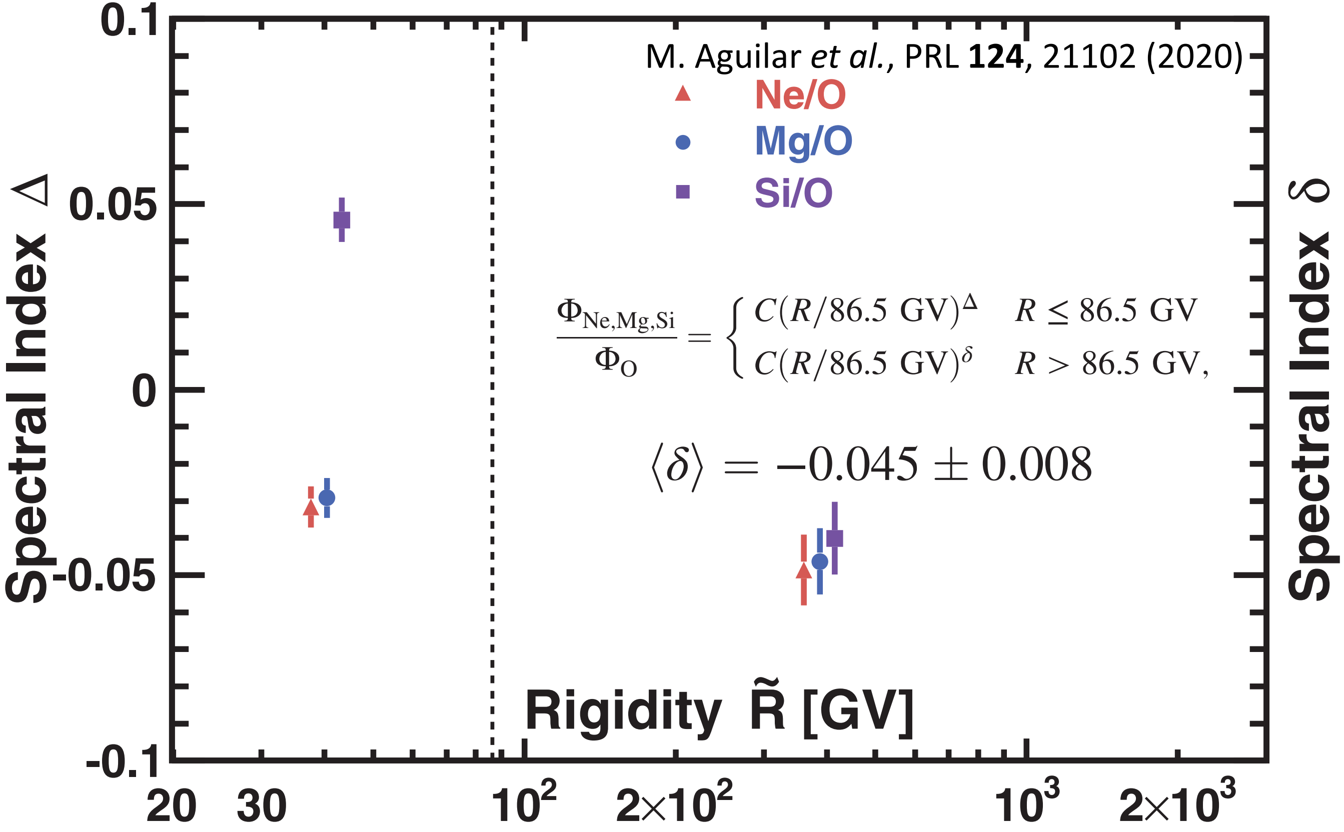
$$\frac{\Phi_{\mathrm{Ne,Mg,Si}}}{\Phi_{\mathrm{O}}} = \begin{cases} C(R/86.5\ \mathrm{GV})^{\Delta} & R \leq 86.5\ \mathrm{GV} \\ C(R/86.5\ \mathrm{GV})^{\delta} & R > 86.5\ \mathrm{GV}, \end{cases}$$







