

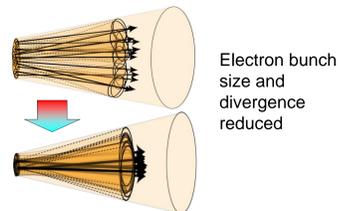
# Development of the CoRDIA pixel detector ASIC for high-speed X-ray experiments.



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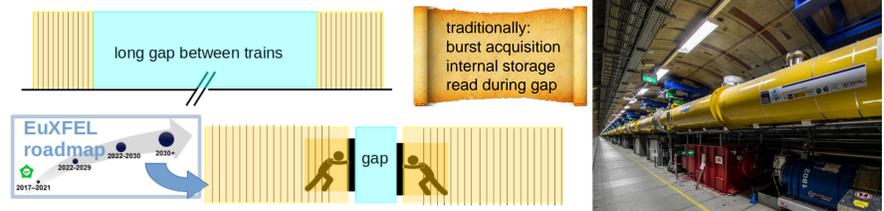
## New X-ray sources demand fast, high-dynamic range pixel detectors

### Synchrotrons being upgraded to the diffraction-limit



X 100 ~ 1000 increase in brilliance and high coherence  
Enables time-resolved experiments and rapid raster scanning to study large 3D samples on all length scales down to atoms

### EuXFEL considering switch to "long-train" operation



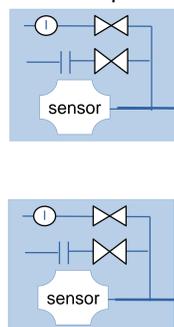
Experiments continuously receive FEL pulses at 100 kHz – 1 MHz rate  
Enables higher throughput of experiments and simplifies sample delivery

### CoRDIA ASIC design targets:

- 150 kHz continuous frame rate
- 110 μm pixel pitch
- Compatible with high-Z sensors for hard X-rays
- Large, TSV-compatible ASIC for multi-megapixel systems
- Single-photon sensitive @12 keV (and below)
- A-few-k photons/pix/img signal range (~5e8 ph/pix/s)
- HDR function to increase effective range to ~5e9 ph/pix/s

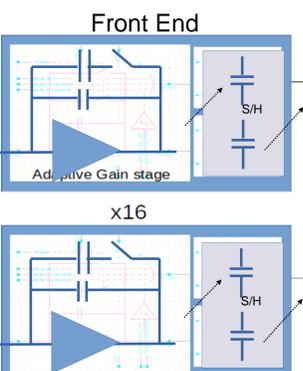
## ASIC design (TSMC 65nm)

### Calibration circuits + sensor input



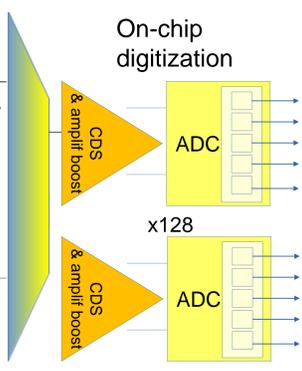
### Sensor options:

N-on-p Si  
High-Z, e.g. CZT, CdTe, GaAs  
LGAD



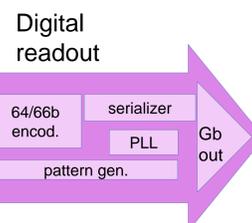
Adaptive Gain switching amplifier (like AGIPD)  
Electron-collecting polarity

Design and test at:  
>150 kframe/s



On-chip ADCs  
11b SAR

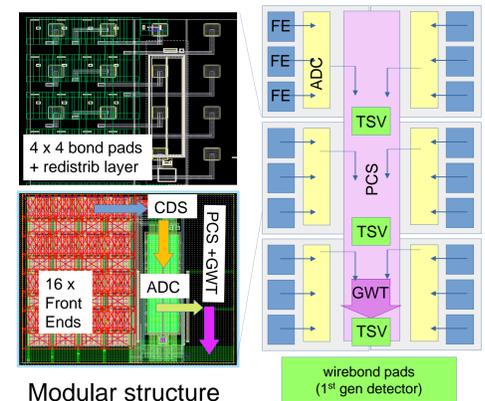
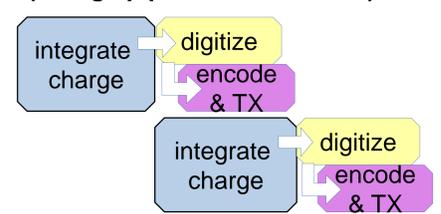
16 FEs → 1 ADC :  
≥2.4MS/s  
design, test @ 2.5MS/s  
 $\frac{2.5 \text{ MS/s}}{16 \text{ FE}} > 150 \text{ kframe/s}$



