XP-831 Investigation of Transport with Beam Modulation

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Results Review
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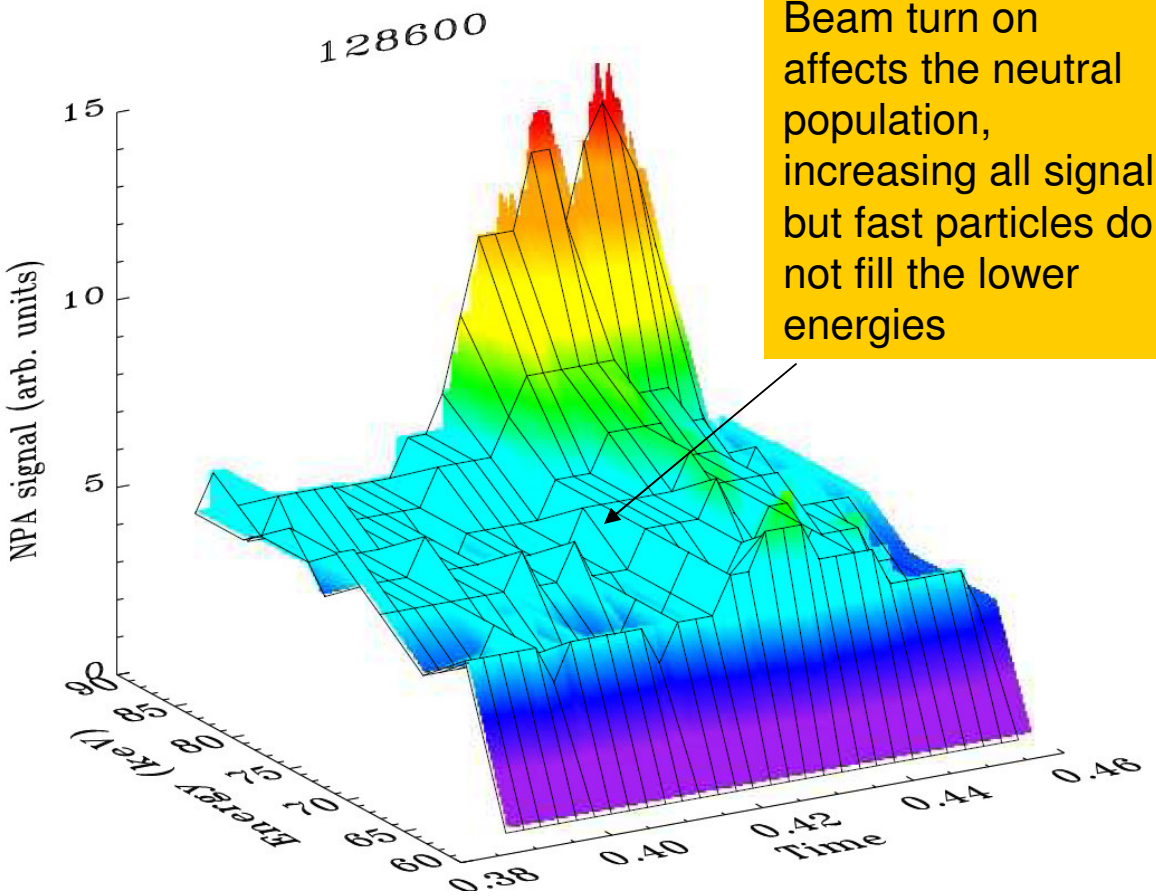
Purpose of XP 831

The purposes of XP 831 were

- Modulate the beams on the beam slowing-down time scale (~30 ms) to observe changes in the fast ion distribution function
- Modulate the beams on the confinement time scale (60 ms) to observe changes in the thermal ion population

