Experimental Studies of a Relativistic Backward Wave Oscillator with Gaussian Radiation

Ahmed M. Elfrgani, Sarita Prasad, Mikhail I. Fuks, and Edl Schamiloglu
Department of Electrical and Computer Engineering, MSC01 1100
University of New Mexico,
Albuquerque, NM, USA
elfrgan@unm.edu

***Abstract*— A high power Gaussian radiation is always attractive for many applications such as short pulse radar, plasma diagnostics, and sounding systems. An X-band relativistic backward wave oscillator (RBWO) is proposed with a two-spiral corrugated Bragg reflector to provide such a radiation. BWOs are typically known to radiate in the TM_{01} mode, where a cavity or cut-off section reflector is used. A Bragg reflector has been designed and optimized using the fully electromagnetic, relativistic particle-in-cell (PIC) code MAGIC. Such a reflector converts the operating TM_{01}-mode of the BWO to the forward TE_{11}-mode with a Gaussian microwave beam at the output. The RBWO was driven by a voltage pulse that has a half sine wave-like shape, 460 kV amplitude, and FWHM duration of 12 ns (SINUS-6 Accelerator). With these parameters a microwave power of 330 MW at a frequency of 9.9 GHz in a clean TE_{11} mode pattern was detected at the output of the simulations.**

Keywords- backward wave oscillator; Bragg reflector; linearly polarize

I. INTRODUCTION

A backward wave oscillator (BWO) is an O-type Cerenkov device that is designed to effectively convert electron beam energy into electromagnetic radiation. This electromagnetic energy is generated with negative group velocity, where the wave is traveling in a direction opposite to that the electron beam, with a power varied from several 100 MW to several GW. The output mode pattern of the BWO is the TM_{01} mode where the field distribution is a doughnut shape (i.e., with a hole at the axis of the mode pattern). In order to make the RBWO more applicable in scientific research and for some practical applications, a two-spiral corrugated Bragg reflector has been used downstream of the cathode as shown in Fig. 1. The Bragg reflector allows the device to radiate a TE_{11} mode (a narrow Gaussian-like mode) at the axial output.

II. RBWO with BRAGG REFLECTOR

The oscillator consists of two slow wave structures (SWS) with sinusoidal corrugations. BWO-SWS is an axisymmetric sinusoidal corrugation while Bragg-SWS is a combination of left- and right-single-fold spiral corrugations. The SWSs can be described by

$$R(\theta,z)=R_0+ l_0*\sin(h*z + m*\theta), \quad (1)$$

where z and θ are the axial and azimuthal coordinates, respectively. R_0 is the average radius; l_0 is the amplitude of the corrugation; $h=2\pi/d$ and d is the axial periodicity of the corrugations; and m is the number of folds. The dimensions of the SWSs are summarized in Table I.

TABLE I. THE PERIODIC STRUCTURES DIMENSIONS

Quantity	The SWS Dimensions in cm	
	BWO-SWS	*BRAGG-SWS*
R_0	1.74	2.03
l_0	0.19	0.25
d	1.3	1.74
m	0	±1
Lenght	9*d	8*d

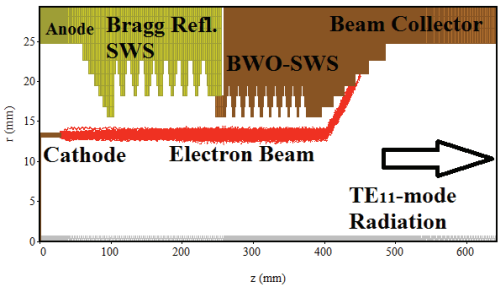

Figure 1. Design of the BWO with Bragg reflector.

REFERENCES

[1] A. Elfrgani, S. Prasad, M. Fuks, and E. Schamiloglu, "Relativistic BWO with Linear Polarized Gaussian Radiation Pattern," IEEE Trans. Plasma Sci. (under review, 2014).

[2] E. B. Abubakirov, J.-P. Brasile, A.N. Denisenko, M.I. Fuks, N.F. Kovalev, A.V. Saveljev, M. Simon, E.I. Soluyanov and V.V. Yastrebov, "Oversized Relativistic BWO with Selective Bragg Mode Converter," Digest of Technical Papers of the International Workshop on HPM Generation and Pulse Shortening. Edinburgh, UK: 1997, pp. 179-183.

This research supported by AFOSR Grant FA9550-11-1-0200.