



Updates on strip modules

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Layout considerations

- Front-end size
- Chip positioning on the staves
- Concept of a hybrid bus
- Possible ideas for on-stave power and signal routing

Front-end size

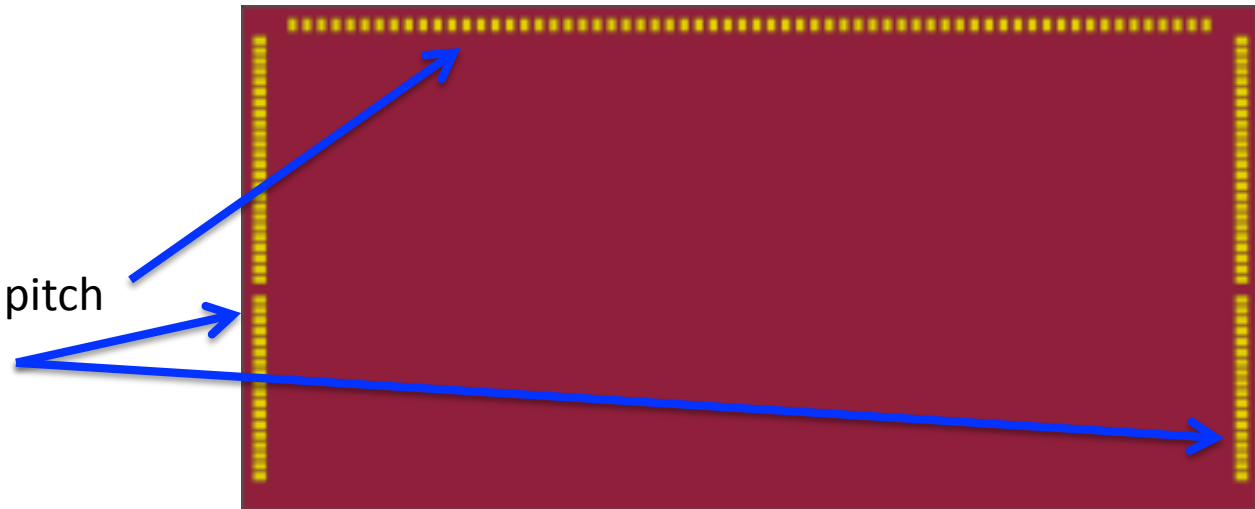
TOFPET layout:

7.15 x 3.55 mm² die

Front-end pads: 102.2 μm pitch

Lateral pads: 73 μm pitch

Back-end pad-free



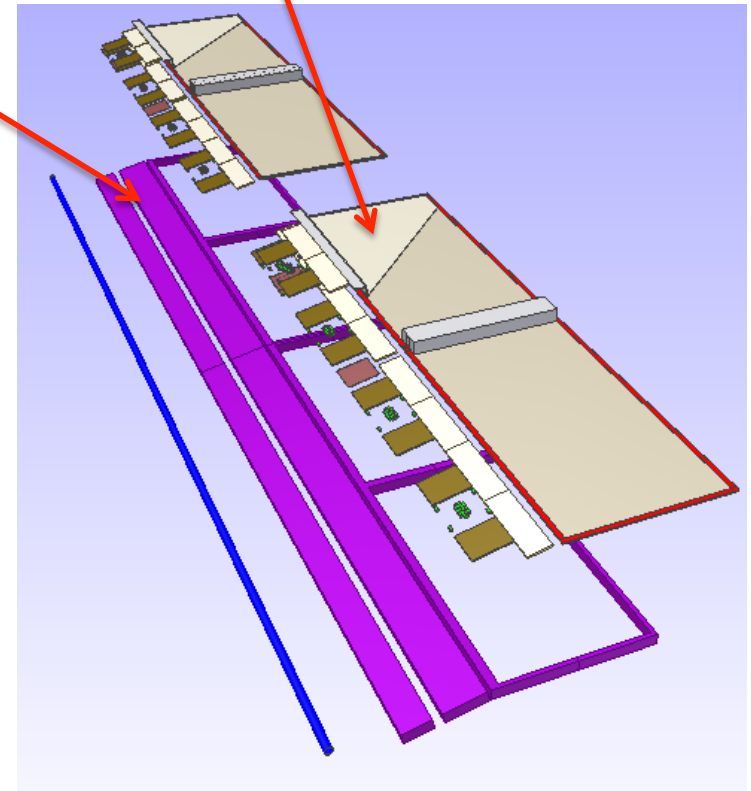
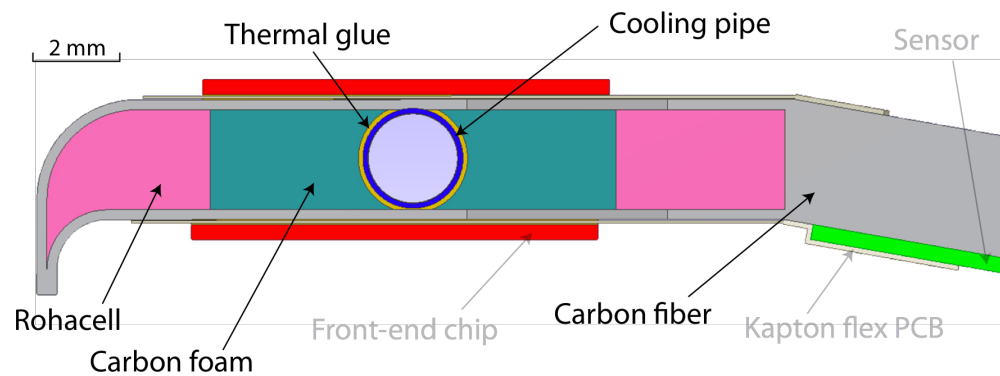
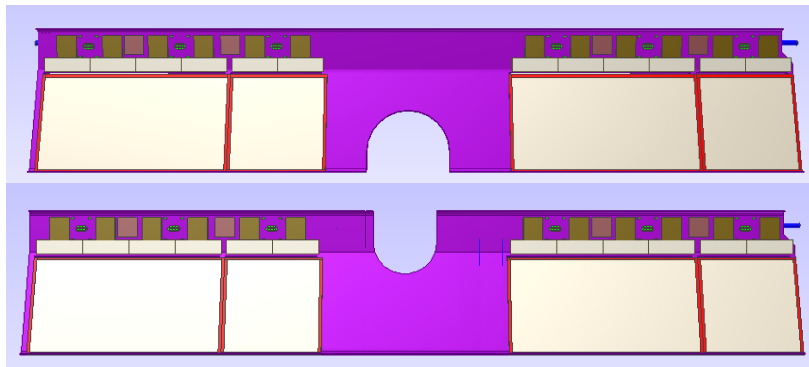
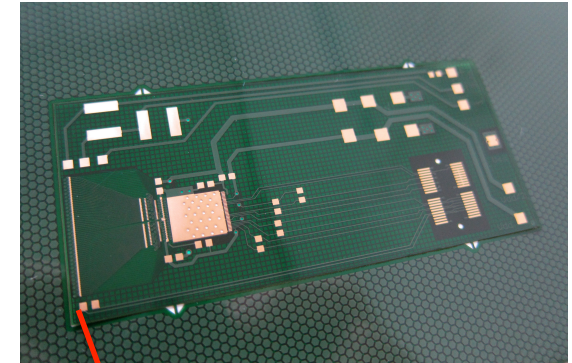
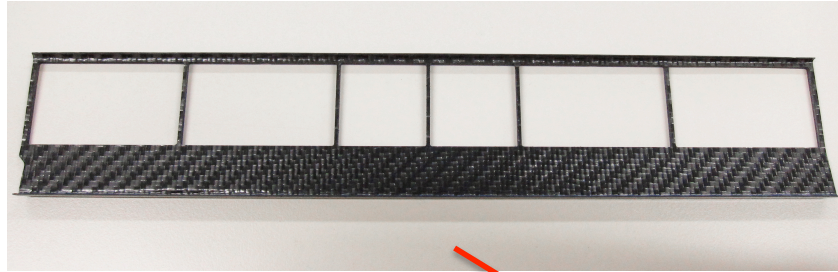
Working hypothesis:

64-channels 7.15 x 4 mm² chip

FE pads: 102.2 μm pitch (sensor pitch: 130 μm)

Lateral/back pads ???

Stave layout – general scheme



Chip arrangement on stave

Barrel 3, internal (p-side)

32 chips = 228.8 mm

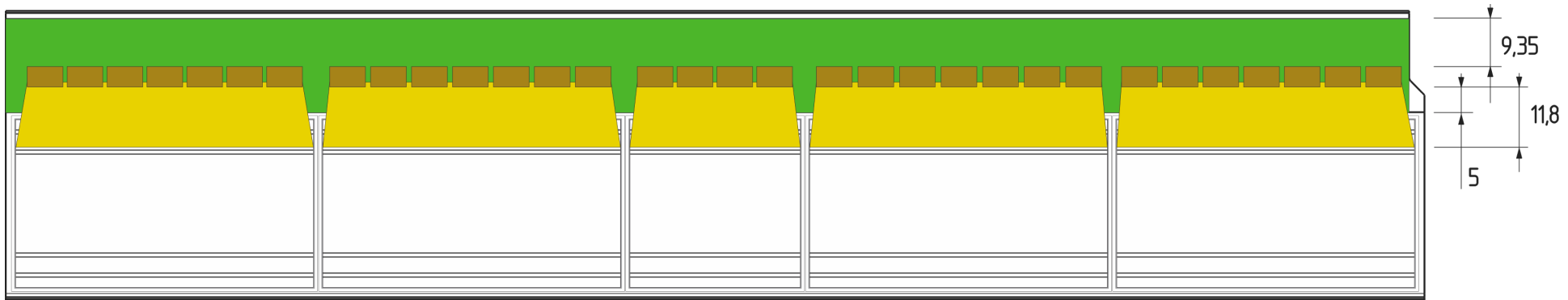
Available length = 275.1 mm

Total free space = 46.3 mm (average 1.5 mm between two chips)

→ Space is not sufficient for wire bonding on the short sides!!

Total flex size: 18.35 x 275.1 mm²

Available space for back-end routing: 9.35 x 275.1 mm²



Chip arrangement on stave

Barrel 3, external (n-side)

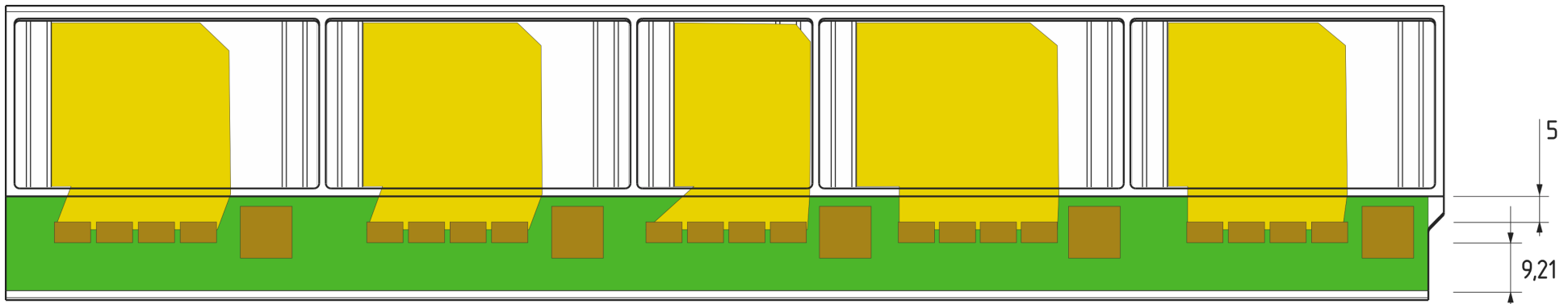
20 chips = 142 mm + 5 MDC = ????

Available length = 275.1 mm

Free space in z-direction should not pose problems.

