# INVITED SESSION: BENCHMARK MEASUREMENTS, DIGITAL TWINS, AND MODEL VALIDATION FOR AM COMPONENTS

**JAKE BENZING [1], JORDAN WEAVER [2], NIK HRABE [1], AND LYLE LEVINE [3]**

[1] National Institute of Standards and Technology Materials Measurement Laboratory Boulder, CO, 80305, USA jake.benzing@nist.gov and nik.hrabe@nist.gov
[2] National Institute of Standards and Technology Engineering Laboratory Gaithersburg, MD, 20899, USA Jordan.weaver@nist.gov
[3] National Institute of Standards and Technology Materials Measurement Laboratory Gaithersburg, MD, 20899, USA Lyle.Levine@nist.gov

## ABSTRACT

Additive manufacturing (AM) is a multi-scale and multi-physics process that is being used for demanding applications in aerospace, biomedical device, power generation, automotive, defense, and other sectors. To accurately model these physical processes, numerical models must be validated against trusted, high-quality physical measurements. This approach is particularly important for integrating AM modeling into industrial product design, formal qualification, and the development of comprehensive AM digital twins.

As the AM community moves from standardized test artifacts to real components with geometric complexity, the demand for rigorous validation data is unprecedented. Complex part geometries pose significant challenges to the modeling community, requiring quantitative models that capture intricate transient thermal histories, residual stress accumulations, and variations across the entire processing-structures-properties-performance space.

The Additive Manufacturing Benchmark Tests (AM Bench) organization [1], spearheaded by the National Institute of Standards and Technology (NIST), provides a continuing series of AM benchmark measurements and challenge problems to enable modelers to test their simulations. SIM-AM is a natural partner for AM Bench. This invited session will include select speakers involved in AM model validation measurements, validated AM simulations of complex components, and AM data management emphasizing FAIR (Findability, Accessibility, Interoperability, and Reusability) principles.

The primary objective of this session is to bring modelers, experimentalists, and data scientists together to explore ways to increase synergy and the impact of our work. Additionally, lessons learned will be reviewed regarding modeling and digital twins, highlighting what is needed moving forward to accelerate the trust of numerical modeling in industrial AM product development.

## REFERENCES (Not mandatory, maximum 2 references)

[1] Levine, L., Lane, B., et al., Outcomes and Conclusions from the 2022 AM Bench Measurements, Challenge Problems, Modeling Submissions, and Conference, Integr Mater Manuf Innov, 13, 598–621, 2024.