J. Delayed Neutron Background in Pulsed Spallation Neutron Sources, J. M. Carpenter, ANL

When fissionable material (for example ^{238}U) is used as a target in a pulsed spallation neutron source, delayed neutrons are produced from certain "precursor" fission fragments which decay by neutron emission following beta decay. The decay half-lives range from a few tenths of one second to about one minute. When the interpulse time is short by comparison with these decay times, delayed neutrons constitute a nearly steady source of neutrons (unless there exist yet-undiscovered, shorter-lived precursors) between source pulses. Although their energies are smaller ($\sim$ 0.5 MeV) than those of fission, evaporation, or cascade neutrons, one may assume that they are moderated and emerge in neutron beams with roughly the same probability as prompt source neutrons. Figure II-J.1 indicates how these delayed neutrons produce a background in a neutron beam.

At distance D, prompt neutrons from the source pulse spread out according to wavelength, arriving to produce a time distribution which reflects the wavelength distribution. Delayed neutrons of all wavelengths arrive continuously at D.

The magnitude of the delayed neutron background can be estimated by comparing the average rate of arrival of prompt neutrons ("signal", S) to the rate of arrival of delayed neutrons ("background", B). The ratio is equal to the ratio of the number of prompt neutrons produced by the source, to the number of delayed neutrons. In ^{238}U, the delayed-neutron fraction from fission is about 1.5%. In a ^{238}U spallation source, about half the neutrons are produced from fission so that the fraction of neutrons which are delayed is about 0.75%. Thus, the ratio S/B is about $1/.0075 \approx 130$.

Such a background is likely to be troublesome in only a few classes of measurement; in those cases it may be necessary to reduce the delayed neutron background by use of a chopper close to the source. In that case, the delayed neutron background would be reduced by the duty cycle of the chopper.

These comments do not apply to the interpulse neutrons which might be produced by fissions induced by low-energy neutrons. This would occur if there were fissile material in the target, as in natural uranium, or in the case in which Pu is allowed to build up in the target.

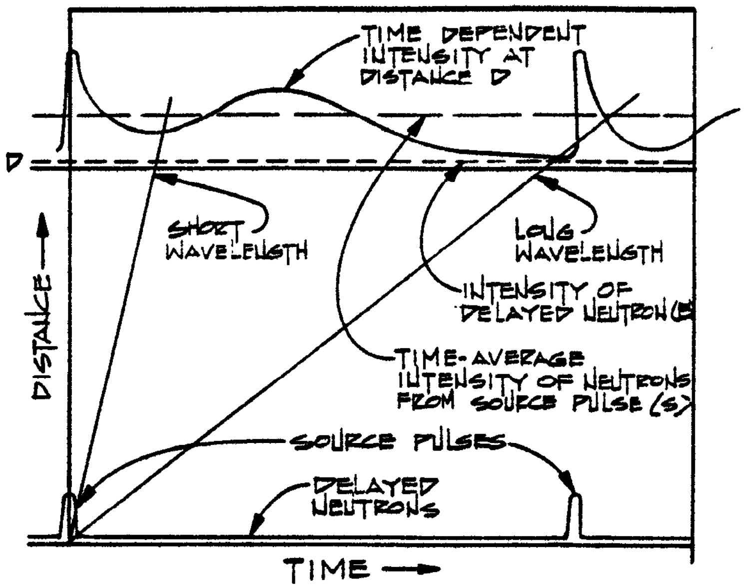

Fig. II-J.1. Illustration of how delayed neutrons produce a background in a neutron beam from a pulsed spallation neutron source.

K. Beam Port and Shutter Design at the WNR, H. Robinson, LASL

The beam ports that penetrate the WNR target 1 shield are 3.7-m long and are fabricated from carbon steel stepped pipes ranging in size from 26-cm to 59-cm diam.

When not in use, these ports are plugged with a blank beam plug consisting of 3.1 m of steel, 10 cm of polyethylene, and an outer canister of 30 cm of magnetite concrete. These ports and the target crypt are operated in a vacuum of ~ 25 microns.

The first collimator installed in the bulk shield was a drilled set of blank beam plugs with a vacuum window installed on the outside of the shield. When not in use, a 1.4-m-long brass rod is inserted into the plug. Any changes for this collimator require shutting off the proton beam.

The five remaining collimators have moving shutters or liquid filled canisters which can be drained and refilled while operating.

A typical example of the collimators used at the WNR would be the one installed on the Small Angle Scattering Experiment, Flight Path #12 (see Fig. II-K.1). The front step has a 15-cm-long collimator wheel fabricated from tungsten-boron-carbide; the collimator has six appertures ranging in size from 0.3-cm to 2.9-cm diam. This wheel is driven with an