

# (TG1) Multi-ion group report



Jan. 28, 2022 (M. Kobayashi)

Date: Jan. 28, 2022

Time: 9:49 -18:45

Shot#: 177559 – 177727 (169 shots)

Prior wall conditioning: No

Divertor pump: On

Gas puff: H<sub>2</sub>, He IPD: No

LID: On

NBI#(1, 2, 3, 4, 5)=gas(H, -, H, H, He)=P(3.3, -, 4.0, 2.6/2.6, 2.4/1.7) MW

ECH(77GHz)=ant(5.5-U, 2-OUR)=P(703, 792)kW

ECH(154GHz)=ant(2-OLL, 2-OUL, 2O-LR)=P(-, 799, 825) 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

Neutron yield integrated over the experiment =  $5.2 \times 10^{11}$

## Topics

1. Commissioning of impurity beam injections with NBI#5 into LHD plasmas (N. Tamura)
2. He exhaust property in helical divertor (S. Sereda, M. Kobayashi, H. Funaba, O. Schmitz, M. Goto et al.)
3. Helium removal in helium beam experiments (G. Motojima, K. Hanada)

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

**Experimental conditions:** ( $R_{ax}$ , Polarity,  $B_t$ ,  $\gamma$ ,  $B_g$ ) = (3.90 m, CCW, 2.5384 T, 1.2538, 100.0%), (3.75 m, CCW, 2.6400T, 1.2538, 100.0%), (3.60 m, CCW, 2.7500T, 1.2538, 100.0%)

**Shots:** [3.90 m] #177579 - #177584 (6 shots), [3.75 m] #177633 - 177637 (5 shots), [3.60 m] #177683 - 177706 (24 shots)

