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SHIELDING STUDIES FOR THE COLLIDING BEAM EXPERIMENTAL AREA AT B-ZERO

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Introduction

As an aid in the design of the proposed colliding beam experimental area B-Zero some calculated results of biological dose in and around this planned structure are presented. This report concentrates on two-problems identifiable with this region: (i) dose in the detector assembly hall when beam is accidentally lost nearby. It is contemplated that personnel will be present in the assembly hall when beam is being accelerated (and without the benefit of the detector being in place, which by itself provides significant shielding), (ii) dose on top of the roof due to accidental beam loss. Because of the large dimensions of this structure significant economies are possible by making the roof as thin as shielding standards allow.

The doses of interest are predicted by means of Monte Carlo simulations using the program CASIM[1]. Two different designs are analyzed here: The one presently contemplated[2] and an earlier version[3]. The latter is included since its study was essentially completed before the design change and because its simple character might make it of general interest.

Calculations

Figure 1a presents elevation and plan views of an idealized version of the present design. The beam travels along the center line surrounded by a vacuum chamber of 3.5 cm inside radius. In addition magnets and experimental apparatus

are expected to be present. These are not specifically included in the calculation for reasons of simplicity in coding and interpretation and also because of the sensitivity to future alterations. Instead, the effects of the magnets, etc. are estimated by repeating the calculations for various (uniform) thicknesses of the beam pipe. A conservative design can then be based on the maximum does rate as a function of "effective" beam pipe thickness. This is likely not the utmost conservative design since the maximum dose rate for a uniform pipe may be exceeded if one permits the thickness (and/or composition) to vary. For the present problems there do not appear to be any obvious configurations for which dose rates are expected which are substantially higher than the maximum rate for the uniform case. Therefore an investigation into non-uniform beam pipes is not attempted.

Inspection of Figure 1a suggests a simplification to a cylindrically symmetric configuration i.e. a beam pipe traversing a set of four adjacent tunnels with different inside radii and possibly different composition (Figure 1b). This geometry is readily adapted to the general version of CASIM. Dose rates are calculated for a set of 20 (longitudinal) by 30 (radial) array of volume bins. The radii of the (circular) tunnels of the calculation are such that their cross sections are equal in area to those of the (rectangular) tunnels of the design. For convenience in interpretation there are added to the tunnel radii and lengths small regions of air so as to make them integral multiples of the elementary bin size (200 cm long by 50 cm radially). These air volumes hardly affect the simulation but serve as "detectors", like the concrete and soil of the walls.

Figure 2 shows the cross section of an earlier design again drastically simplified for ease of coding and for gain in statistical significance via symmetry considerations. A further reduction to cylindrical symmetry is not attempted. In contrast to Figure 1 the same cross section extends the entire length of the configuration (40m).

For both geometries a 1000 GeV proton beam of infinitesimal cross section is lost on the beam pipe displaced an infinitesimal distance inside the material and parallel to the axis. Given such a beam and the geometry of Figure 1 the dose rate at any particular location is then a function of two variables: (a) effective beam pipe thickness and (b) longitudinal position of beam loss. In Figure 2 since translational symmetry applies, the beam loss point is arbitrarily fixed at zero depth and only variation with pipe thickness need be studied.

A few modifications to CASIM are made expressly for this study. These are prompted by the large dimensions of the geometry and by the fact that a large fraction of the incident energy escapes through the end of the tunnel. These modifications include: (i) use of a collision length multiplier value of three but only for trajectories outside of the beam pipe, (ii) enhanced probability to select a neutron for low energy particles, (iii) increased "splitting" of recording particles over azimuthal angle of production (for the rectangular geometry of Figure 2 only).

Results

Figure 3 presents the variation of dose with beam pipe thickness in the neighborhood of the air-concrete boundary of Figure 1b, for beam being lost at zero depth. The dose is calculated for a radial region between 1100 and 1150 cm, divided further into longitudinal bins of 200 cm length. From a radiation safety point of view this region appears the most critical and it is therefore chosen as a test case. Both the largest value (including its Monte Carlo statistical error) and the average of the longitudinal bins are shown in Figure 3. The error of the average is not calculated. Because of the sizable errors associated with the largest values the "fit" through these point is simply a constant multiple of the curve through the average dose. There is less jitter in the average and the dependence on pipe thickness is expected to be roughly the same. A broad maximum is seen for a thickness of about 5 cm. This value is now adopted to study variation with beam loss position.

Figure 4 shows the largest calculated dose among the longitudinal bins as well as its average value in the region defined above, for a constant 5 cm thick beam pipe versus the depth where the beam begins to interact. A broad maximum occurs at about 10 m. For the present problem this value is likely to be more sensitive to test location than is the optimum pipe thickness.

From Figures 3 and 4 it is then concluded that the "worst case" occurs for a pipe thickness of (about) 5 cm and for a beam striking the pipe (about) 10 m into the configuration of Figure 1b. Table I presents the dose as a function of

location in detail for this case. From the variation of dose with radius within the concrete, the dose in the air region can be estimated for different thicknesses of the concrete. The dose in the soil and concrete surrounding the tunnel may be consulted to estimate the required roof thickness. Some adjustments are needed where concrete and soil are interchanged[4].

For the geometry of Figure 2 only the dependence on pipe thickness need be studied. The test case employed is once again the air region adjacent to the concrete which here extends the entire distance along the configuration. Because of the lack of azimuthal symmetry, statistical errors for this case tend to be much larger thereby making it difficult to study the dependence on pipe thickness in this region. Instead the dependence is obtained from the calculated dose averaged over a large region within the concrete (0-300 cm high, from 730 to 790 cm laterally and from 1000 to 3000 cm in depth) where statistics is good. This same dependence is then assumed to apply in the test location to find the maximum dose there. The bins for the test locations are to 0 to 150 cm high, from 1000 to 1100 cm laterally. The entire length is divided into eight bins 500 cm long.

Figure 5 shows the largest value of the longitudinal bins (with error bars) in the test location as a function of pipe thickness. Also shown are the averaged values over the concrete region upon which the thickness dependence is based. Table II presents dose as a function of location in some detail for a 3 cm thick uniform pipe.

I wish to thank D. Theriot and R. Yamada for discussion.

References

1. A. Van Ginneken, "CASIM Program to Simulate Hadronic Cascades in Bulk Matter", FNAL-FN-272 (1975).

2. D. Theriot, private communication.

3. R. Yamada, private communication.

4. In the present work a soil density of 2.0 $g.cm^{-3}$ and a concrete density of 2.4 $g.cm^{-3}$ are assumed.

Table I

DOSE IN REM/INT.PROTCN AS A FUNCTION OF DISTANCE ALONG THE BEAM(DOWN,CM) AND RADIAL DISTANCE(ACROSS,CM)
RELATIVE ERROR IN PARENTHESES

		0.0 50.00		50.00 100.00		100.00 150.00		150.00 200.00		200.00 250.00	
0.0	200.00	0.0	(0.0)	0.0	(0.0)	6.25E-15	(0.40)	6.63E-18	(0.25)	5.17E-19	(0.07)
200.00	400.00	0.0	(0.0)	0.0	(0.0)	5.17E-15	(0.22)	1.03E-16	(0.09)	1.16E-17	(0.17)
400.00	600.00	0.0	(0.0)	0.0	(0.0)	3.15E-14	(0.11)	1.48E-15	(0.15)	2.95E-16	(0.10)
600.00	800.00	0.0	(0.0)	0.0	(0.0)	2.06E-13	(0.08)	2.76E-14	(0.07)	1.07E-14	(0.22)
800.00	1000.00	0.0	(0.0)	0.0	(0.0)	4.43E-12	(0.04)	2.58E-12	(0.05)	1.77E-12	(0.04)
1000.00	1200.00	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
1200.00	1400.00	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
1400.00	1600.00	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
1600.00	1800.00	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
1800.00	2000.00	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
2000.00	2200.00	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
2200.00	2400.00	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
2400.00	2600.00	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
2600.00	2800.00	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
2800.00	3000.00	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
3000.00	3200.00	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
3200.00	3400.00	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
3400.00	3600.00	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
3600.00	3800.00	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
3800.00	4000.00	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)

		250.00 300.00		300.00 350.00		350.00 400.00		400.00 450.00		450.00 500.00	
0.0	200.00	1.03E-19	(0.25)	2.63E-20	(0.14)	1.15E-20	(0.13)	5.03E-21	(0.27)	1.69E-21	(0.21)
200.00	400.00	3.94E-18	(0.25)	9.39E-19	(0.14)	3.21E-19	(0.12)	1.59E-19	(0.12)	9.27E-20	(0.21)
400.00	600.00	7.78E-17	(0.10)	3.37E-17	(0.09)	2.11E-17	(0.29)	1.10E-17	(0.21)	7.85E-18	(0.36)
600.00	800.00	4.30E-15	(0.21)	2.03E-15	(0.13)	1.26E-15	(0.07)	9.86E-16	(0.10)	1.17E-15	(0.40)
800.00	1000.00	1.36E-12	(0.05)	1.08E-12	(0.04)	8.41E-13	(0.04)	6.65E-13	(0.03)	5.90E-13	(0.03)
1000.00	1200.00	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
1200.00	1400.00	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
1400.00	1600.00	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
1600.00	1800.00	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
1800.00	2000.00	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
2000.00	2200.00	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
2200.00	2400.00	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
2400.00	2600.00	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
2600.00	2800.00	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
2800.00	3000.00	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
3000.00	3200.00	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
3200.00	3400.00	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
3400.00	3600.00	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
3600.00	3800.00	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)
3800.00	4000.00	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)

Table I (Cont.)

DOSE IN REM/INT.PROTON AS A FUNCTION OF DISTANCE ALONG THE BEAM(DOWN,CM) AND RADIAL DISTANCE(ACROSS,CM)
RELATIVE ERROR IN PARENTHESES

		500.00 550.00	550.00 600.00	600.00 650.00	650.00 700.00	700.00 750.00
0.0	200.00	7.29E-22 (0.11)	5.51E-22 (0.29)	9.80E-22 (0.75)	4.46E-22 (0.62)	1.75E-22 (0.27)
200.00	400.00	4.73E-20 (0.12)	5.64E-20 (0.47)	1.46E-19 (0.86)	2.38E-20 (0.31)	1.68E-20 (0.33)
400.00	600.00	5.95E-18 (0.42)	5.83E-18 (0.51)	6.33E-18 (0.62)	9.86E-18 (0.78)	1.42E-17 (0.91)
600.00	800.00	1.15E-15 (0.53)	1.54E-15 (0.73)	1.48E-15 (0.75)	5.55E-16 (0.52)	1.64E-16 (0.36)
800.00	1000.00	5.28E-13 (0.10)	1.99E-13 (0.07)	6.17E-14 (0.07)	1.93E-14 (0.05)	6.19E-15 (0.05)
1000.00	1200.00	0.0 (0.0)	9.36E-13 (0.02)	2.30E-13 (0.03)	6.86E-14 (0.11)	1.90E-14 (0.10)
1200.00	1400.00	0.0 (0.0)	2.27E-12 (0.04)	5.28E-13 (0.04)	1.48E-13 (0.07)	4.08E-14 (0.09)
1400.00	1600.00	0.0 (0.0)	4.20E-12 (0.02)	1.04E-12 (0.07)	2.77E-13 (0.14)	6.85E-14 (0.13)
1600.00	1800.00	0.0 (0.0)	8.53E-12 (0.04)	2.98E-12 (0.04)	1.02E-12 (0.07)	4.93E-13 (0.11)
1800.00	2000.00	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
2000.00	2200.00	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
2200.00	2400.00	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
2400.00	2600.00	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
2600.00	2800.00	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
2800.00	3000.00	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
3000.00	3200.00	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
3200.00	3400.00	0.0 (0.0)	8.67E-12 (0.06)	7.19E-12 (0.06)	6.59E-12 (0.03)	6.21E-12 (0.04)
3400.00	3600.00	0.0 (0.0)	5.50E-12 (0.08)	1.64E-12 (0.23)	6.58E-13 (0.11)	5.49E-13 (0.33)
3600.00	3800.00	0.0 (0.0)	4.41E-12 (0.03)	6.56E-13 (0.08)	1.44E-13 (0.17)	3.91E-14 (0.10)
3800.00	4000.00	0.0 (0.0)	4.38E-12 (0.06)	6.69E-13 (0.14)	1.28E-13 (0.16)	2.67E-14 (0.17)

		750.00 800.00	800.00 850.00	850.00 900.00	900.00 950.00	950.00 1000.00
0.0	200.00	1.10E-22 (0.29)	7.08E-23 (0.18)	8.30E-23 (0.48)	7.07E-23 (0.54)	9.56E-23 (0.82)
200.00	400.00	1.45E-20 (0.45)	3.60E-20 (0.80)	2.37E-20 (0.86)	8.77E-21 (0.76)	2.19E-21 (0.54)
400.00	600.00	3.22E-18 (0.72)	9.14E-19 (0.53)	2.45E-19 (0.26)	1.36E-19 (0.35)	5.09E-20 (0.32)
600.00	800.00	5.68E-17 (0.28)	2.09E-17 (0.23)	7.91E-18 (0.19)	3.05E-18 (0.13)	1.21E-18 (0.12)
800.00	1000.00	1.98E-15 (0.06)	6.28E-16 (0.07)	1.98E-16 (0.06)	6.12E-17 (0.06)	1.90E-17 (0.05)
1000.00	1200.00	5.39E-15 (0.09)	1.57E-15 (0.09)	4.54E-16 (0.08)	1.35E-16 (0.07)	3.98E-17 (0.07)
1200.00	1400.00	1.11E-14 (0.08)	3.13E-15 (0.10)	9.00E-16 (0.11)	2.61E-16 (0.13)	7.58E-17 (0.13)
1400.00	1600.00	1.83E-14 (0.12)	5.76E-15 (0.20)	1.52E-15 (0.15)	4.27E-16 (0.13)	1.28E-16 (0.15)
1600.00	1800.00	1.39E-13 (0.12)	3.09E-14 (0.12)	9.17E-15 (0.18)	2.31E-15 (0.12)	6.55E-16 (0.10)
1800.00	2000.00	1.76E-12 (0.06)	2.70E-13 (0.12)	5.71E-14 (0.17)	1.56E-14 (0.28)	4.27E-15 (0.29)
2000.00	2200.00	4.36E-12 (0.03)	1.15E-12 (0.05)	3.12E-13 (0.10)	7.70E-14 (0.09)	2.06E-14 (0.17)
2200.00	2400.00	5.04E-12 (0.05)	1.36E-12 (0.08)	3.96E-13 (0.09)	1.31E-13 (0.11)	3.87E-14 (0.10)
2400.00	2600.00	5.55E-12 (0.04)	1.28E-12 (0.06)	3.69E-13 (0.08)	1.77E-13 (0.18)	7.36E-14 (0.26)
2600.00	2800.00	5.70E-12 (0.06)	1.27E-12 (0.07)	3.18E-13 (0.10)	1.35E-13 (0.28)	6.02E-14 (0.30)
2800.00	3000.00	5.14E-12 (0.03)	1.44E-12 (0.14)	4.79E-13 (0.28)	1.35E-13 (0.26)	3.37E-14 (0.19)
3000.00	3200.00	4.89E-12 (0.07)	9.77E-13 (0.13)	2.72E-13 (0.23)	8.35E-14 (0.28)	2.53E-14 (0.28)
3200.00	3400.00	3.12E-12 (0.02)	9.16E-13 (0.07)	2.01E-13 (0.13)	5.04E-14 (0.19)	1.68E-14 (0.36)
3400.00	3600.00	3.11E-13 (0.15)	2.38E-13 (0.14)	7.63E-14 (0.17)	2.01E-14 (0.12)	6.47E-15 (0.16)
3600.00	3800.00	1.39E-14 (0.12)	9.88E-15 (0.27)	5.47E-15 (0.20)	1.77E-15 (0.16)	6.82E-16 (0.20)
3800.00	4000.00	7.83E-15 (0.19)	2.61E-15 (0.18)	1.56E-15 (0.53)	5.20E-16 (0.54)	1.62E-16 (0.55)

Table I (Cont.)

