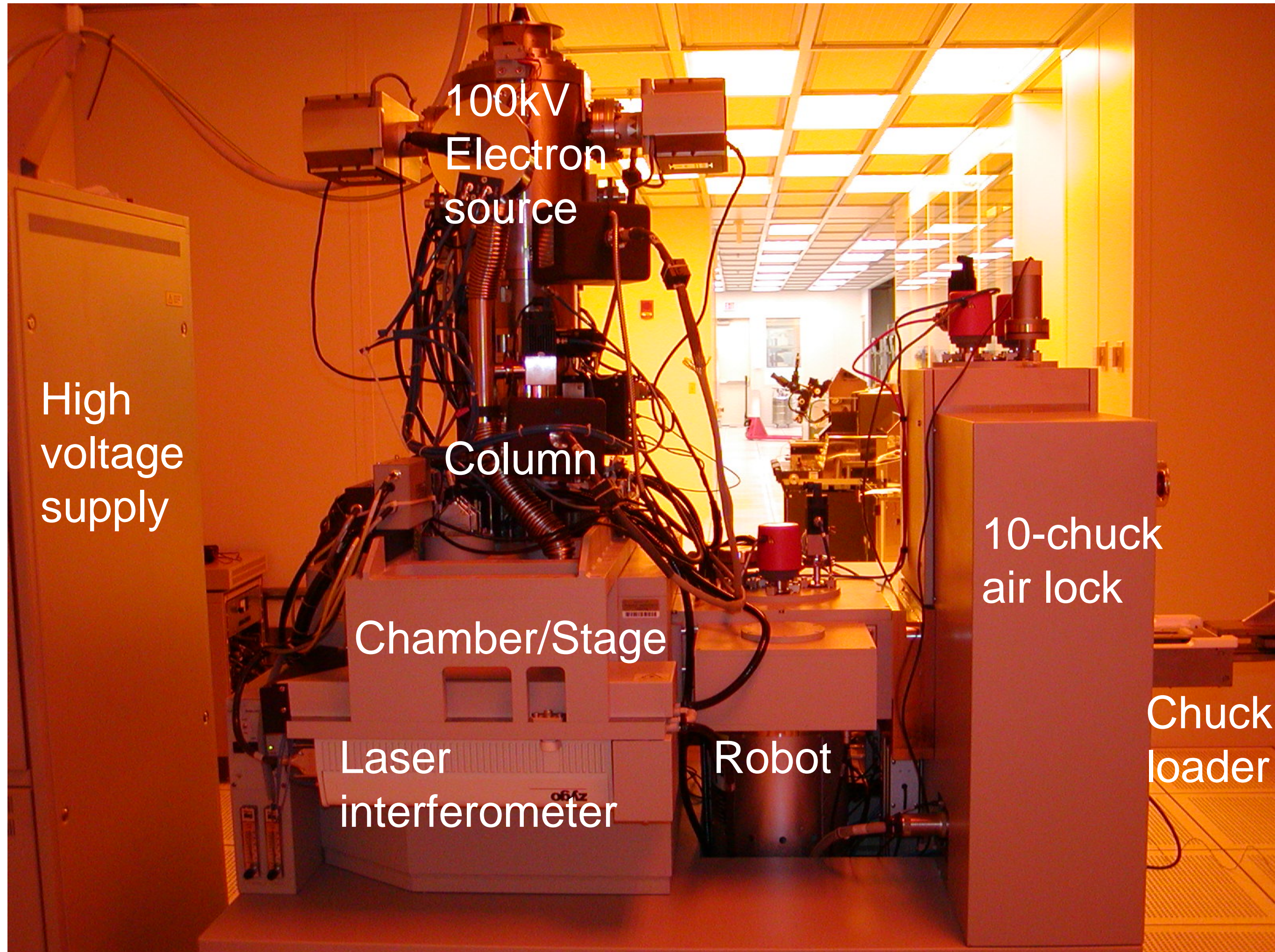
Nanometer Scale Patterning and Processing

