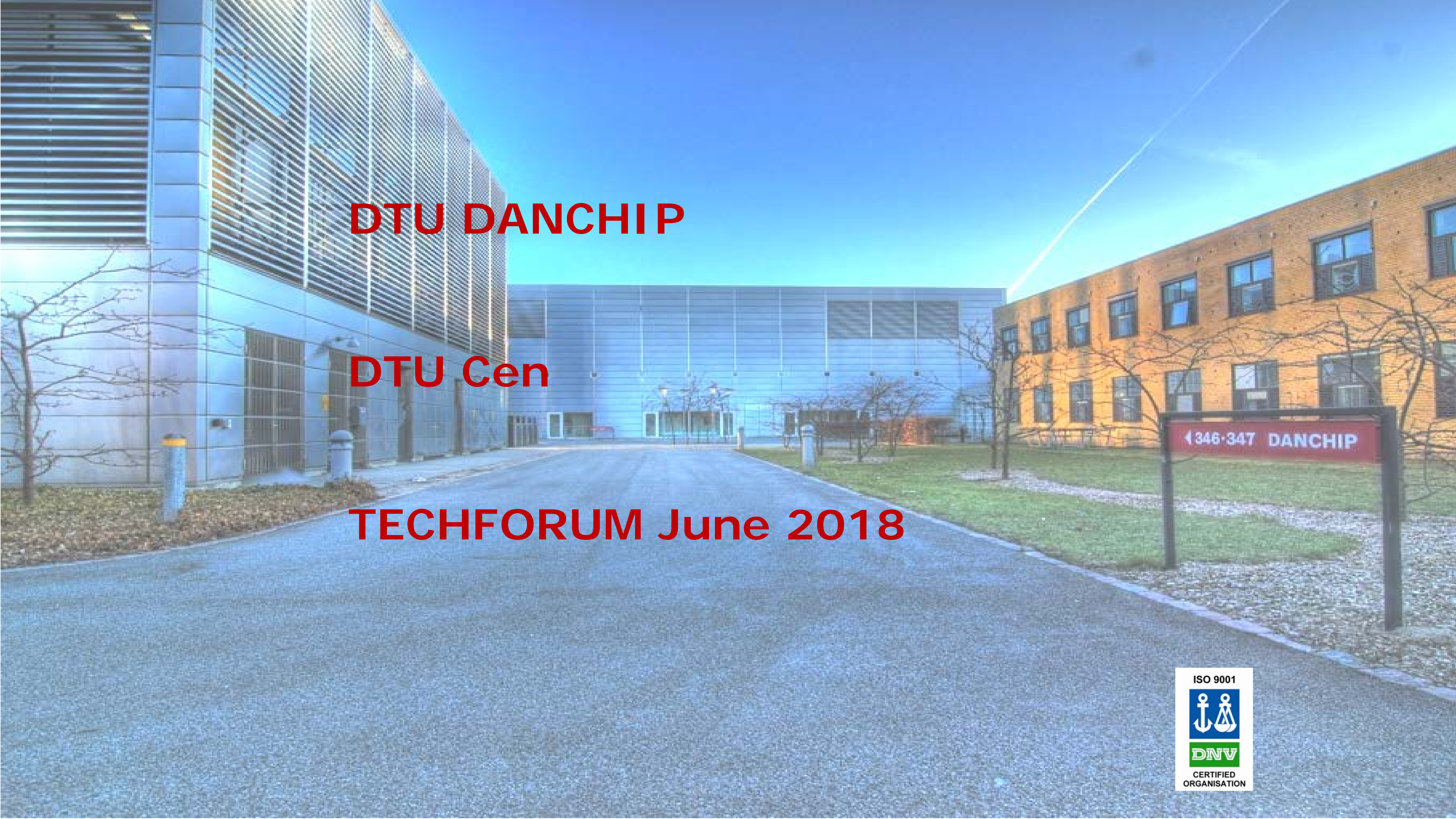

DTU DANCHIP
DTU Cen
TECHFORUM June 2018
346-347 DANCHIP
ISO 9001
DNV
CERTIFIED ORGANISATION

Agenda

- **Short news and updates**
- **Light rail**
- **CEN development**
- **New cleanroom equipment**
- **DUV Stepper II and process review**

PhD course 33651, Methods in Micro and Nanofabrication

- Accelerate your research at Danchip!
- 4 weeks crash course and earn 5 ECTS points!
- 5 TPTs (Safety, Litho, Mask design, Dry etch, SEM). Drivers license to tools!
- Original literature in micro and nanofabrication!
- Design masks and make process flow recipes for your own project
- Signup before 23/4, course start 30/4, and exam 30/5

Launched May 2018

4 students participated

Very positive feed-back

- Look up http://kurser.dtu.dk and contact Assistant Prof. Anpan Han (anph@dtu.dk) for more information.
- Sign up before 23/4 by e-mail to Louise Søby Møller, (lsmo@nanotech.dtu.dk) and Anpan Han (anph@dtu.dk)

Energy saving

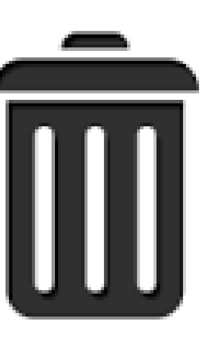
- CAS, MOE and Transition have been working with DTU Danchip to identify potential for energy saving
- “Quick fix”
  - Replace old FFUs with new ones
  - Replace fluorescent lamps with LED
  - Stop using cleanroom air for makeup air to new basement
  - Requires cleanroom shutdown for > 1 week. Planned for 2019.
- “Not so quick fix”
  - Harvest heat from exhaust systems
  - Use reclaimed heat to condition air to cleanroom
  - Improve system for controlling cleanroom air
  - Big project. CAS will return later.

