High Power Microwave Source Development

HPM Progress at the University of Strathclyde

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***Abstract*— Research progress during recent years at the University of Strathclyde in microwave source development is presented. The main research themes include fast-wave gyro-devices with particular emphasis on gyro-TWAs and gyro-BWOs, novel Cherenkov mm-wave sources and pseudospark-driven sub-THz sources The research has included theoretical work, with the majority of the research having involved laboratory experiments and numerical simulations.**

Keywords-gyro-TWA; gyro-BWO; Cherenkov sources; millimeter wave sources; pseudospark-driven sources

I. INTRODUCTION

The University of Strathclyde has been engaged in research in high power microwaves for over 40 years although it is more recent progress that is reported here.

II. GYRO-DEVICES

Most of our research on gyro-devices has involved helical waveguide interaction structures [1-4]. This interest began in the 1990's when the early experiments were in the 10 GHz frequency range, whereas our more recent experiments have been in the 90 to 100 GHz range. The applications for these mm-wave amplifiers include DNP-NMR, cloud radar and communications.

III. CHERENKOV DEVICES

One of the aims of the research on Cherenkov sources is to retain reasonably high output power levels as the frequency increases. Traditionally Cherenkov sources have followed the trend that as the frequency increases and the wavelength decreases the interaction structures shrink to retain low order mode operation and the power handling capacity decreases as a result. Novel methods of selecting and driving modes in highly overmoded structures have been explored. [5-7] Mode coupling to form an unique eigenvalue is a promising method able to achieve efficient excitation of a single high power mode in an overmoded structure. An alternative to high power microwave sources is to use pulse compression of lower power sources [8].

IV. PSEUDOSPARK-DRIVEN SOURCES

Pseudosparks have been known since at least the 1970's and have been developed for several applications including switching. Our interest in pseudosparks [9,10] is related to their ability to emit intense high brightness electron beams. It has been found that by optimizing the pseudospark geometrical configuration and by employing micro collimating apertures, micro electron beams can be produced that are ideal for driving small structures suitable for creating sub-THz sources [11]. A W-band (75-110 GHz) Extended Interaction Oscillator (EIO) millimeter wave source was designed and constructed to operate in the 2π mode. With a 35 kV discharge voltage, the EIO successfully produced 20 ns pulses of W-band radiation, in agreement with 3D Particle-in-Cell (PiC) simulations. With beam currents, in the 1A to 10A range, the efficiency of the measured 200W output pulses is, at present, less than 1%. In this experiment the pseudospark was operated at low pulse repetition frequencies (PRFs), however pseudosparks are capable of PRFs up to a few kHz. This low cost, compact, portable source, that does not need an applied magnetic field, has potential for producing 20 ns pulses of W-band, 200 W radiation, at kHz PRFs.

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