(TG4) Plasma instability group report

Nov. 25, 2022 (R. Seki)

Date: Nov. 24, 2022
Time: 9:30 -18:45
Shot#: 184251-184387 (137 shots)

Prior wall conditioning: No

Divertor pump: On
Gas puff: D2 Pellet: No
NBI#(1, 2, 3, 4, 5)=gas(D, D, D, D, D)=P(2.0, 2.2, 2.1, 7.0, 8.0)MW
ECH(77GHz)=ant(5.5-Uout (or 1.5U), 2-OUR)=P(0.703, 0.792)MW
ECH(154GHz)=ant(2-OLL, 2-OUL, 2-OLR)=P(0.723, 0.799, 0.986)MW
ECH(56GHz)=ant(1.5U)=P(0.288)MW
ICH(3.5U, 3.5L, 4.5U, 4.5L)=P(0.73, 0.63, 0.85, 0)MW
Neutron yield integrated over experiment = 2.8×10^{17}

Topics

1. Study of Fast-Ion Stiffness in Alfven-Eigenmode at Helical Device (S. Kamio, K. Nagaoka)
2. Extension of total neutron emission and fusion gain database (M. Isobe, K. Ogawa)
3. Alpha particle confinement simulation experiment (K. Ogawa)
4. Investigation of the fast-ion confinement time and its mechanism (H. Nuga)

Study of Fast-Ion Stiffness in Alfven-Eigenmode at Helical Device (S. Kamio)

Shot #:184251-184275

Experimental conditions: (R_{ax}, Polarity, B_t, γ, B_q) = (3.6, CW, 1.375 and 1.0, 1.2538, 100), NBI#(1, 2, 3, 4, 5)=gas(D, D, D, D, D)=P(2.1, 2.2, 2.4, 6.4, 0) MW

Background and motivation:

- Experiments in the tokamak device showed that fast-ion profile becomes stiff above a critical threshold of fast-ion pressure gradient in the presence of multiple-AEs. In this experiment, we verify that the fast-ion profile stiffness occurs in helical devices with deuterium beams.

Results:

- We observed the fast-ion distribution with FIDA when tangential-NBI power with deuterium was scanned in the LHD experiment in 1.375 T and 1.0 T with 1.0 and 0.4×10^{19} m^{-3}.
- We are now carefully comparing the FIDA signals.

