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2-Dimensional Studies of the Disk-and-Washer and Side-Coupled Resonant Cavity Structures

LeRoy D. Larry, Jr.
Fermi National Accelerator Laboratory
P.O. Box 500, Batavia, Illinois 60510

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2-DIMENSIONAL STUDIES OF THE DISK-AND-WASHER AND SIDE-COUPLED RESONANT CAVITY STRUCTURES

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Abstract

The work done consists of three parts: 1) Optimizing the disk-and-washer (DAW) structure at $\beta = 0.5662$ corresponding to $E = 200$ MeV. 2) Comparing the DAW structure with the side-coupled (SCS) structure at various values of beta, ranging from $\beta = 0.4569$ and $E = 116$ MeV to $\beta = 0.7131$ and $E = 400$ MeV. 3) Re-optimizing the DAW structure at $\beta = 0.7131$.

One object of the analyses was to determine a configuration for the DAW cavity in which the effective shunt impedance ZT^2 would be maximized. Starting from the initial configuration given in appendix A,[1] runs were made varying the nose cone radius R_n, and the nose cone angle θ, while keeping all other cavity parameters fixed. See Figure 1. Figure 6 shows that ZT^2 is highest for $R_n = 0.3$ cm. However, a resonant cavity experiences electrical sparking beyond a certain value of the electric field at its surface, known as the *Kilpatrick limit*. This limit is given by the formula

$$f = 1.643 E_k^2 e^{-8.5/E_k}$$

where f is the frequency in MHz of the cavity, and E_k is the value of the surface electric field limit in MV/m. For a frequency of $f = 805$ MHz, the operating frequency of the DAW cavity, the field limit $E_k = 26$ MV/m. It is considered safe to exceed the sparking limit by a factor of about 1.6, giving $E_m = 1.6E_k = 42$ MV/m. The accelerating electric field is then $E_0 = 7.5$ MV/m. Because the SUPERFISH calculations are normalized to $E_0 = 1.0$ MV/m, the maximum acceptable surface gradient from a SUPERFISH run is 5.6 MV/m. Figure 12 shows that for $R_n = 0.3$ cm, the maximum surface electric field $E_m = 5.9$ MV/m. This exceeds the chosen voltage limit and could lead to an intolerable rate of sparking. But for $R_n = 0.41$ cm, $E_m = 5.0$ MV/m, and so is acceptable. In figure 6, for $R_n \geq 0.41$ cm, ZT^2 does not increase significantly, if at all, for $\theta \geq 15$ deg. This led to fixing the nose cone radius and angle to $R_n = 0.41$ cm and $\theta = 15$ deg, respectively, for all succeeding analyses, except for those where R_n is varied. The remaining analyses at $\beta = 0.5662$ consisted of varying the other cavity parameters around this standard configuration of $R_c = 27.22$ cm, $R_d = 20.119$ cm, $T_d = 1.336$ cm, $T_w = 0.317$ cm, $R_n = 0.41$ cm, $C_z = 2.525$ cm, $L_r = 2.986$ cm, and $\theta = 15$ deg.

Figures 7 to 18 show that the only way of significantly increasing ZT^2 is by increasing the cavity radius R_c. However this may lead to the introduction of unwanted modes in the cavity.[2] It has therefore been decided, for the present, that the standard configuration is also the optimum configuration.

Another objective was to determine the tuning sensitivity of the various segments in the DAW cavity. Table 7 gives the perturbation coefficients for these segments. Each segment is one from which copper can be removed. The table shows that segment 4, which is the top of the cavity, is the most sensitive in the coupling mode, while the tip of the nose cone, which is segment 11, is the most sensitive in the accelerating mode. Varying the cavity parameters around the standard configuration does not change this, as shown in Tables 8 to 20. But these tables do show that the values of the perturbation coefficients change significantly for some of the segments, especially in varying the washer radius R_w.

[1] calculated by A. Moretti

[2] R. K. Cooper, Radio-Frequency Structure Development for the Los Alamos/NBS Racetrack Microtron, LA-UR-83-95, Los Alamos National Laboratory, January 1983

Figures 19 to 34 show that the power dissipation is greatest on segment 9 for all the configurations except the one with $R_u = 19.604$ cm, in which the power loss is greatest on segment 7.

The next set of analyses involved comparing the properties of the DAW cavity with the side-coupled cavity (SCS) over a range of energies. In order to make these comparisons, the SCS cavities were constructed with $R_n = 0.41$ cm, $\theta = 15$ deg, and *bore radius* $= 1.5$ cm, as in the DAW cavities. Figures 35 and 36 show a sample output from a SUPERFISH run of an SCS cavity, along with a diagram of the electric field lines. Note that the SCS cavity only has the one TM010 accelerating mode, with no coupling mode. The lengths of the cavities were calculated using the formula

$$L = \frac{\beta\lambda}{2} = \frac{c\beta}{2f}$$

where $c = 2.998 \times 10^8$ m/s and $f = 805$ MHz, from which $L = 18.62\beta$ cm. Because the geometry of the cavity cell specified in the AUTOMESH input file represents a quarter of the actual cavity cell, the cavity lengths specified in the AUTOMESH input file are actually $l = \frac{L}{2} = 9.31\beta$ cm. The results of these analyses are shown in Figures 37 to 41. From the standpoint of maximizing ZT^2 without a voltage breakdown, the DAW cavity would appear to be superior to the SCS cavity.

Before analyzing the DAW cavity at $\beta = 0.7131$, the effect of the grid size of the mesh generated by LATTICE, on the SUPERFISH calculations, was investigated. The grid size is also specified in the AUTOMESH input file. From the specified DX increment, SUPERFISH automatically calculates the increment

$$DY = \frac{\sqrt{3}}{2} DX$$

and the grid size is thus determined. See Figures 42 and 43. It is also possible here to specify break points, which produce different grid sizes in different regions of the cavity. For example in Figure 44, the break point specified in the AUTOMESH input file is $YREG1 = 3.1$ cm, with $DX = 0.09$ cm, while in Figure 45 an additional break point $YREG2 = 7.0$ cm is specified. SUPERFISH then automatically calculates $DY = 0.08$ cm. DX remains the same throughout the cavity, but DY doubles in size for any value of Y greater than the break point value:

Figure 42: $f = 803.315$ MHz, $ZT^2 = 60.61$ MOhm/m, $T = 0.835$, and $E_m = 4.610$ MV/m

Figure 43: $f = 802.753$ MHz, $ZT^2 = 60.71$ MOhm/m, $T = 0.835$, and $E_m = 4.624$ MV/m

Figure 44: $f = 802.999$ MHz, $ZT^2 = 60.72$ MOhm/m, $T = 0.835$, and $E_m = 4.623$ MV/m

Figure 45: f = 804.005 MHz, ZT^2 = 60.78 MOhm/m, T = 0.835, and E_m = 4.622 MV/m

These results show that grid size does not have an appreciable effect on the SUPERFISH calculations of frequency f, effective shunt impedance ZT^2, transit time factor T, and maximum electric field E_m, in the cavity.

The analyses of the DAW cavity at $\beta = 0.7131$ were carried out in the same way as those at $\beta = 0.5662$. The results are shown in Figures 46 to 51. In this case as well, a standard configuration was arrived at which also turned out to be, for the present, the optimum configuration: $R_c = 27.22$ cm, $R_d = 21.067$ cm, $T_d = 1.336$ cm, $R_w = 17.604$ cm, $T_w = 0.317$ cm, $R_n = 0.41$ cm, $C_z = 3.949$ cm, $L_r = 2.970$ cm, and $\theta = 15$ deg.

The conclusions reached in these analyses are based on the SUPERFISH calculations. These calculations are not 3-dimensional, but 2-dimensional, and also are unable to take into account the cavity stems which connect the disk to the washer. As such these conclusions are tentative. But they are useful for a starting point in understanding the properties of the DAW and SCS cavities. Acknowledgement to J. MacLachlan and A. Moretti for their assistance and guidance.

A Running SUPERFISH and Cavity Tuning

The analyses of the cavities were done by making SUPERFISH runs. The following is an example of one such run:

1) command: run/nodeb automesh

2) input file: d08.200

3) command: run/nodeb lattice

4) input file: tape73.dat

5) con( ) input values: skip

6) command: run/nodeb superfish

7) type: tty

8) dump num: 0

9) con( ) input values: *65 805. *106 .5662 s

10) command: run/nodeb sfo

11) type: tty

12) dump num: 1

13) con( ) input values: *50 10 s

14) iseg's values: 2 3 4 6 7 8 9 10 11 12

The geometry of the cavity is specified in the AUTOMESH input file, here d08.200. By editing d08.200 the cavity parameters R_c, R_d, T_d, R_w, T_w, R_n, C_z, L_r, and θ are varied. See Figure 1.

The output of AUTOMESH is tape73.dat. SUPERFISH automatically sets the electric field line boundary conditions for the cavity as 1 0 1 1:

1 - field lines $\perp$ to top of cavity

0 - field lines $||$ to bottom of cavity

1 - field lines $\perp$ to right side of cavity

1 - field lines $\perp$ to left side of cavity

By editing tape73.dat, before running LATTICE, the desired boundary conditions are specified: for example, 1 0 1 0 for the TM01π coupling mode, and 1 0 0 1 for the TM02π accelerating mode, in the DAW cavity. SUPERFISH also automatically sets the drive point at the upper right-hand corner of the cavity. Again by editing tape73.dat, the desired drive point location can be specified: for example on the disk at $X = 1.1876$ cm and $Y = 20.1190$ cm in the DAW cavity.

The con( ) input values *50, *65, and *106 specify the desired number of cavity segments on which the power loss is to be calculated, the frequency, and the beta, respectively, of the cavity. The iseg's values specify which cavity segments the power loss is to be calculated on. See Figure 1. Figures 2 to 5 show sample outputs of two SUPERFISH runs, along with diagrams of the electric field lines, for the DAW coupling and accelerating modes.

After a run, if needed, the cavity is tuned to within ± 4 MHz of the 805 MHz operating frequency for both the TM01π and TM02π modes. This is accomplished by moving the nose cone of the washer in the $\pm z$ direction, keeping the other cavity parameters fixed, except for the point on the washer where the nose cone begins. The following is an example of cavity tuning: The initial cavity configuration, from which the various configurations would evolve, was given as $R_c = 27.22$ cm, $R_d = 20.119$ cm, $T_d = 1.336$ cm, $R_w = 17.604$ cm, $T_w = 0.317$ cm, $R_n = 0.5$ cm, $C_z = 2.615$ cm, $L_r = 3.928$ cm, and $\theta = 30$ deg. After making a run using this configuration, the output from SUPERFISH gave the frequency of the cavity as $f = 802.222$ MHz, requiring the cavity to be tuned by an amount of

$$df = 805 \text{ MHz} - 802.222 \text{ MHz} = 2.778 \text{ MHz}$$

The output also gave the perturbation coefficient for segment 11 as

$$\frac{df}{dz} = 5.40528 \text{ MHz/mm}$$

$$dz = \frac{2.778 \text{ MHz}}{5.40528 \text{ MHz/mm}} = 0.051 \text{ cm}$$

$x = 4.955 \text{ cm} + 0.051 \text{ cm} = 5.006 \text{ cm}$

$$y = \frac{y_2 - y_1}{x_2 - x_1}(x - x_1) + y_1$$

$x_1 = 4.955$ cm, $y_1 = 3.928$ cm, $x_2 = 2.365$ cm, $y_2 = 2.433$ cm

$y = 0.577x + 1.069$

for $x = 5.006$ cm : $y = 3.958$ cm

$dr = 3.958 \text{ cm} - 3.928 \text{ cm} = 0.03 \text{ cm}$

$L_r = 3.928$ cm $- 0.03$cm $= 3.898$ cm

$C_z = 2.615$ cm $+ 0.051$ cm $= 2.666$ cm

Going from 802.222 MHz to 805 MHz required changing the value of C_z from 2.615 cm to 2.666 cm, and the value of L_r from 3.928 cm to 3.898 cm, keeping all other cavity parameters fixed. When increasing C_z in the $+z$ direction L_r decreases in the $-r$ direction, and when decreasing C_z in the $-z$ direction L_r increases in the $+r$ direction.

B Tables and Figures

All graphs represent third order least squares fits to the data contained in the tables.

The graphs of ZT^2 and E_m vs R_c and R_d are similiar because when varying one by a certain amount, it is necessary to vary the other by approximately the same amount, in order to keep the cavity tuned.

In some graphs E_m appears to vary more than it actually does due to the scale.

List of Tables

1 Tuning Key for Table 2 17
2 Effective Shunt Impedance ZT^2 vs Nose Cone Angle θ for four different Nose Cone Radii R_n 17
3 Tuning Key for Tables 5 and 6 with the Standard Configuration being R_c = 27.22 cm, R_d = 20.119 cm, T_d = 1.336 cm, R_w = 17.604 cm, T_w = 0.317 cm, R_n = 0.41 cm, C_z = 2.525 cm, L_r = 2.986 cm, and θ = 15 deg 19
4 Location Key for Table 5 19
5 Effective Shunt Impedance ZT^2, and Maximum Electric Field E_m on Segment 11, vs Cavity Parameters R_c, R_d, T_d, R_w, T_w, and R_n at $\beta = 0.5662$ 20
6 T, TP, TP^2, S, SP, and SP^2 vs Cavity Parameters R_c, R_d, T_d, R_w, T_w and R_n at $\beta = 0.5662$ 27
7 Perturbation Coefficients for the Ten Copper Removal Segments in the DAW Structure for the Standard Configuration 34
8 Perturbation Coefficients df/dr for Segment 2 vs Cavity Parameters R_c, R_d, T_d, R_w, T_w, and R_n 35
9 Perturbation Coefficients df/dz for Segment 3 vs Cavity Parameters R_c, R_d, T_d, R_w, T_w, and R_n 36
10 Perturbation Coefficients df/dr for Segment 4 vs Cavity Parameters R_c, R_d, T_d, R_w, T_w, and R_n 37
11 Perturbation Coefficients df/dz for Segment 6 vs Cavity Parameters R_c, R_d, T_d, R_w, T_w, and R_n 38
12 Perturbation Coefficients df/dr for Segment 6 vs Cavity Parameters R_c, R_d, T_d, R_w, T_w, and R_n 39
13 Perturbation Coefficients df/dz for Segment 7 vs Cavity Parameters R_c, R_d, T_d, R_w, T_w, and R_n 40
14 Perturbation Coefficients df/dz for Segment 8 vs Cavity Parameters R_c, R_d, T_d, R_w, T_w, and R_n 41
15 Perturbation Coefficients df/dz for Segment 9 vs Cavity Parameters R_c, R_d, T_d, R_w, T_w, and R_n 42

16 Perturbation Coefficients df/dz for Segment 10 vs Cavity Parameters R_c, R_d, T_d, R_w, T_w, and R_n 43
17 Perturbation Coefficients df/dr for Segment 10 vs Cavity Parameters R_c, R_d, T_d, R_w, T_w, and R_n 44
18 Perturbation Coefficients df/dz for Segment 11 vs Cavity Parameters R_c, R_d, T_d, R_w, T_w, and R_n 45
19 Perturbation Coefficients df/dr for Segment 11 vs Cavity Parameters R_c, R_d, T_d, R_w, T_w, and R_n 46
20 Perturbation Coefficients df/dr for Segment 12 vs Cavity Parameters R_c, R_d, T_d, R_w, T_w, and R_n 47
21 Power Loss per Segment for Standard Configuration 48
22 Power Loss per Segment with $R_c = 25.22$ cm and $R_d = 18.093$ cm 48
23 Power Loss per Segment with $R_c = 29.22$ cm and $R_d = 22.211$ cm 51
24 Power Loss per Segment with $R_c = 31.22$ cm and $R_d = 24.299$ cm 51
25 Power Loss per Segment with $T_d = 0.336$ cm 54
26 Power Loss per Segment with $T_d = 0.836$ cm 54
27 Power Loss per Segment with $T_d = 2.336$ cm 57
28 Power Loss per Segment with $R_w = 13.604$ cm 57
29 Power Loss per Segment with $R_w = 15.604$ cm 60
30 Power Loss per Segment with $R_w = 19.604$ cm 60
31 Power Loss per Segment with $T_w = 0.117$ cm 63
32 Power Loss per Segment with $T_w = 0.217$ cm 63
33 Power Loss per Segment with $T_w = 0.517$ cm 66
34 Power Loss per Segment with $R_n = 0.3$ cm 66
35 Power Loss per Segment with $R_n = 0.5$ cm 69
36 Power Loss per Segment with $R_n = 0.6$ cm 69
37 Effective Shunt Impedance ZT^2, Maximum Electric Field E_m, and Transit Time Factor T, vs β for SCS and DAW Structures . 74
38 Accelerating Gradient E_0T and Power Loss per meter $P/m = (E_0T)^2/ZT^2$ vs β for SCS and DAW Structures with Maximum Electric Field $E_m = 42$ MV/m 78
39 Power Loss per meter P/m vs β for SCS and DAW Structures with Accelerating Gradient $E_0T = 6.427$ MV/m 78
40 Tuning Key for Table 41 with the Standard Configuration being $R_c = 27.22$ cm, $R_d = 21.067$ cm, $T_d = 1.336$ cm, $R_w = 17.604$ cm, $T_w = 0.317$ cm, $R_n = 0.41$ cm, $C_x = 3.949$ cm, $L_r = 2.970$ cm, and $\theta = 15$ deg 85
41 Effective Shunt Impedance ZT^2 and Maximum Electric Field E_m vs Cavity Parameters R_c, R_d, T_d, R_w, T_w, and R_n at $\beta = 0.7131$ 86

List of Figures

1 Cavity geometry of DAW Structure 12

2 TM02π Sample SUPERFISH Output 13
3 DAW TM02π Accelerating Mode 14
4 TM01π Sample SUPERFISH Output 15
5 DAW TM01π Coupling Mode 16
6 from Table 2 18
7 from Table 5 21
8 from Table 5 22
9 from Table 5 23
10 from Table 5 24
11 from Table 5 25
12 from Table 5 26
13 from Table 6 28
14 from Table 6 29
15 from Table 6 30
16 from Table 6 31
17 from Table 6 32
18 from Table 6 33
19 from Table 21 49
20 from Table 22 50
21 from Table 23 52
22 from Table 24 53
23 from Table 25 55
24 from Table 26 56
25 from Table 27 58
26 from Table 28 59
27 from Table 29 61
28 from Table 30 62
29 from Table 31 64
30 from Table 32 65
31 from Table 33 67
32 from Table 34 68
33 from Table 35 70
34 from Table 36 71
35 TM010 Sample SUPERFISH Output 72
36 SCS TM010 Accelerating Mode 73
37 from Table 37 75
38 from Table 37 76
39 from Table 37 77
40 from Table 38 79
41 from Table 39 80
42 $DX = 0.15$, $DY = 0.13$ 81
43 $DX = 0.09$, $DY = 0.08$ 82
44 $DX = 0.09$, $DY_1 = 0.08$, $DY_2 = 0.16$ 83
45 $DX = 0.09$, $DY_1 = 0.08$, $DY_2 = 0.16$, $DY_3 = 0.32$ 84

46 from Table 41 87
47 from Table 41 88
48 from Table 41 89
49 from Table 41 90
50 from Table 41 91
51 from Table 41 92

Figure 1: Cavity geometry of DAW Structure

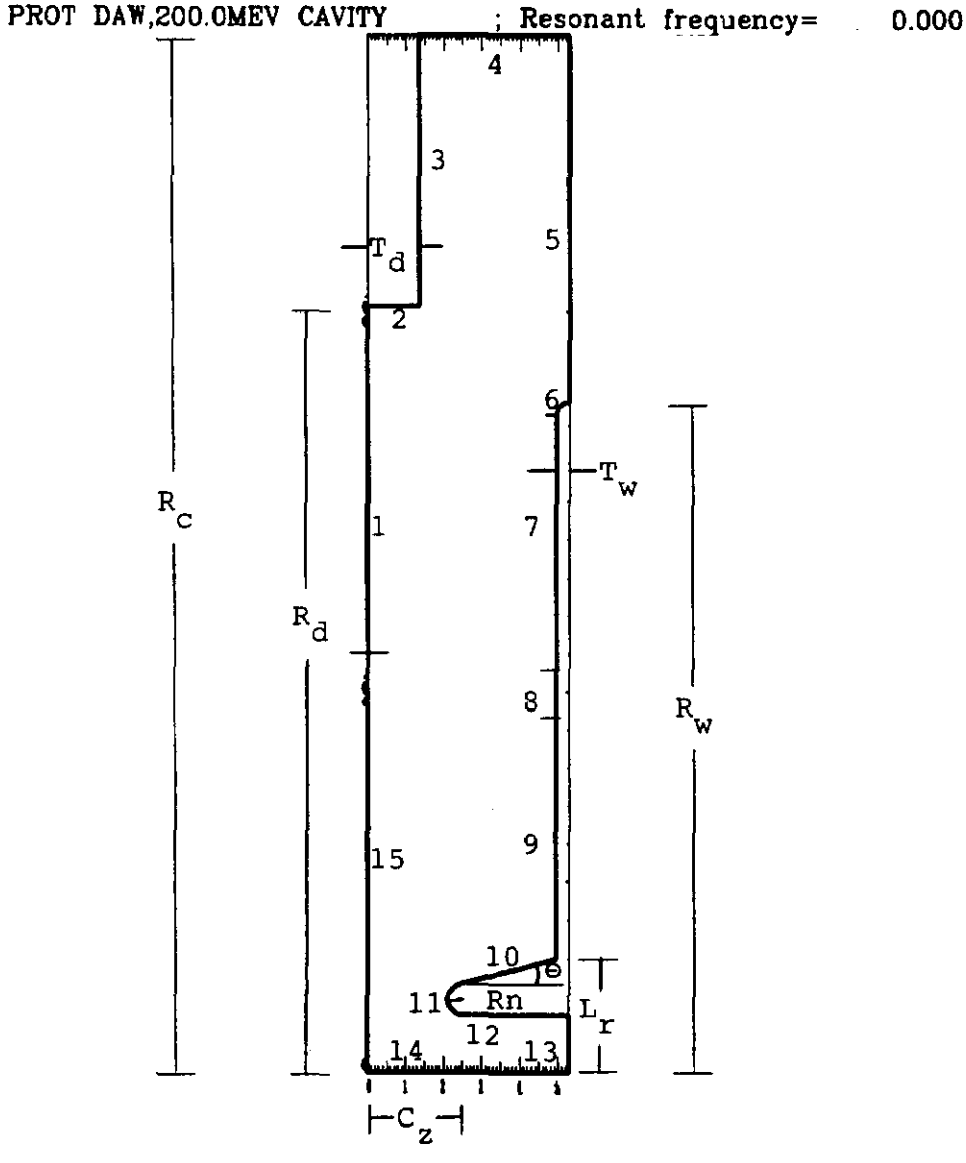


Figure 2: TM02π Sample SUPERFISH Output

```
superfish dtl output summary        16:13:25  11-JAN-8
problem name =  PROT DAW,200.0MEV CAVITY
cavity length  =  10.544 cm      cavity diameter  =    54.440 cm
     d.t. gap  =   2.672 cm          stem radius  =     1.000 cm
frequency (starting value = 805.000)              =   805.495 mhz
beta =  0.5862                       proton energy =   200.029 mev
normalization factor   (e0=1 mv/m)        ascale  =    1461.9
stored energy (mesh problem only)                 =  5.6183338E-03 joules
power dissipation (mesh problem only)             =  7.7920911E+02 watts
t,tp,tpp,s,sp,spp  =   0.875   0.076   0.019   0.393   0.105   0.018
q  =   36537                      shunt impedance  =  6.7658348E+01 mohm/m
product z*t**2                                 ztt  =  5.1777493E+01 mohm/m
magnetic field on outer wall                      =              2 amp/m
maximum electric field on boundary                =  5.0998763E+00 mv/m
```

lseg	zbeg (cm)	rbeg (cm)	zend (cm)	rend (cm)	emax (mv)	power (w)		d-freq (delz)	d-freq (delr)
2	0.0000E+00	2.0119E+01	1.3360E+00	2.0119E+01	4.4034E-01	1.1323E+01	wall	0.0000E+00	0.0000E-02
3	1.3360E+00	2.0119E+01	1.3360E+00	2.7220E+01	5.2401E-01	7.0638E+00	wall	4.2751E-01	0.0000E+00
4	1.3360E+00	2.7220E+01	5.2720E+00	2.7220E+01	3.4402E-02	1.0630E-01	wall	0.0000E+00	1.0452E-02
6	5.2720E+00	1.7604E+01	4.9550E+00	1.7287E+01	1.0250E+00	9.4302E-01	wall	2.0019E+00	3.2547E+00
7	4.9550E+00	1.7287E+01	4.9550E+00	1.2000E+01	1.0029E+00	1.0124E+02	wall	7.0096E-02	0.0000E+00
8	4.9550E+00	1.2000E+01	4.9550E+00	1.1365E+01	5.3660E-02	3.6714E+01	wall	-4.4040E-01	0.0000E+00
9	4.9550E+00	1.1365E+01	4.9550E+00	2.9060E+00	5.6200E-01	4.2937E+02	wall	-3.5944E+00	0.0000E+00
10	4.9550E+00	2.9060E+00	2.4190E+00	2.3060E+00	3.0000E+00	1.0521E+02	wall	3.5050E-01	1.3071E+00
11	2.4190E+00	2.3060E+00	2.5250E+00	1.5000E+00	5.0991E+00	7.0069E+00	wall	5.9772E+00	3.0062E+00
12	2.5250E+00	1.5000E+00	5.2720E+00	1.5000E+00	1.0002E+00	5.0250E-02	wall	0.0000E+00	0.5063E-02

