(TG4) Plasma instability group report

Dec. 19, 2022 (R. Seki)

Date: Dec. 16, 2022
Time: 9:45 – 18:45
Shot#: 186249-186405 (157 shots)

Prior wall conditioning: No

Divertor pump: On (13:45)
Gas puff: H2 Pellet: No
NBI#(1, 2, 3, 4, 5)=gas(H, H, H, H, H)=P(2.3, 4.0, 3.4, 3.6, 4.0)MW
ECH(77GHz)=ant(5.5-Uout (or 1.5U), 2-OUR)=P(0.703, 0.0)MW
ECH(154GHz)=ant(2-OLL, 2-OUL, 2-OLR)=P(0.723, 0.799, 0.482)MW
ECH(56GHz)=ant(1.5U)=P(0.0)MW
ICH(3.5U, 3.5L, 4.5U, 4.5L)=P(0.0, 0.0, 0.0, 0.0)MW
Neutron yield integrated over experiment = 5.8×10^{13}

Topics
1. Validation of high-energy NB shine-through model (M. Osakabe, S. Sumida)
2. Effect of divertor pumping on external RMP penetration (K. Watanabe)
3. Collisionality dependence of RMP penetration threshold for various magnetic axis config (K. Watanabe)
4. Study of the mechanism on shielding external RMP by plasmas (Y. Mori, K. Watanabe)

Validation of high-energy NB shine-through model
(M. Osakabe and S. Sumida *et al*.,)

Shot#: 186354-186384(31 shots)
Magnetic configurations:
(R_{ax}, Polarity, B_t, γ, B_q) = (3.60 m, CCW, 2.75 T, 1.2538, 100.0%)
Background & motivation:

- Validation of high-energy NB shine-through (NB-ST) model is one of the high priority research items for ITER PFPO-2 phase (H plasma)
  - ✓ *Multistep ionization (MI)* effect
  - ✓ *Beam-particle self-interaction (BPSI)* effect

  must be taken into account in the shine-through model
- The purpose of this experiment is to systematically obtain the NB-ST data under various n_e, T_e and N-NB conditions for validation of the model
  - For the model validation, no/small change in n_e and T_e during NBI is preferable
  - For contribution to ITER PFPO-2, exp. with H plasma & H NBI is also preferable

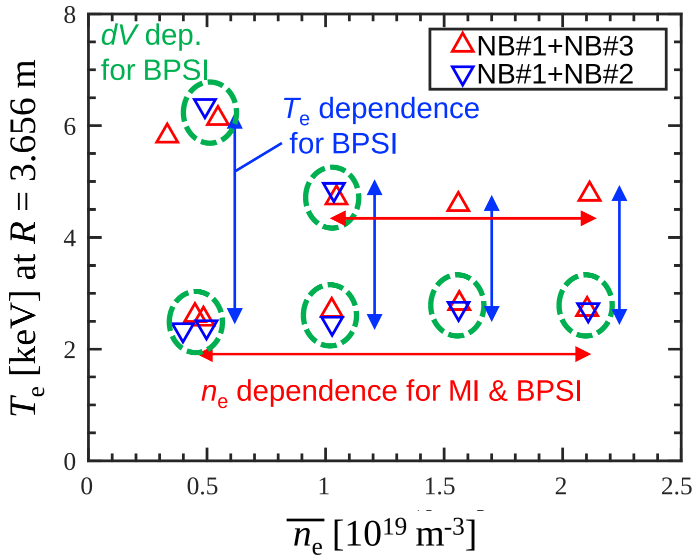
Results:

- ➢ Obtained systematic NB-ST data in almost const. n_e & T_e phase
- ➢ Successfully performed n_e, T_e and N-NB scans
- ➢ Will analyze n_e, T_e, and dV dependences of meas. shine-through rates
- ➢ Will also confirm ion mass effect by comparison with D exp. on Nov. 11, 2022
- ➢ Will compare meas. NB-ST with HFREYA and GNET

