Intermittent filaments in NSTX

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With

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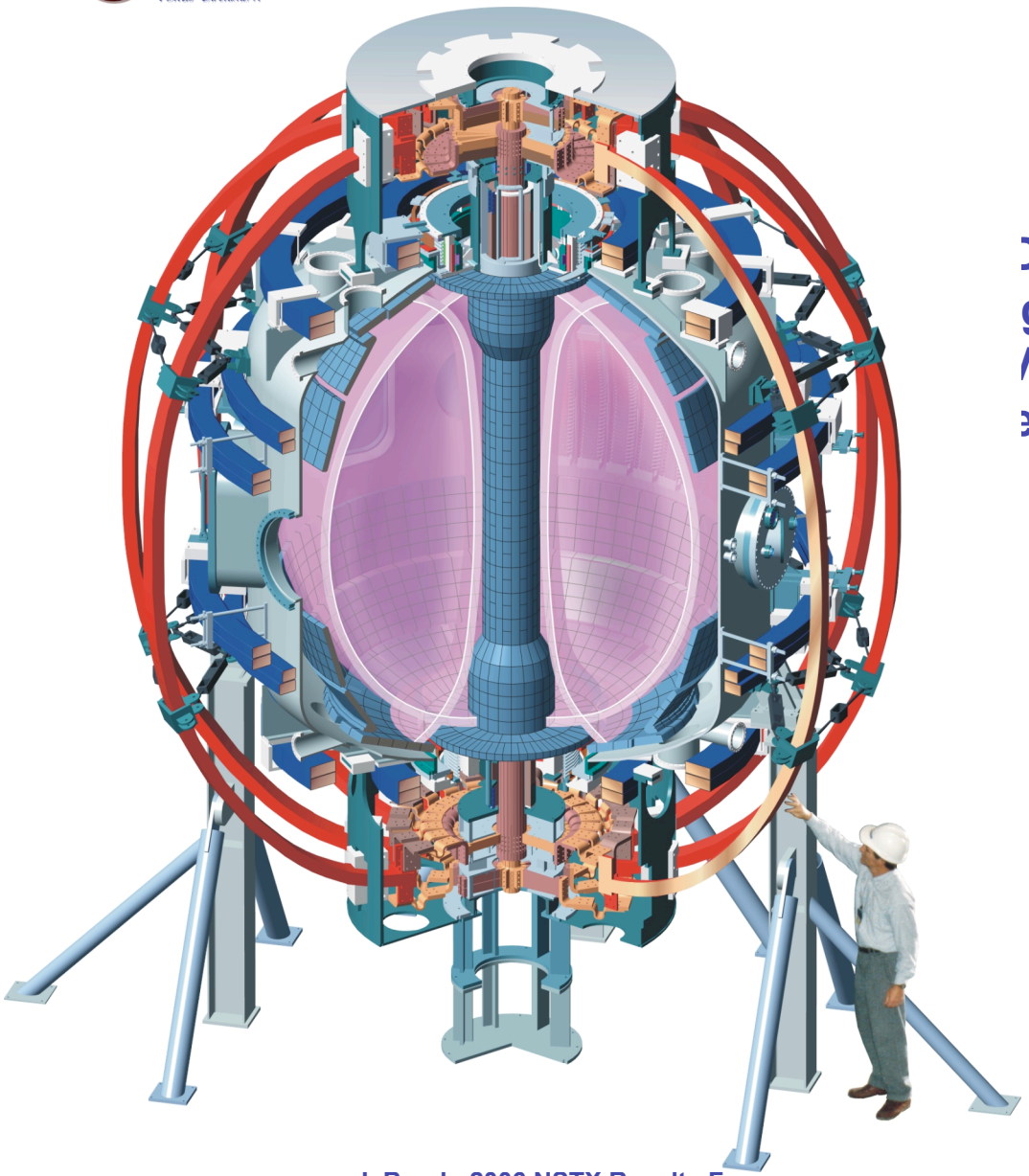
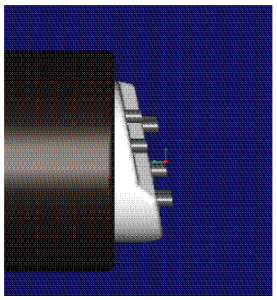
The UCSD and NSTX Teams

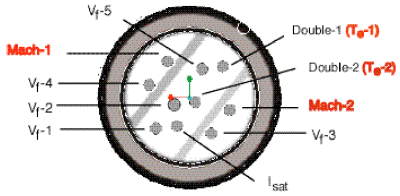


Probe Introduction

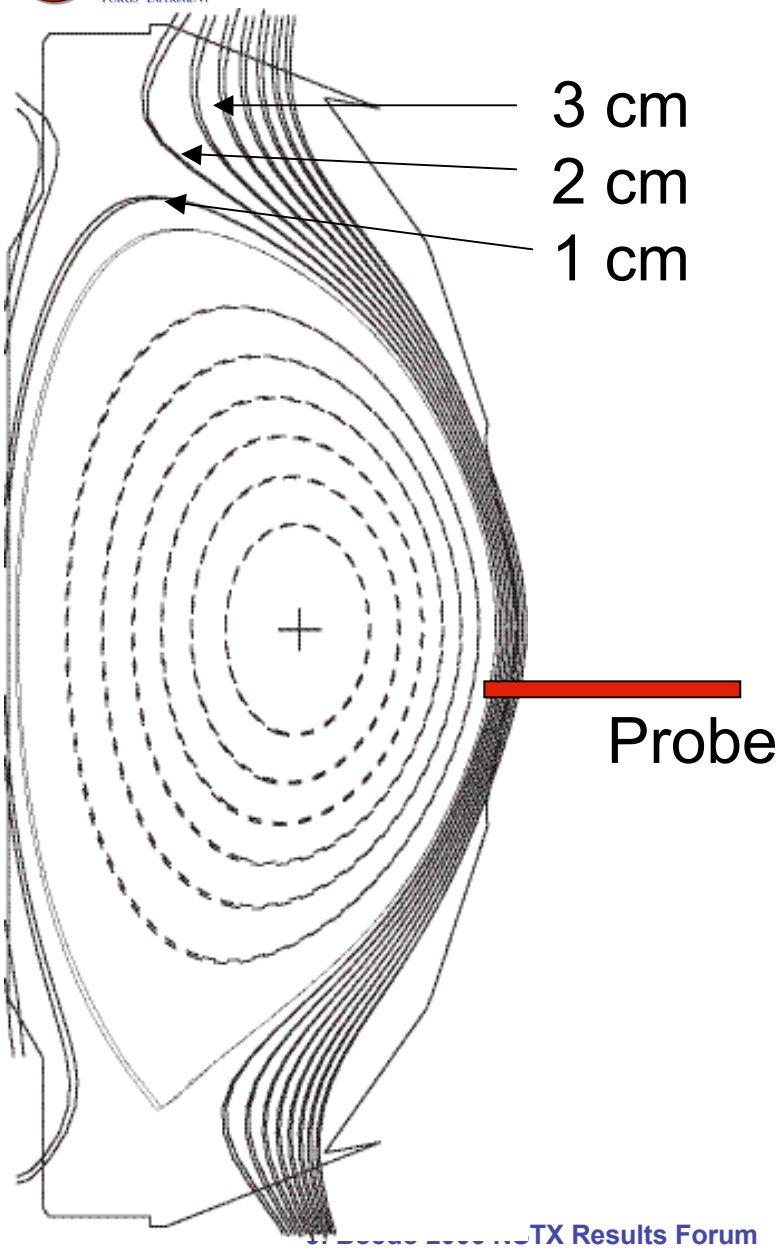
- General Information:
  - Located ~7” below midplane
  - 10 tips (1xIsat, 2xDP, 2xImach, 4xVf (Er, E_θ)
  - Measures: Te, Ne (~3 ms), Isat, 2xE_r, 2x E_θ, Mach #, V_{par} , Γ_r, V_r, etc)
  - Yet to be implemented (Fast Te, Ne, Bfluct)
  - Bandwidth ~ 4 MHz
  - DAQ Sampling 1MS/s
  - In/out time ~ 80 ms

