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THE H E T BACKGROUND SUPPRESSING CHOPPER

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INTRODUCTION

The high speed fast Fermi chopper on HET [1] has proved to be an effective and versatile primary monochromating device for energies ranging from 100 meV to 2000 meV [2]. At energies above 350 meV, however, a source of background, due to very energetic neutrons penetrating the light aluminium body and boron slit package of the fermi chopper and downscattering in the sample to thermal energies, becomes significant. This had been anticipated in the original design, and provision had been included for a background-suppressing chopper to be located upstream of the monochromator. This paper gives details of the design and construction of this device and illustrates its effectiveness in extending the incident energy range of the spectrometer to several eV.

DESIGN

The background chopper is designed to be closed at the beginning of each ISIS pulse to prevent high energy neutrons and gamma rays from entering the spectrometer. It must then be fully open a few hundred microseconds later to allow the required epithermal beam to be monochromated by the Fermi chopper.

To achieve this the device has a rotor in the form of a vane (like a double bladed paddle wheel), see Figure 1, which rotates on a horizontal axle mounted 250 mm above and parallel to the neutron beamline of the spectrometer. The vane is 300 mm long in the direction of the beam and at each tip there are 60 mm wide by 55 mm high rectangular blocks of nimonic 75 alloy (75% Ni, 19.5% Cr, 4% Fe). Nimonic is chosen for its good high energy neutron cross-section and its high tensile strength. A rotor completely made of this alloy would have excessive mass and inertia, and so the design has the outer nimonic tips linked to the 60 mm diameter central steel axle by a spaced assembly of 14 tapered plates and 2 end discs machined from 12 mm thick aluminium alloy and distanced by 8 mm thick 120 mm diameter spacing rings. The attachment of the nimonic blocks to these plates is by means of two pairs of 25 mm diameter titanium tie rods which are fitted, through the length of the vane, into jig-bored and reamed holes 25 mm in from their outer ends and similar pairs of holes in tabs, machined on the inner surface of the top blocks, which interleave the plates.

The chopper can rotate at 50 Hz or 100 Hz. All operation so far has been at 50 Hz. At these speeds, there is an enormous amount of stored energy in the rotor and seizure of an axle bearing would result in its catastrophic break-up. The Al/alloy plates are therefore not rigidly joined to the axle. Instead at their central point they are keyed onto a cylindrical phosphor bronze bush which sleeves the axle to form a safety bearing. A pair of 4 mm diameter shear pins, which fit into this bush and into a flange on the axle, provide driving force to the vane but in the event of seizure of the axle these break to allow the vane to freewheel on the shaft.

The axle is suspended at each end on dual-row self aligning ball races, carried in housings which bolt to the end plates of the evacuated spinning tank, and is rotated by a toothed pulley and belt system driven from a 30 kW induction motor powered by a phase-controlled inverter system.

The speed and phase control electronics permits the choice of rotational frequencies of either 50 Hz or 100 Hz. The chopper is located 8 m from the source and so at these frequencies it transmits neutrons with energies below 1 eV an 4 eV respectively.

PERFORMANCE

Before the introduction of this chopper on HET, a time-dependent background, originating at the same time as the proton pulse and having an effect decay constant of 1.5 ms, limited the quality of data taken at high incident energies. As a result, prior to the installation of this chopper, the bulk of running had been confined to energies less than 350 meV. Attempts to improve shielding and minimise scatter failed to reduce this background component. Further it had been shown that this background was entirely sample dependent and disappeared when the sample was removed. Careful tests proved that it was due to high energy neutrons penetrating the fast chopper at zero time and being inelastically scattered, sometimes to sub-cadmium energies, in the sample.

The slow nimonic chopper was installed on March 1986 and has proved to be invaluable on HET for performing experiments on weak magnetic systems with high energy neutrons. Figure 2 compares scattering data from vanadium taken with and without the chopper. The background levels before and after the elastic line are close to source off values.

This chopper has contributed greatly to the success of many of the experiments described in reference [2].

REFERENCES

[1] T J L Jones, J H Parker, I Davidson, K Boden and J K Fremery, 'Experience with the KFA/IGV (Julich) Magnetic Bearing System on as SNS Neutron Chopper', in Proceedings of the Eighth Meeting of ICANS, Rutherford Appleton Laboratory Report RAL-85-110 (1985), p707.

[2] A D Taylor, B C Boland and Z A Bowden, ' HET : The High Energy Inelastic Spectrometer at ISIS', these proceedings.