(PCS + ) Gigabit Wire Transmitter from NIKHEF for Timepix4

2k pixels, 12~16b, 64/66b encoding  
PCS-GWT @ 5.12Gb/s  
 $\frac{5.12 \text{ Gb/s}}{12-16b * 2k \text{ pixels} * 66/64} > 150 \text{ kframe/s}$

### Continuous Write-Read scheme (2-stage pipeline architecture)

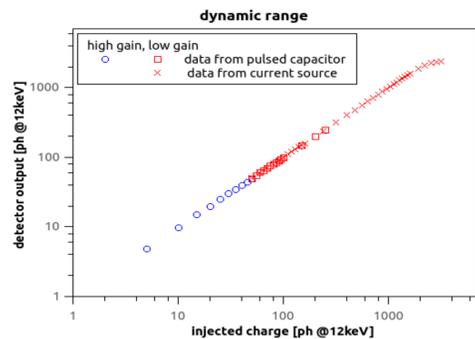


## Testing key building blocks with MPWs

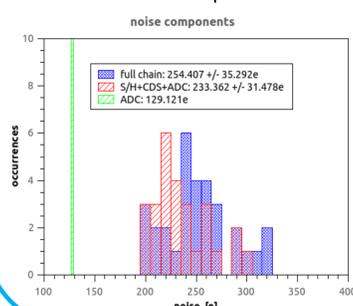
### Functionality of 16-pixel array with ADCs confirmed



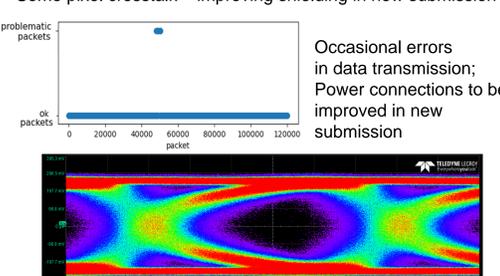
### 2-stage gain switching tested



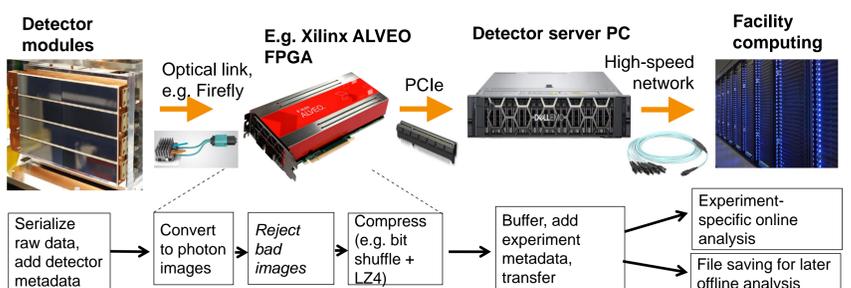
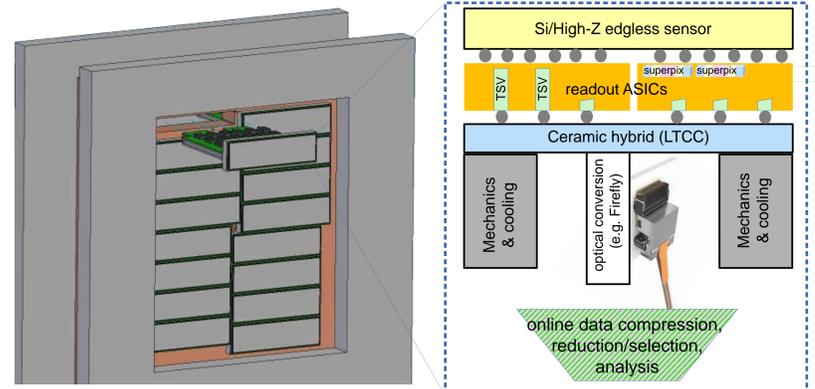
### Noise of amplifier + ADC within specs



### Some pixel crosstalk – improving shielding in new submission



## System design concept



Thanks to Vladimir Gromov at NIKHEF for providing the GWT block used in Timepix4