POLOIDAL DIVERTOR RFP EXPERIMENTS IN THE LEVITATED OCTUPOLE VACUUM VESSEL

(Poster (5T15) presented at the 29th Annual Meeting of the
Division of Plasma Physics of the American Physical Society
November 2-6, 1987, San Diego, CA)

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PLP 1026

November 1987

Plasma Studies

University of Wisconsin

REVISED ABSTRACT

Poloidal Divertor RFP Experiments in the Levitated Octupole Vacuum Vessel*, J.S. SARFF, A.F. ALMAGRI, S. ASSADI, R.N. DEXTER, S.C. PRAGER, and J.C. SPROTT, *University of Wisconsin-Madison*—Despite the presumed nead of a nearby conducting boundary in reversed-field pinches, we have examined the possibility of obtaining an RFP in a four-node poloidal-divertor configuration. To allow a larger ratio of plasma current to divertor current, the Levitated Octupole vacuum vessel ($R=1.39$ m, 1 m^2 non-circular cross-section) was fit with small-diameter rings, and using an aided-reversal technique, discharges were obtained with a reversal time of ~1.5 msec. Typical parameters are plasma current ~130 kA, central chord line-averaged density of $\sim 1\times10^{13}\ cm^{-3}$ and central electron temperature of ~55 eV. Although reversed on average, the equilibrium magnetic field exhibits poloidal ($m=1$) and toroidal asymmetry large enough to prevent a reversed toroidal component at the edge in some locations. In contrast, low-q tokamak discharges and the vacuum fields are symmetric. It is not known if this asymmetry is inherent to this divertor configuration or the result of known, large field errors.

*Work suported by U.S.D.O.E.

REVERSED-TOROIDAL FIELD EXPERIMENTS IN A POLOIDAL DIVERTOR CONFIGURATION

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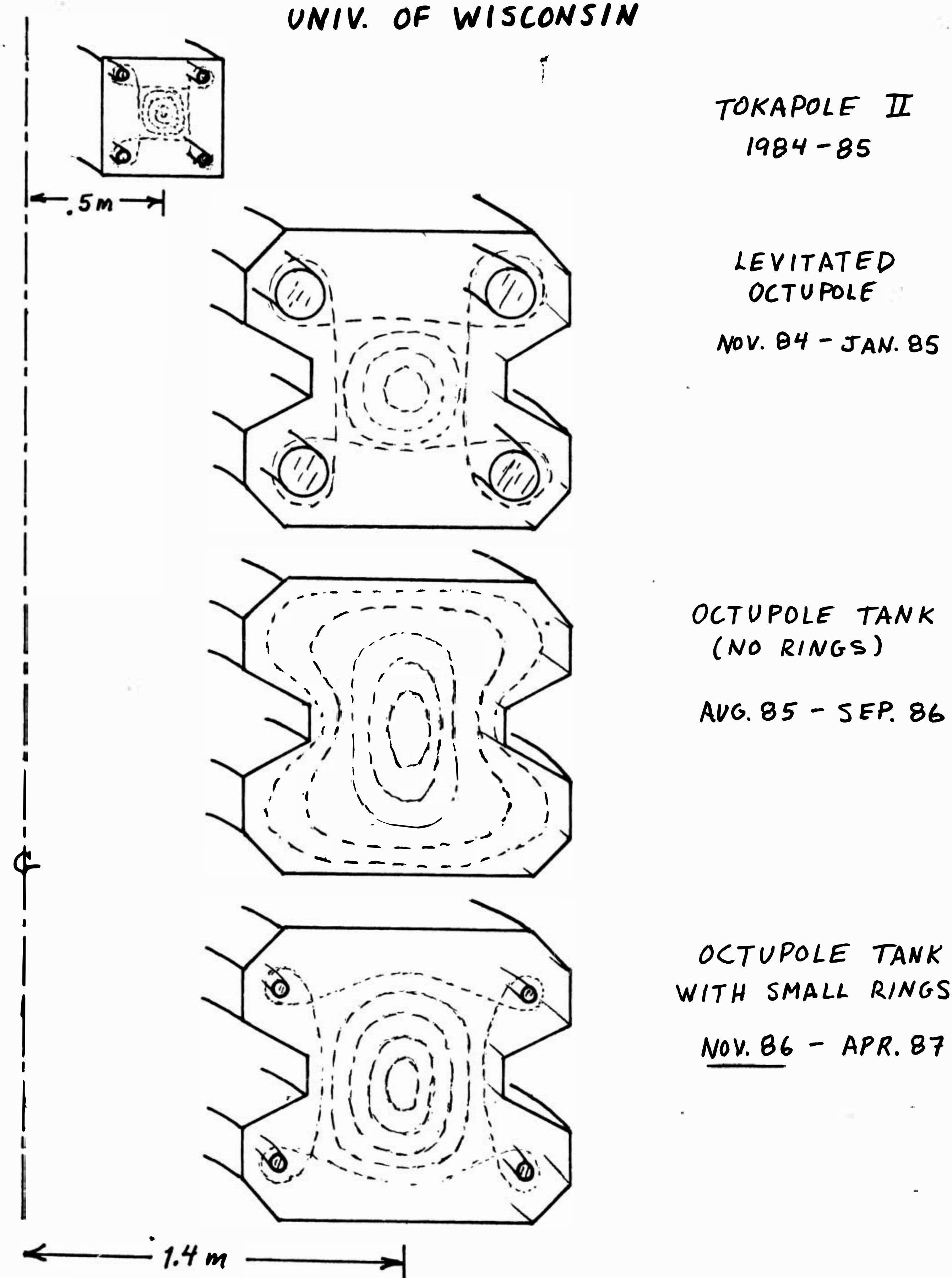
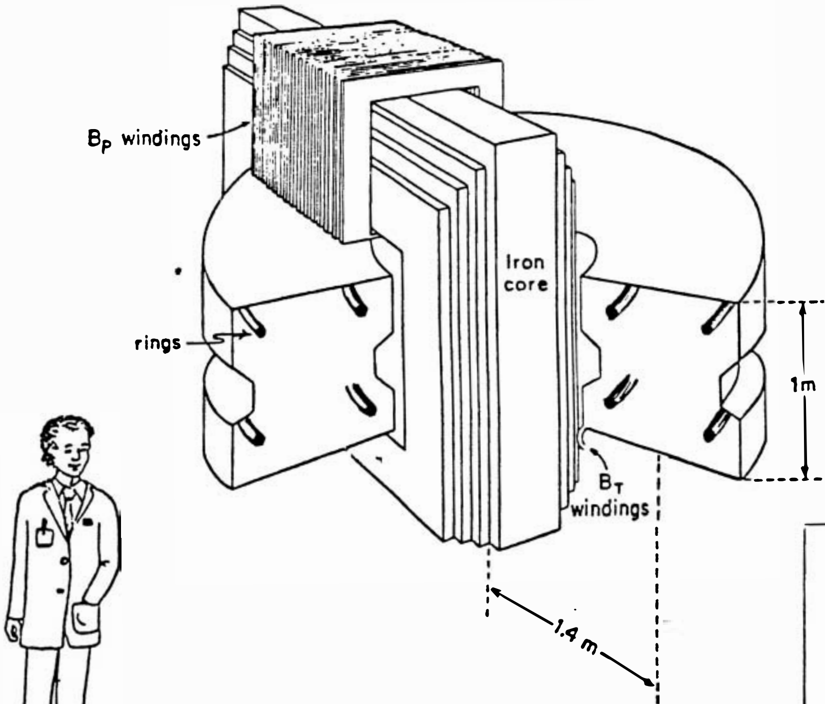
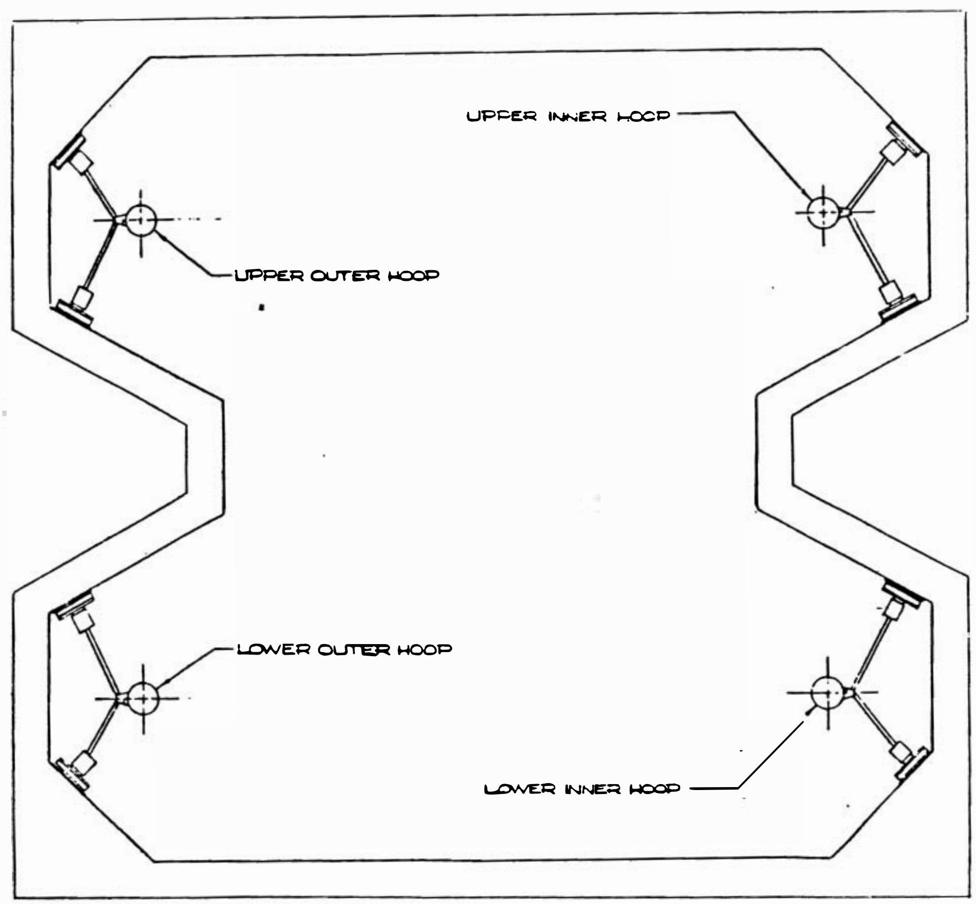