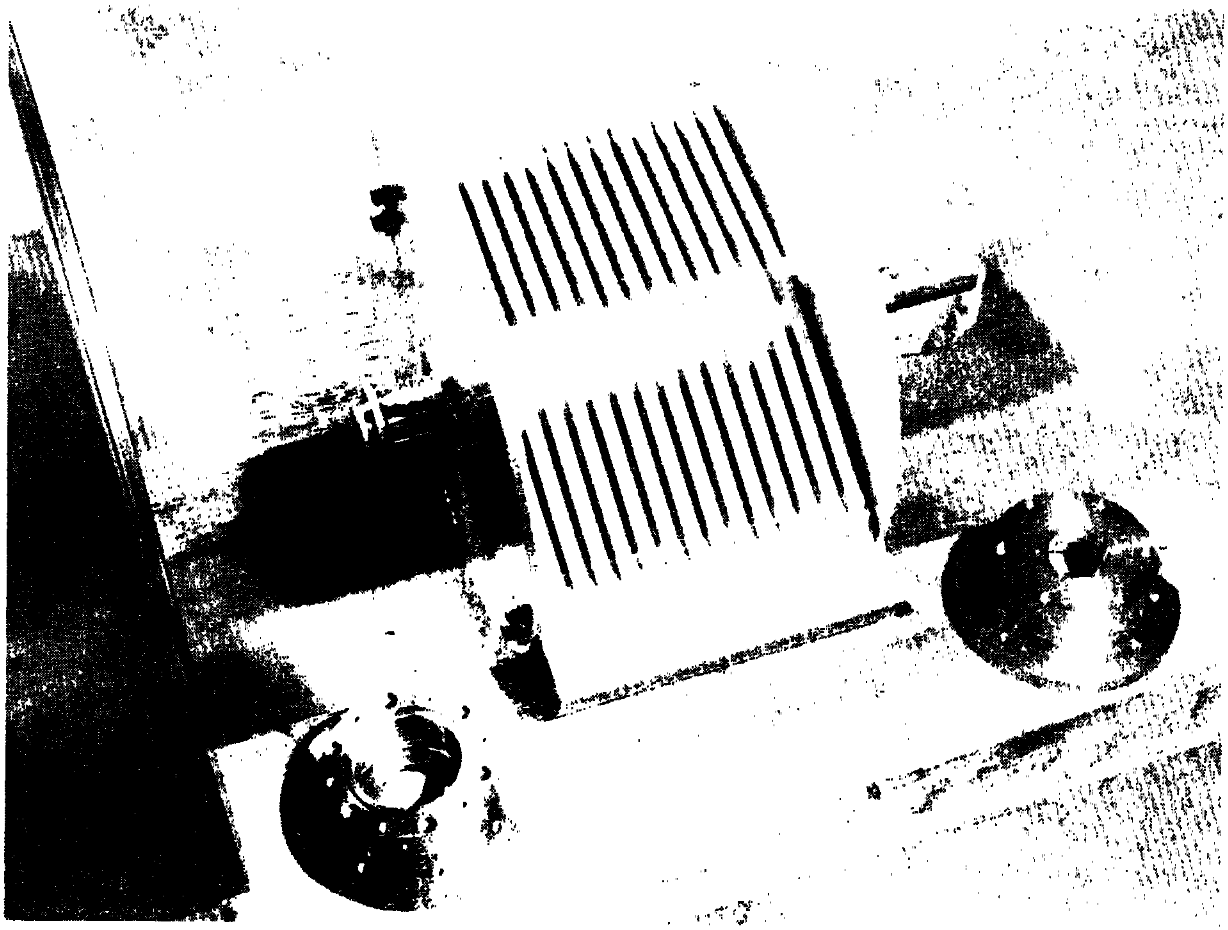

Figure 1 The HET nimonic background-suppressing chopper removed from its housing.

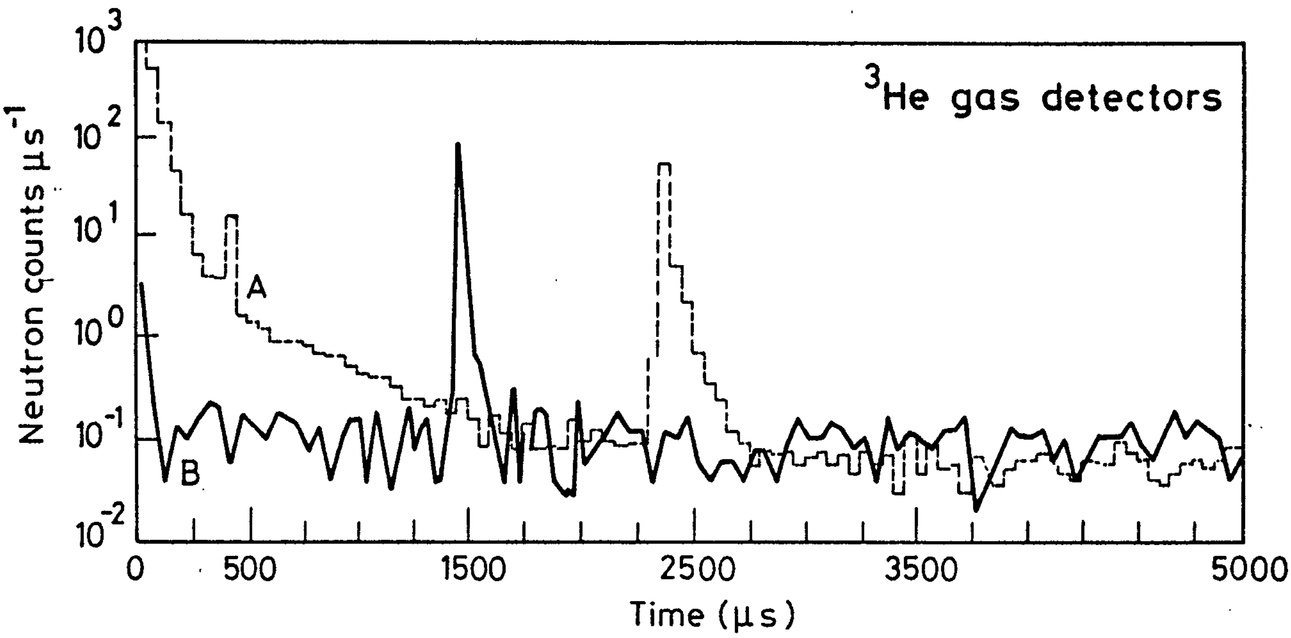

Figure 2 Comparison of time-of-flight scattering data from vanadium taken without (A) the chopper and with (B) the chopper. For clarity two different incident energies (A : 220 meV and B: 600 meV) are shown. The background effect is independent of the choice of fast chopper energy.