ICANS IX

INTERNATIONAL COLLABORATION ON ADVANCED NEUTRON SOURCES

22-26 September, 1986

M A R S -- A Multi-Angle Rotor Spectrometer at the Pulsed Neutron Source ISIS

A D Taylor[X], R C Ward[X], W G Williams[X], Y Endoh[+] and N Watanabe[+]

[X]Rutherford Appleton Laboratory, Chilton, Didcot, UK
[+]KEK, Oho-Machi, Tsukuba-Gun, Ibaraki-Ken, Japan

INTRODUCTION

The design for the Multi-Angle Rotor Spectrometer, MARS, currently being constructed on the ISIS pulsed neutron source is presented. MARS is a direct geometry chopper spectrometer designed for studying inelastic processes with an energy transfer resolution $\Delta\varepsilon/\varepsilon$ ~ 1%. The spectrometer will have an extensive detector bank with a continuous angular coverage from 3^{o} to 135^{o} and a Q resolution $\Delta Q/Q$ ~ 2-5% allowing interpolation of $S(\phi,t)$ to $S(Q,\varepsilon)$ and the spectrometer will view the 100K liquid methane moderator giving an effective lower bound for the incident energy of 50meV.

The instrument design parameters have been optimised for experiments in the following four main scientific categories.

(1) Coherent excitations: measurement of the dynamic structure factor $S(Q,\varepsilon)$ in polycrystalline and amorphous solids, liquids and gases.

(2) Magnetism: measurement of the magnetic response of 3d-systems over the whole excitation spectrum; magnetic spectroscopy in f-electron metals and alloys.

(3) Molecular spectroscopy: measurement of a large range of energy transfers (eg. 10meV to 250meV) with good energy resolution ($\Delta E_o/E_o$~1%) over a large Q range.

(4) Momentum distribution: mesurement of the dynamic structure factor $S(Q,\varepsilon)$ at large Q where the impulse approximation becomes valid.

SPECIFICATION

The instrument will be sited on the S6 beam hole viewing the gadolinium poisoned 100K methane moderator. A Fast Fermi chopper with a variety of interchangeable curved slit-slot packages optimised for several incident energies in the range 50 to 1000 meV will be used as the monochromating chopper. An additional chopper positioned between the moderator and the monochromating chopper will be used for background suppression. The beam line will have the option to accomodate a neutron beam polariser between the monochromating chopper and the sample. The sample position is at 11.7 metres from the moderator and typical beam sizes will be 6 x 6 cm^2.

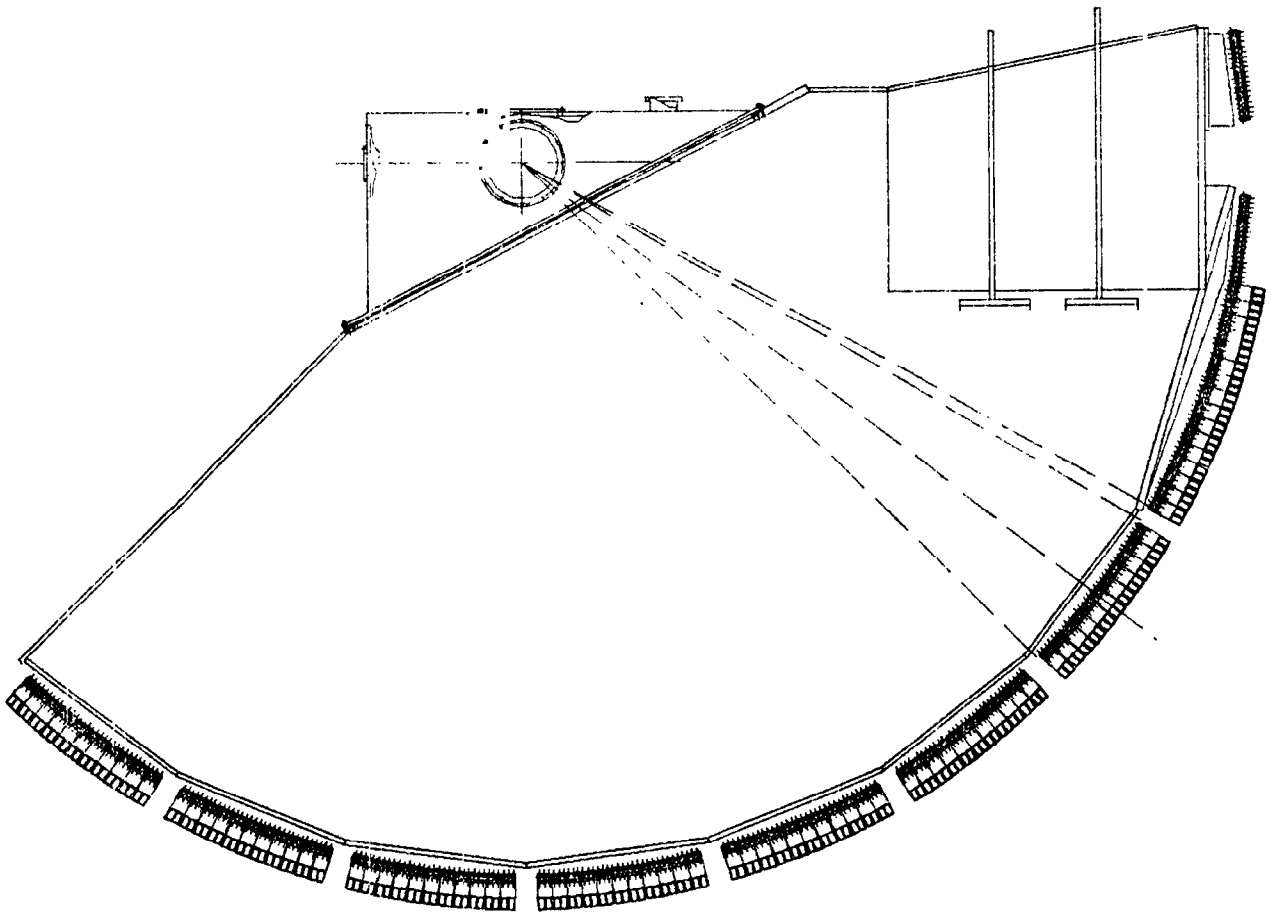
Due to constraints imposed by neighbouring instruments, the 4 metre evacuated secondary flight path will be in the vertical scattering plane and there will be the potential to have a continuous coverage of 30cm ^{3}He detectors in the angular range of $2\theta \simeq 10^\circ$ to 135° with a total of 3 detectors on the Debye Scherrer cone at any one angle. In addition there will be a low angle detector bank with 6 linear arrays of detectors positioned around the straight through beam in the angular range of 3° to 10°. The detector tank has been designed such that there will be <u>continuous</u> detector coverage without any shadows from structural supports inside the tank in the angular range 3° to 30°. Between 30° and 135°, the gaps in the detector array due to structural supports will be less than 1.3° every 15°. The sample and detector tanks will have a common rough vacuum system, but will be separated by a thin aluminium membrane, thus allowing the sample region to be differentially pumped to a cryogenic quality vacuum.

