Jin Whan Bae

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SUMMARY

Nuclear engineer with demonstrated experience in producing sustainable and reproducible analysis and software for a variety of sponsors. Experience collaborating with multi-organizational teams and communicating workflow and project direction for transparency. Focus in fission and fusion reactor neutronics analysis and design optimization, safeguards, and nuclear fuel cycle analysis, with emphasis on developing agile design environments with software stacks and leveraging data science and machine learning 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
  - Graduation delayed due to 21-month military service (Korean Army, Landmine Displacement and Installment).

RESEARCH EXPERIENCE

Nuclear Energy and Fuel Cycle Division
Oak Ridge National Laboratory

- Associate R&D Staff   Jan 2022- Present
  - Supervisor: Eva Davidson, Benjamin Betzler
  - Develop a workflow for full neutronics analysis suite for for CAD-geometry fusion reactors including activation, tritium breeding ratio, shutdown dose rate, and coupling with multiphysics solvers.
  - Performed optimization of High Flux Isotope Reactor (HFIR) low enriched uranium (LEU) fuel design using high-fidelity monte carlo simulator and genetic algorithms.
  - Optimized light water reactor (LWR) assembly designs using metaheuristic optimization.
  - Leverage machine learning and data science for automated analysis of gamma spectra data for uranium enrichment prediction for safeguard applications.
  - Develop modular software framework for optimization of reprocessing of used nuclear fuel.
  - Calculated future U.S. nuclear fuel cycle infrastructure (enrichment, natural uranium) demand from projected nuclear electricity demand for netzero goals.
- 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] 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.

[3] Hartanto, Donny, et al. "Californium-252 production at the High Flux Isotope Reactor− I: Validation study using campaign data." Annals of Nuclear Energy 211 (2025): 110960.

[4] Chandler, David, et al. "Californium-252 production at the High Flux Isotope Reactor-II: Comparison between the highly enriched uranium and a proposed low-enriched uranium core." Annals of Nuclear Energy 211 (2025): 110920.

[5] Chandler, D., Bae, J.W., Betzler, B.R., Hartanto, D., Daily, C.R., 2023. Fuel cycle depletion validation and code-to-code verification studies for High Flux Isotope Reactor highly and low-enriched uranium fuel designs. Annals of Nuclear Energy 190, 109895. https://doi.org/10.1016/j.anucene.2023.109895

[6] Borowiec, K., Bae, J. W., Badalassi, V. (2024). 3D high-fidelity automated neutronics guided optimization of fusion blanket designs. Fusion Engineering and Design, 200, 114159.

[7] Bae, J. W., Young, D., Borowiec, K., Badalassi, V. (2024). Integral Analysis of the Effect of Material Dimension and Composition on Tokamak Neutronics. Nuclear Fusion.

[8] Bae, Jin Whan, Bor Kos, and Elliott Biondo. "Shutdown dose rate analysis with the Shift Monte Carlo radiation transport code and modular verification workflow." Fusion Engineering and Design 194 (2023): 113895.

[9] Badalassi, V., Sircar, A., Solberg, J.M., Bae, J.W., Borowiec, K., Huang, P., Smolentsev, S., Peterson, E., 2023. FERMI: Fusion Energy Reactor Models Integrator. Fusion Science and Technology 79, 345–379. https://doi.org/10.1080/15361055.2022.2151818

[10] Bae, J.W., Peterson, E., Shimwell, J., 2022. ARC reactor neutronics multi-code validation. Nucl. Fusion. https://doi.org/10.1088/1741-4326/ac5450

[11] Bae, J.W., Andrei, R., Chee, G., Huff, K.D., 2019. Deep Learning Approach to Nuclear Fuel Transmutation in a Fuel Cycle Simulator. Annals of Nuclear Energy.

[12] Bae, J.W., Peterson-Droogh, J.L., Huff, K.D., 2019. Standardized verification of the CYCLUS fuel cycle simulator. Annals of Nuclear Energy 128, 288–291.

