NSTX

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Fast ion redistribution during high performance discharges on NSTX

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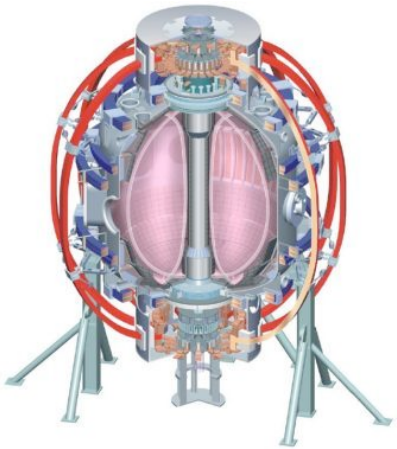
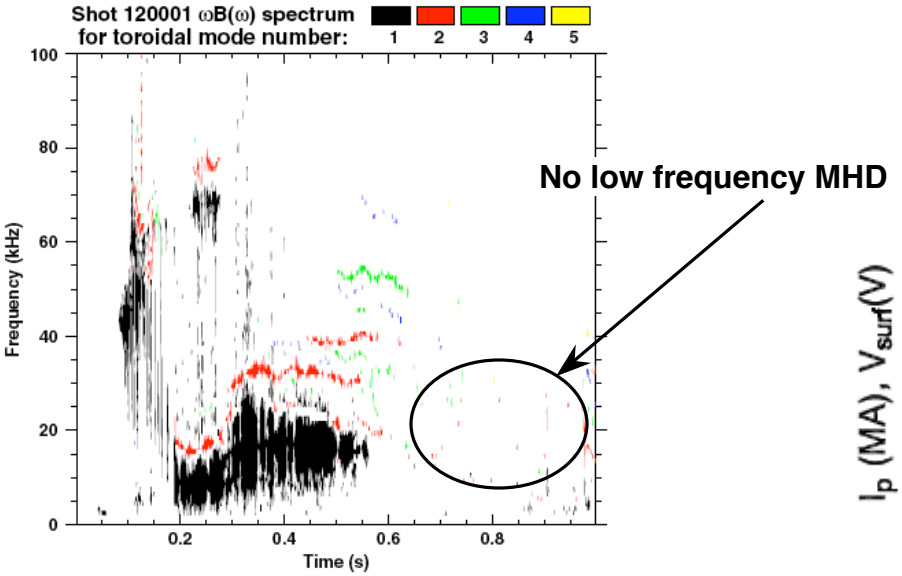
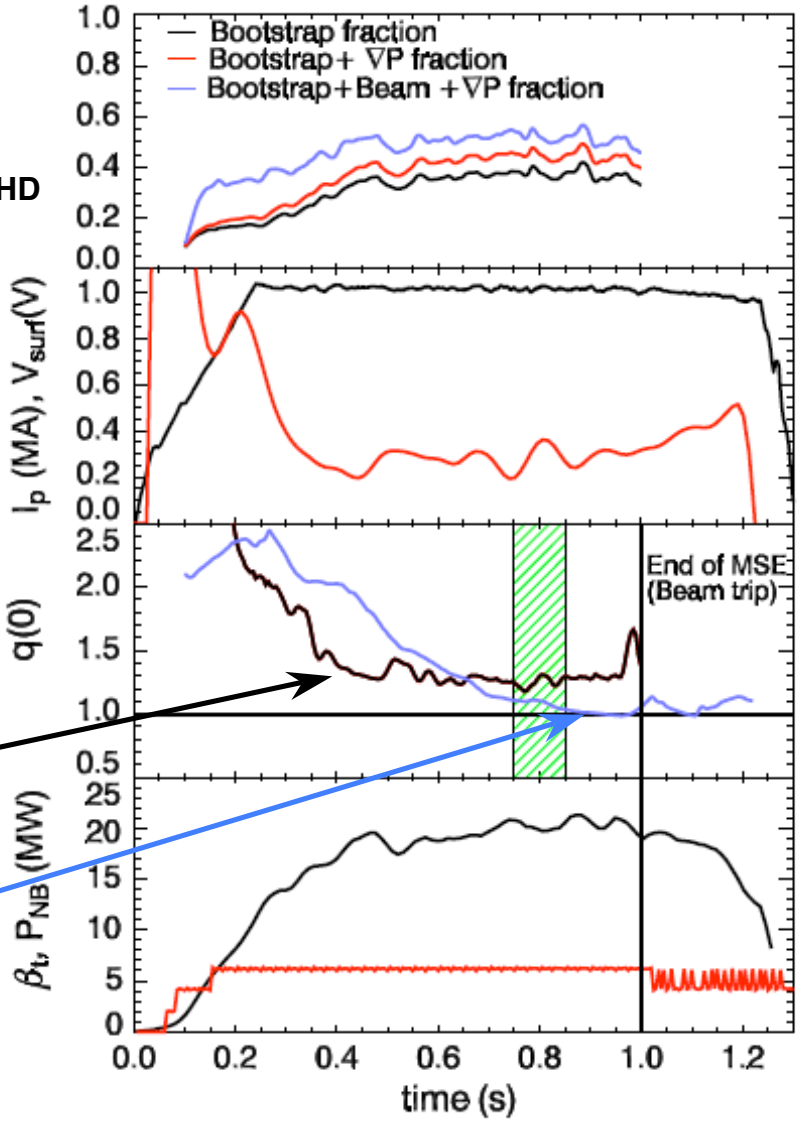
EP SFG meeting
December 2,, 2008



