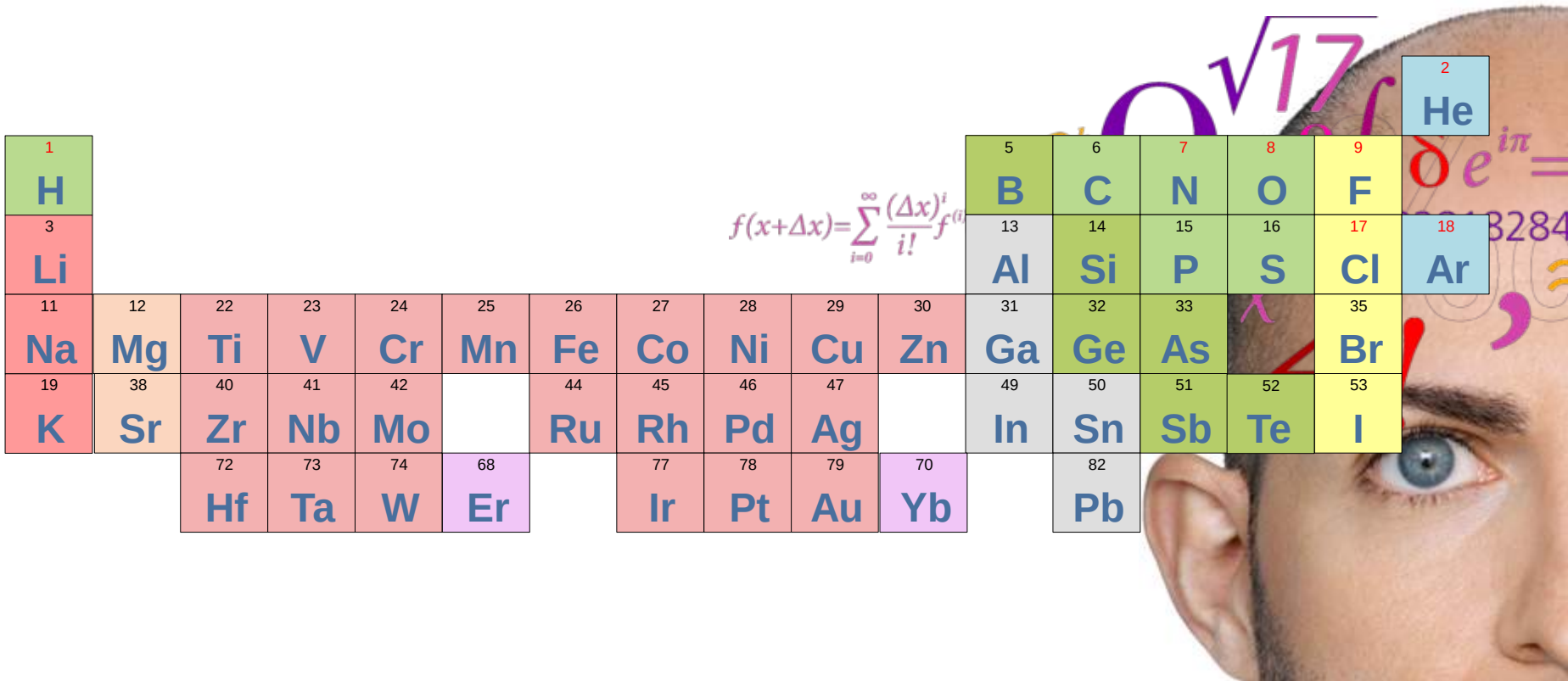
Danchip customer meeting 2015



Danchip/Cen fundations

- Access to the cleanroom, equipment and microscopes
- Expertise in cleanroom processing/microscopy
- State of the art processing/characterization
- Beyond state of the art – technology/characterization research

The old payment model:

Pay per use like taxi, lawyer etc.

Paying for a services:

Fine – if you have the money

AND - if you know exactly which service you want

The problem with service- what exactly do you want and how do you want it

> 450 registered users

Pay per use service has fostered a ”workshop usage pattern” among a larger number of users at Danchip that causes:

- Focus on device (indifference about fabrication technology)

presumed shortest route to device

Ignorance of new possibilities and opportunities

Ignorance of new and faster processes and materials

A facility like Danchip is far too complex for a workshop usage pattern.

AT DTU:

There are many (assoc.) Prof. level researchers that focus on specific applications

There are too few (assoc.) Prof. level researchers that are deeply interested in cleanroom fabrication technology.

This implies:

AT DTU:

There are fundmental and overall large enabling technology areas that are orphanized i.e. no research is going on, current practice is below or at state of the art

Existing technology research is not able or willing to attract funding for cleanroom equipment.

The cleanroom usage pattern is very device orientated using process flows that have been designed years ago, have been adapted but did not undergo major revisions

Devices can be fabricated faster, more efficient and with higher yield by revision of process flows and process experts advice.

