PMJ 2013: Future of Mask Pattern Generation

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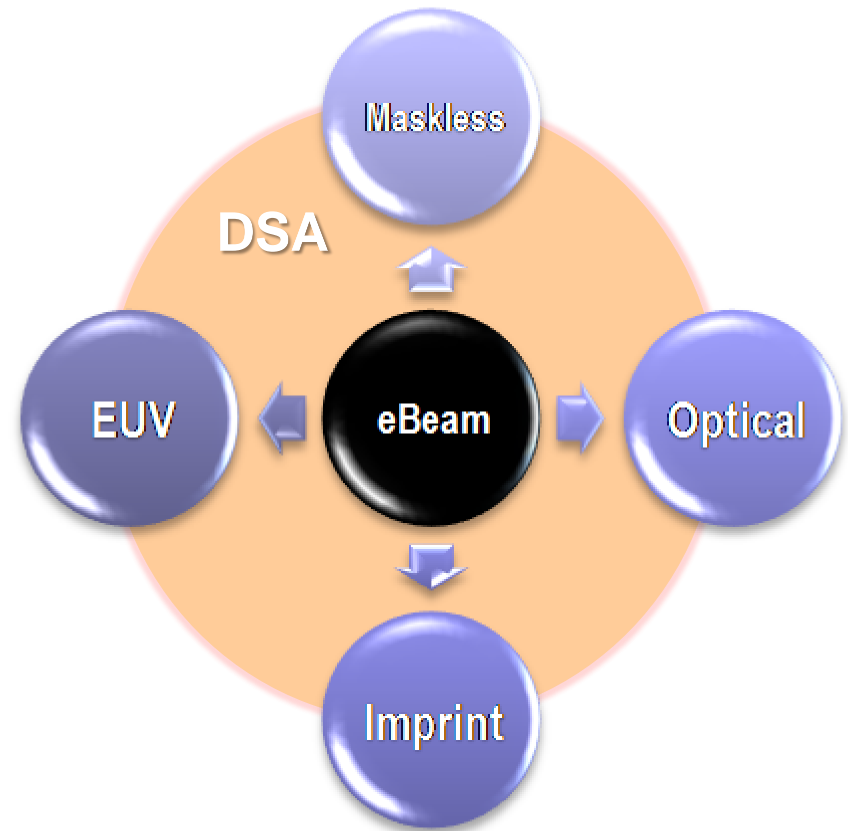
D2S is the managing sponsor of:

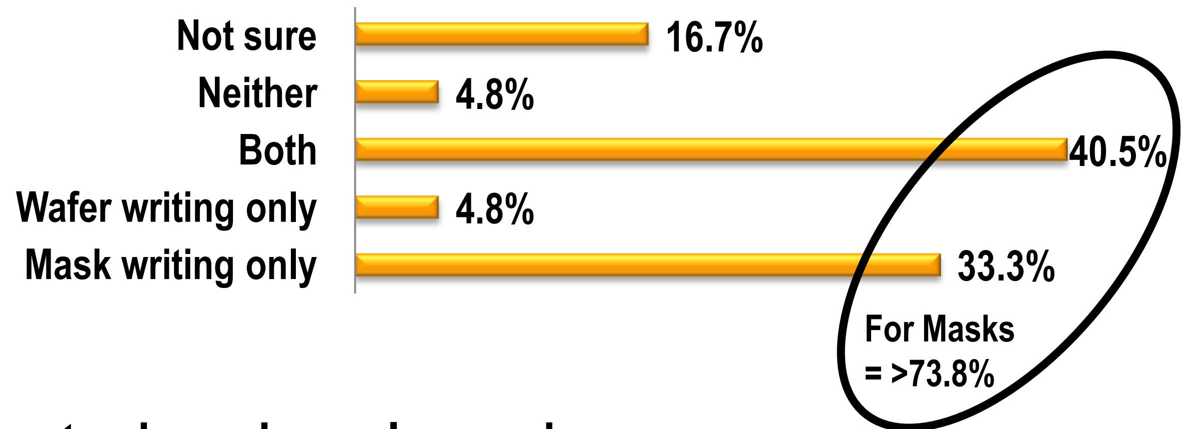
Future is Bright for eBeam Technologies

- DSA requires accurate guide patterns written by eBeam
- EUV requires eBeam masks
- Imprint requires eBeam masks
- Multibeam promising
- eBeam mask simulation required at 16/14nm – VSB or Multibeam



Will the Future be Multibeam?

