why SHARP?

2015

SHARP IS HERE *NOW*,

*imaging masks **today** and for **many generations** into the future.*

Where other tools hit their

RESOLUTUION LIMITS

SHARP *is just getting started!*

SHARP *LENSES*

IMAGE ANY POSSIBLE EUV FUTURE

Conventional 4x NA

6°: 0.25, **0.33**

8°: 0.42, 0.50,

10°: *0.625*

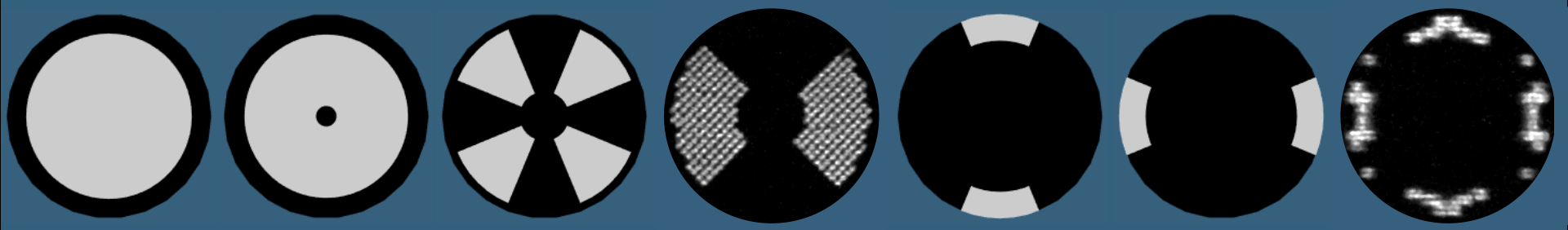
ultra-high resolution

Anamorphic 4x/8x NA

6°: **0.6**x, **0.33**y

Coming in 2015

SHARP *HAS*
TOTAL COHERENCE CONTROL

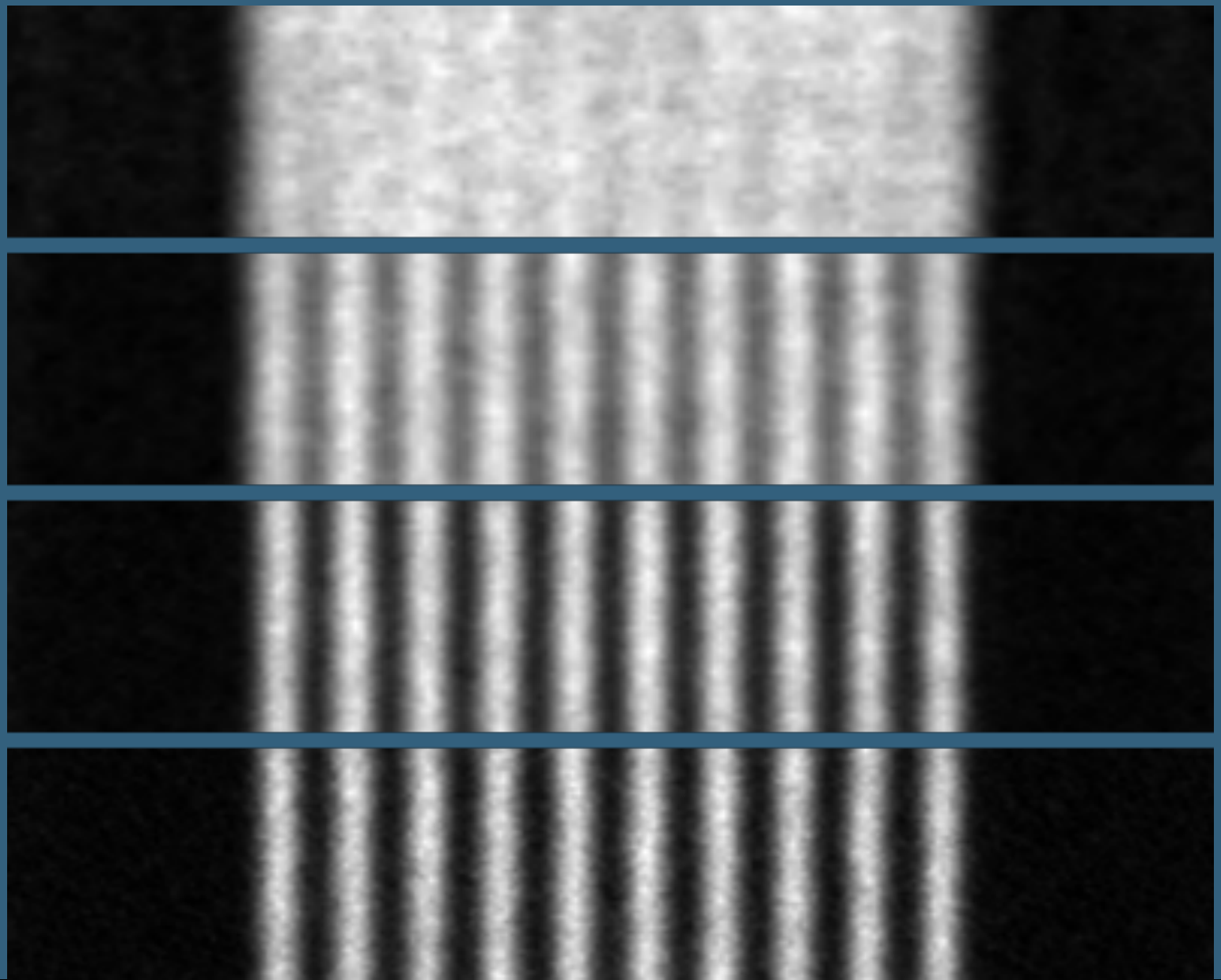


Emulate ***any current*** or ***future*** scanner with lossless illumination pupil and coherence engineering: **conventional, dipole, quasar, cross-pole, FlexRay, grayscale, etc.**

