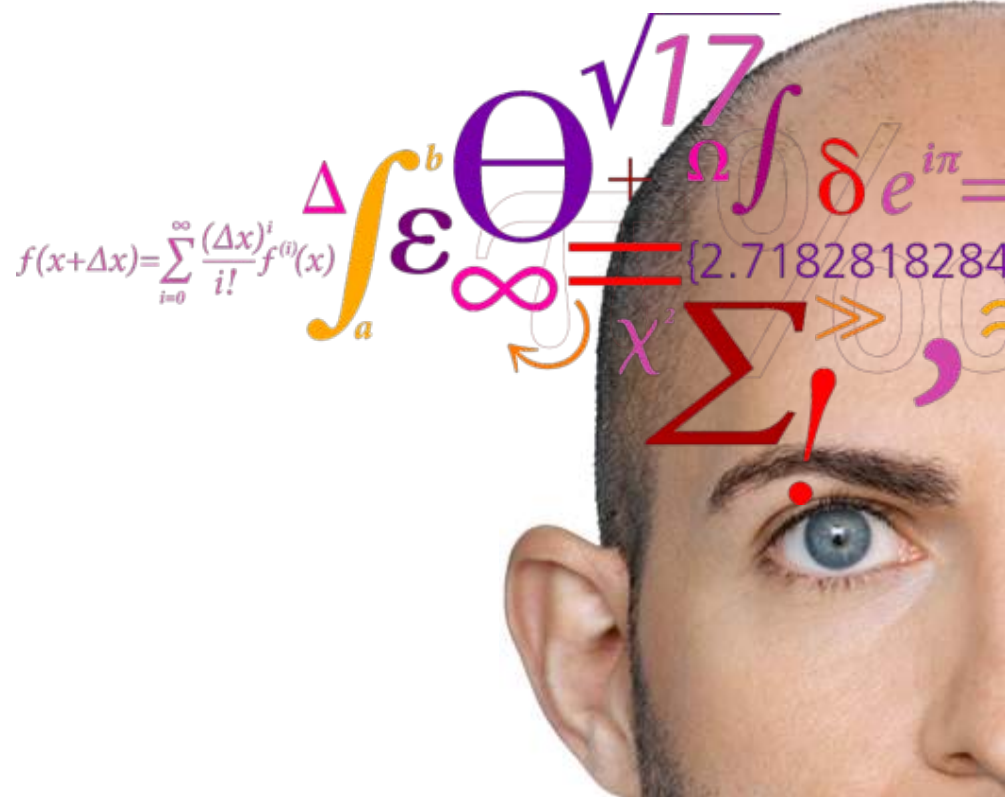


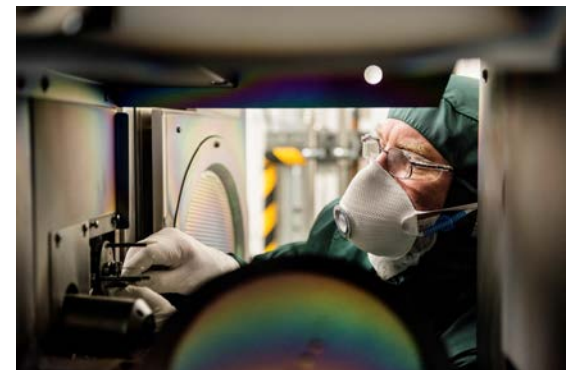
Technology Forum 1 2014

March 11th 2014



tech forum

**Intensify dialog especially
on a strategic level
between Danchip/Cen
and Danchip/Cen users**



DTU Cen – 7 Complementary Microscopes

- Titan ETEM 300 kV, environmental cell, monochromated, image corrected, HR imaging
- Titan ATEM, 300 kV, analytical TEM, monochromated, probe corrected, EELS, EDS, Holography
- Tecnai TEM, workhorse, 200 kV, EDS, EELS
- Helios Nanolab, dual beam SEM, FIB milling, EBSD, EDS, HR imaging
- Quanta FEG SEM, cryo, EDS, imaging
- Quanta 3D, dual beam, general FIB milling
- Inspect S, training SEM, EDS, WDS

DTU Cen operational changes and updates

- Quanta 3D dual beam to Building 307, room 111
- Nova SEM to building 314 (will occupy room vacated by Q3D).
Microscope will be dedicated to EBSD research
- Soft matter prep lab (locked down) to be established in building 314
- Review of access to centre's microscopes (later this month)
- Charging model under review

Planned Purchase #1

Digiscan (for the Titan ATEM)

bypasses FEI proprietary system software (TIA) and takes control of the scan coils in STEM mode.

Acquisition of EELS and EDS maps much faster due to lower dwell times compared to TIA.

