The Impact of Context-Dependent Mask-Effects on Mask Hotspots

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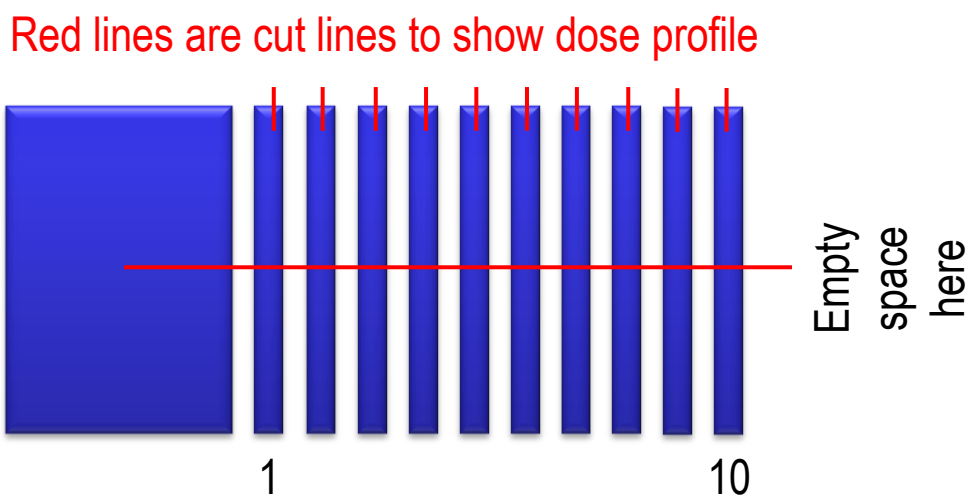
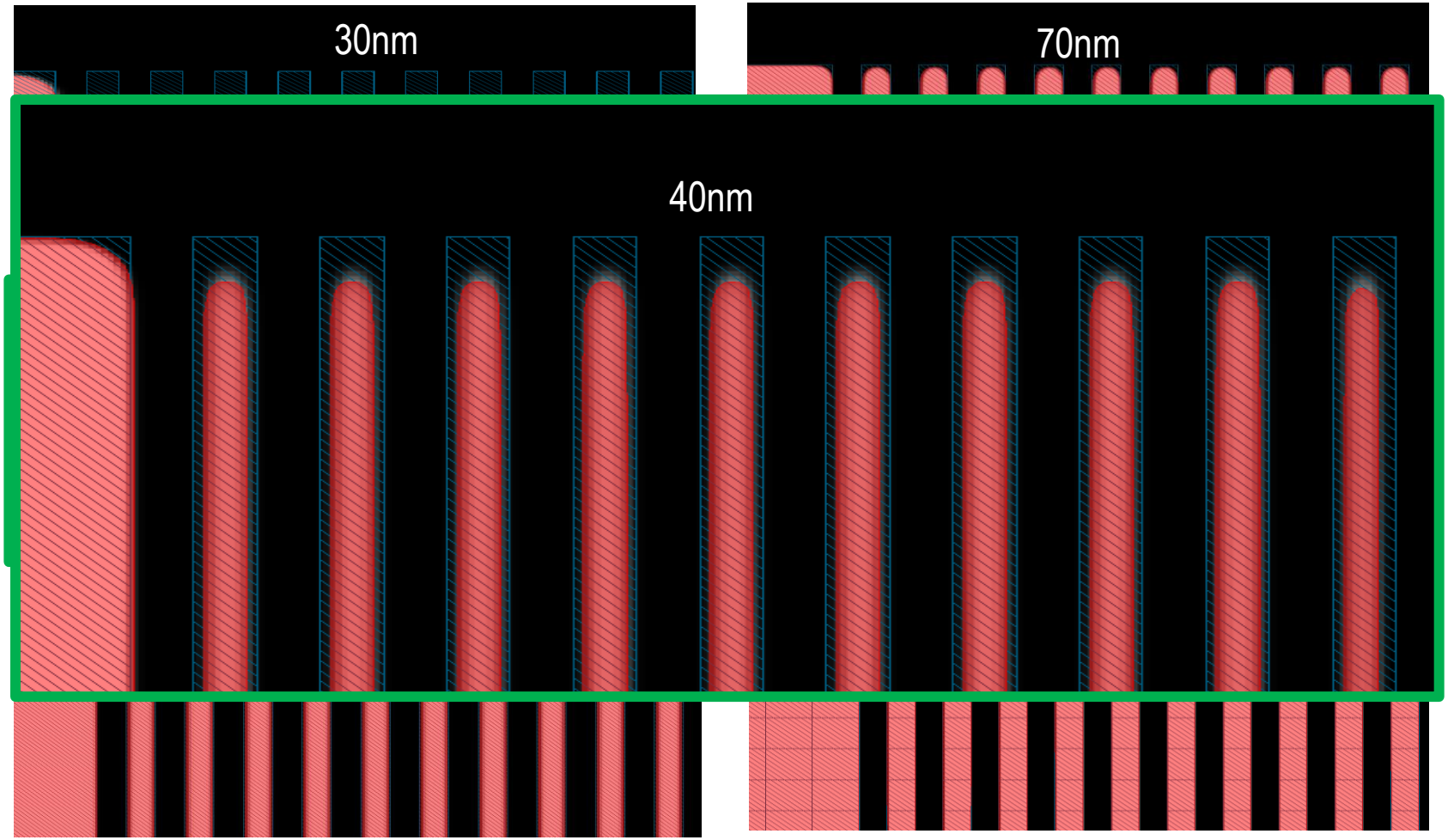
Below 50nm, Context is Critical



