Moataz Harb

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SUMMARY

Nuclear engineer (Ph.D.) with over 9 years of a broad experience in the application and development of advanced computational tools/methods for radiation transport using both deterministic and stochastic (Monte Carlo) methods with application of variance reduction techniques. Experienced with CAD modeling of complex advanced reactor systems, computational nuclear analysis supporting shielding designs, and biological shutdown dose rate (SDDR) assessment using advanced multi-step computational schemes. Ph.D. thesis involved developing and implementing computational tools for Monte Carlo statistical uncertainty propagation in activation & SDDR calculation workflows.

EDUCATION

Ph.D., Nuclear Engineering   **May 2019**
University of Wisconsin - Madison, USA

- Thesis Topic: **Propagation of statistical uncertainty in mesh-based shutdown dose rate calculations**
- Advisor: Paul P. H. Wilson
- Major: Nuclear Engineering and Engineering Physics
- Minor: Mathematics and Computer Science
- Funding: covered in part by projects DE-FG02-99ER54513 and DE-SC0017122 from the US Department of Energy (DOE), Office of Fusion Energy Sciences.

M.S., Nuclear Engineering   **December 2018**
University of Wisconsin - Madison, USA

- GPA: 3.63/4

B.S., Nuclear Engineering   **June 2010**
Alexandria University, Egypt

- Major: Nuclear Engineering
- GPA: 3.65/4 (Distinction with First Degree of Honor)

WORK EXPERIENCE: RESEARCH

R&D Associate Staff Member   **October 2022 - present**
Oak Ridge National Laboratory (ORNL), USA

- Nuclear Analysis:
    - Assessment of the Occupational Radiation Exposure (ORE) for various maintenance activities around irradiated components in ITER upper ports no. 02, 08, and 14.

- Revising various radiation shielding benchmarks from the Shielding Integral Benchmark Archive and Database (SINBAD) in collaboration with CFS, funded by Department of Energy (DOE).

- Consultation:

  - Serving as a nuclear analysis expert for US ITER in support of the US design efforts of ITER upper ports no. 02, 08, 11, and 14.

  - Aiding the design of upper port plug no. 11 through the development of a high fidelity radiation transport model.

  - Advising nuclear analysis efforts of ITER upper port no. 11; covering assessment of radiation fields, shielding design, radiation damage, and biological doses.

- Code development:

  - Development and maintenance of the CAD-to-CSG conversion code McCAD.

  - Benchmarking McCAD conversion algorithm.

Postdoctoral Researcher   **April 2019 - October 2022**

Karlsruhe Institute of Technology (KIT), Germany

- Nuclear Analysis of ITER Test Blanket Module (TBM):

  - Preparation of isolated MCNP models of the Pipe Forest (PF) and Bio-shield Plug (BP) from CAD and integration into C-Model (40°sector).

  - Assessment of radiation fields (neutron & gamma) during machine operation in one of the equatorial ports using MCNP.

  - Assessment of shielding performance and recommendation on shielding optimization of the BP.

  - Assessment of Shutdown Dose Rate (SDDR) at several cooling times in the port interspace using D1S method.

  - Radioactive waste classification due to activation using FISPACT-II code.

- Code development:

  - Refactoring and development of McCAD, an automatic CAD-to-CSG conversion tool, by implementing modern coding practices in C++; modularization and parallel processing.

  - Development of a novel and robust conversion algorithm for CAD-to-CSG conversion of complex models.

Graduate Research Assistant (RA)   **September 2013 - March 2019**

University of Wisconsin - Madison, USA

- Propagation of statistical uncertainty in mesh-based shutdown dose rate calculations (Dissertation):

  - Development of a computational scheme for the quantification and propagation of Monte Carlo statistical uncertainty in the Rigorous 2-step (R2S) workflow for shutdown dose rate (SDDR) calculation in complex advanced reactors.

- Fusion Energy Systems Studies - Fusion Nuclear Science Facility (FESS-FNSF):
  - Design of transportation cask for irradiated components and setting a maintenance schedule.
    * Performed neutron & gamma transport using UW-Madison CAD-based code, DAG-MCNP5, and activation analysis using UW-Madison code, ALARA.
    * Assessed the radiation fields due to activated components after shutdown and produced SDDR maps.
  - Nuclear Analysis during Operation:
    * Performed nuclear analyses on a high fidelity 3D model of the facility, using UW-Madison CAD-based neutron transport code DAG-MCNP5.
    * Aided the design of divertor plates and shielding as well as the configuration of plasma facing components.
    * Assessed the effect of design details (FW, SW, cooling channels, penetrations) on the tritium breeding ratio (TBR) of dual coolant lithium lead (DCLL) design.
    * Provided design-necessary radiation damage parameters at FW and magnets.
- High Temperature Superconducting - Fusion Nuclear Science Facility (HTS-FNSF):
  - Developed a high fidelity 3D CAD model of the facility.
  - Performed neutronics analyses in support of developing the conceptual design using UW-Madison CAD-based neutron transport code DAG-MCNP5.
    * Optimization of the breeding blanket configuration via analysis of the tritium breeding ratio (TBR) for the dual coolant lithium lead (DCLL) design.
    * Calculated radiation damage parameters at FW and magnets.

