(TG1) Multi-ion group report

Dec. 6, 2022 (G. Motojima)

Date: Dec. 2, 2022
Time: 9:53-18:44
Shot#: 185001-185111 (111shots)

Prior wall conditioning: No

Divertor pump: Yes
Gas puff: D_2, H_2
H/D pellet: Yes

NBI#(1, 2, 3, 4, 5) = gas(H, H, H, D, D) = P(3.2,3.7,3.7,0.9,8.7)MW

ECH(77 GHz) = ant(5.5-Uout, 2-OUR) = P(209,0) kW
ECH(154 GHz) = ant(2-OLL, 2-OUL , 2-OLR) = P(205,203,237) kW
ECH(56 GHz) = ant(1.5U) = P(-) kW
ICH(3.5U, 3.5L, 4.5U, 4.5L) = P(0.63,0.55,0.76,0.33) MW
Neutron yield integrated over the experiment = 3.1×10^{15} (TG1)
Topics

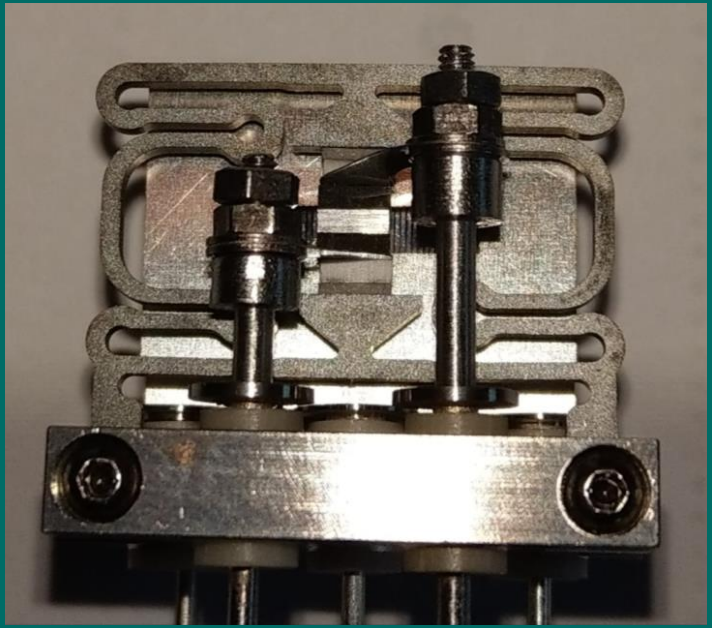
1. Performance of the ITER pressure gauge during D-D operation (U. Wenzel (IPP), G. Motojima)
2. Optimization of Minority proton ratio for ICRF long pulse discharge. (R. Seki)
3. Controls of heat load on divertor tiles and fuel recycling in long pulse discharges (S. Masuzaki)
4. Demonstrated controlled plasma operation for long-pulse plasmas duration with ICRF heating and time evolution of particle confinement time in D plasmas(H. Kasahara)

NIFS

MAX-PLANCK-INSTITUT FÜR PLASMAPHYSIK

Performance of the ITER pressure gauge during D-D operation

- -Performance check after D-D phase
- -Extension of the electron current to 800 μA
- -Demonstrate high-pressure operation
- -Demonstrate long-pulse operation



