(TG1) Multi-ion Plasma group report

Nov. 10, 2022 (H. Kasahara)

Date: Nov. 9, 2022
Time: 9:50~18:45
Shot# 182812~182963(152shots)
Prior wall conditioning: No
Gas puff: D_2, H_2, He, Ar, TESPLE: LiF, Fe, Teflon

NBI(1, 2, 3, 4, 5) = gas(D, D, D, D, D) = P(2.6, 3.0, 3.3, 8.1, 7.6) MW
ECH(56GHz,15U) = P(0.0) MW
ECH(77GHz, 55Uo, 2Our) = P(0.70,0.79) MW
EH(154GHz, 2Oll, 2Oul, 2Olr) = P(0.72,0.80,0.83) MW
ICH(38.47MHz, 3.5U, 3.5L, 4.5U, 4.5L) = P(0.84, 0.76 ,0.78, 0) MW
Neutron yield integrated over the experiment = 2.2×10^{17}

Topic

1. Measurement of edge plasma parameters profiles using the fast scanning Langmuir probes (S. Masuzaki)
2. Deuterium retention in damaged tungsten (S. Masuzaki)
3. Asymmetric Distributions of ECH-driven Toroidal Rotation in LHD (W.H.Ko)
4. ICRF-accelerated impurity exhaust in LHD (D. Moseev)
5. Investigation of He density profile in mixture plasmas (I. C. Chan)
6. Mixture induced phase transition in multi-ion transport (A. Dinklage, N. Tamura)

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

S. Masuzaki, T. Sugiyama, Y. Hayashi

Shot #: 182814 - 182833

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

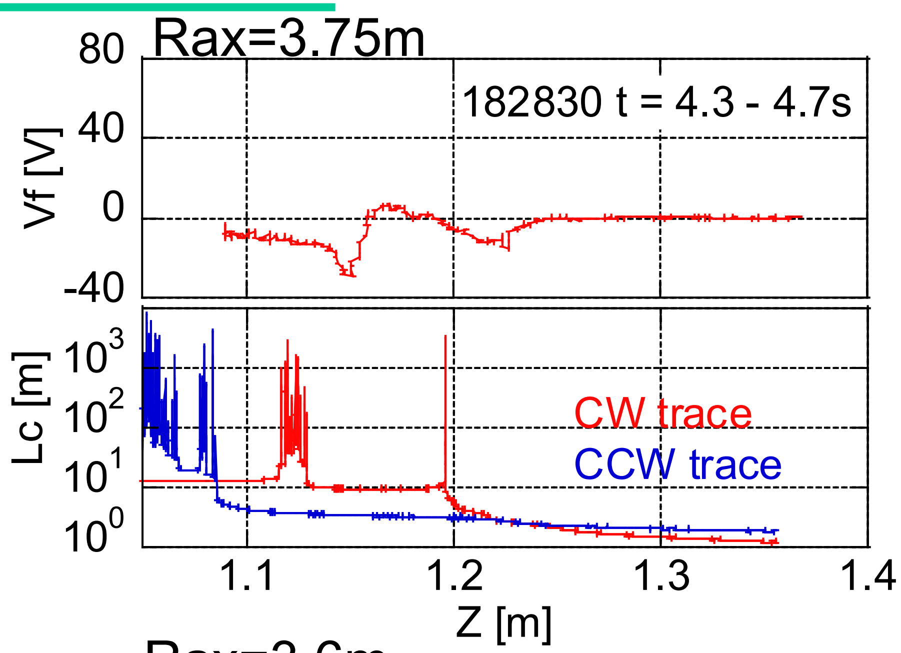
Shot #: 182834 – 182841

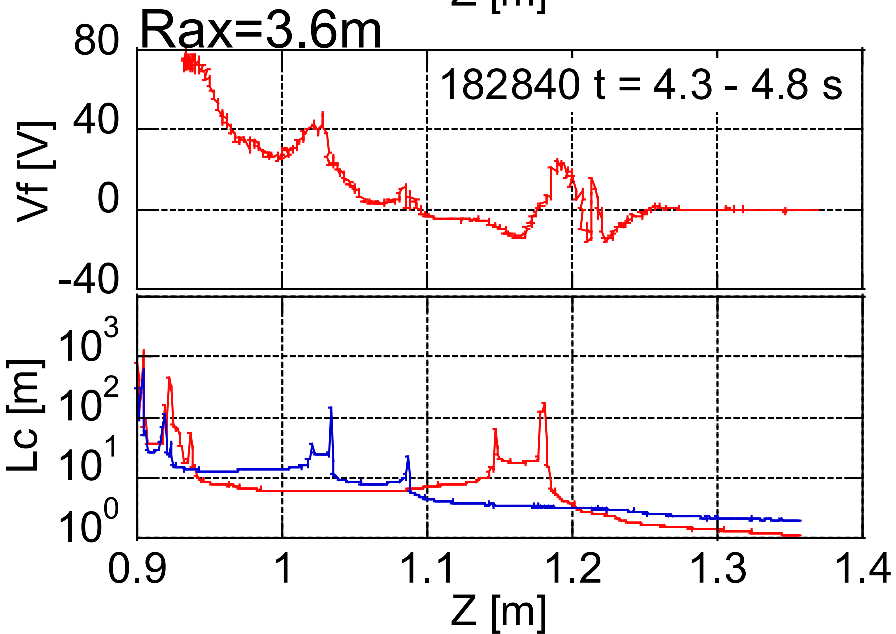
(R_{ax}, B_t, γ, B_q) = (3.6 m, -2.75 T, 1.2538, 100.0%)

