(TG2) Turbulence Topical Group Report

Dec. 1, 2021 (T. Tsujimura and T. Kobayashi)

Date: Nov. 30, 2021
Time: 9:50 – 18:42
Shot#: 173689 – 173844 (156 shots)

Prior wall conditioning: D_2
Divertor pump: On except for 2-I
Gas puff: D_2
Pellet: None

NBI#(1, 2, 3, 4, 5) = gas(D, D, D, D, D) = P(2.3, 1.6, 2.1, 6.2, 5.0) MW

ECH(77 GHz) = ant(5.5-Uout (or 1.5U), 2-OUR) = P(703, 792) kW
ECH(154 GHz) = ant(2-OLL, 2-OUL , 2-OLR) = P(979, 930, 986) kW
ECH(56 GHz) = ant(1.5U) = P(-) kW
ICH(3.5U, 3.5L, 4.5U, 4.5L) = P(-, -, -, -) MW
Neutron yield integrated over the experiment = 1.2×10^{17}

Topics

1. Interaction between turbulence and fast ion (K. Tanaka[1,2], H. Sakai[2], and T. Kinoshita[2] ([1]NIFS, [2]Kyushu U.))
2. Magnetically driven self-sustained divertor oscillation (T. Kobayashi, M. Kobayashi, and R. Yasuhara)
3. Response of turbulence in SOL (T. Tokuzawa)

Interaction between turbulence and fast ion K. Tanaka[1,2], H. Sakai[1], T. Kinoshita[1]

1 NIFS, 2 Kyushu University

1. Motivation and background

Interaction between fast ion and turbulence is important issues for the understanding of transport physics in reactor plasma. Fast ion pressure can stabilize ion scale turbulence in tokamak (Citrin PRL 2013). In LHD, EIC stabilize ITG turbulence in short time scale (Tanaka NF2017, Michael NF 2018). In 21st LHD campaign, enhancement of ion scale turbulence was found during isotope experiments with injection of 20msec NB#4 pulse for CXRS.

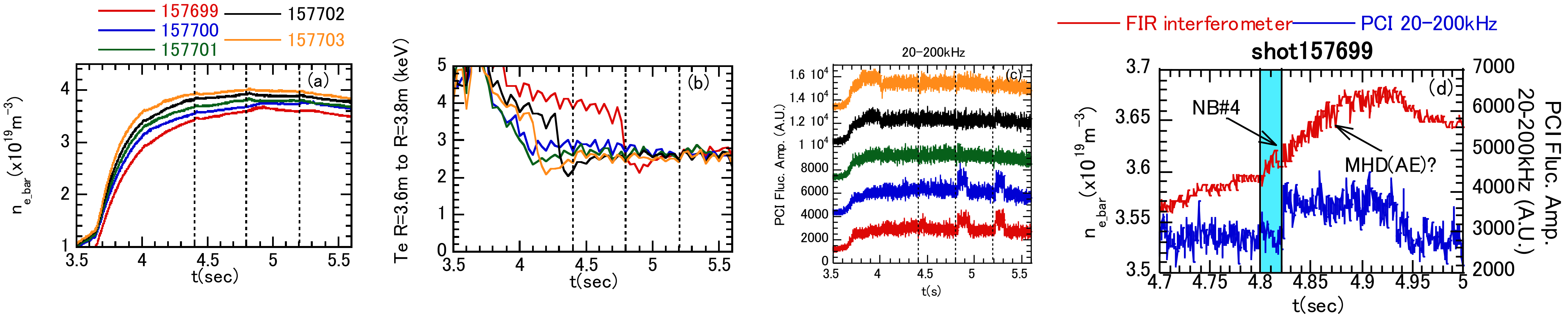


Fig.1 Interaction of fast ion and ion scale turbulence obtained in the 21st campaign
Time history of (a) line averaged density, (b) central Te, (c) line integrated turbulence signal and (d) turbulence amplitude and MHD mode

The observations were not intended and these observations were only 2 shots. However, the observation suggests important physics of interaction between fast ion and ion scale turbulence. In addition, fast ion driven mode like instability (Fig.1 (d)) was also found. Such MHD instability may interact with turbulence as well. Thus, systematic datasets were obtained scanning density and pulse width of NB#4.

2. Experimental condition and setup

173690~173737, Rax=3.6m, Bt= - 2.75T (CCW*), BQ=100%, γ=1.254, D plasma
Density was scanned 1.5~4x10^{19}m^{-3}. Main part of discharge was heated by 2x154GHz balanced injection (each 1MW).
#4 was injected every 400msec. Pulse width was scanned (20,40,80, and 160msec).
#4 power was scanned (full ~8MW and half ~4MW), #5 is superimposed (totally~15MW).
Iota profiles were measured by MSE.
Injection direction of ECREH was set to be same as in 21st campaign exp.
* CW Bt did not show turbulence enhancements in 21st campaign.

