

DTU





DTU Nanolab

Techforum 2019 #1

Agenda

- DTU Nanolab
- Network issues
- Shutdown September 2019
- Update on lightrail and non-cleanroom labs
- New TPT: Thínfilm TPT
- New equipment



DTU Nanolab

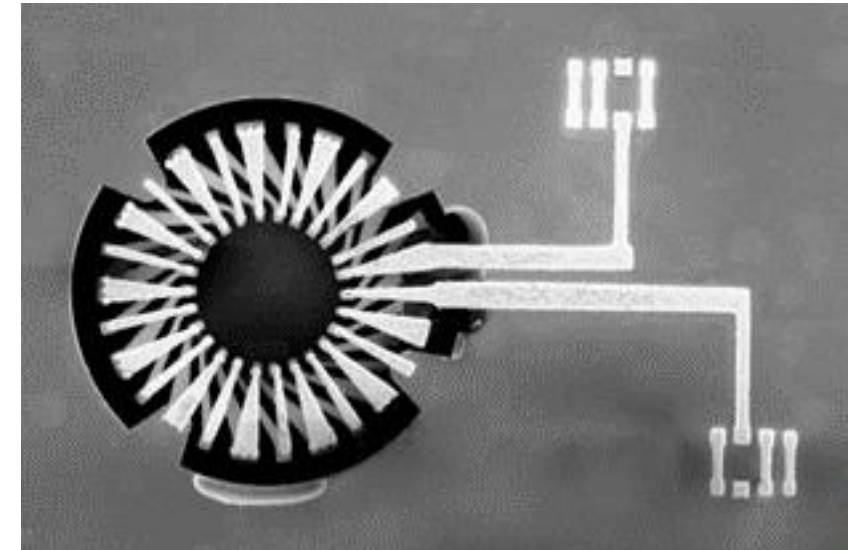
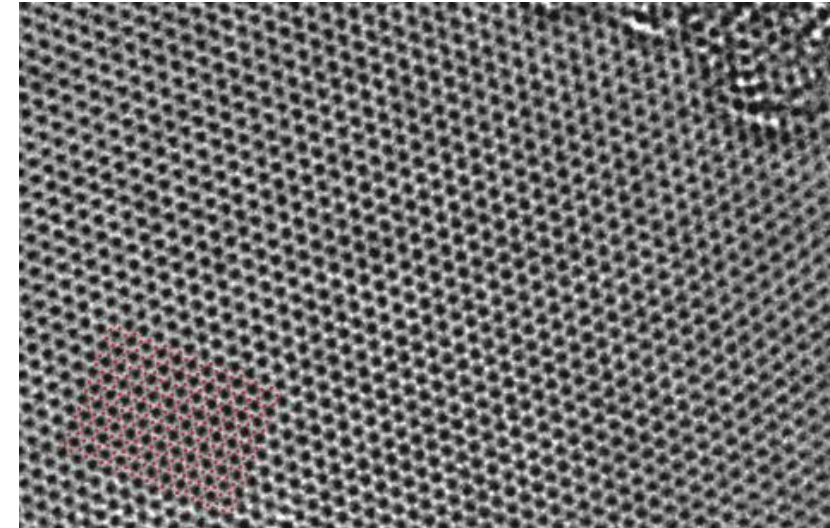
National Centre for Nano Fabrication and Characterization

Scope:

- top down, scalable, cleanroom based nanofabrication technology
- E-beam+ based characterization

What:

- around 105 staff
- Ph.D. school
- Education and teaching (under DTU Fysik umbrella)
- No changes concerning operation and access to the facilities





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 ² /month	2000	NA	NA	NA
Materials		At cost+20%	At cost+44% OH	At cost	At cost

Prices for 2018

Service from Danchip	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	380+44% OH	380	0
Category A tools	Kr/hour	370	120+44% OH	120	0
Category B tools	Kr/hour	630	240+44% OH	240	0
Category C tools	Kr/hour	3600	875+44% OH	875	0
Category D tools	Kr/hour	1200	180+44% OH	180	0
Category E tools	Kr/hour	1700	375+44% OH	375	0
Category F tools ⁴	Kr/hour	0	0	0	0
Danchip assistance	Kr/hour	1250	515+44% OH	515	0
Area rent	Kr/m ² /month	1600	NA	(200)	NA
Materials		At cost	At cost	At cost	At cost

Changes in 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		-125 +44% OH	-125	
Category A tools	Kr/hour	+40	+5 +44% OH	+5	
Category B tools	Kr/hour	+20	+90 +44% OH	+90	
Category C tools	Kr/hour		-35 +44% OH	-35	
Category D tools	Kr/hour		+60 +44% OH	+60	
Category E tools	Kr/hour		+40 +44% OH	+40	
Category P tools	Kr/hour	+410			
Nanolab assistance	Kr/hour	+100	-185 +44% OH	-185	
Area rent	Kr/m ² /month	+400			
Materials		+20%			

ISO certification

The ISO 9001 certification of DTU Danchip will continue under DTU Nanolab:

The scope will change slightly:

”Access to cleanroom facilities and use of equipment for micro- and nanofabrication, and in-sourcing of customer processes”

The certification will not include the added research groups.



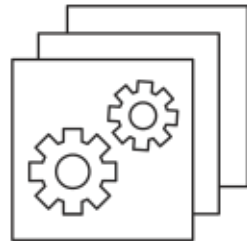
Compared to former version of ISO 9001, the present standard 9001:2015 has more focus on strategy and risk based thinking.