U. Wenzel, G. Motojima, V. Haak

F4E, ITER IO

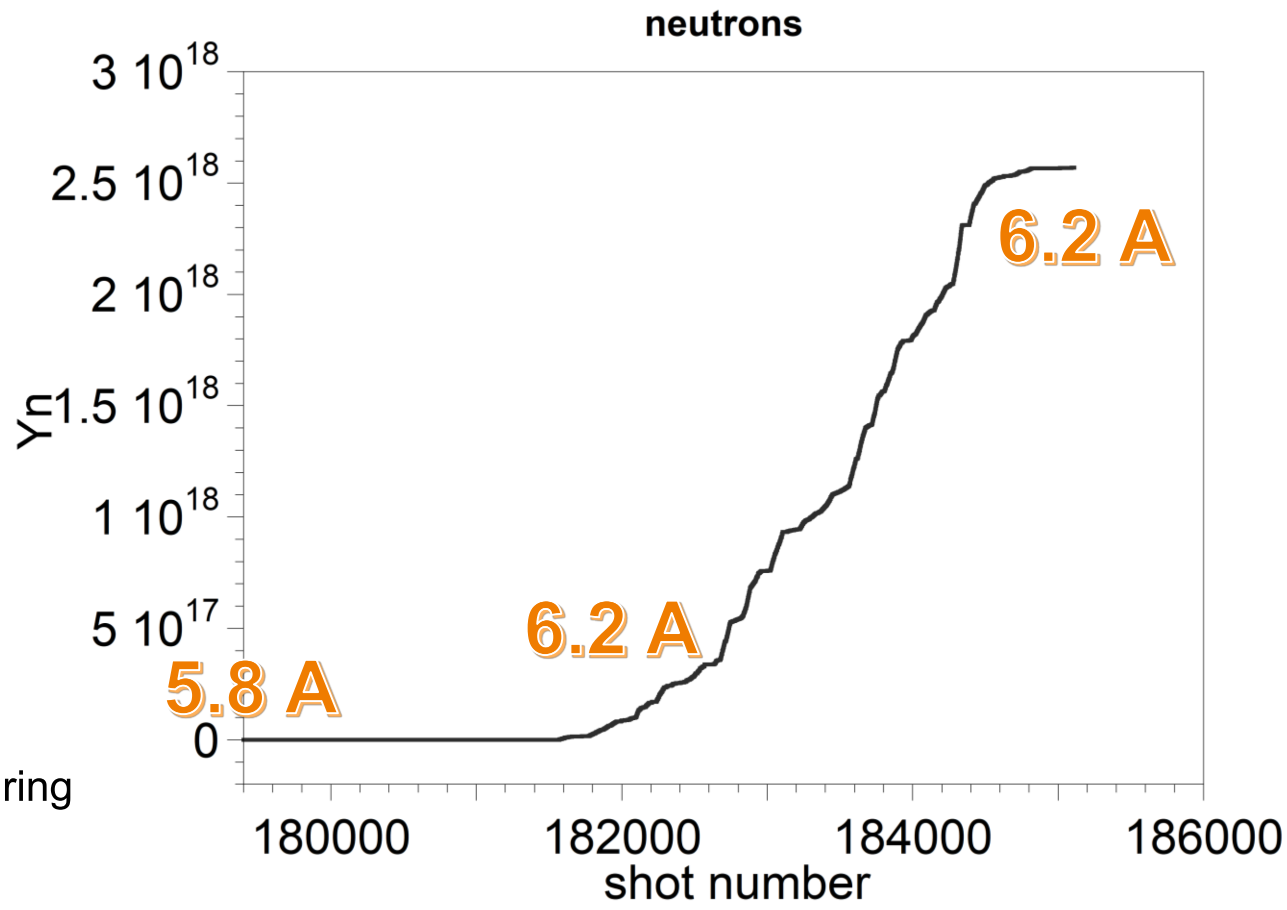
EUROfusion

This work has been carried out within the framework of the EUROfusion Consortium, funded by the European Union via the Euratom Research and Training Programme (Grant Agreement No 101052200 — EUROfusion). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Commission. Neither the European Union nor the European Commission can be held responsible for them.

Performance during D-D operation

Performance means basically the heating current in order to generate an electron current of 200 μA at the anode grid. It must be lower than the current limit of 9 A. The lower, the better.