Total flex size: 18.2 x 275.1 mm²

Available space for back-end routing: 9.2 x 275.1 mm²



Chip arrangement on stave – BL4

External → p-side; 36 chips = 255.6 mm

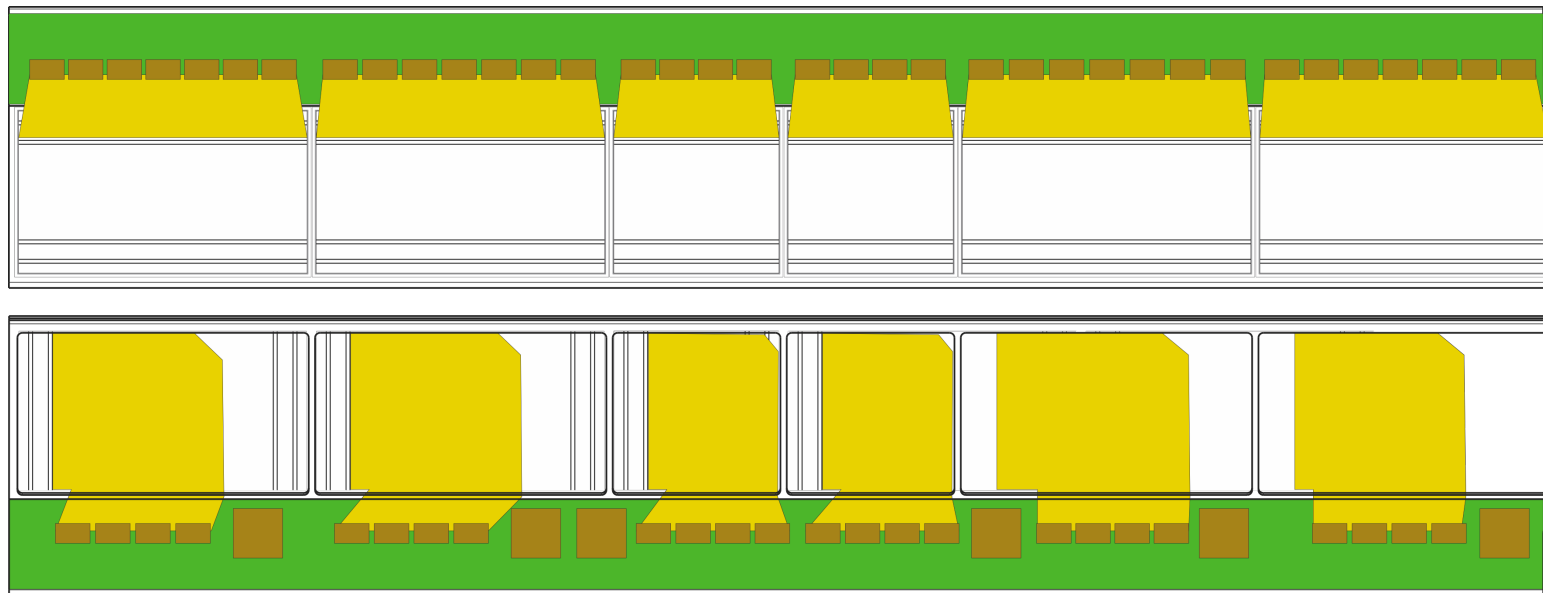
Internal → n-side; 24 chips = 170.4 mm + 6 MDC = ????

Available length = 310.3 mm

Total free space on p-side = 54.7 mm (average 1.6 mm between two chips)

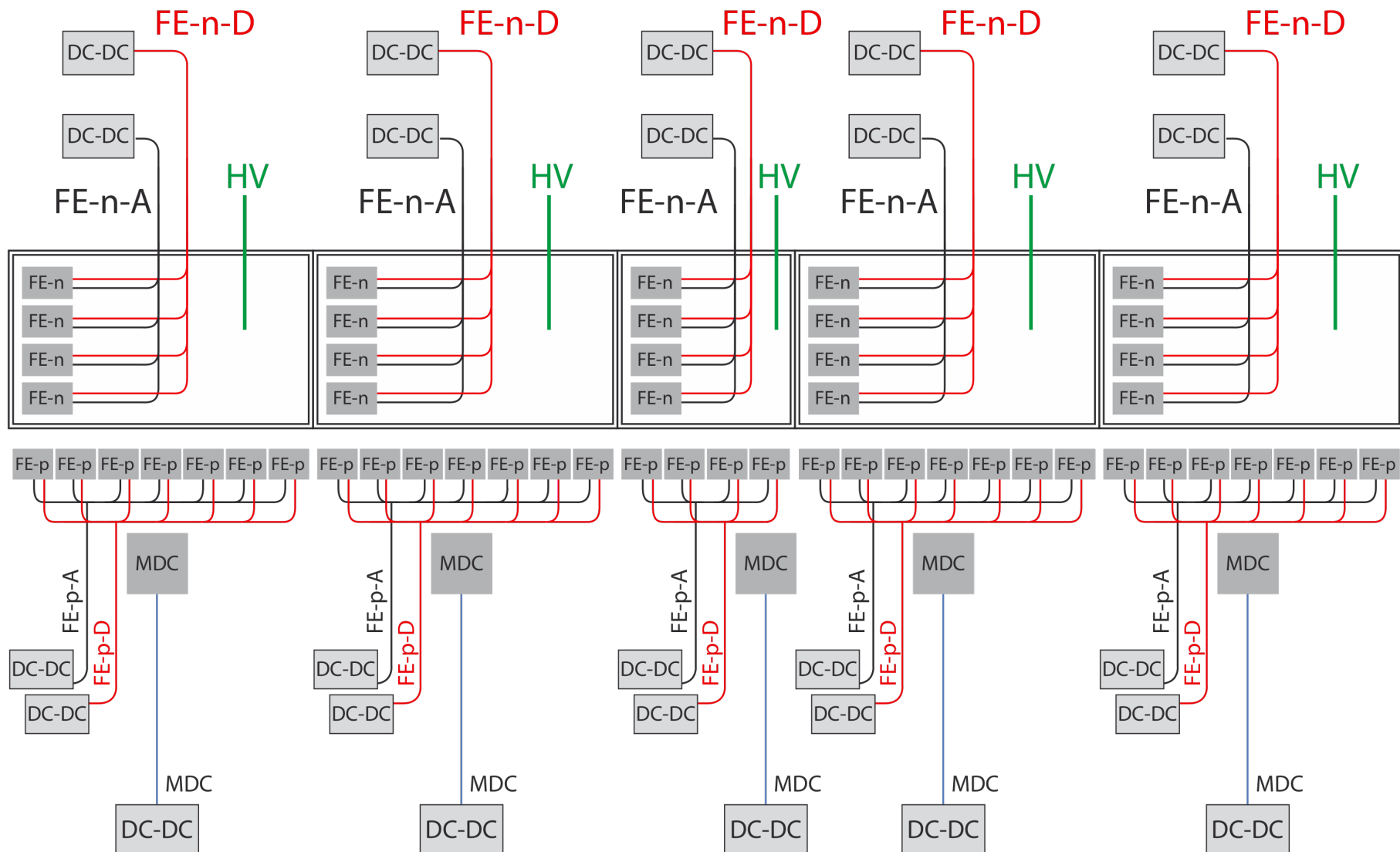
Total flex size: $18.2 \times 310.3 \text{ mm}^2$

Available space for back-end routing: $9.2 \times 310.3 \text{ mm}^2$



Powering concept - staves

N.B. each line in this schematic has two wires!



