(TG1) Multi-ion group report

Date: Oct. 21, 2022 Oct. 24, 2022 (G. Motojima)
Time: 15:10-18:42
Shot#: 181212-181279 (68shots)

Prior wall conditioning: NO

Divertor pump: YES（except for 2I）
Gas puff: H_2, He
H pellet: NO

NBI#(1, 2, 3, 4, 5) = gas(H, H, H, H, He) = P(1.9,3.5,3.4,3.7,3)MW

ECH(77 GHz) = ant(5.5-Uout, 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(0.80,0.77,0.97,-) MW
Neutron yield integrated over the experiment = 5.7×10^{12} (TG1)

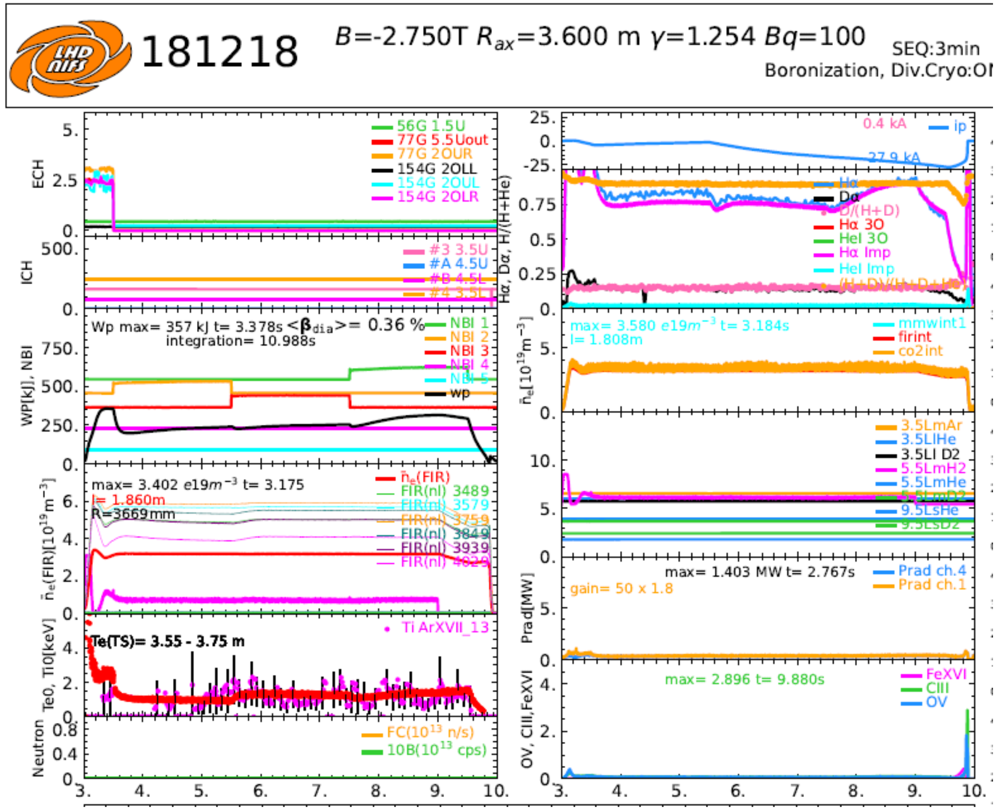
Topics

1. Exposure of W samples to divertor plasma (C.P. Dhard, D. Naujoks (IPP), S. Masuzaki)
2. Investigation of He density profile in mixture plasmas (I.C. Chan, H.Yamada(U. Tokyo)+)
3. Characteristics of He plasma heated by ECH or by ECH + He-NBI (N. Tamura+)
4. He removal dependence on target electron density (G. Motojima, K. Hanada(Kyushu Univ.))

Exposure of W samples to divertor plasma

C.P. Dhard, D. Naujoks (IPP), S. Masuzaki

Shot #: 181213 - 181226
(R_{ax}, B_t, γ, B_q) = (3.6 m, -2.75 T, 1.2538, 100.0%)
Working gas: H2
P_{NBI-1} ~ 1.5 MW, P_{NBI-2} ~ 2 MW, P_{NBI-3} ~ 2 MW
Three t-NBIs were injected in a “train”-style



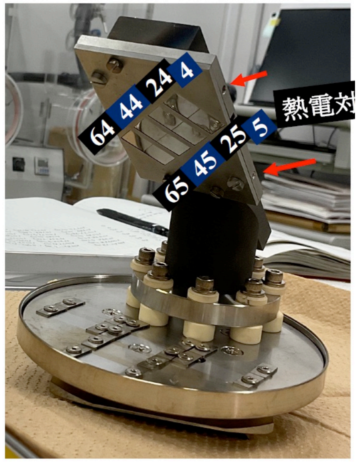
Summary of a typical discharge in this exp.

