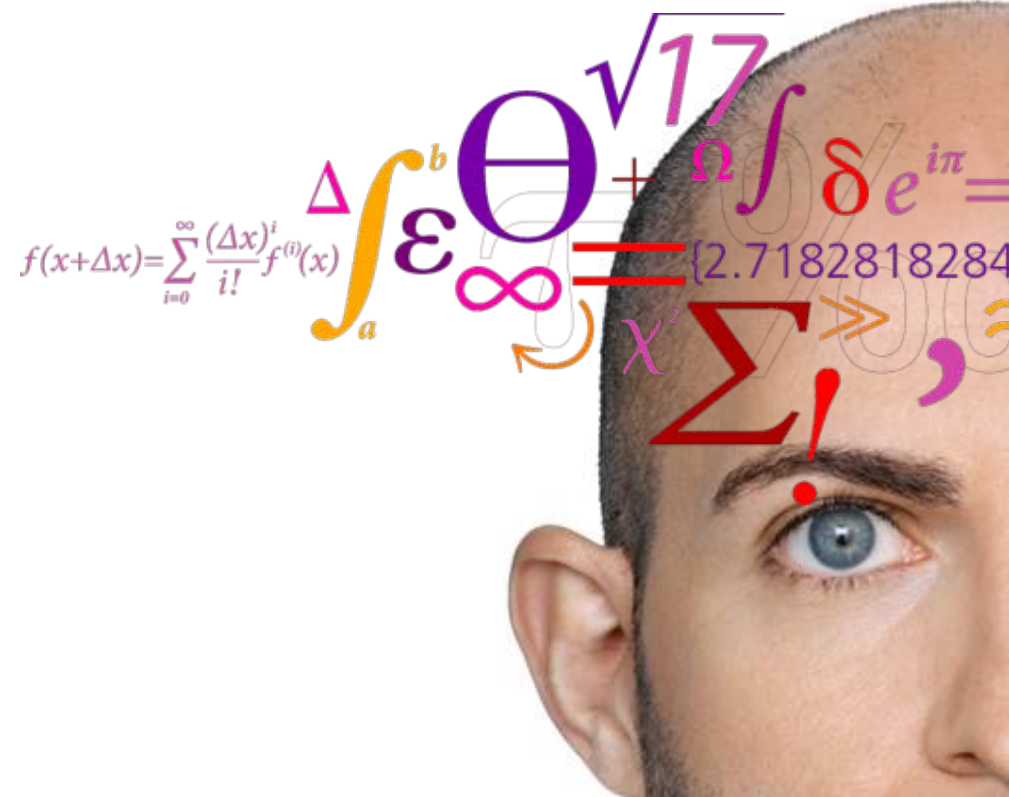


# Customer meeting 2013



# AGENDA

**Introduction Jørg**

**Price and Payment model Anders**

**Safety & facility Leif**

**Equipment and Technology Leif & Flemming**

**Wrap-up Jørg**

## DTU CEN AND DTU DANCHIP

DANCHIP, CENSHIP, CENDAN, CHIPCEN AND ALLE THE OTHER PERMUTATIONS.....

Cen and Danchip will be merged from 1/1 2014

This implies:

- they will be one administrative unit
- they will have Jörg Hübner as the director
- Andrew Burrows will be head of Cen

The two units will not:

- co-locate
- change name/brand

## DTU CEN AND DTU DANCHIP

### REASONS FOR THE MERGER:

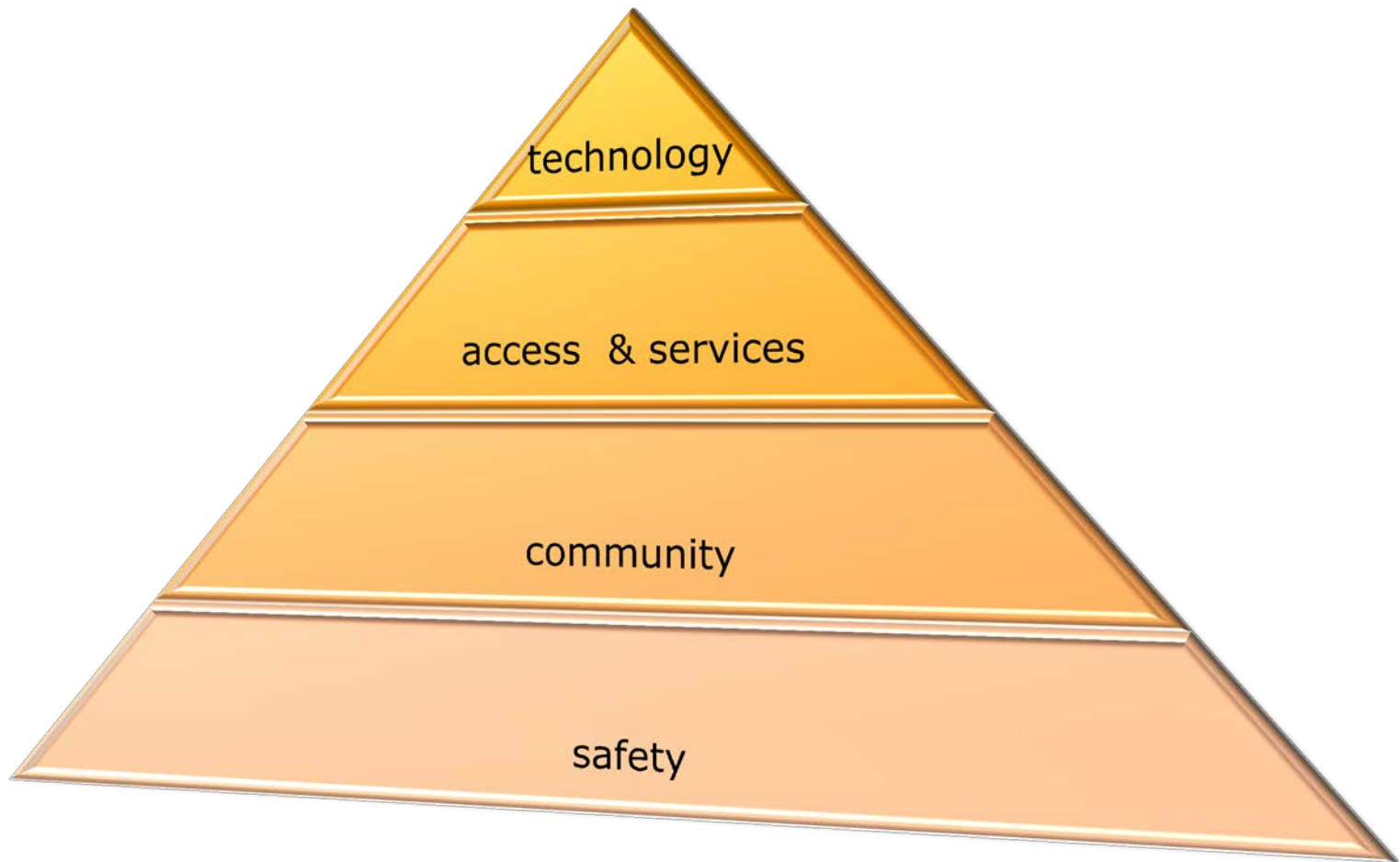
Both units are rather small compared to other DTU units

Exploit synergies: one unit is fabrication nanostructures the other is visualizing and analyzing nanostructures

One unit has extensive research the other unit has research plans

One unit has spent a considerable effort on access, booking, registration and payment systems of which the other unit will profit

# WHAT IS DANCHIP



**Use of Danchip is free of charge  
for all DTU departments for  
internal projects**

# What are internal projects ?

Projects started by a research group without specific external financing

Example:

- Ph.D. project exclusively paid by DTU stipend/ base funding
- Clean room work carried out by base-financed personnel not attached to externally financed projects

# What does free of charge mean ?



All (reasonable) cleanroom usage including hourly rate of cleanroom fee and machine use.....

