Experimental Study on 100MW X-band Relativistic Backward Wave Oscillator

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Abstract – : An rippled-wall RBWO is operated at the beam voltage of 250~400kV and current of 2.1~3.4 kA using the 130nsec, single shot using Seoul National University's Electron Beam Accelerator(SEBA). SEBA produces a hollow beam of 19.2mm-outer radius, 0.7-thickness guided by an axial magnetic field of 1.7~3.4 Tesla. The uniform ripple has a period of 11mm, mean radius of 14mm and ripple amplitude of 2mm. A single cavity-type reflector which excites a TM02 mode and cutoff a TM01 mode at the operating frequency is chosen. Microwave generated by the RBWO is radiated through an 11cm-diameter horn antenna. The radiation pattern of TM01 mode is measured by fluorescent lamps. The measured and simulated angle of radiation is about 14.9 degree and 13.1 degree, respectively. 110MW microwave was measured at the operating diode voltage of 330kV, the beam current of 2.8kA with the guiding magnetic field of 3.0 T. Efficiency of 12% is obtained by both numerically and experimentally. A typical 20 nsec microwave pulse is measured in the preliminary experiment. The frequency of 11.8GHz is measured by a heterodyne method.

1. Introduction

The rippled-wall relativistic backward wave oscillator (RBWO) is well-known as a high power microwave (HPM) device where slow-wave structure (SWS) supports the Cerenkov synchronism between cylindrical TM0n mode and hollow electron beam.

An X-band RBWO is operated at the beam voltage of 250~400kV and current of 2.1~3.4 kA using the 130nsec , single shot Seoul National University's Electron Beam Accelerator(SEBA) as shown in Figure. 1.

SEBA produces a hollow beam guided by an axial magnetic field of 1.7~3.4 Tesla. Outer radius and thickness of the beam are measured to be 19.2mm, 0.7mm, respectively as shown in Figure. 2 and are in good agreement with those by the simulation. The uniform ripple has a period of 11mm, mean radius of 14mm and ripple amplitude of 2mm. A single cavity-type reflector which excites a TM02 mode and cutoff a TM01 mode at the operating frequency is chosen.

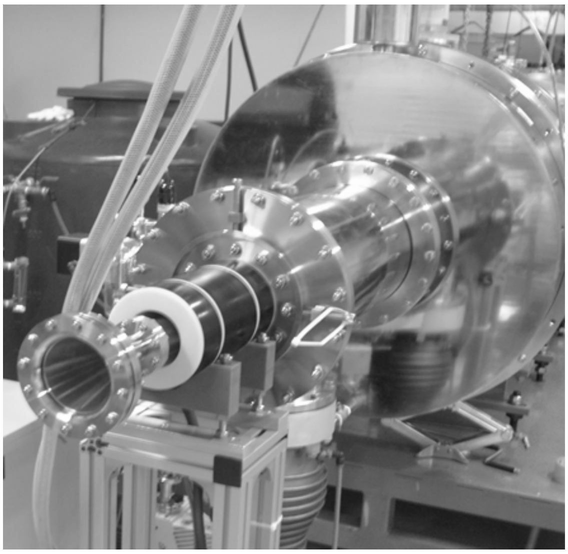

Fig. 1. Experimental setup for RBWO.

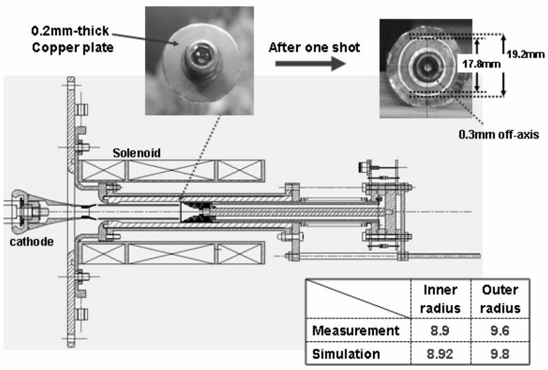

Fig. 2. Beam size measurement by a 0.2mm thin copper plate

Microwave generated by RBWO is radiated through an 11cm-diameter horn antenna. The radiation pattern of TM01 mode is measured by fluorescent lamps. The measured and simulated angle of radiation is about 14.9 degree and 13.1 degree, respectively.

