ESTIMATION OF THE CONTRIBUTION OF DISSIPATED AND REFLECTED GAMMA-QUANTA TO THE VALUE OF THE DAP DEPENDING ON THE PARAMETERS OF THE X-RAY PROCEDURE

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In modern life, X-ray diagnostic procedures have a big role. We use it in epidemiology, traumatology and oncology for the diagnosis and visual presentation of the picture of the disease. So, in order to minimize harmful affection on patients it's necessary to most accurately account contribution of X-rays dose received during medical procedures to annual dose of radiation.

DAP – Dose Area Product, that show how much energy transported to square by particle.

$$DAP = \int_S D_{air}(\mathrm{S})\,\mathrm{dS} \quad (1)$$

This is a main parameter to control the X-ray medicine diagnostic procedures. The problem is to subtract from DAP value the contribution of dissipated and reflected gamma-quanta which was obtained from the detector. DAP detectors are established in the collimation system. They measure passing and dissipated, reflected radiation. Initially, a point source radiates into a cone with a given angle solution. The real X-ray machine have a collimation system, that transform a source radiation by cutting down some beams. It's known that gamma-quanta have strong penetrating power, and have reflections and dissipations in collimation system. Further it's also registered by DAP detector.

In this research the X-ray diagnostic procedure of rib thorax with DAP changes depending on different parameters of the X-ray machine is observed.

In this work Monte-Carlo modelling is used as most suitable and accurate method. In this approach we used a model of static X-ray machine. In MCNP (Monte-Carlo N-Particle Transport Code) [1] used two functionals – functional of transferred energy (f6) and functional of absorbed energy (f8*) [2]. We can use both this functionals, because we have an electron equal in air.

The model of X-ray machine consists of collimation system and X-ray source.

This model includes changeable parameters, that can influence on DAP value.

List of main parameters that was changing in research:

- Voltage of X-ray tube (in kV)
- Focal spot radius at anode (in mm)
- Voltage ripple (in %)
- DAP detector position (in mm)
- Filter depth (in mm)

In this approach data for X-ray energy spectra was taking from TASMIP [3], and include dependents from aluminum filter, voltage and voltage ripple. MCNP used for computation energy, that was delivered to detector by gamma-quanta.

Geometrically such simulated experiment is represented as a source of variable sizes that placed in front of water column. This water column is one of admissions in this model, because, as you can see later, reflected gamma-quanta don't make huge influence on DAP value. This water column has a parameters of averaged human body. In this model there are some detectors, located in front of source per each 10 cm, and 5 of them took place in collimator system per each 1 mm of lead curtains.

1. Results obtained from both functionals (f6 and f8*) have the same order, and their maximum discrepancy is 7%. In addition, the dependence obtained with F6 has a smoother appearance than its analogue obtained with F8 *. Also F6 has a smaller mistake (1% vs 3.5%). F6 faster than F8* in 10^3 but needs an additional processing.
2. DAP value in collimation system has only 0.05% reflected gamma-quanta. Value of reflected gamma-quanta fall in 35 times at 40 cm distance.
3. Contribution of dissipated gamma-quanta to the value of DAP in the collimation system varies from 0.02% to 0.1% and it's depend on radius of source.
4. Changes in voltage lead to changes in DAP for 15%
5. Filters have a strong influence on DAP value – 5 mm of aluminum change DAP in 2 times.

According to the obtained results, location of the detector satisfy requirement for accuracy of the DAP value [4]. This results can apply only for systems that satisfy this research model. The optimal position for the detector placement was found, excluding consideration of reflected and dissipated gamma quanta.

[1] MCNP-A General Monte Carlo N-Particle Transport Code. Version 4B. / Los Alamos National Laboratory, editor J.F. Briesmeister. – Los Alamos NM, 1997. – 736 p.
[2] Denise B. Pelowitz MCNPXTM USER'S MANUAL USA, 2008. -551p
[3] John M. Boone J. Anthony Seibert TASMIP USA, 1997.
[4] ICRP Publication 103