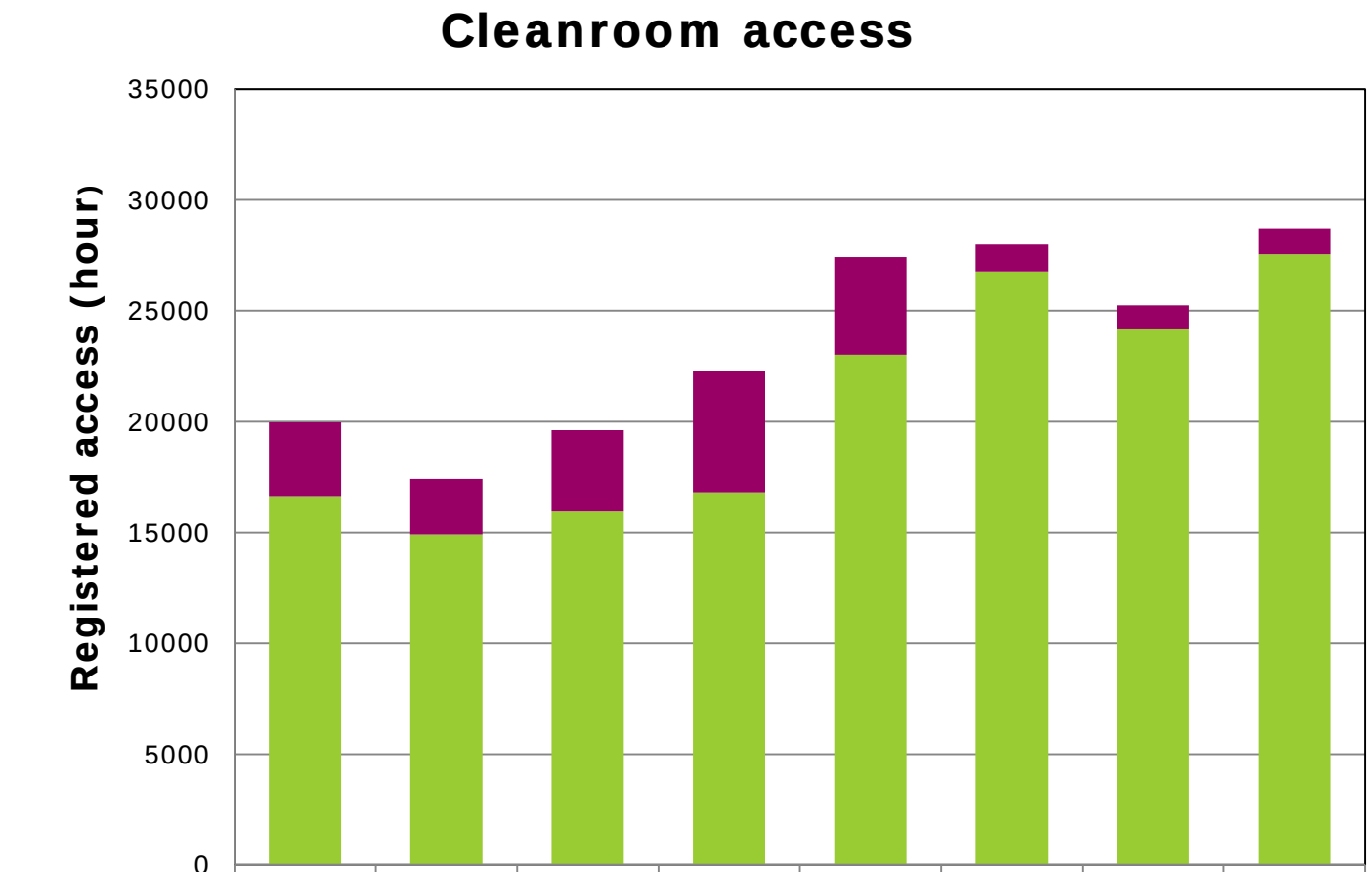
Possibilities at Danchip are on par with Stanford, Harvard, Cornell if we want to have the same impact on technology - we have to do technology research

New technology enables new devices, the real high impact papers combine new ideas, deep insight in application areas with beyond state of the art technology

So what can we do:

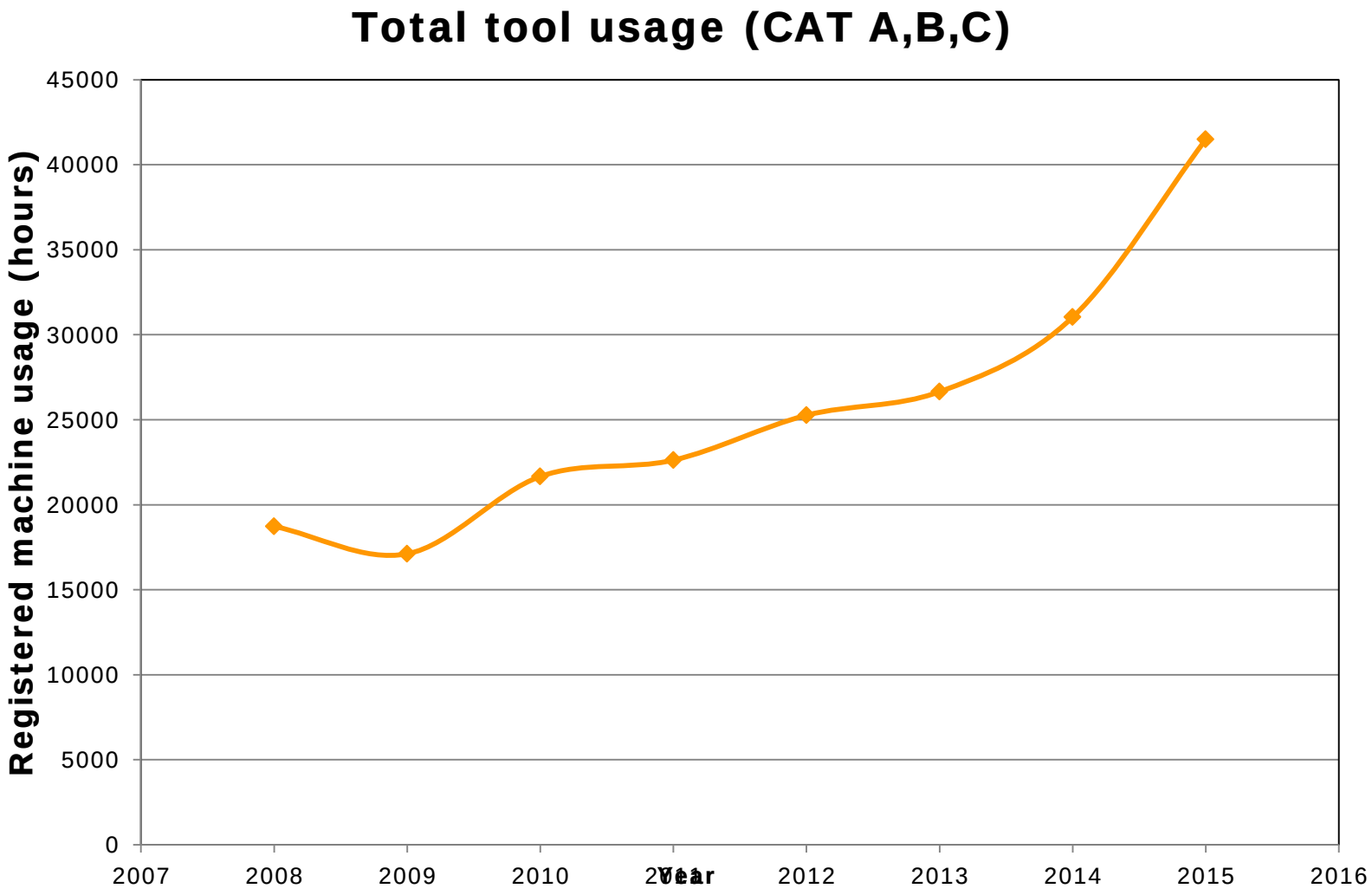
Look at the data

A look at the development:



	2008	2009	2010	2011	2012	2013	2014	2015
Commercial	3323	2504	3660	5477	4410	1213	1082	1174
Academic total	16644	14916	15953	16814	23014	26775	24165	27542

A look at the development:



More users inside the cleanroom

Machine usage more than doubled since 2010

It is getting increasingly crowded

In addition:

several study reforms have caused that master students:

- **all start in January**
- **all finish in June**
- **only have 5 months to complete their projects**

It is getting increasingly crowded

(with a huge peak in January, February, March, April)

We must react to these changes:

- Cleanroom usage
- Payment model
- Investments
- Technology research

Cleanroom usage has to be more efficient so those who are interested in devices get their devices faster and with less resources spent.

Better planning

- somebody knows on beforehand when a student is going to start
- more fixed time training slots
- tool package training

Higher level usage (not only teaching which buttons to press)

Tools, equipment and materials optimized

Payment model (in place since 2013)

Internal usage free

no payment for master projects

technology research is no more a safe way to financial ruin

start projects without external financing

External usage covered by projects

costs have to be covered

money must come from somewhere

usage must be registered DIRECTLY to the respective project

Allowing for Danchip being a partner in a research project

Investments

Balance:

Replace old equipment

New equipment increasing efficiency and throughput

New equipment enabling new technologies and materials (financed increasingly through external grants)

The important message:

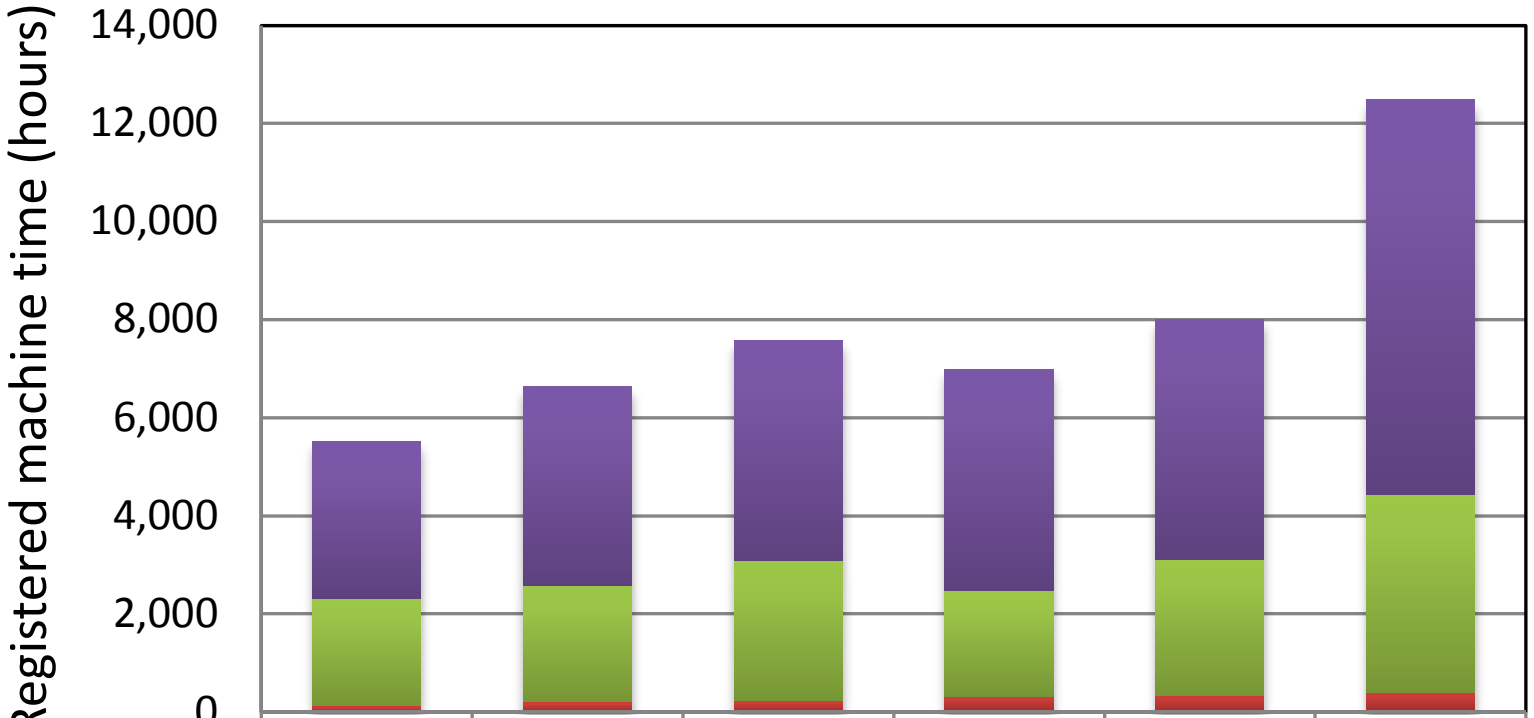
Revision of process flows and process experts advice will be mandatory. Fixed time slots for certain trainings will be established. Training will include fundamental process knowledge.

