(SG1) Multi-phase and Atomic/Molecular physics group report

June 14, 2024 (M. Kobayashi)

Date: June 13, 2024
Time: 10:30 -16:45
Shot#: 193158 – 193271 (114 shots)

Prior wall conditioning: No
Divertor pump: On
Gas puff: H2, Ne, Ar, N2 IPD: Yes
LID: Yes
NBI#(1, 2, 3, 4, 5)=gas(H, H, H, H, H)=P(2.3, 2.3, 2.3, 3.3, 2.8) MW
ECH(77GHz)=ant(5.5-U, 2-OUR)=P(698, 380)kW
ECH(154GHz)=ant(2-OLL, 2-OUL, 2O-LR)=P(705, 889, 982) kW
ECH(116GHz)=ant(2O-LR)=P(-)kW
ECH(56GHz)=ant(1.5-U)=P(-)kW
ICH(3.5U, 3.5L, 4.5U, 4.5L) = P(-, -, -, -) MW

Topics

1. The relation between plasma confinement and edge neutral particle (G. Motojima)
2. Sustainment of divertor detachment by using feedback control impurity seeding (S. Masuzaki)
3. Plasma modification and supplemental wall conditioning through lithium granule introduction (R. Lunsford)

The relation between plasma confinement and edge neutral particle (G. Motojima)

✓ Experimental conditions:

R_{ax}=3.55m, CCW, B=2.78T, γ=1.254, B_q=100%

#193158-193179: Divertor Cryo OFF (Panel > 80 K)

#192968-192974: Divertor Cryo ON (Panel <20K)

Motivation

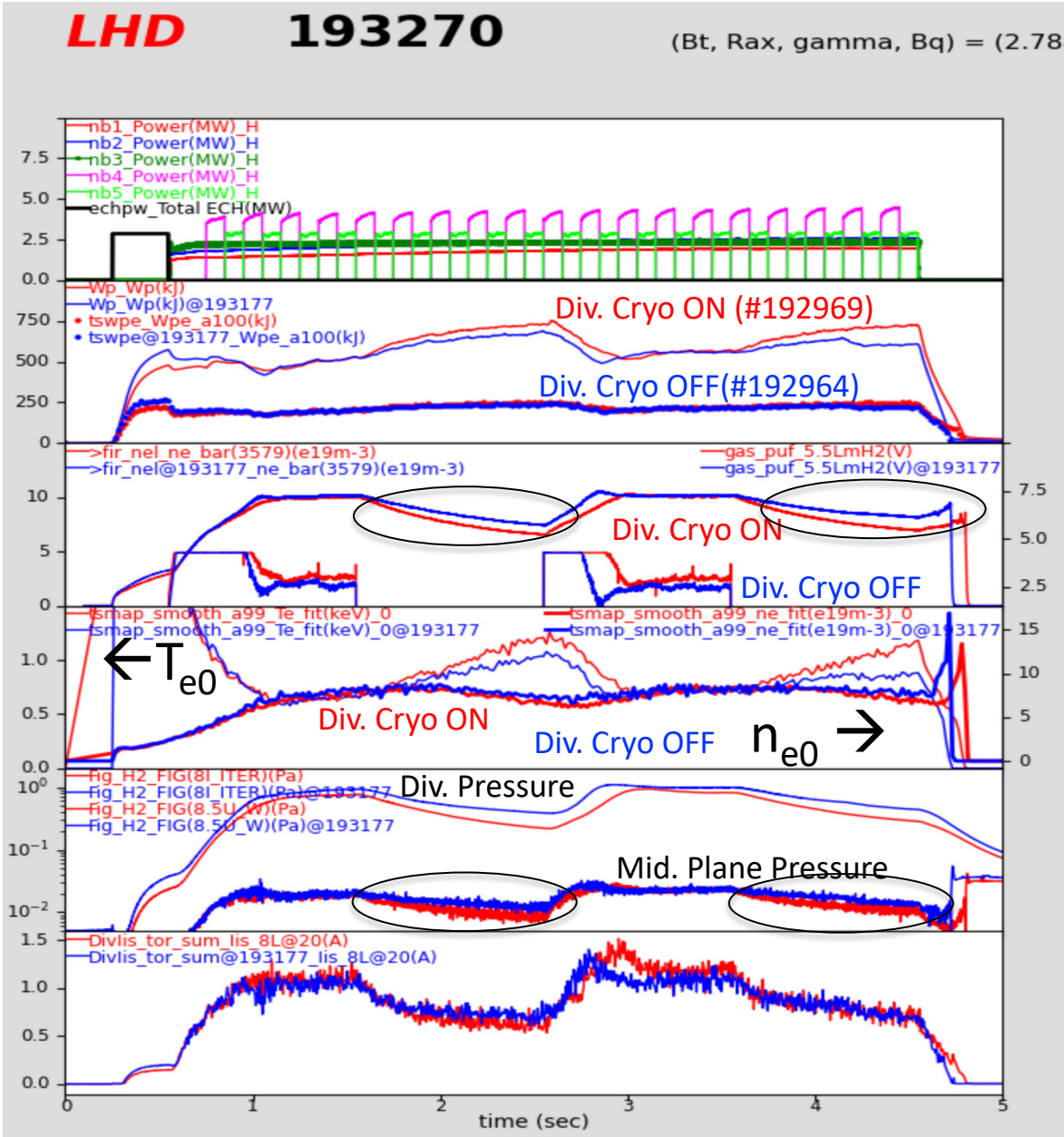
- ❖ In the 24th LHD campaign, very high neutral pressures were measured in the sub-divertor region in R_{ax}=3.55m (Wenzel et al., Nuclear Fusion 2024).
- ❖ In such kind of high neutral compression state, it is tried to control the recycling under the divertor pump condition.

