(TG1) Multi-ion group report

Dec. 27, 2022 (M. Kobayashi)

Date: Dec. 26, 2022
Time: 13:50 – 18:45
Shot#: 187158 – 187249 (92 shots)

Prior wall conditioning: H_2
Divertor pump: Off
Gas puff: H_2, He, N_2, Ne, Ar IPD: No
LID: Off TESPEL (-)
NBI#(1, 2, 3, 4, 5)=gas(H, H, H, H, H)=P(-, -, -, 3.8, -) MW
ECH(77GHz)=ant(5.5-U, 2-OUR)=P(703, -)kW
ECH(154GHz)=ant(2-OLL, 2-OUL, 2O-LR)=P(723, 799, 986) kW
ECH(116GHz)=ant(2O-LR)=P(-)kW
ECH(56GHz)=ant(1.5-U)=P(-)kW
ICH(3.5U, 3.5L, 4.5U, 4.5L) = P(0.45, 0.44, 0.69, 0.56) MW
Neutron yield integrated over the experiment = 3.4×10^{13}

Topics

1. Understanding of the origin and evolution of cosmic organic dust in an astrobiogical context (I. Sakon, M. Kobayashi, M. Shoji)
2. Advanced scenarios of ICRH plasma start-up in hydrogen minority regime (V. Moiseenko, H. Kasahara)
3. Controls of heat load on divertor tiles and fuel recycling in long pulse discharges (S. Masuzaki)

Understanding of the origin and evolution of cosmic organic dust in an astrobiological context

20221226

(I. Sakon, T. Miyata, T. Onaka, K. Kobayashi, Y. Kebukawa, J. Takahashi, M. Kobayashi, H. Nakamura, M. Shoji, S. Masuzaki)

Background & objectives:

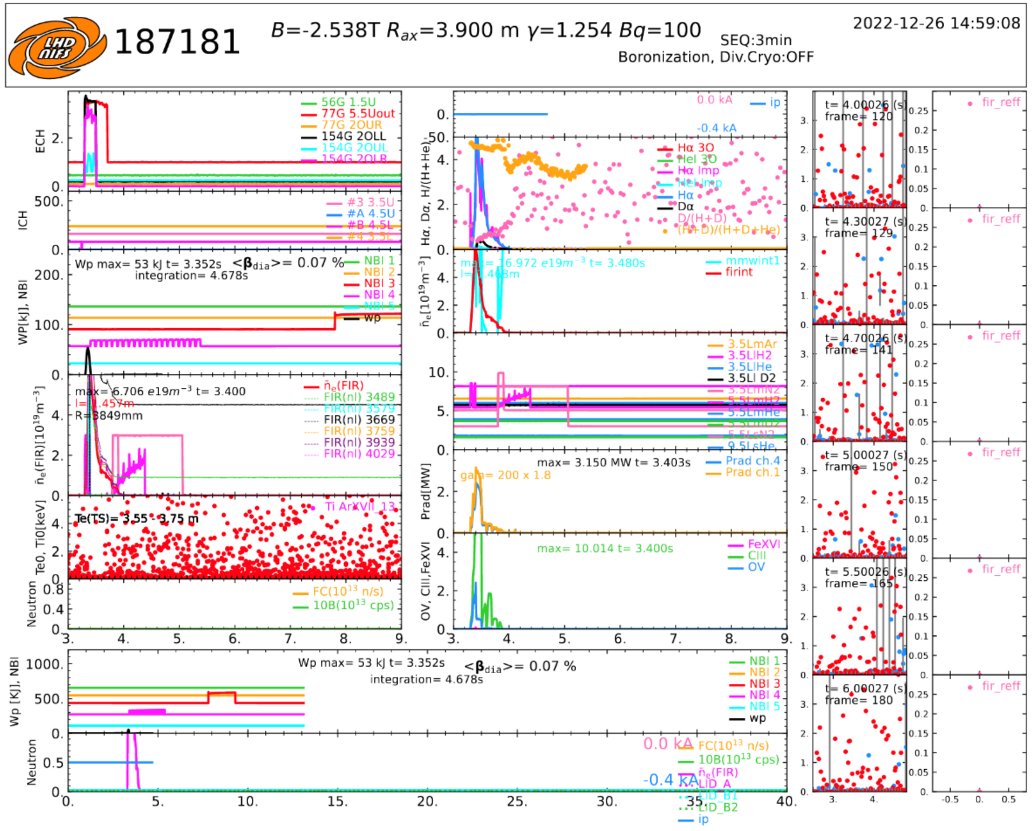
Since after the detection of unidentified infrared (UIR) bands in astrophysical environments, astronomers have demonstrated that the carriers are related to the organic compounds and are ubiquitous members of the interstellar and circumstellar medium of galaxies. However, the firm identification of the organic compounds in an actual astrophysical environment has not been made and our knowledge on their origin and the chemical link to the organic matter in our solar system is quite limited.