Figure 3: DAW TM02π Accelerating Mode

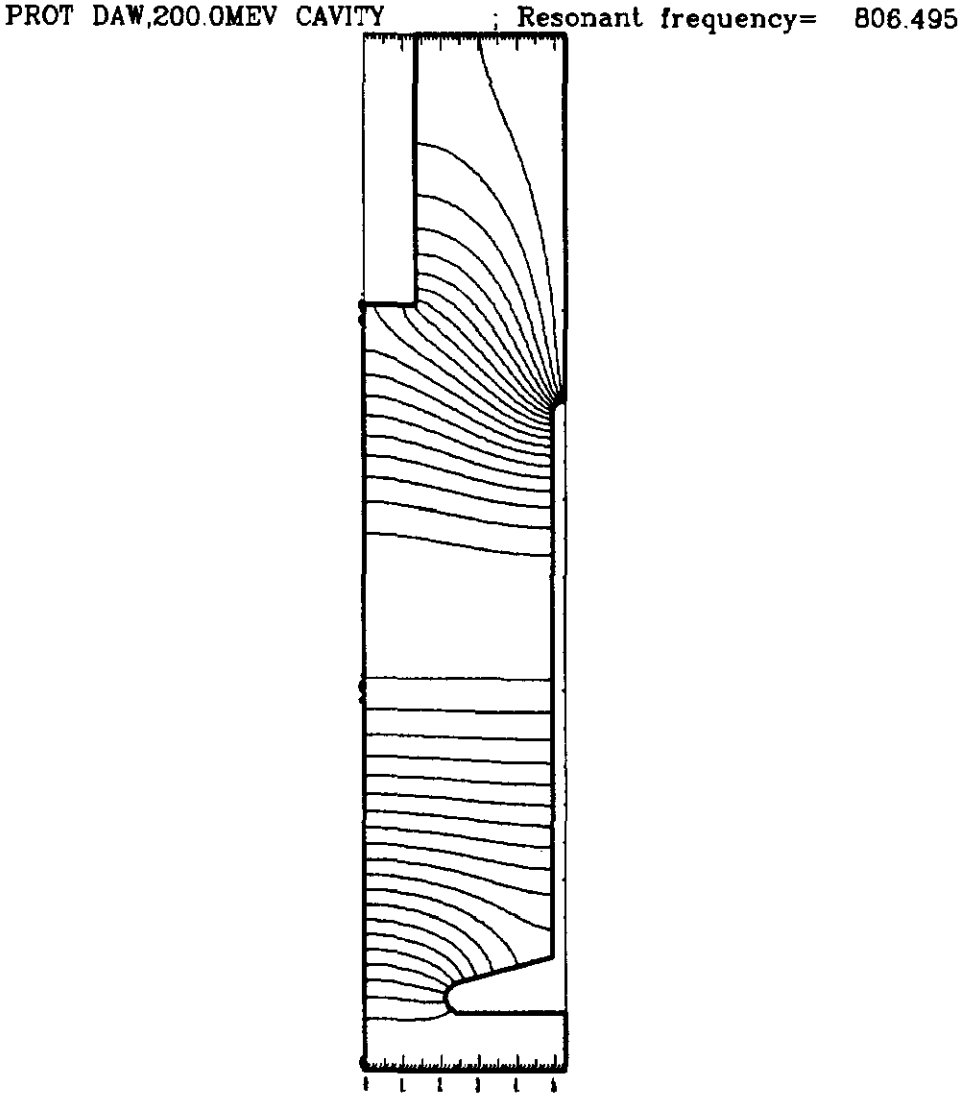
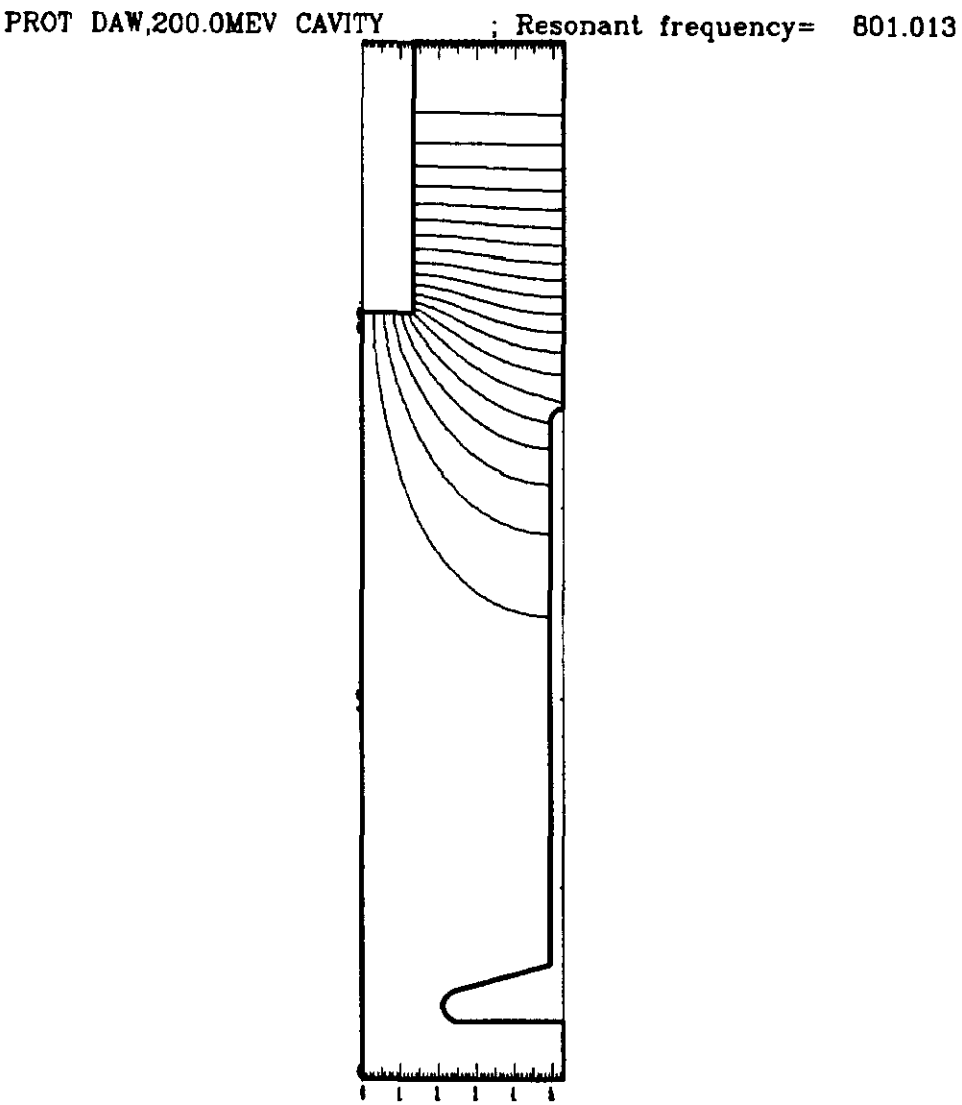


Figure 4: TM01π Sample SUPERFISH Output

```
superfish dtl output summary        16:26:55  11-JAN-8
problem name =  PROT DAW,200.0MEV CAVITY
cavity length  =  10.644 cm     cavity diameter  =    54.440 cm
     d.t. gap  =   2.672 cm          stem radius  =     1.000 cm
frequency (starting value = 805.000)             =   801.013 mhz
beta =  0.5662                       proton energy =   200.029 mev
normalization factor   (e0=1 mv/m)        ascale  =  339269.1
stored energy (mesh problem only)                =  2.0354315E+02 joules
power dissipation (mesh problem only)            =  4.0760492E+07 watts
t,tp,tpp,s,sp,spp  =   0.819   0.169   0.026   0.585   0.131   0.027
q  =   21069                      shunt impedance  =  1.0812032E-03 mohm/m
product z*t**2                                ztt  =  7.2533697E-04 mohm/m
magnetic field on outer wall                     =          289513 amp/m
maximum electric field on boundary               =  3.7213931E+02 mv/m

| iseg | zbeg (cm) | rbeg (cm) | zend (cm) | rend (cm) | emax (mv) | power (w) | | d-freq (delz) | d-freq (delr) |
|---|---|---|---|---|---|---|---|---|---|
| 2 | 0.0000E+00 | 2.0119E+01 | 1.3360E+00 | 2.0119E+01 | 3.3466E+02 | 1.9854E+05 | wall | 0.0000E+00 | 5.6626E+00 |
| 3 | 1.3360E+00 | 2.0119E+01 | 1.3360E+00 | 2.7220E+01 | 3.7214E+02 | 2.6765E+07 | wall | -1.7905E-01 | 0.0000E+00 |
| 4 | 1.3360E+00 | 2.7220E+01 | 5.2720E+00 | 2.7220E+01 | 3.0687E-01 | 2.0660E+07 | wall | 0.0000E+00 | -0.0675E+00 |
| 6 | 5.2720E+00 | 1.7604E+01 | 4.9560E+00 | 1.7287E+01 | 1.0579E+02 | 2.0653E+05 | wall | 2.0219E-01 | 0.9226E-02 |
| 7 | 4.9560E+00 | 1.7287E+01 | 4.9560E+00 | 1.2000E+01 | 9.4341E+01 | 0.0515E+05 | wall | 7.3720E-01 | 0.0000E+00 |
| 8 | 4.9560E+00 | 1.2000E+01 | 4.9560E+00 | 1.1365E+01 | 2.1239E+01 | 1.3141E+04 | wall | 1.2076E-02 | 0.0000E+00 |
| 9 | 4.9560E+00 | 1.1365E+01 | 4.9560E+00 | 2.0000E+00 | 1.0542E+01 | 3.0705E+04 | wall | 2.9392E-02 | 0.0000E+00 |
| 10 | 4.9560E+00 | 2.0000E+00 | 2.4190E+00 | 2.3000E+00 | 1.0207E+01 | 0.7536E+02 | wall | 2.1291E-04 | 7.9396E-04 |
| 11 | 2.4190E+00 | 2.3000E+00 | 2.5250E+00 | 1.5000E+00 | 1.3059E+01 | 3.0153E+01 | wall | 9.3414E-04 | 0.0402E-04 |
| 12 | 2.5250E+00 | 1.5000E+00 | 5.2720E+00 | 1.5000E+00 | 1.7579E+00 | 1.5539E-01 | wall | 0.0000E+00 | 7.0599E-06 |
```

Figure 5: DAW TM01π Coupling Mode



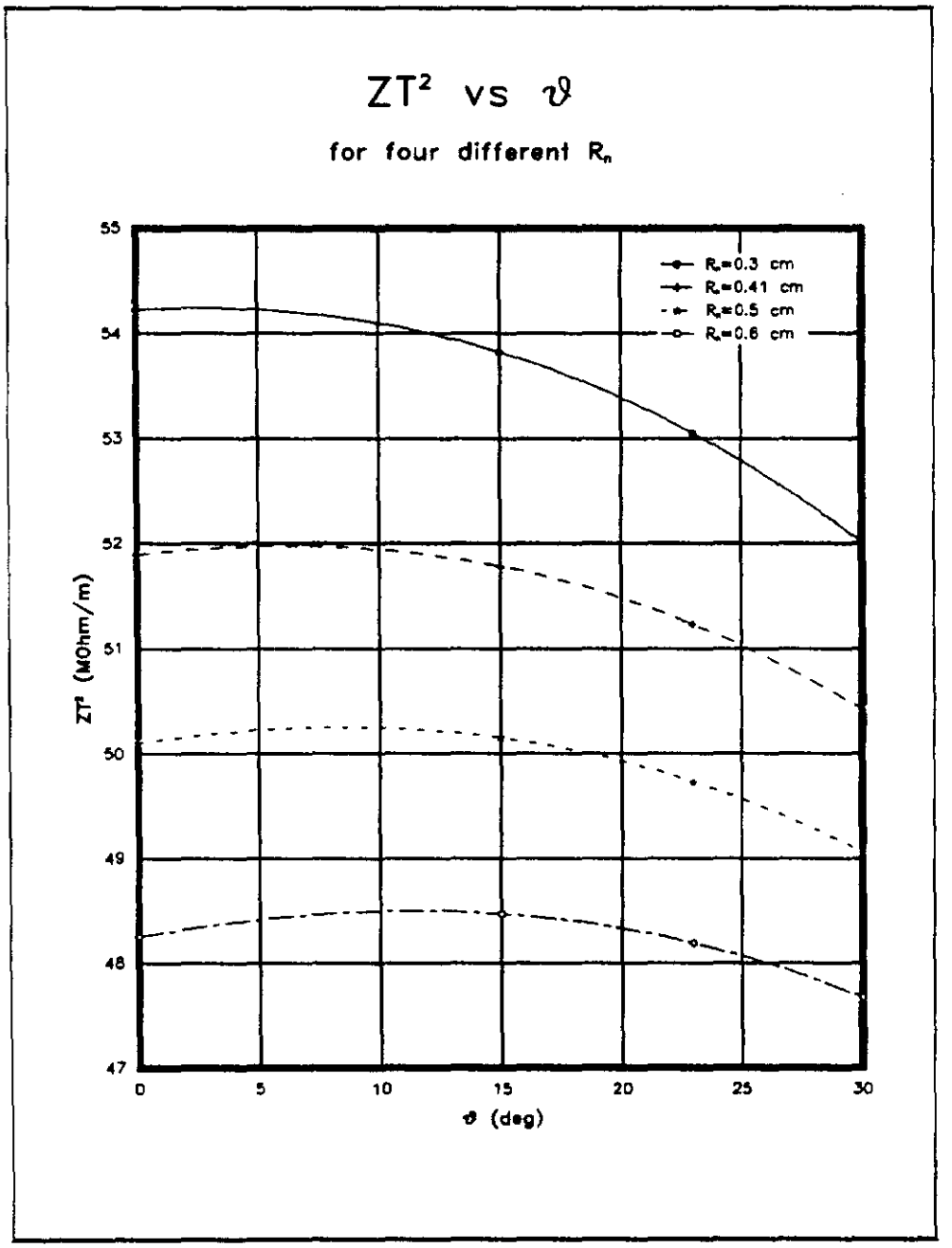
	Tuning (cm)	
1	$C_z = 2.291$	$L_r = 2.1$
2	$C_z = 2.291$	$L_r = 2.8244$
3	$C_z = 2.291$	$L_r = 3.256$
4	$C_z = 2.291$	$L_r = 3.685$
5	$C_z = 2.525$	$L_r = 2.32$
6	$C_z = 2.525$	$L_r = 2.986$
7	$C_z = 2.525$	$L_r = 3.3864$
8	$C_z = 2.525$	$L_r = 3.787$
9	$C_z = 2.699$	$L_r = 2.5$
10	$C_z = 2.674$	$L_r = 3.129$
11	$C_z = 2.666$	$L_r = 3.514$
12	$C_z = 2.666$	$L_r = 3.898$
13	$C_z = 2.869$	$L_r = 2.7$
14	$C_z = 2.869$	$L_r = 3.2801$
15	$C_z = 2.869$	$L_r = 3.6372$
16	$C_z = 2.869$	$L_r = 3.9972$

Table 1: Tuning Key for Table 2

R_n (cm)	θ (deg)	ZT^2 (MOhm/m)	Tuning
0.3	0	54.22	1
0.3	15	53.82	2
0.3	23	53.05	3
0.3	30	52.01	4
0.41	0	51.89	5
0.41	15	51.78	6
0.41	23	51.23	7
0.41	30	50.42	8
0.5	0	50.10	9
0.5	15	50.15	10
0.5	23	49.73	11
0.5	30	49.06	12
0.6	0	48.25	13
0.6	15	48.47	14
0.6	23	48.19	15
0.6	30	47.67	16

Table 2: Effective Shunt Impedance ZT^2 vs Nose Cone Angle θ for four different Nose Cone Radii R_n

Figure 6: from Table 2



		Tuning (cm)		
1	$C_z = 2.445$	$L_r = 3.007$	$R_d = 19.795$	
2	$C_z = 2.605$	$L_r = 2.965$		
3	$C_z = 1.225$	$L_r = 3.334$	$R_d = 19.825$	$T_d = 0.336$
4	$C_z = 1.724$	$L_r = 3.201$	$R_d = 19.825$	$T_d = 0.336$
5	$C_z = 4.357$	$L_r = 2.495$	$R_d = 20.238$	
6		$L_r = 3.0395$		
7		$L_r = 3.013$		
8	$C_z = 2.401$	$L_r = 2.965$	$R_c = 27.134$	
9	$C_z = 2.291$	$L_r = 2.8244$		
10	$C_z = 2.674$	$L_r = 3.129$		
11	$C_z = 2.869$	$L_r = 3.2801$		

Table 3: Tuning Key for Tables 5 and 6 with the Standard Configuration being $R_c = 27.22$ cm, $R_d = 20.119$ cm, $T_d = 1.336$ cm, $R_w = 17.604$ cm, $T_w = 0.317$ cm, $R_n = 0.41$ cm, $C_z = 2.525$ cm, $L_r = 2.986$ cm, and $\theta = 15$ deg

	Location (cm)	
1	$2.140 \leq z \leq 2.203$	$2.050 \leq r \leq 2.164$
2	$2.046 \leq z \leq 2.104$	$2.003 \leq r \leq 2.138$
3	$2.206 \leq z \leq 2.264$	$2.003 \leq r \leq 2.138$
4	$0.815 \leq z \leq 0.840$	$1.922 \leq r \leq 2.050$
5	$1.315 \leq z \leq 1.362$	$1.941 \leq r \leq 2.102$
6	$3.947 \leq z \leq 3.972$	$1.922 \leq r \leq 2.050$
7	$2.016 \leq z \leq 2.079$	$2.050 \leq r \leq 2.164$
8	$1.995 \leq z \leq 2.068$	$1.847 \leq r \leq 2.001$
9	$2.191 \leq z \leq 2.241$	$2.130 \leq r \leq 2.250$
10	$2.281 \leq z \leq 2.322$	$2.220 \leq r \leq 2.346$

Table 4: Location Key for Table 5

R_c (cm)	R_d (cm)	ZT^2 (MOhm/m)	E_m (MV/m)	Location
25.22	18.093	50.23	5.103	1
27.22	20.119	51.78	5.099	1
29.22	22.211	52.42	5.101	1
31.22	24.299	52.67	5.100	1
T_d (cm)	Tuning			
0.336	1	51.62	5.303	2
0.836		51.85	5.099	1
1.336		51.78	5.099	1
2.336	2	51.41	5.029	3
R_w (cm)				
13.604	3	32.09	9.715	4
15.604	4	44.78	7.029	5
17.604		51.78	5.099	1
19.604	5	34.63	2.891	6
T_w (cm)				
0.117	6	54.12	5.133	1
0.217	7	52.99	5.115	1
0.317		51.78	5.099	1
0.517	8	49.09	5.287	7
R_n (cm)				
0.3	9	53.82	5.930	8
0.41		51.78	5.099	1
0.5	10	50.15	4.696	9
0.6	11	48.47	4.256	10

Table 5: Effective Shunt Impedance ZT^2, and Maximum Electric Field E_m on Segment 11, vs Cavity Parameters R_c, R_d, T_d, R_w, T_w, and R_n at $\beta = 0.5662$

