An Overview of SEPs During the October-November 2003 Storms

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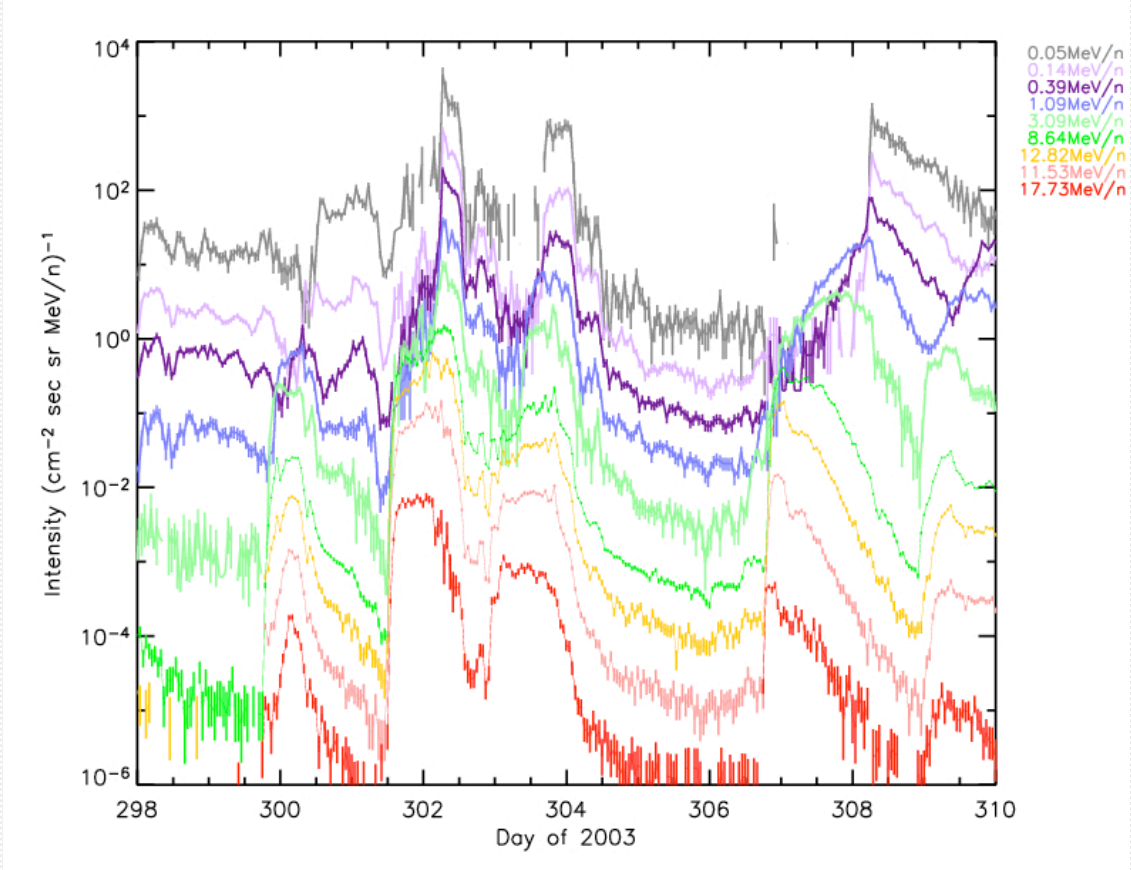
Time Evolution

- 5 distinct events at 10 MeV/n
- Less clear at 1 MeV/n



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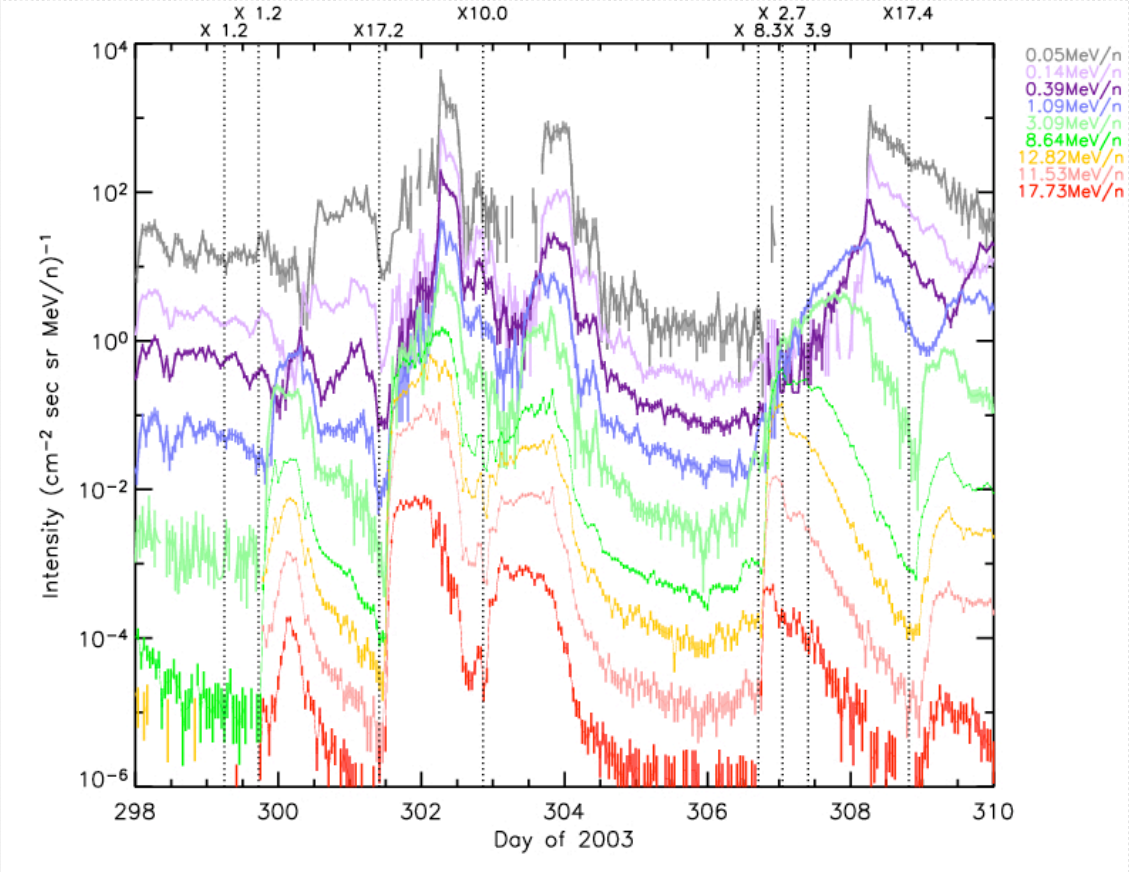
- 8 X-class flares
- Largest SEP events with X17, X10, X8



