NEW

InSPEC

Integrated SEM Metrology and Inspection

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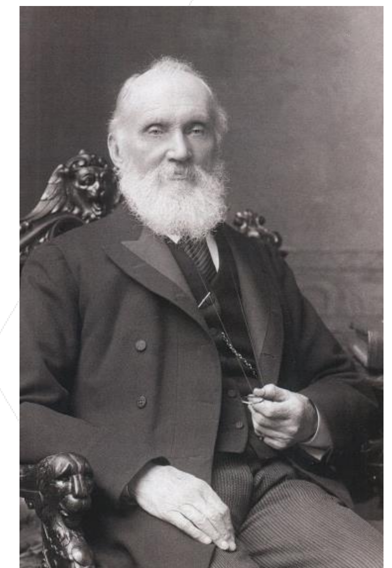
InSPEC

SEM Metrology & Inspection Kit

Motivation

If you cannot measure it – you cannot improve it

Lord Kelvin



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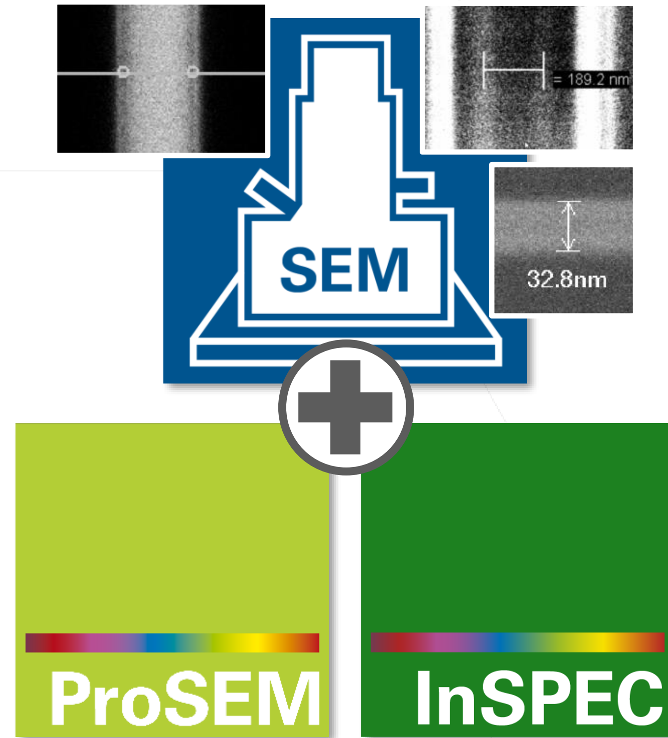
The Metrology Challenge

Various dedicated and optimized lithography tools

Images vendor webpages

Metrology with a versatile microscope...?



Specialized and fully automatic CD-SEM

Image AMAT webpage

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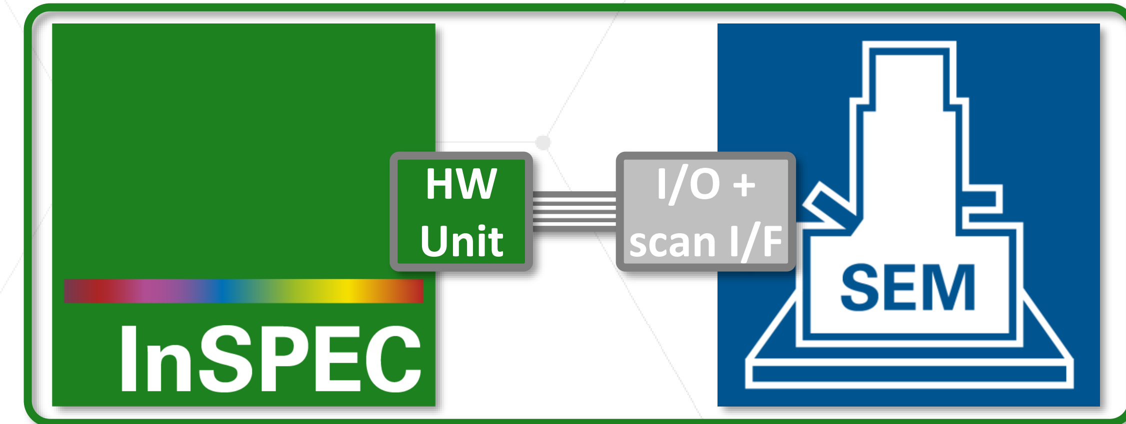
InSPEC Upgrade Kit