- Recent Improvements:
  - New electronics (better S/N, shielded)
  - New shaft (lighter, better shielded)
  - >> Faster probe



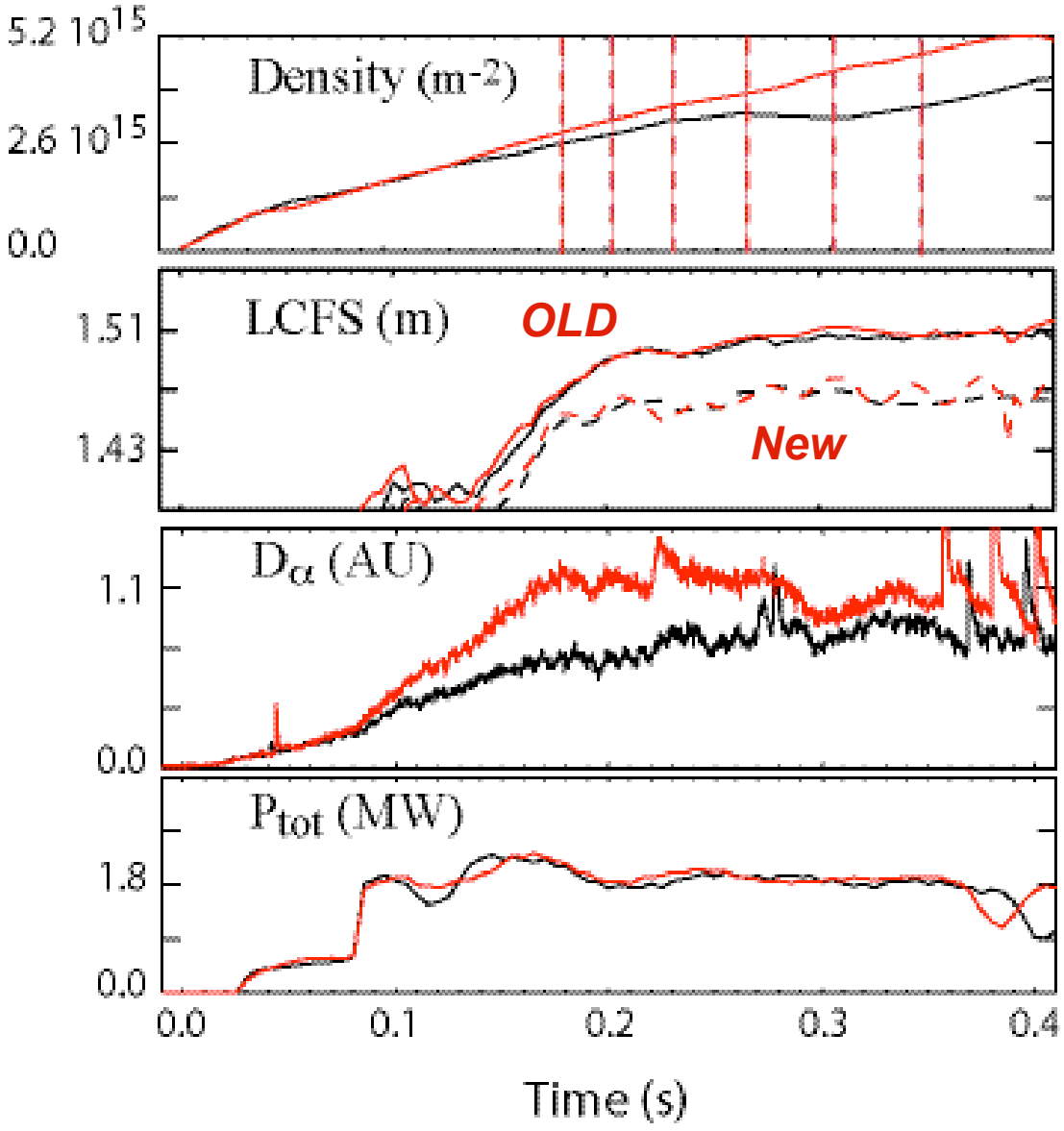


Shape Reproducible



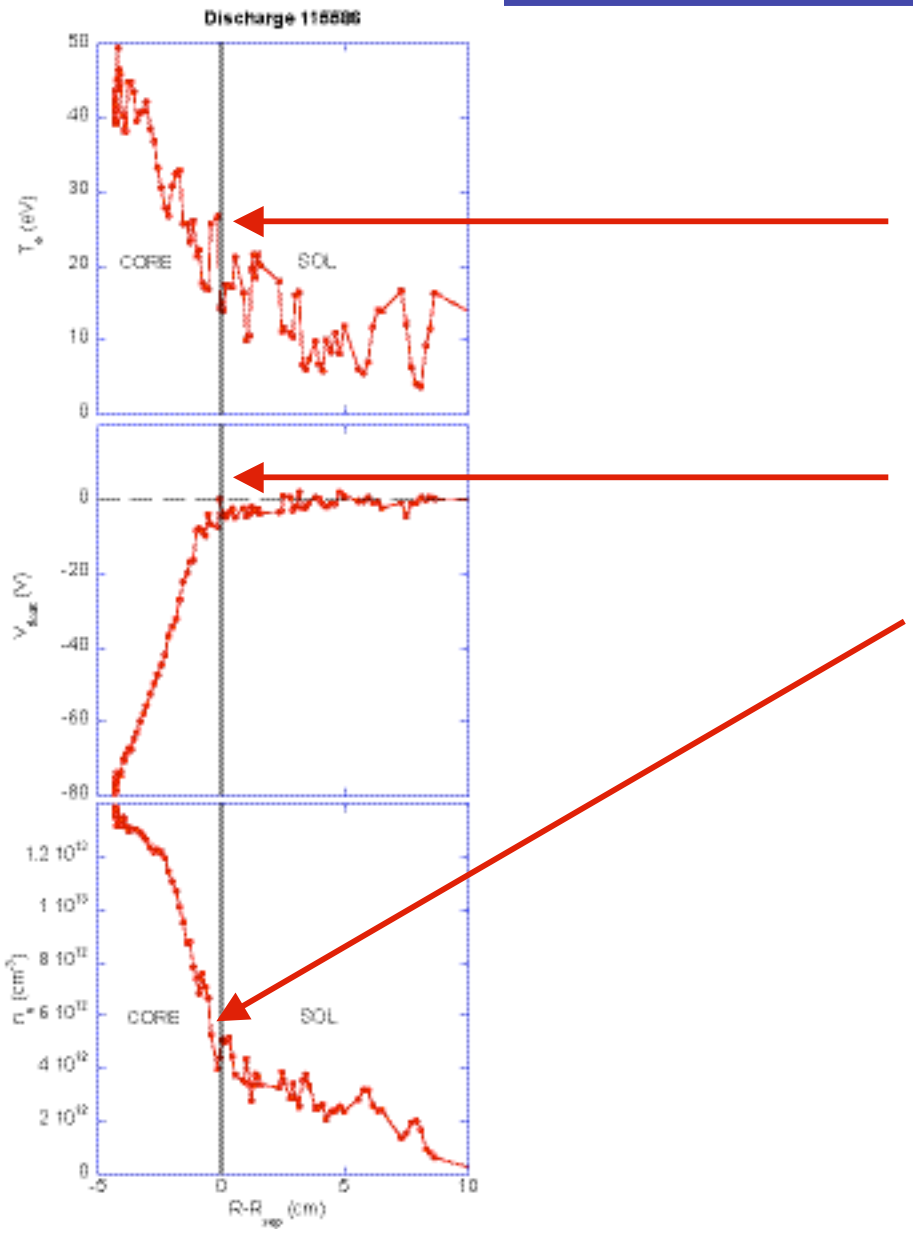
- Used LSN discharges
- L and H-mode (showing mostly L)
- Ptot~ 2 MW
- Bt~0.44 T
- Ip~800 kA
- W~ 0.07 MJ
- Rmidout~ 1.46 m
- Connection length varies rapidly across SOL

Radial Transport vs Density



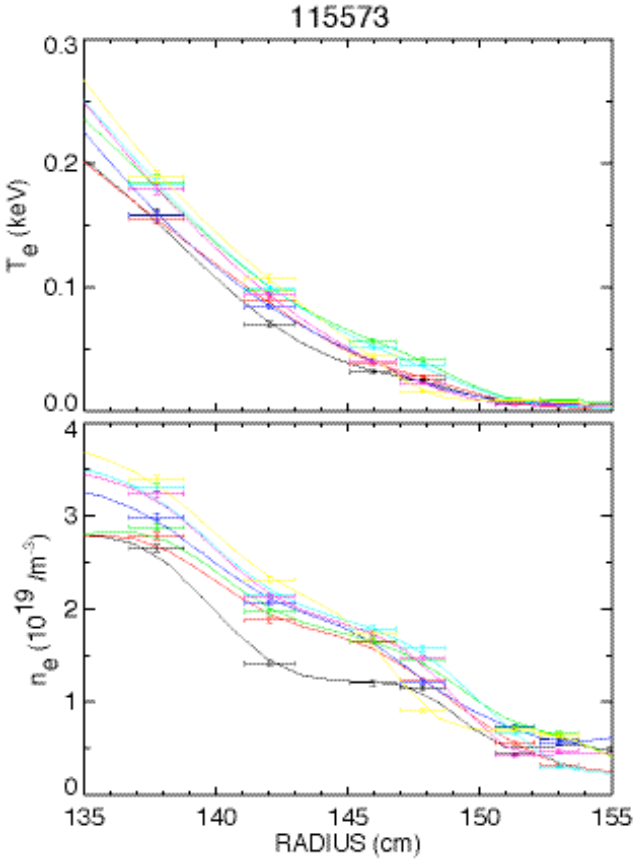
