

Application of ASICs in Astroparticle- and Particle Physics

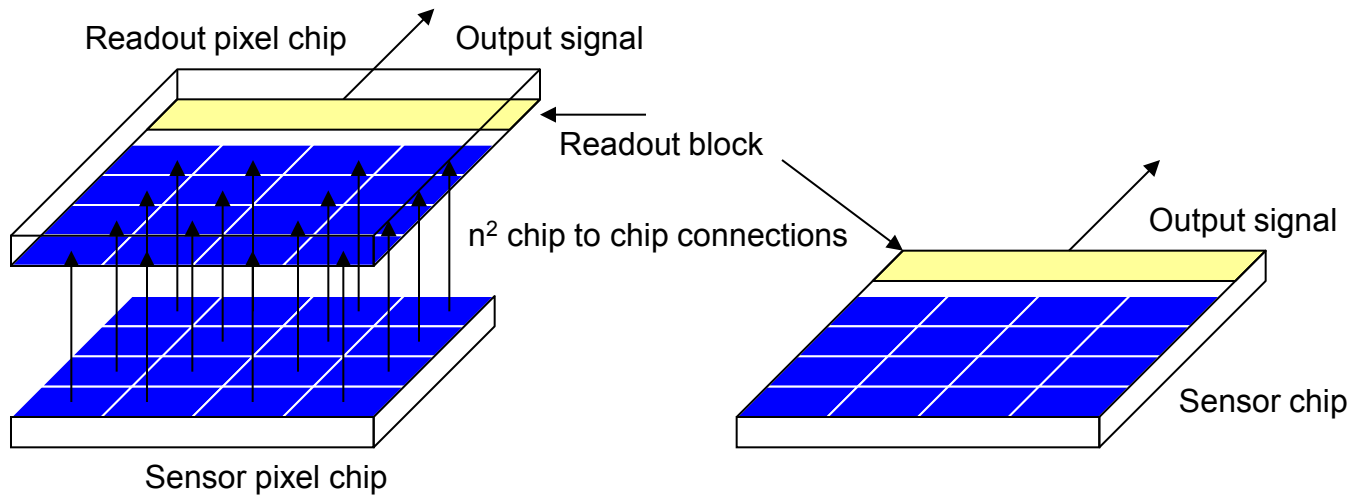
Ivan Peric

...

- ASICs and detector technology
- Readout ASICs for particle- and gamma sensors
- Monolithic (active) sensors
- Monolithic SiPMs
- SiPM readout chips

Monolithic- and hybrid sensors

• ...

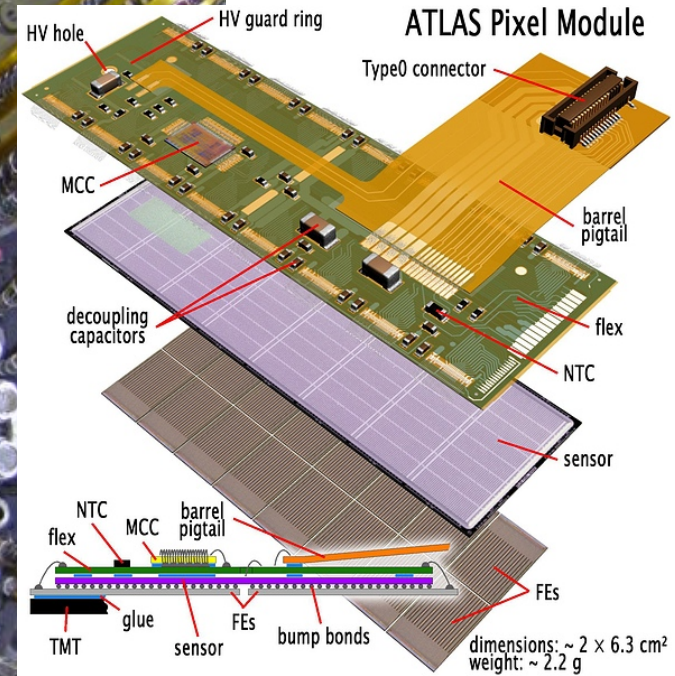
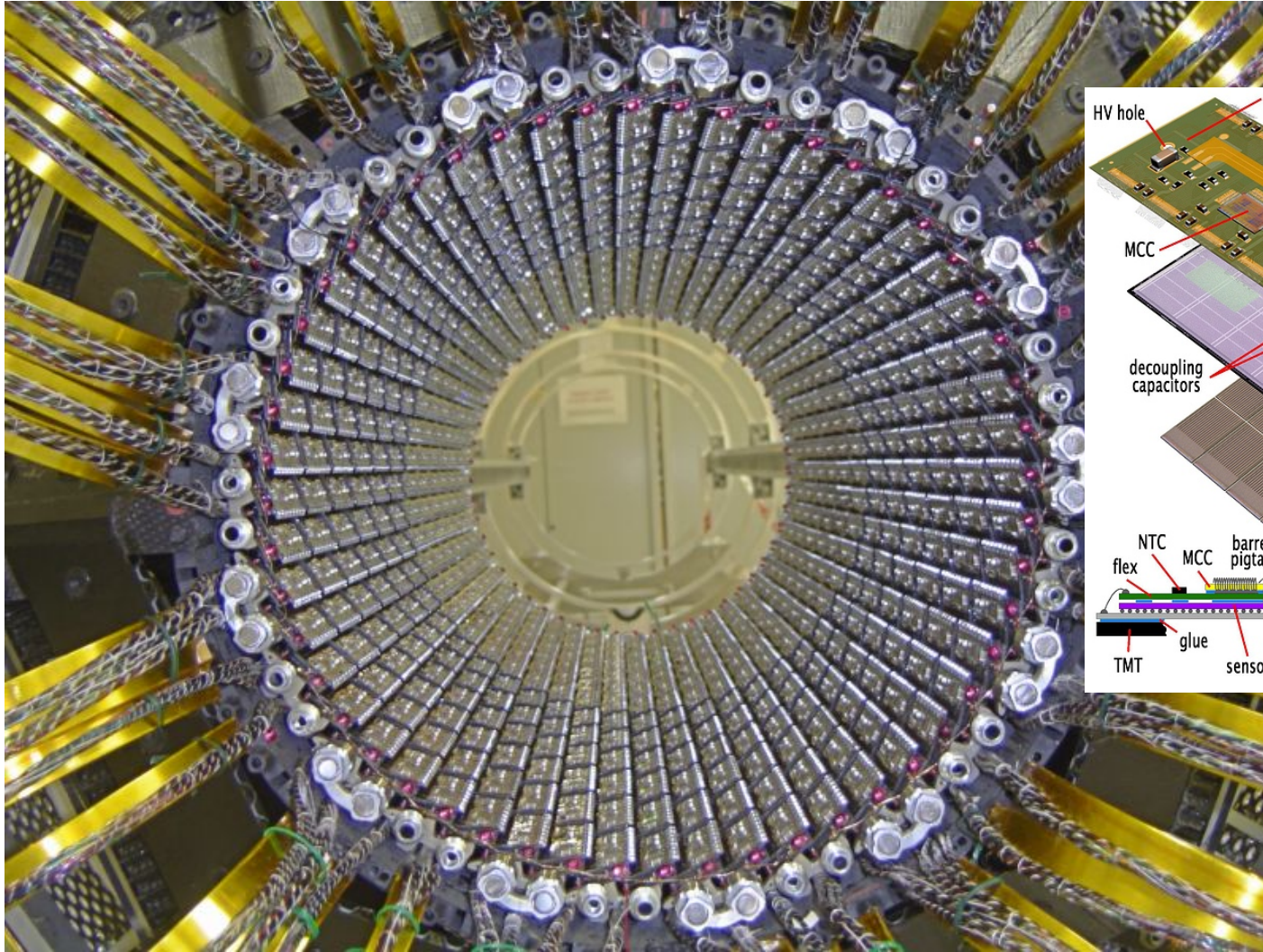


