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Variation of T_e, n_e, and Particle Flux at the Divertor Surface with NBI Power for H-mode Plasmas in NSTX

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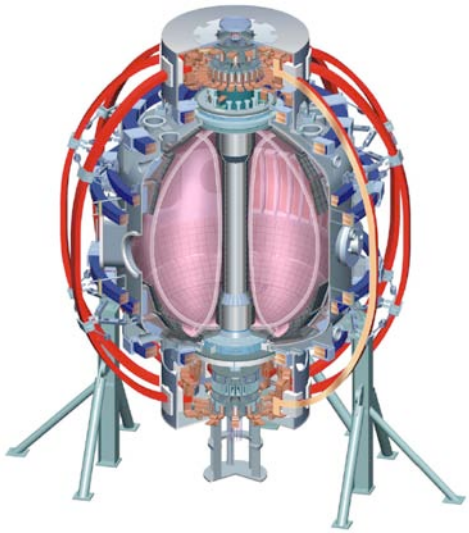

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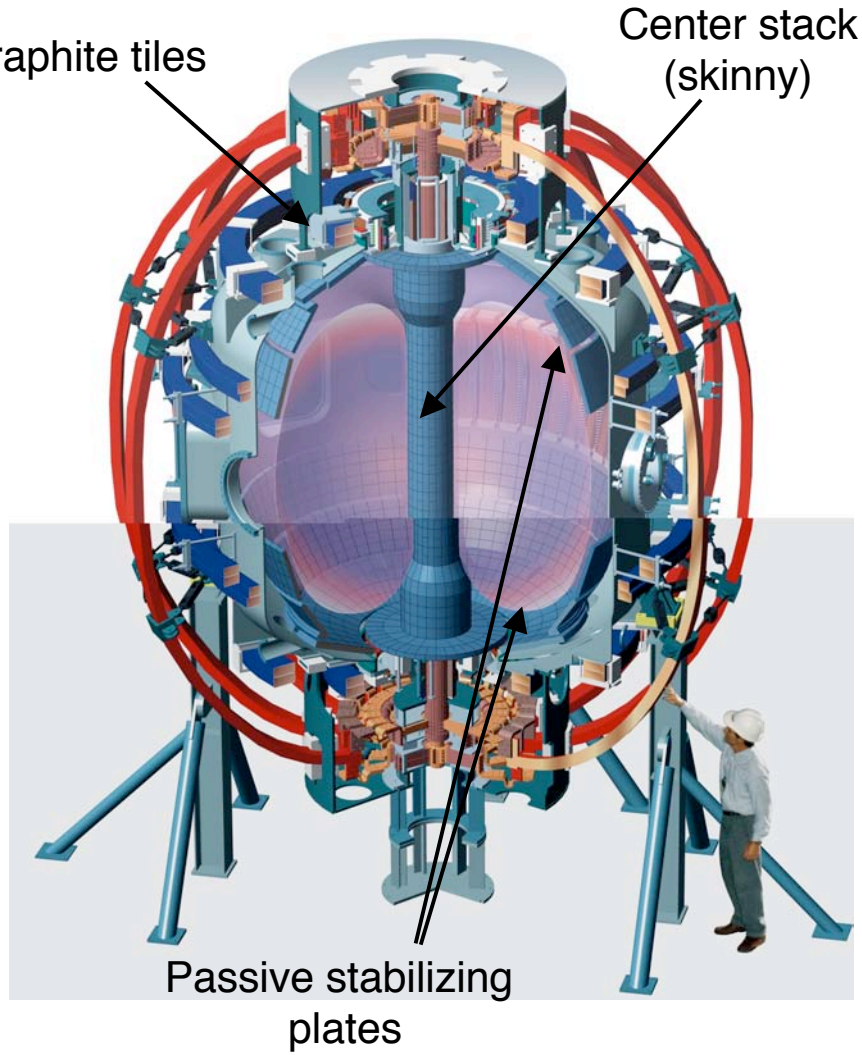
Abstract

•The interaction of the diverted plasma from the edge of NSTX NBI heated H-mode plasmas with the divertor surfaces has been studied using an array of divertor Langmuir probes and other diagnostics. This study included NBI injection power scans and different divertor configurations, including lower single null (LSN) and double null (DN) divertors, over a range of plasma conditions. For a toroidal field of B_t = 0.45 Tesla, the plasma current, I_p, range was 0.6 to 1.0 MA. The NBI power scan was P_b = 1-6MW. An array of Langmuir probes, flush mounted with the plasma facing surfaces of the divertor tiles, were used to obtain divertor T_e, n_e and particle flux. The particle flux to the probes increased with P_b, however, the variation in T_e is more complex, possibly due to divertor strike point drift and variations in dynamics of the main chamber plasma. Results for LSN and DN configurations will be discussed and compared. Correlations between probe T_e, n_e, and particle flux, and divertor heat flux, D_α signals and other divertor diagnostics will also be discussed.

NSTX Explores Low Aspect Ratio (R/a≥1.27) Physics Regime



Enabling Capabilities:

- **350° C bakeout of graphite tiles**
- **Regular boronization (~3 weeks)**
- **Helium Glow between discharges**
- **Center stack gas injection**
- **Error field reduction**

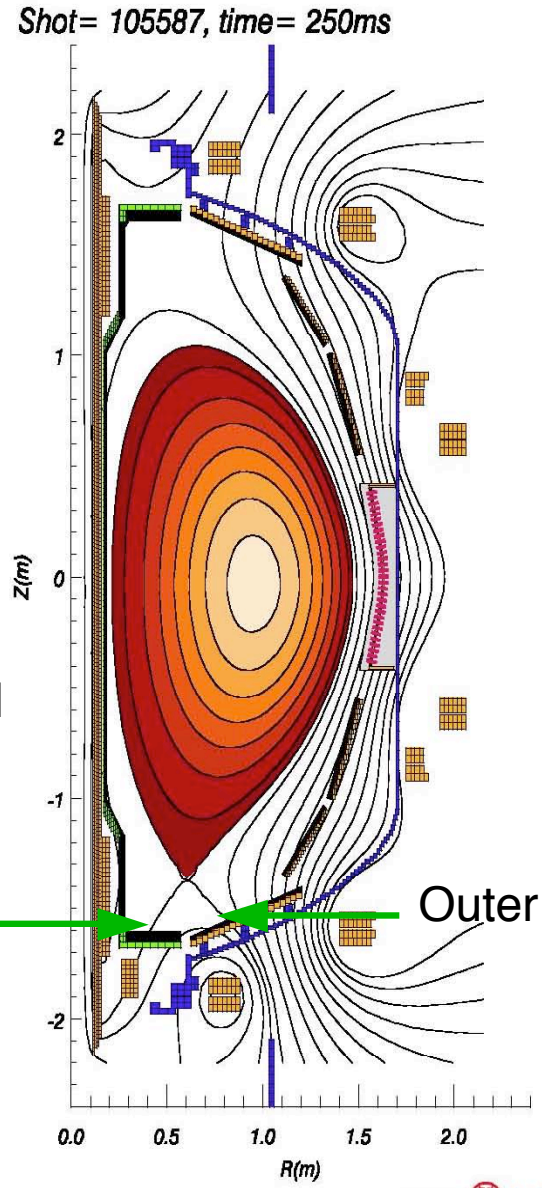
Parameters Achieved:

Major Radius	**0.85m**
Minor Radius	**0.67m**
Plasma Current	**1.5MA**
Toroidal Field	**0.6T**
Heating and Current Drive	
NBI (100keV)	**7 MW**
RF (30MHz)	**6 MW**

Outline

- Initial NSTX Langmuir Probe System is a coarse array
  - Sample IV Characteristic data
- Langmuir Probe data obtained for vast majority of shots
  - Especially the last 3 campaigns
  - Data for many configurations
  - Data for many conditions
- Report Emphasizes a Beam Power Scan
  - Also a series of Gas Puff experiments
- I_{sat}, T_e reported for a limited set of experiments
- Summary

EFIT Equilibrium Plots Show Strike-Points



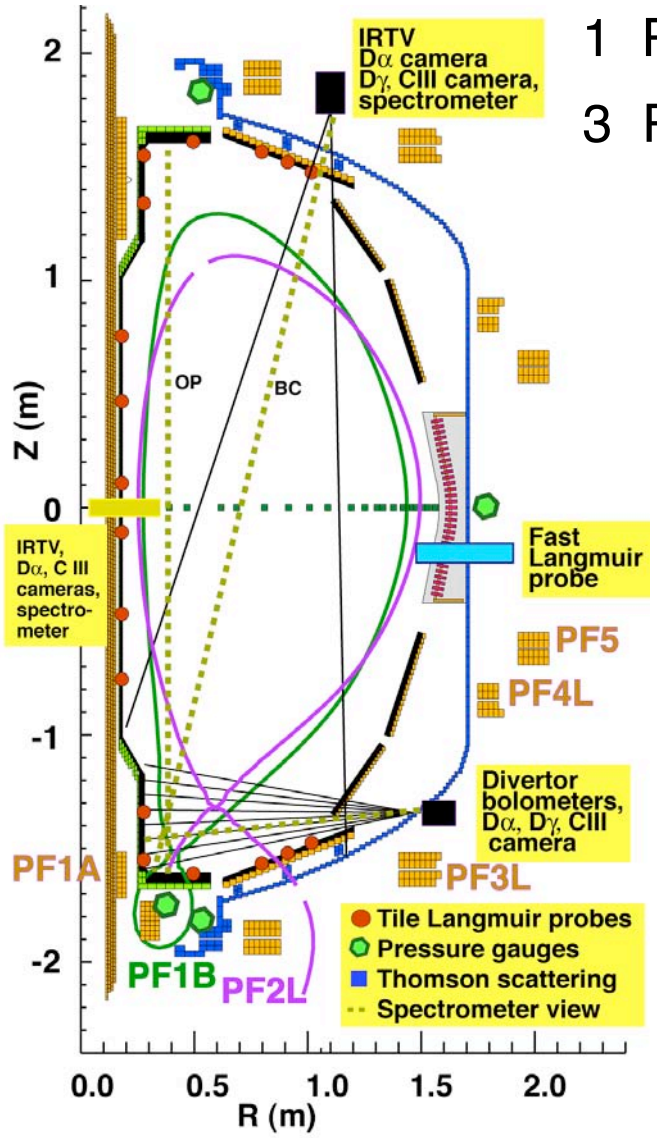
Lower Single-null Divertor

Inner Strike-point

Outer Strike-point

The EFIT equilibrium shows the location of the inner and outer strike-points on the divertor plates of NSTX . In general the strike-points and measured probe positions are in good agreement.