Time Evolution

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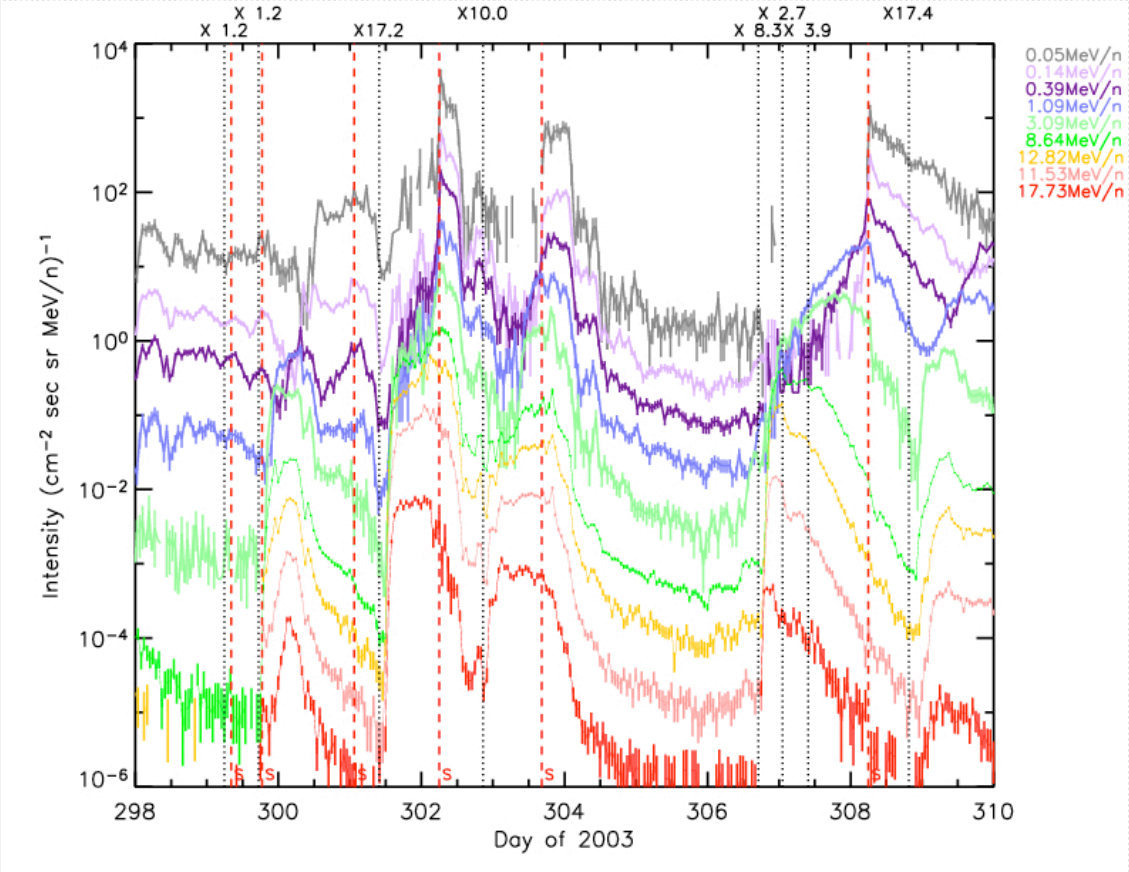
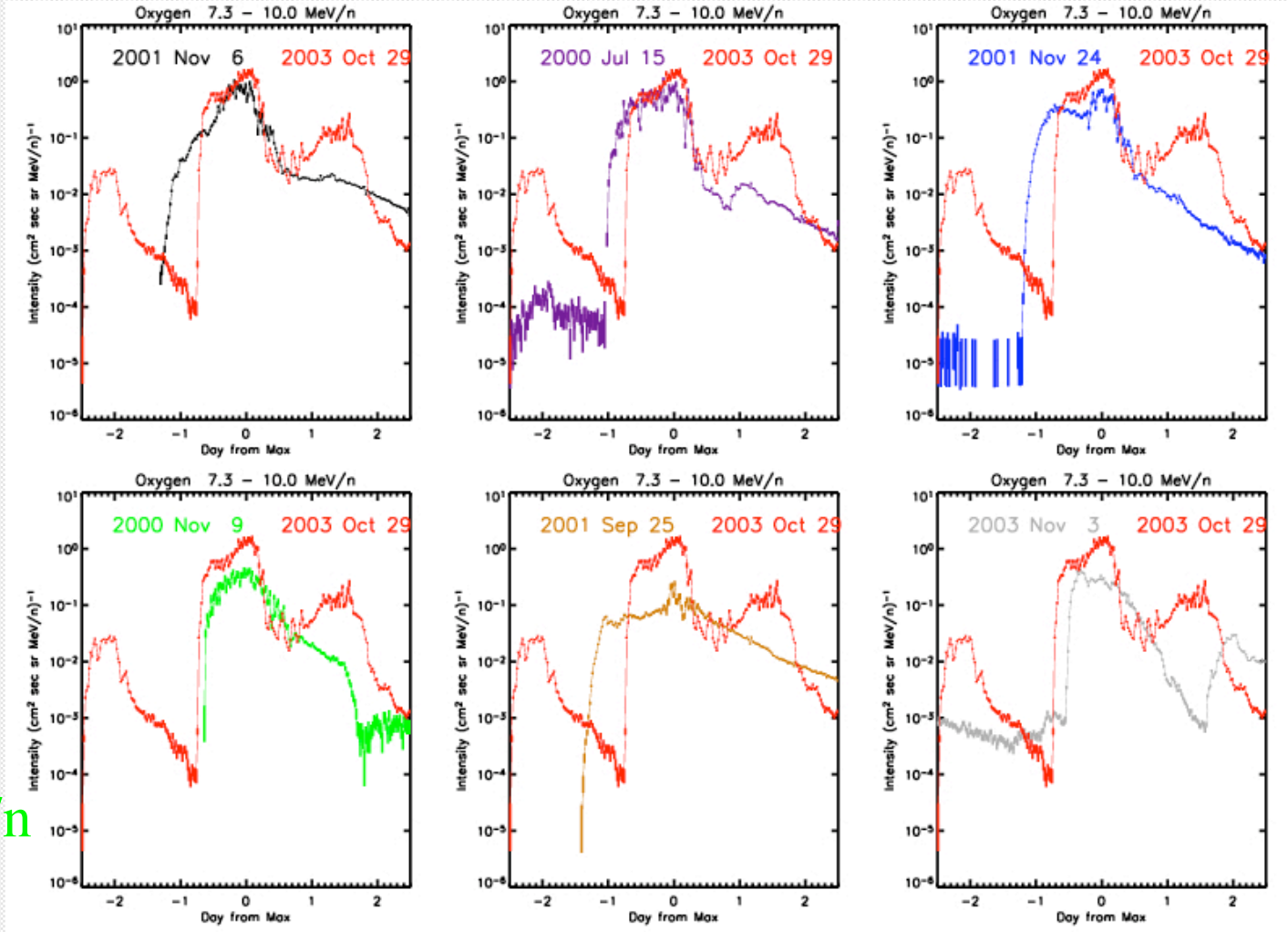
- 8 X-class flares
- Largest SEP events with X17, X10, X8
- 6 shocks, 4 with ESPs



