(TG1) Multi-ion Plasma group report

Jan. 13, 2023 (H. Kasahara)

Date: Dec. 27, 2022, Time: 9:48~11:35, 13:40-18:45
Shot# 187250-187281, 187317-187364, Neutron counts = 3.9×10^{13}, 1.6×10^{14}

Prior wall conditioning: No, Div cryo: ON(w/o 2I), Gas puff: He, H_2, Ar, Ne, IPD: B, Li

NBI(1, 2, 3, 4, 5) = gas(H, H, H, H, H) = P(-, 3.34, 3.28, 0.84, -) MW
ECH(56GHz,15U) = P(-) MW
ECH(77GHz, 55Uo, 2Our) = P(0.21, -) MW
EH(154GHz, 2Oll, 2Oul, 2Olr) = P(0.21, 0.20, 0.24) MW
ICH(38.47MHz, 3.5U, 3.5L, 4.5U, 4.5L) = P(0.56, 0.56 , 0.63, 0.50) MW

Topic

1. Neutral pressure measurements with robust pressure gauges of the ITER type (U. Wenzel)
2. The application of divertor pumping to long pulse discharge in hydrogen plasmas (G. Motojima)
3. Demonstrated controlled plasma operation for long-pulse plasmas duration with ICRF heating(H. Kasahara)
4. Deuterium retention in damaged tungsten(S. Masuzaki)

Neutral pressure measurements with robust pressure gauges of the ITER type

Shot #: plasma 187253 – 187260 and **calibration** 945014, 017, 019, and 022

Experimental conditions: (*R*ax, *B*t, *γ*, *B*q) = (3.6 m, CW, +2.75 T, 1.254, 100 %)

Heating NBI 2 and 3, W_{dia} = 750 kJ, Variation of the density between 3 and 8e19m-3 steady-state and with a density ramp (187260)

Motivation and objective:

Performance check of the ITER pressure gauge

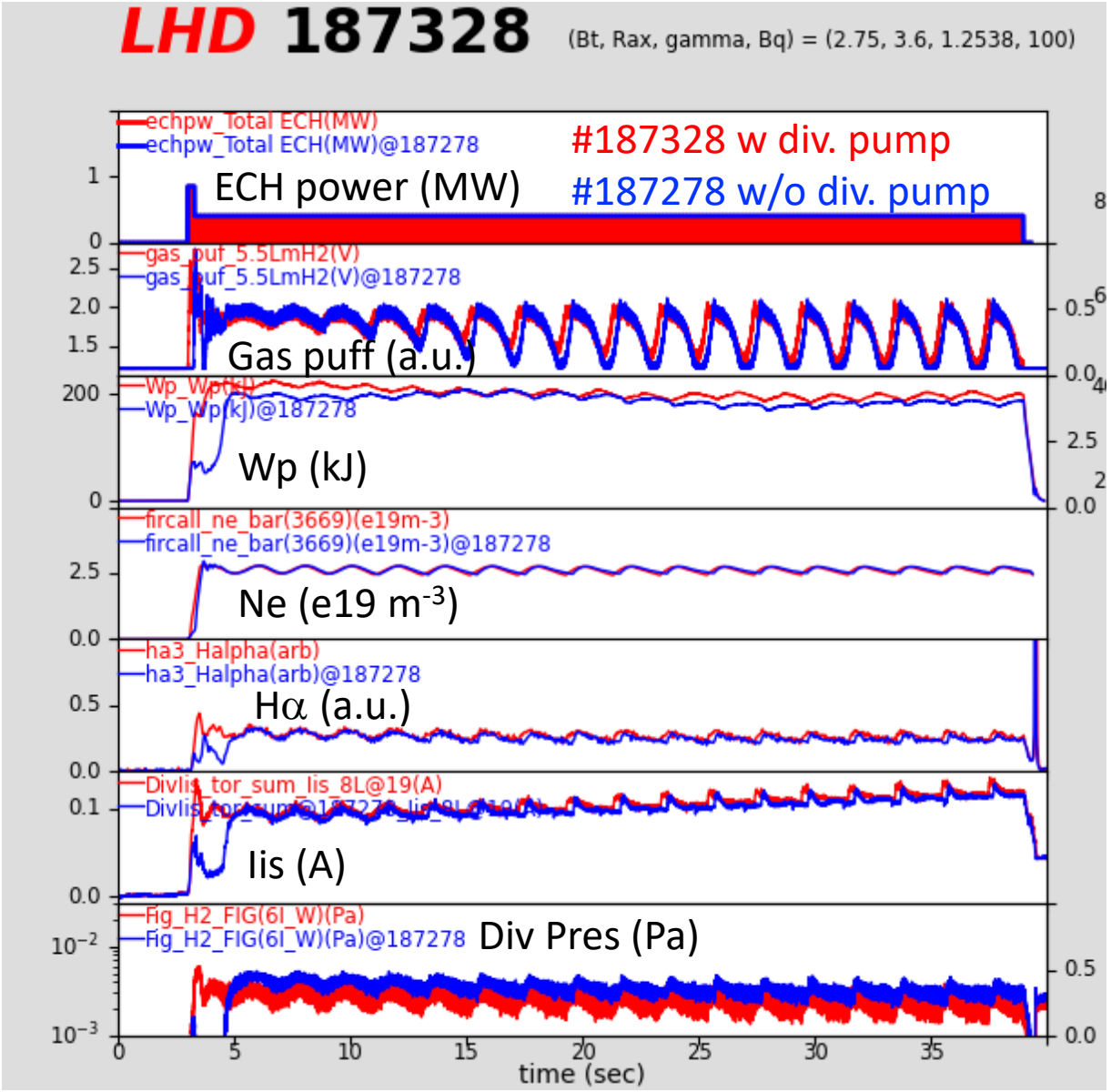
Scaling law of the divertor pressure with density at 750 kJ stored energy