- Probe plunges at various times during the discharge as density increases
- Higher averaged density is obtained by increased initial gas puffing
- New Te-constrained EFIT crucial for edge work

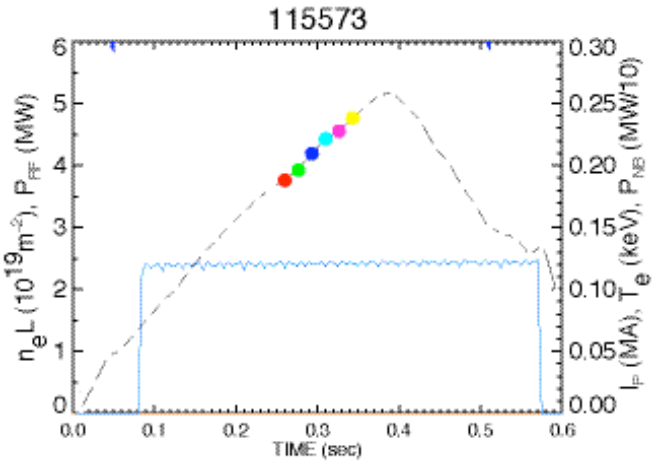
Constrained EFIT consistent with probe data



- Fast rise in Te
- Drop in Vf
- Fast rise in Ne
- Pedestal clearly separated from SOL
- Must also account for R-Rsep fast variations

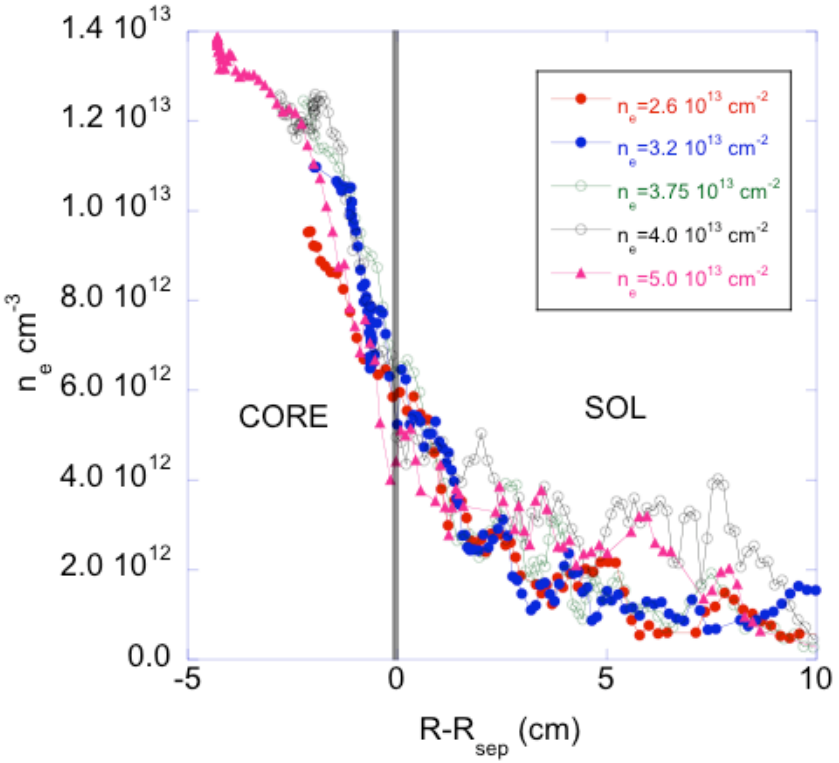
TS profiles show pedestal/edge Ne varies in time

