International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Impact Factor (2012): 3.358

Using Weight Windows in MCNPX to Calculate and Simulate Dose Distribute at Outside of Treatmean Room of Dong Nai General Hospital to Radiation Safety Assessment for this Area

Nguyen Van Hai[1], **Nguyen Van Hung**[2]

[1]Dalat Vocational Training College

[2]Nuclear Research Institute

Abstract: ***Using MCNPX calculation programs at locations away from the source, design complexity, wire material will be difficult with calculate the normal way, some results entirely eliminate, the error is very large, unacceptably. Therefore, finding a solution calculate accurate simulation is absolutely necessary, in order to assess radiation safety for this area.***

Keyword: MCNPX, Weight Windows, Dose Distribute, Safety

1. Introduction

The weight-window variance reduction technique adjusts the weights of particles as they change energy and move through the various cells in the problem geometry. In each cell, a lower weight bound and an upper bound (defined as a multiple of the lower bound) are specified. If a particle entering a cell or a particle created in the cell has a weight above the upper bound, the particle issplit such that all split particles are within the weight window. Similarly, if a particle has a weigh tbe low the lower bound, Russian roulette is used to increase the particle's weight until it lies within the window or until it is killed [1].Use this method to calculate, simulate 15 MV photon dose distribute, in the case of a gantry rotation angle 90^0(radiation beam direction to staff table) at the position of the wall, staff table and lobby.

2. Simulation and Calculation

- **Set the input file for problem**

Simulate, calculate distribution dose rate for 15MV photon energy spectrum energy in the following table 1.

Table 1: Distribution of photon beam with energy of 15 MeV

Energy (MeV)	Relative probabilities (%)	Energy (MeV)	Relative probabilities (%)	Energy (MeV)	Relative probabilities (%)	Energy (MeV)	Relative probabilities (%)
0.10	0.06	0.50	2.28	1.50	4.86	6.00	7.17
0.15	0.73	0.60	2.35	2.00	10.18	8.00	0.72
0.20	0.89	0.80	4.69	3.00	16.98	10.00	4.19
0.30	1.98	1.00	4.65	4.00	13.48	15.00	1.00
0.40	2.19	1.25	5.42	5.00	9.08	20.00	0.00

Note: Refer to this values when performing QA at DongNai General Hospital.

Geometry of the structure is described in Figure 1, the wall is made of concrete, material compositions as follows:

Table 2: Composition of concrete

Mass fraction	O	Ca	C	Si	Al	Fe	Mg	S	K	H
Mass fraction	0.492	0.336	0.079	0.073	0.005	0.003	0.002	0.002	0.001	0.007

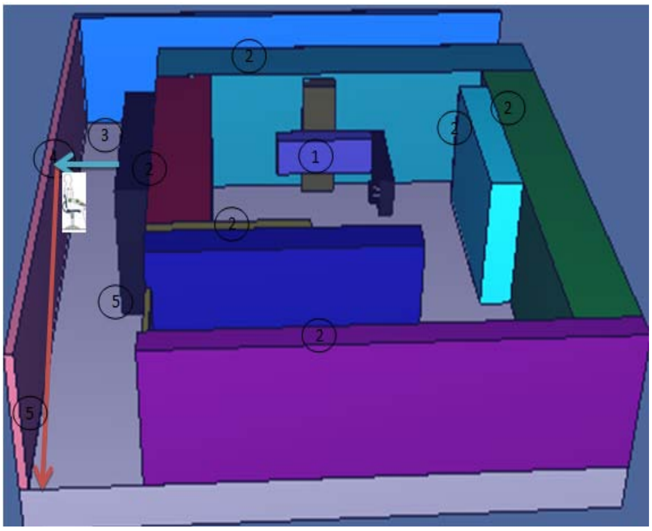

Figure 1: Diagram of radiation treatment room, 1-Linear accelerator, 2-concrete wall, 3- concrete wall near the staff, 4- the Staff, doors lead, 5 lobby.

