DOSIMETRIC EVALUATION OF AN INTRAOPERATIVE CONE SYSTEM

A Thesis Presented to
The Faculty of the Graduate School
Dept. of Physics, De Paul University
In Partial Fulfillment of the
Requirements for the Degree of
Master of Science

by

Timothy George Ochran, B.S.
February, 1987

De Paul University
Chicago, Illinois

ABSTRACT

An Intraoperative Cone System has been dosimetrically evaluated. The beam's profile is the most critical characteristic. This investigation was made on a Siemens Mevatron Linear Accelerator. It revealed that the choice of the collimator field setting was critical in obtaining optimum beam flatness, uniformity, high surface dose, and beam output. The evaluation included a variety of round cones ranging in size from five to nine and one half centimeters with beveled ends from 0° to 30°. The cone system in addition to being used intraoperatively can be very easily used for external beam treatments, thus providing unique field sizes that adapt more readily to the contour of the treatment area.

The lucite cones have zero taper for this application. They are really right circular cylinders with inside diameters ranging from 1.9cm to 9.5cm. The end of the cone may be flat, or may be beveled by an angle of 15°, 30° or 45°. The set of cones for this initial study consisted of seven. Three diameters were used 5.1cm, 7.0cm and 9.5cm. In each of the sizes there was a 15° and 30° beveled cone. There was one flat cone with a diameter of 7.0cm. The wall thickness of the cone is 0.32cm, and the overall length is 30.5cm.

The distance from the effective point source of the treatment machine to the central axis at the end of each of the cones, known as the source-to-skin distance (SSD), is 100cm. The sleeve, into which the cones are inserted, has an inner diameter of 10.5cm. The clearance between the inside of the sleeve and the cone is 0.305mm. This allows the cone to move slightly as the patients breathe. The general design of this system compares to those employed at Howard University, Massachusetts General Hospital (MGH), and the Mayo Clinic. [2,3,8].

Figure 12

CONCLUSIONS

The dosimetry of the cone system described in this work is different from previous results of other systems. The major finding of this research was that the collimator setting had a dramatic effect on the flatness of the treatment beam. The surface dose increased and the output factors were nearly one.

Another interesting finding of this research was the linear association between the cone size and the collimator setting, thus allowing the prediction of field sizes for any size cone.

TABLE I

CONE FACTORS

FOR INTRAOPERATIVE CONES

CONE SIZE	ELECTRON ENERGY 3	7	10	12	15	18
5.1 15'		1.53 (6.4)	1.09 (6.0)	1.33 (7.0)	1.16 (7.0)	1.24 (6.4)
5.1 30'	1.58 (15.0)	1.29 (7.2)	1.162 (7.0)	1.31 (7.0)	1.14 (7.0)	1.26 (6.4)
7.0 0'		1.56 (9.0)	1.27 (9.0)	1.09 (9.0)	1.02 (9.0)	1.02 (8.3)
7.0 15'		1.55 (9.0)	1.27 (9.0)	1.10 (9.0)	1.02 (9.0)	1.03 (8.3)
7.0 30'		1.45 (9.4)	1.23 (9.0)	1.06 (9.0)	0.992 (9.0)	1.00 (8.4)
9.5 15'		0.899 (14.5)	0.933 (13.0)	0.975 (11.6)	0.948 (11.6)	0.989 (10.6)
9.5 30'		0.895 (14.5)	0.895 (13.0)	0.938 (11.6)	0.912 (11.6)	0.960 (10.6)

The first number, under Electron Energy, is the cone factor.

The second number, in parenthesis, is the collimator setting.