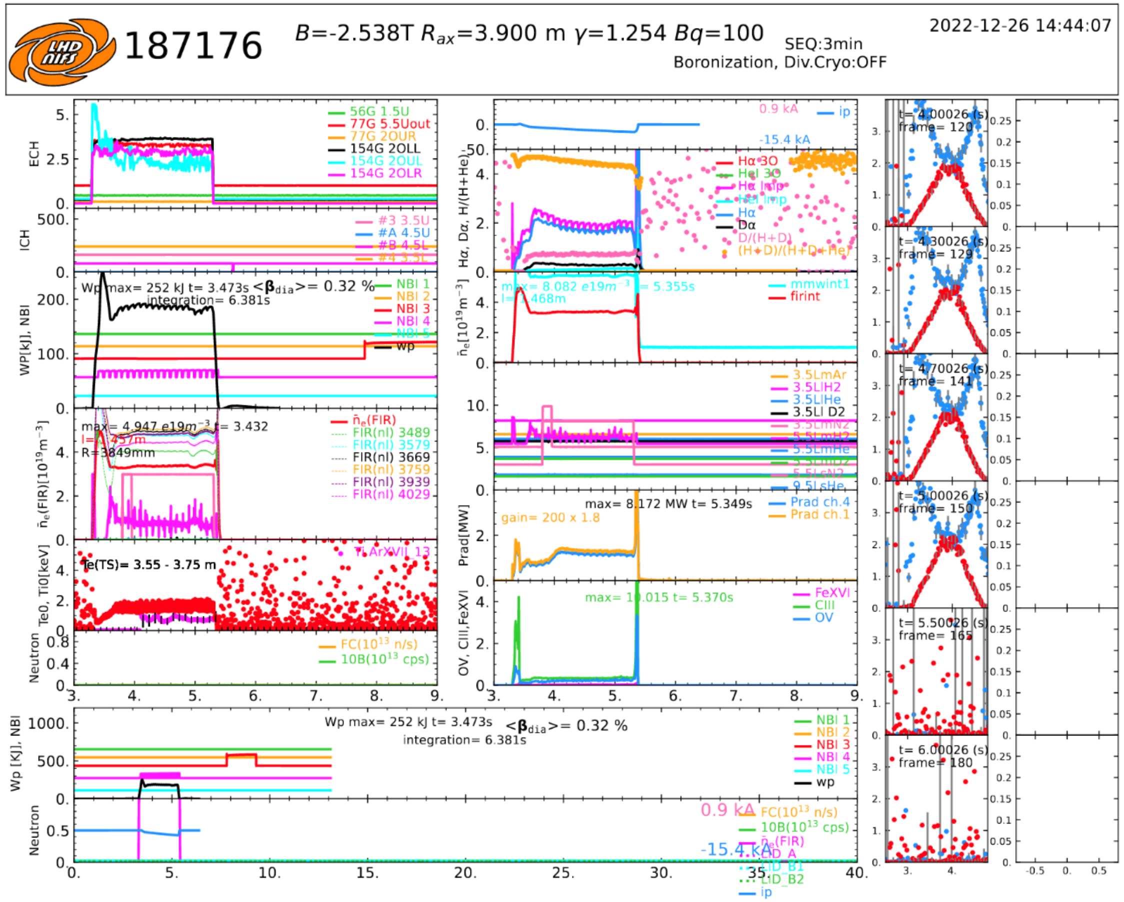
In the experiments on 26 Dec., hydrocarbon solids (filmy QCC and Coronene $C_{24}H_{12}$) are exposed to the LHD plasma (H2, N2) by means of a movable sample holder in the 4.5-U port and collect organic dust on the Si substrate. We aim to investigate how the elements in the LHD plasma (particularly nitrogen) is contained in the collected organic dust.

Results:

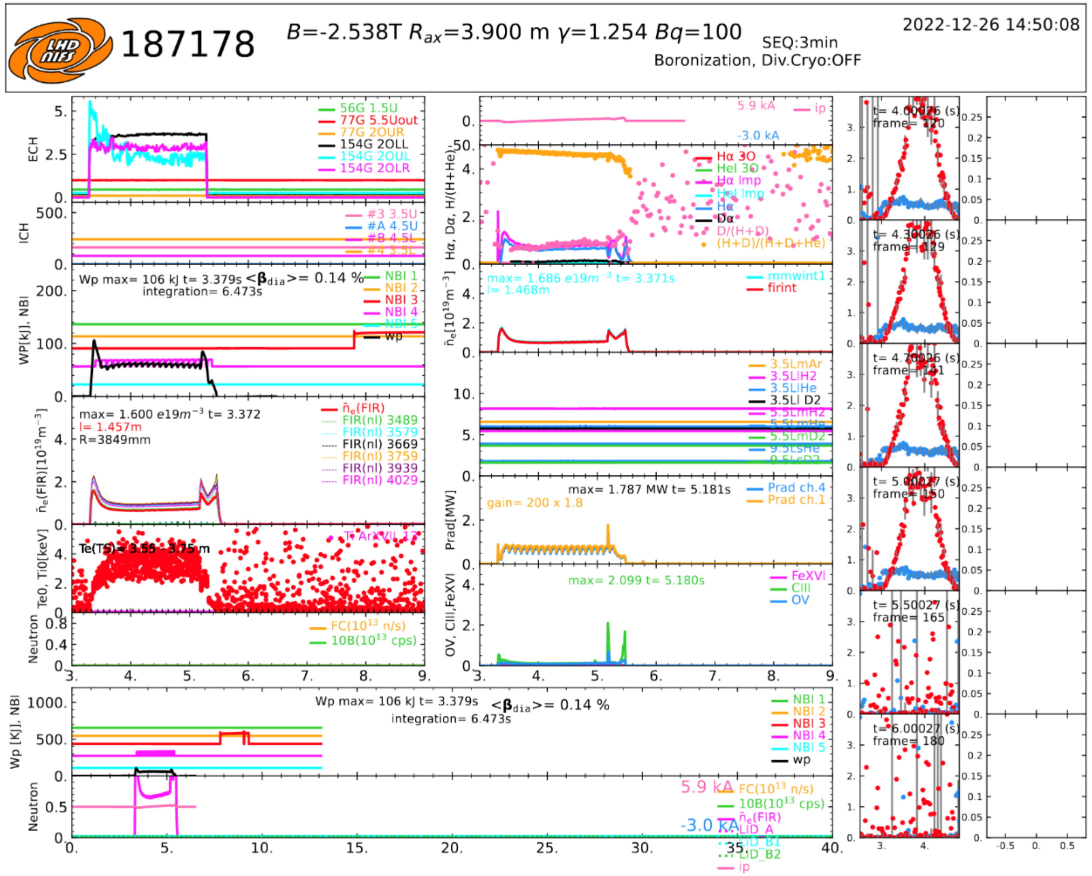
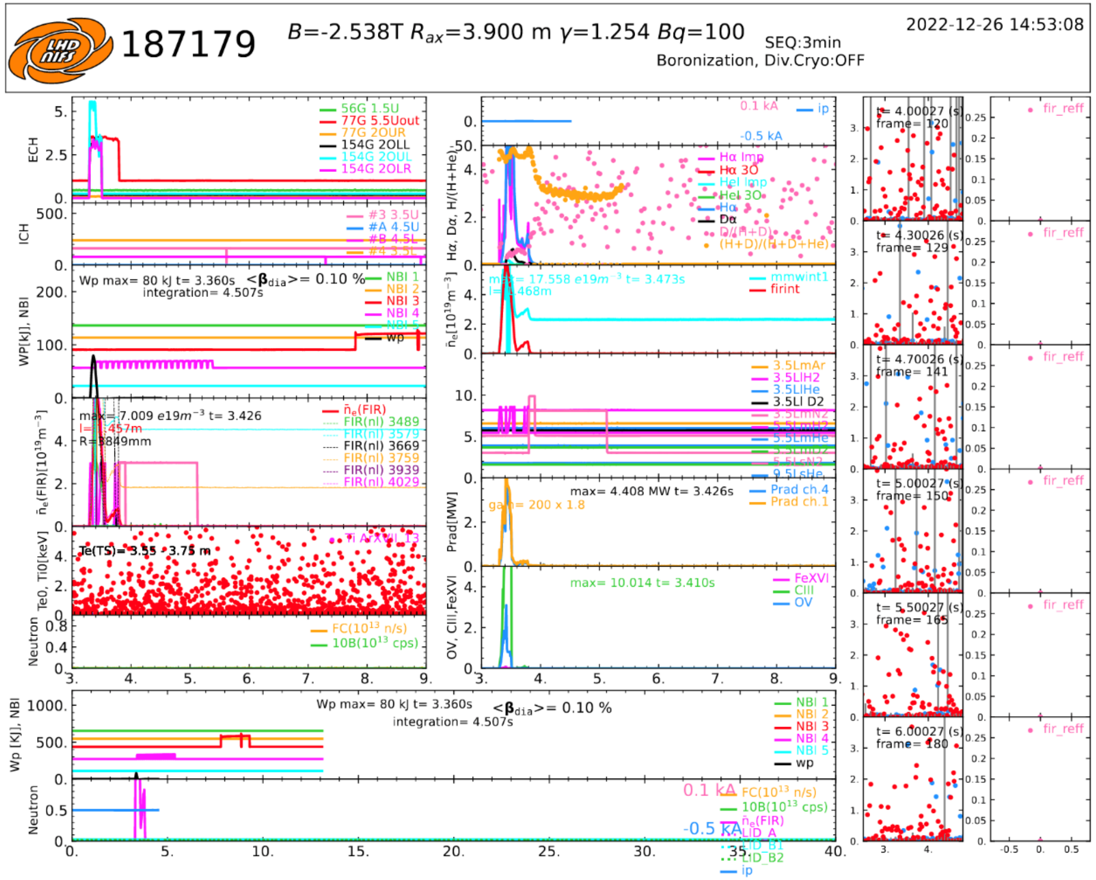
10mg of Coronene $C_{24}H_{12}$ on a Si substrate (x2) and a few mg of filmy QCC on a Si substrate (x2) are exposed to the Hydrogen and nitrogen plasma (low-energy part of the LHD plasma). N2 are supplied at 3.5L port and 5.5L port. Experiment parameters of each shot are given in the following table.

