REVERSED-TOROIDAL FIELD EXPERIMENTS IN A POLOIDAL-DIVERTOR CONFIGURATION

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Reversed-Toroidal Field Experiments in a Poloidal-Divertor Configuration.* J.S. SARFF, R.N. DEXTER, S.C. PRAGER, and J.C. SPROTT, University of Wisconsin-Madison. -- Despite the presumed need for a nearby conducting boundary in Reversed-Field Pinches, we have considered the possibility of obtaining an RFP plasma in a poloidal-divertor configuration in which the magnetic separatrix replaces the conducting shell. We previously have produced transient field reversal in the Tokapole II device using an aided-reversal technique. Although these plasmas were not sustained against resistive diffusion, the reversed-field profile endured for many Alfvén times. To overcome volt-second limitations of Tokapole II, the large Levitated Octupole is being fit with smaller diameter rings to continue investigations of this reversed-field poloidal-divertor configuration. Smaller, higher impedance rings were chosen to optimize the plasma current to ring current ratio while maintaining an adequate divertor topology. Initial results of the modified Octupole experiment will be presented.

*This work is supported by the U.S.D.O.E.

OUTLINE:

* Summary of experiments conducted on TOKAPOLE II
* Summary of experiments conducted on the original LEVITATED OCTUPOLE
* Description of experiment to be conducted on levitated octupole tank with small rings installed

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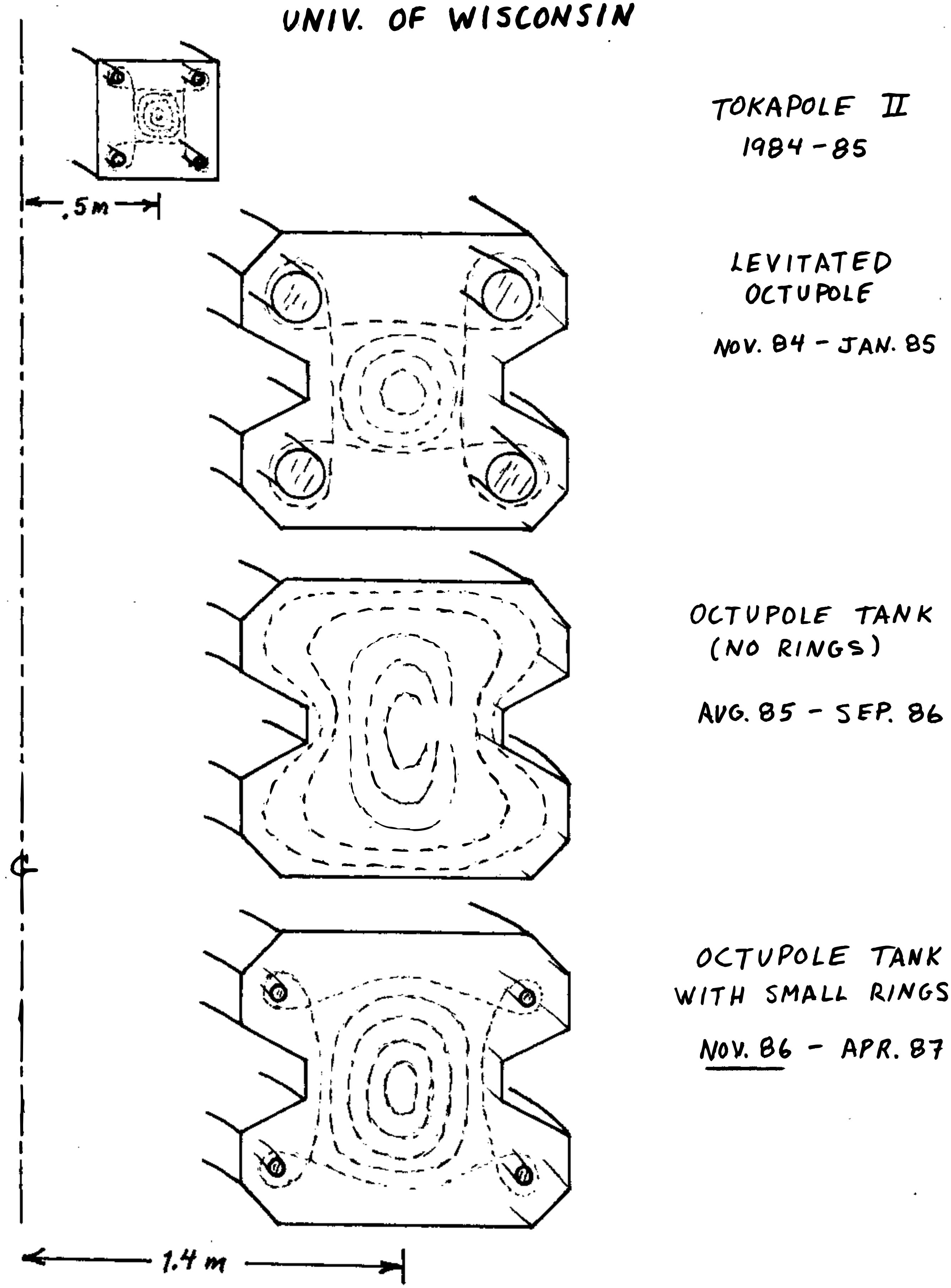


