Instability & Anisotropy (IA) Session Report

Date: Mar. 26, 2024
Time: 10:30 – 16:45
Shot#: 188135 – 188254 (120 shots)
Prior wall conditioning: None
Divertor pump: ON
Gas puff: H2
Pellet: None
NBI#(1, 2, 3, 4, 5)=gas(H, H, H, H, H)=P(3.9, 3.7, 3.9, 4.0, 5.5) MW
ECH(77GHz)=ant(5.5U-Out, 2O-UR)=P(0.698, 0.380) MW
ECH(154GHz)=ant(2-OLL, 2-OUL, 2-OLR)=P(0.705, 0.889, 0.858) MW

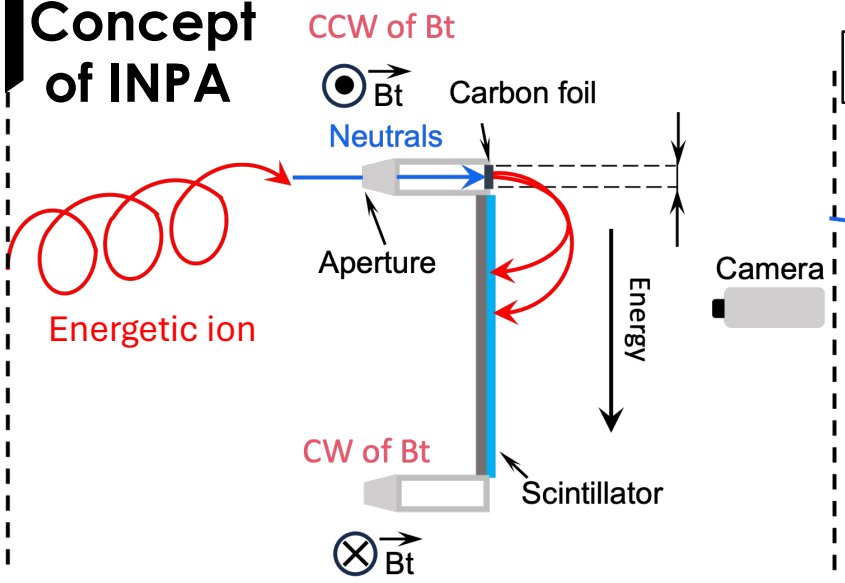
Topic:

1. Understanding Energetic Particle Distribution during Helically-Trapped Energetic-Ion-Driven Resistive Interchange Mode (EIC) in LHD Using Newly Developed Imaging Neutral Particle Analyzer (INPA) (W. Paenthong)
2. Degradation of fast-ion confinement without EP-driven instability (H.Nuga)
3. Fast ion and impurity measurements in sawtoothing stellarator plasmas (D. Moseev)
4. Anomaly detection of radiation profile in radiative collapse K. Mukai

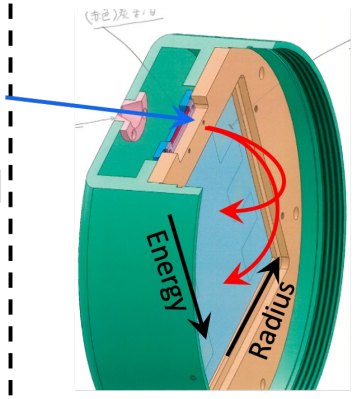
Understanding Energetic Particle Distribution during Helically-Trapped Energetic-Ion-Driven Resistive Interchange Mode (EIC) in LHD Using Newly Developed Imaging Neutral Particle Analyzer (INPA)