The microwave power is measured by a calibrated pickup antenna which is located at a distance of 1m from RBWO and 10 degree off from the horizontal axis. Figure. 3 illustrates the measured power of the radiated microwave overlaid with the measured beam voltage using a capacitive voltage probe.

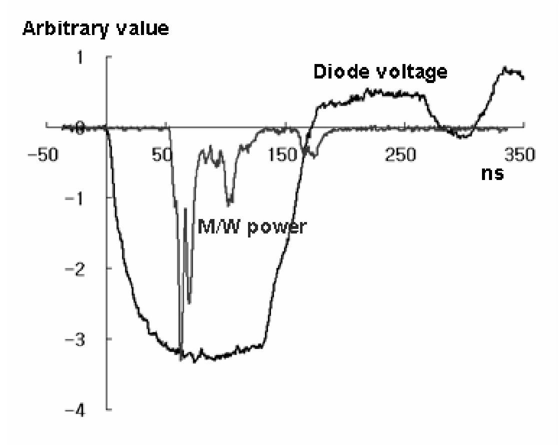

Fig. 3. Beam Diode voltage and microwave power waveform.

In this case, the diode voltage of 330kV, the beam current of 2.8kA and the guiding magnetic field of 3.0 T are used. The measured microwave power is compared with the simulated one using a particle-in-cell code, as shown in Figure. 4. Efficiency of 12% is obtained by both numerically and experimentally. A typical 20 nsec microwave pulse is measured in the preliminary experiment. The frequency is measured by a heterodyne method using a local oscillator of which frequency is 11.4 GHz shown in Fig. 5.

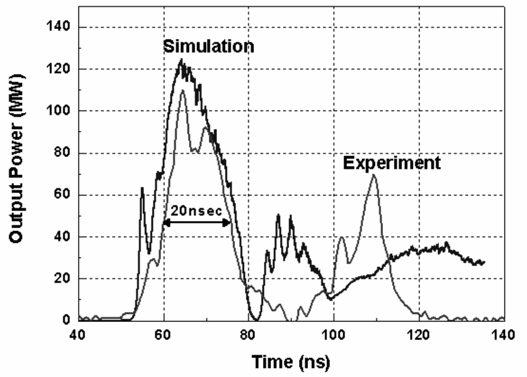

Fig. 4. Experimental result vs. MAGIC code simulation result of microwave power

The further optimization and the cause of the pulse shortening are under investigation. However, the mode competition between two neighboring modes is seen both numerically and experimentally shown in Figure. 5 and 6.

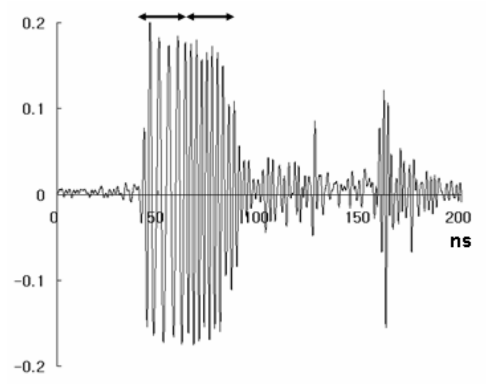

Fig. 5. Microwave signal measured by heterodyne method.

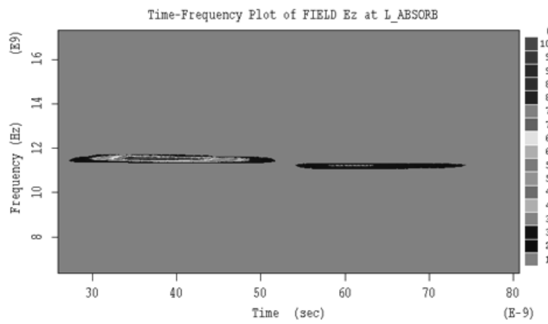

Fig. 6. MAGIC code simulation result; Frequency vs. time

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