Divertor Langmuir Probes

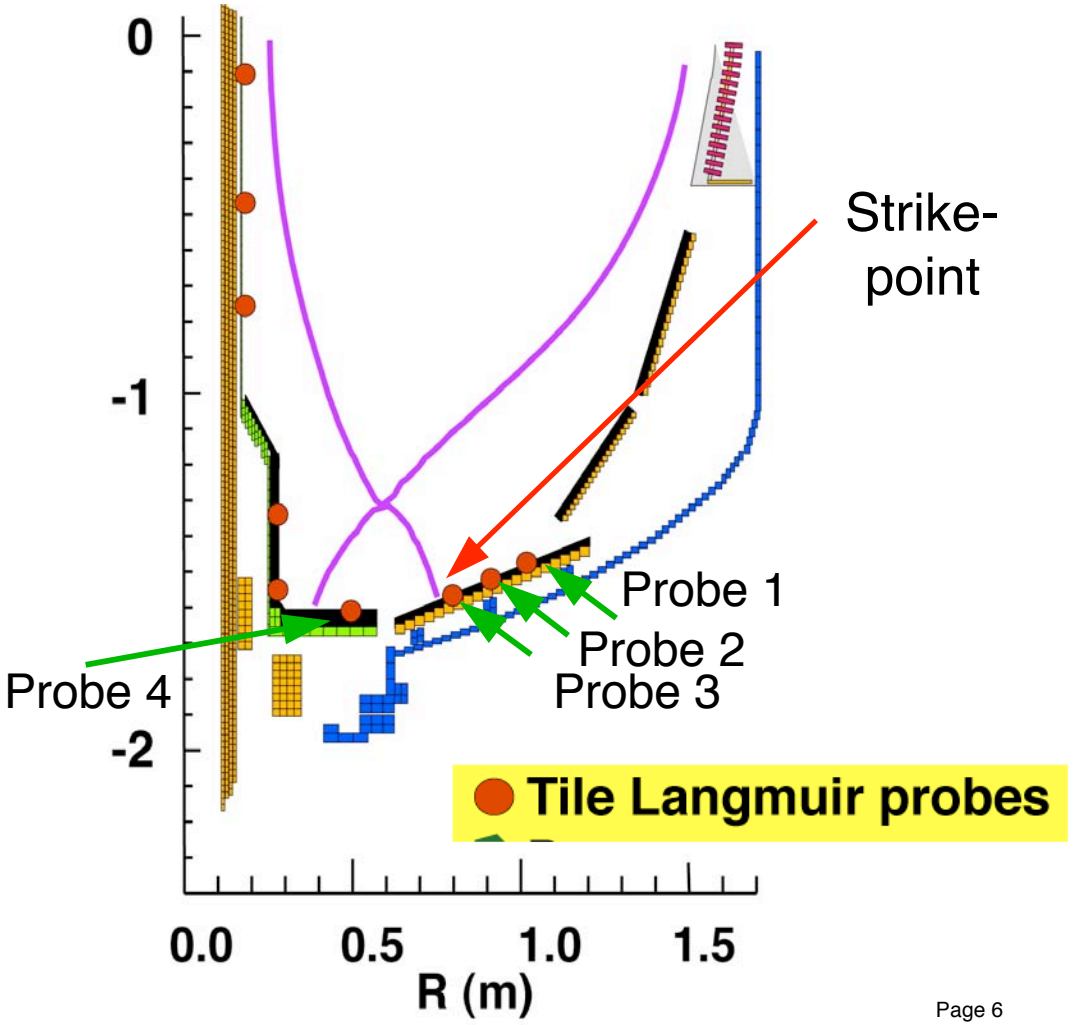


1 R(probe 1) = 1.02 m

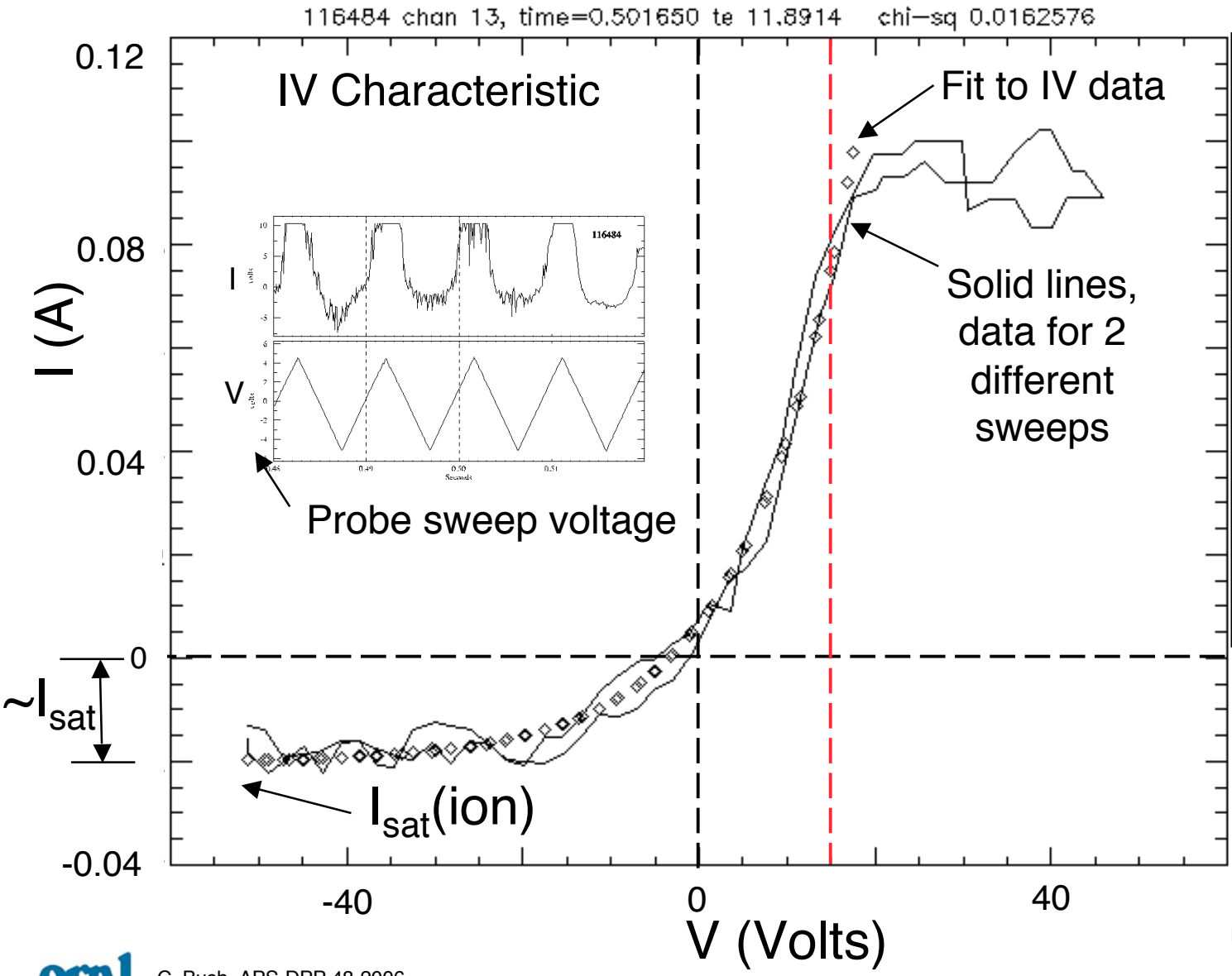
2 R(probe 2) = 0.91 m

3 R(probe 3) = 0.80 m

4 R(probe 4) = 0.49 m



Fit to IV Characteristic for Flush Probe



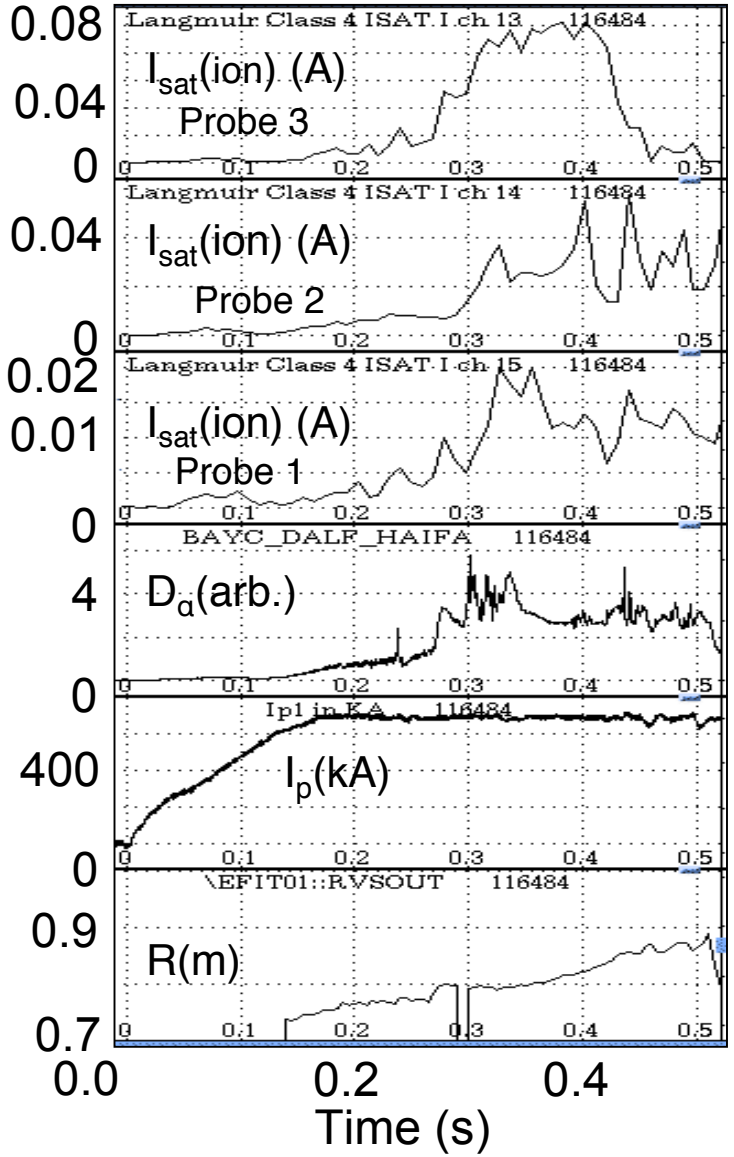
Sweep voltage ± 50 volts

