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Knolls
Atomic Power
Laboratory

Three-Channel Alpha Fission Counter

F. A. White
J. C. Sheffield

July 1, 1957

Operated for the
United States Atomic
Energy Commission by
GENERAL ELECTRIC

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General Electric Company
KNOLLS ATOMIC POWER LABORATORY
Schenectady, New York

THREE-CHANNEL ALPHA FISSION COUNTER

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Authorized Classifier

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ABSTRACT

Two parallel-plate fission counters, utilizing U-235 foils, and a parallel-plate alpha counter, utilizing a B-10 foil, are combined in one chamber for cross-section measurements at low neutron energies. The alpha counter allows a $1/V$ normalization of the neutron beam intensity.

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THREE-CHANNEL ALPHA FISSION COUNTER

F. A. White and J. C. Sheffield

The three-channel alpha fission counter described in this report was developed as necessary instrumentation for measurements of the variation in the capture-to-fission ratio of fuel at low neutron energies.¹ It has been used for relative cross-section measurements² and is presented for possible application in other beam experiments.

The counter is especially useful when variations in neutron beam intensity must be normalized. Such cases arise with experiments utilizing neutron crystal spectrometers and neutron choppers, where neutron energies are known but variations in neutron flux occur during long periods from changes in reactor power level. Relative, rather than absolute, beam intensity is measured by placing a parallel-plate boron counter directly in front of the twin fission counter. This allows a $1/V$ normalization of the beam strength from the number of observed alpha pulses. The advantages of taking simultaneous data in any experiments with variable beam intensity are obvious.

Reference is made to Figure 1. The collecting electrodes are designated C1 and C2 and the two U-235 foils are located back to back between them. The chamber was designed so that variable thicknesses of fuel could be inserted between the thin samples of U-235. These samples were sputtered on 2-mil aluminum foils with a thickness of ~ 0.1 mg/cm² and uniformity of better than 3%. The transmission sample was then essentially sheathed by 2-mil aluminum so that the fission fragments could not escape. The thin film of B-10 was also deposited on 2-mil aluminum by the same sputtering technique.

It is clear that if the number of neutron-induced fissions in the two fission counters is to be used to measure the true absorption of a sample placed between them, one assumes the incident neutron beam is uniform or guarantees the uniformity of the fission-foil detectors. In the general case, the assumption of a uniformly intense neutron beam cannot be justified. Thus, a technique was developed for sputtering uranium, plutonium, and enriched boron from a central 50-mil wire cathode of these materials to a concentric cylinder of aluminum foil of a few centimeters radius. Krypton was used as a sputtering gas, and the resultant foils were acceptable from the standpoint of uniformity of deposition and adherence to aluminum. The aluminum foils were then mounted on rugged foil holder rings as shown.

Quantitative determination of the relative weights of the thin fission foils was made by isotopic analysis with a mass spectrometer and standard techniques.

FIGURE 1

A top view of the counter showing attached preamplifiers is shown in Figure 2. A 2-mil aluminum window separating the two portions of the chamber prevents contamination of the boron counter and serves as an electrostatic shield. All the counters are enclosed in a single housing and so have a common filling gas. Changes in counter sensitivity are determined by observing the number of alpha particle "pile-up" pulses as a function of discriminator bias voltage with either fission chamber.

Figure 2

Three-Channel Chamber

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An interesting feature of the boron counter is that not only was it able to differentiate the Li-7 recoils from the alpha particles, but it resolved the two alpha groups corresponding to the 94% branching ratio. This is shown in Figure 3, where counting rate is plotted against discriminator bias volts. Data were taken with a single-channel, pulse height analyzer. The high degree of asymmetry on the low energy side of the Li-7 differential curve is due to preamplifier noise.

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