NSTX has also observed "hybrid" mode with no low frequency MHD modes

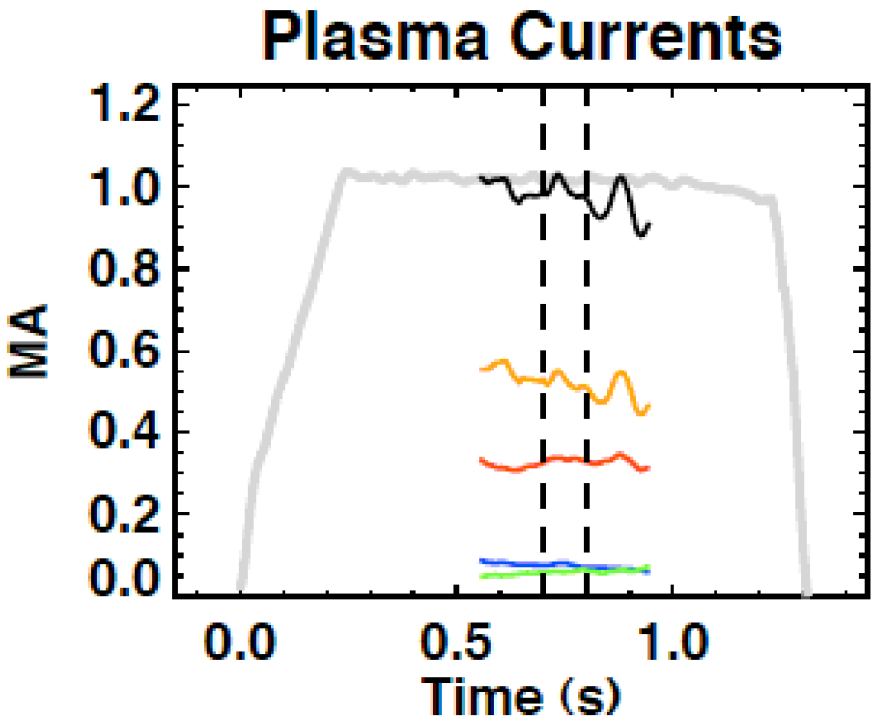


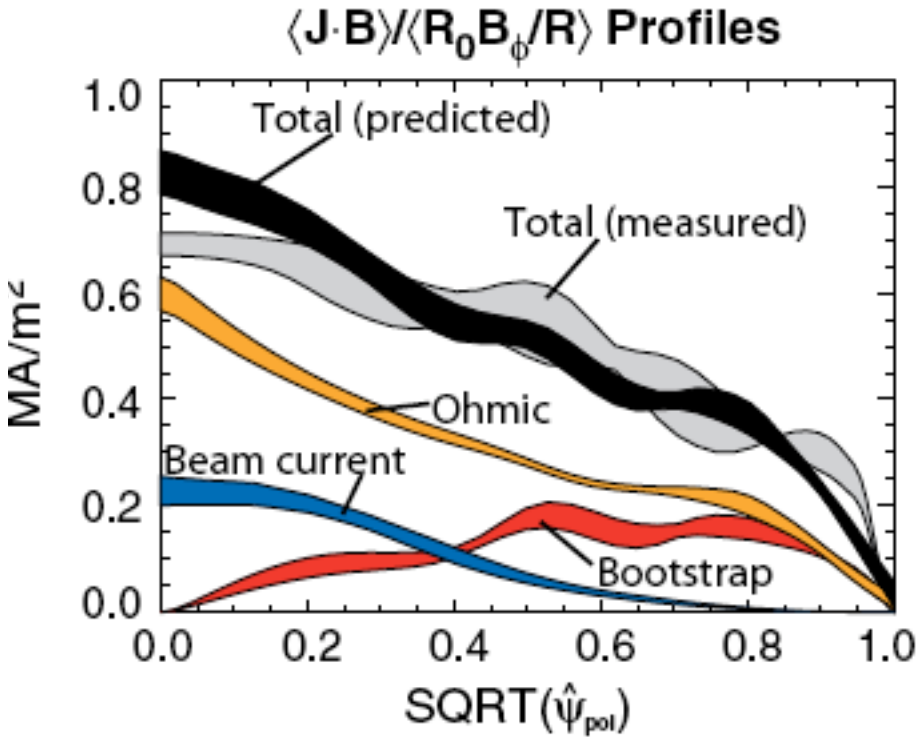


- No degradation of confinement as with n=1 mode case
- q(0) maintained above one for τ_{CR}
- TRANSP current diffusion calculation indicates q(0)~1 (Gates, Nucl. Fusion 2007)
