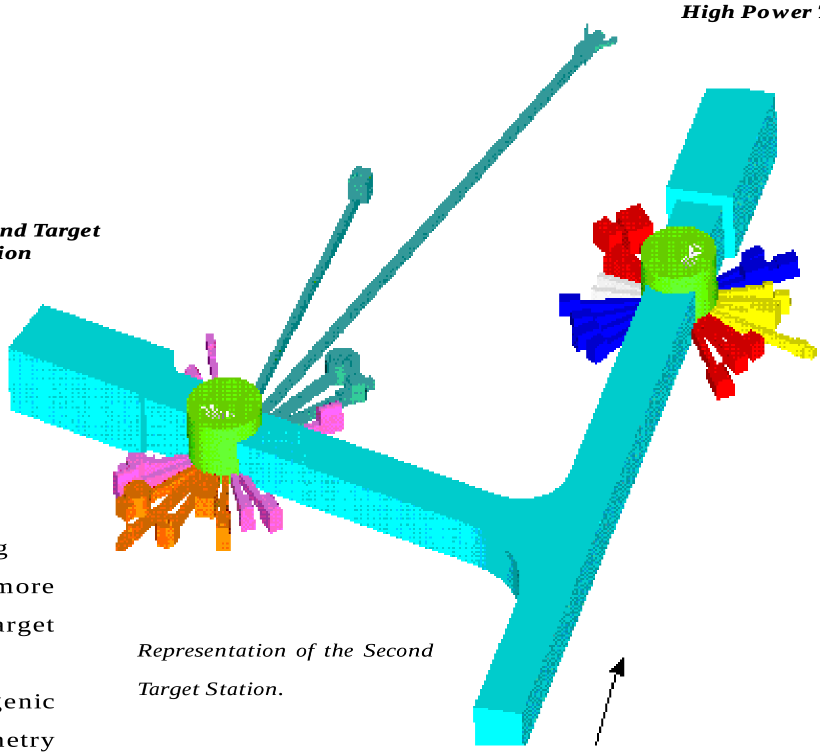
Technical description of the Second Target Station

Introduction

The Second Target Station will be situated on the southern side of the existing High Power Target. One pulse in five from the ISIS synchrotron will be directed into the target along a new proton beam line. The relatively low proton power will allow target and moderator designs which are optimised for the production of long wavelength neutrons and hence are more efficient than those on the existing target station.

A tungsten target with two cryogenic moderators, positioned in 'wing' geometry relative to the target, will be used to produce the neutron beams. A beryllium reflector will surround the target and moderators, and the core target components will be contained within a cylindrical void vessel surrounded by shielding. Eighteen neutron beam ports will penetrate the shield, some of which will feed two neutron guides and so serve two instruments.

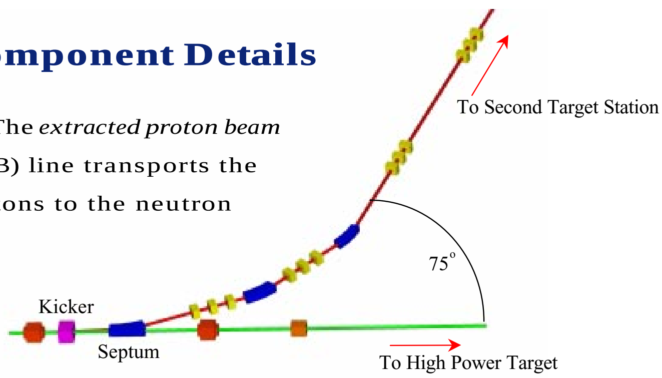
Shown top right is a plan for the Second Target Station layout, including the beam lines and, schematically, the new instrument suite



Representation of the Second Target Station.

Component Details

The *extracted proton beam* (EPB) line transports the protons to the neutron production target in the experimental hall. The new EPB will be extracted horizontally, at 75º to the south side of the existing one using a small angle pulsed kicker and a dc septum magnet.



The Extracted Proton Beam line.

