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INITIAL MEASUREMENTS ON THE ANGULAR DISTRIBUTION OF DEUTERIUM PLASMA PRODUCED BY A PULSED SPARK SOURCE

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ABSTRACT

The deuterium plasma which is ejected by a 6000-ampere pulsed current through a rail-type spark source has a yield in the forward direction which is a factor of 5 to 10 greater than that in the perpendicular direction. This effect is believed to be due to the magnetic propulsion of the plasma.

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This report briefly describes probe measurements that have been made to ascertain to what extent the plasma ejected from a spark source is anistropic in its density distribution. The spark source is pictured in Fig. 1. The pulser, which is photographed in Fig. 2, consists of nine 0.02 μf, 10 kv Glassmike capacitors arranged in a parallel ring with a 0.5 ohm series damping resistor and a modified microswitch to switch the current to the source. This assembly is mounted on a vacuum bulkhead which can be bolted to either 2-in. or 4-in. industrial glass pipe. The pulse produces an approximately critically damped wave (which has a half-period of 0.5 μsec if the damping resistor is removed.) The peak current at 10kv on the condenser is about 6000 amperes.

The experimental arrangement is diagrammed in Fig. 3. The signals can be measured at $\theta = 0°$ and $\theta = 85°$ (in the plane of the mica) with probes and masks which are as identical as possible. The alnico bar magnet presumably measures saturated positive ion current which can be directly related to the ion density that comes through the hole in the mask. The signals at $\phi = 85°$ (perpendicular to the plane of the mica) can be measured by rotating the source and its mounting flange 90° about its center line. The measurements proved to be consistent from pulse to pulse. The experimental results are shown in the oscilloscope traces of Figs. 4 and 5, from which it can be seen that the yield in the forward direction is $> \times 10$ that for $\theta = 85°$ and $\sim \times 5$ that for $\phi = 85°$.

The author believes that these results are evidence of the fact that the plasma is being magnetically[1] accelerated by the magnetic field

278 003

[1] Winston H. Bostick, Magnetic Acceleration of a Plasma by a Rail Source, University of California Radiation Laboratory Report [illegible], March 18, 1955.

configuration produced by the current in the rails. The translational energies of the deuterons in the leading edge of the probe signal are about 100 ev. The ion density at the probe at the peak of the signal in Fig. 4 can be computed to be 2.5×10^{11} ions/cc.

An experimental arrangement is being constructed to perform yield measurements at intermediate angles.

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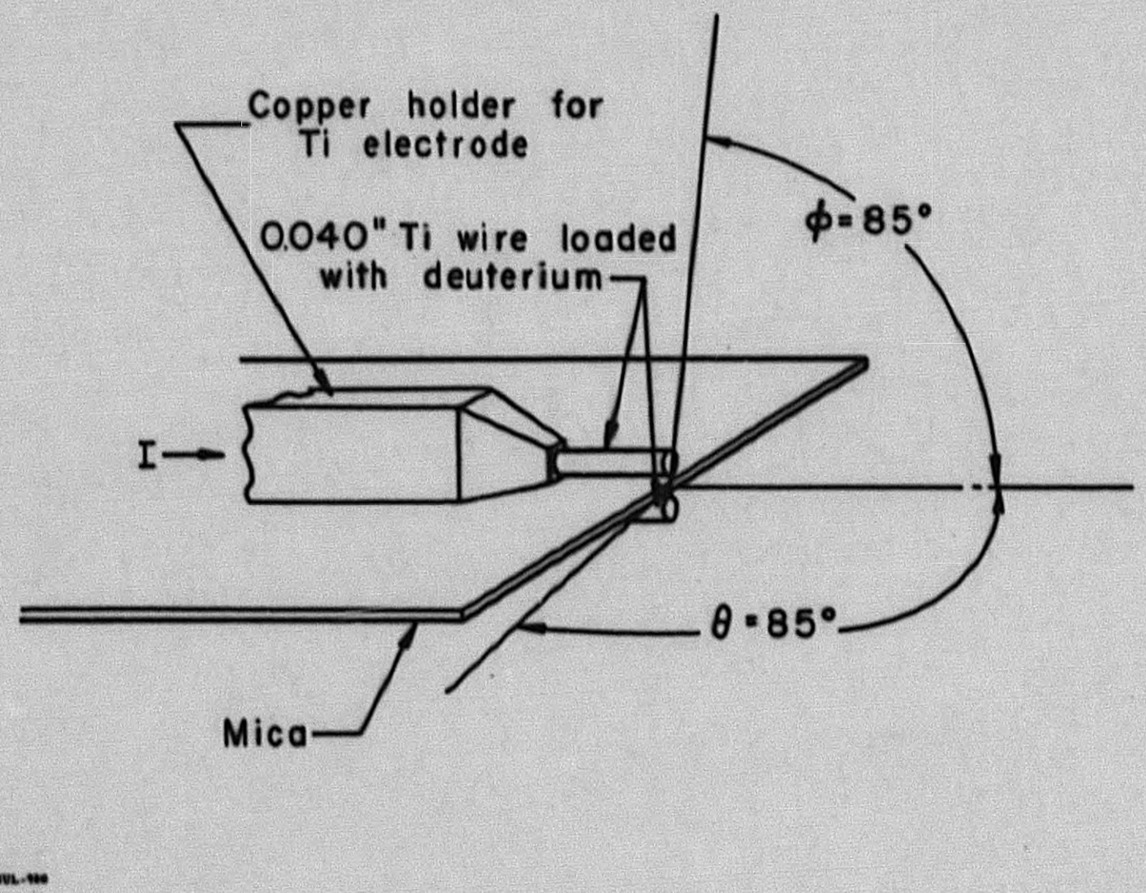