[13] Bae, J.W., Singer, C.E., Huff, K.D., 2019. Synergistic spent nuclear fuel dynamics within the European Union. Progress in Nuclear Energy 114, 1–12.

[14] Bae, J.W., Hu, J, 2024. Machine Learning Framework for Predicting Uranium Enrichments from M400 CZT Gamma Spectra. Nuclear Inst. and Methods in Physics Research, A.

[15] Smolentsev, S., Aduloju, S., Bae, J.W., Fan, Y., Humrickhouse, P., 2024. Pre-conceptual design and proof of principle assessments of self-cooled Toroidally Symmetrci Lead-Lithium (TSLL) blanket. Fusion Engineering and Design.

CONFERENCES

[1] Bae, Jin Whan, Benjamin Betzler, David Chandler, and Germina Ilas. "Automated Fuel Design Optimization for High Flux Isotope Reactor Low Enriched Uranium Core Design." In PHYSOR 2020. Cambridge, UK, 2020.

[2] Bae, Jin Whan, Benjamin R. Betzler, and William A. Wieselquist. "Characteristic Solutions for Advection Problems with Isotopic Evolution with SCALE/ORIGEN." Raleigh, NC, 2021.

[3] Bae, Jin Whan, Benjamin Betzler, and Andrew Worrall. "Molten Salt Reactor Neutronic and Fuel Cycle Sensitivity and Uncertainty Analysis." In ANS WINTER 2019. Washington D.C., United States, 2019.

[4] ———. "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, 2019.

[5] Bae, Jin Whan, Katarzyna Borowiec, Arpan Sircar, and Vittorio Badalassi. "Integrated Fusion Neutronics Workflow for MCNP, OpenMC, and Shift." Indianapolis, IN: Oak Ridge National Laboratory (ORNL), Oak Ridge, TN (United States), 2023. https://www.osti.gov/biblio/1985383.

[6] Bae, Jin Whan, Eva Davidson, Robert Gregg, and Andrew Worrall. "Functionality Isolation Test for Fuel Cycle Code ORION - MOX Fuel Fabrication." In GLOBAL 2019. Seattle, WA, United States, 2019.

[7] Bae, Jin Whan, Kathryn Huff, and Clifford Singer. "Synergistic Spent Nuclear Fuel Dynamics Within the European Union." In Proceedings of ANS Winter 2017. Washington, D.C.: American Nuclear Society, 2017.

[8] Bae, Jin Whan, Ugur Mertyurek, and Mehdi Asgari. "LEU+ BWR Lattice Design Optimization of Using SCALE/POLARIS." In PHYSOR 2022: International Conference on Physics of Reactors. Pittsburgh, Pennsylvania, 2022.

[9] Bae, Jin Whan, William Roy, and Kathryn D. Huff. "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, 2017

[10] Bae, J.W, B.R. Betzler, D. Chandler, G. Ilas, and J.L. Meszaros. "Neutronic and Thermal-Hydraulic Design Studies for High Flux Isotope Reactor Conversion to Low-Enriched Uranium High Density Silicide Dispersion Fuel." In ANS Winter Meeting and Nuclear Technology Expo. Chicago, Illinois, USA, 2020.

[11] Betzler, B.R., J.W. Bae, D. Chandler, G. Ilas, and E.E. Davidson. "Reactor Physics Characteristics of High Flux Isotope Reactor Core Designs with Low-Enriched Uranium." In PHYSOR 2022: International Conference on Physics of Reactors. Pittsburgh, Pennsylvania, 2022.

[12] Chandler, D., B.R. Betzler, J.W. Bae, D.H. Cook, and G. Ilas. "Conceptual Fuel Element Design Candidates for Conversion of High Flux Isotope Reactor with Low-Enriched Uranium Silicide Dispersion Fuel." In PHYSOR2020. Cambridge, UK, 2020.