- Vary L:S = 13nm to 300nm using 30nm and 15nm blurs
- Will compare the differences of line 1 and line 10, as well as line end shortening

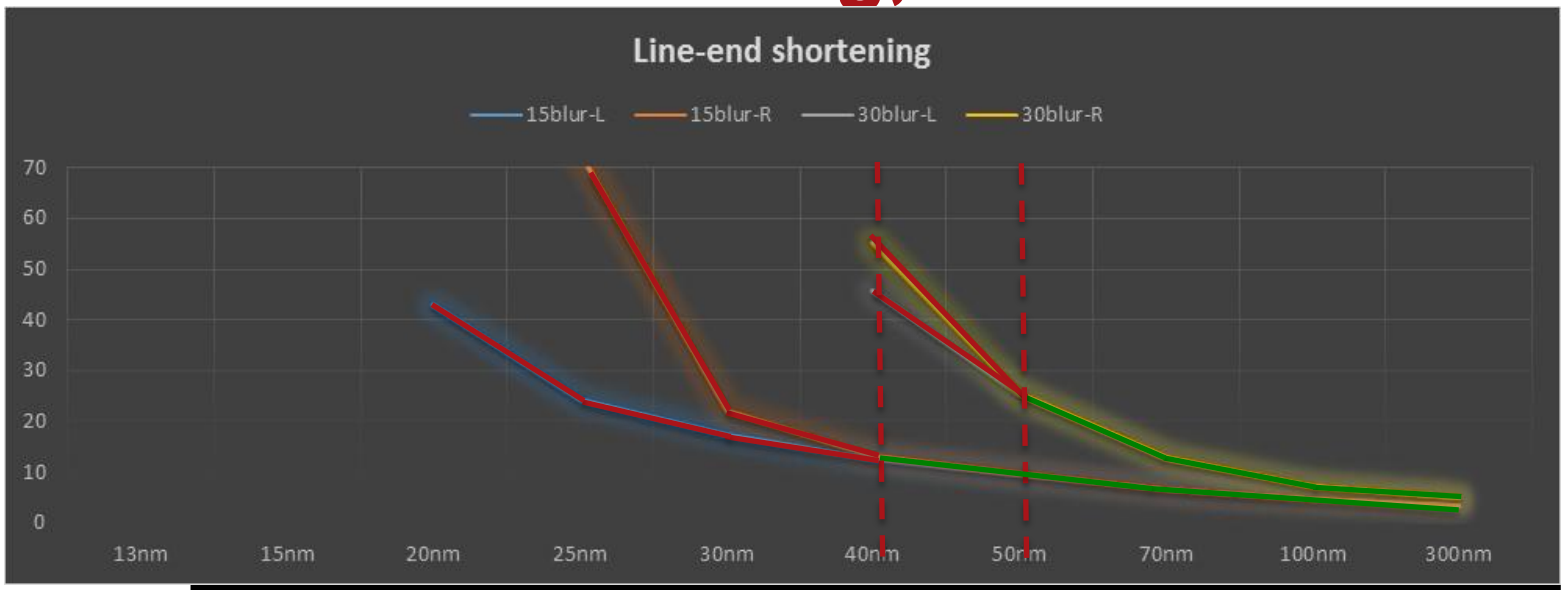
- Above 50nm, context-independent rules-based processing works well enough
- Below 50nm, context is critical
- If we can't push below 40nm, we leave the benefits of Moore's Law on the table
- Simulation-Based Mask Processing is the inevitable answer

