(TG1) Multi-ion Plasma group report

Oct. 14, 2021 (N. Tamura)

Date: Oct. 14, 2021
Time: 11:31 – 18:42
Shot#: 170023 – 170158 (136 shots)
Prior wall conditioning: NO
Divertor pump: OFF
Gas puff: H_2, D_2, He
Pellet: Solid Hydrogen (+ Ne-doped) pellet, Impurity pellet(C, Al, LiF), TESPEL (PS)

NBI#(1, 2, 3, 4, 5) = gas(H, H, H, H, H)=P(3.3, 3.3, 3.3, 4.0, 3.0) MW
ECH(77GHz) = ant(1.5-Uo, 5.5-U, 2-OUR)=P(0.253, 0.253, 0.267) MW
ECH(154GHz) = ant(2-OLL, 2-OUL, 2-OLR)=P(0.205, .0.203, 0.237) MW
ICH(3.5U, 3.5L, 4.5U, 4.5L) = P(0.5, 0.75, 0.75, 0.5) MW
Neutron yield integrated over the experiment = 9.5×10^{12}

Topics
1. Plasma/Device Commissioning (N. Tamura)
2. Commissioning of ICRF antenna (H. Kasahara)
3. Plasma exposure of W samples (C.P. Dhard, D. Naujoks (IPP), S. Masuzaki)
4. Scan of ECH focal position in plasma/New 1.5UO ECH antenna commissioning (R. Yanai)
5. Performance of new pressure gauges of the ITER type (G. Motojima)

Plasma/Device Commissioning (N. Tamura et al.)

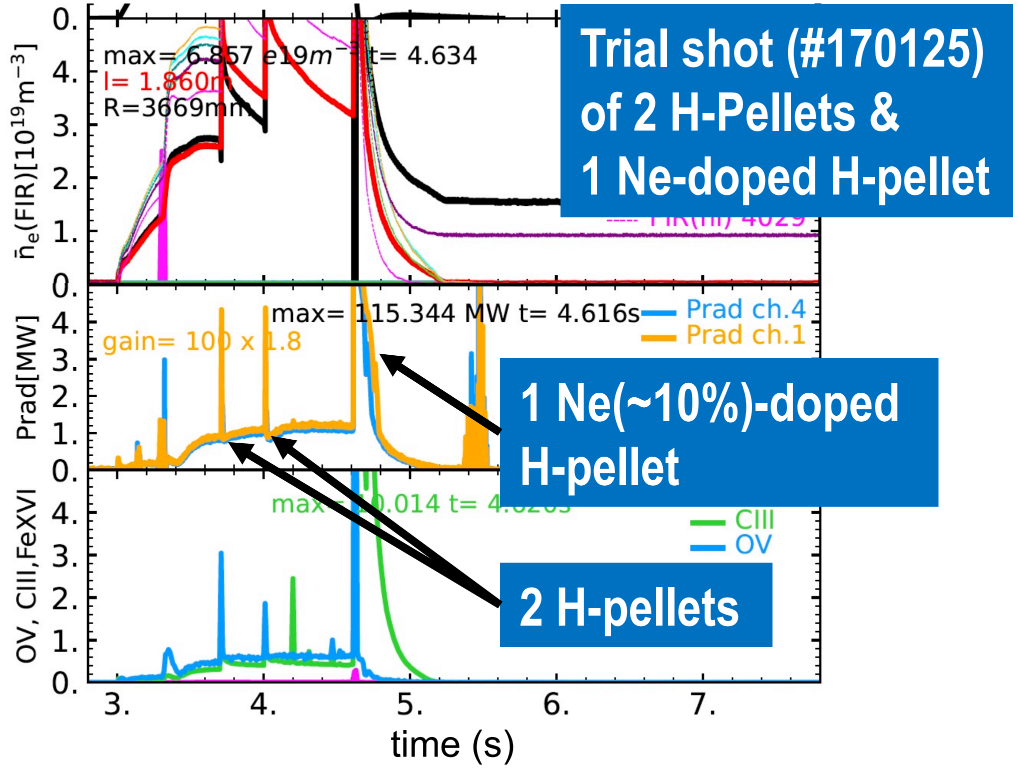
Experimental conditions: (R_{ax}, Polarity, B_t, γ, B_q) = (3.60 m, CCW, 2.75 T, 1.2538, 100.0%)

Goal of this experiment:

- To confirm the plasma startup and the stable sustainment of the plasmas
- To confirm the operation of diagnostics, data collection/display system, each heating devices(ECH, ICH and NBI)