→ *Upgrade your versatile microscope to an integrated "Metrology & Inspection SEM"*



- 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"

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InSPEC Hardware Setup

Integrated Upgrade Kit

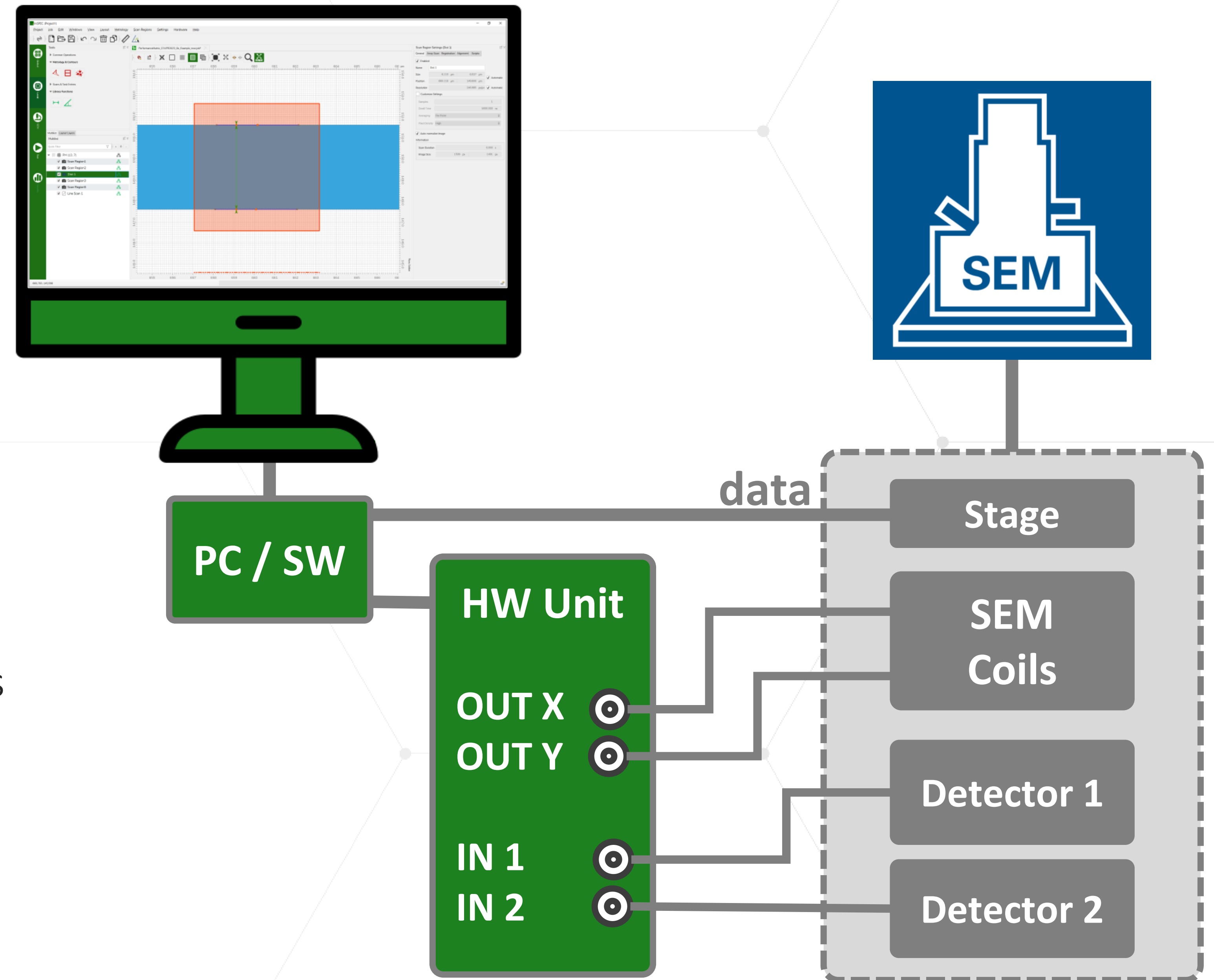
- Software package
- PC and screen
- Scanning and I/O hardware

