Towards a 100 wph e-beam direct write cluster

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In the past years MAPPER has been developing its massively parallel electron beam system for CMOS manufacturing. This has resulted in two prototype machines which have been installed in 1) TSMC and 2) CEA Leti. In parallel developments have been ongoing at MAPPER on the main three subsystems of the machine: The electron optics, the data path and the wafer stage. In this presentation we will present development highlights of these three subsystems as follows:

1. Electron optics: Beam stability measurements

For a reliable multi-beam system we must be able to measure the initial position of the beams after integration of the machine and individually correct for an offset with respect to an ideal grid. Then after the offset has been measured and corrected for, all beams need to remain stable for a full wafer exposure, i.e. 6 minutes for a 10 wafers per hour system. Worst case we assume that we need to measure the individual beam position every 6 minutes. This presentation will show the measurement and correction scheme for the beam position and also show measurements of beam stability over time such as in figure 1.

2. Data path:

To obtain a 10 wph throughput for one electron optics column a total data rate of 3 TBytes per second is required to feed the electron beam blanker. In addition corrections on the data, like magnification adjustment to compensate process variations, require real-time calculations. We will show that this is both technically and economically possible based on results we have obtained with implementing our real time algorithms on an FPGA test board.

3. Wafer stage: Scanning exposures and beam-to-beam stitching

Once the positions of the electron beams are stable over time we can start stitching different beams together. For this we have integrated an interferometer on our wafer stage to allow different beams, spaced 150 µm apart, to stitch patterns exposed by the individual beams. In this presentation we will show the status of these experiments. A first result can be seen in figure 2.

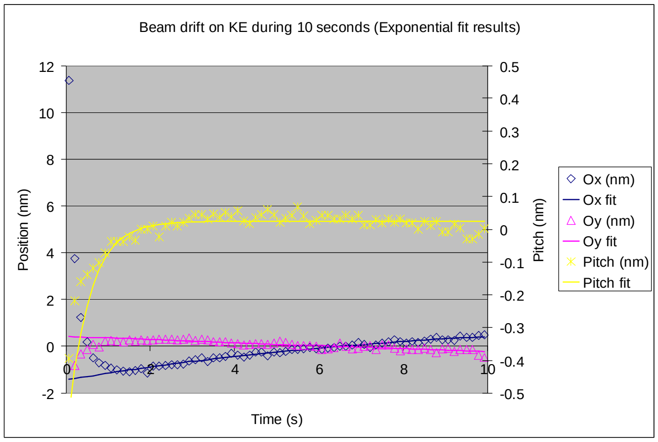
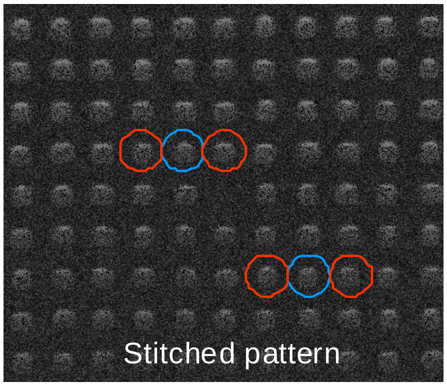


Figure 1: Beam stability of 110 beams over 10 s



Wir 222 D8-D9 picture 3	**X error**	**Y error**	**R error**
Mu [nm]	-1.97	0.86	4.93
3sigma [nm]	13.36	9.13	8.83
mu+3sigma [nm]	15.33	9.99	13.75

Figure 2: Beam-to-beam stitched pattern image and error. Dots in blue and red circles are exposed by different beams