(TG1) Multi-ion group report

Jan. 18, 2022 (G. Motojima)

Date: Jan. 14, 2022
Time: 9:50-14:30, 16:00-17:30
Shot#: 176346–176429 (84 shots), 176458-176479 (22 shots)

Prior wall conditioning: None
Divertor pump: Yes
Gas puff: H_2
Pellet: TESPEL

NBI#(1, 2, 3, 4, 5) = gas(H, H, H, H, He) = P(4.2, 3.7, 3.9, 3.5, 4.0) MW

ECH(77 GHz) = ant(5.5-Uout (or 1.5U), 2-OUR) = P(703, 792) kW
ECH(154 GHz) = ant(2-OLL, 2-OUL , 2-OLR) = P(723, 799, 825) kW
ECH(56 GHz) = ant(1.5U) = P(-) kW
ICH(3.5U, 3.5L, 4.5U, 4.5L) = P(0.86, 0.78, 1.1, 0.46) MW
Neutron yield integrated over the experiment = 1×10^{13} (total)

Topics

1. Commissioning of He beam injection with NBI#5 into LHD plasmas (N. Tamura on behalf of TG1)
2. Helium beam injection experiments and study of impurity transport (N. Tamura)
3. He removal in He beam experiment (G. Motojima)

1. Commissioning of He beam injection with NBI#5 into LHD plasmas (N. Tamura on behalf of TG1)

Experimental conditions: (R_{ax}, Polarity, B_t, γ, B_q) = (3.75 m, CW, 2.6400 T, 1.2538, 100.0%)

