(TG2) Turbulence Topical Group Report

Nov. 1, 2022 (M. Nishiura)

Date: Oct. 28, 2022
Time: 9:50-18:45
Shot#: 181863-182031
Prior wall conditioning: NO
Divertor pump: OFF
Gas puff: H2, D2, He, Ar
Pellet: D, C
NBI#(1, 2, 3, 4, 5)=gas(H, H, H, D, D)=P(3.2, 3.7, 3.2, 5.9, 7.1)MW
ECH(77GHz)=ant(5.5-Uout (or 1.5U), 2-OUR)=P(0.703, 0.792)MW
ECH(154GHz)=ant(2-OLL, 2-OUL, 2-OLR)=P(0.723, 0.799, 0.825)MW
ECH(56GHz)=ant(1.5U)=P(-)MW
ICH(3.5U, 3.5L, 4.5U, 4.5L)=P(-,-,-,-)MW
Neutron yield integrated over the experiment = 4.4×10^{16}

Topics

1. Investigation of cross-scale coupling / behavior between electron scale and ion-scale turbulence(T. Nasu)
2. Enhanced control of turbulence-driven zonal flow with eta-i control(T. Nasu)
3. Study of electron temperature fluctuation behavior in e-ITB plasmas(R. Yanai, M. Gong)
4. Feedback control using turbulence level(H. Sakai)

Investigation of cross-scale coupling between electron scale and ion-scale turbulence

(T. Nasu, T. Tokuzawa, M. Nakata)

Shot #: 181865 - 181921

Experimental conditions: (R_{ax}, Polarity, B_t, γ, B_q) = (3.55 m, CW, 2.789 T, 1.2538, 100 %)

Motivation and objective: To investigate cross-scale coupling or behavior between electron and ion-scale turbulence. Especially, we aimed to observe coupling between ITG turbulence and ETG turbulence.

Results:

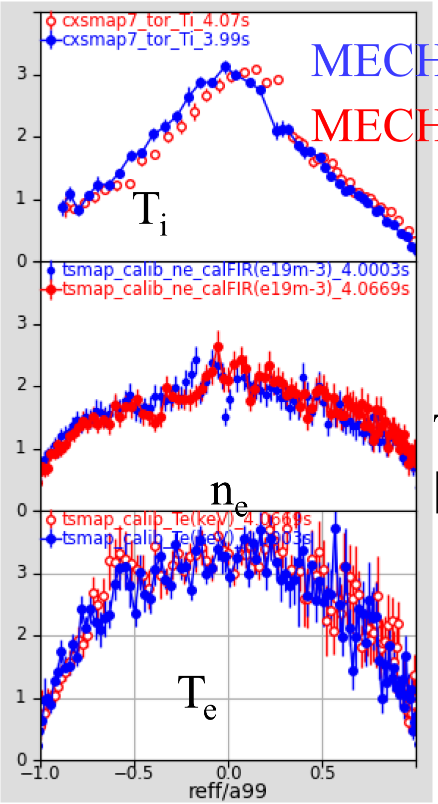
- Perpendicular and tangential NBIs are used for generating ITG turbulence dominated plasma. Then, Modulation ECH was added to drive and stabilize ETG turbulence in this plasma.
- An antenna of Backscattering system, which used for observing electron-scale turbulence, was scanned shot-by-shot in order to observe same positions with DBS system, for ion-scale turbulence.
- T_e/T_i was scanned by on-axis ECH injection.

➢ T_e profile was changed by MECH.

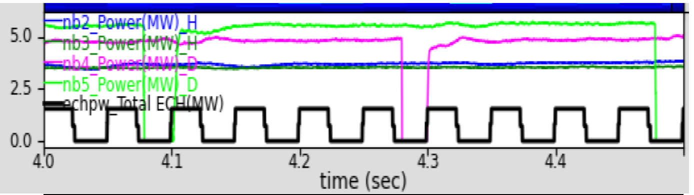
➢ Electron-scale and ion-scale turbulences were observed simultaneously at ρ~0.6, where ∇T_e will be the largest. However, the change was not responded to the T_e modulation.

