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Neutral particle - electron collision effect for branching plasma current ramp-up on 28 GHz 2nd harmonics ECCD

In order to realize nuclear fusion power plant, spherical tokamak (ST) which can obtain high beta has an economical advantage and is a good candidate. However, one of the problems of STs is that they not suitable for using the use center solenoid (CS) coil for the inductive current drive, because STs do not have enough cross-section in CS coil. To overcome this issue, in QUEST, the electron cyclotron resonance heating (ECRH) by the 2nd harmonic wave of 28GHz has been carried out for plasma current start-up. In 2nd harmonic ECRH, the electron energy branching from the bulk electron heating (T_e~100 eV, n_e~3×10^{18} m^{-3}, without hard X-ray radiation (HXR)) to the tail electron heating (T_e~10 eV, n_e~3×10^{18} m^{-3}, HXR energy~50 keV and high counts) was observed. In the bulk electron heating phase, plasma current is relatively low (~15 kA). On the other side, in the tail electron heating phase, plasma current was relatively high (~ 50 kA) accompanied by an increment of HXR counts. The increment of HXR counts shows the increase of tail electron. We consider that this heated electron energy branching might be caused by the shift of deposited RF energy from bulk electrons to tail electrons. The increase of high plasma current with tail electrons was observed after a decrease in H alpha. The effect of a neutral particle was confirmed by calculating the collision time of electron-electron, ion and neutral particles. By calculation, it is clear that the bulk electrons are not affected by neutral particle collision, because the effect of electron-electron, ion collision is much larger and the tail electrons are affected strongly by neutral particle collision. In addition to each collision time, the confinement time included the effect of an increase of connection length by the plasma current increase to model for each electron energy. This model showed correspondencewith the increase of confinement time by reducing neutral particles and the increase of plasma current.

Primary author: KOJIMA, Shinichiro (Kyushu university)

Co-authors: HANADA, kazuaki; Prof. IDEI, Hiroshi (Research Institute for Applied Mechanics, Kyushu University); Dr ONCHI, Takumi (Research Institute for Applied Mechanics, Kyushu University); Dr IKEZOE, Ryuya (Research Institute for Applied Mechanics, Kyushu University); Dr NAGASHIMA, Yoshihiko (Research Institute for Applied Mechanics, Kyushu University); Dr HASEGAWA, Makoto (Research Institute for Applied Mechanics, Kyushu University); Dr KURODA, Kengo (Research Institute for Applied Mechanics, Kyushu University); Prof. NAKAMURA, Kazuo (Research Institute for Applied Mechanics, Kyushu University); Mr ELSERAFY, Hatem (Research Institute for Applied Mechanics, Kyushu University); Mr FUKUYAMA, Masaharu (Kyushu university); Dr EJIRI, Akira (Graduate School of Frontier Sciences, The University of Tokyo); Prof. SHIKAMA, Taiichi (Kyoto university); YONEDA, Nao (Kyoto university); Dr YONEDA, Ryota (UCLA); KARIYA, Tsuyoshi (Tsukuba university); Prof. TAKASE, Yuichi (Graduate School of Frontier Sciences, The University of Tokyo); Prof. MURAKAMI, Sadayoshi (Graduate School of Engineering, Kyoto University, Kyoto); BERTELLI, Nicola; Prof. ONO, Masayuki (Princeton Plasma Physics Laboratory, Princeton University)

Presenter: KOJIMA, Shinichiro (Kyushu university)