

Percentage depth dose and beam profile measurements for electron and photon beam in reference field size for different energies

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Abstract—In this study the measurements for PDDs were measured using a linear accelerator (Electa synergy) with 6 MV, 10 MV and 12MV photon energies and electron energies of 6MeV, 9MeV and 12MeV at reference field size under constant condition. The measurements were made through farmer type ionization chamber (PTW30013-7001), volume 0.6cm^3 and PTW Pin Point Chamber (Reference Chamber) for photon beams and Parallel plate Marcus chamber for electron beam. The measurement of PDDs were done using a beam analysis tool of Monaco TPS. The measured PDD curves were obtained for 6MV, 10 MV and 15MV photon beams for reference field sizes and 9MeV, 12MeV and 15MeV electron energies. The measured depth dose (d_{\max}) are 1.6cm, 2cm and 2.6cm for 6, 10 and 15MV photon beams respectively. The PDDs at 10 cm depth (D_{10}) are 97.6%, 91.4% and 85.2% photon energies, respectively. The measured depth dose for electron beams are also obtained to be 1.4cm, 1.9cm and 2.3cm for 6MeV, 9MeV and 12MeV respectively. The obtained results, d_{\max} and PDD are within the limit of IEC recommendations. The PDD curves for both photon energies and electron energies show in a good agreement with the literatures.

Index Terms— *Percentage depth dose, Electron beam, Photon beam, Beam profile*

1. INTRODUCTION

In radiotherapy, quality of a radiation beam is most usefully expressed in terms of its penetrating power, which is a function mainly of the mean photon energy, and may be fully described by its depth dose characteristics in water but an increase in surface dose with field size is also noted due to electron scattering from intervening materials [1].

The depth of dose maximum d_{\max} beneath the patient's surface depends on the beam energy and beam

field size[1]. The beam energy dependence is the main effect; the field size dependence is often ignored because it represents only a minor effect. Nominal values for d_{\max} range from zero for superficial and ortho voltage X ray beams, through 0.5cm for ^{60}Co beams, to 5cm for 25MV beams [1-4]. The quantity percentage depth dose may be defined as the quotient, expressed as a percentage, of the absorbed dose at any depth d to the absorbed dose at a fixed

reference depth d_{ref} , along the central axis of the beam at fixed SSD 100 at phantom surface. In our present works we evaluated the percentage depth dose along with their profiles for three photon energies and electron energies at different depths.

2. PROCEDURES AND MEASUREMENT SET UP

The measurement is done based on IAEA TRS-398 code of practice. The gantry was set to upright position initially to zero degree rotation and then leveled using spirit level to ensure correct alignment. The water tank is set to SSD of 100cm and the moving mechanism is leveled to the cross hair of collimator and phantom axis line. The ion chamber was positioned using a detector positioning system at the effective point of measurement. The centering of the chamber along the central axis of the beam was verified by the radiation center check, which Checks the symmetry of the in-plane and cross-plane profiles at two different depths. Once the radiation center check was performed, the detector positioning was verified to be along the central axis to be within a fraction of a millimeter.

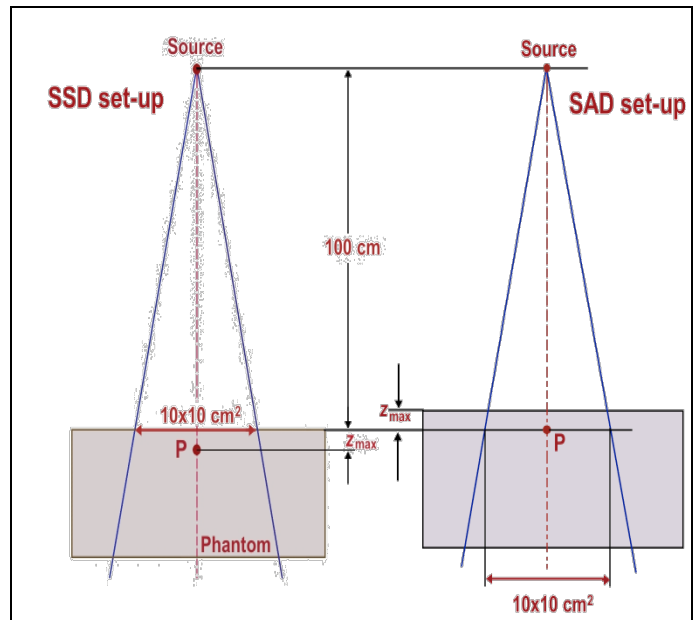


Fig 1: Schematic diagram of the experimental set up [1]

PDD data is measured along the central axis of the open photon beam with reference field size 10cm x 10cm in 42cmx42cmx42cm water tank.

When the water surface is properly aligned with laser/mechanical pointer for 100 cm, the detector position is set such that the center of the detector splits the water.

3. RESULT AND DISCUSSION

From our measurements of PDD the following results (Table 1) are obtained for the three photon energies.

