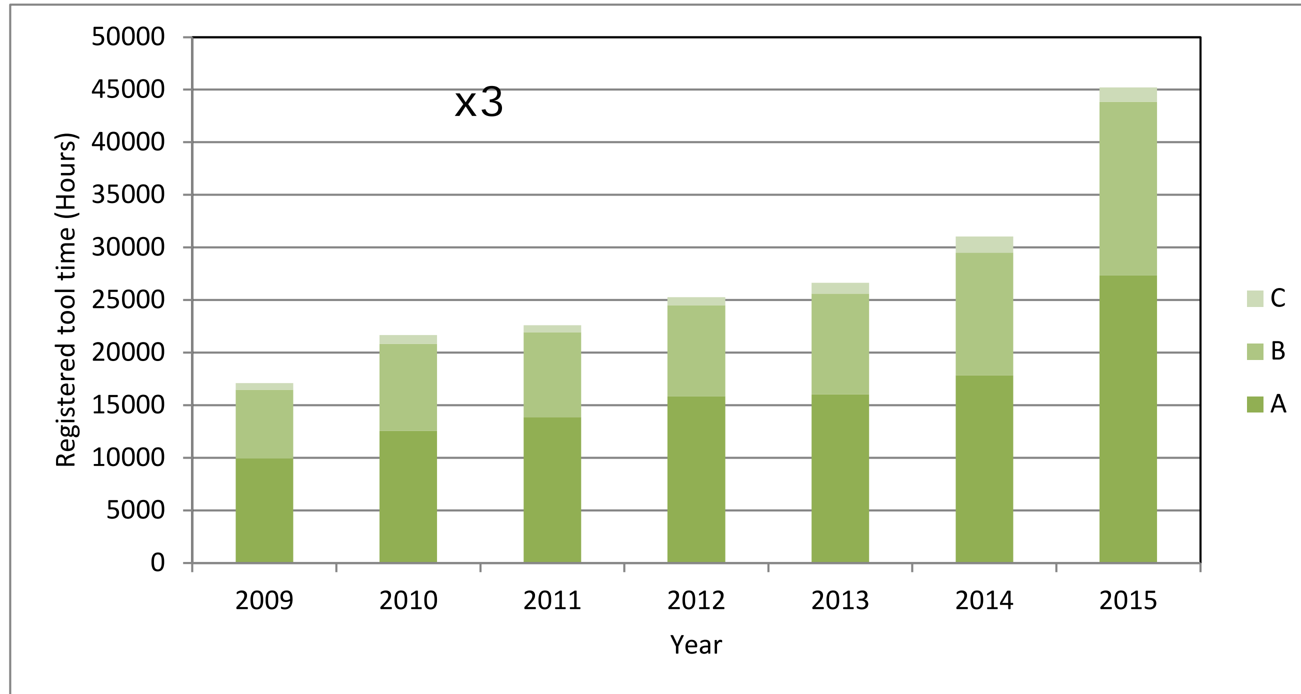
DTU DANCHIP

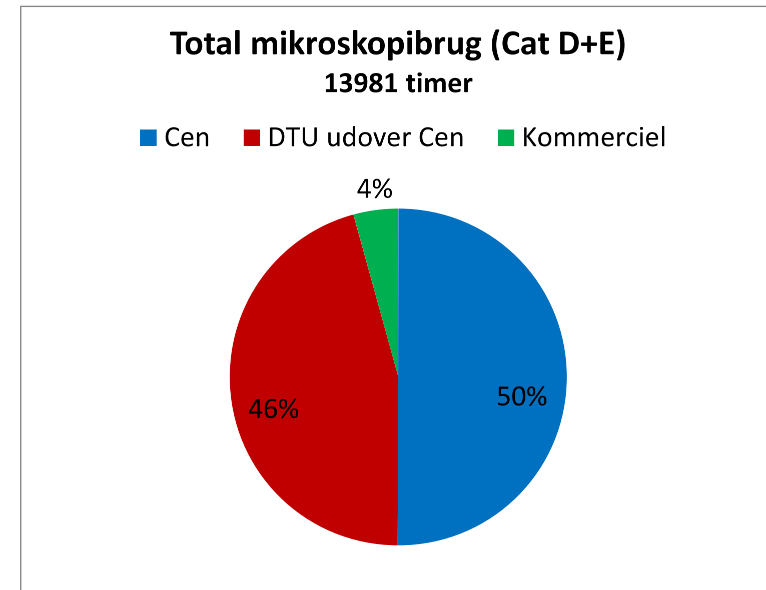
DTU Cen

TECHFORUM March 2017

Facts and figures

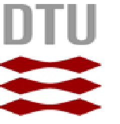
Total machine/microscope usage Danchip/Cen





- 500 registered users
- 80 total staff, 15 research staff, 7PhD stud.
- 77 peer reviewed publications (2015) with DCH/CEN staff directly involved (authored/co-authored); 6 publications in Nature Publishing Group
- Used by 15 departments and 4 Centers of Excellence (Grundforskningscentre)
- 20 companies
- 170 ext. financed research projects with budgeted activities in Danchip/Cen last 5 years

Facts and figures



Agenda

Planned Equipment purchase in 2017

Renewal of PVD equipment (=decomminssion of existing equipment)

Information on cleanroom closure week 11

E-beam update

Equipment in and out during the next few months

Following slides are leftovers and should be removed/updated

It is getting crowded.......

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Increase throughput ---- increase efficiency

A lot has changed over the last years (equipment, resists, safety)

There are plenty of new technologies available (ALD, DUV, etc)

Get a Danchip co-supervisor

Get your processes flows checked and updated

It is much more efficient **for all** to update the process flow and plan training according to an updated flow instead asking for single tool training.