- **Requirements of calculation and simulation**

Simulate image scattering of photons in the case gantry rotation angle 0^0, 90^0. Calculate of photon dose distributions in follow the direction of the arrow in Figure 1 when beam radiation most impact.

3. Results and Discussion

Simulate scattering

Using MCNP Visual Editor software version 19L to simulate scattering of photons in room at two the gantry angle, the image can be as follows:

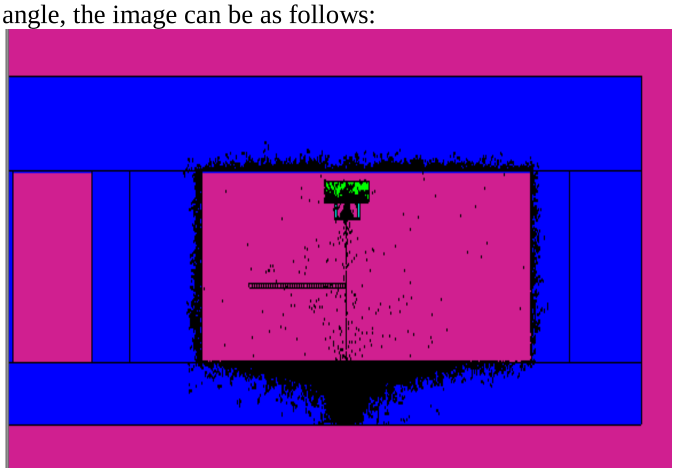

Figure 2: Photons scattering of 15 Mev, gantry 0^0

In in this case, mainly scattered on the floor, the scattering in the walls around affected negligible.

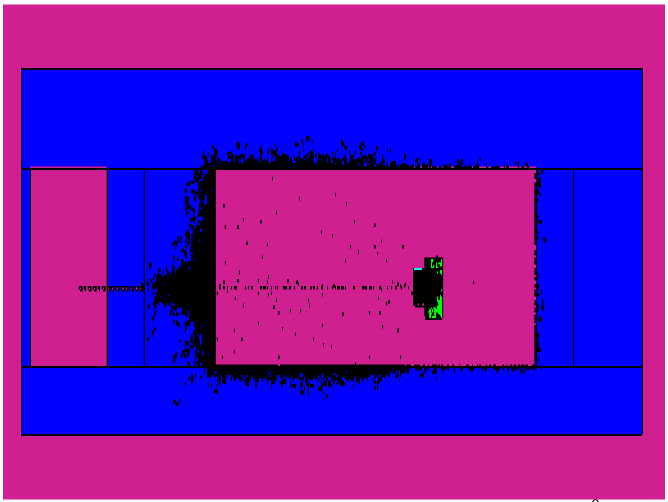

Figure 3: Photons scattering of 15 Mev, gantry 90^0

Based on the results of scattering images and analysis of the direction of travel of the Photons beam[2],recognize that the photons scattering influence outside lobby in case 90^0 more than 0^0, We chose calculated in 90^0, to obtain reliable data.

Calculate distribution dose rate

With Weight Windows method of MCNPX, results calculated distribution dose rate photon 15 MeV, from wall 3to table of staff, in the following table:

Table 3: Distribution dose rate from the concrete wall (4) to the table of staff

Position (cm)	Dose rate (µSv/h)	Position (cm)	Dose rate (µSv/h)
460,0,120	11.5727	520,0,120	1.811332
470,0,120	8.15212	530,0,120	1.339282
480,0,120	6.34918	540,0,120	1.163636
490,0,120	4.65672	550,0,120	1.124212
500,0,120	3.35848	560,0,120	1.112512
510,0,120	2.46115	570,0,120	1.111550