→ 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**



Integrated Workflow along 5 Main Modes

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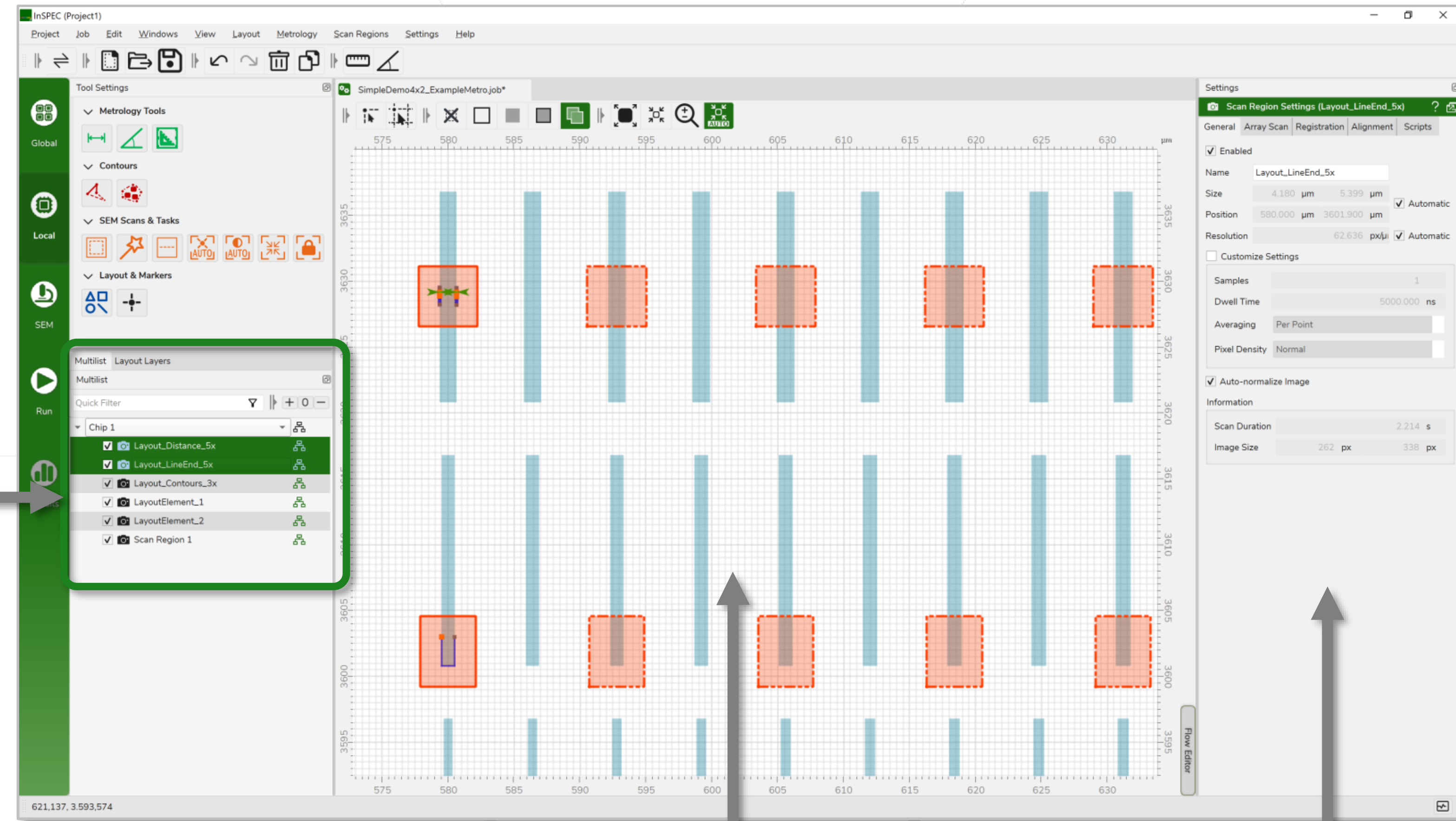
InSPEC Software GUI

5 Main modes with adaptive panels

- Global/ local definition of metrology job
- SEM control "live" and layout-based
- Run job: parallel scanning, metrology, analysis
- Results review and further processing



Job sequence

- Smart and simplified metrology job
- Project with multiple jobs/ multiple result files

Working area and details

- Center visual area with layout
  - Can split for layout view & FLOW editor
- Right: details and advanced settings