Results:

- We have initiated the plasmas only with ECH, and then the pulse length of ECH was gradually increased. After the plasma has been sustained successfully only by ECH, we have added NBI #1. Some time after the adding NBI#1, we have added NBI #3. At last, we have added the NBI #2 to obtain the stable ECH+NBI-heated plasmas.
- **Finally, we have confirmed the stable sustainment of the NBI+ECH heated plasmas and the ECH+ICH heated plasmas.**
  - ✓ Therefore, we were able to carry out several experiment programs.
- Successful operations of hydrogen ice pellet, impurity pellet, impurity powder dropper and TESPEL have been confirmed.
  - ✓ Some minor troubles (wrong timing set for TS, no data displaying in the shot summary, and so on) have been occurred during the experiment.
    → Almost solved.



Commissioning of ICRF antenna (ICH group)

Goal of ICRF antenna commissioning

- Exhausting gas by repeated RF power injection into the ICRF antenna
- Confirmation of the emission status of the ICRF antenna during LHD experiment
- Confirmation of the impedance matching system using plasma
- Conditioning of high-power amplifiers by repeated operation

Motivation and objective

- Initial check for interaction between ICRF antenna and fast ions NBI particles.
- Checking the health of control equipment and identifying problems in operation.

Results(SN170073~170108, B_{ax} ~ 2.75T(CCW), R_{ax}~3.6m, B_q=100%, g=1.254)

- No clear NBI (BL1~3) interaction to antennas was observed with an antenna–plasma gap of 8cm (SN170043~170072).
- Total heating power for ICRF heating was up to 2.5 MW (1.25 MW (#3.5 HAS antenna) + 1.25 MW (#4.5 FIAT antenna))@3.6s (SN170086~170108) on the density ratio of hydrogen over 30% in He plasmas. There was not clear density rising during ICRF heating.

Remains for ICRF commissioning

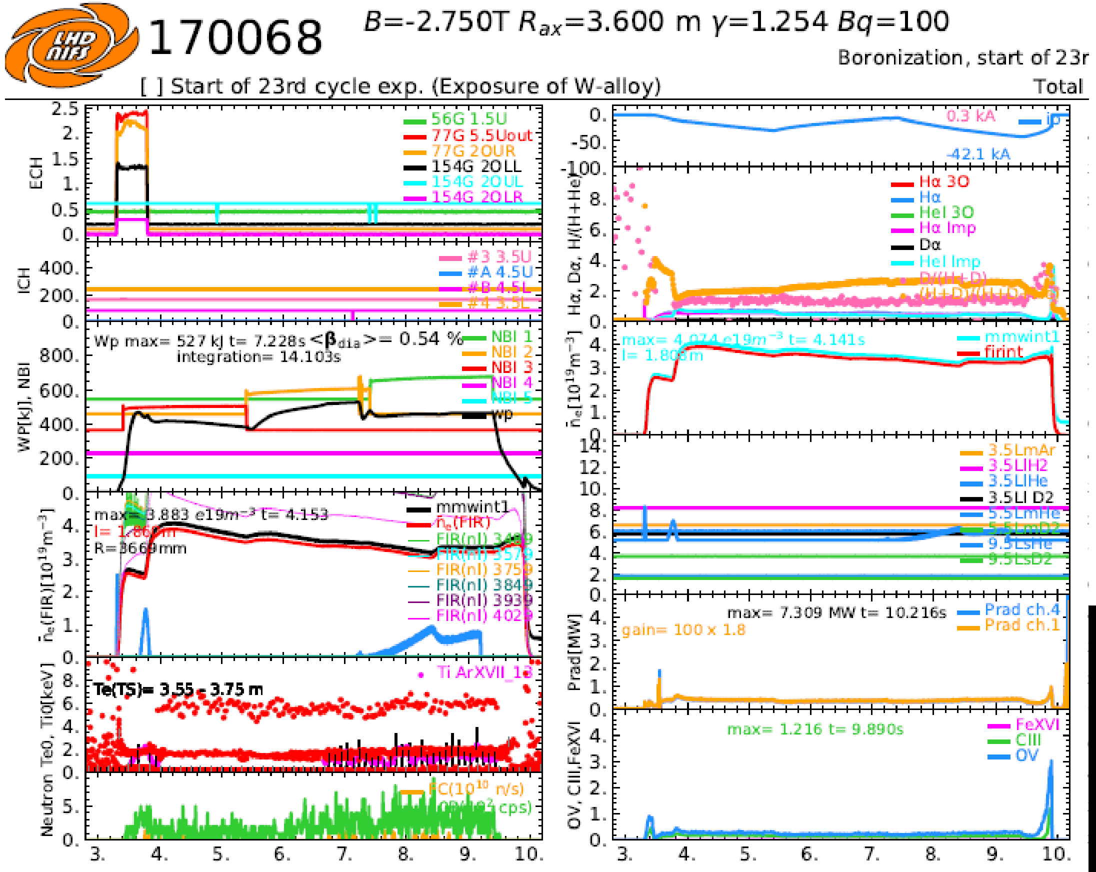
- Conditioning ICRF antennas and amplifier with high power injection(> 1MW).
- Challenge for plasma sustain only by ICRF heating (He(H), D(H) etc.)

