BRNO UNIVERSITY OF TECHNOLOGY
FACULTY OF INFORMATION TECHNOLOGY

ThermoFisher SCIENTIFIC

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MEASURING THE THICKNESS OF CONTAMINATION LAYERS

IN SCANNING ELECTRON MICROSCOPY USING IMAGE PROCESSING

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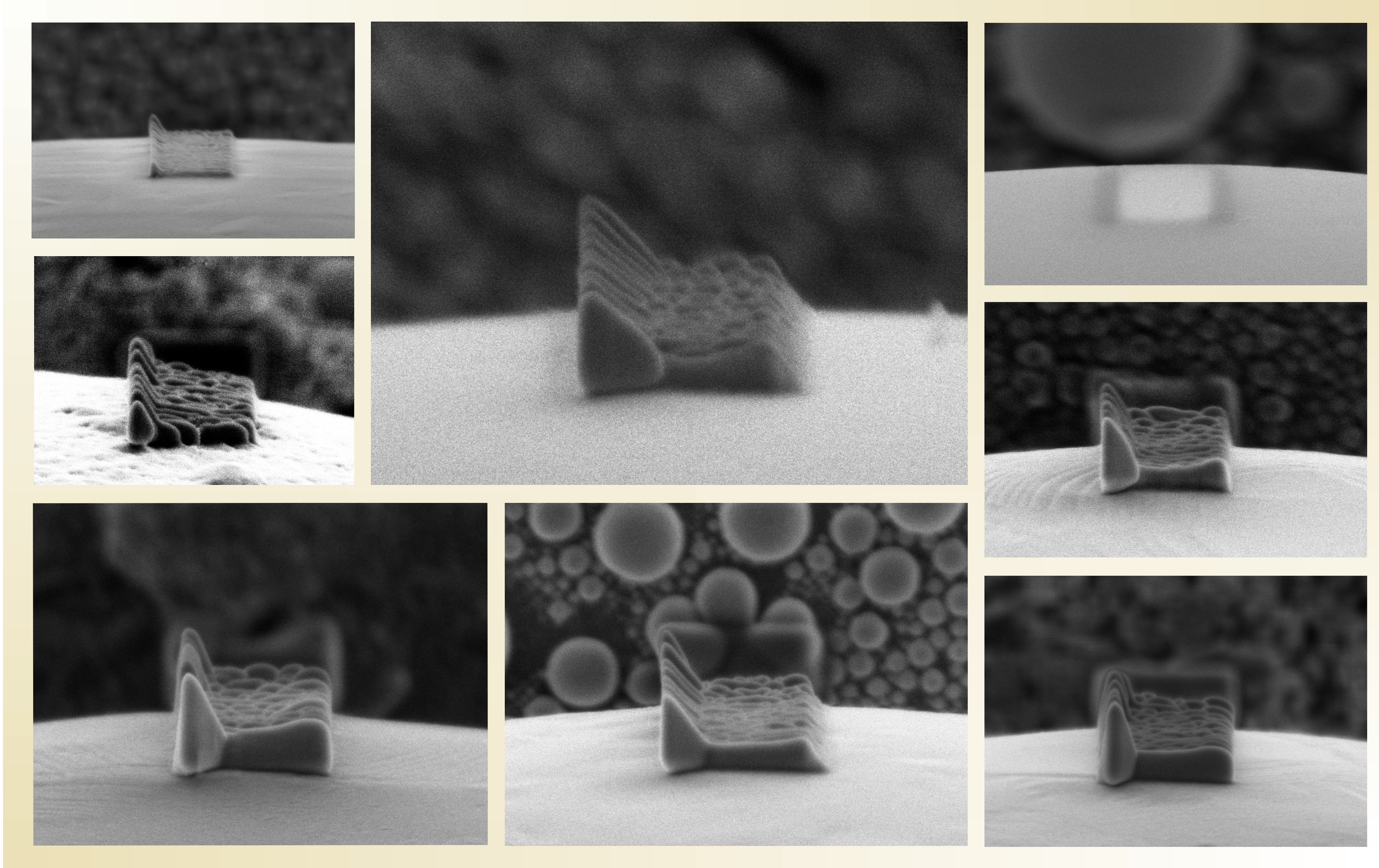
What is Contamination?

