DTU DANCHIP

DTU Cen

TECHFORUM June 2017

Facts and figures

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Agenda

- DUV stepper II
- Facility stuff
- Litho news
- E-beam downtime
- Thermal evap
- Diamond CVD
- Pegasus II, III, and IV
- RIE II end of life
- Renewal of PVD equipment (= decommission of existing equipment)
- Planned Equipment purchase in 2017
- RIE II end of life

It is getting crowded.......

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Increase throughput ---- increase efficiency

Things keep changing 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

USE Tool Package Training where available

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.

DUV stepper II

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In the process of looking for funding

Increasingly difficult to get money for equipment

Anticipated cost: ~30 mio DKK

Time line: secure funding during 2018, installed tool medio 2019

Anticipated specs: CD 150nm – 200nm, 150mm wafers, 200mm wafers

If you have a case or project where a new stepper would make a difference please tell us !

FACILITY STUFF

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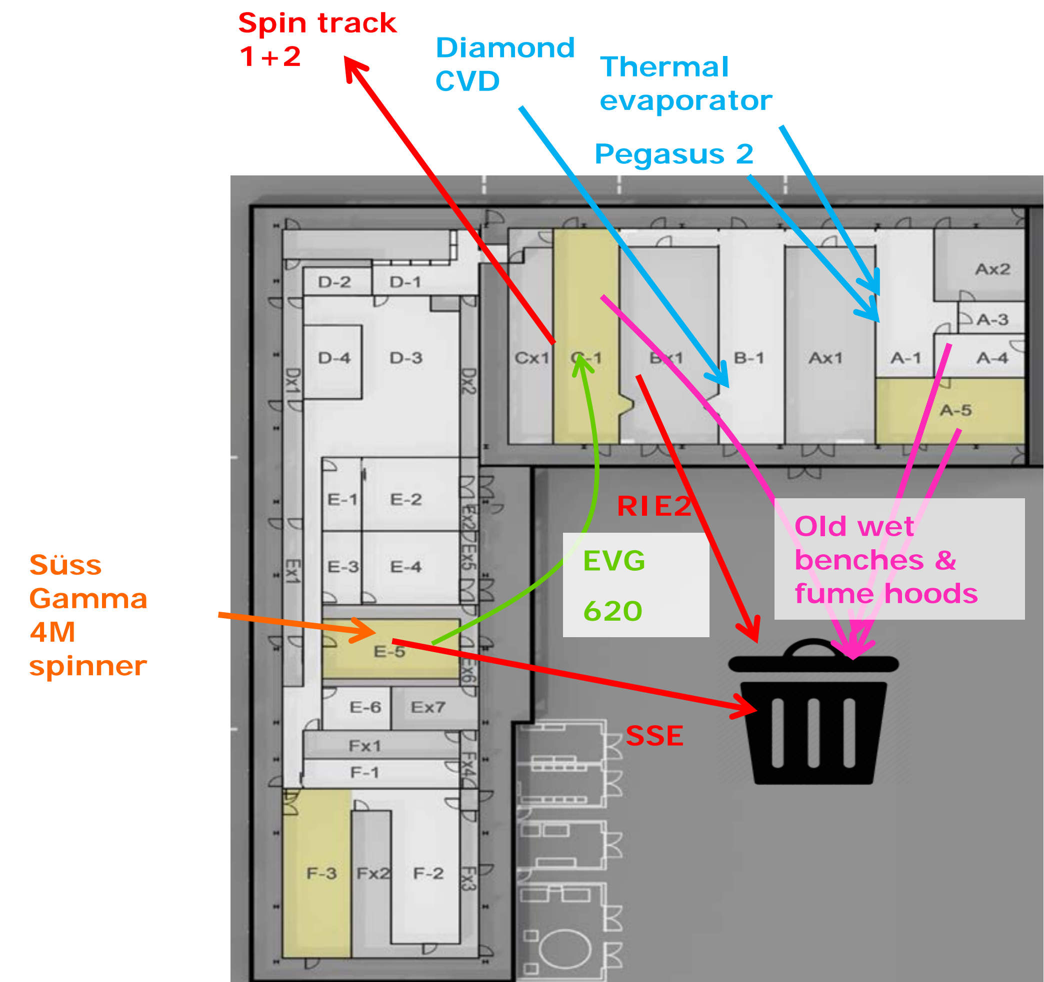
Equipment Departures and Arrivals