Shots: #176346 - #176387

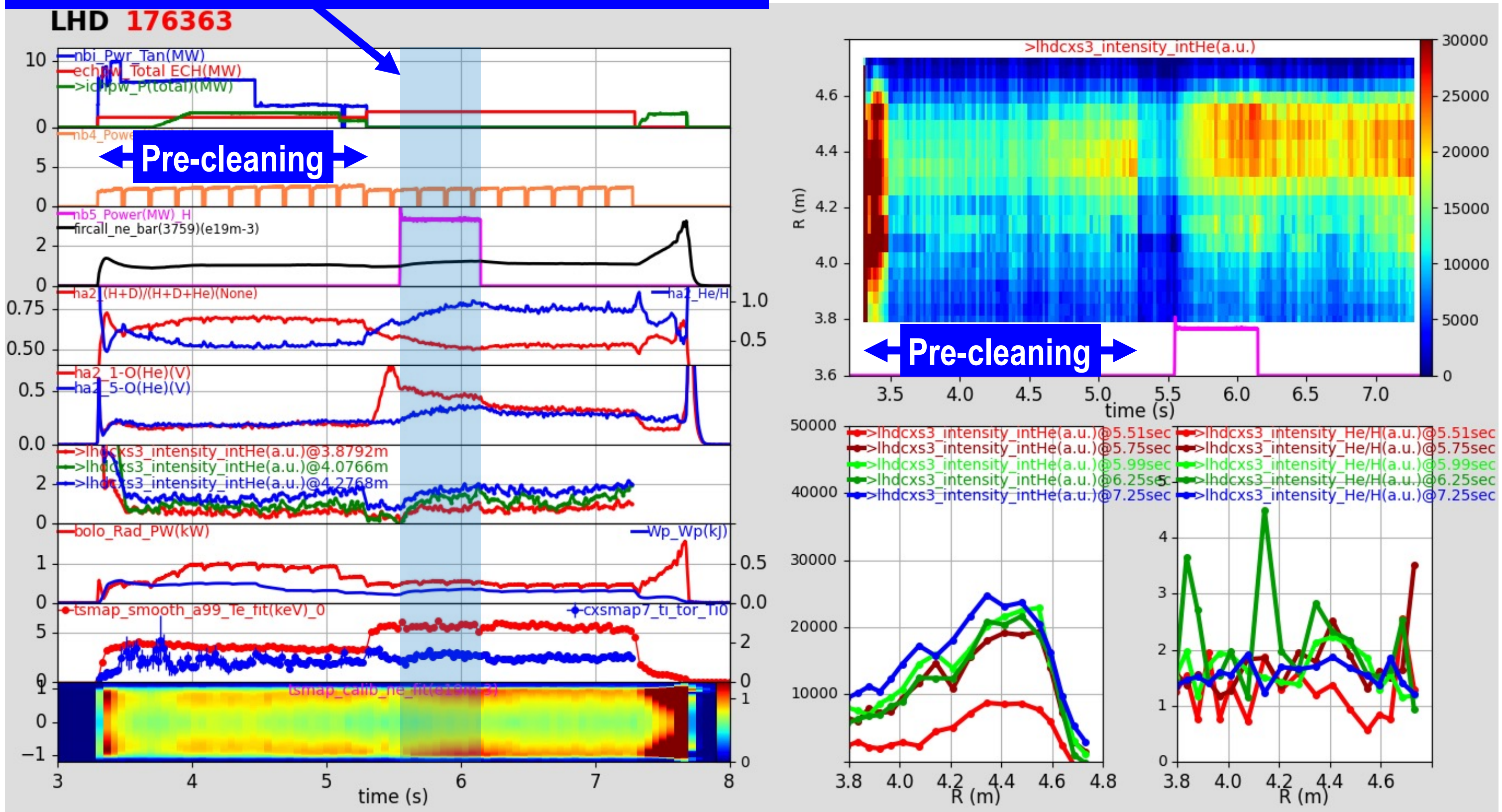
Goal of this experiment

- Commissioning of the He beam injection with NBI#5 into LHD plasmas

Main results of this experiment

- **We achieved a more reduction of He gas influx from the NBI device** (compared to the results on Dec. 17)
  → Density scan (1E19 m and 2E19 m-3) has been performed this time
- To observe more clearly the responses of plasma parameters to the He-NBI, **we set a pre-cleaning (ECH+ICH +NBI) phase before the He-NBI**
  → Seems to be succeeded
- We have installed the additional pumping system at Port 6-O
  → To check the effectiveness of the other pumping system, we have again conducted He gas influx calibration with NBI#5, 1) only NBI#5 w/o a beam extraction, 2) only NBI#5 w/ a beam extraction, under the situation where the gate valves for cryopumps of LHD are closed

