(TG4) Plasma instability group report

Nov. 18, 2021 (K. Nagaoka)

Date: Nov. 17, 2021
Time: 9:40 - 18:45
Shot#: 172781 – 172944 (163 shots)

Prior wall conditioning: None
Divertor pump: On
Gas puff: D2, Impurity pellet: C
NBI#(1, 2, 3, 4, 5)=gas(D, D, D, D, D)=P(2.5, 2.5, 2.5, 8, 8)MW
Neutron yield integrated over experiment = 1.3×10^{17}

Topics

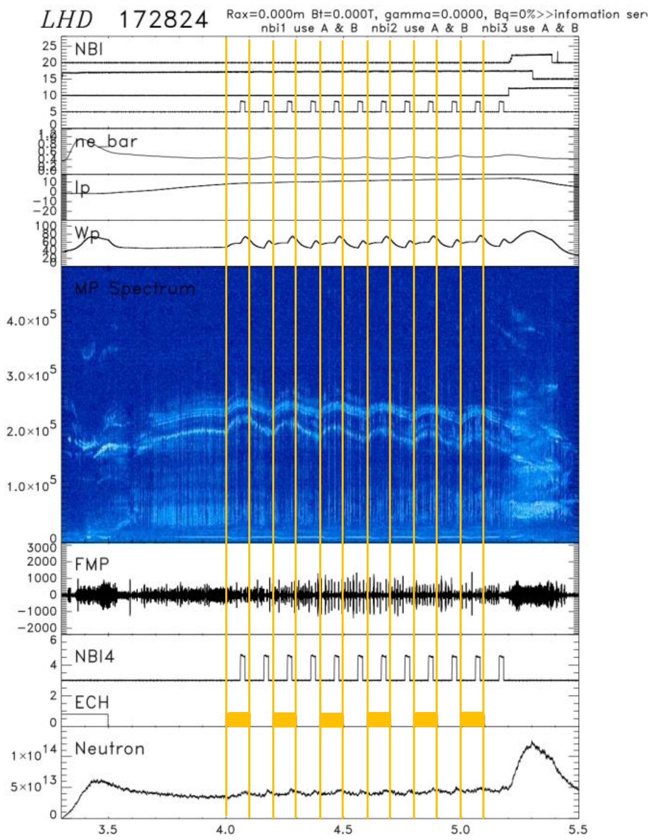
1. Active Control of Energetic-Particle-Driven MHD Instabilities by ECH/ECCD (K. Nagasaki (Kyoto Univ.) / K. Nagaoka)
2. Generation of high energy electrons by 3rd harmonic 116GHz wave coupled with 2nd harmonic heating by 77GHz wave (Y. Yoshimura)
3. Observation of whistler frequency waves excited by nonlinear wave-wave coupling during abrupt bursting events (H. Igami)
4. Validation of neutral beam current drive in LHD for numerical estimation (H. Nuga)

Control of Energetic-Particle-Driven MHD Modes by ECH/ECCD

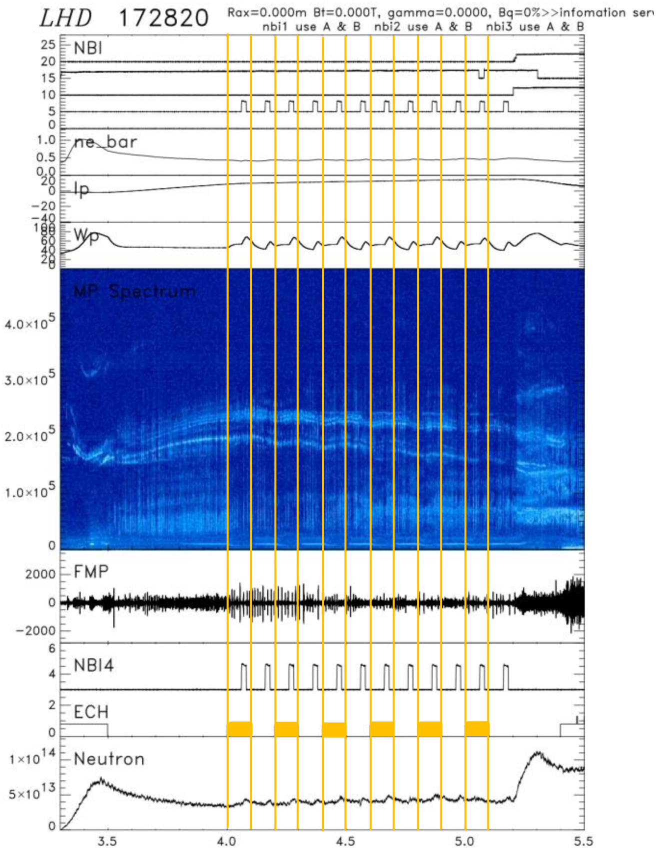
Experimental conditions:
Shot numbers: #172783 - #172841
(R_{ax}, Polarity, B_t, γ, B_q) = (3.75 m, CCW, 1.375 T, 1.2538, 100 %)
1. ECH 77GHz 5.5U modulation
    rho_EC = 0.2 – 0.7 (6 cases)
2. ECH 77GHz 2O modulation
    Co-ECCD, ρ_{EC} = 0.0, 0.5 (2 cases)
    Ctr-ECCD, ρ_{EC} = 0.0, 0.5 (5 cases)

