Computational ASCAL verification with inline ASCAL in high volume manufacturing fab for ArF XT:1460K with LOCO-B

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Outline

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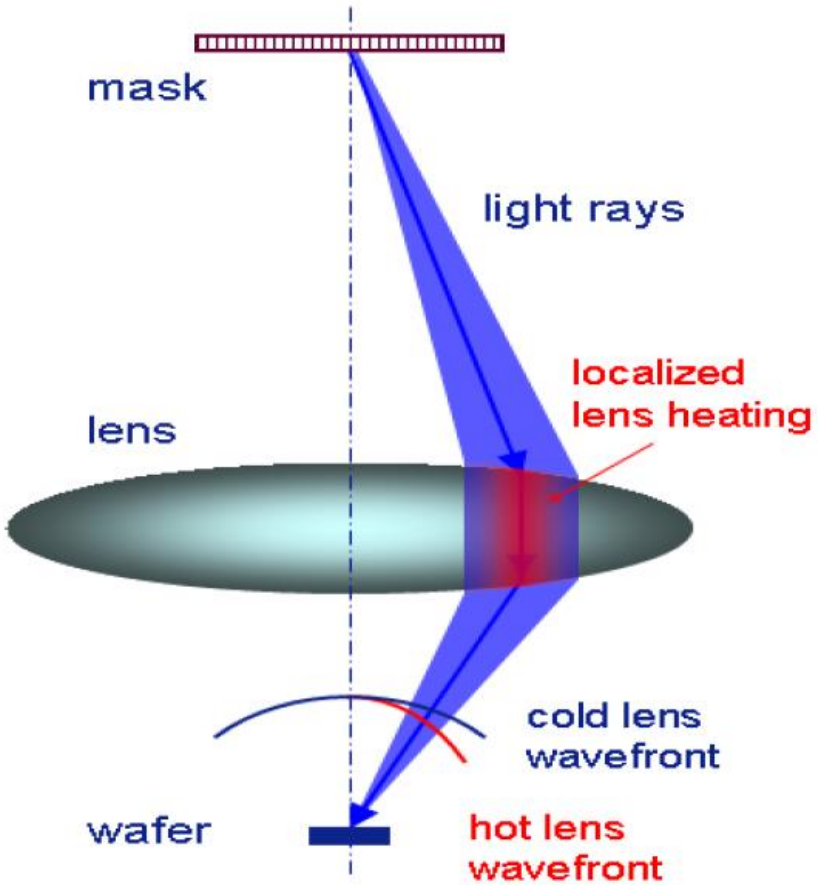
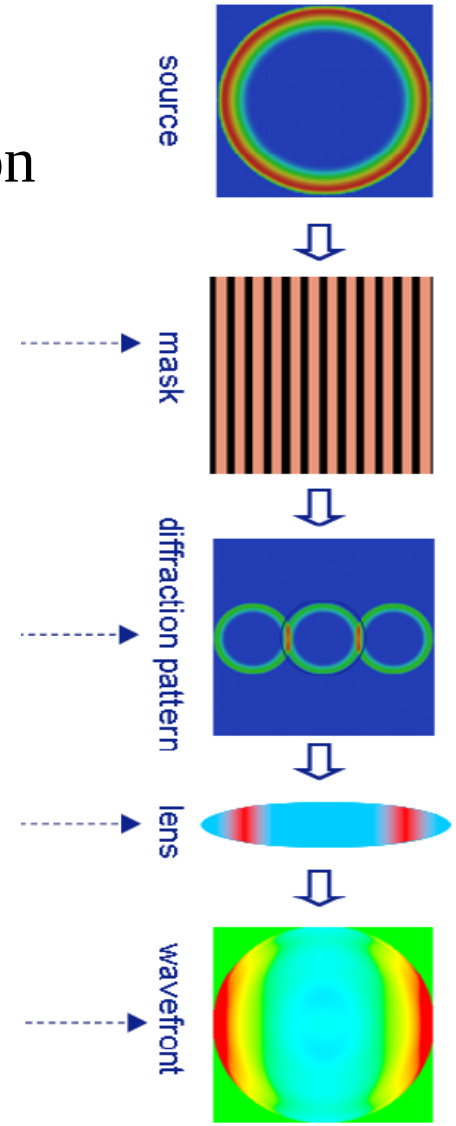
Introduction