A summary of the full instrument specification is given in Table 1 and a schematic layout of the detector and sample tank, together with the low angle detector array, is given in Figure 1.

Table 1

Instrument specification

Moderator	100K CH_4 poisoned at 2.25cm
Monochromating Chopper	10.0m from moderator, 400-600 Hz phased to ISIS pulse to within 1/2 μs
Sample position	11.7m from moderator
Beam size	6cm x 6cm
Detectors	3^o-10^o 4m low angle counter bank, 10 atms ^3He 6 azimuthally symmetrical detectors at each angle
	10^o-135^o 4m high angle counter bank, 10 atms ^3He 3 detectors at each angle
Incident energy	50-1000 meV
Energy resoultion	$\Delta E_o/E_o$ ~ 1%



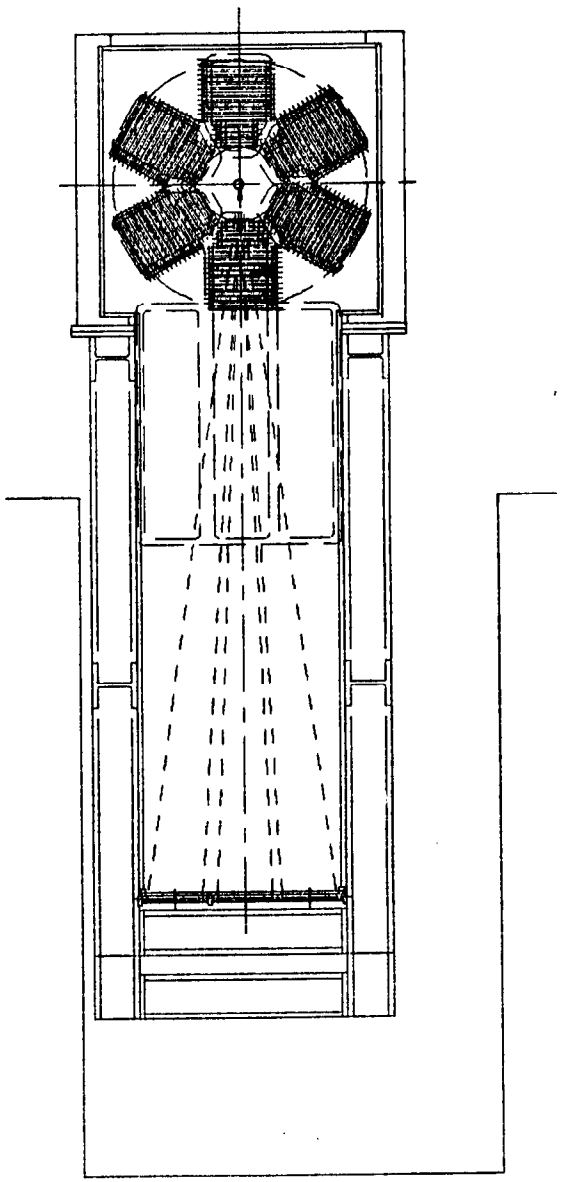


Figure 1 A schematic layout of the sample and detector tank showing the location of the high and low angle detector arrays. The high angle detector bank is in the vertical scattering plane with three detectors at each angle. The low angle detector bank has six-fold symmetry about the straight through beam