[13] Chandler, D, J.L. Meszaros, B.R. Betzler, J.W. Bae, D.H. Cook, V.D. Fudurich, T. Howard, et al. "Fuel Conversion Efforts at the High Flux Isotope Reactor - a 2020 Status Update." In 2020 ANS Winter Meeting and Nuclear Technology Expo. Chicago, Illinois, USA, 2020.

[14] Fletcher, Jack, Jin Whan Bae, Arpan Sircar, and Vittorio Badalassi. "Optimization of a Simplified ARC Reactor Design Through Coupled Neutronics, Thermal Hydraulics Modeling." In 2021 ANS Winter Meeting and Technology Expo. Washington D.C., 2021.

[15] Huff, Kathryn D., Jin Whan Bae, Kathryn A. Mummah, Robert R. Flanagan, and Anthony M. Scopatz. "Current Status of Predictive Transition Capability in Fuel Cycle Simulation." In Proceedings of Global 2017 (Submitted). Seoul, South Korea, 2017.

[16] Sircar, Arpan, Jin Whan Bae, Vittorio Badalassi, and Ethan Peterson. "Multi-Physics Simulations for Fusion Reactor Blankets." In 2021 ANS Winter Meeting and Technology Expo. Washington D.C., 2021.

[17] Sircar, Arpan, Jin Whan Bae, Ethan Peterson, Jerome Solberg, and Vittorio Badalassi. "FERMI: A MULTI-PHYSICS SIMULATION ENVIRONMENT FOR FUSION REACTOR BLANKET." In 19th International Topical Meeting on Nuclear Reactor Thermal Hydraulics (NURETH-19). Brussels, Belgium, 2022.

[18] Sircar, Arpan, Katarzyna Borowiec, Jin Whan Bae, Jerome Solberg, and Vittorio Badalassi. "Multiphysics Code Coupling for Fusion Blankets." In 2022 ANS Winter Meeting and Technology Expo. Pheonix, Arizona, USA, 2022.

[19] Sircar, Arpan, Katarzyna Borowiec, Jin Whan Bae, and Vittorio Badalassi. Coupled neutronics and thermal hydraulics simulation of Tritium breeding and its transport in the ARC-class fusion blanket." In 2024 Technology of Fusion Energy Meeting (TOFE). Madison, Wisconsin, USA, 2024.

TECHNICAL REPORTS

[1] Hoffman, E., Richards, S., Kim, T.K., Davidson, E., Bae, J., Asgari, M., Worrall, A., Options to Address Enriched Uranium Shortage for Large-Scale Reactor Deployment (ANL/NSE-23/53). ARGONNE NATIOANL LABORATORY, Lemont, IL.

[2] Hartanto, D., Hu, J., McElroy, R., Venkataraman, R., Bae, J.W., Hiscox, B., Identify and Assess Technical Challenges in Safeguards Measurements of Fresh Advanced Reactor Fuels (ORNL/SPR-2023/3237). OAK RIDGE NATIONAL LABORATORY, Oak Ridge, TN.

[3] Davidson, E., Bae, J.W., Asgari, M., Richards, S., Hoffman, E., Kim, T.K., Kim, S., Impacts of Energy Price and Demand on US Nuclear Fuel Cycle Capacity Sufficiency (ORNL/SPR-2023/3082). OAK RIDGE NATIONAL LABORATORY, Oak Ridge, TN.

[4] Davidson, E., Bae, J.W., Asgari M., Worrall, A., Hoffman, S., Richards, S., Kim, T.K., HALEU Facility Capacities and Production Rates Needed for Projected Nuclear Growth (ORNL/SPR-2023/3041). OAK RIDGE NATIONAL LABORATORY, Oak Ridge, TN.

[5] Bae, J.W., Mertyurek, U., Asgari, M., 2023. Pressurized Water Reactor Gadolinia Pin Location Optimization (No. ORNL/TM-2023/3098). OAK RIDGE NATIONAL LABORATORY, Oak Ridge, TN.

