Contribution ID : **383** Type : **not specified**

6.6 Study of electron temperature fluctuation evolution with upgraded ECE Imaging on DIII-D

Tuesday, 17 April 2018 10:30 (120)

A new generation of millimeter-wave heterodyne imaging detector arrays has been developed with liquid crystal polymer (LCP) substrate modules and demonstrated on the DIII-D ECEI system. These arrays exhibit ˜ 15 dB additional gain and > 30x reduction in noise temperature compared to the previous generation and provide ECEI capability for absolute electron temperature calibration. In each LCP horn-waveguide module, a 3x3 mm GaAs MMIC (Monolithic Microwave Integrated Circuit) chip, consisting of a low noise amplifier (LNA), balanced mixer, local oscillator multiplier chain and IF amplifier, was employed to generate LO with ˜12 GHz input via an RF cable to the enclosure box. A proof-of-principle instrument with 5 poloidal channels was installed on DIII-D in 2017. The full system installation (20 poloidal channels) is scheduled for early in 2018. The LCP ECEI system is used for pedestal region measurements, especially focusing on temperature evolution during ELM bursting. The DIII-D ECEI signal has been significantly improved with extremely effective shielding of out-of-band microwave noise. In H-mode ELM bursting, the radial propagation of electron heat flow has been detected on DIII-D. The LCP ECEI is expected to be a valuable diagnostic tool for ELM physics investigations.

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Session Classification : Session #6, Tuesday Morning Poster Session