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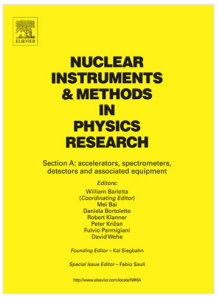

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An energy analyzing detector for cold neutrons

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ABSTRACT

We describe the design, fabrication, and performance of an energy analyzing detector package for cold neutron spectrometers at the NIST Center for Neutron Research (NCNR). The detector package consists of arrays of highly oriented pyrolytic graphite crystals set at takeoff angles corresponding to different neutron energies. Neutrons incident down the array will be selected out by the appropriate crystal and directed onto an associated neutron detector. The arrays are capable of binning neutrons into one of 54 bins over an energy range of 2.29 meV to 5.11 meV.

We describe theory of operation, the development of a highly efficient ultrathin neutron sensor, and the development of the arrays themselves. We present preliminary results for this detector array along with a mature design of the scintillator neutron detector. We also present enhancements we are pursuing prior to deployment of this technology.

1. INTRODUCTION

Canonical neutron scattering instruments at continuous sources have typically operated around a monoenergetic beam of neutrons selected from the source spectrum via crystal monochromators or mechanical selectors. Neutrons scattered from the sample are collected by a neutron detector. As the detectors are insensitive to the energy of the neutron entering them, any energy analysis is performed using crystal monochromators, filters, or time of flight techniques. The upshot is that most of the usable neutrons produced by the source are discarded (Figure 1). Furthermore, for techniques like reflectometry in which the signal decays rapidly over at least eight decades, it can take a great deal of time to accumulate signal with statistical accuracy where it is the weakest.

The Chromatic Analysis Neutron Diffractometer or Reflectometer (CANDOR) [1] is a form of white (polychromatic) beam spectrometer in which neutrons scattered from the sample will be energy analyzed by a multi-crystal detector. Scattered neutrons will pass through an array of highly ordered pyrolytic graphite (HOPG) crystals set off at different angles with respect to the centerline of the array. Neutrons of energies corresponding to the Bragg condition for a crystal will be diffracted out towards a neutron sensitive scintillator detector. By collecting the scattered radiation into energy bins simultaneously it will be possible to perform measurements 50 times faster using the 54-analyzer array than is currently