Bring Source-Mask Optimization to EUVL

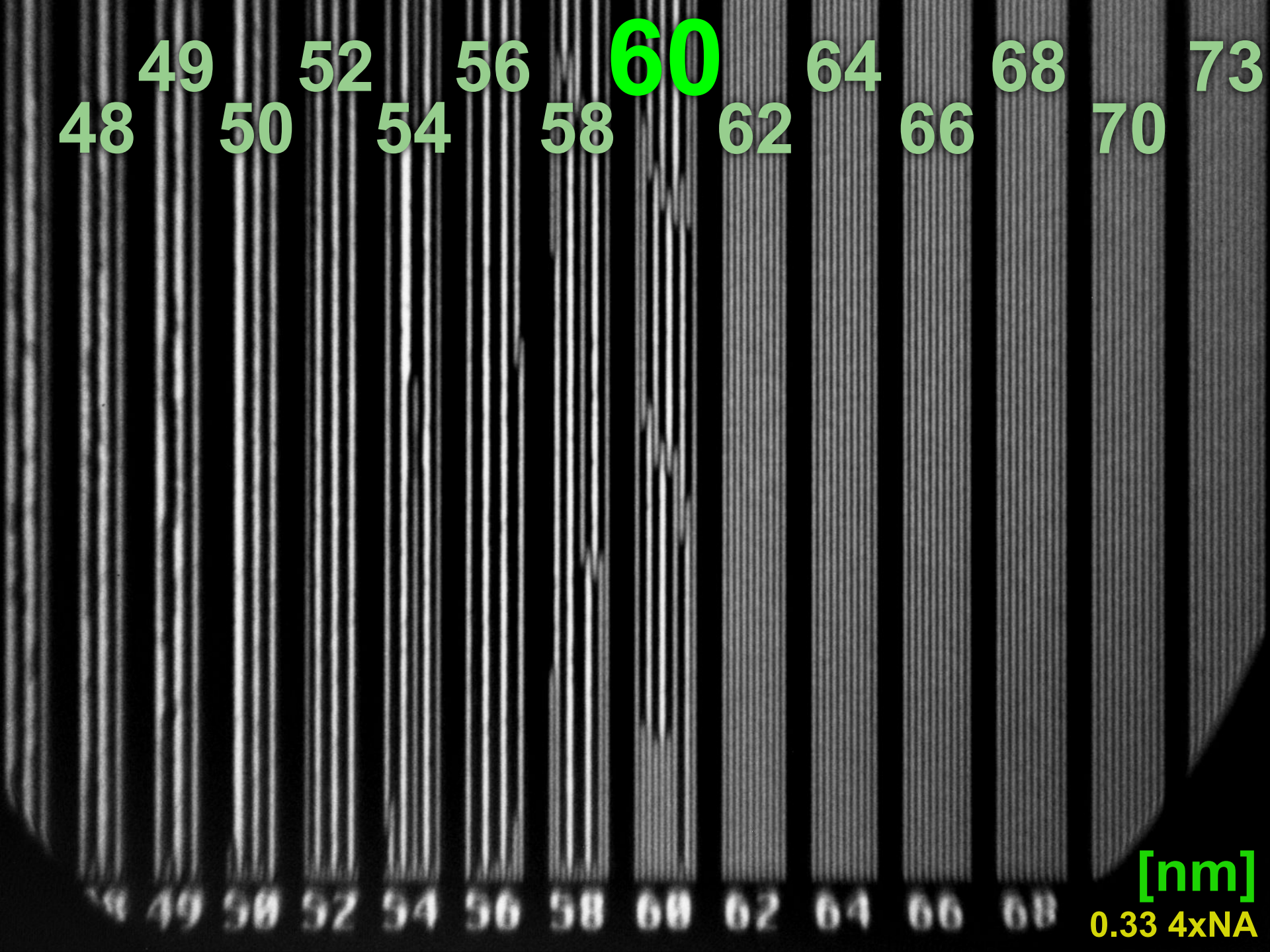
SHARP SEES WHAT OTHERS CANNOT

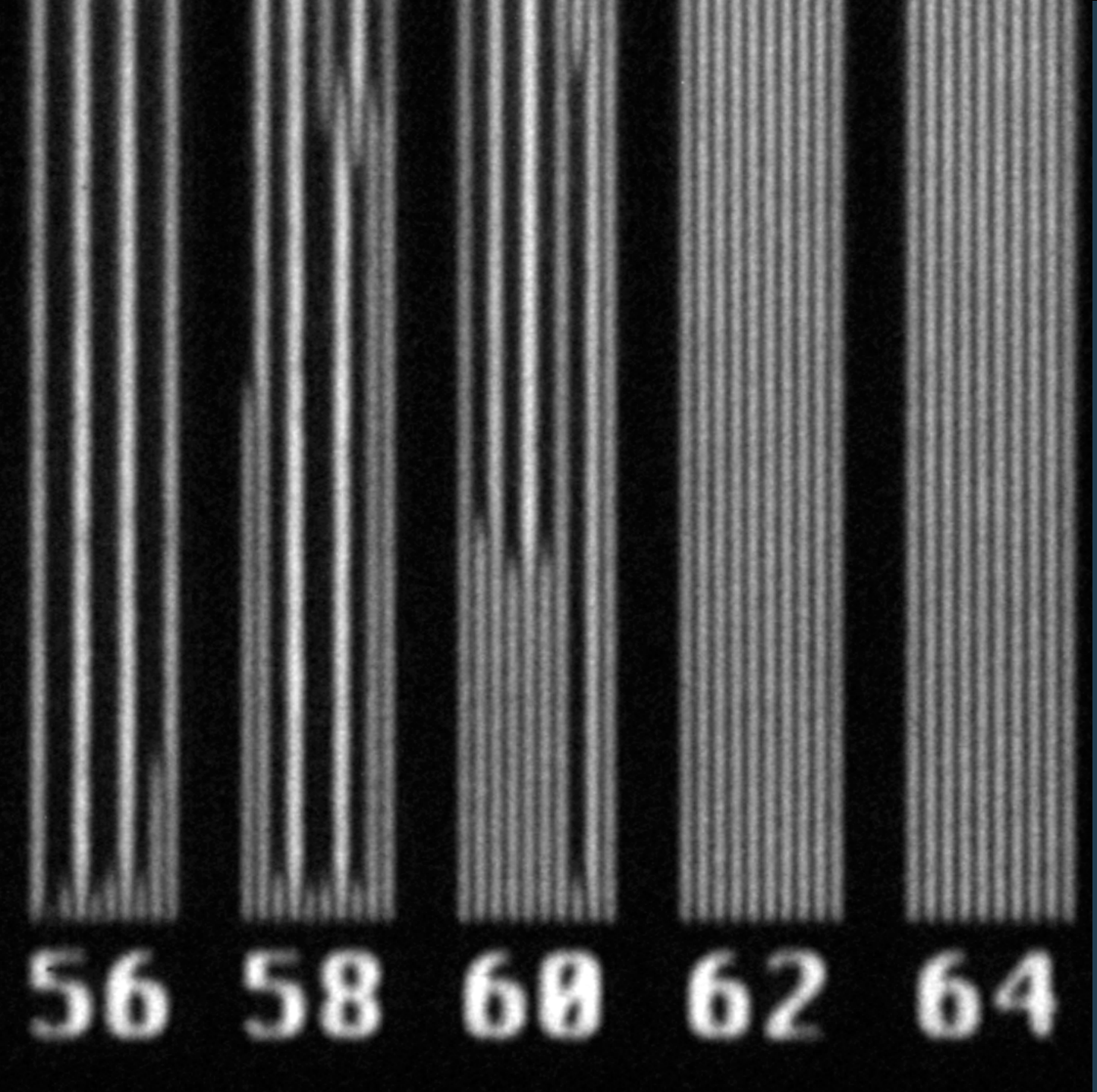
wafer 15.5 nm = mask 62 nm