DOSE IN REM/INT.PROTCN AS A FUNCTION OF DISTANCE ALONG THE BEAM(DOWN,CM) AND RADIAL DISTANCE(ACROSS,CM)
RELATIVE ERROR IN PARENTHESES

		1000.00 1050.00	1050.00 1100.00	1100.00 1150.00	1150.00 1200.00	1200.00 1250.00
0.0	200.00	8.08E-23 (0.85)	1.91E-23 (0.78)	7.29E-24 (0.65)	1.87E-24 (0.35)	6.79E-25 (0.26)
200.00	400.00	6.57E-22 (0.37)	2.38E-22 (0.16)	1.27E-22 (0.34)	5.93E-23 (0.38)	2.08E-23 (0.34)
400.00	600.00	1.60E-20 (0.21)	6.52E-21 (0.19)	2.60E-21 (0.23)	1.19E-21 (0.20)	3.98E-22 (0.13)
600.00	800.00	4.64E-19 (0.11)	1.76E-19 (0.12)	6.47E-20 (0.11)	2.34E-20 (0.10)	8.77E-21 (0.09)
800.00	1000.00	5.94E-18 (0.05)	1.87E-18 (0.04)	5.78E-19 (0.04)	1.79E-19 (0.04)	5.47E-20 (0.04)
1000.00	1200.00	1.27E-17 (0.07)	3.74E-18 (0.07)	1.15E-18 (0.07)	3.51E-19 (0.07)	1.10E-19 (0.08)
1200.00	1400.00	2.12E-17 (0.11)	6.30E-18 (0.12)	1.87E-18 (0.10)	5.67E-19 (0.11)	1.73E-19 (0.11)
1400.00	1600.00	3.87E-17 (0.13)	1.23E-17 (0.12)	3.74E-18 (0.11)	1.21E-18 (0.10)	4.07E-19 (0.11)
1600.00	1800.00	1.99E-16 (0.10)	6.06E-17 (0.11)	1.80E-17 (0.09)	5.52E-18 (0.09)	1.69E-18 (0.10)
1800.00	2000.00	1.32E-15 (0.24)	3.93E-16 (0.22)	2.01E-16 (0.31)	2.14E-16 (0.57)	1.74E-16 (0.64)
2000.00	2200.00	6.03E-15 (0.14)	2.02E-15 (0.14)	7.99E-16 (0.14)	6.19E-16 (0.11)	5.50E-16 (0.11)
2200.00	2400.00	1.68E-14 (0.24)	4.92E-15 (0.21)	2.11E-15 (0.20)	1.92E-15 (0.23)	1.74E-15 (0.27)
2400.00	2600.00	2.37E-14 (0.22)	7.83E-15 (0.23)	3.27E-15 (0.24)	2.58E-15 (0.23)	2.37E-15 (0.22)
2600.00	2800.00	1.74E-14 (0.18)	6.65E-15 (0.19)	2.61E-15 (0.10)	2.43E-15 (0.11)	2.26E-15 (0.15)
2800.00	3000.00	1.25E-14 (0.15)	4.27E-15 (0.14)	2.67E-15 (0.25)	2.43E-15 (0.23)	2.22E-15 (0.24)
3000.00	3200.00	7.07E-15 (0.27)	1.96E-15 (0.26)	8.24E-16 (0.27)	3.31E-16 (0.22)	2.90E-16 (0.30)
3200.00	3400.00	3.63E-15 (0.28)	8.55E-16 (0.16)	2.25E-16 (0.14)	7.70E-17 (0.14)	2.08E-17 (0.13)
3400.00	3600.00	3.23E-15 (0.39)	9.24E-16 (0.41)	2.84E-16 (0.35)	8.29E-17 (0.27)	7.20E-17 (0.72)
3600.00	3800.00	2.75E-16 (0.34)	1.73E-16 (0.36)	9.01E-17 (0.57)	1.52E-17 (0.40)	6.54E-18 (0.29)
3800.00	4000.00	8.04E-17 (0.38)	3.31E-17 (0.36)	6.38E-18 (0.38)	2.77E-18 (0.27)	1.33E-18 (0.46)

		1250.00 1300.00	1300.00 1350.00	1350.00 1400.00	1400.00 1450.00	1450.00 1500.00
0.0	200.00	2.81E-25 (0.14)	1.48E-25 (0.32)	4.75E-26 (0.19)	2.75E-26 (0.32)	1.48E-26 (0.56)
200.00	400.00	8.35E-24 (0.34)	2.93E-24 (0.18)	1.34E-24 (0.20)	5.12E-25 (0.16)	1.75E-25 (0.11)
400.00	600.00	1.64E-22 (0.13)	6.50E-23 (0.13)	2.42E-23 (0.12)	9.49E-24 (0.15)	3.69E-24 (0.13)
600.00	800.00	3.03E-21 (0.07)	1.06E-21 (0.07)	3.74E-22 (0.08)	1.26E-22 (0.07)	4.36E-23 (0.07)
800.00	1000.00	1.71E-20 (0.03)	5.31E-21 (0.03)	1.64E-21 (0.03)	5.14E-22 (0.04)	1.59E-22 (0.04)
1000.00	1200.00	3.29E-20 (0.07)	1.02E-20 (0.08)	3.17E-21 (0.07)	9.88E-22 (0.08)	3.09E-22 (0.08)
1200.00	1400.00	5.34E-20 (0.12)	1.62E-20 (0.11)	5.07E-21 (0.11)	1.54E-21 (0.11)	4.90E-22 (0.11)
1400.00	1600.00	1.34E-19 (0.11)	4.30E-20 (0.11)	1.32E-20 (0.11)	4.52E-21 (0.09)	1.39E-21 (0.10)
1600.00	1800.00	5.45E-19 (0.10)	2.01E-19 (0.18)	5.74E-20 (0.11)	1.73E-20 (0.08)	9.27E-21 (0.25)
1800.00	2000.00	6.97E-17 (0.35)	4.68E-17 (0.26)	3.80E-17 (0.26)	3.31E-17 (0.23)	3.03E-17 (0.18)
2000.00	2200.00	5.27E-16 (0.12)	4.62E-16 (0.12)	4.11E-16 (0.14)	3.36E-16 (0.15)	3.04E-16 (0.16)
2200.00	2400.00	1.24E-15 (0.17)	1.07E-15 (0.16)	8.90E-16 (0.17)	8.18E-16 (0.14)	7.00E-16 (0.12)
2400.00	2600.00	2.45E-15 (0.24)	2.22E-15 (0.24)	2.18E-15 (0.24)	1.62E-15 (0.18)	1.52E-15 (0.18)
2600.00	2800.00	2.21E-15 (0.16)	2.17E-15 (0.16)	1.97E-15 (0.16)	2.16E-15 (0.21)	2.01E-15 (0.22)
2800.00	3000.00	2.17E-15 (0.26)	1.98E-15 (0.20)	2.01E-15 (0.21)	1.97E-15 (0.20)	1.88E-15 (0.22)
3000.00	3200.00	2.19E-16 (0.29)	1.54E-16 (0.20)	2.86E-16 (0.43)	1.52E-16 (0.28)	4.23E-16 (0.67)
3200.00	3400.00	1.13E-17 (0.34)	8.64E-18 (0.45)	1.97E-17 (0.66)	4.32E-17 (0.64)	6.67E-18 (0.55)
3400.00	3600.00	7.47E-18 (0.22)	2.69E-18 (0.32)	9.91E-19 (0.53)	2.85E-19 (0.37)	2.58E-19 (0.77)
3600.00	3800.00	2.36E-17 (0.83)	3.09E-18 (0.69)	4.38E-19 (0.43)	1.11E-19 (0.51)	3.49E-20 (0.47)
3800.00	4000.00	9.36E-18 (0.97)	2.76E-18 (0.96)	5.38E-19 (0.75)	1.85E-19 (0.83)	2.80E-20 (0.83)

RETURN CODE FROM 'IEWLDRGO' ... 00000000000

Table II

DOSE IN ASSEMBLY HALL IN REM/INT.PROTON FOR X(VERTICAL)-REGION FROM 0.0 TO 150.00 CM (RELATIVE ERROR)
AS A FUNCTION OF LATERAL DISTANCE (ACROSS) & LONGITUDINAL DISTANCE (DOWN) , IN CM

		1000.00 1100.00	1100.00 1200.00	1200.00 1300.00	1300.00 1400.00	1400.00 1500.00	1500.00 1600.00
0.0	500.00	1.70E-16 (0.10)	1.46E-16 (0.10)	1.54E-16 (0.19)	1.35E-16 (0.18)	1.22E-16 (0.22)	1.08E-16 (0.22)
500.00	1000.00	2.98E-16 (0.14)	3.47E-16 (0.22)	3.68E-16 (0.30)	4.68E-16 (0.49)	4.65E-16 (0.54)	4.63E-16 (0.56)
1000.00	1500.00	4.11E-16 (0.28)	3.50E-16 (0.26)	4.12E-16 (0.22)	3.84E-16 (0.22)	4.71E-16 (0.34)	4.61E-16 (0.39)
1500.00	2000.00	3.20E-16 (0.21)	3.13E-16 (0.17)	2.76E-16 (0.16)	2.58E-16 (0.14)	2.63E-16 (0.11)	4.89E-16 (0.50)
2000.00	2500.00	1.88E-15 (0.56)	1.10E-15 (0.37)	7.31E-16 (0.23)	5.94E-16 (0.21)	5.18E-16 (0.24)	4.32E-16 (0.20)
2500.00	3000.00	2.04E-15 (0.65)	2.01E-15 (0.55)	1.65E-15 (0.48)	1.45E-15 (0.47)	1.17E-15 (0.42)	1.05E-15 (0.32)
3000.00	3500.00	1.31E-15 (0.56)	1.09E-15 (0.39)	9.04E-16 (0.32)	9.41E-16 (0.29)	8.10E-16 (0.26)	6.96E-16 (0.29)
3500.00	4000.00	1.55E-16 (0.34)	1.88E-16 (0.39)	3.27E-16 (0.40)	2.49E-16 (0.32)	3.75E-16 (0.37)	4.68E-16 (0.29)

		1600.00 1700.00	1700.00 1800.00	1800.00 1900.00	1900.00 2000.00	2000.00 2100.00	2100.00 2200.00
0.0	500.00	1.02E-16 (0.27)	8.76E-17 (0.26)	8.38E-17 (0.32)	6.53E-17 (0.22)	4.61E-17 (0.12)	5.76E-17 (0.25)
500.00	1000.00	4.98E-16 (0.62)	4.58E-16 (0.64)	3.12E-16 (0.53)	2.79E-16 (0.50)	2.68E-16 (0.52)	2.62E-16 (0.54)
1000.00	1500.00	5.53E-16 (0.52)	8.01E-16 (0.46)	1.10E-15 (0.54)	1.10E-15 (0.57)	9.50E-16 (0.51)	7.78E-16 (0.49)
1500.00	2000.00	6.16E-16 (0.57)	4.08E-16 (0.32)	3.72E-16 (0.30)	3.69E-16 (0.29)	5.18E-16 (0.47)	4.85E-16 (0.49)
2000.00	2500.00	4.06E-16 (0.19)	3.51E-16 (0.20)	4.06E-16 (0.27)	3.52E-16 (0.26)	4.01E-16 (0.26)	3.90E-16 (0.26)
2500.00	3000.00	1.02E-15 (0.28)	7.92E-16 (0.26)	7.46E-16 (0.26)	5.99E-16 (0.23)	5.09E-16 (0.23)	4.56E-16 (0.24)
3000.00	3500.00	7.52E-16 (0.34)	7.92E-16 (0.29)	7.25E-16 (0.29)	7.54E-16 (0.35)	7.10E-16 (0.30)	5.33E-16 (0.26)
3500.00	4000.00	5.34E-16 (0.33)	4.81E-16 (0.37)	5.20E-16 (0.41)	6.64E-16 (0.32)	6.93E-16 (0.32)	7.24E-16 (0.30)

DOSE IN ASSEMBLY HALL IN REM/INT.PROTON FOR X(VERTICAL)-REGION FROM 150.00 TO 300.00 CM (RELATIVE ERROR)
AS A FUNCTION OF LATERAL DISTANCE (ACROSS) & LONGITUDINAL DISTANCE (DOWN) , IN CM

		1000.00 1100.00	1100.00 1200.00	1200.00 1300.00	1300.00 1400.00	1400.00 1500.00	1500.00 1600.00
0.0	500.00	2.43E-16 (0.39)	1.89E-16 (0.32)	1.36E-16 (0.20)	1.18E-16 (0.17)	1.10E-16 (0.17)	1.01E-16 (0.18)
500.00	1000.00	2.18E-15 (0.80)	1.69E-15 (0.79)	1.35E-15 (0.77)	1.04E-15 (0.71)	8.69E-16 (0.68)	7.25E-16 (0.64)
1000.00	1500.00	3.24E-16 (0.18)	3.76E-16 (0.22)	4.96E-16 (0.43)	6.80E-16 (0.56)	7.01E-16 (0.61)	5.58E-16 (0.55)
1500.00	2000.00	2.68E-16 (0.21)	2.26E-16 (0.18)	4.55E-16 (0.48)	5.42E-16 (0.59)	5.41E-16 (0.59)	3.04E-16 (0.23)
2000.00	2500.00	3.85E-16 (0.23)	5.95E-16 (0.40)	6.90E-16 (0.43)	6.51E-16 (0.35)	5.04E-16 (0.30)	4.21E-16 (0.36)
2500.00	3000.00	6.88E-16 (0.43)	1.07E-15 (0.31)	1.08E-15 (0.30)	7.85E-16 (0.23)	1.03E-15 (0.29)	9.95E-16 (0.29)
3000.00	3500.00	1.38E-15 (0.34)	1.59E-15 (0.42)	1.75E-15 (0.41)	1.48E-15 (0.37)	1.17E-15 (0.42)	1.21E-15 (0.30)
3500.00	4000.00	1.85E-16 (0.32)	3.09E-16 (0.35)	3.34E-16 (0.34)	4.76E-16 (0.40)	5.40E-16 (0.37)	4.29E-16 (0.29)

		1600.00 1700.00	1700.00 1800.00	1800.00 1900.00	1900.00 2000.00	2000.00 2100.00	2100.00 2200.00
0.0	500.00	8.60E-17 (0.16)	8.50E-17 (0.19)	7.42E-17 (0.15)	8.05E-17 (0.32)	9.95E-17 (0.51)	8.10E-17 (0.44)
500.00	1000.00	5.28E-16 (0.57)	3.62E-16 (0.48)	3.48E-16 (0.50)	2.68E-16 (0.49)	2.34E-16 (0.50)	1.88E-16 (0.43)
1000.00	1500.00	5.20E-16 (0.54)	4.38E-16 (0.51)	3.19E-16 (0.36)	2.96E-16 (0.32)	2.60E-16 (0.28)	3.49E-16 (0.36)
1500.00	2000.00	2.50E-16 (0.22)	2.35E-16 (0.21)	2.35E-16 (0.26)	2.51E-16 (0.29)	2.61E-16 (0.31)	2.26E-16 (0.26)
2000.00	2500.00	4.05E-16 (0.31)	4.18E-16 (0.31)	3.05E-16 (0.21)	2.92E-16 (0.20)	2.73E-16 (0.19)	1.98E-16 (0.17)
2500.00	3000.00	7.36E-16 (0.31)	5.45E-16 (0.20)	5.23E-16 (0.17)	5.08E-16 (0.15)	5.47E-16 (0.20)	5.74E-16 (0.19)
3000.00	3500.00	1.08E-15 (0.40)	8.68E-16 (0.42)	7.54E-16 (0.35)	4.64E-16 (0.44)	5.53E-16 (0.40)	7.32E-16 (0.44)
3500.00	4000.00	5.20E-16 (0.38)	6.30E-16 (0.42)	8.39E-16 (0.36)	9.70E-16 (0.45)	8.67E-16 (0.42)	7.28E-16 (0.47)

Table II (Cont.)

DOSE IN ASSEMBLY HALL IN REM/INT.PRCTCN FOR X(VERTICAL)-REGION FROM 300.CC TO 450.CC CM (RELATIVE ERRCR)
AS A FUNCTION OF LATERAL DISTANCE (ACRCSS) & LONGITUDINAL DISTANCE (DCWN) , IN CM

		1000.00 1100.00	1100.00 1200.00	1200.00 1300.00	1300.00 1400.00	1400.00 1500.00	1500.00 1600.00
0.0	500.00	1.48E-16 (0.24)	1.27E-16 (0.29)	1.44E-16 (0.39)	9.55E-17 (0.20)	8.28E-17 (0.23)	7.95E-17 (0.23)
500.00	1000.00	1.63E-15 (0.56)	1.37E-15 (0.60)	1.26E-15 (0.66)	1.03E-15 (0.65)	7.75E-16 (0.65)	5.29E-16 (0.51)
1000.00	1500.00	2.97E-16 (0.32)	3.04E-16 (0.27)	3.27E-16 (0.28)	4.47E-16 (0.43)	5.50E-16 (0.46)	7.59E-16 (0.65)
1500.00	2000.00	6.10E-16 (0.40)	7.26E-16 (0.54)	5.43E-16 (0.42)	4.48E-16 (0.35)	3.73E-16 (0.31)	2.71E-16 (0.26)
2000.00	2500.00	3.37E-15 (0.95)	2.54E-15 (0.91)	1.80E-15 (0.86)	1.07E-15 (0.76)	1.12E-15 (0.71)	1.02E-15 (0.65)
2500.00	3000.00	3.46E-16 (0.40)	2.93E-16 (0.28)	7.83E-16 (0.36)	1.34E-15 (0.57)	1.26E-15 (0.69)	1.06E-15 (0.63)
3000.00	3500.00	1.09E-15 (0.56)	8.37E-16 (0.42)	7.62E-16 (0.30)	9.01E-16 (0.35)	7.19E-16 (0.32)	7.75E-16 (0.38)
3500.00	4000.00	4.01E-16 (0.41)	6.57E-16 (0.53)	6.65E-16 (0.51)	6.50E-16 (0.53)	7.92E-16 (0.48)	5.39E-16 (0.33)

		1600.00 1700.00	1700.00 1800.00	1800.00 1900.00	1900.00 2000.00	2000.00 2100.00	2100.00 2200.00
0.0	500.00	7.40E-17 (0.21)	7.07E-17 (0.18)	5.99E-17 (0.17)	6.16E-17 (0.20)	5.21E-17 (0.21)	4.33E-17 (0.20)
500.00	1000.00	4.84E-16 (0.51)	5.09E-16 (0.57)	4.24E-16 (0.58)	2.56E-16 (0.36)	2.06E-16 (0.21)	2.11E-16 (0.27)
1000.00	1500.00	6.69E-16 (0.63)	7.07E-16 (0.66)	7.23E-16 (0.65)	8.49E-16 (0.72)	7.78E-16 (0.71)	5.54E-16 (0.65)
1500.00	2000.00	2.95E-16 (0.23)	3.10E-16 (0.25)	2.82E-16 (0.24)	2.75E-16 (0.23)	2.66E-16 (0.28)	3.11E-16 (0.36)
2000.00	2500.00	8.54E-16 (0.62)	6.59E-16 (0.57)	4.65E-16 (0.47)	4.24E-16 (0.46)	3.74E-16 (0.48)	3.99E-16 (0.48)
2500.00	3000.00	1.15E-15 (0.57)	1.15E-15 (0.48)	9.62E-16 (0.48)	7.71E-16 (0.46)	7.46E-16 (0.55)	6.48E-16 (0.59)
3000.00	3500.00	7.98E-16 (0.32)	9.88E-16 (0.27)	1.16E-15 (0.43)	9.28E-16 (0.50)	6.58E-16 (0.50)	4.21E-16 (0.30)
3500.00	4000.00	4.63E-16 (0.28)	4.20E-16 (0.30)	3.98E-16 (0.33)	3.39E-16 (0.32)	2.83E-16 (0.28)	3.20E-16 (0.34)

