



# Heavy Metal and Rock in Space: Cluster RAPID Observations

Stein Haaland <sup>1,2,3</sup>

Esa Vilenius<sup>3</sup>, Patrick W. Daly<sup>3</sup>, Patrik Krcelic<sup>4</sup>

*Presented by Esa Vilenius*

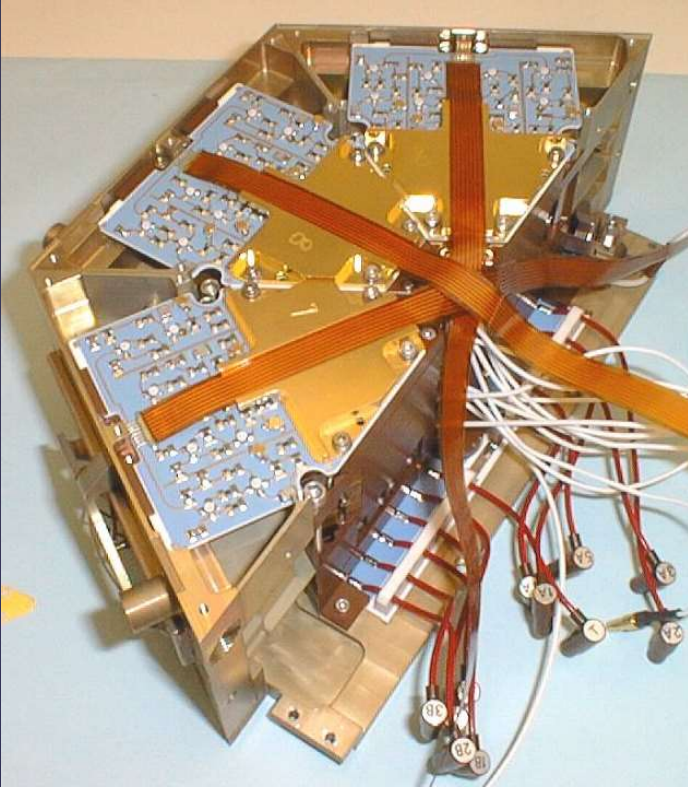
<sup>1</sup> Birkeland Centre for Space Science, University of Bergen, Norway

<sup>2</sup> University Centre in Svalbard, Longyearbyen, Svalbard

<sup>3</sup> Max Planck Institute for Solar System Research, Göttingen, Germany

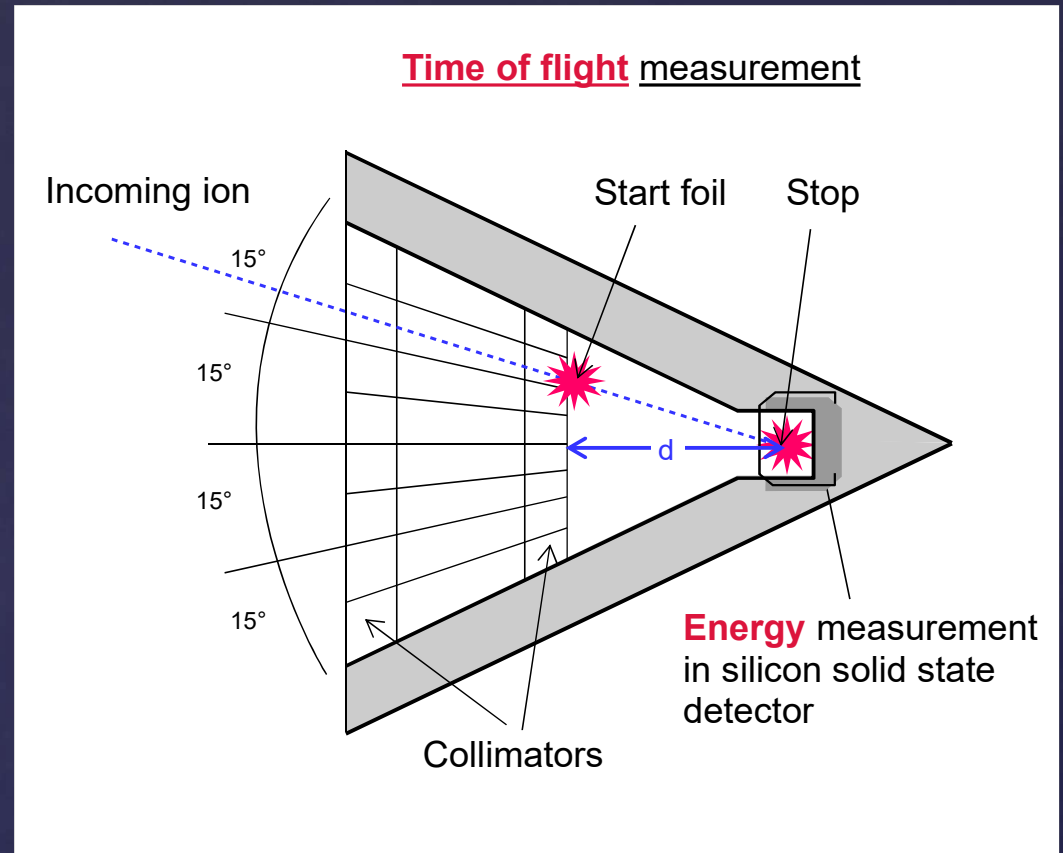
<sup>4</sup> University of Southampton, United Kingdom

