Heat Flux and Radiated Power in the NSTX Divertor

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Divertor power balance a part of boundary research program in NSTX

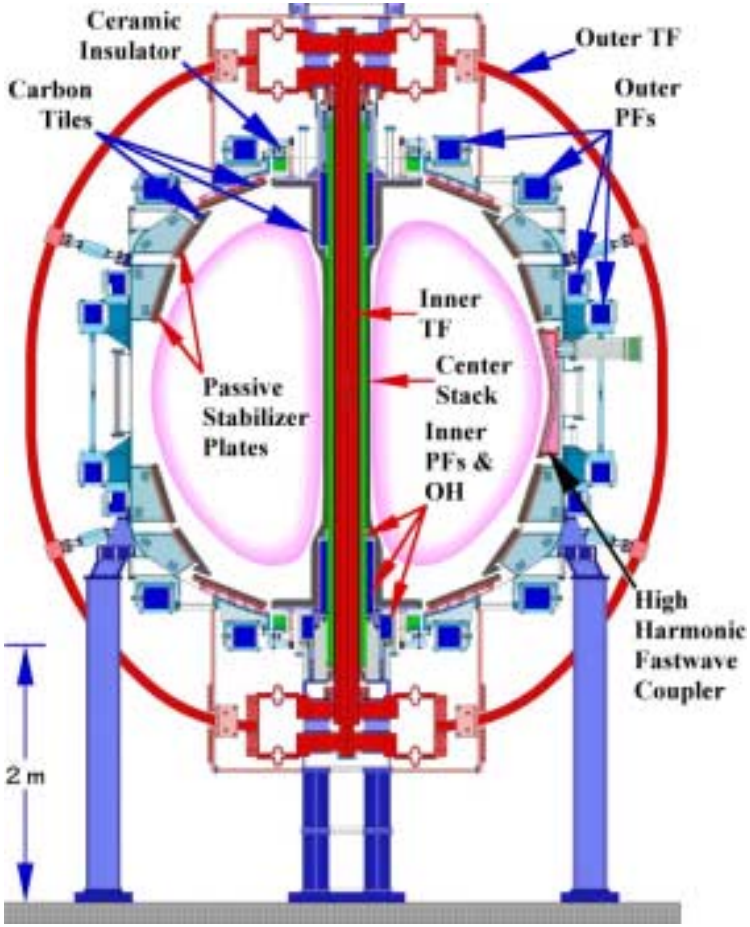
- Using a set of existing and recently installed edge diagnostics, an examination of the characteristics of the edge plasma in NSTX has begun.

- 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.

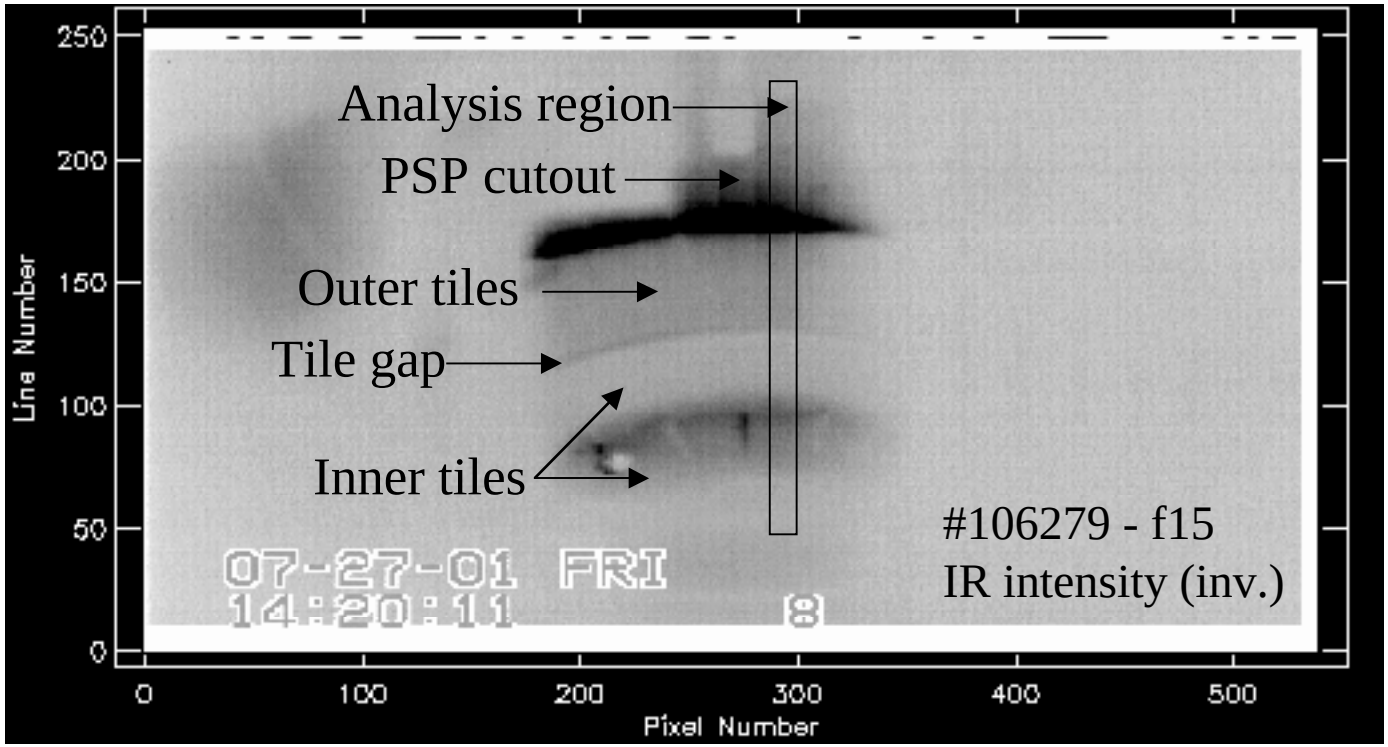
Divertor access

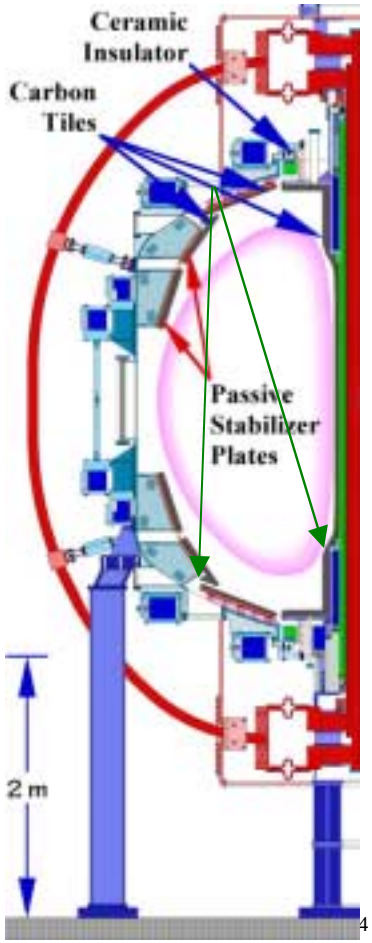


- Open divertor configuration
- Allows viewing from midplane and between plate structures