DOSE IN ASSEMBLY HALL IN REM/INT.PRCTCN FCR X(VERTICAL)-REGICN FROM 450.CC TO 600.CC CM (RELATIVE ERRCR)
AS A FUNCTION OF LATERAL DISTANCE (ACRCSS) & LONGITUDINAL DISTANCE (DOWN) , IN CM

		1000.00 1100.00	1100.00 1200.00	1200.00 1300.00	1300.00 1400.00	1400.00 1500.00	1500.00 1600.00
0.0	500.00	5.11E-17 (0.06)	6.80E-17 (0.23)	5.27E-17 (0.12)	9.03E-17 (0.41)	9.10E-17 (0.37)	8.17E-17 (0.36)
500.00	1000.00	3.27E-16 (0.30)	6.36E-16 (0.49)	6.81E-16 (0.53)	4.49E-16 (0.45)	4.30E-16 (0.42)	5.74E-16 (0.61)
1000.00	1500.00	3.01E-16 (0.40)	2.59E-16 (0.24)	2.83E-16 (0.22)	3.03E-16 (0.24)	2.57E-16 (0.22)	2.58E-16 (0.29)
1500.00	2000.00	6.32E-16 (0.57)	5.26E-16 (0.45)	4.31E-16 (0.34)	4.19E-16 (0.36)	4.56E-16 (0.49)	4.28E-16 (0.52)
2000.00	2500.00	6.08E-16 (0.80)	9.51E-16 (0.84)	9.55E-16 (0.80)	6.44E-16 (0.70)	4.94E-16 (0.61)	5.25E-16 (0.56)
2500.00	3000.00	2.32E-16 (0.63)	1.92E-16 (0.39)	2.61E-16 (0.38)	6.19E-16 (0.45)	4.44E-16 (0.31)	3.41E-16 (0.29)
3000.00	3500.00	5.54E-16 (0.64)	4.64E-16 (0.50)	3.86E-16 (0.39)	2.74E-16 (0.30)	4.19E-16 (0.30)	3.07E-16 (0.25)
3500.00	4000.00	1.13E-15 (0.55)	7.36E-16 (0.50)	5.65E-16 (0.40)	5.23E-16 (0.32)	5.01E-16 (0.26)	5.45E-16 (0.33)

		1600.00 1700.00	1700.00 1800.00	1800.00 1900.00	1900.00 2000.00	2000.00 2100.00	2100.00 2200.00
0.0	500.00	9.82E-17 (0.46)	1.06E-16 (0.54)	7.14E-17 (0.31)	4.58E-17 (0.19)	5.42E-17 (0.29)	6.41E-17 (0.28)
500.00	1000.00	4.36E-16 (0.54)	3.43E-16 (0.43)	2.77E-16 (0.38)	2.97E-16 (0.42)	2.93E-16 (0.49)	2.76E-16 (0.45)
1000.00	1500.00	3.47E-16 (0.32)	3.65E-16 (0.37)	4.33E-16 (0.42)	4.03E-16 (0.35)	3.56E-16 (0.30)	5.04E-16 (0.41)
1500.00	2000.00	3.17E-16 (0.43)	2.59E-16 (0.37)	3.14E-16 (0.35)	3.10E-16 (0.28)	3.08E-16 (0.34)	2.97E-16 (0.33)
2000.00	2500.00	3.17E-16 (0.37)	2.87E-16 (0.30)	2.27E-16 (0.22)	1.97E-16 (0.17)	2.19E-16 (0.18)	1.92E-16 (0.20)
2500.00	3000.00	4.58E-16 (0.53)	5.85E-16 (0.57)	6.14E-16 (0.57)	6.53E-16 (0.46)	5.35E-16 (0.40)	6.10E-16 (0.44)
3000.00	3500.00	2.93E-16 (0.29)	3.88E-16 (0.25)	4.54E-16 (0.24)	3.57E-16 (0.35)	4.65E-16 (0.49)	4.66E-16 (0.42)
3500.00	4000.00	3.54E-16 (0.29)	3.49E-16 (0.32)	3.18E-16 (0.33)	3.81E-16 (0.25)	4.34E-16 (0.26)	3.93E-16 (0.23)

Table II (Cont.)

DOSE IN ASSEMBLY HALL IN REM/INT.FRCTCN FOR X(VERTICAL)-REGICN FROM 600.00 TO 750.CO CM (RELATIVE ERROR)
AS A FUNCTION OF LATERAL DISTANCE (ACROSS) & LONGITUDINAL DISTANCE (DOWN) , IN CM

		1000.00 1100.00	1100.00 1200.00	1200.00 1300.00	1300.00 1400.00	1400.00 1500.00	1500.00 1600.00
0.0	500.00	2.34E-17 (0.06)	4.19E-17 (0.26)	3.77E-17 (0.15)	3.92E-17 (0.16)	3.70E-17 (0.11)	4.61E-17 (0.23)
500.00	1000.00	1.99E-16 (0.57)	2.02E-16 (0.41)	2.39E-16 (0.31)	4.04E-16 (0.37)	3.77E-16 (0.39)	2.43E-16 (0.37)
1000.00	1500.00	3.91E-16 (0.46)	4.08E-16 (0.43)	3.43E-16 (0.40)	2.97E-16 (0.31)	3.53E-16 (0.36)	3.10E-16 (0.35)
1500.00	2000.00	1.63E-16 (0.27)	2.83E-16 (0.36)	3.22E-16 (0.44)	2.82E-16 (0.43)	2.79E-16 (0.40)	2.70E-16 (0.39)
2000.00	2500.00	2.54E-16 (0.66)	2.06E-16 (0.35)	3.04E-16 (0.45)	3.82E-16 (0.48)	4.13E-16 (0.48)	3.89E-16 (0.43)
2500.00	3000.00	7.91E-16 (0.75)	4.92E-16 (0.72)	3.05E-16 (0.54)	3.65E-16 (0.41)	5.66E-16 (0.49)	5.74E-16 (0.57)
3000.00	3500.00	2.96E-16 (0.39)	2.84E-16 (0.34)	2.42E-16 (0.38)	2.89E-16 (0.39)	3.56E-16 (0.42)	3.60E-16 (0.36)
3500.00	4000.00	1.20E-16 (0.29)	2.60E-16 (0.31)	4.10E-16 (0.40)	4.07E-16 (0.32)	3.78E-16 (0.34)	3.60E-16 (0.32)

		1600.00 1700.00	1700.00 1800.00	1800.00 1900.00	1900.00 2000.00	2000.00 2100.00	2100.00 2200.00
0.0	500.00	6.98E-17 (0.42)	8.60E-17 (0.46)	8.85E-17 (0.31)	9.44E-17 (0.48)	9.77E-17 (0.59)	8.11E-17 (0.56)
500.00	1000.00	3.31E-16 (0.45)	2.59E-16 (0.40)	2.51E-16 (0.39)	2.03E-16 (0.37)	1.82E-16 (0.35)	2.17E-16 (0.42)
1000.00	1500.00	2.54E-16 (0.33)	2.22E-16 (0.29)	1.92E-16 (0.26)	2.08E-16 (0.27)	2.74E-16 (0.46)	3.29E-16 (0.54)
1500.00	2000.00	3.34E-16 (0.34)	2.89E-16 (0.32)	2.67E-16 (0.35)	2.12E-16 (0.36)	2.07E-16 (0.42)	1.35E-16 (0.16)
2000.00	2500.00	3.18E-16 (0.36)	2.48E-16 (0.42)	2.28E-16 (0.29)	2.34E-16 (0.33)	2.07E-16 (0.24)	1.76E-16 (0.25)
2500.00	3000.00	5.02E-16 (0.42)	3.09E-16 (0.31)	1.83E-16 (0.22)	2.71E-16 (0.37)	3.75E-16 (0.48)	4.73E-16 (0.50)
3000.00	3500.00	4.74E-16 (0.36)	3.65E-16 (0.40)	3.09E-16 (0.25)	3.85E-16 (0.24)	3.54E-16 (0.21)	2.95E-16 (0.19)
3500.00	4000.00	3.21E-16 (0.36)	1.65E-16 (0.22)	2.30E-16 (0.29)	2.98E-16 (0.30)	3.26E-16 (0.27)	3.73E-16 (0.28)

DOSE IN ASSEMBLY HALL IN REM/INT.FRCTCN FOR X(VERTICAL)-REGION FROM 750.CC TO 920.00 CM (RELATIVE ERROR)
AS A FUNCTION OF LATERAL DISTANCE (ACROSS) & LONGITUDINAL DISTANCE (DOWN) , IN CM

		1000.00 1100.00	1100.00 1200.00	1200.00 1300.00	1300.00 1400.00	1400.00 1500.00	1500.00 1600.00
0.0	500.00	2.64E-17 (0.61)	2.80E-17 (0.53)	2.38E-17 (0.33)	2.42E-17 (0.30)	3.15E-17 (0.28)	3.57E-17 (0.29)
500.00	1000.00	7.83E-17 (0.73)	9.05E-17 (0.68)	9.11E-17 (0.53)	1.14E-16 (0.31)	1.38E-16 (0.32)	2.27E-16 (0.48)
1000.00	1500.00	5.53E-17 (0.28)	1.06E-16 (0.33)	1.66E-16 (0.36)	2.01E-16 (0.46)	2.07E-16 (0.47)	2.31E-16 (0.32)
1500.00	2000.00	3.07E-16 (0.64)	1.18E-16 (0.27)	1.46E-16 (0.31)	1.85E-16 (0.35)	1.90E-16 (0.40)	1.92E-16 (0.35)
2000.00	2500.00	1.41E-16 (0.42)	1.50E-16 (0.32)	1.98E-16 (0.28)	2.13E-16 (0.30)	2.06E-16 (0.22)	2.63E-16 (0.30)
2500.00	3000.00	1.10E-16 (0.37)	3.17E-16 (0.70)	4.00E-16 (0.75)	3.39E-16 (0.74)	4.12E-16 (0.57)	4.26E-16 (0.45)
3000.00	3500.00	4.92E-16 (0.80)	2.61E-16 (0.65)	2.44E-16 (0.60)	1.88E-16 (0.49)	1.66E-16 (0.40)	2.51E-16 (0.55)
3500.00	4000.00	1.93E-16 (0.50)	1.95E-16 (0.44)	1.66E-16 (0.39)	2.15E-16 (0.33)	2.15E-16 (0.35)	2.72E-16 (0.37)

		1600.00 1700.00	1700.00 1800.00	1800.00 1900.00	1900.00 2000.00	2000.00 2100.00	2100.00 2200.00
0.0	500.00	3.16E-17 (0.25)	2.75E-17 (0.20)	4.10E-17 (0.31)	5.75E-17 (0.53)	6.03E-17 (0.47)	6.18E-17 (0.44)
500.00	1000.00	2.07E-16 (0.45)	1.47E-16 (0.35)	1.45E-16 (0.45)	1.77E-16 (0.35)	1.81E-16 (0.37)	1.74E-16 (0.39)
1000.00	1500.00	2.60E-16 (0.39)	2.14E-16 (0.37)	1.71E-16 (0.31)	1.62E-16 (0.39)	1.46E-16 (0.31)	9.55E-17 (0.20)
1500.00	2000.00	1.96E-16 (0.34)	2.22E-16 (0.37)	1.90E-16 (0.40)	2.20E-16 (0.33)	2.16E-16 (0.29)	2.46E-16 (0.33)
2000.00	2500.00	2.22E-16 (0.28)	2.80E-16 (0.42)	3.27E-16 (0.30)	3.44E-16 (0.33)	3.05E-16 (0.25)	2.60E-16 (0.28)
2500.00	3000.00	3.50E-16 (0.52)	2.85E-16 (0.36)	2.22E-16 (0.40)	2.21E-16 (0.36)	2.02E-16 (0.35)	1.03E-16 (0.21)
3000.00	3500.00	2.31E-16 (0.34)	3.39E-16 (0.39)	3.87E-16 (0.49)	2.73E-16 (0.63)	2.24E-16 (0.43)	2.21E-16 (0.42)
3500.00	4000.00	3.88E-16 (0.34)	3.98E-16 (0.34)	2.90E-16 (0.30)	2.42E-16 (0.36)	3.25E-16 (0.39)	3.13E-16 (0.33)

Table II (Cont.)

DOSE IN WALL IN REM/INT.PROTON FOR X(VERTICAL)-REGION FROM 0.0 TO 150.00 CM (RELATIVE ERROR)
AS A FUNCTION OF LATERAL DISTANCE (ACROSS) & LONGITUDINAL DISTANCE (DOWN) , IN CM

		640.00 670.00	670.00 700.00	700.00 730.00	730.00 760.00	760.00 790.00	790.00 820.00
0.0	500.00	1.49E-12 (0.05)	6.15E-13 (0.07)	2.74E-13 (0.08)	1.25E-13 (0.10)	5.58E-14 (0.10)	2.56E-14 (0.11)
500.00	1000.00	4.77E-12 (0.06)	2.01E-12 (0.11)	8.01E-13 (0.14)	2.96E-13 (0.14)	1.21E-13 (0.14)	4.82E-14 (0.14)
1000.00	1500.00	8.78E-12 (0.11)	3.06E-12 (0.11)	1.07E-12 (0.14)	4.43E-13 (0.28)	1.82E-13 (0.27)	8.54E-14 (0.29)
1500.00	2000.00	9.84E-12 (0.23)	3.30E-12 (0.14)	1.40E-12 (0.23)	3.86E-13 (0.20)	1.26E-13 (0.23)	6.19E-14 (0.28)
2000.00	2500.00	7.56E-12 (0.11)	2.58E-12 (0.12)	1.25E-12 (0.20)	4.40E-13 (0.20)	1.70E-13 (0.18)	9.88E-14 (0.47)
2500.00	3000.00	8.07E-12 (0.16)	2.98E-12 (0.32)	9.05E-13 (0.39)	3.96E-13 (0.44)	1.83E-13 (0.46)	8.16E-14 (0.43)
3000.00	3500.00	6.16E-12 (0.15)	1.52E-12 (0.15)	6.35E-13 (0.26)	3.82E-13 (0.48)	1.55E-13 (0.56)	1.04E-13 (0.56)
3500.00	4000.00	5.26E-12 (0.20)	1.45E-12 (0.26)	5.43E-13 (0.32)	2.22E-13 (0.40)	7.49E-14 (0.35)	2.75E-14 (0.33)

		820.00 850.00	850.00 880.00	880.00 910.00	910.00 940.00	940.00 970.00	970.00 1000.00
0.0	500.00	1.20E-14 (0.11)	5.73E-15 (0.11)	2.68E-15 (0.10)	1.21E-15 (0.12)	5.76E-16 (0.09)	2.78E-16 (0.11)
500.00	1000.00	2.35E-14 (0.17)	1.00E-14 (0.17)	4.57E-15 (0.16)	2.03E-15 (0.17)	9.03E-16 (0.16)	4.88E-16 (0.19)
1000.00	1500.00	3.92E-14 (0.27)	1.59E-14 (0.26)	6.89E-15 (0.30)	2.94E-15 (0.29)	1.43E-15 (0.31)	6.04E-16 (0.30)
1500.00	2000.00	2.41E-14 (0.31)	1.34E-14 (0.33)	5.92E-15 (0.30)	2.74E-15 (0.33)	1.26E-15 (0.35)	5.42E-16 (0.33)
2000.00	2500.00	3.90E-14 (0.49)	1.49E-14 (0.31)	8.96E-15 (0.31)	5.65E-15 (0.29)	2.62E-15 (0.34)	2.30E-15 (0.56)
2500.00	3000.00	3.24E-14 (0.44)	1.20E-14 (0.36)	7.06E-15 (0.41)	2.83E-15 (0.37)	1.28E-15 (0.36)	2.03E-15 (0.69)
3000.00	3500.00	5.88E-14 (0.55)	2.38E-14 (0.52)	1.65E-14 (0.55)	7.35E-15 (0.46)	2.83E-15 (0.45)	1.38E-15 (0.47)
3500.00	4000.00	1.34E-14 (0.32)	5.49E-15 (0.31)	2.16E-15 (0.31)	9.57E-16 (0.29)	4.59E-16 (0.34)	1.95E-16 (0.32)

DOSE IN WALL IN REM/INT.PROTON FOR X(VERTICAL)-REGION FROM 150.00 TO 300.00 CM (RELATIVE ERROR)
AS A FUNCTION OF LATERAL DISTANCE (ACROSS) & LONGITUDINAL DISTANCE (DOWN) , IN CM

		640.00 670.00	670.00 700.00	700.00 730.00	730.00 760.00	760.00 790.00	790.00 820.00
0.0	500.00	1.41E-12 (0.07)	5.71E-13 (0.08)	2.25E-13 (0.07)	9.86E-14 (0.08)	4.52E-14 (0.09)	2.09E-14 (0.09)
500.00	1000.00	4.33E-12 (0.09)	1.84E-12 (0.23)	6.28E-13 (0.19)	3.54E-13 (0.31)	1.29E-13 (0.20)	6.02E-14 (0.21)
1000.00	1500.00	5.44E-12 (0.03)	1.55E-12 (0.07)	7.40E-13 (0.10)	2.85E-13 (0.20)	1.24E-13 (0.27)	4.34E-14 (0.23)
1500.00	2000.00	6.78E-12 (0.10)	1.96E-12 (0.12)	9.10E-13 (0.28)	3.51E-13 (0.25)	1.25E-13 (0.21)	4.83E-14 (0.20)
2000.00	2500.00	6.82E-12 (0.06)	2.20E-12 (0.11)	8.10E-13 (0.10)	3.25E-13 (0.16)	1.02E-13 (0.12)	4.94E-14 (0.20)
2500.00	3000.00	6.81E-12 (0.12)	1.41E-12 (0.11)	4.26E-13 (0.12)	1.40E-13 (0.18)	5.19E-14 (0.21)	2.58E-14 (0.27)
3000.00	3500.00	6.10E-12 (0.12)	1.96E-12 (0.22)	9.80E-13 (0.24)	2.25E-13 (0.18)	1.22E-13 (0.37)	4.72E-14 (0.36)
3500.00	4000.00	5.54E-12 (0.13)	1.70E-12 (0.23)	3.93E-13 (0.16)	1.34E-13 (0.23)	4.58E-14 (0.26)	2.22E-14 (0.23)

		820.00 850.00	850.00 880.00	880.00 910.00	910.00 940.00	940.00 970.00	970.00 1000.00
0.0	500.00	9.82E-15 (0.10)	4.25E-15 (0.08)	2.06E-15 (0.08)	1.92E-15 (0.50)	8.22E-16 (0.45)	4.04E-16 (0.44)
500.00	1000.00	7.19E-14 (0.67)	4.77E-14 (0.77)	2.68E-14 (0.78)	1.56E-14 (0.84)	7.34E-15 (0.84)	3.61E-15 (0.82)
1000.00	1500.00	1.80E-14 (0.20)	7.91E-15 (0.19)	3.79E-15 (0.21)	1.82E-15 (0.20)	8.72E-16 (0.20)	4.34E-16 (0.22)
1500.00	2000.00	1.82E-14 (0.18)	7.94E-15 (0.25)	3.45E-15 (0.25)	1.46E-15 (0.23)	9.82E-16 (0.31)	4.26E-16 (0.26)
2000.00	2500.00	2.91E-14 (0.39)	1.33E-14 (0.42)	6.96E-15 (0.44)	3.61E-15 (0.48)	1.30E-15 (0.33)	5.24E-16 (0.29)
2500.00	3000.00	1.20E-14 (0.28)	1.65E-14 (0.73)	6.97E-15 (0.74)	2.75E-15 (0.64)	1.46E-15 (0.51)	1.22E-15 (0.56)
3000.00	3500.00	3.15E-14 (0.53)	1.45E-14 (0.49)	8.11E-15 (0.45)	3.53E-15 (0.39)	1.76E-15 (0.41)	8.01E-16 (0.32)
3500.00	4000.00	8.38E-15 (0.24)	3.38E-15 (0.22)	1.32E-15 (0.16)	5.96E-16 (0.19)	2.64E-16 (0.16)	1.38E-16 (0.15)

Table II (Cont.)

