CURRICULUM VITAE

JungHyun Bae, Ph.D.

Eugene P. Wigner Distinguished Staff Fellow
Used Fuel and Nuclear Material Disposition Group
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EMPLOYMENT

Oct 2022 – present **Eugene P. Wigner Distinguished Staff Fellow,** Oak Ridge National Laboratory

- Monitoring of spent nuclear fuels (SNFs) and nuclear materials in non-reactor environments, such as dry storage and transportation
- Research projects
  - Cosmic radiation noise cancellation algorithm development in Radiation Portal Monitors (RPMs)
  - Development of an advanced muon tomography system by deploying a Cherenkov muon spectrometer
  - Development of a muon detector to analyze geological characteristics of permanent repository in the underground research laboratory (URL) located in Yucca Mountain area
  - Vacuum drying study of simulated failed spent nuclear fuel
  - Fatigue data analyses using a Cyclic Integrated Reversible-bending Fatigue Tester (CIRFT) for spent nuclear fuel vibration reliability study
  - Back-filled Helium gas sensor for interim dual-purpose SNF dry canisters

Sep 2012 – Nov 2010 **Sergeant (E-5),** Bravo Battery, 6-52 Air Defense Artillery, 35th Brigade, 8th United States Army
Served as KATUSA sergeant in the CBRN (Chemical, Bacteriological, Radiological and Nuclear) Defense Unit

EDUCATION

May 2022 – Aug 2017 **Doctor of Philosophy in Nuclear Engineering, Purdue University, West Lafayette**

- Dissertation: A Novel Muon Spectrometer Using Multi-Layer Pressurized Gas Cherenkov Radiators for Muon Tomography| GPA: 3.92/4.00
- Academic Advisor: Prof. Stylianos Chatzidakis

May 2016 – Aug 2015 **Master of Science in Nuclear Engineering, University of California, Berkeley**

- Academic Advisor: Prof. Per Peterson
- Thesis: Offshore Co-generation of Electricity and Desalinated Water: Floating Fluoride-Salt-Cooled High-Temperature Reactors (FHR) | GPA: 3.61/4.00

Aug 2015 – Mar 2013 **Bachelor of Science in Nuclear and Quantum Engineering, Korea Advanced Institute of Science and Technology (KAIST), Republic of Korea**

- Academic Advisor: Prof. Mansung Yim and Prof. Gyuseong Cho
- Thesis: Optimization of Signal to Noise Ratio by Analyzing Gamma Spectrum from PIN diode | GPA: 3.70/4.00

RESEARCH PROJECTS

Oct 2022 – Present

1. **A momentum integrated muon scattering tomography (MMST) for spent nuclear fuel cask imaging**
   - Role: Principal Investigator
   - ORNL Laboratory Director Research Development fund awarded for 3 years
2. **Cosmic radiation noise cancellation algorithm development in Radiation Portal Monitors**
   - Role: Principal Investigator
   - ORNL Laboratory Director Research Development fund awarded for 2 years
3. **Develop and establish experimental capabilities of flow diagnostics featuring ultrasound imaging technology**
   - Role: Co-Principal Investigator
   - 3D flow reconstruction from 2D ultrasound images
4. **Vacuum drying experiment for damaged spent nuclear fuel rods**
   - DOE Office of Nuclear Energy (NE) funded project
   - Development of mathematical model, computational simulation, and design of damaged fuel rod vacuum drying experiment
5. **Underground research laboratory muon detector project**
   - Supported by US DOE NE Spent Fuel and Waste Disposition, Spent Fuel and Waste Science and Technology
   - Collaborated with research groups of PNNL and Purdue University

6. **Fatigue data analyses using a Cyclic Integrated Reversible-bending Fatigue Tester (CIRFT) for spent nuclear fuel vibration reliability study**
- A part of US DOE-NE High Burnup Spent Fuel Data Project
- Test is performed to determine periodic impacts of the rod with other rods or the packaging during transport

Aug 2020 – Oct 2022

1. **Momentum integrated PoCA algorithm for muon scattering tomography**
- Develop a muon momentum integrated Point-of-Closest Approach (PoCA) algorithm to improve muon scattering tomography imaging resolution

