GenISys
Advancing the Standard

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Automated Layout-based SEM Metrology

…with ProSEM and InSPEC

BEAMER LAB TRACER MASKER ProSEM InSPEC

OUTLINE

- Introduction & Motivation
- **ProSEM** Software with SEM Automation
- New **InSPEC** Metrology Upgrade Kit
- Summary

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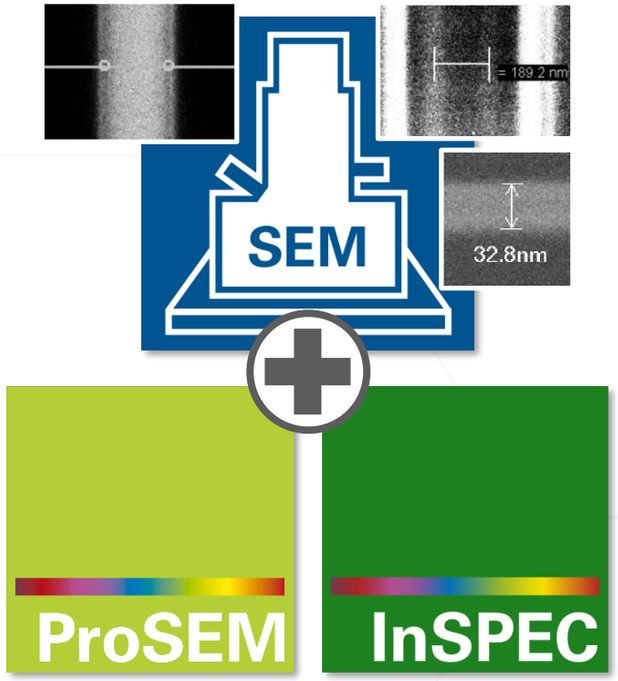
The Metrology Challenge

Various dedicated and optimized lithography tools

Images vendor webpages

Metrology with a versatile microscope…?



Specialized and fully automatic CD-SEM

Image AMAT webpage

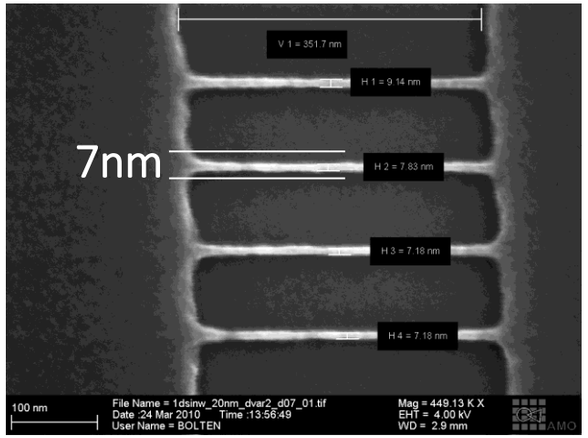
Applications vs. Limitations

Growing Customers and Use Cases

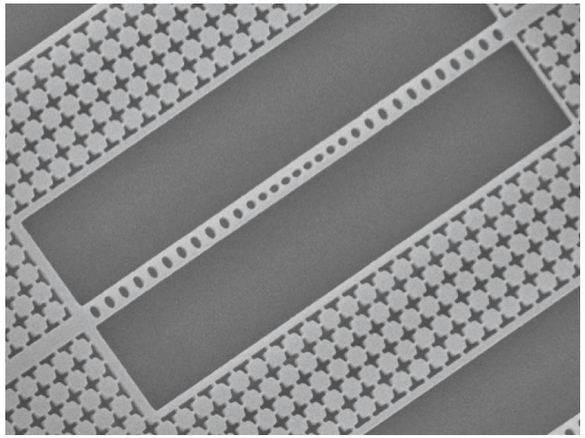
- Large R&D institutes or nano centers
- Small batch manufacturing companies
- E-beam, laser, optical, and imprint litho
- Micro/ nano fabrication processes & devices
- Calibration, monitoring, optimization

Open SEM Requirements

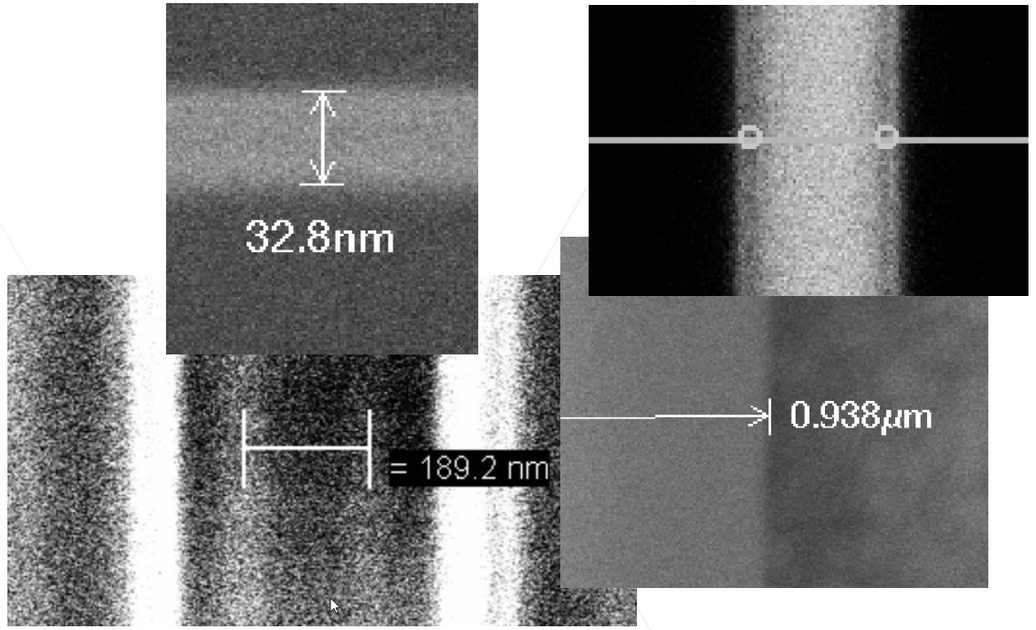
- Hand-drawn cursors
- Subjective and operator dependent
- Tedious and time-consuming
- Inconsistent and no statistics



AMO GmbH – Germany



NIST CNST – USA



Process Calibration, Checks, Modelling …

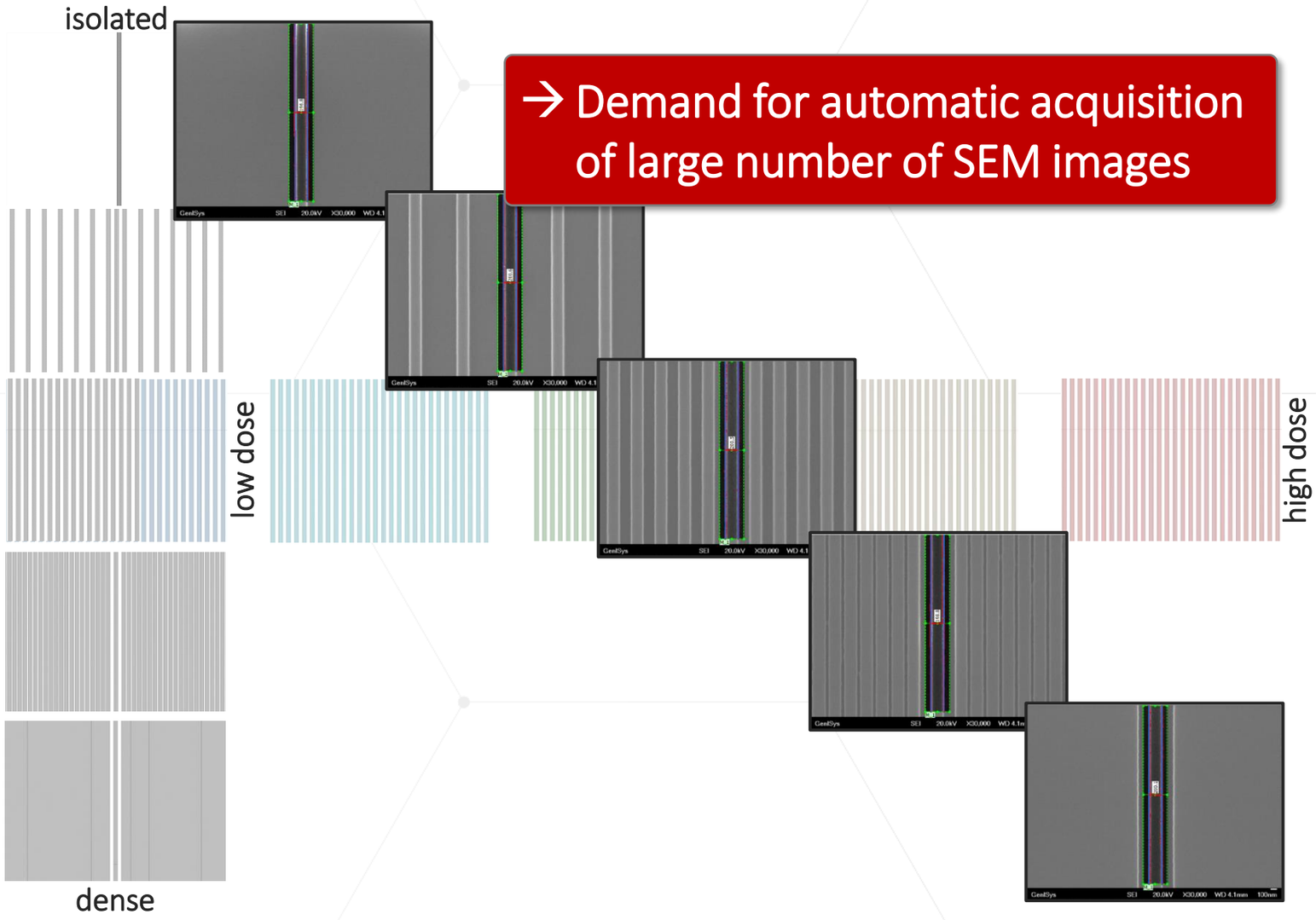
Determining process and correction parameters

Expose calibration pattern

- Dose scaling
- Density of shapes

Evaluation with numerous images

- Scan images automatically
- Measure line width
- Analyze data



→ Demand for automatic acquisition of large number of SEM images

Metrology Solutions

ProSEM

SEM Metrology &

Automation Software

→ Fully launched package including SEM interfacing

InSPEC

Integrated SEM Metrology &

Inspection Upgrade Kit

→ New product in pilot phase

→ Launch planned for June

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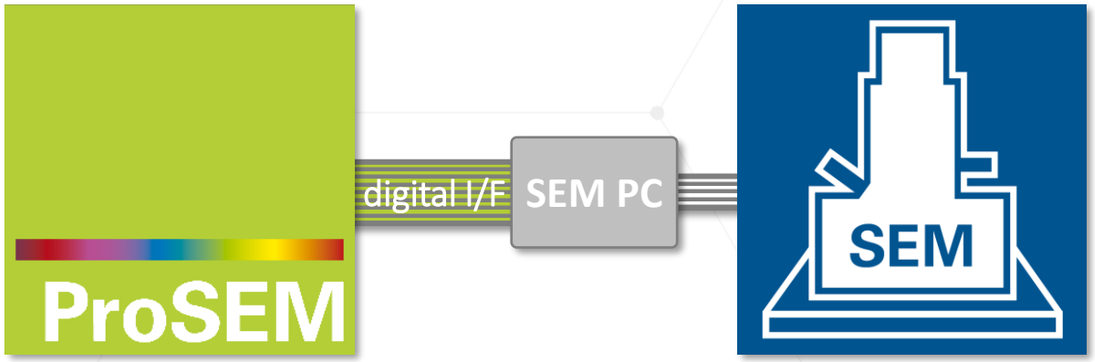
ProSEM vs. InSPEC