In scanning electron microscopy (SEM), contamination refers to the unintended deposition of materials on the specimen surface, primarily caused by the electron beam's interaction with hydrocarbon molecules present on or near the sample. This interaction can lead to the deposition of a carbon-rich layer on the specimen, obscuring fine details and altering the material's electron emission properties. Contamination typically manifests from two main sources:

1. **Internal Sources:** Components within the SEM, such as oil from the vacuum pumps and outgassing from other parts of the microscope.
2. **External Sources:** Residues from specimen handling and environmental exposure.



Why Measure Contamination?

Rationale:

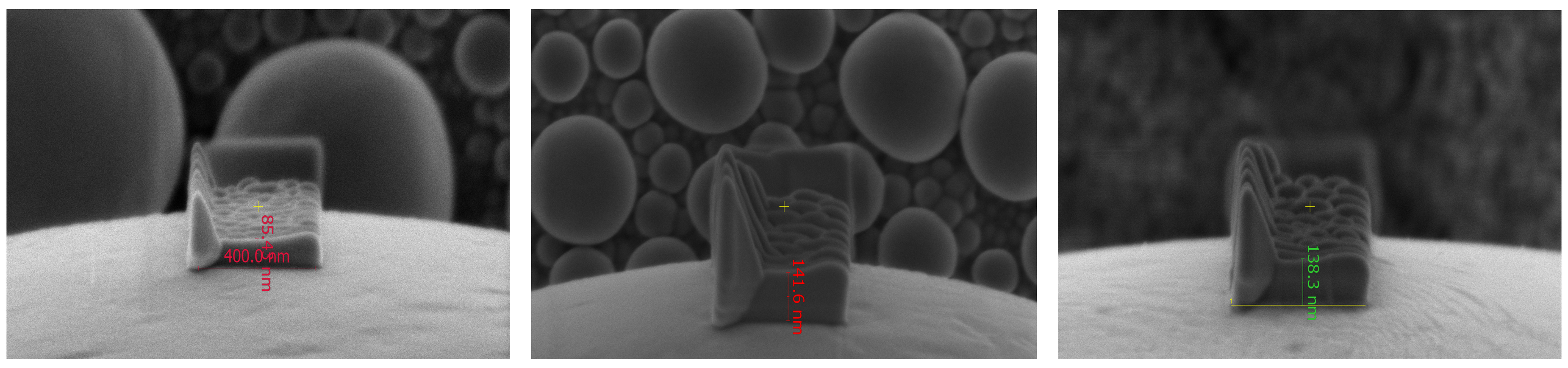
Measuring contamination in scanning electron microscopy (SEM) is crucial for ensuring the accuracy of imaging and analysis. Contamination can obscure microscopic details and alter material properties, resulting in misleading data. Understanding and quantifying contamination is vital for maintaining the quality of SEM images and the precision of analyses.

Creation of Contamination:

Contamination occurs when the electron beam in an SEM scans over a specific area for an extended period, causing hydrocarbon molecules present on or near the specimen to decompose and deposit as a carbon-rich layer. This layer can significantly affect the specimen's electron emission properties and image quality.

Measurement Focus:

Thickness of Contamination Layers: Quantifying the intentionally created buildup thickness of contamination on the specimen surface for analytical purposes.