**See informal report PLP 958 "Studies of a Poloidal Divertor RFP on Tokapole II", Nov. 1985 for more detailed information on Tokapole II results.

SUMMARY OF TOKAPOLE II RESULTS:

* Transient reversed–toroidal field profiles were obtained.

* Although not sustained, the profile decay time (≅100 μsec) is substantially longer than Alfvenic times (few μsec).

* Separatrix acts as limiting boundary.

* Reduced fluctuations in magnetic field and plasma density are coincident with field reversal.

* The (surface) loop voltage was limited by the machine hardware preventing operation with a steady–state plasma current.

**See informal report PLP 958 "Studies of a Poloidal Divertor RFP on Tokapole II", Nov. 1985 for typical electrical waveforms of the original Octupole divertor experiment (last page of PLP 958).

SUMMARY OF OCTUPOLE RESULTS:

* Transient reversal obtained as in Tokapole II.

* Increasing the applied electric field to overcome the low impedance rings caused destructive arcing at the poloidal gap.

* The rings were removed to facilitate gap protection development and to study large non-circular plasmas. Smaller, higher impedance rings would be installed later.

SUMMARY OF OCTUPOLE WITH SMALL RINGS:

* Smaller rings have recently been installed in the Octupole tank.

* The new, lower impedance rings should allow plasmas with a plasma current to ring current ratio of $I_P/I_R \leq 60\%$. The old rings were limited to $I_P/I_R < 10\%$.

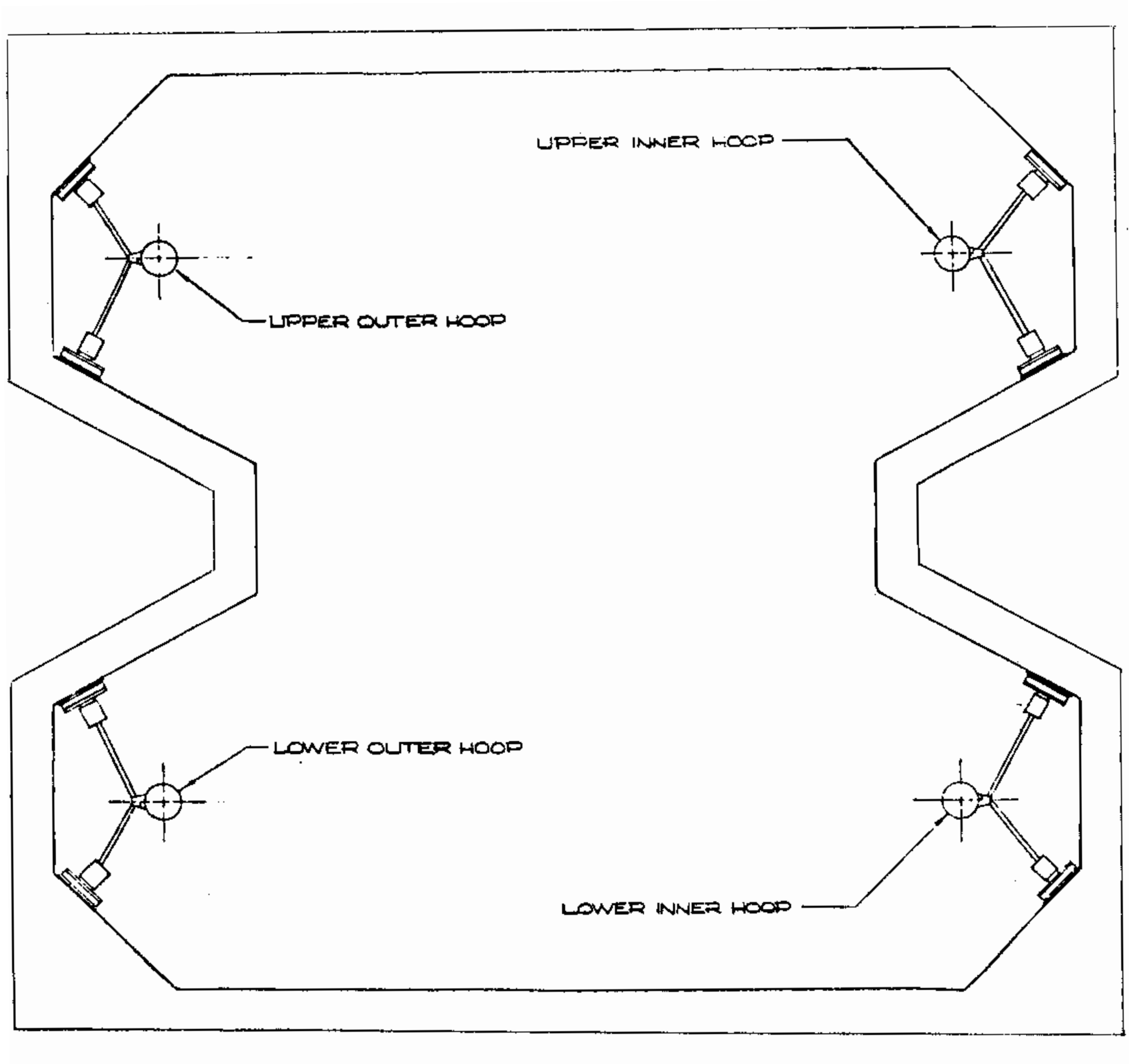
* The poloidal gap is reliably insulated to $\cong 250$ volts, a voltage which will start large non-cirular RFP plasmas.