Below 50nm, Context is Critical



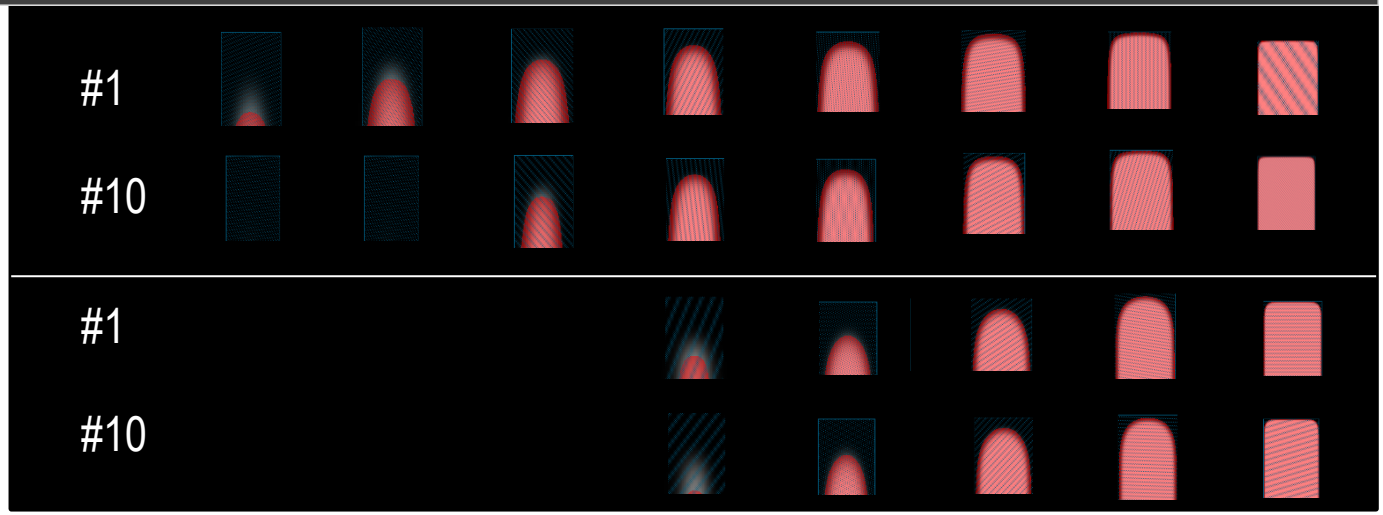
Each picture is scaled up to show the contour

