Dependence of Edge Flow on Magnetic Configuration in NSTX

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Work in Progress.

XP447 successfully executed, with mixed results:

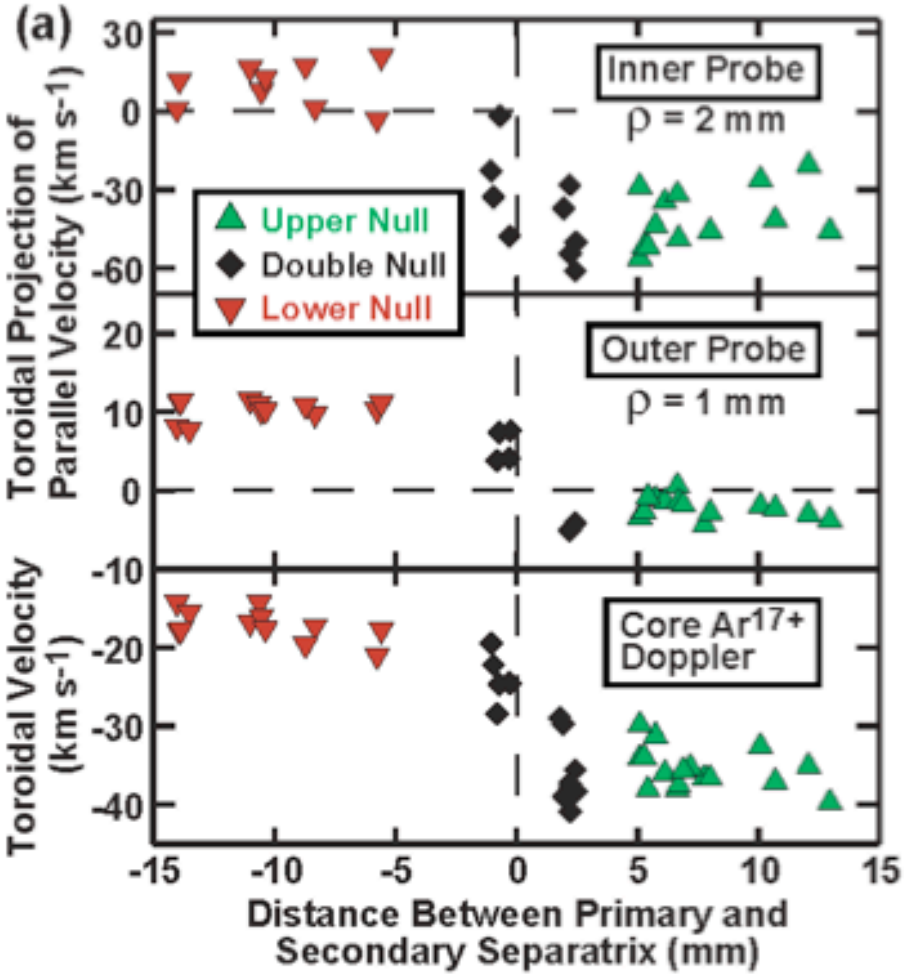
- Careful configuration control (dR_{sep}) from rtEFIT.
- Edge flow varies with magnetic configuration.
- Core & GPI flow data pending.

But, effect on H-mode power threshold undocumented due to failure to achieve H-mode except in DND configuration.

Motivation

- Recent results from Alcator C-Mod indicate that the plasma flow directions in the SOL changes direction as the magnetic configuration varies from USN to DND to LSN in ICRF heated plasmas.
- Change in the core rotation is also coincident with the SOL flow change.
- Flow directions account for the L-H power threshold difference in USN v. LSN in C-Mod.
- Similar experiments attempted in NSTX (XP447):
  - Use rtEFIT to control the plasma shape as dR_{sep} is smoothly varied in Ohmic and HHFW heated plasmas.
  - The ERD provided poloidal and toroidal measurements of flow in the edge and SOL.
  - CHERS gave profiles of rotation from edge to core.

