SERPENT 2 – ANSYS CFX COUPLING

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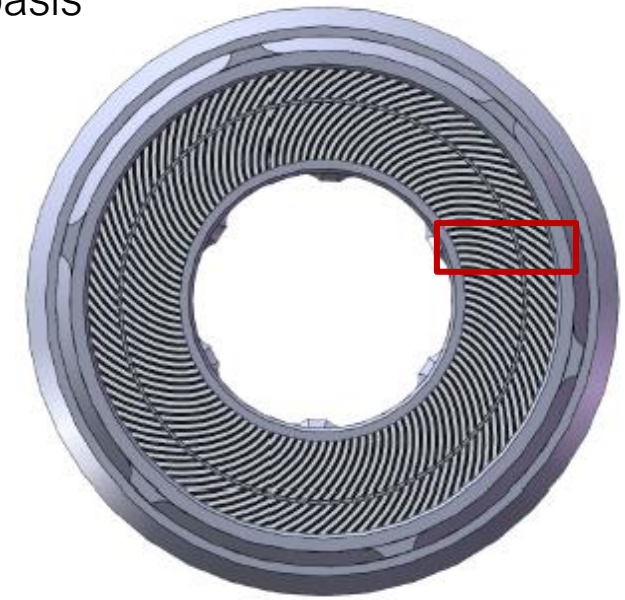
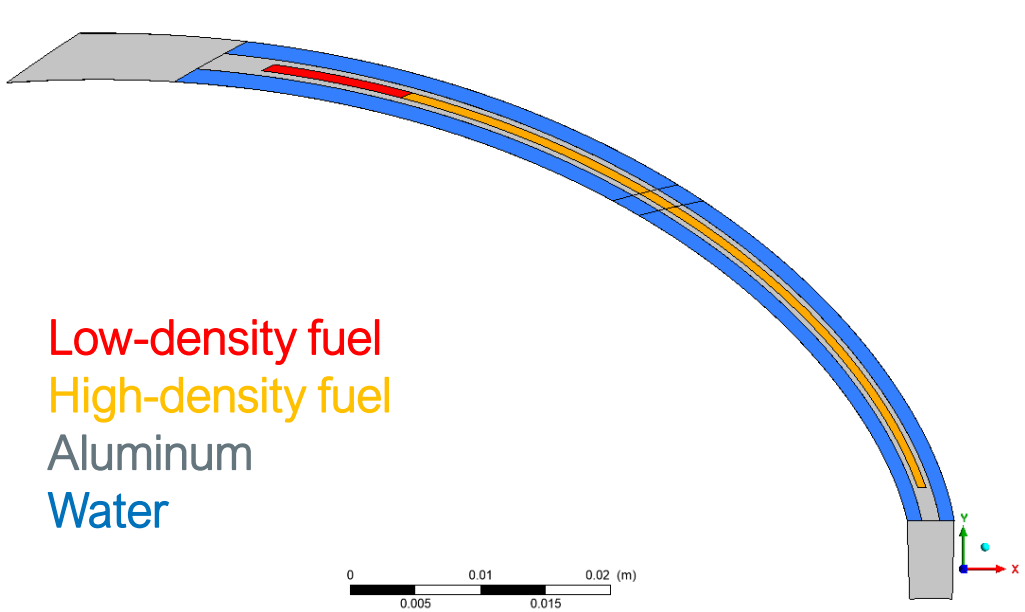
Serpent User Group Meeting
Garching