Fig. 1. Spark source used for investigating the angular distribution of the plasma ejected.

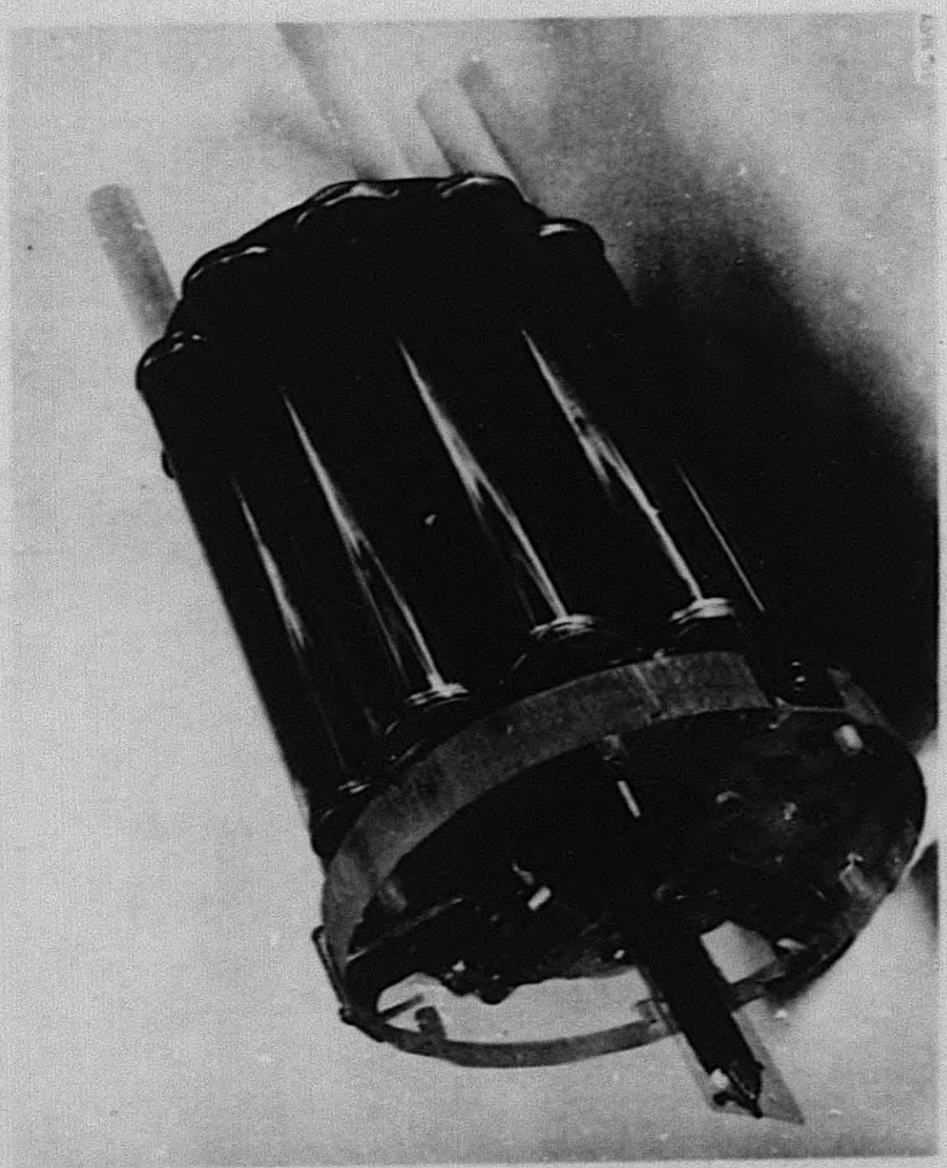

Fig. 2. Photograph of source and pulser.