0.625 0.50 0.33 0.25

4xNA, σ = 0.8


49 52 56 60 64 68 73
48 50 54 58 62 66 70
[nm]
0.33 4xNA



0.33 4xNA

σ = 0.5–0.7

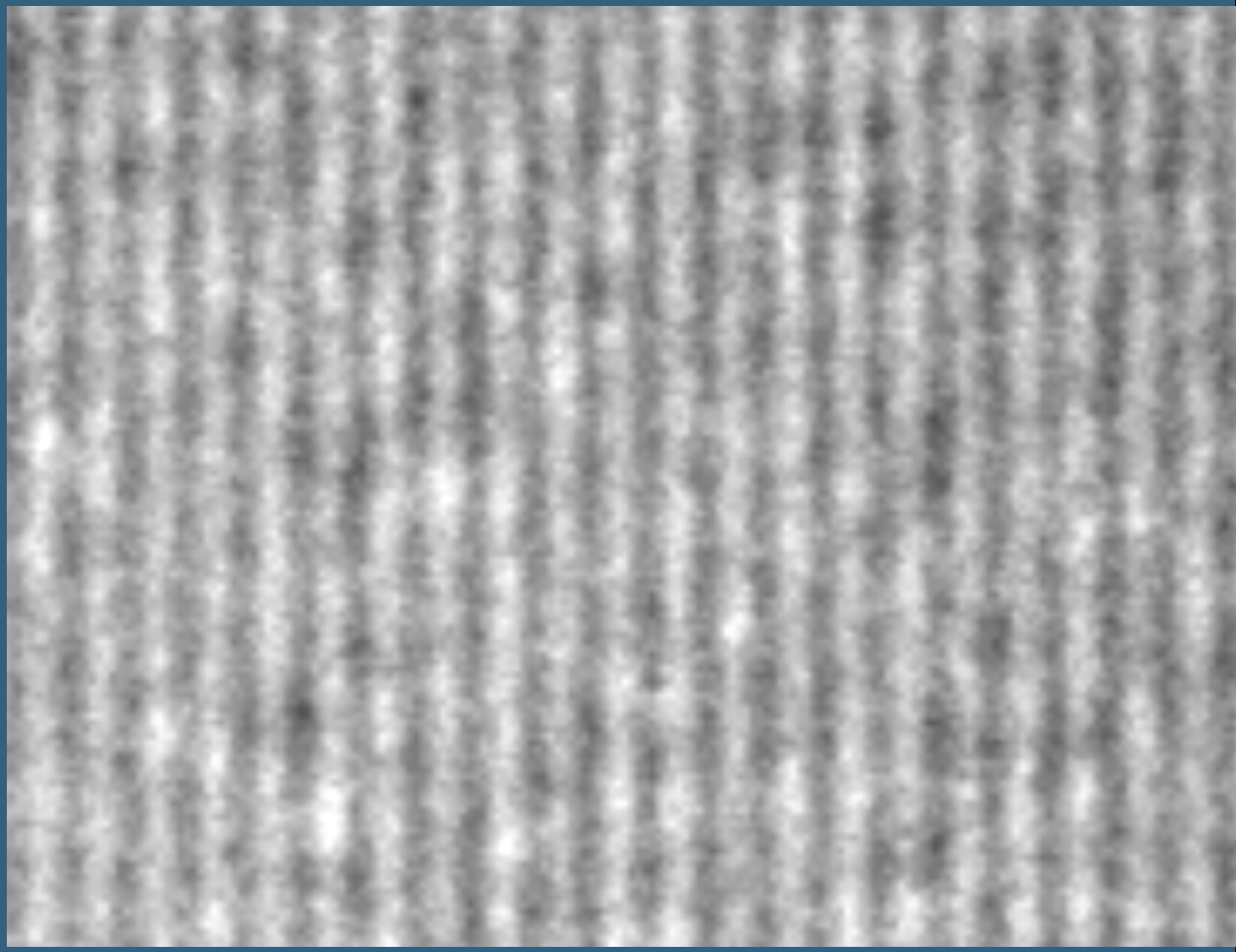
SHARP *IMAGES EUV'S FUTURE*

