Tech Talks
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Serkan Butun, PhD
NUFAB Facility
Equipment Manager

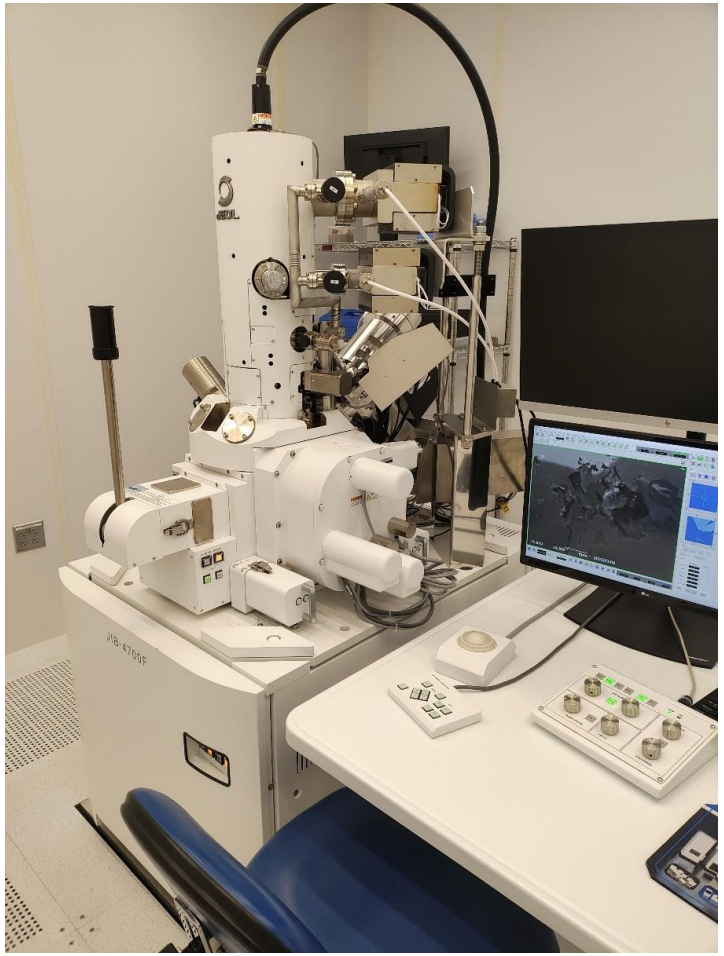
APRIL 17, 2025 - 11:00 AM

Drawing CAD files with scripting for Micro/Nanofabrication & Introducing NUFAB's new JEOL 4700 FIB/SEM

Nathan Dvorak, PhD
NUFAB Facility
Postdoctoral Scholar

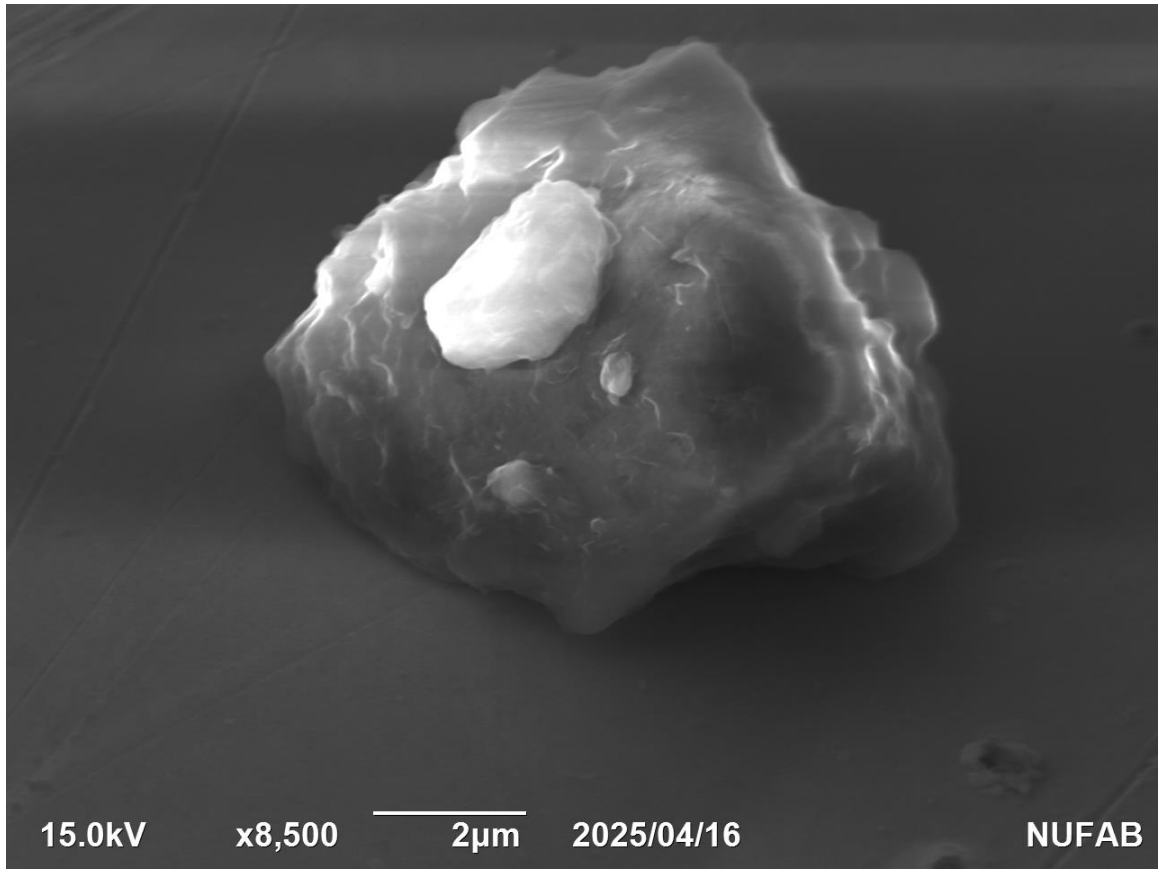
System Overview

- The JEOL JIB-4700F features a focused ion beam installed within a high-resolution SEM.
  - Schottky field-emission.
  - Stable high current emission.
- Pieces up to 4” wafers are allowed.
- Gallium Liquid Metal Ion Source.
- Energy Dispersive X-Ray Spectroscopy.



