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RESEARCH ARTICLE

QUALITY CONTROL OF LINEAR ACCELERATOR OF NOUAKCHOTT.

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Abstract

At the National Center of Oncology of Nouakchott, the external radiotherapy treatments are performed using a linear accelerator particles of two energies 6 MV and 18 MV.
This particle accelerator is originally set to deliver a dose under reference conditions.
It is essential that the measured data on the particle accelerator be consistent with the data calculated by the Treatment Planning System (TPS).
The purpose of this work is to perform a general quality control of this accelerator, and to compare the results obtained by two ionization chambers (PTW 0.125 cm^3 and PTW 0.6 cm^3).
This control is based on the measure of percentage depth dose (PDD) and beam profiles (BP) and the comparison of these measurements with the same results performed by TPS calculations for different field sizes.
In general, the results measured are in good concordance with the results calculated by TPS.
Regarding comparison between the two ionizations chambers, we notice that the light difference between the percentage depth doses measured by the two ionizations is related to the energy and to the field size of the incident photons beam.

Introduction:-

Ionizing radiation is widely used in radiotherapy for the treatment of cancer which consists to control the irradiations applied to the patient in order to destroy only the tumor and ovoid to irradiate the healthy cells (Mawenn Le Roy, 2012; Léone Blazy-aubignac, 2007; Ould Mohamed Yeslem et al, 2017).

Therefore, it is vital and mandatory to know and to check systematically the dose delivered to the tumor during the irradiation process and to control the quality of the used equipment to ensure the success of the treatment (Jean Claude Rosenwald et al, 2010; George X Ding, 2002; James A. Purdy, 1986; Mark J. Engler, 1984).

In order to check the quality of the accelerator and related equipment, we have performed measurements (percentage depth dose and beam profiles) in water phantom by an ionization chamber for energies of 6 MV and 18 MV for different four field sizes.

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To compare the measured results we have calculated the same parameters by Treatment Planning Systems (TPS), in order to compare measurements with calculation following the (IAEA) recommendations (N. Villani, 2010; Charles W. Coffey,1980; C.McKerracher, 1985)

The (TPS) is a treatment planning software allowing to predict, according to a given ballistics, an established medical prescription, a chosen energy, an anatomical configuration, the dose at all points of the space (G. Krithivas, 1985; Haluk Yucel, 2016; Sang Hyoun Choi, 2016; Miljenko Markovic, 2014).

To perform a comparison between the two chambers (PTW 0.125 cm^3 and PTW 0.6 cm^3), we have measured the PDD by these two ionizations, for different field sizes and for the two energies 6 MV and 18 MV.

Materials and Methods:-

Measurements of percentage depth dose and dose (beam) profile were carried out using a water phantom, connected to a PC. The system is controlled for the acquisition of the dosimetric data by MEPHYSTO mc^2 software. The dosimetric measurements were realized using an ionization chamber associated with an electrometer and the chamber used for acquisition can move in three directions (K.A. Johansson, 1986; JP Manens, 1998; Dorin dusciac, 2016).

The material used in this work is:
1) Linear accelerator CLINAC 2100DHX, developed by the constrictor VARIAN MEDICAL SYSTEM, of two energies of photons of 6 MV and 18 MV.
2) Mini water tank MP3-P (water phantom): The phantom used in this work is a cubic tank with a length of 60 cm.
3) Cylindrical ionization chambers: TM31010 Semiflex chamber of 0.125 cm^3 and PTW 0.6 cm^3.
4) PTW electrometer: The collected charge (or intensity) produced in an ionization chamber is extremely low, its measurement requires a very sensitive device called electrometer;
5) Medical Physics Control Center MEPHYSTO mc^2: MEPHYSTO is a software for the acquisition of therapeutic beam data and data analysis in radiotherapy.

Results:-

Results and comparison with TPS calculations:-

Measurement of PDD and BP have carried out and compared to (TPS) calculation for 6 MV and 18 MV photons beam, using the 0.125 cm^3 ionization chamber for the most used treatment field dimensions in treatment by linear accelerator. The all measures were performed for Skin- Source-Distance (SSD) of 100 cm.