mask CD
36 nm

wafer CD
9.0 nm

Mask made on BMET in ***thin*** Inpria *Sn-based photoresist*

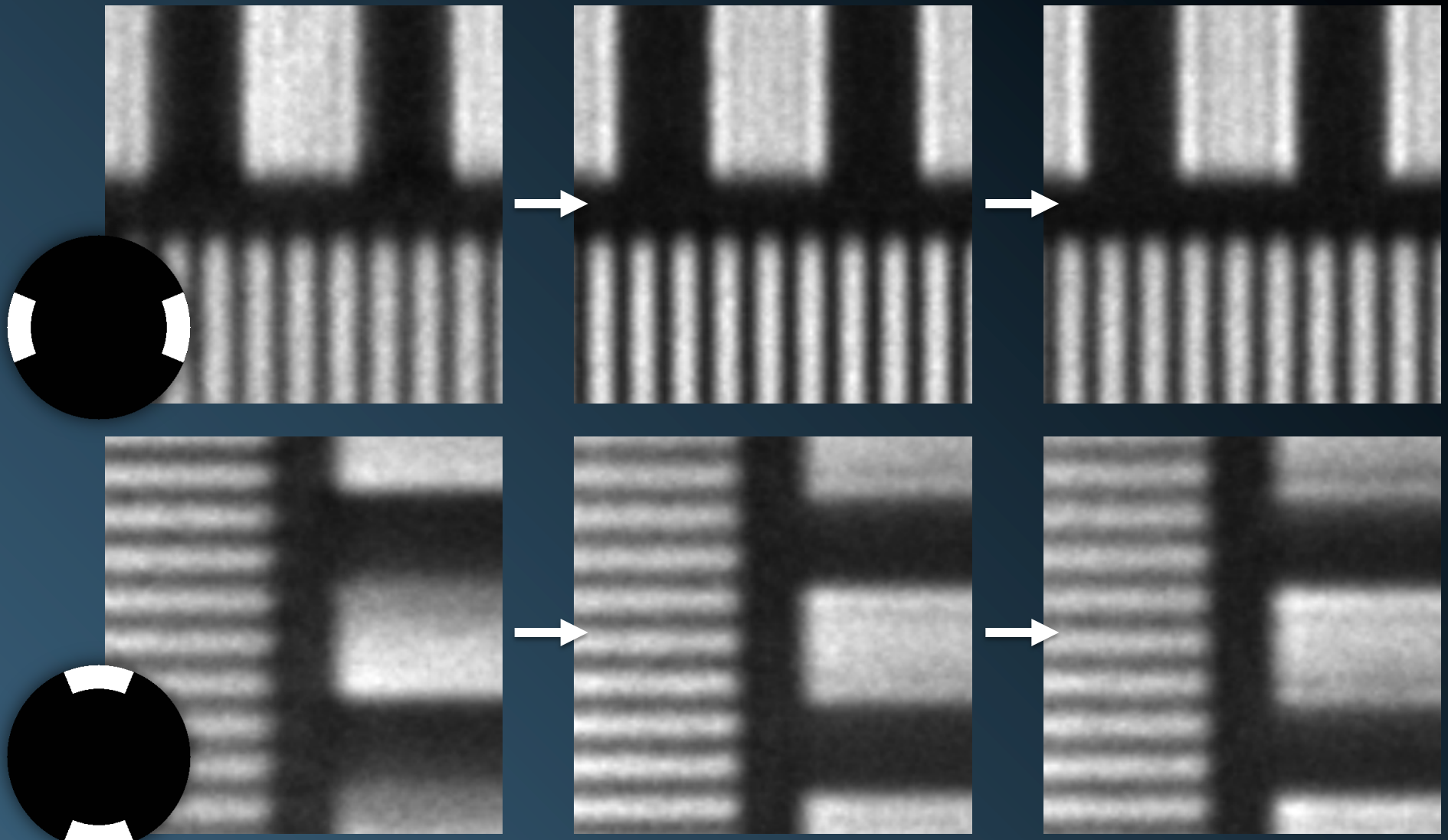
We will publish 24-nm images EIPN 2015.



