ESP Spectral Evolution

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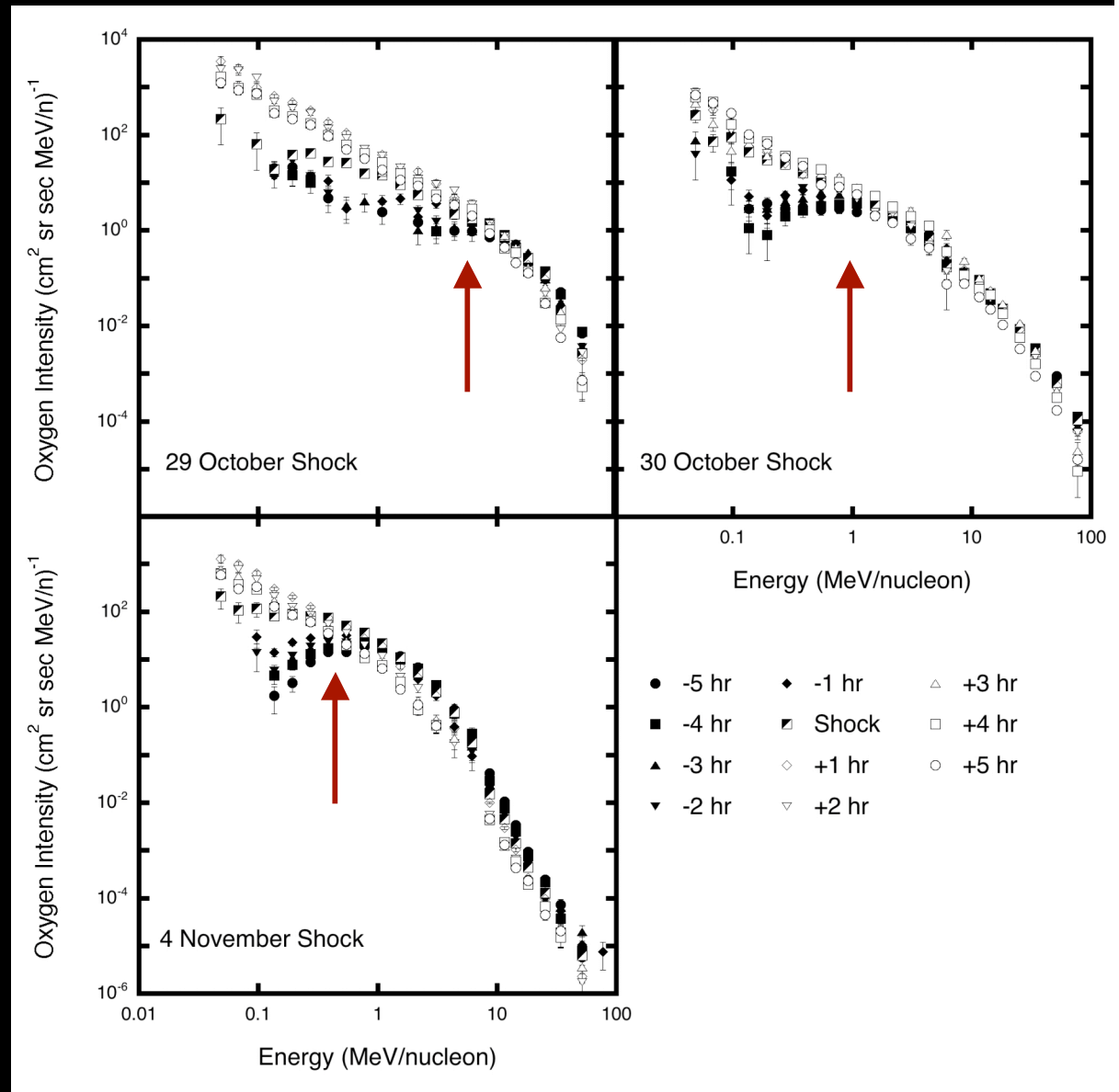G.M. Mason, J.C. Kasper,

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Study Motivation

- ✓ Saw unrolling of spectra before shock passage
- ✓ Point of unrolling varied with event
- ✓ Thought might be related to shock properties and how well confined ions were to shock region

Oct/Nov 2003

✓ Solid = preshock

✓ Open = postshock

✓ Rollover point varies in energy from <1 to > 5 MeV/n

Event Selection

- ✓ Started with 400 shocks from 1997-2006
- ✓ Examined 1 hour O intensities at 0.5, 1, and 3 MeV/n within ± 10 hours of shock
- ✓ Selected shocks with
  - ✓ Peak intensities at 0.5 MeV/n within 2 hours of shock passage
  - ✓ Peak intensity at 0.5 MeV/n > 2 times the intensity 5 hours before shock
  - ✓ All 1 MeV/n intensities correspond to >5 counts
- ✓ 14 events selected