Results from C-Mod



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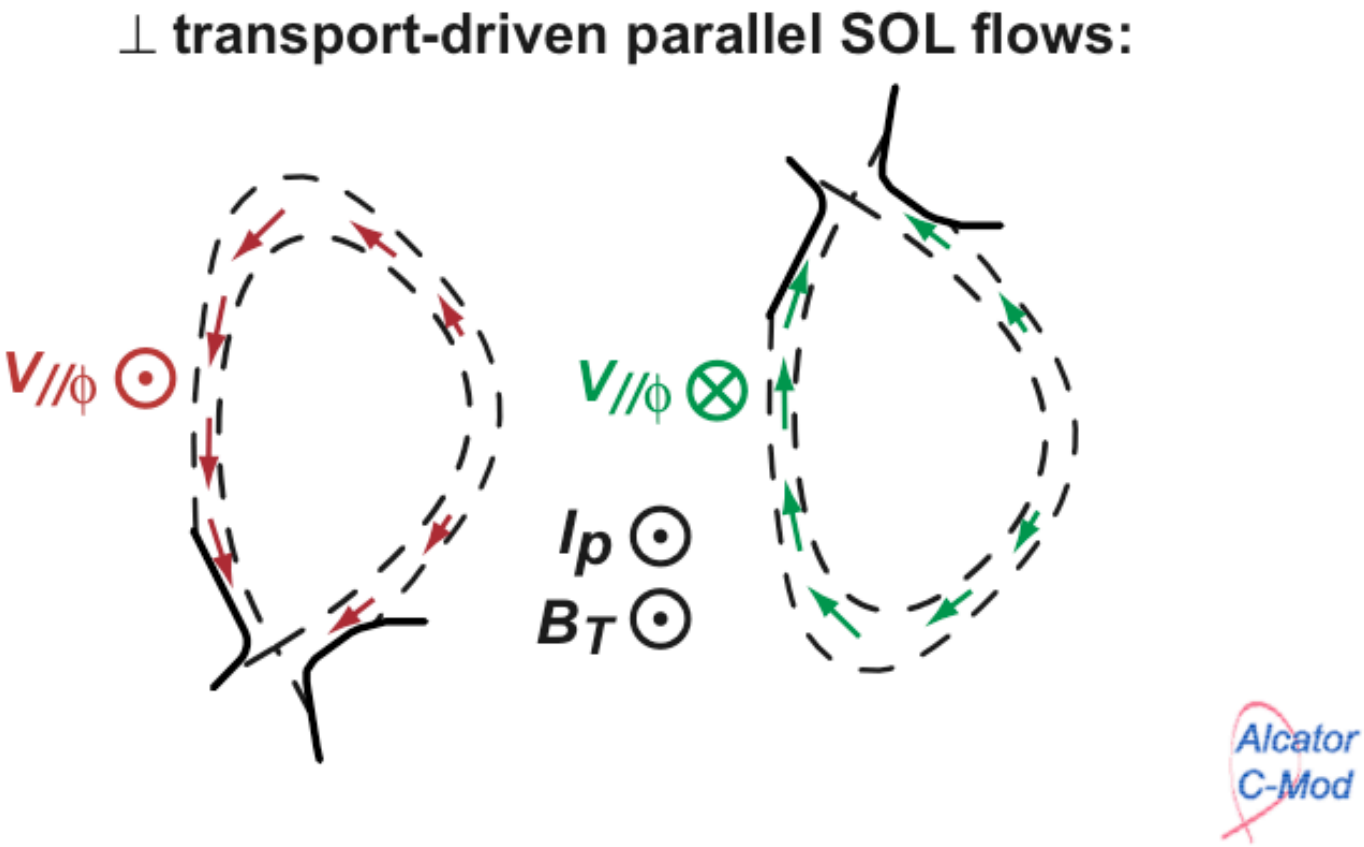
- Change in core flows with topology is in same direction and same magnitude as SOL flows
- Core flows exhibit the same extreme sensitivity to edge topology! – each mm counts
- SOL flows are near sonic on high-field side.

