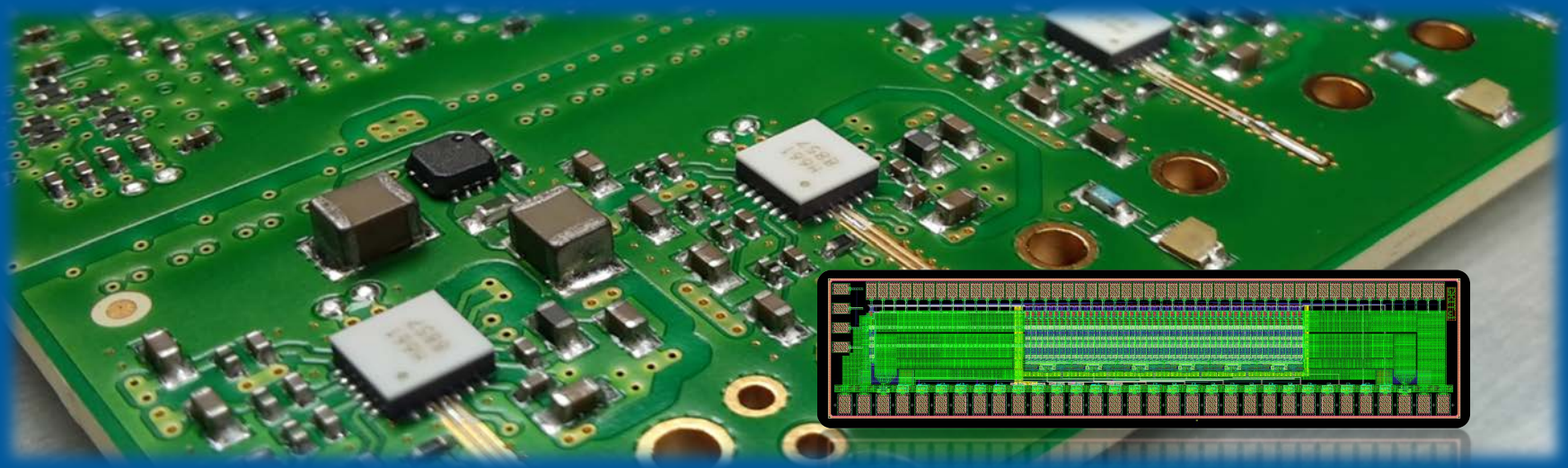
MATTER AND TECHNOLOGIES

KALYPSO systems – update

M. Caselle, M. Patil, L. Rota, M. Balzer, M. Weber (***KIT***)
M. Boscardin, G. Borghi and S. Ronchin (***FBK Trento***)



ARD-ST3 Annual Workshop, 19-21 July 2017, DESY, Zeuthen

HELMHOLTZ ASSOCIATION

KALYPSO III: toward real-time beam diagnostic at 10 Mfps

***Novel front-end electronics ASIC*: "Gotthard- High Rate":**

- low-noise
- **Up to 10 Mfps** @ full occupancy

Novel linear array sensors:

- **512/1024 and 2048** pixels with pitch of **25 µm** with Anti-reflective Coating (**Near-IR, Near-UV** and **standard**)
- 512, 1024 LGAD (**Low Gain Avalanche Detector**) with pitch 50 µm

First "wide" linear array silicon system operating over 10Mfps optimized for "wide-spectrum" region from NUV to NIR with high-spatial resolution (25 µm)

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New front-end ASIC for KALYPSO

BMBF-Verbund Speaker
A.-S. Müller, 2016 - 2019

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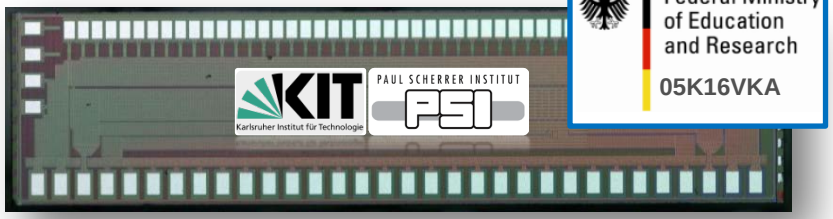
Gotthard-HR (High-Rate)