3. Results

Results in the 21st campaign was reproduced.
The enhancement was the highest at ~ 3x10^{19}m^{-3}. At lower and higher density, enhancement became smaller.

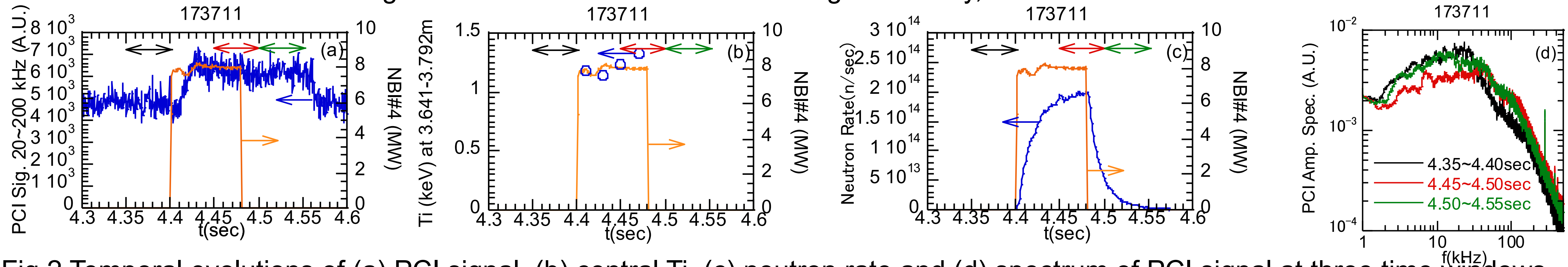


Fig.2 Temporal evolutions of (a) PCI signal, (b) central Ti, (c) neutron rate and (d) spectrum of PCI signal at three time windows

- ✓ Turbulence (PCI signal) increases with NB#4 injection under almost constant Ti.
- ✓ Turbulence enhancement remains constant after turning off of NB#4.
- ✓ Growth rate of turbulence amplitude is comparable of growth rate of neutron rate.
- ✓ Low freq. components (<40kHz) decreases then increases and high freq. components(>40kHz) increase after #4 injection.
- ✓ Correlation with MHD and change of turbulence profiles will be clarified.

Magnetically driven self-sustained divertor oscillation

T. Kobayashi,
M. Kobayashi,
R. Yasuhara

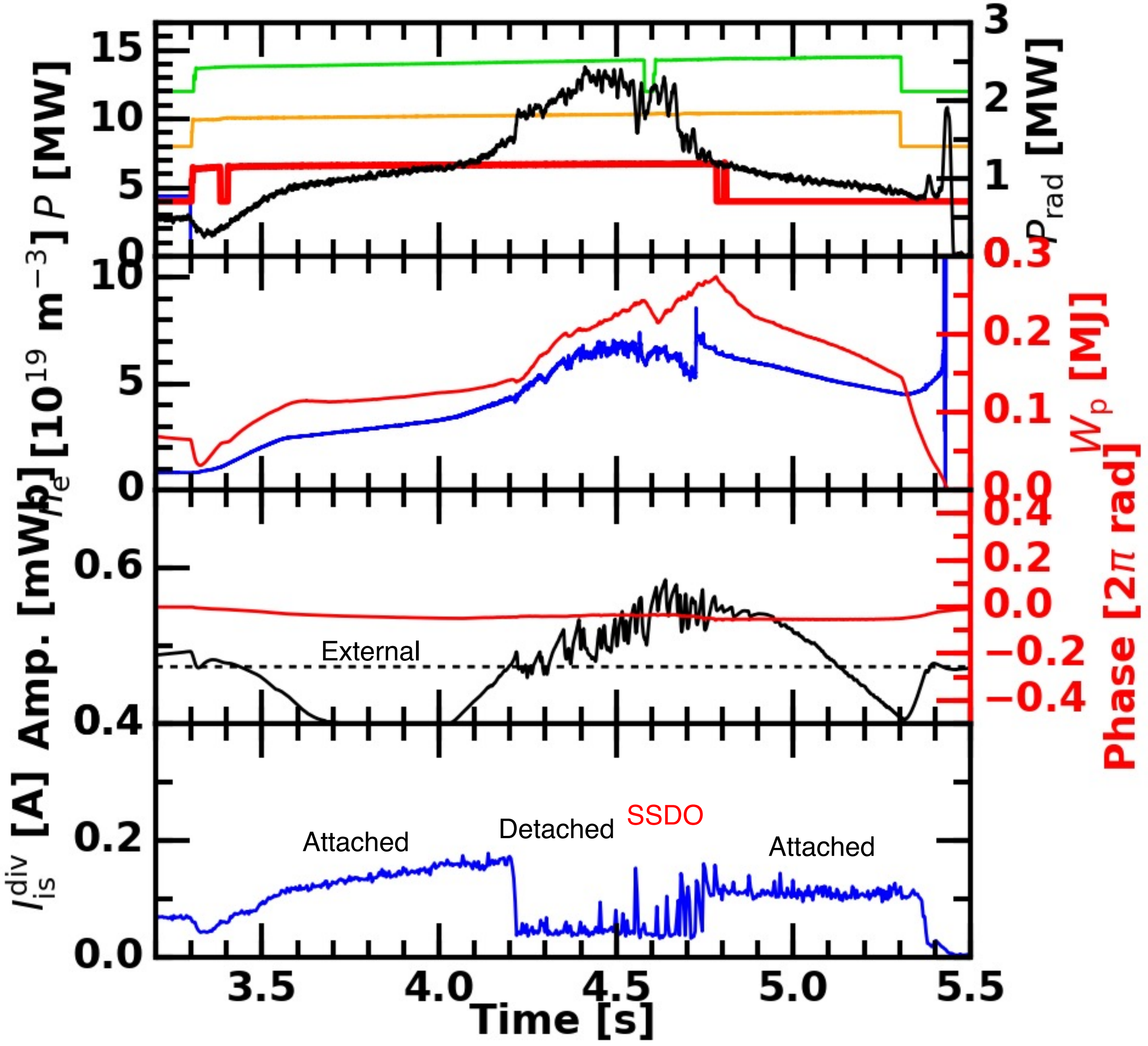
Shot #: 173739 - 173785
Experimental conditions: (R_{ax}, Polarity, B_t, γ, B_q) = (3.9 m, CCW, 2.54 T, 1.2538, 100 %)

