Edge characterization experiments in the National Spherical Torus Experiment

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Session CO1 - NSTX
ORAL session, Monday afternoon, November 11
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Acknowledgements

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Details are in the posters!

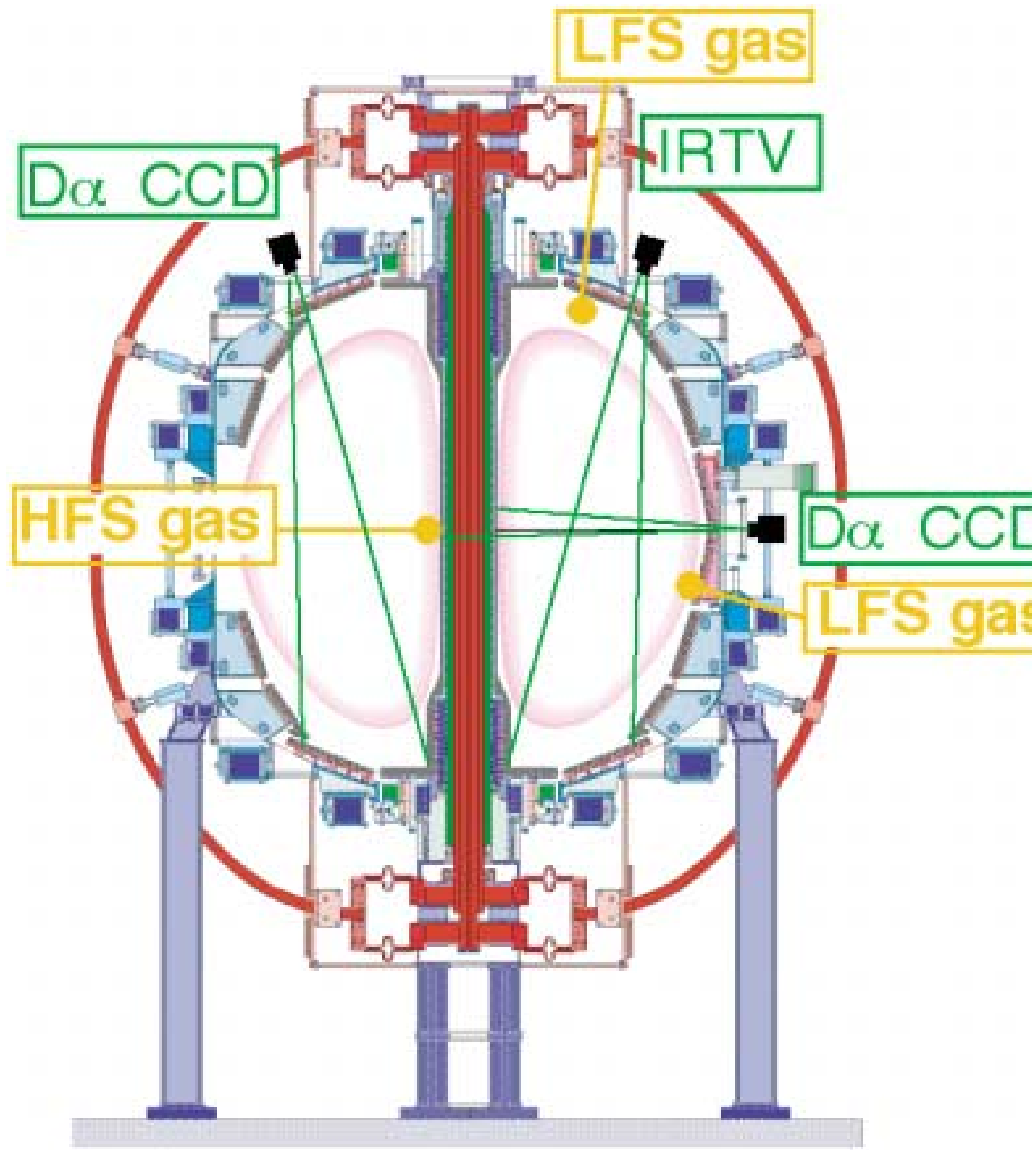
NSTX poster session

Session GP1, Tuesday afternoon, November 12