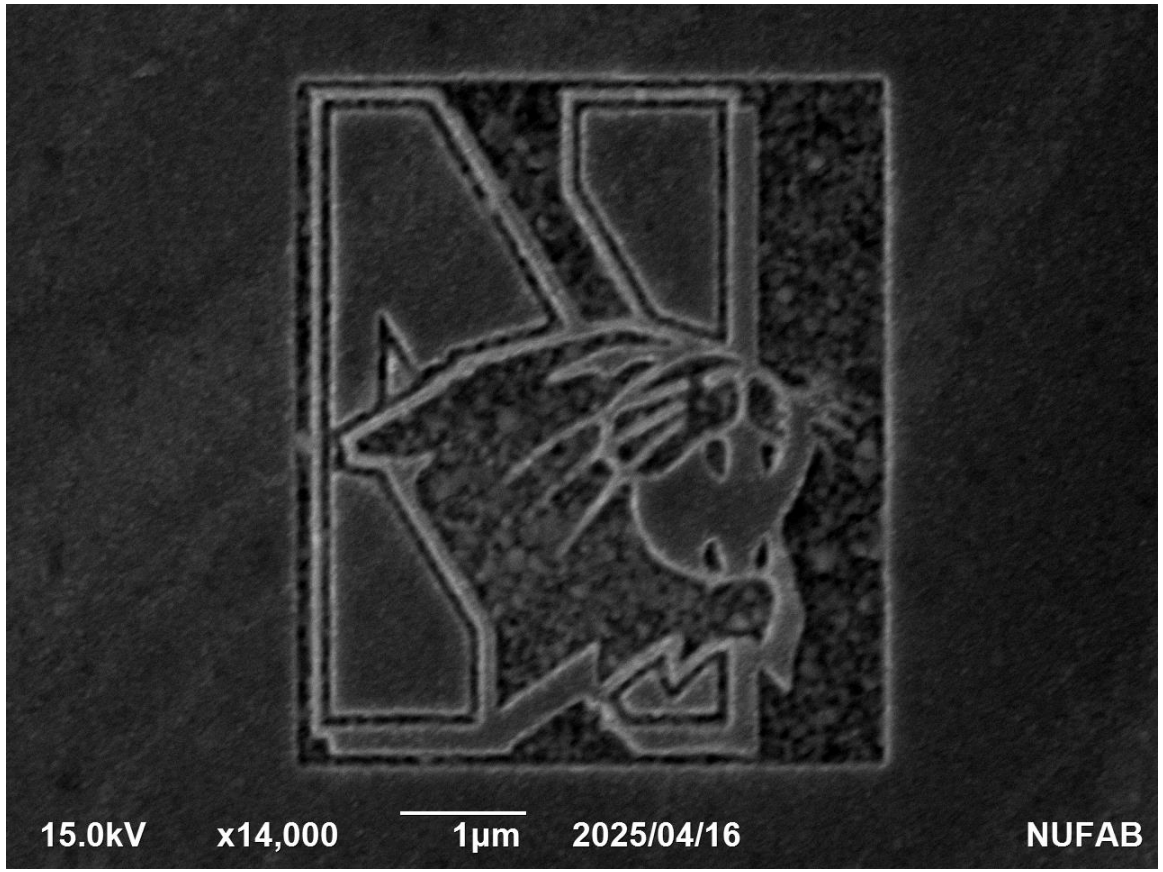
Available Detectors

- Lower Electron Detector (Everhart–Thornley detector)
  - Electron and Gallium Ion Detection.
- Upper Electron Detector (In lens detector).
  - Secondary and backscattered detection with screening.
- Backscattered Electron Detector.
  - Contrast and topographical imaging.
- Energy Dispersive X-Ray Spectroscopy.



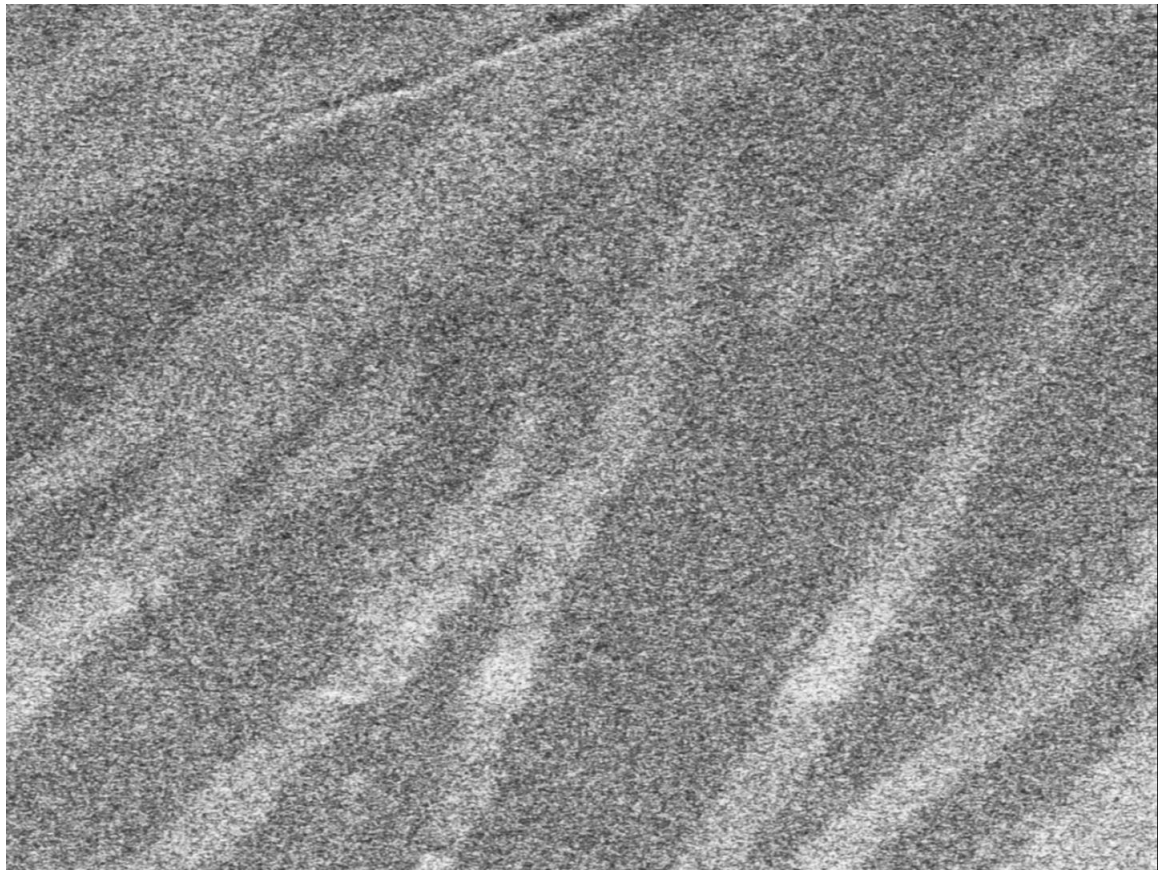
Electron Optical System

- ZrO/W Cathode.
- Resolution: $1.2\ nm$ at $15.0\ kV$.
  - $\times 20$ to $19{,}000$ in Large Depth of Focus (LDF) mode.
  - $\times 20$ to $1{,}000{,}000$ magnification.
  - Working Distance: 1.5 to $40\ mm$.
- Accelerating Voltage: 0.5 to $30\ kV$.
- Beam Current: $1\ pA$ to $300\ nA$.
- Specimen Bias Voltage: to $\neg 2.0\ kV$.



