NURESAFE WP1.4
HIGHER-RESOLUTION VVER MSLB

Fine mesh preprocessor for COBRA-TF

Slides to complement KIT part in presentation:
Overview of CTF integration and N/TH coupling for hexagonal geometry

J. Jimenez, V. Sanchez

Presented by J. Jimenez

victor.sanchez@kit.edu
or
javier.jimenez@kit.edu

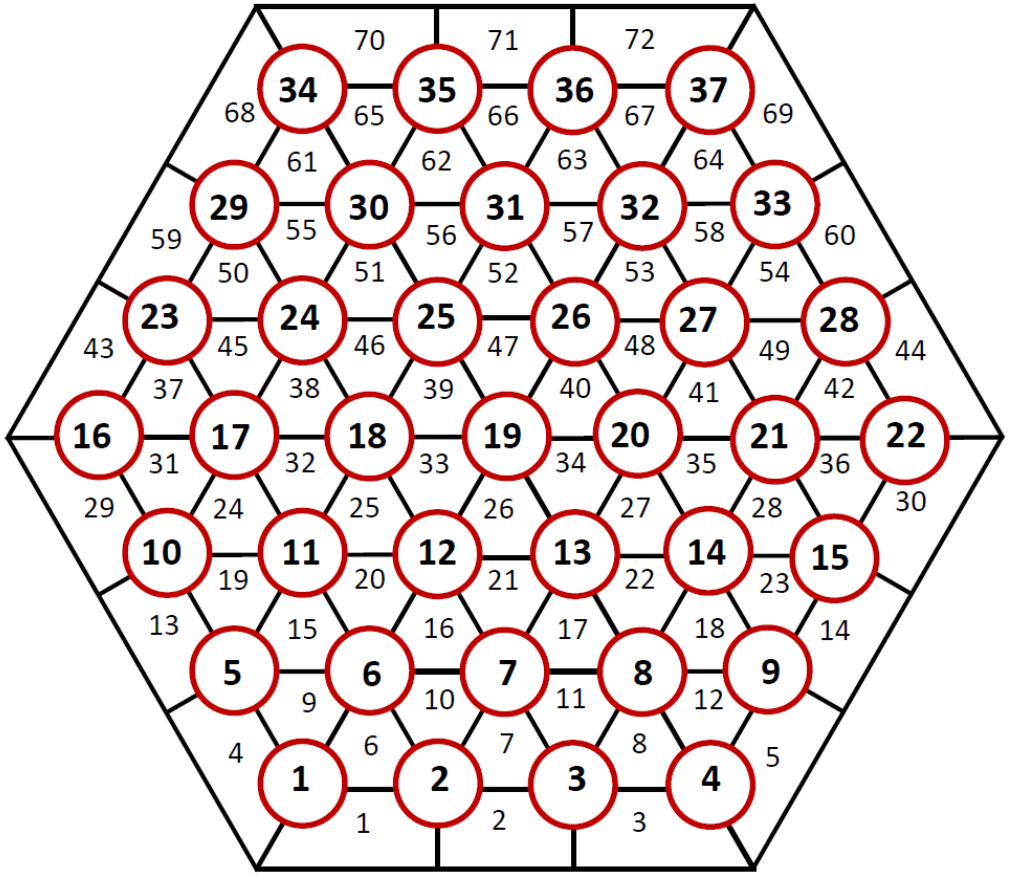
Outline

- **Since the last meeting a good progress was achieved in several tasks.**
  - Intensive email exchange between March and May
- **A fine mesh preprocessor for hexagonal geometry was produced: Hexbundle**
  - Working for SUBCHANFLOW and COBRA-TF.
  - Operative SUBCHANFLOW MEDCoupling interface was released on 09.03.2015, generation of MED files enabled.
  - Adaptation of the MEDCoupling interface recently achieved in COBRA-TF (June 2015).
- **Conclusion and Outlook**

Fine mesh preprocessor (KIT Fortran code)

