(TG1) Multi-ion group report

Nov. 9, 2022 (M. Kobayashi)

Date: Nov. 8, 2022
Time: 9:50 - 18:45
Shot#: 182655 – 182811 (157 shots)

Prior wall conditioning: No
Divertor pump: On
Gas puff: D2, H2   IPD: No
LID: Off
NBI#(1, 2, 3, 4, 5)=gas(D, D, D, D, D)=P(2.1, 2.2, 2.4, 5.6, 8.0) MW
ECH(77GHz)=ant(5.5-U, 2-OUR)=P(703, 792)kW
ECH(154GHz)=ant(2-OLL, 2-OUL, 2O-LR)=P(723, 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(0.80, 0.73, 0.76, -) MW
Neutron yield integrated over the experiment = 1.9×10^{17}

Topics

1. Measurement of edge plasma parameters profiles using the fast scanning Langmuir probes (S. Masuzaki et al.)
2. Asymmetric Distributions of ECH-driven Toroidal Rotation in LHD (W.H. Ko, K. Ida)
3. Isotope effect on the impurity hole phenomenon (S. Satake, M. Nishiura)
4. Deformation of velocity distribution by ICRF heating (H. Kasahara)
5. Mode conversion wave absorption from fast wave in multi-ion plasmas (H. Kasahara)

Measurement of edge plasma parameters profiles using the fast-scanning Langmuir probes

S. Masuzaki, T. Sugiyama, Y. Hayashi

Shot #: 182653 - 182679

(R_{ax}, B_t, γ, B_q) = (3.75 m, 2.64 T, 1.2538, 100.0%)