First prototype received Dec. 2016

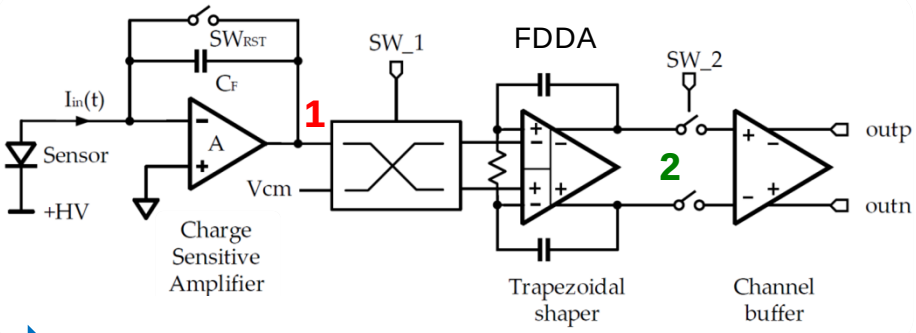
- Over *10 Mfps*, 48 channels, three different gain settings
- CSA: diff. folded-cascode, open-loop gain > 60 dB, GBW > 2 GHz
- CDS: fully-differential switched capacitor Correlated Double Sampling
- Output buffer: fully-differential → which can be directly connected to a differential Analog to Digital Converter (ADC)



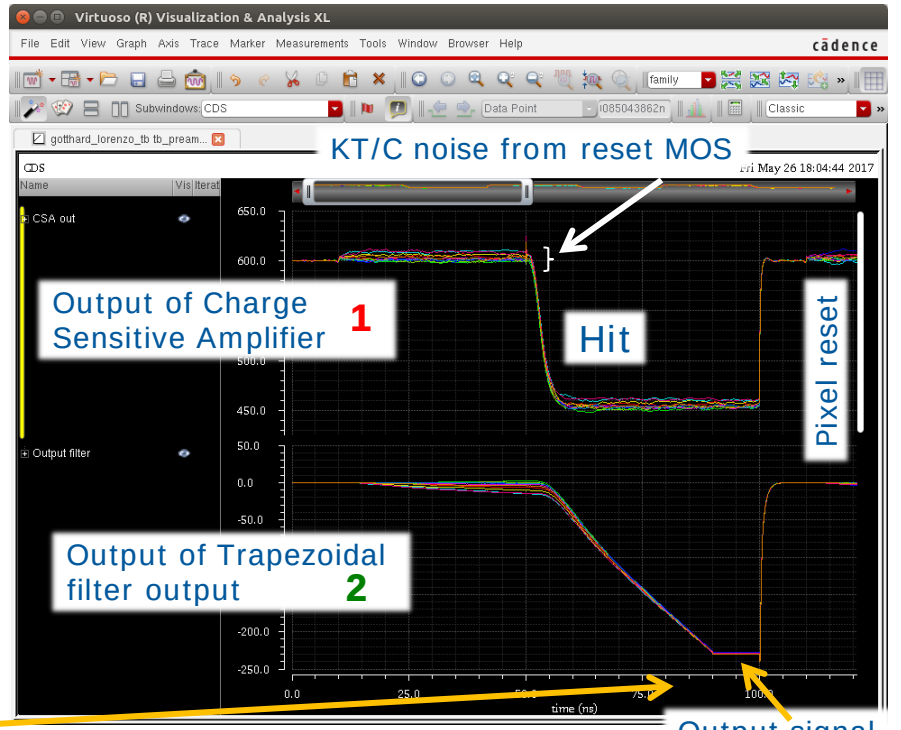
Prototype of new ASIC - UMC 110 nm technology

→ *Fully working*

Improvement: Fully-differential trapezoidal filter → to reduce the electronic noise