- You can find it in the svn repository

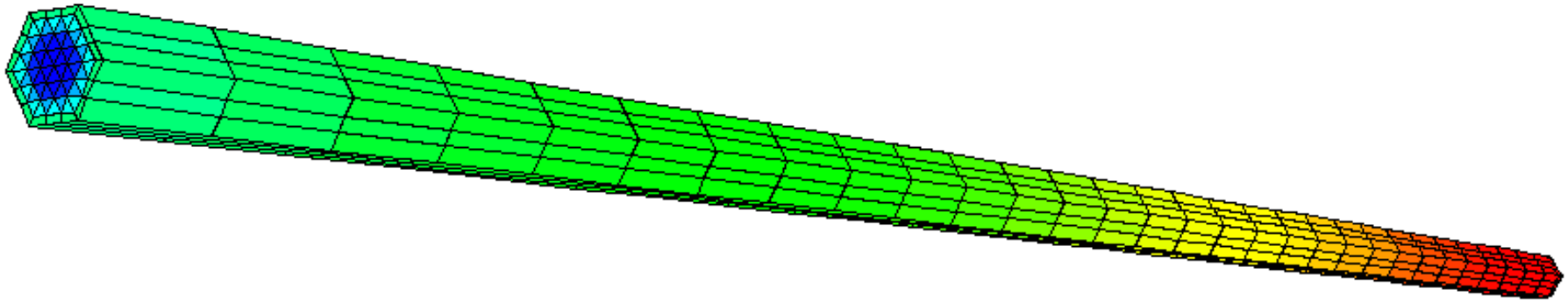
  /SAT/TEST/RESSOURCES/HexBundle



- Fully operational for SUBCHANFLOW and COBRA-TF geometry tables generation.
- Inclusion of Guide tubes and instrumentation rods in SCF.
- MEDCoupling enabled in SCF and CTF.
- TO DO
  - Extension to minicores

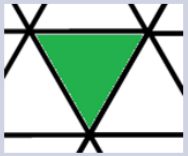
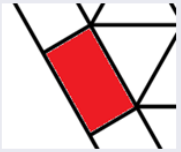
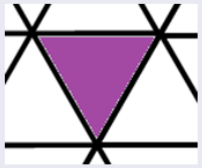
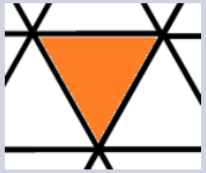
Fine mesh preprocessor (KIT Fortran code)

- **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**)



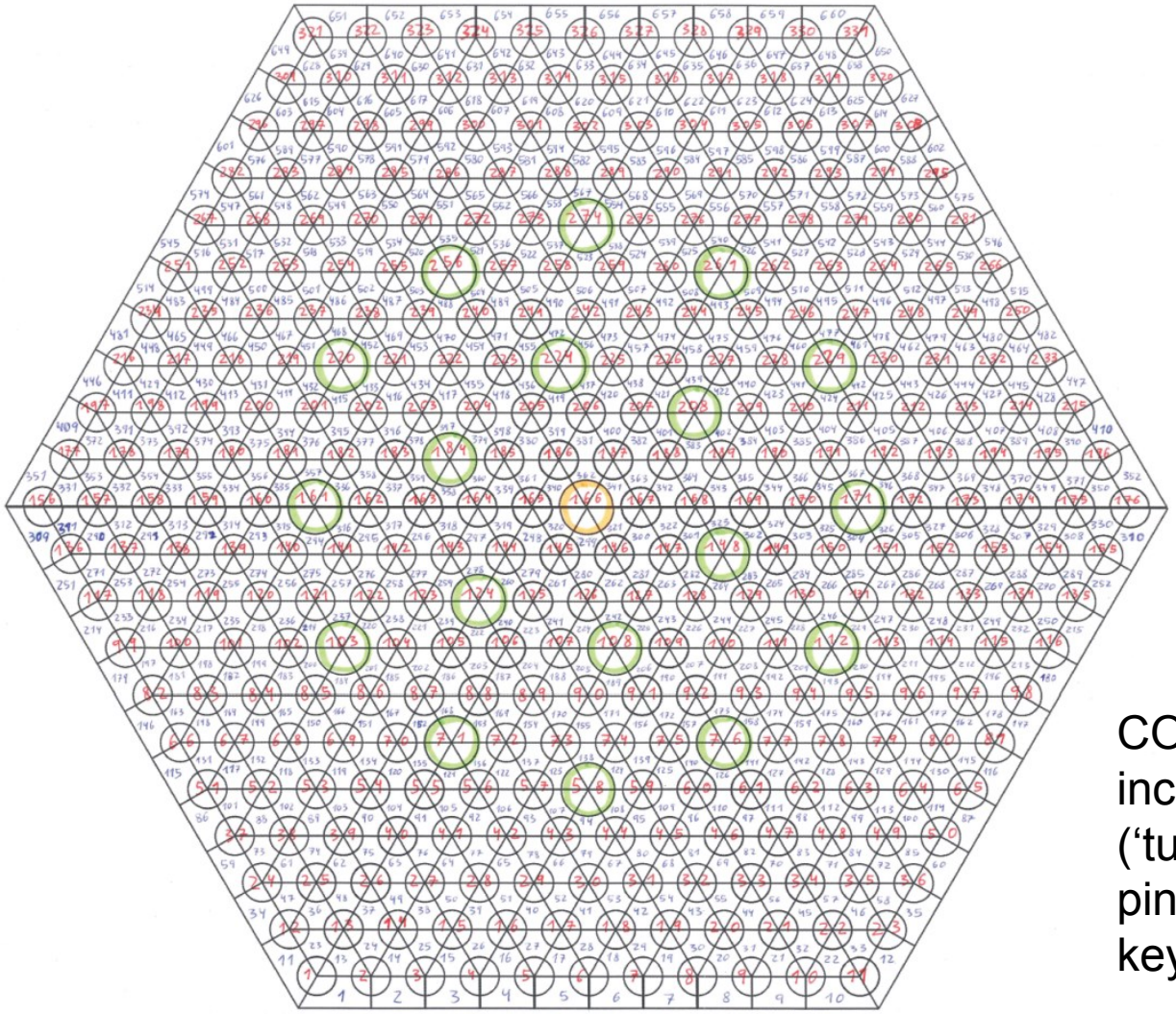
Fine mesh preprocessor (KIT Fortran code)