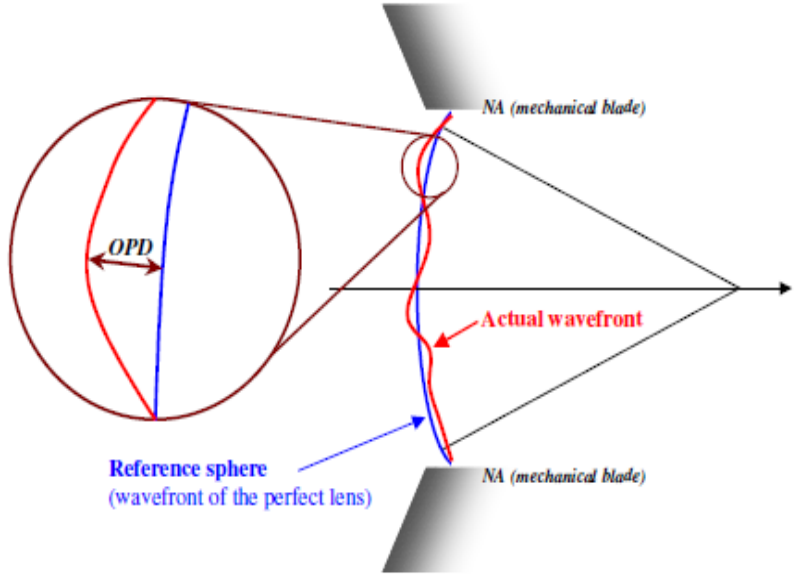
Lens Heating induce aberration

- Localized lens heating during exposure causes wave-front aberration



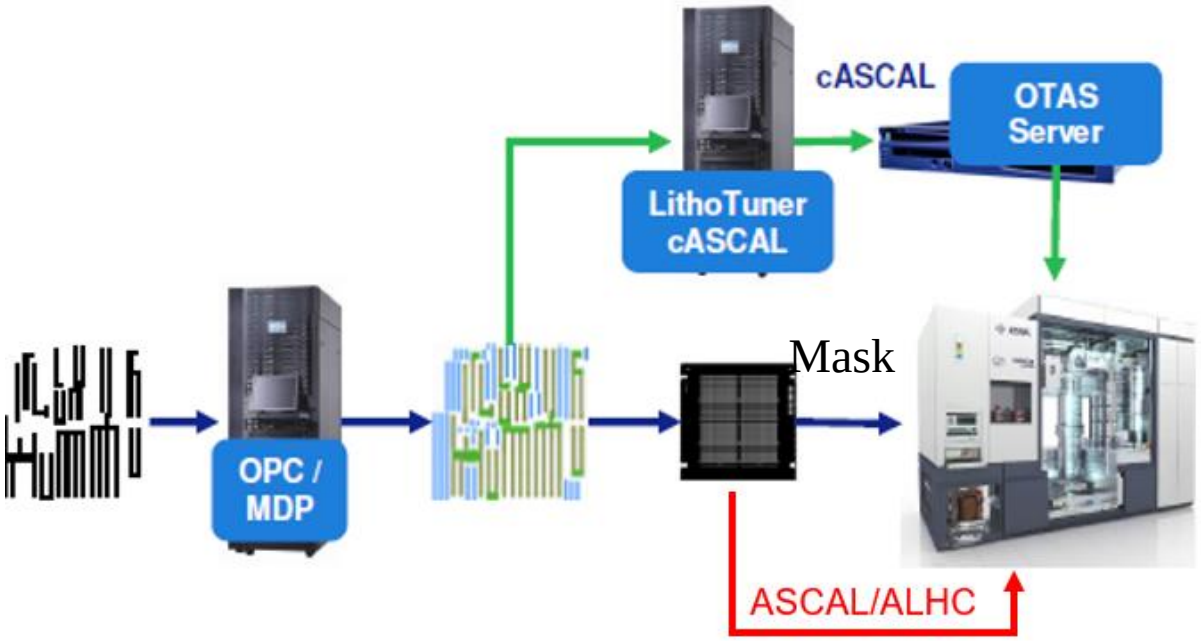


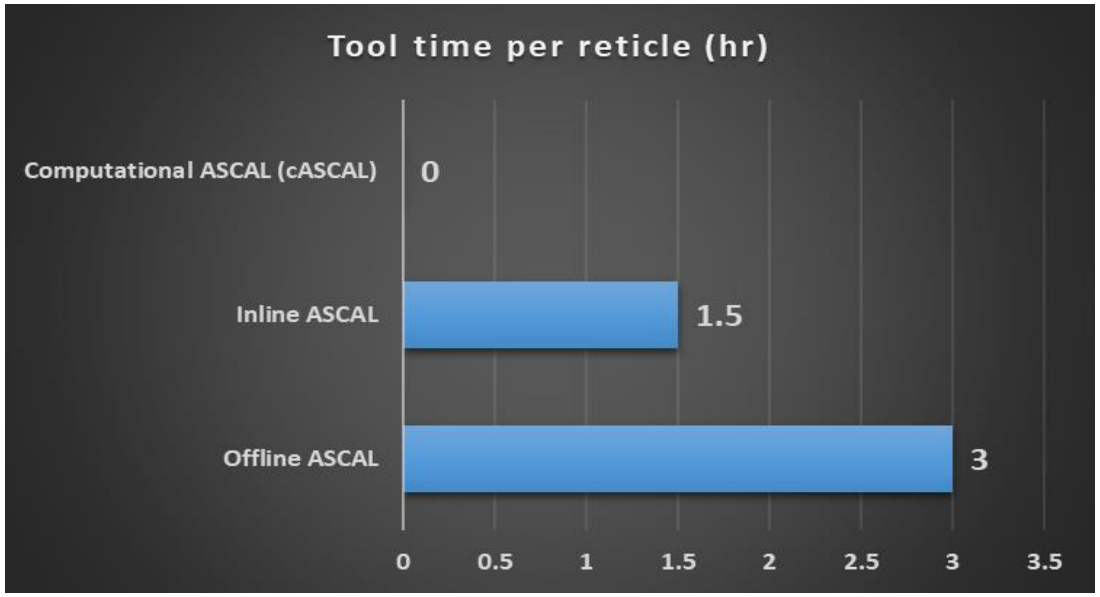
- Wave-front aberration impacts overlay and imaging control



Lens Heating calibration method

cASCAL calibration for all scanners before reticle is made and no scanner time required and is popular to use in immersion tool.





ASML dry ArF cASCAL requirement

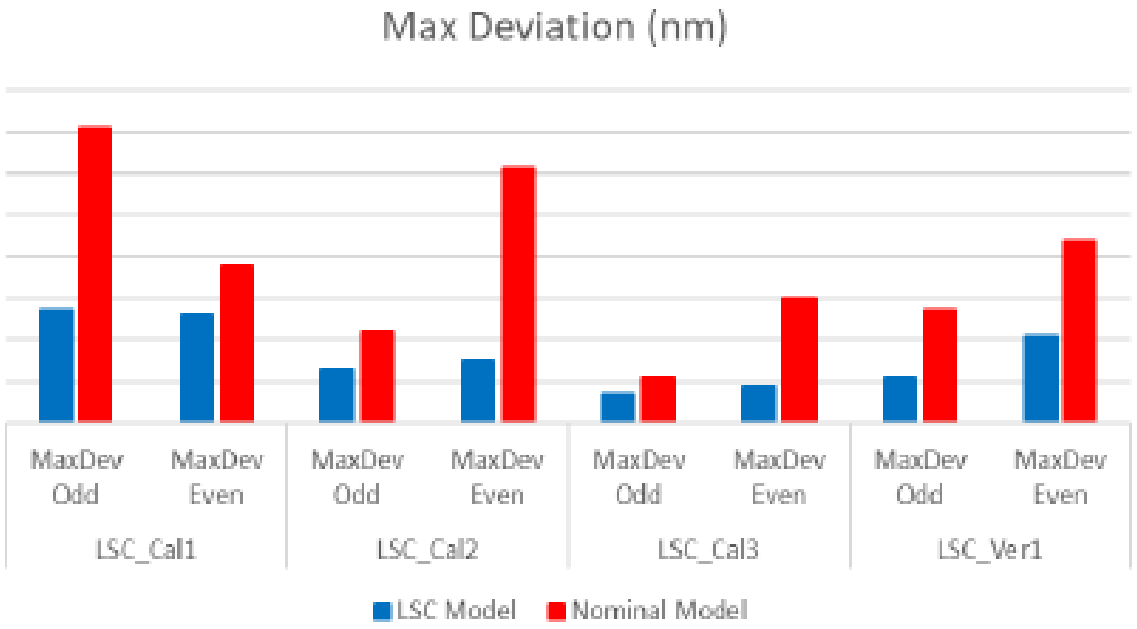
ASML item	Dry XT (193nm)	Dry XT (193nm)	Wet XT ; NXT
Software Release	**3.5.0c/4.0.0.c/4.1.0c**	**4.5.0c/4.5.7.b/5.0.0c/5.1.0c**	**6.0.0c/6.1.0c/6.2.0b /6.3.0b**
Tool type	XT:1200; XT:1400(E/F); XT:1450(G/H)	XT:1460; NXT:1470	XT:19x0i ;All NXT
Lens element	ALE; mini-BALE; BALE; MF-EPLE; MALE	BALE; MF-EPLE; MALE	ALC(R); ALC(XY); Flexwave-prepare; Flexwave-full
Litho Tuner version	Not support	L.T 4.8 (XT:1460/ NXT 1470)	L.T 4.3 (NXT 1980) L.T 4.8 (NXT 2050i)
OTAS/LCP software release	Not support	Support	Support
cASCAL database available	Not available	Available	Available

