GENERATION AND USE OF AN ULTRAHIGH SPEED FLOW FROM A PLASMA FLOW SWITCH

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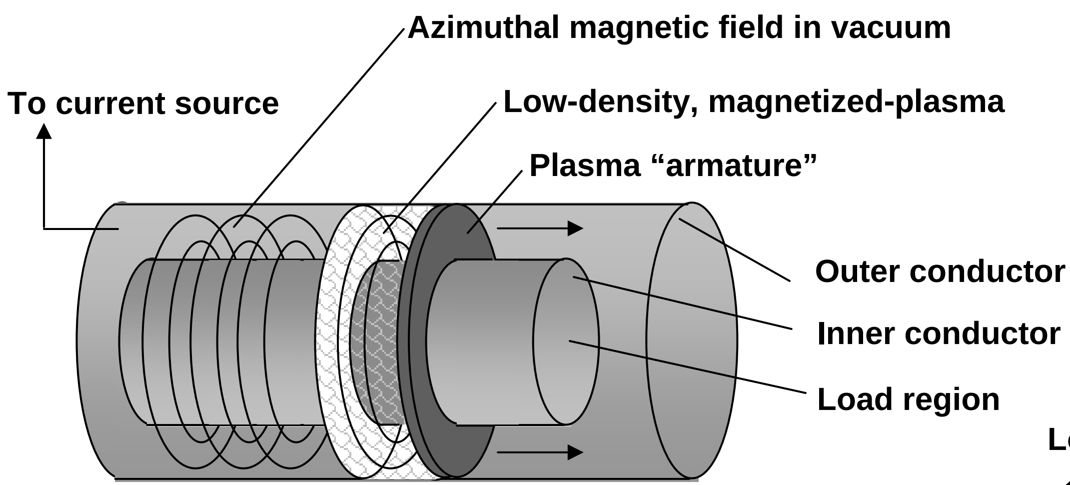
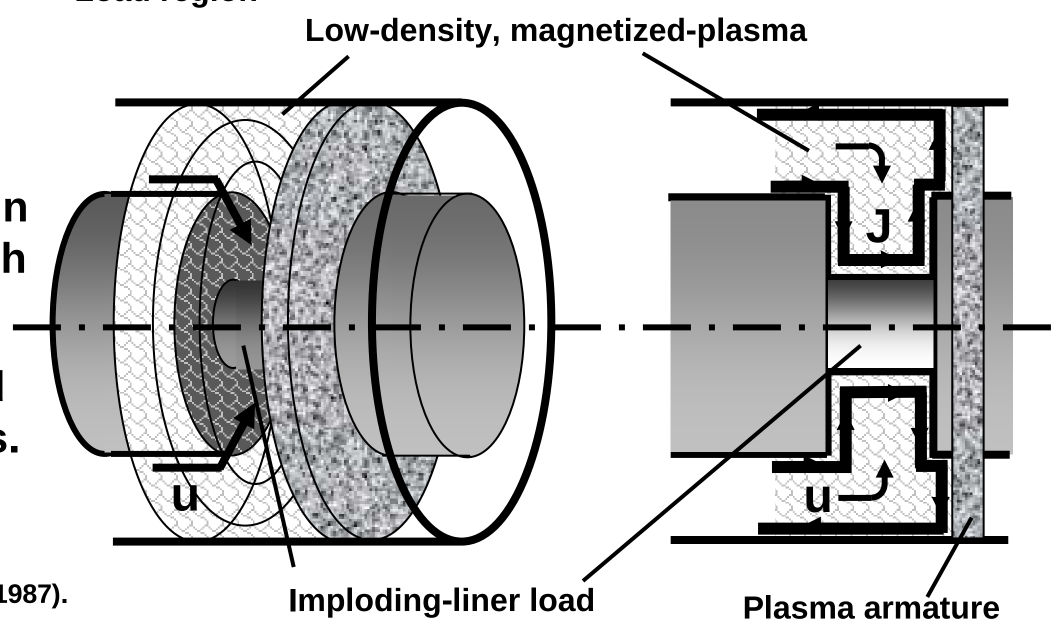
Plasma Flow Switch Couples Multi-megampere Sources to High Energy-density Loads