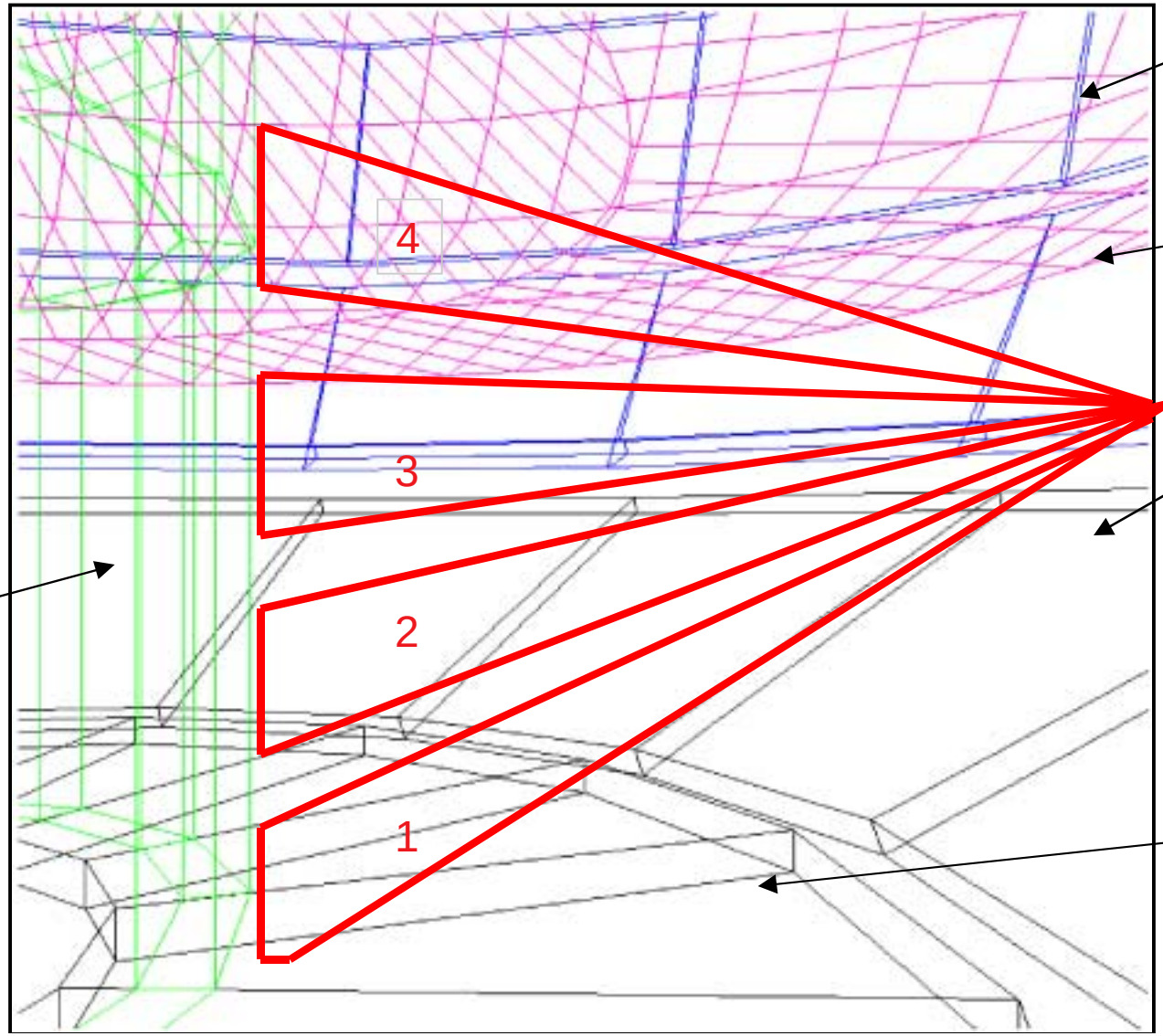
IR camera view allows radial profile measurements

IR camera: 7-13 μm range, 30 Hz, 25 ms thermal e-folding time, spatial resolution ~ 1 cm with present optics





Divertor bolometer view resolves vertically



4 channel divertor bolometer array installed

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

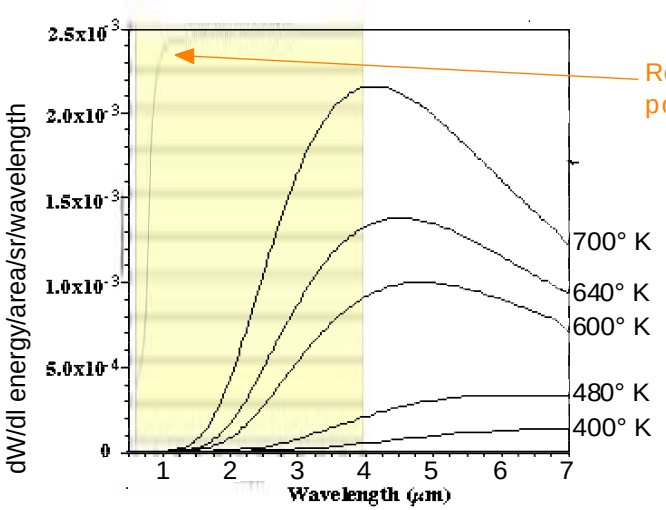
4 μm gold foil on 20 μm mica substrate, able to tolerate 160°C

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

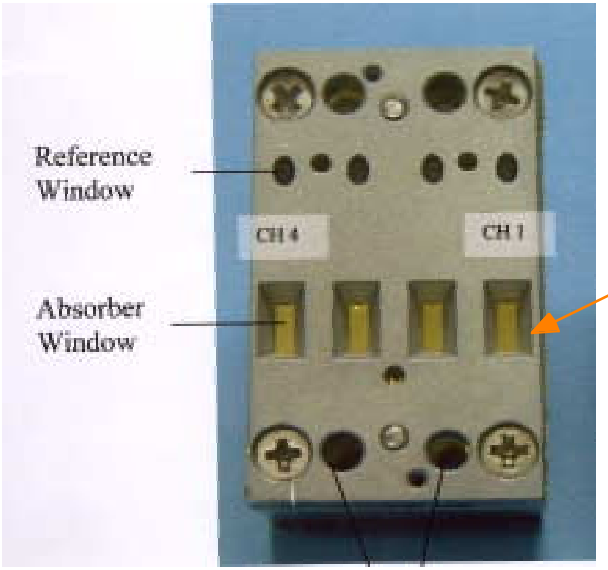
Array is water cooled to prevent overheating during bakeout; normal operation is at room temperature