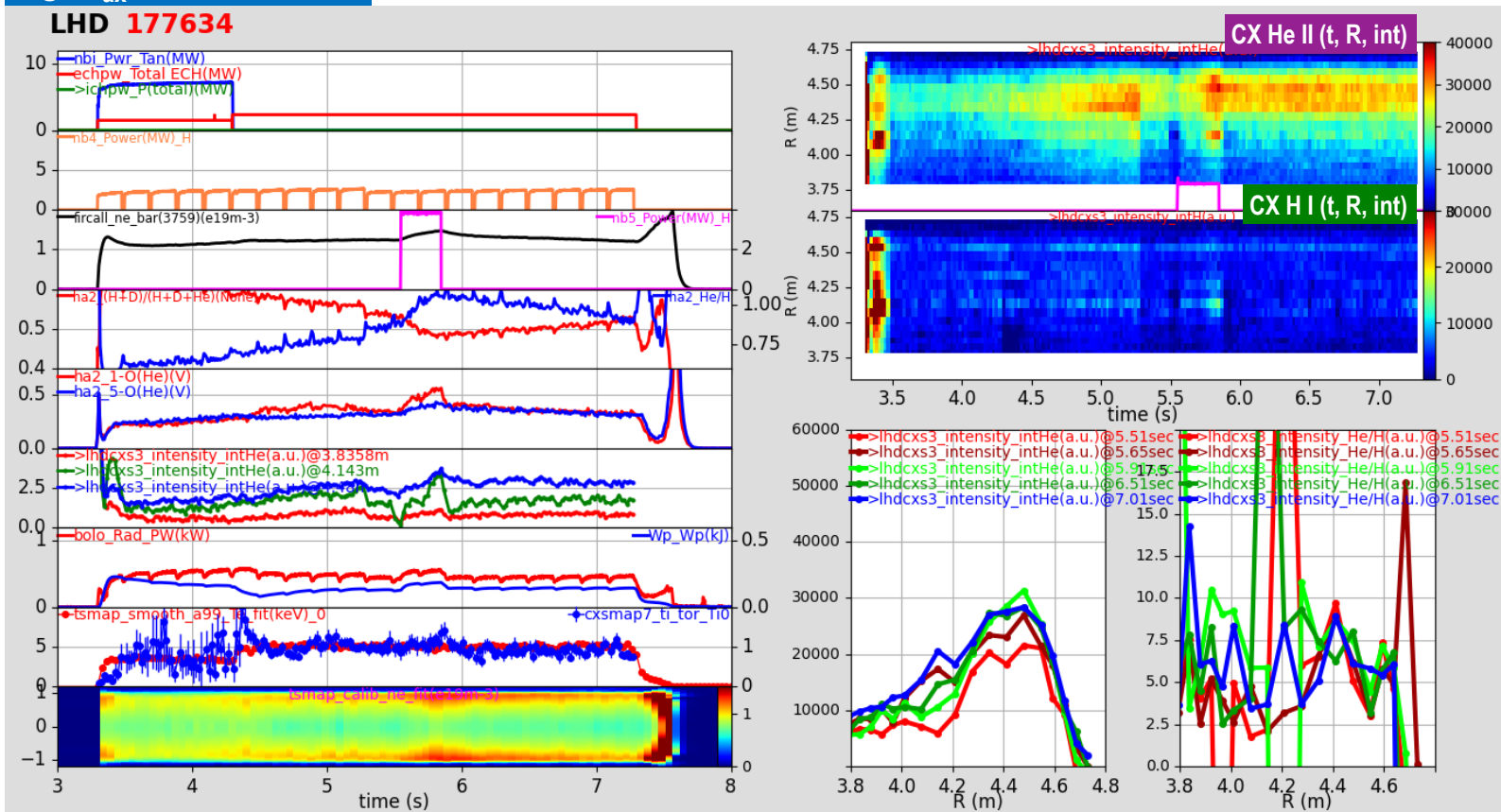
## Goal of this experiment

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

## Main results of this experiment

- Ar beam injection with NBI#5 was given up due to the difficulties in beam acceleration
- Here, we have tried to inject the He beam during the EC-heating phase to check the impact of heating scheme on the He recycling
  - ✓ In the exp. for the He pumping (SS, MK) the He beam has injected during the NBI-heating phase
  - ✓ CX Hell has still been increased before He-NBI, and then maybe the difference of heating scheme is not important
- To observe the core fueling of He by the He-NBI, we have performed the experiments with He beam injection and without He beam injection (a He gas was introduced in the NBI#5 device) as before

e.g.  $R_{ax} = 3.75$  m case



## Motivation & Objectives:

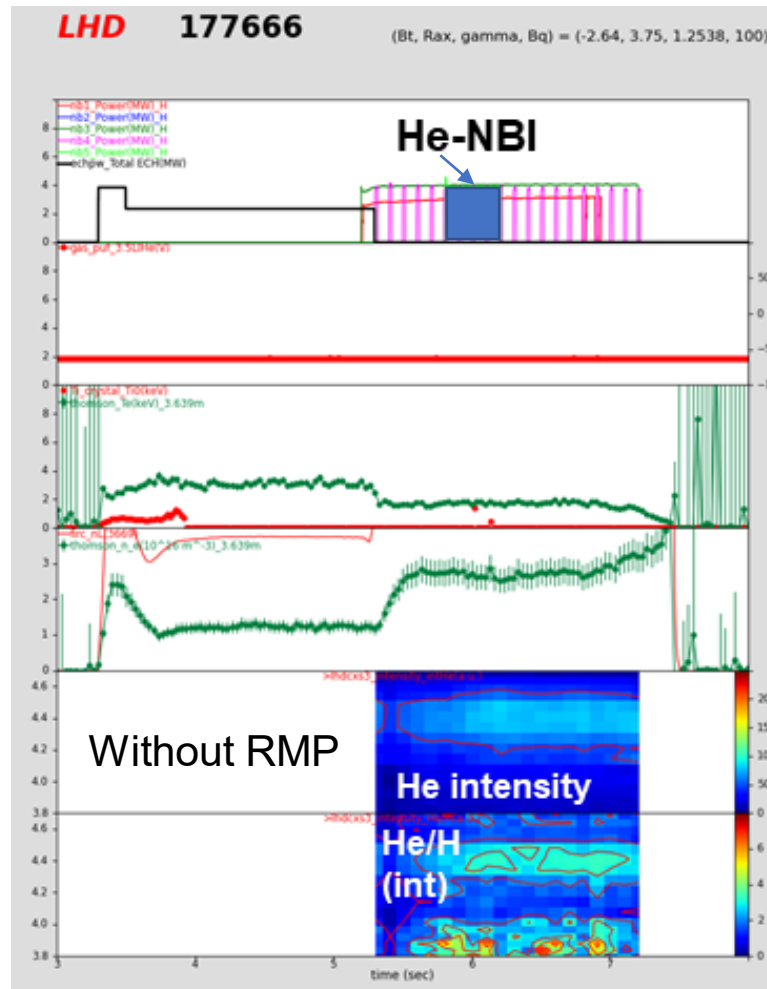
He exhaust is most important issue for fusion reactor to assure high burning efficiency. The experiments were conducted to study effects of magnetic field structure (edge stochasticity, RMP field) on He exhaust properties.