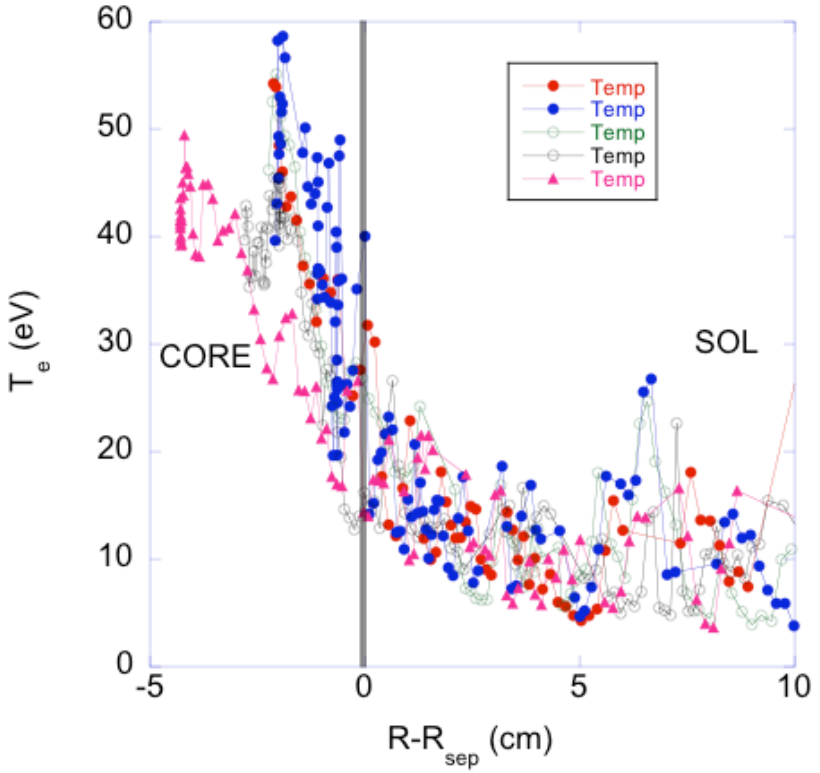




- Pedestal profile evolves with time as core Ne evolves

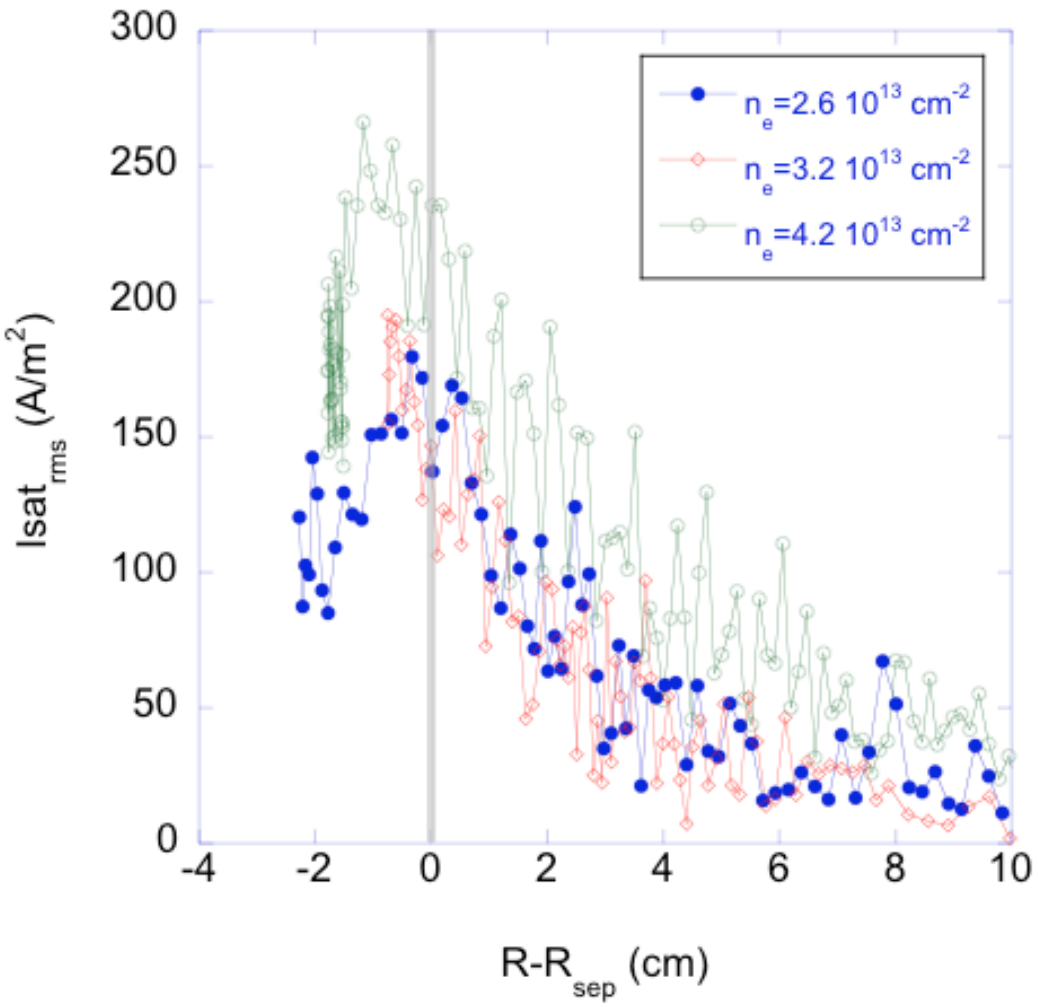
SP profiles show edge Ne, Te vary





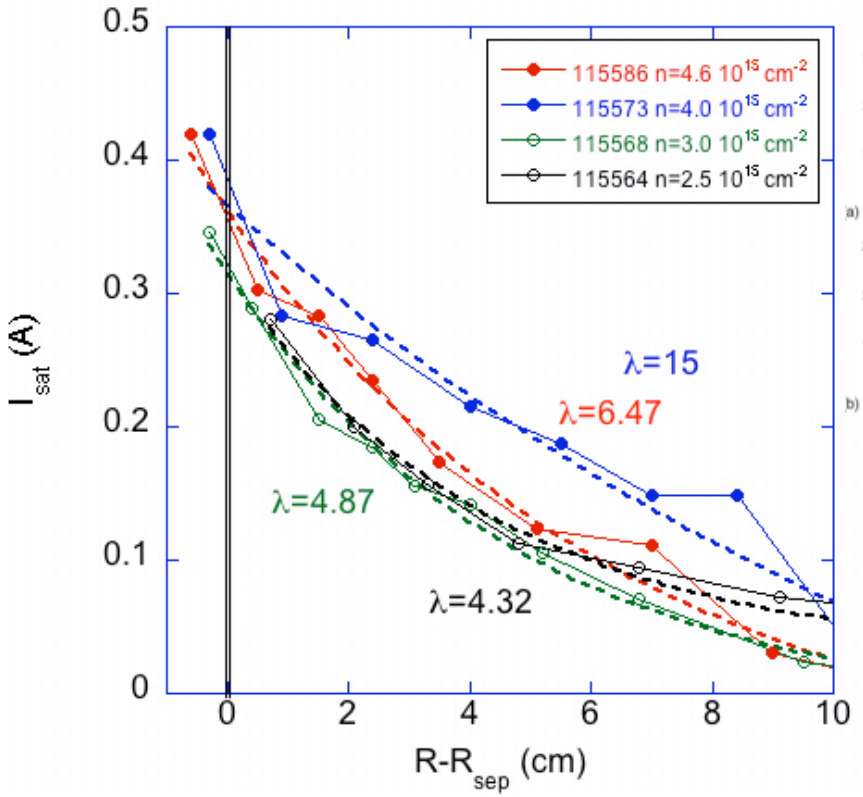
- SP profiles of pedestal/edge Ne, Te show significant change with average density.
  - SOL plateau at high Ne >> fast radial transport in SOL increasing w collisionality
  - Pedestal Ne increases
  - Pedestal Te drop > thermal catastrophe (D'ippolito, Myra)?

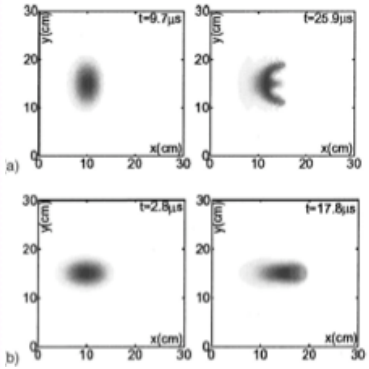
Isat rms Increases w Ne



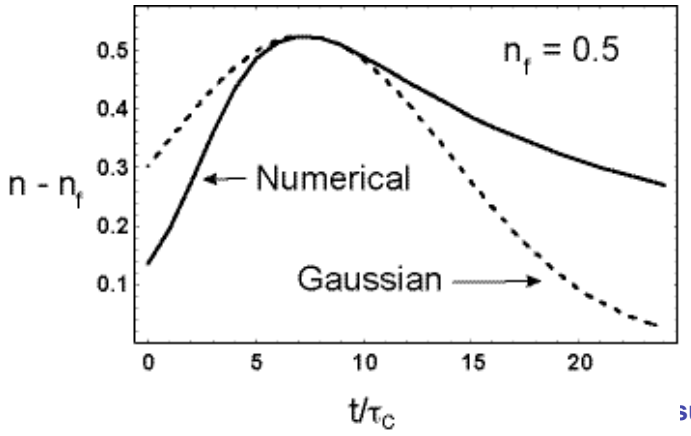
- Isat rms peaks ~ @LCFS (high gradient)
- Drop of rms value INSIDE separatrix> Filament birth region
- Dependence on density apparent only at highest values
- Decay with R
- What does this mean microscopically?