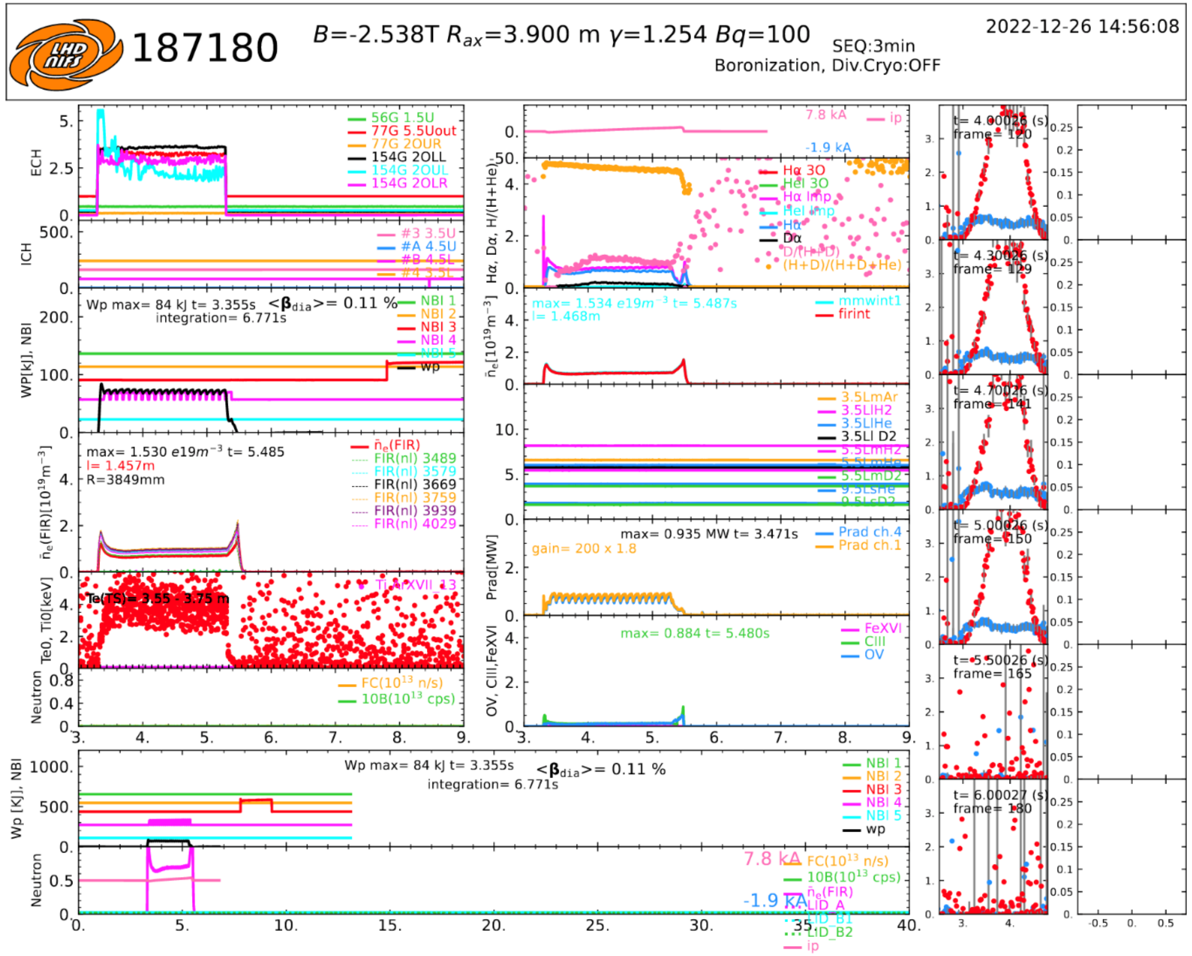
Shot ID	N2 (5.5L)	N2 (3.5L)	H (5.5L)	comment
187176	1500msec	150ms		2.806m
187177	1500msec	150ms		2.820m, collapse
187178	None	None		2.820m
187179	1500msec	100msec		2.830m
187180	None	None		2.840m
187181	1500msec	100msec		2.850m, collapse

