SECOND SYMPOSIUM ON INTRAOPERATIVE RADIATION THERAPY

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1 Fill in No. of topic (see programm) duration 10 minutes

Title: DOSIMETRIC EVALUATION OF IORT CONE MISALIGNMENT WITH ELECTRON SOURCE AND A DEMONSTRATION OF A VIDEO CAMERA SYSTEM TO ASSIST IN THE CORRECTION THEREOF


An intraoperative electron treatment system was developed as an accessory to our Siemens Mevatron 20 Linear Accelerator. This system includes a set of plexiglas cones of various sizes and bevels, an adaptor plate permitting fixed docking to the accelerator, and a color video camera viewing system. The camera viewing system allows for inspection of the treatment alignment. A recent study of the system demonstrated that only a two degree or less misalignment of the cone with the adaptor plate is permitted for acceptable target dose. A five degree misalignment of the cone with the plate will result in a 50% dose variation across the target volume. Misalignment of the system can be quickly confirmed through the video system and rapid adjustments can be made to bring the system into alignment. Work is presented showing the dose variation with misalignment and how the video camera assists in correcting this to assure proper target dose.

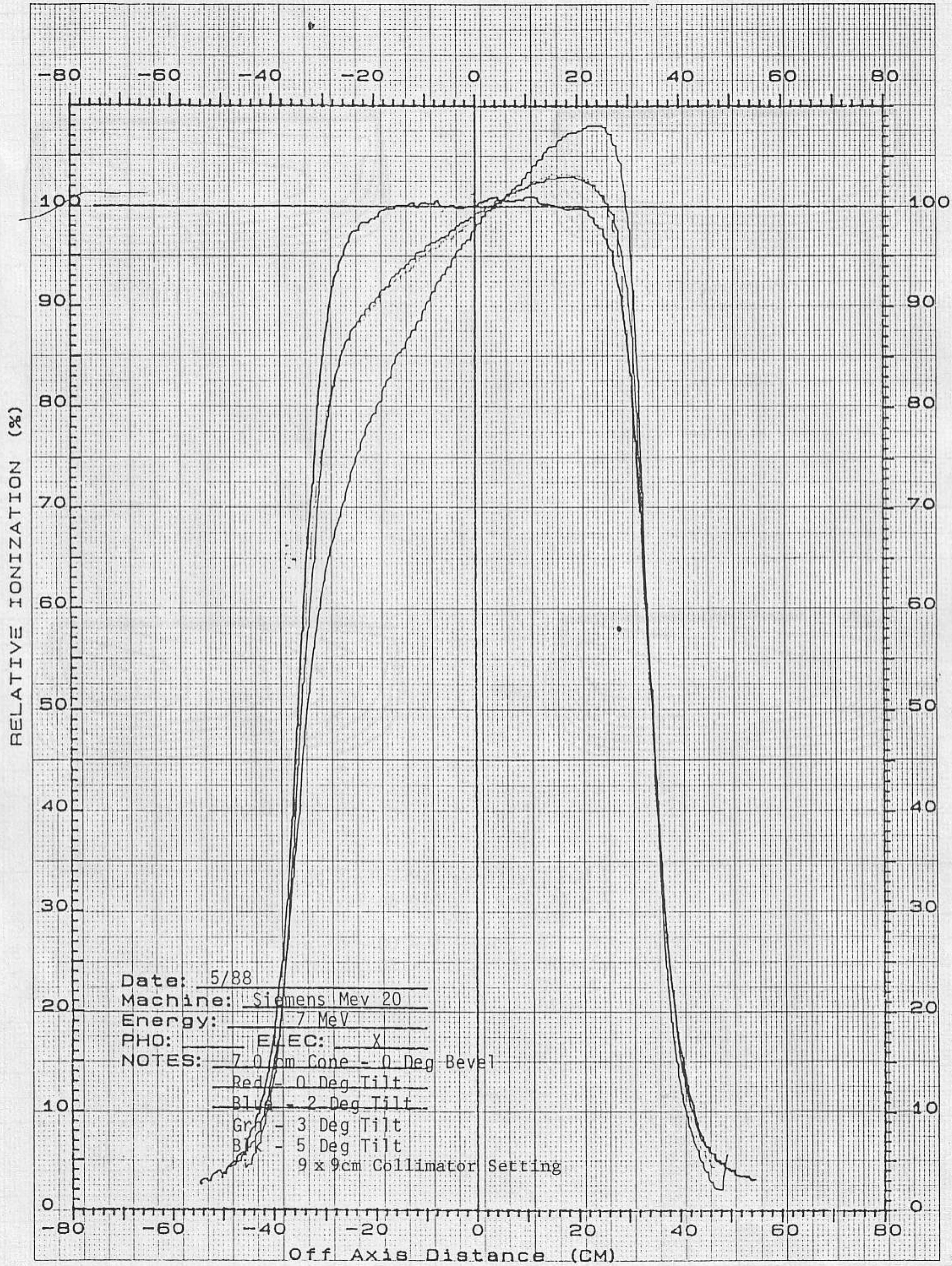

TITLE: DOSIMETRIC EVALUATION OF IORT CONE MISALIGNMENT WITH ELECTRON SOURCE AND A DEMONSTRATION OF A VIDEO CAMERA SYSTEM TO ASSIST IN THE CORRECTION THEREOF

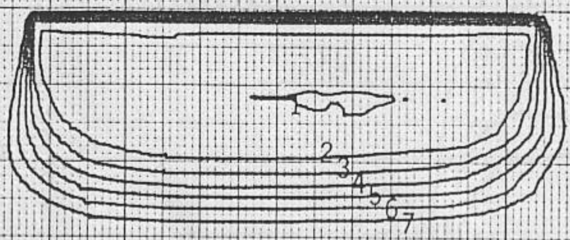
During initial setup and dosimetric evaluation of our IORT cone system we were able to achieve an overall flatness and symmetry which did not exceed ± 2% for any cone at any angle over 80% of the field. This was done by determining the optimum collimator opening for each cone for each energy. This work was done with film and water phantom analysis under strict conditions, these being: 1) The cone firmly seated into the cone plate holder, 2) the phantom surface normal to the bottom of the cone opening for any bevel of cone. In practice however, we discovered that these ideal conditions of cone placement and docking were not always achievable and so a study was made to determine what conditions of cone docking still achieved acceptable dose delivery. The most common problem during the procedure was the inability to fully dock the cone into the cone holder, thus some slight angle is achieved between the geometrical center of the cone and the center of the