200 nm

0.625 4xNA, σ = 0.7

SHARP STUDIES MLs & TELECENTRICITY

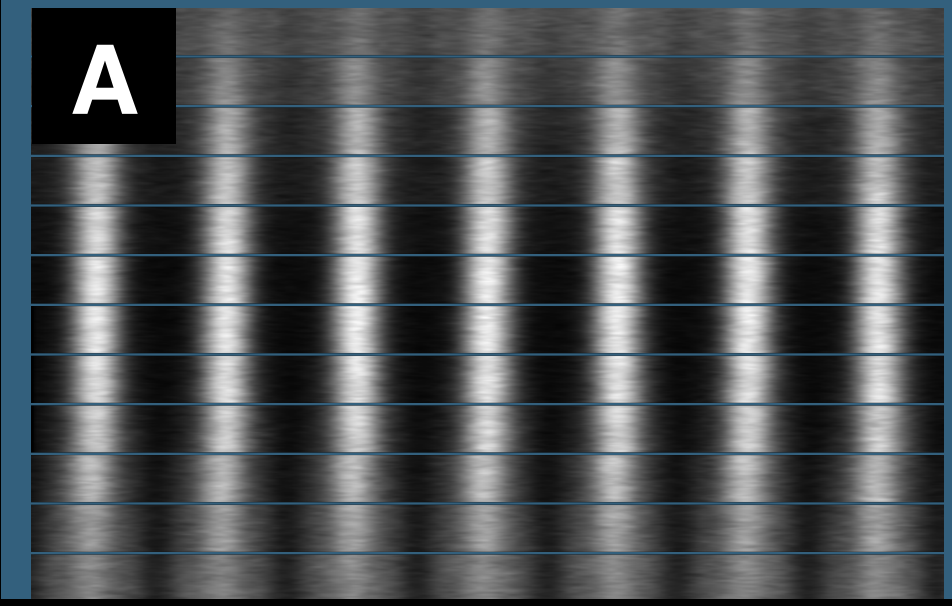


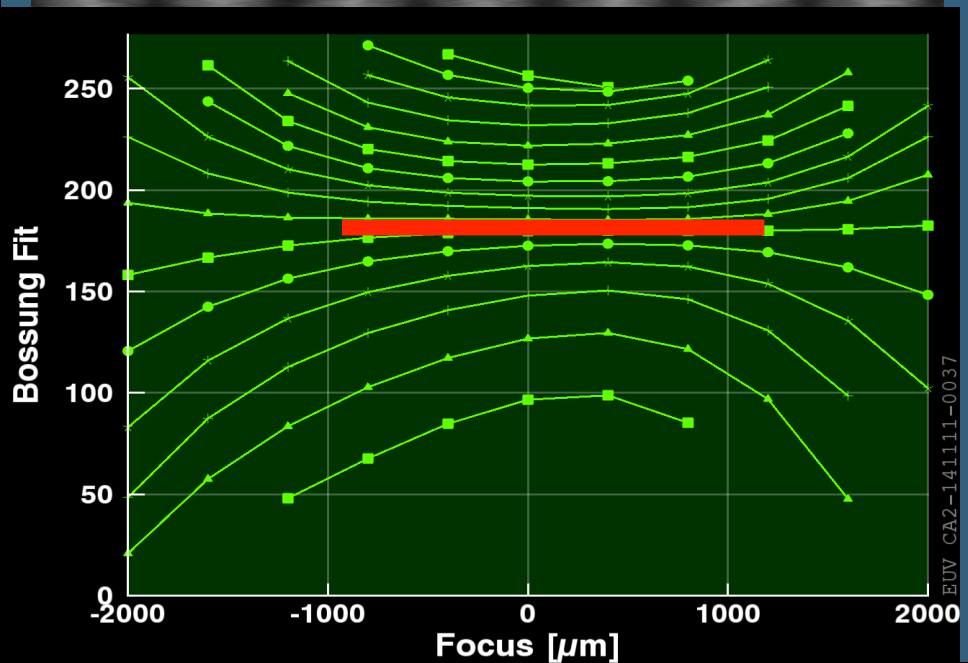
focus →

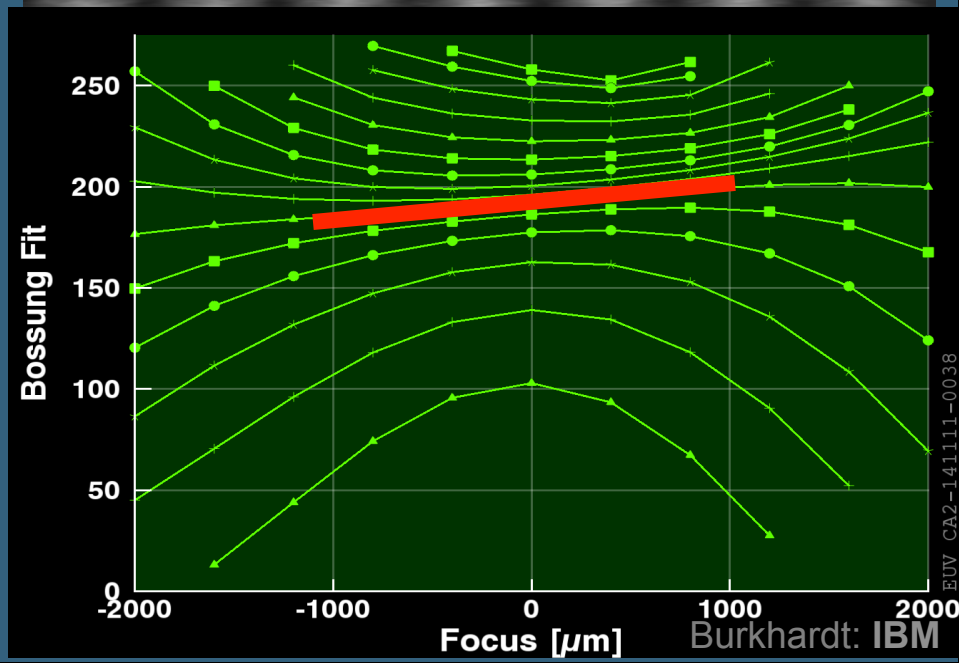
20 (80) nm CD, 0.35 4xNA

Wood, Mangat: **GlobalFoundries**

SHARP SEES SRAF PHASE







Burkhardt: IBM

SHARP QUANTIFIES ROUGHNESS

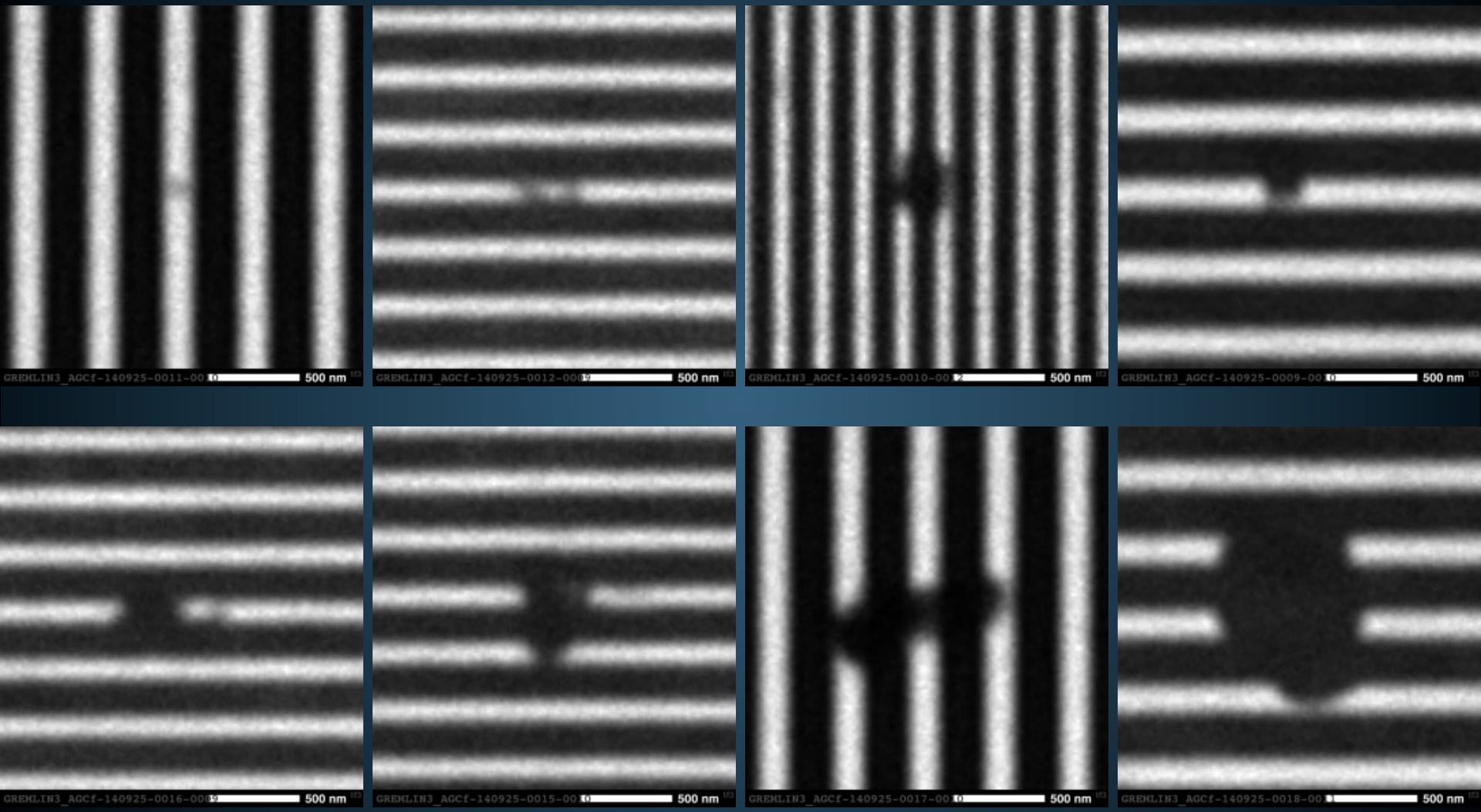