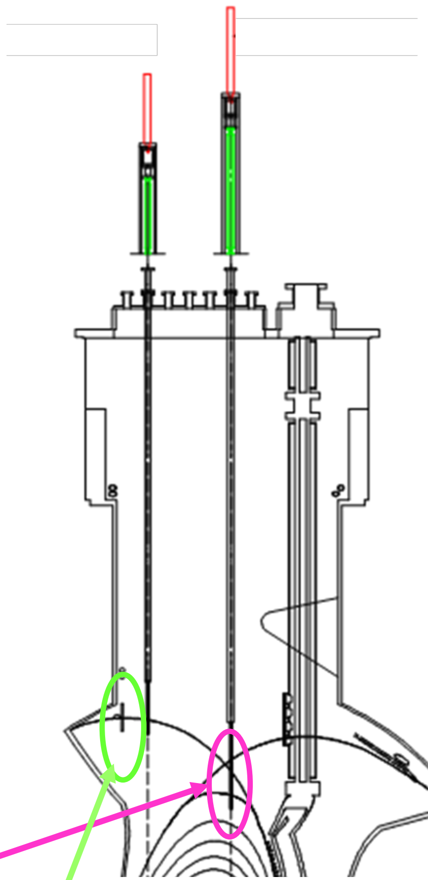
Shot #: 182680 – 182681

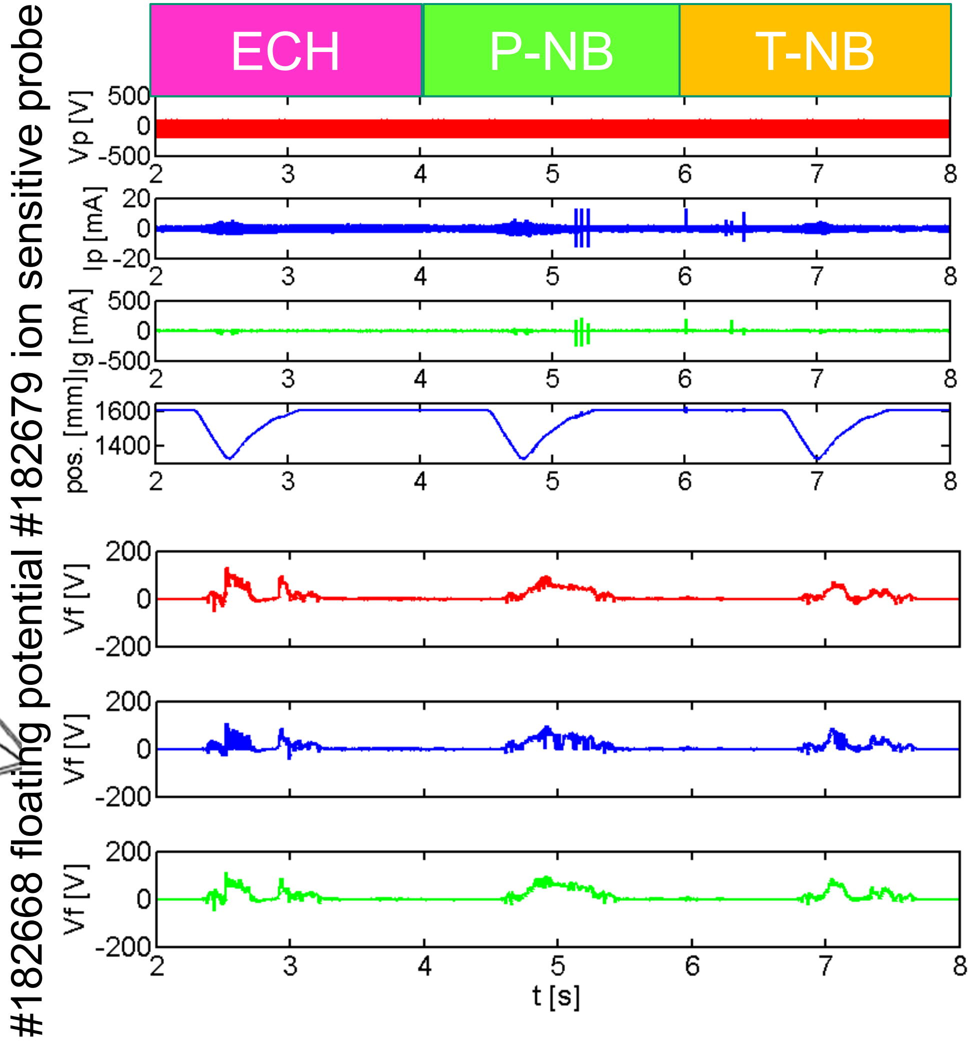
(R_{ax}, B_t, γ, B_q) = (3.6 m, 2.75 T, 1.2538, 100.0%)

Working gas: D2

$P_{NBI\text{-}1}$ ~ 2.4 MW, $P_{NBI\text{-}2}$ ~ 2.8 MW, $P_{NBI\text{-}3}$ ~ 2.8 MW, $P_{NBI\text{-}4}$ ~ 3.8 MW(modulated), $P_{NBI\text{-}5}$ ~ 3.7 MW

- To understand the edge plasma transport plasma parameters profiles are necessary. The fast-scanning Langmuir probes were utilized for the measurement of the profiles.
- Floating potential profiles in the edge plasma were measured to obtain the edge electric field profile which possibly plays an essential role in the observed asymmetry of the divertor particle and heat loads.
- Ion and electron temperature profiles in a divertor leg were measured by using the “ion sensitive probe”.





Asymmetric Distributions of ECH-driven Toroidal Rotation in LHD

Won-Ha Ko(KFE), K. Ida, M. Yoshinuma and T. Kobayashi (NIFS)

Experimental conditions: (#182682 ~ #182710)