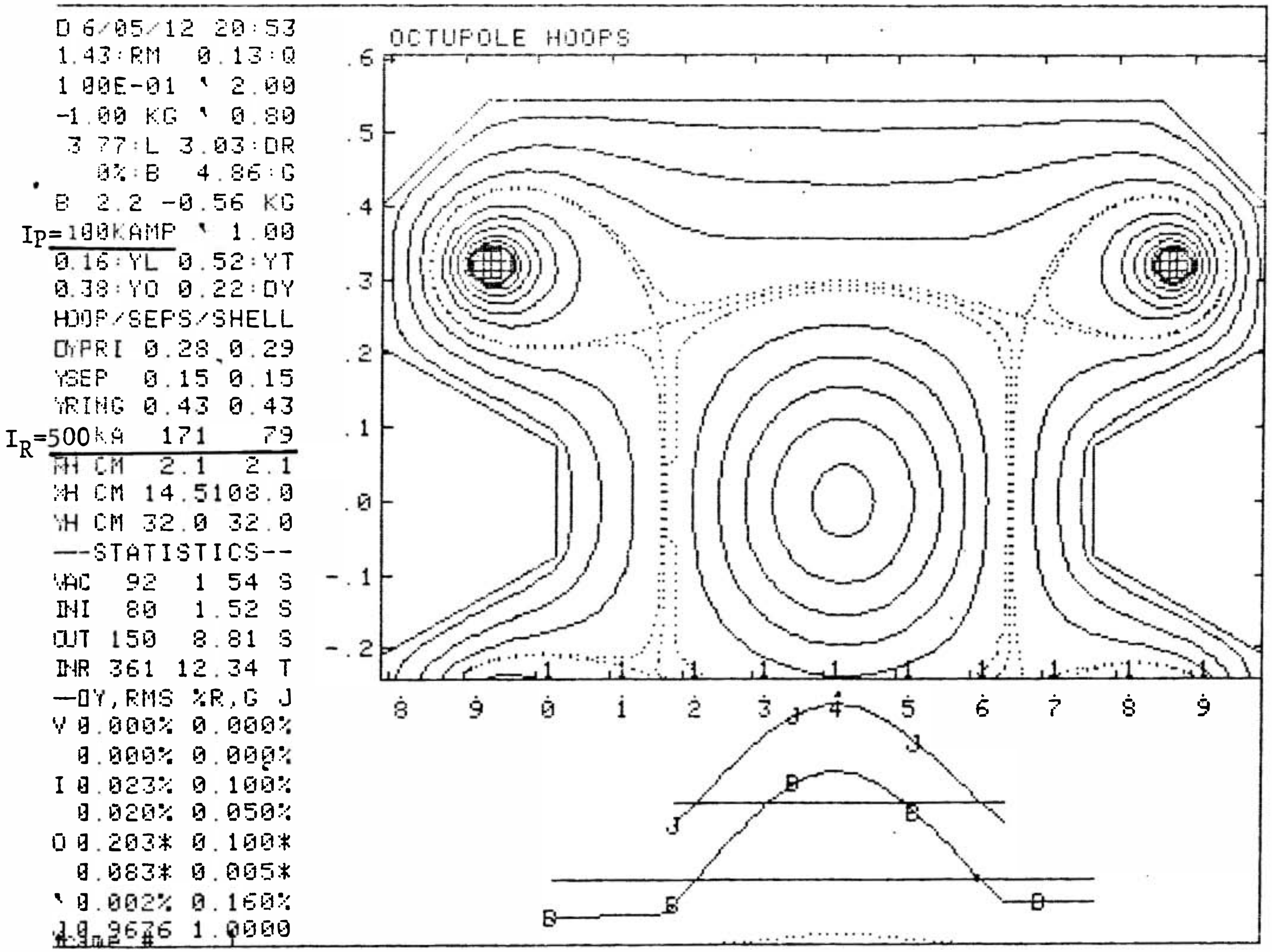
MACHINE SPECIFICATIONS

Major Radius	1.39 m
Minor Dimensions	1.1 x 1.2 m
Walls	5 cm 1100 Aluminum
Iron Core Volt-Seconds	1.9

RINGS	INNER	OUTER
Material	2219-T8 Aluminum	
Resistance	256	511 microhms
Major Radius	.94 m	1.87 m
Minor Diameter	4.13 cm	4.13 cm
Hanger Sets	6	8
Maximum Total Current	500 kA	



FLUX PLOT FOR DIVERTOR RFP



SUMMARY OF DIVERTOR RFP RESULTS

1. Reversed-field plasmas are obtained using 'aided-reversal' field programming with reversal time ~1.5 msec. The basic discharge parameters for a typical I_p=135 kA discharge are

$$\langle n_e \rangle \sim (1-2) \times 10^{13}\ \mathrm{cm}^{-3}$$

$$T_e(r=0) \sim 55\ \mathrm{eV}$$

2. Large, global asymmetry is observed in the equilibrium magnetic field.

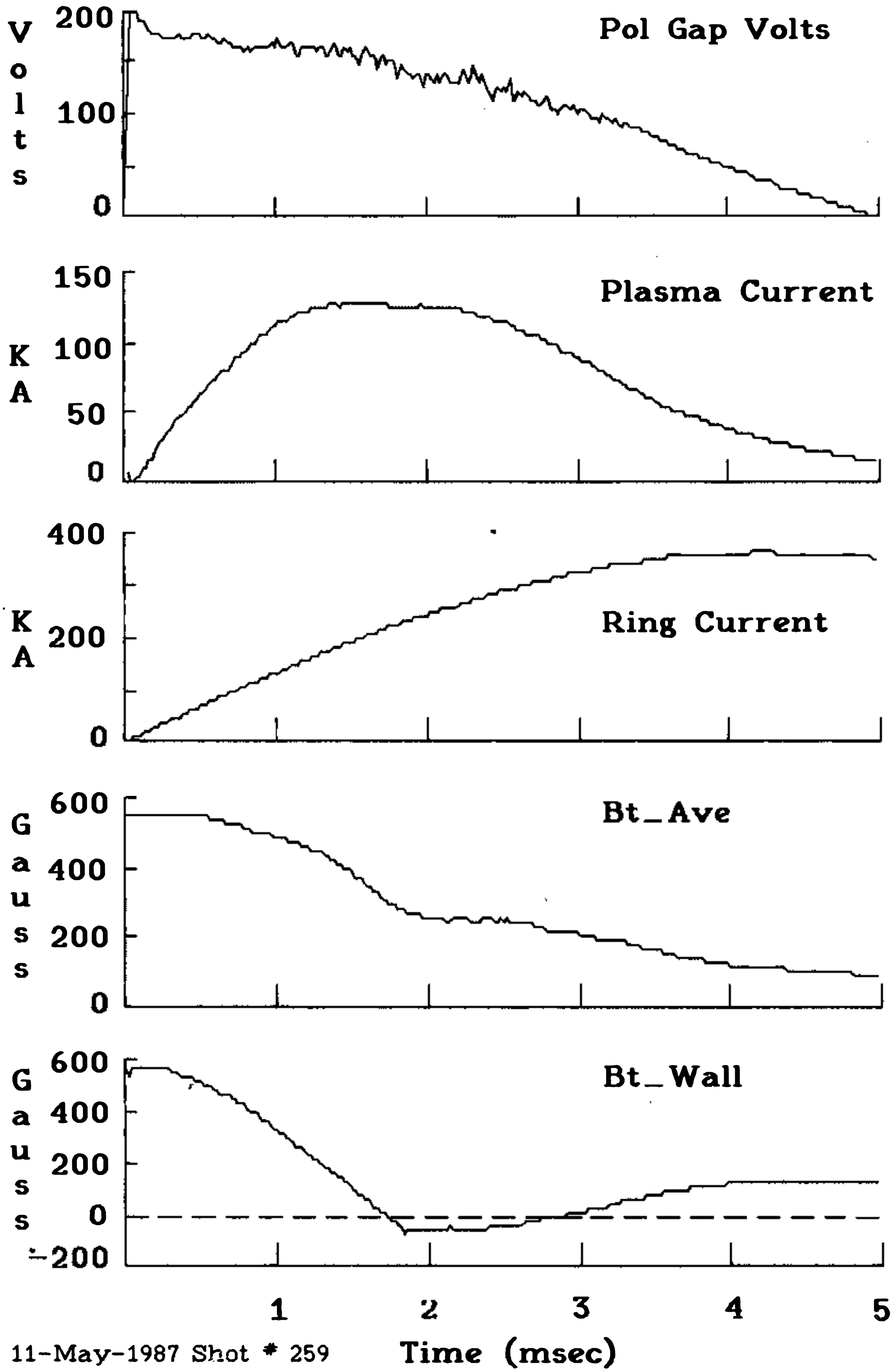
   a) The poloidal structure is dominantly m=1.