Results:

1) Excellent performance of the ITER pressure gauge was proven
2) High electron current operation with 800 µA was demonstrated. Calibration done for 800 µA.
3) Pressure scaling has significantly changed. Scaling is still now approximately linear. The new scaling law was established after the powder dropping experiments from 2022-12-20 with Boron and Lithium. Details will be shown later.

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

- ✓ #187264-187281: w/o divertor pump (SAES only), #187317-187331: w divertor pump (SAES + Cryo)
- ✓ 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 modulation were used to analyze the particle transport with and without divertor pumping.
  - ❖ Gas puff modulation was successfully conducted.
  - ❖ In the case with divertor pumping, the gas puff timing is faster to create the same density modulation. Divertor pressure is lower with divertor pumping.
  - ❖ Further analysis of particle transport will be carried out in the future.



Demonstrated controlled plasma operation for long-pulse plasmas duration with ICRF heating (H. Kasahara)

Magnetic Configuration(R_{ax}, Polarity, B_t, γ, B_q) , Shots

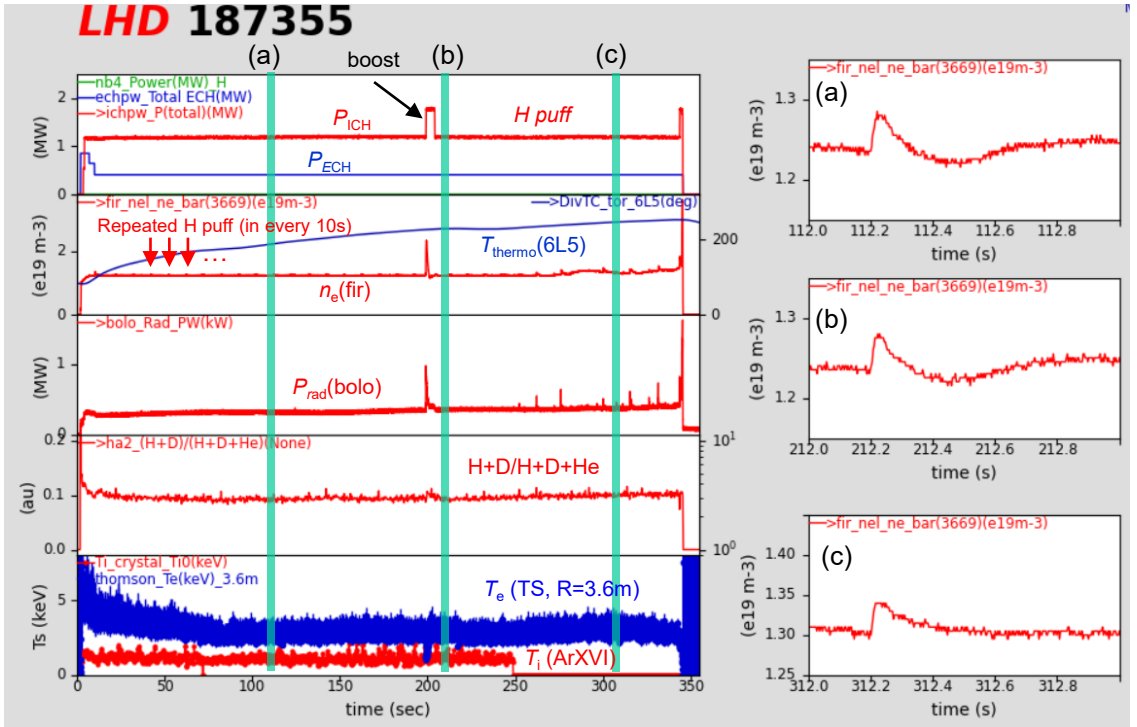
(3.6 m, CW, 2.75 T, 1.2538, 100.0%), #187332-187349
(3.6-3.69 m, CW, 2.75 T, 1.2538, 100.0%), #187350-187358
(3.85 m, CW, 2.66 T, 1.2538, 100.0%), #187359-187364