Examples of Selection
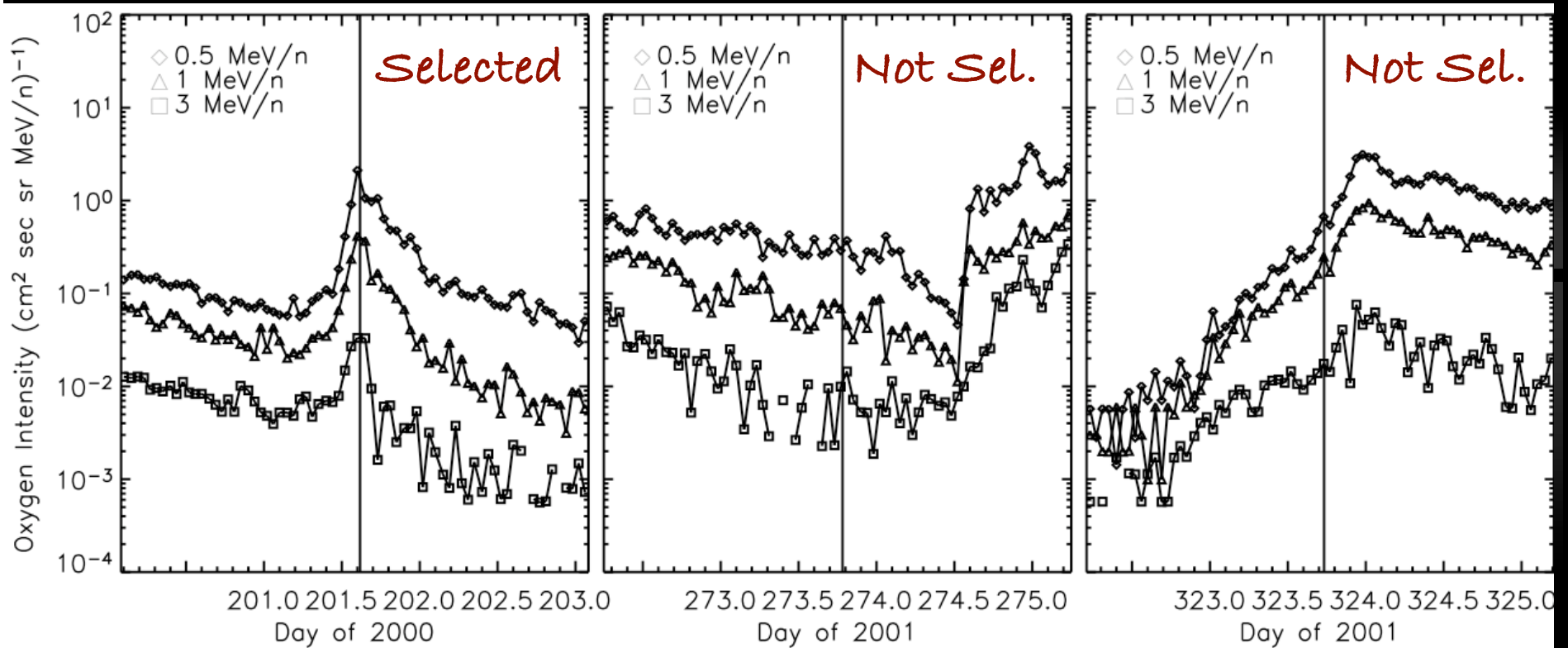
Shock Evolution Examples


Shock Time = 2000 201.62 · Shock Time = 2000 331.21
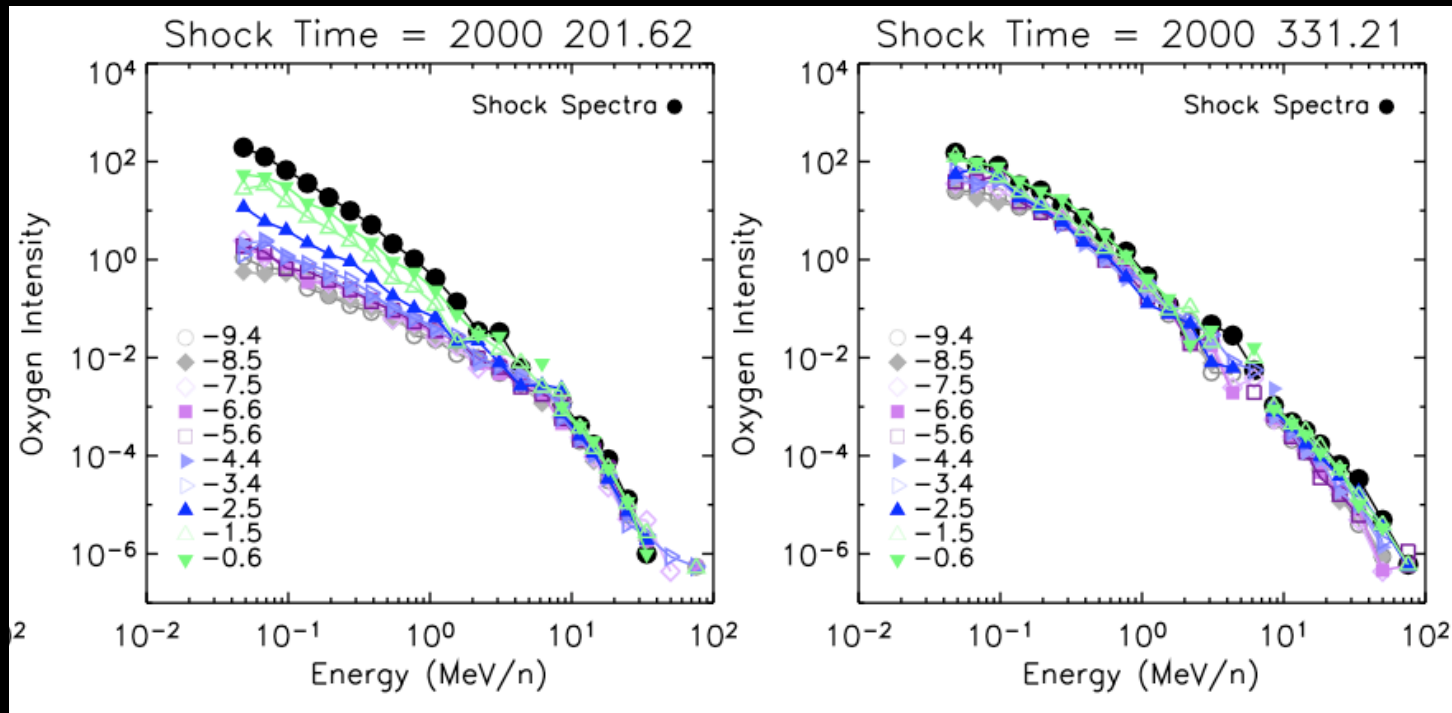
✓ Some shocks show unrolling (left)

