Investigation of Ion Transport with Beam Modulation

XP Proposal

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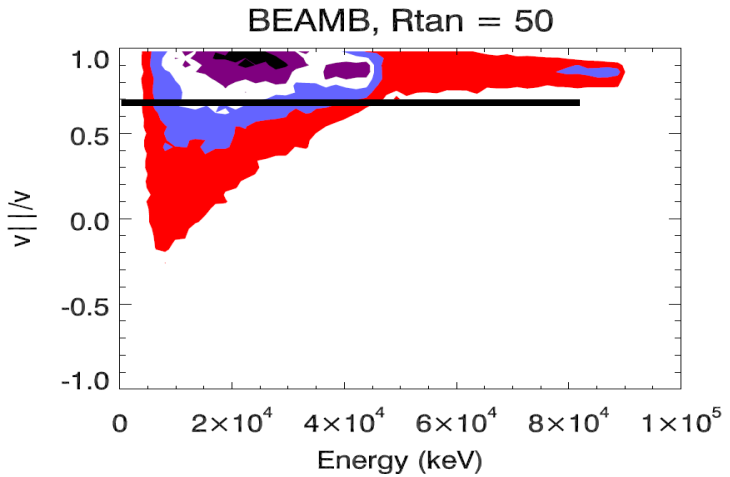
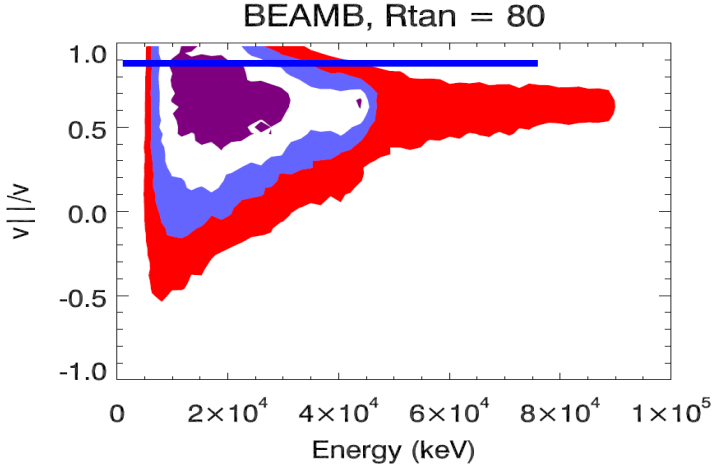
OP-XP-831