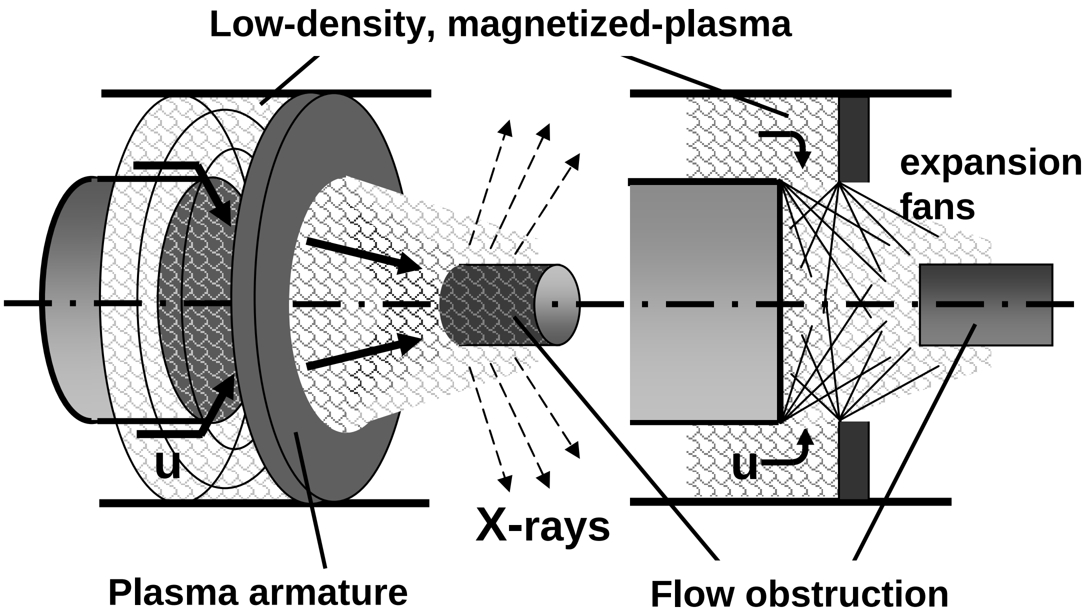


Multi-MJ, multi-MA sources operate in microseconds to store energy as high magnetic field.

Plasma Flow Switch connects stored magnetic energy to high speed loads.

P.J. Turchi, *et al, IEEE Trans. Plasma Science* P-15 6, 747 (1987).

By Removing the Liner Load, the Plasma Flow Switch Provides Ultrahigh Speed Particles for the Plasma Flow Radiator



X-ray pinhole photo of radiation from stagnated plasma

P.J. Turchi, et al, "Generation of High Energy X-Radiation Using a Plasma Flow Switch", JAP 69 (4), 1999.

