Taking a detailed cross section out of a 3D model

To increase performance and accuracy.

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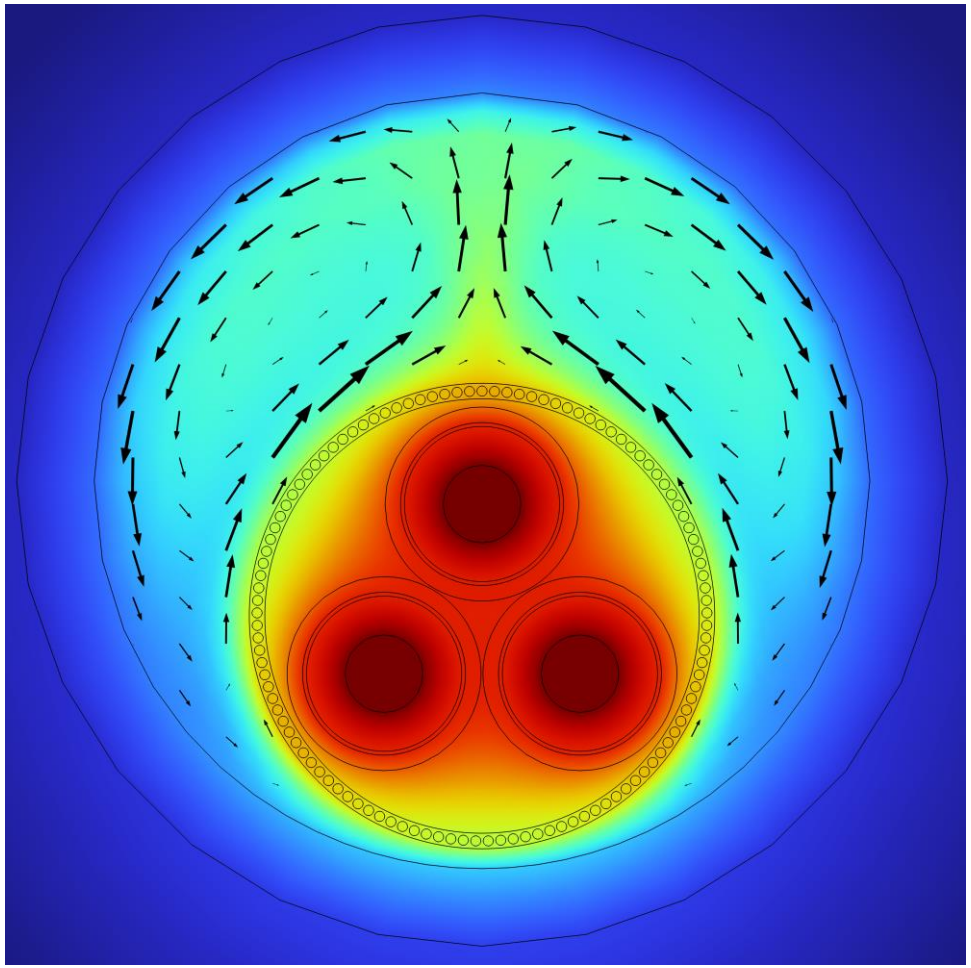
VATTENFALL