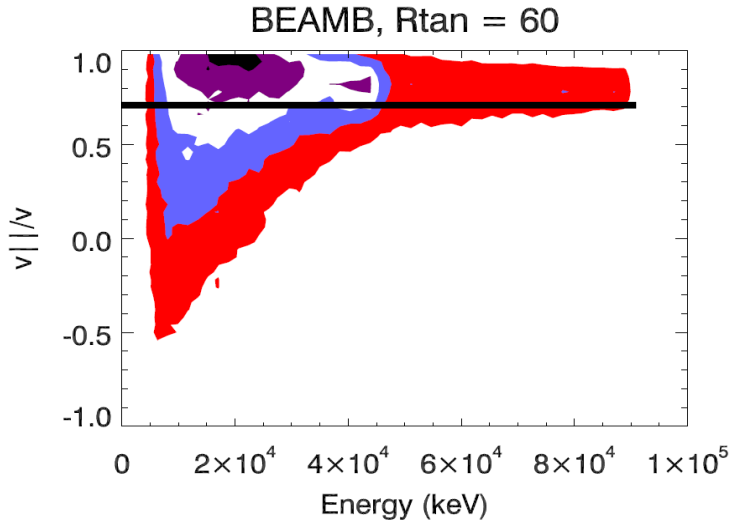
Last Year's Motivation – XP 737

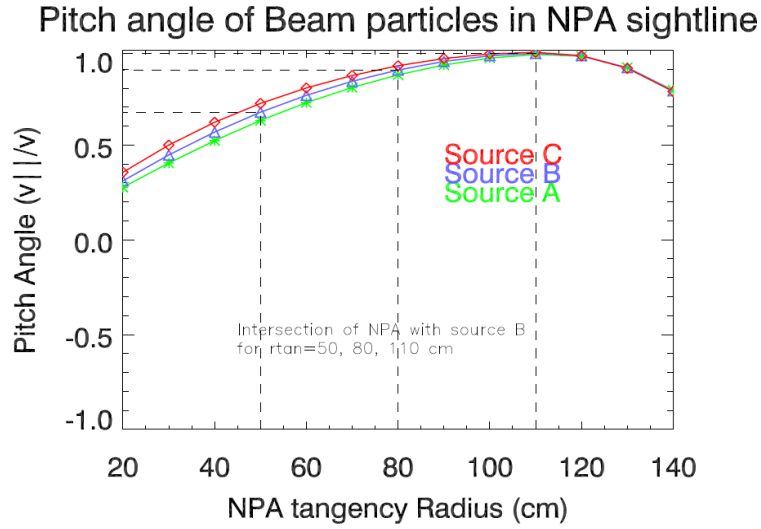
- Goal: To investigate ion power balance and the effects of beam modulations on fast and thermal ions
  - Fast ion distribution function has been shown to be anomalous during periods free of low amplitude MHD modes. This anomaly may be due to high frequency MHD activity. The amplitude of the high frequency modes can be reduced by decreasing the beam power. This XP will study the effects of beam power modulations on the fast ion population distribution.
    - Beam modulations using NPA at various angles. Necessary to show the redistribution of fast ions.
    - NPA analysis will incorporate Edge Neutral Density Diagnostic. Edge neutral density has been shown to have an effect on NPA and neutron signals in TRANSP.
  - Study effects of altered source term (fast ions) on thermal ion power balance. By modulating the beam at different rates, it may be possible to determine if the fast ions are transferring energy to the thermal ions at an anomalously fast rate, possibly via high frequency modes. Such an interaction could be responsible for Ti>Te.
    - Beam will be modulated at various time steps covering the slowing down time (~30 ms) and the energy confinement time (~80 ms) with a duty cycle of ~50%.