TABLE II

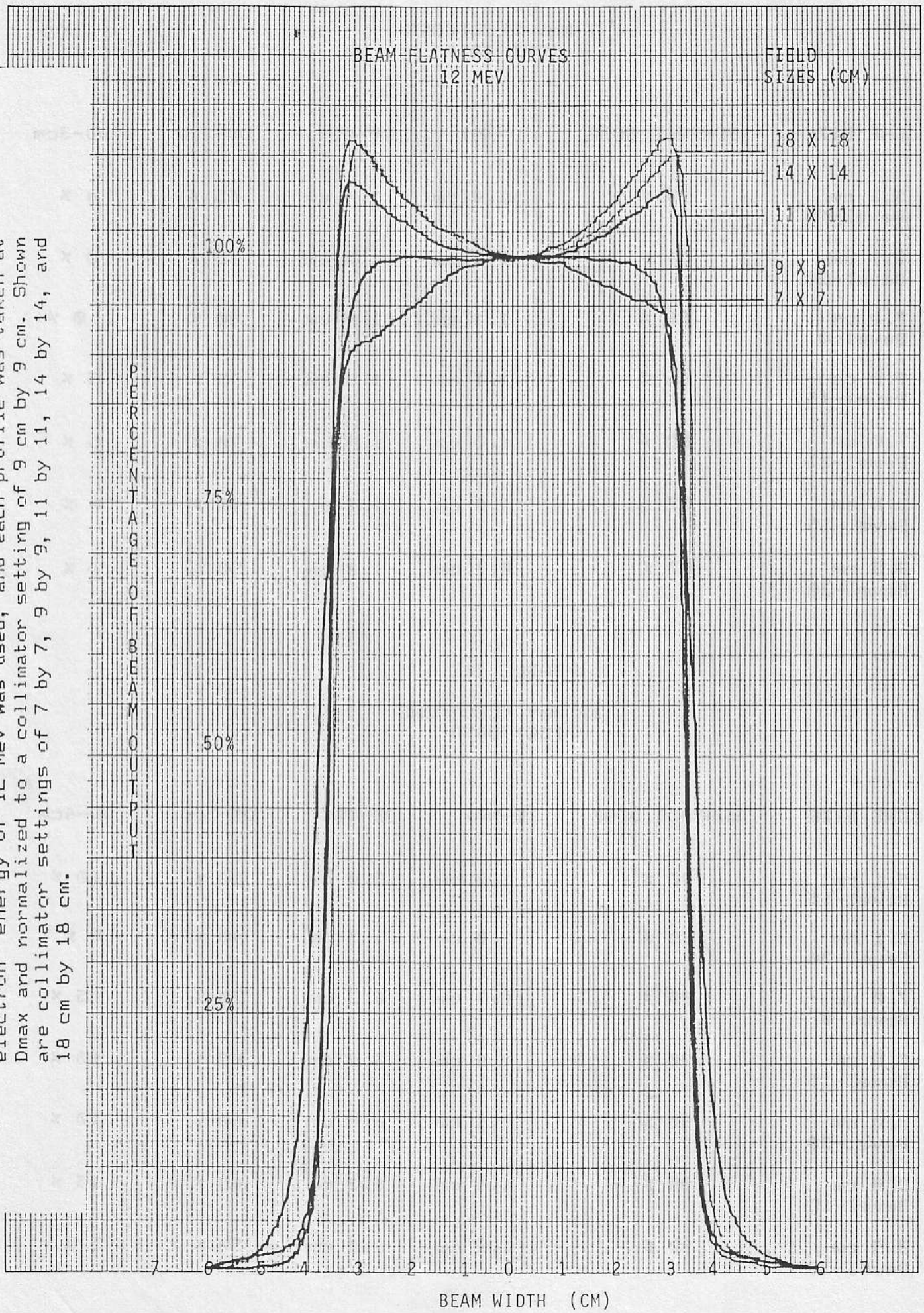
7 MeV ELECTRONS
IORT DATA

CONE SIZE	SURFACE DOSE	D-MAX	DD-90%	DD-2cm	DD-3cm
5.1 cm Bevel-15	84 %	1.0 cm	1.4 cm	65 %	4 %
5.1 cm Bevel-30	84 %	0.7 cm	1.3 cm	45 %	0 %
7.0 cm Bevel-0	88 %	1.1 cm	1.8 cm	80 %	10 %
7.0 cm Bevel-15	84 %	1.1 cm	1.6 cm	75 %	5 %
7.0 cm Bevel-30	82 %	1.0 cm	1.4 cm	70 %	5 %
9.5 cm Bevel-15	87 %	1.0 cm	1.7 cm	70 %	0 %
9.5 cm Bevel-30	87 %	0.7 cm	1.3 cm	50 %	1 %

TABLE III

10 MeV ELECTRONS
IORT DATA

CONE SIZE	SURFACE DOSE	D-MAX	DD-90%	DD-3cm	DD-4cm
5.1 cm Bevel-15	90 %	1.3 cm	2.0 cm	60 %	10 %
5.1 cm Bevel-30	88 %	1.0 cm	1.7 cm	40 %	5 %
7.0 cm Bevel-0	90 %	1.7 cm	2.3 cm	70 %	15 %
7.0 cm Bevel-15	90 %	1.6 cm	2.3 cm	65 %	10 %
7.0 cm Bevel-30	90 %	1.1 cm	2.0 cm	60 %	10 %
9.5 cm Bevel-15	90 %	1.4 cm	2.3 cm	65 %	15 %
9.5 cm Bevel-30	90 %	1.2 cm	2.0 cm	50 %	5 %



Beam flatness curves for a 7.0 cm non-beveled circular cone. An electron energy of 12 MeV was used, and each profile was taken at Dmax and normalized to a collimator setting of 9 cm by 9 cm. Shown are collimator settings of 7 by 7, 9 by 9, 11 by 11, 14 by 14, and 18 cm by 18 cm.

FIGURE 8

Isodose curve for a 7.0 cm nonbeveled circular cone. An electron energy of 12 MeV was used. The collimator setting 9 cm by 9 cm.