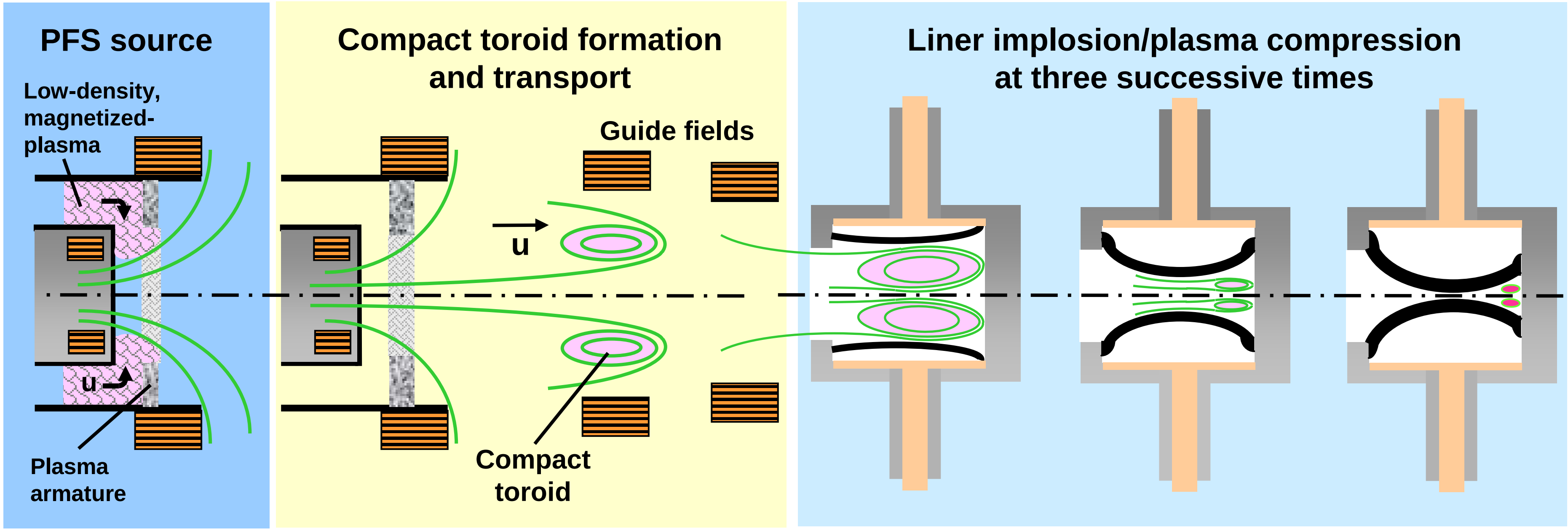
Generation of plasma bremsstrahlung to balance the energy deposition by high-speed ions in the background electrons:

$$K_b n_e^2 Z T_e^{1/2} = K_s n_e^2 Z^2 u_i^2 / 2 T_e^{3/2} \longrightarrow T_e \sim u_i$$

"Open Fire" Test on Shiva Star at 12 MA (B_o = 0.3 MG):

u_i = 2000 km/s, T_e = 30 keV

Ultrahigh Speed Flow from the Plasma Flow Switch Provides High Temperature Plasma Target for Liner Implosion



