HV-CMOS active sensor design for CLICpix v2

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HVCMOS CCPD

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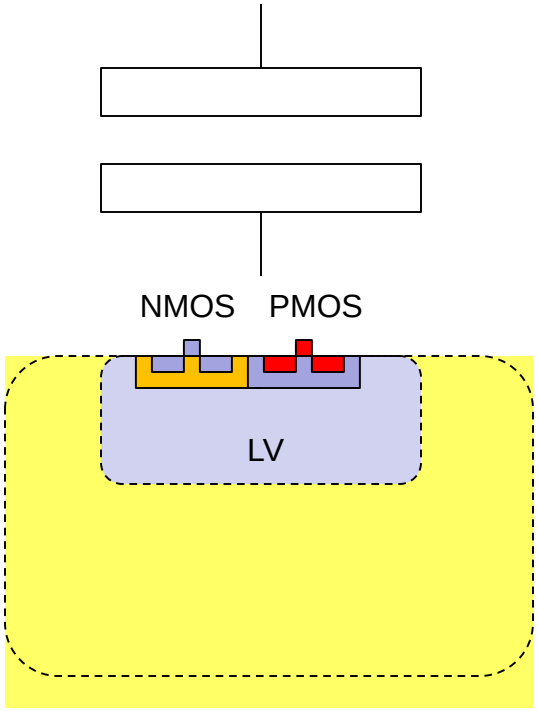
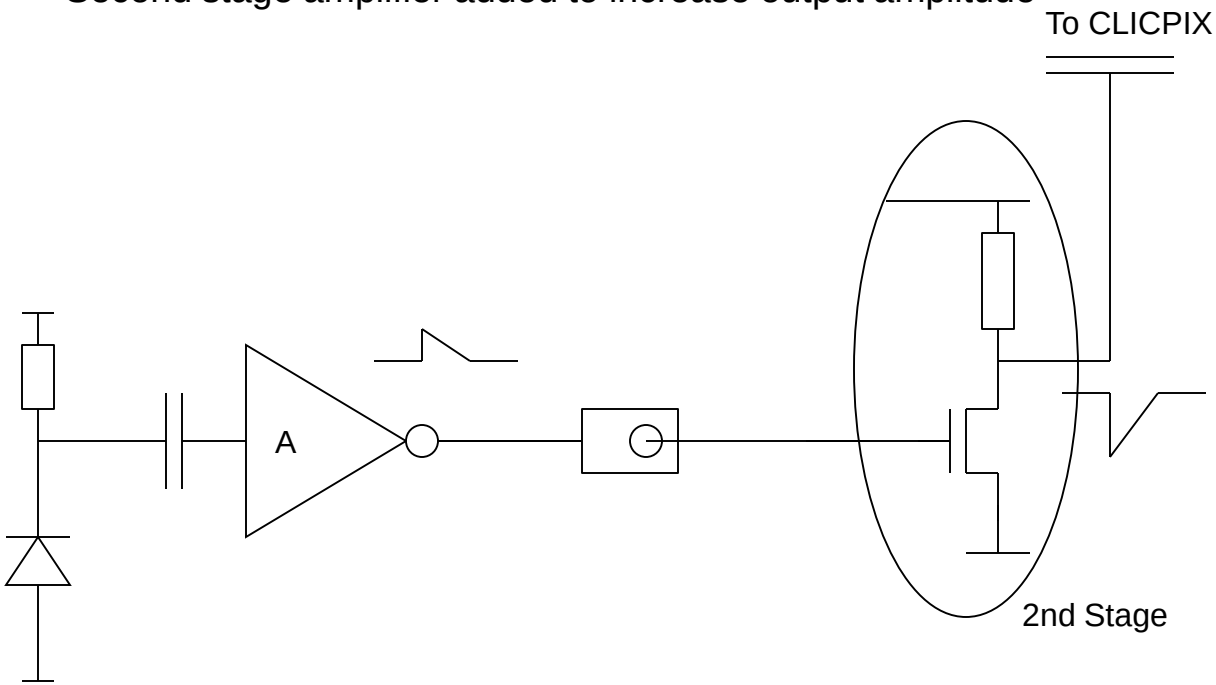


Plans

- AMS H18 on high resistive substrate run ~November 2015
- Substrate resistivities 20 Ohm – 1k Ω cm
- Depleted zone thicknesses: 15/30µm (20/80Ω cm), 50µm (200Ω cm), 100µm (1kΩ cm)
- Improvements – added source follower for better timing and less power consumption
- Segmented pixels (16.6 µm)
- Run shared within ATLAS, Mu3e and CLIC
- CLIC area ~ 5cm x 5cm
- Cost of the whole run ~ 160k for two substrate types
- Intended power CLIC power per pixel ~1-2µW – peaking time 20ns (capacitance 20fF) 160-320mW
- Pixel size 25 µm x 25 µm
- Probably possible 16.6 µm
- Present scheme ~10µA for 200fF (50 x 250) – peaking time 20ns
- Runs in several other technologies planned – e.g. Lfoundry and ESPROS
- Possibility to implement tests structures
- Possible synergy with ATLAS – CCPD pixels for new RD53 chip will be 25µm x 25µm