Conditional Averaging Separates Intermittency



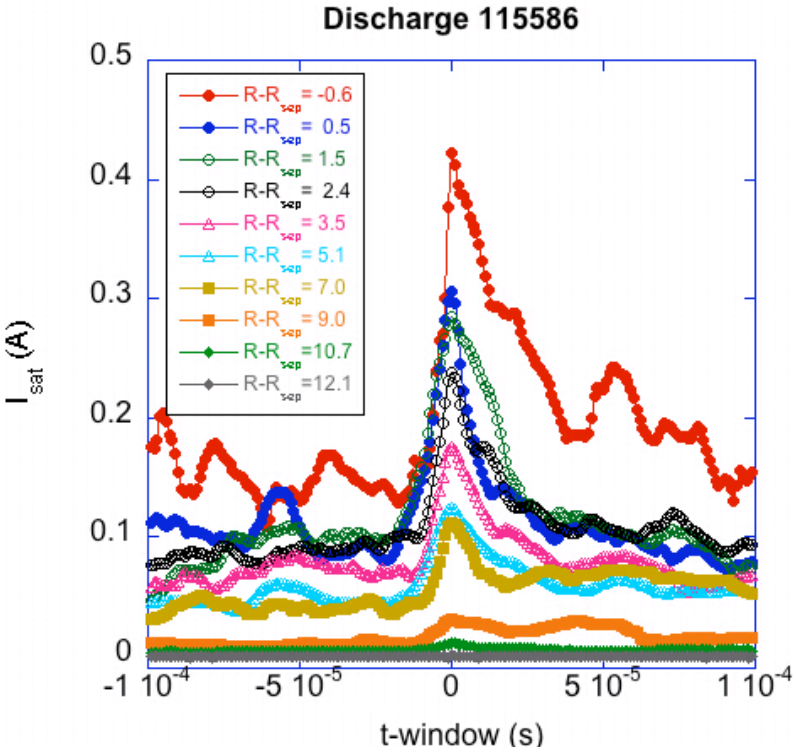


- Intermittent objects density decays quickly
- Decay length increases w/ Ne

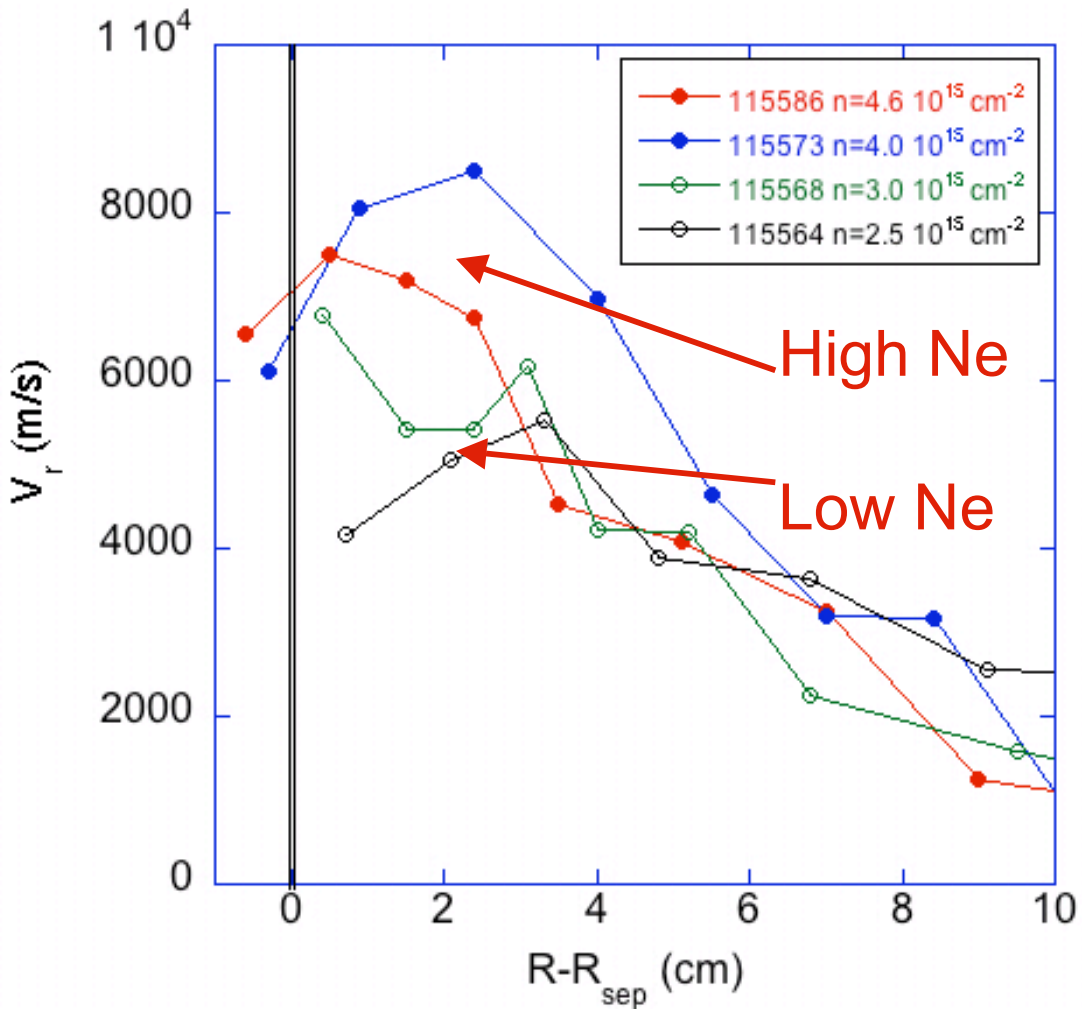


Simulations reproduce tail

D'Ippolito, Myra, et al.