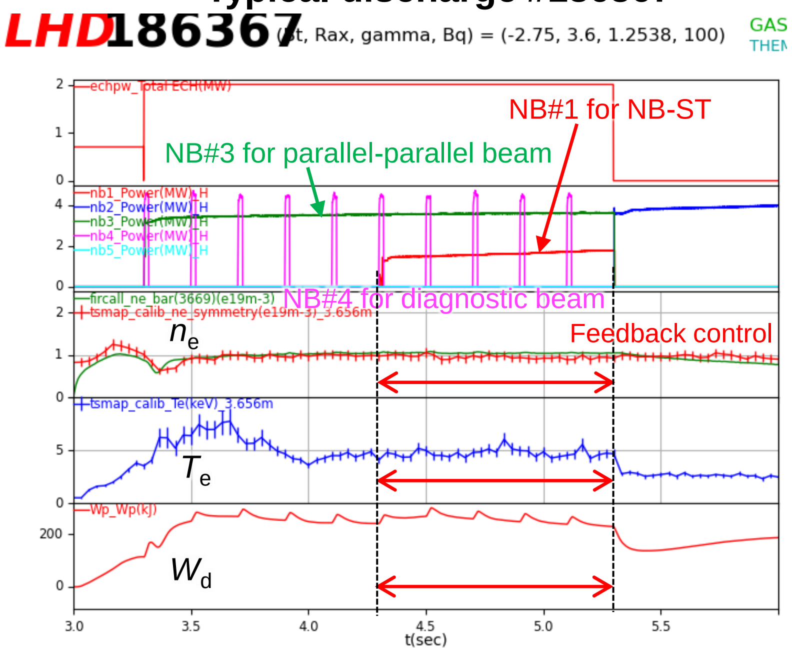
Enhancement conditions of NB stopping cross section by MI & BPSI effects

	E_b	n_e	T_e	Relative speed from fast ion dV
MI	High	High		
BPSI	High	Low	High	Low

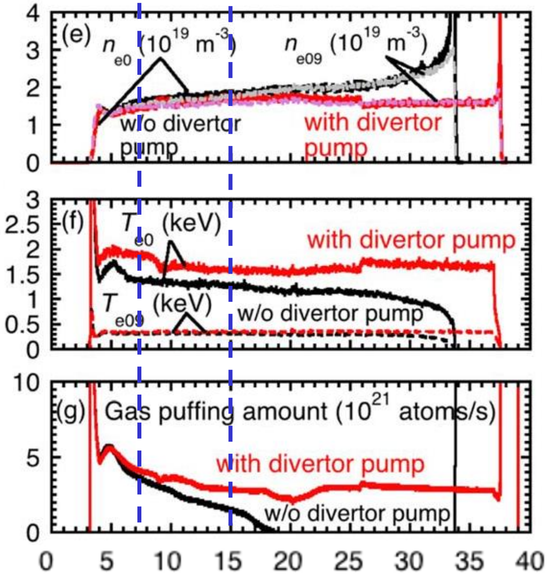
Parameter regime



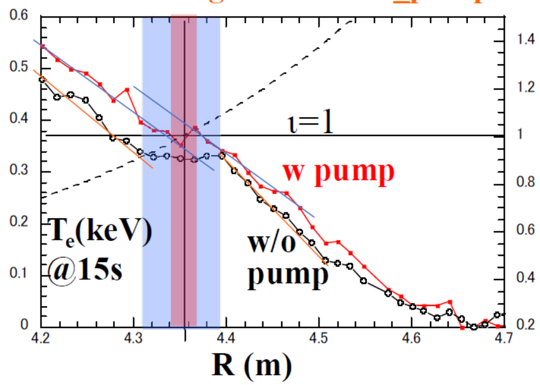
Typical discharge #186367



2. Effect of divertor pumping on external RMP penetration (K.Y.Watanabe, G.Motojima)



smaller mag. island in w_pump



Background and motivation:

According to the study on divertor pumping by G.Motojima (in Phy. Scripta), the divertor pumping would affect the confinement performance in core, which would be related with appearance condition of the magnetic island.

In order to confirm the above and investigate the reason, we get the dependence of the external RMP penetration threshold on divertor pumping.

