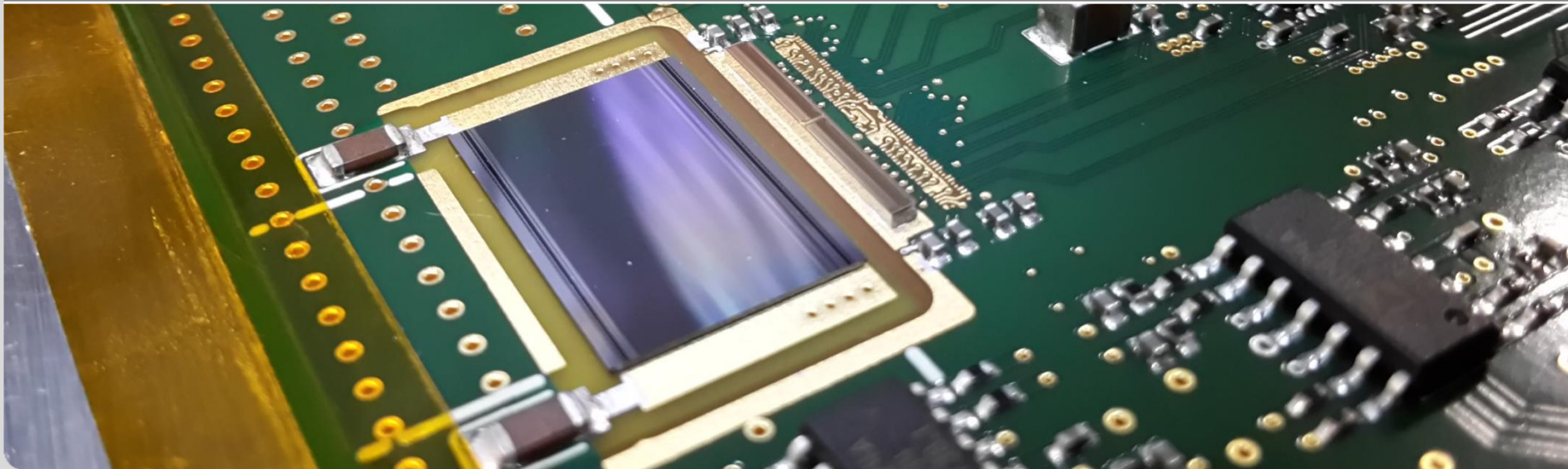


IR-Spectrometer for beam monitoring: from pico- to femto-second acquisition?

L. Rota, M. Caselle, N. Hiller

KIT, Institute for Data Processing and Electronics (IPE)

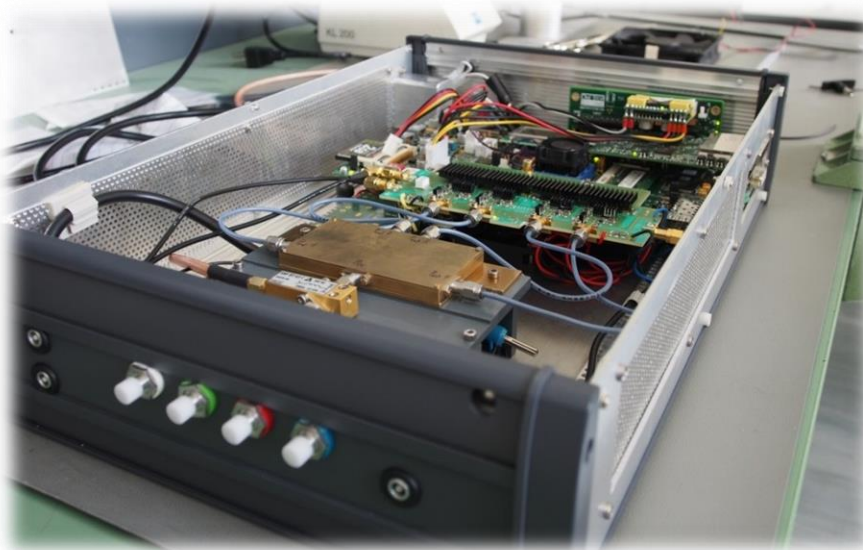
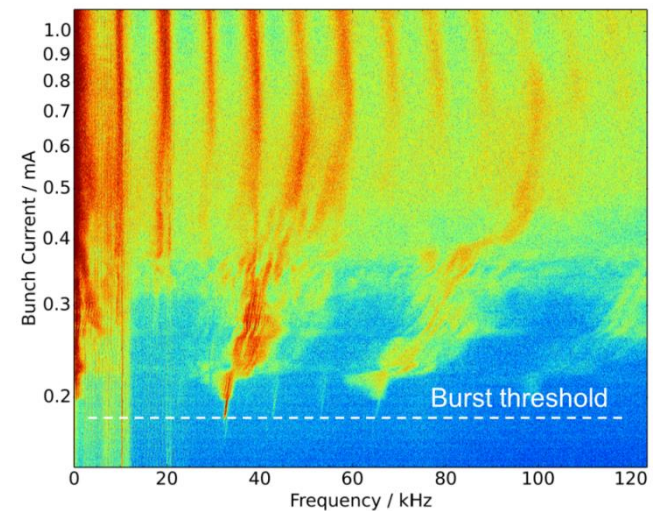
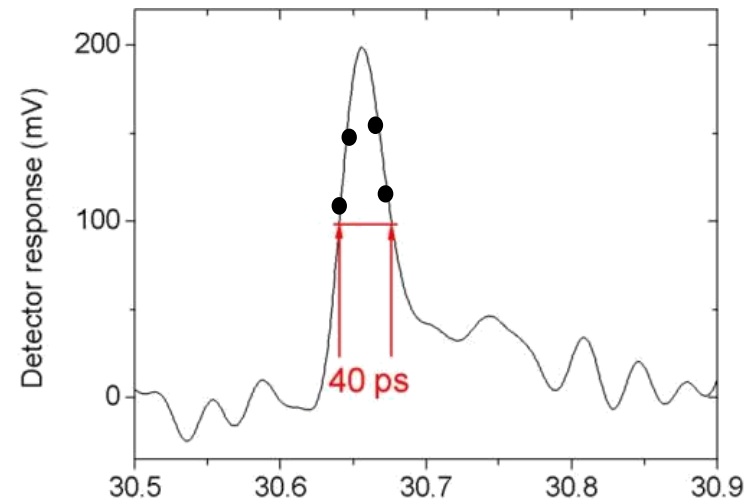