✓ Experiments

- ❖Density steady state (8-11x10^{19} m^{-3})
- ❖Density modulation

✓ Results

- ❖Divertor pressures of around 50-100 times higher than mid plane pressures have been achieved.
- ❖In gas puff modulation, density decay after gas puff off is faster with Div. On (effective confinement time is lower). Mid. plane pressure is also lower with Div. On, confirming low recycling.



Sustainment of divertor detachment by using feedback-controlled impurity seeding

S. Masuzaki

Shot #: 193180 – 193209

(R_{ax}, B_t, γ, B_q) = (3.65 m, 2.7123 T, 1.2538, 100.0%) ,

Working gas: H2, Impurity gas: N2, Ne

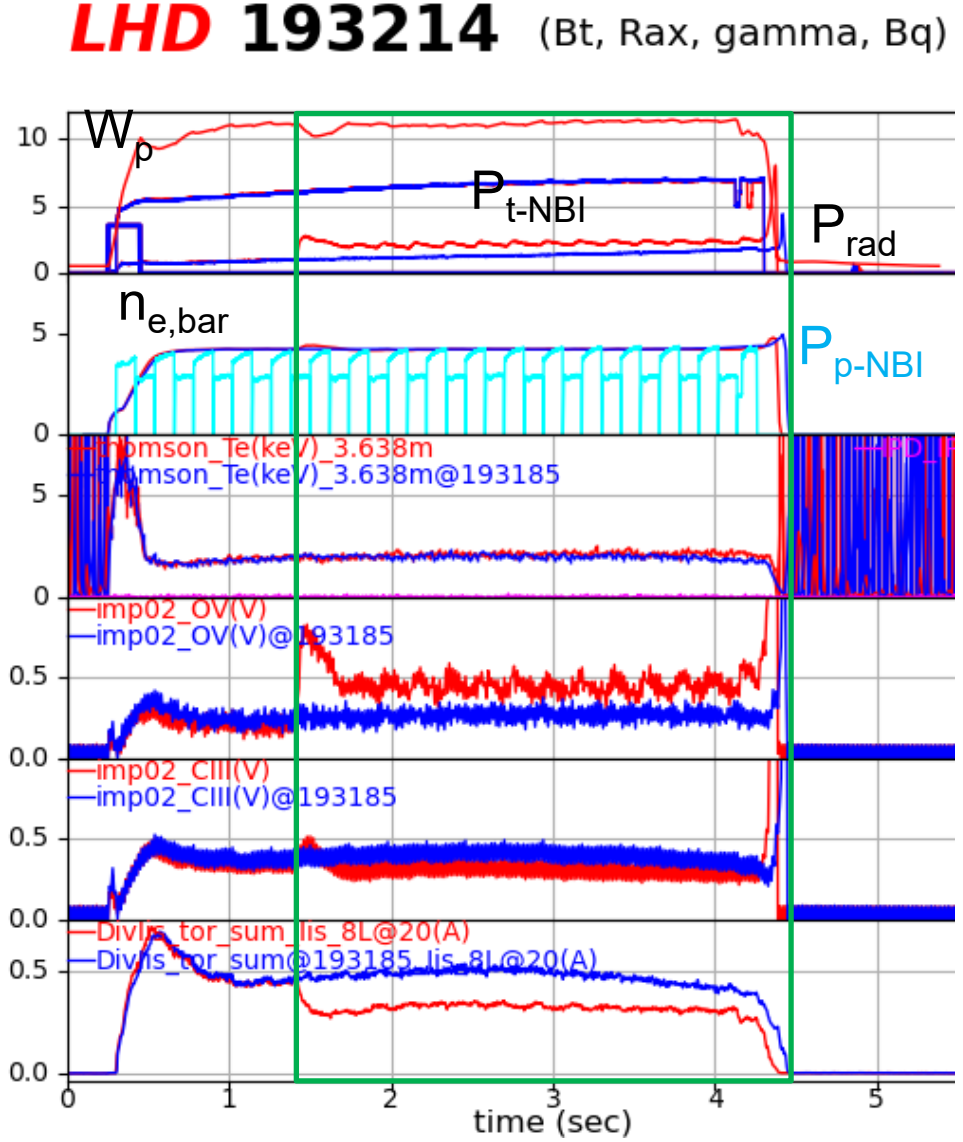
P_{ECH}～0.4 MW, $P_{t\text{-}NBI}$~ 2.3MW/injector (pulse length:4s),
$P_{p\text{-}NBI}$~3 MW/injector (modulated)

Background and Purpose

- In the Rax=3.65m configuration, the stable complete detachment without impurity seeding was obtained (SURPENS mode).
- However, the density in the operation is near the density limit.
- To conduct a more flexible detachment operation, impurity seeding has been examined in the Rax=3.65m configuration.

Result

- Using feedback-controlled Ne gas puffing (pulse puffing), a stable “mild” detachment state was obtained.
- The expected deeper detachment state, in which ion saturation current to divertor tiles less than 50% of the attached case, could not be obtained for radiative collapse.