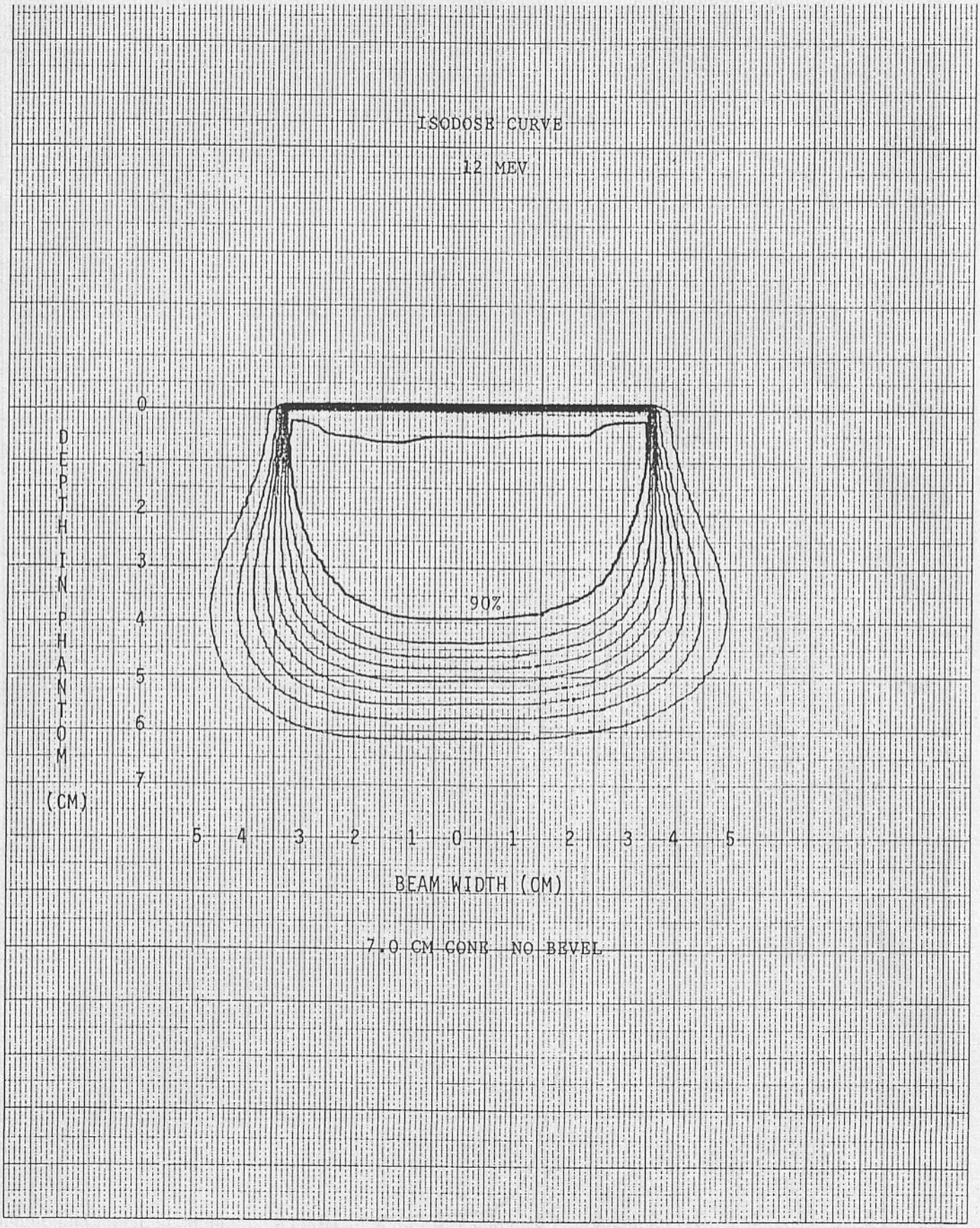


FIGURE 9

Depth dose curve for a 7.0 cm non-beveled circular cone at an electron energy of 12 Mev, and a collimator setting of 9.0 cm by 9.0 cm.

