Karlsruher Institut für Technologie

C19- Use and applications of COBRA-TF at KIT

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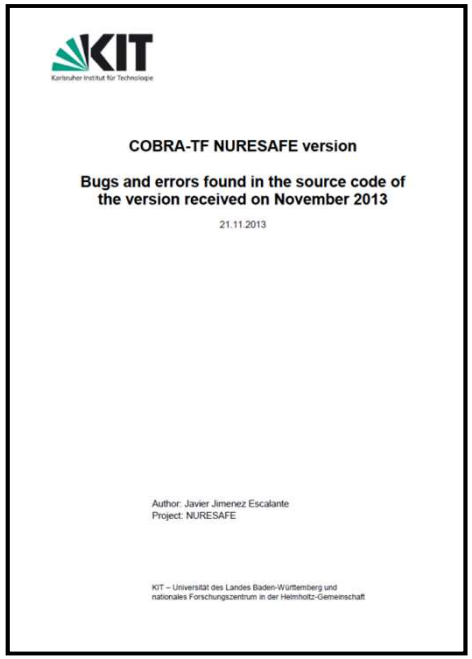
Content

- Assessment of the COBRA-TF CASL source code at KIT
  - Third internal reports submitted to the maintenance team
    - Fixes done in the source code of the version received on April 2014 (28.5.2014)
- Application of COBRA-TF to two big cases
  - UO2/MOX core HFP
  - UO2/MOX core HP
- Preprocessor for Hexagonal geometry
- Conclusions

Assessment of the source code at KIT (before 1st CTF User group Meeting)

- Two reports submitted to the maintenance team. Effective communication via email exchange.


COBRA-TF NURESAFE version

Bugs and errors found in the source code of the version received on November 2013

21.11.2013

Author: Javier Jimenez Escalante
Project: NURESAFE

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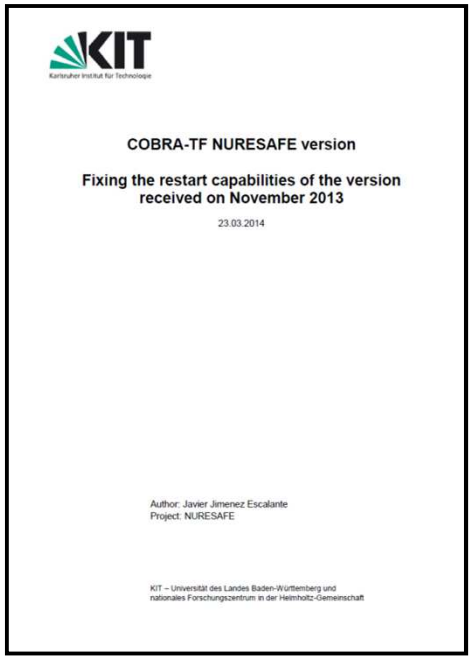
COBRA-TF NURESAFE version

Fixing the restart capabilities of the version received on November 2013

23.03.2014

Author: Javier Jimenez Escalante
Project: NURESAFE

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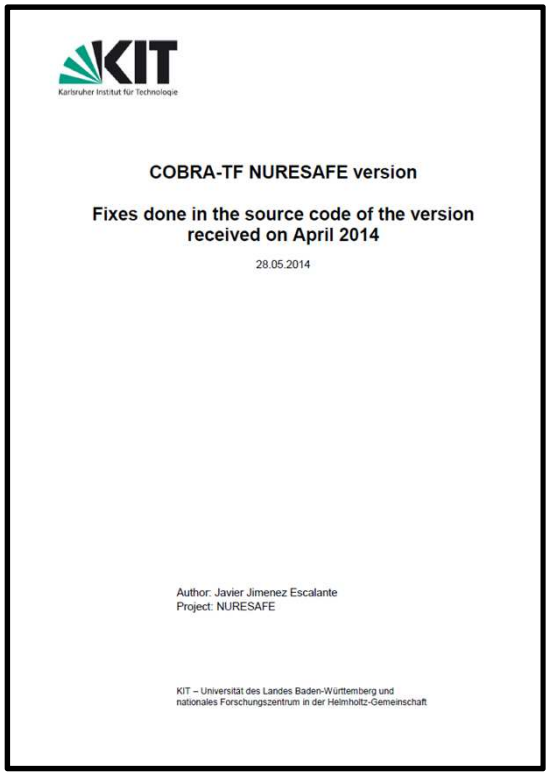
- The restart capabilities of the CTF version doesn´t properly
  - The new modules have not been included in dumpit.f and restart.f. (rks171)
  - Modules parallel, solid_material_props, transfer_io, vtk, powermod
- When reading the restart, variables are not allocated and code crashes

Assessment of the source code at KIT (after 1st CTF User group Meeting)

- Another report submitted to the maintenance team at the end of May 2014.