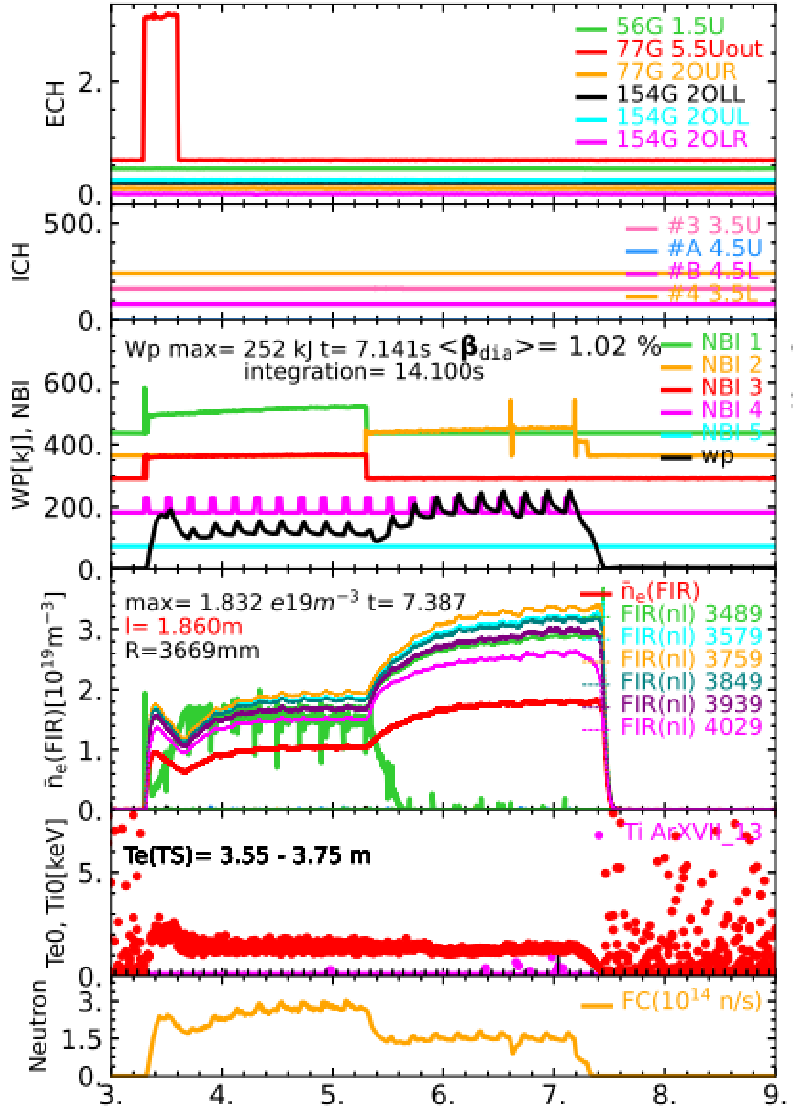


Fig.1 Time evolutions of the typical discharge for fast-ion stiffness experiments.

Extension of S_n/Q database

M. Isobe, K. Ogawa, and M. Yokoyama

Background and objective

- We extended the total neutron emission rate by supporting regression analysis based on so-called "Big data analysis".
- We aim to further extend of regression analysis performed for the total neutron emission (S_n) and fusion gain (Q) database.
- By experimental data obtained in the 19th to 21st campaigns with R_{ax}=3.55 m, B_t=2.89 T (CCW), we obtained the following regression expression [K. Ogawa et al., Fusion Eng. Des. **167** (2021) 112367].

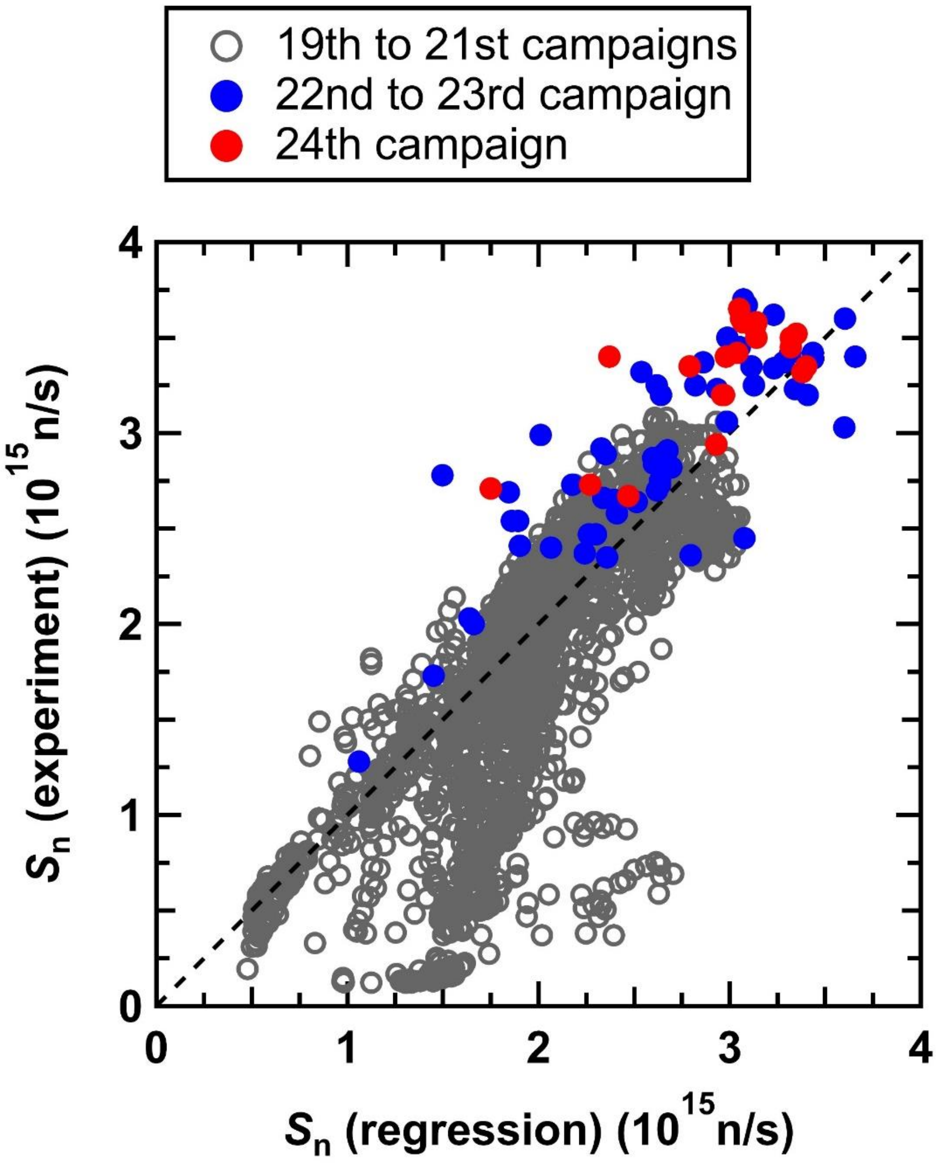
$$S_n = 10^{14.25} \times n_{e\_avg}^{0.52} \times P_{N\text{-}NB}^{0.69} \times P_{P\text{-}NB}^{0.37} \text{ (n/s)}$$