Motivation

- Tungsten is an appearing as a potential material for fusion reactor application. However,, because of its hardness and brittleness it is not so easy to manufacture thin tiles with edges in the order of 1-2 mm. W-alloys are being explored to overcome these problems.
- In this experiment, W-alloys samples are exposed to the LHD divertor plasma to investigate influences of them on plasma operation, and effects of the exposure on samples properties.

Results

✓ Three sets of W alloy samples (W-Cu/Ni, W-Fe/Ni) and a set of W were exposed to divertor plasma using the manipulator at a 10.5L port.
✓ Total ~40s exposure was conducted.
✓ Line averaged density was kept to be ~ 4E19/m3.
✓ No influences on plasma operation.
✓ Surface analyses will be conducted soon.



Sample	Composition of samples
4, 5	W
24, 25	W95NiCu
44, 45	W97NiFe
64, 65	W95NiFe

Investigation of He density profile in mixture plasmas

(I.C. Chan, Y. Isobe, H. Yamada (UTokyo), K. Ida, N. Tamura, M. Yoshinuma, R. Sakamoto)

2022/10/21

Background and objective

- While He particle transport depending on its concentration has been pointed out in the earlier work (K.Ida et al. PPCF 2016), further investigation is required to comprehend particle transport in mixture plasmas.
- For the purpose of identification of He transport property, compilation of He density profile in mixture plasmas is prerequisite.