Plasma exposure on W alloys samples

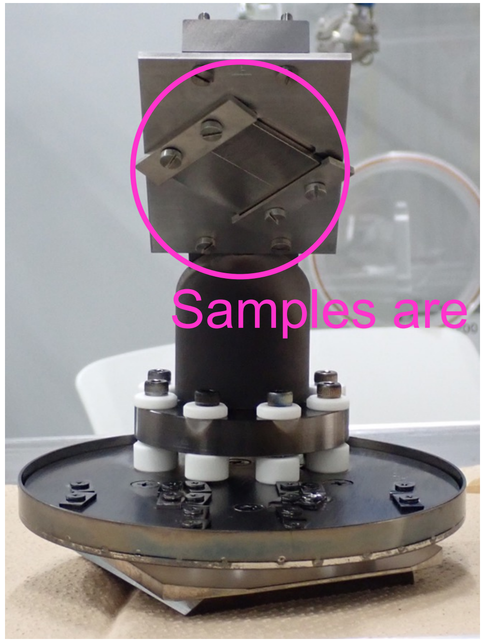
C.P. Dhard, D. Naujoks (IPP), S. Masuzaki

Shot #: 170065-170072
(R_{ax}, B_t, γ, B_q) = (3.6 m, -2.75 T, 1.2538, 100.0%)
Working gas: He
P_{NBI} ~ 3.4 MW
Three t-NBIs were injected in a “train”-style

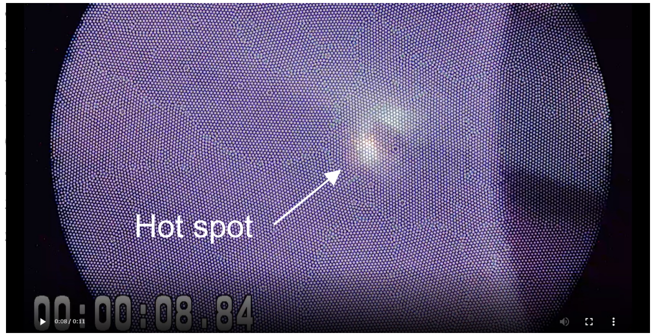
- ✓ Two W alloys (W-Cu/Ni, W-Fe/Ni) samples were exposed to divertor plasma using the manipulator at 10.5L port.
- ✓ Total ~30s exposure was conducted.
- ✓ A Hot spot was observed during exposures.
- ✓ Line emission of W is not significant,
- ✓ Surface analyses will be conducted soon.



Summary of a typical discharge in this exp.



W alloys samples on the holder (before exposure)