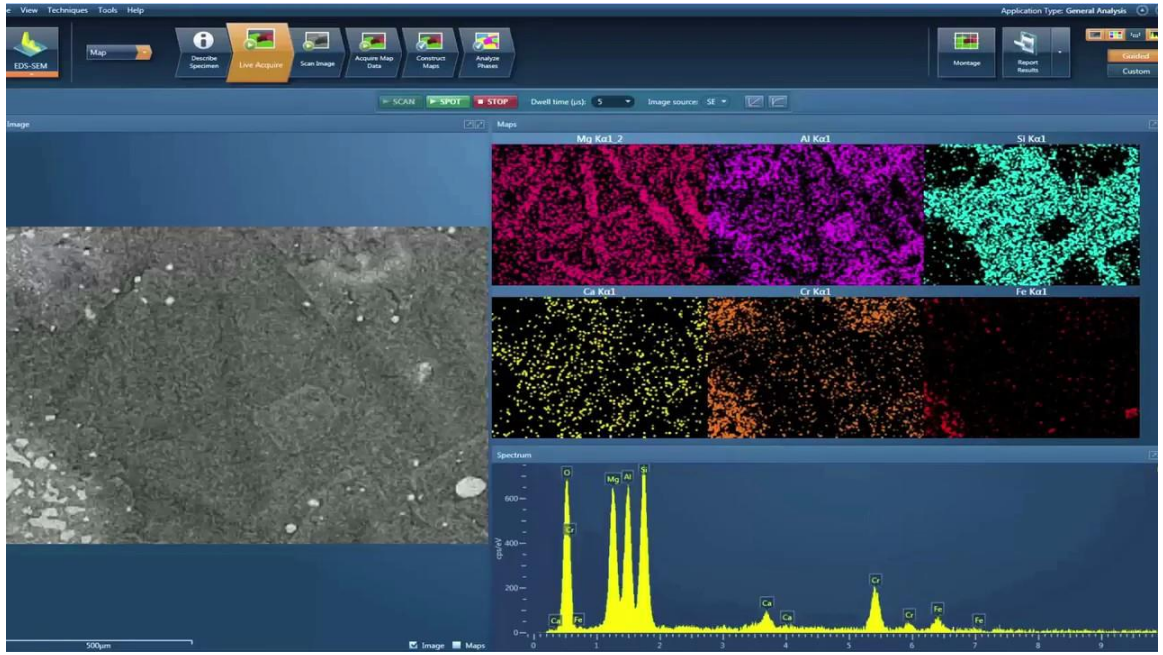
Ion Optical System

- Resolution $4.0\ nm$ at $30\ kV$.
  - $\times 50$ to $300{,}000$ magnification
- Beam Current: $1\ pA$ to $90\ nA$.
- Maximum processing dimension: $1.28\ mm \times 0.96\ mm$.
- Dwell Time: $0.4\ \mu s$ to $100{,}000\ \mu s/point$.
- Milling and Deposition possible.
  - Carbon, Platinum, and Tungsten precursors available.