✓ Some just show 'lifting' (right)

More Examples

- ✓ Unrolling point can differ in energy
  - ✓ Bottom example has higher value than top example
- ✓ Unrolling 'rate' can differ
  - ✓ Bottom example is more gradual than top example

Categorization

Shock Time = 2002 198.64

Shock Time = 2000 160.36

Shock Time = 2002 200.62
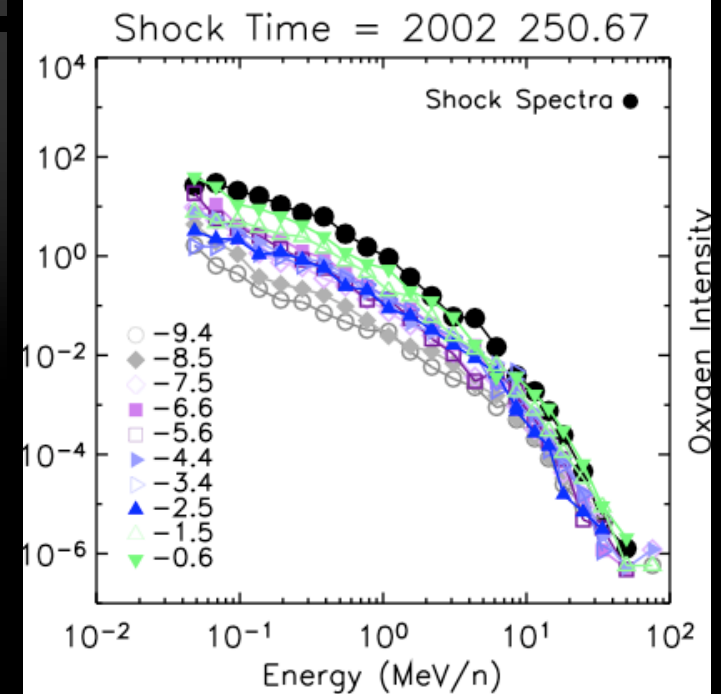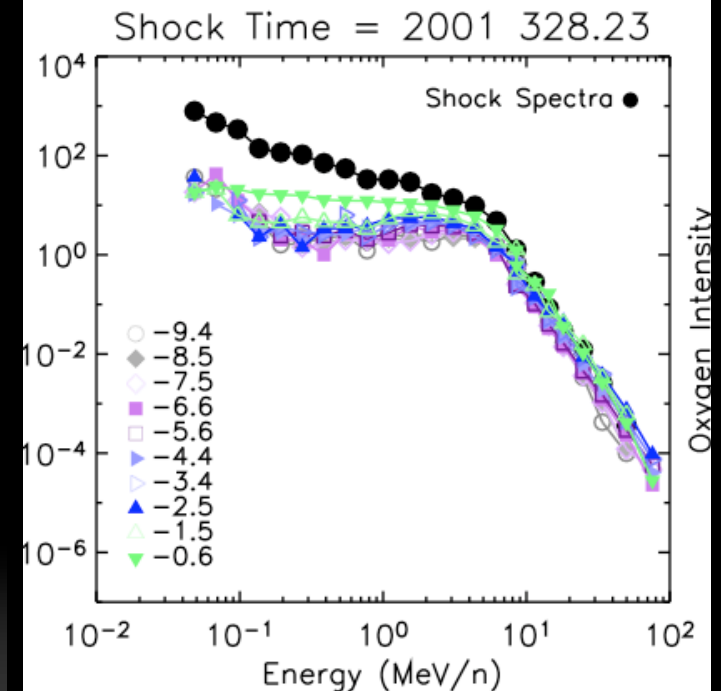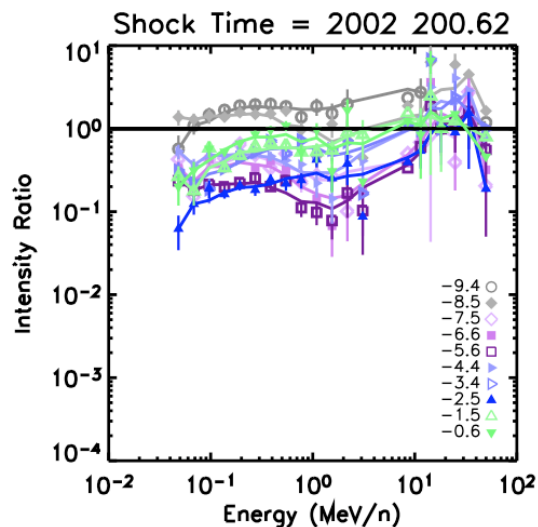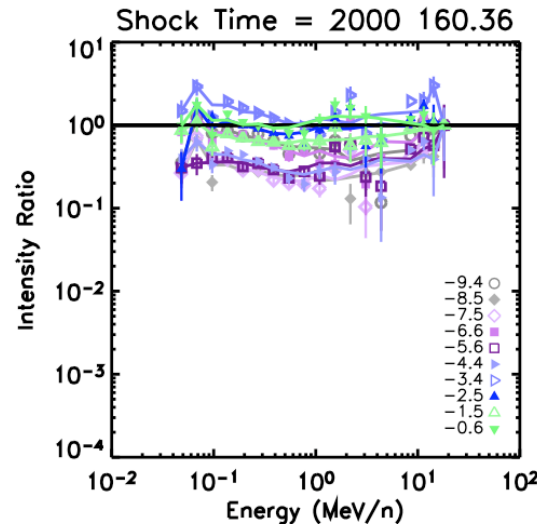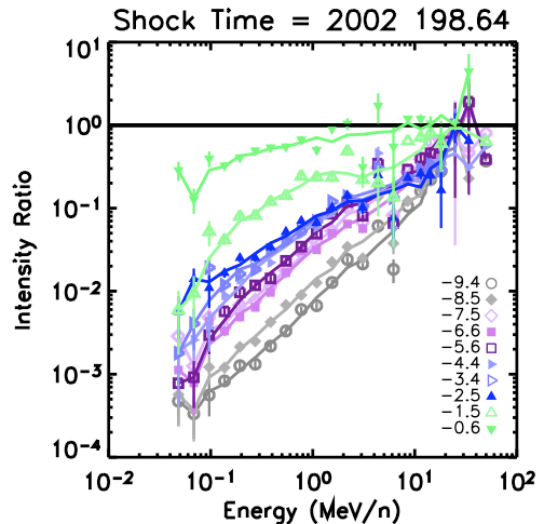
Delta = reduction factor relative to shock value

✓ Pre-shock spectra normalized to shock spectra, and again at 24 MeV/n point
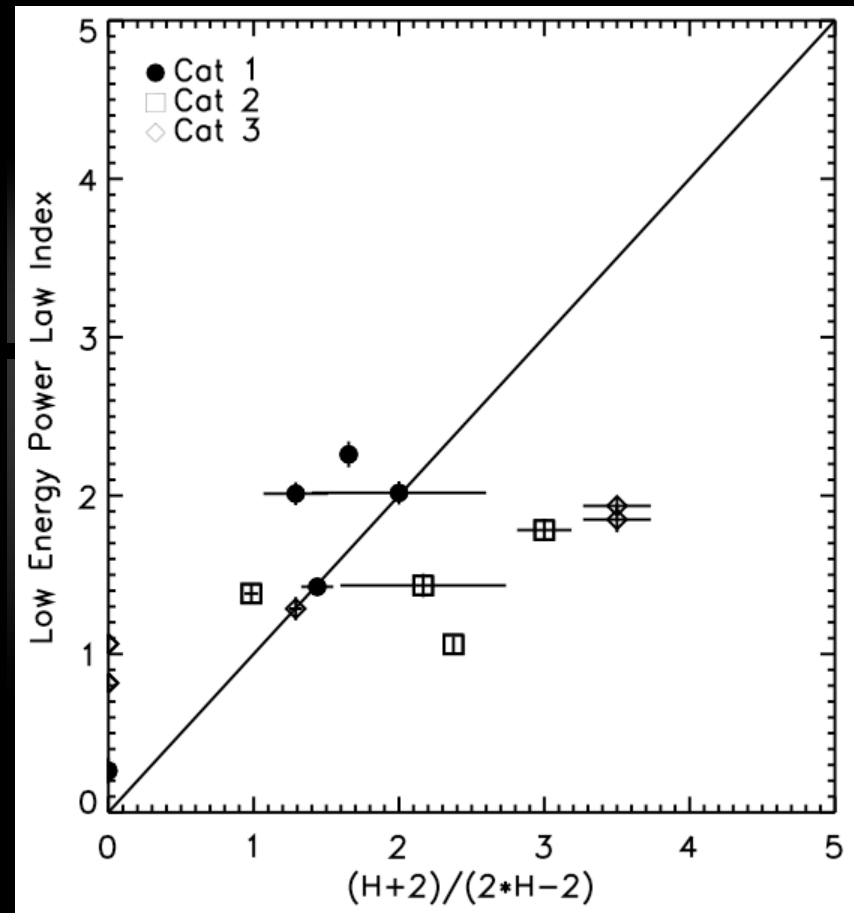
✓ Cat 1 = unrolling (5 events)

