Properties of Iron Primary Cosmic Rays: Results from the Alpha Magnetic Spectrometer

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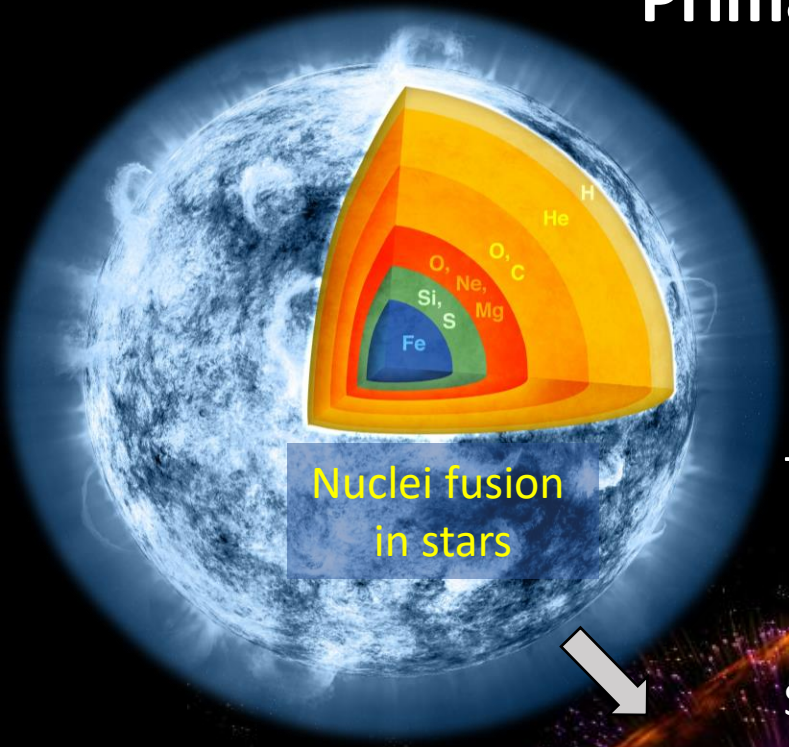
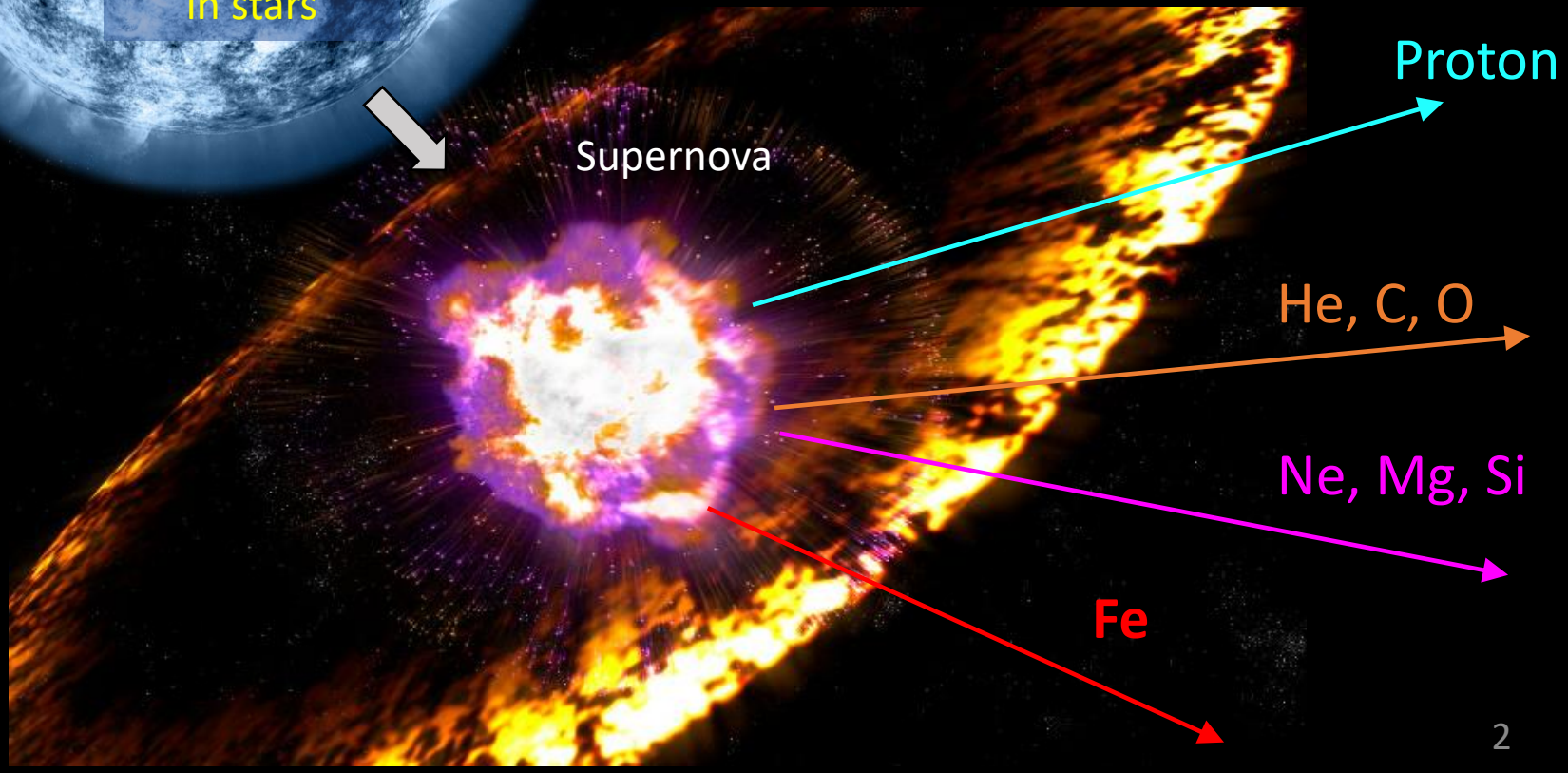
on behalf of the AMS collaboration