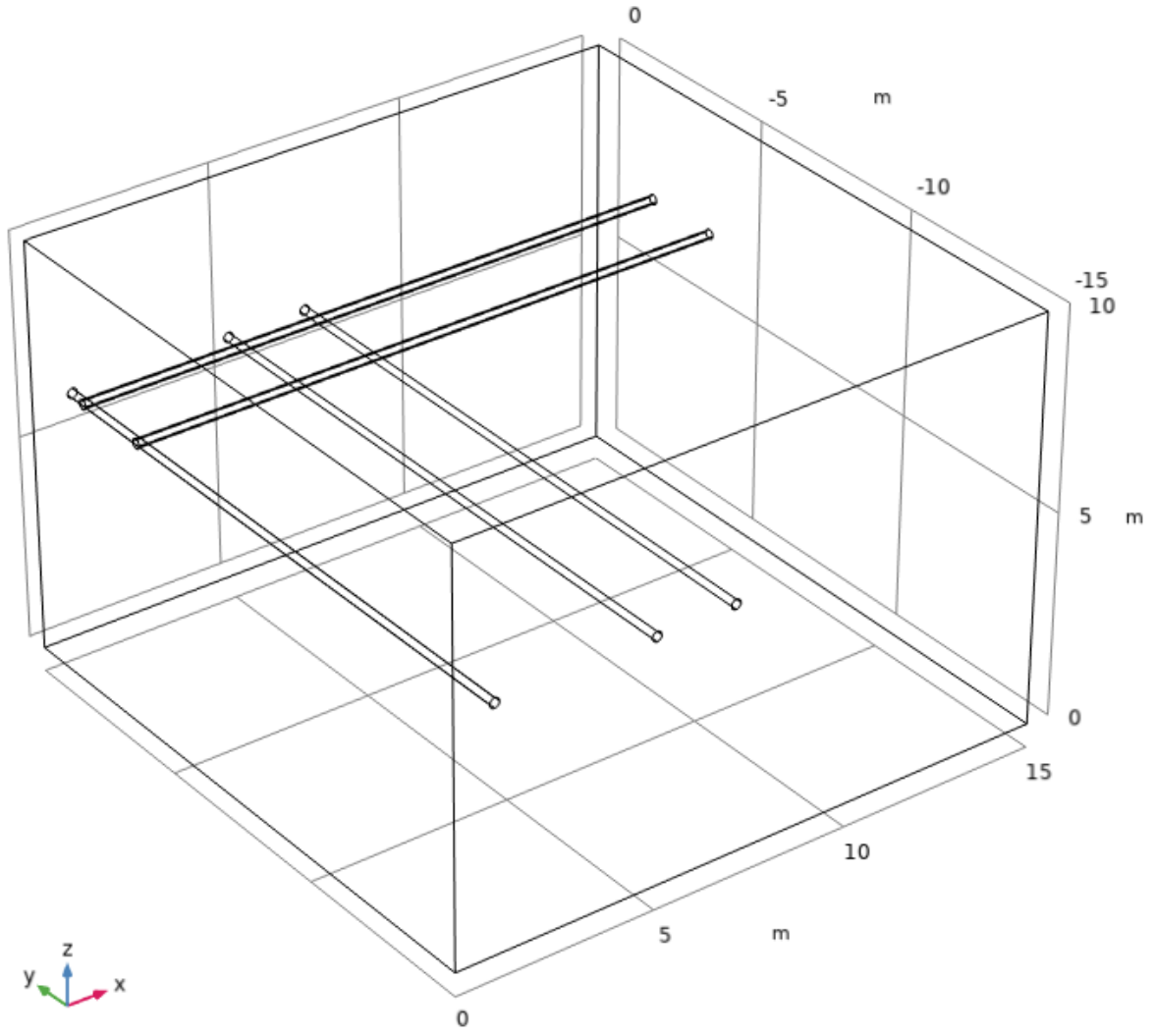
Introduction

Problem: Avoid overheating of cable insulation.

Task: Locate the hot-spot temperature.

3D challenges:

- Crossing in ground
- J-tube



Methods and use of COMSOL Multiphysics®

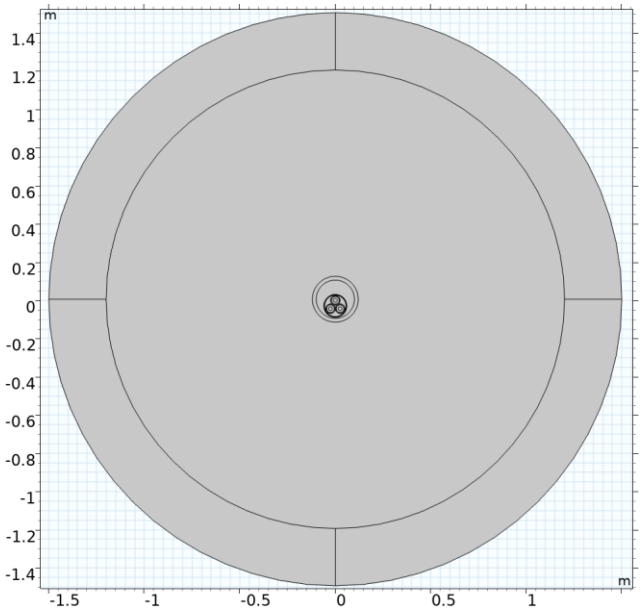
AC/DC and heat transfer module.