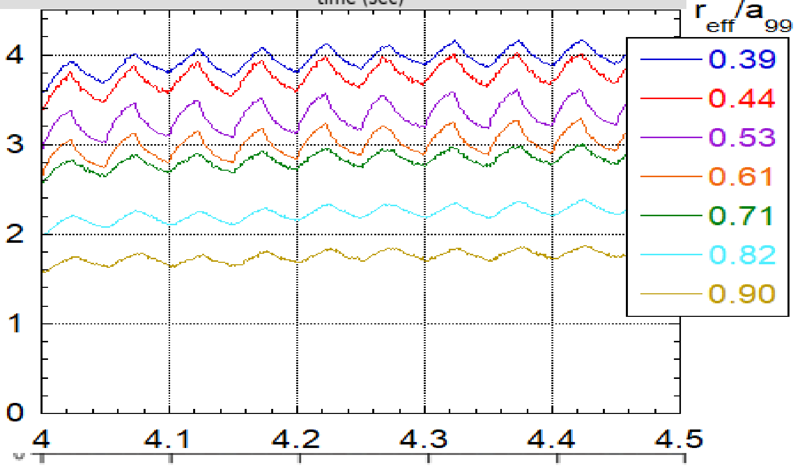
➢ We will investigate data of the other positions or the other conditions.

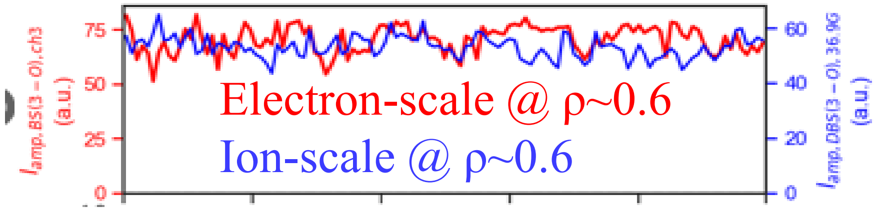
Off-axis MECH @ ρ=0.4



#181888 nb2 nb3 nb4 nb5 ECH







30-150 kHz

Enhanced control of turbulence-driven zonal flow with eta-i control

(T. Nasu, T. Tokuzawa, D. Carraleo(CIEMAT))

Shot #: 181925 - 181970

Experimental conditions: (R_{ax}, Polarity, B_t, γ, B_q) = (3.55 m, CW, 2.789 T, 1.2538, 100 %)

(R_{ax}, Polarity, B_t, γ, B_q) = (3.6 m, CW, 2.75 T, 1.2538, 100 %)

Motivation and objective: To investigate high-T_i mechanism from a view point of relation between zonal flow and ITG turbulence. We controlled ∇n_e to control eta-i and then to destabilize ITG turbulence and zonal flow. Moreover, we aimed to observe zonal flow by measuring long range correlation of slowly oscillated ExB flow by DBS system.

Results:

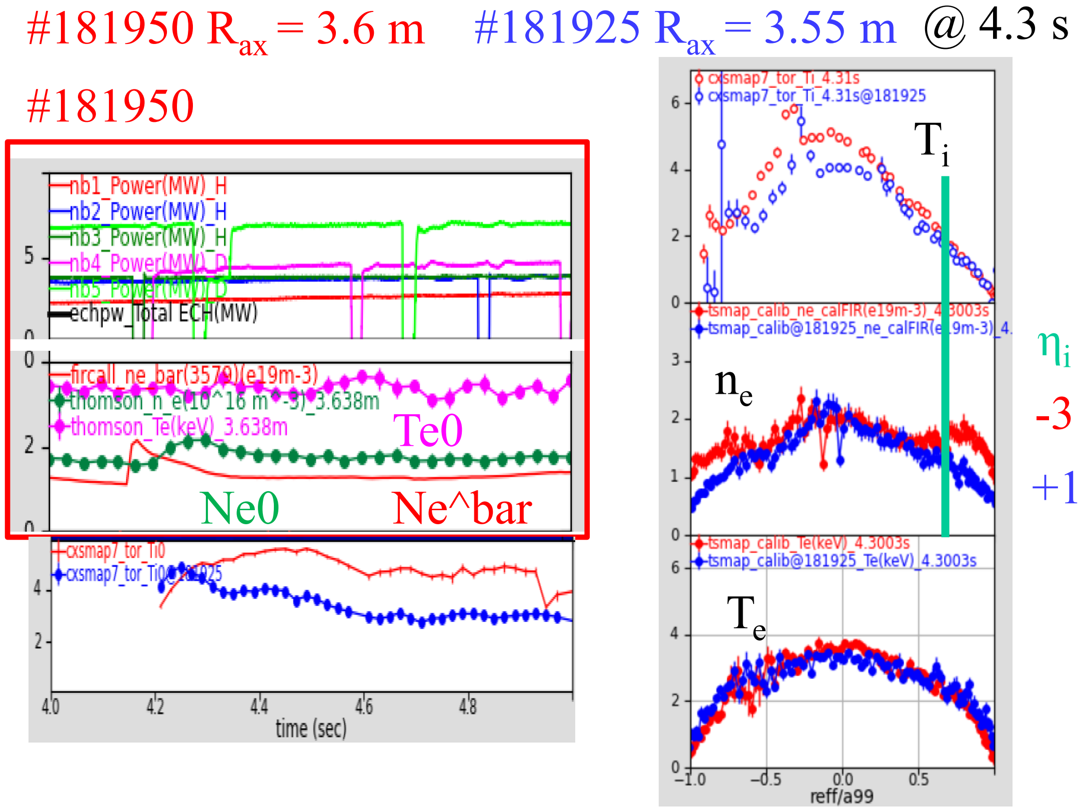
- Standard high-T_i discharge in LHD was carried out using perpendicular NBIs, tangential NBIs, and C pellet.
- To scan ∇n_e, we controlled the number of injected NBIs, on-axis ECH, and magnetic configuration and used gas puff, SSGP, and D pellet.
- TESPEL was used at 4.35 s for driving perturbations.