Only points V < V_{Limit} included in fit.

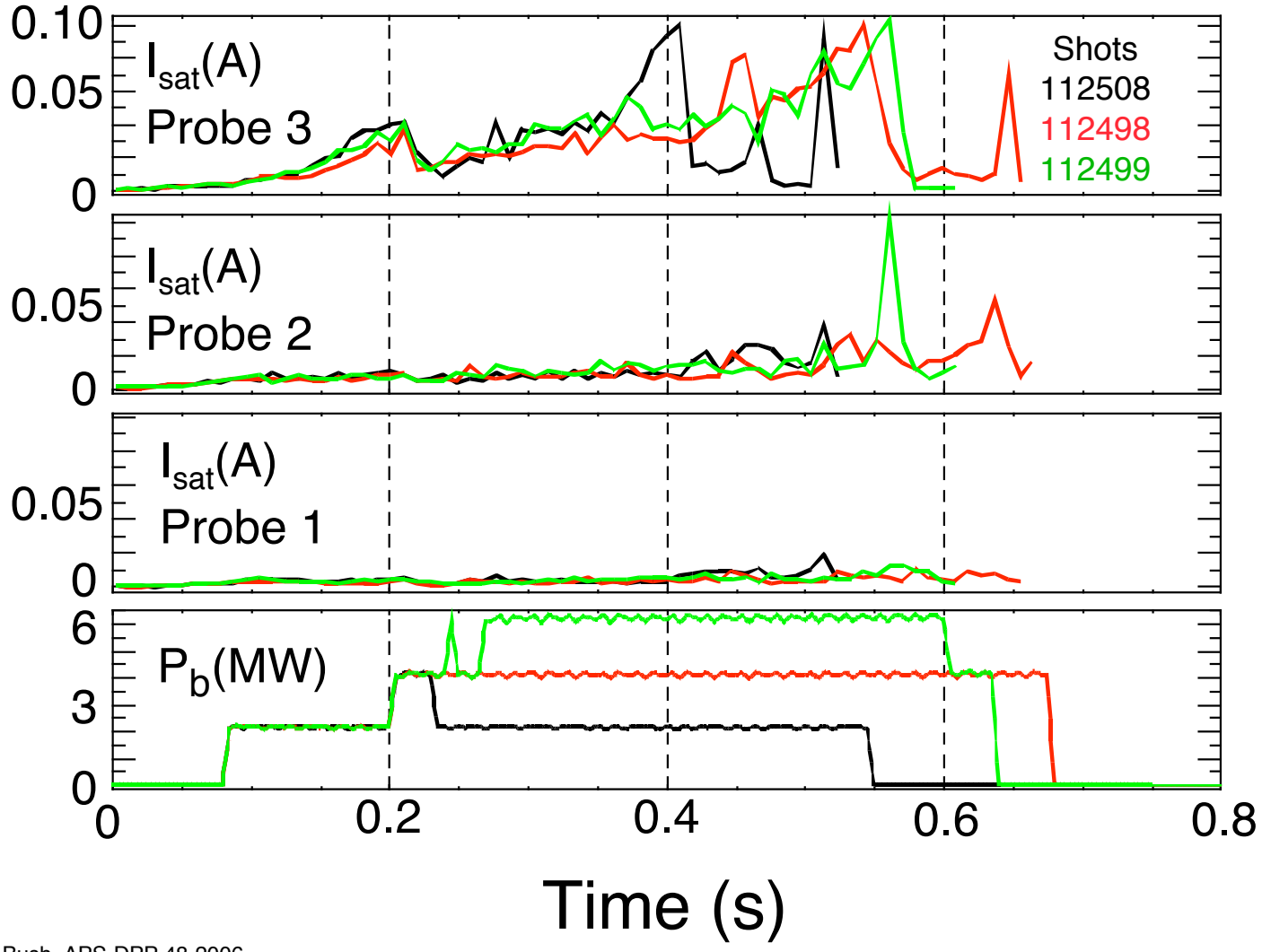
Here V_{Limit} = +15 V

The relatively flat upper part of curve due to 10 volt limit on digitizer *not* to electron current saturation

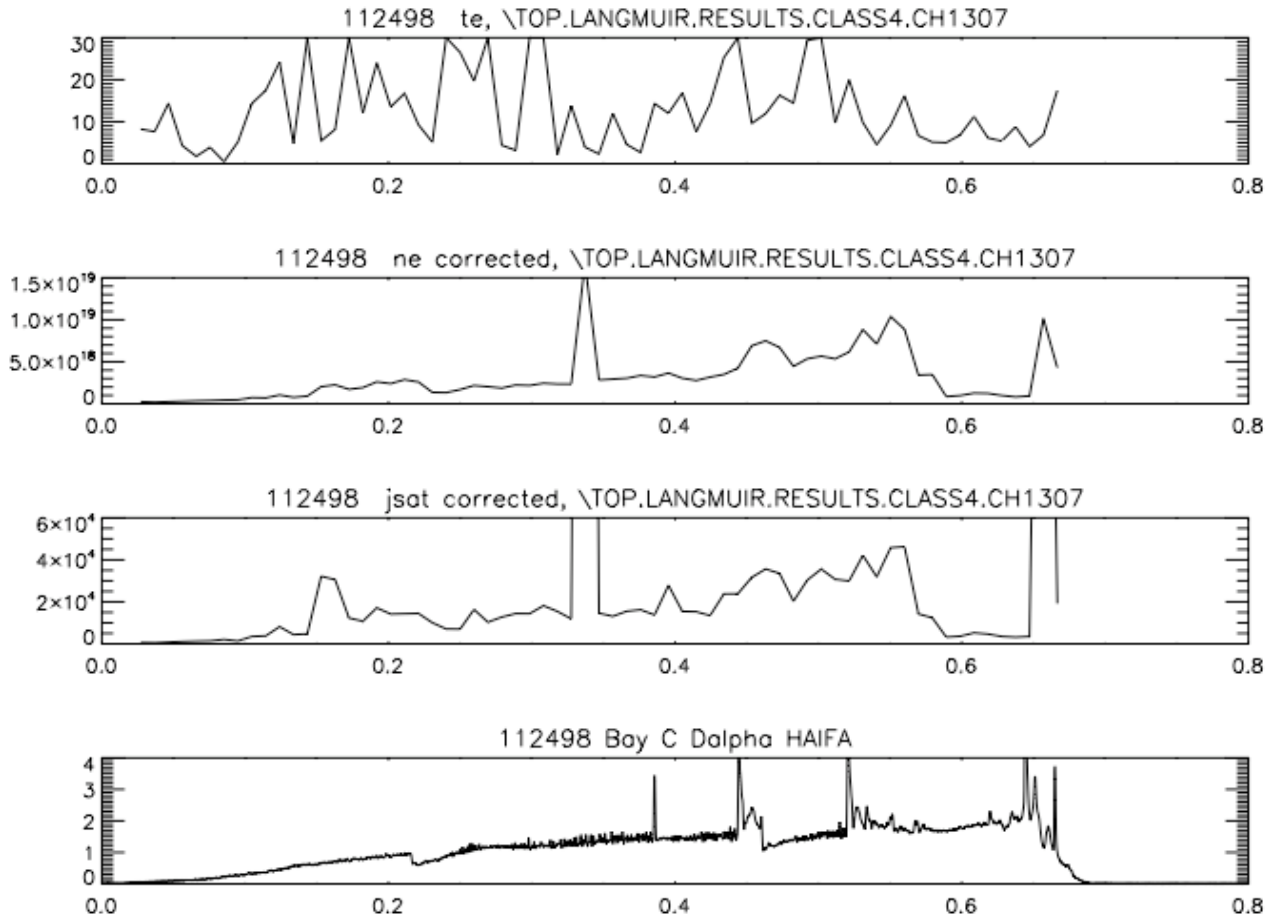
Waveforms of I_{sat}- Outer Divertor Probes



