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Spectroscopic Comparison of Cable-Gun and Marshall-Gun Opening Switch Plasmas*

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The characteristics of opening switch plasmas initialized by two methods—cable guns and gas-fed Marshall guns—were compared spectroscopically, as part of an effort to understand the effect of multi-species plasma composition on opening switch performance. Anecdotal observations of slower switching with single-species plasma sources compared to multi-species sources have led to the hypothesis that multi-species composition plays a role in fast switching. Studies of the underlying physics in multi-species plasmas have resulted in observations of fast magnetic field penetration; the work reported here is an assessment of the differences between multi-species and single-species sources that might affect this fast field penetration. A time-gated spectrometer was used to diagnose opening switch plasmas driven by NRL's Hawk pulsed-power generator, with a peak current of up to 700 kA and a quarter-cycle time of 1.2 μs. The cable-gun initialization method is commonly used in plasma opening switches and produced an inherently multi-species plasma from the ionization of Teflon, composed of carbon and fluorine. The Marshall-gun initialization method allowed for more control of the initial plasma composition through adjustment of the gas mixture feeding the gun, typically pure argon, pure helium, or a mixture of both. The constituent plasma ions resulting from each initialization method were identified spectroscopically and compared, both prior to and during the application of the main Hawk pulse.

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