Title

Berkeley MET5 enters mature phase of research

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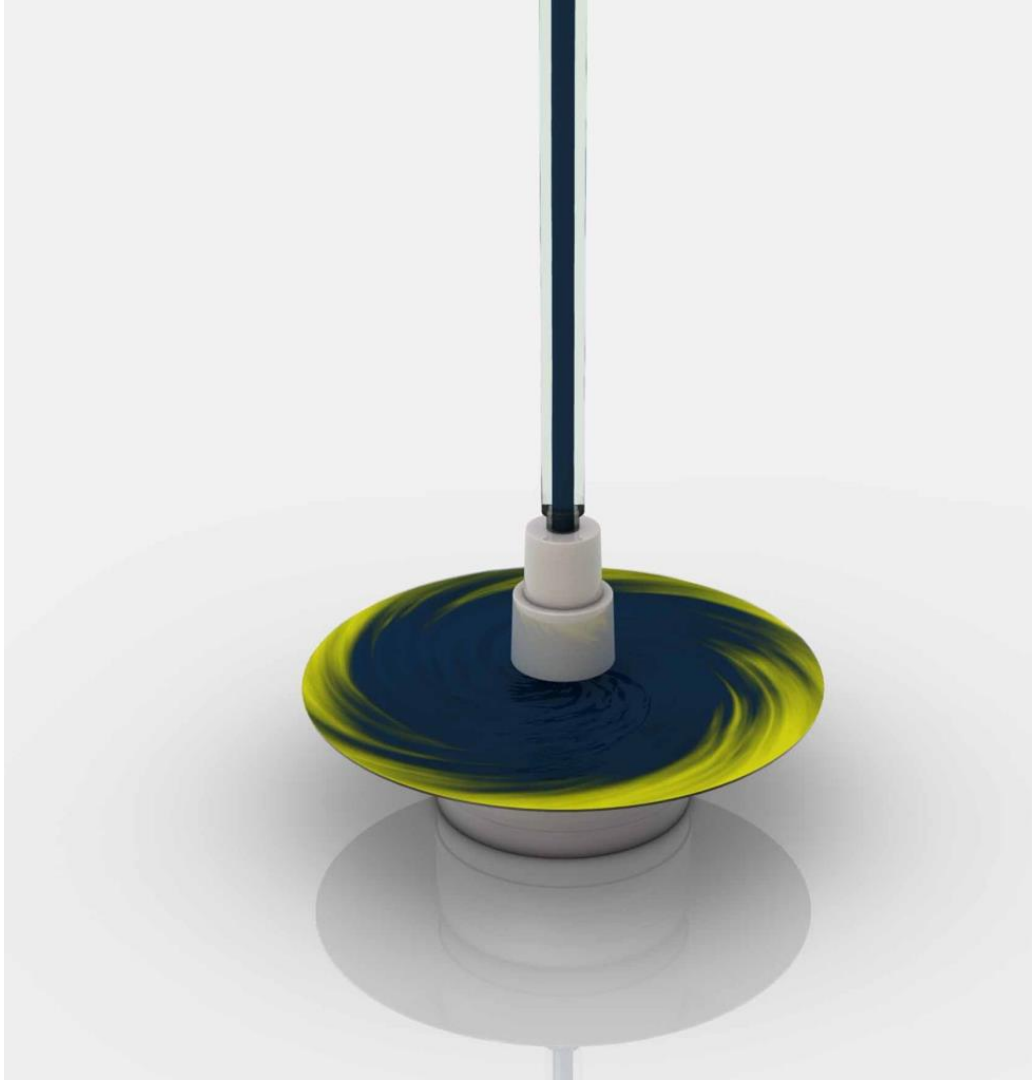
Berkeley MET5 enters mature phase of research

Arnaud Allezy, **Chris Anderson**, Weilun Chao, Carl Cork, Will Cork, Rene Delano, Jason DePonte, Michael Dickinson, Geoff Gaines, Jeff Gamsby, Eric Gullikson, Warren Holcomb, Martin Izquierdo, Gideon Jones, Ryan Miyakawa, Patrick Naulleau, Seno Rekawa, Farhad Salmassi, Brandon Vollmer, Jinyuan Yan, Daniel Zehm, Wenhua Zhu, Farid Zuberi.

Research areas

Research areas

EUV materials & process

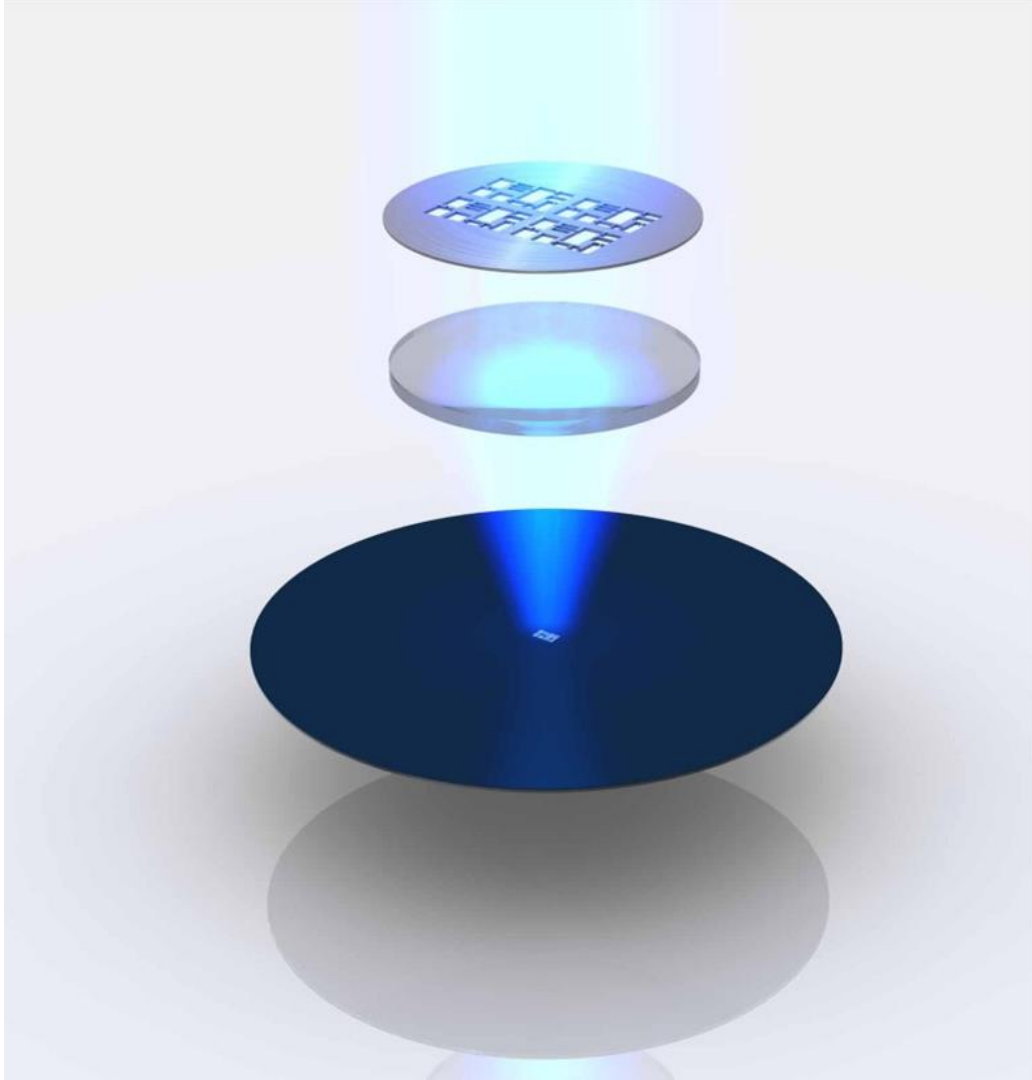


Research areas

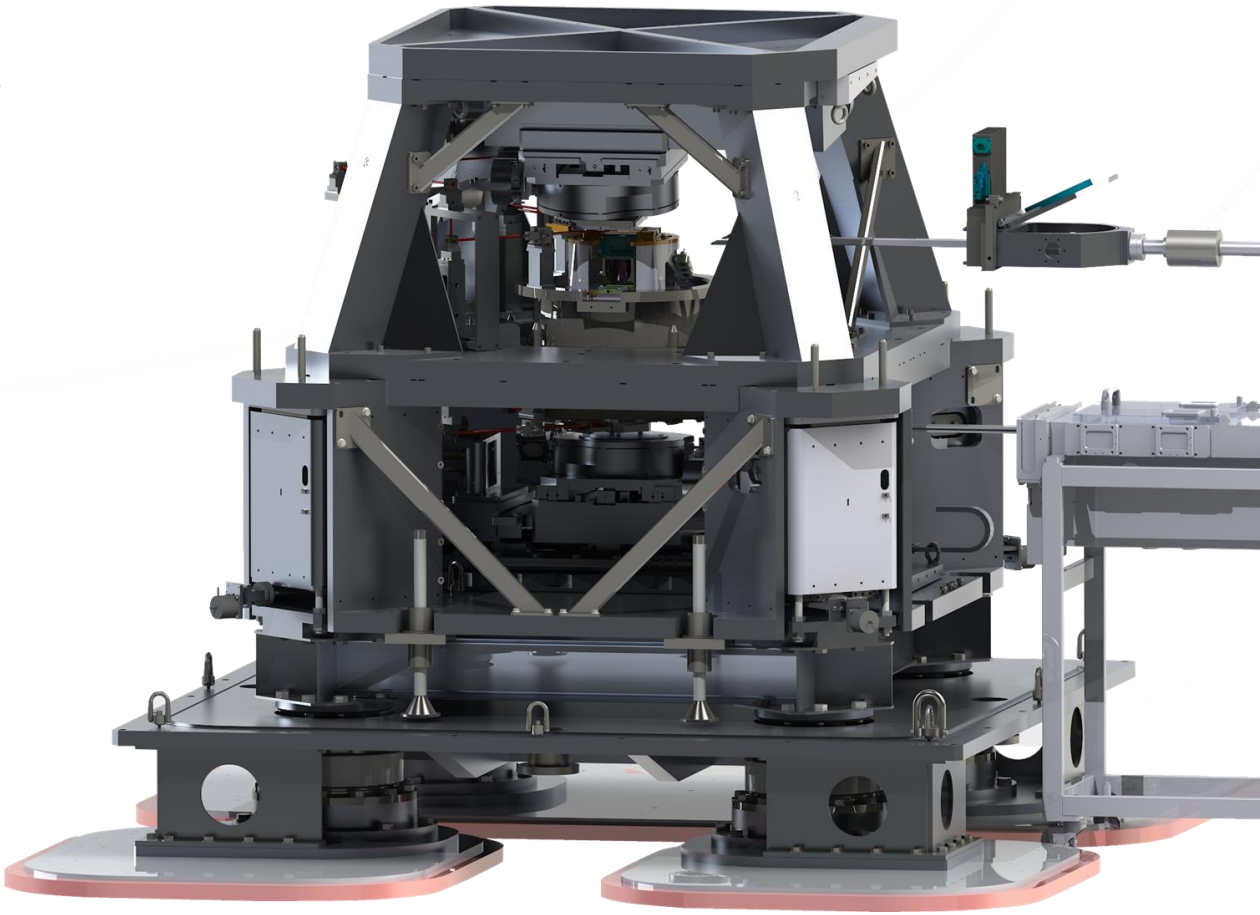
EUV materials & process

0.5-NA Imaging

- Image modeling validation
- Polarization effects
- Reduced depth of focus



Features & benefits



Features & benefits

Synchrotron light source

- Linearly polarized in X
- 1/100 spectral purity

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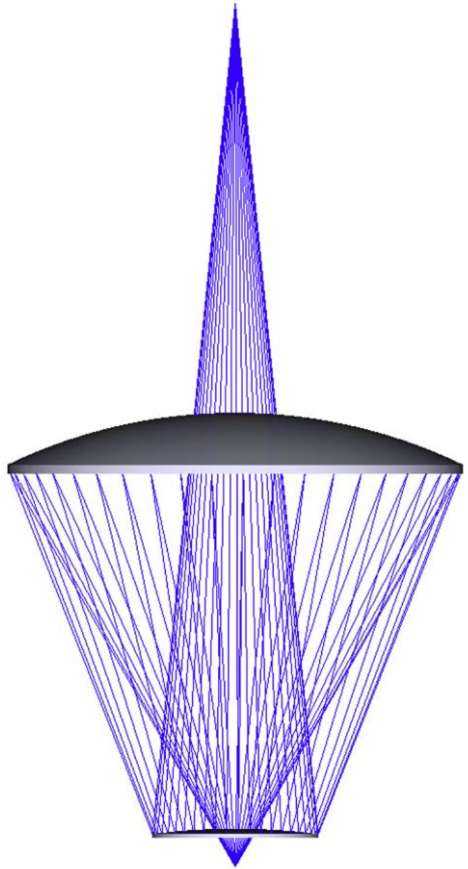
0.5 numerical aperture