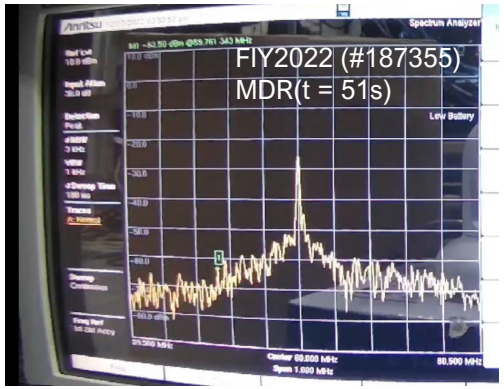
The goal of this experiment:

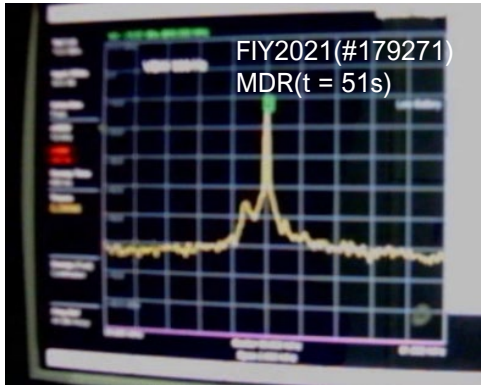
Demonstrating steady-state plasmas in He plasma, revealing long-timescale plasma physics associated with PWI, RF heating, transport, and particle confinement.

Results:

- Demonstrated the long-pulse operation with a duration time of over 300 sec with magnetic axis sweeping, but increased RF heating power limited the plasma durations.
- Steady state divertor detach plasma with a duration time of over 780 sec was demonstrated by controlling the fueling rate for Ne puffing with ECH + ICH.
- In the steady-state discharge experiment a year ago, a specific frequency fluctuation was observed in the microwave doppler reflectometer, but no clear peak was observed in this experiment. Since the magnetic field coordination, heating power, density, etc., are also different; we will investigate the apparent differences and study why they were not observed.