Figure 7: from Table 5

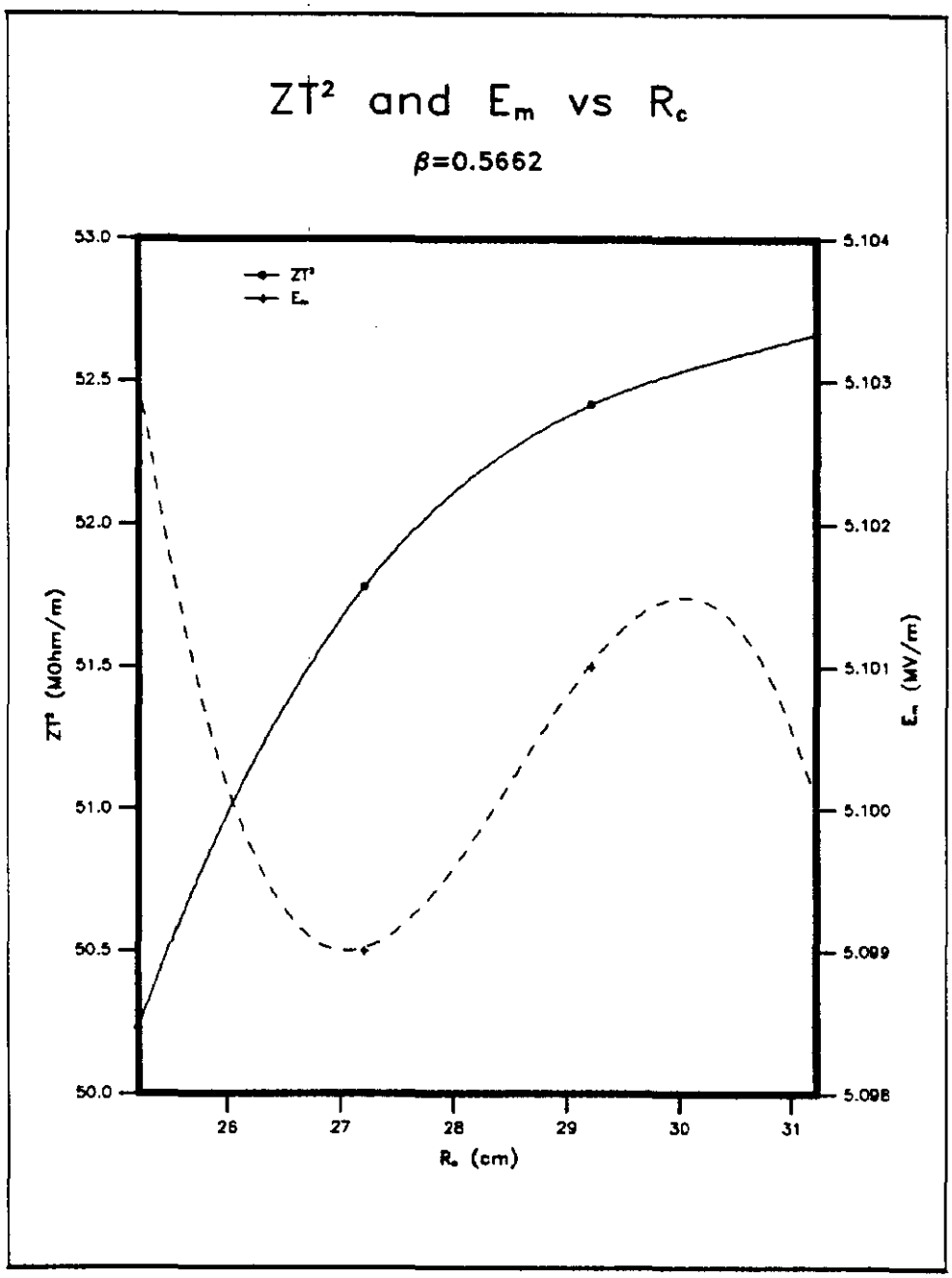


Figure 8: from Table 5

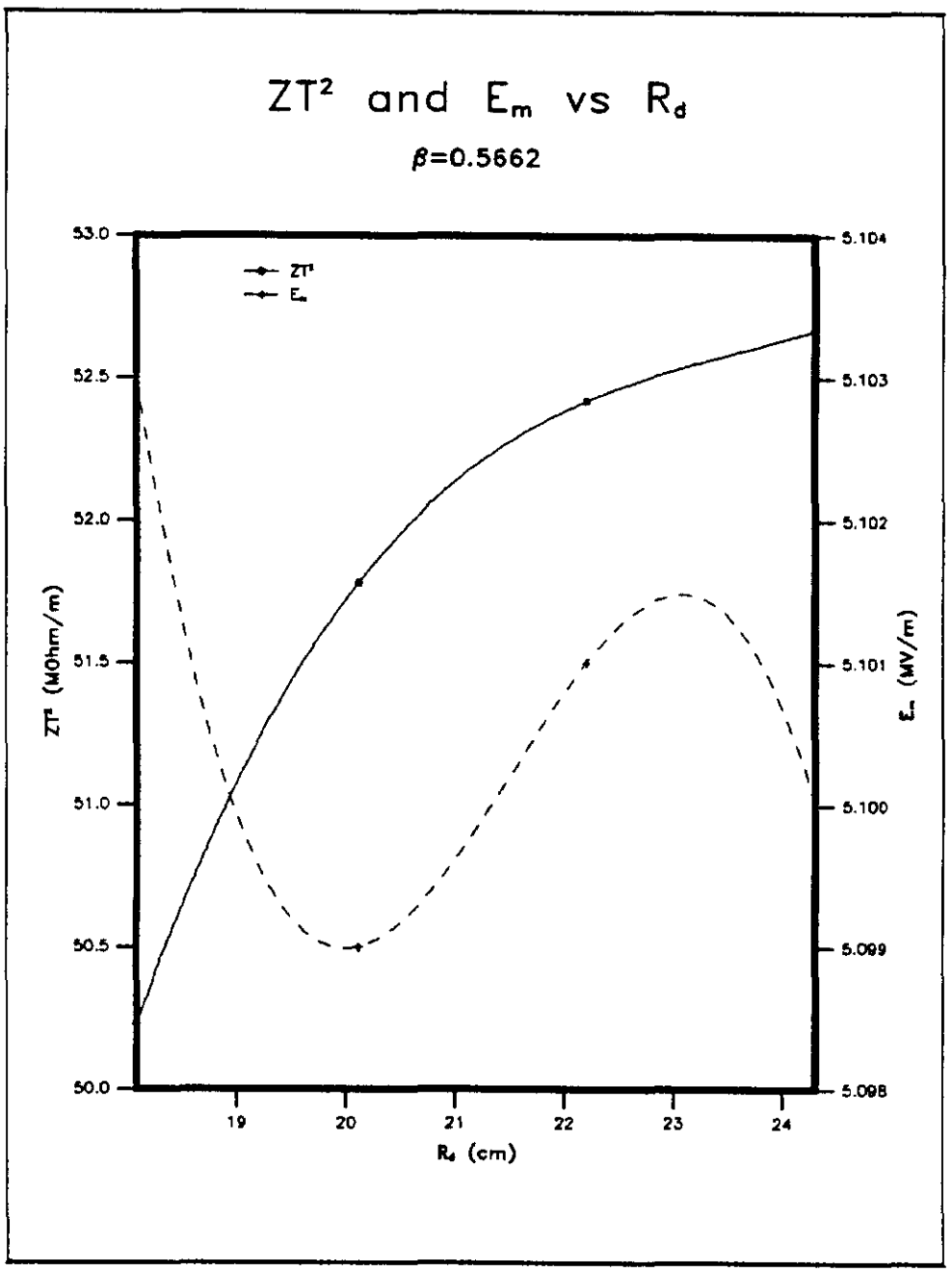


Figure 9: from Table 5

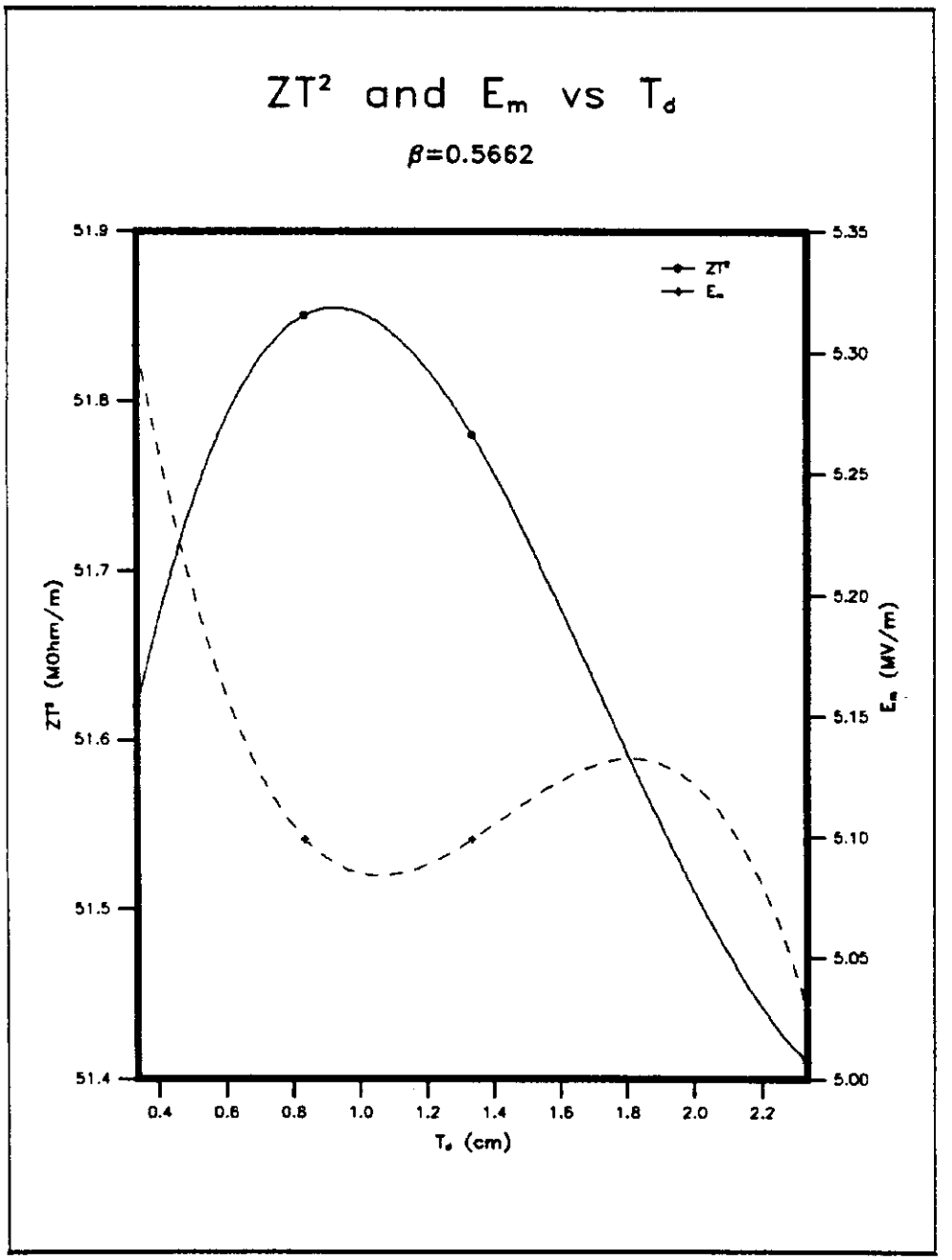


Figure 10: from Table 5

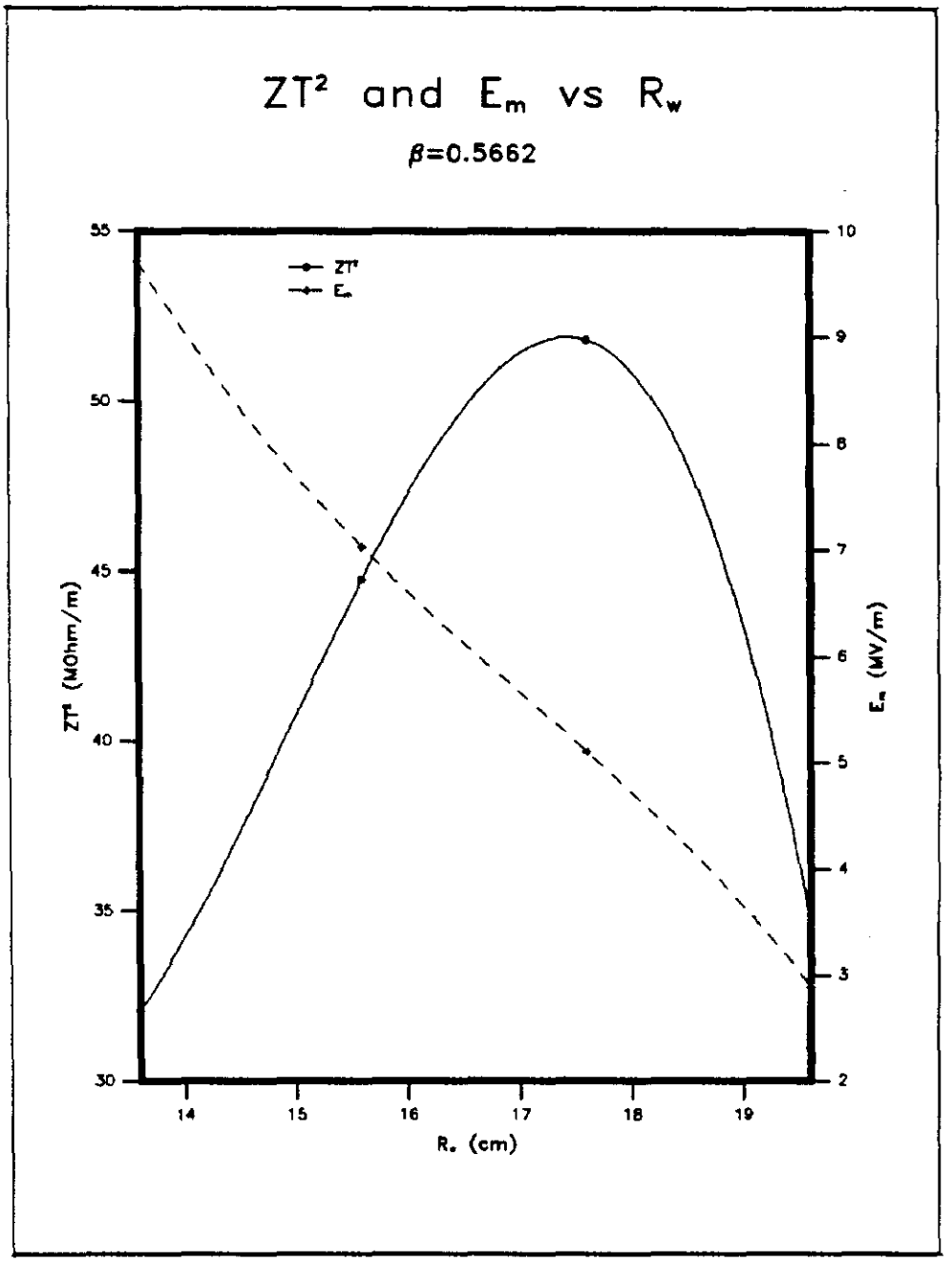


Figure 11: from Table 5

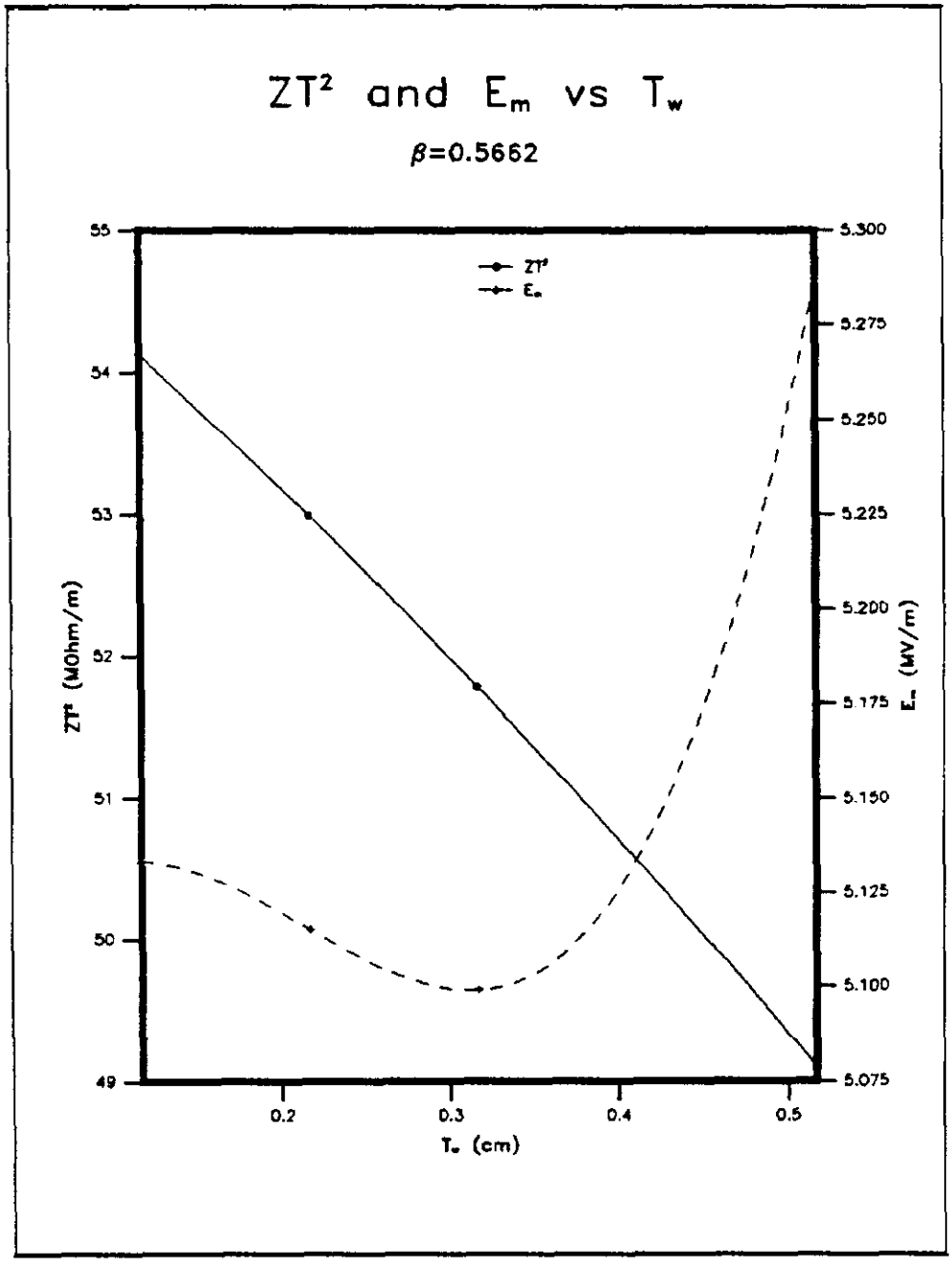
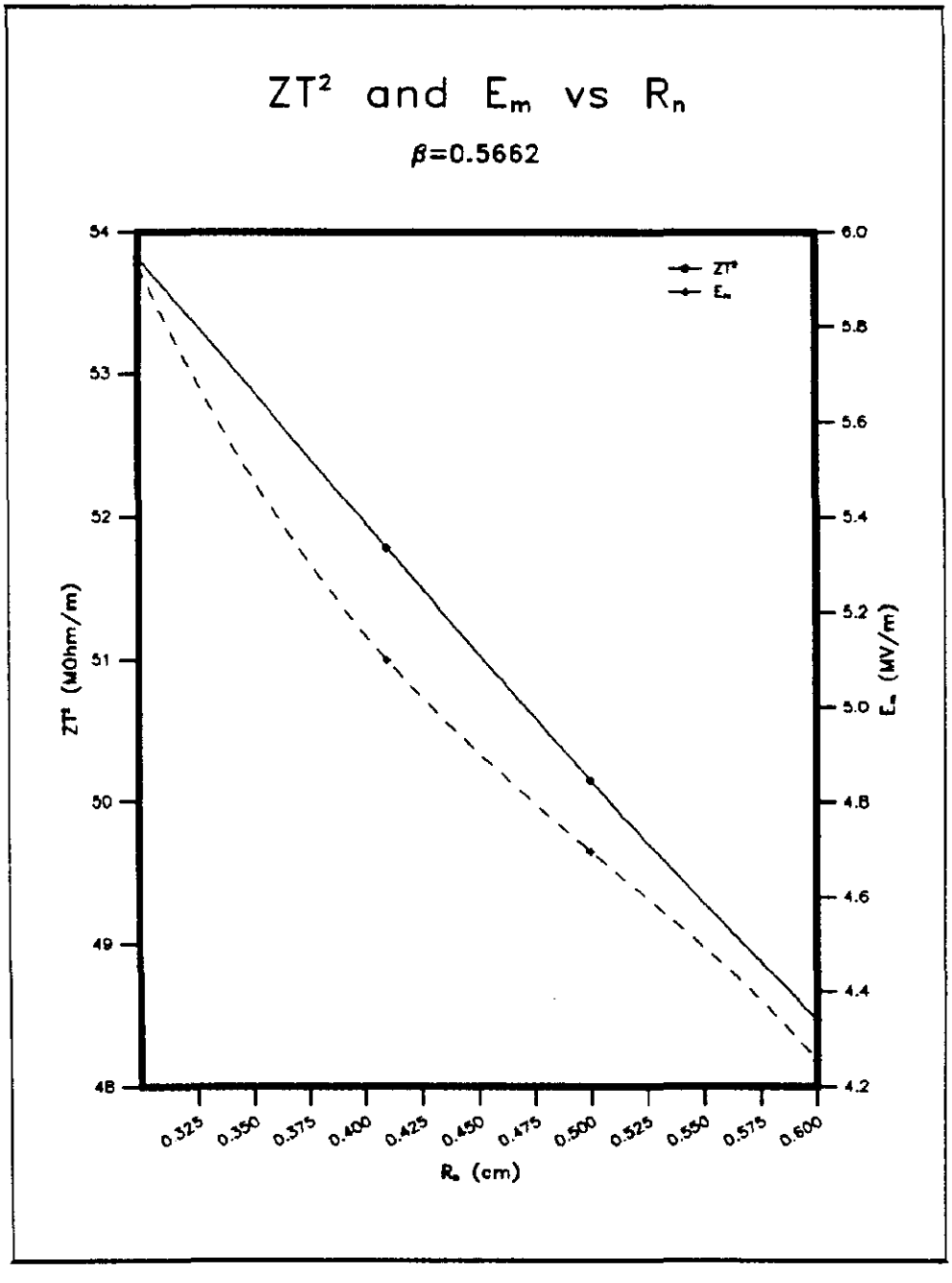


Figure 12: from Table 5



R_c (cm)	R_d (cm)	T	TP	TP^2	S	SP	SP^2
25.22	18.093	0.876	0.075	0.019	0.391	0.106	0.017
27.22	20.119	0.875	0.075	0.019	0.393	0.105	0.018
29.22	22.211	0.874	0.075	0.019	0.394	0.105	0.018
31.22	24.299	0.874	0.075	0.019	0.394	0.105	0.018
T_d (cm)	Tuning						
0.336	1	0.881	0.072	0.018	0.384	0.104	0.017
0.836		0.874	0.075	0.019	0.394	0.105	0.018
1.336		0.875	0.075	0.019	0.393	0.105	0.018
2.336	2	0.870	0.078	0.019	0.401	0.107	0.019
R_w (cm)							
13.604	3	0.937	0.038	0.010	0.269	0.078	0.007
15.604	4	0.919	0.049	0.013	0.311	0.088	0.010
17.604		0.875	0.075	0.019	0.393	0.105	0.018
19.604	5	0.747	0.148	0.030	0.553	0.125	0.046
T_w (cm)							
0.117	6	0.876	0.075	0.019	0.392	0.106	0.018
0.217	7	0.875	0.075	0.019	0.392	0.106	0.018
0.317		0.875	0.075	0.019	0.393	0.105	0.018
0.517	8	0.884	0.070	0.018	0.378	0.103	0.016
R_n (cm)							
0.3	9	0.883	0.071	0.018	0.381	0.103	0.016
0.41		0.875	0.075	0.019	0.393	0.105	0.018
0.5	10	0.871	0.078	0.019	0.399	0.106	0.018
0.6	11	0.863	0.082	0.020	0.410	0.108	0.020

Table 6: T, TP, TP^2, S, SP, and SP^2 vs Cavity Parameters R_c, R_d, T_d, R_w, T_w and R_n at $\beta = 0.5662$