→ *Simulation shows a drastic reduction of FEE electronic noise*



Submission Oct/Nov 2017 together PSI

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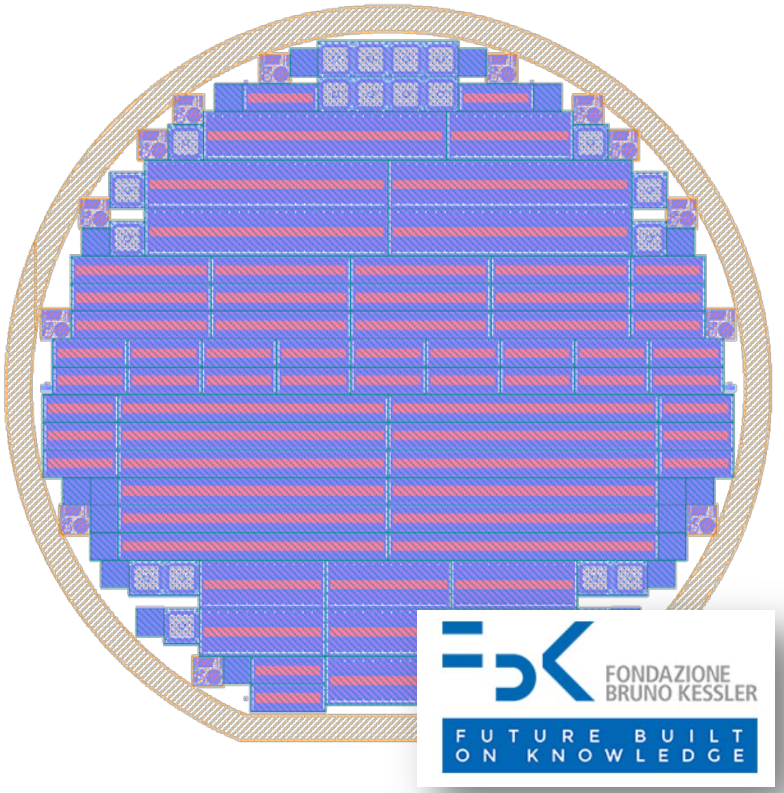
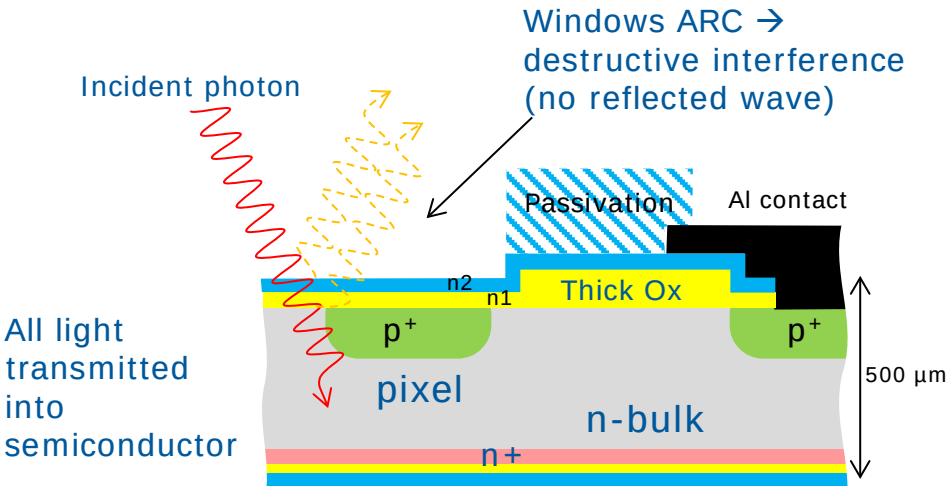
New sensors for KALYPSO

Optimized sensor layout/process for longitudinal beam diagnostics

- Linear array micro-strip with pixel pitch *25 μm*:
  - Size: 512 / 1024 and 2048 (Front and Back illumination)
- Linear array micro-strip with pixel size *50 μm*:
  - Size 512 and 1024 (Front and Back illumination)
- Anti-Reflection Coatings layers: for IR and UV spectrum



