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TORMAC EXPERIMENTAL APPARATUS

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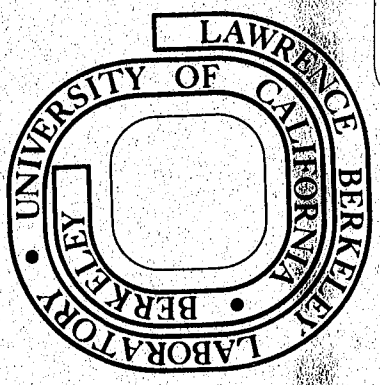

Tormac Experimental Apparatus

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In the Tormac Program, two approaches are being followed for the creation of the Tormac plasma. Tormac (toroidal magnetic cusp) is a high-beta cusp in which the sheath particles are mirror contained. Start-up in this configuration is difficult. The problem is that slow injection of particles leads to a situation in which all particles are on open magnetic field lines. In order to avoid this difficulty, two approaches are being followed for creating the plasma. In one approach, the plasma is created in situ and the magnetic field is pulsed on. In a second approach, the magnetic field is held on steady-state and the plasma is pulsed injected.

Tormac IV is a device with a pulsed magnetic field. The vacuum vessel is made from pyrex glass and is shown in cross-section in Fig. 1. The vessel is fabricated from two pyrex cylinders and two pyrex disks. A low vapor pressure epoxy, Emerson & Cummings Eccobond 1266, is used to assemble the system. The cylinders are cut to length and ground to matching heights to within .01 cm. They are then glued together by warming the glass to about 50° c. The parts to be joined are placed in contact and shimmed with wire. The epoxy is placed on the outside surface of the vessel, and capillary action is used to fill the void.

The second approach to Tormac plasma is the pulsed injection system in which the magnetic field is virtually steady state. In this experiment, dubbed puffer, a plasma gun is used to pulse inject a high density plasma. The plasma must be toroidally symmetric and dense enough so that the gyroradius in the magnetic field is small compared to the size of the plasma. The system is built in a large stainless

steel vacuum vessel, 2 m in diameter and 2 m long. The magnetic field coils are fabricated from copper bar, and are inside the vacuum. Instead of a DC magnetic field, a magnetic field pulse of 3 miliseconds is used, powered by electrolytic capacitors and crowbarred using solid state diodes.

In Fig. 2 is a schematic of the experiment. The gas is emitted from a fast acting gas valve in which a toroidally symmetric puff of gas is injected between the electrodes of the plasma gun. The plasma gun itself is driven by a 50 kV 2 micro F capacitor. The gun depends on magnetic insulation to prevent unwanted breakdown, and has been high potted to 100 kV.

The vacuum system is made from a surplus evaporation tank, and has a base plate and a bell jar. The base plate is a little over 2 meters in diameter, and the bell jar is 2 meters long. The system is placed on its side with the base mounted permanently in place. The stainless steel bell-jar is on a track with wheels, so it can be rolled open and cloed. A large rubber "o" ring is used to seal the system.

The base has been fitted with a large number of Varian flanges for diagnostic access. A relatively poor vacuum is required for operation of this experiment. On the other hand, by using a 200 liter/sec turbomolecular pump, and an 8 inch titanium evaporation pump in tandem, pressures in the vessel of below 10^{-6} Torr have been measured.

Experiment	Major Plasma Diameter	Vessel	Magnetic Field	Plasma Density
Tormac IV	35 cm	Boro-silicate	.7 Tesla	10^{15}
Tormac V	70 cm	Bora-silicate	.7 Tesla	10^{15}
Puffer	50 cm	Stainless steel	.7 Tesla	10^{15}