electron beam. When the cone is fully docked and the tightening knobs are fully set only a 0.5° deviation of these centers is possible. If the clamping door is slightly ajar and the tightening knobs are not fully seated, deviations of up to 4° are possible. A 5° deviation or greater is only possible when the door is ajar and the tightening knobs are not engaged. A film dosimetry system was set up to evaluate how such deviations from the full docking procedure will effect the dosimetry. The film phantom remained normal to the surface of the cone opening in any deviation since typically patient surfaces would tend to conform to the bottom of the cone surface. Measurements were made of the most commonly used cones i.e. 7.0 cm with 0° bevel and 7.0cm cone with a 30° bevel at three electron energies 7, 10 and 12 MEV. Analysis was made at deviations of

0, 2, 3, 4, and 5° to determine what changes in 1) flatness, 2) symmetry, 3) output, and 4) isotope curves. A review of the isodensity slides demonstrates how these various factors deviate. (Dr. S. - I have packaged the slides so that for each energy and cone I show first of all the curves taken at dmax for the various deviations of cone angulation and the second slide is a set of isodensity [similar to isodese] curves for each deviation of cone angulation.) The red line of the flatness and symmetry curves is taken at 0° deviation. This demonstrates our ability to achieve excellent flatness and symmetry when the cone is in the fully docked position. The other three deviations are demonstrated on the same graph and are normalized to the 0° deviation to demonstrate changes from the normal fully docked position. It will be noted that as expected, an increase in the deviation dramatically changes one's ability to achieve good flatness and symmetry. Also noted should be the peak height of the curves which shows that as the cone is angulated, the dose output various dramatically. The second slide of the set shows how the isodensity of the entire irradiated volume changes with respect to cone angle deviation.

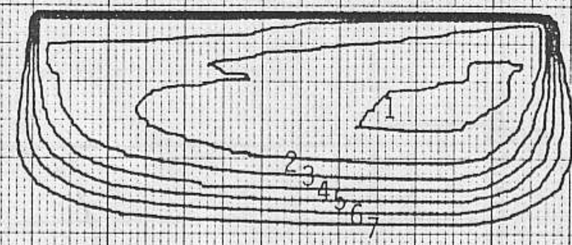
The second slide also demonstrates that when the cone is fully docked, there is perhaps a 5% change in isodese throughout the target volume whereas 2° tilt shows about 10%, 3° about 20% and 4° and 5° angulation show isodese changes of 50% and greater. Clearly, cone angle deviations of greater than 2° are unacceptable for adequate target volume dose.