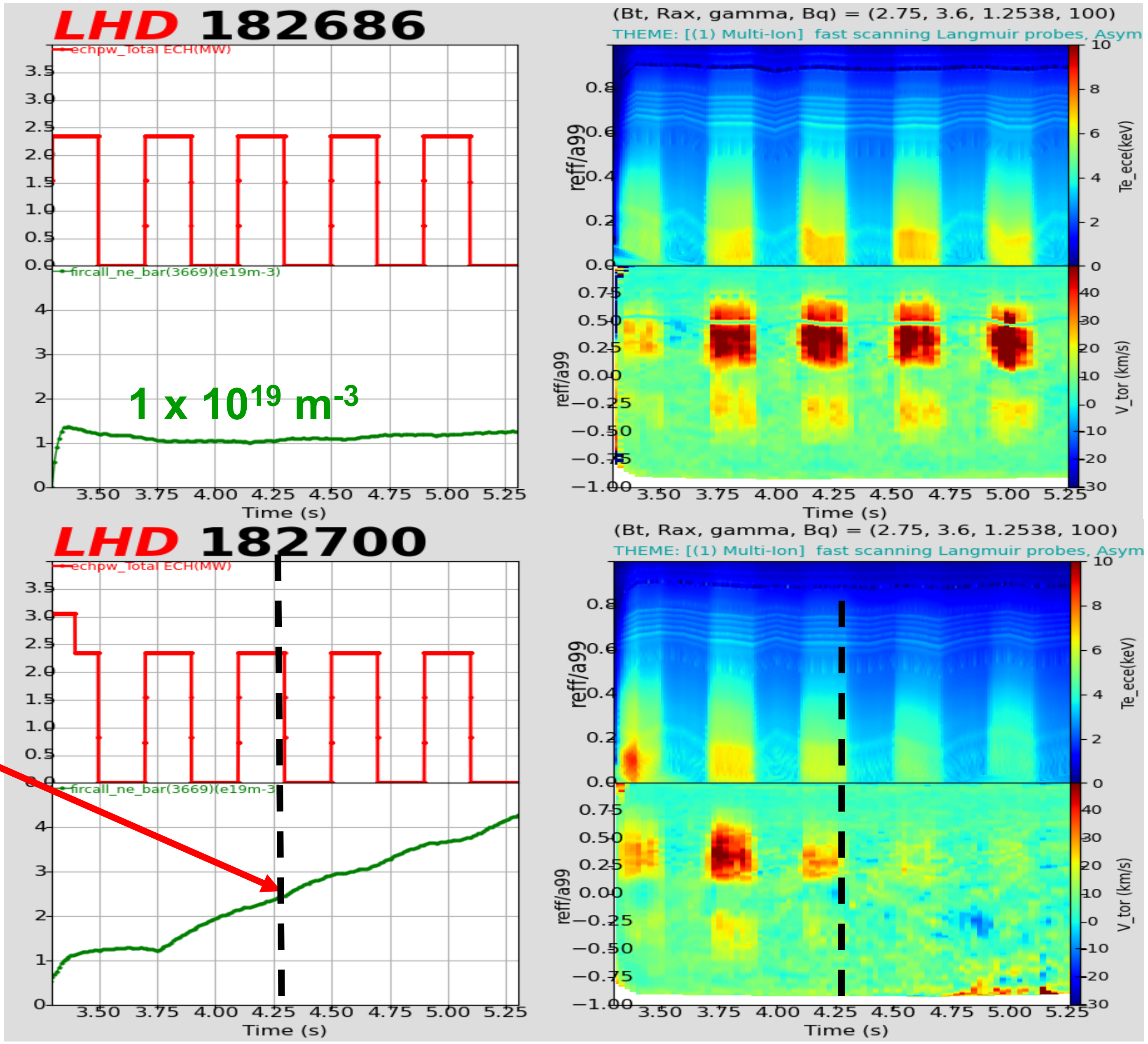
(R_{ax}, Polarity, B_t, γ, B_q) = (3.6 m, CW, 2.75 T, 1.2538, 100.0%)

Objective and background:

- The stronger ECH power with the more on-axis, the more asymmetry distribution of toroidal flow.
- Searching the source of ECH-driven flow asymmetry in a balance NBI plasma from density scan (limit of ne)
- Searching the source of the **ECH-driven flow asymmetry**. (i) Asymmetric toroidal rotation by the ECH-driven **asymmetric flux** surfaces and the Effect of Pfirsch–Schlüter flow

Results:

- Asymmetry of toroidal flow appears during ECH ON phase for low density (~ 1 x 10^{19} m^{-3})
- There is a density limit (~ 2.5 x 10^{19} m^{-3}) in ECH(2.4MW)-driven flow asymmetry in a balance NBI plasma
- The direction of the toroidal magnetic field will be reverse to correct the toroidal flow offset in the measurement.



