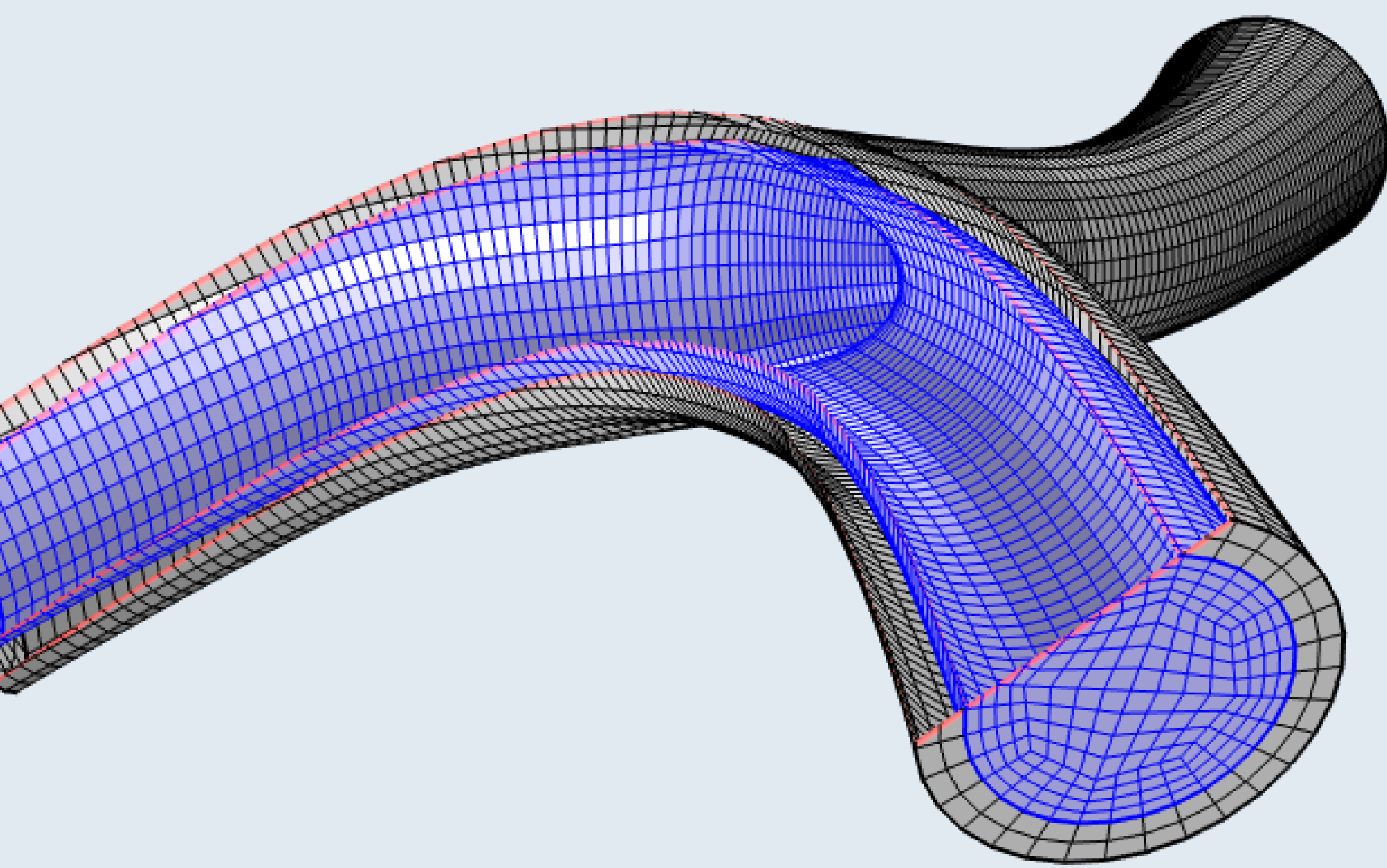


Automated MATLAB®–COMSOL Generation of Solver-Ready Cerebrovascular FSI Models

An automated MATLAB®–COMSOL pipeline that converts cerebral artery centreline data into solver-ready, structured hexahedral FSI models—with no manual domain or boundary selection at any stage.

A. Bartko¹, S. Yang¹

¹. School of Mechanical Engineering, University of Leeds, Leeds, United Kingdom.



Introduction

Wall shear stress and related blood-flow forces are key indicators of cerebral atherosclerosis, a leading cause of stroke. Capturing them accurately requires fluid–structure interaction (FSI) simulations — but these are slow to build and run, and the machine-learning models that could replace them need large libraries of such simulations to train on.