Danchip will do technology research in areas that are not covered by existing activities but are enabling for a large number of possible devices. The results will be accessible to all cleanroom users as fast as possible.

Danchip will use technology research to attract funding for new advanced cleanroom tools and infrastructure in order be on the forefront of development.

USAGE

Q1 usage of Danchip



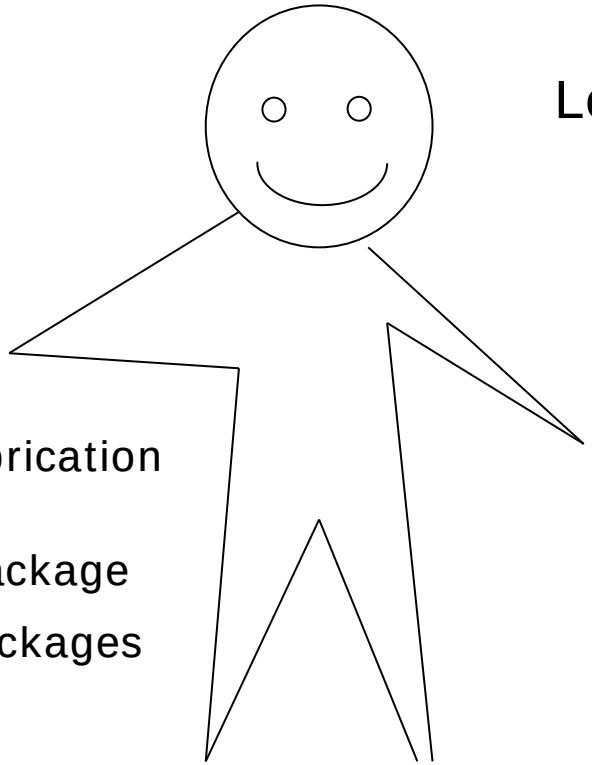
	2010	2011	2012	2013	2014	2015
Category A	3,203	4,056	4,499	4,518	4,892	8,034
Category B	2,178	2,370	2,855	2,149	2,773	4,053
Category C	123	205	221	315	338	381

