

Jin Whan Bae

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SUMMARY

Nuclear engineer with demonstrated experience in producing sustainable and reproducible analysis work for a variety of sponsors. Experience collaborating with multi-organization teams and communicating workflow and project direction for transparency. Focus in fission and fusion reactor neutronics analysis and design, with emphasis on developing agile design environments with software stacks and leveraging data science for computational nuclear engineering.

EDUCATION

University of Illinois - Urbana Champaign, Urbana, IL, USA

- M.S. in Nuclear, Plasma, Radiological Engineering Jan 2017 – Dec 2018
 - Adviser: Prof. Kathryn Huff
 - Focus: Fuel Cycle Simulation and Advanced Fuel Cycles
- B.S. Nuclear, Plasma, Radiological Engineering Aug 2011 – May 2017

RESEARCH EXPERIENCE

Nuclear Energy and Fuel Cycle Division, Oak Ridge National Laboratory

- Associate R&D Staff Jan 2022- Present
 - Supervisor: Benjamin Betzler
 - Performed optimization of High Flux Isotope Reactor (HFIR) low enriched uranium (LEU) fuel design using high-fidelity monte carlo simulator and genetic algorithms.
 - Develop a workflow for full-analysis suite for neutronics for CAD-geometry fusion reactors including activation, tritium breeding ratio, and shutdown dose rate.
 - Optimize light water reactor (LWR) assembly designs using stochastic optimization.
 - Leverage machine learning and data science for automated analysis of gamma spectra data for safeguard applications.
- Technical Professional Feb 2020 – Dec 2021
 - Supervisors: William A Wieselquist, Andrew Worrall, Benjamin Betzler
 - Performed uncertainty quantification, sensitivity analysis, and multiobjective, multivariate optimization for fuel cycle transition scenarios.
 - Developed SCALE/Polaris to output extended nodal data with microscopic cross sections in HDF5 format.
 - Performed neutronics calculations for a fusion reactor prototype for tritium breeding ratios and energy deposition.
 - Performed lattice design optimization for HALEU PWR and BWR lattices using genetic algorithms to find pin-wise optimal enrichment and burnable poison concentration.
 - Developed a GIS application that assess 10 categories for reactor siting in a user-defined region.
 - Analyzed the neutronics and fuel cycle feasibility of a novel reactor design.
 - Developed methods and tools for Molten Salt Reactor depletion and source term analysis
 - Perform criticality and depletion analyses on novel reactor design to determine design scope and feasibility.
 - Analyzed recent fuel cycle technologies and their larger impact on the supply chain and resource demand.
- Postmaster Research Associate Feb 2019 – Feb 2020
 - Supervisors: Germina Ilas, Benjamin Betzler
 - Performed reactor physics analysis in support of High Flux Isotope Reactor (HFIR) low enriched uranium (LEU) Conversion project.
 - Streamlined neutronics and thermal hydraulics analysis in support of the HFIR fuel design study.
 - Generated artificial neural network models to predict Mixed Oxide (MOX) Fuel assembly criticality value before and after irradiation.
 - Generated artificial neural network models to predict transition coefficients for Oak Ridge Isotope GENeration (ORIGEN) reactor libraries in SCALE.
 - Leveraged metaheuristic optimization algorithms to optimize HFIR fuel shape for californium production and safety margin.
 - Performed uncertainty and sensitivity analysis of Molten Salt Demonstration Reactor (MSDR) for safeguard and R&D effort scoping applications.
 - Calculated dose rates for various samples from Molten Salt Reactor (MSR) and Light Water Reactor (LWR) fuel cycles using SCALE and MCNP.
 - Developed a graphical user interface for Cyclus, a fuel cycle simulator, to provide cross-platform user interface.
 - Demonstrated gaps in the (MOX) Fuel fabrication estimation in Fuel Cycle Simulators (FCSs) ORION and Cyclus.
 - Developed tools to convert SCALE binary files to HDF5 files for visualization and data analytics.
- Graduate Intern May 2018 – Aug 2018
 - Supervisors: Dr. Joshua L. Peterson-Droogh
 - Compared different fuel cycle transition scenarios for U.S. using ORION and Cyclus
 - Performed sensitivity analysis of modeling U.S. UNF assemblies using the UNF-ST&DARDS database
 - Compared the modeling methods of fuel cycle simulators Cyclus and ORION

Advanced Reactors and Fuel Cycles, University of Illinois - Urbana Champaign

- Graduate Research Assistant, Fuel Cycle Division Jan 2017 – Dec 2018
 - Project: Demand Driven Deployment for Fuel Cycle simulator, CYCLUS
 - Supervisor: Prof. Kathryn Huff
 - Performed fuel cycle simulation for a wide range of fuel cycle technology transition scenarios.
 - Coupled high-fidelity reactor analysis codes (SERPENT, SCALE) and fuel cycle simulators (Cyclus)
 - Implemented demand-driven facility deployment capabilities in Cyclus using various predictive algorithms (ARMA, ARCH, Fast Fourier Transform)
 - Created reduced-order models of high-fidelity codes using artificial neural networks for implementation in fuel cycle simulation (e.g. LWR depletion)