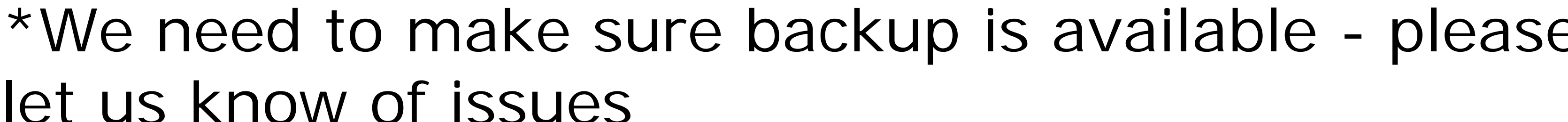
Mild evacuations

- Still many mild evacuations – all time high: 3 within 28 hours!
- Problem located to US013 – acid/bases exhaust fan for section D (new part of cleanroom)
- What happens?
  - Fan is switched off and back on within 170 ms => Fan reboots and slows down => Pressure drops below limit for ca. 40 seconds=> Evacuation alarm
- Corrective actions so far (didn't help):
  - Verify all fans on UPS
  - Swap VLT units
  - Change PLC unit
  - Update firmware and software
  - Monitor for power spikes/dips (no clear correlation)
  - Increase alarm limit to 60 seconds
- Escalated talks with CAS and Schneider to find root cause – and fix it soon!