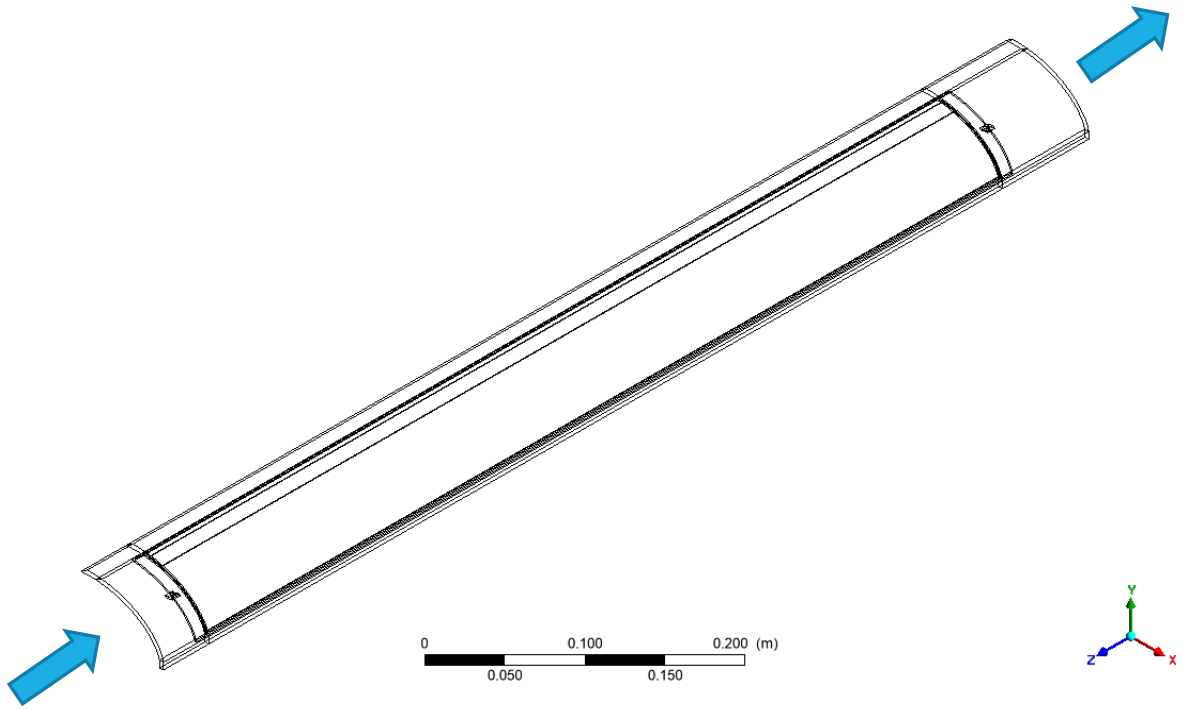
FORSCHUNGS-NEUTRONENQUELLE HEINZ MAIER-LEIBNITZ (FRM II)

- 20 MW power
- Compact core with one fuel element
- Conversion to lower enriched fuel.
- Data of the current HEU core is used as a verification and validation basis



FRM II CORE


Low-density fuel
High-density fuel
Aluminum
Water
0
0.01
0.02 (m)
0.005
0.015
Y
X


0
0.100
0.200 (m)
0.050
0.150
Y
Z
X

1D VS 3D

- 1D calculations → more conservative and based on empirical correlations
  → well-known procedure for licensing
- 3D calculations → more accurate to reality
  → relatively "new"

Need for verification and validation of 3D methods ⟷ Possibility to explore numerous reactor designs

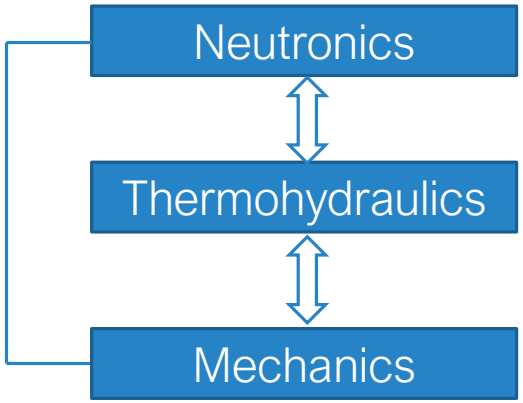
THE INVOLUTE WORKING GROUP (IWG)