Figure 13: from Table 6

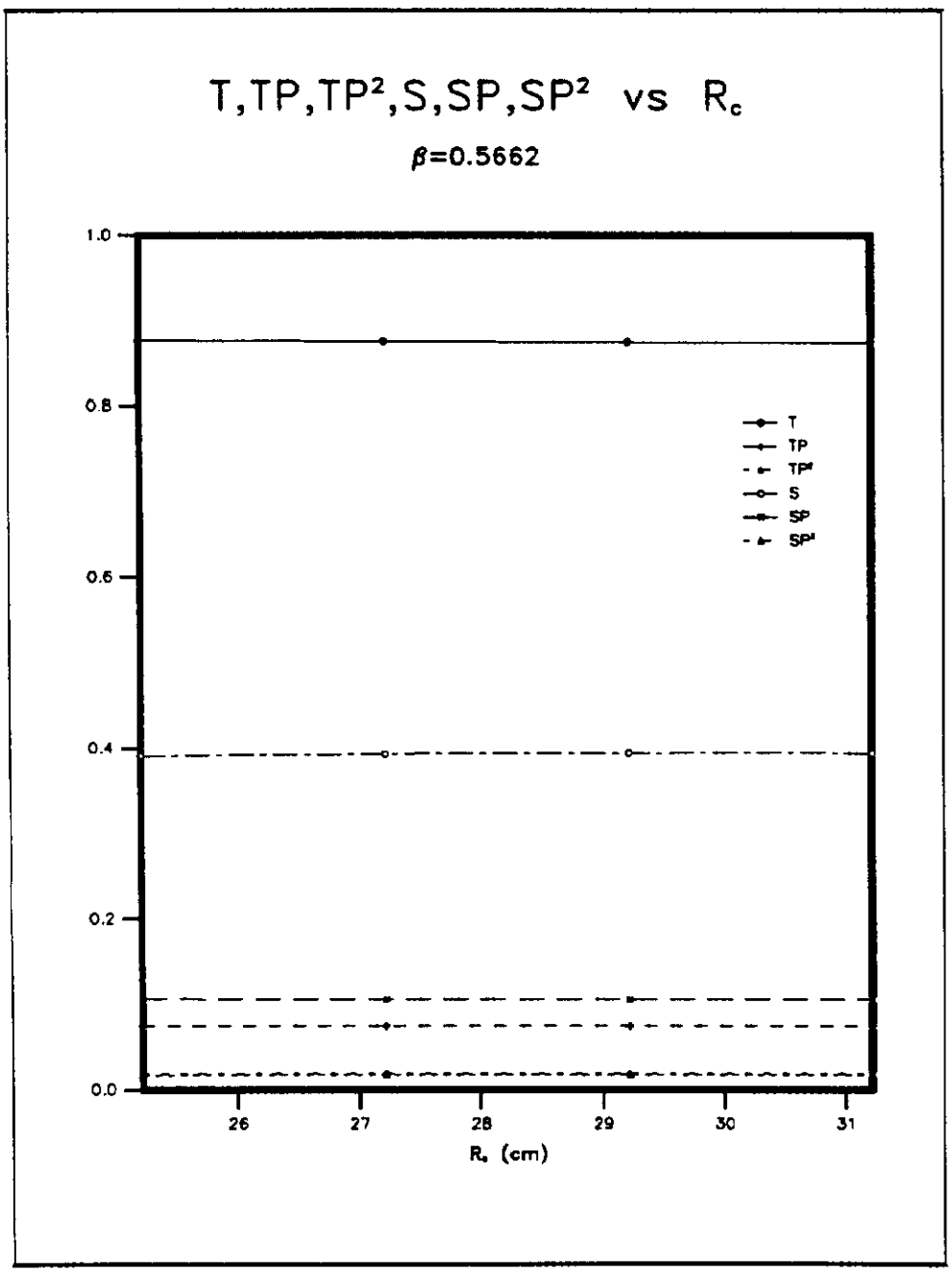


Figure 14: from Table 6

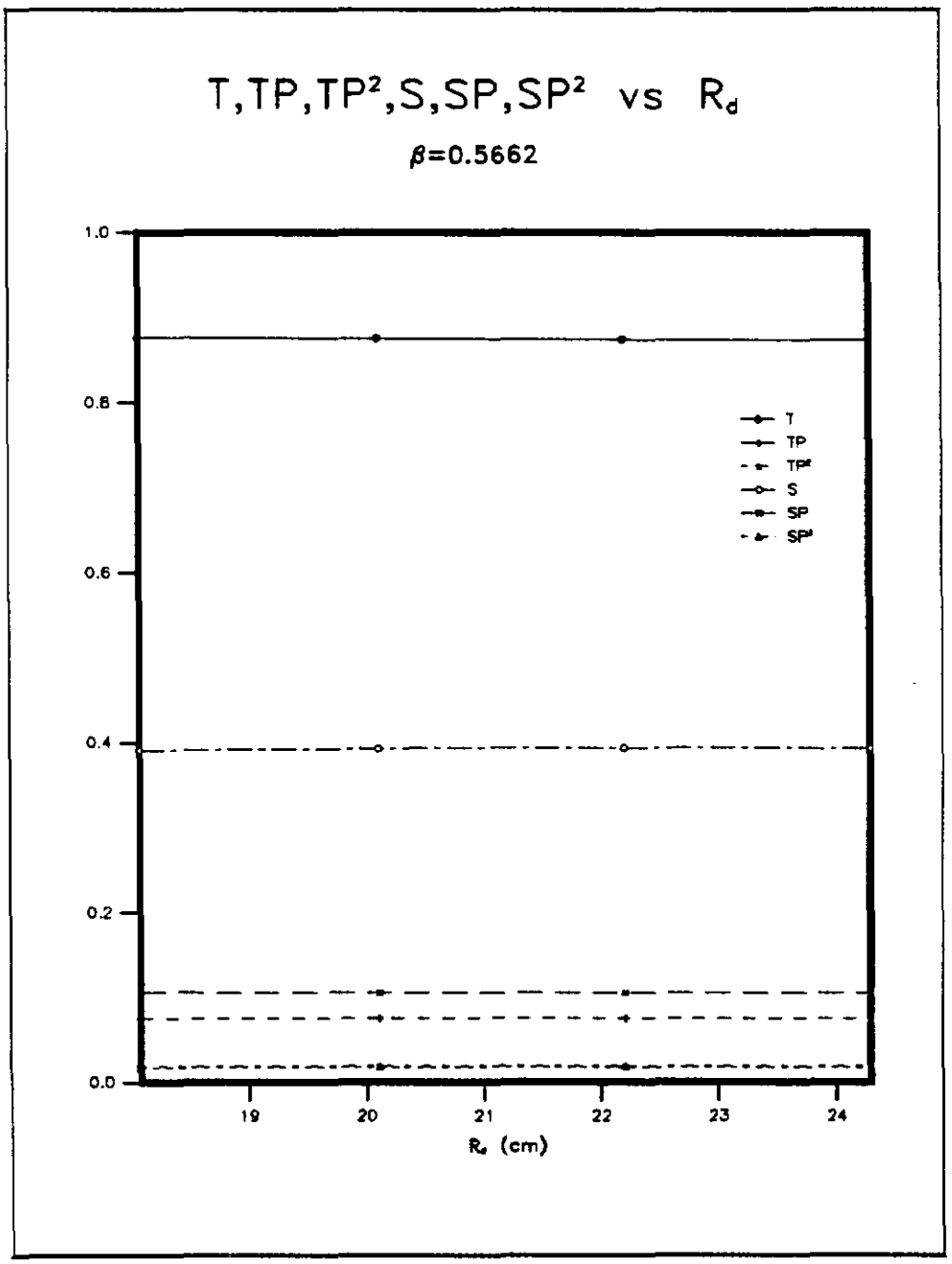


Figure 15: from Table 6

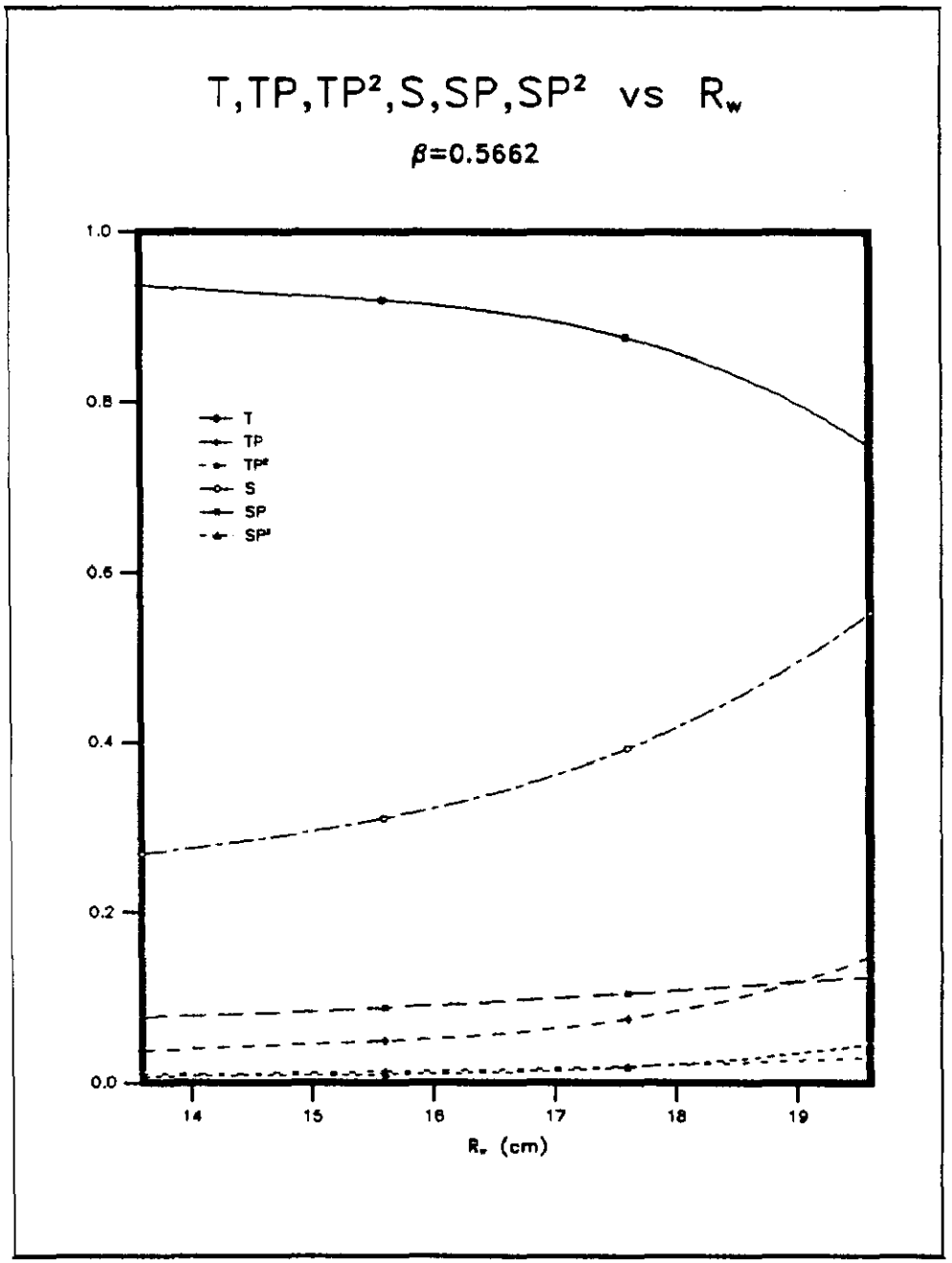


Figure 16: from Table 6

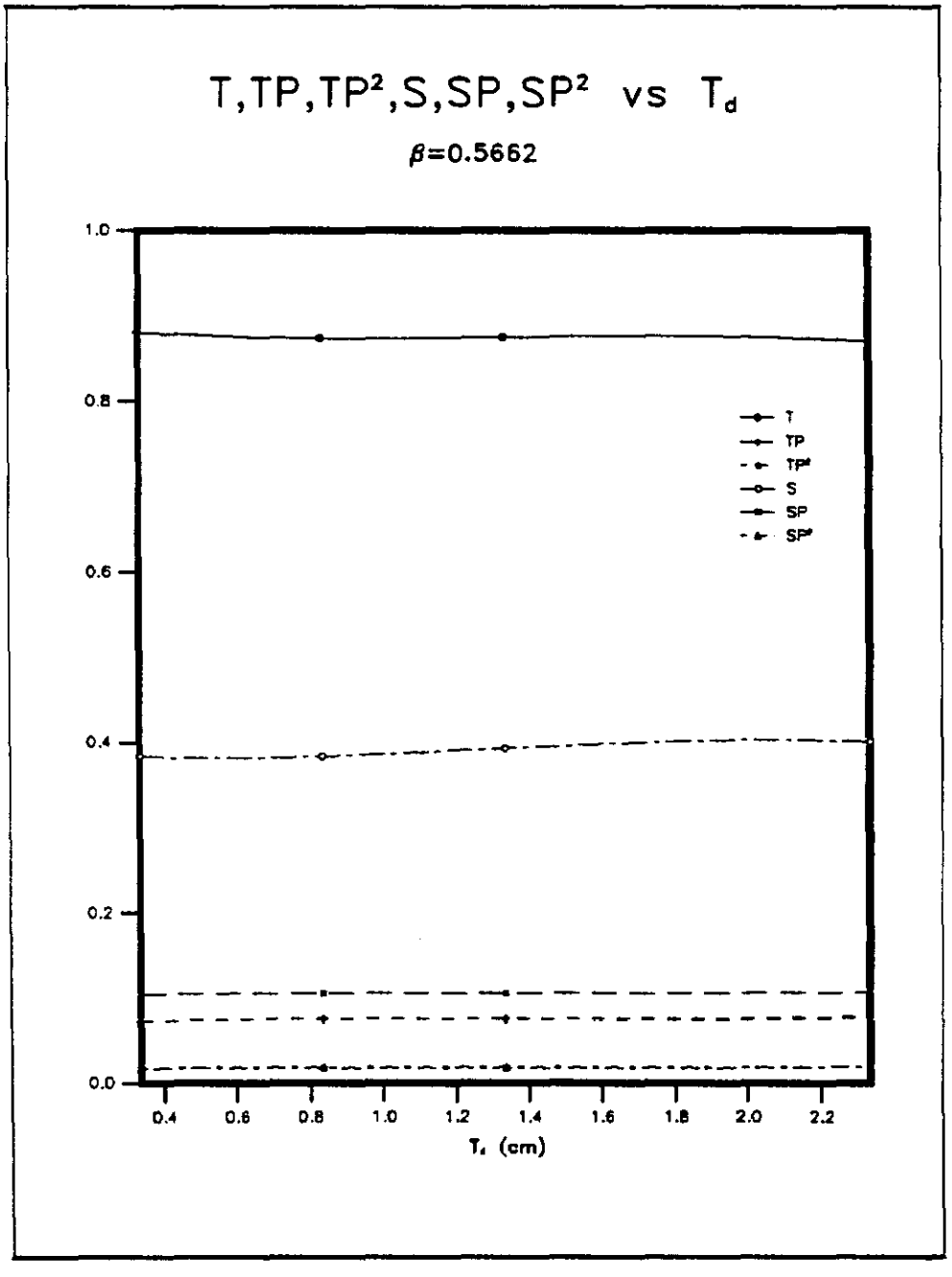


Figure 17: from Table 6

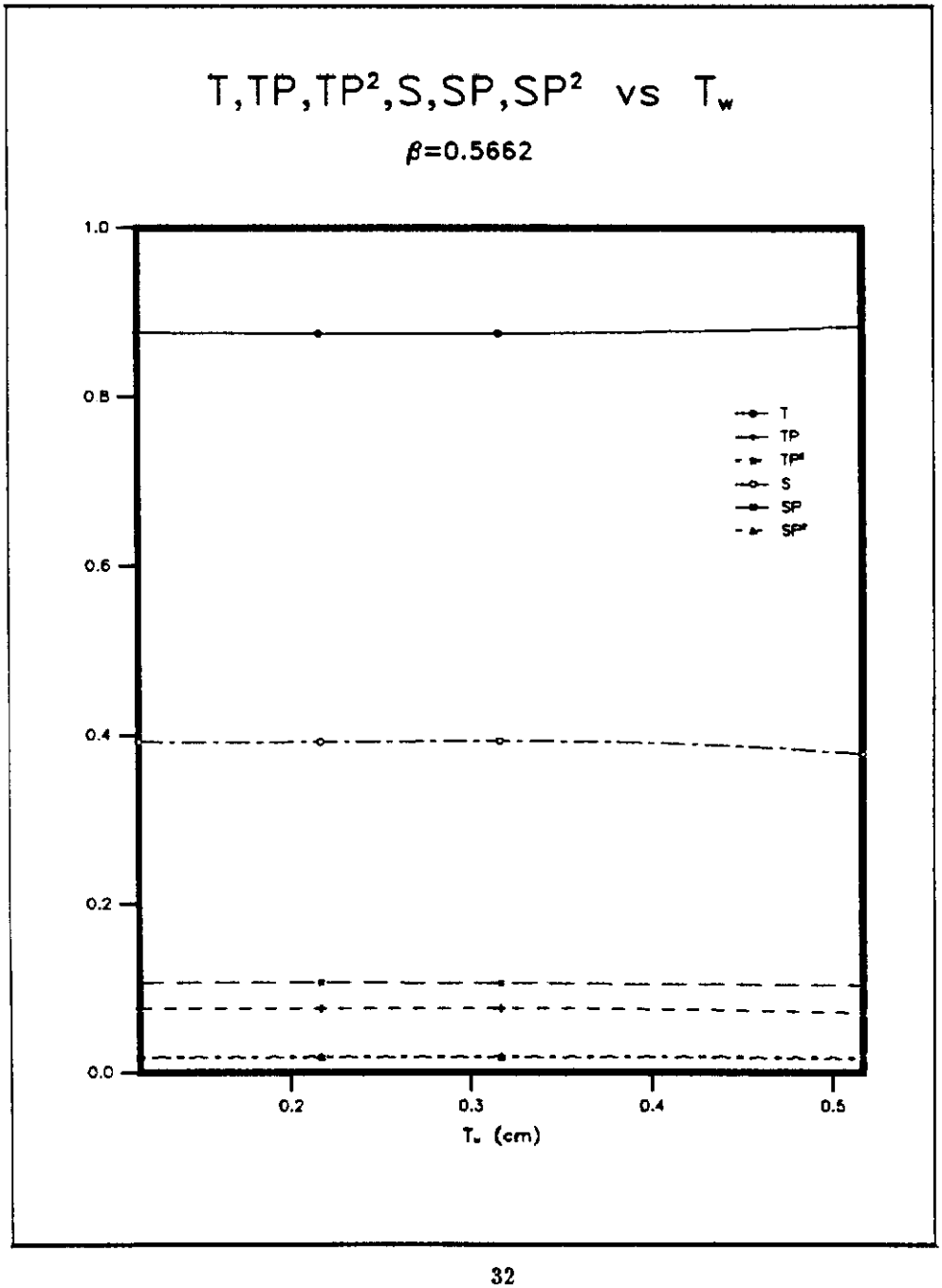
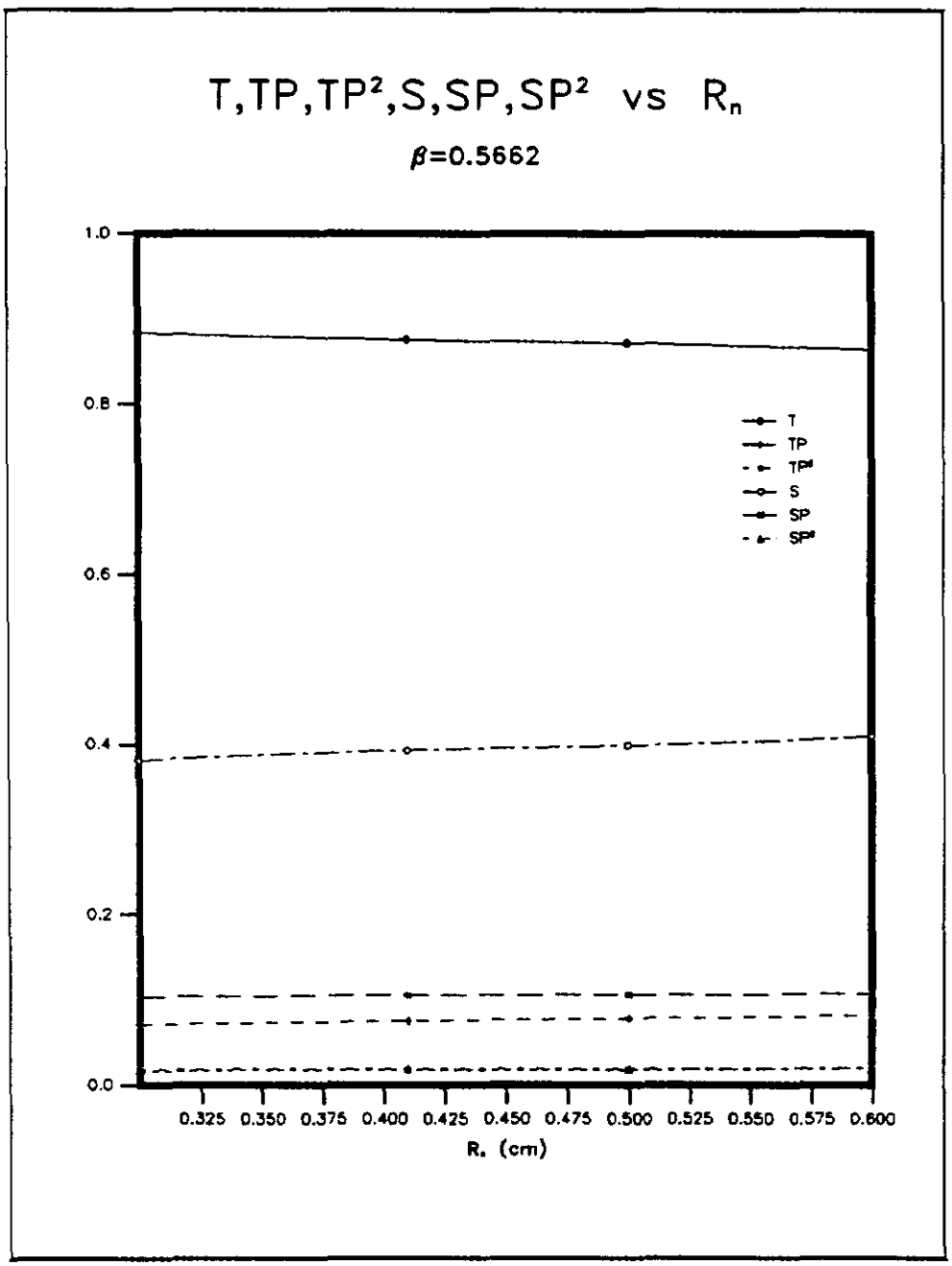


Figure 18: from Table 6



Segment	TM01π (MHz/mm)	TM02π (MHz/mm)	Direction
2	5.6626	0.0801	r
3	-0.1790	0.4275	z
4	-6.9675	0.0105	r
6	0.2022	2.6019	z
6	0.0892	3.2547	r
7	0.7372	0.0768	z
8	0.0121	-0.4484	z
9	0.0294	-3.5943	z
10	0.0002	0.3506	z
10	0.0008	1.3071	r
11	0.0009	5.9773	z
11	0.0007	3.8062	r
12	0.0000	0.0957	r

Table 7: Perturbation Coefficients for the Ten Copper Removal Segments in the DAW Structure for the Standard Configuration

R_c (cm)	R_d (cm)	TM01π (MHz/mm)	TM02π (MHz/mm)
25.22	18.093	5.6390	0.0146
27.22	20.119	5.6626	0.0801
29.22	22.211	5.8786	0.0470
31.22	24.299	5.9845	0.0188
T_d (cm)	Tuning		
0.336	1	5.4347	-0.0055
0.836		5.5652	0.0173
1.336		5.6626	0.0801
2.336	2	5.9042	0.3170
R_w (cm)			
13.604	3	5.4126	0.5458
15.604	4	5.4247	-0.0002
17.604		5.6626	0.0801
19.604	5	5.9708	0.0524
T_w (cm)			
0.117	6	5.6119	0.0749
0.217	7	5.6369	0.0773
0.317		5.6626	0.0801
0.517	8	5.9415	0.0949
R_n (cm)			
0.3	9	5.6625	0.0798
0.41		5.6626	0.0801
0.5	10	5.6625	0.0806
0.6	11	5.6625	0.0808

Table 8: Perturbation Coefficients df/dr for Segment 2 vs Cavity Parameters R_c, R_d, T_d, R_w, T_w, and R_n

R_c (cm)	R_d (cm)	TM01π (MHz/mm)	TM02π (MHz/mm)
25.22	18.093	-0.0982	0.8409
27.22	20.119	-0.1790	0.4275
29.22	22.211	-0.3144	0.1646
31.22	24.299	-0.3152	0.0606
T_d (cm)			
0.336	1	3.0117	0.1488
0.836		1.1552	0.2857
1.336		-0.1790	0.4275
2.336	2	-2.5573	0.6179
R_w (cm)			
13.604	3	2.9862	0.0195
15.604	4	3.0033	0.0666
17.604		-0.1790	0.4275
19.604	5	-0.2414	0.8643
T_w (cm)			
0.117	6	-0.1991	0.3895
0.217	7	-0.1889	0.4083
0.317		-0.1790	0.4275
0.517	8	-0.2832	0.4394
R_n (cm)			
0.3	9	-0.1790	0.4237
0.41		-0.1790	0.4275
0.5	10	-0.1789	0.4285
0.6	11	-0.1789	0.4322

Table 9: Perturbation Coefficients df/dz for Segment 3 vs Cavity Parameters R_c, R_d, T_d, R_w, T_w, and R_n

R_c (cm)	R_d (cm)	TM01π (MHz/mm)	TM02π (MHz/mm)
25.22	18.093	-6.9720	0.0308
27.22	20.119	-6.9675	0.0105
29.22	22.211	-7.0643	0.0039
31.22	24.299	-7.1613	0.0015
T_d (cm)	Tuning		
0.336	1	-6.9980	0.0309
0.836		-7.1024	0.0199
1.336		-6.9675	0.0105
2.336	2	-7.0273	0.0014
R_w (cm)			
13.604	3	-7.0484	0.0018
15.604	4	-7.0416	0.0113
17.604		-6.9675	0.0105
19.604	5	-7.1172	0.0341
T_w (cm)			
0.117	6	-6.9866	0.0094
0.217	7	-6.9780	0.0100
0.317		-6.9675	0.0105
0.517	8	-7.0440	0.0116
R_n (cm)			
0.3	9	-6.9675	0.0103
0.41		-6.9675	0.0105
0.5	10	-6.9674	0.0105
0.6	11	-6.9674	0.0106

Table 10: Perturbation Coefficients $df/d\tau$ for Segment 4 vs Cavity Parameters R_c, R_d, T_d, R_w, T_w, and R_n

R_c (cm)	R_d (cm)	TM01π (MHz/mm)	TM02π (MHz/mm)
25.22	18.093	0.3676	2.6566
27.22	20.119	0.2022	2.6019
29.22	22.211	0.0826	2.5388
31.22	24.299	0.0320	2.5291
T_d (cm)	Tuning		
0.336	1	0.1708	2.4842
0.836		0.1804	2.5517
1.336		0.2022	2.6019
2.336	2	0.2454	2.8024
R_w (cm)			
13.604	3	0.0328	2.6839
15.604	4	0.0827	2.5248
17.604		0.2022	2.6019
19.604	5	0.3554	2.8402
T_w (cm)			
0.117	6	0.0217	2.4455
0.217	7	0.1175	2.5607
0.317		0.2022	2.6019
0.517	8	0.3957	2.6470
R_n (cm)			
0.3	9	0.2022	2.5782
0.41		0.2022	2.6019
0.5	10	0.2022	2.6073
0.6	11	0.2022	2.6311

Table 11: Perturbation Coefficients df/dz for Segment 6 vs Cavity Parameters R_c, R_d, T_d, R_w, T_w, and R_n

R_c (cm)	R_d (cm)	TM01π (MHz/mm)	TM02π (MHz/mm)
25.22	18.093	0.1388	3.3097
27.22	20.119	0.0892	3.2547
29.22	22.211	0.0378	3.1741
31.22	24.299	0.0149	3.1642
T_d (cm)	Tuning		
0.336	1	0.0730	3.1014
0.836		0.0778	3.1890
1.336		0.0892	3.2547
2.336	2	0.1126	3.5208
R_w (cm)			
13.604	3	0.0150	3.3159
15.604	4	0.0370	3.1022
17.604		0.0892	3.2547
19.604	5	0.1330	3.5316
T_w (cm)			
0.117	6	0.0217	2.4455
0.217	7	0.0484	3.0447
0.317		0.0892	3.2547
0.517	8	0.1808	3.3600
R_n (cm)			
0.3	9	0.0892	3.2248
0.41		0.0892	3.2547
0.5	10	0.0892	3.2608
0.6	11	0.0892	3.2912

Table 12: Perturbation Coefficients df/dr for Segment 6 vs Cavity Parameters R_c, R_d, T_d, R_w, T_w, and R_n

R_c (cm)	R_d (cm)	TM01π (MHz/mm)	TM02π (MHz/mm)
25.22	18.093	1.6476	0.0946
27.22	20.119	0.7372	0.0768
29.22	22.211	0.2799	0.0717
31.22	24.299	0.1018	0.0468
T_d (cm)	Tuning		
0.336	1	0.6573	0.1037
0.836		0.6734	0.0745
1.336		0.7372	0.0768
2.336	2	0.8218	0.0488
R_w (cm)			
13.604	3	0.0636	1.5332
15.604	4	0.2421	1.1556
17.604		0.7372	0.0768
19.604	5	1.6109	-1.2895
T_w (cm)			
0.117	6	0.6977	1.7091
0.217	7	0.7228	0.6216
0.317		0.7372	0.0768
0.517	8	0.7389	-0.6044
R_n (cm)			
0.3	9	0.7373	0.0838
0.41		0.7372	0.0768
0.5	10	0.7371	0.0828
0.6	11	0.7370	0.0745

Table 13: Perturbation Coefficients df/dz for Segment 7 vs Cavity Parameters R_c, R_d, T_d, R_w, T_w, and R_n

R_c (cm)	R_d (cm)	TM01π (MHz/mm)	TM02π (MHz/mm)
25.22	18.093	0.0332	-0.4505
27.22	20.119	0.0121	-0.4484
29.22	22.211	0.0043	-0.4487
31.22	24.299	0.0016	-0.4491
T_d (cm)	Tuning		
0.336	1	0.0113	-0.4416
0.836		0.0114	-0.4493
1.336		0.0121	-0.4484
2.336	2	0.0125	-0.4505
R_w (cm)			
13.604	3	0.0143	0.0821
15.604	4	0.0123	-0.3012
17.604		0.0121	-0.4484
19.604	5	0.0109	-0.4063
T_w (cm)			
0.117	6	0.0126	-0.4216
0.217	7	0.0124	-0.4347
0.317		0.0121	-0.4484
0.517	8	0.0116	-0.4656
R_n (cm)			
0.3	9	0.0121	-0.4440
0.41		0.0121	-0.4484
0.5	10	0.0121	-0.4492
0.6	11	0.0121	-0.4537

Table 14: Perturbation Coefficients df/dz for Segment 8 vs Cavity Parameters R_c, R_d, T_d, R_w, T_w, and R_n

R_c (cm)	R_d (cm)	TM01π (MHz/mm)	TM02π (MHz/mm)
25.22	18.093	0.0813	-3.5376
27.22	20.119	0.0294	-3.5943
29.22	22.211	0.0105	-3.6452
31.22	24.299	0.0038	-3.6663
T_d (cm)	Tuning		
0.336	1	0.0276	-3.7740
0.836		0.0278	-3.6405
1.336		0.0294	-3.5943
2.336	2	0.0306	-3.3188
R_w (cm)			
13.604	3	0.0318	-6.8128
15.604	4	0.0290	-6.0324
17.604		0.0294	-3.5943
19.604	5	0.0285	0.5079
T_w (cm)			
0.117	6	0.0325	-3.8192
0.217	7	0.0310	-3.6999
0.317		0.0294	-3.5943
0.517	8	0.0265	-3.5891
R_n (cm)			
0.3	9	0.0296	-3.5731
0.41		0.0294	-3.5943
0.5	10	0.0292	-3.6530
0.6	11	0.0291	-3.6626

Table 15: Perturbation Coefficients df/dz for Segment 9 vs Cavity Parameters R_c, R_d, T_d, R_w, T_w, and R_n

R_c (cm)	R_d (cm)	TM01π (MHz/mm)	TM02π (MHz/mm)
25.22	18.093	0.0006	0.3538
27.22	20.119	0.0002	0.3506
29.22	22.211	0.0001	0.3500
31.22	24.299	0.0000	0.3500
T_d (cm)	Tuning		
0.336	1	0.0002	0.3697
0.836		0.0002	0.3507
1.336		0.0002	0.3506
2.336	2	0.0002	0.3386
R_w (cm)			
13.604	3	0.0005	0.1942
15.604	4	0.0003	0.4391
17.604		0.0002	0.3506
19.604	5	0.0000	0.0357
T_w (cm)			
0.117	6	0.0003	0.3694
0.217	7	0.0003	0.3608
0.317		0.0002	0.3506
0.517	8	0.0001	0.3532
R_n (cm)			
0.3	9	0.0002	0.5303
0.41		0.0002	0.3506
0.5	10	0.0002	0.2539
0.6	11	0.0002	0.1668

Table 16: Perturbation Coefficients df/dz for Segment 10 vs Cavity Parameters R_c, R_d, T_d, R_w, T_w, and R_n

R_c (cm)	R_d (cm)	TM01π (MHz/mm)	TM02π (MHz/mm)
25.22	18.093	0.0022	1.3192
27.22	20.119	0.0008	1.3071
29.22	22.211	0.0003	1.3049
31.22	24.299	0.0001	1.3050
T_d (cm)	Tuning		
0.336	1	0.0008	1.3793
0.836		0.0008	1.3075
1.336		0.0008	1.3071
2.336	2	0.0008	1.2617
R_w (cm)			
13.604	3	0.0017	0.7248
15.604	4	0.0013	1.6367
17.604		0.0008	1.3071
19.604	5	0.0001	0.1328
T_w (cm)			
0.117	6	0.0013	1.3776
0.217	7	0.0010	1.3456
0.317		0.0008	1.3071
0.517	8	0.0005	1.3181
R_n (cm)			
0.3	9	0.0009	1.9790
0.41		0.0008	1.3071
0.5	10	0.0007	0.9470
0.6	11	0.0007	0.6225

Table 17: Perturbation Coefficients $df/d\tau$ for Segment 10 vs Cavity Parameters R_c, R_d, T_d, R_w, T_w, and R_n

R_c (cm)	R_d (cm)	TM01π	TM02π
25.22	18.093	0.0026	5.9753
27.22	20.119	0.0009	5.9773
29.22	22.211	0.0003	6.0042
31.22	24.299	0.0001	6.0182
T_d (cm)	Tuning		
0.336	1	0.0009	6.2611
0.836		0.0009	6.0079
1.336		0.0009	5.9773
2.336	2	0.0010	5.6187
R_w (cm)			
13.604	3	0.0005	16.5173
15.604	4	0.0007	10.6827
17.604		0.0009	5.9773
19.604	5	0.0006	1.5266
T_w (cm)			
0.117	6	0.0014	6.2119
0.217	7	0.0011	6.0896
0.317		0.0009	5.9773
0.517	8	0.0006	6.1533
R_n (cm)			
0.3	9	0.0008	5.6980
0.41		0.0009	5.9773
0.5	10	0.0010	6.1664
0.6	11	0.0012	6.2262

Table 18: Perturbation Coefficients df/dz for Segment 11 vs Cavity Parameters R_c, R_d, T_d, R_w, T_w, and R_n

R_c (cm)	R_d (cm)	TM01π (MHz/mm)	TM02π (MHz/mm)
25.22	18.093	0.0019	3.8053
27.22	20.119	0.0007	3.8062
29.22	22.211	0.0002	3.8234
31.22	24.299	0.0001	3.8322
T_d (cm)	Tuning		
0.336	1	0.0006	3.9062
0.836		0.0007	3.8257
1.336		0.0007	3.8062
2.336	2	0.0007	3.5046
R_w (cm)			
13.604	3	0.0004	10.1166
15.604	4	0.0005	6.6687
17.604		0.0007	3.8062
19.604	5	0.0004	0.9180
T_w (cm)			
0.117	6	0.0010	3.9668
0.217	7	0.0008	3.8827
0.317		0.0007	3.8062
0.517	8	0.0005	3.9086
R_n (cm)			
0.3	9	0.0006	3.6608
0.41		0.0007	3.8062
0.5	10	0.0008	3.8592
0.6	11	0.0009	3.8049

Table 19: Perturbation Coefficients df/dr for Segment 11 vs Cavity Parameters R_c, R_d, T_d, R_w, T_w, and R_n

R_c (cm)	R_d (cm)	TM01π (MHz/mm)	TM02π (MHz/mm)
25.22	18.093	0.0000	0.0953
27.22	20.119	0.0000	0.0957
29.22	22.211	0.0000	0.0958
31.22	24.299	0.0000	0.0961
T_d (cm)	Tuning		
0.336	1	0.0	0.0997
0.836		0.0000	0.0962
1.336		0.0000	0.0957
2.336	2	0.0000	0.0891
R_w (cm)			
13.604	3	0.0000	0.2986
15.604	4	0.0000	0.1857
17.604		0.0000	0.0957
19.604	5	0.0000	0.0342
T_w (cm)			
0.117	6	0.0000	0.0987
0.217	7	0.0000	0.0971
0.317		0.0000	0.0957
0.517	8	0.0000	0.0996
R_n (cm)			
0.3	9	0.0000	0.1702
0.41		0.0000	0.0957
0.5	10	0.0000	0.0649
0.6	11	0.0000	0.0427

Table 20: Perturbation Coefficients df/dr for Segment 12 vs Cavity Parameters R_c, R_d, T_d, R_w, T_w, and R_n

Segment	Power Loss (W)
2	11.3
3	7.1
4	0.2
6	0.9
7	181.2
8	36.7
9	429.4
10	105.2
11	7.1
12	0.1

Table 21: Power Loss per Segment for Standard Configuration

Segment	Power Loss (W)
2	26.0
3	19.5
4	0.5
6	1.0
7	183.3
8	36.9
9	427.3
10	104.1
11	7.0
12	0.1

Table 22: Power Loss per Segment with $R_c = 25.22$ cm and $R_d = 18.093$ cm

Figure 19: from Table 21

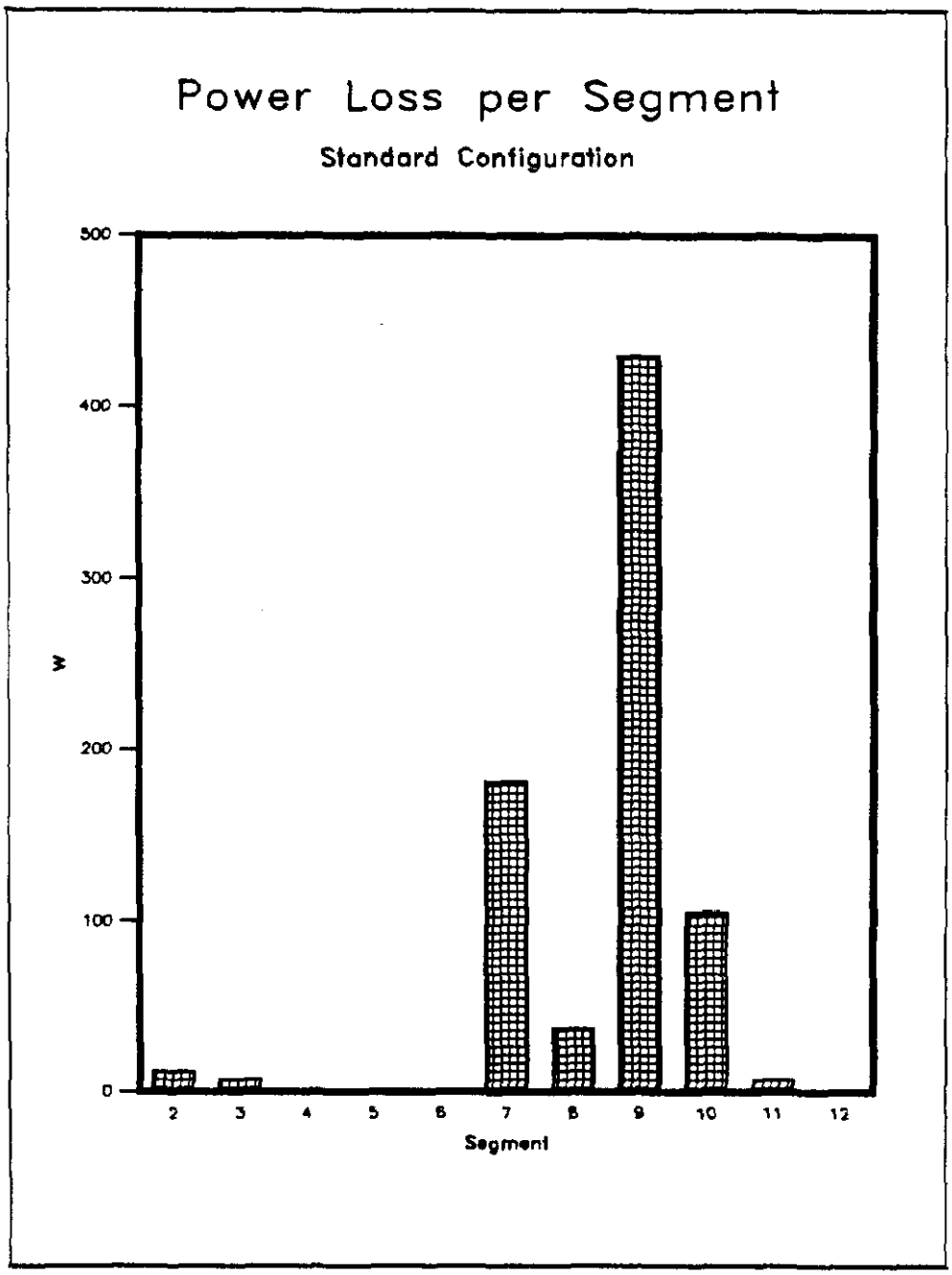
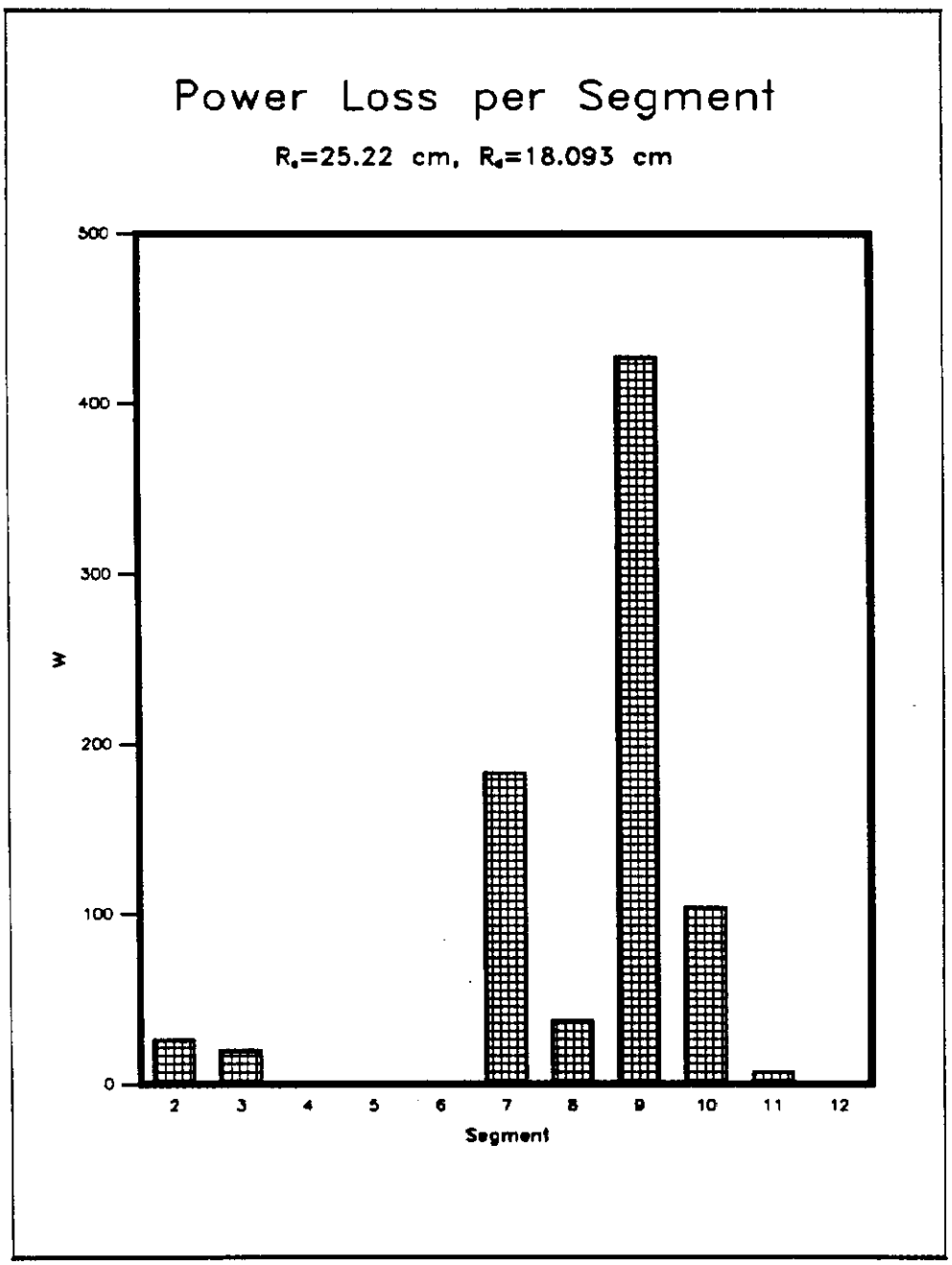


