

New Observations on MHD Activity in the Hybrid Regime and Implications for Current Profile Sustainment

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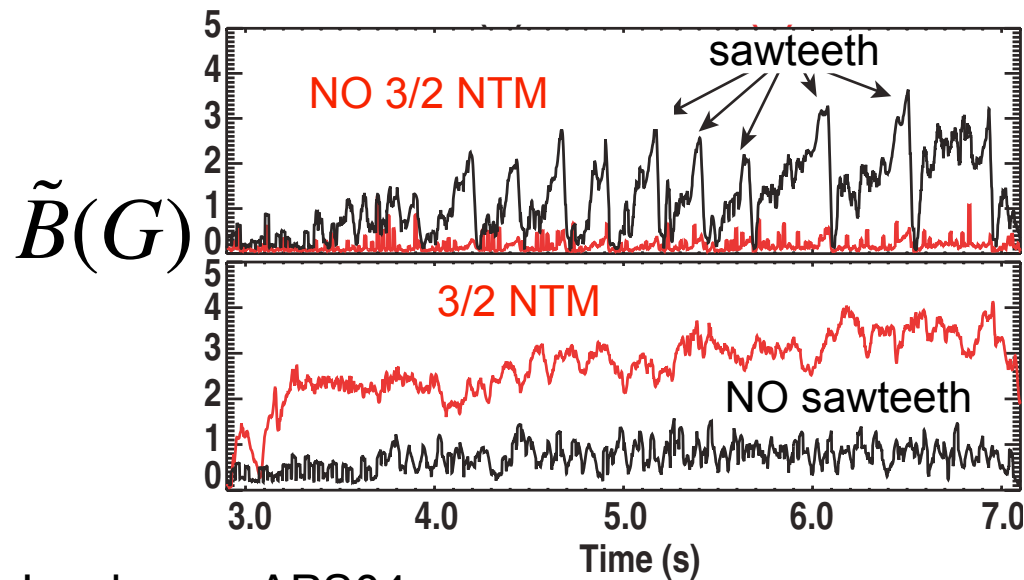
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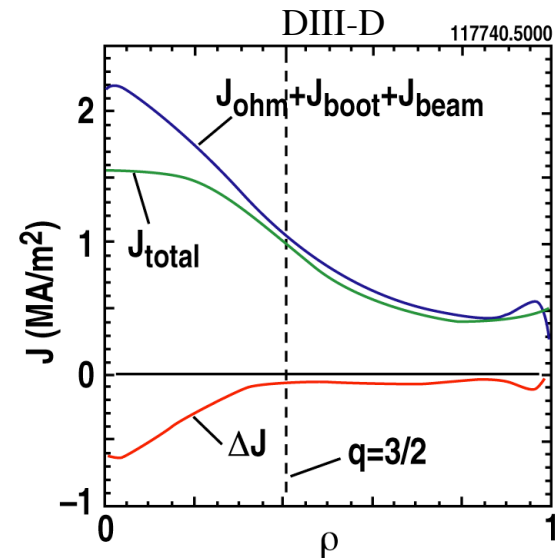
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Hybrid Plasmas Exhibit MHD Activity that Lead to Steady State Plasmas With no (or Very Weak) Sawteeth