Oct 28 - Biggest Event?

NOAA top 6
2001 Nov 4
2003 Oct 28
2000 Jul 14
2001 Nov 22
2000 Nov 8
2001 Sep 24
(2003 Nov 2)



Oxygen 7 MeV/n

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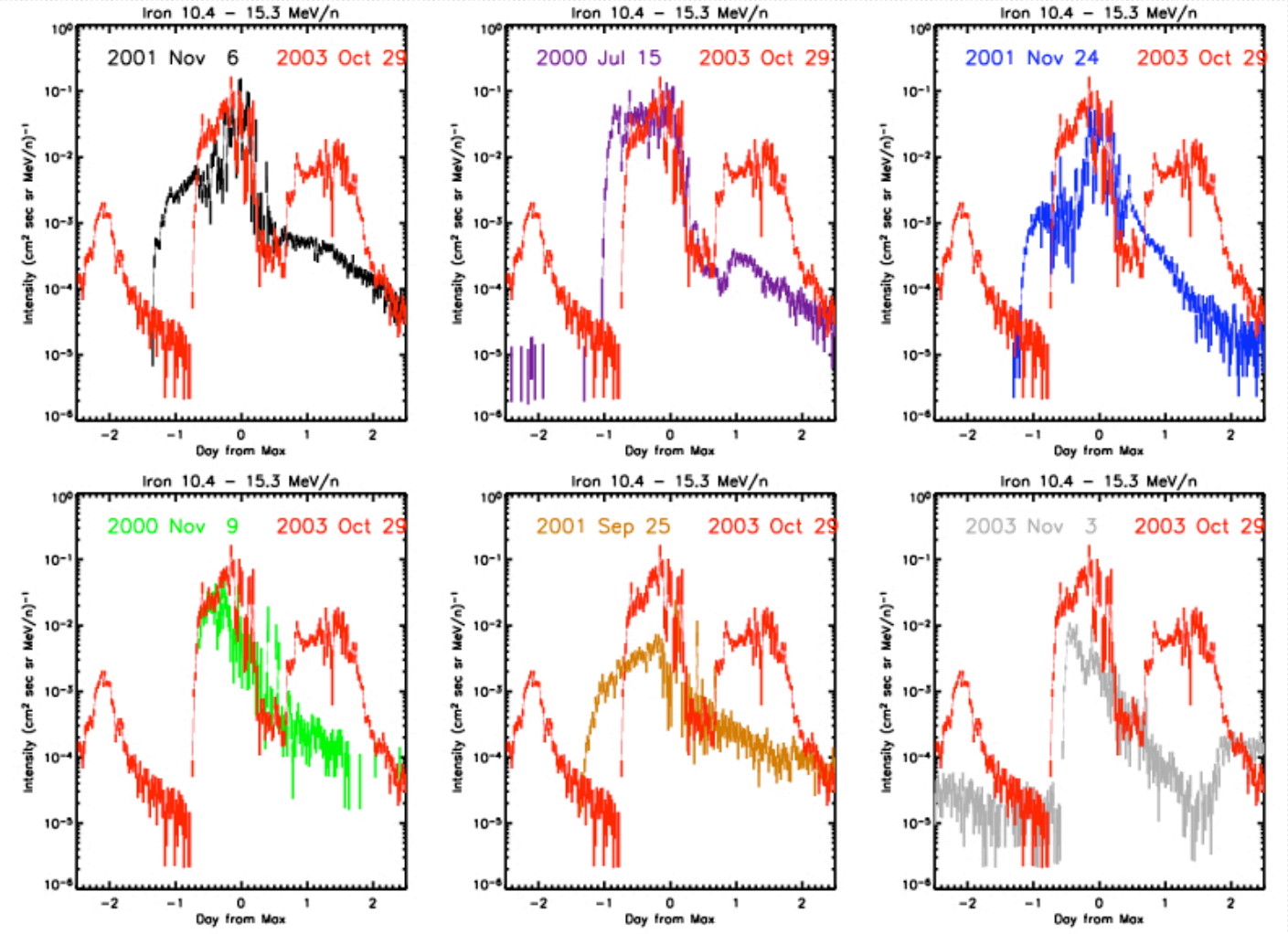
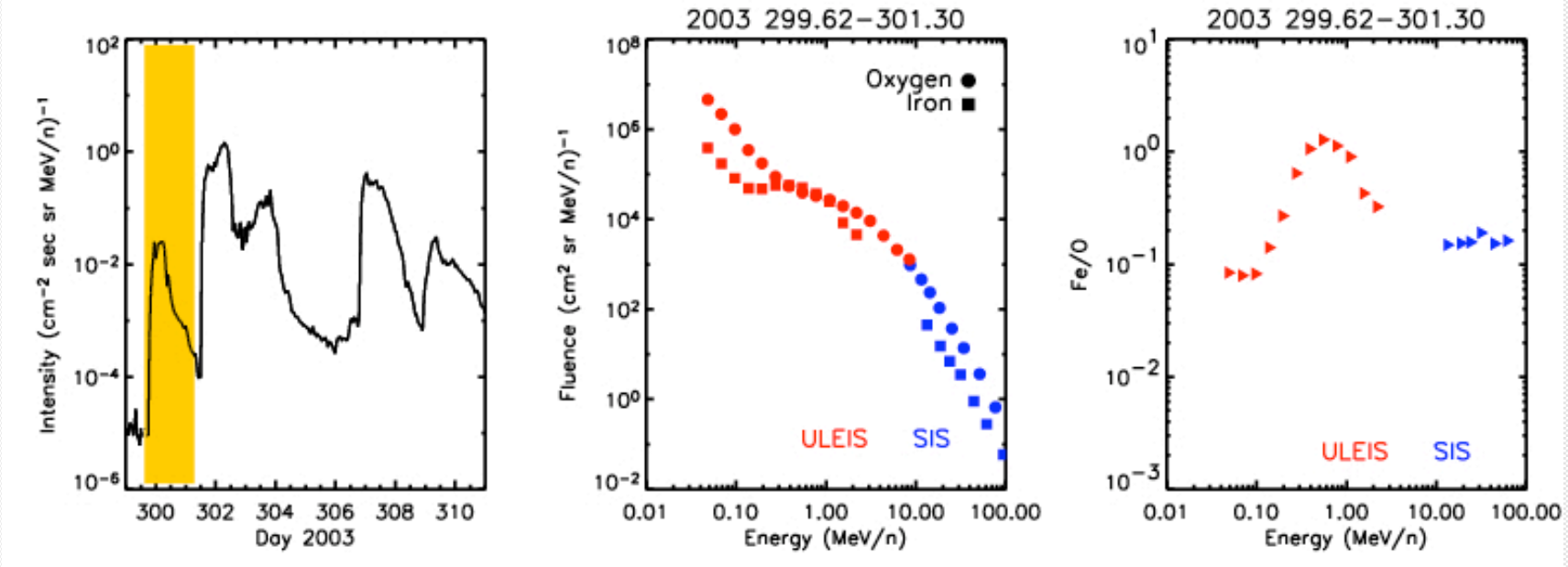
Iron 10 MeV/n