Experimental conditions

- #184279 ~ #184316 (37 shots),
  (R_{ax}, B_t, γ, B_q) = (3.60 m, 2.75 T, 1.2538, 100%)
- #184317 ~ #184339 (23 shots),
  (R_{ax}, B_t, γ, B_q) = (3.55 m, 2.89 T, 1.2538, 100%)
- n_{e_bar} = 1~3 x 10^{19} m^{-3}
- All NBs inject D beam.

Results

- We extend S_n database in R_{ax}=3.55 m, B_t=2.89 T (CCW).
- We compared S_n obtained in experiment and S_n predicted by regression expression.
- Experimentally obtained results almost follow the regression expression.



Alpha particle confinement simulation K. Ogawa, Y. Matsumoto et al.,

Background and objective

- We have performed an alpha particle confinement simulation using D-D fusion born 1 MeV triton because the kinetic parameter of 1 MeV triton is almost identical to the parameter of an alpha particle.
- The validation of numerical simulation code in the existing devices is important to predict alpha particle confinement in a fusion reactor.

Experimental conditions

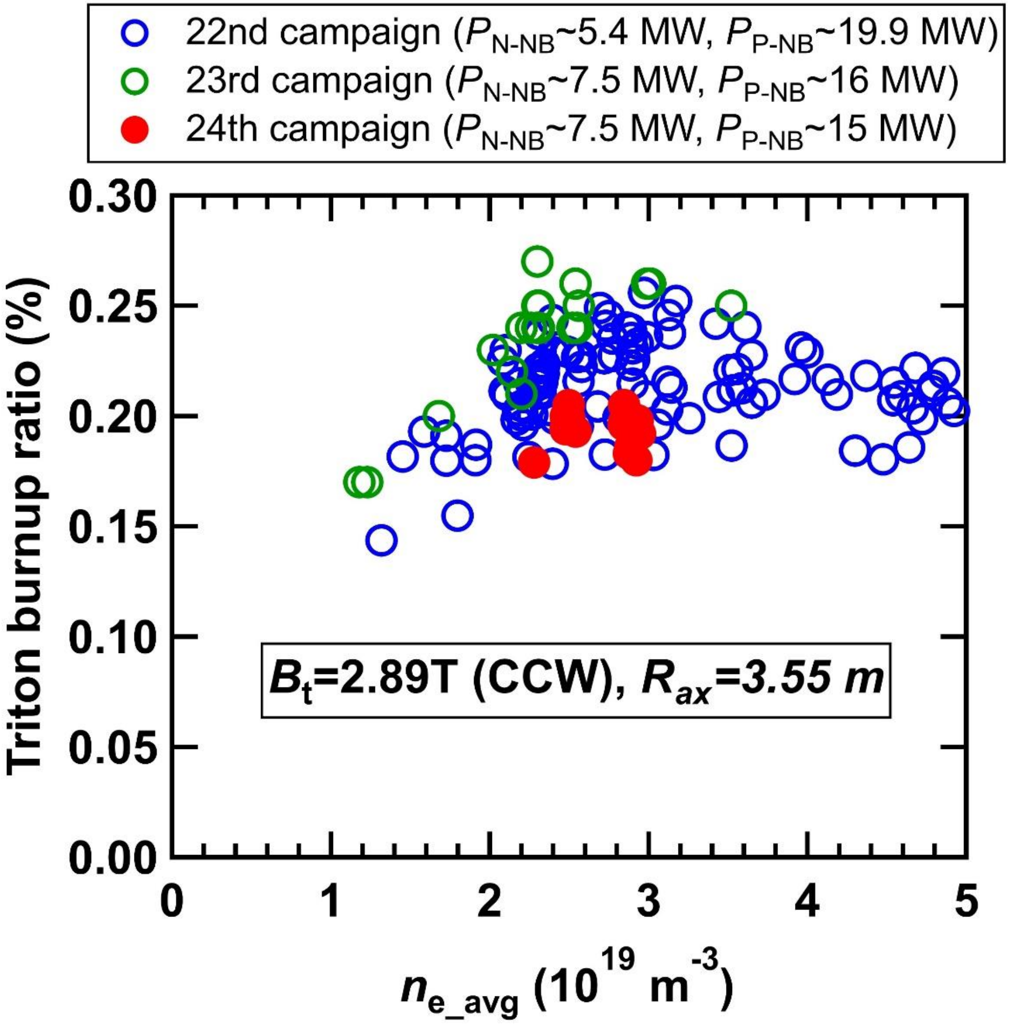
- #184279 ~ #184316 (37 shots),
  (R_{ax}, B_t, γ, B_q) = (3.60 m, 2.75 T, 1.2538, 100%)
- #184317 ~ #184339 (23 shots),
  (R_{ax}, B_t, γ, B_q) = (3.55 m, 2.89 T, 1.2538, 100%)
- n_{e_bar} = 1~3 x 10^{19} m^{-3}
- All NBs inject D beam.