Variation of I_{sat} with NBI Power

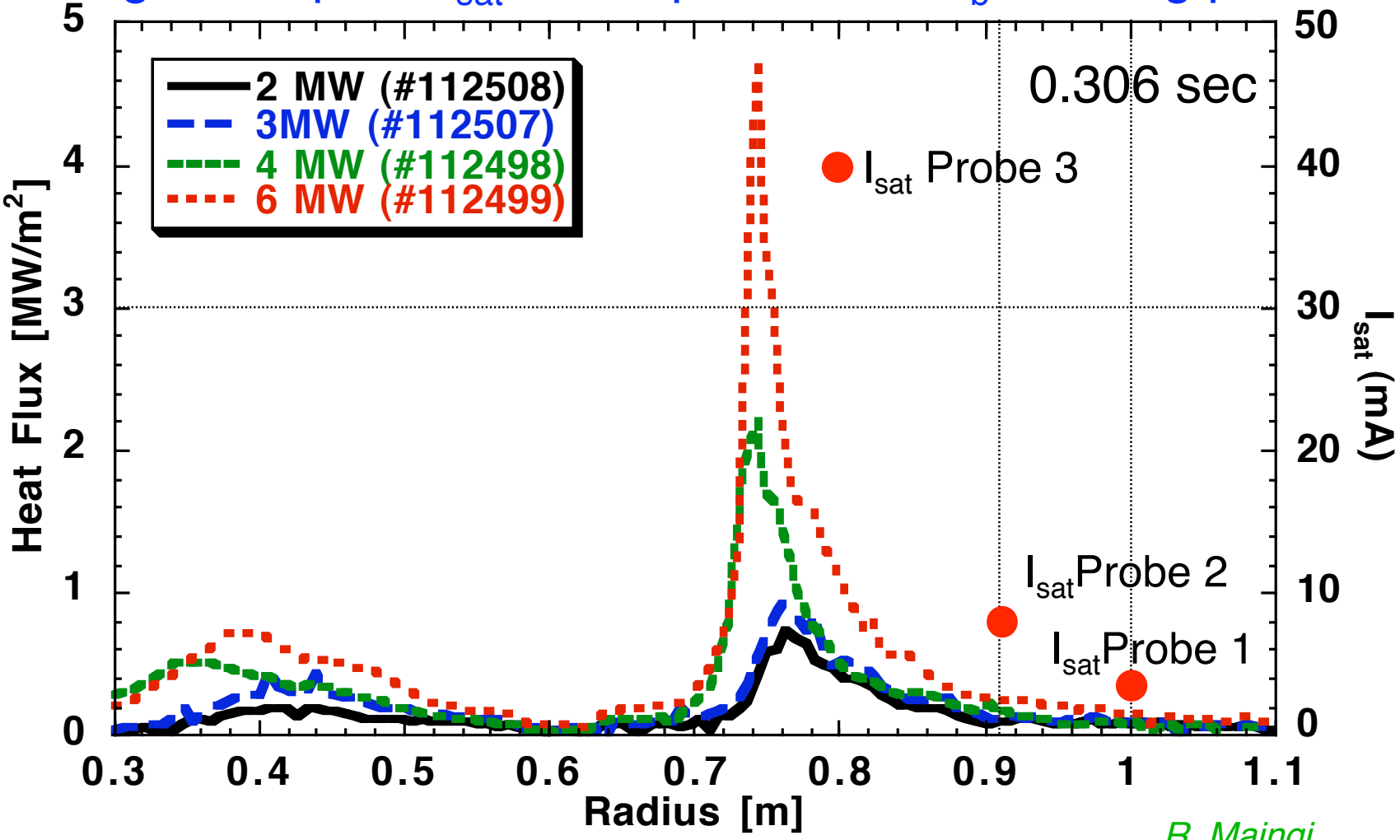


Variation of J_{sat}, t_e and n_e vs time



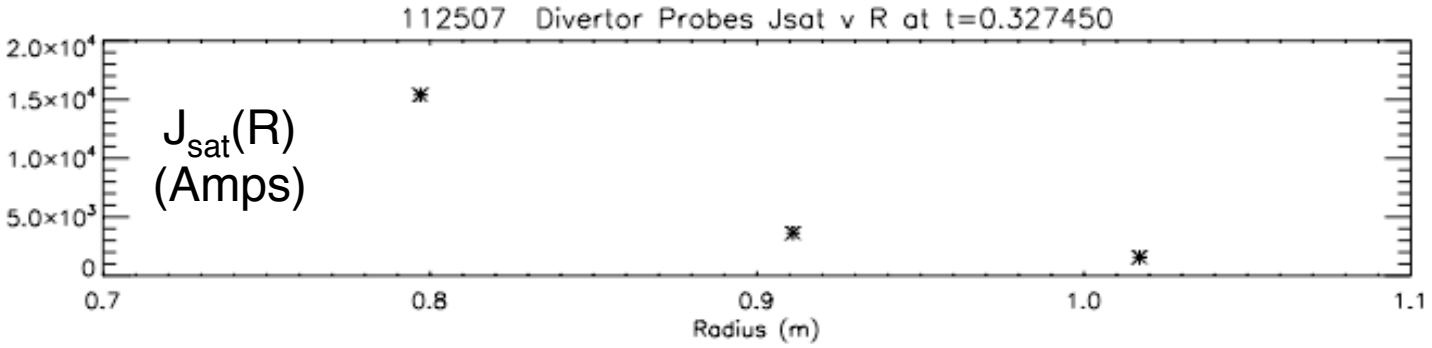
Heat Flux Profile Becomes More Peaked with Increasing NBI Power

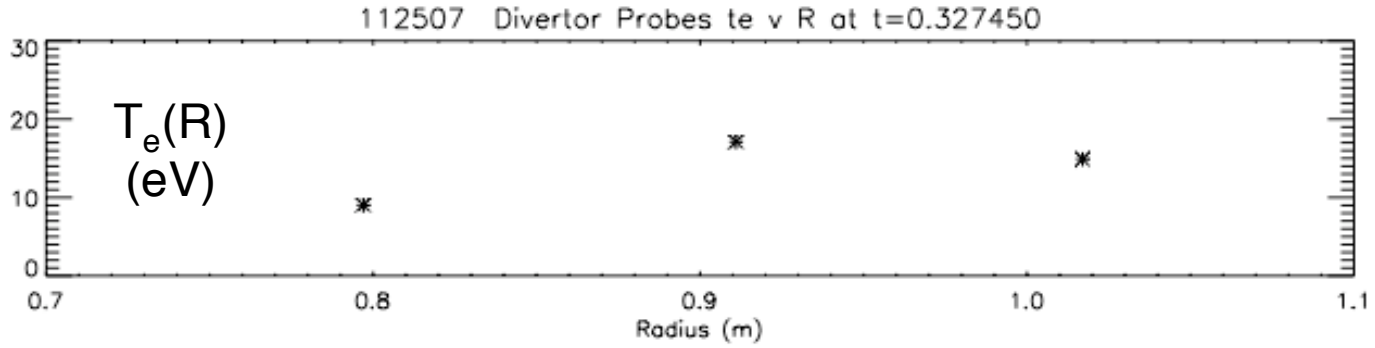
- Peak in I_{sat} occurs near peak heat flux
- In general peak I_{sat} is independent of P_b, heating power

