

Controls at the ISIS Neutron and Muon Source

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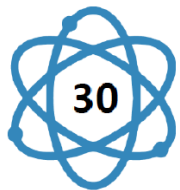
Rutherford Appleton Laboratory, Oxfordshire UK



ISIS Neutron and
Muon Source

ISIS NEUTRON AND MUON SOURCE

- World leading materials science research centre near Oxford, serving the UK and international scientific community
- First neutron spallation in 1984
- Study materials at the atomic level using a suite of advanced scientific instruments



Neutron
instruments



5 muon
instruments

Every year...



1600 proposals
from over
35 countries



3500 researcher
visits



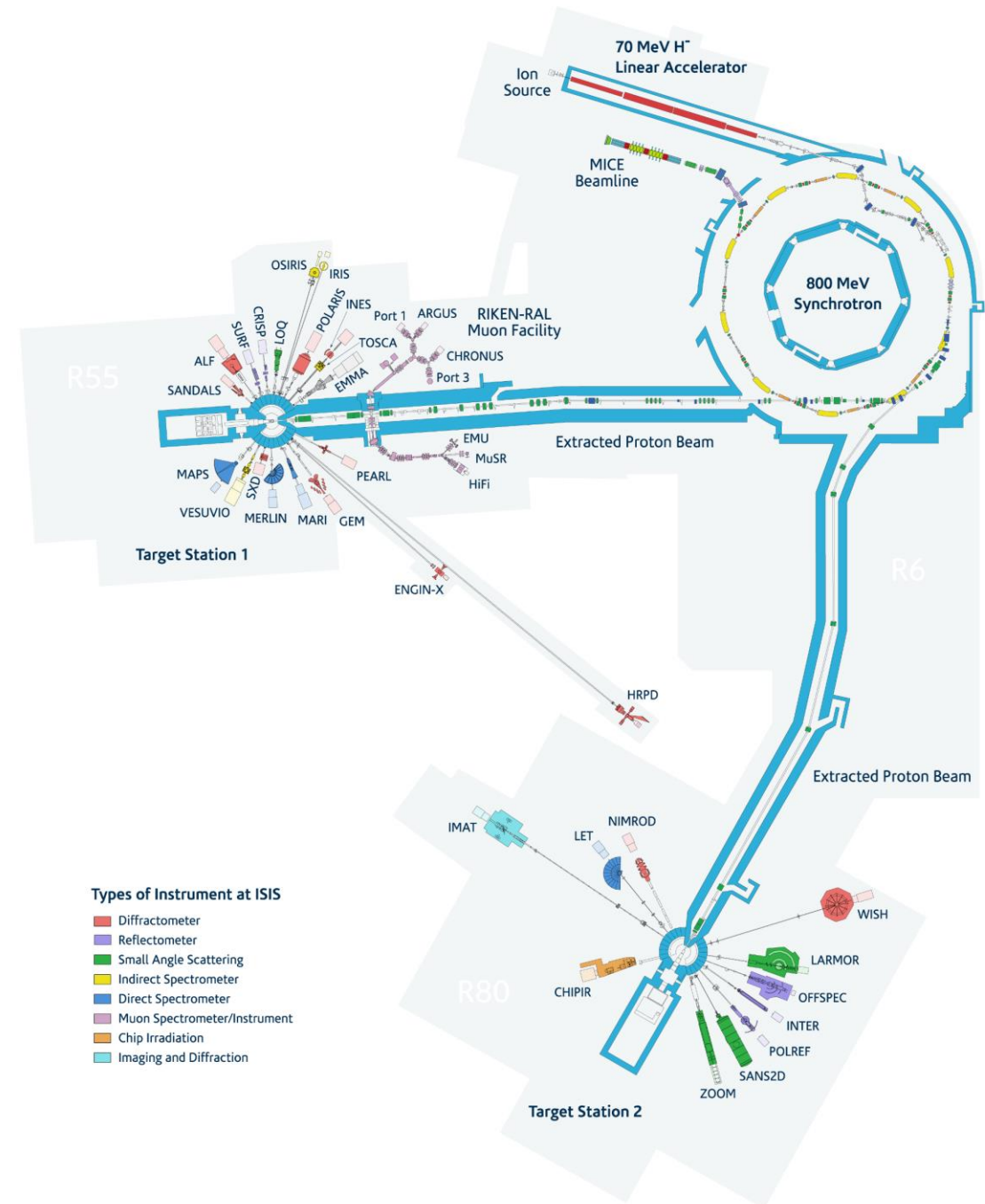
1000
experiments



Journal
publications

THE FACILITY

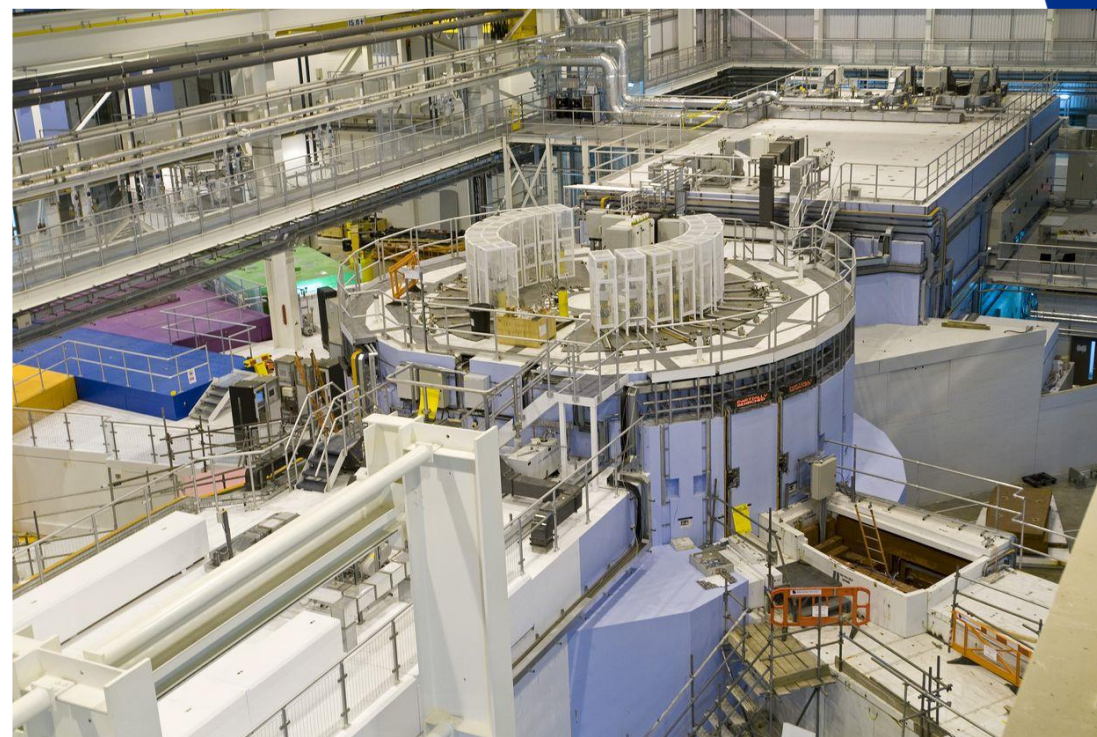
- Accelerated Proton beam to impact various Targets for generating Neutrons and Muons
- Negative Hydrogen ions are generated in the ion source
- A Radio Frequency Quadrupole (RFQ) and four Drift Tube Linac (DTL) cylinders in series accelerate the ions further
- The ions are converted into protons and the synchrotron performs the final acceleration
- The protons are sent to the two Target stations where they generate Neutrons and Muons for use in Instruments