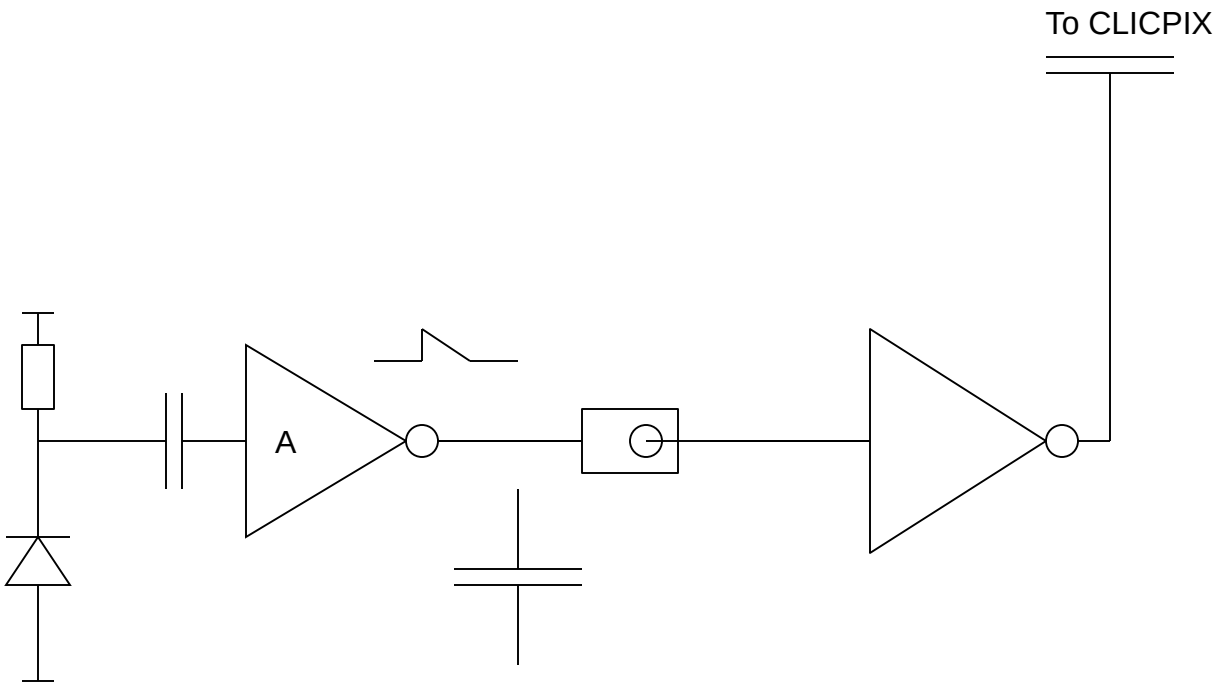
CLIC Pixel

- CLIC Pixel
- Size: 25µm x 25µm
- Analog signal is transferred to CLICPIX readout chip, no discriminator in pixel
- Simple and small pixels, small capacitance, smaller noise
- Spatial resolution can be improved and time-walk can be corrected by measuring of signal amplitudes
- Second stage amplifier added to increase output amplitude