We were praised for our approach to this during the recertification audit that was held last week.

Network/namechange issues

Namechange:

- Namechange from CEN/Danchip to Nanolab established in DTUs central systems in February 2019
- Some problems were encountered – especially with network drives and access systems
- Small changes remain ie some mail addresses



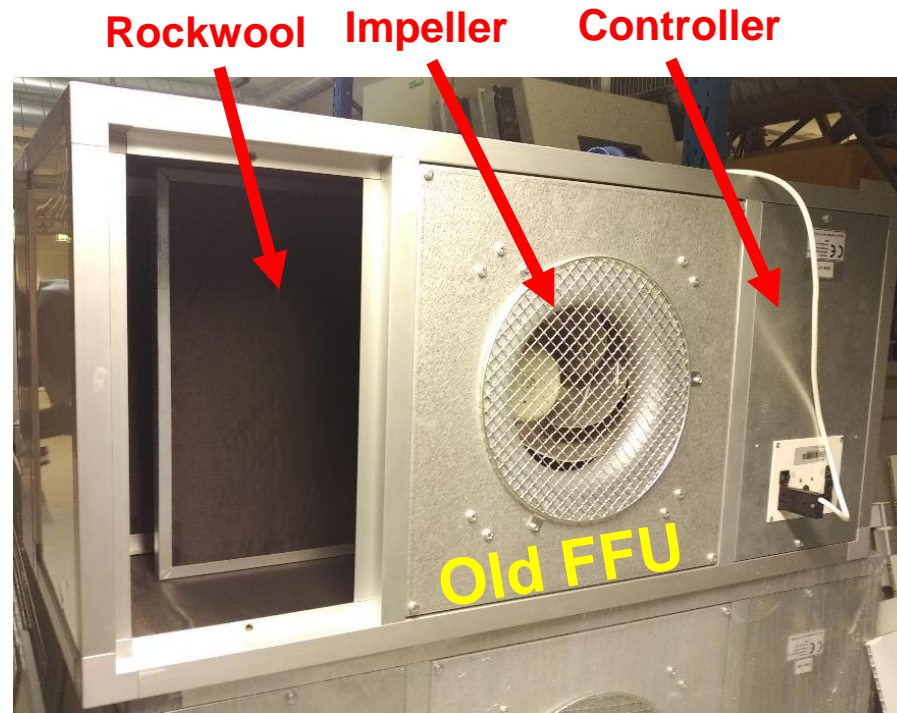
Network issues:

- New, faster and safer network components installed
- Installed last year, but still not fully operational. This is not acceptable.
- In 346/347 we still have the old network
- We expect it up and running this spring
- Regardless of new/old network – a series of incidents have reduced access
- We aim for more focus on the IT solutions we are using.
- We need a new file transfer mechanism between equipment computers and network drives

SEPTEMBER 2019 SHUTDOWN

FFU change

- Candidate for new FFU very noisy
- Old FFU boxes very quiet (rockwool padded)
- Alternatives:
 - Find other FFUs (2 candidates)
 - Refurbish existing FFUs (2 candidates)
 - Long lead time
 - Outcome unknown
- Time schedule affected
- September shutdown cancelled
- New date not set
- Will give 6 months notice