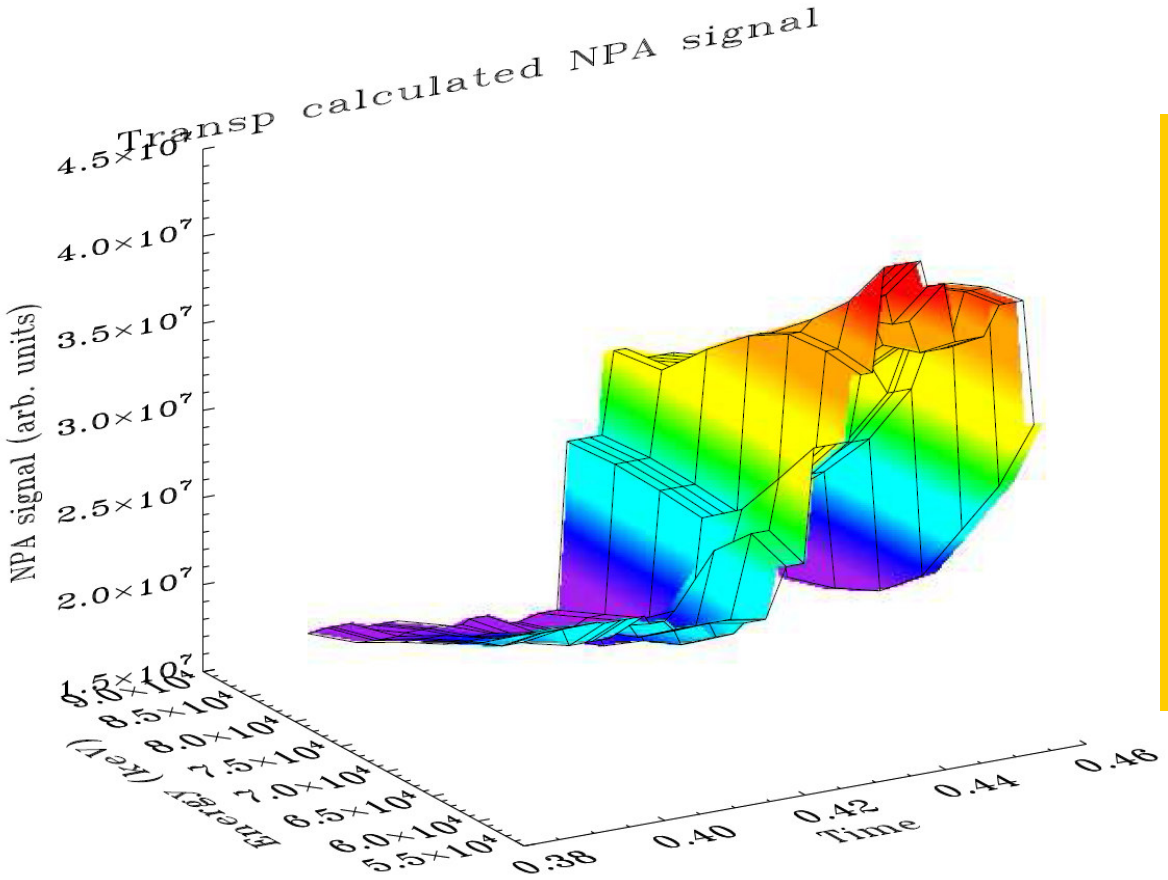
Measured NPA signal Does Not Show Slowing Down Spectrum

The beam turn-on and turn-off are visible at the full energy, but the data does not show the classical slowing-down spectrum that is expected. This was true at a variety of tangency radii.