✓ Cat 2 = lifting (4 events)

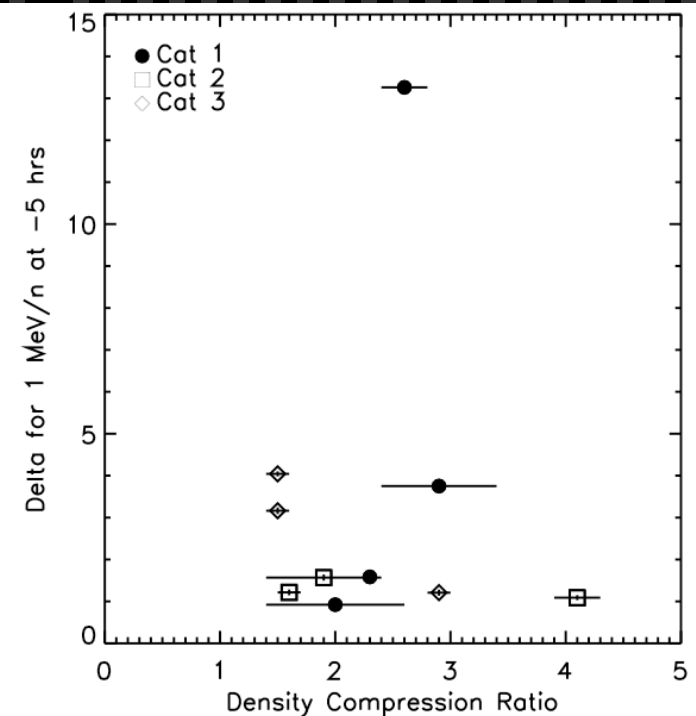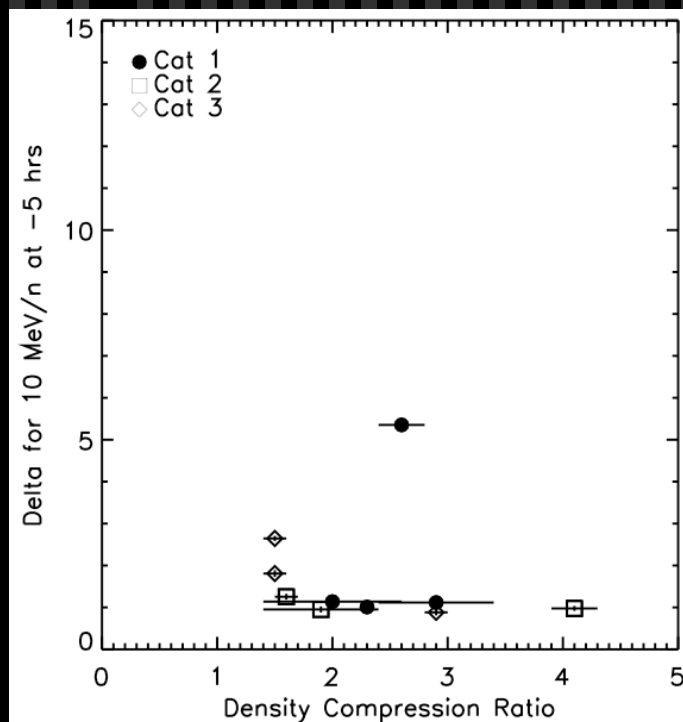✓ Cat 3 = other (5 events)