LHD experiment summary 2022/11/08 impurity-hole experiment

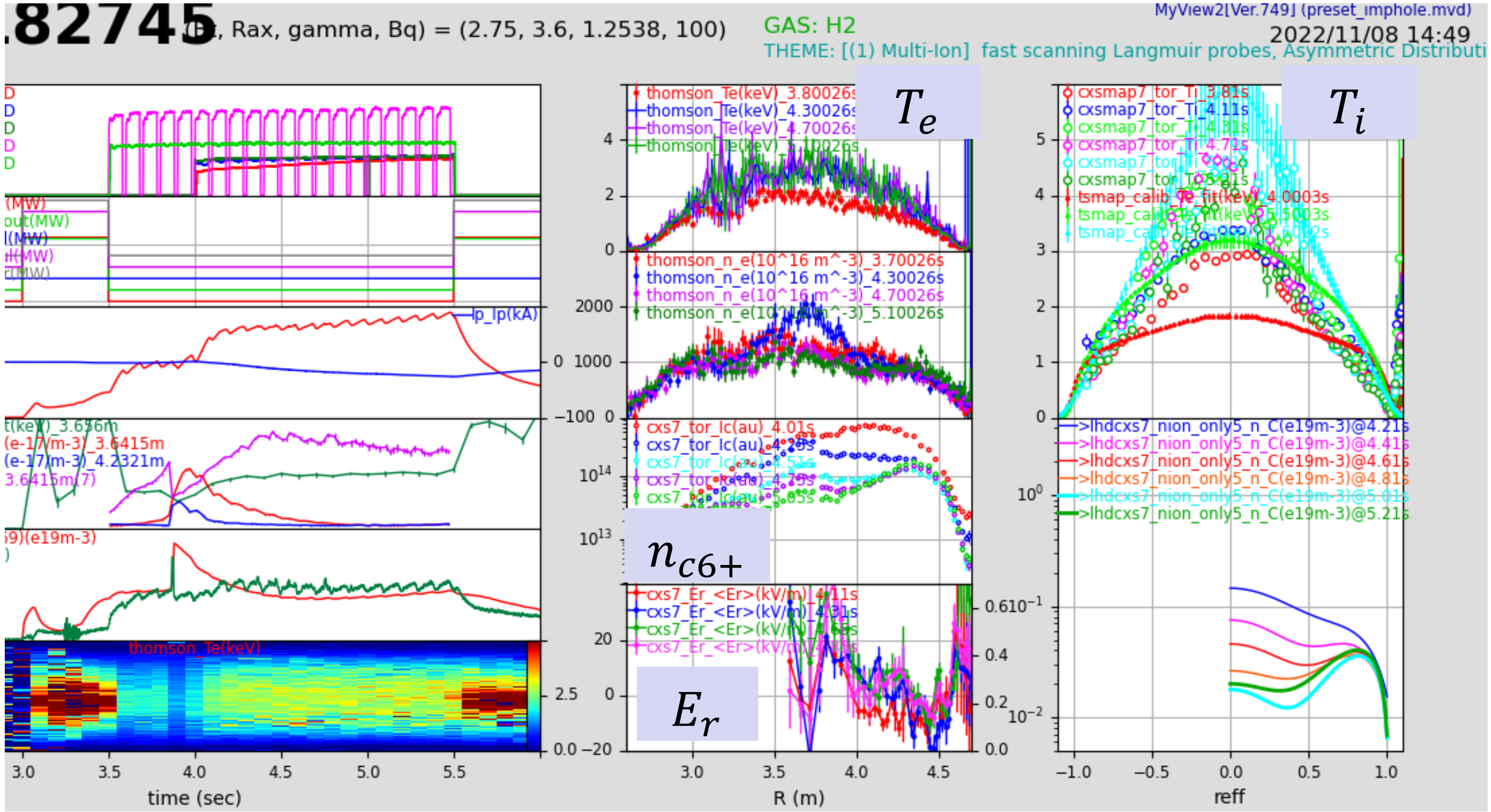
S. Satake, K. Fujita, M. Nishiura, A. Shimizu

Experimental Condition

#182711−#182746(Rax, Polarity, Bax, gamma, Bq)=(3.6, CW, 2.75, 1.2538, 100)

- Main subject

  Measure Er profile in impurity hole plasma by HIBP and examine the impurity hole phenomenon in pure-D plasma, and analyze the impurity neoclassical / turbulent transport and the isotope effect.