- Aspheric Schwarzchild



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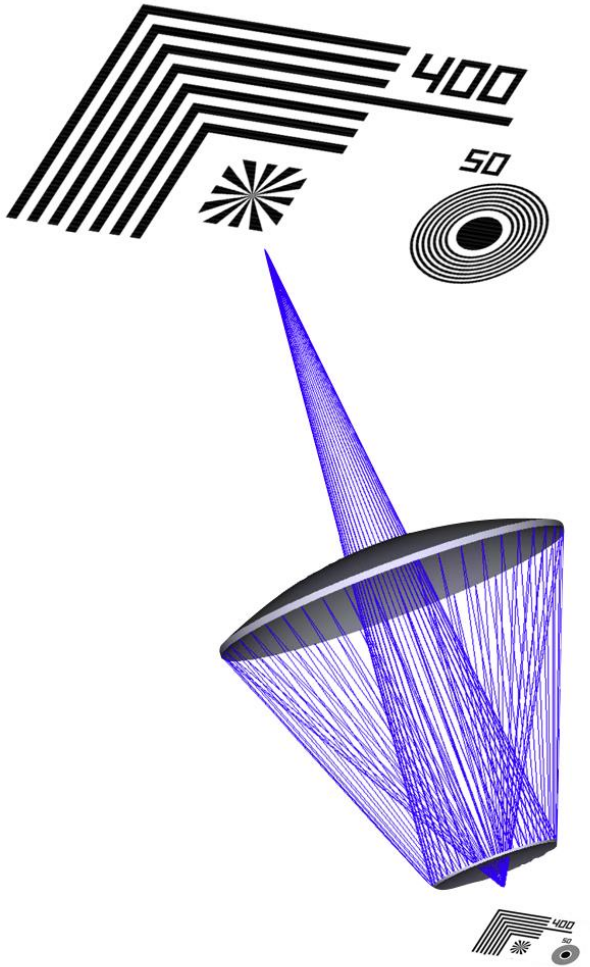
5X demag



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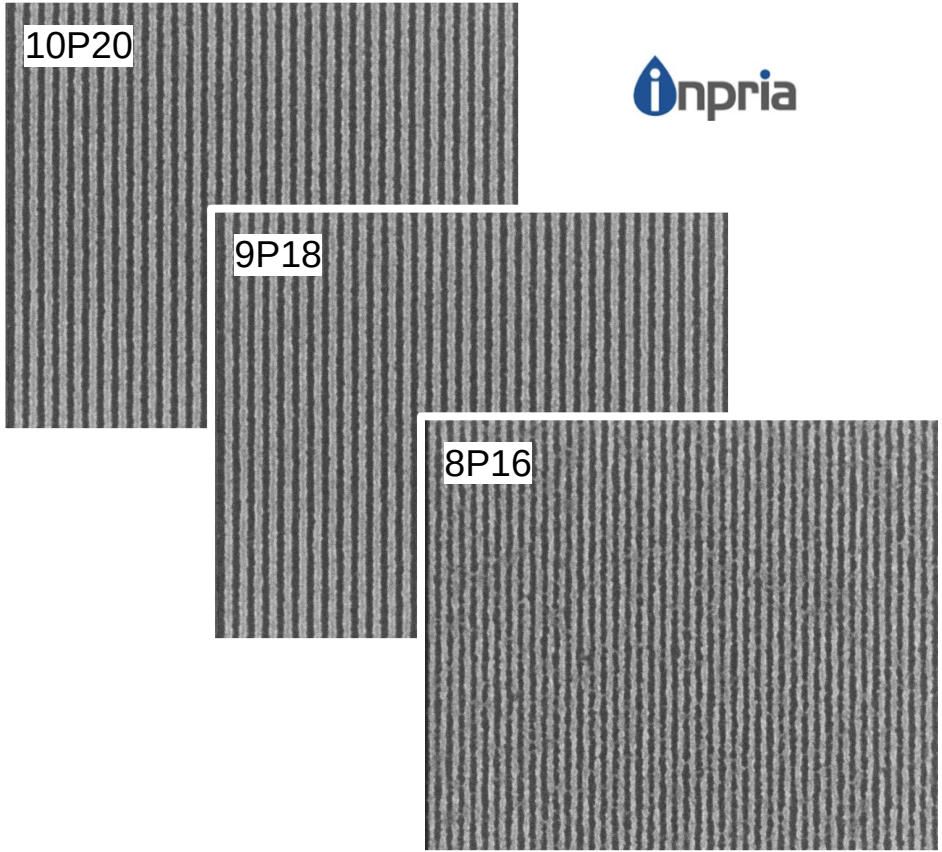
9 nm resolution proven



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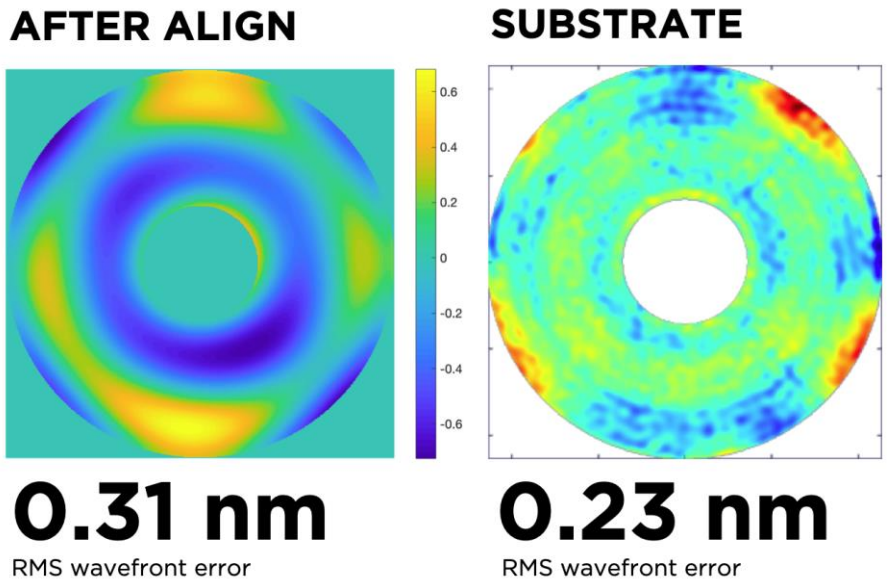
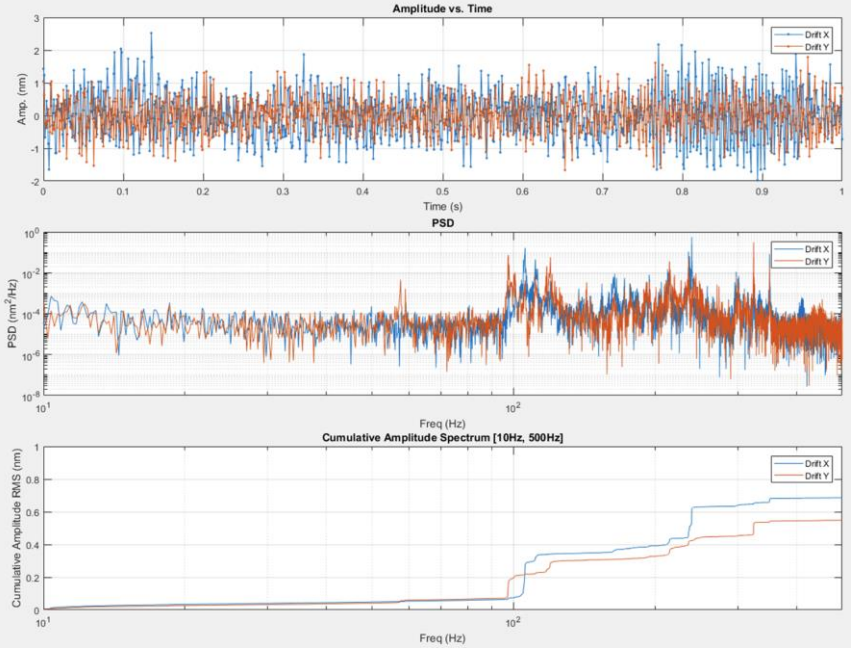
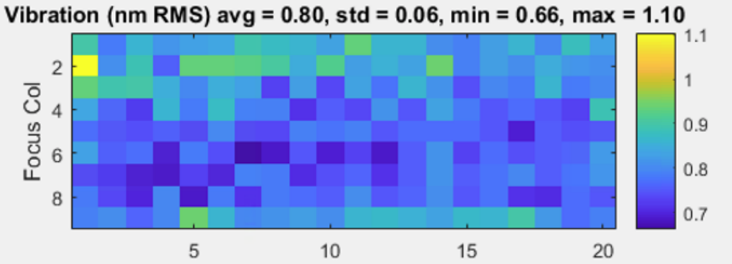
λ/43 wavefront error
- Measured with built-in EUV shearing interferometer
- Substrate is λ/58



Features & benefits (cont.)

0.8 nm image stabilization

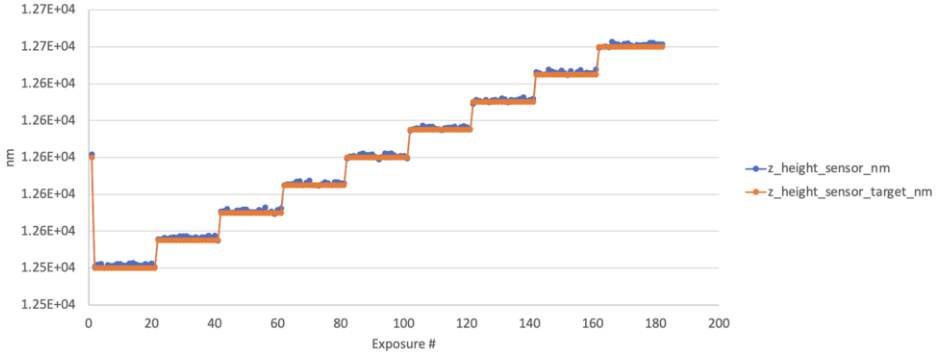




Features & benefits (cont.)

0.8 nm image stabilization

0.9 nm focus lock to target (1σ)



15 nm focus steps

Features & benefits (cont.)

