PRIOR INFORMATION NOTICE

UKSBS PR19033 ISIS MODERATORS

TECHNICAL BRIEF

ISIS Moderators

ISIS is a facility which produces neutrons for scientific research. The neutrons are generated by firing high energy protons into a heavy metal target. The neutrons produced in this way are too energetic and need to be moderated. The moderation is carried out in hydrogenous materials such as ambient temperature water, liquid methane at 110K (-163°C), solid methane at 40K (-233°C) and liquid hydrogen at 20K (-253°C). The moderating materials need to be contained in metallic vessels which allow them to be placed inside a neutron reflector assembly close to the neutron production target.

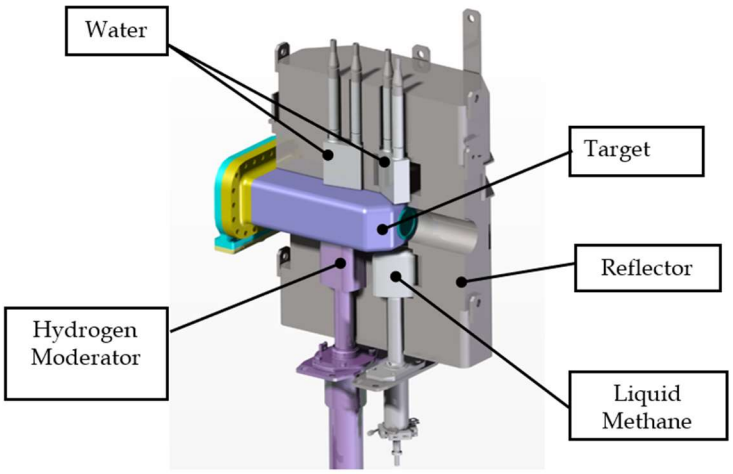

fig1

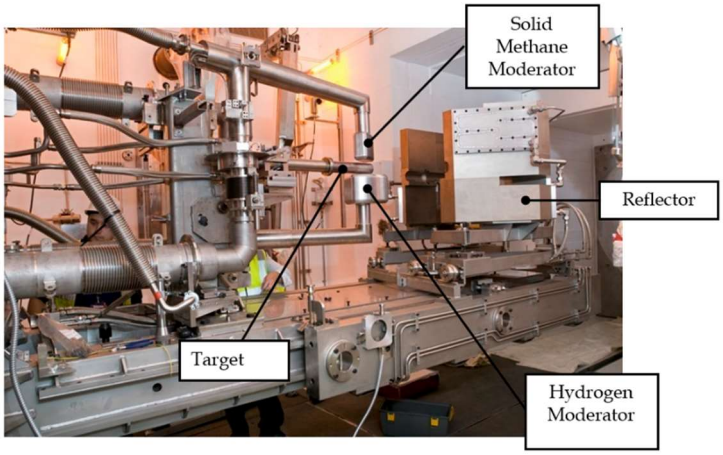

fig2

The vessels containing the moderating material need to be as transparent to neutrons as possible whilst being sufficiently strong to operate safely and reliably for extended periods of time at significant pressure (sometimes several bar) in an extreme radiation environment. Because of this the vessels are generally made from aluminium alloys and where appropriate, austenitic stainless steel.

The moderating process generates significant amounts of heat which needs to be extracted from the moderator and so they are connected to a remote cooling system via a transfer

line which allows the coolant, often the liquid moderating material its self, to be flowed in and out of the moderator to extract this heat.

The moderator vessel performance gradually deteriorates over time in the high radiation environment and they need to be replaced periodically with new ones. The period for replacement varies according to the moderating material used and because the vessels are highly radioactive they need to be changed by remote handling in a remote handling cell.

There is often a need to know the operating temperature of the moderator and so they are usually fitted with thermocouples too.

Several of the moderator vessels are operating at cryogenic temperatures and as such they have the usual requirements associated with this type of equipment such as high vacuum integrity and containment, low temperature capability, low heat leak and specialist cryogenic connections which need to connect to existing transfer lines with specialist seals.

The ISIS facility operates to a demanding scientific programme which sets a requirement for moderators to be fitted and operational to a schedule often agreed several years in advance. Because of this the timely delivery to site of replacement moderators is critical. Typically, each year there is a requirement for 3 to 5 moderators of the different types to be delivered. The facility is always developing, and periodically new moderator designs will be developed, and these will need to be prototyped and tested before being used on the main science programme too.

Ambient Temperature Water Moderators

fig3

fig4

Notes:

- Moderator bodies fabricated from 5000 series Al alloy.

- Usual stst to al alloy friction welded joints.

Liquid Methane Moderator

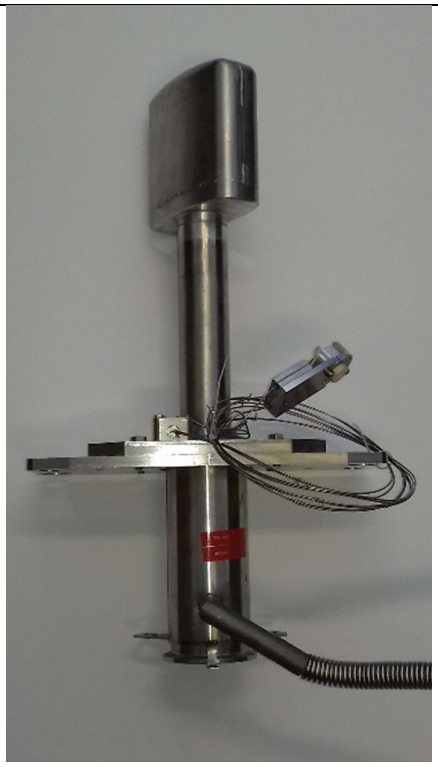

fig5

Notes:

- Moderator head fabricated from 5083 Al alloy.
- Design to spirit of PD5500, allowable stress in 5083 Al alloy 83N/mm2
- Inner cold head and outer vacuum containment
- Stst to al alloy friction welded joints where head is joined to body and bayonet.

Solid Methane Moderator

fig6

Notes:

- Typical heat load with 40□A beam ~120W (currently no poisoning)
- Designed to spirit of PD5500, allowable stress in 5083 Al alloy 83N/mm^2
- Inner cold head and outer vacuum containment
- Cryogenic bayonet connection to transfer line
- Outer tertiary containment layer too
- Al alloy to Stainless steel friction welded joints
- High purity aluminium foam insert and strain gauge on cold can.

Liquid Hydrogen Moderator

fig7

Notes:

- Typical heat load with 40□A beam ~100W (currently only hydrogen)
- Designed to spirit of PD5500, allowable stress in 5083 Al alloy 83N/mm2
- Inner cold head and outer vacuum containment
- Cryogenic bayonet connection to transfer line
- Outer tertiary containment layer too
- Al alloy to Stainless steel friction welded joints.

Helpful links:

- https://stfc.ukri.org/research/our-science-facilities/isis-neutron-and-muon-source/
- https://www.isis.stfc.ac.uk/Pages/home.aspx
- https://www.uksbs.co.uk/pages/default.aspx