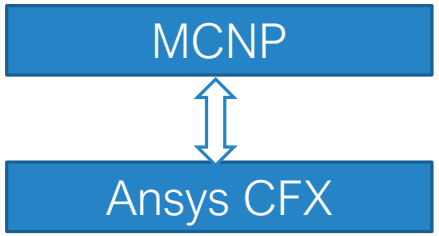
- Collaboration among Oak Ridge National Laboratory (ORNL), Argonne National Laboratory (ANL), Institute Laue Langevin (ILL) and Technical University of Munich (TUM)

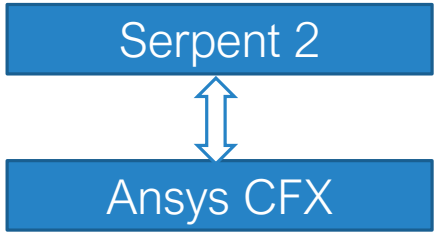
- Common GOAL: Validating and verifying CFD codes for High Performance Research Reactors (HPRRs)

Development of new techniques for safety calculations

PARAMETER STUDY

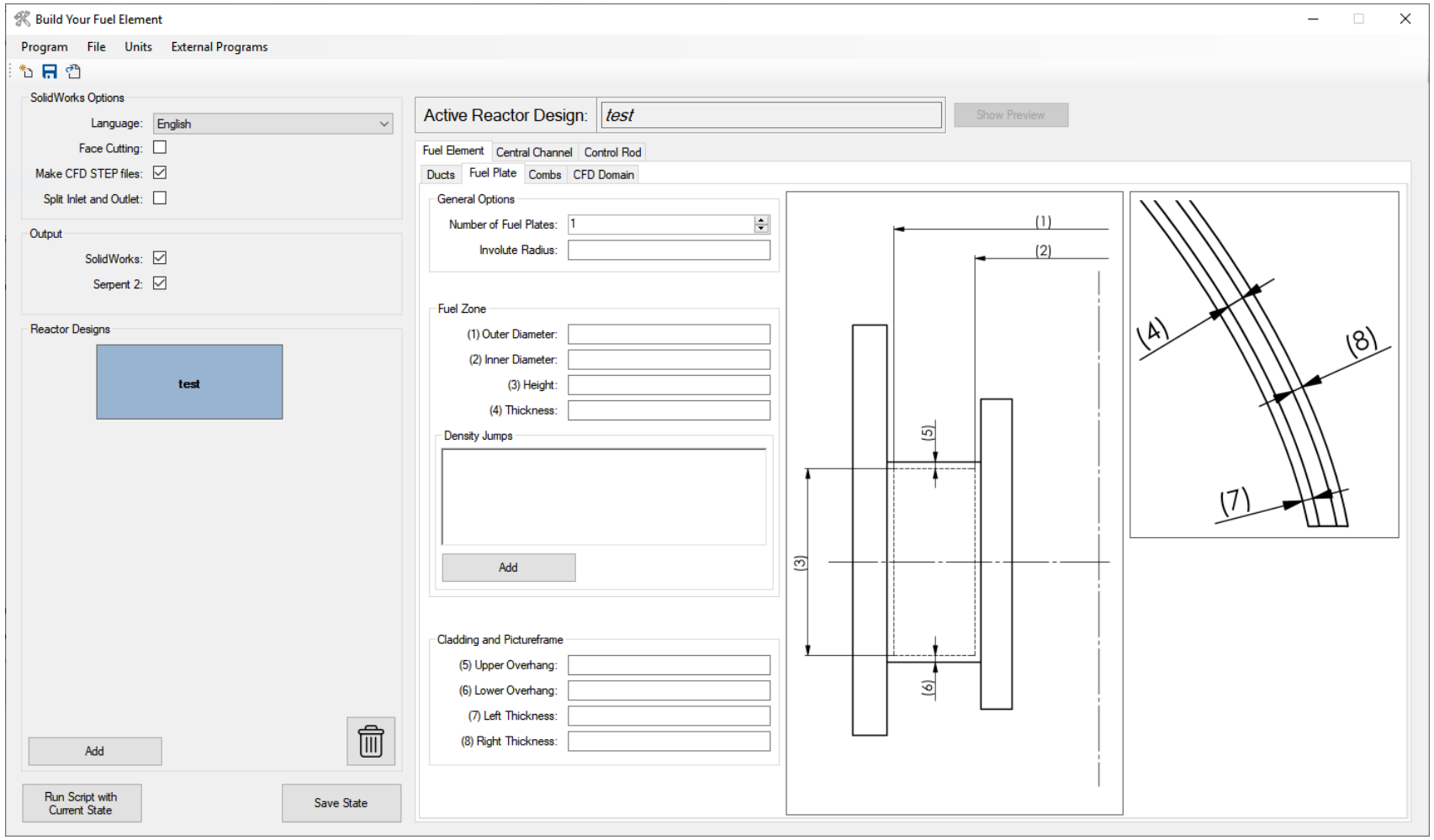






Around 200 models to find an optimal core

AUTOMATIC MODEL GENERATION



Graphical user interface yields input for a script

- Macro for CAD model generation
- Serpent geometry

