Supported by Office of Science

Divertor heat flux reduction and detachment in low δ, κ NBI-heated H-mode LSN plasmas

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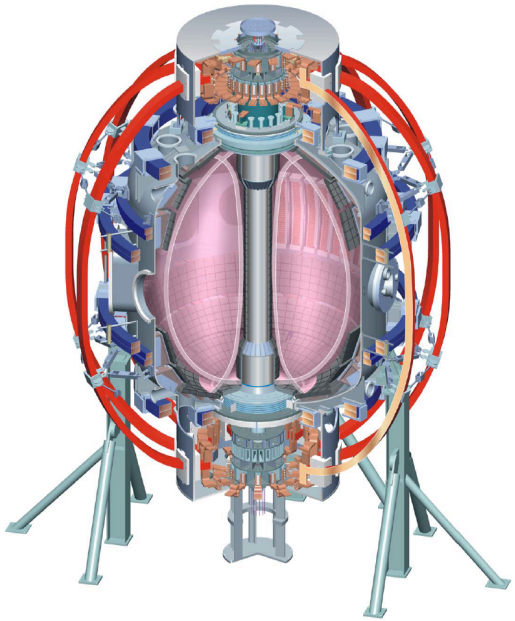
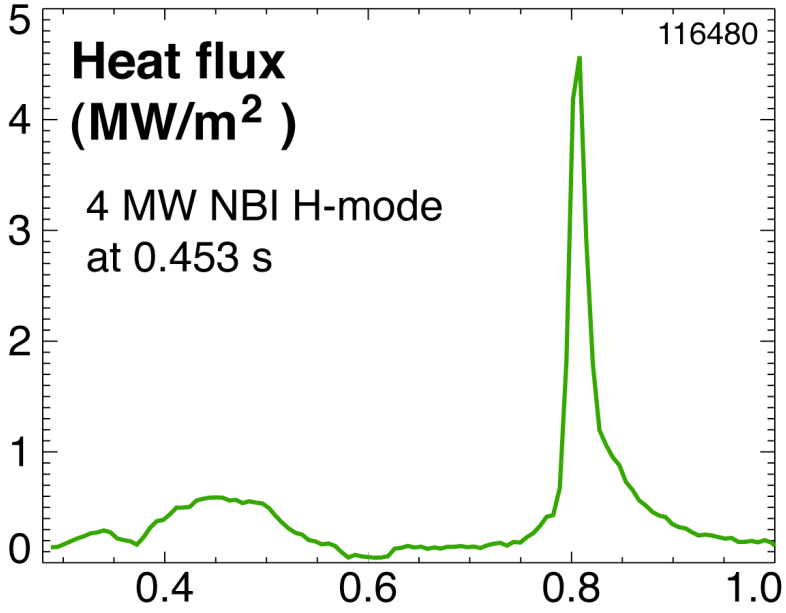
and NSTX Team