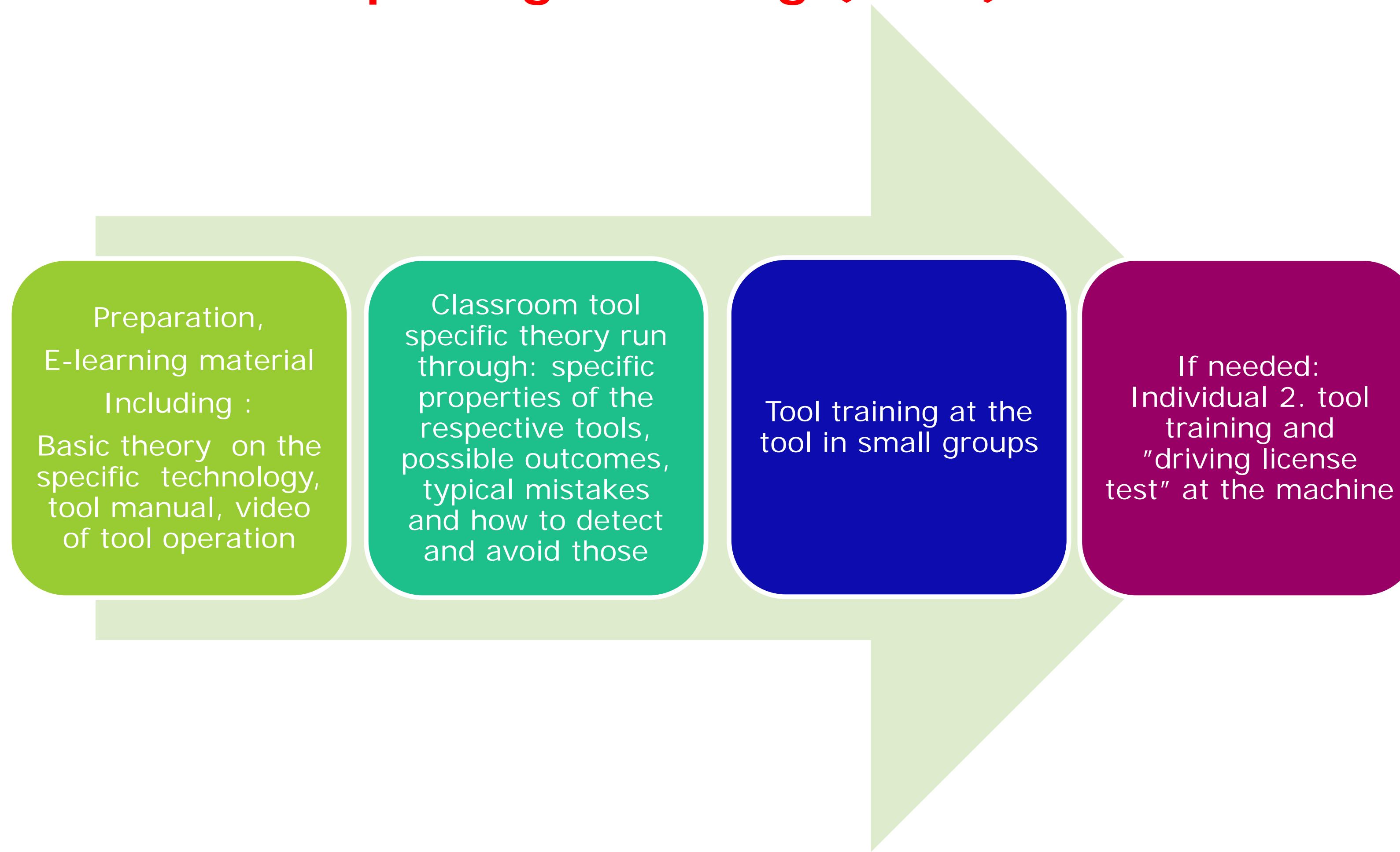
Prepare to process during fringe hours.

A more thorough introduction to cleanroom processing

Training engineers - not operators

Prevent downtime and accidents through understanding and insight

scheduled tool package training (STPT)



scheduled tool package training (STPT)

Status:

Lithography TPT

in place v1.0 (3h theoretical, 2 (1) practical training session(s), monthly

aim for: more electronic material, 1h theoretical, 1 practical training session, bi-weekly

SEM training

from 15/12 : 2h theory 2h practical training at SEM basement 346

Mask design TPT

from February 2017: 6-8 participants, distributed course over 2 weeks, ~4h classroom in total

