

OPERA: Advanced Radiation Transport Solutions with CAD Integration and Hybrid Methodologies

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OPERA, a CEA Paris-Saclay initiative, gathers cutting-edge tools for fixed-source radiation transport. In the early stages, our goals are:

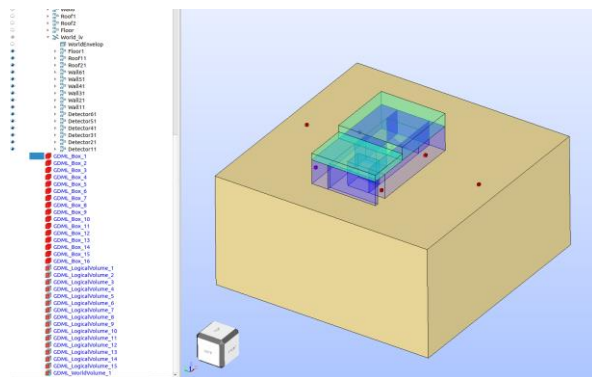
- A 3D modeling tool, capable of CAD import and meshing;
- Enhanced hybrid capabilities, accelerating Monte Carlo fixed-source calculations with deterministic methods and offering standalone 3D deterministic calculations.

Leveraging TRIPOLI-4® [1] Monte Carlo and APOLLO3® [2]'s IDT Cartesian S_N deterministic codes, OPERA utilizes the open-source SALOME [3] platform for pre- and post-processing, which includes SHAPER for parametric CAD modeling and SMESH for meshing.

OPERA's geometry is described using GDML [4], an XML-based language. TRIPOLI-4® is compatible with CERN ROOT [5] geometry format, derivable from GDML. The project's initial goal is to integrate GDML into SHAPER, enabling geometry primitive manipulation via GUI and Python scripting. Then, GEOUNED [6] will be employed to add CAD import capabilities.

The latest variance reduction feature in TRIPOLI-4® employs a FW-CADIS hybrid scheme [7]. From within TRIPOLI-4®, this process involves an automatic forward IDT flux evaluation followed by an adjoint IDT calculation, with the adjoint source covering the entire phase space, calibrated at the numerical inverse of the forward flux. From the adjoint flux is derived an importance map for the Monte Carlo calculation.

Future updates will enable users to perform standalone IDT calculations on a pixelized Cartesian geometry directly derived from the TRIPOLI-4® geometry.



3D modeling in SHAPER: An example of the GDML capacity in development

References: [1] F.X. Hugot et al, “Overview of the TRIPOLI-4® Monte Carlo code, version 12”, EPJ Nuclear Sci. Technol. 10, 17 (2024). [2] P. Mosca et al, “APOLLO3® : Overview of the New Code Capabilities for Reactor Physics Analysis”, Nuclear Science and Engineering, Volume 199 S17-30 2024. [3] Salome-platform.org [4] R. Chytrcek, “The Geometry Description Markup Language”, CHEP 2001, p. 473-476, Beijing, China. [5] R. Brun and F. Rademakers, ROOT - An Object Oriented Data Analysis Framework, Nucl. Inst. & Meth. in Phys. Res. A 389 (1997) 81-86 [6] J.P. Catalán et al, “GEOUNED: A new conversion tool from CAD to Monte Carlo geometry”, Nuclear Engineering and Technology, 2024, 1738-5733. [7] J. Wagner et al, “Forward-Weighted CADIS Method for Global Variance Reduction”, ANS Winter 2007, Washington DC, USA

Oral Contribution