

Development of microwave imaging reflectometry at NIFS

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The Imaging Science Project of National Institute of Natural Sciences (NINS) is to investigate science of complex systems. At National Institute for Fusion Science (NIFS), which belongs to NINS, microwave imaging is under development in this project. There are two types of microwave imagings, one is the electron cyclotron emission imaging (ECEI) and another microwave imaging reflectometry (MIR). Both are under development in the Large Helical Device (LHD). In this paper, we present development of MIR, which is useful to obtain the 2-D/3-D image of the electron density fluctuation. Present system is a prototype of MIR, as it has 3 frequencies (53, 66, 69 GHz) for illuminating wave and 3 horn antennas to receive reflection wave. Further improvement of 2-D detector is required to obtain the wave vector (k_{θ} , k_{ϕ}) of density fluctuations. We develop 1-D V-band (50-75 GHz) detector array using horn antenna array and PC board. The detector element consists of a horn antenna, a mixer, filters and RF amplifiers. This detector uses heterodyne detection. By stacking this 1-D array, a 2-D array is composed. A tunable microwave source is also under development for the illumination wave. This source consists of 8 – 13 GHz voltage controlled oscillator (VCO) and a frequency multiplier, which multiplies the source frequency by 6 times. a crystal oscillator, a up-converter and two The local oscillation (LO) for the heterodyne detection is made by up-converting the VCO signal and a crystal oscillator's signal, to generate an intermediate frequency (IF) of 110 MHz. We are also developing band-pass filter-banks, IF amplifiers and I-Q demodulators. The band-pass filter-bank uses the microwave strip line technology. The I-Q demodulator is a phase detector of reflected signals. This new system is installed onto LHD in order to observe turbulence and instabilities. This work is supported by the National Institute for Fusion Science (Grant No. NIFS07ULPP525) and the National Institute of Natural Sciences (Grant No. NIFS07KEIN0021). This work was also financially supported by the Budget for Nuclear Research of the Ministry of Education, Culture, Sports, Science and Technology, based on the screening and counseling of the Atomic Energy Commission.