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High Power Amplification Experiments on a Recirculating Planar Crossed-Field Amplifier

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The Recirculating Planar Crossed-Field Amplifier (RPCFA) is an S-band high-power microwave amplifier adapted from the Recirculating Planar Magnetron developed at the University of Michigan.1 The RPCFA has demonstrated amplification in excess of 16 dB for input signals up to 40 kW at frequencies ranging from 2.40 to 3.05 GHz. Pulsed power for the RPCFA is provided by the Michigan Electron Long Beam Accelerator with Ceramic insulator stack (MELBA-C), which generates pulses of -300 kV, 1 –10 kA, for approximately 400 ns. The injected RF power is produced by various magnetrons ranging in both power (10-40 kW) and frequency (2.40-3.05 GHz), as well as a moderate power (˜1 kW) generator with continuously variable frequency.

The RPCFA has been fabricated and tested experimentally, verifying the results of MAGIC particle-in-cell simulations.2 The RPCFA has demonstrated amplification over a continuous frequency band from 2.6 to 3.05 GHz. For injected powers up to 40 kW, the amplifier is unsaturated, producing output powers approximately proportional to the input. These amplified, output microwave power levels have high variance and measures have been taken to understand and improve reproducibility. Cathodes with carbon brazed emitters have been tested to improve electron emission and create a more reproducible beam. These cathodes have decreased the variation of emission current, which has decreased the variation of amplification. Current research is focused on delivering input powers on order of 1 MW. A pulse forming network has been built to drive a 2.5 MW-rated MG5193 magnetron. Two existing magnetrons have consistently generated up to 2 MW on a test-stand.3 Amplification at MW input drive would confirm the high-power capabilities of the design and may also reduce variations in gain due to the stronger fringing RF fields.

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