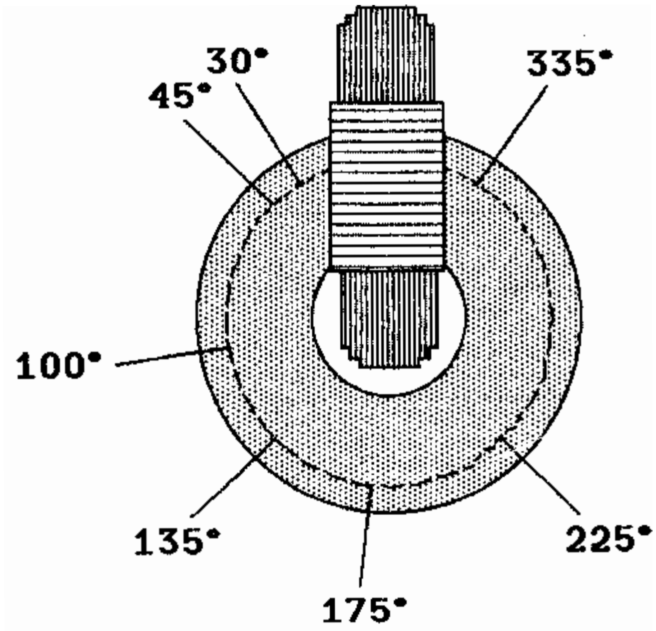
   b) The toroidal structure is 'high n', but no single n value fits the data well.

   c) Low q tokamak discharges are symmetric, as are the vacuum fields.

3. Large field errors are present at both the toroidal and poloidal gaps in the vacuum vessel.

TYPICAL DIVERTOR RFP DISCHARGE USING AIDED-REVERSAL





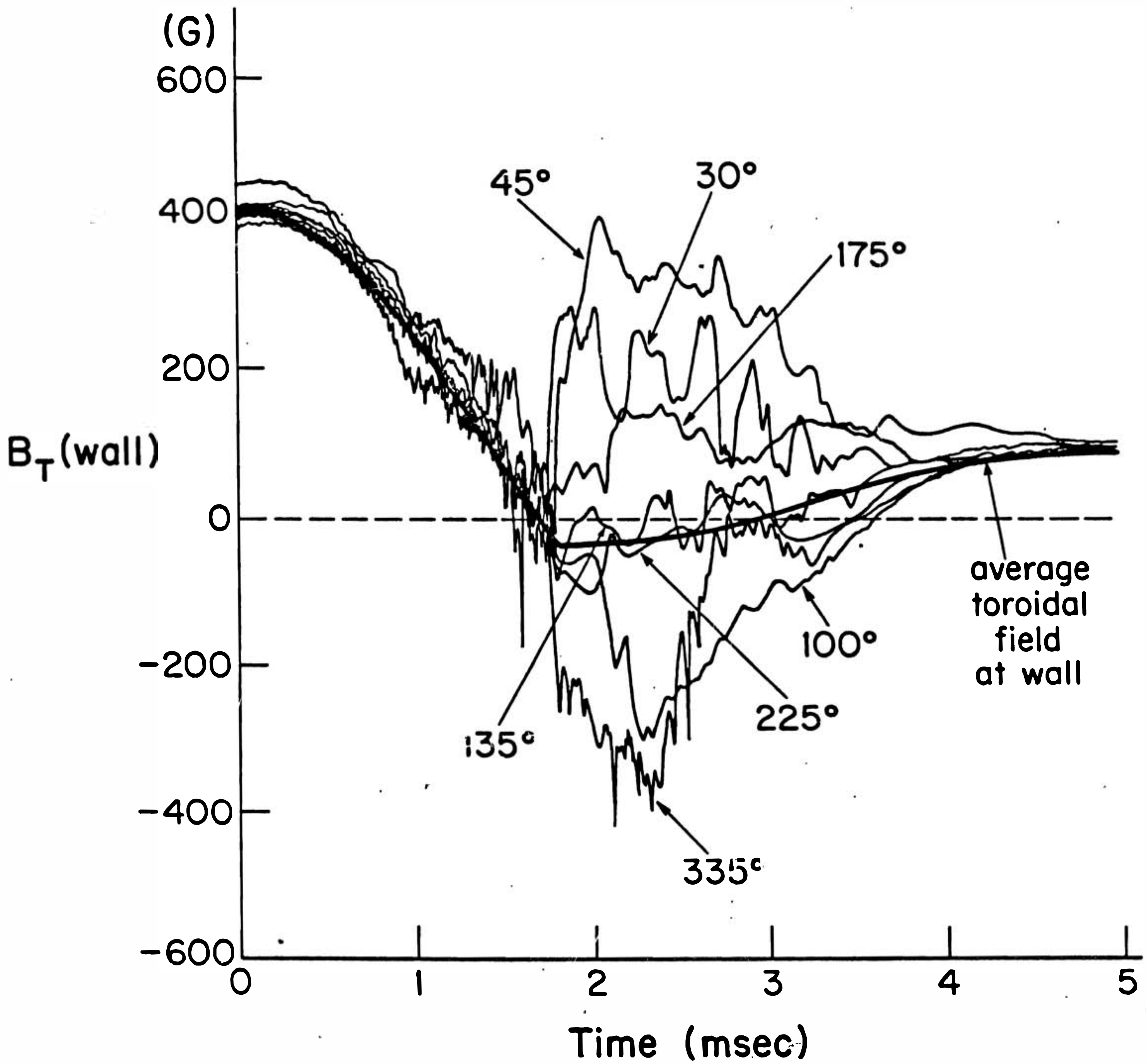
TOP VIEW

7 Probes
on
Midplane

Seven small magnetic probes were separated toroidally to check toroidal symmetry. The coils were located near the vacuum vessel wall on the midplane.

