



NSTX

Heat Flux and Radiated Power in the NSTX Divertor

S.F. Paul, (PPPL) J. Boedo (UCSD), R. Maingi (ORNL), V.
A. Soukhanovskii (PPPL) ,

S.Z. Zweben (PPPL), M. Rensink (LLNL), and the NSTX
Research Team

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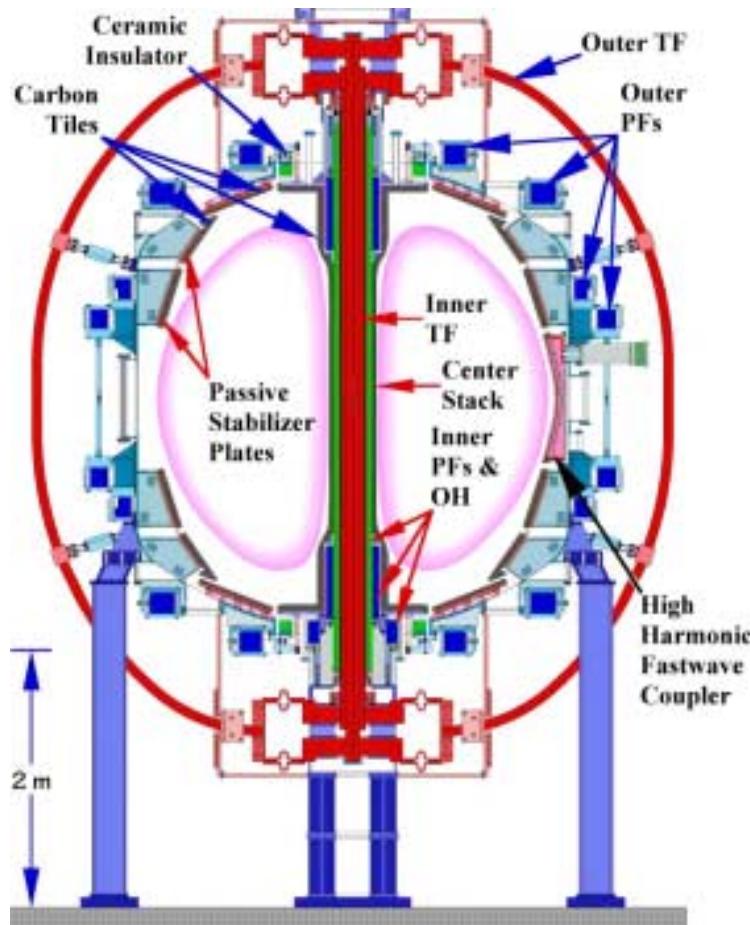


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Divertor power balance a part of boundary research program in NSTX

- Using a set of existing and recently installed edge diagnostics, an examination of the characteristics of the edge plasma in NSTX has begun.
- To date, the plasma edge conditions in an $I_p = 900$ kA, $B_T = 4$ kG, lower single-null diverted discharge were varied by:
 - increasing NBI heating power from 2 to 6 MW
 - comparing with L-mode discharges.

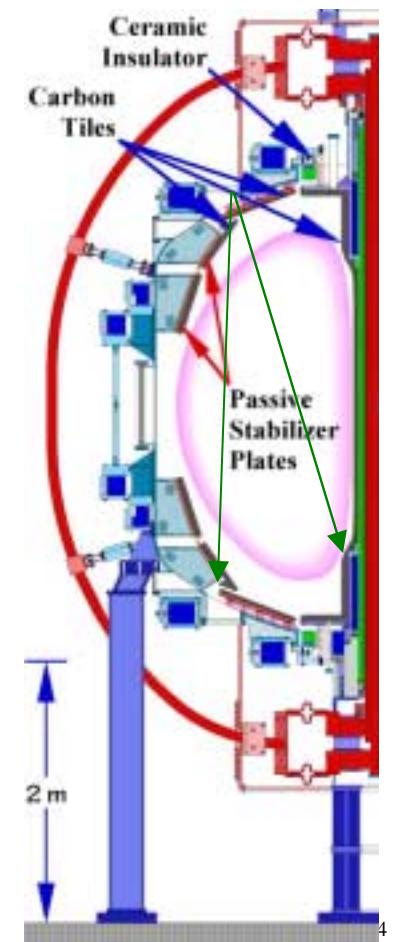
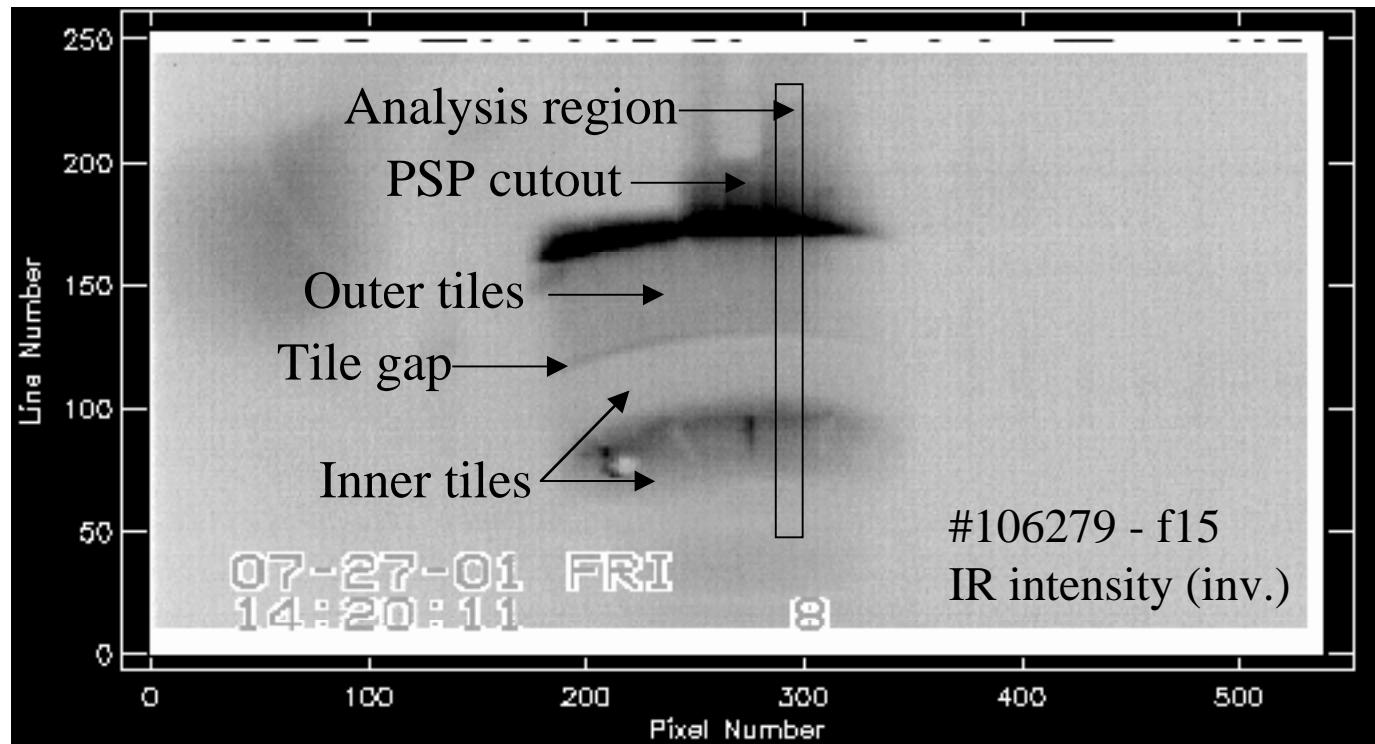
Divertor access