Spring 2016

Lecture 19

Vector Beam Performance and Operation

The Raith VB6 UHR-EWF EBL tool



Environmental Control for high stability

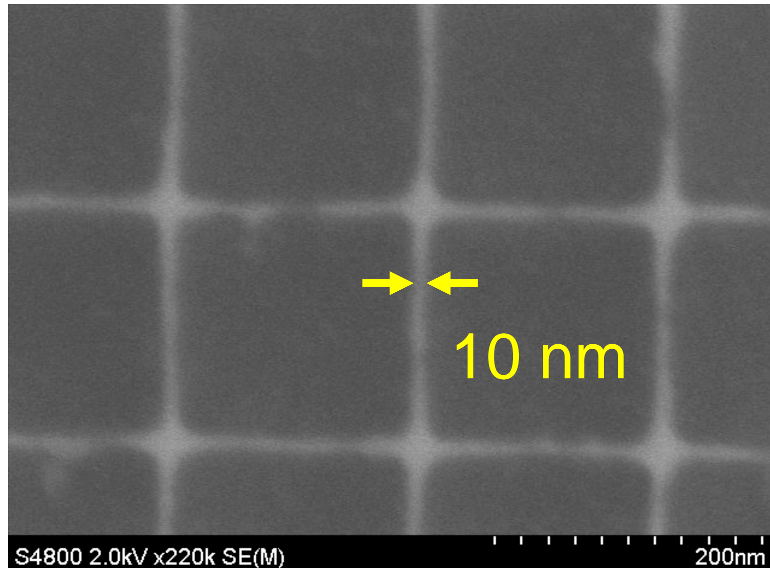
Water chiller (±0.01 °C)

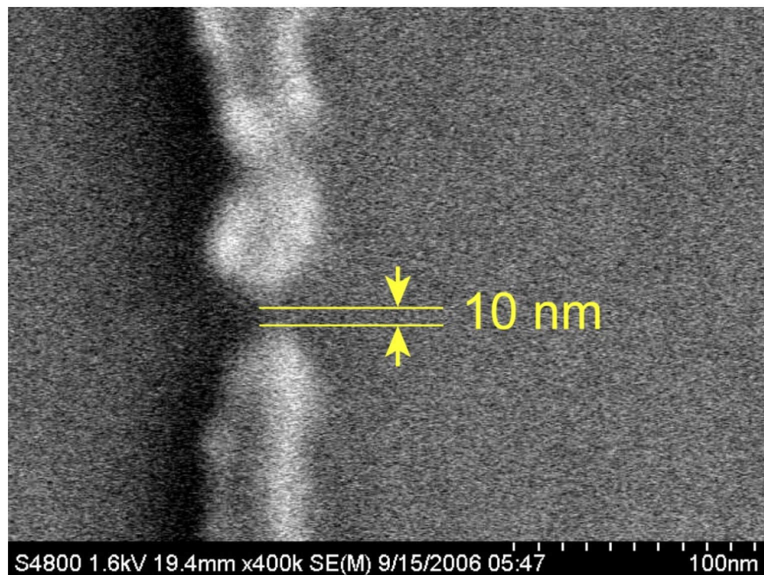
Temperature stabilized column, chamber and air lock

