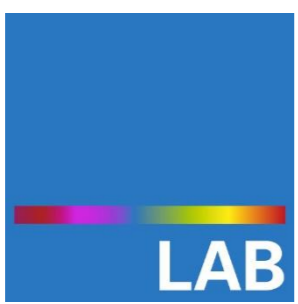


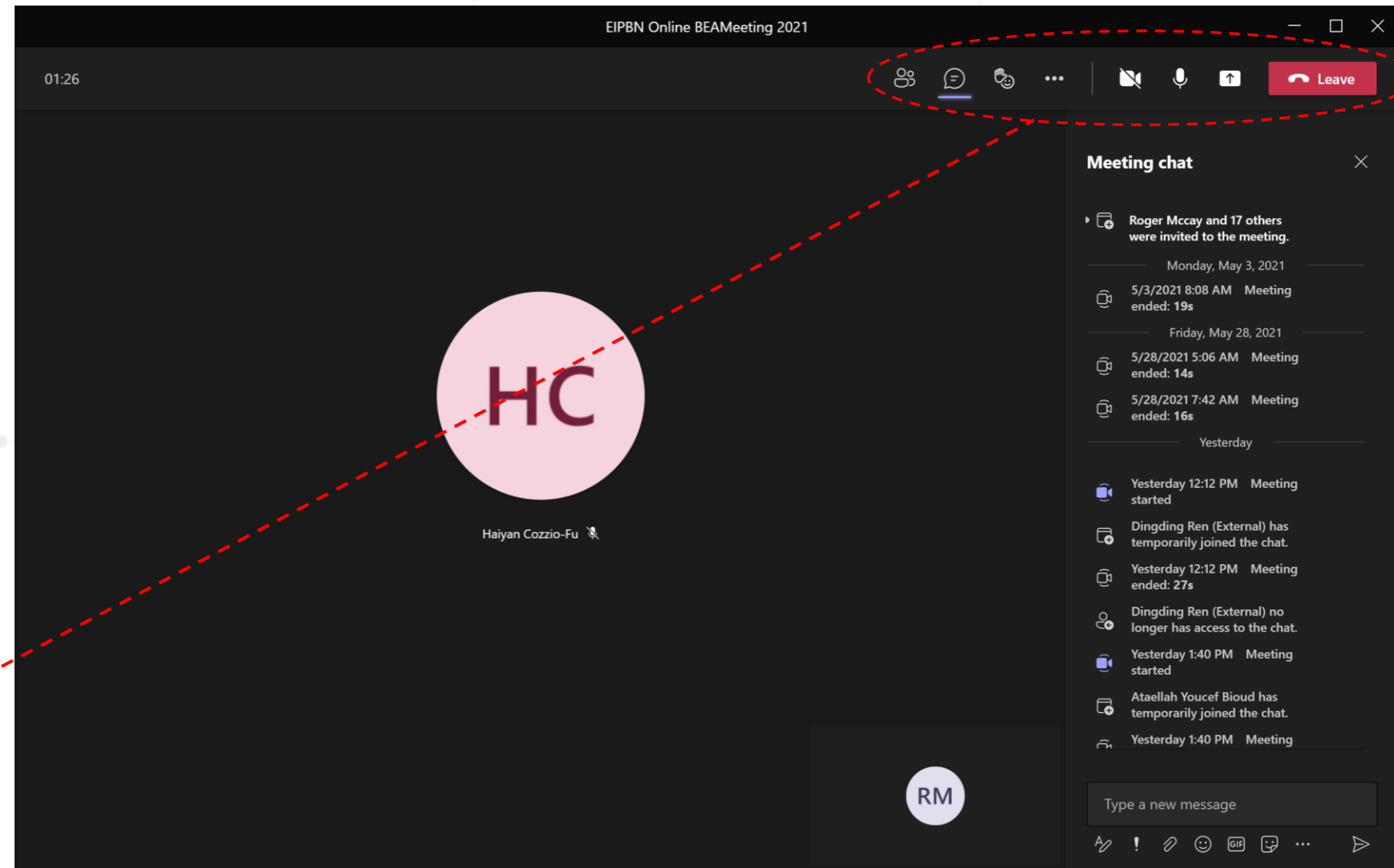
# BEAMeeting



Technical Workshop & Discussion



- Session is being recorded and will be available within ~14 days
- Please keep your microphone muted, video off
- TEAMS Info panel is at the upper right of screen



Raise Hand

Chat

Microphone

# Why are we in Montpellier?

- One of oldest Universities in the world, founded in 1289
- Center for medical and other science back in early 12th century
- Montpellier has been tolerant to different cultures and religions which attracted Arabic, Jewish and Christian scientist to work together
- It played a key role in transition of science from Islamic world (Avicenna, Averroes, Al-Razi;...) via Al-Andalus in Spain to the European Christian world



GenISys offers software solutions for the optimization of micro- and nano-fabrication processes

- Founded in 2005 in Munich
  - joined RSBG Group LAB14 in 2018
- Headquarter in Taufkirchen - Munich, Germany
  - Subsidiaries in USA, Japan and Turkey
  - Development locations in Jena, Erlangen & Urla
- Worldwide leader on proximity and process correction for electron and laser lithography processes



GenISys continues to grow while maintaining customer centric spirit!



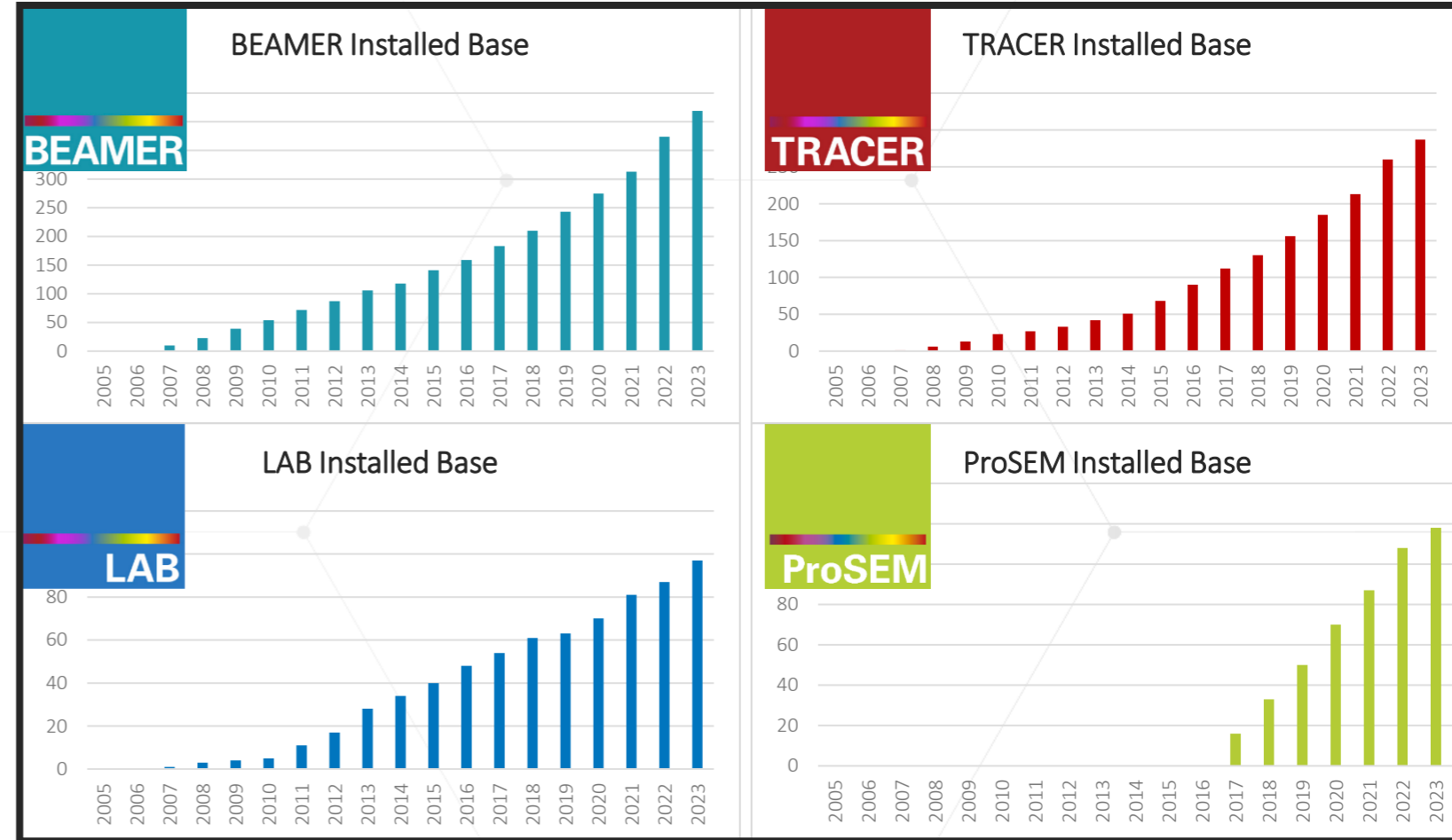


- From Max Plank Institute Erlangen
- GenISys customer > 10a
- Start November 1st
- Sales Manager Europe