Working gas: D2

P_{NBI-1} ~ 2.4 MW, P_{NBI-2} ~ 2.8 MW, P_{NBI-3} ~ 2.8 MW, P_{NBI-4} ~ 3.8 MW(modulated), P_{NBI-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.
- The Bt direction was CW while the direction on 8 Nov. was CCW.
- 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. Figures show examples of floating potential profiles.



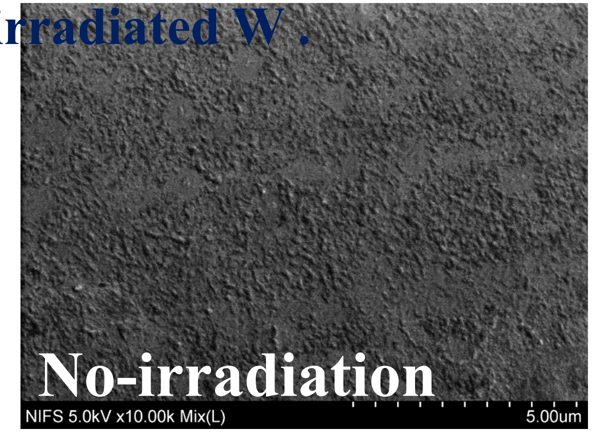


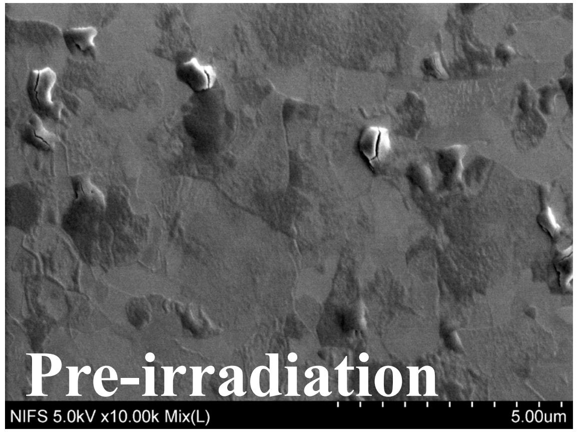
Deuterium retention in damaged tungsten

M. Zhao, S. Masuzaki, M. Tokitani, M. Yajima

- Understand the effect of irradiation defect on the hydrogen isotope retention and microstructure modification in ITER W under divertor plasma exposure.
- Clarify the distribution of hydrogen isotopes retention and microstructure modification around divertor strike line.

C23 result: larger blisters were formed in the pre-irradiated W .





