(IA) Instability and Anisotropy group report

May 23, 2024 (R. Seki)

Date: May. 22, 2024
Time: 10:30 - 16:45
Shot#: 191641 –191767 (127 shots)

Prior wall conditioning: OFF
Divertor pump: off
Gas puff: He, Pellet: B, SiB6
NBI#(1, 2, 3, 4, 5)=gas(H, H, H, H, H)=P(4.0,3.8,4.1,3.4,4.5)MW
ECH(56GHz)=ant(1.5-U)=P(-.-)MW
ECH(77GHz)=ant(5.5-U, 2-OUR)=P(0.698, 0.38)MW
ECH(154GHz)=ant(2-OLL, 2-OUL, 2O-LR)=P(0.705, 0.889, 0.982)MW
ICH(3.5U, 3.5L, 4.5U, 4.5L) = P(0.6, 0, 0.62, 0)MW

Topics

1. Study of the fast-ion acceleration by ICRF heating for p-11B fusion reaction. (R. Magee, M.Osakabe)
2. Validation of improved p-11B fusion reactivity using MeV ICRF tail ions in LHD. (J. Wang)
3. Dependence of p-11B fusion reactivity on the boron density profile and fast ion confinement time. (Y. Fujiwara, M. Osakabe)

Study of fast-ion acceleration by ICRF heating with p-^{11}B fusion reaction

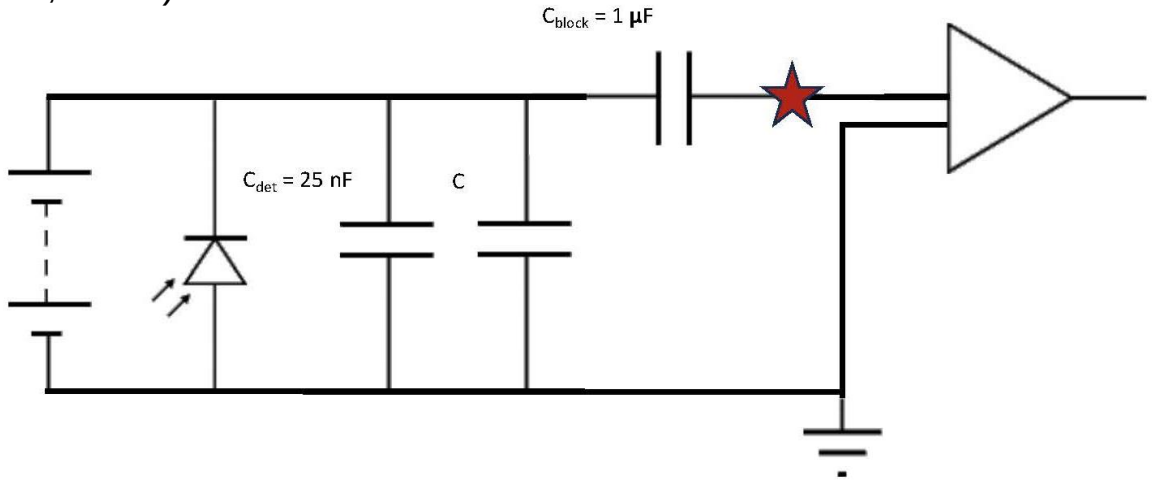
(R. Magee, J. Wang, K. Ogawa, H. Gota, R. Seki., S. Kamio, M. Isobe, M. Osakabe et al.)

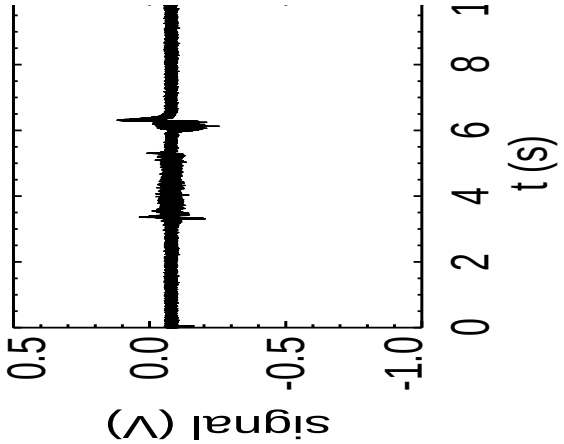
Shot #:191649-1917691 (42 shots)