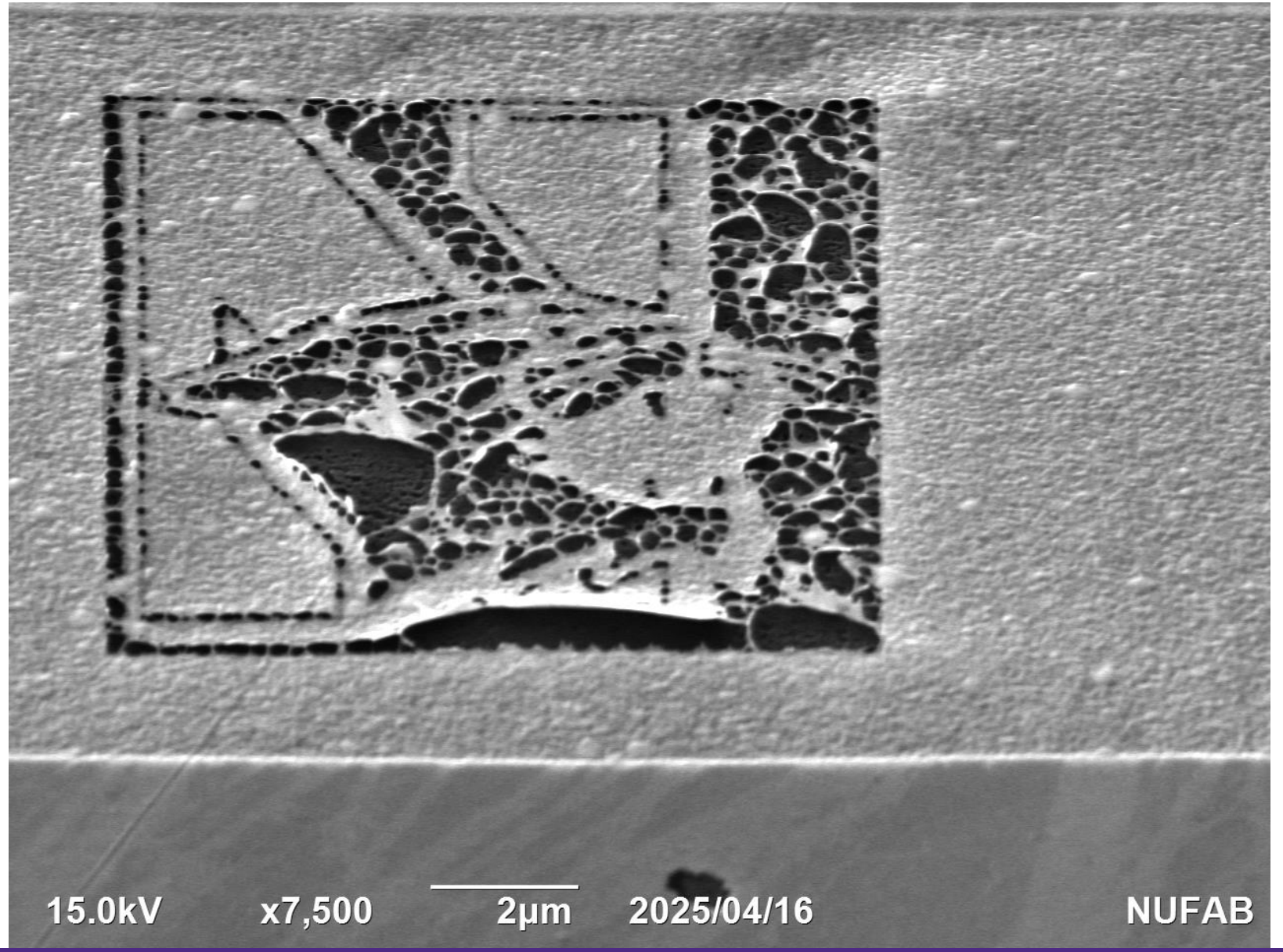


Energy Dispersive X-ray Spectroscopy

- Oxford Ultim Max
  - High speed SDD Detector (No LN2 required).
- Energy resolution: Less than $127\ eV$.
- Detector area: $100\ mm^2$.
- Element detection range: Be(4) – Am(95).
- Maximum input count rate: $>$ $150\ kcps$.
- Live data processing.

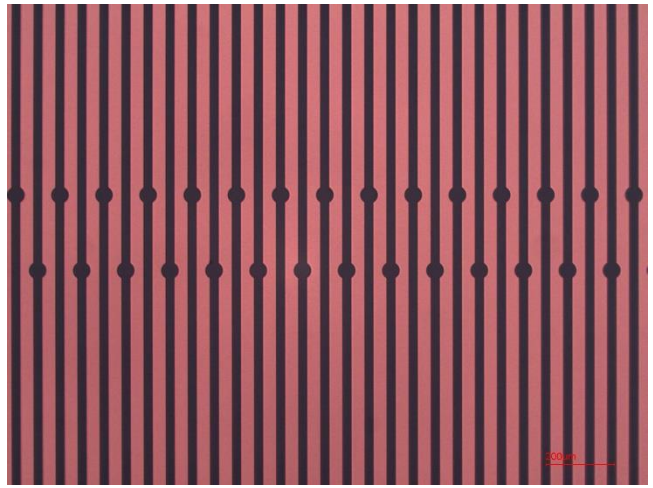


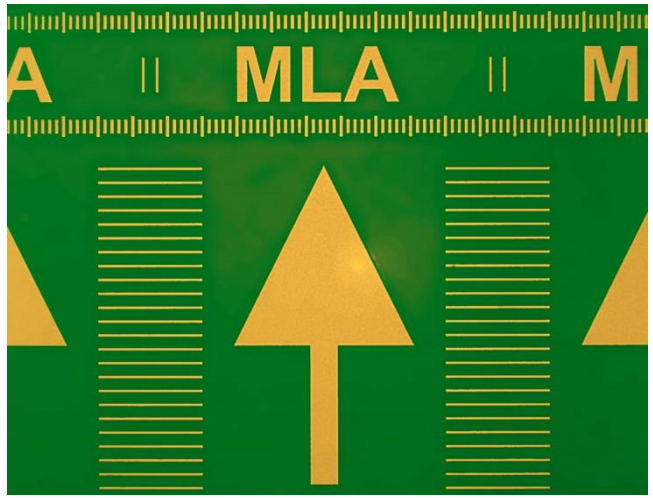
Source: https://nano.oxinst.com/campaigns/product/azteclive-ultim-max


15.0kV
x7,500
2µm
2025/04/16
NUFAB

Computer Aided Design (CAD)

- Maskless Aligner Heidelberg MLA150
  - GDS, DXF
- Maskless Aligner Heidelberg uPG501
  - GDS, DXF
- LPKF Protolaser R4
  - DXF
- Raith Voyager100
  - GDS, CSF (Raith GDS)





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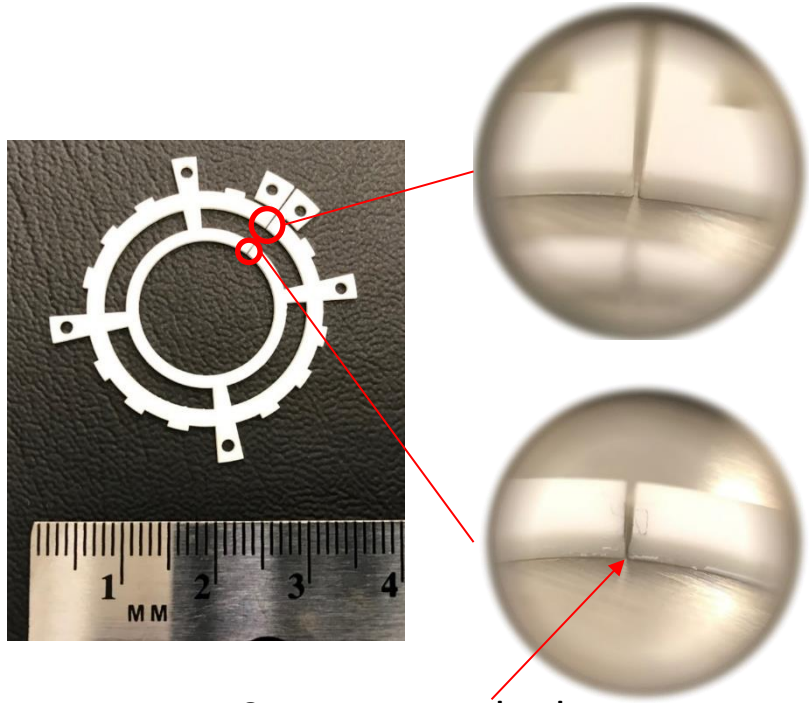