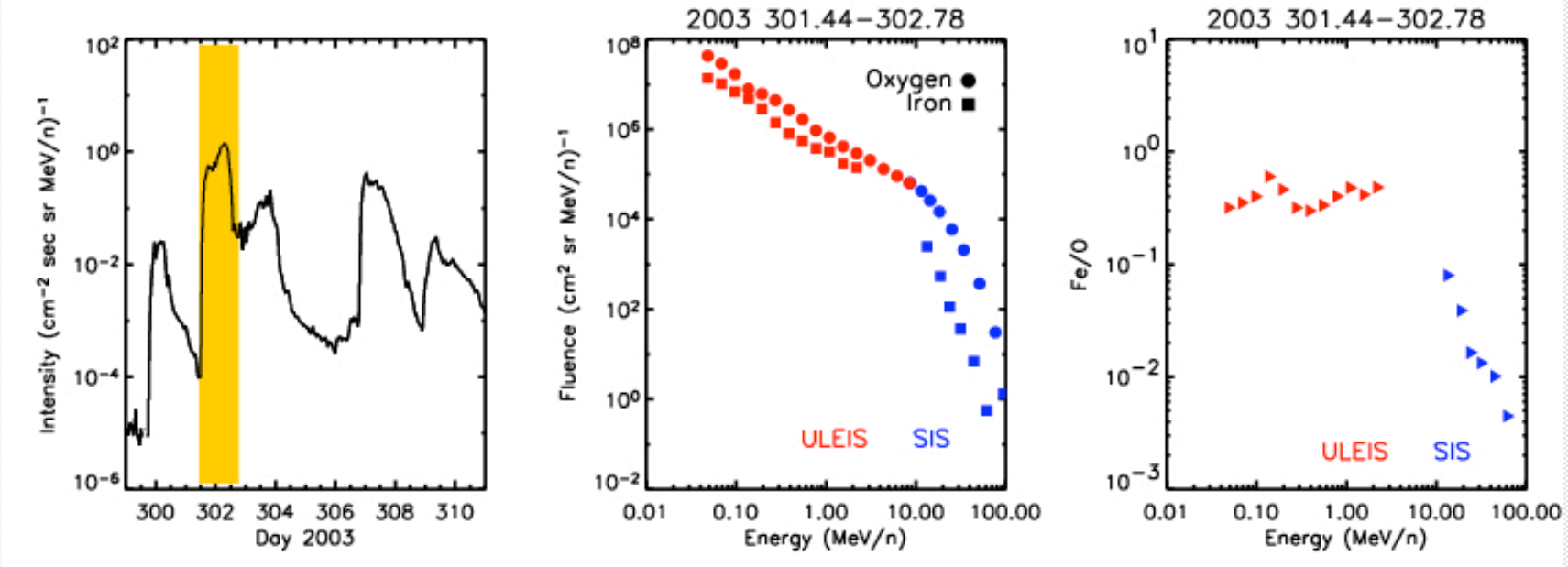


O, Fe Fluences for Event 1



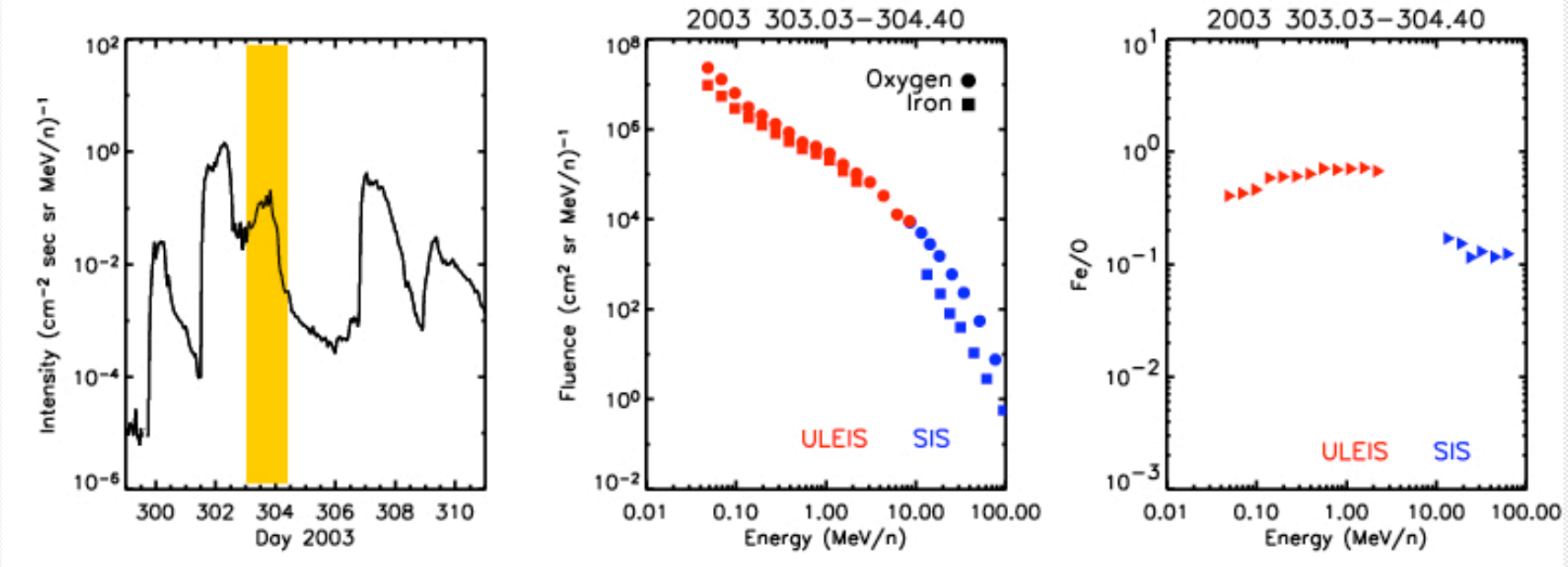
- Roll-off in spectra ~few MeV/n to softer power law
- Fe/O independent of energy above 10 MeV/n