Acquisition of multiple maps of the same region continuously and summing them is possible. This decreases the possibility of sample damage and drift while giving rise to high quality signal maps.

Added benefit is being able to utilise full 64 bit capabilities of the EDS software



Planned Purchase #2

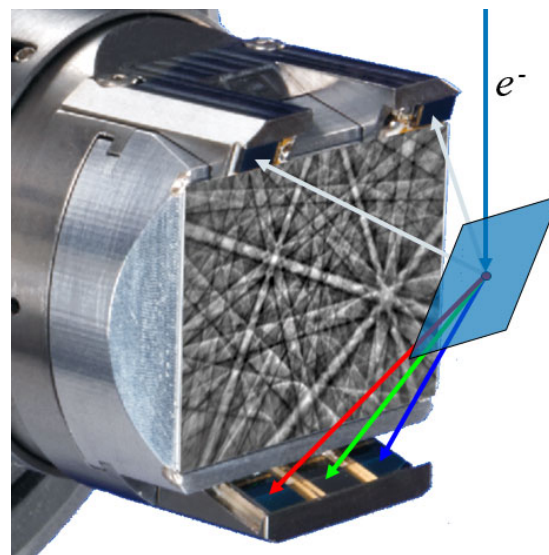
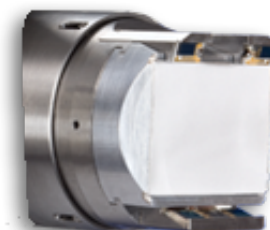
In-situ vertically adjustable e-Flash EBSD detector and EDS System (for Nova SEM).

Fast acquisition with 630 patterns/s (4x4 binning) or 930 patterns/s (8x8 binning) using the e-Flash¹⁰⁰⁰ detector

It supports measurements at low acceleration voltages (down to 5 kV) and low beam currents (down to 0.1 nA).

Fully software controlled detector with all electronics integrated

Simultaneous EBSD and EDS acquisition at up to 930 patterns/s, supported by in-situ tilt feature to optimally position both detectors



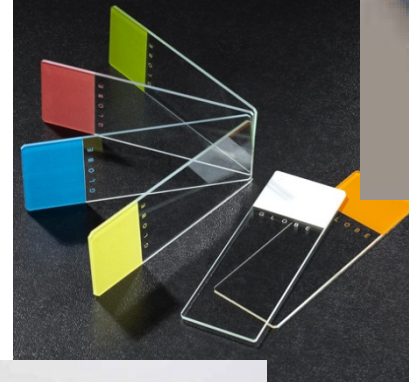
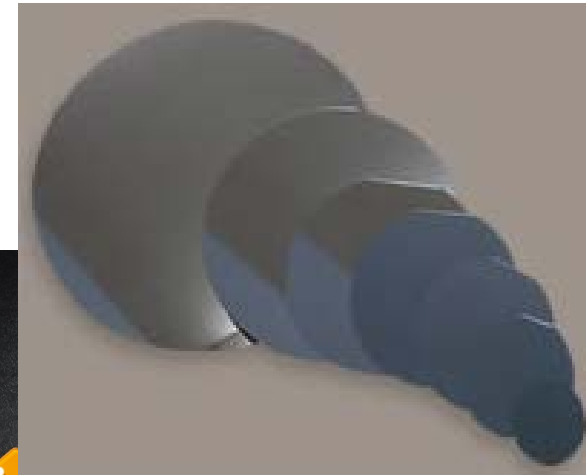
Trend over the last couple of years

Flexible processing

- Tool activity changes dramatically from quarter to quarter
- Processes turn exotic fast
- Fumehood processing on the rise



More sample types



Cleanroom will be reorganized

Why ?

- infrastructure supplies and utilities (economical reasons)
- flexibility activities on certain activities grow and shrink fast (dependant on external funding)
- demand for exotic processes and weird substrate size

Cleanroom will be reorganized guiding principles:

- fumehood processing ensures flexibility
- other substrate sizes than 100 mm round
- no ghettos
- possibility for exotic processes

Disclaimer

- Danchip will create more possibilities for exotic processes
 - we will not participate actively in development of exotic processes (e.g. gray scale lithography, etc)
 - we will not offer a standard recipe on exotic processes
 - we will merely guarantee the basic functionality of a tool

Cleanroom will be reorganized when and how:

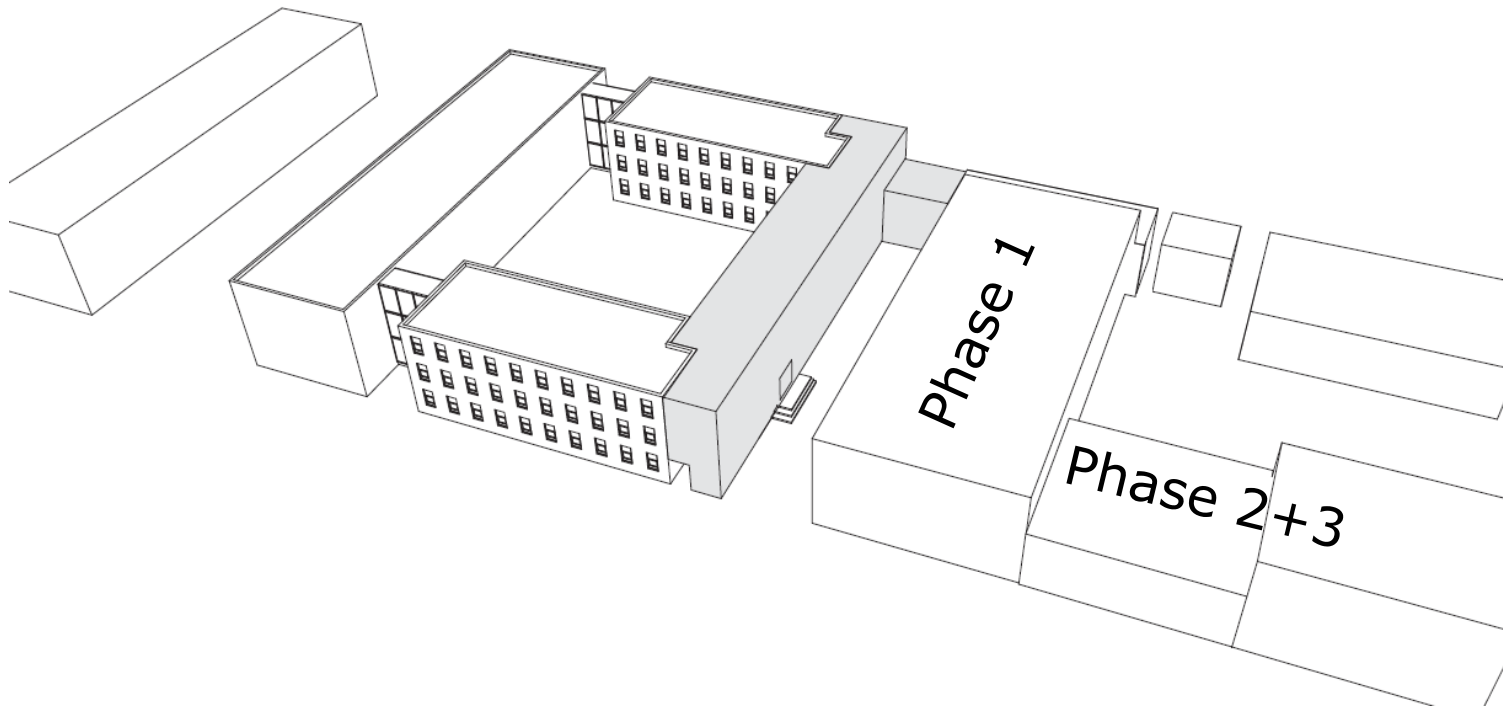
- Photolithography will expand to old E-beam room (april/may)
- Imprio will be moved out (ultimo march)
- ballroom will undergo major rearrangement (requires closing – construction phase of 345C)
- characterization finger has to be partly cleared –possible new industrial tenant (april)

Tools scheduled for decommissioning

Tool	Reason for decom.	Decom.
PECVD1	End of life. Old tool ~20 years Hard to repair, hard to (11 users, 117 runs for 53 hours) PECVD2: (10 users, 117 runs for 53 hours) PECVD3: (21 users, 132 runs for 237 hours)	2013Q3
RIE1	End of life. Old tool ~20 years Hard to repair, hard to Tool will not come online again Processes transfer to AOE, Metal ICP in progress. AOE: (258 runs for 336 hours) ICP Metal: (300 runs for 199 hours)	2014Q1

Construction work

- New building: 345C
- Construction start: 28 July 2014
- Pilars will be drilled – not hammered
- However: Noise, dust and vibrations should be expected.