The goal then during treatment is to achieve a cone angle deviation of less than 2° to assure proper target dose. This goal can be achieved in one of several ways 1) Assuring full and complete docking and full seating of the tightening knobs 2) When number one is not possible a sterilized angle protractor can be used or 3) by observing the video image of the treatment volume-deviations in cone angle will be observed by changes in concenttricity [I know another big word - delicatessen]. The circular shape of the target will begin to look more ellipsoidal. Deviations greater than 0.5° can be picked up on the video monitor. An analysis of the video display has not been made to determine exactly what a 2° deviation looks like, that remains for further work.

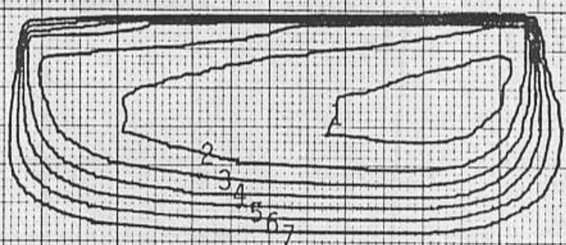

-80 -60 -40 -20 0 20 40 60 80
RELATIVE IONIZATION (%)
100 90 80 70 60 50 40 30 20 10 0
Off Axis Distance (CM)
Date: 5/88
Machine: Siemens Mev 20
Energy: 7 MeV
PHO: ELEC: X
NOTES: 7.0 cm Cone - 0 Deg Bevel
Red - 0 Deg Tilt
Blue - 2 Deg Tilt
Grn - 3 Deg Tilt
Blk - 5 Deg Tilt
9 x 9cm Collimator Setting