C24 LHD experiment condition

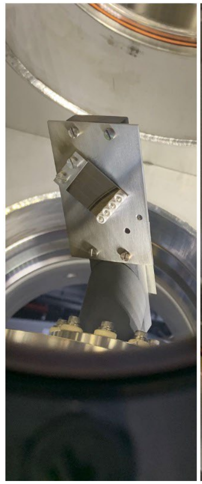
Shot number: 182844 – 182858

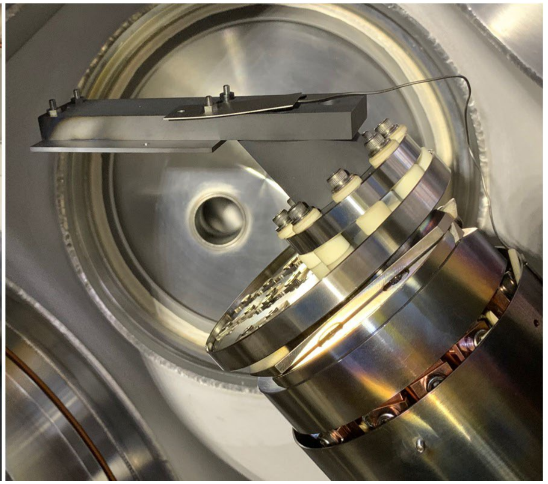
Working gas: D_2

$(R_{ax}, B_t, \gamma, Bq) = (3.6\ \text{m}, 2.64\ \text{T}, 1.2538, 100\%)$

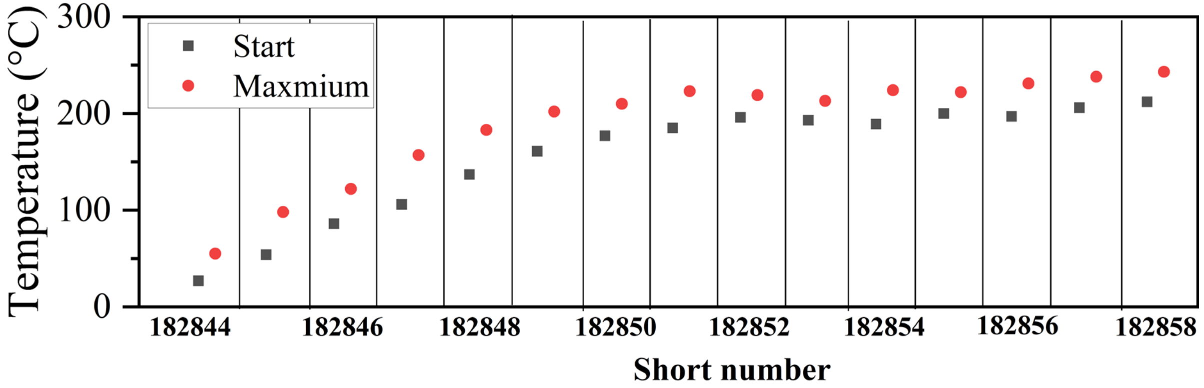
Material: Mirror finish ITER grade W tiles (28 × 6 × 1).

Iron (Fe) ion irradiation, with peak damage 1dpa, was performed to simulate neutron irradiation defects.





Temperature variation during plasma exposure



Maximum temperature: 243 °C

Asymmetric Distributions of ECH-driven Toroidal Rotation in LHD

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

Experiments : #182859 ~ #182884

Experimental conditions:

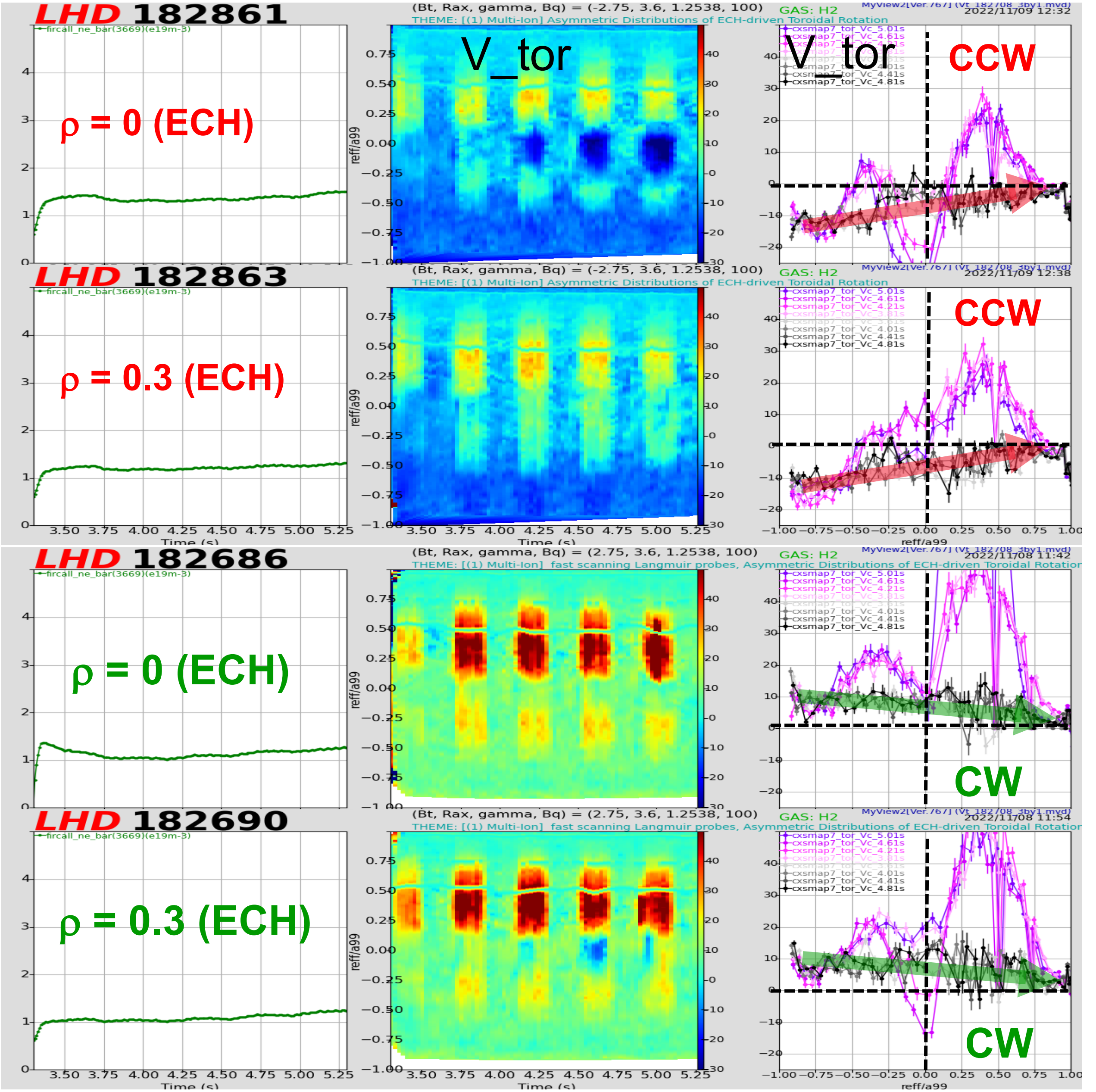
(R_{ax}, Polarity, B_t, γ, B_q) = (3.6 m, CCW, 2.75 T, 1.2538, 100.0%)