Below 50nm, Context is Critical For Line-End Shortening, Too

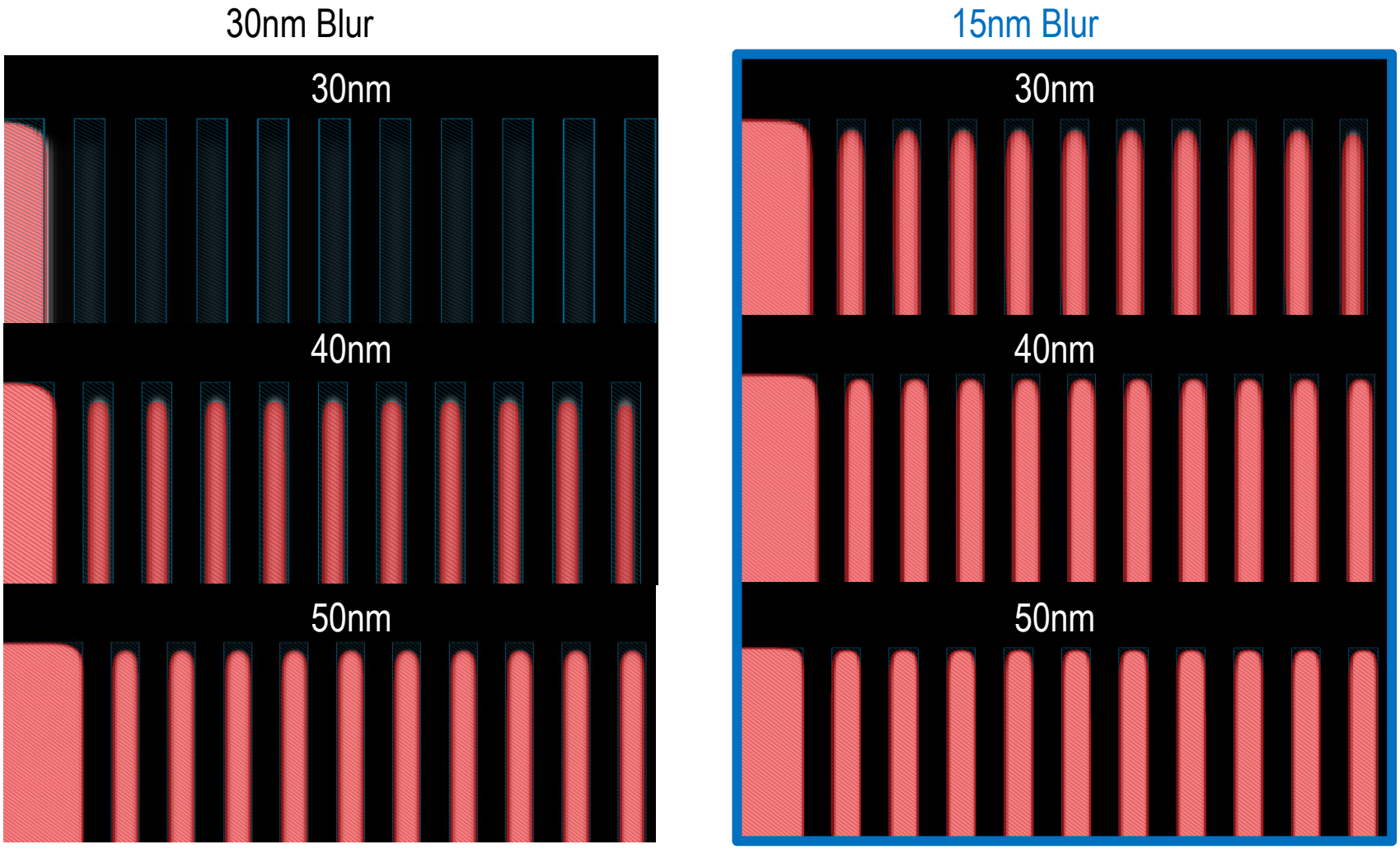


15nm blur

30nm blur



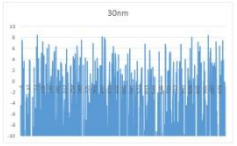
Slower Resists Do Print Much Better



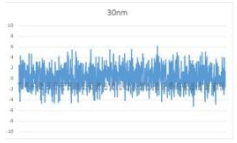
Each picture is scaled up to show the contour