Highly sensitive -- 1 μW/cm2 noise limit, measured 1,000 μW /cm2 on NSTX, but noise pickup is quite high -- grounding reworked for upcoming run

Bolometer has gold foil face, reflects above .5 μm

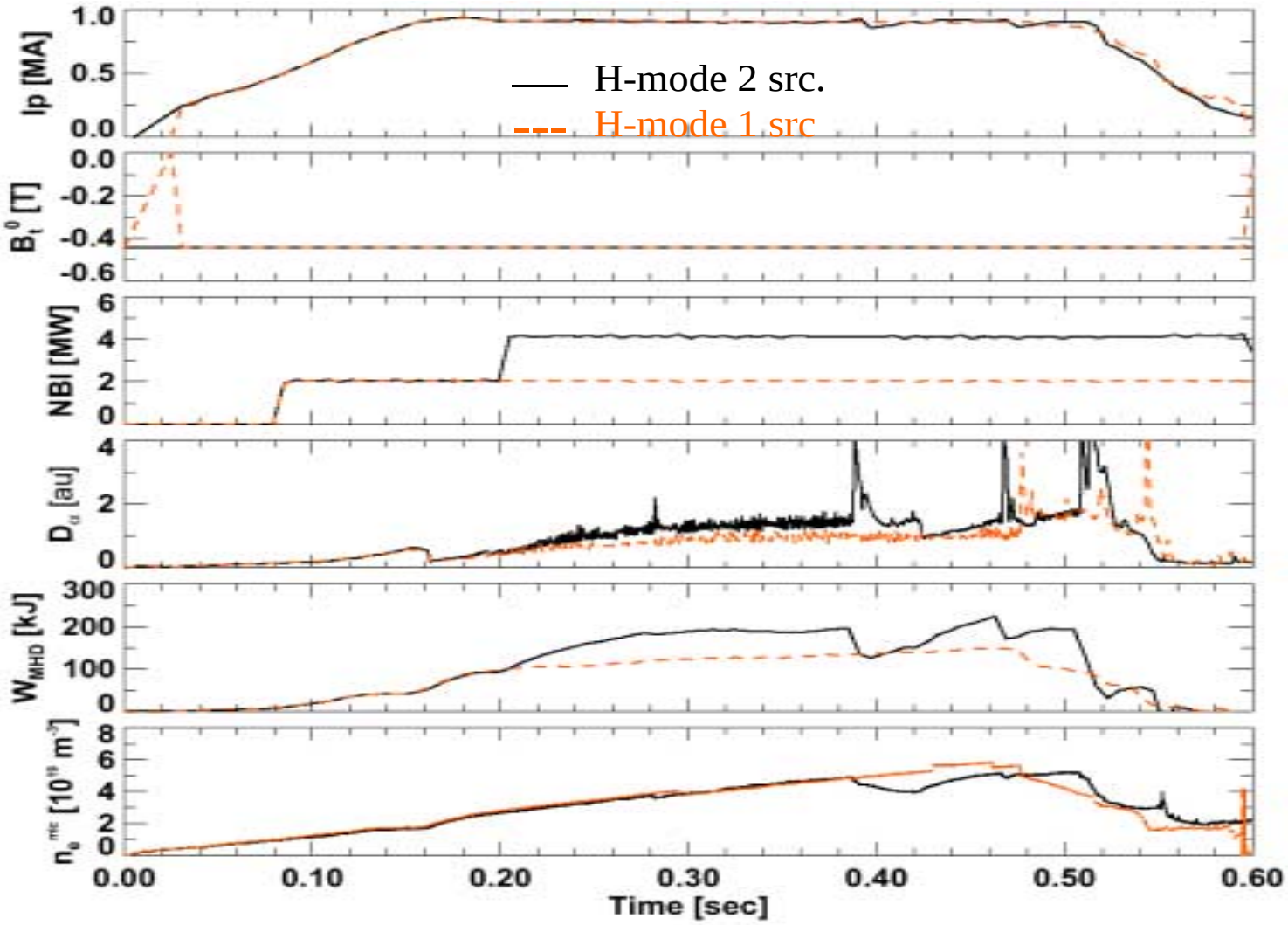


Divertor bolometer sensor

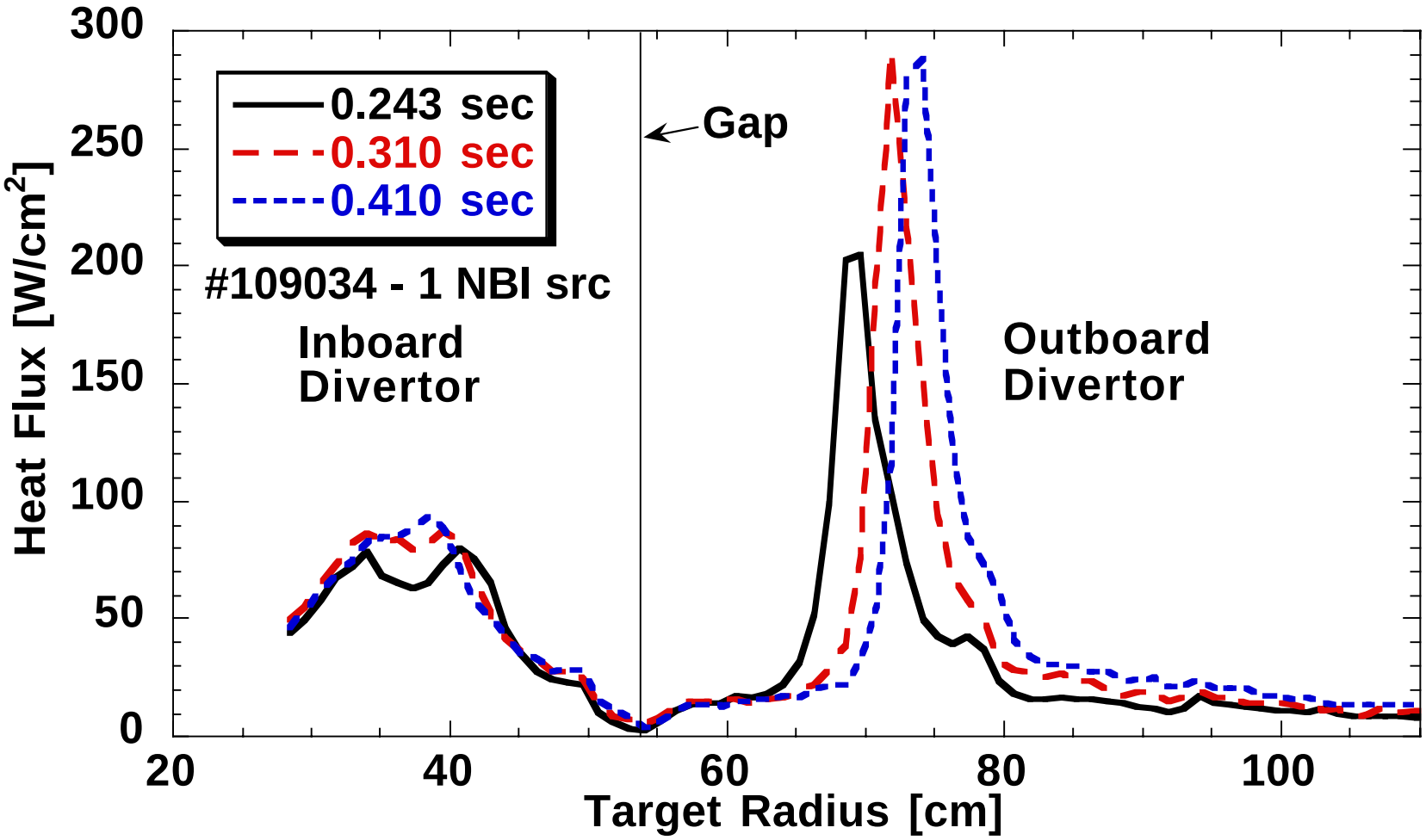