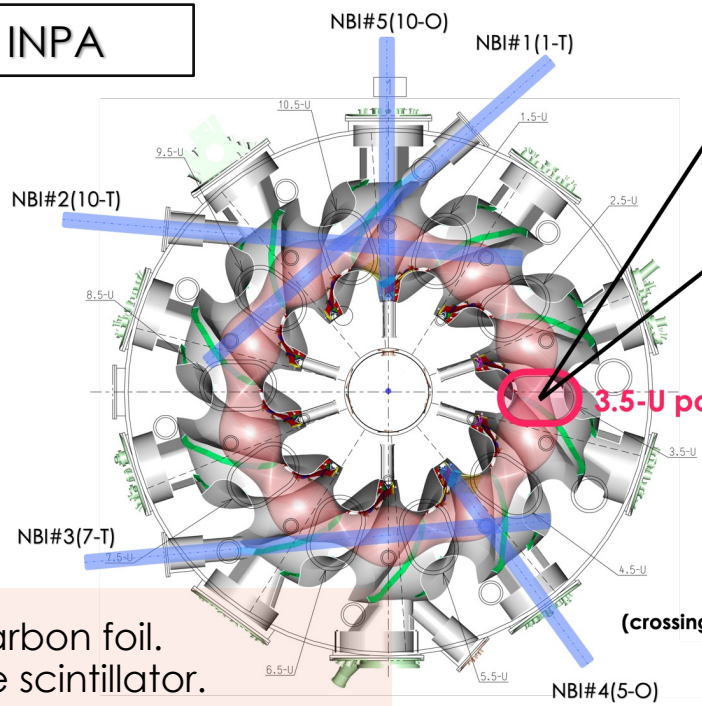
Proponent: Worathat Paenthong(SOKENDAI)
Co-authors: Kunihiro Ogawa(NIFS), Mitsutaka Isobe(NIFS), Siriyaporn Sangaroon(MSU), Xiaodi Du(GA), Apiwat Wisitsorasak(KMUTT)

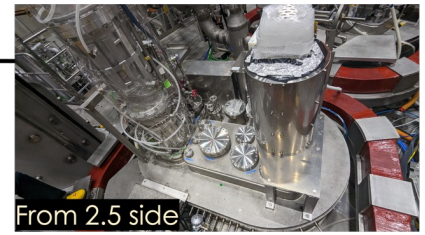
Concept of INPA

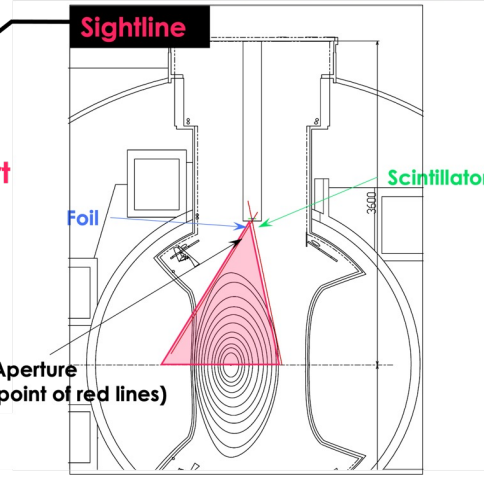


Schematic view of INPA









An energetic neutral passing through the aperture is ionized by a thin carbon foil.
The energetic ion is deflected by LHD magnetic field and then strikes the scintillator.
The scintillation position provides information about the energy and radial position of the ion.

INPA in LHD has two apertures for measurement in CW and CCW B_t configurations and measures energetic neutral passively.

Design to measure helically-trapped beam ion injected by NBI#4 and NBI#5 or ICRH tail ions

Understanding Energetic Particle Distribution during Helically-Trapped Energetic-Ion-Driven Resistive Interchange Mode (EIC) in LHD Using Newly Developed Imaging Neutral Particle Analyzer (INPA)

Proponent: Worathat Paenthong(SOKENDAI)
Co-authors: Kunihiro Ogawa(NIFS), Mitsutaka Isobe(NIFS), Siriyaporn Sangaroon(MSU), Xiaodi Du(GA), Apiwat Wisitsorasak(KMUTT)

