STAND-ALONE PULSED POWER GENERATOR FOR HPM GENERATION

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The challenges in developing and designing a 5 GW stand-alone pulsed power generator for driving a > 100 MW high power microwave, HPM, source are discussed. Both, applied physics aspects of operating principles and limits of the individual sub-systems will be addressed. The energy, initially provided through a set of lithium-ion batteries internal to the generator, is boosted by an explosively driven flux compressor, FC, and inductively stored at a several kJ level. While the energy is stored on a microsecond timescale, it is, however, released into the load on a nanosecond timescale via an electro-explosive fuse, EEF, thus delivering GWs of electrical power to the HPM source for a duration of about 100 ns.

The EEF has been optimized through modeling its properties in detail utilizing a smaller scale test-bed for basic comparison of EEF behavior in opening switch mode. It was such revealed that the conductivity models available for strongly coupled dense plasmas were insufficient to properly model the plasma conductivity (e.g. the fuse’s conductivity in the “open” state) in the presence of merely a moderate electric field of around ~6 kV/cm. Based on a finite difference hydrodynamic model, the contribution to the conductivity through thermal and field induced effects revealed that three modes of fuse restrike may occur in EEFs depending on the dense plasma’s density, temperature, and electric field history.

From the full scale EEF opening process, roughly 400 kV are available to drive the electron emission of the HPM diode with a large cathode of about 15 cm² area. Since uniform electron emission from such cathodes is paramount for successful HPM generation, details of the electron emission in ultra-high vacuum from CsI coated carbon velvet with differing metallic anodes are presented utilizing PIC code simulations and experimental results. The AK-gap plasma formation is tracked with temporally resolved optical measurements simultaneously with gap current and voltage. Finally, from a systems engineering perspective, the physical limitations of the other generator sub-systems such as the integrated seed source, the FC, and the energy storage will be discussed.

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