Slower Resist: Less CD Variation

30nm

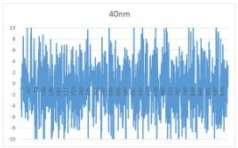


30nm blur

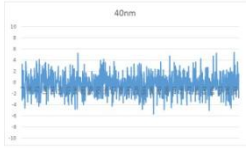


15nm blur

40nm

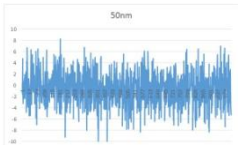


30nm blur

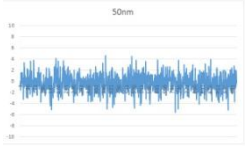


15nm blur

50nm

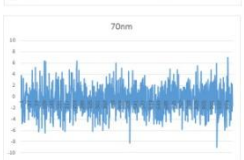


30nm blur

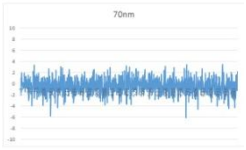


15nm blur

70nm

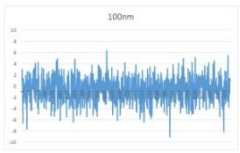


30nm blur

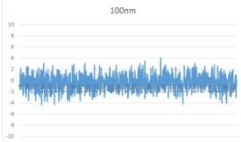


15nm blur

100nm

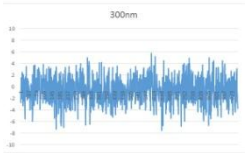


30nm blur

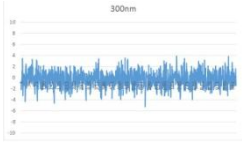


15nm blur

300nm



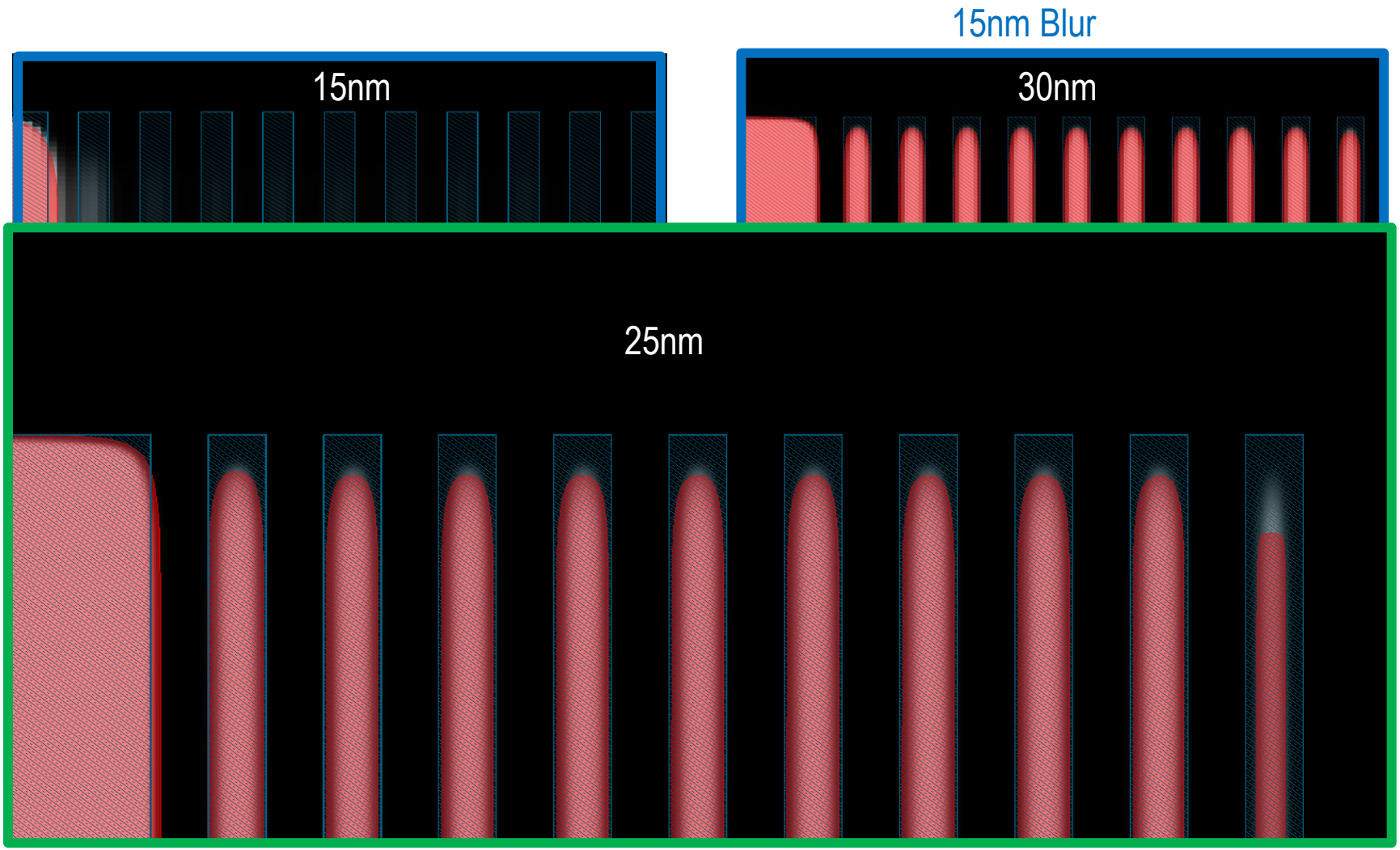
30nm blur



15nm blur

1000 epoch Monte Carlo of threshold variation