Grand Ballroom CDE, Rosen Centre Hotel

Edge characterization experiments in NSTX

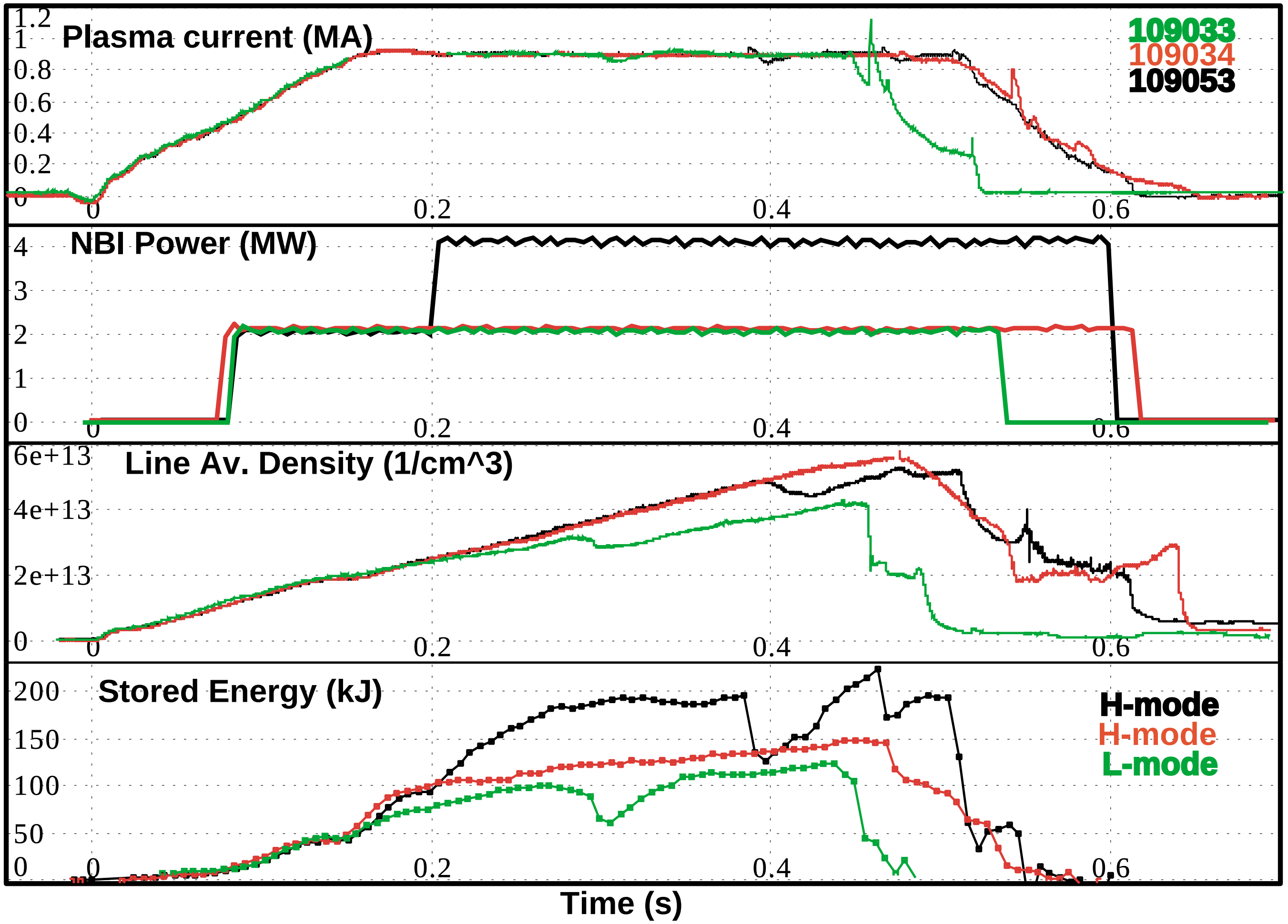
- **Study dependence of edge conditions on heating power and density**
- **Model edge power and particle flows with UEDGE 2D fluid code**



Diagnostics:

- 20-pt MPTS
- Dα filtered 1-D CCD cameras
- IRTV (heat profiles)
- Divertor bolometry
- Neutral pressure gauges
- Spectroscopy
- Fast reciprocating probe