Tile blackbody radiation > 1 μm

H-mode with 2 NBI sourses has higher Est



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



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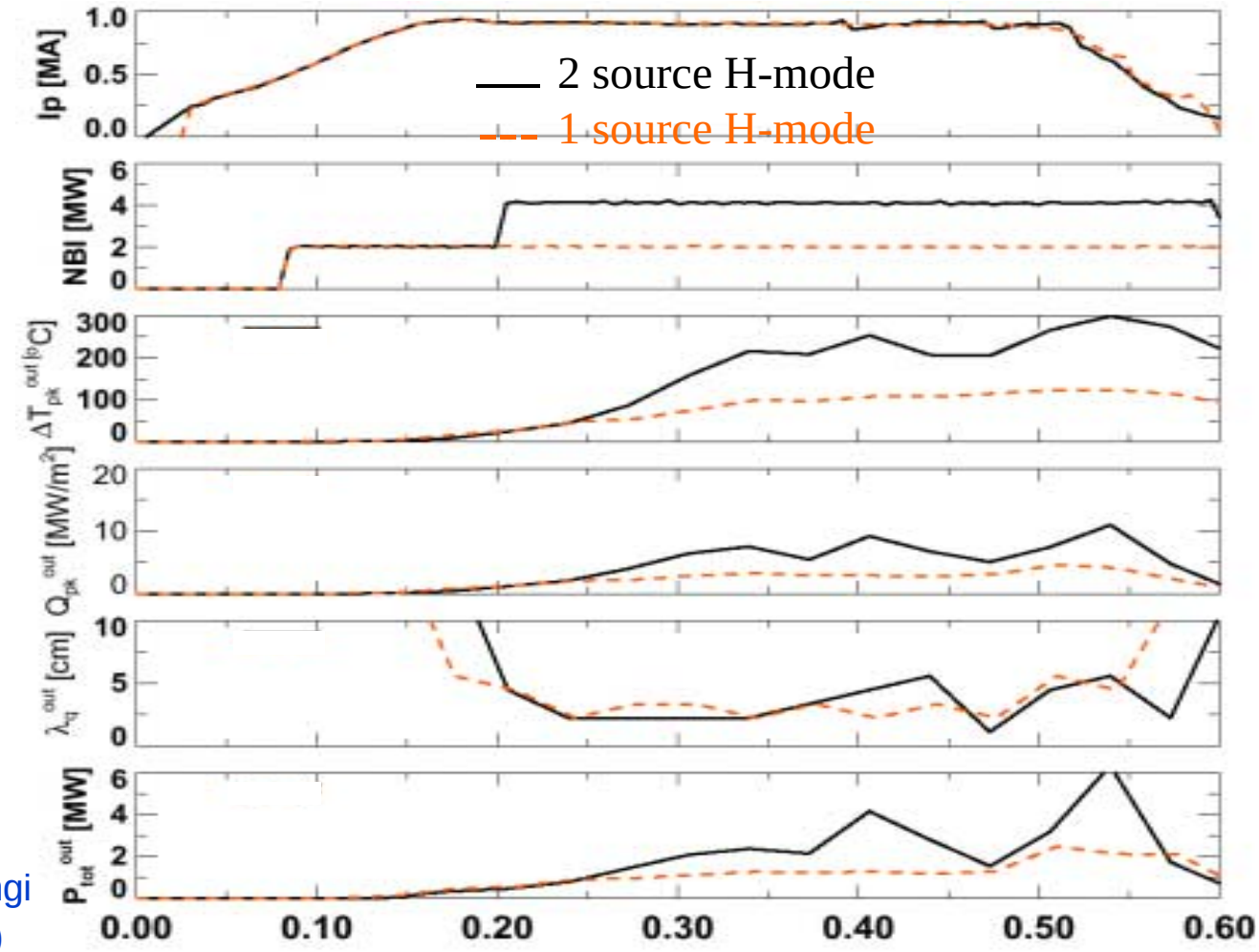
Outer strike plate:
Higher heat flux -> higher wall temp. narrow width of strikepoint independent of P

