NSTX

Supported by

U.S. DEPARTMENT OF ENERGY | Office of Science

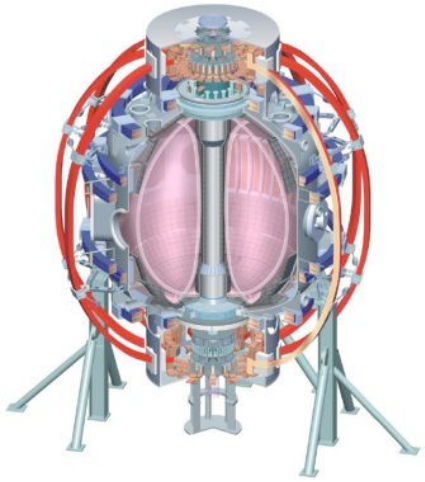
Summary of XP-827(2009): Recovery of Lithium Wall Conditions and ELM Mitigation in High-δ Discharges

College W&M
Colorado Sch Mines
Columbia U
CompX
General Atomics
INEL
Johns Hopkins U
LANL
LLNL
Lodestar
MIT
Nova Photonics
New York U
Old Dominion U
ORNL
PPPL
PSI
Princeton U
Purdue U
SNL
Think Tank, Inc.
UC Davis
UC Irvine
UCLA
UCSD
U Colorado
U Illinois
U Maryland
U Rochester
U Washington
U Wisconsin

H. W. Kugel, *PPPL*

and the NSTX Research Team

NSTX 2009 Results Review
September 15-16, 2009



Culham Sci Ctr
U St. Andrews
York U
Chubu U
Fukui U
Hiroshima U
Hyogo U
Kyoto U
Kyushu U
Kyushu Tokai U
NIFS
Niigata U
U Tokyo
JAEA
Hebrew U
Ioffe Inst
RRC Kurchatov Inst
TRINITI
KBSI
KAIST
POSTECH
ASIPP
ENEA, Frascati
CEA, Cadarache
IPP, Jülich
IPP, Garching
ASCR, Czech Rep
U Quebec

XP827(2009): Recovery of Lithium Wall Conditions and ELM Mitigation in High-δ Discharges

- XP-827(2008), *"LITER Characterization and ELM Mitigation in Low-δ Discharges"* which used the first 2008 Li discharges was rerun as *"Recovery of Lithium Wall Conditions and ELM Mitigation in High-δ Discharges"*.

- High-δ, Ip = 1 MA, 5MW NBI discharges were established. Lithium was evaporated on to the lower divertor, in increasing amounts from 16 to 50 mg/minute, in deposition sequences applied for 10 or 8 minutes each, with the pre-deposition HeGDC gradually decreased from 10, 8, 6, 4, to 0 min.
  - the high-δ discharges, became increasingly ELM-free, relative to the pre-lithium reference discharges, and finally ELM-free.

- Then, low-δ discharges were obtained for two different conditions, and closely reproduced the same 2008 ELM-free discharges.