Jayakumar APS04



$\Delta I \approx -50 \text{ kA}$

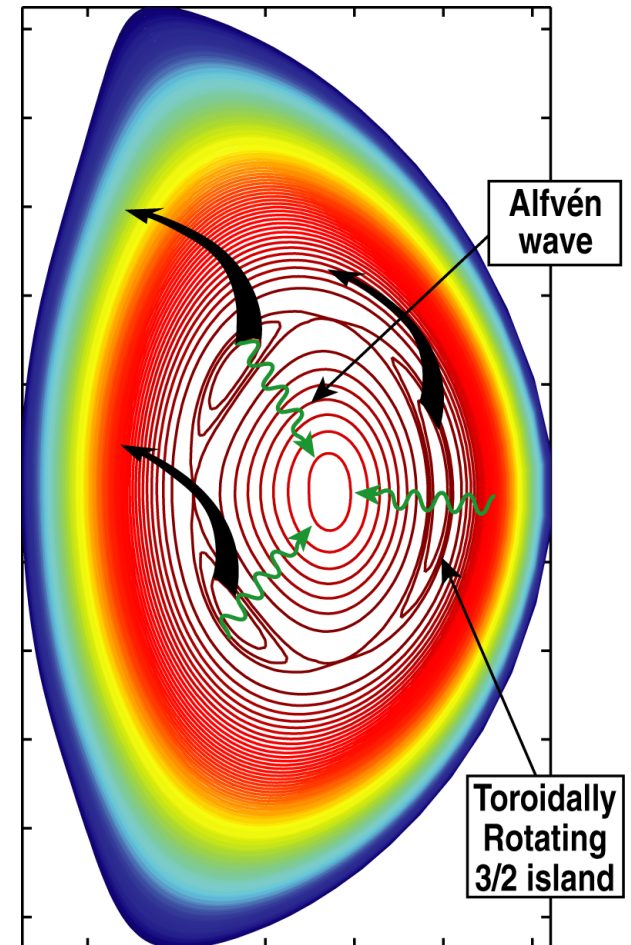
Politzer EPS05

- 50-100 kA counter current drive needed (Politzer EPS'05)
- 3/2 NTM a prime suspect

