ROXIE23: Python Extensions for Advanced Conductor Design and Eddy Current Problems

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Outline

Differential geometry based Conductor Design

Eddy Current Problems

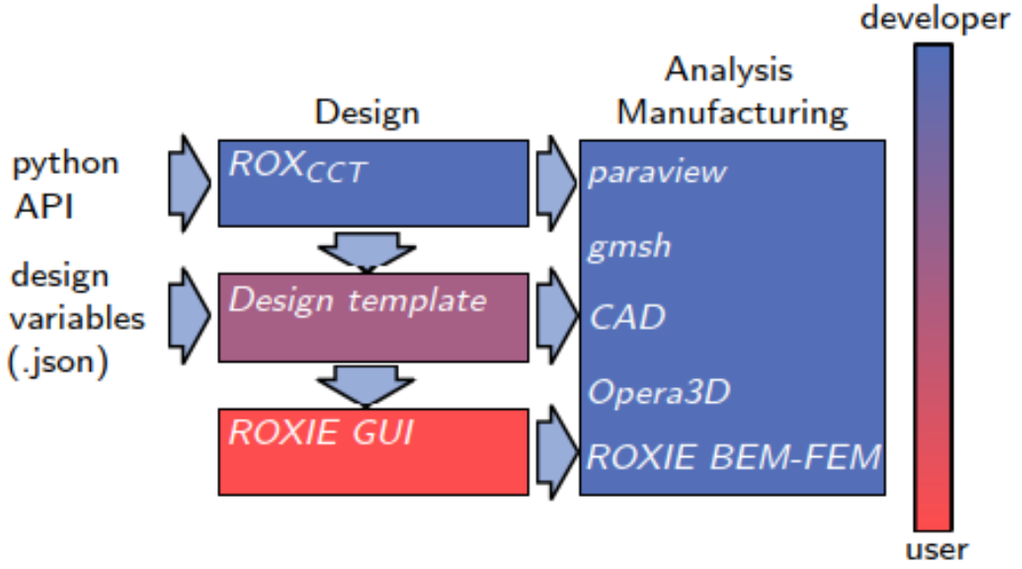
Conclusion

Outline

Python developer environment for ROXIE

- A ***back door to fast and flexible solutions***, beyond the capabilities of the ROXIE GUI
- It is a tool for ***developers not for users***
- The ***ROXIE23 CCT template*** has been developed in this workflow
- ***Your next idea is realized quickly!***

