

DTU





DTU Nanolab

# Techforum 2019 #3

# Agenda

- Prices
- SEM intro
- Decommissioning
- Facility update
- New Equipment
- Labspace 307

# General News

- Two new centers of excellence
- Cleanroom filled up – subfab

# PRICE CHANGES

# Prices for 2020 – Pending auditor approval



Service from Nanolab	Unit	Commercial activity	External project work, Danish academia	DTU Partner with budget in external projects	Internal DTU projects
Cleanroom access (below cap)	Kr/hour	850	?+44% OH	?	0
Category A tools	Kr/hour	400	?+44% OH	?	0
Category B tools	Kr/hour	650	?+44% OH	?	0
Category C tools	Kr/hour	3700	?+44% OH	?	0
Category D tools	Kr/hour	1250	?+44% OH	?	0
Category E tools	Kr/hour	1750	?+44% OH	?	0
Category P tools	Kr/hour	400	?+44% OH	?	0
Nanolab assistance	Kr/hour	1400	?+44% OH	?	0
Area rent	Kr/m <sup>2</sup> /month	2100	NA	NA	NA
Materials		At cost+20%	At cost+44% OH	At cost	At cost



# Prices for 2019

Service from Nanolab	Unit	Commercial activity	External project work, Danish academia	DTU Partner with budget in external projects	Internal DTU projects
Cleanroom access (below cap)	Kr/hour	800	255+44% OH	255	0
Category A tools	Kr/hour	410	125+44% OH	125	0
Category B tools	Kr/hour	650	330+44% OH	330	0
Category C tools	Kr/hour	3600	840+44% OH	840	0
Category D tools	Kr/hour	1200	240+44% OH	240	0
Category E tools	Kr/hour	1700	415+44% OH	415	0
Category P tools	Kr/hour	410	0	0	0
Nanolab assistance	Kr/hour	1350	330 + 44% OH	330	0
Area rent	Kr/m <sup>2</sup> /month	2000	NA	NA	NA
Materials		At cost+20%	At cost+44% OH	At cost	At cost

# Price change 2020 – Pending auditor approval



Service from Nanolab	Unit	Commercial activity	External project work, Danish academia	DTU Partner with budget in external projects	Internal DTU projects
Cleanroom access (below cap)	Kr/hour	50	?+44% OH	?	0
Category A tools	Kr/hour	-10	?+44% OH	?	0
Category B tools	Kr/hour	0	?+44% OH	?	0
Category C tools	Kr/hour	100	?+44% OH	?	0
Category D tools	Kr/hour	50	?+44% OH	?	0
Category E tools	Kr/hour	50	?+44% OH	?	0
Category P tools	Kr/hour	-10	?+44% OH	?	0
Nanolab assistance	Kr/hour	50	?+44% OH	?	0
Area rent	Kr/m <sup>2</sup> /month	100	NA	NA	NA
Materials		At cost+20%	At cost+44% OH	At cost	At cost



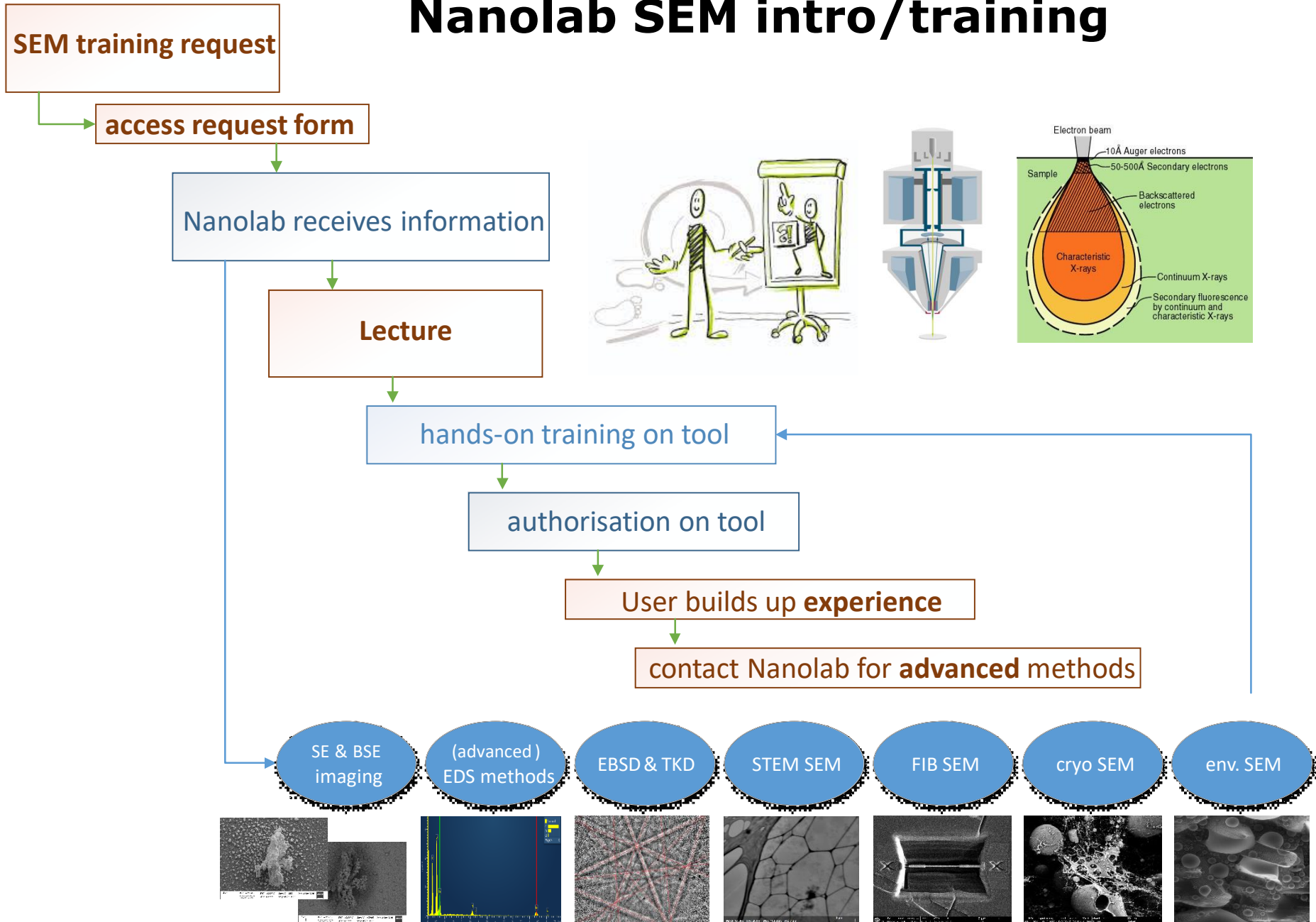
# Materials 2020 – pending auditor approval