➢ Center peaking n_e profile was gotten when B_t = 2.75 T at R_{ax} = 3.55 m (red), and n_e profile having three peaks was gotten by changing R_{ax} to 3.6 m and B_t to 2.75 T (blue) while hardly changing T_e profile.

➢ As a result, T_i became higher at 4.3 s by changing R_{ax} to 3.6m. We attained different eta-is of -3 and +1 at that time.

➢ Additionally, High T_i was maintained in cases of R_{ax} = 3.6 m longer than cases of R_{ax} = 3.55 m.

➢ We will investigate turbulence and flow behavior of these data sets.



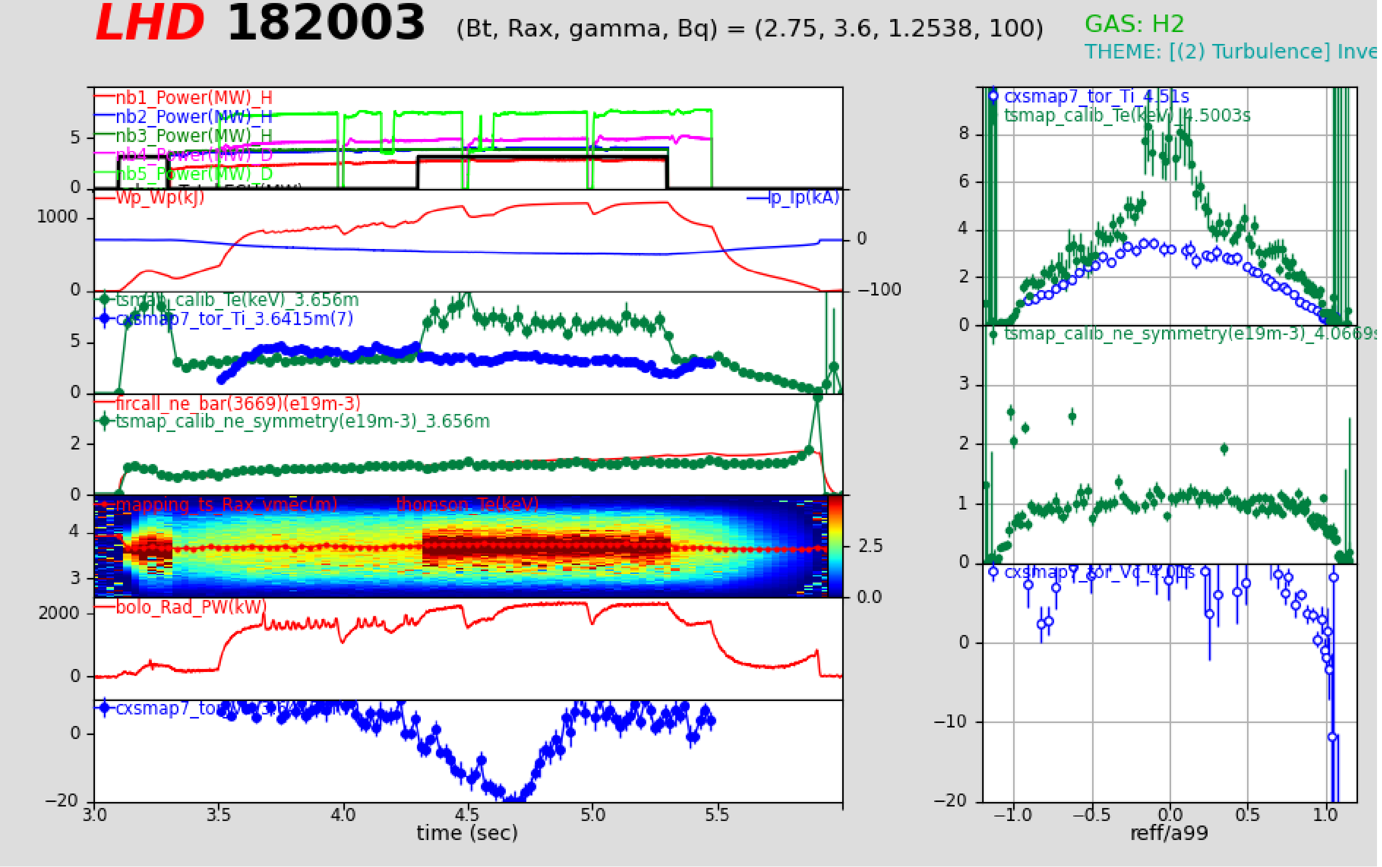
Investigation of Te fluctuations in e-ITB plasma (R. Yanai, M. Gong(UT), M. Nishiura, T. Tokuzawa)

