PixFEL: high resolution, fast, multi-tier detectors for diffraction imaging at next generation X-ray FELs

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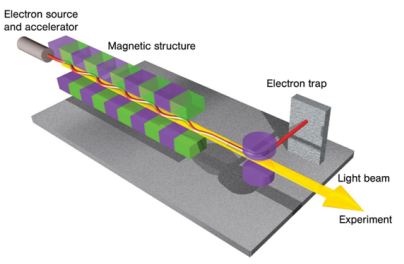
Introduction

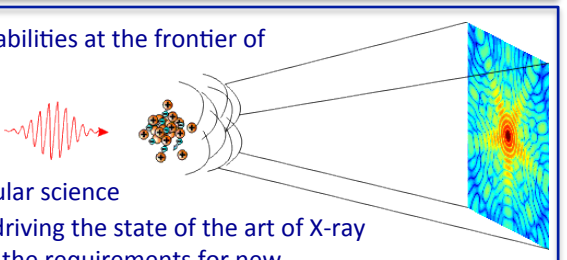
FELs provide high intensity beam of ultrafast X-rays

- energy range: 100 eV to >10 keV (λ from 10 nm to 0.1 nm)
- pulse duration: femtoseconds to picoseconds
- repetition rate: 10 Hz (continuous mode) to 5 MHz (burst mode)
- peak brightness may exceed 10^{33} ph s^{-1} mm^{-2} $mrad^{-1}$



Novel experimental capabilities at the frontier of science

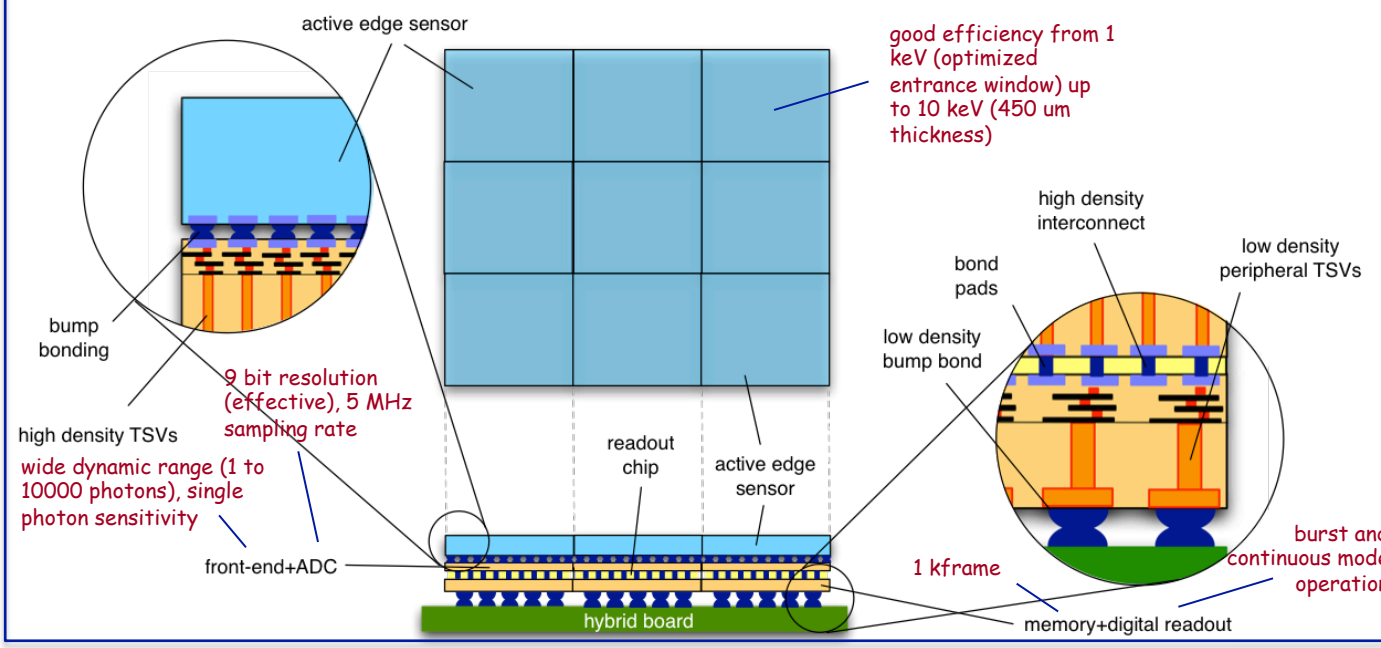
- structural biology
- chemistry
- material science
- atomic and molecular science



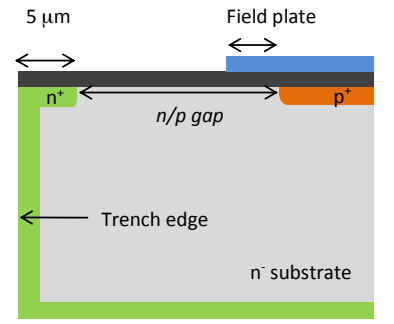
These new sources are driving the state of the art of X-ray science and are shaping the requirements for new instrumentation