# Products Installed Base 2023

## Growing Customer Base (>1000)

- BEAMER and TRACER
  - > 430 BEAMER installation
  - > 300 TRACER installation
- LAB Lithography Simulation
  - > 100 LAB installation
- ProSEM SEM Metrology
  - > 130 ProSEM installation



*GenISys* offers “more than software”:

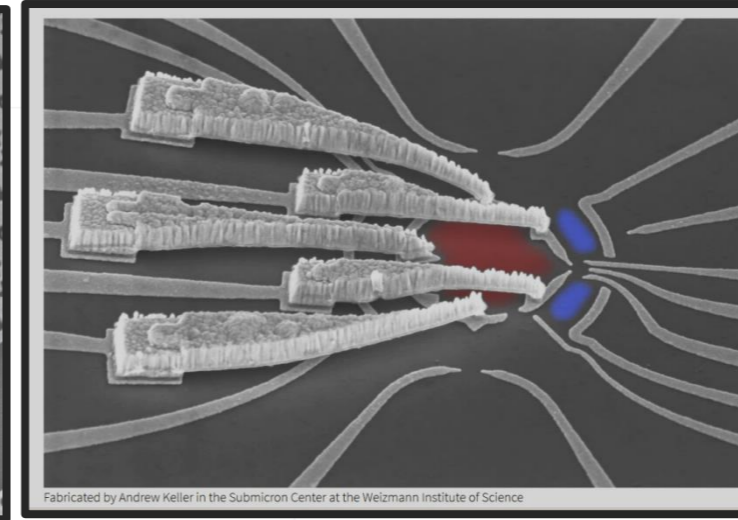
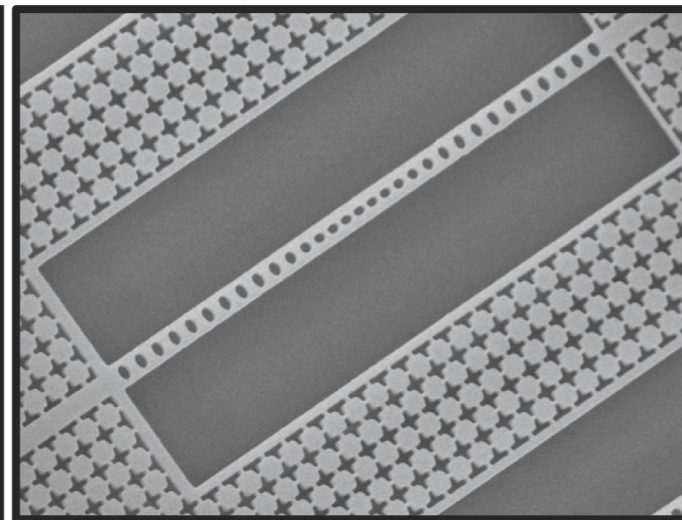
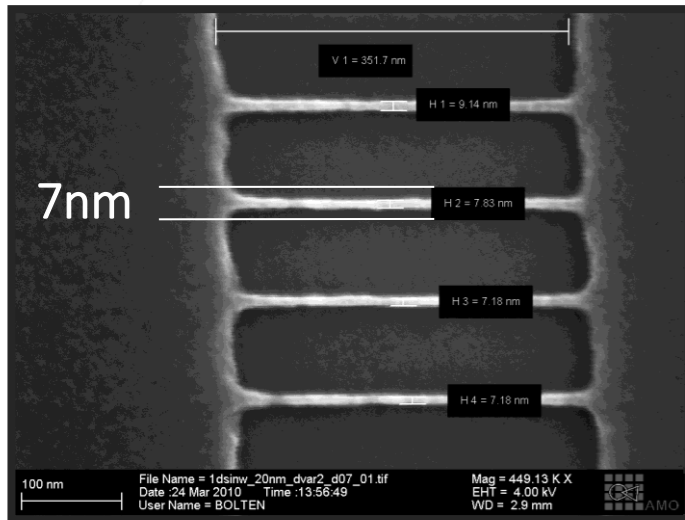
- Application support including process (~ 10 Application Engineer)
  - Experience from coloboration with > 200 advanced Nano-Centers
- Active user comunity beyond exposure tool
  - ~ 500 users meet at BEAMeetings worldwide
- Always at the „spearhead“ of technology with two major releases and frequent patches per year
  - new feature, enhancements and fixes
  - all development is driven by users / equipment partners
  - fast reaction on critical issues (patch in 24 hours)





Lithography equipment and processes need to overcome the limits of nano devices:

- Proximity and process effects
- Complexity of design and materials



Source: AMO GmbH - Germany

Source: NIST CNST - USA

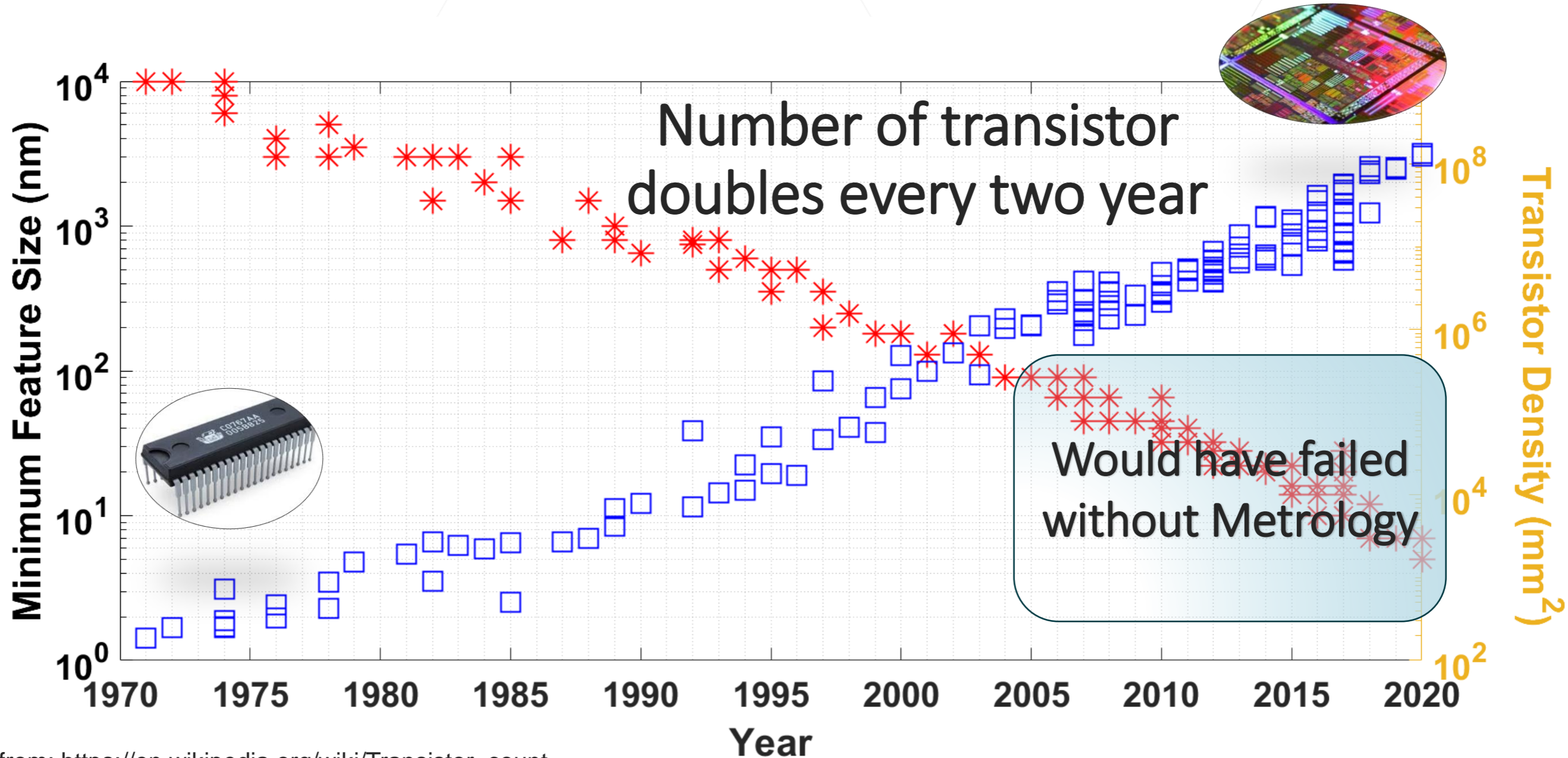
Source: Weizmann Institute – Israel  
Stanford University, USA