CAD MODEL

SERPENT - CFX COUPLING

- MCNP-CFX coupling used as a validation source for Serpent-CFX coupling

- Serpent-CFX coupling →
  - Serpent calculates the power deposition
  - Script-based post-processing results
  - Serves as an input for a CFX setup (linear interpolation between calculated values)

MAIN DIFFERENCES BETWEEN MCNP AND SERPENT MODELS

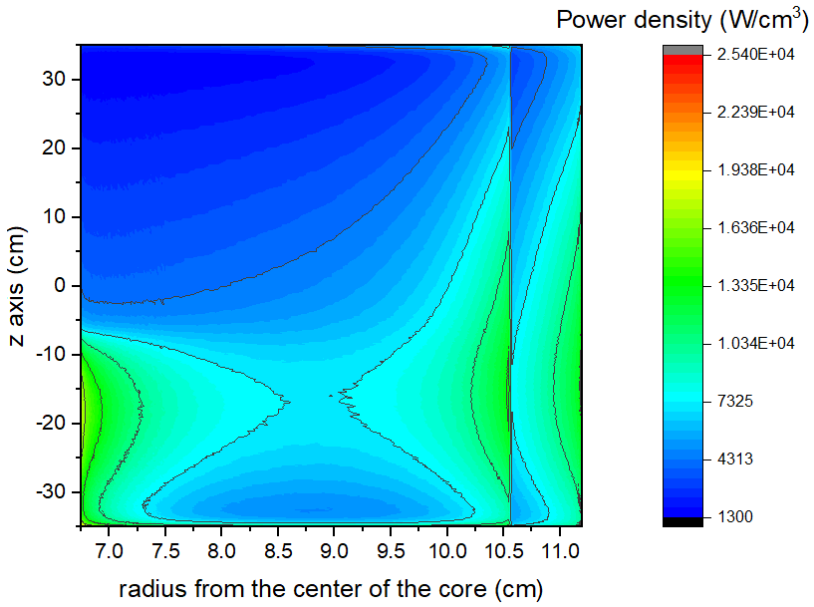
Difference	MCNP-CFX	Serpent-CFX
Geometry	parabola-hyperbolic approximation	exact involute shape
Total heating	20 MW 18.02 MW in the fuel 1.98 MW gamma heating	18.23 MW Only in the fuel
Approach of heating	Direct coupling	In line coupling