NBI



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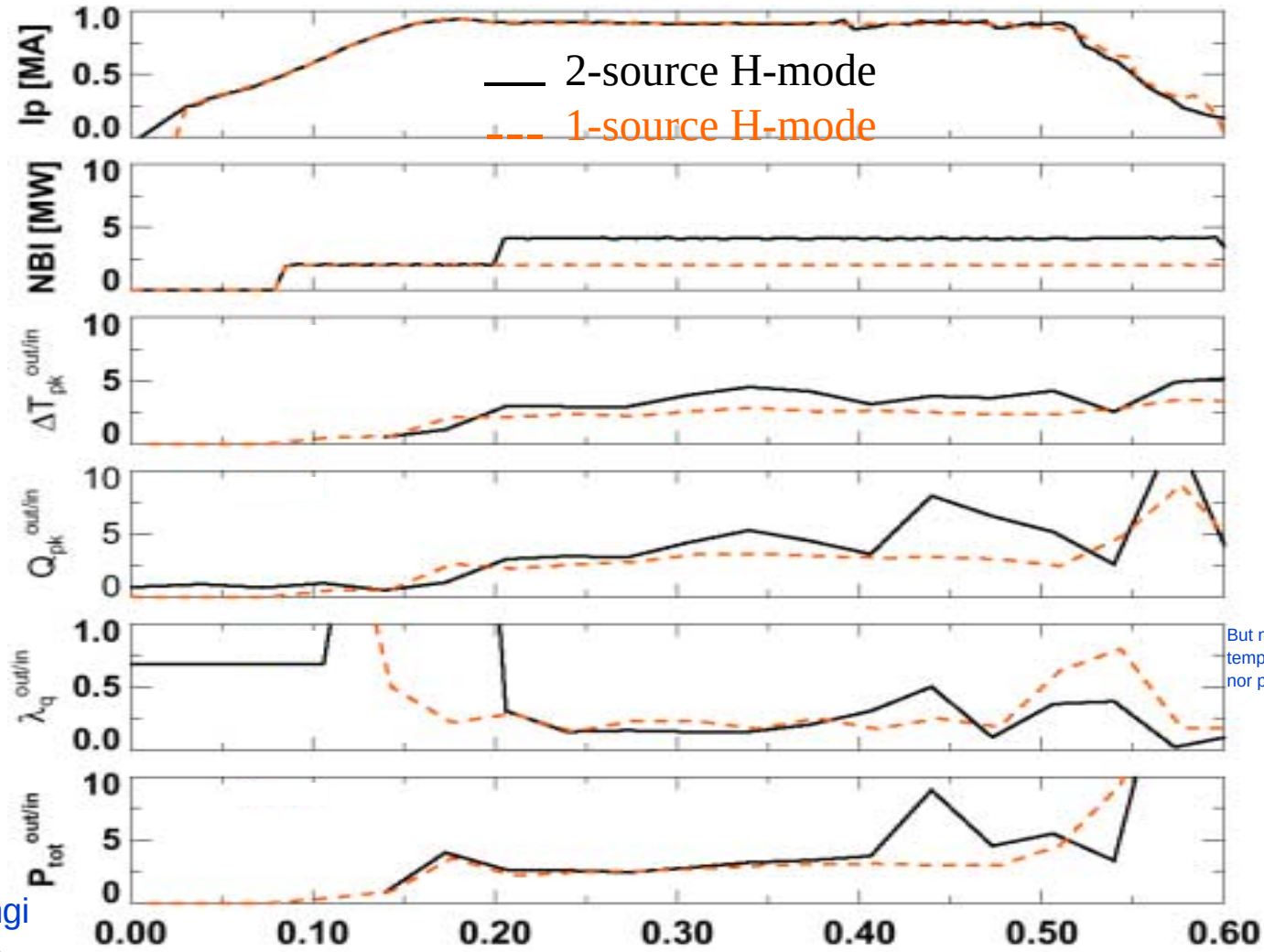
(ORNL)

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

NBI



But neither is peak temperat ure rise nor peak heat flux.

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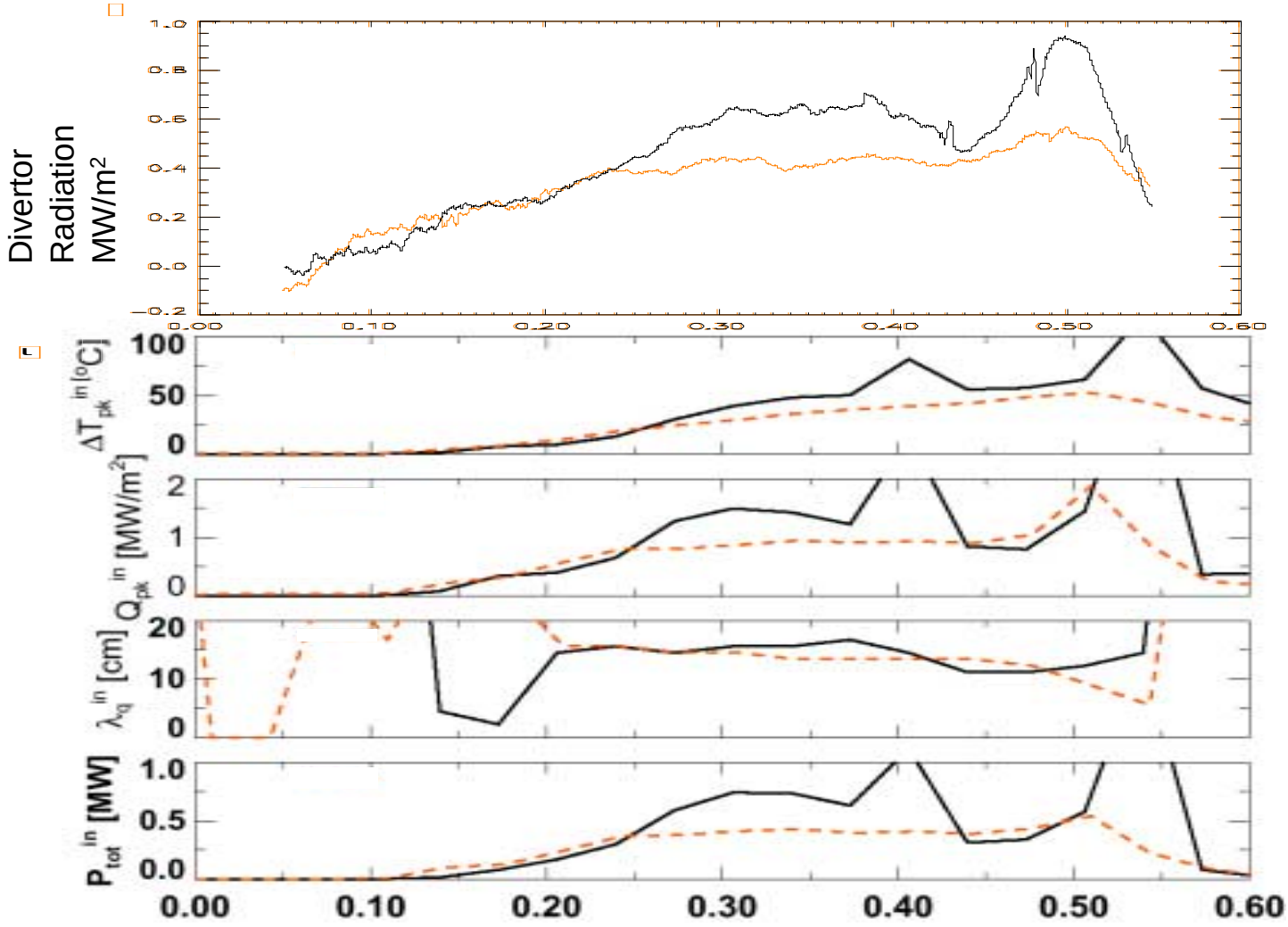
H-mode power scan: Higher heat flux,wall temp. width of strikepoint independent of P_{NBI}

