Upgrades to the ISIS moderator configuration

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ABSTRACT: Possible upgrades to the ISIS moderator configuration are discussed in the light of the current and projected instrument suite.

Introduction

The current ISIS moderator configuration, shown in Fig. 1, was designed in 1980 to provide a flexible set of beams for a hypothetical instrument suite. The use of fluid moderators at three different temperatures offering six faces to the instruments, see Table I, has proved to be effective.[1] In this paper we discuss an upgrade of these moderators in the light of the current and projected instrument configuration.

Table I ISIS moderator-instrument configuration

Beam	Moderator	Instrument
S1	H_2O (Gd at 3.0 cm)	POLARIS
S2	H_2O (Gd at 3.0 cm)	eVS
S3	H_2O (Gd at 3.0 cm)	SXD
S4	H_2O (Gd at 2.2 cm)	—
S5	H_2O (Gd at 2.2 cm)	—
S6	CH_4 at 100 K	MARI
S7	CH_4 at 100 K	LAD
S8	CH_4 at 100 K	HRPD
S9	CH_4 at 100 K	TEST
N1	CH_4 at 100 K	SANDALS
N2	CH_4 at 100 K	PRISMA
N3	CH_4 at 100 K	—
N4	H_2 at 25 K	CRISP
N5	H_2 at 25 K	LOQ
N6	H_2 at 25 K	IRIS
N7	H_2O (Gd at 1.5 cm)	—
N8	H_2O (Gd at 1.5 cm)	TFXA
N9	H_2O (Gd at 1.5 cm)	HET