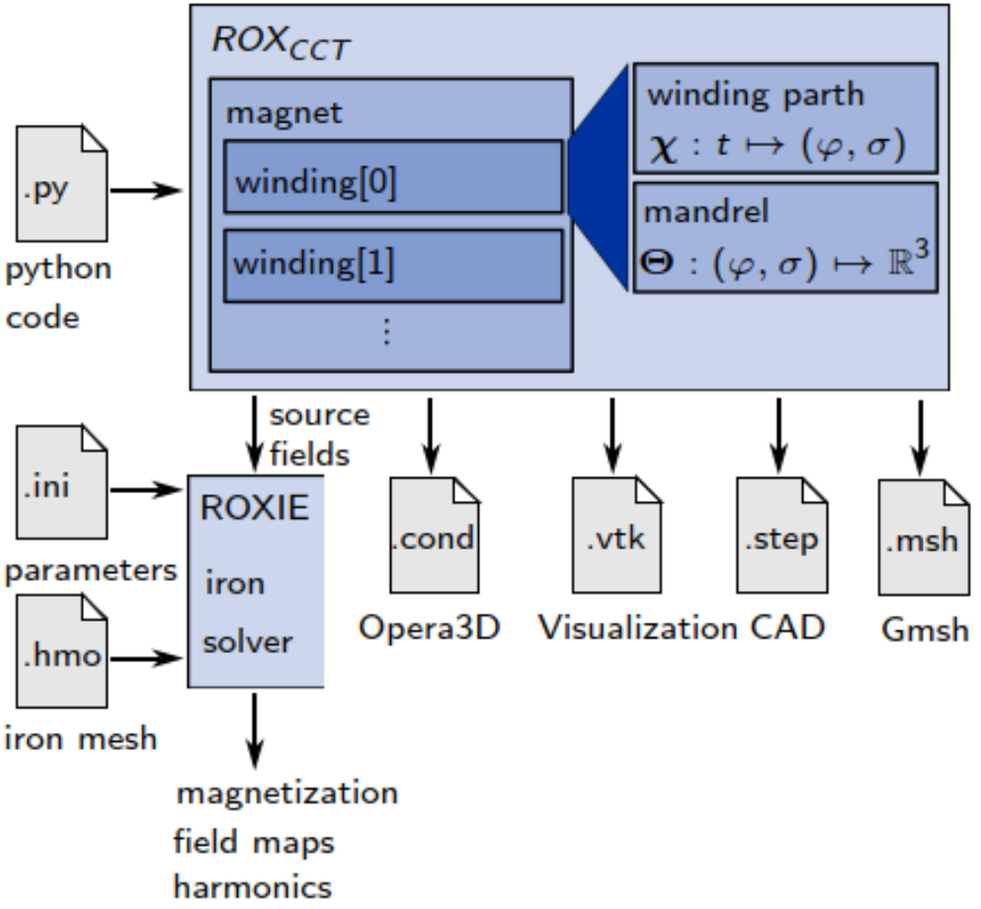
The developer environment



The ROX_{CCT} architecture

Features

- ***Flexible*** winding path and mandrel surface definition
- ***Differential geometry*** based coil design
- ***Interfaces*** to ROXIE, Opera3D, VTK, Gmsh
- ***BSpline*** representation for CAD



Accelerator magnet footprints

- A winding ***composed*** from a ***winding path*** and a ***mandrel surface***

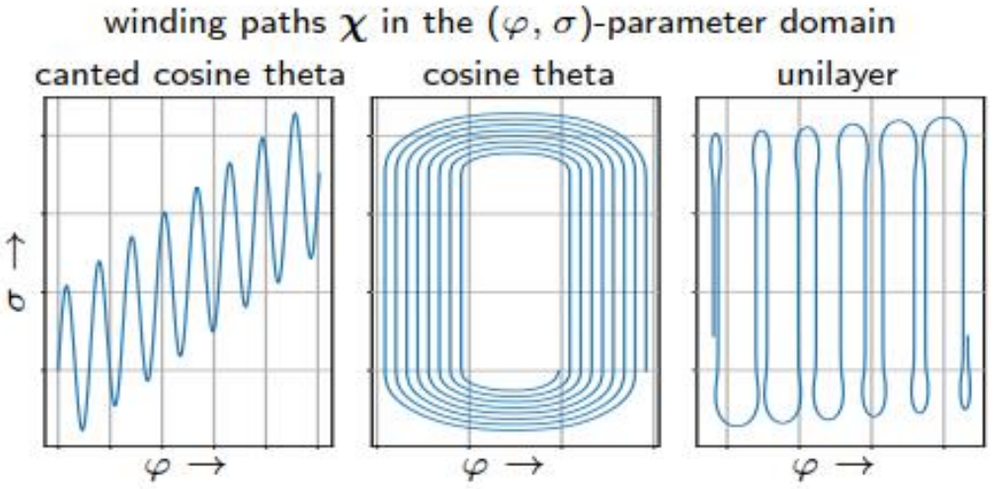
$$\boldsymbol{r}(t) = \boldsymbol{\Theta} \circ \boldsymbol{\chi}(t)$$