Improve Process



BETTER DEVICE

# Moore's Law



Data from: [https://en.wikipedia.org/wiki/Transistor\\_count](https://en.wikipedia.org/wiki/Transistor_count)

# Metrology in Manufacturing

This is how  
IC manufacturing  
patterns...



Images vendor webpages

This is how  
IC manufacturing  
measures...



Image AMAT webpage

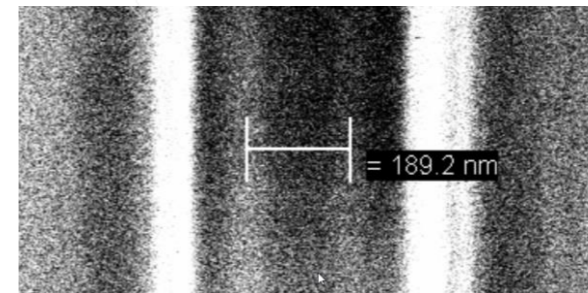
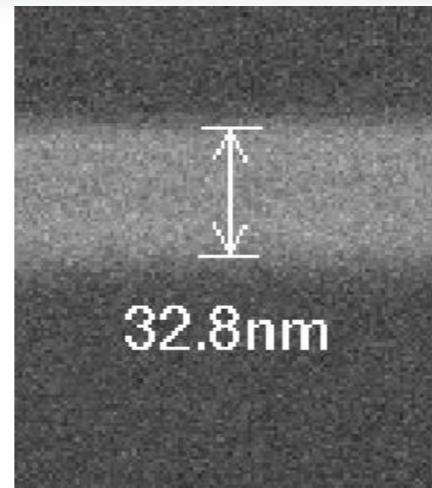
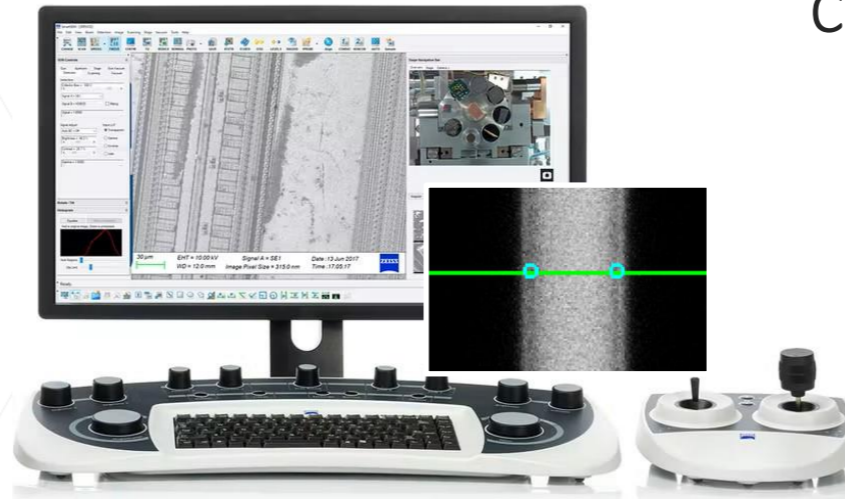
- Consistent and reliable measurements are critical for IC manufacturing
- Fully automated, very fast, consistent using reliable algorithm
- CDSEMs are expensive and inflexible – not affordable for most nanofabrication facilities

# The Metrology Challenge in Nanofabrication

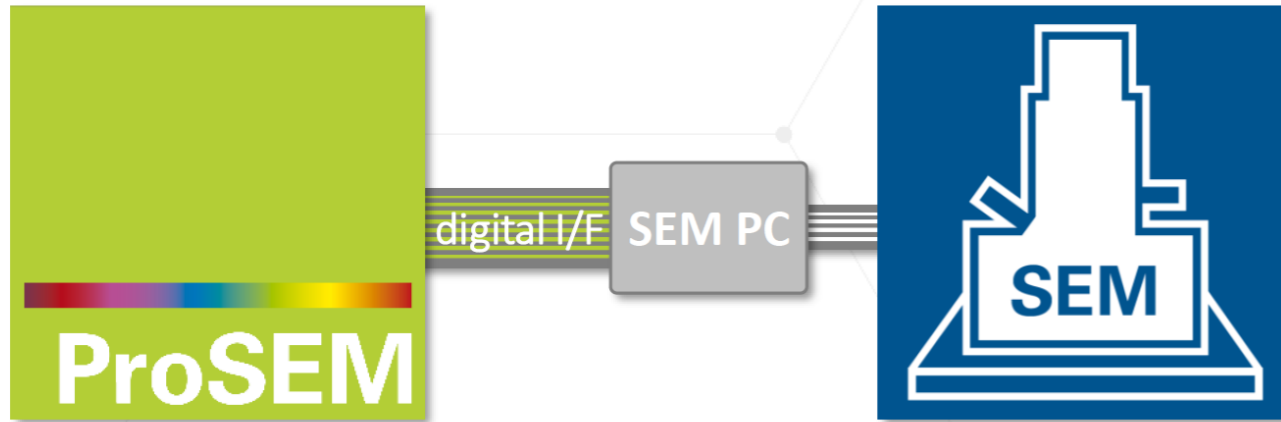
This is how  
you create  
nano patterns...

*This is how  
you measure  
nano patterns..?*

- Consistent and reliable SEM measurements are critical for process characterization
- Hand-drawn cursors are subjective, tedious, time-consuming, inconsistent

