(TG1) Multi-ion Plasma group report

Dec. 7, 2022 (H. Kasahara)

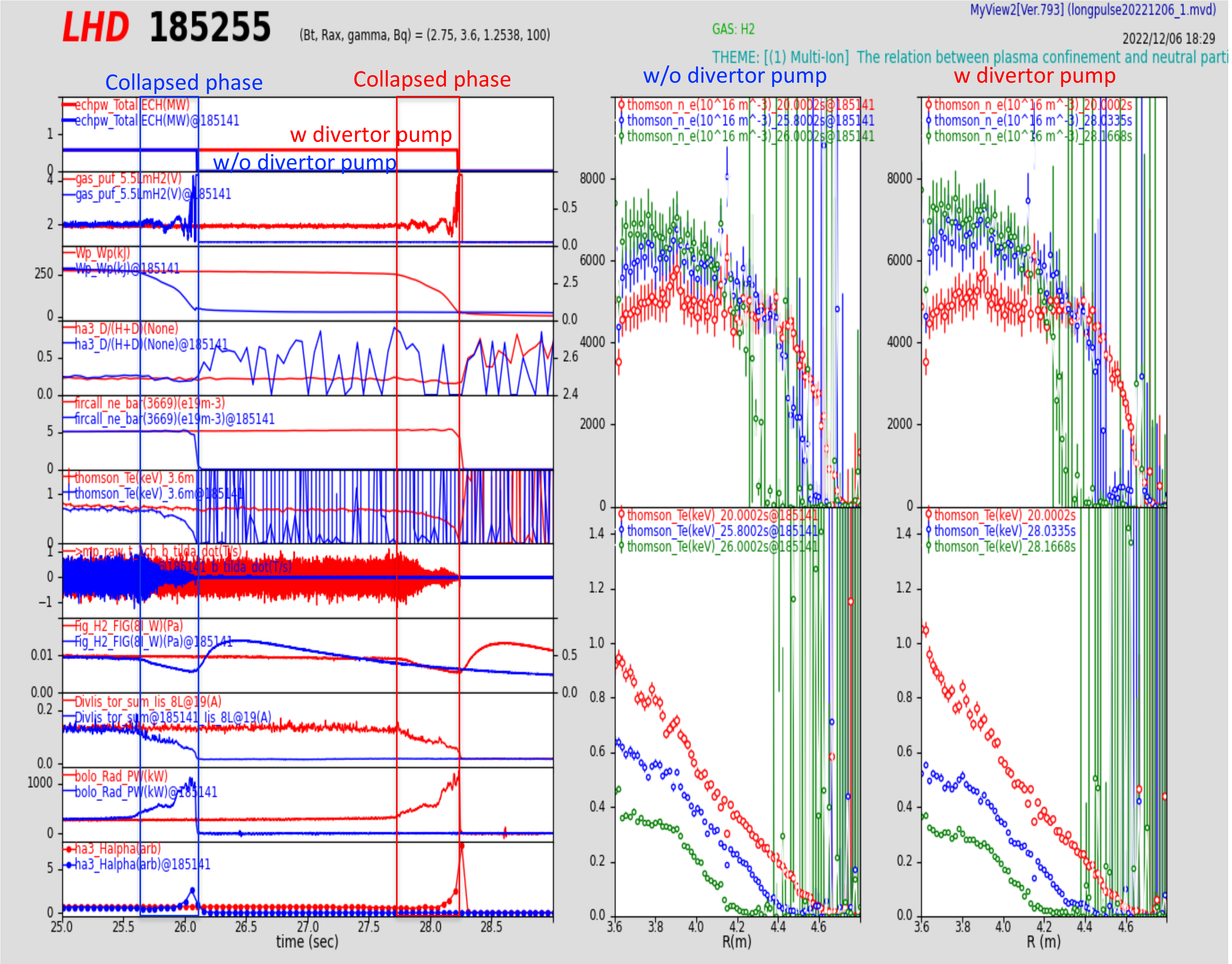
Date: Dec. 6, 2022, Time: 9:45~18:45
Shot# 185112~185258
Prior wall conditioning: GD-H2, Div cryo: OFF -> ON, Gas puff: H_2, Ar, Pellet: C, TESPEL: Ti, Cu, Mo

NBI(1, 2, 3, 4, 5) = gas(H, H, H, H, H) = P(3.41, 4.16, 4.04, 5.52, 5.36) MW
ECH(56GHz,15U) = P(-) MW
ECH(77GHz, 55Uo, 2Our) = P(0.45,-) MW
EH(154GHz, 2Oll, 2Oul, 2Olr) = P(0.46,0.48,0.48) MW
ICH(38.47MHz, 3.5U, 3.5L, 4.5U, 4.5L) = P(0.82, 0.79 ,0.85, 0.75) MW
Neutron counts = 1.2e14