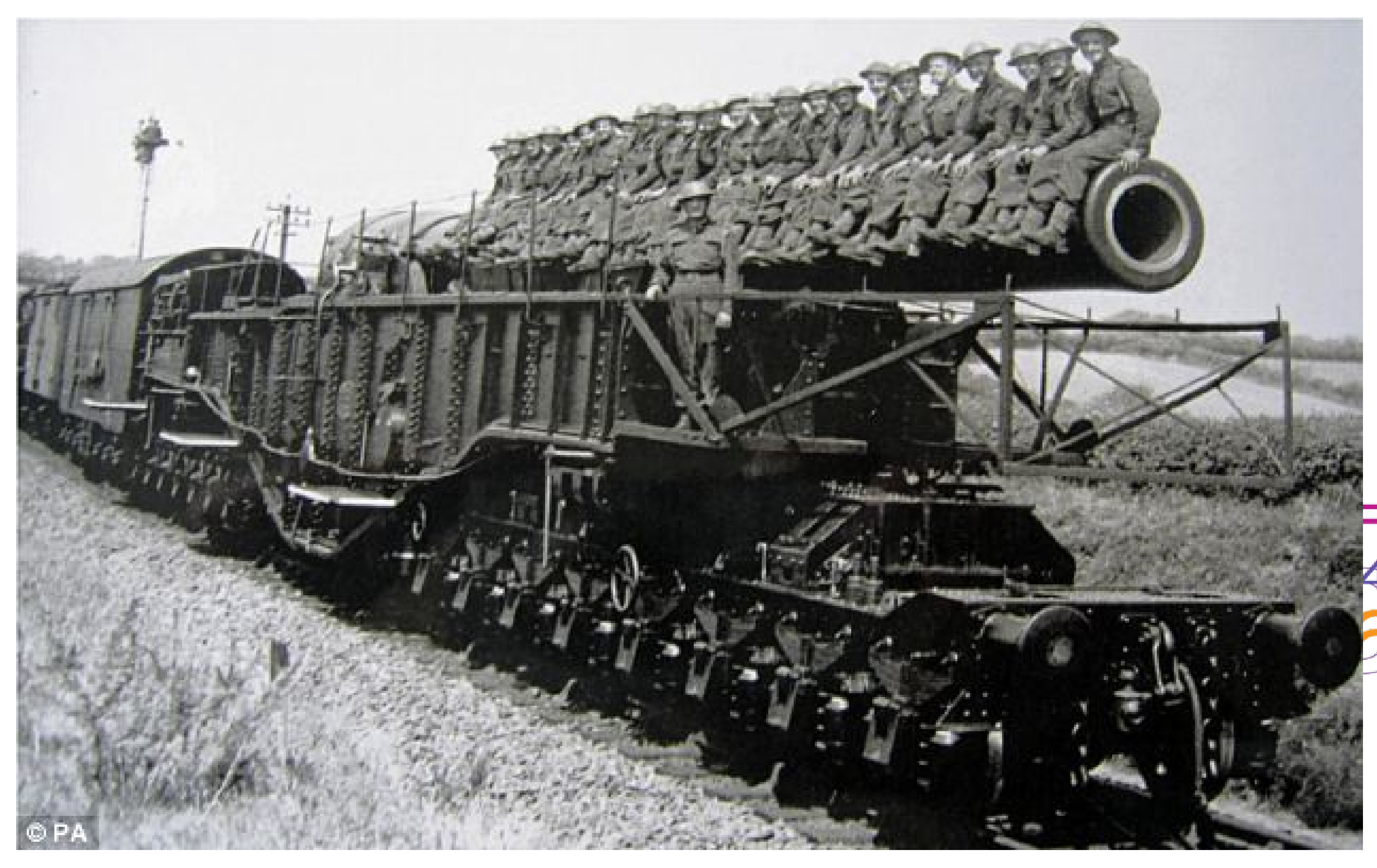
Tools leaving the cleanroom

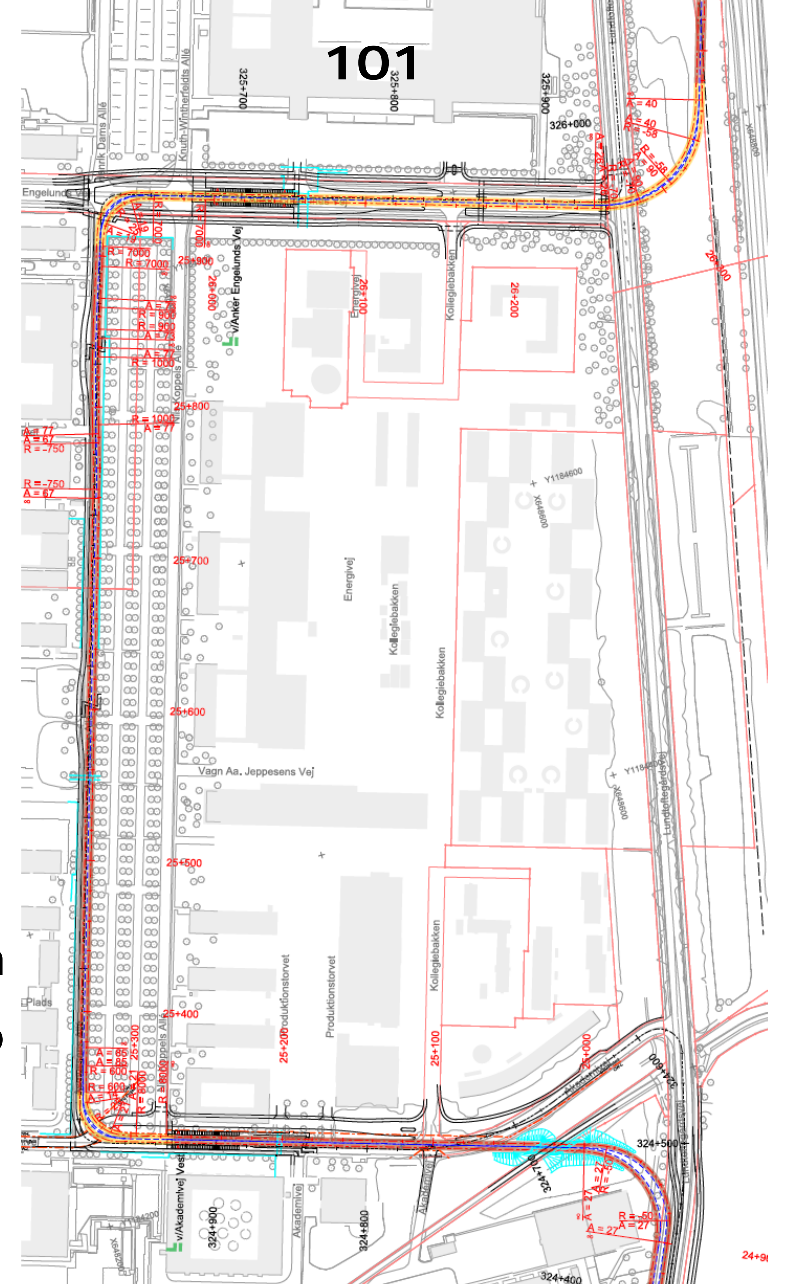
- Alcatel
- EVG 620
- Noble furnace
- Old ATV Pyrolysis furnace
- SVG Track
- III-V Asher* (alternative Asher 1)
- III-V Oven* (alternative dedicated VCSEL tool)




*We need to make sure backup is available - please let us know of issues

The light rail is coming





Fotonik

Nanotech

Danchip

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
  - Wires might be locally modified (segmentation)
  - Tracks might be locally modified (damping)

THE ALIGNMENT AT DTU, ENTERING FROM LYNGBY

Danchip

Sharp corner

Tram stop

Substation

Building will be demolished by DTU

Road project to be carried out by DTU before the CW-L contract begins.

Existing sidewalk to be removed by DTU

01.5d - Existing retaining walls

01.4 - UP

01.7 - UP

Path to be closed

DTU Project

CW-L

Asmussens Allé

Nils Koppels Allé

Produktionstorvet

Kollegiebakken

Lundtoftegårdsvej

Akademivej

325+100

325+000

25+400

25+200

25+100

324+900

324+800

324+500

324+400

Vibrations

Need for vibration damping:

DANCHIP (B345, B346) 12 dBV

NANOTECH (B347) 6 dBV

ENERGI (B301) 12 dBV

MEKANIK (B425) 12 dBV

KEMI (B206) 6 dBV

FOTONIK (B340) 6 dBV

Sving?	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No	No	No	No	No	Yes	Yes	Yes	No	Yes	Yes
Byg	101	115	202	206	207	212	220	301	304	307	309	310	314	321	327	340	346	346	347	375	425	425
Hz\Rum	2904	213	5101	051	240	003B	210	956	M4	205	956	49	042	919	929	911H	C1	E2	81	903	901	917
10	-43,1	-26,5	-10,2	-8,7	-19,7	-9,3	-10,7	-4,9	-34,9	-15,2	-10,1	-17,3	-10,2	-30,8	-33,0	-17,0	-0,8	2,2	-5,7		-5,4	-4,4
12,5	-41,3	-21,1	-13,2	-12,5	-24,1	-13,2	-10,9	-0,1	-36,5	-17,7	-10,8	-27,9	-18,4	-32,8	-45,1	-25,8	0,1	-1,3	-9,1		-10,4	-14,0
16	-47,6	-23,9	-9,1	-18,4	-25,2	-20,4	-12,2	-2,7	-35,1	-8,6	-12,6	-27,2	-20,4	-31,1	-49,0	-23,6	-3,0	-4,8	-11,5		-13,4	-23,4
20	-38,0	-25,6	-21,2	-15,4	-23,6	-23,7	-10,7	-1,9	-24,7	-4,0	-17,6	-20,0	-15,4	-24,4	-43,1	-18,5	-1,0	-7,1	-15,9		-12,2	-16,9
25	-32,9	-26,0	-17,9	-20,9	-20,5	-27,2	-20,9	4,1	-24,5	-16,4	-17,1	-26,3	-18,6	-25,6	-42,1	-7,0	-6,3	-6,8	-23,3		-13,7	-11,6
31,5	-29,9	-24,6	-8,0	0,1	-15,0	-22,0	-13,9	6,4	-30,8	-15,3	-14,7	-22,5	-20,3	-22,6	-39,1	0,4	1,4	0,5	-17,9		-10,7	-11,5
40	-20,6	-20,6	-9,4	2,9	-16,6	-19,5	-13,6	12,3	-11,9	-8,4	-7,8	-20,6	-16,7	-20,2	-32,7	2,1	5,7	4,6	1,5		-0,8	-0,7
50	-20,4	-23,3	-8,2	-6,7	-23,7	-15,3	-9,8	0,0	-16,1	-21,0	-16,8	-31,1	-32,4	-27,3	-48,7	-5,7	7,7	6,8	-7,1		-3,3	-9,1
63	-28,3	-37,1	-19,6	-20,4	-32,6	-35,1	-10,2	-6,8	-0,4	-25,0	-23,3	-39,7	-35,8	-38,3	-42,3	2,6	7,9	1,9	-6,0		-6,6	-11,1
80	-42,7	-46,5	-26,0	-19,0	-24,0	-25,4	-23,0	-10,2	-1,5	-27,9	-25,3	-45,3	-40,8	-30,4	-49,2	-2,0	12,3	6,0	6,0		4,7	1,2
100	-53,5	-43,9	-15,8	-24,6	-26,4	-18,9	-21,9	-18,1	-17,5	-23,0	-32,1	-44,8	-49,0	-35,3	-55,1	-9,0	1,5	-3,2	0,3		5,2	11,6
125	-59,9	-49,5	-27,2	-34,6	-35,0	-33,0	-34,5	-12,3	-29,0	-31,5	-41,3	-38,7	-54,3	-31,5	-57,3	-19,8	-12,1	-15,2	-8,9		-3,1	-6,6
160	-54,3	-58,1	-28,0	-38,3	-47,9	-45,6	-23,6	-12,6	-36,4	-49,7	-36,1	-58,0	-55,7	-40,2	-66,4	-29,6	-16,7	-20,5	-19,0		-12,8	-15,5
200	-55,7	-51,4	-27,8	-32,3	-42,4	-42,7	-22,9	-11,2	-34,8	-50,8	-35,3	-58,0	-55,6	-40,1	-63,2	-31,6	-17,0	-18,2	-7,7		-15,6	-20,0
250	-64,2	-44,3	-34,7	-33,2	-41,6	-40,3	-31,3	-0,6	-43,2	-55,4	-40,4	-59,8	-52,7	-40,8	-61,5	-52,9	-27,0	-17,3	-2,4		-21,0	-31,8
315	-58,8	-50,7	-34,7	-32,3	-34,3	-29,7	-31,5	4,3	-41,9	-51,7	-29,8	-54,5	-51,9	-42,7	-52,4	-52,9	-26,7	-11,8	-8,7		-31,7	-30,1

