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TITLE: A NEW STRINGER FOR THE LAMPF RADIATION EFFECTS FACILITY

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A NEW STRINGER FOR THE LAMPF RADIATION EFFECTS FACILITY*

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Summary

New stringer design, allowing access to the spallation neutron flux at the Clinton P. Anderson Meson Physics Facility (LAMPF) beam stop is described, together with information on the neutron spectrum.

Introduction

The radiation effects facility (REF) at LAMPF was built to allow study of radiation damage in materials produced by spallation neutrons. These are generated by the stopping of the 800-MeV LAMPF proton beam in the isotope production targets and the copper beam stop. Access to the neutron flux is via three stringers that penetrate the 8 m of shielding around the beam stop. Previous stringers allowed insertion of samples having diameters to 50 mm, but sample lengths were restricted due to bends in the tubing required to reduce radiation streaming. In addition, samples had to be inserted and removed in the pit region, access to which required a lengthy m[illegible] shutdown for personnel safety.

To overcome these problems, a stringer design was sought that would allow samples to be inserted and removed from outside the isotope production facility building and that would increase the available sample volume.

Experimental studies of the neutron flux as a function of neutron energy have been made.[1] A summary[2] of a recent experiment[3,4] has been provided. The results are in reasonable agreement with calculations done earlier.[5]

Stringer Design

To allow easy sample insertion and removal, we decided on the concept of a wheeled cart pulled through a rectangular tube by a come-along. The maximum tube size (76 by 102 mm outside dimensions) was determined by the available size of the stringer housing and the need for radiation shielding. The final inside cart dimensions are 63 by 76 by 305 mm. To allow preassembly of samples to be irradiated in a given run and to reduce contamination problems, a disposable aluminum sample box was designed to slip into the cart. The box's usable volume is about 1 ℓ (Fig. 1). Provision has been made for instrumentation wiring between the samples and the outside. Since temperatures of small uncooled samples in the present stringers have approached 363 K, a water-cooled copper plate was installed through the floor of the rectangular tube at the irradiation position. During irradiation, the cart straddles this plate, while the sample box rests directly on it. In addition, air can be blown directly over the samples, providing some additional cooling.

For a length of 4.6 m, the rectangular tube lies atop a steel shield block. To reduce the radiation streaming through the rectangular tube, it was necessary to place a movable shield block between the pit and the neutron source. The constraints imposed by the stringer housing dictated the use of a vertically moving shield block, which in its upper position covers the rectangular tube opening and, when down, allows the cart to ride on its top surface while being inserted or withdrawn. The shield block is 1.8 m long, and is raised and lowered by end wedges moved by a motor-driven lead screw. The shield block's vertical position is monitored by microswitches interlocked with the radiation safety system, which allows the proton beam to be on only if the block is in the raised position.

To allow insertion and removal of samples outside the building, it was necessary to design a guide tube extending from the pit to the outside. To prevent interference with the isotope production facility in the pit area, the guide tube must be withdrawn from the pit area unless samples are being transferred. The solution arrived at was to place the guide tube on wheels. This allows the guide tube to be pushed across the pit where it mates with the door, permitting the sample cart to be transferred either way. The guide tube can then be retracted into the north stringer housing. The guide tube can also be pulled several feet outside the isotope production facility building to facilitate sample box transfer. This transfer to a cask is effected with a long-handled gripper, to minimize personnel radiation exposure. A windlass (used to position the cart) is mounted outside the building. Installation of this stringer is scheduled for the end of March 1981 (Fig. 2).

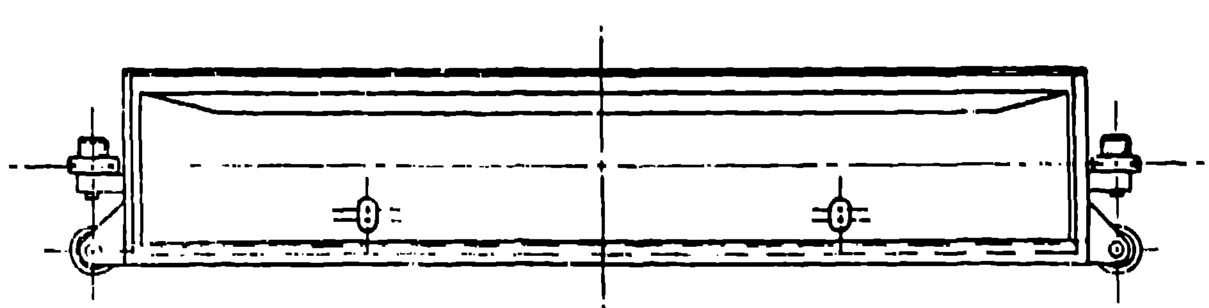

Fig. 1. Sample cart and disposable sample box.