Hybrid detector

Monolithic detector

Hybrid detectors for HEP

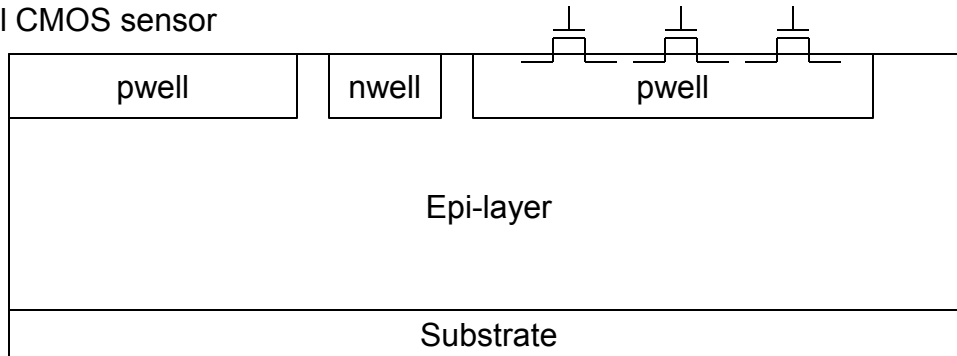
- ATLAS pixel detector



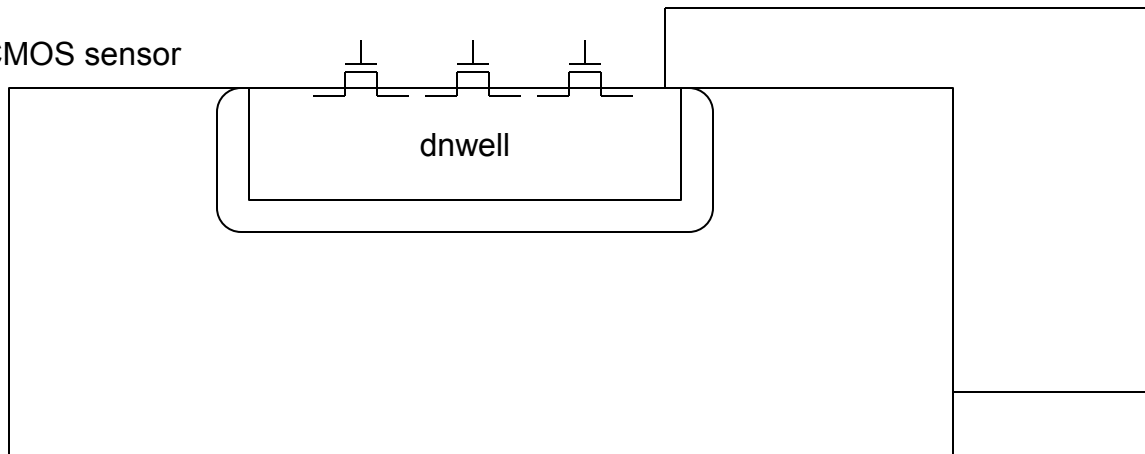
Monolithic sensors for HEP: HVCMOS sensors