37th International Cosmic Ray Conference (ICRC), July 2021

Primary Cosmic Rays

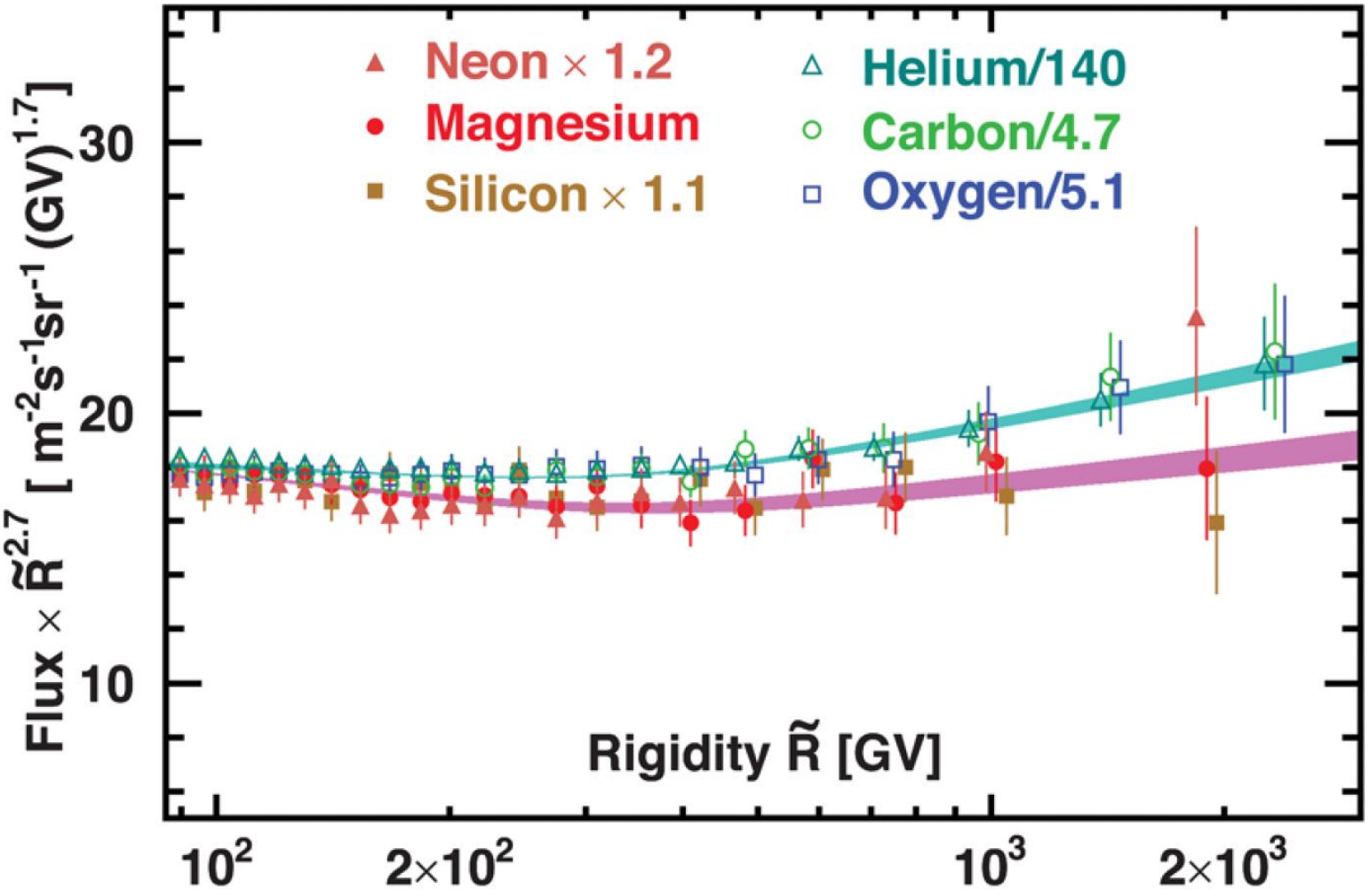


Primary elements:
Proton,
He, C, O,
Ne, Mg, Si,
..., **Fe**)
are produced during the lifetime of stars.
They are accelerated in supernovae explosions.



AMS Primary flux measurement

PHYSICAL REVIEW LETTERS **124,** 211102 (2020)

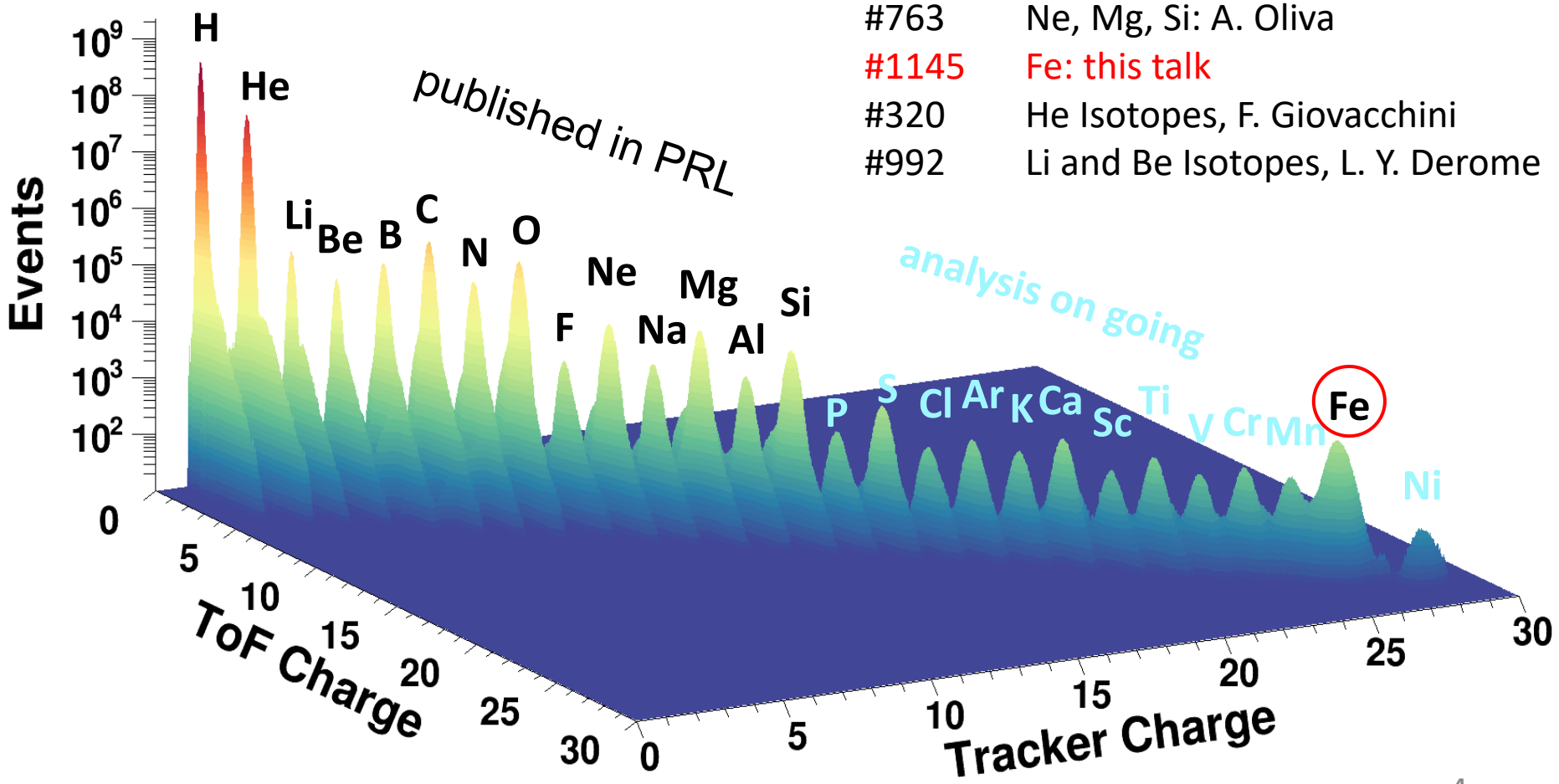


Ne, Mg, Si and He, C, O are two different classes of primary cosmic rays (see details in A. Oliva's talk #763)