Objective and background:

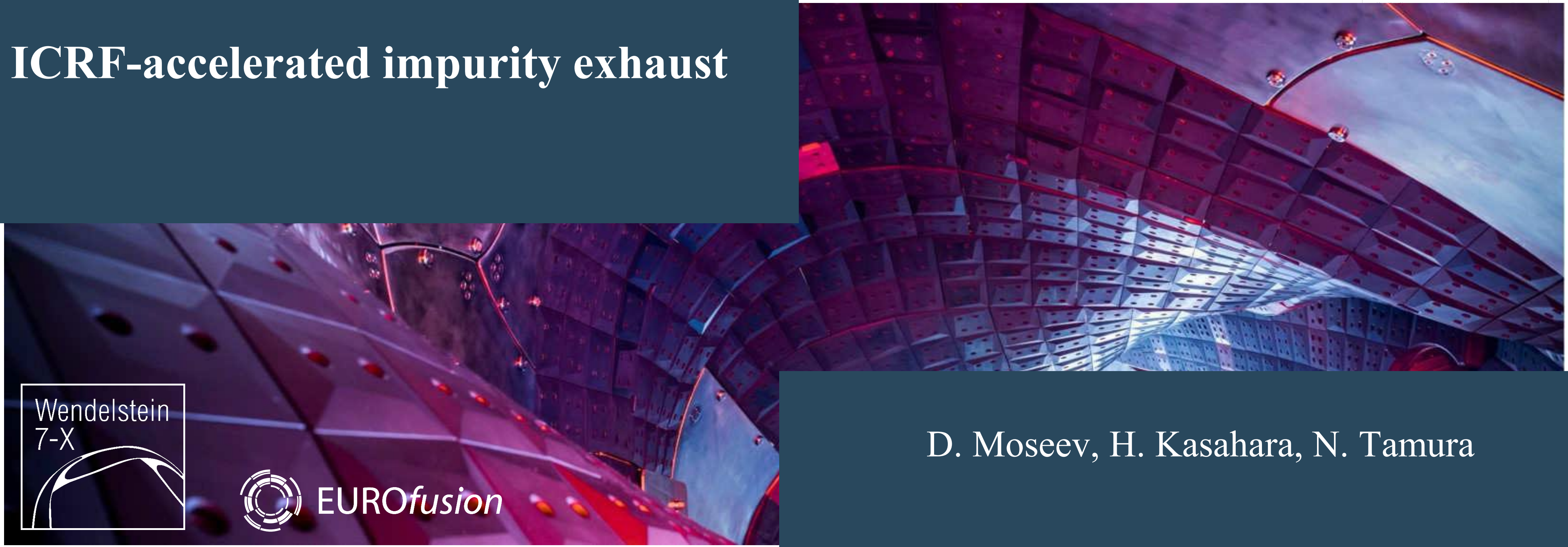
- The stronger ECH power with the more on-axis, the more asymmetry distribution of toroidal flow.
- Searching the source of ECH-driven flow asymmetry in a balance NBI plasma from density scan for **CW and CCW of magnetic field**
- Searching the source of the **ECH-driven flow asymmetry**.

Results:

- Asymmetry of toroidal flow appears during ECH ON phase for low density (~ 1 x 10^{19} m^{-3})
- The density limit (~ 2.5x10^{19} m^{-3}) is also in ECH(2.4MW)-driven flow asymmetry for CCW
- When the direction of the toroidal magnetic field was reverse, the toroidal flow offset also in the measurement
- There is different behavior of ECH-driven flow asymmetry (core reverse) for CW and CCW