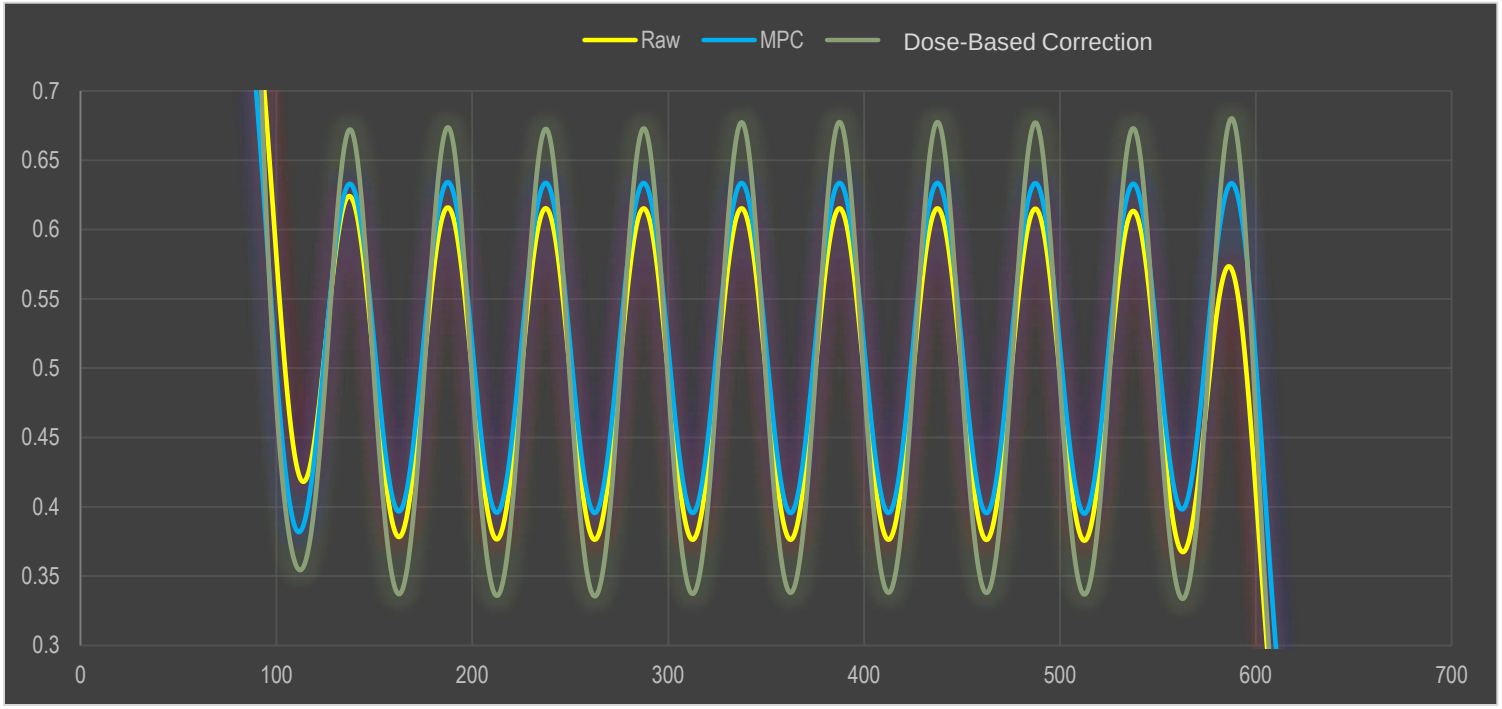
But Slower Resists Have Limits, Too

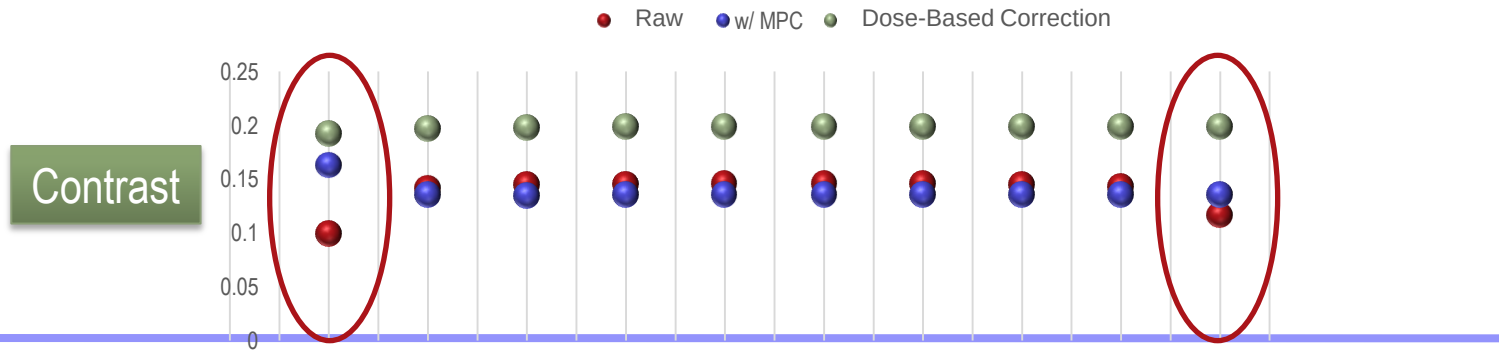


Each picture is scaled up to show the contour

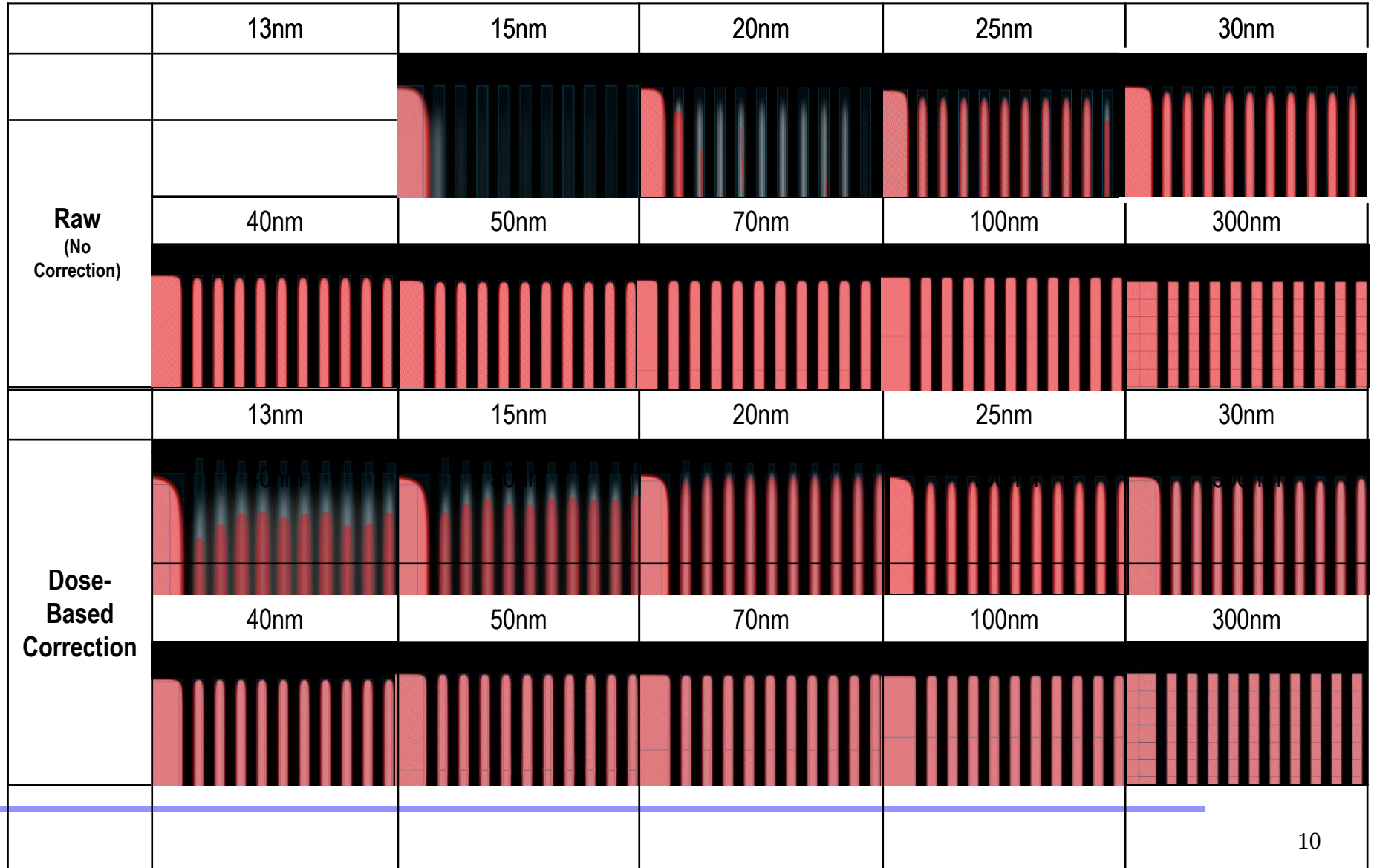
Dose Up for Better Contrast

15nm beam blur



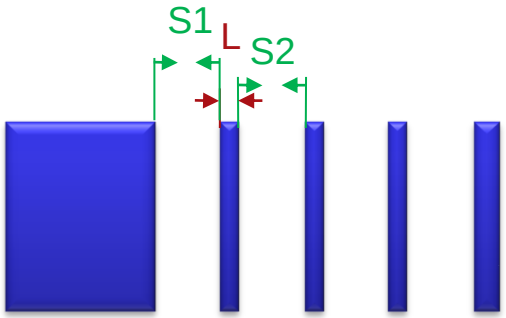


Use Simulation to Dose Up for Better Contrast