Background and motivation:
- ECH/ECCD is an effective tool to control EP-driven modes
- The balance between the driving term and the damping term is investigated by scanning EC power deposition

#172824
5.5U, on-axis ECH (ρ_{EC}=0.2)



#172820
5.5U, off-axis ECH (ρ_{EC}=0.7)



Results:
- At on-axis ECH, the modes around 50 kHz were mitigated a little, and the mode frequency around 200 kHz changed.
- The ECH effect seems stronger at 2O launch.
- At off-axis ECH, the effect is weak.
- Fast ion distribution were measured with FIDA.

Nagasaki (Kyoto Univ.), Nagaoka

Observation of whistler frequency waves excited by nonlinear wave-wave coupling during abrupt bursting events

H. Igami

Shot #: 172865 - 172895

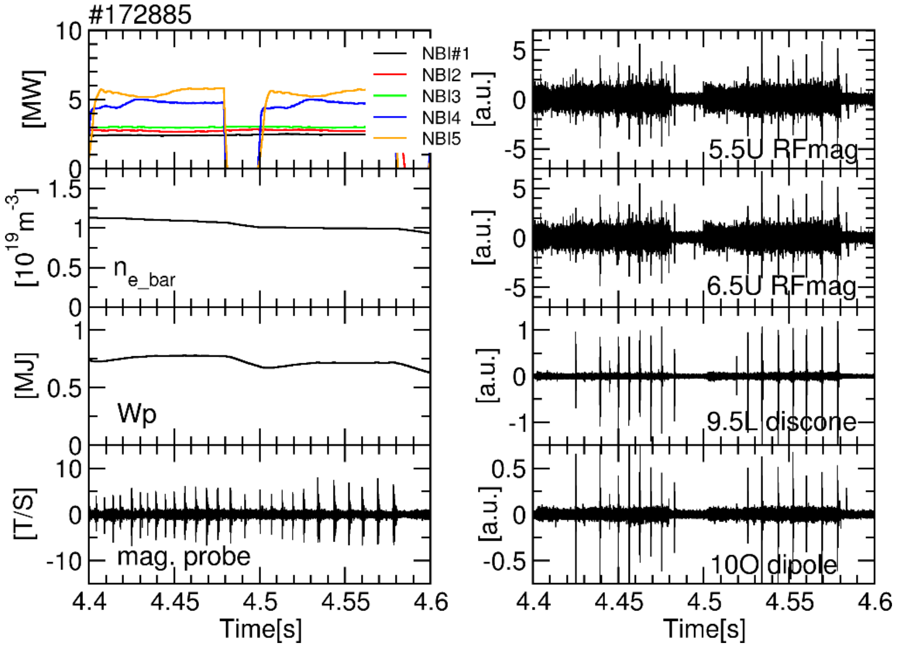
Experimental conditions: (R_{ax}, Polarity, B_t, γ, B_q) = (3.6 m, CCW, 2.75 T, 1.2538, 100.0%)