rough substrate

smooth substrate

132-nm hp

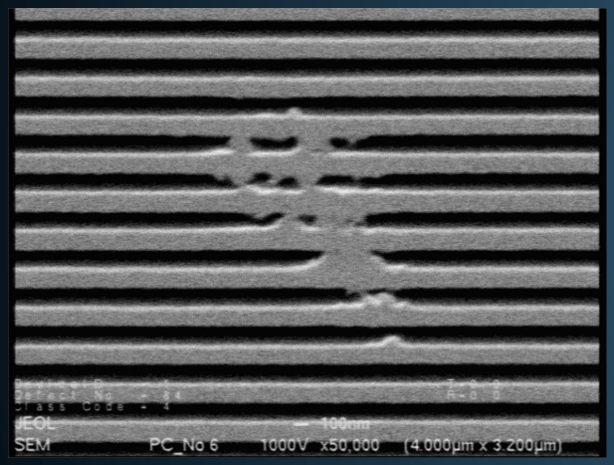
Yan: **Intel**

SHARP STUDIES DEFECTS

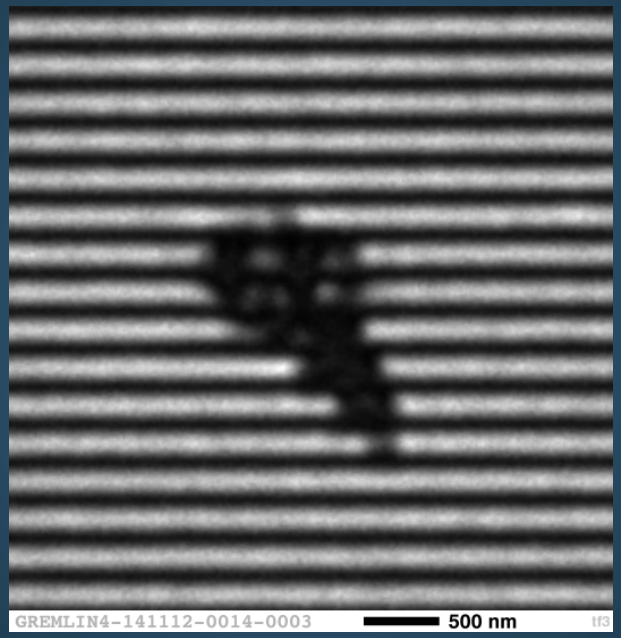


Mangat, Wood: **GlobalFoundries**

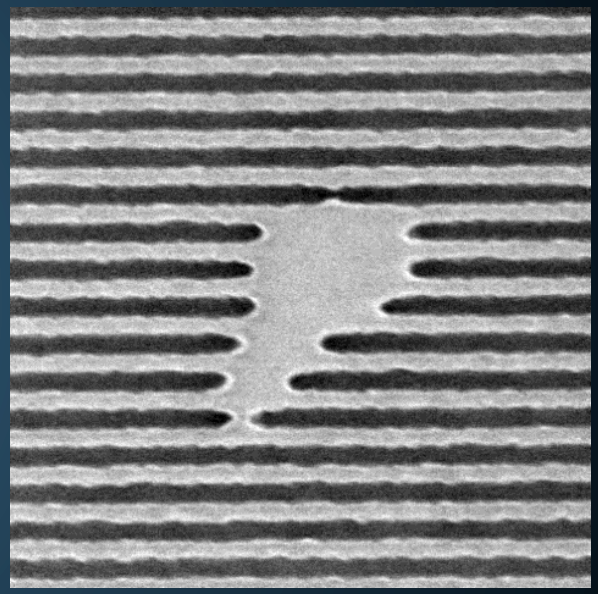
SHARP *TRUE TO THE WAFER PRINT*



Mask SEM



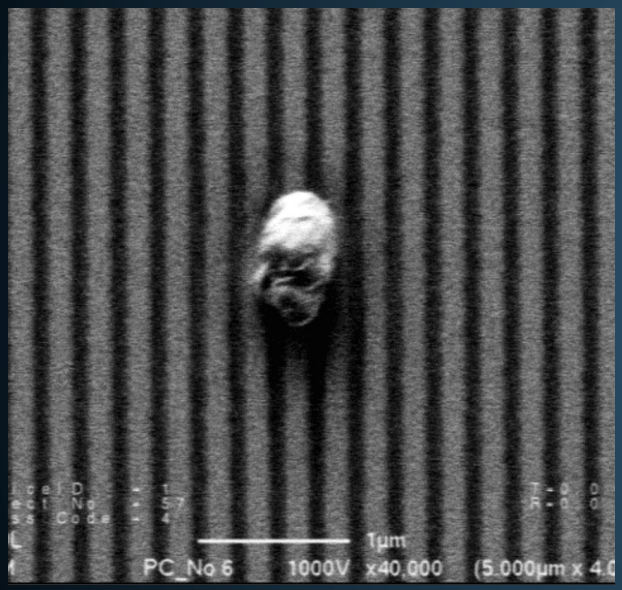
SHARP EUV



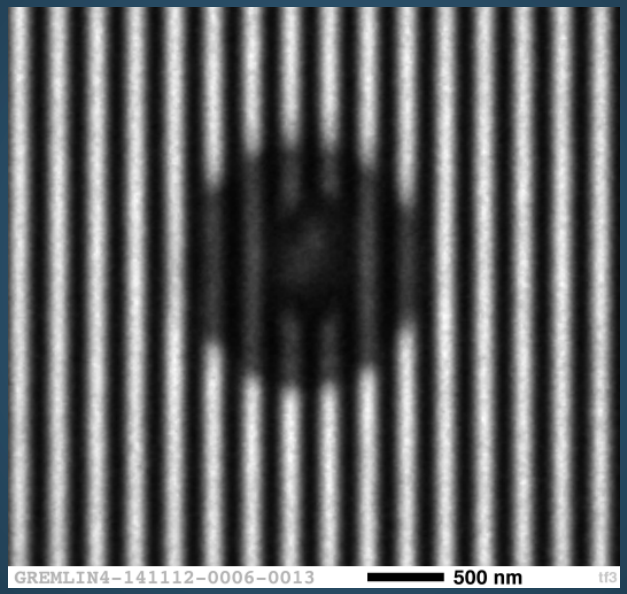