DOSE IN WALL IN REM/INT.PROTON FOR X(VERTICAL)-REGION FROM 300.00 TO 450.00 CM (RELATIVE ERROR)
AS A FUNCTION OF LATERAL DISTANCE (ACROSS) & LONGITUDINAL DISTANCE (DOWN) , IN CM

		640.00 670.00	670.00 700.00	700.00 730.00	730.00 760.00	760.00 790.00	790.00 820.00
0.0	500.00	1.02E-12 (0.07)	3.86E-13 (0.07)	1.63E-13 (0.10)	6.87E-14 (0.12)	3.15E-14 (0.12)	1.41E-14 (0.13)
500.00	1000.00	3.67E-12 (0.07)	1.66E-12 (0.19)	9.82E-13 (0.31)	3.89E-13 (0.26)	1.46E-13 (0.27)	7.80E-14 (0.32)
1000.00	1500.00	4.91E-12 (0.06)	1.56E-12 (0.09)	5.87E-13 (0.09)	2.28E-13 (0.12)	8.65E-14 (0.17)	3.56E-14 (0.21)
1500.00	2000.00	5.76E-12 (0.07)	1.99E-12 (0.15)	6.73E-13 (0.23)	2.12E-13 (0.19)	8.34E-14 (0.15)	5.13E-14 (0.39)
2000.00	2500.00	5.41E-12 (0.07)	1.96E-12 (0.30)	5.85E-13 (0.25)	2.15E-13 (0.30)	7.16E-14 (0.29)	2.86E-14 (0.28)
2500.00	3000.00	4.77E-12 (0.06)	1.43E-12 (0.14)	4.41E-13 (0.25)	1.27E-13 (0.24)	5.44E-14 (0.34)	1.96E-14 (0.25)
3000.00	3500.00	5.15E-12 (0.14)	1.05E-12 (0.13)	2.80E-13 (0.17)	9.48E-14 (0.18)	3.80E-14 (0.15)	2.02E-14 (0.25)
3500.00	4000.00	4.24E-12 (0.13)	1.18E-12 (0.17)	3.27E-13 (0.26)	7.25E-14 (0.22)	2.22E-14 (0.17)	9.97E-15 (0.20)

		820.00 850.00	850.00 880.00	880.00 910.00	910.00 940.00	940.00 970.00	970.00 1000.00
0.0	500.00	6.32E-15 (0.10)	3.04E-15 (0.13)	1.44E-15 (0.15)	7.09E-16 (0.15)	3.29E-16 (0.13)	1.52E-16 (0.13)
500.00	1000.00	3.21E-14 (0.35)	2.54E-14 (0.60)	1.22E-14 (0.62)	6.00E-15 (0.65)	2.42E-15 (0.62)	1.61E-15 (0.62)
1000.00	1500.00	1.57E-14 (0.21)	6.63E-15 (0.21)	3.01E-15 (0.17)	1.40E-15 (0.15)	8.30E-16 (0.28)	4.83E-16 (0.45)
1500.00	2000.00	4.19E-14 (0.69)	1.53E-14 (0.60)	5.66E-15 (0.49)	2.81E-15 (0.49)	1.43E-15 (0.43)	9.92E-16 (0.48)
2000.00	2500.00	3.58E-14 (0.68)	1.89E-14 (0.68)	5.96E-15 (0.58)	1.08E-14 (0.90)	6.62E-15 (0.92)	3.87E-15 (0.94)
2500.00	3000.00	9.65E-15 (0.29)	3.53E-15 (0.23)	1.69E-15 (0.21)	9.13E-16 (0.21)	2.00E-15 (0.64)	9.83E-16 (0.71)
3000.00	3500.00	9.08E-15 (0.30)	4.19E-15 (0.29)	2.16E-15 (0.31)	1.44E-15 (0.43)	2.12E-15 (0.78)	1.72E-15 (0.80)
3500.00	4000.00	6.05E-15 (0.29)	1.03E-14 (0.82)	4.13E-15 (0.77)	2.66E-15 (0.81)	6.63E-16 (0.69)	2.62E-16 (0.60)

DOSE IN WALL IN REM/INT.PROTON FOR X(VERTICAL)-REGION FROM 450.00 TO 600.00 CM (RELATIVE ERROR)
AS A FUNCTION OF LATERAL DISTANCE (ACROSS) & LONGITUDINAL DISTANCE (DOWN) , IN CM

		640.00 670.00	670.00 700.00	700.00 730.00	730.00 760.00	760.00 790.00	790.00 820.00
0.0	500.00	7.21E-13 (0.03)	3.17E-13 (0.17)	1.14E-13 (0.16)	4.52E-14 (0.15)	1.92E-14 (0.10)	8.09E-15 (0.09)
500.00	1000.00	2.25E-12 (0.09)	6.57E-13 (0.11)	2.58E-13 (0.14)	1.10E-13 (0.24)	5.00E-14 (0.29)	3.84E-14 (0.46)
1000.00	1500.00	4.01E-12 (0.08)	1.60E-12 (0.26)	3.75E-13 (0.16)	1.34E-13 (0.16)	4.82E-14 (0.13)	1.86E-14 (0.13)
1500.00	2000.00	4.85E-12 (0.10)	2.23E-12 (0.28)	6.96E-13 (0.28)	1.90E-13 (0.30)	6.17E-14 (0.34)	2.32E-14 (0.35)
2000.00	2500.00	4.86E-12 (0.14)	1.85E-12 (0.16)	4.11E-13 (0.15)	1.37E-13 (0.23)	4.57E-14 (0.21)	1.74E-14 (0.24)
2500.00	3000.00	4.86E-12 (0.21)	1.68E-12 (0.45)	7.65E-13 (0.48)	2.43E-13 (0.45)	1.15E-13 (0.36)	3.53E-14 (0.43)
3000.00	3500.00	3.12E-12 (0.11)	7.39E-13 (0.16)	5.95E-13 (0.69)	3.55E-13 (0.78)	8.65E-14 (0.76)	3.18E-14 (0.73)
3500.00	4000.00	3.06E-12 (0.13)	7.06E-13 (0.17)	2.83E-13 (0.33)	1.01E-13 (0.25)	4.24E-14 (0.31)	1.84E-14 (0.26)

		820.00 850.00	850.00 880.00	880.00 910.00	910.00 940.00	940.00 970.00	970.00 1000.00
0.0	500.00	3.46E-15 (0.08)	1.50E-15 (0.06)	6.53E-16 (0.05)	3.24E-16 (0.07)	1.48E-16 (0.06)	7.60E-17 (0.07)
500.00	1000.00	2.45E-14 (0.48)	8.54E-15 (0.43)	3.78E-15 (0.42)	1.63E-15 (0.41)	7.10E-16 (0.36)	3.10E-16 (0.35)
1000.00	1500.00	1.22E-14 (0.36)	1.34E-14 (0.74)	6.41E-15 (0.77)	3.31E-15 (0.68)	1.38E-15 (0.61)	5.42E-16 (0.58)
1500.00	2000.00	1.18E-14 (0.32)	5.10E-15 (0.33)	7.01E-15 (0.56)	5.11E-15 (0.68)	2.05E-15 (0.65)	8.20E-16 (0.61)
2000.00	2500.00	6.69E-15 (0.22)	3.11E-15 (0.21)	1.50E-15 (0.17)	6.83E-16 (0.18)	3.94E-16 (0.27)	2.95E-16 (0.55)
2500.00	3000.00	1.19E-14 (0.42)	1.45E-14 (0.76)	4.99E-15 (0.75)	7.23E-15 (0.93)	2.20E-15 (0.88)	4.81E-16 (0.74)
3000.00	3500.00	1.68E-14 (0.57)	2.34E-14 (0.80)	9.32E-15 (0.81)	3.03E-15 (0.81)	3.08E-15 (0.88)	1.63E-15 (0.79)
3500.00	4000.00	6.22E-15 (0.24)	2.61E-15 (0.26)	1.32E-15 (0.31)	2.29E-15 (0.58)	4.98E-15 (0.75)	1.71E-15 (0.66)

Table II (Cont.)

DOSE IN WALL IN REM/INT.PROTCN FCR X(VERTICAL)-REGICN FROM 6CO.00 TO 750.0C CM (RELATIVE ERROR)
AS A FUNCTION OF LATERAL DISTANCE (ACROSS) & LONGITUDINAL DISTANCE (DCWN) , IN CM

		640.00 670.00	670.00 700.00	700.00 730.00	730.00 760.00	760.00 790.C0	790.00 820.00
0.0	500.00	5.15E-13 (0.09)	1.59E-13 (0.06)	5.90E-14 (0.05)	2.23E-14 (0.05)	9.72E-15 (0.08)	4.04E-15 (0.10)
500.00	1000.00	1.34E-12 (0.03)	4.16E-13 (0.08)	1.41E-13 (0.09)	4.94E-14 (0.08)	1.79E-14 (0.05)	1.15E-14 (0.40)
1000.00	1500.00	2.29E-12 (0.06)	7.C5E-13 (0.10)	2.37E-13 (0.24)	8.60E-14 (0.29)	3.08E-14 (0.26)	1.50E-14 (0.29)
1500.00	2000.00	3.80E-12 (0.07)	7.89E-13 (0.11)	7.02E-13 (0.56)	2.97E-13 (0.57)	7.59E-14 (0.52)	2.4CE-14 (0.51)
2000.00	2500.00	3.04E-12 (0.10)	7.66E-13 (0.12)	1.90E-13 (0.19)	7.91E-14 (0.31)	4.06E-14 (0.40)	1.44E-14 (0.33)
2500.00	3000.00	4.20E-12 (C.12)	1.C1E-12 (0.17)	3.19E-13 (0.20)	1.24E-13 (0.25)	8.06E-14 (0.60)	1.47E-14 (0.24)
3000.00	3500.00	4.20E-12 (C.20)	6.45E-13 (0.16)	3.15E-13 (0.28)	1.55E-13 (0.34)	8.43E-14 (0.61)	2.48E-14 (0.35)
3500.00	4000.00	3.05E-12 (0.18)	9.52E-13 (0.30)	2.76E-13 (0.23)	1.09E-13 (0.18)	6.64E-14 (0.26)	2.38E-14 (0.27)

		820.00 850.0C	850.00 880.00	880.0C 910.00	910.0C 940.00	940.00 970.00	970.00 1CC0.00
0.0	500.00	1.83E-15 (0.1C)	7.98E-16 (0.06)	3.69E-16 (0.08)	1.56E-16 (0.07)	7.42E-17 (0.07)	3.24E-17 (0.07)
500.CC	1000.00	5.22E-15 (0.42)	2.27E-15 (0.23)	2.96E-15 (0.70)	1.49E-15 (0.68)	5.92E-16 (0.62)	2.75E-16 (0.63)
1000.00	1500.00	5.13E-15 (0.18)	2.03E-15 (0.15)	1.07E-15 (0.27)	1.05E-15 (0.43)	6.82E-16 (C.48)	3.65E-16 (C.51)
1500.00	2000.00	8.96E-15 (0.41)	3.5CE-15 (0.24)	1.28E-15 (0.20)	5.36E-16 (0.20)	2.62E-16 (0.19)	1.17E-16 (0.24)
2000.00	2500.00	8.48E-15 (0.23)	4.71E-15 (0.33)	1.80E-15 (0.26)	7.60E-16 (0.27)	3.18E-16 (0.30)	1.25E-16 (0.19)
2500.00	3CC0.00	5.84E-15 (C.21)	2.42E-15 (0.2C)	1.14E-15 (C.19)	7.62E-16 (0.3C)	1.27E-15 (0.81)	1.20E-15 (C.65)
3000.00	3500.00	9.77E-15 (0.31)	3.84E-15 (0.30)	1.74E-15 (0.27)	2.40E-15 (0.72)	9.09E-16 (0.70)	3.95E-16 (0.58)
3500.00	4000.00	8.83E-15 (0.24)	3.44E-15 (0.21)	1.30E-15 (C.21)	5.35E-16 (0.19)	3.00E-16 (C.23)	1.19E-16 (C.19)

DOSE IN WALL IN REM/INT.PROTON FCR X(VERTICAL)-REGICN FROM 750.0C TC 920.00 CM (RELATIVE ERRCR)
AS A FUNCTION OF LATERAL DISTANCE (ACROSS) & LONGITUDINAL DISTANCE (DOWN) , IN CM

		640.00 67C.00	670.00 7C0.00	700.00 730.C0	730.00 760.0C	760.00 79C.00	790.00 820.00
0.0	500.00	4.04E-13 (0.10)	1.49E-13 (0.24)	1.02E-13 (0.58)	3.87E-14 (0.59)	1.48E-14 (0.66)	5.56E-15 (0.66)
5C0.00	1000.00	9.93E-13 (0.08)	2.47E-13 (0.11)	7.70E-14 (0.14)	2.53E-14 (0.10)	9.25E-15 (0.10)	3.92E-15 (0.17)
1000.00	1500.00	1.94E-12 (0.08)	1.22E-12 (0.58)	2.73E-13 (0.41)	7.05E-14 (0.29)	2.19E-14 (0.28)	6.59E-15 (0.21)
1500.00	2000.00	2.67E-12 (0.07)	4.92E-13 (0.10)	1.62E-13 (0.20)	6.45E-14 (C.26)	6.86E-14 (0.50)	2.68E-14 (0.46)
2000.00	2500.00	3.22E-12 (0.23)	7.35E-13 (0.19)	1.74E-13 (0.22)	5.52E-14 (0.25)	2.10E-14 (0.21)	1.19E-14 (0.39)
2500.CC	3000.00	2.68E-12 (0.13)	9.69E-13 (0.37)	1.82E-13 (0.25)	4.62E-14 (0.17)	1.73E-14 (0.17)	7.64E-15 (0.24)
3000.00	3500.00	2.43E-12 (0.15)	6.56E-13 (0.24)	1.59E-13 (0.43)	4.38E-14 (C.35)	1.25E-14 (C.28)	4.39E-15 (0.24)
3500.00	4000.00	1.95E-12 (0.13)	3.93E-13 (0.33)	9.85E-14 (0.26)	3.29E-14 (0.24)	2.58E-14 (0.62)	2.04E-14 (0.61)

		820.00 850.00	850.00 880.00	880.00 910.00	910.0C 940.0C	940.00 970.00	970.00 1000.00
C.0	500.00	2.04E-15 (0.61)	9.1CE-16 (0.65)	4.11E-16 (0.65)	1.97E-16 (0.67)	8.57E-17 (0.69)	3.33E-17 (0.61)
500.00	1000.00	2.69E-15 (0.47)	1.05E-15 (0.48)	5.77E-16 (0.54)	3.40E-16 (0.69)	2.07E-16 (0.77)	8.98E-17 (0.75)
1000.00	1500.00	3.37E-15 (C.34)	1.17E-15 (0.25)	5.05E-16 (0.21)	2.01E-16 (0.16)	1.04E-16 (0.17)	5.83E-17 (C.24)
15CC.CC	2000.00	5.33E-14 (0.76)	2.21E-14 (0.65)	6.51E-15 (0.65)	2.30E-15 (0.62)	7.85E-16 (0.60)	3.34E-16 (C.59)
2000.00	2500.00	7.00E-15 (0.54)	3.63E-15 (0.45)	2.43E-15 (0.57)	9.87E-16 (0.52)	4.31E-16 (0.50)	2.27E-16 (0.44)
25C0.0C	3000.00	3.40E-15 (0.31)	1.99E-15 (C.39)	7.23E-16 (0.32)	3.70E-16 (0.37)	1.24E-16 (C.28)	7.98E-17 (0.27)
3000.00	3500.00	1.78E-15 (0.19)	6.6CE-16 (0.16)	3.61E-16 (0.17)	1.48E-16 (0.12)	9.41E-17 (0.19)	1.25E-16 (C.68)
35C0.00	4000.00	2.67E-14 (0.79)	9.28E-15 (0.79)	3.42E-15 (0.76)	2.22E-15 (0.62)	7.94E-16 (0.61)	3.49E-16 (0.60)

Table II (Cont.)