Tool	Moves to	Date
Old wet benches in C-1	Trash	July 2017
III-V fume hoods	Trash	June 2017
Spin track 1+2	Trash	August 2017
SSE Spinner	Trash	May 2017
Spinner rinser dryer	D-3	July 2017
New spinner for 2/4/6″ UV and e-beam resist	E-5	June 2017
Thermal evaporator	A-1	May 2017
Diamond CVD	B-1	July 2017
Pegasus 2	A-1	August 2017
RIE 2	Trash	Dec 2017
Pegasus 3+4	C-1	June 2018

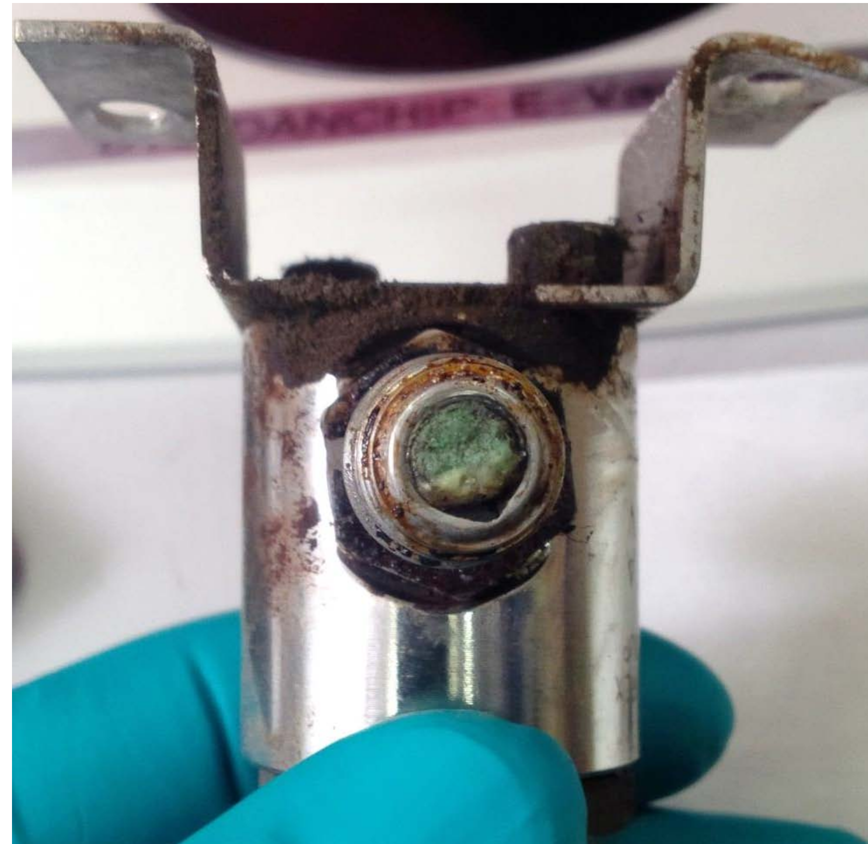


Summer schools and 3-weeks courses

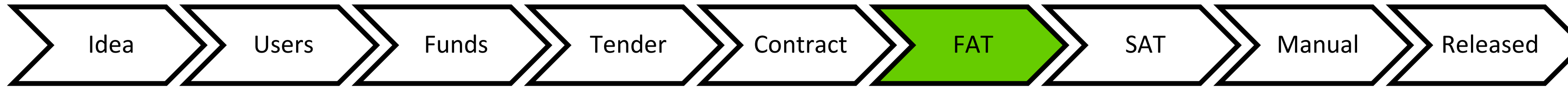
- Large influx of inexperienced users
- Cleanroom should still be usable for all
- Advise Danchip in advance
  - How many?
  - Who will supervise?
  - Do supervisors need retraining on equipment?
- Consider insurance status of non-DTU students
- Everybody must swipe their card
- Assist students when they gown up for the first time
- Do not leave students unattended in the cleanroom

HBr issue

- Metal ICP line valve clogged
- AGA trying to find time
- Potentially need line change
- If long waiting time we will open up III-V ICP line