Figure 20: from Table 22



Segment	Power Loss (W)
2	4.3
3	2.5
4	0.1
6	0.9
7	179.6
8	36.6
9	431.3
10	106.1
11	7.1
12	0.1

Table 23: Power Loss per Segment with $R_e = 29.22$ cm and $R_d = 22.211$ cm

Segment	Power Loss
2	1.6
3	0.9
4	0.0
6	0.9
7	179.0
8	36.6
9	431.8
10	106.4
11	7.2
12	0.1

Table 24: Power Loss per Segment with $R_e = 31.22$ cm and $R_d = 24.299$ cm

Figure 21: from Table 23

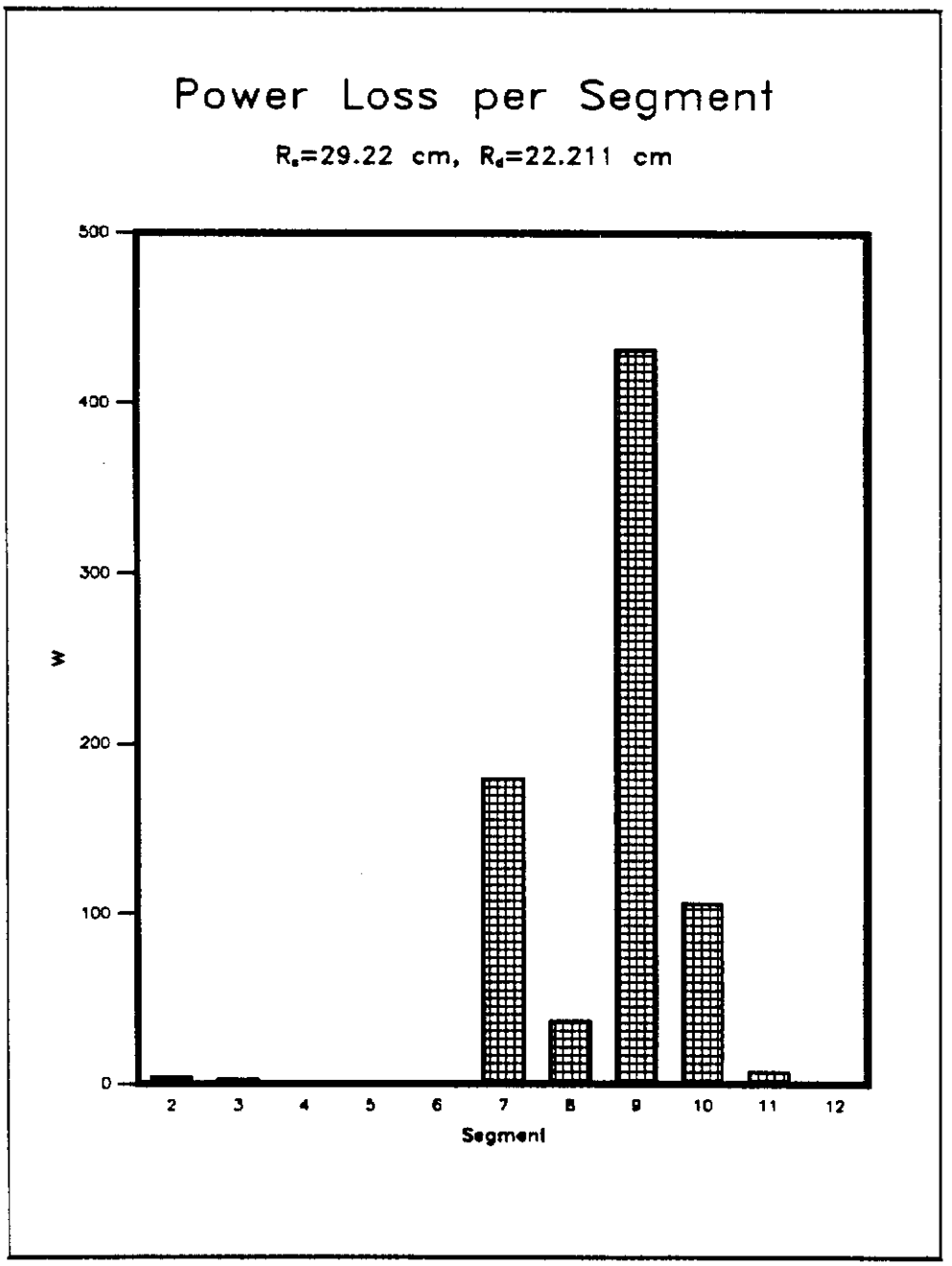
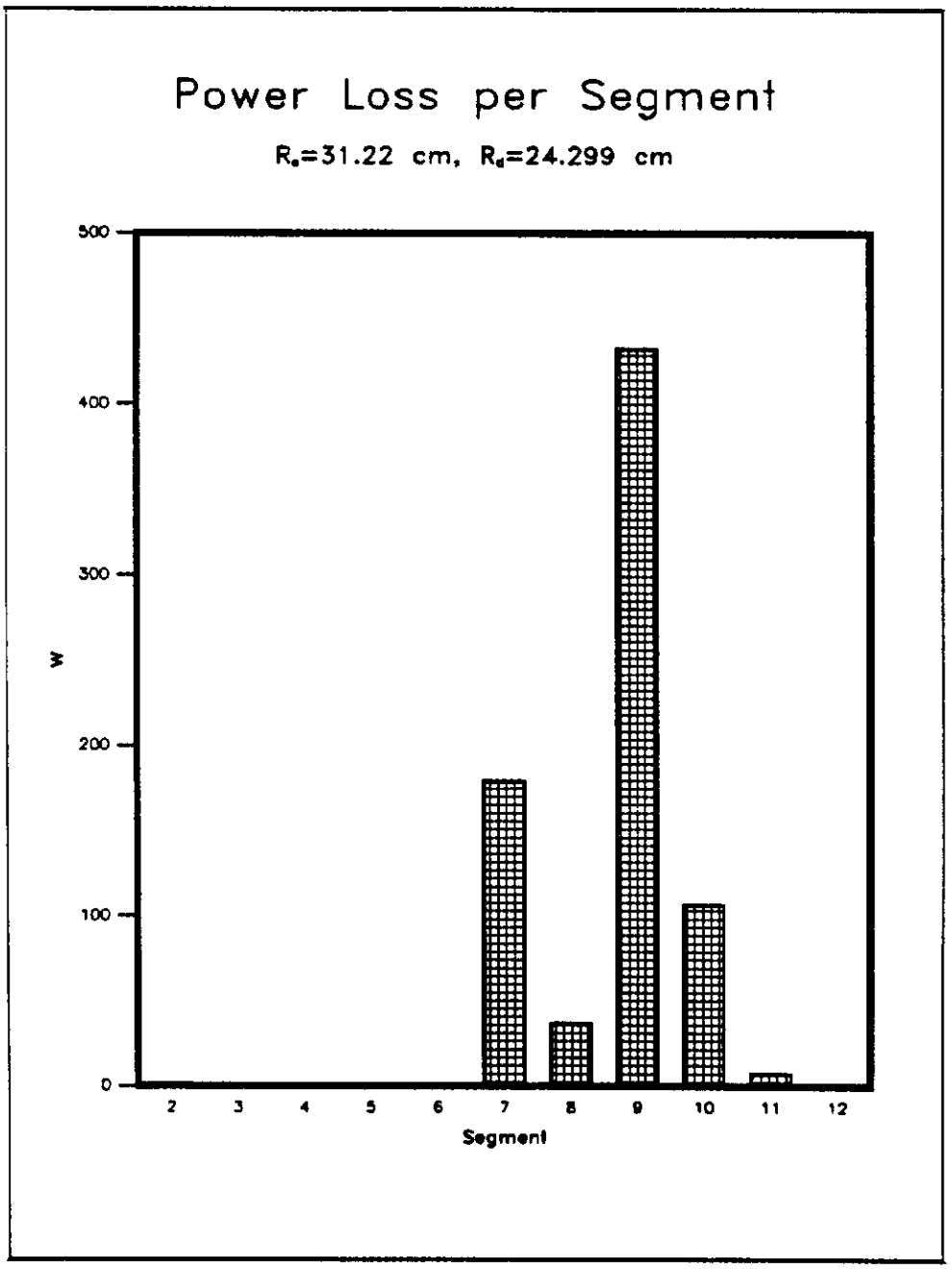


Figure 22: from Table 24



Segment	Power Loss (W)
2	2.5
3	13.3
4	1.0
6	0.9
7	176.9
8	36.3
9	438.1
10	115.3
11	7.4
12	0.1

Table 25: Power Loss per Segment with $T_d = 0.336$ cm

Segment	Power Loss (W)
2	6.3
3	9.3
4	0.5
6	0.9
7	179.7
8	36.6
9	430.6
10	105.8
11	7.1
12	0.1

Table 26: Power Loss per Segment with $T_d = 0.836$ cm

Figure 23: from Table 25

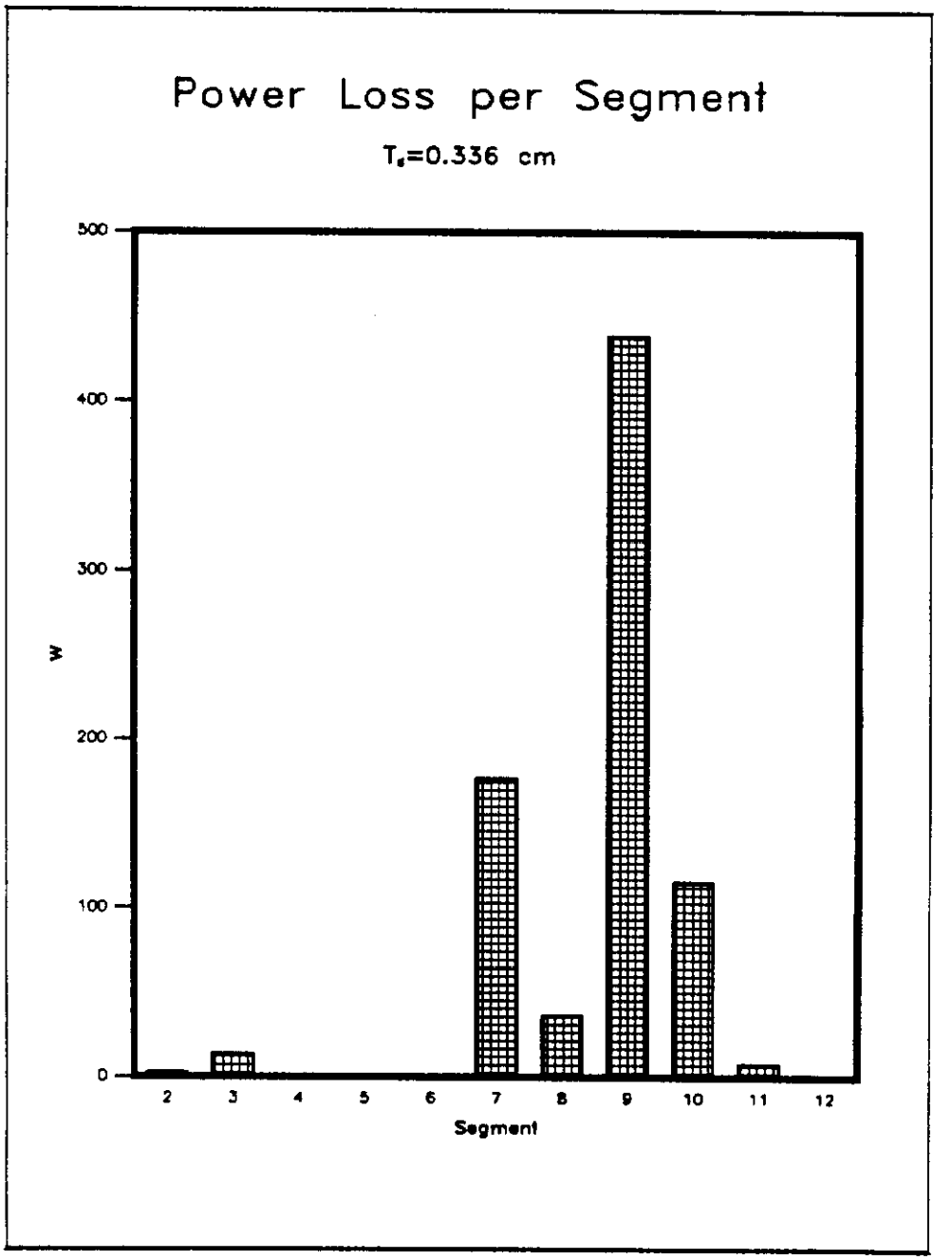
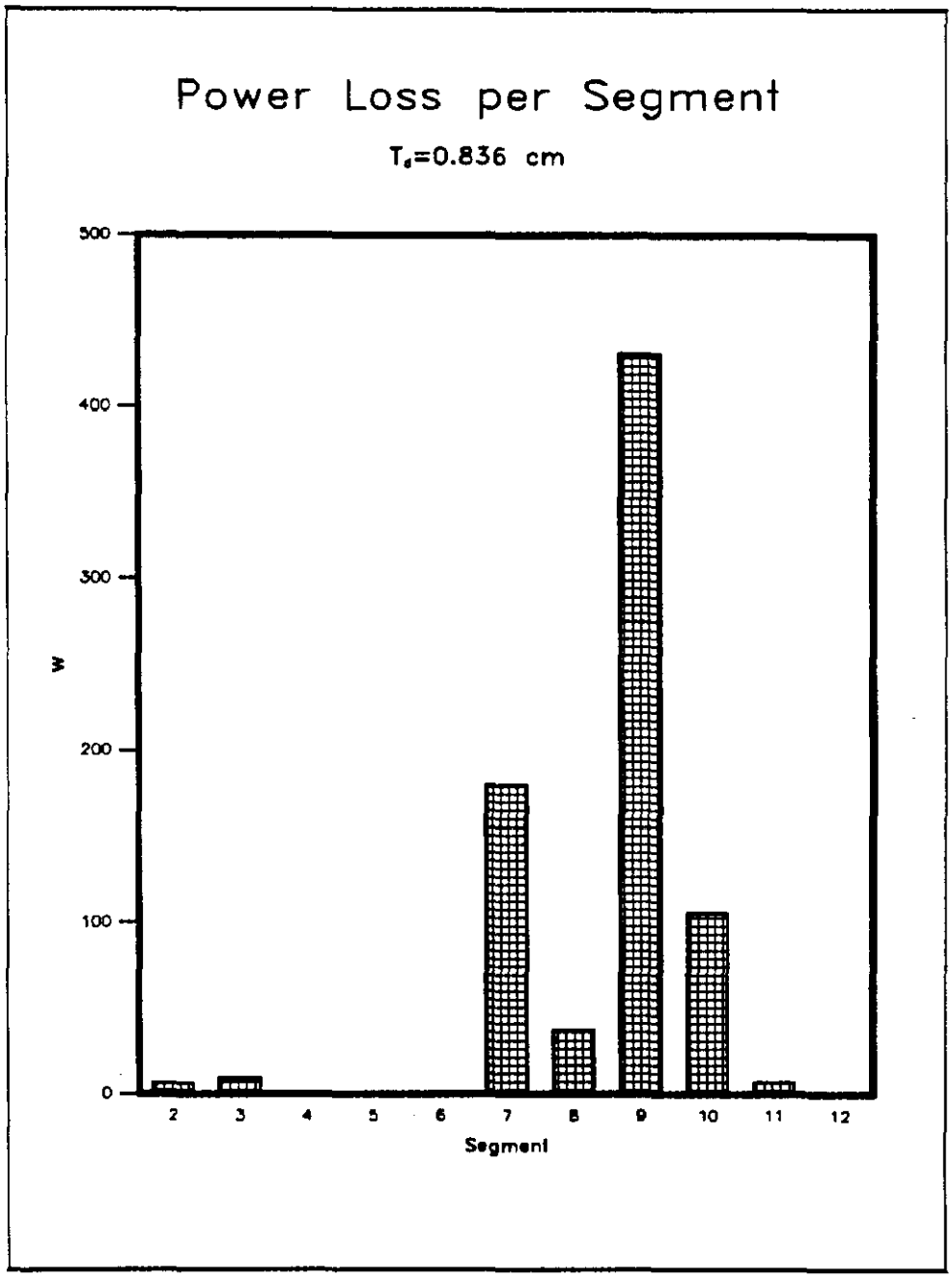


Figure 24: from Table 26



Segment	Power Loss (W)
2	24.0
3	3.6
4	0.0
6	1.0
7	188.5
8	37.3
9	419.7
10	94.9
11	6.7
12	0.1

Table 27: Power Loss per Segment with $T_d = 2.336$ cm

Segment	Power Loss (W)
2	0.0
3	0.8
4	0.1
6	1.3
7	23.4
8	21.7
9	775.9
10	592.6
11	27.1
12	0.2

Table 28: Power Loss per Segment with $R_w = 13.604$ cm

Figure 25: from Table 27

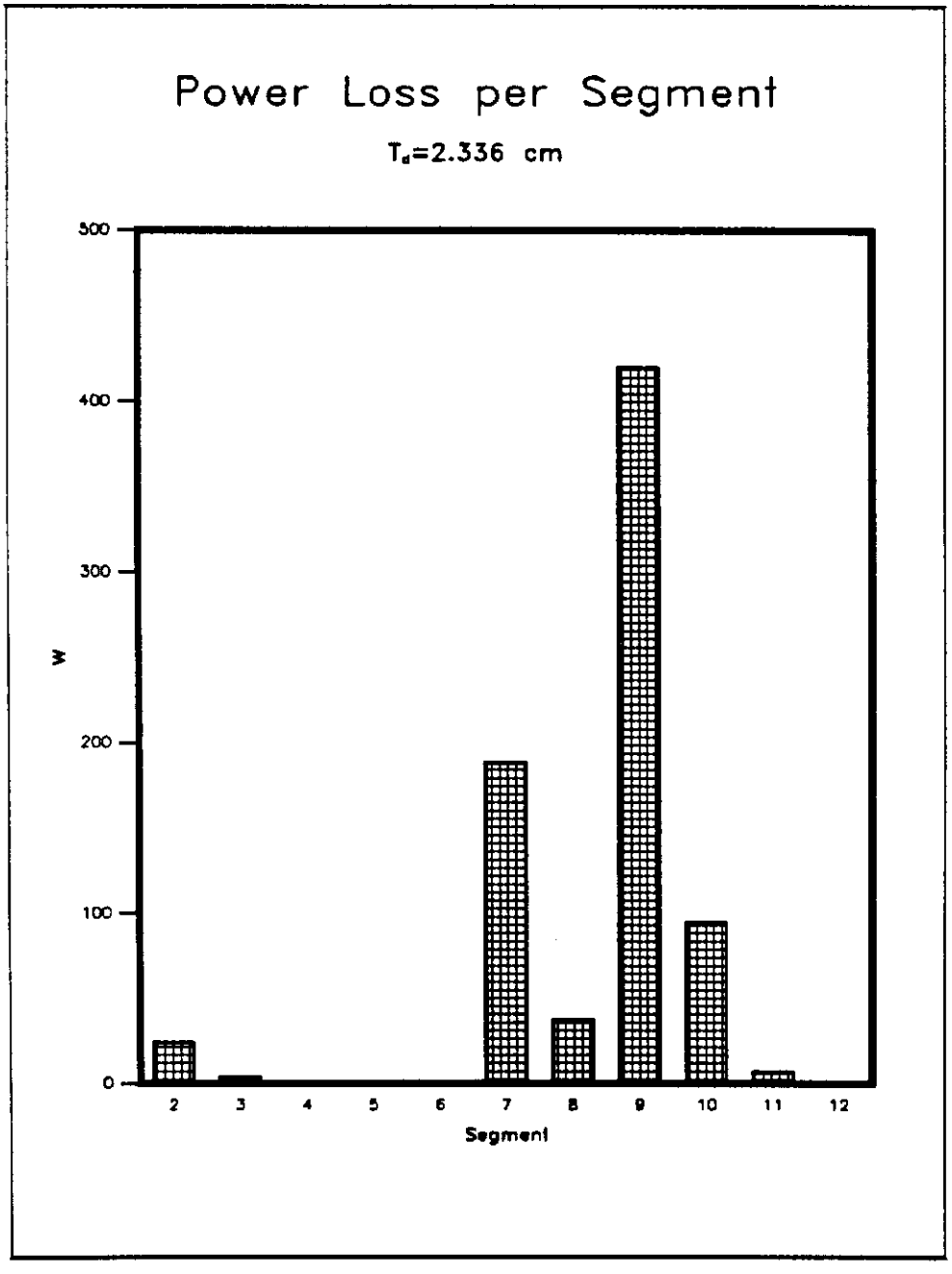
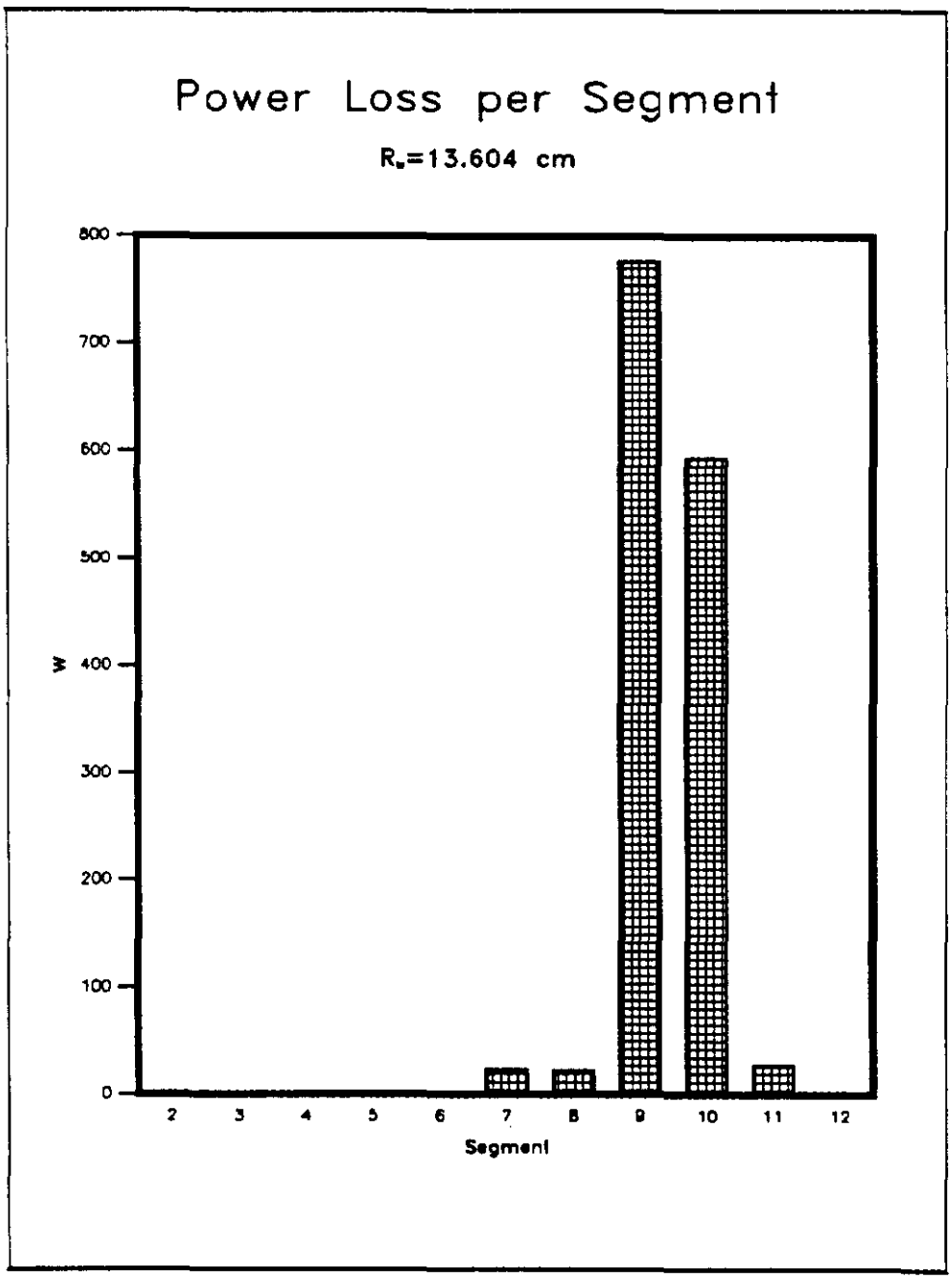


Figure 26: from Table 28



Segment	Power Loss (W)
2	1.0
3	5.2
4	0.4
6	1.0
7	83.7
8	30.0
9	574.2
10	285.3
11	13.8
12	0.1

Table 29: Power Loss per Segment with $R_w = 15.604$ cm

Segment	Power Loss (W)
2	33.1
3	24.3
4	0.7
6	1.3
7	396.1
8	48.7
9	336.3
10	5.6
11	2.4
12	0.0