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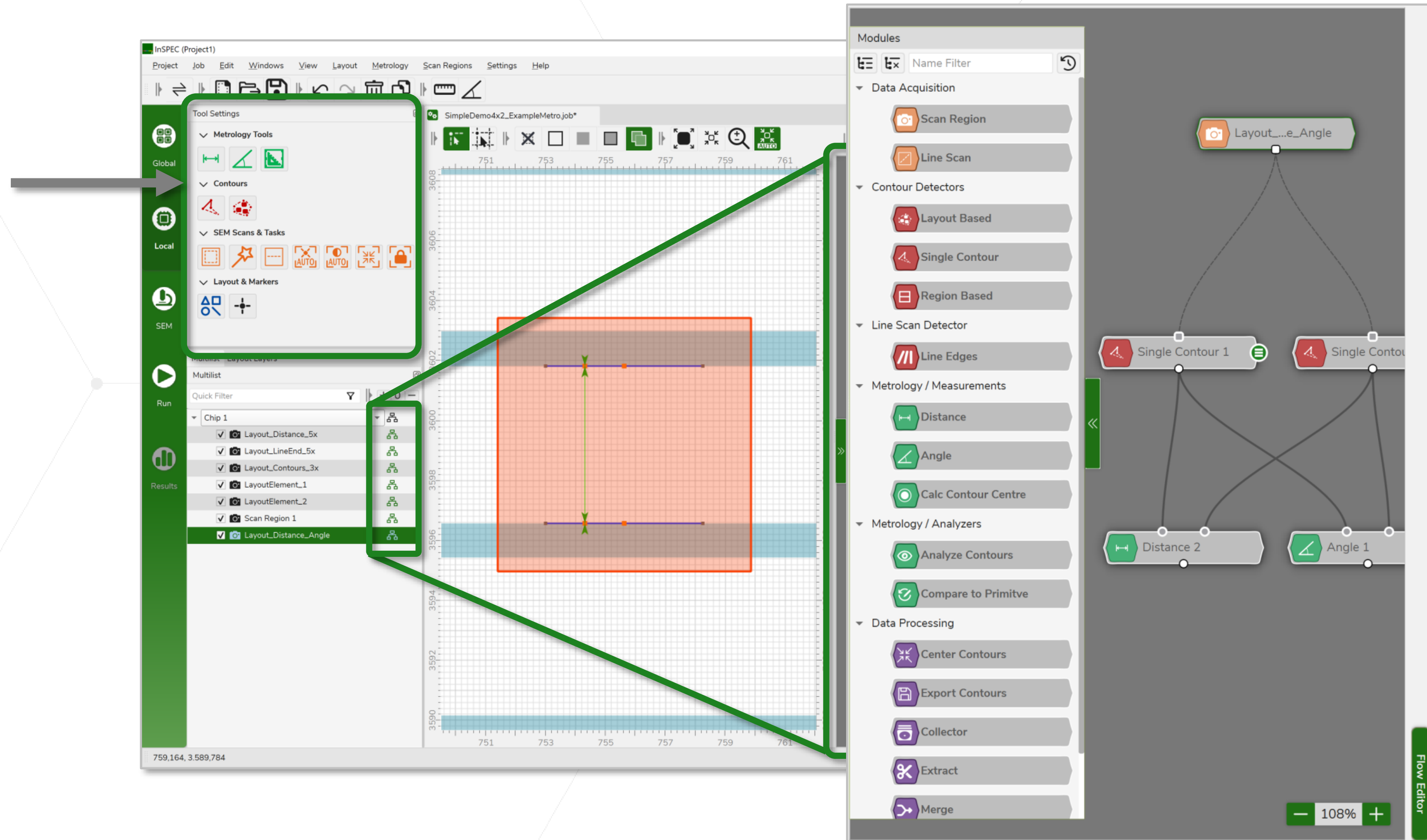
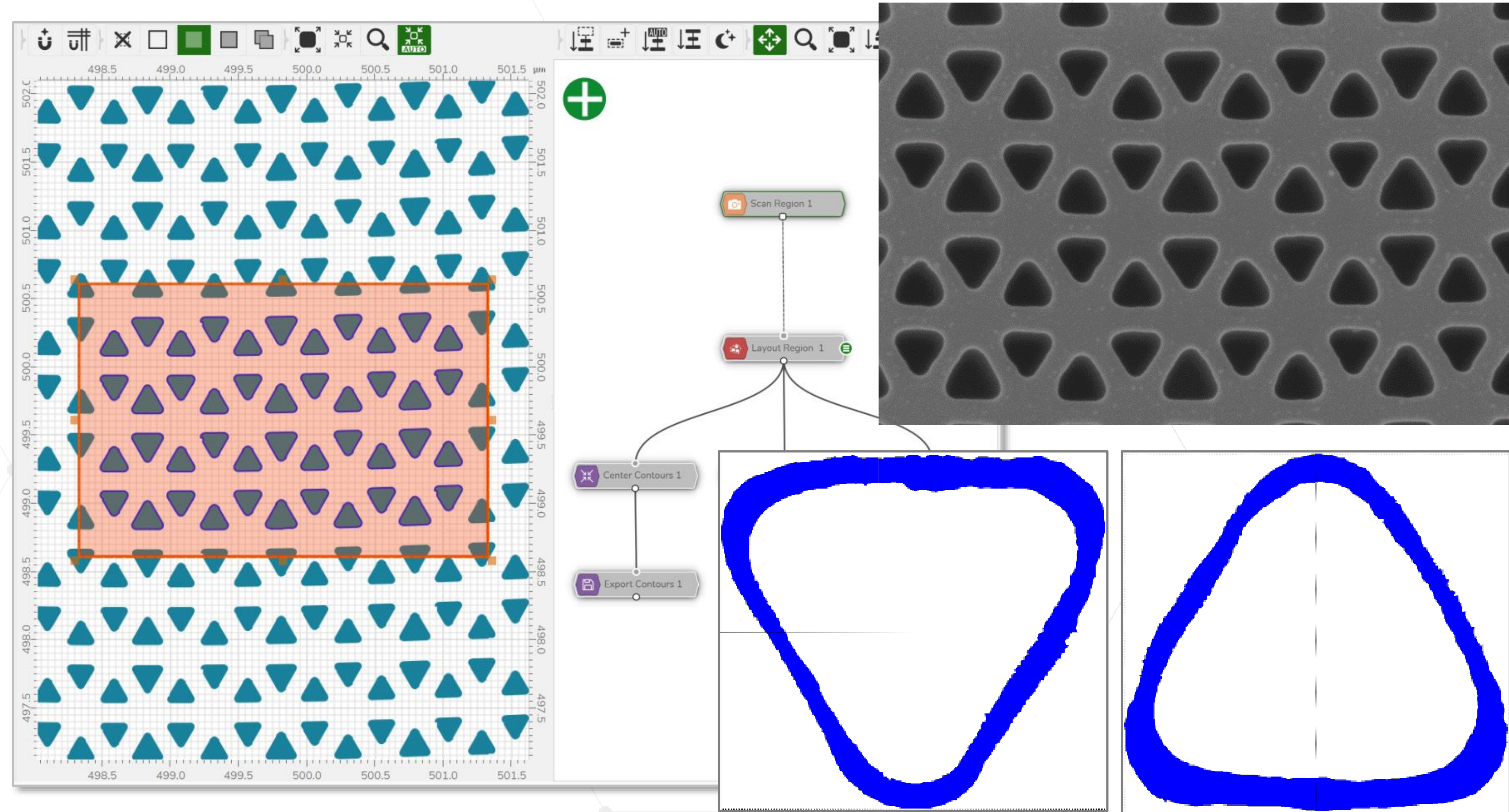
Advanced Jobs with FLOW