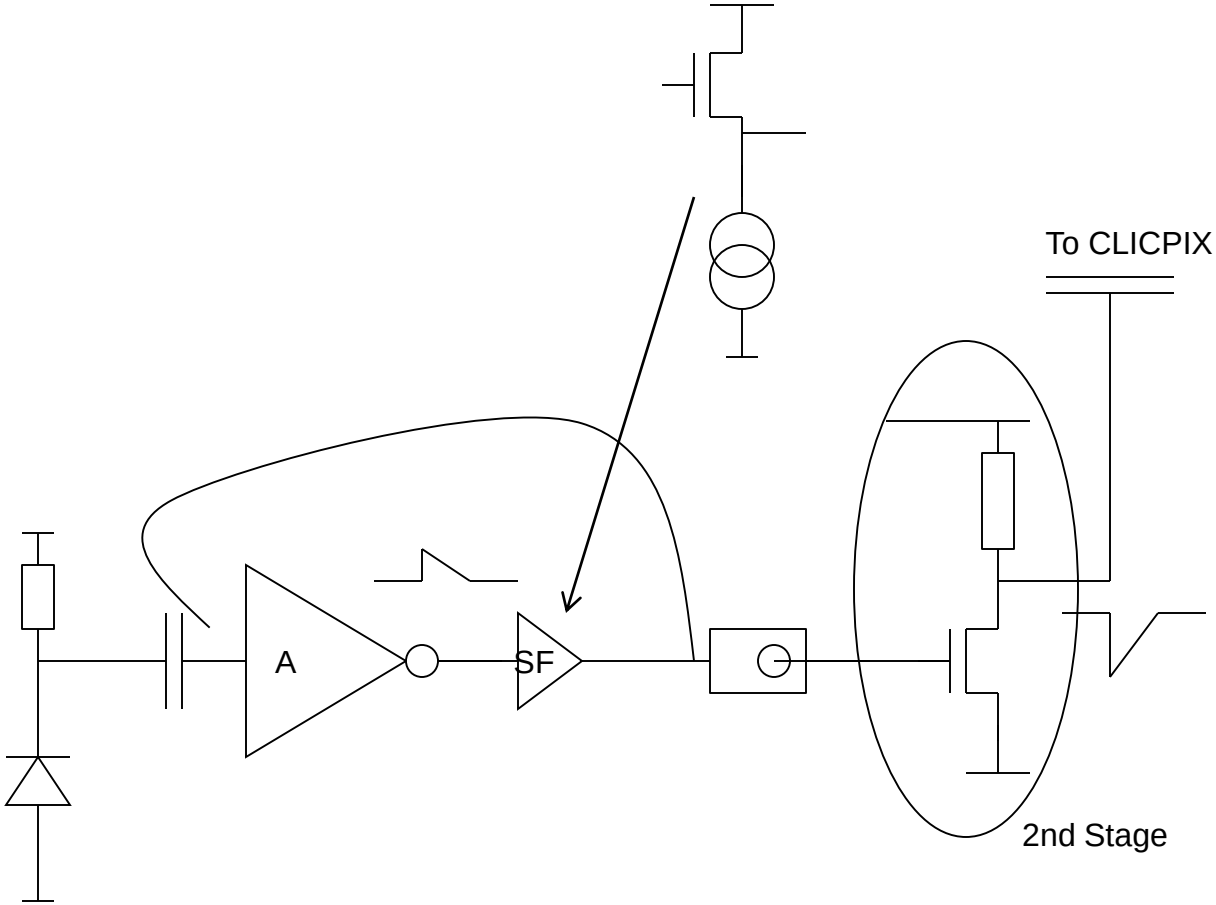
CLIC Pixel

- Simplified schematics
- Problem – amplifier too slow



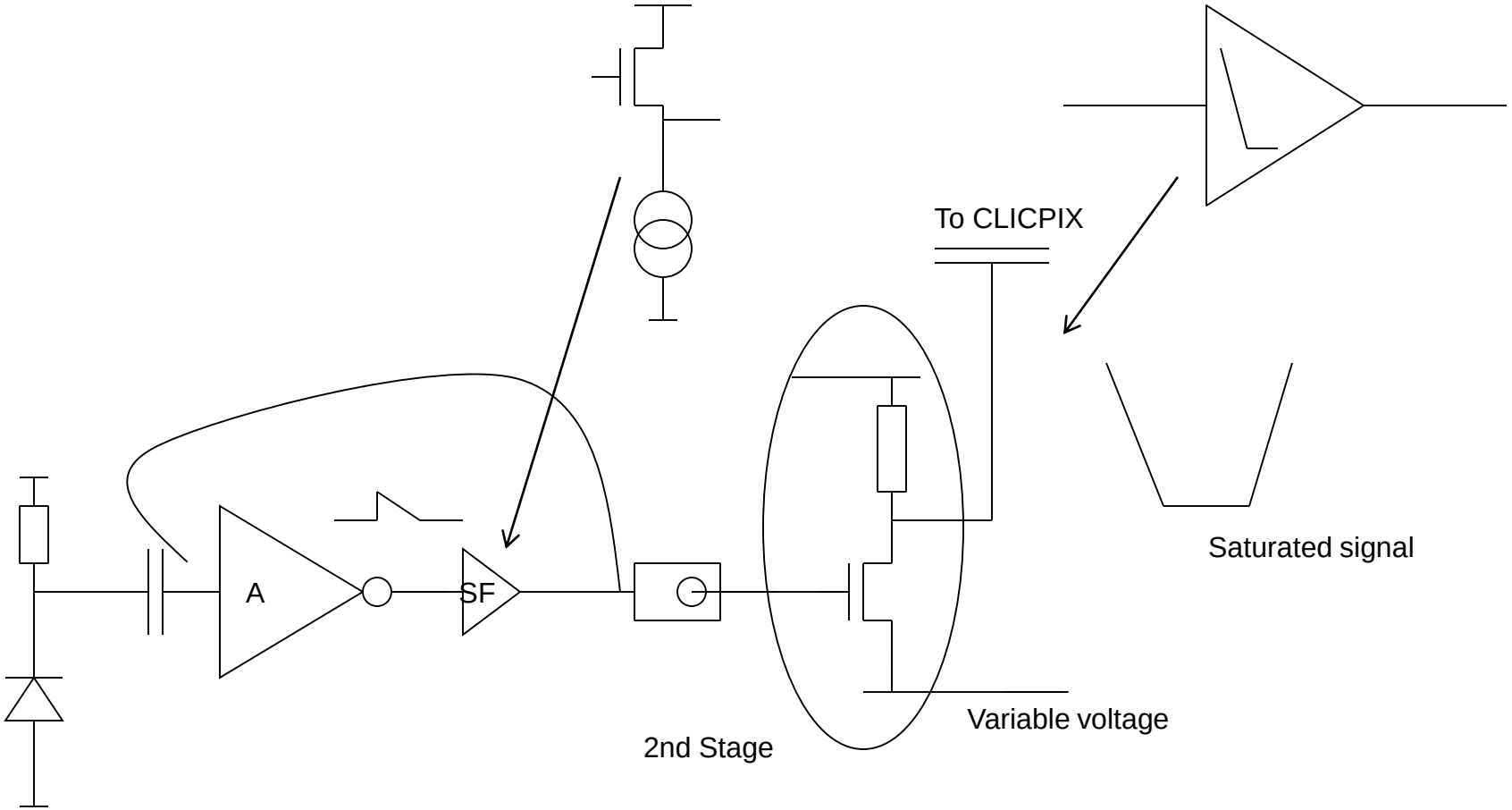
Improvement

- Improvement
- Adding of buffer (source follower - SF) makes the circuit faster



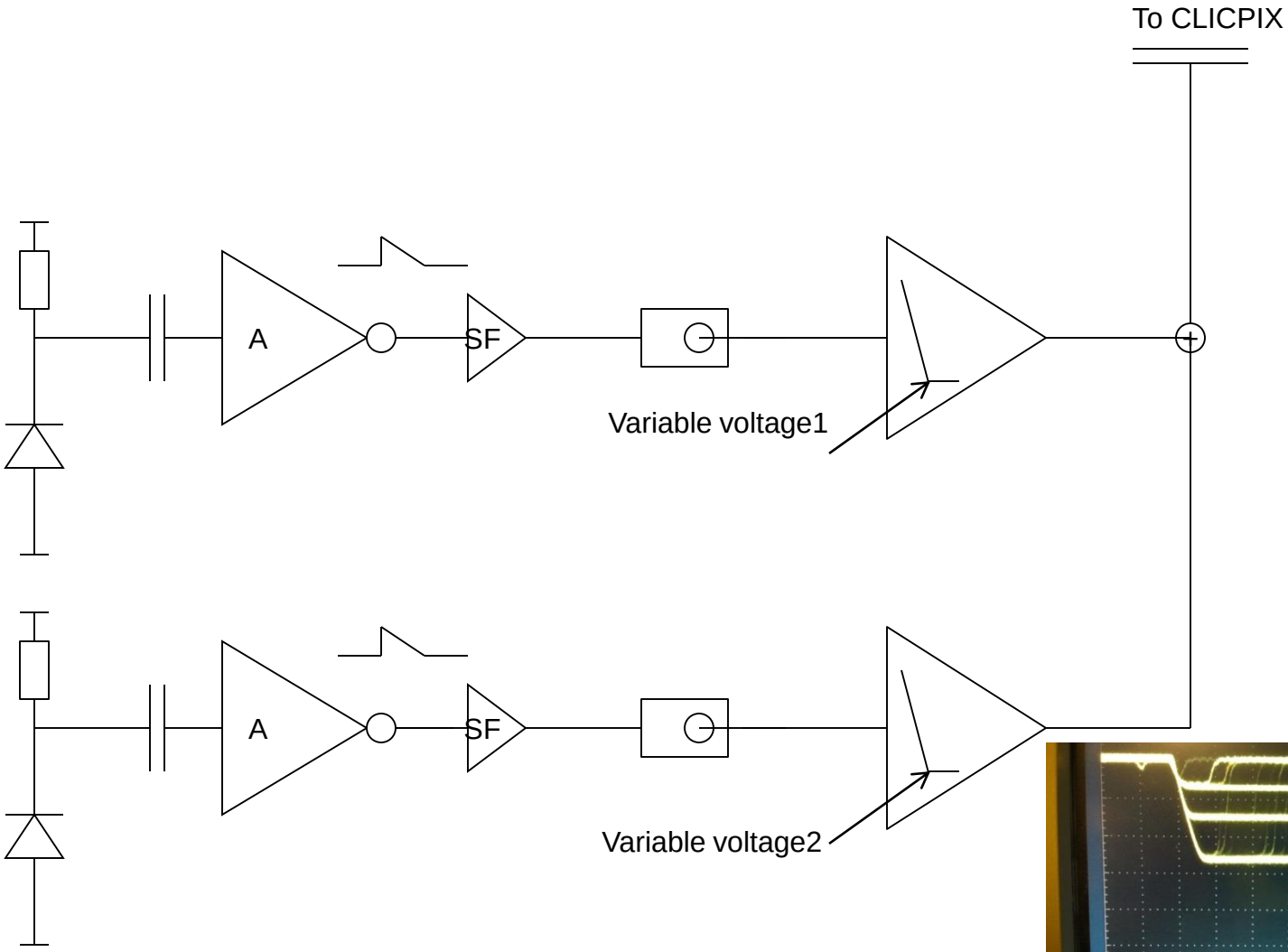
Improvement

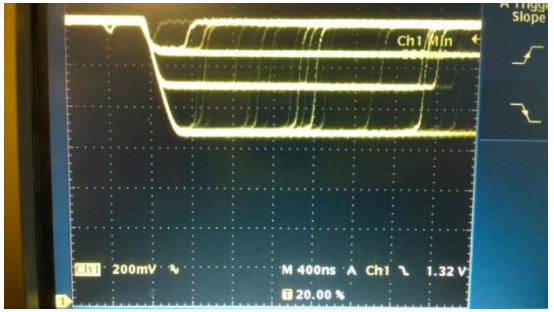
- The second amplifier saturates for typical MIP signals (signals > 1500e)