Not Support **Support**

Lens Specific Calibration for cASCAL

- LSC is needed to enable cASCAL to create a machine specific LHFF model that accurately accounts for tool variations for ArF XT tool type. Without LSC, it may cause cASCAL LHFF model predication accuracy errors especially for XT:1460K tool.

LSC Settings for 14x0 Systems										
LSC Condition	Reticle	NA	Sigma outer	Sigma inner	DOE	Source	Dose	Pol	Image Size	Image Placement
Cal1	**BA-XYZ-0.2-HT 4022.455.62031 Open Frame**	**0.93**	**0.25**	**--**	**15**	**Conv**	**30**	**Unpol**	**26x33**	**0,0**
Cal2	**BA-SCAN-65 4022.455.66331 Binary 65nm L/S (V)**	**0.93**	**0.65**	**0.47**	**111**	**Dip35X**	**80**	**y-pol**	**26x16.6**	**0, 32.95**
Cal3	**BA-SCAN-100 4022.455.637411 Binary 100nm L/S (H)**	**0.93**	**0.5**	**--**	**15**	**Conv**	**80**	**Unpol**	**26x16.6**	**0, -32.95**
Verif1	**BA-SCAN-65 4022.455.66331 Binary 65nm L/S (H)**	**0.93**	**0.65**	**0.47**	**110**	**Dip35Y**	**80**	**x-pol**	**26x16.6**	**0, -32.95**



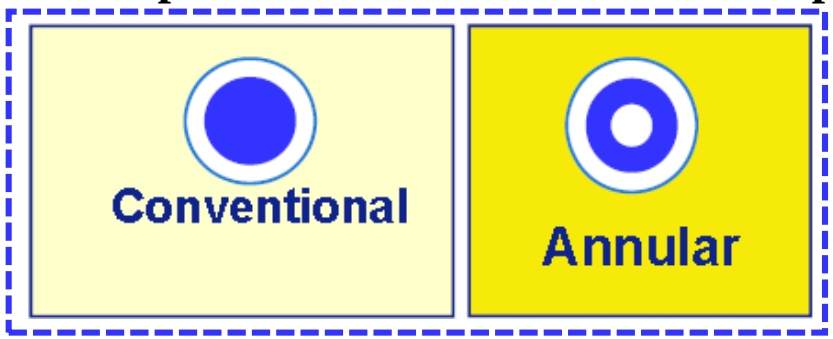
Experiment conditions

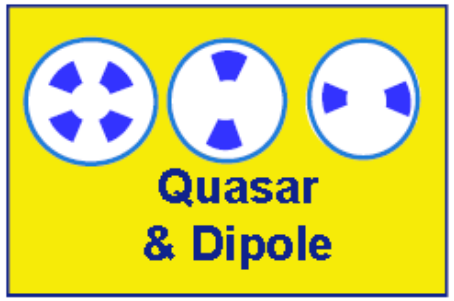
Experiment conditions

- Different processing wafer counts, illumination shapes and exposure energies are designed for inline ASCAL and cASCAL comparison for XT:1460K with LOCOB

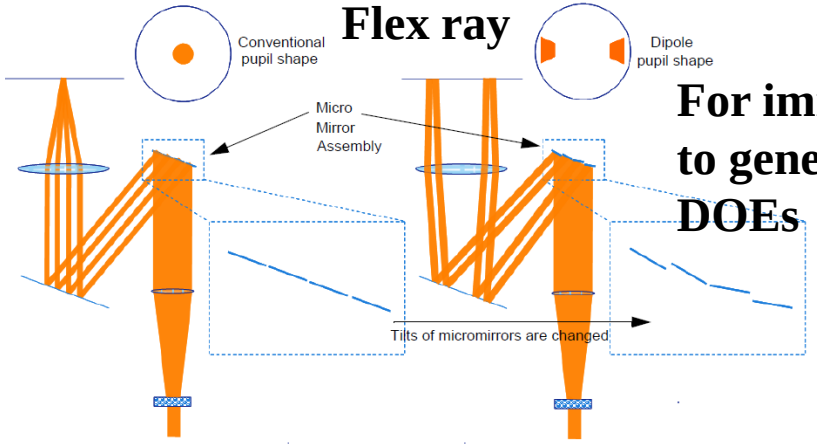
Condition	Layer	Process wafer	Illumination type	Apertures (NA)	Sigma outer/inner	Exposure Energy (mj)	Mask transmission ratio
1.	LayerA	25	Conventional	0.93	0.65/NA	19	50.08
2.	LayerB	25	Annular	0.92	0.72/0.45	30.5	50.44
3.	LayerB	75	Annular	0.92	0.72/0.45	30.5	50.44