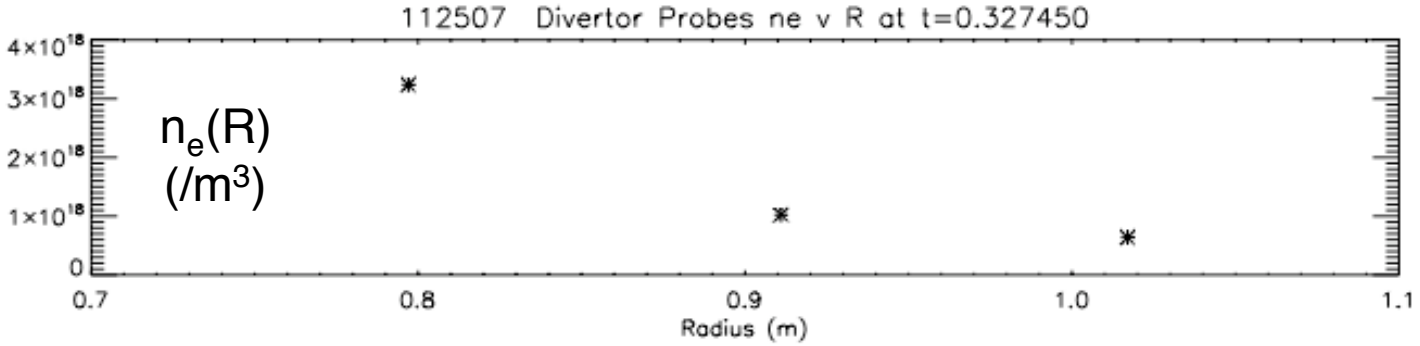


R. Maingi

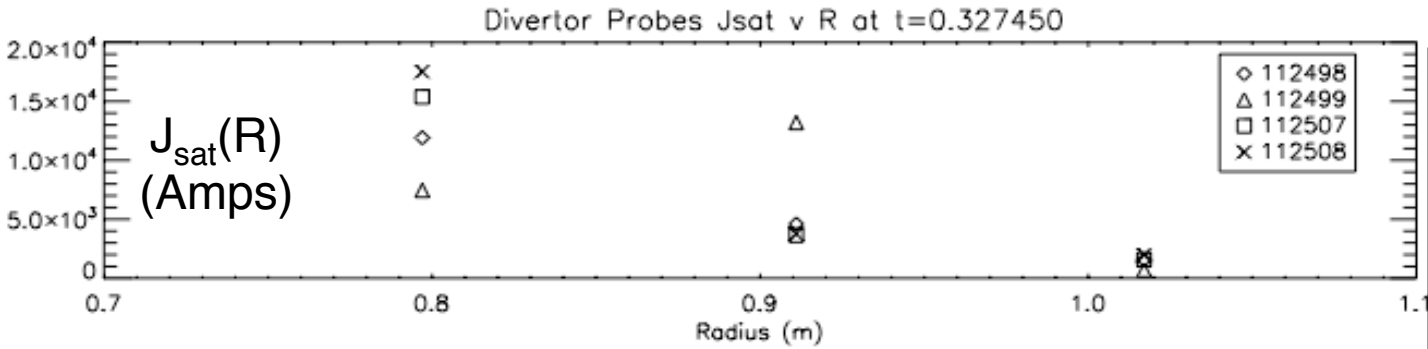
Radial Variation of J_{sat}, t_e and n_e on Divertor Plate for NBI Power = 3 MW