LSN L-mode and H-mode plasmas with input power scan



$T_e(0) \cong 0.8\ keV$

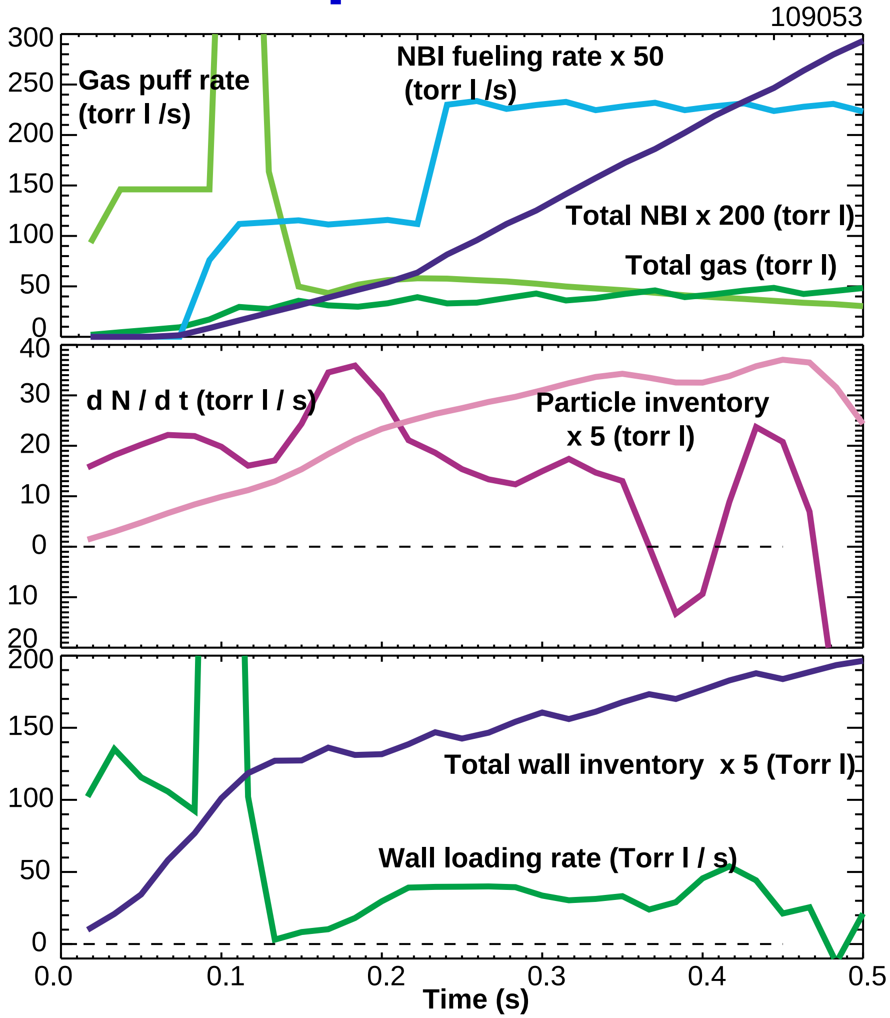
$\tau_E \cong 30\ ms\ (L)$

$\tau_E \cong 45\ ms\ (H)$

$P_{OH} \cong 0.7\ MW$

$B_t \cong 0.4\ T$

Global particle balance indicate pumping walls

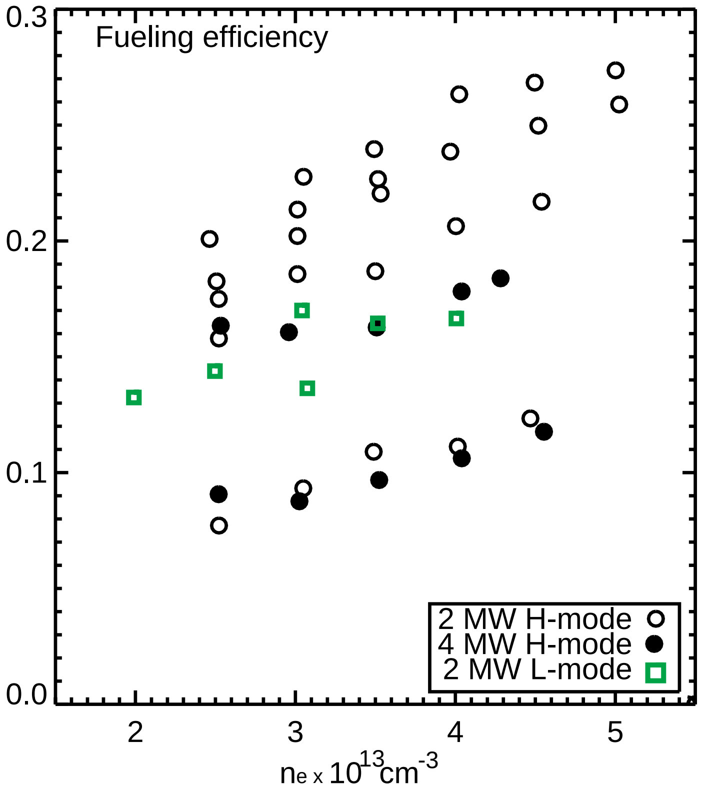


- dN/dt is ~ 20 Torr l / s
- NBI rate is ~ 2 - 4 Torr l / s
- HFS gas rate ~ 50 Torr l / s
- Net result - wall pumping