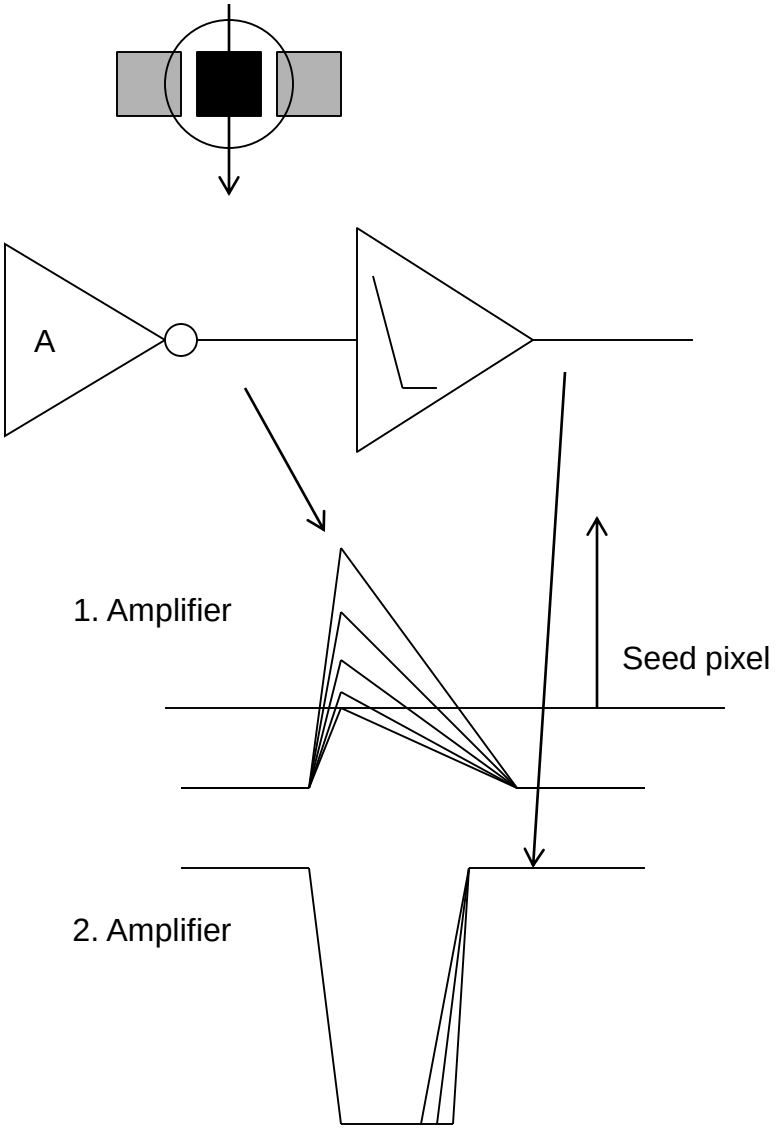
Improvement

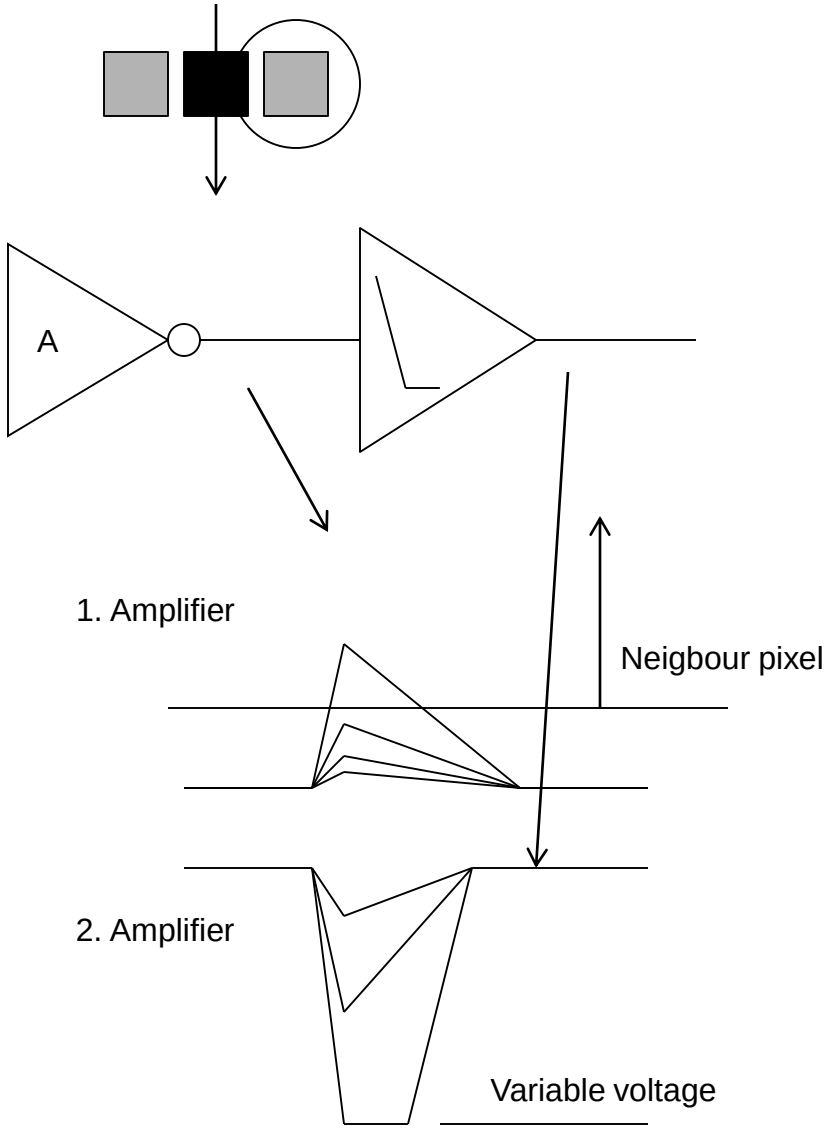
- The second amplifier saturates for typical MIP signals (signals > 1500e)
- This feature can be used to connect two pixels to one readout channel