- High frequency (~ ω_{ci}/2) Alfven waves are observed

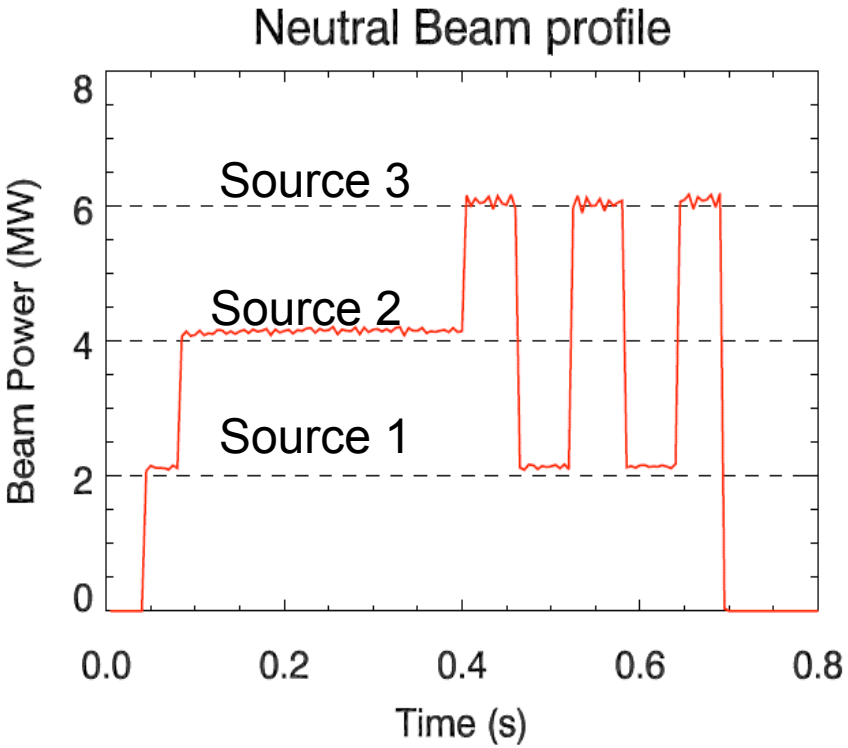
Current profile analysis indicates current redistribution

- Discrepancy between observed and predicted current profiles is similar in shape to MHD driven case, lower amplitude
- Independent calculation of predicted steady state current profile confirms TRANSP diffusion calculation