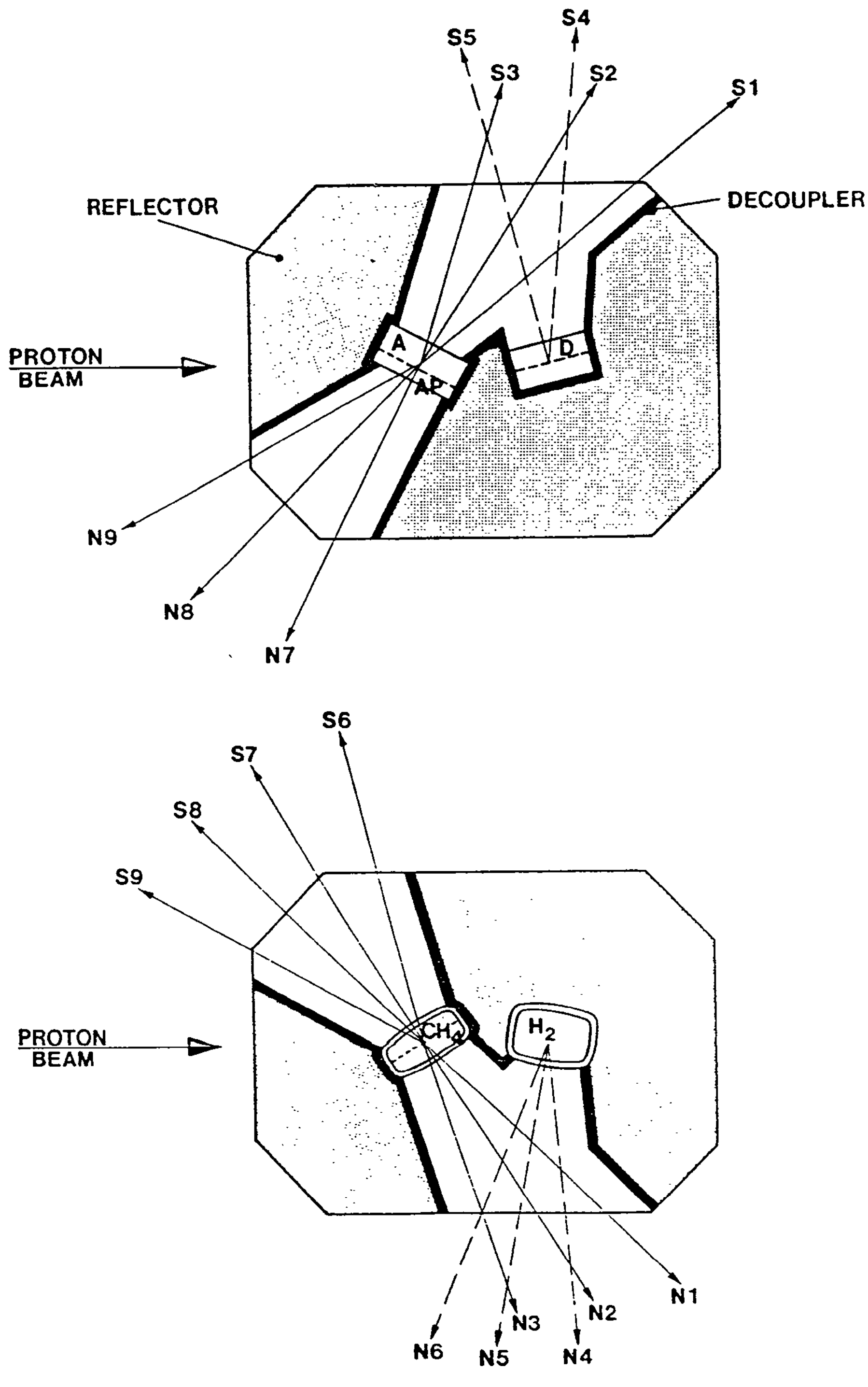

Fig. 1 Current configuration.

Change in poison depth for beams S1, S2 and S3

The southwest corner group S1, S2, S3 currently views an ambient water moderator poisoned at a depth of 3 cm. This group was designed to optimise the thermal intensity at the expense of lineshape. This was originally felt to be the appropriate configuration for polarisation tests on POLARIS and the development of single crystal studies on SXD. The eVS spectrometer only utilises the slowing down part of the spectrum, which is independent of poison depth.

The new use of POLARIS is as a medium-resolution powder diffractometer. This would greatly benefit from having the lineshape in the thermal region improved from the current 30-μs decay to a 20-μs decay (see Figs. 2 and 3). SXD would similarly be improved. Neither of these diffractometers is intensity-limited at 100 μA operation. Again current uses of eVS are neutral to such a change.

We propose to reduce the poison depth on the south side of the ambient water moderator from 3 cm to 1.5 cm. This will be accomplished by replacing the entire moderator vessel early in 1989.

Cold beam lines at ISIS

Successful instruments have been built on all three of the beam lines that view the 25 K hydrogen moderator. The construction of a double guide on the IRIS beam is a long-term option to provide a new cold beam, but there is an immediate demand for a new cold beam for CRISP-II (a reflectometer optimised for liquids work with *10 the intensity of the current CRISP). It would be possible to site CRISP-II on S4 if this beam could view the back of the hydrogen moderator. The initial flexibility of the ISIS moderator assembly allows each line to view any moderator. The beryllium/D_2O reflector layer in the plane of the lower moderators would have to be replaced, see Fig. 4, and the window on the target station void altered to permit S4 to view a lower moderator. Such changes were anticipated on the original design. The change in performance of the front face of the hydrogen moderator would be less than 10%.[2]

A design study will begin shortly on a new reflector layer to allow S4 to view the back of the hydrogen moderator.

Improved pulse shape for HRPD

HRPD currently has a 35-μs decay constant in the thermal region. A significant improvement in its performance could be obtained if this were reduced to say below 20 μs. This is possible in two ways.

Firstly, by reducing the poison depth. Studies show (see Fig. 5)[3] that a 1-cm poison depth would give a decay of less than 20 μs at the expense of a factor of two in thermal flux. The effect of this on LAD, MARI and S9 would have to be determined. Such a change is not as simple as altering an ambient moderator and might require the development of significant remote handling expertise.