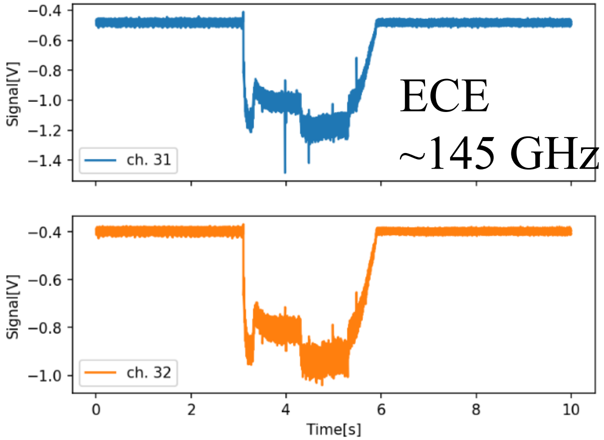
Shot #: 181972 – 182005

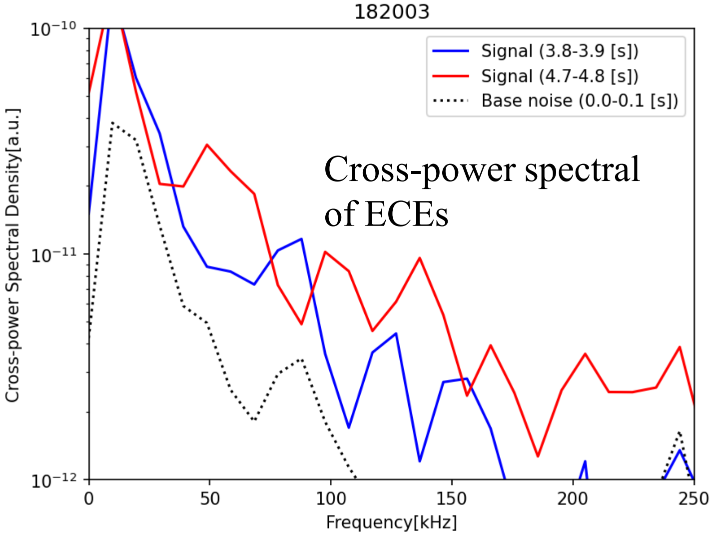
Experimental conditions: (R_{ax}, Polarity, B_t, γ, B_q) = (3.6 m, CW, 2.75 T, 1.2538, 100 %)

Motivation and objective: To investigate the characteristics of Te fluctuations in e-ITB plasma using correlation ECE (CECE).