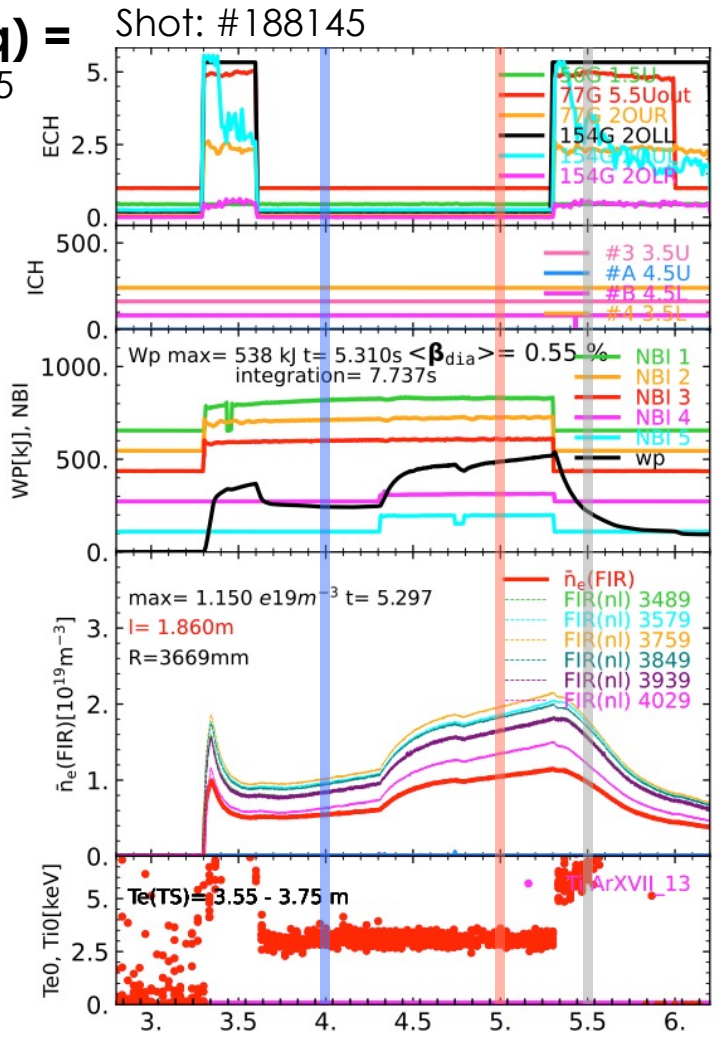
Experimental conditions: (Rax, Polarity, Bt, γ, Bq) =
(3.6 m, CCW, 2.75 T, 1.2538, 100.0%) Shots: #188135 - #188155

Motivation & Objectives

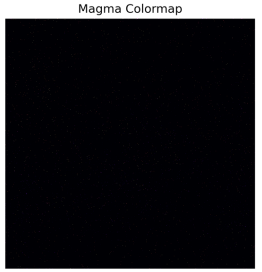
- We newly installed INPA as part of a collaboration between Japan, Thailand, and the US to gain a deeper understanding of energetic particle behavior in the presence of EIC [1].
- In this experiment, we mainly focused on checking whether the INPA image was reasonable or not.

Results

- We successfully observed a scintillation spot correlated with perpendicular neutral beam (P-NB) injection.
  - The direction of B_t from the top is CCW
    -> Beam ions hit the lower side of scintillator.
- We will check the result in CW-B_t configuration in this Friday.
- We will investigate EIC effect of energetic ion behavior.



N-NB injection phase

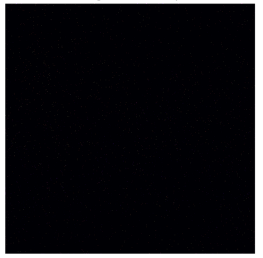


#188145
t=4.0 s

N-NB and P-NB injection phase

#188145
t=5.0 s

ECRH phase



#188145
t=5.5 s

[1] X. D. Du, et al., *Nuclear Fusion*, **56**, 016002 (2016).

Degradation of fast-ion confinement without EP-driven instability (H.Nuga)

Shot #:188156-188192

Experimental conditions:

(R_{ax}, Polarity, B_t, γ, B_q) = (3.6, CCW, 2.75, 1.2538, 100)

Background and motivation:

- The degradation of the NB fast-ion confinement without EP-driven instabilities were observed after NB superpose through the neutron measurement.
- FIDA signal also showed the confinement degradation after NB superpose.
- The mechanism is still unclear.

Summary:

- To investigatate the mechanism, the similar experiments with hydrogen plasma were performed.
- Data in 7 beam patterns and 3 densities scan were taken to show FIDA signal before/after NB superpose.

Results in the previous cycle (24th)

