(TG2) Turbulence Topical Group Report

Dec. 9, 2022 (T. Kobayashi)

Date: Dec. 8, 2022
Time: 9:30 - 18:45
Shot#: 185414 – 185576 (163 shots)

Prior wall conditioning: NO
Divertor pump: YES
Gas puff: H2 Pellet: NO
NBI#(1, 2, 3, 4, 5)=gas(H, H, H, H, H)=P(2.9, 4.0, 3.6, 4.4, 3.7)MW

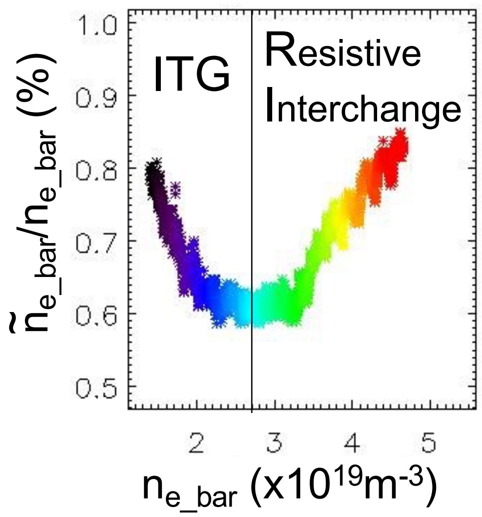
ECH(77GHz)=ant(5.5-Uout (or 1.5U), 2-OUR)=P(703, -)kW
ECH(154GHz)=ant(2-OLL, 2-OUL , 2-OLR)=P(723, 729, 825)kW
ECH(56GHz)=ant(1.5U)=P(-)kW
ICH(3.5U, 3.5L, 4.5U, 4.5L)=P(0.86, 0.80, 0.80, 0.78)MW
Neutron yield integrated over the experiment = $6.4\text{x}10^{13}$

Topics

1. Plasma control using turbulence level (H. Sakai (Kyushu Univ.), K. Tanaka, T. Kinoshita)
2. Investigation of isotope effect on high-T_i plasma (H. Sakai (Kyushu Univ.), K. Tanaka, T. Kinoshita)
3. Turbulence stabilization by fast ions (D. Moseev and H. Kasahara)
4. 5D-velocity space tomography for fast ions (M. Nishiura, N. Kenmochi, R. Yanai, G. Mingzheng)
5. Study of nonlinear interaction between multiple-scale fluctuations (C. Moon)
6. Density limit in relation to edge turbulence (G. Motojima, K. Ida, T. Tokuzawa, K. Tanaka, P. Diamond, G. Tynan)

Plasma control using turbulence level (H. Sakai (Kyushu Univ.), K. Tanaka, T. Kinoshita)

Shot No: #185416~185466 (51 shots)
Experimental conditions: (R_{ax}, Polarity, B_t, γ, B_q) = (3.6 m, CCW, 2.75 T, 1.2538, 100 %)
Gas-puff: H_2

