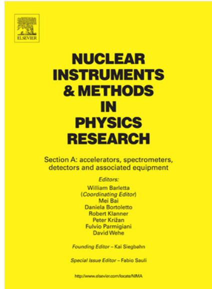
Accepted Manuscript



Design of an ultrathin cold neutron detector

A. Osovizky, K. Pritchard, Y. Yehuda-Zada, J. Ziegler, E. Binkley, P. Tsai, A. Thompson, N. Hadad, M. Jackson, C. Hurlbut, G.M. Baltic, C.F. Majkrzak, N.C. Maliszewskyj

PII: S0168-9002(18)30227-4
DOI: https://doi.org/10.1016/j.nima.2018.02.073
Reference: NIMA 60602

To appear in: *Nuclear Inst. and Methods in Physics Research, A*

Received date : 19 September 2017
Revised date : 14 February 2018
Accepted date : 15 February 2018

Please cite this article as: A. Osovizky, K. Pritchard, Y. Yehuda-Zada, J. Ziegler, E. Binkley, P. Tsai, A. Thompson, N. Hadad, M. Jackson, C. Hurlbut, G.M. Baltic, C.F. Majkrzak, N.C. Maliszewskyj, Design of an ultrathin cold neutron detector, *Nuclear Inst. and Methods in Physics Research, A* (2018), https://doi.org/10.1016/j.nima.2018.02.073

Design of an Ultrathin Cold Neutron Detector

A. Osovizky[1,2,3], K. Pritchard[1], Y. Yehuda-Zada[4], J. Ziegler[1], E. Binkley[1], P. Tsai[1], A. Thompson[1], N. Hadad[1], M. Jackson[5], C. Hurlbut[5], G. M. Baltic[1], C. F. Majkrzak[1] and N. C. Maliszewskyj[1]

[1] NIST Center for Neutron Research, Gaithersburg, Maryland
[2] Rotem Industries Ltd, Rotem Industrial Park, Israel
[3] University of Maryland, College park, Maryland
[4] Nuclear Research Center Negev, Beer-Sheva Israel
[5] Eljen Technologies, Sweetwater, Texas

Corresponding Author: nicholas.maliszewskyj@nist.gov

Key word: scintillator, neutron detector, LiF:ZnS(Ag), silicon photomultiplier, CANDOR

ABSTRACT

We describe the design and performance of an ultrathin (< 2mm) cold neutron detector consisting of ^{6}LiF:ZnS(Ag) scintillator in which wavelength shifting fibers have been embedded to conduct scintillation photons out of the medium to a silicon photomultiplier photosensor. The counter has a neutron sensitive volume of 12 mm wide × 30 mm high × 1.4 mm deep. Twenty-four 0.5 mm diameter wavelength shifting fibers conduct the scintillation light out of the plane of the detector and are concentrated onto a 3 mm × 3 mm silicon photomultiplier. The detector is demonstrated to possess a neutron detection efficiency of 93% for 3.27 meV neutrons with a gamma ray rejection ratio on the order of 10^{-7}.

1. INTRODUCTION

Neutron scattering is a well-established technique for exploring the structure and dynamics of condensed matter [1]. Traditional diffractometers and reflectometers at continuous sources use many means to select out and direct a monochromatic beam of neutrons onto a sample under study. Neutrons scattered from this sample are then detected by a neutron sensitive detector. Recently, neutron scattering instruments utilizing polychromatic beams at continuous sources have begun to be developed, e.g., the Chromatic Analysis Neutron Diffractometer or Reflectometer (CANDOR) spectrometer [2] at the NIST Center for Neutron Research (NCNR).

In such an instrument, a polychromatic ("white") incident beam of neutrons illuminates a sample and the resultant scattered neutrons pass through arrays of highly oriented pyrolytic graphic (HOPG) crystals set at different angles with respect to the centerline of the array. Neutrons of the appropriate energy are subsequently Bragg-diffracted by the crystals into an associated neutron detector. By collecting the scattered radiation in these discrete energy bins simultaneously, it will be possible to perform measurements much more efficiently than is currently possible on a traditional instrument of this type.

To achieve this enhanced rate of measurement (and to more efficiently use the neutrons produced by the source), it is essential to have as many of these energy-analyzing channels as possible packed into a tight angular range. If the neutron detector is exceedingly thin (~2mm), the spectrometer can accommodate numerous analyzing channels.

The ^{3}He gas filled proportional counter has been a mainstay technology for neutron detection for decades. It exhibits excellent gamma rejection and its neutron sensitivity can be tuned by adjusting the pressure of the counting gas mixture. Unfortunately, it is exceedingly difficult to design a pressure vessel of the appropriate