COBRA-TF NURESAFE version

Fixes done in the source code of the version received on April 2014

28.05.2014

Author: Javier Jimenez Escalante
Project: NURESAFE

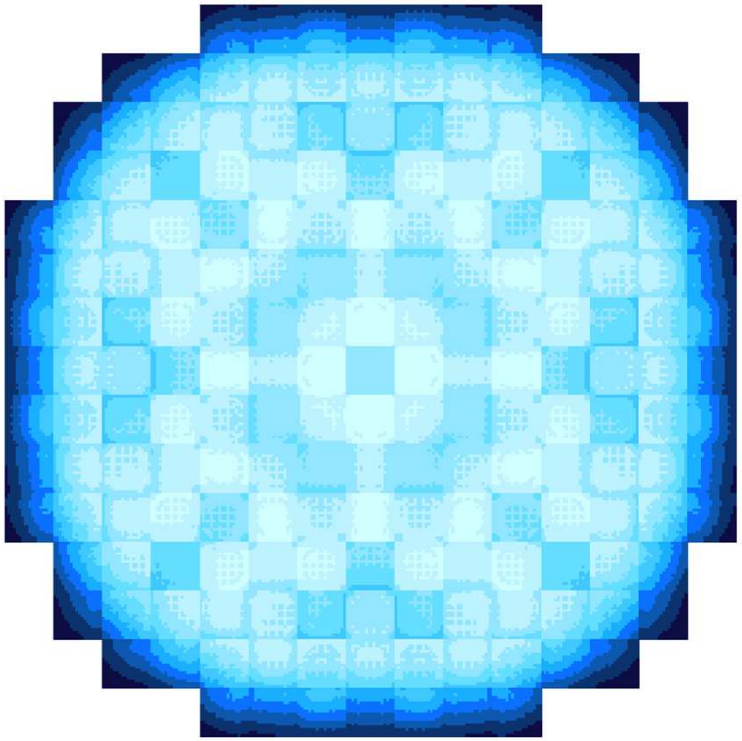
KIT – Universität des Landes Baden-Württemberg und nationales Forschungszentrum in der Helmholtz-Gemeinschaft

- Extension of printing formats in the preprocessor for very big cases, see next.
- Portability with Intel Fortran was improved.

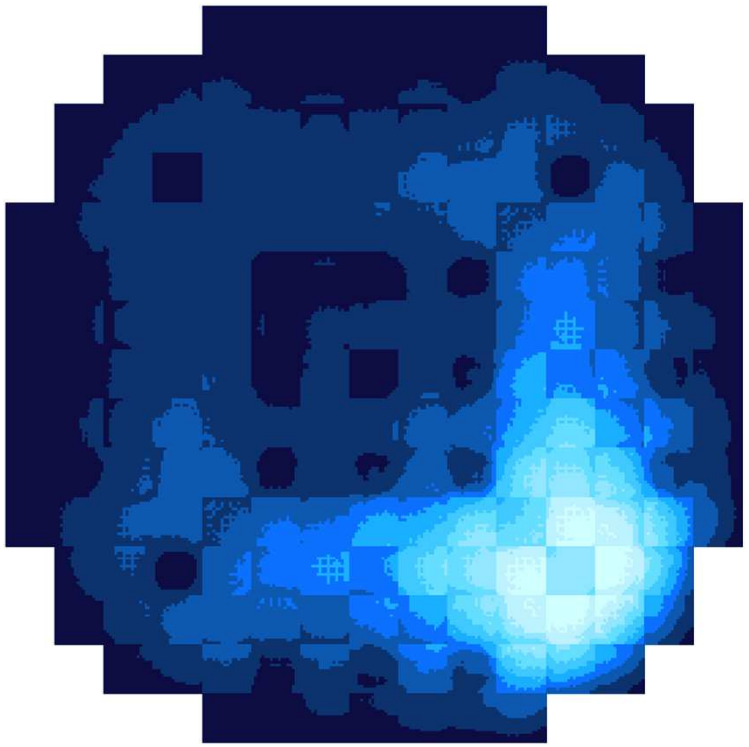
Application to big cases, verification cases.