Active vibration isolation

EM field cancellation system

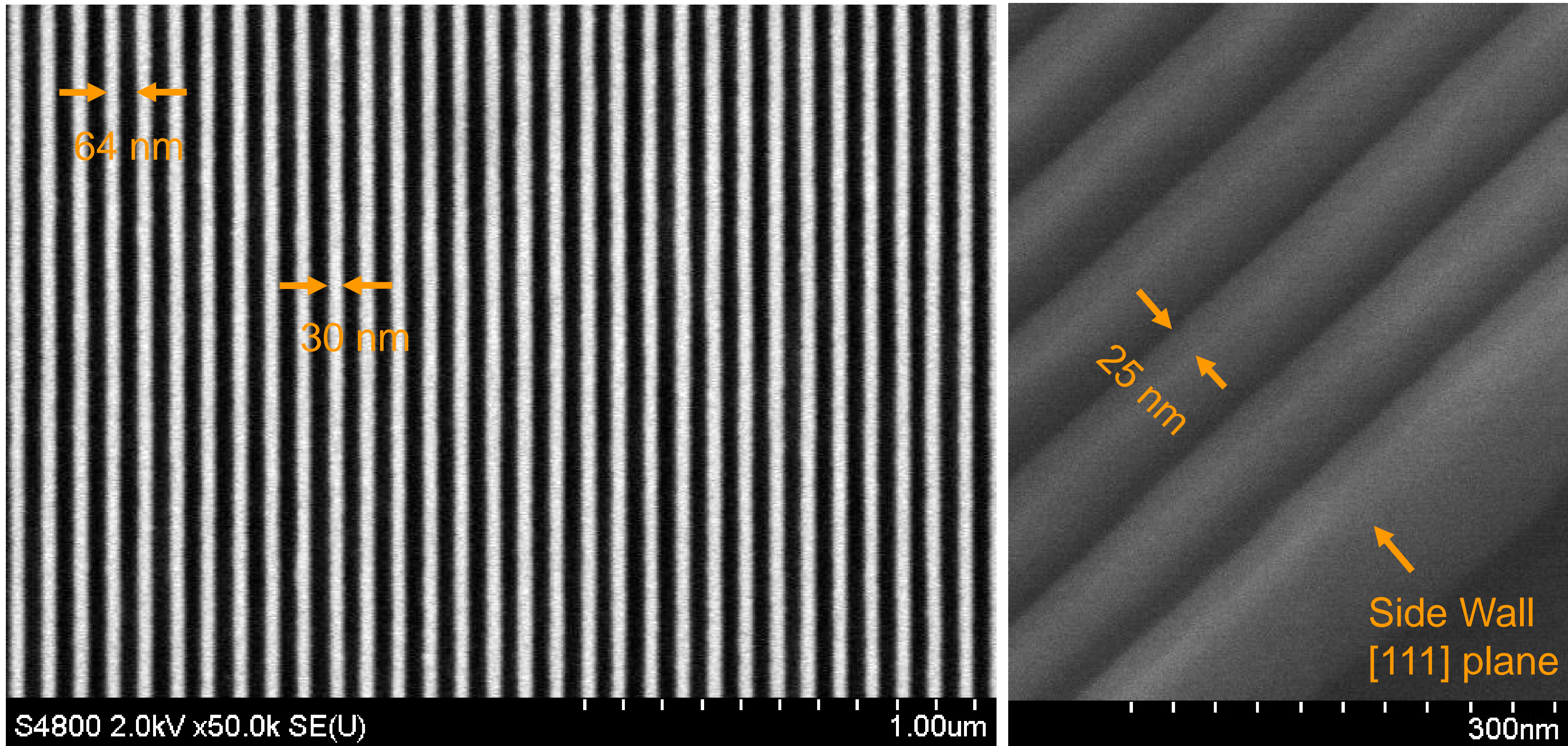
Performance of the E-beam tool





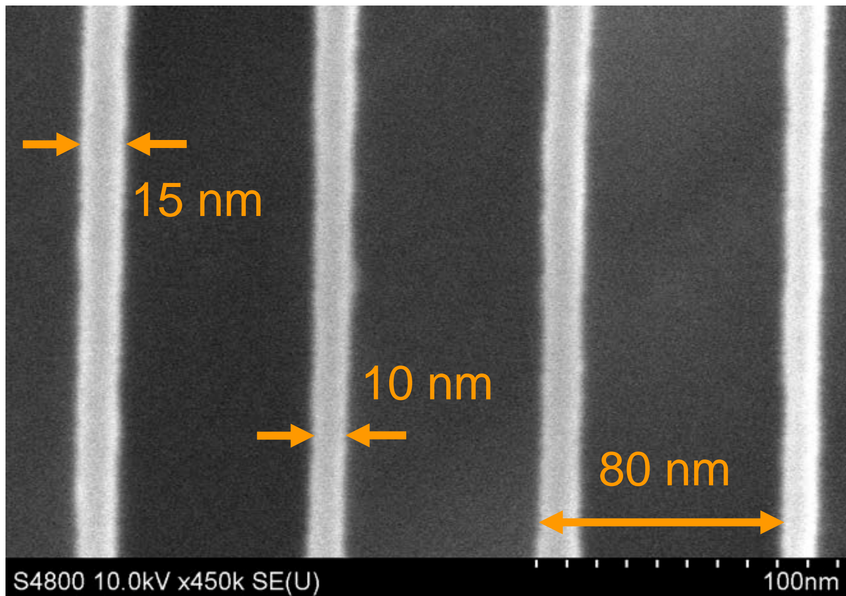
- Resolution:
  10 nm or less
- Intra-field distortion:
  < 10 nm
- Stitching error: < 20 nm
- Overlay: < 25 nm
- Maximum field size:
  1.3 mm
- Maximum deflection speed: 25 MHz
- Maximum wafer size:
  200 mm (8 inch)
- Beam position stability:
  < 70 nm/hr