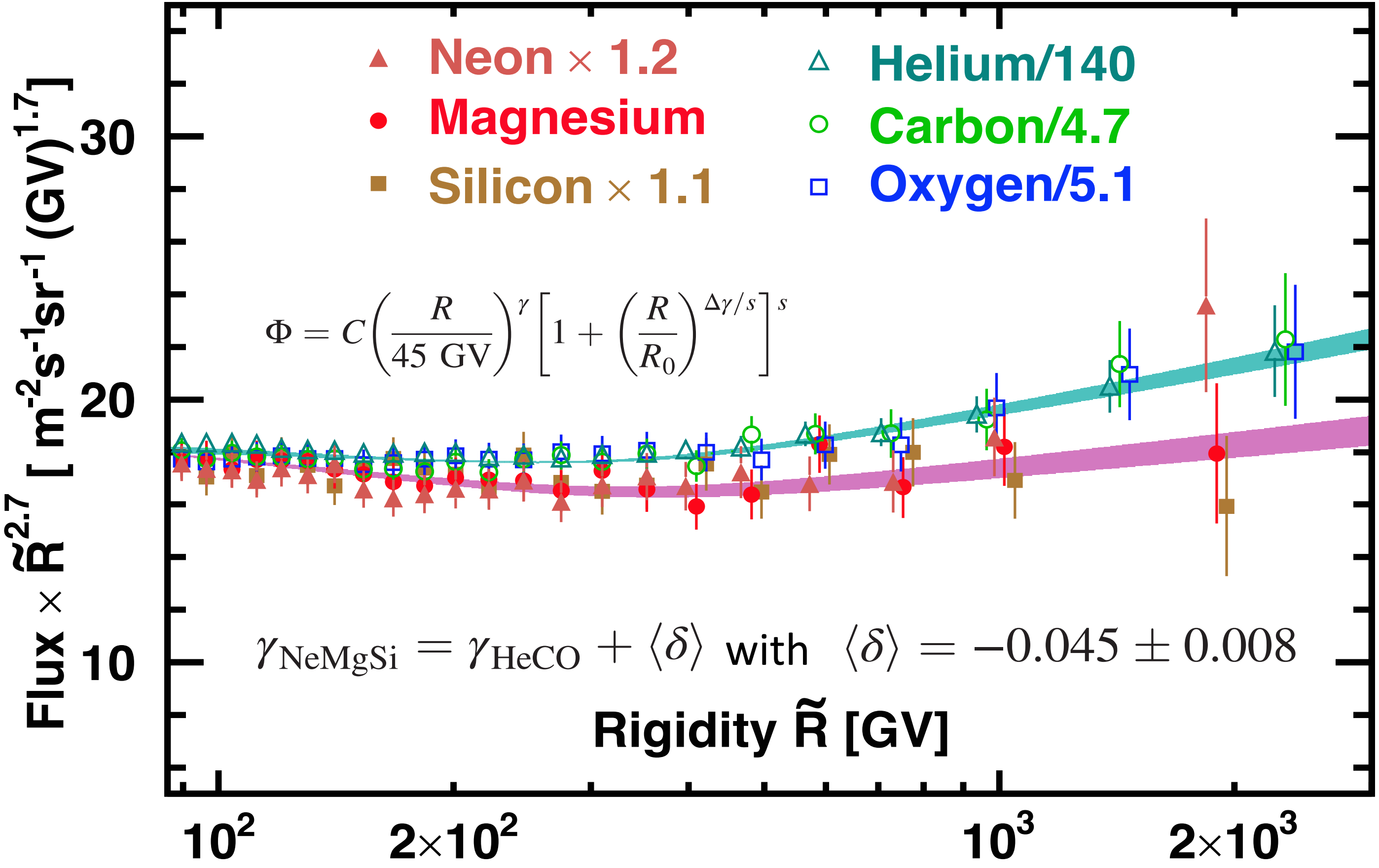
Ne/O, Mg/O and Si/O Ratio Spectral Indices



The difference of <δ> from zero by more than **5σ** shows that Ne, Mg, and Si is a different class of primary cosmic rays than He, C, and O.