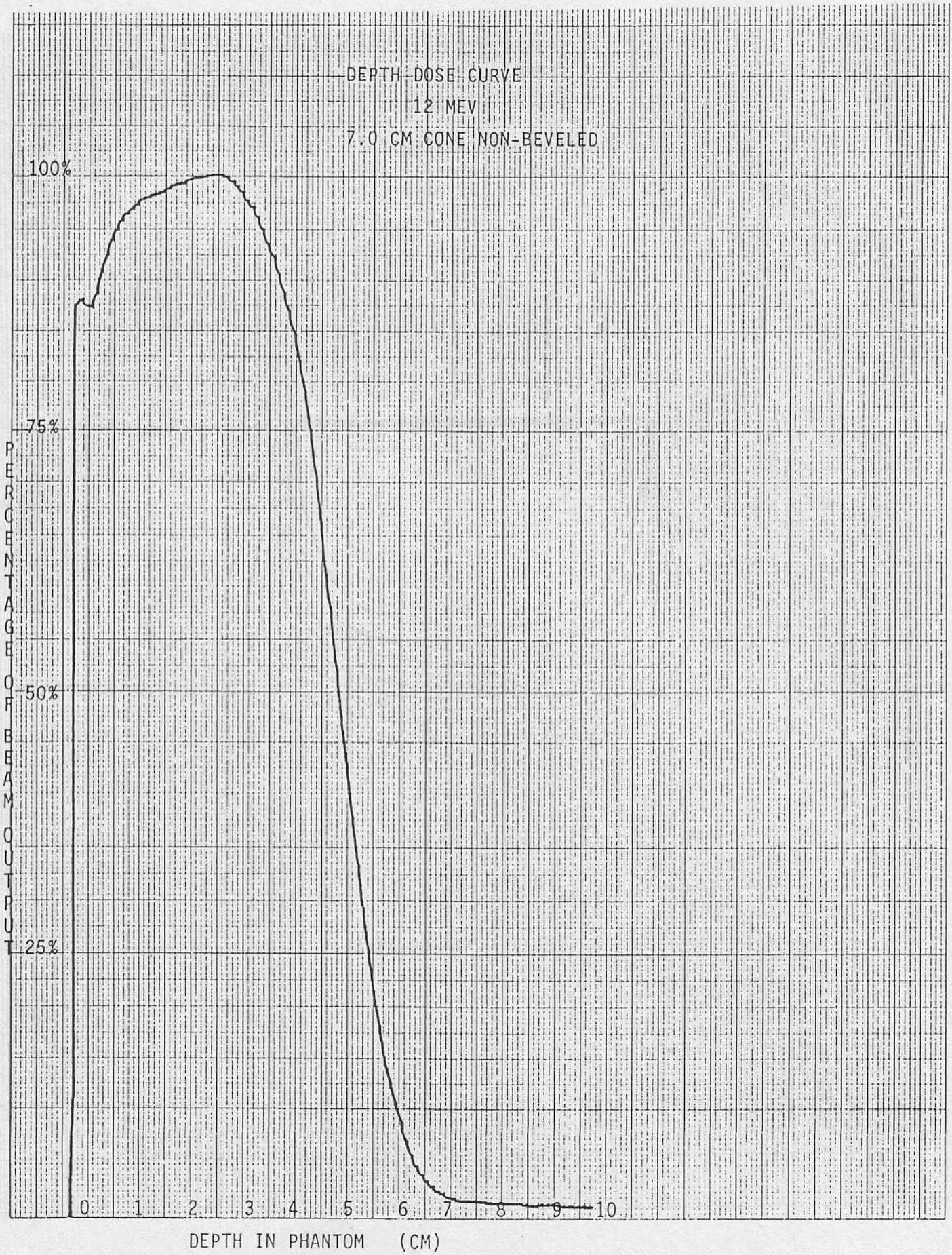


FIGURE 10

Beam Flatness curves for a 7.0 cm non-beveled circular cone. An electron energy of 12 MeV was used, and each profile was taken at Dmax and normalized to a collimator setting of 9cm by 9cm. Shown are collimator settings of 7 by 7, 9 by 9, 11 by 11, 14 by 14, and 18 by 18cm. The width of the 90% dose line can be measured with an accuracy of plus or minus 1mm. One can see that the width increases as the collimator setting increases, but one can also see that flatness decreases. The width of the 90% isodose line is 6.4cm. The inner diameter of the cone is 6.886cm.