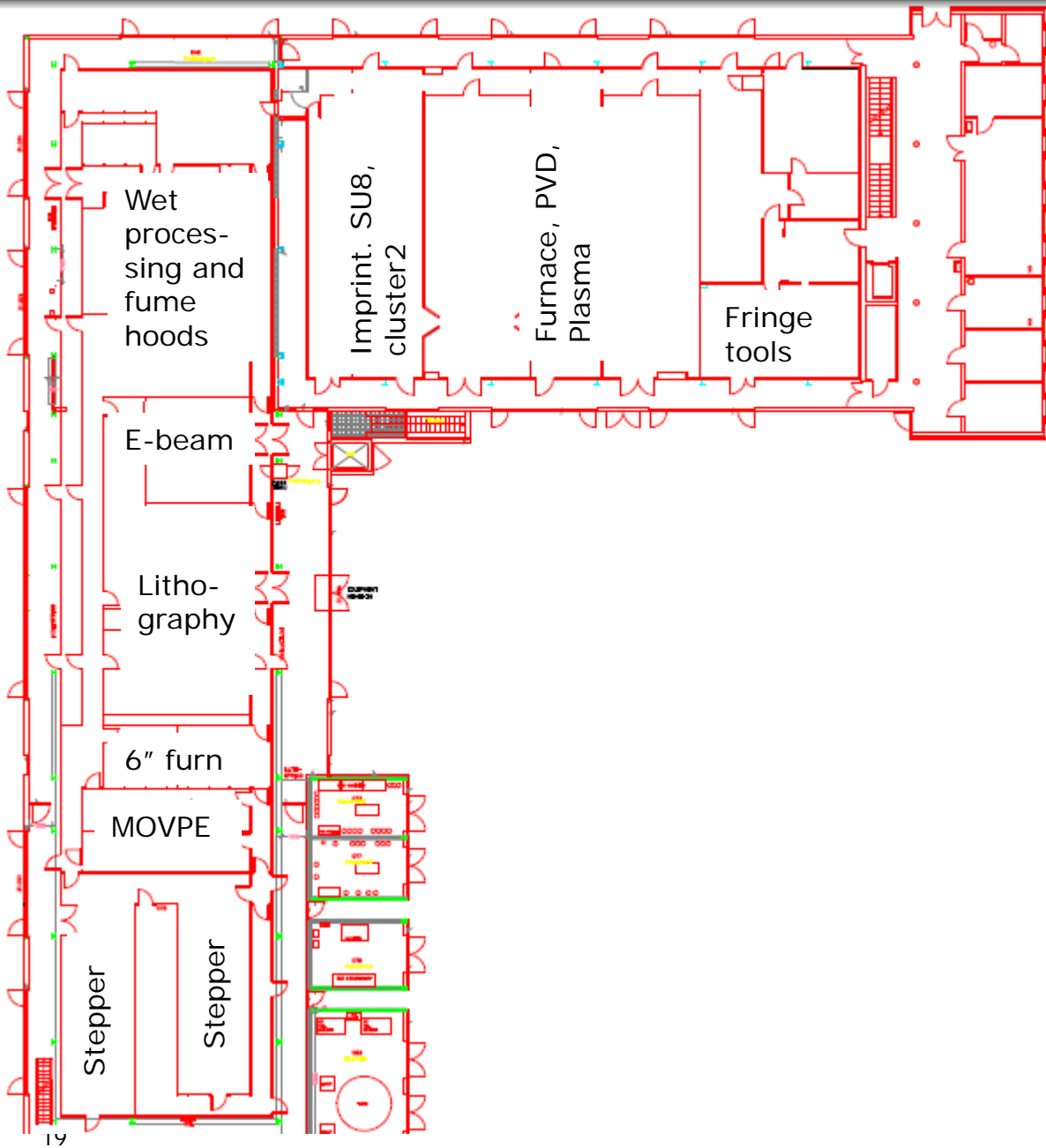


Construction work

- 28-Jul-2014 til 08-Sep-2014: Old main entrance between B345 and B346 being pulled down.
- 11-Aug-2014 til 22-Aug-2014: Excavation for foundation
- 20-Aug-2014 til 02-Sep-2014: Drilling and casting of pillars
- 01-Sep-2014 til 26-Sep-2014: Casting of foundation
- 22-Sep-2014 til 31-Jul-2015: "Other building activities"