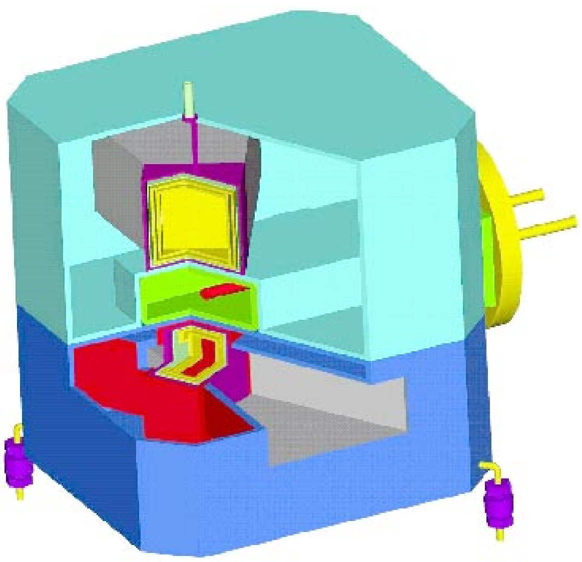
The *target* produces neutrons by the spallation process resulting from the interaction of the high-energy (800 MeV) proton beam and the target nuclei. The target will be a 50 mm diameter tungsten rod clad with tantalum to eliminate corrosion problems and cooled by heavy water. The low power of the proton beam for the Second Target Station will enable a small diameter target to be used, giving excellent coupling between the leakage neutrons and the moderators.

The *moderators* reduce the energy of the spallation neutrons to energies useful for the experimental programme. The dimensions, moderator material and temperature of each moderator for the Second Target Station have been chosen to match instrument requirements. The proposed configuration consists of two moderators:

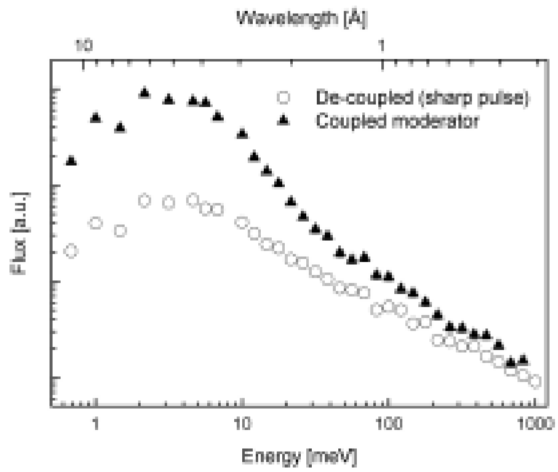
- 25 K decoupled, solid methane with an asymmetric poisoning layer producing broad and sharp pulse widths.

- 25 K coupled liquid hydrogen.

The complete target, moderator and reflector assembly is shown below. The use of solid methane is only possible at low proton beam powers - the effects of radiation damage at high powers make its use there impractical. The coupled liquid hydrogen moderator will be in 'wing' geometry with two viewed faces to give maximum intensity to those instruments for which a relatively wide time pulse is acceptable. The solid methane moderator, also in wing geometry, will be decoupled with an asymmetric poison foil which will give beam characteristics similar to the hydrogen and liquid methane moderators on the existing target station but with enhanced flux. The *reflector* scatters fast neutrons back into the moderators. It consists of a stainless steel vessel filled with beryllium rods, cooled



The target, moderator and reflector assemblies.