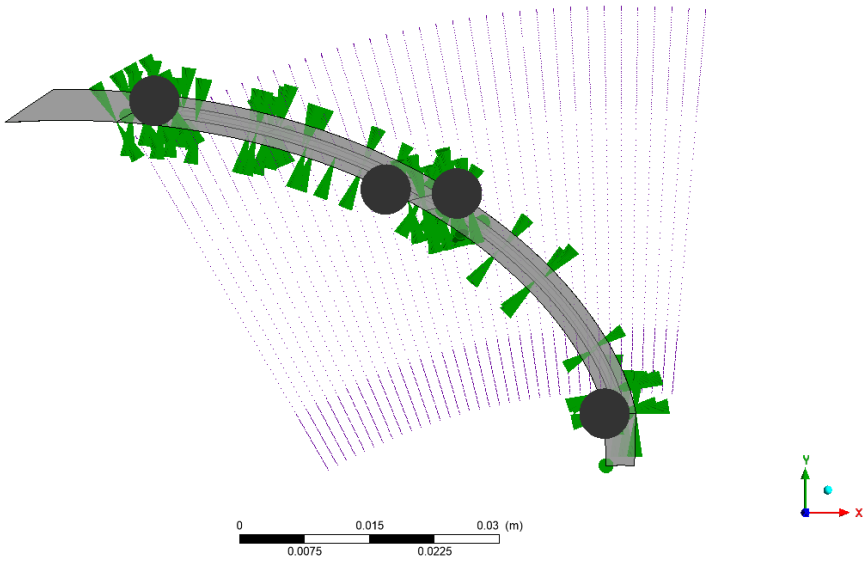
CFX SETUP

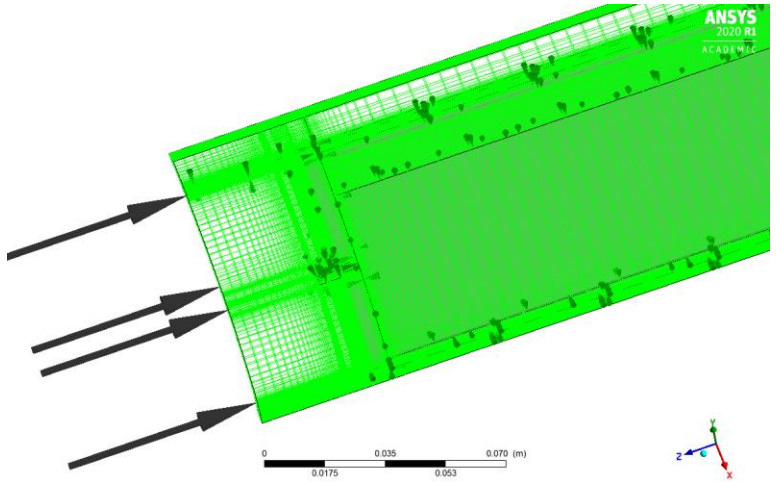
Mesh (ICEM CFD)

⇩

Setup (CFX-Pre)



