Fusion neutron measurements using a BF$_3$ counter have been performed in the ICRF heated and neutral beam heated plasmas in CHS. The counter is operated at the center of CHS torus in order to get a high detection capability to the extended toroidal neutron source because even the maximum total neutron yield is expected to be $10^8$ neutrons / shot in CHS$^3$. Our calculation indicates that if the deuteron temperature is above around 0.5keV, the CHS neutron detection system can deduce the central deuteron temperature.

ICRF heating experiments in the H$^+$ minority heating regime had been performed on CHS. Figure 1(a) exhibits a typical time evolution of neutron emission rate of the ICRF heated plasma, and that of the averaged electron density. Applying 560kW of ICRF power to the target plasma resulted in an abrupt increase of the neutron emission. Assuming that only H$^+$ ions were accelerated by ICRF wave and the bulk ion (deuteron) distribution remains in Maxwellian, the deuteron temperature at the plasma center, $T_D(0)$, was evaluated from the neutron emission rate. The time evolution of $T_D(0)$ and that of $T_I(0)$ measured by NPA are shown in Figure 1(b).

During the neutral beam heating phase, the neutron emission has been observed all the time. Most of neutrons seem to originate from beam-plasma reaction in spite of the H$^0$ beam injection, because, firstly, the abrupt increase of neutron emission due to D$^+_2$ gas puffing was observed in the NB heated plasmas. Secondly, the attainable $T_I$ in NB heated plasmas are expected to be 3-400eV. This means that the contribution of thermonuclear neutrons to total neutrons is rather small. For these reasons we have come to conclusion that almost all neutrons result from beam-plasma reaction. One of candidates for small deuterium fraction in the neutral beam is natural abundant one in a hydrogen gas. An additional deuterium component due to a back flow of D$^+_2$ gas puffing into the NB ion source may also exist in the neutral beam.

In order to study the deceleration state of injected energetic ions in CHS plasmas, our interest was focused on the decay of the neutron emission rate following the neutral beam termination, because it reflects the slowing-down of energetic ions. In CHS, this kind of study is limited to the condition $E_0 > E_{kin}$, where $E_0$ is the beam energy. The neutron emission rate decays approximately exponentially with the time constant of $\tau_n$ ($\sim 1.1$ms) (see Fig.2). The predicted $\tau_n$ from classical slowing-down theory was $\sim 1.3$ms in this shot.

![Fig.1](image1)

**Fig.1** (a) Typical time evolution of neutron emission rate of the ICRF heated plasma, and that of the averaged electron density. (b) Time evolution of $T_D(0)$ deduced from neutron measurement and that from NPA.

![Fig.2](image2)

**Fig.2** Decay of the neutron emission rate following the neutral beam termination. The emission decays approximately exponentially with the time constant $\tau_n$.

References