Result for 6MV Photon Beam:-

Results of PDD and BP measurement and their comparison with TPS calculations are given in figures 1 and 2 for different treatments field dimensions. These figures allow a comparison between the measured results and those calculated by TPS for 6 MV photon beam for the four chosen field sizes (10×10 cm^2, 20×20 cm^2, 30×30 cm^2 and 40×40 cm^2).

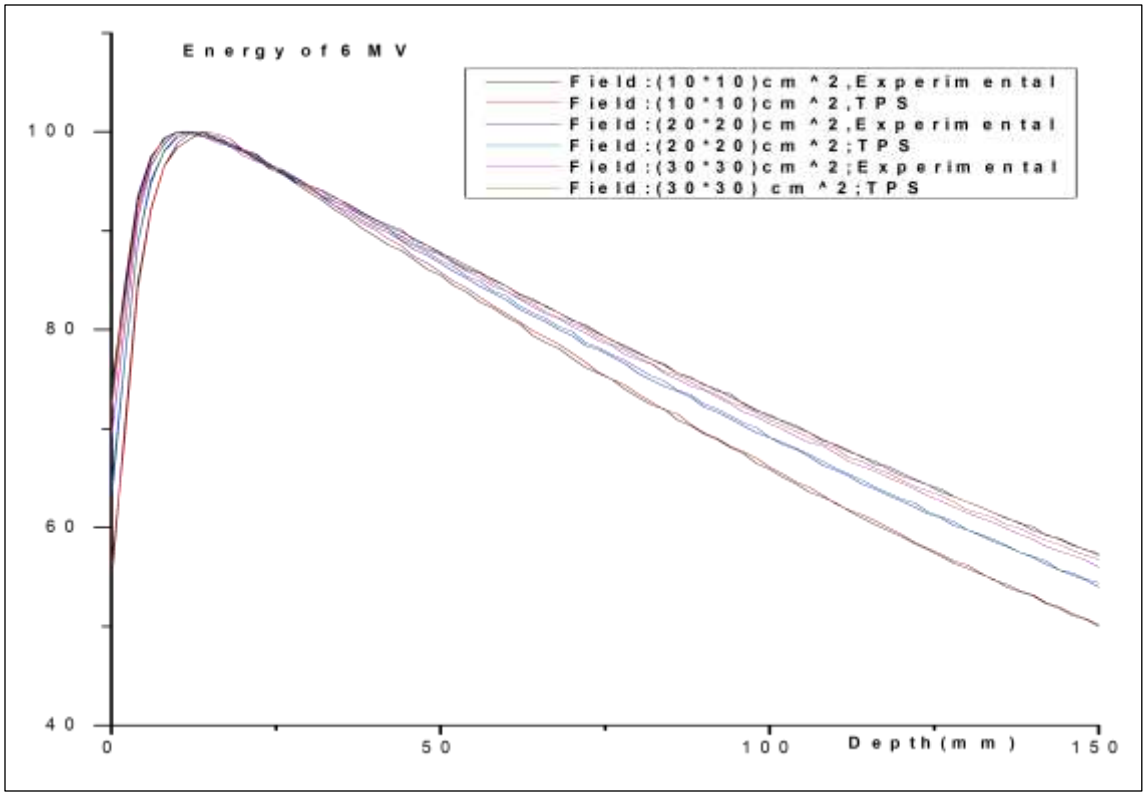


Figure 1:- comparison of measured and calculated results of percentage depth dose curves of the 6 MV photon beam for different field sizes