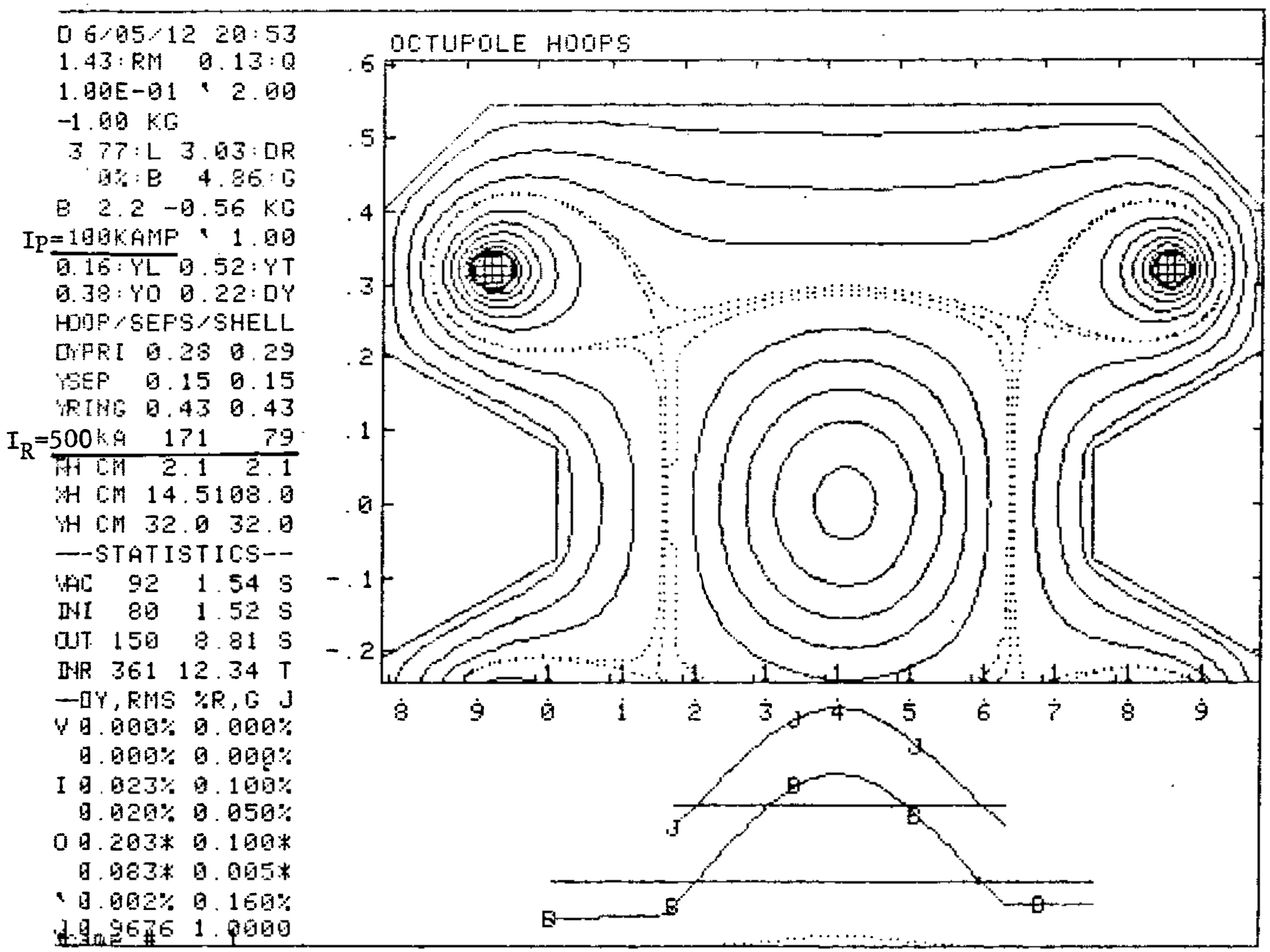
* Anticipated results are presented below.