ICRF-accelerated impurity exhaust



D. Moseev, H. Kasahara, N. Tamura

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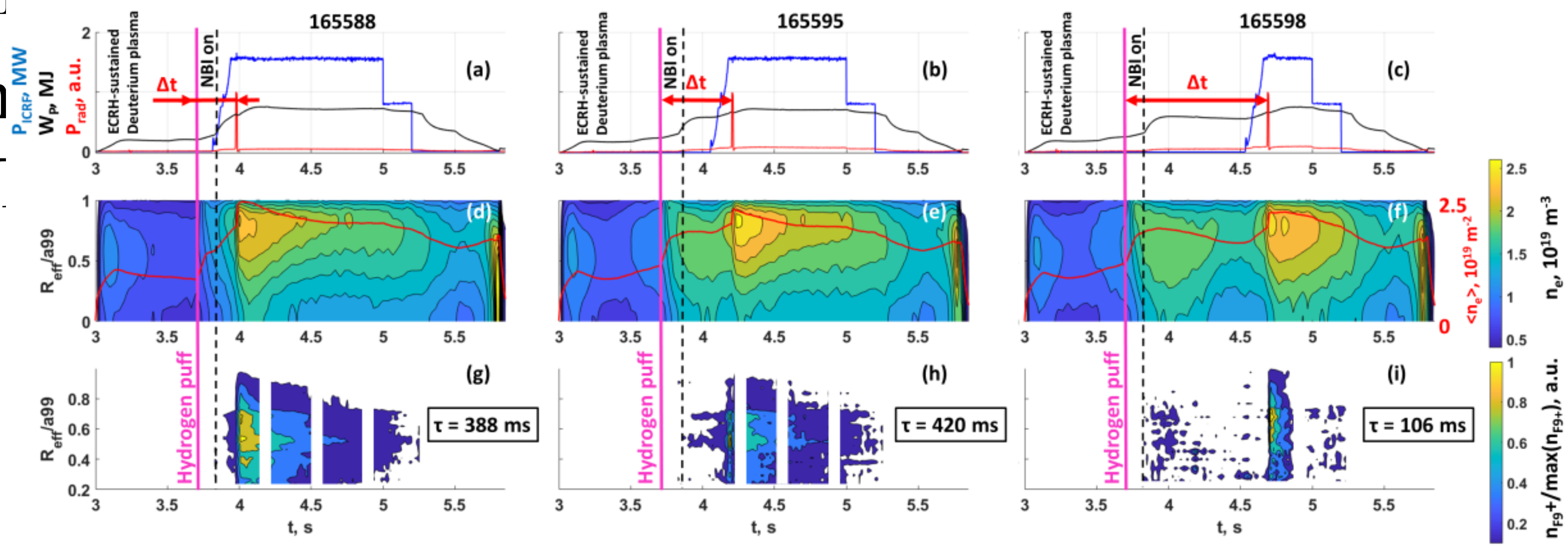
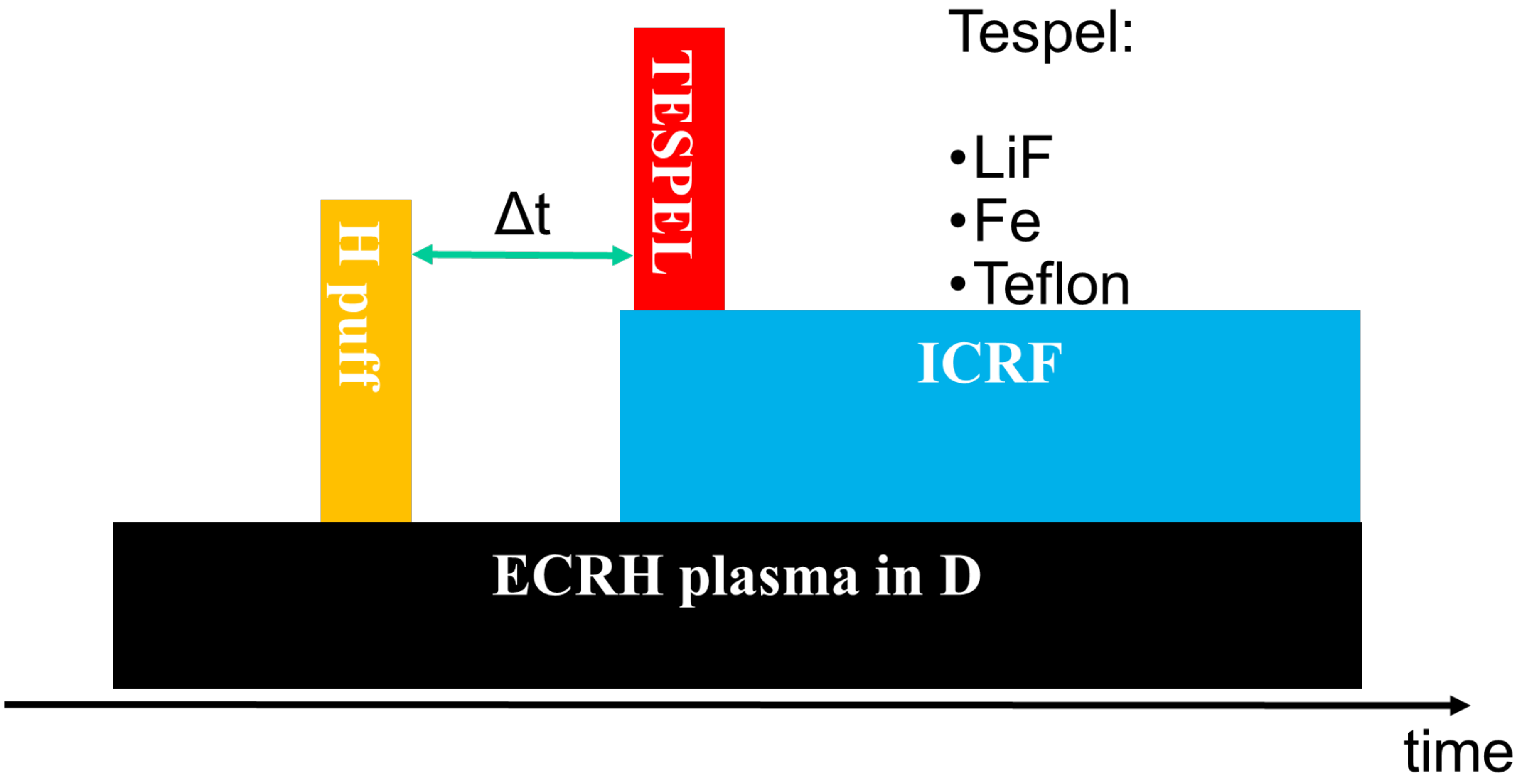
Purpose of experiment

