Daily Report for 2025-12-19

T. Tokuzawa

Date: December 19, 2025
Time: 10:00 – 18:45
Shot: 199774 – 199929 (156 shots)
Prior wall conditioning: No
Divertor pump: ON
Gas puff: H2, N2 **Pellet**: H2 **IPD**: Li

NBI: #1, #2, #3, #4, #5
ECH: 2-OUR (77GHz), 2-OUL (154GHz), 2-OLL (154GHz)
ICH: 4.5U/L

Topics

1. Investigation of density limit and improved confinement regime in high density regime (K. Tanaka)
2. Demonstration of plasma parameter optimization by the data assimilation control system ASTI with plasma navigation (S. Murakami (Kyoto U.), N. Kenmochi)
3. Advanced turbulence control for achieving high pressure plasma (H. Sakai (QST), K. Tanaka)
4. Experimental measurement of bootstrap current (H. Nuga)
5. Sustainment of divertor detachment by using feedback control impurity seeding (S. Masuzaki)

Density limit and improved confinement in high density regime

K.Tanaka, H. Okuwada （Kyushu Univ.）

Experimental conditions:

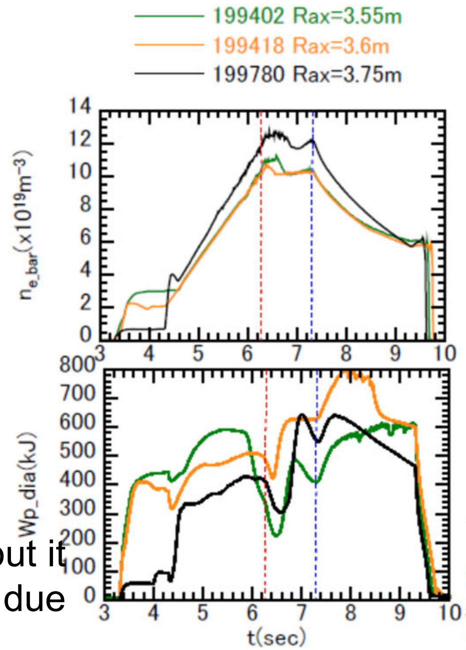
(R_{ax}, Polarity, B_t, γ, B_q) = (3.75 m, CCW, 2.64 T, 1.2538, 100.0%)
#199775- #199797

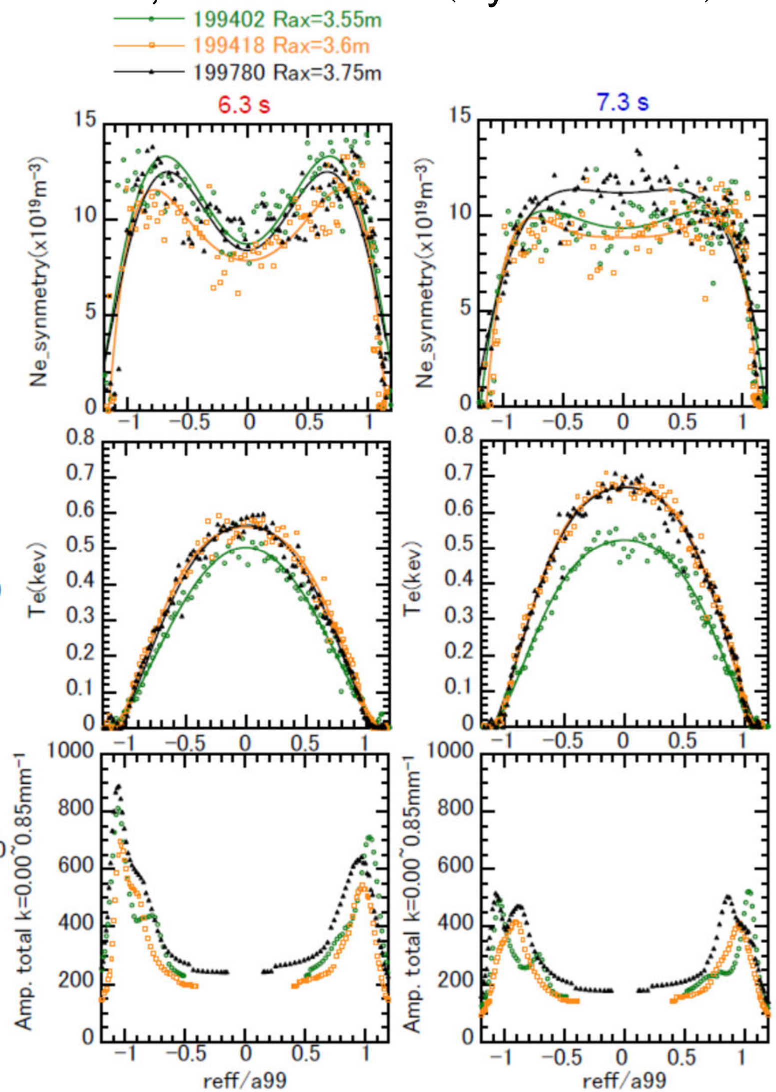
Motivation and method:

- The purpose is understanding of physical mechanism of density limit from the view point of turbulence.
- We observed the density ramping up, remaining constant and decaying after puff-off in order to determine the density limit clearly. Flat top constant density was scanned.
- Density limit should be the maximum controllable density.
- On Dec. 16th, the data was obtained at Rax=3.55 and 3.6m, then the dcata at Rax=3.75m was obtained additionally on Dec. 19th

Results:

- Line averaged density was the highest at Rax=3.75m, but it should be careful to compare the line averaged density due to the difference of thickness of ergodic layer.
- At the end of flat top (t=7.3s), Rax=3.75 shows the highest kinetic energy.
- Turbulence is likely to be RI and reduced from t=6.3s to 7.3s at all configuration. This is likely to be the reduction of resistivity.





Demonstration of plasma parameter optimization by the data assimilation control system ASTI with plasma navigation (S. Murakami, Y. Morishita, N. Kenmochi)

Shot #: 199799-199844

Experimental conditions:

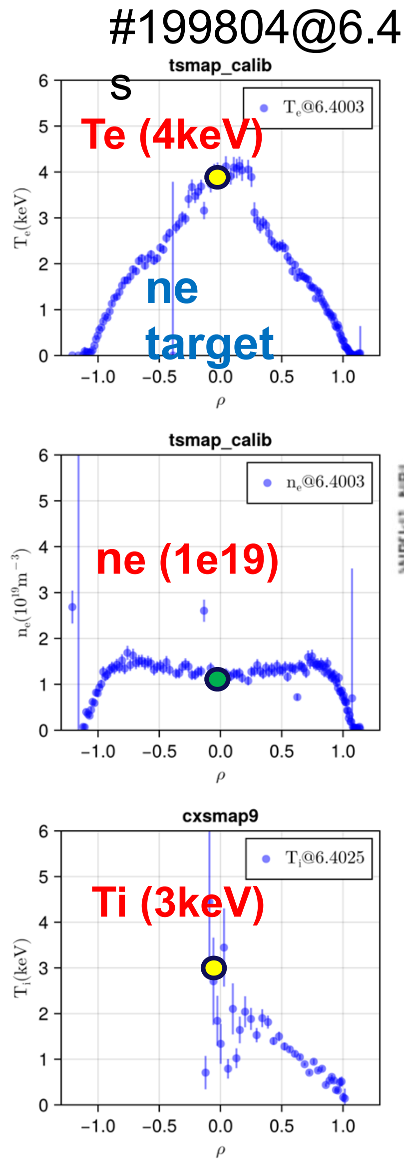
(R_{ax}, Polarity, B_t, γ, B_q) = (3.6 m, CCW, 2.75 T, 1.254, 100 %)