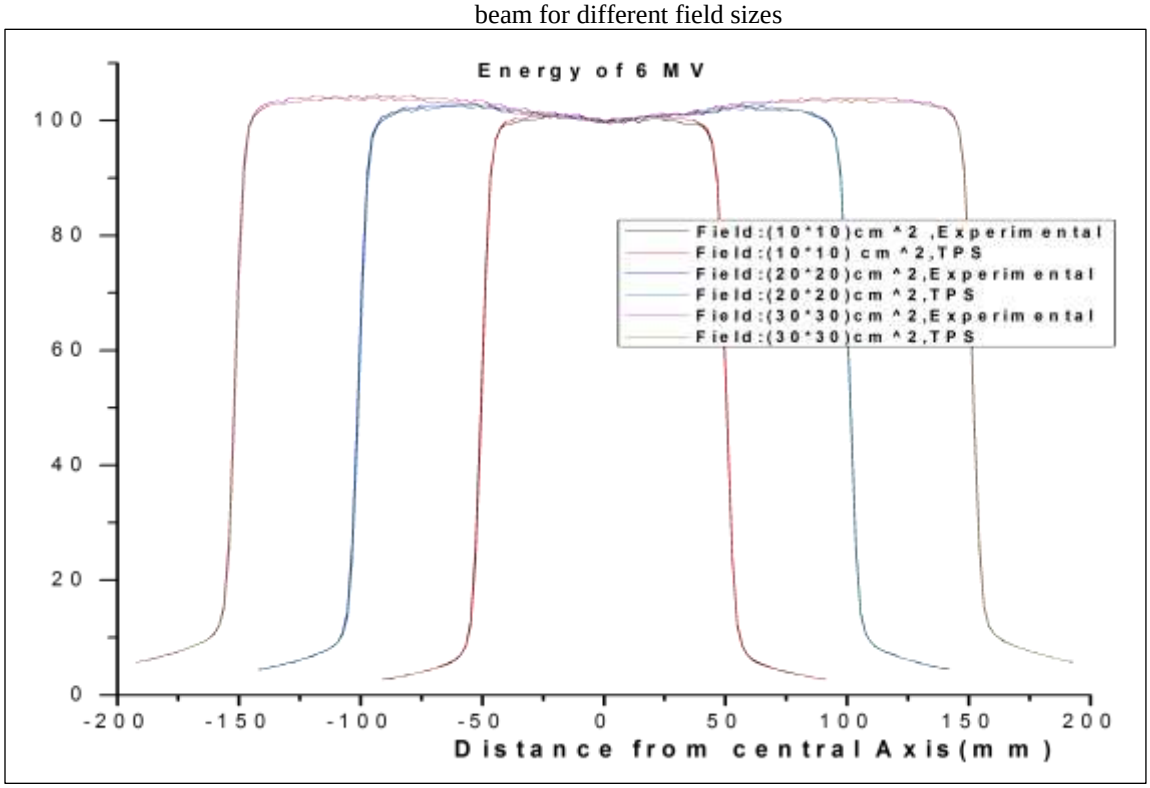


Figure 2:- comparison of measured and calculated results of beam profiles of the 6 MV photon beam for different field sizes

Result for 18MV Photon Beam:-

The same measurement beam carried out with the same ionization chamber 0.125cm^3 and for the same treatments field dimensions for 18 MV energy. The results and their comparison with TPS calculation are given in figures 3 and 4.