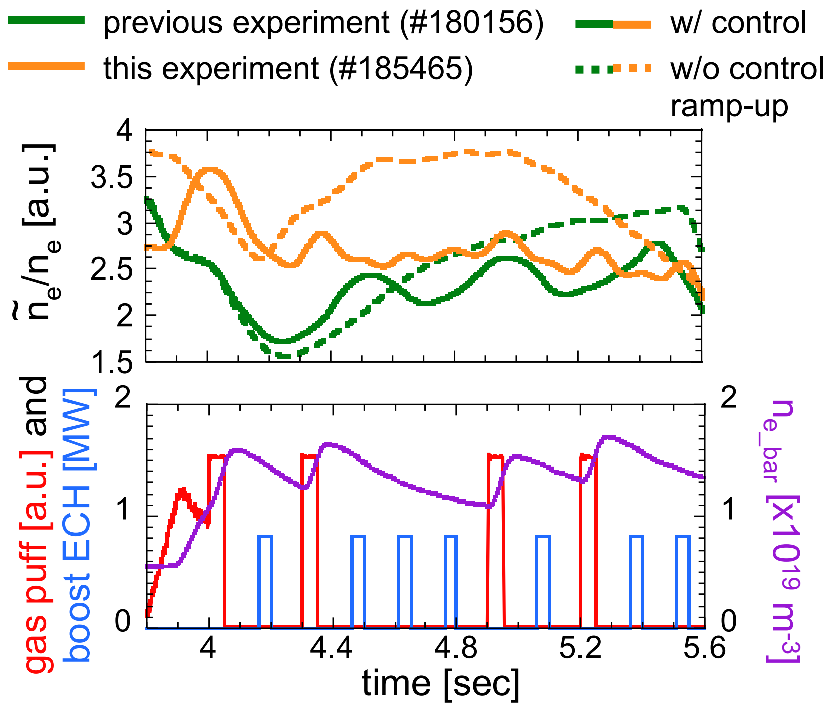


Motivation

When the electron density is increased, a bottom appears in the turbulence level due to the turbulence transition. (by Kinoshita-san)
→Experiments to control turbulence level to the bottom have been conducted with several times.
Overshoot was a problem in the previous experiment and needed to be improved.

Approach

Electron density and turbulence level are used instead of differentiated signal in previous experiments.
The response from plasma is reformed to logic signal (0 or 1) and feedback control was conducted by using this signal.



Results

- ✓ Turbulence level remains relatively constant.
- ✓ The overshoot is smaller than that in the previous experiment.

In final trial, more improvements will be applied and we will challenge experiment to change the heating during the control.

☆We sincerely appreciate Nagahara-san.

Investigation of isotope effect on high-T_i plasma

(H. Sakai (Kyushu Univ.), K. Tanaka, T. Kinoshita)

Motivation

"Investigation of isotope effects with ion heating"
In Nagaoka et al, NF2019, lower χi in D plasma than in H plasma was reported adjusting ion heating power. However, electron heating power was not adjusted and there are uncertainties of NB deposition power (P_{dep})with different ion species (H or D) due to the different fast ion orbit. Being free from the uncertainty of P_{dep}, experiments were performed by using H beam both for D rich and H rich. Precise investigation of isotope effects with ion heating can be possible.

Results

- ✓ Both PNB and NNB power were adjusted under identical density→P_{dep} will be identical.
- ✓ D/(H+D) was 0.75 in D rich plasma (180178 on 2022/10/12) and was 0.2 in H rich plasma (185426 on 2022/12/8).
- ✓ Turbulence amplitude, ne, Te, Ti profiles were almost identical in H and D plasma.
- ✓ k_{perp} is slightly lower in D plasma →kρ_i~const in ITG,
- ✓ NB power scan (1MW step) was performed. This will be good database for the analyses of ion stiffness