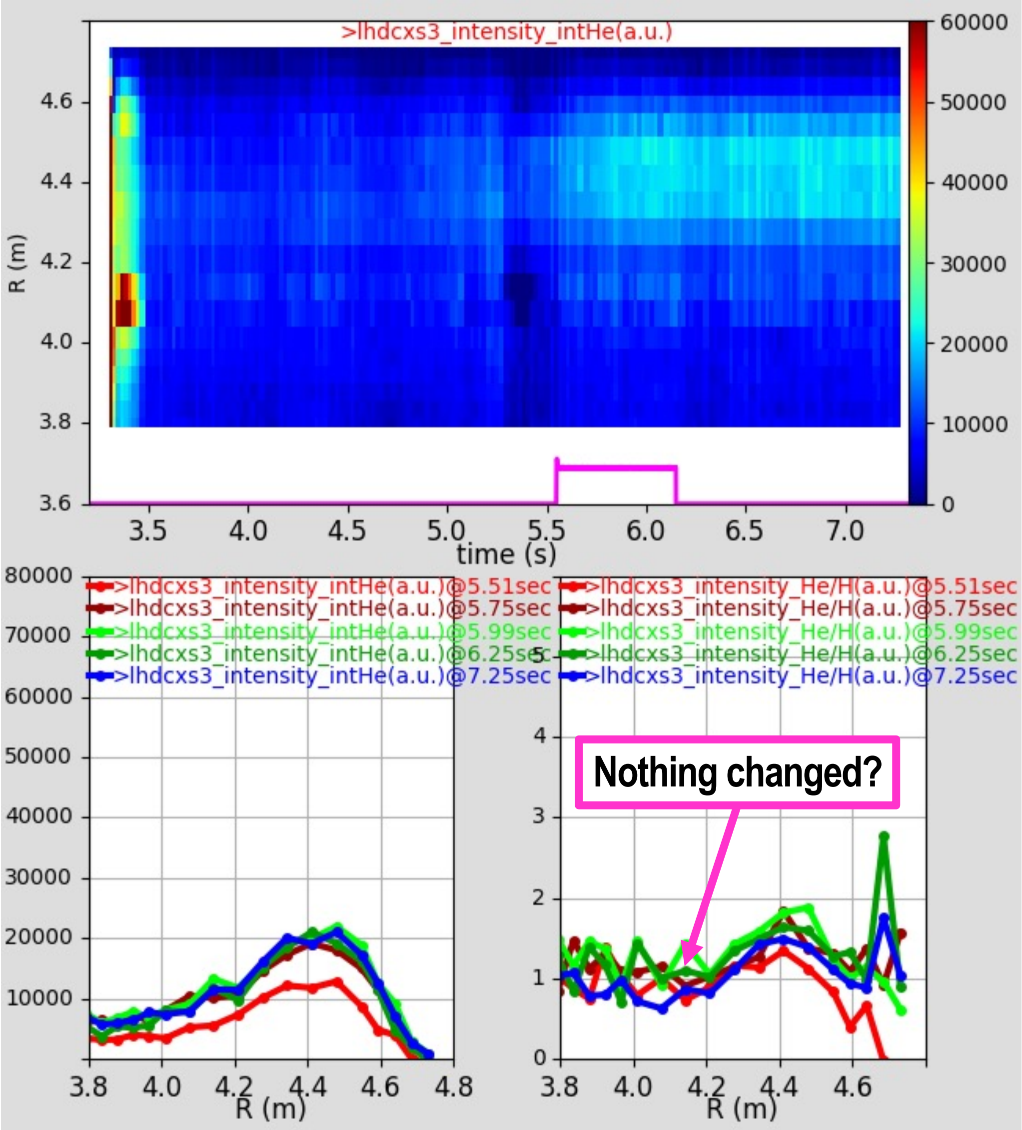
Example: He-NBI into the EC-heating phase



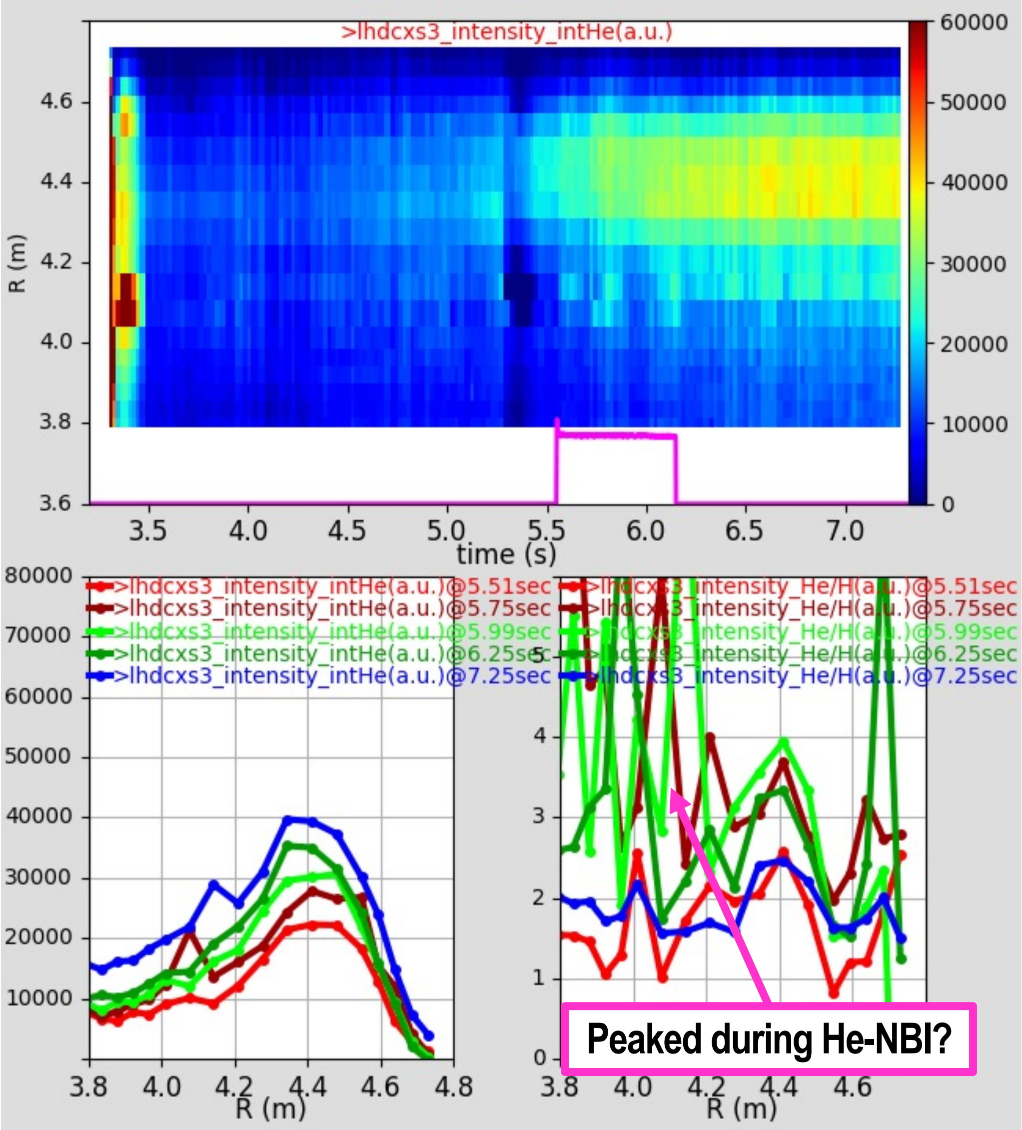
1. Commissioning of He beam injection with NBI#5 into LHD plasmas (N. Tamura on behalf of TG1)