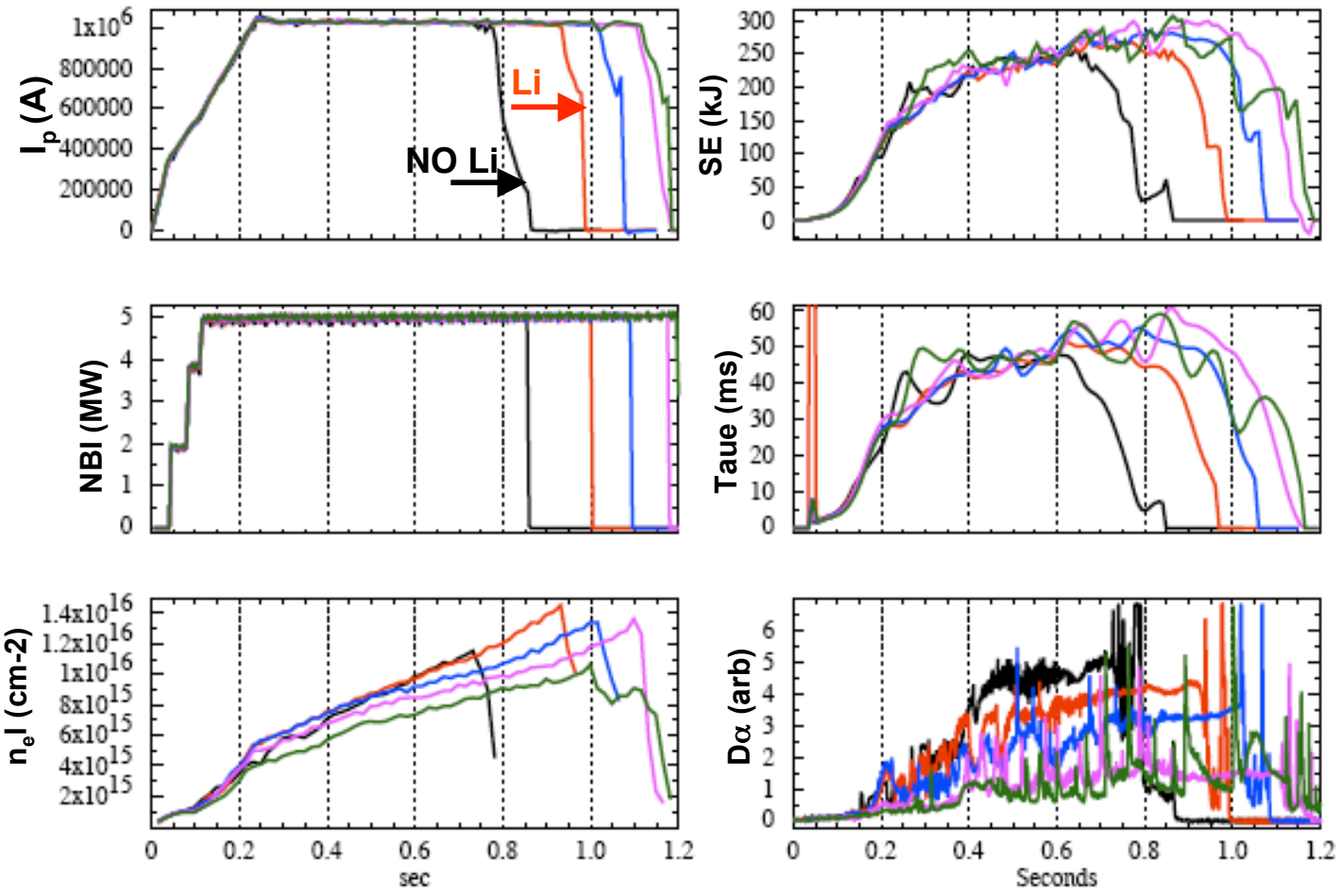
Discharge Performance Responded Promptly to Lithium Wall Conditions