	6MV	10MV	15MV
Depth(cm)	PDD(%)	PDD(%)	PDD(%)
0	52.1	40.9	36
1	97.6	91.4	85.2
2	98.7	100	98.6
3	94.9	98.5	99.7
4	90.7	94.7	97.3
5	86.6	90.9	93.6
6	82.5	87.2	89.8

7	78.5	83.3	86.4
8	74.9	79.8	82.8
9	70.8	76.2	79.4
10	67.3	72.8	76
11	64	69.6	73.2
12	60.4	66.4	70
13	57.5	63.5	66.9
14	54.5	60.6	64
15	51.6	57.9	61.3
16	49	55.1	58.7
17	46.3	52.7	56.4
18	44	50.4	53.9
19	41.7	48	51.6
20	39.5	45.8	49.5
21	37.4	43.7	47.4
22	35.5	41.7	45.3
23	33.7	39.9	43.5
24	31.9	38	41.7
25	30.3	36.3	39.9
26	28.7	34.6	38.3
27	27.3	33.2	36.7
28	25.9	31.6	35.1

Table 1: PDD of photon beam for 6MV, 9MV and 15MV at different depth

The percentage depth dose graph for all our data of measurements for the three photon energies are presented as in the following graph Fig1.

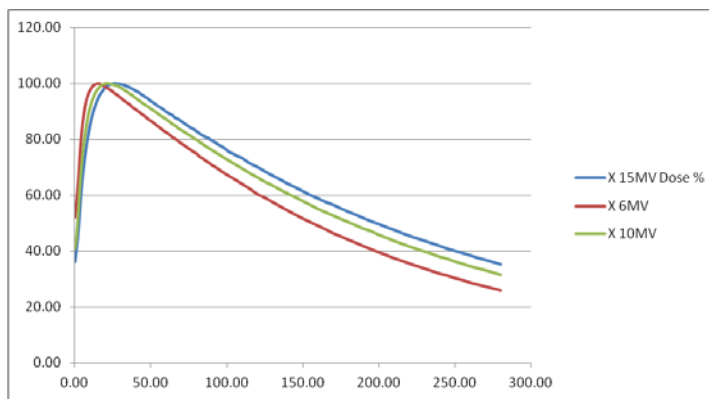


Fig 2: Graph of Percentage depth dose for the three photon beams(the vertical axis is PDD(%) and the horizontal axis is depth in mm)

From the above tables and graphs it is obtained that percentage depth dose at reference depth (10cm) are 67.3%, 72.8% and 76% for 6MV,10MV and 15MV photon beams respectively and depth of maximum dose are measured to be 1.6 cm for 6MV , 2cm for 10MV and 2.6cm for 15MV which are in agreement with IEC recommendations. All the three PDD curves are in a good agreement with literatures.

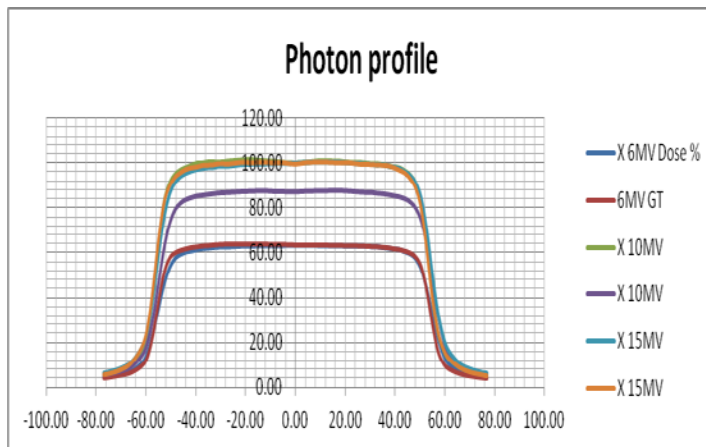


Fig 3: Beam profile for photon beam of 6MV, 10MV and 15MV.

From the above beam profile graph of photon beam we can see that the beam profile is within acceptable range, the symmetry of the beam are obtained to be 1.9%, 1.96% and 1.78 % for 6MV,10MV and 15MV

respectively which are all within the range of acceptable value of 2% according to IEC recommendation.

The calculated penumbra from our measurements are 6.5%, 8.8% and 8.9% for 6MV, 10MV and 15MV respectively which are within the range of 20%.

The electron PDD for different depth for three electron energies 6MeV, 9MeV and 12MeV are obtained as shown in Table 2 below.