This Experiment select illumination shapes





Flex ray

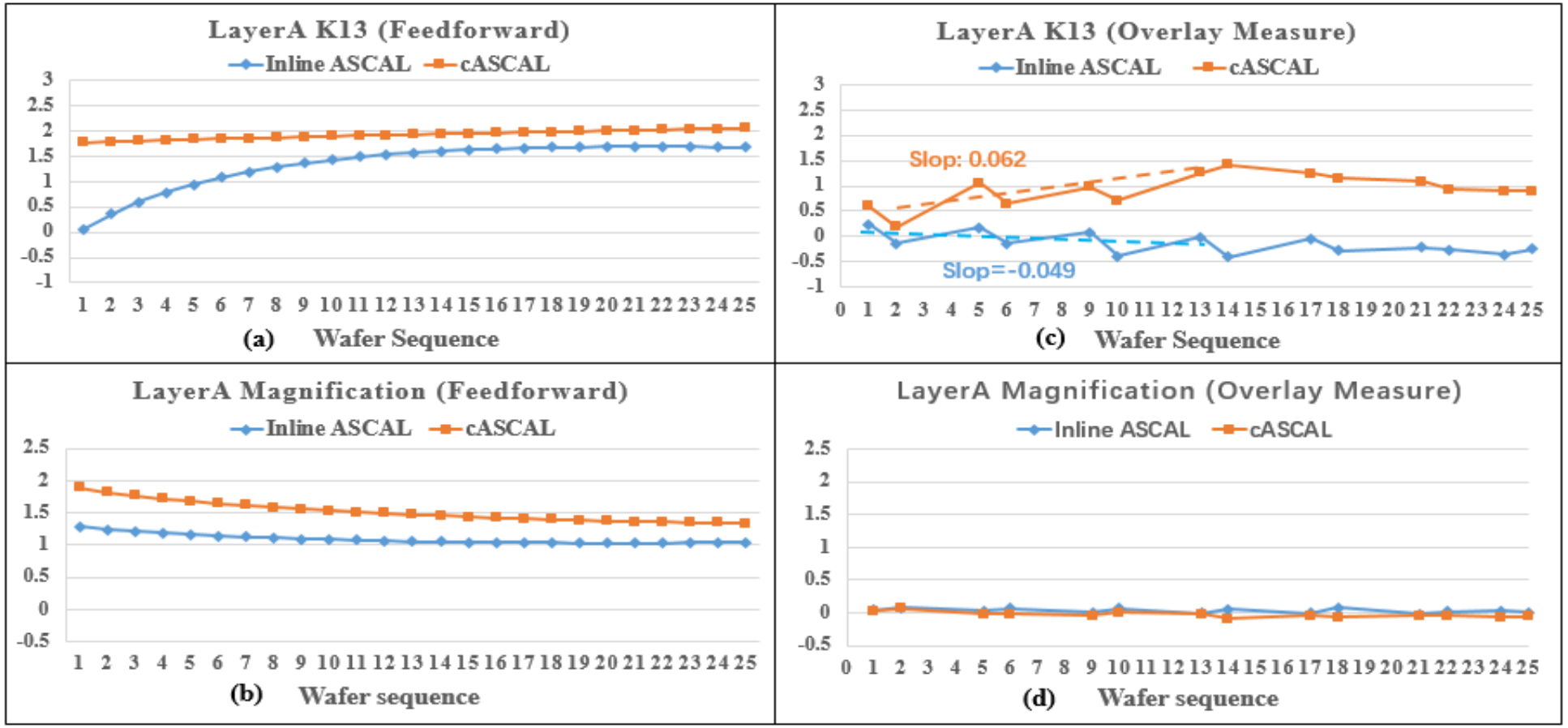


For immersion tool to generate different DOEs

Result

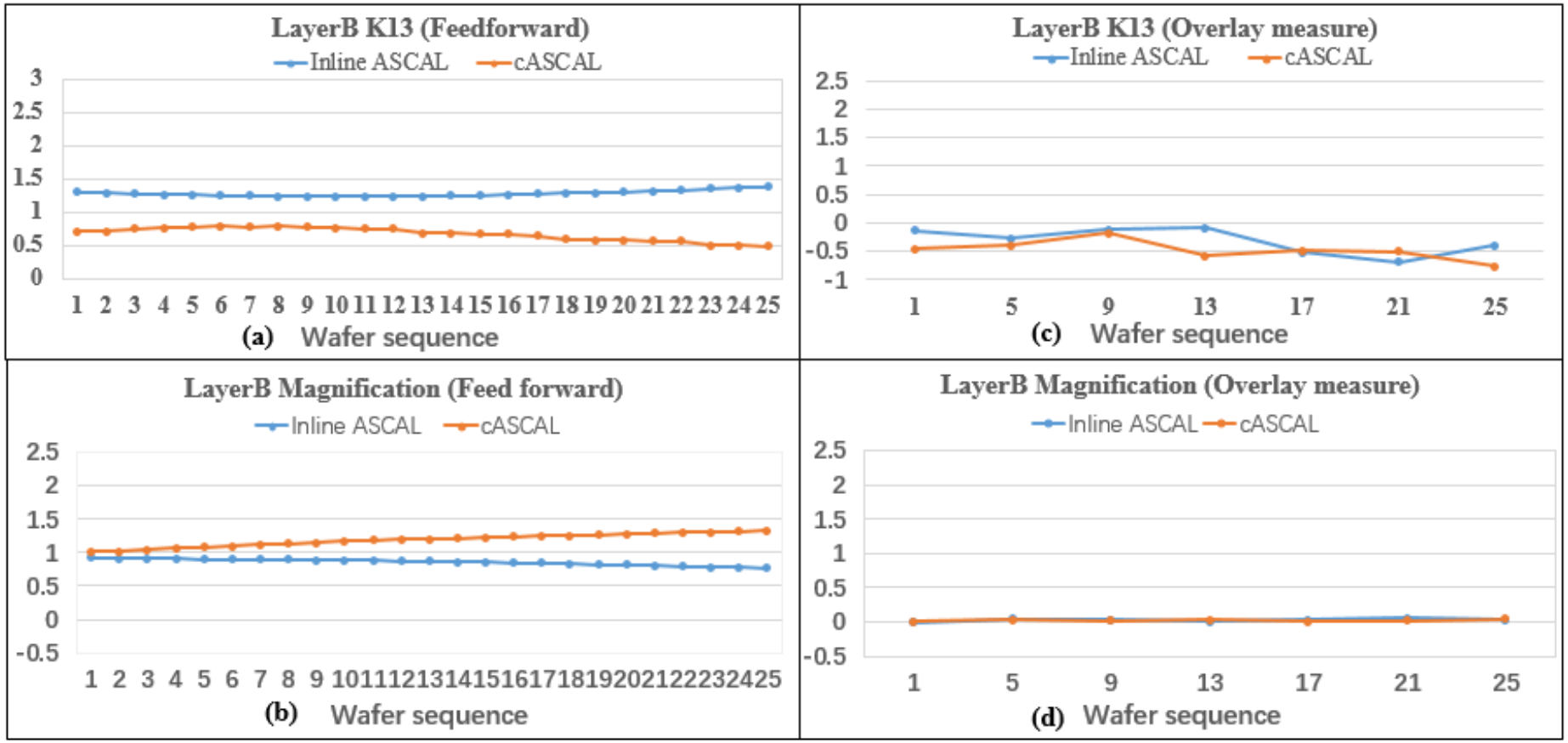
Inline ASCAL VS cASCAL experiment_Condition1

Condition	Layer	Process wafer	Illumination type	Apertures (NA)	Sigma outer/inner	Exposure Energy (mj)	Mask transmission ratio
1.	LayerA	25	Conventional	0.93	0.65/NA	19	50.08



