Contribution ID: **613** Type: **Poster**

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Thursday, 20 October 2016 14:00 (4h 45m)

Observation of KBM and MTM in JIPPT-IIU tokamak plasmas using a heavy ion beam probe
Hamada Y.*, Watari T., Nishizawa A., Narihara K., Ida K., Kawasumi Y., Ido T., Nakanishi H., Toi K. and JIPPT-IIU Group
National Institute for Fusion Science, Oroshi, Toki, Gifu 509-5292, Japan
E-mail: hamada.yasuji @toki-fs.jp
There is a long history of research of magnetic fluctuations of low-frequency tearing mode using HIBP at TEXT tokamak. They succeeded to study tearing mode study, but abandoned the extension of their study into higher frequency above 10 kHz (typical tearing mode frequency). We invented metal-plate detector utilizing the secondary electron emission like a photomultiplier tube. Metal plates are hit by 0.5 MeV thallium secondary beam instead of light. With the higher detection efficiency, we are able to conduct the measurement with small diameter beam cross-section, leading to higher detection frequency of toroidal beam shift caused by poloidal magnetic fluctuations. Thus we were able to observe magnetic fluctuations of microtearing mode (MTM).
MTM is efficient for the breaking the magnetic surfaces and producing magnetic island because of the even parity (perturbative magnetic field does not change its sign on the magnetic field line). Gutterfelder stated that about 90% of electron heat loss in high-beta ST plasmas is estimated to be due to MTM. MTM has been studied theoretically for long time. MTM was considered to be induced by the resisitviy, however, it is now considered to be caused by gradient B drift, therefore, collisionless instability. Accordingly it may have large effect on ITER plasma. In addition, the numerical simulation requires very fine radial mesh of order of electron gyroradius, and it is very difficult to estimate the effect on the transport by the global simulation of ITER plasmas in near future. In addition, kinetic ballooning mode is not also studied experimentally because magnetic fluctuation measurement by CPS (cross-polarization scattering) using millimeter wave is not widely used.
Our experimental result is the first experimental finding of coexistence of MTM and KBM in the tokamak plasmas. Also we observe coexistence of KBM, ITG and TEM. In addition, we are able to observe ballooning effect of KBM predicted by Swarmy.

Paper Number

EX/P6-49

Country or International Organization

Japan

Primary author: Mr WATARI, Tetsuo (NIFS)

Co-author: Mr HAMADA, Yasuji (NIFS)

Presenter: Mr HAMADA, Yasuji (NIFS)

Session Classification: Poster 6

Track Classification: EXS - Magnetic Confinement Experiments: Stability