## Results:

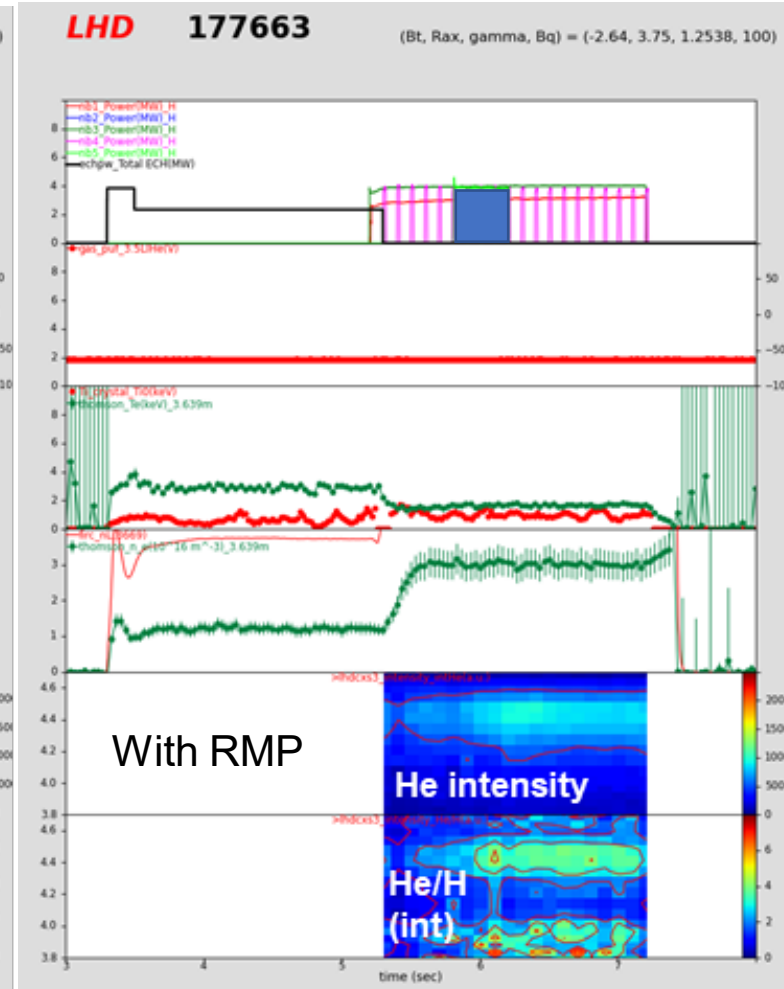
( $R_{ax}=3.90\text{m}$ , 2.54T, CCW,  $R_{ax}=3.75\text{m}$ , 2.64T, CCW  
 $R_{ax}=3.60\text{m}$ ,  $B=2.75\text{T}$ , CCW)

- In order to extend the database of the He beam injection experiments for various magnetic configurations,  $R_{ax}$  was scanned from 3.90 to 3.60m.
- The He was injected by NB#5 or by He puff, density was scanned between  $1.5$  to  $4.0 \times 10^{19} \text{ m}^{-3}$ . RMP was also applied to change edge magnetic topology. The core He profile was measured by CXS, and divertor He concentration was measured by WISP gauge, which was supplied by Univ. Wisconsin group. The visible and EUV spectroscopies also measured He emission in edge and core region.
- As shown in the figures, clear difference in the decay time of He is observed with and without RMP. Detailed transport analysis will be conducted and compared with W7-X, DIII-D in future.

LHD #177666,  $R_{ax}=3.75\text{m}$ ,  $I_{n=1}=0\text{kA}$ , density  $4 \times 10^{19} \text{ m}^{-3}$



LHD #177663,  $R_{ax}=3.75\text{m}$ ,  $I_{n=1}=3.3\text{kA}$ , density  $4 \times 10^{19} \text{ m}^{-3}$