– Demonstrate the impurity exhaust scheme based on the coupling of ICRF power to the impurity ions via 3 ion heating -> reproduce the results from 2 years ago + add some new:

- Demonstrate the exhaust scheme for fluorine, as in 165598.
  - H/(H+
- Demon ... ties -> added



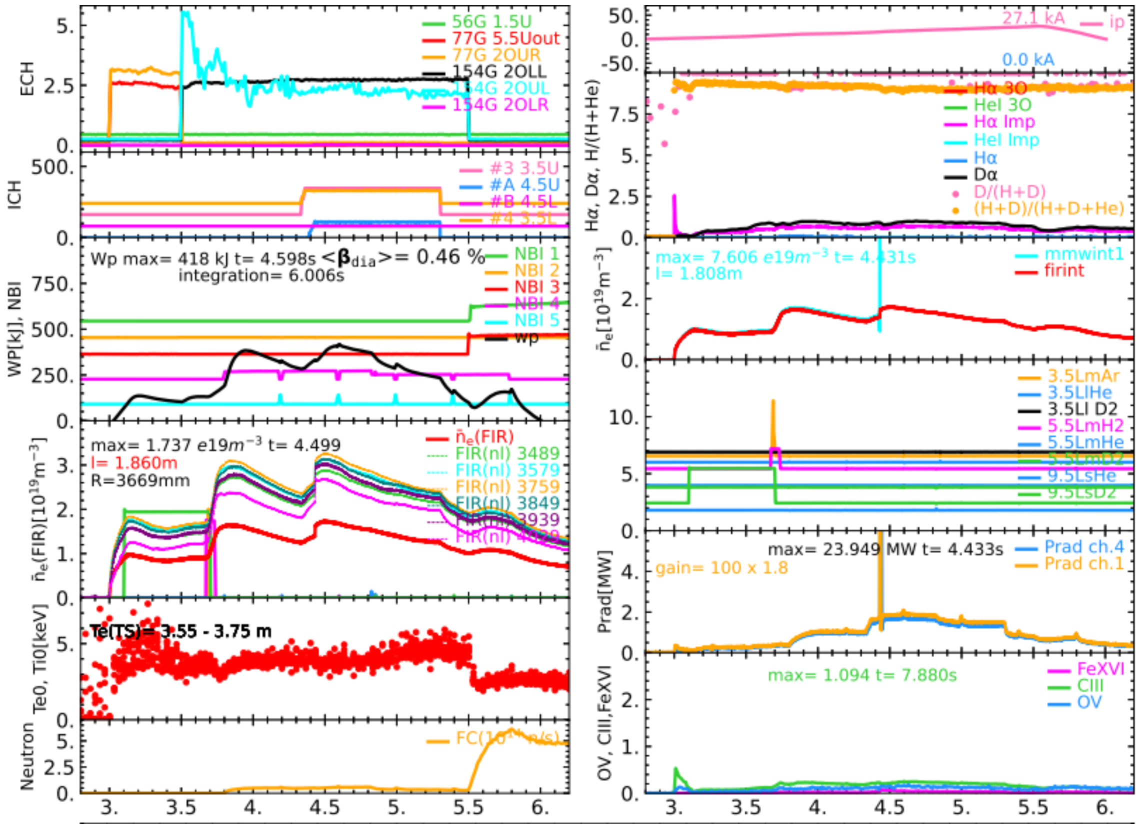
Scheme of the conducted experiments



Shot statistics

– 35 shots

- 4 technical shots
- 3 ICRF interlock
- Small Wp
- Physics investigation is ongoing



Investigation of He density profile in mixture plasmas

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

2022/11/09

Background and objective

While He particle transport depending on its concentration has been pointed out in the earlier work, further investigation is required to comprehend particle transport in mixture plasmas. For this purpose, compilation of He density profile is prerequisite.