- FLOW structure and editor
  - Basis for standard tools with pre-defined functionality
  - FLOW contains all methods for obtaining metrology results
  - Modules for
    - Scanning (region, line)
    - Edge/ contour detection
    - Metrology & analysis
    - Data processing
  - Enables complex tasks without programming/ scripting
  - 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

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Global Setup and (Wafer) Arrangement

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

Local Content with Metrology

- Chip/ field level
  - Metrology based on layout

  → Automatic scan definition
  - SEM scans (region, line)
- Job list can contain
  - Scans
  - Scans and contour
  - Scans and metrology
  - Plus data processing
  - Focusing/ alignments

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„Layout-less“ based on Metrology Region

- Use case
  - No (full) layout available
  - No good representation
  - Strong process bias
- Metrology region
  - Layout only as background
  - No comparison with layout
  - Provides contours
  - Fitting with primitives

SEM Live Mode

- SEM beam/ image control
  - Preset scan speeds
  - Control of beam shaping
    - Contrast/ brightness
    - Magnification/ focus
    - Stigmation/ focus
  - Stage control

SEM Layout Mode

- SEM work with Layout
  - Alignment via markers
  - SEM scans interactively
  - Scans in list and shown on layout
  - Navigation and positions
  - Focus points and mapping
    - Working distance
    - Stigmator X/Y
    - Contrast/ brightness

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Run the Metrology Job

- Job execution
  - Job start and pause/ stop
  - Progress of job sequence
  - Live scans on layout
  - Parallel activities
    - Scanning
    - Corrections
    - Contour detection
    - Metrology
    - Data processing
  - Creates results file