Sensor with Anti-Reflective Coating (ARC) layers



ARC process compatible with both front and back illumination

Mini-run of 5 wafers

Number of wafer	Spectrum	Facility
2	Visible (no ARC)	ANKA, TELBE
1	NUV-ARC (400 nm)	SLS/SLS-2
2	NIR-ARC (1050 nm)	ANKA, FLASH, XFEL, SOILEIL

Poster

Programme Matter and Technologies

KALYPSO systems -update

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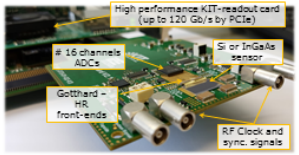
Institute for data Processing and electronics (IPE- KIT)

KALYPSO III: toward real-time beam diagnostic at 10 Mfps

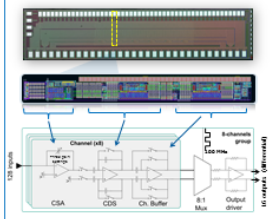
***Novel front-end electronics ASIC*: "Gotthard- High Rate":**
- low-noise
- Up to 10 Mfps @ full occupancy

Novel linear array sensors:
- 512/1024 and 2048 pixels with pitch of 25 µm with Anti-reflective Coating (Near-IR, Near-UV and standard)
- 512, 1024 LGAD (Low Gain Avalanche Detector) with pitch 50 µm



KALYPSO Version 2.1

New Gotthard – High Rate

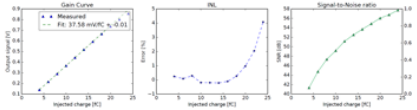


Charge Sensitive Amplifier (CSA): differential folder-cascode, open loop gain > 60 dB → to mitigate the charge trapper effect on the sensor and the cross-talk between channels

Correlated Double Sampling (CDS): fully-differential switched capacitor time-variant filter → to reduce the noise

Output buffer: fully-differential → which can be directly connected to a differential Analog to Digital Converter (ADC)

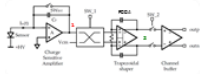
First prototype received Dec, 2016 (UMC CMOS 110 nm):
- **Frame-rate up to 12 Mfps** (continuous, interleaved integration and readout time)
- Compatible with different sensors **Si** (*p-in-n* or *n-in-p*) and **InGaAs**
- Fully-differential architecture → high PSRR & CMRR



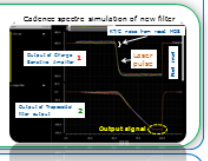
Measured transfer curve, integral non linearity (INL) and signal-to-noise ratio of the readout chip, not connected to the external sensor, high-gain setting with a line-rate of 10 MHz.

Second prototype to be submitted Oct, 2017

Improvement: Fully-differential trapezoidal filter → to reduce the electronic noise

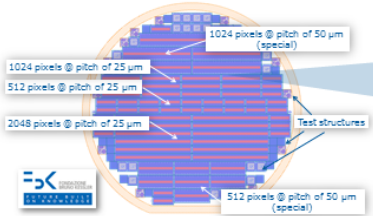


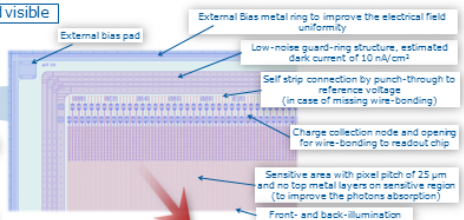
Simulation shows a drastic reduction of FEE electronic noise



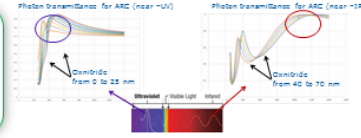
New linear array sensors technology for Kalypso

5 wafers submitted to FBK Trento for NUV, NIR and visible



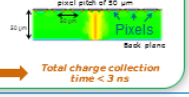


Sensors with Anti-Reflective Coating (ARC) layers → all photons transmitted into semiconductor (no reflected wave)



Low-Gain Avalanche Detector for "fast" transverse bunch profile

Improvement:
- Reduced substrate thickness from 300 µm to 50 µm → reduced collection time
- Integrate a small-gain (10 – 30) in a sensor while maintaining similar noise levels
- No quenching circuit is necessary



Total charge collection time < 3 ns

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