(TG4) Plasma instability group report

Feb. 8, 2022 (K. Nagaoka)

Date: Feb. 4, 2022
Time: 9:40 – 18:45
Shot#: 178243 – 178384 (142 shots)
Prior wall conditioning: None
Divertor pump: On
Gas puff: H2, Ar, Ipellet: H2, Impurity pellet: None
NBI#(1, 2, 3, 4, 5)=gas(H, H, H, H, H)=P(4.0, 2.0, 4.0, 4.0, 4.0)MW
ECH(77GHz)=ant(5.5-Uout (or 1.5U), 2-OUR)=P(800, 700)kW
ECH(154GHz)=ant(2-OLL, 2-OUL , 2-OLR)=P(700, 700, 700)kW
ICH(3.5UL)=(0.69, 0.44)MW, ICH(4.5UL)=(0.03, 0.59)MW
Neutron yield integrated over experiment = 1.9×10^{11}
Topics

1. Low field plasma experiment for energetic particle confinement study (K. Nagaoka, T. Morisaki, S. Sakakibara, H. Kasahara)
2. Development of plasma initiation technique for low magnetic field plasma experiments (S. Kobayashi(Kyoto Univ.)/K. Nagaoka)
3. Rotational transform dependency of CDCs (H. Thomsen(IPP)/S. Ohdachi)
4. Corrupt mechanism of CDC events (S. Ohdachi)
5. OXB heating by 115.5GHz at the strongly Doppler-shifted ECR in the SDC plasma (H. Igami)

Low field plasma experiment for energetic particle confinement study

K. Nagaoka, T. Morisaki, S. Sakakibara

Shot #: 178356 - 178383

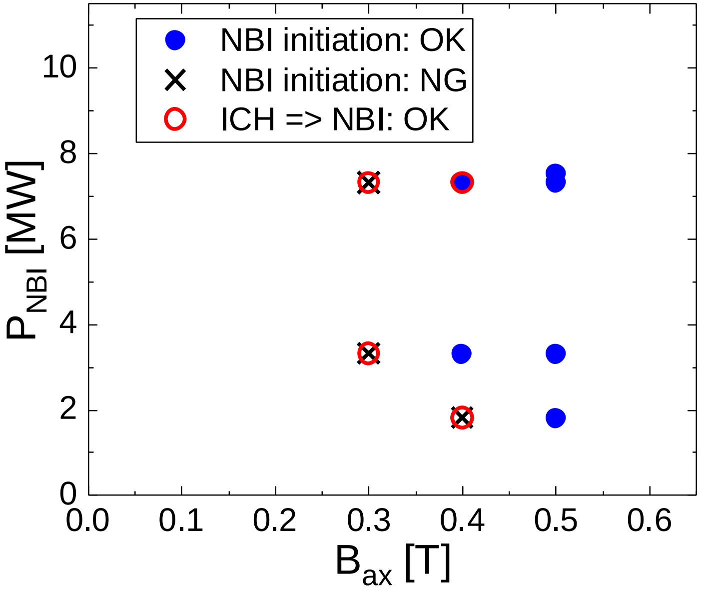
Experimental conditions: (R_{ax}, Polarity, B_t, γ, B_q) = (3.50-3.90 m, CCW, 0.5, 0.4, 0.3 T, 1.2538, 100.0%)