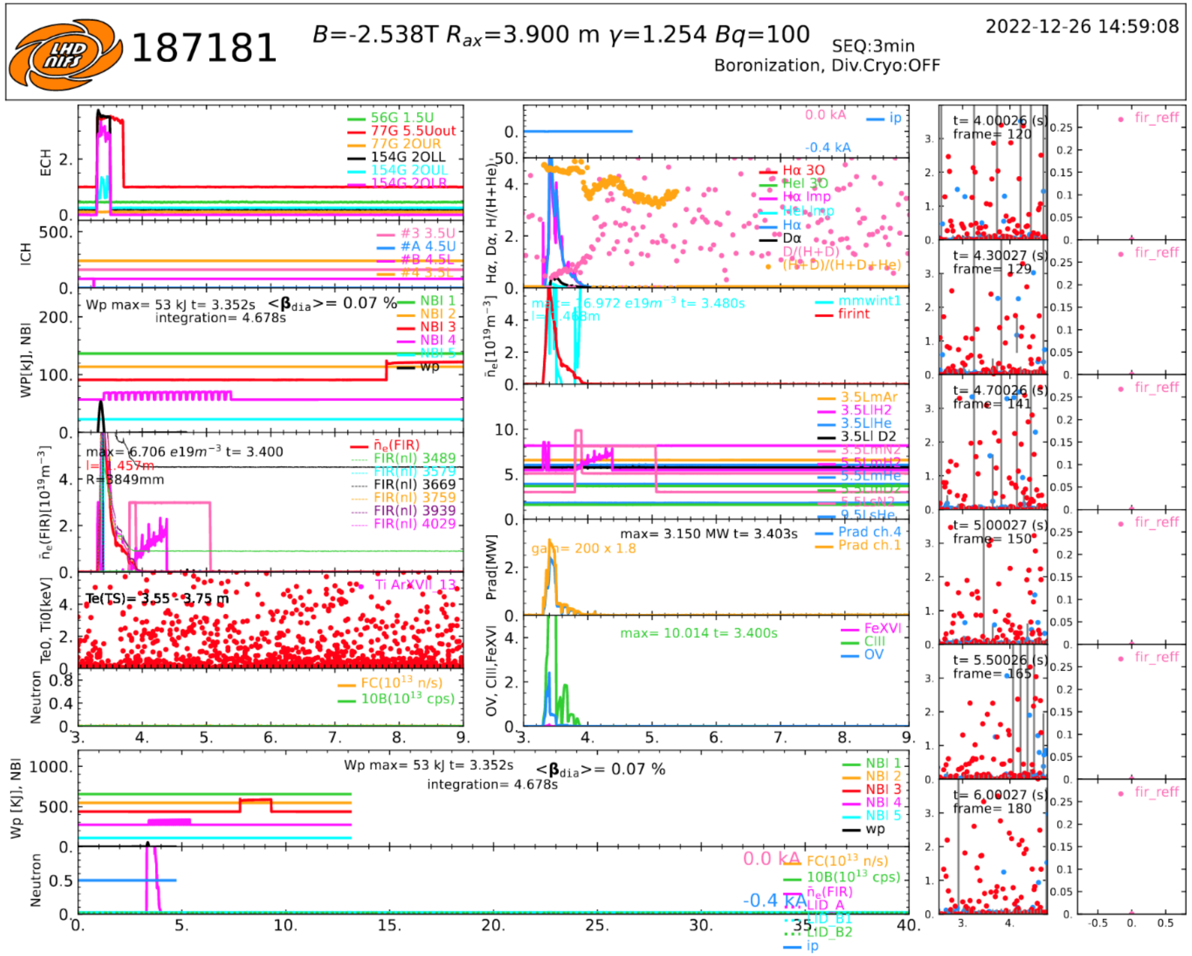



187176
B=-2.538T Rax=3.900 m γ=1.254 Bq=100
SEQ:3min
Boronization, Div.Cryo:OFF
2022-12-26 14:44:07
Wp max= 252 kJ t= 3.473s
integration= 6.381s

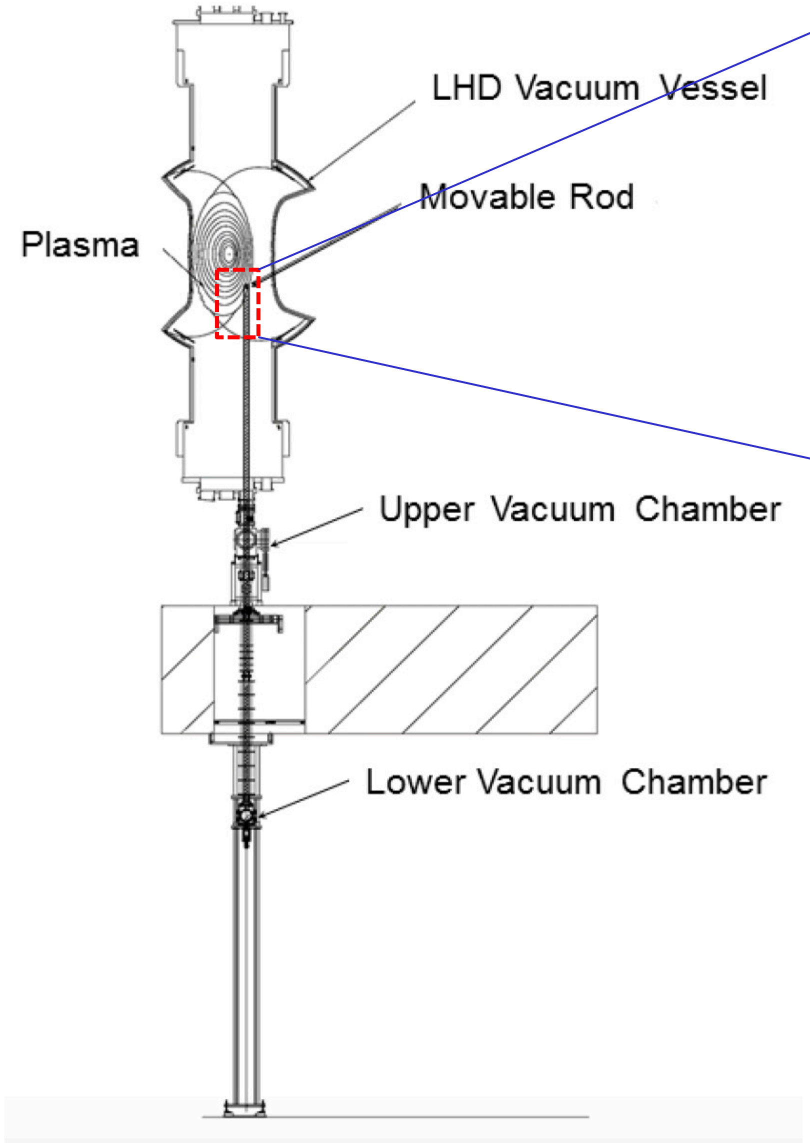

187177
B=-2.538T Rax=3.900 m γ=1.254 Bq=100
SEQ:3min
Boronization, Div.Cryo:OFF
2022-12-26 14:47:08
Wp max= 75 kJ t= 3.354s
integration= 4.584s


187178
B=-2.538T Rax=3.900 m γ=1.254 Bq=100
SEQ:3min
Boronization, Div.Cryo:OFF
2022-12-26 14:50:08
Wp max= 106 kJ t= 3.379s <βdia>= 0.14 %
integration= 6.473s
max= 1.600 e19m-3 t= 3.372
R=3849mm
max= 1.787 MW t= 5.181s
gain= 200 x 1.8
max= 2.099 t= 5.180s
ECH
ICH
WP[kJ], NBI
Te0, Ti0[keV]
Neutron
Prad[MW]
OV, CIII,FeXVI
Wp [KJ], NBI
5.9 kA
-3.0 kA

187179
B=-2.538T Rax=3.900 m γ=1.254 Bq=100
SEQ:3min
Boronization, Div.Cryo:OFF
2022-12-26 14:53:08
Wp max= 80 kJ t= 3.360s <βdia>= 0.10 %
integration= 4.507s
max= 7.009 e19m-3 t= 3.426
max= 4.408 MW t= 3.426s
max= 10.014 t= 3.410s
ECH
ICH
WP[kJ], NBI
Te0, Ti0[keV]
Neutron
Prad[MW]
OV, CIII,FeXVI
Wp [KJ], NBI
0.1 kA
-0.5 kA