EXPERIMENTAL HALLS



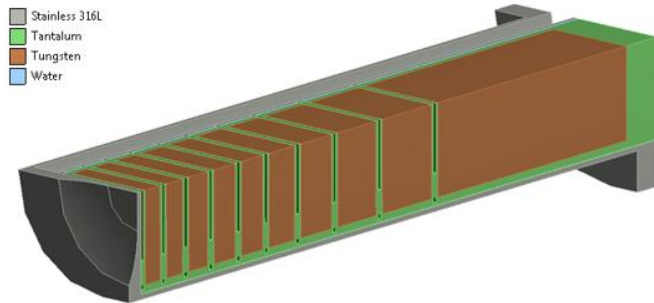
Target Station 1



Target Station 2

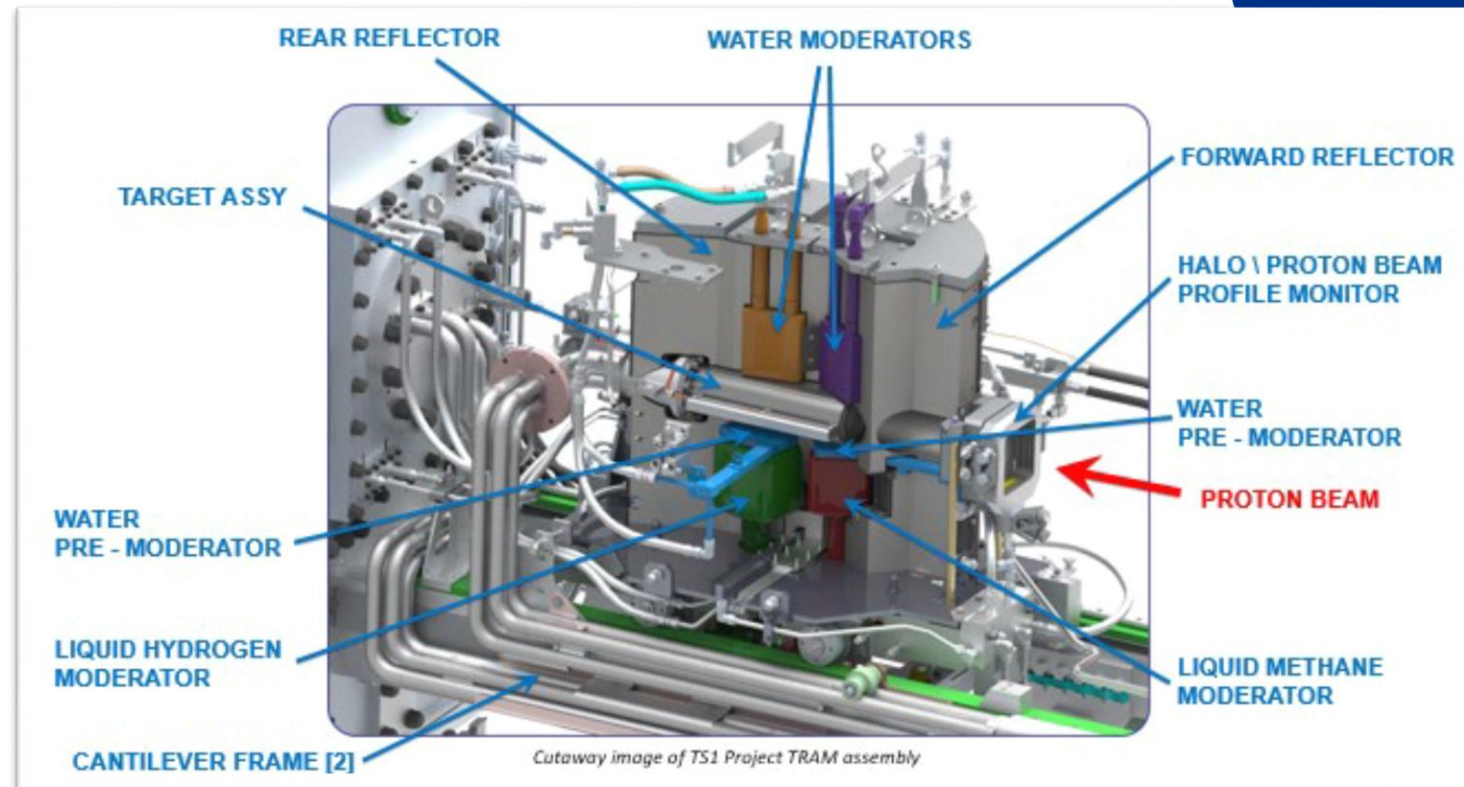
TARGET CONTROLS

- Design and Operational Support
- Tungsten Targets
- Triple Water-cooling circuits
- Cryogenics: Methane and Hydrogen moderators
- Beryllium Reflectors