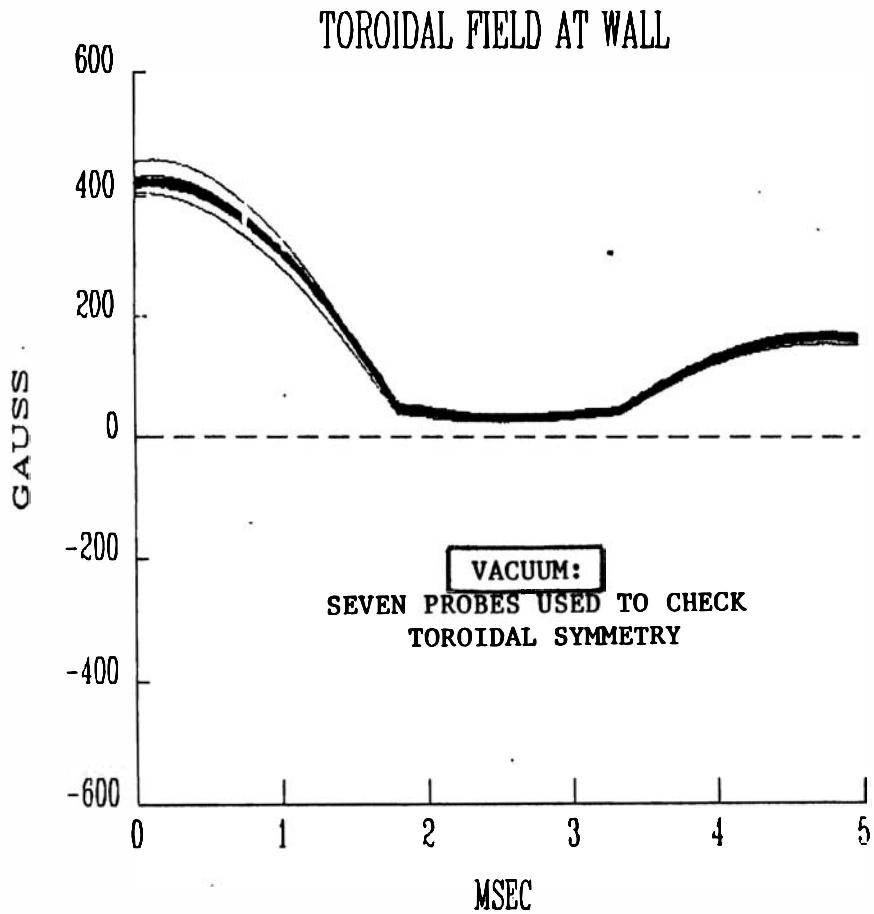
DIVERTOR RFP

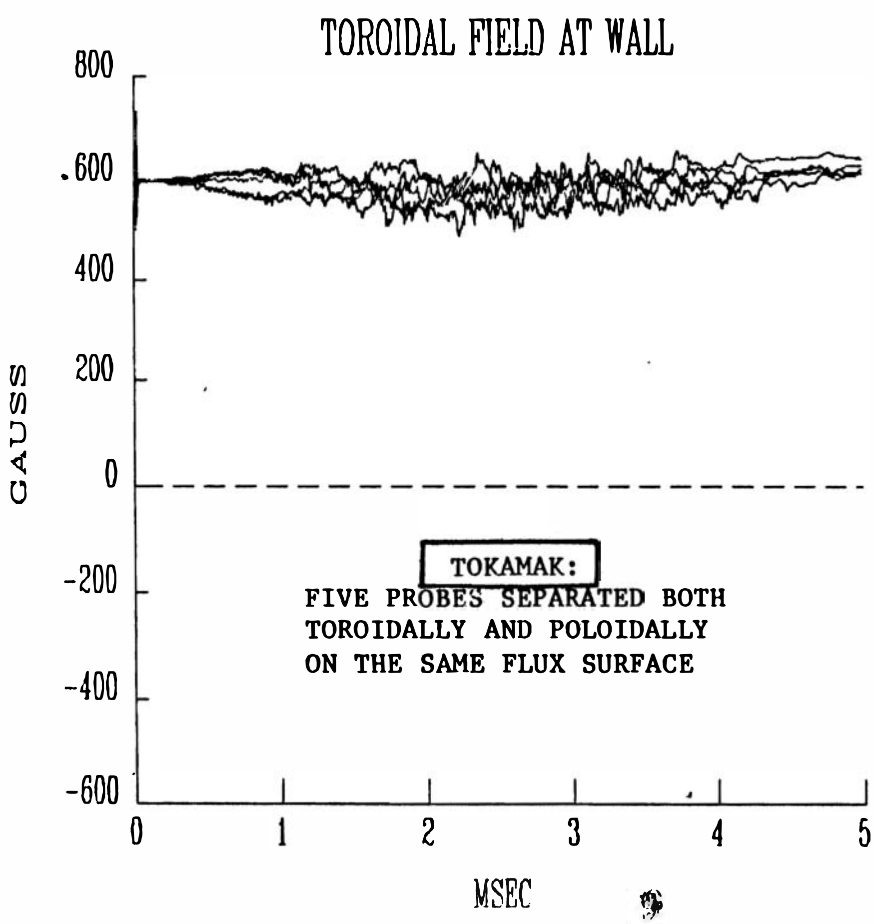
TOROIDAL FIELD AT WALL

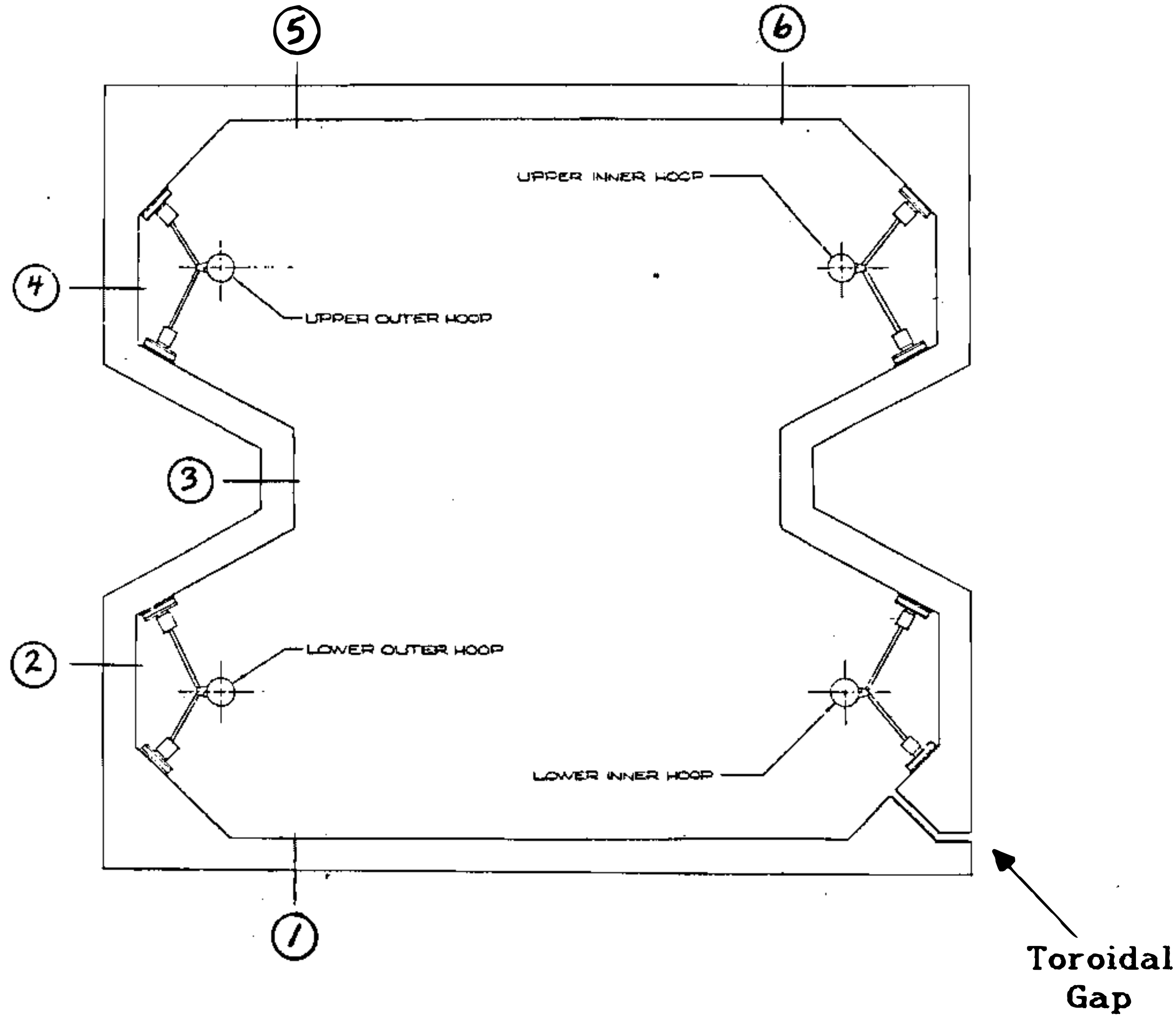


This figure illustrates the toroidal asymmetry in the magnetic field at the edge of the plasma. Similar behavior is observed at