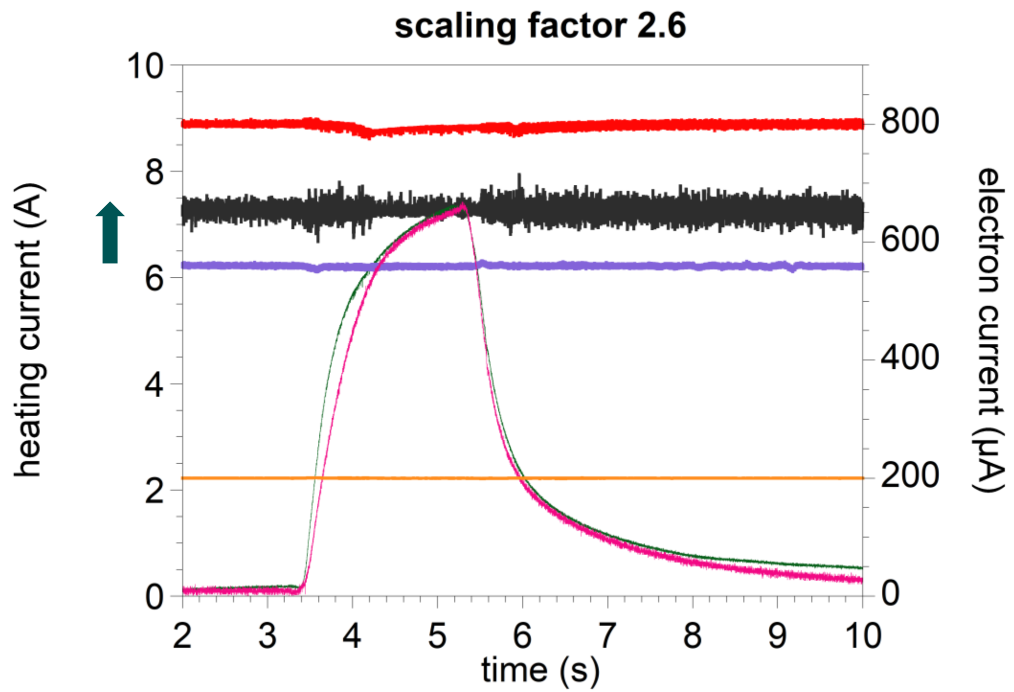
Small increase during the hydrogen operation, but no change during D-D operation!



ZrC cathodes have a great performance also during D-D operation with neutrons.

The Wendelstein design with LaB_6 is not suited for this purpose. The mechanism of the crash of electron emission is not clear.

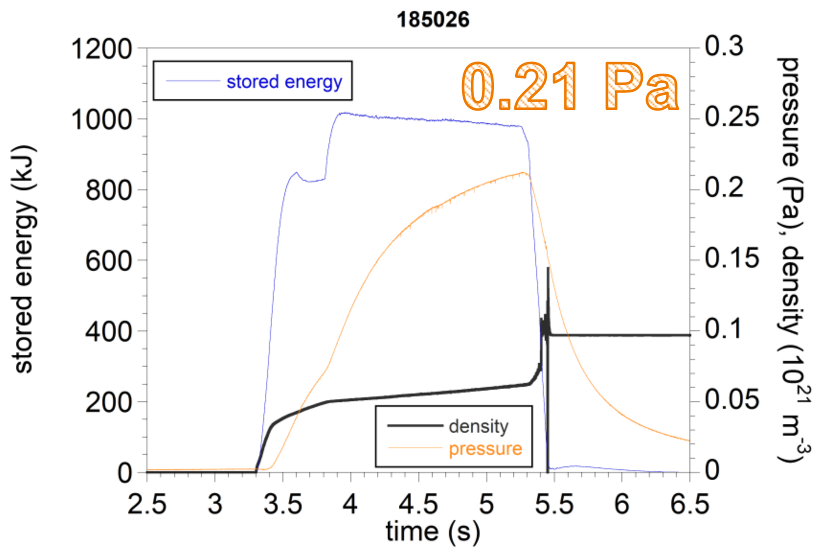
Extension of the electron current range



#185004 with 200 μA and 6.2 A

#185022 with 800 μA and 7.3 A

- High-pressure operation with 800μA



- Long-pulse operation with 800 μA over 340 s was also demonstrated on the same day (#108111)