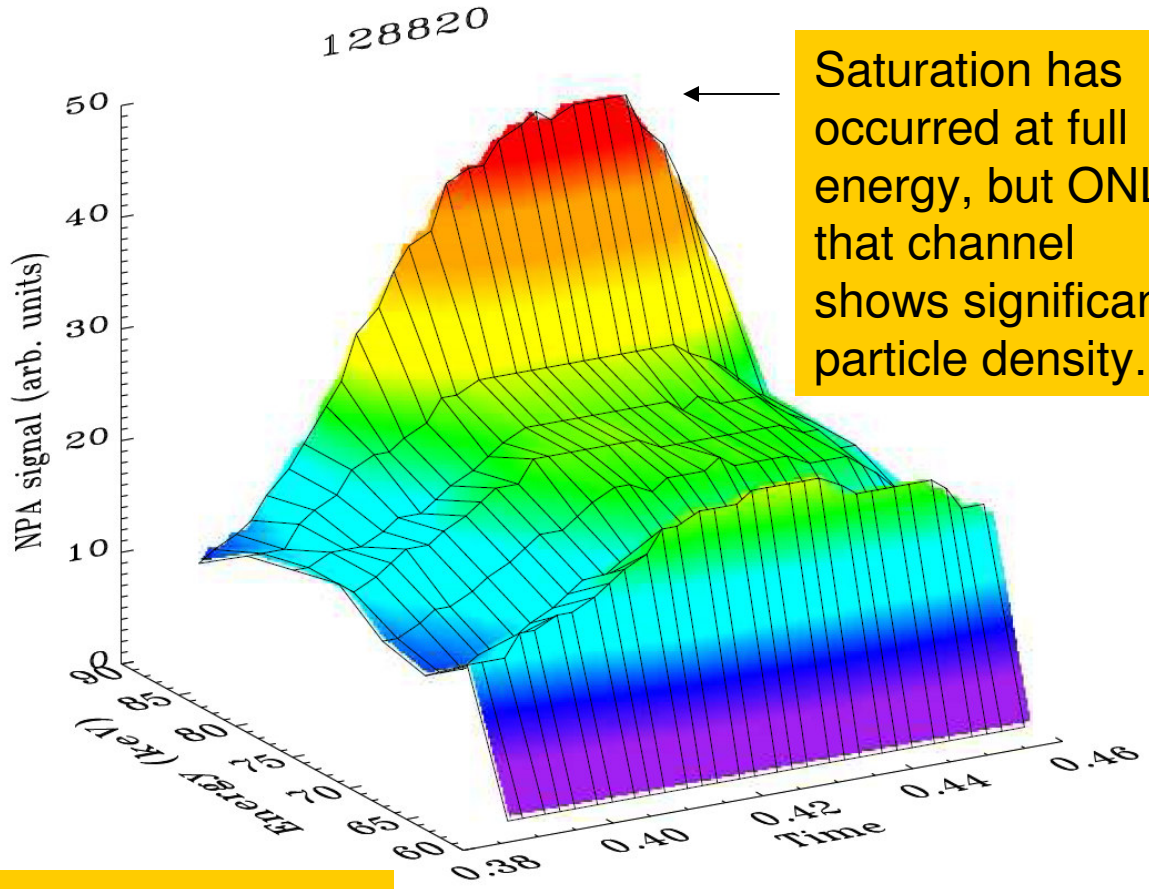
Beam turn on affects the neutral population, increasing all signal, but fast particles do not fill the lower energies

TRANSP Simulation Shows Expected Slowing Down 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.