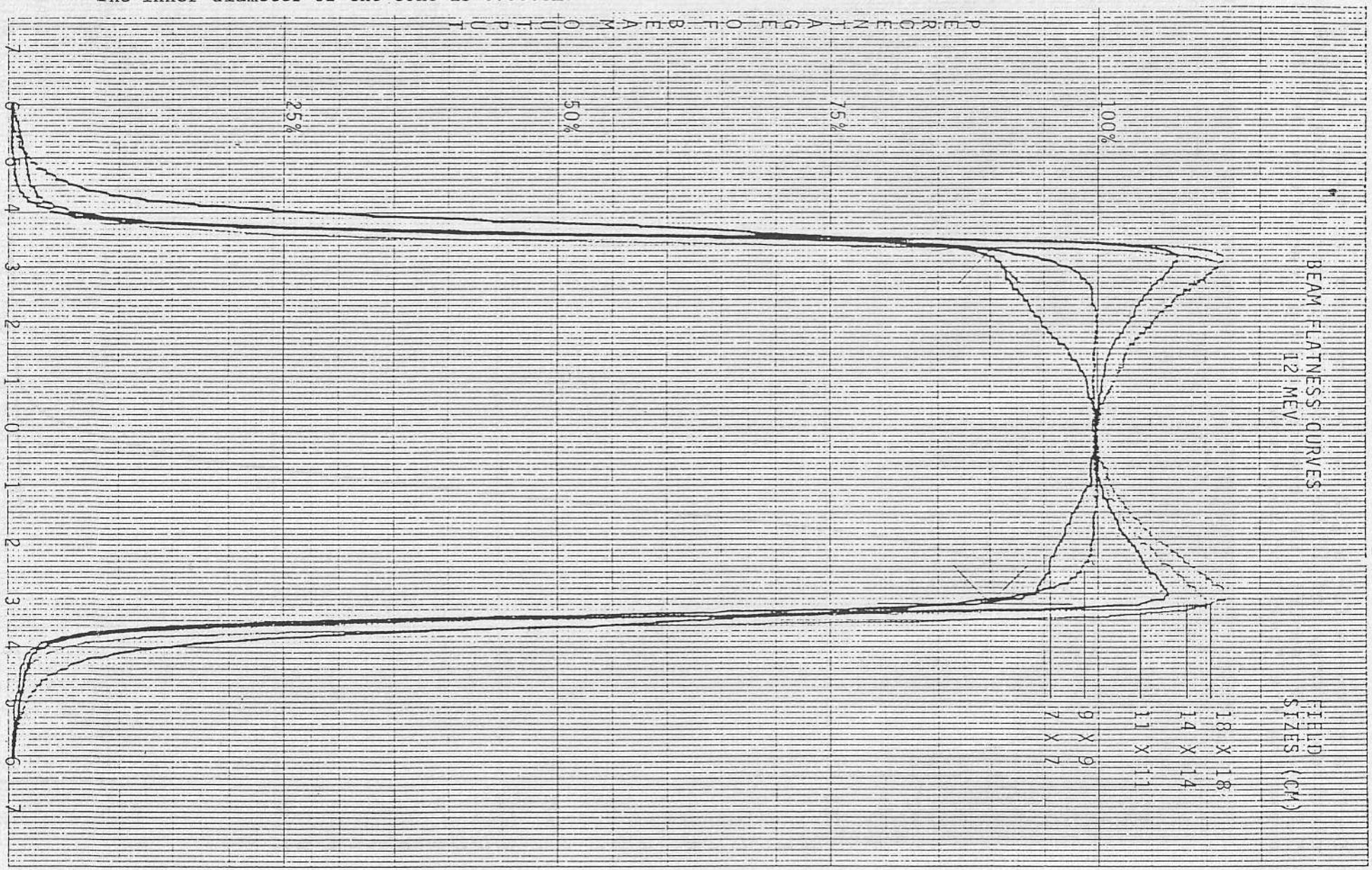


FIGURE 11

Depth dose curve for a 7.0 cm non-beveled circular cone at an electron energy of 12 MeV, and a collimator setting of 9.0 cm by 9.0 cm. The amount of bremsstrahlung radiation is found by measuring the "tail" of the curve.

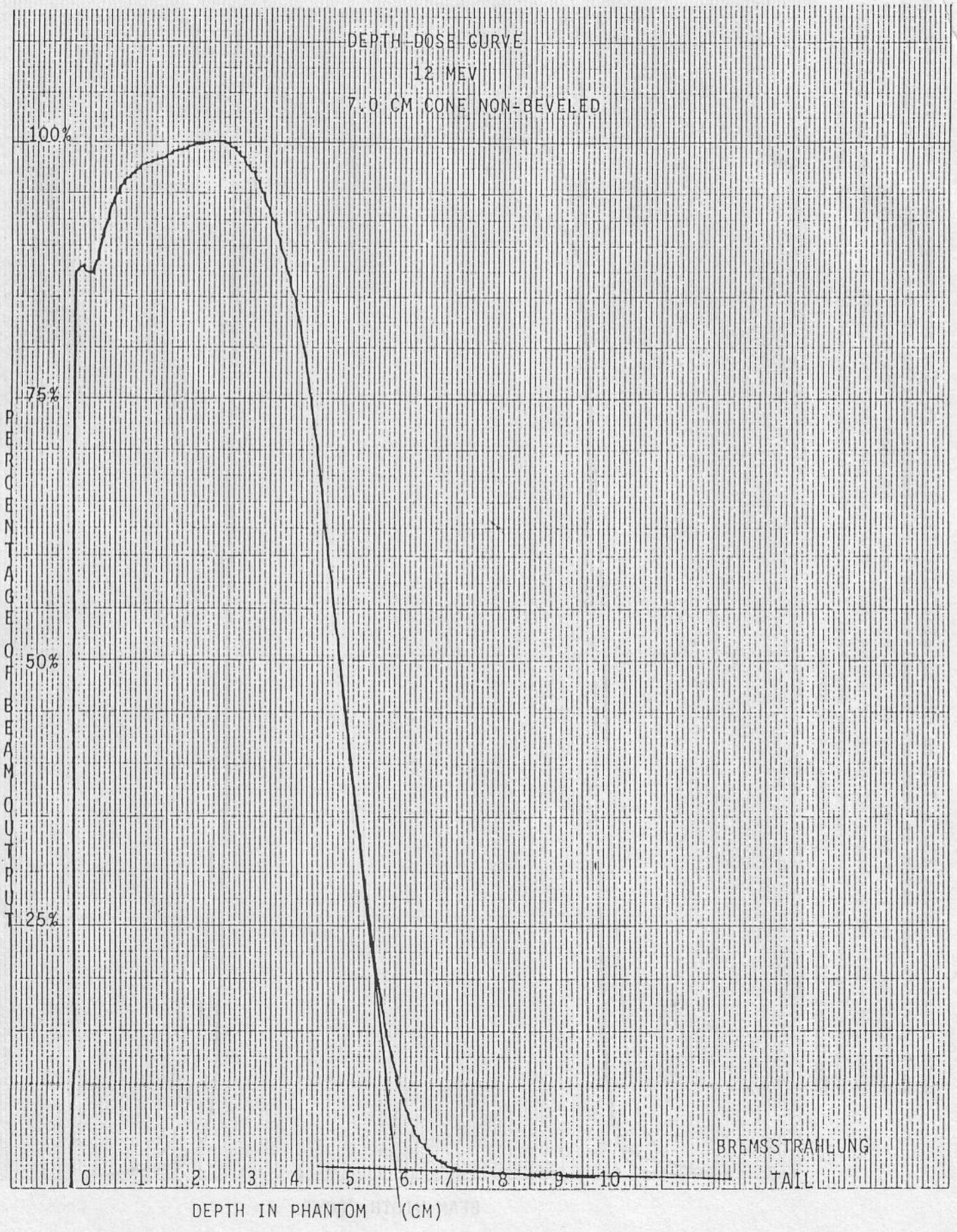


FIGURE 12

A Graph of the collimator setting vs. the 15° bevel cone size.