2. **Effective solid angle model for cosmic ray muons flux estimation**
- Develop an improved cosmic muon flux estimation model
- Mathematically integrate detector configurations with cosine-squared model

3. **Cosmic ray muon in nuclear security applications**
- Investigate the effect of cosmic ray muon momentum measurement for monitoring the well-shielded special nuclear materials
- Demonstrated that scanning time in muon tomography and monitoring system can be shortened by a factor of 3 to 4 by measuring muon momentum

Aug 2019 - Aug 2020

Investigation of the thermohydraulic limits of PUR-1 reactor which is LEU plate-fueled, pool type, and cooled by natural circulation using CFD.
- Studied the maximum operating power without coolant boiling of PUR-1 reactor under the current coolant environment (natural circulation) and enhanced cooling capacities

Aug 2017 - Aug 2019

Computational Fluid Dynamics (CFD) analysis of thermohydraulic performances within spent nuclear fuel (SNF) dry casks with additives.
- Developed a Homogenous Additive Model (HAM) to simulate thermohydraulic behaviors of millions of small spherical additives within the SNF dry casks
- Collaborated with industrial partner, RGA Inc.

Aug 2015 - May 2017

Offshore electricity/desalination co-generation FHR nuclear power plant.
- Designed the concept of the floating Fluoride-Salt-Cooled High-Temperature Reactors (FHR) nuclear power plant

Mar 2014 - Aug 2015

1. **Optimization of SNR by analyzing gamma spectrum from PIN diode.**
- Analyzed the source of noise quantitatively and developed the algorithm to maximize the signal to noise ratio (SNR)

2. **Electric power generation with gamma battery from spent nuclear fuels.**
- Developed gamma battery charged by high-level radiation from the SNFs

SKILLS

[1] Stochastic Particle Transport/Monte Carlo Code Simulation
- GEANT4 | MCNP6.3

[2] Data Acquisition, Analysis, and Visualization
- ROOT | QT | R | Origin | ParaView

[3] Multiphysics, CFD, Thermohydraulic Simulation
- COMSOL-Multiphysics | ANSYS-FLUENT | RELAP5-3D

[4] Programming
- C/C++ | MATLAB | Python

TEACHING AND MENTORING

- Mentor graduate student | 2022 – present
  Student: Reshma Ughade (Purdue University)
  Mentoring for: M.S and Ph.D. Theses, Master of Science in Nuclear Engineering
- Mentor undergraduate student | 2021 – Present
  Student: Asif Anwar (Purdue University)
  Mentoring for: Undergraduate student research program in nuclear engineering education and training using virtual labs
- Nuclear Engineering Radiation Experiment I (NUCL 205)
  Delivered the fundamental knowledge of nuclear radiation measurement and detection for 40 engineering, physics, health physics sophomores | Spring 2019, Spring 2020
- Nuclear Engineering Radiation Experiment II (NUCL 305)
  Taught practical knowledge of nuclear radiation measurement and detection for 29 nuclear engineering seniors | Fall 2019
- Advanced Nuclear Engineering Radiation Experiment (NUCL 504: Graduate level)
  Taught the advanced knowledge for nuclear engineering graduate students | Spring 2018

CERTIFICATES

- Engineer in Training (EIT)
  Licensed by National Council of Examiners for Engineering and Surveying (NCEES)
- Completion of Thermal-hydraulic and Accident Analysis course at Korean Atomic Energy Research Institute (KAERI)
- Completion of Nuclear Policy School at Korean Nuclear International Cooperation Foundation (KONICOF)