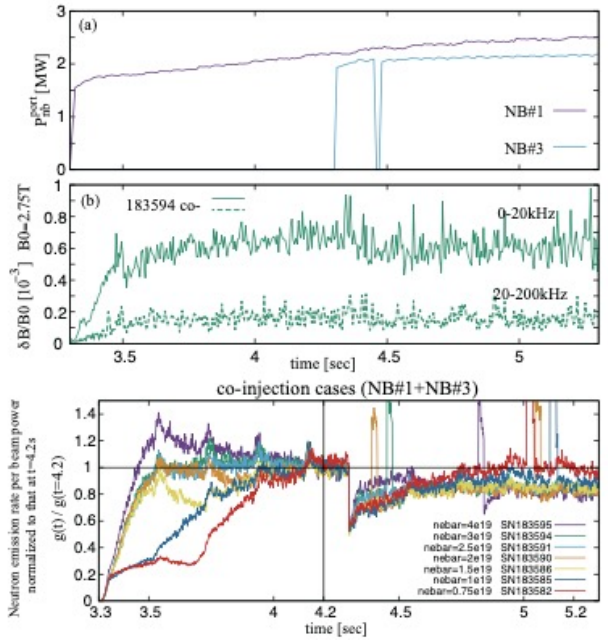


Fig.1 Confinement degradation appeared in Sn/Pnb

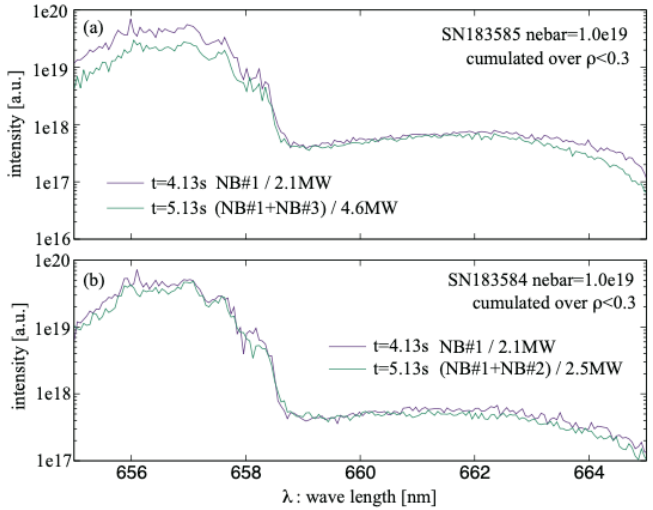


Fig.2 FIDA also showed the degradation after NB superpose.

Interaction of fast ions and impurities with sawteeth

Experimental conditions:

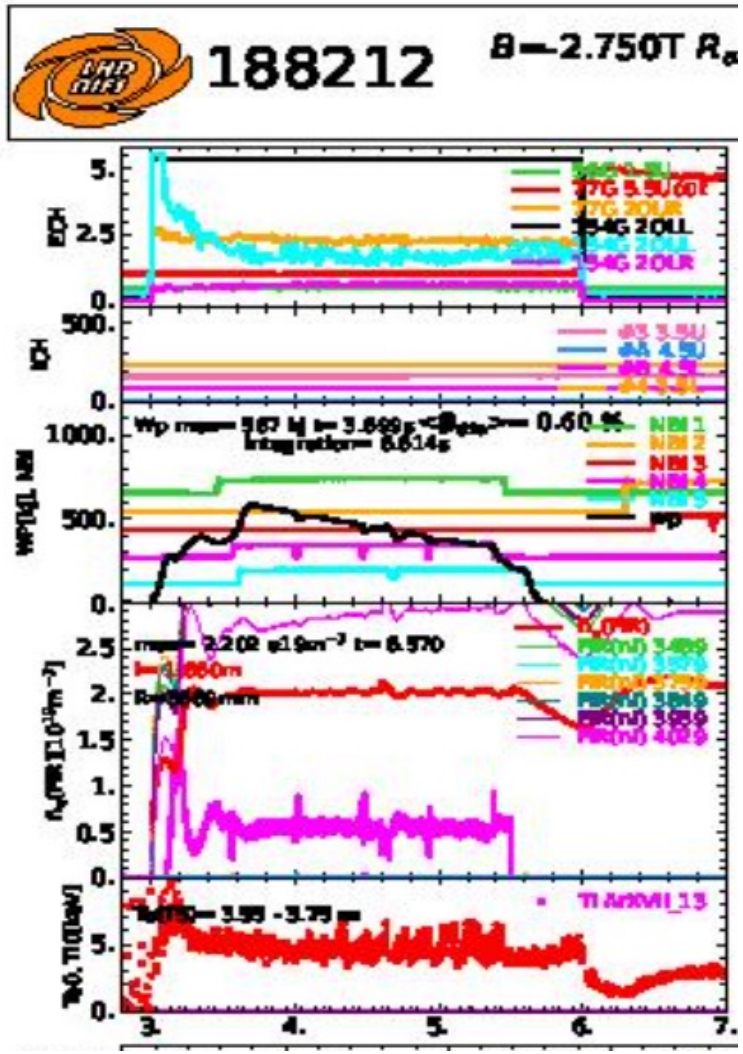
(R_{ax}, Polarity, B_t, γ, B_q) = (3.6 m, CCW, 2.75 T, 1.254, 100.0%)