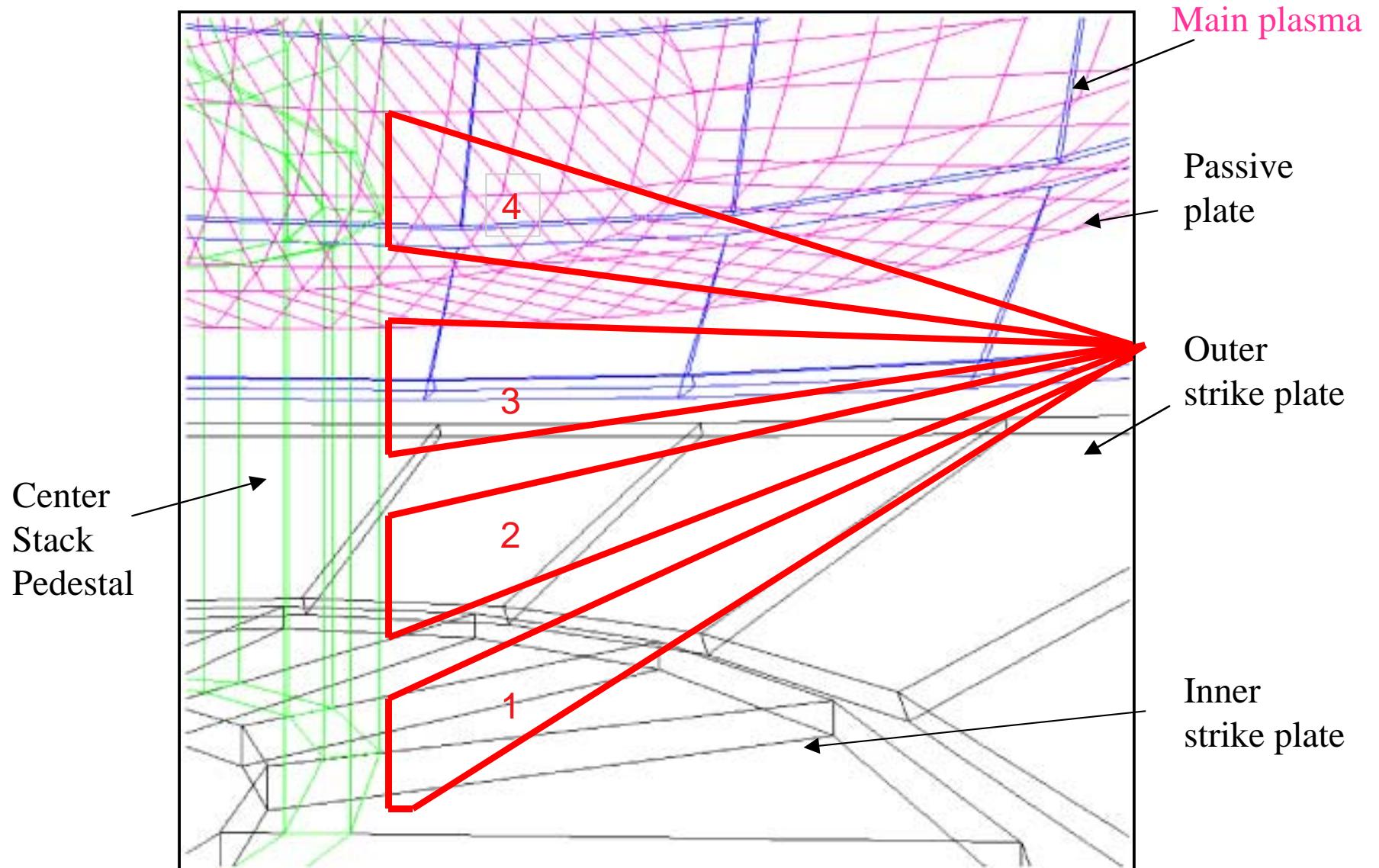
- Open divertor configuration
- Allows viewing from midplane and between plate structures

IR camera view allows radial profile measurements

IR camera: 7-13 μm range, 30 Hz, 25 ms thermal e-folding time, spatial resolution $\sim 1 \text{ cm}$ with present optics



Divertor bolometer view resolves vertically





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4 channel divertor bolometer array installed

Prototype for 12-16 channel system; similar to that used on JT-60 and ASDEX.

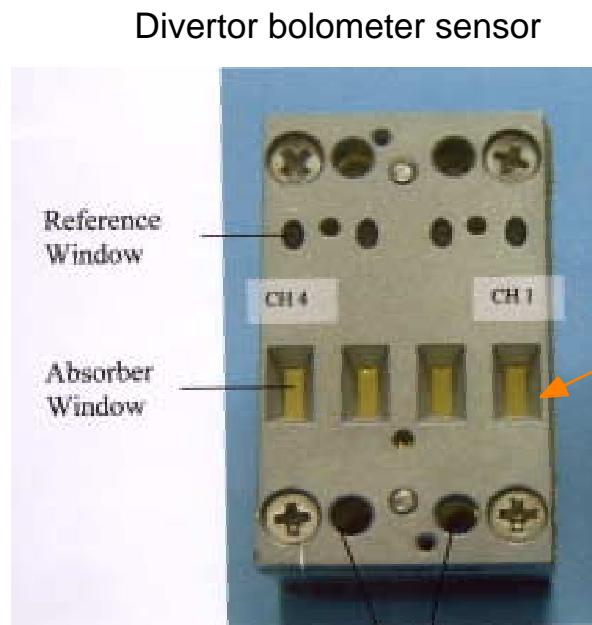
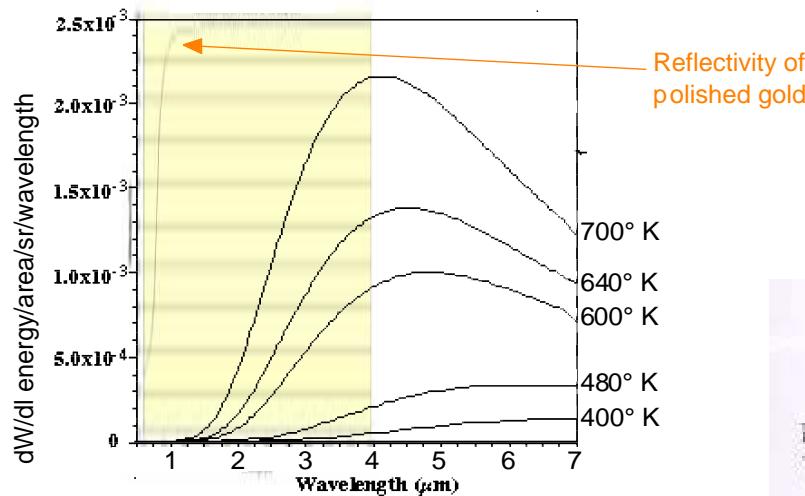
4 μm gold foil on 20 μm mica substrate, able to tolerate 160°C