10 um gap at the bottom

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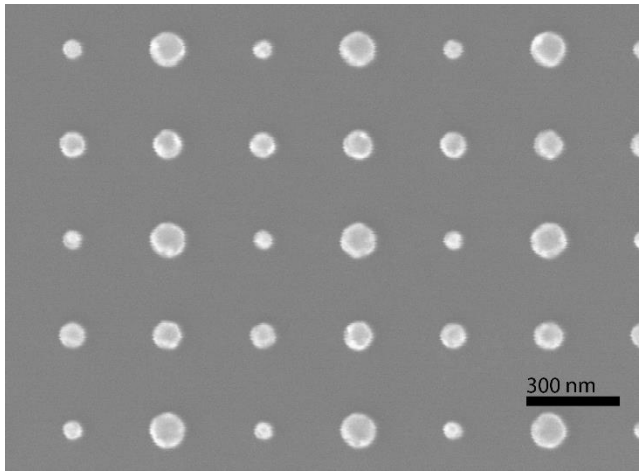
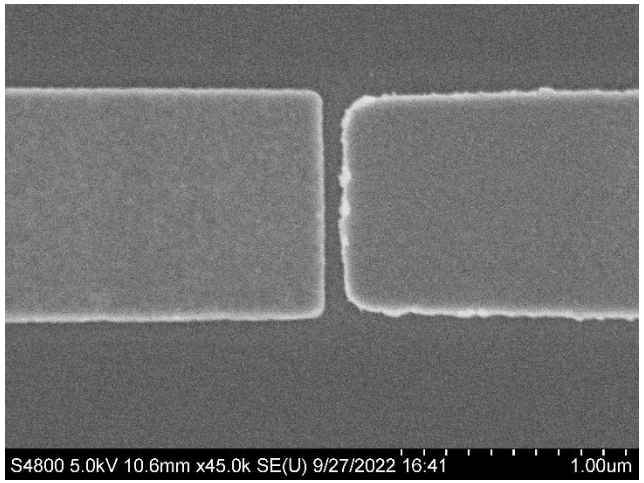
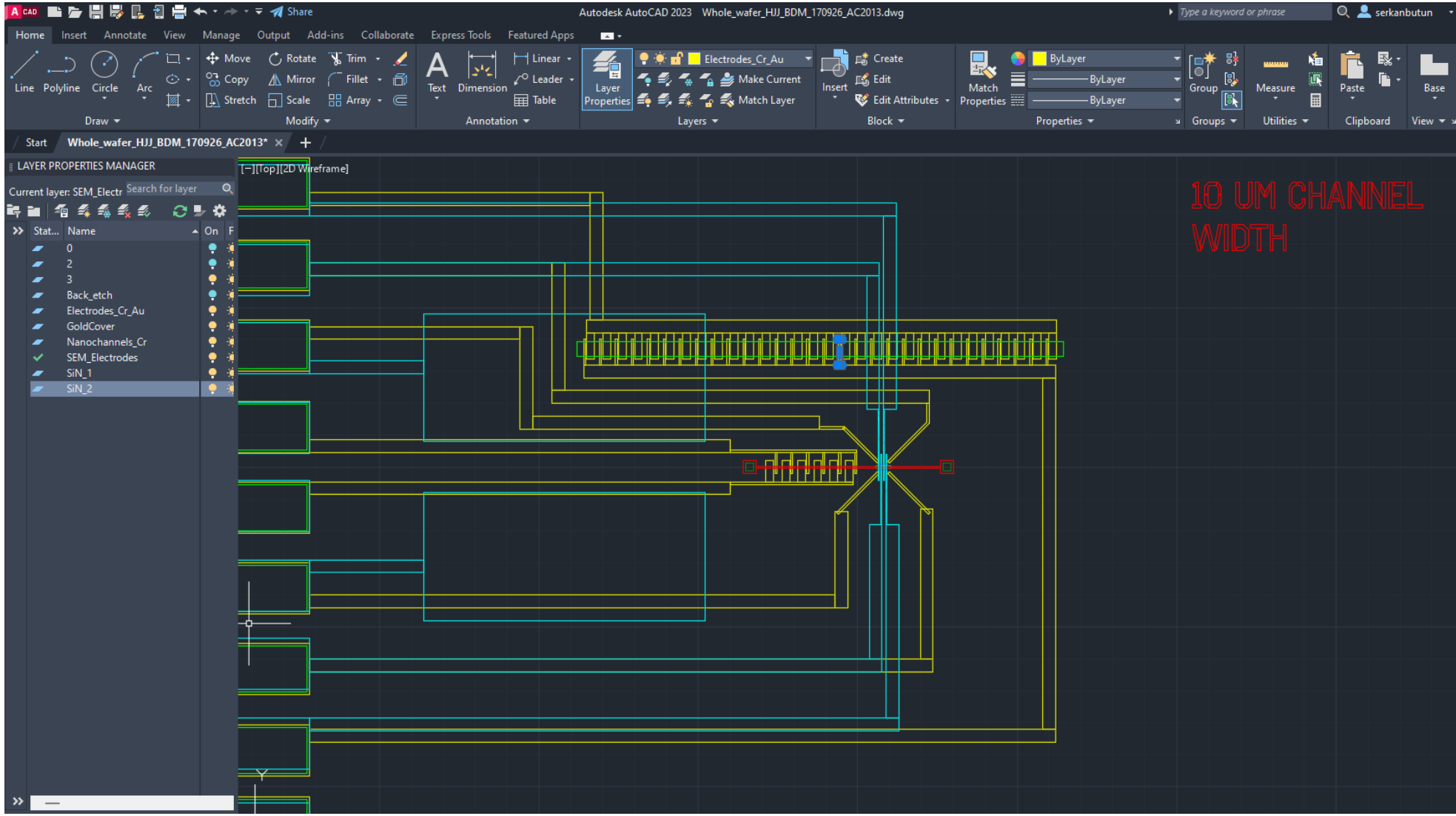




