



Improved Monte Carlo Methods Using Automated Variance Reduction and Reliability Diagnostics

MTV Kickoff Meeting

May 22, 2019

Brian Kiedrowski
University of Michigan



Introduction and Motivation

- Monte Carlo calculations are often used to find radiation fields, detector responses, etc. in nonproliferation applications, especially when high-fidelity results are needed
 - No inherent physics approximations
 - Slow convergence and uncertainties can lead to unreliable results
 - Variance reduction is a solution, but time consuming for the analysis
- This project will develop new automated variance reduction schemes to accelerate calculations and limit burdens on analyst
- Revisit statistical diagnostics to ensure results have been adequately converged and reliable



Mission Relevance

- Simulation of radiation fields are used throughout NNSA for technical analyses involving radioactive and nuclear materials
- Ensuring these calculations can be performed efficiently and that the results can be trusted is important to making informed decisions in a timely manner



Technical Work Plan

- Year 1: Transport Model Database
 - Develop database of MCNP models in common format with information about which VR techniques are useful
- Year 2: Selection of Variance Reduction Techniques
 - investigate data analytics and computer vision methods to identify similarities of application models to database models
- Years 3-4: Tuning of Variance Reduction Parameters
 - Use automated variance reduction techniques developed during CNEC to optimize parameters
- Year 5: Reliability Diagnostics
 - Supplement “10 statistical checks” in MCNP with modern statistical methods
- Project will involve heavy collaboration with LANL’s MCNP Development Team



Expected Impact

- Provide a prototype platform for next-generation automated variance reduction and statistical reliability diagnostics using MCNP
- This project will be shared with LANL for potential integration into the MCNP distribution
- This impact is more efficient radiation transport calculations that produce more reliable results



MTV Impact

- MTV will provide research collaborations with other universities and national laboratories to provide relevant radiation transport application models to focus the work
 - Also collaborate with ETI and take lessons from CNEC Data Fusion thrust area
- The goal is to continue the robust UM pipeline into the national laboratory system
 - CNEC trained two new staff for the MCNP Development Team, will need to provide new junior staff in the next 3-5 years
- Methods and capabilities developed in this project will be transferred over to LANL for integration into the MCNP package



Conclusion

- This project will provide new methodologies and capabilities to improve the workflow for radiation transport calculations within the nonproliferation mission
- Faster and more reliable results mean more efficient turnaround in nonproliferation analyses
- Continue student pipeline from the University of Michigan to DOE national labs



Acknowledgements



The Consortium for Monitoring, Technology, and Verification would like to thank the NNSA and DOE for the continued support of these research activities.



This work was funded by the Consortium for Monitoring, Technology, and Verification under Department of Energy National Nuclear Security Administration award number DE-FOA-0001875