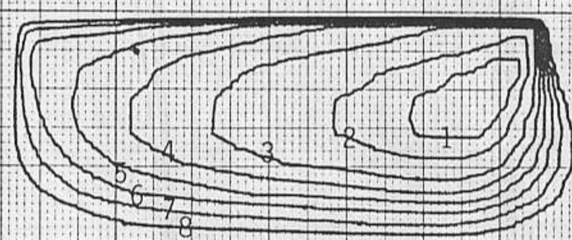

Zero Degree Tilt




2 Degree Tilt




3 Degree Tilt

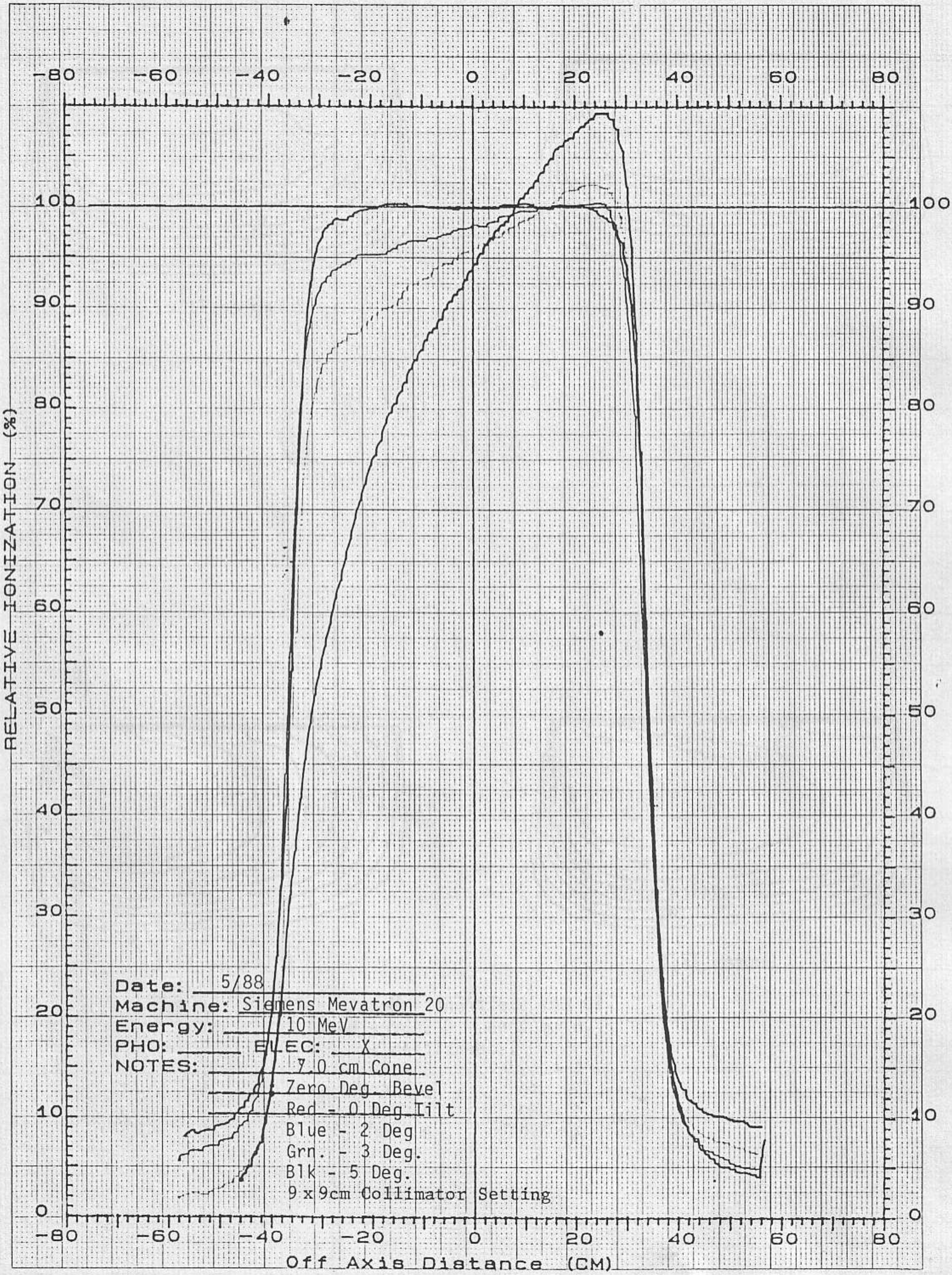


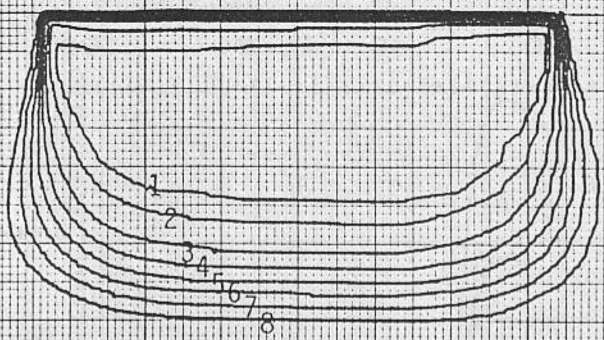

5 Degree Tilt

7 MeV Electrons - Mevatron 20
7.0 cm Cone - 0 Degree Bevel

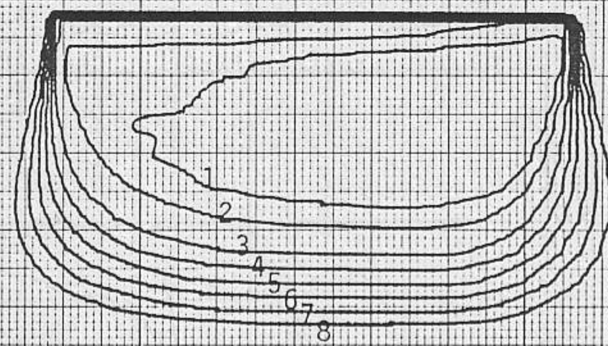
Isodensities

| | |
|---|---|
| 1 - 95 | 5 - 60 |
| 2 - 90 | 6 - 50 |
| 3 - 80 | 7 - 40 |
| 4 - 70 | 8 - 30 |

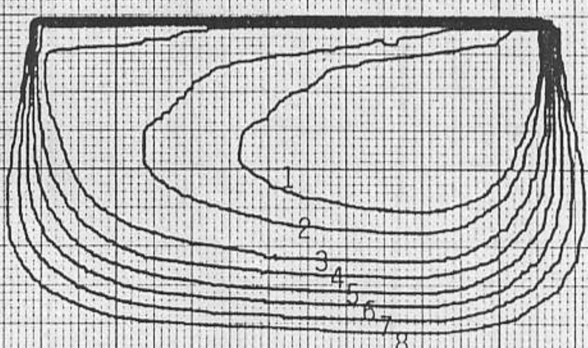

RELATIVE IONIZATION (%)
Off Axis Distance (CM)
-80 -60 -40 -20 0 20 40 60 80
0 10 20 30 40 50 60 70 80 90 100
Date: 5/88
Machine: Siemens Mevatron 20
Energy: 10 MeV
PHO: ELEC: X
NOTES: 7.0 cm Cone
Zero Deg. Bevel
Red - 0 Deg Tilt
Blue - 2 Deg
Grn. - 3 Deg.
Blk - 5 Deg.
9 x 9cm Collimator Setting