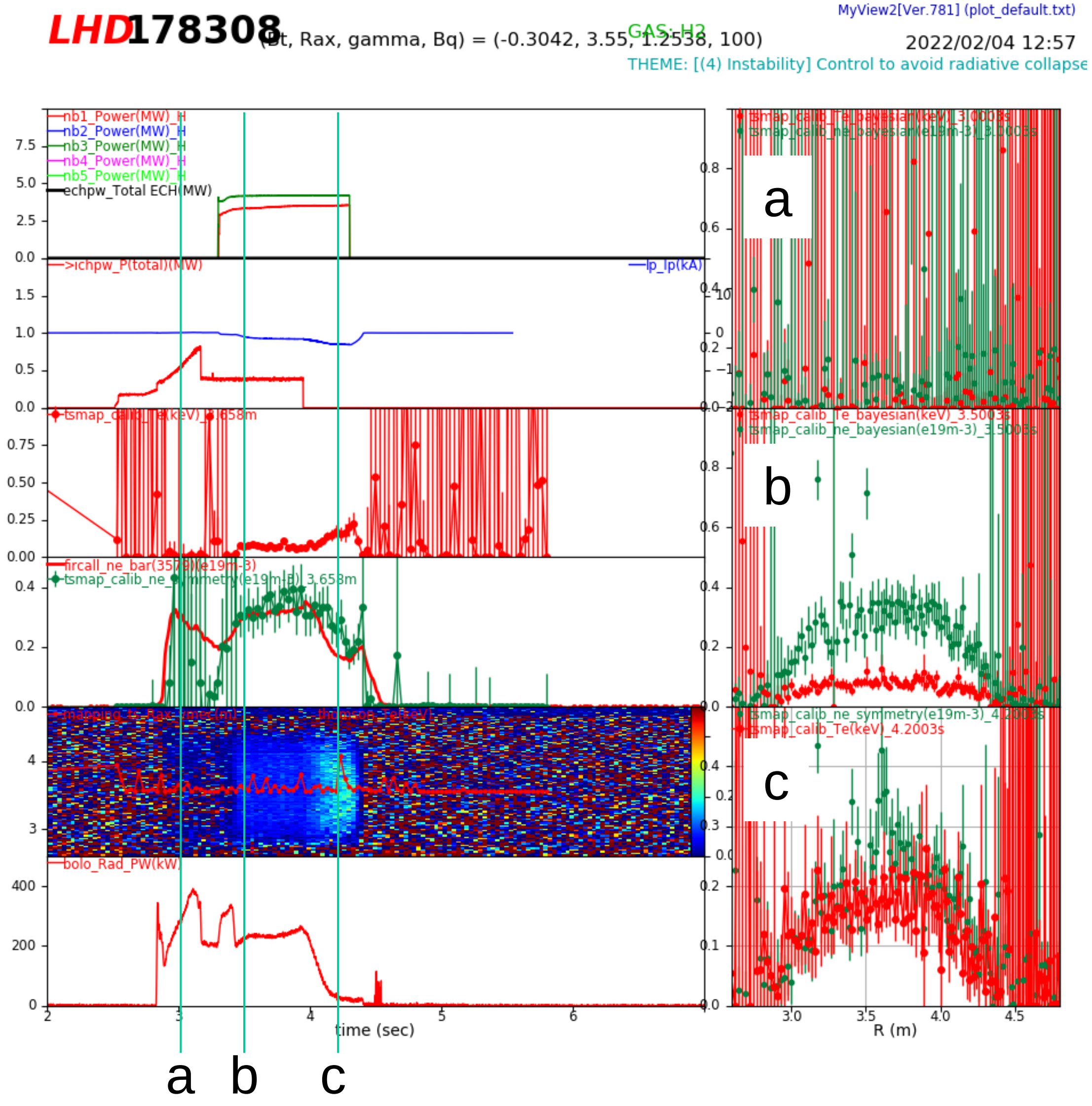
Purpose:

- Demonstration of plasma initiation with low field.

Experimental result:

- NBI plasma was obtained with B_t >= 0.3T
- ICRF is effective to breakdown, low Te, density control
- Flux swing operation could produce energetic electrons
- Rax=3.53m is the best among 3.53, 3.55, 3.60.