- Motivation at ANKA
- Collaboration
- Ultrafast 1D Linear Array Detector:
 - Specifications
 - 1 Mfps Version
 - 5 Mfps Version
- Outlook

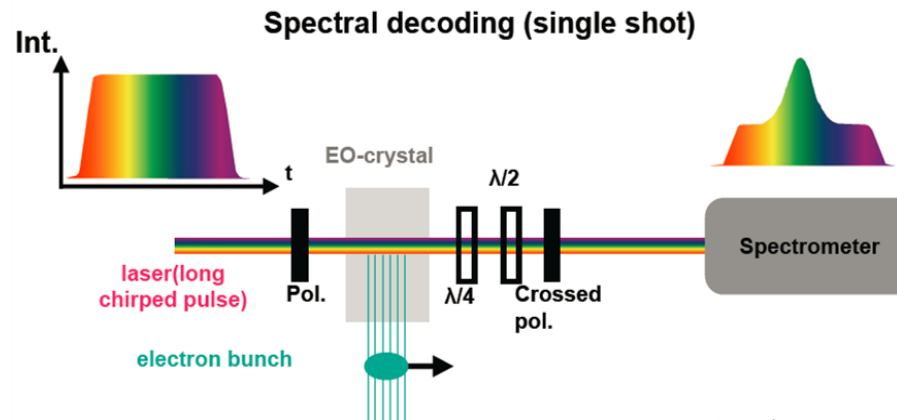
KAPTURE: from picosecond sampling...

- Repetition rate = 500 MHz
- Timing resolution = 3 ps
- Continuous data acquisition
- Real-time data analysis

See M.Caselle presentation...



Motivation at ANKA



EOSD @ ANKA: near-field single-shot bunch profile monitor, with a sub-ps resolution (down to 390 fs granularity) down to bunch lengths of 1.5 ps RMS.

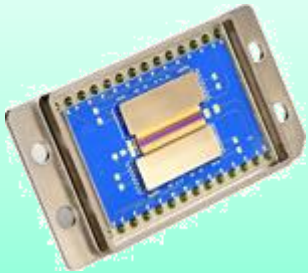
Scientific goal: compare the bunch substructures directly to the bursting behavior of the CSR

Current limitation: readout rate of spectrometer (~ 7 Hz)

[1] STATUS OF SINGLE-SHOT EOSD MEASUREMENT AT ANKA, *N. Hiller et al., Proceedings of IPAC2014, Dresden, Germany*

Motivation at ANKA

Commercial InGaAs detectors (sensor + FE electronics):



☐ Xlin 1.7: 512,	1024 pixels	@ 40kfps
☐ ANDANTA LDA	512 pixels	@ 97Kfps
☐ Hamamatsu G12231	1024 pixels	@ 97Kfps
☐ ...		
☐ Goodrich SU1024LE-1.7	1024 pixels	@ 123 kfps

**Frame rate is
not enough for
turn-to-turn
measurements
@ 2.7 MHz**

➤ Develop a novel and fast line detector

Requirements:

- InGaAs ($\lambda_{\text{LASER}}=1050 \text{ nm}$) and Si linear array detector
- Fast read-out rate: min 0.9 Mfps, ideal 2.7 Mfps (f_{REV} @ ANKA)
- High-throughput for continuous data acquisition over long observation periods
- Real-time data analysis

Collaboration

Institutes:



- Hardware development, assembly and testing
- Firmware and software development for ANKA-ELBE ver.



- Firmware and software development for μ TCA ver.
- Firmware for input stage



- Front-end chip (GOTTHARD)
- Si sensors



- Scientific interest

Application at:



System Specifications

Two versions are planned:

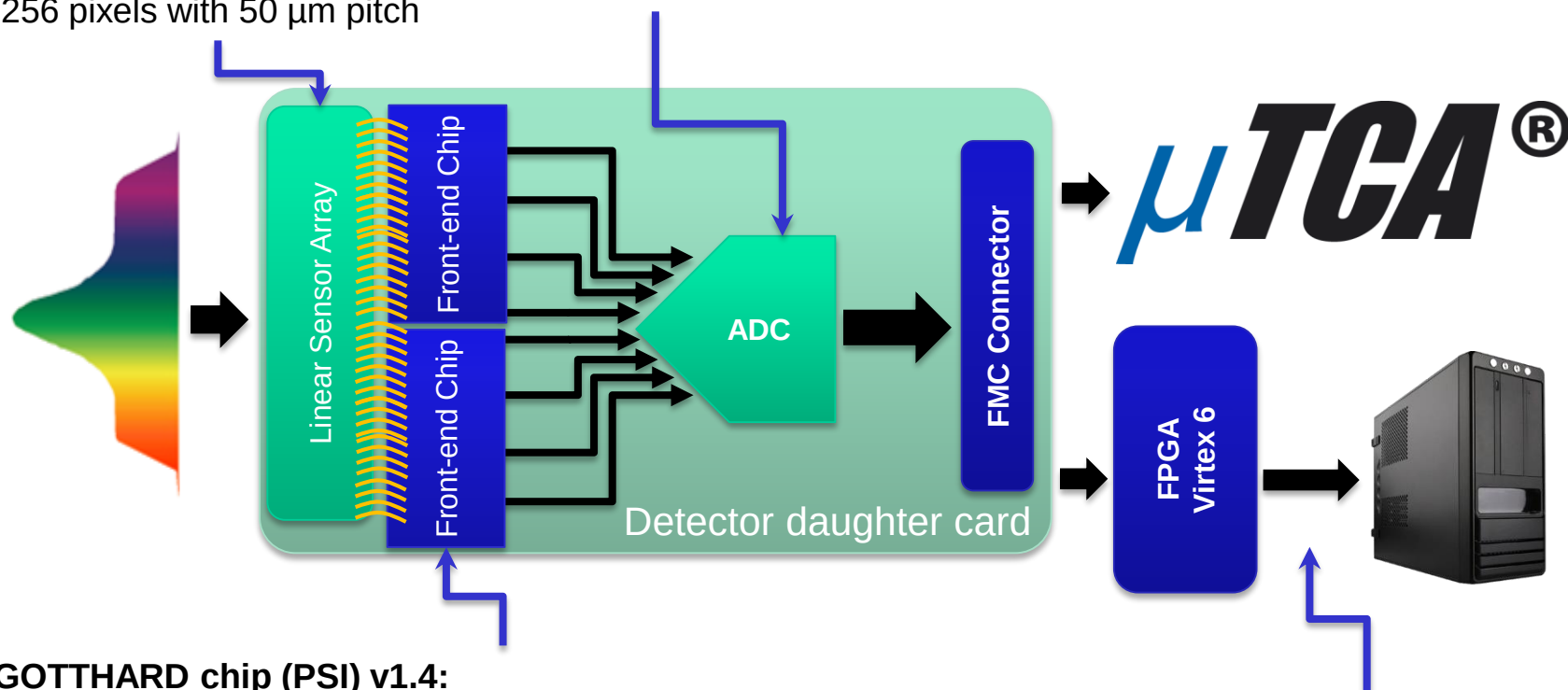
- **1 Mfps:** evaluate the performance of the front-end chip with InGaAs sensors and the general architecture
- **5 Mfps:** specs to be reviewed after tests with 1 Mfps version

	1 Mfps	5 Mfps
Sensor: InGaAs / Si	256 pixels, 50 μm pitch	512 pixels, 50 μm pitch
Integration time (min.)	2 ns (programmable by FPGA)	
Data Throughput	4 Gbit/s	40 Gbit/s

1 Mfps Version: System Architecture

InGaAs (Xenics) / Si (PSI):
256 pixels with 50 μm pitch

ADC9252: 8 channels @ 14-bit, 50 MSPS



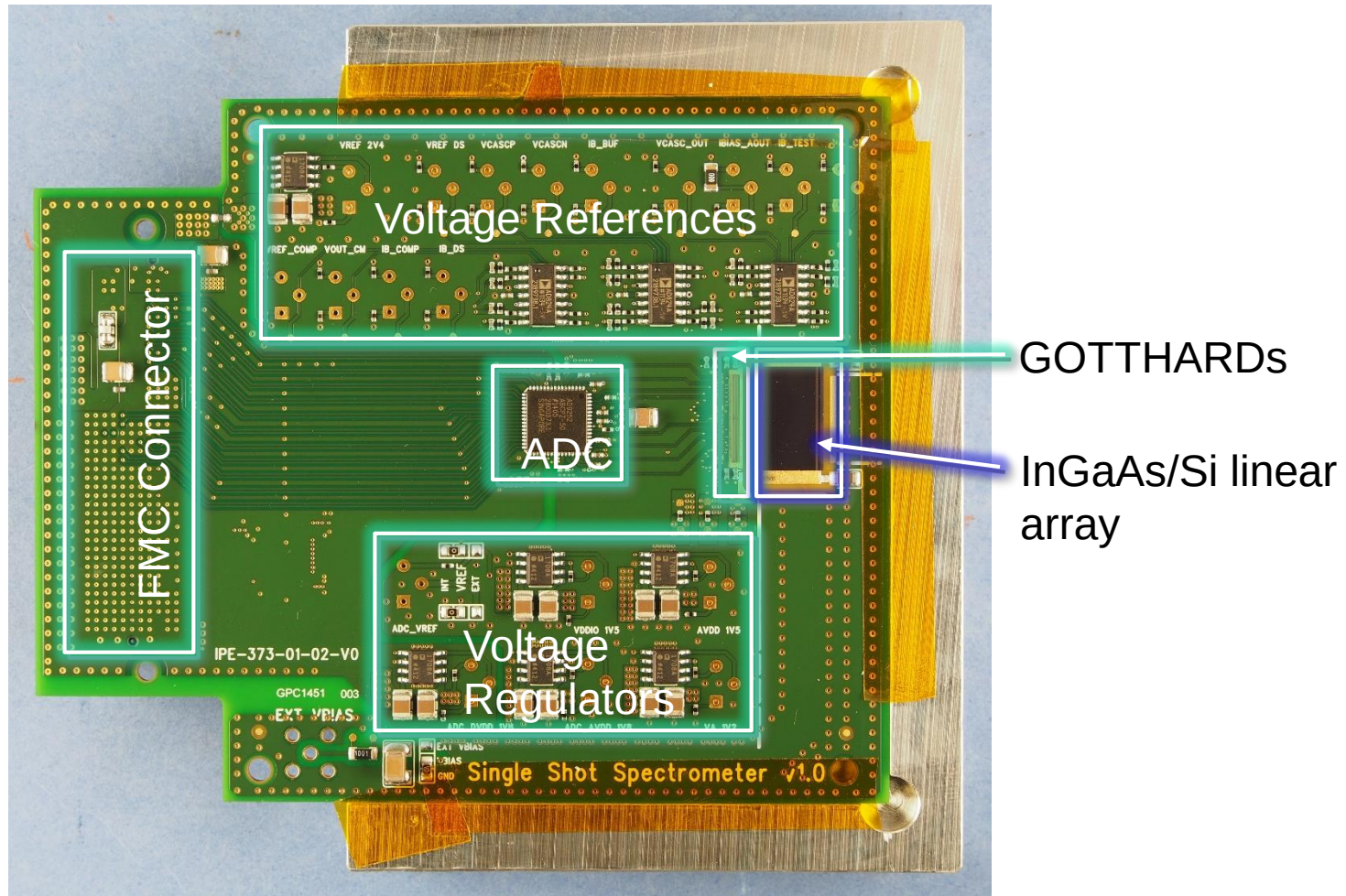
GOTTHARD chip (PSI) v1.4:

Gain Optimizing microSTrip system with H Analog Readout
Charge Integrating readout for XFEL strip-detector - IBM 0.13 μm
128 inputs, 4 analog outputs operating at 32 MHz
Max. read-out rate: 1 Mfps

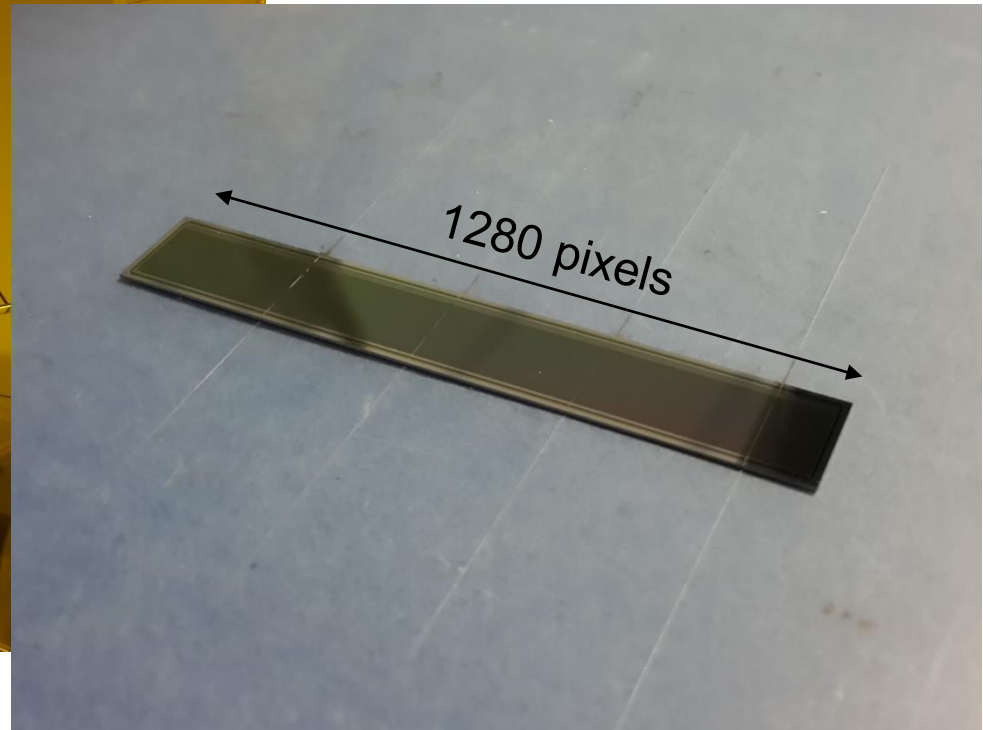
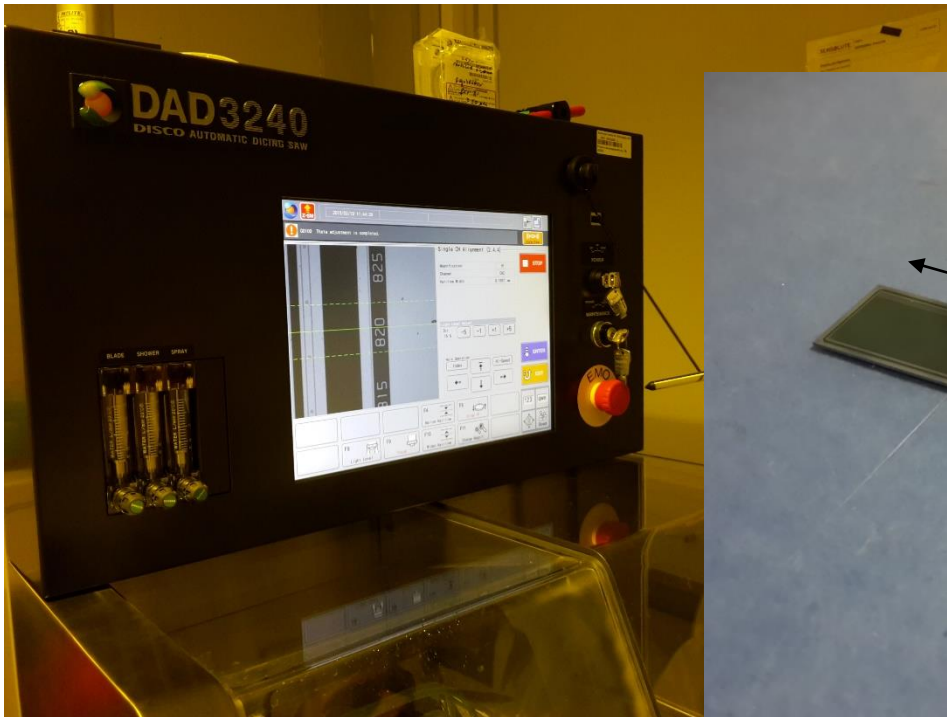
Fast KIT-DAQ:

Based on PCIe/DMA
See M.Caselle & T. Dritschler presentations

1 Mfps Version: PCB

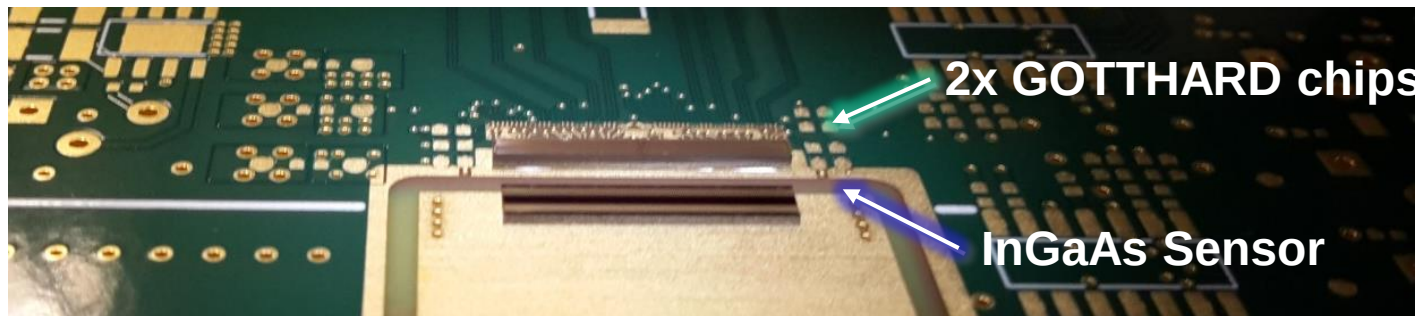


1 Mfps Version: Dicing of Si Sensors from PSI

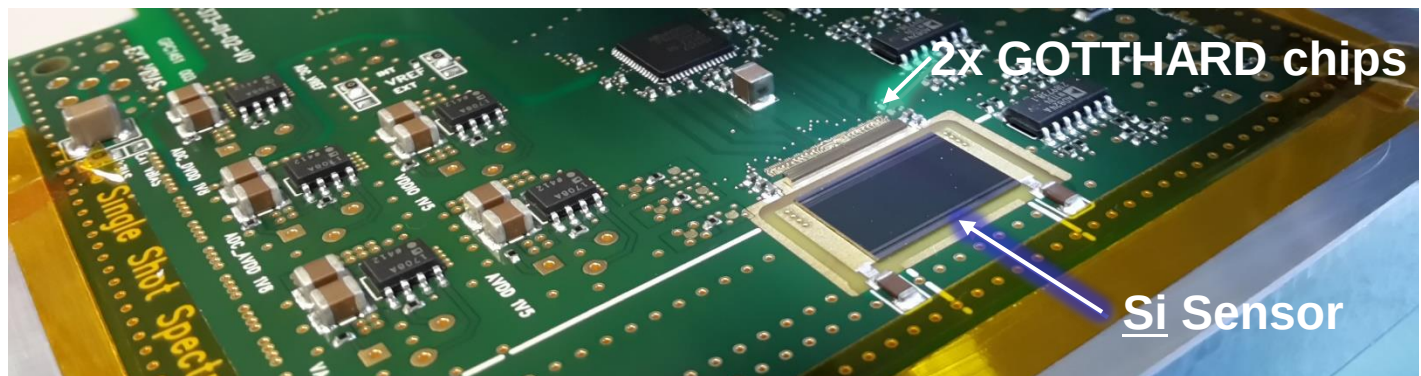


- 3 sensors ok
- 1 sensor damaged, used for gluing and wire-bonding tests

1 Mfps Version: Status

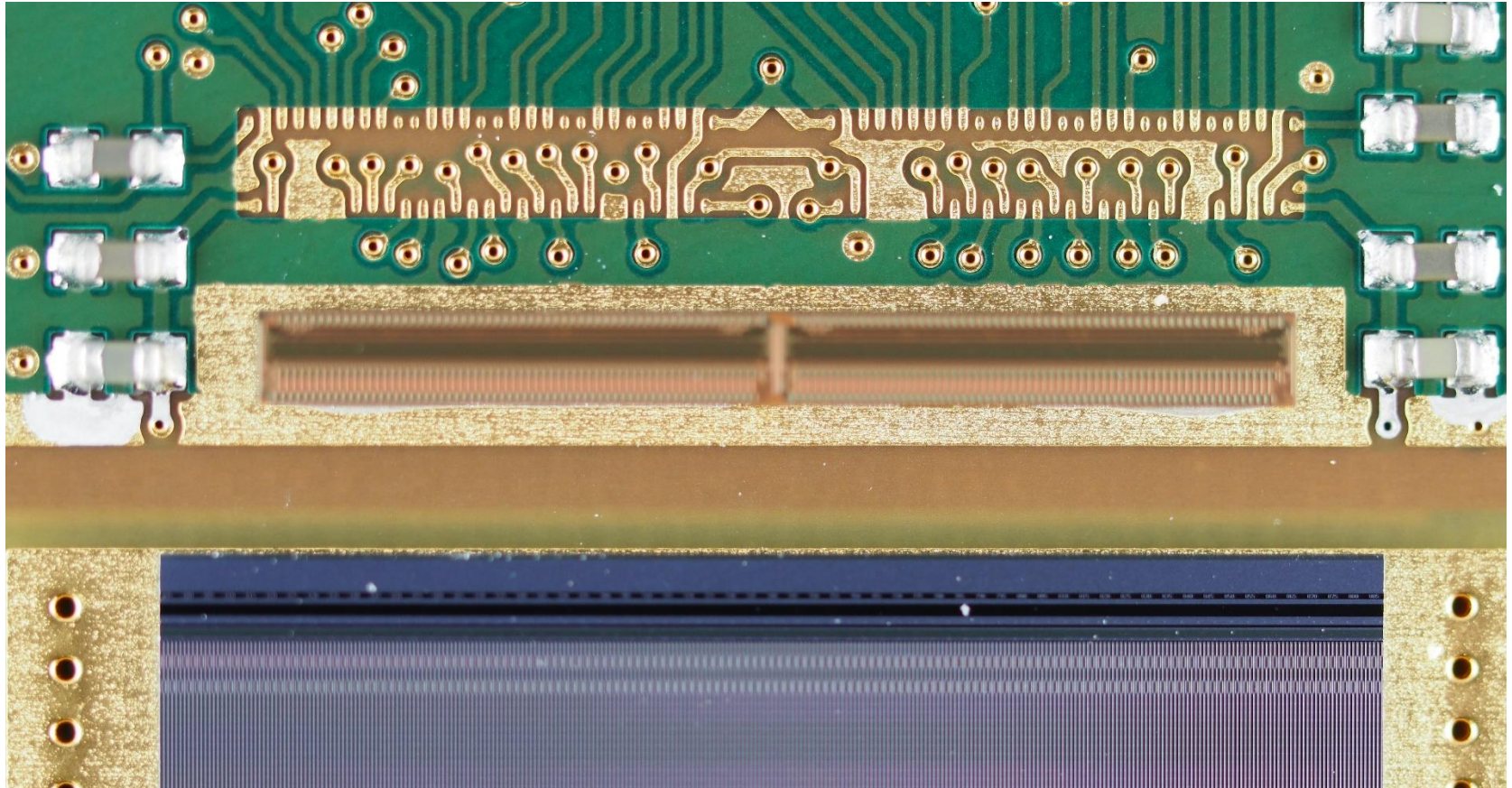


- Dummy board (gluing, wire-bonding)