- Results for exercise 2 of the *OECD/US-NRC MOX Core Transient Benchmark* produced with COBAYA3/COBRA-TF using domain decomposition (2010).
- Converged SS 3D power distribution has been extracted.

HFP 3D ARO



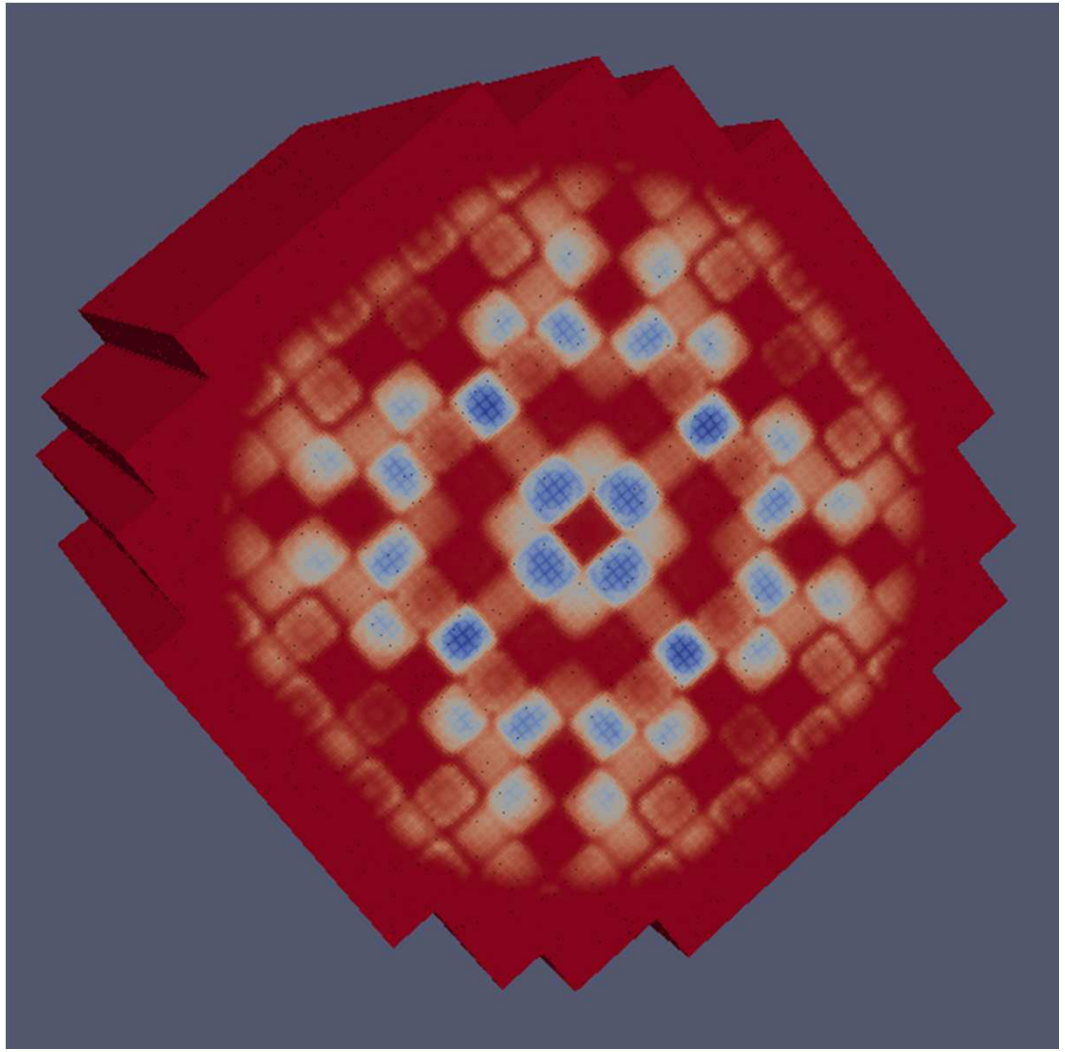
HP 3D ARI-1



Postscript plots done with VISUALSUB tool developed at UPM

CASL COBRA-TF applied to the HFP 3D ARO