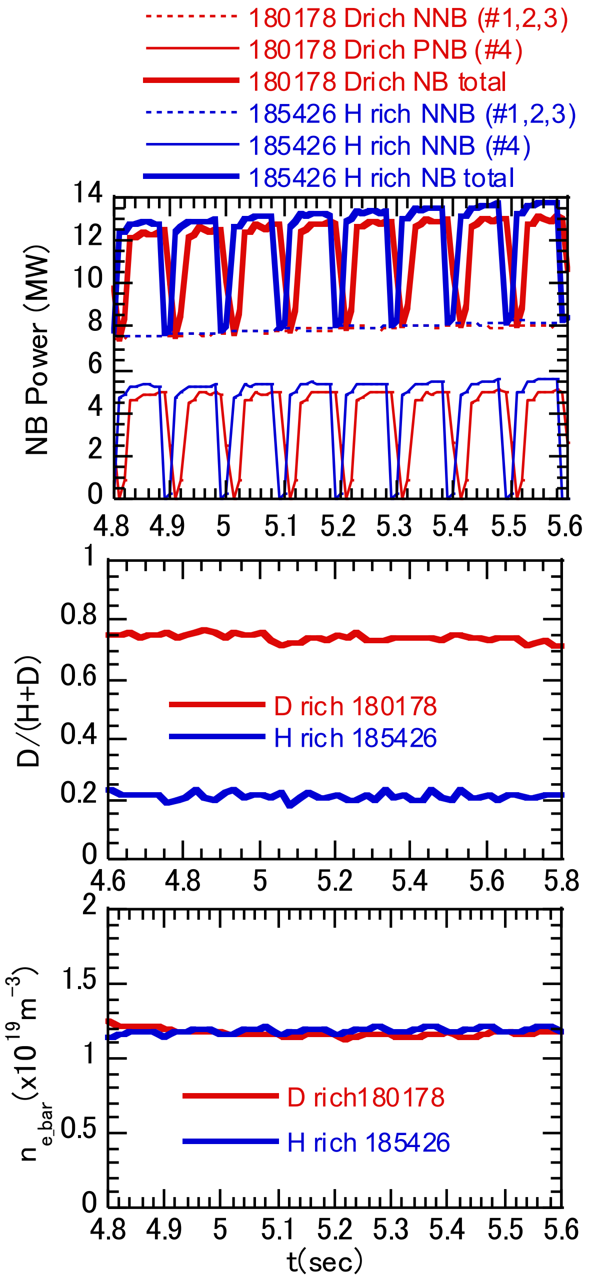


Fig.1 Comparison of time trace in D rich and H rich plasma. All NBs are H beam

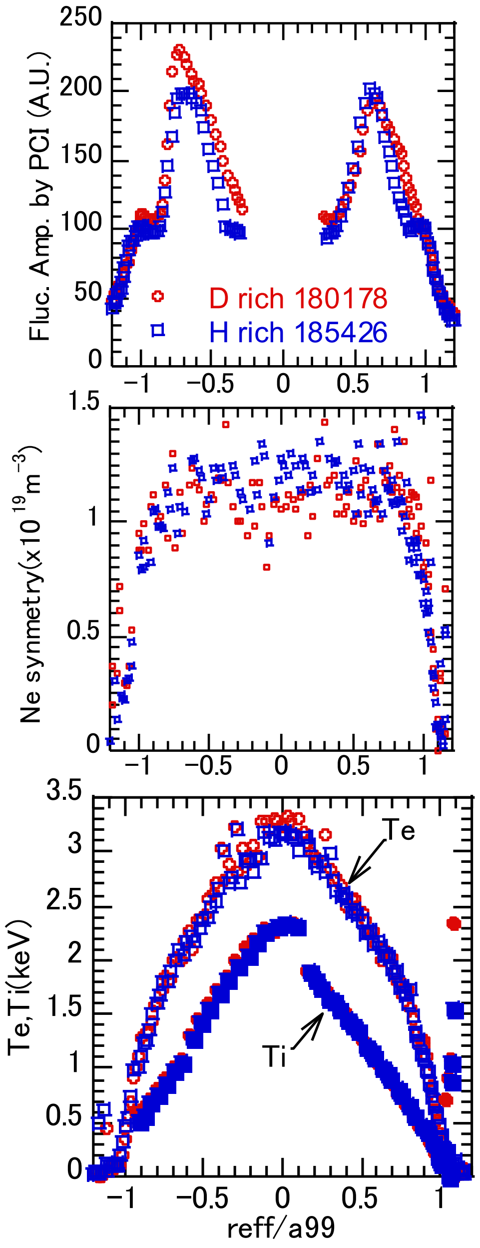


Fig.2 Comparison of profiles in D rich and H rich plasma

Turbulence stabilization by fast ions (D. Moseev and H. Kasahara)

