Application of the FW-CADIS Variance Reduction Method to Calculate a Precise N-Flux Distribution for the FRJ-2 Research Reactor

F. Abbasi*, R. Nabbi, B. Thomauske, J. Ulrich and F. Charlier
*Email: abbasi@net.rwth-aachen.de
Institute of Nuclear Engineering and Technology Transfer, RWTH-University Aachen

Background and Motivation:
- Detailed activity and dose rate atlases (ADAs) in the decommissioning process of research reactor FRJ-2 to:
  - Speed up of decommissioning/approval process
  - Determine radiation field for optimal radiation protection
  - Quantify and characterize nuclear waste for disposal
- Monte Carlo N-Particle code is widely used for N-transport calculations

Numerical and statistical limitation of MCNP:
- Limited application of MCNP variance reduction methods for complex geometry

Application of FW-CADIS Method:
- To improve the particle sampling by generation of properly distributed particle weight
- Is based on forward and adjoint flux calculation using deterministic method embedded in MARVIC
- Allows automatic variance reduction through consistent source and transport biasing

Efficiency of the FW-CADIS Method:

<table>
<thead>
<tr>
<th>Parameters</th>
<th>MCNP</th>
<th>MCNP + VR</th>
<th>FW-CADIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPU Time (h)</td>
<td>1192</td>
<td>1425</td>
<td>864</td>
</tr>
<tr>
<td>Rel. error</td>
<td>85.50%</td>
<td>55%</td>
<td>17%</td>
</tr>
<tr>
<td>Avg. FOM</td>
<td>1.6E-03</td>
<td>2.3E-03</td>
<td>5E-02</td>
</tr>
</tbody>
</table>

Conclusion:
- The limited capability of analog MC method for deep penetration
- MCNP simulation with FW-CADIS based importance map resulted in:
  - Low variance for the entire MCNP model
  - Significant enhancement of the simulation performance