Experimental conditions: (R_{ax}, Polarity, B_t, γ, B_q) = (3.60 m, CCW, 2.75 T, 1.254, 100%)

Executive Summary:

- 15 MHz low pass filter added to collection electronics (★) allow PIPS detector to operate during ICRH pulses





Study of fast-ion acceleration by ICRF heating with p-^{11}B fusion reaction

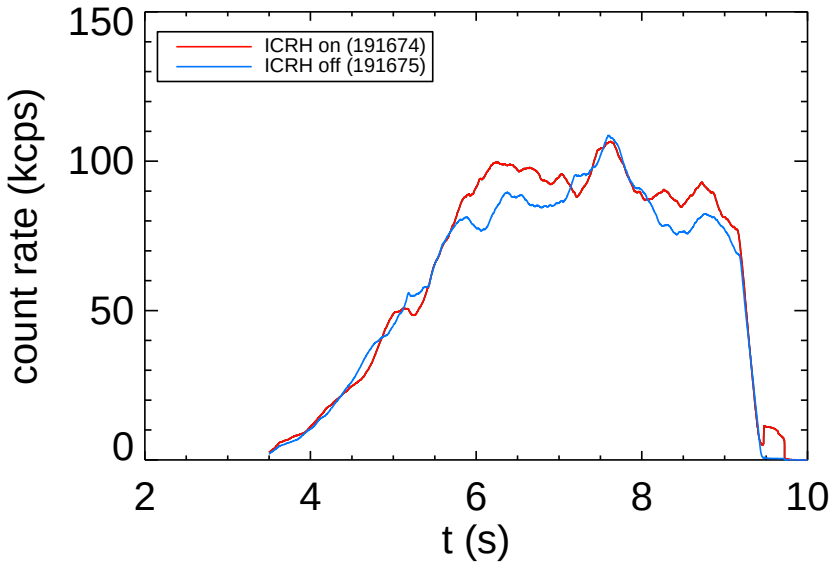
(R. Magee, J. Wang, K. Ogawa, H. Gota, R. Seki., S. Kamio, M. Isobe, M. Osakabe et al.)

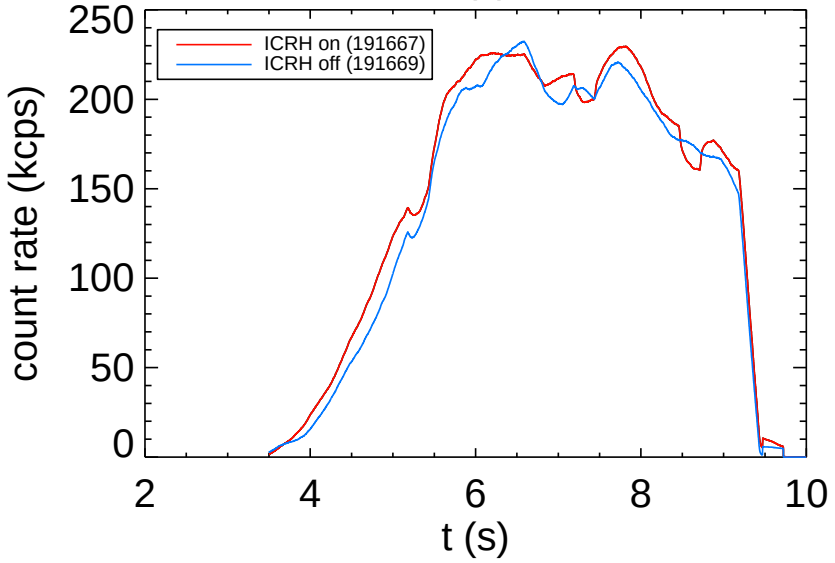
Shot #:191649-1917691 (42 shots)

Experimental conditions: (R_{ax}, Polarity, B_t, γ, B_q) = (3.60 m, CCW, 2.75 T, 1.254, 100%)

Executive Summary:

- 15 MHz low pass filter added to collection electronics (★) allow PIPS detector to operate during ICRH pulses
- Performed plasma density, boron density, and beam energy scans
- ICRH impact on fusion reactivity is small, requires careful data analysis