Experimental Condition

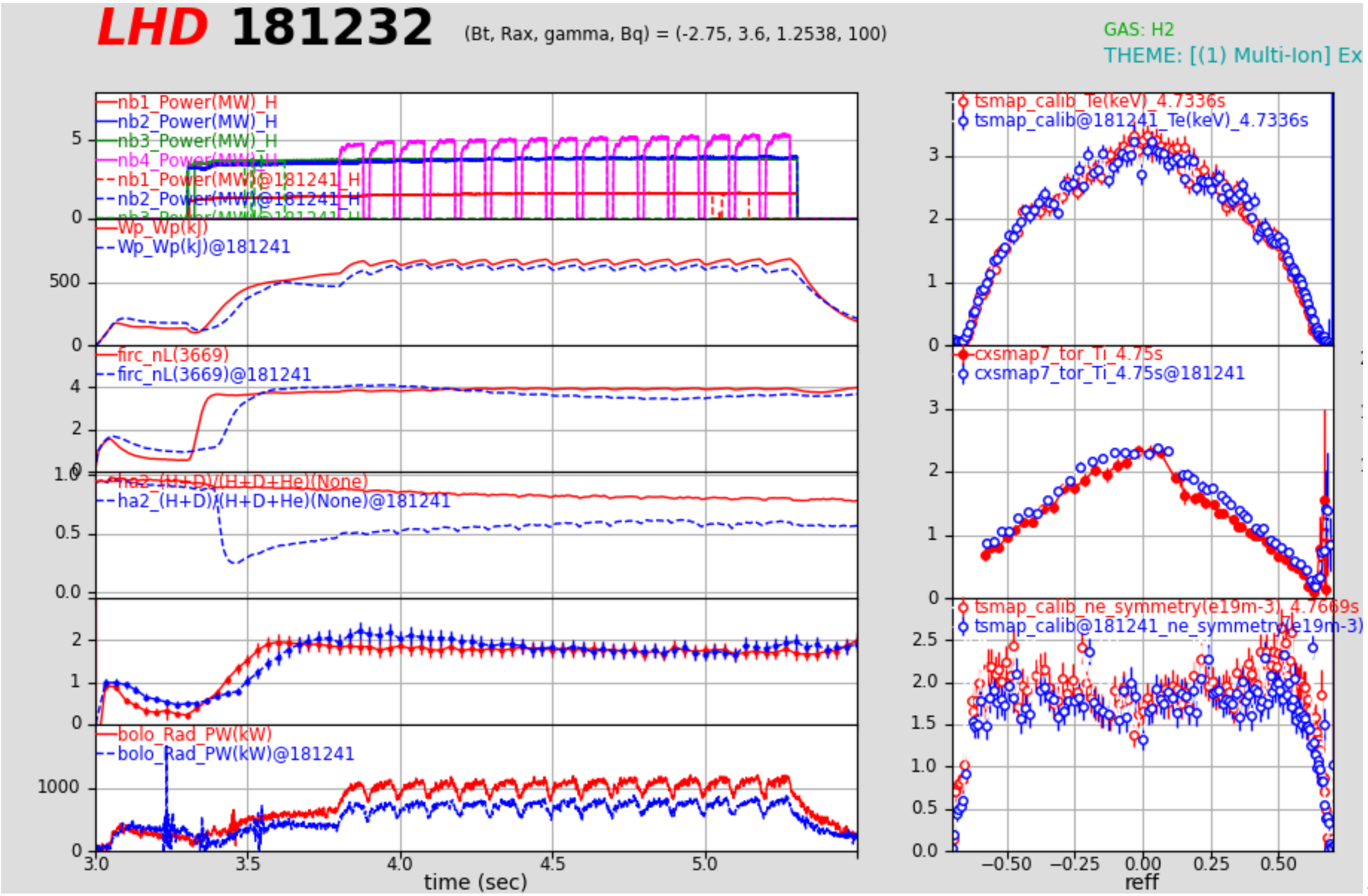
#181227 - #181241

R_{ax}=3.6m, B= 2.75T, CCW

Feedback control of density by either H or He gas puff to control He fraction.

Results

1) The fraction of He (note. from the passive spectroscopy) can