

# ARC Divertor and Heat Exchanger Thermal Hydraulic Modeling using the Nek5000 CFD Code

*Tuesday 9 December 2025 14:55 (25 minutes)*

As the efforts to develop a fusion pilot plant progresses, there is a significant need for open-source computational fluid dynamics tools for studying component design of Fusion Energy Systems. Plasma Facing Components (PFCs) such as the divertor monoblock experience significant impinging heat fluxes on the order of 1-10 MW/m<sup>2</sup> and neutron heating. These high heat fluxes are often exposed to one side of PFCs such as the divertor monoblock, creating an uneven heating profile, while the neutron heating occurs throughout the divertor monoblock. Adequately cooling PFCs, reducing thermal stresses, and remaining within material limits is an active design challenge in fusion energy systems. One way to increase the thermal performance of PFCs is through the use of passive heat transfer enhancements (HTEs). Adding HTEs such as twisted-tape inserts to the divertor or first wall coolant channels can lead to greater heat transfer capabilities. This increase in heat transfer is accompanied by an increase in frictional pressure losses, which need to be accounted for in finding optimal use-cases for HTEs.

To address these modeling gaps, the authors have investigated ARC component behavior using Nek5000/NekRS, The U.S. Department of Energy's open-source high-fidelity computational fluid dynamics code developed by Argonne National Laboratory. The investigated cases in ARC's divertor coolant lines and heat exchanger tubes were done with Nek's Large Eddy Simulations capabilities. The cases were done for a range of Prandtl numbers at a nominal expected Reynolds number with uniform and one-side heat fluxes. This has enabled the understanding of the heat flux boundary condition from ideal to realistic on heat transfer coefficients with and without twisted tape-inserts. This work enables a road map towards usage of high-fidelity open-source tools for fusion engineering applications for varying multi-physics objectives.

## Country or International Organisation

United States of America

## Affiliation

Virginia Commonwealth University

## Speaker's email address

lbcarasik@vcu.edu

**Author:** TUTWILER, Sierra (Virginia Commonwealth University)

**Co-authors:** Dr SHAVER, Dillon (Argonne National Laboratory); CARASIK, Lane (Virginia Commonwealth University)

**Presenter:** CARASIK, Lane (Virginia Commonwealth University)

**Session Classification:** Simulation and Modelling Techniques

**Track Classification:** Simulation and Modelling Techniques