Chip powering - on-stave routing

Number of incoming power lines per stave (worst case: barrel 4)

External (p-side)

FE_digital: $4 \times 0.71 \text{ mm}^2 + 2 \times 0.40 \text{ mm}^2$

FE_analog: $4 \times 1.29 \text{ mm}^2 + 2 \times 0.74 \text{ mm}^2$

- MDC: $0.25 \text{ A @ } 2.5 \text{ V} = 625 \text{ mW}$
- FE analog: $0.275 \text{ A @ } 1.2 \text{ V} = 330 \text{ mW}$
- FE digital: $0.15 \text{ A @ } 1.2 \text{ V} = 180 \text{ mW}$

Internal (n-side)

FE_digital: $6 \times 0.40 \text{ mm}^2$

FE_analog: $6 \times 0.74 \text{ mm}^2$

MDC: $6 \times 0.17 \text{ mm}^2$

4 7-chips- and 2 4-chips-groups on the p-side

only groups of 4 chips on the n-side

Total of **30 power domains (60 physical wires)**, total section 36.3 mm^2

(with $12 \mu\text{m}$ of Cu on the flex bus, one needs a bus width of 1.5 m !

→ Section must be reduced and thickness increased on stave)

Chip bias pads

Where to put bias pads?

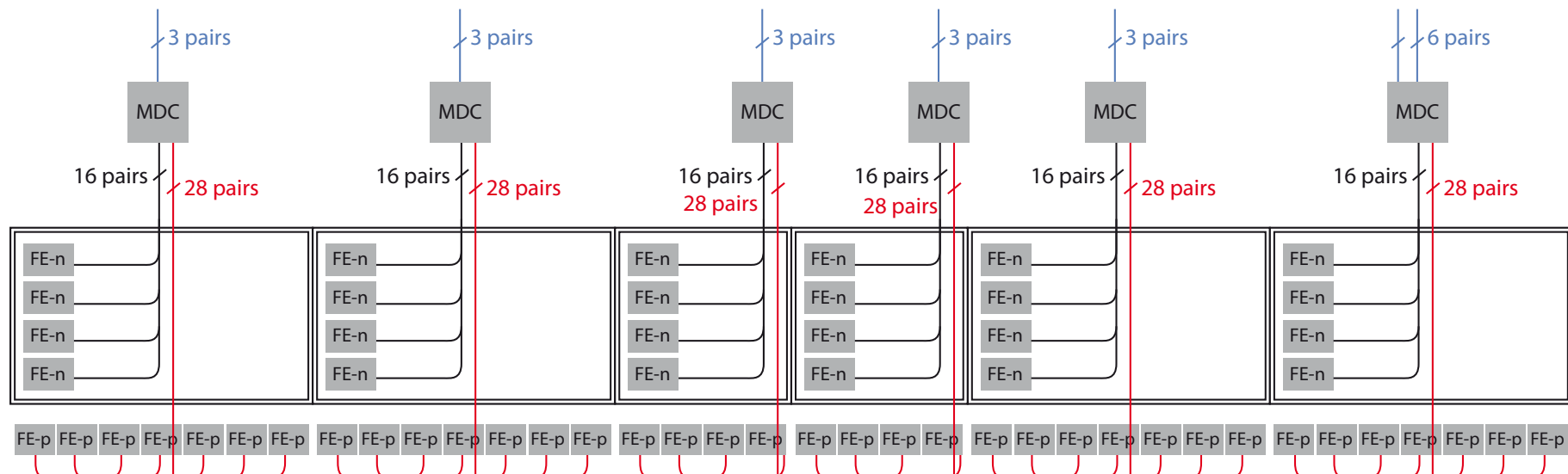
- front-end (APV-like layout)
 - fanout layout problematic
- lateral sides (TOFPET-like layout)
 - No wire bonding possible;
another solution is required to
connect the chip to the bus
(e.g. a separate power bus
above the chips with tab or
laser bonding)
- back-end
 - Is it feasible/efficient?



p-side – n-side connection

Why is it needed?

- I/O is performed only through the MDC, which sits on the n-side
- the p-side chips must be connected to the MDC
- there are 4 differential pairs (1 elink + 1 pair) from each FE to the respective MDC
→ 56 physical lines for rectangular sensors and 32 for squared ones



Data output lines

Number of e-links:

- each “red” sensor: 2 e-links
- each “blue” sensor: 1 e-link

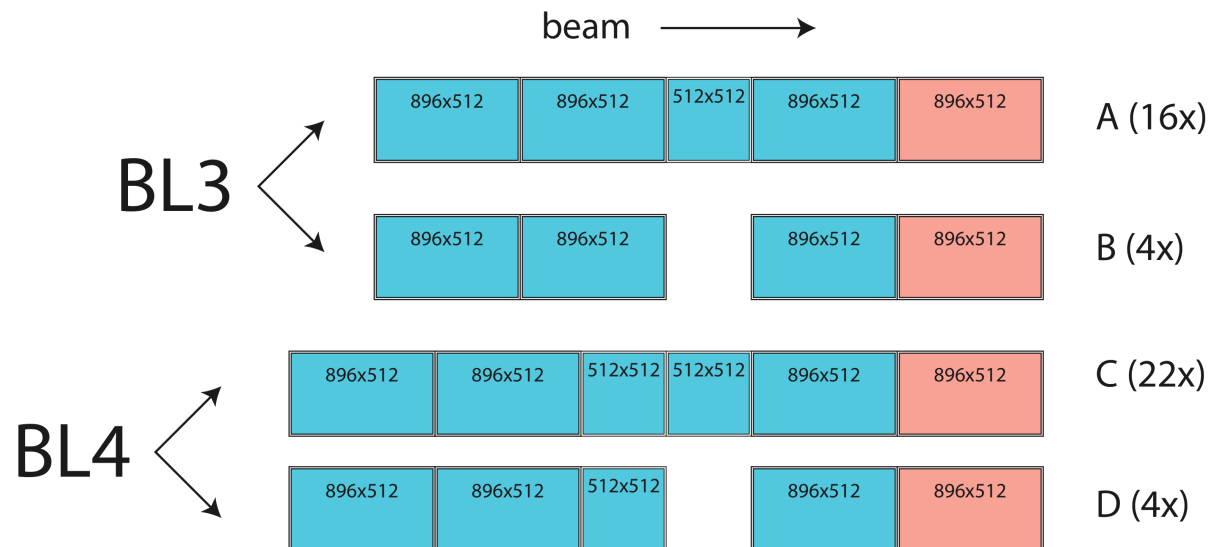
e-links per stave:

- A-type: 6 e-links
- B-type: 5 e-links
- C-type: 7 e-links
- D-type: 6 e-links

Number of data lines:

- 3 differential (=6 single ended) lines per e-link
- 16 single-ended lines per stave

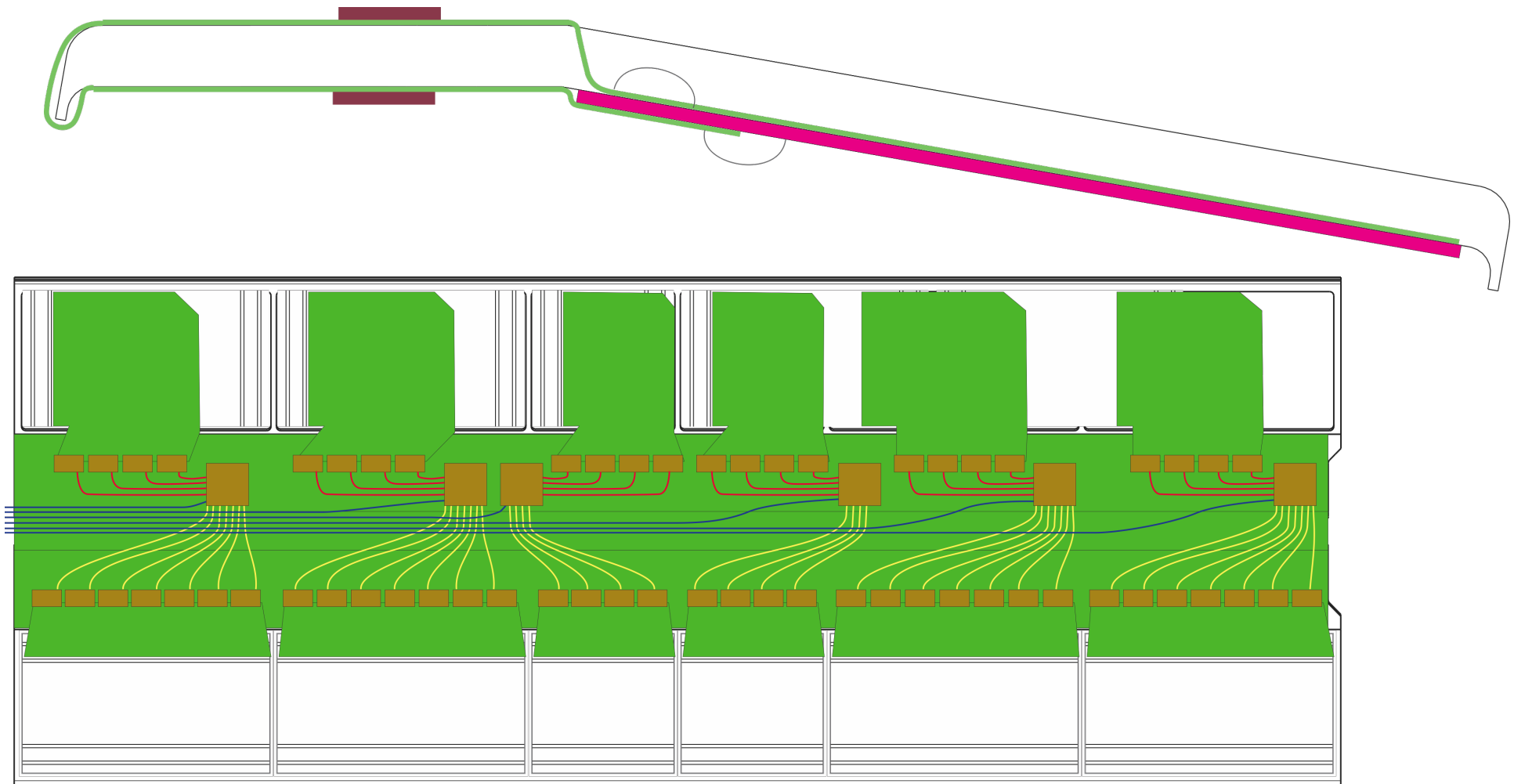
- A-type: $6 \times 6 + 16 = 52$ s.e. lines
- B-type: $5 \times 6 + 16 = 46$ s.e. lines
- C-type: $7 \times 6 + 16 = 58$ s.e. lines
- D-type: $6 \times 6 + 16 = 52$ s.e. lines



p-side – n-side connection

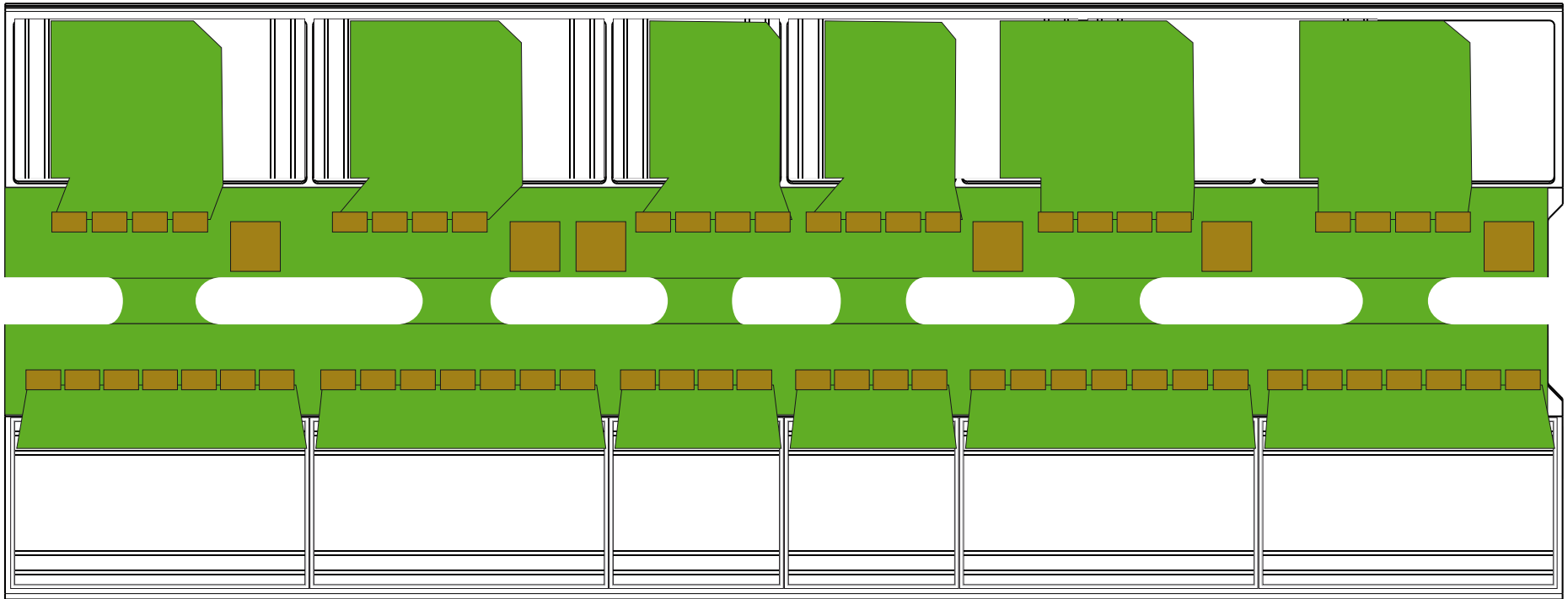
Possible solution: large flex folded on the stave