No vibration damping needed:

CEN (B314)

ENERGI (B310)

ELEKTRO (B349)

KEMI (B204, B212)

KEMITEKNIK (B227)

FYSIK (B307, B309, B310)

SPACE (B327)

Elecromagnetic fields

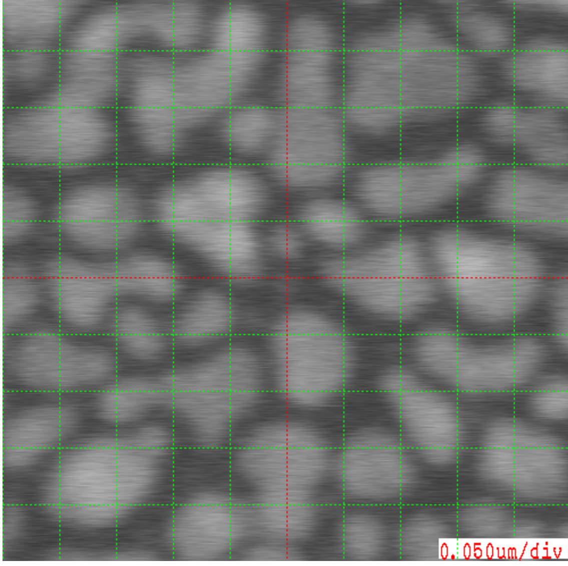
- Time varying electromagnetic fields 6000 nT (60 m away) to 22000 nT (10 m away)
  Earth's magnetic field: 25000 to 65000 nT
- Spark generation when pantograph jumps: RF noise
- Tram CB radio: RF noise

Recommendations of Force/Rambøll/CAS

- Report with recommendations will soon be released
- Vibrations
  - Damping on light rail recommended (rubber under tracks)
- EMI
  - EMI damping on light rail (wire segmentation) not recommended "only reduces field 50%" at DCH (60 m away)
  - Damping on individual equipment recommend instead (Helmholz coils)
  - 95% damping of 6000 nT still gives 300 nT (limit is 50 nT!)
  - DTU Danchip is objecting to these recommendations
- RF (jumping pantograph and tram CB radio)
  - Some equipment on campus will have a problem with this (Potentiostats)
  - DTU Danchip equipment "should not be affected"

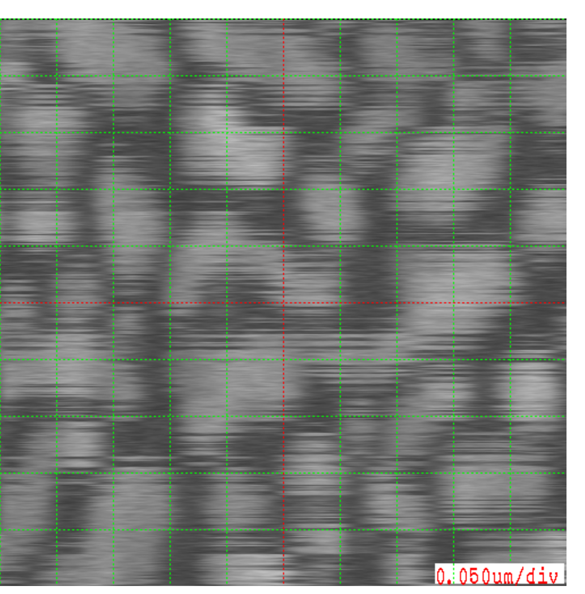
E-beam

No field applied



E-beam

150 nT p-p white noise



CEN DEVELOPMENT

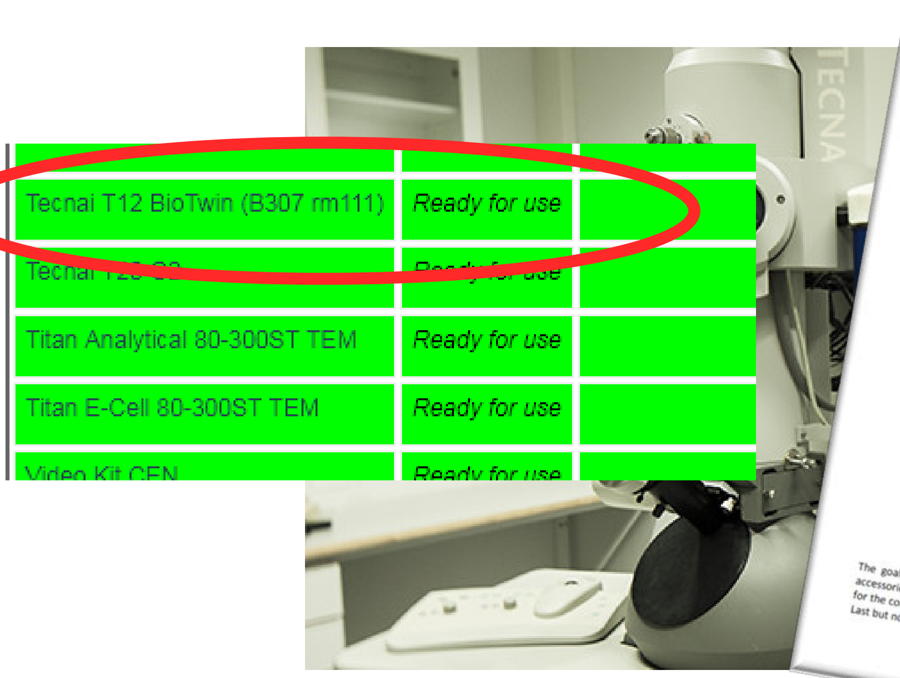
New (second hand) TEM (~~April~~ 2017)