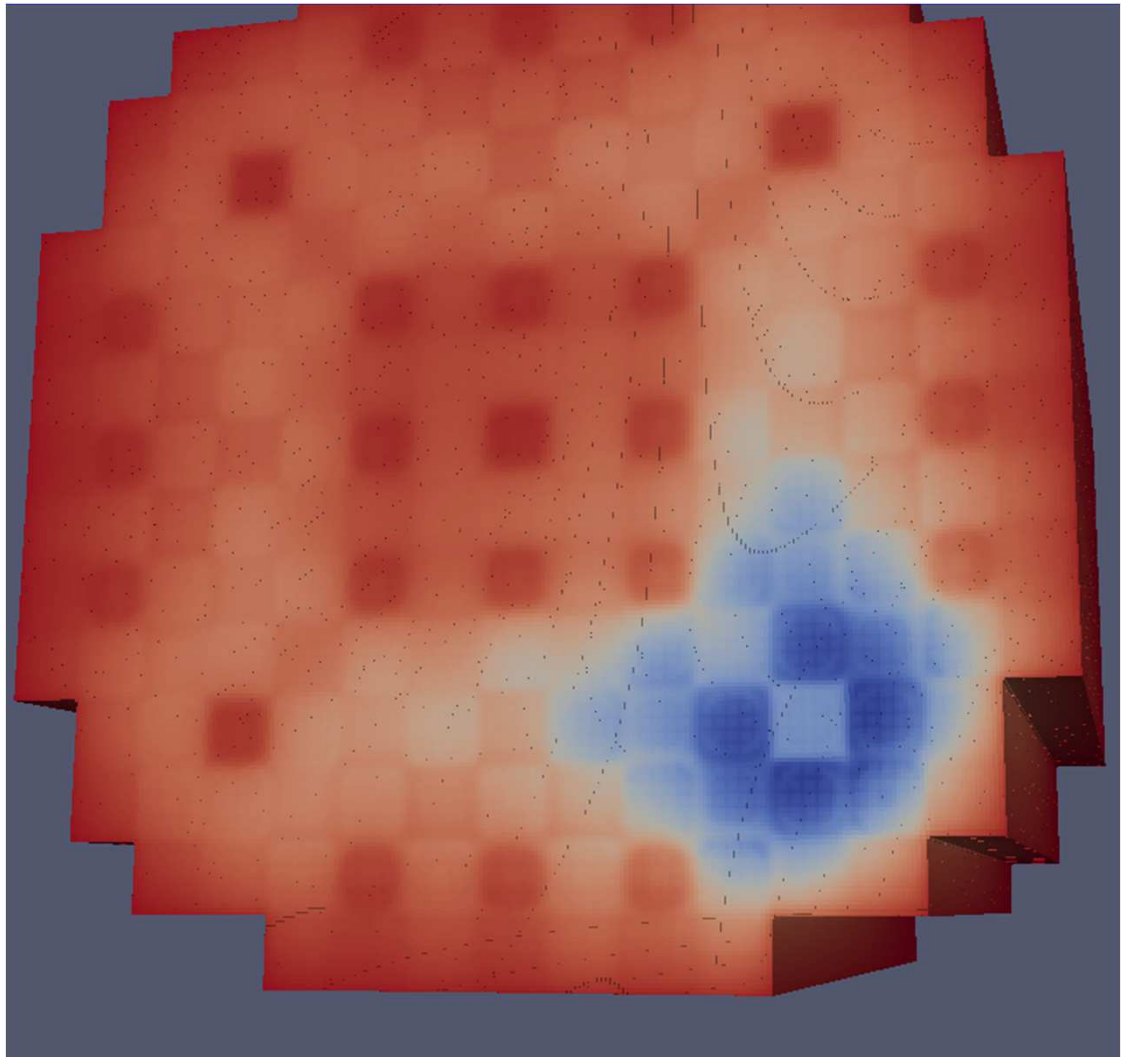
- COBRA-TF standalone execution in serial mode took 15h 24m.
- Input deck has 884k lines, 56288 channels, 55777 rods.
- 3D power distribution per fuel pin from CBY3-CTF.
- Post-processing of VTK files with PARAVIEW.
- Memory consumption and speed have been very much optimized with the code refactoring.