be ranged from 17% to 38 % at the same electron density ($2\times10^{19}m^{-3}$).



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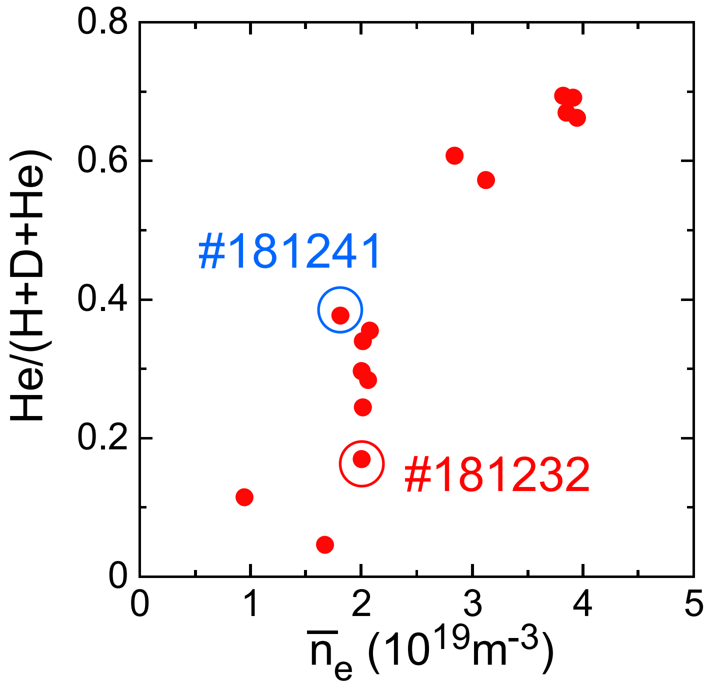
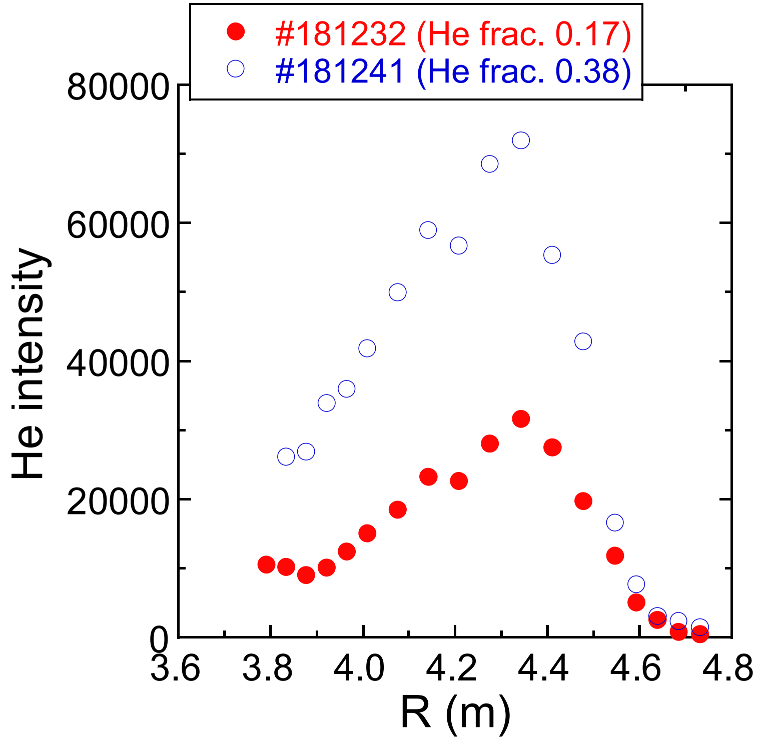
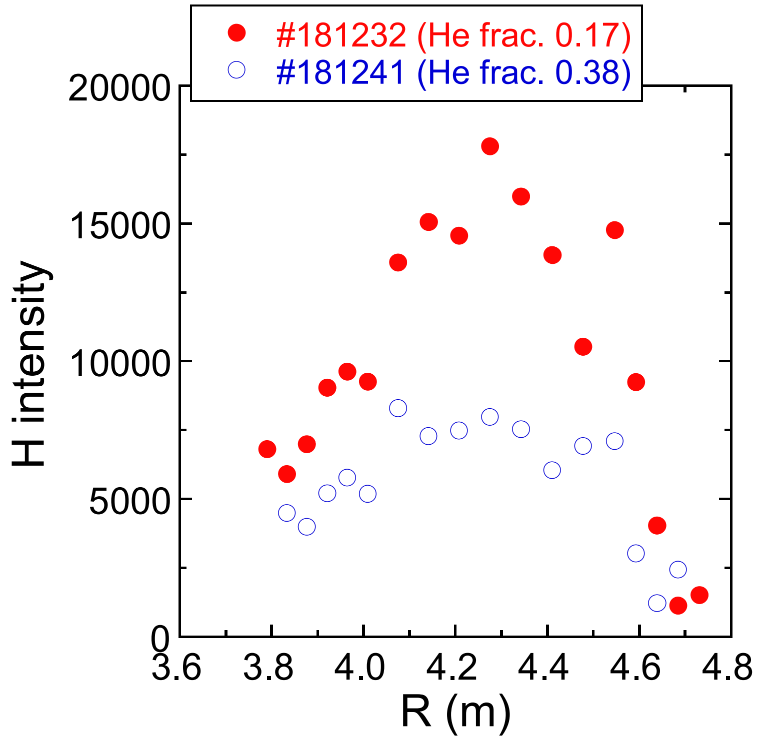