SHOT

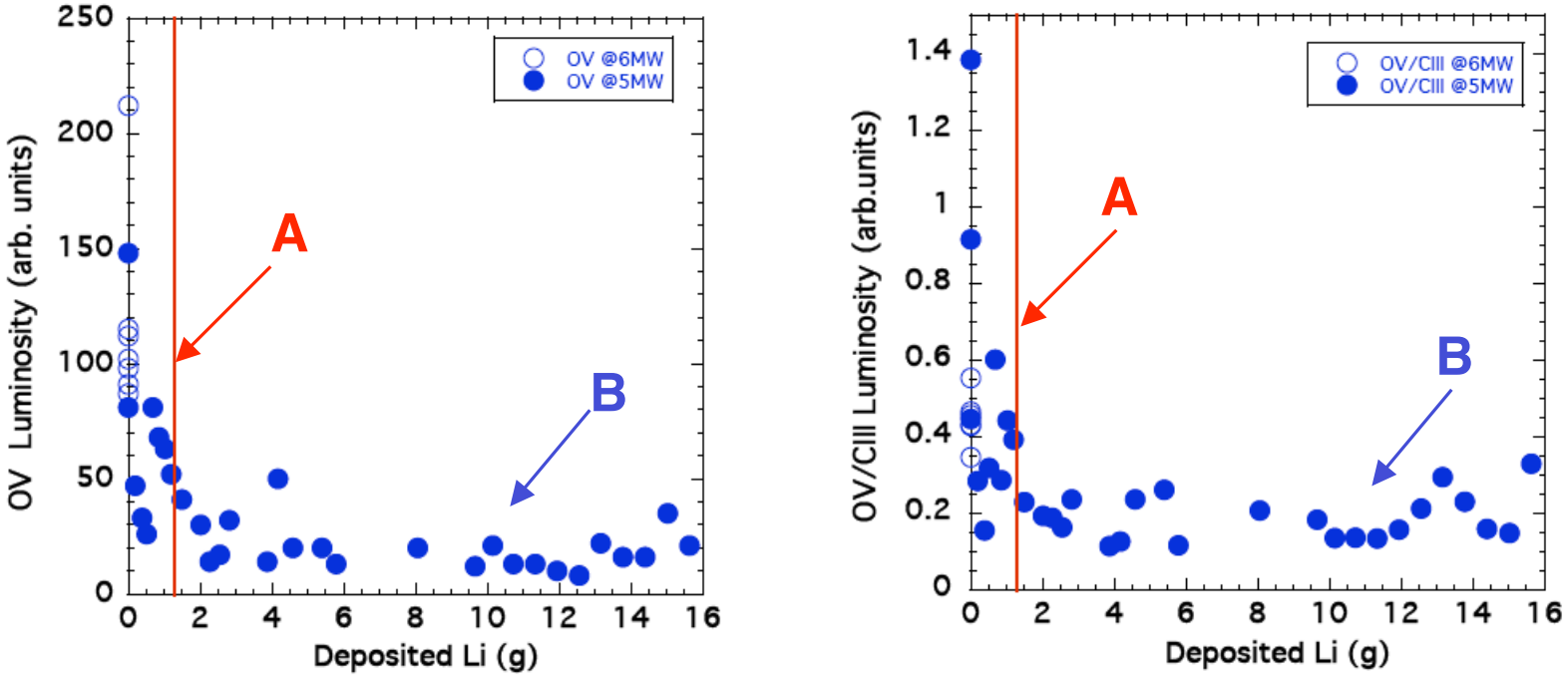
132547
132550
132556
132557
132560

Li

0 g
0.2 g
1.2 g
1.5 g
2.3 g



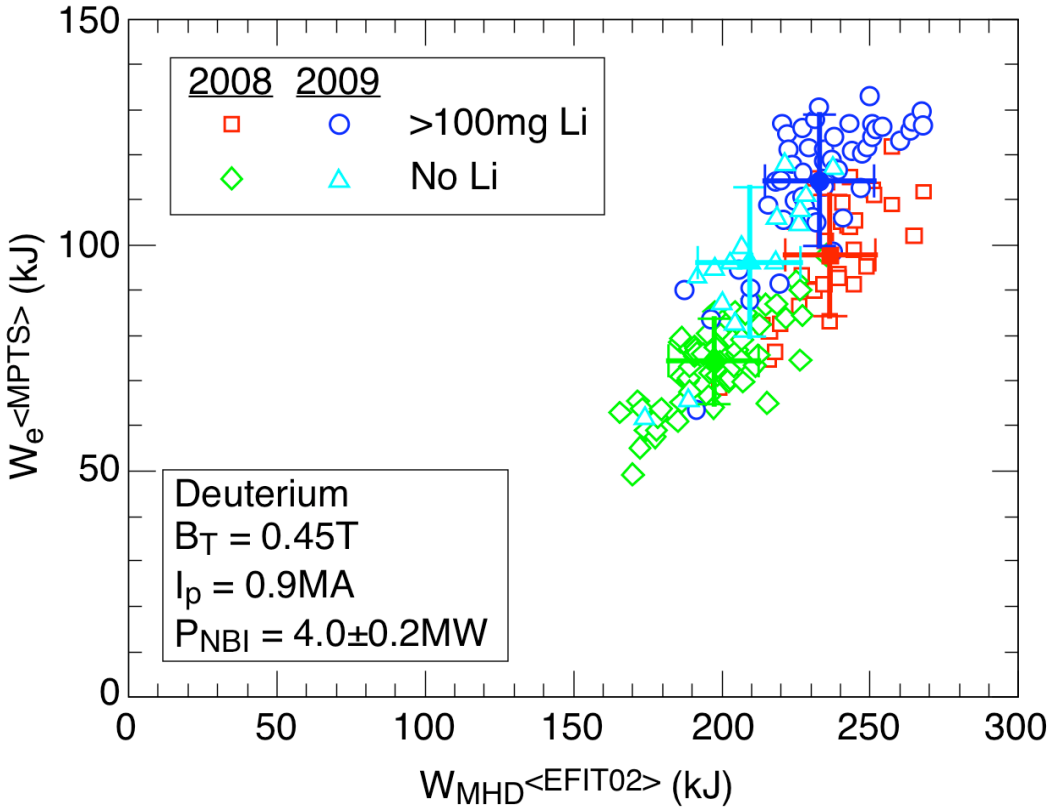
Oxygen V Luminosity Decreased as Li Deposition on Lower Divertor Increased



(A) At ~1.3 g, average Li deposition thickness over lower 25% of vessel becomes comparable to the 250 nm range of incident D.