Study of fast-ion acceleration by ICRF heating with p-^{11}B fusion reaction

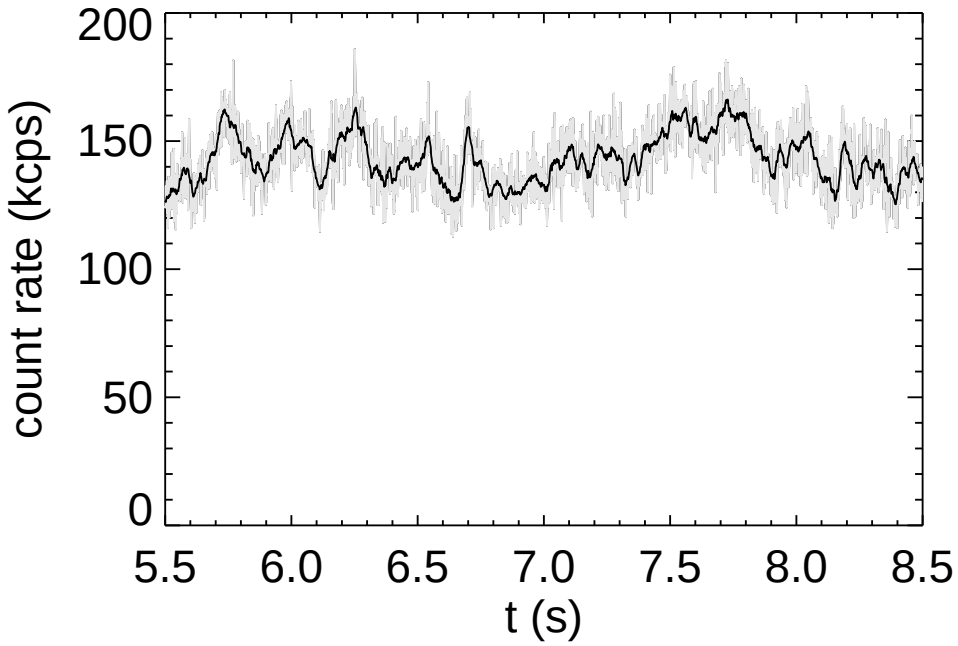
(R. Magee, J. Wang, K. Ogawa, H. Gota, R. Seki., S. Kamio, M. Isobe, M. Osakabe et al.)

Shot #:191649-1917691 (42 shots)

Experimental conditions: (R_{ax}, Polarity, B_t, γ, B_q) = (3.60 m, CCW, 2.75 T, 1.254, 100%)

Executive Summary:

- 15 MHz low pass filter added to collection electronics (★) allow PIPS detector to operate during ICRH pulses
- Performed plasma density, boron density, and beam energy scans
- ICRH impact on fusion reactivity is small, requires careful data analysis
- Effect is observed most clearly during ICRH modulation



Validation of improved p-11B fusion reactivity using MeV ICRF tail ions in LHD

(J. Wang, R. Magee, K. Ogawa, H. Gota, R. Seki., S. Kamio, M. Isobe, M. Osakabe et al.)

Shot #:191692-191728 (37 shots)

Experimental conditions: (R_{ax}, Polarity, B_t, γ, B_q) = (3.60 m, CCW, 2.75 T, 1.254, 100%)

Background and motivation:

- In the previous campaigns, n-NBI induced p-^{11}B fusion has been successfully measured in LHD.
- It has also been identified in previous campaigns that ICRF wave can effectively accelerate particles to the MeV-energy range.
- We perform the p-^{11}B experiment with an ICRF wave accelerated minority hydrogen/beam hydrogen tail in LHD under a standard ICRF heating scenario. A higher count rate on the fusion-born alphas is expected by the superposition of ICH to n-NBI.