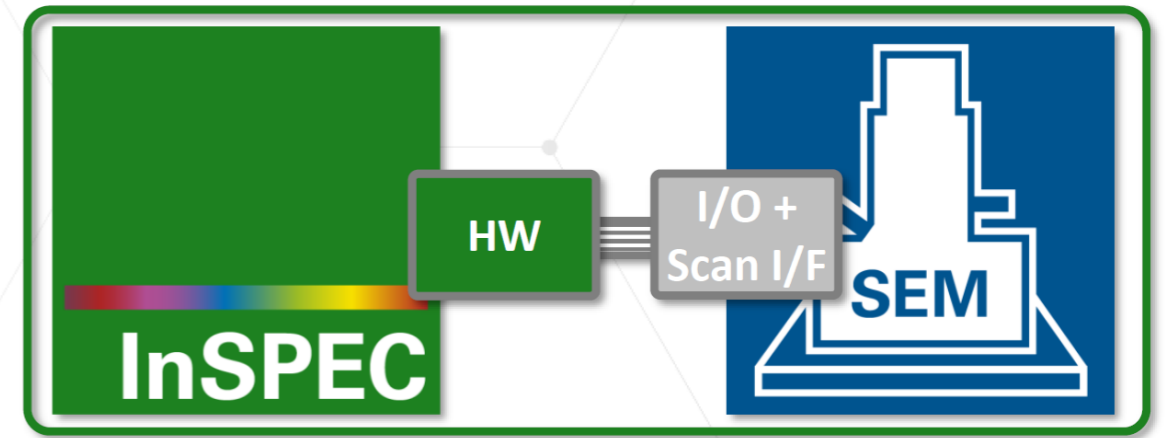


# Upgrade SEM for Metrology



Remote control of SEM  
via digital PC interface

Easy to get SEM images  
and metrology results

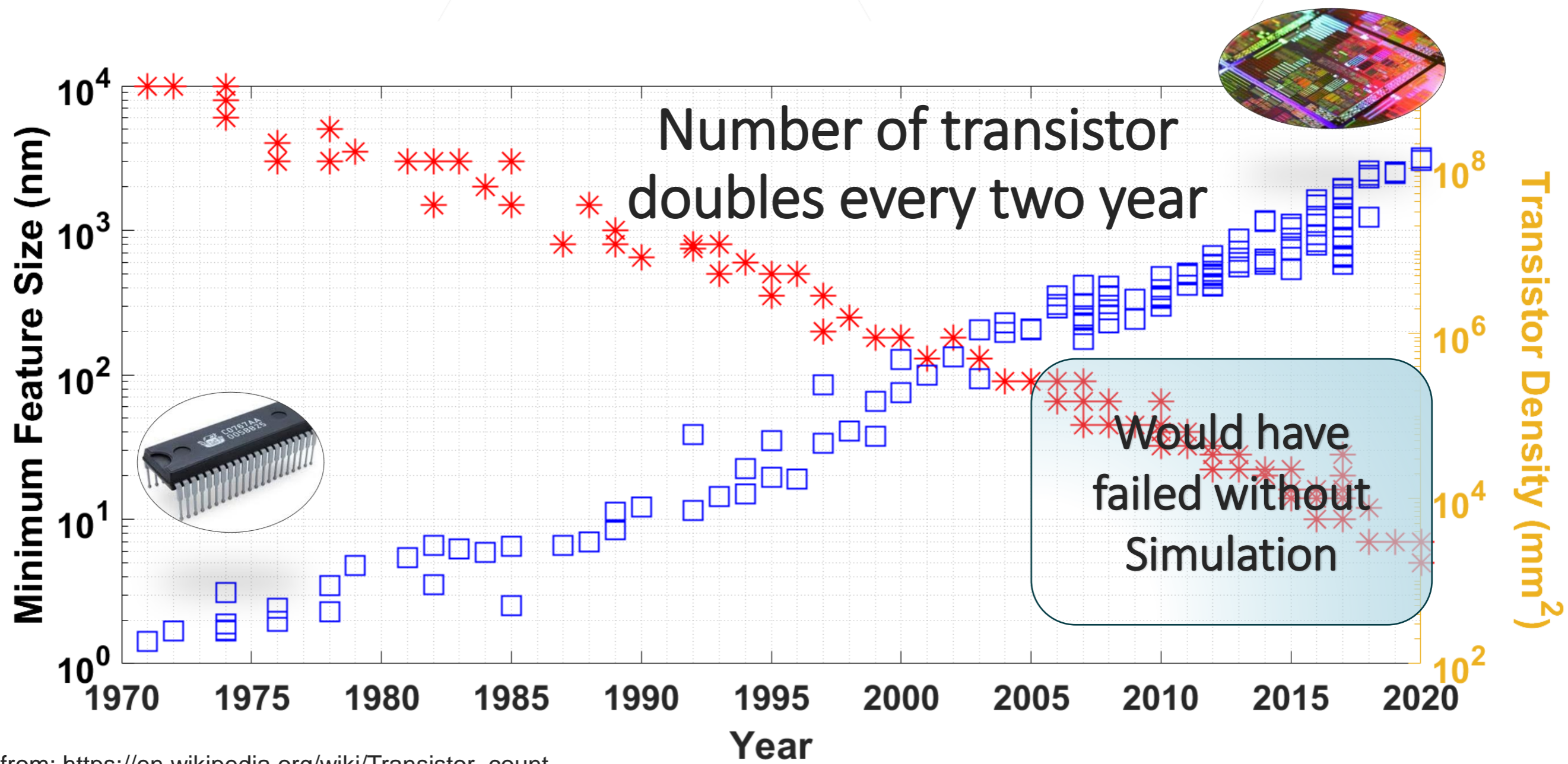


Direct SEM control with  
hardware integration

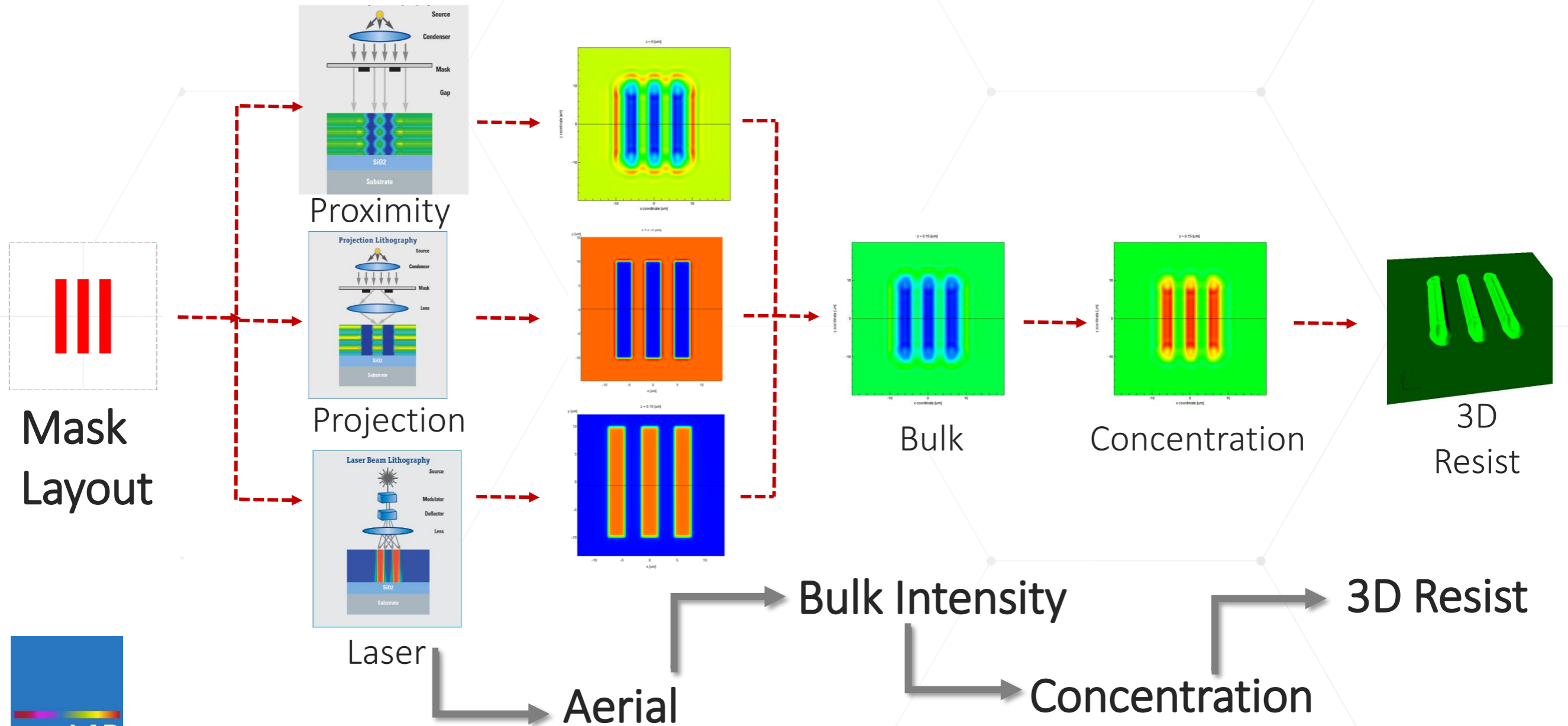
Comprehensive full  
layout-based workflow