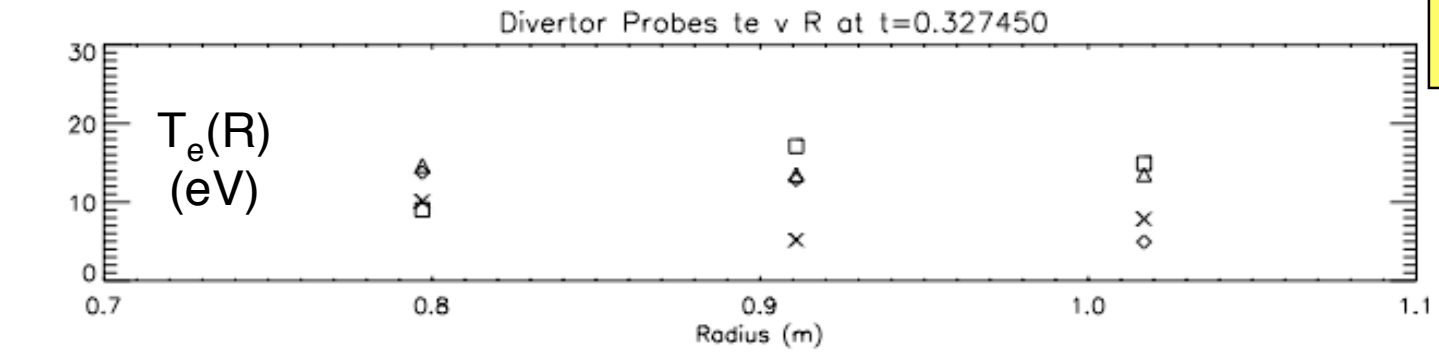


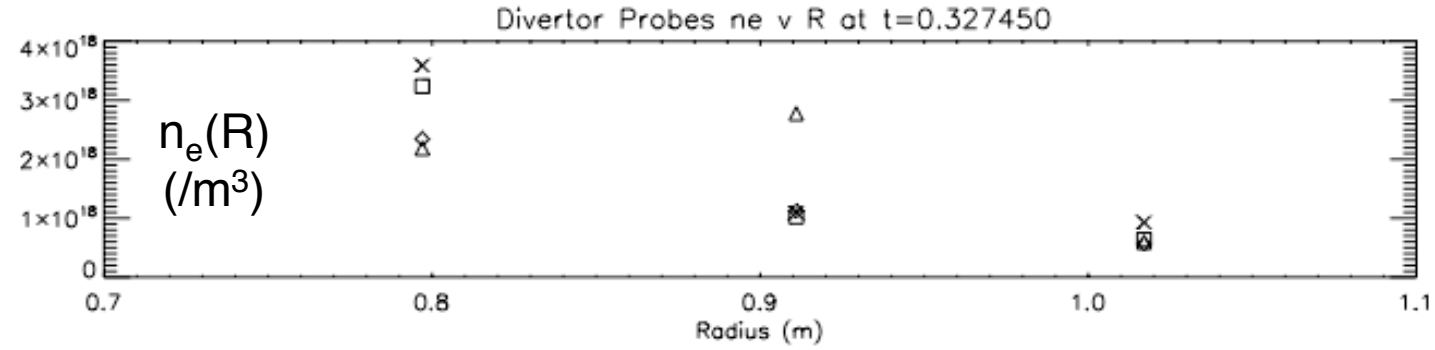




Radial Variation of J_{sat}, t_e and n_e on Divertor Plate with NBI Power







NBI Power Scan

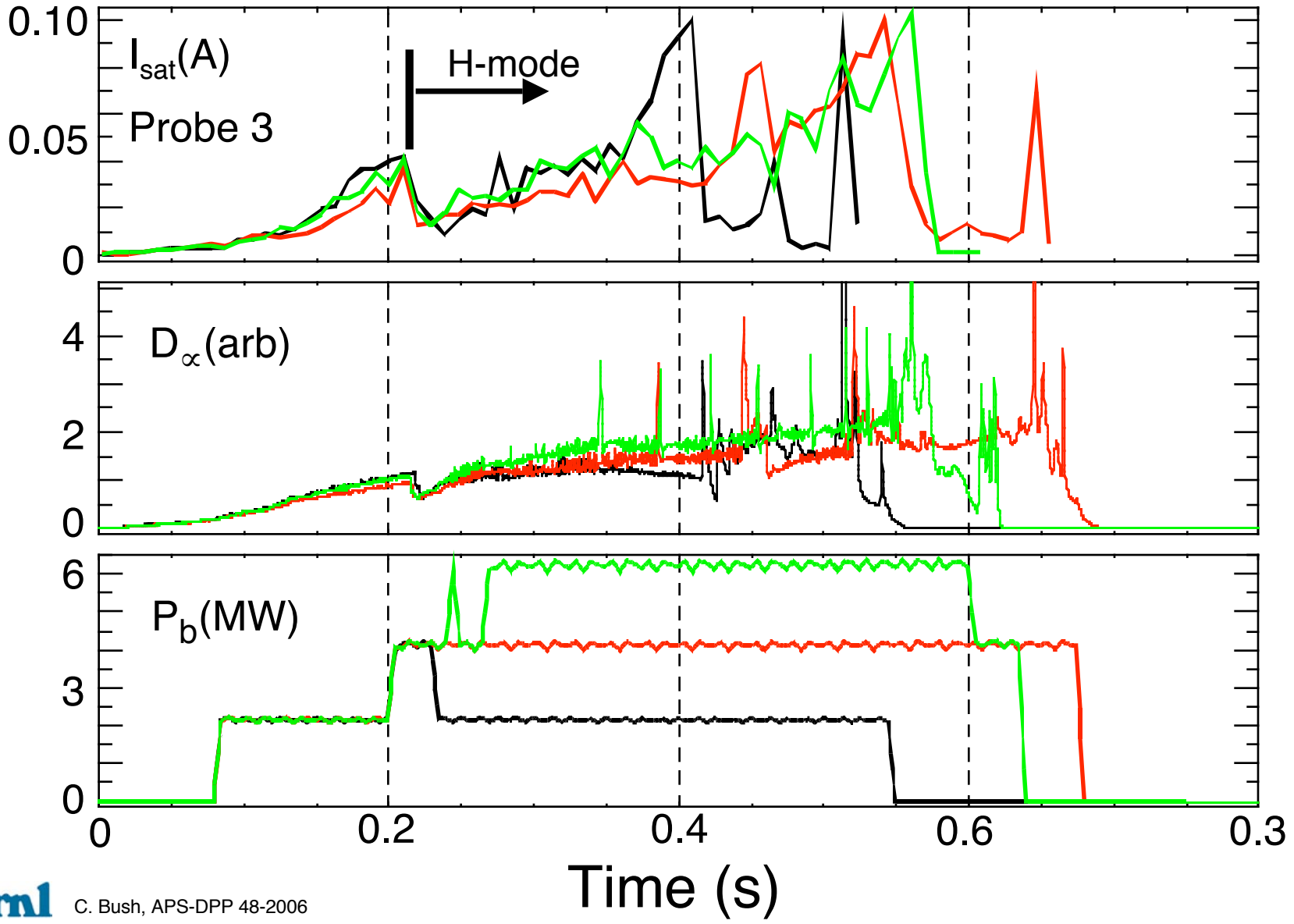
2 MW 112508

3 MW 112507

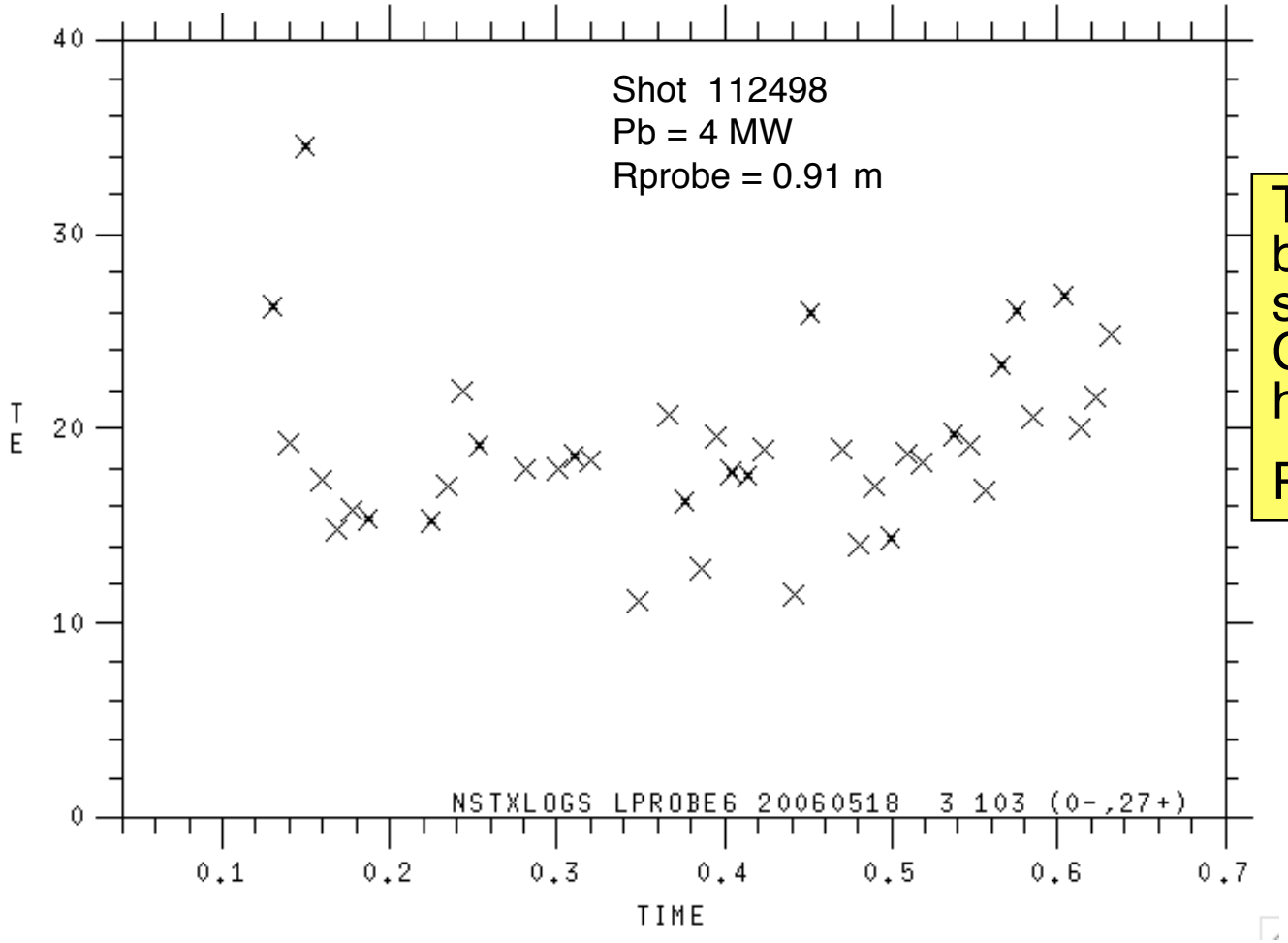
4 MW 112498

6 MW 112499

I_{sat} Decreases at L-H transition



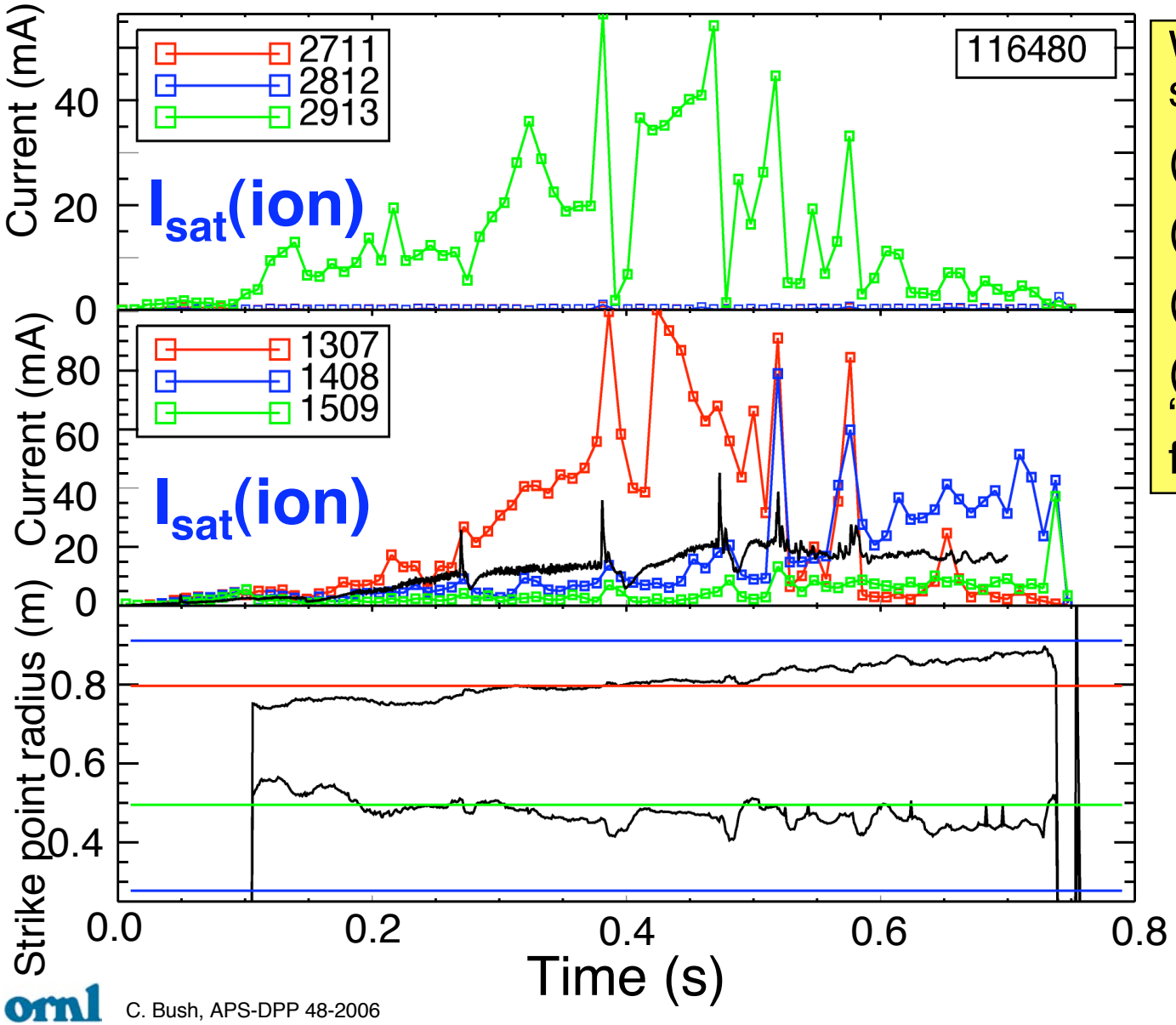
Outer Divertor Probe Te vs Time, Pb = 4 MW



Te for 4 MW case before probe non-saturation correction. Corrected T_es about half those shown.

Probe #2 (R = 0.91m)