- Frequently observe density rise in LSN and DND plasmas
- Source of fueling is gas injection and recycling, NBI source small
- LFS fueling only: wall degassing, LFS+HFS: fueling: wall pumping
- Where is the recycling source?

$$\frac{dN_p}{dt} = \Gamma_{gas} + \Gamma_{NBI} + \Gamma_{NBI\_cold} + \Gamma_{NBI\_cryo} + \Gamma_{wall} + \Gamma_{pump} + \frac{dN_n}{dt}$$

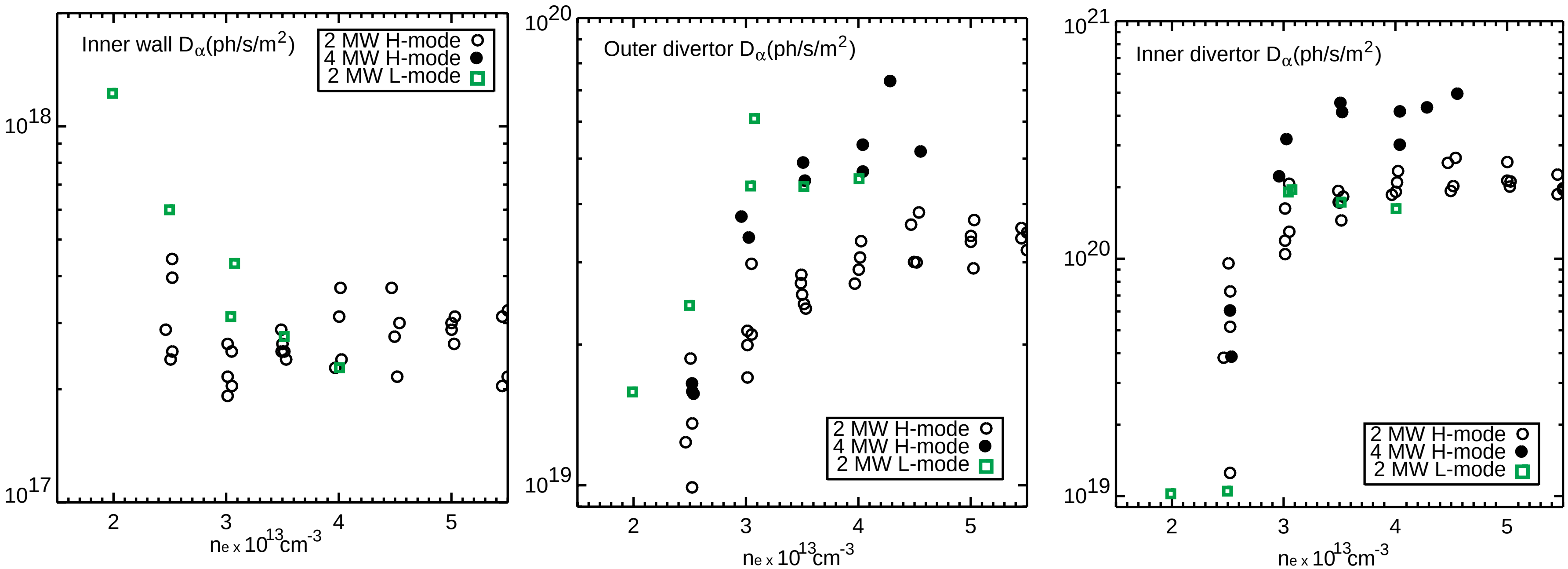
Gas fueling efficiencies are 0.1 - 0.25 (“low”)



- **Gas fueling efficiency weakly depends on density in one discharge**
- **Variability between discharges is due to wall conditions**
- **NBI fueling efficiency FE ~ 0.9 (“high”)**
- **Core fueling by impurities insignificant**
- **Poloidal location of fueling is unimportant in L-mode plasmas**
- **Fueling efficiency does not depend on gas inj. rate**

- Fueling efficiency $\eta = \frac{N_i(t)}{N_p(t)}$ or $\eta = \frac{dN_i / dt}{\Gamma}$

