AIDAN JOHN FURLONG

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EDUCATION

North Carolina State University, Raleigh, NC — Expected May 2026
Ph.D. in Nuclear Engineering
Thesis: "Development, Refinement, and Deployment of Explainable and Interpretable Critical Heat Flux Machine Learning Models"

North Carolina State University, Raleigh, NC — May 2024
M.Sc. in Nuclear Engineering
Thesis: "Prediction of CIPS Susceptibility in PWR Assemblies Using 3D Convolutional Neural Networks"

University of Florida, Gainesville, FL — May 2022
B.Sc. in Nuclear Engineering
Honors: *Cum Laude*

RESEARCH AFFILIATIONS

Artificial Intelligence for the Simulation of Advanced Nuclear Systems Group — Raleigh, NC
Graduate Research Assistant — Jan. 2023 – Present

- Principal areas: deep learning, hybrid modeling, uncertainty quantification (UQ), transfer learning (TL)
- Advisor: Dr. Xu Wu (xwu27@ncsu.edu)

Florida Advanced Multiphysics Modeling and Simulation Group — Gainesville, FL
Undergraduate Research Assistant — Sep. 2020 – Apr. 2023

- Principal areas: deep neural networks (DNNs), convolutional neural networks (CNNs), reactor physics
- Advisor: Dr. Justin Watson (justin.watson@ufl.edu)

PROFESSIONAL EXPERIENCE

Oak Ridge National Laboratory (II) — Oak Ridge, TN
Machine Learning Appointment, Advisor Robert Salko (salkork@ornl.gov) — June 2025 – Present

- Developed and validated a problem-agnostic, uncertainty-aware TL framework using a Bayesian domain adversarial neural network
- Built hybrid critical heat flux (CHF) models for geometries including annuli and rod bundles
- Integrated ML capabilities into the ORNL CTF repository for external use

Oak Ridge National Laboratory (I) — Oak Ridge, TN
Machine Learning Appointment, Advisor Xingang Zhao (xzhao47@utk.edu) — June 2024 – Dec. 2024

- Compared hybrid physics-based and pure ML models for CHF prediction under dryout conditions
- Demonstrated superior interpretability and performance of hybrid approaches in data-scarce, noisy regimes compared to purely data-driven surrogates
- Quantified prediction uncertainties using ensembling and Bayesian neural networks

Westinghouse Electric Company — Cranberry Township, PA
Radiation Engineering & Analysis Intern — May 2023 – Aug. 2023

- Transitioned pressure vessel fluence benchmarks to discrete ordinates methodology
- Enhanced Serpent/MCNP interface scripts for eVinci microreactor shielding analysis
- Modeled as-built Vogtle Unit 4 hatches in MCNP for updated radiation field estimates

Palo Verde Nuclear Generating Station — Tonopah, AZ
Nuclear Analysis Intern — May 2022 – Jul. 2022

- Investigated fresh center assemblies as an alternative to typical twice-burnt elements
- Produced viable three-cycle configurations using SIMULATE; results adopted by PVNGS
- Performed control rod lifetime calculations for the subsequent reload campaign

Inyo Pool Products — Longwood, FL
Customer Service Representative — May 2019 – Aug. 2020

- Managed orders, coordinated vendors, and contributed to technical Q&A threads
- Achieved the highest customer satisfaction rating in a 10-member department

SELECTED PROJECTS

Hybrid Modeling of CHF Raleigh, NC
Artificial Intelligence for the Simulation of Advanced Nuclear Systems Group Feb. 2024 – Present

- Investigated hybrid modeling techniques to improve the interpretability, explainability, and performance of CHF models
- Employed UQ techniques such as ensembles, Bayesian neural networks (BNNs), and deep Gaussian processes (DGPs) to evaluate prediction quality
- Developed in-house transfer learning methodologies to support CHF prediction in alternate geometries
- Implemented the pure and hybrid ML methods in the Fortran-based CTF nuclear subchannel code and validated against accepted benchmarks

Optimization of Extended 4-Loop PWR Cycles Raleigh, NC
Artificial Intelligence for the Simulation of Advanced Nuclear Systems Group Sep. 2024 – Present

- Demonstrated that a reference PWR core can make a direct jump to a 24-month cycle with a 6.7% uprate
- Produced, via simulated annealing, a set of viable loading patterns adhering to all design limits
- Presented results to Duke Energy at the Consortium for Nuclear Power Industry Advisory Board's 2025 Meeting

Fortran–TensorFlow Framework Raleigh, NC
Artificial Intelligence for the Simulation of Advanced Nuclear Systems Group Aug. 2024 – Jan. 2025

- Developed a software framework that allows TensorFlow-trained DNNs and BNNs to be used natively within a Fortran code
- Verified the methodology with multiple benchmarks to ensure one-to-one performance between the two environments
- Released the framework as open source and code agnostic for general use

Extending CHF Predictions in Limited Data Scenarios Raleigh, NC
Artificial Intelligence for the Simulation of Advanced Nuclear Systems Group Feb. 2024 – May 2024

