DynAMiTe: radiation-hard wafer-scale CMOS Imager


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Abstract

World’s largest radiation-hard 0.35 um CMOS imager (approx. 13 cm square) for medical imaging applications with superior performance compared to existing technology – faster speed and lower patient dose. Largest possible device on 8” (200 mm) silicon wafer. Demonstrated true charge binning in CMOS imagers for the first time, dual resolution pixel arrays, multiple read-out of selected regions for faster speed and reduced data bandwidths, “lossless” butting for large imager mosaics, fully radiation-hard pixel array (tested up to 8 MRad at 38 MeV protons), and non-destructive readout for accumulating weak signals. Funded by £1.2m EPSRC Translation Grant (EP/G037671/1), which was follow-on from £4.4m Basic Technology Mi-3 (GR/S85733/01) consortium. Fully met one of EPSRC Grand Challenges for microelectronics - large-area images for medical applications. Variant of the device transferred into industry through Perkin-Elmer Corp (major global supplier) - "Slingshot" imager (10 x 15 cm) was realised in Autumn 2012 and will feature in Perkin-Elmer product by Autumn 2013. DynAMiTe was first reported in M Esposito, T Anaxagoras, A Fant, K Wells, A Konstantinidis, J P F Osmond, P M Evans, R D Speller and N M Allinson, "DynAMiTe: A Wafer Scale Sensor for Biomedical Applications", J. Instrumentation 6, 1-12 (2011). Shortlisted for British Engineering Excellent Award, 2011 and exhibited at Photonics Europe 2012, Brussels. Design produced two patents – realisation of multiple resolution arrays, edgeless butting technology, etc. (GB2011/051300 and P300185GB). Led to formation of ISDI Ltd (2011) – spinout company, with substantial commercial current order book and 7 contracted CMOS designers, with plans for commercial 20 cm square devices (12” wafer) by 2013.

Additional Information:
Complete cameras working at University College London (Dept of Medical Physics and Engineering), University of Surrey (Centre for Vision, Speech and Signal Processing) and University of Lincoln (School of Computer Science). Individual sensors at University of Lincoln, aSpect GmbH, Dresden, and ISDI Ltd, Oxford. Articles reporting it are: 10.1088/1748-0221/6/12/C12064 and 10.1117/12.911541

Keywords: CMOS image sensors, bmjtype, bmjlink, Active area, Active Pixel Sensor, Breast biopsies, Breast cancer diagnosis, Breast tissues, CMOS APS, Digital detector, Digital x-ray detector, Intelligent imaging, Key characteristics, Large area sensors, Low noise, Medical imaging technology, Metal-oxide, Scientific applications, Specific materials, Wide dynamic range, X-ray diffraction measurements, X-ray diffraction studies, breast biopsy, large area image sensors, mammography, x-ray diffraction

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B Subjects allied to Medicine > B800 Medical Technology

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A 3-side butttable radiation-hard 8” wafer-scale CMOS image sensor for use in an X-ray mammography detector was developed. The comparatively low noise of the CMOS imager contributes to a higher DQE at lower X-ray dose. The negligible lag and high frame rate of the CMOS imager has an asymptotic time dependence of $t^{-1}$, even though the asymptotic time dependence of the average (deterministic) PD voltage is as slow as $\log t$. The flush reset method is effective because the hard reset part eliminates image lag, and the soft reset part reduces the noise to soft reset level. CMOS APSs can now be scaled up to the standard 20 cm diameter wafer size by means of a reticle stitching block process. Recently CMOS active pixels sensors (APSs) have become a valuable alternative to amorphous silicon and selenium flat panel imagers (FPiS) in bio-medical imaging applications. CMOS APSs can now be scaled up to the standard 20 cm diameter wafer size by means of a reticle stitching block process. However, despite wafer scale CMOS APS being monolithic, sources of non-uniformity of response and regional variations can persists representing a significant challenge for wafer scale sensor response.