Results (cont.)

1) In the comparison of typical two cases (#181241 and # 181232) shows no significant difference in plasma performance, and profiles of electron density and electron/ion temperatures (see the figure in the previous page.
2) In contrast, some difference in the shape of He and H intensity from CXRS is suggested.
3) The data process to He and H ion density profile is awaited.
4) Further compilation of data is planned on Nov.9

3. Characteristics of He plasma heated by ECH or by ECH + He-NBI (N. Tamura et al.)

Experimental conditions: (R_{ax}, Polarity, B_t, γ, B_q) = (3.60 m, CCW, 2.75 T, 1.2538, 100.0%):

Shots: #181242 - #181260

Motivation

- In LHD, a He-beam injection by utilizing NBI#5 has been started from the 22nd campaign
- He-NBI can be used to investigate the properties of pure He plasma further

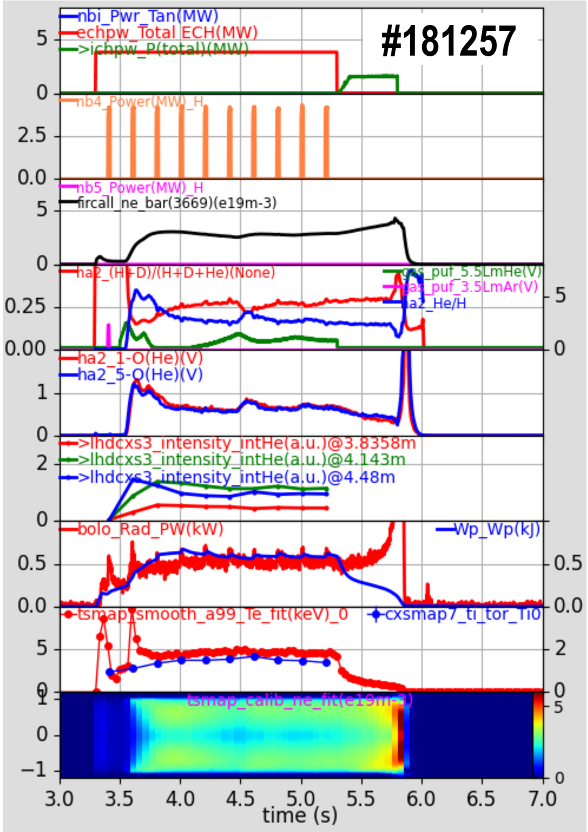
Goal of this experiment

- Characterize pure He plasmas with different heating conditions

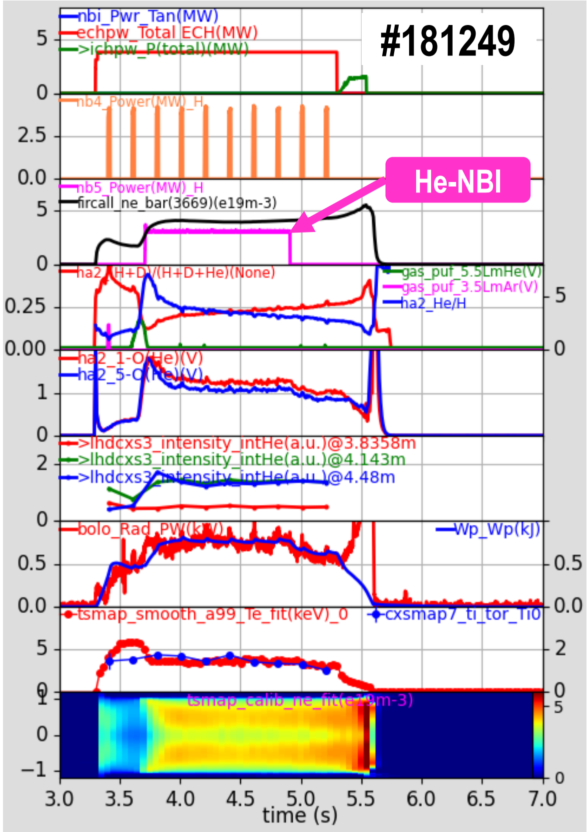
Results

- We produced plasmas heated by ECH and by ECH+He-NBI with a He gas-puff
- (H+D)/(H+D+He) of ~0.25 was obtained with a line-averaged n_e of ~3e19 m^{-3}
- Plasma profiles (n_e, n_{He}, n_H, T_i, E_r, etc.) and fluctuations obtained will be analyzed
  - ✓ Ar gas-puff was performed for the impurity transport analysis