LEADERSHIP EXPERIENCES

- Session Chair
  - Technical Session: Modeling and Testing for UNF Storage, Integrity, and Transportation
  - American Nuclear Society Annual Meeting, *June 9-12, 2024*, Las Vegas, NV
- Session Chair
  - Technical Session: Spent Fuel Transportation Needs and Alternative Fuel Options
  - American Nuclear Society Winter Meeting, *Nov 12-15, 2023*, Washington, DC
- Technical Session Judge
  - American Nuclear Society Student Conference, *April 13-15, 2023*, Knoxville, TN
  - Radiation Detection and Imaging III
- Session Chair
  - Technical Session: Advanced Monitoring and Characterization I
  - American Nuclear Society Winter Meeting*, Nov 13-17, 2022*, Phoenix, AZ
  - https://www.ans.org/meetings/wm2022/session/view-1534/
- Session organizer
  - Hosted the international INMM conference (CAN 2019) in Purdue University
- Founding Member of the Institute of Nuclear Materials Management Purdue Chapter
- Graduate representative of Department of Nuclear Engineering in UC Berkeley
- Mentor UAE students at the KUSTAR-KAIST program
- Student President of Department of Nuclear and Quantum Engineering at KAIST
- 2012 KATUSA (Korean Augmentation to the United States Army) of the year

PROFESSIONAL AFFILIATIONS

- American Nuclear Society (ANS)
- Korean-American Scientists and Engineers Association (KSEA)
- Institute of Nuclear Materials Management (INMM)
- American Society of Mechanical Engineering (ASME)
- Institute of Electrical and Electronics Engineers (IEEE)

INVITED PRESENTATIONS

- GEN IV International Forum (**GIF**) | July 2022
- Wigner Distinguished Staff Fellow (**ORNL**) | May 2022
- US-Korea Conference (**UKC**) | Jan 2022
- Waste Management Symposium (**WMS**) | March 2020

INVITED ACTIVITIES

- Reviewer for peer-reviewed journal (**Scientific Reports, Nature**) | March 2024 - present
- Reviewer for 2024 **ANS annual conference** transactions | June 2024

- Reviewer for 2024 **ANS student conference** transactions | April 2024
- Reviewer for 2023 **ANS winter meeting** transactions | Aug 2023
- Reviewer for 2023 **ANS annual meeting** transactions | Feb 2023
- Reviewer for 2023 **ANS student conference** transactions | Feb 2023
- Reviewer for peer-reviewed journal (**Chinese Journal of Aeronautics, Science Direct**) | April 2023 – Present
- Reviewer for peer-reviewed journal (**Journal of Atmospheric and Solar-Terrestrial Physics, Elsevier**) | Jan 2023 – Present
- Reviewer for peer-reviewed journal (**Journal of Radiation Research and Applied Sciences, Elsevier**) | October 2022 – Present
- Reviewer for peer-reviewed journal (**Nuclear Science and Engineering, ANS**) | April 2022 – Present
- Reviewer for peer-reviewed journal (**Advances, AIP**) | Aug 2021 – Present
- Invited journal article submission (**Energies, MDPI**) | April 2022

FELLOWSHIP AND SCHOLARSHIPS

1. Eugene P. Wigner Distinguished Staff Fellowship
    - Organization: Oak Ridge National Laboratory
    - Date of award: 10/2022
    - Award for: Recognition for outstanding contributions to cosmic ray muon tomography
2. American Nuclear Society (ANS) Graduate Scholarship
    - Organization: American Nuclear Society
    - Date of award: 8/2022
    - Award for: Recognition for contributions to waste management
3. Korean American Science and Engineering Association (KSEA) Scholarship
    - Organization: Korean American Science and Engineering Association
    - Date of award: 4/2021
    - Award for: Outstanding graduate students who excel in academics and have demonstrated a potential to become future leaders of the society
4. Purdue Outstanding Graduate Scholarship
    - Organization: Purdue University
    - Date of award: 3/2021
    - Award for: Recognition by the College of Engineering, Purdue University for outstanding research contribution and academic record
5. American Nuclear Society (ANS) Outstanding Graduate Scholarship
    - Organization: American Nuclear Society
    - Date of award: 8/2020
    - Award for: Recognition for contributions to waste management

6. Roy G. Post Foundation Scholarship (March 2020)
    - Organization: Roy G. Post Foundation
    - Date of award: 3/2020
    - Award for: Recognition for outstanding contributions to waste management