DOSE CN RCOF IN REL/INT.PROTCN FGR X(VERTICAL)-REGION FROM 920.00 TO 970.00 CM (RELATIVE ERRCR)
AS A FUNCTION OF LATERAL DISTANCE (ACRCSS) & LONGITUDINAL DISTANCE (DOWN) , IN CM

		0.0 150.00	150.00 300.00	300.00 450.00	450.00 600.00	600.00 750.00	750.00 900.00
0.0	500.00	5.19E-13 (0.05)	4.64E-13 (0.04)	4.15E-13 (0.07)	3.32E-13 (0.05)	1.59E-13 (0.07)	4.27E-15 (0.38)
500.00	1000.00	1.86E-12 (0.07)	1.40E-12 (0.08)	1.12E-12 (0.06)	9.86E-13 (0.12)	4.55E-13 (0.13)	3.24E-15 (0.14)
1000.00	1500.00	2.42E-12 (0.08)	2.74E-12 (0.10)	1.89E-12 (0.07)	1.63E-12 (0.09)	7.01E-13 (0.10)	1.11E-14 (0.32)
1500.00	2000.00	3.80E-12 (0.11)	3.03E-12 (0.09)	2.67E-12 (0.07)	2.70E-12 (0.11)	1.16E-12 (0.15)	1.29E-14 (0.24)
2000.00	2500.00	4.15E-12 (0.21)	3.81E-12 (0.17)	2.97E-12 (0.15)	2.43E-12 (0.07)	1.54E-12 (0.25)	2.19E-14 (0.38)
2500.00	3000.00	4.34E-12 (0.23)	2.91E-12 (0.10)	3.03E-12 (0.09)	3.10E-12 (0.27)	1.76E-12 (0.31)	2.34E-14 (0.73)
3000.00	3500.00	3.03E-12 (0.12)	2.97E-12 (0.09)	2.96E-12 (0.14)	2.65E-12 (0.12)	8.31E-13 (0.17)	5.82E-15 (0.41)
3500.00	4000.00	2.88E-12 (0.17)	2.82E-12 (0.13)	2.67E-12 (0.15)	2.23E-12 (0.11)	9.75E-13 (0.26)	4.44E-15 (0.25)

		900.00 1050.00	1050.00 1200.00	1200.00 1350.00	1350.00 1500.00	1500.00 1650.00	1650.00 1800.00
0.0	500.00	5.85E-17 (0.61)	5.35E-18 (0.42)	5.57E-18 (0.07)	6.19E-18 (0.15)	9.95E-18 (0.34)	3.67E-17 (0.21)
500.00	1000.00	4.21E-17 (0.25)	1.11E-17 (0.31)	2.46E-17 (0.56)	3.82E-17 (0.39)	4.25E-17 (0.38)	1.64E-16 (0.39)
1000.00	1500.00	4.67E-16 (0.78)	1.87E-17 (0.29)	3.51E-17 (0.29)	5.36E-17 (0.41)	6.46E-17 (0.38)	2.90E-16 (0.37)
1500.00	2000.00	1.07E-15 (0.61)	1.32E-16 (0.64)	2.91E-17 (0.24)	4.43E-17 (0.40)	7.22E-17 (0.38)	1.99E-16 (0.30)
2000.00	2500.00	3.01E-16 (0.22)	4.26E-17 (0.20)	7.71E-17 (0.34)	8.21E-17 (0.50)	6.66E-17 (0.42)	3.04E-16 (0.41)
2500.00	3000.00	3.36E-16 (0.61)	1.75E-17 (0.32)	9.73E-17 (0.66)	6.96E-17 (0.65)	2.18E-16 (0.65)	5.95E-16 (0.53)
3000.00	3500.00	8.82E-17 (0.38)	1.25E-16 (0.78)	9.16E-17 (0.54)	9.75E-17 (0.61)	5.69E-17 (0.42)	3.28E-16 (0.26)
3500.00	4000.00	2.41E-16 (0.79)	5.47E-17 (0.44)	8.50E-17 (0.47)	4.20E-17 (0.38)	8.90E-17 (0.46)	4.35E-16 (0.28)

DOSE CN RCOF IN REL/INT.PROTCN FGR X(VERTICAL)-REGION FROM 970.00 TO 1020.00 CM (RELATIVE ERRCR)
AS A FUNCTION OF LATERAL DISTANCE (ACRCSS) & LONGITUDINAL DISTANCE (DOWN) , IN CM

		0.0 150.00	150.00 300.00	300.00 450.00	450.00 600.00	600.00 750.00	750.00 900.00
0.0	500.00	1.70E-13 (0.14)	1.36E-13 (0.05)	1.16E-13 (0.06)	9.02E-14 (0.06)	5.94E-14 (0.10)	2.95E-15 (0.26)
500.00	1000.00	5.82E-13 (0.10)	5.54E-13 (0.28)	3.25E-13 (0.11)	2.39E-13 (0.12)	1.57E-13 (0.24)	3.07E-15 (0.11)
1000.00	1500.00	7.95E-13 (0.18)	7.76E-13 (0.14)	4.20E-13 (0.13)	3.58E-13 (0.16)	2.58E-13 (0.20)	1.23E-14 (0.34)
1500.00	2000.00	1.14E-12 (0.19)	9.48E-13 (0.14)	8.74E-13 (0.28)	5.72E-13 (0.15)	5.09E-13 (0.35)	4.80E-14 (0.87)
2000.00	2500.00	1.25E-12 (0.23)	1.22E-12 (0.37)	6.31E-13 (0.23)	4.23E-13 (0.09)	4.10E-13 (0.29)	1.57E-14 (0.27)
2500.00	3000.00	1.43E-12 (0.17)	6.00E-13 (0.15)	7.39E-13 (0.15)	7.63E-13 (0.28)	4.27E-13 (0.35)	5.27E-15 (0.23)
3000.00	3500.00	9.16E-13 (0.27)	8.90E-13 (0.20)	5.74E-13 (0.20)	5.37E-13 (0.25)	2.09E-13 (0.32)	4.22E-15 (0.30)
3500.00	4000.00	4.18E-13 (0.19)	4.87E-13 (0.22)	5.92E-13 (0.28)	3.62E-13 (0.20)	3.98E-13 (0.72)	2.96E-15 (0.22)

		900.00 1050.00	1050.00 1200.00	1200.00 1350.00	1350.00 1500.00	1500.00 1650.00	1650.00 1800.00
0.0	500.00	4.47E-17 (0.44)	2.00E-18 (0.67)	1.05E-18 (0.18)	7.67E-17 (0.98)	3.20E-18 (0.51)	3.77E-18 (0.16)
500.00	1000.00	4.13E-17 (0.24)	1.97E-18 (0.21)	2.94E-18 (0.31)	5.69E-18 (0.31)	6.14E-18 (0.54)	2.33E-17 (0.42)
1000.00	1500.00	5.63E-16 (0.73)	1.73E-17 (0.65)	4.88E-18 (0.29)	1.21E-17 (0.45)	8.17E-18 (0.50)	3.81E-17 (0.43)
1500.00	2000.00	9.78E-16 (0.43)	6.14E-17 (0.53)	5.94E-18 (0.23)	5.69E-18 (0.39)	1.07E-17 (0.48)	2.14E-17 (0.34)
2000.00	2500.00	3.36E-16 (0.34)	1.93E-17 (0.36)	7.86E-18 (0.33)	1.62E-17 (0.61)	9.54E-18 (0.37)	4.91E-17 (0.46)
2500.00	3000.00	3.59E-16 (0.59)	1.17E-17 (0.40)	2.45E-17 (0.78)	1.82E-17 (0.75)	1.50E-17 (0.37)	2.72E-16 (0.85)
3000.00	3500.00	8.61E-17 (0.39)	3.30E-17 (0.73)	1.83E-17 (0.53)	9.11E-18 (0.54)	1.50E-17 (0.56)	5.82E-17 (0.28)
3500.00	4000.00	1.46E-16 (0.52)	1.08E-17 (0.69)	3.39E-17 (0.81)	1.08E-17 (0.77)	1.37E-17 (0.64)	6.45E-17 (0.42)

Table II (Cont.)

DOSE CN RCOF IN REL/INT.PROTCN FCR X(VERTICAL)-REGION FROM 1020.00 TO 1070.00 CM (RELATIVE ERRCR)
AS A FUNCTION OF LATERAL DISTANCE (ACRCSS) & LCNGITUDINAL DISTANCE (DOWN) , IN CM

		0.0 150.00	150.00 300.00	300.00 450.00	450.00 600.00	600.00 750.00	750.00 900.00
0.0	500.00	7.13E-14 (0.21)	4.87E-14 (0.08)	4.38E-14 (0.15)	2.85E-14 (0.07)	2.04E-14 (0.08)	2.41E-15 (0.28)
500.00	1000.00	2.16E-13 (0.17)	2.62E-13 (0.50)	1.21E-13 (0.20)	6.27E-14 (0.10)	4.58E-14 (0.19)	3.30E-15 (0.19)
1000.00	1500.00	1.91E-13 (0.22)	2.78E-13 (0.30)	1.82E-13 (0.29)	9.38E-14 (0.18)	7.53E-14 (0.17)	1.40E-14 (0.42)
1500.00	2000.00	3.10E-13 (0.30)	3.78E-13 (0.27)	3.42E-13 (0.34)	1.65E-13 (0.16)	2.33E-13 (0.44)	1.55E-14 (0.65)
2000.00	2500.00	2.50E-13 (0.18)	3.19E-13 (0.34)	1.45E-13 (0.24)	1.02E-13 (0.14)	2.05E-13 (0.31)	9.27E-15 (0.21)
2500.00	3000.00	2.98E-13 (0.20)	1.92E-13 (0.23)	1.62E-13 (0.28)	1.69E-13 (0.33)	7.62E-14 (0.31)	4.04E-15 (0.24)
3000.00	3500.00	3.89E-13 (0.43)	2.77E-13 (0.45)	1.01E-13 (0.11)	1.09E-13 (0.23)	1.06E-13 (0.51)	3.19E-15 (0.39)
3500.00	4000.00	8.99E-14 (0.21)	1.10E-13 (0.22)	1.55E-13 (0.31)	1.58E-13 (0.43)	2.68E-13 (0.70)	4.20E-15 (0.61)

		900.00 1050.00	1050.00 1200.00	1200.00 1350.00	1350.00 1500.00	1500.00 1650.00	1650.00 1800.00
0.0	500.00	6.05E-17 (0.48)	1.14E-18 (0.47)	5.64E-19 (0.59)	5.73E-17 (1.00)	9.96E-19 (0.80)	9.92E-19 (0.42)
500.00	1000.00	3.81E-17 (0.31)	1.16E-18 (0.28)	5.88E-19 (0.38)	8.78E-19 (0.48)	1.43E-18 (0.35)	4.61E-18 (0.51)
1000.00	1500.00	2.64E-16 (0.41)	1.07E-17 (0.50)	2.30E-18 (0.32)	2.32E-18 (0.49)	1.37E-18 (0.58)	5.21E-18 (0.38)
1500.00	2000.00	9.58E-16 (0.71)	4.24E-17 (0.45)	1.45E-18 (0.33)	9.42E-19 (0.46)	1.14E-18 (0.37)	3.94E-18 (0.40)
2000.00	2500.00	1.53E-15 (0.61)	2.63E-17 (0.46)	3.22E-18 (0.43)	2.42E-18 (0.48)	2.29E-18 (0.65)	1.01E-17 (0.56)
2500.00	3000.00	1.84E-16 (0.42)	9.56E-18 (0.69)	3.42E-18 (0.79)	5.55E-18 (0.70)	3.05E-18 (0.55)	3.71E-17 (0.78)
3000.00	3500.00	4.77E-17 (0.42)	7.82E-18 (0.74)	4.22E-18 (0.59)	3.30E-18 (0.68)	3.21E-18 (0.54)	1.35E-17 (0.36)
3500.00	4000.00	6.84E-17 (0.32)	4.58E-18 (0.51)	2.13E-18 (0.41)	1.81E-18 (0.78)	2.85E-18 (0.78)	1.07E-17 (0.45)

DOSE CN RCOF IN REL/INT.PRCTCN FCR X(VERTICAL)-REGICN FRCM 1070.00 TC 1120.00 CM (RELATIVE ERRCR)
AS A FUNCTICN OF LATERAL DISTANCE (ACRCSS) & LCNGITUDINAL DISTANCE (DOWN) , IN CM

		0.0 150.00	150.00 300.00	300.00 450.00	450.00 600.00	600.00 750.00	750.00 900.00
0.0	500.00	3.03E-14 (0.26)	1.75E-14 (0.14)	1.58E-14 (0.16)	9.60E-15 (0.07)	6.59E-15 (0.08)	1.71E-15 (0.18)
500.00	1000.00	7.45E-14 (0.22)	9.92E-14 (0.44)	5.77E-14 (0.49)	1.85E-14 (0.08)	1.37E-14 (0.18)	2.74E-15 (0.19)
1000.00	1500.00	4.84E-14 (0.18)	6.45E-14 (0.25)	8.90E-14 (0.34)	3.61E-14 (0.27)	1.32E-13 (0.84)	5.97E-15 (0.29)
1500.00	2000.00	1.02E-13 (0.42)	1.33E-13 (0.41)	9.86E-14 (0.38)	4.24E-14 (0.22)	4.55E-14 (0.35)	1.21E-14 (0.54)
2000.00	2500.00	1.34E-13 (0.65)	1.59E-13 (0.55)	5.71E-14 (0.31)	3.36E-14 (0.20)	2.00E-13 (0.79)	5.72E-15 (0.29)
2500.00	3000.00	1.24E-13 (0.23)	6.15E-14 (0.38)	7.60E-14 (0.54)	4.18E-14 (0.34)	1.92E-14 (0.32)	1.79E-15 (0.22)
3000.00	3500.00	8.67E-14 (0.38)	6.37E-14 (0.33)	2.23E-14 (0.10)	3.48E-14 (0.26)	2.43E-14 (0.52)	2.23E-15 (0.48)
3500.00	4000.00	3.06E-14 (0.42)	5.23E-14 (0.40)	1.10E-13 (0.50)	2.94E-14 (0.46)	3.57E-14 (0.62)	4.90E-15 (0.80)

		900.00 1050.00	1050.00 1200.00	1200.00 1350.00	1350.00 1500.00	1500.00 1650.00	1650.00 1800.00
0.0	500.00	4.28E-17 (0.34)	5.97E-19 (0.37)	5.73E-20 (0.44)	3.44E-17 (1.00)	1.04E-17 (0.99)	2.03E-19 (0.51)
500.00	1000.00	3.00E-17 (0.24)	1.24E-18 (0.40)	1.34E-19 (0.29)	2.65E-19 (0.45)	1.92E-19 (0.45)	1.15E-18 (0.53)
1000.00	1500.00	1.65E-16 (0.28)	7.06E-18 (0.45)	6.03E-19 (0.49)	4.96E-19 (0.43)	3.47E-19 (0.50)	9.65E-19 (0.39)
1500.00	2000.00	1.16E-15 (0.79)	3.05E-17 (0.54)	1.43E-18 (0.33)	2.07E-19 (0.17)	2.47E-19 (0.47)	6.83E-19 (0.37)
2000.00	2500.00	1.24E-15 (0.64)	3.52E-17 (0.42)	1.02E-18 (0.34)	4.47E-19 (0.29)	9.65E-19 (0.82)	3.02E-18 (0.71)
2500.00	3000.00	7.73E-17 (0.24)	1.20E-17 (0.56)	4.53E-19 (0.32)	1.72E-18 (0.65)	9.36E-19 (0.85)	7.26E-18 (0.74)
3000.00	3500.00	4.85E-17 (0.37)	1.61E-17 (0.95)	1.12E-18 (0.56)	1.25E-18 (0.78)	7.11E-19 (0.63)	2.75E-18 (0.48)
3500.00	4000.00	5.63E-17 (0.25)	1.63E-18 (0.39)	1.87E-19 (0.32)	4.83E-19 (0.61)	7.13E-18 (0.98)	6.02E-18 (0.56)

Table II (Cont.)