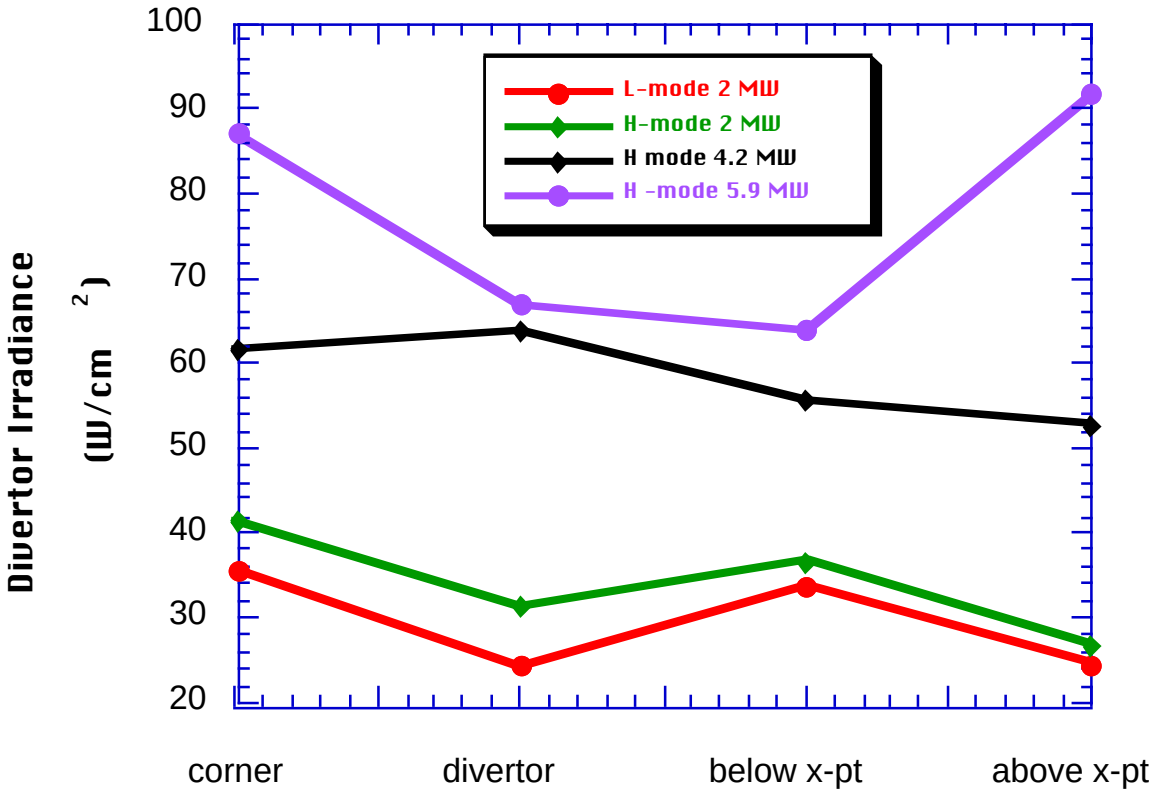


2-source H-mode

1-source H-mode

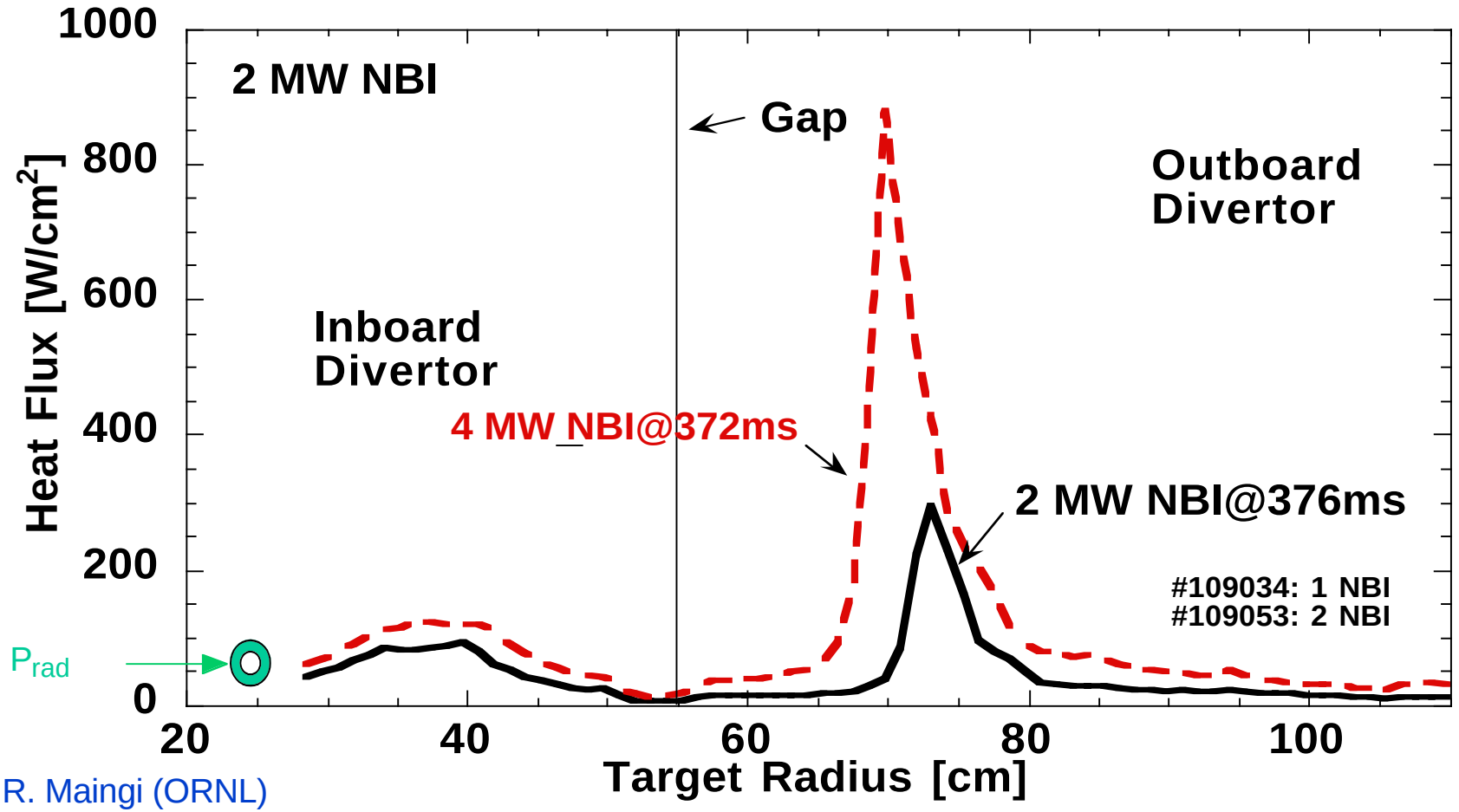
Divertor bolometer radiated power profiles