Topic
1. The relation between plasma confinement and neutral particle on divertor condition (G. Motojima)
2. Isotope effect on the impurity hole phenomenon and study on impurity transport with internal transport barrier in plasmas (M. Nishiura, S. Satake)
3. Transport studies of LBO and TESPEL injected impurities during impurity hole (D. M. Roque, N. Tamura, I. G. Cortés, K. J. McCarthy)

The relation between plasma confinement and neutral particle on divertor condition(G. Motojima)

- ✓ #185116-185141(w/o divertor pump), #185236-185258 (w divertor pump)
- ✓ R_{ax}=3.6m, B=2.75T, γ=1.254, Bq=100%
- ✓ Working gas: H_2
- ✓ Motivation
  - ❖ There must be close relationship between wall recycling and confinement. The relationship between neutral particles and confinement was investigated under different divertor pumping conditions.
- ✓ Results
  - ❖ Discharges for 40 seconds ECH with a density ramped up to 3-5e19 m^{-3} were used. The timing of collapses was delayed with divertor pumps.
  - ❖ Degradation of confinement phenomena have been observed just before collapses. Interestingly, as the confinement begins to degrade, the neutral pressure drops and the ion saturation current also drops. The drop might be due to that the plasma is shrinking.
  - ❖ On the other hand, radiation increases and the H_α signal also becomes larger just before collapses. The increase in H_α is thought to be due to the recombination process with lower temperature. (Discussion with M. Goto)
  - ❖ The measurement of PCI using event triggers and DBS are also available and will be analysed in detail. (Couretesy of Y. Yoshimura, T. Kinoshita, K. Tanaka, T. Tokuzawa).



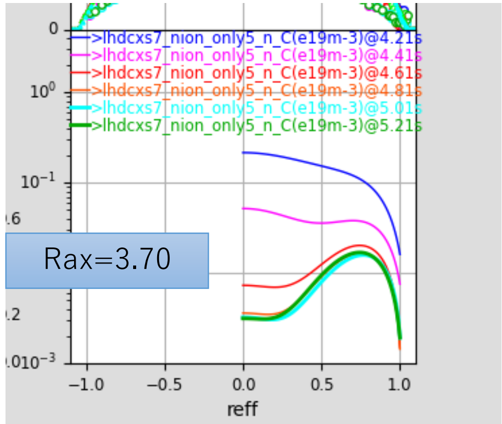
LHD experiment summary 2022/12/06 impurity-hole experiment

M. Nishiura , S. Satake, Y. Zhang, K. Fujita, A. Shimizu

- Main subject
  Measure Er profile in impurity hole plasma by HIBP and examine the impurity hole phenomenon in H plasma for Rax=3.60, 3.70, 3.75, and analyze the impurity neoclassical / turbulent transport and the isotope effect.
  Focused on the relations between core n_e-peaking and impurity hole.
- Condition : R_{ax}/Bax=(3.60/2.750), (3.70/2.676), (3.75/2.640), Bq=100, gamma=1.254, H gas , C pellet

RESULTS:

- Though we intended pure-H shots to compare with pure-D impurity-hole shots on 11/8, some D remained (~30%). Anyway, we have succeeded in expanding the observational data for different configuration cases as in the table below.
- Constantly obtained low-density (n_e ~1.e19) plasma, which is suitable for HIBP measurement.
- As in the previous experiments, inward-shifted case (Rax=3.60) was difficult to observe impurity hole.
- When NBI#5 was strong, peaked n_e profile was created (r/a<0.2), and impurity hole did not fully evolve in such cases. As NBI#5 power decreased (3/4,1/2,1/4) the central peak shrunk, and clearer impurity hole emerged.
- When tangential NBI power was half, impurity hole did not emerge. Applying balanced full-power NBI #2+#3, clear impurity hole emerged.



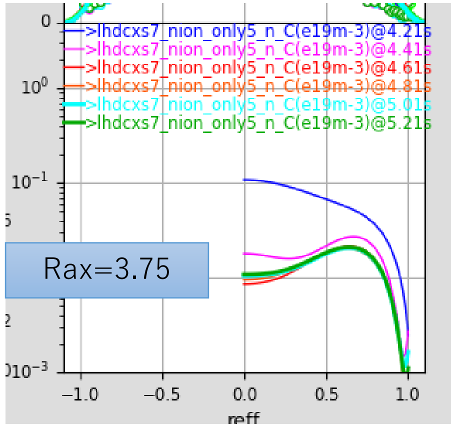


Fig.1 Temporal carbon density with an impurity hole and a weak hole.