CCD camera view from 10.5U during an exposure

Scan of ECH focal position in plasma R. Yanai

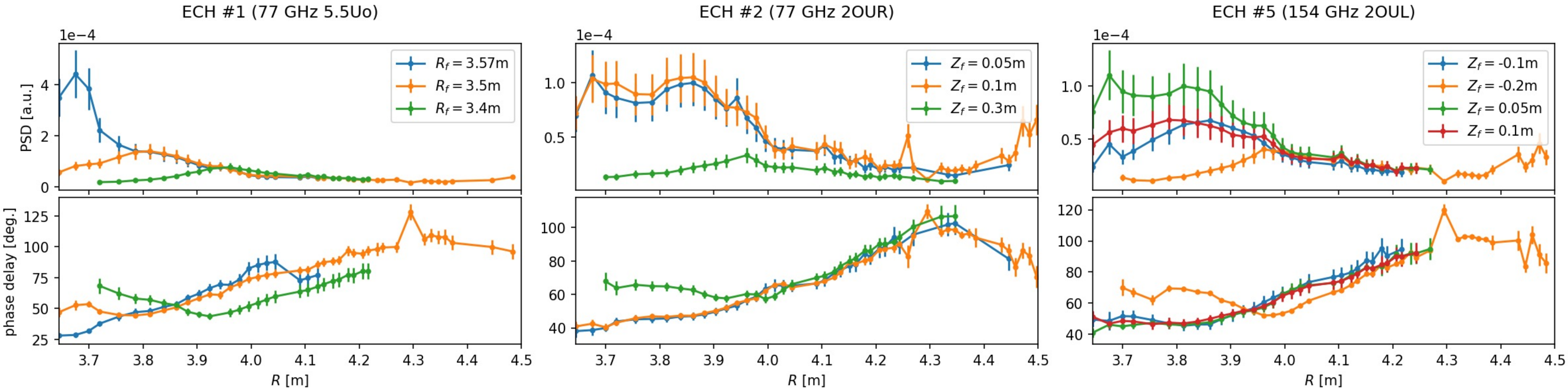
Experimental conditions: (R_{ax}, B_t, γ, B_q) = (3.6 m, -2.75 T, 1.2538, 100.0%)

- Conducting the power modulation of ECH injected into ICH plasma ($\overline{n_e} \approx 1{\times}10^{19}\ \mathrm{m}^{-3}$).
- Scanning the focal point of each antennas:

  #1 77 GHz 5.5Uo : (Tf,Zf) = (-0.05 m, 0 m), Rf = (3.57, 3.5, 3.4) m

  #2 77 GHz 2-OUR : (Rf,Tf) = (3.9 m, -0.6 m), Zf = (0.05, 0.1, 0.2, 0.3) m

  #5 154 GHz 2-OUL : (Rf,Tf) = (3.9 m, 0.2 m), Zf = (0.05, -0.1, -0.2, 0.1) m

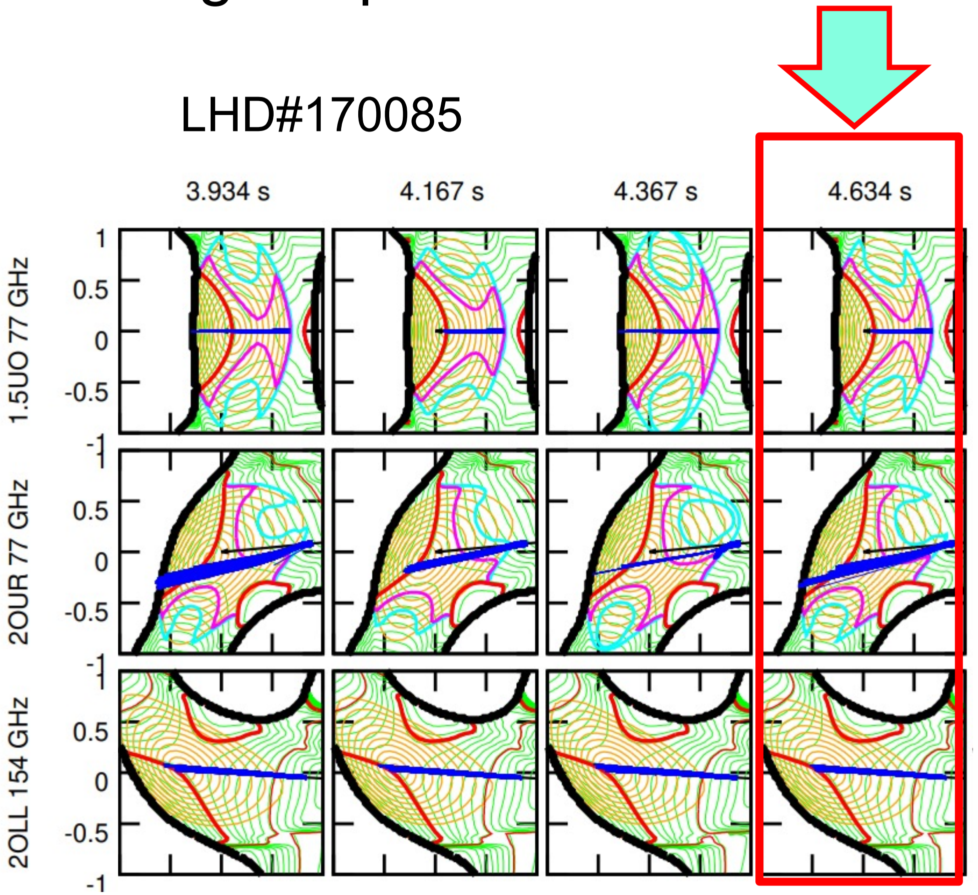


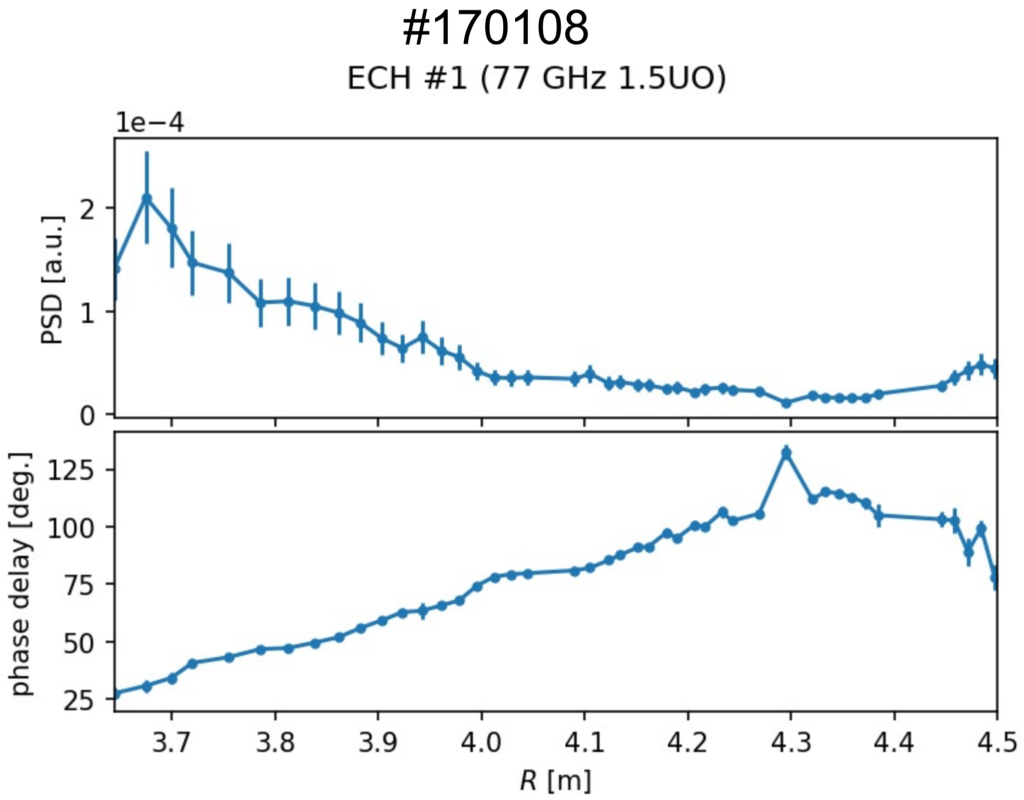
By changing each antenna direction, the PSD and phase delay profiles of ECH modulation frequency component of ECE signal were changed. We will compare these profiles with the power deposition profiles calculated by raytracing.

New 1.5UO ECH antenna commissioning R. Yanai

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

- Conducting the power modulation of ECH injected into ICH plasma ($\overline{n_e} \approx 1{\times}10^{19}\ \mathrm{m}^{-3}$).



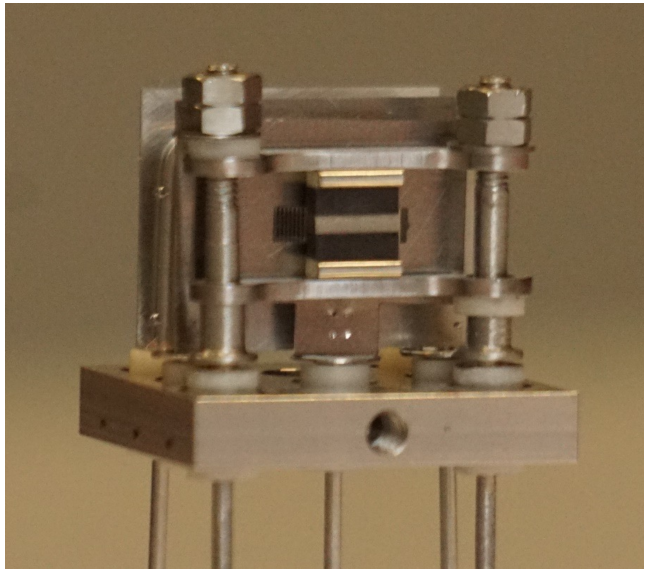


1.5-UO 77GHz beam focused well on the magnetic axis. At t = 4.634s, the difference between the new and the oblique beams is clearly observed from the raytracing results. The radial profile of the ECE PSD and phase delay also implied that the ECH power was deposited around the magnetic axis.