SW for SEM Image Analysis & Metrology

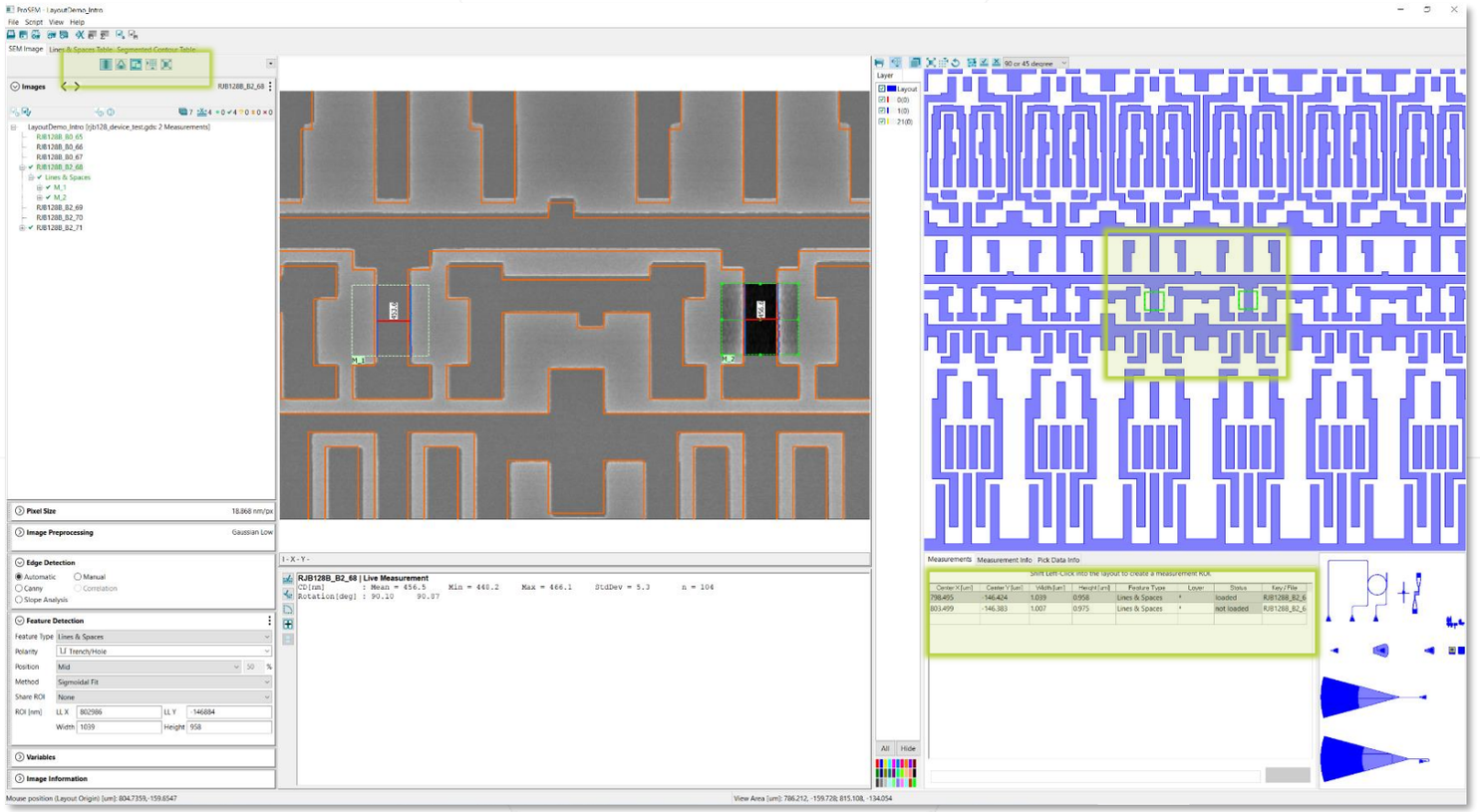
Easy-to-use Offline Software Package

Optional Automation via digital PC interface

Layout & SEM Automation

User Interface with CAD layout

- Display area for image and layout
- Viewer functionality integrated
- Metrology job with measurements corresponding to layout
- Used for navigation and automated SEM image acquisition



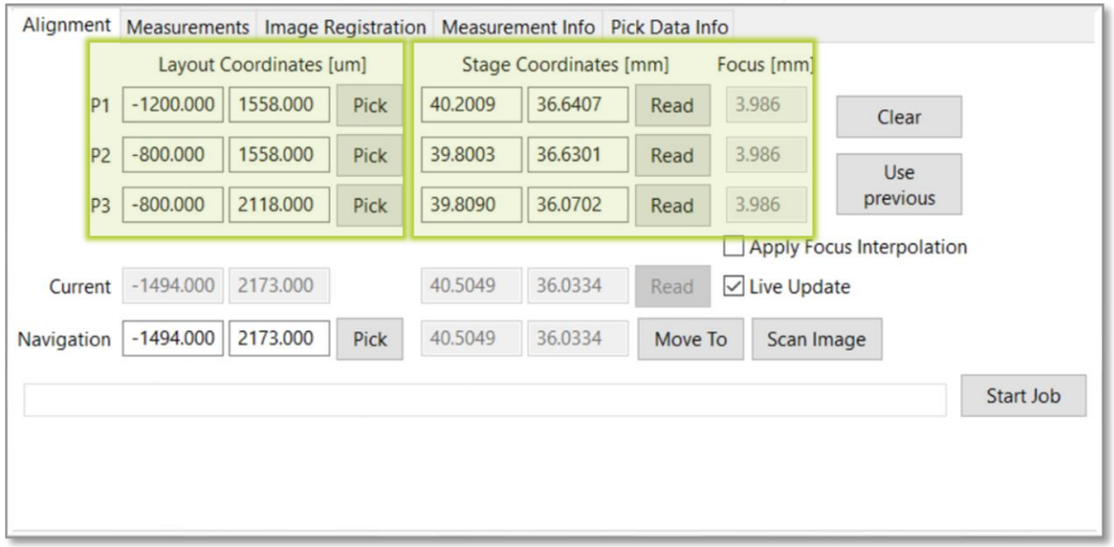
→ Enables advanced SEM investigation of nano patterns

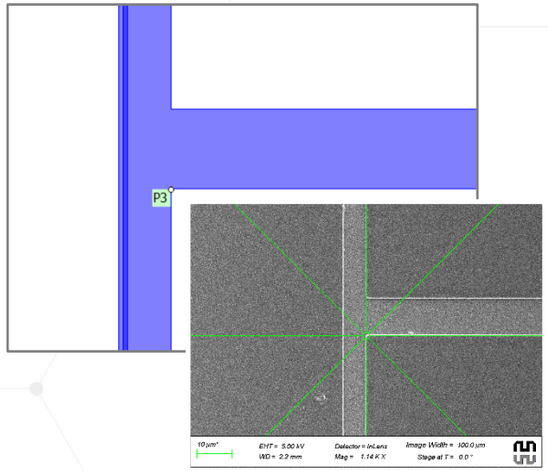
→ Automated layout-based SEM image acquisition and metrology

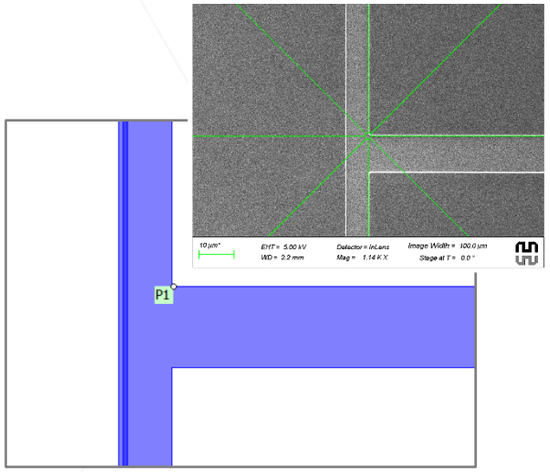
Align ProSEM/ Layout to SEM/ Sample

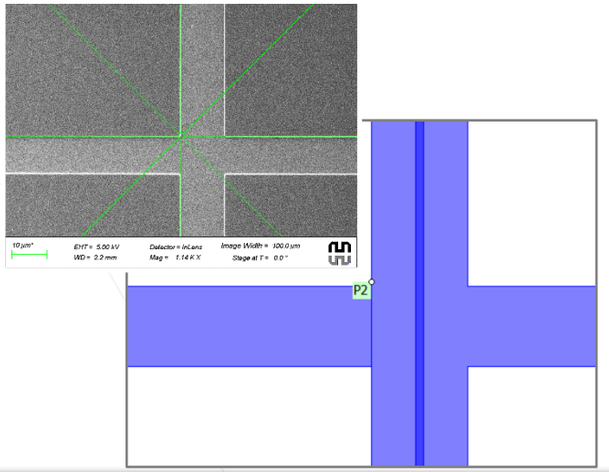
Match positions and coordinate systems

- Use 3 markers or specific locations
- Pick layout coordinates from design in ProSEM
- Drive SEM to corresponding sample locations
- Read stage coordinates into ProSEM