Cooling time constant is .15 sec, both a direct heat sensor and an integrator

Array is water cooled to prevent overheating during bakeout; normal operation is at room temperature

Highly sensitive -- 1 $\mu\text{W}/\text{cm}^2$ noise limit, measured 1,000 $\mu\text{W}/\text{cm}^2$ on NSTX, but noise pickup is quite high -- grounding reworked for upcoming run

Bolometer has gold foil face, reflects above .5 μm

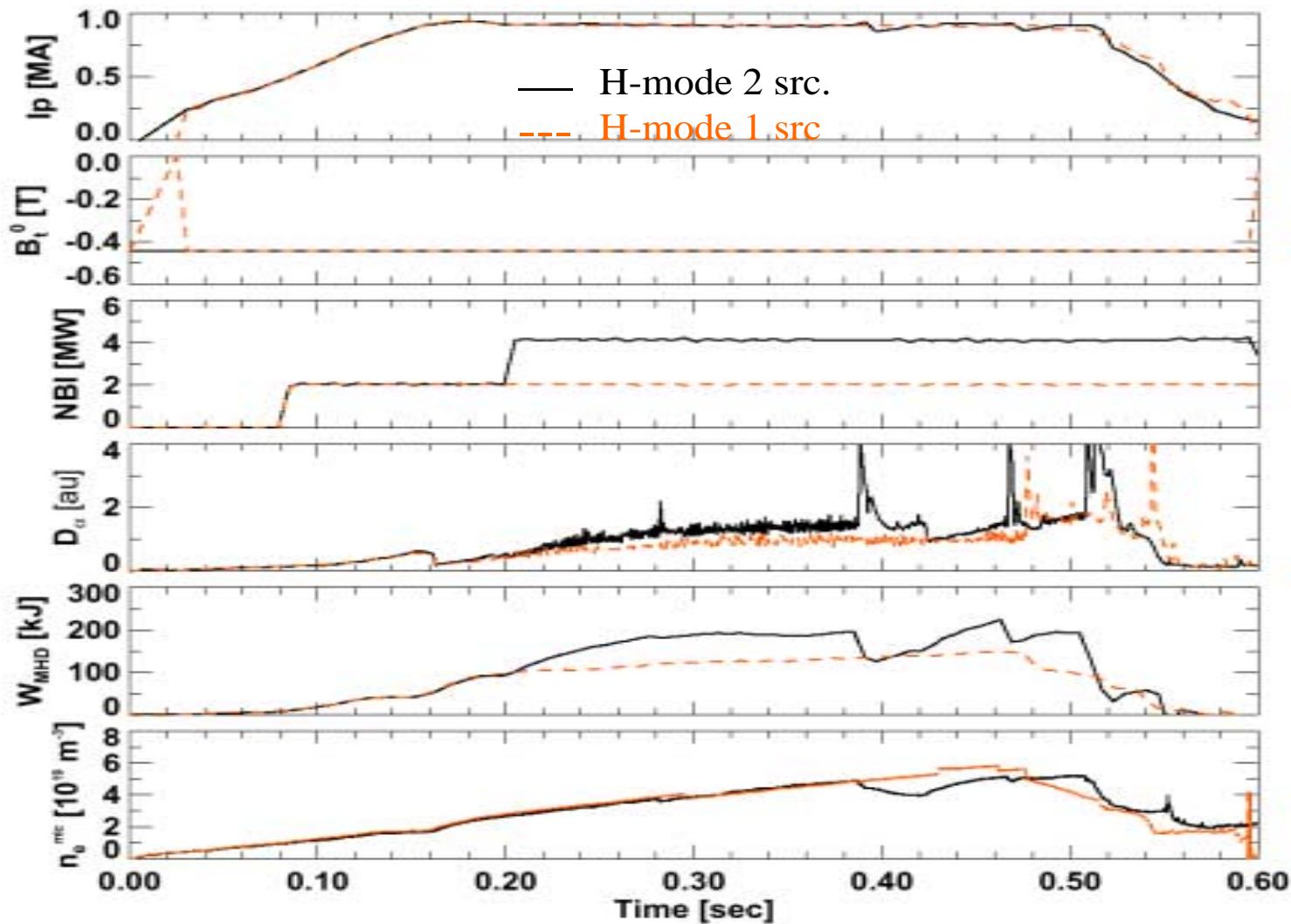