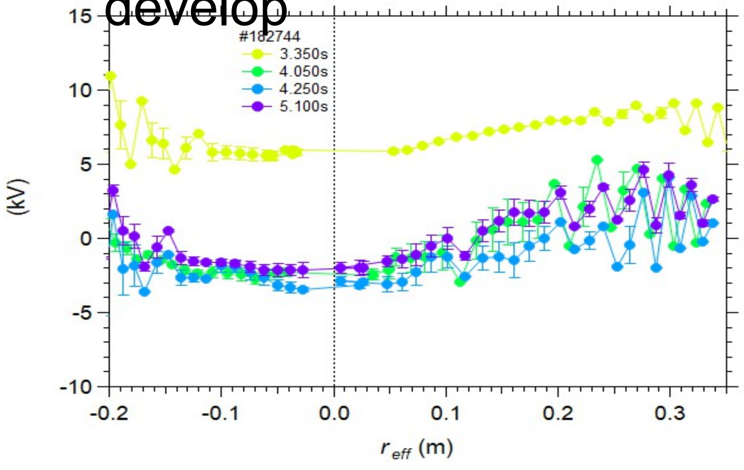


Result

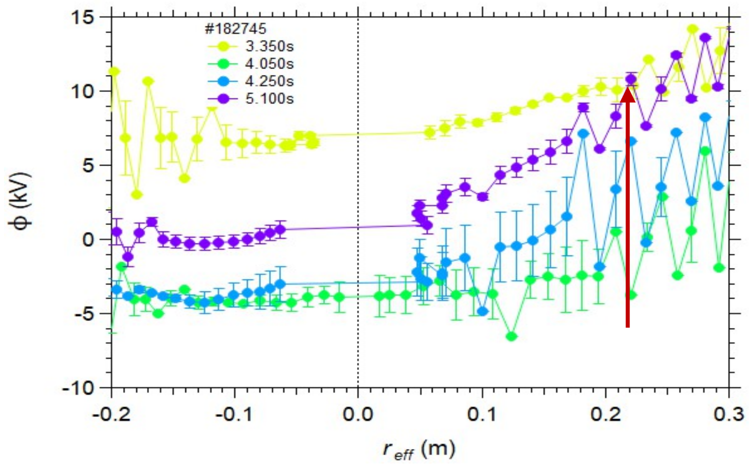
- Intended low-$n_e(\sim 1e19)$ by feedback control, but n_e tends to peak at center $(2\sim 3e19)$. Impurity hole was not constantly observed, but when core n_e was not peaky, impurity hole developed.
- $T_{i0} = 3\sim 4$keV was higher than last year's impurity hole experiment in H plasmas.
- From CXRS, E_r seems to be negative in wide region except for very close to LCFS. This is different from previous impurity hole experiment, in which $E_r > 0$ at r>0.3a.
- HIBP measurement also shows the same tendency (next page).

HIBP measurement shows negative E_r in the core region.

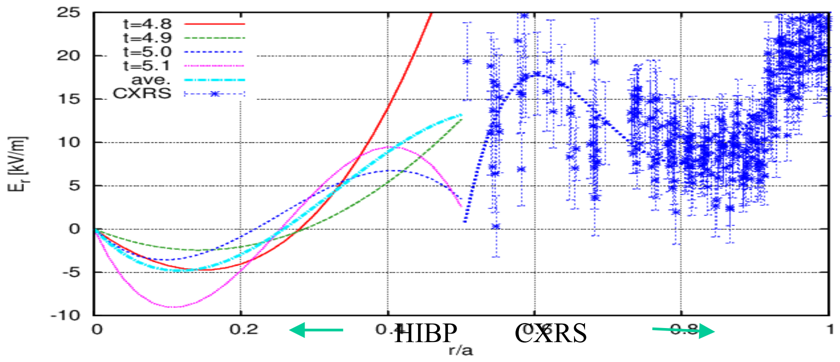
Impurity hole did not develop



Impurity hole developed



Example : Er profile of impurity hole (H, Rax=3.70)