Performance of new pressure gauges of the ITER type

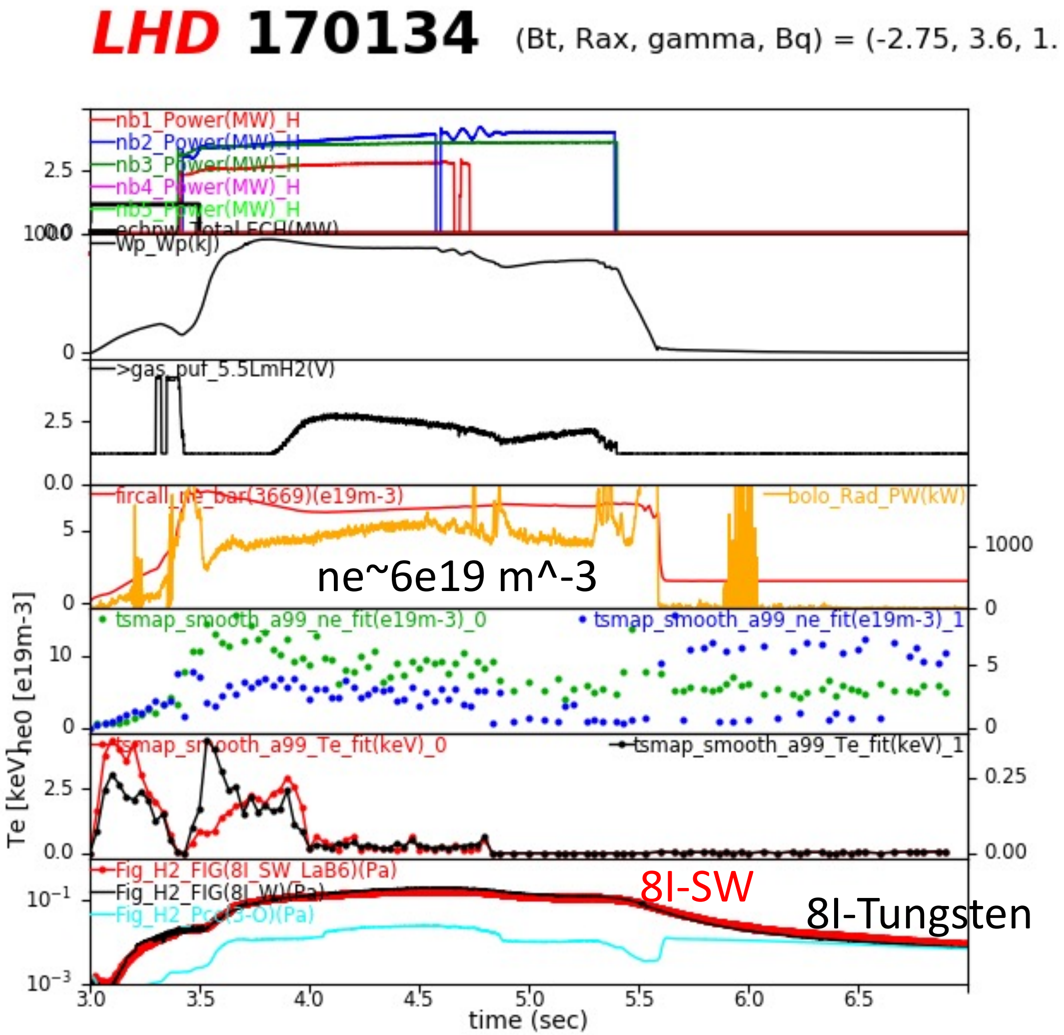
U. Wenzel (IPP), G. Motojima (NIFS), V. Haak (IPP)

SandWich type (SW)



Higher technical current limit of the cathode

LaB6 and ZrC crystal (no boron)



#171028-170134 (H gas)
#170146-170155 (D gas)

✓ Sandwich type of filament is functional. The pressure was similar to conventional tungsten filament.
✓ Density scan was conducted for the investigation of performance.