O, Fe Fluences for Event 2



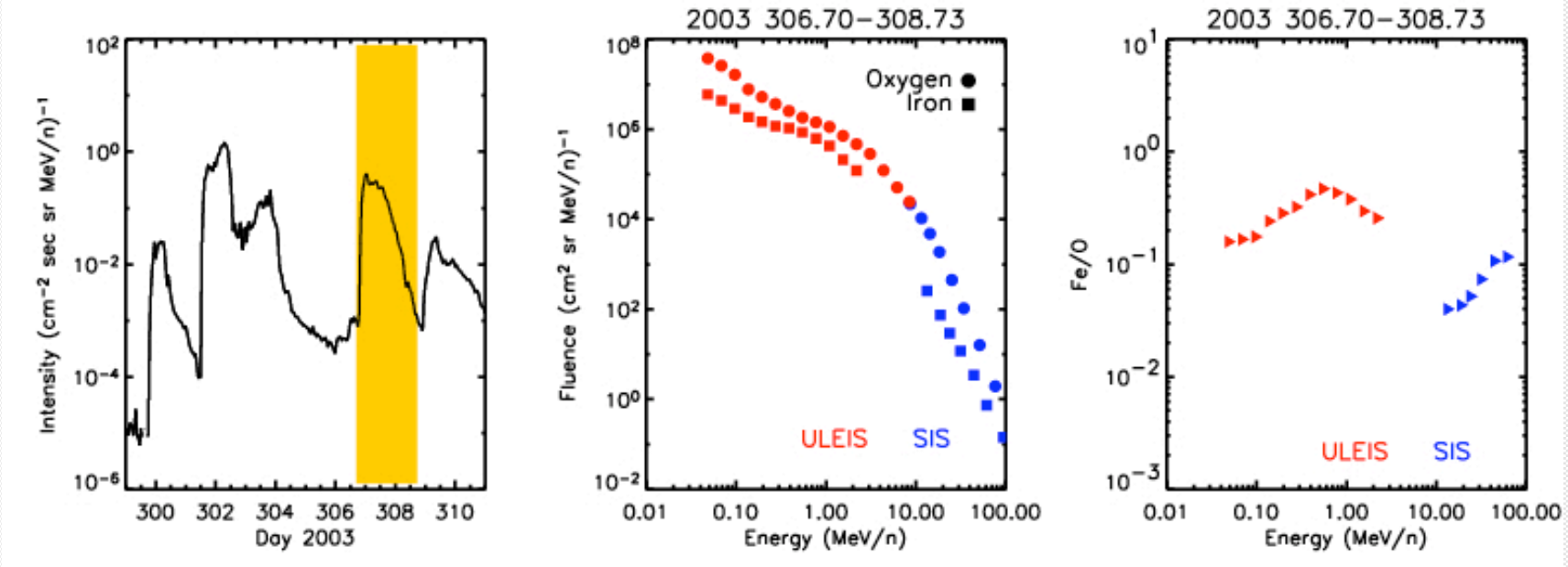
- Roll-off in spectra ~few MeV/n, maybe exponential
- Power law below roll-off
- Fe/O decreases with energy above 10 MeV/n