Shot #: 185467 - 185486

Experimental conditions: (R_{ax}, Polarity, B_t, γ, B_q) = (3.6 m, CCW, 2.75 T, 1.2538, 100 %)

Motivation and objective: Demonstrate stabilization of ITG by ICRF-generated fast ions

Results:

- Shots 185467 – 185472: machine conditioning for He operation
- Shots 185473 – 185486: physics program

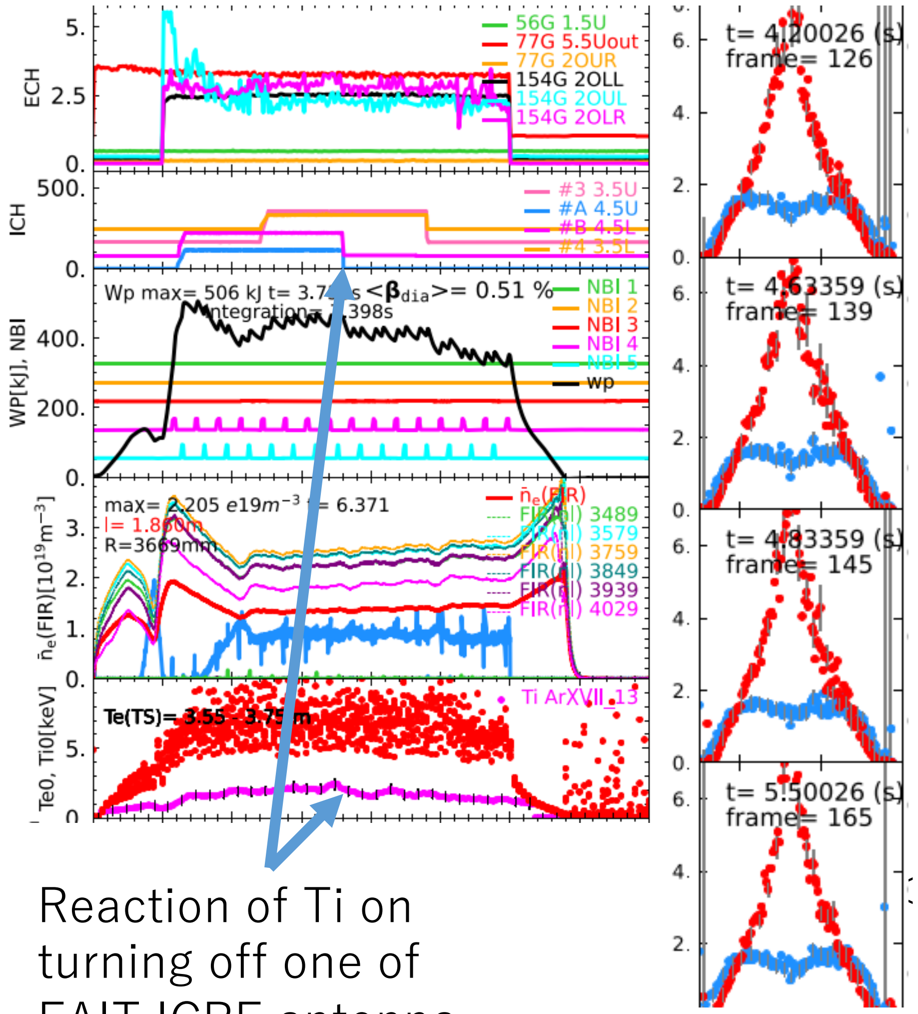
- He plasma, NBI is a source of hydrogen for the minority heating.
- NBI4 and NBI5 were operated at half power in blips with different duty cycle: 20 ms on/180 off, 20 ms on/140 off, 20 ms on/100 off and 20 ms on/60 off

Turbulence stabilization by fast ions (D. Moseev and H. Kasahara)