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/cm^2



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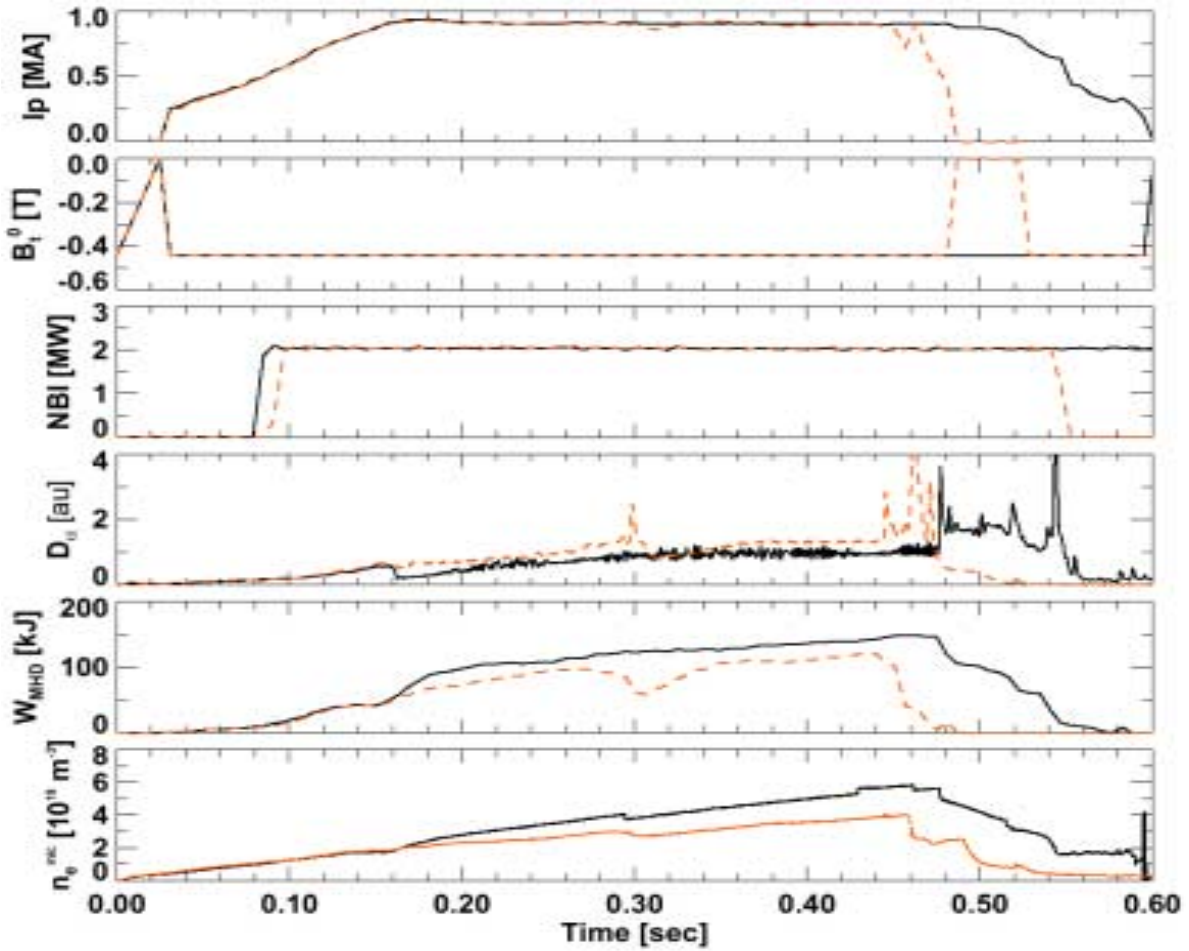
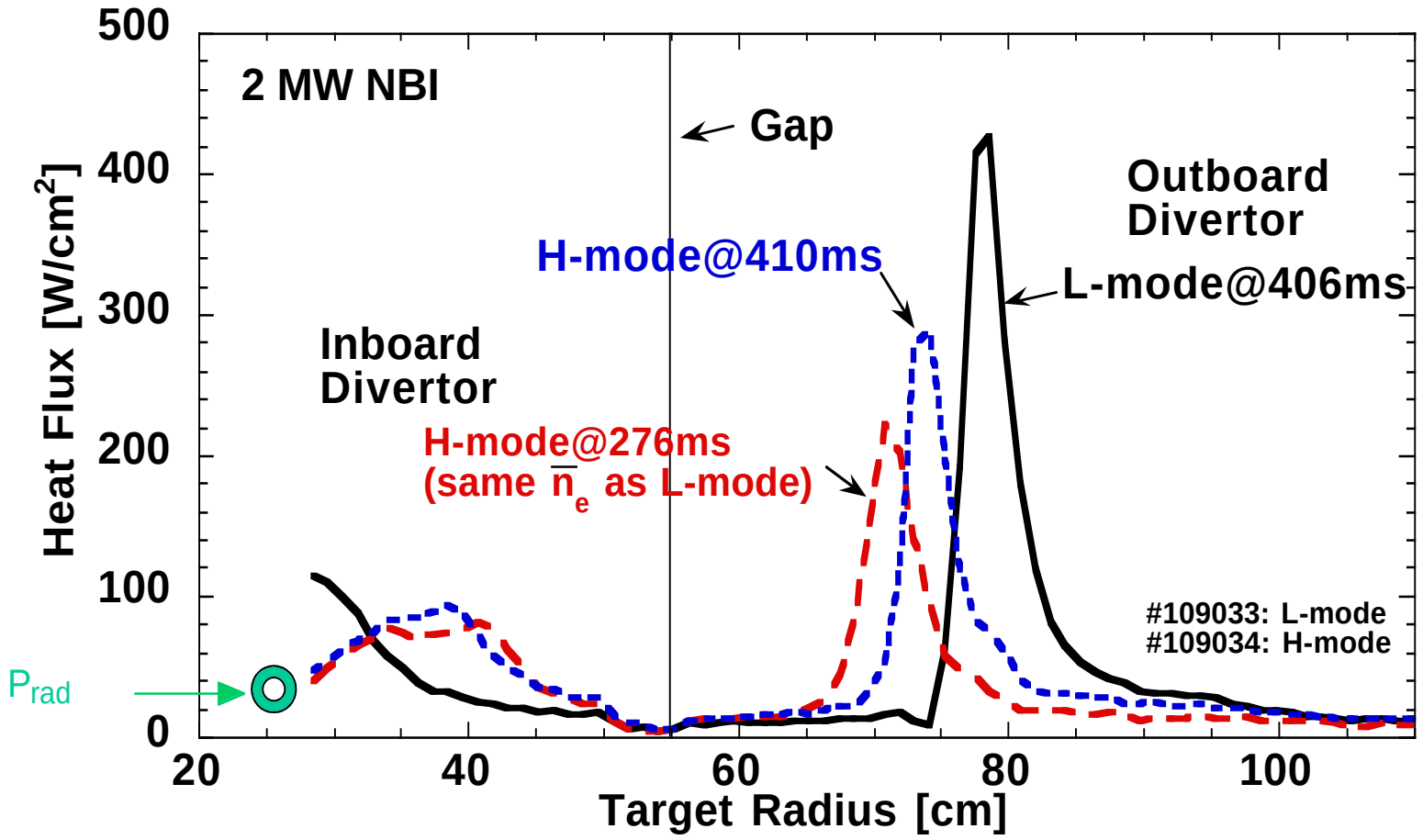
Comparison of 2 MW L and H-modes in LSN diverted configuration