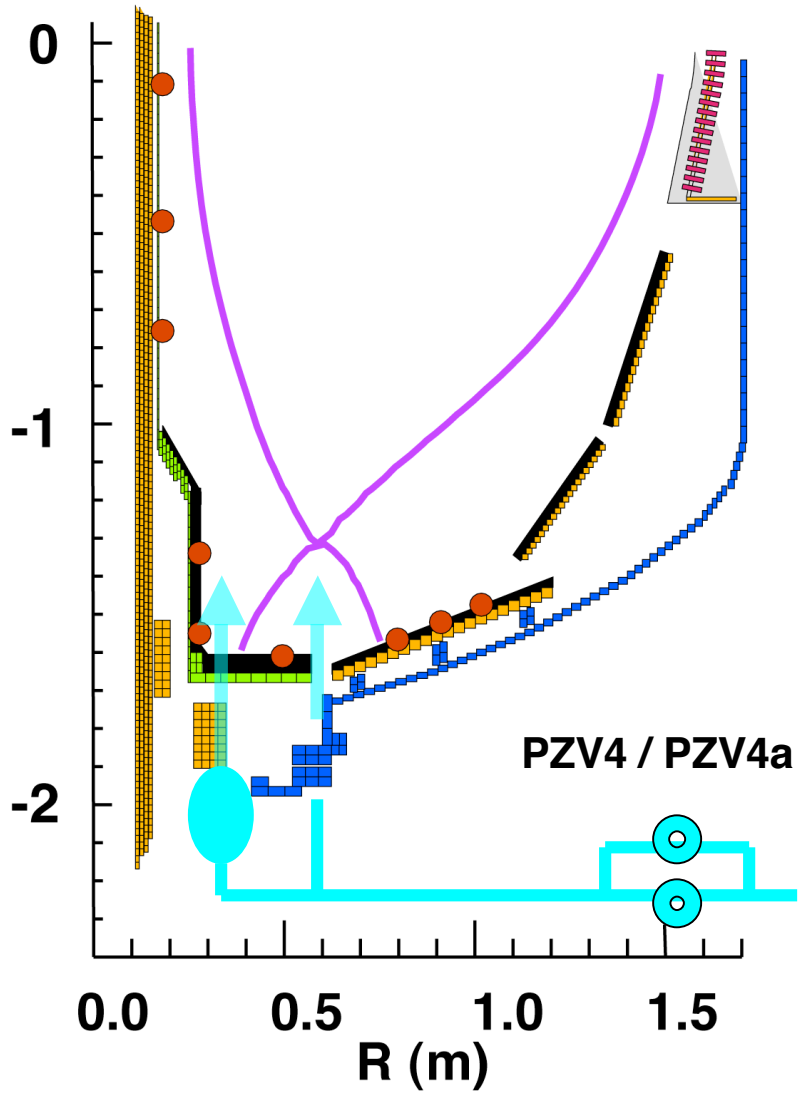


NSTX Monday Physics Meeting
03 March 2006
Princeton, NJ

Understand and control divertor heat and particle fluxes at low aspect ratio

- XP 605 includes three parts - study divertor heat flux reduction and detachment
  - in LSN shape with $\delta \sim 0.5$, $\kappa = 1.8\text{-}2.0$ with D_2 puffing
  - in LSN shape with $\delta \sim 0.7$, $\kappa = 2.2\text{-}2.5$ with D_2 puffing
  - in LSN shape with $\delta \sim 0.5$, $\kappa = 1.8\text{-}2.0$ with CD_4 puffing





Radiative and partially detached divertors in NSTX have achieved OSP peak heat flux reduction by 3-4

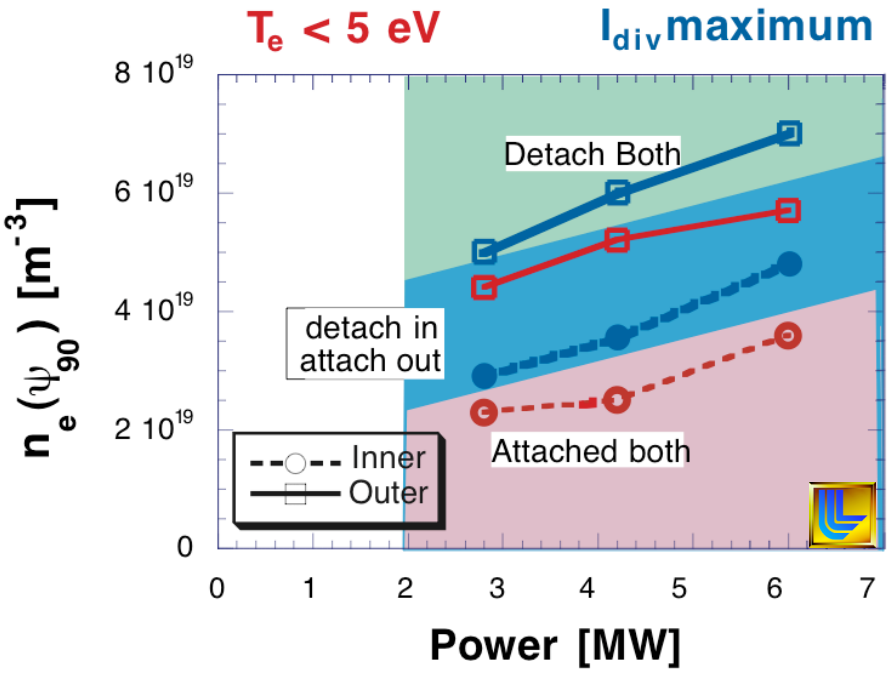
- Ran before "lithium" to eliminate uncertainties in divertor heat flux measurements
- Installed an additional piezovalve to increase divertor gas injection flow rate
- Established target - rtEFIT-controlled LSN plasma -
  4 MW NBI-heated 0.7 MA 0.45 T H-mode with small ELMs
- Injected D_2 from B5 and LDGIS "steady-state" using rates 80 - 160 Torr.l /s

- D_2 puff in private flux region at 100, 120, 140, 160 Torr.l/s - (**Radiative divertor**)
  - OSP peak heat flux reduction by 3-4 (to 1.5 MW/m^2)
  - Retained small ELM H-mode -> compatible with H-mode confinement
  - No clear signs of volume recombination
  - Divertor bolometer signal increases from 10-15 W/m^2 to 20-30 W/m^2

- D_2 puff in inner divertor at 80, 120, 160 Torr.l/s - (**Partially detached divertor)**
  - OSP peak heat flux reduction by 3-4 (to 1.5 MW/m^2)
  - Onset of volume recombination (D_γ / D_α ratio and Balmer line spectroscopy)
  - Divertor bolometer signal increases from 10-15 W/m^2 to 15-20 W/m^2
  - H-L transition within 100 ms

- Physics analysis will be presented at PSI-17 and IAEA FEC 2006

Backup slides



G. Porter, N. Wolf

Attempt to change parallel momentum and power balance:

$$\frac{d}{ds}(m_i n v^2 + p_i + p_e) = -m_i(v_i - v_n)S_{i-n} + m_i v S_R$$

$$\frac{d}{ds}((-\kappa T_e^{5/2}\frac{dT_e}{ds}) + n v_{||}(\frac{5}{2}(T_i + T_e) + \frac{1}{2}m_i v_{||}^2 + I_0)) = S_E$$