Waveforms of I_{sat}(ion) for Outer Divertor Probes



With Gas Puffs I_{sat} shows correlation,

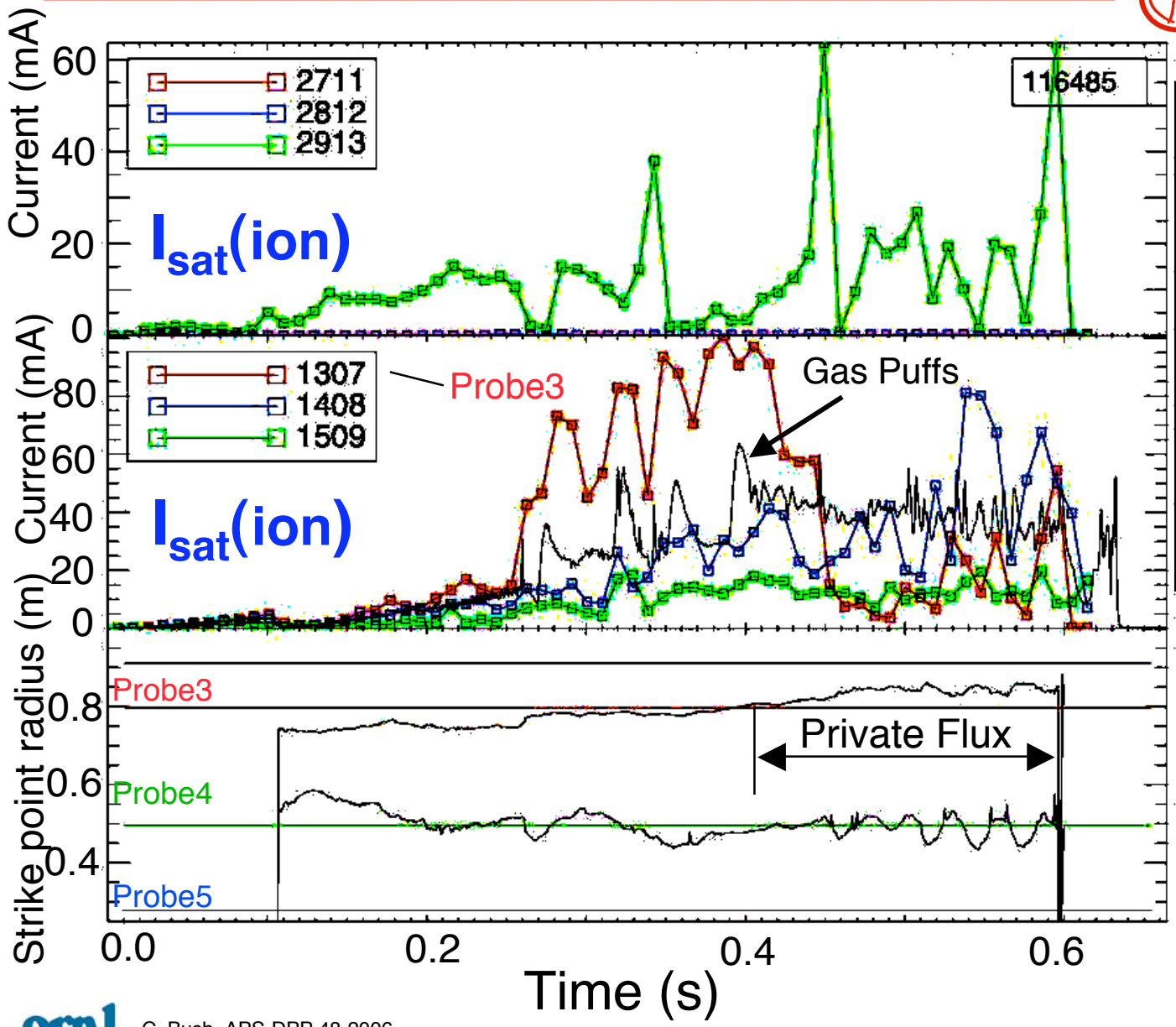
(1) between probes,

(2) with gas puffs

(3) with D_α

(4) when probes "move" to private flux region

I_{sat} for Probes: Divertor GAS Injector Puff - 500 Torr



LRDFIT

With Gas Puffs I_{sat} shows correlation,

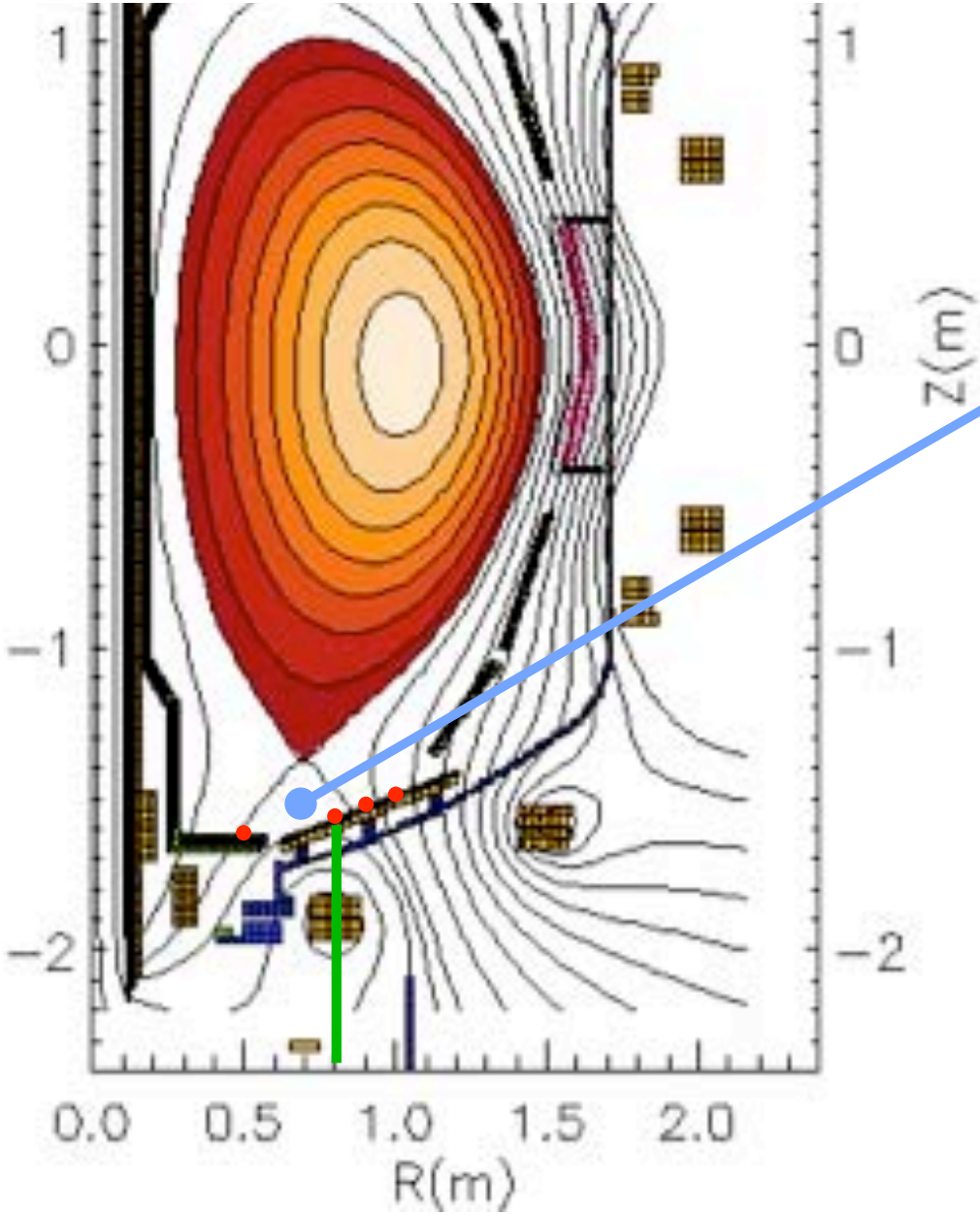
(1) between probes,

(2) with gas puffs

(3) with D_α

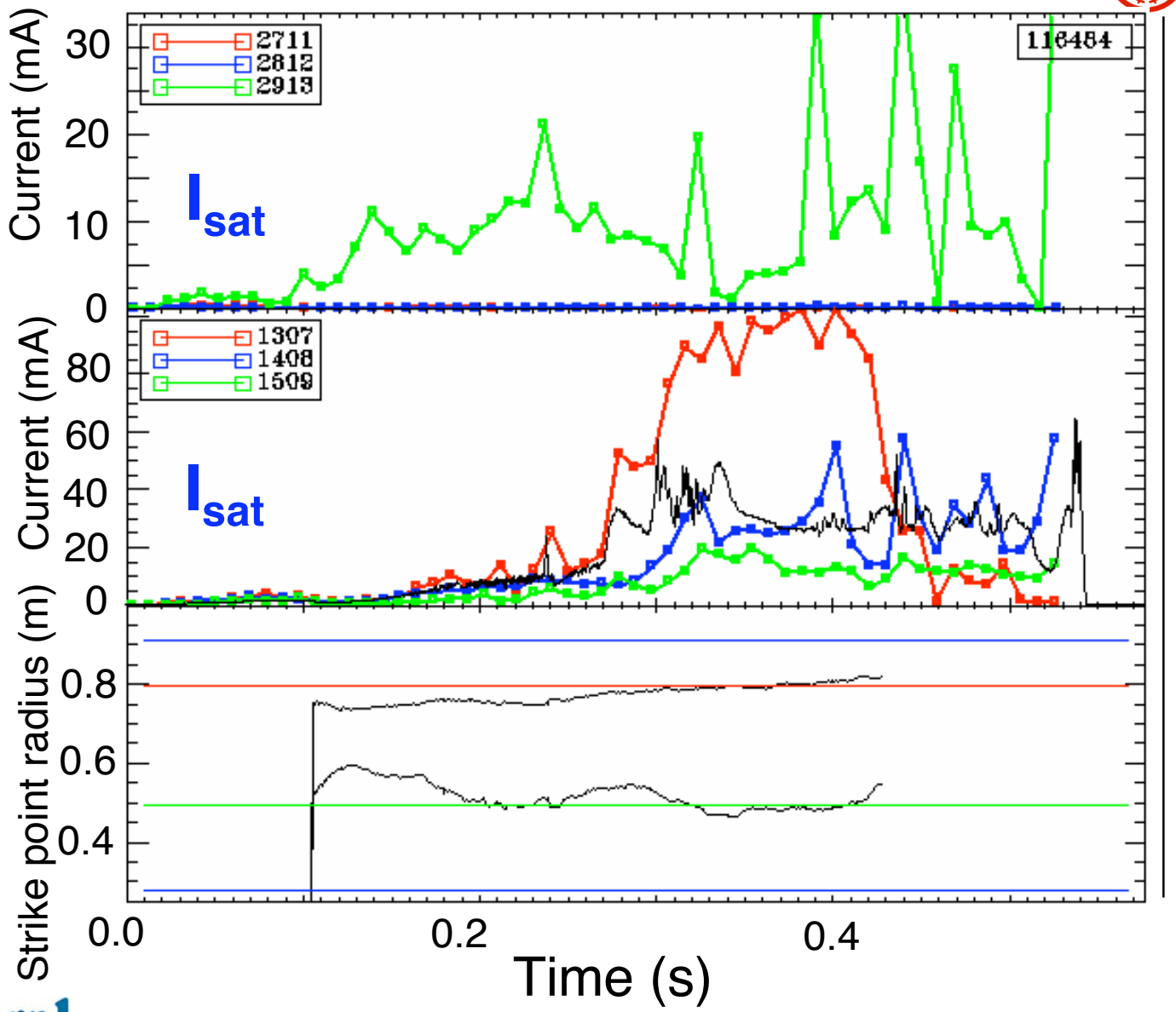
(4) when probes "move" to private flux region

