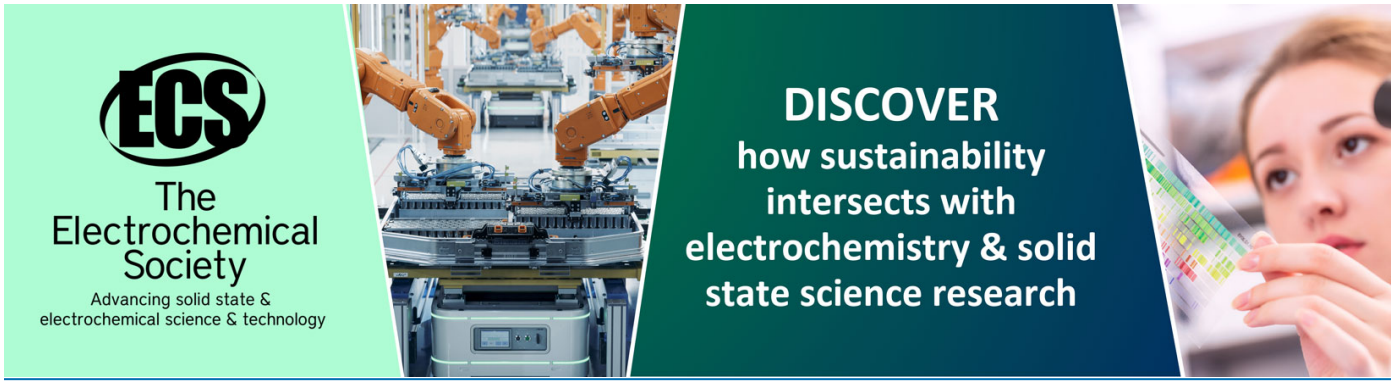
ISIS TS1 Project mock-ups and testing



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ISIS TS1 Project mock-ups and testing

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Abstract. The ISIS TS1 target station has operated with the current tantalum clad tungsten design of target for over a decade with only minor changes to the accompanying moderators and reflector since ISIS's creation in the 1980s. The TS1 upgrade project is currently being undertaken to redesign the target, moderators, and reflector (TRaM), as well as their associated support structure, and also the services located in the target services area (TSA). This paper will detail the work being undertaken to underpin design, verify and validate through an on-site testing programme. As the area that the new equipment will be installed in is already radiologically active, everything must be comprehensively tested for fit and function before installation. Most of the testing will be performed on a full scale representation of the remote handling cell (RHC), complete with the remote handling manipulator arms. There will also be rigs in place for testing the new water pumps and instrumentation prior the installation into the TSA. In addition to these testing mock-ups, there is also work planned to support and verify various aspects of the fluid circuits that are required for operation of the target station. Presently, all ISIS targets are flow-tested on a dedicated rig to ensure that the cooling channels are clear and can achieve the required cooling flow rate. This rig is to be replaced with a dual purpose rig that will also allow cooling testing to be performed while improving the operability of the rig's design. Testing is scheduled to begin in summer 2017 and will continue until installation in 2019/2020.

1. Introduction

As ISIS TS1is now over 30 years old, the TS1 Project is working to improve its operability and efficiency by modifying the target, reflector, and moderators (TRaM), the associated services and support structures. The radiation level in the areas where the new equipment is to be installed restrict or prevent access, and will activate and/or contaminate any equipment that is introduced. To ensure that anything that enters a radiation area is fit for purpose prior to installation, a program of off line testing will be performed, necessitating a number of testing rigs and full scale mock-ups.

2. RHC Mock-Up

The TS1 TRaM is supported within the void vessel on a cantilever frame which attaches to the door of the vessel. This door attaches to the target services trolley, which can be rolled back to move the TRaM components into the remote handling cell (RHC). All operations within the RHC are conducted using four master/slave manipulator arms; two on either side of the cell. As the arms do not have any power amplification, any heavy lifting is performed by the in cell 1tonne crane. The RHC has two operator rooms, one north of the cell and one to the south; each room has a liquid zinc bromide window to view the cell, with a viewing area of 550x550mm^2 [1]. There are also four pan/tilt cameras,

one in each corner of the cell, and two flying lead cameras (one on each side of the cell) which can be held in the manipulator arms.