Properties of Primary Cosmic Rays with AMS

M. Aguilar *et al.*, PRL **124**, 21102 (2020)

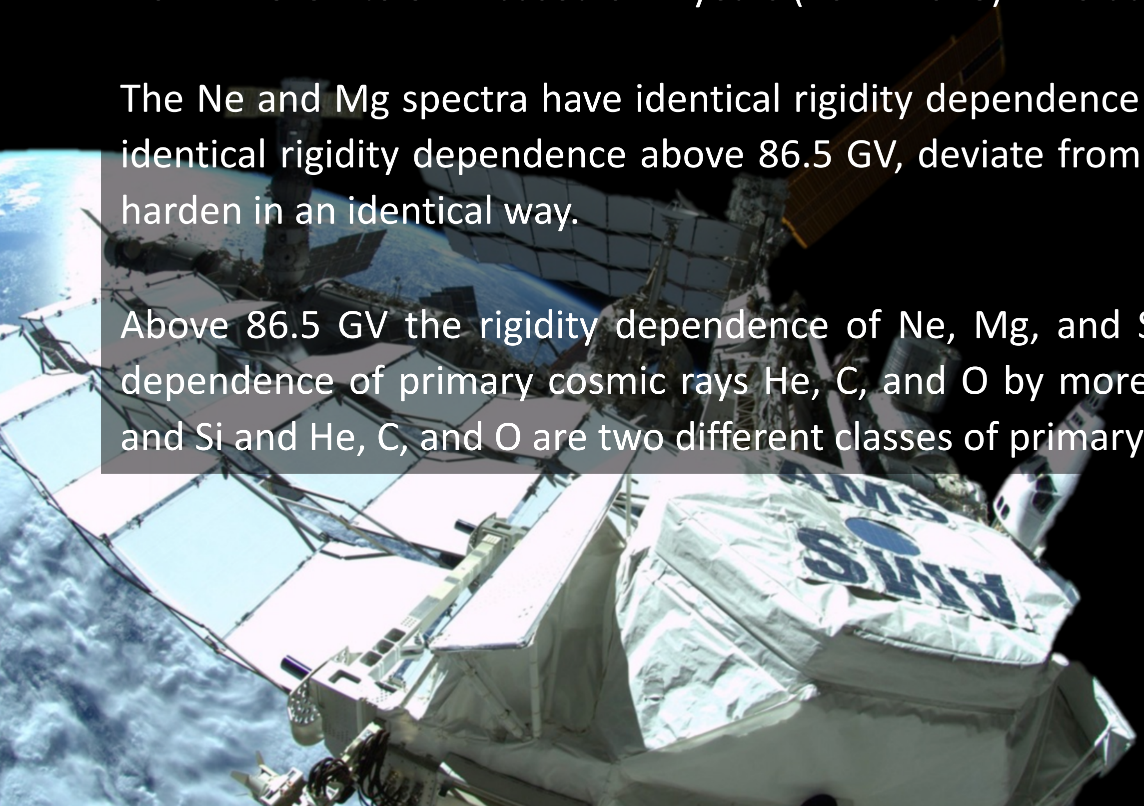


Conclusions

Precision measurements of primary cosmic rays Neon, Magnesium, and Silicon (Z=10,12,14) fluxes from 2.15 GV to 3 TV based on 7 years (2011-2018) AMS data have been presented.

The Ne and Mg spectra have identical rigidity dependence above 3.65 GV. The three spectra have identical rigidity dependence above 86.5 GV, deviate from a single power law above 200 GV, and harden in an identical way.

Above 86.5 GV the rigidity dependence of Ne, Mg, and Si spectra is different from the rigidity dependence of primary cosmic rays He, C, and O by more than 5σ. This shows that the Ne, Mg, and Si and He, C, and O are two different classes of primary cosmic rays.



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