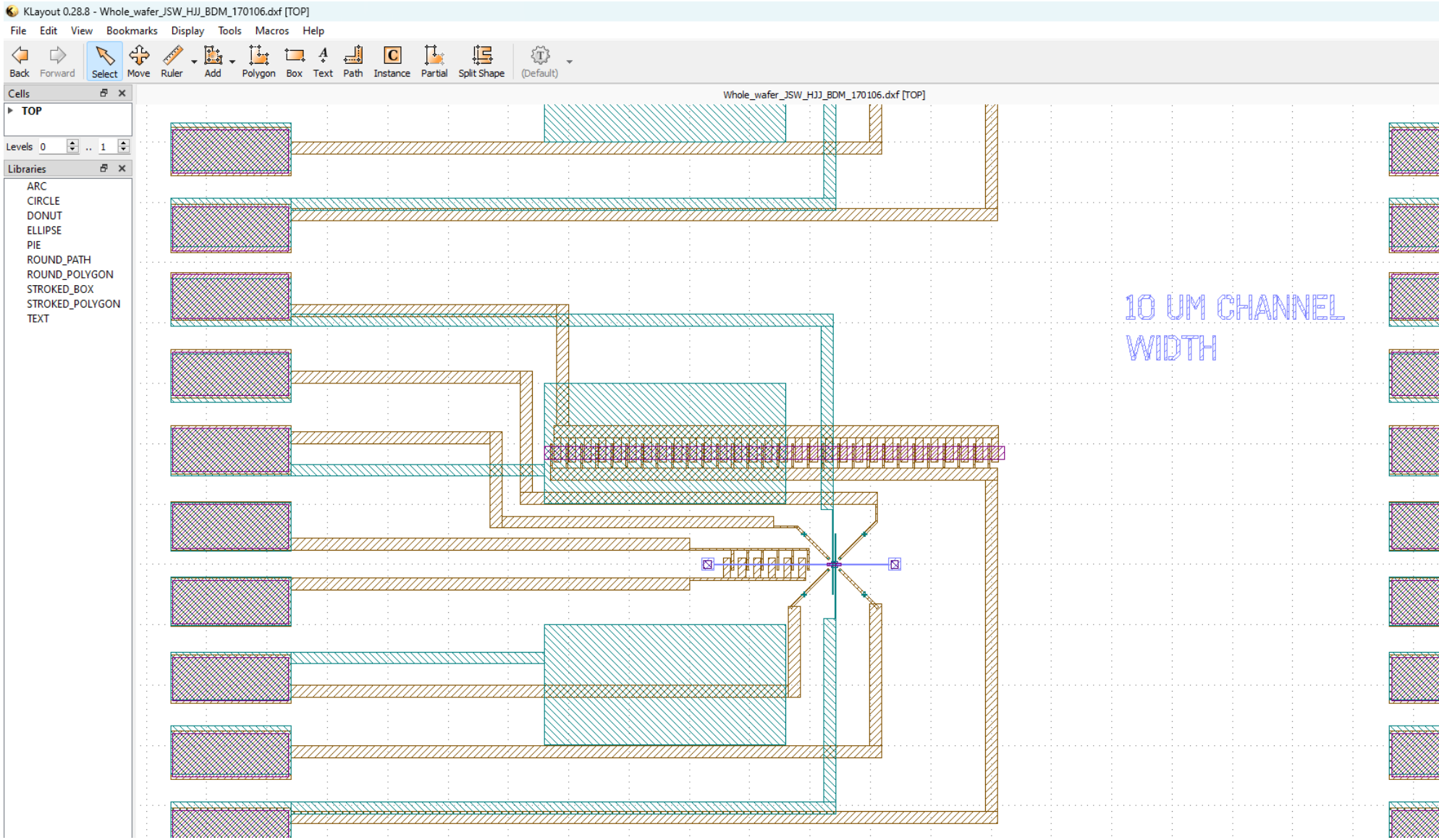
AutoCAD



DXF

Expensive but free with your edu email

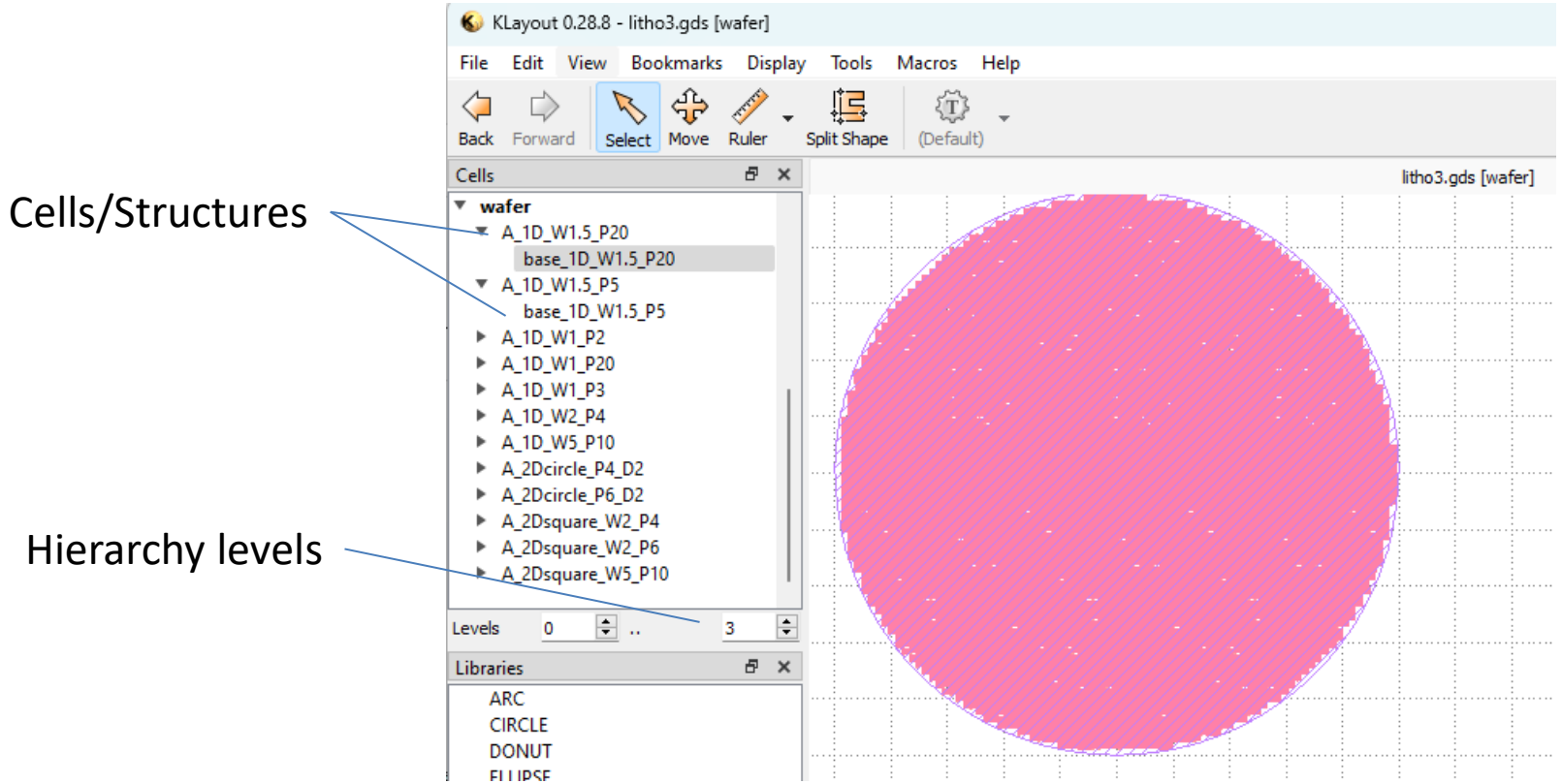
Klayout



GDS, DXF
opensource

Gds file type

- Memory efficient



Gds file type

- Objects available – polygons and paths (NO CIRCLES)
- 8191 points per object
  - Practical limit 600-1000 points
- EBL specific objects
  - Curved elements
  - Single pixel lines
  - Single pixel dots