LITHO NEWS



Spin Coater: Gamma E-beam and UV

- Partly new possibilities, partly back-up; 100% nice
- In-line HMDS priming
- 4 hotplates, 1 cool plate
- 4/6” coater station
  - AZ5214E
  - MIR 701
  - AZ 4562
  - CSAR 62
  - EBR
- 2” coater station
  - AZ5214E
  - CSAR 62
  - Syringe dispense
  - One available low visc. line
  - EBR
- SAT in July 2017
- Expected release in Q4 2017

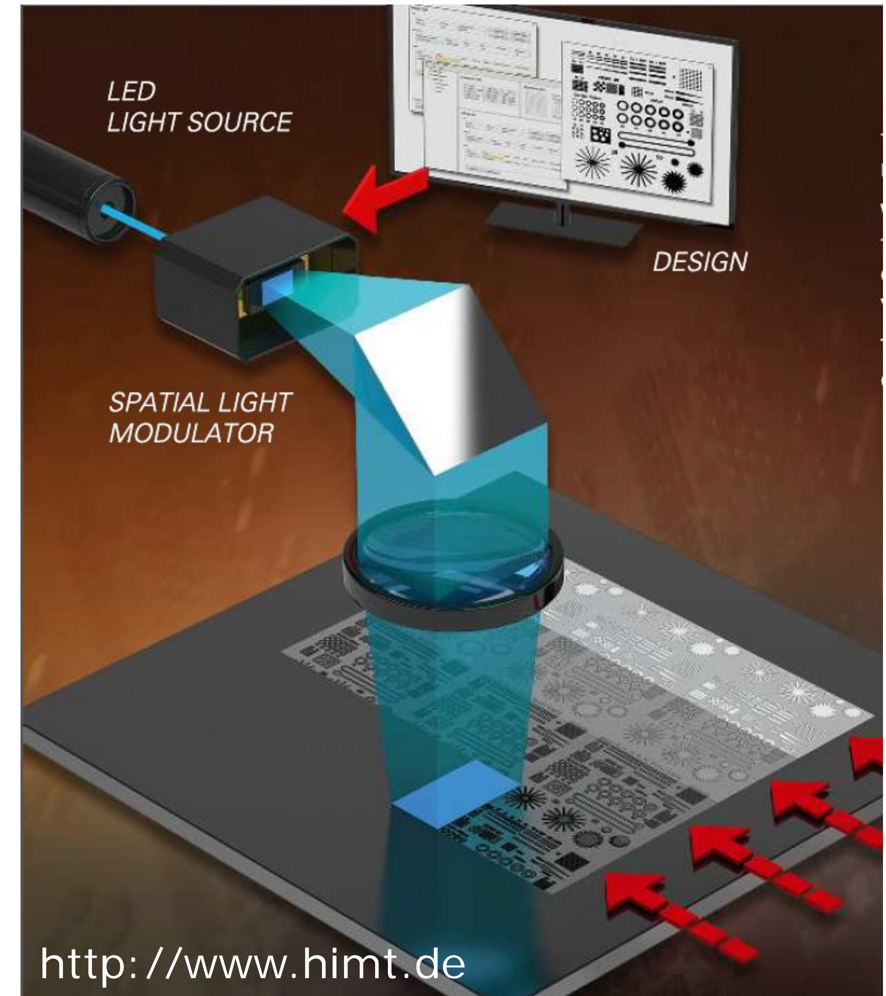
Aligner: Maskless 01: Principle

- The light source illuminates a Digital µ-Mirror Device
- The image from the DMD is projected onto the sample
- The dose and uniformity is controlled by the on-time of the individual mirrors/pixels
- The stage steps, stitching the design together

- DMD: 600 X 800 pixels
- "Writing field": 300 X 400 μm^2
- Projected pixel size: 0.5µm X 0.5µm

- Process parameters: dose and focus
- Projection lithography → proximity errors!

- Writing time is affected by dose and area, not by feature size. Pattern load has non-linear effect.
- Full 4" wafer: 2-3 hours!