Plasma ignition support experiment in low magnetic field configuration with ICRF heating (H. Kasahara)

Magnetic Configuration: (Polarity, γ, B_q)=(CCW, 1.2538, 100%), (R_{ax}, B_{ax}) = (3.55m, 0.3T), (3.6m, 0.3T), (3.53m, 0.31T), (3.6m 0.4T), (3.6m 0.5T)

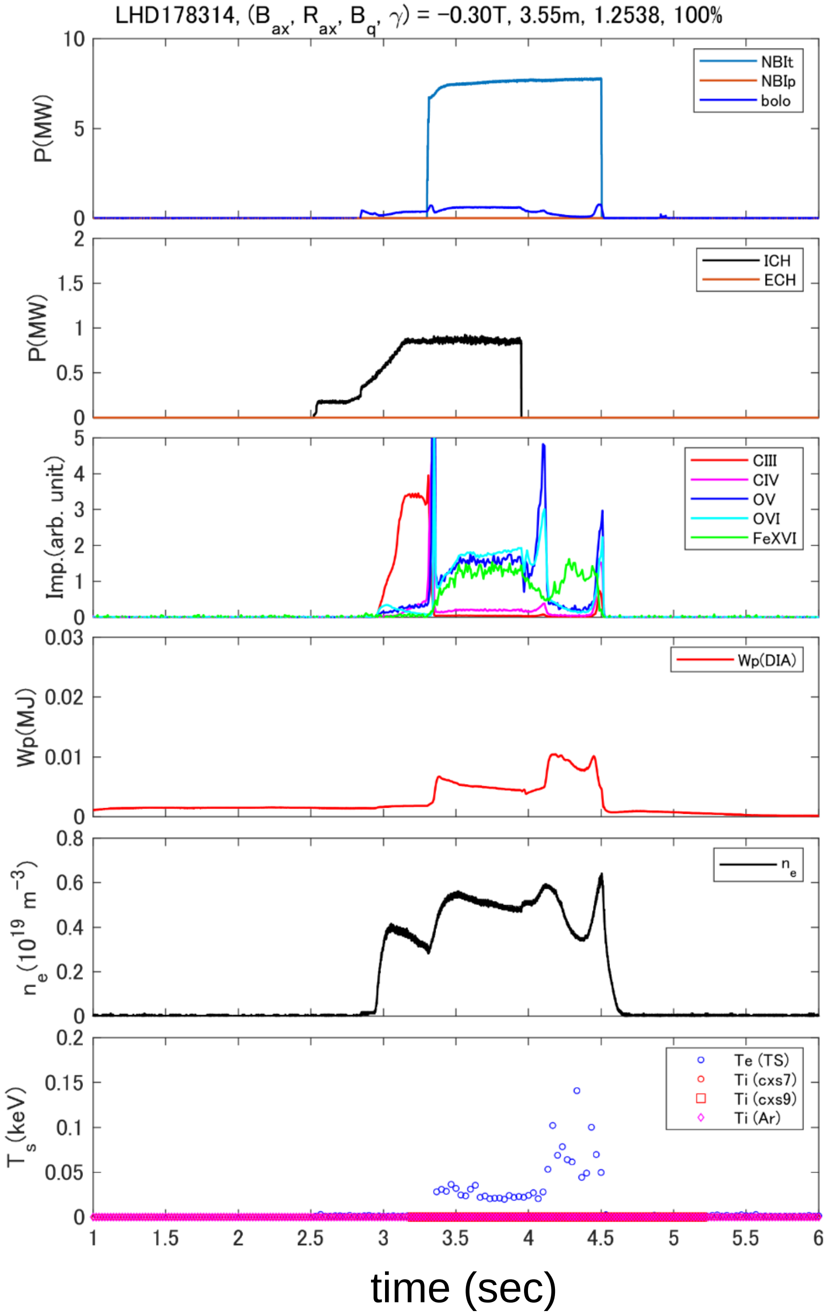
Shots: #178244 ~ #178319 (72 shots)

The goal of this experiment

We want to know the potential of ICRF plasma ignition in the low magnetic field configuration on the collisional damping scenario and confirm the initial plasma parameters to understand the heating scenarios in the ignition phase.