120 kV TEM (FEI Tecnai 12)

120 kV TEM especially for soft-matter analysis.

FEI Tecnai 12 Bio-Twin Information Card

Manufacturer	FEI
Model	Tecnai 12 Bio-Twin
Emitter	LaB_6 (or W)
Resolution	0.49 nm (point)
Acceleration voltage	40 - 120 kV
Camera	Orius
Objective lens	C_s 6.3 mm C_c 5.0 mm



Tecnai T12 BioTwin (B307 rm111)	Ready for use	
Tecnai T20 G2	Ready for use	
Titan Analytical 80-300ST TEM	Ready for use	
Titan E-Cell 80-300ST TEM	Ready for use	
Video Kit CEN	Ready for use	

EDS Swap

- New windowsless EDX detector for the ATEM
- 'Old' ATEM EDX detector -> ETEM
- 'Old' ETEM EDX detector -> Tecnai T12 Bio Twin

- All this happened March 12-18
- ...and it is working ☺

Ultramicrotome (April 2018)

Ultramicrotome for Perfect Sectioning at Room Temperature and Cryo Leica EM UC7

The Ultramicrotome Leica EM UC7 provides easy preparation of semi- and ultrathin sections as well as perfect, smooth surfaces of biological and industrial samples for TEM, SEM, AFM and LM examination.

New Standard in Ultramicrotomy

Combining ergonomic design and innovative technology the Ultramicrotome Leica EM UC7 sets new standards in Ultramicrotomy. It offers a range of outstanding features and benefits of use for the ultramicrotomist, whether highly skilled or absolute beginners.

For research use only

High-Pressure Freezer

- We are aiming at purchasing a high-pressure freezer this year
- More will follow…

Associate Professor in Soft Matter EM

- Starting date June 18
- **Mériem Er-Rafik, Strassbourg**

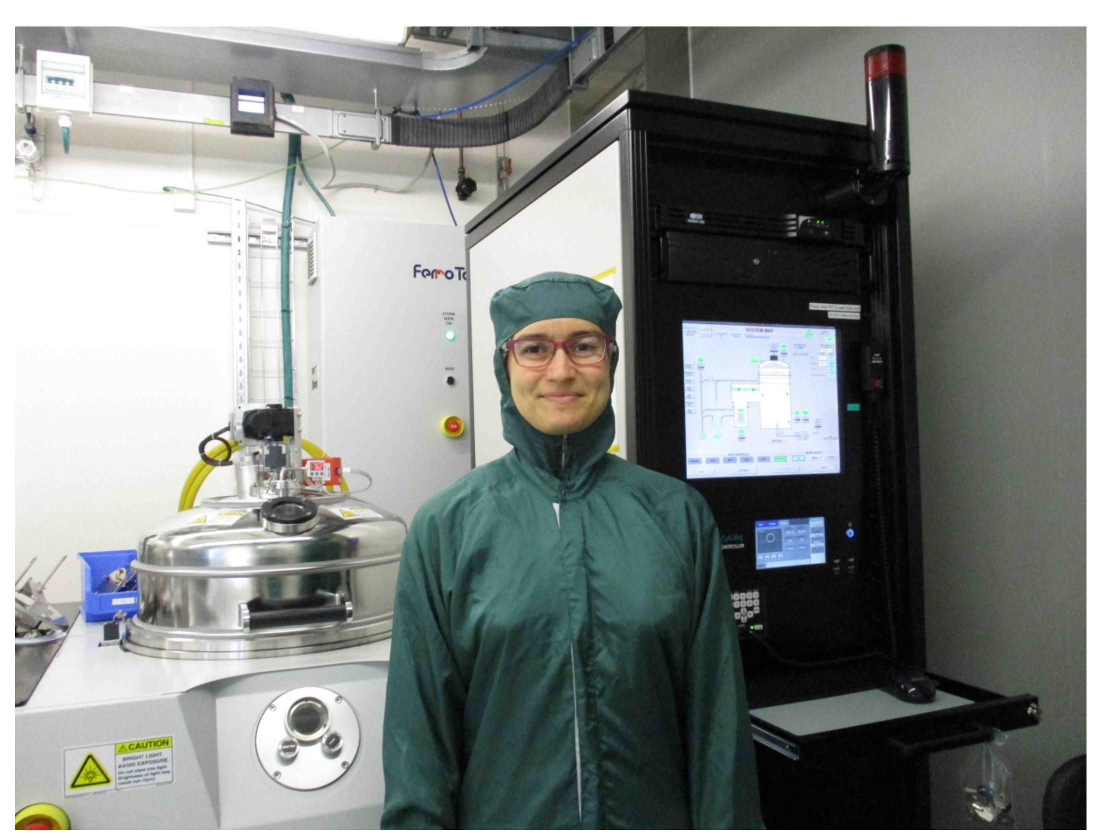
- **Scientific keywords:**
- Structure-function, self-assembling systems, intermediate filaments, antimicrobial polymers-membrane, recognition-adhesion of (bio)-polymers/synthetic molecules/nanoparticles-membranes