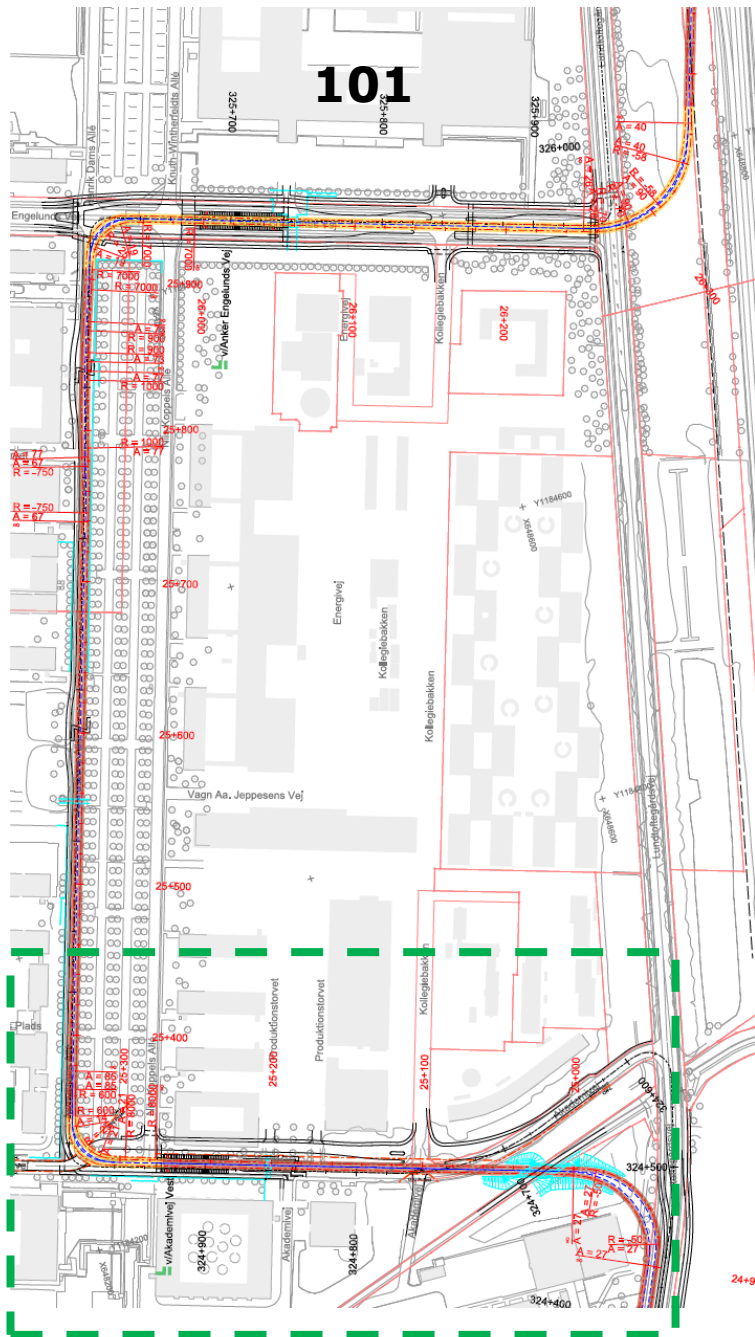


LIGHTRAIL

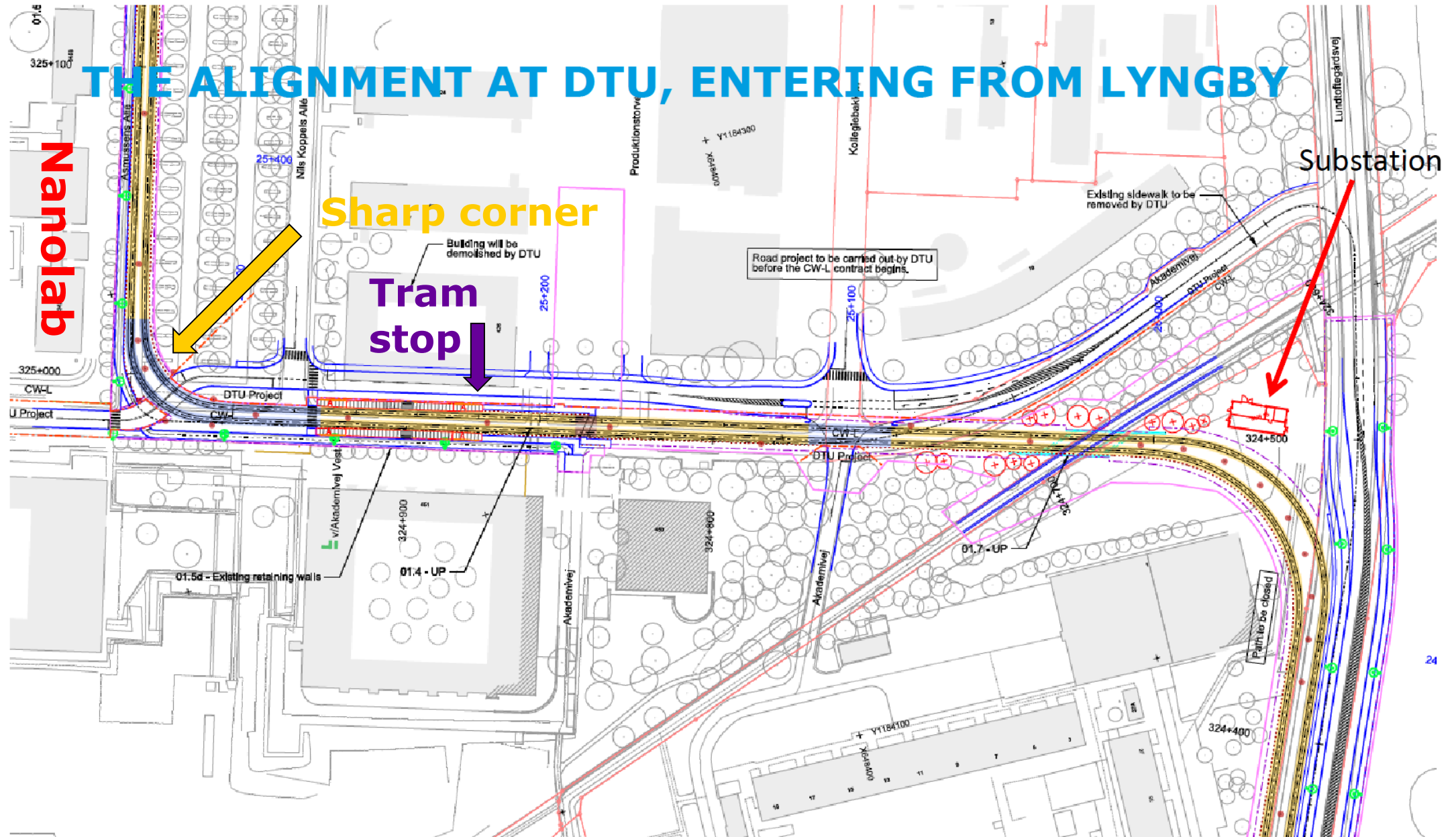
Light rail alignment on DTU Lyngby campus

- Expected operational in 2024
- Tracks: Per Aarsleff A/S
- Trains: Siemens Avenio
- Boundary conditions
 - Alignment fixed
 - Tram type fixed
 - Tracks will be damped
 - Wires (mostly) fixed – no segmentation

**Fotonik
Healthtech
Nanolab**



THE ALIGNMENT AT DTU, ENTERING FROM LYNGBY



Electromagnetic fields from light rail

- E-beam limit: 50 nT peak-peak
- Simulated time varying field: 1200 nT p-p at e-beam (24x over limit!)
- Existing EMI noise cancellation system proven insufficient