- HVCMOS

Normal CMOS sensor



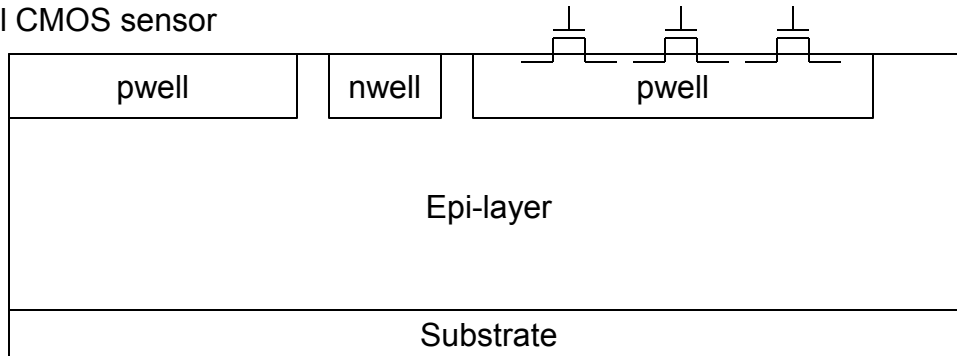
HVCMOS sensor



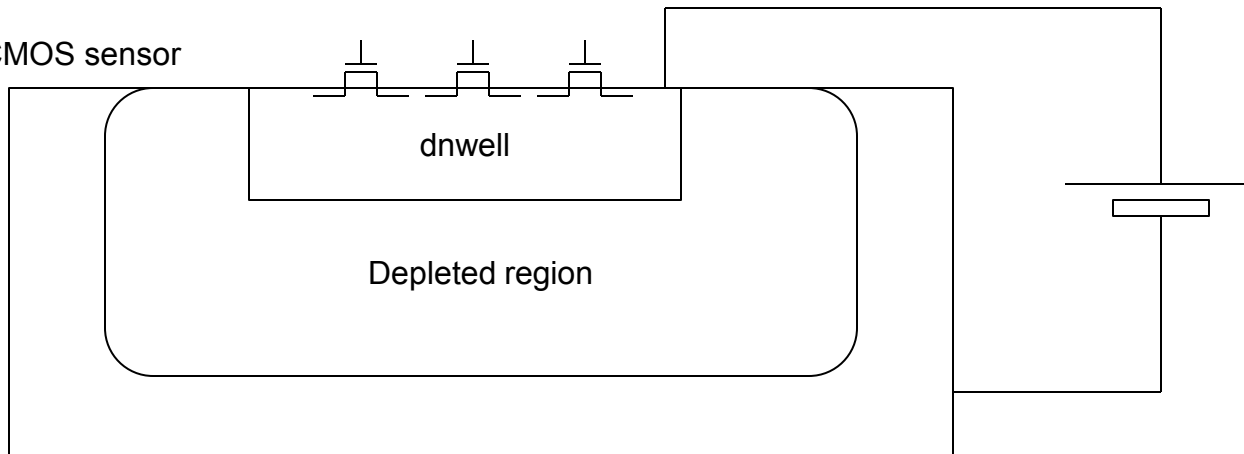
HVCMOS sensors

- HVCMOS

Normal CMOS sensor

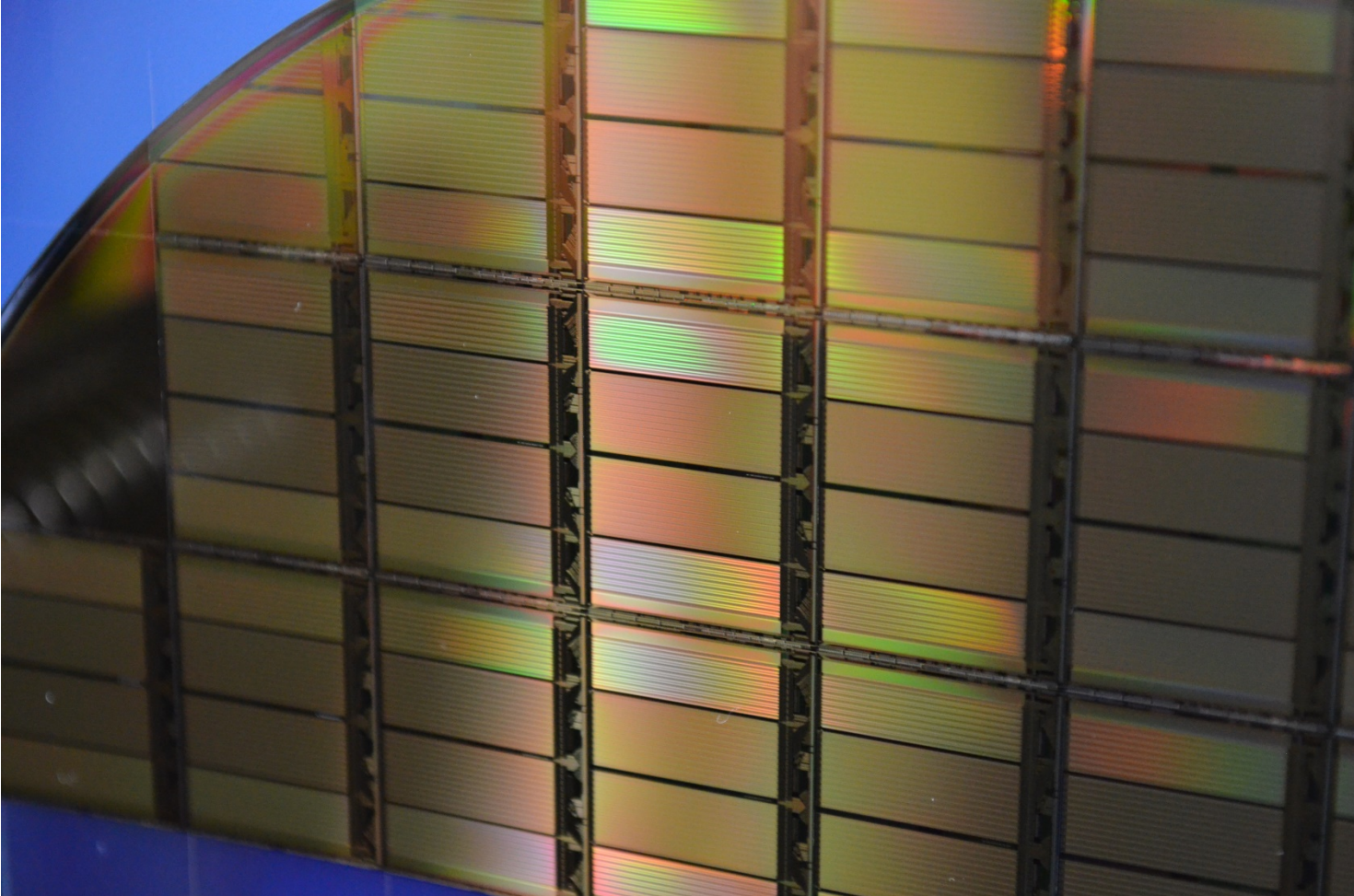