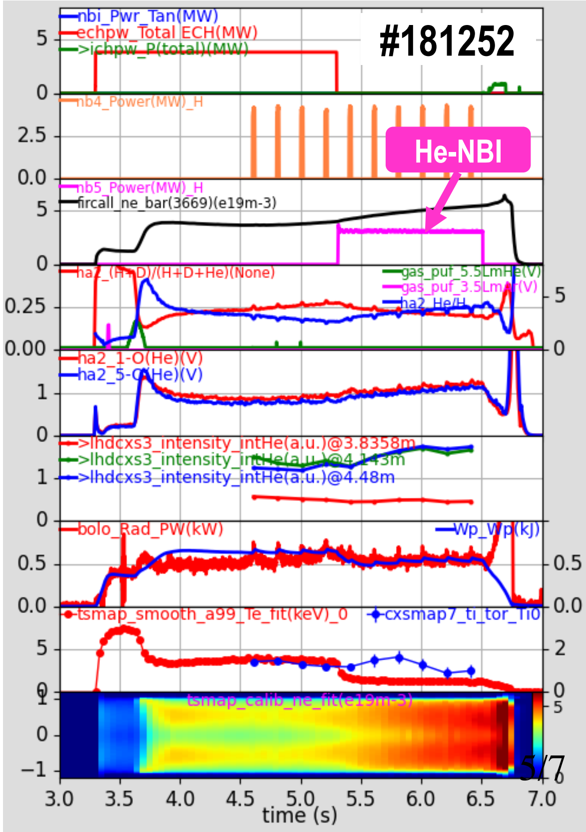
EC-heated



(EC + He-NBI)-heated



EC-, He-NBI-heated



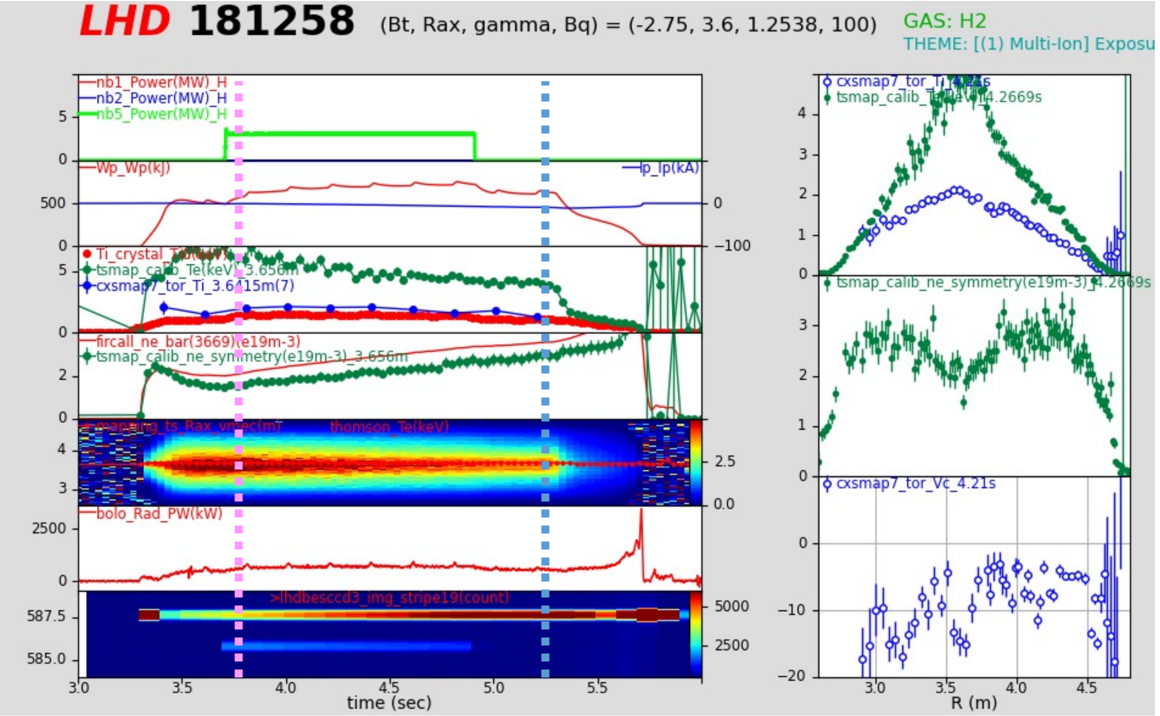
Beam component of HeI line emission measurements for He-BES

S. Kobayashi(Kyoto Univ.),
T. Kobayashi,
M. Yoshinuma, W. Hu

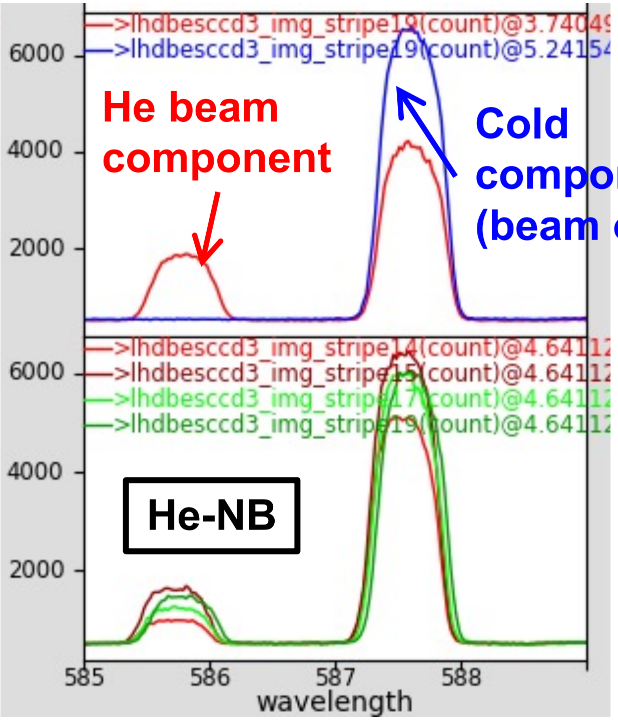
Purpose: To discuss feasibility of He-BES by measuring beam component of HeI-line emissions in He-NB.