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

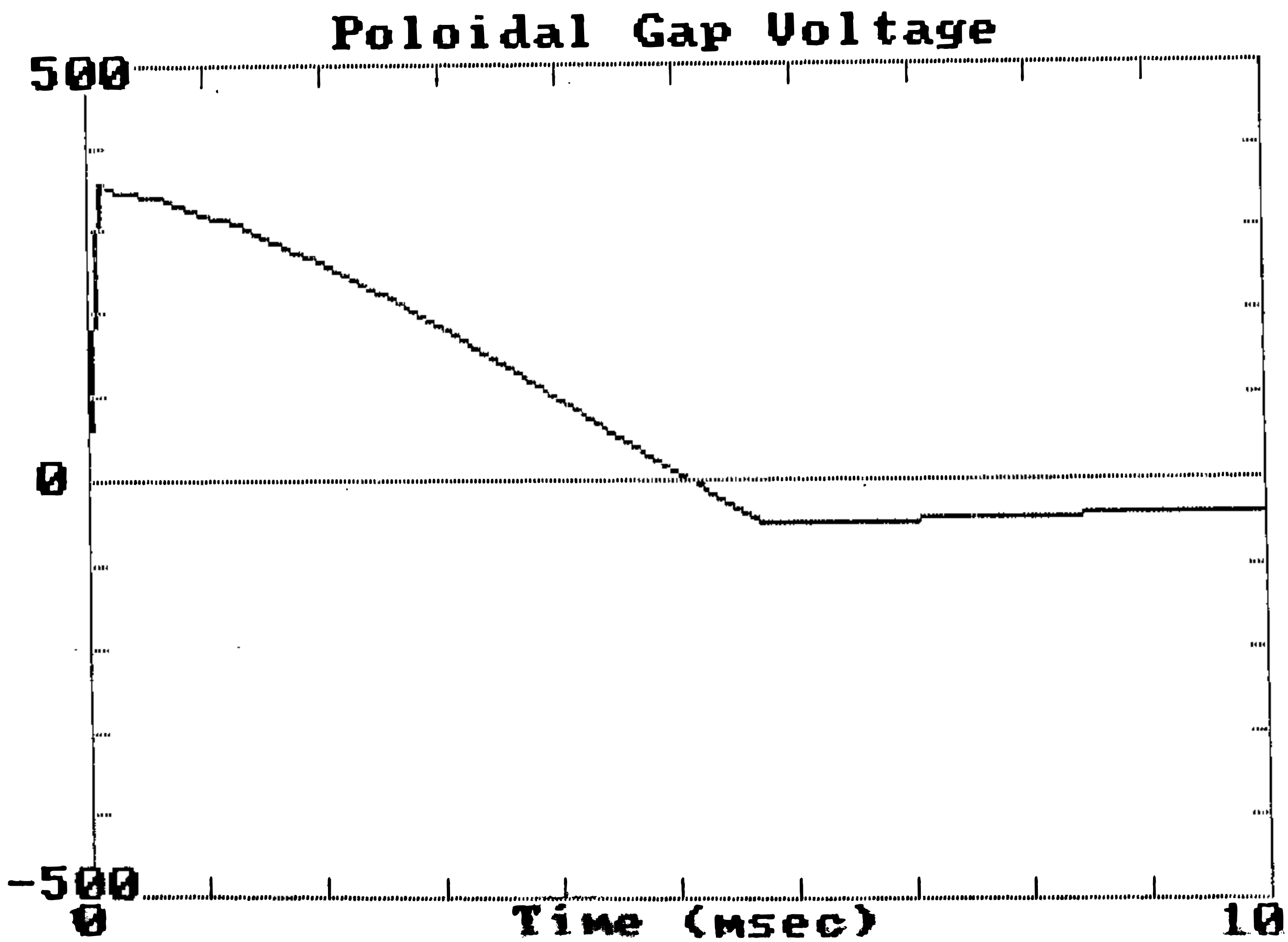
RINGS	INNER	OUTER
Material	2219-T8 Aluminum	
Resistance	256	511 microhms
Major Radius	.94 m	1.87 m
Minor Diameter	4.13 cm	4.13 cm
Hanger Sets	6	8
Maximum Total Current	500 kA	