Beam Deposition was at the edge of the NPA view





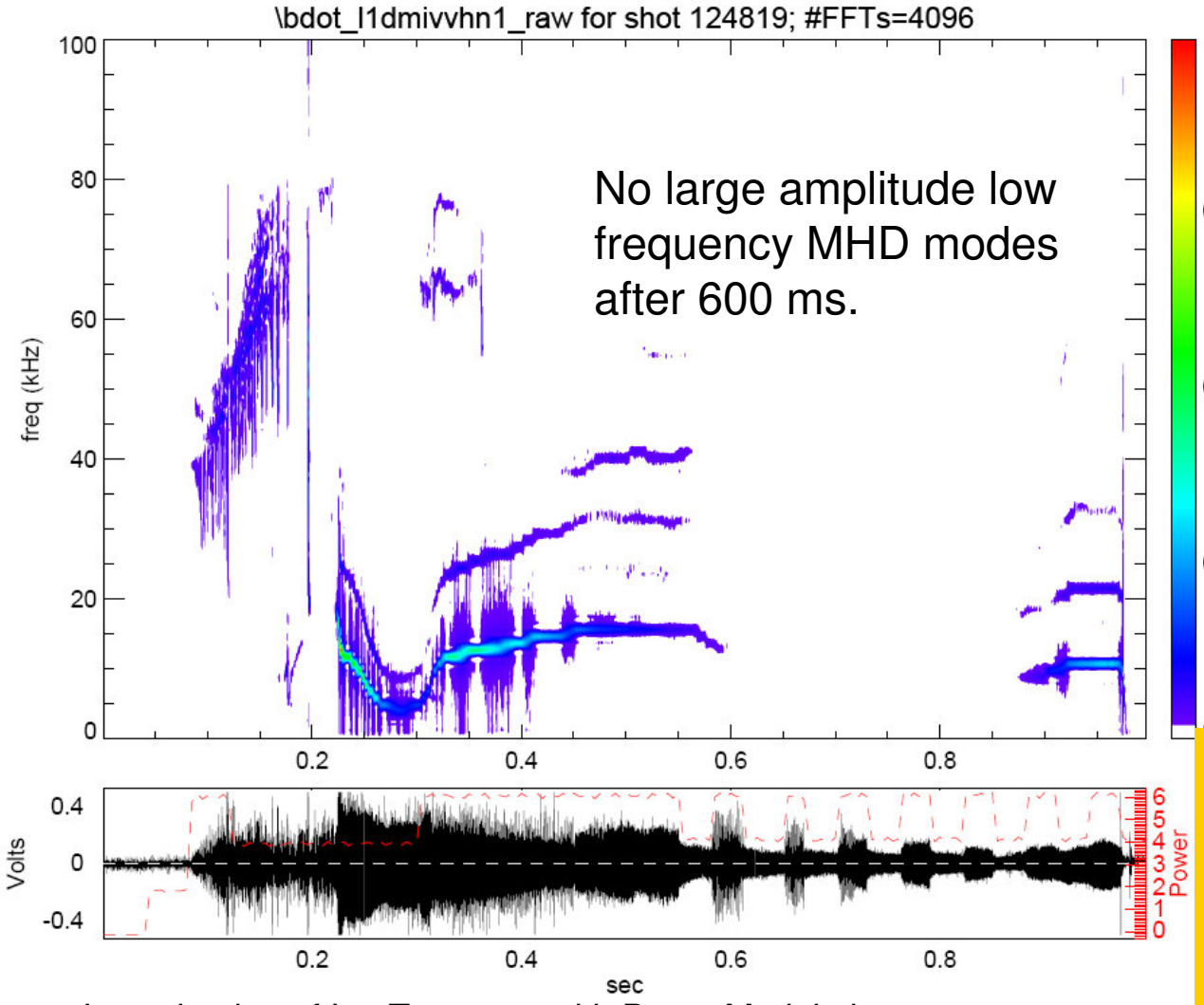




Motivation – Continuing XP 737

- Last year, beam modulations showed a lack of modulations in the NPA and FIDA diagnostics (xp 737). This occurred even when the neutron signal was strongly correlated with the beam modulations, indicating a change in the fast ion population. This may be attributable to the beam depotition profile and the viewing radius of the NPA. Transp simulations show that the modified source (source B) deposits most of its particles at a tangency radius of 40-60 cm, while the NPA was viewing at 80, 100, and 120 cm. This XP will continue with the goals of XP 737, but will revise the viewing angle of the NPA to correspond with beam deposition (~60 cm). The exact angle will be following S.Medley's XP, which is based on some shots from XP 737.
- Additionally, the discharges in XP 737 showed extremely high radiated power. It is believed that this contributed to the failure to establish the anomalously high ion temperature regime. If this high radiated power was caused by the ablation of stainless steel, the corrective measures taken during the recent vessel opening could lead to the desire regime