Number of IS dependence of He and He/H profiles in the NBI heating phase

1IS with n_{ebar} = 1E19 m^{-3}



2IS with n_{ebar} = 1E19 m^{-3}



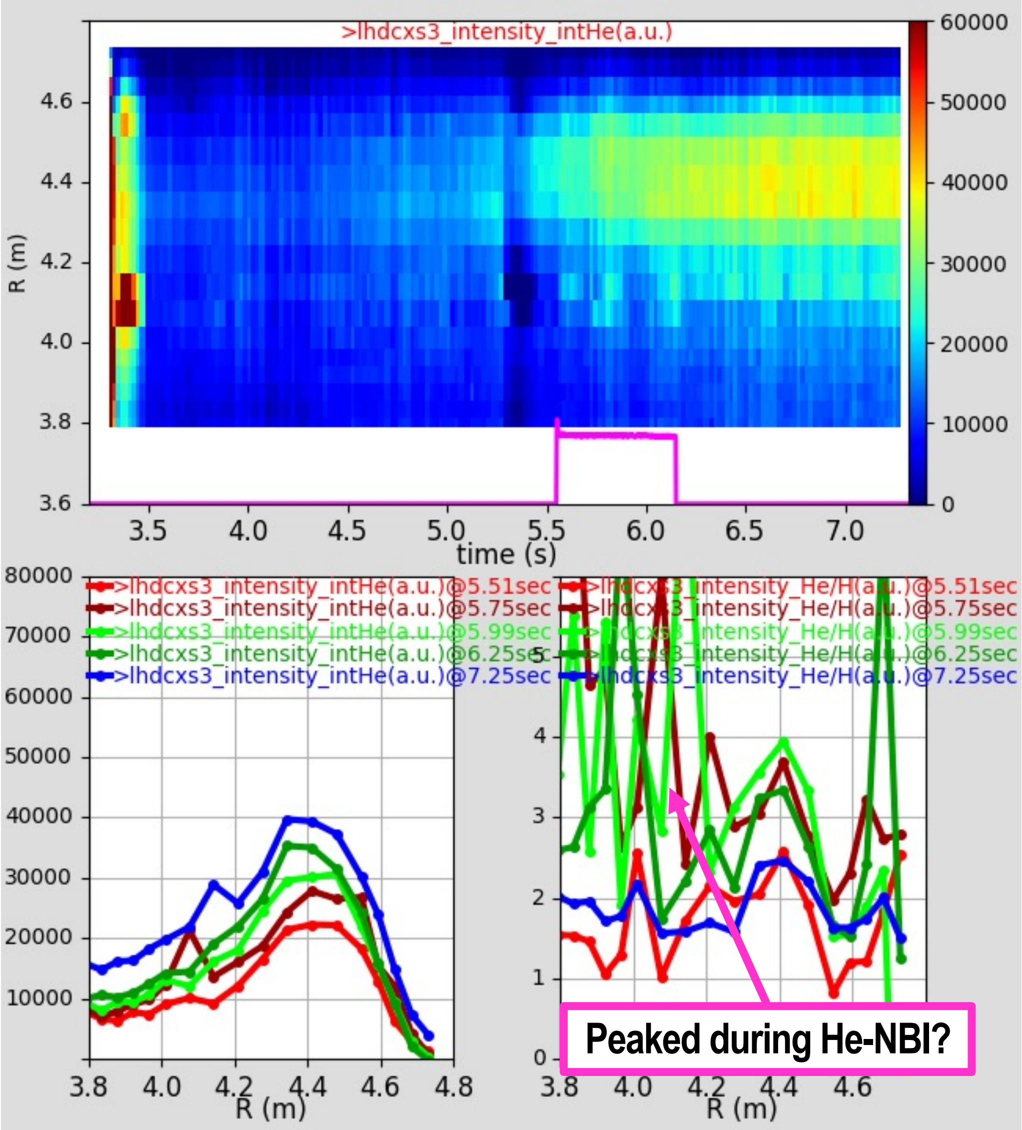
- Core He fueling could be obtained with 2IS case
- He/H ratio in the previous exp. was around 6-10.
  → Contamination level of He is much improved!

