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RF Pre-Ionization to Create Faster, Hotter MHD-Driven Jets and Studies of Plasma Expansion Into a Vacuum VERNON CHAPLIN, PAUL BELLAN, Caltech — We are studying MHD-driven jets relevant to astrophysical jets and fusion plasmas. Previous experiments at Caltech have focused on plasmas created by breaking down neutral gas using high voltage. The Paschen breakdown criterion governing this process sets an undesirable lower limit for the jet density. To overcome this constraint, we have developed a pre-ionization system powered by a pulsed, battery-powered, 3 kW 13.56 MHz RF amplifier. Pre-ionization of plasma in a tube behind the jet experiment's center electrode is expected to enable the formation of lower density, hotter, faster jets. Thus far, argon jets have been created with $v > 30$ km/s, twice as fast as was previously achievable. The expansion of the RF plasma into the chamber prior to the discharge of the main capacitor bank involves surprisingly complex dynamics. There are two phases: initially plasma expansion along the background magnetic field is inhibited and the primary source of emission away from the RF antenna appears to be neutral atoms excited by fast electrons or photons from the RF source. At a later time, either before or after RF turn-off depending on the magnetic field configuration, a relatively high density ($n_e > 10^{18}$ m^{-3}), cold ($T_e < 0.5$ eV) cloud of plasma emerges from the source tube.

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