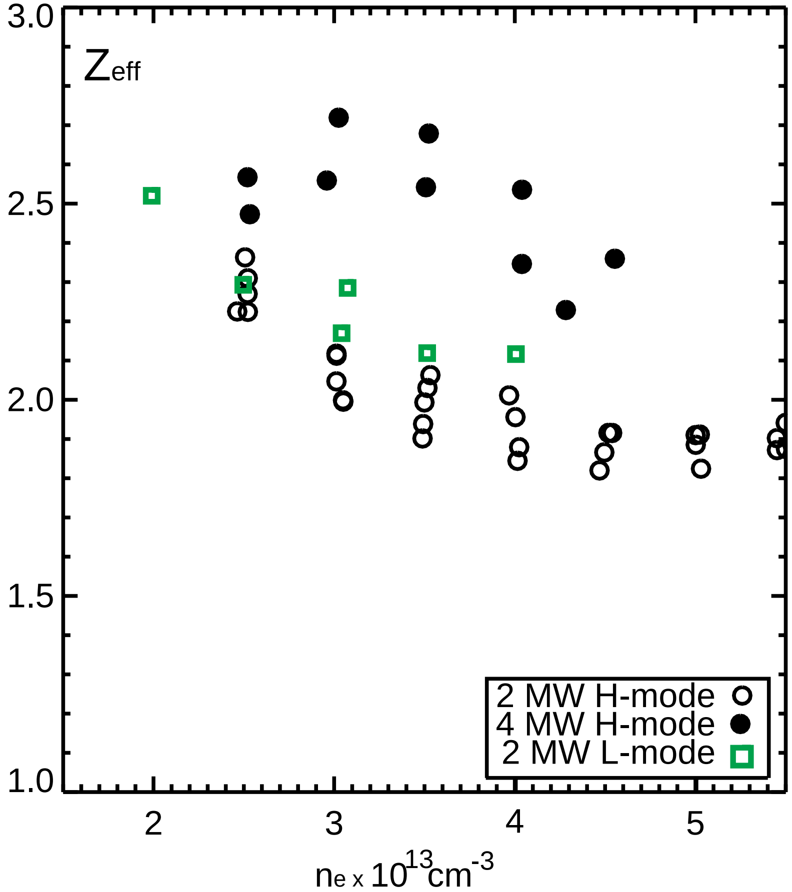
Observations of wall and divertor recycling



Dα brightness:

- Similar on inner wall in L- and H-mode at medium density
- Increases with heating power in outer and inner divertor
- Similar in 2 MW L- and H-modes in inner divertor
- Higher in 2 MW L- vs H-mode in outer divertor
- Factor of 3 - 6 higher in inner divertor vs outer divertor

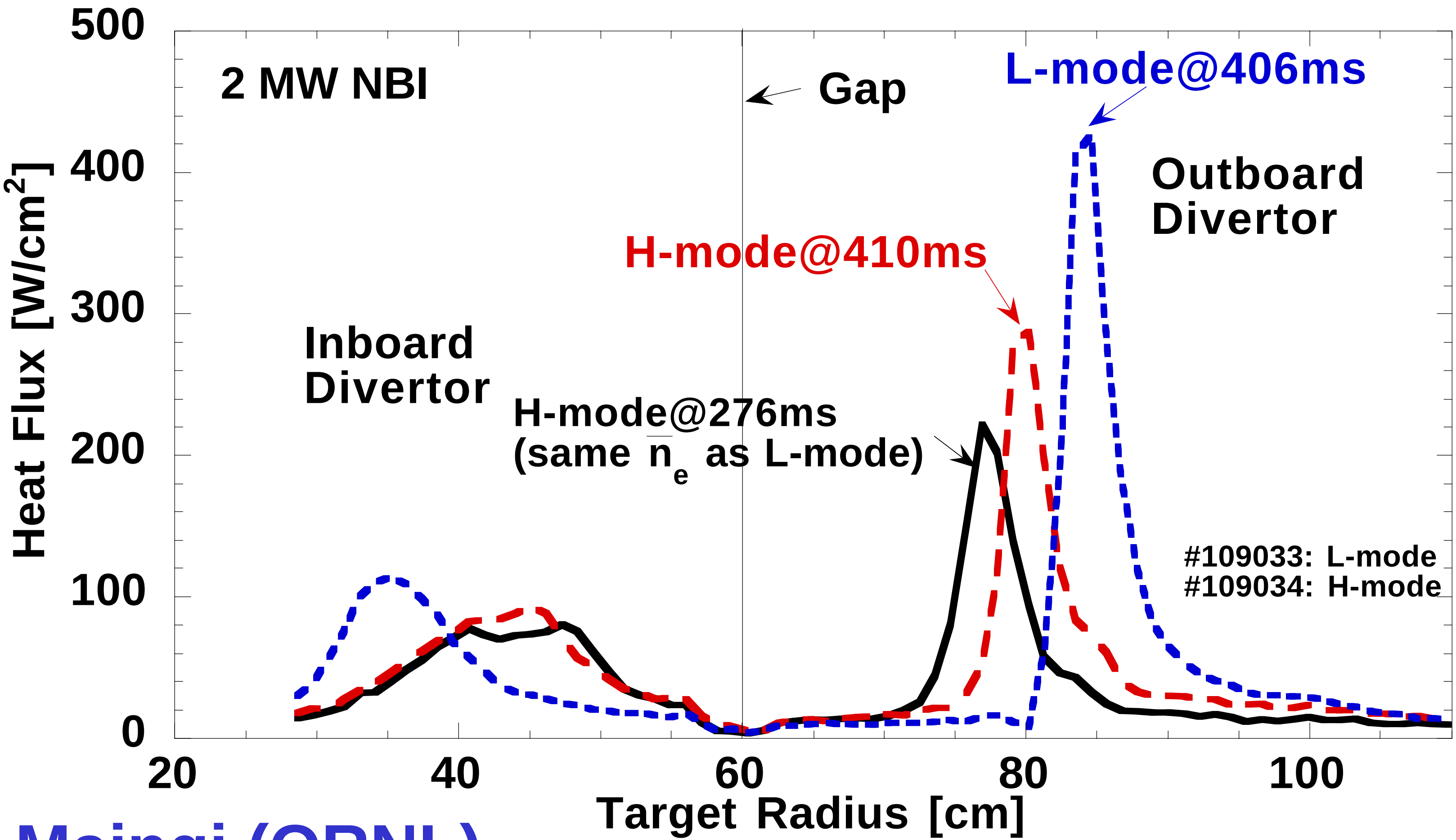
Z_{eff} scales with NBI power in H-mode; similar for same input power L- and H-modes