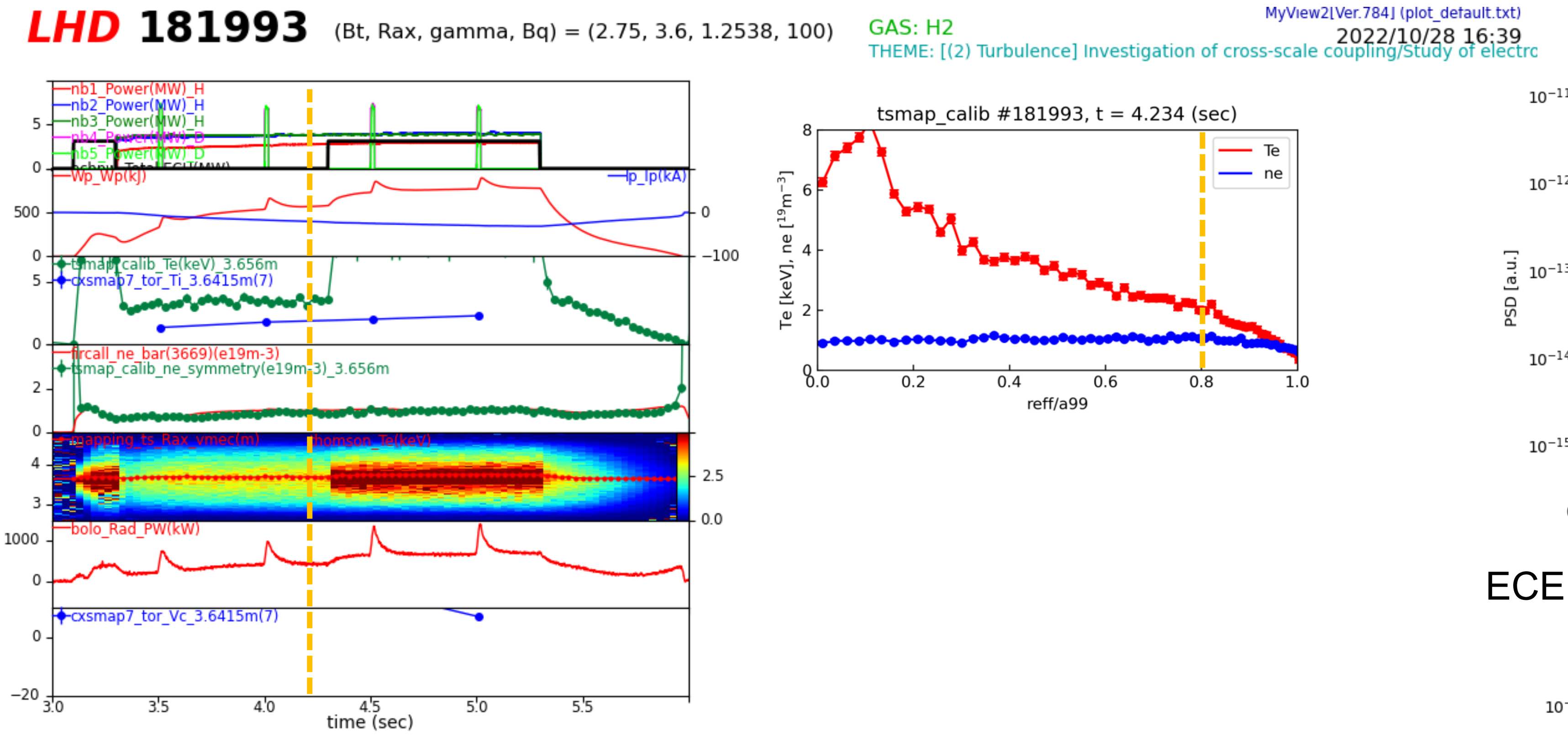
Results: The CECE measurement system used in this experiment covered $\rho\sim0.3\text{-}0.5$. The change of cross-power spectral was observed during e-ITB formation by ECH injection although this CECE could not observe inside of e-ITB. We will check the CECE measured by the CTS system which can access to $\rho\sim0.1$.