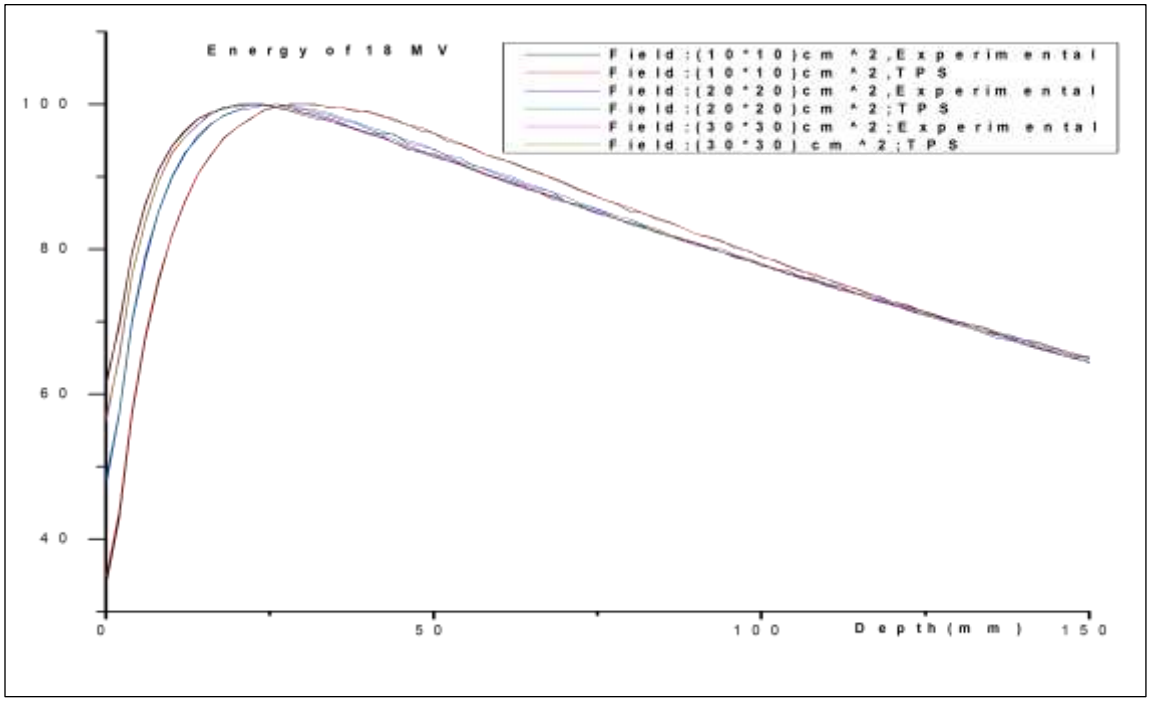


Figure 3:- comparison of measured and calculated results of percentage depth dose curves of the 18 MV photon beam for different field sizes.

