Control of sheared flow stabilized Z-pinch plasma properties with electrode geometry

E.L. Claveau[1], U. Shumlak[1]

[1] *University of Washington, Seattle, USA*

The FuZE device produces a 0.3 cm radius by 50 cm long Z-pinch between the end of the inner electrode of a coaxial plasma gun and an end wall 50 cm away. The plasma column is stabilized for thousands of instability growth time by an embedded radially-sheared axial plasma flow, a method proposed in Shumlak and Hartman Phys. Rev. Lett. 1995 and demonstrated experimentally in other sheared flow-stabilized Z-pinch devices, ZaP and ZaP-HD. The mechanisms that affect sheared flow are investigated. Sheared flow is generated upstream of the pinch in the coaxial accelerator and can be influenced by the downstream boundary conditions, composed of the anode end wall. Different nose cone geometries are tested and their effects on flow and pinch properties are analyzed. MACH2 MHD simulations show that abrupt transitions from the coaxial accelerator to the Z-pinch create less favorable sheared flow profiles while gradual transitions promote adiabatic compression and favorable shear. Different end wall geometries are also tested. The transparency is increased by changing the center hole design to a spoked design. It is found that the end wall influence on the upstream Z-pinch is minimal. The plasma is frozen in the magnetic field, preventing the increased end wall transparency from allowing plasma to escape the assembly region, which acts as a flux conserver. However, plasma can be transiently allowed to exhaust with increased ram pressure. The ram pressure can be increased by changing the input energy, controlled by the bank voltage, and changing the injected density, controlled by the gas valves. At low density and low energy, it is found that the upstream properties are minimally affected by the end wall geometries as stagnated, frozen in flux plasma create a virtual end wall. Increasing the plasma velocity and density can lead to a short-lived exhaust and a delay in the formation of the virtual end wall.