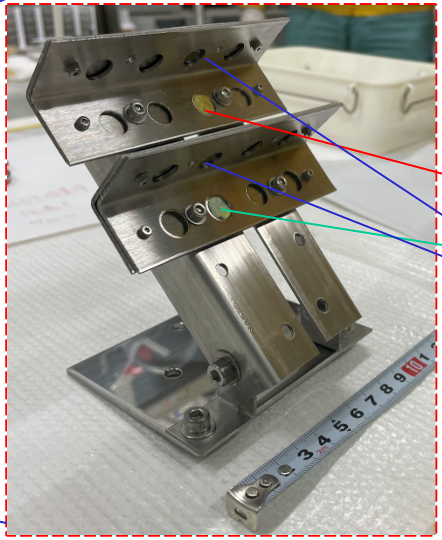

187180
B=-2.538T Rax=3.900 m γ=1.254 Bq=100
SEQ:3min
Boronization, Div.Cryo:OFF
2022-12-26 14:56:08
Wp max= 84 kJ t= 3.355s <βdia>= 0.11 %
integration= 6.771s


187181
B=-2.538T Rax=3.900 m γ=1.254 Bq=100
SEQ:3min
Boronization, Div.Cryo:OFF
2022-12-26 14:59:08
Wp max= 53 kJ t= 3.352s <βdia>= 0.07 %
integration= 4.678s

Experiment on LHD: Approach and Methodology (24 October, 2022)



the movable sample holder installed in 4.5-U port (M. Shoji 2020)



Experiment on 24 Oct.

$C_{24}H_{12}$ on Si substrate x 1
$C_{14}H_{10}$ on Si substrate x 1
Blank Si Substrates x 2

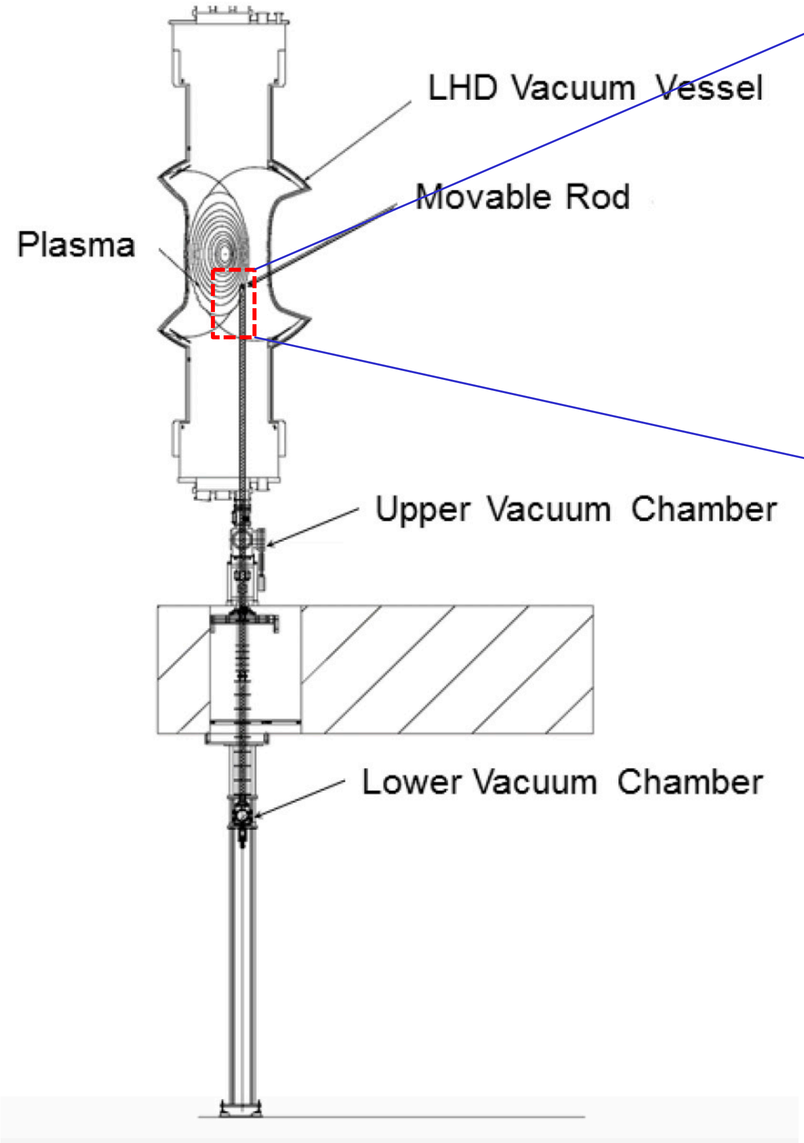
We plan to compare the IR (ATR FT-IR Microspectroscopy) and X-ray (X-ray Absorption Near-Edge Structure Analysis) properties of organic dust collected on the Si substrates at different slots

- The flow level of plasma
- The chemical composition of the plasma (H, D, N, C)
- The chemical composition of the raw carbonaceous solids (PAHs, filmy QCC, C60, Graphite, CNT etc.)

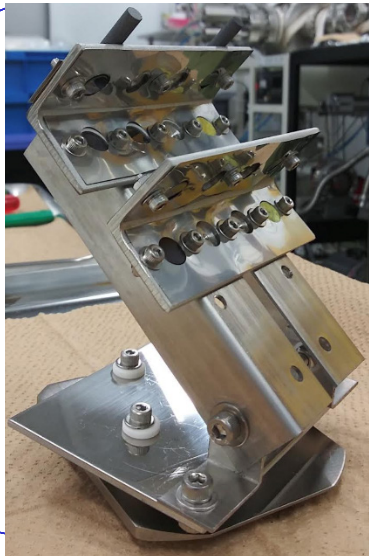
The obtained knowledge will help

- interpret the nature of the carriers of UIR bands observed around dusty novae with TAO/MIMIZUKU
- investigate the evolutional link between the organic dust synthesized in the stellar ejecta and the primitive organics in our solar system.