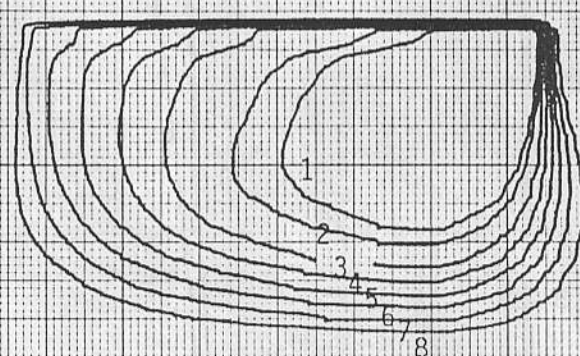

Zero Degree Tilt




2 Degree Tilt




3 Degree Tilt

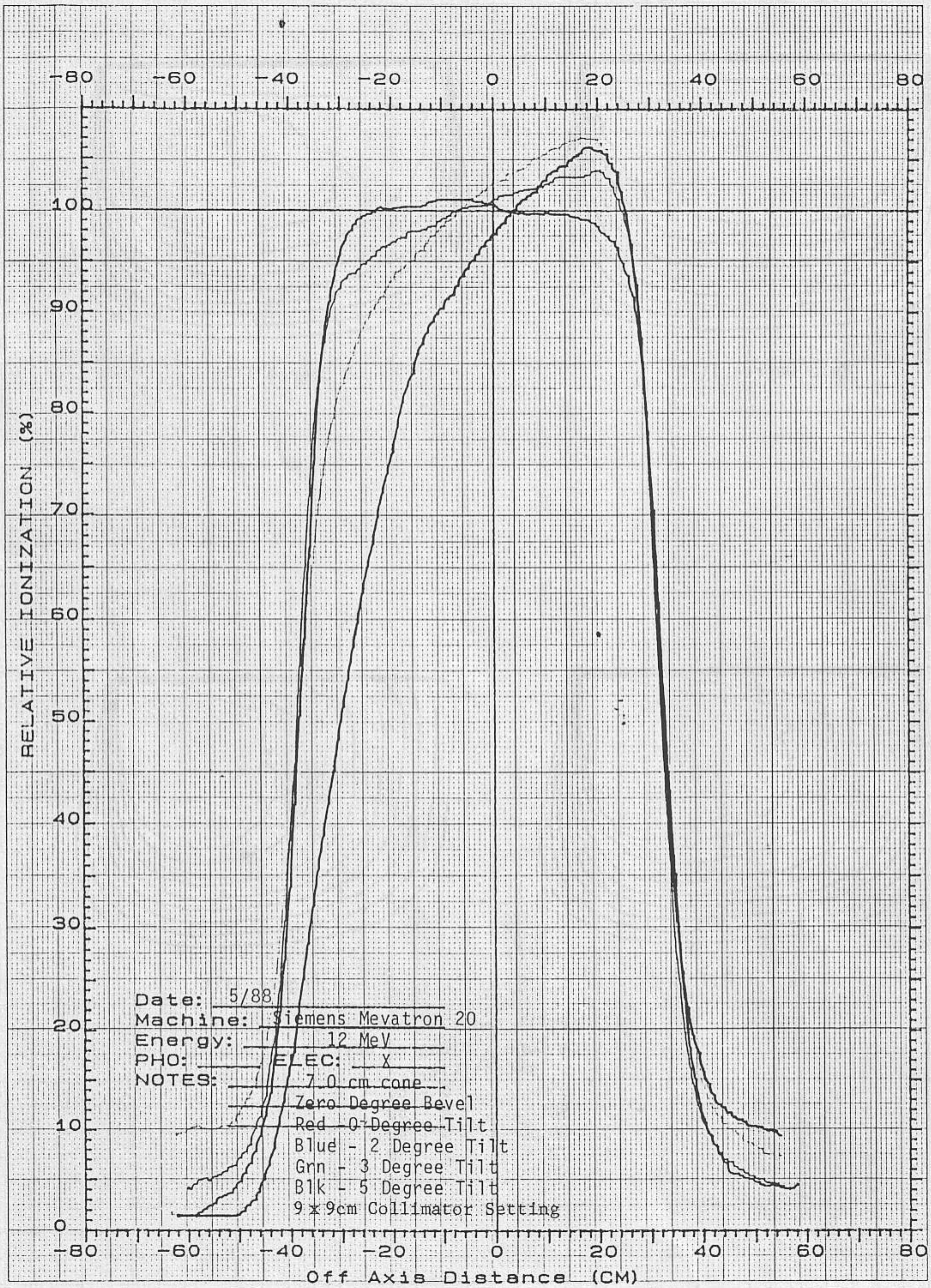


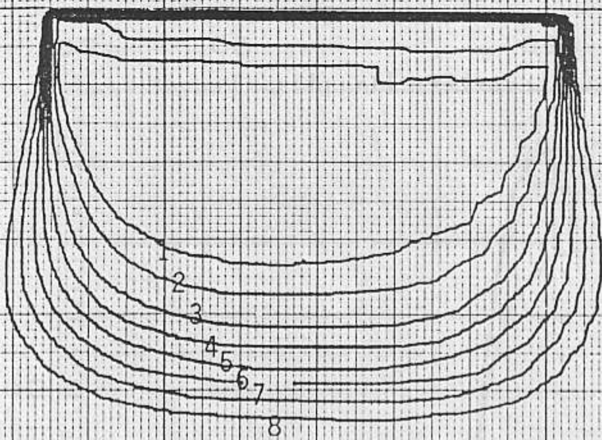

5 Degree Tilt

10 MeV Electrons - Mevatron 20
7.0 cm Cone - 0 Degree Bevel

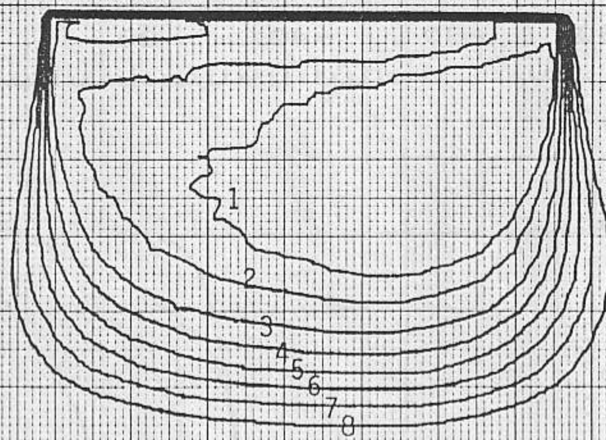
Isodensities

| | |
|---|---|
| 1 - 95 | 5 - 60 |
| 2 - 90 | 6 - 50 |
| 3 - 80 | 7 - 40 |