The TS1 project will be replacing all of the TRaM components, as well as the cantilever beam, all of which will have to take place within the RHC. This means that all of the work must be able to be performed with the manipulation equipment already available in the RHC, and with the view restrictions of the operator windows and cameras.

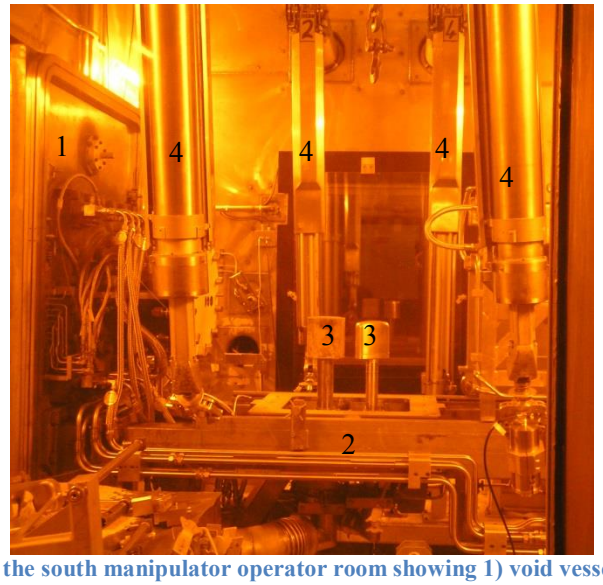

Figure 1 View of RHC from the south manipulator operator room showing 1) void vessel door 2) cantilever beam 3) cryogenic moderators 4) manipulator arms

Prior to installation, the alignment, fit, and operability of the new TRaM components need to be tested. As the design of the cantilever beam is to be altered (see figure 2 & figure 3), the existing full scale mock-up of the cantilever beam and door cannot be used, so a new mock-up is required.

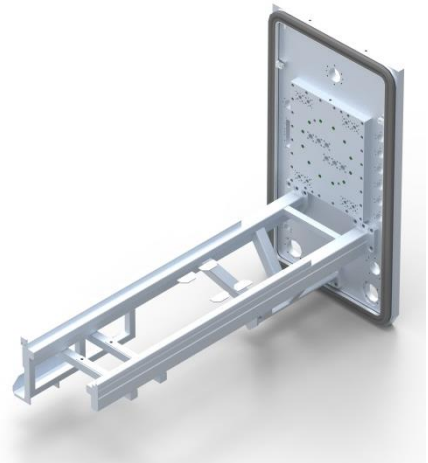

Figure 2 Current TS1 cantilever beam design

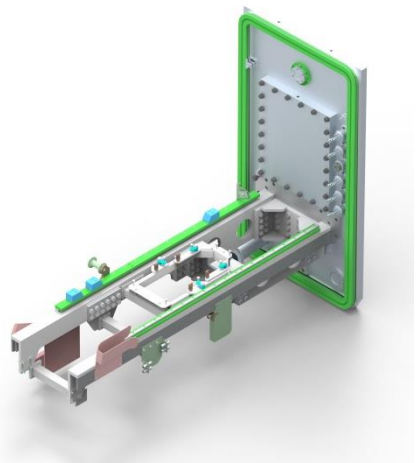

Figure 3 New (Mk 7) TS1 cantilever beam design

The test reflector blocks will be delivered and require testing before the design of the new cantilever beam is finalised, meaning that it would not make financial sense to have a detailed beam manufactured. Due to this, a functional replica will be made, using Bosch Rexroth aluminium profile to form the basic support structure, with machined attachment plates and rails. This will allow the initial testing and alignments to be performed; further testing will be completed once the cantilever design in completed and a true mock-up can be manufactured to replace the 'table' style frame. The mock-up frame will be accompanied manipulator arm frame which will allow manipulator accessibility to be established.