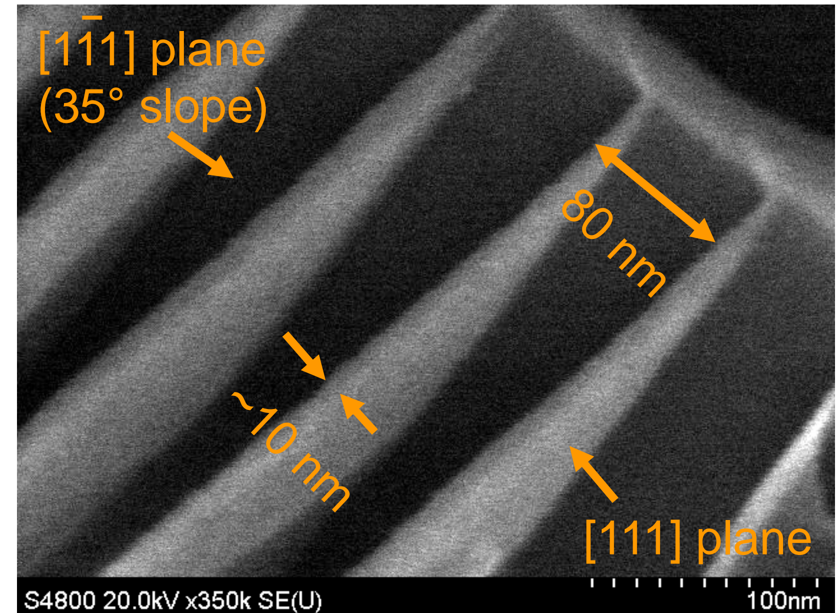
64 nm Pitch Grating in 110 Si



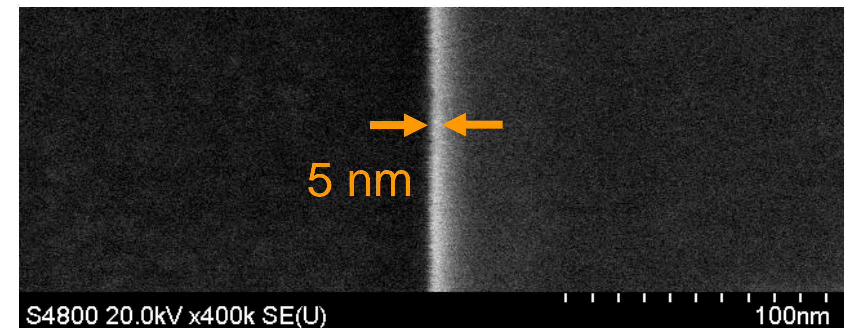
- 45 nm thick HSQ as etch mask, 2 min. etch in 60 C KOH.
- Good alignment to the crystal orientation.
- High contrast in top view indicates etch into Si substrate