Not including explicit materials e.g. wafers, thick noble metal layers, masks etc



# Commercial use vs. academic use

Academic use includes all cleanroom use for any academic research project internally and externally financed  
Eg. HTF, FTP, Innovationfonden etc.

Commercial use is all use of Danchip carried out by or for a commercial entity.

Unless the specific work is carried out under the frame of a publicly financed research project.

# Do we get a bill for academic cleanroom use?

No, all cleanroom work has to be registered to a project (internally or externally financed)

If the project is externally financed it will be billed to the project's cleanroom budget according to the registration with so-called UK95 cost

If the project has no external source of finance (left) only materials will be billed.

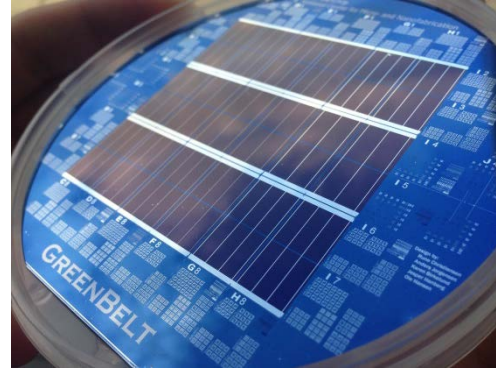
**All use of Danchip has to be registered in LabManager under the specific project by the respective user**

**Commercial use of  
Danchip has to be  
registered in LabManager  
under the respective  
commercial entity**

**When applying for a project the anticipated cleanroom costs have to be included in the application and should be carried by the external funding agency**

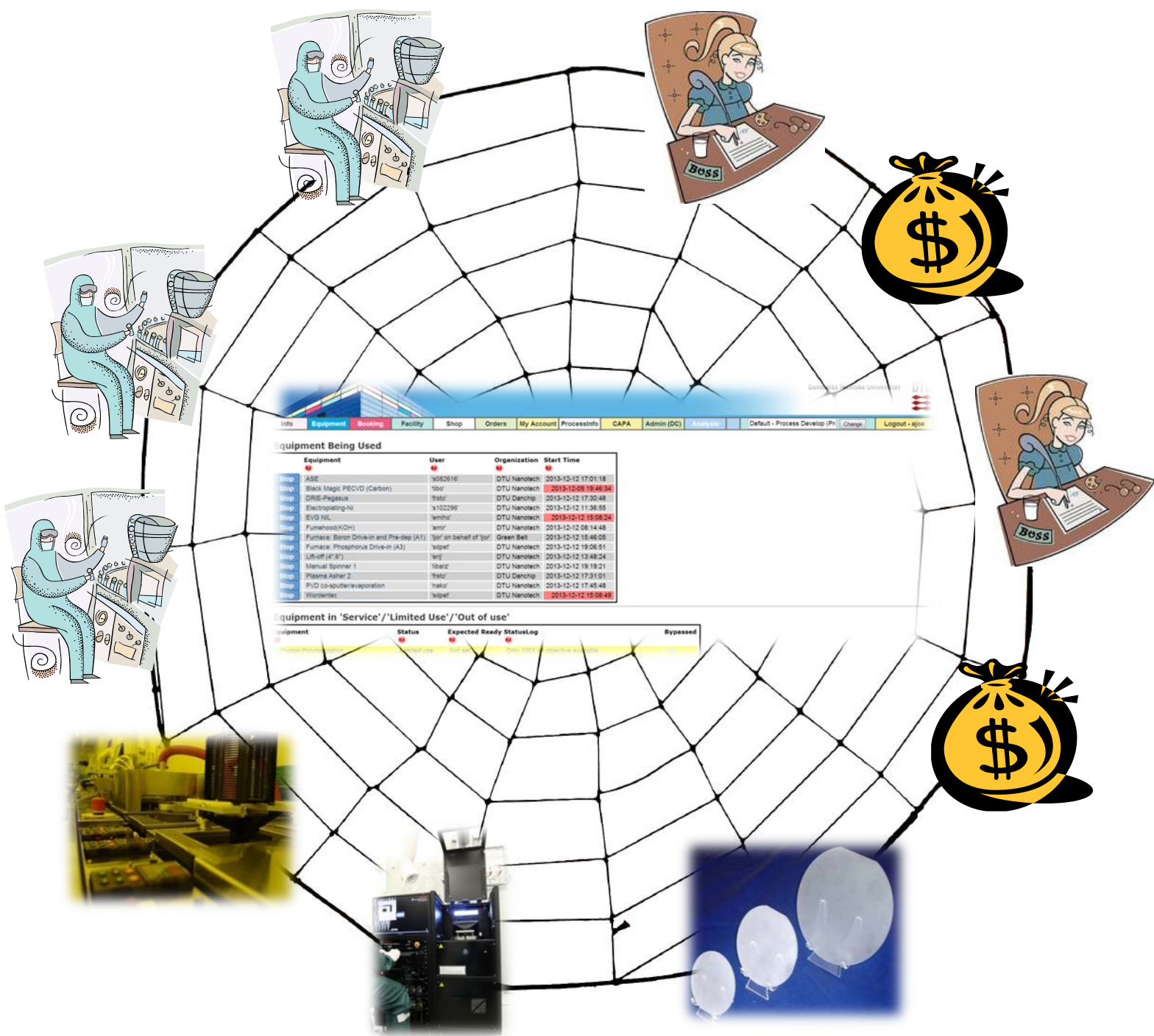
please ask us for assistance to estimate the cleanroom cost

# PRICE AND PAYMENT MODEL



- Building
- Facility
- Materials
- Tools
- Danchip staff







# Labmanager - Sponsor and Projects

Danchip user 'AJOE'



LM Sponsor '87035 – HTF Stepper'

Picks up 'bill'

Has an administrator 'Boss'