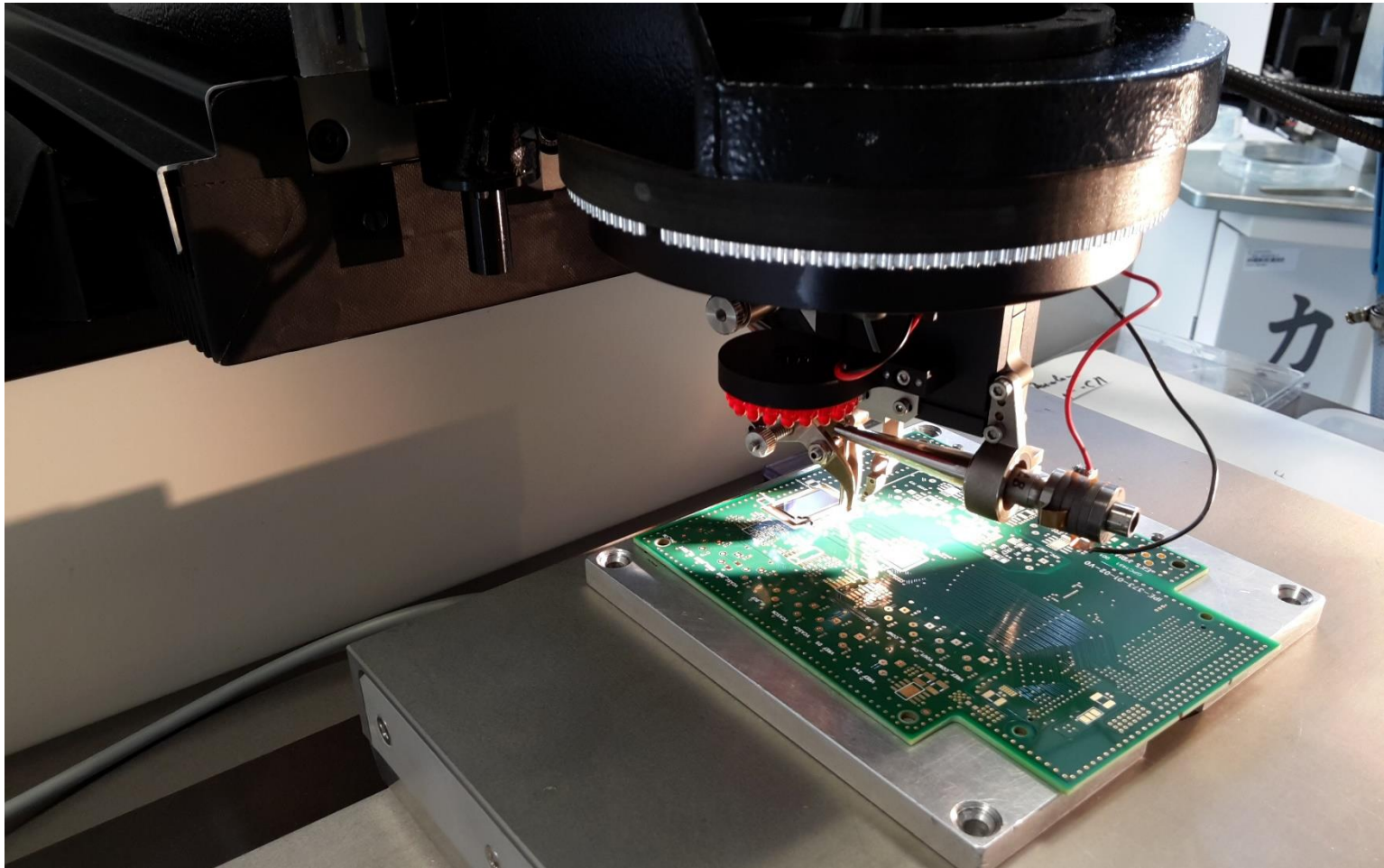
- Populated board with Si Sensor

1 Mfps Version: PCB detail

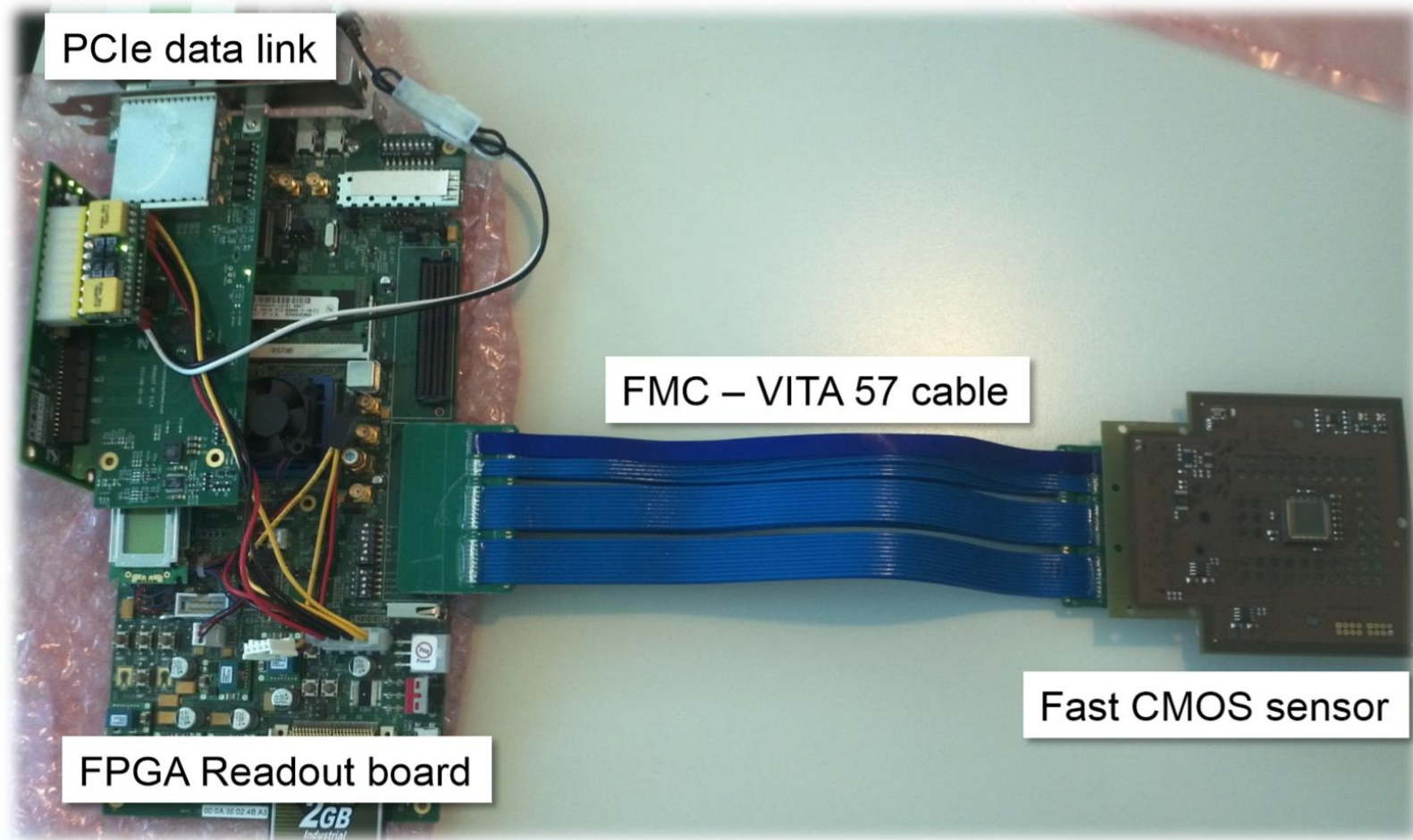