CASL COBRA-TF applied to the HP 3D ARI-1

- The input deck has the same number of lines.
- Post-processing of VTK files with PARAVIEW.
- Those cases were run just to verify the new COBRA-TF capabilities.
- Added to the validation data base.

- COBRA-TF has now the option for doing a steady state looking for convergence.



CASL COBRA-TF portability check at KIT

- Last version received on 4 May 2015. Compiled in Mageia 4, 64 bits.

- Results of the test with gcc 4.8.2 and cmake 2.8.12.1:

```
30% tests passed, 185 tests failed out of 263
```

- Results of the test with ifort 15.0.0:

```
29% tests passed, 187 tests failed out of 263
```

- In most of the cases the code runs properly and the output is almost identically except few values in the last decimal:
  - Suggestion to improve the tolerance of differences in `utils/test_res.py`

```
# The maximum allowable relative error between a parameter and its gold value
max_rel_err = 0.001
# The maximum allowable absolute error between a parameter and its gold value
max_abs_err = 0.1e-6   INCREASE THIS VALUE!!
```

  - Could be due to wrong settings, no HDF5 support, …

Hexagonal fine-mesh preprocessor

- Developed within NURESAFE WP1.4 framework.
- Fully operational for SUBCHANFLOW and COBRA-TF geometry tables generation.
- Coded in FORTRAN.
- Few input parameters:

  Number of rods in the bundle (fuel and guide tubes). (**37**)

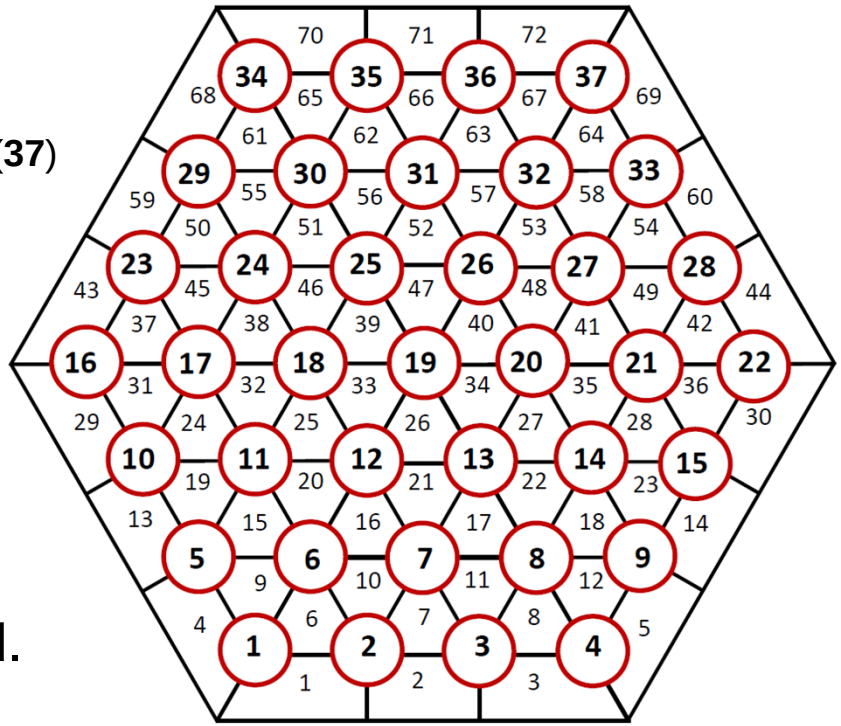
  Pitch between the fuel pins. (**12.81380e-3 m**)

  Side length of the aristae. (**47.408e-3 m**)

  Rod diameter. (**9.1455e-3 m**)