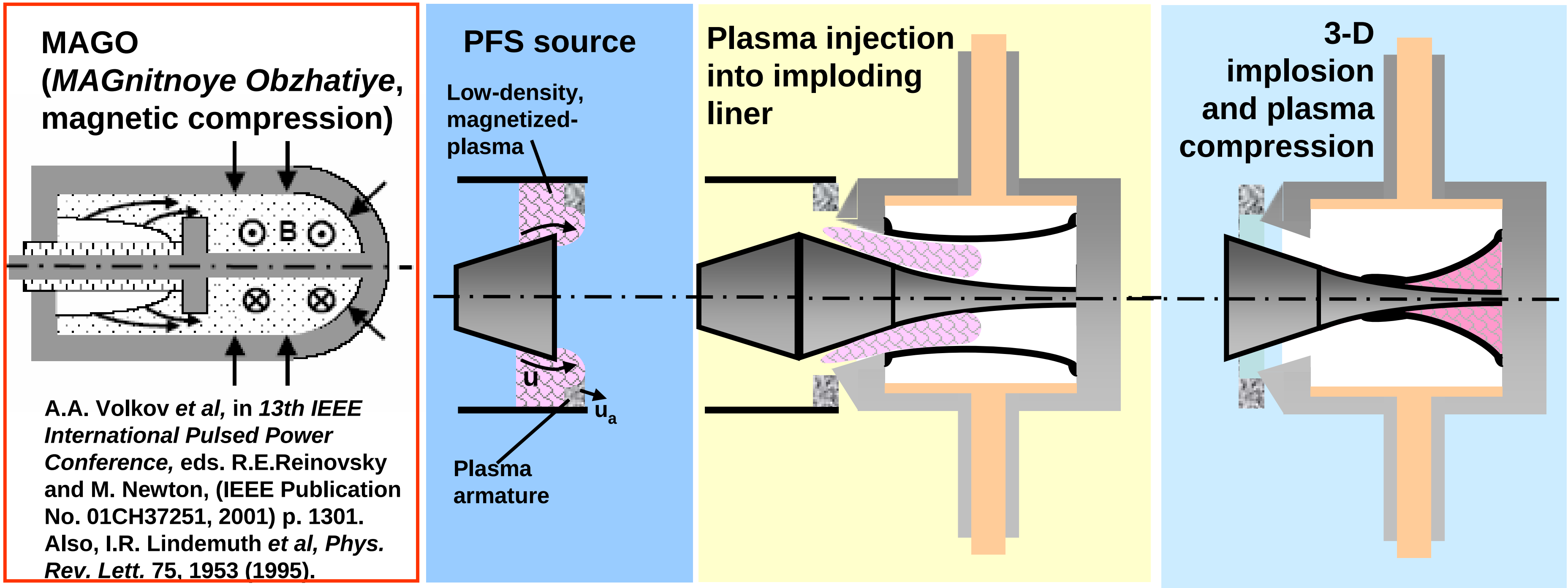
For a D-T plasma, at 2.5 amu and 2000 km/s, the initial temperature of the target plasma is 17.4 keV.

Three-D implosion, with a radial compression of 10:1, takes the plasma density to $n_D = n_T = 3.9 \times 10^{19}$ cm^{-3} for 1 MJ from PFS.

An isothermal compression requires 4.6 MJ of work and allows a dwell time of about $\tau = 0.5$ μs; note: heat loss helps!