Precious metal costs	Price 2019	Price 2020	Change	Details
Gold	3.2	3.3	+0.1	kr/nm
Platinum	3.5	2.8	-0.7	kr/nm
Palladium	1.5	1.0	-0.5	kr/nm

Photoresists	Value 2019	Value 2020	Change	Details
DUV42S-6	3.8			kr/g
KRF M35G	2.4			kr/g
KRF M230Y	2.5			kr/g

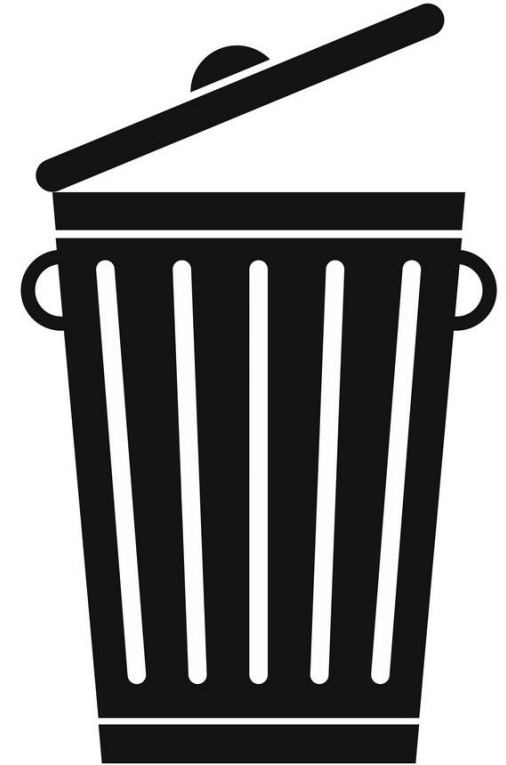
ALD sources	Value 2019	Value 2020	Change	Details
TMA	3.4	3.4	0	kr/s
DEZ	14.2	14.2	0	kr/s
TiCl	1.0	1.0	0	kr/s

# Nanolab SEM intro/training



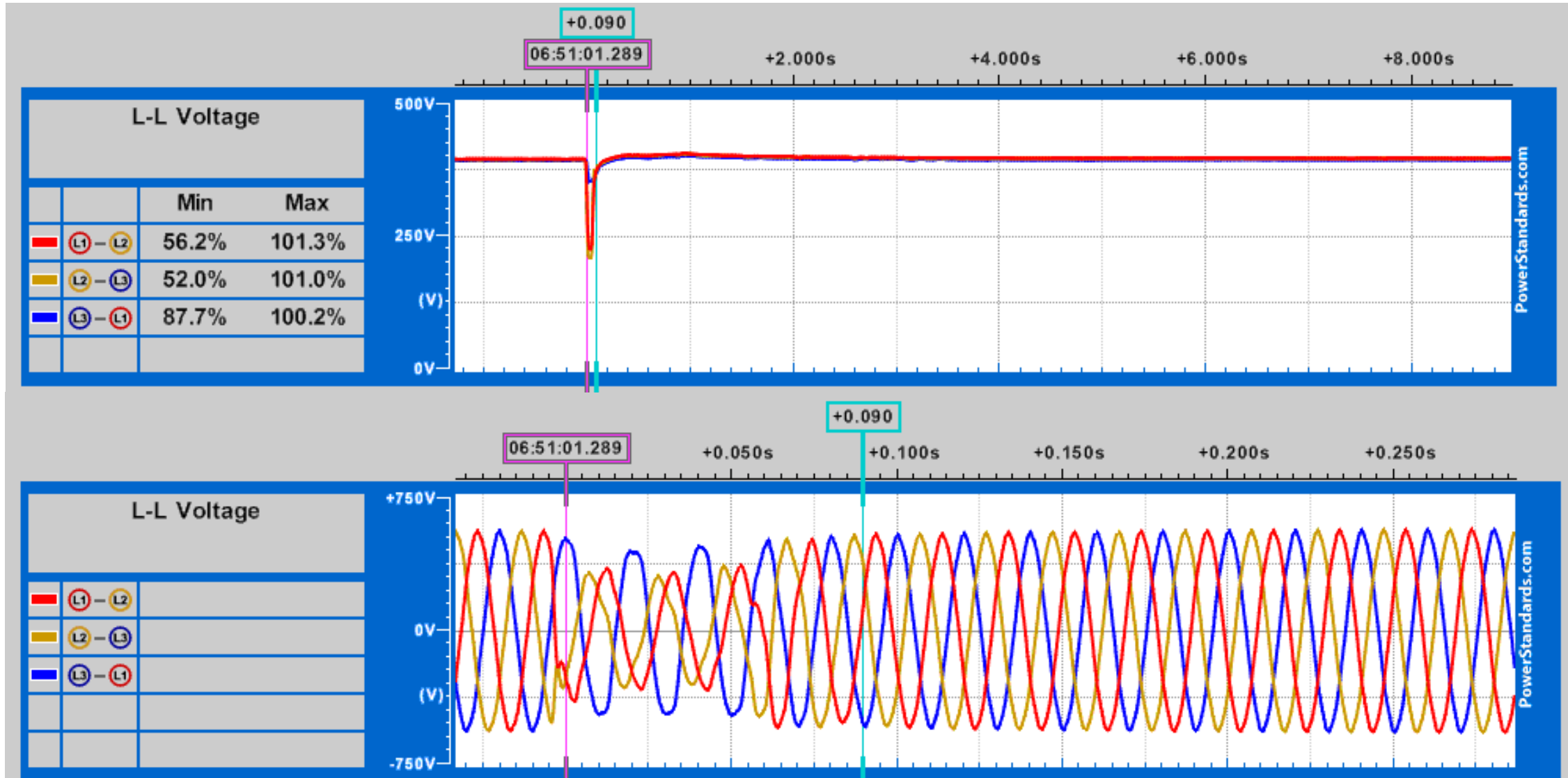
# Equipment for decommissioning soon

- Noble Furnace
- Jipelec RTP (Jørgen Schou, DTU Fotonik)
- III-V Dielectric Evaporator (Jørgen Schou, DTU Fotonik)
- Black Magic (will go to B310)
- Developer 6 Inch (make room for new MLA 150)
- Old semi-automatic scribe in Cx1



