SALOME-CŒUR : une plate-forme pour des études neutroniques à EDF

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Summary

1. WHAT IS SALOME-CŒUR ?

2. USES OF SALOME-CŒUR FOR NEUTRONIC STUDIES

3. DEMONSTRATION OF SALOME-CŒUR
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ANDROMEDE: EDF’s new core calculation chain

- The core calculation chain:
  - Performs **operation** studies
    - Optimal core loading patterns research
    - Key safety parameters calculations for those loading patterns
    - Vessel Fluence computation (for plant life extension for example)
    - Residual power and burnup computations for fuel cycle issues
  - Performs **design** studies
    - New fuel managements
    - New reactor types
    - Calculation methodologies improvements

- From CASSIOPEE (the operating core calculation chain)…
  … to ANDROMEDE (the future core calculation chain)

- **ANDROMEDE** will be used for the operation
  of the 58 PWR’s french fleet as of 2019
  - Assembly calculations performed with APOLLO2 (CEA)
  - Core calculations performed with COCAGNE (EDF)

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Salome-Cœur: the needs

- The goal of a neutronic core code (COCAGNE for instance) is to give an accurate and fast resolution of the neutronic flux within a core.

- Reactor physicists share with other fields the generic needs for:
  - **Post-processing**: results visualization
  - **Calculation management**: supervision and distribution
  - **Uncertainty propagation, data assimilation**

- The SALOME platform aims at answering these generic needs.

- **SALOME-CŒUR** packages the core code COCAGNE and generic numerical simulation modules of the SALOME platform.
Salome-Cœur: a specific platform for neutronic services

- **Salome-Core** is a platform dedicated to neutronic studies. It packages:
  - The Salome modules required for neutronic purposes
    - YACS, JOBMANAGER, PARAMETRIC
    - PARAVIS
    - ADAO, OpenTURNS
  - The core code COCAGNE
  - Several services have been added to the platform
    - Nuclear libraries management
    - COCAGNE studies management
    - Results post-processing
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Meshes for APOLO2-MoC calculations

- **Goal:** mesh 2D PWR assemblies up to 2D cores for APOLO2 calculations
  - Solution based on the GEOM module of the SALOME platform
  - It is necessary to have good performances for the core meshes

- **Example on:**
  - the mesh of 1/8\textsuperscript{th} of a PWR assembly
    - For cross-section libraries generation
      - A few seconds for less than one thousand areas
  - the mesh of 1/8\textsuperscript{th} of a 1450 MW PWR core
    - For core calculations V&V
      - More than 200 000 areas
      - Needs the mesh of the « reflector » area
      - Less than one hour of mesh computation
      - Excellent agreement between the APOLO2 calculation and stochastic (TRIPOLI4) calculations

- **Easy visual verification of the region / medium association**
Energy mesh optimization for core calculations

- **Goal**: find an appropriate energy mesh for COCAGNE core calculations
  - A few groups (less than ten) from a 26-group energy mesh
  - For a target precision of less than 1% pin power discrepancy on core calculations versus calculation references
  - The less energy groups, the better for core calculation performances
  - Solution based on calculation supervision and distribution of core calculations (YACS and JOBMANAGER modules of Salome)
    - For a few energy groups, we can try every energy mesh (53,130 meshes for 6 energy groups within 26)
    - For more energy groups meshes, we cannot test every possible mesh (more than 4 million calculations needed for a 12-groups energy mesh)
      ⇒ We use a heuristic optimisation algorithm (ant colony)
Reflector constants generation with data assimilation

- **Goal:** generate 2D radial sets of reflector cross-sections in order to improve the accuracy of the power distribution and of control rods worth

- Solution based on the ADAO (Data Assimilation) module of Salome

- Data assimilation of a reference calculation

Efficient results visualization in neutronic studies

- **Goal**: provide an efficient visualization tool for neutronic studies
  - Solution based on the PARAVIS module of the SALOME platform
  - Every post-treatment can be performed with Graphic or Text (python) User Interface

Comparison of production rates between
- 2D APOLLO2 calculation (deterministic reference)
- 2D COCAGNE homogeneous per pin diffusion calculation on a beginning of life 1450 MWe reactor core loading pattern.
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Thank you!

Any questions?