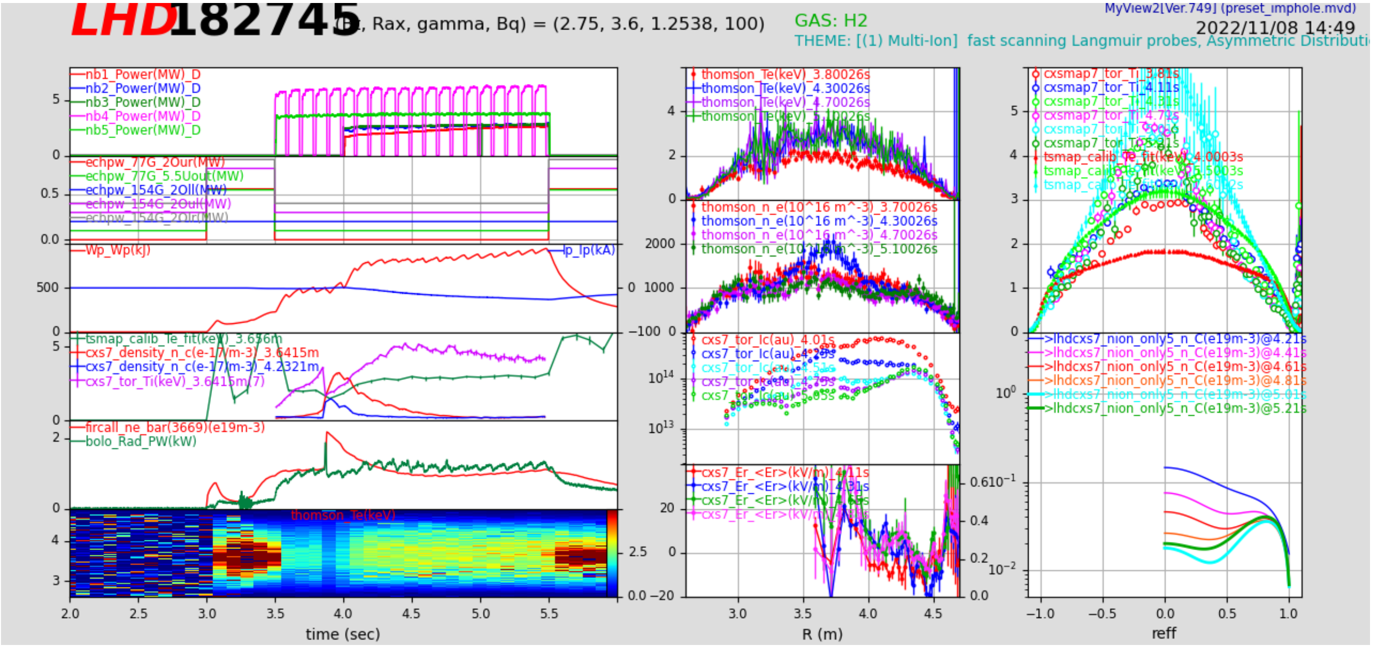


Measured potential in both cases (no impurity hole, with impurity hole) show that $E_r = -\frac{d\Phi}{dr} < 0$ in the core region. The E_r profile is different from the Rax=3.65 and 3.70 cases in which clear impurity hole were observed (right figure).

When impurity hole was observed in yesterday's experiment, core negative-E_r developed in time (t=5.1s is about the time impurity hole fully developed and became steady). ← because of higher-T_i ?