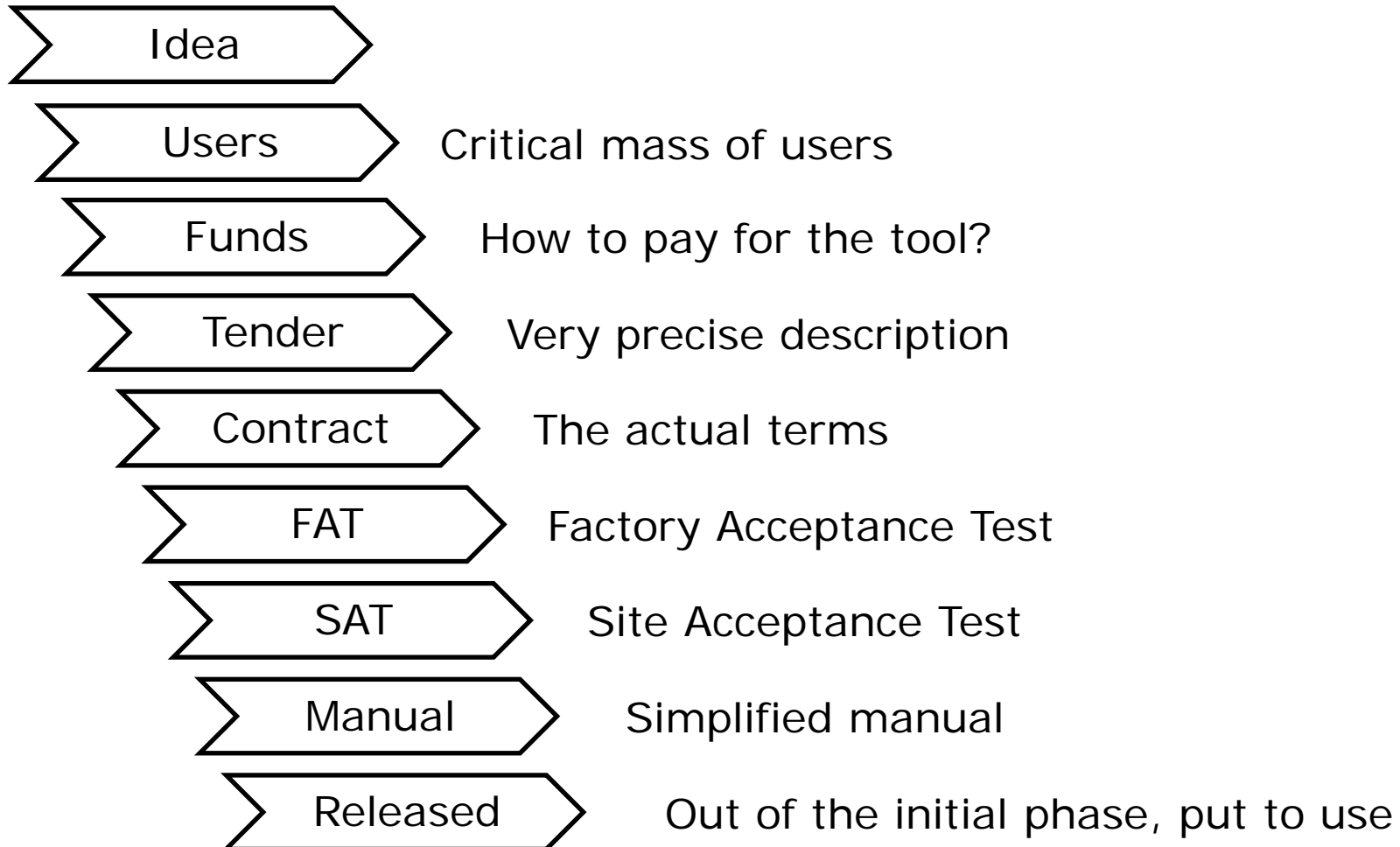
Changed boundary conditions

- New e-beam writer installed in new room
- General use of the cleanroom has changed
- Before: 100 mm
- Now: 100 mm, 150 mm, 2" and other formats
- A more flexible approach needed
- A design centered around research activities or process flows is unflexible
- A design centered around process types is more long-term secure
- Now is a good time to rearrange some of the equipment





Situation indicator



New SEM: Zeiss Supra 60VP

- now with load-lock

- Background: Replacement of the FEI-SEM
- Detectors: SE-, VPSE-, In-lens & BSE
- 8" load-lock (<2 min)
- 6-Axes stage:
x,y : 152 mm; z: 43 mm
- Supplemental acquisition:
New EDS-detector (Energy Dispersive X-ray Spectroscopy):
Aztec (Oxford), incl. 50 mm² SDD det.
- Future life for the FEI-SEM
- will go to CEN March 2014