In barrel 3, two cutouts in the flex are needed for the sawtooth structure



p-side – n-side connection

Alternative layout, with cutouts in the folded part:



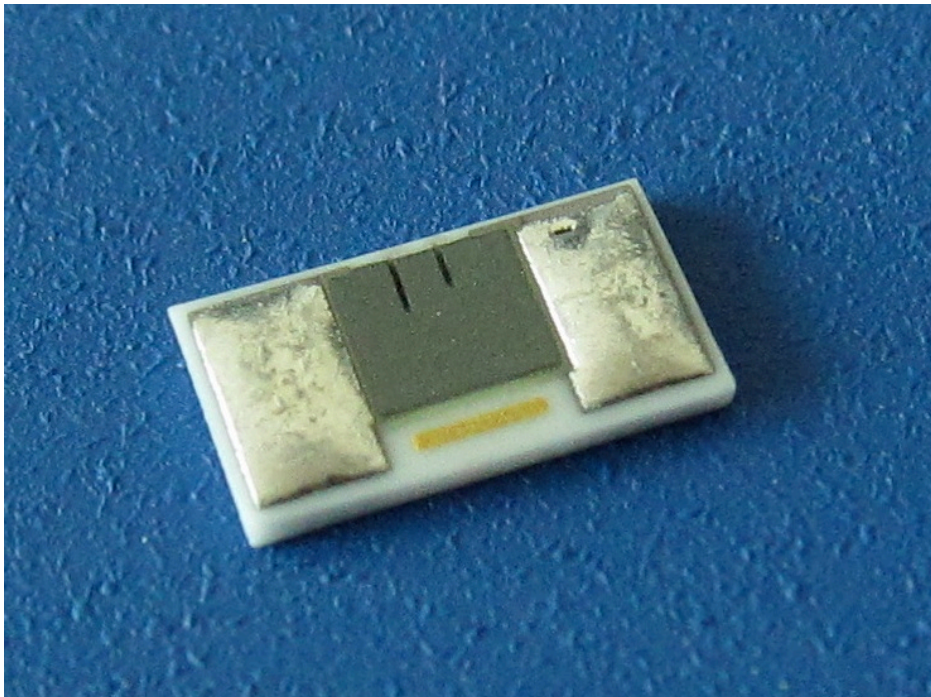
Recent hardware developments

- Resistors for thermal tests
- Rigid sensor module
- Flex sensor module
- Lab equipment in Gießen

Resistors for thermal tests

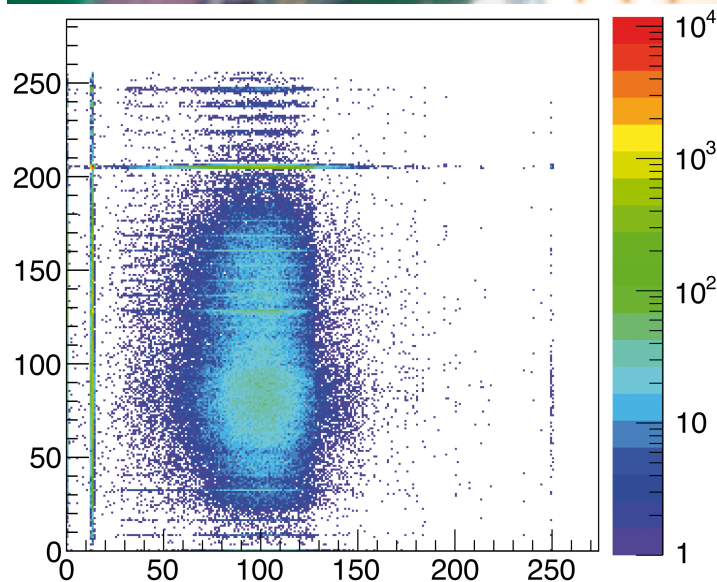
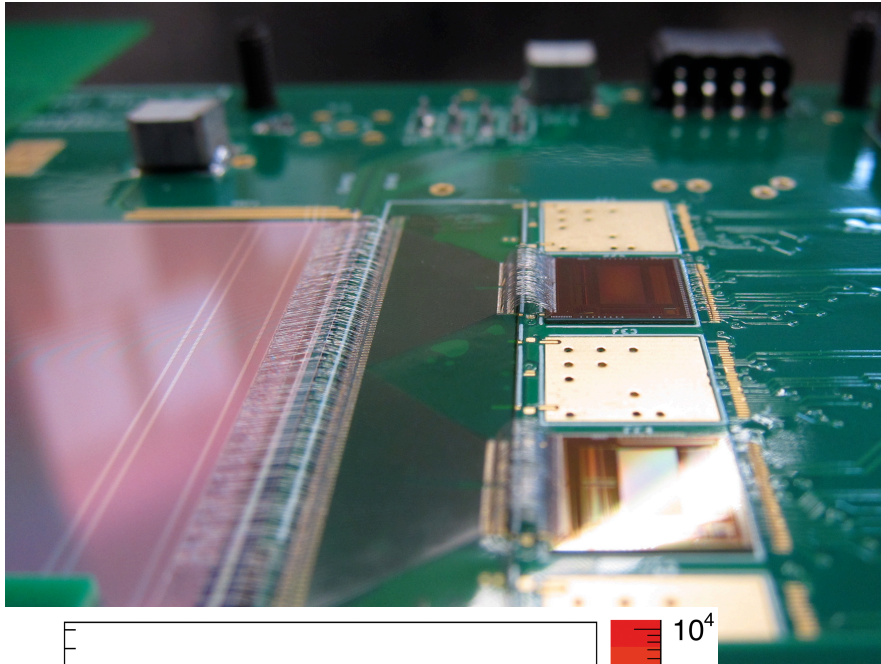
Dummy-chip resistors:

- size 7.15 x 4 mm
- maximum power 600 mW (nominal 256 mW)
- gold-plated bonding pad for connection between sensor and dummy chip

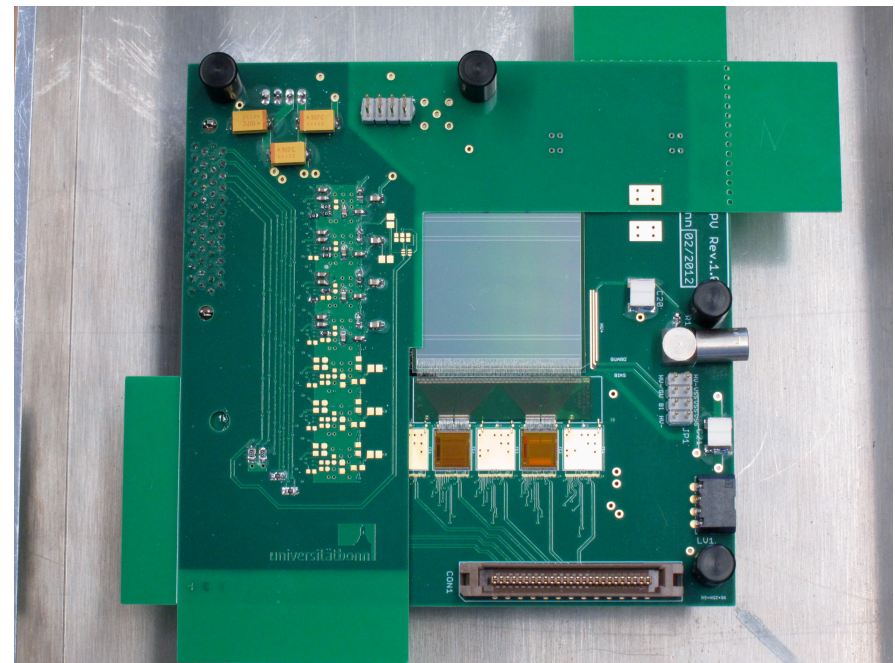


Useful for future tests of the cooling system in collaboration with ZEA-1, Jülich

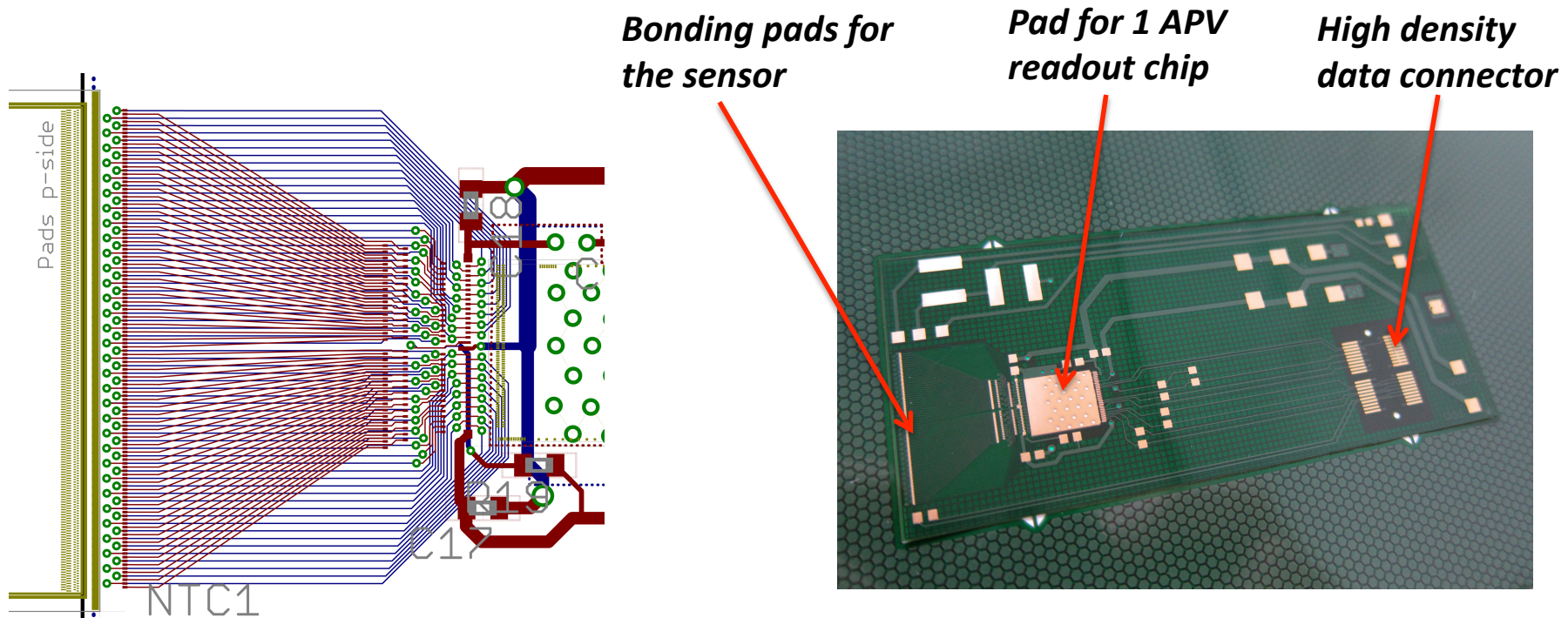
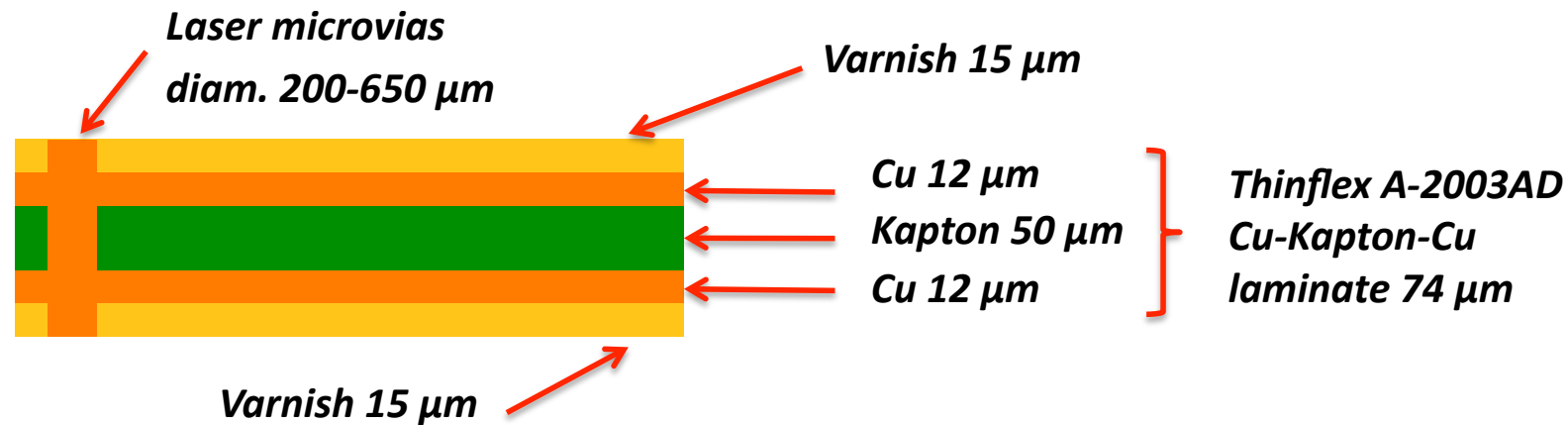
Rigid sensor module