Emulation of light rail fields

- Force Technology
- Able to apply up to ca. 1400 nT p-p
- Existing EMI noise cancellation system proven insufficient

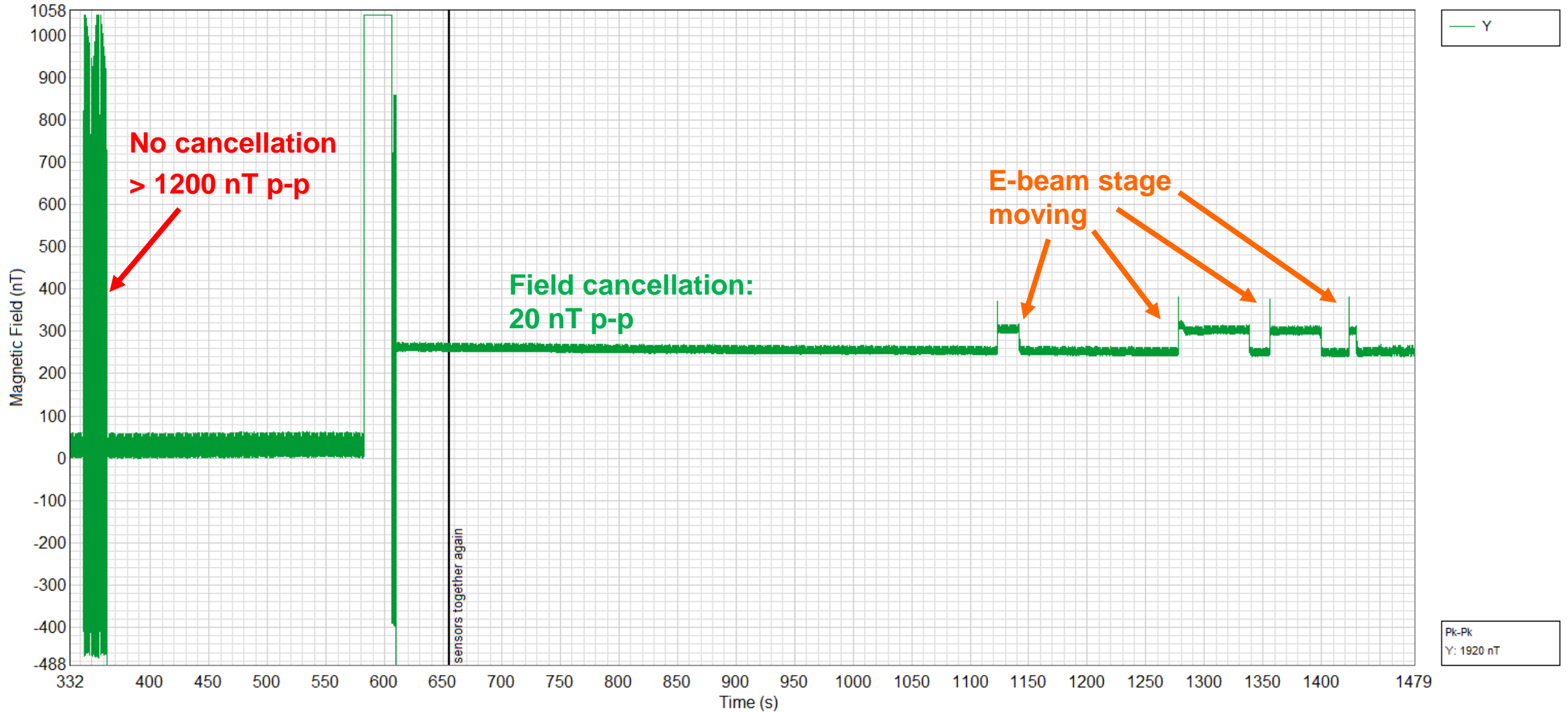


Field cancellation test setup

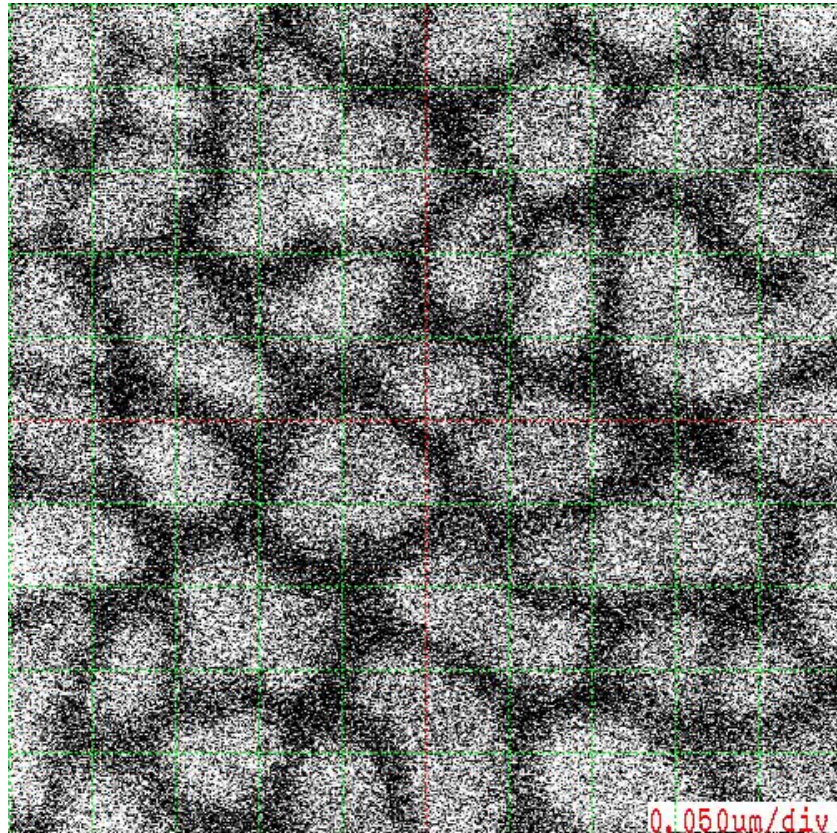


First field cancellation results – 1

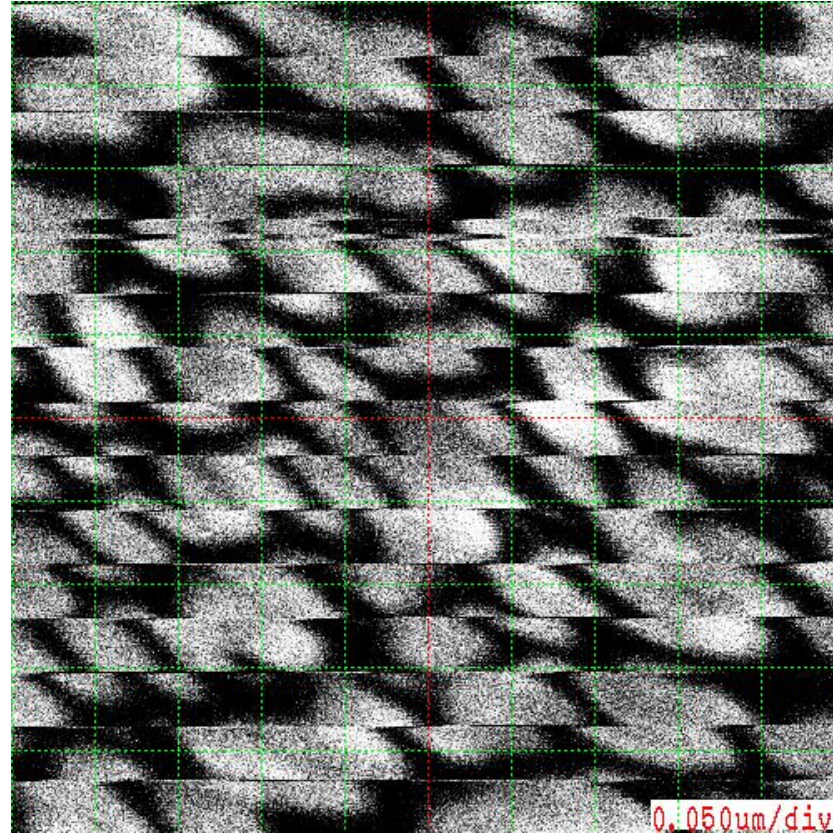
Magnetic Field
2019/03/26 17:24:39



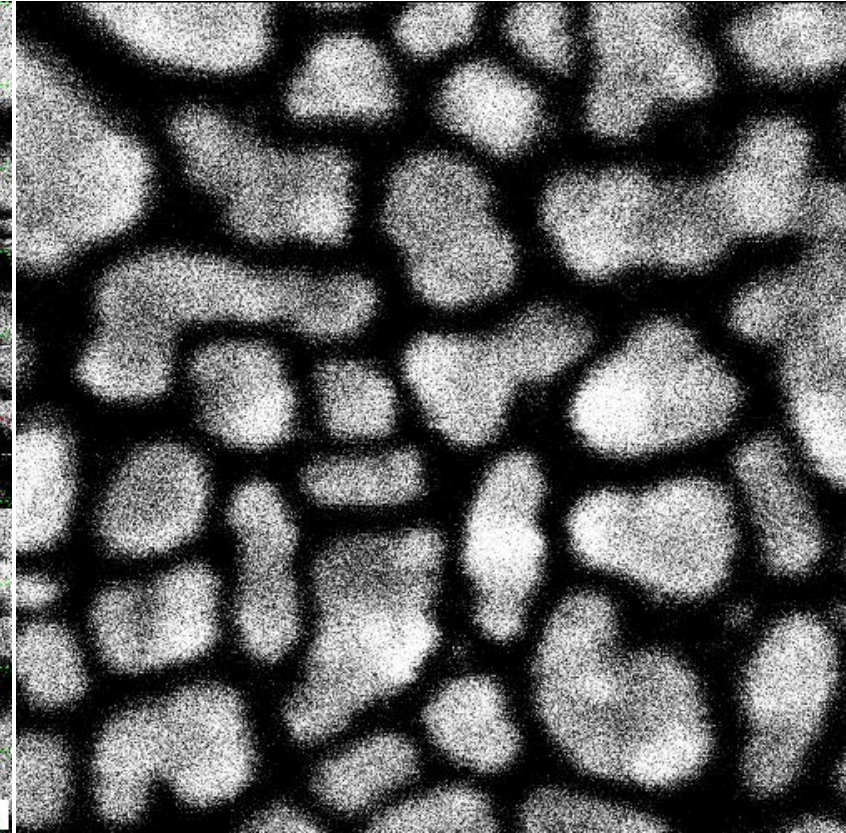
First field cancellation results - 2



No applied field
Field cancellation off



Applied field > 1200 nT p-p
Field cancellation off



Applied field > 1200 nT p-p