# FACILITY

# Power dips - 1



# Power dips - 2

- Small dips often damage equipment: Long down time
- Sometimes the soft evacuation is also triggered – CAS is not notified
- Short-term solution: Most mission critical equipment on local UPS
  - Safety systems
  - E-beam
  - Stepper
  - XRD (being investigated)
- Case study with CAS: All equipment protected
  - 2 x Giant UPS (2 x 35 m<sup>2</sup> needed)
  - Sag ride through system (UPS-like)
  - Flywheel (new building needed)
  - *Very expensive (> 10 mill. DKK)*



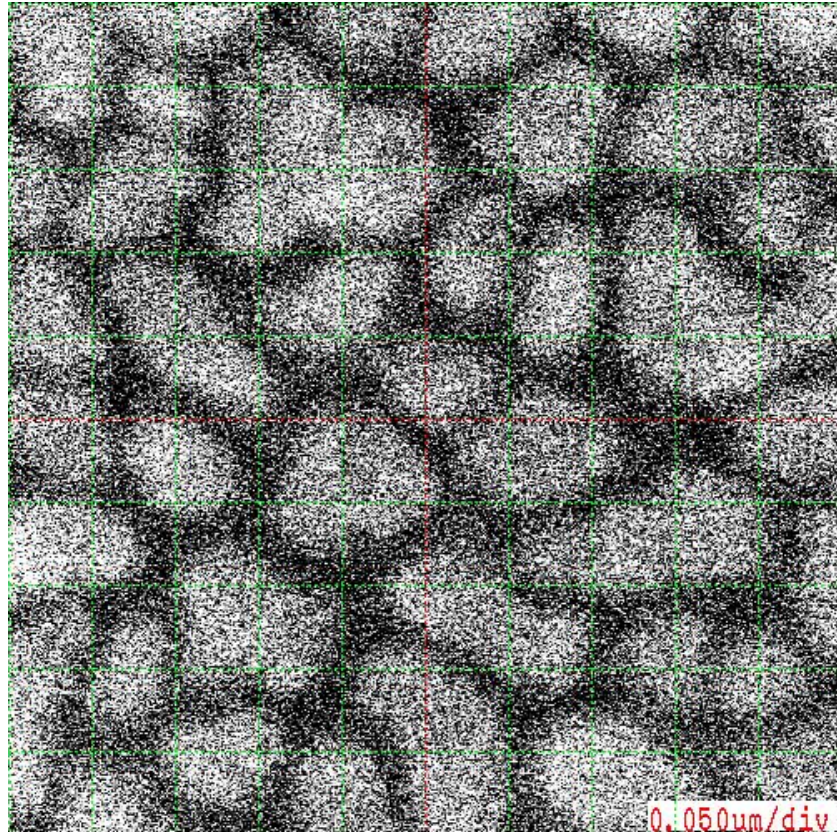
# Ozone treatment of air handling units – week 43

- Both air inlets for sections D & E ozone treated
- Software changes to improve temperature stability
- General service on ventilation equipment (new fan belts, bearing checks)
- We don't know if ozone has helped
- Need to wait for humidifier turning off (dry to moist weather & not too cold)