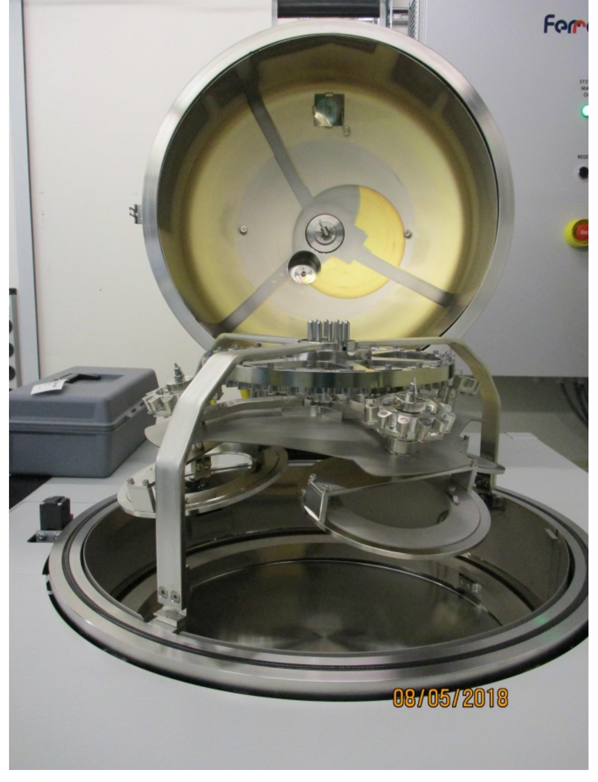
NEW EQUIPMENT

New workhorse on E-Beam Evaporation:

Direct award: FC2000 from FerroTec-Temescal

- High throughput (25 min)
- High flexibility (special holders)
- High uniformity (HULA substrate holder)





Materials so far (6 crucibles): Au, Al, Ti, Cr, Ni, Pd, Ru

Uniformity: WiW<2.5%; WtW<1%; BtB<3%

Backup/replacing Wordentec, Alcatel

Idea | Users | Funds | Tender | Contract | FAT | SAT | Manual | Released

Coming up – 2018

X-Ray Diffractometer (Rigaku SmartLab)

Material properties (crystalline/ poly/nano-crystalline):

- crystal orientation
- grain size
- electron density
- film thickness

Released to superusers

General release in June ‘18

High Vacuum RTP-system for sidewall smoothening

Direct award: (expected delivery October 2018)
ANNEALSYS: AS-Premium

Purpose/specs:

Sidewall smoothening after DRIE nano etching

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

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)

Summary Plasma etching / PVD Renewal

- **Renewal** of our old (15-25 years) **Plasma etching tools**

  - Conventional RIE – various materials — replacement found

  - AOE (STS) for etching dielectrics (oxides/nitrides) — supplement found

  - Deep Si-etch of 6″+ substrates — replacement found

- **Renewal** of our old (10-25 years) **PVD tools** - looking for:

  - New workhorse on E-beam evaporation — supplement found

  - PVD multi-chamber tool: Dielectric sputter / DC sputter / central dealer — not decided

Coming up: Twin-Pegasus (version 2010)

DTU

SPTS

Twin-Pegasus: The Plan

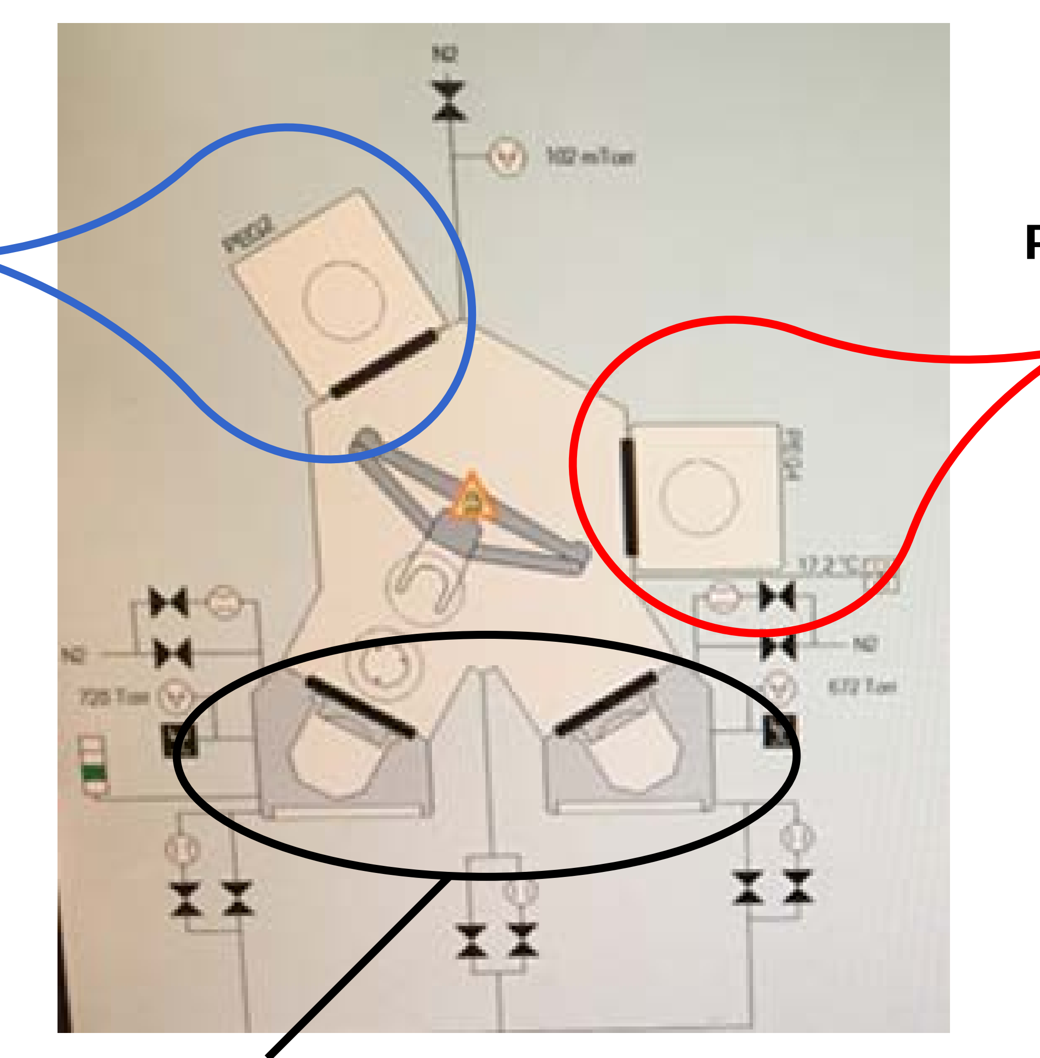
Pegasus 3

DRIE (Si) – 6″

High-throughput

Cassette-Cassette

″Workhorse″



Pegasus 4

DRIE (Dielectrics) – 6″

Reconfigure (Dielectrics)

