(IA) Instability & Anisotropy Session report

June 19, 2024 (Y. Takemura)

Date: June 18, 2024
Time: 10:30 - 16:45
Shot#: 193394-193476 (83 shots)

Prior wall conditioning: None, Divertor pump: Off
Gas puff: H2, Pellet: None
NBI#(1, 2, 3, 4, 5)=gas(H, H, H, H, H)=P(4.1, 2.5, 3.1, 3.8, 3.6)MW
ECH(56GHz)=ant(1.5-U)=P(-)MW
ECH(77GHz)=ant(5.5-U, 2-OUR)=P(0.337, 0.380)MW
ECH(116GHz)=P(-)MW
ECH(154GHz)=ant(2-OLL, 2-OUL, 2O-LR)=P(-, -, 0.982)MW
ICH(3.5U, 3.5L, 4.5U, 4.5L) = P(0.20, -, -, -)MW
Topics

1. Development operational scenarios of stochastic acceleration in LHD (S. Kobayashi (Kyoto-U), K. Nagaoka)
2. Construction of exp. scaling law of Ext.-RMP penetration threshold (K.Y.Watanabe, S.Shimode(Nagoya-U))
3. Plasma shape effect on BSC in high collisional regime (O.Mitarai, K.Y.Watanabe)

Development operational scenarios of stochastic acceleration in LHD

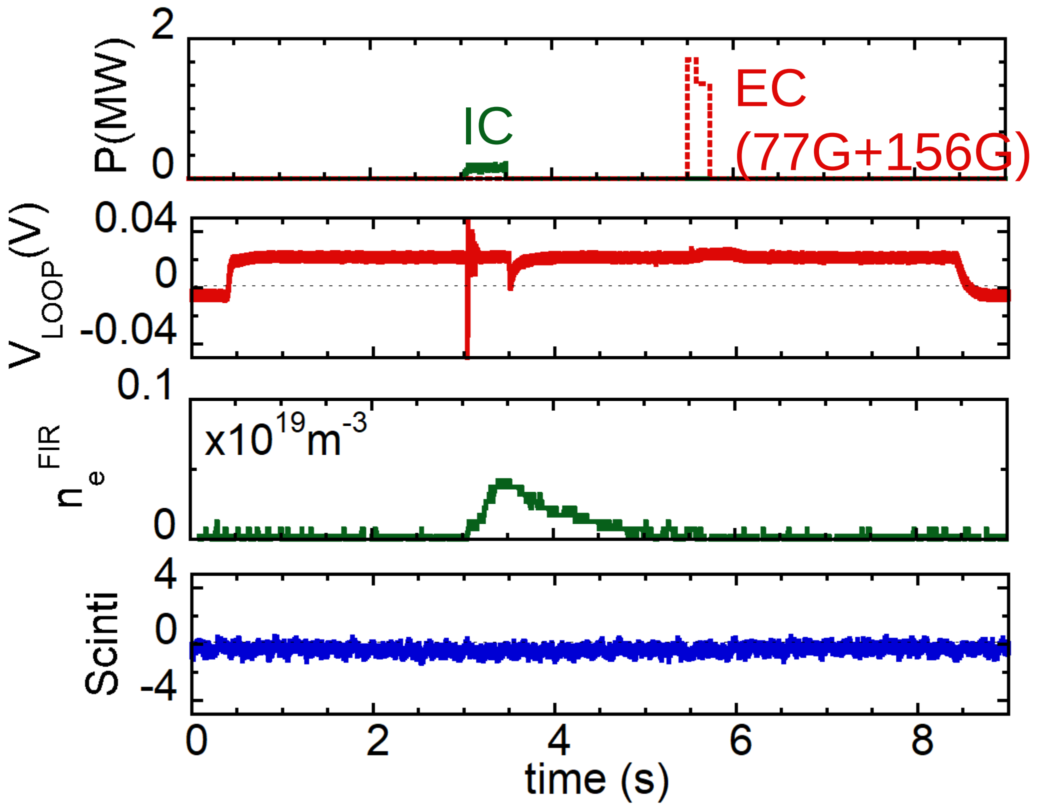
(S. Kobayashi (Kyoto-U), K. Nagaoka)

Experimental conditions:

(R_{ax}, Polarity, B_t, γ, B_q) = (3.55 m, CW, 0.5 T, 1.2538, 100.0%)
(#193440 - #193459) w/ flux swing (R_{ax} = 3.55-3.75 m)