IPD for very long pulse discharges

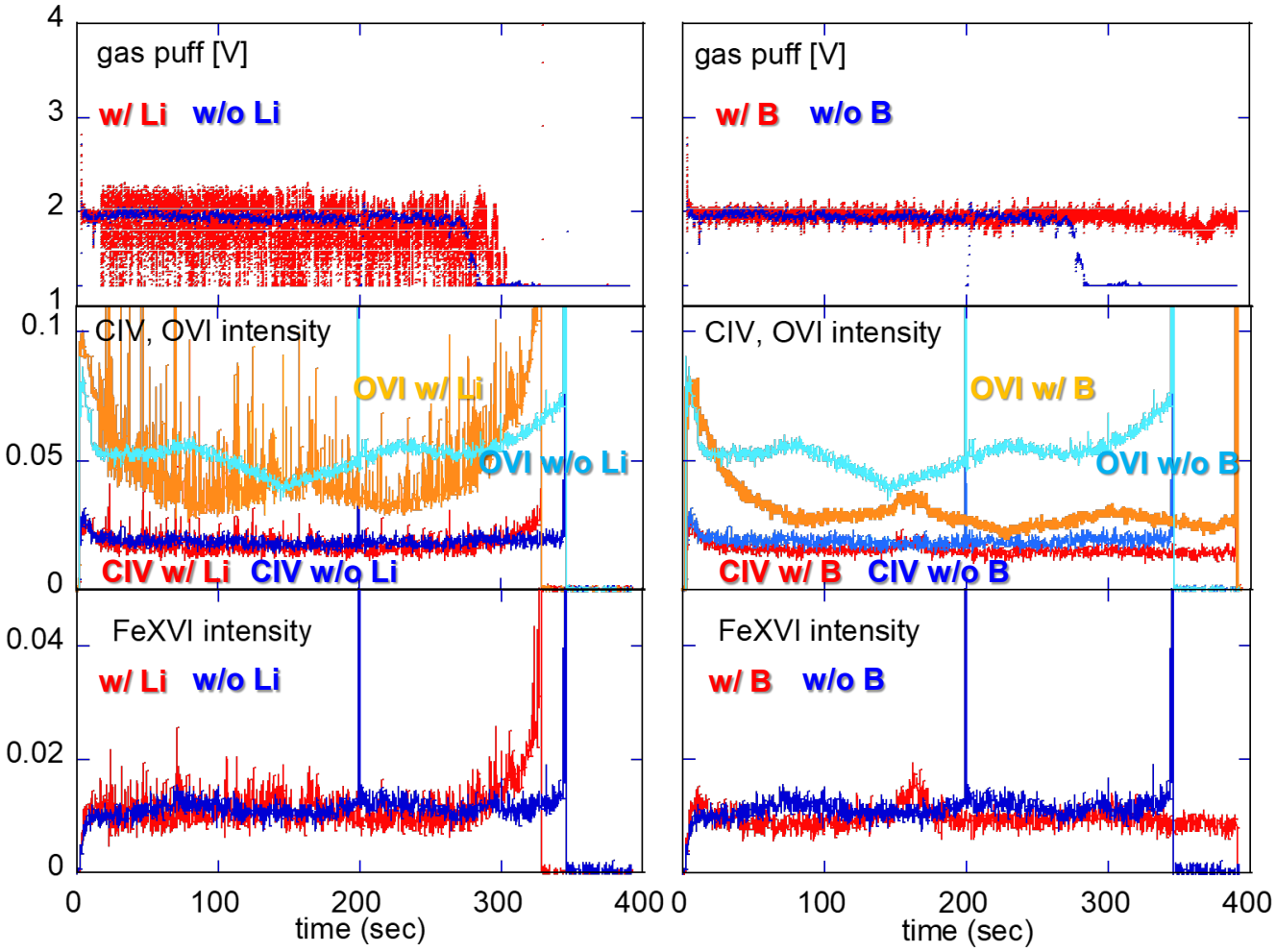
S. Masuzaki

Shot #: 187350 - 187358

(R_{ax} γ, B_q) = (3.65 - 3.69 m Rax scan, 1.2538, 100.0%)

Working gas: He, Powder: B and Li

- B and Li powder dropping were performed during long pulse discharges with the Rax swinging, respectively, for real-time wall conditioning.
- Effect of B and Li powder dropping on recycling was not clearly observed. In the Li case, density perturbation by Li powder possibly caused the large gas-puffing
- Decreases in oxygen and carbon during discharges were observed clearly in the case of B.
- Decrease in iron was not clearly observed.
- The effects in density and temperature profiles were not clearly observed.
- Exploring the dropping amount and the size of powders is still necessary



Ne seeding for very long pulse discharges

S. Masuzaki, M. Kobayashi

Shot #: 187361 - 187364
(R_{ax}, B_t, γ, B_q) = (3.9 m, 2.63T (sub-cooling), 1.2538, 100.0%)
Working gas: He, Seeding gas: Ne

- Ne seeding was performed in long pulse discharges with Rax=3.9m.
- RMP (Icoil=1920A) was applied to form the magnetic island (m/n=1/1).
- Ne gas was supplied by the feedback-controlled gas puffing using the total radiation power.
- The temperature rises of divertor tiles was clearly reduced by the Ne seeding.