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Aligner: Maskless 01: Design philosophy

Choose maskless aligner:

- If your device design is new
- If you know you will only print a few wafers with the same layout/design
- Write only a few devices and test one/few designs at a time
- ″Draw and shoot″, no feature creep
- Order a mask when the design is perfected

Choose mask aligner:

- If your device design is mature
- If you know you will be printing 10′s of wafers with the same layout/design
- Fill the mask with as many devices as possible, testing as many designs as possible
- Spend days/weeks perfecting and reviewing
- Order a new mask when the design changes

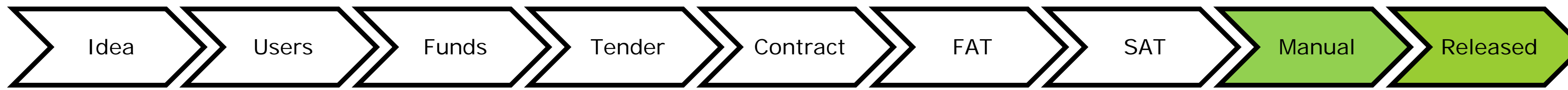
Or combine mask and maskless:

- Print all the static parts of the design using the mask aligner, then fill in the (few) parts of the design that change with design iterations using the maskless aligner
- With a positive resist like AZ5214E, this can even be done using the same resist coating:
  - Expose in the mask aligner and develop the pattern
  - Align in maskless aligner and write the missing parts, then develop again

E-beam down time

- Column upgrade – Scheduled: 2 weeks. Actual 4 weeks (software/hardware issues)
- After column upgrade: Cleanroom closed 1 week
- Failure of new gun (presumably JEOL induced): 3 weeks
- Loadlock turbo crash (JEOL induced): 3 weeks
- Aperture instability (JEOL induced): 3 weeks
- Total down time: ca. 13 weeks (!)
- E-beam seems OK now (famous last words)
- We are complaining to JEOL on several levels

NEW EQUIPMENT



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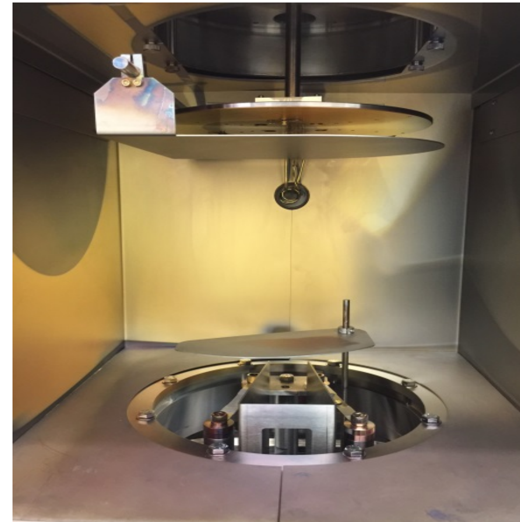
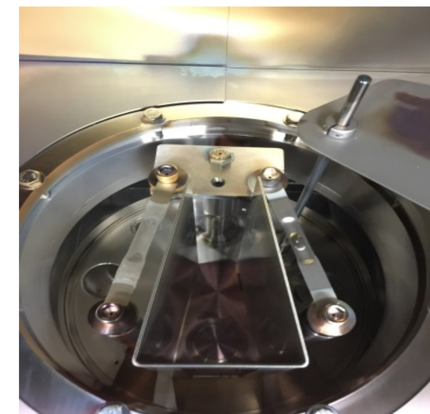
Thermal Evaporation: Lesker NANO 36
- resistive heated boats

- Turbomolecular pumping
- An integrated touch-screen operation system
- Substrate holder : up to 8″ wafer
- 2 evaporation sources
- Quartz crystal sensor