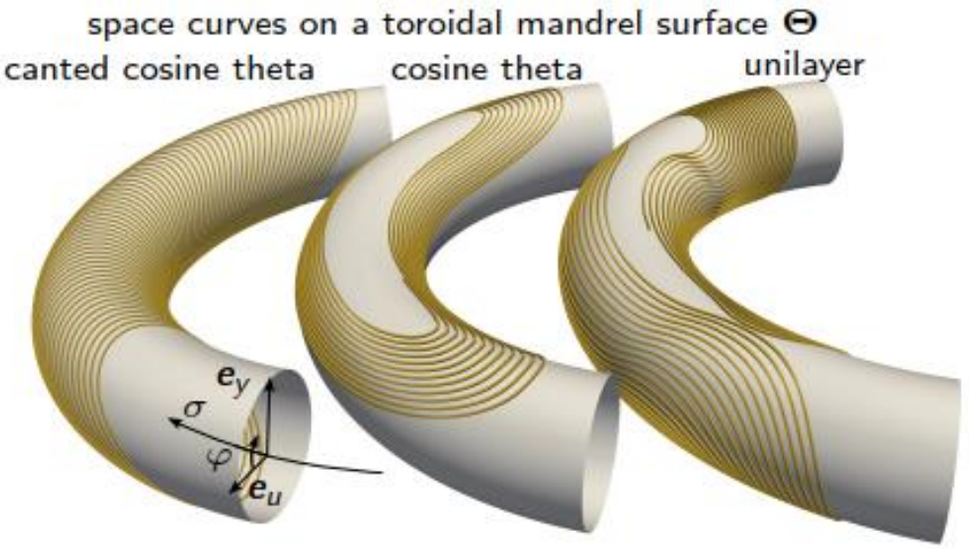
- Both objects are exchangeable

$\Rightarrow$ ***great flexibility***

Winding path templates

- Tilted helices
- Superellipses
- Leads
- NURBS $\Rightarrow$ general purpose





The new CCT template in ROXIE23

Mandrel features

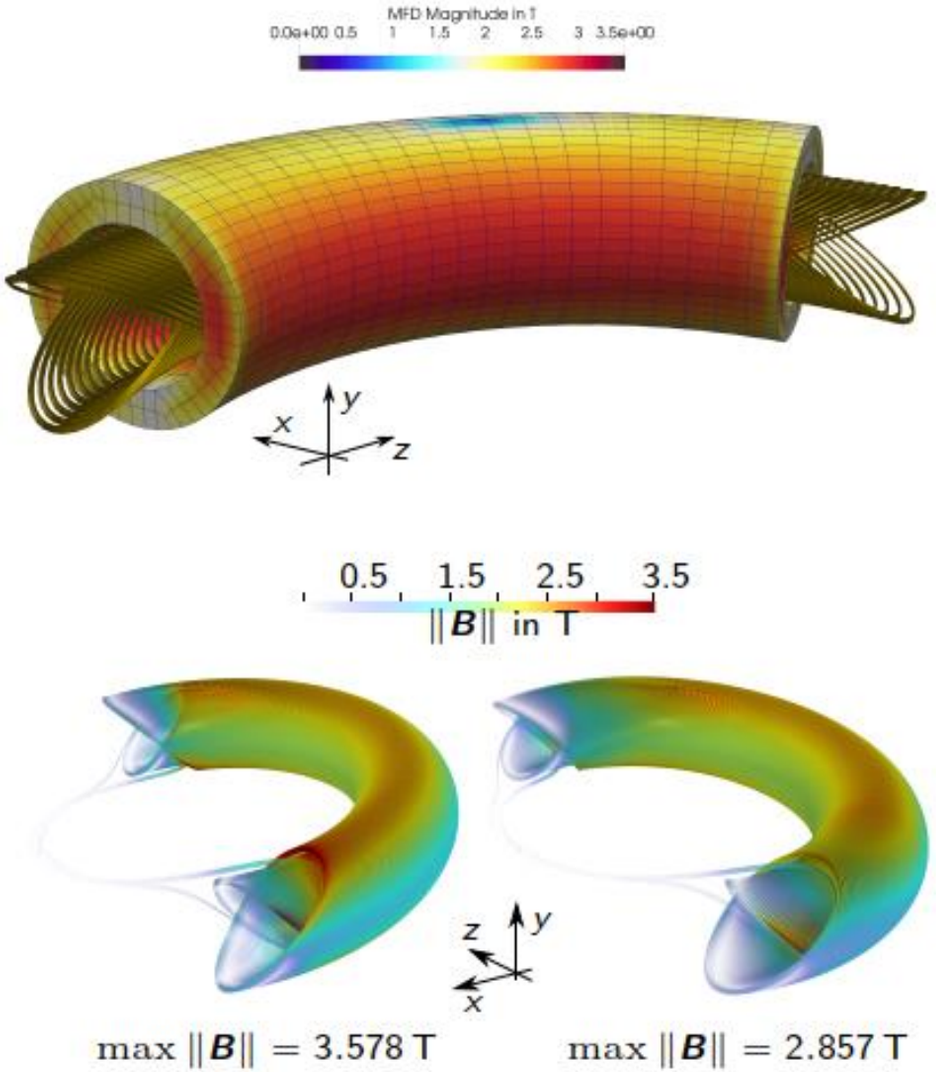
- Curved
- Elliptical