Field cancellation on

Very initial conclusions

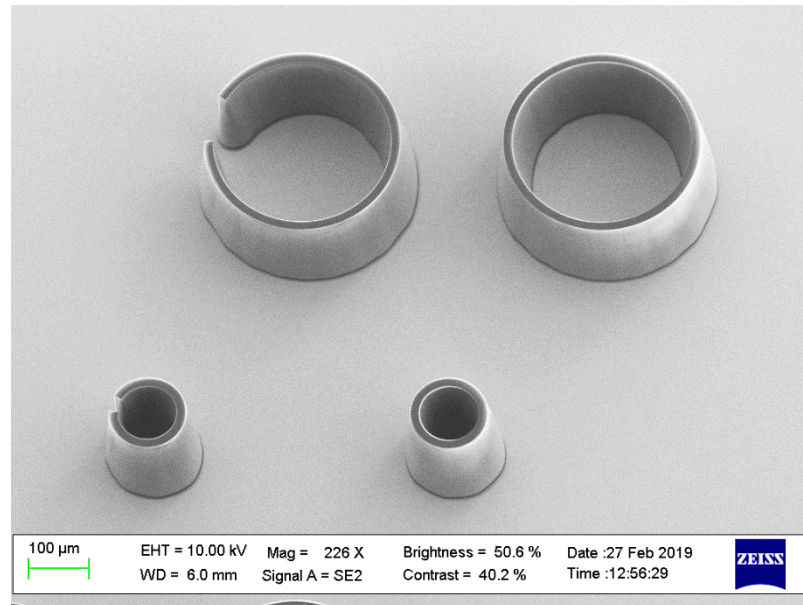
- The Spicer SC-24 seems capable of cancelling 1200 nT p-p
- Peace in our time? Not yet!
- Actual tram field strength might be higher
- Some instabilities in cancellation field observed
- Investigations with long writing times needed
- Adjacent cancellation systems might cross talk
- Price of cancellation system > 200.000 DKK



NEW EQUIPMENT

Heidelberg MLA 150

- Chips, 2, 4, 6 and 8 inch
- 375 & 405 nm
- 0.6 μm lines in 0.5 μm resist
- Down to 1 μm lines in 1.5 μm resist
- BSA ca. +/- 1 μm
- High aspect ratio mode