Table 30: Power Loss per Segment with $R_w = 19.604$ cm

Figure 27: from Table 29

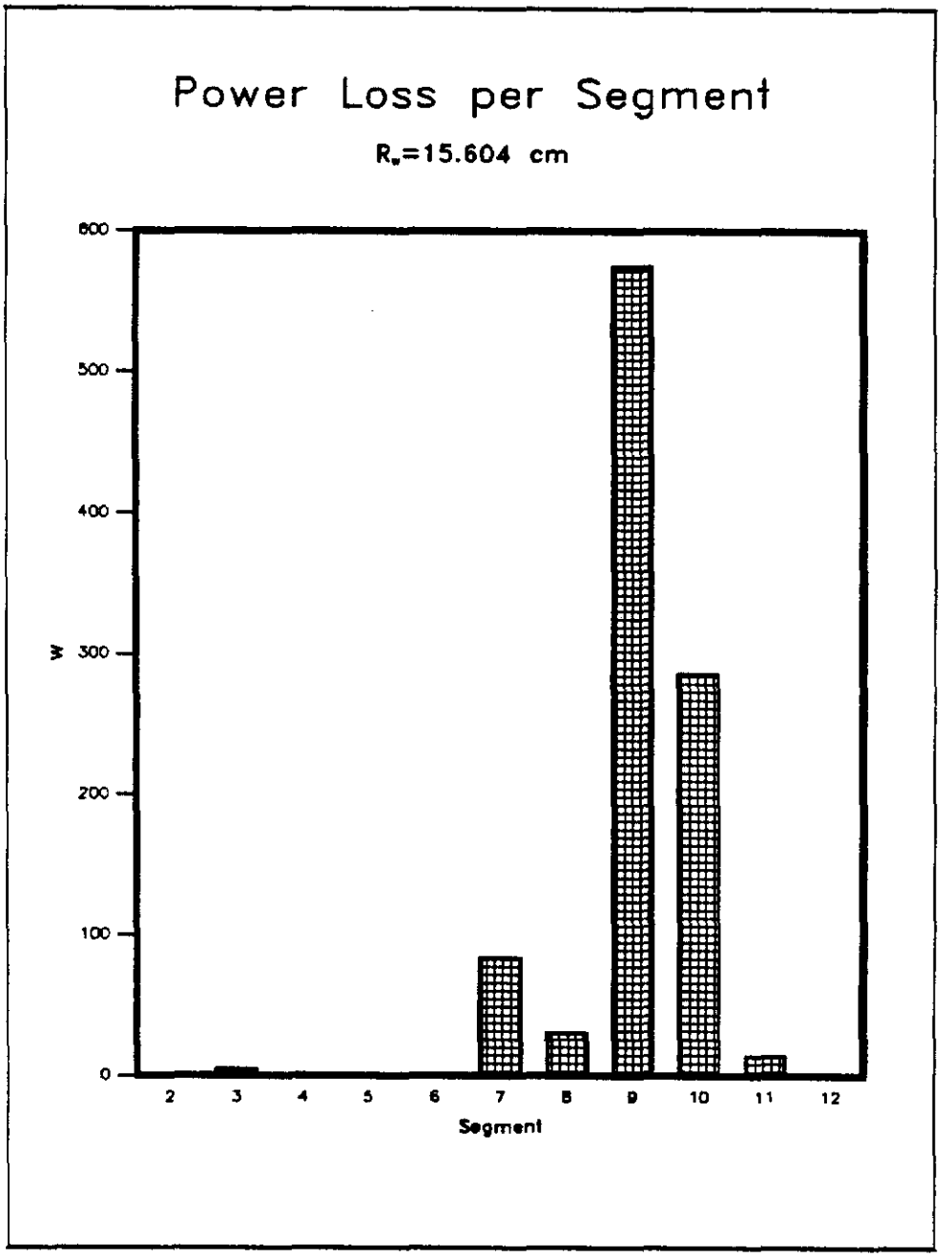
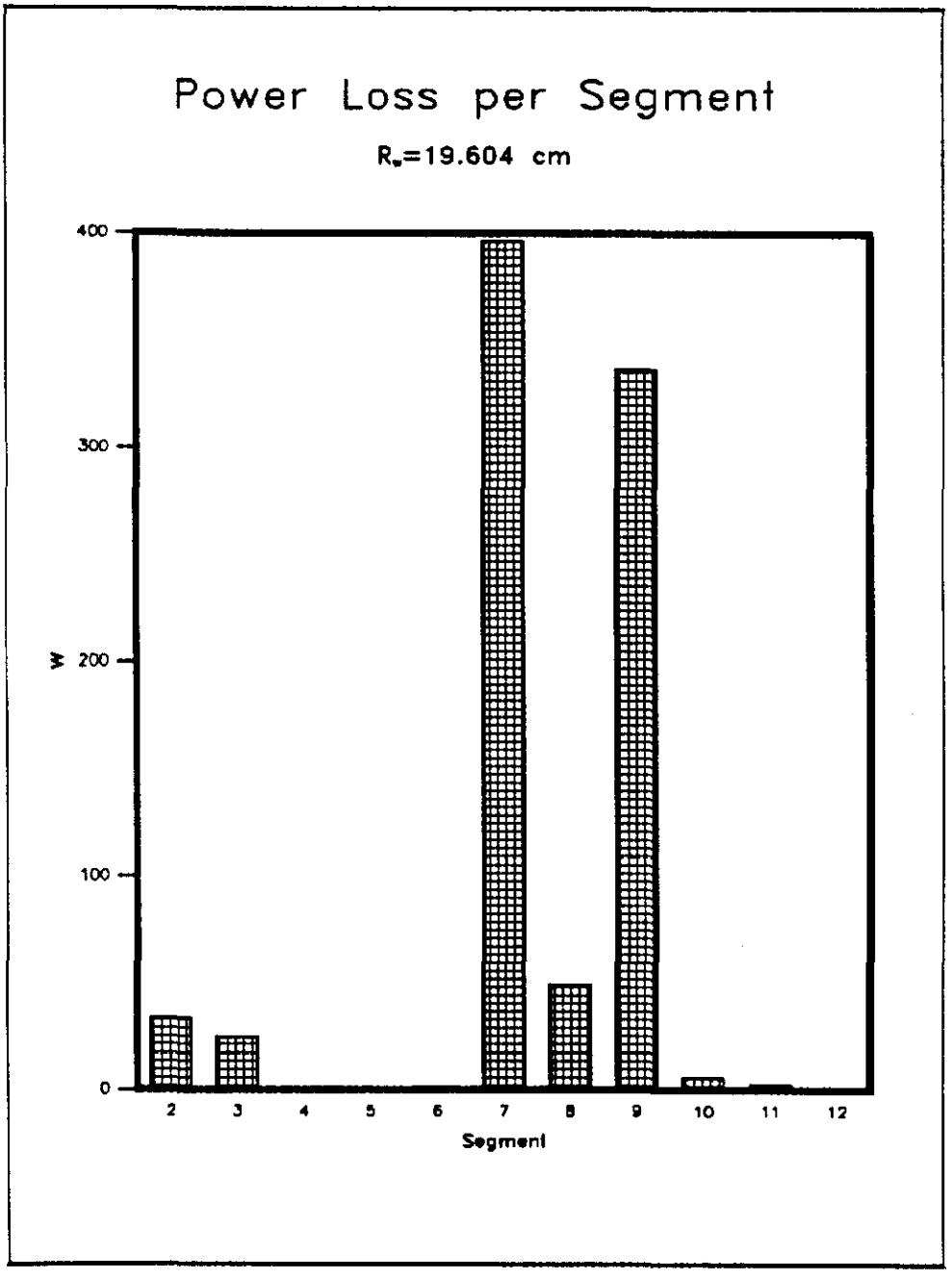


Figure 28: from Table 30



Segment	Power Loss (W)
2	9.9
3	6.1
4	0.2
6	0.1
7	159.1
8	33.4
9	413.1
10	118.1
11	7.1
12	0.1

Table 31: Power Loss per Segment with $T_w = 0.117$ cm

Segment	Power Loss (W)
2	10.6
3	6.6
4	0.2
6	0.4
7	170.5
8	35.0
9	420.6
10	111.5
11	7.1
12	0.1

Table 32: Power Loss per Segment with $T_w = 0.217$ cm

Figure 29: from Table 31

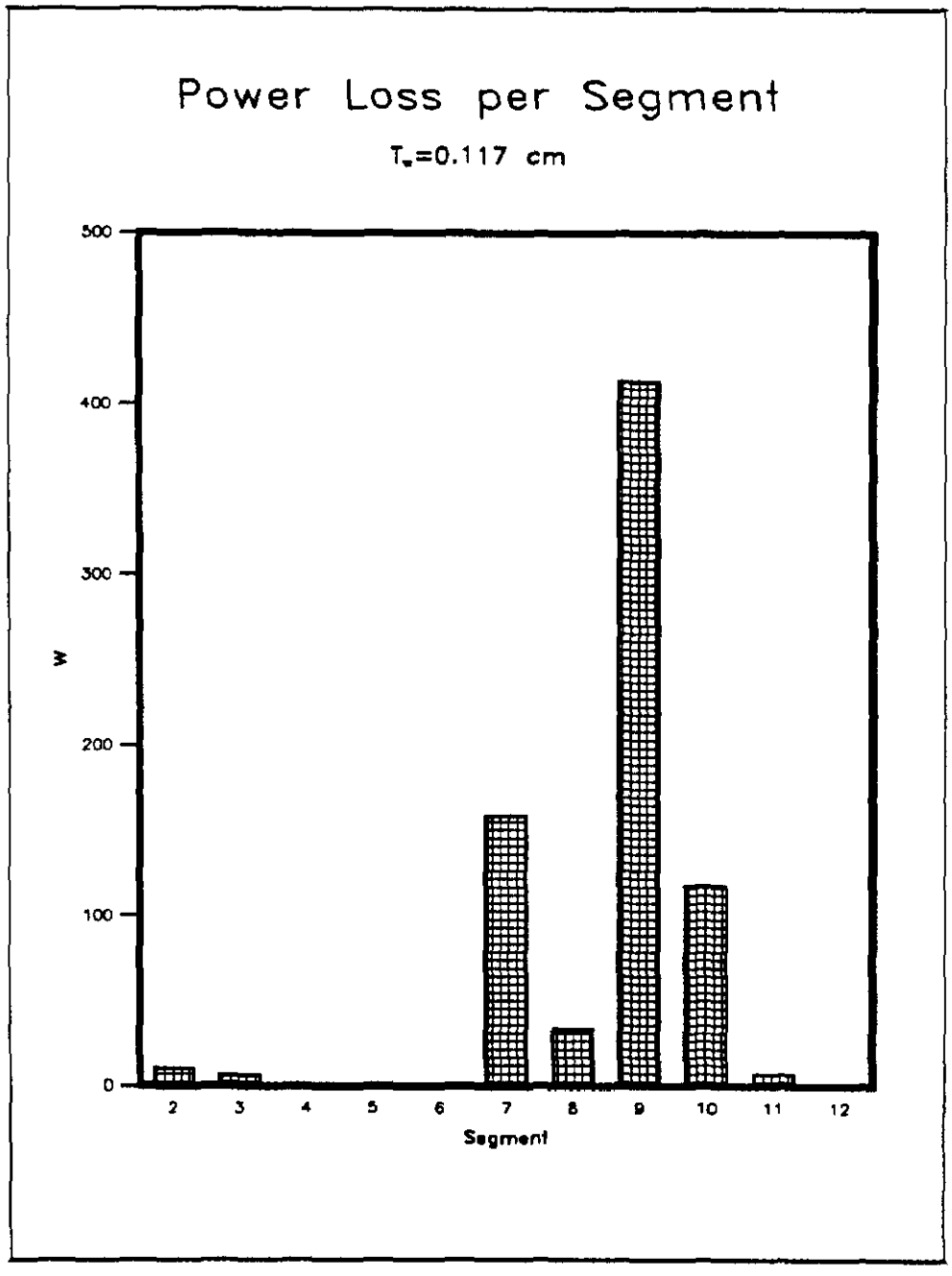
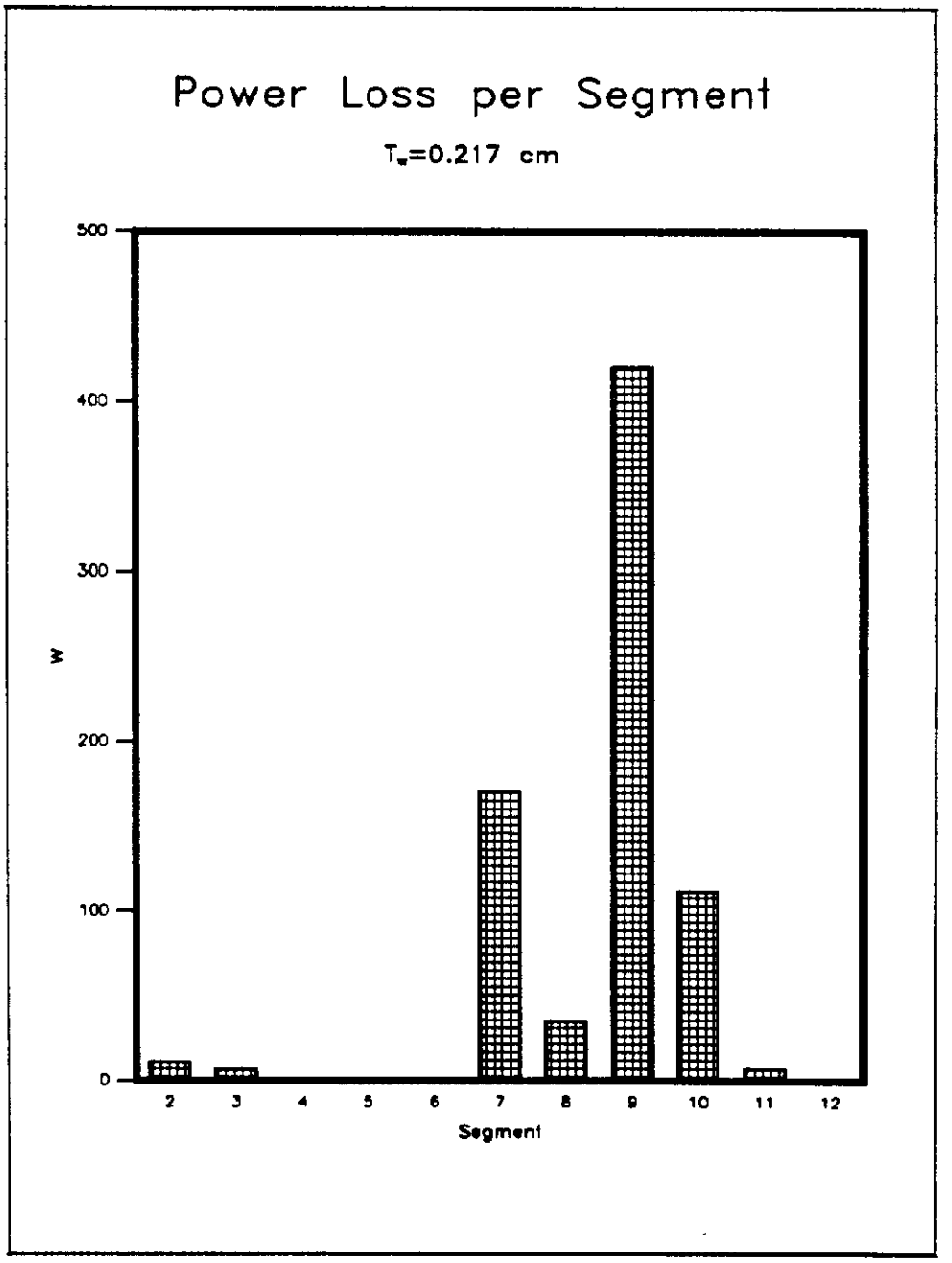


Figure 30: from Table 32



Segment	Power Loss (W)
2	12.4
3	7.7
4	0.2
6	2.8
7	199.4
8	40.0
9	461.2
10	107.3
11	7.6
12	0.1

Table 33: Power Loss per Segment with $T_w = 0.517$ cm

Segment	Power Loss (W)
2	10.9
3	6.8
4	0.2
6	0.9
7	174.9
8	35.5
9	421.4
10	108.1
11	4.4
12	0.1

Table 34: Power Loss per Segment with $R_n = 0.3$ cm

Figure 31: from Table 33

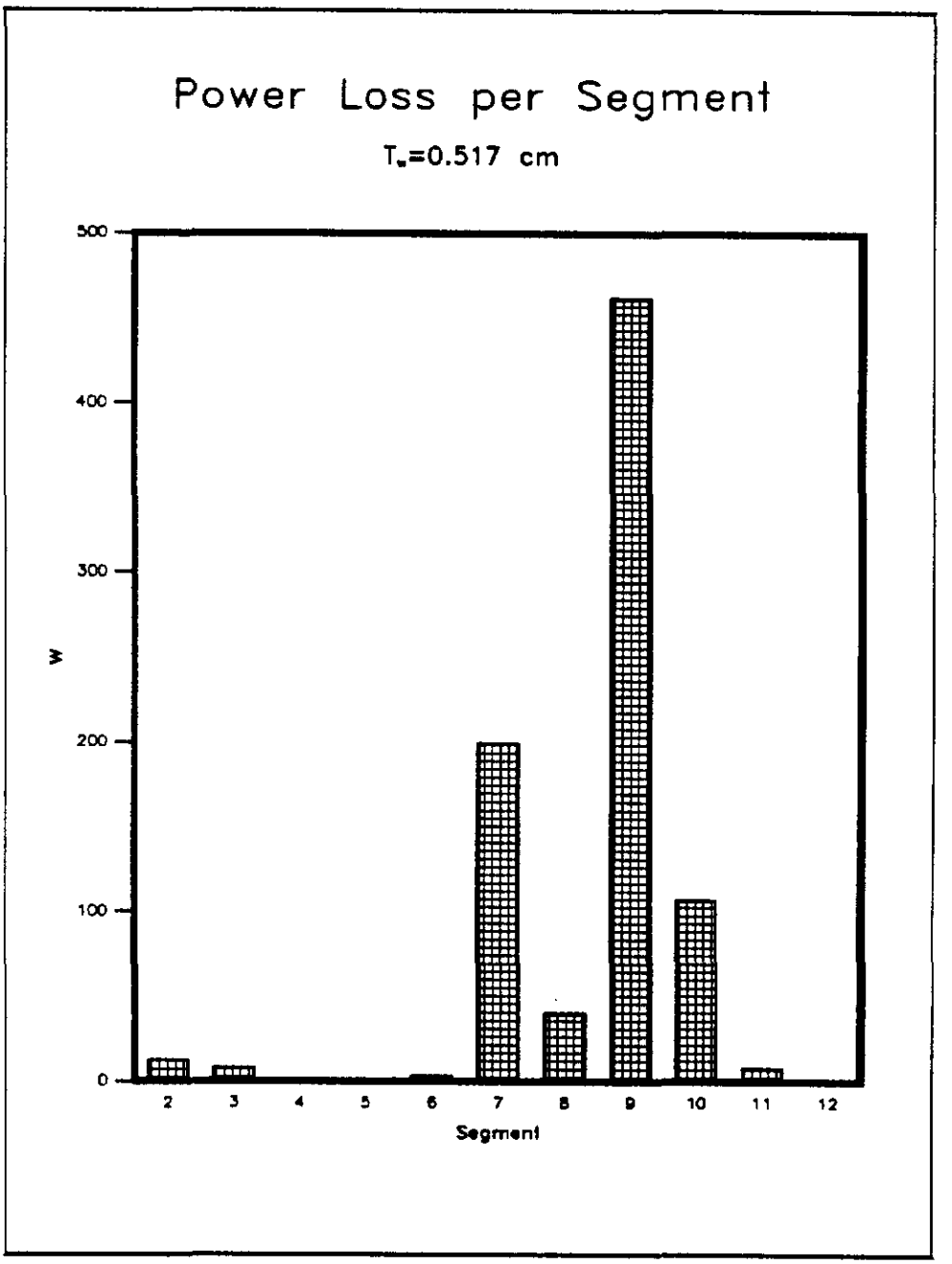
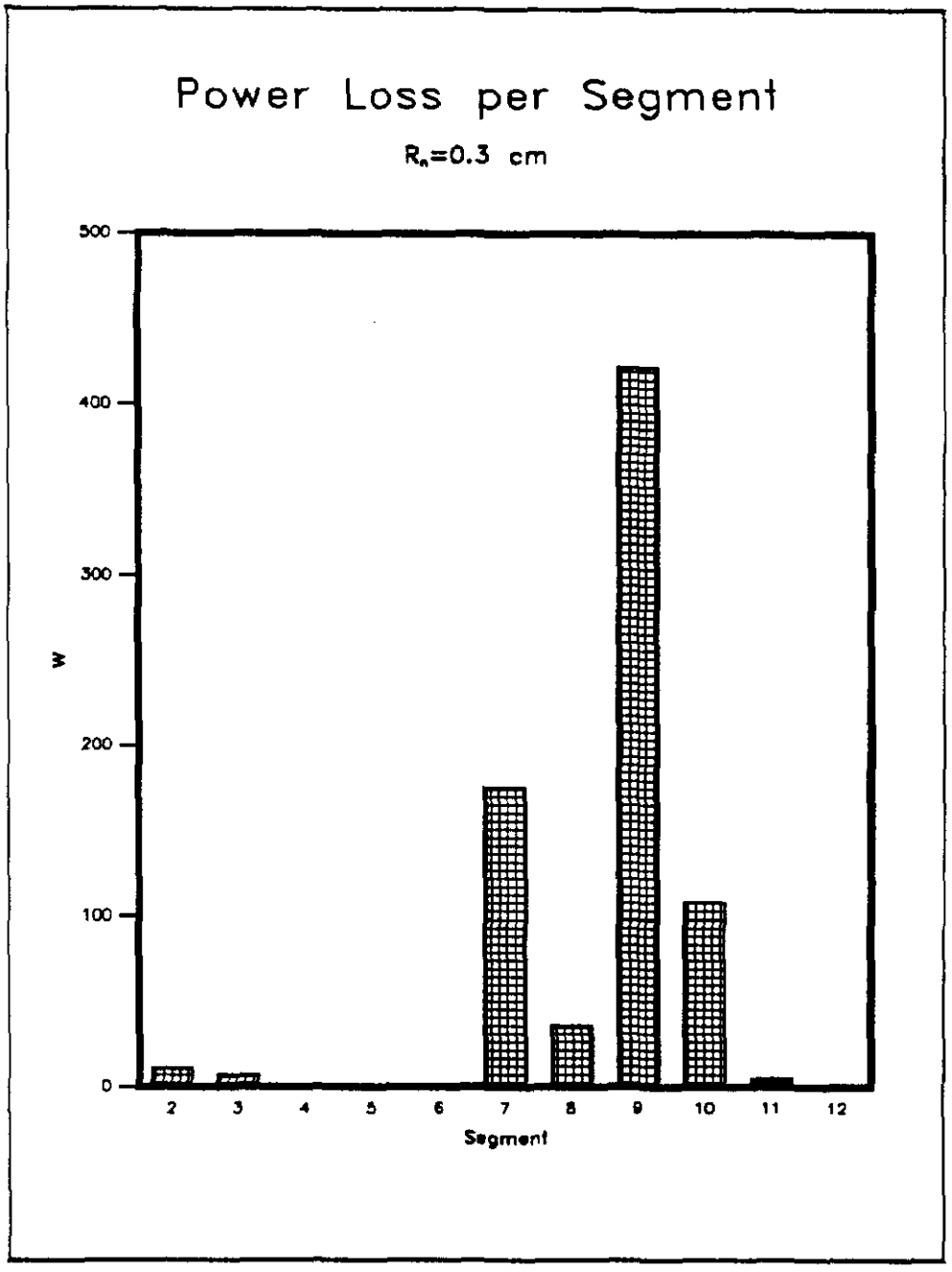


Figure 32: from Table 34



Segment	Power Loss (W)
2	11.6
3	7.2
4	0.2
6	1.0
7	185.7
8	37.7
9	438.1
10	106.1
11	9.8
12	0.0

Table 35: Power Loss per Segment with $R_n = 0.5$ cm

Segment	Power Loss (W)
2	12.0
3	7.5
4	0.2
6	1.0
7	191.6
8	38.8
9	444.1
10	102.9
11	13.1
12	0.0

Table 36: Power Loss per Segment with $R_n = 0.6$ cm

Figure 33: from Table 35

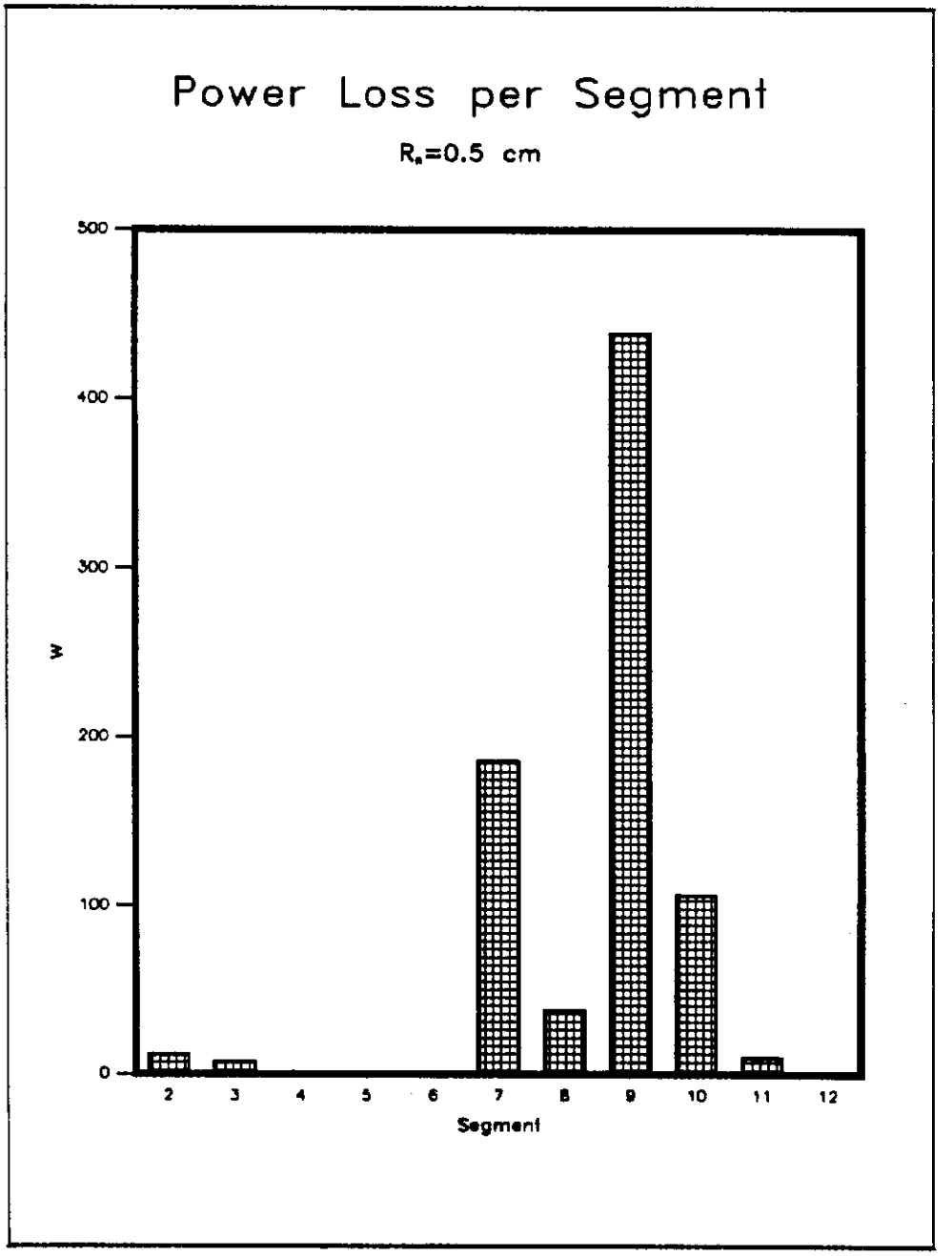


Figure 34: from Table 36

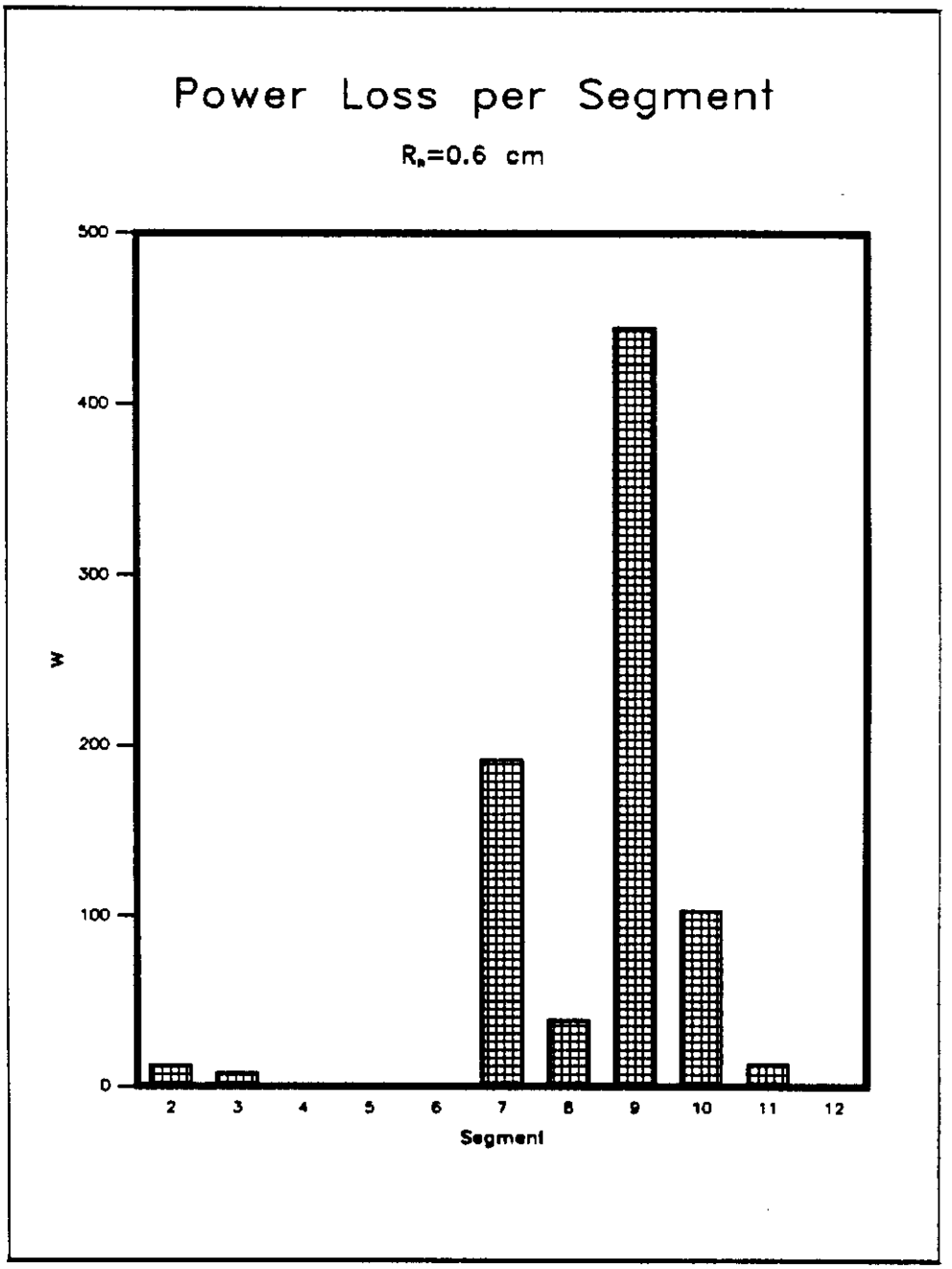
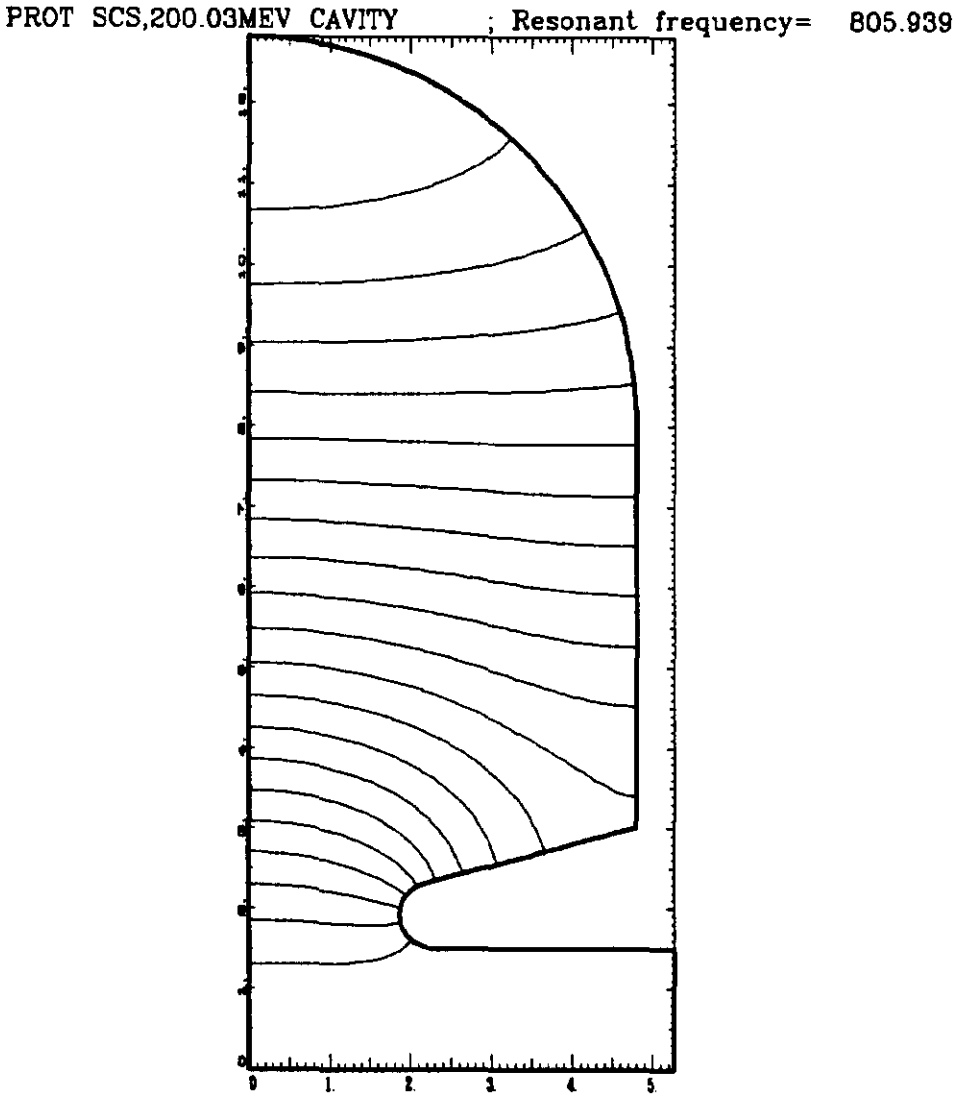