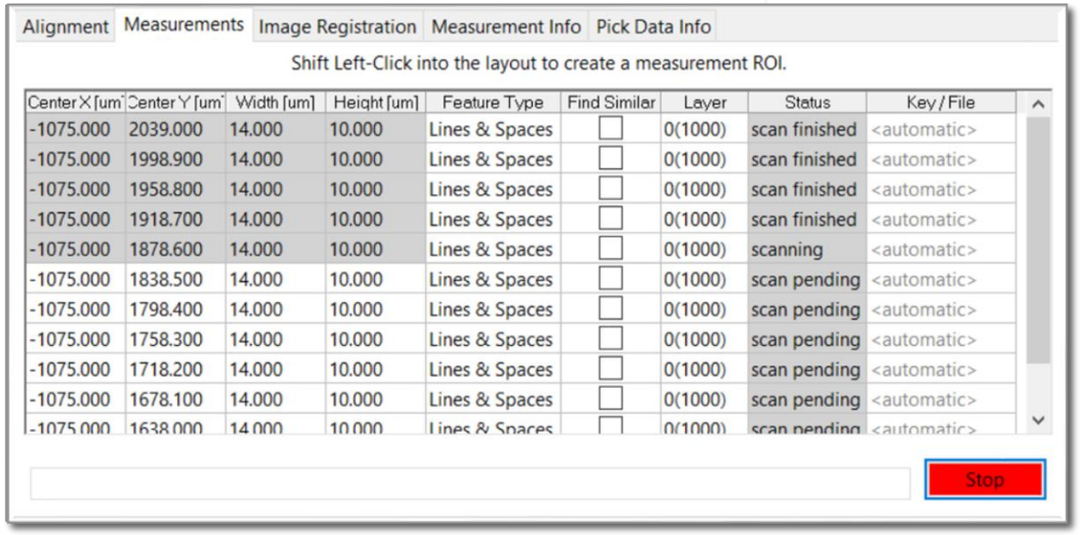


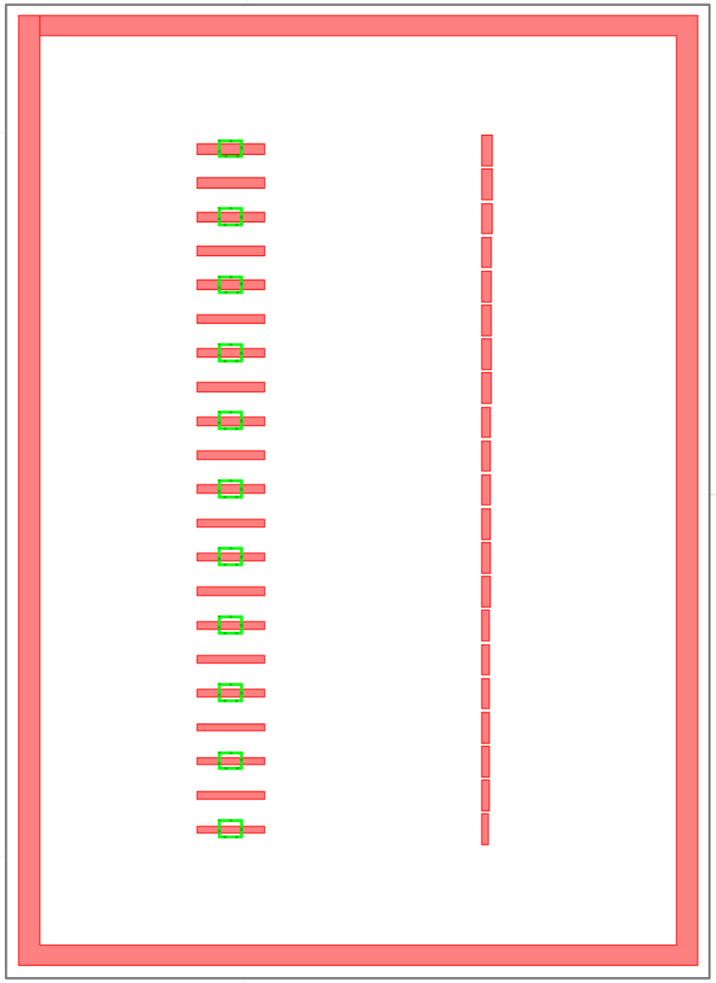
Load and Run Job List

Automation and measurement list

- Load pre-defined project with metrology job
- Import/ export of measurement list

→Start job execution

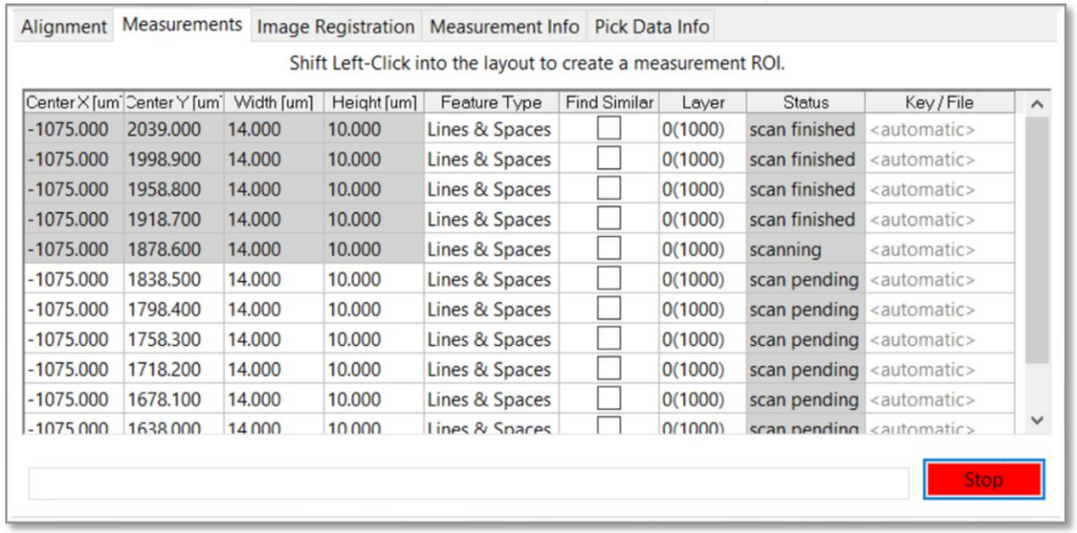


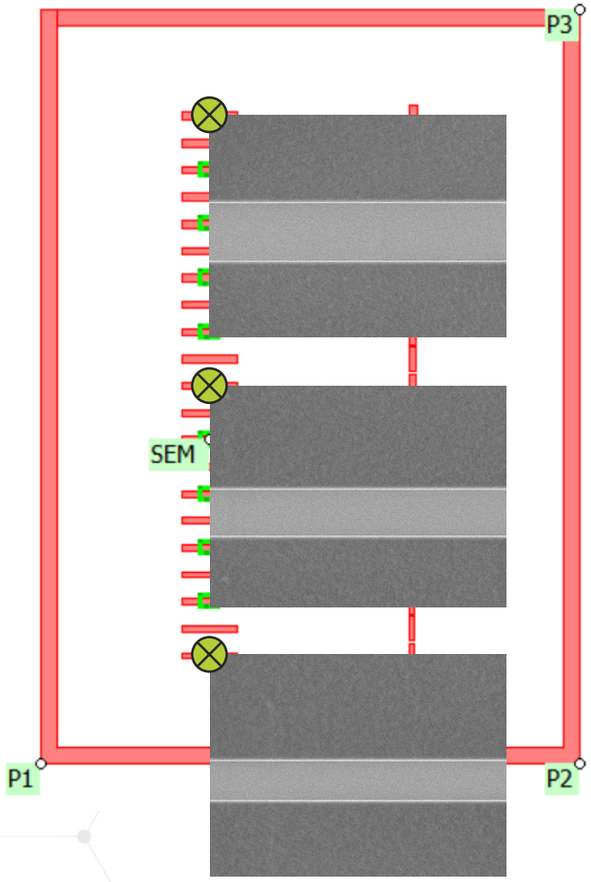


Step 1: Image Acquisition

Automated metrology

- Drive SEM stage and acquire set of images





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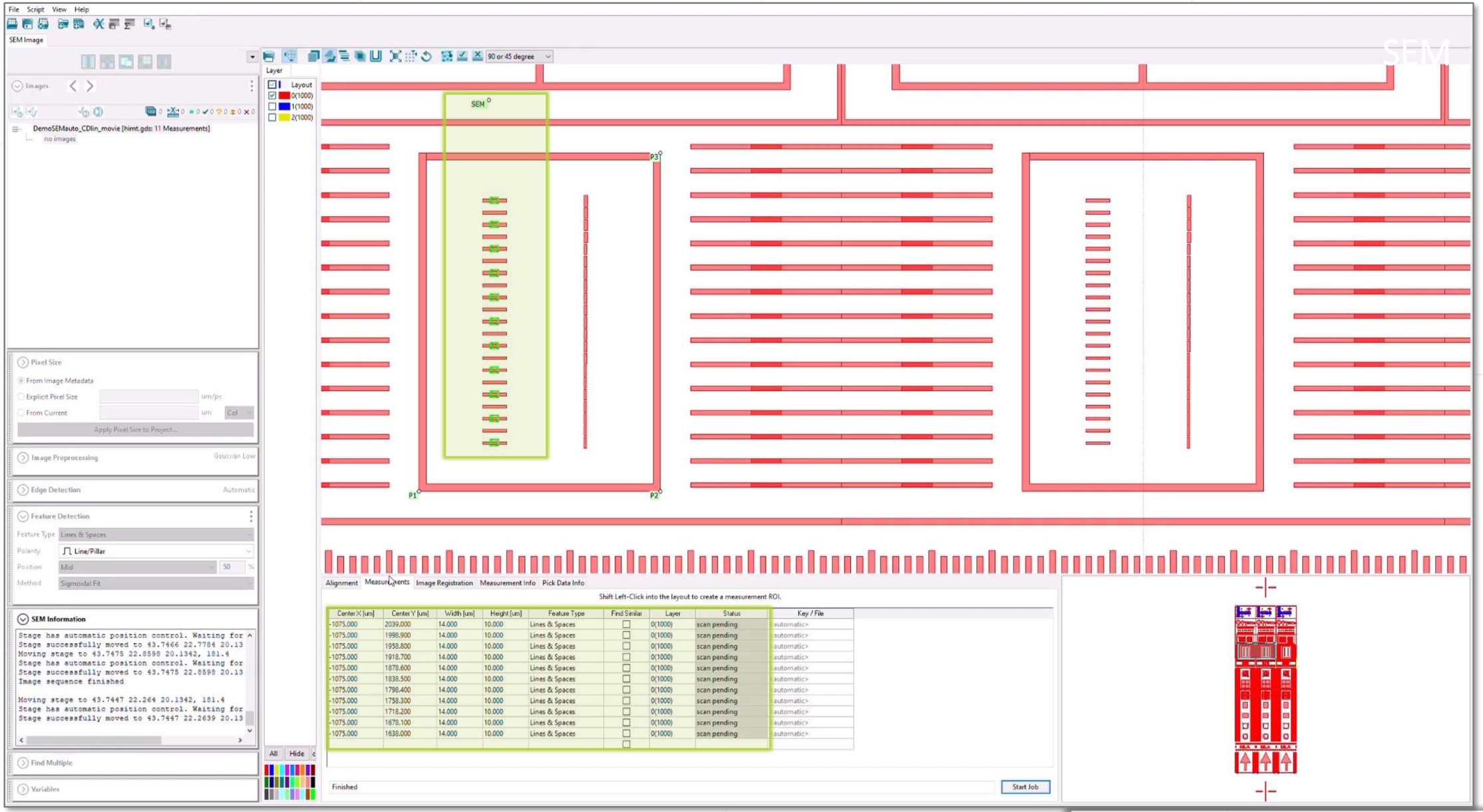
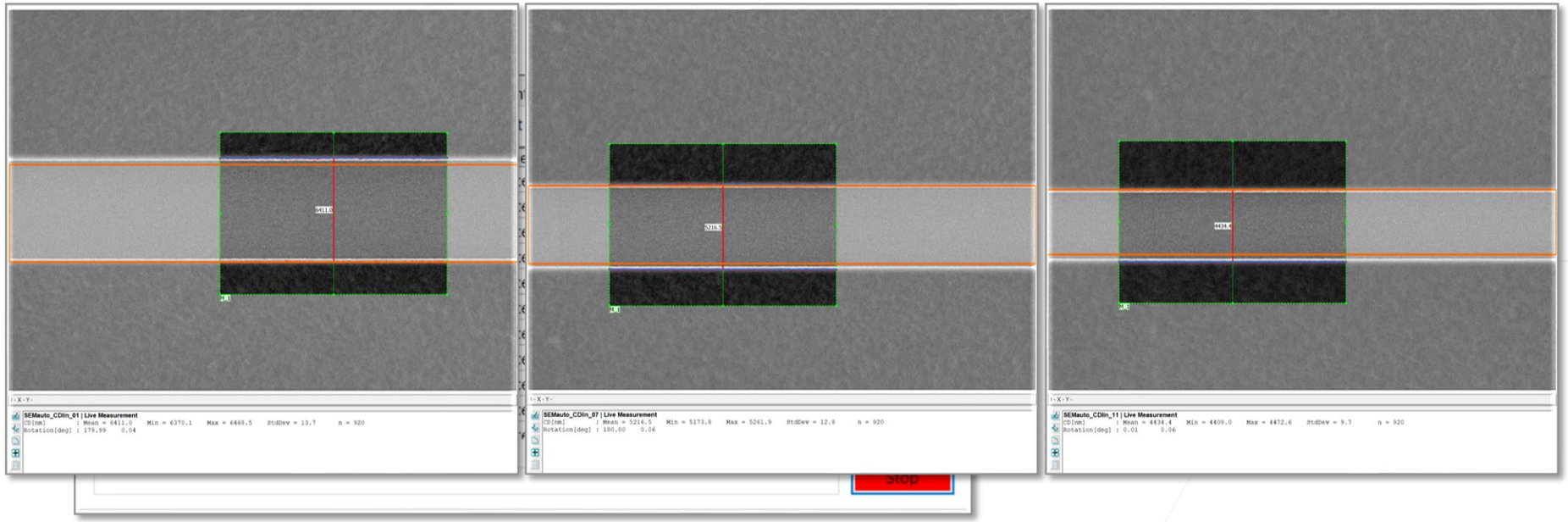
Step 1: Image Acquisition