Many students at once

Tight timing

Fremdriftsreform

Increased Q1 usage



Learning objectives

Cleanroom fabrication

- Prepare process flows
- Prepare safety approvals

Understanding fabrication work

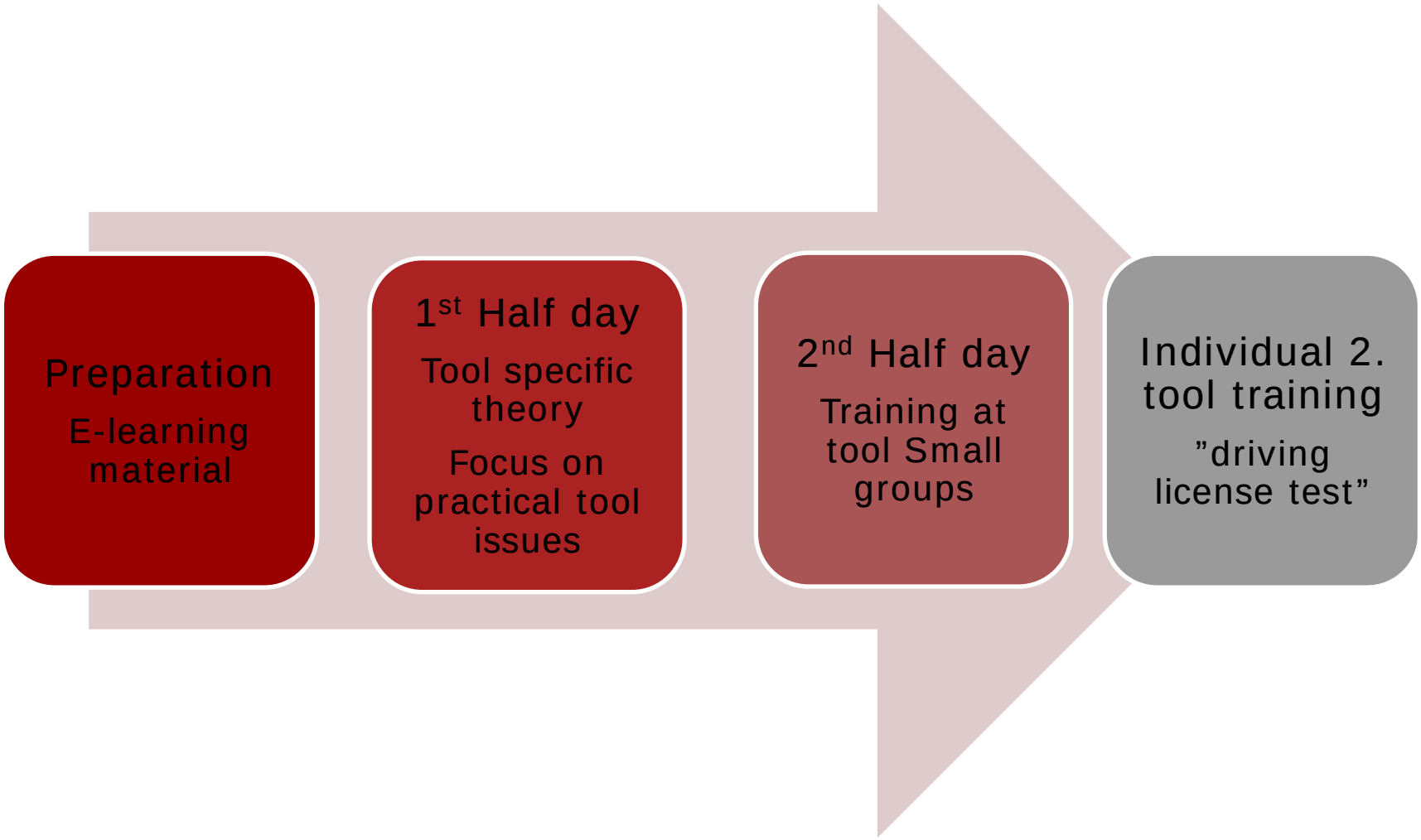
- Increased intro package
- Scheduled tool packages

Use of devices

- Follow fabrication by a colleague
- Consider if training is needed

Student

STPT: Scheduled Tool Package Training



So far planned for **SEM**- and **Lithography** training (February 2016)

Experimental education in micro/nano fabrication

Ph.D. course (Nanotech/Danchip) in
"methods of micro/nano fabrication", 5 ECTS points
Individual course

Self-study of e-learning material used in course number 33255

Scheduled exercises

Participation in Journal Club course number 33903

At least one presentation

Establish process flow for own project present and defend to supervisor and Danchip contact (Danchip co-supervisor)

STPT 1

Safety course

Hands-on chemical handling

STPT 2
SEM

STPT 3
UV-Lithography

STPT 4
Individual unit

General SEM situation

- SEM Supra 1 (Old Zeiss):
  - Relocated to the basement in 346
  - Training and ex-situ (CR) inspection
- SEM Supra 2 (Supra 60):
  - General inspection in CR
- SEM Supra 3 (New Supra 40):
  - General inspection in CR
- SEM-Leo: Will be dedicated for Raith lithography including Ice lithography

TOOLS LEAVING

Tools leaving – decommissioning 2016

Decommissioning of equipment

- Noble Furnace/old Resist Pyrolysis Furnace (replaced by ATV Furnace)
- PECVD-2 (replaced by PECVD-4)
- Developer 1+2
- SSE Maximus spinner (replaced by Süss Gamma coater)
- Prism Coupler
- EVG 520 NIL
- III-V aligner (use KS Aligner 2 instead)
- SIMS (when it requires the next major repair)
- Cryofox (will be remodified)

NEW EQUIPMENT

New FE-SEM: Zeiss Supra 40VP

- Background: SEM-LEO (our training tool) is being used for dedicated lithography applications
  - Raith-ELPHY system
  - Ice lithography (Anpan/William)

- Detectors: SE-, VPSE-, In-lens, & BSD
- 6” samples
- 5-axes eucentric stage:
  x,y :130 mm; z: 50 mm

- After release: Old Zeiss Supra 40VP will be re-located to the basement – replace old SEM-JEOL
  - future training tool
  - high-quality FE-SEM outside CR

plasma/thermal ALD from Picosun

Motivation

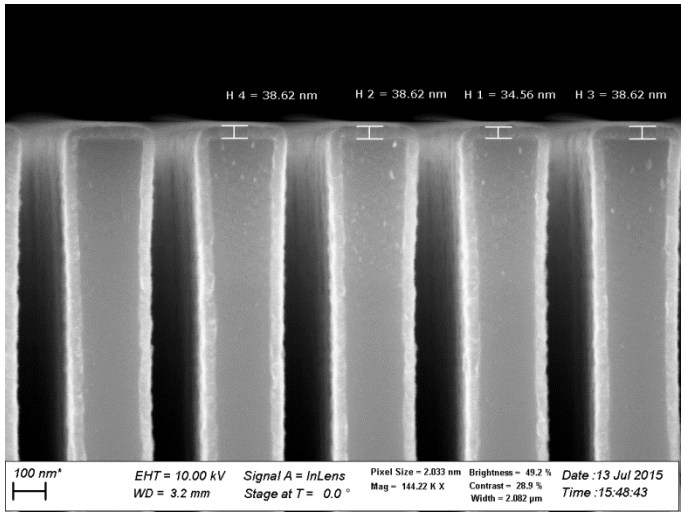
- High utilization, bottleneck tendency
- No in-house back-up
- Limited capacity for new precursors