Alcator C-Mod

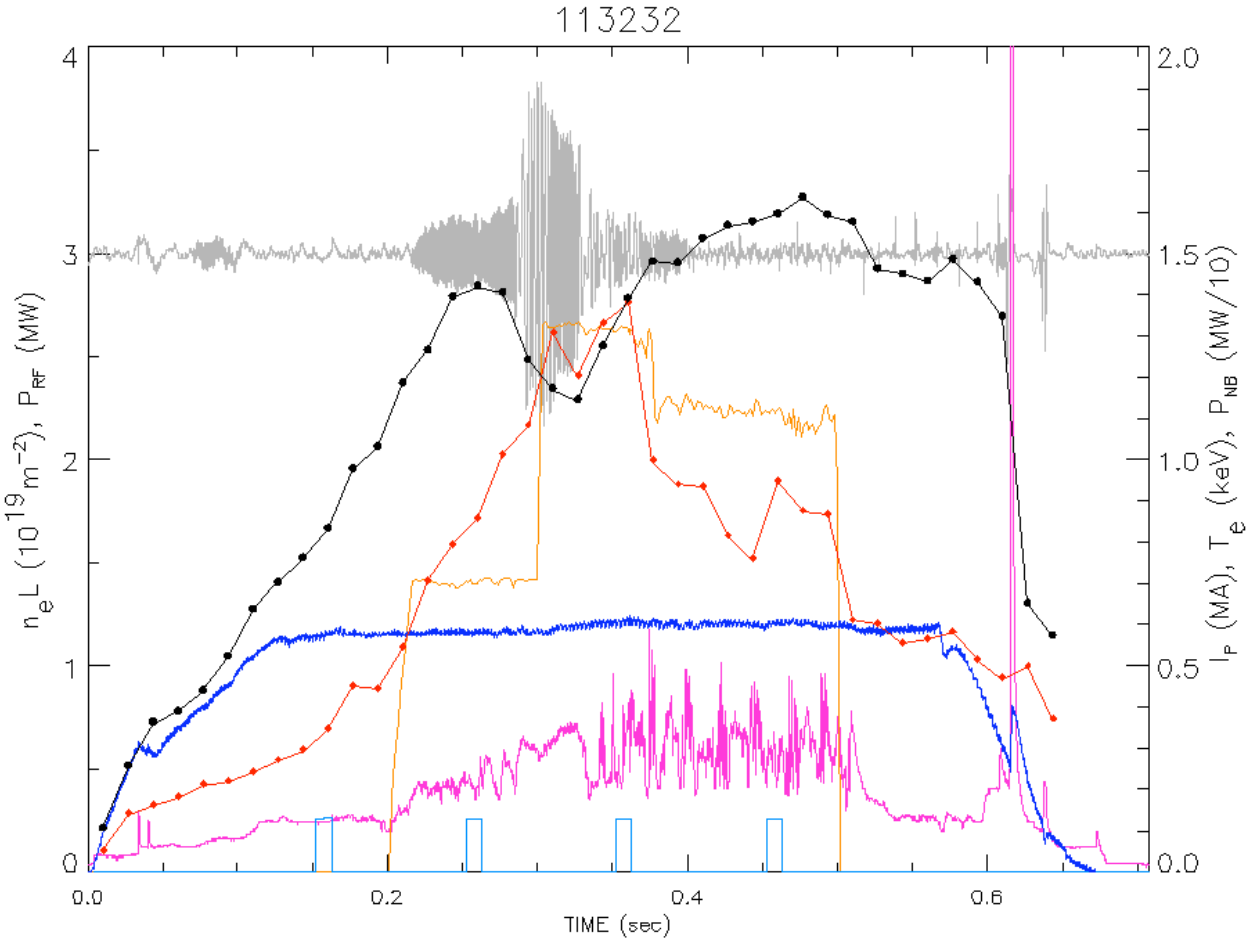
C-Mod flow explanation



Run Plan

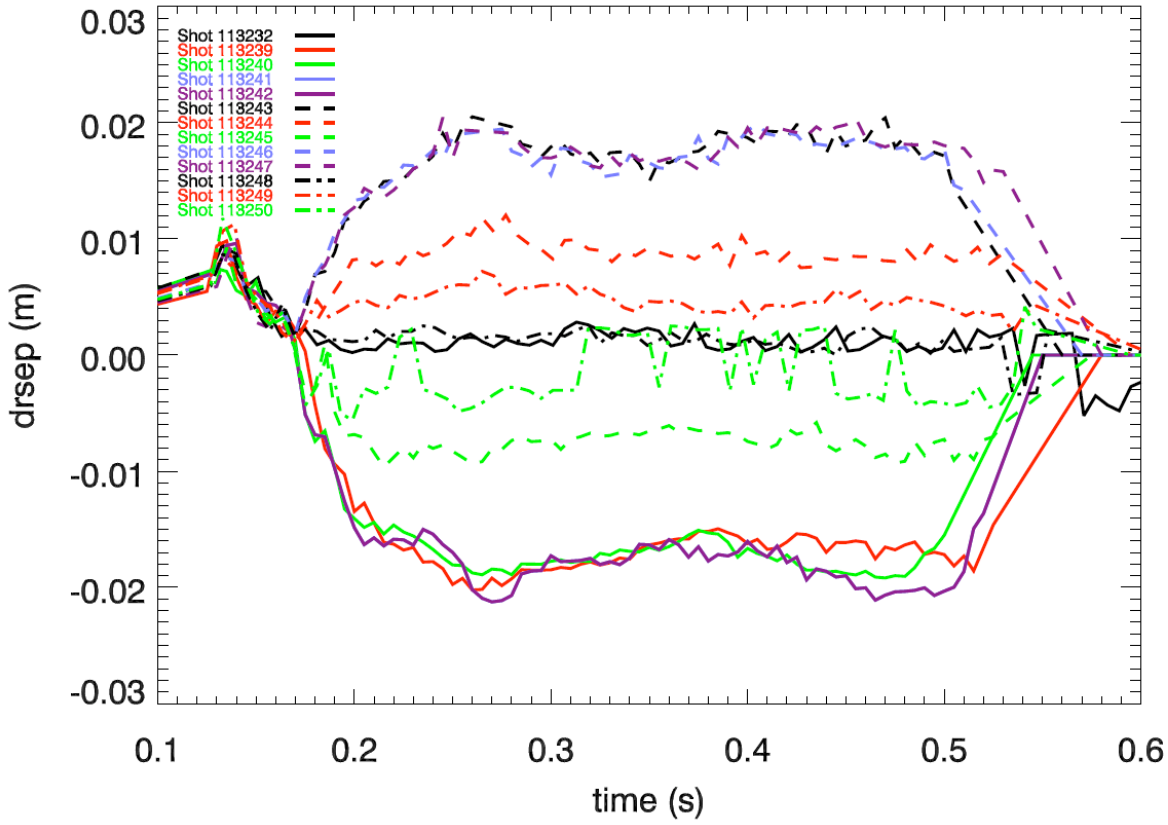
- Establish target plasma: (113040) DND, D_2 fueled, rtEFIT controlled, 600 kA, 0.42 T, n_e~4x10^{19} m^{-3}, gap_{in}~4-6 cm, gap_{out}~4 cm, outboard midplane fueled. Flattop from t=200-400 ms, at t=300 ms apply 2 MW of HHFW at 14 m^{-1}, at t=253-260 and 353-360 blip NBI source C (75 kV) for CHERS. dR_{sep}=0, 2 shots
- Scan dR_{sep}
  - dR_{sep}=-2 cm, 2 shots
  - dR_{sep}=+2 cm, 2 shots
  - dRsep=+1 cm, 2 shots
  - dRsep=+0.5 cm, 2 shots
  - dRsep=-0.5cm, 2 shots
  - dRsep=-1 cm, 2shots
- Monitor presence of H-mode in the dR_{sep} scan
  - Take shots at lower or higher RF to search for power threshold in particular configurations.

Representative discharge



- DND, dR_{sep}=0
- D_2 fueled
  - outboard midplane
- rtEFIT controlled
- I_p~600 kA
- B_T~ 0.42 T
- n_e~3x10^{19} m^{-3}
- gap_{in}~4-6 cm
- gap_{out}~4 cm
- Flattop from t=100-500 ms or greater
- at t=200 ms apply 2 MW of HHFW at 14 m^{-1}
- 10 ms blip NBI source C (75 kV) every 100 ms for CHERS

rtEFIT was extremely useful.

