

From Acquisition to Insight: AI-Driven Automation for Scalable Multimodal Imaging

Abstract

The rapid growth of imaging complexity and data volumes across life sciences and materials research is driving the need for increasingly automated, reproducible, and scalable microscopy workflows. Automation is therefore evolving beyond individual acquisition steps toward integrated pipelines connecting instrument control, image acquisition, analysis, and data management.

This presentation will explore how advanced microscopy platforms can combine automated acquisition with AI-assisted image analysis to reduce operator dependency, increase throughput, and improve workflow reproducibility. In electron microscopy, advanced software solutions enable visual workflow development integrating microscope control, acquisition, measurements, image analysis, logic, and closed-loop feedback within standardized and repeatable processes.

Complementary examples in light microscopy will illustrate how automation can support complex life-science applications, including workflows related to genomic editing, where automated imaging and image-based decision making can facilitate more efficient and standardized experimental pipelines.

The discussion will also address X-ray microscopy and multimodal imaging, highlighting AI-supported reconstruction, segmentation, quantitative analysis, and correlative approaches across different imaging modalities and spatial scales.

Finally, as automated microscopes generate increasingly large and complex datasets, scalable image analysis becomes essential. Solutions including advanced local analysis, cloud-based computation and collaboration, and microscopy data management can extend automation beyond image acquisition, enabling efficient processing, interpretation, sharing, and management of imaging data.

Together, these developments outline a transition from automated microscopy toward automated scientific workflows, in which acquisition, analysis, and data infrastructure operate as an interconnected ecosystem to accelerate insight while improving consistency, scalability, and reproducibility.