Experiment on LHD: Approach and Methodology (26 December, 2022)



the movable sample holder installed in 4.5-U port (M. Shoji 2020)



Experiment on 26 Dec.

C24H12 on Si substrate x 2
Filmy QCC on Si substrate x 2
Blank Si Substrates x 5

We plan to compare the IR (ATR FT-IR Microspectroscopy) and X-ray (X-ray Absorption Near-Edge Structure Analysis) properties of organic dust collected on the Si substrates at different slots

- The flow level of plasma
- The chemical composition of the plasma (H, N)
- The chemical composition of the raw carbonaceous solids (PAHs, filmy QCC)

The obtained knowledge will help

- interpret the nature of the carriers of UIR bands observed around dusty novae with TAO/MIMIZUKU
- investigate the evolutional link between the organic dust synthesized in the stellar ejecta and the primitive organics in our solar system.

Advanced scenarios of ICRH plasma start-up in hydrogen minority regime (V. Moiseenko, Y. Kovtun, H. Kasahara)

Magnetic Configuration, Shots

(R_{ax}, Polarity, B_t, γ, B_q) = (3.6 m, CCW, 2.75 T, 1.2538, 100.0%), #187182 – #187236

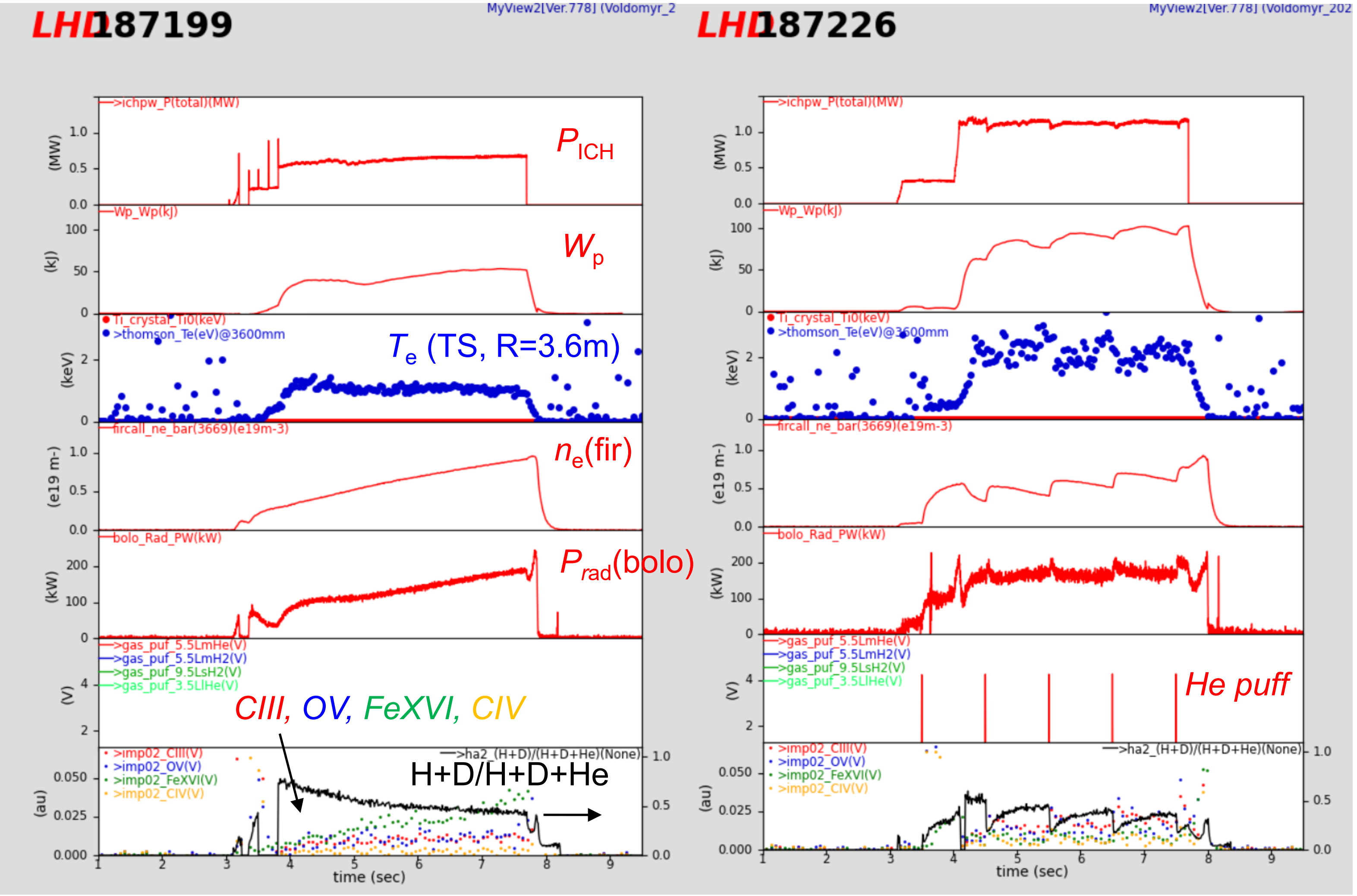
The goal of this experiment:

Demonstration of plasma production only by ICH in He(H) plasma with T_{e0} > 1 keV and n_{e0} > $1\text{x}10^{19}$ m^{-3}.