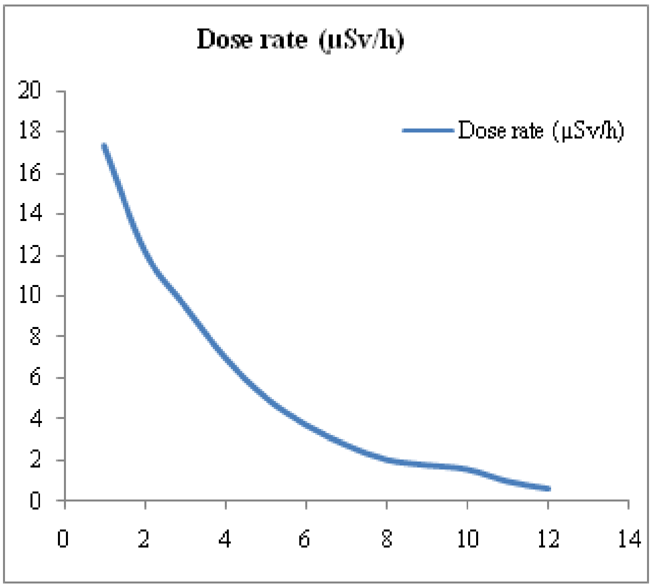

Figure 4: The decline in dose rate from the wall (460,0,120) to table staff (570,0,120).

Figures calculated by MCNP software shows Photons dose rate decreased very rapidly in the concrete wall to the table, the staff was 0.1.2 µSv/hour.

Calculate the time with the highest total radiation dose equivalent of 1 year to the atmosphere at the 6.9mSv staff positions and compare them with regulations of International System of Radiological Protection (ICRP). This dose completely in the ability to allow[3], thereby confirming the photon shielding for this case fully meets the requirements of radiation safety.

4. Experiment

To test the accuracy of the simulation results, we have made measurements at several locations by Aloka dosimeters TSS121 (of course can only be measured at several positions), the results obtained from experimental comparison with calculations as follows:

Table 4: Comparison of calculated and experimental results

Position (cm)	Calculation(µSv/h)	Experimental(µSv/h)	Position(cm)	Calculation (µSv/h)	Experimental(µSv/h)
540,0,120	1.163636	1.3	540,0,120	0.335651	0.35
550,0,120	1.024212	1.3	550,0,120	0.320591	0.33
560,0,120	0.628512	0.9	560,0,120	0.319723	0.33
570,0,120	0.391455	0.5	570,0,120	0.301313	0.32

From the comparison calculation results with experimental, the calculations have acceptable and reliability, at table staff when emission, dose rate 3 times higher than background environment, should continue to calculate dose distributions simulated from staff table along the lobby(where the patient's home, the doctor usually present), results calculated as follows:

Table 5: Distribution of dose rate from the staff table to the lobby area

Distance (cm)	Dose rate (µSv/h)	Distance (cm)	Dose rate (µSv/h)	Distance (cm)	Dose rate (µSv/h)	Distance (cm)	Dose rate (µSv/h)	Distance (cm)	Dose rate (µSv/h)
0	1.1652	330	0.9249	670	0.9687	1010	0.7761	1350	0.4944
10	1.1535	350	0.9165	690	0.978	1030	0.7662	1370	0.4941
30	1.148	370	0.9138	710	0.999	1050	0.7512	1390	0.492
50	1.1367	390	0.9066	730	1.0212	1070	0.7221	1410	0.4893
70	1.1277	410	0.8823	750	1.0383	1090	0.714	1430	0.4863
90	1.1007	430	0.8559	770	1.0284	1110	0.6954	1450	0.4836
110	1.0731	450	0.8442	790	0.9987	1130	0.6834	1470	0.4821
130	1.0503	470	0.8214	810	0.9702	1150	0.6564	1490	0.4806
150	1.0242	490	0.8199	830	0.9447	1170	0.6384	1510	0.48
170	1.0044	510	0.8211	850	0.9237	1190	0.6117	1530	0.4779
190	0.9975	530	0.8397	870	0.9045	1210	0.5856	1550	0.4764
210	0.9837	550	0.8691	890	0.8778	1230	0.579	1570	0.4746
230	0.9672	570	0.8946	910	0.864	1250	0.5628	1590	0.4743
250	0.9633	590	0.8994	930	0.8592	1270	0.5379	1610	0.4719
270	0.9528	610	0.9237	950	0.8514	1290	0.5205	1630	0.4698
290	0.9528	630	0.9309	970	0.825	1310	0.51	1650	0.4674
310	0.9351	650	0.9435	990	0.7968	1330	0.4965	1670	0.4653