Lesker NANO 36 – initial tests

Pump-down time

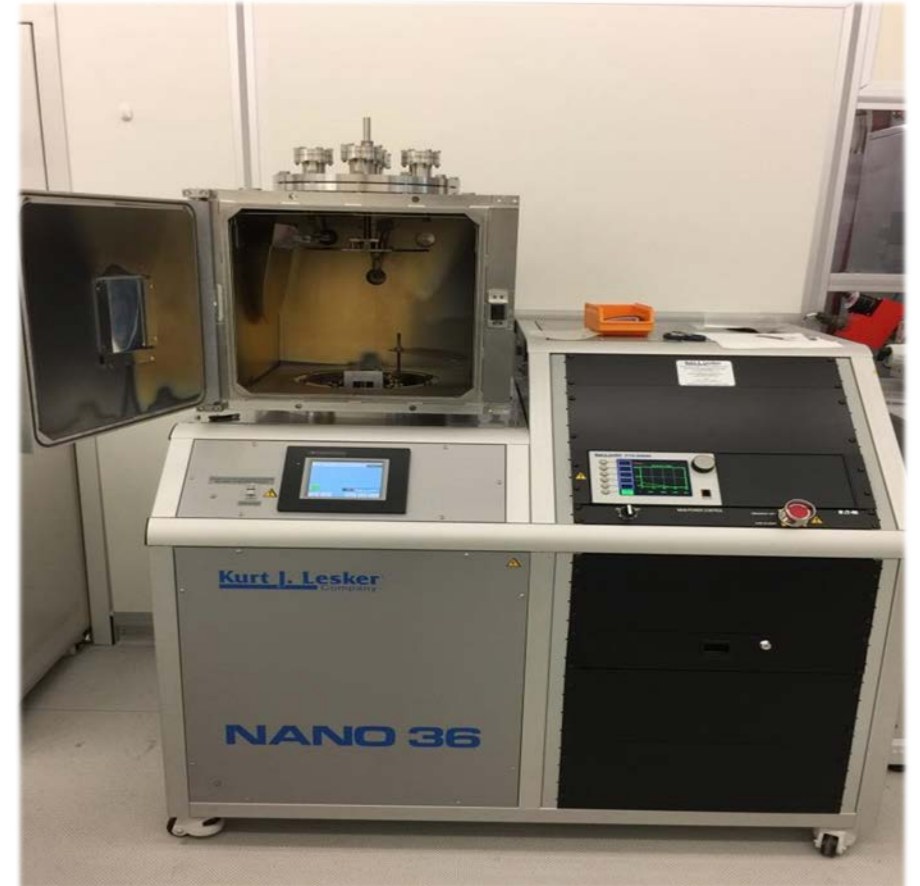
- 10 min => $1x10^{-5}$ Torr (Process can be started)
- 20 min => $3x10^{-6}$ Torr

Film uniformity on 4 inch wafer

- < 5% for 100 nm Al
- < 10% for 100 nm Ag

Tested materials

Al Ag Ti Au



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Diamond thin film: Seki SDS 5250S

Key features

- Microwave Plasma CVD (2nd hand system)
- Generator: 5 kW @ 2.45 GHz
- Substrate: 4″ max (2″ standard)
- Gases: N_2 , H_2 , CH_4 , O_2
- Installation: Q2-Q3 2017

Growth process

- H2:CH4:O2 (478:20:2 sccm) @ 600-1000 C
- Power 1.5 – 5 kW (typical)

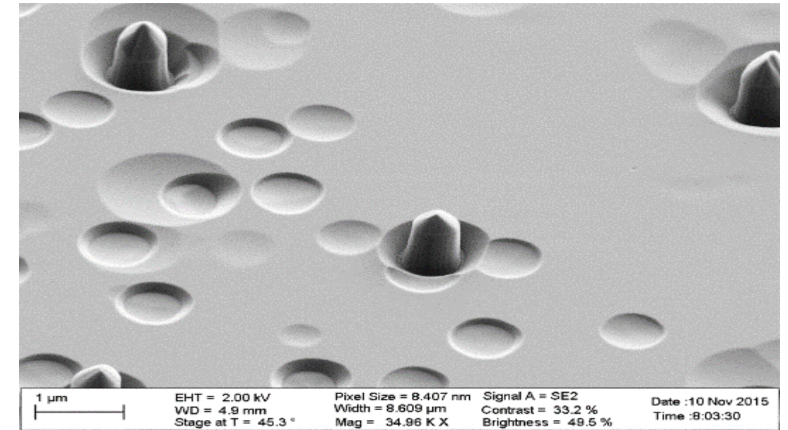
Thin-film diamond CVD

Diamond substrates and layers - variety of applications

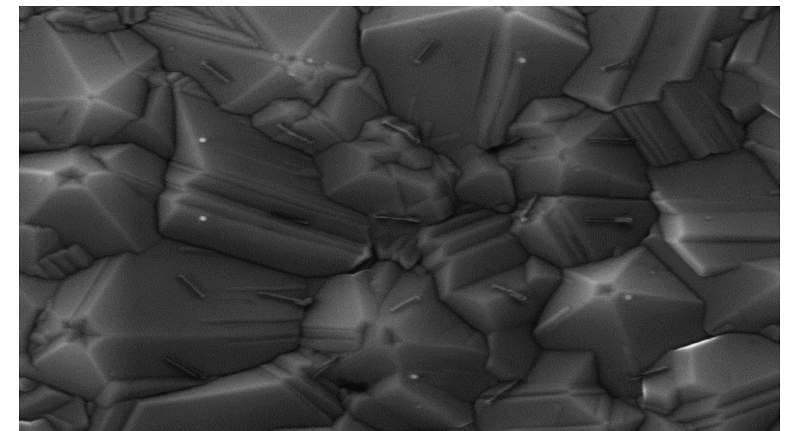
Quantum optics
MEMS
High power electronics
...

