AN ABSOLUTE MEASUREMENT OF NEUTRON FLUX USING CALORIMETRY

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We are developing an instrument that can measure the flux (neutrons per second) of a low energy neutron beam to an absolute accuracy below 0.1%. The primary motivation for the proposed work is to improve the accuracy of the NIST-Indiana measurement of the decay rate of the neutron.[1] The effort in progress at NIST is expected to be limited to an accuracy of 0.3% without further progress in the accuracy with which the neutron flux can be measured. A calibration of the neutron flux monitor used in the neutron lifetime experiment with our proposed instrument would improve the accuracy of the lifetime to the 0.1% level, which would make it the most accurate measurement of the neutron lifetime to date.

Our instrument will measure neutron flux by sensing the heat produced by neutron absorption in a target which absorbs the entire beam and thermalizes the reaction products.[2,3] For neutron fluxes in the range of interest (10^6 to 10^8 neutrons per second), the total heat generated in a totally absorbing target is in the microwatt range. The required sensitivity can be attained by cooling the target to temperatures near or below 4 K with a helium cryostat.

Tests of the sensitivity of the device to a 1.25 μW electrical heat input have already shown a statistical error of less than 0.2% in 20 minutes and a systematic error of less than 0.01%. Initial test runs at IUCF at a temperature of 4.5 K have reproduced the sensitivity achieved at NIST.

We are now constructing a new helium cryostat to reach lower temperatures ($\leq$ 1.5 K). The lower temperature will decrease the heat capacity of the target, which will increase the sensitivity of the calorimeter. We will also cool crucial parts of the temperature control bridge circuit to liquid helium temperature to reduce room temperature noise. We have also developed a new calorimeter target based on a ^{6}Li-Mg alloy that has a higher lithium content than the current target, a ^{6}LiPb compound.

Ultimately, it would be highly desirable to verify in an independent measurement that all of the energy released in the neutron absorption reaction appears as heat in the target. For example, defects created in the target will not anneal at low temperatures. We are pursuing two possible techniques: measurements with a monoenergetic alpha source of known absolute activity and intercomparison with a carefully-designed Faraday cup on a monoenergetic proton beam.

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DEVELOPMENT OF MICROSTRIP GAS CHAMBERS

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We report here the first results of a project to develop microstrip gas chambers (MSGCs) for use in nuclear physics experiments. The project is a collaborative effort between researchers in the Physics Department and the Electrical Engineering Department at the University of Louisville and the Wire Chamber Laboratory at the IUCF. The MSGC is a multiwire proportional chamber (MWPC) fabricated using the photolithographic and microfabrication techniques developed for the semiconductor industry.[1] The anode wires of the MWPC are replaced by metal traces on a glass substrate in the MSGC. The precise control of the size ($\approx$ 10-μm wide anodes) and spacing (as small as 50-μm anode-cathode separation) can result in a detector with position resolution of $\approx$ 50-μm, nanosecond timing, radiation hardness, and measured count rate capability[2] of $\approx 1 \times 10^6$ counts/mm^2/sec.

One ultimate goal of this project is the production of a MSGC detector suitable for use in the demanding environments of storage rings such as the Cooler and LISS. In particular, the MSGC offers a radiation-hardened alternative to the large area silicon detectors that are commonly used in Cooler experiments.[3] One particularly intriguing application, for example, would be "tagging" the atomic state of the pionium ($\pi^+\pi^-$) atom through detection of the X-ray emitted as the atom is formed. Another possible application might be using an MSGC array as the first detector element in the small angle spectrometer required for measurements of the charge-symmetry-violating ^{2}H(d,π^0)^{4}He reaction.

The significant accomplishment to date has been the successful operation of a detector fabricated in-house at the University of Louisville. A detector was reproduced from a commercially produced master photomask, and designed using an electrode configuration known to give good performance.[4] This electrode structure has a pitch of 1 mm, with an active area of 40 mm $\times$ 40 mm (Fig. 1). The metal layer is 0.1 μm chromium, deposited on soda-lime glass. All anodes were coupled in common to an Ortec 124 preamp and 472