- **Subchannel types are predefined:**

Type (tchan)	Shape	Area	Wetted Perimeter	Heated Perimeter
1 Central subchannel		pitch^2· $\sqrt{3}/4$ - 0.5·rod_area	0.5·rod_perimeter	0.5·rod_perimeter
2 Lateral subchannel		pitchb·pitch - 0.5·rod_area	0.5·rod_perimeter	0.5·rod_perimeter
3 Corner subchannel		pitchb·pitch + 0.5·pitchb^2·tan(30) - rod_area·(7/12)	rod_perimeter· (7/12)	rod_perimeter· (7/12)
4 Guide tube subchannel		pitch^2· $\sqrt{3}/4$ – 1/3·rod_area – 1/6·guideT_area	1/3·rod_perimeter+ 1/6·guideT_perimeter	1/3·rod_perimeter
5 Instrumentation rod subchannel		pitch^2· $\sqrt{3}/4$ – 1/3·rod_area – 1/6·InstR_area	1/3·rod_perimeter+ 1/6·InstR_perimeter	1/3·rod_perimeter

Fine mesh preprocessor (KIT Fortran code)

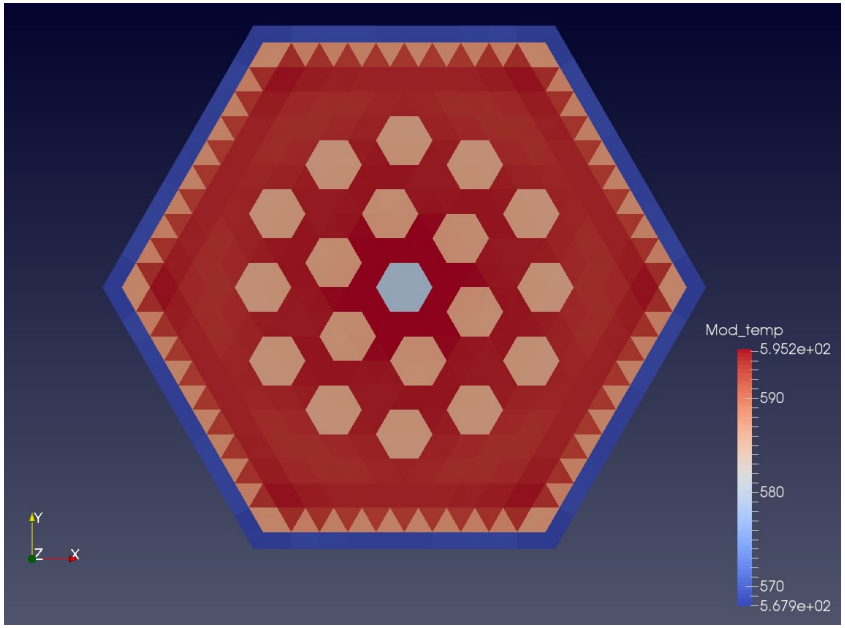
- The final goal was to be able to mesh the hot FA