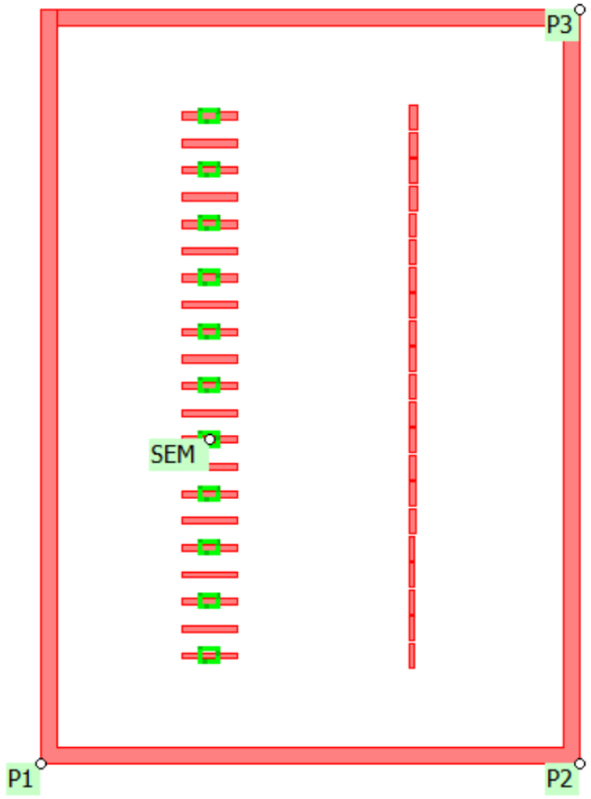


Step 2: Metrology

Automated metrology

- Drive SEM stage and acquire set of images
- Load images with (local) alignment
- Apply pre-defined measurements automatically
- Save results to data table





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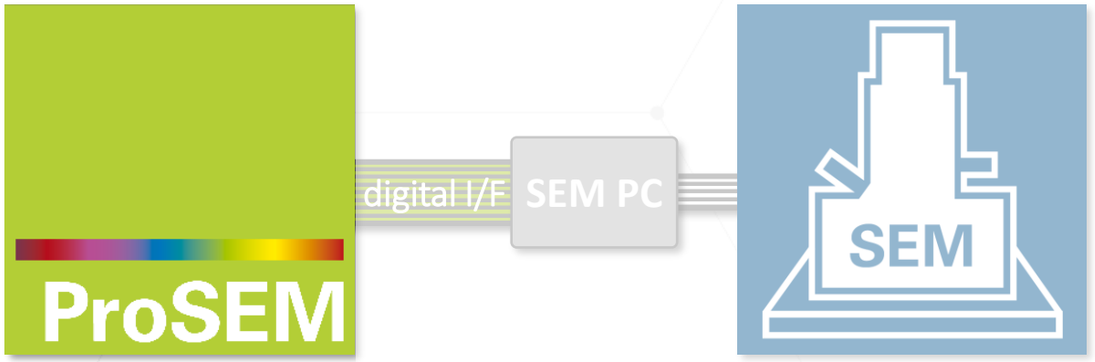
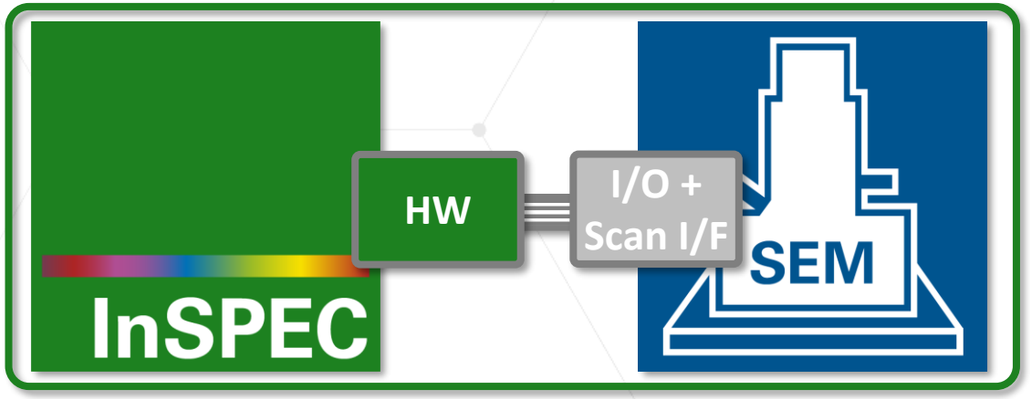
ProSEM vs. InSPEC





- SW for SEM Image Analysis & Metrology
- Easy-to-use Offline Software Package
- Optional Automation via digital PC interface

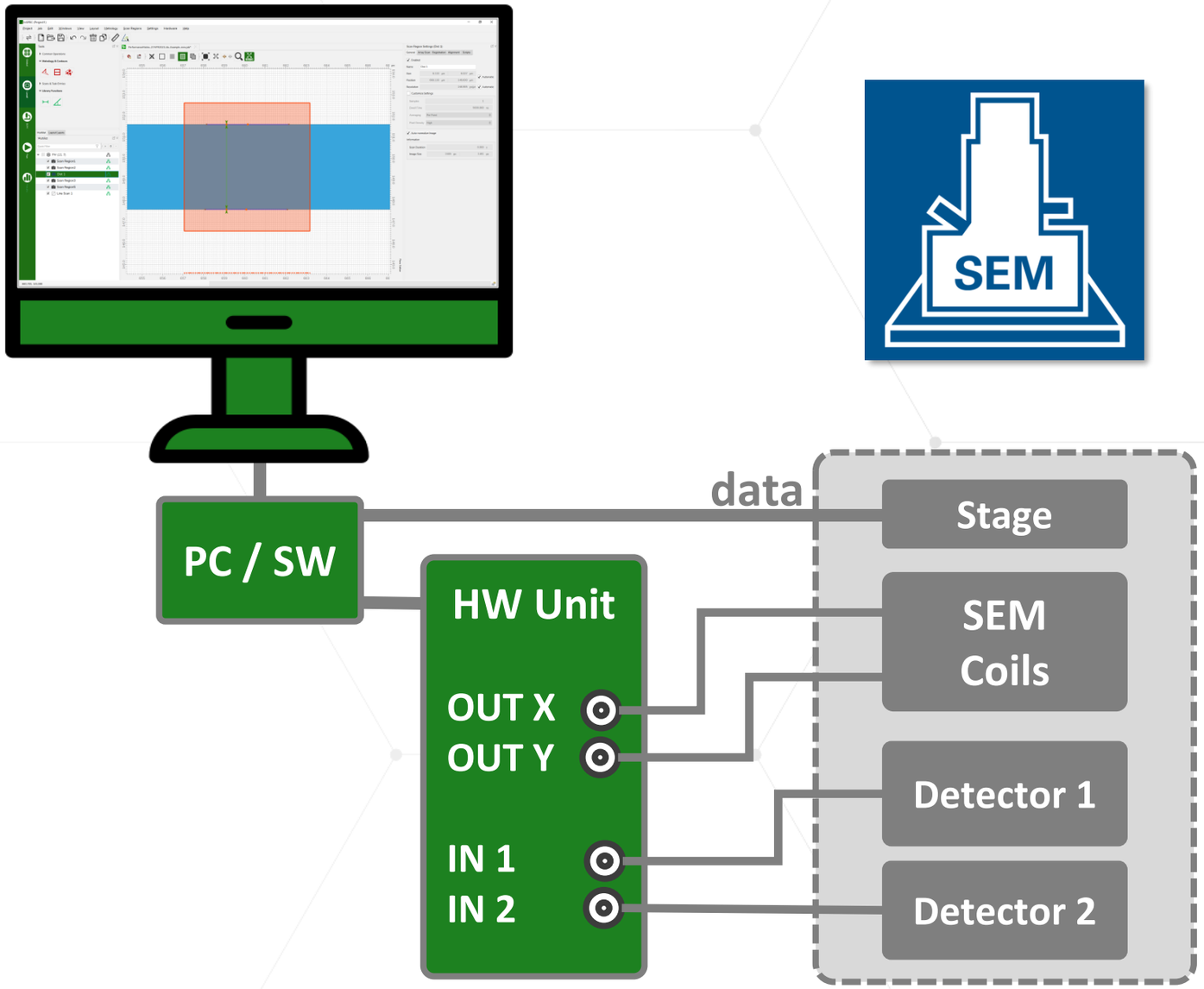
- Upgrade Kit for a Metrology SEM
- Integrated scanning, automation & metrology
- Direct SEM control with hardware integration
- Multi-Chip jobs with hierarchical structure
- Comprehensive full layout-based workflow
- Expert metrology & data processing with “FLOW”