Integrated scanning,  
automation and analysis

# Moore's Law

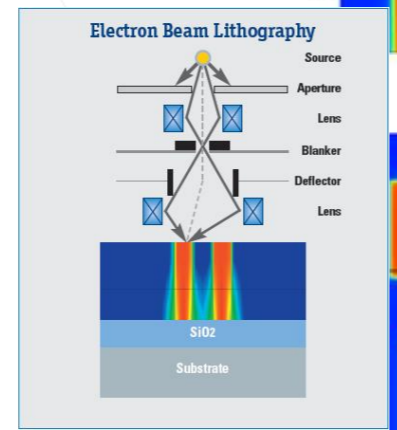
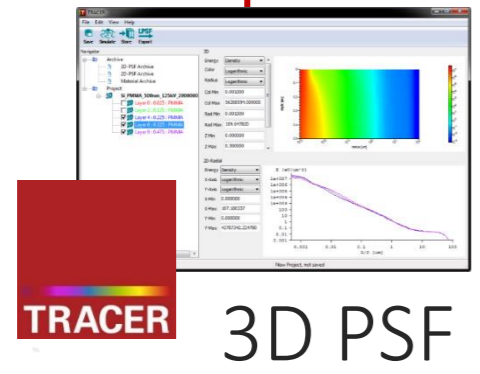
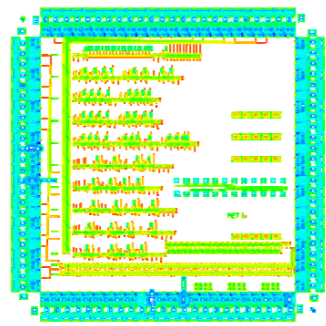


Data from: [https://en.wikipedia.org/wiki/Transistor\\_count](https://en.wikipedia.org/wiki/Transistor_count)

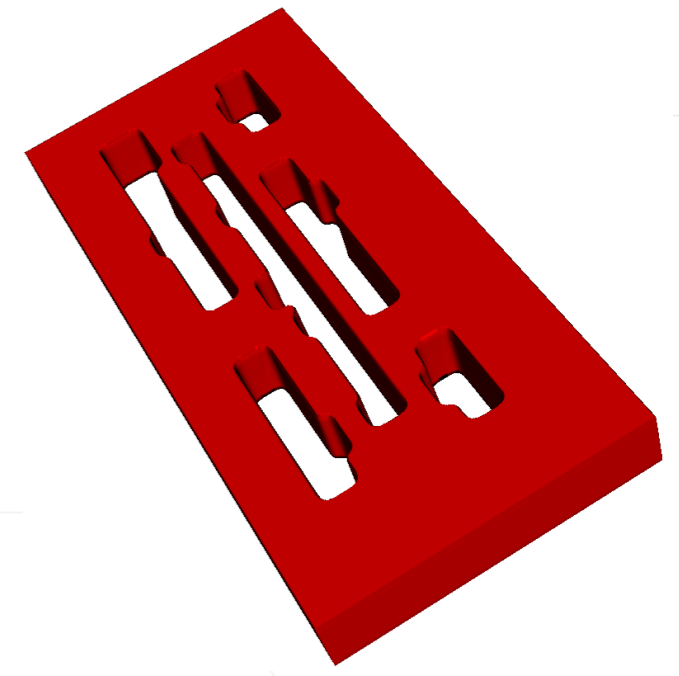
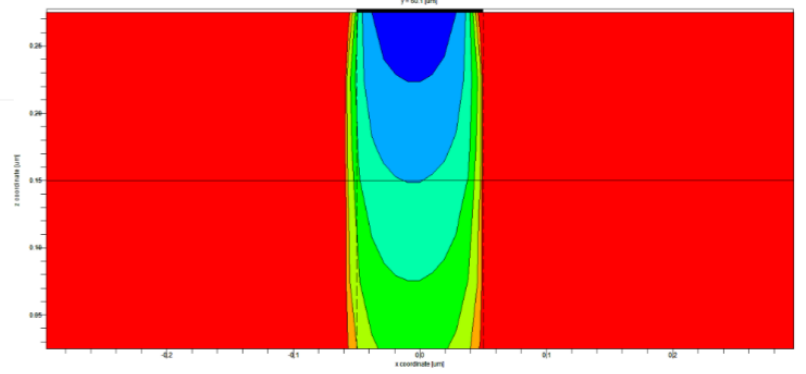
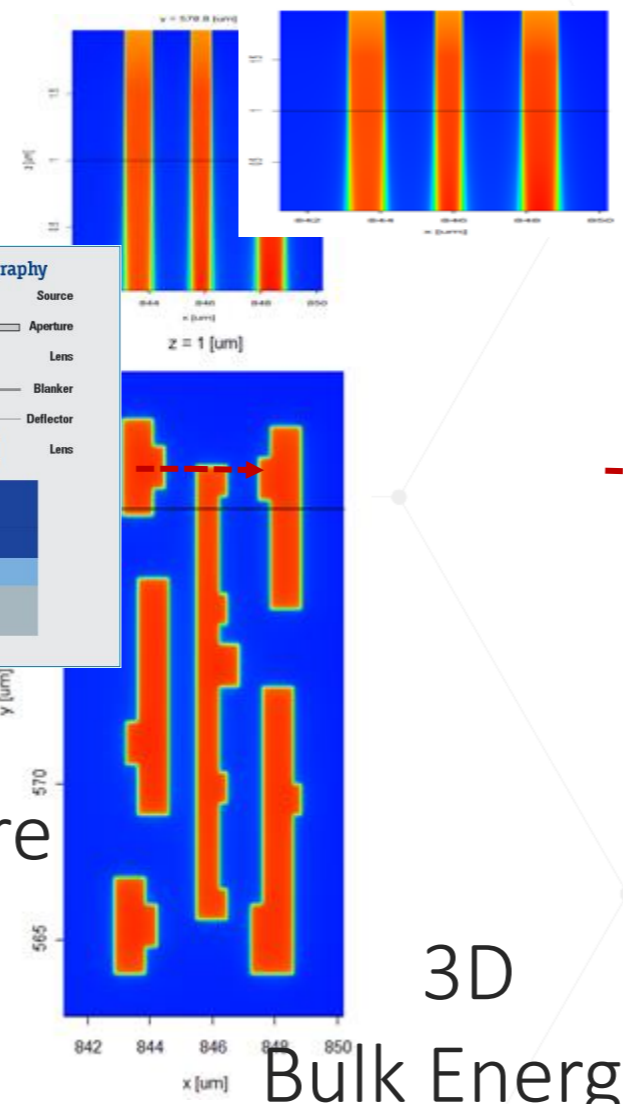