HVCMOS sensor



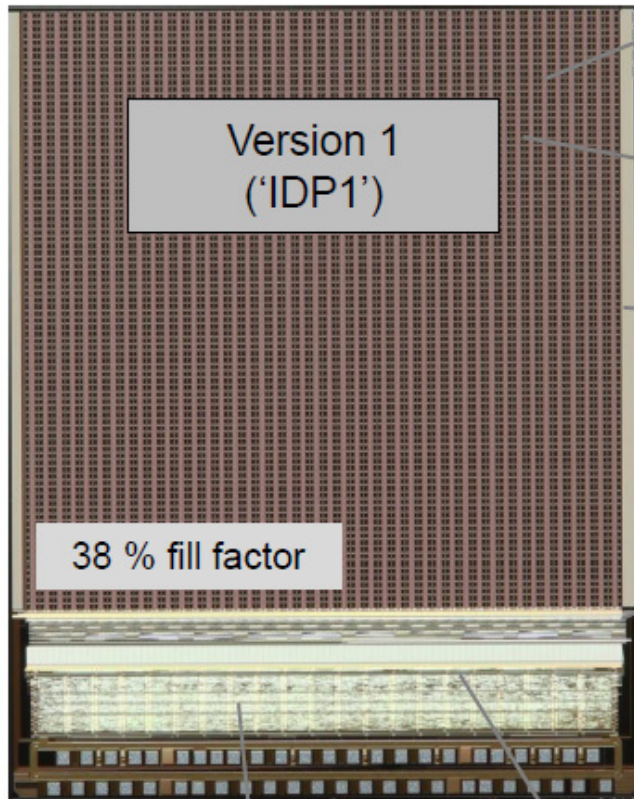
HVCMOS sensors

- High time resolution
- Large area (low cost)
- Radiation tolerant





Chip Photographs



Version 1
(‘IDP1’)