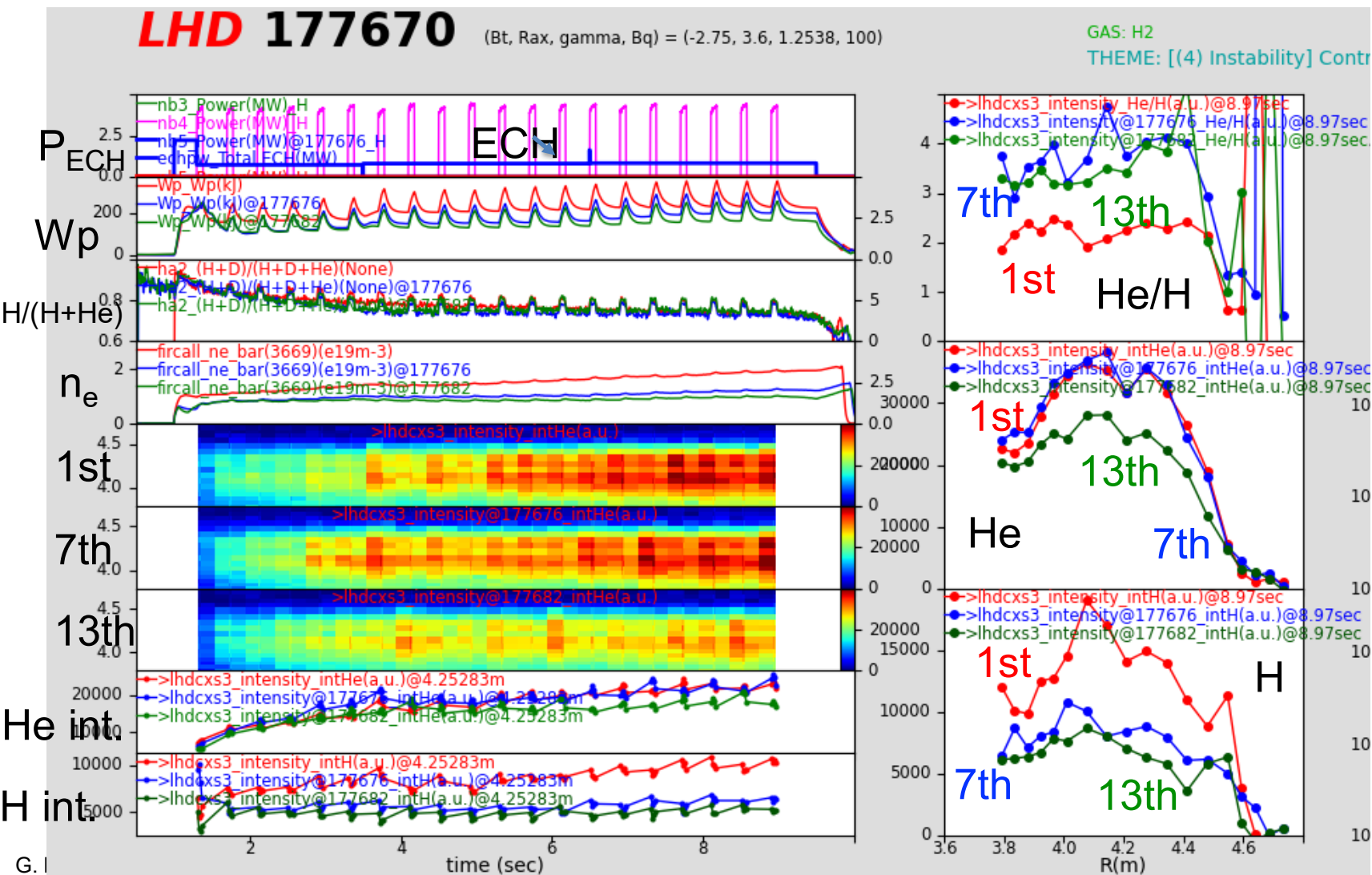


# Helium removal in helium beam experiments (G. Motojima, K. Hanada (Kyushu Univ.))

S O K E N D A I

**Magnetic Configuration:** ( $R_{ax}$ , Polarity,  $B_t$ ,  $\gamma$ ,  $B_q$ ) = (3.90 m, CCW, 2.53 T, 1.254, 100.0%), (3.75 m, CCW, 2.64 T, 1.254, 100%), (3.60 m, CCW, 2.75 T, 1.254, 100%)

**Shots:** 177559-177578, 177617-177632, 177670-177682



- ✓ ECH discharges with ~800kW are continuously applied for He removal.
- ✓ Due to lack of assist of ICH, higher density ( $> 1e19 \text{ m}^{-3}$ ) was difficult to sustain the plasma.
- ✓ He intensity decreased as a result of repeated discharge.
- ✓ Detailed investigation of the shot (ECH input power) dependence of He intensity reduction is necessary.