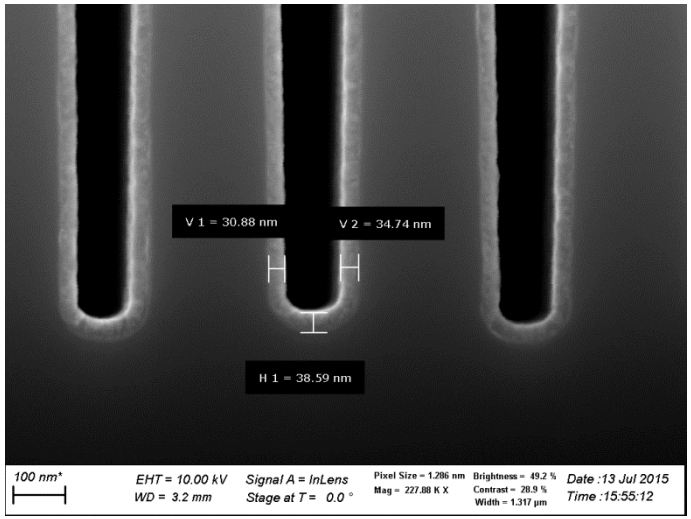
Key features

- 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

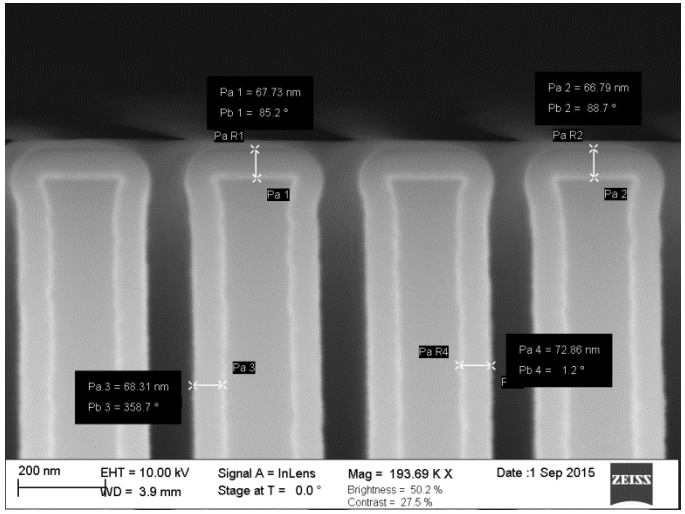
Contract signed – tool arrives 15 April 2016

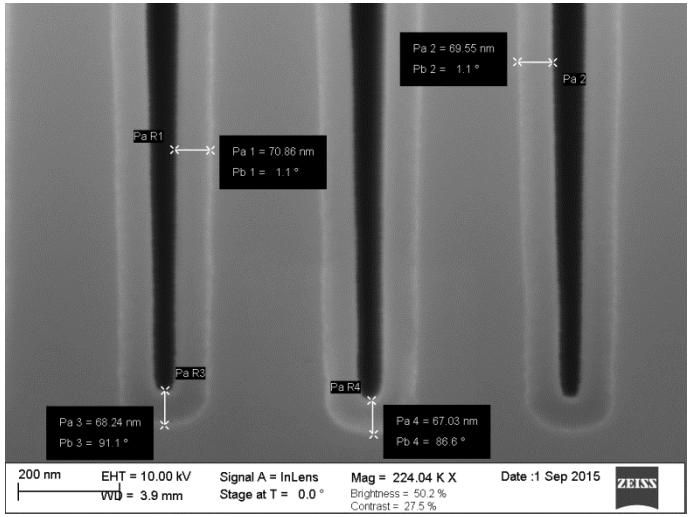
plasma ALD: AlN in trenches (20:1)





plasma ALD: SiO2 in trenches (20:1)