Time stamp notes:
5.51 s
just before He-NBI
5.75 s, 5.99 s
during He-NBI
6.25 s
after He-NBI
7.25 s
before the end of NBI#4

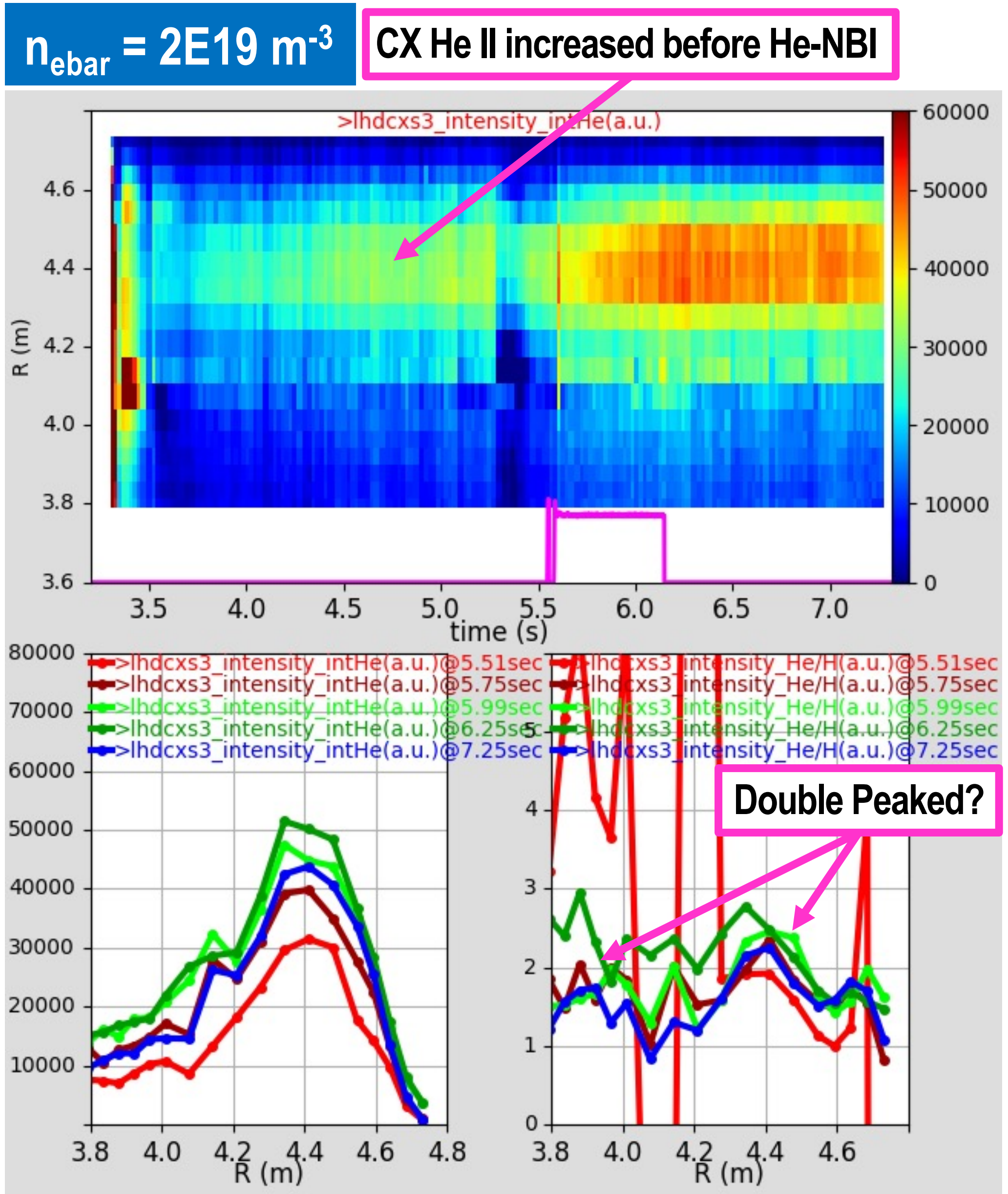
1. Commissioning of He beam injection with NBI#5 into LHD plasmas (N. Tamura on behalf of TG1)

Density dependence of He and He/H profiles with He-NBI (2 IS) in the NBI heating phase

n_{ebar} = 1E19 m^{-3}



n_{ebar} = 2E19 m^{-3}



- Core He fueling could be obtained in the low-ne plasma with 2IS case

Time stamp notes:
5.51 s
just before He-NBI
5.75 s, 5.99 s
during He-NBI
6.25 s
after He-NBI
7.25 s
before the end of NBI#4

2. Effect of a Mixed-Ion Plasma on Impurity Transport (N. Tamura et al.)

Magnetic Configuration: (R_{ax}, Polarity, B_t, γ, B_q) = (3.60 m, CW, 2.75 T, 1.2538, 100.0%)