Tile blackbody radiation > 1 μm

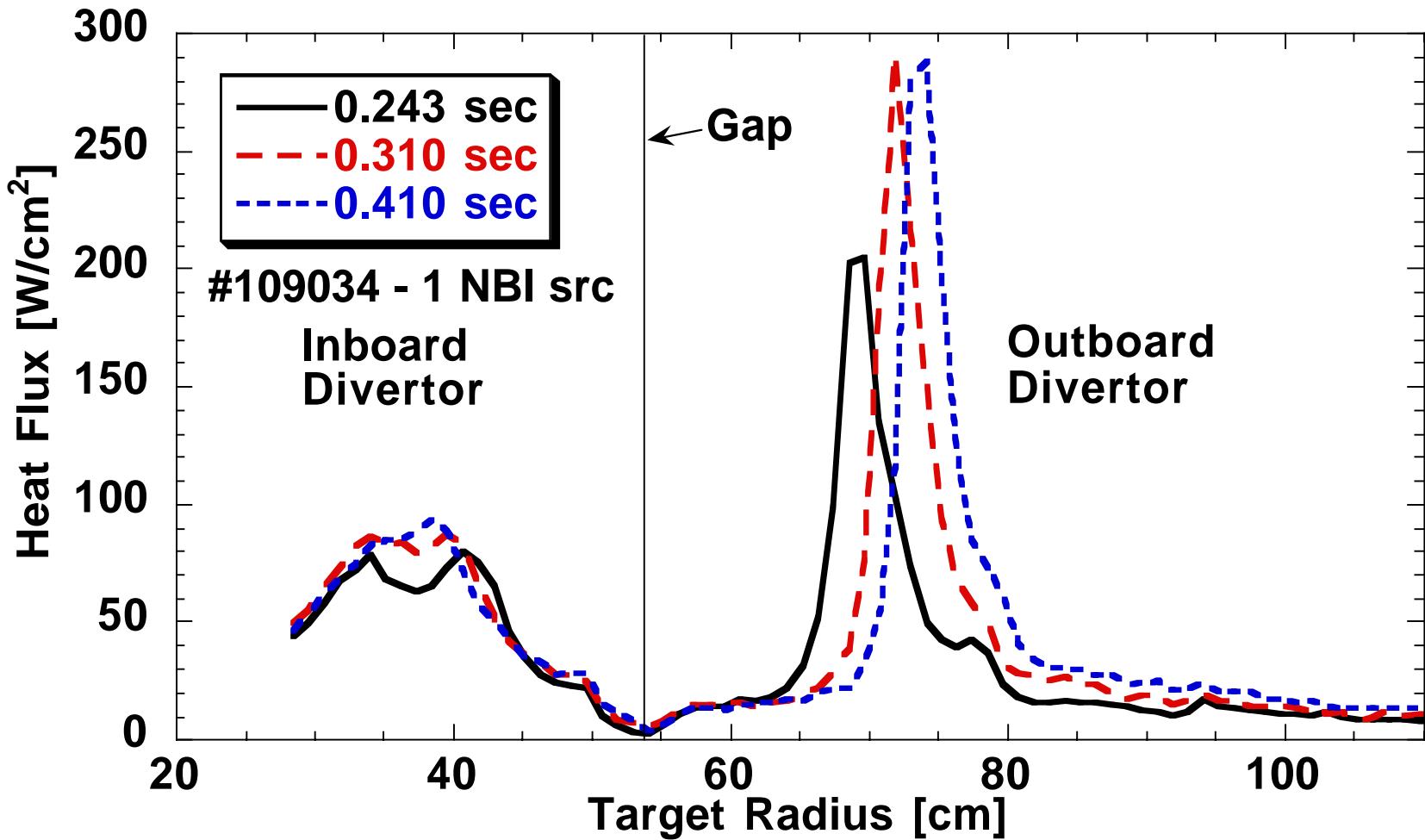


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H-mode with 2 NBI sources has higher Est



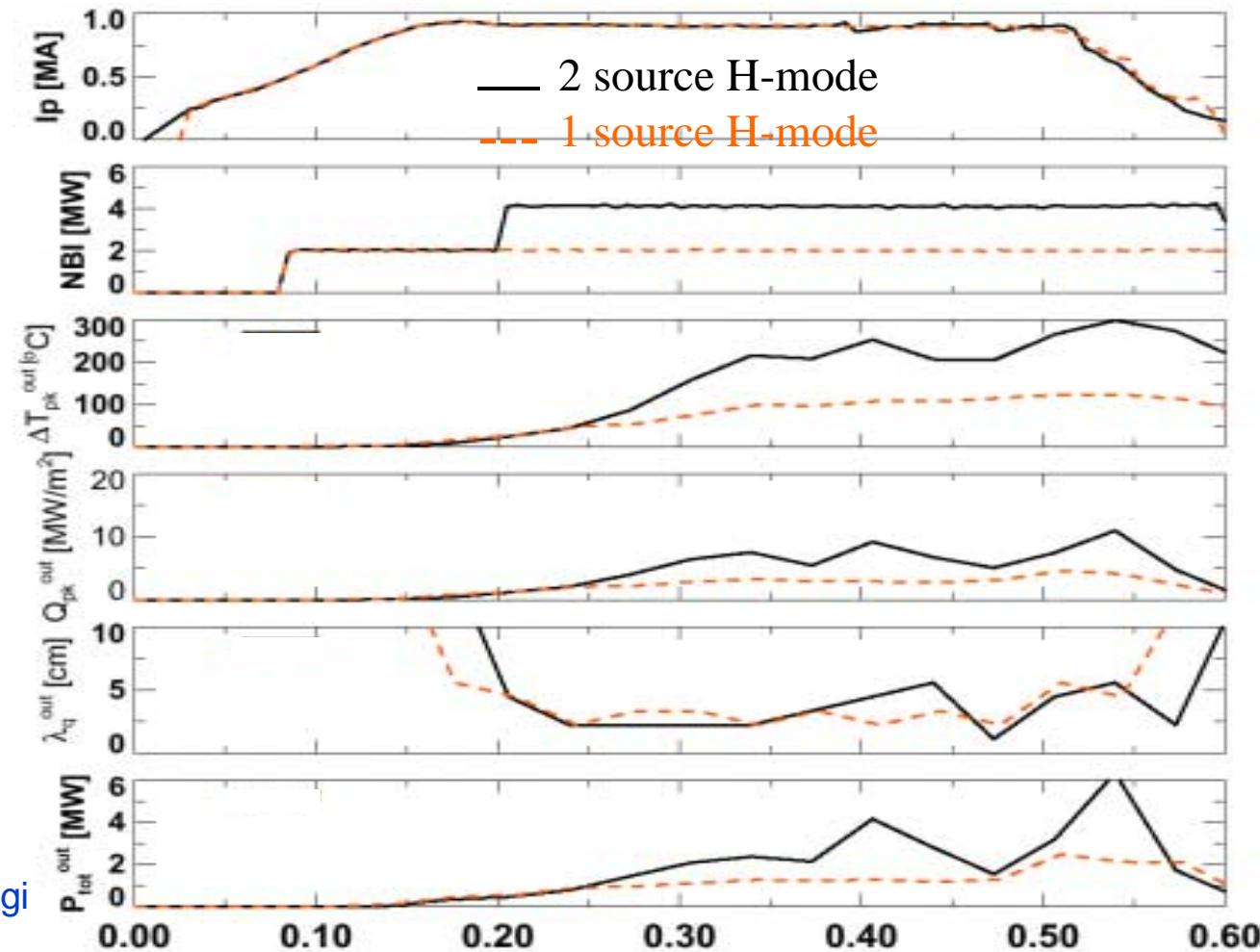
Heat flux profile in 1 src. NBI shot comes into equilibrium
(1 source H-mode shot shown)





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Outer strike plate:
Higher heat flux -> higher wall temp. narrow width of
strikepoint independent of P NBI