# 3D e-Beam Lithography Simulation

Layout



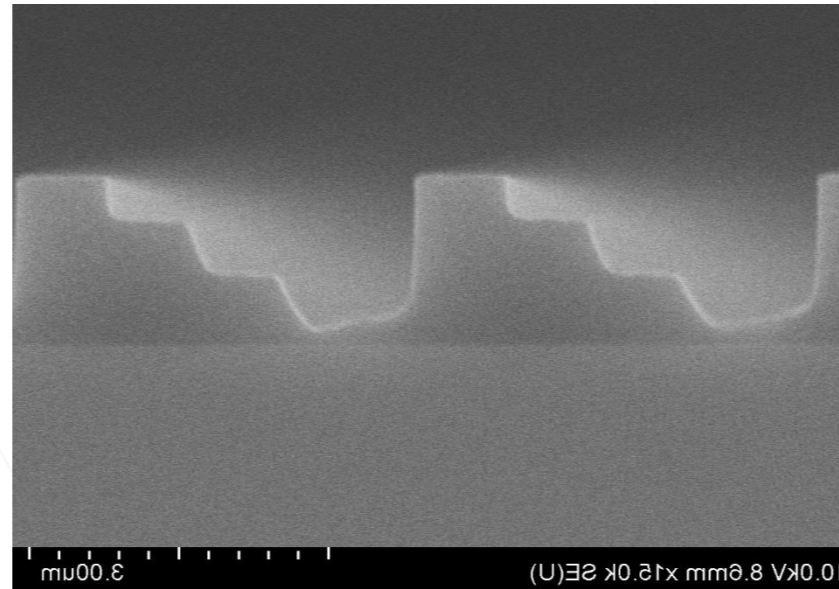
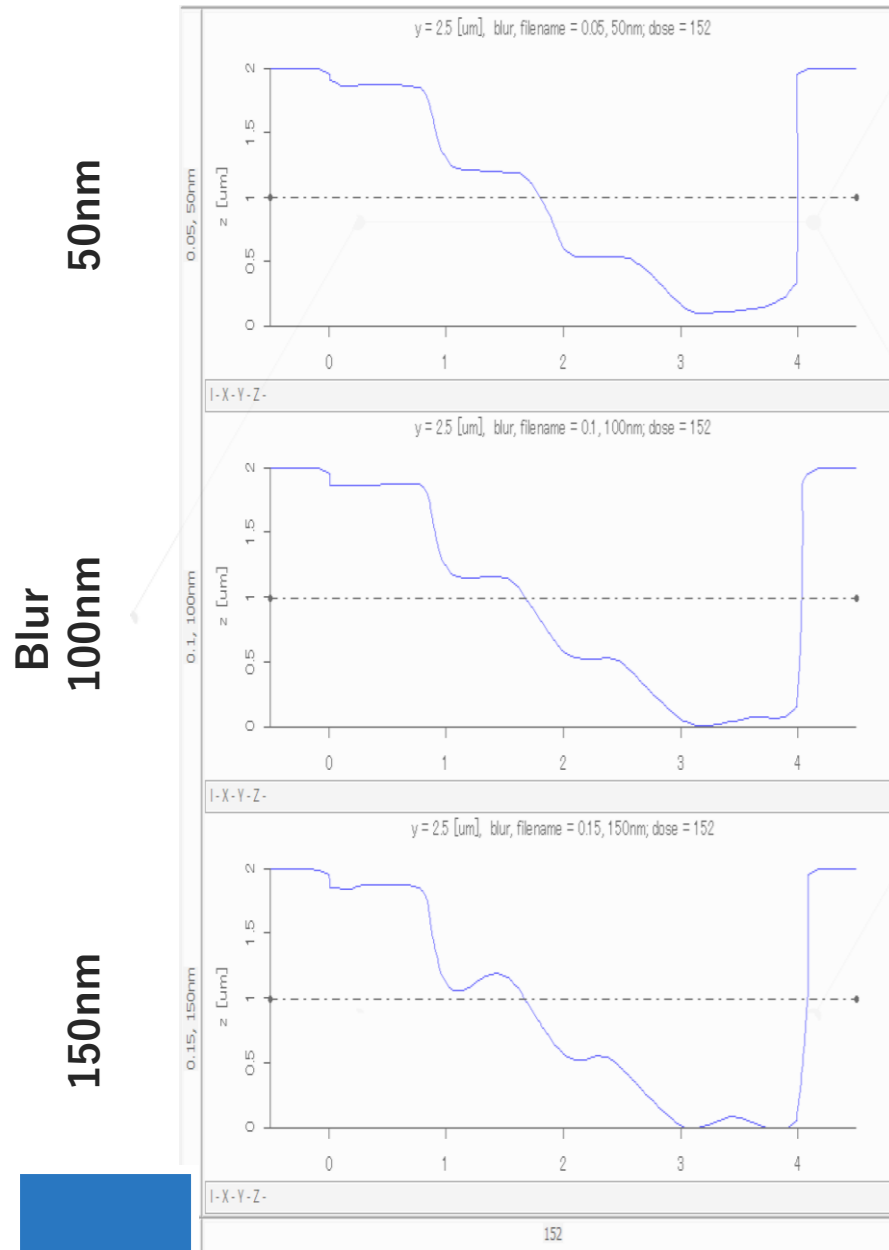
E-Beam Exposure



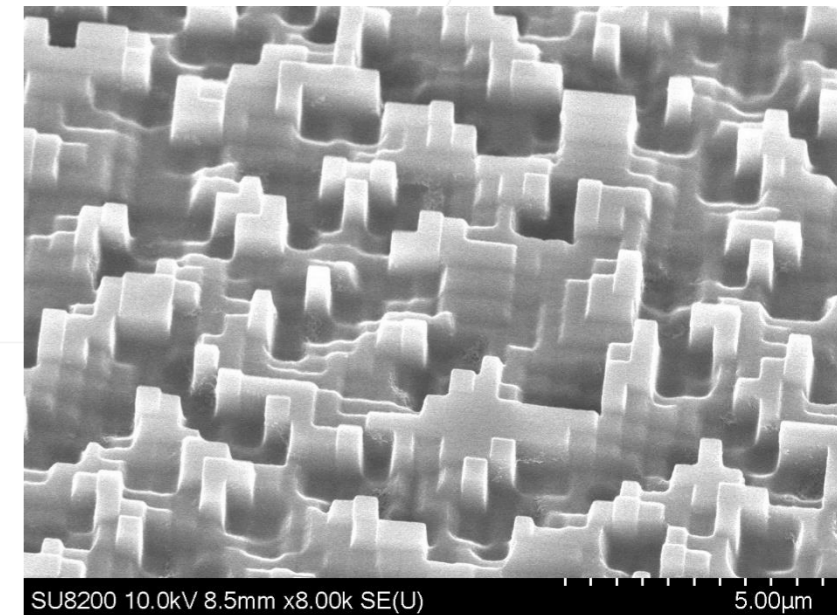
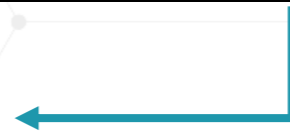
3D Resist Development



# E-Beam 3DPEC & LAB (BushClover)



E-Beam 3D, data prep. by BEAMER.  
→ Compared with LAB simulation.



Stable results are obtained by  
BushClover (Mr. Nizeki)