Shock Parameters

- ✓ Cat 1 events show ~ correlation expected between power law index and compression ratio (ala DSA)
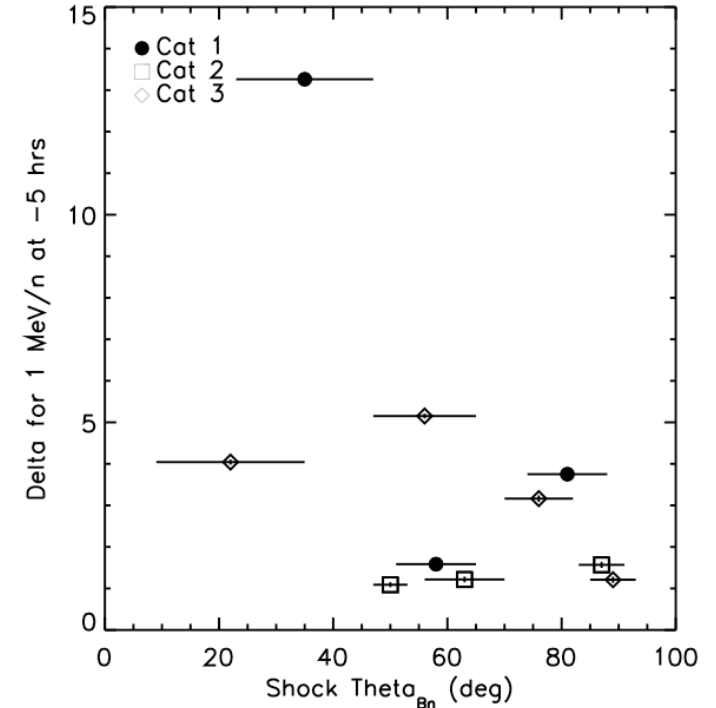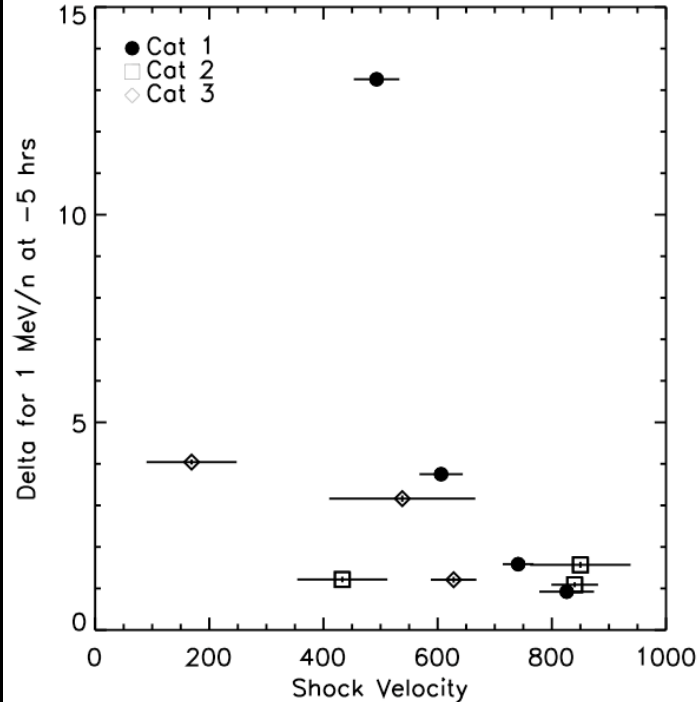
- ✓ Cat 2 events are harder than DSA predicts

Delta Values

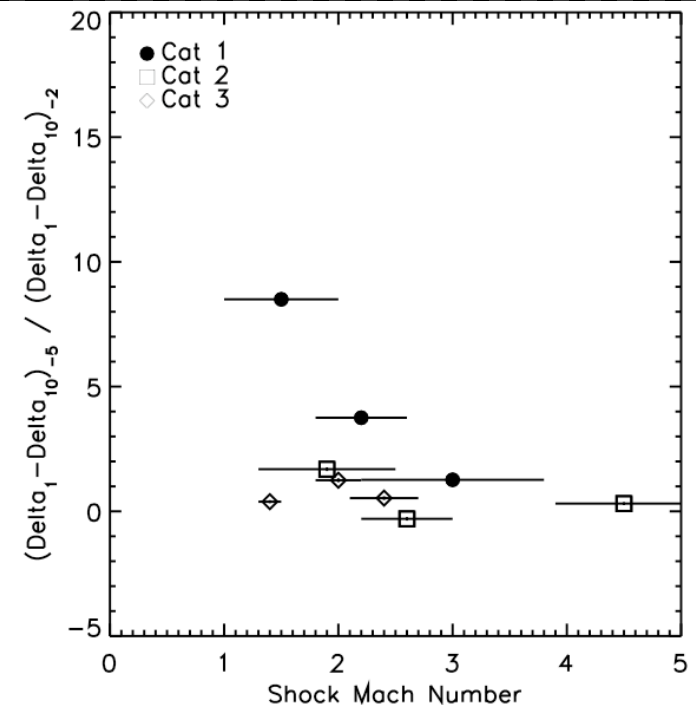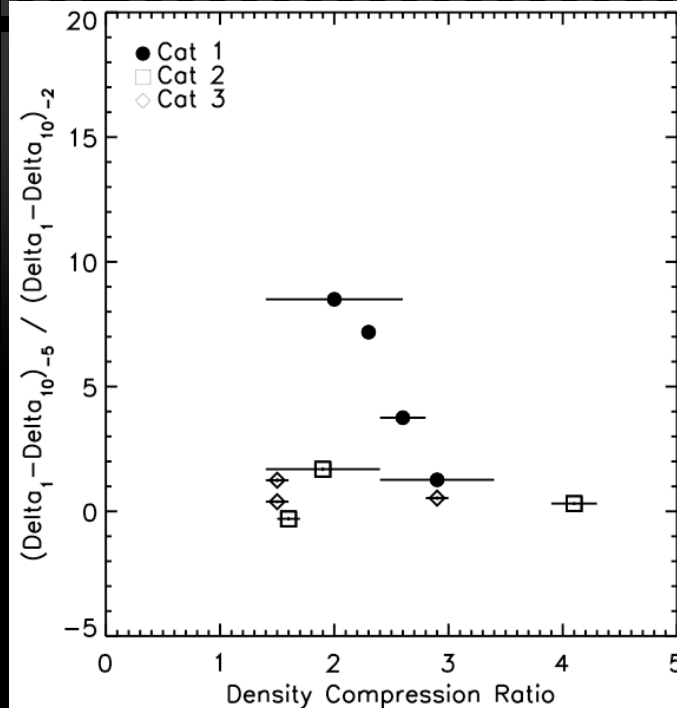✓ Not correlated with density compression ratios

