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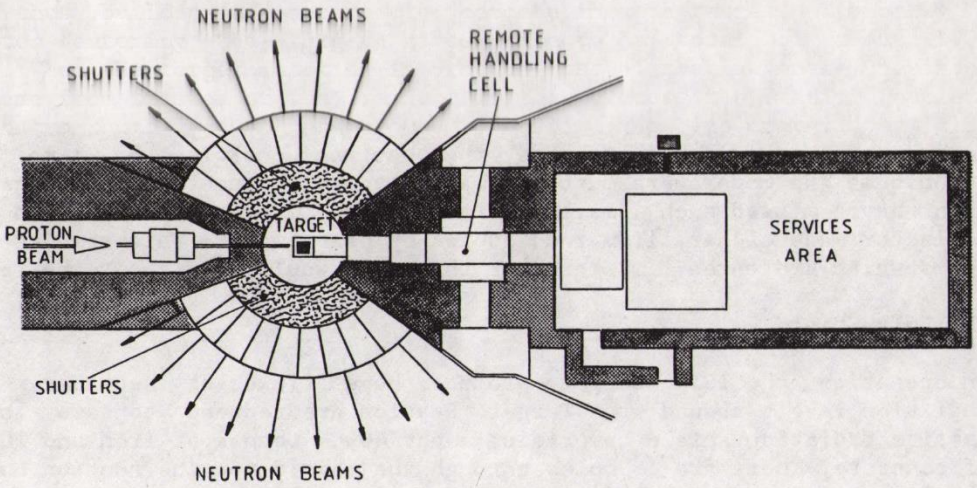
RUTHERFORD APPLETON LABORATORY

SCIENCE AND ENGINEERING RESEARCH COUNCIL

THE ISIS TARGET STATION

The main features of the Target Station are shown in the diagram.

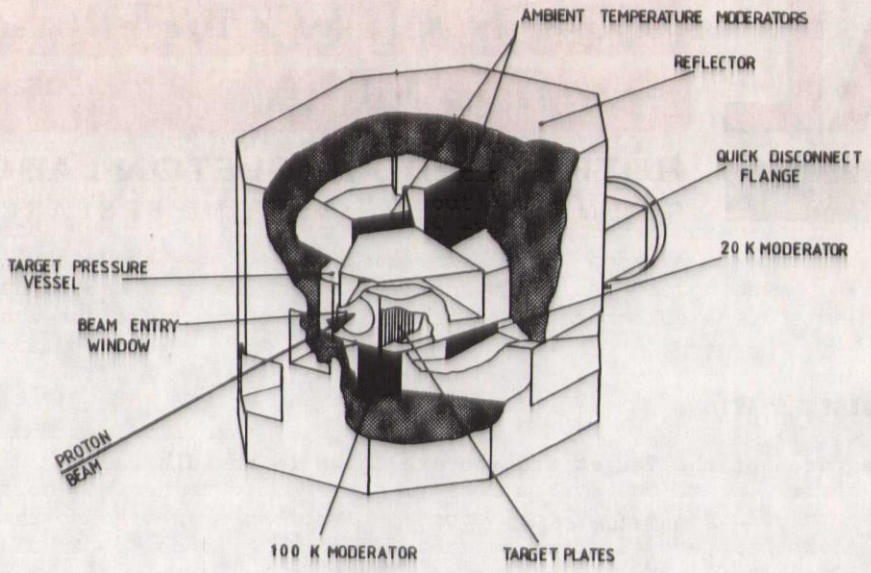


The Target Moderator Reflector Assembly

Fast neutrons are produced by directing the 800 MeV proton beam from the accelerator onto a heavy metal target. When a proton interacts in the target part of its energy is deposited as heat, part to create low energy neutrons and part to create high energy particles including neutrons. The high energy secondaries undergo further interactions, depositing heat and producing more particles, thus building up a particle cascade in the target. Typically a single proton entering the target gives rise to a total of about 1000 collisions. When the target material is Uranium most of the low energy neutrons produced come from fission of the Uranium. In this process the Uranium nucleus splits into two roughly equal mass pieces, when hit by a high energy particle, emits neutrons and deposits further energy.

A total of 216 kW of heat is deposited in a Uranium target at full power operation. This heat is removed by a heavy water cooling circuit. In order to remove the heat effectively cooling channels are created by making the target from a stack of Uranium plates and flowing the water between them

The average energy of the neutrons which escape from the surface of the target is about 1 MeV and they must be 'slowed down' to about 1 eV for use in the neutron scattering experiments. This is accomplished by scattering the neutrons in moderators situated above and below the target. The average energy of a neutron emerging from a moderator is determined by the temperature, size and material of the moderator. The various neutron scattering experiments require different energy neutrons and these are produced by having two water moderators at about 300 K, one liquid methane at 100 K and a liquid hydrogen moderator at 20 K.



Because the experiments measure the neutron energies by time of flight techniques the moderators must be small (typical volume 0.5 l). Neutrons which might have missed such small moderators are scattered back into the by a Reflector made of Beryllium rods cooled by heavy water. This results in neutron beams which are three times greater than they would be without the reflector.

The Bulk Shield

In operation the ISIS target produces huge fluxes of secondary particles. Radiation levels around the Target Station are reduced to safe levels by a massive radiation shield comprising about 4000 tonnes of iron and 1000 tonnes of concrete. There are 18 holes through the shield for the neutron beams. Each beamline is equipped with a shutter weighing 22 tonnes to open and close the beam: when closed work on the experiment with the proton beam on is allowed. Collimators and other equipment are used.to shape and define the beams for the experiments.

Remote Handling Facilities

In operation the target becomes highly radioactive and has a limited lifetime. Targets are changed in a dedicated Remote Handling Cell built into the Target Station. It is equipped with manipulators, a remotely operated crane and other specialised equipment. Used targets are stored in shielded containers in the Cell prior to final disposal. Maintenance and replacement of the other components of the Target Moderator Reflector Assembly is also carried out remotely in the cell.

Control Systems and Support Areas

The cooling systems for the Target, Water Moderators and the Reflector are situated in the shielded Services Area together with part of the refrigeration plant for the methane and hydrogen moderators. There is a hierarchy of control systems designed to ensure safe operation of the Target Station. The running state of the Target Station equipment is monitored in the Main Control Room and the Target Station local control room is only used during routine maintenance or repair operations.

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