~10 nm lines at 80 nm pitch



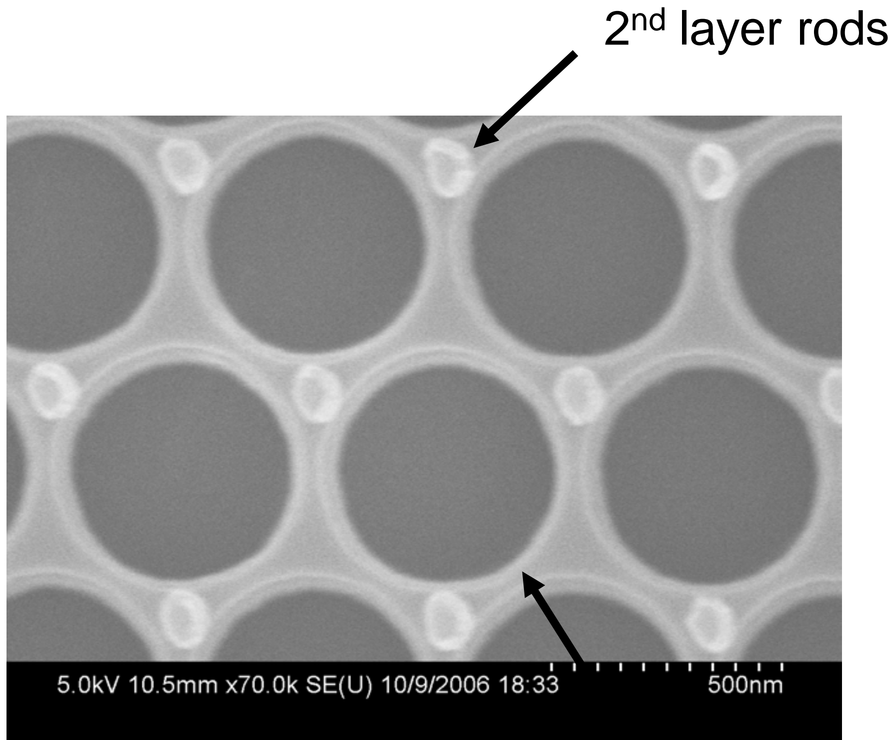


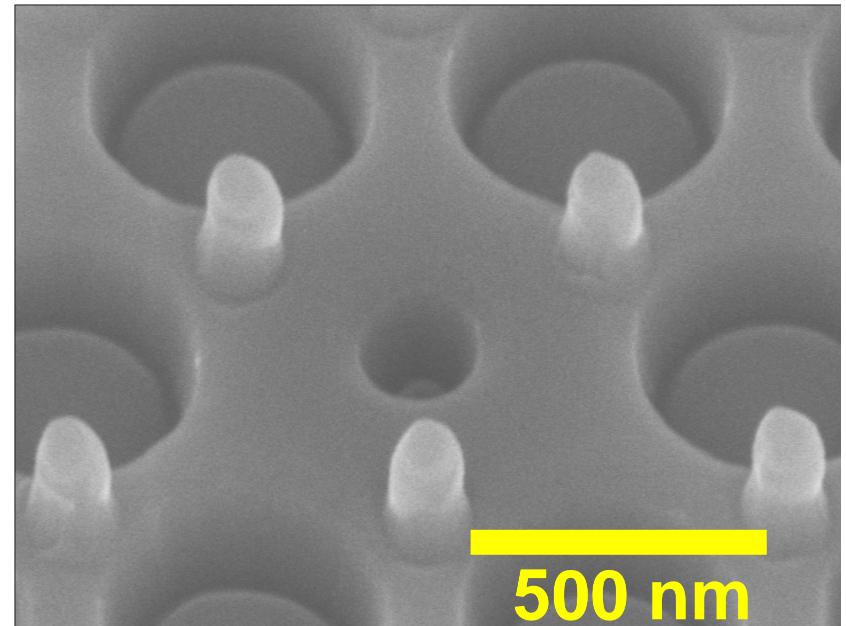
- Linewidth variation around 5 nm
- Smooth sidewalls preserved down to 10 nm lines.
- Isolated line at 5 nm.