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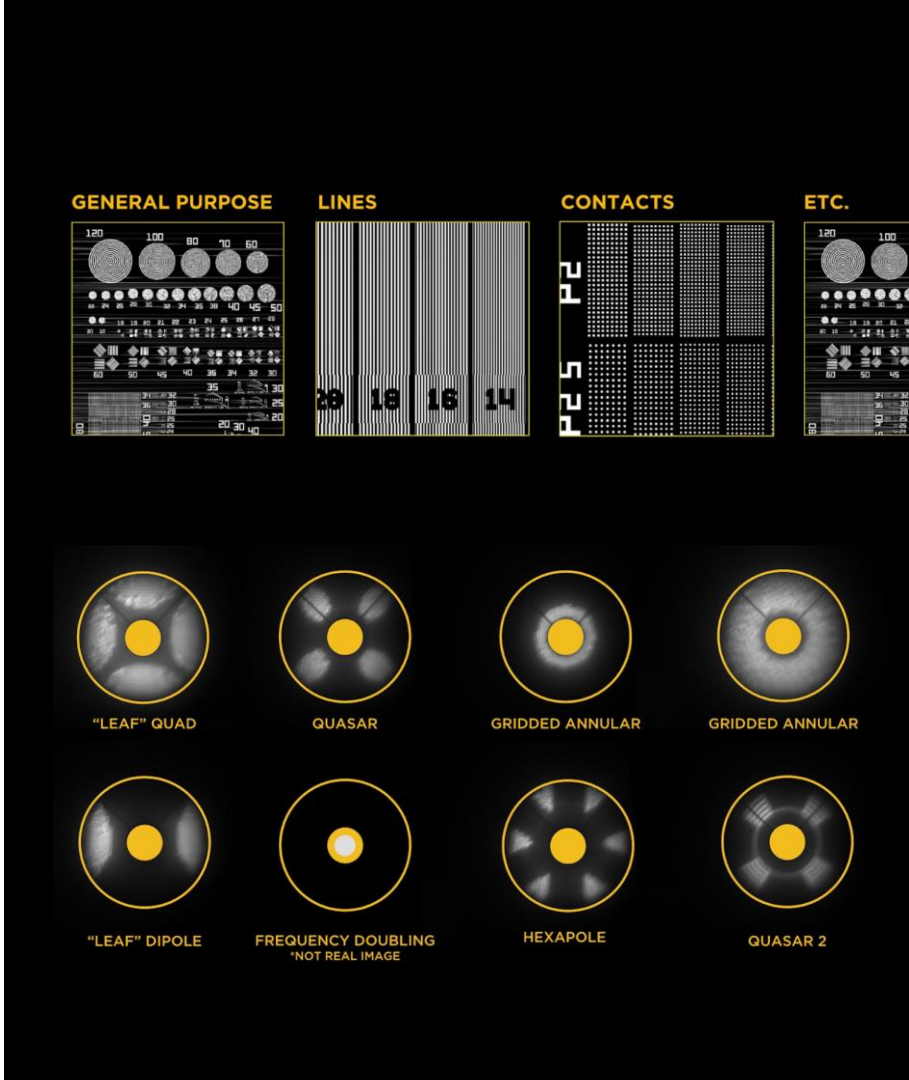
0.9 nm focus lock to target (1σ)

Programmable pupil fill for fine-tuning image properties



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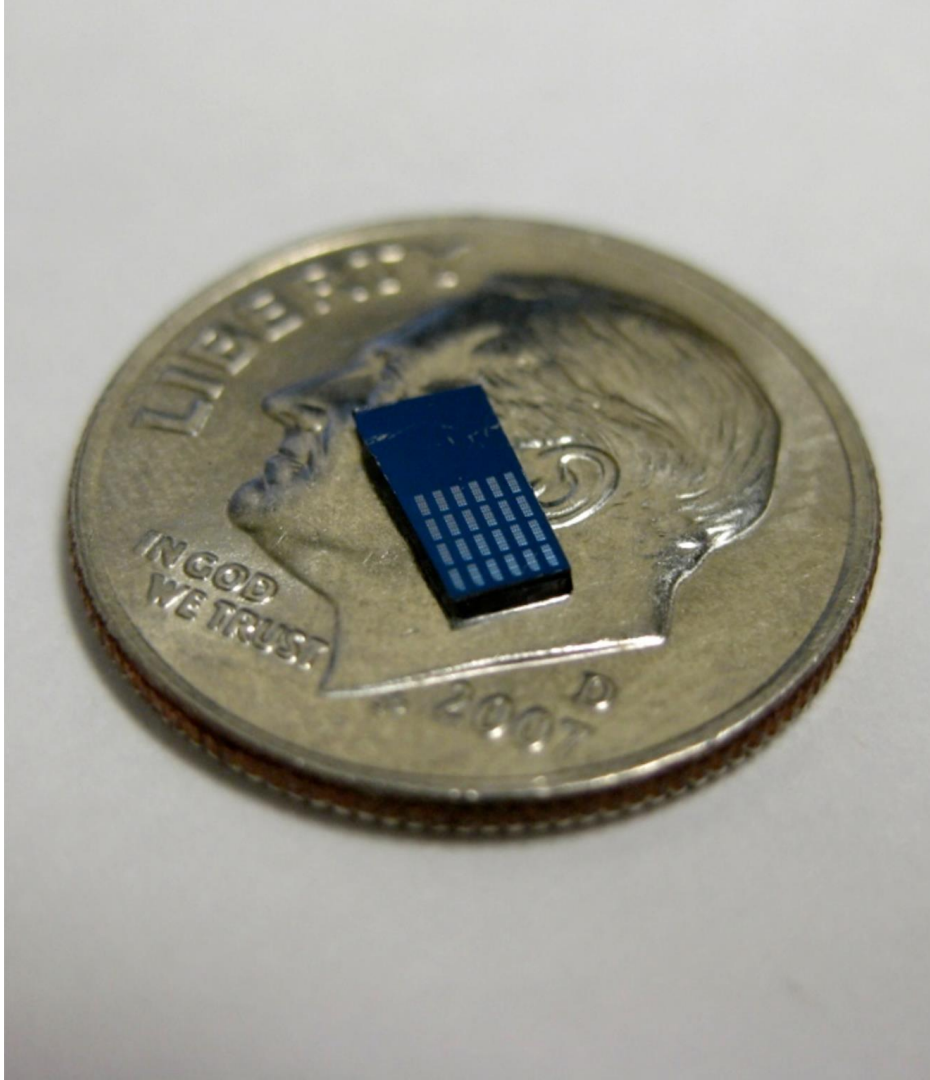
200 um x 30 um field



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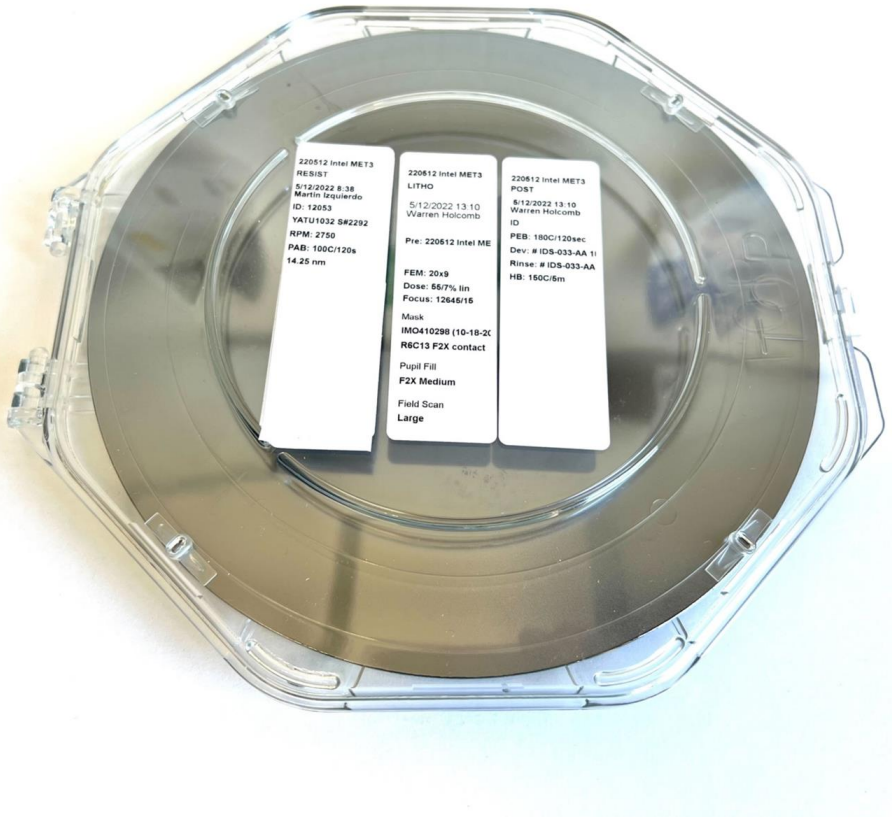
200 mm wafers



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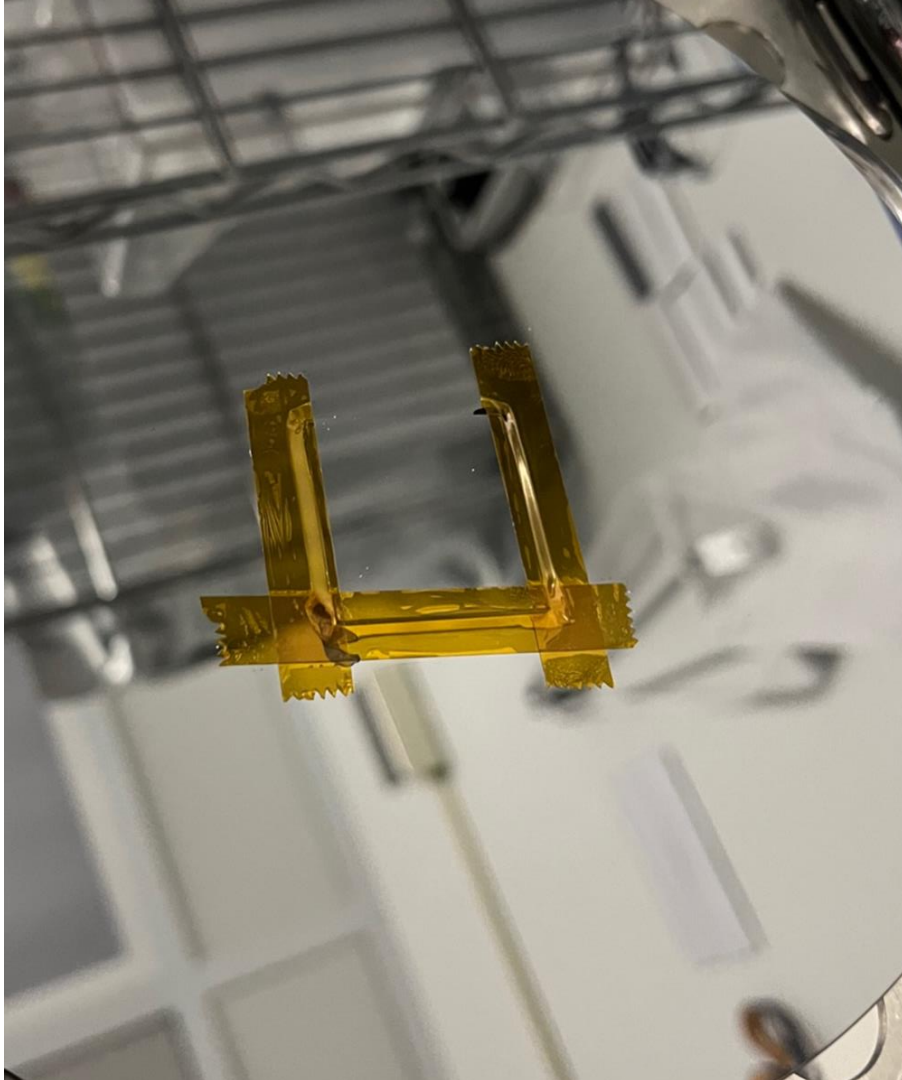
Coupons OK



Features & benefits (cont.)