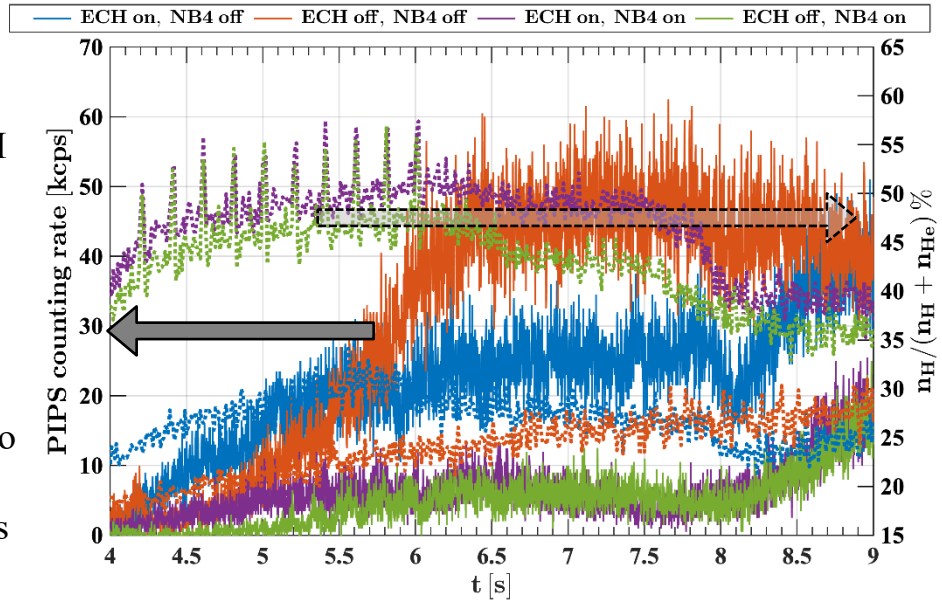
Results:

- [Left panel] ICRF-induced p-^{11}B fusion is successfully identified. A higher Alpha-particle-induced PIPS counting rate is achieved in the absence of modulated NB4.
- [Left panel] Superposition of ECH (77GHz, 2O-UR, ~0.4MW) to the ICH decreases the PIPS counting rate. We will check the boron behavior by ECH.
- [Right panel] Enhanced PIPS counting rate is observed by the superposition of ICH to the half-power n-NBI.
- [Right panel] Superposition of ECH (77GHz, 2O-UR, ~0.4MW) to the ICH-NBI synergy slightly increases the PIPS counting rate. Contrary to the minority ion heating.

1MW ICRF without n-NBI

Solid: PIPS
Dashed: H ratio

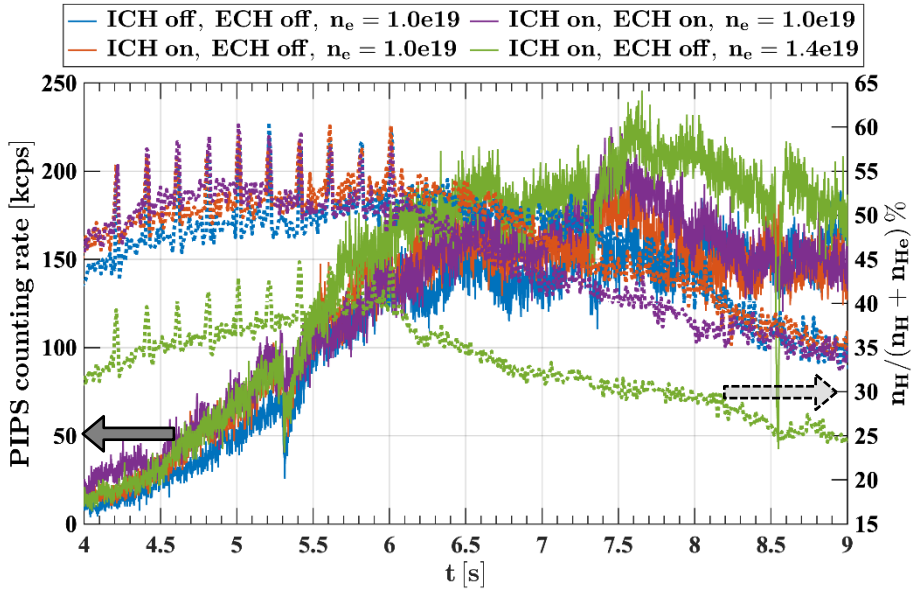
ECH ends @8s



1MW ICRF + 2MW n-NBI

Solid: PIPS
Dashed: H ratio

ECH ends @8s



Dependence of p-11B fusion reactivity on the boron density profile and fast ion confinement time

(Y. Fujiwara, S. Kamio, R. Magee, H. Gota, K. Ogawa, N. Tamura, et al.,)

Shot #:191729-191767 (39 shots)

Experimental conditions: (R_{ax}, Polarity, B_t, γ, B_q) = (3.60 m, CCW, 2.75 T, 1.254, 100%)

Background and motivation:

- Building upon the success of the previous experimental campaigns that observed alpha particles resulting from proton-boron (p-11B) fusion reactions induced by NBI, we aim for an efficient alpha particle generation condition.
- The purpose of this proposal is to investigate the relationship between the boron ion density profile in high-temperature plasma and the alpha particle production rate with NBI heating by comparing discharges with boron powder and boron pellet injection.