Objects/Shapes are defined differently in each type

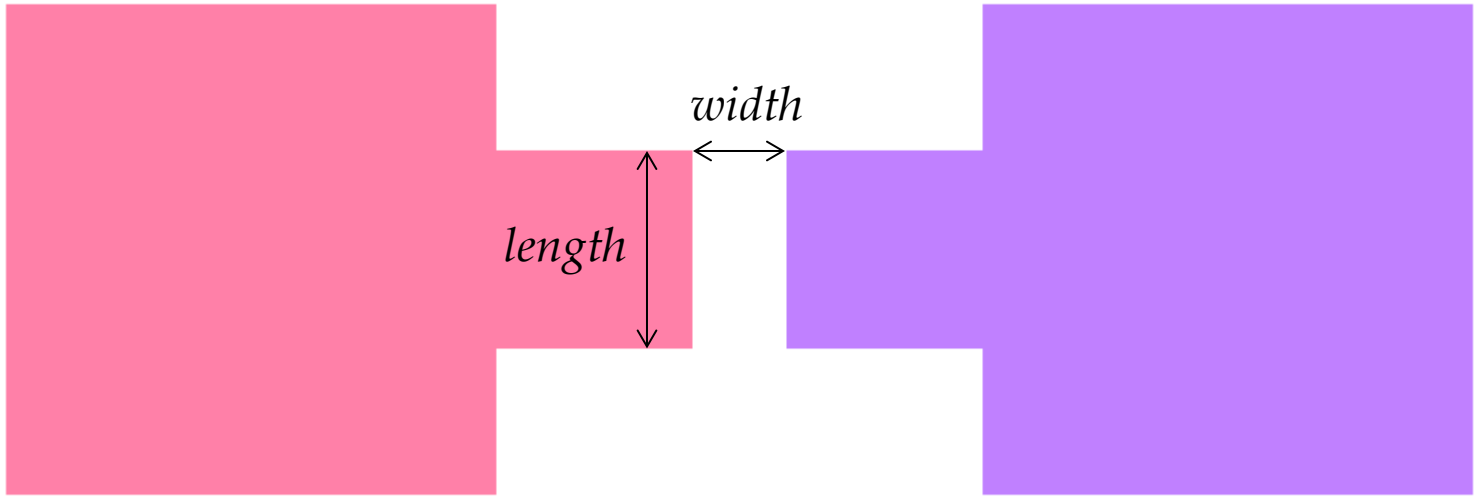
GDS	DXF
Polygon	Polyline
Path	n.a.
n.a.	Circles
RaithCircles	n.a.
FBMS paths	n.a.

Available script libraries in GitHub

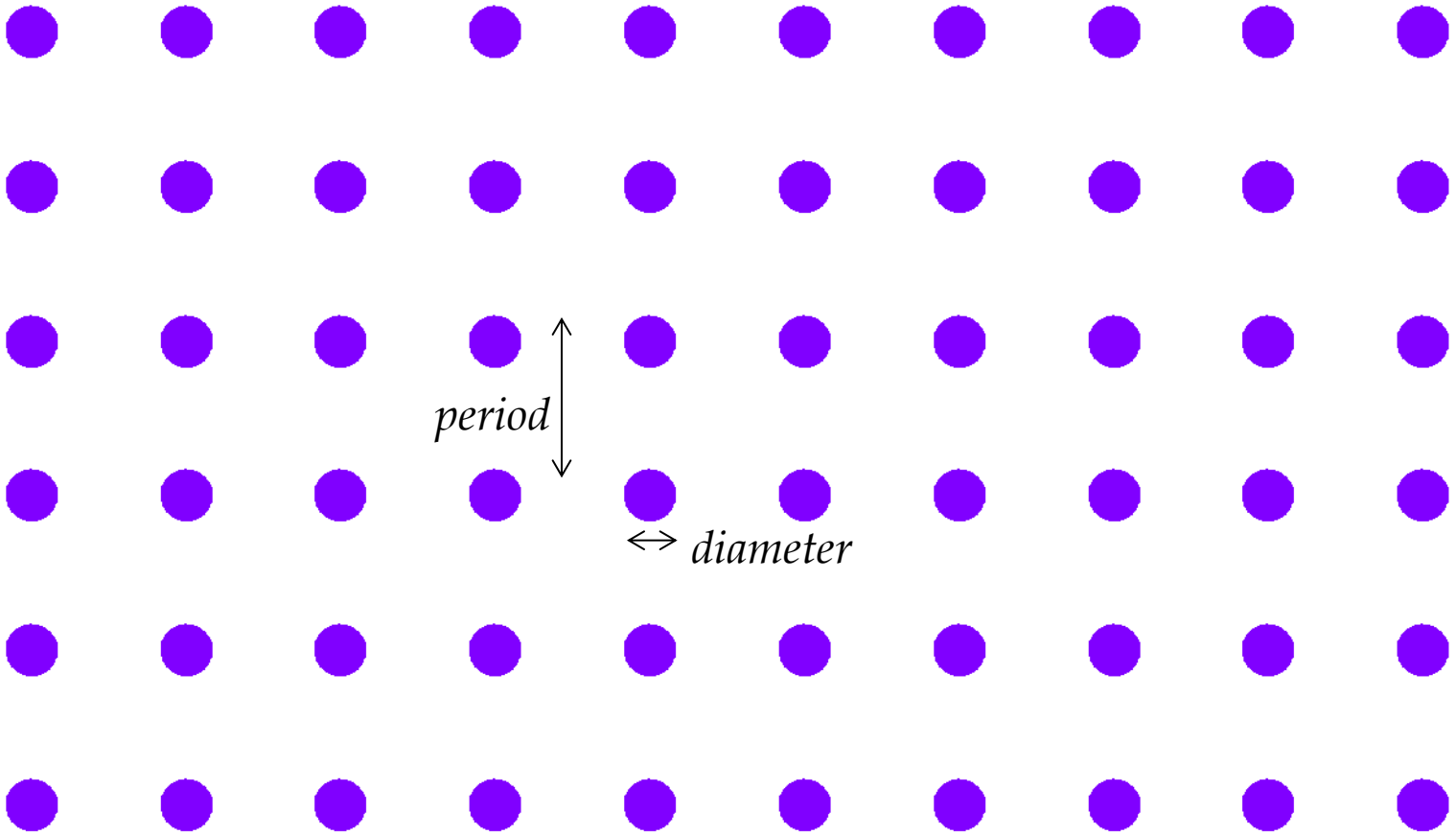
- **gdstk** – python library for handling standard GDS files
- **python-gdsii-raith** – adds support for Raith EBL specific shapes
- **Raith_GDSII** – Matlab library for Raith EBL
- **Gdsfactory** – python library capable of autorouting