Material-based dose calibration

- Can transfer doses between tools, e.g. NXE

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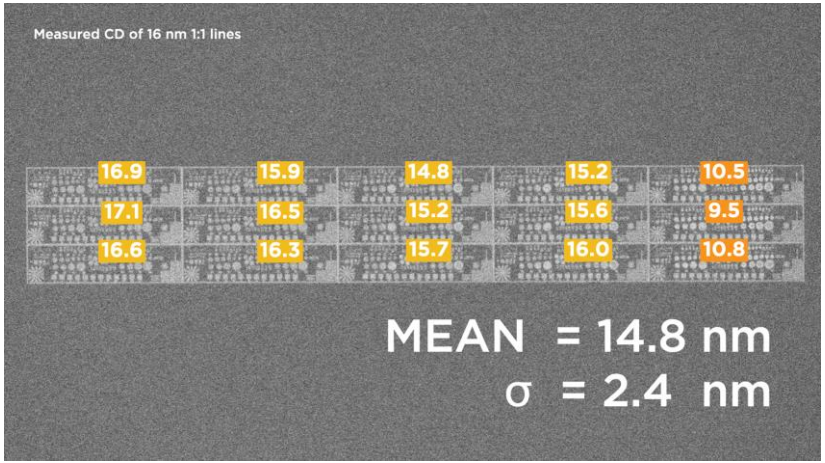
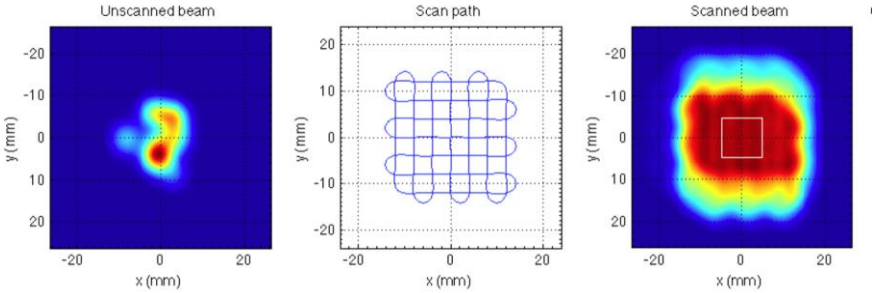
18% dose variation across field





Features & benefits (cont.)

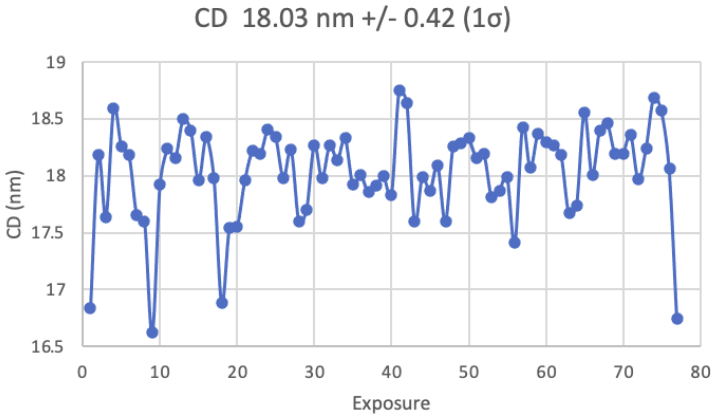
Material-based dose calibration

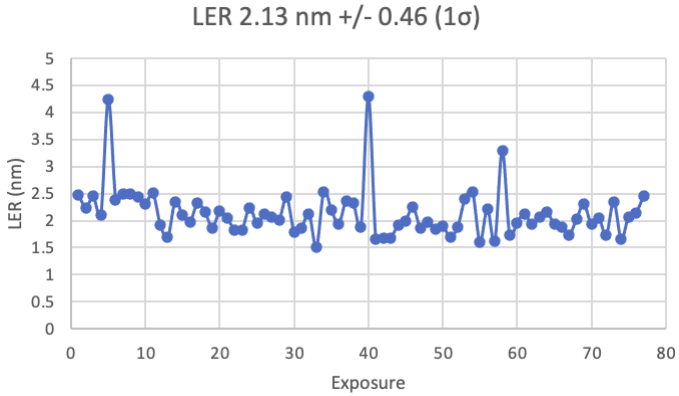
- Can transfer doses between tools, e.g. NXE

18% dose variation across field

2.3% CDU

- Constant dose/focus FEM, plot CD vs. exposure 16 nm 1:1 lines





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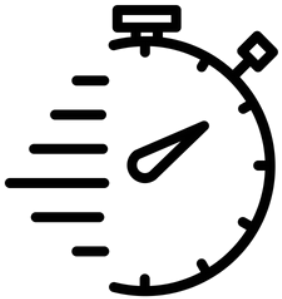
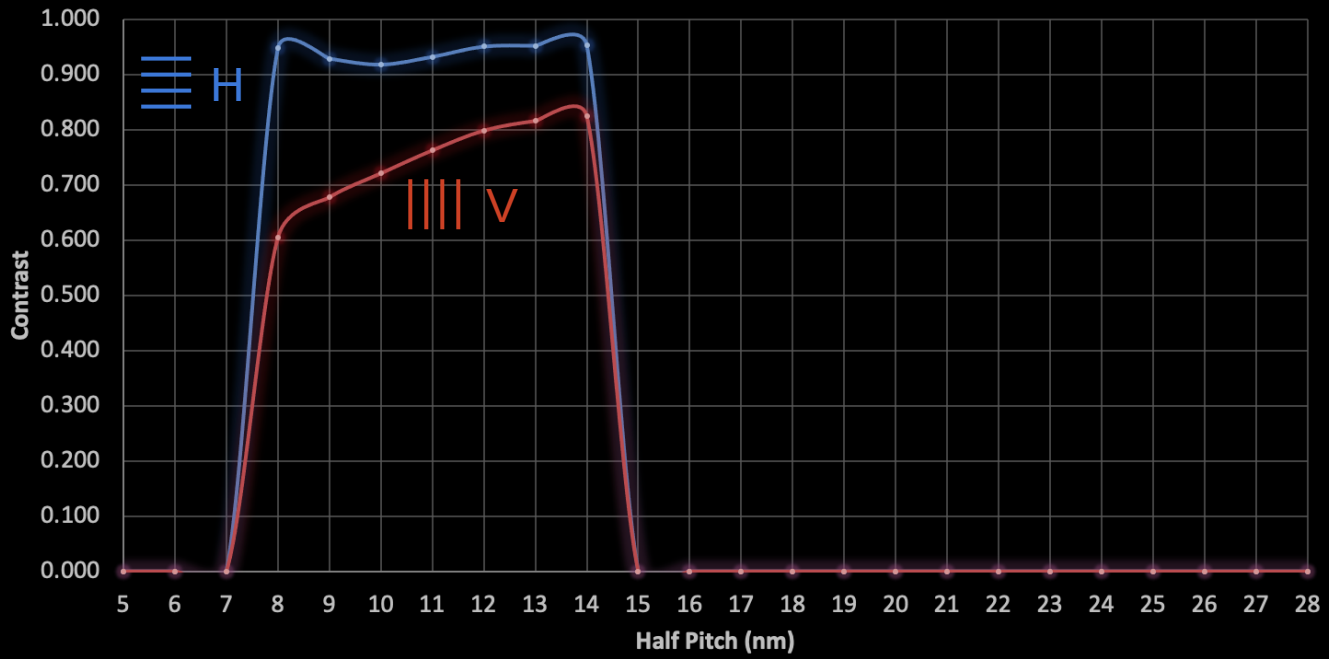
- Constant dose/focus FEM, plot CD vs. exposure 16 nm 1:1 lines

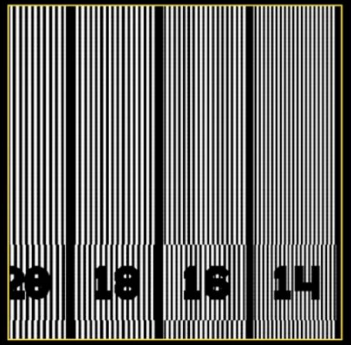
~1 wafer per hour (9x11 FEM)