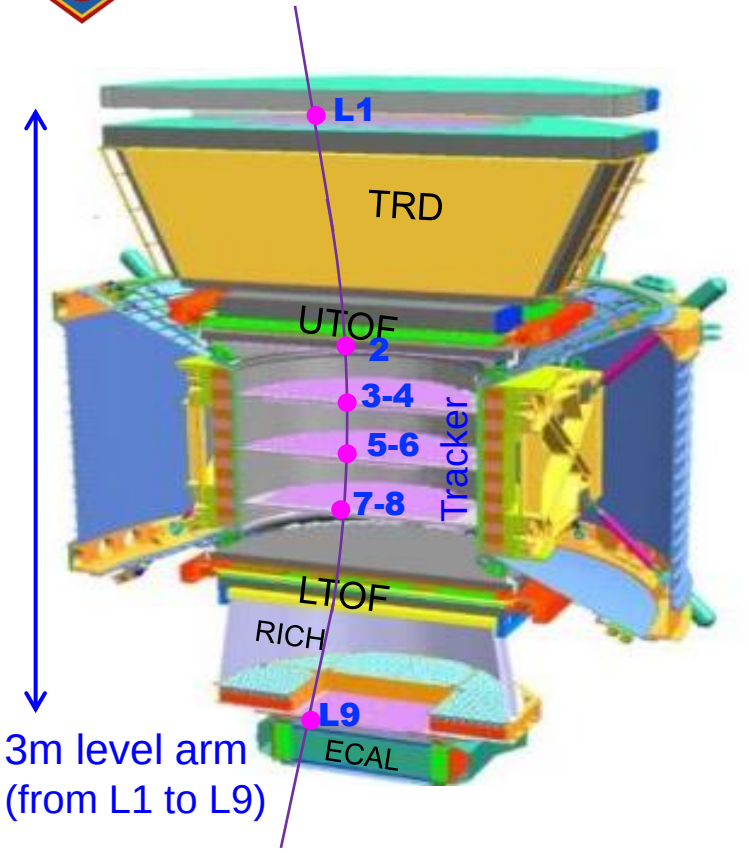
Cosmic Ray Chemical Composition measured by AMS

ICRC2021 on AMS CR nuclei:

#1008	He, Li, Be, B, C, O: H. Gast
#707	F: Q. Yan
#743	Na: C. Zang
#803	Al: Z. Liu
#763	Ne, Mg, Si: A. Oliva
#1145	Fe: this talk
#320	He Isotopes, F. Giovacchini
#992	Li and Be Isotopes, L. Y. Derome



AMS Cosmic-Ray Nuclei measurement



Tracker (9 Layers) + Magnet: Rigidity (Momemtum/Charge)

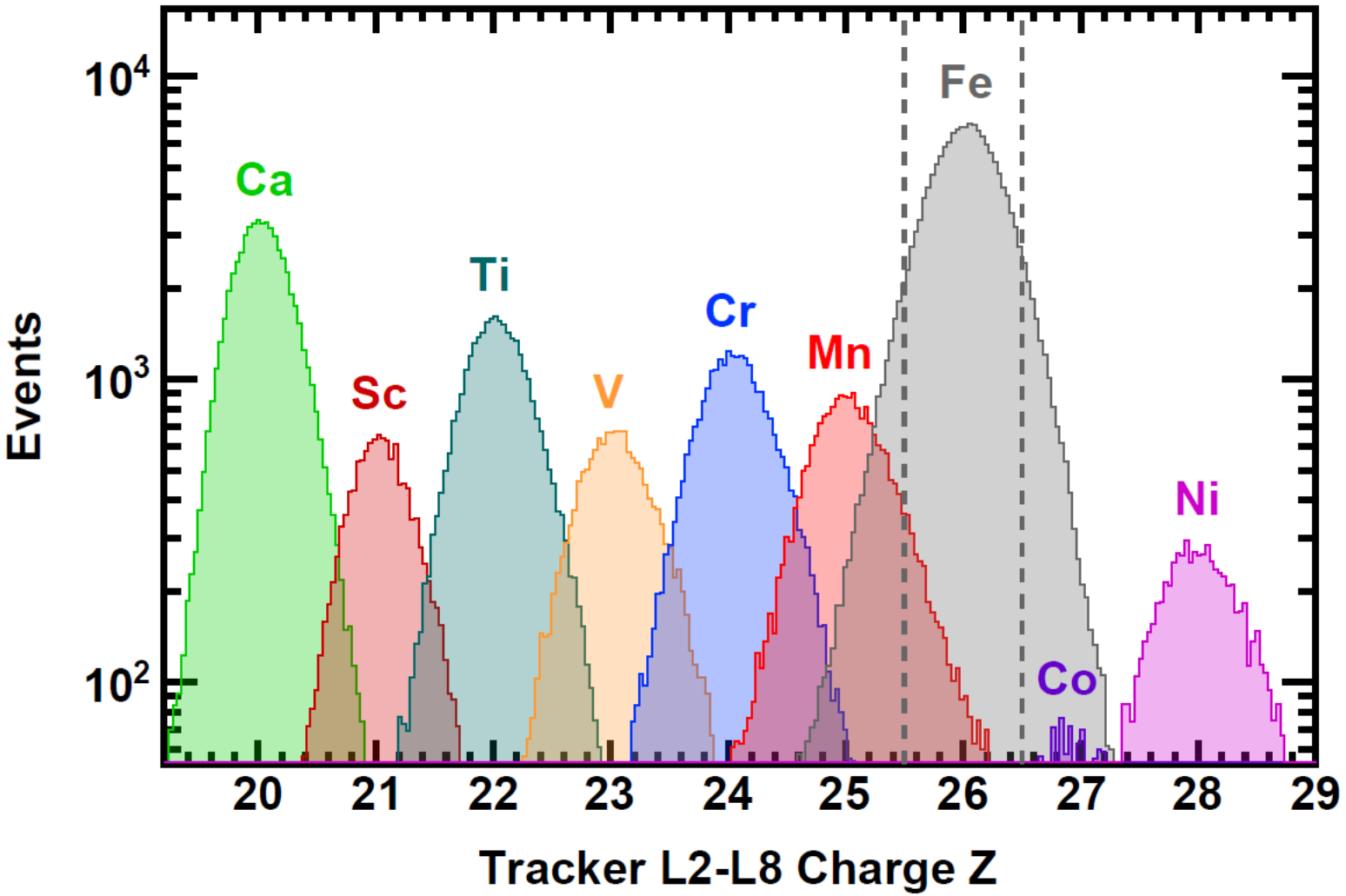
	Coordinate Resolution	MDR
Z=1	~10 μm	2 TV
2≤Z≤8	5-7 μm	3.2-3.7 TV
9≤Z≤14	6-8 μm	3-3.5 TV
15≤Z≤26	5-7 μm	3.2-3.7 TV