Very good performance of the ITER design in the high-current electron range and with neutrons

Optimization of Minority proton ratio for ICRF long pulse discharge. (R. Seki)

Shot #:185033-185079

Experimental conditions: (R_{ax}, Polarity, B_t, γ, B_q) = (3.6, CW, 2.75, 1.2538, 100), H/(D+H) =5%-15 %,Picrf~1.8 MW

Background and motivation:

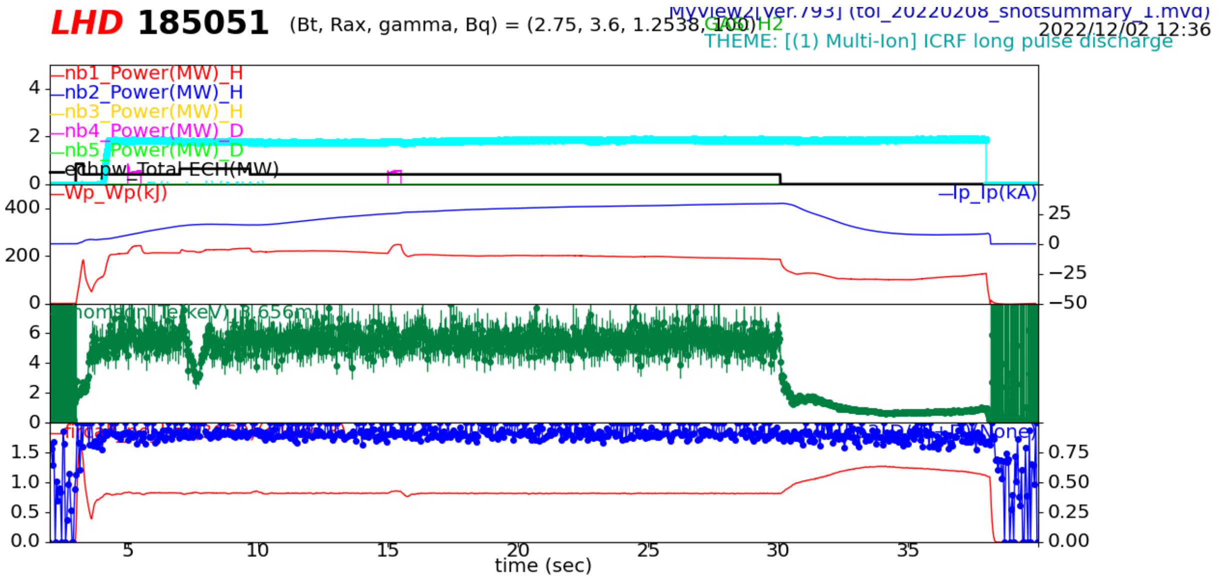
・It is difficult to maintain the D plasma with a minority proton ratio << 1% by only ICRF heating.