Best resolution lines

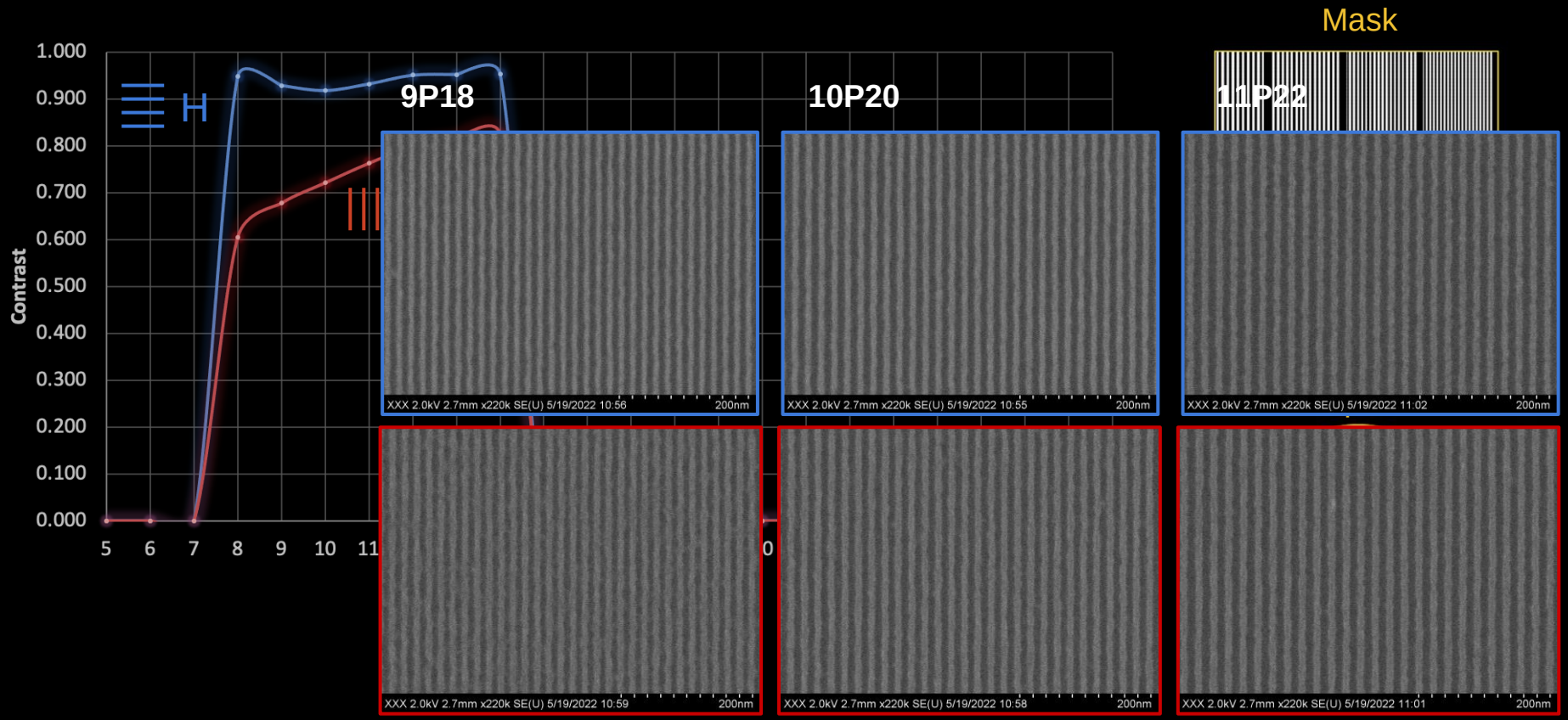


Mask

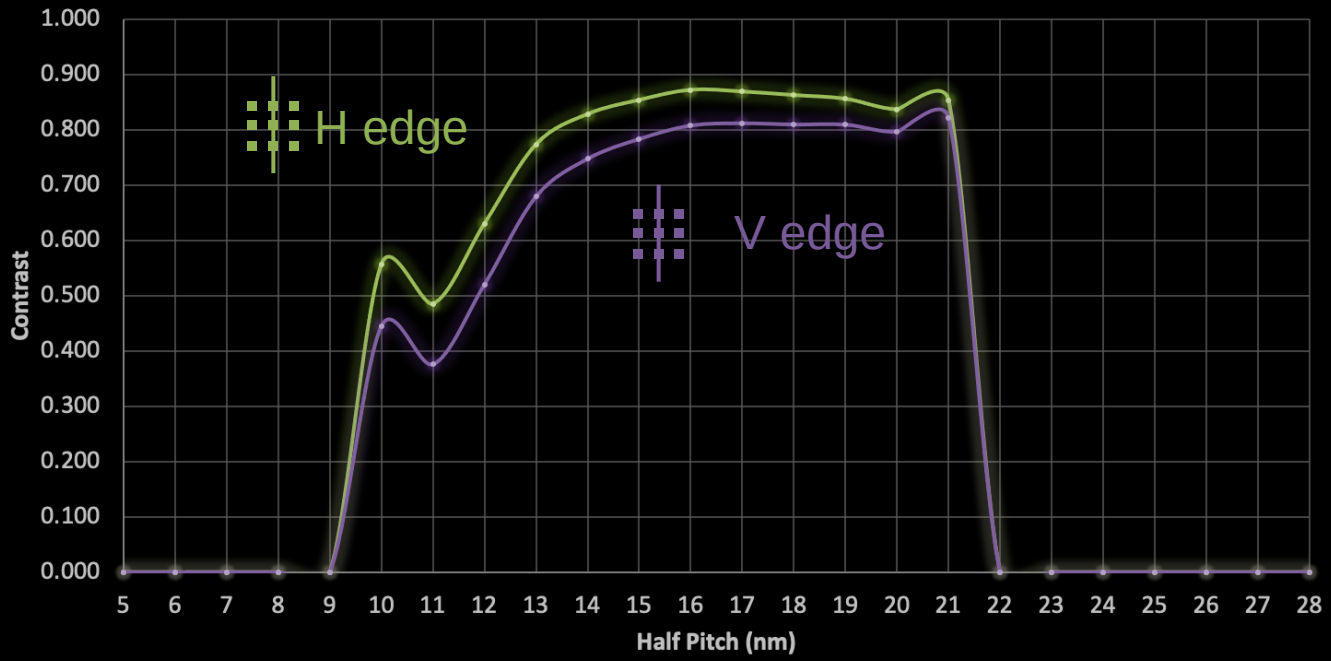


Pupil fill

Best resolution lines



Best resolution contacts



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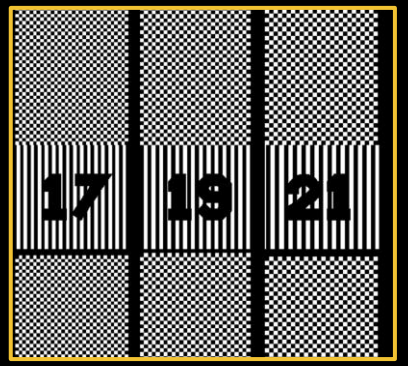
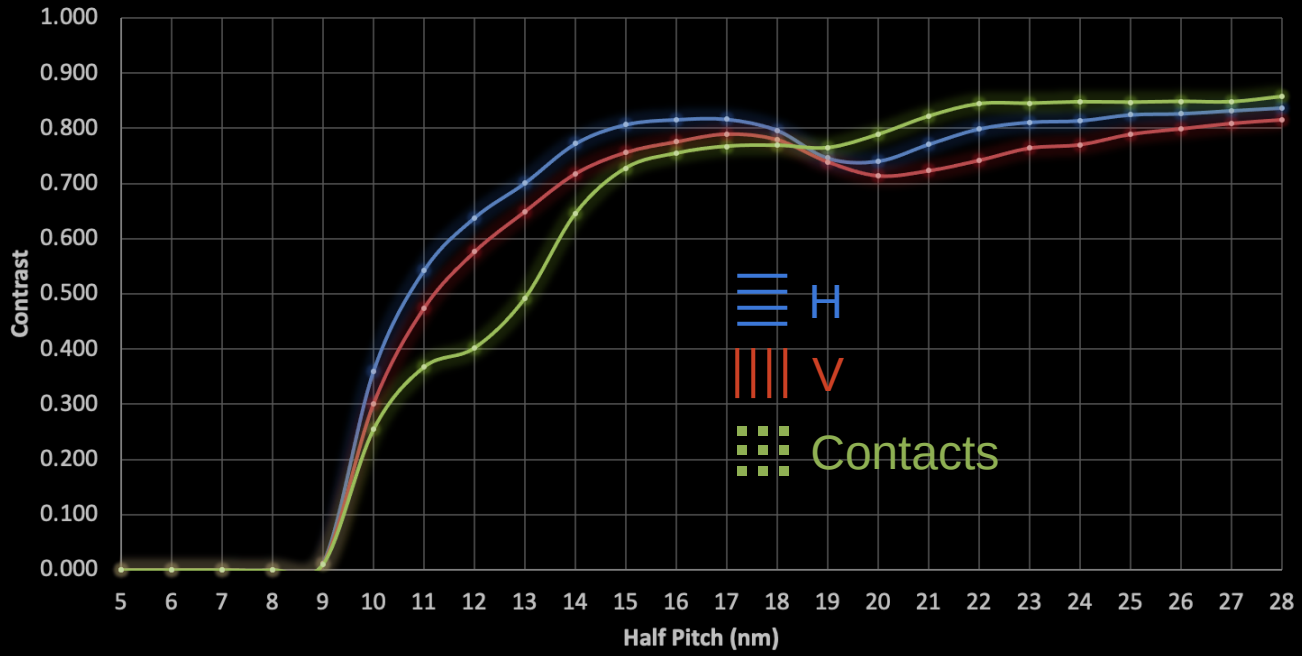


Pupil fill

General purpose imaging



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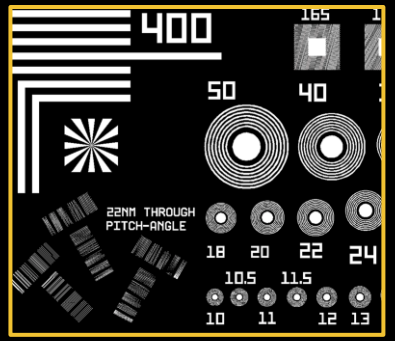
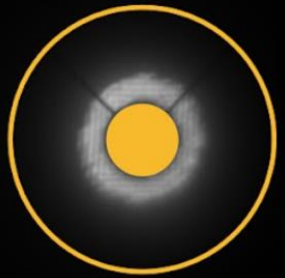


Pupil fill



CEE XPro-II Processing Modules Coming Soon

Solvent
Spin/Coat

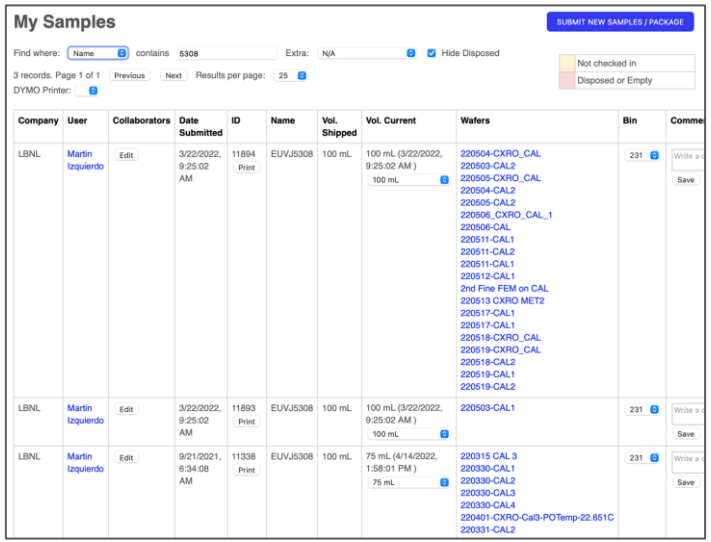
Aqueous
TMAH develop

Bake X4
400C

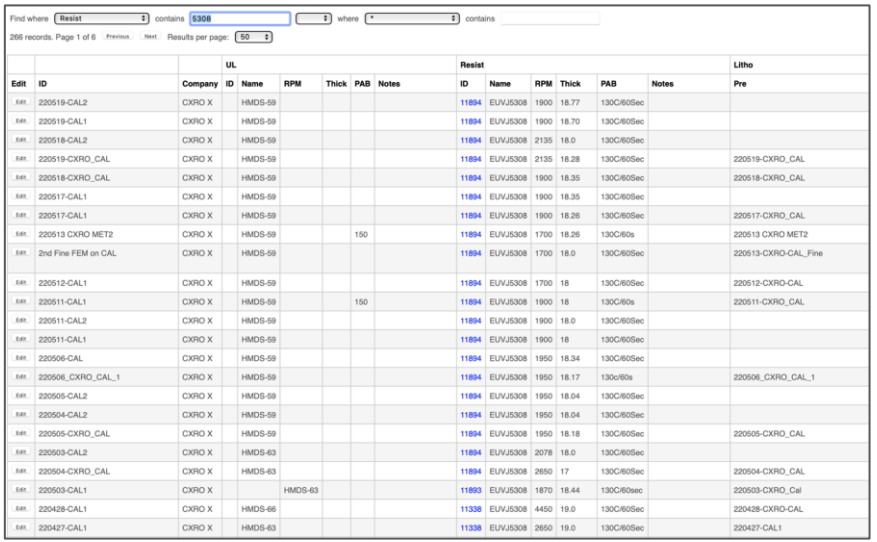
CEE XPro-II Processing Modules Coming Soon

