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E. B. Iverson

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E. B. Iverson

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1. INTRODUCTION

Yuri Efremenko (UT-K) and Kate Scholberg (Duke) indicated, during discussions on 12 January 2006 with the SNS Neutronics Team, interest in a new type of neutrino detector to be placed within the proposed neutrino bunker at SNS, near beam-line 18, against the RTBT. The successful operation of this detector and its associated experiments would require fast-neutron recoil rates of approximately one event per day of operation or less. To this end, I have attempted the following order-of-magnitude estimate of this recoil rate in order to judge whether or not a full calculation effort is needed or justified.

2. MODEL DESCRIPTION

For the purposes of this estimate, I consider a one-dimensional slab geometry, in which fast and high-energy neutrons making up the general background in the target building are incident upon one side of an iron slab. This iron slab represents the neutrino bunker walls. If we assume that a significant fraction of the dose rate throughout the target building is due to fast or high-energy neutrons, we can estimate the flux of such neutrons based upon existing shielding calculations performed for radiation protection purposes. In general, the dose rates within the target building are controlled to be less than 0.25 mrem per hour. A variety of calculations have indicated that these dose rates have significant fast and high-energy neutron components. Thus we can estimate the fast neutron flux incident on the neutrino bunker, and thereby the fast neutron flux inside that bunker. Finally, we can estimate the neutron recoil rate within a nominal detector volume. Such an estimate is outlined in Table 1.

Table 1.

Quantity	Unit	Worst Case	Reasonable	Desirable
Average External Doserate	mrem/hr	0.1	0.03	0.01
Flux-to-dose Conversion Factor	mrem/hr per n/cm2/s	1.43E-01	1.43E-01	1.43E-01
Average External Fast Flux	n/cm2/s	0.7	0.21	0.07
Iron Thickness	cm	100	125	150
Iron Cross Section	1/cm	0.1404	0.1404	0.1404
Iron Transmission	fractional	7.95E-07	2.37E-08	7.09E-10
Average Internal Fast Flux	n/cm2/s	5.56E-07	4.99E-09	4.96E-11
Nominal Detector Area	cm2	1000	1000	1000
Average Rate of Neutron Incidence	n/s	5.56E-04	4.99E-06	4.96E-08
Recoil Reaction Probability	fractional	0.1	0.1	0.1
Average Recoil Reaction Rate	recoils/s	5.56E-05	4.99E-07	4.96E-09
Average Recoil Reaction Rate	recoils/day	4.81E+00	4.31E-02	4.29E-04
Duty Factor	fractional	6.00E-04	6.00E-04	6.00E-04
Instantaneous Reaction Rate	recoils/day	8.01E+03	7.18E+01	7.15E-01

The dominant factor in the analysis is the thickness in the iron shielding. All other factors have modest effects on the final outcome. In the worst case scenario, the dose rate on the outside of the bunker is near the maximum allowable for the target building (0.25 mrem per hour), the shielding is approximately one meter thick, and approximately 10% of the neutrons reaching the inside of the bunker result in recoil reactions within the detector. These fast neutrons are in general limited to occurring no more than a few microseconds after the prompt flash, resulting in the neutron recoil rate being limited to that short period. Unfortunately, that is the same period in which the neutrino recoil events will take place. Given this analysis, my preliminary conclusions would be that 1) this neutrino experiment might enjoy reasonable success given a minimum of 1.5 m iron wall-thickness for the neutrino bunker, and 2) the large computational effort required to fully model this background rate is probably not justified at this time.