the center of the plasma when the probes are inserted in that region.

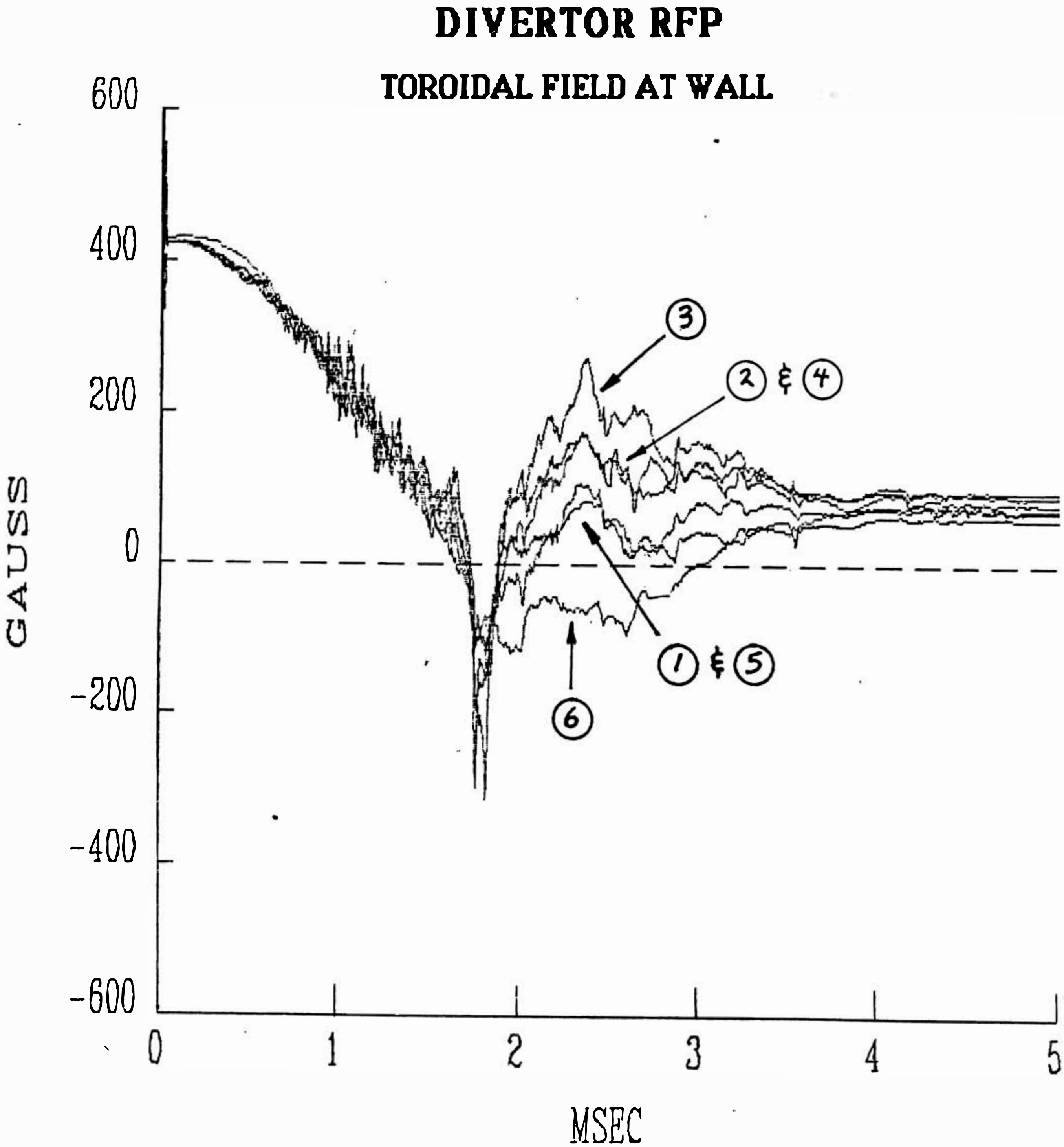
Only the divertor RFP exhibits the large asymmetry, as the same experiment performed in the low q tokamak mode and in vacuum reveals symmetric equilibrium magnetic fields.