Motivation

- Magnetically driven self-sustained divertor oscillation (SSDO) was discovered in the previous campaign.
- Plasma parameter dependence of the SSDO frequency and amplitude was investigated.

Results

- Shot-to-shot RMP current scan was performed with I_{LID}=2100A, 2400A, 2700A, 2800A, 3000A, 3300A.
- Divertor oscillation was successfully observed.
- T_e and n_e profile evolutions were measured by the fast Thomson scattering system.
- Parameter dependence of the SSDO features will be analyzed in detail.



Response of turbulence in SOL

T. Tokuzawa

Experimental conditions:

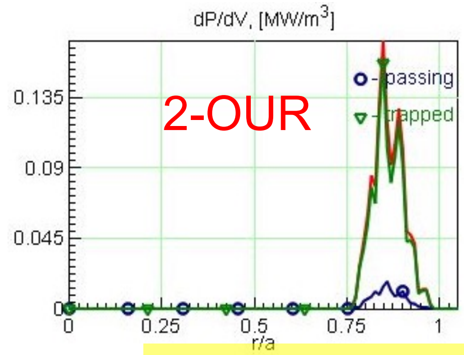
(R_{ax}, B_t, γ, B_q) = (3.75 m, -1.75 T, 1.2538, 100.0%): #173786 - #173819
(R_{ax}, B_t, γ, B_q) = (3.90 m, -1.75 T, 1.2538, 100.0%): #173820 - #173836
(R_{ax}, B_t, γ, B_q) = (3.60 m, -1.75 T, 1.2538, 100.0%): #173837 - #173844
LID current 7O-mode and 6O-mode : cancel and +/-1920A (expand, reverse expand)

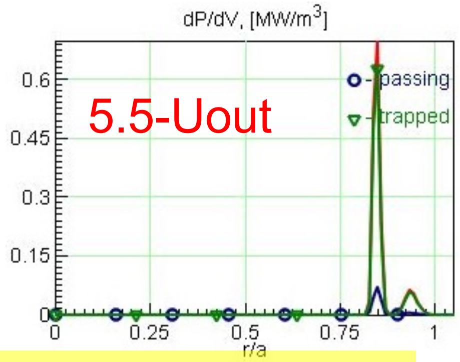
Motivation: Investigation of turbulence excitation in edge and SOL regions.

Subjects: Off-axis 77GHz ECH is applied to control the turbulence intensity.
MECH : repetition rate: 10Hz, off-axis beam deposition: r/a~0.8

Results:

- Magnetic islands were formed with several different phase differences and magnetic-axis scans were performed.
- response of SOL turbulence with MECH timing were clearly observed.
- Fast Thomson and divertor probe signals were also acquired.





Calculated deposition of off-axis ECH

Turbulence intensity r/a~1.05@9-O&3-O