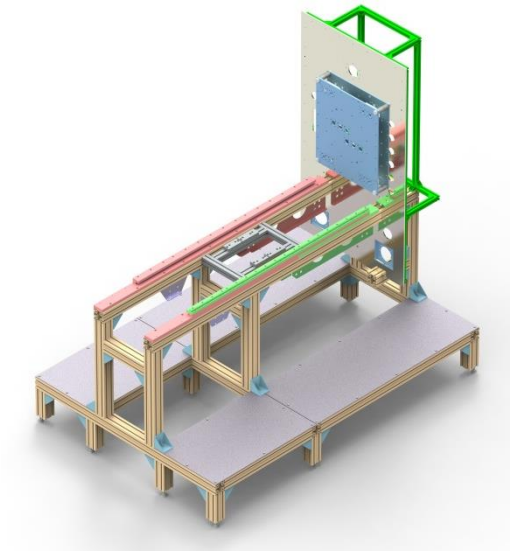

Figure 4 Mock-Up TS1 table frame

3. Target Flow Test Rig

All ISIS targets are flow tested prior to use to ensure that the cooling channels can achieve the required flow rates and that the pressure drop across the target is within acceptable limits. In order to extend the capability of the existing test rig, it will be altered to include heat extraction and improved flow control. The inclusion of a heat exchanger and chiller unit will allow cooling tests to be run to test different target designs and to verify FEA results. The present valve arrangement on the rig does not lend itself to easy or accurate control of the flow; using more appropriate valves in the return branches and at a distance from the flow metres should improve ease of operation.

Figure 5 Fig. 5: Current target cooling water flow test rig

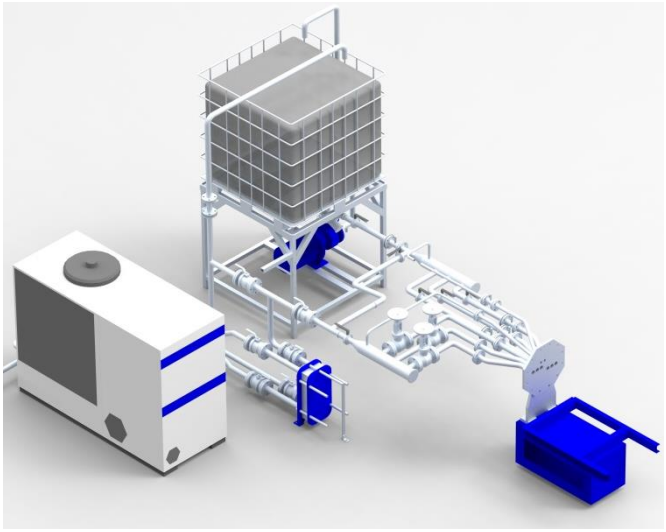

Figure 6 Altered target cooling water flow test rig with heat extraction and improved flow control

4. Target Services Area

The target services area (TSA) is located behind the RHC and contains the target services trolley which houses all of the services equipment required to operate the TRaM. These services were designed for use with uranium targets [1], some of which has been deemed unnecessary via a HAZOP analysis now that ISIS runs with the more stable tungsten/tantalum targets. Since removing this superfluous equipment will allow easier access for the project installation, and for general maintenance, this task has been deemed important to include as part of the TS1 Project.

4.1. Skids

As a lot of equipment will need to be moved to facilitate this strip out, the opportunity will be taken to rearrange the target services trolley in order to improve future accessibility and to speed up maintenance procedures. The intension is to arrange the trolley such that the equipment associated with each service (water, hydrogen, methane, etc) is allocated its own skid, separate from the others. This should make future works easier as new skids can be assembled and worked on offline, allowing the skid to be introduced to the TSA as a single entity, reducing radiation exposer of workers.

4.2. Pump test area

New pumps are to be installed into the TSA to replace the existing aging pumps. A pump test area will be required, including a representative pipe which will mimic the pressure drop over the pipework connecting the main cooling water circuit pump to the target. This area will allow the new pumps to be run under conditions similar to operating conditions and will allow testing of instrumentation.

4.3. Cryogenic transfer lines

The new cryogenic transfer lines will have to be assembled and inspected prior to installation. A mock-up of the forward shielding will be created to allow the operations personnel to practice feeding the transfer lines through between the TSA and the void vessel door.

5. Conclusion

There is a very real need for the provision of full scale mock-ups for testing to be carried out prior to any installation work commencing. This allows alignment adjustments to be made while access is still available, and means that if any errors are found, they can be rectified before the items have been introduced to a high radiation area. The offline testing also allows the operations personnel to become familiar with the how they will be interacting with the new equipment which will allow for more efficient installation and maintenance work.

References

[1] Carne A and Eaton G H 1983 *SNS target station safety assessment SNSPC/P6/82*