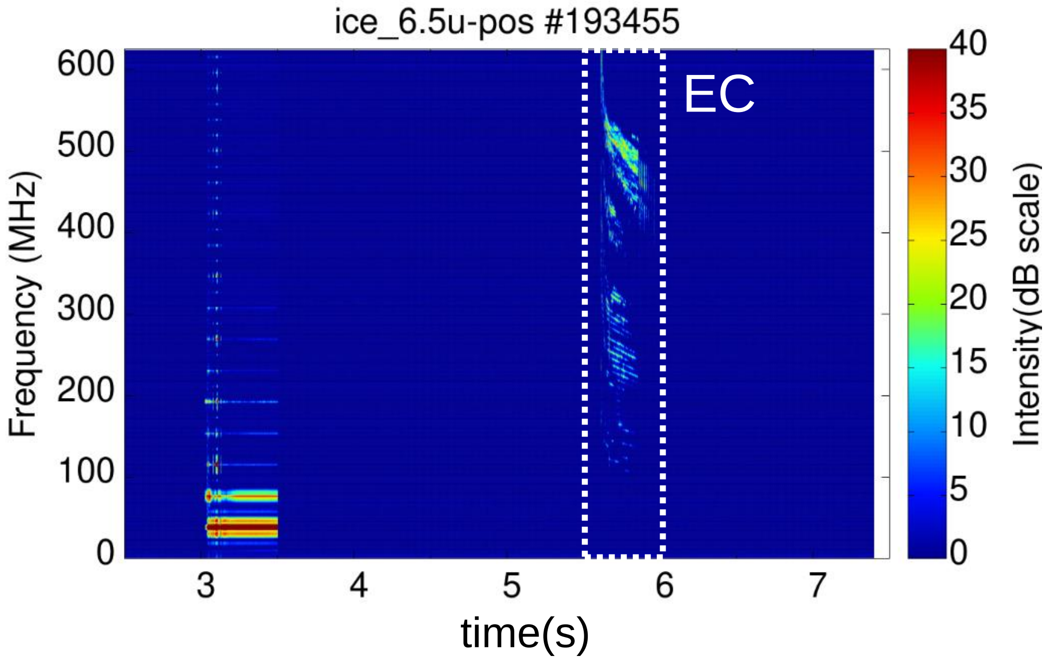
Objective:

To develop operation scenarios of stochastic acceleration in LHD
(1) Production of initial electrons w/ IC initiation and flux swing
(2) Electron acceleration by non-resonant ECH



Results:

- ✓ Obtained a sustainment of initial electrons during flux swing (closed GVs of NBI)
- ✓ No significant response in scintillator signals
- ✓ Observed a clear high frequency (~70 x ω_{ci}) signals → due to WPI of high energy electrons?



Construction of exp. scaling law of Ext.-RMP penetration threshold

(K.Y.Watanabe, S.Shimode)

Background and motivation:

In early LHD researches, the RMP penetration threshold on the collisionality is investigated for magnetic configurations with various plasma aspect ratio. In order to compare the RMP penetration behavior in tokamaks, the scaling with the beta, the collisionality and the normalized gyro-radius is effective. However, the data set is not enough to extract the beta and the normalized gyro-radius independently.

Then, we try to get the additional experiments to construct the scaling with the beta, the collisionality and the normalized gyro-radius.

Experimental conditions:

(R_{ax}, Polarity, B_t, γ, B_q) = (3.60m, CW, 1.8T/1T, 1.2538, 100%);

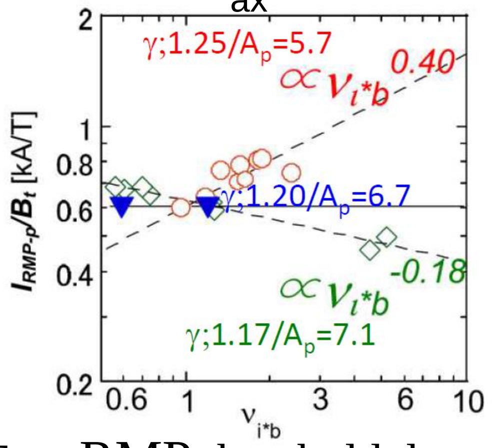
#193397-418(1.8T), 193422-38(1T)

RMP calibration; #193394 #7O enlarged@3.6m, ramp up rate 300A/s@B2 coil

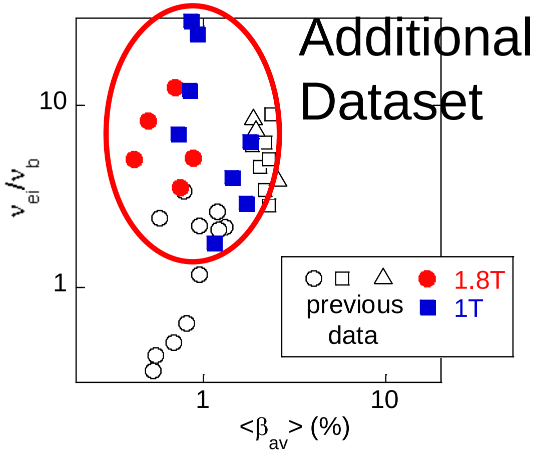
Results:

We can extend the dataset of the Ext.-RMP penetration threshold in the (β, ν_{ei}/ν_b) diagram as shown in the right-bottom figure. Now we are analyzing the Ext.-RMP penetration threshold, and try to construct the the scaling law scaling with the beta, the collisionality and the normalized gyro-radius.

