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Simulation-driven innovation for instrumentation development at DESY and European XFEL

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Simulation is becoming a key driver of digital transformation strategies. Through AI/ML and data-driven methodologies, the "shift left" approach is increasing the impact of simulation on instrumentation R&D. This contribution presents two examples illustrating this progress at DESY and European XFEL. The first focuses on CFD simulations for the cryogenic liquid jet platform at the High Energy Density (HED) instrument at EuXFEL, supporting high-repetition-rate sample delivery. The simulations study the sensitivity of jet behavior to nozzle geometry, boundary conditions, physical and numerical parameters, showing strong agreement with experimental data and providing insights for optimization. The second highlights a novel simulation-driven design for detector cooling system. With extreme energy intensity and heat load from the x-ray laser beam, efficient and compact cooling solutions are crucial. Using the generative design tool Coldstream, innovative cooling structures are developed through an automated, multi-objective optimization process considering manufacturability. Across both examples, systematic validation and verification are implemented to ensure simulation reliability.

Footnotes

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