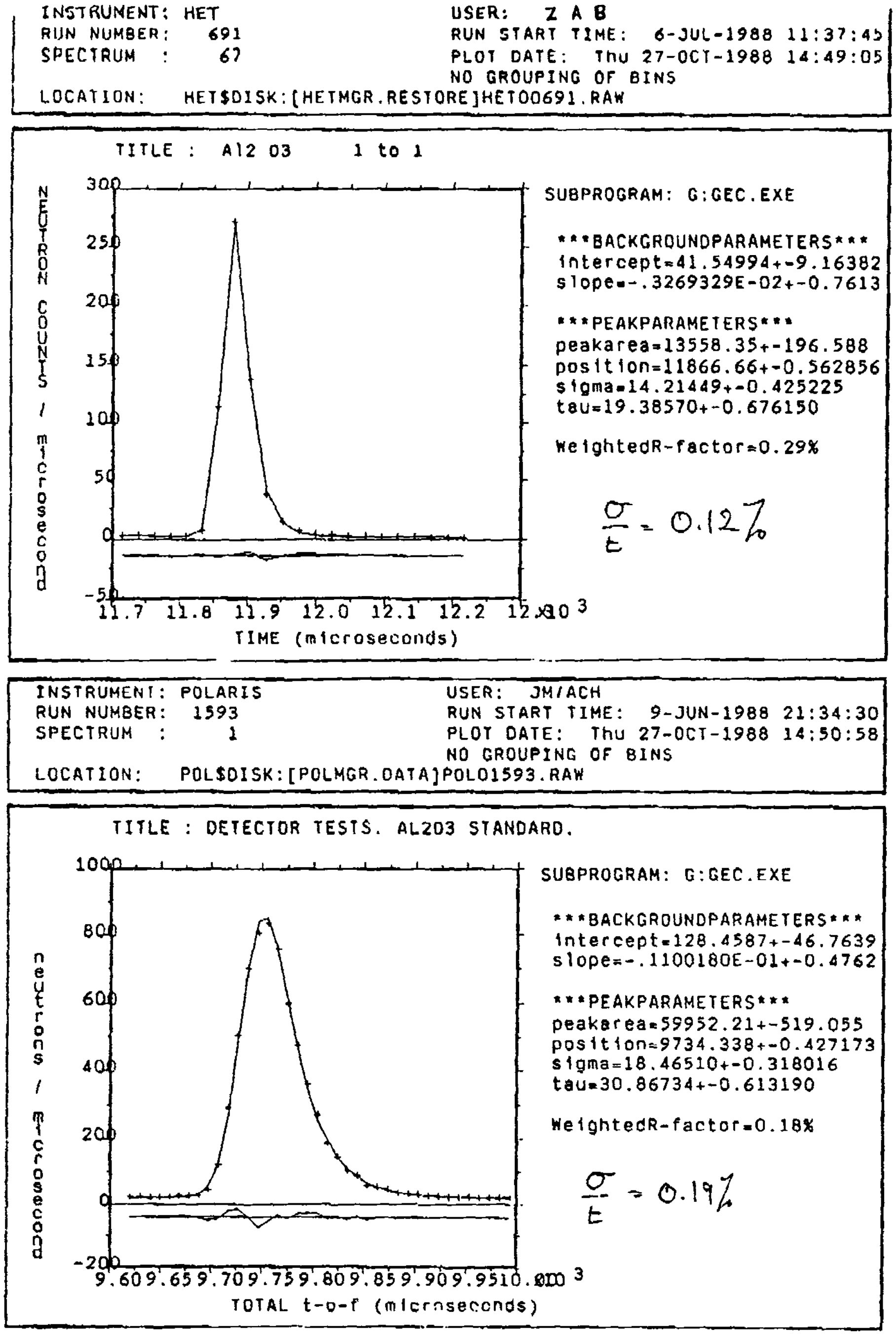

Fig. 2 Lineshape analysis of the same Al_2O_3 reflection as measured on HET and POLARIS. Note the reduction in width and decay constant.