Even Long Modulations Showed No Slowing Down Spectrum

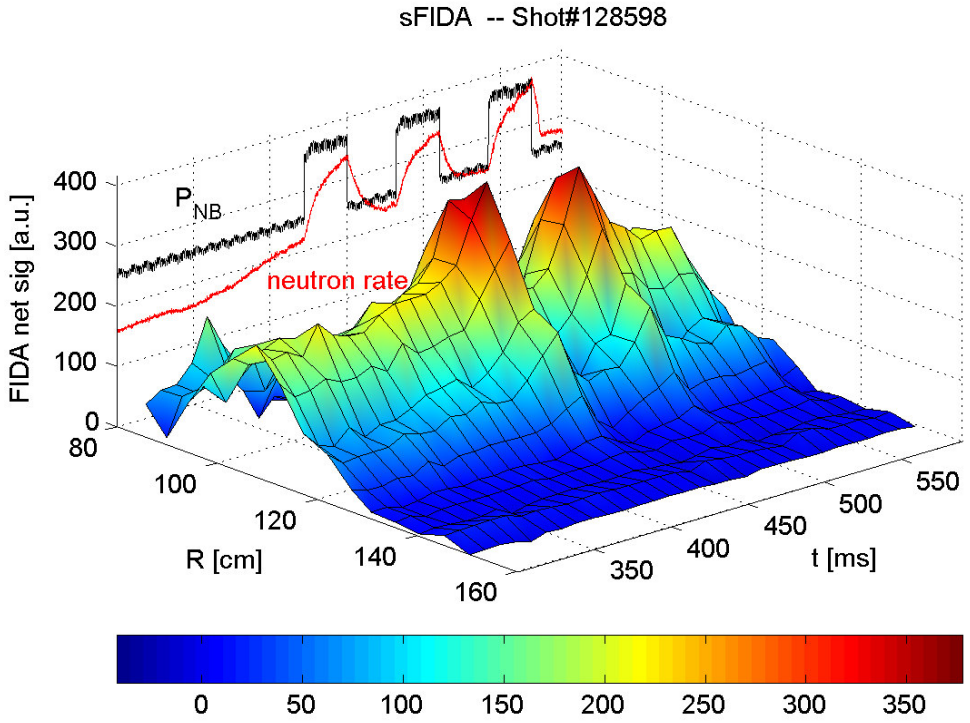


Saturation has occurred at full energy, but ONLY that channel shows significant particle density.

Even when the modulation lasted significantly longer than the slowing-down time, no evidence of slowing-down is seen in the NPA spectrum.

Where did the fast ions go?

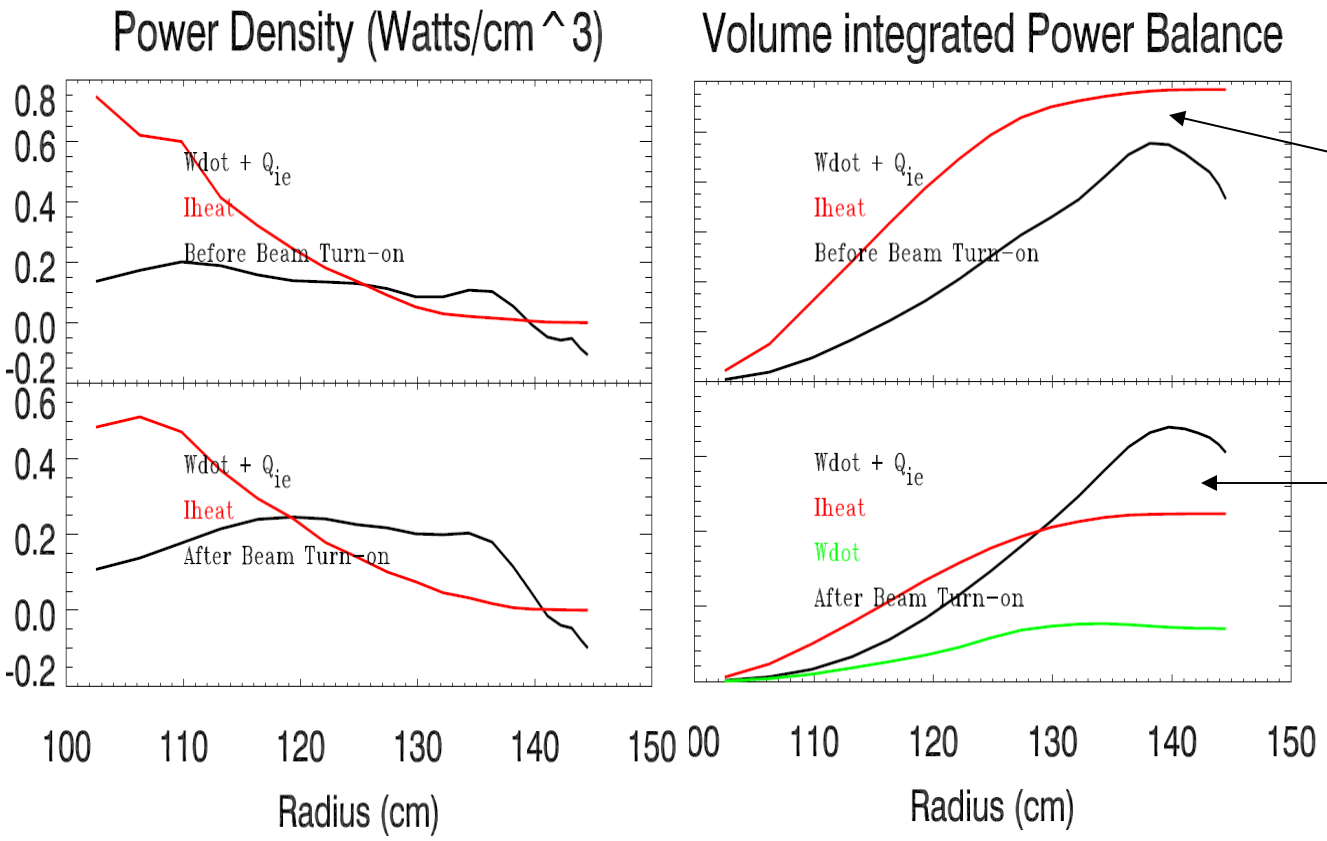
FIDA Data Does Not Indicate Redistribution