Target

TRaM

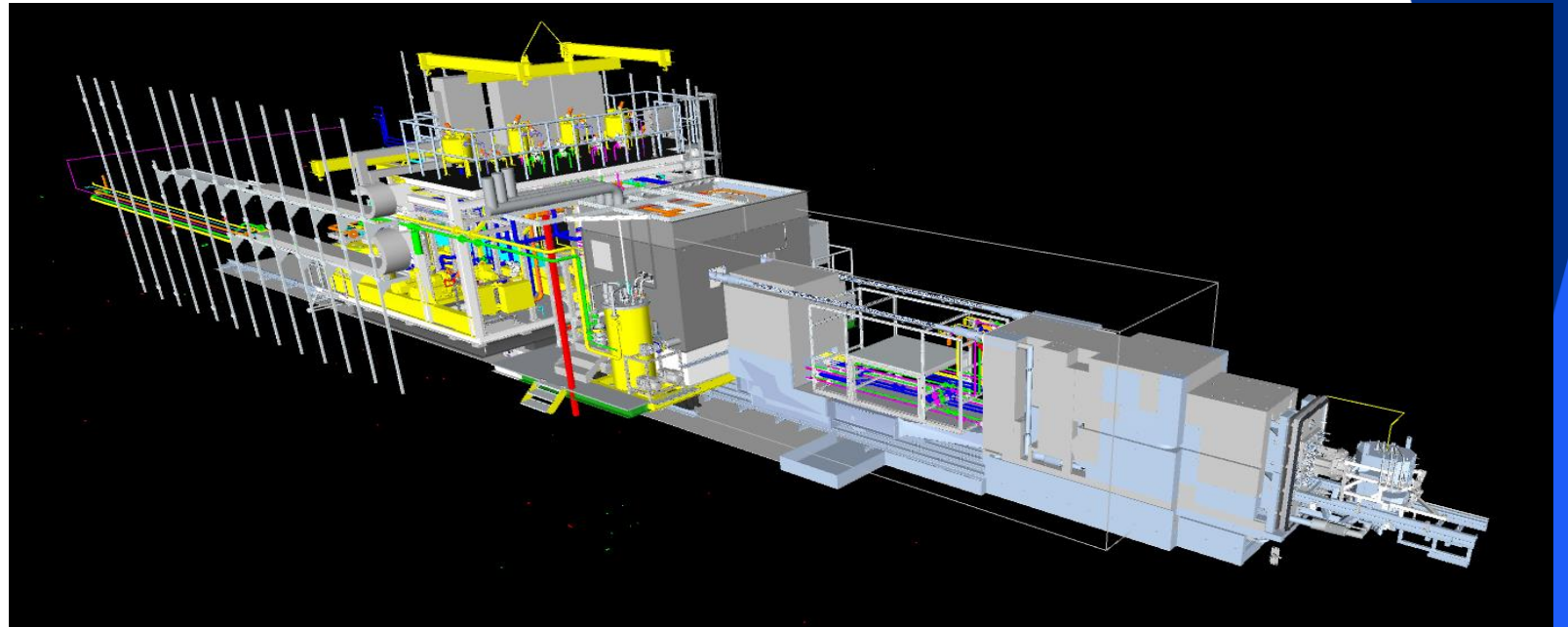


OTHER SYSTEMS



Graphite Muon Target

Target Services Area with Void Vessel in the front



TECHNOLOGY

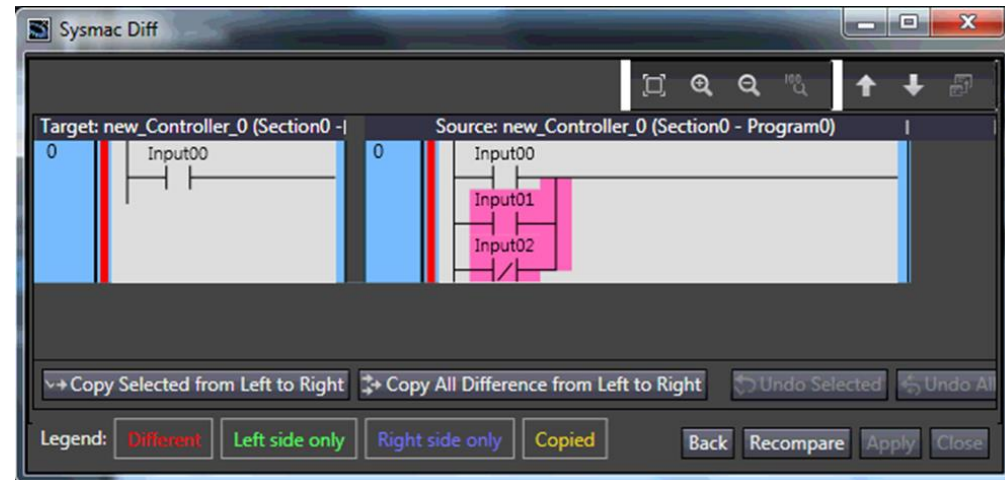
- Bespoke electronics in early days
- Control by Omron PLC
 - Originally designed on C500, CS PLC
 - Most systems transitioned to CJ PLC
 - EtherNet/IP, with DeviceNet for Remote I/O
- Some turnkey solutions on Siemens S7-300 in Target Station 2
- Interfaces
 - Process Instruments via PR, Pepperl+Fuchs converters
 - Radiation monitoring (radiation count, alarms)
 - Vacuum Pump control (Roughing/TMP) directly from PLC/HMI
 - Cryogenics, Water cooling pumps controlled by ABB drives
 - Safety PLCs for beam trip (Omron/Pilz/Allen Bradley)

RECENT UPGRADE

- Target Station 1 mechanical upgrade
- Transition to Omron NJ PLC on base systems (Cryogenics/Cooling)
 - Tag based addressing
 - EtherCAT for Remote I/O
 - EtherNet/IP to connect with Main Control Room, HMI, DC Power Supplies in cabinet
 - Online edits via network gateway
 - Sysmac Studio: one software instead of previous CX-One suite, one program file
- Ladder Logic, ST (inline), Functional Blocks (safety)
- Documentation
 - Drawing database on Autodesk Vault
 - Digital User Manuals (critical information on HMI help prompts)
- EPICS integration

ONGOING PROJECTS

- Using code blocks standardized in upgrade
- TS1 auxiliary systems (RGA, shutters)
- Intermediate Target upgrade
- TS2 existing Siemens S7 turnkey solution to Omron
- New Version Control in Sysmac Studio
- Collaborations for planned ISIS-II facility (Investigating Reinforcement learning, Data-driven, MPC)



Sysmac Version Control

CHALLENGES

- Reverse Engineering (Upgrading Turnkey solutions)
 - Some code blocks locked as contractor IP so needed to call them for servicing
 - Not written to standards
 - Lack of proper documentation
- Limitations of smart, complicated electronics in Radiation areas
- Balancing design work with operational support hinders speed of upgrades

THANK YOU