$n_D\tau$ (17.4 keV) ⟶ $Q_{sci} > 1$

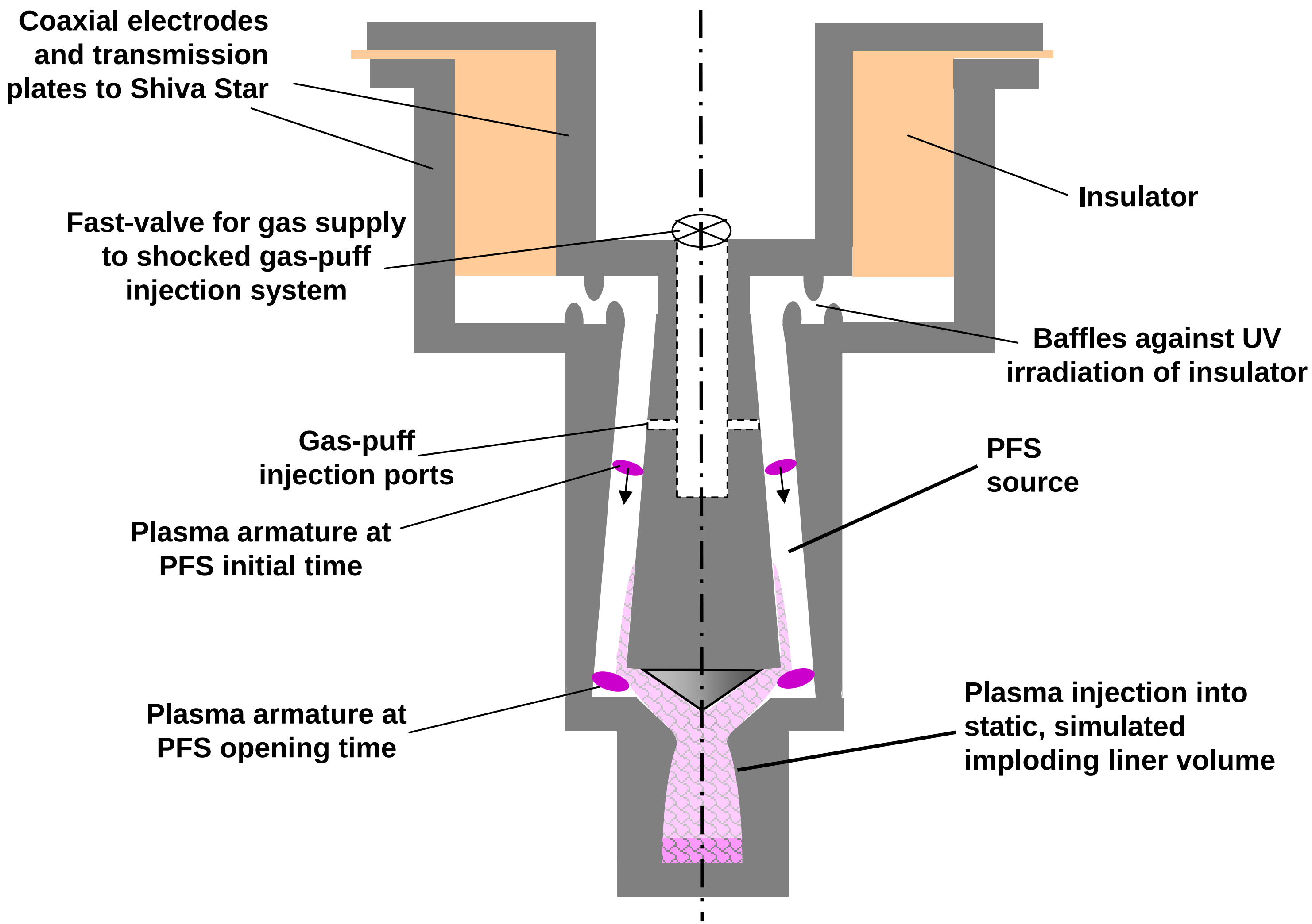
An Alternative Plasma Target Uses Magnetic Field Only for Thermal Insulation and Offers a Simpler Test



