M2P 2027 – Invited Session Proposal

Imaging-Based Digital Twins: Mathematical and Computational Modeling for Biomedical and Industrial Applications

Organized by: L. F. Pavarino (University of Pavia, Italy), R. Chen (Shenzhen Institutes of Advanced Technology CAS, China) and X.-C. Cai (University of Macau, Macau, China)

Contact: *[luca.pavarino@unipv.it] · [r.chen@siat.ac.cn] · [xcai@um.edu.mo]*

Scope and Description

Medical and industrial imaging increasingly serve as the foundation for digital twins — virtual, patient- or process-specific replicas that support diagnosis, monitoring, design, and decision-making. This minisymposium brings together mathematicians, computational scientists, and engineers working at the intersection of imaging, mathematical modeling, and scientific machine learning to build imaging-based digital twins with real-world impact, spanning biomedical and industrial applications.

We will discuss algorithmic advances for digital twins and for solving the underlying governing equations, covering both classical numerical methods and emerging machine-learning-based techniques. Talks will address model-driven, data-driven, and hybrid strategies that combine physics-based simulation with learned representations, together with methods for uncertainty quantification, model-order reduction, and real-time simulation needed to make digital twins deployable in practice.

Particular attention will be devoted to the translation of these methods beyond the laboratory: validation against real data, integration into clinical and industrial workflows, and the challenges of scaling personalized or process-specific models to cohorts or production settings. By connecting biomedical applications (e.g., cardiovascular and organ-level digital twins) with broader industrial and sustainability-oriented use cases, the session aims to foster cross-fertilization between academia, industry, and end users, in line with M2P's mission of turning mathematical and computational advances into deployable, reliable quantitative tools.

Topics:

Imaging-based digital twins for diagnosis, monitoring, and decision support,
Model-driven, data-driven, and hybrid (physics + machine learning) simulation strategies,
Scientific machine learning for image reconstruction and for forward/inverse problems,
Model-order reduction and real-time / near-real-time simulation for deployable digital twins,
Uncertainty quantification and validation for imaging-based models,
Translation from personalized (biomedical) to process-specific (industrial) digital twins.

Candidate Speakers:

Speaker	Affiliation
V. Kheyfets	**University of Colorado Anschutz, USA**
C. Zhu	**Peking University, China**
Z. Zhao	**Universidad Politécnica de Madrid, Spain**
F. Hwang	**National Central University, Taiwan**
E. Centofanti	**University of Pavia, Italy**
Y. Yang	**University of Macau, China**
J. Kowalski	**Inria Saclay IdF, France**
T. Kanemoto	**Tokyo University of Science, Japan**
J. Huang	**Academy of Mathematics and Systems Science, China**
F. Viola	**Gran Sasso Science Institute, Italy**
N. Barnafi	**Pontificia Universidad Católica de Chile**
Y. Qin	**Shanxi University, China**
M. Oshima	**The University of Tokyo, Japan**
C. Vergara	**Politecnico di Milano, Italy**
Y. Cai	**Beijing Normal University**
H. Zhang	**Tsinghua University**