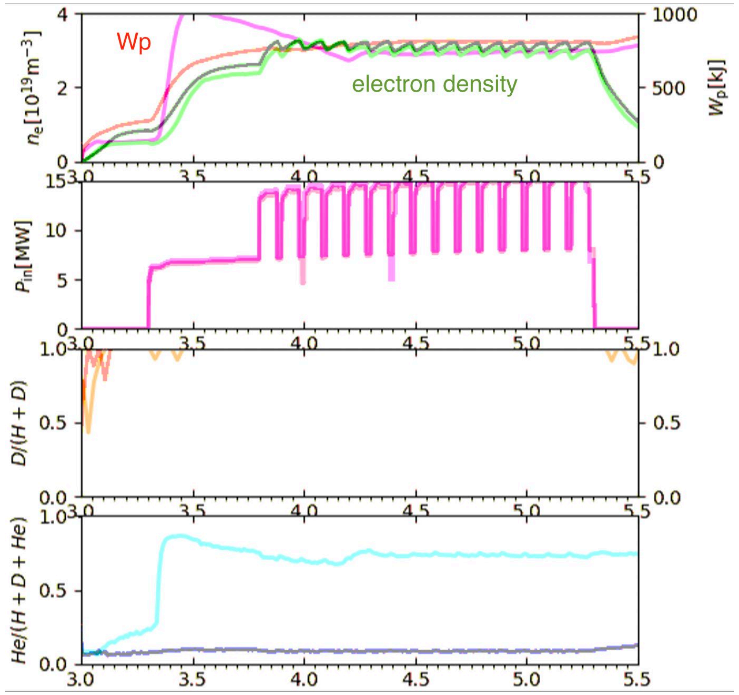
Experimental Condition

 # 182921~#182940, B= 2.75T, R_{ax}=3.6m, Bq= 100% CCW, feedback control of density by either D or He gas puff to manipulate the He fraction.

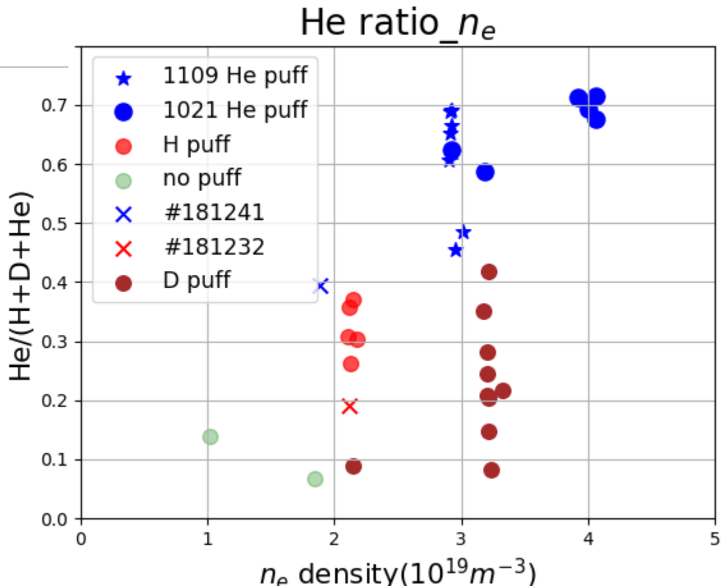
Results

1) Combining with the result of the experiment on Oct.21st, the ratio of He puff shots generally lie in the regime over twice than those D puff shots.

2). The shots with the electron density （around 3*10¹⁹） yield the He ratio ranging from about 10% to 40%.



Light color #182937
Deep color #182922



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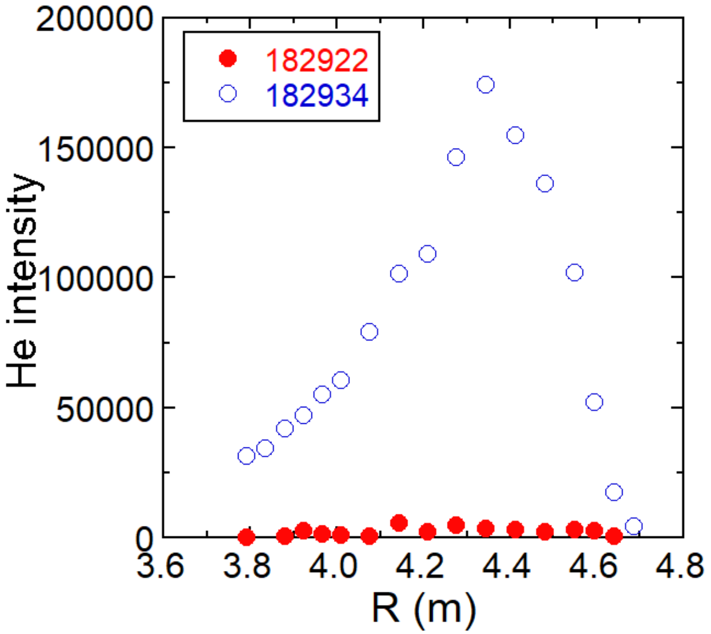