Wafer SEM

Mangat, **GlobalFoundries**, PMJ 2015

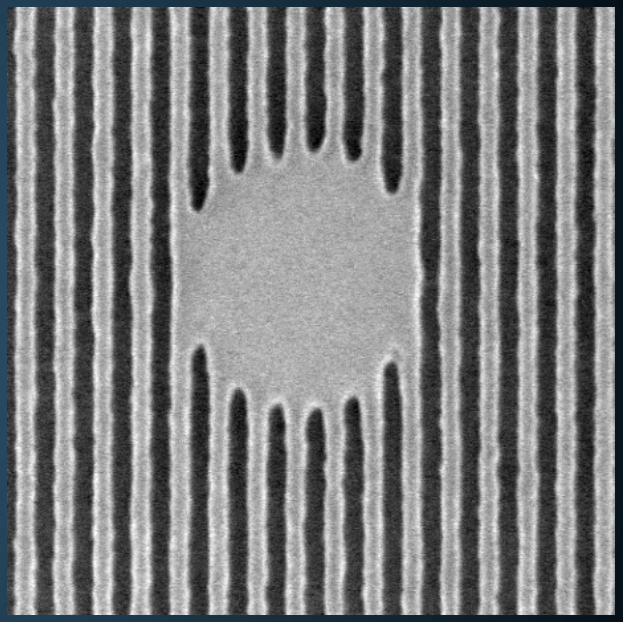
SHARP *TRUE TO THE WAFER PRINT*



Mask SEM



SHARP EUV



Wafer SEM

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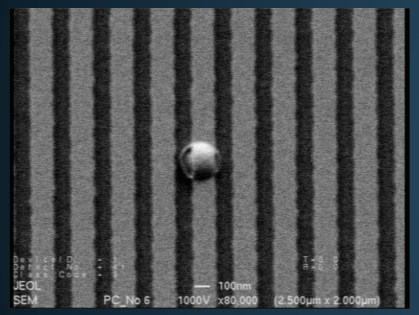
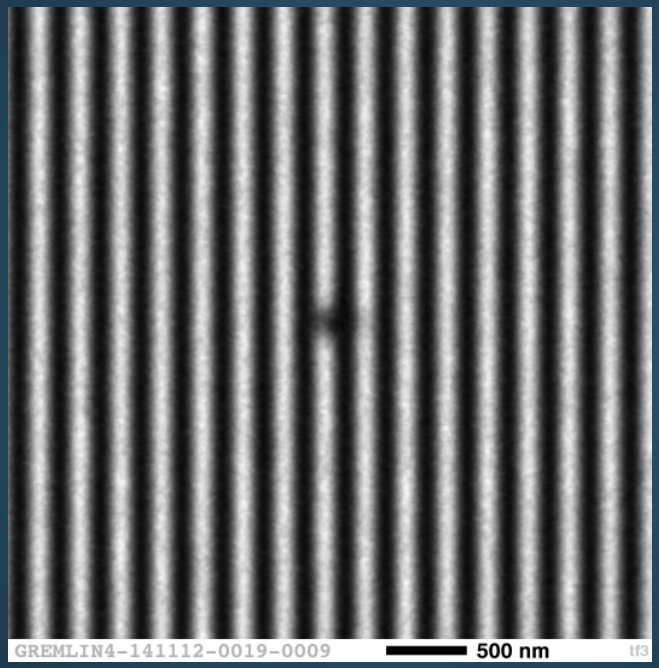
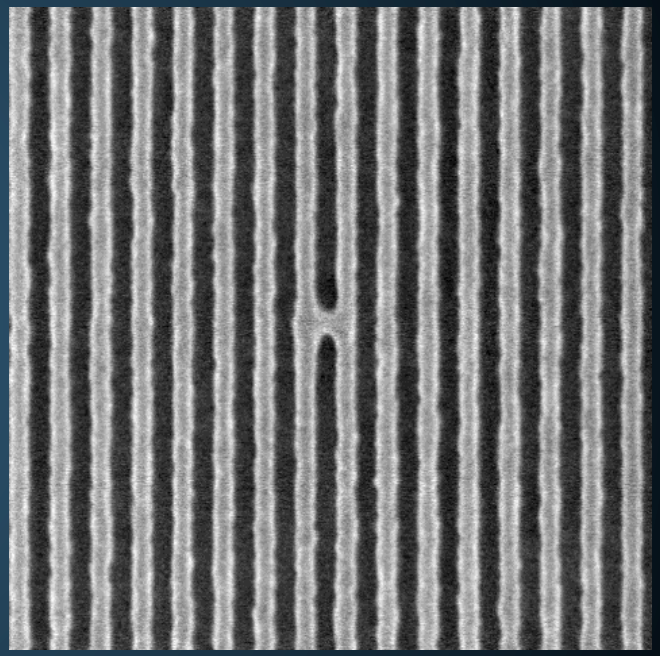
SHARP *TRUE TO THE WAFER PRINT*