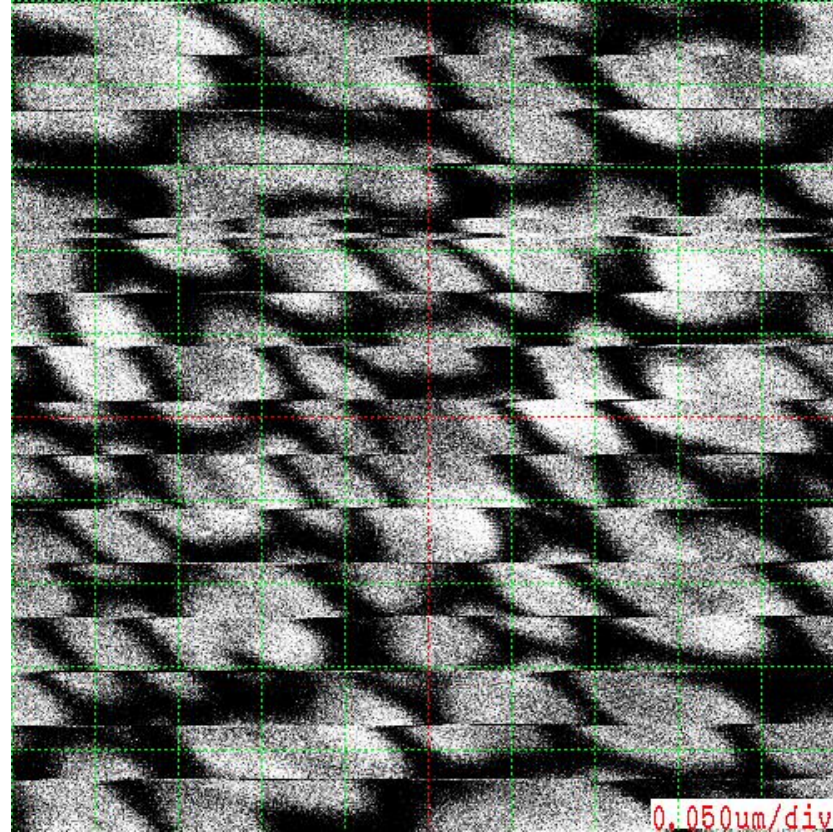


# LIGHT RAIL

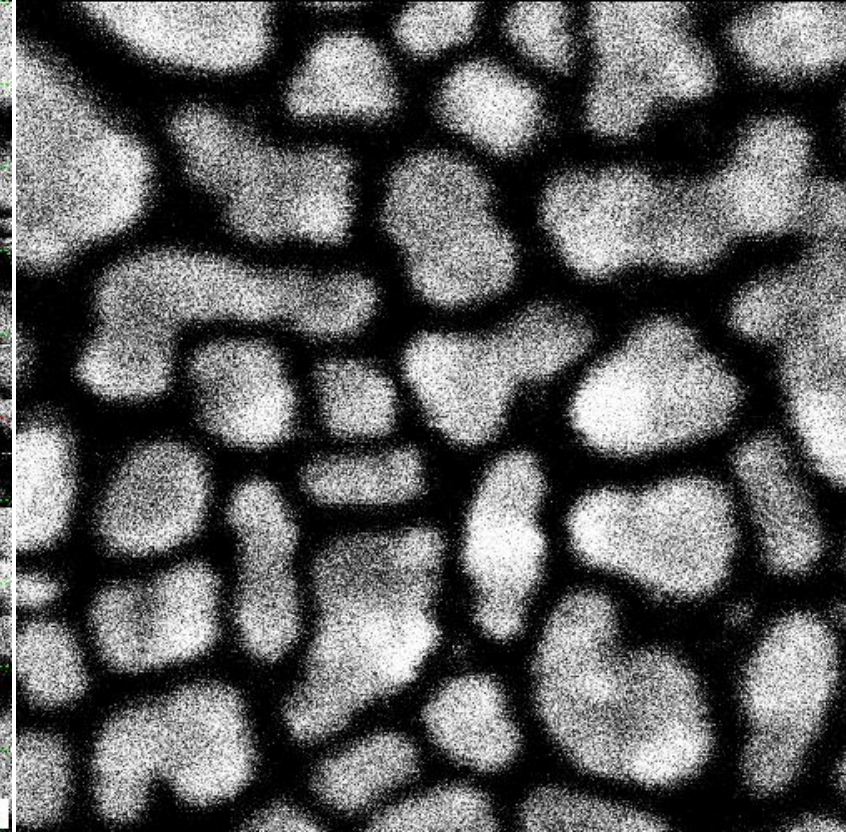




No applied field  
Field cancellation off



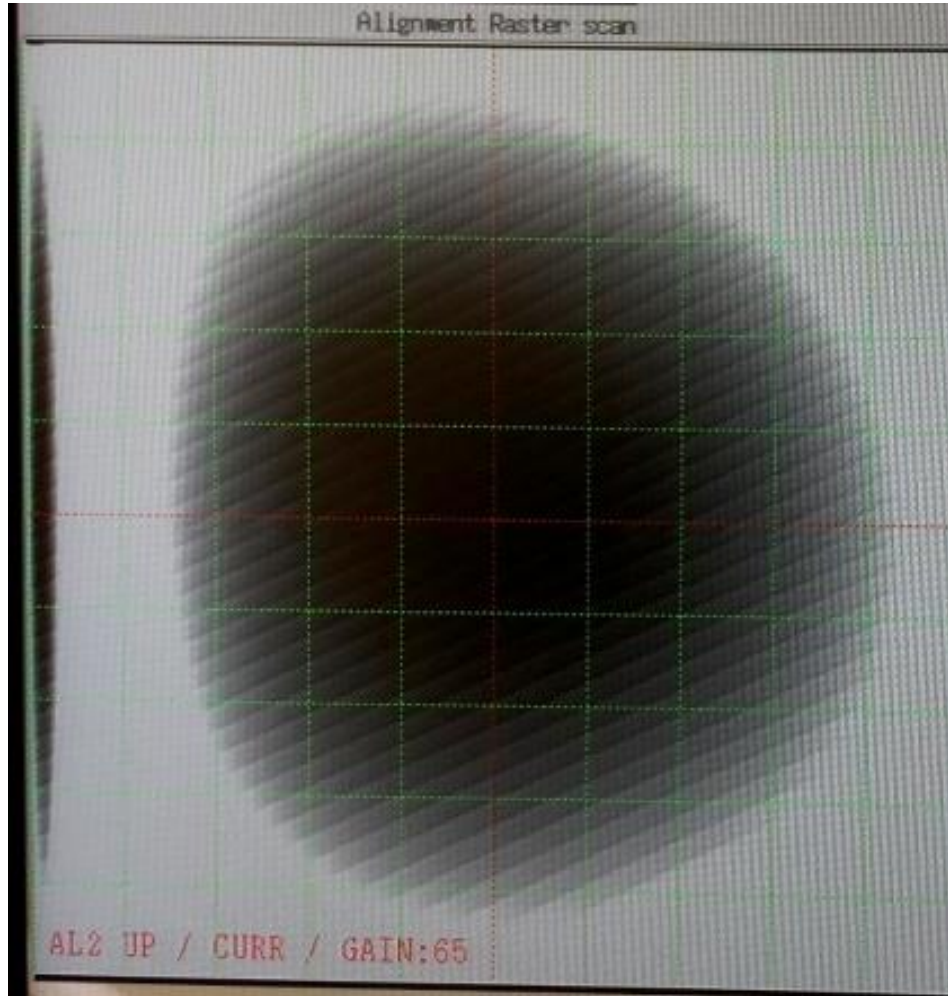
Applied field > 1200 nT p-p  
Field cancellation off



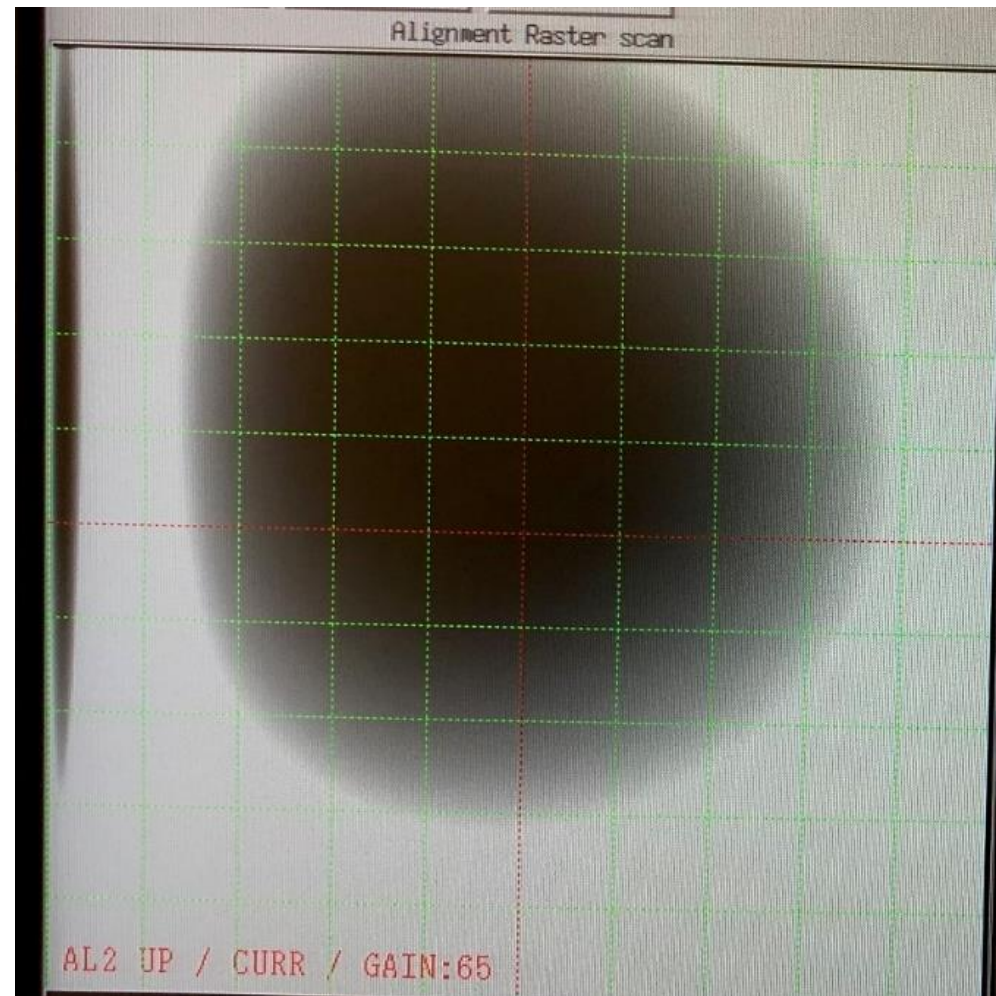
Applied field > 1200 nT p-p  
Field cancellation on