Current Drive Can be Induced by Coupling of $m/n=3/2$ NTM with $2/2$ Sideband — Chu IAEA'06

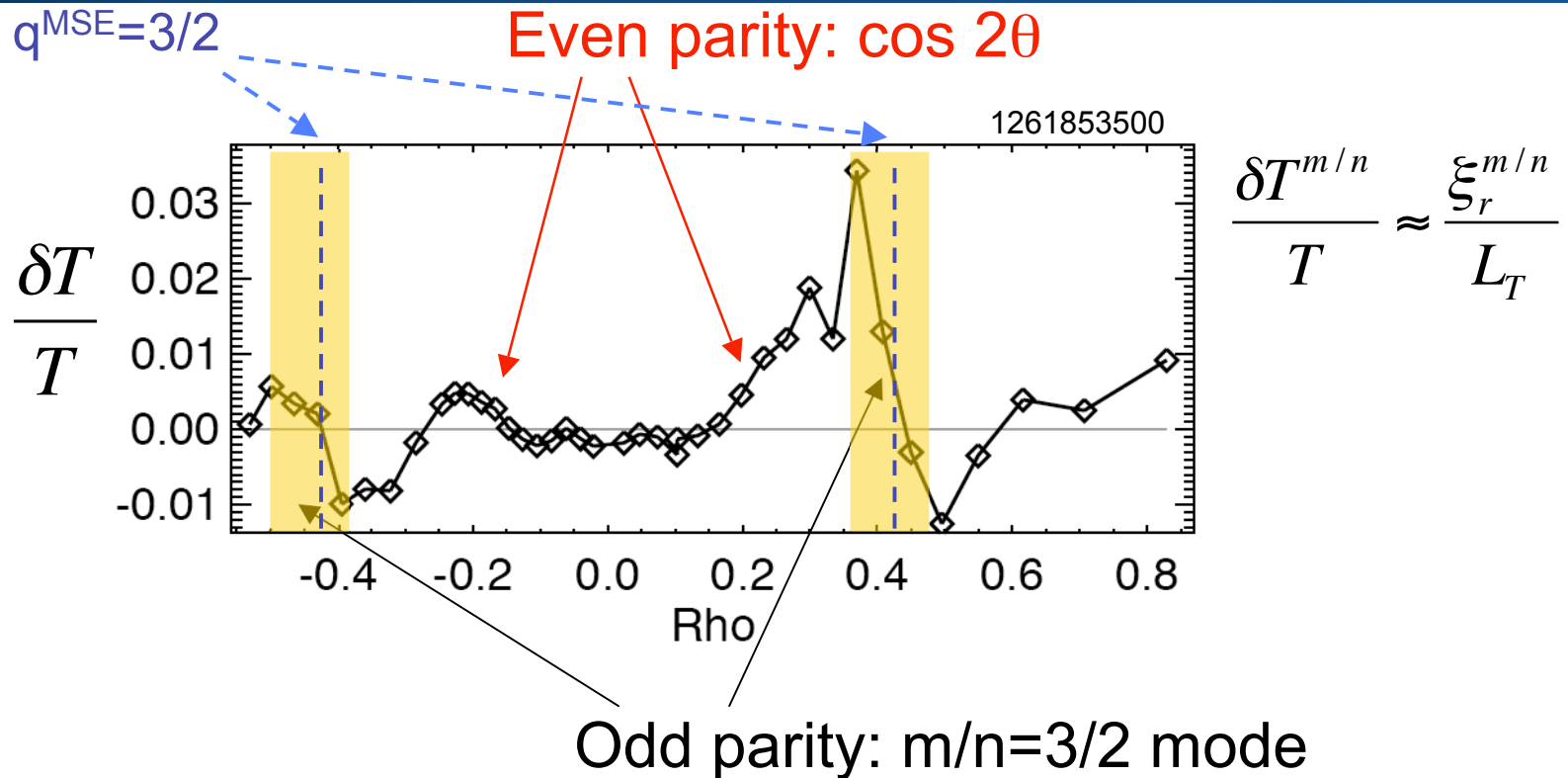
Rotating $3/2$ NTMs can drive current through