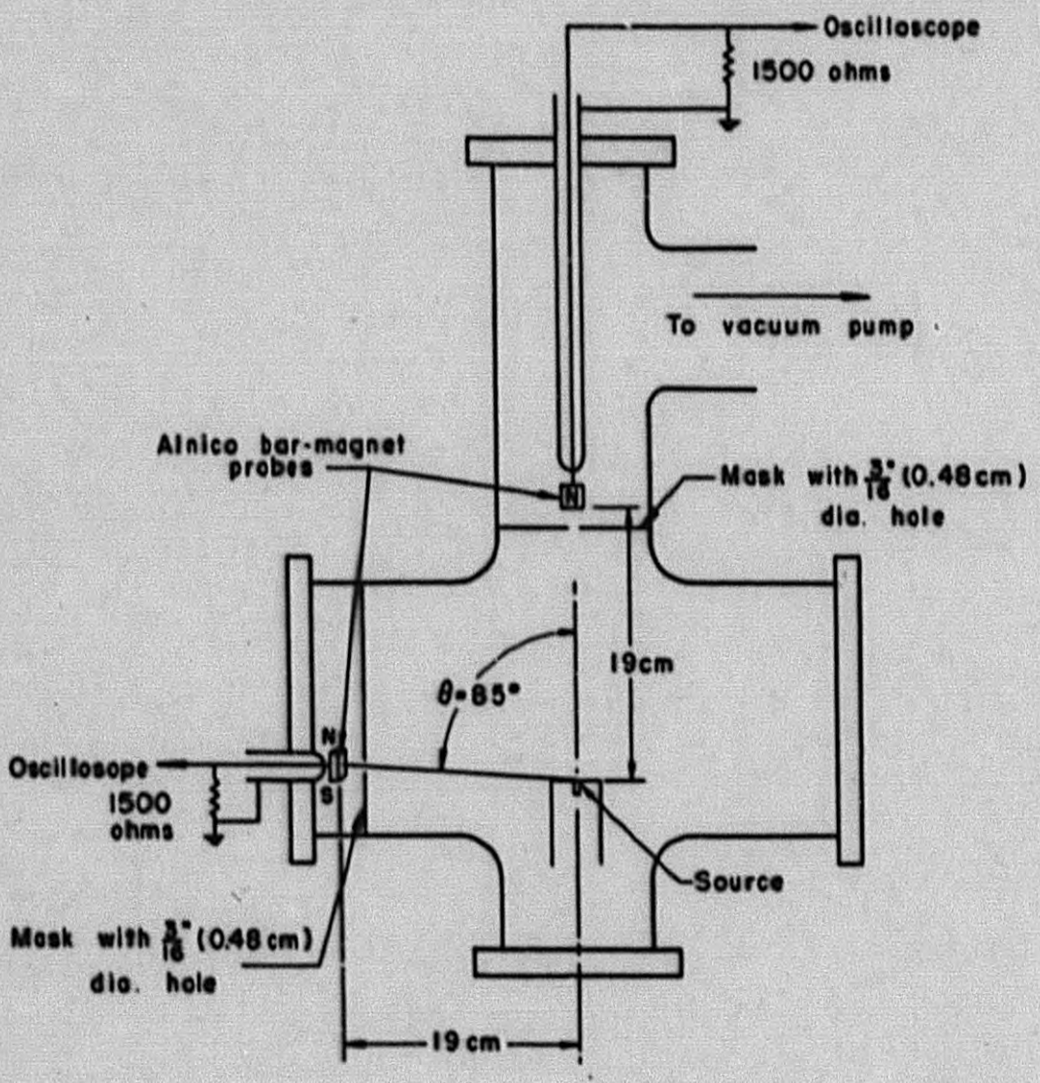

Fig. 3. Experimental geometry for measuring the angular distribution of the plasma ejected by a spark source.

Probe straight ahead (θ = 0°)

Probe straight ahead (θ = 0°)

Probe at θ = 85° (in plane of mica)

Fig. 4. Probe measurements made with the arrangement of Fig. 3 with 10 kv on the pulser capacitor. Sensitivity is 30 volts/cm. Sweep speed is 5 μsec/cm. Time goes from right to left. The small pulse at the beginning is due to photoelectrons that are ejected from the probe.

Probe straight ahead (ϕ = 0°)

Probe straight ahead (ϕ = 0°)

Probe at ϕ = 85° ($\perp$ to plane of mica)

Fig. 5. Probe measurements made with the arrangement of Fig. 3 with 8 kv on the pulser capacitor. Sensitivity is 30 volts/cm. Sweep speed is 5 μsec/cm. Time goes from right to left.