Mature logistics infrastructure

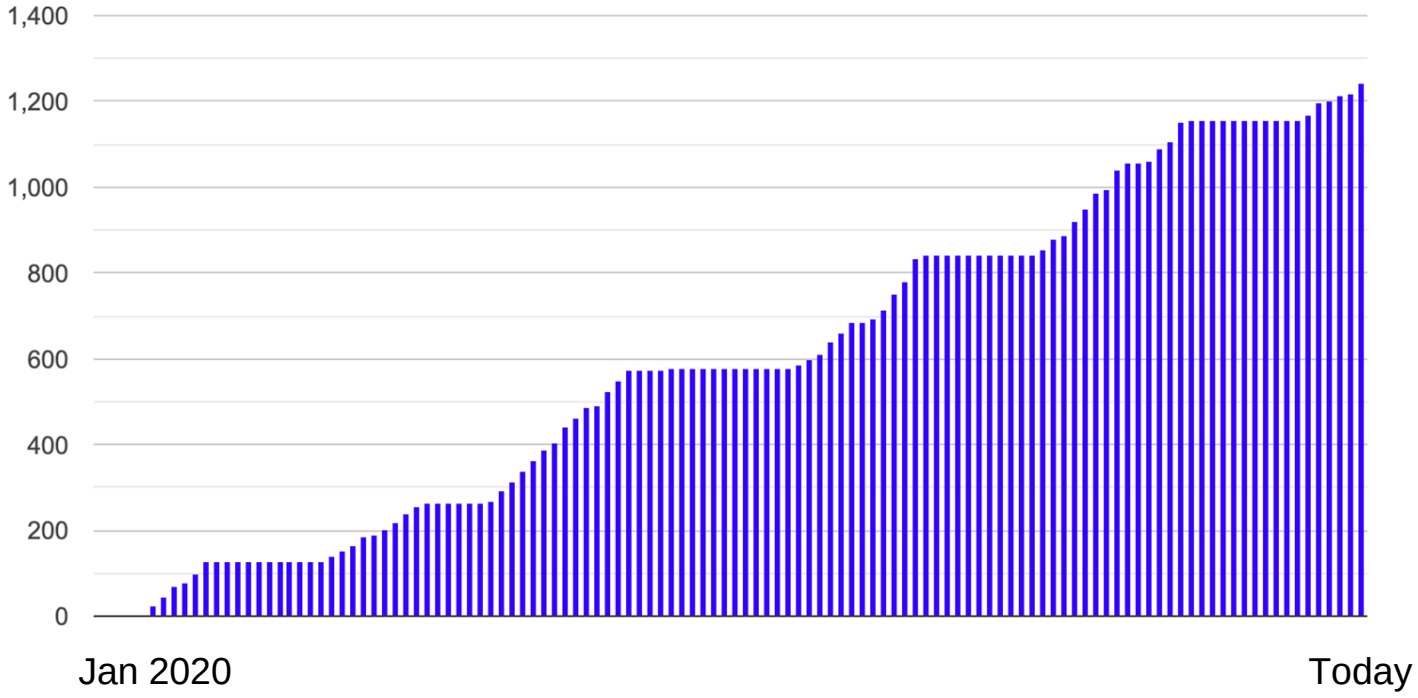
Sample Inventory



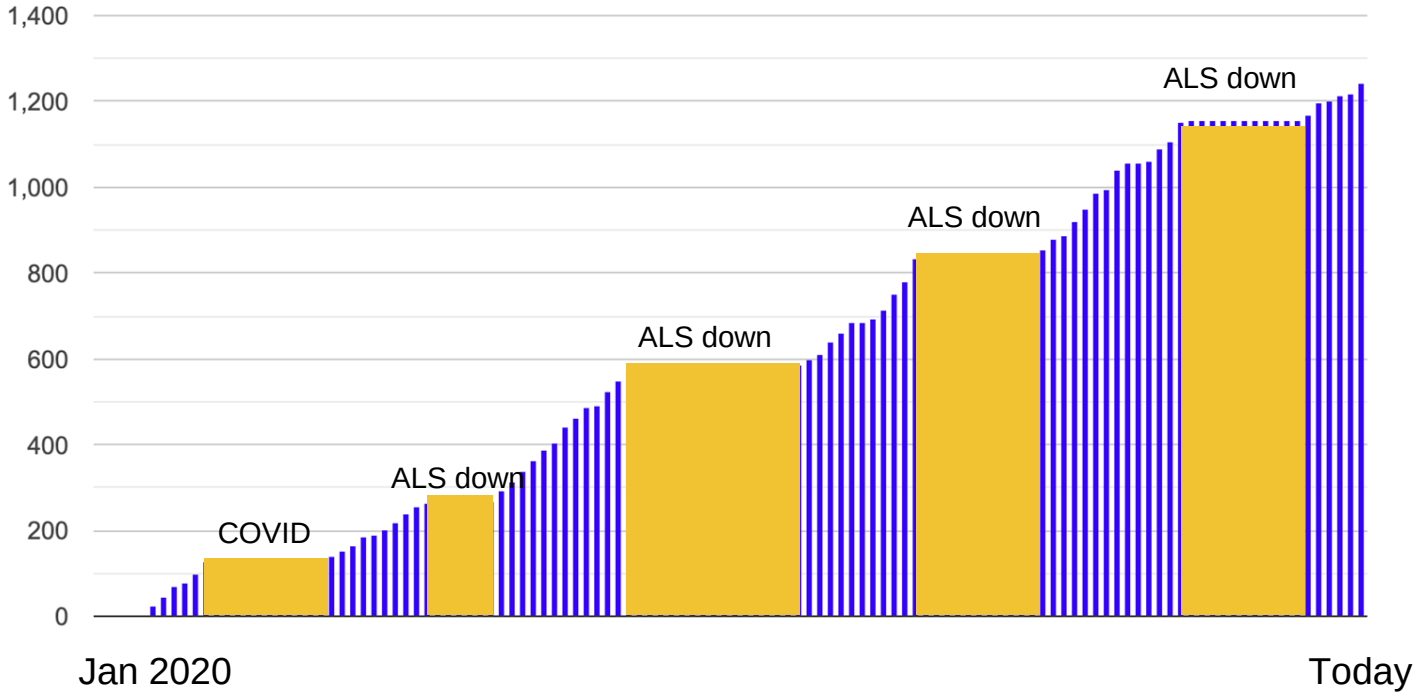
Wafer Database



1.2k unique materials since Jan 2020



ALS down ~50%


1,400
1,200
1,000
800
600
400
200
0
COVID
ALS down
ALS down
ALS down
ALS down
Jan 2020
Today


50% unavailable next three years

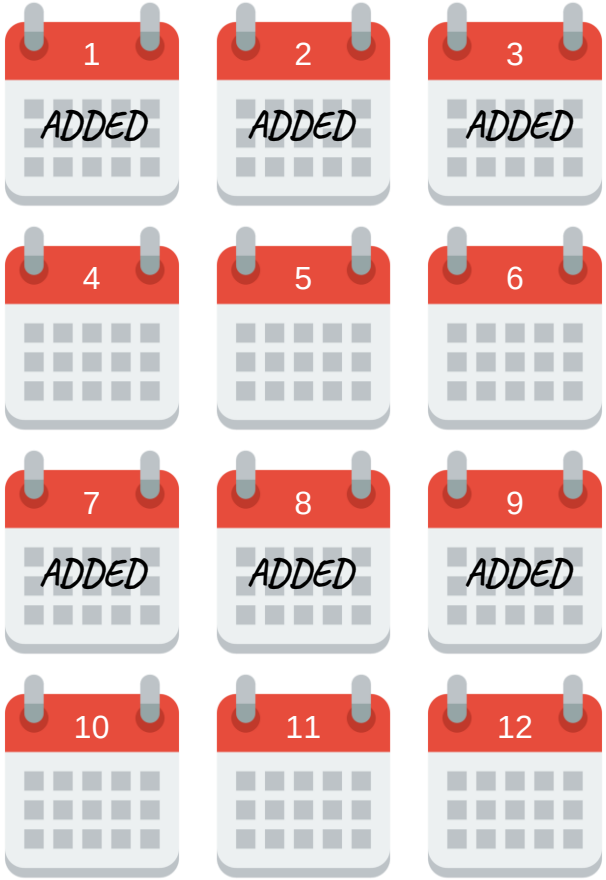

Closed min 1 year starting Q4 2025

Stand alone source Q4 2021

Features & benefits

Doubles shift supply

- Immune to ALS outages
- Consistent operation Tue-Fri



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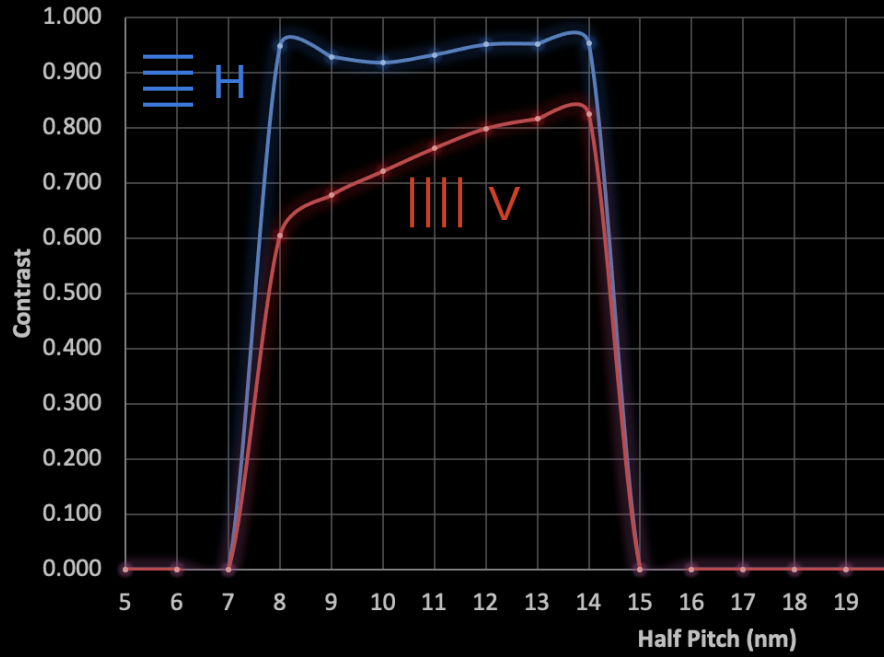
Polarizer preserves 8 nm resolution



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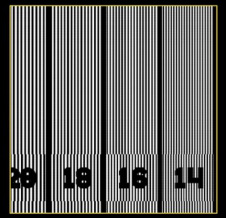

Pupil fill

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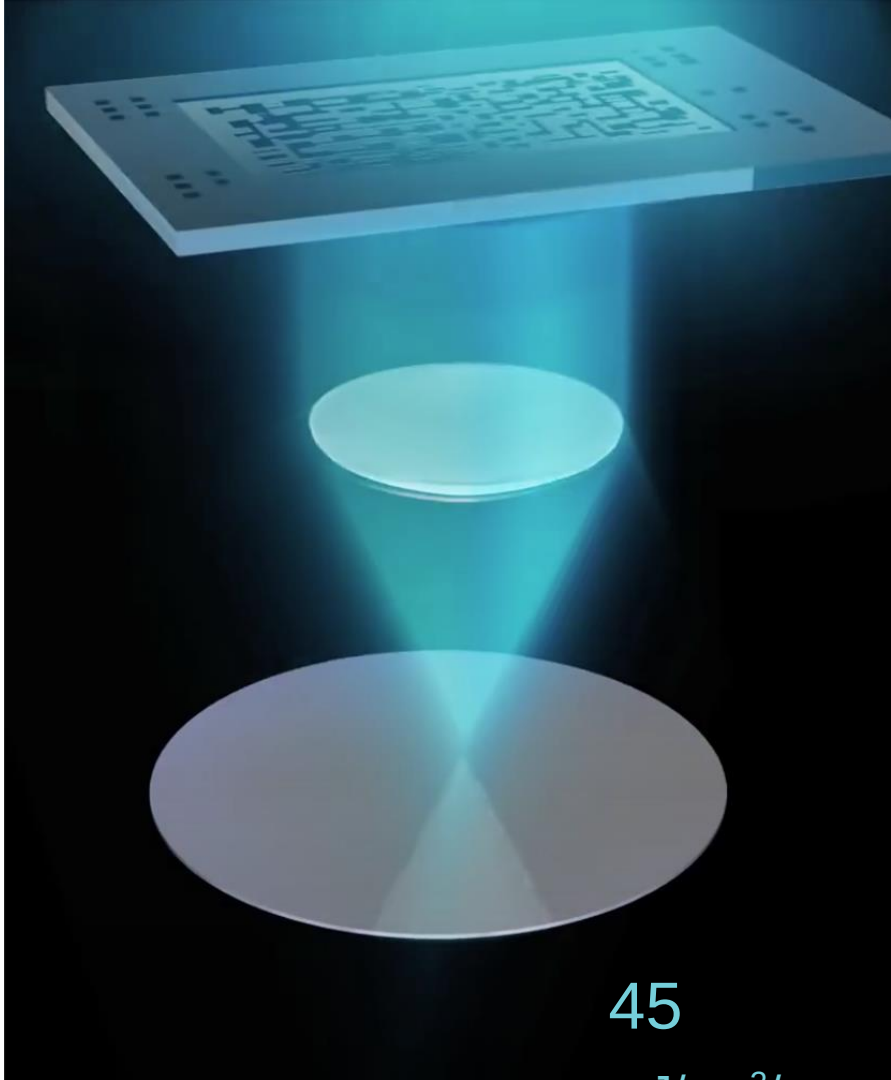
Same throughput as ALS