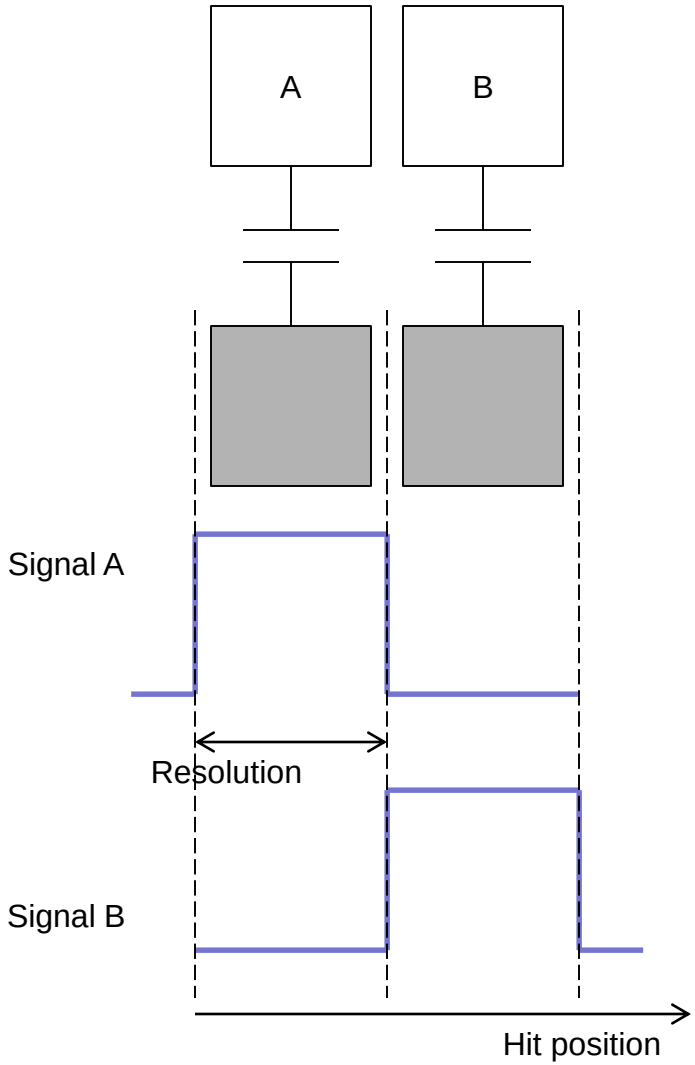
Waveforms


A
1. Amplifier
Seed pixel
2. Amplifier

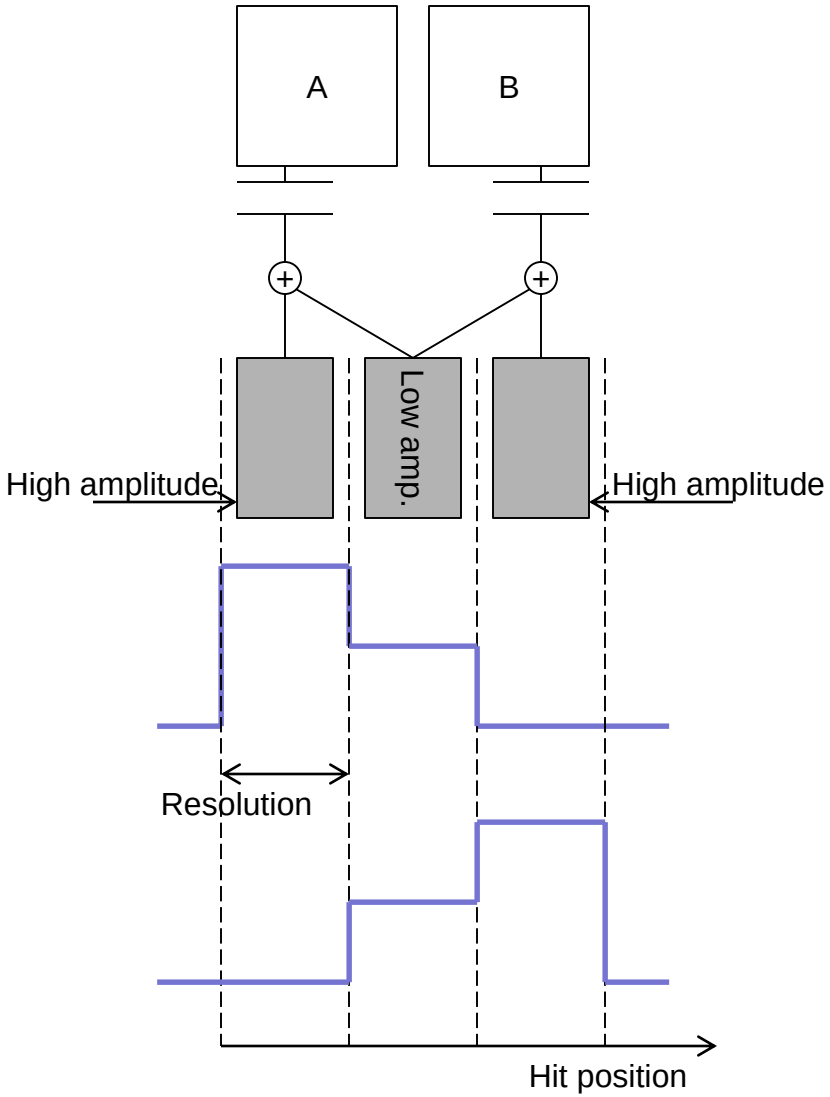

A
1. Amplifier
Neigbour pixel
2. Amplifier
Variable voltage

Comparison of two pixel sizes (no charge sharing)