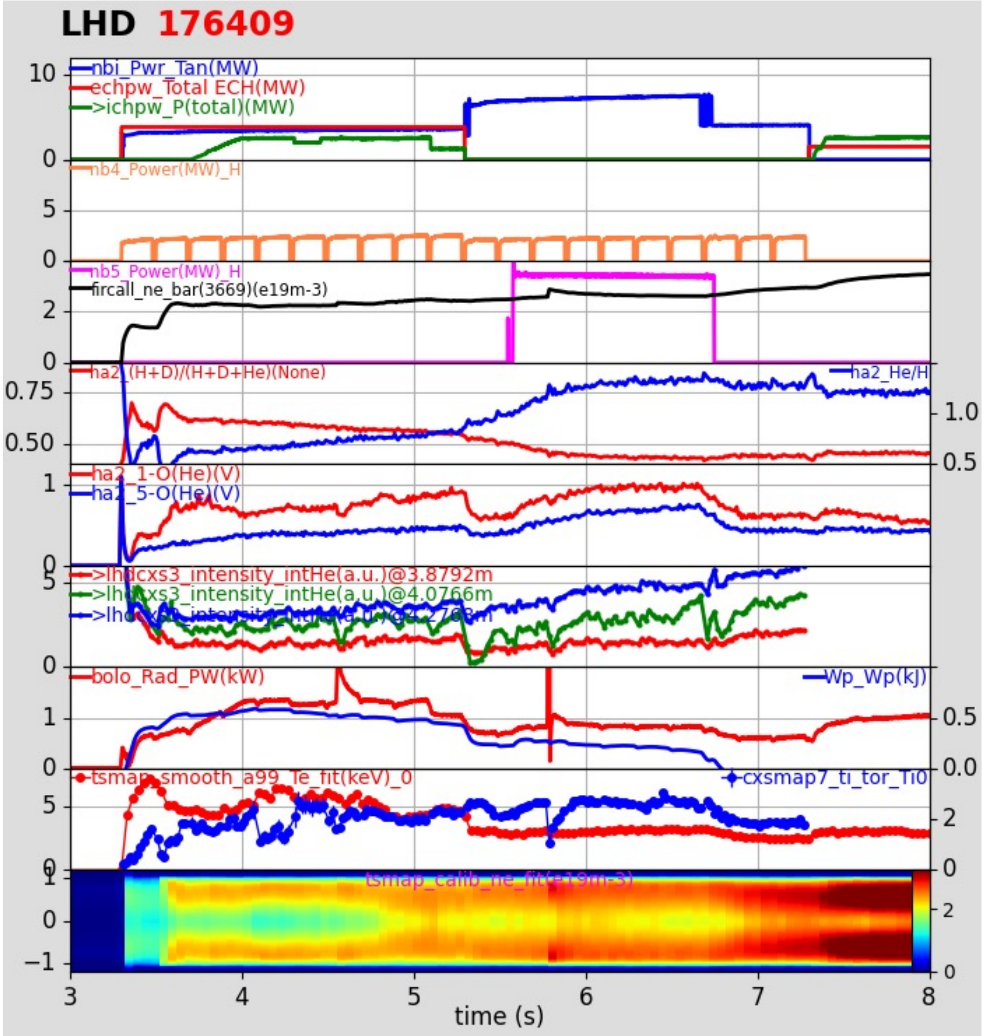
Shots: #176388-#176429

Goal of this experiment

- To study the effect of a mixed ion plasma (i.e. He contamination level in this exp.) on impurity transport

Main results of this experiment

- **We have injected Li_2TiO_3-TESPEL into the Balanced-NBI heating phase with and without He-NBI (1IS, 2IS, w/o beam extraction)**
  - ✓ We could study the impact of difference of a He contamination scheme (core from beam & edge from gas (= w/o beam extraction) on the impurity transport
  - ✓ **After this experiment, we found the problem on the TESPEL injector (maybe at a pressure reducer), but it already fixed**
- **Ratio of (H+D)/(H+D+He) before He-NBI in this exp. seems to be lower than that in the exp. (Rax = 3.75 m) just before this experiment**
  - ✓ He recycling at Rax = 3.6 m is higher than that at Rax = 3.75 m?
- Impact of He contamination level/scheme on the behaviors of Li, Ti, and O will be investigated



3. Helium removal in helium beam experiments
(G. Motojima, K. Hanada (Kyushu Univ.), K. Nagaoka)

Magnetic Configuration: (R_{ax}, Polarity, B_t, γ, B_q) = (3.55 m, CW, 2.78 T, 1.2538, 100.0%)
Shots: 176458-176479 (22 shots)
Goal of this experiment:

- To study the wall changeover (divertor, first wall, NBI armor tiles) behavior from He to D

Results:

- The two turbo molecular pumps has been installed in 6O during a maintenance period of new year 2022 (Fig. 1). Their pumping speed is estimated at 10-15 m^3/s in He.
- We continued 10 s ECH/ICH discharges of hydrogen with and without He beam injection (Fig. 2).
  → In the case with He beam at low density, H/(H+He) is higher if the additional turbo pumps are working. However, in the case at high density case, the difference of H/(H+He) was not significant. The efficiency of He exhaust by turbo pumps might be different in the target density. Further discussion is required.

Fig 1. Additional turbomolecular pumps in 6O

Special thanks to N. Suzuki, H. Kato, D. Chimura (Gijutsu bu)

Fig 2. H/(H+He)