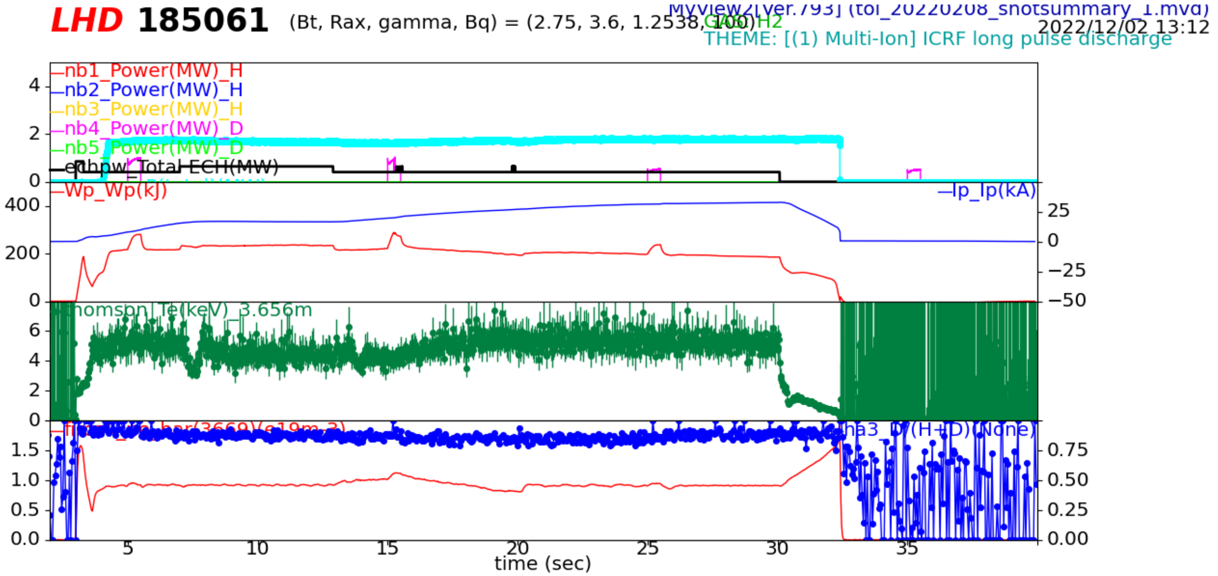
・An independent heating system that can maintain plasma is required for discharges of about 1 hour.

・Optimization of ICRF minority proton heating is important for steady-state operation.

Results:

- The D plasma with plasma density of 0.8×10^{19} m^{-3} before ECH turn off can be sustained by only ICRF heating. After ECH turns off, controlling the plasma density in the only ICRF heating phase is difficult.
- The plasma density of more than 0.8×10^{19} m^{-3} cannot be sustained because the amount of H gas could not be increased while maintaining the plasma density.





Controls of heat load on divertor tiles and fuel recycling in long pulse discharges