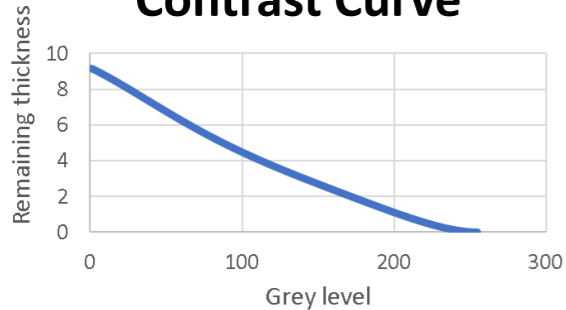
Dose 152 uC/cm<sup>2</sup>



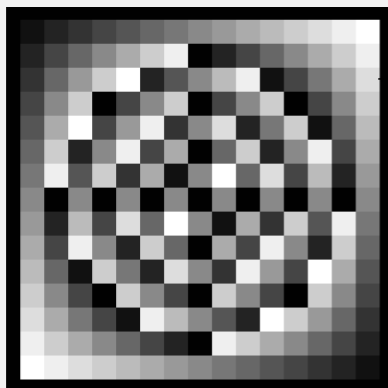
# Simulation of Laser Exposure Process

## Input

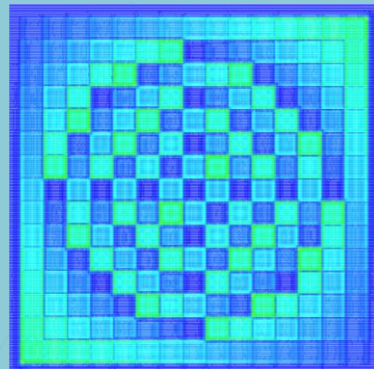
### Contrast Curve



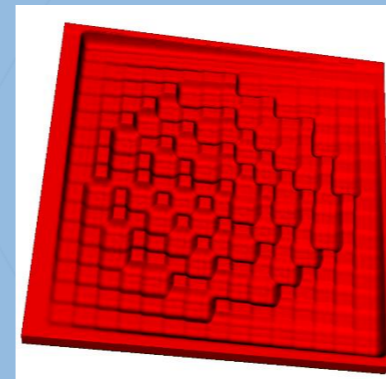
### Layout



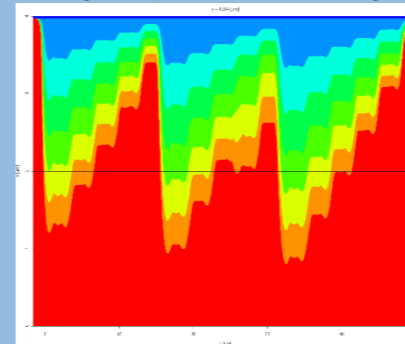
### Calculated energy distribution



### Simulated 3D profil (after development)



### Development process (Crosssection)



## Result

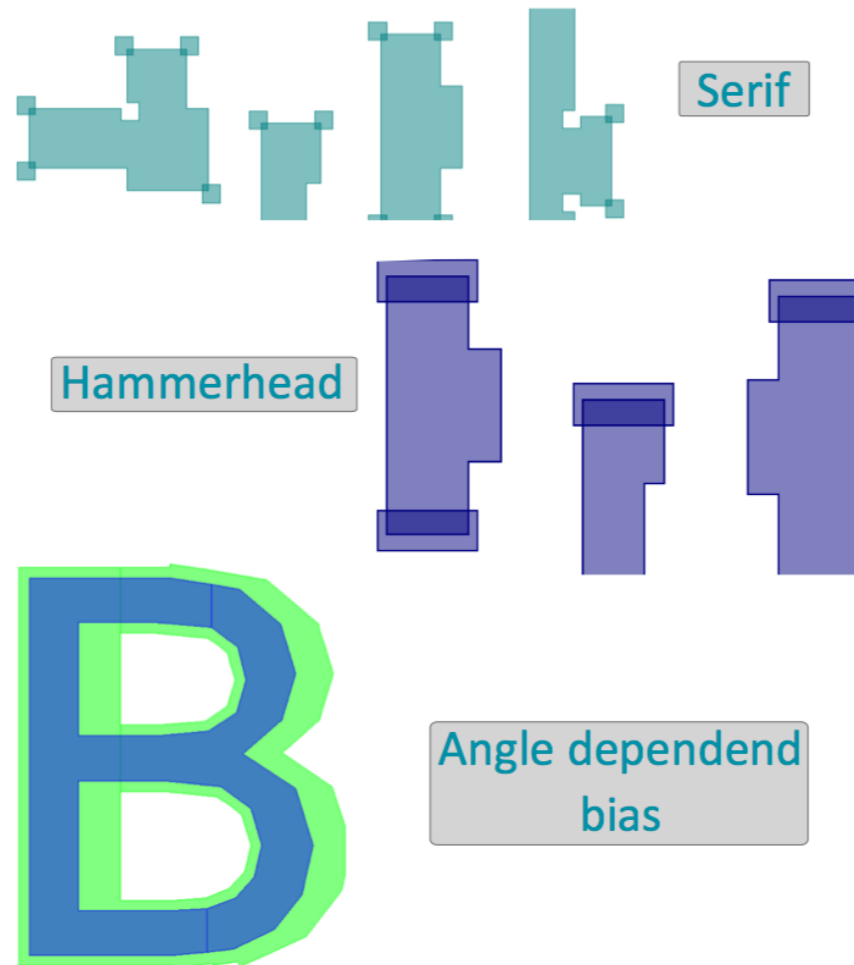
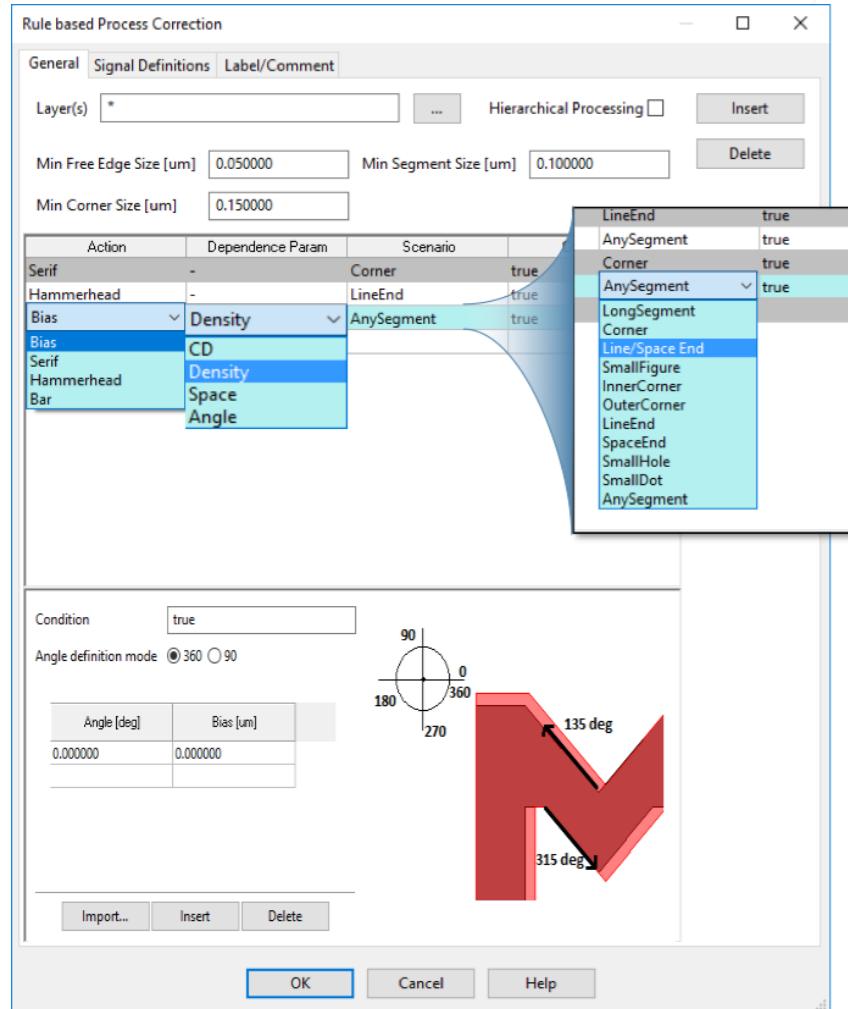