Results

- Although neutral beam power was almost same as last campaign, triton burnup ratio obtained in this campaign was relatively lower compared to that obtained last campaign.

-> Lower ECH power (5 gyrotrons in 23rd campaign, 4 gyrotrons in 24th campaign)? T_e dependence of triton burnup ratio.

- Comparison with orbit following simulation MORH will be performed.

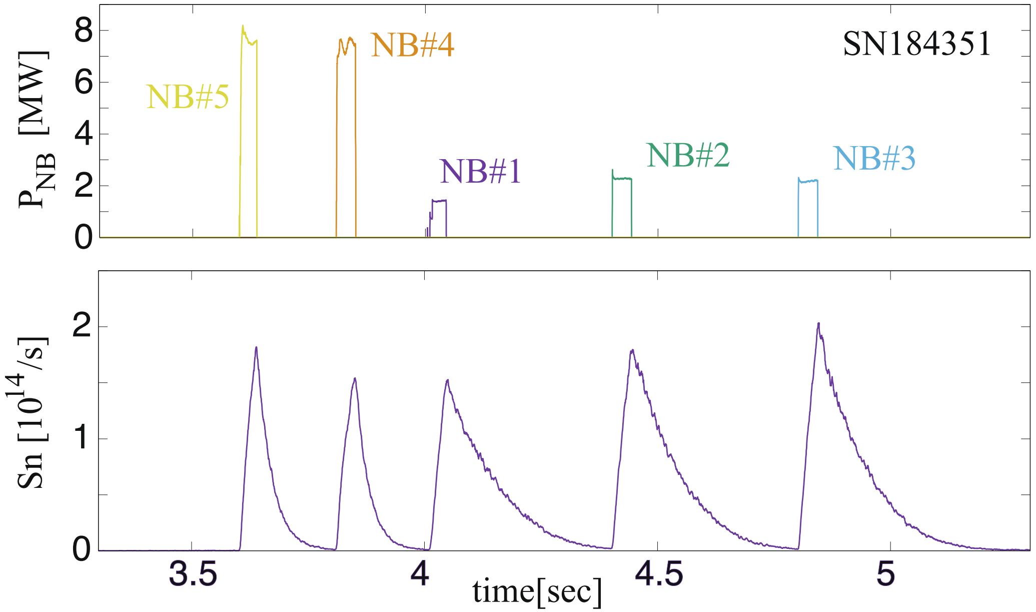


Investigation of the fast-ion confinement time and its mechanism

Shot #: 184342-184387 (45 discharges) H. Nuga

Experimental conditions:

(R_{ax}, Polarity, B_t, γ, B_q) = (3.55 m, CCW, 2.89 T, 1.254, 100 %)
= (3.55 m, CCW, 2.79 T, 1.254, 100 %)
= (3.75 m, CCW, 2.64 T, 1.254, 100 %)



Background and motivation:

- According to the experimental results until 22cycle, it is found that NB fast-ion loss can not be explained by the neo-classical theory (GNET can not reproduce the exp. results).
- The most prousible candidate is CX loss, which depends on the neutral density.
- The neutral density profile can be measured by Hα spectrum.
- To take fast-ion confinement data with the neutral density profile, NB short-pulse injection experiments were performed.

Summary:

- Density scan in three configurations were performed.
- Density scan range is 0.5e19< ne< 3e19
- GNET simulation including measured neutral density profile will be performed.