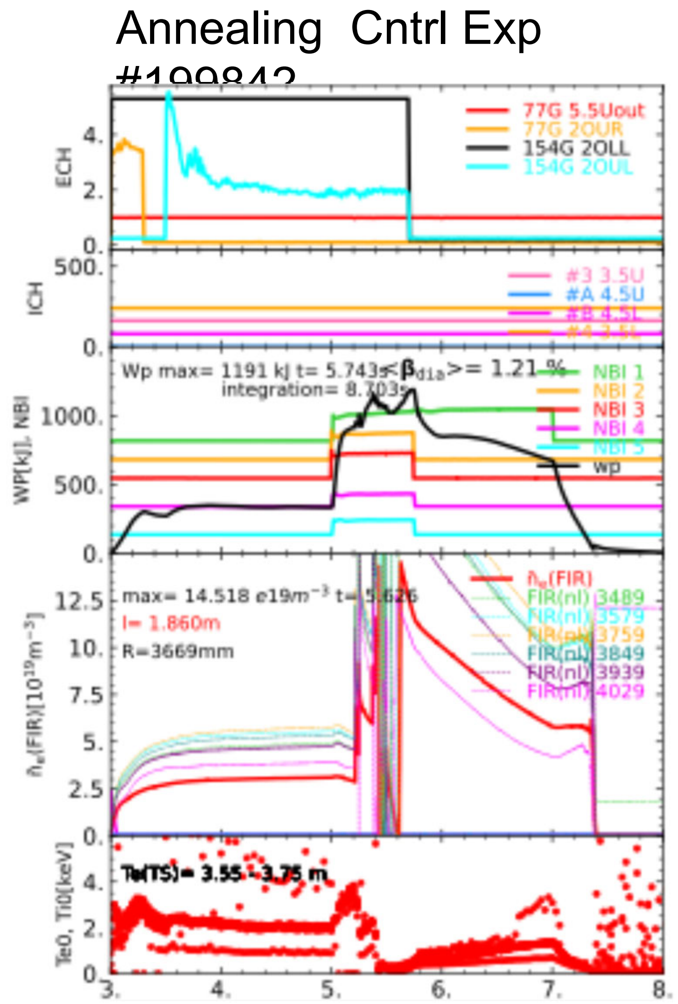
Motivation and objective:

To demonstrate the real-time plasma control and plasma parameter optimization using ASTI running at the new PS@Rokkasho.

Results:

- We conducted control experiments using all available actuators: ECH (#1, 2, 4, 5), NBI (#1–4), and pulsed gas puff, to control the electron density, electron temperature, and ion temperature.
- We successfully demonstrated the control. The figures show representative examples of the results.
- We conducted an experiment using ASTI for shot-by-shot fusion triple-product optimization.
- Using Thomson measurement data of the previous shot, we estimated the timing for turning off NBI heating to maximize the triple-product via annealing.
- The results are currently under analysis.





Advanced turbulence control for achieving high-pressure plasma

H. Sakai (QST)

Experimental conditions:

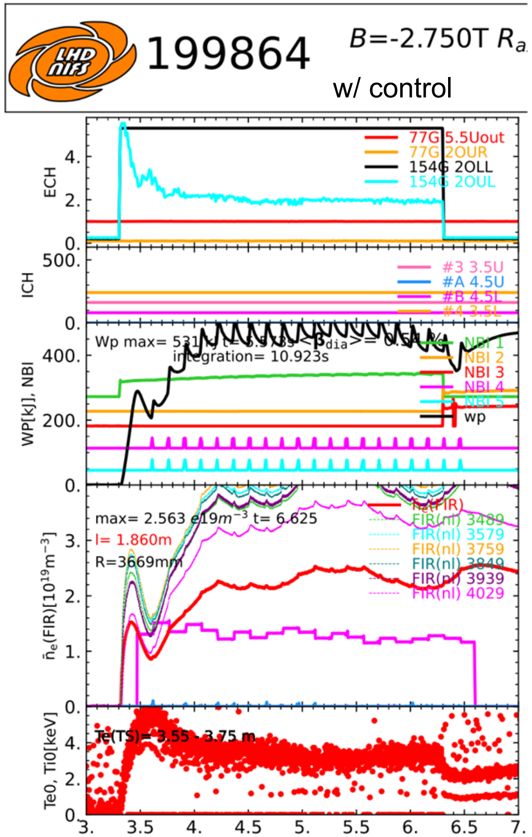
(R_{ax}, Polarity, B_t, γ, B_q) = (3.6 m, CCW, 2.75 T, 1.2538, 100.0%)
#199846 – #199877