25µm CMOS pixels (as now) connected to CLICPIX

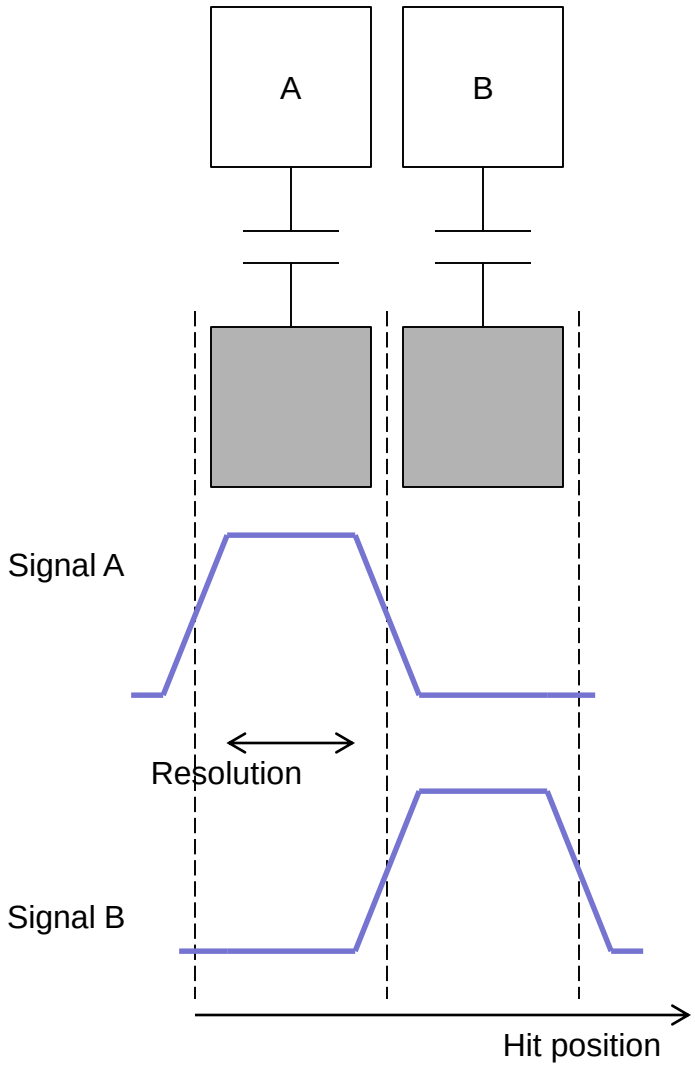


16.6µm CMOS pixels connected to CLICPIX

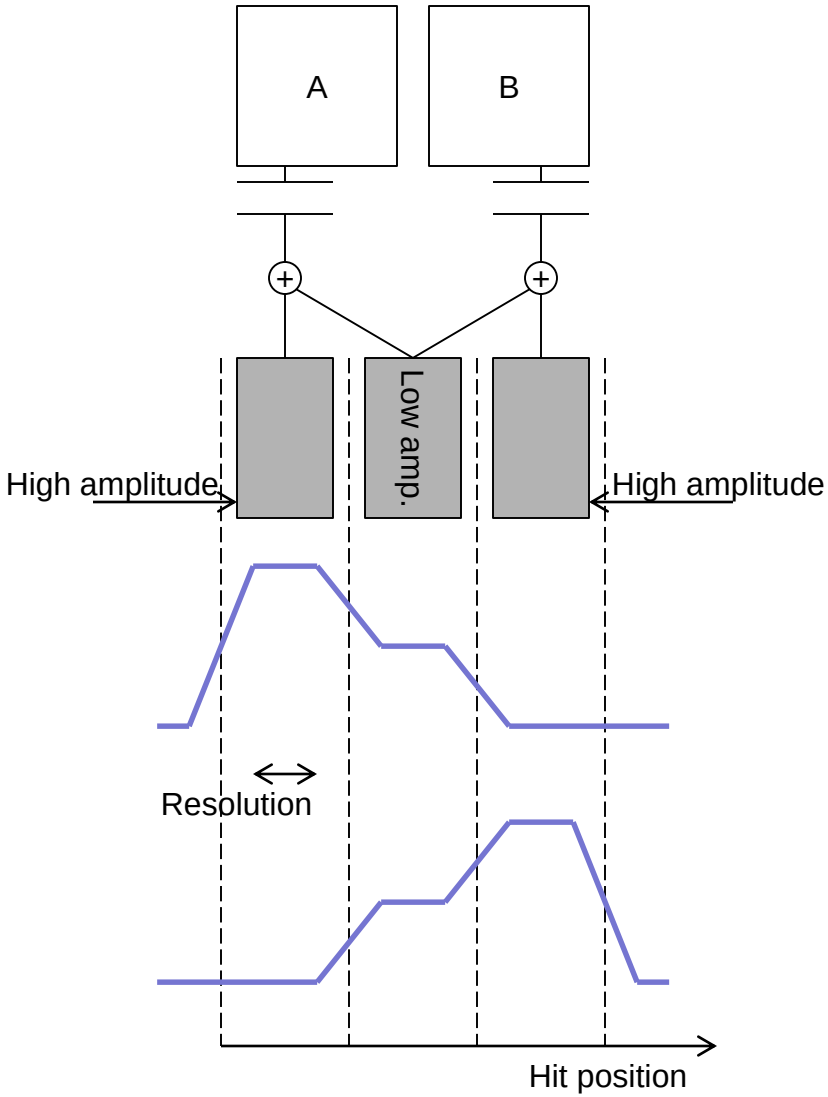


Comparison of two pixel sizes (charge sharing)

25µm CMOS pixels (as now) connected to CLICPIX



16.6µm CMOS pixels connected to CLICPIX



TSV

Assembly Possibilities