Safety course TPT

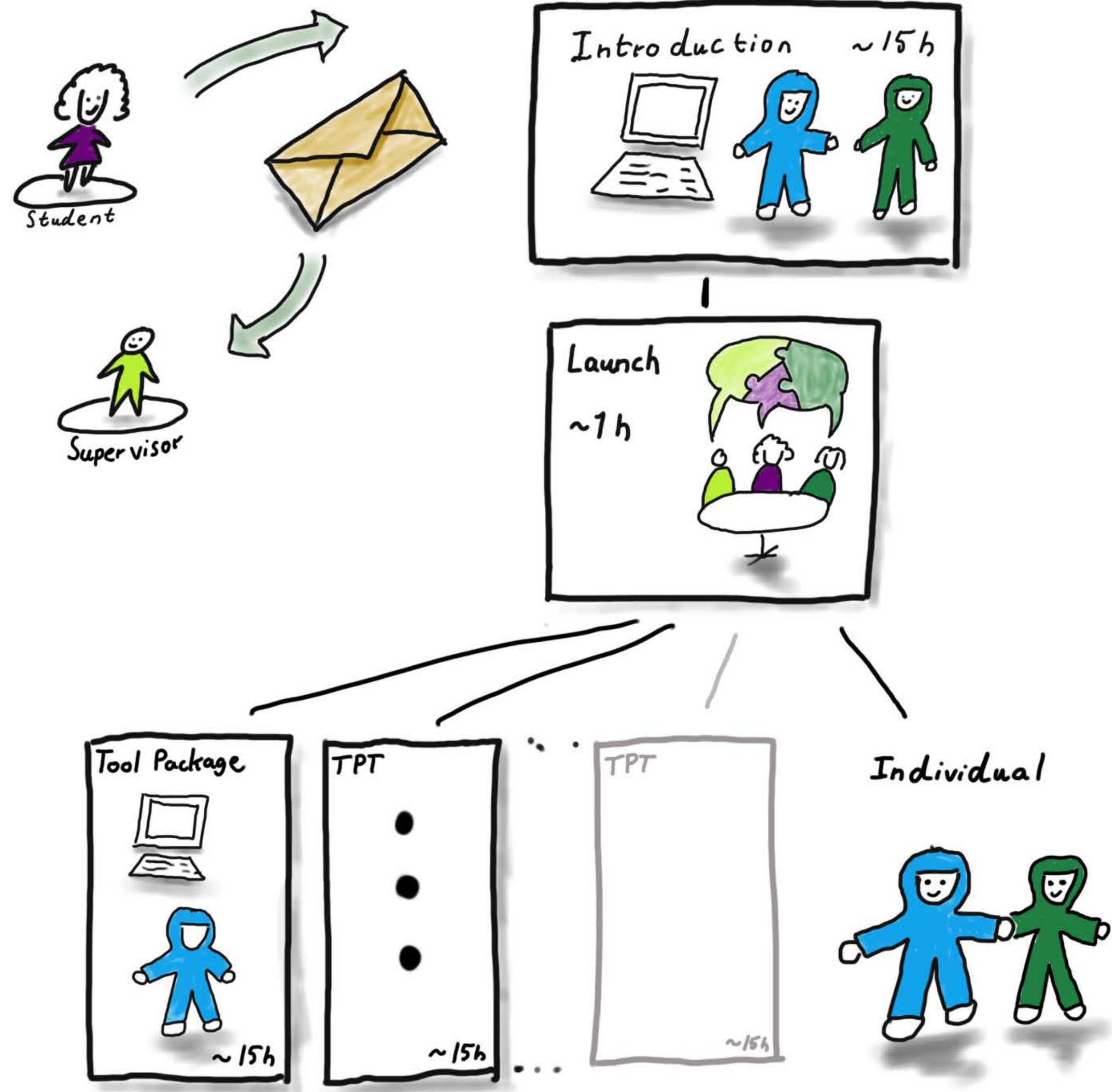
from 1/11: safety + former hands on

Soon: Etch TPT , Thin Film TPT, ...

New clean room access procedure

....faster, more efficient....

a better start into the cleanroom



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New clean room access procedure

Introduction:

Student/postdoc signs on:

- Supervisors Email (supervisor is cc′ed)
- Project type
- Projectnumber (for labmanager)
- Teaching goals
- Expected cleanroom time
- A short project description
- A possible meeting time danchip/supervisor/student

New cleanroom access procedure

Student/postdoc get the software/e-learning package

- Theoretical safety course is E-learning (video + PP with speak)
