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Towards wafer-scale monolithic CMOS integrated pixel detectors for X-ray photon counting

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A new semiconductor process is being developed for manufacturing monolithic CMOS pixel detectors. The technology is based on direct bonding of 200 mm CMOS wafers to an absorber in a low-temperature, oxide-free, covalent wafer bonding process. It is applicable to any material such as Si, GaAs and epitaxial SiGe. The latter are realized by means of space-filling arrays of SiGe crystals which can be grown up to at least 100 µm by a plasma-enhanced chemical vapor deposition process on patterned Si substrates. The absorber enables ~ 100% detector fill factor, direct conversion of X-rays, and charge collection at the CMOS readout pixels.
To demonstrate the technology, a chip was designed in 150 nm CMOS process featuring 240 x 300 pixels of 100 µm pitch. Each analog pixel has a charge sensitive amplifier, leakage current compensation and a shaper. On the digital side, two threshold-programmable discriminators feed the output to 12-bit asynchronous counters. The counters can work in parallel, or in cascade-mode by using the second counter as register for simultaneous acquisition/ reading. A data acquisition system was developed to readout the front-end board hosting the CMOS chip. The board integrates an FPGA for hardware control and software processing, it handles the image acquisition protocols and assembles data frames to a computer.
In this conference, we shall discuss the first experimental tests and X-ray characterization measurements obtained on the novel kind of detector.

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