Soft X-ray measurement in IRE on the TST-2 tokamak

K. Sasaki\textsuperscript{1}, K. Hanada\textsuperscript{2}, K. N. Sato\textsuperscript{2}, H. Zushi\textsuperscript{2}, K. Nakamura\textsuperscript{2}, M. Sakamoto\textsuperscript{2}, H. Idei\textsuperscript{2}, M. Hasegawa\textsuperscript{2}, S. Kawasaki\textsuperscript{2}, T. Nakashima\textsuperscript{2}, A. Higashijima\textsuperscript{3}, Y. Takase\textsuperscript{3}, A. Ejiri\textsuperscript{3}, S. Shiraishi\textsuperscript{3}, \textsuperscript{3} H. Kasahara\textsuperscript{3}, T. Yamada\textsuperscript{4} and N. Nishino\textsuperscript{5}

\textsuperscript{1} Graduate School of Engineering Sciences, Kyushu Univ., Fukuoka 816-8580, Japan
\textsuperscript{2} Research Institute for Applied Mechanics, Kyushu Univ., Fukuoka 816-8580, Japan
\textsuperscript{3} Graduate School of Sciences, Kyushu Univ., Fukuoka 816-8580, Japan
\textsuperscript{4} Graduate School of Science, Univ. Tokyo, Tokyo 113-0033, Japan
\textsuperscript{5} Graduate School of Engineering, Hiroshi Univ., Higo-hiroshima, 736 8527, Japan

\textbf{Back ground and purpose}

Spherical tokamak (ST) having aspect ratio $a/s>1.5$ have been investigated as cost effective alternative to the tokamak fusion concept [1], the avoidance of a characteristic relaxation phenomenon in ST, that is Internal Reconnection Event (IRE) [2], is one of the crucial issues to execute the stable operation. When IRE takes places, the large amount of magnetic energy stored in plasmas is converted to the kinetic energy of plasmas by magnetic reconnection process and then the stored thermal energy and particles in the core region is lost abruptly. In this experiment, there is feature that $n$ and $m$ can be determined by measurement only Soft X-ray (SR).

\textbf{Experimental apparatus}

\textbf{Experimental results}

In Fig. 4, the IRE occurred at about 35.8 ms. Precursor was observed during several milliseconds before IRE. The frequency of SXR precursor was analyzed by fast Fourier transform (FFT) technique, and it turned out that the fluctuation had two dominant Fourier components ($F_c$) with 10 kHz and 4 kHz. $F_c$ with 10 kHz and 2 kHz were existed sometimes independently without IREs. The presence of both components with 10 kHz and 4 kHz leads to IREs.

\textbf{Summary and Discussion}

Two modes ($\rho=10$ kHz and 4 kHz) exist before IRE, only when two modes exist, IRE occurs. And these structures of precursor were identified. It turns out that about 10 kHz mode structure is $n=1$, and about 4 kHz mode structure is $n=3/4$. There is no change of frequency until precursor begins to take place and it results in IRE, but amplitude increases. The overlap of modes is considered to be the cause of IRE in TST-2 from the positional relation of islands, and changes of amplitude.

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|}
\hline
Parameter & Value & Unit \\
\hline
Major radius & 2.28 m & \\
Minor radius & 0.25 m & \\
Aspect ratio & $\alpha$ & 1.6 \\
$\beta$ & 1.6 & \\
$P_t$ & $\leq 140$ kA & \\
$P_h$ & $<10^3$ m$^2$ & \\
\hline
\end{tabular}
\caption{The parameter of TST-2}
\end{table}