- I. Polarization drift mode conversion to $2/2$ kinetic Alfvén waves
- II. Magnetic curvature drift excitation of $2/2$ electrostatic sideband
- III. Redistribution of energetic ion density and reduce NBI central current drive



- Note: $2/2$ sideband is not an island

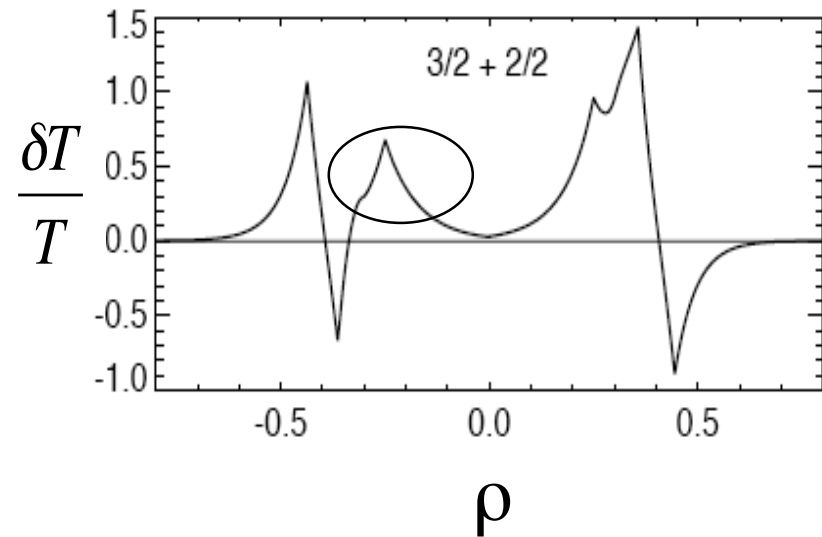
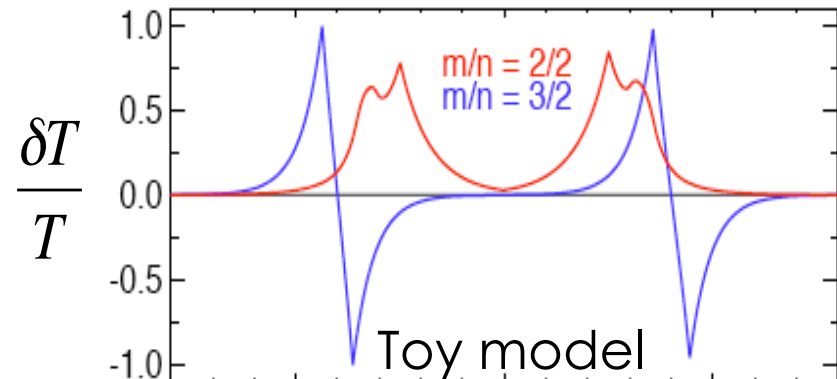
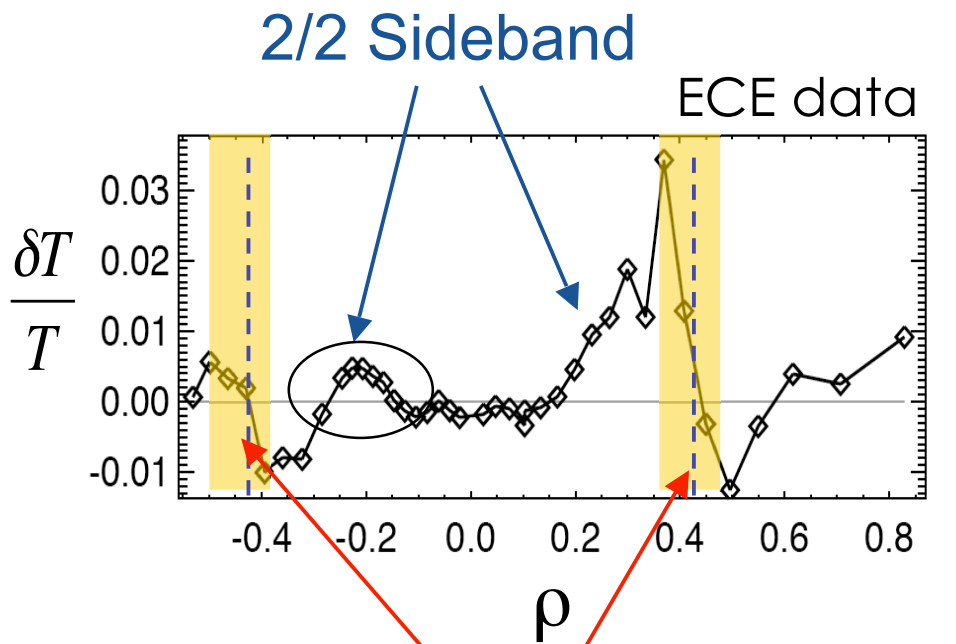
New Finding: ECE “Snapshot” Reveals Even Parity δT_e Component Superimposed on Odd Parity 3/2 Island



- $\Delta/\rho \approx 0.12$ for $m/n=3/2$ island inside
- data shows “anomalous” node at $\rho=-0.2$
 - Consistent with 2/2 sideband

Ad-hoc 2/2 and 3/2 Perturbations Reproduce Anomalous Node on High Field Side of Magnetic Axis