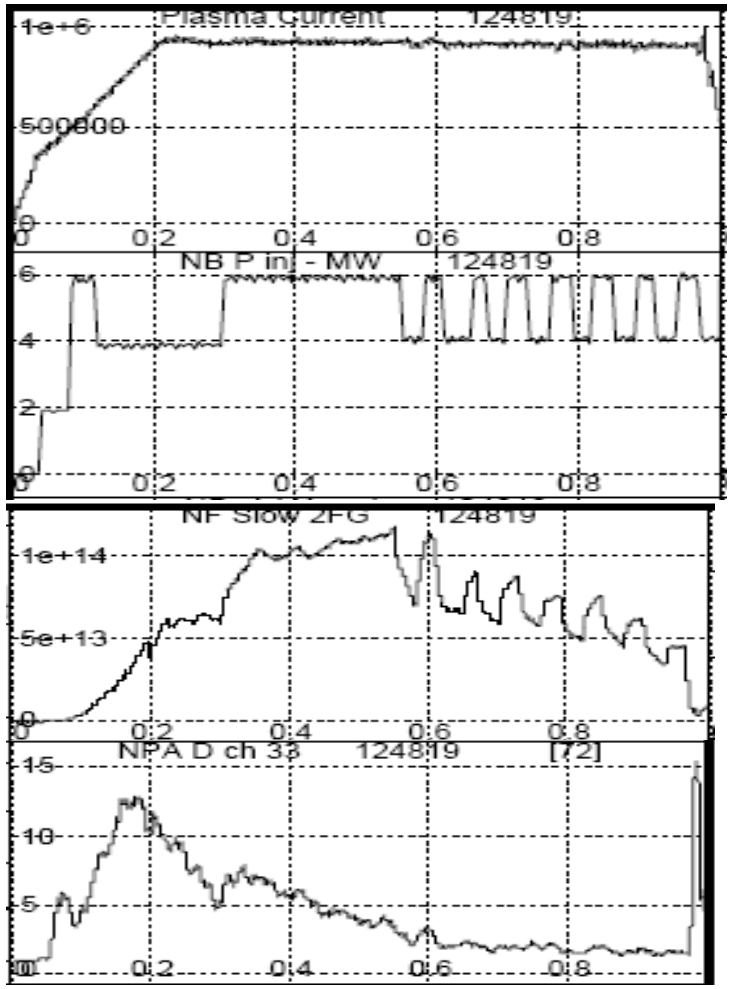
Base Shot: 124819



This shot is useful because it has a reproducable MHD free period, which is critical in determining the fast ion distribution.

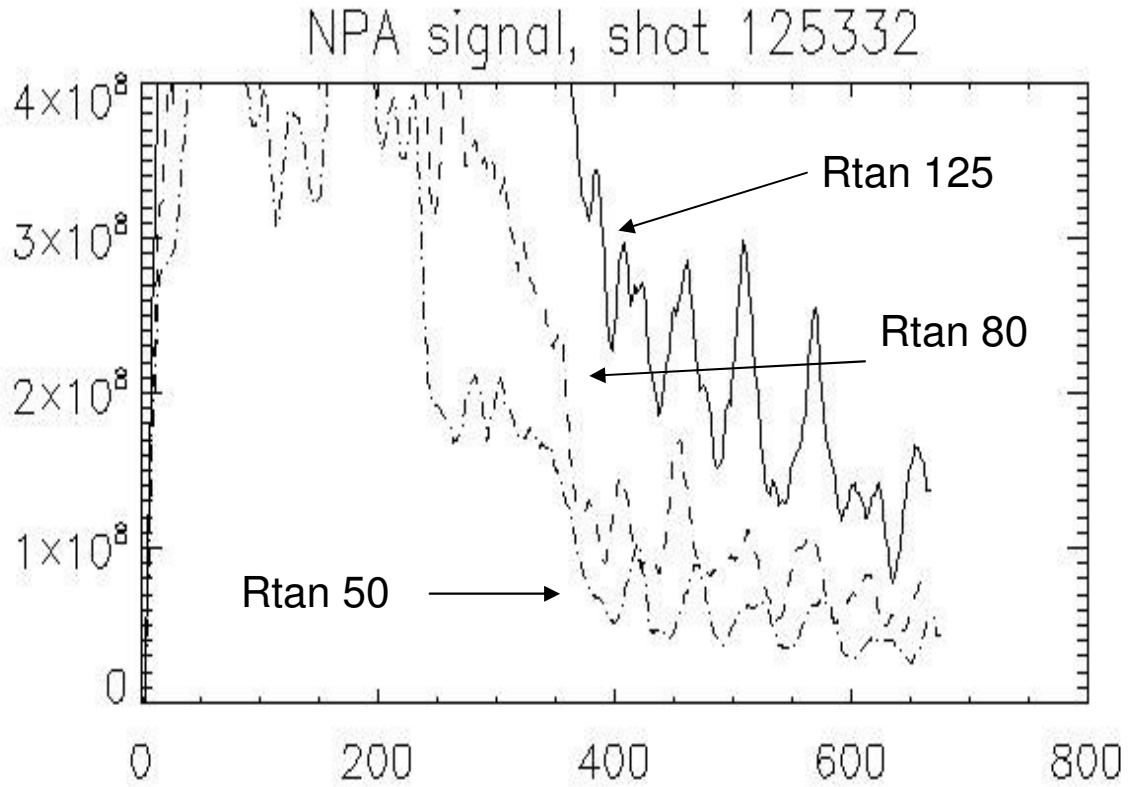
δB/B follows the modulation. This is most likely the high frequency MHD activity (not shown)