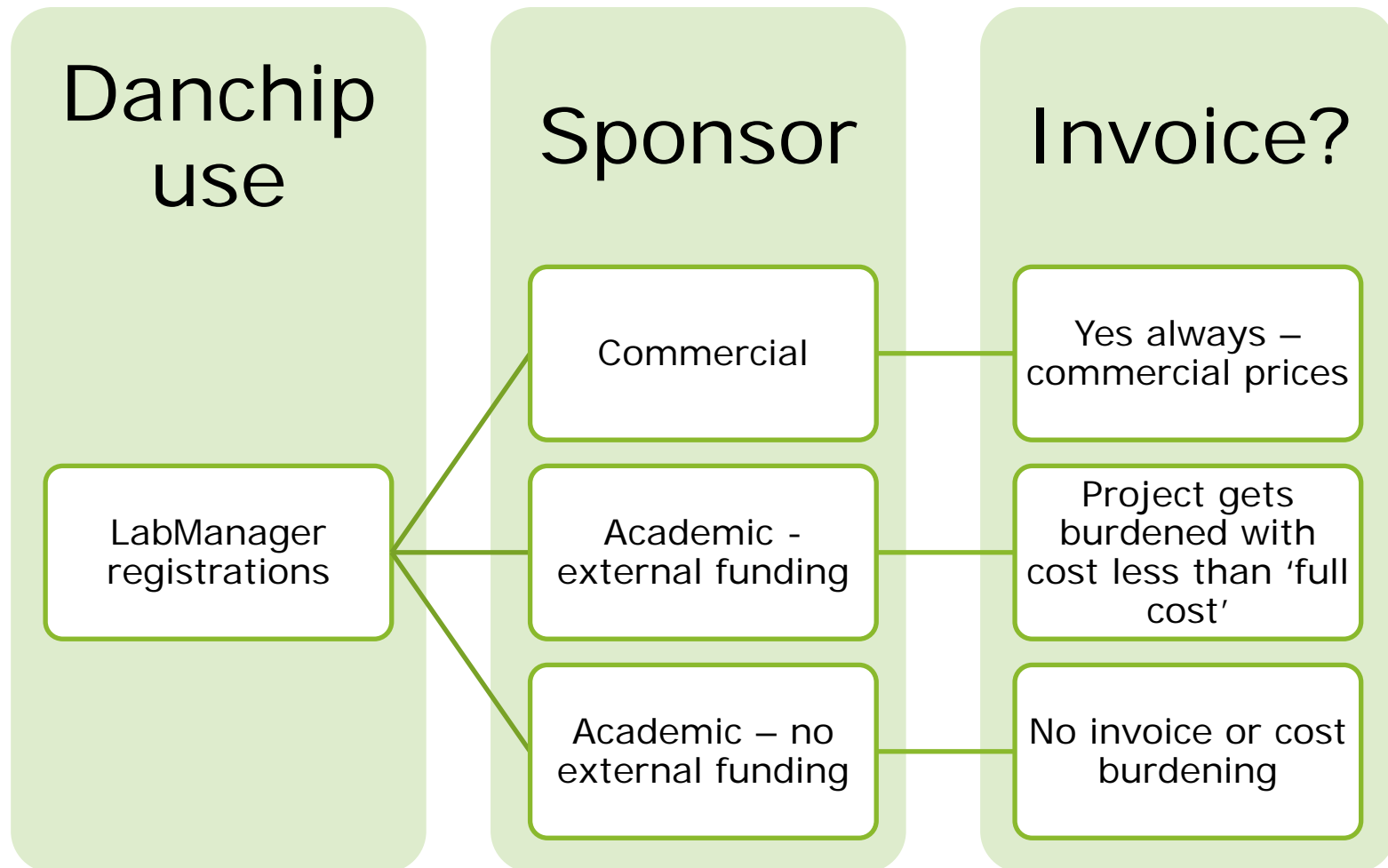


LM Project 'Default - 87035...'

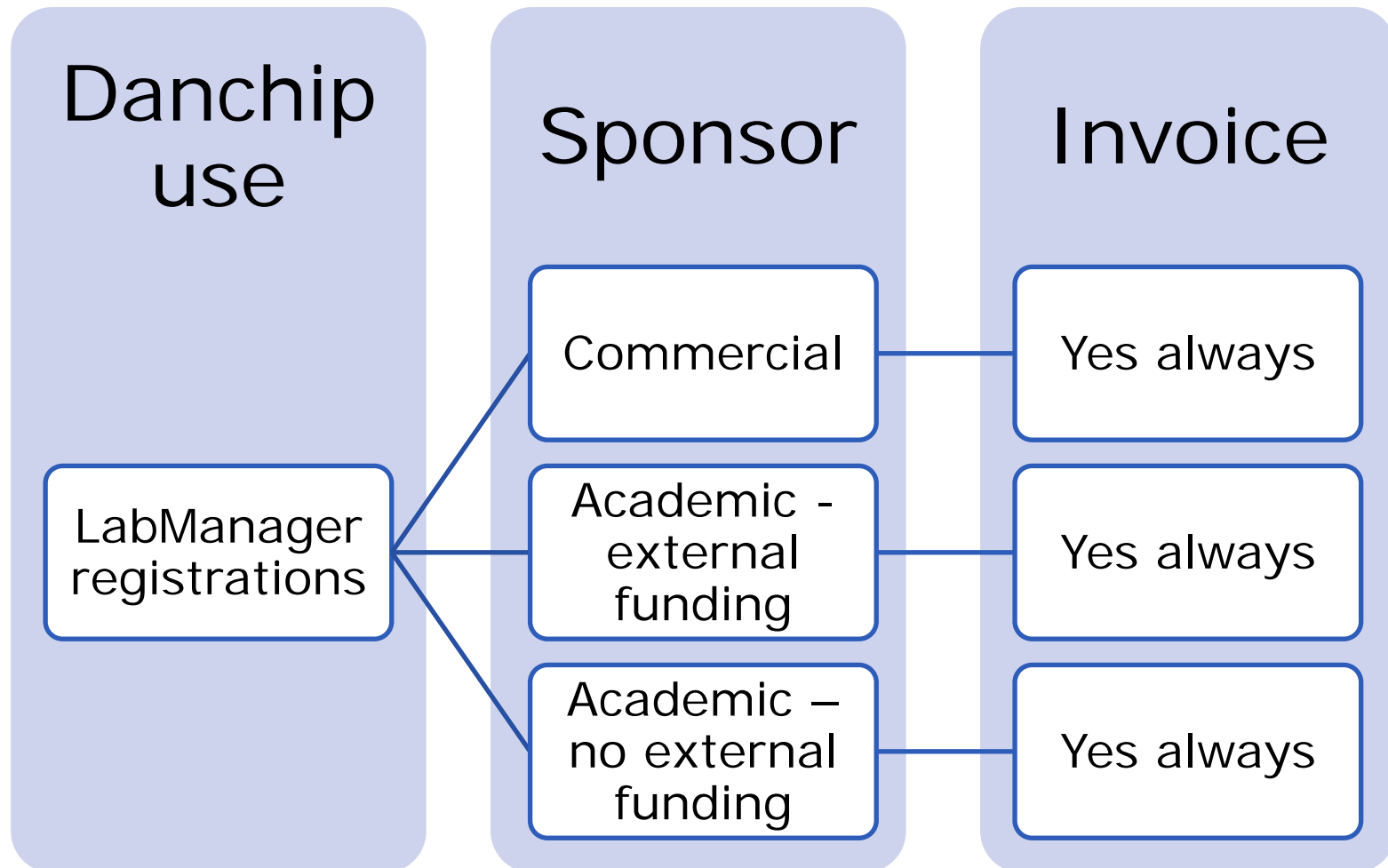
Could be 'Broadband grating'