InSPEC Upgrade Kit

Integrated Metrology & Inspection Kit

- Software package
- PC and screen
- Scanning and I/O hardware

→ Direct control of SEM beam, stage, scanning
→ Use the designed I/F and safety mechanisms
→ All beam shaping settings
→ Scanning and tool operation through **InSPEC**



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Integrated Workflow along 5 Main Modes

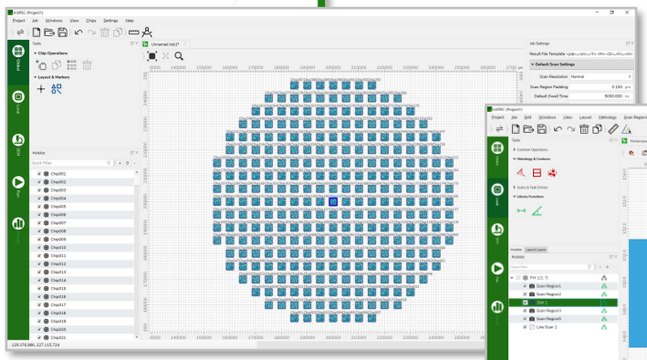
Global Setup

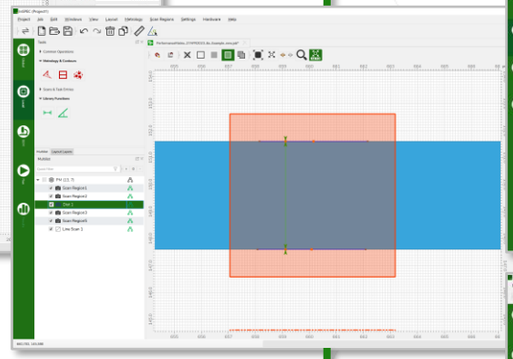
Local Content

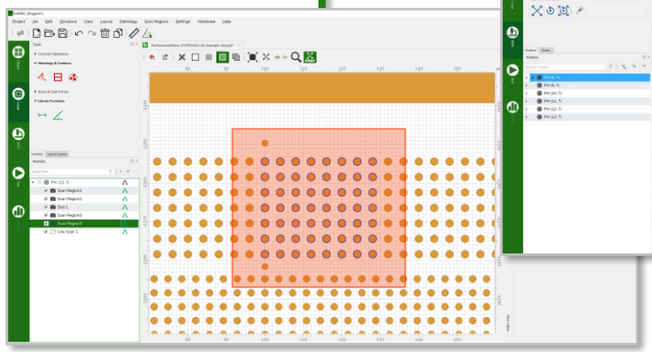
SEM Control

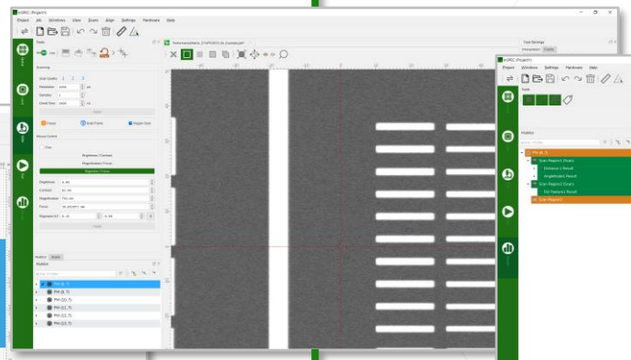
Run Job

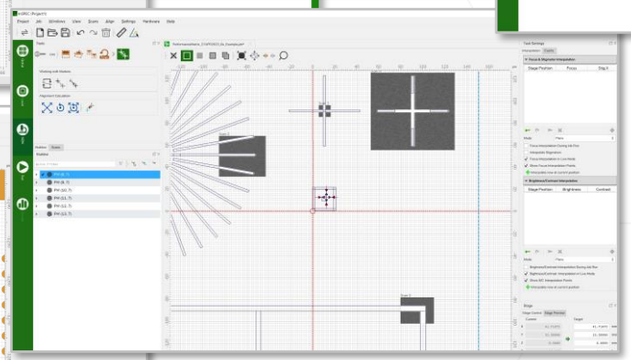
Results Review

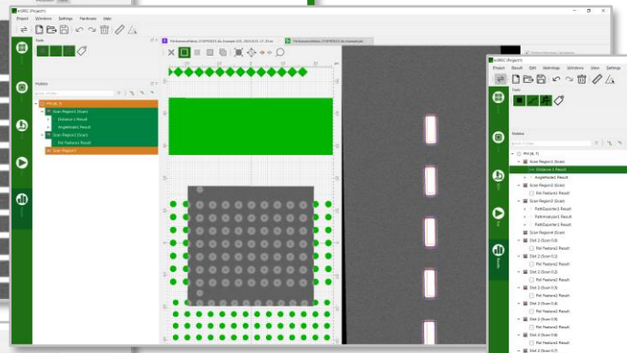


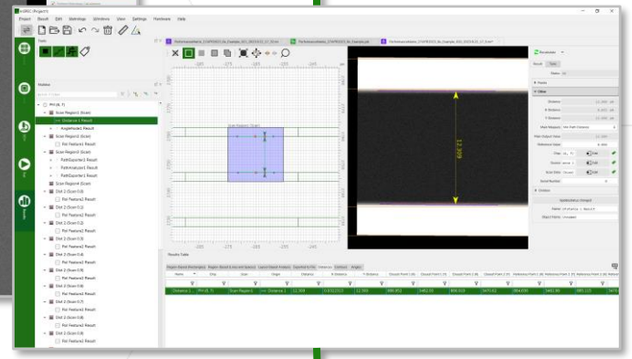


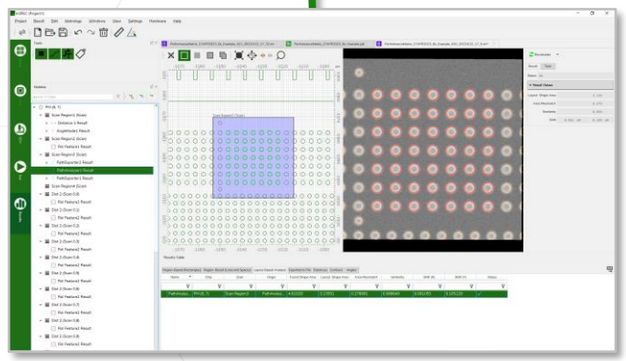












InSPEC Software GUI

5 Main modes with adaptive panels

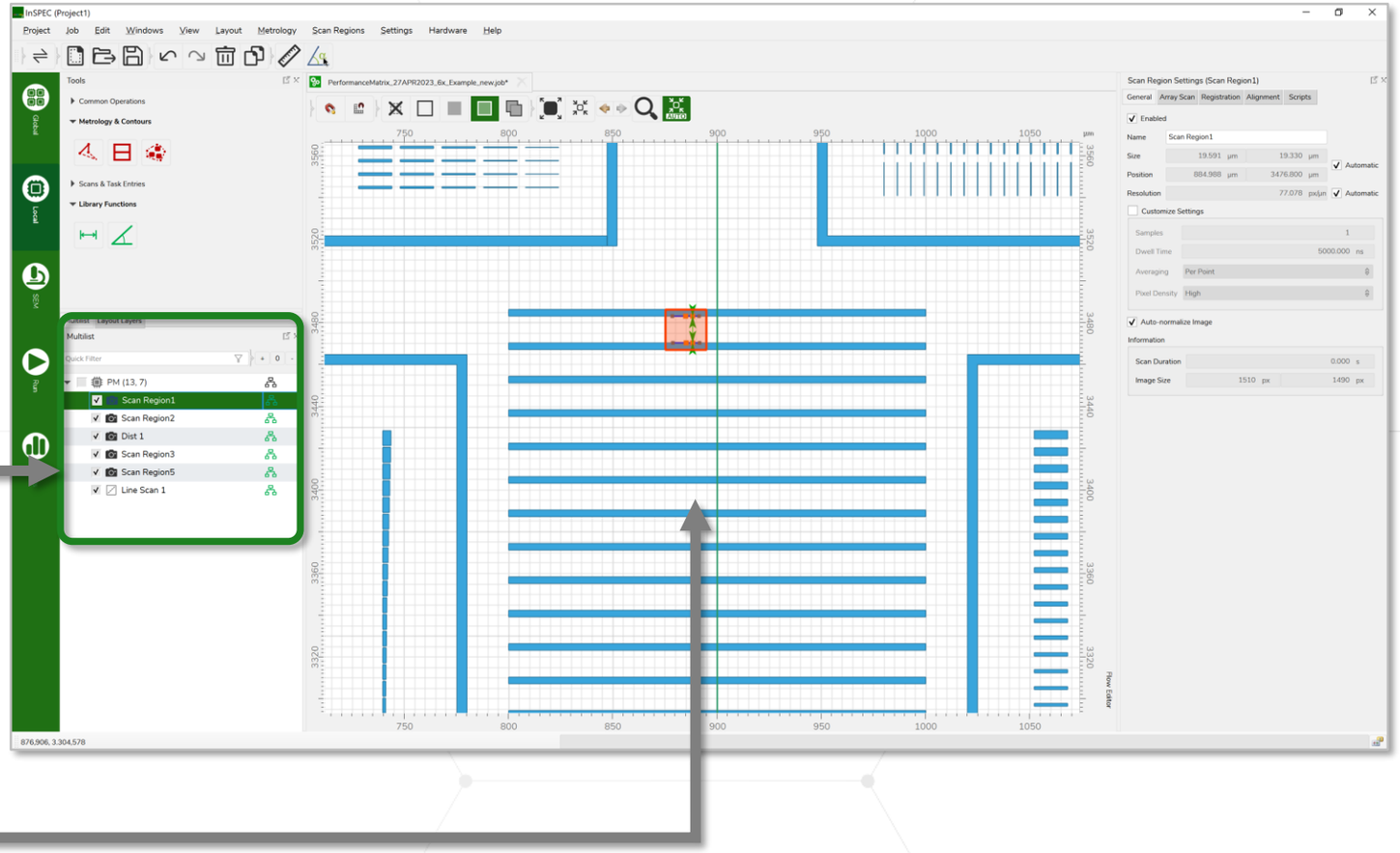
- Global and Local definitions
- SEM Live and SEM Layout
- Run job and Results review/ tune

