**Appalachian Regional Electron Microscopy Society Topical Conference**

**Third Summer School on ML for Electron Microscopy**

University of Tennessee Knoxville, with Oak Ridge National Laboratory and Pacific Northwest National Laboratory (?), Thermo Fisher, AtomQ, Mat3ra

Organizers: Gerd Duscher, Sergei V. Kalinin,

Tutorials by: Austin Houston, Utkarsh Pratiush, Elizabeth Heon, Kamyar Barakati, Kevin Roccapriore,

 If you are working on machine learning for microscopy—whether it’s for data analysis, real-time analytics, or running microscopes autonomously—keep your schedule open for the Third Summer School on ML for Electron and Scanning Probe Microscopy, hosted by [University of Tennessee, Knoxville](https://www.linkedin.com/company/university-of-tennessee-knoxville/) in collaboration with [Thermo Fisher Scientific](https://www.linkedin.com/company/srcare/), ORNL, and PNNL.

📍 When? May 19-23, 2025

📍 Where? Hybrid format (join us in-person or online!)

The school will cover core ML topics, but the real focus will be on the latest advances in automated microscopy, including:

✅ Building AI-driven experimental workflows – General principles of decision-making for autonomous instruments.

✅ Leveraging reward-driven workflows – Transitioning from manual, biased image analysis to unsupervised, highly robust exploration.

✅ Making automation real – Hands-on deep dive into AutoScript ([Paolo Longo](https://www.linkedin.com/in/paolo-longo-8a231945/)), exploring how to automate and control STEM and SPM instruments.
 Participants will gain access to diverse STEM and SPM imaging, spectral, and structure-property datasets, as well as instrument digital twins, providing a unique opportunity to apply ML to real experimental challenges. A major focus of the course will be on engineering the transition from human-controlled to AI-augmented and fully autonomous workflows. Special emphasis will be placed on the AutoScript interface, which allows researchers to implement Python-based automation directly on Thermo Fisher electron microscopes, providing hands-on experience in running real-time data analytics, automated imaging optimization, and AI-driven decision-making workflows. Attendees will learn how to develop and deploy ML workflows on their own microscopes, tackling key challenges such as real-time API integration, stochastic optimization for decision-making, and adaptive AI models. Whether you are interested in microscopy data analysis, automated instrument control, or AI-enhanced materials discovery, this course will provide a comprehensive overview of the state-of-the-art and future directions in the field.

**Fees:**

The fees for participants will be $150,

AReMS members and UTK students have a reduced fee of $75

**Schedule**

**Monday May 19: Atomic Resolution STEM and Physics from Atomic Positions**

8:30 – 9:00 Welcome

9:00-10:00 Principles of Electron Optics and Aberration Correction in STEM (Duscher)

10:00-10:50 Remote Aberration Correction in STEM (Duscher, Houston)

11:10-12:00 Simulation of Ronchigrams [Participant computer] (Duscher)

12:00-1:00 Lunch (provided for registered onsite participants)

1:00-2:00 Remote Atomic Resolution Imaging (Duscher)

2:00-2:50 Methods of Atom Position determination [Participant computer] (Duscher, Barakati)

3:20 -4:00 Introduction to Neural Networks (Heon)

4:00-5:00 First Machine Learning Algorithms for Atomically Resolved Images

**Tuesday May 20: Electron Diffraction, 4D-STEM, and Variational Auto Encoder**

9:00-10:00 Introduction to Diffraction (Duscher)

10:00-10:50 Remote Diffraction Acquisition in STEM (Duscher, Houston)

11:10-12:00 Simulation of Diffraction Pattern (Duscher)

12:00-1:00 Lunch (provided for registered onsite participants)

1:00-2:00 Analyzing Diffraction pattern [Participant computer] (Duscher, Houston)

2:00-2:50: Clustering Algorithms for 1 and 2D datasets

3:20-4:00 Conventional and Smart Acquisition of 4D STEM (Houston)

3:20 -4:00 Clustering of 4D Datasets

**Wednesday May 21: Remote and Conventional Acquisition of Energy Dispersive X-Ray Spectra; Fundamentals and Data Analysis with Machine Learning**

9:00-10:00 Introduction to Spectroscopy (Duscher)

10:00-10:50 Remote Acquisition of EDS spectra in STEM (Duscher, Houston)

11:10-12:00 Analysis of EELS [Participant computer] (Duscher)

12:00-1:00 Lunch (provided for registered onsite participants)

1:00-2:00 Machine Learning of Spectroscopic Datasets [Kalinin]

2:00-2:50 Remote and Smart Acquisition of spectra in STEM (Duscher, Houston)

3:20-4:00 Conventional Analysis of EELS [Participant computer] (Duscher)

4:00- 5:00 ML enhanced Analysis of EELS EELS [Participant computer] (Kalinin)

**Thursday May 22: Introduction to Machine learning for STEM**

9:00-10:00 Introduction to Workflows in Machine Learning

10:00-10:50 VAE for Image Analysis *(Kalinin),*

11:10-12:00 Autonomous Operation *(TF),*

12:00-1:00 Lunch (provided for onsite participants)

1:00-2:00 Convolutional Neural Network (Heon)

2:00-2:50 Deep Kernel Neural Networks (Pratiush)

3:20 -4:00 Principles of Neural Networks for Images II [Participant computer] (Kalinin, Houston, Pratiush)

4:00-5:00 Decision Making for Autonomous Workflows

**Friday May 23: Decision making in electron microscopy, Reward based workflow sand human-in the loop automated experiment (hAE)**

9:00-10:00 Decision Making from BO to DKL and hAE (Kalinin)

10:00-10:50 Streaming to Theory (Pratius, Houston)

11:10-12:00 Digital Twin Microscopy [participants computer]

12:00-1:00 Lunch (provided for onsite participants)

1:00-2:00 Principles of Bayesian Optimization (Kalinin)

2:00-2:50 New methods enabled by remote computer-controlled acquisition (Houston)

3:20 -4:00 Atomic Fabrication with STEM (Kalinin, Kevin, Timur)

4:00-5:00 Conclusion