WORK EXPERIENCE: TEACHING

Teaching Assistant (TA)   **September 2010 - June 2013**

Assisted in teaching the following classes in the Nuclear and Radiation Engineering department at Alexandria University, Egypt.
- Modern physics
- Introduction to engineering materials sciences
- Introduction to nuclear and radiation engineering
- Nuclear physics
- Heat transfer
- Plasma and electromagnetic theory
- Nuclear reactor physics
- Radiation shielding

PROFESSIONAL SKILLS

Nuclear Engineering/Scientific

- Monte Carlo transport codes such as MCNP6, DAGMC, KENO-VI, MAVRIC, SRIM/TRIM and deterministic codes such as PARTISN/DANTSYS, ADVANTG.
- Activation and inventory analysis codes such as ALARA, FISPACT-II, ORIGEN.
- Scientific/numerical analysis tools such as NumPy, SciPy, MATLAB, Maple.

Software/Coding

- Operating systems: Linux (Ubuntu, Debian, etc.), Windows.
- Programming languages: Python, C++, FORTRAN (familiar).
- Version control: GitHub, Docker.
- Building systems: CMake.
- Database formats: HDF5 (familiar), MOAB (familiar).
- CAE/CAD tools: CUBIT/Trelis, SpaceClaim, FreeCAD.
- Visualization: Visit, Paraview.
- Productivity tools: LaTeX, Beamer, Sphinx, Microsoft office packages.

Spoken Languages

- English: fluent.
- Arabic: native.

CERTIFICATES

Certificates of Reviewing   December 2023

- Recognition of 16 reviews from ELSEVIER, Fusion Engineering and Design (FED).
- Recognition of 1 review from ELSEVIER, Nuclear Engineering and Design (FED).
- Recognition of 8 reviews from MDPI (Sustainability, Applied Sciences, and Energies).

ORNL Certificate of Completion   March 2023

- SCALE: Criticality Safety and Radiation Shielding
- SCALE: ORIGEN

LANL Certificate of Completion/Participation   February 2021

- New and advanced MCNP6 features and utilities.

HONORS & AWARDS

ANS RPSD Best Presentation Award   November 2017

- Selected for the outstanding presentation/paper in 'Dose Rates Assessment due to Spent Fuel and Activated Materials' session, Washington D.C.

Mohammed Sawan Award   June 2010

- Scholastic achievements and excellence award for graduating top of B.S. class with distinction and first degree of honor.

ORGANIZATIONS & SERVICE

MDPI (Journal of Nuclear Engineering), reviewer board member	**2021 - present**
ANS (American Nuclear Society), RPSD & FE member	**2013 - present**
CNERG (Computational Nuclear Engineering Research Group, UW-Madison), member	**2013 - 2019**
FTI (Fusion Technology Institute, UW Madison), member	**2013 - 2019**
EES (Egyptian Engineers Syndicate, Egypt), member	**2010 - present**

SELECTED PUBLICATIONS

- **Thesis**

    - **Moataz S. Harb**, "Propagation of Statistical Uncertainty in Mesh-Based Shutdown Dose Rate Calculations," The University of Wisconsin-Madison (2019).

- **Journal Papers**

    - **M. Harb**, A. Davis, P. P.H. Wilson, "Uncertainty Quantification of the Decay Gamma Source in Mesh-Based Shutdown Dose Rate Calculations," Fusion Science and Technology, vol. 79, Iss. "Special issue featuring Young Investigators in Fusion" (2023).

    - **M. Harb**, D. Leichtle, et. al, "Status of Scoping Nuclear Analyses for the Evolving Design of ITER TBM Port Cells," MDPI Journal of Nuclear Engineering (2023).

    - **M. Harb**, D. Leichtle, B.Y. Kim, J.P. Martins, J.G. van der Laan, L. Bergman, E. Polunovskiy, A. Serikov, "Scoping Nuclear Analyses of Shielding Options and ShutDown Dose Rate Contributions in ITER TBSs," Fusion Science and Technology (2022).

    - **M. Harb**, J.H. Park, D. Leichtle, J.P. Martins, B.Y. Kim, J.G. van der Laan, J. Bergman, "Neutronics Analysis and Assessment of Shielding Options of Pipe Forest and Bioshield-Plug Design for ITER TBSs," Fusion Engineering and Design, vol. 168 (2021).

    - **M. Harb**, T. Bohm, A. Davis, P. P.H. Wilson, FESS-FNSF Team, "Calculation of Shutdown Dose Rate in Fusion Nuclear Science Facility During a Proposed Maintenance Scheme," Fusion Science and Technology, vol. 75 (2019).

    - Tim D. Bohm, Andrew Davis, **Moataz S. Harb**, Edward P. Marriott, Paul PH Wilson, "Initial Neutronics Investigation of a Liquid-Metal Plasma-Facing Fusion Nuclear Science Facility," Fusion Science and Technology, vol. 75 (2019).