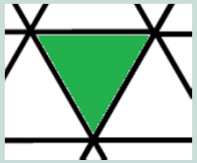
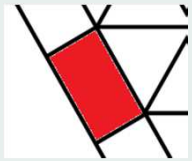
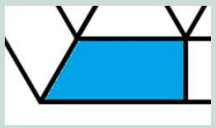
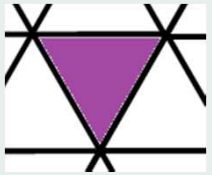
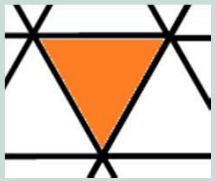
  Guide tube diameter. (**12.663e-3 m**)

  Instrumentation rod diameter. (**11.256e-3 m**)



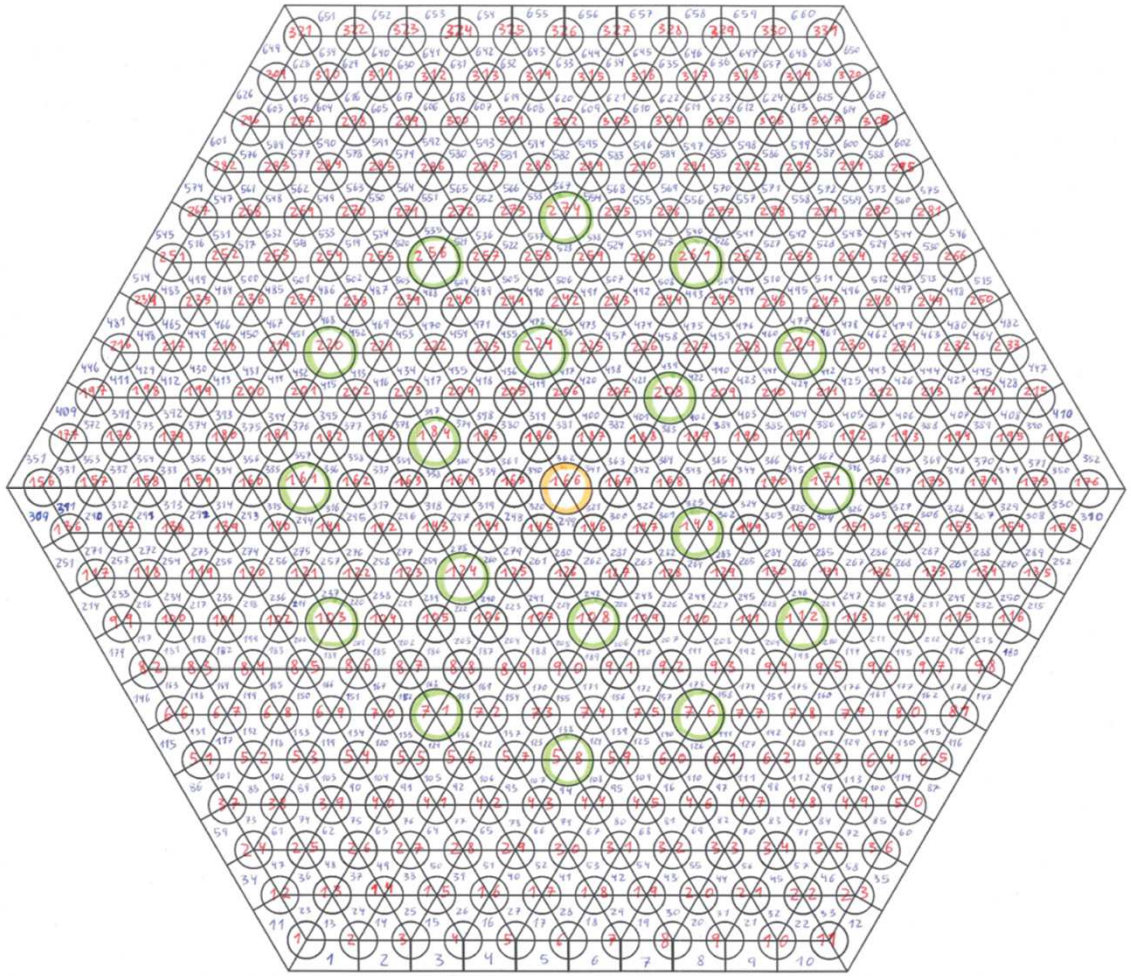
- Any number of rods can be modelled.