Workflow along job sequence

- Smart and simplified metrology job

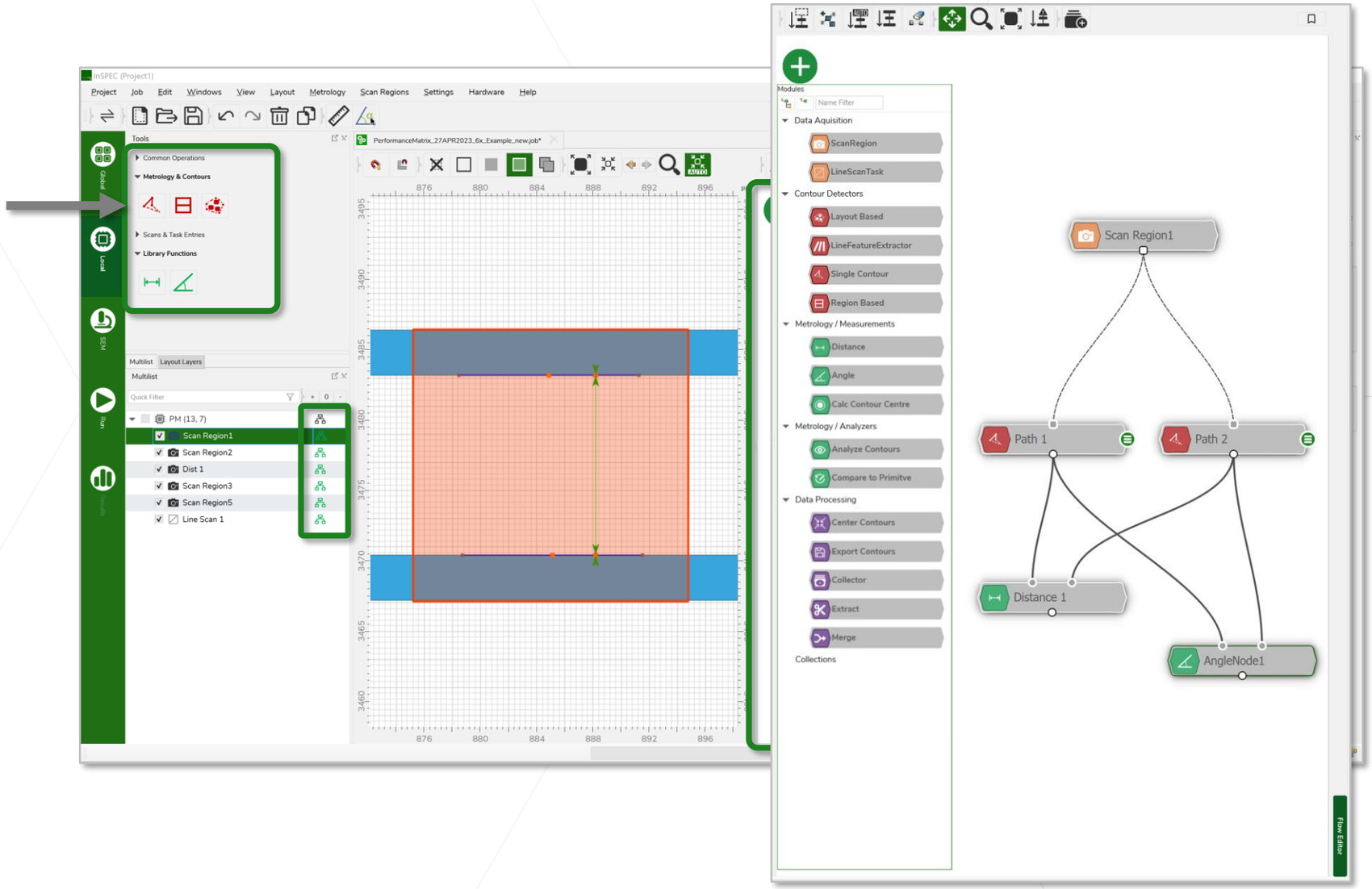
Working area

- Center visual area with layout
  - Can split for layout view & FLOW editor



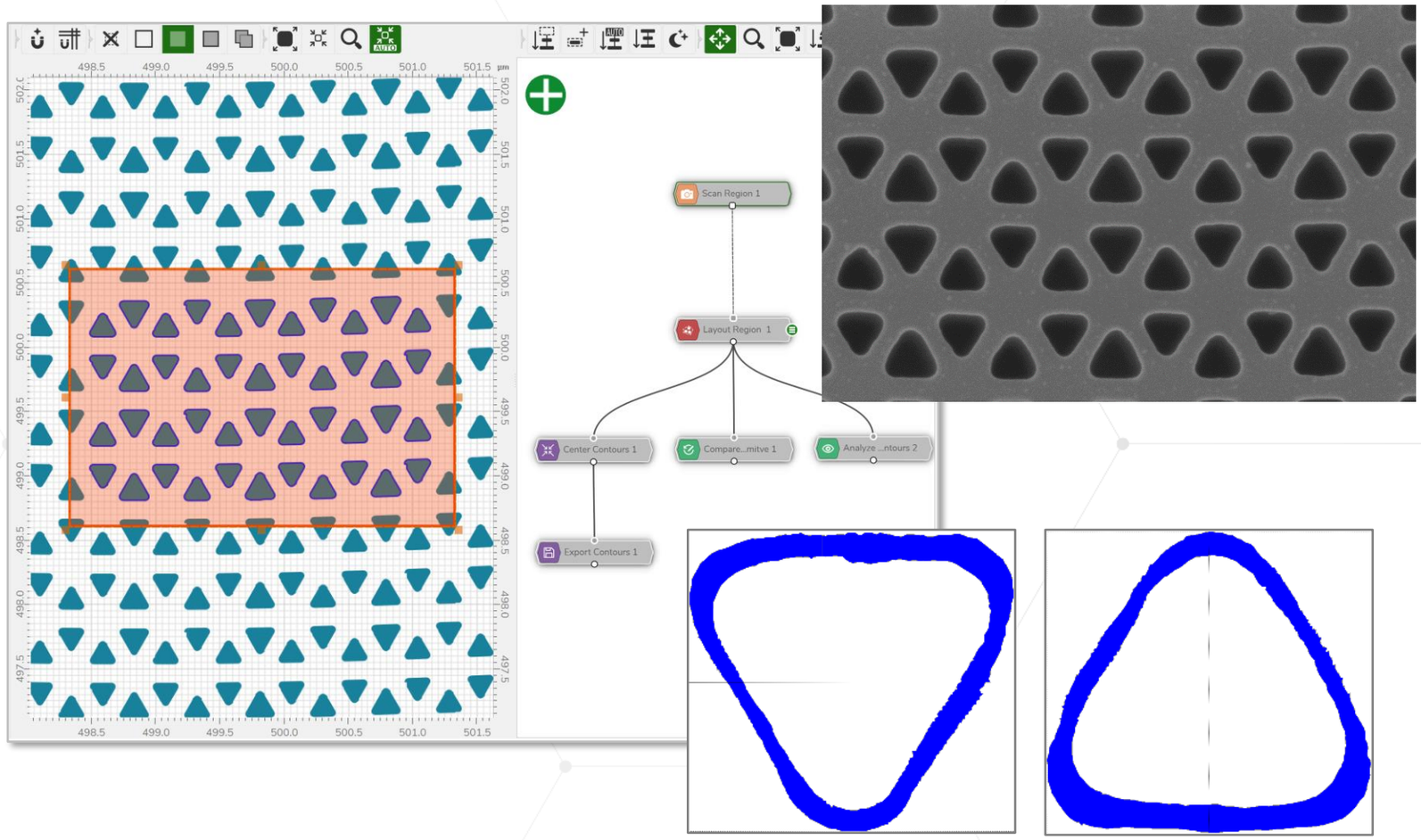
Advanced Jobs with FLOW

- Definition of job entries
  - Using visual tools with pre-defined functionality/ FLOW
  - FLOW contains all methods for obtaining metrology results
  - Modules for
    - Scanning (region, line)
    - Edge/ contour detection
    - Metrology & analysis
    - Data processing
  - Extended comprehensive tasks
  - Create personal templates



Example with FLOW Editor

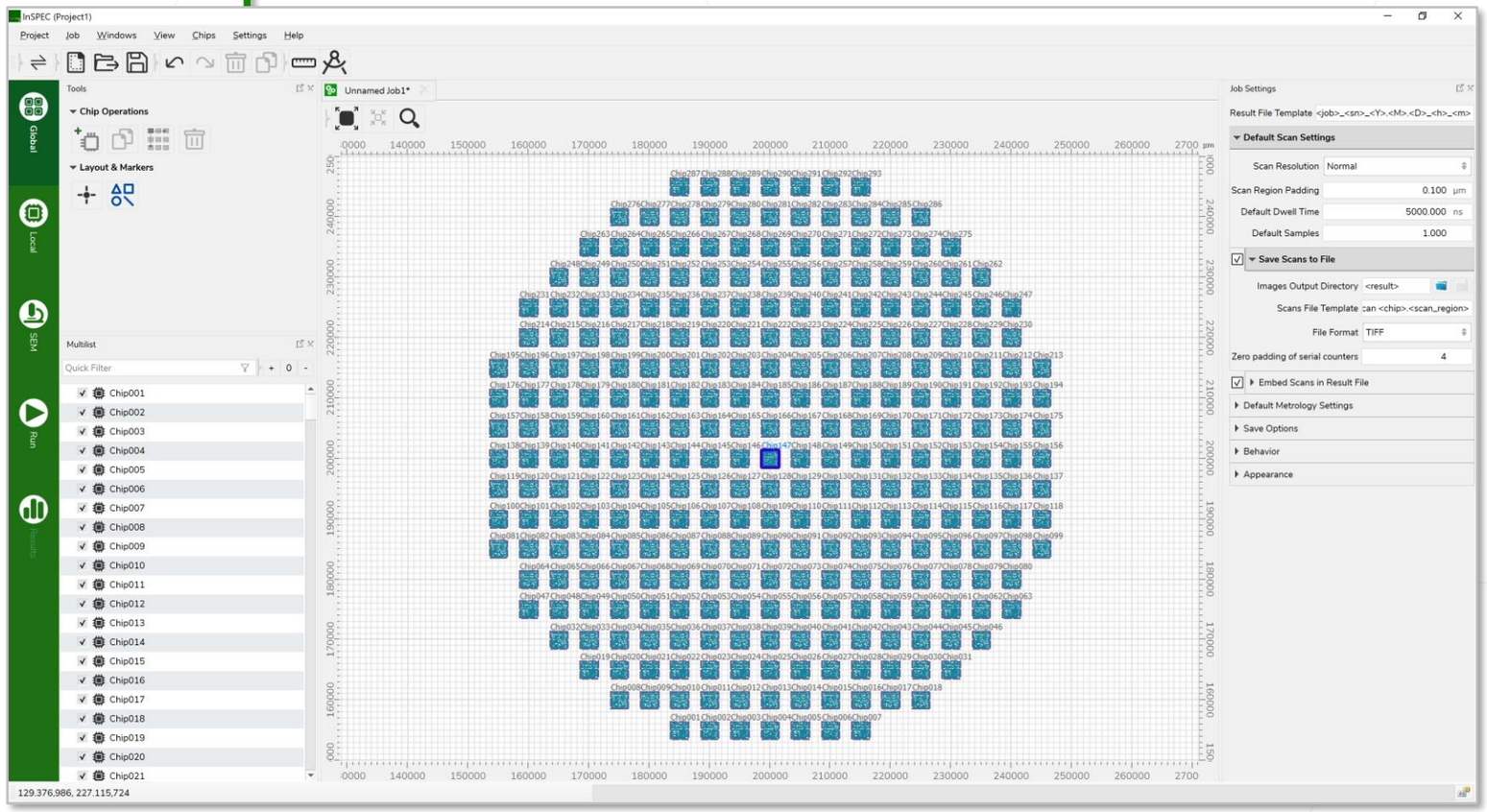
- FLOW editor
  - FLOW contains all methods for obtaining metrology results
  - Modules for
    - Scanning (region, line)
    - Edge/ contour detection
    - Metrology & analysis
    - Data processing
  - Example (PSU)
    - SEM scanning region
    - Mutiple contour extraction
    - Compare to triangle and layout
    - PV band creation/ export (process variation)



