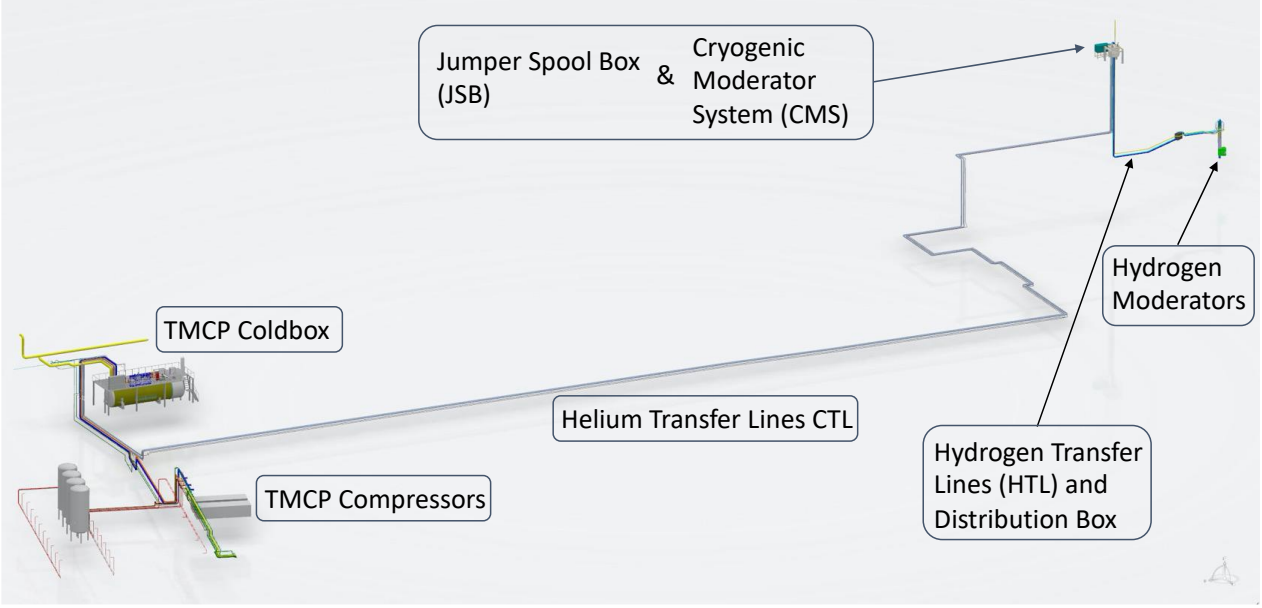
Dynamic Simulation of the Cryogenic System for the ESS Target

Master Thesis proposal

The European Spallation Source (ESS) is a neutron research facility, designed to provide long-pulsed cold and thermal neutron fluxes at very high brightness and is currently under construction at the outskirts of Lund in southern Sweden. A linear proton accelerator provides a high energetic pulsed beam to a rotating tungsten spallation target, generating fast neutrons [1], [2].

The Cryogenic System for the ESS Target consists of a large helium refrigeration plant (TMCP), helium transfer lines CTL (>240m), the Cryogenic Moderator System (CMS) with hydrogen pumps [3], hydrogen transfer lines (HTL), a distribution box and the moderator / reflector plug. The TMCP provides cold helium to cool the liquid hydrogen circulating through the cryogenic moderator(s) which surround the spallation target. Thereby the neutrons are decelerated to form a useful radiation for the neutron instruments.



The system is built up by different stand-alone items that are in different project phases from installation through commissioning to operation. Some of the challenges of operating the installation as an integrated system are

- Adequate responses on fast load changes
- Efficient controls of the helium system when cooling down or warming up the hydrogen system while respecting thermal constraints
- Efficient pressure control in the hydrogen system during transient and upset scenarios

The purpose of this master thesis project is to study the existing system, verify and extend an existing Dymola model, evaluate and integrate operational data, propose and test control strategies including pre-emptive controls and assist parts of the acceptance testing.

The work will be carried out at ESS in Lund in collaboration with the Department of Mechanical engineering Sciences, Division of Mechanics at Lund Institute of Technology.

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References

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[2] Arnold, P., Hees, W., Jurns, J., Su, X. T., Wang, X. L., & Weisend, J. G. (2015, November). ESS cryogenic system process design. In *IOP Conference Series: Materials Science and Engineering* (Vol. 101, No. 1, p. 012011). IOP Publishing.

[3] Tatsumoto, H., Lyngh, D., Beßler, Y., Klaus, M., Hanusch, F., Arnold, P., & Quack, H. (2020, March). Design status of the ESS cryogenic moderator system. In *IOP Conference Series: Materials Science and Engineering* (Vol. 755, No. 1, p. 012101). IOP Publishing.