offset mechanical shaft from the back of the plug. The remainder of this step is filled with a fixed-hole collimation. The second and third steps have a fixed hole collimation located in a rotatable shutter. The shutters are geared to a 2:1 ratio for closure from the back of the plug. The plug is fabricated from carbon steel.

The collimator plugs at the WNR have ranged in cost from $5 K to $75 K. In an attempt to reduce the cost of these units, a universal design is being considered.

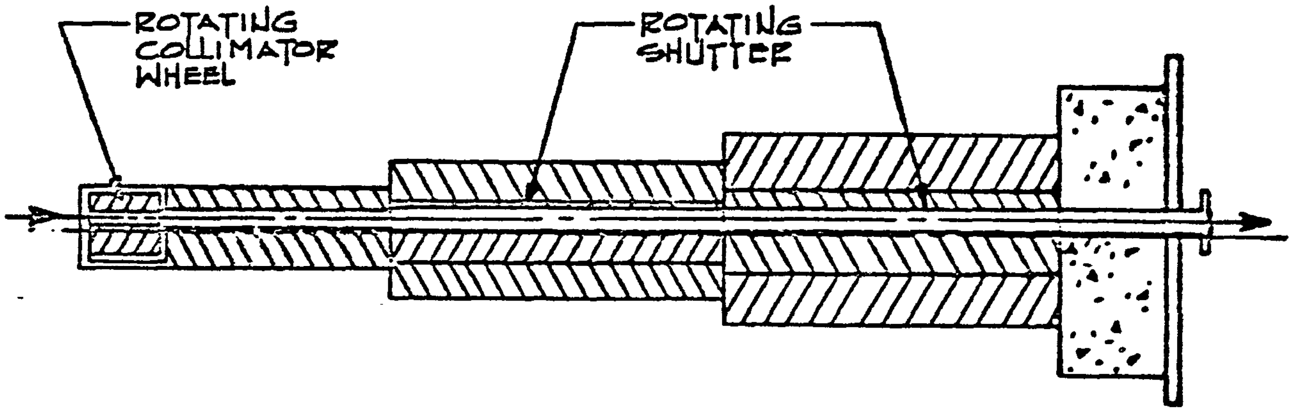

Fig. II-K.1. Flight path #12 beam plug at the WNR.

L. Neutron Radiation Detection at Pulsed Spallation Neutron Sources, R. J. Buchanan, LASL

1. Introduction

At ICANS-III, a lot has been said about new intense neutron source facilities being proposed and built around the world. I would like to address the problems of personnel radiation safety in the following areas:

- How will the neutron radiation dose rates be monitored around the source and in particular, when it is a pulsed source in the ns or μs range?
- What levels of radiation are we working with?
- How will the approximate neutron spectrum be determined over such a wide energy range (thermal to 800 MeV)?
- How will access to the flight paths and experimental areas be controlled?

2. Neutron Dose Rate Monitoring

Generally, commercial instruments are not compatible with beam parameters around pulsed neutron sources because of their long detector resolving time compared to the width of the neutron pulse. Therefore, a system was developed at LASL which has proven to provide a satisfactory answer to the neutron dose rate measurement problem (see Fig. II-L.1). This instrument is called an Albatross IV Portable Pulsed Neutron Radiation Survey Instrument. The Albatross IV is a revised version of the Albatross III developed at Fermi-Lab. The Albatross IV uses a microcomputer and digital electronics instead of the analog system used in the Albatross III. This allows for a much more versatile and easier to calibrate instrument.

The detection system for the Albatross is a 0.25-mm-thick Ag foil wrapped around a GM tube that is located in the center of a 25-cm-diam polyethylene pseudosphere. The neutrons are thermalized in the moderator and then captured by ^{109}Ag to form ^{110}Ag plus a γ-ray. the ^{110}Ag beta decays with a half-life of 24.4 s. There is also a second GM tube wrapped with tin that is used to subtract counts due to γ-rays created in the moderator and also external gamma fields. The β^- plus the γ-ray counts from the Ag wrapped G-M tube and the γ counts from the Sn wrapped G-M tube are sent to a microcomputer where they are manipulated to give the net counts due to neutrons. This information is accumualted in bins for a predetermined time interval which can be varied between 15 s and 8 min.

The meter reads directly in mrem/h when the neutron energy spectrum being detected is approximately the same as the neutron energy spectrum of the neutron source used to calibrate the instrument. Because of the integrating nature of the silver foil and microcomputer program, the response of the instrument is independent of the beam's repetition rate and/or pulse width.

The Albatross IV shows the same energy dependence as other 23-cm and 25-cm diameter polyethylene-moderated neutron survey instruments such as the PNR-4 and Model 6. Such instruments over respond to low-energy neutrons and under respond to high-energy neutrons (see Fig. II-L.2). When calibrated using PuBe neutrons they read correctly within approximately ± 50% in neutron fields with average neutron energies of 0.5-14 MeV.

3. Radiation Levels at the WNR

Although radiation levels will vary greatly depending on the facility, an idea of what radiation levels we are working with at the WNR is shown in Fig. II-L.3. With 19 nA on a thin Al target (simulating a beam spill) the neutron dose rates were in the neighborhood of 20-40 mrem/h through 4 to 8 feet of concrete and 50-100 mrem/h through 2 to 4 feet of steel. The dose rates due to thermal neutron, which were approximately equal to the higher energy neutron dose rates, are also of concern outside of the steel shielding.