38 % fill factor

Synthesized, fully
autonomous readout

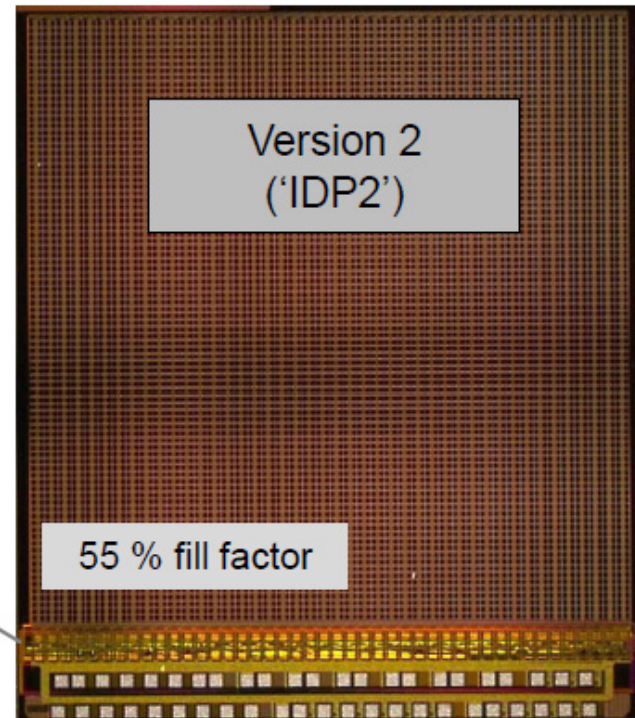
Periphery
~ 1.5 mm

88 × 88 Pixel
56.44 × 56.44 μm^2

Pixel Area
~ 5 × 5 mm^2

3 side buttable

Hit-OR, Multiplicity



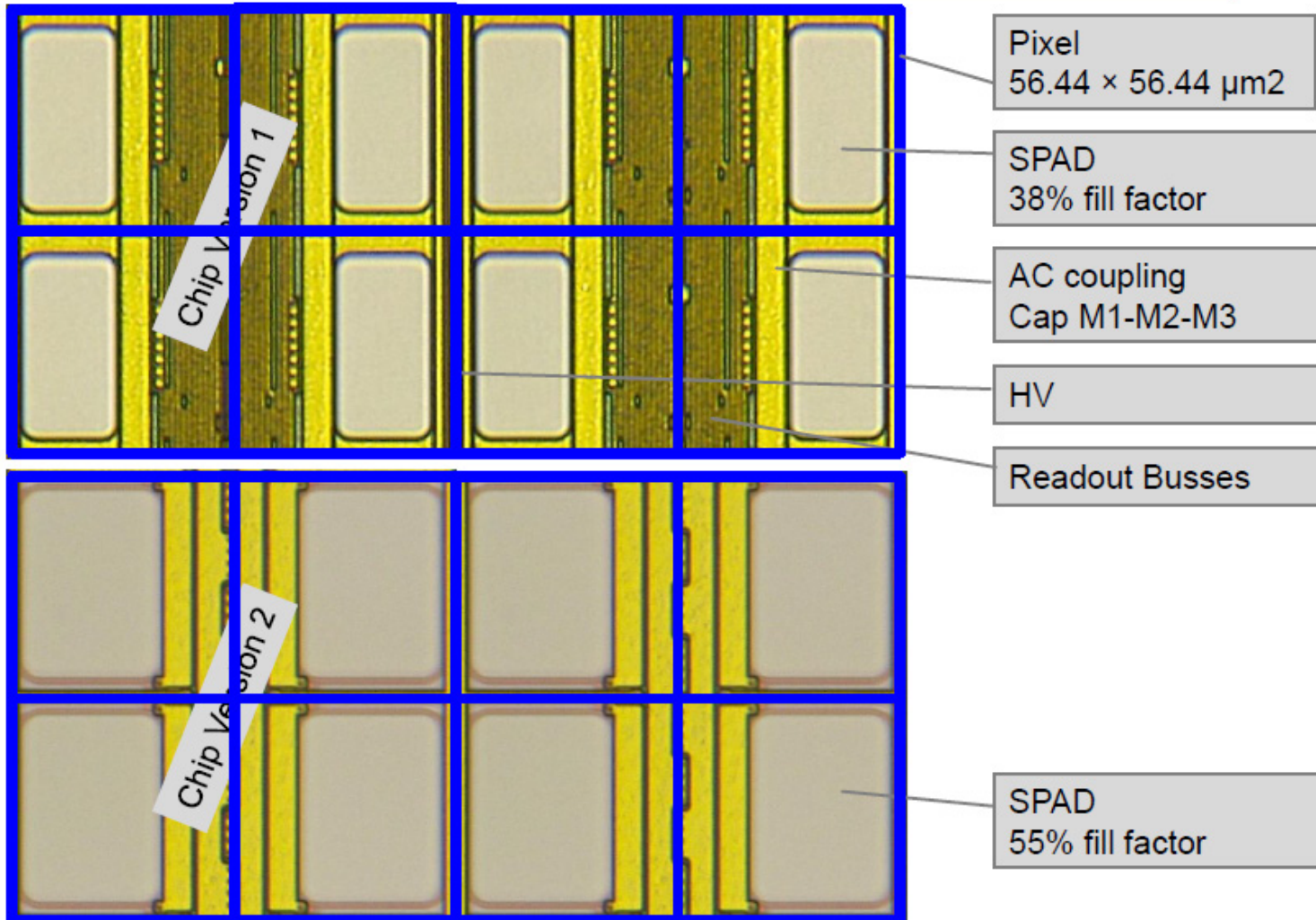
Version 2
(‘IDP2’)

55 % fill factor

Technology (FHG IMS):
- 0.35 μm CMOS+SPAD
- 4 metal levels



Chip Photo: Pixel Array





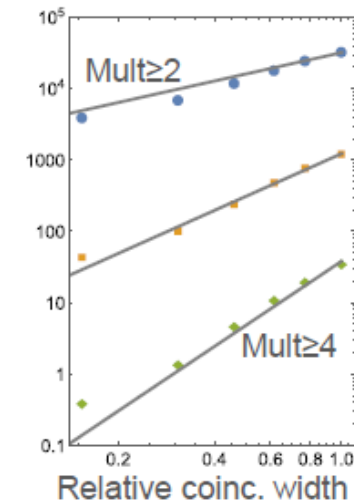
Multiplicity Rates (IDP1, one chip tested...)

- Chip generates a *true* multiplicity of ColumnOR signals (i.e. groups of 88)
- Rates depend *strongly* on Coincidence *time window* (set by pixel monoflop)