- Investigated parameter transfer schemes to predict CHF in rectangular channels by leveraging knowledge of tubular CHF experiments
- Found that TL can significantly increase DNN performance compared to standalone DNN methods
- Compared DNN ensemble performance to that of conditional variational autoencoders regarding synthetic data generation, concluding that they are comparable in large-data scenarios

Prediction of Crud-Induced Power Shift Raleigh, NC
Artificial Intelligence for the Simulation of Advanced Nuclear Systems Group Jan. 2023 – May 2024

- Developed a 3D CNN-based framework to quickly and accurately predict the CIPS susceptibility of a modeled core's fuel assemblies
- Trained using a combination of calculated and measured data from the Catawba Nuclear Station, the model can predict CIPS instances for a complete cycle with an accuracy of 92% in under 17 milliseconds
- Performed UQ using Monte Carlo Dropout (MCD) to assess the model's prediction confidence

PWR Neutronics Predictions using Neural Networks Gainesville, FL
Florida Advanced Multiphysics Modeling and Simulation Group Sep. 2020 – Apr. 2023

- Investigated the use of neural networks in the prediction of neutronics features such as pin powers and k-eigenvalues
- Using the in-house CNN framework, single-assembly pin power and multiplication factor predictions can be made within 0.5% from OpenMC-calculated values while using a tenth of the computational expense
- This work was geared towards developing methods for the acceleration of conventional neutronics codes

Neutronics of a SMR Core for Puerto Rican Deployment Gainesville, FL
Coursework - Senior Design Nov. 2021 – May 2022

- Made design decisions for core geometry, loading pattern, and reactivity control for a small modular paper reactor
- Found a viable 22-month equilibrium cycle using CASMO/SIMULATE while adhering to all safety and performance limits
- Thermal hydraulic, safety, and balance-of-plant analyses performed with other team members

Fast Flux Test Facility Isotopic Modeling Gainesville, FL
Florida Advanced Multiphysics Modeling and Simulation Group Feb. 2021 – Apr. 2022

- Modeled radial concentrations of various nuclides in generic assemblies using Serpent
- Compared calculations with experimental data to estimate assembly-specific as-operated power histories

Modeling Historical PWRs with OpenMC Gainesville, FL
Coursework - Nuclear Materials Feb. 2021 – Apr. 2021

- Simulated core from the early-era modular PM-3A "Antarctica Reactor" using OpenMC
- Validated model accuracy using historical technical reports and measurements
- Investigated the use of modernized corrosion-resistant materials on neutronics performance

SKILLS

- **Relevant Coursework:** Mathematical Modeling, Nuclear Reactor Design Calculations, Nuclear Fuel Performance, Scientific Machine Learning, Uncertainty Quantification
- **Languages and Tools:** C++, Fortran, LaTeX, Linux, MATLAB, Python
- **Nuclear Codes:** CASMO/SIMULATE, CTF, DOORS, MCNP, MOOSE, OpenMC, Serpent
- **Python Packages:** Matplotlib, NumPy, Pandas, PyTorch, scikit-learn, seaborn, TensorFlow

JOURNAL ARTICLES

1. **Furlong, A.**, and Wu, X. (2026). A Review of Transfer Learning in Nuclear Engineering. (*in preparation*)
2. **Furlong, A.**, Salko, R., Zhao, X., and Wu, X. (2025). A Three-Stage Bayesian Transfer Learning Framework to Improve Predictions in Data-Scarce Domains. (*arXiv:2510.26541, under review at Engineering Applications of Artificial Intelligence*)
3. **Furlong, A.**, Zhao, X., Salko, R., and Wu, X. (2025). Deployment of Physics-Based Hybrid Machine Learning in the CTF Thermal Hydraulics Code. (*arXiv:2505.14701, in press at Nuclear Technology*)
4. **Furlong, A.**, Zhao, X., Salko, R., and Wu, X. (2025). Physics-Based Hybrid Machine Learning for Critical Heat Flux Prediction with Uncertainty Quantification. *Applied Thermal Engineering.* 279:127447.
5. Alsafadi, F., **Furlong, A.**, and Wu, X. (2025). Critical Heat Flux Data Augmentation using Conditional Variational Autoencoders. *Annals of Nuclear Energy.* 220:111502.
6. **Furlong, A.**, Alsafadi, F., Palmtag, S., Godfrey, A., Hayes, S., and Wu, X. (2025). The Prediction of Crud-Induced Power Shift Susceptibility in PWR Fuel Assemblies using Convolutional Neural Networks. *Energy.* 316:134447.
7. Akins, A., **Furlong, A.**, Kohler, L., Clifford, J., Brady, C., Alsafadi, F., and Wu, X. (2024). ARTISANS–Artificial Intelligence for Simulation of Advanced Nuclear Systems for Nuclear Fission Technology. *Nuclear Engineering and Design.* 423:113170.
8. **Furlong, A.** and Watson, J. (2024). Analysis of the LatticeNet neural network framework's performance using prediction-calculated temperature coefficients in PWR assemblies. *Annals of Nuclear Energy.* 203:110498.
9. **Furlong, A.**, Watson, J., and Shriver, F. (2023). Investigation of Monte Carlo-trained CNNs for neutronics predictions of typical and atypical PWR assemblies. *Progress in Nuclear Energy.* 166:104961.