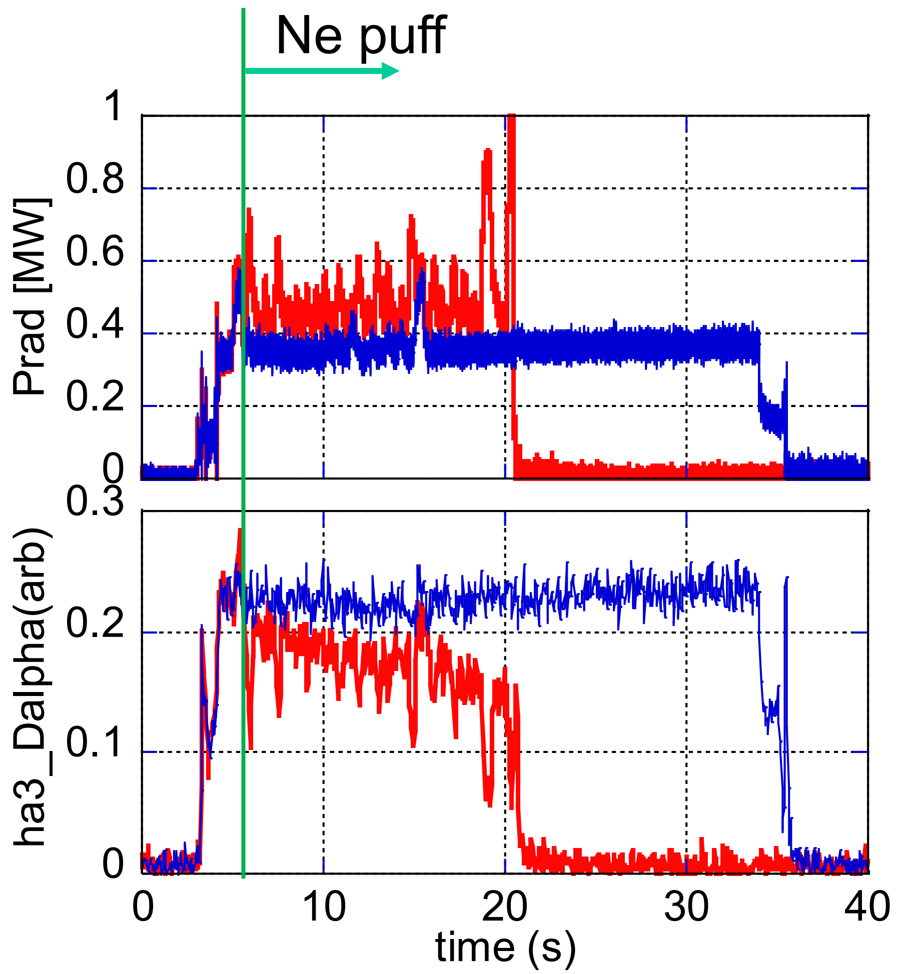
S. Masuzaki

(Rax, Polarity, Bt, γ, Bq) = (3.6 m, CW, 2.75 T, 1.2538, 100.0%), #185062 – #185111
ICH: 1.5-1.8MW, ECH: 0.4-0.6MW

- Reduction of divertor heat load and recycling control are necessary to sustain very long pulse discharge.
- The impurity seeding was conducted to increase the radiation power and the degree of detachment during long pulse discharges.
- IPD was also operated to reduce recycling and impurities in plasma.

Results

- Neon seeding was conducted with feedback control using the radiation power signal. If the radiation power is smaller than the set point such as 0.6 MW, neon gas was injected.
- During long pulse discharges, the heating power was not so stable. Therefore plasma collapsed when the heating power decreased.
- The feedback control for impurity seeding should be improved to be able to go along with the change of the heating power.



Prad and Da intensity in #185087 (w/o Ne) and #185088 (w/ Ne)

Demonstrated controlled plasma operation for long-pulse plasmas duration with ICRF heating and time evolution of particle confinement time in D plasmas(H. Kasahara)

Magnetic Configuration, Shots

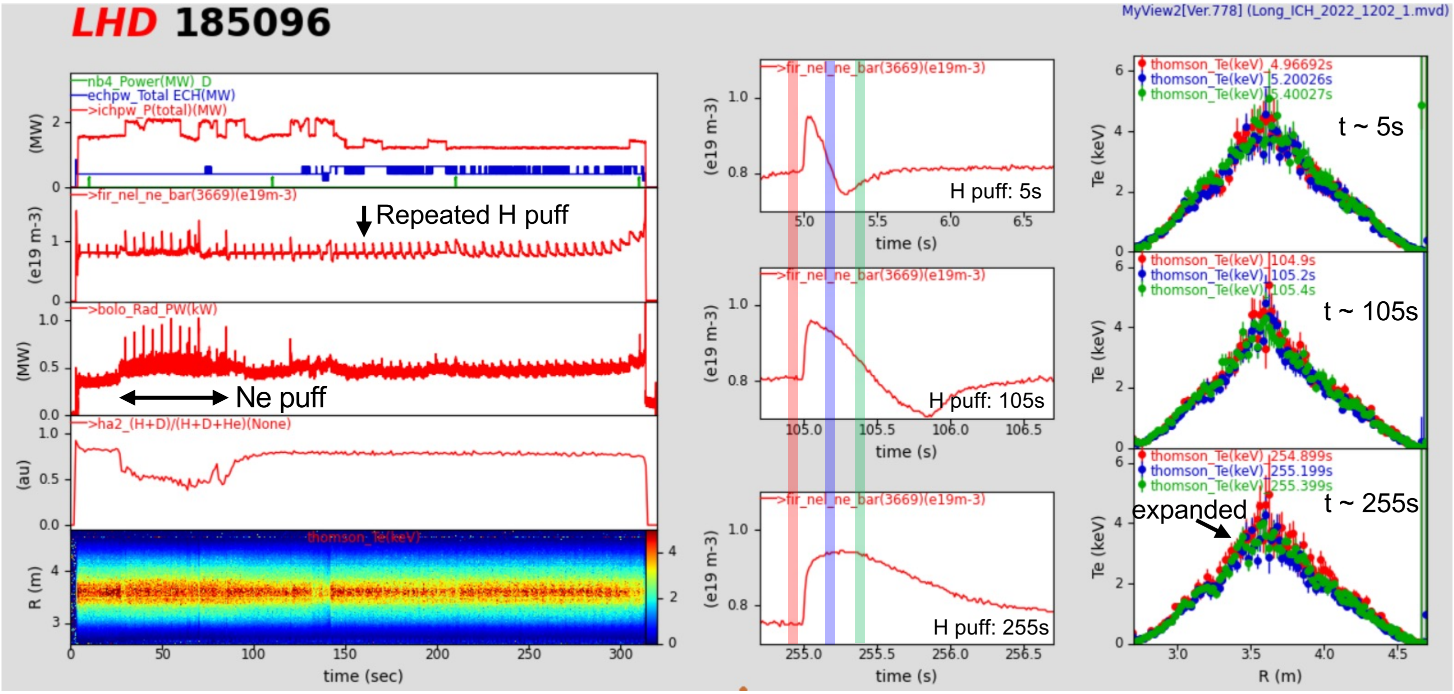
(R_{ax}, Polarity, B_t, γ, B_q) = (3.6 m, CW, 2.75 T, 1.2538, 100.0%), #185082 – #185111