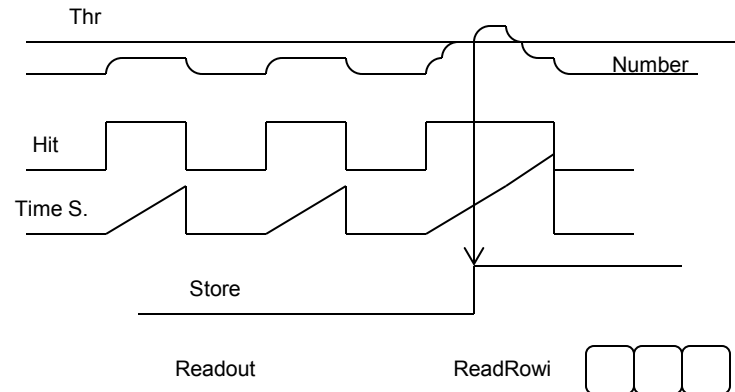
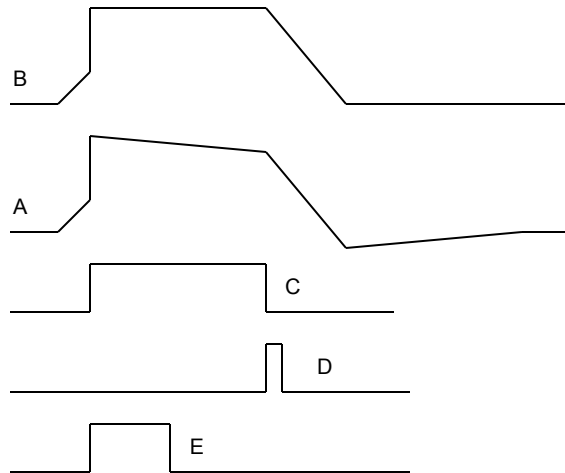
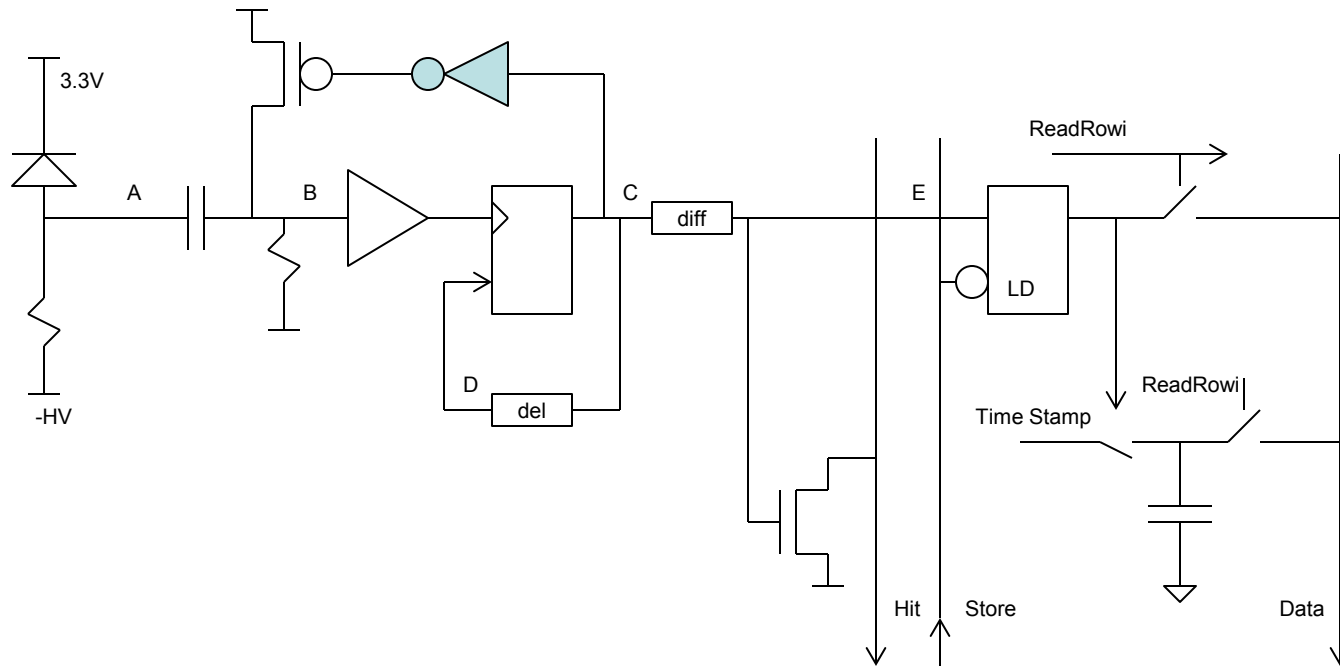
Multiplicity Output	Coinc. ~20ns	Coinc. ~40ns	Coinc. ~60ns	Coinc. ~80ns	Coinc. ~100ns	Coinc. ~130ns
≥ 1	217882	324620	451114	528760	591078	652704
≥ 2	4075	7192	12370	18721	25583	34005
≥ 3	43	99.9	238	479	767	1203
≥ 4	0.4	1.4	4.8	11.2	20.1	36

Rates in Hz, T~30°C, OV = 4.0 V

- **No** pixels killed in this measurement
- Can reach very low noise trigger rates of ~Hz!
- Measurement agrees quite well with theory
- Issue: dispersion in coincidence times (improved in IDP2)