Experimental conditions:

(R_{ax}, Polarity, B_t, γ, B_q) = (3.60, CCW, 1.375T, 1.2538, 100%),

#186250-280(without divertor pumping), #186385-186405(with div. pumping)

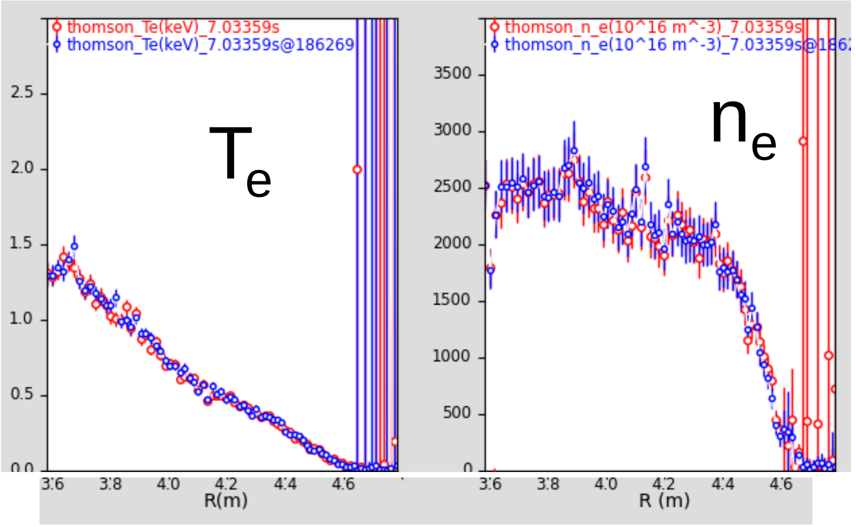
ECH with ~500kW is injected for 5 second.

RMP calibration; #186250 #7O cancel@3.60m, ramp up rate 300A/s@B2 coil

Results:

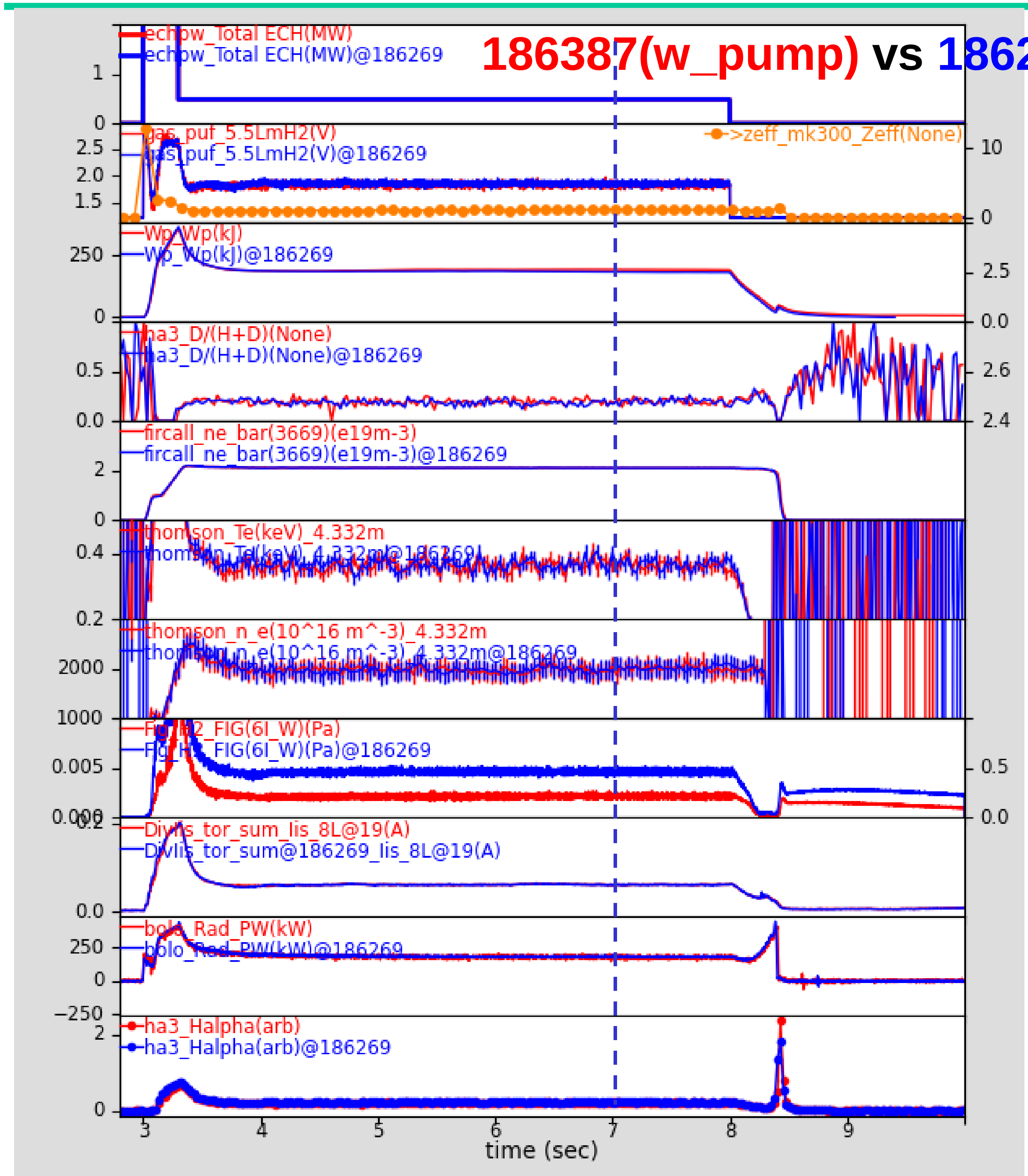
In two discharges with almost same density and heating but with or without divertor pumping, Te is almost same(Te flattening itself is not observed).