Shot: #181242-#181258, (R_{ax}=3.60 m, B_t=-2.75T, γ=1.2538, B_q=100.0%)

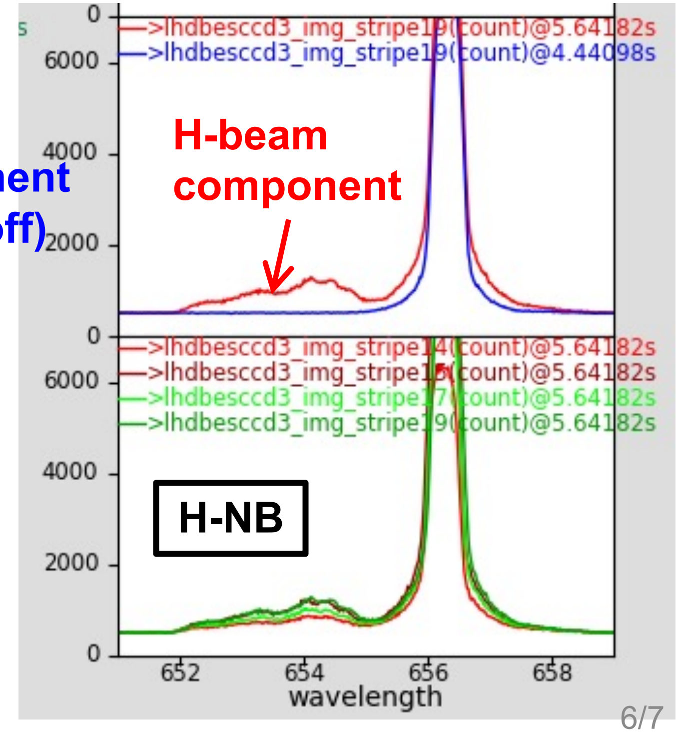
- Measured Doppler shifted HeI-lines (587nm, 389nm, 447nm) in **He-NB (NB#5).**
- Beam component (HeI) is most significant for 587nm, same order of H-NB.
- Beam attenuation of He-beam seems to be much stronger than H-NB (by Dr. Yoshinuma).
  - ➢ Better for edge BES in He-NBI?