# RAPID / IIMS on Cluster mission

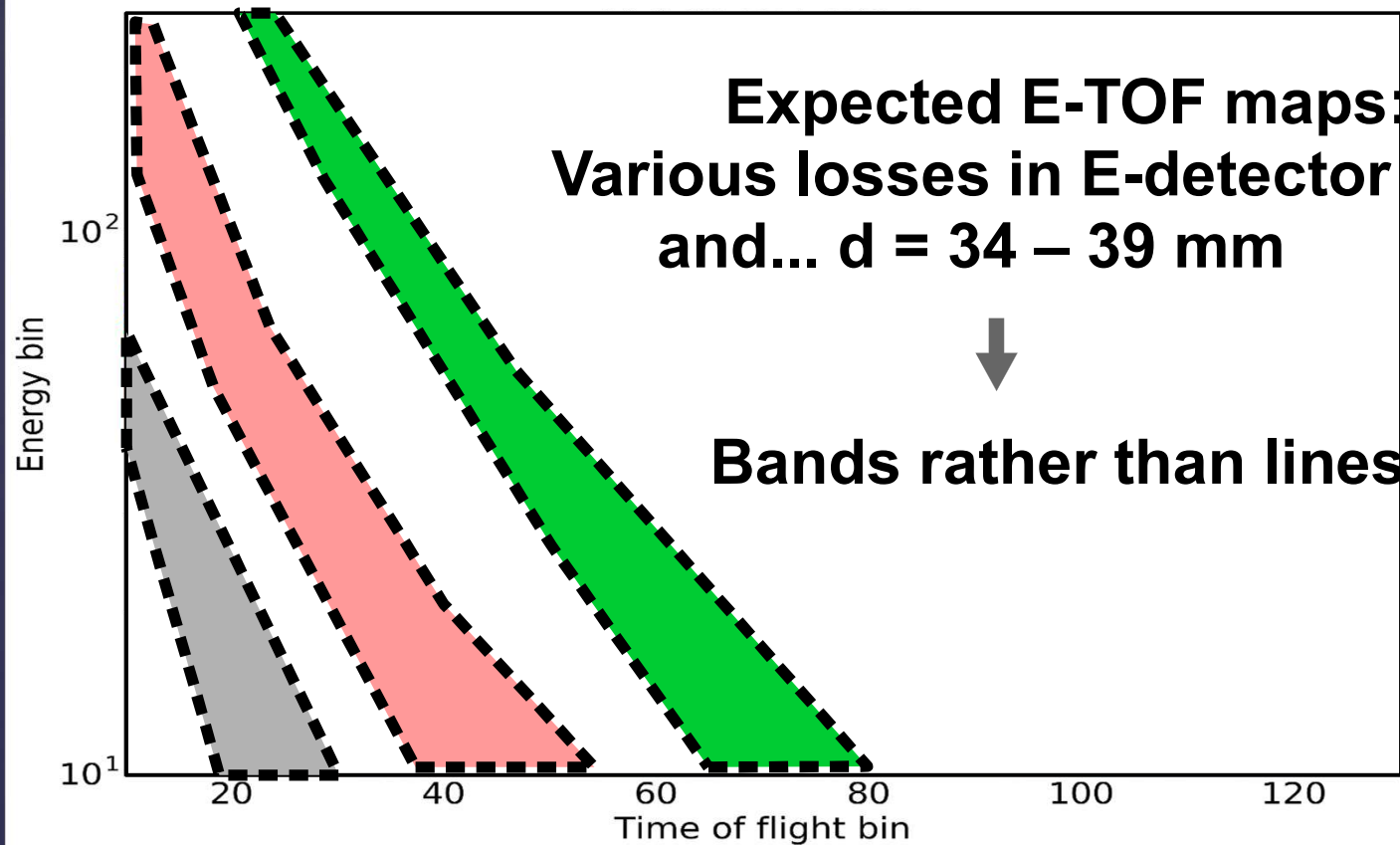


MPS

- Combine 3 heads gives  $\sim 180^\circ$  elevation
- Satellite spin takes care of azimuth to give full 3D coverage.
