Development of high power and long pulse 170GHz gyrotron

K.Sakamoto, A.Kasugai, K.Takahashi, R.Minami, N.Kobayashi, T.Kariya*, Y.Misunaka*
Japan Atomic Energy Agency, 801-1 Mukoyama, Naka 311-0193, Japan
Toshiba Electron tube and Device co, 1385 Shimoishigami, Ohtawara, Tochigi 324-8550
Sakamoto.keishi@jaea.go.jp

Long pulse oscillation of the 170GHz gyrotron

In ITER, the electron cyclotron (EC) system capable of 20MW injection power is planned for a heating (ECH) to ignition, current drive (ECCD) and control of plasma instabilities. For a power source of ECH/ECCD system, the development of the 1 MW 170 GHz gyrotron is under way in JAEA (Japan Atomic Energy Agency).

The oscillation mode of the gyrotron at the cavity is $TE_{31,8}$ at 170GHz, which is converted to the Gaussian beam by a built-in mode converter and outputted through a diamond window. In the previous pulse extension experiment, the electron beam current decrease due to the cathode cooling was observed. The current decreased from 35A to25A for 100sec. As a result, the oscillation power decreased from 560kW to 440kW. To avoid the current decrease during the shot, a heater power boost was introduced to keep the emitter temperature constant with a pre-programmed control. In the preliminary experiment, the power and the pulse duration were 0.2 MW and 1000sec, respectively. Temperatures of all components remained constant, and the pressure in the gyrotron kept a level of ~10^{-7} torr. These results yield the prospect for CW operation at higher power levels. The higher power experiment is underway. In addition, it was identified that the large stray radiation was caused by the mechanical strain on the built-in mode converter in the fabrication process. An improved gyrotron is under fabrication and the experiment will be started in April 2006 aiming 1MW operation for CW operation, in which a modified built-in mode converter is installed. The designed value of the stray radiation from the mode converter is within 3%, which is 1/4 of the present gyrotron.

Sable high power oscillation at the high order mode of $TE_{31,12}$

Because the cavity diameter increases as the mode number does, the heat load caused by the Ohmic loss on the cavity wall decreases. In high order modes, 1.5MW level CW operation will be available. Then, a study of the high order mode oscillation of $TE_{31,12}$ has been carried out intensively using a short pulse gyrotron (~1 msec). A crucial concern is a stability of the oscillation that may be disturbed by other modes. In the experiment, a stable single mode oscillation of $TE_{31,12}$ was demonstrated at the power of 1.56 MW. The power increases with the beam current without saturation. The maximum oscillation efficiency was 30% at 1MW output, which is the same level with the design. This result indicates that high order modes up to the level of $TE_{31,12}$ will be able to increase the power to ~1.5MW or to reduce the heat load on the cavity wall at 1MW output. These will contribute to the extension of lifetime of gyrotron.