Excellent Alignment Capability

2nd layer rods



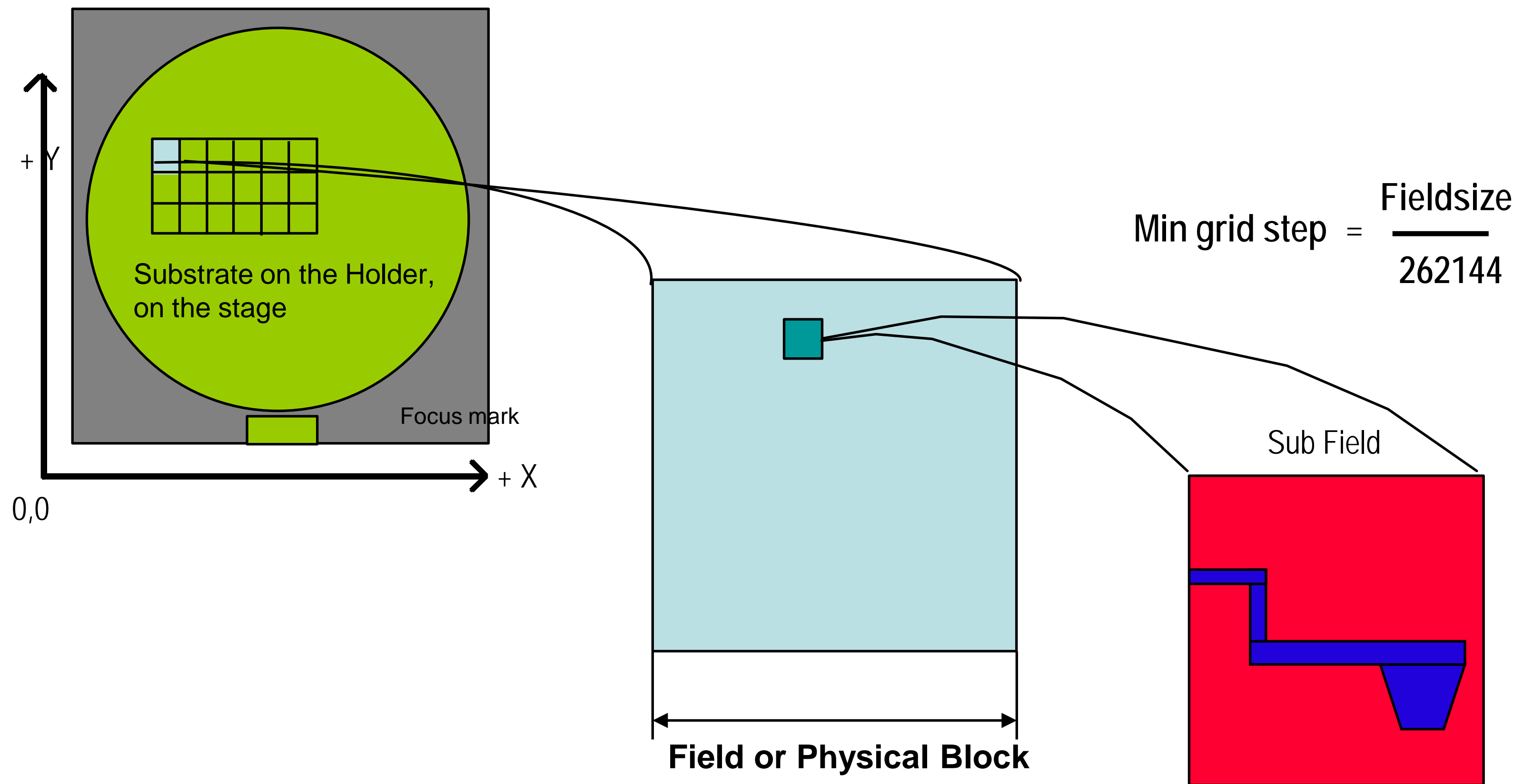


1st layer holes

Top view

Tilted view

Writing Strategy (Wide Field)



$$\text{Min grid step} = \frac{\text{Fieldsize}}{262144}$$

1. **Stage moved to position of Field or Physical Block within pattern.**
2. **Sub-field positioned by Main deflection scan**
3. **Subfield area scanned by "Trapezium scan coils"**

Dose Control

The correct dose is achieved by setting the time duration that the beam dwells at each exposure point within the pattern.

This time duration is determined by the frequency of the **DOSE CLOCK.**

A clock frequency of 1MHz sets the exposure time per exel to 1 micro-second.

A pattern shape containing 10,000,000 exposure points will take 1 Second to expose with a clock set to 10MHz.

The maximum frequency possible is 25MHz

The Dose required for correct exposure depends on the

- Resist Sensitivity
- Field Size
- Beam Current
- EHT
- Variable Resolution factor (VRU)
- Electron beam back-scatter

Corrections

Corrections are applied in real time for:

Main field scan corrections

- Scale, rotation & keystone over the main field

Trapezium field scan corrections

- Scale, rotation & keystone over the main field

Focus and Astigmatism

- Focus and Stigmation correction over main field
- Focus correction for each stage position dependant on substrate height

Beam Error Feedback

- Scale and Rotation corrections dependant on mainfield deflection.

Height

- Real time or Pre-map corrections of focus and deflection scan rotation

Stage Position

- Beam Error Feedback
- Magnetic effect
- Orthogonality
- Machine mapping