 # 185481

NBI4: 20 on/140 off; NBI5 20 on/140 off, 4 gyrotrons

$<P_{heating}>$= 7 MW

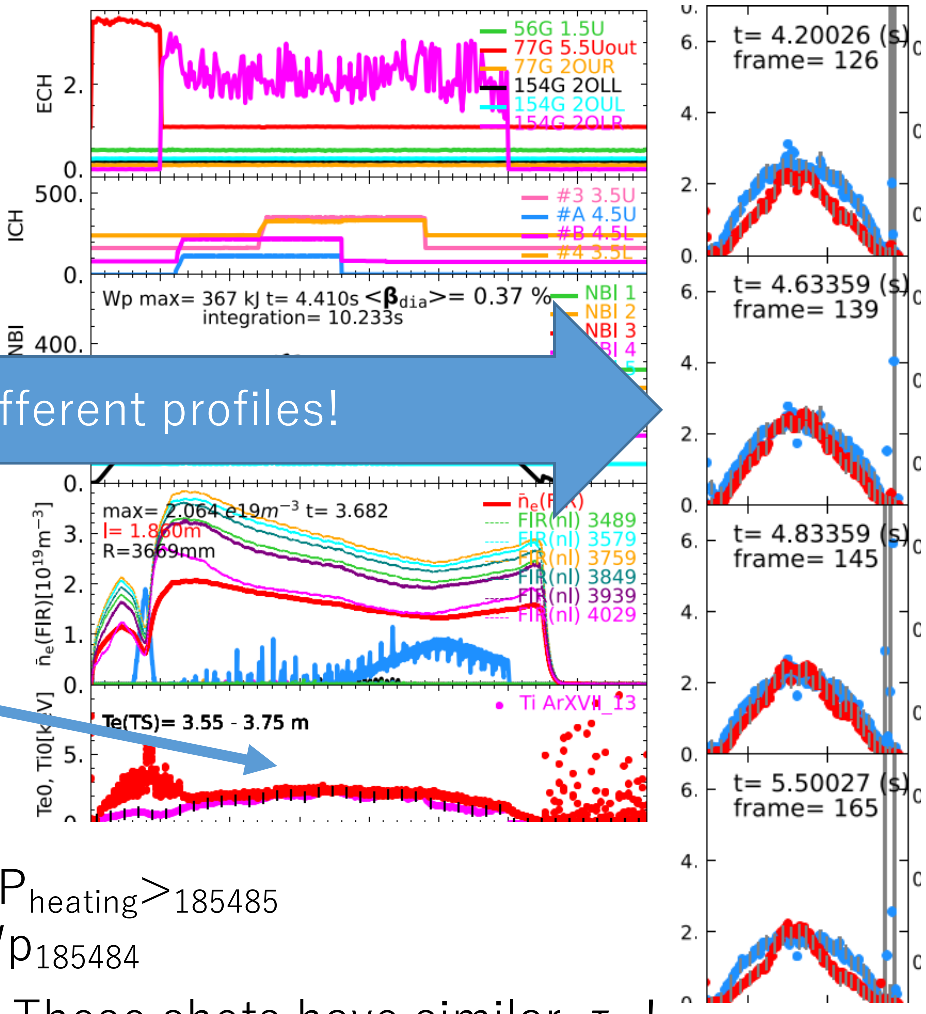


Reaction of Ti on turning off one of FAIT ICRF antenna

#185484

NBI4: 20 on/140 off; NBI5 20 on/20 off, 1 gyrotron

$<P_{heating}>$= 5.7 MW



Very different profiles!