- Tapered

Winding path features

- Rib-thickness calculation
- Combined function
- Alternating gradient
- Pitch-fading

BEM-FEM features

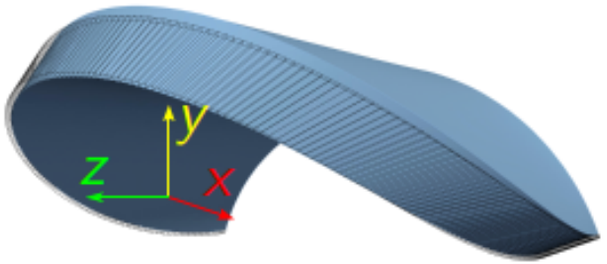
- Iron-magnetization

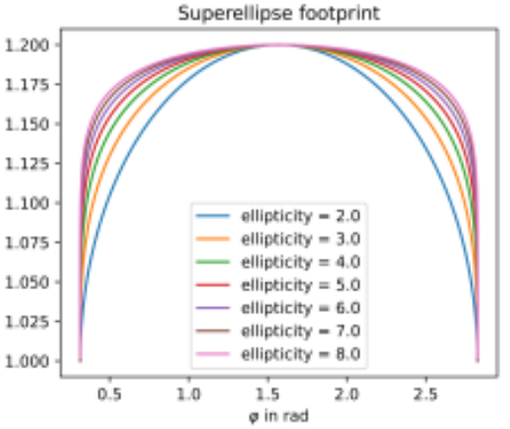


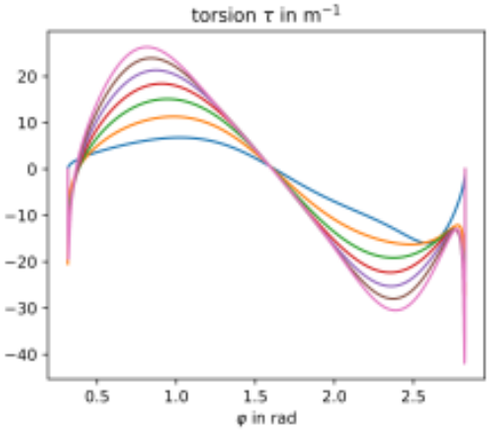
Coil head design for curved cos(θ) magnets