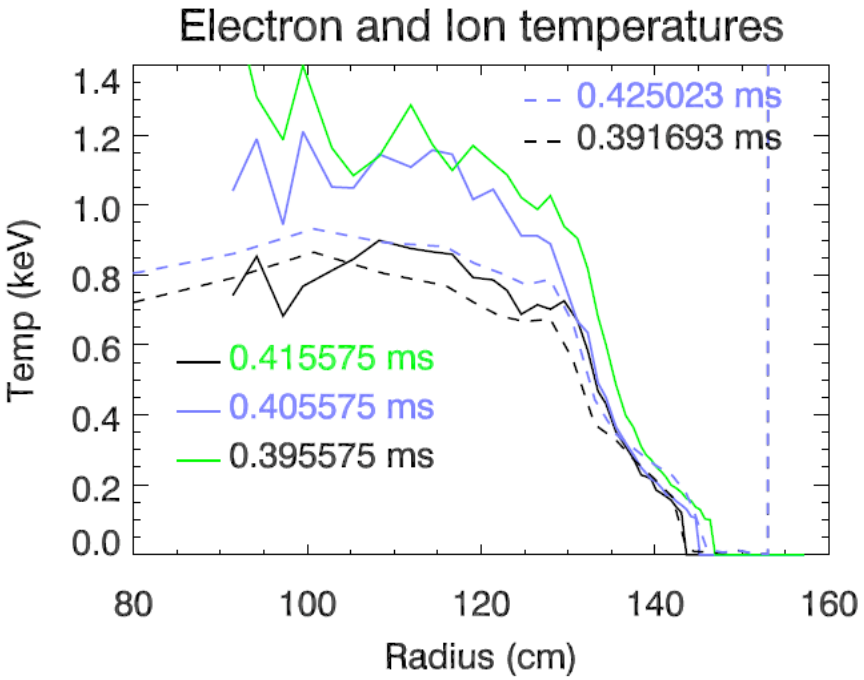




Beam modulation experiments optimize fast ion diagnostic capabilities



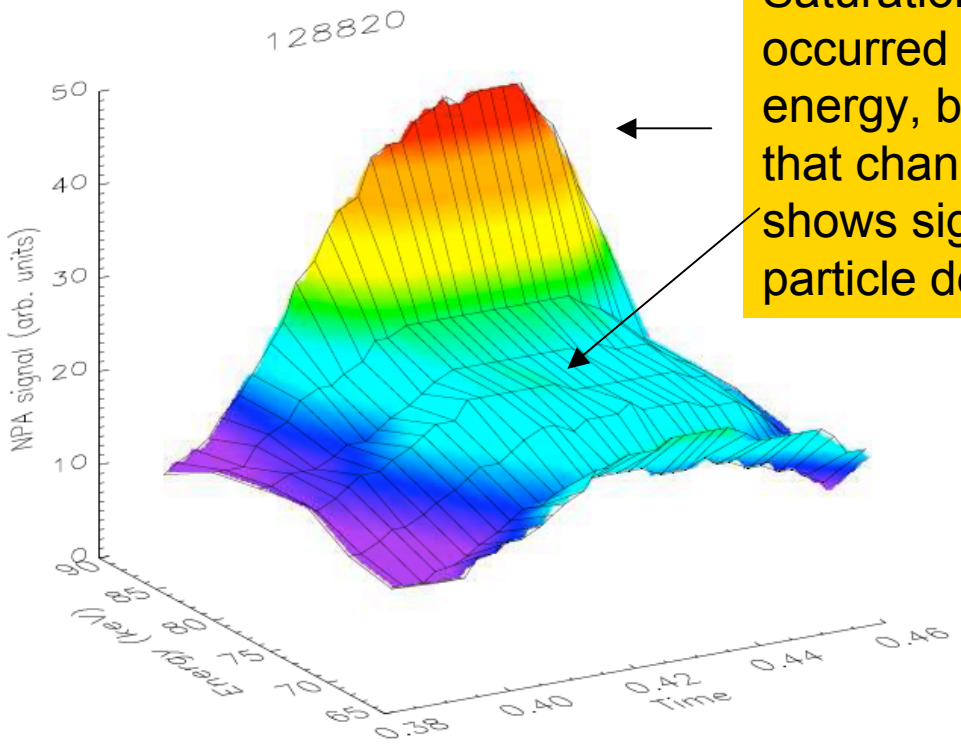
The Neutral Beam profile. The Third beam turns on at 400 ms. This coincides with a low frequency MHD free period.