High-throughput

Cassette-Cassette

″Workhorse″

Bring the Twins home end of June

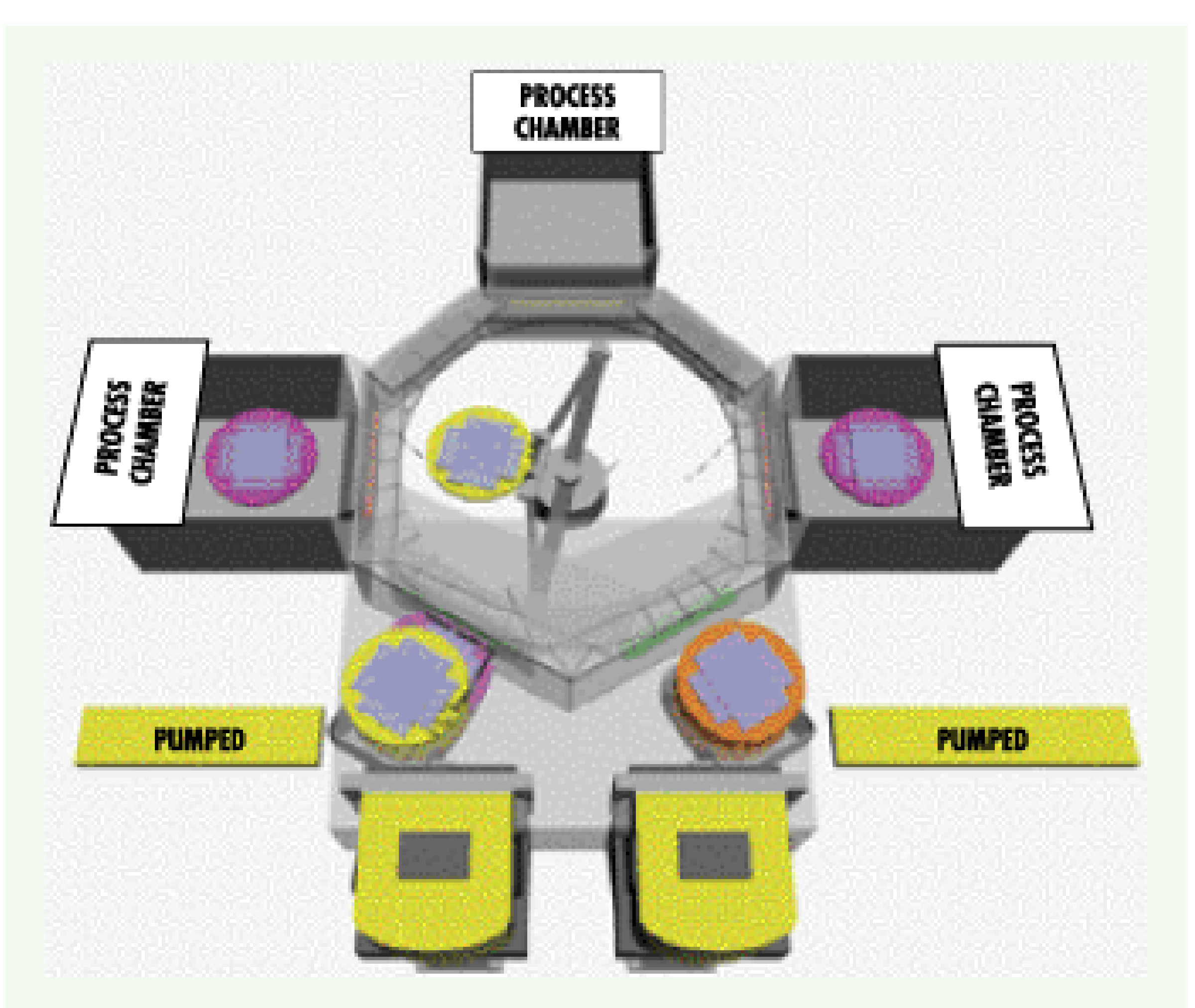
CPX Platform

twin vacuum cassette cluster

(Brooks handler)

PVD multi-chamber tool

Dual-Sputter system: New functionalities



PVD **multi-chamber** tool:

- Metals (DC sputter)
- Dielectrics (RF-sputter)
- (pulsed) DC sputter (reactive sputtering)
- Separate nitrides/oxides
- Central dealer

PVD multi-chamber tool: Candidate from Lesker

OCTOS robotic cluster tool:

- 2 x PVD75 sputter systems
- Distribution chamber (Genmark robot)
- Cassette station (10 wafer cassette)

Tests:

AlN: samples from demo-site provide (for XRD/XPS)

