LA-UR- 99-604

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Title: DETERMINATION OF PROTON AND NEUTRON SPECTRA IN THE LANSCE SPALLATION IRRADIATION FACILITY

CONF-990605--

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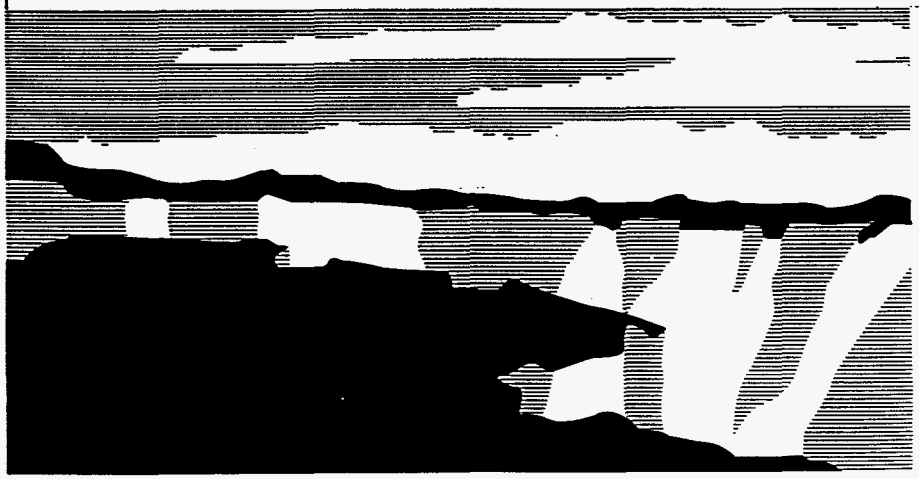
Submitted to: Embedded Topical Mtg.
Boston, MA
6/6-10/99



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Determination of Proton and Neutron Spectra in the LANSCE Spallation Irradiation Facility

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Introduction

Materials samples were recently irradiated in the Los Alamos Radiation Effects Facility (LASREF) at the Los Alamos Neutron Science Center (LANSCE) to provide data for the Accelerator Production of Tritium (APT) project on the effect of irradiation on the mechanical and physical properties of materials. The targets were configured to expose samples to a variety of radiation environments including, high-energy protons, mixed protons and high-energy neutrons, and low-energy neutrons. The samples were irradiated for approximately six months during a ten month period using an 800 MeV proton beam with a circular Gaussian shape of approximately $2\sigma = 3.0$ cm. At the end of this period, the samples were extracted and tested [1]. Activation foils were also extracted that had been placed in proximity to the materials samples. These were used to quantify the fluences in various locations.

Description

The activation foils used to quantify the fluences were arranged in stacks, each stack consisted of 6 disks of >99.95% pure Al, Fe, Co, Ni, Cu and Nb. After irradiation, the stacks were shipped to the CST-11 group at LANL and were analyzed with gamma spectroscopy to quantify the amount of radioactive isotopes created. From the differing amounts of radioactive isotopes and knowledge of the appropriate cross sections from proton and neutron reactions, the overall fluences could be estimated.

The time history (i.e. beam history) of the irradiation was combined with the isotopic quantities using the BCF code [2] to compute the saturation activities for each spallation/activation reaction. Also used as inputs are estimates of the proton and neutron fluences derived from calculations using the LAHET (Los Alamos High Energy Transport) Code System (LCS) [3]. LCS is a Monte-Carlo based code that in this case uses a model of the LASREF target area to calculate proton and neutron transport during the irradiation. The calculated fluence estimates are combined with the saturation activities from 10-12 reactions among the 6 foils as input to the STAYSL2 code [4]. STAYSL2 is a modified version of the STAY'SL code which has been used for many years in neutron activation analysis [5]. STAYSL2 expands the STAY'SL code to include protons to enable analysis in mixed proton/neutron spectra. The STAYSL2 code returns information comparing isotopic levels expected from the input fluences and adjusts the fluences to conform to the measured activities.