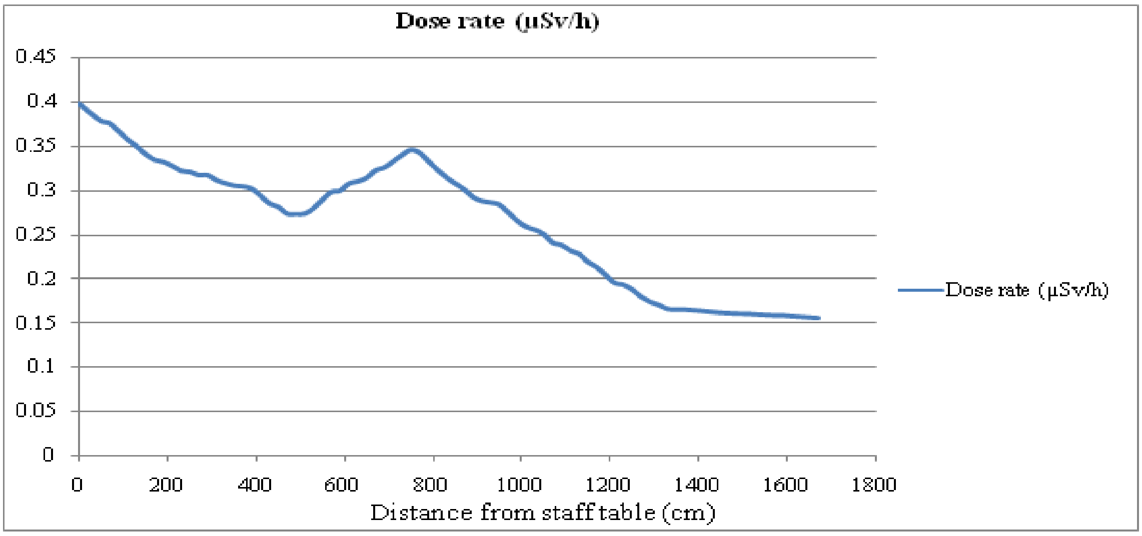

Figure 5: Distribution of photon dose rate from table of staff to lobby

Dose rate decreases from a staff position to lobby area and then increases at place 5.5m to 7.5m(this is the location radiotherapy room entrance) and then decreased gradually to the outside out lobby continues decreasing dose rate and higher background environment negligible.

After calculated, we have measured a some locations, measured and calculated results are relatively consistent, this chart shows the distribution is completely reliable, on that basis, we recommend knowing the safe locations in radiation area, the locations of high dose, exposure should be limited.

References

[1] J. Kenneth Shultis and Richard E. Faw, An introduction to the MCNP code, April 20, 2005.
[2] Trần Đại Thiệp,Tương tác bức xạ gamma với vật chất và ứng dụng trong thiết kế che chắn, Hà Nội 2004.
[3] http://www.icrp.org
[4] http://www.firstdaytoncyberknife.com
[5] Cyber Knife Robotic radiosurgery system, 2005.
[6] Siemens Medical Solutions USA, Inc, 1970.
[7] Nguyễn Văn Hùng, Bài giảng về một số tai nạn điển hình và bài học kinh nghiệm, Viện Nghiên cứu hạt nhân, 2008.
[8] Julian Becker, Simulation of neutron production at a medical linear accelerator 2007.