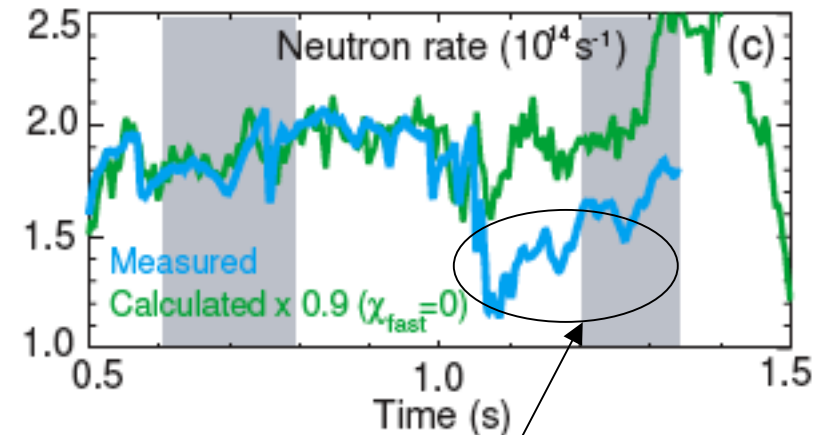
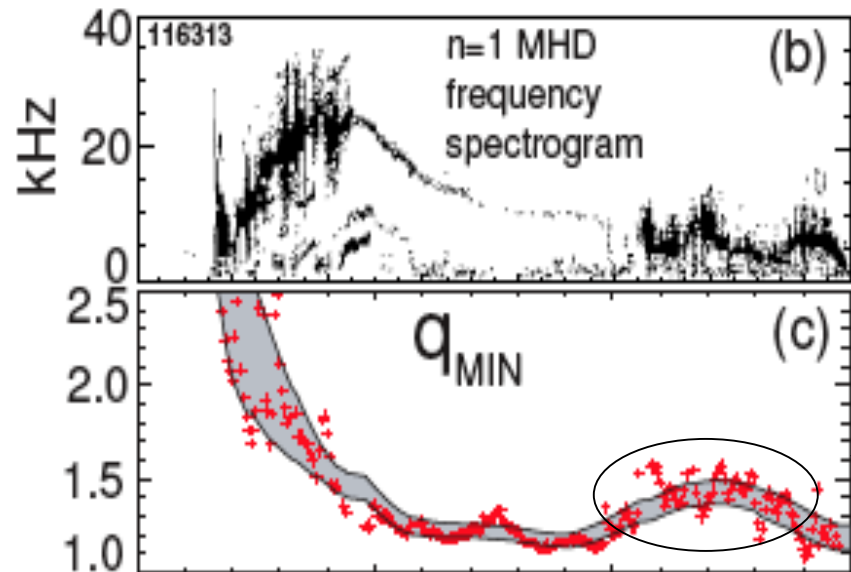
- Anomalous node at negative radii consistent with $m/n=2/2$ sideband



- 2/2 component extends deeper into plasma core

Implications: Can Core MHD Reduce Efficiency of NBI Current Drive: The Answer on NSTX Appears to be “Yes”*