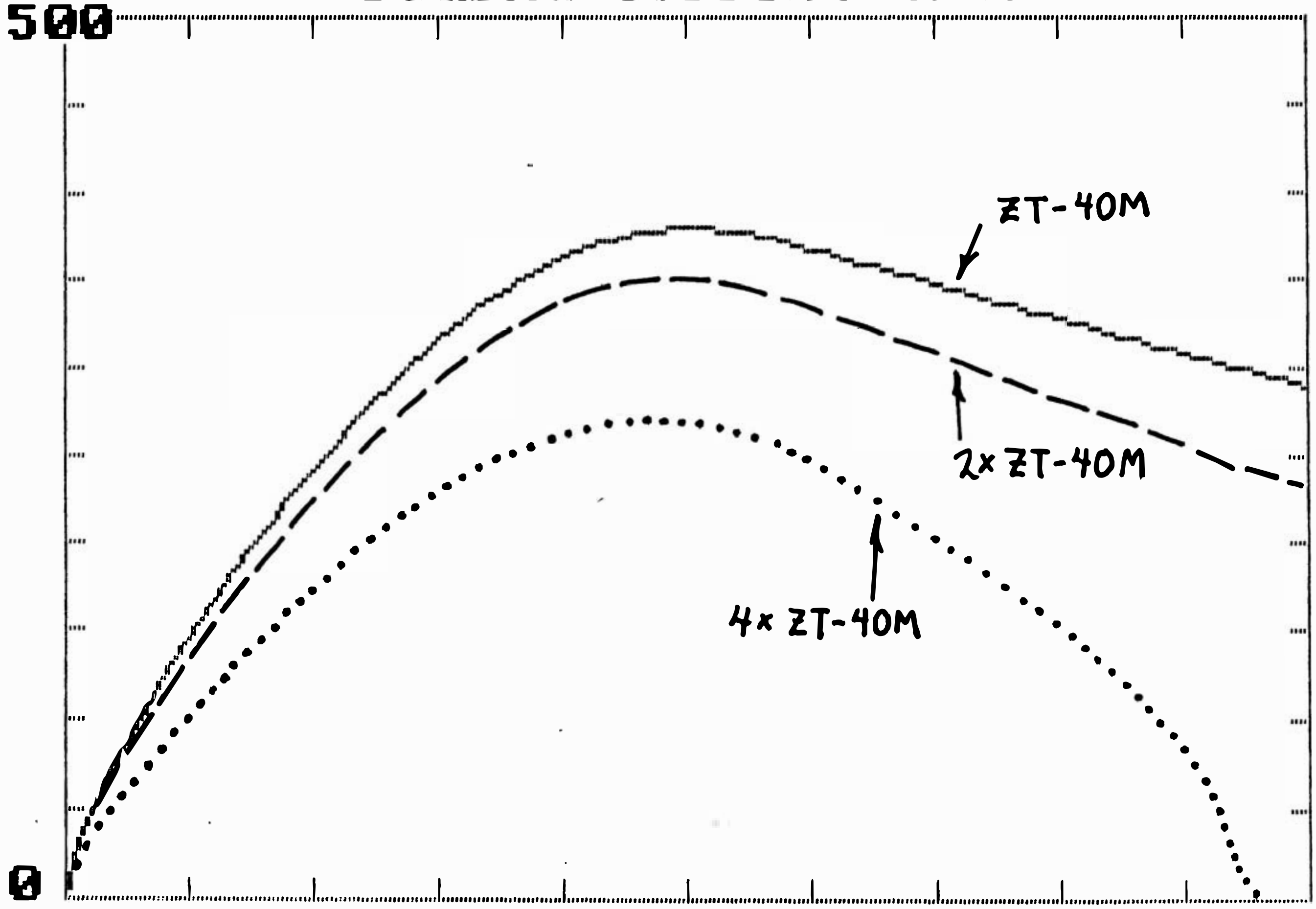

D 6/05/12 20:53
1.43:RM 0.13:Q
1.00E-01 ` 2.00
-1.00 KG
3.77:L 3.03:DR
0%:B 4.86:G
B 2.2 -0.56 KG
Ip=100KAMP ` 1.00
0.16:YL 0.52:YT
0.38:YO 0.22:DY
HOOP/SEPS/SHELL
DYPRI 0.28 0.29
YSEP 0.15 0.15
YRING 0.43 0.43
IR=500KA 171 79
HH CM 2.1 2.1
XH CM 14.5108.0
YH CM 32.0 32.0
---STATISTICS--
VAC 92 1.54 S
INI 80 1.52 S
OUT 150 8.81 S
INR 361 12.34 T
--DY,RMS %R,G J
V 0.000% 0.000%
0.000% 0.000%
I 0.023% 0.100%
0.020% 0.050%