Other materials: SiO_2, ITO, TaO_2, TiO_x , NiV

2″ TORUS magnetron: 4″ and 6″ substrates

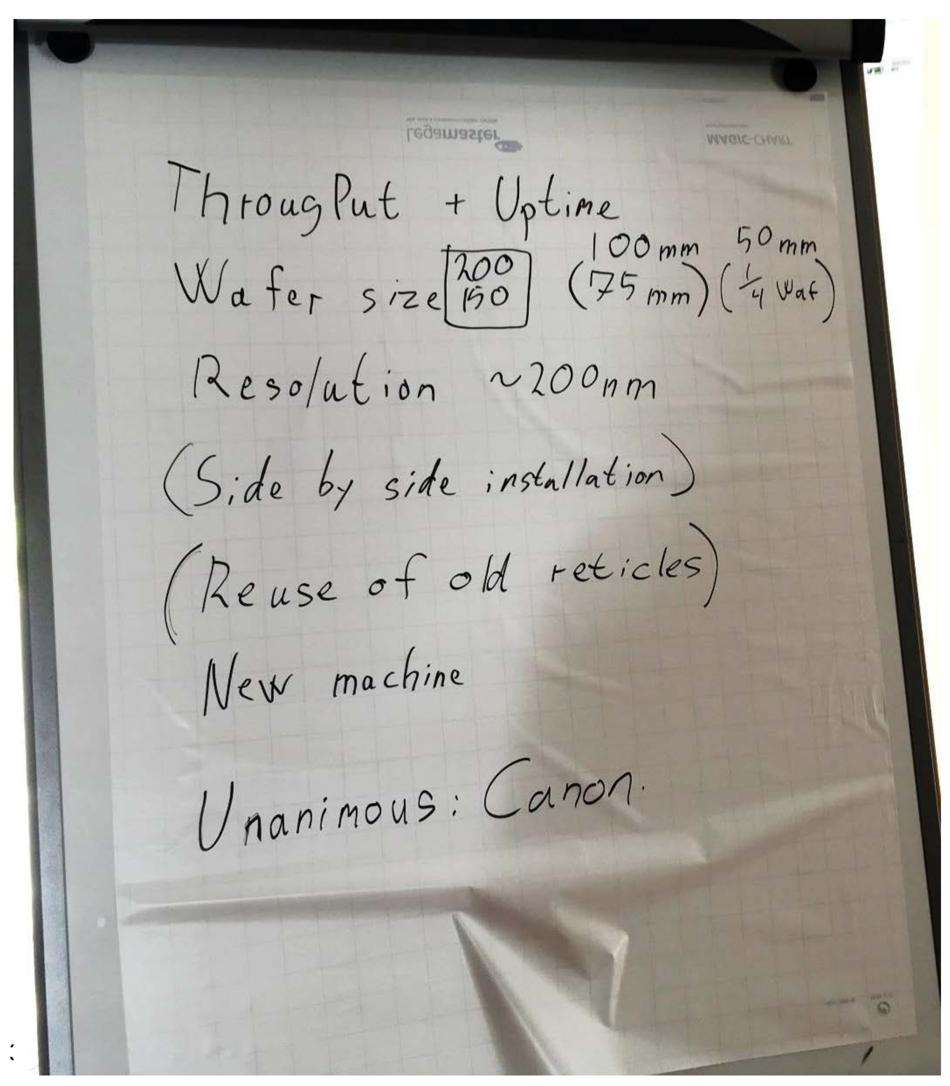
Logitech Orbis CMP sytem

- Purchased in co-operation with DTU Fotonik
- Polishing of 2, 4 and 6 inch wafers
- Polishing of 20x20mm Pieces
- Highly smooth initial surfaces, no lapping
- SF1 polish fluid and Chemcloth
- No acids or bases
- Si + SiO_2 polishing only with SF1
- Released in limited mode
  - Waste water system still under development
  - Can only be used in co-operation with Danchip staff (Rune or Claus)

Nano-Master SWC-4000

- For cleaning of polished wafers
- Cleaning of 2, 4 and 6 inch wafers
- Cleaning of 20x20mm Pieces
- Megasonic (water) and brush cleaning
- No acids and bases
- Ionizer
- Installation ongoing
- Expected release end July

DUV stepper II meeting – May 29th



Resolution

- -> 160 nm
- 150-200 nm ?
- 180 nm x2
- 200 nm x4
- As now

Wafer sizes

- 200 mm
- 150 mm
- 100 mm
- 75 mm
- 2″, 50 mm
- ¼ 75 mm, ¼ 50 mm

New DUV stepper

- DTU Danchip requirements
  - Easy to maintain
  - Fast, easy conversion between 150 mm and 200 mm
  - Acceptable process window to obtain resolution required by users
- User feedback
  - Prefer new machine – stability is a key factor
  - Resolution below 200 nm not required (now)
- Seems the new Canon 3030EX6 is the best choice
  - Only new machine
  - Most flexible

	New?	Ca. price in DKK	Light source	Type	Exp. Area	NA	Res. Limit	Ovl. Accuracy	Foot print
Canon FPA-3030EX6	Yes	40-48 mill.	KrF 248 nm	5X stepper	22 x 22 m^2 or 17 x 26 mm^2	0.5-0.65	150-180 nm	25 nm	2x4 m^2
Nikon S203B	No	30 mill.	KrF 248 nm	4 X scanner	26 x 33 mm^2	0.68	150-180 nm	30 nm	4x5 m^2
Nikon S207D	No	??	KrF 248 nm	4 X scanner	26 x 33 mm^2	0.55-0.82	110 nm	15 nm	?
ASML PAS 5500/350	No	16-30 mill.	KrF 248 nm	4 X stepper	22 x 22 m^2 or 27.4 x 14.7 mm^2	0.40–0.63	150 nm	28 nm	?

Process flow review – a standing offer

Mail: process_flow@danchip.dtu.dk

3 Lithography – 1.5µm standard		Target thickness: 100±10nm	All wafers
3.1 Surface treatment	HMDS oven	Load all wafers in oven for ~30 mins Recipe: program 4	Note time in logbook
3.2 Clean spinner	SSE spinner	Clean spinner nozzle and run the dummy wafers Recipe: 1.5 4inch	1-3 dummies Note time in logbook
3.3 Coat wafers	SSE spinner	Coat the device wafers 1.5 µm AZ5214e Novolac resist Softbake on hotplate Recipe: 1.5 4inch (Temp: 90°C, time:60 sec)	Resist thickness not checked Note time in logbook
3.4 Exposure	Aligner-6inch	Align to flat. Hard contact Recipe: xxxxxx Exposure time: 3 sec Mask: CONTACTS (dark field)	Note time in logbook
3.5 Develop	Developer bench	Develop in 351B for 60±10 sec	Note time in logbook
3.6 Rinse/dry	Wet bench/ Spin dryer	Rinse in DI water for 5 min (300±30 sec). Spin dry	
3.7 Inspection	Optical microscope	Check pattern and alignment marks	

Get feedback on:

- ✓ Process flow completeness
- ✓ Choice of processes/new possibilities
- ✓ Obvious clash with cross contammination rules
- ✓ Safety issues

The well-made process flow:

- ➢ Makes it easier to process
- ➢ Helps avoid (some) rework
- ➢ Enhances communication with Danchip and others interested in the work

http://labadviser.danchip.dtu.dk/index.php/Process_flow_approval

Outlook