O, Fe Fluences for Event 3



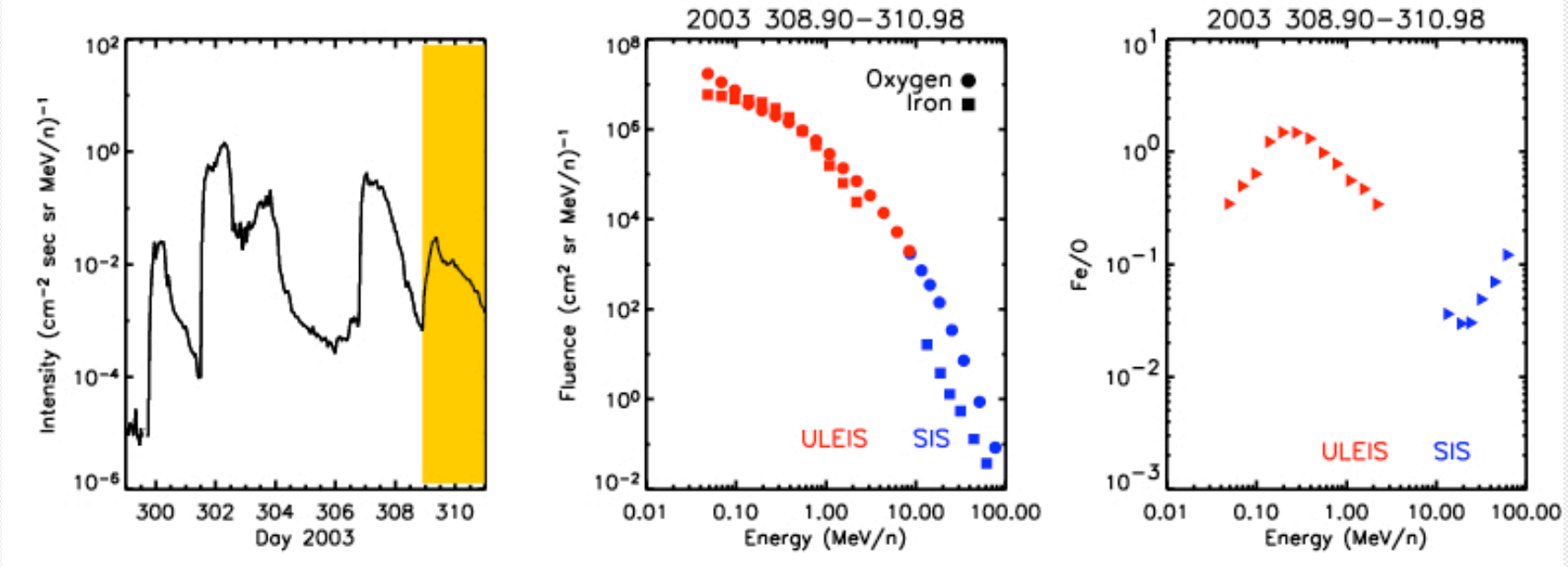
- Roll-off in spectra ~few MeV/n to softer power law
- Power law below roll-off
- Fe/O independent of energy above 10 MeV/n

O, Fe Fluences for Event 4



- Roll-off in spectra ~1 MeV/n to softer power law
- Power law below roll-off
- Fe/O increasing with energy above 10 MeV/n

O, Fe Fluences for Event 5

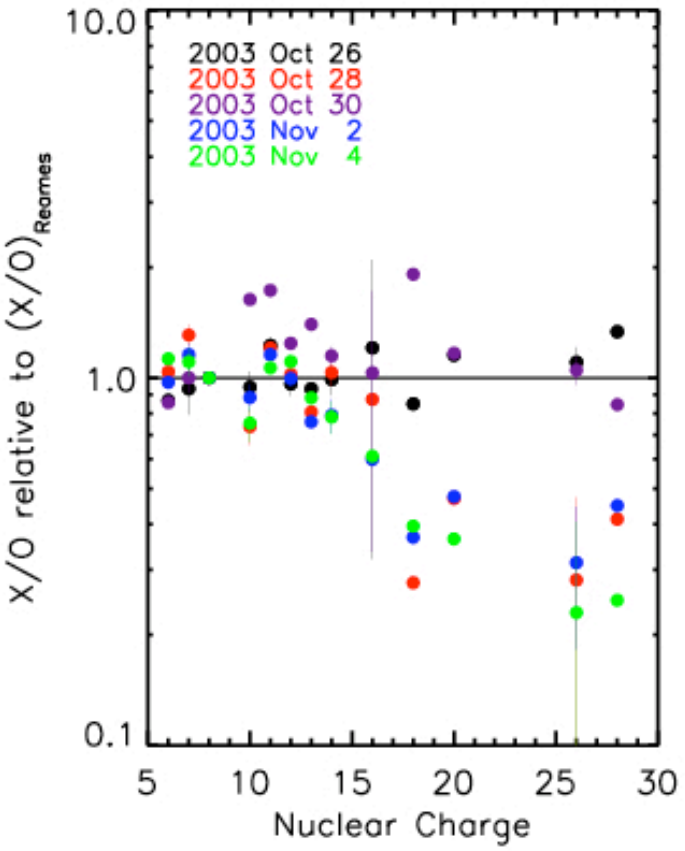


- Roll-off in spectra below ~1 MeV/n to softer power law
- Fe/O increasing with energy above 10 MeV/n

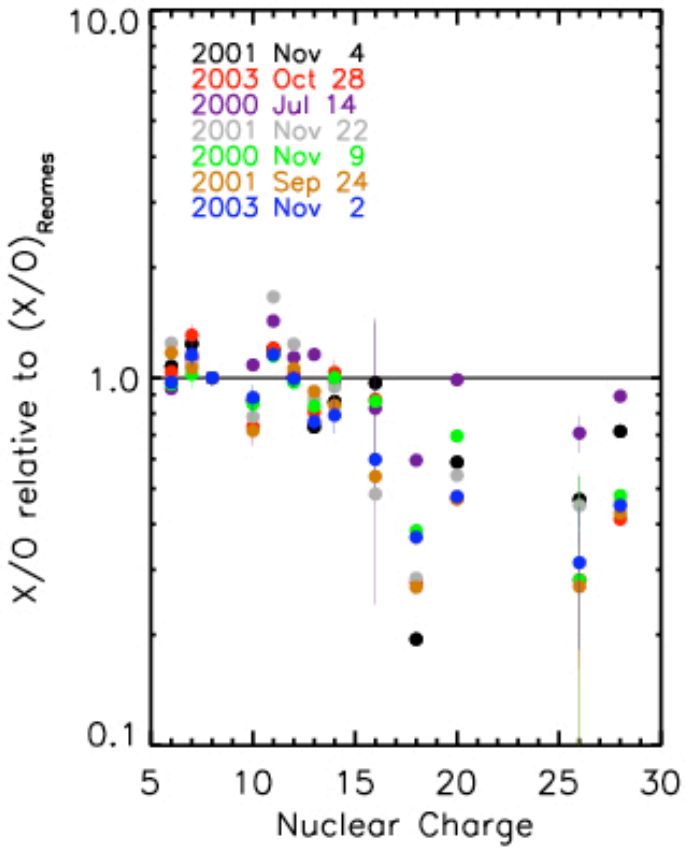
Event Integrated Abundances From 12 to 60 MeV/n