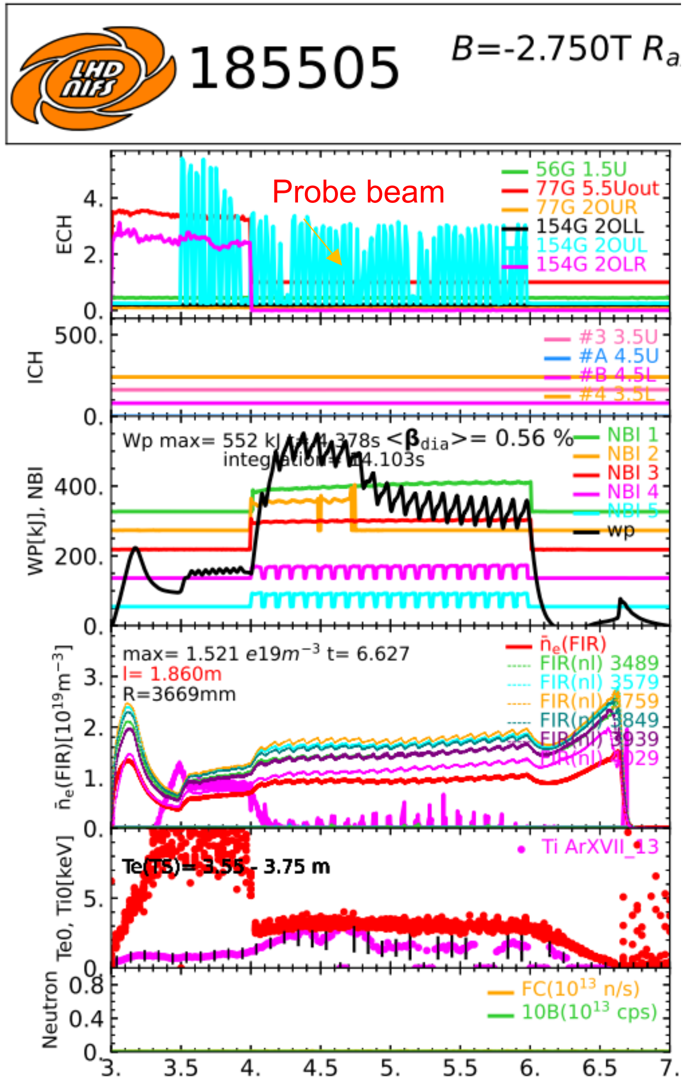
$T_e = T_i$

$<P_{heating}>_{185481} = 1.35x<P_{heating}>_{185485}$

$Wp_{185481} = 1.39xWp_{185484}$

$\tau_E \propto 1/\sqrt{P}$ These shots have similar τ_E!

5D-velocity space tomography for fast ions (M. Nishiura, N. Kenmochi, R. Yanai, G. Mingzheng)

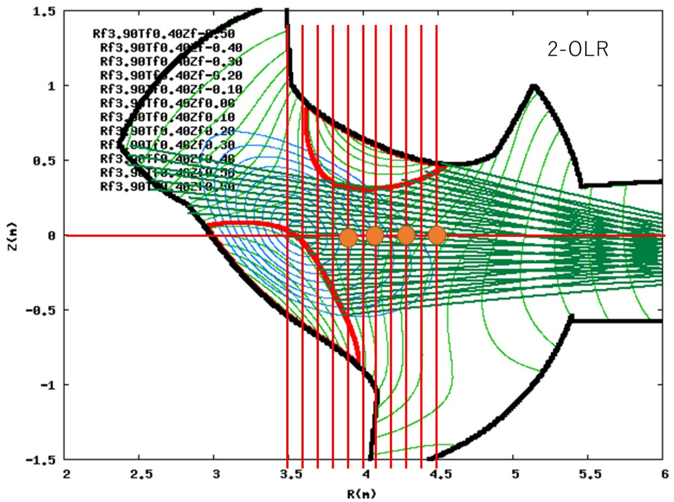


Experimental conditions: (R_{ax}, B_t) = (3.6 m, 2.75, CCW), γ = 1.2538, and B_q = 100 %, #185487-507

