

# Nuclear Science and Engineering



VOLUME 197 · NUMBER 8 · AUGUST 2023

**Special issue featuring papers from the 2022 International Conference on Physics of Reactors (PHYSOR 2022)**

## Contents

- vii Foreword  
*Vefa N. Kucukboyaci*

### RESEARCH ARTICLES

- 1545** On the Effect of Scalar Flux Weighting of Linearly Anisotropic Scattering Matrices in Higher-Order Transport Calculations  
*Zoltán István Böröczki, Boglárka Babcsány, János Endre Maróti, Máté Szieberth*
- 1564** Geometry Extension and Assemblywise Domain Decomposition of nTRACER for Direct Whole-Core Calculation of VVERs  
*Seongchan Kim, Han Gyu Joo*
- 1584** Spherical Harmonics and Discontinuous Galerkin Finite Element Methods for the Three-Dimensional Neutron Transport Equation: Application to Core and Lattice Calculation  
*Kenneth Assogba, Lahbib Bourhrara, Igor Zmijarevic, Grégoire Allaire, Antonio Galia*
- 1600** Enhancing Monte Carlo Workflows for Nuclear Reactor Analysis with Metamodel-Driven Modeling  
*Peter J. Kowal, Camden E. Blake, Kurt A. Dominesey, Robert A. Lefebvre, Forrest B. Brown, Wei Ji*
- 1621** Bayesian Estimation of Cross Section, Experimental Error, and Calculation Error: Comparison with Bias Factor Method  
*Satoshi Takeda, Takanori Kitada*
- 1634** Capability Extension of the High-Resolution Thermal-Hydraulic Code ESCOT for Hexagonal Geometry Core Multiphysics Analysis  
*Jorge Gonzalez-Amoros, Marianna Papadionysiou, Seongchan Kim, Han Gyu Joo*
- 1656** MOOSE Reactor Module: An Open-Source Capability for Meshing Nuclear Reactor Geometries  
*Emily Shemon, Yinbin Miao, Shikhar Kumar, Kun Mo, Yeon Sang Jung, Aaron Oaks, Scott Richards, Guillaume Giudicelli, Logan Harbour, Roy Stogner*
- 1681** An Inline Burnup Algorithm  
*P. Cosgrove, E. Shwageraus, J. Leppänen*

—continued—

## Contents continued

VOLUME 197 · NUMBER 8 · AUGUST 2023

- 1700** An Efficient High-to-Low Iterative Method for Light Water Reactor Analysis Based on NEAMS Tools  
*Kan Ni, Jason Hou*
- 1717** Development of a 3D APOLLO3® Neutron Deterministic Calculation Scheme for the CABRI Experimental Reactor  
*Tommy Coissieux, Julien Politello, Claire Vaglio-Gaudard, Karim Ammar*
- 1733** Experimental Estimation of the Kinetic Parameters of MINERVE Zero Power Reactor  
*Guy Shtotland, Assaf Kolin, Benoit Geslot, Patrick Blaise, Nir Kastin*
- 1743** Multiphysics Analysis System for Heat Pipe–Cooled Micro Reactors Employing PRAGMA-OpenFOAM-ANLHTP  
*Jaeuk Im, Myung Jin Jeong, Namjae Choi, Kyung Min Kim, Hyoung Kyu Cho, Han Gyu Joo*
- 1758** Preliminary Neutronics Design and Analysis of the Fast Modular Reactor  
*Hangbok Choi, Darrin Leer, Matthew Virgen, Oscar Gutierrez, John Bolin*
- 1769** Variable Dynamic Mode Decomposition for Estimating Time Eigenvalues in Nuclear Systems  
*Ethan Smith, Ilham Variansyah, Ryan McClaren*
- 1779** Beta-Ray-Bremsstrahlung Contributions to Short-Lived Delayed Photoneutron Groups in Heavy Water Reactors  
*Yanuar Ady Setiawan, Hemantika Sengar, Douglas A. Fynan, Arief Rahman Hakim*
- 1800** Influence of Quantum Oscillations in the Thermal Scattering Law of Zirconium Carbide on Neutron Thermalization and Criticality  
*J. L. Wormald, J. C. Holmes, M. L. Zerkle*
- 1814** Feynman- $\alpha$  Analysis Using BGO Gamma-Ray Detector in a University Training and Research Reactor  
*Masaki Goto, Tadafumi Sano, Kunihiro Nakajima, Takashi Kanda, Atsushi Sakon, Kengo Hashimoto*
- 1823** High-Performance and High-Fidelity GPU-Based Monte Carlo Solutions to the BEAVRS Benchmark  
*Kyung Min Kim, Jaeuk Im, Namjae Choi, Han Gyu Lee, Han Gyu Joo*