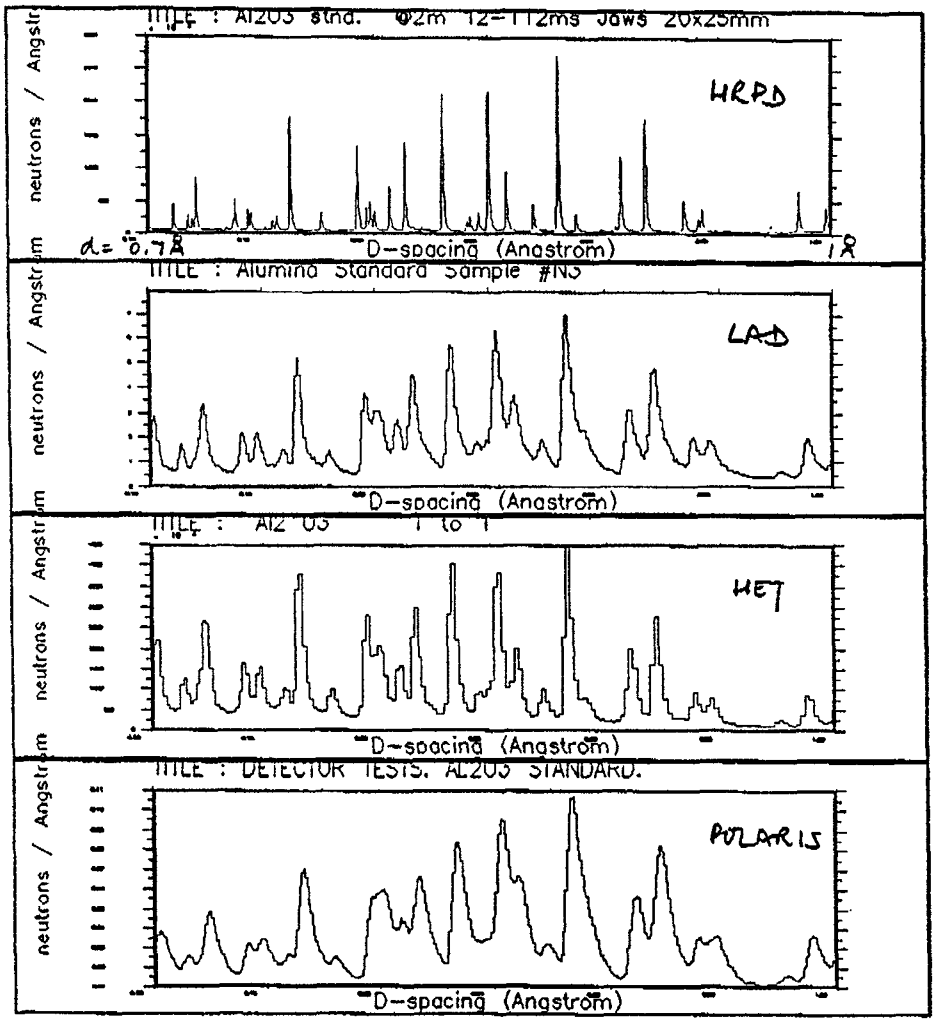

Fig. 3 A comparison of the lineshape from the various diffractometers at ISIS. The advantages of the 1.5 cm poison depth (HET) over the 3 cm poison depth (POLARIS) are obvious.

A second approach is to change the moderator material from 95 K liquid methane to a 20 K methane slurry in liquid hydrogen or a liquid-hydrogen-cooled metal hydride. Such moderators would suppress the effects of thermalisation but might still maintain the high hydrogen density necessary for a good epithermal pulse shape. These concepts would require a major development programme on new moderator materials.

The impact of a reduced poison depth on LAD and MARI will be investigated as will the potential of high-density, low-temperature moderating materials.