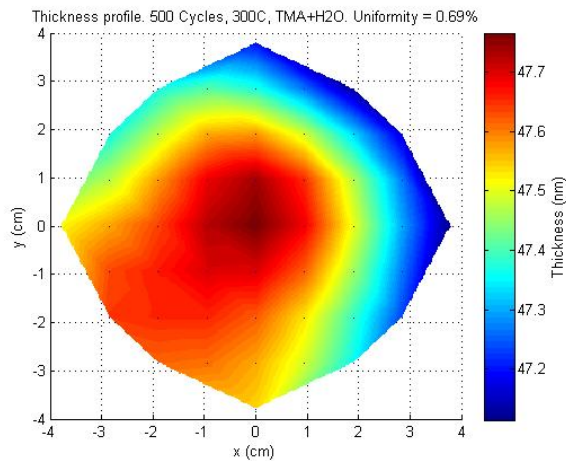
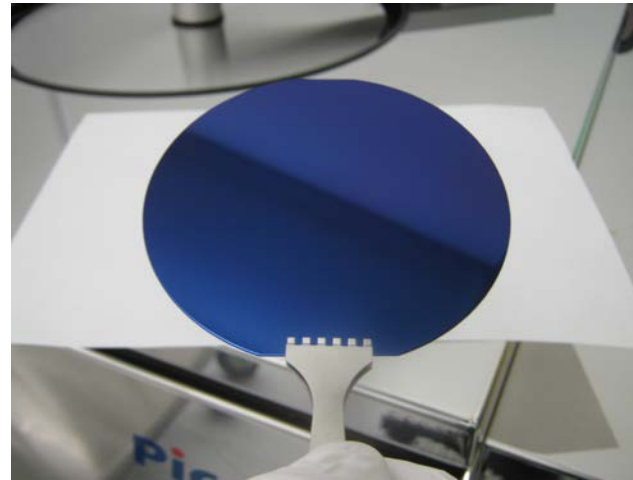
Atomic Layer Deposition – Picosun R-200

- Tool installed in February
- Key features:
 - Highly flexible Thermal ALD system
 - Plasma source optional
 - Stacked substrates (pieces – 8" wafers)
 - Initial processes: Al_2O_3 , TiO_2 , (Cu), (Pt)

PhD project with focus on process development initiated November 2013 (Danchip/Fotonik)



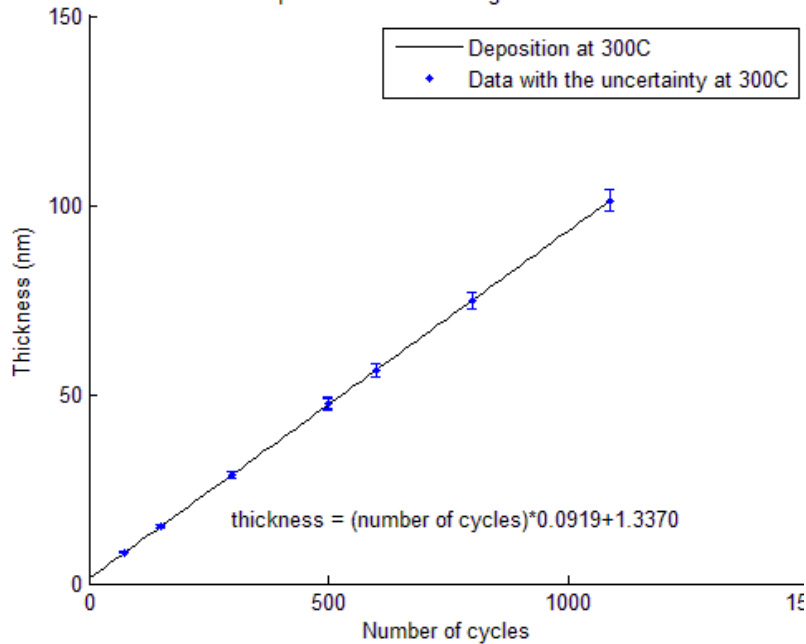
Atomic Layer Deposition – Picosun R-200



- Al₂O₃, 50 nm, 300 C
- Uniformity (thickness): ca 0.7% (RMS)

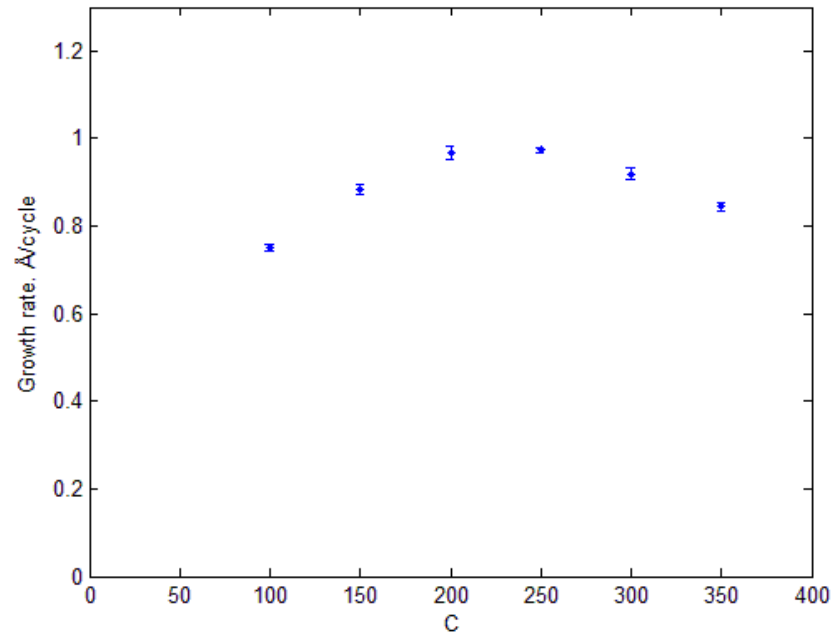
Growth rate of Al_2O_3 on Si wafer

Deposition of Al_2O_3 using TMA and H_2O



Thickness of Al_2O_3 as a function of number of cycles at $T=300\text{C}$.