4. Neutron Energy Spectrum

The point was brought out that the high-energy component of the neutron spectrum may be contributing some additional dose which is not being fully detected by the Albatross IV, because it is calibrated using PuBe neutrons. Preliminary neutron-energy spectra and average neutron energy measurements have been made and it is believed that a large error is not being introduced by the higher energy neutron component. Work is presently in progress to determine more clearly the neutron energy spectrum from thermal to 800 MeV and, therefore, the correct neutron dose rates.

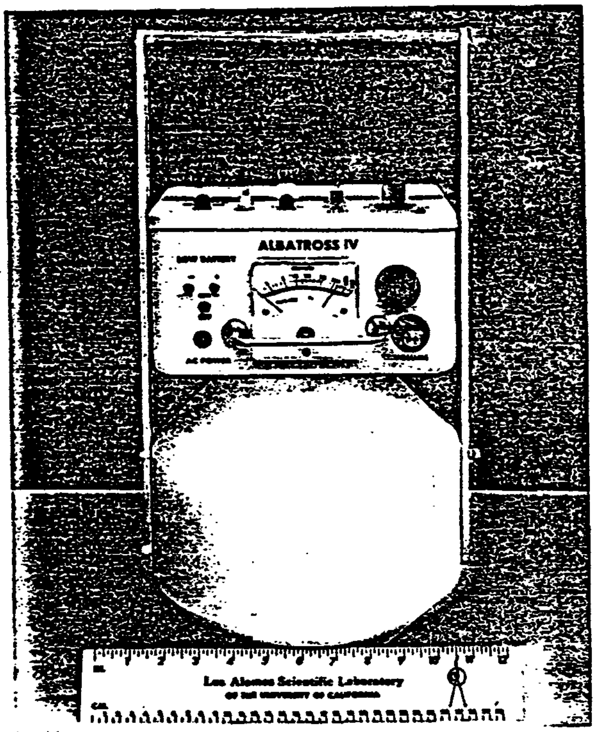

Fig. II-L.1. Front view of Albatross IV pulsed neutron survey instrument.

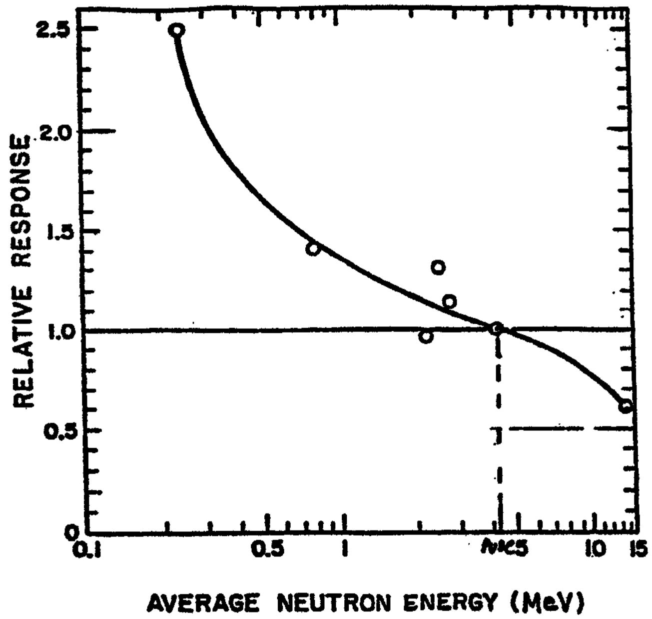

Fig. II-L.2. Relative response of polyethylene-moderated neutron survey instruments as a function of neutron energy.

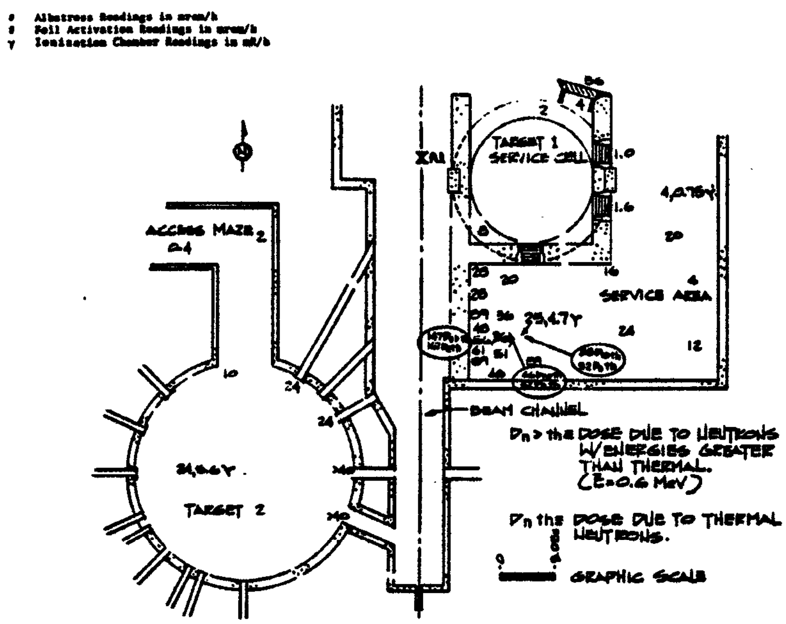

Fig. II-L.3. Measured neutron and γ-ray dose rates at the WNR for 19 nA of protons striking a thin Al target in the beam channel.