SPONSORED BY THE

Federal Ministry of Education and Research

An Ultra-Fast and Wide-Spectrum Linear Array Detector For High Repetition Rate and Pulsed Experiments

M. M. Patil[1], M. Balzer[1], E. Bründermann[1], M. Caselle[2], A. Ebersoldt[1], S. Funkner[1], B. Kehrer[1], G. Niehues[1], W. Wang[1], M. Weber[1], A-S Müller[1]

[1]Karlsruhe Institute of Technology, Eggenstein Leopoldshafen, Germany
[2] GSI, Darmstadt, Germany

Motivation

Improve the time and spatial resolution of modern beam diagnostics setups at several European accelerator facilities **[1]**, overcoming the technological limitations of existing system

Challenges

- Very fast charge collection (< 2ns)
- High resolution sensor
- Low noise & high linearity electronics
- Continuous data acquisition

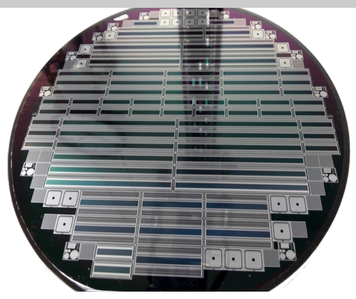
Silicon sensor technologies

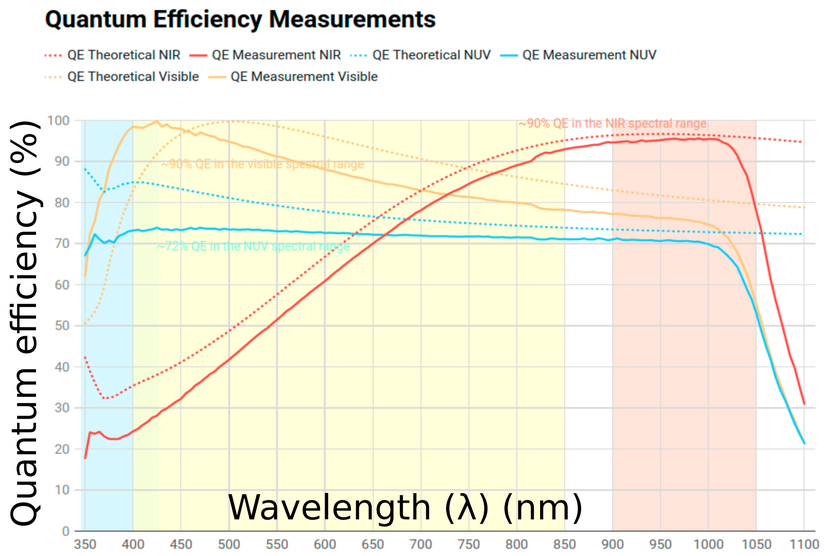
FONDAZIONE BRUNO KESSLER

Fine-pitch Si microstrip sensors:

- Different options: 512/1024/2048 channels, 25/45 µm pitch
- Anti-reflective coatings (ARC) optimized for different applications

near-UV (350 nm) - visible (400-850 nm) - near-IR (1050 nm)

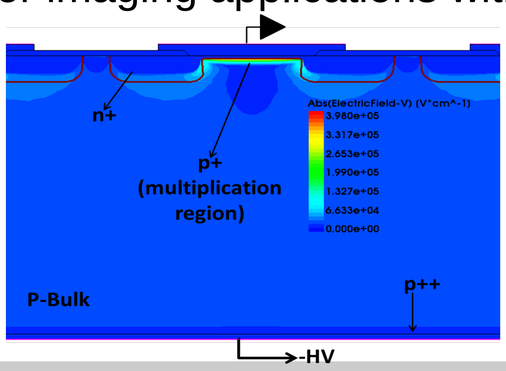




Low Gain Avalanche Detectors [2]:

RD50

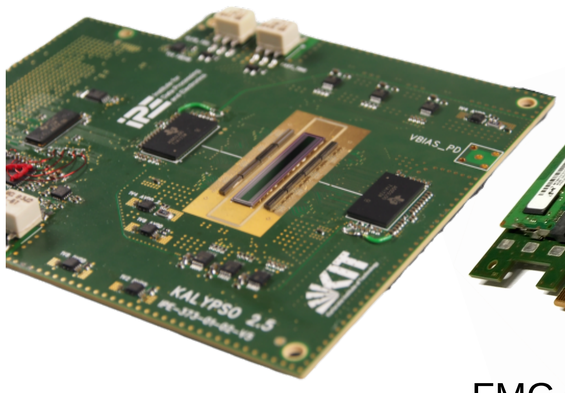
- Charge collection time < 3 ns → repetition rates over 100 MHz
- Internal gain ~ 20 → improve SNR, no quenching circuit
- LGADs designed for imaging applications with 45 µm pitch