L1, UToF, Inner Tracker (L2-L8), LToF and L9

Consistent Charge along Particle Trajectory

Charge	Tracker L2-L8 Charge Resolution (c.u.)
1≤Z≤8	$\Delta Z \approx 0.05 - 0.12$
9≤Z≤14	$\Delta Z \approx 0.13 - 0.17$
15≤Z≤26	$\Delta Z \approx 0.18 - 0.35$

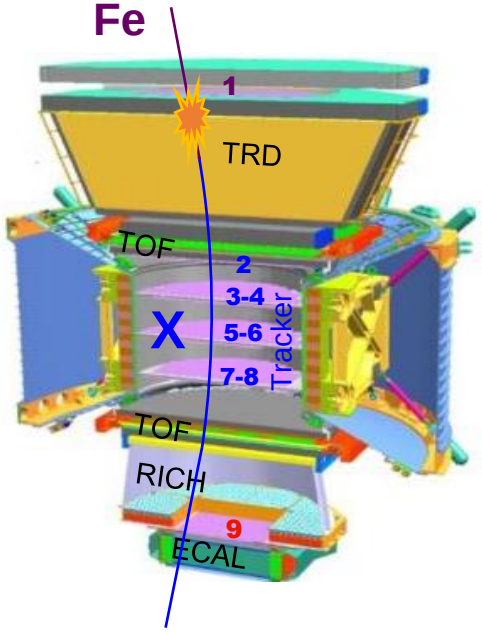
AMS Iron event selection

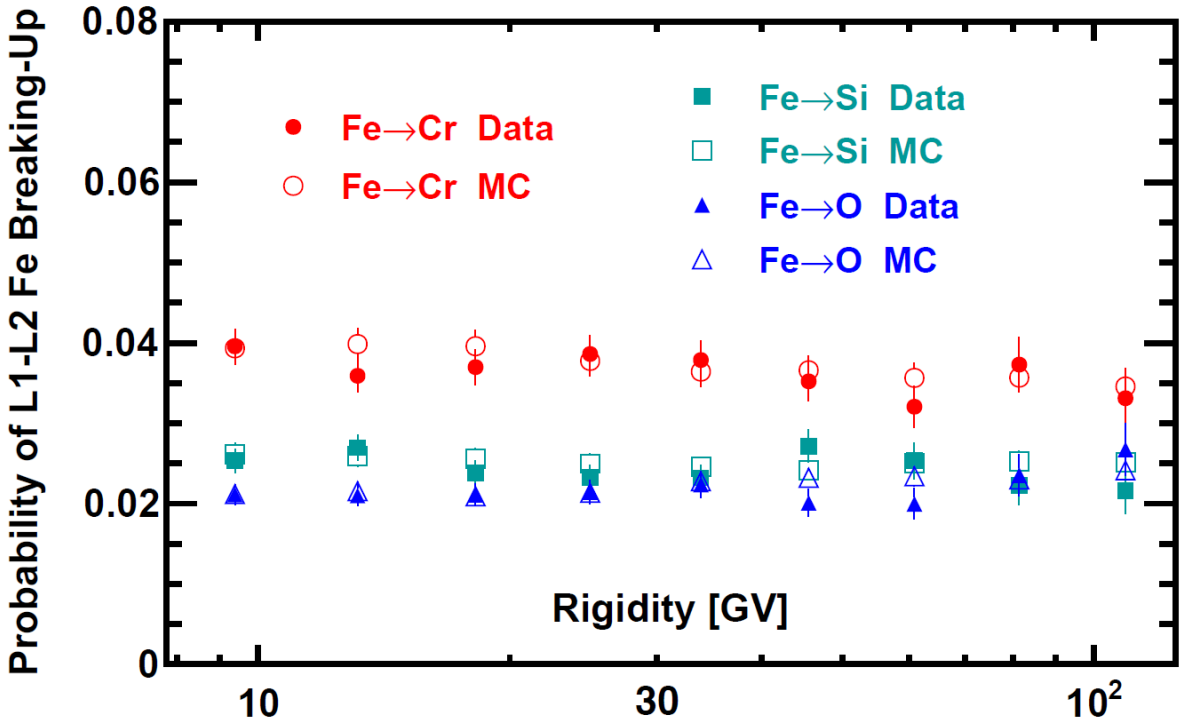


Nuclear Inelastic Interaction Measurement with AMS

The AMS material is composed primarily of carbon and aluminum. The survival probabilities of nuclei due to inelastic interactions with the detector materials are important for determination of cosmic-ray nuclei fluxes, which were measured precisely by AMS:

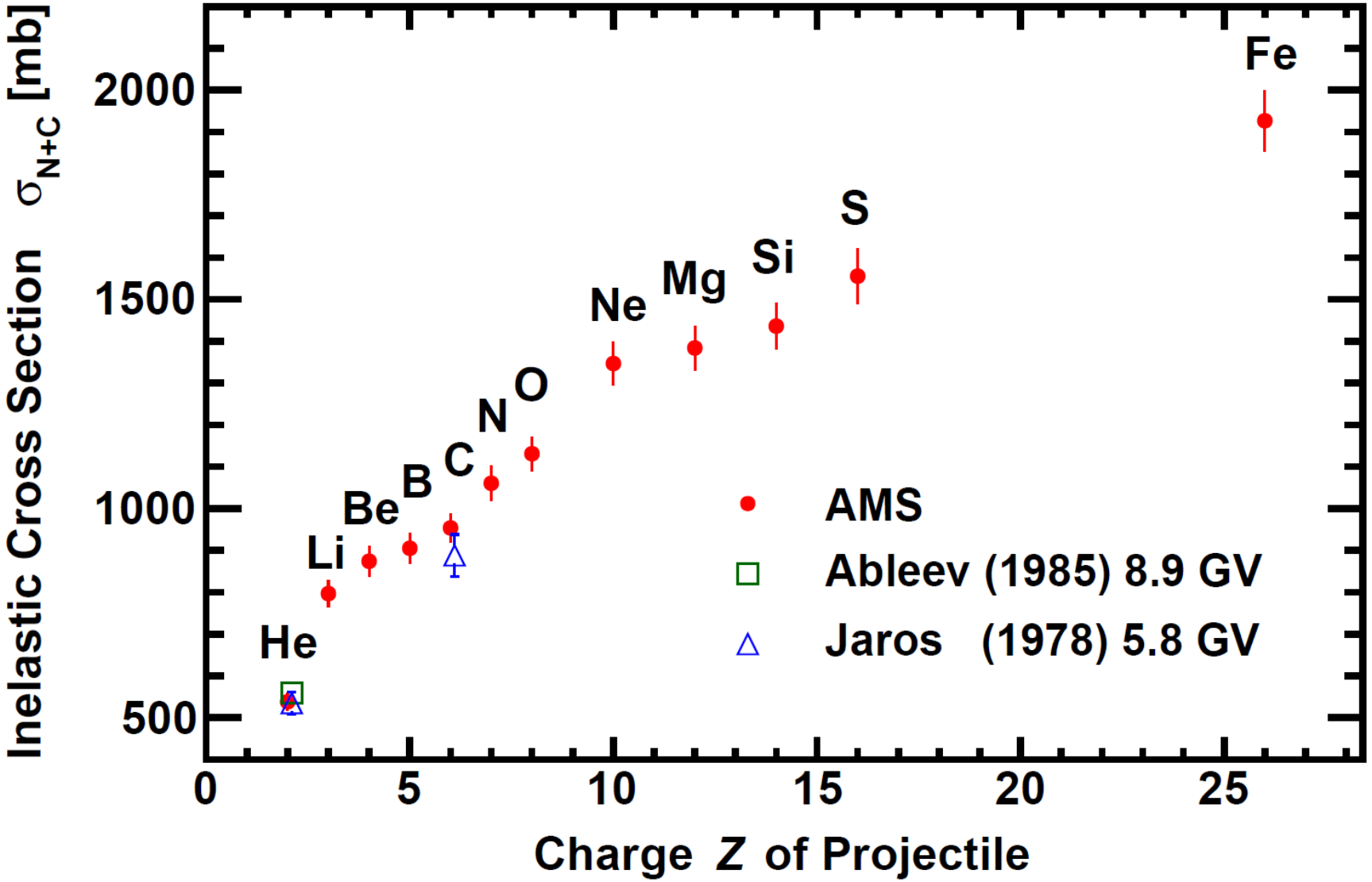
- Select primary nuclei by L1 charge
- Measure nuclei breaking-up probability channel by channel (Fe->X)





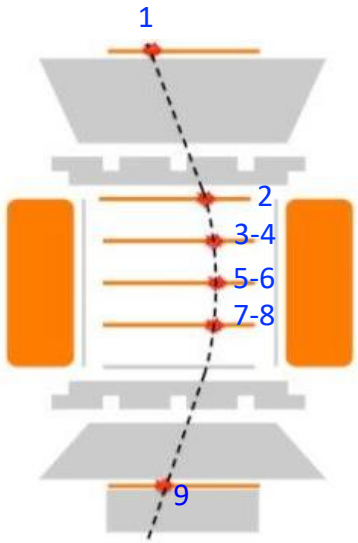
See details in "Q. Yan *et al.*, Nuclear Physics A 996, 121712 (2020)".

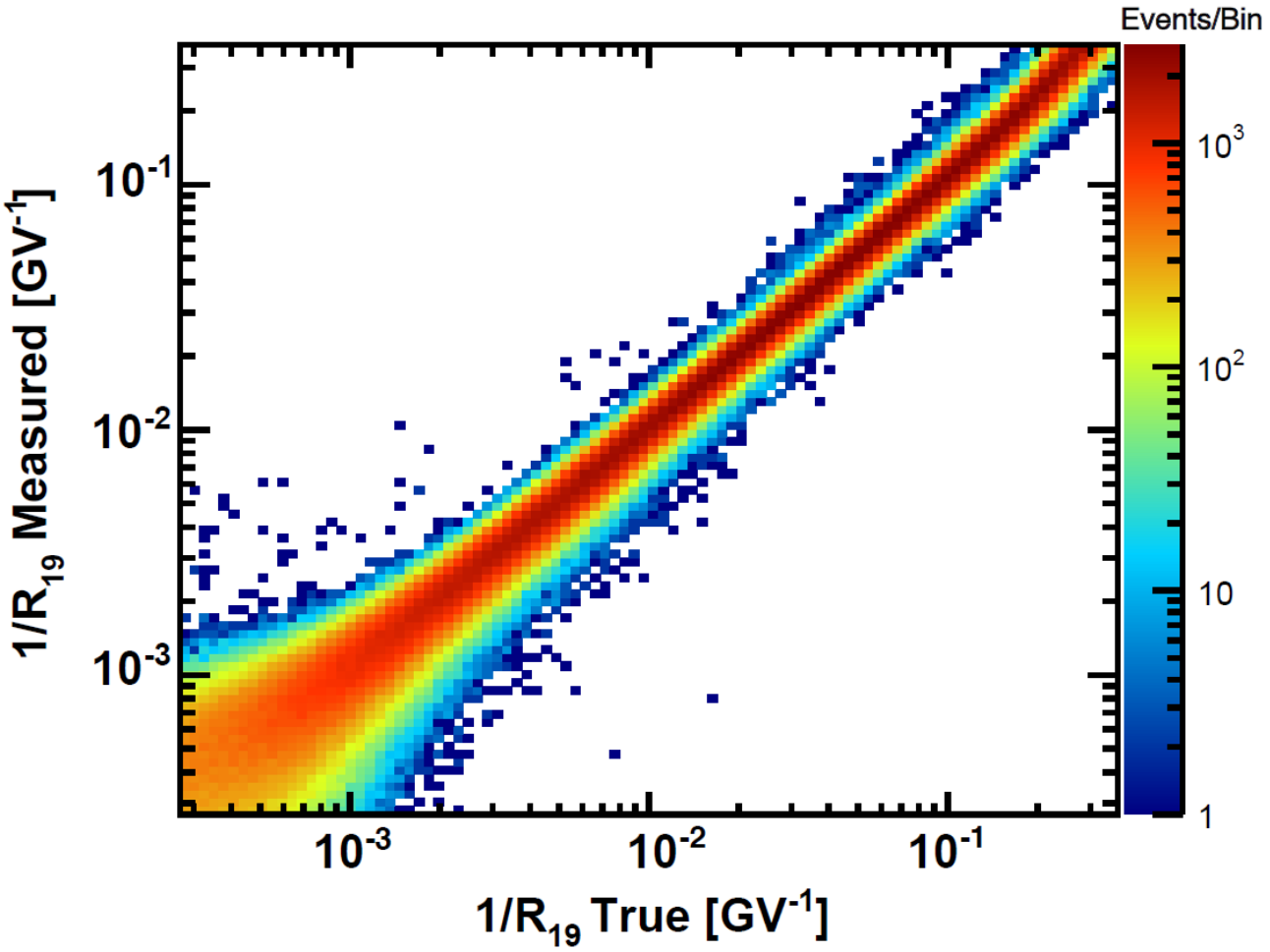
AMS measured Nucleus + C Inelastic Cross Sections (5-100 GV Rigidity)