ALD windowTemperature. Deposition of Al_2O_3 using TMA and H_2O .



Growth rate as a function of temperature.

Electron Beam Lithography add-on (SEM-LEO)

Raith ELPHY Quantum system

- PCI bus technology
- 6 MHz pattern generator (vector scan)
- 16-bit D/A converters
- "Cheapish" supplement to JEOL-9500
- Easy access – no "tough" requirements to sample quality
- Installation a.s.a.p. (pending service work on SEM-LEO)



Furnace with reducing atmosphere

Candidate: PEO-604 (ATV)

- Multi-purpose process furnace with vacuum capability
- Capacity: 50 x 200 mm wafers
- Process temp: 1100 C, rate < 100 C/min
- Multi-purpose: Easy swap of quartz glass
- Ultimate vacuum: $\sim 10^{-6}$ mbar
- Reducing atmosphere: H_2 / N_2
- $\text{O}_2 < 1\text{ppm}$

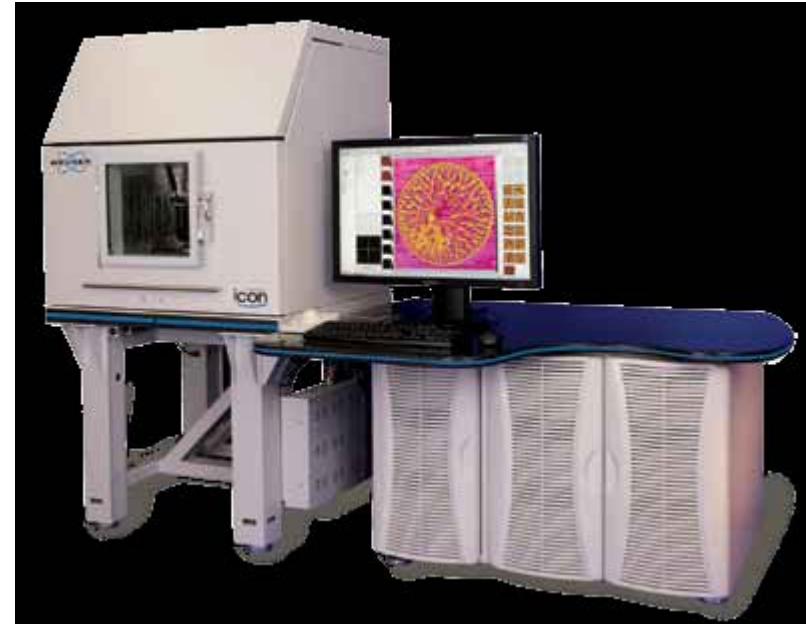
Tender done – expect contract finalized end of this week



AFM – replacement of present NanoMan

Candidate: Dimension Icon

- Upgrade from Dimension 3100 platform
- Trade-in with present NanoMan system – significant discount
- Pursue new functionalities
- Compare with **Park NX20** (at DFM)



Raman spectroscopy?

- Characterizing graphene
- Other application areas?



Example of a Raman microscope

Idea

Users

Funds

Tender

Contract

FAT

SAT

Manual

Released



3DMM Laser micromachining tool 7.013



Machine introduction and results so far.

March 26th 2014

At 15:00

Seminar room 347

Micro Vickers Hardness tester

- Innovatest 412A is being investigated
- Analogue microscope
- Automatic, loading/dwell/unloading
- Test forces 0.01kgf/0.098N to 1kgf/9.8N
- Meets or exceeds, ISO, ASTM, JIS (Nadcap) standards
- Rafael from Nanotech will pay 30 kkr



Idea

Users

Funds

Tender

Contract

FAT

SAT

Manual

Released



Cassette-to-cassette stepper developer robot

- Built on Gamma 2M frame
- 0.26 N TMAH (AZ 726)
- DIW rinse
- N2 dry
- 4" and 6" w/o size conversion
- Tool accepted
- Process for thick resist (KRF M35G) ready
- Process for thin resist (KRF M230Y) being developed
- All processes need new dose tests