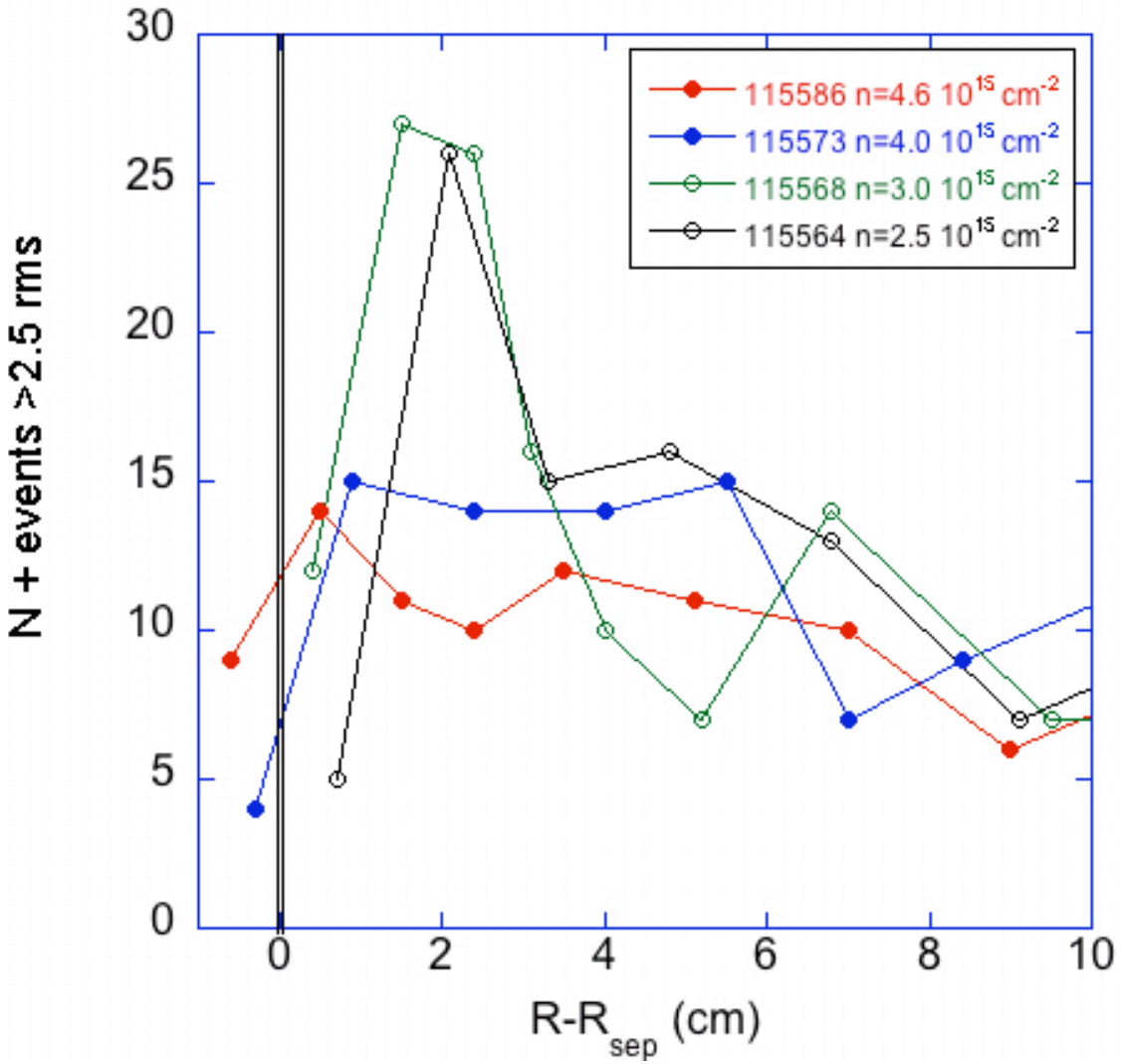
Radial Velocity Decays w R



- $Vr=E_\theta/B_T$
- Bt~ 0.24 T
- Velocity drops with R >> Filaments slow down due to lower Te*
- Higher Vr at High Ne near LCFS >> Filaments are sheath-disconnected near LCFS at high Ne*

