# Microcolumn design for a large scan field and pixel number

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The ongoing miniaturization of structures in electronics and storage calls for new production and examination methods. The desired structures can be generated and inspected by a low voltage scanning electron beam. For increased efficiency, it is desirable to miniaturize these electron optical systems and operate them in parallel [1]. Most microcolumn designs up to now have been dedicated to achieve small beam sizes for lithography or microscopy purposes [2], usually exhibiting rather small working distances and scan fields. This work takes a different approach by aiming the design of the microcolumn geometry at a large number of addressable pixels while keeping the pixel size, i.e. the beam size, as small as possible. An array of such large scan field microcolumns might be of interest for inspection purposes.

The design presented here features a large working distance of 40 mm and therefore magnifies the effective electron source into the final spot. Less than 1 $cm^3$ in size, the electron optical system consists of a microfabricated pre lens double deflector and an asymmetric einzel lens operated in accelerating mode. Simulations for 1 keV electrons from an electron source of 10 nm in size and 0.5 eV energy spread predict an increase in beam size from 85 nm on axis up to only about 300 nm for a beam deflected 5 mm off axis (Fig 1). Within a 1 mm scan field this microcolumn could address over 100 Megapixels of less than 100 nm in size.

Tests of this design were performed using the electron probe of an XL30 SEM as the electron source. Fig 2 shows the ability of the microcolumn to scan field sizes of more than 7x7 $mm^2$ once dynamic correction of focus and distortion is implemented. The achieved beam size of the entire setup depending on the beam deflection was determined by the knife edge method as well as by the application of intelligent detectors [3] (Fig 3). The design methodology, experimentally evaluated performance and comparison with simulations will be presented.

[1] T.H.P. Chang et al., J. Vac. Sci. Technol. B8 (1990) 1698
[2] L. Muray et al., Microelectron. Eng., doi : 10.1016/j.mee.2008.11.065
[3] H. Weigand et al, Microelectron. Eng. 85, 1429 (2008).

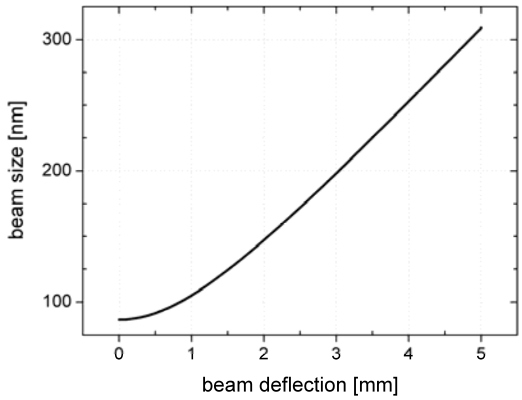


*Fig 1:* Calculated size of a 1 keV beam at 40 mm working distance versus deflection presuming a 10 nm source and 0.5 eV beam energy spread.

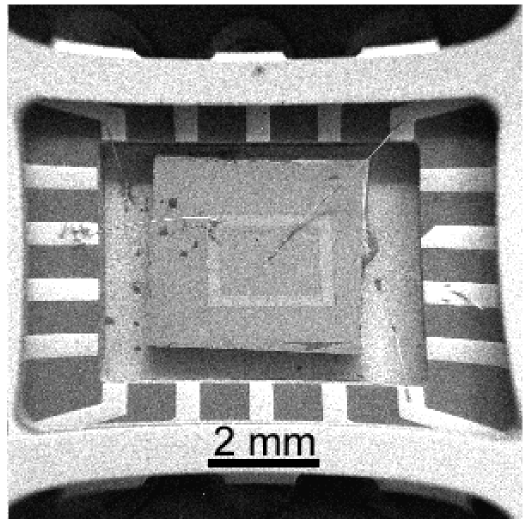


*Fig 2:* Scan of a chip carrier with a mounted detector performed with the described microcolumn at a working distance of 39 mm and 1 keV beam energy. Field curvature and distortion are not corrected.

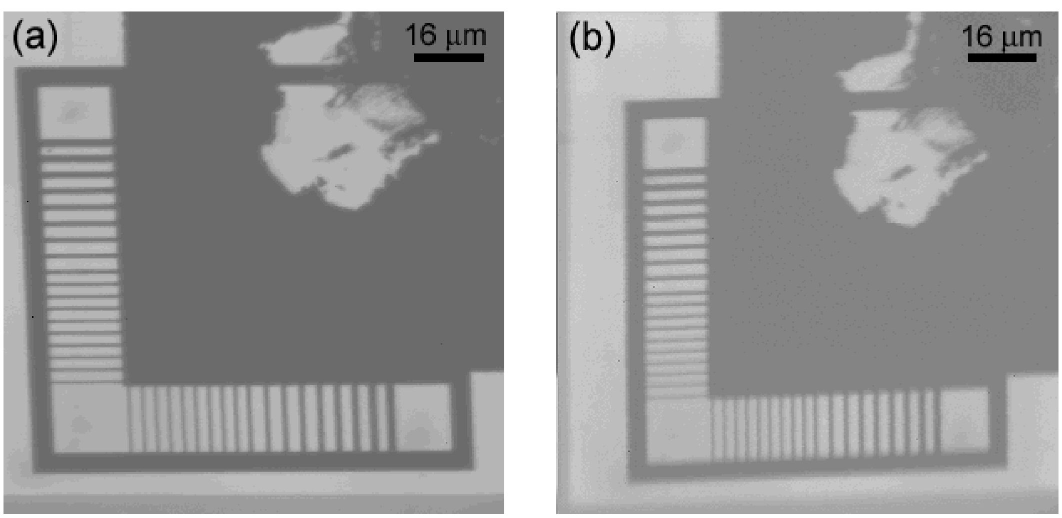


*Fig 3:* Imaging of a detector employing its own signal (transferred beam current imaging). The detector consists of metal bars on a pn-Si-substrate [1]. Picture (a) was taken by the microcolumn with the beam scanning the structure on axis while for scan (b) the structure was positioned 5 mm off axis. Focus and astigmatism was readjusted for scan (b) but no dynamic corrections were performed. Pictures were taken at 39 mm working distance and 1 keV beam energy.