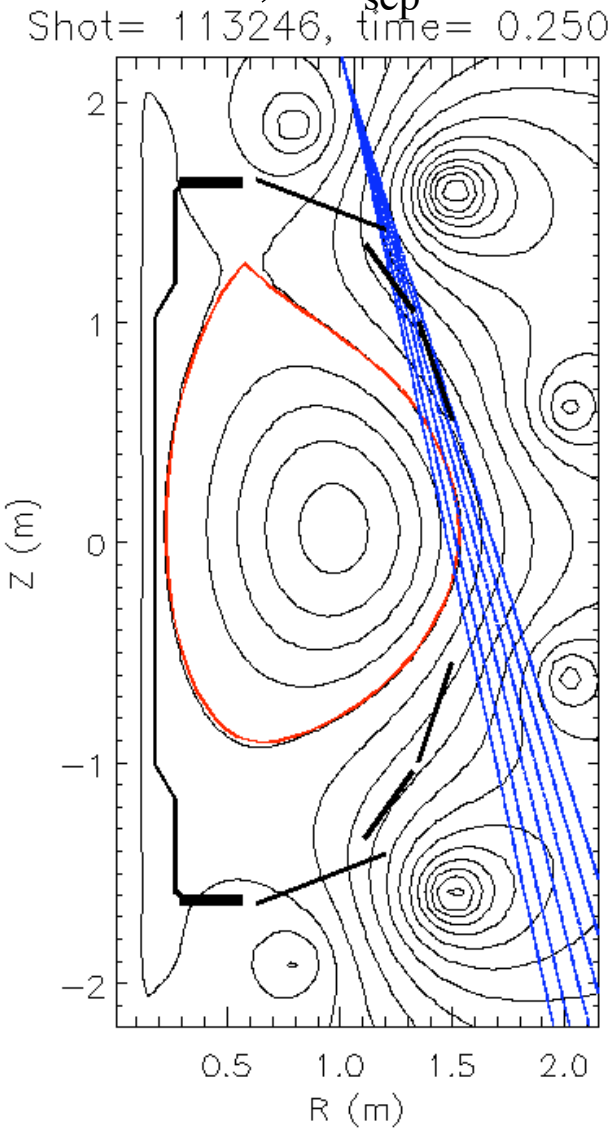


- Started with a DND plasma.
- Used rtEFIT shape control to transistion into USN or LSN.
- Excellent control of the plasma.

