COMBINED FLUX COMPRESSION AND PLASMA OPENING SWITCH ON SATURN

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A wire-array flux-compression cartridge installed on Sandia's Saturn pulsed power generator doubled the peak current into a 3-nH load and halved its rise time[1]. The current into the load, however, was unexpectedly delayed by almost 1 μs. A simple model of a plasma flow switch (PFS) acting as a long-conduction-time opening switch is consistent with key features of the power compression. The results suggest that microsecond-conduction-time PFSs can be combined with flux compression both to amplify currents and to sharpen pulse rise times in pulsed power drivers.

The goal of the experiments was to develop a flux-compression cartridge that, when installed on the Saturn generator, would amplify the current and sharpen the pulse rise time. The goal was achieved, but the amplified and sharpened current pulse was observed in the load only long after the Saturn pulse had peaked. In the best shot, the Saturn peak current of 3.1 ± 0.3 MA was doubled to 6.3 ± 1.0 MA in the load, and the 200-ns rise time of the Saturn current was halved to about 100 ns. The peak rate of current rise from Saturn, 26.1 ± 0.05 MA/μs, was increased to 114 ± 29 MA/μs in the load after a 700 to 800 ns delay.

Conditions for a microsecond-conduction-time PFS may have been created naturally in the flux-compression cartridges in the three shots in which switch-like behavior was observed. A PFS conducts current across a plasma as the plasma is accelerated down a coaxial channel by magnetic pressure. The current driving the plasma opens when the plasma is ejected from the channel. A 30-mg diffuse plasma mass shorting the gap at the entrance of the channel could have been accelerated by the magnetic pressure of the 6-MA current along the 1.5-cm channel to the load. The plasma would transit the channel in 700 to 800 ns, exit the channel into the load at 4 cm/μs, and move a distance beyond the channel equal to the 4-mm width of the channel and shunt the current into the load in about 100 ns.

The simple model suggests that a specific plasma opening switch may be particularly well suited to be *combined* with a specific embodiment of a plasma flux-compression generator to amplify currents and sharpen their rise times to scales applicable to inertial confinement fusion and next-generation radiation simulators.

1. F. S. Felber *et al*., "Demonstration of Current Doubling and Pulse Sharpening on Saturn," Conf. Record of ICOPS 2009, San Diego, California, Paper IO3C-3.