FIDA profile data shows fast ions only in the core of the plasma. Since the FIDA does not depend on pitch (unlike the NPA), a redistribution would be visible on FIDA.

(Profile for longer modulations look similar)

Power Balance Shows Additional Ion Heating

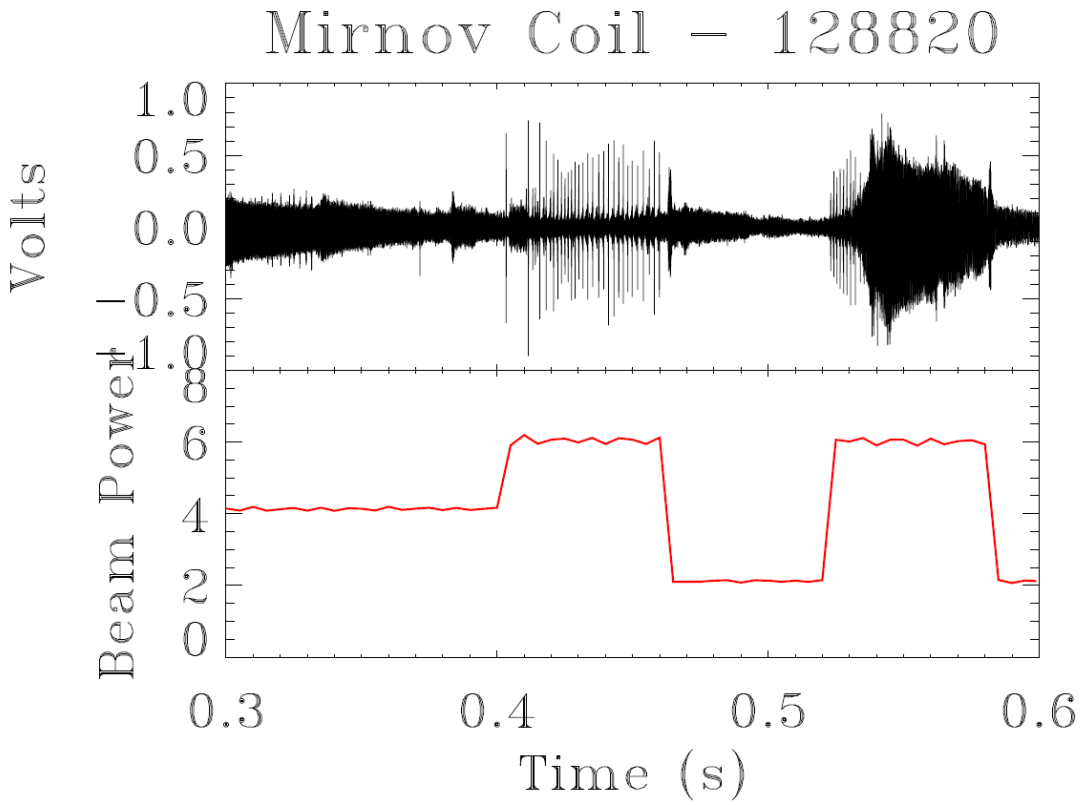


Before the 3rd source turns on, heating follows the expected pattern

After the 3rd source turns on, additional heating is required to satisfy the power balance.