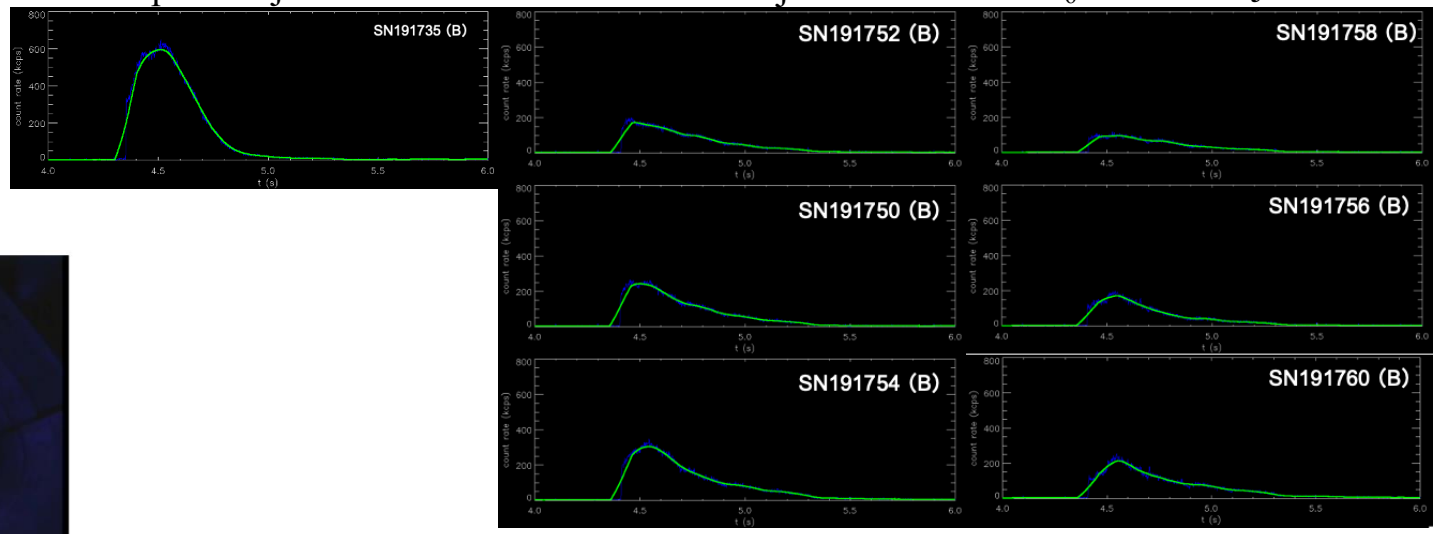
Results:

- We have successfully detected alpha particle emission rate in three different boron injection experiments that were using B pellet, B TESPEL, and SiB_6 TESPEL.
- In that order, the alpha particle emission rates were more significant for B pellet, B TESPEL, and SiB6 TESPEL.
- The alpha particle emission decay was faster for B pellet than for TESPEL.
- Future analysis will include boron density distribution and fast ion distribution in plasma.

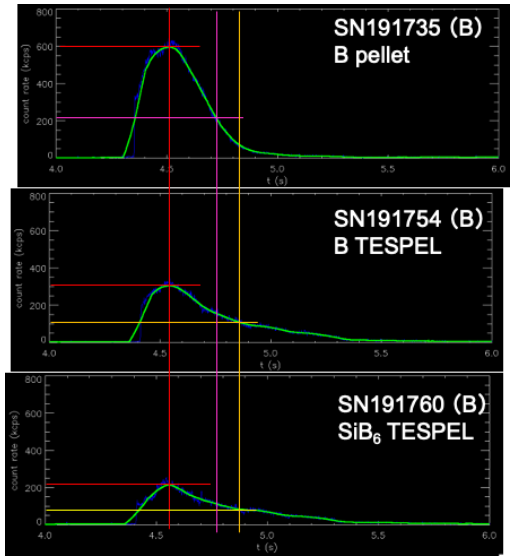
B pellet injection

B TESPEL injection

SiB_6 TESPEL injection



Alpha particle emission decay



SN191732 boron pellet injection