| 4 - 70 | 8 - 30 |

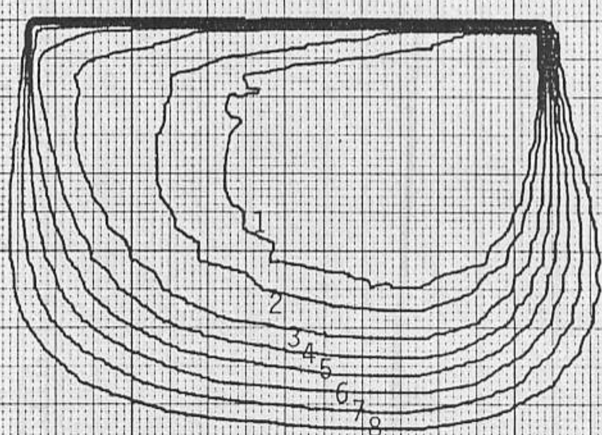

RELATIVE IONIZATION (%)
Off Axis Distance (CM)
-80 -60 -40 -20 0 20 40 60 80
0 10 20 30 40 50 60 70 80 90 100
Date: 5/88
Machine: Siemens Mevatron 20
Energy: 12 MeV
PHO: ELEC: X
NOTES: 7.0 cm cone
Zero Degree Bevel
Red - 0 Degree Tilt
Blue - 2 Degree Tilt
Grn - 3 Degree Tilt
Blk - 5 Degree Tilt
9 x 9cm Collimator Setting