Main results of this experiment

- In lower magnetic configuration (B < 0.4T), ICRF heating could be supported by plasma ramp-up with the NBI phase.
- Initial electron density strongly depended on the ICRF heating power and gas-puffing in the ICRF phase.
- By the relatively large amount of gas puffing in the ICRF phase, electron temperature could not increase until the stop of ICRF heating.
- In the B of 0.3T and R_{ax} of 3.55T, ICRF antenna protector is lighted during NBI operation with the antenna-plasma distance of 12 cm.
- Short injection width of ICRF heating may be one of the candidates for the ignition scenarios to mitigate gas-puffing effect.



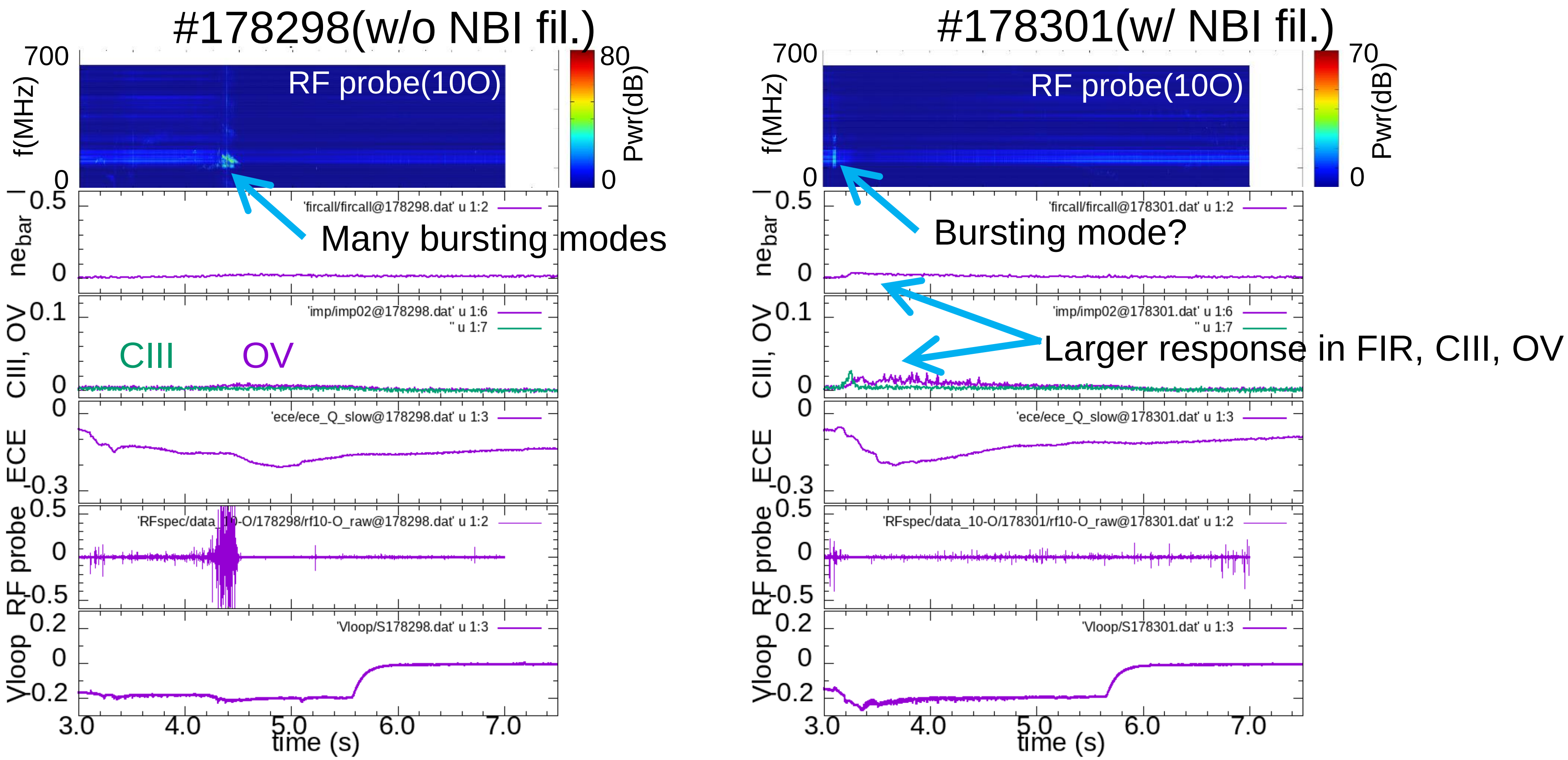
Plasma startup experiment at low B

S. Kobayashi(Kyoto Univ.)

Shot: #178244 - #178319

Experimental conditions: (3.60 m (w/ flux swing), CCW, 0.3-0.5T, 1.2538, 100.0%)