Energy	6MeV	10MeV	15MeV
Depth(mm)	PDD(%)	PDD(%)	PDD(%)
0.0	84.6	88.7	91.7
0.2	85.6	89.4	92.6
0.4	89	91.6	94.5
0.6	92	93.2	95.9
0.8	94.8	94.5	96.7
1.0	97.4	96	97.4
1.2	99.4	97.1	98
1.4	100	98.3	98.6
1.6	98.6	99.2	98.9
1.8	94.3	99.9	99.4
2.0	86.9	100	99.8
2.2	76.9	99.2	99.8
2.4	64.5	97.3	99.9
2.6	50	93.8	99.7
2.8	36.1	89	99.2
3.0	23	82.2	98
3.2	13	73.7	96.2
3.4	6.5	64	93.7
3.6	3	53.4	90
3.8	1.6	42.4	85.4

4.0	1.3	31.5	79.6
4.2	1.2	22.6	72.6
4.4	1.2	14.8	65.1
4.6	1.2	9.2	56.3
4.8	1.1	5.3	47.6
5.0	1.1	3.3	38.2
5.2	1.1	2.2	29.8
5.4	1.1	1.8	21.7
5.6	1.1	1.7	15.1
5.8	1.1	1.6	9.7
6.0	1.1	1.6	6.2

Table 2: Percentage depth dose data for 6MeV, 9MeV and 12MeV at different depth

From obtained results of measurements the PDD graph for the three electron beams are drawn with the Microsoft office excel 2007 and shown as figure below.

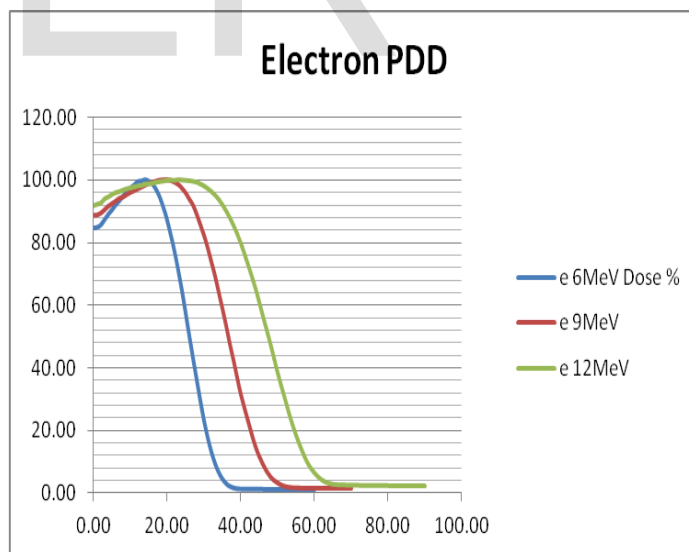


Fig 4: PDD for electron beam of 6MeV, 9MeV and 12MeV.

From electron PDD data it is obtained that the maximum depth dose for 6MeV, 9MeV and 12MeV are 1.4cm, 1.9cm and 2.3cm respectively. The surface doses are 84%, 88% and 92% for 6MeV, 9MeV and 12MeV respectively which are in a good agreement with IEC recommendations.

From our measurement results the electron beam profile is obtained as shown in figure 3 below.

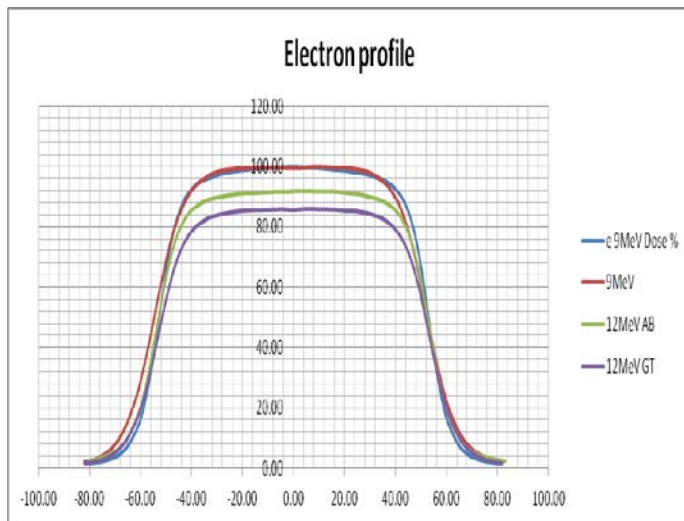


Fig 5: Beam profile of 9MeV, 9MeV and 12MeV electron energies
GT = Gun-Target (up down)
AB = left right

From beam profile above we have evaluated the symmetry and penumbra of the beams. The symmetries are 1.96%, 1.89% and 0.92% for 6MeV, 9MeV and 12MeV respectively which are within the range of recommended value of 2% according to IEC and the corresponding penumbra are 12.16%, 14% and 10.13% in which all are within the range of 20%.

4. CONCLUSION

D_{max} and D_{10} for all photon beam and electron beam were found within the limit mentioned in the IEC Scale. The measured PDD and literature are in a good agreement. Based on our result the surface dose and R_{50} and all the other measured parameters were within the typical dose parameters of photon and electron beams. Besides, there were very slight variations in the penumbra and the symmetry of the radiation beams for they were within the tolerance of 20% and 2% as per IEC.

5. ACKNOWLEDGEMENT

I would like to thanks my beautiful wife Tigist Tajebe for her encouragement in all aspects of my life.

6. REFERENCES

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