Experiments and Analysis

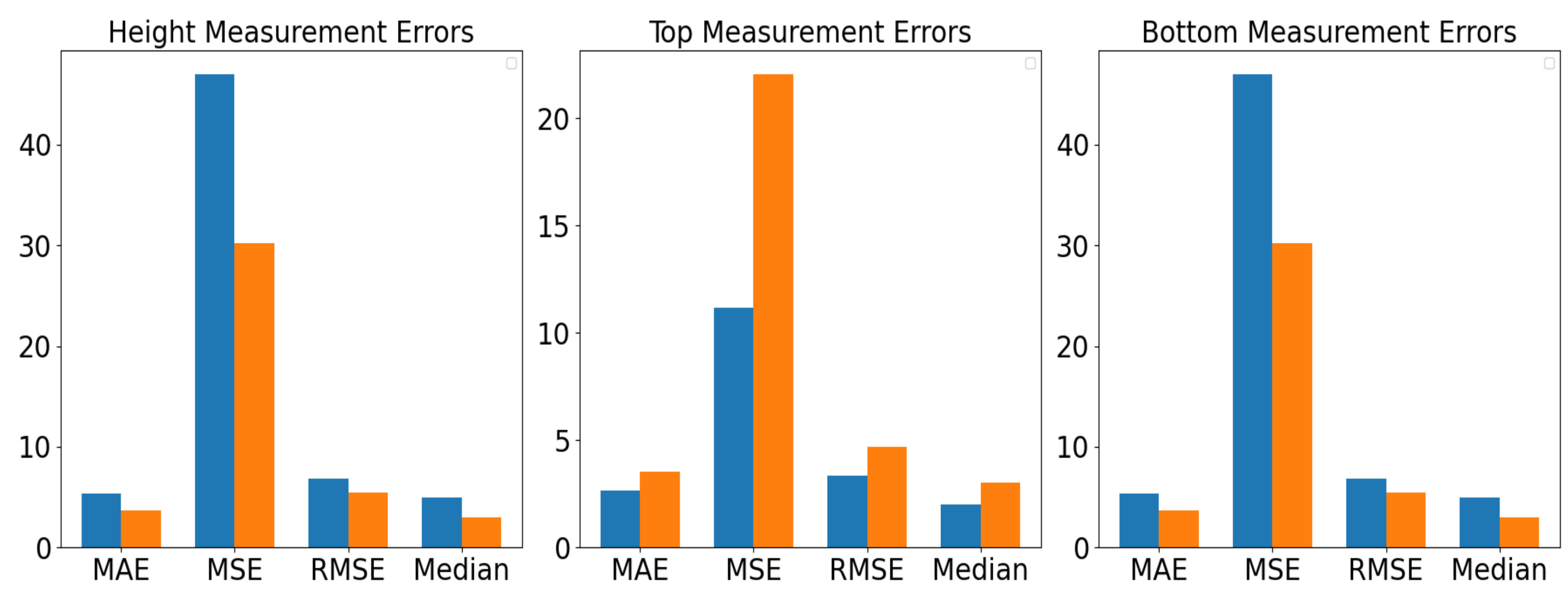
Error Metrics for SEM Contamination Measurement:

Comparison Against Ground Truth: Utilize manually annotated images as a benchmark to compare against the results obtained from the Edge Detection-Based Contamination Analyzer and the DeepLabv3 segmented outputs.

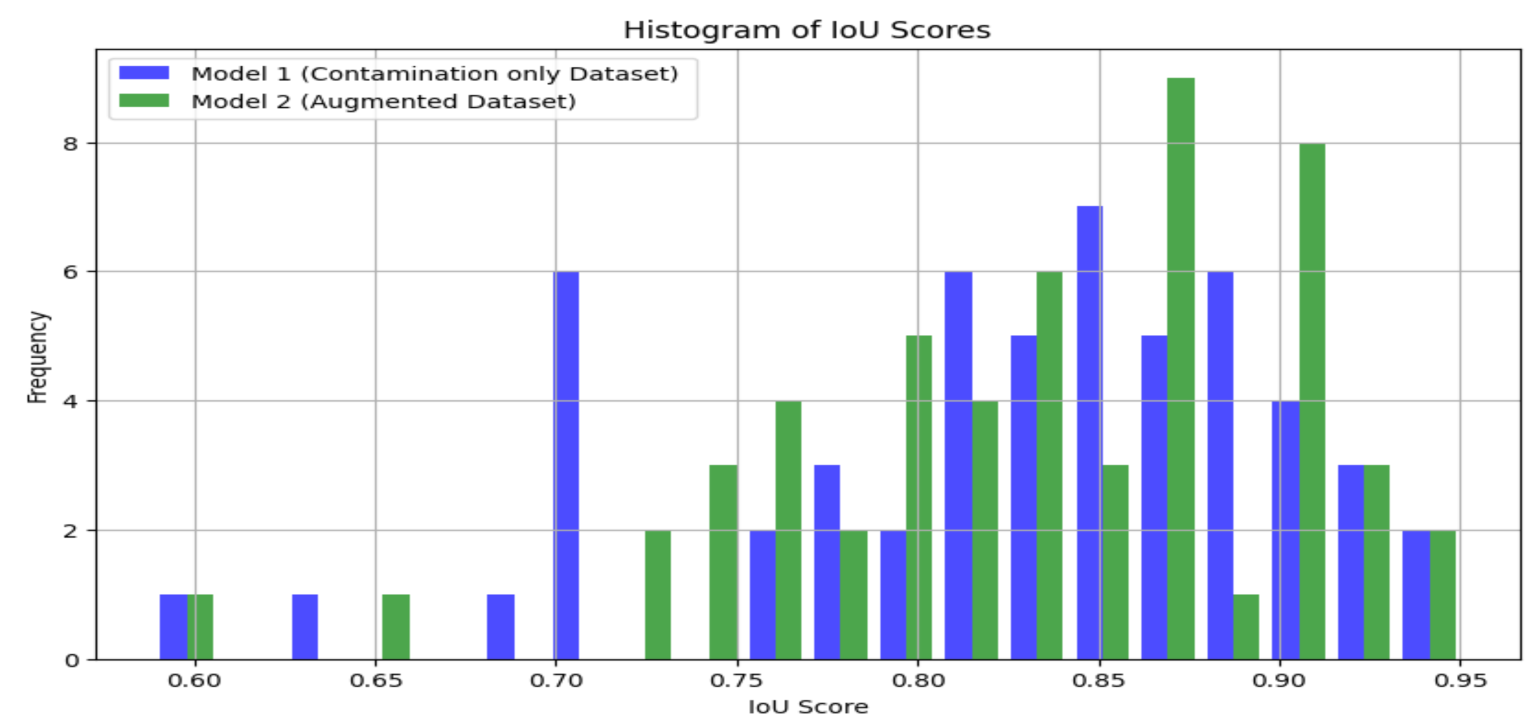
Used Error Metrics:

Mean absolute error (**MAE**)

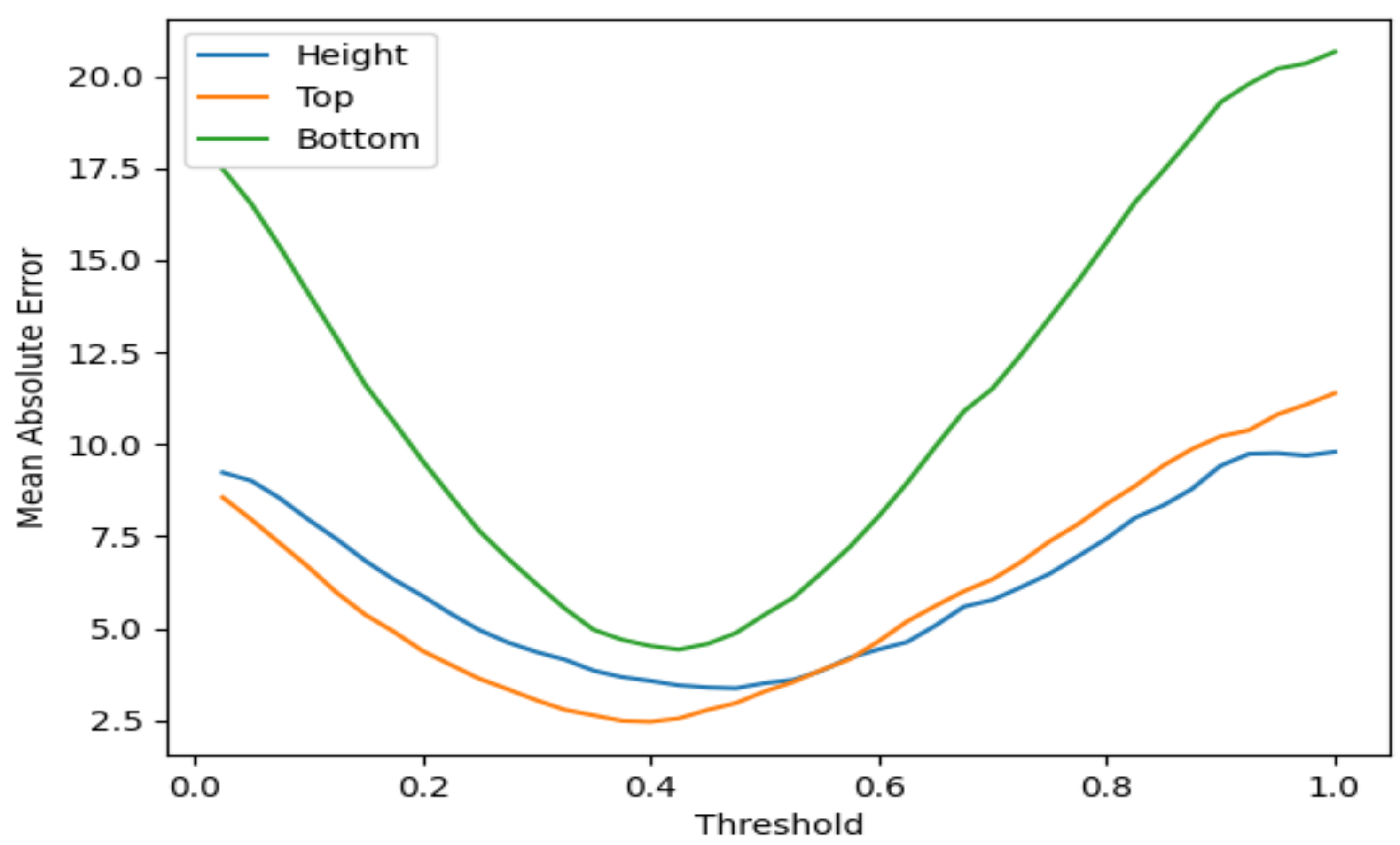
Root mean squared error (**RMSE**)