[6] 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.

[7] Hartanto, D., Chandler, D., Bae, J. W., Betzler, B., Burg, K., Sizemore, C. (2023). Uncertainty Quantification of Fuel Inhomogeneity in Low-enriched Uranium Silicide High Flux Isotope Reactor Design (No. ORNL/TM-2023/2923). Oak Ridge National Laboratory (ORNL), Oak Ridge, TN (United States).

[8] 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).

[9] 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

[10] 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.

[11] 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).

[12] 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).

[13] 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	

Model for the Assessment of Reprocessing and Recycle with Innovative Execution (MARIE), 2023
Advanced Research Projects Agency - Energy
Principal Investigator: A. Worrall (Oak Ridge National Laboratory)
With: R. Lefebvre, L. Martin, **J. Bae**, R. Ngelale (Oak Ridge National Laboratory)
Role: Used Nuclear Fuel capability and framework developer

Fusion REactor Design and Assessment (FREDA), 2023
SCIentific Discovery through Advanced Computing
Principal Investigator: C. Collins (Oak Ridge National Laboratory)
With: V. Badalassi, P. Snyder, **J. Bae**, et al. (Oak Ridge National Laboratory)
Role: Neutronics analysis and development lead

Engineering Optimization of First Wall Protection Limiters, 2023
ORNL Internal Laboratory Directed Research and Devlopment
Principal Investigator: K. Borowiec (Oak Ridge National Laboratory)
With: J. Rapp, **J. Bae**, A. Sircar, et al. (Oak Ridge National Laboratory)
Role: Neutronics analysis and development lead

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)
Role: Machine learning and data engineer and developer

AWARDS

- **Supplemental Performance Award**, Oak Ridge National Laboratory, 2022
  Recognized for exceeding expectation
- **Future Award**, North American Young Generation in Nuclear, 2023
  Recognized for contribution to the benchmarking committee

PROFESSIONAL INVOLVEMENT

EDITORIAL & REVIEW ACTIVITIES

- Nuclear Engineering and Design, 1 review p.a., 2021 - present
- Nuclear Engineering and Technology, 1 review p.a., 2024 - present
- Energies, 2 review p.a., 2021 - present
- Journal of Nuclear Engineering, 2 review p.a., 2021 - present

PROFESSIONAL SOCIETY INVOLVEMENT

- American Nuclear Society

- (2024) Oak Ridge / Knoxville Local ANS Section Executive Committee - Chair
    - (2023) Oak Ridge / Knoxville Local ANS Section Executive Committee - Vice Chair
- (2023) North American Young Generation in Nuclear (NAYGN) Benchmark Committee

RESEARCH MENTORING EXPERIENCE

Nathan Ryan, Graduate student, advised on developement of modular-fidelity reactor model for fuel cycle simulator CYCLUS, 2024.

Alexander DePillis, Graduate student, advised on research of nuclear reactor capital cost and fuel cycle cost, 2024.

Nathaniel Rogalski, Undergraduate student, advised on developing decoupled activation module for material irradiation calculation using open-source software, 2023.

Jack Fletcher, Undergraduate Research Assistant, advised on optimization of fusion reactor structural dimensions for tritium breeding ratio, 2021. Proceeded to be enrolled as a graduate student in MIT.

Dinara Ermakova, Graduate Research Assistant, advised on life-cycle externality assessment of electricity generation systems, 2021. Proceeded to Kairos power and Anthropocene Institute.

INTERNATIONAL WORKING GROUPS

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

SKILLS

- **Documentation:** LaTeX, MS Office
- **Analysis Tools:**
    - MCNP, Shift, SCALE/Polaris, SCALE/TRITON, OpenMC, SERPENT, PHITS — Transport Codes
    - Cyclus, ORION — Fuel Cycle Codes
    - OpenFOAM, 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