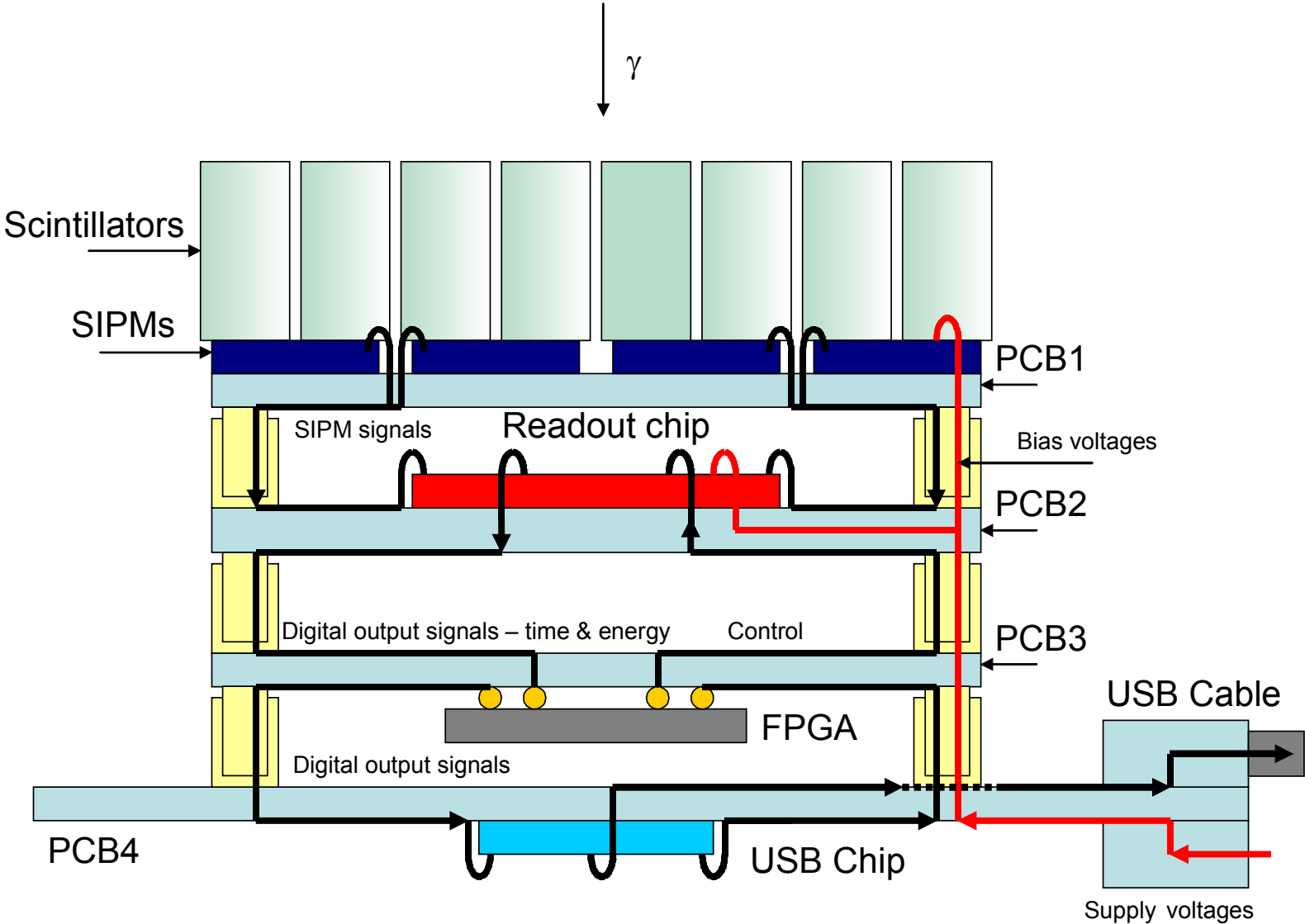


CMOS SiPMs

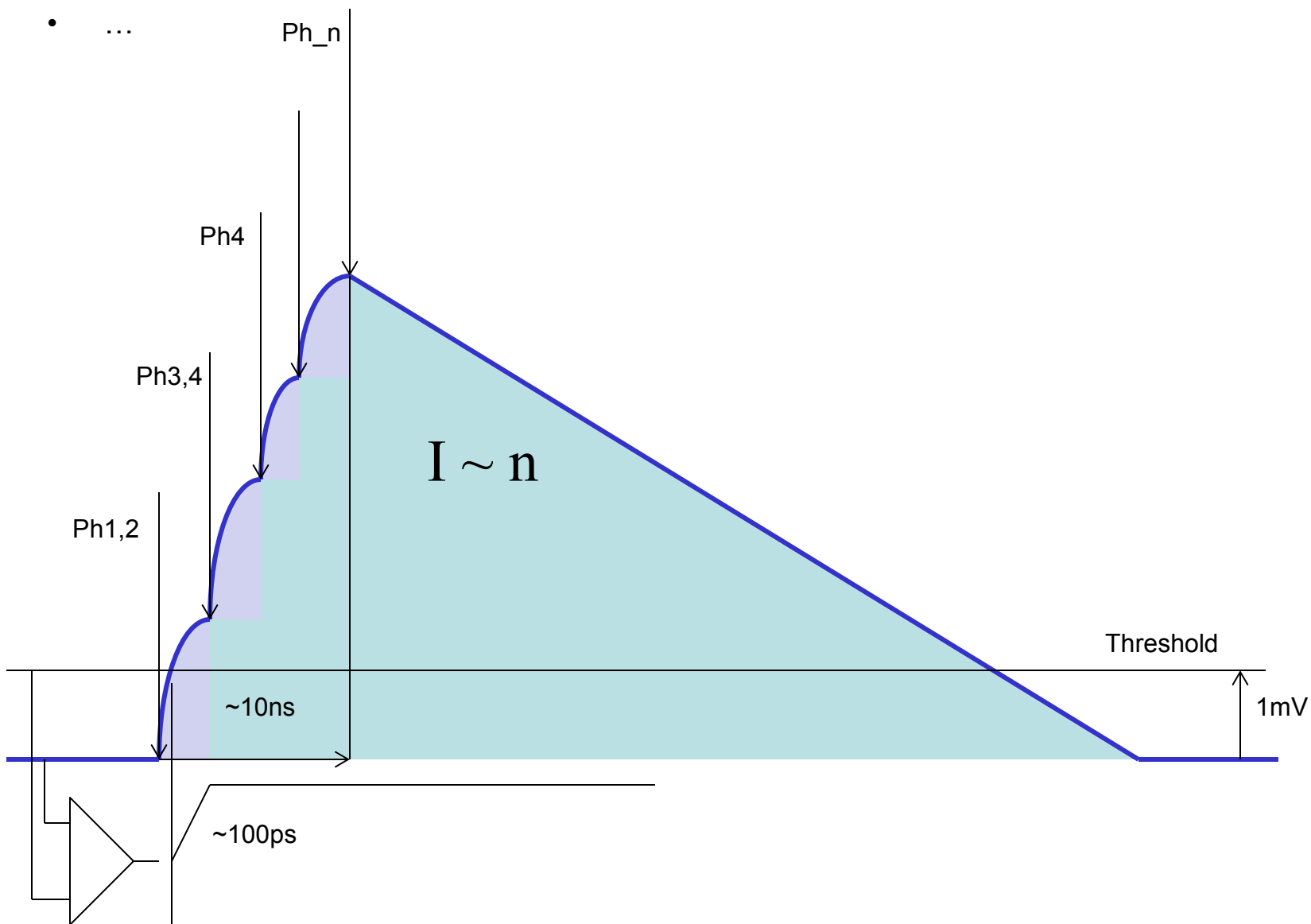


Hybrid SiPM system

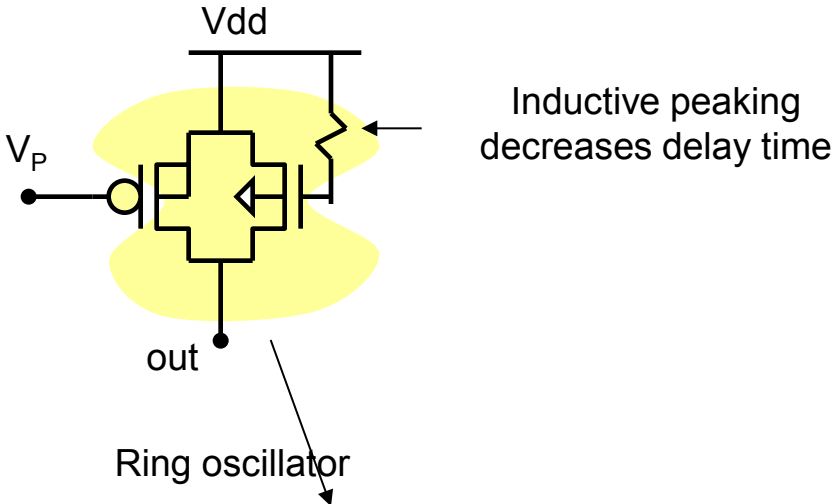
- PET/MR



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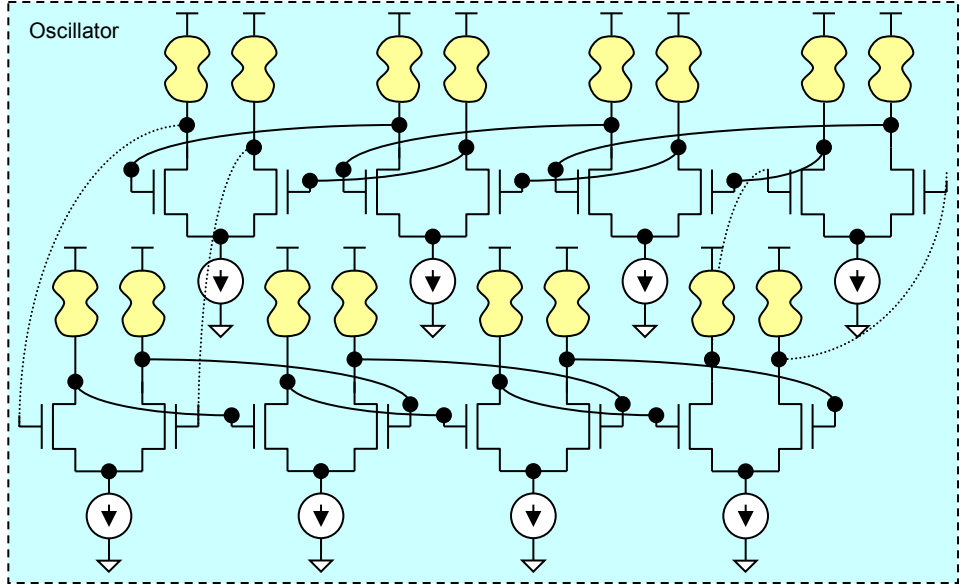