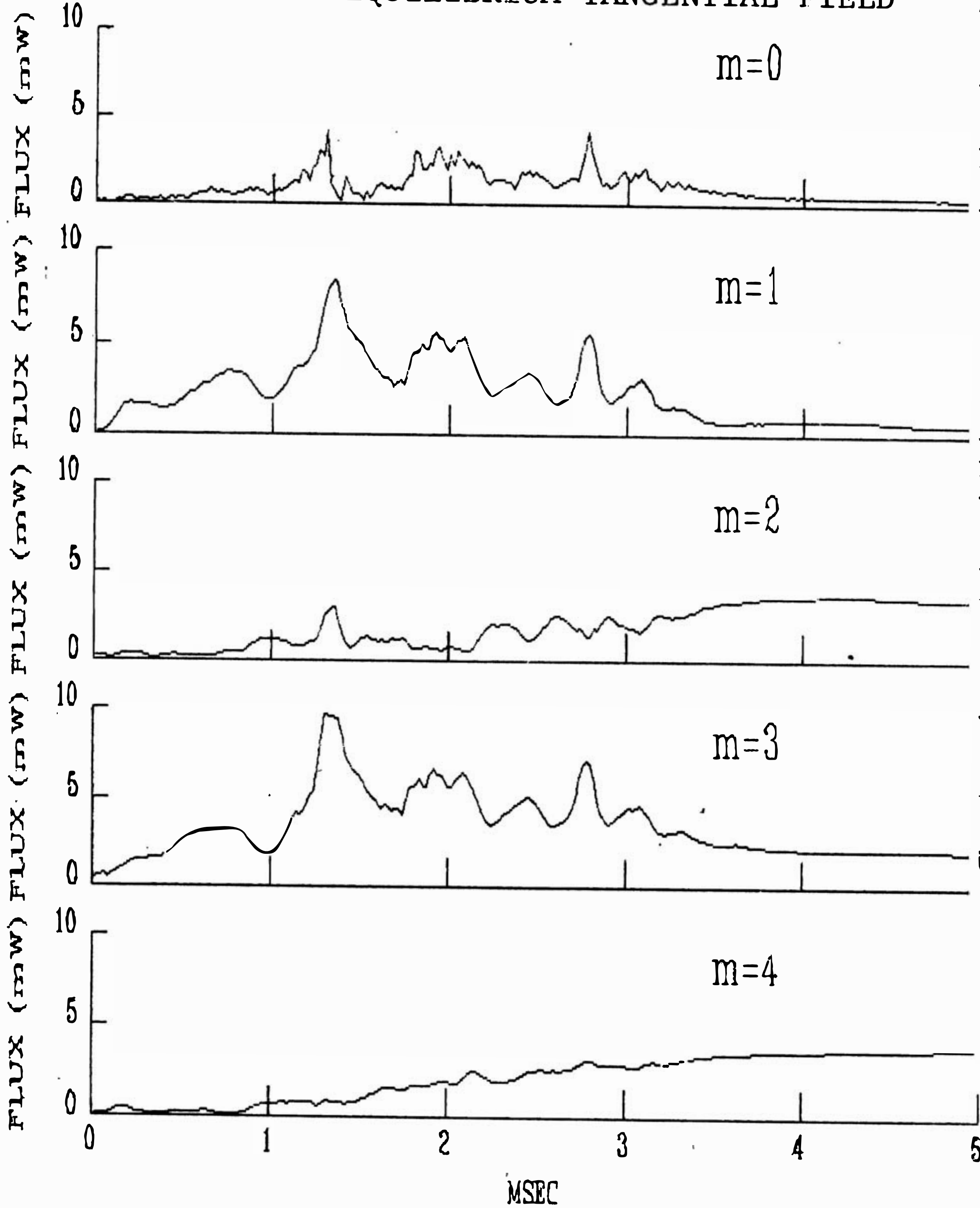
Six small magnetic probes were separated poloidally to check poloidal symmetry. The coils are located near the wall at the 225° toroidal azimuth. The values of RB_{ϕ}/R_3, where R_3 is the major radius at which coil 3 is located, are plotted below.



This figure illustrates the poloidal asymmetry in the magnetic field at the edge of the plasma. The five probe signals fit well to an m=1 distribution.