Hexagonal fine-mesh preprocessor (2)

Type (tchan)	Shape	Area	Wetted Perimeter	Heated Perimeter
1 Central subchannel		$pitch^2 \cdot \sqrt{3}/4 - 0.5 \cdot rod\_area$	$0.5 \cdot rod\_perimeter$	$0.5 \cdot rod\_perimeter$
2 Lateral subchannel		$pitchb \cdot pitch - 0.5 \cdot rod\_area$	$0.5 \cdot rod\_perimeter$	$0.5 \cdot rod\_perimeter$
3 Corner subchannel		$pitchb \cdot pitch + 0.5 \cdot pitchb^2 \cdot \tan(30) - rod\_area \cdot (7/12)$	$rod\_perimeter \cdot (7/12)$	$rod\_perimeter \cdot (7/12)$
4 Guide tube subchannel		$pitch^2 \cdot \sqrt{3}/4 - 1/3 \cdot rod\_area - 1/6 \cdot guideT\_area$	$1/3 \cdot rod\_perimeter + 1/6 \cdot guideT\_perimeter$	$1/3 \cdot rod\_perimeter$
5 Instrumentation rod subchannel		$pitch^2 \cdot \sqrt{3}/4 - 1/3 \cdot rod\_area - 1/6 \cdot InstR\_area$	$1/3 \cdot rod\_perimeter + 1/6 \cdot InstR\_perimeter$	$1/3 \cdot rod\_perimeter$

Hexagonal fine-mesh preprocessor (3)

- It is possible to mesh a single FA (minicores are subjected to future work)



MESH DETAILS:
331 fuel rods
660 subchannels
990 gaps

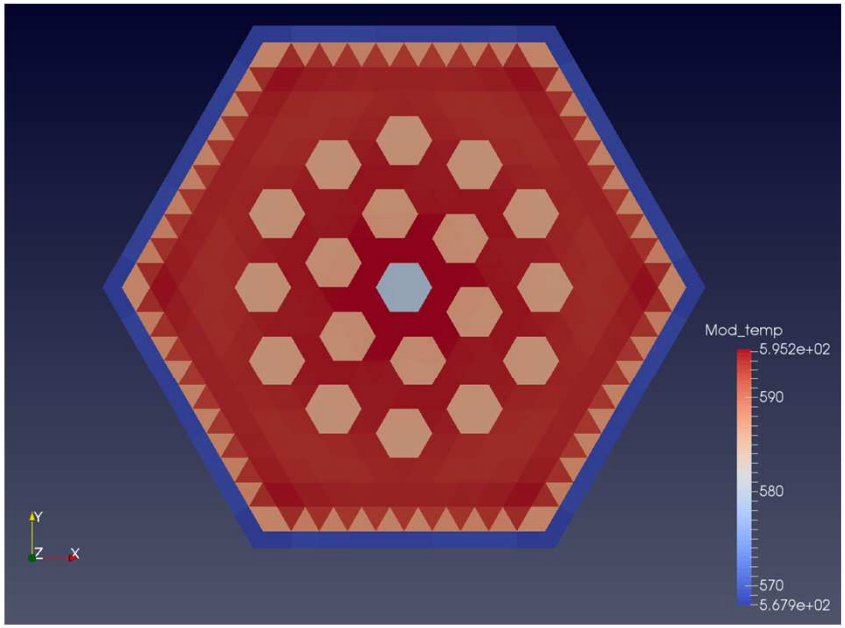
Hexagonal fine-mesh preprocessor (4)