### Developed sample



## Rule-based correction :

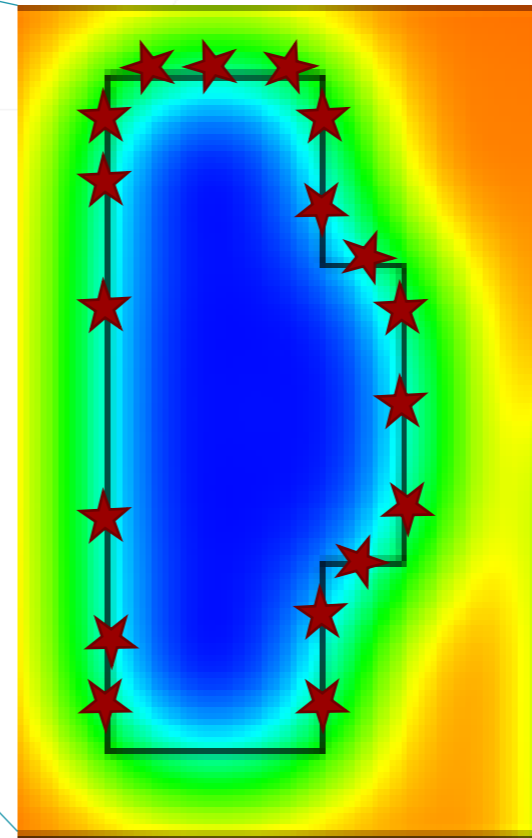
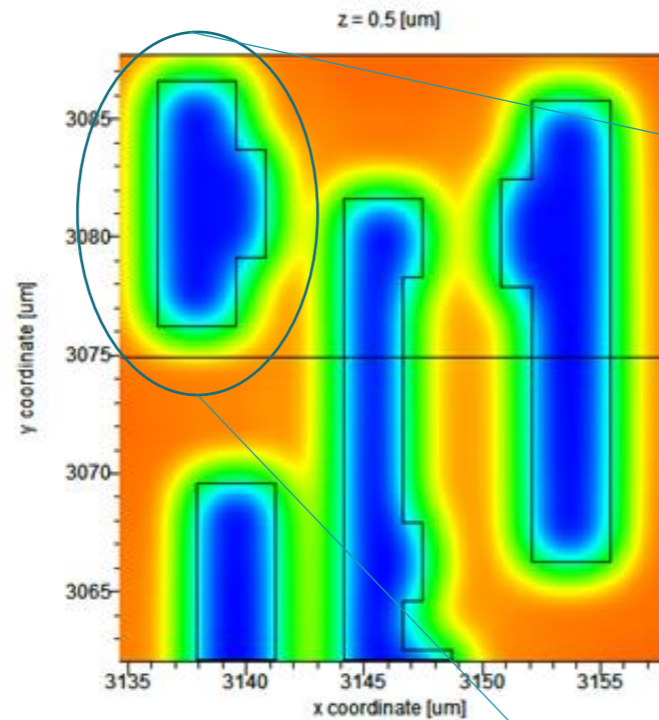
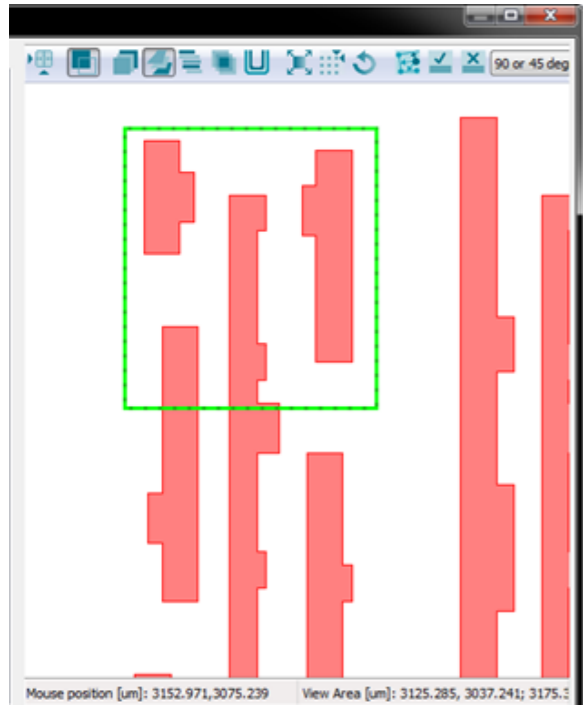
- Variable bias
  - Depending on angle, size, density, or space
- Serifs, hammerheads and bars can be applied based on user-defined rules
- Rules can be combined
- Applicable to all exposure techniques (laser, mask aligner, projection, e-beam)



# Model-OPC for Projection (Stepper)

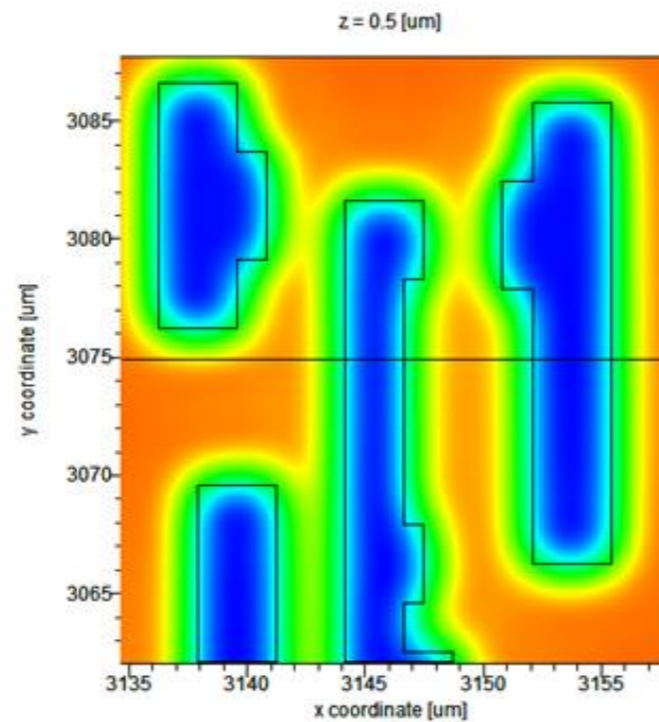
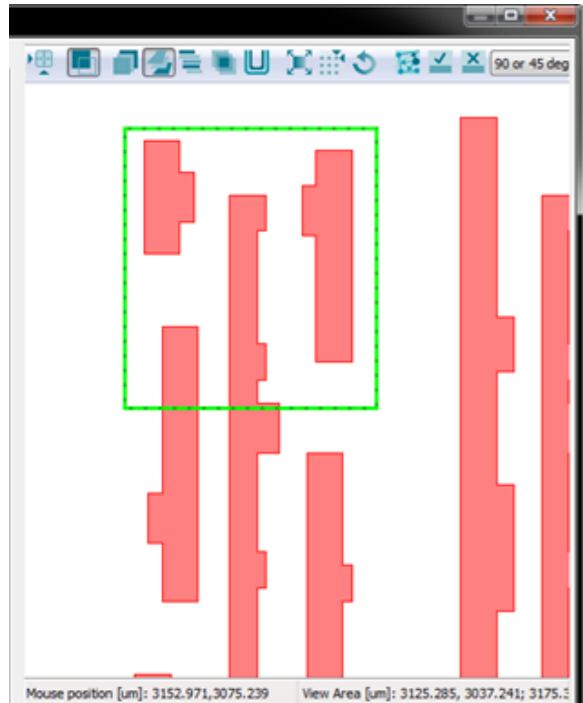
## Fully automated correction:

- Iterative process
- The exposure is modelled at layout edges (fast simulation)



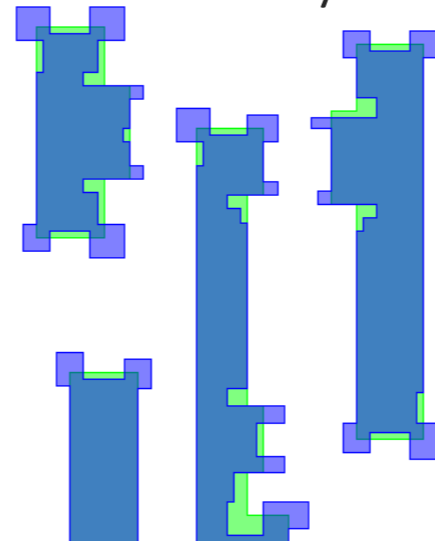
- Placing of evaluation points at layout edge
- Compare intensity level
  - at target: no action
  - Below or above target: move edges

# Model-OPC for Projection (Stepper)



## Fully automated correction:

- Iterative process
- The exposure is modelled at layout edges (fast simulation), compared to target
- the layout is modified (shape correction) to compensate for mismatch
- Full layout import



GenISys is offering Full-Chip OPC for special and mature application!

Mike Butler GenISys	Welcome & Introduction	9:00
Nezih Ünal GenISys	GenISys Update	9:10
Qiucheng Chen Fudan University	Applications of 3D Grayscale Electron Beam Lithography in Nanofabrication: X-ray Kinoform zone plates, HEMTs, and more	9:30
Jing Becker GenISys	Building Niemeyer-Dolan Bridges in BEAMER using 3D E-Beam Edge PEC	9:50
Sven Bauerdick GenISys	Introducing the NEW InSPEC	10:10
	Coffee Break	10:30
Zdenek Benes EPFL	Automated SEM Metrology with InSPEC	10:50
Jana Chaaban HIMT Nano	Thermal scanning probe lithography with the NanoFrazor: Exploring paths for scale-up and automation	11:10
Jens Bolten AMO	HSQ -- Do different flavours differ? An open discussion about alternatives to Corning's XR1541 resist	11:30
Sven Bauerdick GenISys	ProSEM vs. InSPEC: the "best" metrology solution	11:50
Thomas Michels GenISys	What's New in BEAMER Roadmap Discussion	12:00
	Break	12:30
Afternoon:	Maskless Laser Lithography for the Advanced Micro- and Nanofabrication	13:30
	Closing	17:45



# Thank You!

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