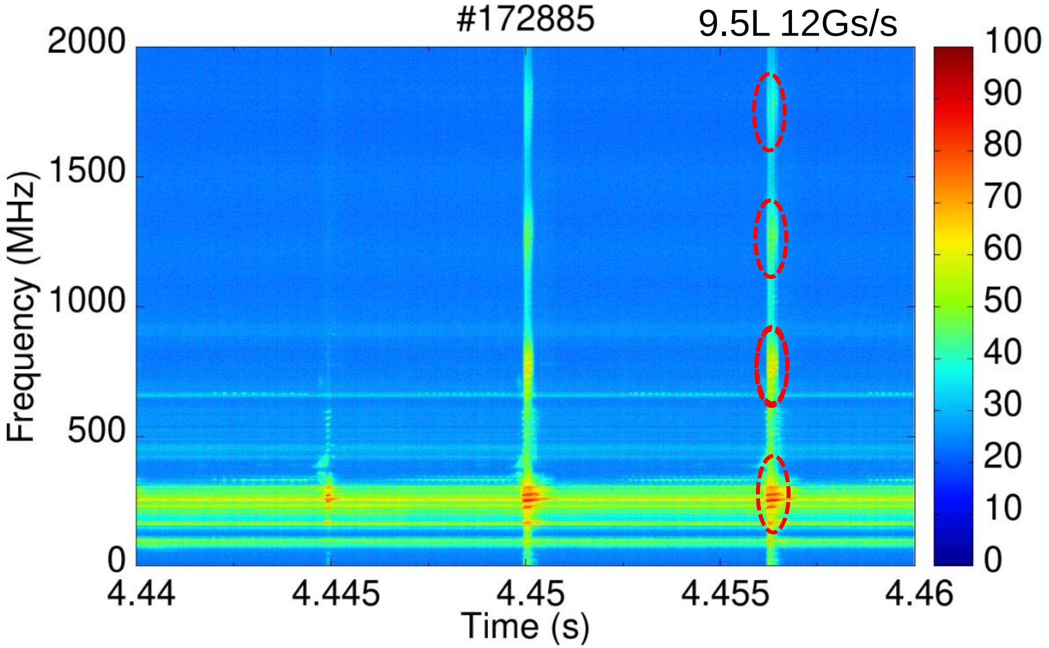
Purpose:

- Investigation of wave-particle and wave-wave coupling during the RF burst that appears with the “tongue”

Experimental result:

- RF waves were detected with fast digitizers, 2.5 GHs/0.2s and 12.5GHs/0.08s at different locations during tongue/EIC
- Packets of the intense frequency peaks at intervals of 500 MHz were observed during the RF burst for ~0.5 ms





Ultra fast ECE (80 Gs/s) data will be analyzed to examine the wave-wave coupling in the whistler wave frequency range

Generation of high energy electrons by 3rd harmonic heating by 116GHz wave coupled with 2nd harmonic heating by 77GHz wave (Y. Yoshimura)

Experimental conditions: #172845 - #172863
(Polarity, R_{ax}, B_t, γ, B_q) = (CCW, 3.75 m, 1.375 T, 1.2538, 100%)
ECH Power:
77GHz#1 (5.5-Uo) = 0.703MW
77GHz#2 (2-OUR) = 0.792MW
116GHz (2-OLR) = 0.497MW