    - A. Davis, **M. Harb**, L. El-Guebaly, P. Wilson, E. Marriott, "Neutronics aspects of the FESS-FNSF," Fusion Engineering and Design, vol. 135 (2018).

    - L. El-Guebaly, **M. Harb**, A. Davis, J. Menard, T. Brown, "ST-based fusion nuclear science facility: Breeding issues and challenges of protecting HTS magnets," Fusion Science and Technology, vol. 72, iss. 3, p.354-361 (2017).

    - **M. Harb**, L. El-Guebaly, A. Davis, P. Wilson, E. Marriott, J. Benzaquen, "3-D Neutronics Assessment of Tritium Breeding Capacity and Shielding of Tokamak-Based Fusion Nuclear Science Facility," Fusion Science and Technology, vol. 72, iss. 3. p. 510-515 (2017).

- J. E. Menard, T. Brown, L. El-Guebaly, M. Boyer, J. Canik, B. Colling, R. Raman, Z. Wang, Y. Zhai, P. Buxton, B. Covele, C. D'Angelo, A. Davis, S. Gerhardt, M. Gryaznevich, **M. Harb**, T. C. Hender, S. Kaye, D. Kingham, M. Kotschenreuther, S. Mahajan, R. Maingi, E. Marriott, E. T. Meier, L. Mynsberge, C. Neumeyer, M. Ono, J-K Park, S. A. Sabbagh, V. Soukhanovskii, P. Valanju, R. Woolley, "Fusion nuclear science facilities and pilot plants based on the spherical tokamak," Nuclear Fusion, IOP Publishing, Vol. 56, number. 10 (2016).

- L. El-Guebaly, **M. Harb**, J. Menard, T. Brown "Shielding and Breeding Considerations for ST-Based HTS-FNSF Design,", 18th Internaonal Spherical Torus Work. Princet. Univ. (2015).

- **Conference Papers**

  - **Moataz S. Harb**, C. Wegmann, U. Fischer, "McCAD v1.0L An Improved CAD to MCNP Interface Library," Transactions of the American Nuclear Society, Vol. 122, p. 613 - 616 (2019).

  - **Moataz S. Harb**, Paul P. H. Wilson, A. Davis, "The Effect of Constructed Mesh-Based Fluxes on Shutdown Dose Rate Calculations in Fusion Energy Systems," Transactions of the American Nuclear Society, Vol. 117, Washington, D.C., October 29 - Nov 2 (2017).

- **Technical Reports**

  - **M. Harb**, M. Loughlin, "Assessment of Occupational Radiation Exposure in ITER Upper Ports 2, 8, and 14," under review internally at ORNL.

  - **M. Harb**, "Delivery: DES-ENG.NUCENG.NUCAN-T008-D001, Technical report on McCAD new conversion algorithm," EUROfusion internal report (2022).

  - **M. Harb**, D. Leichtle, "6D01: Task Report (D5+D6) Nuclear Analysis using the Revised PF & BP Models," ITER Organization internal report. Contract: IO/19/CT/4300001953 (2022).

  - **M. Harb**, D. Leichtle, "5D01: Draft Task Report (D5) on Subtask 3: Nuclear Analysis using the Revised PF & BP Models," ITER Organization internal report. Contract: IO/19/CT/4300001953 (2022).

  - **M. Harb**, D. Leichtle, "4D01: Final Report for Subtasks 1 & 2. Report on Nuclear Analysis of TBM-PP with Revised PF," ITER Organization internal report. Contract: IO/19/CT/4300001953 (2021).

  - **M. Harb**, D. Leichtle, "1D02: Subtask 1 Report (supplementing 1D01). Intermediate Report on Nuclear Analysis of TBM-PP with Revised PF using Agreed Simplified Model," ITER Organization internal report. Contract: IO/19/CT/4300001953 (2021).

  - **M. Harb**, D. Leichtle, "WCLL-TBM Conceptual Design – Phase II. Part A: Design Activities for the TBM Set. Report on the Nuclear Analyses of EP no. 16 up to Port Cell," EUROfusion internal report. EUROfusion ref.: PMI-7.1.1. Phase II - Task 3-T003-D001 (2020).

  - **M. Harb**, D. Leichtle, "WCLL-TBM Conceptual Design – Phase II. Part A: Design Activities for the TBM Set. Report on the MCNP Model of EP no. 16 up to Port Cell," EUROfusion internal report. EUROfusion ref.: PMI-7.1.1. Phase II - Task 3-T003-D001 (2020).

– **Moataz S. Harb**, L. El-Guebaly, "Preliminary 3-D Modeling and Neutronics Analysis for FESS-FNSF Design," Fusion Technology Institute report, University of Wisconsin-Madison, UWFDM-1421, Madison, WI (2015).

RELEVANT LINKS

- **Professional**

    – **Google Scholar: Moataz Harb**
    – **ResearchGate: Moataz Harb**
    – **ORCID: 0000-0002-0037-9087**
    – **Scopus: 57191163450**
    – **GitHub: moatazharb**
    – **LinkedIn: Moataz Harb**