- 4" wafer: 1/2 hour
- Training starting next week



New Stepper

- Canon, FPA3030-EX6 248 nm stepper
- New machine
- Very similar to existing tool
- Footprint: 2x4 m²
- 6" to 8" change in 10 min
- Our bid too far from Canon's target
- Purchase postponed



High Vacuum RTP-system for sidewall smoothing

ANNEALSYS: AS-Premium – start-up/acceptance on going

Purpose/specs:

Sidewall smoothing after DRIE nano etching

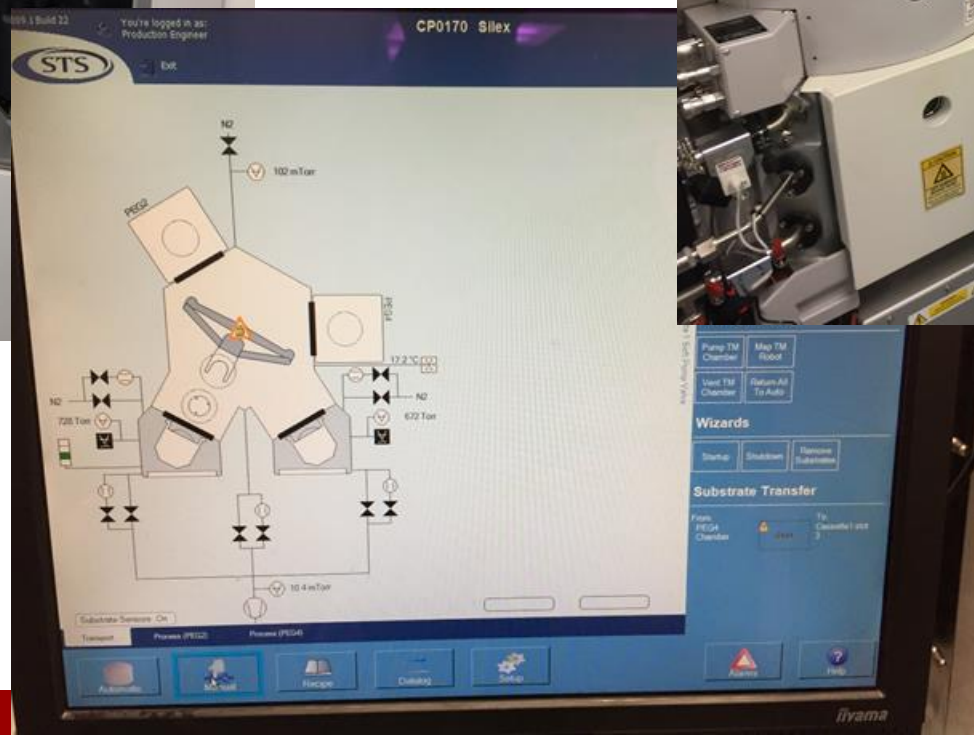
- high vacuum (10^{-6} mbar base press)
- ultra-clean (load-lock)
- cold-wall chamber technology
- up to 1200 C (max 10 min)