On RMP penetration behavior, we are investigating.



186387(w_pump)
vs 186269(wo_pump)

2. Effect of divertor pumping on external RMP penetration (Cont.)



Gas pressure around divertor pump with the pumping is smaller than that wo pumping.=> recycling changes.
On the contrary, gas-puffing amount looks same (In previous results, the difference on gas-puffing amount appears.)

=> What is divertor pumping effect??

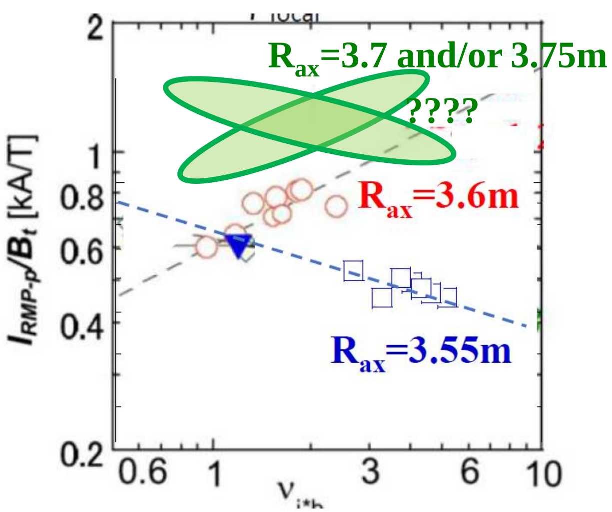
=> Now we are investigating.

3. Collisionality dependence of RMP penetration threshold for various magnetic axis config (K. Y. Watanabe)

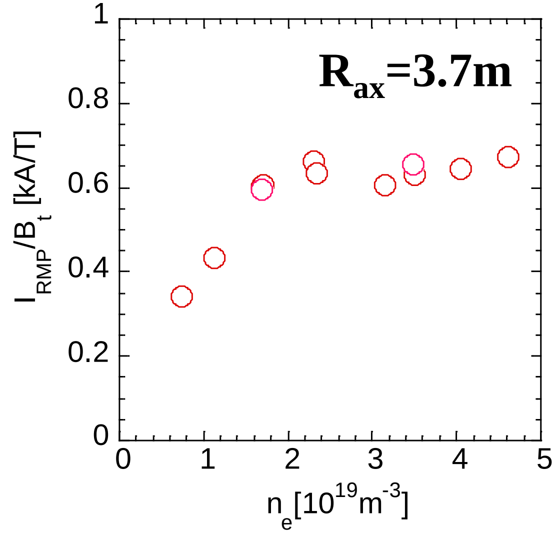
Background and motivation:
External RMP is sometimes shielded by plasmas. In order to understand the mechanism, we investigate the collisionality dependence of the penetration threshold. In the LHD, the dependence is different in the plasma aspect ratio. The candidate of the reason is due to the neoclassical effect of the 3D magnetic field structure. The neoclassical effect would be affected by the magnetic configuration on the magnetic axis location. Then, we investigate the collisionality dependence for various magnetic axis configuration.