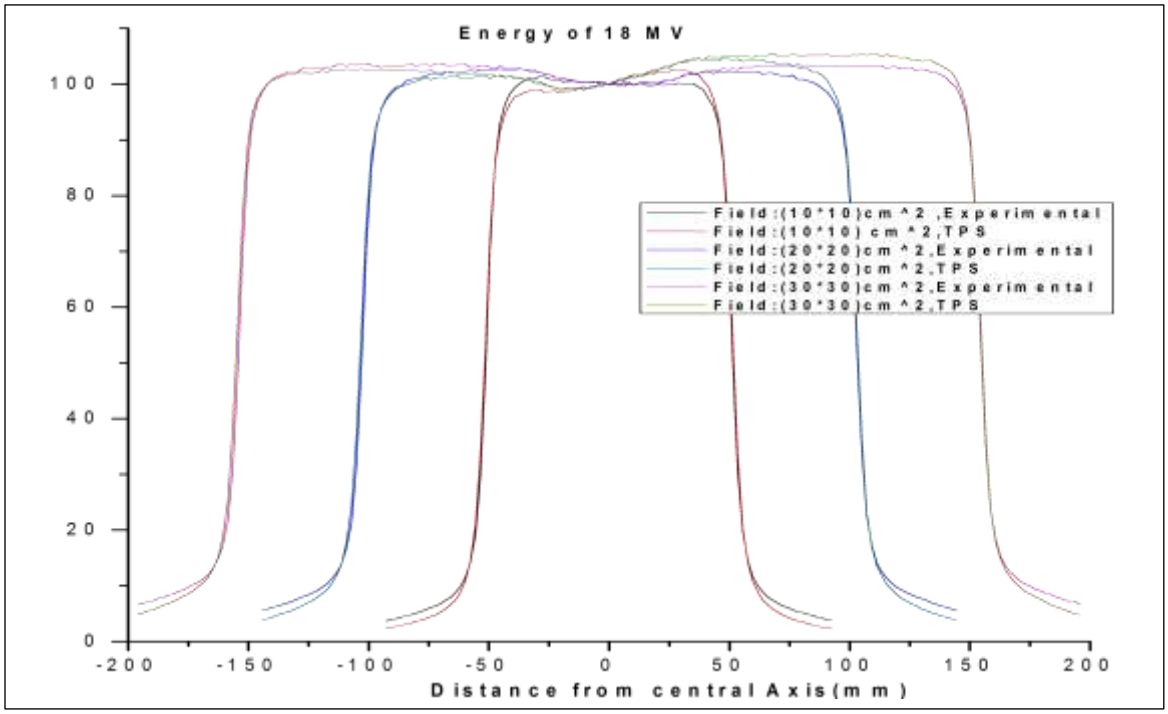


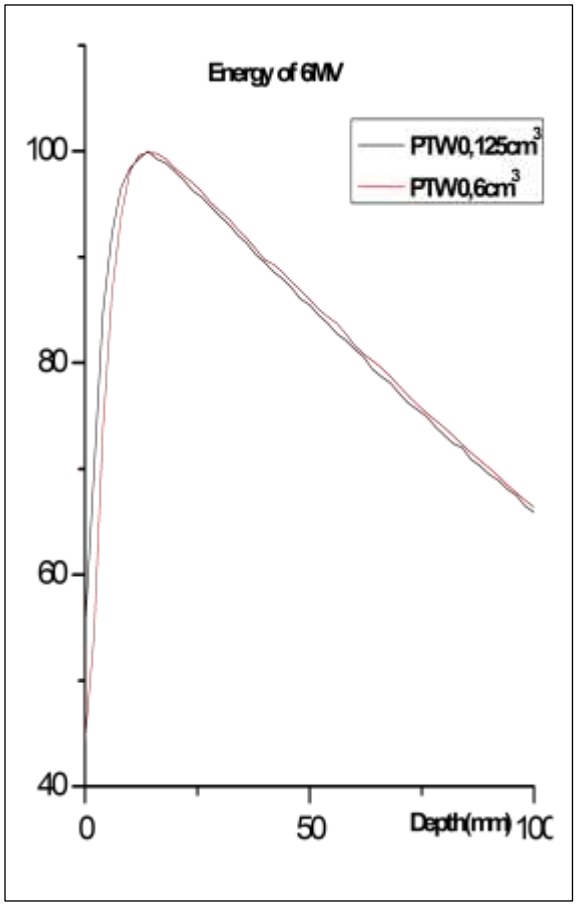
Figure 4:- comparison of measured and calculated results of beam profiles of the 18 MV photon beam for different field sizes

Looking at the previous figures, we notice the following; for PDD, we find that the PDD measurements agree with TPS calculations, for the two energies.

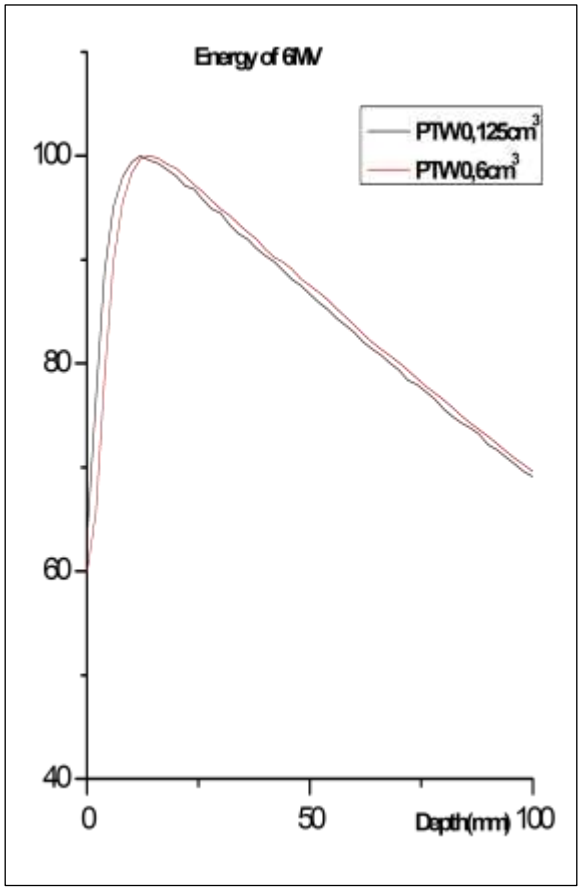
For the BP, there are some light differences between the curves; these differences exist in the tails of the curves and in the maximum of doses. The difference is greater for the energy of 18 MV than for the energy of 6 MV but this difference is still acceptable.