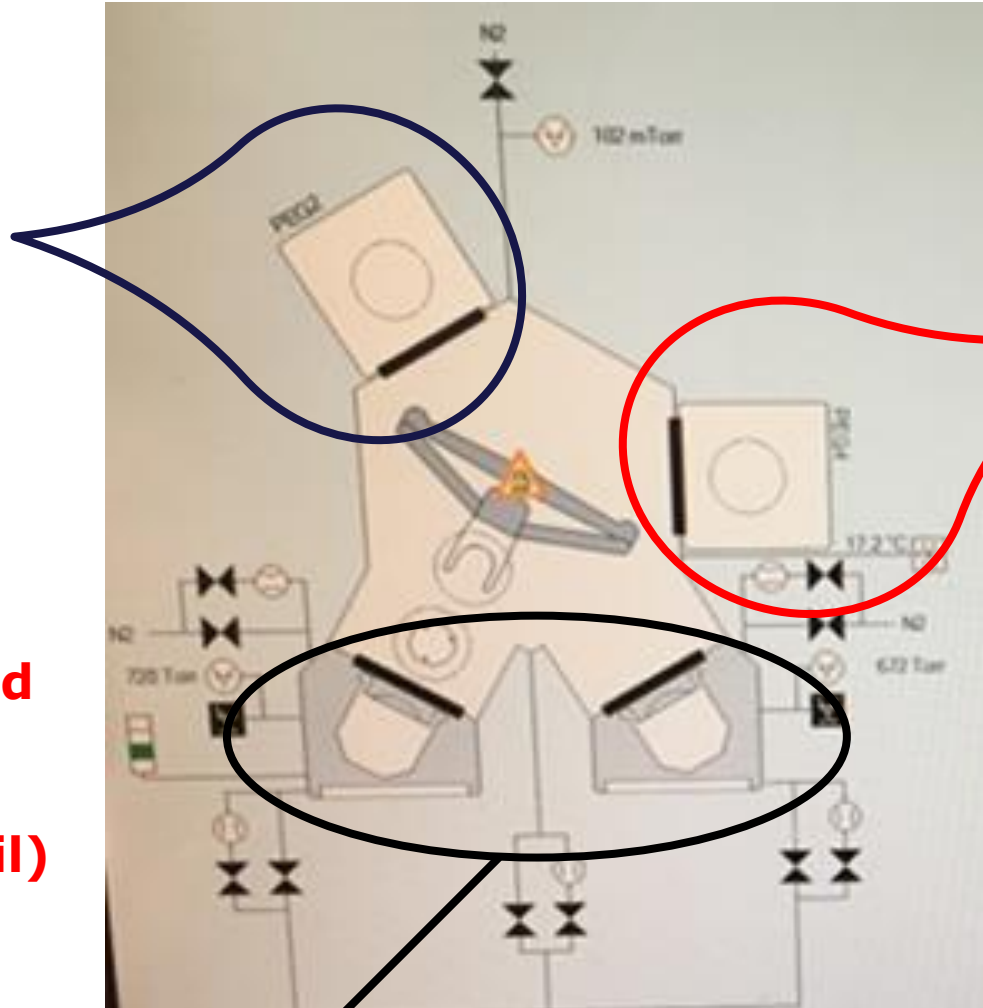
Configuration:

- turbo/dry scroll pumps (chamber + load-lock)
- 4 process gas lines
- water-cooled stainless steel chamber
- up to 1200 C (max rate 100 C/s)



Coming up: Twin-Pegasus (version 2010)





CPX Platform

twin vacuum cassette cluster (Brooks handler)

Pegasus 3

DRIE (Si) – 6”
 High-throughput
 Cassette-Cassette
 "Workhorse"

A little later:

- **gas lines being tested**
- **then plasma test**
- **150 mm TDESC (April)**
- **Ar line, final welding**
- **H₂ addition**

Pegasus 4

DRIE (Dielectrics) – 6”
 Reconfigure (Dielectrics)
 High-throughput
 Cassette-Cassette
 "Workhorse"

Almost ready:

- **plasma tested**
- **gas manifold for H₂/He**
- **H₂ addition (install)**
- **200 mm transfer working**
- **reconfig to 150 mm (April)**

PVD multi-chamber tool: Dual-Sputter system Candidate from Lesker



OCTOS 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:

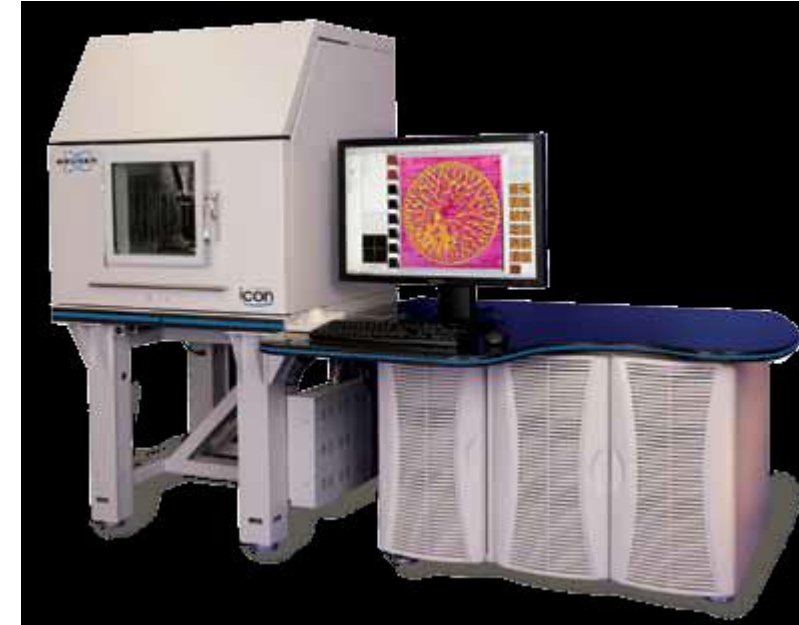
Contract signed: Primo December, **expected FAT: Primo July**