- Instructions how to use Labmanager/Labadvisor
- Access to Labmanager test site
- Exercises on usage of Labmanager/Labadvisor
- Online Test on safety in cleanroom pass/fail

New cleanroom access procedure

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Student/postdoc has passed and gets access to book practical safety course

- At least once a week
- Limited to 4 participants
- Includes chemistry handling, gowning, etc
- End with a second test pass/failed

New cleanroom access procedure

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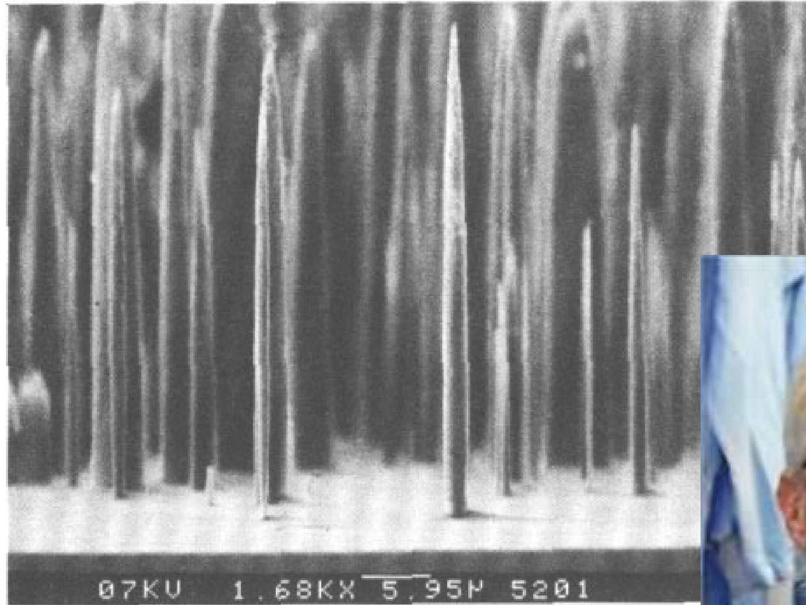
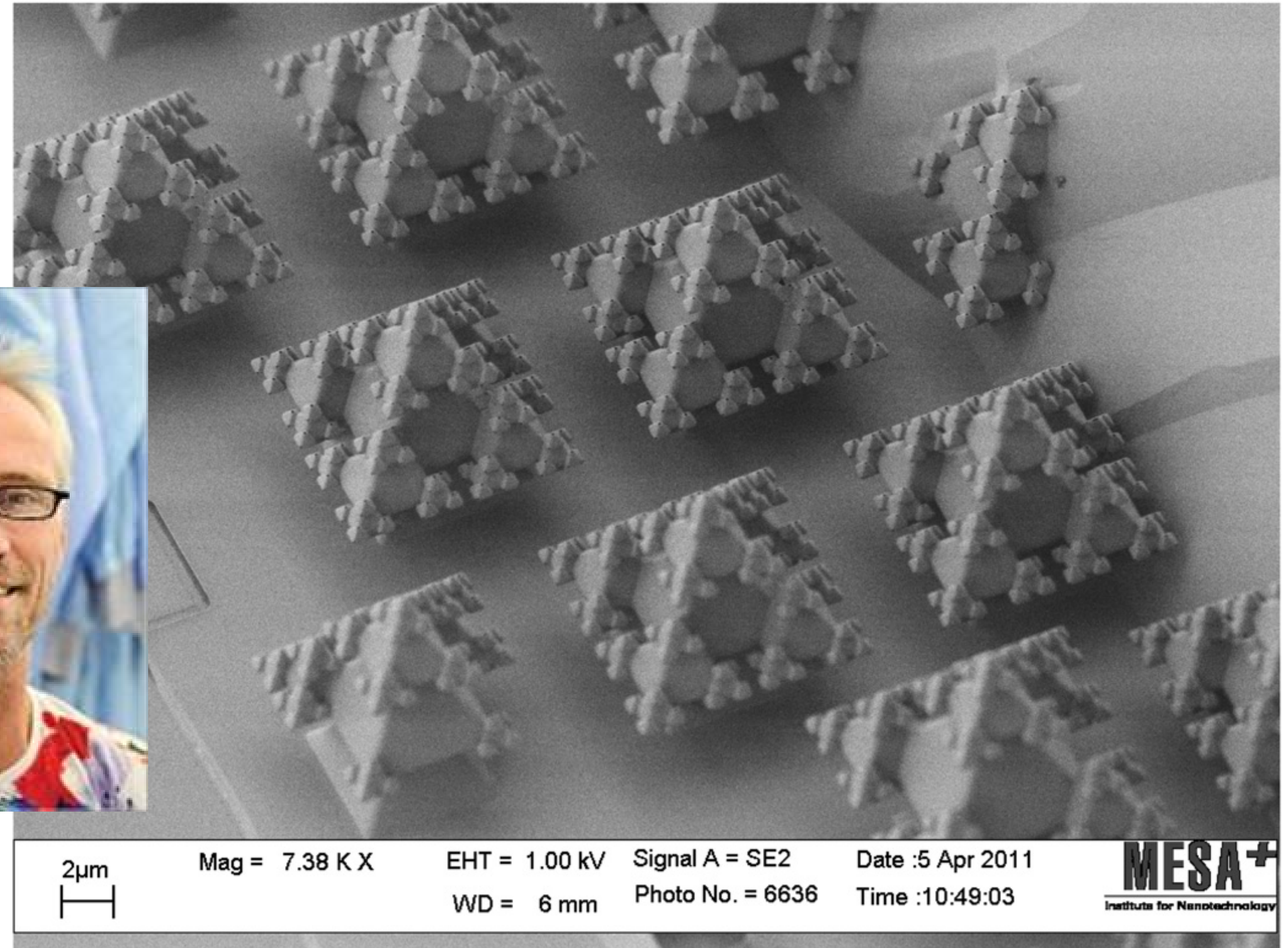
Student/postdoc has passed and books a launch meeting with Danchip and supervisor