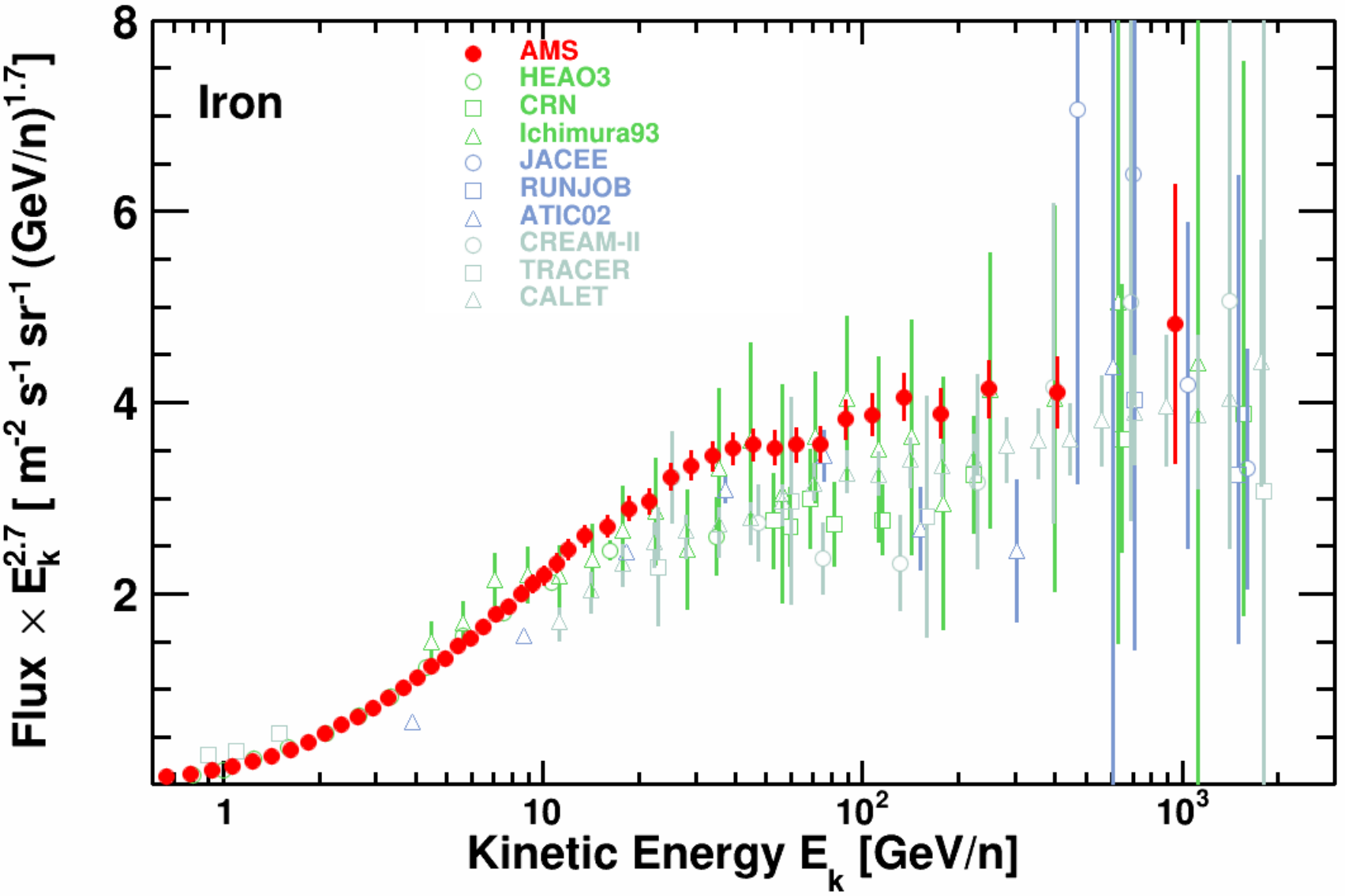
AMS Iron rigidity resolution smearing matrices

The AMS tracker + magnet measure the Rigidity of charged cosmic rays.