DOSE ON ROOF IN REL/INT.PROTON FOR X(VERTICAL)-REGION FROM 1120.00 TO 1170.00 CM (RELATIVE ERROR)
AS A FUNCTION OF LATERAL DISTANCE (ACROSS) & LONGITUDINAL DISTANCE (DOWN) , IN CM

		0.0 150.00	150.00 300.00	300.00 450.00	450.00 600.00	600.00 750.00	750.00 900.00
0.0	500.00	1.00E-14 (0.26)	6.24E-15 (0.13)	5.46E-15 (0.14)	3.30E-15 (0.10)	2.21E-15 (0.08)	8.56E-16 (0.10)
500.00	1000.00	2.45E-14 (0.19)	2.83E-14 (0.40)	1.58E-14 (0.32)	1.03E-14 (0.27)	4.04E-15 (0.12)	1.52E-15 (0.22)
1000.00	1500.00	2.51E-14 (0.40)	3.10E-14 (0.46)	3.34E-14 (0.48)	1.26E-14 (0.37)	7.82E-14 (0.86)	4.72E-15 (0.47)
1500.00	2000.00	4.27E-14 (0.49)	2.94E-14 (0.31)	6.07E-14 (0.73)	1.24E-14 (0.24)	1.35E-14 (0.37)	4.79E-15 (0.32)
2000.00	2500.00	3.81E-14 (0.54)	6.29E-14 (0.69)	2.03E-14 (0.37)	1.88E-14 (0.48)	6.98E-14 (0.86)	3.82E-15 (0.38)
2500.00	3000.00	3.89E-14 (0.35)	2.53E-14 (0.57)	2.92E-14 (0.58)	1.38E-14 (0.37)	5.99E-15 (0.26)	9.87E-16 (0.21)
3000.00	3500.00	2.55E-14 (0.28)	2.23E-14 (0.31)	1.14E-14 (0.38)	1.11E-14 (0.23)	9.90E-15 (0.69)	8.08E-16 (0.40)
3500.00	4000.00	1.43E-14 (0.62)	1.34E-14 (0.30)	5.36E-14 (0.69)	1.86E-14 (0.72)	4.86E-15 (0.35)	1.72E-15 (0.76)

		900.00 1050.00	1050.00 1200.00	1200.00 1350.00	1350.00 1500.00	1500.00 1650.00	1650.00 1800.00
0.0	500.00	2.59E-17 (0.27)	1.11E-18 (0.46)	3.45E-20 (0.53)	1.80E-18 (0.99)	8.22E-18 (1.00)	1.76E-19 (0.75)
500.00	1000.00	2.70E-17 (0.22)	7.78E-19 (0.29)	4.28E-20 (0.36)	1.12E-19 (0.77)	8.33E-20 (0.58)	1.87E-19 (0.54)
1000.00	1500.00	2.99E-16 (0.52)	5.13E-18 (0.49)	5.18E-19 (0.65)	1.30E-19 (0.44)	7.30E-20 (0.45)	2.05E-19 (0.44)
1500.00	2000.00	8.13E-16 (0.63)	3.83E-17 (0.74)	8.78E-19 (0.41)	7.03E-20 (0.21)	8.92E-20 (0.50)	1.27E-19 (0.37)
2000.00	2500.00	4.36E-16 (0.54)	4.19E-17 (0.53)	1.01E-18 (0.48)	1.54E-19 (0.31)	2.86E-19 (0.83)	1.04E-18 (0.81)
2500.00	3000.00	3.91E-17 (0.24)	6.53E-18 (0.43)	4.11E-19 (0.48)	2.63E-19 (0.63)	1.84E-19 (0.71)	1.26E-18 (0.67)
3000.00	3500.00	2.67E-17 (0.30)	1.33E-17 (0.95)	5.84E-19 (0.80)	4.33E-19 (0.69)	5.80E-20 (0.53)	7.31E-19 (0.66)
3500.00	4000.00	5.64E-17 (0.68)	2.32E-18 (0.44)	1.32E-19 (0.59)	1.53E-19 (0.59)	5.41E-19 (0.97)	3.49E-18 (0.74)

DOSE ON ROOF IN REL/INT.PROTON FOR X(VERTICAL)-REGION FROM 1170.00 TO 1220.00 CM (RELATIVE ERROR)
AS A FUNCTION OF LATERAL DISTANCE (ACROSS) & LONGITUDINAL DISTANCE (DOWN) , IN CM

		0.0 150.00	150.00 300.00	300.00 450.00	450.00 600.00	600.00 750.00	750.00 900.00
0.0	500.00	3.63E-15 (0.26)	2.26E-15 (0.13)	1.79E-15 (0.12)	1.17E-15 (0.10)	7.61E-16 (0.07)	3.80E-16 (0.09)
500.00	1000.00	9.64E-15 (0.17)	8.30E-15 (0.37)	4.10E-15 (0.19)	5.20E-15 (0.38)	1.22E-15 (0.07)	6.62E-16 (0.21)
1000.00	1500.00	2.68E-14 (0.80)	8.04E-15 (0.32)	8.58E-15 (0.44)	3.67E-15 (0.25)	1.58E-14 (0.77)	2.96E-15 (0.59)
1500.00	2000.00	1.36E-14 (0.43)	9.28E-15 (0.27)	2.92E-14 (0.83)	9.42E-15 (0.56)	3.76E-15 (0.33)	2.63E-15 (0.36)
2000.00	2500.00	1.28E-14 (0.40)	1.44E-14 (0.59)	5.78E-15 (0.40)	1.18E-14 (0.48)	8.82E-14 (0.95)	1.71E-15 (0.46)
2500.00	3000.00	8.77E-15 (0.25)	1.01E-14 (0.46)	6.91E-15 (0.51)	4.41E-15 (0.31)	2.12E-15 (0.22)	3.90E-16 (0.24)
3000.00	3500.00	1.27E-14 (0.41)	8.17E-15 (0.27)	8.69E-15 (0.35)	4.00E-15 (0.22)	1.93E-15 (0.45)	2.92E-16 (0.36)
3500.00	4000.00	4.10E-15 (0.51)	3.98E-15 (0.28)	1.66E-14 (0.69)	5.57E-15 (0.65)	1.53E-15 (0.37)	5.06E-16 (0.63)

		900.00 1050.00	1050.00 1200.00	1200.00 1350.00	1350.00 1500.00	1500.00 1650.00	1650.00 1800.00
0.0	500.00	1.72E-17 (0.30)	7.63E-19 (0.44)	1.34E-20 (0.30)	1.93E-19 (0.98)	2.26E-18 (1.00)	1.56E-19 (0.89)
500.00	1000.00	3.09E-17 (0.29)	3.73E-19 (0.21)	3.90E-20 (0.53)	4.96E-20 (0.81)	2.77E-20 (0.61)	4.82E-20 (0.51)
1000.00	1500.00	5.56E-16 (0.50)	5.57E-18 (0.38)	2.18E-19 (0.45)	3.80E-20 (0.58)	2.65E-20 (0.49)	4.59E-20 (0.44)
1500.00	2000.00	7.67E-16 (0.57)	2.05E-17 (0.74)	6.57E-19 (0.59)	5.71E-20 (0.28)	2.32E-20 (0.49)	2.60E-20 (0.39)
2000.00	2500.00	5.25E-16 (0.62)	2.34E-17 (0.54)	1.77E-18 (0.56)	4.92E-20 (0.31)	4.48E-20 (0.67)	3.00E-19 (0.83)
2500.00	3000.00	2.82E-17 (0.24)	3.57E-18 (0.69)	3.27E-19 (0.59)	1.03E-19 (0.68)	5.05E-20 (0.47)	4.24E-19 (0.72)
3000.00	3500.00	1.50E-17 (0.32)	4.23E-18 (0.77)	3.29E-19 (0.78)	9.00E-20 (0.60)	4.13E-20 (0.81)	1.90E-19 (0.74)
3500.00	4000.00	1.62E-17 (0.46)	2.00E-18 (0.46)	6.12E-20 (0.43)	4.36E-20 (0.84)	1.71E-19 (0.99)	6.39E-19 (0.71)

Table II (Cont.)

DOSE ON ROOF IN REL/INT.PROTON FOR X(VERTICAL)-REGION FROM 1220.00 TO 1270.00 CM (RELATIVE ERROR)
AS A FUNCTION OF LATERAL DISTANCE (ACROSS) & LONGITUDINAL DISTANCE (DOWN) , IN CM

		0.0 150.00	150.00 300.00	300.00 450.00	450.00 600.00	600.00 750.00	750.00 900.00
0.0	500.00	1.22E-15 (0.24)	8.92E-16 (0.17)	6.37E-16 (0.11)	4.12E-16 (0.13)	2.50E-16 (0.06)	1.49E-16 (0.09)
500.00	1000.00	3.10E-15 (0.19)	5.31E-15 (0.63)	1.53E-15 (0.19)	1.63E-15 (0.37)	4.40E-16 (0.14)	2.95E-16 (0.19)
1000.00	1500.00	1.10E-14 (0.82)	2.99E-15 (0.35)	2.51E-15 (0.36)	1.27E-15 (0.23)	3.61E-15 (0.79)	1.43E-15 (0.59)
1500.00	2000.00	4.45E-15 (0.43)	5.34E-15 (0.41)	9.48E-15 (0.65)	2.19E-15 (0.36)	1.74E-15 (0.37)	8.79E-16 (0.38)
2000.00	2500.00	3.81E-15 (0.37)	4.01E-15 (0.54)	1.70E-15 (0.42)	3.36E-15 (0.49)	2.52E-14 (0.83)	8.33E-16 (0.49)
2500.00	3000.00	3.70E-15 (0.28)	8.45E-15 (0.77)	1.99E-15 (0.43)	1.57E-15 (0.35)	7.72E-16 (0.22)	1.58E-16 (0.25)
3000.00	3500.00	3.13E-15 (0.34)	3.94E-15 (0.39)	2.51E-15 (0.38)	2.54E-15 (0.53)	5.76E-16 (0.39)	1.12E-16 (0.36)
3500.00	4000.00	1.74E-15 (0.49)	1.35E-15 (0.24)	3.80E-15 (0.36)	1.58E-15 (0.52)	5.30E-16 (0.49)	1.40E-16 (0.51)

		900.00 1050.00	1050.00 1200.00	1200.00 1350.00	1350.00 1500.00	1500.00 1650.00	1650.00 1800.00
0.0	500.00	1.24E-17 (0.21)	3.87E-19 (0.33)	1.72E-20 (0.43)	2.40E-18 (1.00)	4.51E-19 (1.00)	1.91E-19 (0.98)
500.00	1000.00	1.85E-17 (0.22)	9.58E-19 (0.46)	1.86E-20 (0.35)	1.53E-20 (0.78)	1.42E-20 (0.76)	1.21E-20 (0.47)
1000.00	1500.00	3.71E-16 (0.51)	7.09E-18 (0.60)	3.11E-19 (0.47)	1.17E-20 (0.50)	9.42E-21 (0.57)	7.90E-21 (0.37)
1500.00	2000.00	4.05E-16 (0.54)	1.31E-17 (0.43)	1.42E-18 (0.68)	5.79E-20 (0.51)	6.70E-21 (0.33)	7.68E-21 (0.46)
2000.00	2500.00	2.35E-16 (0.63)	1.30E-17 (0.52)	7.10E-19 (0.40)	5.73E-20 (0.58)	7.32E-21 (0.42)	1.26E-19 (0.88)
2500.00	3000.00	1.52E-17 (0.27)	1.39E-18 (0.25)	1.89E-19 (0.47)	1.34E-20 (0.54)	2.54E-20 (0.71)	5.50E-20 (0.53)
3000.00	3500.00	8.43E-18 (0.29)	1.58E-18 (0.76)	1.54E-19 (0.90)	2.20E-20 (0.60)	1.92E-20 (0.89)	6.66E-20 (0.82)
3500.00	4000.00	8.33E-18 (0.51)	5.92E-19 (0.38)	7.17E-20 (0.35)	1.25E-20 (0.61)	4.24E-20 (0.98)	1.96E-19 (0.70)

DOSE ON ROOF IN REL/INT.PROTON FOR X(VERTICAL)-REGION FROM 1270.00 TO 1320.00 CM (RELATIVE ERROR)
AS A FUNCTION OF LATERAL DISTANCE (ACROSS) & LONGITUDINAL DISTANCE (DOWN) , IN CM

		0.0 150.00	150.00 300.00	300.00 450.00	450.00 600.00	600.00 750.00	750.00 900.00
0.0	500.00	4.38E-16 (0.24)	3.27E-16 (0.17)	2.22E-16 (0.10)	1.52E-16 (0.15)	8.74E-17 (0.08)	5.56E-17 (0.10)
500.00	1000.00	1.08E-15 (0.20)	2.28E-15 (0.71)	7.09E-16 (0.35)	5.56E-16 (0.37)	1.45E-16 (0.11)	1.92E-16 (0.53)
1000.00	1500.00	5.51E-15 (0.88)	1.69E-15 (0.45)	8.81E-16 (0.32)	4.86E-16 (0.28)	8.13E-16 (0.70)	3.20E-19 (0.94)
1500.00	2000.00	1.63E-15 (0.49)	1.17E-15 (0.32)	2.69E-15 (0.63)	7.98E-16 (0.45)	5.45E-16 (0.35)	3.93E-16 (0.43)
2000.00	2500.00	1.14E-15 (0.38)	1.24E-15 (0.48)	7.00E-16 (0.37)	1.04E-15 (0.60)	5.83E-15 (0.77)	6.42E-16 (0.59)
2500.00	3000.00	1.16E-15 (0.30)	1.96E-15 (0.65)	7.13E-16 (0.39)	4.27E-16 (0.30)	2.81E-16 (0.30)	6.17E-17 (0.18)
3000.00	3500.00	9.32E-16 (0.29)	1.38E-15 (0.43)	6.20E-16 (0.31)	4.89E-15 (0.92)	2.38E-16 (0.35)	4.21E-17 (0.40)
3500.00	4000.00	5.01E-16 (0.48)	4.51E-16 (0.24)	1.04E-15 (0.42)	4.85E-16 (0.44)	2.07E-16 (0.57)	4.23E-17 (0.37)

		900.00 1050.00	1050.00 1200.00	1200.00 1350.00	1350.00 1500.00	1500.00 1650.00	1650.00 1800.00
0.0	500.00	1.03E-17 (0.19)	2.75E-19 (0.27)	1.33E-20 (0.53)	6.80E-19 (1.00)	8.97E-20 (1.00)	7.18E-20 (0.98)
500.00	1000.00	3.37E-17 (0.45)	6.35E-19 (0.40)	8.26E-20 (0.88)	4.12E-21 (0.60)	7.32E-21 (0.83)	2.27E-21 (0.51)
1000.00	1500.00	1.45E-16 (0.44)	9.35E-18 (0.46)	2.22E-19 (0.59)	1.57E-20 (0.50)	3.06E-21 (0.44)	1.33E-21 (0.32)
1500.00	2000.00	2.05E-16 (0.59)	3.35E-17 (0.68)	1.58E-18 (0.71)	7.32E-20 (0.66)	3.03E-21 (0.21)	2.31E-21 (0.40)
2000.00	2500.00	7.79E-17 (0.57)	6.80E-18 (0.42)	3.24E-19 (0.49)	3.92E-20 (0.51)	2.45E-21 (0.36)	3.24E-20 (0.79)
2500.00	3000.00	9.44E-18 (0.27)	7.76E-19 (0.26)	1.86E-19 (0.68)	1.45E-20 (0.37)	5.89E-21 (0.72)	9.92E-21 (0.75)
3000.00	3500.00	4.67E-18 (0.23)	5.37E-19 (0.68)	7.96E-20 (0.68)	6.11E-21 (0.62)	5.36E-21 (0.75)	2.37E-20 (0.84)
3500.00	4000.00	5.51E-18 (0.31)	2.19E-19 (0.54)	2.59E-20 (0.29)	5.07E-21 (0.36)	2.62E-21 (0.74)	7.74E-20 (0.69)

Table II (Cont.)

DOSE ON ROOF IN REL/INT.PROTON FOR X(VERTICAL)-REGION FROM 1320.00 TO 1370.00 CM (RELATIVE ERROR)
AS A FUNCTION OF LATERAL DISTANCE (ACROSS) & LONGITUDINAL DISTANCE (DOWN) , IN CM

		0.0 150.00	150.00 300.00	300.00 450.00	450.00 600.00	600.00 750.00	750.00 900.00
0.0	500.00	1.53E-16 (0.22)	1.15E-16 (0.16)	7.99E-17 (0.09)	5.38E-17 (0.16)	3.03E-17 (0.08)	1.95E-17 (0.13)
500.00	1000.00	3.89E-16 (0.22)	5.95E-16 (0.59)	2.99E-16 (0.47)	2.05E-16 (0.40)	5.08E-17 (0.12)	9.30E-17 (0.69)
1000.00	1500.00	1.10E-15 (0.78)	4.17E-16 (0.36)	2.74E-16 (0.28)	4.79E-16 (0.70)	2.31E-16 (0.62)	1.38E-15 (0.97)
1500.00	2000.00	5.37E-16 (0.49)	4.64E-16 (0.34)	7.80E-16 (0.66)	2.44E-16 (0.38)	2.07E-16 (0.42)	1.40E-16 (0.34)
2000.00	2500.00	3.23E-16 (0.37)	4.25E-16 (0.46)	2.65E-16 (0.37)	4.11E-16 (0.66)	1.59E-15 (0.73)	3.09E-16 (0.61)
2500.00	3000.00	5.52E-16 (0.34)	5.23E-16 (0.60)	2.90E-16 (0.35)	1.50E-16 (0.32)	9.09E-17 (0.32)	2.31E-17 (0.19)
3000.00	3500.00	3.49E-16 (0.29)	6.28E-16 (0.44)	1.83E-16 (0.23)	1.02E-15 (0.87)	1.15E-16 (0.50)	1.35E-17 (0.35)
3500.00	4000.00	1.50E-16 (0.36)	1.58E-16 (0.22)	2.88E-16 (0.40)	1.31E-16 (0.36)	6.87E-17 (0.51)	1.46E-17 (0.35)

		900.00 1050.00	1050.00 1200.00	1200.00 1350.00	1350.00 1500.00	1500.00 1650.00	1650.00 1800.00
0.0	500.00	5.84E-18 (0.09)	2.08E-19 (0.30)	1.28E-20 (0.43)	1.67E-19 (1.00)	3.79E-20 (1.00)	2.11E-20 (0.98)
500.00	1000.00	1.58E-17 (0.48)	1.55E-18 (0.77)	3.64E-20 (0.57)	2.29E-21 (0.61)	4.60E-21 (0.96)	3.83E-22 (0.77)
1000.00	1500.00	5.04E-17 (0.57)	7.98E-18 (0.54)	2.55E-19 (0.51)	1.65E-20 (0.62)	1.06E-21 (0.42)	4.55E-22 (0.50)
1500.00	2000.00	1.06E-16 (0.55)	3.63E-17 (0.88)	7.33E-19 (0.61)	3.20E-20 (0.56)	2.57E-21 (0.61)	7.98E-22 (0.35)
2000.00	2500.00	2.38E-17 (0.48)	4.99E-18 (0.45)	3.00E-19 (0.49)	3.12E-20 (0.64)	1.88E-21 (0.56)	1.11E-20 (0.82)
2500.00	3000.00	5.24E-18 (0.27)	4.44E-19 (0.23)	6.99E-20 (0.55)	4.37E-21 (0.48)	1.95E-21 (0.58)	2.44E-21 (0.78)
3000.00	3500.00	3.05E-18 (0.35)	2.12E-19 (0.43)	5.08E-20 (0.79)	5.85E-21 (0.64)	1.20E-21 (0.59)	5.40E-21 (0.70)
3500.00	4000.00	3.90E-18 (0.38)	8.76E-20 (0.34)	1.52E-20 (0.44)	1.04E-21 (0.30)	1.05E-21 (0.69)	2.56E-20 (0.80)