R_{ax}=3.6m



Ext.-RMP threshold dependence on the collisionality in the LHD [K.Y.Watanabe et al., NF (2019)]



Plasma shape effect on BSC in high collisional regime (O.Mitarai[, K.Y.Watanabe])

Background and motivation:

According to a helical fusion reactor design, there is a possibility the BSC(BootStrap Current) affect the MHD equilibrium and instability. We already investigated the BSC dependence on the magnetic axis location and the collisionality, and found that it is reduced in more torus-inward magnetic axis and in more collisional regime. Now, we focus on the magnetic surface shape effect on the BSC. According to a theoretical prediction, elongated deformation of the magnetic surface vertically(B_q0%) reduces the BSC comparing with quasi-circular shape(B_q100%) in a low collisional regime [N. Nakajima et al., NF 29 (1989) 605, and K.C.Shaing et al., POF B1, (8) (1989) 1663]. Now we would like to confirm the plasma shape effect in the relatively high collisional plateau regime in LHD.

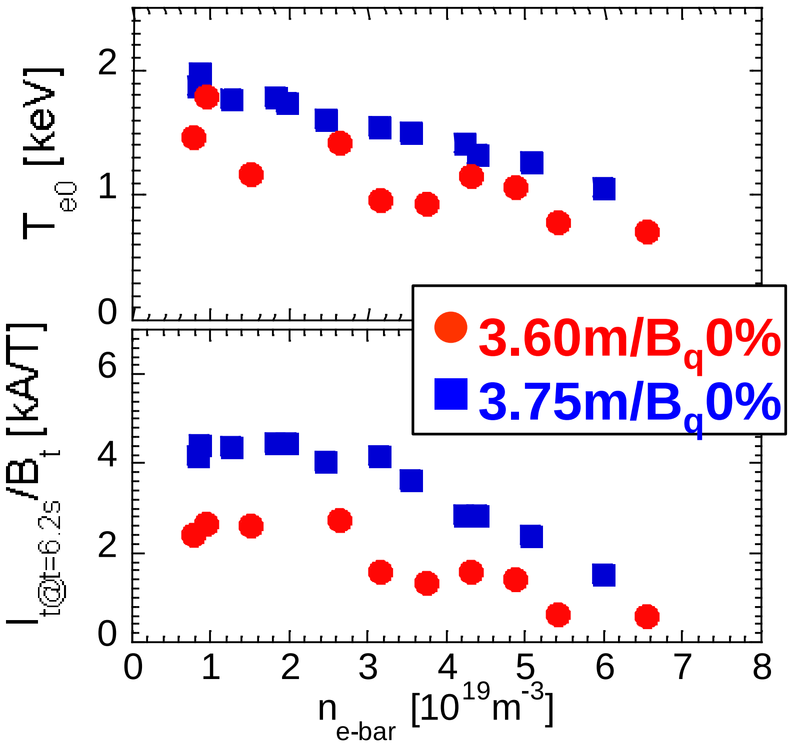
Experimental conditions:

(R_{ax}, Polarity, B_t, γ, B_q) = (3.60m, CW, 2.64T, 1.2538, 0%); #193460-75
Balanced NB(BL2+BL3) is injected for 3 second.

Results:

We compare I_p(around the end of discharge) and central elec. temp. dependence in between R_{ax}3.6m/B_q0% and R_{ax}3.75m/B_q0% with almost same NBI power. I_p decreases with density in both cases. In the same density, I_p in R_{ax}3.6m/B_q0% is smaller than that in R_{ax}3.75m/B_q0%, which is consistent with those in the configuration with B_q100%. However, the central temperature of R_{ax}3.6m/B_q0% is lower than that of R_{ax}3.75m/B_q0%, and we have not compared the BSC of between R_{ax}3.6m/B_q0% and R_{ax}3.6m/B_q100%. They are our future subjects.

results(tentative)



T_{e0} and I_p at the end of discharge dependence on density in balance-injected NB discharges.