Shot 124819



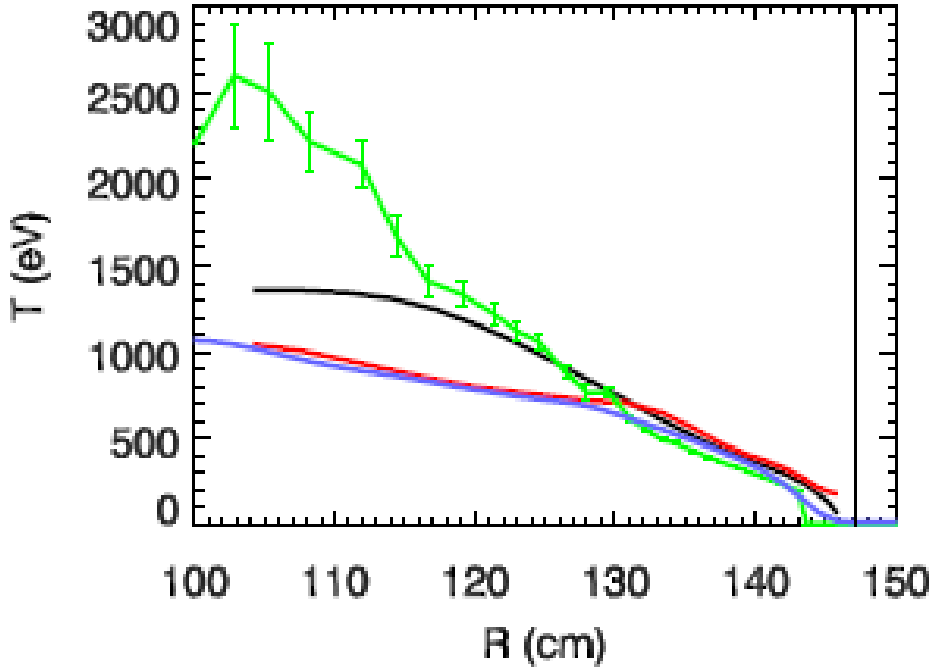
Shot 124819 is from XP 737. However, the NPA channels show no correlation with the beam modulations and neutron signals, even at the highest channel. This may be due to the NPA sightline viewing outside of the beam deposition region. The expectation is that if the NPA sightline is adjusted, the modulations will be visible.