DOSE ON ROOF IN REL/INT.PROTON FOR X(VERTICAL)-REGION FROM 1370.00 TO 1420.00 CM (RELATIVE ERROR)
AS A FUNCTION OF LATERAL DISTANCE (ACROSS) & LONGITUDINAL DISTANCE (DOWN) , IN CM

		0.0 150.00	150.00 300.00	300.00 450.00	450.00 600.00	600.00 750.00	750.00 900.00
0.0	500.00	5.44E-17 (0.21)	4.31E-17 (0.17)	2.93E-17 (0.09)	1.89E-17 (0.15)	1.08E-17 (0.08)	6.60E-18 (0.14)
500.00	1000.00	1.30E-16 (0.22)	2.19E-16 (0.60)	9.89E-17 (0.45)	7.04E-17 (0.39)	2.21E-17 (0.12)	7.18E-17 (0.86)
1000.00	1500.00	3.88E-16 (0.78)	1.51E-16 (0.42)	7.78E-17 (0.21)	2.27E-16 (0.78)	8.65E-17 (0.63)	2.66E-16 (0.94)
1500.00	2000.00	1.66E-16 (0.45)	1.72E-16 (0.35)	2.31E-16 (0.66)	9.28E-17 (0.42)	6.43E-17 (0.29)	7.35E-17 (0.51)
2000.00	2500.00	1.14E-16 (0.38)	1.37E-16 (0.41)	1.07E-16 (0.36)	1.40E-16 (0.62)	4.93E-16 (0.72)	1.11E-16 (0.58)
2500.00	3000.00	2.20E-16 (0.39)	1.54E-16 (0.58)	9.84E-17 (0.35)	5.45E-17 (0.33)	3.92E-17 (0.47)	1.06E-17 (0.22)
3000.00	3500.00	1.38E-16 (0.32)	2.36E-16 (0.51)	6.28E-17 (0.23)	1.27E-15 (0.97)	2.13E-16 (0.90)	7.79E-18 (0.39)
3500.00	4000.00	5.63E-17 (0.22)	4.67E-17 (0.21)	8.54E-17 (0.39)	4.83E-17 (0.33)	2.24E-17 (0.49)	5.30E-18 (0.36)

		900.00 1050.00	1050.00 1200.00	1200.00 1350.00	1350.00 1500.00	1500.00 1650.00	1650.00 1800.00
0.0	500.00	2.67E-18 (0.07)	1.15E-19 (0.27)	7.35E-21 (0.38)	4.50E-20 (0.99)	2.66E-20 (1.00)	7.33E-21 (0.98)
500.00	1000.00	1.94E-17 (0.79)	6.01E-19 (0.74)	2.21E-20 (0.70)	3.21E-21 (0.69)	1.53E-21 (0.96)	2.69E-22 (0.89)
1000.00	1500.00	3.57E-17 (0.80)	4.63E-18 (0.52)	2.09E-19 (0.54)	7.98E-21 (0.51)	9.91E-22 (0.54)	2.11E-22 (0.51)
1500.00	2000.00	3.04E-17 (0.46)	7.19E-18 (0.79)	4.88E-19 (0.73)	2.66E-20 (0.47)	1.70E-21 (0.60)	3.01E-22 (0.35)
2000.00	2500.00	1.23E-17 (0.42)	1.68E-18 (0.43)	1.76E-19 (0.51)	7.84E-20 (0.91)	1.04E-20 (0.94)	2.96E-21 (0.74)
2500.00	3000.00	2.43E-18 (0.30)	1.98E-19 (0.21)	3.01E-20 (0.31)	3.56E-21 (0.59)	6.03E-22 (0.37)	9.96E-22 (0.85)
3000.00	3500.00	1.38E-18 (0.30)	9.14E-20 (0.32)	1.86E-20 (0.69)	2.88E-21 (0.69)	2.90E-22 (0.55)	2.00E-21 (0.72)
3500.00	4000.00	1.28E-18 (0.33)	6.90E-20 (0.36)	5.23E-21 (0.39)	5.13E-22 (0.34)	4.73E-22 (0.75)	8.10E-21 (0.73)

Table II (Cont.)

DOSE ON ROOF IN REL/INT.PROTON FOR X(VERTICAL)-REGION FROM 1420.00 TO 1470.00 CM (RELATIVE ERROR)
AS A FUNCTION OF LATERAL DISTANCE (ACROSS) & LONGITUDINAL DISTANCE (DOWN) , IN CM

		0.0 150.00	150.00 300.00	300.00 450.00	450.00 600.00	600.00 750.00	750.00 900.00
0.0	500.00	1.99E-17 (0.21)	1.60E-17 (0.19)	1.06E-17 (0.10)	7.31E-18 (0.17)	3.87E-18 (0.08)	2.45E-18 (0.14)
500.00	1000.00	4.60E-17 (0.21)	5.77E-17 (0.47)	4.53E-17 (0.58)	2.48E-17 (0.35)	8.40E-18 (0.15)	3.46E-17 (0.91)
1000.00	1500.00	1.21E-16 (0.74)	4.84E-17 (0.37)	2.68E-17 (0.17)	8.76E-17 (0.82)	4.83E-17 (0.65)	3.72E-17 (0.86)
1500.00	2000.00	5.97E-17 (0.46)	5.85E-17 (0.31)	8.70E-17 (0.67)	3.08E-17 (0.32)	1.85E-16 (0.89)	3.65E-17 (0.61)
2000.00	2500.00	3.46E-17 (0.29)	4.94E-17 (0.38)	3.88E-17 (0.37)	4.64E-17 (0.61)	1.36E-16 (0.68)	4.71E-17 (0.55)
2500.00	3000.00	7.79E-17 (0.42)	4.12E-17 (0.45)	3.18E-17 (0.36)	2.01E-17 (0.32)	1.08E-17 (0.35)	5.82E-18 (0.40)
3000.00	3500.00	4.91E-17 (0.26)	1.65E-16 (0.72)	2.48E-17 (0.21)	2.00E-16 (0.93)	2.05E-16 (0.94)	4.93E-18 (0.60)
3500.00	4000.00	4.86E-17 (0.57)	2.59E-17 (0.27)	3.04E-17 (0.35)	1.65E-17 (0.35)	8.35E-18 (0.46)	2.08E-18 (0.45)

		900.00 1050.00	1050.00 1200.00	1200.00 1350.00	1350.00 1500.00	1500.00 1650.00	1650.00 1800.00
0.0	500.00	1.09E-18 (0.07)	8.13E-20 (0.23)	3.43E-21 (0.32)	9.54E-21 (0.97)	1.56E-20 (1.00)	3.09E-21 (0.99)
500.00	1000.00	3.83E-18 (0.57)	5.37E-19 (0.71)	3.35E-20 (0.62)	5.20E-22 (0.47)	5.76E-22 (0.65)	2.37E-22 (0.95)
1000.00	1500.00	2.18E-17 (0.88)	4.32E-18 (0.60)	1.35E-19 (0.64)	5.74E-21 (0.36)	2.95E-22 (0.38)	1.08E-22 (0.62)
1500.00	2000.00	3.87E-17 (0.73)	2.87E-18 (0.59)	2.39E-19 (0.69)	1.88E-20 (0.73)	9.57E-22 (0.47)	1.86E-22 (0.46)
2000.00	2500.00	7.01E-18 (0.48)	6.82E-19 (0.53)	8.91E-20 (0.43)	7.07E-21 (0.48)	7.12E-21 (0.95)	1.02E-21 (0.56)
2500.00	3000.00	1.18E-18 (0.32)	1.24E-19 (0.22)	7.81E-21 (0.30)	3.76E-21 (0.70)	1.05E-22 (0.51)	1.93E-22 (0.67)
3000.00	3500.00	6.62E-19 (0.36)	5.09E-20 (0.27)	6.15E-21 (0.51)	1.55E-21 (0.74)	1.78E-22 (0.53)	6.11E-22 (0.64)
3500.00	4000.00	5.54E-19 (0.30)	5.35E-20 (0.37)	2.53E-21 (0.36)	2.95E-22 (0.38)	9.37E-23 (0.75)	2.45E-21 (0.80)

DOSE ON ROOF IN REL/INT.PROTON FOR X(VERTICAL)-REGION FROM 1470.00 TO 1520.00 CM (RELATIVE ERROR)
AS A FUNCTION OF LATERAL DISTANCE (ACROSS) & LONGITUDINAL DISTANCE (DOWN) , IN CM

		0.0 150.00	150.00 300.00	300.00 450.00	450.00 600.00	600.00 750.00	750.00 900.00
0.0	500.00	7.16E-18 (0.21)	5.54E-18 (0.19)	3.93E-18 (0.11)	2.65E-18 (0.15)	1.42E-18 (0.10)	8.76E-19 (0.14)
500.00	1000.00	1.65E-17 (0.21)	2.08E-17 (0.48)	1.58E-17 (0.53)	8.70E-18 (0.33)	3.72E-18 (0.24)	1.12E-17 (0.90)
1000.00	1500.00	4.19E-17 (0.71)	1.77E-17 (0.42)	8.92E-18 (0.17)	2.06E-17 (0.73)	1.85E-17 (0.53)	8.66E-18 (0.78)
1500.00	2000.00	1.86E-17 (0.35)	1.95E-17 (0.32)	2.80E-17 (0.66)	1.50E-17 (0.40)	5.71E-17 (0.86)	1.18E-17 (0.33)
2000.00	2500.00	1.36E-17 (0.26)	1.63E-17 (0.35)	1.40E-17 (0.33)	1.71E-17 (0.57)	3.94E-17 (0.66)	1.87E-17 (0.57)
2500.00	3000.00	2.62E-17 (0.40)	1.42E-17 (0.43)	1.06E-17 (0.34)	8.42E-18 (0.29)	3.84E-18 (0.31)	3.17E-18 (0.51)
3000.00	3500.00	1.74E-17 (0.24)	5.16E-17 (0.69)	1.09E-17 (0.28)	4.25E-17 (0.88)	6.82E-16 (1.00)	7.02E-18 (0.88)
3500.00	4000.00	1.08E-17 (0.36)	1.01E-17 (0.26)	9.22E-18 (0.34)	6.32E-18 (0.35)	2.82E-18 (0.49)	9.93E-19 (0.48)

		900.00 1050.00	1050.00 1200.00	1200.00 1350.00	1350.00 1500.00	1500.00 1650.00	1650.00 1800.00
0.0	500.00	4.15E-19 (0.08)	6.30E-20 (0.17)	4.03E-21 (0.55)	1.21E-21 (0.88)	7.64E-21 (1.00)	1.10E-21 (0.99)
500.00	1000.00	1.95E-18 (0.71)	4.20E-19 (0.67)	5.59E-20 (0.68)	4.05E-22 (0.60)	1.87E-22 (0.89)	5.01E-23 (0.73)
1000.00	1500.00	5.24E-18 (0.84)	1.49E-18 (0.61)	6.24E-20 (0.55)	6.29E-21 (0.61)	1.46E-22 (0.47)	5.18E-23 (0.52)
1500.00	2000.00	1.21E-17 (0.69)	1.11E-18 (0.54)	1.65E-19 (0.77)	4.73E-21 (0.65)	7.04E-22 (0.52)	6.33E-23 (0.36)
2000.00	2500.00	9.56E-18 (0.86)	4.22E-19 (0.57)	6.35E-20 (0.44)	4.53E-21 (0.47)	1.39E-21 (0.83)	2.88E-22 (0.57)
2500.00	3000.00	5.22E-19 (0.41)	7.54E-20 (0.27)	7.83E-21 (0.43)	1.01E-21 (0.54)	3.31E-23 (0.32)	5.74E-23 (0.56)
3000.00	3500.00	2.73E-19 (0.35)	2.57E-20 (0.28)	2.55E-21 (0.30)	3.45E-22 (0.54)	1.49E-22 (0.58)	1.81E-22 (0.70)
3500.00	4000.00	1.71E-19 (0.26)	3.36E-20 (0.43)	1.54E-21 (0.35)	2.64E-22 (0.47)	4.93E-23 (0.55)	5.63E-22 (0.80)

Figure Captions

1(a). Schematic elevation and plan views of present design of colliding beam hall at B Zero (Beam pipe is not shown.)

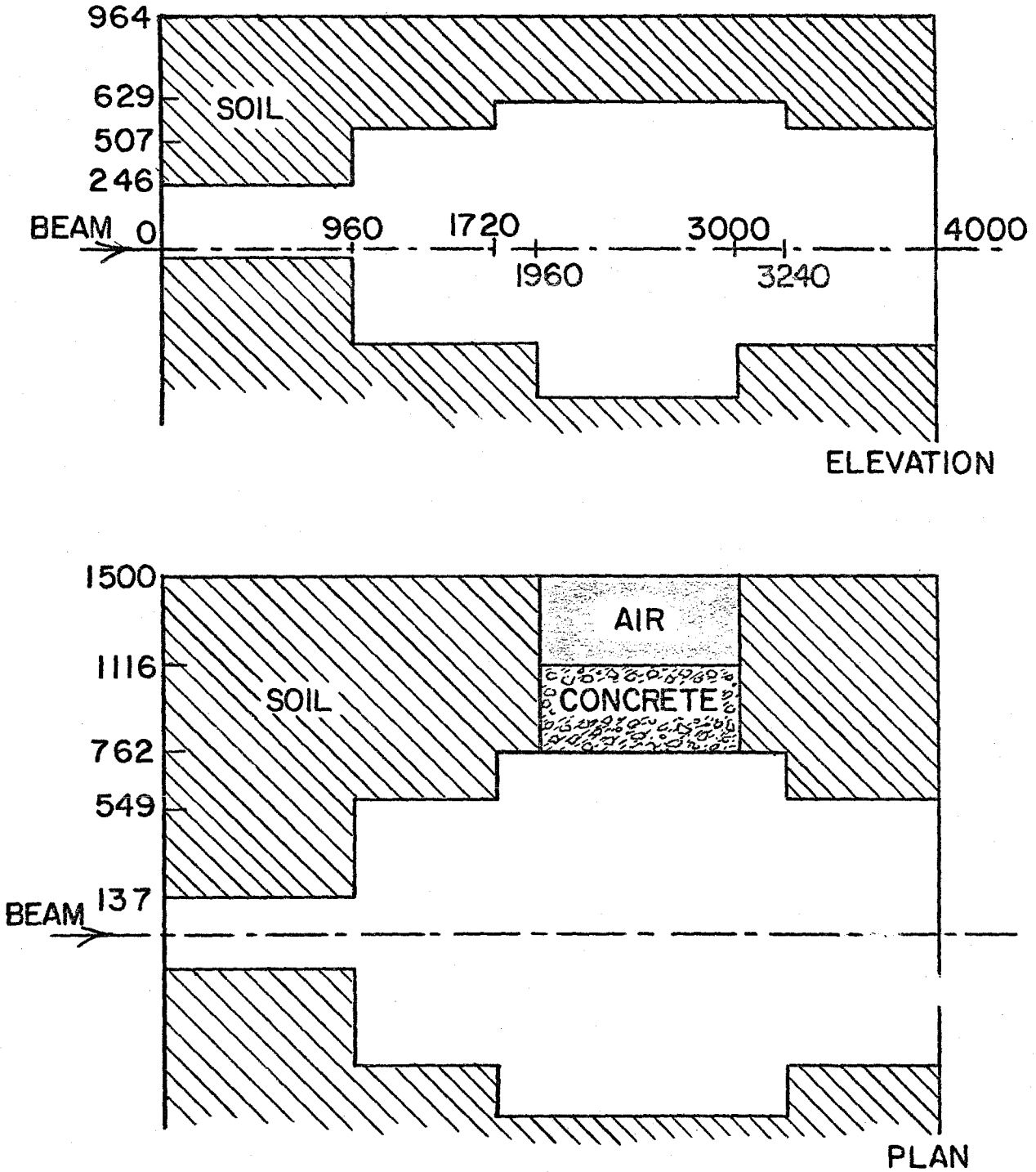
(b) Cylindrically symmetric geometry used in CASIM to represent (a). The air strips are added for convenience in binning the output (see text). Concrete walls of the tunnels are replaced by soil. Small adjustments in soil thickness will compensate for this. All dimensions are in cm.

2. Simplified version of a previous design of B-Zero colliding beams hall as used in CASIM. All dimensions are in cm.

3. Maximum dose rate in air region behind concrete of Figure 1b (open circles) and dose rate averaged longitudinally along the concrete (closed circles) as a function of pipe thickness. Beam interacts as zero depth.

4. Maximum dose rate in air region behind concrete of Figure 1b (open circles) and dose rate averaged longitudinally along the concrete (closed circles) as a function of distance along pipe where beam is lost. The beam pipe is uniformly 5 cm thick.