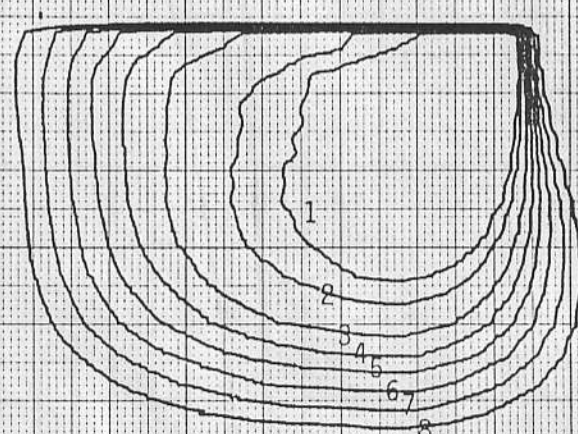

Zero Degree Tilt




2 Degree Tilt




3 Degree Tilt

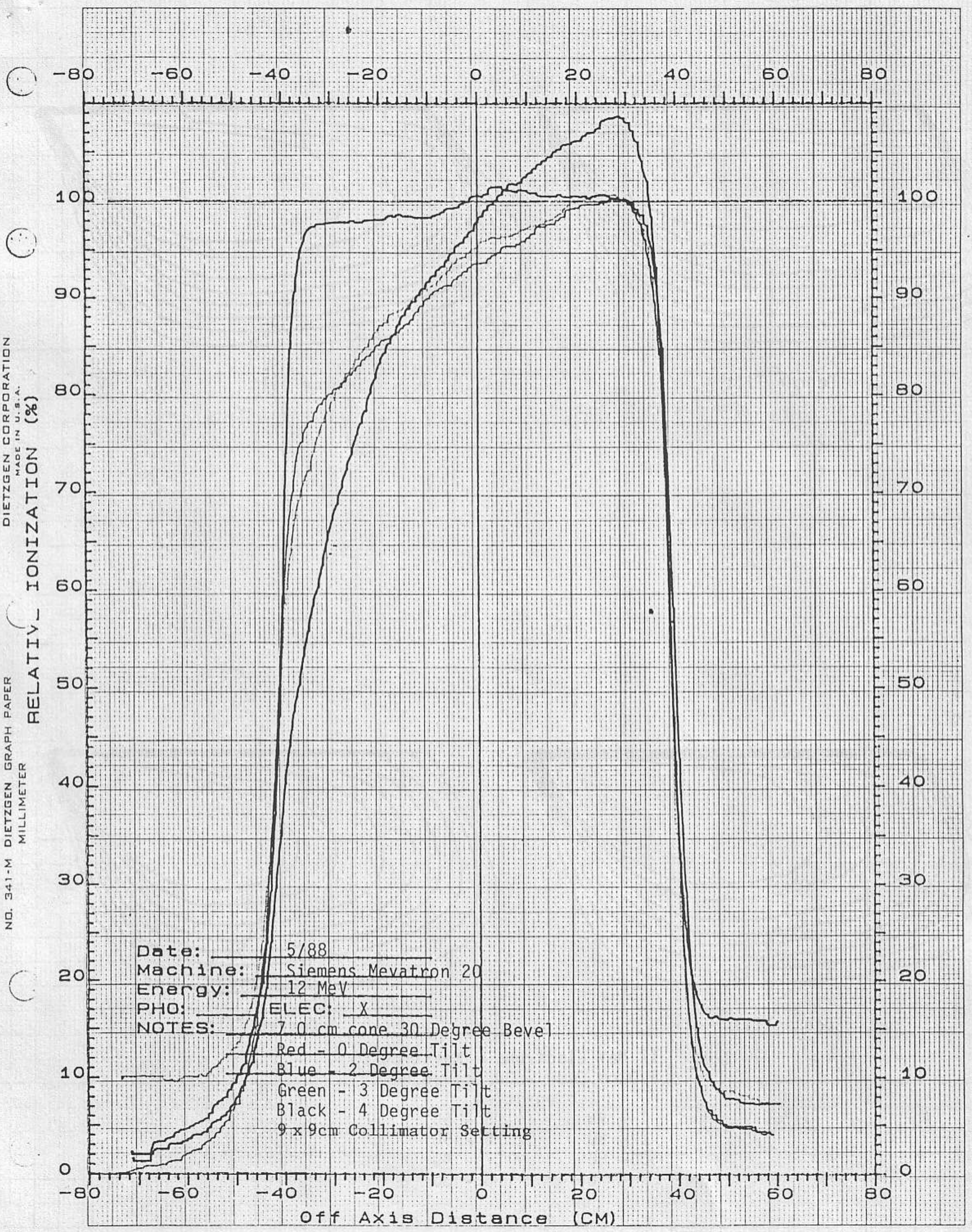



5 Degree Tilt

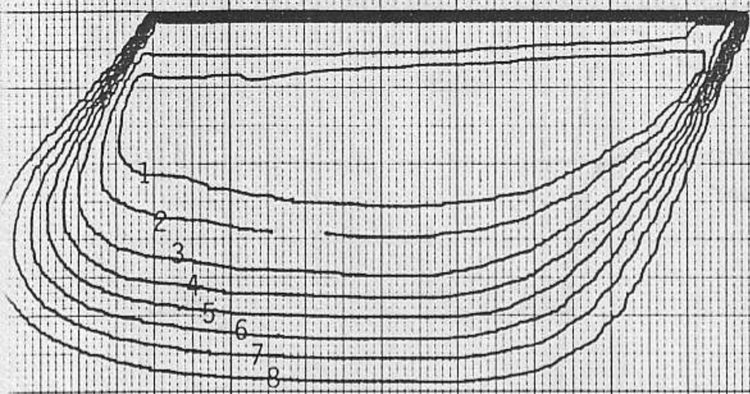
12 MeV Electrons - Mevatron 20
7.0 cm Cone - 0 Degree Bevel

Isodensities

| | |
|---|---|
| 1 - 95 | 5 - 60 |
| 2 - 90 | 6 - 50 |
| 3 - 80 | 7 - 40 |
| 4 - 70 | 8 - 30 |

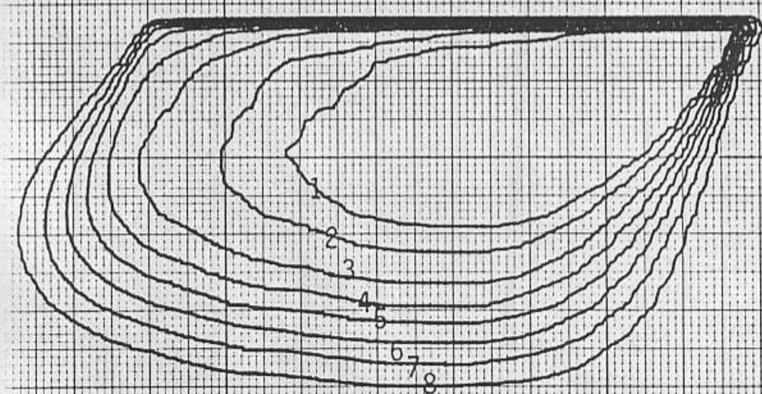


NO. 341-M DIETZGEN GRAPH PAPER MILLIMETER
DIETZGEN CORPORATION MADE IN U.S.A.
RELATIV_ IONIZATION (%)
Off Axis Distance (CM)