TRANSP shows NPA modulations at all pitch angles



TRANSP shows modulations at all tangency radii that match the beam modulations. This is not seen in the measured NPA signal, particularly for Rtan 80, near the magnetic axis. (The measured NPA signal is not shown)

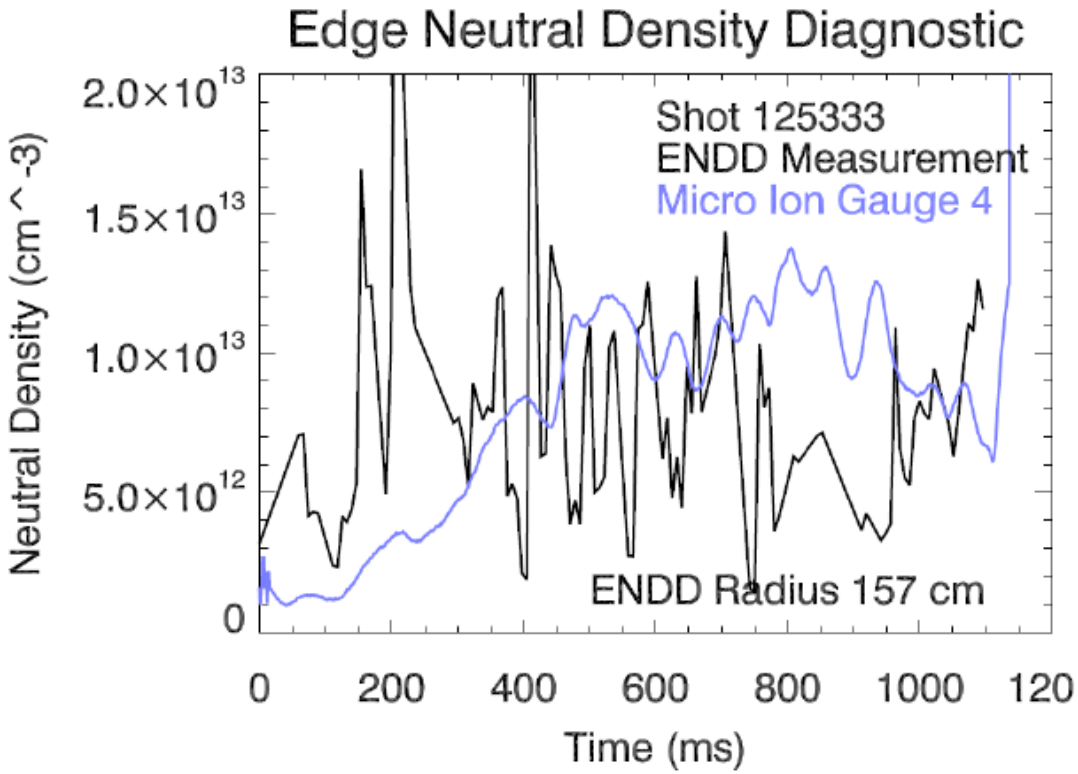
2008 Run Campaign shows high Ion Temperature (maybe)



Shot 127953, t=450 msec.
Calculated ion temperaure (black) severely underestimates the measured ion temperature (green).

It is not yet clear that the ion temperature measurements are correct. If they are, they require anomalous ion heating, to prevent $\chi_i < 0$.

ENDD is up and running



The Edge Neutral Density Diagnostic is working and was compared with a micro ion gauge to verify results.