PixFEL: advanced instrumentation for X-ray diffraction imaging

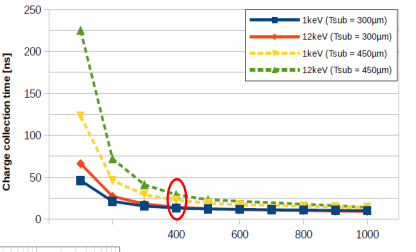
Advanced interconnection technologies for high density integration



Slim/active edge sensors for minimum dead area

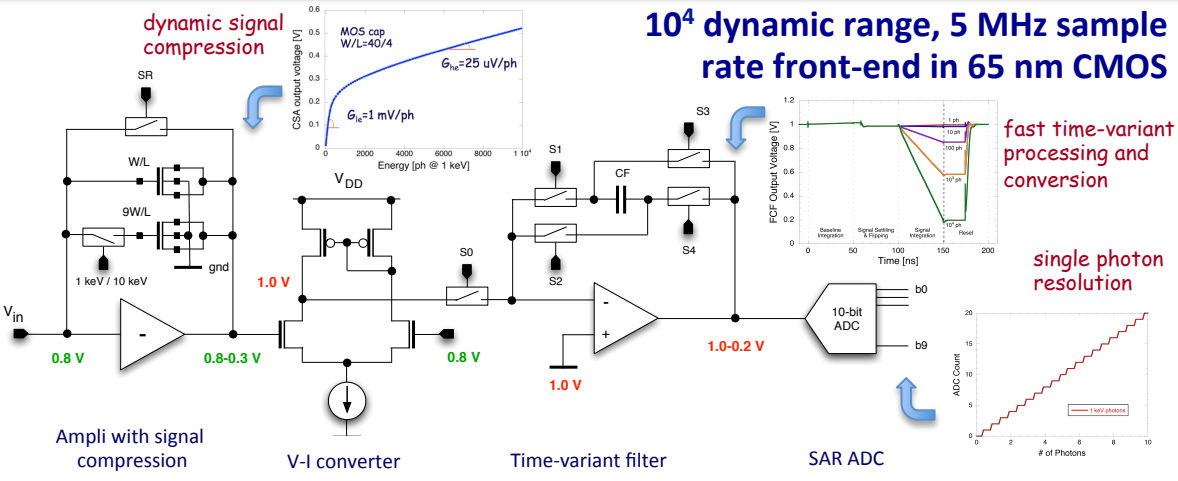


minimize the gap between the sensor and the edge while avoiding leakage



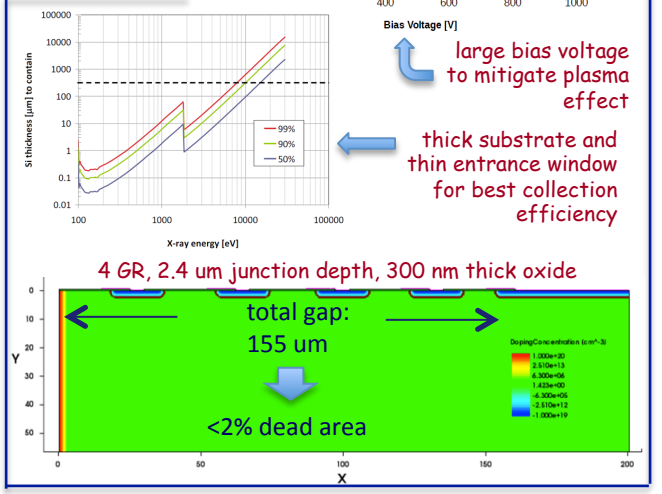
10^4 dynamic range, 5 MHz sample rate front-end in 65 nm CMOS

dynamic signal compression



fast time-variant processing and conversion

single photon resolution



Potential impact

The PixFEL project will tackle the growing need for new and advanced instrumentation able to take advantage of the outstanding features of FELs at different levels

- the availability of state-of-the art instrumentation will facilitate progress in strategic fields of life science and materials science and, ultimately, in key sectors like health care, green transportation and quality of life enhancement
- because of the aggressive specifications of the developed sensors, the knowledge gained through this project will also benefit other fields of radiation instrumentation, where fast, minimum dead area, intelligent pixel sensors are needed, such as particle trackers in high energy physics experiments, beam monitors for hadrontherapy, devices for medical radio-diagnostic systems
- the program is expected to spawn significant advancements in microelectronic circuit design for imaging sensors - this will be achieved also by means of the application of state-of-the art interconnection processes and pixel sensor fabrication technologies to scientific instrumentation