-- L-mode
-- H-mode

L/H comparison: Higher divertor heat flux in L-mode
Radiated power flux increases from 30 to 42 W/cm^2



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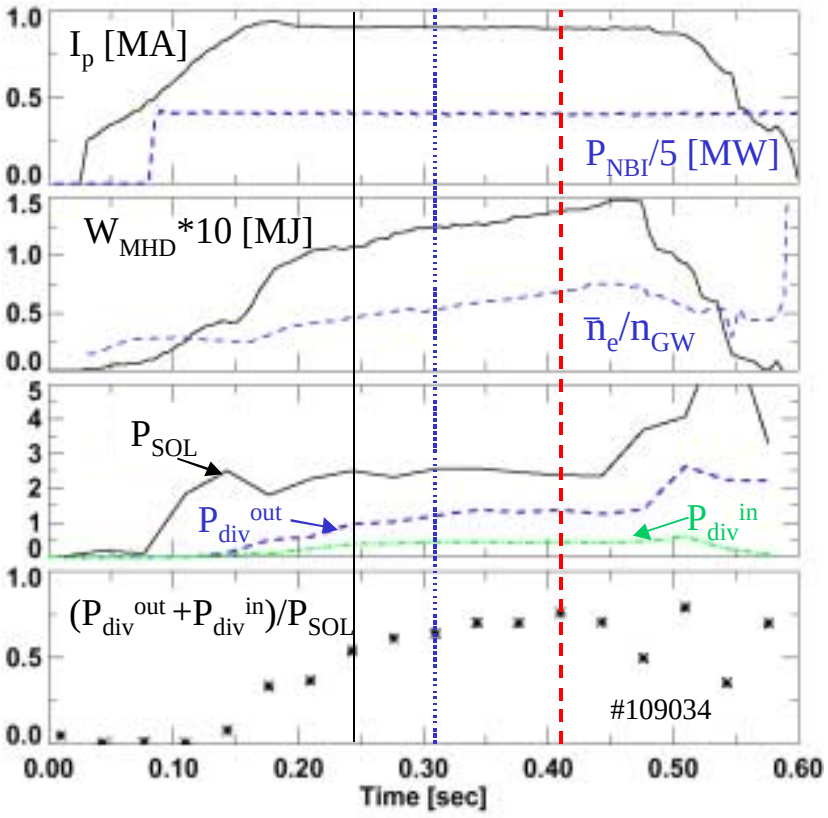
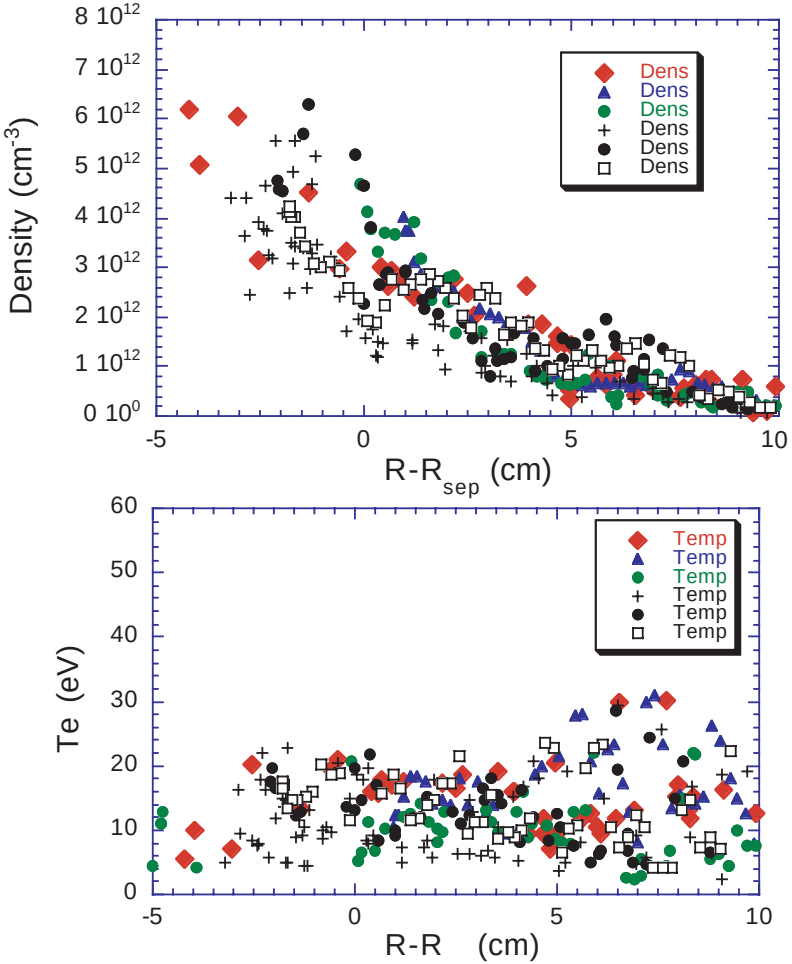
High fraction of heating power flows into divertor (1 source H-mode shown)



- 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

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

- Dα 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 oxigen
  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)