R_{ax}	3.55	3.60	3.65	3.70	3.75
H+D		○(C,Fe,Mo) ☆(12/6)		☆(12/6)	☆(12/6)
H	○		○	○	
D		☆(11/8)			

○=year2021, ☆=year2022

Transport studies of TESPEL injected impurities in plasmas with and without an impurity hole (D. Medina Roque, N. Tamura, I. García Cortés, K. J. McCarthy et al.)

Magnetic configuration: (R_{ax}, Polarity, B_t, γ, B_q) = (3.60 m, CW, 2.75 T, 1.2538, 100.0%)
Shots: #185170 - #185189

Goal of this experiment

- To characterize impurity transport in impurity hole hydrogen plasma conditions in LHD, we use 700um-shell type and 900um-ball type TESPELs containing single tracers to reach different penetration depths.
- Obtain data for comparisons with future results in W7-X

Background & Motivation

- The impurity hole phenomenon seems to be characterized by a **+ve E_r** at **the plasma edge** and a -ve **E_r** in the **plasma core → different convection velocities** of impurities in each region.
  - ✓ Estimate an impurity decay time from the line intensity evolution for injected elements (**Ti, Cu, and Mo**) for plasmas w/ and w/o impurity hole using EUV/VUV spectrometer SOXMOS (its wavelength range from 19.7 to 34.1 nm with a 133.6 g/mm grating for Ti, from 14.5 to 27.4 nm with a 133.6 g/mm for Cu, and from 8.9 to 13.2 nm with a 600 g/mm grating for Mo).
- Comparison of experimental results obtained with and without impurity hole in NBI heated plasmas with a considered electron density range of 1E19

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Results

- **17 TESPELs are successfully injected (11 into w/ imp hole)** with ne 1-2e^{19} m^{-3} and **(6 into w/o imp hole)** with n_e of 1e19 m^{-3}

  2 heating patterns are applied

  A) w/ imp. hole, NB#1-NB#3(4.0s-6.0s), mod. NB#4(4.3s-5.3s), mod. NB#5(3.3s-5.3s)

  B) w/o imp. hole, NB#1-NB#3(3.3s-5.3s) , mod. NB#4(4.3s-5.3s), mod. NB#5(3.3s-5.3s)

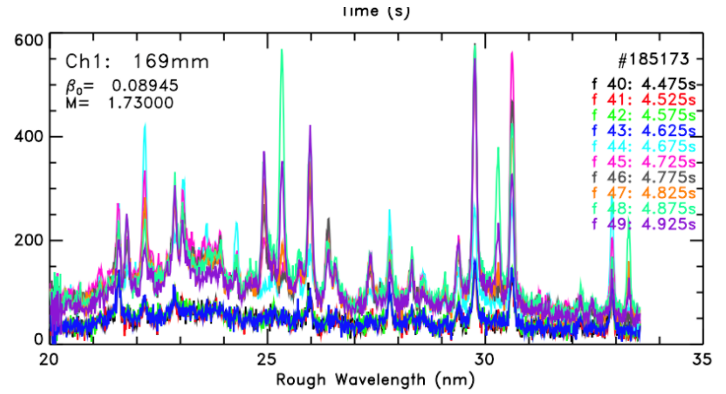
Ti, Cu, Mo

700 um shell	Ti	Cu	Mo
w/ Imp hole	✓	✓	✓
w/o Imp hole	✓	✓	✓

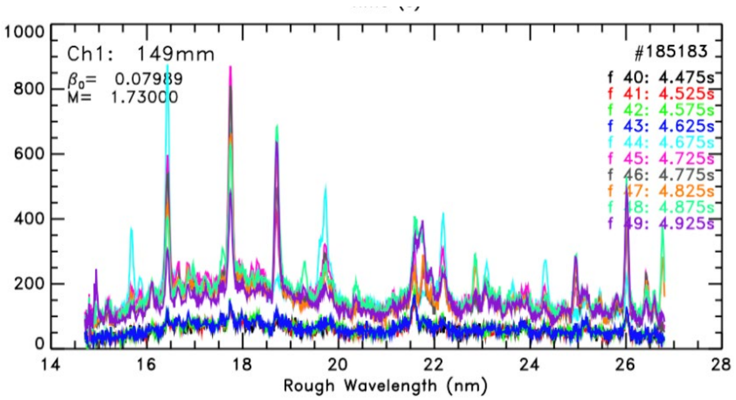
900 um ball	Ti	Cu	Mo
w/ Imp hole	✓	✓	✓
w/o Imp hole	✓	✓	✓

- We obtained data for all impurities w/ and w/o imp. hole plasmas.
- Emission lines from Ti(22), Cu(29) and Mo(42) have been observed clearly (see right figs.) → To be analyzed
- Data from HIBP is also of great interest.

A) **#185173-900um Ti**
TESPEL@4.82s



B) **#185183-900um Cu**
TESPEL@4.82s



C) **#185185-900um Mo**
TESPEL@4.82s