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COMPUTATIONAL MODELING, SIMULATION AND VALIDATION FOR CARDIOVASCULAR DEVICES AND CLINICAL TOOLS

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ABSTRACT

As the leading cause of death worldwide, cardiovascular diseases drive demand for better devices and diagnostics. Computational modeling supports their development, from stents, heart valves, and blood pumps to patient-specific tools such as CT-derived fractional flow reserve [1]. Regulatory acceptance of in-silico evidence is also growing.

Translating such models into industrial and clinical R&D requires methods that are accurate yet efficient enough for iterative design, validation, and clinical workflows. Computational fluid dynamics (CFD) and fluid–structure interaction (FSI) can capture blood flow in vessels and devices, while biomechanical models describe the mechanics of vessel walls, pumps, and valves. Further models address blood damage and biological responses, including hemolysis, thrombosis, and in-stent restenosis. To make these approaches practical, high-fidelity simulations can be complemented by reduced-order, surrogate, and data-driven models, and supported by high-performance computing.

The session invites contributions from academia and industry on computational models developed or tailored for R&D of cardiovascular devices and clinical tools, including:

- CFD, FSI and biomechanical models of devices and patient-specific anatomies;
- models of hemolysis, thrombosis, restenosis and device–tissue interaction;
- reduced-order, surrogate and efficient models for many-query simulations;
- validation and uncertainty quantification against bench and clinical data;
- in-silico trials and computational design testing of devices at R&D level;
- software tools supporting clinical decision-making, planning and guidance.

REFERENCES

[1] C.A. Taylor, T.A. Fonte and J.K. Min, *Computational fluid dynamics applied to cardiac computed tomography for noninvasive quantification of fractional flow reserve: scientific basis*. J. Am. Coll. Cardiol. (2013) 61(22): 2233–2241.