- Production of seed-electrons by flux swing using magnetic axis sweep (R_{ax} = 3.9 ⬄ 3.6 m), w/ & w/o NBI filament.
- Significant ECE but small response in FIR, CIII and OV can be seen,
  ➔ Not obtained burn-through but seems to be effective to produce seed electrons



rotational transform dependency of CDCs

H.Thomsen/IPP
S.Ohdachi/NIFS
Y.Suzuki/Hiroshima Univ. NIFS

Shot #: 178320-178348, 178349-178355

Experimental conditions:

(R_{ax}, Polarity, B_t, γ, B_q) = (3.75 / 3.85 m, CCW, -2.64T/-2.57T, 1.254, 100 %)

Background and motivation:

- Rotational transform profile dynamics during CDCs should be characterized in different R_{ax} configurations
- Similar crashes were observed in W7-X pellet fueled high performance discharges.

→ Possible common explanation and role of magnetic resonances should be investigated

Results:

- Several good CDC shots achieved
- Data for R_{ax} =3.75 m and R_{ax} =3.85 m
- *preliminary*: best data for R_{ax} =3.85 m (#178349)
- Further data recorded in R_{ax} =3.90 m configuration (in following session)
- Detailed analysis of MSE data upcoming

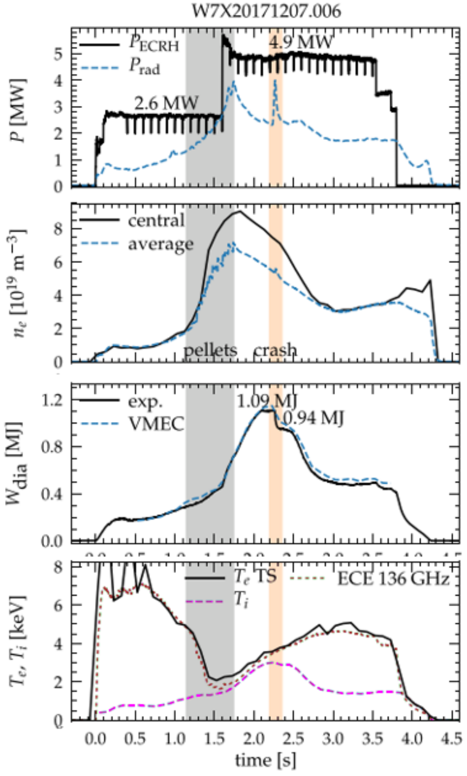


Fig. 1. MHD event (W7-X high performance)