PECVD-4 – replacement of PECVD-1/2

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

Installation under preparation

- expect most installation work to be finalized primo February 2016

New Süss Gamma Spinner

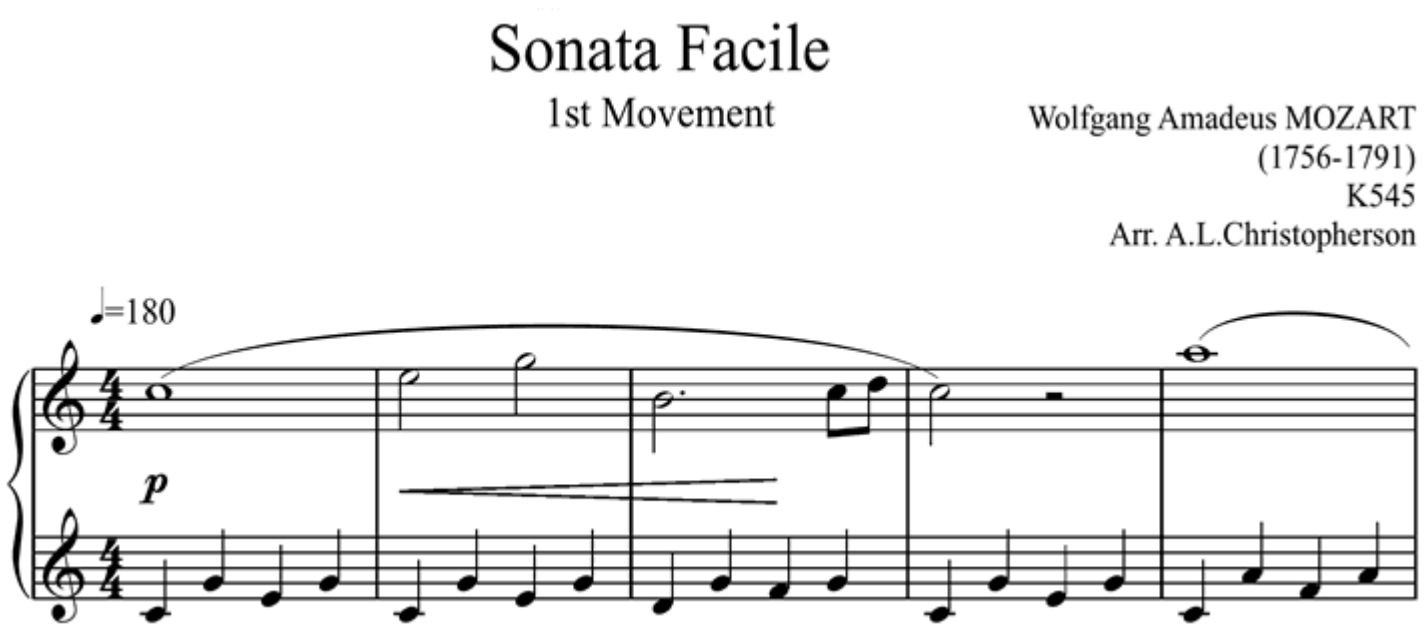
- Willl replace SSI Maximus
- Will be released in 2016
- Equipped with
  - AZ5214E
  - MIR
  - nLOF
- Can run 4 and 6 inch without any size change or special recipes
- Long process run-in due to lack of manpower tool issues.

New bonder tool

- Replaces the bonding functionality in EVG NIL
- No imprint
- Demo at Süss highly successful – both on 4” and dies.
- Tool ordered in November 2015
- Expected ready 2016Q4
- Will be placed in E-4, next to KS aligners.

New CNI Imprinter

- Can perform 90% of all imprint jobs presently run on EVG NIL
- Can NOT align samples



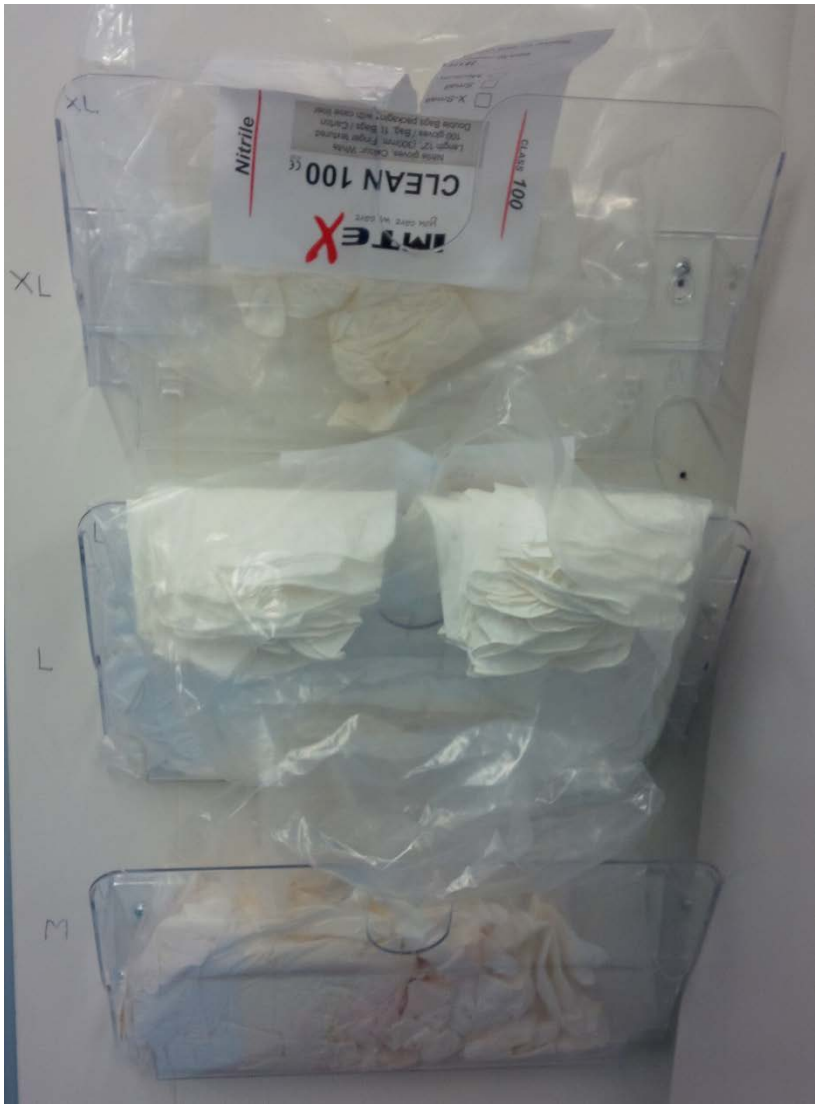
SONATA FACILITY

Construction work B345C

- Construction work completed with minimum impact on cleanroom
- Building handed over to users last week
- Doors from B345C to B346 to be installed in December