PennState

Global Setup and (Wafer) Arrangement

Global Setup | Local Content | SEM Control | Run Job | Results Review



- General arrangement
  - Chips/ field size and position
  - Matrix setups
  - Enable/ disable chips/ fields
  - Reference layout(s)

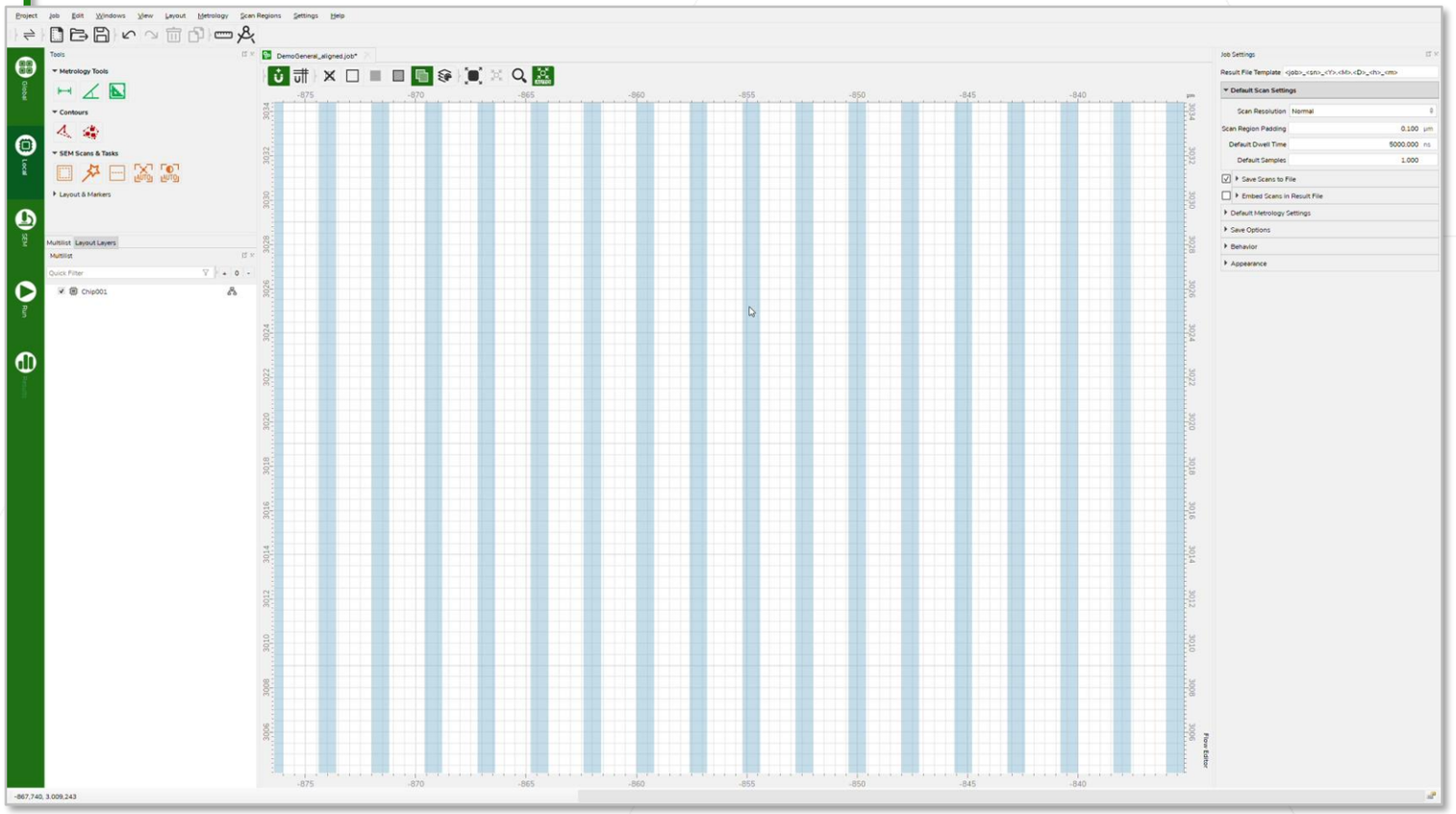
Local Content with Metrology

Global Setup | **Local Content** | SEM Control | Run Job | Results Review

- Chip/ field level
  - Based on detailed layout
    - Create measurements
    - Extract contours

    → Automatic scan definition
  - SEM scans (region, line)

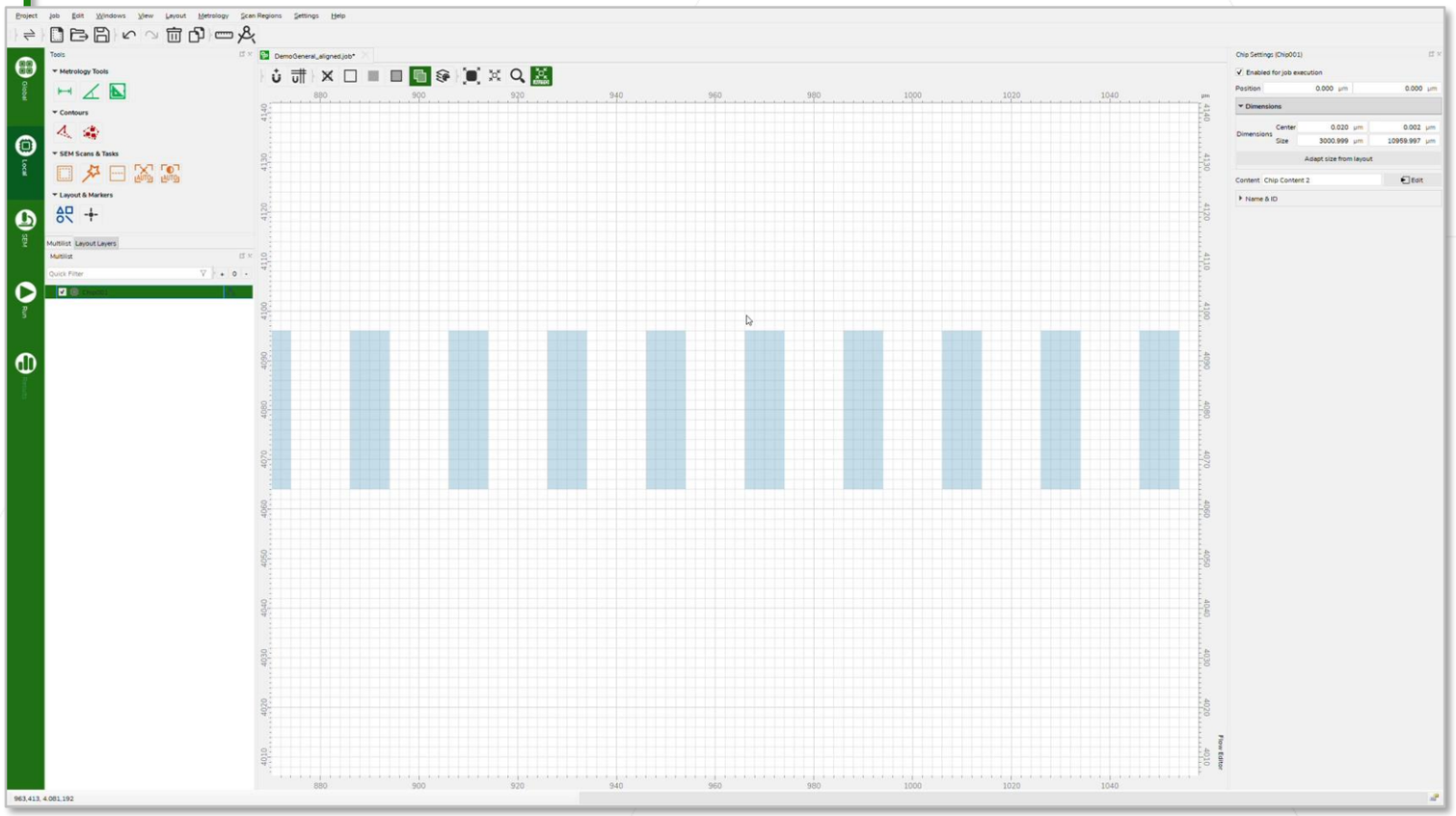
- Job list can contain
  - Scans
  - Scans and contour
  - Scans and contour/ metrology
  - Plus data processing
  - Chip level data processing



„Layout-less“ based on Metrology Region

Global Setup | Local Content | SEM Control | Run Job | Results Review

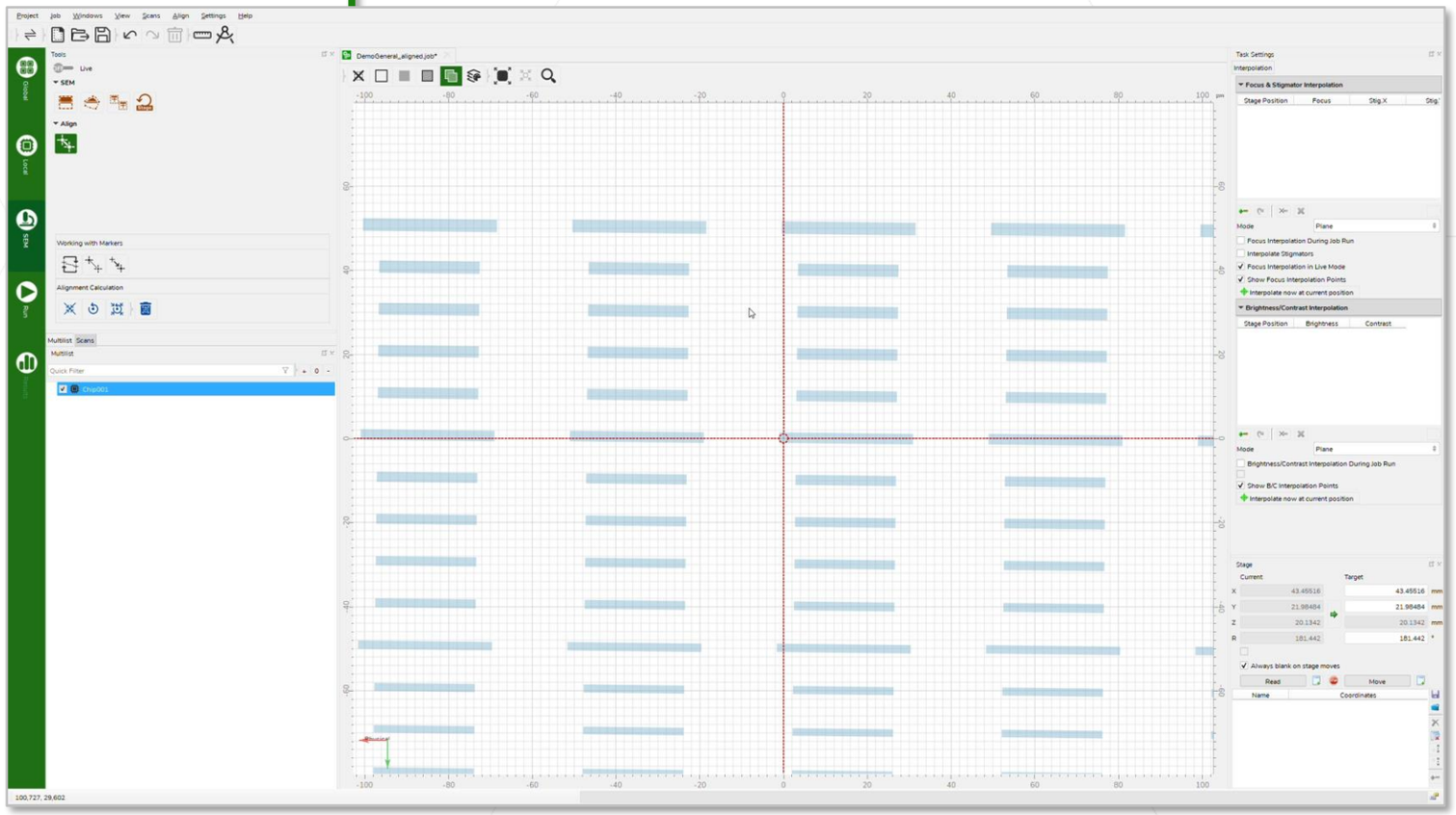
- Use case
  - No (full) layout available
  - Layers are bad representation
  - Strong process bias/ issues
- Metrology region
  - Layout only as background
  - No comparison with layout
  - Provides contours (shapes)
  - Fitting for
    - Lines&Spaces
    - Circle, ellipse
    - Rectangle, triangle