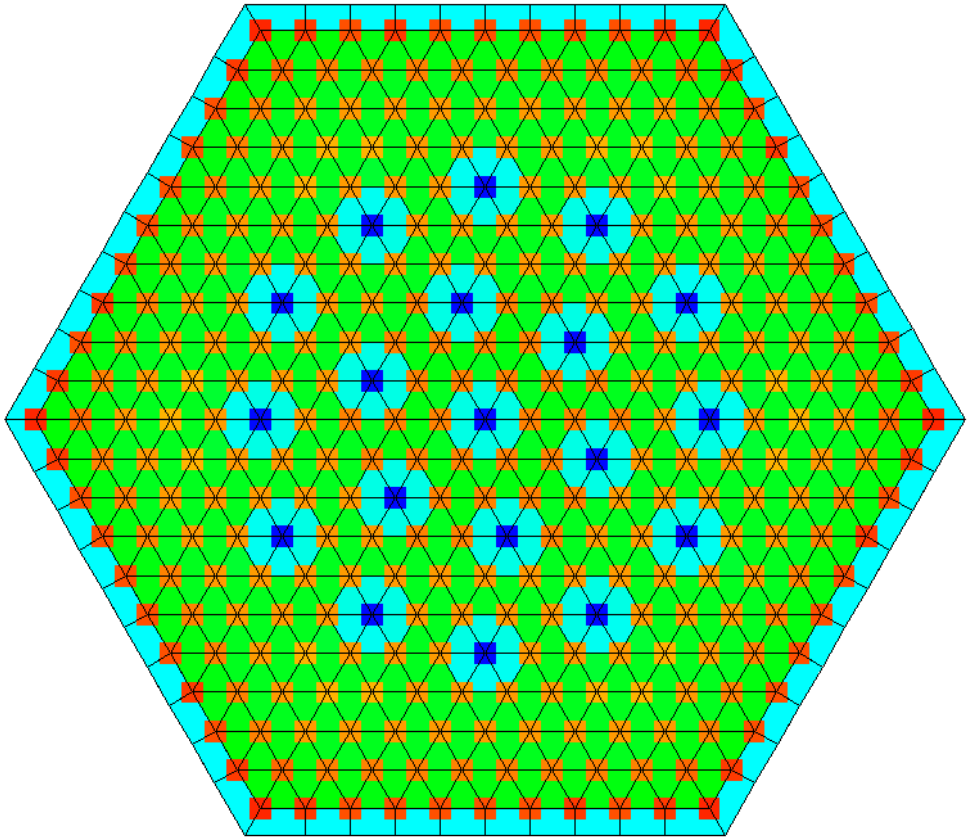


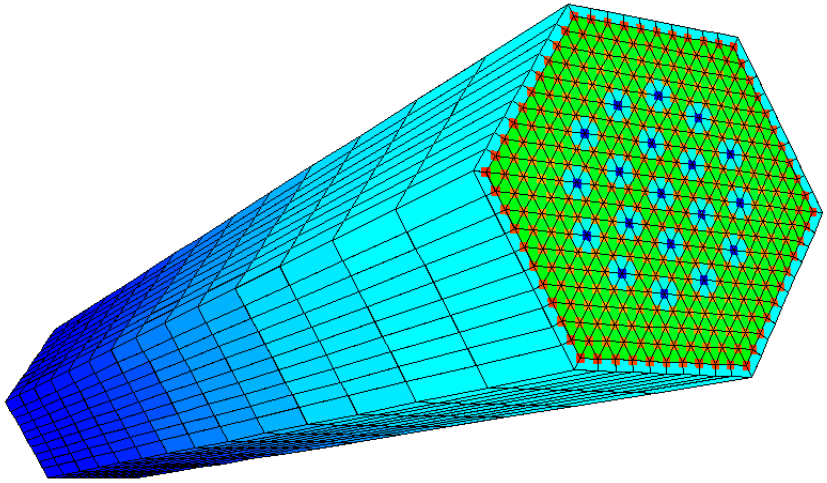
MESH DETAILS:
331 fuel rods
660 subchannels
876 gaps

COBRA-TF deck.inp does not include unheated structures (‘tube’ keyword) yet, all the pins are treated with ‘nucl’ keyword

Thermal and fluid mesh visualization using SCF







COBRA-TF MED generation

- **Changes in the CTF API were done.**
- **New method fine_triangular_mesh_external taken from SUBCHANFLOW API (June 2015).**
  - All the geometrical information could not be read from the deck.inp, natural input of COBRA-TF.
    - Channels coordinates (YES)
    - Rods coordinates (NO: arrays does not exist)
  - Coordinates are read from external files as auxiliary solution.
    - mesh_parameters.txt
    - table_rods.txt 
    - table_channels.txt
    - table_levels.txt
  - Those files are also generated by the hexbundle tool.