References

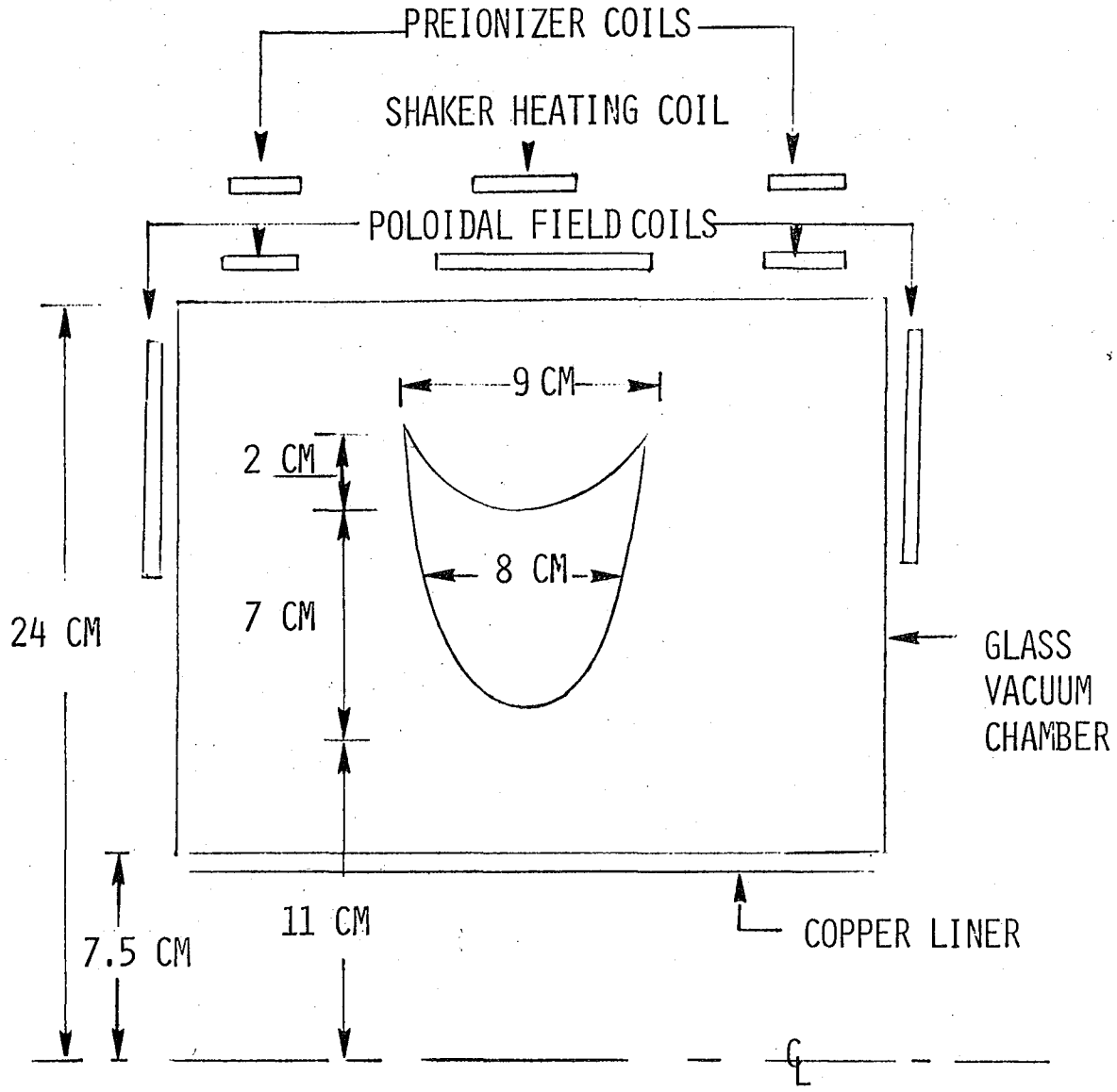
1. Levine, M. A., Brown, I. G., Gallagher, C.C., Plasma Physics Supplement (Pulsed High Beta Plasmas, 1976).

2. Boozer, A. H., Plasma Physics Supplement (Pulsed High Beta Plasmas, 1976).

FIGURE CAPTIONS

Fig. 1. Schematic of Tormac IV cross section. The device is toroidally symmetric around the bottom center line. In the center is shown the plasma equilibrium shape as obtained in a plotting tank. Not indicated are two axial windings which produce the bias and the cusp toroidal magnetic field.

Fig. 2. Schematic diagram with an artist conception of how a plasma ring is formed in a plasma gun and is driven radially out into the bi-cusp magnetic field. The fast gas valve is also toroidally symmetric and fills the gun to about 1 Torr pressure. Plasma energies in the kilowatt range are anticipated from this system.



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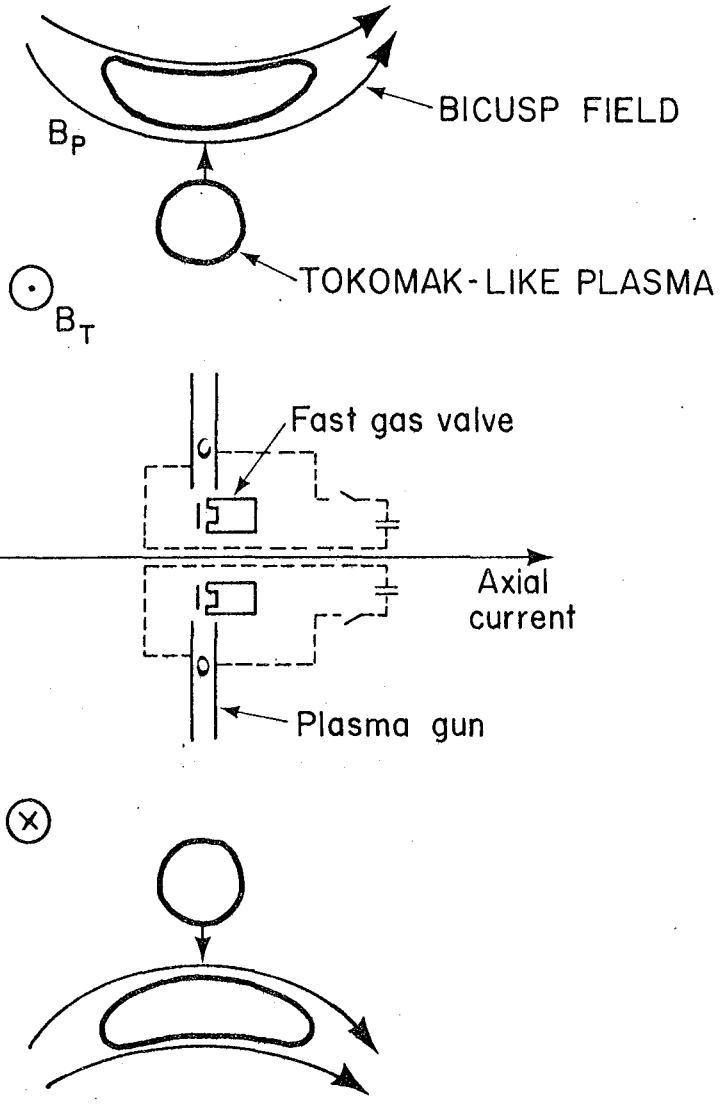
PUFFER EXPERIMENT



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