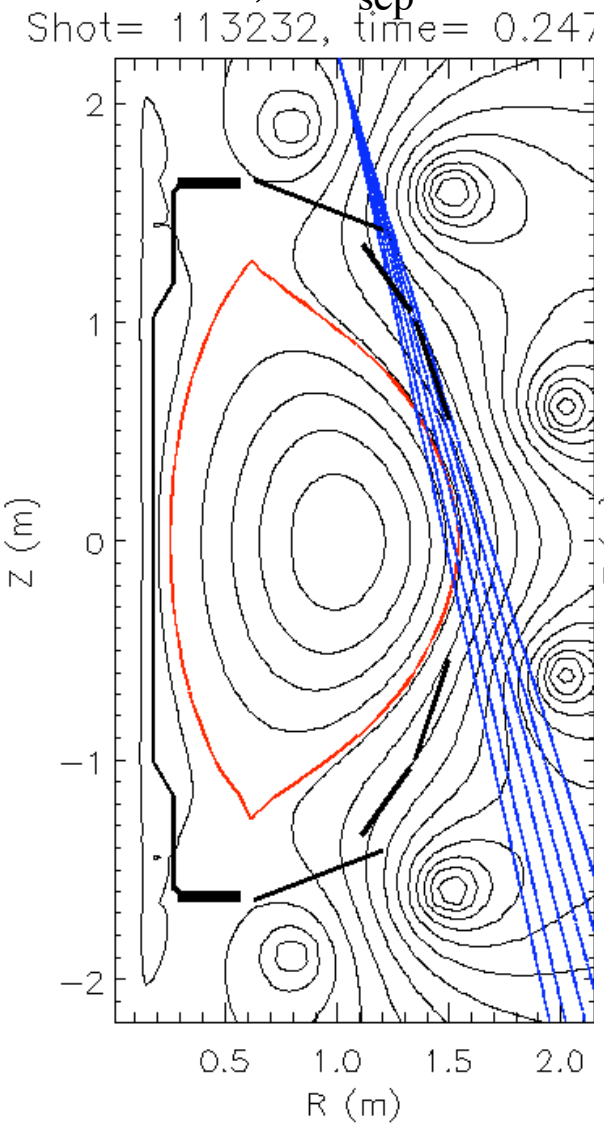
D. Gates

NSTX configuration scan

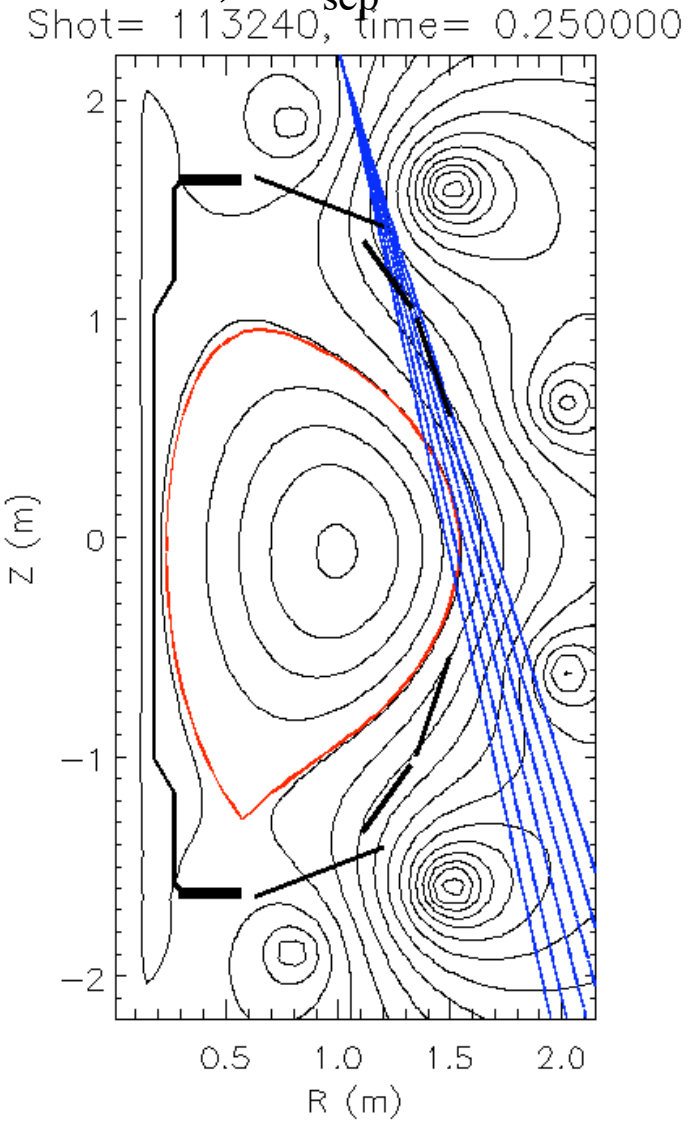
USN, dR_{sep}~+2 cm



DND, dR_{sep}~0 cm

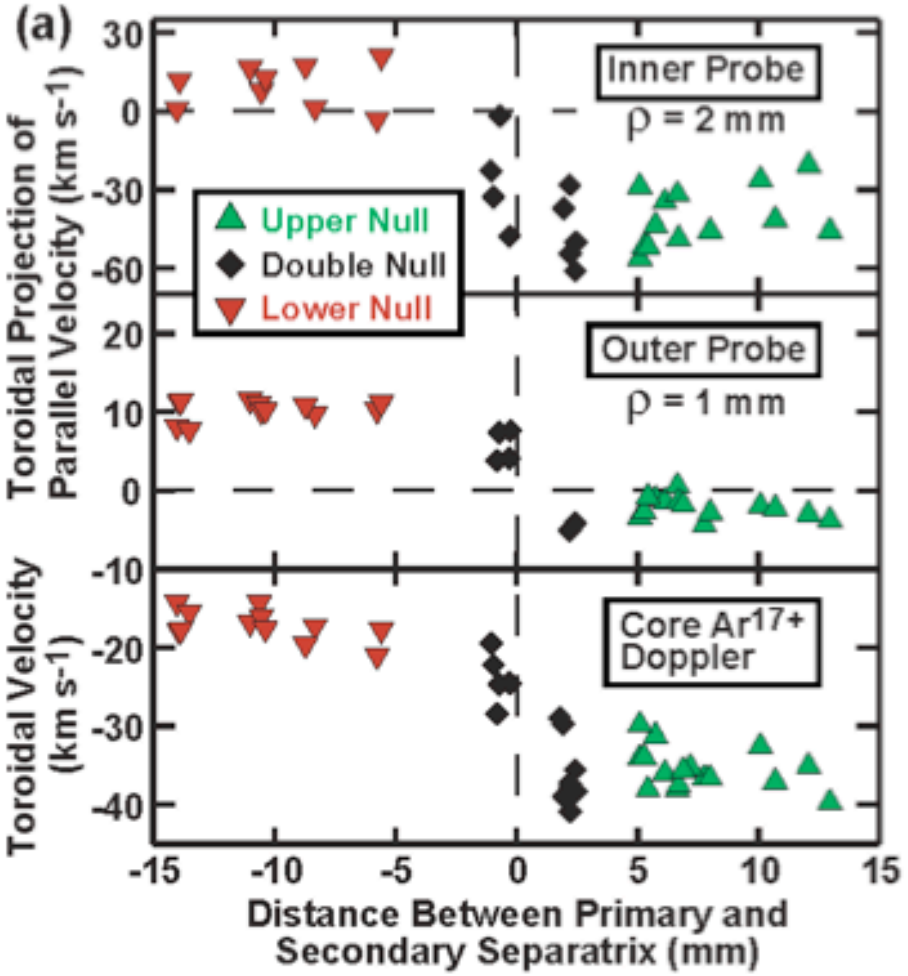


LSN, dR_{sep}~-2 cm



Toroidal flow variation

C-Mod results



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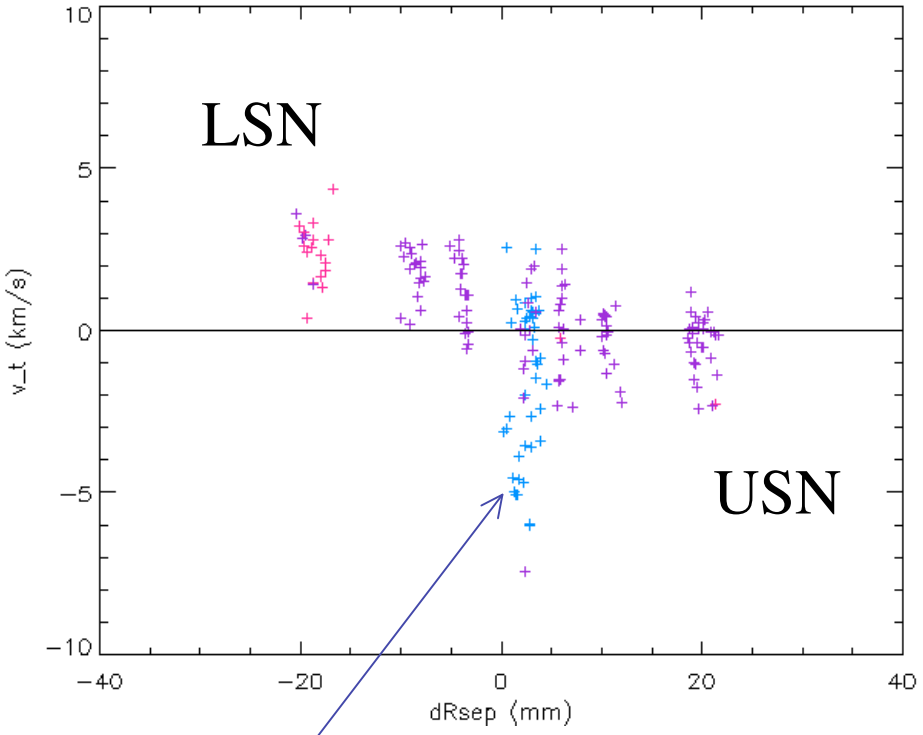
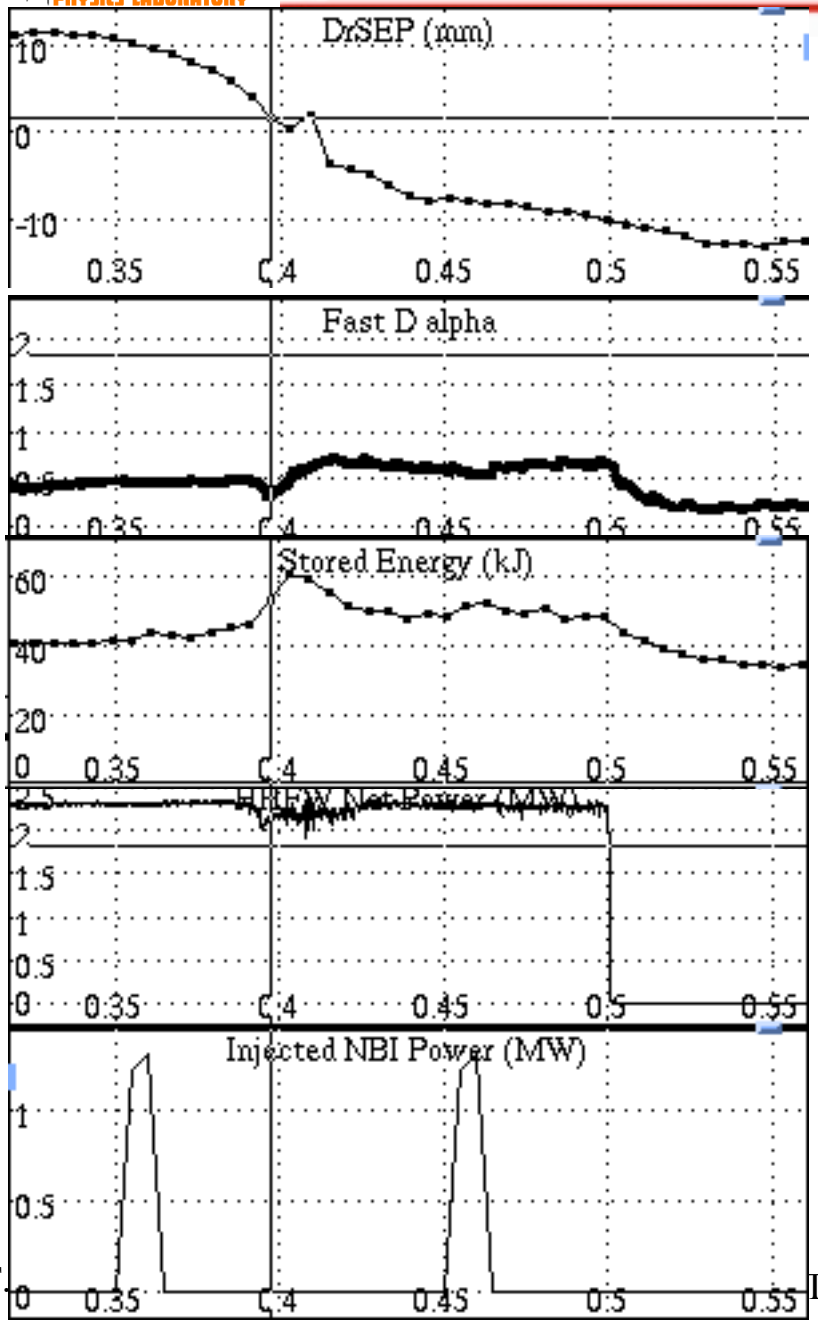
NSTX results



Blue points are during H-mode

H-mode access elusive except in DND



- Plasma transitioned into H-mode readily in DND at P_{RF}~1.5 MW.
- However transition could not be induced in LSN or USN.
- Scanning dR_{sep} within a shot (thanks to rtEFIT) shows H-mode transition only near dR_{sep}~0, i.e. DND.

Summary

- rtEFIT has proven to be a very useful tool in plasma shape control.
- Edge flow in NSTX appears to have similar dependence on magnetic configuration as C-Mod.
- Planned Analysis
  - Thorough analysis of ERD measured edge flows.
  - Comparison of CHERS measured core flows.
  - Velocity field calculations of GPI flows.
- Future Work
  - Develop understanding of H-mode access limitations in LSN and USN configurations.
  - Examine L-H power threshold as function of edge/SOL flows (i.e. variation with magnetic configuration).

Parallel flow variation.