Cleanroom gloves

- After the tender: Most users unsatisfied with gloves from new supplier.
- Complaints collected from users
- Talks with supplier.
- New (green) gloves to be tested next month.
- Thank you for your patience



Upcoming disturbances in the Force

- January: PECVD gasses. Ca. 2 weeks shutdown of
  - SiH_4
  - 3% B_2H_6 in N_2
  - 5% PH_3 in N_2
  - NH_3
- Late January: New purifier. 1 week shutdown of process N_2
- 2 days in Q1: Cleanroom closed due to ventilation bug fix (should remove most soft evacuation alarms).

Importing Samples to the Cleanroom - An important message

- Too many users have been found brining samples from the outside directly into the cleanroom.
- No change of sample carrier
- No cleaning of samples
- **This behaviour damages a lot of other user's work!**
  - **Contamination of sensitive equipment (furnaces etc.)**
  - **Cross contamination of other people's wafers**
  - **Yield killer**
- **Nobody really want to destroy other people's work – do they?**
- **You may NOT take outside samples to SEM, Dektak etc. without cleaning. Cross-contamination!**

What does LabAdviser say?

Items that have been outside the cleanroom

*Items that have been outside the cleanroom should always be **cleaned in soap and ultra sound followed by a 7-up or Piranha clean** before entering the cleanroom.*

- All supervisors must inform their students about this basic rule.
- If in doubt, always ask. We can usually find a solution.

Importing people into the Cleanroom - A just as important message

- You are NOT allowed to take ANY other person into the cleanroom on your own card. Safety issue! Get a guest card.
- You can only take guests into the cleanroom who have a real purpose there (e.g. project collaboration partner)
- The guest may not do processing of any kind
- You are responsible for your guest – stay beside him/her all the time.
- Your DTU login is personal and may NOT be handed over to others.
- Do NOT log in to tools for others. They HAVE to use their own login credentials

CLEANROOM ADMISSION

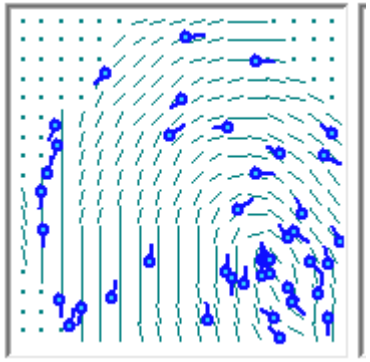
access by biometry - fingerprint

Why?

- outdated access system – could break anytime
- card conflicts with DTUs ‘skalsikring’
- card replacement is inconvenient in a 24/7 open lab

CLEANROOM ADMISSION

access by biometry - fingerprint



Considerations?

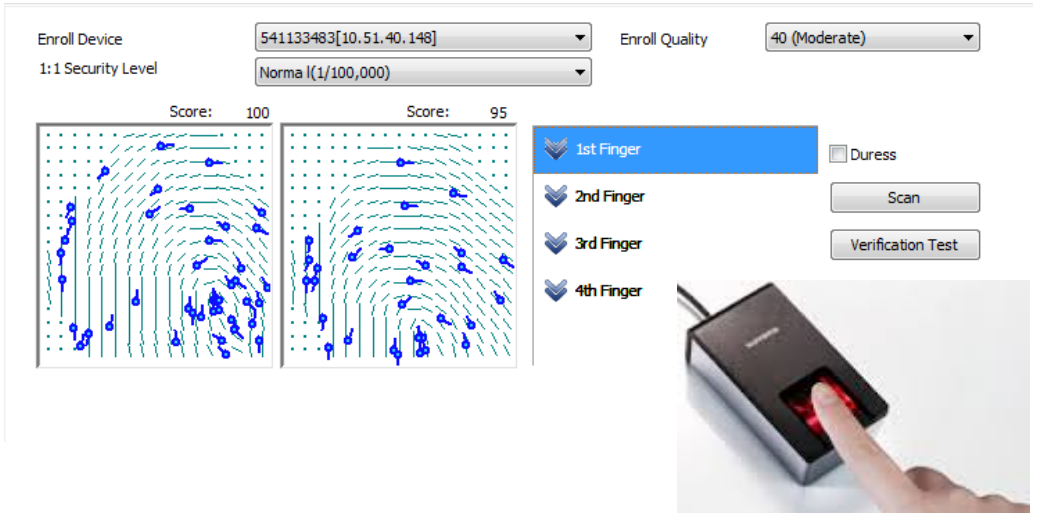
- IT-security – fingerprint template
- Local system, full DCH control
- Outer doors separated from time registration
- Integration with LabManager
  - User profiles synchronized
  - Access based on Safety Course/Lab-Intro competence

CLEANROOM ADMISSION

access by biometry - fingerprint

How?

- Fingerprint template
- Readers installed 2016
  - cleanrooms
  - chemistry storage
  - wafer storage
- Fingerprint registration 9-15 at DCH Administration, access 24/7



Take home messages

- Help your students – sign up for scheduled trainings
- Technology research helps strengthen the foundation for others to build upon
- Talk to us
- We can act as co-supervisors