Mask SEM



SHARP EUV



Wafer SEM

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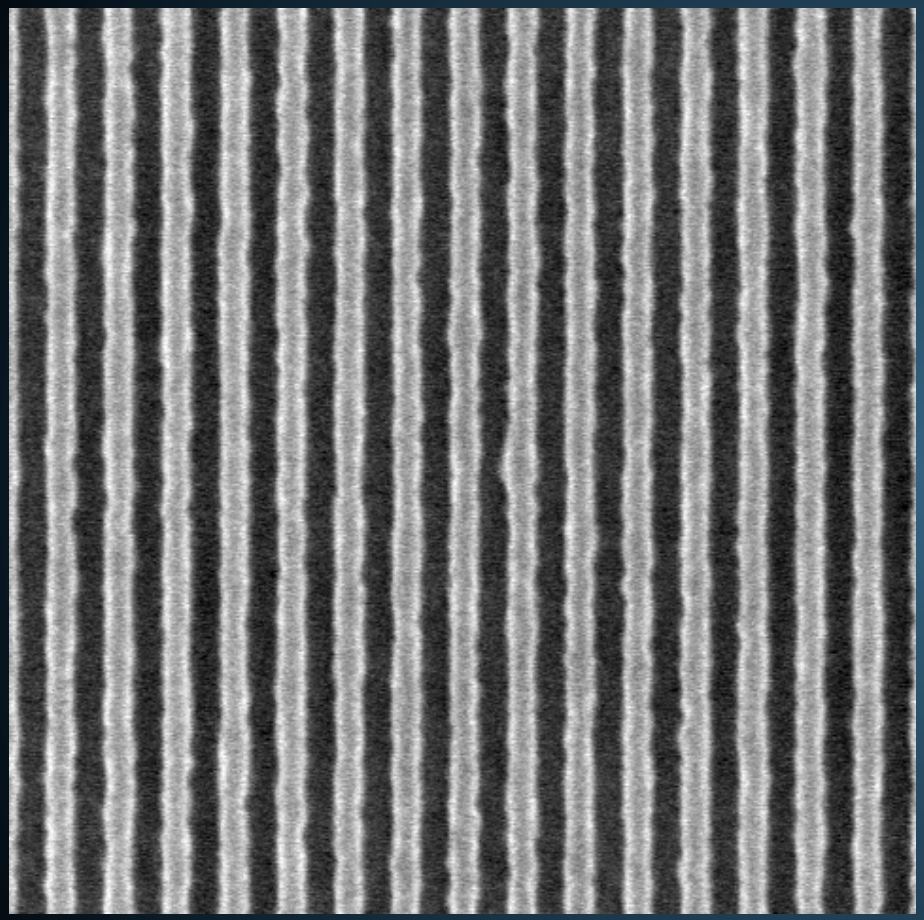
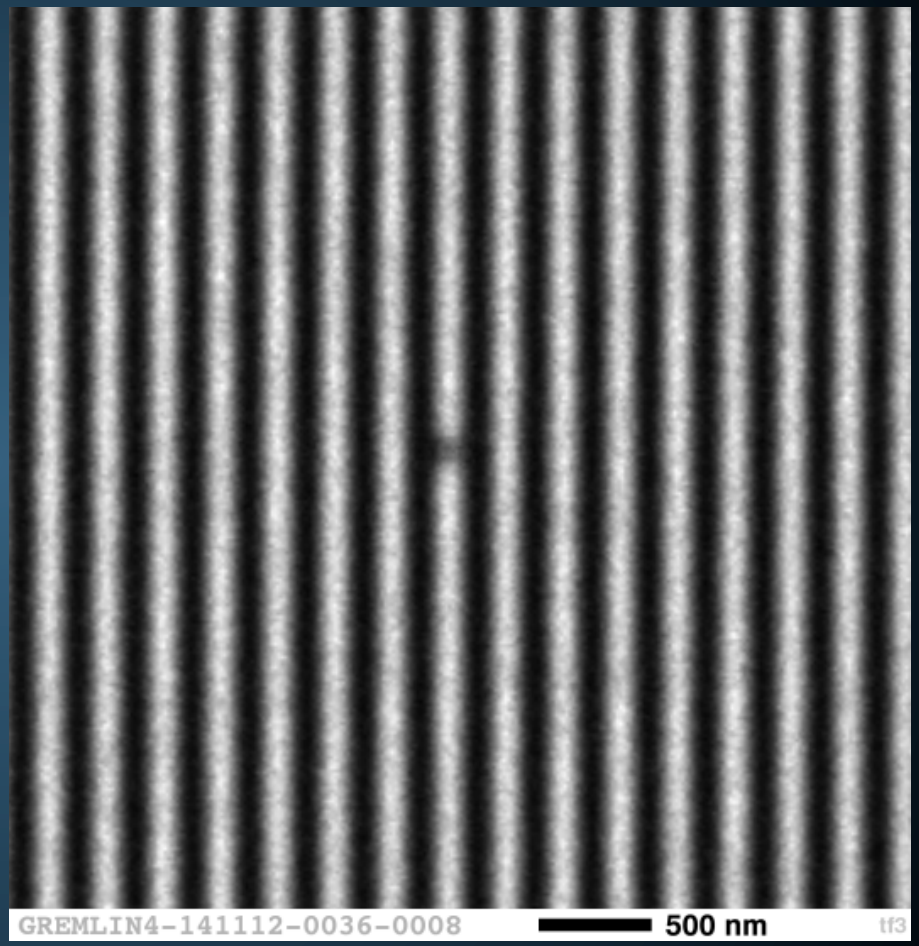


Wafer SEM



SHARP EUV

Mangat, **GlobalFoundries**, PMJ 2015

	SHARP	OTHERS
Resolution		
4xNA: 0.33	✔	✔
4xNA: 0.42, 0.50, 0.625	✔✔✔	✗ ✗ ✗
4/8xNA: *anamorphic*	✔ *2015*	?
Illuminator		
pixellated *FlexRay* sources	✔	✗
customize for SMO	✔	✗
grayscale pixels	✔	✗
coherent mode, $\sigma \leq 0.05$	✔	?
azimuthal ±25° *cross-smile*	✔	✔
Mask Architecture		
use new mask materials	✔	✗

	SHARP	OTHERS
Wavefront		
diffraction-limited	✔	?
Phase imaging		
through focus	✔	?
Fourier ptychography	✔	✗
differential phase contrast	✔	?
Lens Replacement		
as necessary	✔	✗
Wavelength		
13.5 nm	✔	✔
13.2–13.7 nm, tunable	✔	✗

SHARP Team

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Primary Team

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