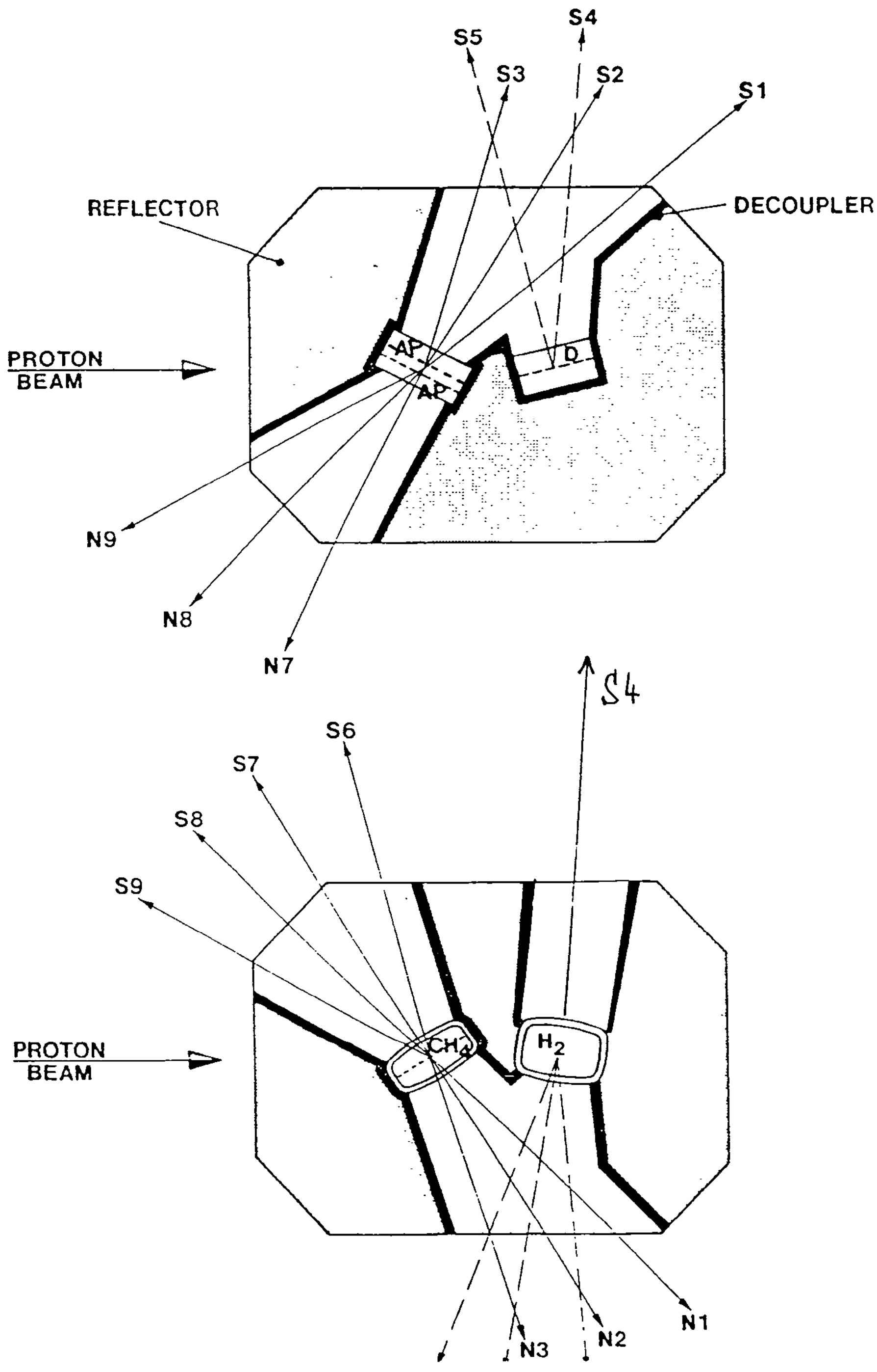

Fig. 4 Proposed configuration.

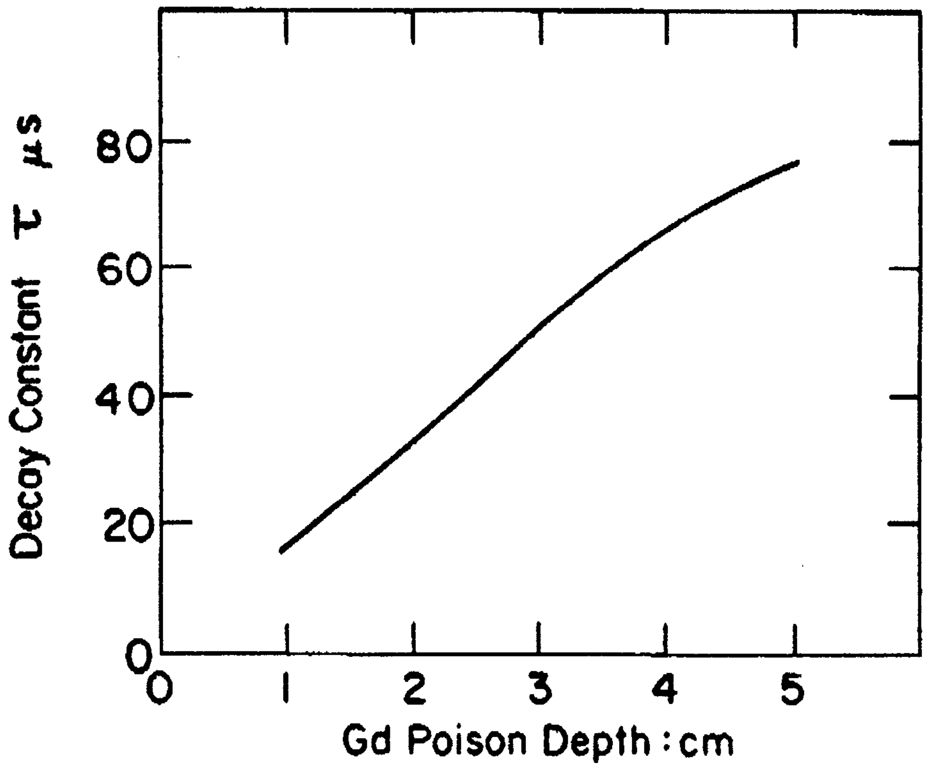

Fig. 5 The calculated behaviour of the exponential decay constant τ as a function of the gadolinium poison depth in a 10 x 10 x 5 cm^3 liquid methane moderator.

References

1. A. D. Taylor, "SNS Moderator Performance Predictions," RAL-84-120.
2. A. D. Taylor, "Neutron Transport from Target to Moderators," RL-81-057.
3. J. M. Carpenter, R. A. Robinson, A. K. Taylor, and D. J. Picton, 1985, "Measurement and Fitting of Spectrum and Pulse Shapes of a Liquid Methane Moderator," Nucl. Inst. and Meth. A234, 542-551.