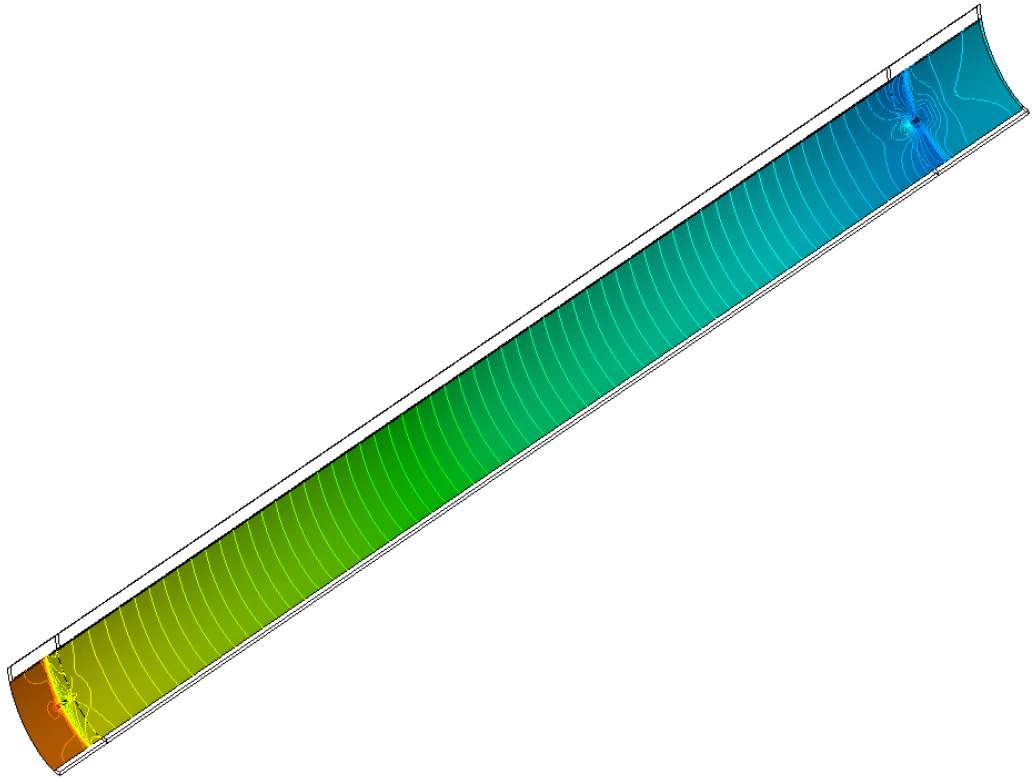


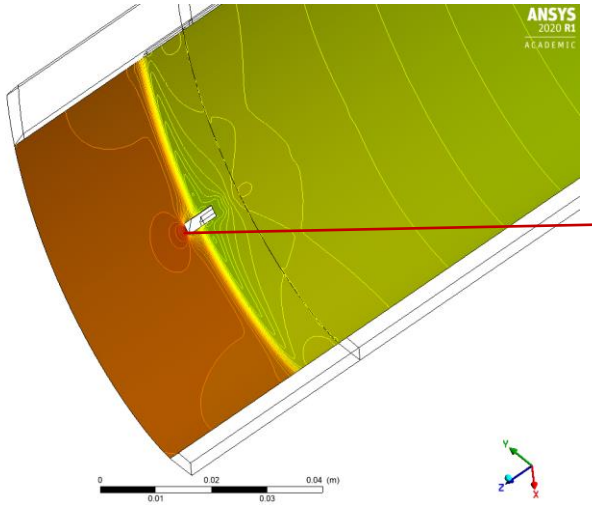


Main differences:

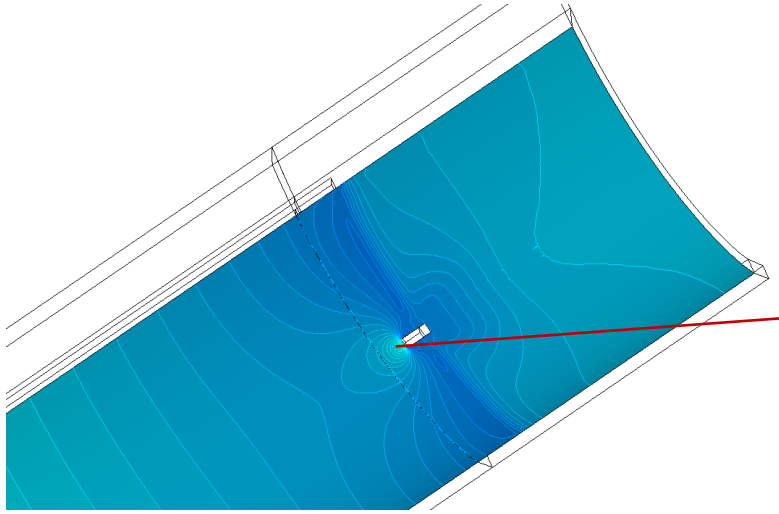
- Mesh: hybrid for MCNP-CFX, hex for Serpent CFX
- Combs modelling