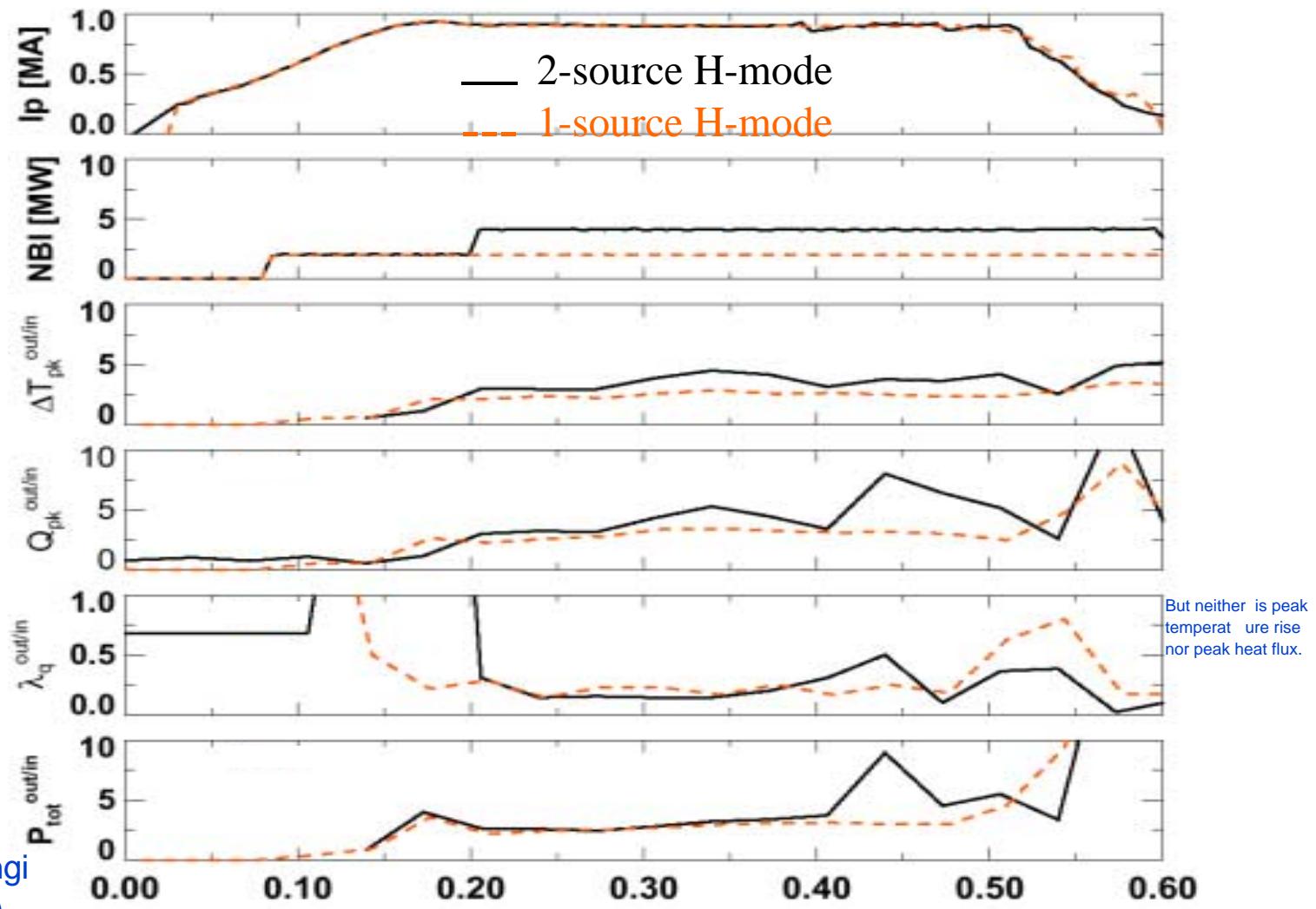




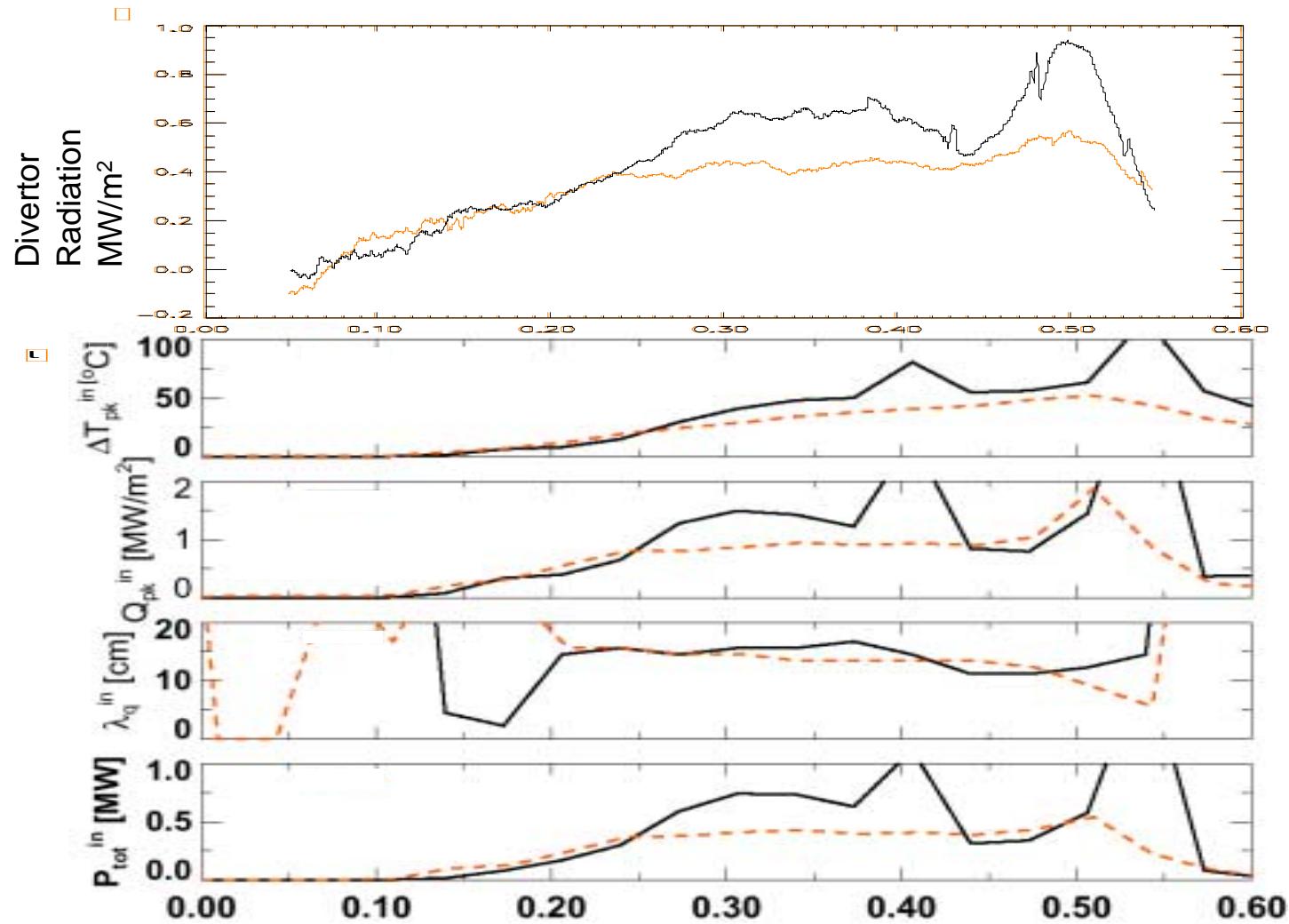
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NBI