Structuring, cooperation

# Payment model – non-material usage



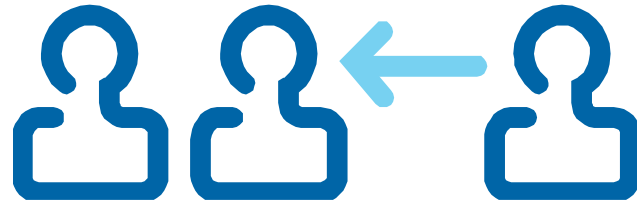
# Payment model – Material usage



# LabManager Administrative changes

Strengthen Admin to accept/reject users

In essence the user asks Admin if she will sponsor the user's work

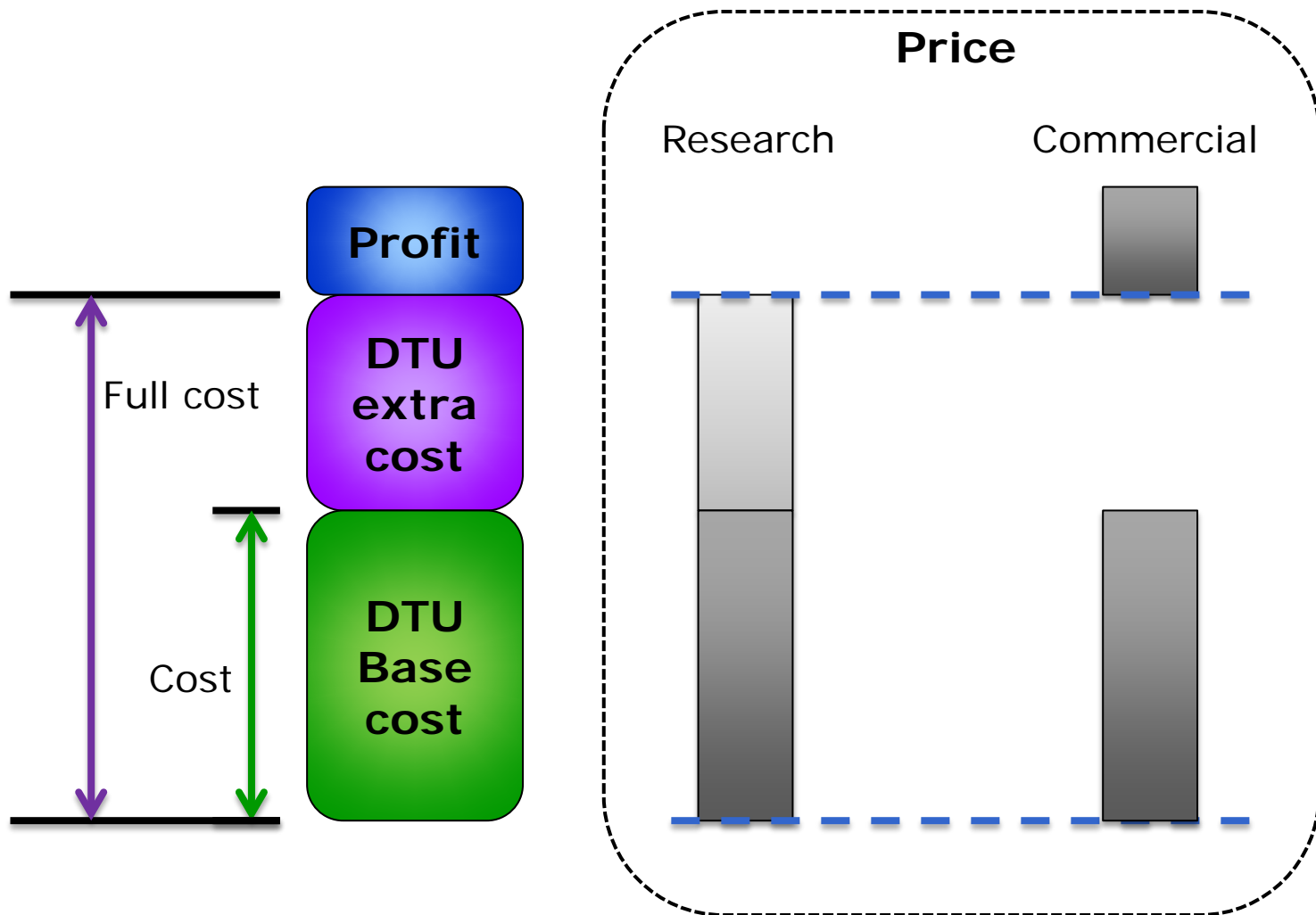


Let Admin check usage before specifications are made

Close the month on the 20<sup>th</sup> - allow 5 days for changes



# Cost and price of Danchip services – University Economy 101



## Prices – external commercial users (UK90)

Service from Danchip	New price 2014	Present price 2013	Unit
Cleanroom access (below cap) <sup>a)</sup>	750	750	kr/h
Danchip assistance	1200	1200	kr/h
Cleanroom area	1600	1600	kr/m <sup>2</sup> /mo
Category A tools	350	350	kr/h
Category B tools	600	600	kr/h
Category C tools	3500	3500	kr/h
Category F tools <sup>b)</sup>	0	0	kr/h

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

b) Tools paid for by their booking (8.x, not SIMS, XPS) are of type F but charged as Category A when booked

c) Materials (e.g. Wafers, metals, masks) are charged at cost

# Cost – external funded projects and users (UK95, other universities: UK10)

**+ overhead**

Service from Danchip	New cost 2014	Present cost 2013	
Cleanroom access (below cap) <sup>a)</sup>	500	333	kr/h
Danchip assistance	450	450	kr/h
Cleanroom area	350	400	kr/m <sup>2</sup> /mo
Category A tools	150	150	kr/h
Category B tools	250	250	kr/h
Category C tools	1500	1500	kr/h
Category F tools <sup>b)</sup>	0	0	kr/h

- a) Cleanroom access above cap of 20 hours is 0 kr/h
- b) Tools paid for by their booking (8.x, not SIMS, XPS) are of type F but charged as Category A when booked
- c) Materials (e.g. Wafers, metals, masks) are charged at their cost price, Electronic invoicing system will be used if at all possible

## Prices – DTU Internal projects (UK10)

Service from Danchip	New price/cost 2014	Present price/cost 2013	Unit
Cleanroom access (below cap)	0	0	kr/h
Danchip assistance <sup>a)</sup>	0	0	kr/h
Cleanroom area	0	0	kr/m <sup>2</sup> /mo
Category A tools	0	0	kr/h
Category B tools	0	0	kr/h
Category C tools	0	0	kr/h
Category F tools	0	0	kr/h

a) Training is available as normal, Danchip fabrication is usually not possible

b) Materials (e.g. Wafers, metals, masks) are charged at their cost price, Electronic invoicing system will be used if at all possible



# Shelves in cleanroom – commercial entities

- Charge for the area covered by the shelves + 70 cm in front, monthly basis



# Shelves in cleanroom – Academic usage

- One box per person active in cleanroom
- "license" renewed in February and September
- Boxes must be placed on shelves marked with "Academic work in progress"



Academic work in progress



# **SAFETY INITIATIVES**

# Alarm – What do I do ?



## Alarm Levels

Two-tone wobbler (constant) + Blinking lamp: IMMEDIATE EVACUATION  
(Meet: Build. 358)

3 sec single tone/3 sec pause + Blinking Lamp: Evacuation (normal exit)

**NEW:** Blinking Yellow Lamp (no sound): Building 346 is closed - Stay out

# New initiatives – chemistry safety

## New hands-on course (~ 2 hrs)

Focus on working with chemistry at Danchip

preparation of work

overview of lab (chemistry)

practical exercises

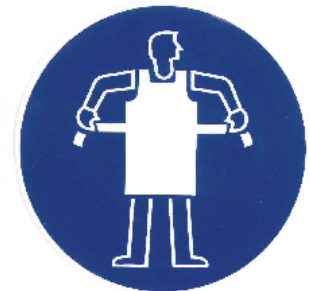


## Fume cupboards

APV (safety instructions) at all fume hoods

Max 1 special setup at a time unless permission is given by Danchip (ask lab technician)

When working with toxic or corrosive chemicals in the fumehood, always, apart from the faceshield, wear apron and two 4H gloves (instead of as normal, one).