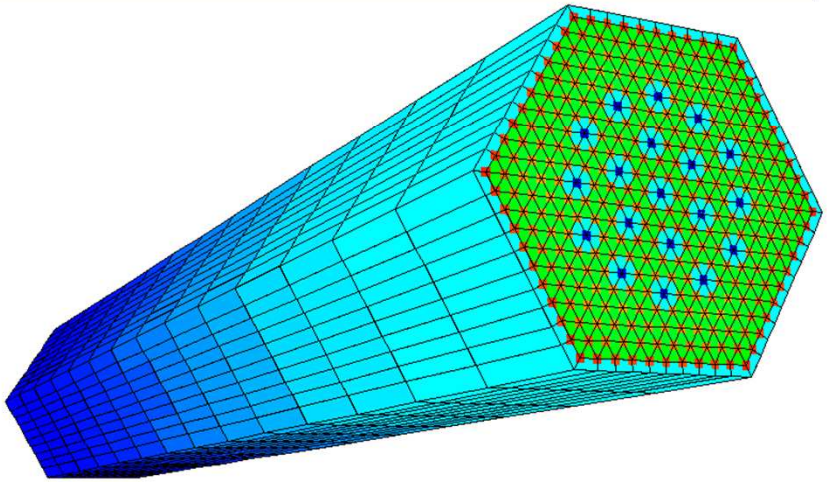
- Within NURESAFE project, the preprocessor has been used to generate the geometry tables (channels and rods) of COBRA-TF (GRS) and SUBCHANFLOW (KIT).

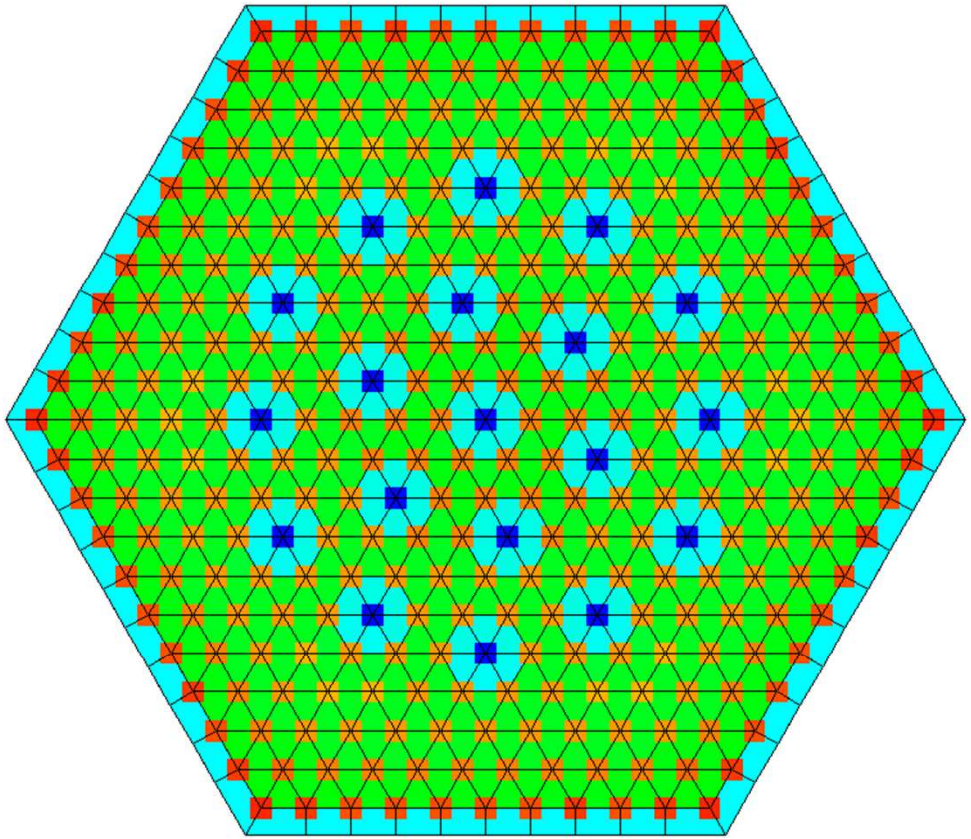
- Some input decks (37 pins and 331 pins) have been generated.

- Using SUBCHANFLOW SALOME component, the MEDCoupling interface was extended for allowing:
  - Coupled NK-TH analysis.
  - Post-processing via PARAVIS. See next slide.

Thermal and fluid mesh visualization using SCF







SHOW VIDEO

Conclusions

- Assessment of the COBRA-TF CASL source code at KIT was conducted.
- Two big cases added to the validation matrix.
- Development of a generic VVER FA preprocessor:
  - Suitable for COBRA-TF and SUBCHANFLOW
- The geometry information is also used within the code components under the SALOME platform (NURESAFE EU project).

Acknowledgements

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