In/out ratio: footprint and power not dependent on P

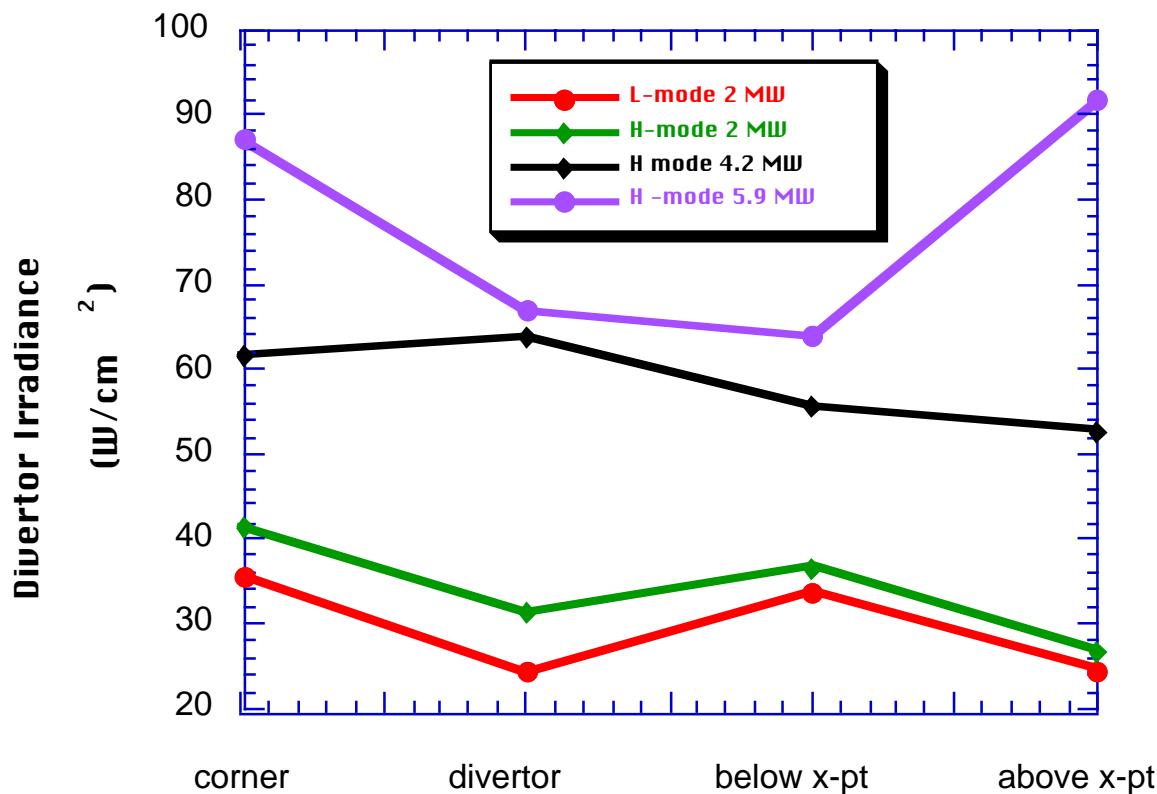


H-mode power scan: Higher heat flux,wall temp.
width of strikepoint independent of P_{NBI}



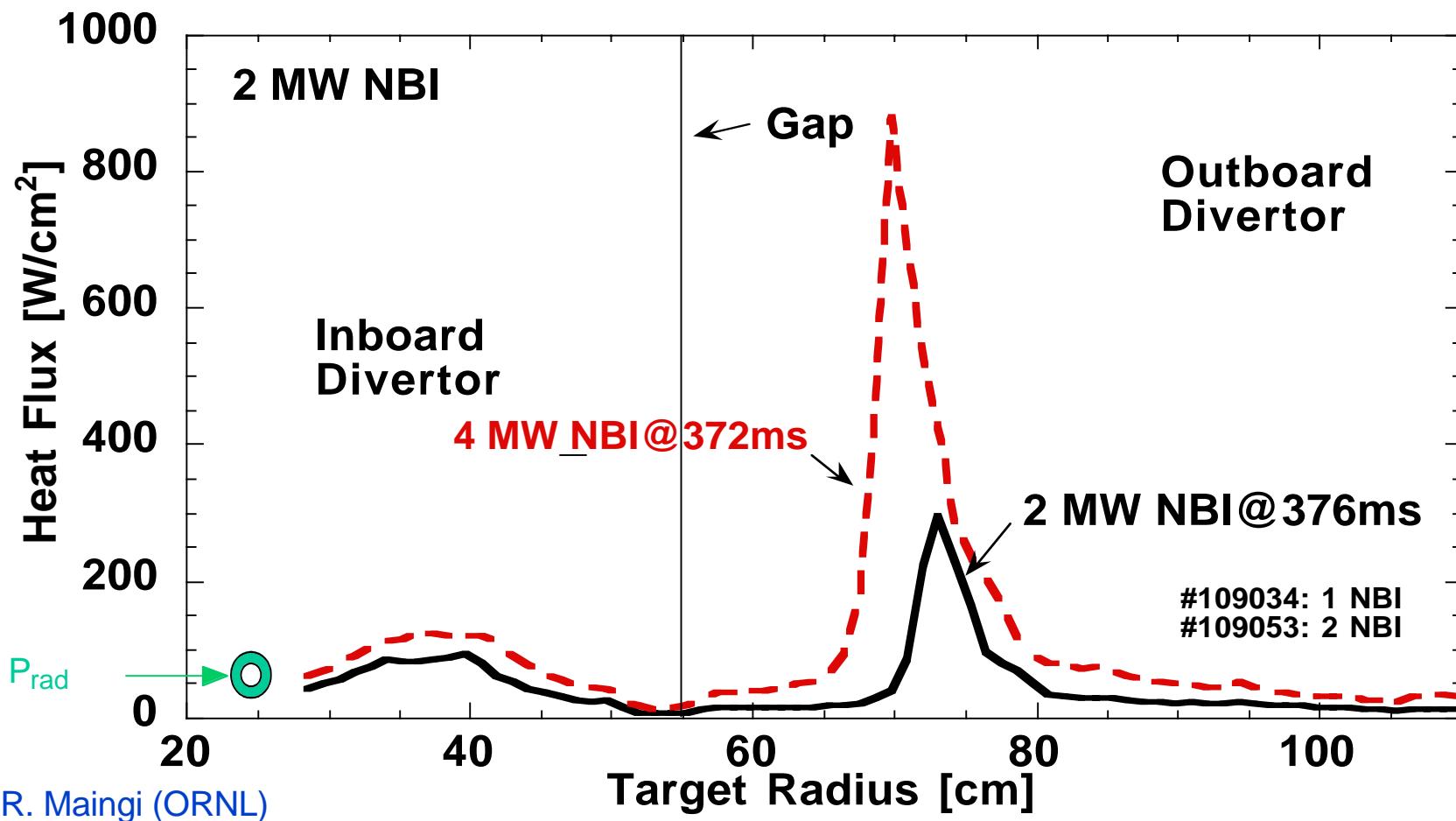
Divertor bolometer radiated power profiles