O 0.203* 0.100*
0.083* 0.005*
` 0.002% 0.160%
OCTUPOLE HOOPS
.6
.5
.4
.3
.2
.1
.0
-.1
-.2
8 9 0 1 2 3 4 5 6 7 8 9
J
B

` 0.80

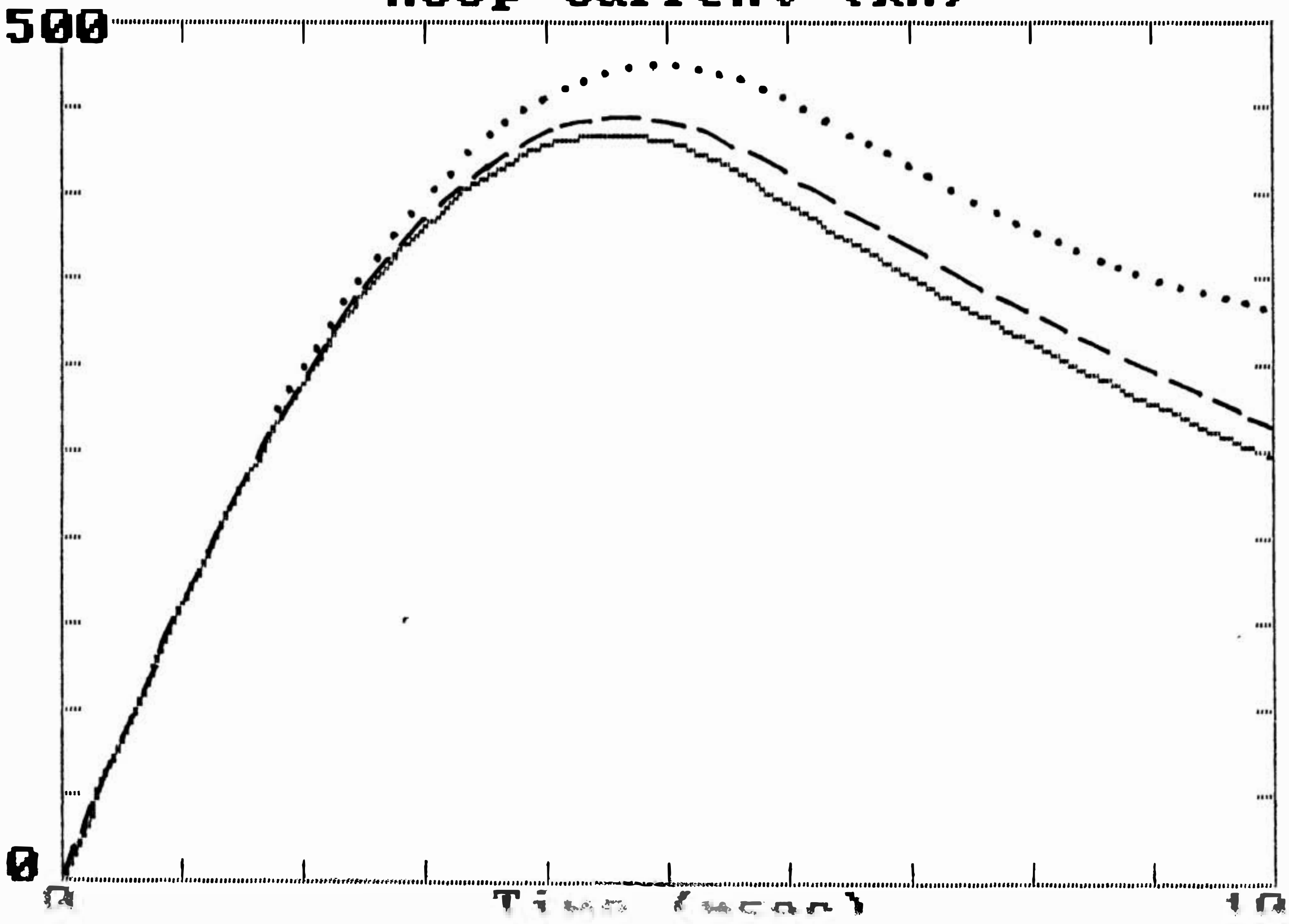
A 0-D (circuit) model is used to predict the electrical waveforms. This model assumes the absence of plasma outside the separatrix and uses a Spitzer-like resistivity scaling (assuming $T_e \sim I_p$). Cases are shown for the resistivities of the ZT-40M experiment, 2 x ZT-40M and 4 x ZT-40M.