Electron (dashed) and ion (solid) temperatures. The ion temperature rises quickly after the beam turn on at 400 ms. The electron temperature rises only slightly.

NPA does not see expected slowing down distribution

Even when the modulations last significantly longer than the slowing-down time, slowing-down distribution is not seen in the NPA spectrum.

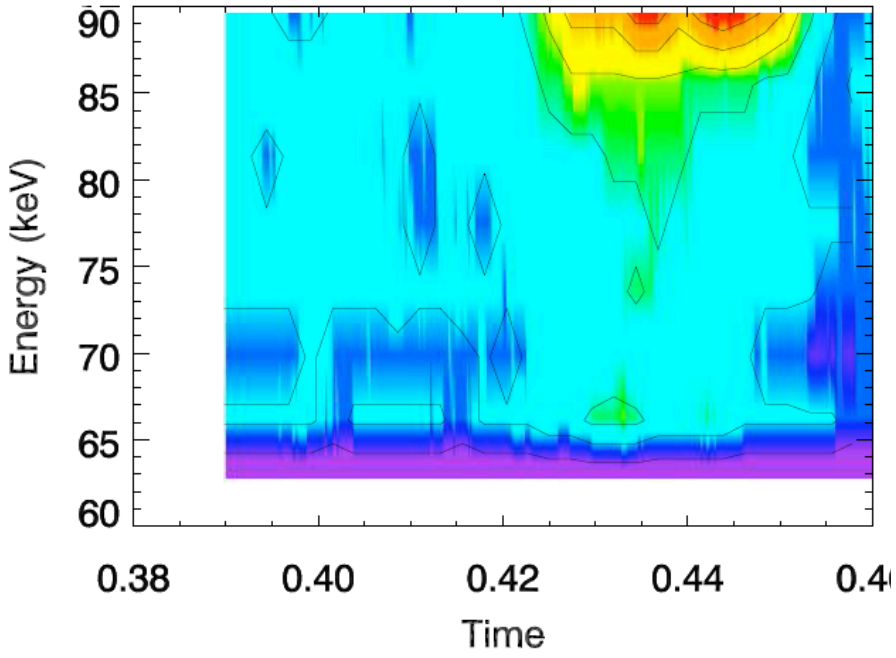


Saturation has occurred at full energy, but ONLY that channel shows significant particle density.

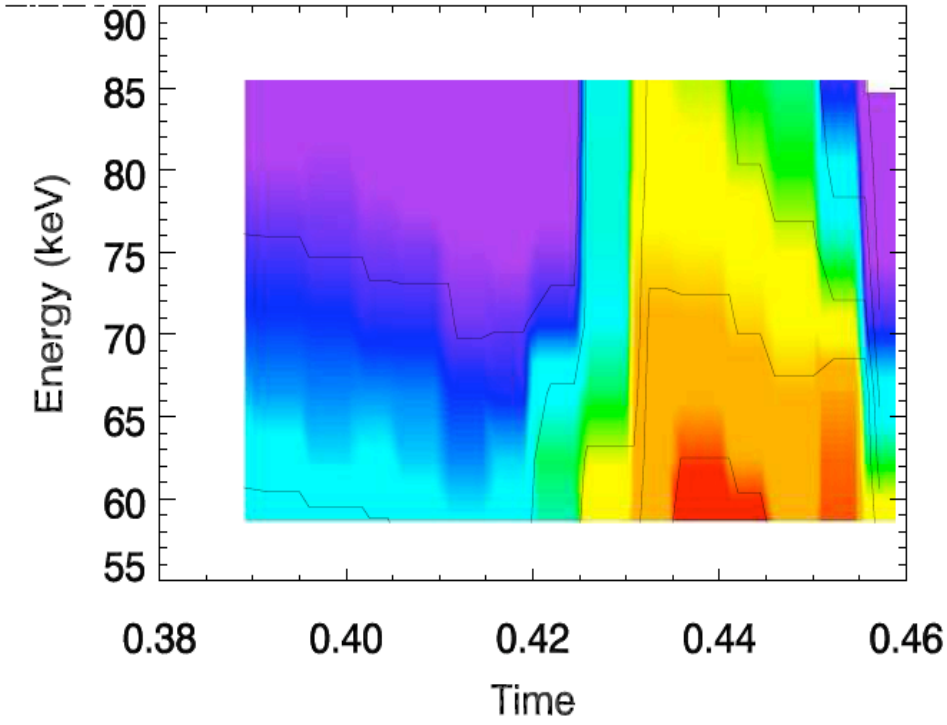
Where did the fast ions go?