SEM Live Mode

Global Setup | Local Content | **SEM Control** | Run Job | Results Review

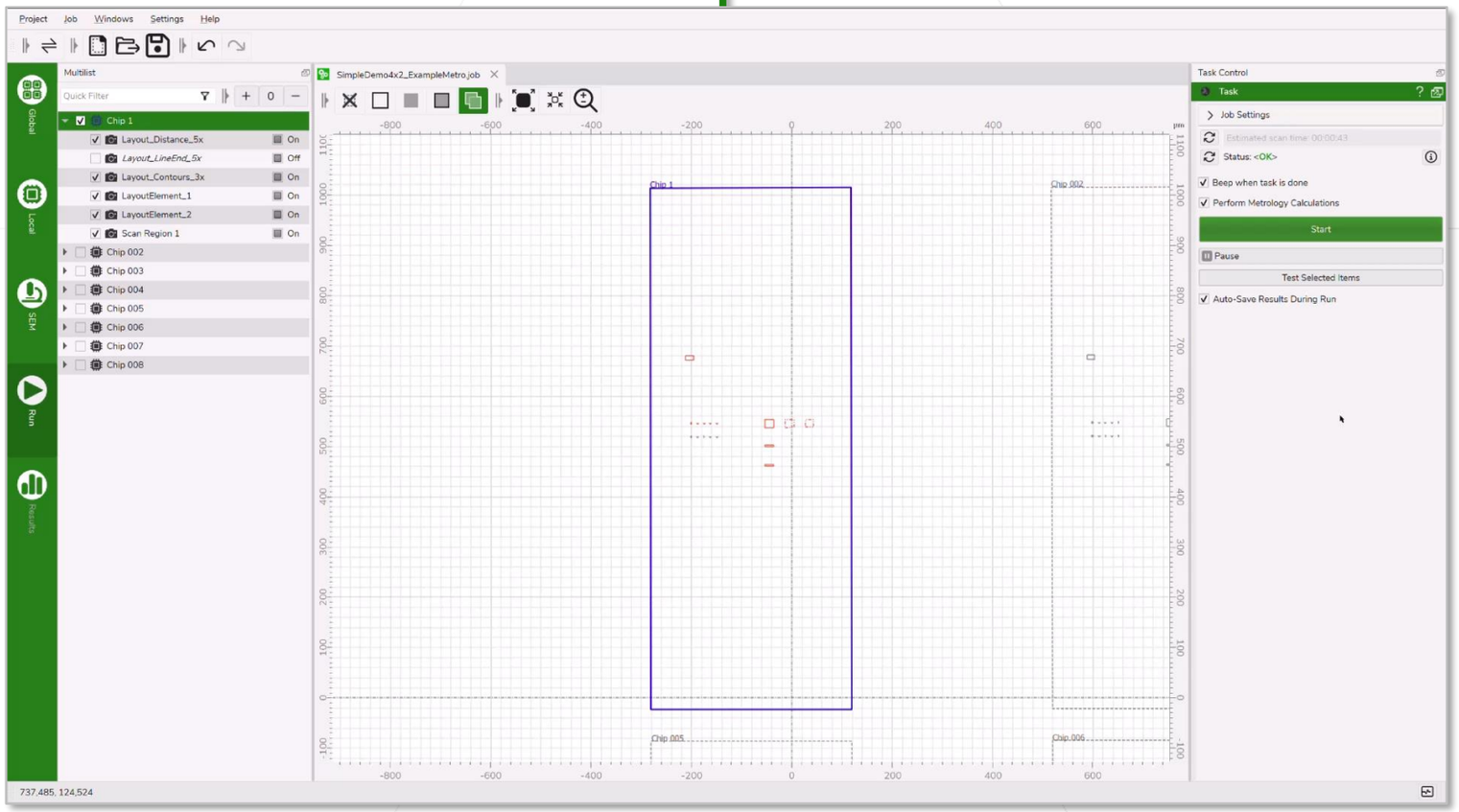
- SEM Control “LIVE”
  - Scanning with preset speeds
  - Full control of beam shaping
    - Contrast/ brightness
    - Magnification/ focus
    - Stigmation/ focus
  - Stage control



Run the Metrology Job

Global Setup | Local Content | SEM Control | **Run Job** | Results Review

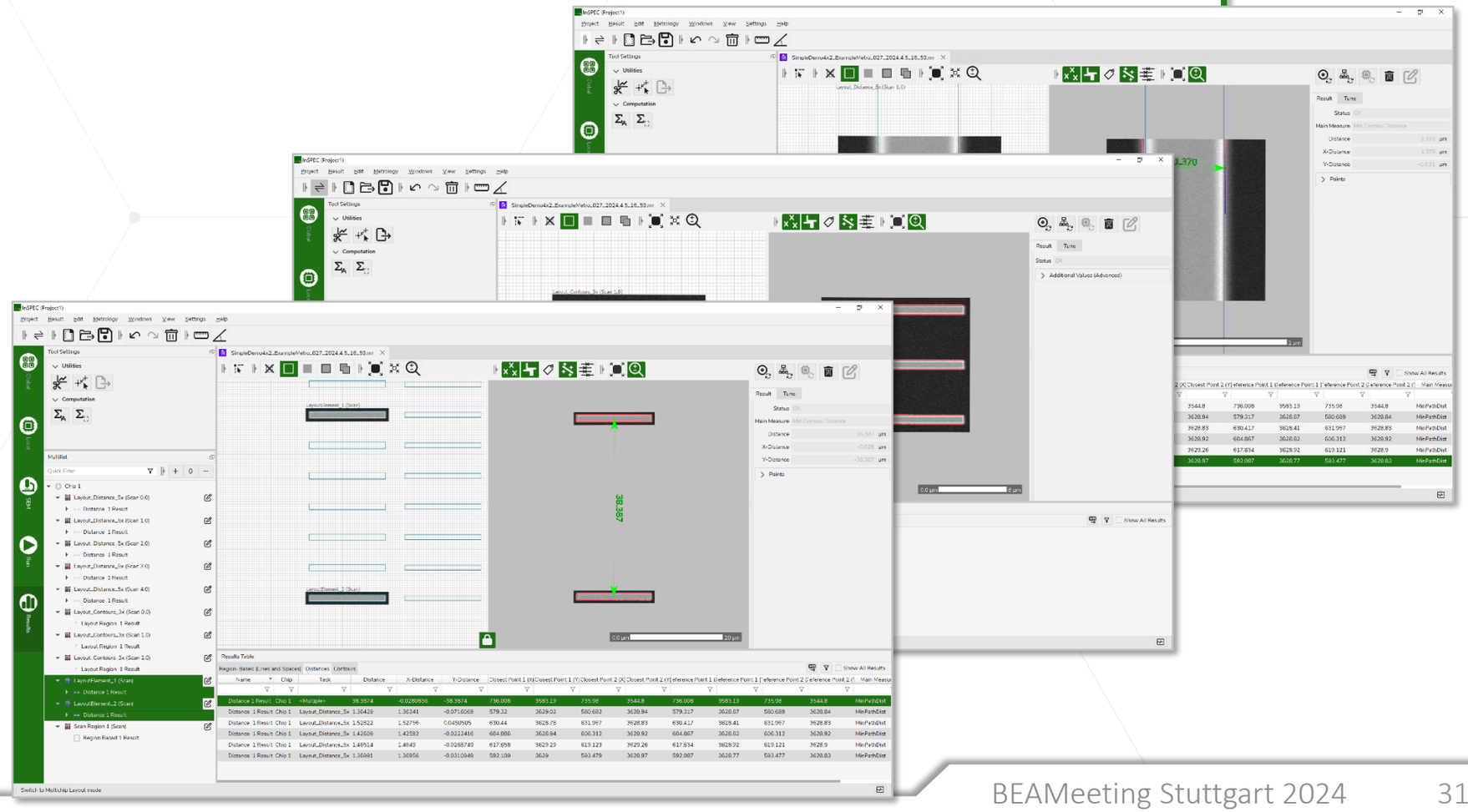
- Job execution and progress
  - Job start and pause/ stop
  - Progress along job sequence
  - Live display of scans on layout
  - Remaining time estimate
  - Parallel activities
    - Scanning
    - Contour detection
    - Metrology
    - Data processing
  - Result file created



Results Review

Global Setup | Local Content | SEM Control | Run Job | Results Review

- Results summary
  - Job list including data
  - Display
    - Layout with definitions
    - Scan with measurements
    - Results tables with tabs
  - Details for review/ tuning



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Demand for Automated SEM Metrology

- Lithography and application advancements need to be complemented in process monitoring
- Improvements between analytical SEM and CD-SEM are an opportunity

ProSEM with SEM Automation Package

- Offline software helps getting more data (quality) out of existing images
- Offers easy-to-use basic automation for SEM acquisition and measurements

NEW InSPEC Integrated SEM Metrology Kit

- Upgrade package enables a versatile SEM with additional inspection capabilities
- Hardware integration and more corrections plus hierarchical jobs with advanced FLOW
- Next level: hardware/ scan control, automation, contour extraction, metrology, data processing

Thank You!

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