(B) Relatively constant OV/CIII ratio as Li deposition over lower divertor increased may be due to oxygen contributions from the regions of partially coated graphite (upper and outer vessel hardware).

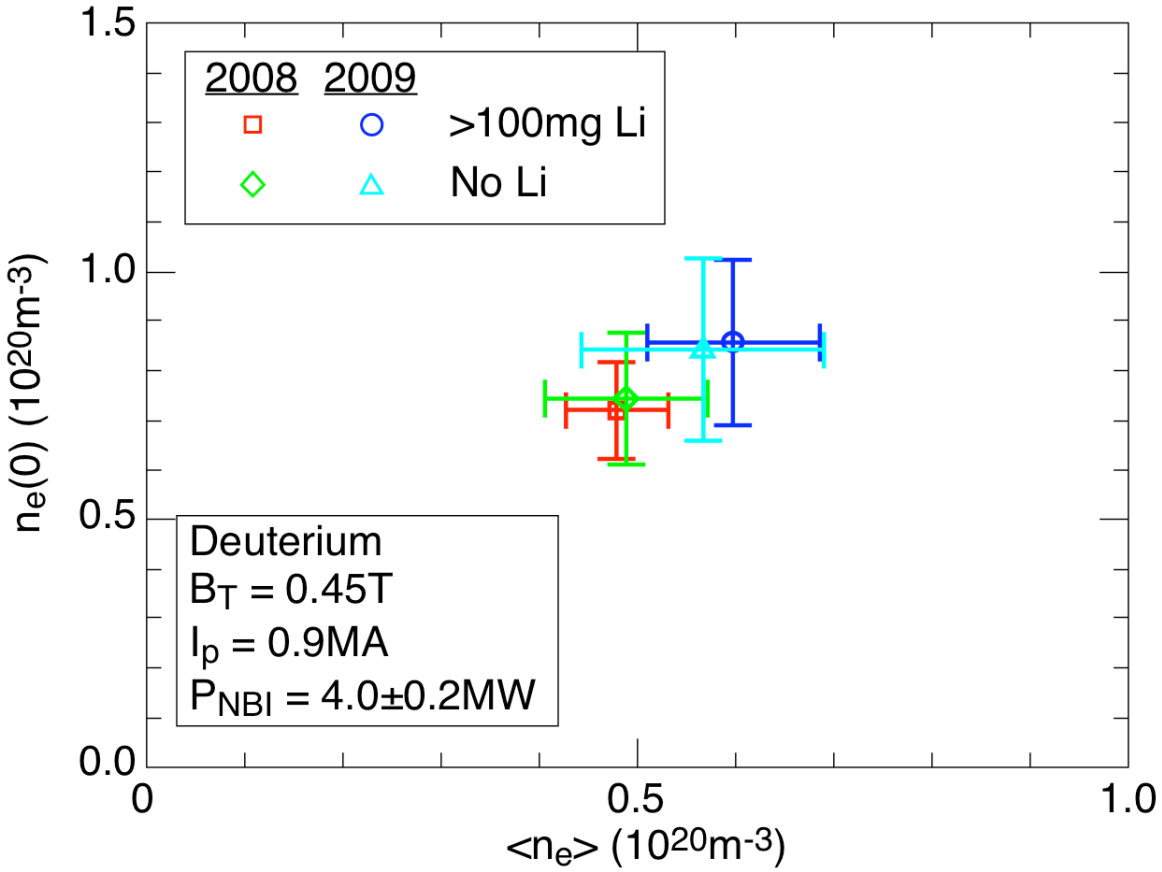
Similar Total Stored Energies in 2008 and 2009



- 2009 reference discharges had ~20% higher W_e both with and without Li. Difference attributable to higher densities. Difference not due to MPTS calibration.
- Difference between Li and non-Li more pronounced in 2008 than in 2009. More "non-Li shots" in 2009 were taken after Li started. Appears to be a residual benefit from earlier evaporation which raises the overall confinement.