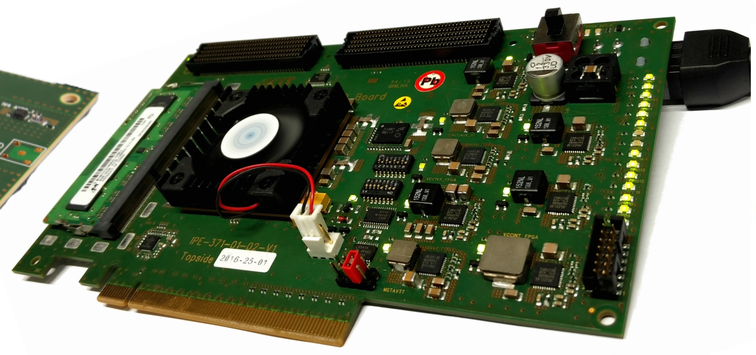
Electric field simulation of an LGAD using TCAD

Detector readout electronics

Kalypso 2.5

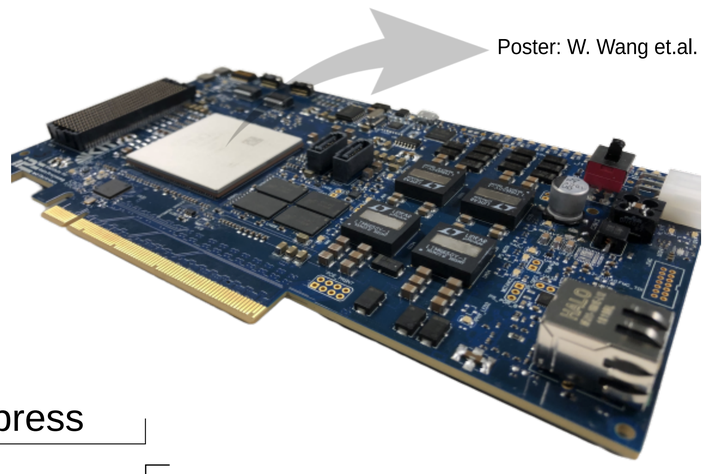


Hi-Flex Readout card



GPU Cluster

Hi-Flex 2 Readout card

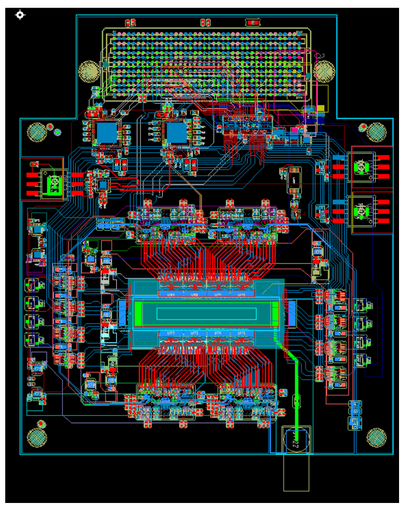


Poster: W. Wang et.al.

FMC Connector — PCI Express — PCI Express

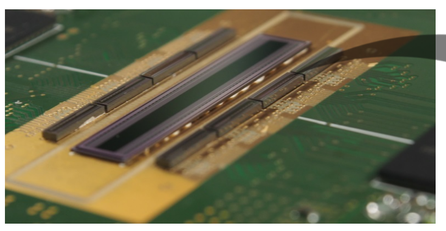
FMC+ Connector

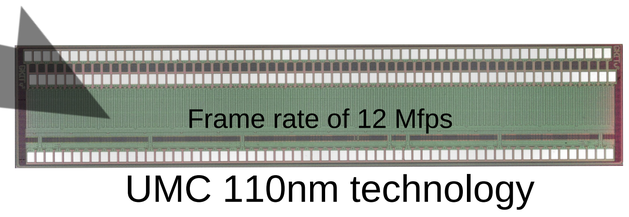
Kalypso 3



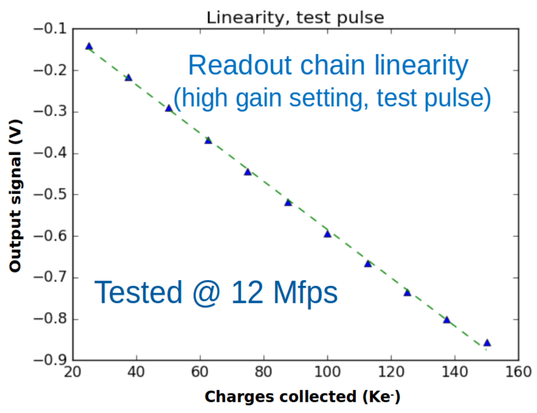
- Modular detector design →extendability from 512 pixels to 1024 pixels **[3]**
- Heterogenous FPGA-GPU data acquisition system
- Novel Direct Memory Access architecture working close to the theoretical limit of data link

New Front-end ASIC - GOTTHARD-KIT v2





UMC 110nm technology



- High-linearity and wide output signal **[4]**
- Preliminary estimation of S/N > 60 dB
- Preliminary noise measurements of ENC = 205 e-

[1] L. Rota *et al.*, IBIC 2014 ,
[2] G. Paternoster *et al.*, C02077, JINST 2017 ,
[3] M. M. Patil *et al.*, An Ultra-Fast and Wide-Spectrum Linear Array Detector for High Repetition Rate and Pulsed Experiments, IPAC 2019
[4] L. Rota et al., Development of a Front-End ASIC for 1D Detectors with 12 MHz Frame-Rate, TWEPP 2017

Contact Author: meghana.patil@kit.edu