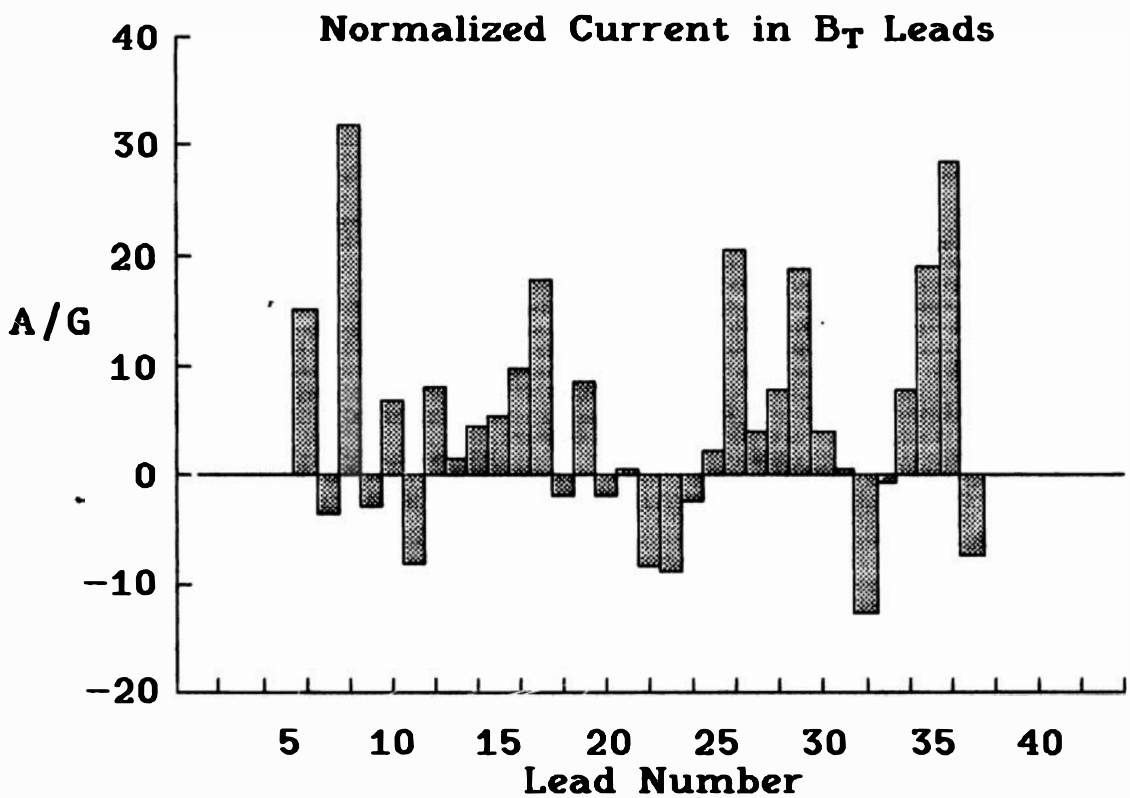
FOURIER AMPLITUDES OF THE ERROR FLUX AT THE POLOIDAL GAP

USING THE t=0 WIDTH OF THE GAP
THE ERROR FIELD IS COMPARABLE
TO THE EQUILIBRIUM TANGENTIAL FIELD

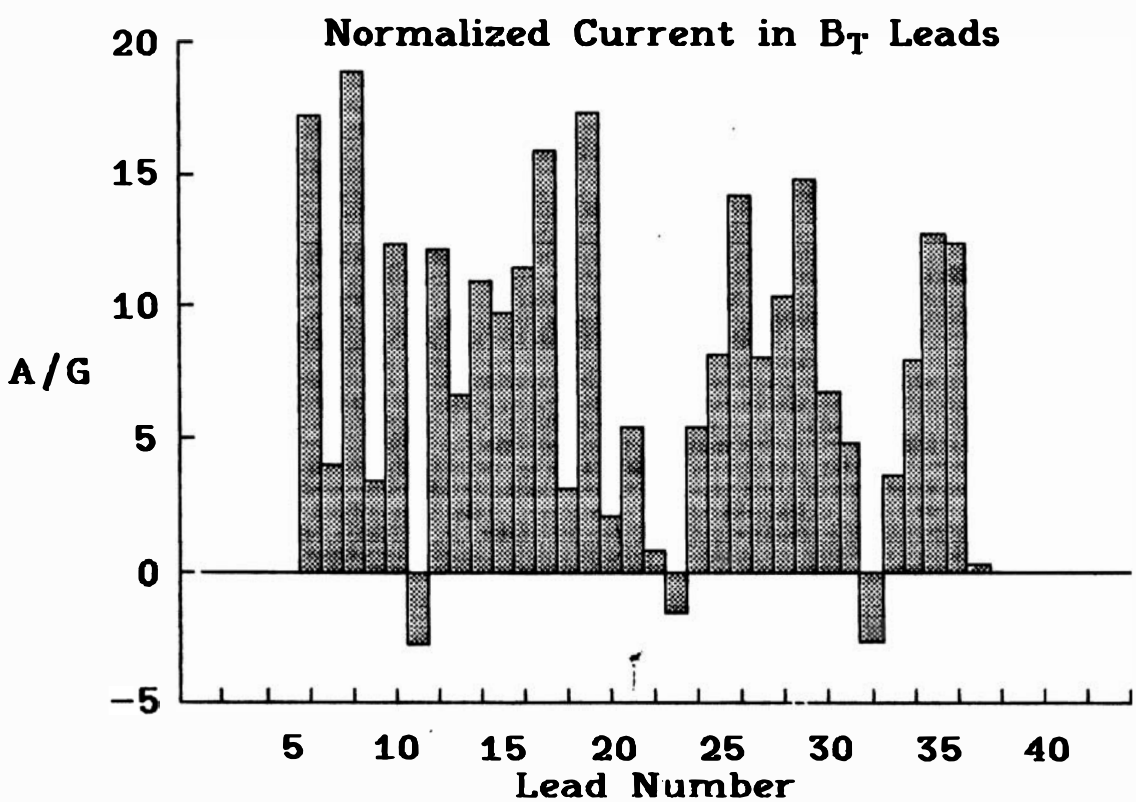


The circumference of the poloidal gap was covered with eight coils sensitive to the normal component of the magnetic flux entering the gap and were used to construct the m=0–4 Fourier amplitudes of the error (normal) flux

RFP PLASMA DURING REVERSAL



VACUUM CASE



The toroidal field is produced by driving the aluminum vacuum vessel wall at 44 uniformly spaced locations around the toroidal gap. The current in the connecting leads is highly non-uniform for both the plasma and vacuum cases.

OBSERVATIONS ON THE DIVERTOR RFP

- The large, global asymmetry onsets near the time when the average toroidal field at the wall reverses.

- If the tenuous plasma region outside the separatrix is treated as vacuum, theoretical results predict instability of a variety of modes, including m=1 external kink modes growing on the Alfvén time scale (see poster 5T28, Y.L. Ho, et. al., this session).

- Manipulation of the field errors can alter the nature of the asymmetry observed in the RFP discharges, but it is striking that the low q tokamak discharges remain symmetric (as well as the non-reversed portion of the RFP discharges).