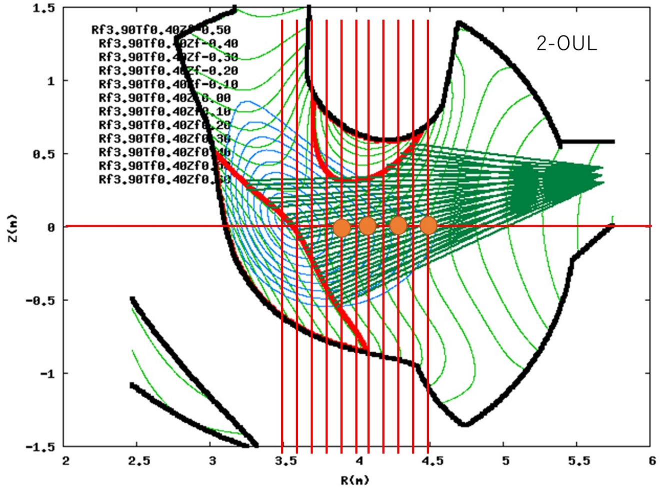
Motivation and objective: Fast ions are measured by CTS. Those data are combined for a tomographic inversion to reconstruct bulk and fast ion distribution on the velocity space. Two probe beams are first trial.

Results:

- ➢ We have measured the fast ions and their spatial profiles in hydrogen plasmas with energetic-ion-driven resistive interchange mode (EIC).
- ➢ Two probe beams (2-OUL#5 and 2-OLR#7) was modulated to subtract the ECE background. The CTS spectra were measured at several radial locations from 2-OLL.
- ➢ This was a first trial to use 154GHz CTS system. The ECE level(2nd X-mode) was too high to detect a CTS spectrum. → If we have a chance, the half magnetic field Bt=1.375T reduces an ECE level.



Probe beam #7 for CTS



Probe beam #5 for CTS

Study of nonlinear interaction between multiple-scale fluctuations (C. Moon)

Shot #: 185511 - 185528

Experimental conditions: (R_{ax}, Polarity, B_t, γ, B_q) = (3.9 m, CCW, -2.538 T, 1.2538, 100 %)