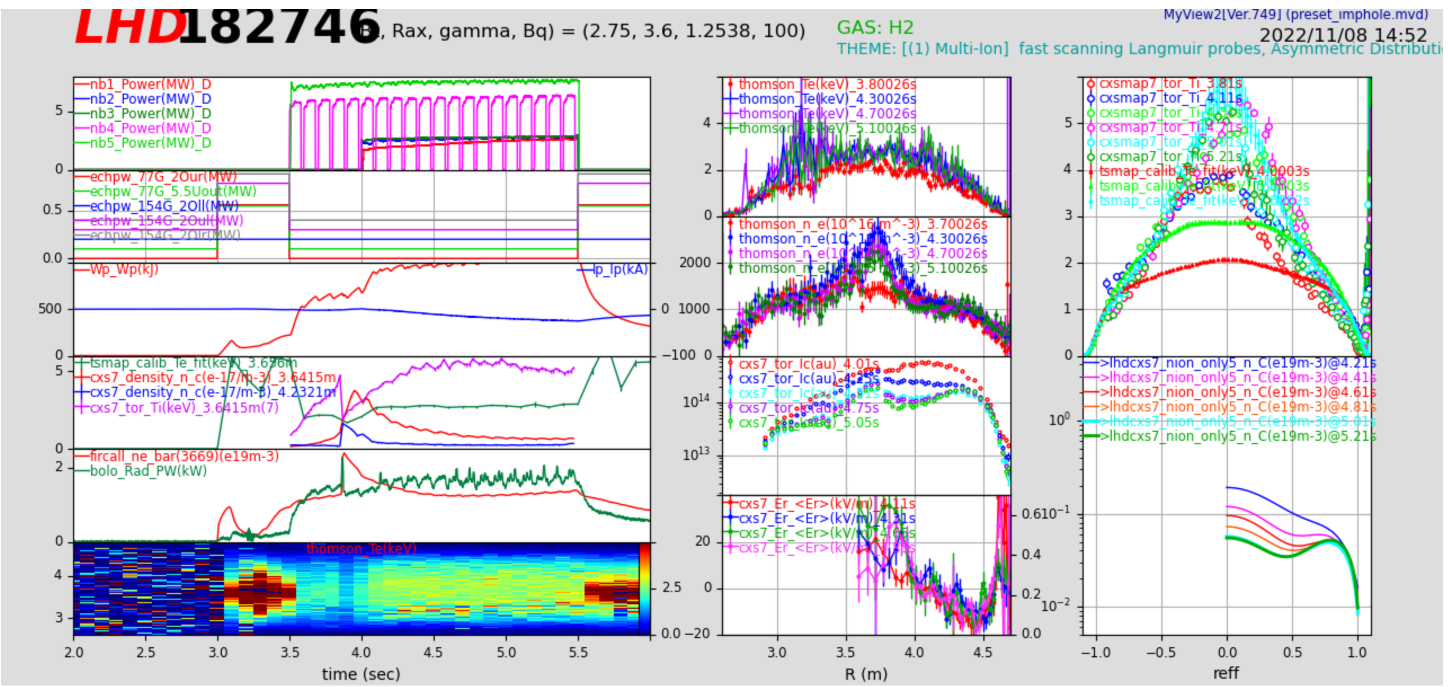
Why impurity hole was not constantly created? Rax-dependence (outer axis position is better for impurity hole) is already known, but the hole was observed in [H, Rax=3.60] in the last year's experiment.

- Because of different NBI power or heating efficiency b/w H and D plasma?
- Because of peaked n_e profile? (Why peaked?)
- Hydrogen isotope effect on neoclassical or/and turbulent transport ?



w/o imp. hole

w/ imp. hole



Deformation of velocity distribution by ICRF heating and mode conversion wave absorption from the fast wave in multi-ion plasmas

H. Kasahara

Shot #: 182747 - 182811 (64shots)

Experimental conditions: (R_{ax}, Polarity, B_t, γ, B_q) = (3.60 m, CW, 2.75T, 2.73T, 2.65T, 2.6T, 1.2538, 100.0%);

Purpose:

- Measuring the deformation profile of the velocity distribution of fast ions during ICH measured by CXS.
- Confirming electron heating profile measured by ECE, which IBW and ICW cause in hydrogen mixture deuterium plasma.

Experimental result:

- Square power modulations were conducted with several power of ICH and various hydrogen concentration by controlling superimposed hydrogen fueling. To reveal deformed velocity distribution during D(H) heating regime, we will analyze the hydrogen spectrum profile measured by CXS.
- We observed significant time evolution of electron temperature measured by ECE, confirming the direct electron absorption profile with the break-in-slope techniques after ICH.