PEER-REVIEWED CONFERENCE PAPERS AND SUMMARIES

1. **Furlong, A.**, Salko, R., Zhao, X., and Wu, X. (2026). Prediction of Critical Heat Flux in Rod Bundles Using Tube-Based Hybrid ML Models in CTF. (*in preparation for the American Nuclear Society 2026 Annual Meeting*)
2. **Furlong, A.**, Zhao, X., Salko, R., and Wu, X. (2025). Development and Deployment of Hybrid ML Models for Critical Heat Flux Prediction in Annulus Geometries. In *Transactions of the American Nuclear Society.* Washington, D.C., November 9 – 12, 2025.
3. **Furlong, A.**, Zhao, X., Salko, R., and Wu, X. (2025). Prediction of Critical Heat Flux with Hybrid Machine Learning: Uncertainty Quantification and CTF Deployment. In *International Topical Meeting on Nuclear Reactor Thermal Hydraulics (NURETH-21).* Busan, Republic of Korea, August 31 – September 5, 2025.
4. Bevans, Z., **Furlong, A.**, and Palmtag, S. (2025). Cycle Optimization for a 4-loop PWR Using Multicycle Constraint Annealing. In *Advances in Nuclear Fuel Management (ANFM 2025).* Clearwater Beach, FL, July 20 – 23, 2025.
5. **Furlong, A.**, Zhao, X., Salko, R., and Wu, X. (2025). Native Implementation of TensorFlow-Trained Deep and Bayesian Neural Network Models in Fortran. In *Transactions of the American Nuclear Society.* Chicago, IL, June 15 – 18, 2025.
6. **Furlong, A.**, Zhao, X., Salko, R. (2024). Behavior of Hybrid Physics-based and Pure Machine Learning Models in Limited Data Scenarios. In *Transactions of the American Nuclear Society.* Orlando, FL, November 17 – 21, 2024.
7. **Furlong, A.** and Wu, X. (2024). The Use of Transfer Learning to Extend Critical Heat Flux Predictions. In *Proceedings of the 2024 Advances in Thermal Hydraulics (ATH 2024).* Orlando, FL, November 17 – 21, 2024.
8. Alsafadi, F., **Furlong, A.**, and Wu, X. (2024). Comparative Analysis and Uncertainty Quantification in Critical Heat Flux Prediction via Generative Conditional Variational Autoencoders and Deep Neural Networks. In *Proceedings of the 2024 Advances in Thermal Hydraulics (ATH 2024).* Orlando, FL, November 17 – 21, 2024.
9. **Furlong, A.**, Alsafadi, F., Palmtag, S., Godfrey, A., Hayes, S., and Wu, X. (2024). Predicting PWR Fuel Assembly CIPS Susceptibility with Convolutional Neural Networks: Performance and Uncertainty Quantification. In *Proceedings of the International Conference on Physics of Reactors (PHYSOR 2024).* San Francisco, CA, April 21 – 25, 2024.
10. **Furlong, A.**, Alsafadi, F., Kohler, L., Wu, X., Palmtag, S., Godfrey, A., and Hayes, S. (2023). Machine Learning-based Prediction of Crud Buildup Locations in Pressurized Water Reactors. In *Transactions of the American Nuclear Society.* Washington, D.C., November 12 – 15, 2023.
11. **Furlong, A.**, Shriver, F., and Watson, J. (2022). Using neural networks to predict pin powers in reflective PWR fuel assemblies with varying pin size. In *Proceedings of the International Conference on Physics of Reactors (PHYSOR 2022).* Pittsburgh, PA, May 15 – 20, 2022.

SERVICE AND MEMBERSHIP

- Delegate, 2025 Nuclear Engineering Student Delegation (NESD)
- Member, American Nuclear Society (ANS)
- Peer Reviewer, *Applied Computing and Geosciences*
- Peer Reviewer, *International Journal of Heat and Mass Transfer*
- Peer Reviewer, *Nuclear Engineering and Design*
- Peer Reviewer, *Nuclear Engineering and Technology*
- Peer Reviewer, *Scientific Reports*
- Peer Reviewer, *Transactions on Nuclear Science*
- Technical Session Chair, NURETH-21 (2025)
- Technical Program Committee Member, NURETH-21 (2025)

SOFTWARE

- **Furlong, A.** (2025). Staged Bayesian Domain Adversarial Neural Network (Staged B-DANN) (Version 1.0.0). https://github.com/ajfurlong/staged_bdann_project
- **Furlong, A.** (2024). Making Predictions in Fortran using Pre-Trained TensorFlow DNN Models (Version 1.3.0). https://github.com/ajfurlong/fortran_dnn_from_tf
- **Furlong, A.** (2024). Making Predictions in Fortran using Pre-Trained TensorFlow Bayesian NN Models (Version 1.1.0). https://github.com/ajfurlong/fortran_bayesian_nn_from_tf