- Flex-PA and squared sensor assembled on a test board and tested at SPS, CERN (September 2012)
- Lab tests in progress
- Similar module with rectangular sensor will be assembled soon

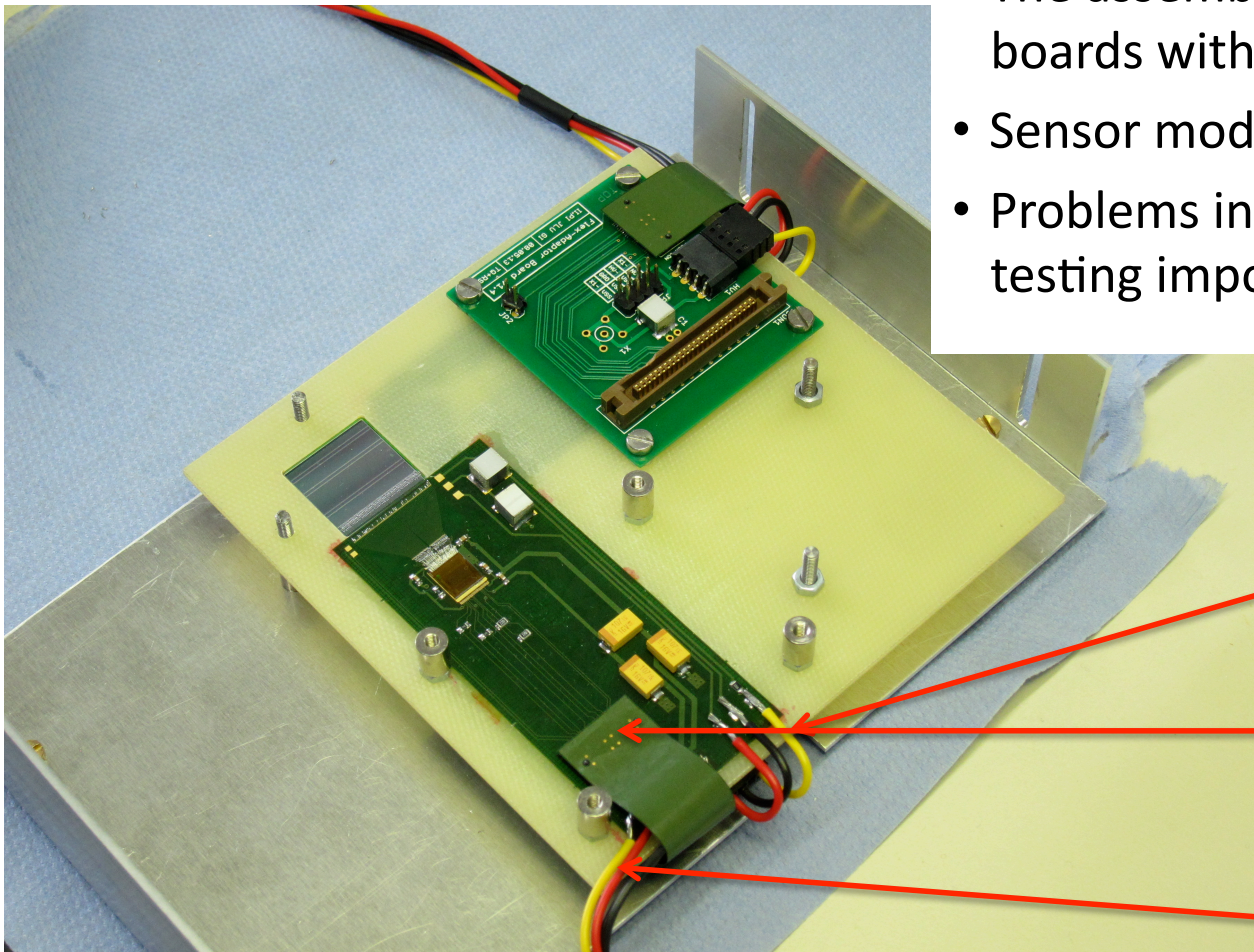


Flex sensor module



Flex sensor module

- Two flex boards with 1 APV each read out both sides of a 2x2 cm² sensor
- The assembly features two transition boards with larger connectors
- Sensor module complete and ready (?)
- Problems in the APV bonding make testing impossible until repair



*Sensor biasing
connectors*

*High density
data cable*

*APV power
supply connector*

Lab equipment in Gießen

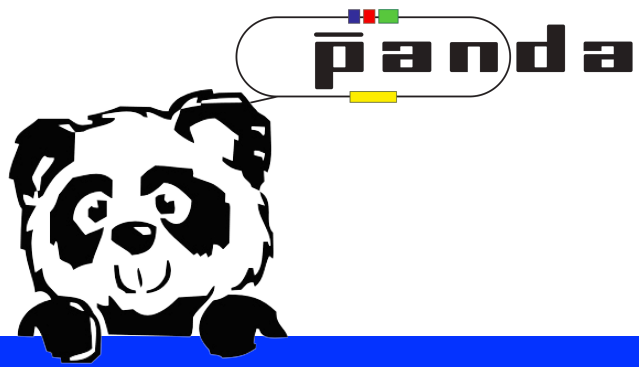
- Until now: cleanroom with tables and chairs
- Microscope
- Bonding machine (still in a box)
- ...



Lab equipment in Gießen

...probe station!





Thank you for your attention!