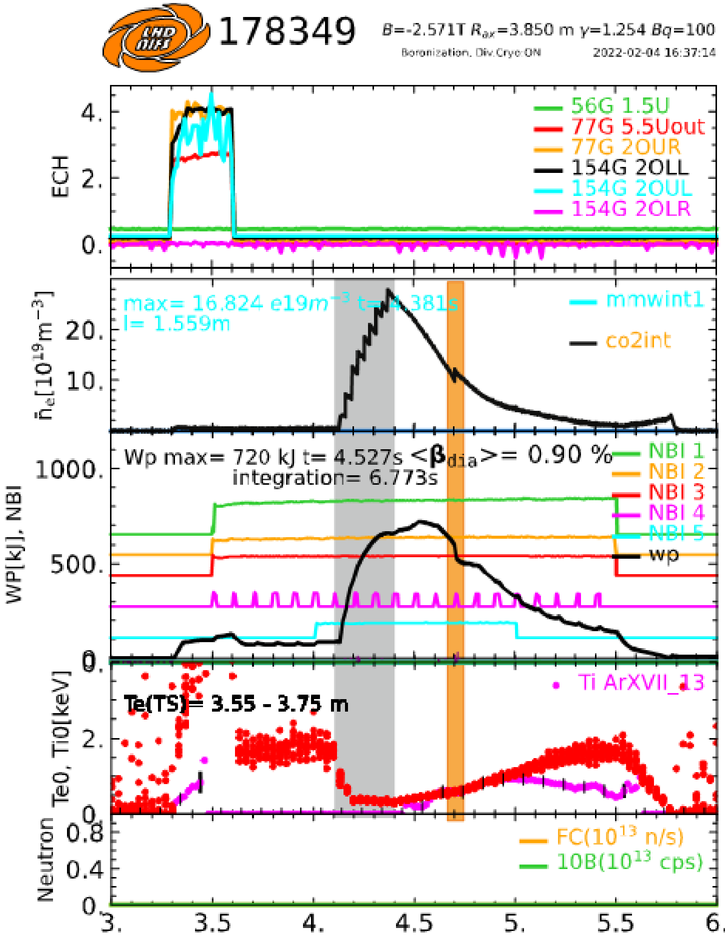


Fig. 2 CDC in LHD, R_{ax} =3.85 m

Max-Planck-Institut für Plasmaphysik

CDC mechanism S.Ohdachi/NIFS, H.Thomsen/IPP

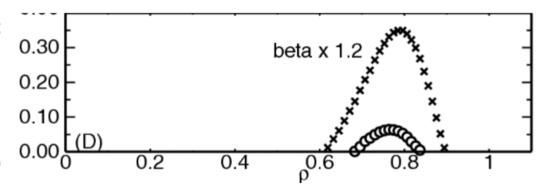
Shot #: 178349-178355

Experimental conditions:

(R_{ax}, Polarity, B_t, γ, B_q) = (3.85 m, CCW, -2.571T, 100 %)

Background and motivation:

- CDCs are driven by the helical type ballooning mode. However, the mode structure is quite localized in the edge region (Fig. 1) where the local shear is zero. The mechanism for the global collapse has not been clarified. Recent non-linear calculation (e.g., C. J Ham et. al. EPS 2018) shows that ballooning finger departs from the inside and moves to the outward in the SOL region (Fig. 2).



S. Ohdachi et al 2017 Nucl. Fusion **57** 066042

Fig. 1. Growth Rate of the ballooning mode

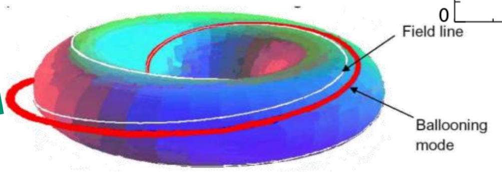


Fig. 2. Conceptual figure of the movement of a flux tube

Results:

- Due to the machine trouble, we have only 4 effective shots and 3 CDC events were observed.
- Fast Thomson measurement could not be synchronized with event with in 3 shots. GPI shows filament-like structure while collapse is going.