Motivation and method:

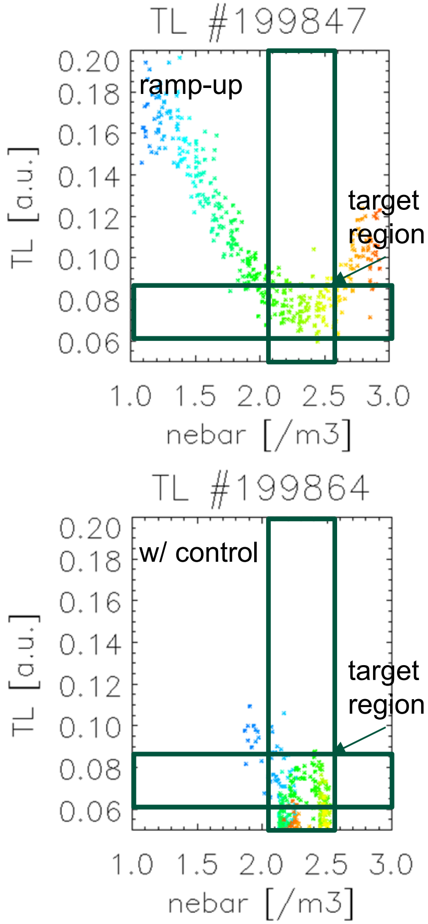
- Previous control scheme is based on turbulence transition curve, but new scheme is not based on it for more general control. New one focus on different plasma response using PNB blip injection.
- A new turbulence control scheme using gas-puff and ECH was verified in long pulse discharge.

Results:

- New turbulence control scheme was worked as programmed.
- Off-axis ECH using #2 was also performed but turbulence control was not converged (control failure).
- In the case of using only gas fueling control as shown in lower right figure, the control was converged around target. The target was not given in this scheme.
- Future task is confirmation of improvement of plasma confinement with turbulence control.



TL: turbulence level ($\widetilde{n_e}/\overline{n_e}$)



Experimental measurement of bootstrap current (H.Nuga)

Shot #:199878-199906 (ECH extension till 199895)

Experimental conditions:

(R_{ax}, Polarity, B_t, γ, B_q) = (3.6, CCW, 2.75, 1.2538, 100)

Background and motivation:

- Although the plasma current consists of several components, bootstrap, beam-driven, RF-driven, and inductive currents, only net current is measurable.
- This experiment aims to measure only bootstrap current to confirm the simulation model (no NBCD, no ECCD).
- To achieve no-inductive current, long pulse discharge is necessary (~30s).
- The difference from the previous experiment (11/04) is polarity.

Summary:

- Density scan (collisionality scan) was performed.
- The difference in ne dependence on Ip appears.
- The contribution of ECCD, plasma profile, & polarity must be investigated.