M.G.Bell

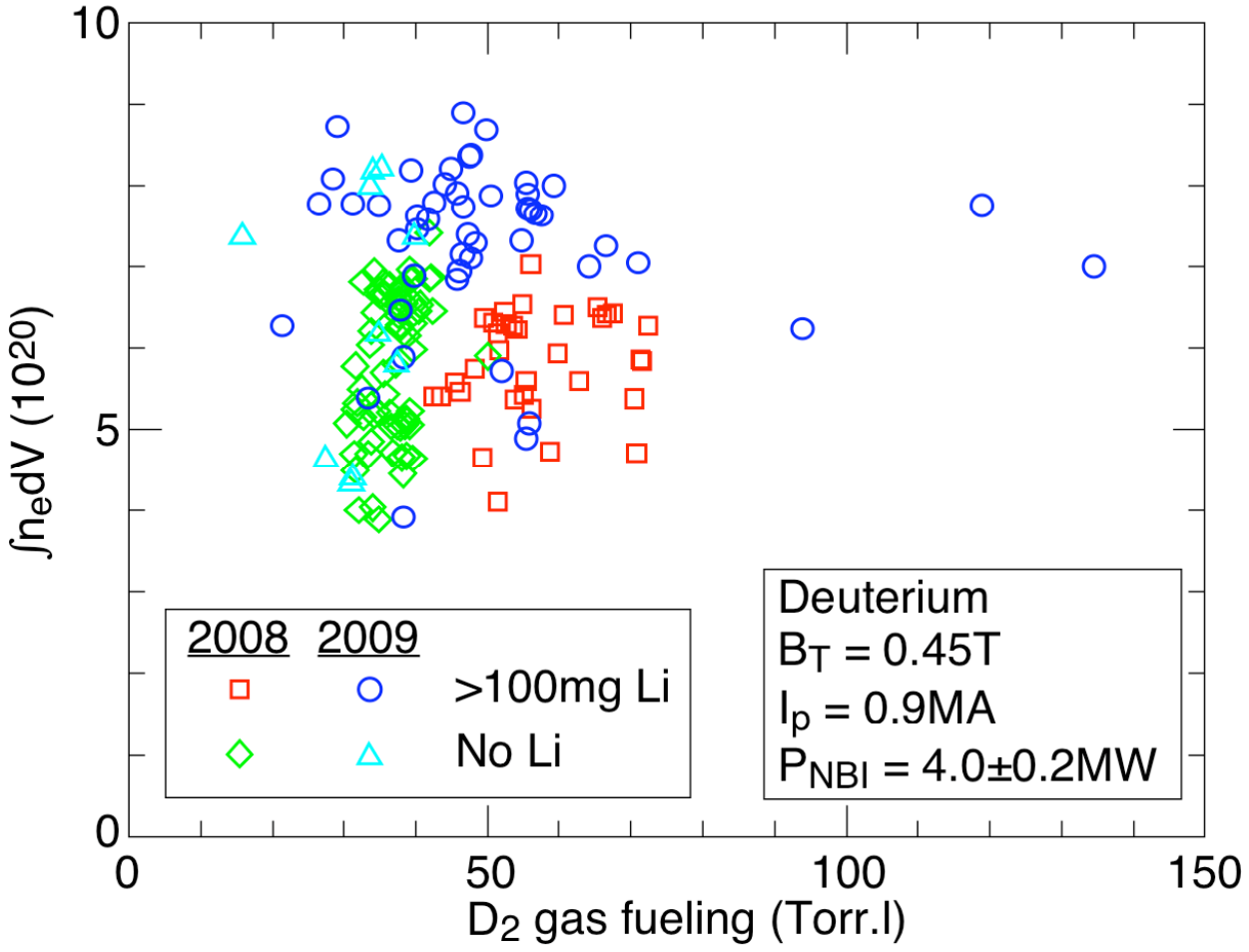
2009 Densities are Higher than in 2008, Electron Temperatures are Unchanged



- The difference between 2008 and 2009 in W_e is mostly attributable to the densities, both central and average being higher. The temperatures, central and average, are essentially unchanged.

M.G.Bell

Higher Fueling Rates Required for Discharges Following Higher Net Lithium Depositions