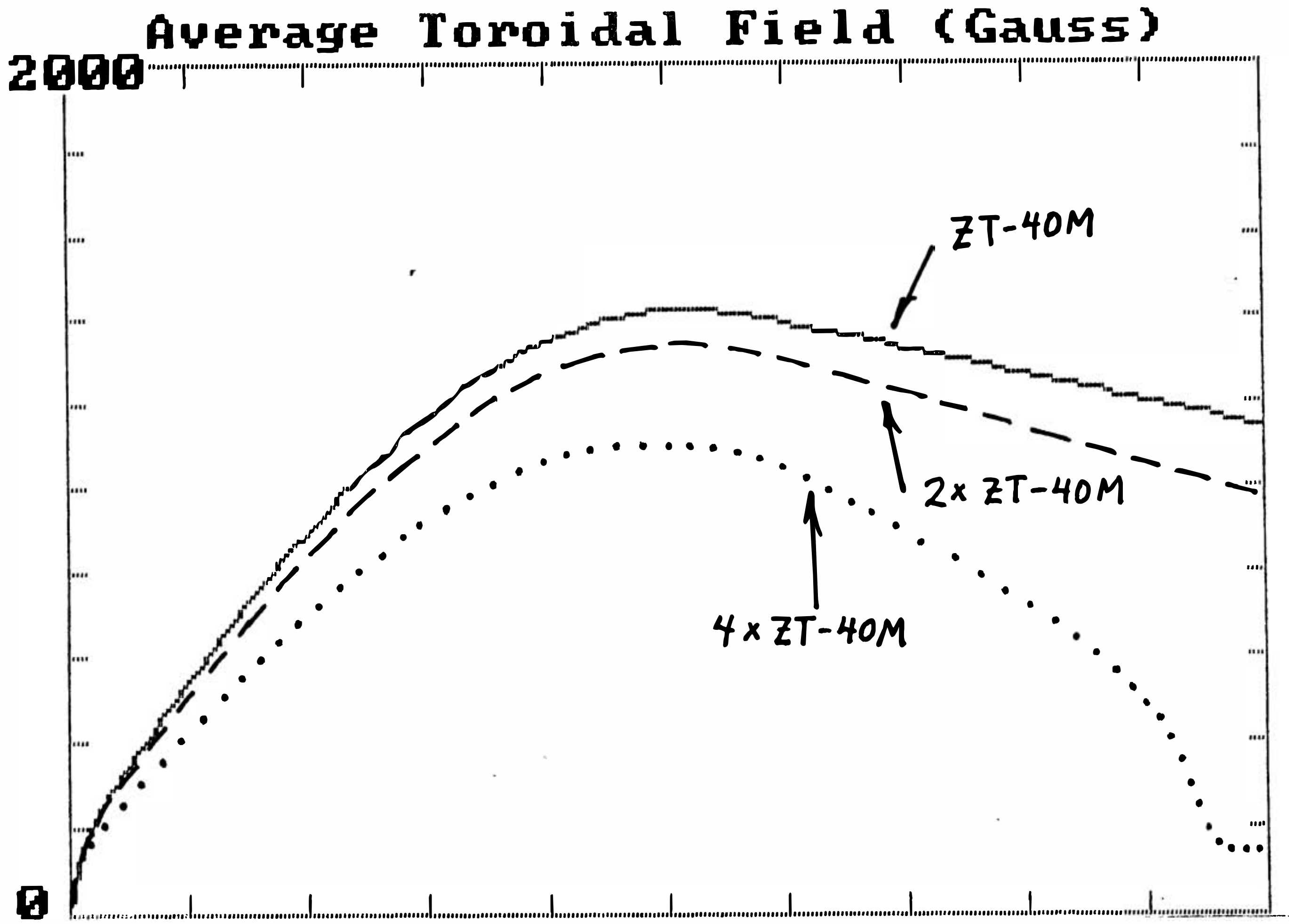


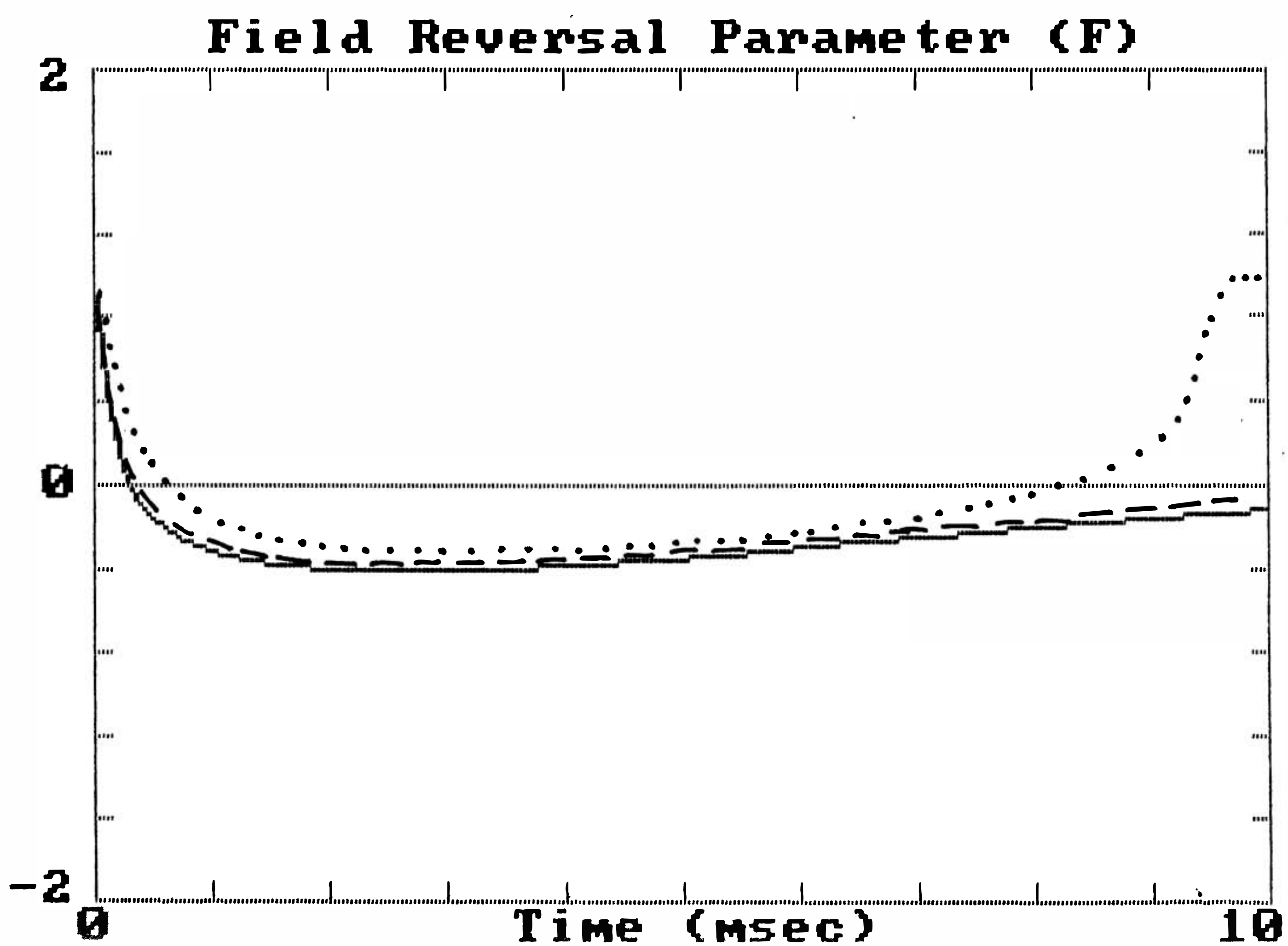
Plasma Current (kA)



Hoop Current (kA)




Average Toroidal Field (Gauss)
2000
0
ZT-40M
2x ZT-40M
4x ZT-40M


Field Reversal Parameter (F)
2
0
-2
0
Time (msec)
10