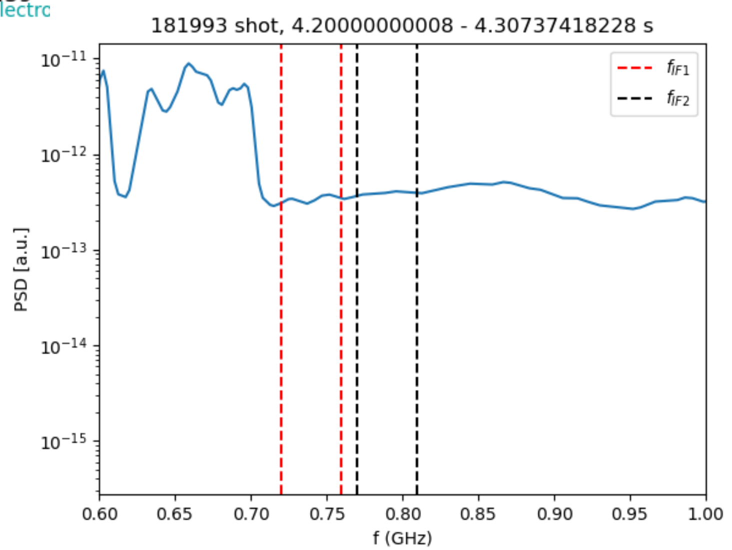




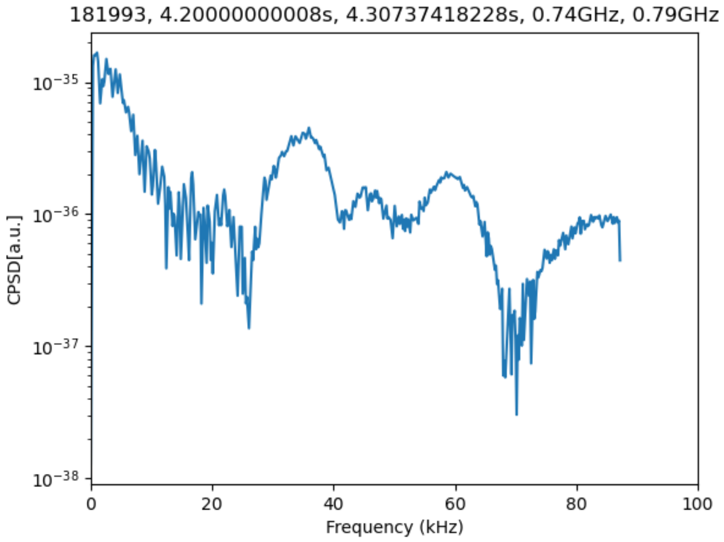


Investigation of drift wave turbulence in eITB plasma (M. Gong(UTokyo), R. Yanai, and M. Nishiura)





ECE spectrum and correlation frequencies



Cross-power spectrum

Purpose: To detect drift wave turbulence in eITB plasma using correlation ECE technique.

Methods: A new digital correlation ECE system is implemented in the CTS receiver. This new system can set arbitrary frequencies (spatial locations) of the cross correlated signals, which can be very closed to each other without overlapping thermal noise.

Results: Some modes at ~30-70 kHz range seem to be detected for $\rho\sim0.8$. The optical depth is not very high (~ 2). Further check is needed.

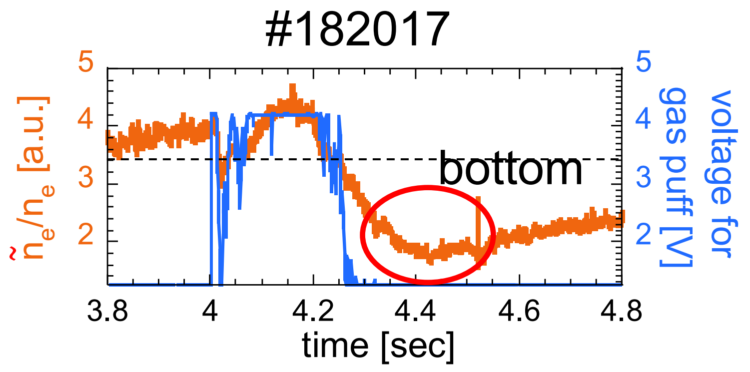
Plasma control using turbulence level (H. Sakai (Kyushu Univ.), K. Tanaka)

Shot No: #182006~182031 (26 shots)
Experimental conditions: (R_{ax}, Polarity, B_t, γ, B_q) = (3.6 m, CCW, 2.75 T, 1.2538, 100 %)
Gas-puff: D_2

Objective: To maintain plasmas with low turbulence level by applying PID control of the gas puff

Approach: Following two types of reference signals were used.

・turbulence level ・derivative signal of turbulence level



Results

✓ By first approach, turbulence level could be controlled.
However, threshold voltage is not universal.

✓ Unfortunately, derivative control did not work as expected…
Gas puff control corresponding to the sign of the derivative signal was achieved, but the waveforms of the derivative signal and gas puff did not match.

We will discuss with Mr. Nagahara, and develop the control system.

And we will retry experiments of plasma control in Nov. 2nd.