Different types of diamond films:

Thin film single-crystal diamond layers on diamond seed x-tal
Polycrystalline diamond on silicon/other substrates
Selective area growth of diamond



Single-crystal diamond (etched mesas)



Poly-Diamond growth on Si

Pegasus 2: DRIE of silicon (Research & development)

- Background:
  - Bottleneck situation on Pegasus 1
  - Backup system & research
- 2nd hand system being installed
- Expected release around August 2017

New acqusition: Twin-Pegasus (version 2010)

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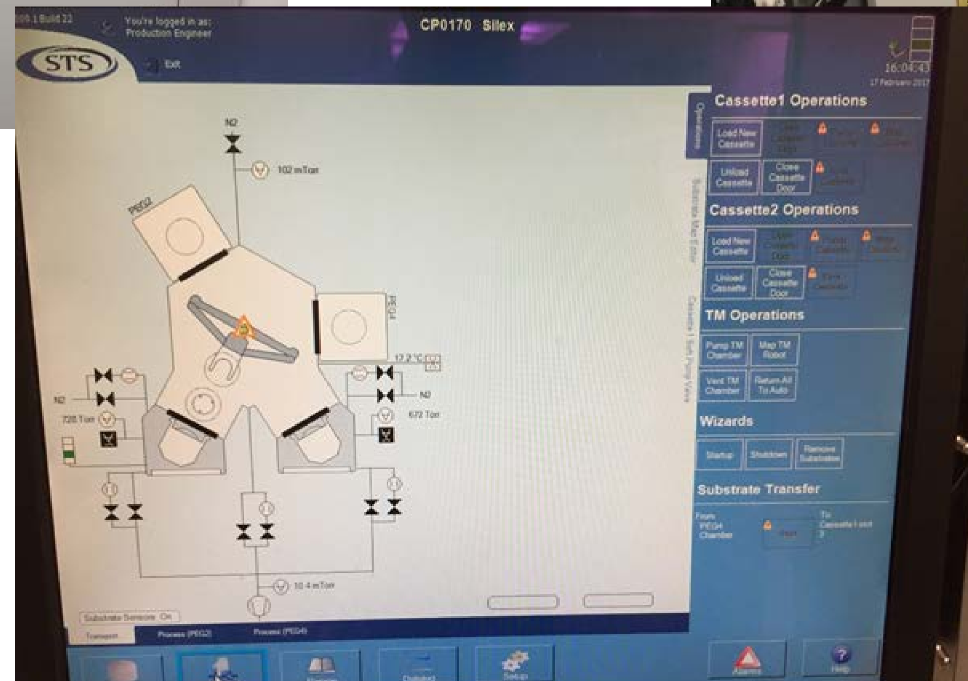