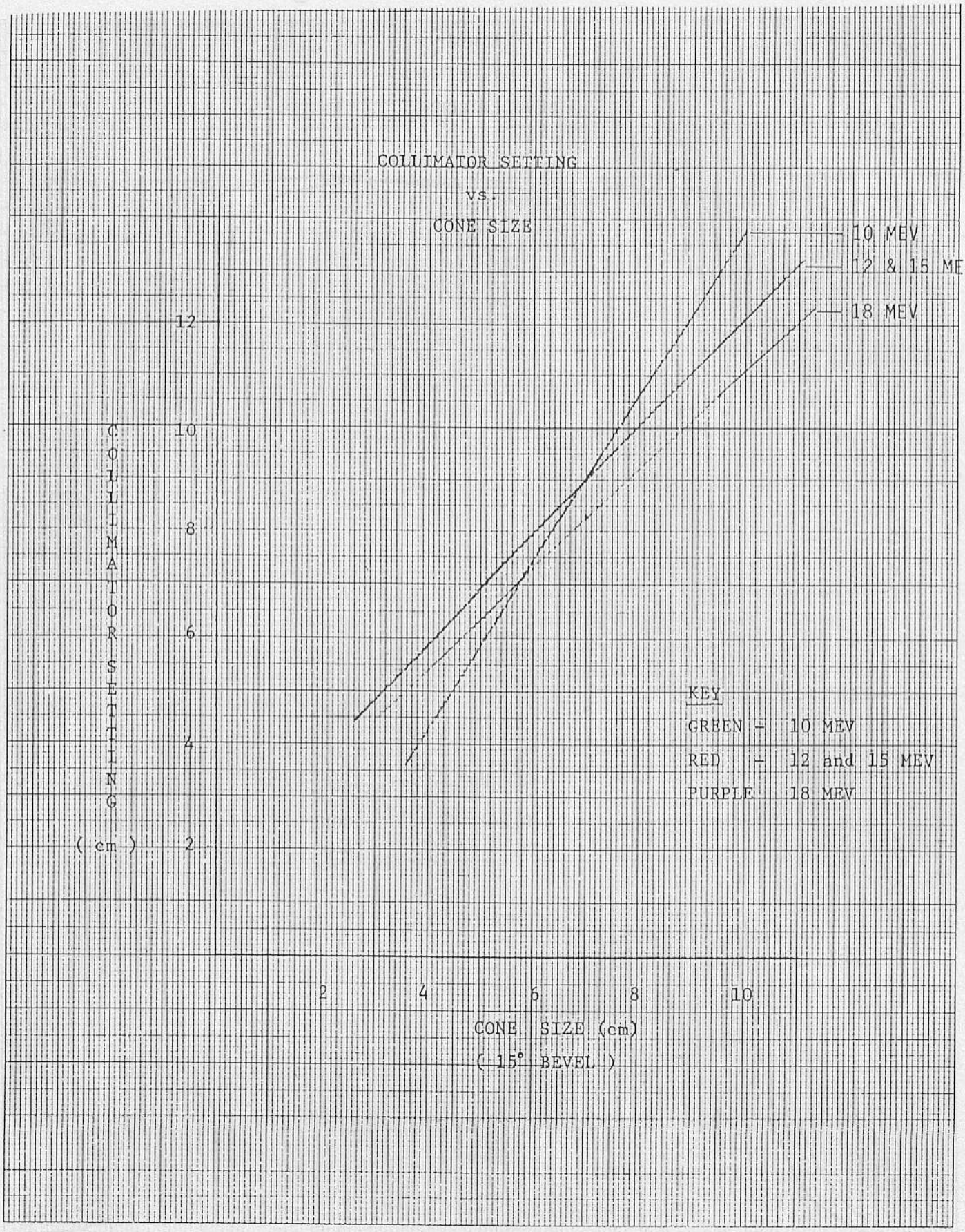


FIGURE 13

Beam flatness curves for a 9.5 cm cone with beveled ends of 15 and 30 degrees. The curves are in the plane with the beveled end of the cone and were taken at Dmax. The beam energy is 12 MeV.