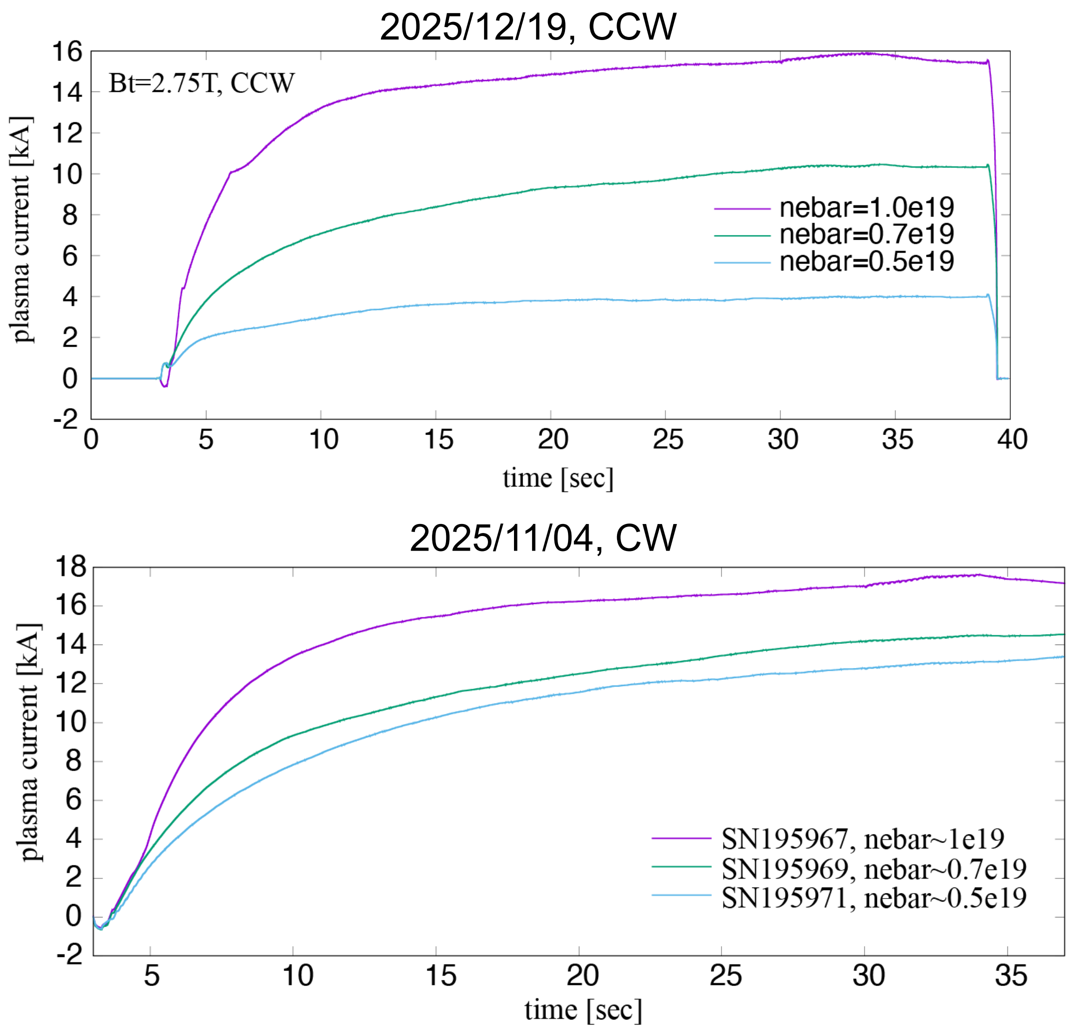


Fig.1: Time evolution of Ip

Sustainment of divertor detachment by using feedback control impurity seeding

S. Masuzaki

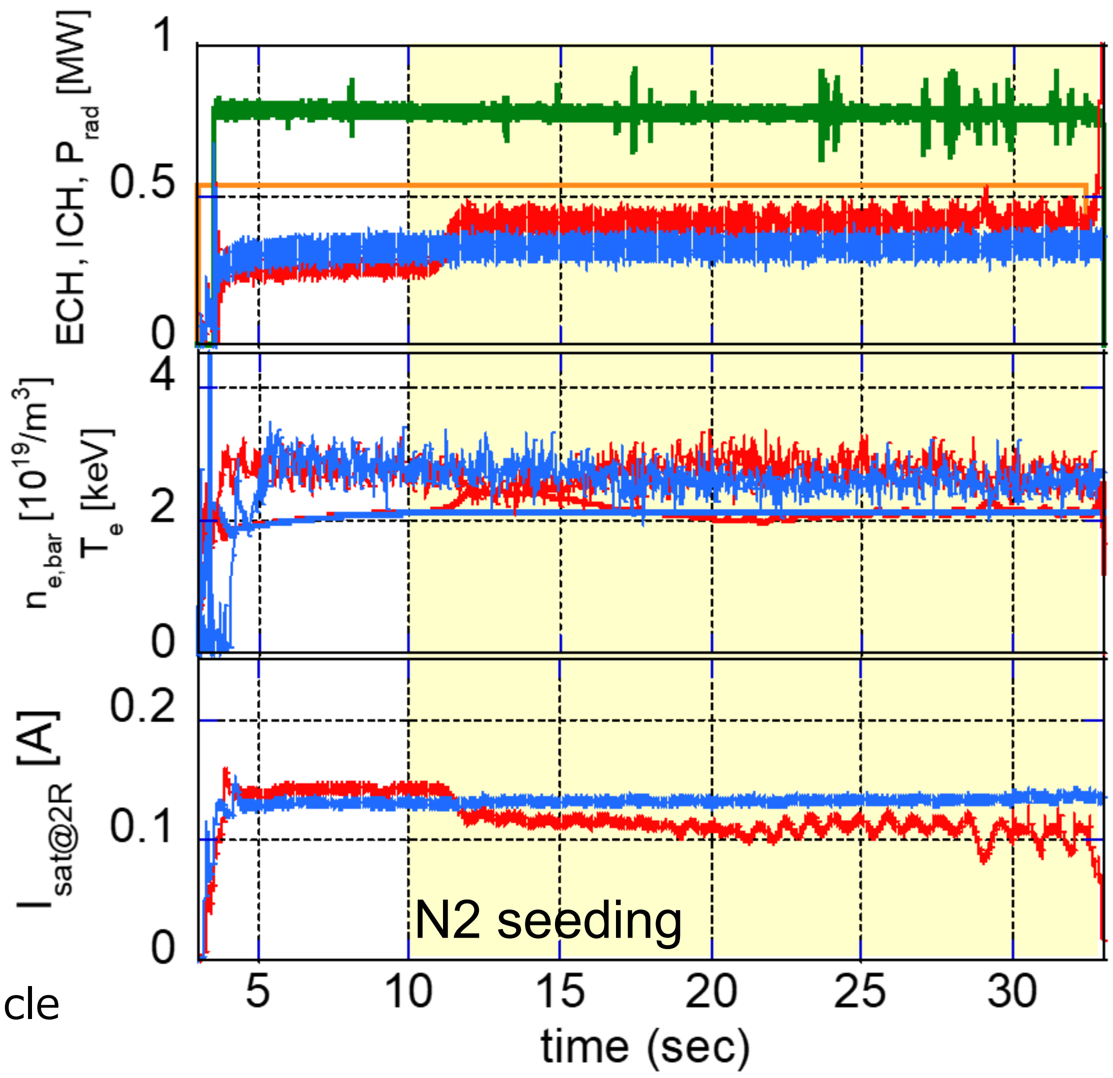
Shot #: 199907 – 199929
(R_{ax}, B_t, γ, B_q) = (3.6 m, -2.75 T, 1.2538, 100.0%)
Working gas: He, Impurity gas: N2, IPD: B, Li
P_{ECH}∼0.5 MW, P_{ICH}~ 0.8 MW, pulse length: 37s

Background and Purpose

- The reduction of divertor heat and particle loads is very important to sustain long pulse discharge.
- In LHD, the heating power for long pulse operation is much smaller than in short pulse operation.
- To sustain reduced divertor heat and particle loads in the low heating power condition, N2 seeding was examined.
- For the toroidal asymmetry of the reduction of divertor heat and particle loads, N2 was seeded from two locations.

Result

- The N2 seeding increased P_{rad} and decreased divertor particle flux for longer than 20 s.
- Boron and Li powder drops were examined, respectively. It was observed that the larger perturbation of Prad caused by Li drop caused radiation collapse during the detachment operation.



Typical time evolutions of w/ and w/o N2 seeding.
#199925 (w/ B), 199913 (w/o B)