DETERMINATION OF PHOTONEUTRON FLUX IN WATER

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In order to estimate the photoneutron flux created during betatron irradiations, a one liter water solution of 0,5 M NaCl was exposed to the bremsstrahlung of the "Siemens" 42 MeV therapeutic unit at the Radiological Institute in Belgrade. The exposure time was 9 minutes and the estimated absorbed dose 700-800 rad.

Induced activity of ^{24}Na was measured via the intensity of 1368 keV transition[+/], and for neutron flux we obtained:

$$\Phi = \frac{(1,21 \pm 0,08) \cdot 10^5}{\sigma_n} \quad n.cm^{-2}.s^{-1},$$

where σ_n is neutron activation cross section in barns. If for σ_n we substitute the thermal neutron activation cross-section $(0,534 \pm 0,007)b$[1], and the 14 MeV neutron activation (capture) cross-section $(0,33 \pm 0,03)mb$[2] respectively, we get:

$$\Phi \text{ (thermal)} = (2,3 \pm 0,2).10^5 \text{ n.cm}^{-2}.\text{s}^{-1} \text{ and}$$

$$\Phi \text{ (14 MeV)} = (3,7 \pm 0,4).10^8 \text{ n.cm}^{-2}.\text{s}^{-1}.$$

However, these neutrons may be created in the target solution mainly via the $^{16}O(\text{gamma,n})^{15}O$ reaction, and also by (gamma,n) reactions on Fe, Al, Cu, etc. of the betatron and its collimator. Considering roughly neutron thermalization in water we tend to believe that the flux is nearer to the fast neutron value.

References: 1. Alijev A.J. et al "Jadernofizičeskie konstanti dlja neitronovo aktivacionovo analiza", Spravočnik, "Atomizdat", Moskva 1969.
2. Gillespie A.S.Jr., Hill W.W., Nucleonics, 19, 170 (1961)

+/ 31 ccm Ge(Li) detector efficiency for this transition and 1 liter source close to the detector was $(2,70 \pm 0,03).10^{-4}$.