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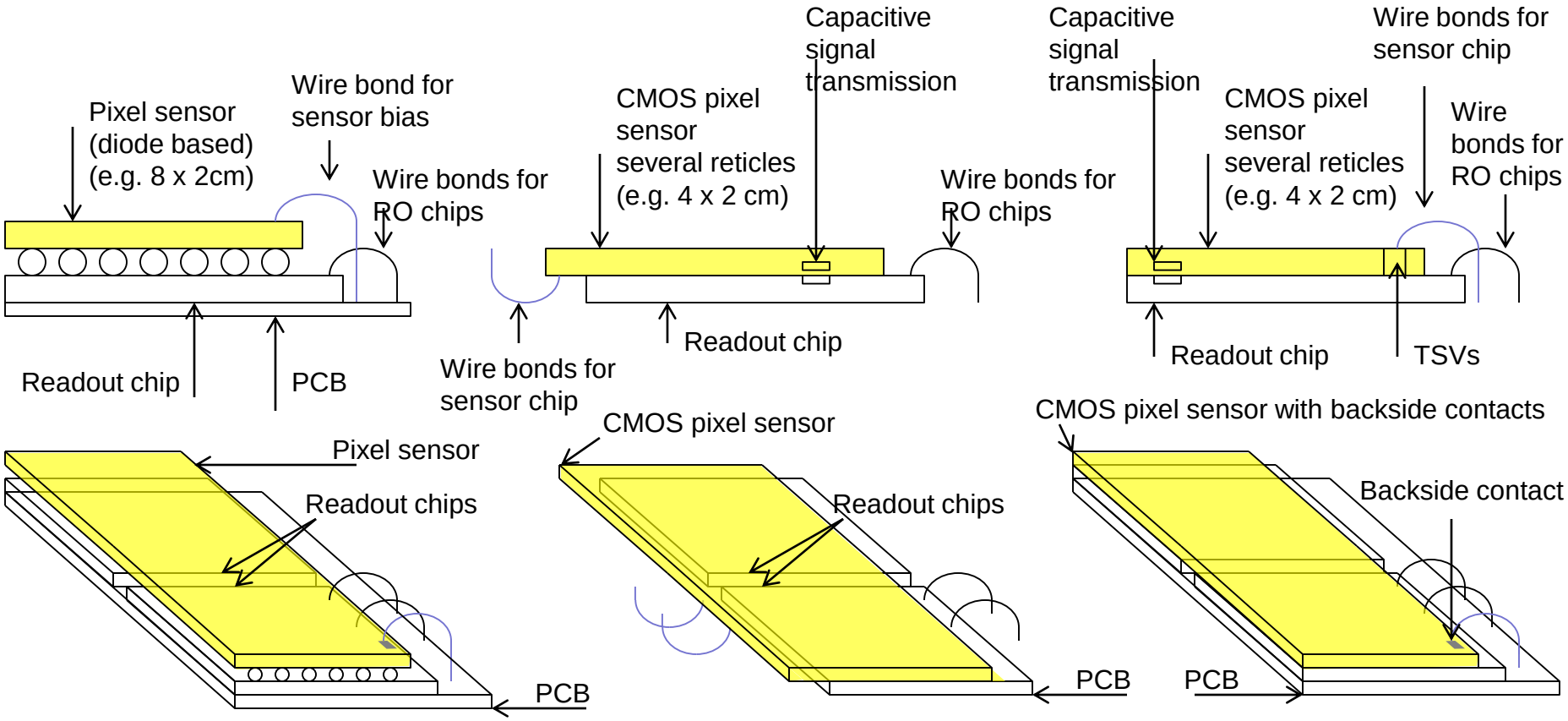

Detector as it is done now:
Diode based pixel sensor bump-bonded to readout ASICs

Present development:
CMOS pixel sensor capacitively coupled to readout ASICs

With TSVs
CMOS pixel sensor with backside contacts capacitively coupled to readout ASICs

Thank you!