- **ezdxf** - python library for handling DXF files

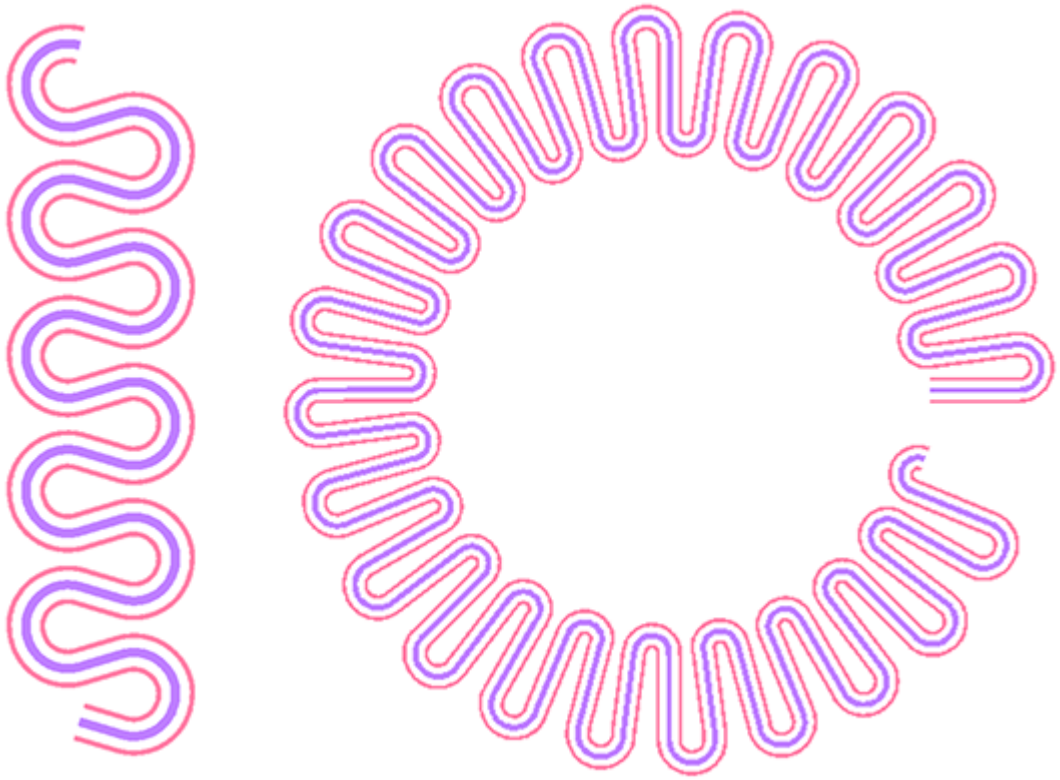
Example 1 – Parametric Device



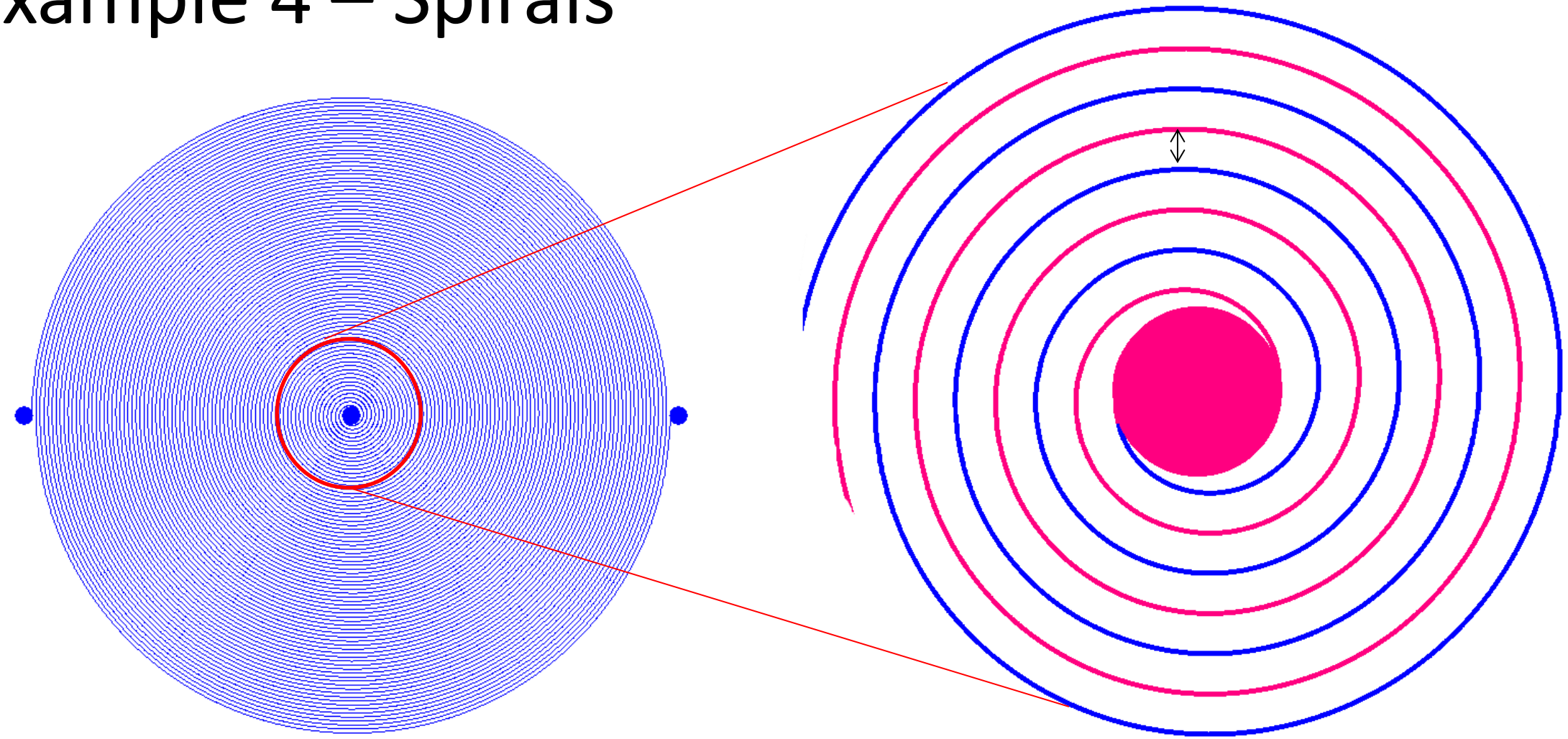
Example 2 – Hierarchical array



Example 3 – Serpentines



Example 4 – Spirals



Contact Us

NUFAB
NORTHWESTERN UNIVERSITY
MICRO/NANO FABRICATION FACILITY

100 µm

nathan@northwestern.edu

butun@northwestern.edu