# FACILITY

# Wallboards



- Already installed outside cleanroom
- Will also be installed inside cleanroom
- Will be used for information and important messages
- Special mode for evacuation alarms

# New cleanroom access system



- Present Buanco readers old
- Buanco system inflexible and difficult to run together with DTU's new system
- Danchip is working with CAS on new card reader system
- Simplified card management
- Only one access card



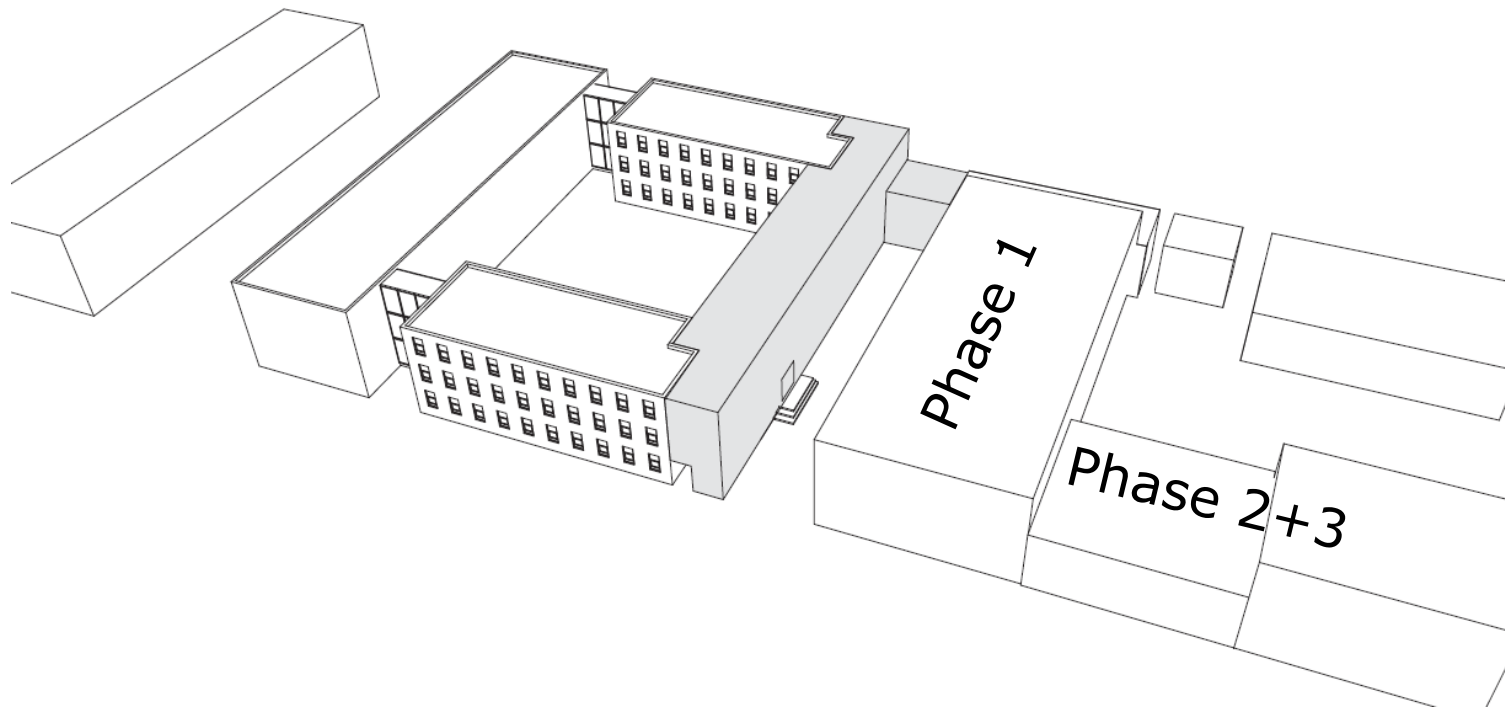
## New humidifier in Phase 2+3

- Change from inefficient and expensive ultrasonic agitation to nozzle spray
- Can save > 200 000 DKK/year
- Phase 1 done
- First Phase 2 humidifier will be changed in February



# Construction work

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



# **NEWS ON TOOLS AT DANCHIP**

## New Spin Track – Released September 2013

- HMDS in-line
- T1 (Positive):  
AZ MIR 701  
Seems to work best  
with i-line (365 nm)  
only
- T2 (Negative):  
AZ nLOF 2020  
Preliminary results  
have yielded excellent  
lift-off
- Set to 4"  
– NO size changes!
- TMAH developer  
recommended

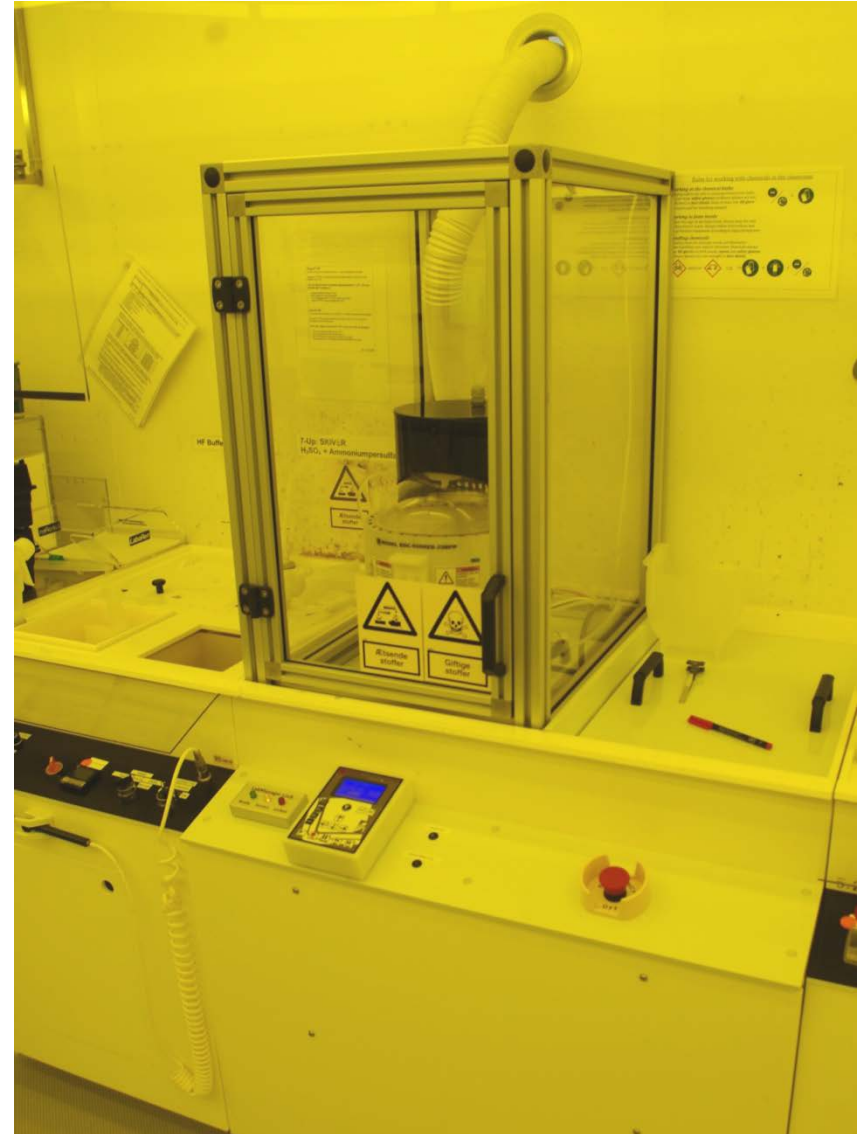


# TMAH– possibly more dangerous than previously known

- 0.26 M (2.38 vol%) Tetra Methyl Ammonium Hydroxyde TMAH is the standard industry developer
- Recently there have been accidents in other fabs that indicate that TMAH is a nerve toxin (at least at high concentrations)
- TMAH has a very low vapor pressure (ionic solution in water), so there are essentially no fumes/vapor from TMAH solutions (be aware of possible aerosols though)
- IBM now considers solutions with TMAH concentrations > 1 vol% as dangerous
- DTU Danchip wants to be on the safe side – tightened safety
- Avoid user contact with TMAH where possible