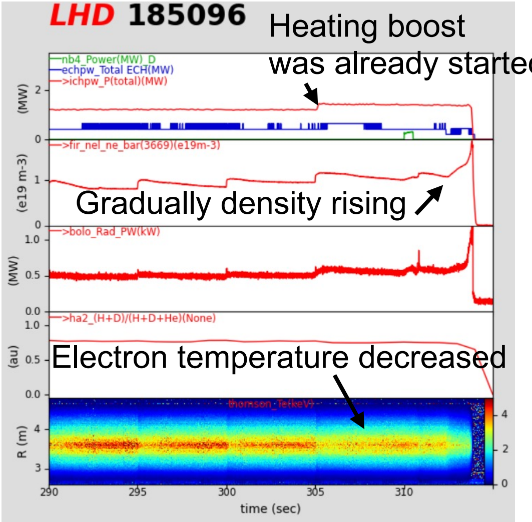
The goal of this experiment:

Demonstrating steady-state long-pulse D plasmas and revealing the time evolution of particle confinement tie in long-pulse operation.

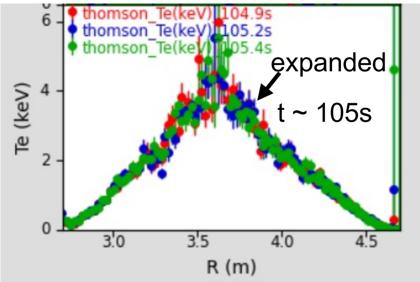
Results:

- Long-pulse plasma duration with a duration time over 300 sec was demonstrated with electron density 0.8-1.2x10^{19} m^{-3}.
- At t ~ 300 sec, we could not mitigate the density rising event with heating power boost and/or Ne puffing. The event seems to be related to the temperature in the vacuum vessel.
- We observed the differences in particle confinement time as increased plasma duration time (t = 5s, 105s, 255s).
- We conduct the transport analysis associated with particle confinement time.

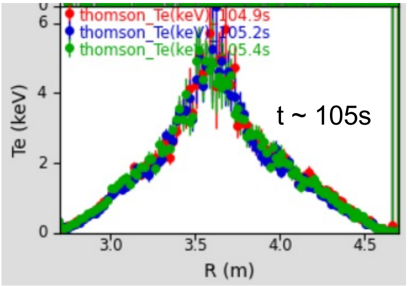




#185099
w/o H puff, n_{e0} ~ 0.8x10^{19} m^{-3}



#185095
with H puff, n_{e0} ~ 0.8x10^{19} m^{-3}



H puff is effectively working to increase the center of electron temperature with P_{RF} ~ 2MW.