Twin-Pegasus: The Plan

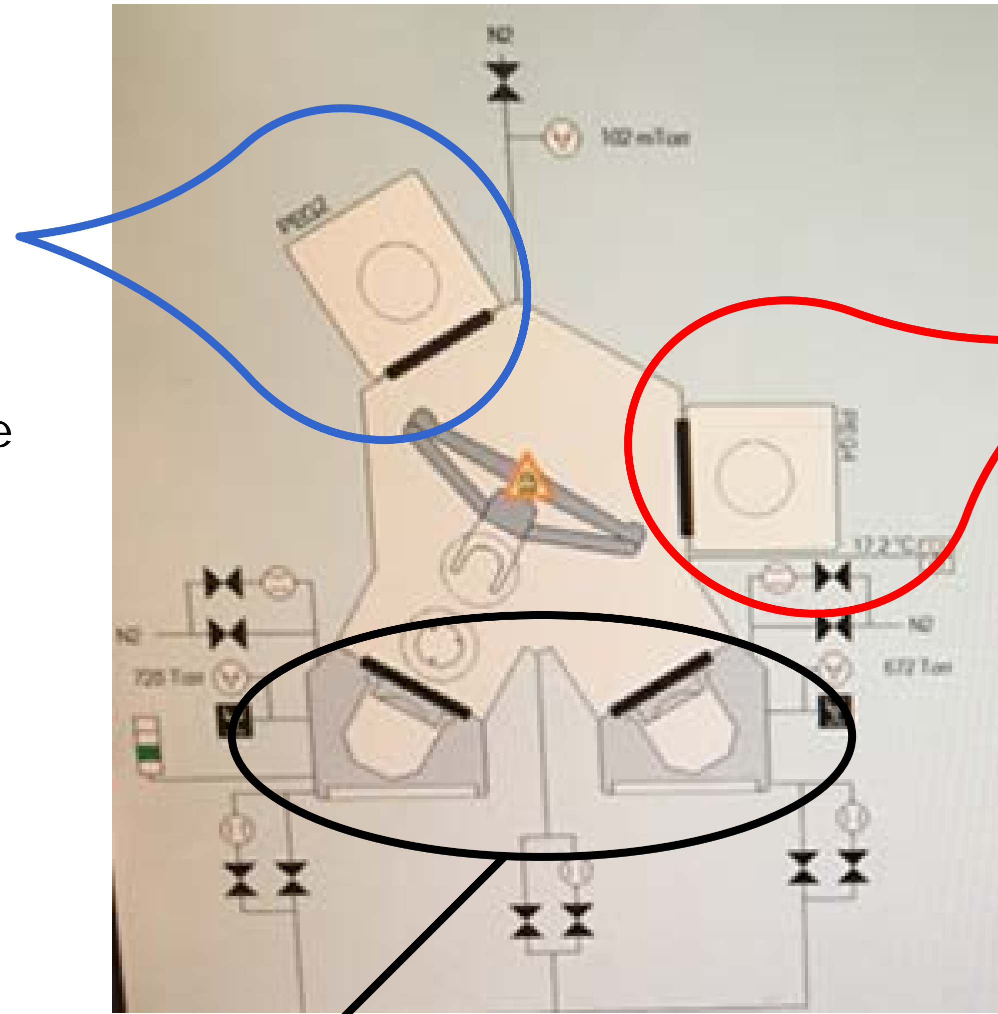
Pegasus 3

DRIE (Si) – 6″

High-throughput

Cassette-Cassette

″Workhorse″



Pegasus 4

DRIE (Dielectrics) – 6″

Reconfigure (Dielectrics)

High-throughput

Cassette-Cassette

″Workhorse″

CPX Platform

twin vacuum cassette cluster

(Brooks handler)

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Logistics: Moving in Twin-Pegasus – Moving out Cluster 2 (RIE-2)

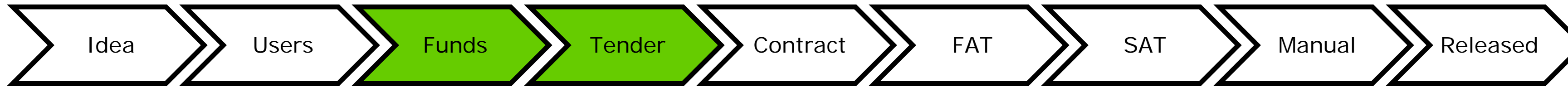
Decommisioning of RIE-2 (latest end of 2017)

Reconfigure ASE (CH_4, CHF_3, H_2, He + MFCs)

Establish Pegasus 2

Transfer RIE-2 processes to ASE (RIE-mode)