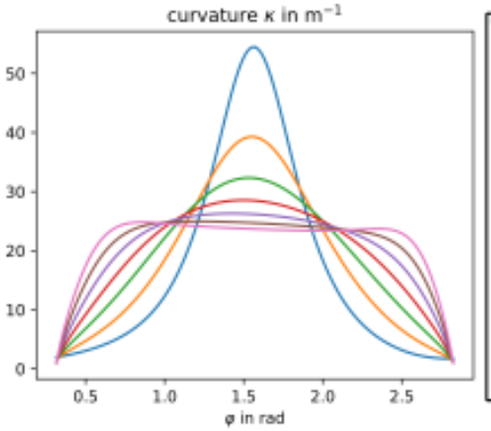
Features

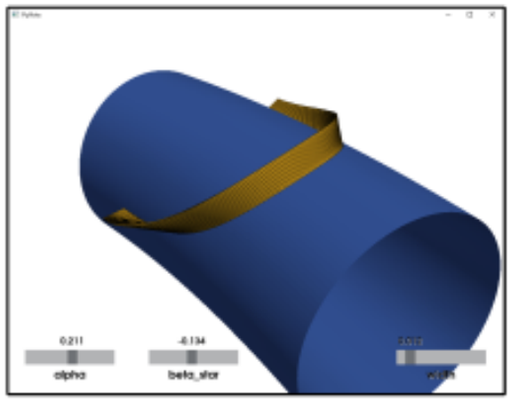
- Superellipse on curved mandrel
- NURBS based winding path
- Natural inclination
- Normal and geodesic curvature
- Cable twist and torsion
- Strip theory
- End-spacer design