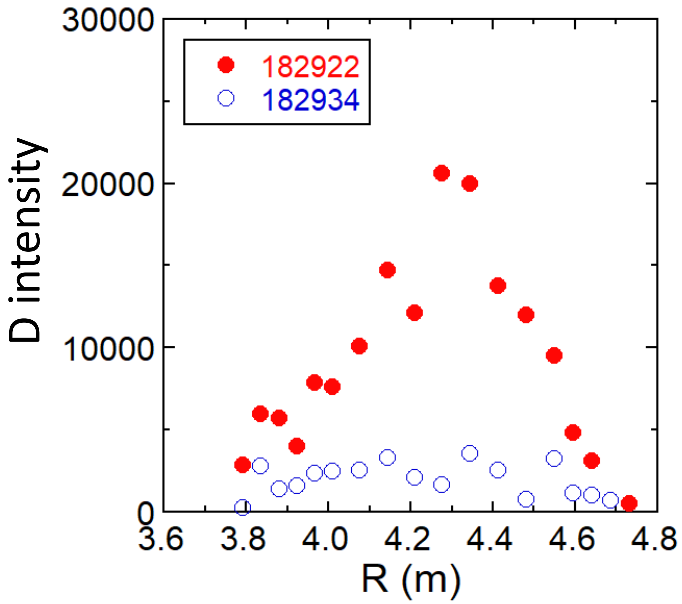

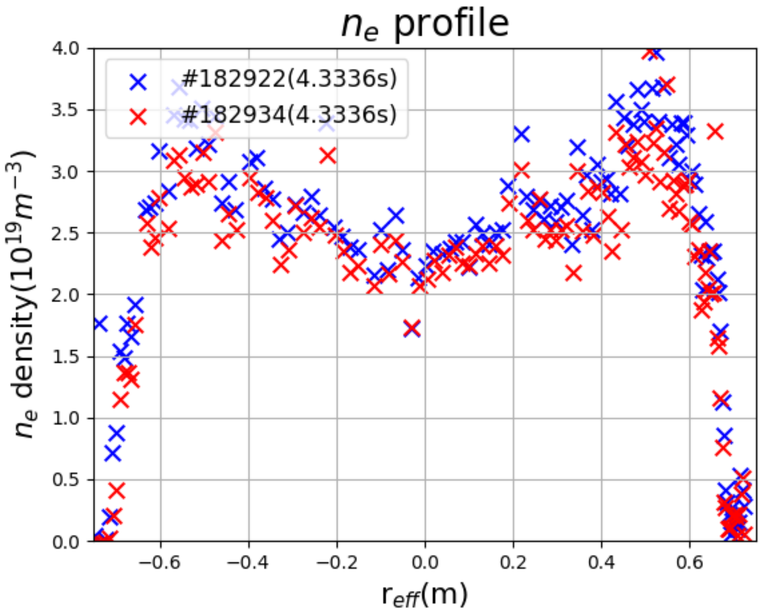

Results(cont.)

3). With the shared closed electron density （around $3*10^{19}$）, the upper bound (about 40%) of the shots is about quadruple to the lower bound(10%)

4). From almost all aspects of performance, they have shown no obvious difference between them.

5). The following experiment taking place in Dec. 1 may bring some further information to our analysis .

Mixture-induced phase transition in multi-ion transport (A. Dinklage, N. Tamura et al.)

Experimental Configuration, Shots

(R_{ax}, Polarity, B_t, γ, B_q) = (3.9 m, CCW, 2.5385 T, 1.2538, 100.0%), #182943 – #182962 (#182962: NBI calib.)

Goal of this experiment: To study the change of the impurity accumulation window in H/D/He-mixed plasmas

Results:

- We tried to change the He contents in the plasma by using different gas puff settings around n_{e_bar} of 4e19 m^{-3} under the **D-dominant condition: D/(H+D) ~ 0.9**
- **When He contents increased**, **the plasma duration was prolonged**, and Bolometer signal level, **C-density level**, and Ar Li-like intensity level **were decreased**
- Ar XVI profile measured with CXS and Er data will be analyzed later

Note: Ar puff(3.45s, 8ms) is applied for each shot

He puff(3.50s, 160ms) 1.50V | He puff(3.50s, 160ms) 2.00V | He puff(3.50s, 160ms) 2.50V | He puff(3.50s, 160ms) 3.00V | He puff(3.5s-8.3s,feedbacked)