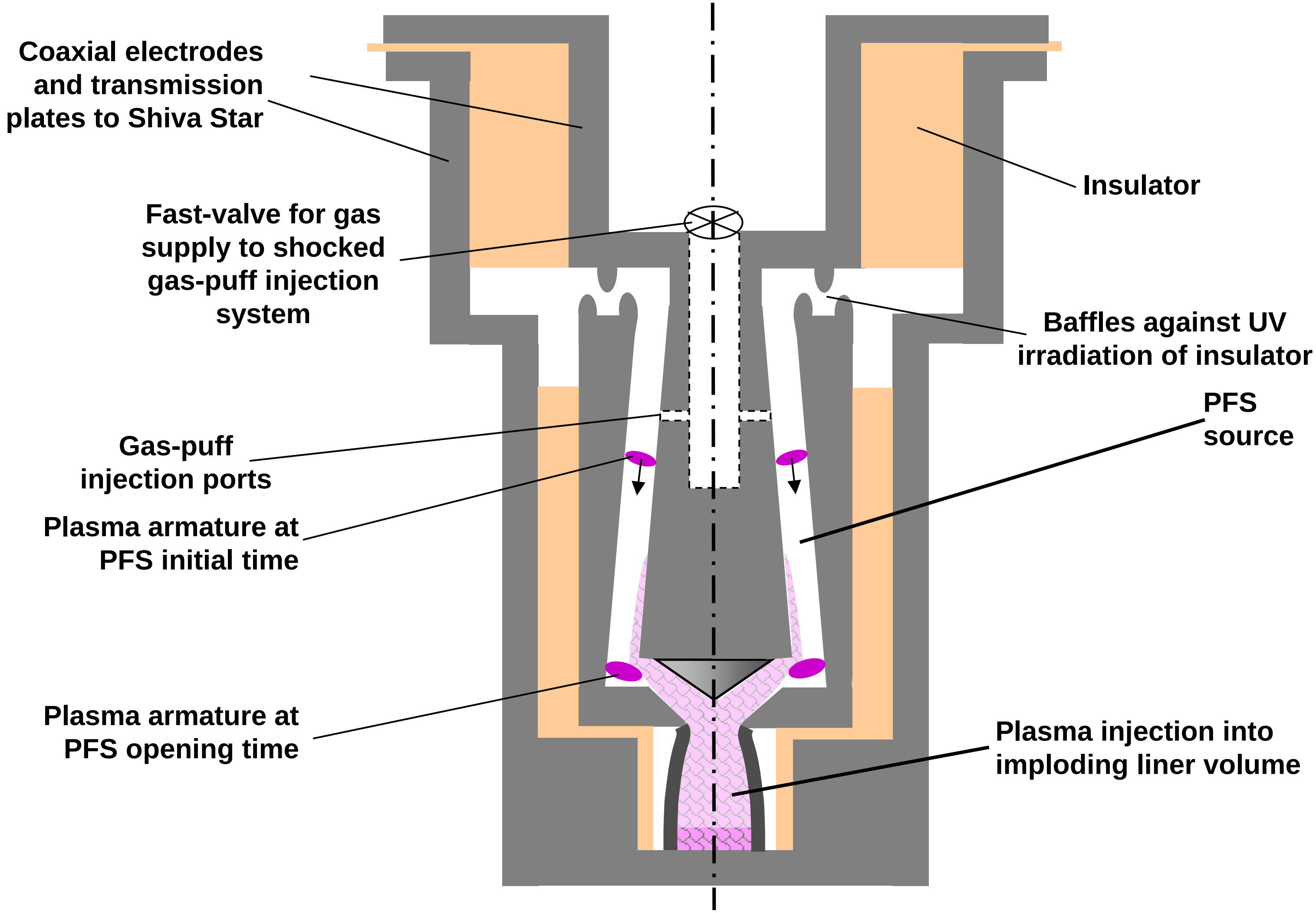
A plasma gun provided the initial plasma for compression by a shaped-liner implosion in AFRL "working-fluid" experiments, F.M. Lehr *et al, Appl. Phys. Lett.* 75, 3769 (1994), J.H. Degnan *et al, Phys. Rev. Lett.* 74, 98 (1995).

The Plasma Flow Switch offers a source of plasma at very high initial temperatures for 3-D compression to high densities.

Initial experiments to test the development and injection of high-energy density D-D plasma from the PFS will be performed on Shiva Star and compared with MACH2 predictions.



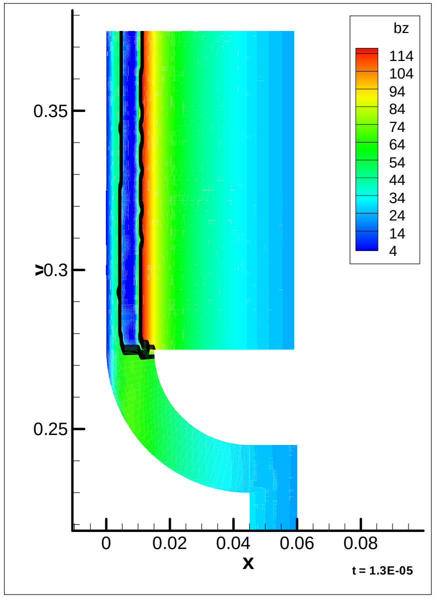
Plasma injection experiments will then be extended to liner compression of the stagnated plasma.