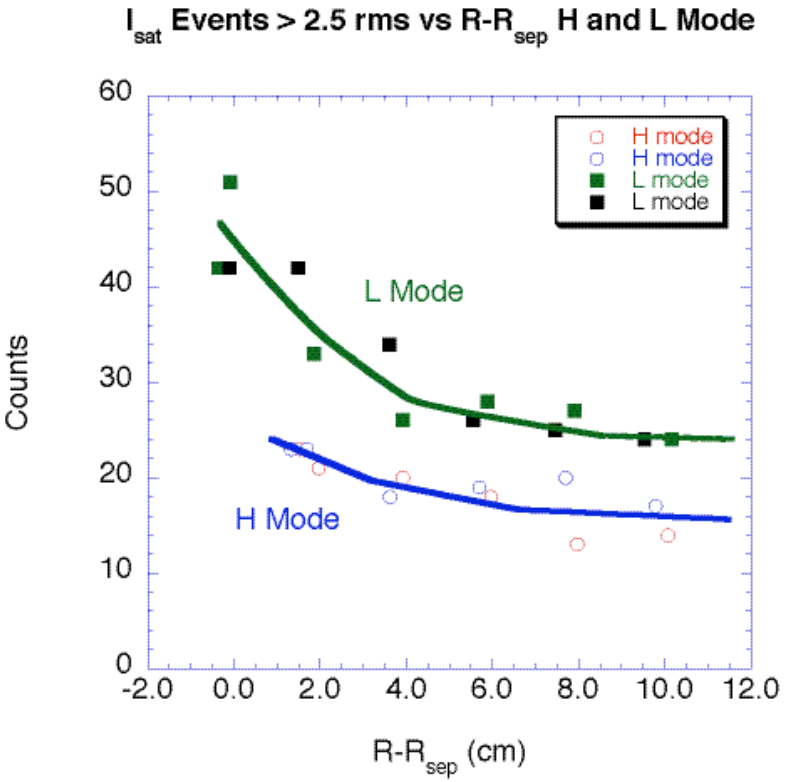
*D'Ippolito, Myra, et al.

Number of Events Dependent on Density

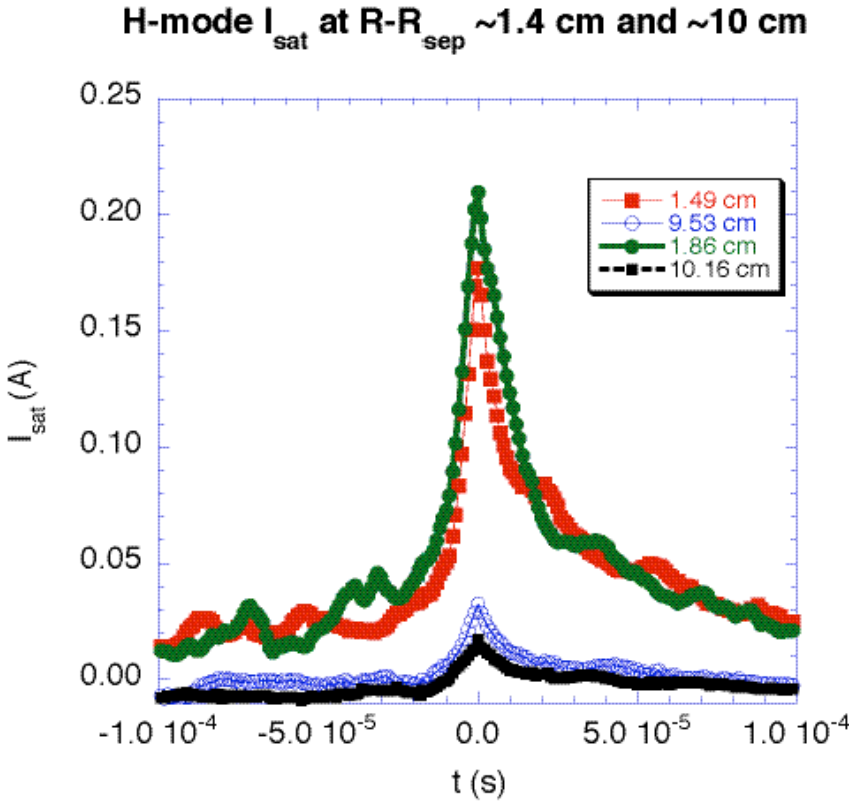


- Number of positive events > 2.5 rms approaches 0 at LCFS (hole region)
- Lower ne discharges have more events near LCFS? >> Due to filament pileup?