■ Wire-bonding is on-going @ IPE

Update about wire-bonding...



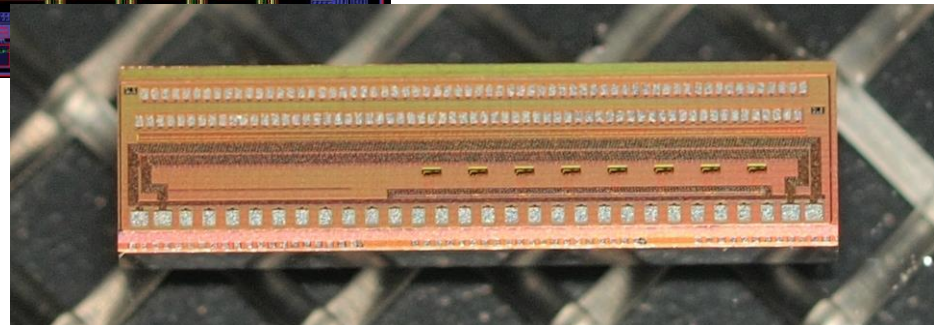
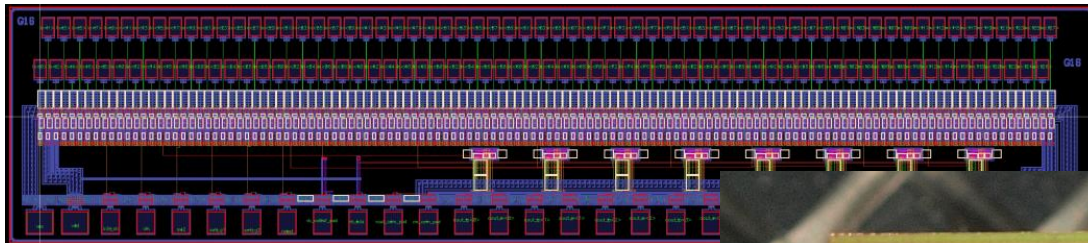
Readout and Interconnections