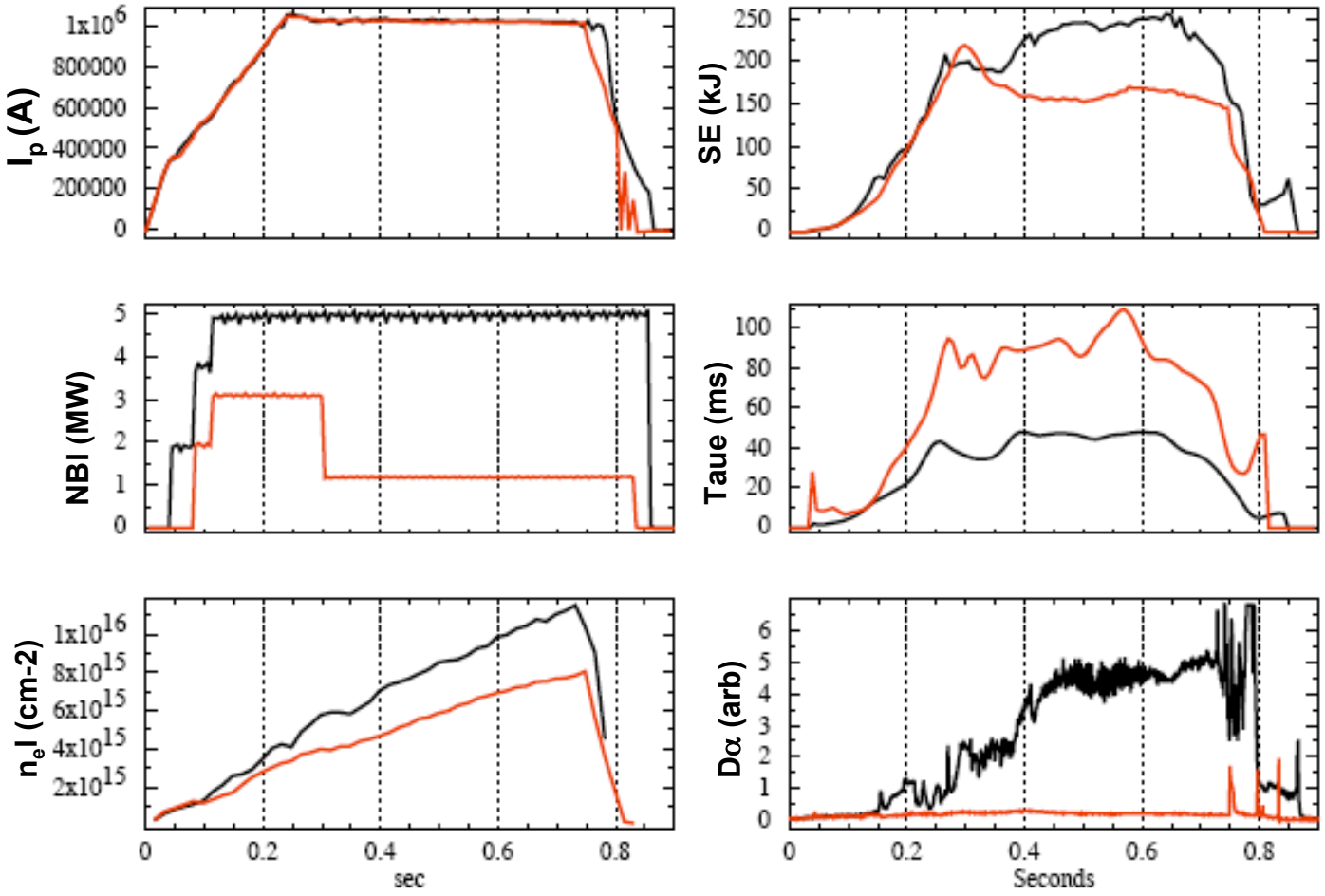


- Higher electron content in 2009 for the same gas input.

M.G.Bell

Lithium Wall Conditions Enable H-Mode with 1 MW NBI

Shots:
132547 5 MW
132590 1MW



Summary and Conclusions

- Initial results found that relatively thin lithium coatings:
  - increased the plasma current pulse length relative to the before-lithium reference discharges,
  - caused earlier H-mode transitions,
  - caused significant density reduction in the early part of discharges calling for more fueling,
  - increased electron temperature, electron stored energy and confinement time,
  - reduced OV/CIII impurity ratios.

- As the net lithium deposition increased:
  - the high elongation discharges, relative to the pre-lithium reference discharges, became increasingly ELM-free, and finally, became ELM-free.
  - the discharge pulse length, with lithium wall conditions and RWM applied, increased to about 1.2 sec.
  - OV and OV/CIII impurity ratios decreased below those following 2009 boronization, and approached the 2008 levels.
  - a high-δ, H-mode, discharge was obtained with 1 MW NBI (1.8 MW total) with Tau-E of about 90ms.
  - Eventually the HeGDC was reduced to 0 minutes, allowing the increased duty cycle.

- Then, low-δ discharges were obtained for two different conditions, that closely reproduced the same 2008 ELM-free discharges.