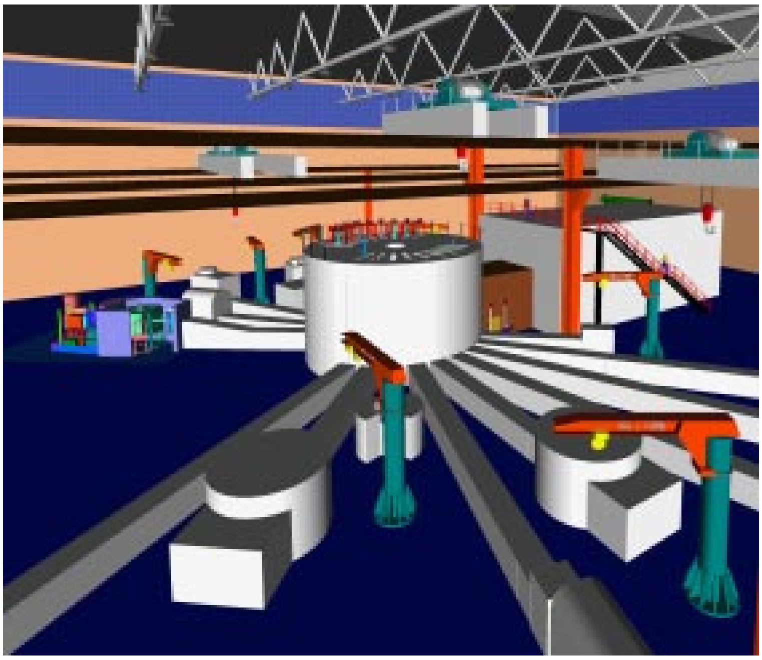


The figure shows some of Monte-Carlo calculations of the target/moderator assembly. The triangles are the flux from a broad pulse coupled moderator and the circles show the flux from a sharp pulse moderator suitable for the instruments that require high-resolution.

using heavy water.

The *void vessel* provides a controlled environment for the target and acts as a containment vessel in the case of a target component failure or water leak. The helium-filled vessel will be embedded within a 12 m diameter, 7 m high steel and concrete *shield*. The shielding will be designed to allow vertical access to the proton beam window, the neutron beam windows, the upper reflector assembly and the shutter assemblies. The target and lower reflector assembly will be installed and removed horizontally. Eighteen neutron beam holes, nine on each side of the target spaced 13° apart, will be provided through the shielding to allow the neutrons to travel to the instruments, and each beam hole will be equipped with a vertical steel and concrete shutter to open and close the beamline. The shielding will be constructed from cast and machined steel blocks with a poured concrete outer layer. To reduce soil and ground water activation to acceptable levels, there will be 2 m of steel and 1 m of concrete shielding below the target. This will also serve as the foundation to support the 8000 tonne load.

SPECIFICATIONS

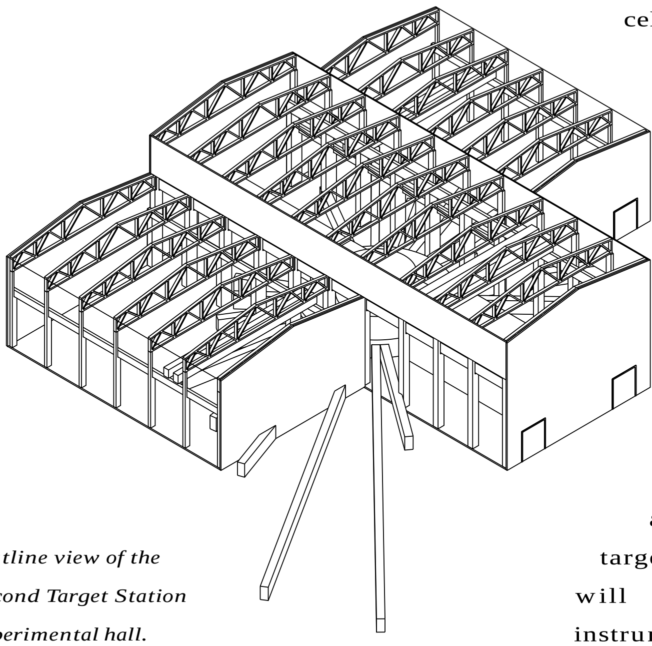


A view of the Second Target Station experimental hall.

Fundamental to the design of the Second Target Station is the ability for all principal target components (target, reflector and moderators) to be removable, to enable their replacement within a period of one week. This requirement dictates the design and configuration of the core region of the target station. The expected working life of some of the principal target components is shown in the technical specifications table opposite.