This work automatically turns cerebral artery centreline data into simulation-ready meshes and builds the FSI model in COMSOL Multiphysics®, removing the manual CAD and meshing steps that create the bottleneck. Wall thickness can be varied, making it practical to generate the large datasets needed to train fast surrogate models of cerebral blood flow.

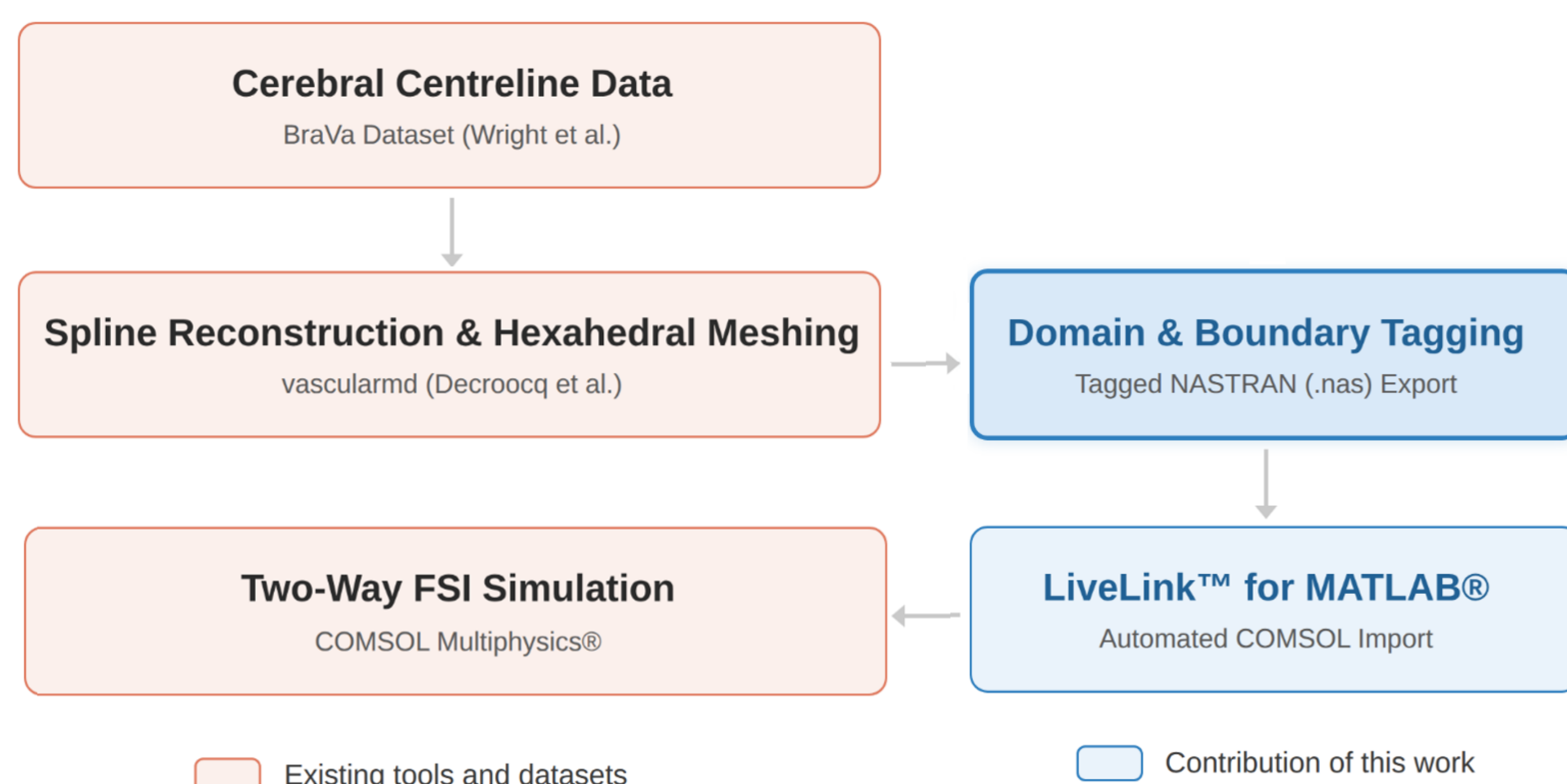


FIGURE 1. Outline of the automated FSI model assembly pipeline.

Methodology

Selection — 65 BraVa [1] bifurcations of subject BG001; radii inflated 5%, making wall thickness an input.

Meshing — O-grid hexahedral meshes via *vascularmd* [2]; the outermost band is the wall.

Tagging — Domains/boundaries identified from element connectivity and assigned NASTRAN PIDs.

Assembly — PIDs mapped to COMSOL selections in the template; the new mesh is imported via LiveLink™ for MATLAB®.