*J. Menard, PRL 2006

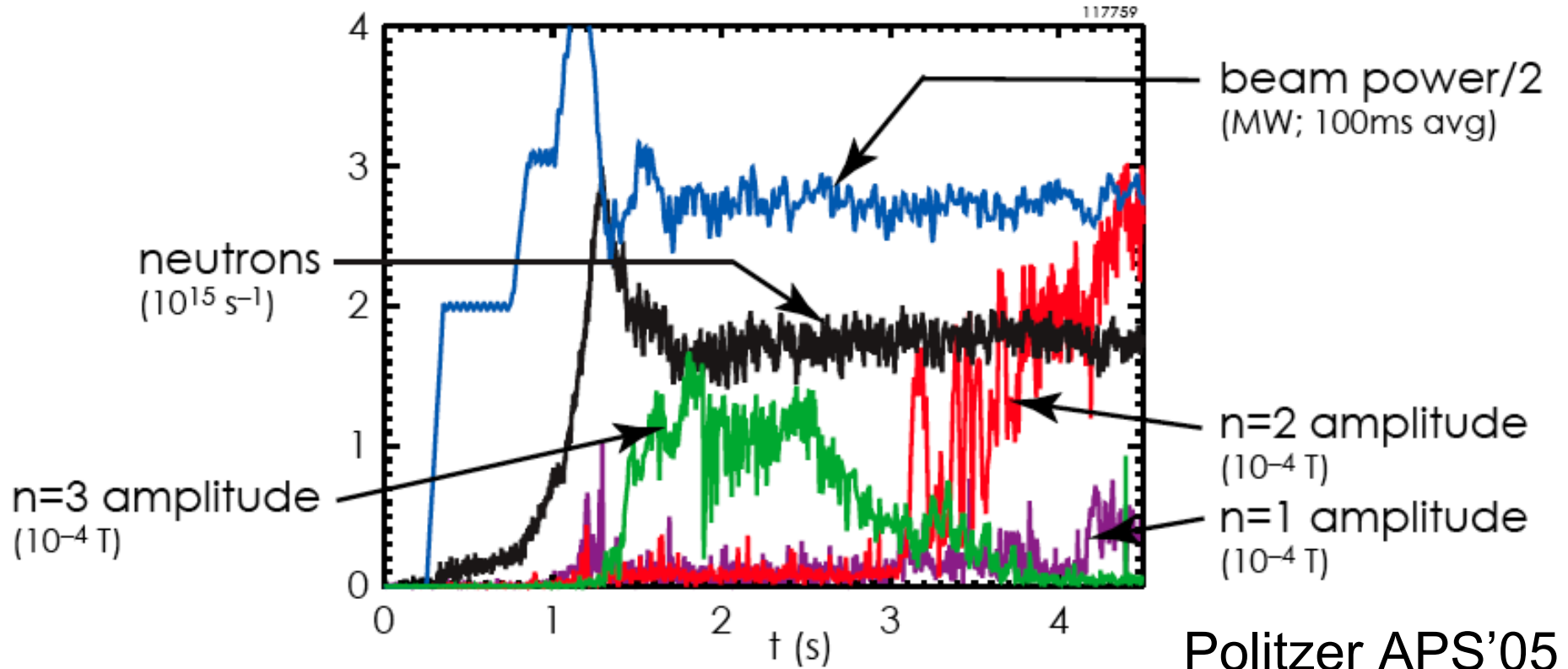


- Neutron deficit associated with $q(0)$ increase during increased MHD

- Caveat: Mechanism of redistribution still needs to be conclusively identified by theory and numerical simulation