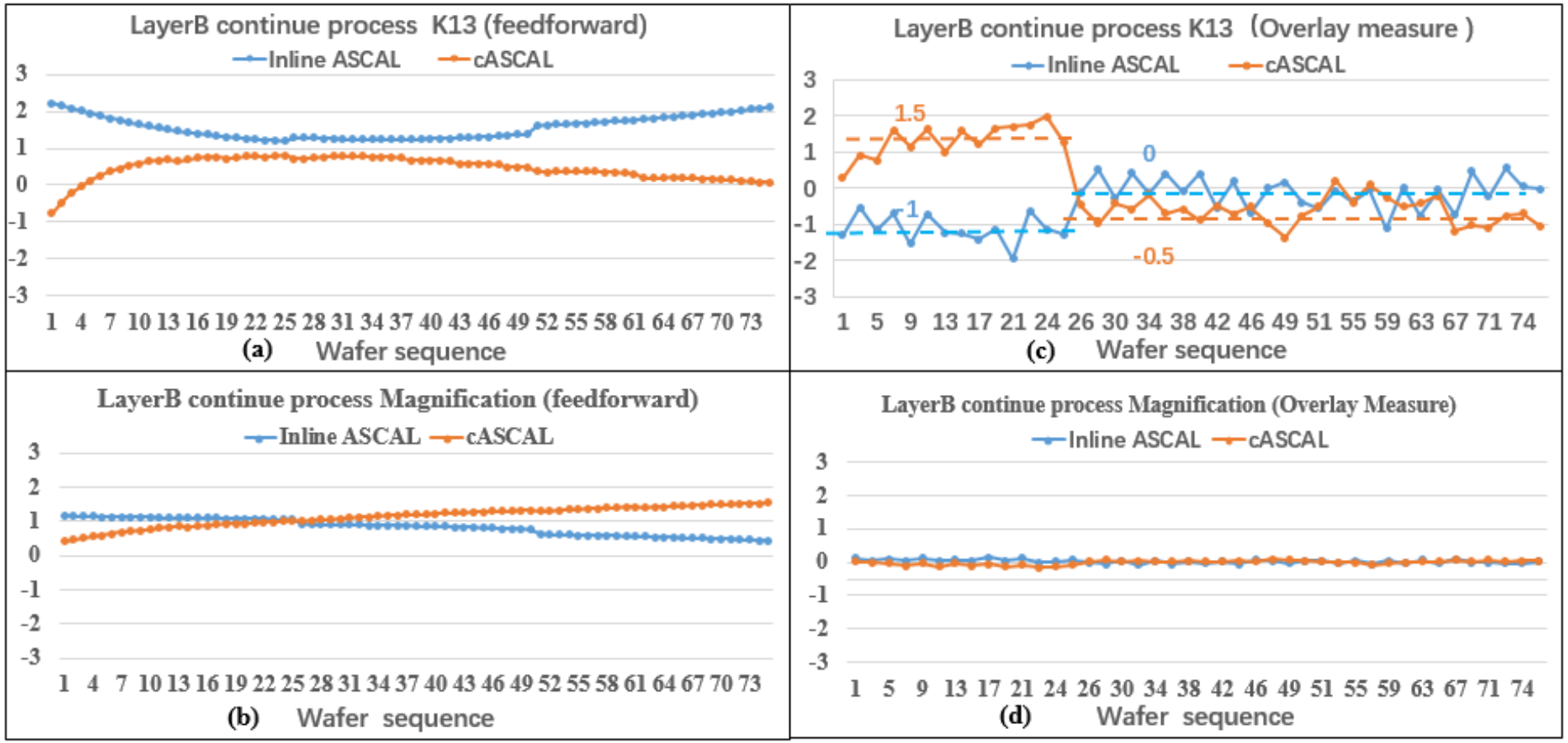
Inline ASCAL VS cASCAL experiment_Condition2

Condition	Layer	Process wafer	Illumination type	Apertures (NA)	Sigma outer/inner	Exposure Energy (mj)	Mask transmission ratio
2.	LayerB	25	Annular	0.92	0.72/0.45	30.5	50.44



