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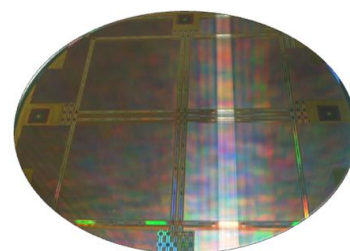
from software to silicon

EDA
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# Big Sensors for Big Business

## Innovation in large CMOS image sensors

Image sensors are big business, over $14B in 2017 according to Markets and Markets Inc. The sector is experiencing great growth led by intense pressure in consumer electronics and automotive. In the specialist X-ray domain, and specifically medical markets, there is a new kid on the block, vivaMOS a UK semiconductor start-up, quietly making big leaps in large CMOS sensors for flat panel detectors.

Their wafer-scale CMOS sensor offers a unique combination of high-speed, high-resolution, and low-noise performance. Optical lenses are not used with X-rays, so a CMOS image sensor must match the size of the target area. Extra-oral imaging, used in dentistry, can use a sensor as small as about 140x120mm. Mammography, on the other hand, needs a much larger sensor, typically 280x240mm. Surgical applications require a range of sizes including magnification modes to zoom into the area of interest while maintaining image quality.
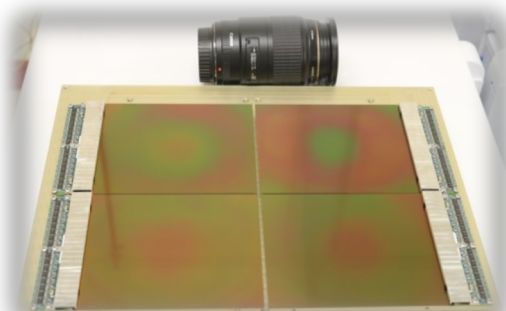
Improving success rates for patients both in diagnostic and surgical outcomes is one of the end goals. And this is achieved through some quite phenomenal advances in CMOS image sensor and supporting analogue ASIC design.



*Large-scale image sensors
(4 die on an 8" wafer)*

## Exacting design creates a superior sensor

vivaMOS's Lassena sensor has a pixel resolution of 50μm, about a quarter of the pixel pitch for incumbent technologies, and a high overall resolution of 6.7Mpixels (2400x2800). The raw device measures 120x140mm and is manufactured using a high yield speciality CMOS process technology in a world-leading image sensor foundry.



*2x2 array of Lassena sensors
(24x28cm active area). Camera lens shown for scale
[Image courtesy of STFC-RAL with support from STFC-CLASP funding]*

Exacting design means the sensors are buttable on 3 sides, which enables multiple sensors to be tiled in any 2xN format, creating larger Flat Panel Detectors. The device can support a wide range of X-ray applications and is ideal for medical equipment in the fields of surgery, cone-beam computed tomography (CBCT), and mammography. These detectors are used to generate 3D representations of patients or scanned objects.

Key features include a low noise readout; HDR mode with 30fps dynamic imaging; external triggering for the optimal image capture point.

The sensor and associated analog mixed signal circuitry were designed with Mentor's Tanner Analog/Mixed-Signal IC solution.

## Experience, knowledge and dedication

Every design has challenges as the needle is pushed hard over. Starting with just 2 semiconductor design engineers in 2016, the team has grown in strength & depth to cover all areas (R&D & operations) of a typical fabless design house.



*Dan Cathie (CEO) and Paul Curtis (Operations Director) accepting
TechWorks 2017 award 'Emerging Technology Company of the Year'*

THE CHALLENGES WE FACED FOR THE DESIGN OF WAFER-SCALE IMAGE SENSORS REQUIRED A RETHINKING OF THE METHODS PREVIOUSLY USED AND DEVELOPED FOR TRADITIONAL SEMICONDUCTOR ASIC DESIGN.

GOOD PIXEL DESIGN KNOW-HOW WITH EXPERTISE IN ANALOGUE MIXED-SIGNAL AND RADIATION-HARD DESIGNS WAS THE FOUNDATION ON WHICH THE SENSOR WAS DEVELOPED. HOWEVER, THE KEY TO SUCCESSFUL X-RAY DETECTORS IS IN THE ABILITY TO BUILD IN SUFFICIENT REDUNDANCY TO ENSURE GOOD WAFER YIELDS WHILE MAINTAINING LEADING IMAGING PERFORMANCE.

SELECTING EDA SOLUTIONS AS OUR PARTNER FOR OUR SENSOR DEVELOPMENT WORK HAS PROVIDED US WITH THE FLEXIBILITY FOR THE TOOLS WE REQUIRE WITH EXCELLENT ONGOING SUPPORT FOR OUR APPLICATION-SPECIFIC DEMANDS

*- DAN CATHIE, CEO*

## Accuracy, performance and complexity

Start-ups are formed to innovate with a novel approach. In the semiconductor world that also means solving a set of very tricky, complex challenges. And when the domain involves analog and mixed signal it also calls on powerful simulation. In this sense, commercialising the vivaMOS design hits all these criteria. Their sensor and accompanying mixed signal circuitry had its specific challenges.

1. The design of a very complex, highly specified IP block in the form of a radiation-hard, low-noise, high-speed image sensor pixel
2. Ability to manually edit the layout of the physical device for complete control, tailoring the design not only for performance but also for yield
3. Rendering large arrays efficiently
4. Exhaustive simulation of the *single* pixel characteristics and performance; including extraction and estimation of ultra-low-level capacitances (fF)
5. Subsequent, exhaustive simulation of the wafer-scale *full pixel array* by extracting results from lines of pixels and combinations of pixels side by side (inclusive of the back annotated parasitics) for further optimisation
6. Physical verification (DRC / LVS) of the array using foundry rules, supported through close working relationships between the vivaMOS design team, EDA Solutions, and the foundry process experts

vivaMOS set out to do something no one else had done before. And although it is early in vivaMOS's life, their design is compelling, and the company is very proud of the accolade presented by the UK's TechWorks semiconductor association for Emerging Technology Company of the Year, 2017, and have been shortlisted for the 'Best Up and Coming Company' award at Image Sensors Europe, 2018.

vivaMOS Ltd is a UK semiconductor company which designs and manufactures large flat panel X-ray detectors. Their wafer-scale CMOS sensor offers a unique combination of high-speed, high-resolution, and low-noise performance. These sensors are buttable on 3 sides, enabling production of large Flat Panel Detectors for a wide range of X-ray applications including medical equipment in the fields of surgery, cone beam computed tomography (CBCT), and mammography.

The company was founded in 2015 as a spin-out of Rutherford Appleton Laboratory, part of the UK's Science and Technology Facilities Council and is now based on the Southampton Science Park.

For more information contact info@vivamos.co.uk

Mentor's Tanner IC Design Flow was created to design analogue and mixed-signal ICs on mainstream process nodes. Just like the solutions intended for leading-edge nodes with the smallest geometries, Tanner needs to be full featured for the job in hand; efficient to use, accurate and fast for simulations.

Where Tanner diverges from solutions for the leading-edge nodes is in its ability to service requirements such as all-angle structures, high-voltage and RF. The solution excels in going broader to match design requirements for in a wider band of applications including image sensors, MEMS and photonics.

Tanner EDA fits a large niche in the industry where it is a critical component; enabling design with the highest level of sophistication for a comprehensive selection of More-than-Moore foundry process nodes.

For more information visit www.mentor.com

EDA Solutions are the European IC design tools business partner for Mentor, a Siemens business. The business provides expert sales and technical support to designers of analog and mixed signal, photonics ICs and MEMS devices.