- Process flow walk through
- Training plan, TPT, individual training
- Possible new APVs, special materials, special chemistry
- Setup regular meetings

Professor in Silicon nanofabrication

Henri Jansen started 1 nov 2016





Danchip Technology Research

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Diamond

Together with DTU Physics

Material Platform for many applications

Danchip Technology Research

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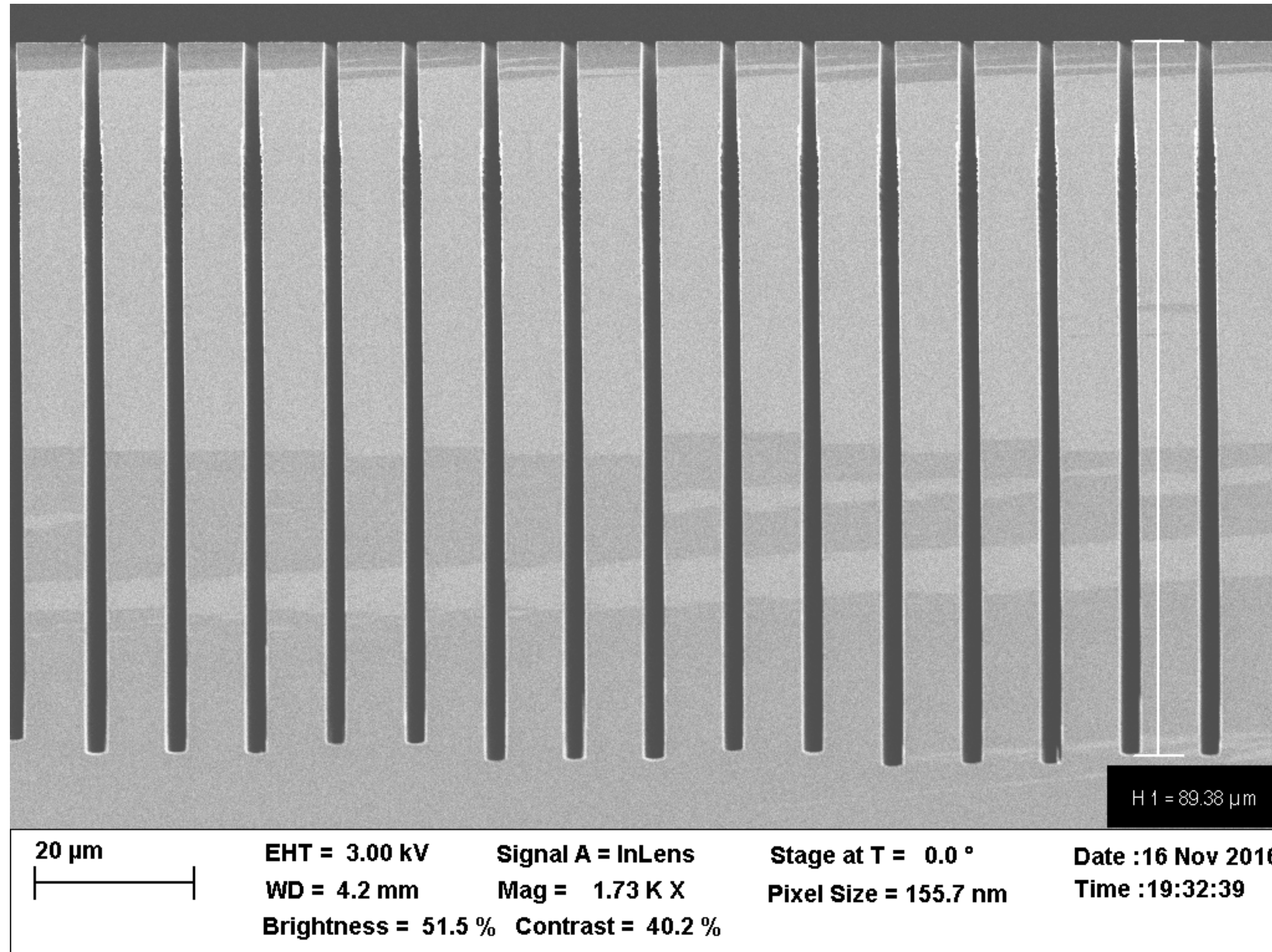
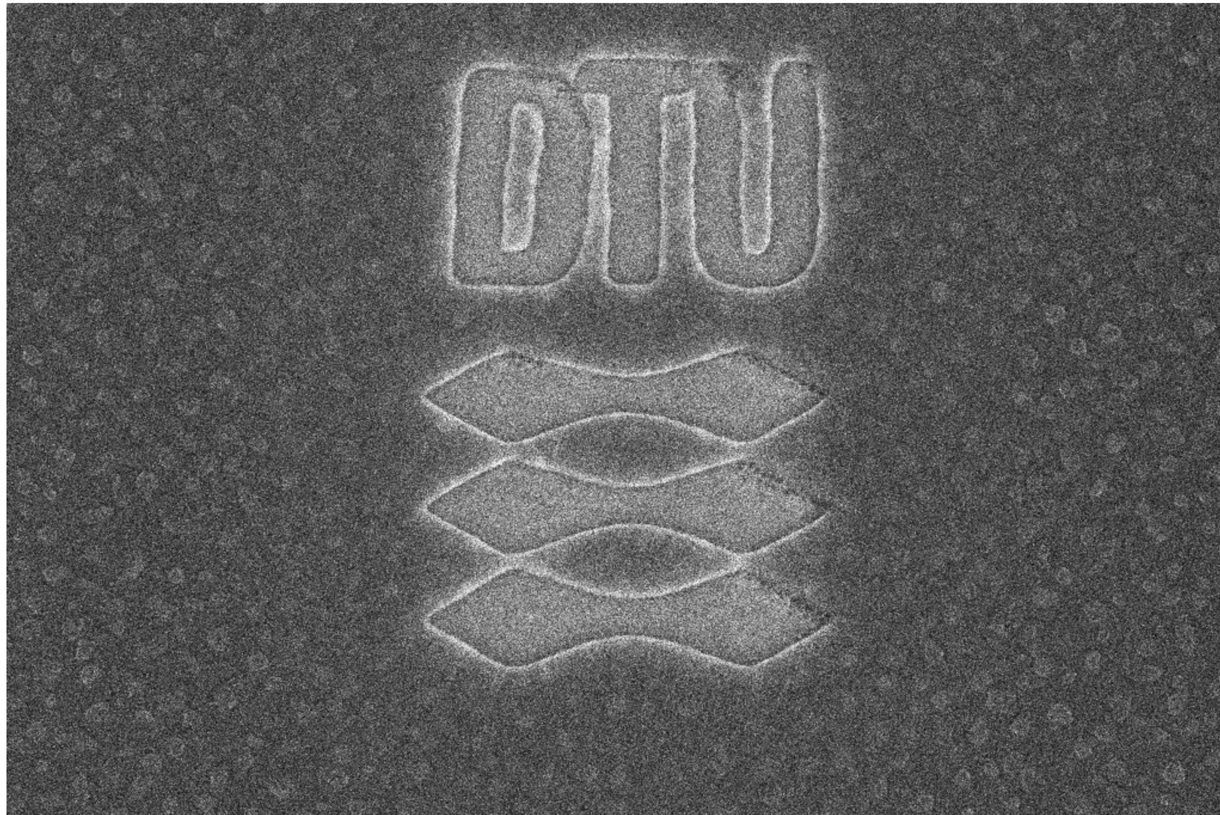
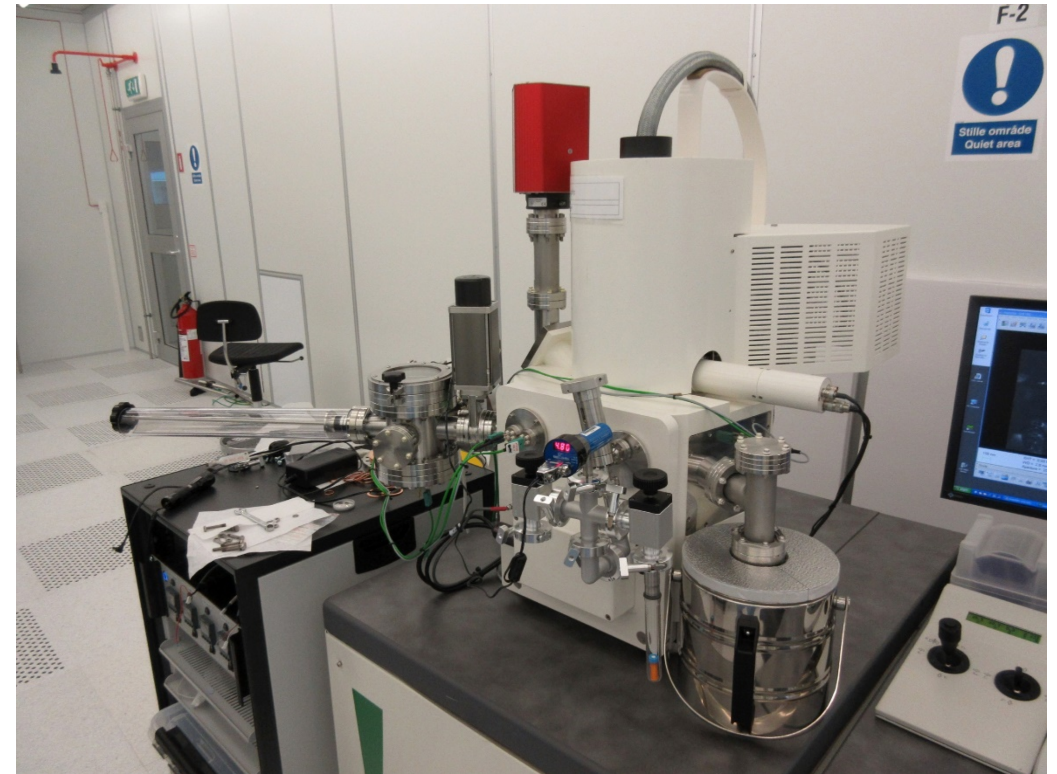
Plasma etch of Si with ASR > 70