Ion Heating from 3rd Source Is Greater Than Predicted

Mrinov Coils show correlation between MHD and Beam Turn-On

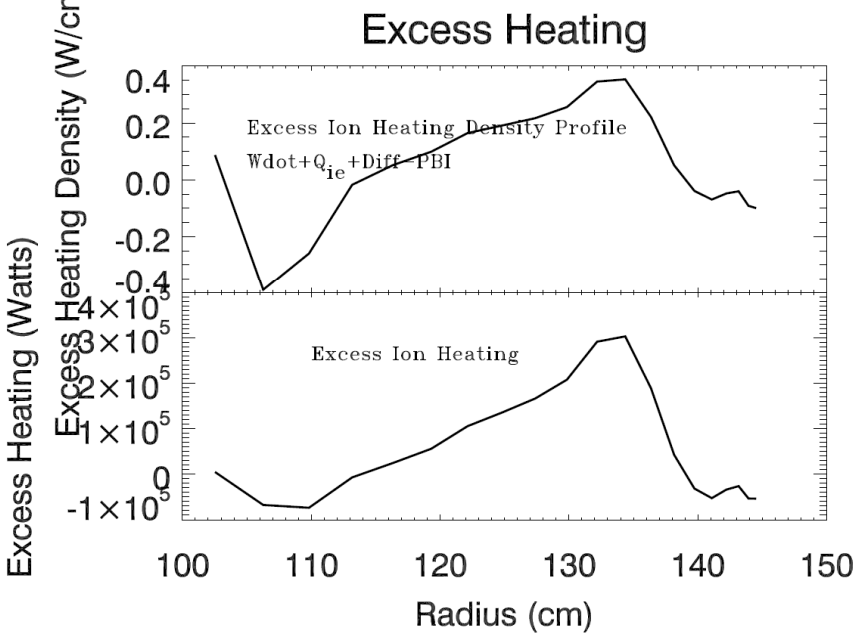


The bursting MHD activity that occurs at the same time as the beam turn-on may be correlated with the extra ion heating. More work is needed to confirm any correlation.

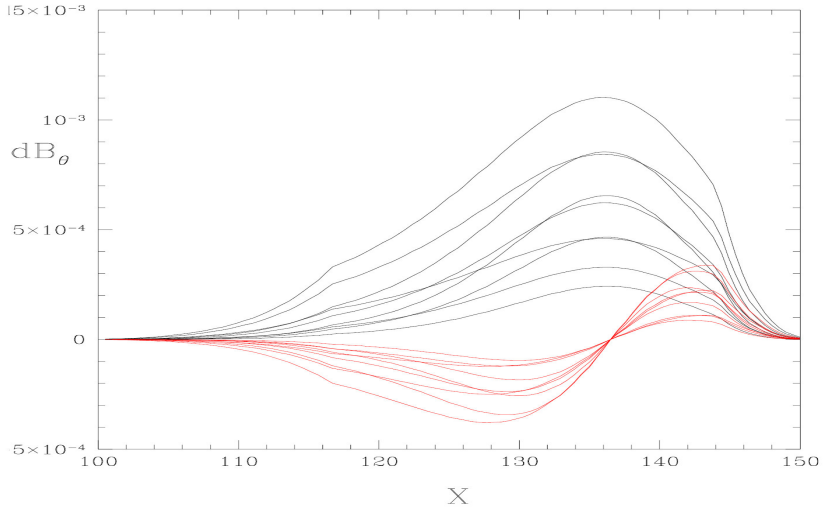
Conclusions/Future Work

- Although the full energy beam ions are clearly visible in the NPA, ions less than the full energy are conspicuously absent.
  - They do not appear to be redistributed.
- Additional thermal ion heating is required to satisfy the power balance.
- MHD activity appears correlated with the 3rd neutral beam source.
- Future Work: Continue to analyze shots and look for strong correlations with MHD/Fast Ions/Thermal Ions

Excess Heating Peaks Near where Alfvén Modes Peak



Excess heating as calculated by Transp. (Top is heating density, bottom is total heating)



High frequency Alfvén modes (black: radial mode=0; red: radial mode=1)

The required excess heating peaks around 134 cm, which is near the peak amplitude of the high frequency Alfvén modes. It is not yet clear if the modes might be responsible for the excess heating.