AWARDS AND HONORS

- ORNL's Laboratory Director Research Development fund for 2024 – 2025 (Principal Investigator) (Aug 2023)
- ORNL's Laboratory Director Research Development Distinguished Staff fellowship fund for 2023 – 2025 (Principal Investigator) (Jan 2023)
- Grant Award from Group of Instrumentation and Measurement Science (GIMS) in American Physical Society (APS) (Sept 2022)
- American Nuclear Society *Alpha Nu Sigma (ANΣ)* honor society lifetime member (May 2022)
- Braslau Family Grant, American Physics Society, APS March meeting (March 2022)
- **Best Presentation Award**, US-Korea Conference on Science and Technology 2021 (Dec 2021)
- Winner of "Pitch your PhD" competition in the 2021 ANS Winter meeting (Dec 2021)
- **Best Paper Award**, 28th International Conference on Nuclear Engineering (Sept 2021)
- Conference Travel Fund from the College of Engineering, Purdue University (August 2021)
- IEEE Nuclear Science Symposium and Medical Imaging Conference Trainee Grant (July 2021)
- Purdue Graduate School CARES scholarship (July 2021)
- Purdue University College of Engineering Magoon Excellence in Teaching Award (March 2021)
  Award for: Outstanding performance as an instructor and teaching assistant.
- Prof. Audeen Fentiman Award for Conference (June 2018)
  Award for: Outstanding research presenter at the professional conference
- Research/Teaching Assistantships at Purdue University (August 2017 to present)
- Full-years Korean government national scholarships (March 2013 – August 2015)
- Best presentation award for the nuclear energy policy competition by KNEPA and KNF
- Achievement scholarship by the department of Nuclear and Quantum Engineering at KAIST
- Army Commendation Medal (ARCOM) awarded by U.S Army
- Army Achievement Medals (AAM) awarded by U.S Army

LIST OF PUBLICATIONS

Peer-Reviewed Journal Articles

[1] **J. Bae**, Rose Montgomery, and S. Chatzidakis, "Nuclear Material Accountancy Using Momentum-Informed Muon Scattering Tomography*", Annals of Nuclear Energy,* **197** (2024) DOI: https://doi.org/10.1016/j.anucene.2023.110240

[2] **J. Bae**, Rose Montgomery, and S. Chatzidakis, "Enhanced Material Identification via Momentum Integrated Muon Scattering Tomography", *Nuclear Science and Technology* (2024) (under review)

[3] **J. Bae**, Rose Montgomery, and S. Chatzidakis, "Monitoring spent nuclear fuel dry casks using momentum integrated muon scattering tomography", *Nature Scientific Reports* (2024) (under review)

[4] **J. Bae**, Rose Montgomery, and S. Chatzidakis, "Image Reconstruction Algorithm for Momentum Dependent Muon Scattering Tomography" *Nuclear Engineering ang Technology,* **55** (2023)
DOI: https://doi.org/10.1016/j.net.2023.12.009

[5] R. Ughade, **J. Bae**, and S. Chatzidakis, "Performance Evaluation of Cosmic Ray Muon Trajectory Estimation Algorithms", *AIP Advances,* **13** (2023)
DOI: https://doi.org/10.1063/5.0174796

[6] **J. Bae** and S. Chatzidakis, "Development of Compact Muon Spectrometer Using Multi-Layer Gas Cherenkov Radiators" *Results in Physics,* **39** 105771 (2022).
DOI: https://doi.org/10.1016/j.rinp.2022.105771

[7] **[Dissertation] J. Bae**, "A Novel Muon Spectrometer Using Multi-Layer Pressurized Gas Cherenkov Radiators for Muon Tomography", *Purdue University*. (2022).
DOI: https://doi.org/10.25394/PGS.19686633.v1

[8] [**INVITED**] **J. Bae** and S. Chatzidakis, **"**Momentum-Dependent Cosmic Ray Muon Computed Tomography Using a Fieldable Muon Spectrometer", *Energies*, **15(7)**, 2666 (2022).
DOI: https://doi.org/10.3390/en15072666

[9] **J. Bae** and S. Chatzidakis, "A Fieldable Muon Spectrometer for Nuclear Security Applications", *Nature Scientific Reports***, 12,** 2559 (2022).
DOI: https://doi.org/10.1038/s41598-022-06510-2

[10] **J. Bae** and S. Chatzidakis, "A New Semi-Empirical Model for Cosmic Ray Muon Flux Estimation", *Progress of Theoretical and Experimental Physics*, **2022**(4) (2022).
DOI: https://doi.org/10.1093/ptep/ptac016

[11] S. Chatzidakis and **J. Bae**, "Advances in Cosmic Ray Muon Computed Tomography and Fieldable Spectroscopy" *HNPS Advances in Nuclear Physics* **28**, 184-190 (2022).