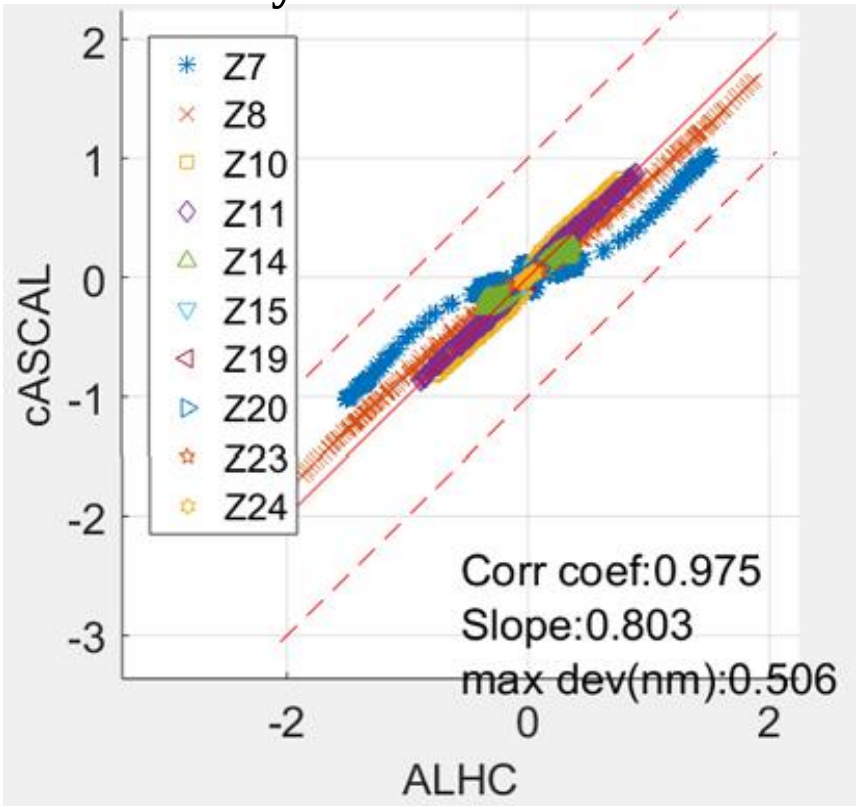
Inline ASCAL VS cASCAL experiment_Condition3

Condition	Layer	Process wafer	Illumination type	Apertures (NA)	Sigma outer/inner	Exposure Energy (mj)	Mask transmission ratio
3.	LayerB	75	Annular	0.92	0.72/0.45	30.5	50.44

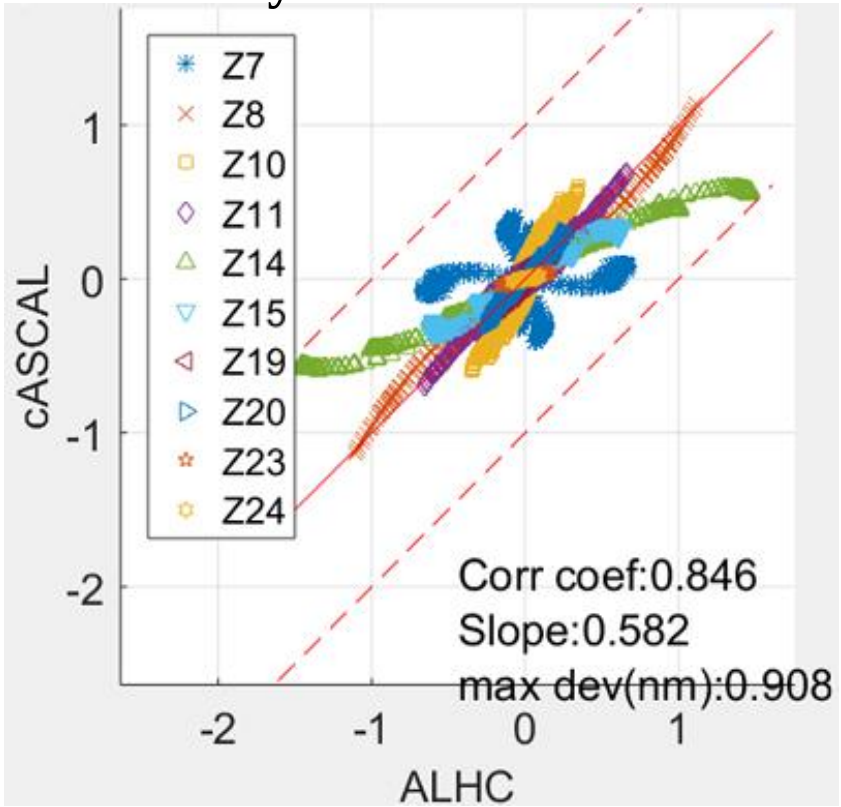


Inline ASCAL VS cASCAL odd Zernikes correlation

Layer A odd Zernikes



Layer B odd Zernikes



For XT:1460K cASCAL vs ALHC, simulation correlation for odd zernikes. Odd zernikes can impact the overlay, from correlation chart, the max deviation is within +/- 1nm in the spec value.

Conclusion

Conclusion

- For ASML ArF XT:1460K tool type, LSC is needed to enable cASCAL to create a machine specific LHFF model that accurately accounts for tool variations.
- Under HVM fab with multiple products and layers, lens heating control with cASCAL is able to save 1.5 hours tool time per reticle compared with inline ASCAL.
- On-product overlay results are comparable with cASCAL compared to inline ASCAL for XT:1460K tool under LOCO B.

Thanks