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Long Pulse and Positive Polarity Operation of a Reflex Triode at the Saturn Accelerator

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The Saturn Accelerator at Sandia National Laboratories was originally designed as a short pulse, negative polarity machine with a power pulse width of approximately 28 ns feeding a three ring diode bremsstrahlung x-ray source supporting the machine's primary function as a high dose-rate x-ray simulator. For upcoming x-ray source designs such as the reflex triode, the machine must be operated in positive polarity. This is a non-trivial setup on Saturn since the pulsed power cannot be easily reconfigured. The solution utilized in this work was to connect the upper and lower cathodes directly to machine ground inside the vacuum stack through a large (˜250 nH) ballast inductance, driving the anodes positive. In the short pulse configuration that means that approximately 1/3 of the current is not available for making bremsstrahlung radiation because the main power pulse is over before the power reflected from the ballast inductances has time to reach the load.

In an attempt to recapture some of this current, recent experiments were run to reconfigure the machine to run in a long pulse mode. This configuration involves shorting the self-break water switches in the pulse forming line. The results indicate that the current pulse rises to a peak after ˜190 ns compared to the normal ˜18 ns rise time. The long rise means that, in the mode where the cathodes are shorted to ground, the power pulse has time to go through the 18.6 nanosecond radial disk feed in the water section, reflect, and travel back to the rods and onto the other side of the disk feed before peak radiation. This means that the current losses are less and that more of the machine power can contribute to making radiation. Machine data are presenting showing this increase in performance.

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