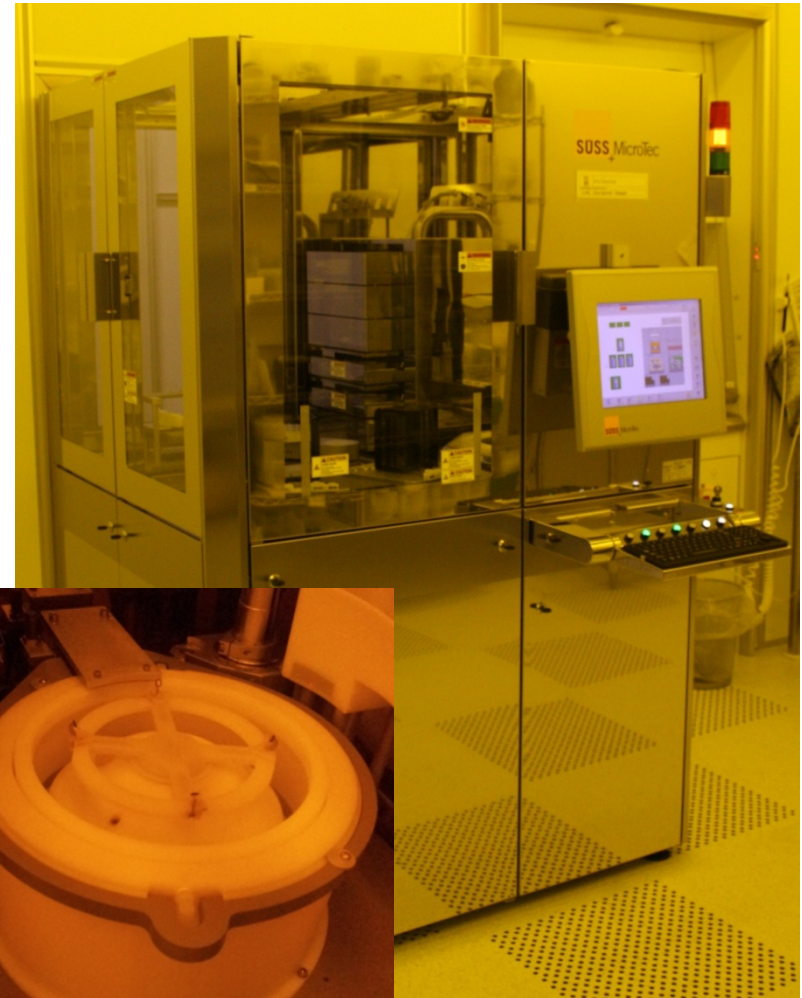
# Laurell – TMAH single wafer developer - alias "R2D2"

- 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
- Development work for MIR701 and nLOF 2020 needed



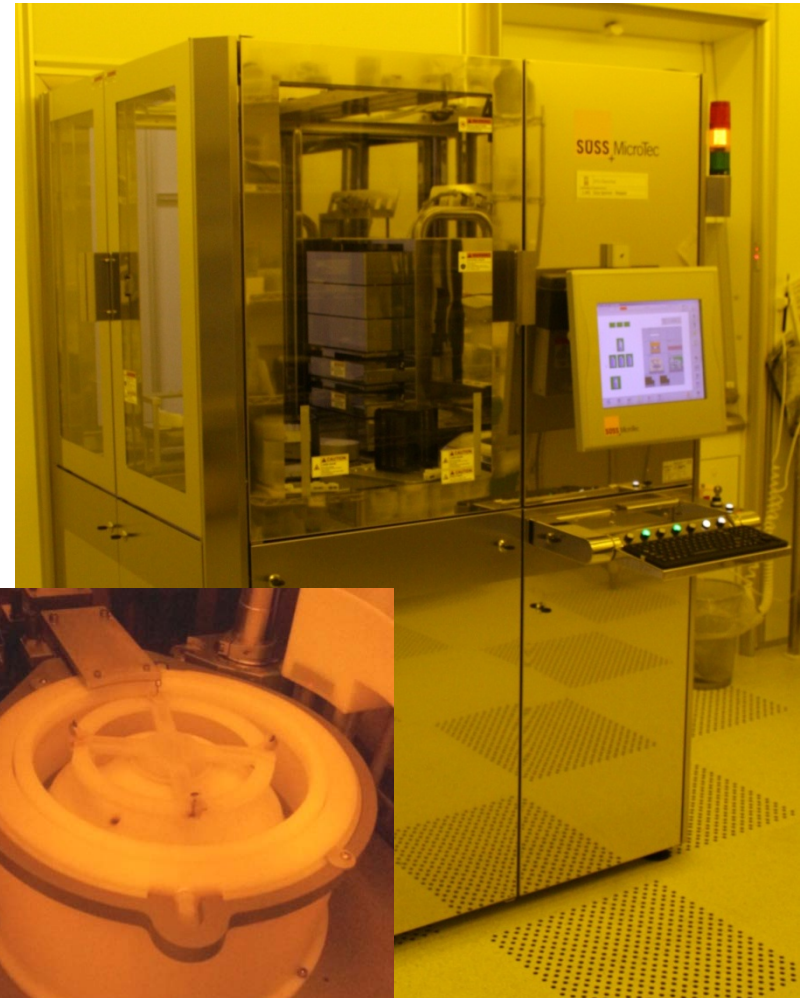
# Cassette-to-cassette stepper developer robot

- Contract signed September 2013
- Built on Gamma 2M frame
- 0.26 N TMAH
- DIW rinse
- N2 dry
- 4" and 6" w/o size conversion
- FAT 2014 WK03
- Expected delivery 2014WK04
- Expected ready 2014Q2
- Will be placed in stepper room