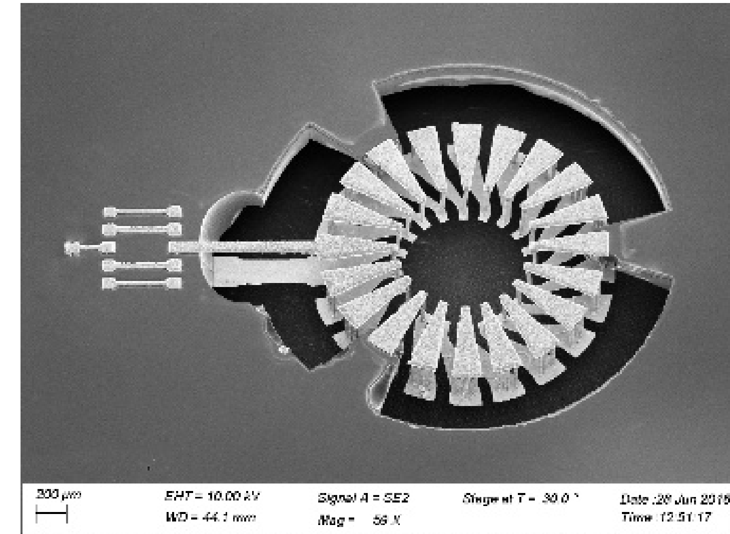
Danchip Technology Research

Ice lithography





Danchip Technology Research



Integrated inductor coils

500 μm

Soft matter electron microscopy

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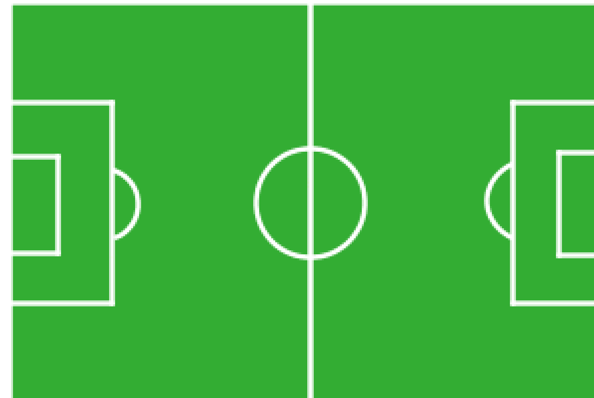
No professor this round.... find a senior associate professor

Strategic frame

useful for the "wet" sciences

characterization

not just imaging



make use of the existing toolpark with few but significant additions

try to exploit synergies with possibilities at Danchip (e.g. MEMS microfluidic sampleholder etc.)

Used BioTwin (FEI Tecnai for optimised for soft matter microscopy) purchased

NEW TOOLS & TOOLS LEAVING

Brave new fume hood world

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What are you sinking ?

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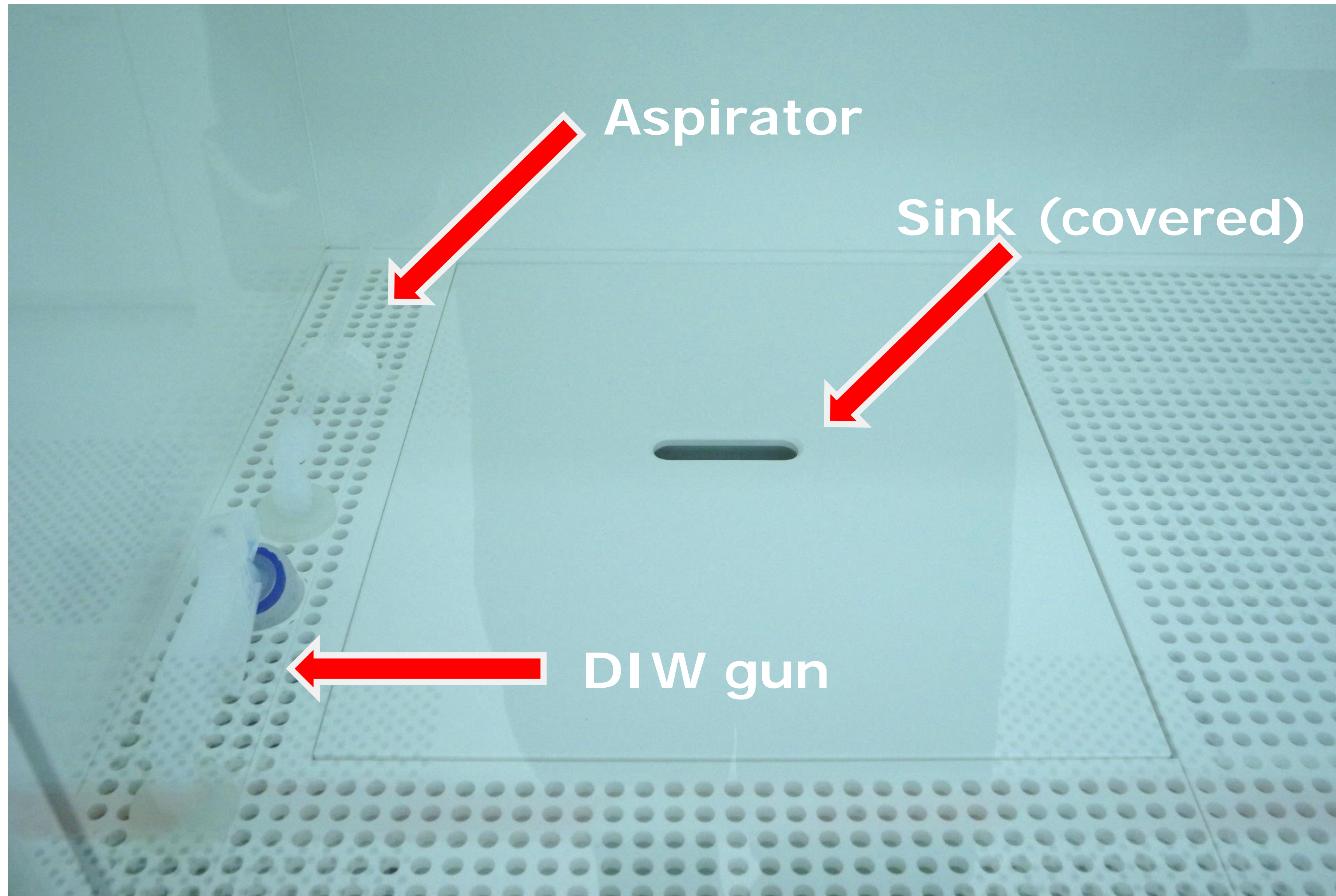
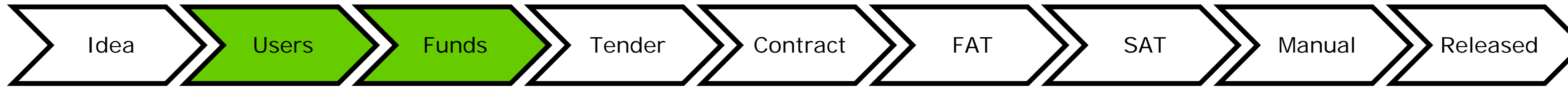


