Contribution ID: **6** Type: **Poster Presentation (120m)**

Conceptual design of a high intensity liquid ortho-deuterium moderator for the European Spallation Source

Tuesday 23 July 2024 14:00 (15 minutes)

The European Spallation Source (ESS) in Lund, Sweden, is designed to become the most powerful accelerator driven spallation neutron source in the world. ESS is currently under construction, first beam on target is planned for 2025, with first user operation expected to start in 2026. As a key component of the neutron production, the cryogenic moderator slows down high-energy neutrons released from the spallation target. In the framework of an European funded research project (HighNESS) the next generation of ESS cold moderators were investigated. The first, already built, cryogenic moderator for ESS was designed for high brightness, using para-hydrogen as a moderator material. For future developments of ESS an additional cryogenic moderator is foreseen. In contrast to the first moderator, the new moderator is optimized for high neutron intensity, which is why liquid ortho-deuterium was chosen as a moderator material. The intensity of the presented liquid ortho-deuterium moderator is about 3-4 times higher than the existing low dimension para-hydrogen moderator. This opens up the possibility of providing significantly more neutrons to the users within the existing infrastructure, resulting into better research results. This paper describes the conceptual design of such a liquid ortho-deuterium moderator system for ESS including mechanical design, manufacturability verification, definition of fluid parameters, cooling process concept design and integrability verification.

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Session Classification: Tue-Po-1.3

Track Classification: Tracks ICEC 29 Geneva 2024: ICEC 14: New devices and novel concepts