# Cassette-to-cassette UV developer robot

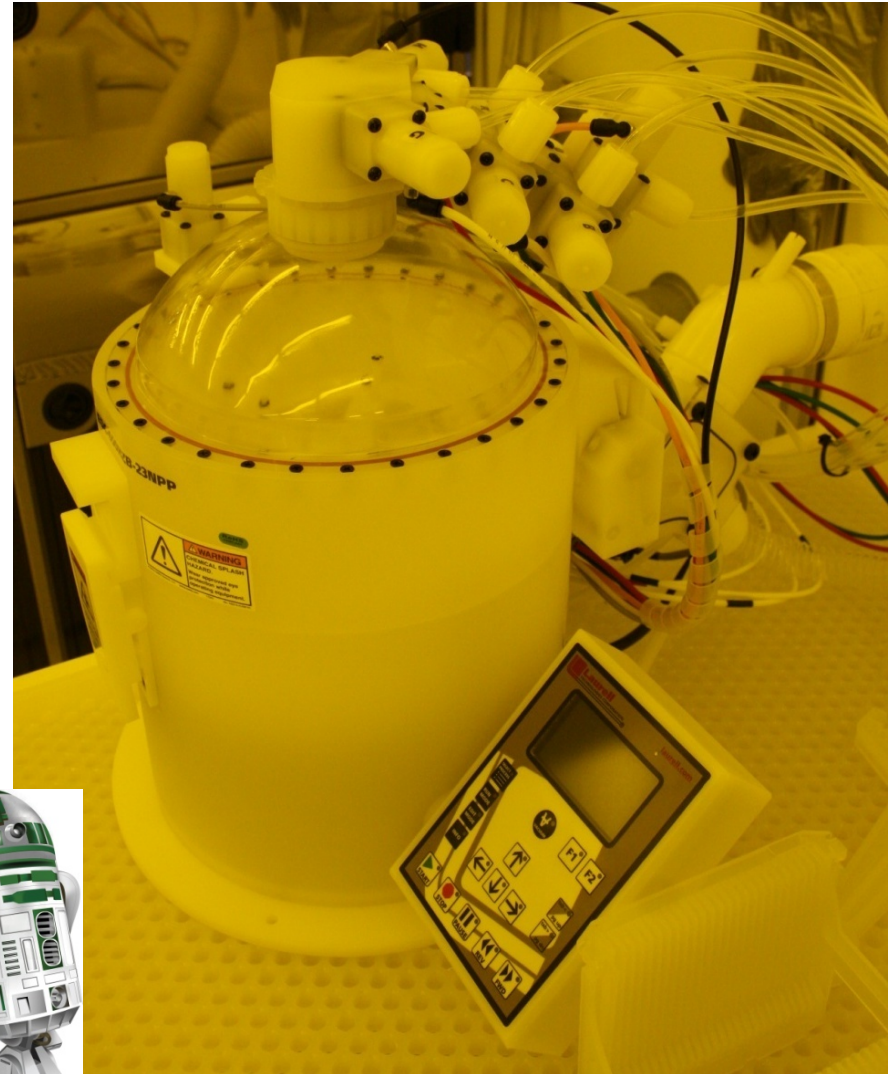
- Decision to buy additional automated tool based on new knowledge of TMAH
- Contract signed in November
- Built on Gamma 2M frame
- 0.26 N TMAH
- DIW rinse
- N2 dry
- 4" and 6" w/o size conversion
- Expected ready 2014Q2
- Expected ready 2014Q3
- Will be placed with UV tools





# Laurell – e-beam single wafer developer - alias "R2D3?"

- 4" and 6" w/o size change
- Lines for
  - N50
  - MIBK (later)
  - IPA
  - DIW
  - N2 blow dry
- Drain diverter
- Waiting for new wet bench
- Expected ready 2014Q3



## JEOL 9500

- Deflector unit issues hopefully resolved
- Cassette loader teething problems resolved ( simple sensor problem)
- New gun installed



# E-beam loaders



- Two daily loading sessions
  - 10:00 - 10:30
  - 13:30 - 14:00
- Book the machine via LabManager
- Show up to the loading session
- Mount your substrate and pre-align if necessary
- E-beam expose at booked time slot
- Fully trained users can unload their cassettes
- But: They can only reload an **empty** cassette
- To request for an e-beam training session, contact [e-beam@danchip.dtu.dk](mailto:e-beam@danchip.dtu.dk)
- Users require at least **4 training sessions** before being allowed full access to the machine.



## Spinner rinser dryer

- One tool for RCA cleaning:
  - 4" and 6" station
- One tool for general use :
  - 6" and 8" rotors
- Tools are here
- 8" SRD in stepper room (temporary position)
- RCA SRD needs installation next to RCA bench. Expected ready 2014Q1



## K&W Aligner Replacement

- New "KS Aligner" to replace K&W aligner
- Karl Süss MA-6
- Almost identical to old KS aligner
- Special objectives and chucks for small samples
- BSA possible
- Familiar maintenance
- Common spare parts
- Tools can backup each other
- Contract signed
- Delivery date unknown
- Expected ready 2014Q3



# 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 pump time)
- 6-Axes stage:  
x,y : 152 mm; z: 43 mm
- Supplemental acquisition:  
New EDS-detector (Energy Dispersive X-ray Spectroscopy):  
Aztec (Oxford), incl. 50 mm<sup>2</sup> SDD det.
- Future life for the FEI-SEM  
- will go to CEN



# Atomic Layer Deposition – Picosun R-200

- Tool being installed in January
- Key features:
  - Highly flexible Thermal ALD system
  - Plasma source optional
  - Stacked substrates (pieces – 8" wafers)
  - Initial processes:  $\text{Al}_2\text{O}_3$  ,  $\text{TiO}_2$  , Pt, (Cu)

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



# 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 in January





# **POSSIBLE ACQUISITIONS FOR 2014**

# 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:  $H_2 / N_2$
- $O_2 < 1$ ppm

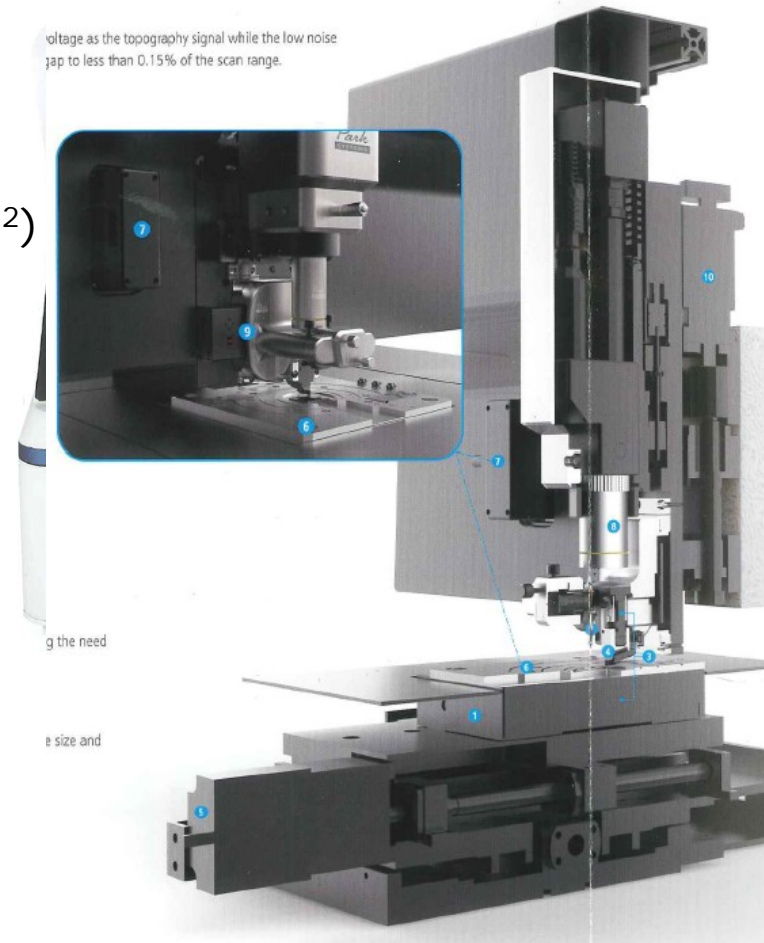


Next: Prepare tender in January 2014

# AFM – replacement of present NanoMan

## Candidate: Park NX20

- Decoupled XY-scanner: piezo-stack ( $100 \times 100 \mu\text{m}^2$ )
- Z-scanner: High speed ( $f_r > 10 \text{ kHz}$ ),  $15 \mu\text{m}$  range
- High resolution for full Z-range (24-bit), low-noise ( $20 \text{ pm}$ )