PUBLICATIONS

JOURNALS

- [1] Bae, J.W., Betzler, B.R., Chandler, D., Hartanto, D., 2023. Automated reactor physics analysis framework of High Flux Isotope Reactor low-enriched uranium silicide dispersion fuel designs. *Nuclear Engineering and Design* 405, 112193. <https://doi.org/10.1016/j.nucengdes.2023.112193>
- [2] Bae, J.W., Peterson, E., Shimwell, J., 2022. ARC reactor neutronics multi-code validation. *Nucl. Fusion*. <https://doi.org/10.1088/1741-4326/ac5450>
- [3] Rykhlevskii, A., Bae, J.W., Huff, K.D., 2019. Modeling and simulation of online reprocessing in the thorium-fueled molten salt breeder reactor. *Annals of Nuclear Energy* 128, 366–379.
- [4] Bae, J.W., Andrei, R., Chee, G., Huff, K.D., 2019a. Deep Learning Approach to Nuclear Fuel Transmutation in a Fuel Cycle Simulator. *Annals of Nuclear Energy*.
- [5] Bae, J.W., Peterson-Droogh, J.L., Huff, K.D., 2019b. Standardized verification of the CYCLUS fuel cycle simulator. *Annals of Nuclear Energy* 128, 288–291.
- [6] Bae, J.W., Singer, C.E., Huff, K.D., 2019c. Synergistic spent nuclear fuel dynamics within the European Union. *Progress in Nuclear Energy* 114, 1–12.

CONFERENCES

- [1] Bae, Jin Whan, Benjamin Betzler, David Chandler, and Germina Ilas. 2020. “Automated Fuel Design Optimization for High Flux Isotope Reactor Low Enriched Uranium Core Design.” In *PHYSOR 2020*. Cambridge, UK.
- [2] Bae, Jin Whan, Benjamin Betzler, and Andrew Worrall. 2019a. “Molten Salt Reactor Neutronic and Fuel Cycle Sensitivity and Uncertainty Analysis.” In *ANS WINTER 2019*. Washington D.C., United States.
- [3] ———. 2019b. “Neural Network Approach to Model Mixed Oxide Fuel Cycles in Cyclus, a Nuclear Fuel Cycle Simulator.” In *ANS WINTER 2019*. Washington D.C., United States.
- [4] Bae, Jin Whan, Eva Davidson, Robert Gregg, and Andrew Worrall. 2019. “Functionality Isolation Test for Fuel Cycle Code ORION - MOX Fuel Fabrication.” In *GLOBAL 2019*. Seattle, WA, United States.
- [5] Bae, Jin Whan, Kathryn Huff, and Clifford Singer. 2017. “Synergistic Spent Nuclear Fuel Dynamics Within the European Union.” In *Proceedings of ANS Winter 2017*. Washington, D.C.: American Nuclear Society. https://github.com/nuclearbae/nuclearbae.github.io/bae_synergistic_2017.pdf.
- [6] Bae, Jin Whan, William Roy, and Kathryn D. Huff. 2017. “Benefits of Siting a Borehole Repository at a Non-Operating Nuclear Facility.” In *Proceedings of the International High Level Radioactive Waste Management Conference*. Charlotte, North Carolina: American Nuclear Society. https://github.com/nuclearbae/nuclearbae.github.io/papers/bae_benefits_2017.pdf.

- [7] Huff, Kathryn D., Jin Whan Bae, Kathryn A. Mummah, Robert R. Flanagan, and Anthony M. Scopatz. 2017. "Current Status of Predictive Transition Capability in Fuel Cycle Simulation." In Proceedings of Global 2017 (Submitted). Seoul, South Korea.
- [8] Bae, J.W., Betzler, B.R., Wieselquist, W.A., 2021. Characteristic Solutions for Advection Problems with Isotopic Evolution with SCALE/ORIGEN. Presented at the The International Conference on Mathematics and Computational Methods Applied to Nuclear Science and Engineering, Raleigh, NC.