Model comparision against Ground truth masks

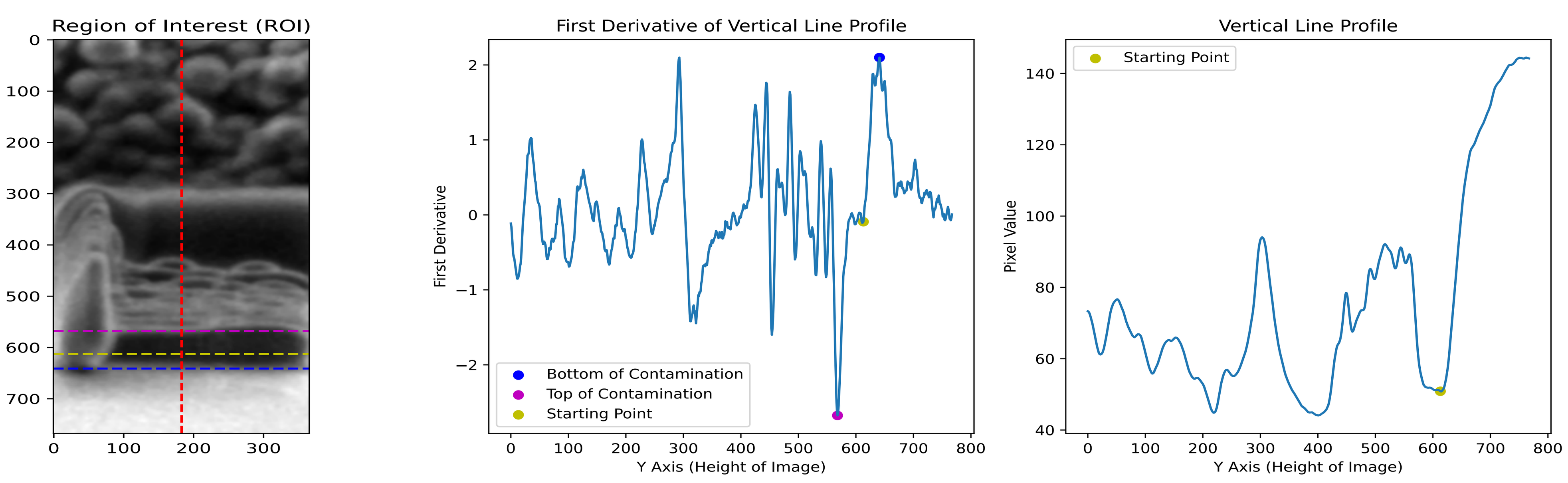


AutomationMask Threshold Finder for model result



Proposed methods

Method 1: Edge Detection-Based Contamination Analyzer (EDCA)



Method 2: DeepLabv3-based Contamination Layer Segmentation