- 45 mJ/cm^2/s @ wafer



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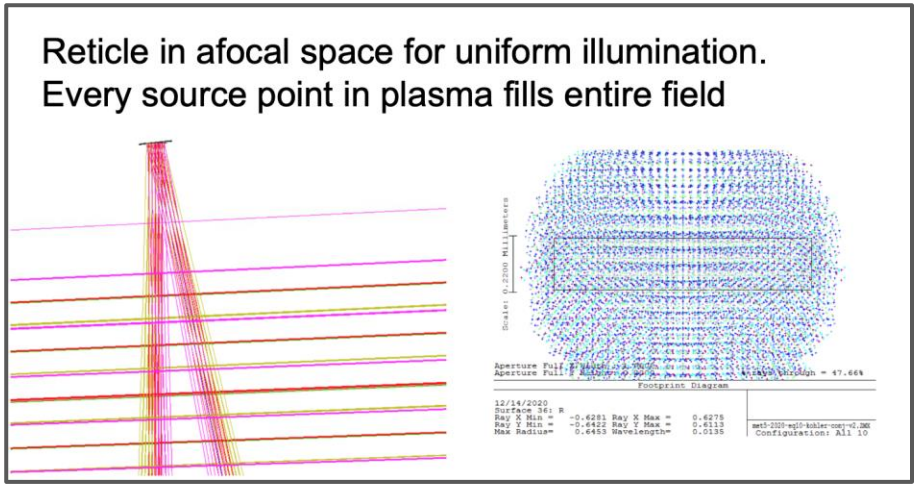

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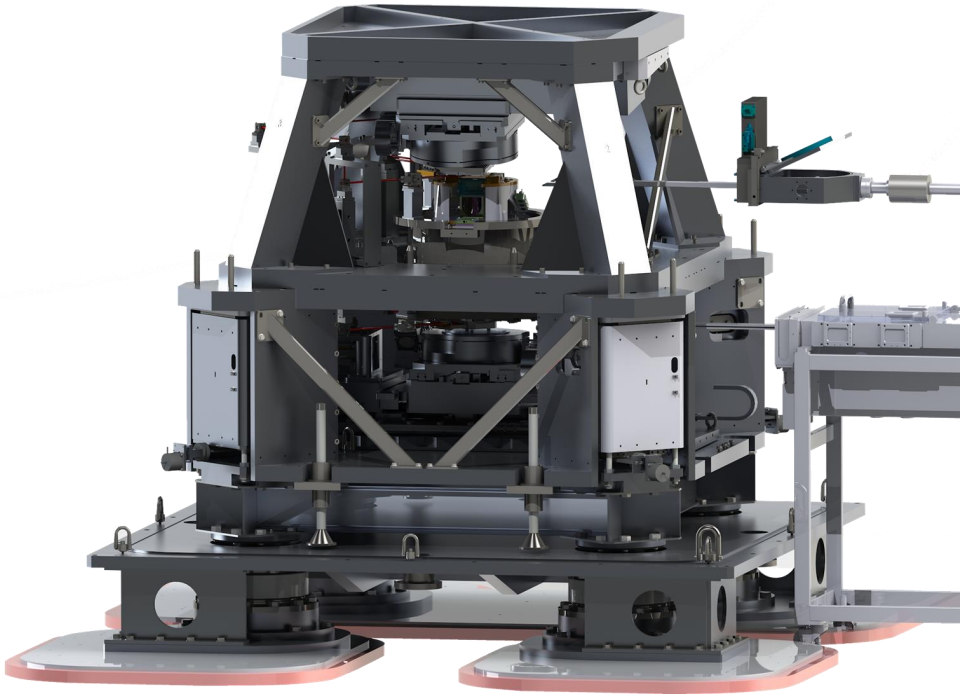
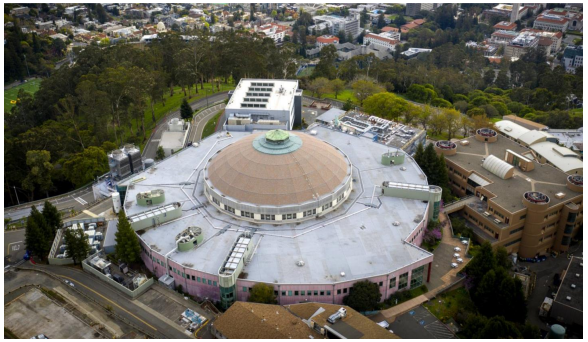


Features & benefits



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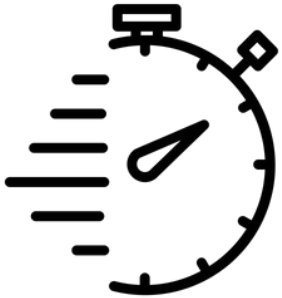


Excellent field uniformity

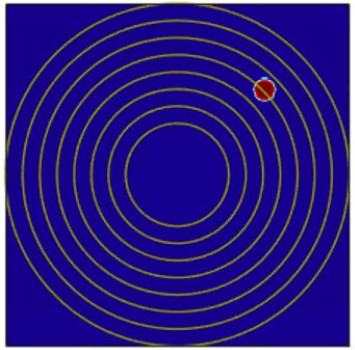
No modifications to existing tool core

½ day swap back to synchrotron

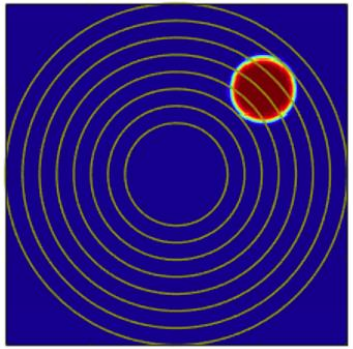
Downsides

3X less coherence

- Reduced pupil fill flexibility



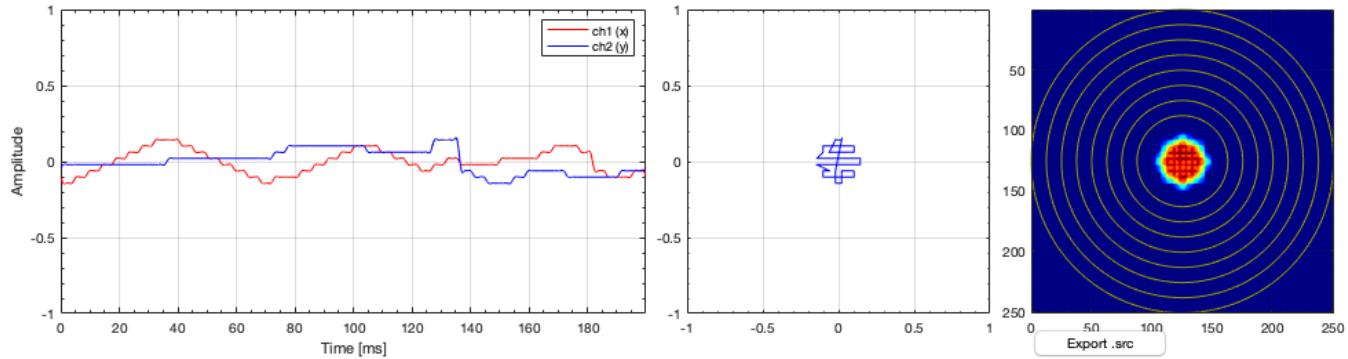
σALS = 0.05



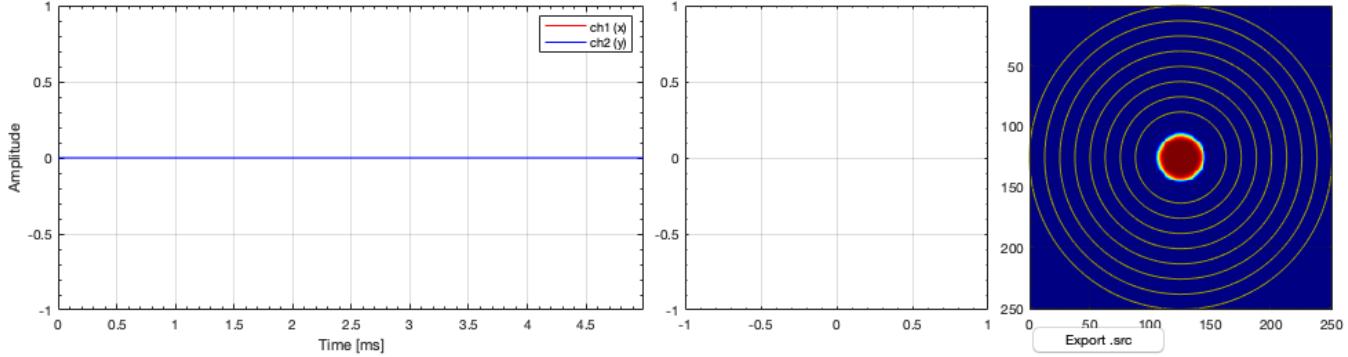
σEQ10 = 0.15

Frequency doubling (F2X)