Comparison of results obtained by 0.125 cm^3 and 0.6 cm^3 ionization chambers

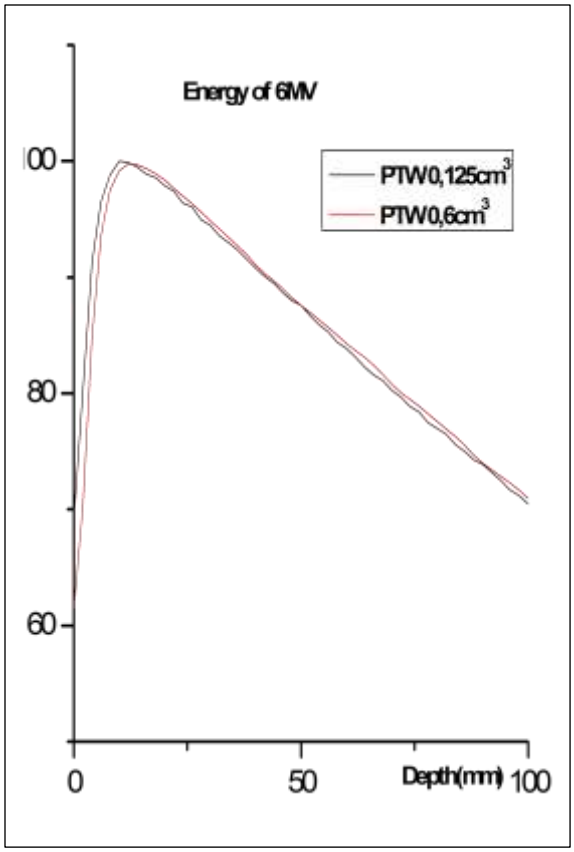
We have undertaken measurements of PDD by the two chambers for 6MV and 18MV for different treatments field dimensions. Figure 5 allows the comparison of results obtained by the two chambers for 6 MV energy for 4 different treatment field dimensions



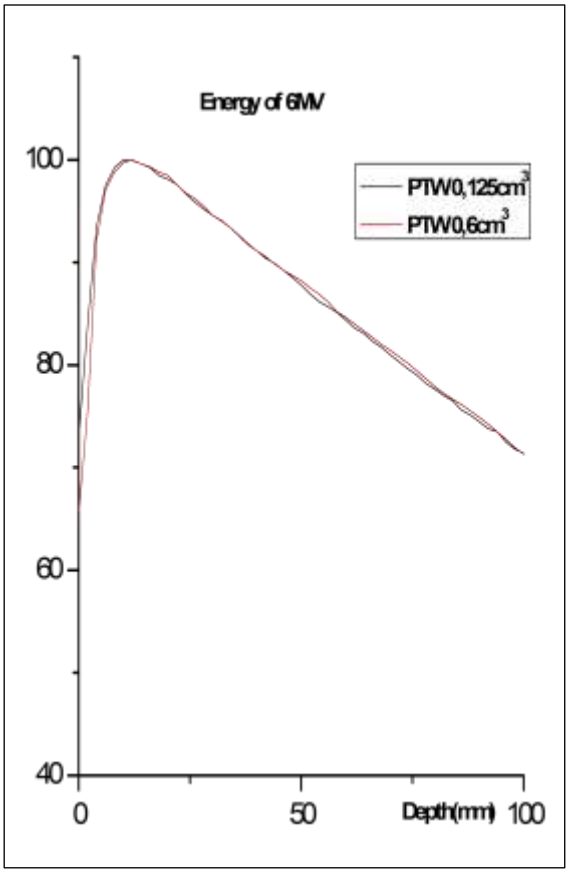
(a)



(b)



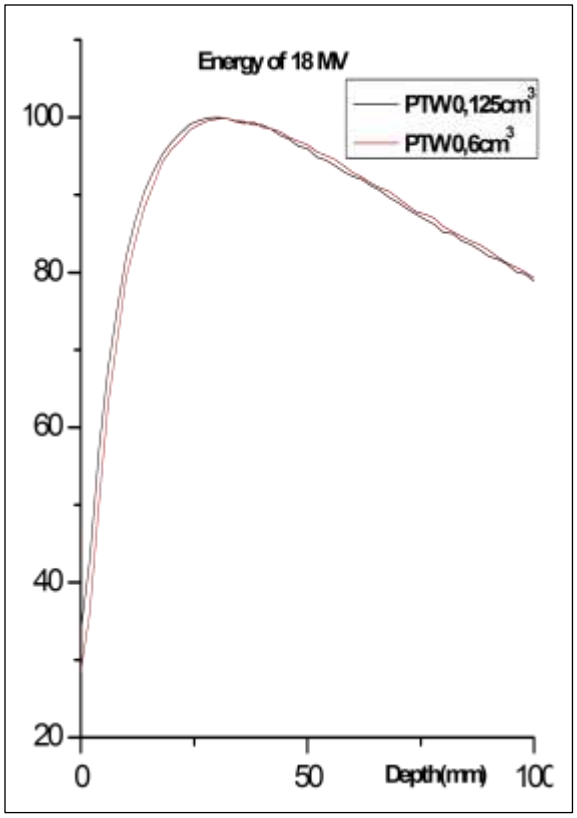
(c)