The Second Target Station has been designed to minimise the amount of remote handling through the use of modularisation and improved accessibility to components with a short lifetime. This includes vertical access in combination with containment flasks for frequently serviced components, and horizontal access and a dedicated remote handling cell for those components with a long working life. The remote handling cell will be similar to the existing ISIS cell but with some design changes to improve accessibility to core target components. The cell will be equipped with master slave manipulators and a remotely operated crane with positional readout. Lead glass windows supplemented by remotely operated cameras provide viewing for the remote handling.

The controlled handling enclosure above the target station will be served by a 100 tonne crane. The building roof will be raised in the middle to allow for the overhead handling of target components. Two 30 tonne cranes will serve the neutron scattering instruments.

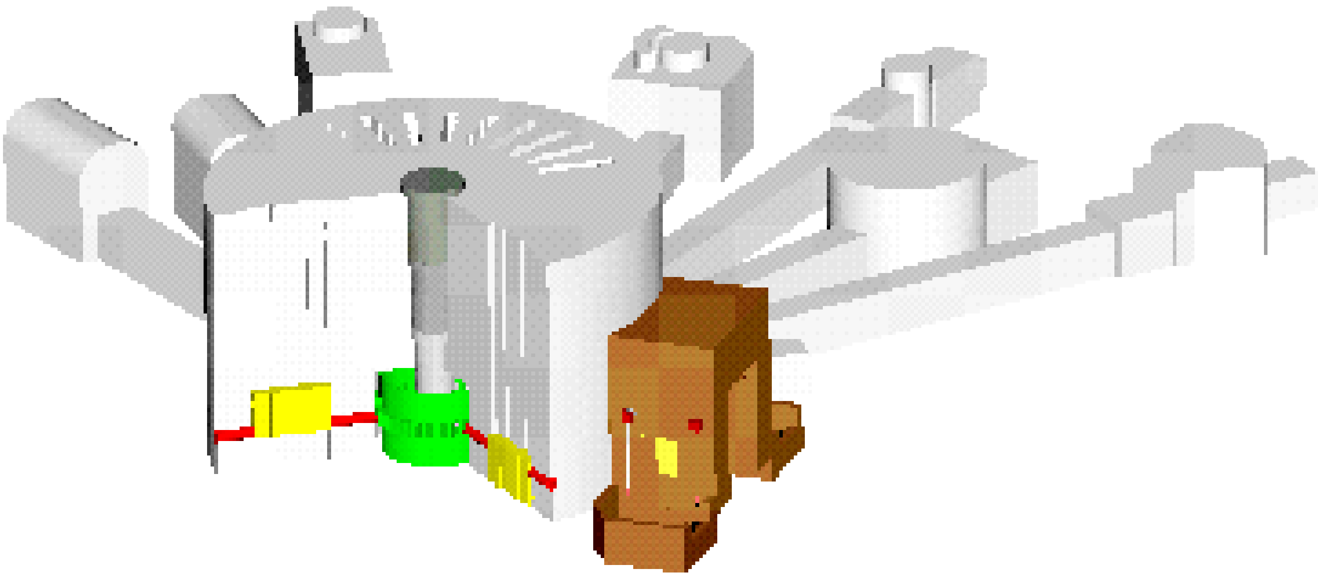


Outline view of the Second Target Station experimental hall.

SPECIFICATIONS

Proton beam	repetition rate	10 Hz
	proton extraction angle	75°
	current	60 μA
	power dissipation in target	48 kW
	proton beamline shielding	1.5 m steel + 0.75 m concrete
	beamline outer surface dose rate	<0.5μSv/hr
Target	material	tantalum clad tungsten
	size	25 mm radius
	cooling	heavy water
	reflector	beryllium rods
	shielding	12 m diameter x 7 m high, steel + concrete, 2 m steel + 1 m concrete below target Surface dose <0.5μSv/hr.
Beam ports	number and spacing	9 on each side of the target, 13° separation
Moderators	25 K decoupled, poisoned solid methane	150 x 150 x 30 mm³
	25 K coupled liquid hydrogen	150 x 150 x 50 mm³
Component Service Lifetimes	Methane Moderator	6 months
	Tungsten Target	2-5 years
	Hydrogen Moderator	15 years
	Neutron Beam Window	15 years

Technical specifications of the Second Target Station.



View of the Second Target Station.