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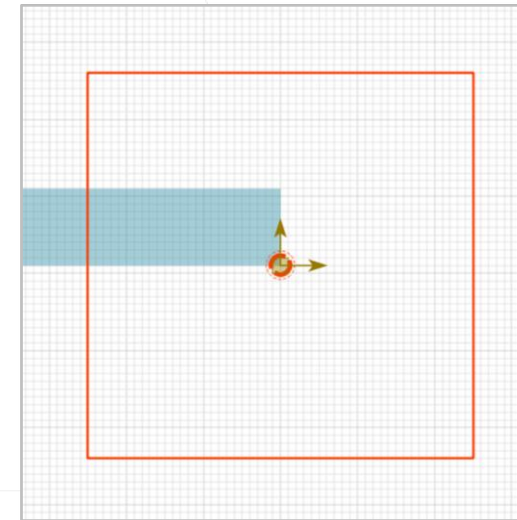
Results Review & Editing

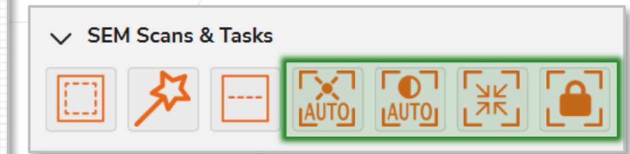
- Results summary
  - Job list including results
  - Display
    - Layout with definitions
    - Scan with metrology
  - Results tables with tabs
  - Details review/ tuning

Addressing SEM Challenges 1: Focus

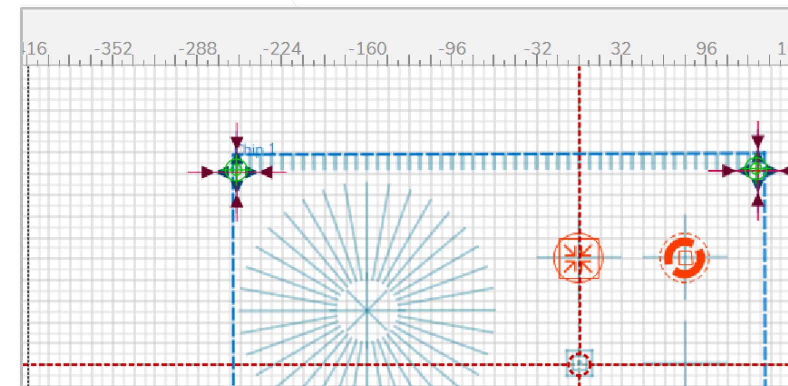
Sample tilt and bow require focus correction

- Automatic focusing
  - Integrated auto focus functionality for job sequence
  - Scanning large-to-small with focusing coarse-to-fine





- Focus correction points and map
  - Linear interpolation or non-linear corrections
  - Many points, optionally including stigmator



Focus & Stigmator Interpolation

Stage Position	Focus	Stig.X	Stig.Y
41.7482, 33.5086 ...	39.86664	0.09	0.12
42.5525, 33.5931 ...	39.85911	0.09	0.12
42.5975, 34.7664 ...	39.85623	0.10	0.13
41.7927, 34.7634 ...	39.84910	0.11	0.14
42.5289, 36.8665 ...	39.85118	0.11	0.14
41.7264, 36.8639 ...	39.87932	0.11	0.14

Mode: Inverse Distance / Plane / Multilevel B-Spline Low Curvature / Multilevel B-Spline High Curvature

- [x] Focus Interpolation During Job F
- [x] Interpolate Stigmators
- [x] Focus Interpolation in Live Mode