- **BUT: middle head** of all 4 spacecraft **failed** in March 2001.



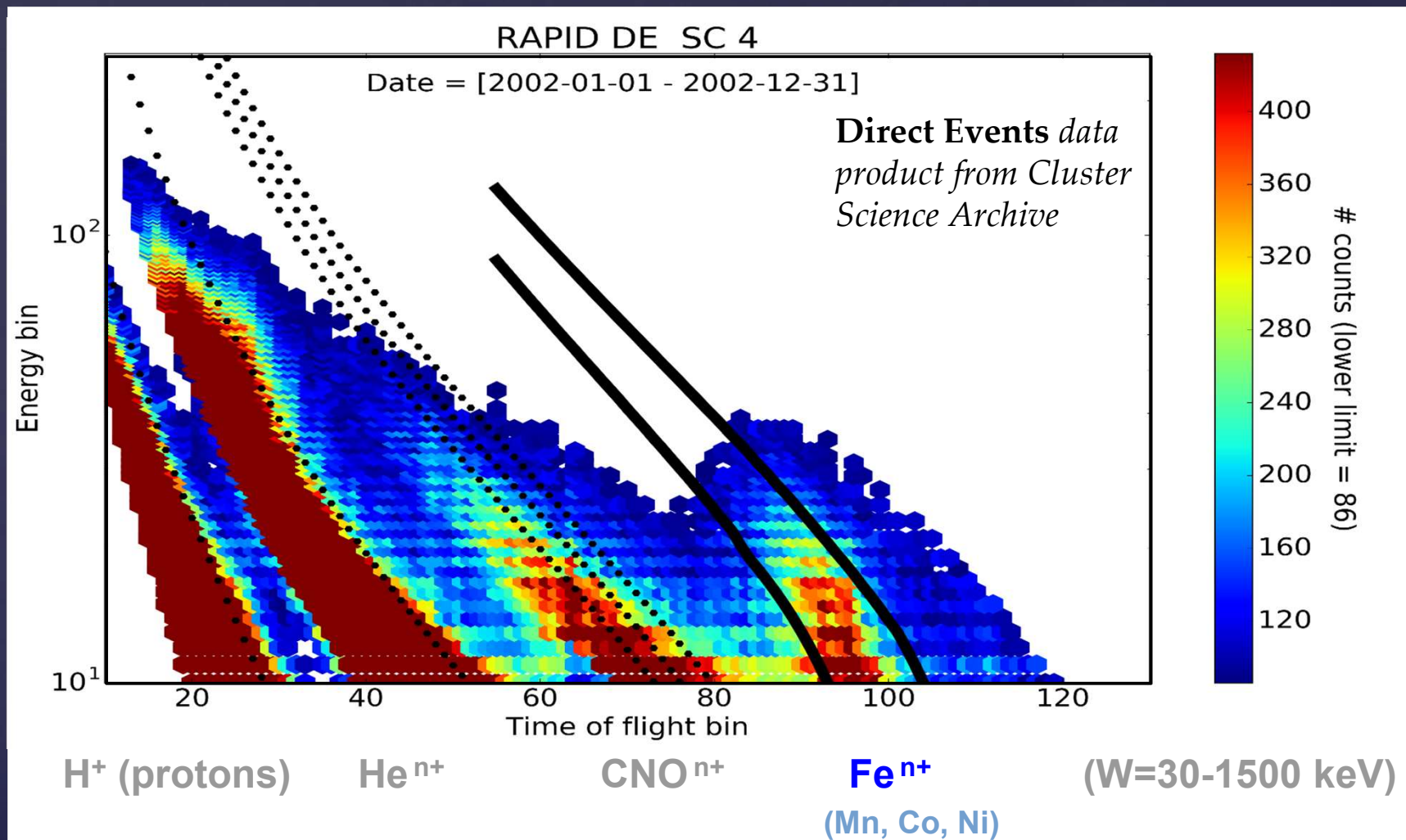
\* E vs TOF  $\rightarrow$  **ion species**  
.. but **not charge state**..