TECHNICAL REPORTS

- [1] Bae, J.W., Betzler, B.R., Chandler, D., Ilas, G., Meszaros, J., 2021. High Flux Isotope Reactor Low-Enriched Uranium High Density Silicide Thick Cladding Fuel Design Parameters (No. ORNL/TM-2021/1964). Oak Ridge National Lab. (ORNL), Oak Ridge, TN (United States).
- [2] Betzler, B.R., Chandler, D., Bae, J.W., Ilas, G., Meszaros, J., 2021. High Flux Isotope Reactor Low Enriched Uranium Low Density Silicide Fuel Design Parameters (No. ORNL/TM-2020/1798). Oak Ridge National Lab. (ORNL), Oak Ridge, TN (United States). <https://doi.org/10.2172/1773657>
- [3] Bae, J.W., Davidson, E., Worrall, A., 2019. Application of Cyclus to a Transition Scenario (Technical Report No. 2019/1286). OAK RIDGE NATIONAL LABORATORY, Oak Ridge, TN, United States.
- [4] Bae, J.W., Mertyurek, U., Asgari, M., 2022. Light Water Reactor LEU+ Lattice Optimization (No. ORNL/TM-2021/2366). OAK RIDGE NATIONAL LABORATORY, Oak Ridge, TN. Betzler, B.R., Chandler, D., Bae, J.W., Ilas, G., Meszaros, J., 2021. High Flux Isotope Reactor Low Enriched Uranium Low Density Silicide Fuel Design Parameters (No. ORNL/TM-2020/1798). Oak Ridge National Lab. (ORNL), Oak Ridge, TN (United States). <https://doi.org/10.2172/1773657>
- [5] Feng, B., Richards, S., Bae, J., Davidson, E., Worrall, A., Hays, R., 2020. Sensitivity and Uncertainty Quantification of Transition Scenario Simulations (No. ANL/NSE-20/38). Argonne National Lab. (ANL), Argonne, IL (United States).
- [6] Greenwood, M.S., Betzler, B.R., Qualls, A.L., Bae, J.W., Worrall, L.G., 2019. Dynamic System Models for Informing Licensing and Safeguards Investigations of Molten Salt Reactors–Revision 1. Oak Ridge National Lab.(ORNL), Oak Ridge, TN (United States).
- [7] Variansyah, I., Bae, J.W., Betzler, B.R., Ilas, G., 2020. Metaheuristic Optimization Tool (No. ORNL/TM-2019/1443). Oak Ridge National Lab. (ORNL), Oak Ridge, TN (United States). <https://doi.org/10.2172/1608209>

FUNDING AWARDS & ROLES

Machine Learning for Rapid Gamma Spectra Analysis, 2022
 Department of Energy (DOE) Office of International Nuclear Safeguards
 Principal Investigator: J. Hu (Oak Ridge National Laboratory)
 With: M. Dion, S. O'Brien, R. Venkataraman, **J. Bae** (Oak Ridge National Laboratory)

AWARDS

- **Supplemental Performance Award**, Oak Ridge National Laboratory, 2022
 Recognized for exceeding expectation

PROFESSIONAL INVOLVEMENT

EDITORIAL & REVIEW ACTIVITIES

- Nuclear Engineering and Design, 1 review p.a., 2021 - present
- Energies, 2 review p.a., 2021 - present
- Journal of Nuclear Engineering, 2 review p.a., 2021 - present

PROFESSIONAL SOCIETY INVOLVEMENT

- American Nuclear Society
- Oak Ridge / Knoxville Local ANS Section Executive Committee - Vice President

- North American Young Generation in Nuclear (NAYGN) Benchmark Committee

**RESEARCH
MENTORING
EXPERIENCE**

Jack Fletcher, Undergraduate Research Assistant, advised on optimization of fusion reactor structural dimensions for tritium breeding ratio, 2021.
Dinara Ermakova, Graduate Research Assistant, advised on life-cycle externality assessment of electricity generation systems, 2021.

**INTERNATIONAL
WORKING GROUPS**

- Nuclear Energy Agency (NEA) Shielding Integral Benchmark Archive and Database (SINBAD) task force

SKILLS

- **Documentation:** L^AT_EX, MS Office
- **Analysis Tools:**
 - MCNP, Shift, SCALE/Polaris, SCALE/TRITON, OpenMC, SERPENT Transport Codes
 - Cyclus, ORION Fuel Cycle Codes
 - Riskman, DAGMC, PyNE, GADRAS, Cubit, Paraview Misc.
- **Programming Languages:** Python, C++, C, Fortran, MATLAB, and Mathematica
- **Software Development:** Git, Docker, Sphinx, and CI
- **Misc.:** Unity 3D, tensorflow, pandas, HDF5, SQL, and ArcGis

CERTIFICATES

- Neural Networks and Deep Learning
 - <https://www.coursera.org/account/accomplishments/verify/KAT7B3V73QSE> 2020
- Convolutional Neural Networks
 - <https://www.coursera.org/account/accomplishments/verify/WBMSLA7GH9A2> 2020
- Building Deep Learning Models with TensorFlow
 - <https://www.coursera.org/account/accomplishments/certificate/2NUGYBYWUXFR> 2020