# Beam alignment after pattern distortion – no tram field!



Cancelling system on -  
interference



Cancelling system off – no  
interference

# Light rail - summary so far

- Field cancelling works, BUT:
- Sometimes oscillates – even without tram field!
- Supplier has not given clear bug fix
- Simulated field: 1200 nT (Rambøll & Siemens)
- Evaluating other cancelling systems
- DTU CAS talking to Light Rail company
- Light rail design now very far without clear solution
- ***This may not end well...***





# FFU update

- 3-4 various FFU solutions evaluated
- Air flow and sound measurement tools purchased
- Waiting for a supplier's interface cable
- 6 months notice before shutdown



# NEW EQUIPMENT

## Heidelberg MLA #003

- Chips, 2, 4, 6 inch – no 8 Inch
- Only 405 nm – no 375 nm
- Only pneumatic focus – no optical focus
- 1.0  $\mu\text{m}$  lines in 0.5  $\mu\text{m}$  resist
- BSA ca. +/- 1  $\mu\text{m}$
- 4" wafer: ca. 10 min
- A fast (but less accurate) supplement to the other MLA 150 (and the MLA 100)
- Not suitable for nLOF and SU-8



# Increased capacity for stepper resist and developer

- Upgrade 1 liter resist canisters to 3.8 litres (1 gallon)
  - New canisters
  - New chemical cabinet
  - All-Süss solution
  - Will be ordered soon
  - Ready 2020
- Upgrade TMAH tanks to autofill
  - Only autofill system from Süss
  - 200 litre TMAH supply station needs design
  - Being considered





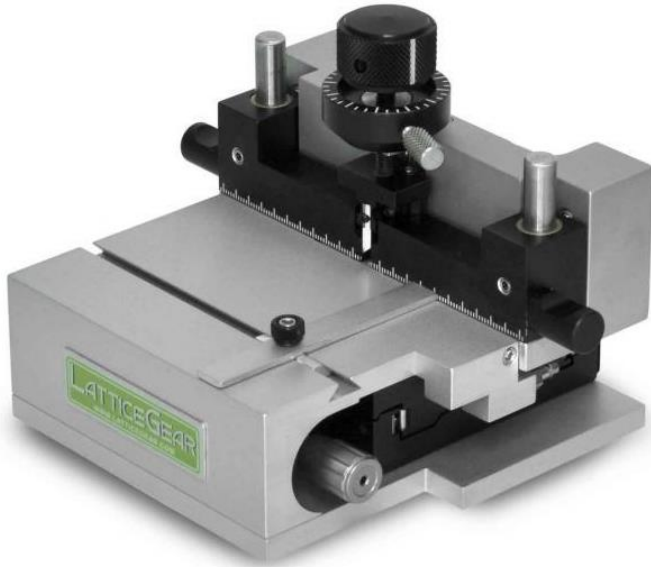
## HF vapour phase etch

- Isotropic oxide etch
- Aluminium as mask
- Tool has arrived
- Remaining supplies
  - HF bottle (lead time from AGA)
  - Scrubber unit
  - Fluorine gas sensors
- Expected ready Q2 2020





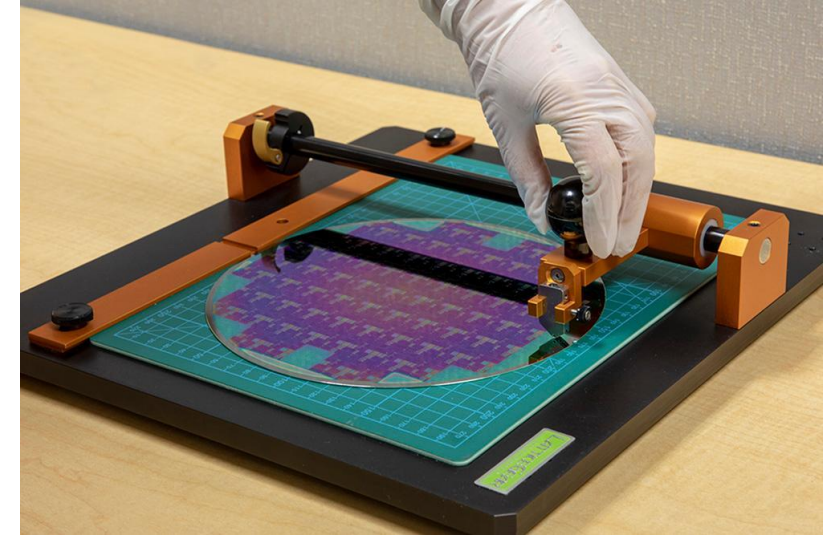
# Cleaving accessories



**Lattice Axe 120**



**Flip Scribe 100**



**Flex Scribe**

- Location: Fume hood 05: Special purpose & nanoparticles
- Expected ready: Q1 2020

# Cluster-Sputter system from Lesker



## Robotic cluster tool including new functionalities:

- **2 x PVD75** sputter systems
- **Separation:** Metal oxides / Metal nitrides
- **Module A:** 6 x 3" magnetrons, DC/RF/pulsed DC/HiPIMS
- **Module B:** 1 x 4" + 2 x 3" magnetrons: DC/RF/pulsed DC/HiPIMS
- Distribution chamber (Genmark robot)
- Cassette station (10 wafer cassette)

## Status:

**expected SAT: Ultimo January 2020**

# PVD-200 ProLine Sputter Lesker system (preowned)



## Stand alone sputter system:

- First installation: Primo 2018
- 4 x 4" magnetrons, DC/RF/pulsed DC
- Setup for ITO & Ni deposition
- Setup done by Lesker-US (Pittsburgh)

## Status:

**Installation in 2020**



## XPS-2: Tender on-going

### Specs (minimum requirements):

Measuring techniques: XPS, UPS, REELS (MR)