L-Mode and H-mode differ

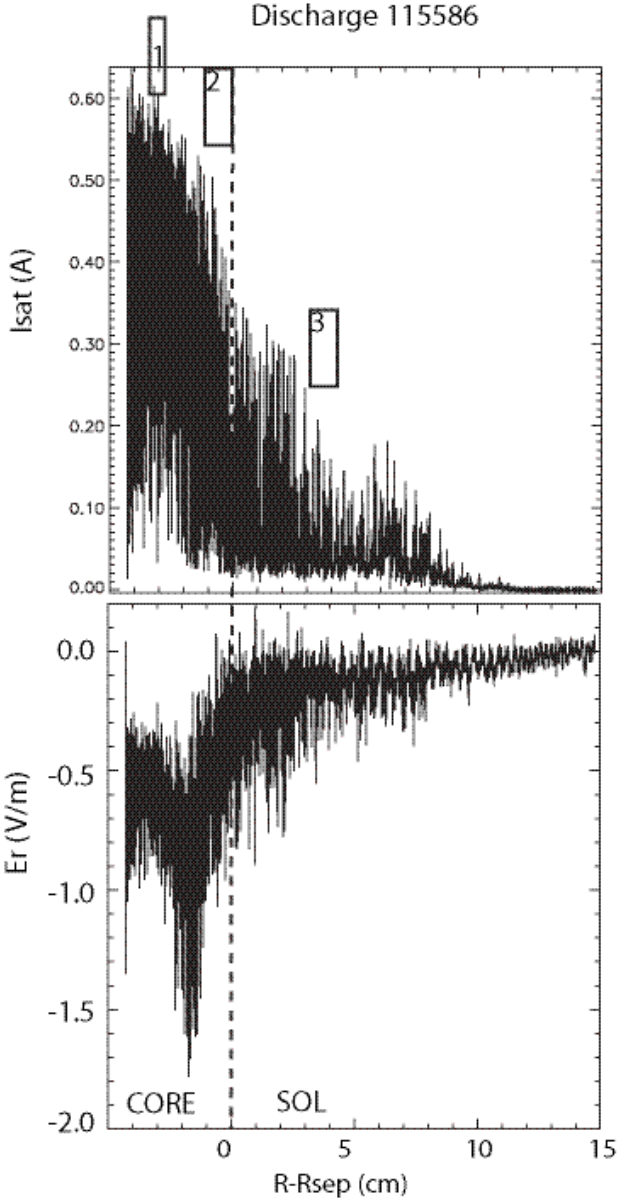


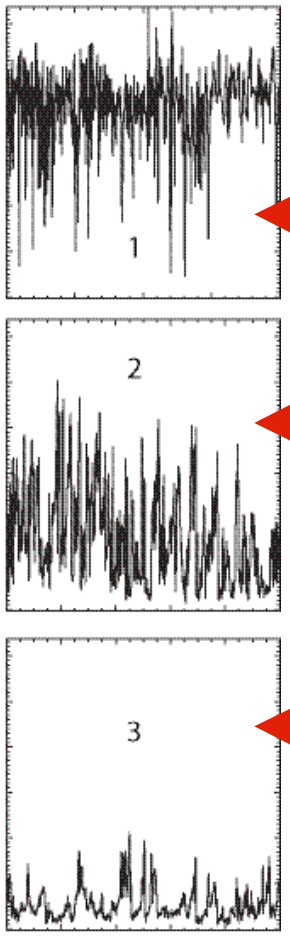
- Intermittent plasma objects decay radially in two ways:
  - Amplitude
  - Number of events per time



- L-mode almost 2x H-mode frequency
- H-mode decay length much shorter
- Amplitude near LCFS 5x that near wall

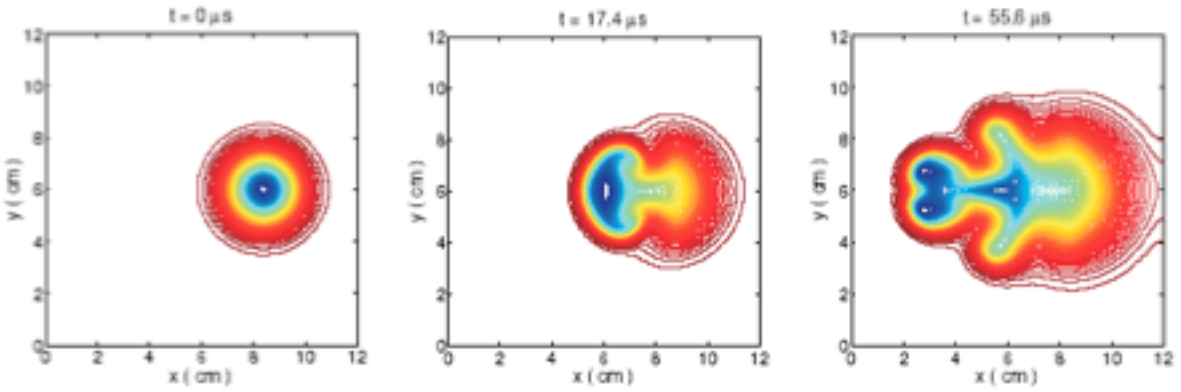
Holes and Peaks Observed





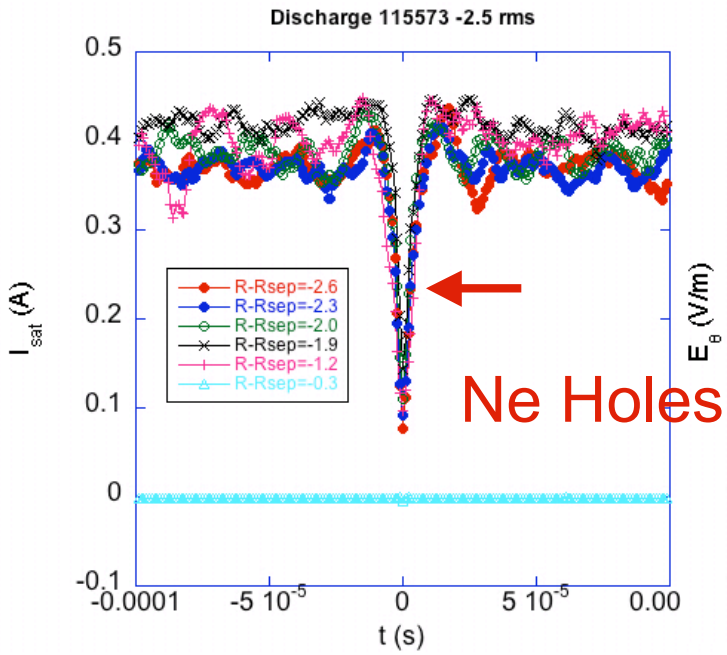
- Density holes observed for R-Rsep < -1
- Mixed -1<R-Rsep <0
- Peaks only R-Rsep>0
- Filaments are born in that region

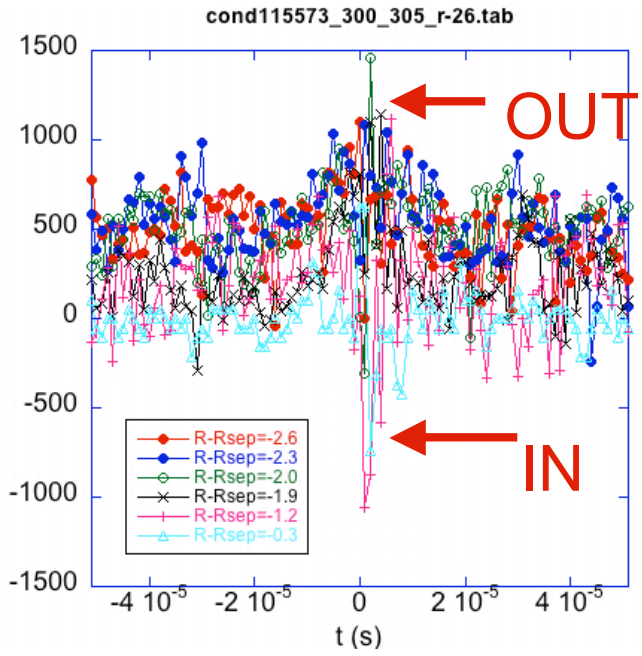
Hole Dynamics



- Holes predicted in simulations
- Holes observed in NSTX (and DIII-D)

Simulations predict holes and hole dynamics
***Yu, Krashenninikov*, et al.**





- Holes move inward ONLY in a narrow zone in NSTX! (Implications?)

Similarities and Differences w DIII-D

- Similarities:
  - Holes inside LCFS
  - Peaks in SOL
  - Radial velocity and density decay with R
  - Filaments form slightly inside LCFS
  - High Vr at LCFS (~3-4 km/s), quick slowdown

- Differences:
  - Weaker Ne dependence in L-mode
  - Holes move inward only in narrow band (wide band and SOL in DIII-D)
  - L-H mode differences mostly # of events