Transfer ASE processes to Pegasus



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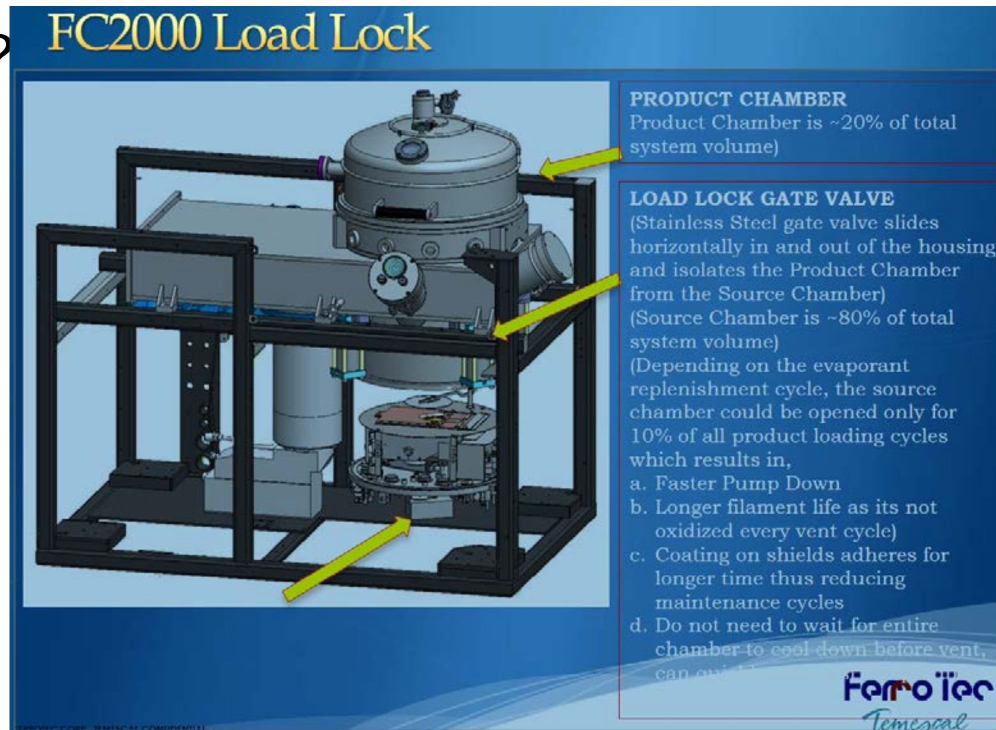
Tender preparation: X-Ray Diffractometer

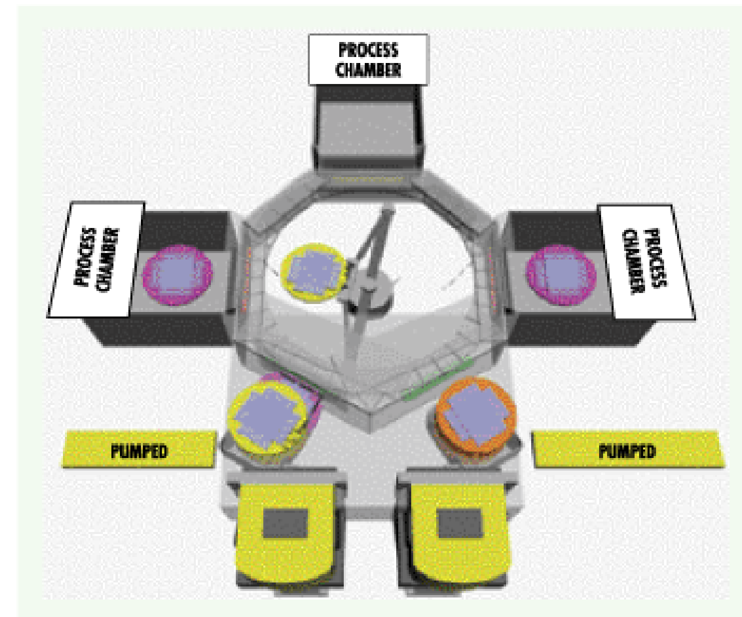
- Background:
  – Complementary in-line material analysis (crystalline/ poly/nano-crystalline)
  – Co-funding (Danchip/Fotonik)

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

What could the future of PVD at Danchip/Cen look like ?

- a work horse (Wordentech replacement) ?
- a circus pony (Physimeca, Alcatel replacement) ?
- new functionality (dielectric films, alternating metal – dielectric films) ?
- ?????





Tools leaving the cleanroom

- SSE Maximus. Moved out
- SVG spin track. Replaced by Gamma 4M
- Old wet benches in Ballroom (replaced by new benches and fume hoods)
- Old fume hoods in III-V lab
- Wet benches in C-1 (old yellow room)
  - Replaced by new wet benches in Ballroom
  - Will stay until new benches are ready
- PECVD 2 (replaced by PECVD 4)
- RIE 2 (will leave by end of 2017)