$m = 1$   
 $H^+$  (protons)

$m = 4$   
 $He^{n+}$

$m \sim 12-16$   
 $CNO^{n+}$



See also: Haaland et al, 2020, *JGR Space Physics*, 125

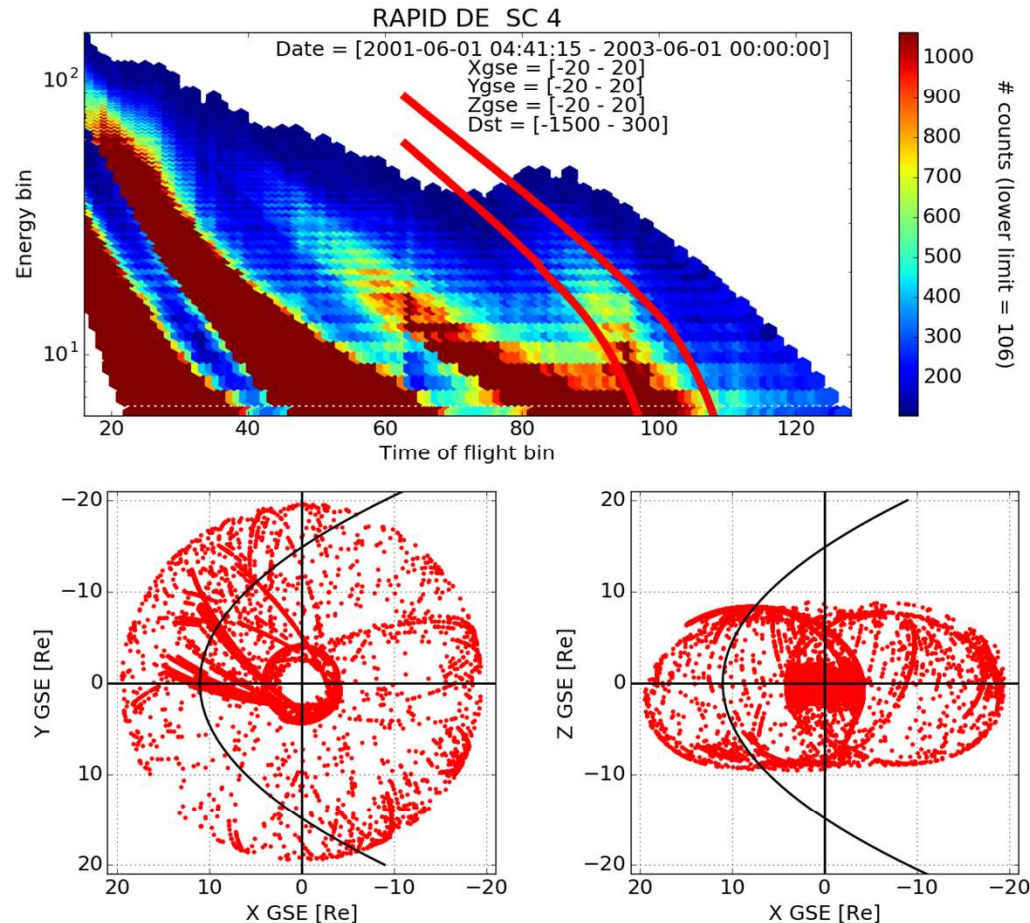


# Where do we see heavy ions?

19 x 4 Re polar orbit

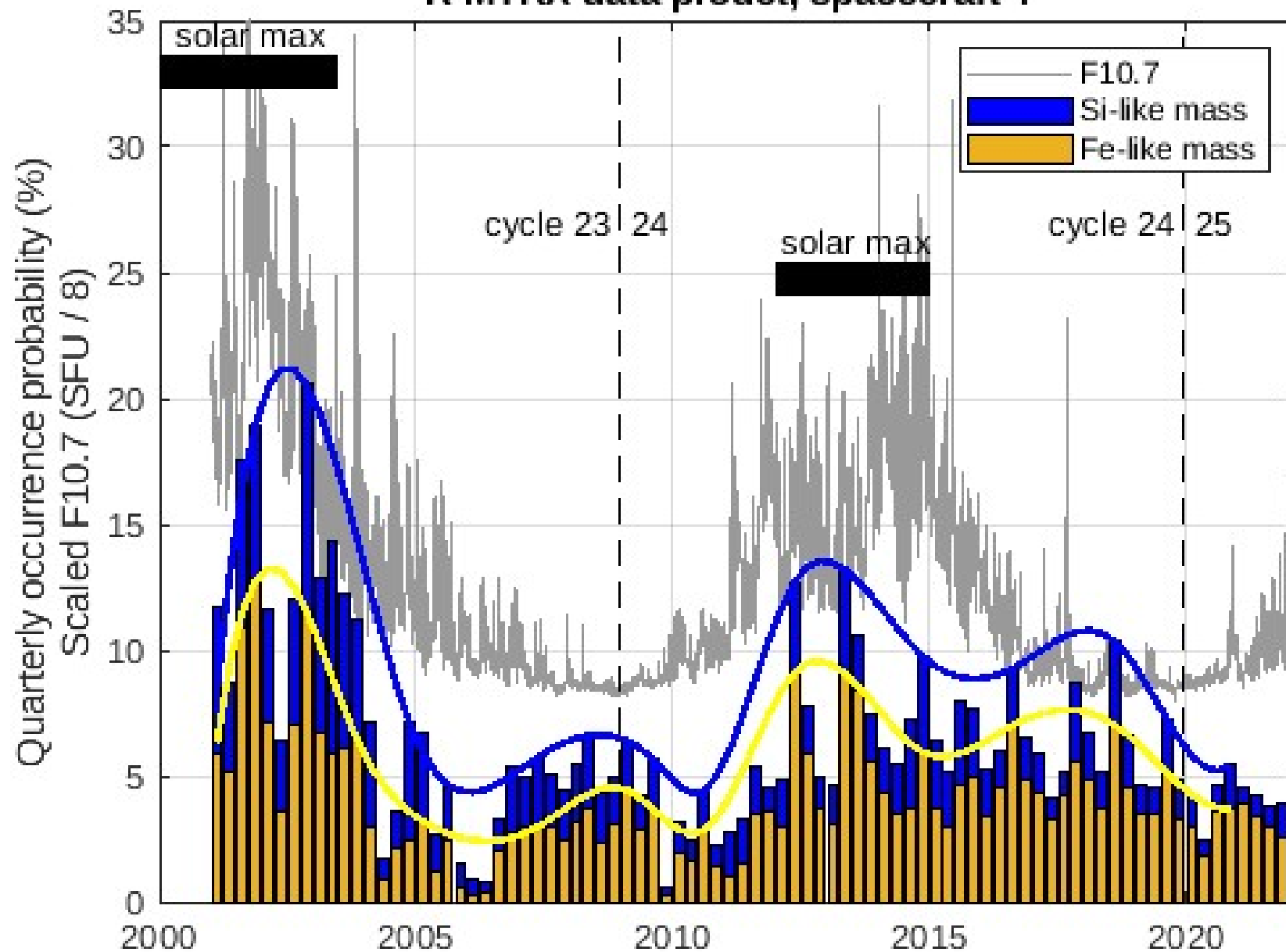
Apogee

- Sep equinox : tail
- Mar equinox : SW



Red dot: 1 record (>10 cts/4min)

# Heavy elements vs solar activity R-MTRX data prodct, spacecraft 4



# Summary



- RAPID observes heavy ions of energies  
Si (28 AMU): 0.4 - 2.1 MeV  
Fe (56 AMU): 0.7 - 2.2 MeV
  - Traces of ions/neutrals with atomic masses of Si-like and Fe-like ions have been found in all regions (solar wind and different regions of magnetosphere).
  - Occurrence rates of Si-like and Fe-like ions are modulated by solar activity. Rates are higher around the years of F10.7 maxima.
- > We infer primarily external origin for magnetospheric ions with Si-like and Fe-like atomic masses.

Haaland et al, 2020, *JGR Space Physics*, 125  
Haaland et al, 2021, *JGR Space Physics*, 126

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