L-H comparison and H-mode power scan

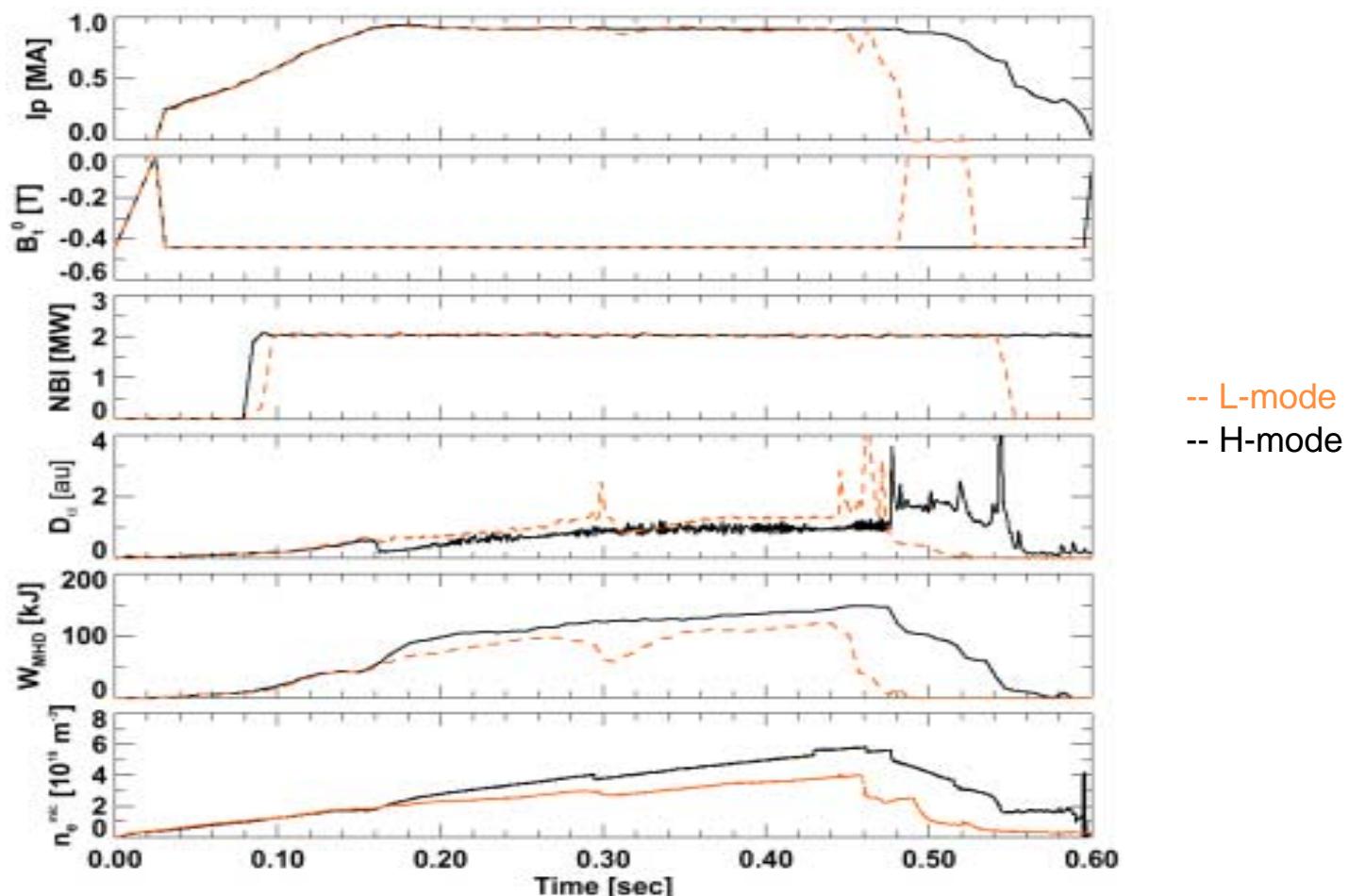


- radiated power in divertor increases with input power
- Profiles are diffuse in all cases
- Flux density is comparable to inner divertor strike plate

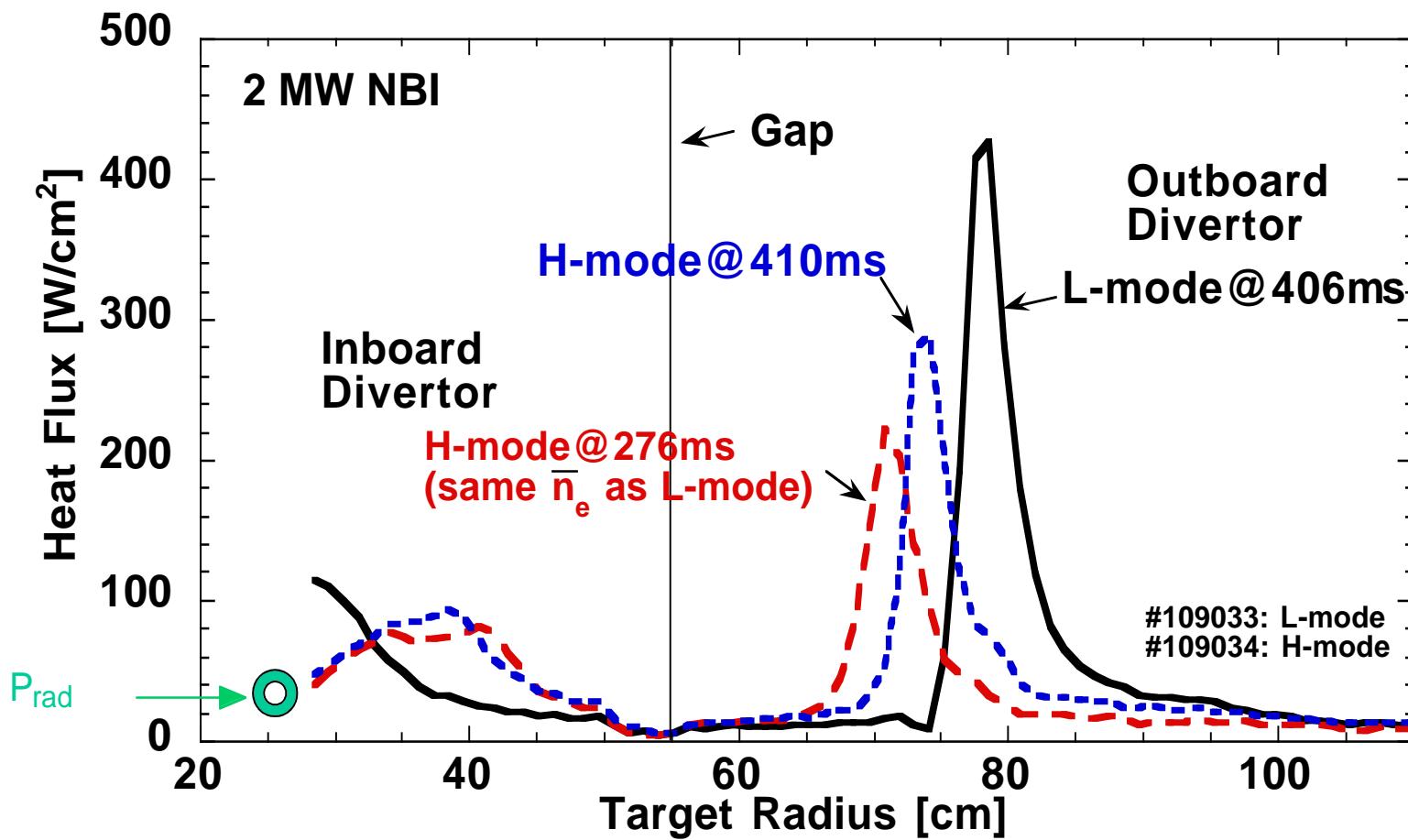
H-mode power scan: higher heat flux, same foot print. Radiated power flux increases from 43 to 64 W/cm²