Results:

- This is the first time to get plasma productions with center electron temperature over one keV using only ICH in He(H) plasma
- In the particular neutral pressure condition for He, electron temperature can increase, and in the lower neutral pressure condition, electron density increases without the increase of electron temperature.
- Neutral pressure seems to be a key role in plasma production only by ICH.

Plasma production by only ICH



No fueling

Additional He fueling

Control of heat load on divertor tiles in long pulse discharges

S. Masuzaki

Shot #: 187237 - 187249
(R_{ax}, B_t, γ, B_q) = (3.6 m, -2.75 T, 1.2538, 100.0%)

Working gas: He, Seeding gas: Ne
Heating: ECH 0.7 ~ 1 MW, ICH; ~2 MW

- During long pulse discharges, more than a minute, with ICH and ECH, it has been observed radiative collapse following the gradual increase of electron density. A possible cause of this density increase is the outgas from plasma facing components such as divertor tiles. Reduction of divertor heat load is a possible method to reduce the outgas. The aim of this experiment is to explore the impurity seeding condition for reduction of divertor heat load during a long pulse discharge with ECH and ICH.
- Ion saturation current measured at 10I divertor tile was used for the reference signal for the feedback control of the impurity seeding.
- The examined impurity seeding condition are shown in the table. Stable reduction of the ion saturation current could not obtained. The proper conditions of impurity seeding for reduction of the divertor heat load could not be found during the limited experimental time. Further explore is necessary.

Gas puff port	impurity	Target voltage [V]	Piezo voltage [V]	Gas puff duration	Frequency
5.5L	Ne	0.5	3, 4, 4.5	5ms	20 Hz
3I	Ne	0.5	3, 5	5ms	20 Hz

Calibration of Optical Penning (7O) and WISP (6I) Gauges

Conditions:

1. (R_{ax}^{VAC}, Polarity, B_t, γ, B_q) = (3.60 m, CCW, 2.75 T, 1.254, 100.0%)
   (18:45 – 19:45) no plasma, Gas and Pressure : H_2 , D_2 and He, 0.05 – 0.5 Pa

Purposes:

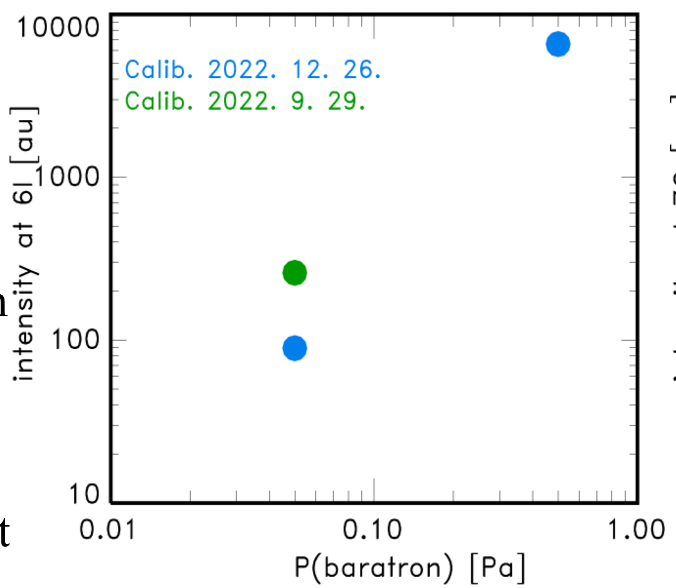
(1) Neutral pressure calibration for the optical Penning gauge at 7O and WISP at 6I with H_2 , D_2 and He.

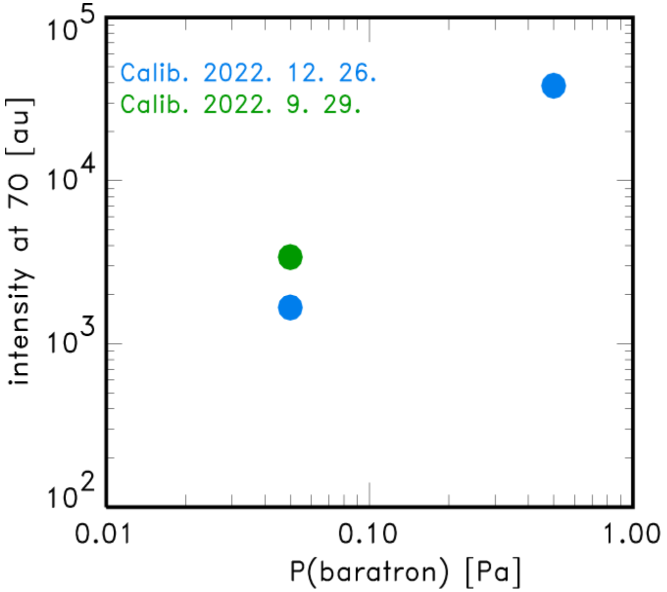
Results:

・ The right Figures show the calibration results with helium on 26 Dec. 2022 and 28 Sep. 2022.
The blue data include small amount of hydrogen.

・ It seems that the intensity become almost half at both 6I and 7O. It is similar in the hydrogen case. The direction of B was CW in 28 Sep, but a permanent magnet is used at 7O.

・ The reason is not clear now, but this is because of not only the change at the side of 6I WISP. It is needed to refer the pressure data during the 24th cycle experiment.





P(baratron) P(baratron)

Fig.: Helium pressure calibration results.
left : WISP at 6I right : 7O Penning gauge