-80 -60 -40 -20 0 20 40 60 80
0 10 20 30 40 50 60 70 80 90 100
Date: 5/88
Machine: Siemens Mevatron 20
Energy: 12 MeV
PHO: ELEC: X
NOTES: 7.0 cm cone 30 Degree Bevel
Red - 0 Degree Tilt
Blue - 2 Degree Tilt
Green - 3 Degree Tilt
Black - 4 Degree Tilt
9 x 9cm Collimator Setting

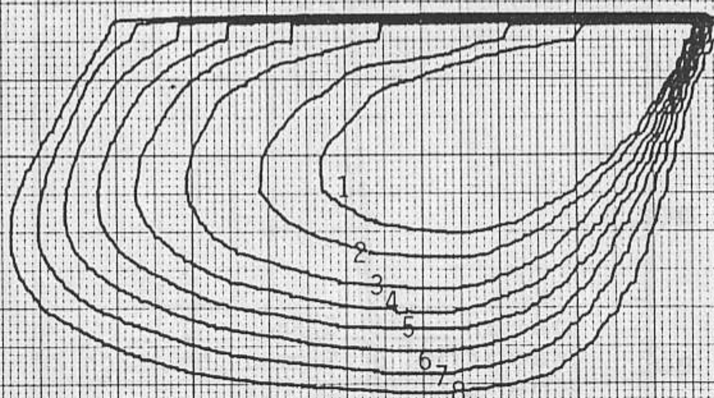


Zero Degree Tilt

2 Degree Tilt



3 Degree Tilt



4 Degree Tilt

12 MeV Electrons - Mevatron 20
7.0 cm Cone - 30 Degree Bevel

Isodensities

| | |
|---|---|
| 1 - 95 | 5 - 60 |
| 2 - 90 | 6 - 50 |
| 3 - 80 | 7 - 40 |
| 4 - 70 | 8 - 30 |