Figure 35: TM010 Sample SUPERFISH Output

```
superfish dtl output summary        16:37:39  11-JAN-8
problem name =  PROT SCS,200.03MEV CAVITY
cavity length  =  10.544 cm     cavity diameter  =    25.654 cm
     d.t. gap  =   9.594 cm          stem radius  =     1.000 cm
frequency (starting value = 805.000)             =   805.939 mhz
beta =  0.5662                      proton energy =   200.029 mev
normalization factor   (e0=1 mv/m)       ascale  =    5416.3
stored energy (mesh problem only)                =  3.9288308E-03 joules
power dissipation (mesh problem only)            =  8.6242920E+02 watts
t,tp,tpp,s,sp,spp  =   0.889   0.067   0.017   0.367   0.100   0.015
q  =   23068                    shunt impedance  =  6.1129654E+01 mohm/m
product zst**2                              ztt  =  4.8287228E+01 mohm/m
magnetic field on outer wall                     =           1440 amp/m
maximum electric field on boundary               =  5.5360179E+00 mv/m
```

iseg	zbeg (cm)	rbeg (cm)	zend (cm)	rend (cm)	emax (mv)	power (w)		d-freq (delz)	d-freq (delr)
2	0.0000E+00	1.2827E+01	4.7970E+00	8.0300E+00	3.2361E-01	4.6203E+02	wall	-4.7488E+00	-5.0245E+00
3	4.7970E+00	8.0300E+00	4.7970E+00	3.0120E+00	5.5316E-01	2.6193E+02	wall	-2.8636E+00	0.0000E+00
4	4.7970E+00	3.0120E+00	2.1650E+00	2.3060E+00	3.3420E+00	1.2996E+02	wall	5.6370E-01	2.1015E+00
5	2.1650E+00	2.3060E+00	2.2710E+00	1.5000E+00	5.5360E+00	8.4320E+00	wall	1.0091E+01	6.4064E+00
6	2.2710E+00	1.5000E+00	5.2720E+00	1.5000E+00	1.1402E+00	7.2696E-02	wall	0.0000E+00	1.6173E-01

Figure 36: SCS TM010 Accelerating Mode



β	DAW ZT^2 (MOhm/m)	SCS ZT^2 (MOhm/m)	DAW E_m (MV/m)	SCS E_m (MV/m)	DAW T	SCS T
0.4569	41.45	41.51	5.796	5.448	0.887	0.875
0.4842	44.48	43.51	5.503	5.521	0.885	0.880
0.5115	47.09	45.34	5.356	5.556	0.883	0.884
0.5389	49.45	46.88	5.280	5.549	0.879	0.889
0.5662	51.78	48.29	5.099	5.536	0.875	0.889
0.5935	53.87	49.56	5.075	5.546	0.871	0.891
0.6208	55.85	50.53	4.966	5.649	0.866	0.893
0.6481	57.56	51.31	4.957	5.713	0.863	0.895
0.6754	58.93	51.86	4.694	5.825	0.846	0.896
0.7027	60.15	52.44	4.527	5.808	0.835	0.894
0.7131	60.61	52.64	4.610	5.797	0.835	0.895

Table 37: Effective Shunt Impedance ZT^2, Maximum Electric Field E_m, and Transit Time Factor T, vs β for SCS and DAW Structures

Figure 37: from Table 37

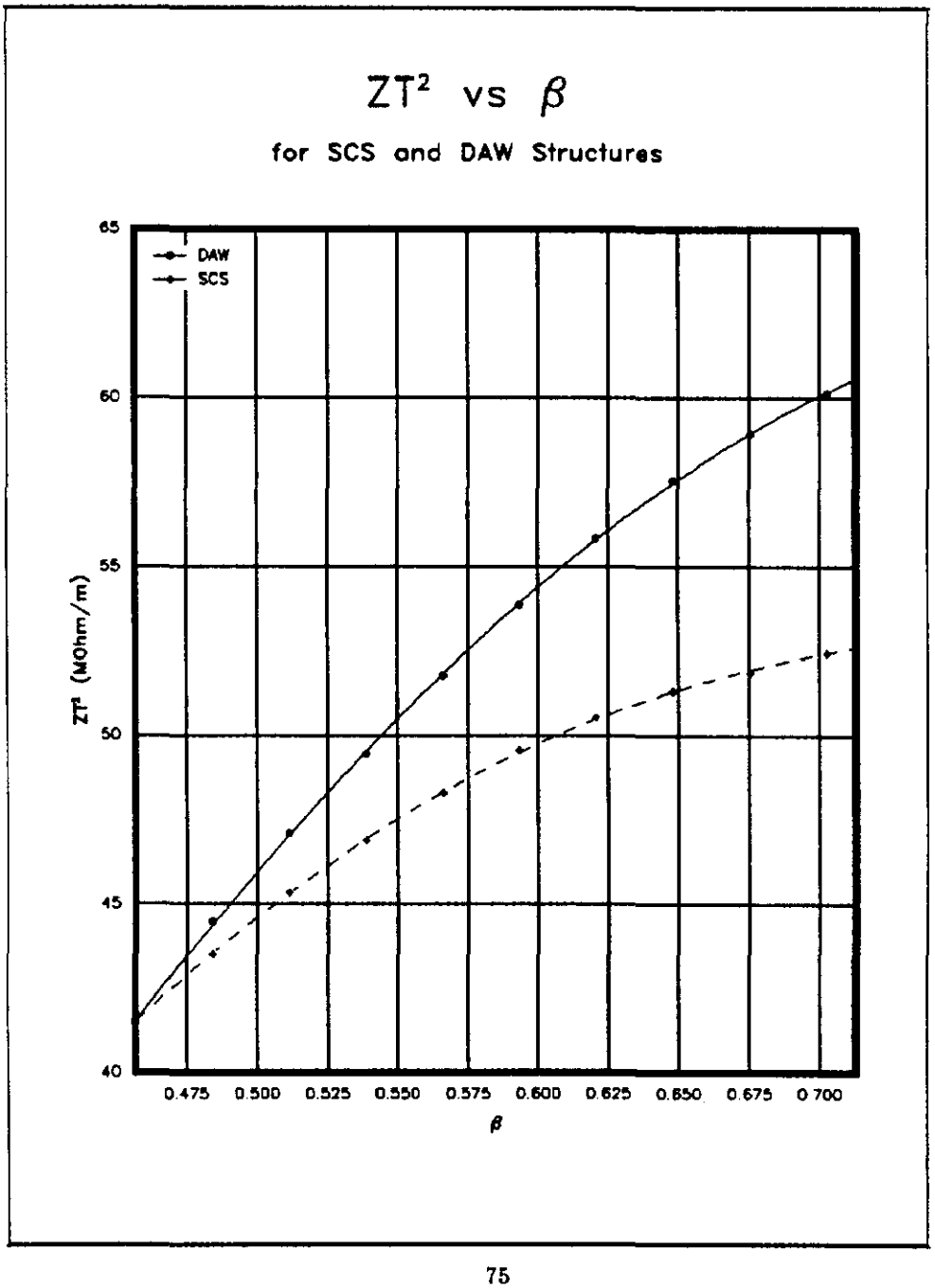


Figure 38: from Table 37

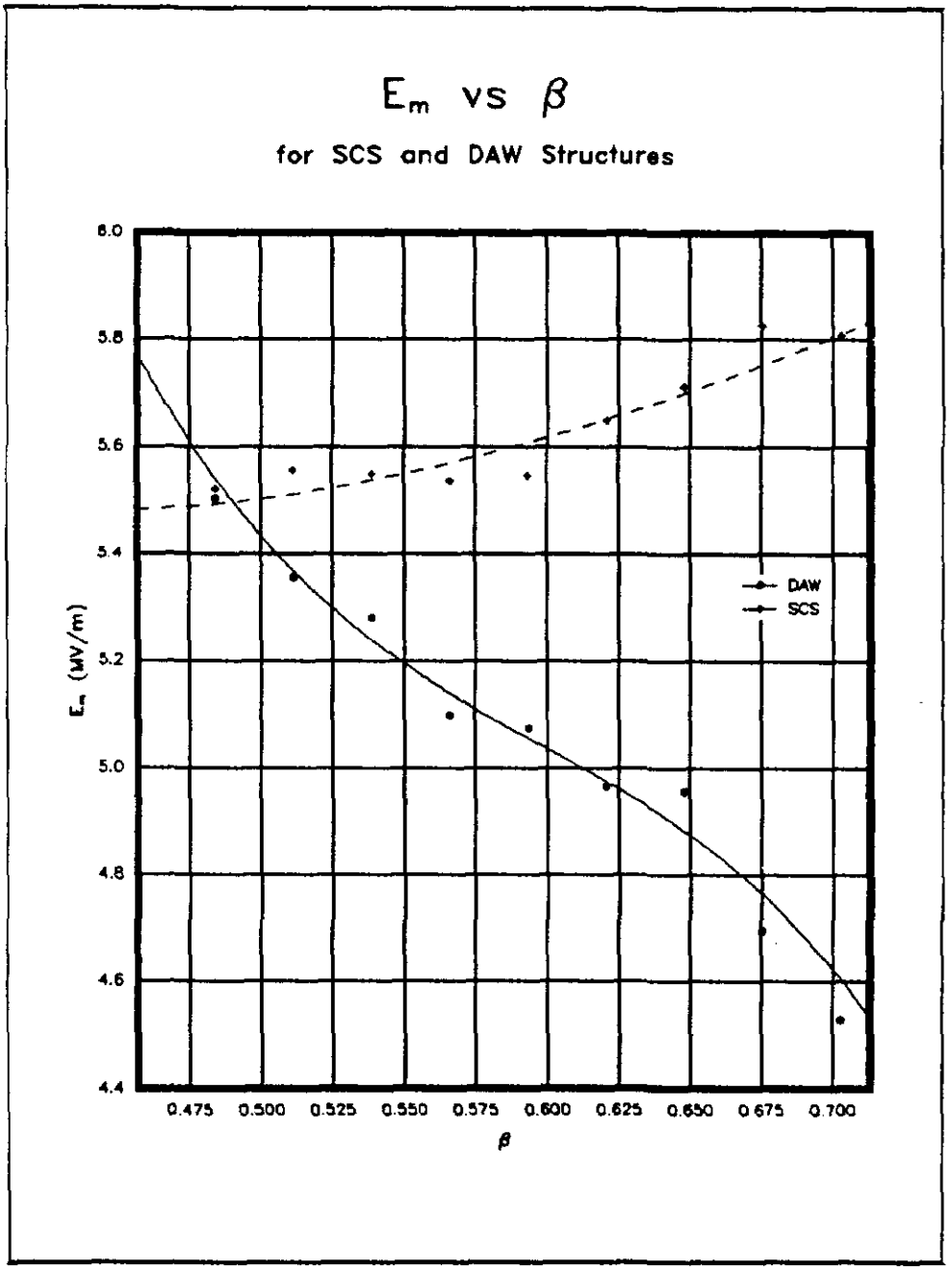
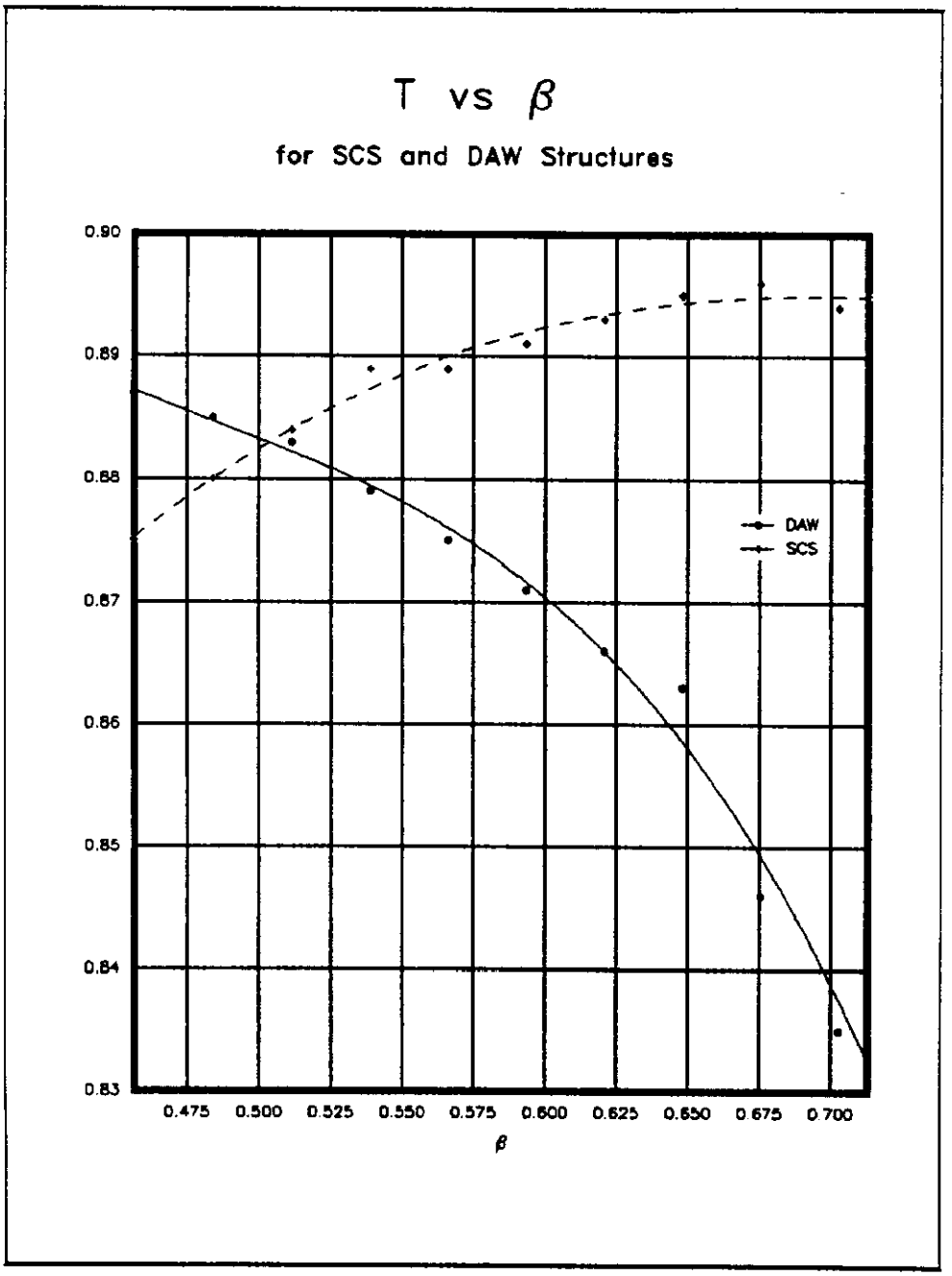


Figure 39: from Table 37



β	DAW E_0T (MV/m)	SCS E_0T (MV/m)	DAW P/m (MW/m)	SCS P/m (MW/m)
0.4569	6.427	6.745	0.997	1.096
0.4842	6.754	6.694	1.026	1.030
0.5115	6.925	6.682	1.018	0.985
0.5389	6.993	6.729	0.989	0.966
0.5662	7.207	6.745	1.003	0.942
0.5935	7.208	6.748	0.965	0.919
0.6208	7.325	6.640	0.961	0.873
0.6481	7.312	6.580	0.929	0.844
0.6754	7.570	6.460	0.972	0.805
0.7027	7.747	6.465	0.998	0.797
0.7131	7.608	6.484	0.955	0.799

Table 38: Accelerating Gradient E_0T and Power Loss per meter $P/m = (E_0T)^2/ZT^2$ vs β for SCS and DAW Structures with Maximum Electric Field $E_m = 42$ MV/m

β	DAW P/m (MW/m)	SCS P/m (MW/m)
0.4569	0.997	0.995
0.4842	0.929	0.949
0.5115	0.877	0.911
0.5389	0.835	0.881
0.5662	0.798	0.855
0.5935	0.767	0.834
0.6208	0.740	0.818
0.6481	0.718	0.805
0.6754	0.701	0.797
0.7027	0.687	0.788
0.7131	0.682	0.785

Table 39: Power Loss per meter P/m vs β for SCS and DAW Structures with Accelerating Gradient $E_0T = 6.427$ MV/m

Figure 40: from Table 38

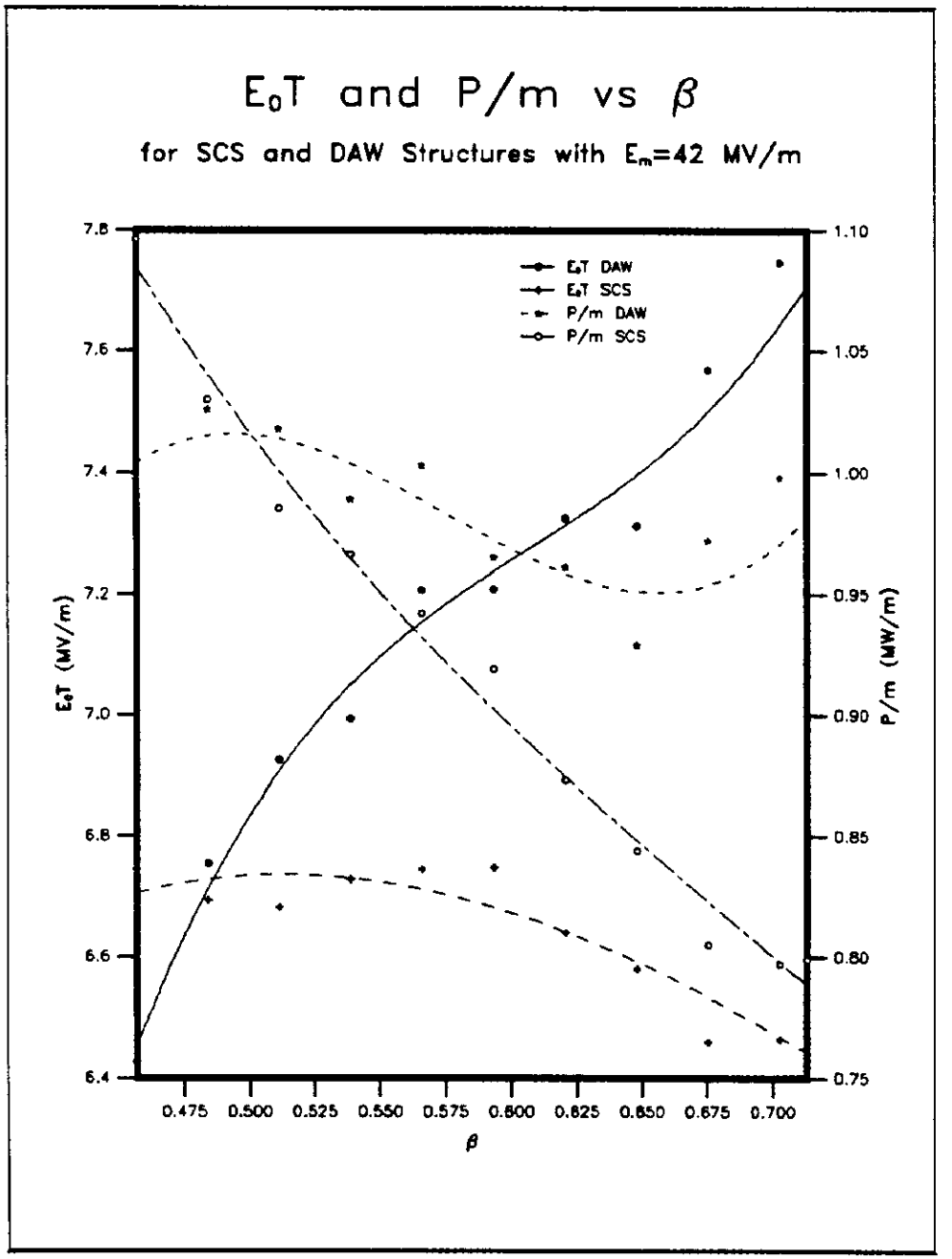


Figure 41: from Table 39

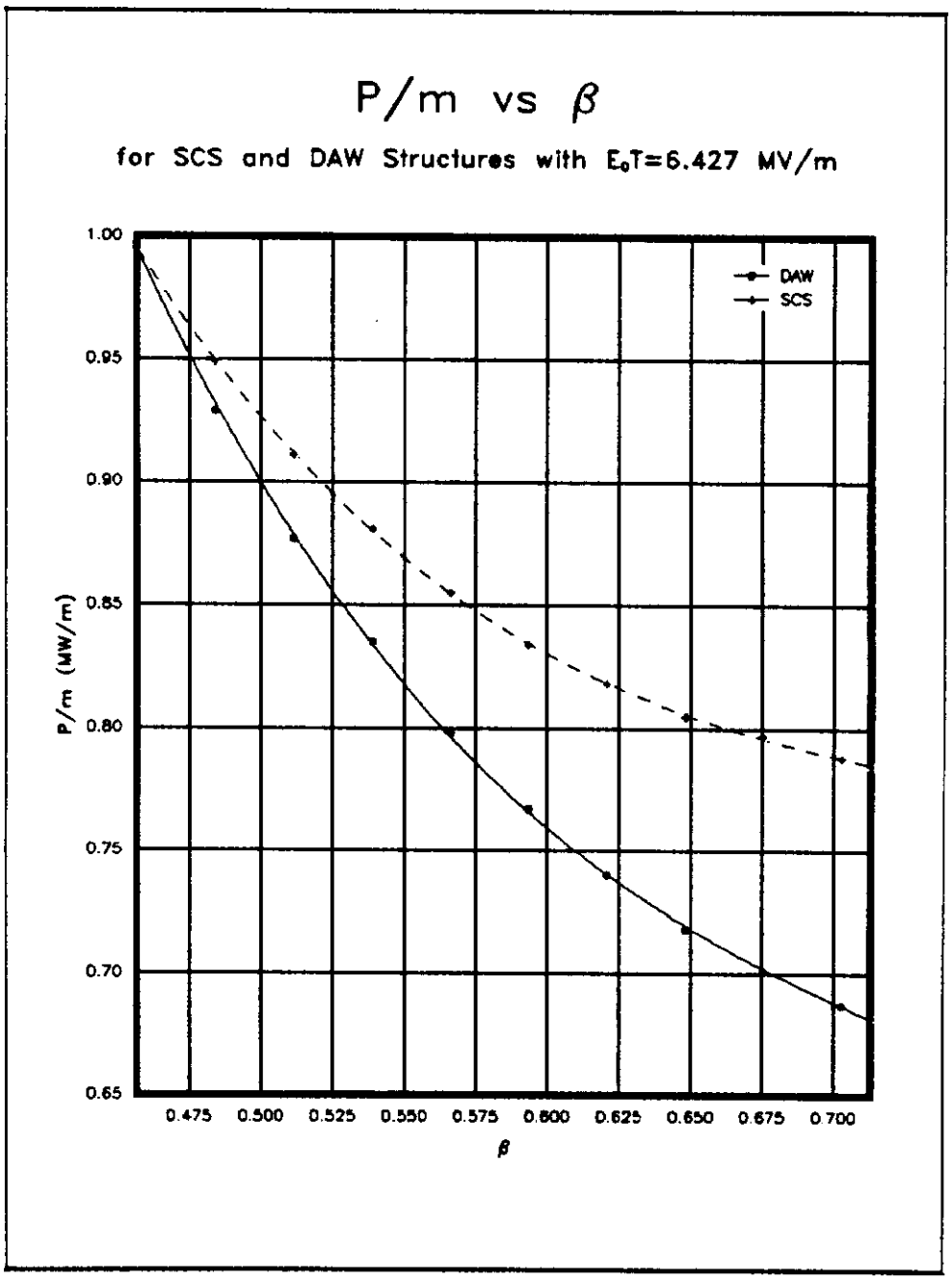


Figure 42: $DX = 0.15$, $DY = 0.13$

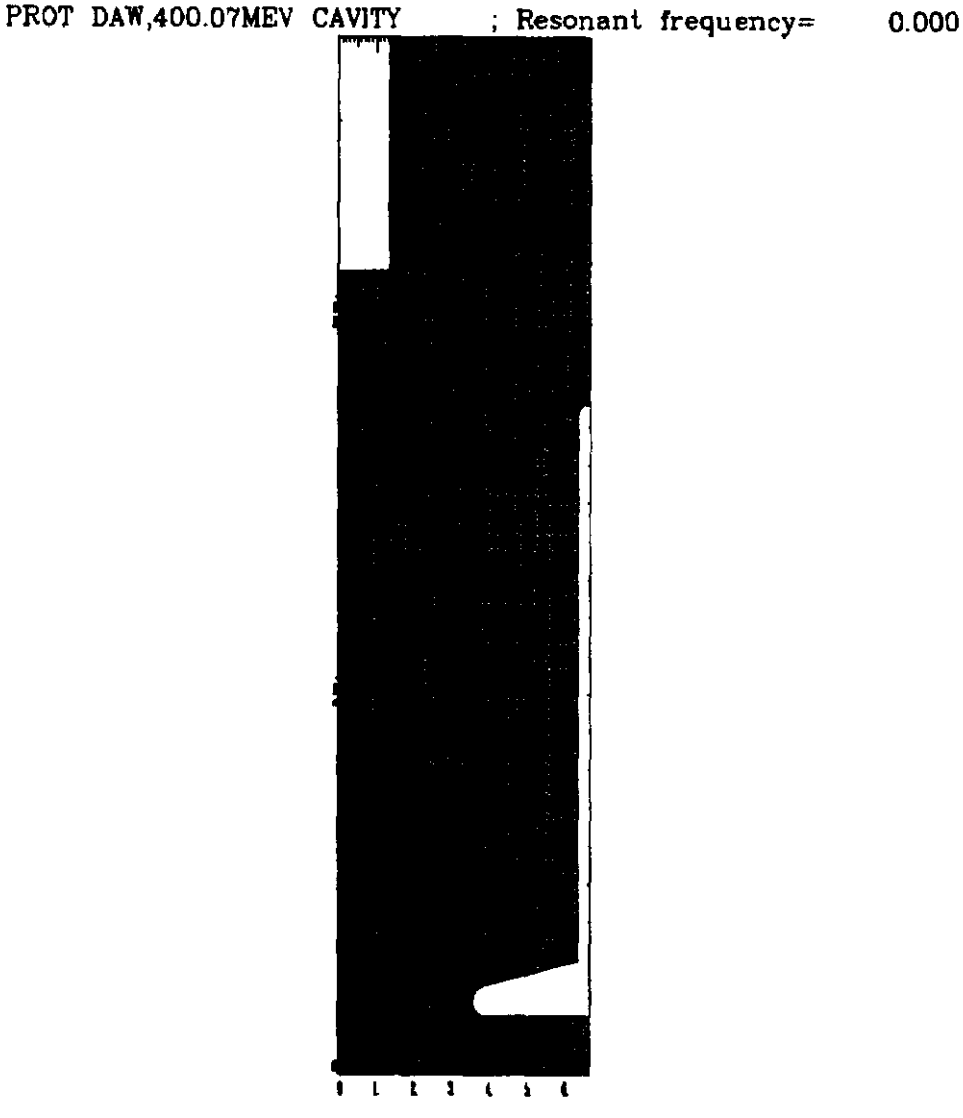


Figure 43: $DX = 0.09$, $DY = 0.08$

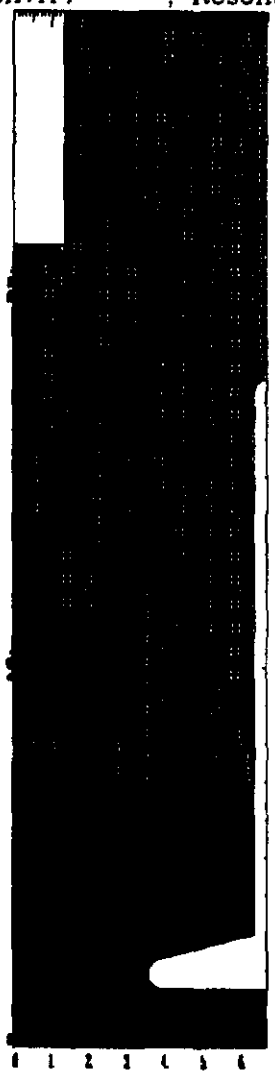
PROT DAW,400.07MEV CAVITY ; Resonant frequency= 0.000