NEW

AFM Outside cleanroom

Dimension Icon from Bruker

- Backup for cleanroom AFM (Primary role)
- Compatible scanner head with current cleanroom AFM
- No samples go into cleanroom just for AFM
- Location in characterization lab in basement 346 (XPS, tabletop SEM)

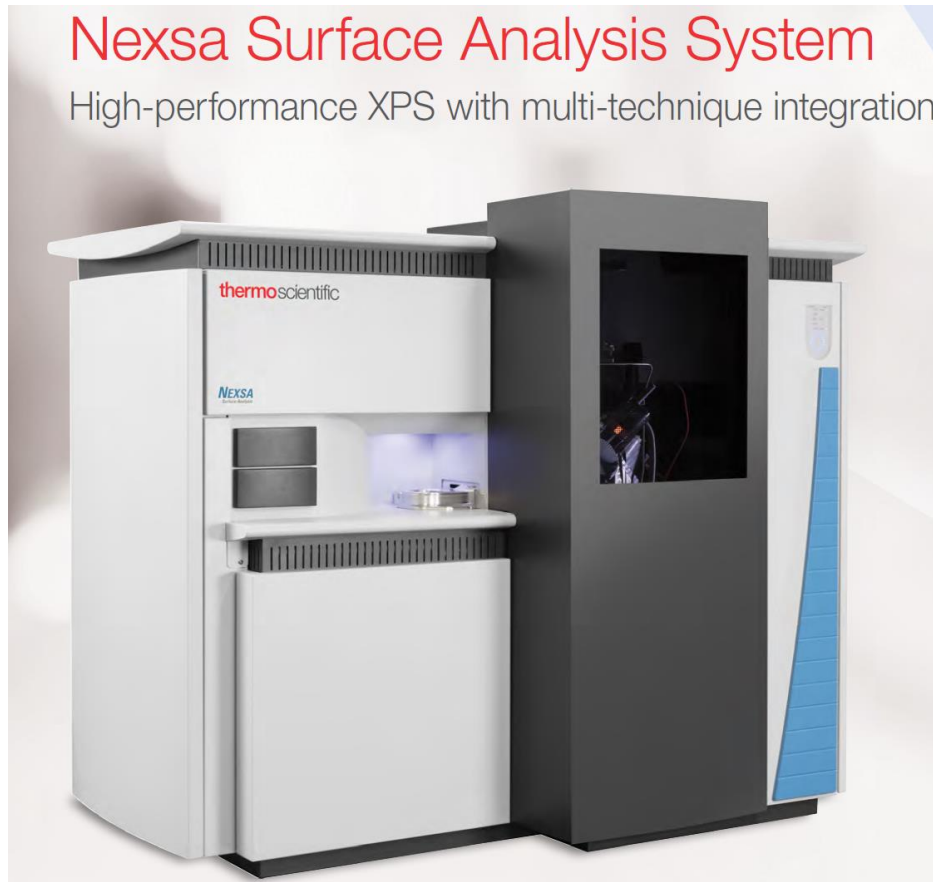




Next XPS etc. ?

Candidate: Nexsa from thermo scientific

- **NEW** set of additional and complementary techniques/options.



- **XPS:** X-ray photoelectron spectroscopy provides quantified chemical state information from the surface of the sample.
- **MAGCIS:** Monatomic & gas cluster ion source which extends the depth profiling capabilities to be able to analyze “soft” layered materials such as polymers.
- **ISS:** Ion scattering spectroscopy provides elemental composition information from the top atomic layer of the surface.
- **Raman:** Molecular bonding and structural information
- **REELS:** Reflected electron energy loss spectroscopy provides information on electronic structure and can measure the presence of hydrogen
- **UPS:** UV photoelectron spectroscopy provides information from the valence electrons

Tool package training (TPT) - Status

Introduction course

3 hrs self-study (videos/documents + test) + practical session

Lithography

lecture videos (self-study) + questions/exercises (2hrs) + practical session

Mask design

ca. 1 day self-study (CleWin & L-Edit), based on exercises

SEM training

3 hrs lecture + practical sessions

Dry etch training

3 hrs self-study (videos) + questions/exercises (1.5 hrs) + practical session



Thin film 1 (non-vacuum techniques)

2 hrs lecture, launched after Easter



Thin film 2 (vacuum techniques)

3 hrs lecture + practical training, launched after Easter



Leica Plungefreezer

- Placed in Tecnai room for proximity reasons (Replacing FEI Vitrobot)
- Dedicated to Cryo-TEM work (Mériem Er-Rafik)



Camera for FEI Tecnai T20

- Testing new cameras for the Tecnai
 - Gatan OneView (test Feb-March, 2019)
 - TVIPS XF416 (test June, 2019)
- 4k x 4k camera with no-deadtime (fast)



...but retractable



Raith ice-lithography e-beam system

- Dedicated to Ice-lithography development and application
- Point of contact: Anna Elsukova
- Planned delivery ultimo April



Goal: convert eLine into ice lithography instrument



Codename CEN II

- Studies on area needed (and placement)
- Compiling a paper on the idea (purpose & vision) intended for possible funding possibilities (CAS & external consultants)



Take home messages

- Nanolab – some things change, most remain the same
- Fan Filter Units situation (shutdown postponed)
- Feed-back/suggestions on surface analysis (XPS etc.) (jmli@dtu.dk)