- Main impurities: carbon and oxygen
- Similar levels of impurities in LSN and DNS plasmas
- No accumulation observed

High fraction (0.5 - 0.75) of heat power flows into divertor in L- and H-modes

Higher outer divertor heat flux in L-mode vs H-mode



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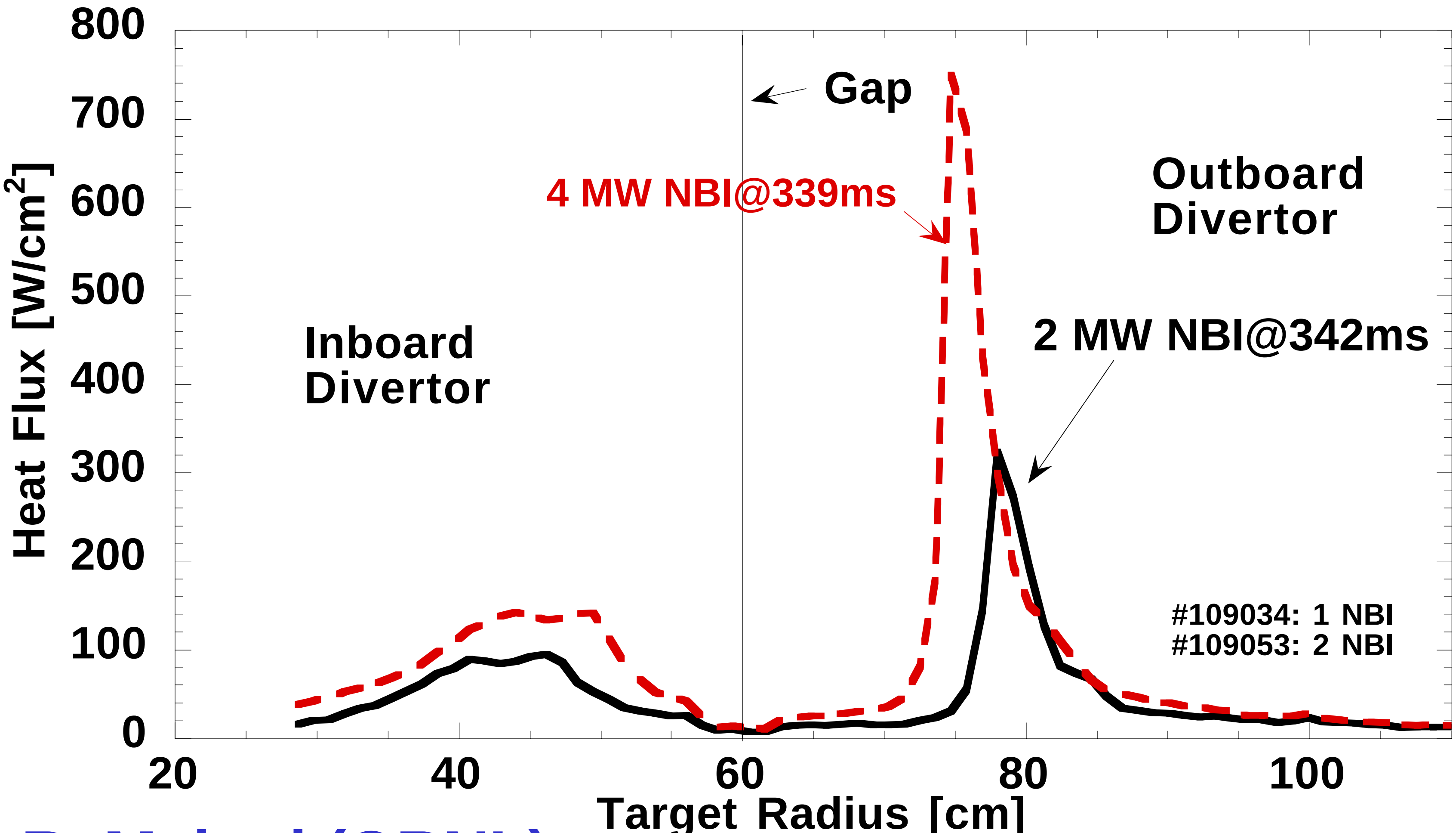
Outer divertor Peak Heat flux increases non-linearly with heating power



