§6. Development of Information Processing System for Microwave Imaging for Plasma and Dielectric Object Observations

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The microwave imaging reflectometer (MIR) measurement system[1] is acquiring valuable data on LHD plasma with well-designed systems of high spatial-temporal resolution antenna array. On the basis of technology of these systems, we built a new diffraction microwave imaging system [2] for the purpose of breast cancer diagnostics. The joint research aims to apply new imaging method based on information science approach to the microwave imaging devices that we have developed and are under developing. The research also aims to develop practical data processing software for three kind of microwave imaging problem: 1. diffraction tomography (CT), 2. microwave imaging reflectometer (MIR), and 3.synthetic aperture imaging (SAR imaging).

1. For the diffraction tomography system, some basic software are developed for the rotational scan type CT device. We have tested the imaging performance of the software for plural objects which have different dielectric constants (Fig.1). The test results brought two problems in the case of practical implementation of the software: (1) The reconstructed image degrades inside an object that has high dielectric constant and has size as large as the incident wavelength, (2) The software has difficulty imaging for narrow space between two objects located near, their distance is less than the incident wavelength. We plan to improve the software to corp with the problems by introducing the wavelength shortening effect of the microwave that passes through the objects.

2. For the LHD plasma refrectometer imaging, the O-mode MIR measurement has operated on the ITB experiment. Some cross spectra information of H-mode MIR signal obtained an interesting result that implies outward propagation of the plasma density turbulence (Fig. 2). Further development of applications of the MIR technology have started: (1) Microwave mammography system[3], and (2) Lens-less microwave camera. Experimental devices of two systems are assembled and some basic measurement tests have done. In the mammography system, by reviewing the measurement result of the diffraction waves for breast phantoms, we have checked some problems on phase accuracy of the received wave that plays important role on the imaging by FBTS method. For the lens-less microwave camera, based on the result of the transmitting / receiving microwave experiment, development of the basic imaging method based on the phase information of the received wave have started.

3. For the SAR imaging, a new laser radar imaging system has constructed and tested. The system uses infrared laser which is modulated by wide-band microwave, and has resulted 1-2mm spatial resolution along the ranging direction. Some 2-dimentional measurement tests have done and their imaging performances were evaluated. Furthermore, a 3-dimentional imaging software that uses the phase information is under developing.

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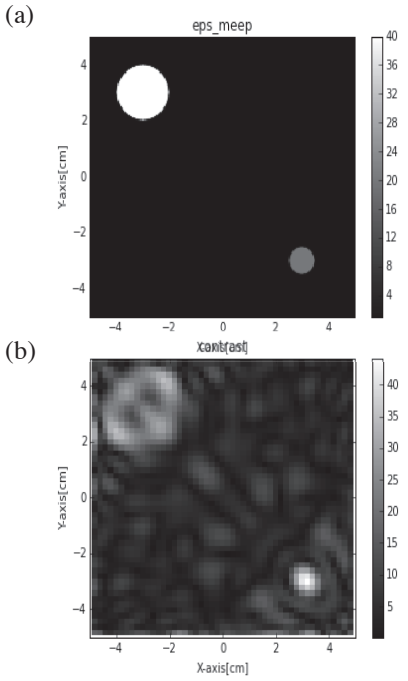

Fig. 1. Reconstruction simulation resuluts of two objects that have different dielectric constants by rotational CT device: (a) assumed locations, sizes, and dielectric constants, (b) reconstructed image.

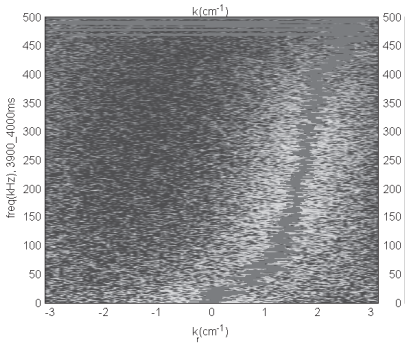

Fig. 2. Cross spectra in toroidal direction of H-mode MIR signal in ITB experiment.

1) Nagayama, Y. et al.: Rev. Sci. Instr., 83, p.10E305-1-10E305-6 (2012).
2) Teranishi, M. et al.: Ann. Rep. NIFS 2015, p.412 .
3) Nagayama, Y. et al.: Ann. Rep. NIFS 2015, p.411.