ALS



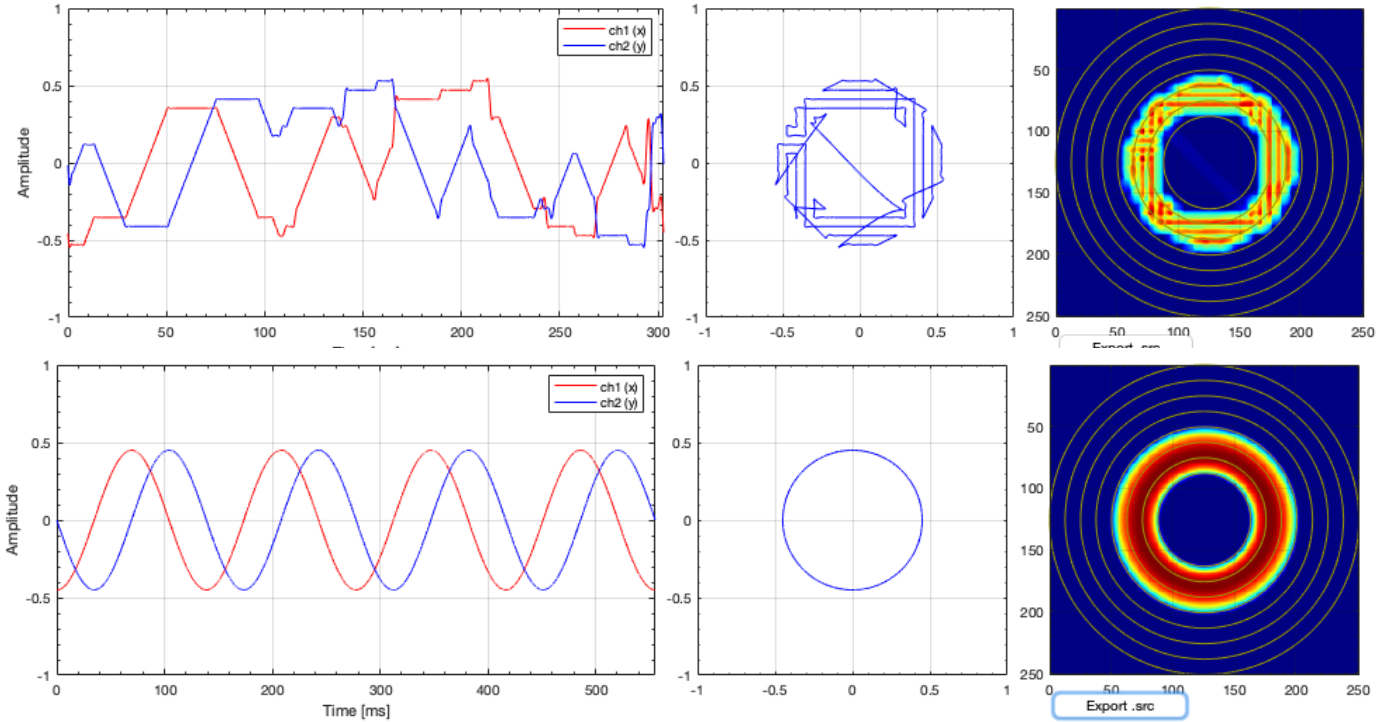
EQ10



Annular 35-55

ALS

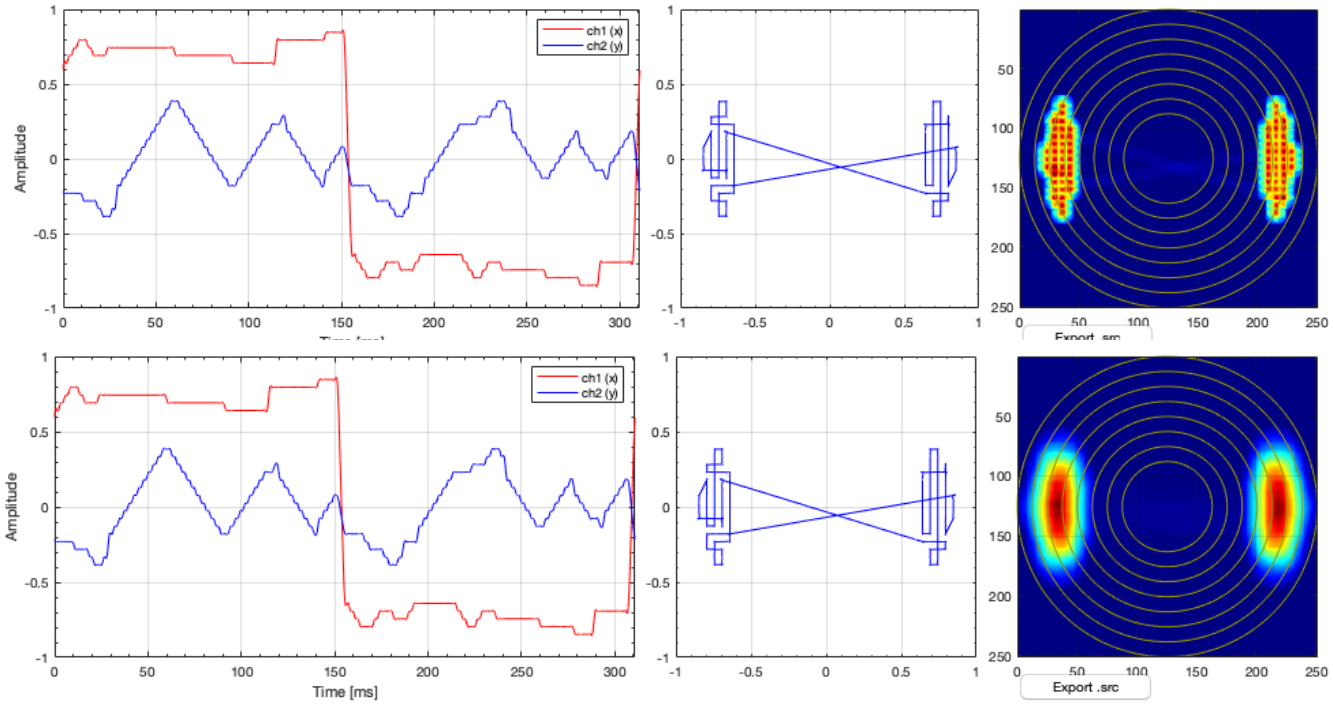
EQ10



Leaf Dipole

ALS

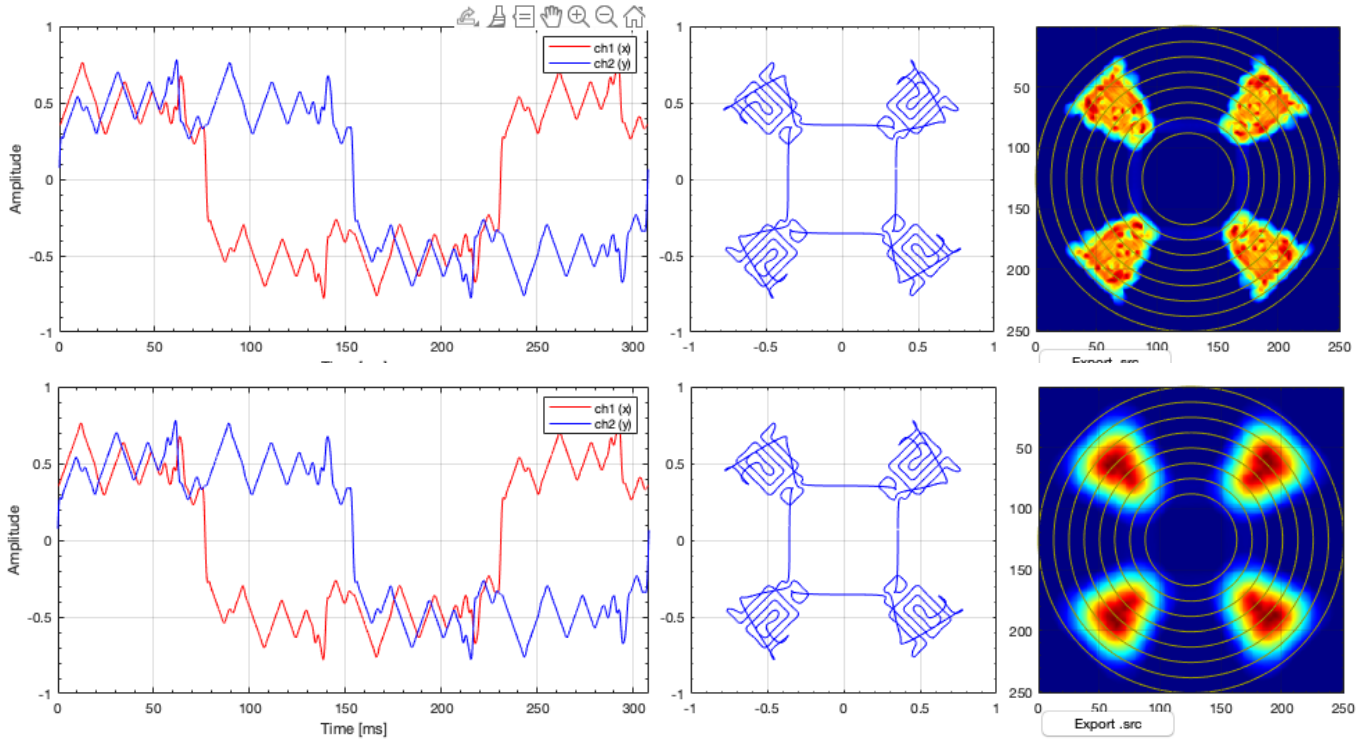
EQ10



Quasar 0.4-0.9

ALS

EQ10



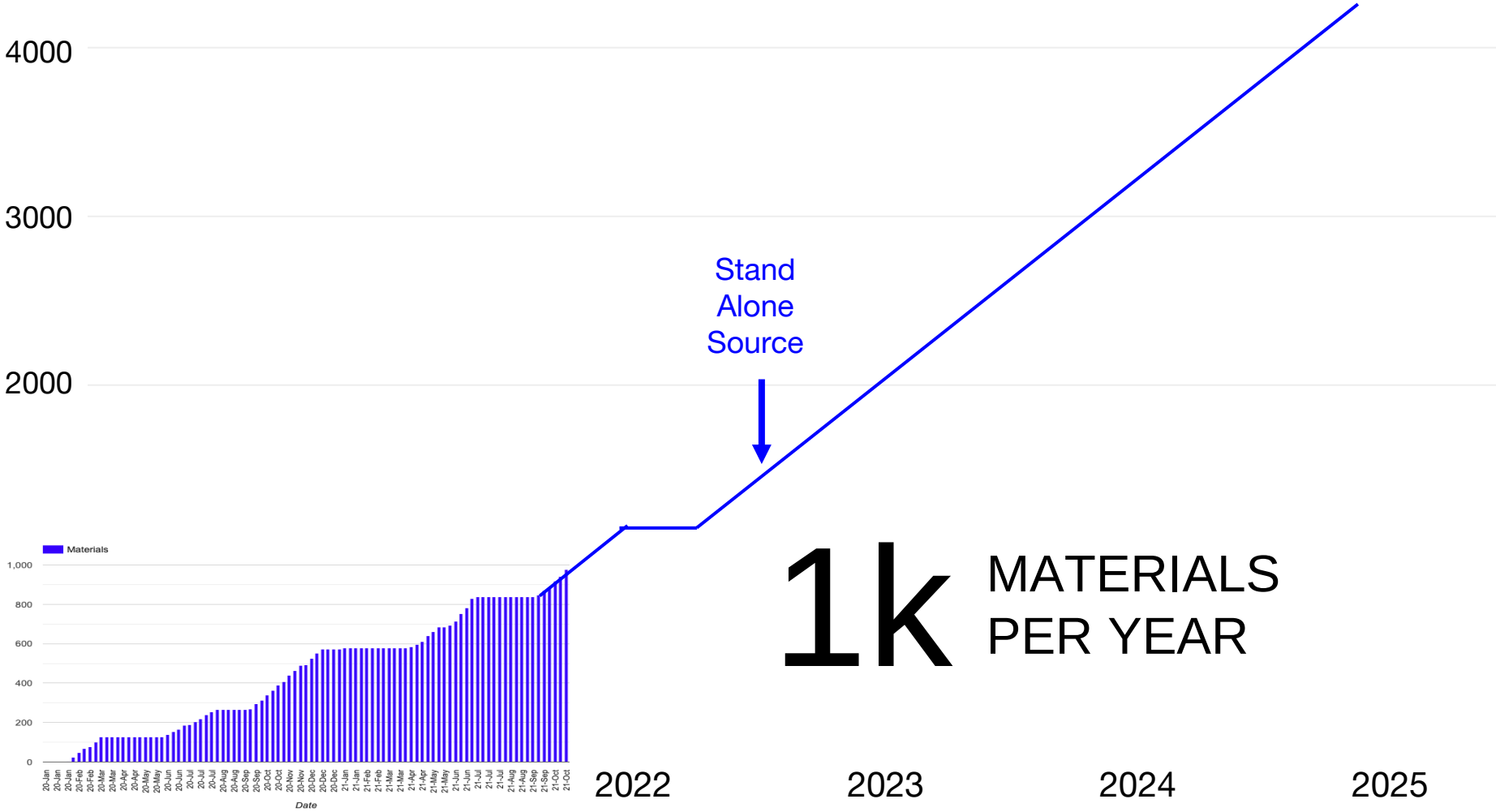
Downsides

3X less coherence

- Reduced pupil fill flexibility

Regular maintenance

- Replace EQ10 bore (weekly)
- Replace sacrificial mirror (every other day)


4000
3000
2000
Stand
Alone
Source
1k
MATERIALS
PER YEAR
2022
2023
2024
2025
Materials
1,000
800
600
400
200
0
Date

Thank you


EUREKA
intel
SAMSUNG
APPLIED MATERIALS
ZEISS
Lam RESEARCH
euvtech
KLA
ASML
FST
DUPONT
inpria
JSR
tok