Probe 3 is in Private Flux Region at 0.5 secs



Both EFIT and LRDFIT equilibrium codes show Probe 3 to be in private flux region at t = 0.5 s

I_{sat} for Probes - Divertor Gas Injector Puff: 400 Torr

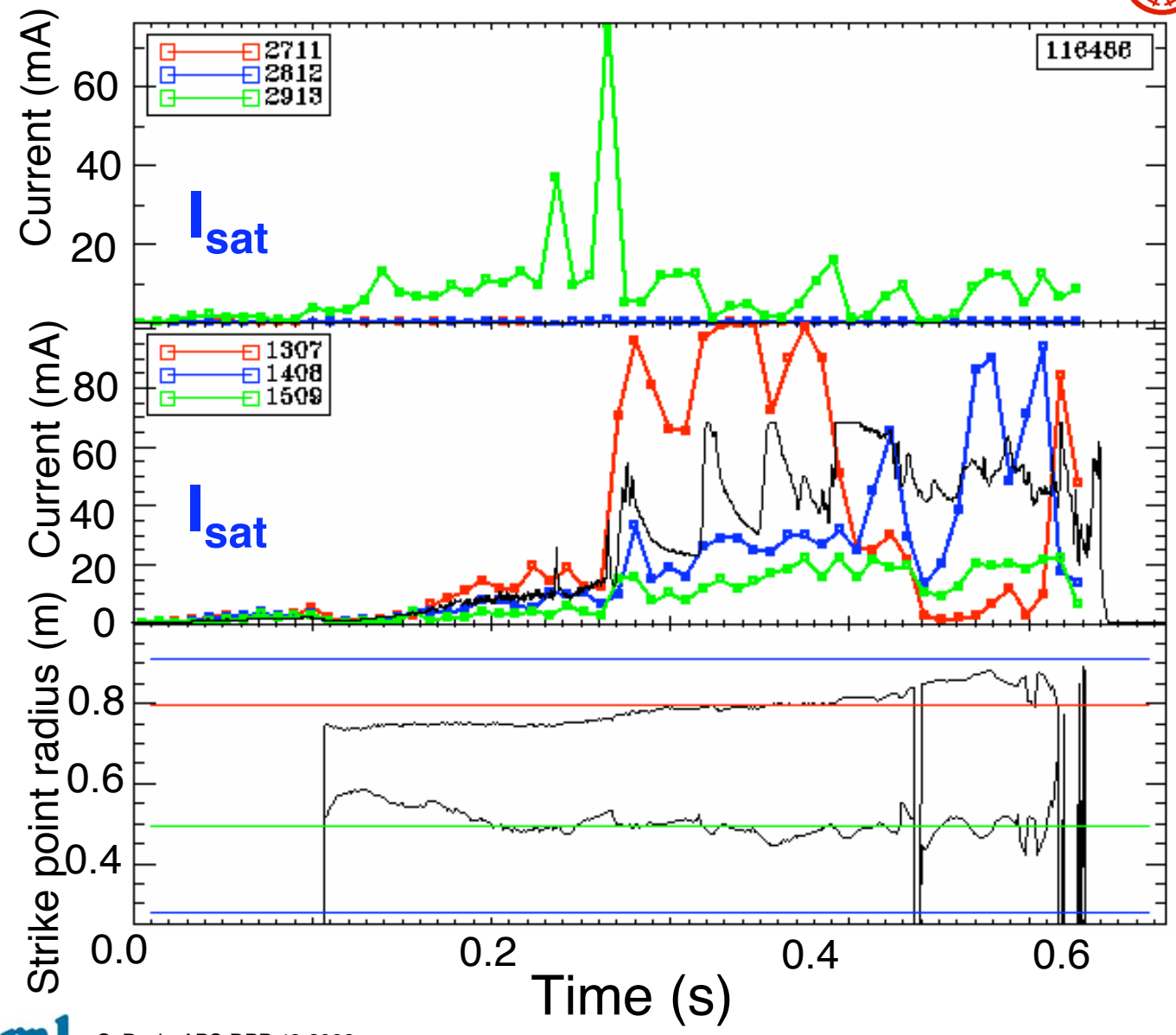


LRDFIT

I_{sat} for Probes: Divertor GAS Injector Puff - 700 Torr

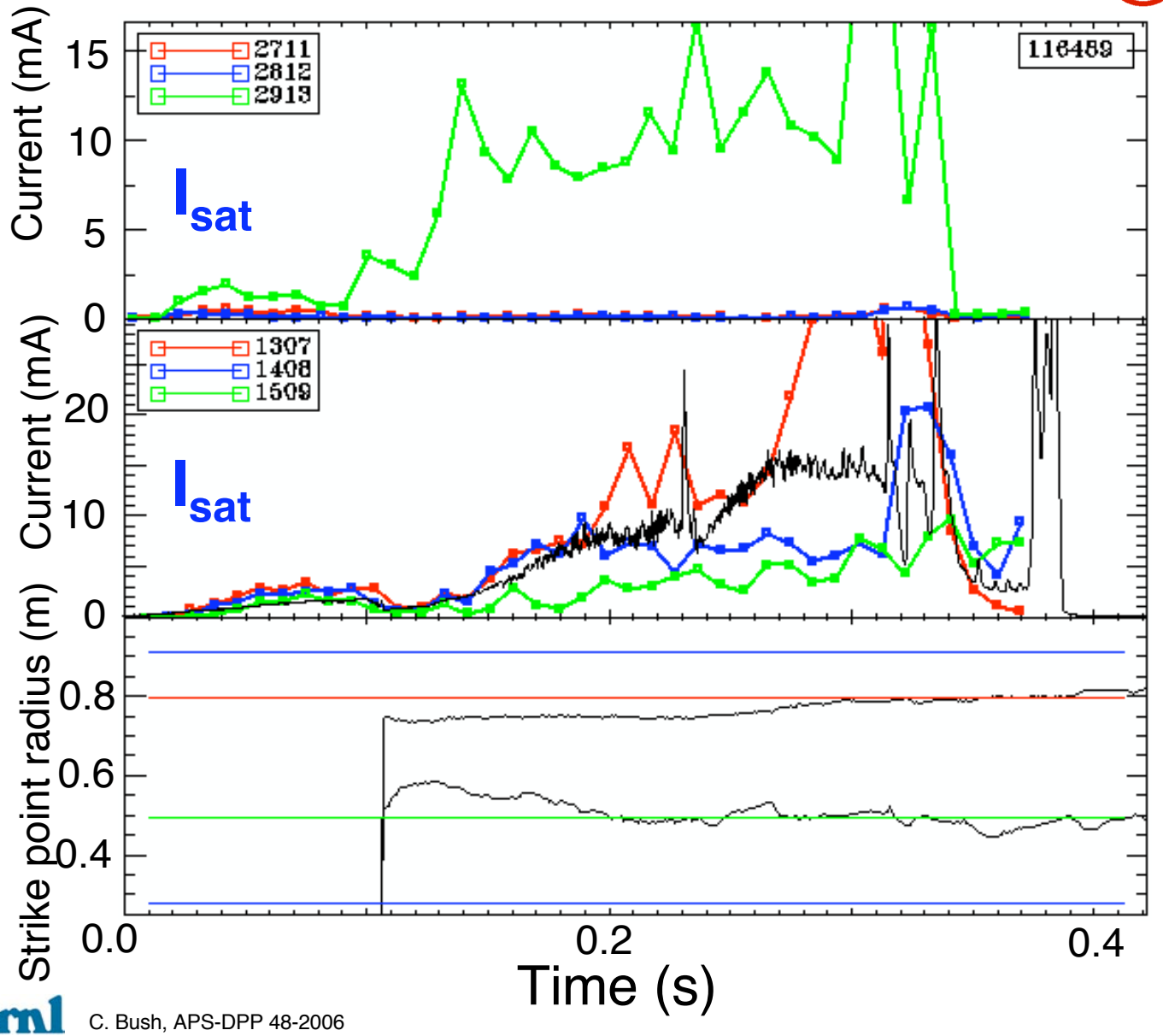
NSTX

LRDFIT



I_{sat} for Probes - Neon GAS Puff 190 Torr, 4TIs

LRDFIT



Summary

- NSTX has a coarse probe array
  - Radial variation of I_{sat} and J_{sat} Outer Divertor similar to that of the heat flux
  - T_e along divertor surface in range 5 to 25 eV over the beam power scan
- Response to Gas Puff Experiments
  - Probes in SOL show correlation with D_α measured at divertor plate (possible ~ few ms lag)
  - Signals large in SOL, smaller in private flux region
  - Other features

END