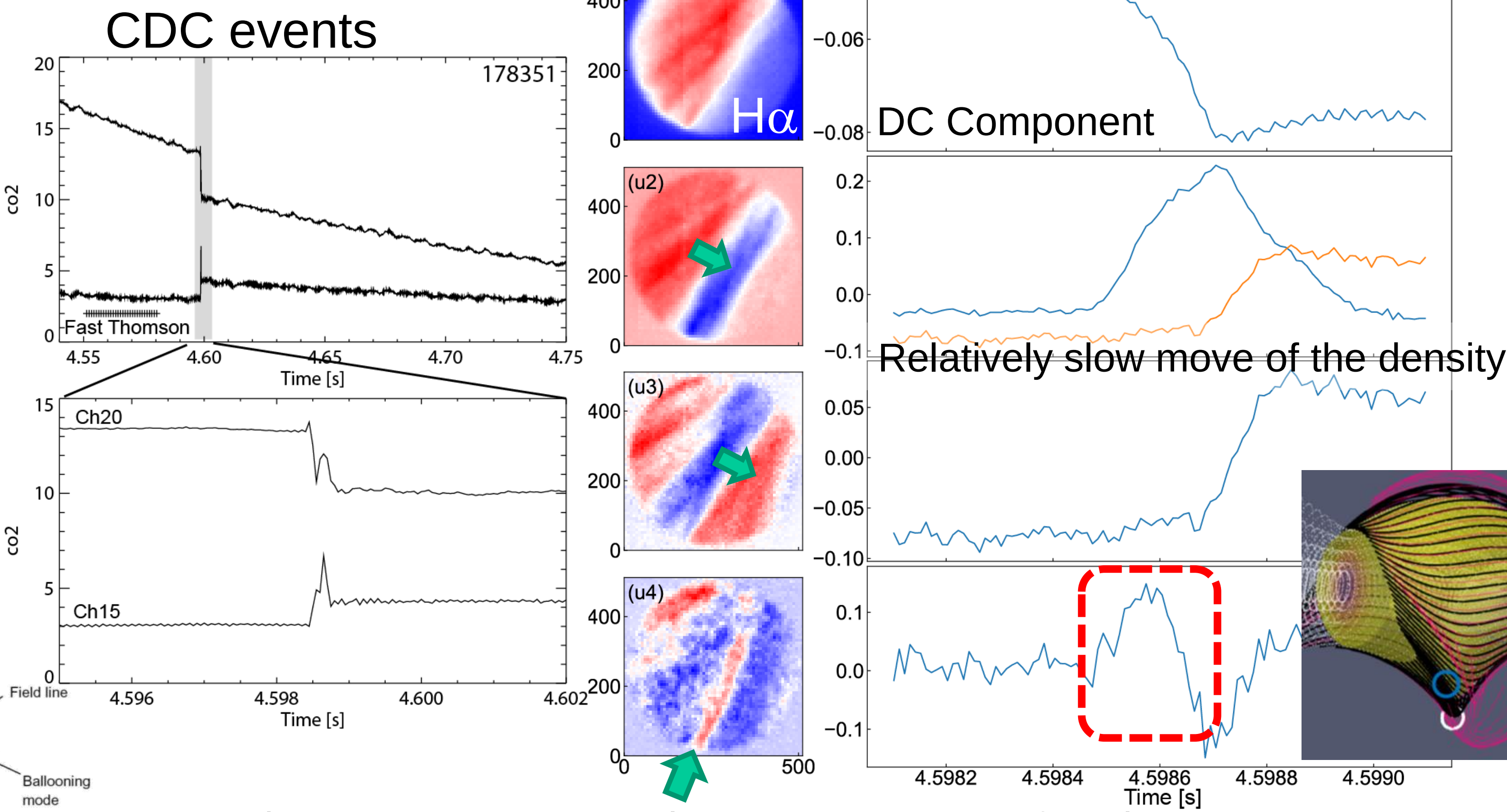


Fig. 3 CDC events and PCA components of Hα image.

OXB heating by 115.5GHz at the strongly Doppler-shifted ECR in the SDC plasma

H. Igami

Shot #: 178356 - 178383

Experimental conditions: (R_{ax}, Polarity, B_t, γ, B_q) = (3.90 m, CCW, 2.631 T, 1.2538, 100.0%)

Purpose:

- To demonstrate effective EBW heating via O-X-B mode conversion process in the SDC plasma

Experimental result:

- 7 SDC discharges were obtained, however, it took time to adjust the ECH interlock parameter for the SDC plasma. Survey of the launching direction cannot be performed to search the O-X-B mode conversion window
- Increase of Wp and T_e were not observed
- To inject EC wave during a restricted density range more than the cutoff density, the gate signal for 115.5 GHz EC wave injection was processed with reference to the CO_2 laser interferometer signal. However, EC wave was injected after the gate signal becomes zero