Transmutation power of ^{nat}U and ^{232}Th in Graphite lead target assembly irradiated by 2.33 GeV deuteron beam at JINR, Dubna

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An experimental setup with spallation lead target (dxl = 8x60cm^2) covered with graphite moderator (x.y.z =110x110x60cm^3) was irradiated by 2.33GeV deuteron beam in March 2007 at JINR Nuclotron, for 25 hours and 17 minutes [1]. Samples weighing 93.1 mg of ^{232}Th and 172.8 mg of ^{nat}U were irradiated at three different positions referred as hole 'a', 'b' and 'c' as shown in fig. 1. The radial distances of the sample from the centre of the spallation target are given in table 1. The distribution of fluxes at the three positions were calculated using Monte Carlo MCNPX code and given in fig. 2.

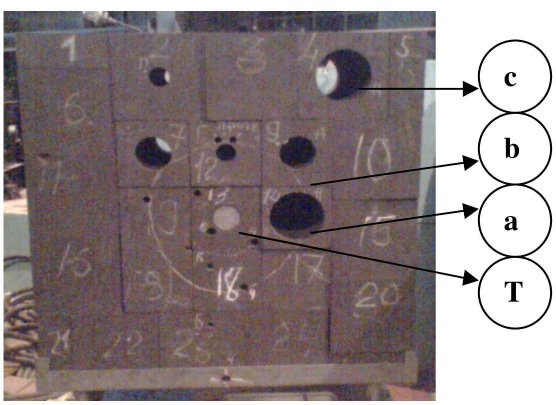

Fig. 1 Graphite assembly with Pb target and three irradiation holes 'a', 'b' and 'c'.

Using the detailed procedure of gamma spectrometry technique, various gamma peaks of different fission, capture and (n,2n) residues are identified and analyzed by applying proper corrections e.g. efficiency, beam, self absorption and coinciding summing. The experimental reaction rates for all the observed elements are calculated as described in ref.[2]. The transmutation power of the system can be given in terms of the reaction rate R (A_r, Z_r), masses of target A_t and residues A_r [2] ,

$$P(A_r, Z_r) = R(A_r, Z_r) \cdot N_d \frac{A_r}{A_t}, \qquad (1)$$

here N_d = Incident deuterons per second, and integral number $N_D = N_d t_{irr}$ On normalizing for 10^9 deuterons, the normalized transmutation power P_{norm} is ,

$$P_{norm}(A_r, Z_r) = 10^9 \frac{P(A_r, Z_r)}{N_D} \qquad (2)$$

In Table 1, the value of P_{norm} of the graphite assembly of this experiment are given for (n,γ) and (n,2n) reactions for ^{232}Th and ^{nat}U. From the table it can be seen that for the nearest position i.e hole 'a' the transmutation power is much higher than at the other two holes 'b' and 'c' for all the three reactions i.e. (n,γ) , (n,f) and (n,2n). The neutron flux in the graphite assembly lies in a wide range from thermal to very high energy show that the assembly is very useful for the studies related to (n,γ) , (n,f) and (n,xn) reactions. A detailed analysis of the data will be published soon.

Table 1: Comparison of transmutation power of three different holes 'a', 'b' and 'c' in Graphite-lead target assembly .

Assembly	**Graphite**		
	Hole a	Hole b	Hole c
Distance 'd'(Th)	d~ 24cm	d~ 34cm	d~ 61cm
$^{232}Th(n,\gamma)^{233}Pa$	3.32(15) E-16	1.97(5)E-16	3.39(16)E -17
$^{232}Th(n,2n)$ ^{231}Th	8.9(11) E-18	1.06(22)E -18	-
Distance 'd'	d~ 19cm	d~ 31cm	d~ 58cm
$^{238}U(n.\gamma)^{239}Np$	3.39(11) E-16	2.32(8)E-16	-
$^{238}U(n,2n)^{237}U$	2.82(19) E-18	7.44(83)E -19	-

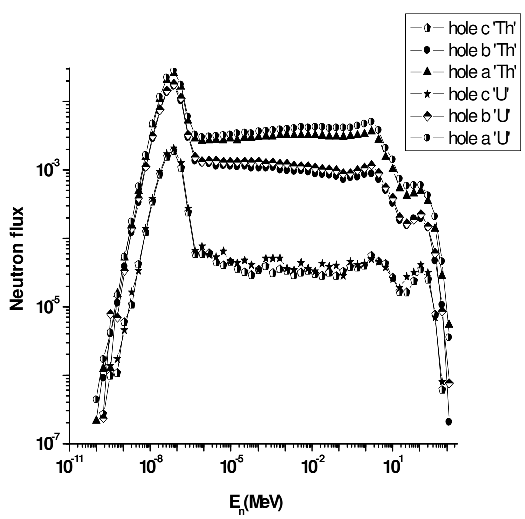

Fig 2: Flux distribution of graphite assembly in hole a, b and c (distances being 23.3, 33 and 59.8 cm from the centre of symmetry axis (Z) of the lead target) at the positions of ^{232}Th and ^{nat}U samples.

References :

[1] J. Adam, V.S. Pronskikh, V.M. Tsoupko-Sitnikov, et al. 'Transmutation of ^{129}I by secondary neutrons of the graphite-lead block exposed to 2.33 GeV deuterons: Experiment and modeling' presented at 'First International Workshop on Accelerator Radiation Induced Activation ARIA 2008' published in ARIA'08 PSI proceedings 09-01, with ISSN number 1019-0643, 231(2009) .

[2] J. Adam, K. Katovsky, M. Majerle, M.I. Krivopustov, V. Kumar, Chitra Bhatia, Manish Sharma, A.A.Solnyshkin,V.M.Tsoupko-Sitnikov, JINR preprint E15-2008-118, revised for EPJ A (September 2009).