COBRA-TF MED generation Example

cd NURESAFE_TEST/RESSOURCES/HexBundle/

./compile.sh

cd VVER-1000-FA

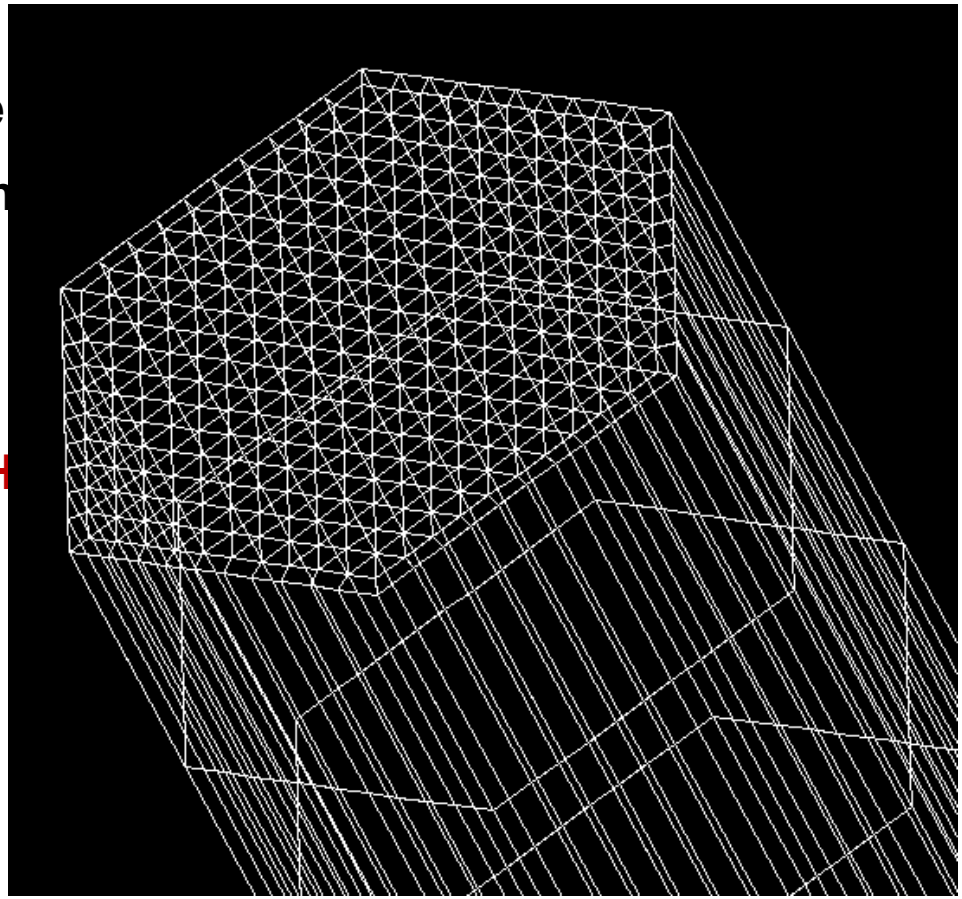
../hexbundle ! This will generate

./merge.sh ! Create the deck.in

source /your/environmental/file

python run_CTF.py

You can open the CTF_FINE_MESH
PARAVIEW



COBRA-TF MED generation Example

- **Right now, the unheated structures are not included in the deck.inp generation process.**
- **To readapt other deck.inp files (such as Sub-channel_CTF_input_VVER_assembly.inp):**
  - Prepare an equivalent geometry within hexbundle preprocessor.
  - Replace geometry cards: 2, 3, 4 and 8 accordingly, so that the channel numeration match the coordinates described in card 2 as well as the rod-to-channel connectivities in group 8. This is due to the different numbering convention between hexbundle and the externally generated files.
  - Try with the run_CTF.py script.

Conclusion

- **Development of a generic FORTRAN VVER FA preprocessor:**
  - Suitable for COBRA-TF and SUBCHANFLOW
- **Extension of the CTF.cxx API: new fine_triangular_mesh_external method taken from SCF**
  - Now the Fluid mesh can be produced to be used within INTERP_2_5D in the coupling scripts.
- **Extension to minicores is not foreseen before the end of the project (5 months)**

FUTURE WORK

- **Enabling in the COBRA-TF API the coupling through the new mesh entities.**
  - Modification of getOutputMEDField to dump the code results in the new MEDCoupling object (GRS).
  - Extension of the hexbundle tool to also deal with unheated structures and generate a complete CARD 8 for COBRA-TF, new array NOSLCHC for CARD 8.5 (KIT?, INRNE?).
- **Open questions in the COBRA-TF API, what to do with the thermal mesh? And with the fields associated to that mesh, such as Doppler fuel temperature?**

THANKS FOR YOUR ATTENTION