HeI(587nm) spectrum



Hα(656nm) spectrum

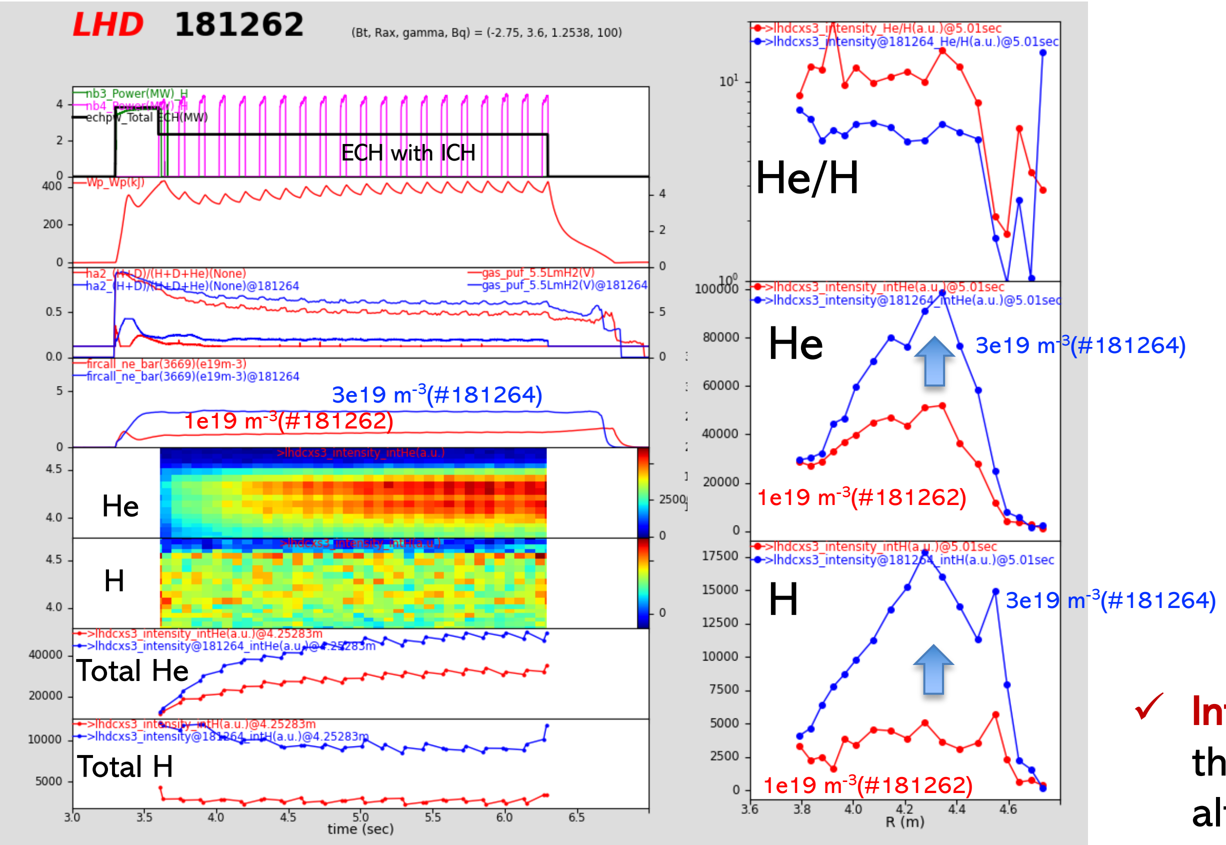


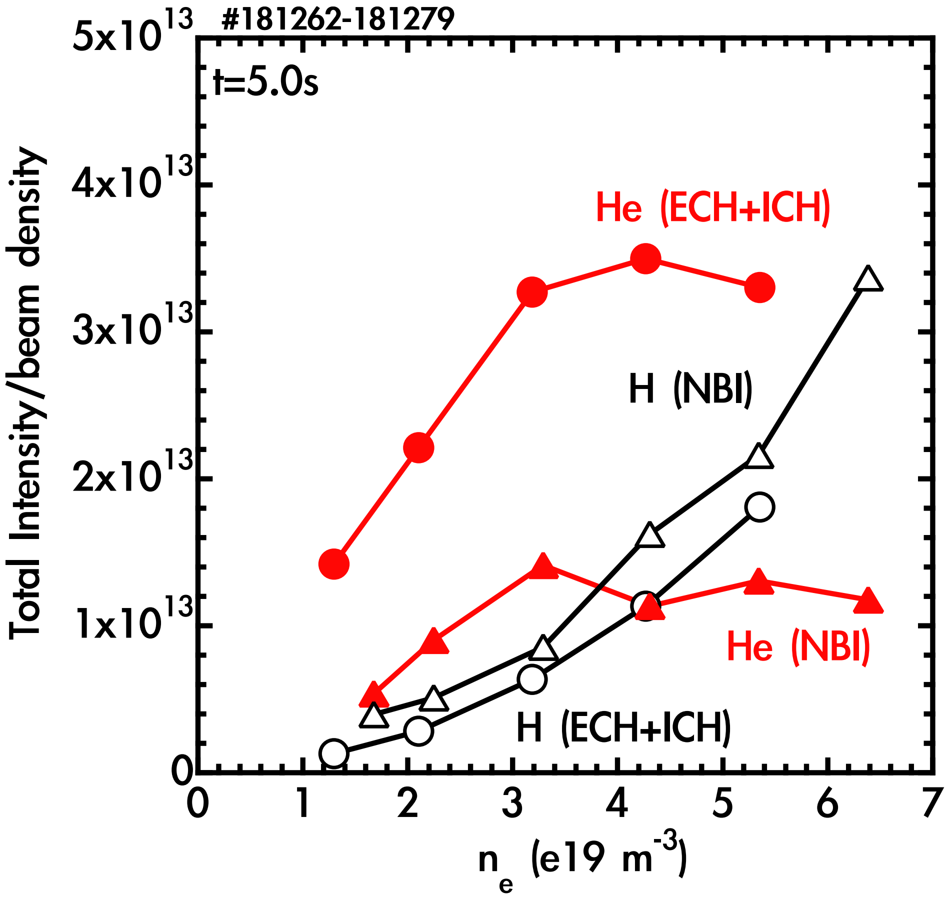
4. He removal dependence on target electron density

G. Motojima, K. Hanada (Kyushu Univ.)

The characteristics of helium removal is investigated by changing the target density

- ✓ #181262-181279 R=3.6m, B=-2.75T, γ=1.254, Bq=100%
- ✓ n_e($e19m^{-3}$): 1-6
- ✓ ECH+ICH: ~2+2.5MW, NBI: ~9MW





✓ **Intensity of He releasing** from the plasma facing wall is significant above the density of 3e19 m^{-3}, and tends to **saturate** at higher densities, although intensity of H increases with density by H gas puff. This trend is similar for both ECH+ICH and NBI only.