Repetitive 100MW Grounded Cathode Relativistic Magnetron

I. Schnitzer, A. Rosenberg, C. Leibovitch, J. Leopold, I. Cohen, and J. Shiloh

Rafael, P.O.Box 2250, Haifa 31021, Israel ; FAX No. 972-4-8795315

Since the first landmark by Bekefi et al. [*Phys. Rev. Lett.* **37**, 379 (1976)], announcing a 900MW relativistic magnetron, substantial improvements accomplished peak power levels of several gigawatts. However, pragmatic considerations emphasized repetitive mode of operation and longer pulse duration (i.e., higher average power) at the expense of peak power. Repetition rate of about 200*pps* with peak power levels around 600-300MW and pulse lengths 30-70ns ($\approx$ 20J/pulse) were achieved by Physics International, USA, and by the Institute of Nuclear Physics, Tomsk, Russia [J. Benford and J. Swegle, "High-Power Microwaves", Artech house, 1992]. It seems that pulse duration, at these power density levels, is restrained by universal, not fully understood, mechanism(s).

At Rafael, we initiated a relativistic magnetron research program aiming for rep-rated generation of 150 - 200ns long pulses with peak power of about 100MW. Our magnetron design (*Patent pending*) is **fundamentally different** from those that led to the achievements mentioned above. The cathode is grounded and the positive H.V. pulse is injected to the anode block (essentially, an A6 resonator) through an external cavity, that serves as a buffer cavity between the anode-cathode interaction region and the output waveguide. In this grounded cathode geometry the axial current is eliminated (improving efficiency). For the cathode, we conceived a special scheme of alternating metal/dielectric disks, employing the principle of triple point plasma initiation [G. Mesyats, *Beams '94*, 93-99].

At present, the magnetron is driven by a rep-rated ($\leq$ 20*pps*), 120Ω, Marx-PFN generator. Pulse trains of **50MW** peak power and **150ns** duration at 10Hz were measured with Vgenerator=300kV, Vdiode=180kV, Idiode=1kA, and η=28%. At higher charging voltage, improved vacuum conditions, and lower rep-rate, **100MW** pulses have been measured with Vgenerator=360kV, Vdiode=180kV, Idiode=1.5kA, and η=37%. However, these pulses tend to be shorter, about **70ns** long. We present detailed studies of the emitted pulse shape, the temporal evolution of its spectral power density and diode impedance, which suggest some physical insight to the relativistic magnetron's operation. We also show some preliminary 2-D computer simulations to support our understanding of the power transfer density. It is concluded that Rafael's novel relativistic magnetron may be further improved to generate more powerful pulses of over 150ns duration. In principle, this magnetron may be tunable through the buffer cavity in a way similar to coaxial magnetrons.