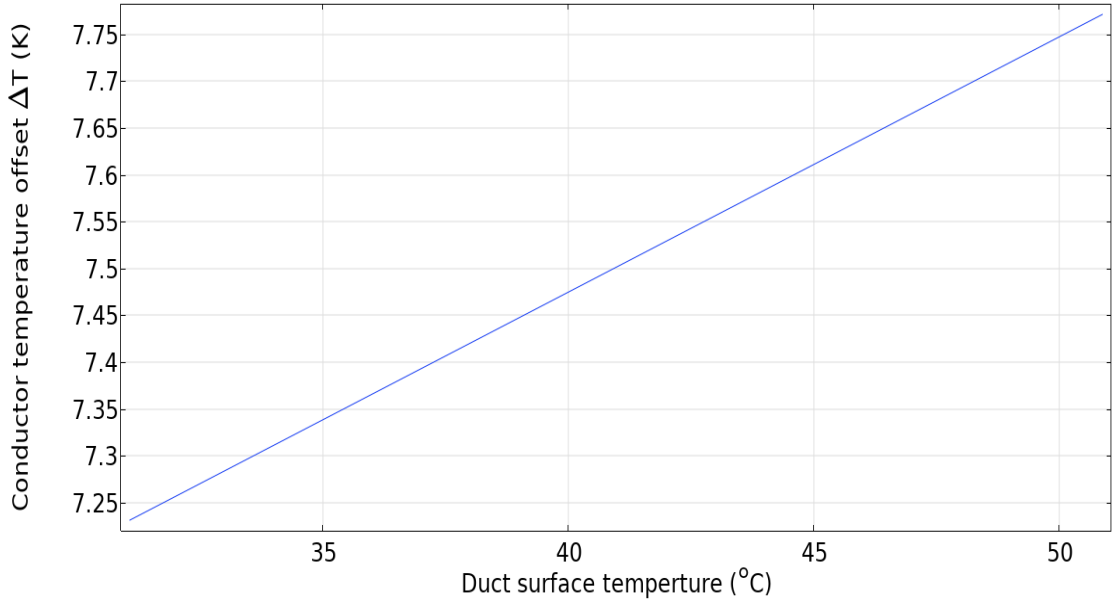
Split the 3D model into two parts.

Replicate the results of the best 3D model.

Duct surface boundary condition:

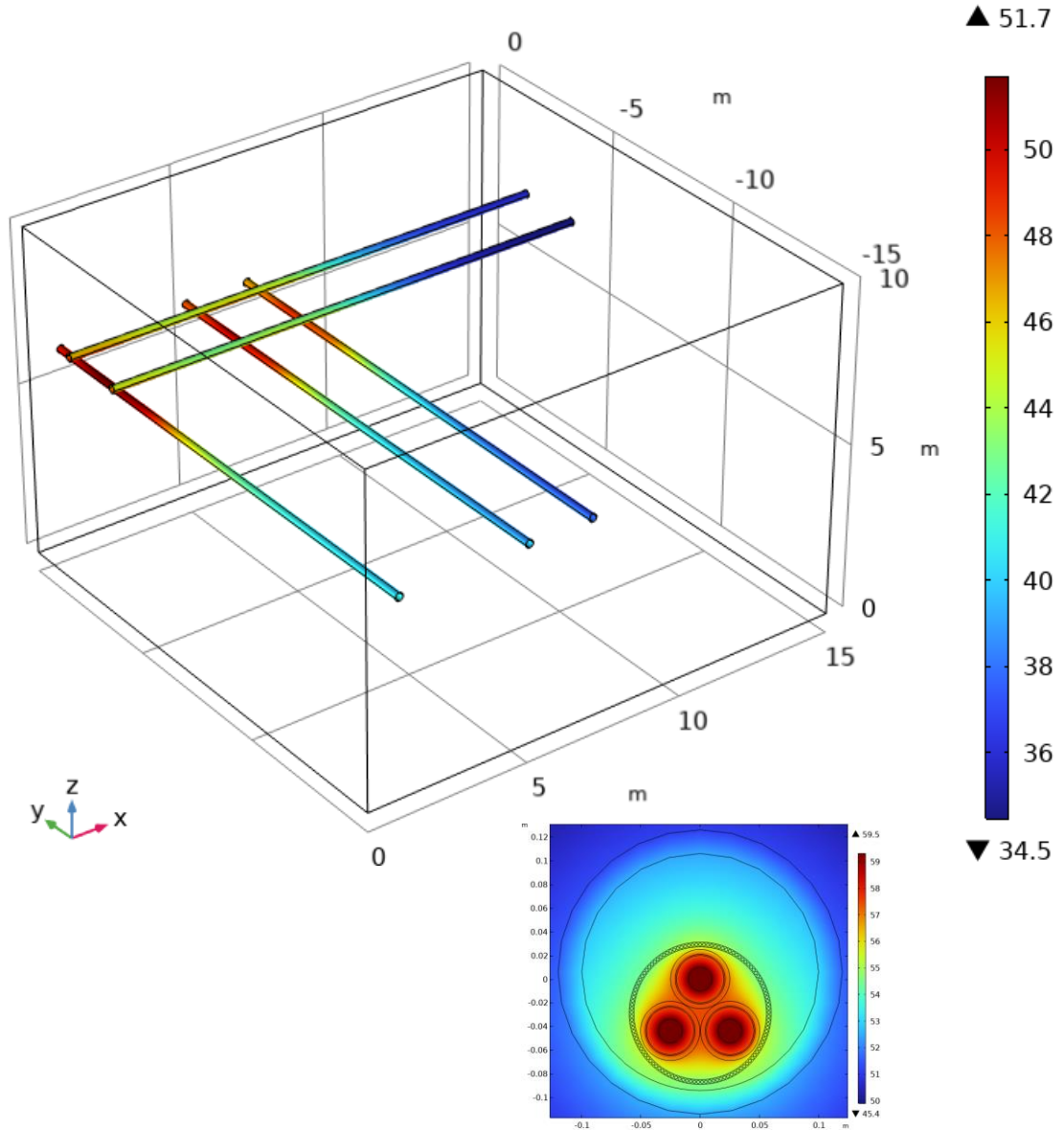
$$q = q_0\left(1 + \alpha_{Cu}\left(ht.Tvar + 7.5\ \mathrm{K} - 20\ ^{\circ}\mathrm{C}\right)\right)$$





Results

	3D	Segregated
Mesh	Extremely fine	Finer
DOFs	114 Millions	1.6 Millions
Physical memory	303 GB	8 GB
Solution time	45 min 11s	2 min 15 s
Hot spot duct	50.4°C (50.9°C)	51.7 °C
Hot spot cable	57.3 °C (59°C)	59.5 °C
Possible physics	Heat conduction	Full multiphysics
Improvements	Mesh scaling	Lazy approach