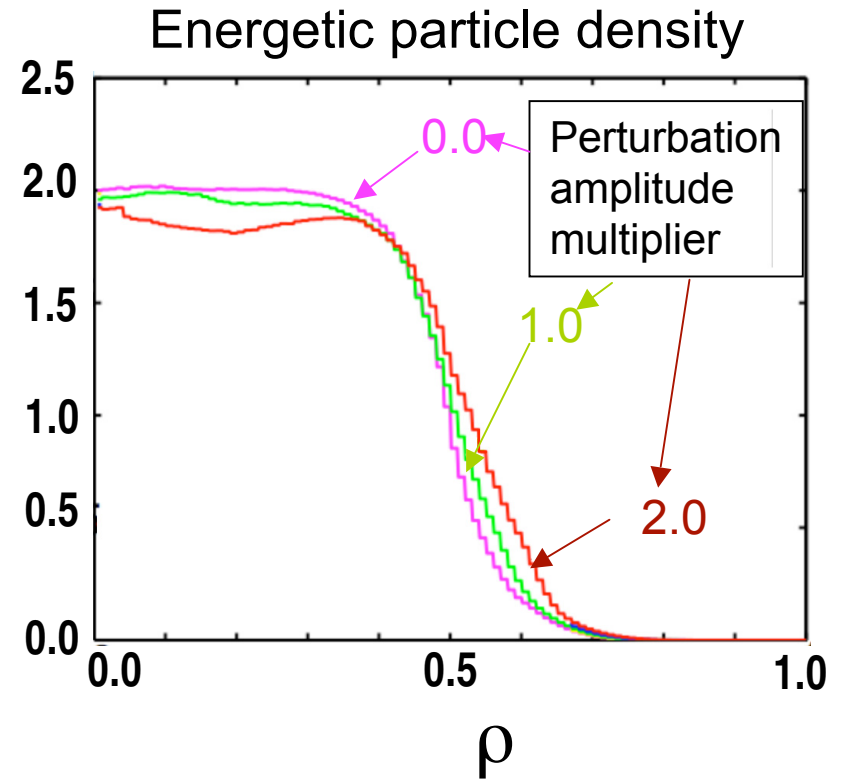
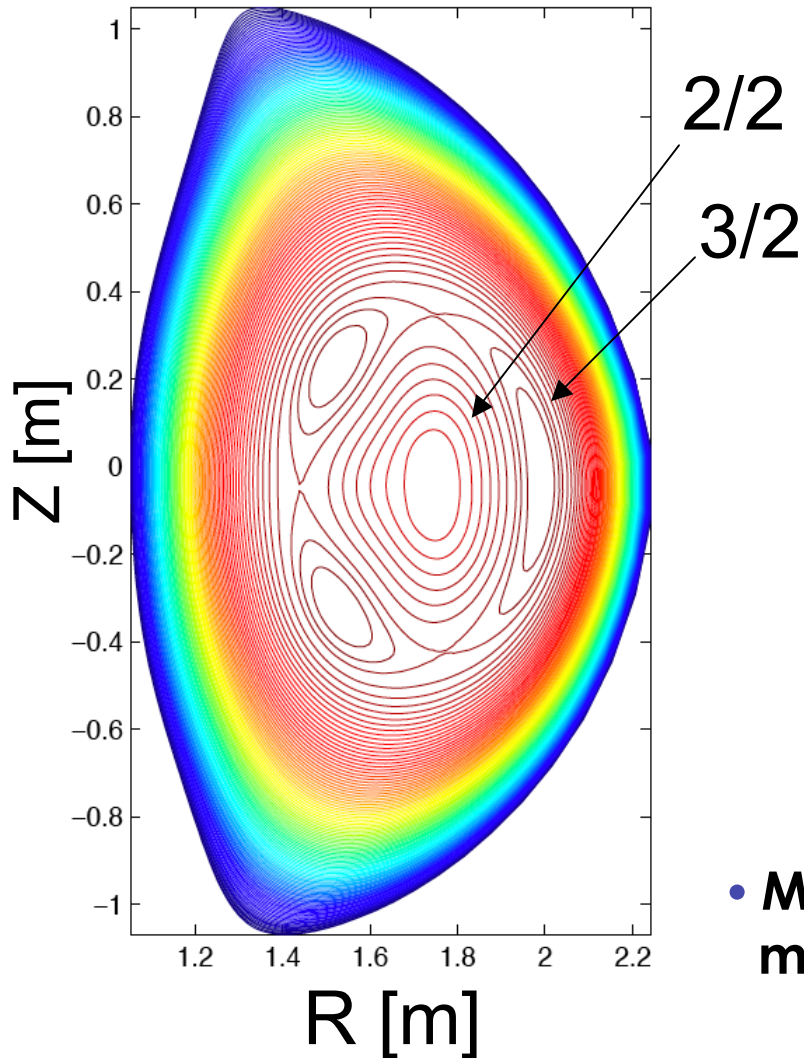


Note, A Strong Decrease in the Neutron Rate is NOT OBSERVED on DIII-D at Onset of MHD



- Can redistribution still occur in the absence of significant loss?

ORBIT Analysis With Model 3/2 and 2/2 Mode Confirms Weak Effect on Passing Ions: 50-80 keV



- Magnetic perturbations \approx experimental magnitude (500 transits \approx 0.5 ms)
- Magnitude of redistribution \approx 10% of required counter current drive

Conclusions

Clear 2/2 component in δT_e phase locked to 3/2 mode penetrating into plasma core

- Redistribution of co-going energetic ions by magnetic perturbation accounts for 10-20% of missing current

Theory predicts dominant counter current driven induced by rotating

- I. 2/2 kinetic Alfvén waves, or
- II. 2/2 electrostatic sideband

Mechanism for counter current drive requires simultaneous density and temperature measurements of 2/2 feature in plasma core