Delta Values

✓ Not correlated with density compression ratios

✓ Not correlated with Theta but larger for slower shocks

Change in Delta values with energy and time (i.e. unrolling rate)

- ✓ Unrolling rate (between 5 and 2 hours pre-shock) is slower for stronger shocks
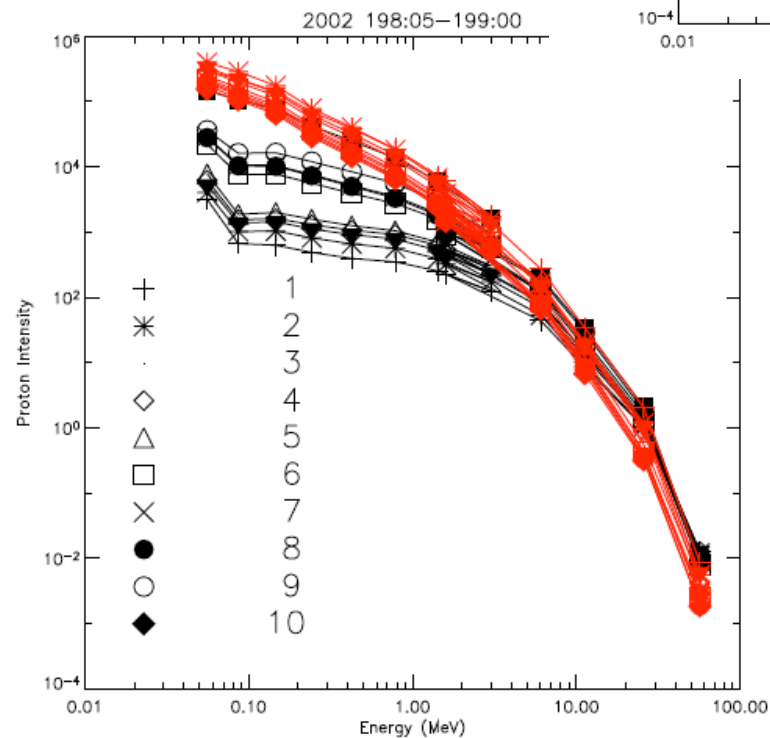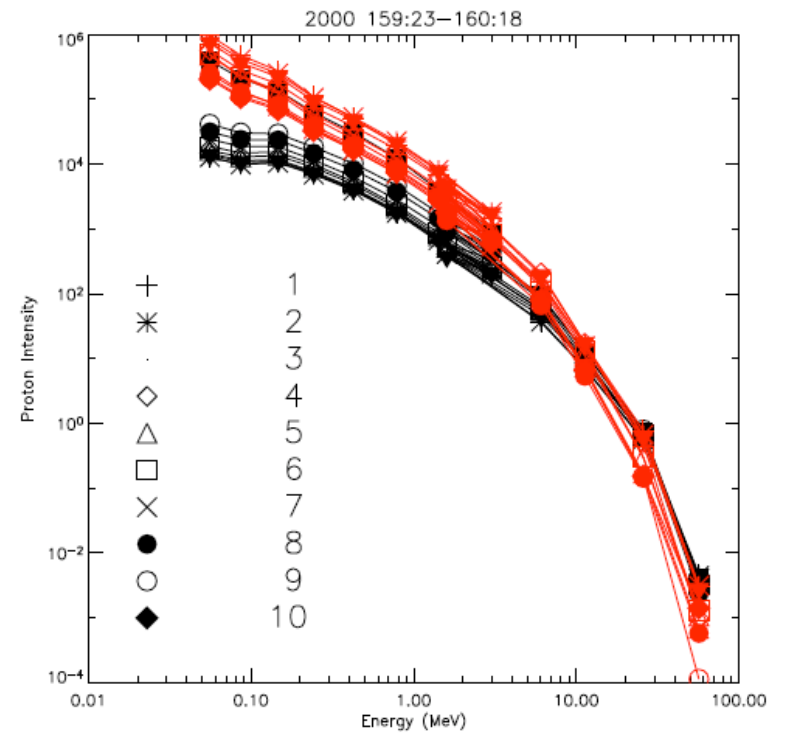
- ✓ A sign of better confinement??