5. Maximum dose rate in air region behind concrete of Figure 2 (open circles, left ordinate) and dose rate averaged over "good statistics" region within concrete (closed circles, right ordinate) as a function of pipe thickness.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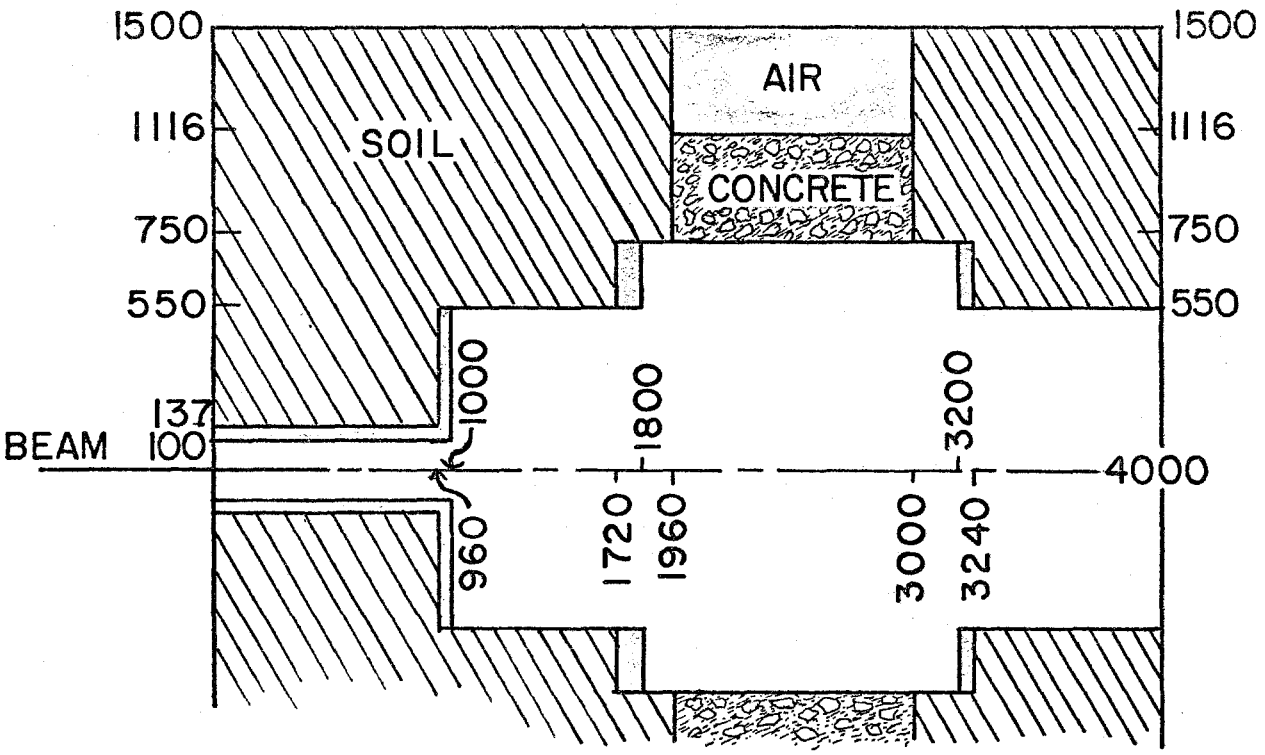
629
507
246
SOIL
BEAM
0
960
1720
1960
3000
3240
4000
ELEVATION
1500
1116
762
549
137
SOIL
AIR
CONCRETE
BEAM
PLAN

Fig. 1a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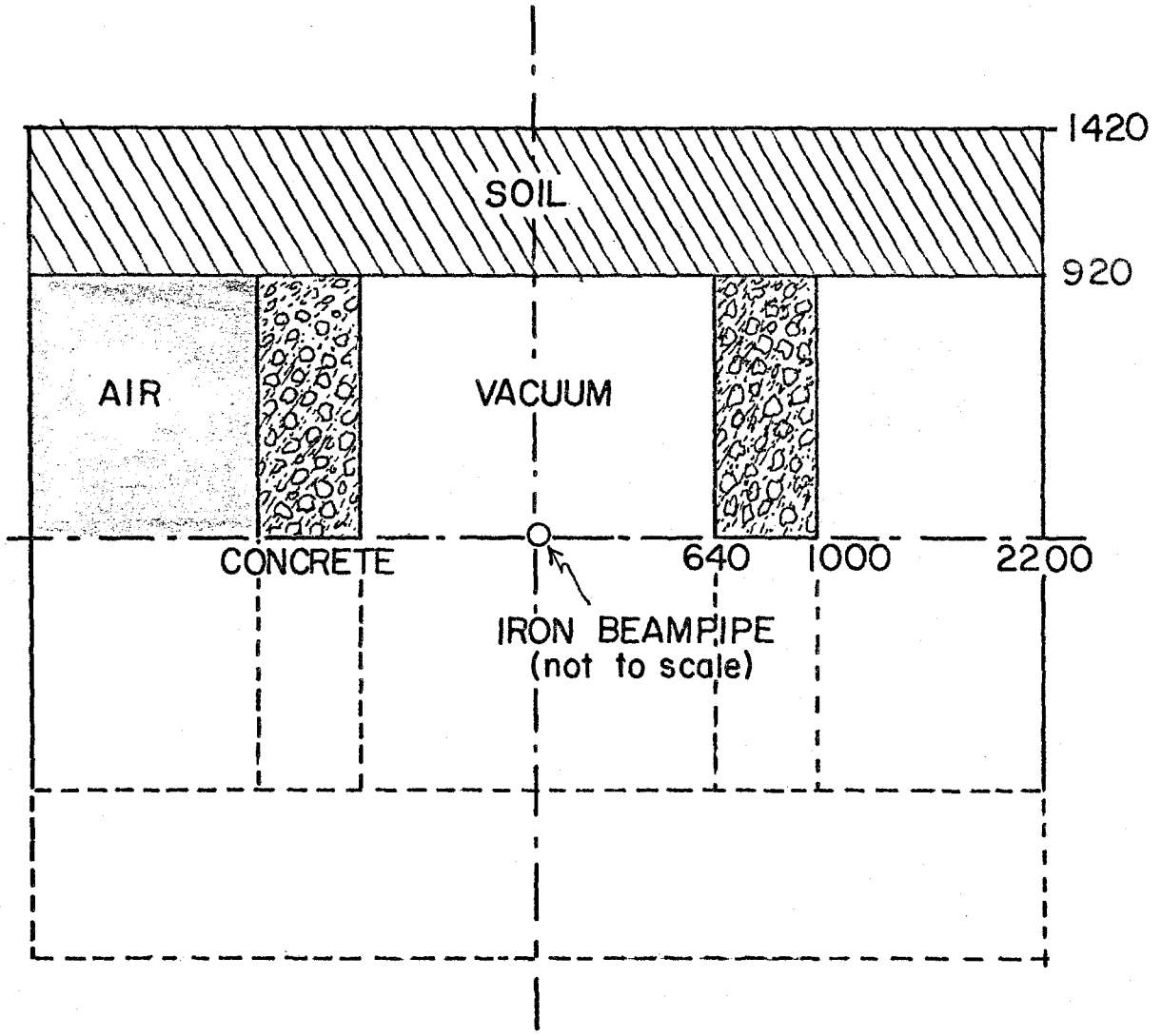
1116
750
550
137
BEAM
100
SOIL
AIR
CONCRETE
1000
960
1800
1720
1960
3200
3000
3240
4000
1500
1116
750
550

Fig. 1b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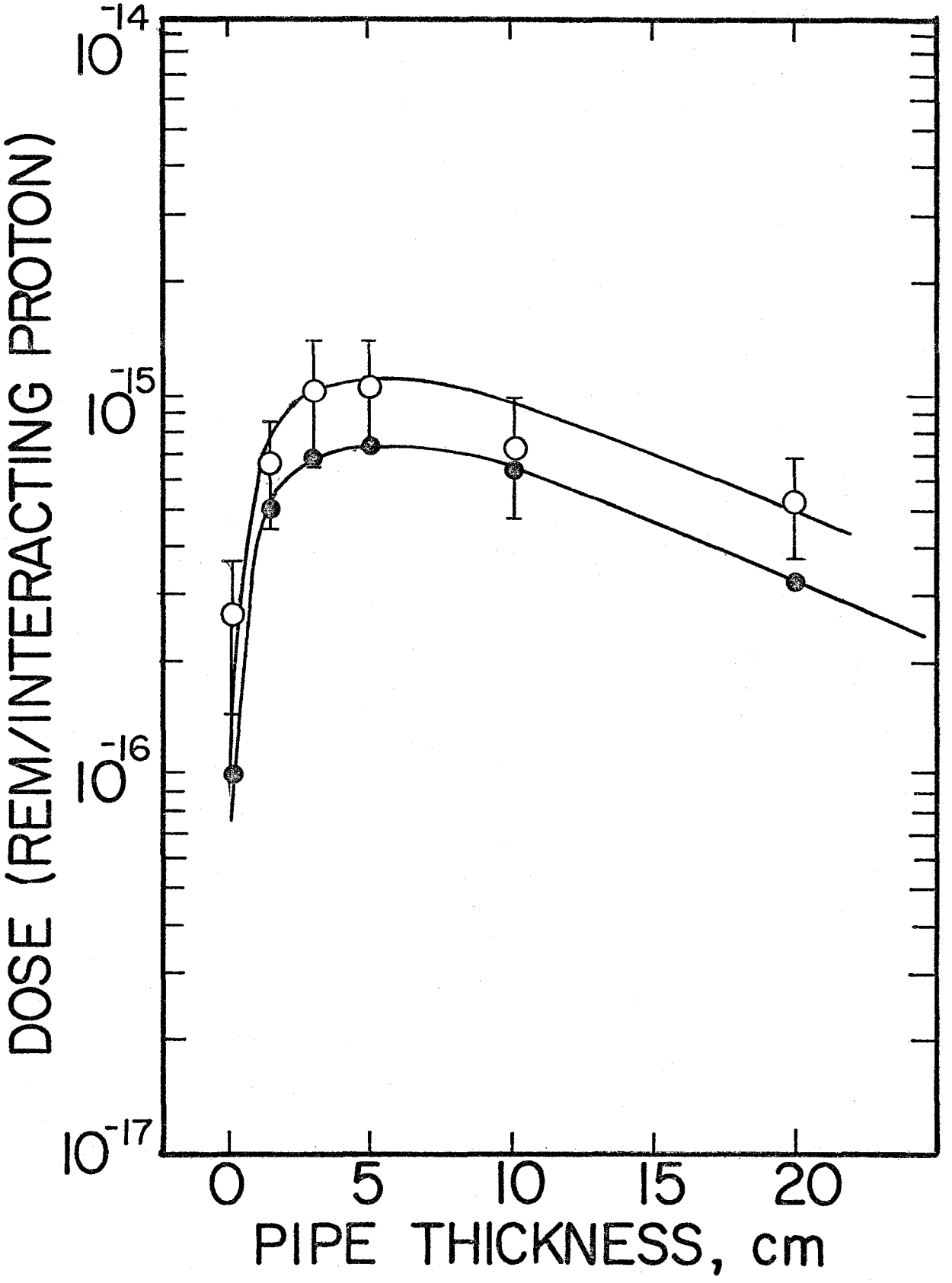
AIR
VACUUM
CONCRETE
640
1000
2200
IRON BEAMPIPE
(not to scale)

Fig. 2


DOSE (REM/INTERACTING PROTON)
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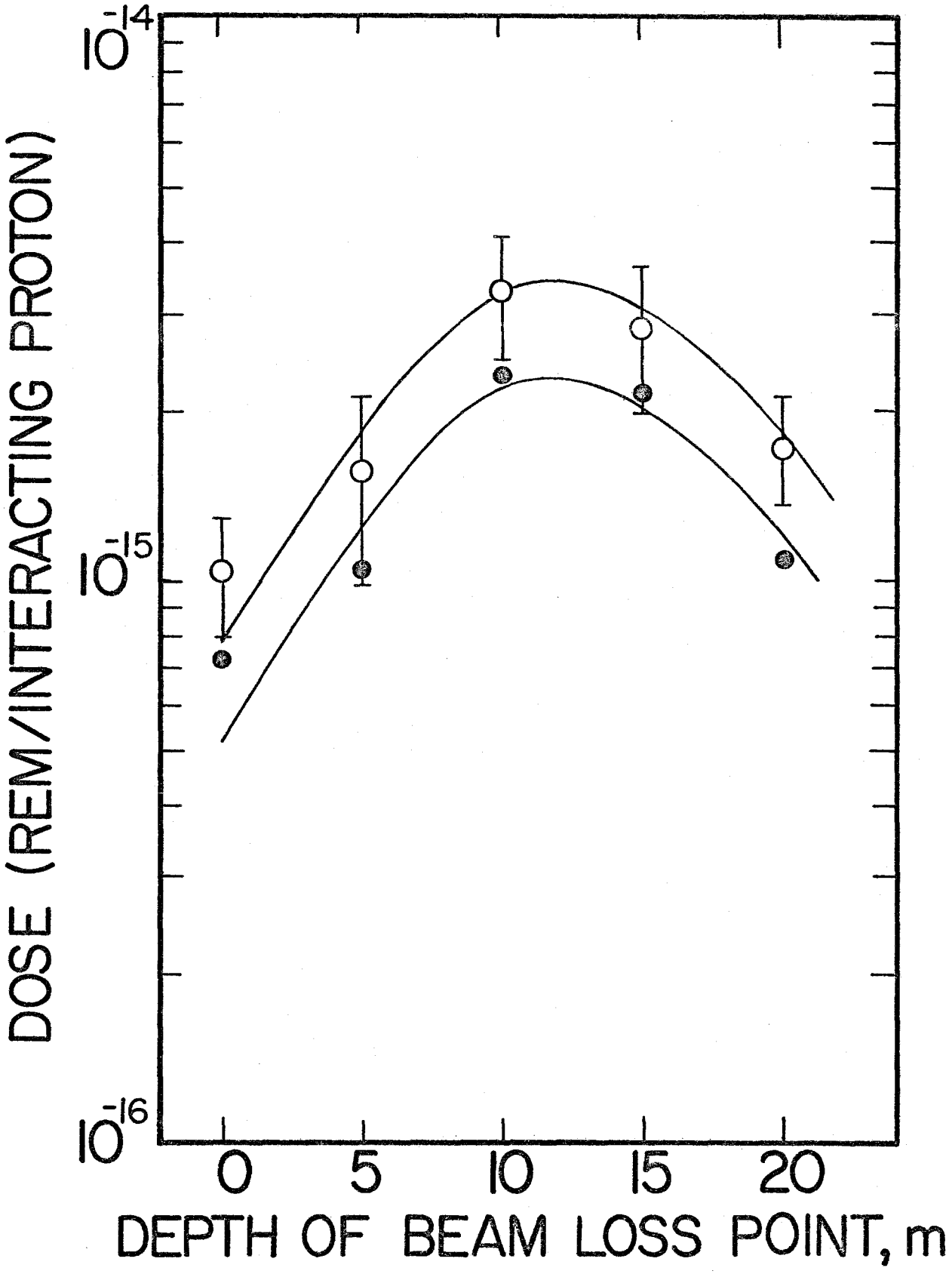
10^{-15}
10^{-16}
10^{-17}
0
5
10
15
20
PIPE THICKNESS, cm

Fig. 3


DOSE (REM/INTERACTING PROTON)
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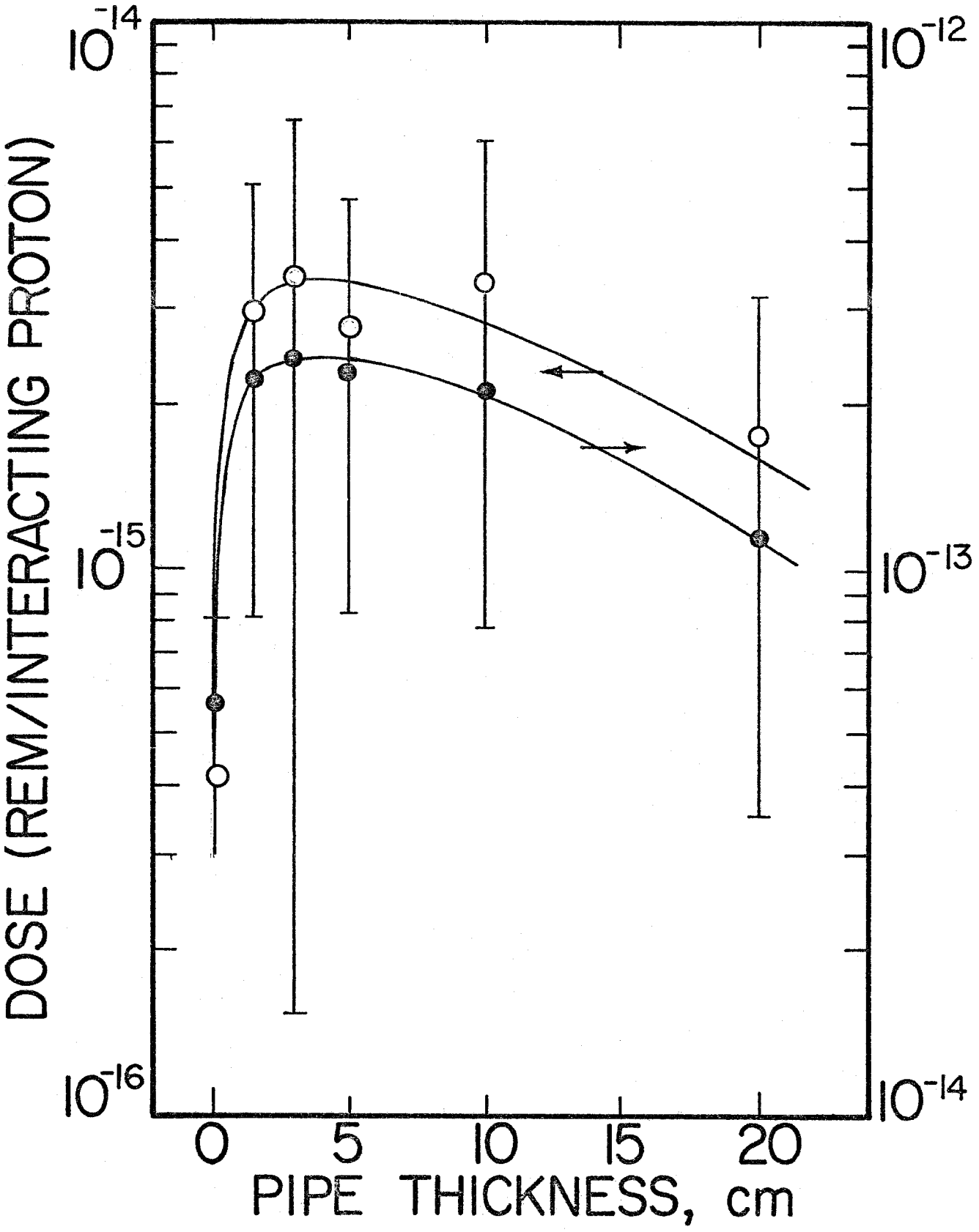
10^{-15}
10^{-16}
0
5
10
15
20
DEPTH OF BEAM LOSS POINT, m

Fig. 4


DOSE (REM/INTERACTING PROTON)
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10^{-15}
10^{-16}
10^{-12}
10^{-13}
10^{-14}
0
5
10
15
20
PIPE THICKNESS, cm

Fig. 5