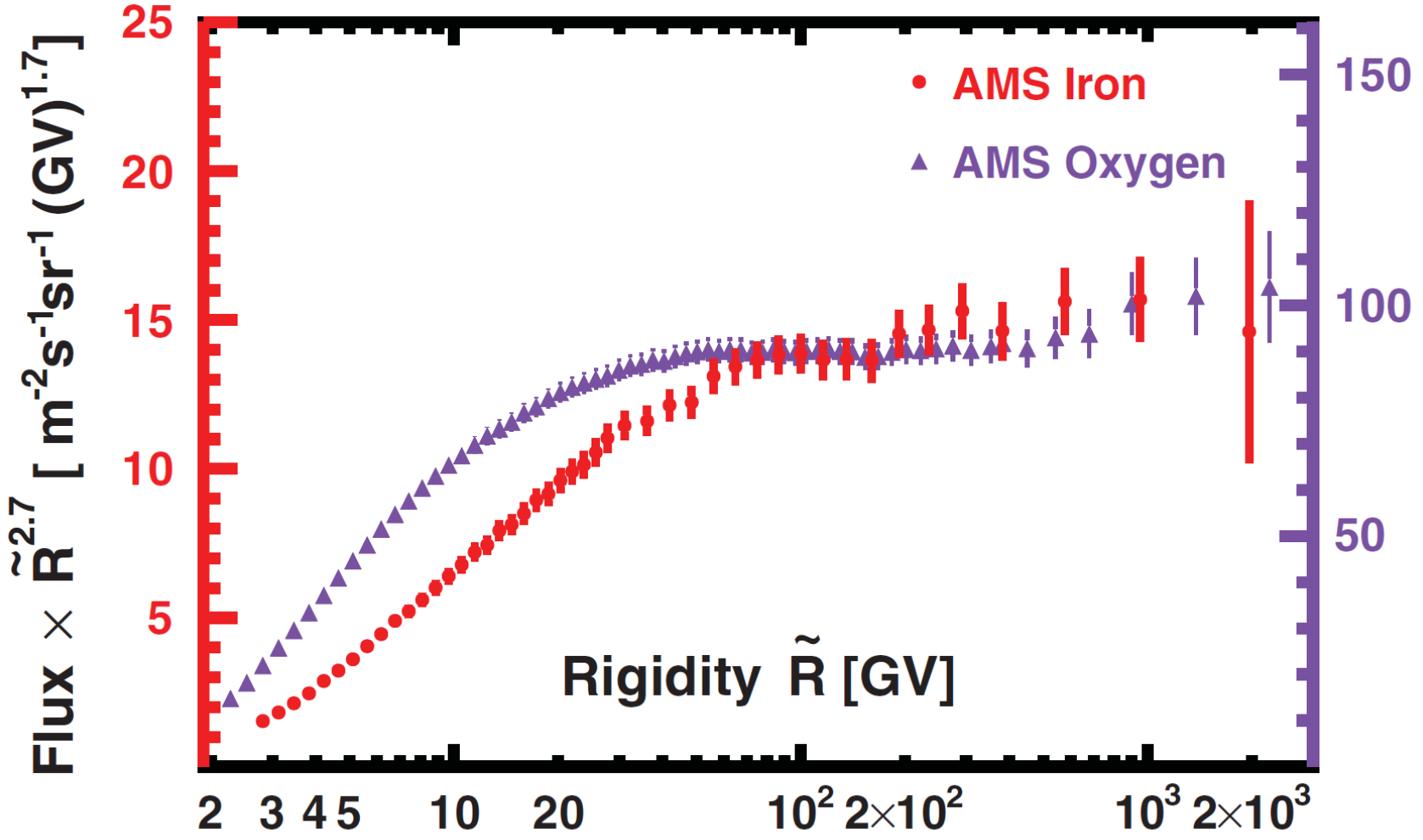


AMS Iron flux compared with other Experiments

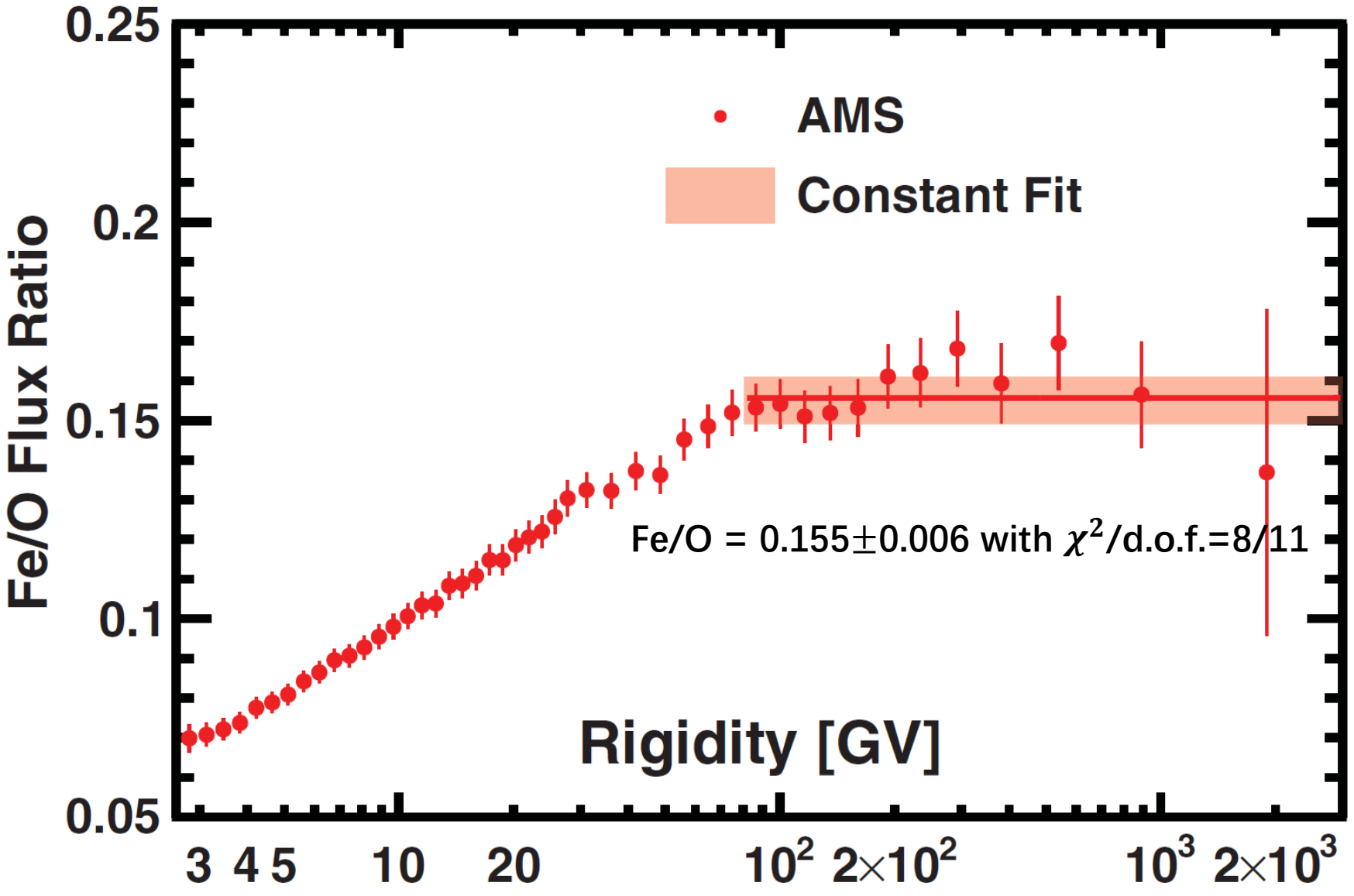


AMS Iron and Oxygen fluxes

Identical rigidity dependence above 80.5 GV

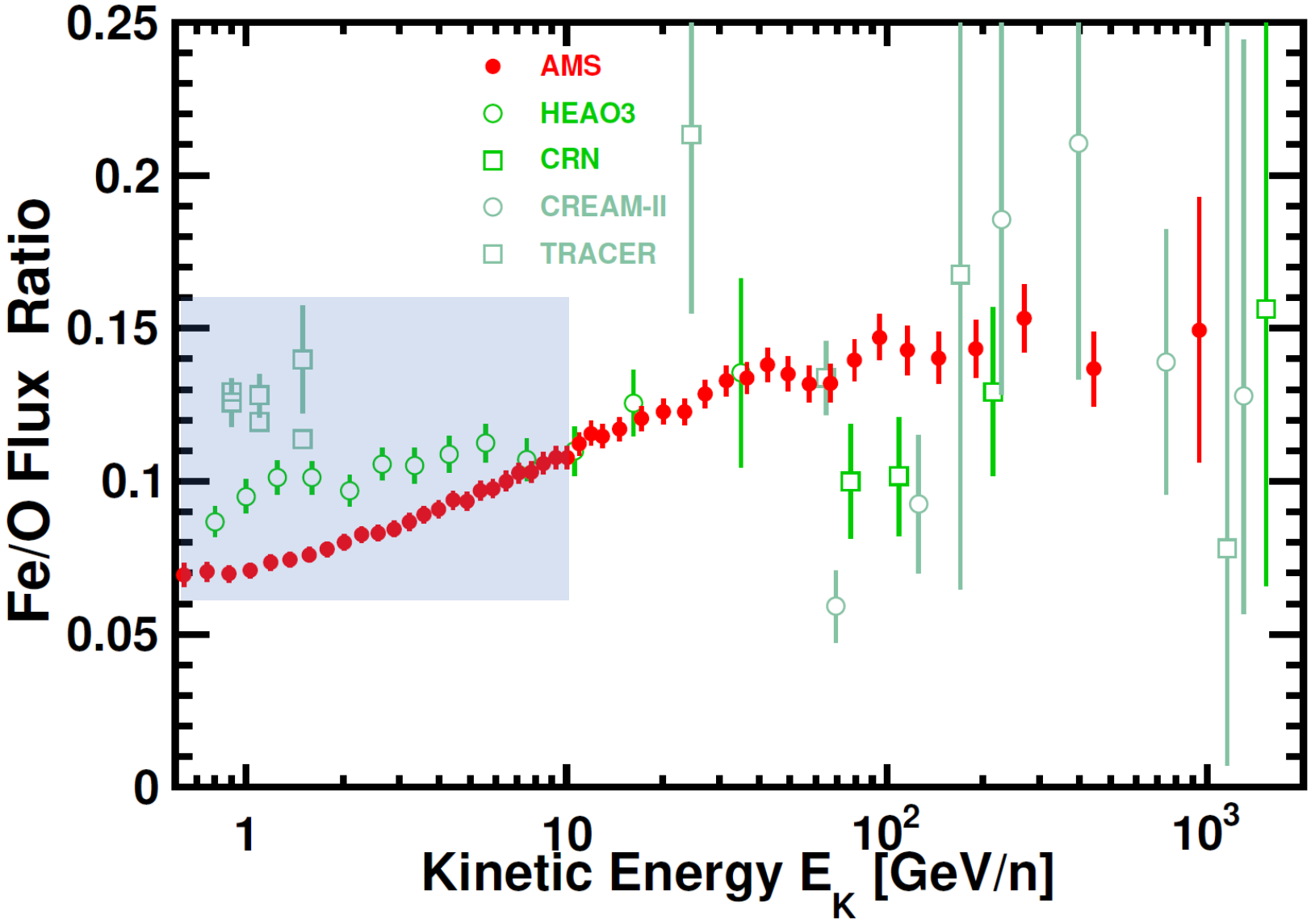


AMS Fe/O ratio

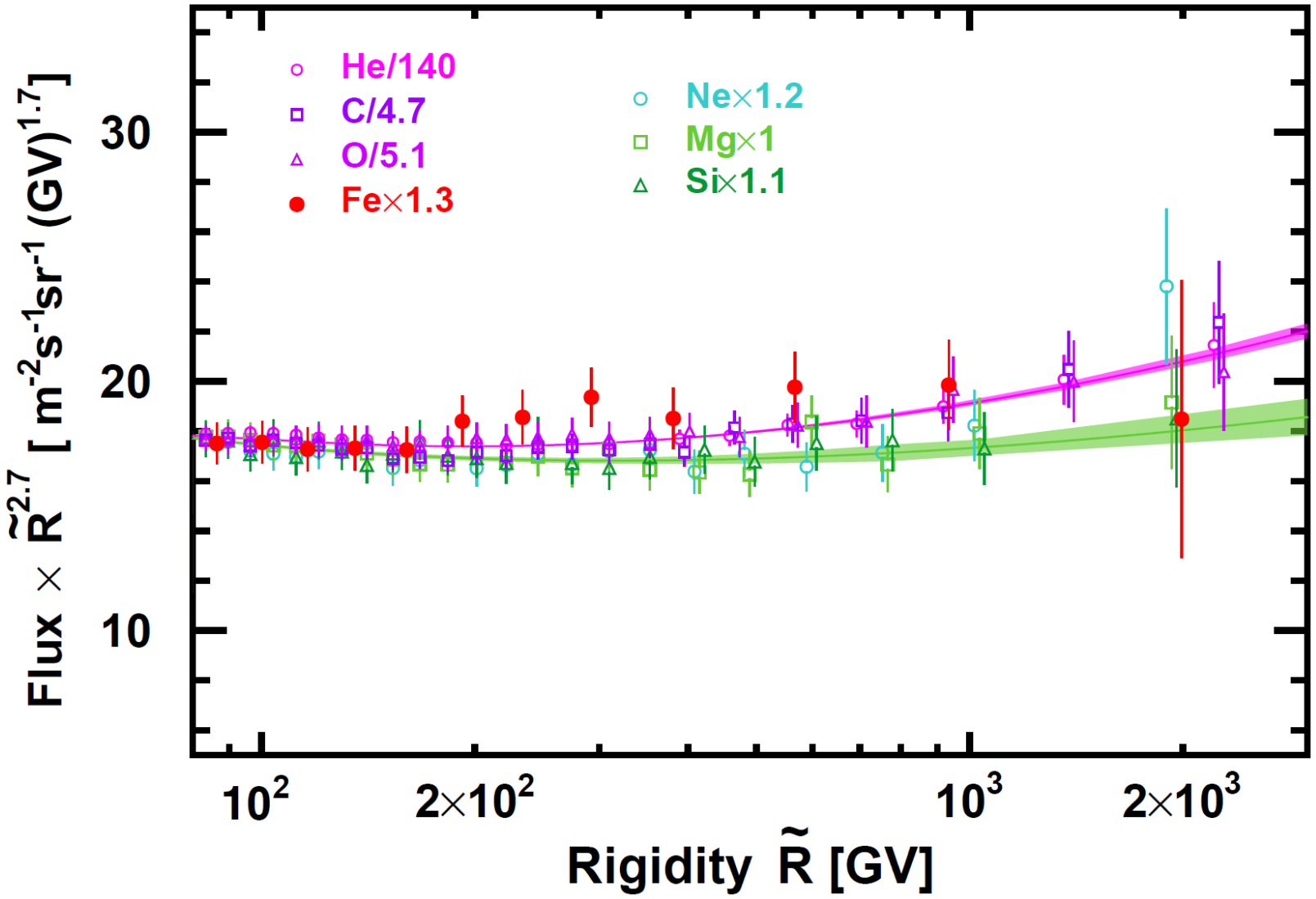


Above **80.5 GV**, the Fe/O ratio is well described by a **constant** value

AMS Fe/O ratio compared with other Experiments



Property of primary cosmic rays



Unexpectedly, Fe and He, C, O (light nuclei) belong to the same class of primary cosmic rays, which are different from the Ne, Mg, Si

Summary

PHYSICAL REVIEW LETTERS **126,** 041104 (2021)

1. Precision measurement of the primary cosmic ray **Iron nuclei** spectrum from **2.65 GV to 3.0 TV** based on events collected by AMS during the first 8.5 years of operation (2011-2019) have been presented.

2. Iron spectrum **deviates from a single power law** and **hardening at high rigidity**.

3. Above **80.5 GV**, the rigidity dependence of the Fe flux is identical to the rigidity dependence of the primary cosmic ray He, C and O, with the **Fe/O ratio** being **constant** at 0.155 ± 0.006. This shows, unexpectedly, **Fe** and **He, C, and O** belong to the **same class** of primary cosmic rays, which is different from the primary cosmic rays Ne, Mg, and Si.