EFFECT OF THE COMBS - PRESSURE



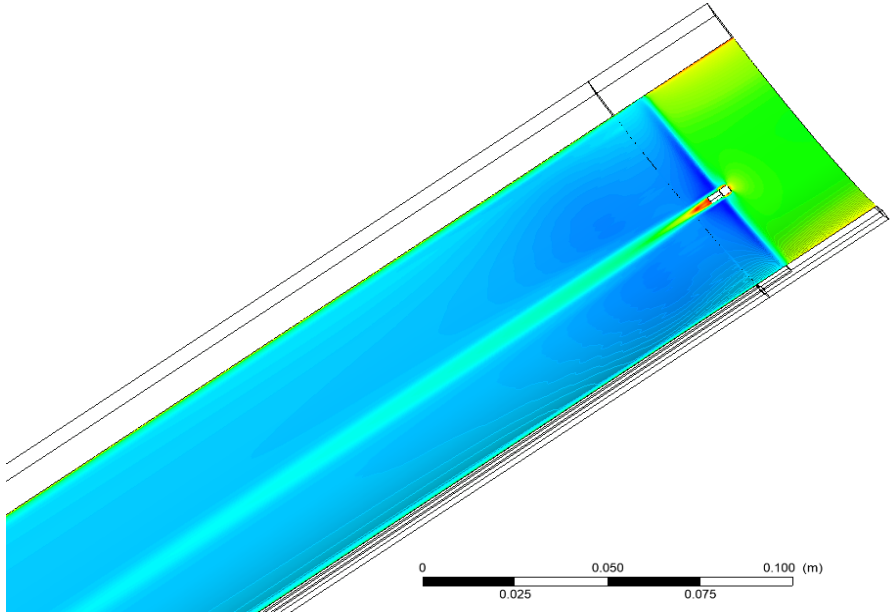


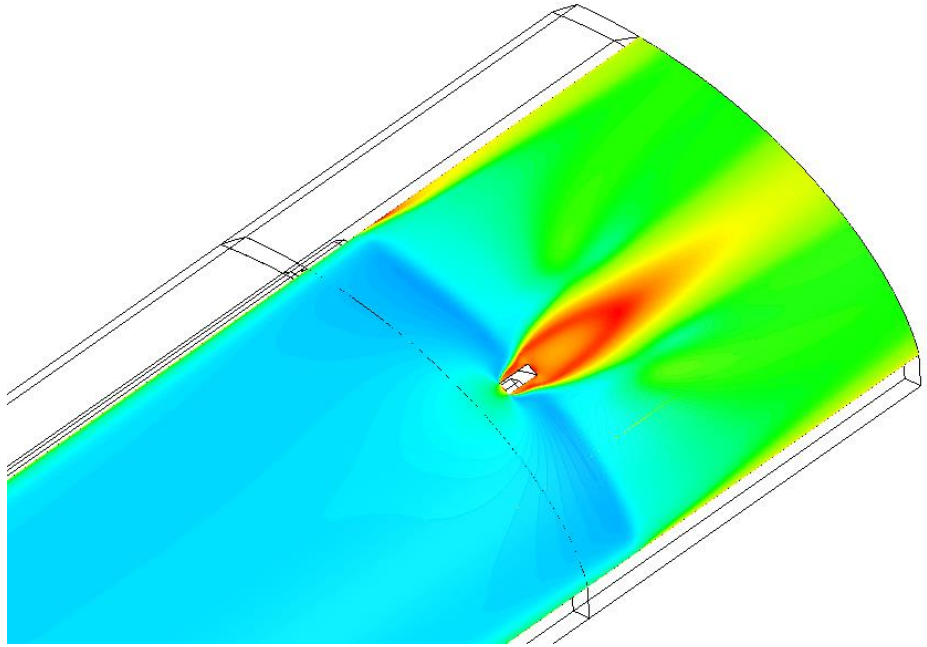
max



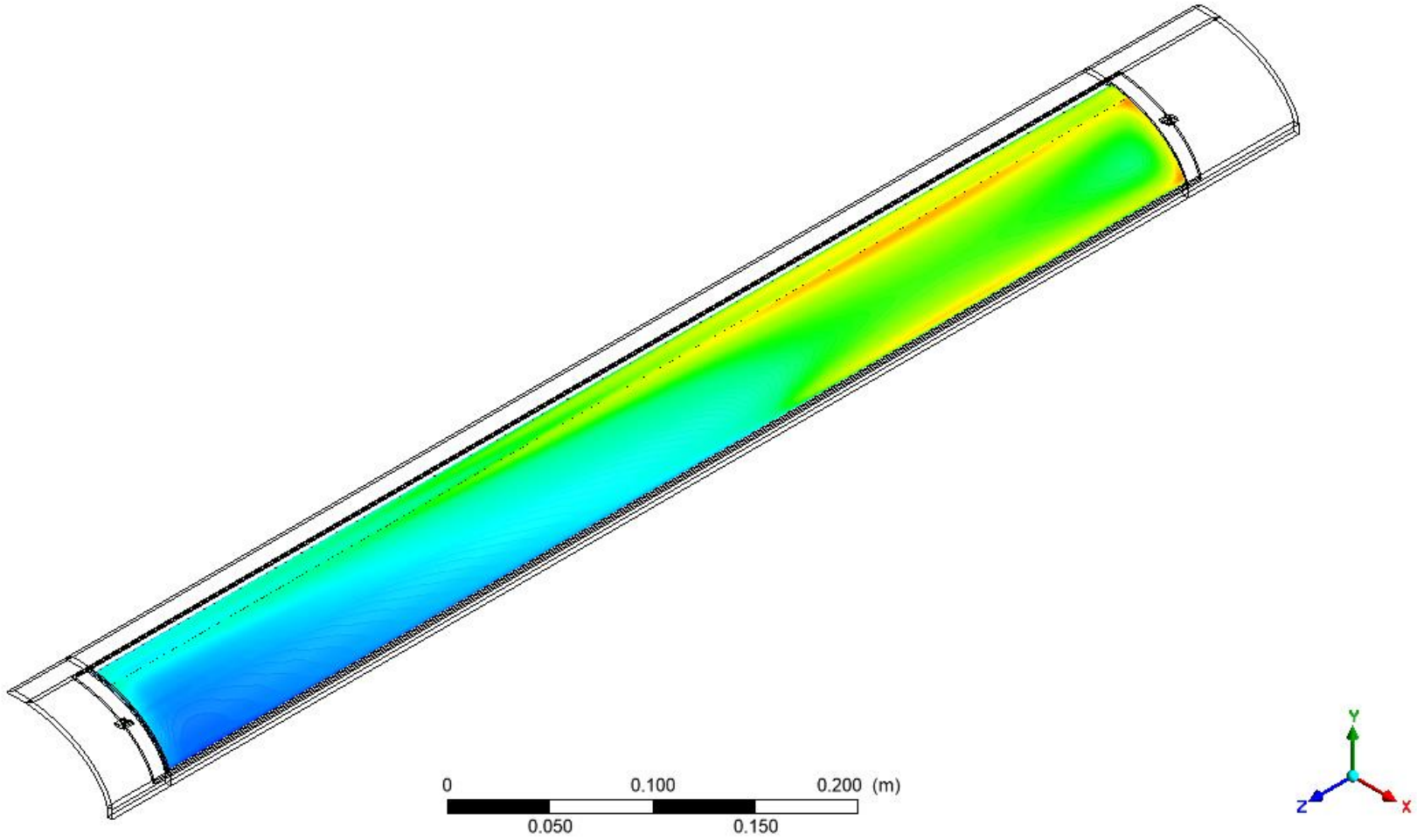
min

EFFECT OF THE COMBS - VELOCITY





FUEL TEMPERATURE



CONCLUSIONS AND OUTLOOK

- Serpent-CFX coupling results match well to the MCNP-CFX results
- Code-to-code verification can be assumed
- Next step: 2-way coupling of Serpent and CFX

THANK YOU!

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