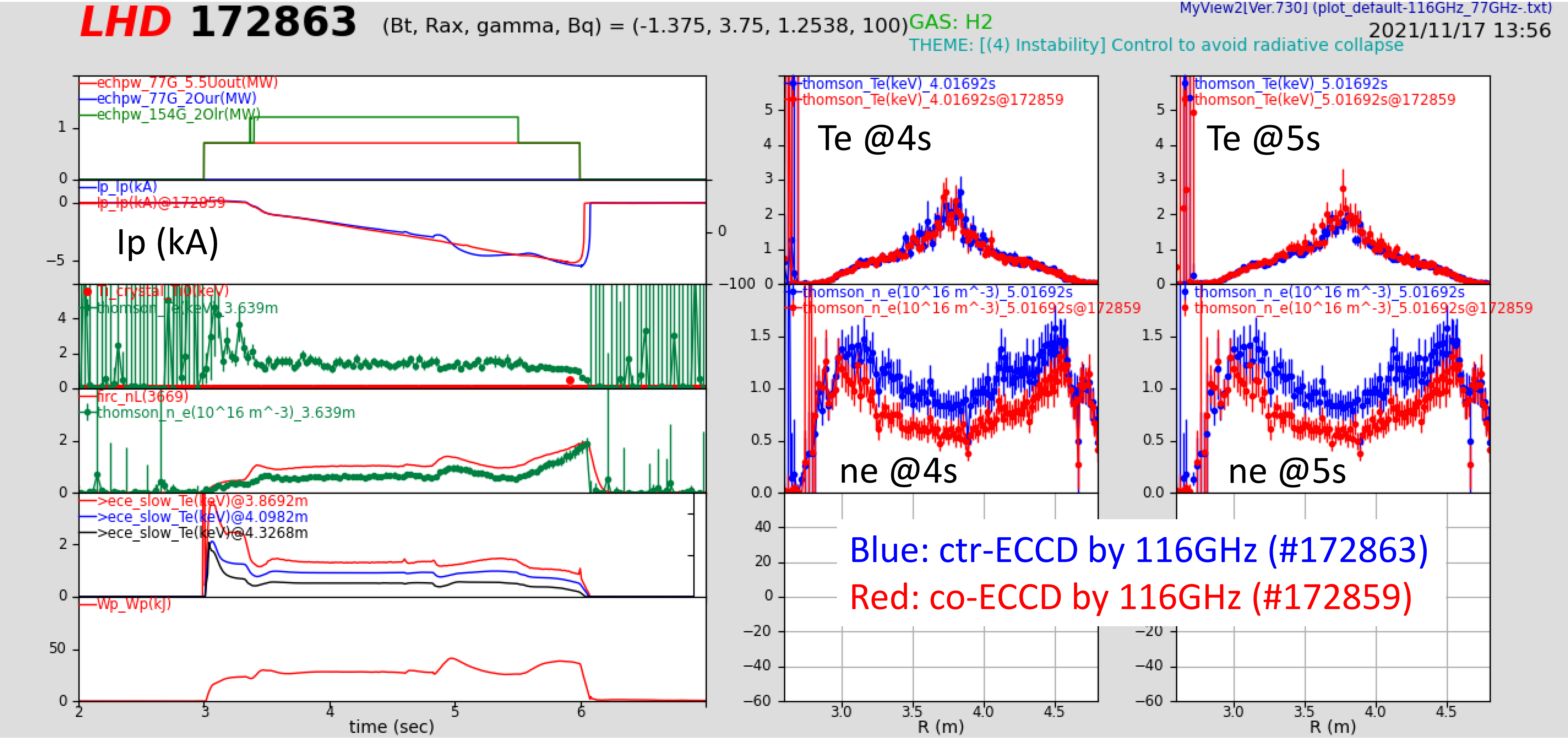
Background and motivation:
154&116GHz dual frequency gyrotron has been available for experiment.
3rd harmonic ECH by 116GHz will generate high energy electrons and it will contribute to an enhancement of current drive efficiency of simultaneously applied 2nd harmonic 77GHz ECCD.

Results:
On-axis heating patterns of
1. 77GHz 5.5-Uo (ECH) + 116GHz 2-OLR (ECCD)
2. 77GHz 5.5-Uo (ECH) + 77GHz 2-OUR (ECCD) + 116GHz 2-OLR (ECCD)

with EC-wave beam direction changes of 77GHz 2-OUR and 116GHz 2-OLR were performed.
In the case of single ECCD by 116GHz (pattern 1), no change in driven current was seen.
In the case of the combined ECCD by 77GHz and 116GHz (pattern 2), variations in driven currents by 116GHz were observed.
This might be a result of nonlinear combination effect, but the variation in Te caused by 77GHz 2-OUR heating should be considered.