Experimental conditions:
(R_{ax}, Polarity, B_t, γ, B_q) = (3.70, CCW, 1.375T, 1.2538, 100%), #186304-328
#Half-BL2, BL3 are almost balanced, and injected for 3 second.
RMP calibration; #186304/328 #7O enlarged, inv-enlarged@3.70m, ramp down rate 300A/s@B2 coil

Results:
We get the data on the RMP penetration threshold dependence on the density for Rax=3.70m config. We expect that the dependence on the collisionality is similar with Rax=3.6m config., which suggests that the collisionality dependence would be qualitatively different between the torus inboard config. and the torus outboard ones. We will investigate the mechanism in terms of the neoclassical viscosity.



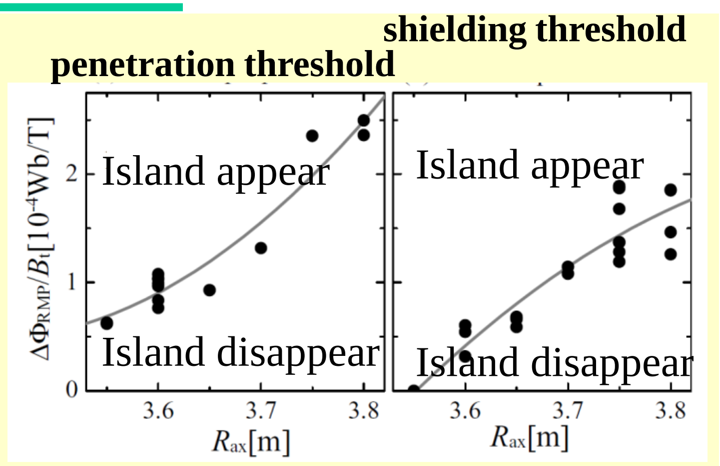
RMP penetration threshold dependence



4. Study of the mechanism on shielding external RMP by plasmas (Y.Mori[Nagoya Univ], K. Y. Watanabe)

Background and motivation:

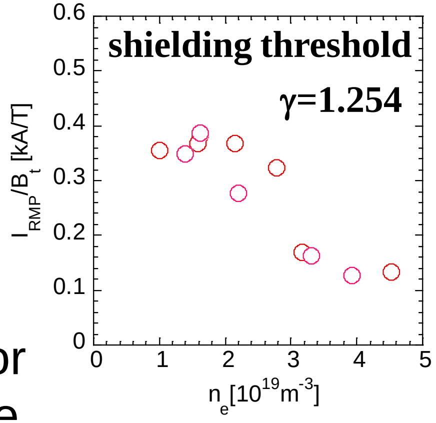
In early researches of the LHD, the RMP penetration threshold is different from the shielding ones. On the contrary, the collisionality dependence of the RMP penetration threshold is also investigated for various aspect plasmas, and it has quantitatively and qualitatively different depending on the magnetic configurations.
 In this study, we focus on RMP shielding threshold dependence on the collisionality for some magnetic configurations, we compare them with some configurations, and try to find a model of the shielding mechanism on external RMP by plasmas.

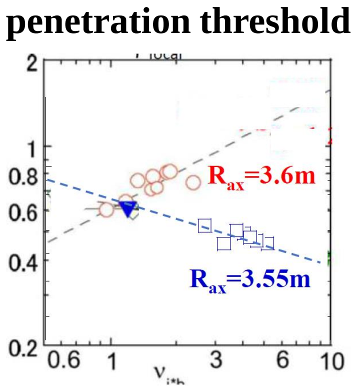


Dependence of RMP penetration and shielding threshold on the mag. Axis location [2015_NF_55_Narushima]

Experimental conditions:

(R_{ax}, Polarity, B_t, γ, B_q) = (3.60, CCW, 1.375T, 1.174/1.2538, 100%),
#186281-303, #186329-350
#Half-BL2, BL3 are almost balanced, and injected for 3 second.
RMP calibration; #186303/329 #7O enlarged, inv-enlarged@3.60m, ramp up rate 300A/s@B2 coil





Results:

We get the data on the RMP shielding threshold dependence on the density for γ=1.254 config. We expect that the dependence on the collisionality is opposite for the penetration. To investigate why the dependence changes is one of the future subjects.