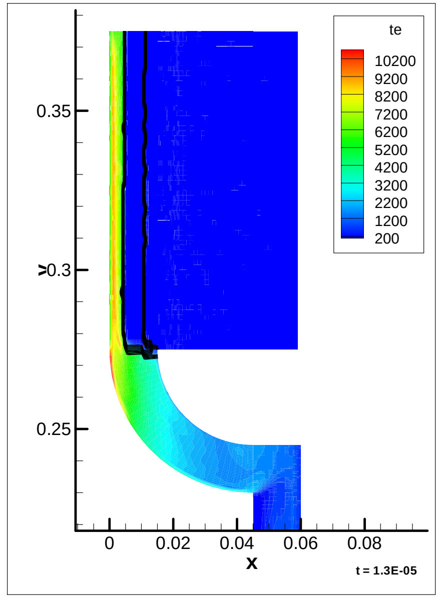
If successful, we can increase the current and energy of operation using other pulsers, such as Atlas and flux-compression generators.

MACH2 couples the liner motion to the driving circuit to predict plasma compression and neutron production.

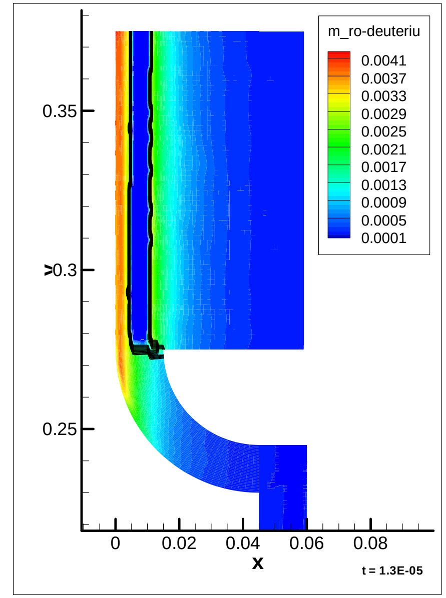
Magnetic Field

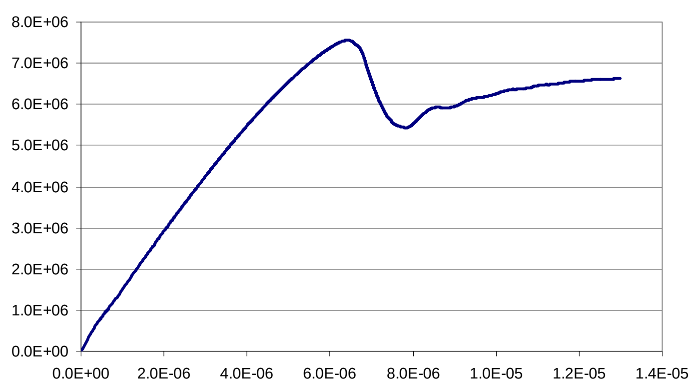


Temperature

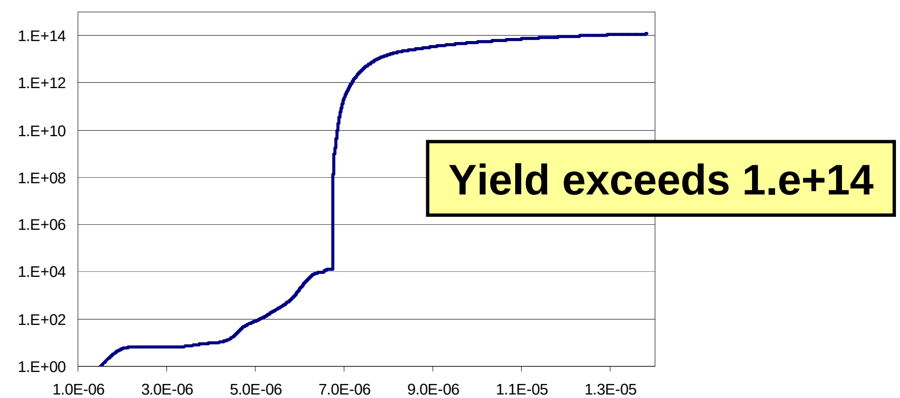


Deuterium Density





Current vs Time



Yield vs Time