Highly automatic, user friendly, high throughput

**Expected signed contract: Ultimo November 2019**

**Thermofisher Nexsa**



**Kratos Axis Supra**



**Phi Versaprobe III**





**NEW**

## Standard RTP system Jipelec JetFirst 200C (ECM)

### Jipelec JetFirst 200C (ECM)

#### Purpose/specs:

Replacing current Jipelec system

- Cold-wall system (water cooled stainless steel)
- Temp range: ambient to 1000 C (1200 C for 1 min)
- Temperature control: TC & Pyrometer
- 3 gas lines (MFCs) + purge line
- Dry pump (nXDS6i scroll)



**NEW**

## Powder XRD outside cleanroom

### “Mini Tender” on-going (deadline today)

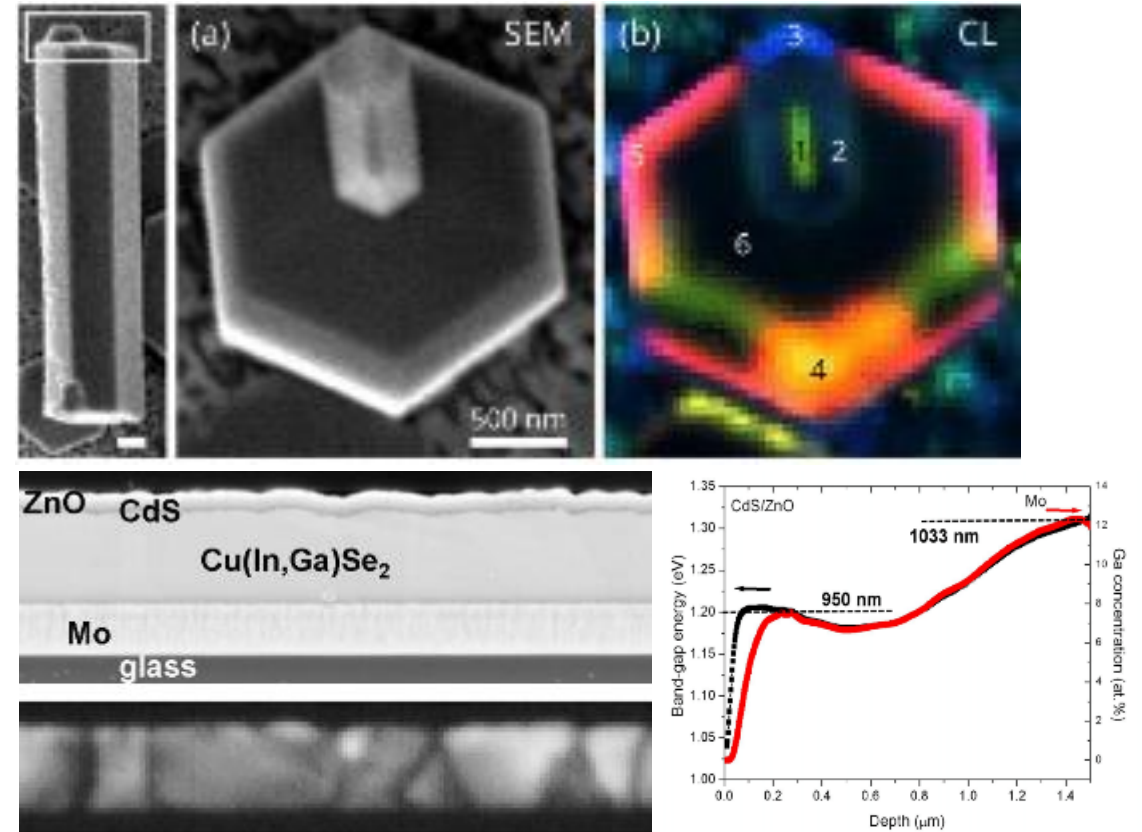
Two relevant systems identified (maybe more out there)

- Dedicated for **powder analysis** – complement thin film tool in cleanroom
- **Crystal structure analysis**: phase identification, crystallinity, piezoelectricity, mechanical strength, conductivity,...
- **Easy to use** – almost “plug & play”



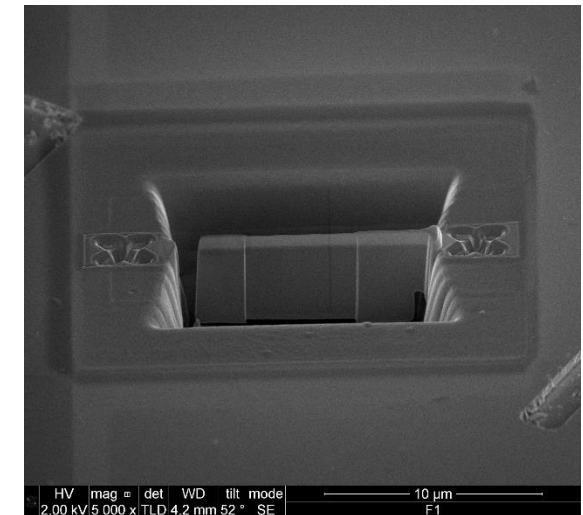
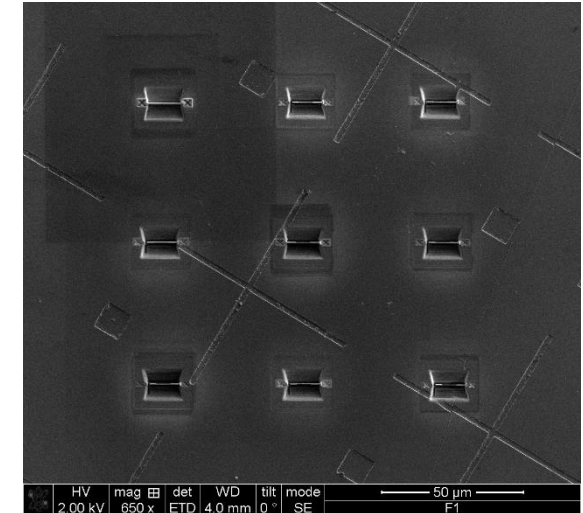
# Delmic Cathodeluminescence

- We have purchased a used Delmic CL system from Solvoltaics
- You ask what is a CL system? That question, it seems, is infinite in the possible answers
- **Cathodoluminescence** is an optical and electromagnetic phenomenon in which electrons impacting on a luminescent material such as a phosphor, cause the emission of photons which may have wavelengths in the visible spectrum
- Discussions are now underway with Delmic to work out where and how to install this system on our current SEMs.