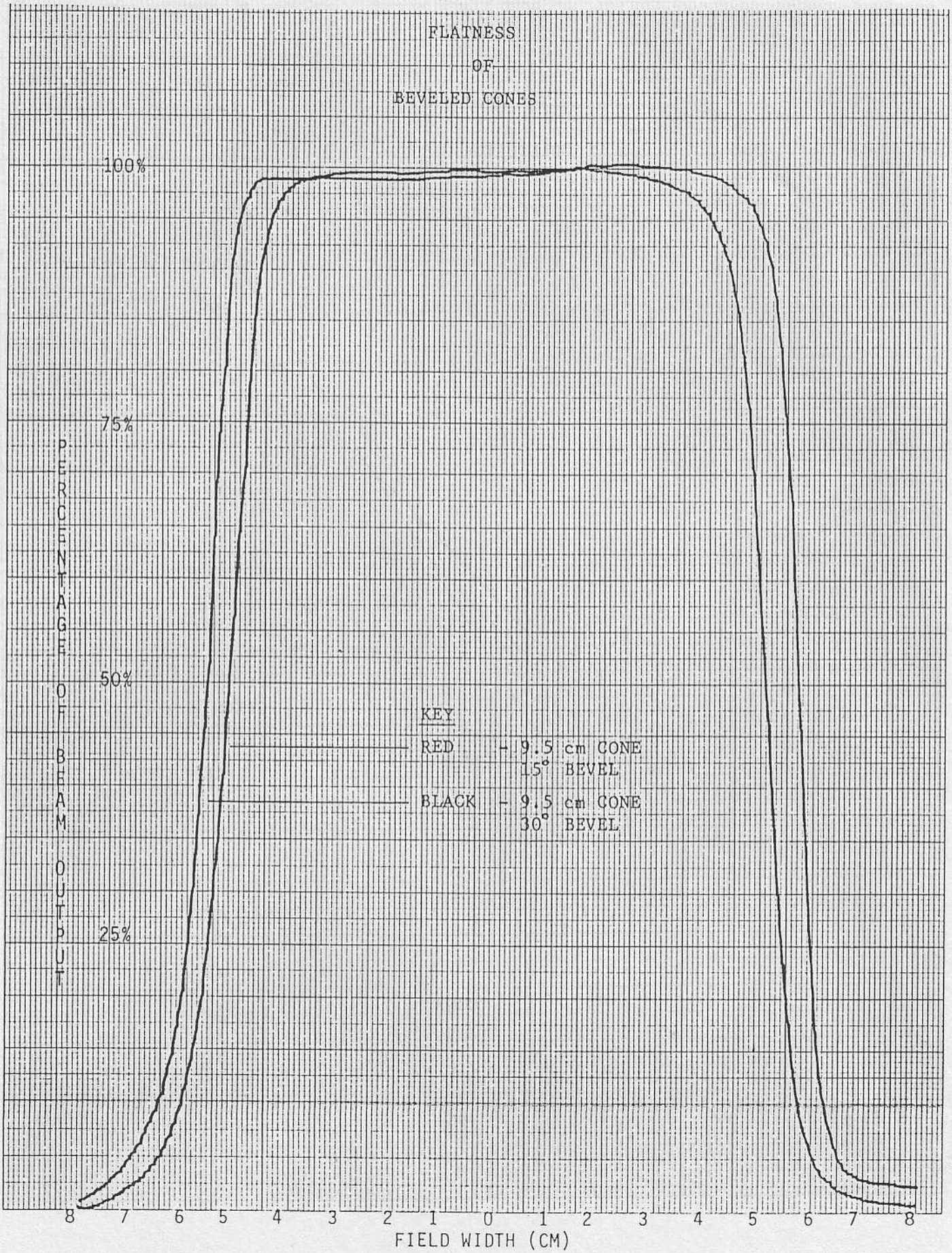


FIGURE 14

Isodose curves for a non-beveled 7.0 cm cone for electrons with the energies of 3,5,7 Mev .The 90% isodose curve is shown in red. The remainding isodose curves are every 10%.