Results

The measured activities from 20 foil stacks were analyzed to provide fluence data for the samples tested for mechanical property changes. Highlights of the data are presented in Fig.1. The data presented shows the distribution of fluences across three leading sample tubes of the irradiation. The Gaussian shape of the proton beam is clearly visible while the neutron data show much less variation across the length of the tube. The oscillations that can be seen in the data for tubes 2 and 3 can be attributed to the staggered geometry of the foil stacks. It should be noted that the analysis provides a complete spectra for each foil stack. Each data point represents a sum of the spectra at that point. The exposure data for each sample are then estimated based on the calculated fluences from the activation foils. Given the proper cross sections, the displacements per atom as well as He and H gas production can also be computed in various materials using the estimated fluences.

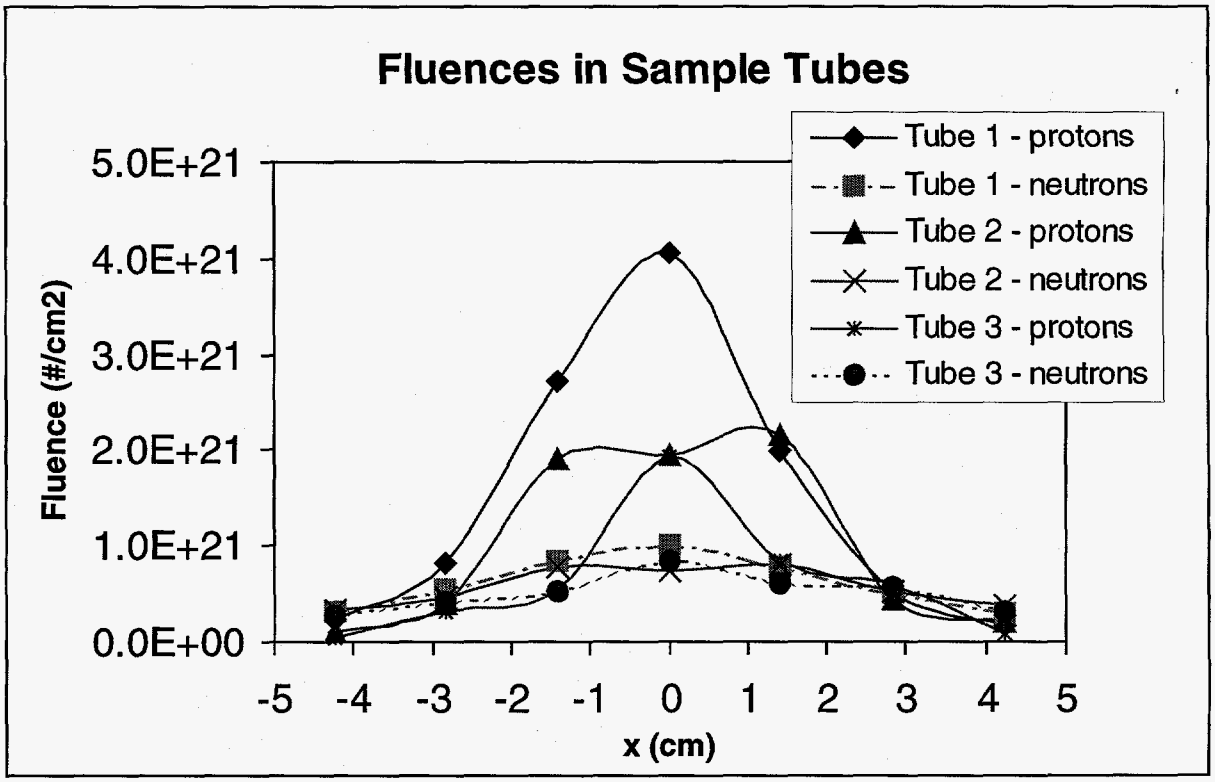

Figure 1. Proton and neutron fluences across the beam profile in various sample tubes.

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