Figure 44: $DX = 0.09$, $DY_1 = 0.08$, $DY_2 = 0.16$

PROT DAW,400.07MEV CAVITY ; Resonant frequency= 0.000

Figure 45: $DX = 0.09$, $DY_1 = 0.08$, $DY_2 = 0.16$, $DY_3 = 0.32$

PROT DAW,400.07MEV CAVITY ; Resonant frequency= 0.000



	Tuning (cm)		
1	$R_d = 20.628$		
2	$R_d = 20.937$		
3	$R_d = 21.191$	$C_z = 4.089$	$L_r = 2.932$
4	$R_d = 20.940$	$C_z = 4.254$	$L_r = 2.888$
5	$R_d = 20.396$	$C_z = 4.528$	$L_r = 2.815$
6		$C_z = 1.992$	$L_r = 3.494$
7		$C_z = 2.752$	$L_r = 3.291$
8		$C_z = 4.989$	$L_r = 2.691$
9		$C_z = 5.687$	$L_r = 2.5042$
10	$R_d = 21.17$		
11		$C_z = 3.588$	$L_r = 2.639$
12		$C_z = 3.768$	$L_r = 2.795$
13		$C_z = 4.130$	$L_r = 3.105$
14		$C_z = 4.311$	$L_r = 3.2603$

Table 40: Tuning Key for Table 41 with the Standard Configuration being $R_c = 27.22$ cm, $R_d = 21.067$ cm, $T_d = 1.336$ cm, $R_w = 17.604$ cm, $T_w = 0.317$ cm, $R_n = 0.41$ cm, $C_z = 3.949$ cm, $L_r = 2.970$ cm, and $\theta = 15$ deg

R_c (cm)	R_d (cm)	ZT^2 (MOhm/m)	E_m (MV/m)
23.22	16.816	53.30	4.607
25.22	19.067	57.95	4.608
27.22	21.067	60.61	4.610
29.22	23.221	62.31	4.607
31.22	25.310	63.14	4.607
33.22	27.386	63.55	4.609
35.22	29.407	63.81	4.607
37.22	31.432	63.95	4.607
38.22	32.432	63.91	4.610
T_d (cm)	Tuning		
0.336	1	59.61	4.610
0.836	2	60.29	4.610
1.336		60.61	4.610
2.336	3	60.03	4.456
3.336	4	58.21	4.282
4.336	5	54.46	3.942
R_w (cm)			
13.604	6	43.12	7.993
15.604	7	56.76	6.227
17.604		60.61	4.610
19.604	8	51.30	3.499
20.104	9	43.54	3.943
T_w (cm)			
0.117		62.85	4.658
0.217		61.76	4.635
0.317		60.61	4.610
0.517		58.15	4.556
0.717	10	55.56	4.496
R_n (cm)			
0.2	11	63.94	5.675
0.3	12	62.35	5.200
0.41		60.61	4.610
0.5	13	59.08	4.172
0.6	14	57.60	3.813

Table 41: Effective Shunt Impedance ZT^2 and Maximum Electric Field E_m vs Cavity Parameters R_c, R_d, T_d, R_w, T_w, and R_n at $\beta = 0.7131$

Figure 46: from Table 41

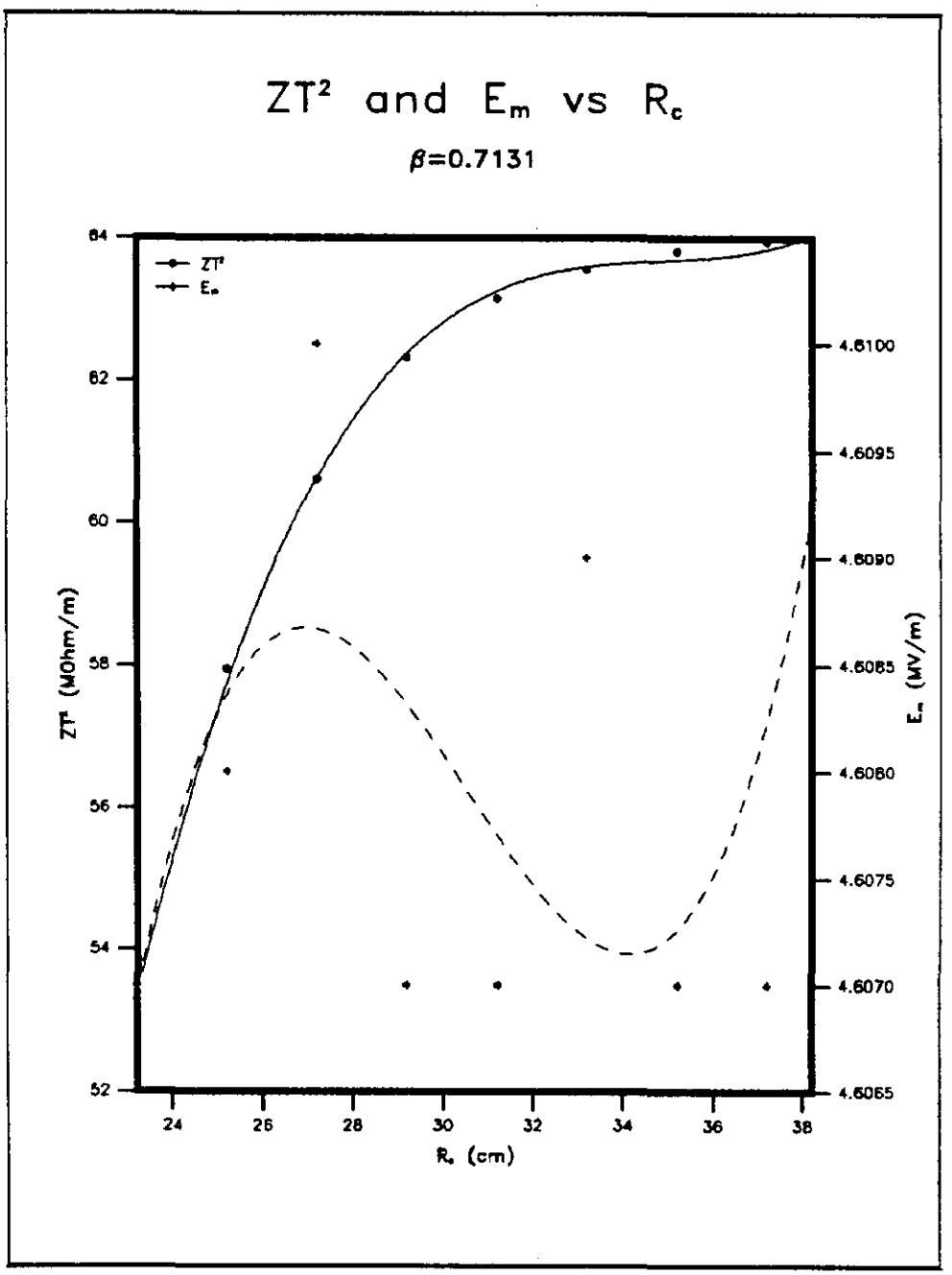


Figure 47: from Table 41

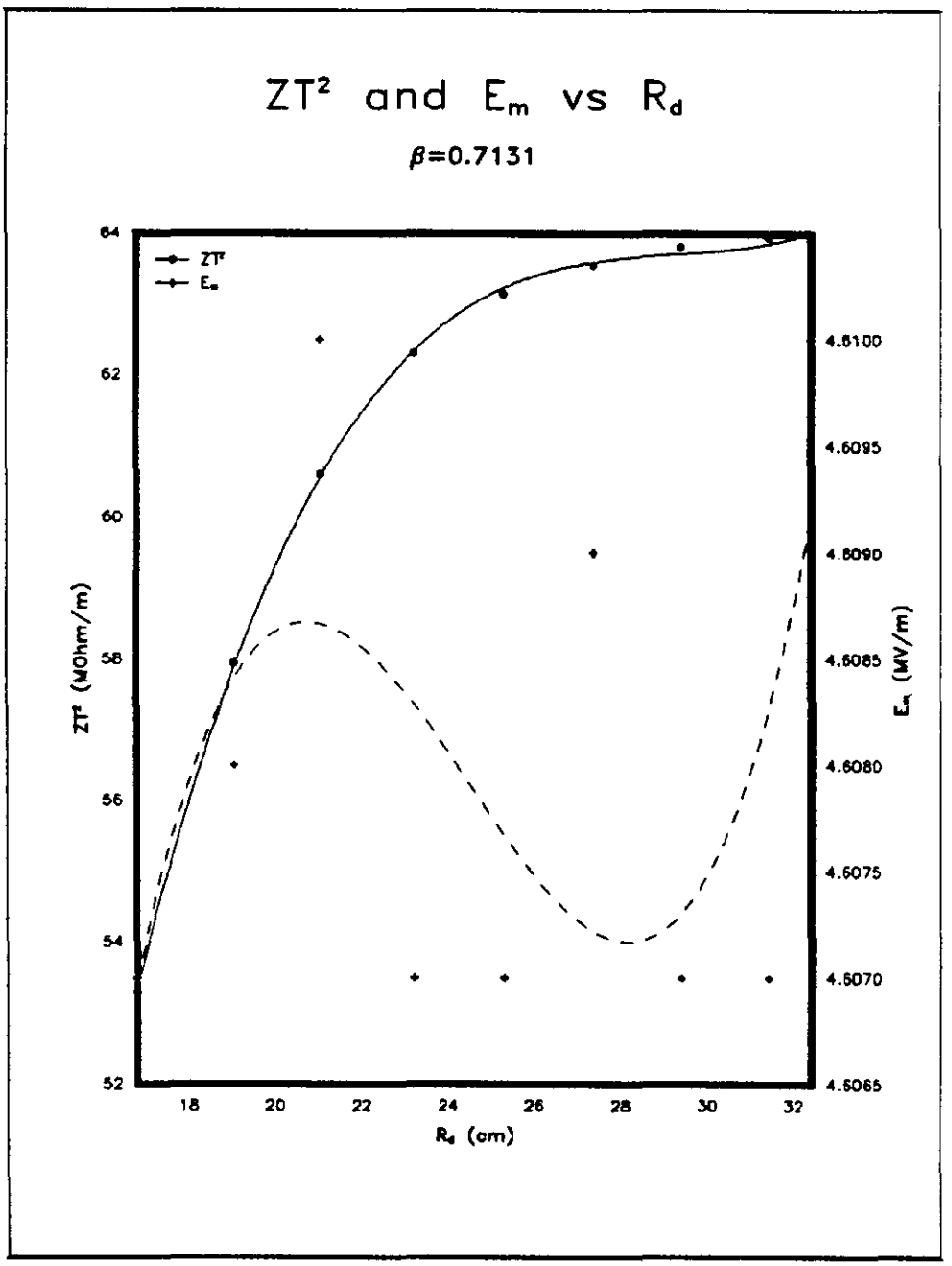


Figure 48: from Table 41

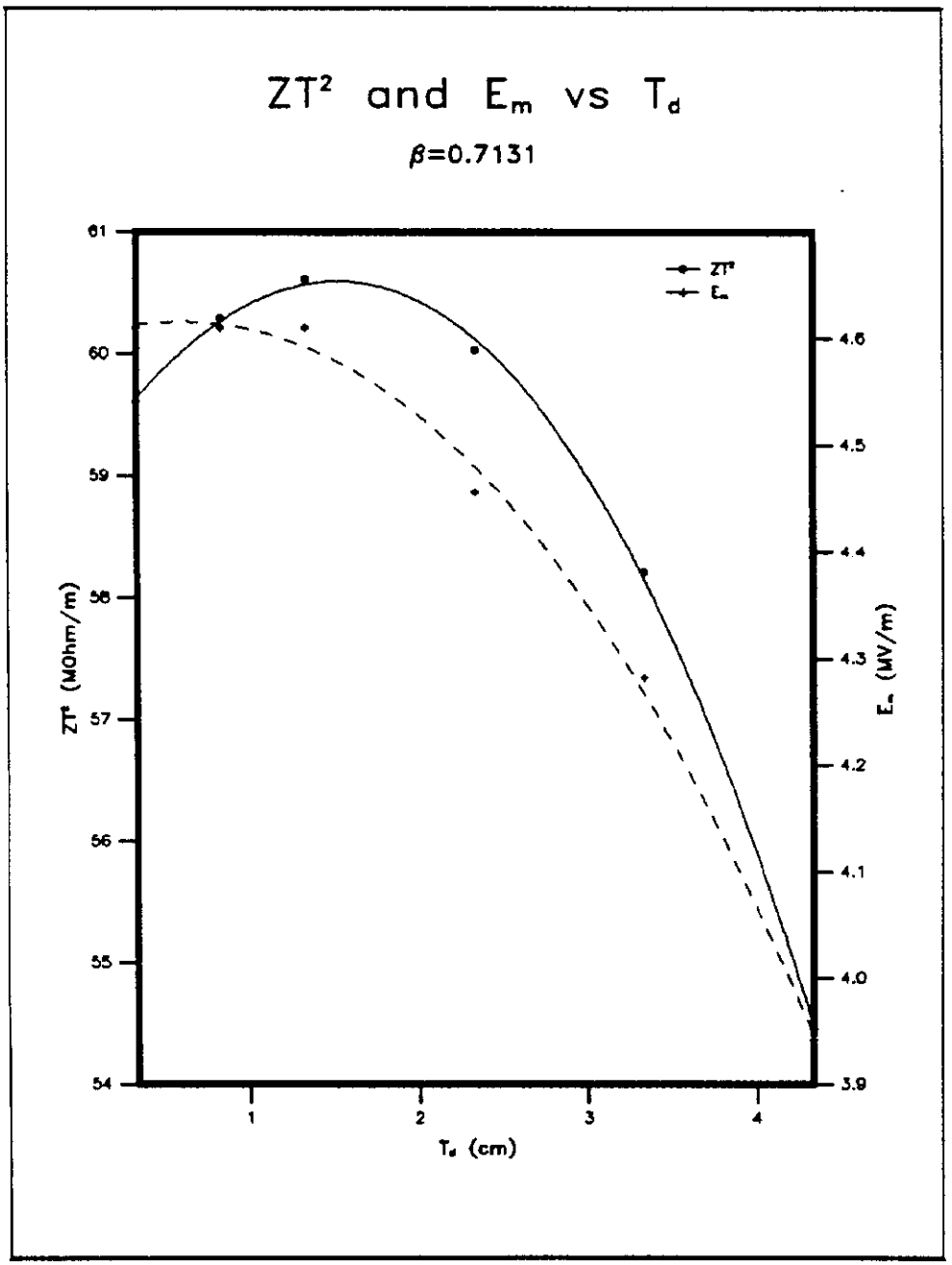


Figure 49: from Table 41

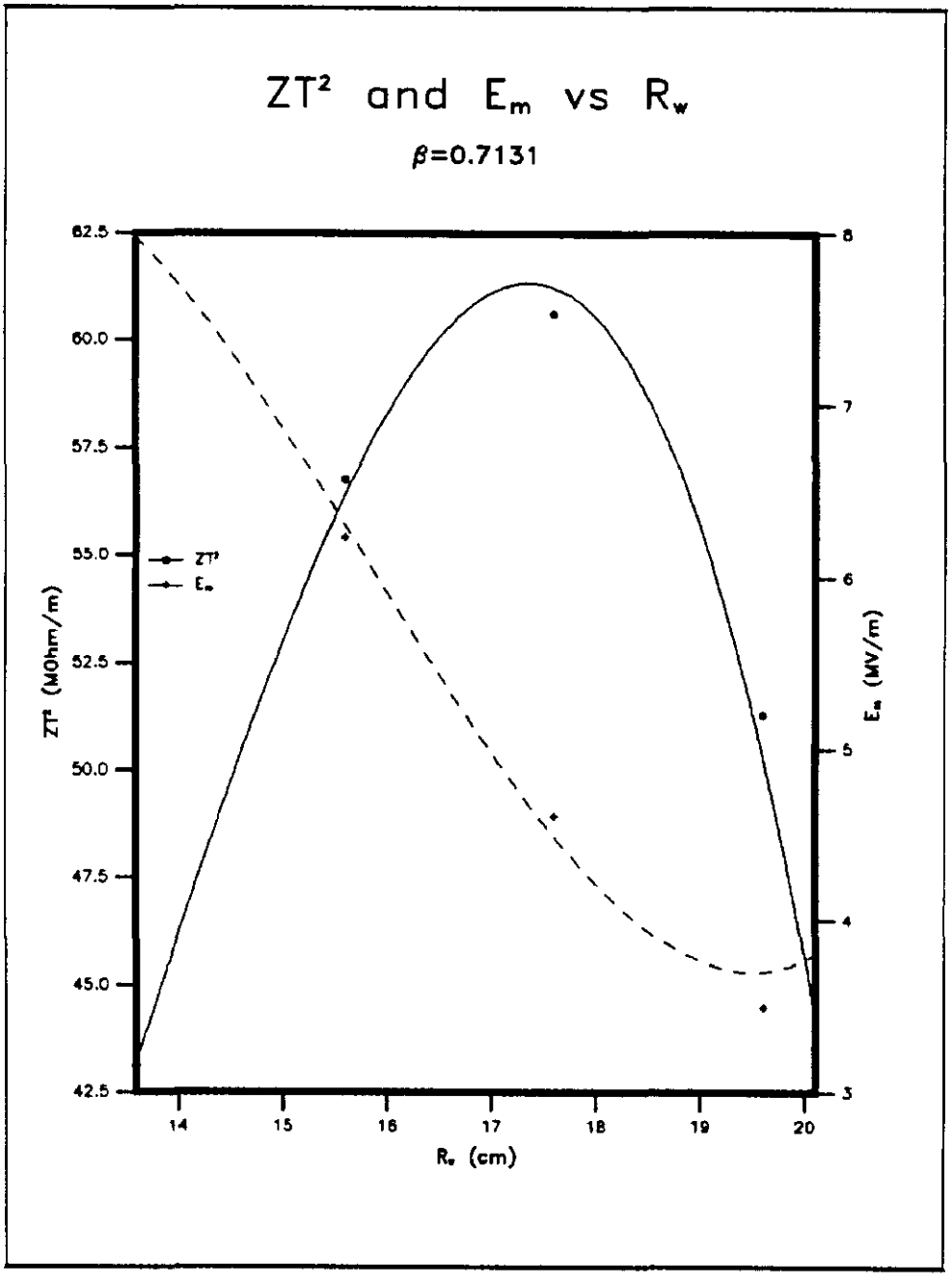


Figure 50: from Table 41

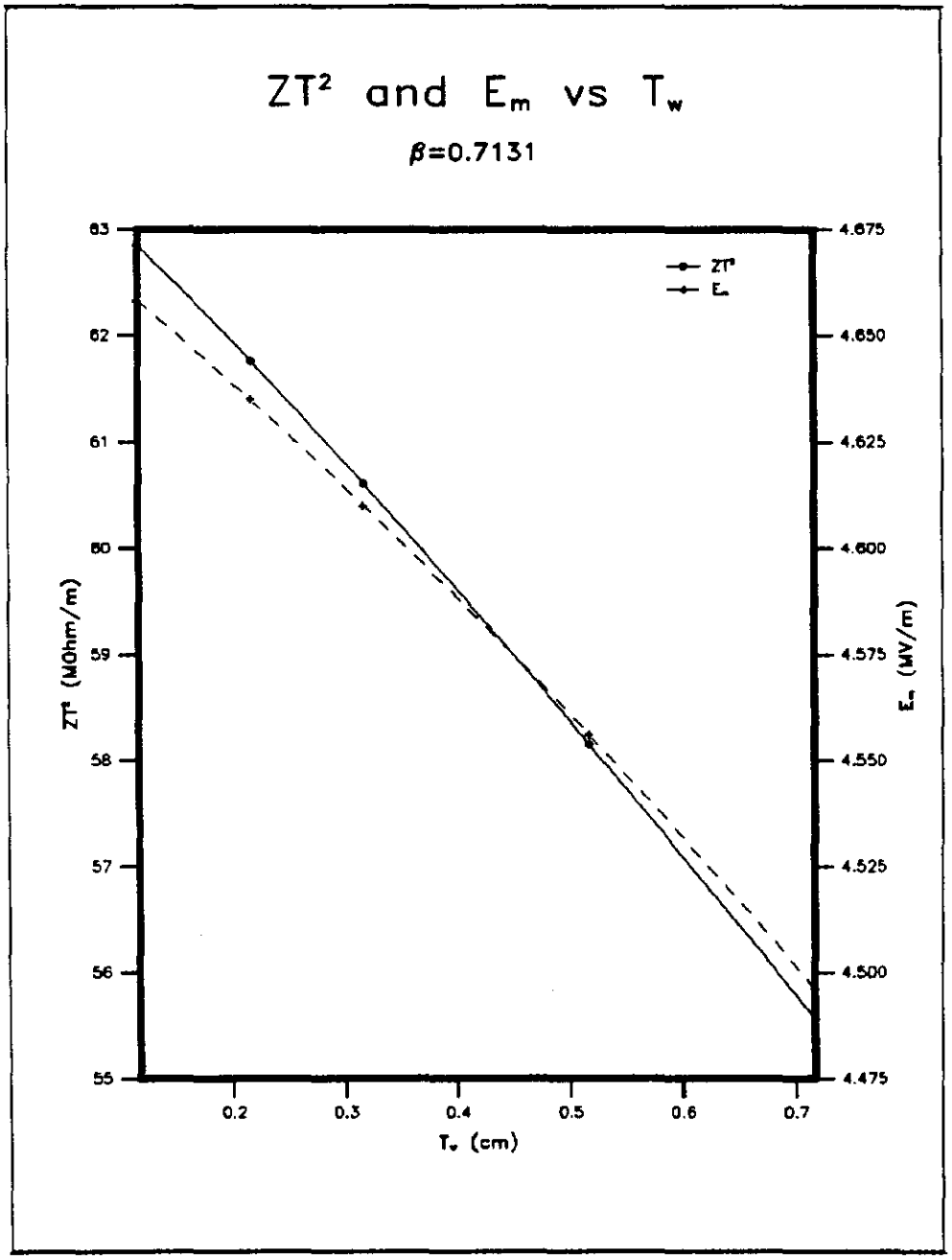
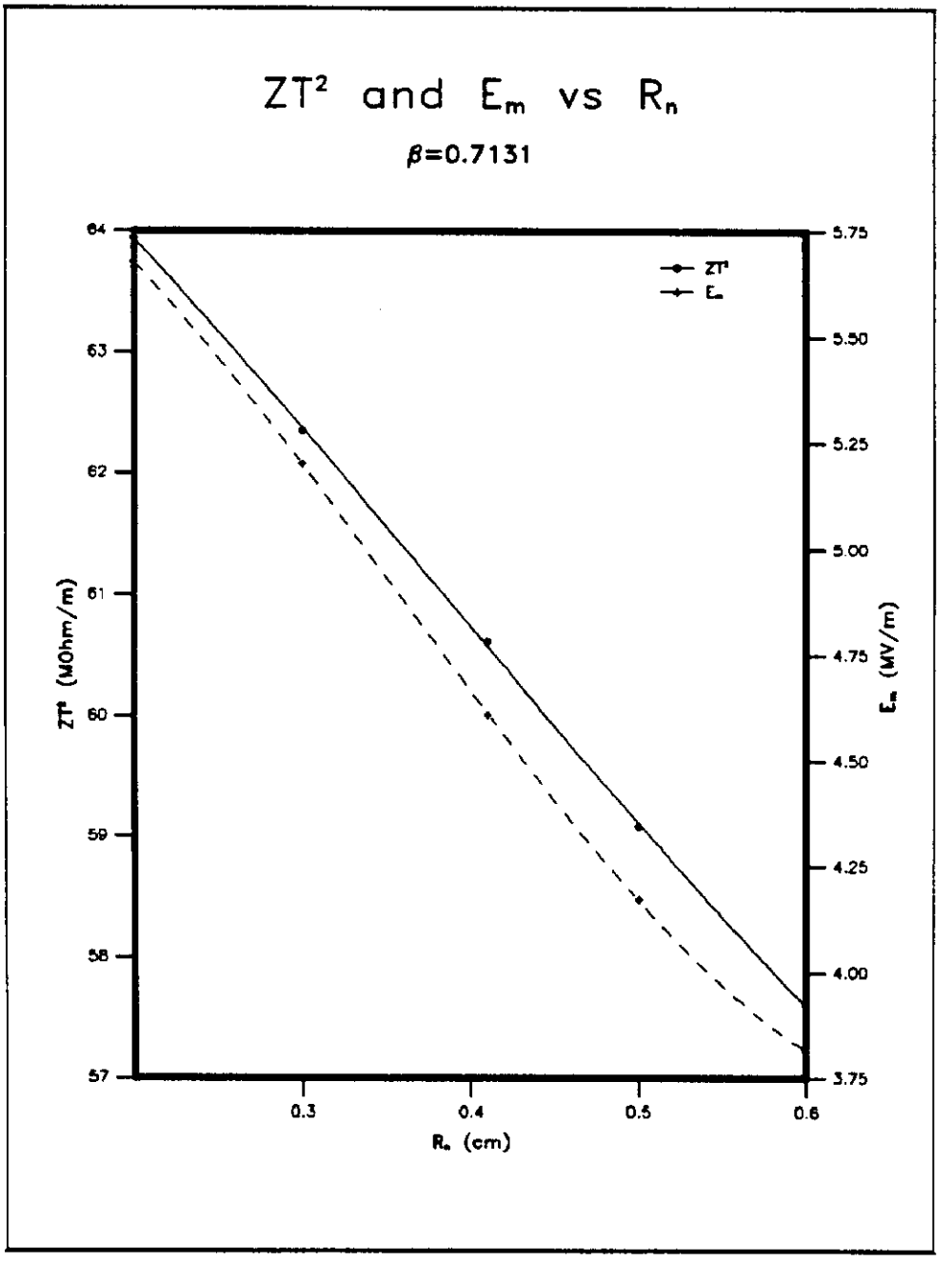


Figure 51: from Table 41



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