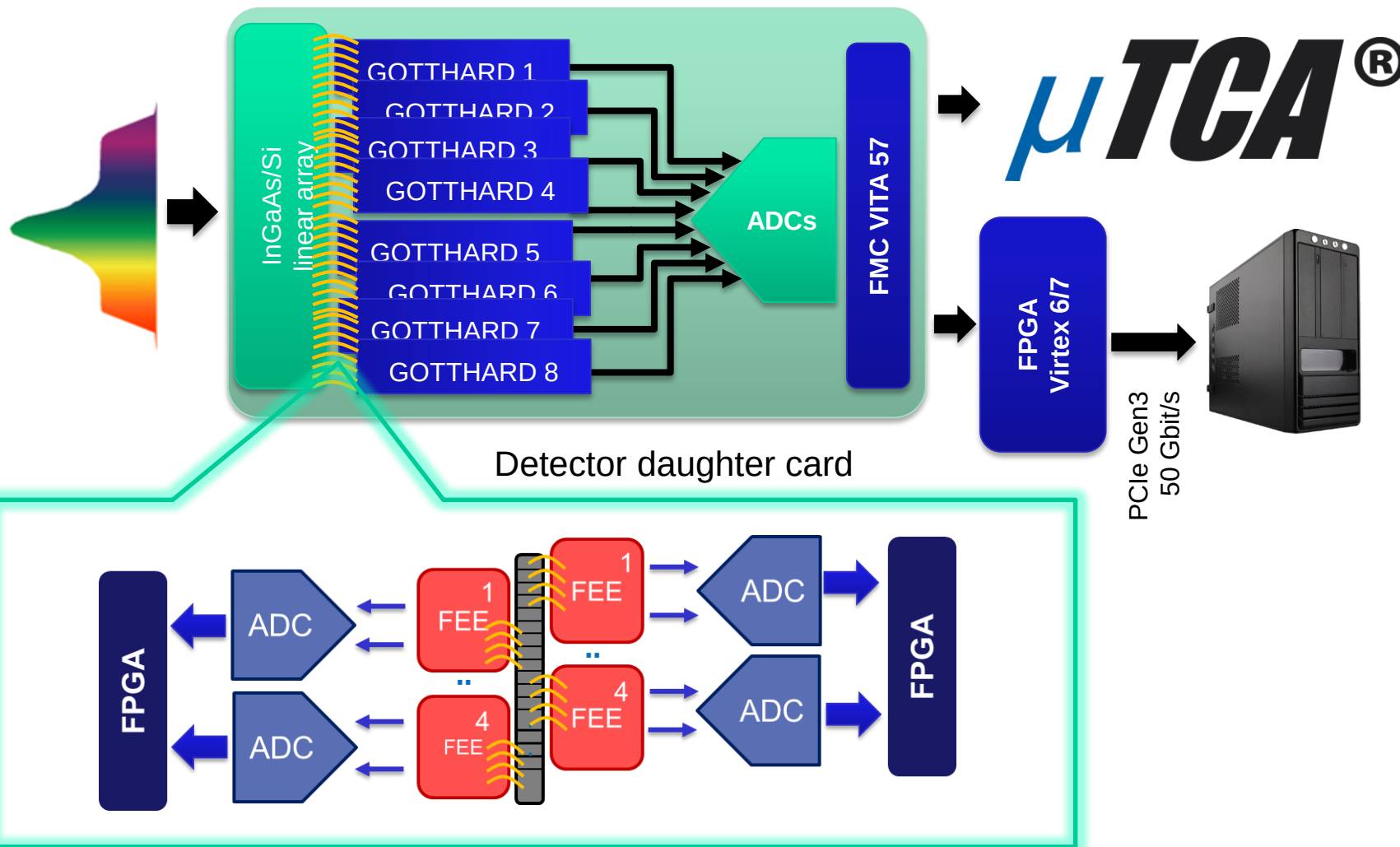
5 Mfps Version: GOTTHARD KIT-Version

Re-designed for this project to increase max. frame rate:

- 128 inputs
- 8 analog outputs operating at 40-50 MHz
- Expected frame rate ~ 2.5 Mfps
- If only 64 inputs are used: frame rate ~ 5 Mfps



5 Mfps Version: System Architecture



Outlook

- All components are available @ KIT
- Firmware development ongoing (TUL-DMCS)
- **Si sensor:**
 - This week: wire-bonding
 - March/April 2015: electrical tests and characterization @ ANKA
- **InGaAs sensor:**
 - Performance of GOTTHARDS with InGaAs?
 - Beam tests @ ANKA, ELBE, FLASH

Outlook

- **5 Mfps version:**
 - New PCB design
 - New wire-bonding scheme
 - Final version available in late 2015 ?

Thank you for your attention!