# FIB Lamella App "Auto TEM"

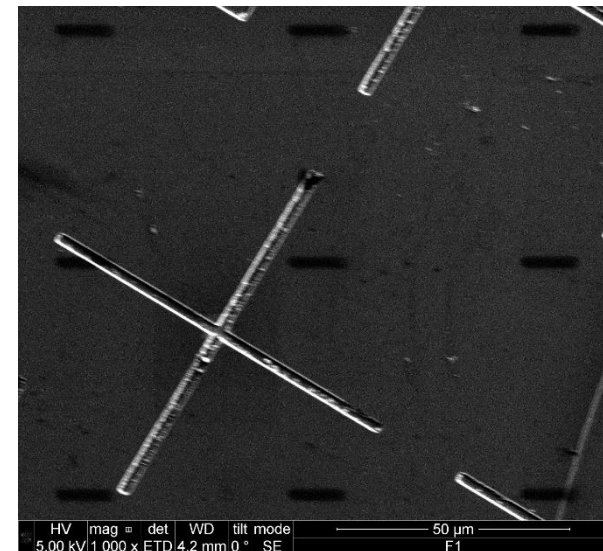
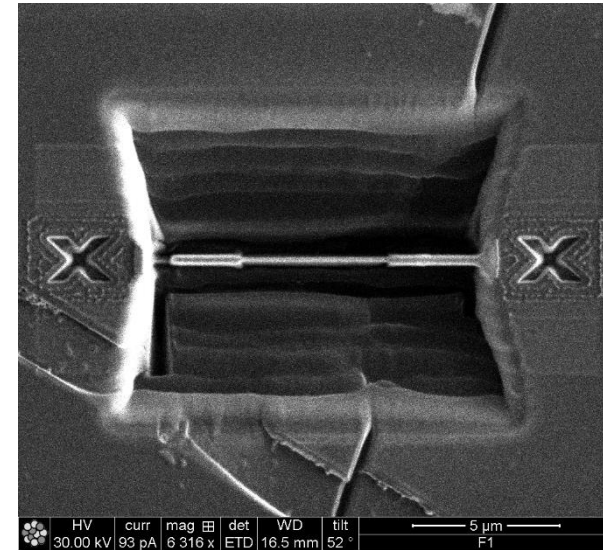
- We have always had this software but no one has bothered to understand how to use it
- We expect with the arrival of DTU Energy that there will be a higher demand on our systems starting with the Helios
- The advantages of this type of software are :-
  - Speed
  - Consistency
  - Multiple samples, positions and recipes can be run in the one process
- Users will be able to set their samples up to run automatically and produce a set of pre-thinned lamellae
- If there is a failure, the system can be adjusted and continue with the aborted results





# Auto TEM

- There is no E Beam deposition built into the software. So we are going to write our own script☺
- In the process of writing an SOP (Standard Operating Procedure) to compliment the sparse instruction manual
- It has been tested on a user sample and we are waiting for the results





## New FIB System

- With workload on our current Helios expected to increase we, have decided to investigate what the new systems today offer and how they could fit into our needs
- Key Features we are looking at are :-
  - Automisation resulting in higher throughput and consistency in :-
    - TEM lamella liftout with Pick and Place
    - Auto Atom and Nano-probe
  - Machine learning
  - Auto alignments CRITICAL
  - Extreme resolution for the Electron beam at lowest possible kV



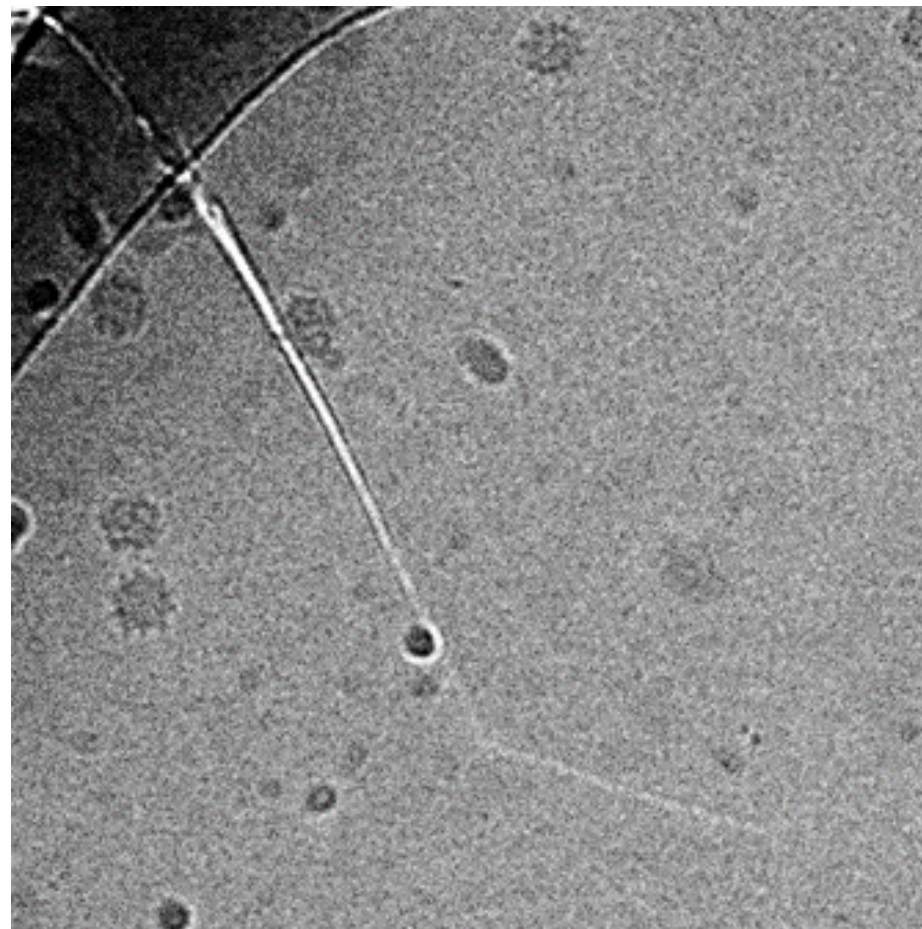
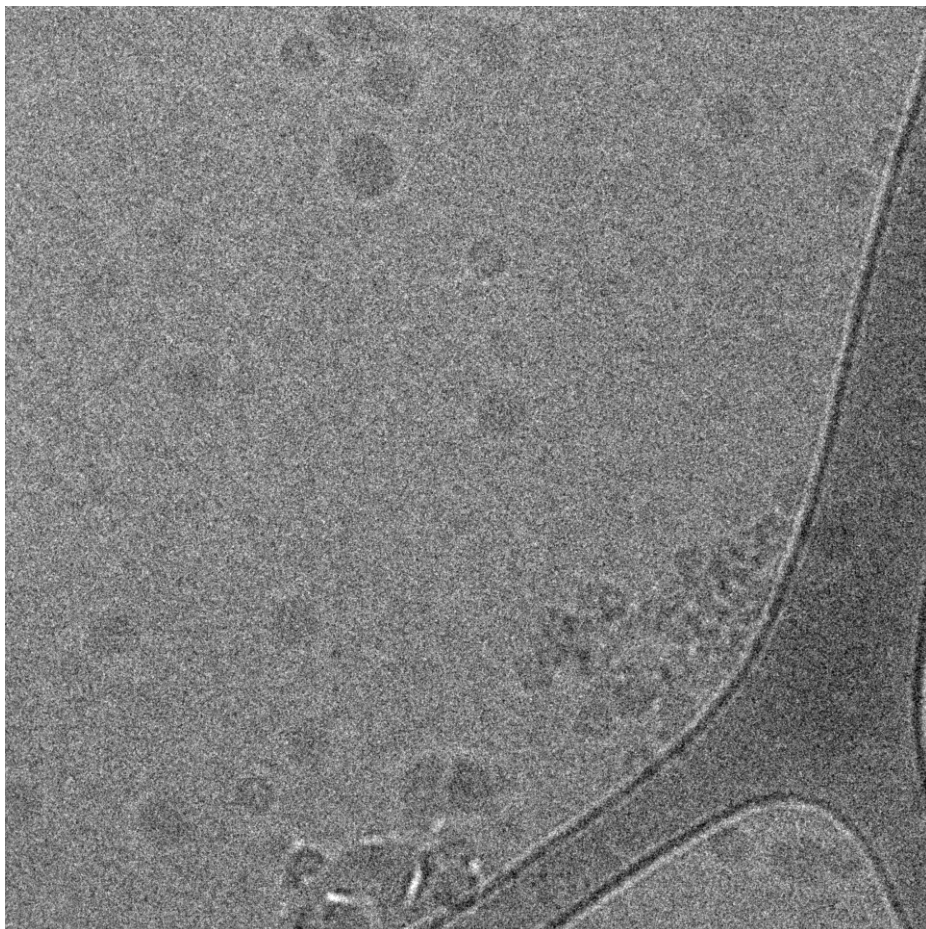
## Tecnai T20 Camera