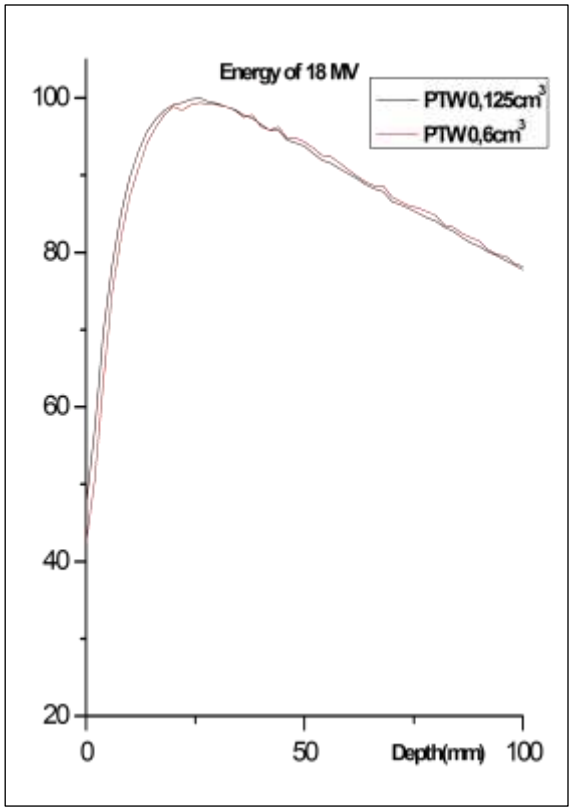
(d)

Figure 5:- For photon beam energy 6 MV, (PDD) acquired by two different ionization chambers PTW 0.125 cm^3 and PTW 0.6 cm^3, (a) is for field size 10 cm × 10 cm, (b) is for 20 cm × 20 cm, (c) is for field size 30 cm × 30 cm and (d) is for 40 cm ×40

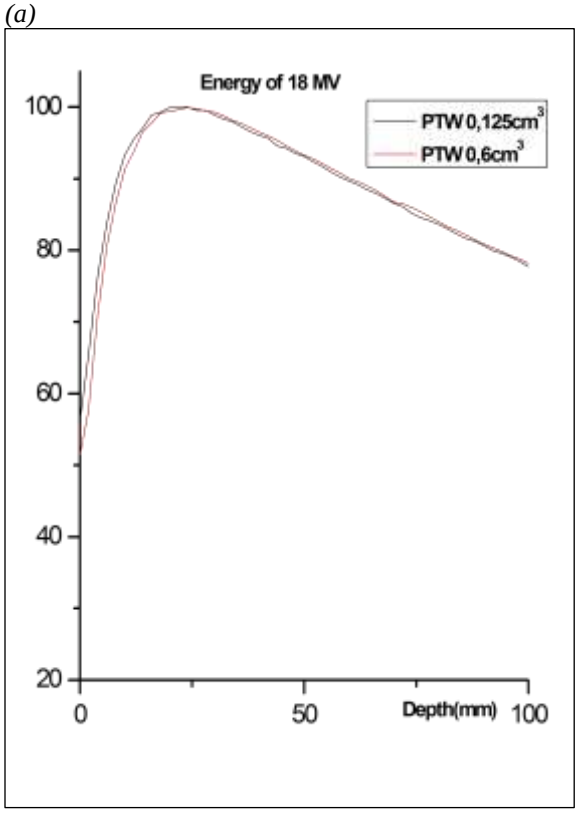
Figure 6 gives the same comparison for 18 MV for the same chosen field sizes.