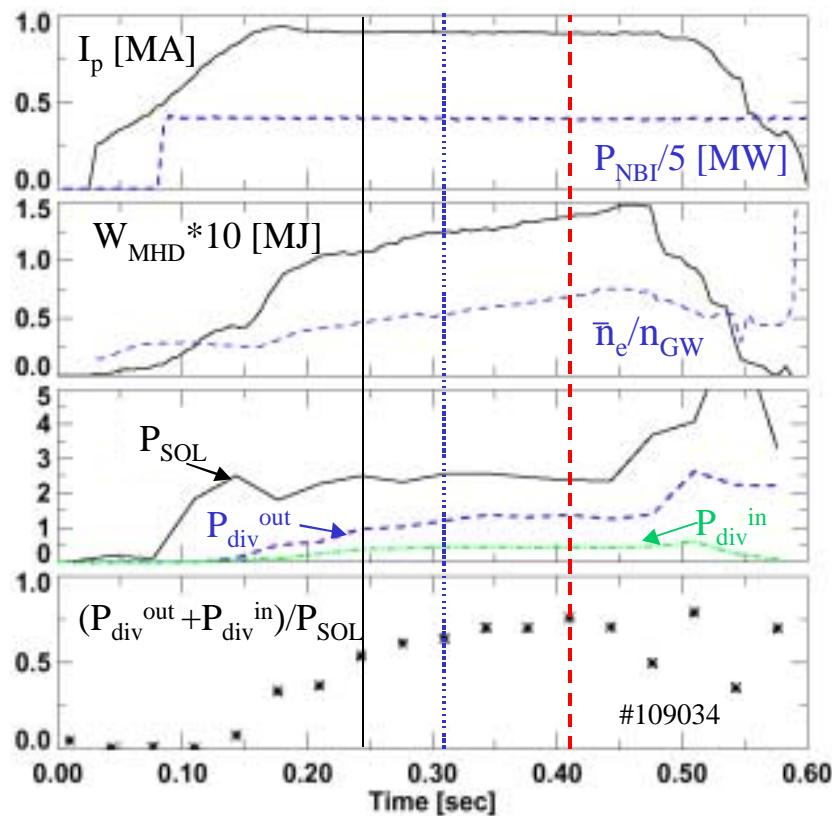
Comparison of 2 MW L and H-modes in LSN diverted configuration



L/H comparison: Higher divertor heat flux in L-mode
Radiated power flux increases from 30 to 42 W/cm²

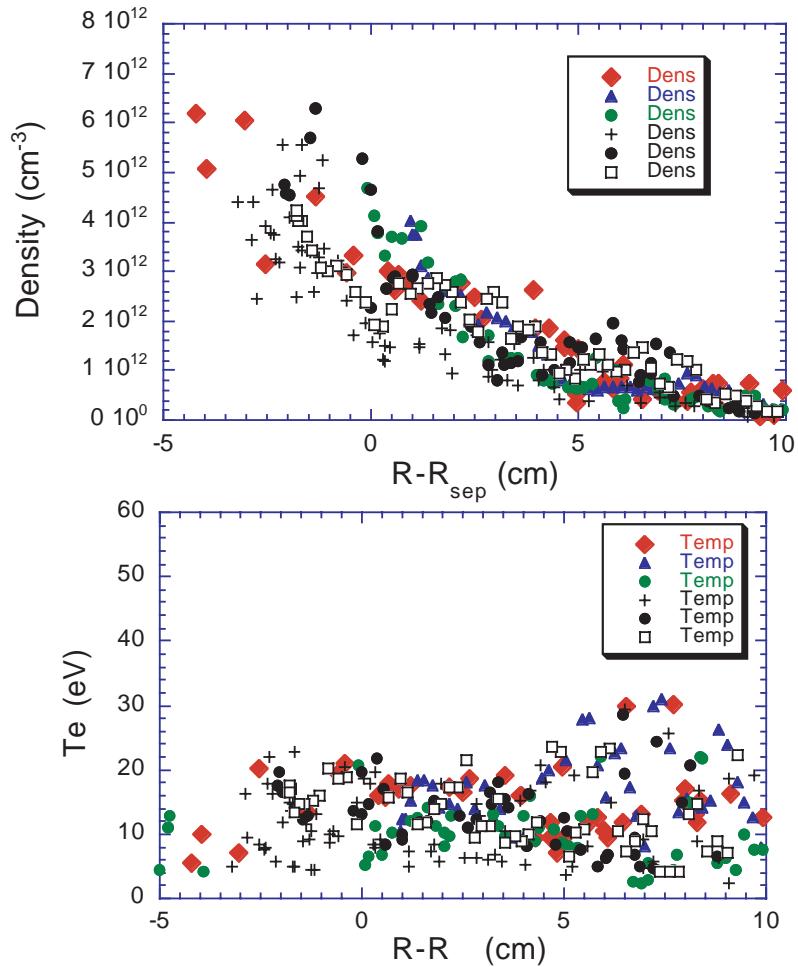


High fraction of heating power flows into divertor (1 source H-mode shown)



- About 75% of the power flowing into the SOL is incident on the divertor plates
- About 20% of the power flowing into the SOL is radiated in divertor
- Fairly constant throughout the H-mode phase

SOL T_e and n_e profiles different than in tokamaks



NSTX SOL profiles:

- T_e profile in the edge/SOL is flat at ~ 20 eV
- n_e profile has a very long decay length (~ 4 cm)
- E_r profile does not show a potential well in H-mode shots



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Summary of Observations

- Power flux to outer divertor is three times flux to inner divertor, radiated power is comparable to inner divertor
- 50% Higher divertor heat flux in L-mode than H-mode with same NBI power
- $D\alpha$ up to five times brighter in inner divertor - partly due to gas injection on the high field side of the plasma
- Divertor detachment has not been clearly observed
- Main impurities: carbon and oxygen
No metallic impurity accumulation
- Te profile in the edge/SOL is flat at ~ 20 eV and ne profile has a very long decay length (~ 4 cm)