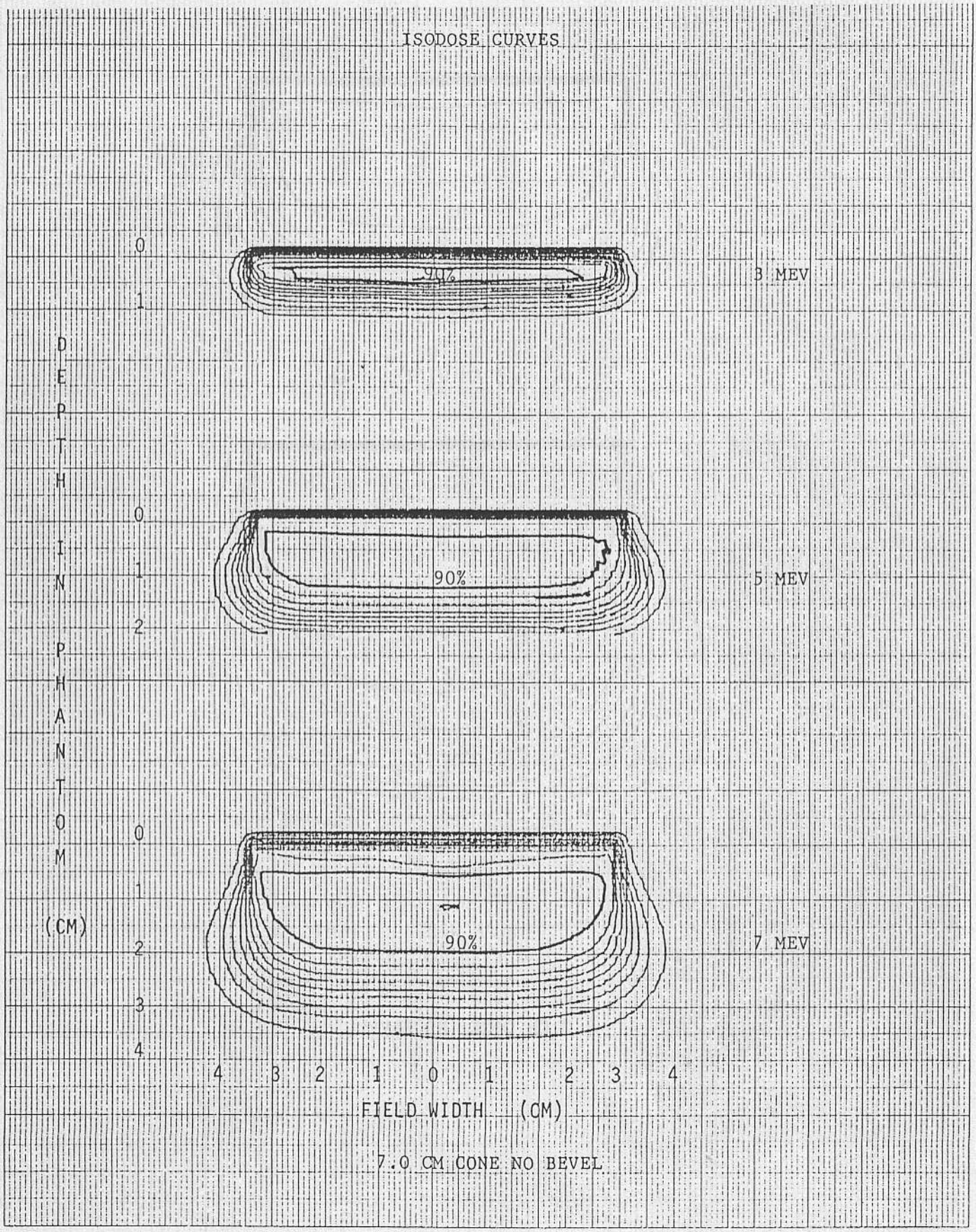


FIGURE 15

Isodose curves for a non-beveled 7.0 cm cone for electrons with the energies of 10, and 15 MeV.

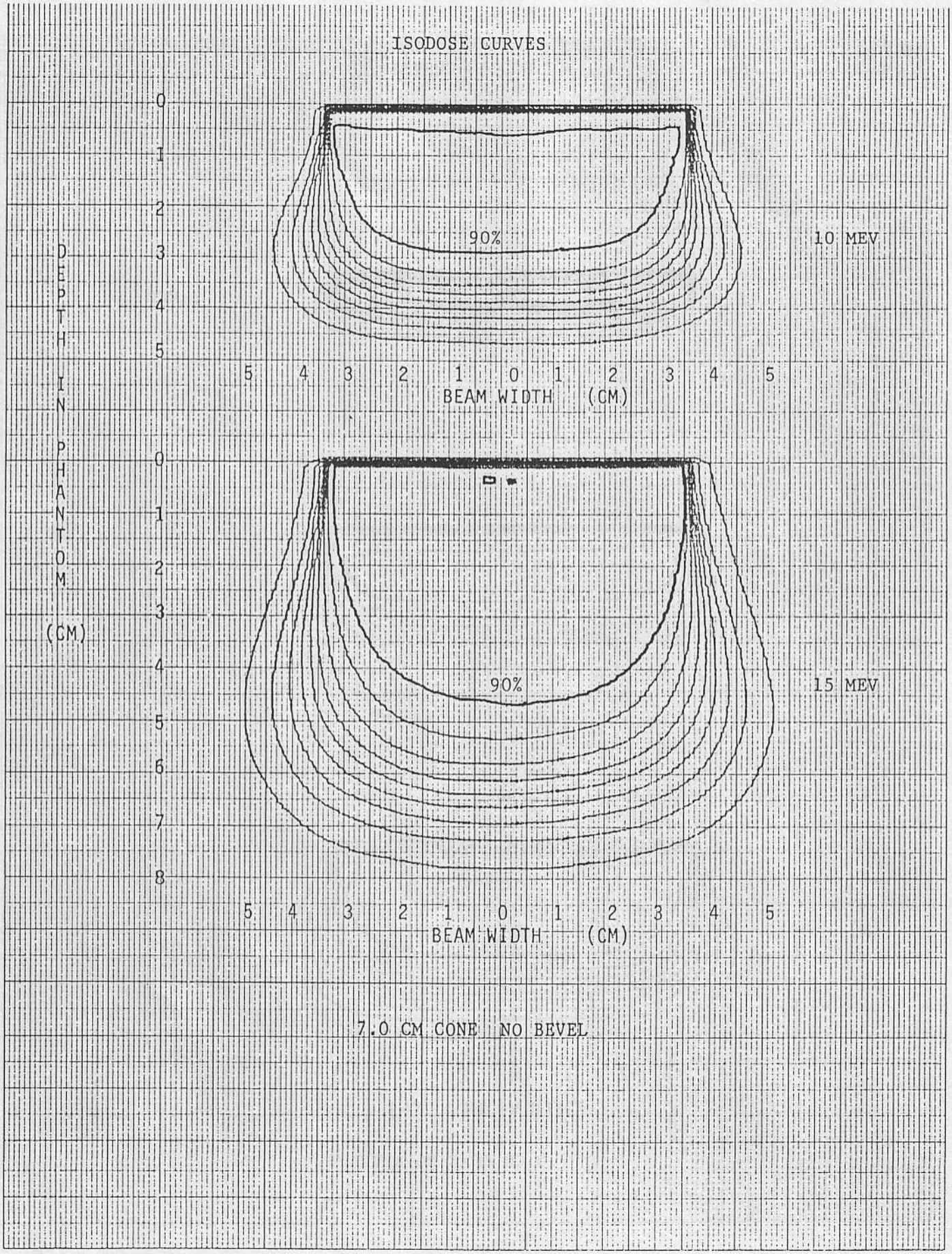


FIGURE 16

Isodose curves for a non-beveled 7.0 cm cone for electrons with the energy of 18 MeV. The isodose curves are 90 %, 80%, 70%, 60%, 50%, 40%, 30%, 20%, and 10%. It should be noted that the maximum is 100%.