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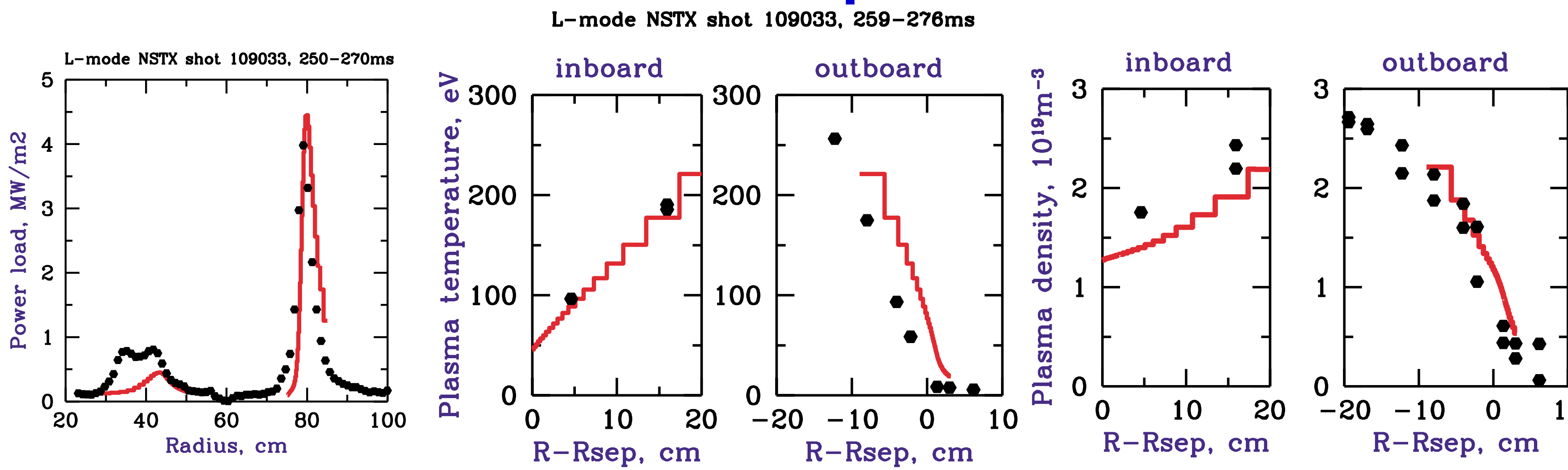
UEDGE: convective transport in L-mode SOL?