TRANSP Simulation varies substantially from observation

NPA Spectrum of shot 128600

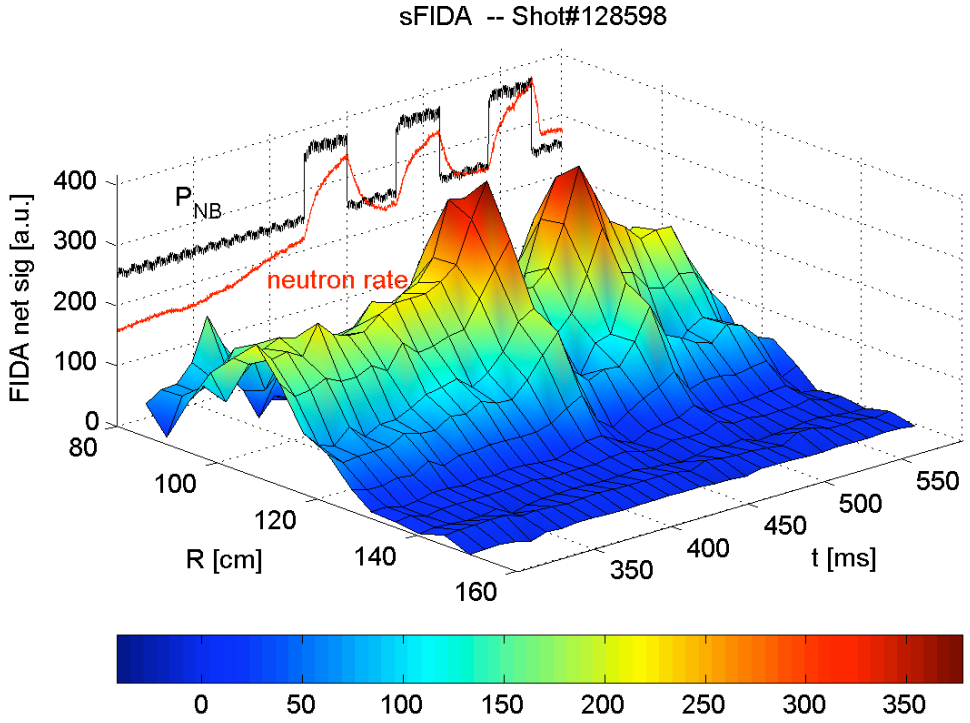


TRANSP Simulation of NPA Spectrum



TRANSP simulations show the expected slowing down spectrum. The beam turn-on is clearly visible, and the lower energies fill up with 30 ms of the beam turn on. This fits well with classical slowing-down theory.

FIDA data shows no spatial redistribution



(Profile for longer modulations look similar)

FIDA profile data shows a peaked density function in the core of the plasma. Since the FIDA averages over a wider pitch angle window (unlike the NPA), a redistribution would be visible on FIDA only if the particles still have an appropriate pitch angle.

Proposed experiment

- Use beam modulated target developed for ion heating experiment
- Do NPA scan searching for fast particles
  - Lack of neutron deficit + lack of FIDA redistribution indicates high probability of core pitch angle scattering into confined orbits (consistent with physics of CAE modes which damp perpendicular energy of the fast particles)
- Focus scan on high pitch angles
  - Issue: NPA simultaneously scans pitch angle and location
  - Motivates multiple NPAs at multiple locations