Simultaneous photon/particle counting and charge integration

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Purpose:

Particle or photon counting pixels have a count rate limitation

→ Cannot distinguish close spaced hits

→ Will saturate at high count rates or even

→ paralyse at high count rates

How to recover information in such cases?

→ Readout also the "old fashioned" integrated charge

→ PRO: not hits lost, no paralysis

→ CON: quantum limited noise is lost, individual particle information is lost (time, charge)

Applications:

• X-ray imaging, particle imaging

• Spectroscopy in the presence of lines with highly different fluxes

• Electron microscopy

• Visible light imaging with SPADs

"3T" integrating pixel

Pulse shaper pixel

Combination pixel

Prototype single pixel [1]

XFAB XS018 technology

Single pinned photodiode 20*100µm

Contains both Pulse Shaper and Charge Integrator

Analog readout of the Integrator

Binary readout of the comparator (real time or latched)

Integration capacitor = 1pF
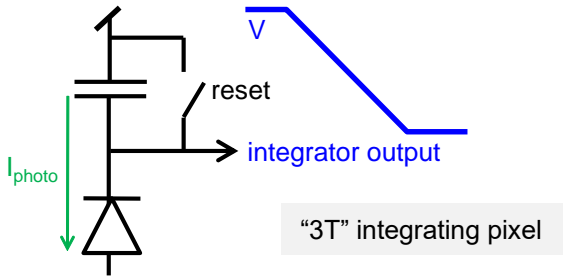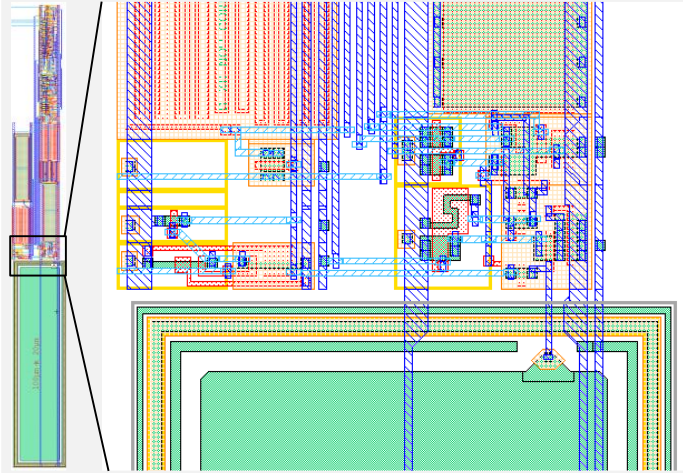
Measured using LED pulses

Minimum charge packet for reliable detection ≈ 350e-

Max count rate >100kHz (electronic channel limited)

Oscilloscope trace

Analog integrator output

Binary comparator output
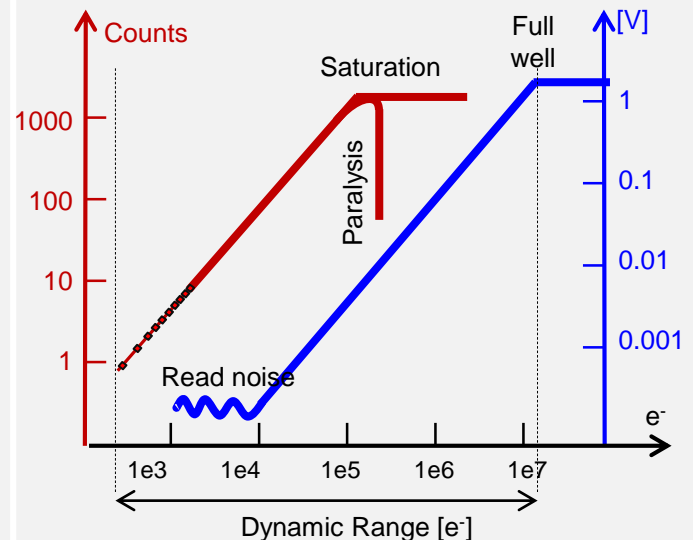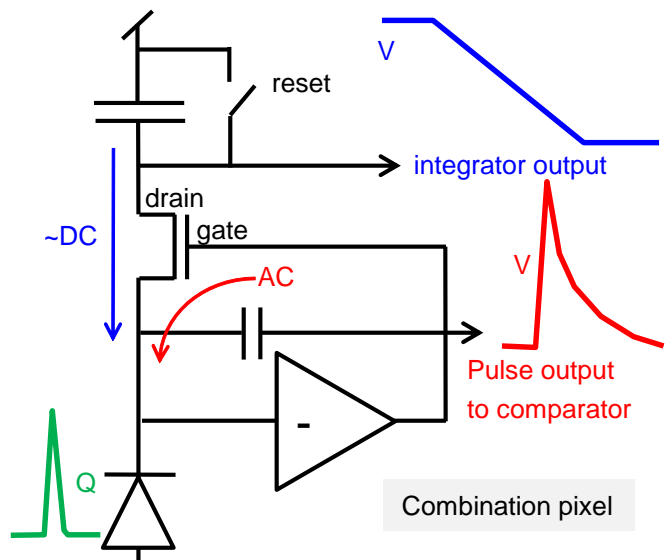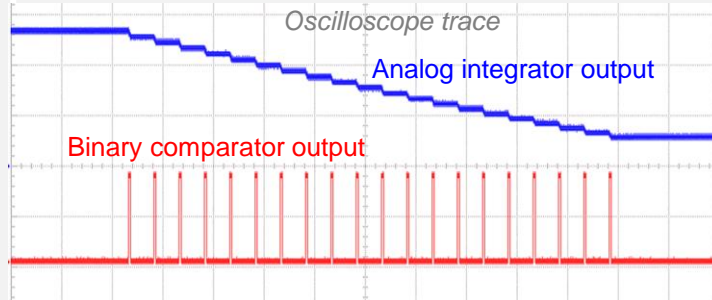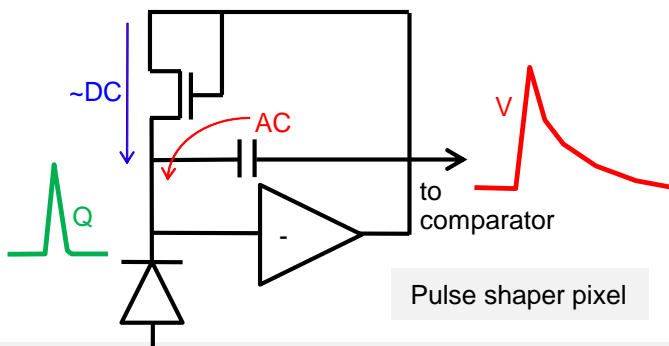
[1] P.Gao & al, "Indirect X-ray Pixel with High Dynamic Range by using combined counting & integration", CNES workshop, Toulouse 17 Nov. 2016