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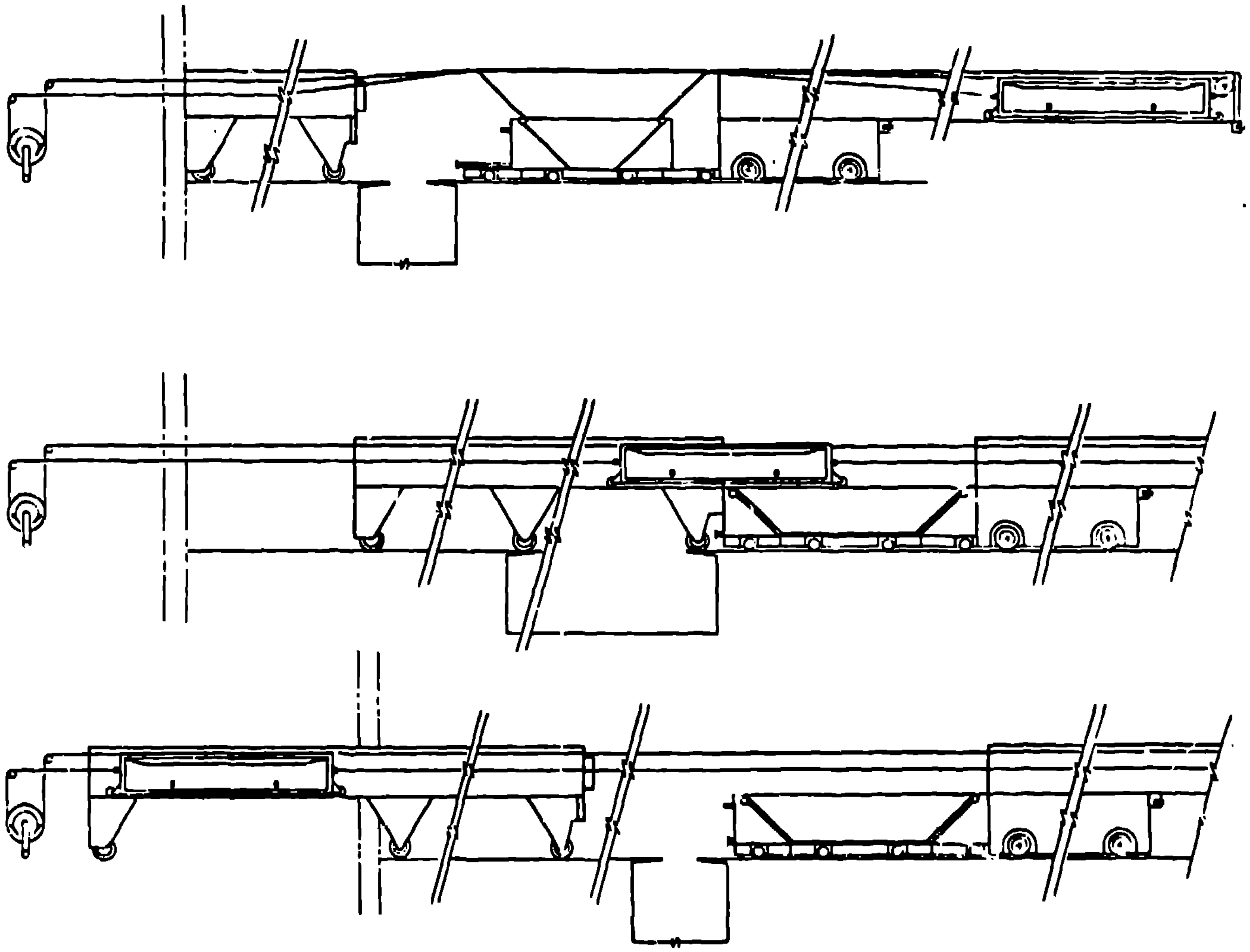

Fig. 2. Operation of the REF stringer is illustrated. At top, the sample cart is in the irradiation position with the shield block raised. The middle view shows the guide tube extended to cross the pit as the cart is withdrawn, and at bottom the guide tube has been pulled outside the building with the cart in position for transfer of samples to a cask.

A mechanism has been designed to allow the positioning of instrumentation wiring so that it can cross the pit and not interfere with isotope production operation.

Neutron Spectrum and Flux

It has been previously suggested[5] that the spallation neutron spectrum available at the REF is suitable for studying (at low fluence) radiation damage produced by neutrons at fusion reactors. It should be noted that the actual spectrum and flux will vary with the sample position in the REF stringers and with the target materials and position of the isotope production targets. There are nine such targets, and several of them may be changed during the period (about 40 days) required to obtain a neutron fluence of 10^{19} n/cm^2.

Results of an experiment to determine the neutron flux vs energy have been summarized.[2] It was reported that the flux of neutrons having $E > 0.1$ MeV was 8.6×10^{12} n/cm^2 per milliampere of proton current. This result was obtained without any isotope production targets in the proton beam. Currently, nine isotope production targets are normally in the proton beam, which is expected to increase the neutron flux. Foil activation measurements indicated that the flux dropped by roughly a factor of ten for each factor of ten increase in neutron energy, with a flux of 3.8×10^{10} n/cm^2 · s · mA for $E \geq 22$ MeV. The thermal neutron flux was about 1×10^{10} n/cm^2 · s · mA. The proton current incident on the isotope production targets is currently about 0.35 mA, and will be increased in the coming year.

Acknowledgment

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