§18. Technology and Application of High Power Millimeter- /Micro-Wave Sources – High Power Electron Tubes –

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i) Objectives

In LHD experiments, a Mega-Watt millimeter wave system (77 GHz and 154 GHz) has been used for strong electron heating and current drive and, recently, is used for a diagnostic power source such as collective Thomson scattering (CTS). In the diagnostic aspects, electron temperature profiles and temperature fluctuations are measured using electron cyclotron emissions from a plasma over a millimeter wave range. The millimeter-wave reflectometry is also used to measure the electron density fluctuation to analyze the turbulence in the plasma.

In these days, microwave, millimeter wave and Tera-Hertz wave oscillators and some components have been progressively developed and applied to plasma, material and medical sciences. Particularly, vacuum electron tubes realize high power and/or steady-state output, eg. tetrodes for ICRF heating, gyrotrons for ECRH.

The objective of this workshop is to promote the exchange of the state-of-the-art informations among the researchers of micro-, millimeter– & TeraHertz-waves for the improvement in each field and the development of combined research fields.

ii) Activities in FY2013

In this fiscal year, we intended to make intensive discussion of the latest research results and the new research trend of the generation, detection and application of millimeter– / micro-waves and also TeraHertz-waves. Main themes in this fiscal year are as follows,

1. Present status of the research, development and manufacturing of micro-, millimeter– & TeraHertz-wave vacuum tubes using electron beams, e.g., klystrons and gyrotrons.
2. New idea, technologies and application of high power micro-, millimeter– & TeraHertz-wave vacuum tubes to the research fields other than nuclear fusion.

We had a workshop in January 15th, 2014 under the keywords of "Technology and Application of High Power Millimeter- / Micro-Wave Sources - High Power Electron Tube". The workshop mainly included seven recent research reports by collaborators.

The participants distributed over wide area related to the micro-, millimeter– & TeraHertz-wave technology and its application. About 22 members joined the workshop. The viewgraphs of each presentation were summarized and distributed in the CD-ROM for convenience.

iii) Brief Summary of the Presentations

In the workshop, the recent research activities were reported by the following researchers. Their presentations covered the power source development, method of analysis and application of millimeter-/ Tera-Hertz waves. The topics are wide spread, for example, gyrotron development for ITER, measuring instruments for astronomical observation, development of millimeter-wave components and so on. We hope the expansion of research field, new idea and new future collaboration through the information exchange within the researches in the various research fields related to power sources, detectors, theories about micro-, millimeter- and Tera-Hertz waves.

There were seven presentations. The presentation title and presenters are listed below.

Presentations: Research Reports

1. "Development of a Millimeter-Wave Range Backward Wave Oscillator"

   by Dr. Y. Soga, Kanazawa University.

2. "Research of G-Band Surface-Excited and Smith-Purcell Radiation Using a Weakly Relativistic Electron Beam"

   by Dr. K. Ogra, University of Niigata.

3. "Research of Pulse Radiolysis in the Tera-Hertz Frequency Range"

   by Dr. K. Kan, The Institute of Scientific and Industrial Research, Osaka University.

4. "Research of Electro-Magnetic Wave Radiation Using a Grating"

   by Dr. D. Li , Institute for Laser Technology.

5. "Present Status of Gyrotron Development for ITER Procurement"

   by Dr. K. Kajiwara, Japan Atomic Energy Agency.

6. "Application of Quantum Optics Techniques to Tera-Hertz Wave Detection "

   by Dr. H. Matsuo, National Astronomical Observatory of Japan, NAOJ.

7. "Development of a TE_{11} Circular Mode Polarizer for Electron Bernstein Wave Heating and Current Drive "

   by Dr. T. Maekawa, Kyoto University.