[12] **J. Bae** and R. Bean, "Investigation of Thermohydraulic Limits on Maximum Reactor Power in LEU Plate-Fueled, Pool-Type Research Reactor", *Nuclear Science and Engineering*, **196**

(2022).
DOI: https://doi.org/10.1080/00295639.2022.2055700

[13] **J. Bae**, R. Bean and R. Abboud, "CFD Analysis of a Dry Storage Cask with Advanced Spent Nuclear Fuel Cask Additives", *Annals of Nuclear Energy*, **145** (2020)

[14] **J. Bae**, A. Shirer, C. Yin and P. Peterson. "Offshore Electricity and Desalination Cogeneration FHR Nuclear Power Plant: TRIDENT," Dept. of Nuclear Engineering*, UCB, Report UCBTH-16-001* (2016)

Book Chapter

[1] **J. Bae**, R. Ughade, S. Chatzidakis, "Chapter title: Gamma Ray and Cosmic Ray Muon Modalities for Cargo Inspection," Elsevier (in preparation)

Technical Reports/Memos

[1] **J. Bae**, and R. Montgomery, "*GEANT4 Simulation and MATLAB Data Processing and Imaging Packages for Momentum-Dependent Muon Scattering Tomography*", ORNL/TM-2023/3181 (under review) (2023)

[2] **J. Bae**, and P. Cantonwine, *"A Vacuum Drying Study of Simulated Failed Nuclear Fuel (FY23)",* ORNL/SPR-2023/3081 (2023)

[3] S. Tognini, **J. Bae**, H. Gadey, and K Deisenroth, "*URL Muon Detector Project Simulation Status Report"*, ORNL/SPR-2023/2987 (2023)

[4] J. Meszaros, S. Tognini, R. Montgomery, R. Howard, H. Gadey, **J. Bae**, and S. Chatzidakis, "*Underground Research Laboratory Muon Detector Project Progress Report*", M4SF 21OR010310051 (2021)

Oral/Poster Presentation and Conference Proceedings

[1] **J. Bae**, R. Bean, K. Mondal, S. Tognini, A. Enders, R. Montgomery, "*Radiation Source Localization Algorithm in the Pedestrian Radiation Portal Monitor*", ANS Annual Conference, June 9-12, 2024, Las Vegas, NV.

[2] S. Tognini, **J. Bae**, R. Bean, K. A. Enders, Mondal, R. Montgomery, "*Simulation Framework for Cosmic Ray Muon Impact on Radiation Portal Monitor*", ANS Annual Conference, June 9-12, 2024, Las Vegas, NV.

[3] **J. Bae**, R. Montgomery, S. Chatzidakis, "*Nuclear Material Accountancy Using Momentum Integrated Muon Scattering Tomography*", ANS Winter Meeting, Nov 12-15, 2023, Washington, DC.

[4] R. Ughade, **J. Bae**, S. Chatzidakis, "*Assessment of Performance for Algorithms Estimating Cosmic Ray Muon Trajectories*", Transactions of American Nuclear Society **129**, 369-372 (2023).

[5] **J. Bae**, R. Montgomery, P, Shikhaliev, R. Bean, "*Momentum-Informed Muon Scattering Tomography for Spent Nuclear Fuel Storage Monitoring*", LDRD Poster Fair, Sep 27, 2023, ORNL.

[6] **J. Bae**, R. Montgomery, S. Chatzidakis, "*A New Momentum-Integrated Muon Tomography Imaging Algorithm*", Transactions of American Nuclear Society **128**, 122-125 (2023).