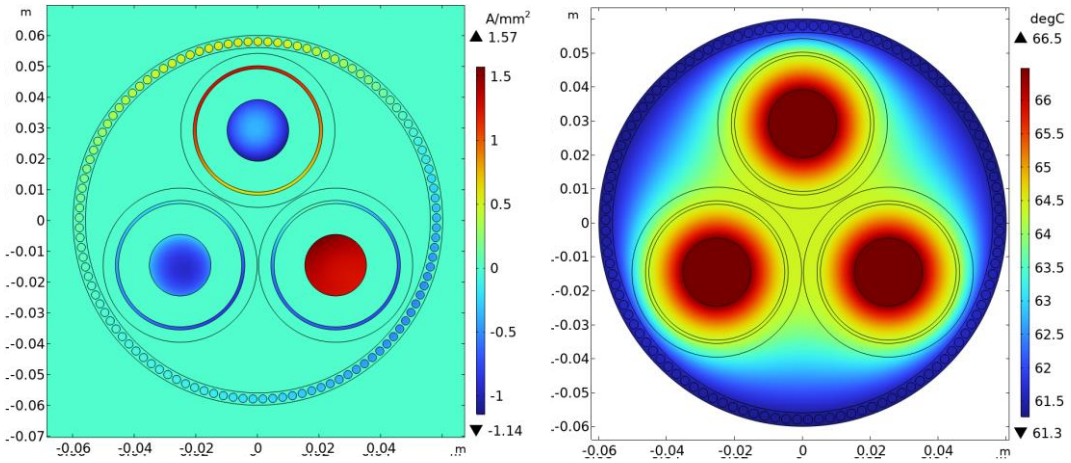


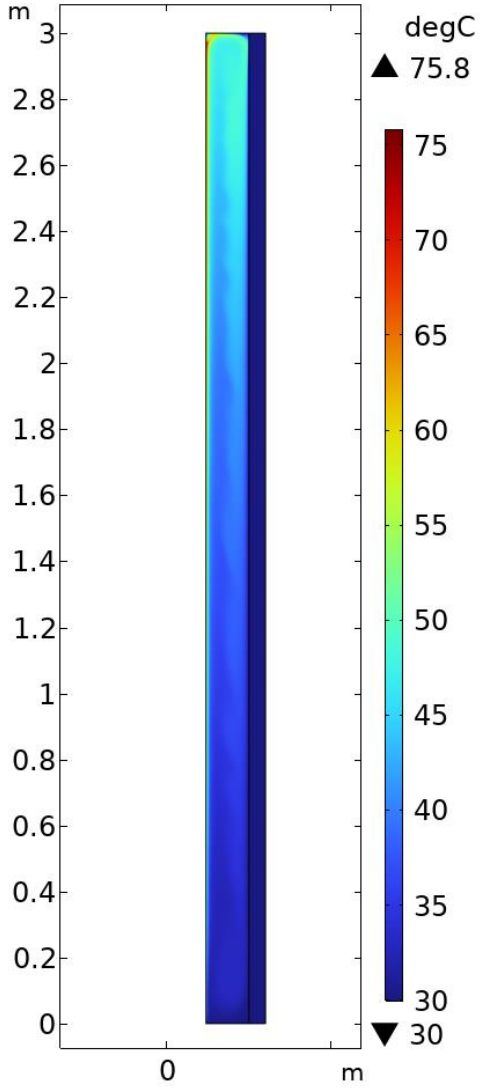
Results

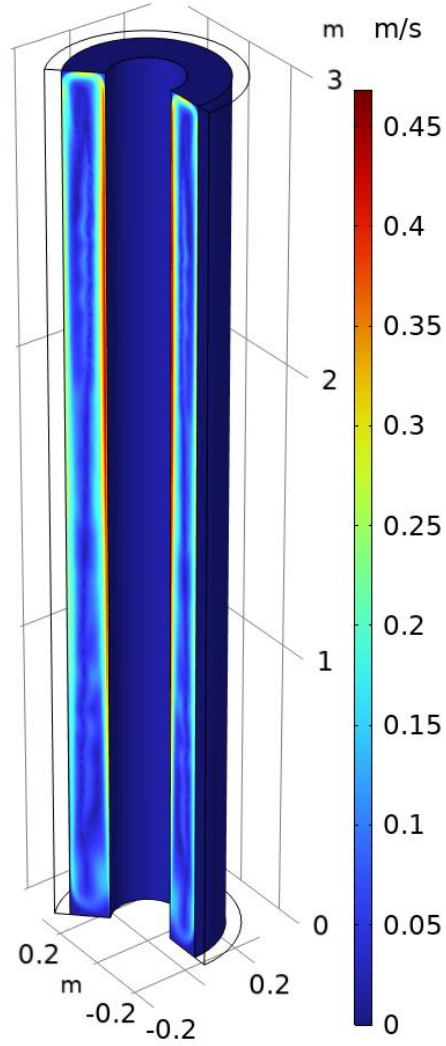
Further results for the J-tube application.

Lazy approach works well

for J-tube case.







Conclusions

Segregated model can replace a 3D model with the same physics.

It is conservative neglecting axial heat flux in conductors.

It can cope better with multiphysics than a 3D model.

It uses a fraction of the memory and the solution time.

In special cases of model split the approach can be simplified.