Results & Conclusion

Stage	Cases	Rate	Time
Selected bifurcations	65		1.3 s
Meshed (vascularmd), & tagged	55	84.6%	306 s
Imported to COMSOL	55	100%	109 s
Solver-ready models	55		8.5 min

55/65 bifurcations were successfully converted to solver-ready FSI models in **8.5 minutes**. This enables automated generation of large-scale FSI datasets for physics-consistent surrogate modelling.

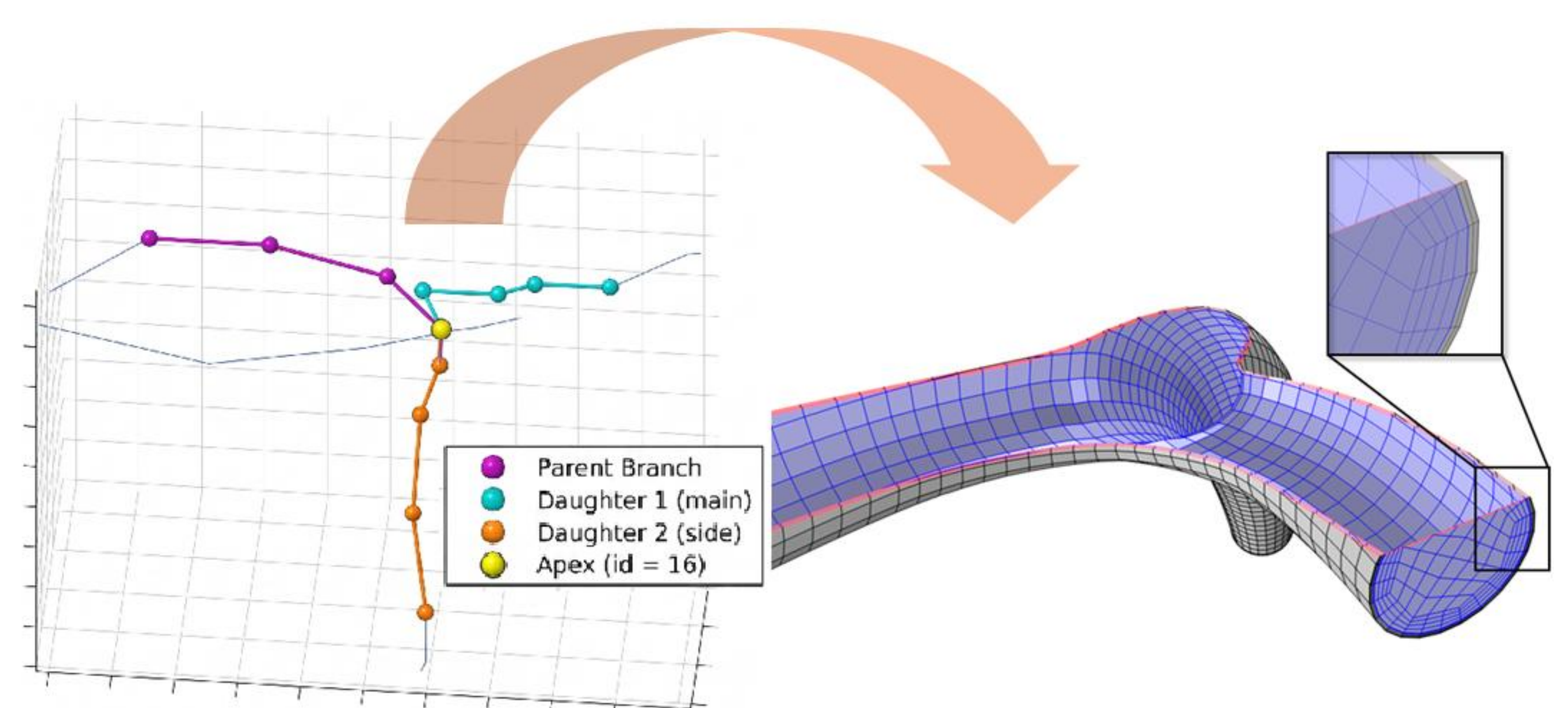


FIGURE 2. Bifurcation 16 of BraVa subject BG001: the cerebrovascular centreline (LEFT), and the resulting FSI-tagged mesh with the fluid domain highlighted (RIGHT).

REFERENCES

[1] S. N. Wright et al. “Digital reconstruction and morphometric analysis of human brain arterial vasculature from magnetic resonance angiography”. In: *NeuroImage* 82 (2013).

[2] M. Decroocq et al. “Modeling and hexahedral meshing of cerebral arterial networks from centerlines”. In: *Medical Image Analysis* 89 (2023), p. 102912.