Motivation and objective

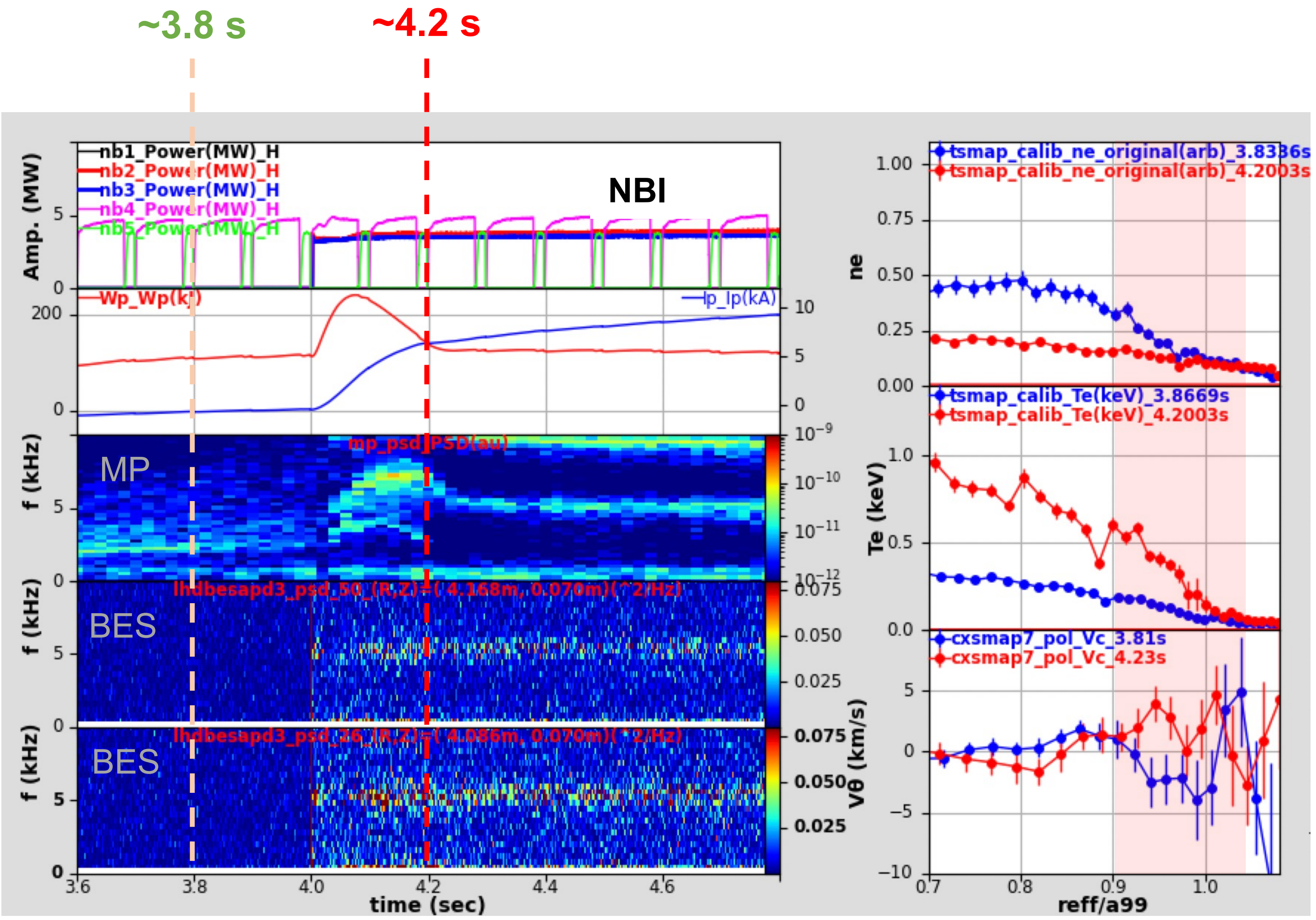
- Investigation of the nonlinear dynamics of low-frequency fluctuations ($f \simeq 2$ kHz), which are excited in a transition of the poloidal flow velocity (V_θ).

Results

- The plasma density scan was performed with n_e = 1.3 - 3.1 (interval 0.3) x 10^{19} m^{-3} .

- The transition of poloidal flow velocity (V_θ) were successfully observed in edge plasmas.

- Data from a 9-O BES lines of sight and a fast poloidal CXS were newly obtained.



Density limit in relation to edge turbulence

G. Motojima, K. Ida, T. Tokuzawa, K. Tanaka, P. Diamond, G. Tynan

#185529-185559 R_{ax}=3.75m, B=-2.64T, g=1.254, Bq=100%
#185560-185576 R_{ax}=3.55m, B=-2.789T, g=1.254, Bq=100%

✓ Motivation

- ❖ We focused on the behavior of edge turbulence at density collapse event.
- ❖ Heating power of t-NBI (#1, #1+#2, #1+#2+#3) was scanned from 3MW to 10.7MW. Different magnetic configurations were selected than on 2 November.

✓ Results

- ❖ We observed many collapse events in different NBI heating power and R_{ax} configurations.

Findings

- ❖ Neutral pressure in the divertor region (6I) was found to decrease before the collapse event occurred. This trend seems to correlate with the plasma effective minor radius (r_{eff}). This indicates that the plasma is shrinking before the collapse.
- ❖ On the other hand, PCI shows $\tilde{n}$ increases with time in the collapsed phase. Is there a relationship between plasma shrinking and density oscillation?
- ❖ We accumulated the experimental data not only PCI and DBS but also CO2 interferometer, CXS (polidal flow), Divertor probe (fixed bias), BES. Further analysis will be conducted.

R=3.75m, #185548