—continued—

# Contents continued

VOLUME 197 · NUMBER 8 · AUGUST 2023

- 1845** EBR-II MOX Fuel Characterization Enabling ARES Phase I Testing  
*John D. Bess, Andrew S. Chipman, Chad L. Pope, Colby B. Jensen, Takayuki Ozawa, Shun Hirooka, Masato Kato*
- 1873** Phonon Sampling Method for Inelastic Thermal Neutron Scattering Events  
*Amelia Trainer, Benoit Forget*
- 1887** FLASSH 1.0: Thermal Scattering Law Evaluation and Cross-Section Generation for Reactor Physics Applications  
*N. Colby Fleming, Cole A. Manring, Briana K. Laramee, Jonathan P. W. Crozier, Eunji Lee, Ayman I. Hawari*
- 1902** Core Reload Design Using Genetic Optimization for Cost Savings in a Two-Reactor Power Plant With Used Fuel Sharing  
*Benjamin Lilley, Todd S. Palmer*
- 1911** Scoping Studies for a Lead-Lithium-Cooled, Minor-Actinide-Burning, Fission-Fusion Hybrid Reactor Design  
*Joshua Ruegsegger, Connor Moreno, Matthew Nyberg, Tim Bohm, Paul P. H. Wilson, Ben Lindley*
- 1928** Multi-Output Gaussian Processes for Inverse Uncertainty Quantification in Neutron Noise Analysis  
*Paul Lartaud, Philippe Humbert, and Josselin Garnier*
- 1952** Deep Subcriticality Determination Using the Source Jerk Integral Method in the SALMON Program  
*A. Kochetkov, A. Krásá, N. Messaoudi, G. Vittiglio, J. Wagemans, A. Bailly, A. Billebaud, S. Chabod, F.-R. Lecolley, J.-L. Lecouey, G. Lehaut, N. Marie*
- 1961** Study of Reactor Core Loading Monitoring at the GUINEVERE Facility  
*A. Bailly, J.-L. Lecouey, A. Billebaud, S. Chabod, A. Kochetkov, A. Krásá, F.-R. Lecolley, G. Lehaut, N. Marie, N. Messaoudi, G. Vittiglio, J. Wagemans*
- 1972** Horizontal Split-Table Conceptual Design to Support Advanced Reactor Validation Needs  
*Mathieu N. Dupont, Daniel J. Siefman, Justin B. Clarity, Catherine M. Percher*
- 1991** State of the Art on Doppler Broadening: Modern Developments on the Fuel Temperature Coefficient  
*David Friant, David Bernard, Patrick Blaise*

—continued—

## Contents continued

VOLUME 197 · NUMBER 8 · AUGUST 2023

- 2007** Benchmark of Neutron Thermalization in Graphite Using a Pulsed Slowing-Down-Time Experiment

*Eunji Lee, N. Colby Fleming, Ayman I. Hawari*

- 2017** Development of Experimental Core Configurations to Clarify  $k_{\text{eff}}$  Variations by Nonuniform Core Configurations

*Satoshi Gunji, Shouhei Araki, Kenya Suyama*

- 2030** Space-Dependent Calculation of the Multiplicity Moments for Shells With the Inclusion of Scattering

*Imre Pázsit, Victor Dykin, Flynn Darby*

- 2047** A Generalized Eigenvalue Formulation for Core-Design Applications

*Nicolo' Abrate, Sandra Dulla, Piero Ravetto, Paolo Saracco*

- 2072** Transition Core Modeling for Extended-Enrichment Accident-Tolerant Fuels in Light Water Reactors Using PARCS/Polaris

*Muhammad Rizki Oktavian, Ugur Mertyurek, Yunlin Xu*

- 2086** Utilizing Sensitivity and Correlation Coefficients from MCNP and Whisper to Guide Microreactor Experiment Design

*Alexis Maldonado, Christopher Perfetti*

- 2099** Estimation of Near-Field and Far-Field Post-Accident Atmospheric Dispersion for Microreactors

*Rohan Biwalkar, Kenneth Redus, Adam Stein, Sola Talabi*

- 2117** Using a Random Forest Model to Choose Optimized Group Structures

*Thomas G. Saller, Vishnu Nair, Andrew Till, Nathan Gibson*

- 2136** Improving the Predictivity of a Steam Generator Clogging Numerical Model by Global Sensitivity Analysis and Bayesian Calibration Techniques

*L. Lefebvre, M. Segond, R. Spaggiari, L. Le Gratiet, E. Deri, B. Iooss, G. Damblin*

- 2150** Neutronic Evaluation and Optimization of the Centrifugal Nuclear Thermal Rocket Concept

*William J. Walters*

- 2161** Feasibility of Using Poisons to Suppress the Positive Temperature Reactivity Coefficient in Hydride-Moderated Reactors

*Vedant K. Mehta, Zachary A. Miller, Dasari V. Rao*

—continued—

# Contents continued

VOLUME 197 · NUMBER 8 · AUGUST 2023

- 2176** Design of a Fast Molten Salt Reactor for Space Nuclear Electric Propulsion  
*F. Quinteros, P. Rubiolo, V. Ghetta, J. Giraud, N. Capellan*

- 2192** A Nonintrusive Nuclear Data Uncertainty Propagation Study for the ARC Fusion Reactor Design  
*Alex Aimetta, Nicolò Abrate, Sandra Dulla, Antonio Froio*

- 2217** The Virtual Test Bed (VTB) Repository: A Library of Reference Reactor Models Using NEAMS Tools  
*Guillaume L. Giudicelli, Abdalla Abou-Jaoude, April J. Novak, Ahmed Abdelhameed, Paolo Balestra, Lise Charlot, Jun Fang, Bo Feng, Thomas Folk, Ramiro Freile, Thomas Freyman, Derek Gaston, Logan Harbour, Thanh Hua, Wen Jiang, Nicolas Martin, Yinbin Miao, Jason Miller, Isaac Naupa, Dan O'Grady, David Reger, Emily Shemon, Nicolas Stauff, Mauricio Tano, Stefano Terlizzi, Samuel Walker, Cody Permann*

- 2234** Evaluating Quantities of Interest Other Than Nuclide Densities in the Bateman Equations  
*Olin W. Calvin, Micah D. Gale, Sebastian Schunert*

## NOTE

- 2251** Reactor Physics Experiment on a Graphite-Moderated Core to Construct Integral Experiment Database for HTGR  
*Shoichiro Okita, Yuji Fukaya, Atsushi Sakon, Tadafumi Sano, Yoshiyuki Takahashi, Hironobu Unesaki*