[7] **J. Bae** and S. Chatzidakis, "*Monitoring Spent Nuclear Fuel in a Dry Cask Using Momentum Integrated Muon Scattering Tomography*," Transactions of American Nuclear Society **127**, 828-832 (2022).

[8] H. Gadey, R. Howard, S. Tognini, J. Meszaros, R. Montgomery, S. Chatzidakis, **J. Bae**, R. Clark, "Using Cosmic Ray Muons to Assess Geological Characteristics in the Subsurface" Transactions of American Nuclear Society **127**, 802-806 (2022).

[9] **[INVITED] J. Bae**, "*A High-Resolution Muon Spectrometer Using Multi-Layer Gas Cherenkov Radiators*", GEN IV International Forum, July 27, 2022, online.

[10] **J. Bae** and S. Chatzidakis, "*Muon Spectrometer-Tomography System for Monitoring Spent Nuclear Fuel Casks*", Proceedings of Institute of Nuclear Materials Management (INMM) (2022).

[11] **J. Bae** and S. Chatzidakis, "*Non-Linear Cherenkov Muon Spectrometer Using Multi-Layer Pressurized C_3F_8 Gas Radiators*", ANS Annual Meeting, Transactions of American Nuclear Society **126**, 818-821 (2022).

[12] Z. Dahm, A. Anwar, S. Chatzidakis, and **J. Bae**, "*Next Generation Nuclear Engineering Education and Training Using Virtual Labs*", Transactions of American Nuclear Society **126**, 45-48 (2022).

[13] A. Anwar, **J. Bae**, and S. Chatzidakis, "*Modeling Helium-3 Neutron Detectors for Virtual Labs in Nuclear Engineering*", ANS Student Conference (2022).

[14] **J. Bae** and S. Chatzidakis, "*A High-Resolution Muon Spectrometer Using Multi-Layer Gas Cherenkov Radiators*", American Physical Society (APS) March Meeting, Mar 14-18, 2022, Chicago, IL.

[15] **J. Bae** and S. Chatzidakis, "*Applied Gas Cherenkov Radiators to Measure Cosmic Ray Muon Momentum*", Proceedings of UKC (2021)

[16] A. Anwar, Z. Dahm, **J. Bae**, M. Sharpe, G. Takahashi, and S. Chatzidakis, "*Developing high fidelity, real-time nuclear-based Virtual Laboratories using physics-based modeling and authentic 3D machine interfaces*", NESTet conference 2021 (virtual).

[17] **J. Bae** and S. Chatzidakis, "*Fieldable Muon Momentum Measurement using Coupled Pressurized Gaseous Cherenkov Detectors*", Trans. Am. Nuc. Soc. **125**, 400-403 (2021).

[18] **J. Bae** and S. Chatzidakis, "*A Cosmic Ray Muon Spectrometer Using Pressurized Gaseous Cherenkov Radiators*", IEEE NSS-MIC Conf. Records (2021).

[19] **J. Bae** and S. Chatzidakis, "*The Effect of Cosmic Ray Muon Momentum Measurement for Monitoring Shielded Special Nuclear Materials*", proceedings of INMM, (2021).

[20] **J. Bae** and S. Chatzidakis, R. Bean, "*Effective Solid Angle Model and Monte Carlo Method: Improved Estimations to Measure Cosmic Muon Intensity at Sea Level in All Zenith Angles*", ICONE28 proceedings, **4** (2021).
[21] [**INVITED**] **J. Bae**, R. Bean, and R. Abboud, "*A Critical and CFD Analysis of a Dry Storage Cask with Advanced Spent Nuclear Fuel Cask Additives*", Waste Management Symposium (WMS), Phoenix, AZ, (2020).
[22] **J. Bae** and R. Bean, "*Analytical Methods in Safeguards for Nuclear Nonproliferation and Complete, Verifiable, Irreversible Denuclearization (CVID) of North Korea*", INMM proceedings (2019).
[23] **J. Bae**, R. Bean, and R. Abboud, "*A Criticality Analysis of a Dry Storage Cask with Advanced Nuclear Fuel Cask Additive*", Trans. Am. Nuc. Soc. **118**, 147-150 (2018).