→ Plane/ map for large area correction + local auto focus

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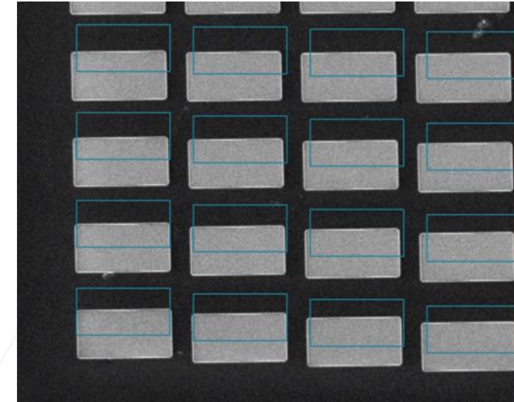
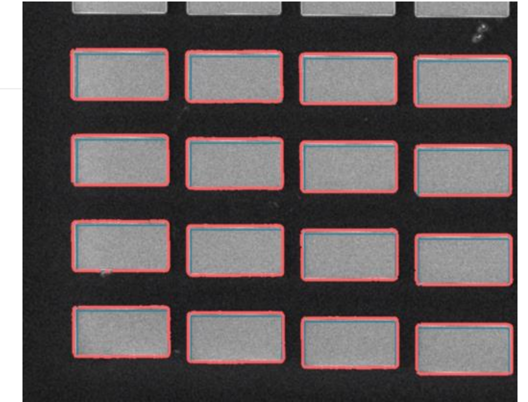
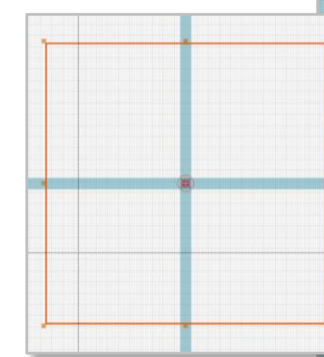
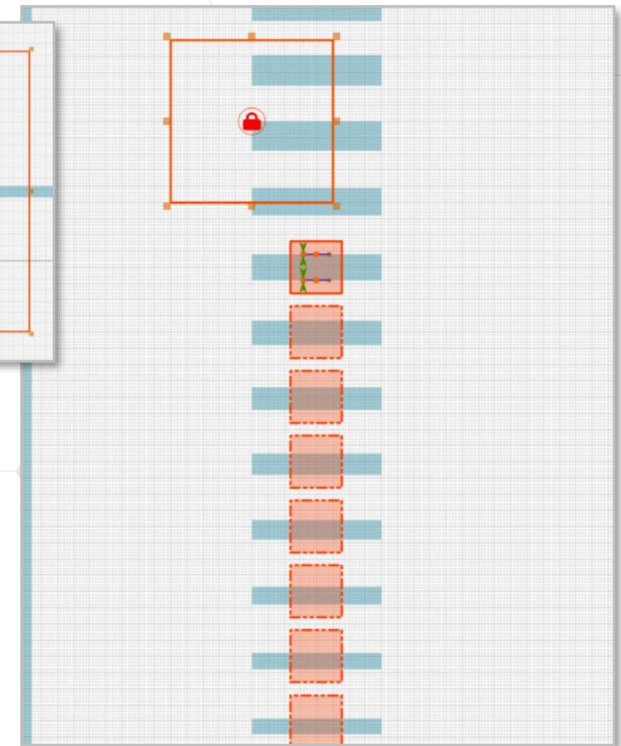
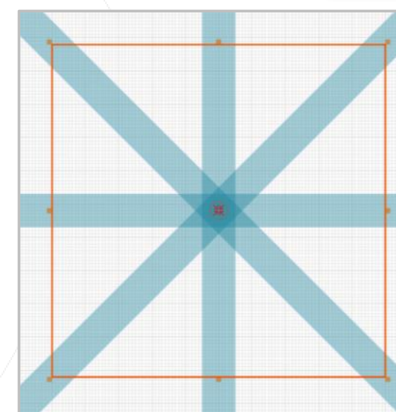
Addressing SEM Challenges 2: Stage Position

Limited accuracy in stage and sample positioning

- Individual image correction
  - Image-to-layout registration
- Local auto alignment for stage offset
  - Chip level: apply marker correction to general alignment
  - Local stage drives and scans
  - Alternatively: stage locked and scans within column range
- Compensation for stage/ sample drift
  - Automatic registration at marker or feature