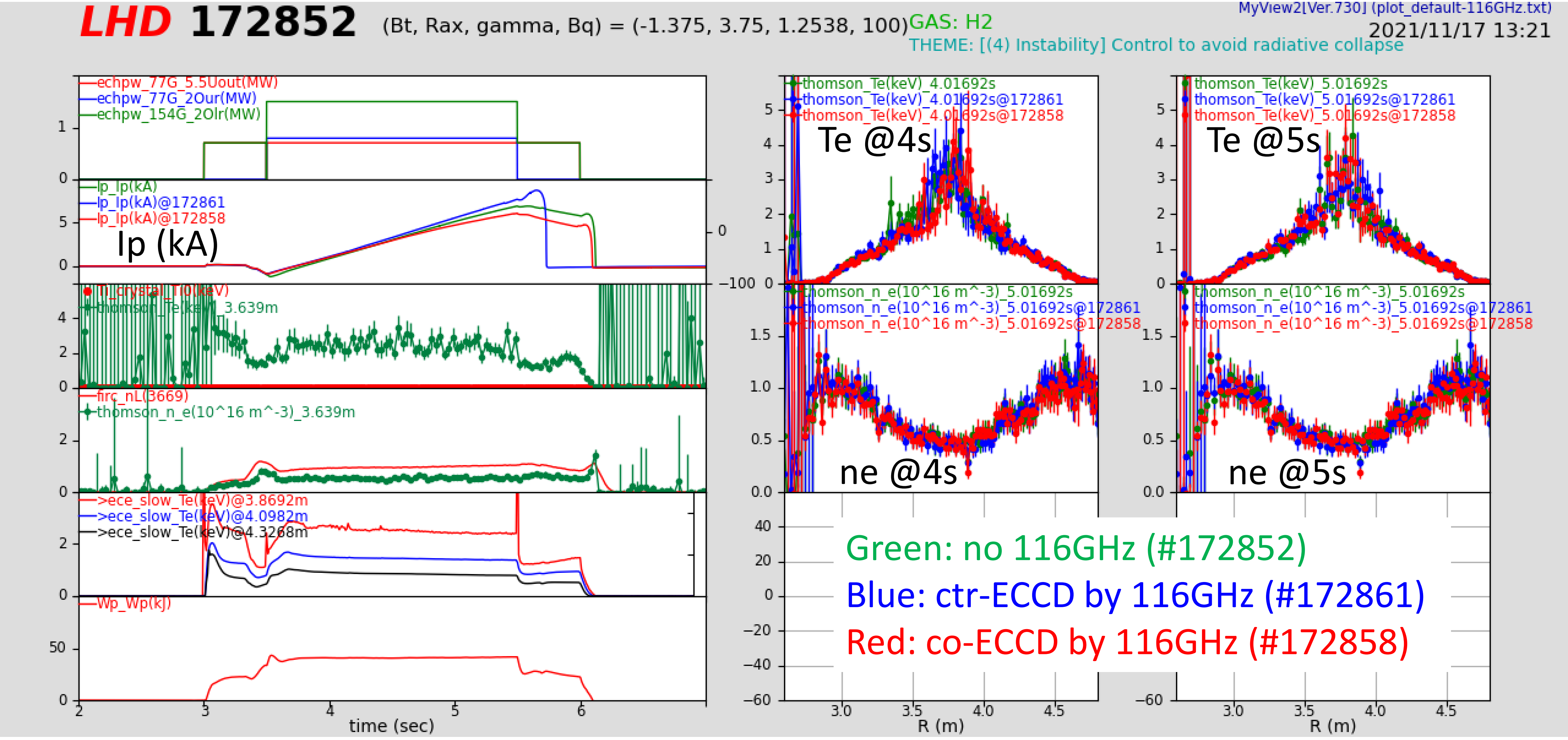
Heating pattern 1: 77GHz 5.5-Uo (ECH) + 116GHz 2-OLR (co/ctr-ECCD)

> No change in driven current by 116GHz co/ctr-ECCDs



Heating pattern 2: 77GHz 5.5-Uo (ECH) + 77GHz 2-OUR (ctr-ECCD) + 116GHz 2-OLR (co/ctr-ECCD)

> Variations in driven current by 116GHz co/ctr-ECCDs



Validation of neutral beam current drive in LHD for numerical estimation H. Nuga

Shot #: 172896-172944 (49 discharges)
Experimental conditions:
(R_{ax}, Polarity, B_t, γ, B_q) = (3.6 m, CCW, 2.75 T, 1.254, 100 %)

Background and motivation:
- MHD instabilities are sensitive to iota (*q* or *j*) profile.
- MSE measurement is not always available.
- Numerical estimation of iota prof. may support instability studies.
- Aim of this exp. is taking reference data for neutral beam current drive (NBCD) simulation benchmark.

Summary:
- Systematic dataset for NBCD calculation was taken with MSE measurement.
- Density scan was performed in 3 beam patterns (co-, counter-, balance).