- Yes, and...

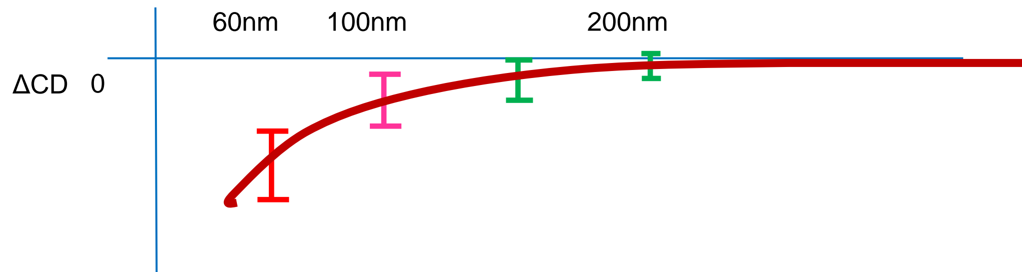


- Ecosystem has to be developed
- Regardless of whether VSB or Multibeam
  - eBeam physics requires eBeam mask simulation at 16/14nm

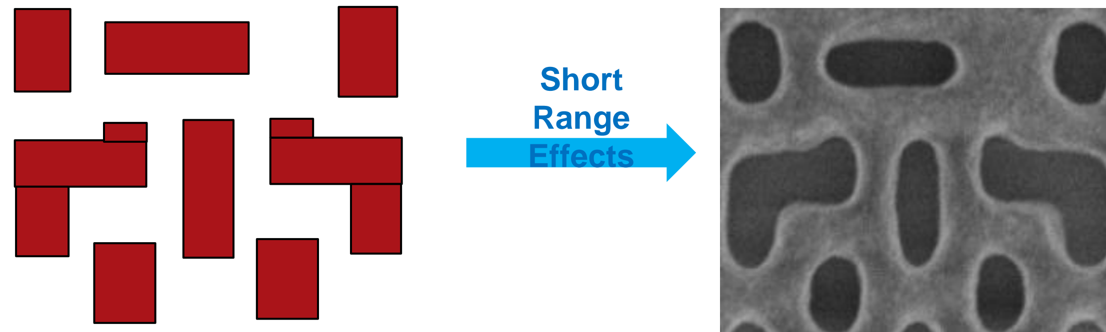
Why eBeam Mask Simulation?

eBeam physics when there's no room for error

1D Linearity Effect



2D Rounding Effect

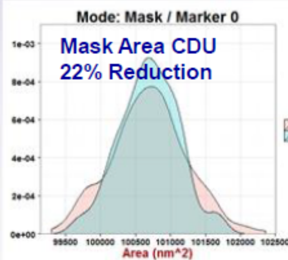


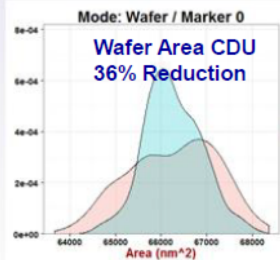
eBeam Simulation Improves Mask CDU

Simulation Results

- MB-MDP method shows improved CDU of area and line-width compared to conventional MDP. Impact at wafer level increased by MEEF.

Marker (Pattern B)	Conventional MDP CDU (1 σ)		MB-MDP CDU (1 σ)		Reduction	
	Mask	Wafer	Mask	Wafer	Mask	Wafer
Area 1 (nm^2)	538	969	420	625	22%	36%
Area 2 (nm^2)	554	1175	418	557	25%	53%
Area 3 (nm^2)	531	1178	415	568	22%	52%
Area 4 (nm^2)	493	742	380	495	23%	33%
Line 1 (nm)	0.96	N.A.	0.62	N.A.	35%	N.A.
Line 2 (nm)	0.78	N.A.	0.55	N.A.	29%	N.A.
Line 3 (nm)	1.73	N.A.	1.47	N.A.	15%	N.A.
Line 4 (nm)	1.26	N.A.	0.89	N.A.	29%	N.A.