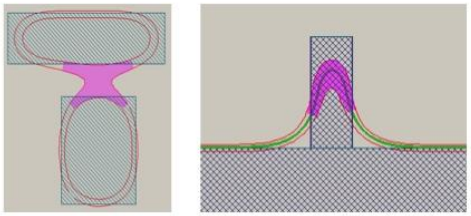
A Choice Between Two Evils?

Conservative Design Rules

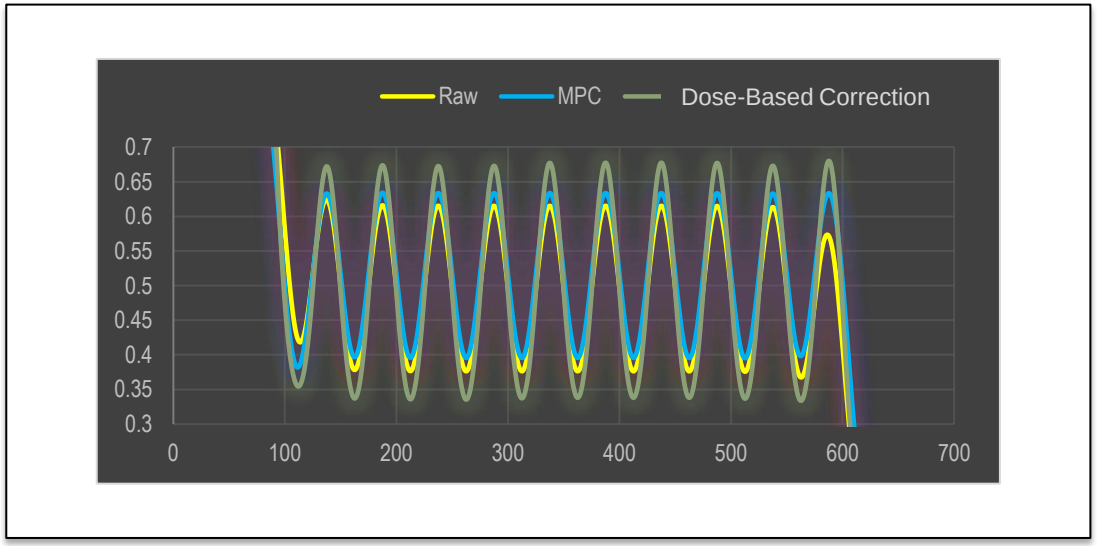


OR

Mask Hotspots Escape Mask Shop



Simulation is the future of MDP



- Dose-modulation based correction provides the best solutions
- Context-dependent correction is needed regardless of writing method


D2S