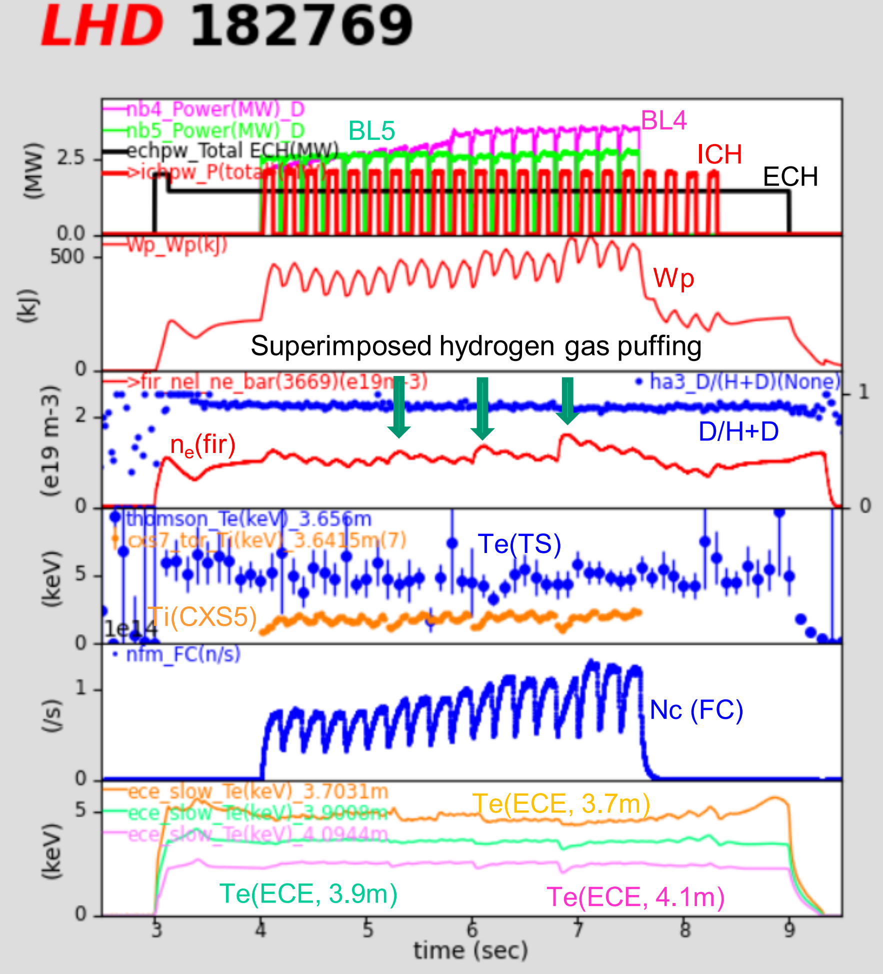


Fig. 1 Typical discharge waveform

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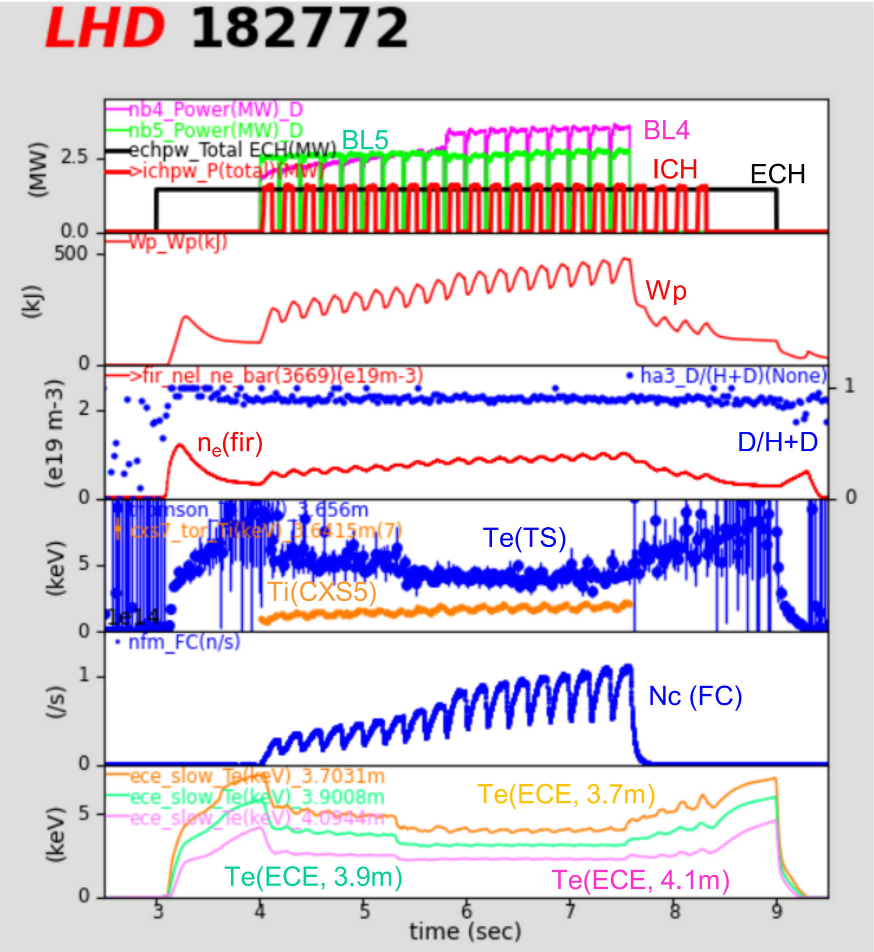

Fig. 1 Typical discharge waveform