All results are in Mask Units

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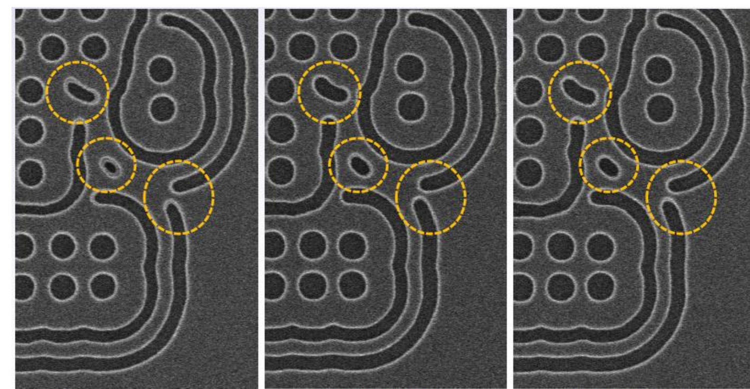
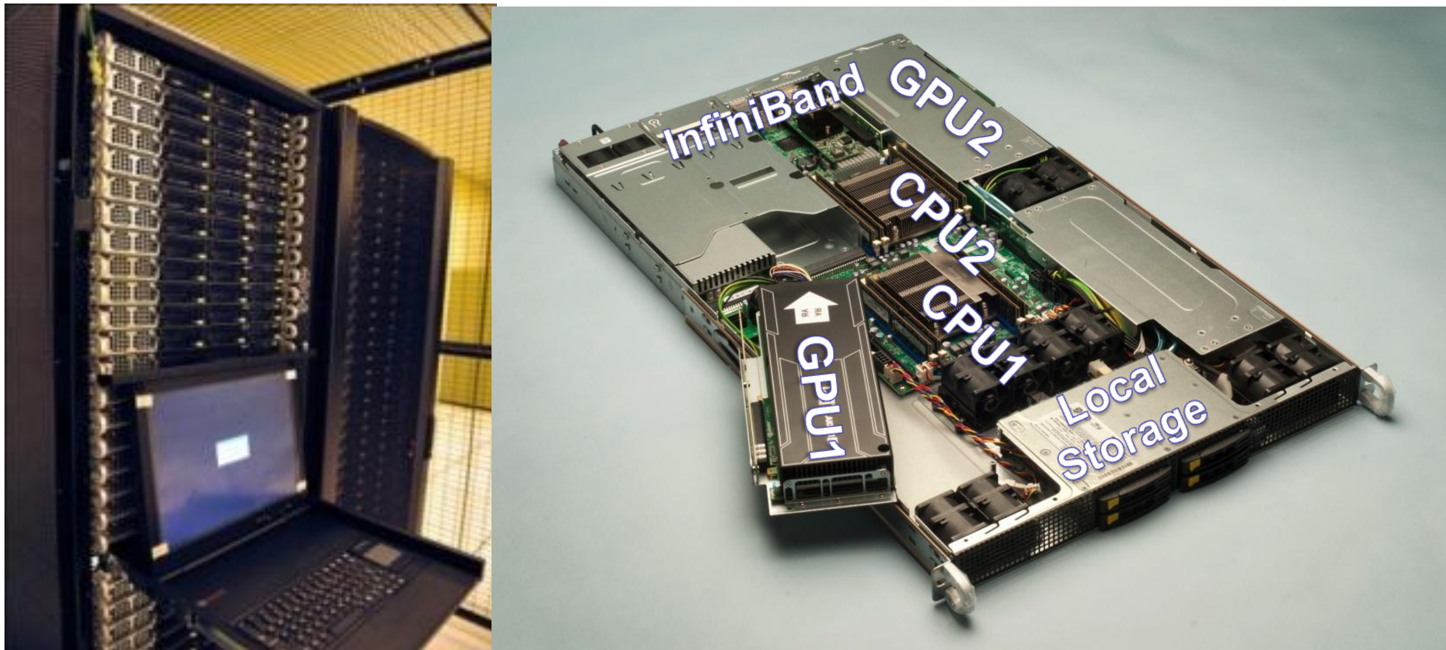


BACUS 2012 Paper 8522-04 by Byung-Gook Kim, Samsung

eBeam Mask Simulation Accuracy in Reasonable Time with GPGPU acceleration



Source: D2S Computational Design Platform

Summary

- Parallel track with VSB and Multibeam
- Whether Multibeam or VSB, eBeam mask simulation is required at 16/14nm logic nodes
- Improved mask CDU leads to better OPC models
- GPGPU acceleration improves accuracy-runtime tradeoff

Future of Mask Pattern Generation Depends on eBeam Mask Simulation