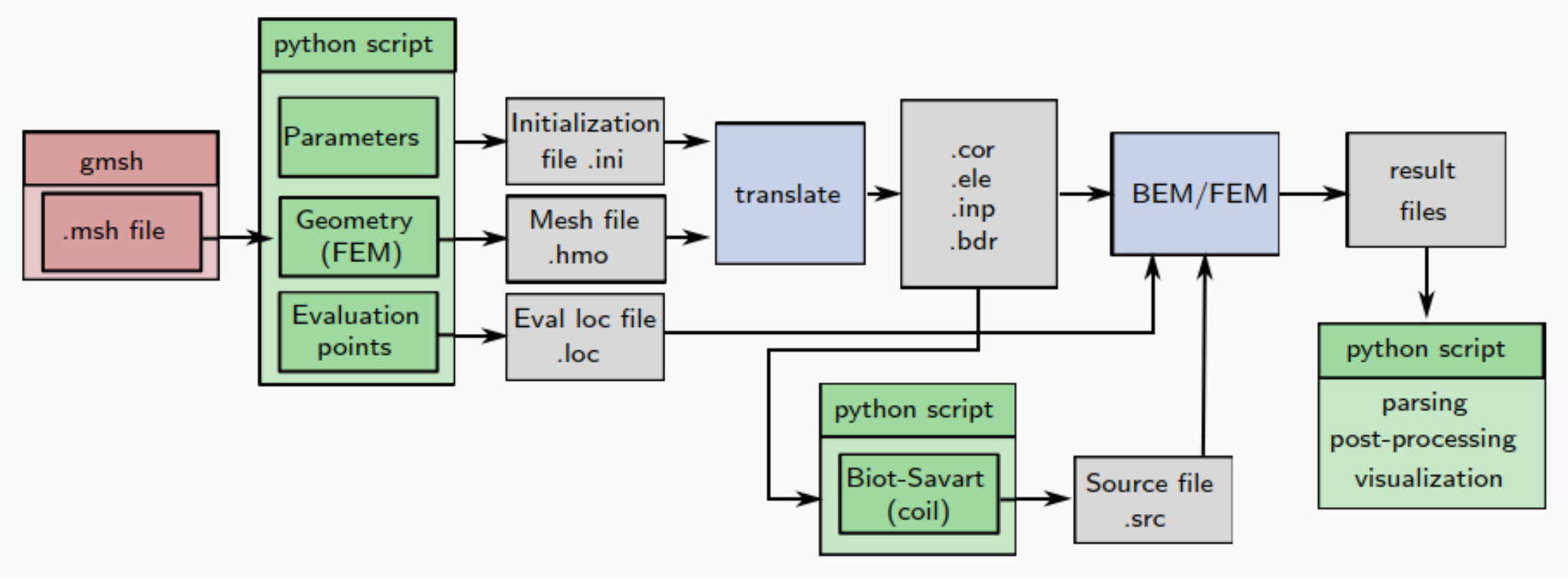




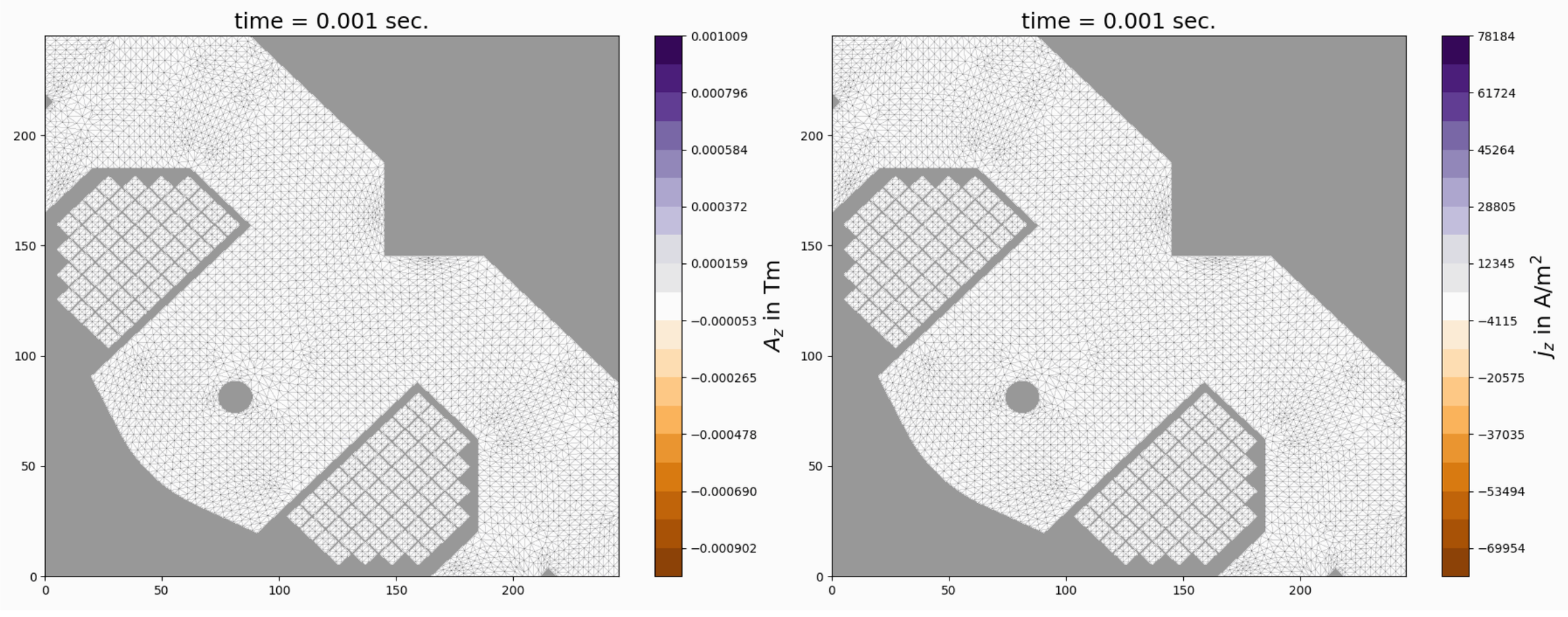
Outline

Eddy Current Problems

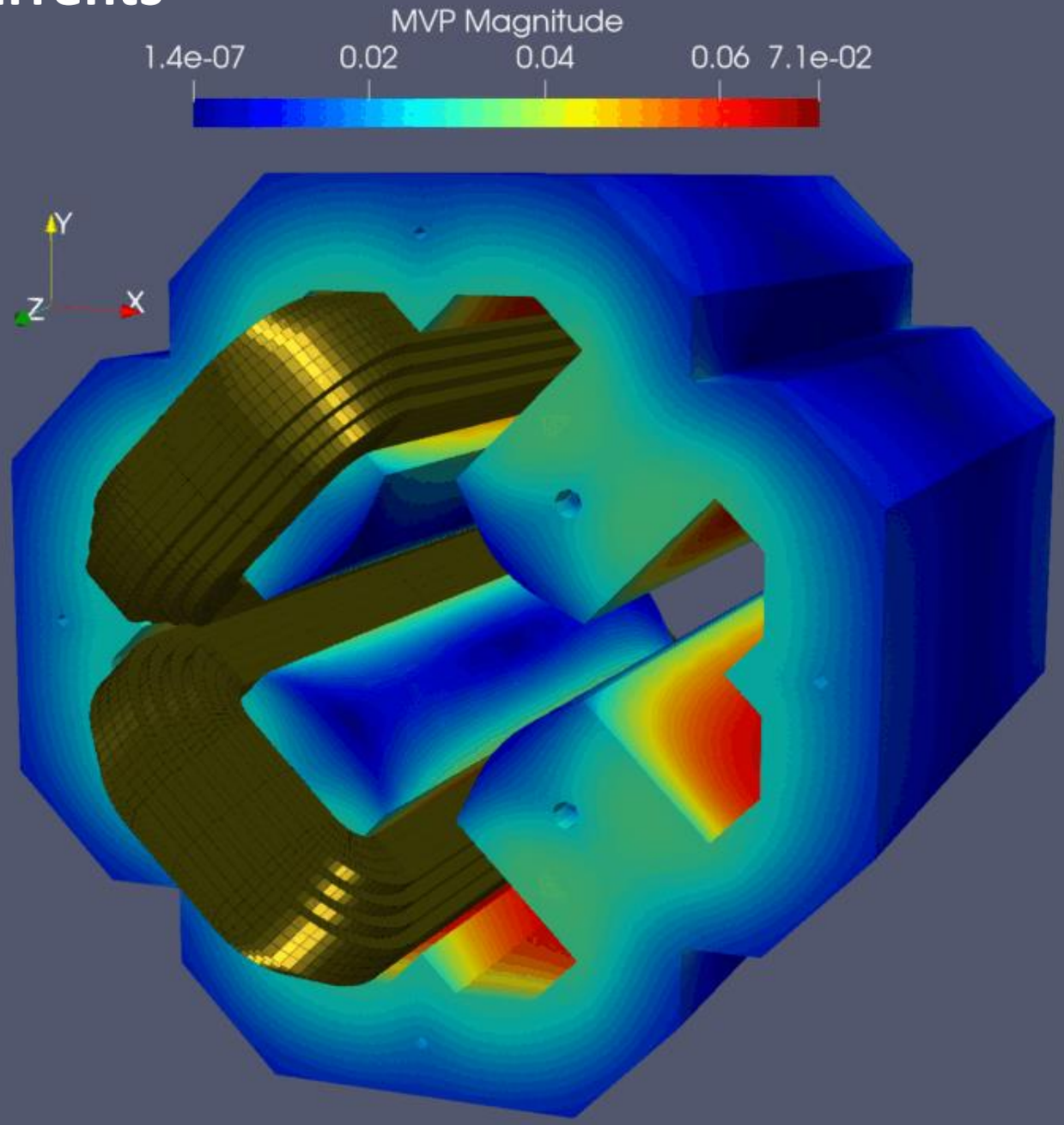
- BEM-FEM coupling can be applied also to the ***Eddy current problems***
- ***Python tools*** have been developed for the ***data translation, file formating, parsing and visualization***
- This feature will be ***accessible soon***.



2D Eddy currents



3D Eddy currents



Work in progress

- So far only ***isotropic materials*** (bulk yokes, vacuum chambers) are possible.
- A transient solver for ***anisotropic materials*** (lamminated iron) is currently ***in development***.

Outline

Conclusion

- The python developer extensions for ROXIE provide a ***back door to fast and flexible solutions***.
- Interfaces to ROXIE's ***BEM-FEM iron solver*** are available.
- ***Differential geometry-based coil head design*** is possible for ***strongly curved magnets***.
- It is possible to solve ***Eddy current problems in 2D and 3D*** using ROXIE's BEM-FEM solver
- Parsing of result files and ***advanced visualization tools*** have been developed.
- The Eddy current solver will be ***available soon!***