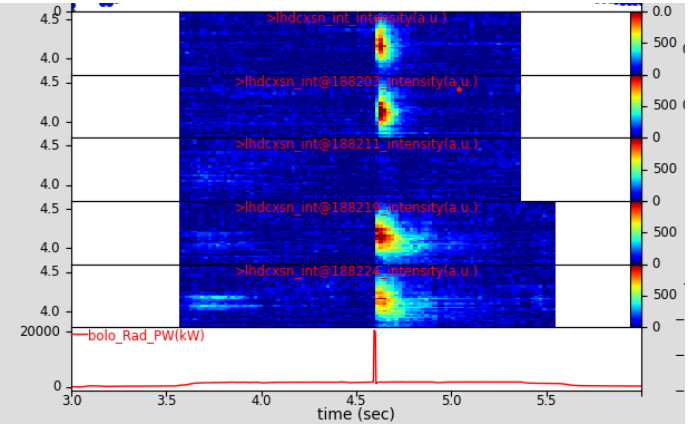
Objective and method:

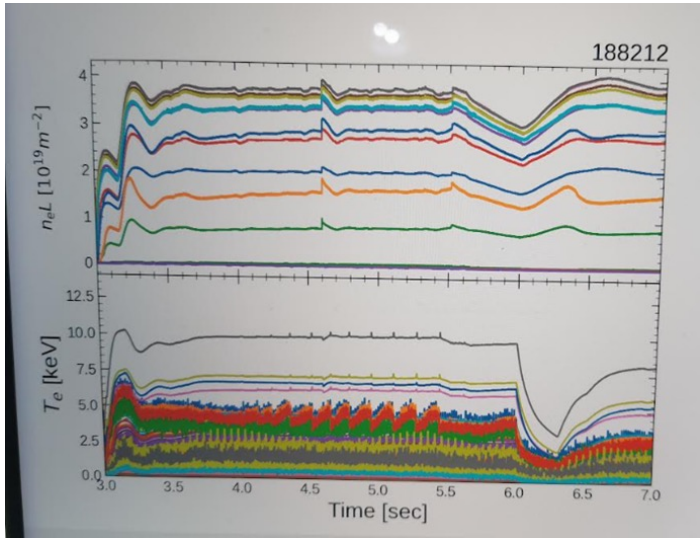
- Fast ion transport and impurity transport due to sawtooth crashes
- FI sources: NBI1,4,5. Impurity sources (F, Fe, W) - TESPEL

Results:

- Very reliable sawtooth generation by CCW NBCD and CW ECCD
- NBI3 and NBI1, though similar, produce different plasmas and different sawteeth
- No clear sign of F redistribution due to the crash
- More analysis needed







Anomaly detection of radiation profile in radiative collapse K. Mukai

Shot #: 188227 - 188254 (28 shots)

Experimental condition

- (R_{ax}, B_t, γ, B_q) = (3.75 m, -2.64 T, 1.2538, 100%)
- NBI #1, 2, 3
- $n_{e,\,bar}$: 4 x 10^{19} m^{-3}
- Divertor pumping: ON
- Gas: H (5.5-L)

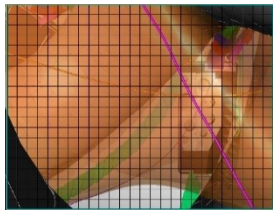
Background and objective

- In the 24th campaign, radiative collapse in the R_{ax} = 3.6 m configuration could be detected from radiation images measured with an IRVB at 6.5-U as an increase of abnormality using autoencoder (AE).
- To investigate the effect of magnetic configuration on the radiation structure to trigger radiative collapse

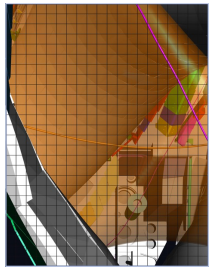
Results

- 2-D radiation profiles were obtained in the R_{ax} = 3.75 m configuration using IRVBs at 6.5-U (100 Hz) and 6.5-L (50 Hz).
- Anomaly detection will be conducted using AutoEncoder.
- Similar experiment in CW polarity will be conducted on Mar. 29.

6.5-U IRVB



6.5-L IRVB



#188236 4.96 s | 5.00 s | 5.04 s | 5.08 s | 5.12 s | 5.16 s