

**DESIGN AND CONSTRUCTION OF A LARGE AREA DETECTOR
SYSTEM AND NEUTRON TOTAL CROSS SECTION MEASUREMENTS
IN THE ENERGY RANGE 0.4 TO 20 MEV**

by

Michael James Rapp

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Approved by the
Examining Committee:

Yaron Danon, Thesis Adviser

Wei Ji, Member

Li (Emily) Liu, Member

Wayne Roberge, Member

Devin Barry, Member

Robert Block, Member

Rensselaer Polytechnic Institute
Troy, New York

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ABSTRACT

In an effort to extend the measurement capabilities of the Gaertner LINAC Laboratory at Rensselaer Polytechnic Institute (RPI) into the MeV region, a new detector system and analysis methods were developed. A large volume modular proton recoil detector was constructed and placed in a collimated neutron beam at an effective distance of 99.95 meters from the neutron source. Transmission measurements were done on natural carbon (graphite), beryllium, molybdenum, zirconium, titanium and tantalum using the time-of-flight method. Combining the long flight path, fast detector response and electronics, and a narrow neutron pulse width, provided good energy resolution, enabling some of the measurements to resolve structure in neutron total cross section never before seen.

In order to obtain accurate transmission calculations, a method was developed to determine the time-dependent background component associated with the measurement, using a combination of experimental data and Monte Carlo methods. This background, combined with the high neutron flux provided by the RPI LINAC, generated high signal-to-background ratios. This signal-to-background and low counting statistics error resulted in low uncertainties and highly accurate data, with uncertainties of less than one percent seen through much of the measured energy range.

The carbon measurement, which has a well measured and agreed upon neutron total cross section in the energy range 0.4 to 20 MeV, provided verification of the accuracy in the measurement and analytical methods used, with an average difference of less than one percent seen between the experimental and evaluated data. The measurements of beryllium, molybdenum, zirconium, titanium and tantalum, also resulted in accurate measurements of neutron total cross section. These high-resolution, high-accuracy results showed that improvements can be made in the current neutron total cross section evaluations, some of which show differences up to 10 %.

The experimental neutron total cross section data are compared to commonly used evaluated nuclear data, prior experimental measurements, as well as optical model calculations using the EMPIRE and TALYS codes.