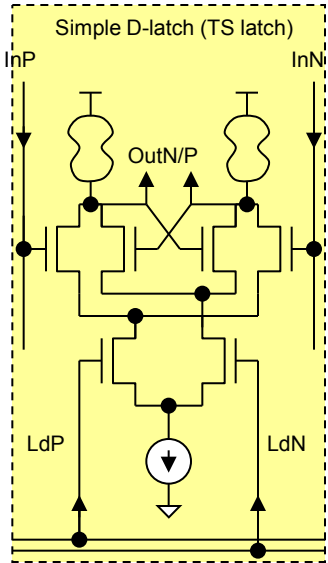
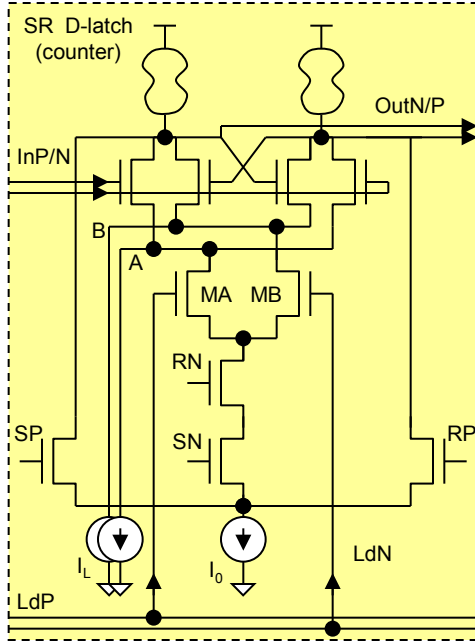
Current mode logic circuits



D-latch for the counter

D-latch for time stamp memory
Optimized for speed

Ring oscillator



Fast comparator