Noramalized to ‘average’ 1□MeV/n abundances

These 5 events

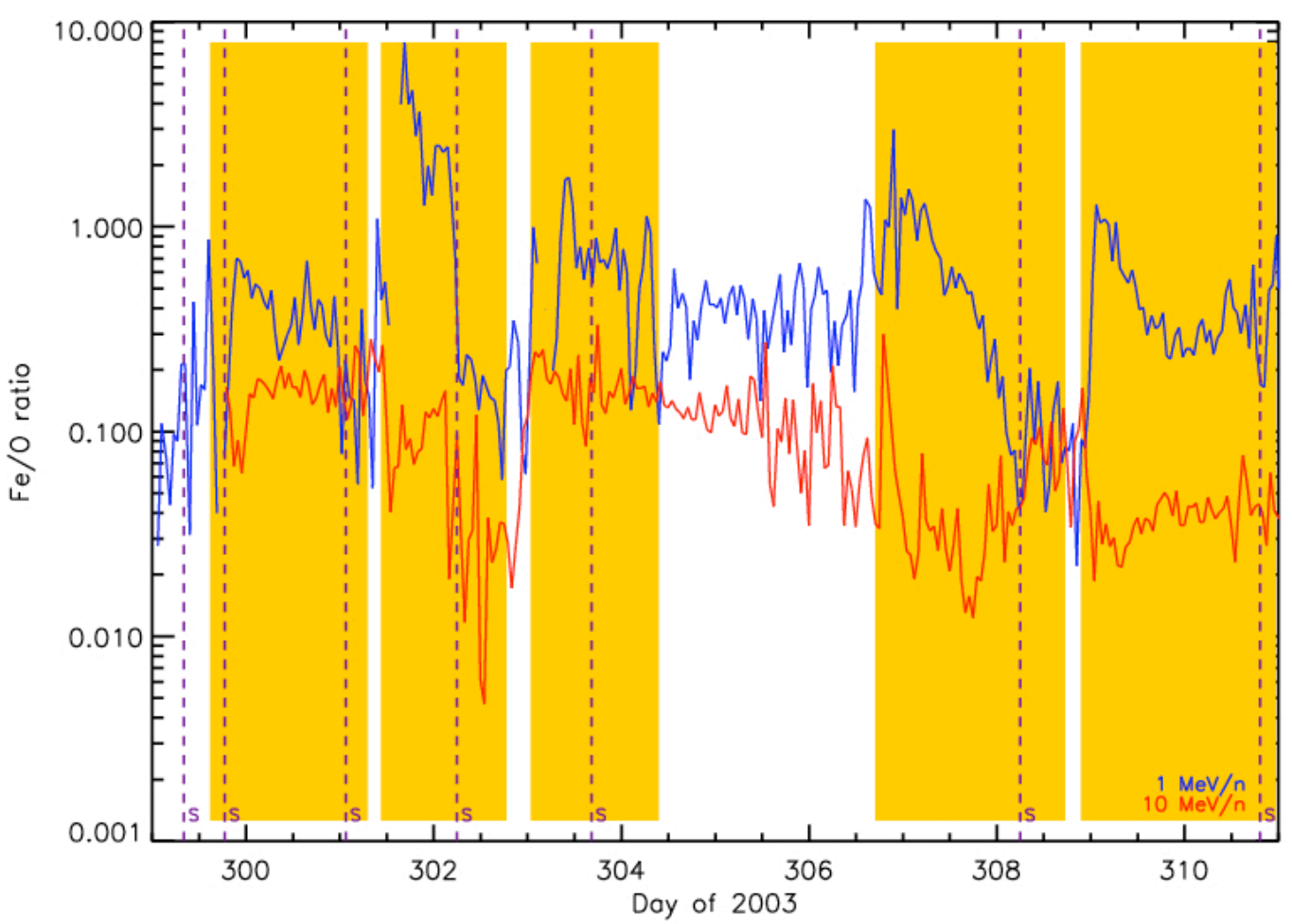


NOAA top events

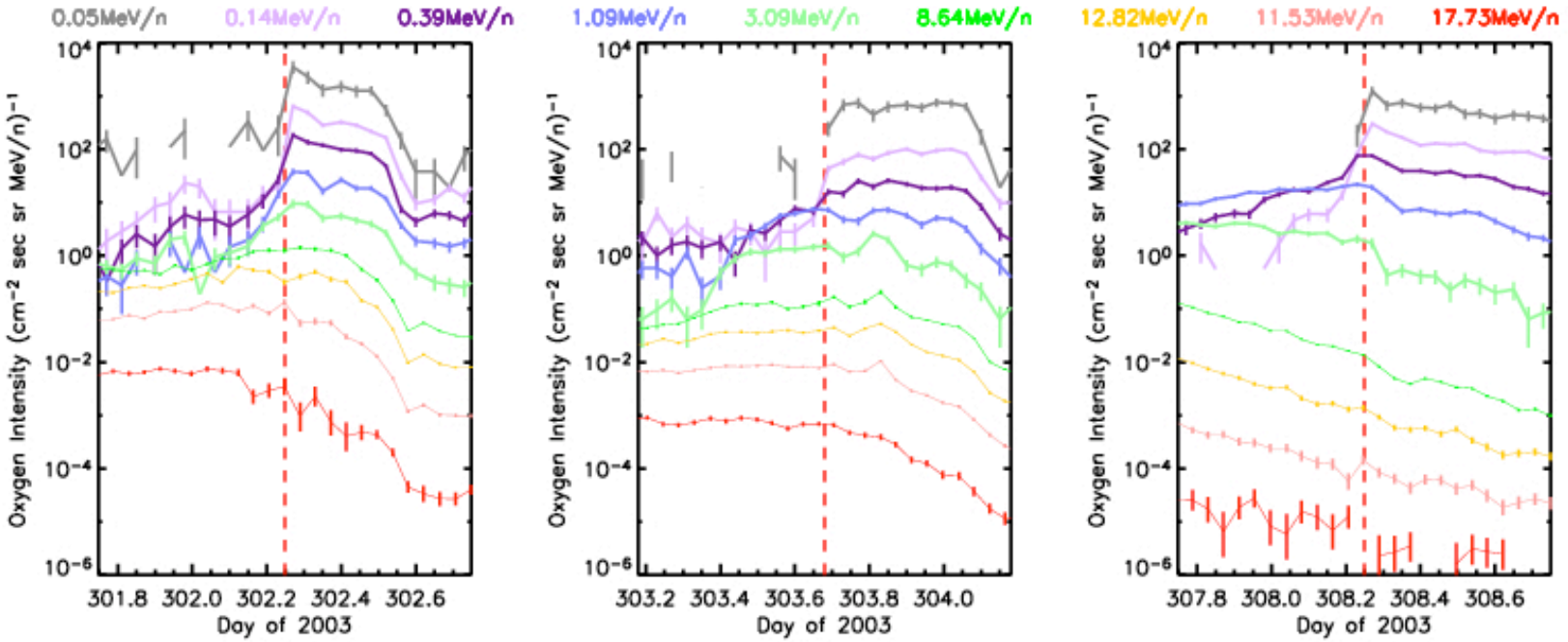


Abundance Variability

- Fe/O at 1 and 10 MeV/n are often anticorrelated
  - Fe/O increases at 1 MeV/n during some events
  - Fe/O decreases at 10 MeV/n during some events
- Fe/O is higher (lower) prior to shock at 1(10) MeV/n

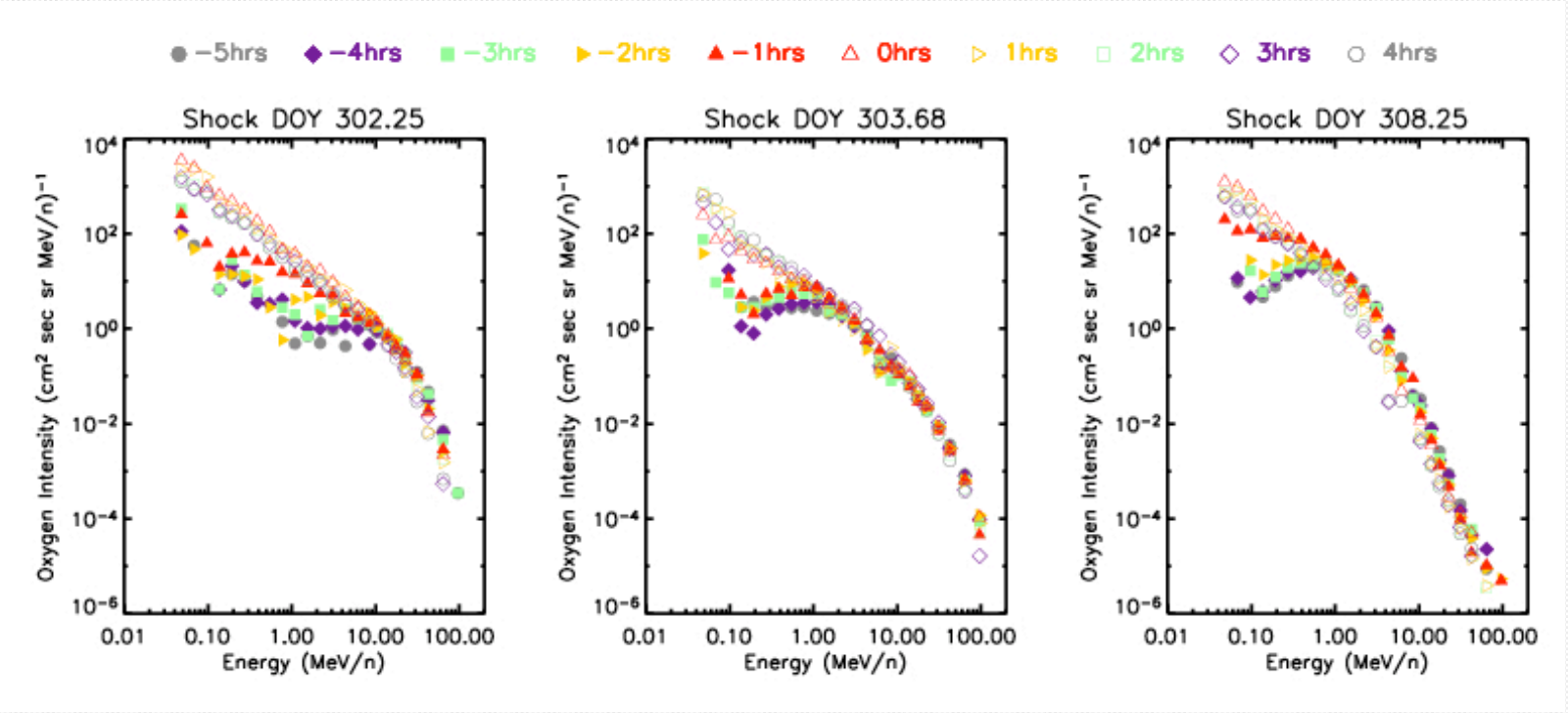


Shock Passages



- 3 shocks show increases at oxygen energies > 3 MeV/n
  - can see post-shock region (trapped ions) up to 17 MeV/n in 2 shocks
- Transit time was ~0.8, 0.8 and 1.5 days

Evolution of Spectra at Shock Passages



- Spectra in post shock region are ~ invariant
- Oxygen ions better confined to shock region in 29 Oct shock

Summary

- For 7 MeV/n O and 10 MeV/n Fe, 28 Oct 2003 event was the largest of the cycle 23
- All 5 events had breaks in spectra (only 28 Oct was ‘exponential’)
  - 2 events had Fe/O increasing with E above 10 MeV/n
- 12-60 MeV/n event-integrated abundances were typical of large events
- Fe/O at 1 and 10 MeV/n are roughly anticorrelated in time during large events
- 3 shocks locally accelerated O up to 3 MeV/n
- 29 Oct shock better confined O to shock region