UEDGE modeling:

- Separatrix position from EFIT challenged
- Transport $D_\perp \cong 1.5\ m^2/s,\ \ \chi_\perp \cong 10\ 1/m\ 1/s,\ V_{conv} \cong 20-80\ m/s$
- Nearly matched: heat flux profile, edge Te and ne profiles, particle balance, midplane neutral pressure
- Dα divertor in-out asymmetry not matched due to uncertainties related to HFS gas injection and calibration

A. Pigarov (UCSD)

Summary

• Analysis of fueling, particle sources and sinks indicate need for advanced fueling schemes and active density control

• Divertor heat flux < 10 MW/m^2 is adequately handled at present. Additional means will be needed for t > 1 s discharges

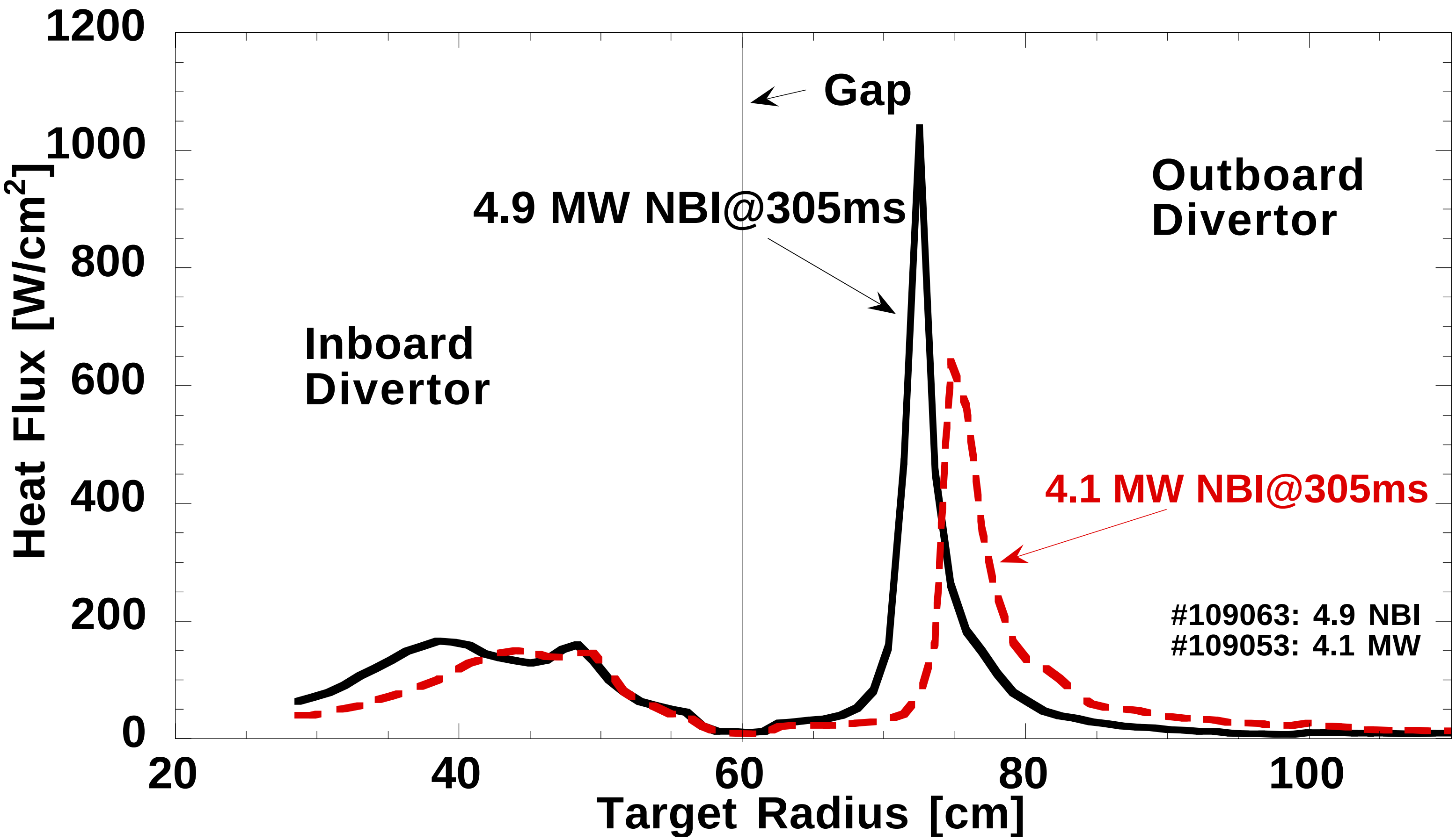
• Divertor detachment has not been clearly observed. High recycling regime is likely at present

• UEDGE modeling of L-mode points to highly convective transport in SOL

Near future improvements:

- New HFS gas injector with ~ 150 torr l / s rate
- Supersonic gas nozzle injector under development
- Low velocity pellet injector to be mounted in FY'03
- Density feedback control system

Highest peak heat flux observed ~ 10 MW/m2



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