Protons

- ✓ Started similar analysis with proton data
  - ✓ EPAM
  - ✓ GOES
- ✓ Complications because GOES is in
  - ✓ different position (so need to time shift data but by how much?)
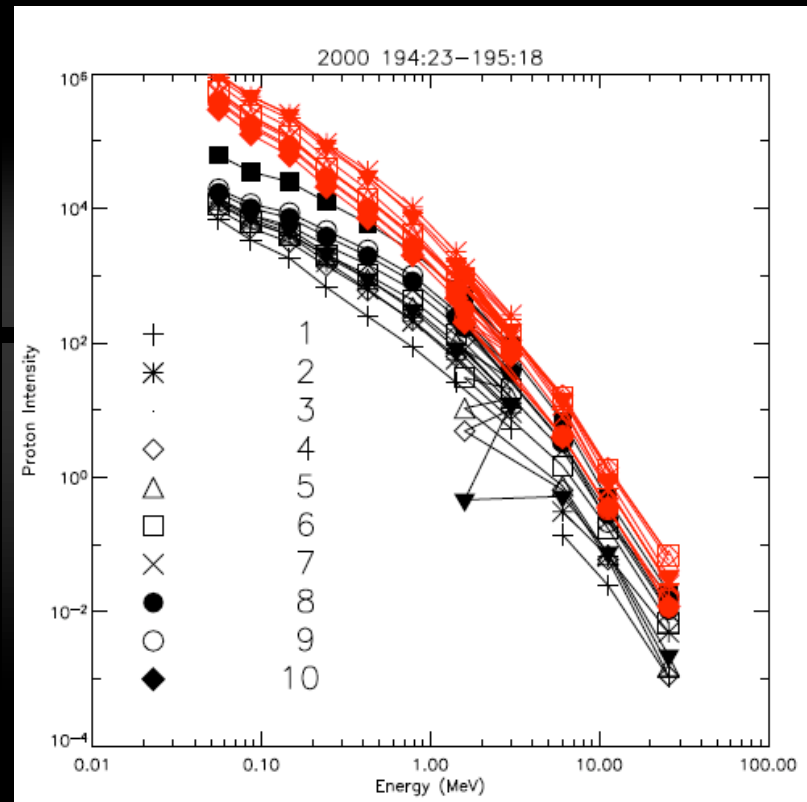 - ✓ the magnetosphere (so get additional effects)

Good, Bad, Ugly
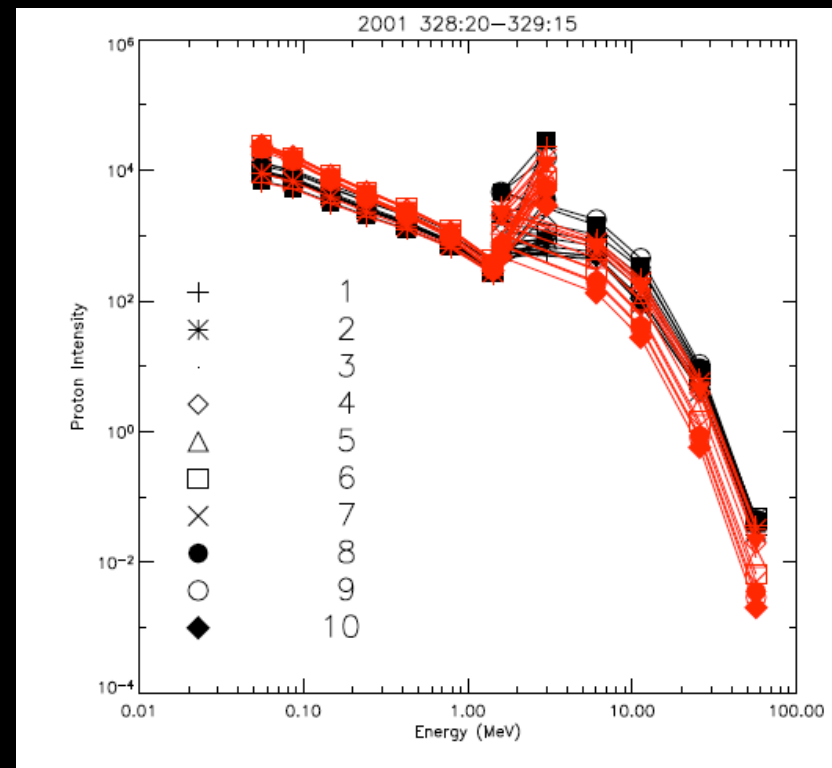
✓ Some events show nice unrolling

Good, Bad, Ugly

- ✓ Some events show nice unrolling
- ✓ Some events show lifting

Good, Bad, Ugly

- ✓ Some events show nice unrolling
- ✓ Some events show lifting
- ✓ Some events EPAM and GOES don't match

Other Complications

- ✓ Kasper shock parameters
- ✓ Local acceleration vs trapped population along for the ride
  - ✓ Richardson and anisotropies may be the answer