A self-insulating high-power microwave source

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We present first predictions for the performance of a novel, mildly relativistic (500keV, 2kA), X-band Cherenkov oscillator, nominally a variant of the backward-wave oscillator. The source operates with no externally-applied magnetic insulation, relying only on the self-fields of the electron beam for propagation. This significantly reduces the overall energy requirements for operation, along with the complexity; conventional (magnetically insulated) sources of this type typically require magnetic field strengths of 1 – 2T for efficient beam propagation, translating to a relatively large solenoid and associated power-supply. By eliminating this factor, the overall-efficiency of the source is tightly coupled to the conversion-efficiency between the beam and the wave.

Conversion efficiencies in excess of 30% have been predicted for the source, when driven by a high-quality electron beam; the parameters of which were determined via numerical modelling of the electron gun. A tolerance study of variation in the beam parameters shows the efficiency remains better than ~25% over the variation in critical control parameters expected in experiment, with clean excitation of the intended TM_{01} operating mode achieved at a stable output frequency of ~9.4GHz. The resonant frequency of the source was found to be insensitive to variation in the electron energy over an extended range $(400 - 600keV)$.