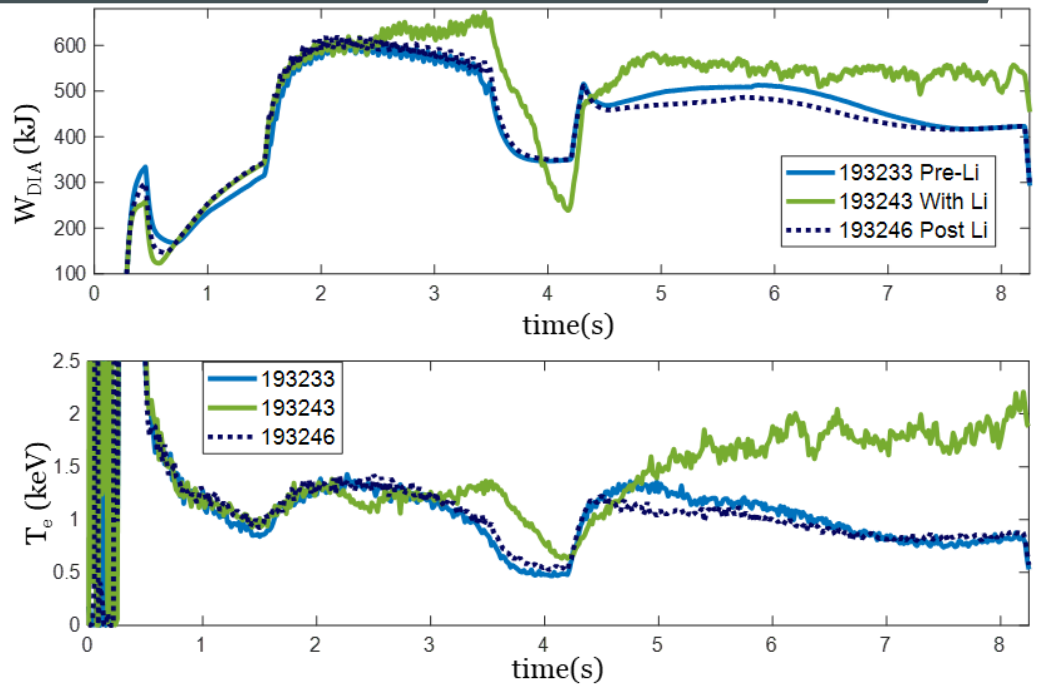


Typical time evolutions of w/ and w/o Ne seeding :#193214 (w/ Ne), 193185 (w/o Ne)

LHD Lithium Granule Injection Experiments (193217 – 193248)

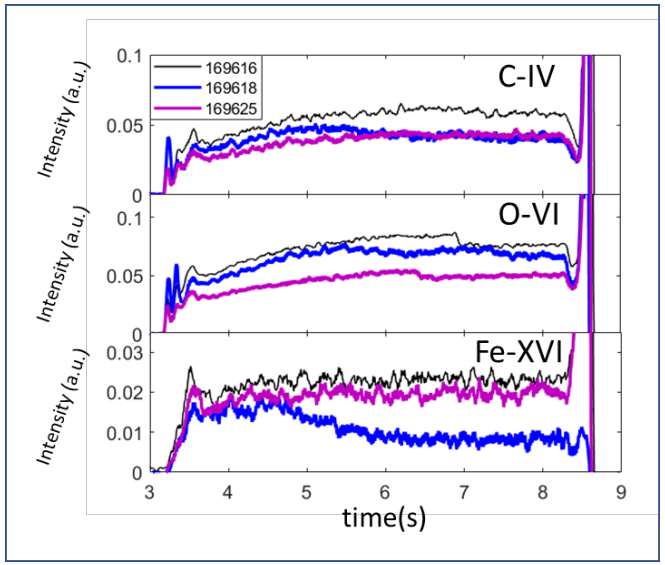
32 Pulses (16 with 850 μm Li granules, 16 without Li)

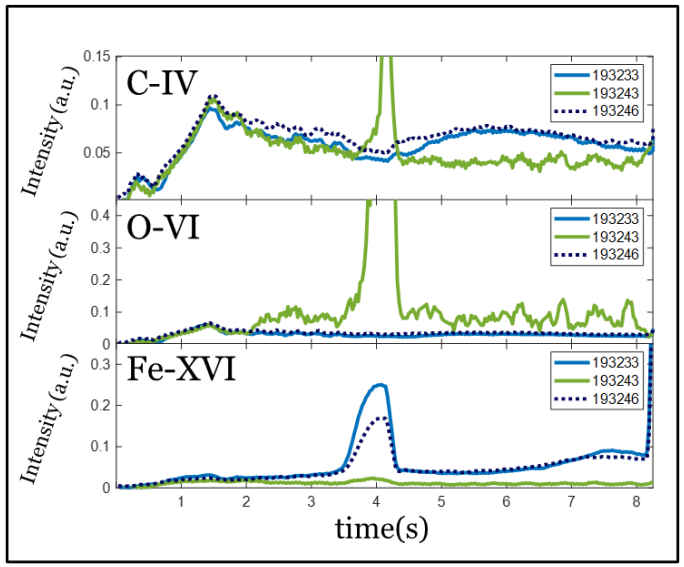
- Large granules are much more perturbative
- This limited applicable IPD voltages and Li quantities
  - Modifications to the plasma were substantial
  - Conditioning effect was minimal when compared to what was achieved with B powder injection.
- **Critical information for ITER as it considers pellet vs powder injection**
- Possible next steps : Smaller Li powder or larger B powder to confirm size effects



B Injection Comparison

169616 – Pre B
169618 – During B
169625 – After B





Li Injection

193233 – Pre Li
193243 – During Li
193246 – After Li

R. Lunsford et al.,
2022 *Nucl. Fusion* 62 086021