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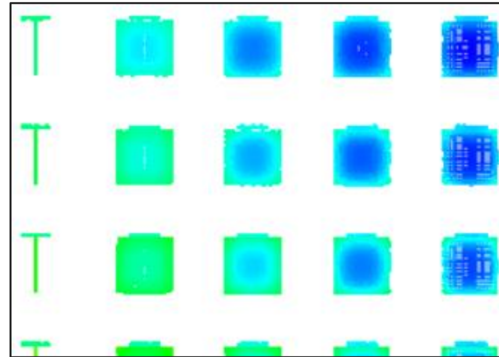
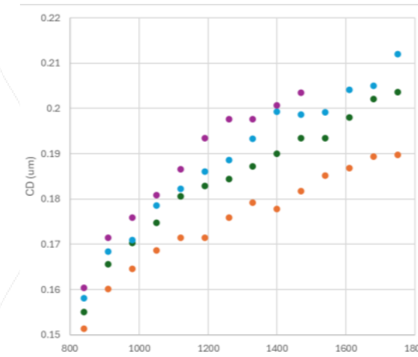
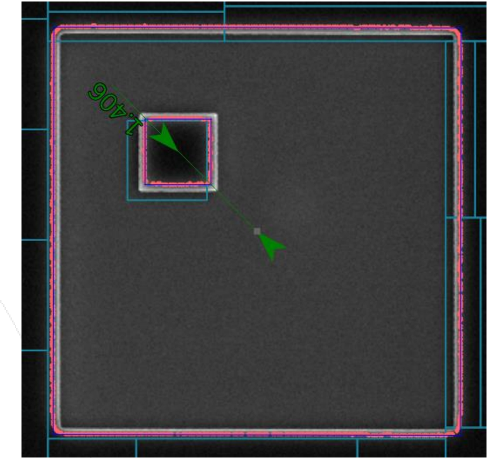
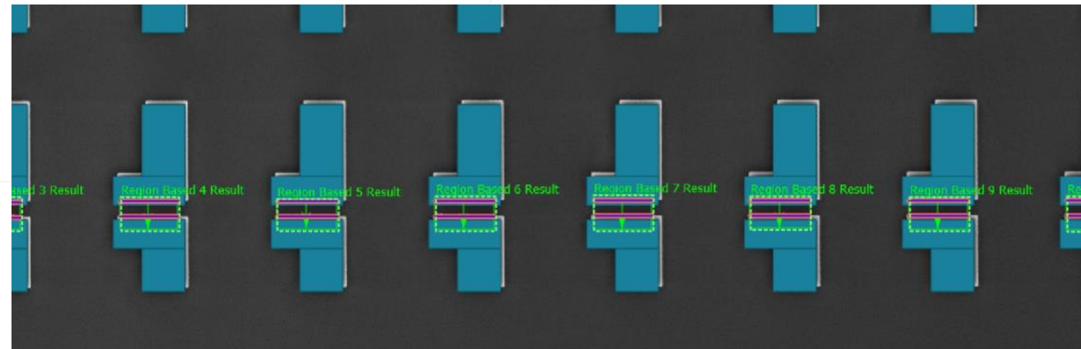
Application Examples

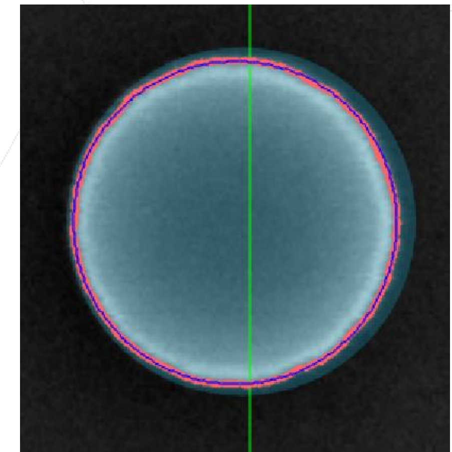
- Resist calibration
- Placement analysis
- Device and pattern CD
- Contours with PV band
- Corner rounding/ blur
- Layout comparison/ bias

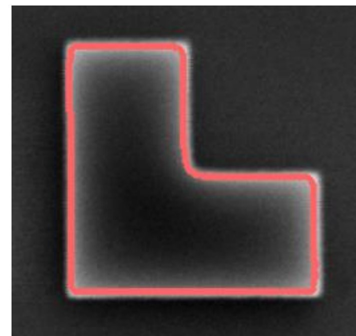


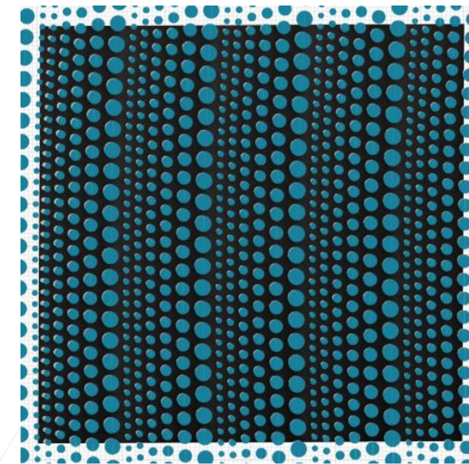












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Acknowledgements

InSPEC sessions during EIPBN

- Thursday morning: Session 3C Industrial Highlights
- Friday 12am – 1.30pm: Luncheon Workshop SEM Metrology → *Registration*
- Friday after lunch: Session 8A Chad Eichfeld, PSU

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Thank You!

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