Energy of 18 MV
PTW0,125cm3
PTW0,6cm3
100
80
60
40
20
0
50
Depth(mm)
100

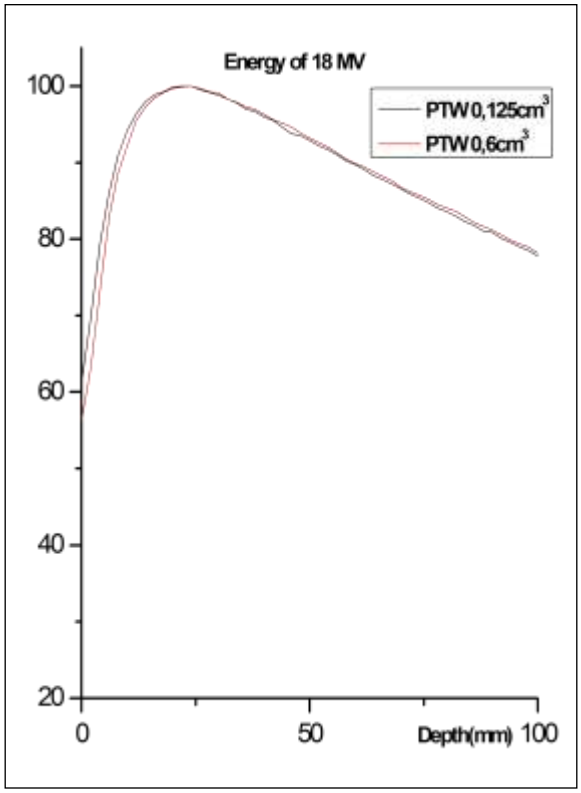
(a)


Energy of 18 MV
PTW0,125cm3
PTW0,6cm3
100
80
60
40
20
0
50
Depth(mm)
100

(b)


Energy of 18 MV
PTW 0,125cm3
PTW 0,6cm3
100
80
60
40
20
0
50
Depth(mm)
100

(c)


Energy of 18 MV
PTW 0,125cm3
PTW 0,6cm3
100
80
60
40
20
0
50
Depth(mm)
100

(d)

Figure 6:- For photon beam energy 18 MV, PDD acquired by two different ionization chamber PTW 0.125 cm^3 and PTW 0.6 cm^3, Fig. (a) is for field size 10 cm × 10 cm, Fig (b) is for 20 cm × 20 cm, Fig (c) is for field size 30 cm × 30 cm, Fig (d) is for 40 cm × 40 cm.

Discussion:-

According to the Figures 5 and 6, there is a difference between the percentage depth doses measured by the two detectors; this difference is mainly and clearly observed in the first zone (the buil-up zone). The largest difference calculated as a relative deviation between results given by the two ionization chambers varies between about 10 % and 22%.

The relative deviations between the measurements obtained by the two ionizations chambers are given for the four field sizes in the following table

Relative deviation between the PTW 0.125 cm^3 and PTW 0.6 cm^3 ,for 6 MV	Relative deviation between the PTW 0.125 cm^3 and PTW 0.6 cm^3 ,for 18 MV	Field size
22.27%	15.9 %,	(10 × 10) cm^2
14. 24 %	11.18 %	(20 × 20) cm^2
12.35 %	11. 77 %	(30 × 30) cm^2
10.36%	10.45 %	(40 × 40) cm^2

Table 1:- Relative deviation between the PTW 0.125 cm^3 and PTW 0.6 cm^3, for 6 MV and 18 MV

These results show that the difference between the curves of the percentage depth doses measured by the two detectors is bigger if the field size is lower, and it is higher when the energy is low

Conclusion:-

In this general quality control work, we have compared the PDD and BP measurements obtained by ionization chamber (PTW 0.125 cm^3) with the results calculated by TPS.

The results of PDD and BP measured by the ionization chamber are comparable for all chosen treatment field dimensions to those calculated by TPS.

This comparison show that the quality of linear accelerator at Nouakchott Center of Radiotherapy is good and assure the conditions of different medical interventions in this Center.

Regarding comparison between the two ionizations chambers, we notice that the difference between the percentage depth doses measured by the two ionizations is related to the energy and to the field size of the incident photons beam.

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