- We are finished with the evaluation of the new camera for the Tecnai T20 which is our primary TEM for Cryo TEM.
- The cameras evaluated the TVIPS and the One View deliver comparable results
- Now there is a mini-tender as price is the determining factor.
- If you are wondering, what's the difference, here is a reference taken with our old US1000 and the same type of sample with one of the new cameras being evaluated



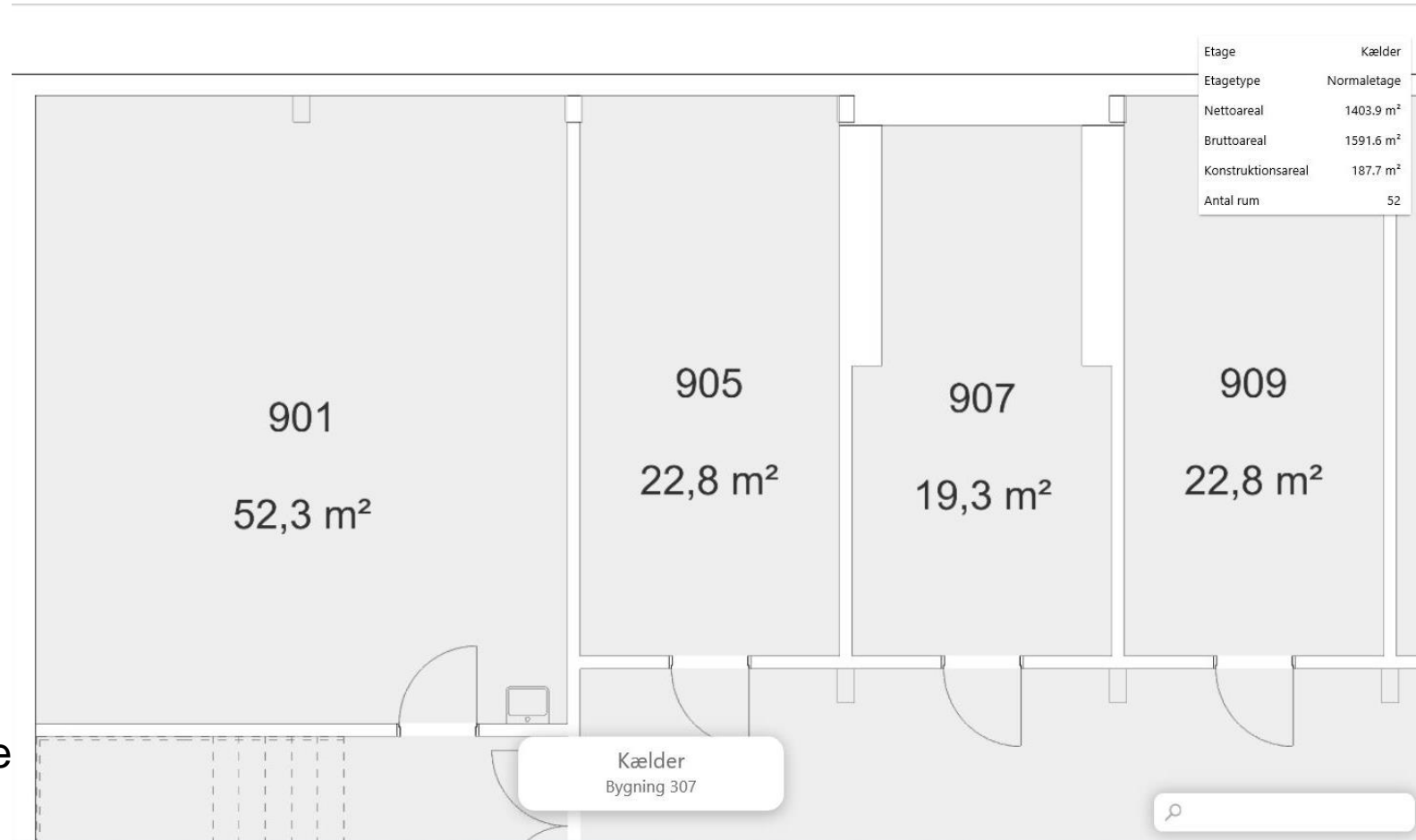


# Tecnai T20 Camera



# B307 Soft Matter Lab

- We are in the process of building a lab in B307 to house a Soft Matter lab for
  - sample preparation
  - Cryo SEM and TEM
  - Possibly Cell/Bacteria Growth
  - Key requirements include :
    - Temperature stability
    - Humidity stability
    - Vibration free
    - Field stability to house a TEM with an EELS detector
- Lab area >100m<sup>2</sup> (901,905,907)
- Technical Room needs to be in 909 due to ventilation access



# E. O. P.

## Comments and Suggestions