Time schedule for fume hoods and wet benches in Ballroom

- 8 fume hoods for ballroom
  - Delivery: August 2016
  - Expected release: December 2016

- 7 Wet benches for ballroom
  - Delivery: October and December 2016
  - Expected release: 2017Q1 and Q2
  - Old nitride etch will not be removed before new bench working
  - Use other KOH baths in transition period

- 2 spinner wet benches + 1 cleaning fume hood for E-5 (litho)
  - Delivery: January 2017
  - Expected release: 2017Q3



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X-Ray Diffractometer

- Background:
  – Complementary in-line material analysis (crystalline/ poly/nano-crystalline)
  – Co-funding (Danchip/Fotonik)

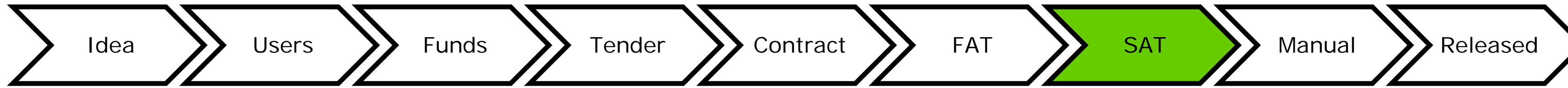
- Material properties:
  - crystal orientation
  - grain size
  - electron density
  - film thickness

Table-top Thermal Evaporation

- resistive heated boat (simple system)

- Background:
  - Heavy load on Wordentec
  - Improve flexibility/costs

- Simple (cheap) system:
  - low budget (ca. 30 kEuro)
  - table-top
  - single stage
  - 1-2 boats (resistive heated)



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Pegasus 2

- Background:
  - Bottleneck situation on Pegasus
  - Plans for intensive research in silicon etching (a.o. nanoetch)

- Actively pursuing 2nd hand system
  - Roy goes to Morocco

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plasma/thermal ALD from Picosun

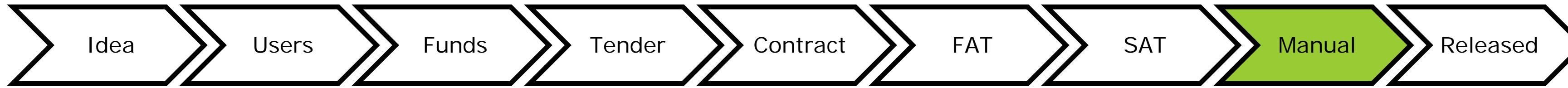
Motivation

- High utilization, bottleneck tendency
- No in-house back-up
- Limited capacity for new precursors

Key features

- Highly flexible ALD system, thermal & plasma-ALD
- Stacked substrates (pieces – 8″ wafers)
- ″Work horse″ as well as new capabilities
- New chemistries, e.g. for metals and metal nitrides
- Low temperature processes

Under installation – acceptance planned for 2016Q4

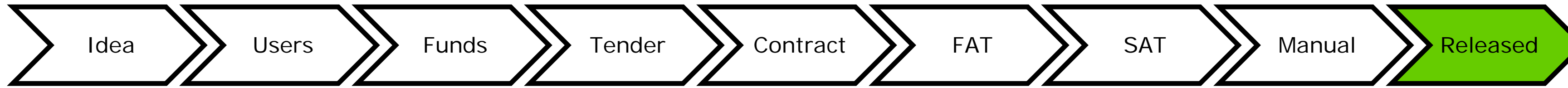


PECVD-4 – replacement of PECVD-1/2

- SiO / SiN / SiON / BPSG / (~~Ge-doped~~)
- Including stress-tuning capability
- Refurbished SPTS system (2011)

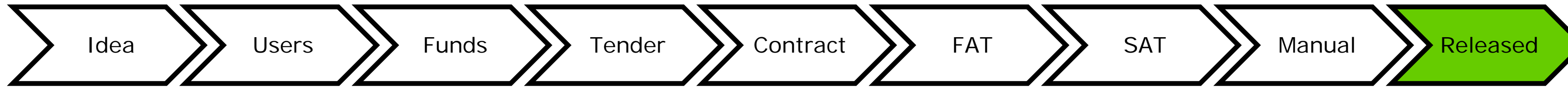
Installation "almost" done

- Initial functional tests
- Toxic lines need running in
- He line missing.



New bonder tool

- Pre-align in KS MA-6 aligner, then bond in KS bonder
- Released for use
- Standard processes established
- No user editing of recipes
- Transfer processes from EVG 520 NIL now – talk to Rune



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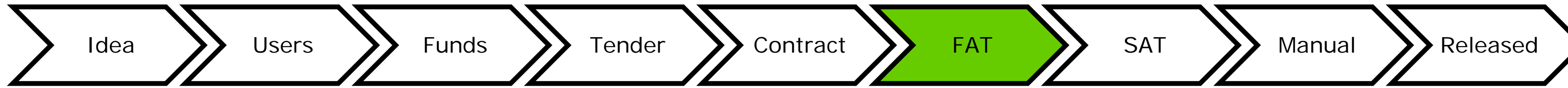
New imprint tool

- CNI 1.5 from NILT replaces NIL on the EVG 520
- Alignment not possible
- Heating up to 280 deg. C
- Later: Also a CNI 2.0



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Heidelberg maskless aligner

- UV LED illumination, 365 nm
  (can expose all g-, h-, and i-line photoresists)
- Minimum feature size: 1 µm (on 0.5 µm resist)
- Linewidth variation, 3σ: 200 nm
- Alignment accuracy, 3σ: 1 µm
- Maximum substrate size: 6″ x 6″
- Minimum substrate size: 5 x 5 mm²
- Maximum write area: 125 x 125 mm²
- Substrate thickness: 0.1 to 6 mm
- Average writing time: Ca. 4 hours for 4″ wafer
- Grey scale exposure possible
  (Process development needed)
- Suitable for rapid prototyping
- Unsuitable for many wafers
- NO mask making! There is no business case.

