

Validation of FESTIM Hydrogen Transport Modeling in FLiBe Through HYPERION Permeation Data

Thursday 11 December 2025 16:20 (25 minutes)

Molten-salt-based breeder blankets for tritium breeding in fusion reactors offer distinct advantages by combining tritium breeding, heat removal, and tritium extraction within a single system. The successful design of these blankets relies on accurate characterization of key transport properties, especially the permeability of molten salts to hydrogen. The HYPERION experiment at MIT PSFC was established to directly measure hydrogen isotope permeation through FLiBe under well-controlled conditions. Its configuration, involving hydrogen transport across both metallic (Ni) and salt (FLiBe) domains, provides data well-suited for benchmarking computational tritium transport models.

FESTIM (Finite-Element Simulation of Tritium in Materials) is an open-source finite-element framework designed for multi-material, multi-species hydrogen isotope transport. In this study, FESTIM is applied to reproduce the permeation flux curves measured in HYPERION across a range of temperatures and operating conditions. By varying FLiBe permeability in the simulations, the model successfully reproduces experimental permeation behavior, with simulated permeability data in good agreement with the measurements.

This benchmarking exercise demonstrates FESTIM's reliability as a tritium transport simulation tool and underscores its capability as a predictive modeling framework applicable to molten salt environments. The results highlight FESTIM's value in interpreting experimental results, constraining uncertain parameters, and supporting the design of tritium-breeding blankets. More broadly, they emphasize the importance of combining experimental measurements with computational modeling to refine material property characterization and reduce uncertainties in future blanket-relevant studies.

Country or International Organisation

United States of America

Affiliation

Plasma Science and Fusion Center (PSFC), MIT

Speaker's email address

huihuay@mit.edu

Author: YANG, Huihua (MIT PSFC)

Co-authors: SARASWAT, Abhishek (MIT PSFC); PETERSON, Eathan (MIT PSFC); DARK, James (Plasma Science and Fusion Center - MIT); WOLLER, Kevin (Massachusetts Institute of Technology); DELAPORTE-MATHURIN, Remi (Plasma Science and Fusion Center, MIT); ZHOU, Weiyue (MIT PSFC)

Presenter: YANG, Huihua (MIT PSFC)

Session Classification: Simulation and Modelling Techniques

Track Classification: Simulation and Modelling Techniques