Idea

Users

Funds

Tender

Contract

FAT

SAT

Manual

Released



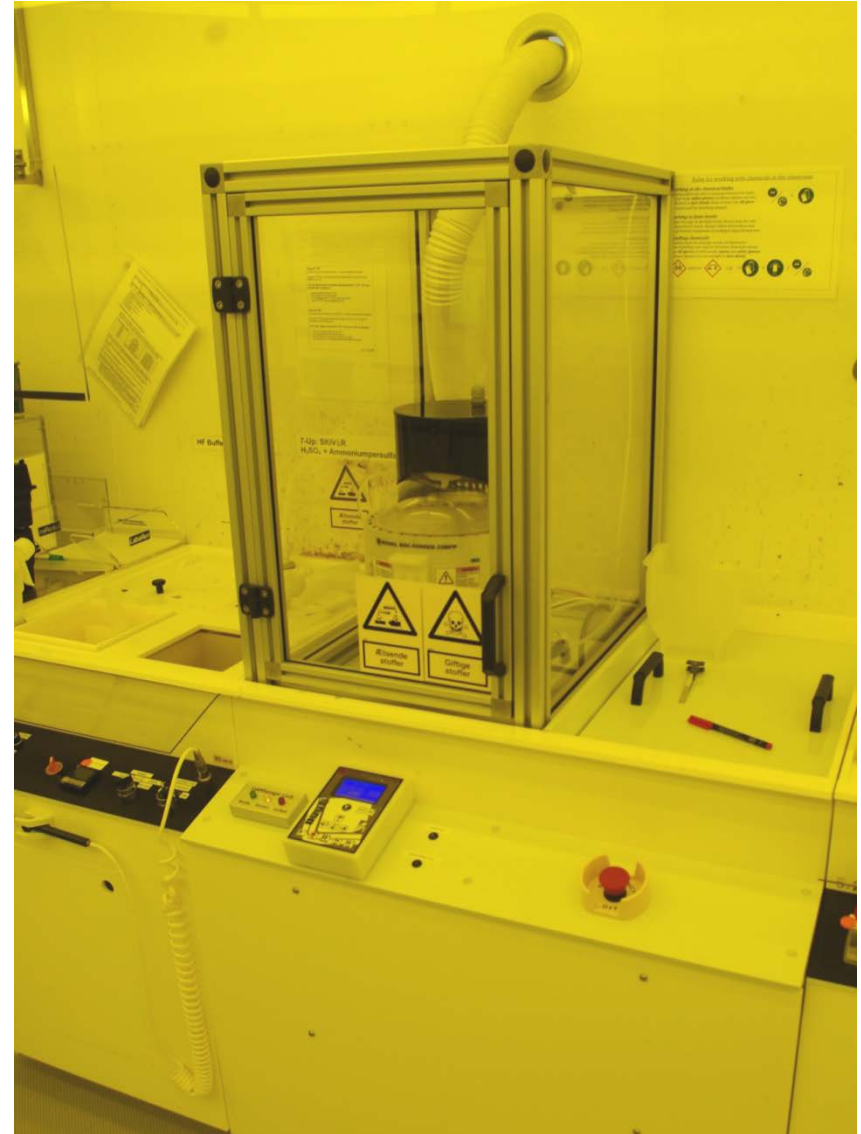
Cassette-to-cassette UV developer robot

- Identical to stepper developer
- Tool accepted and delivered
- Awaiting new litho room
- Expected ready to use 2014Q3



Laurell – TMAH single wafer developer - alias "R2D2"

- Built into wet bench for safety reasons
- 4" and 6" w/o size change
- Lines for
 - 0.26 N TMAH
 - DIW rinse
- N2 blow dry
- Drain diverter
- Programmable
- Processes for thin and thick stepper resist developed
- Basic processes for MIR701 and nLOF 2020 available



Laurell – e-beam single wafer developer - alias "Rasta R2D2"

- 4" and 6" w/o size change
- Lines for
 - N50
 - MIBK (later)
 - IPA
 - DIW
 - N2 blow dry
- Drain diverter
- Needs to be built into bench
- Expected ready 2014Q3



New Karl Süss AI-6 Aligner

- New aligner ordered at Süss
- Very similar to old KS aligner
- Familiar maintenance
- Common spare parts
- Tools can backup each other
- To be installed in new litho room
- Expected delivery 2014Q2
- Expected ready 2014Q3



New III-V spinner

- LabSpin 6 from Süss
- Replaces old Süss RC8
- Simple and robust
- No Gyrset available
- No inserts
- Dedicated bowls
- Expected ready March 2014
- Feedback needed



Spinner rinser dryer

- Rinser dryer for general use :
 - 6" and 8" rotors
 - Presently installed in stepper ro
- Rinser dryer for RCA cleaning:
 - 4" and 6" station
 - In cleranroom
 - Not yet installed at RCA bench