Edge Neutrals might have a significant effect on beam duct ionization

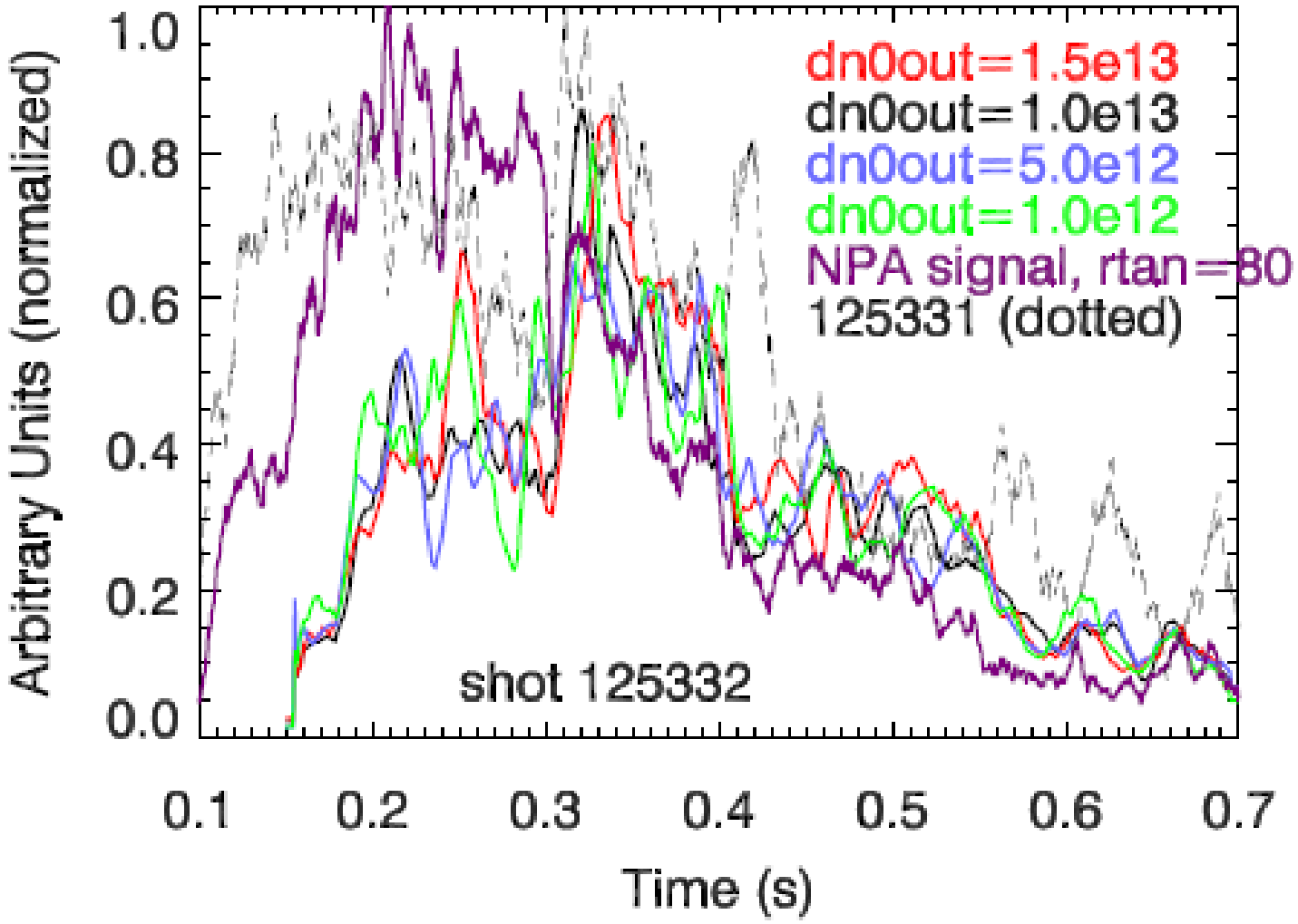
$$\sigma_{80keV} \sim 1.0e-16\ cm^2\ /\ particle$$

$$n_{ENDD} \sim 1.0e13\ cm^{-3}$$

$$l_{beamduct} \sim 2.5\ m$$

Assuming a linear interpolation in density in the beam duct, this leads to a loss of ~10-12% of the beam power

Edge Density Does Not Affect TRANSP modulations



Proposed Shots:

Shots will be run with a modulation time of 30 and 50 ms.

NPA Rtan	NPA Vertical angle (°)
40	0
45	0
50	0,4,8
55	0
60	0,4,8
65	0
70	0,4,8

The angles in these scans may be varied slightly based on calculations and actual NPA measurements.

Contingency Plan

- This XP will run after Sid Medley (XP 808)
- If early shots show no modulation in the NPA signal at 40-60cm tangency radius, the base shot will likely be adjusted to 125331. However, it is not clear if this will prevent the anomalously high ion temperature