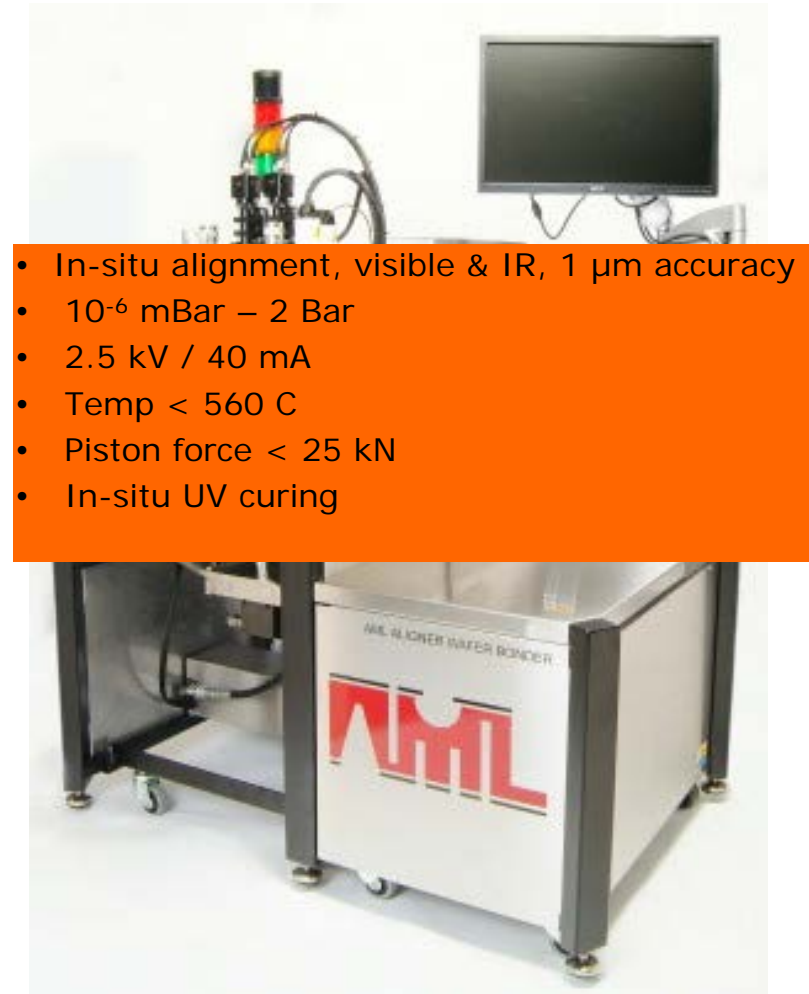
# Bonder – fusion/anodic - pending co-funding

- Alignment in chamber (IR)
- Wish to split NIL and bonding jobs
- CMUT project involved in specifications

Update:

Erik Thomsen/Anders Lei prepare wafers for testing fusion bonding/IR-alignment

Expected test-run: February 2014



Example of a bonder, not in tender or specs yet

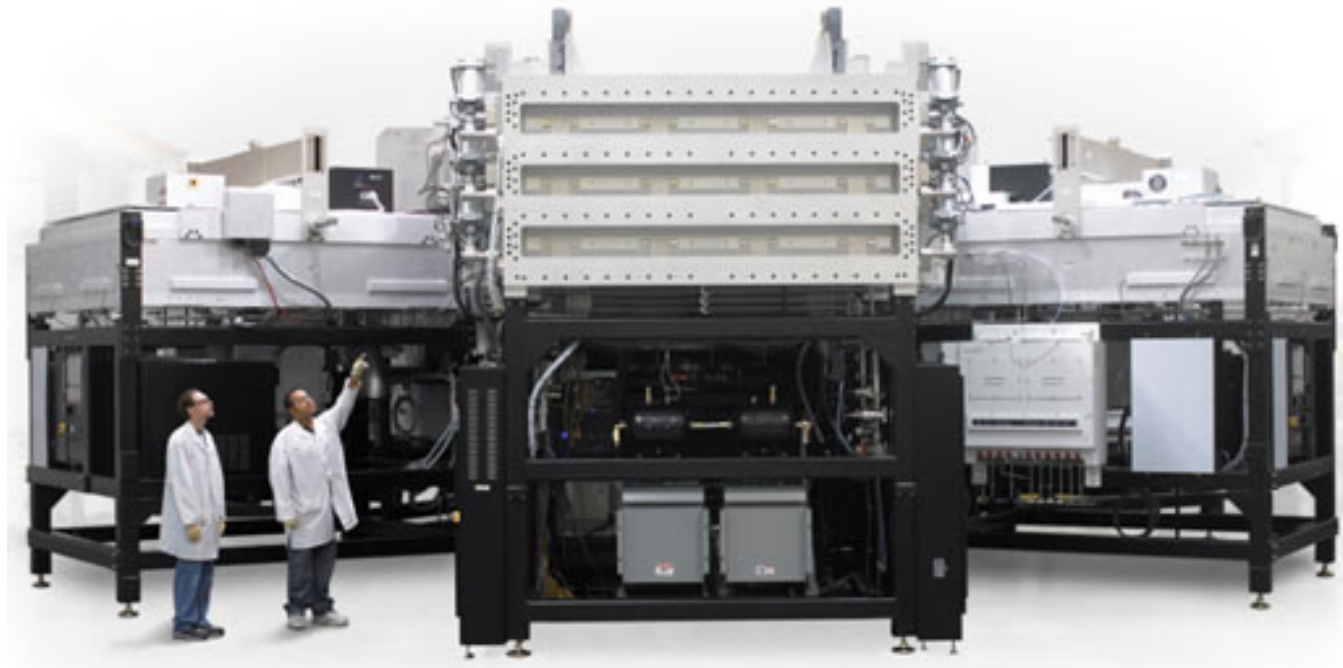
## UV direct writing - Heidelberg $\mu$ PG 501

- Up to 6"x6"
- Down to  $1 \pm 0.3 \mu\text{m}$  feature size
- Up to 50 mm<sup>2</sup> per minute (approximately 10 times faster than DWL66)
- Ability to align to existing pattern  $\pm 1.0 \mu\text{m}$
- Grey scale exposure possible (inherent process stability issues, requires years of development)
- Small footprint 0.6x0.7 m<sup>2</sup>
- Price: Ca. 200 000 EUR (need tender)



## PECVD-4

- Replacement
- PECVD 1 decommissioned
- PECVD-2 & 3 both >15 years
- Preparing for future needs
- Capabilities/materials to be determined





# Raman spectroscopy

- Challenge: Detection of graphene
- Chain of characterization techniques:
  - Optical Microscopy ✓
  - SEM ✓
  - Raman spectroscopy —  
(distinguish graphene/amorphous carbon)



Example of a Raman microscope

# 2013 acquisitions total 13 mio Dkk

Tool description
SEM Zeiss Supra + EDS
Loading elevator for JEOL9500
Aligner, replace III-V Aligner
Woolam Ellipsometer
ALD Picosun
KLA Tencor particle scanner
TMAH robot developer 1
TMAH robot developer 2
Laurell wet process tools
Spinner rinser/dryer (2 tools)
SVG Spinner/Primer/Coater



# ACQUISITIONS FOR 2014

Join us to discuss future tools at the Technology Forum !

Next meeting **March 11 2014** Danchip Seminar Room, 347

# THE END

Danchip is free of charge for internal projects

Remember cleanroom-money when applying for external projects

Register your work in Labmanager