High speed camera

Installed

RESOURCES

MODEL 1095

DATASHEET

OneView camera

SPECIFICATIONS

Specification	Benefit
Base system	
4096 x 4096 pixels, 15 μm pixel size	Enable ultra-high-definition (UHD) image resolution in a large sensor for wide field of view
25 frames per second (fps) while operating at full 4k x 4k resolution	Always operate at TV rates at full sensor resolution, no binning required
Real-time drift correction	Automatically remove drift and outliers in real-time across all image capture modes
Scalable dynamic range	Eliminate restrictions associated with a traditional dynamic range specification
GIF compatible	Install above GIF system, without impact to performance or operation
In-situ option	
Stream 4k x 4k resolution images at 25 fps directly to disk in *.dm format	Eliminate workflow bottlenecks when capturing large *in-situ* datasets
Up to 20 s LookBack capability	Never miss the start of a reaction with post-event triggering
	Capture only data that matters to you
>15 min data storage capability	Store several 4k x 4k resolution at 25 fps data sessions on a single computer; expansion capability available

Tools leaving the cleanroom

- SSE Maximus. Will be shut down in 2-4 weeks
- EVG NIL 520 & aligner 510. Will be shut down in 2-4 weeks
- Nanoscribe 2 photon polymerization. Will be moved out of the cleanroom
- Old wet benches in Ballroom (replaced by new benches and fume hoods)
- Wet benches in C-1 (old yellow room)
  - Replaced by new wet benches in Ballroom
  - Will stay until new benches are ready
- SIMS (no replacement – use external services)
- PECVD-2 (replaced by PECVD-4)
- Cryofox
  - too unstable / too expensive (running costs)

MONEY ISSUES

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Material changes 2017

- Cost of DUV resists is significant and will be added as a materials cost
  - DUV42S-6: €2040 for 4l: 3.80 kr/ml
  - KRF M35G: €1100 for 1 gallon: 2.17 kr/ml
  - KRF M230Y: €1100 for 1 gallon: 2.17 kr/ml

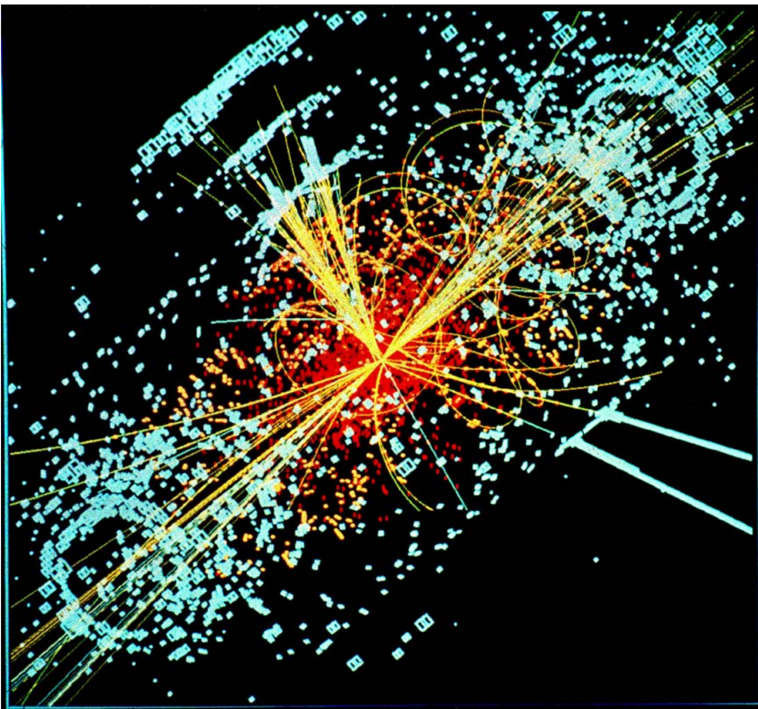
  - For 25 wafer with ~3 ml of BARC and resist: ~450 kr

- Relative prices for noble metals have changed significantly:
  - Separate pricing for Gold, Platinum, Palladium
- Wish to automate registration:
  - Use machine readout - crystal information, internal gauges

Unified price model for Danchip/Cen

Complete overhaul including:

- Re-evaluate cost objects for UK95 (Academic) justification
- All registrations in "Anlægs kartotek" audited and corrected for funding agencies/infra-structure funding/private funding
- Capacity/actual hours puzzle solved for the categories
- We have been requested not to have a buffer for academic prices



Overall results

- Commercial pricing: No changes
- Academic pricing: Mainly increases
- H2020: No change

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Prices – external commercial users (UK90)

Service from Danchip	New price 2017	Present price 2016	Unit
Cleanroom access (below cap)[a)]	800	800	kr/h
Danchip assistance	1250	1250	kr/h
Cleanroom area	1600	1600	kr/m²/mo
Category A tools	370	370	kr/h
Category B tools	630	630	kr/h
Category C tools	3600	3600	kr/h
Category D tools	1200	1200	kr/h
Category E tools	1700	1700	kr/h
Category F tools[b)]	0	0	kr/h

a) Cleanroom access above cap of 20 hours is 0 kr/h

Early warning for costs – external funded projects and users (UK95, other universities: UK10)

+ overhead

Service from Danchip	Ecpected cost 2017	Present cost 2016	
Cleanroom access (below cap)[a)]	550	350	kr/h
Danchip assistance	550	450	kr/h
Cleanroom area	(500)	(200)	kr/m²/mo
Category A tools	170	160	kr/h
Category B tools	400	300	kr/h
Category C tools	2100	1800	kr/h
Category D tools	550	800	kr/h
Category E tools	1300	1200	kr/h
Category F tools[b)]	0	0	kr/h

a) Cleanroom access above cap of 20 hours is 0 kr/h

Subject to auditor approval.

3 TO TAKE HOME

- Changes in access procedure, safety course, training (TPT)
- Professor started – collaboration projects welcome !!
- 16 new fumehoods
- ALD, maskless aliner,