Integration of the strip barrel staves of the PANDA Micro Vertex Detector

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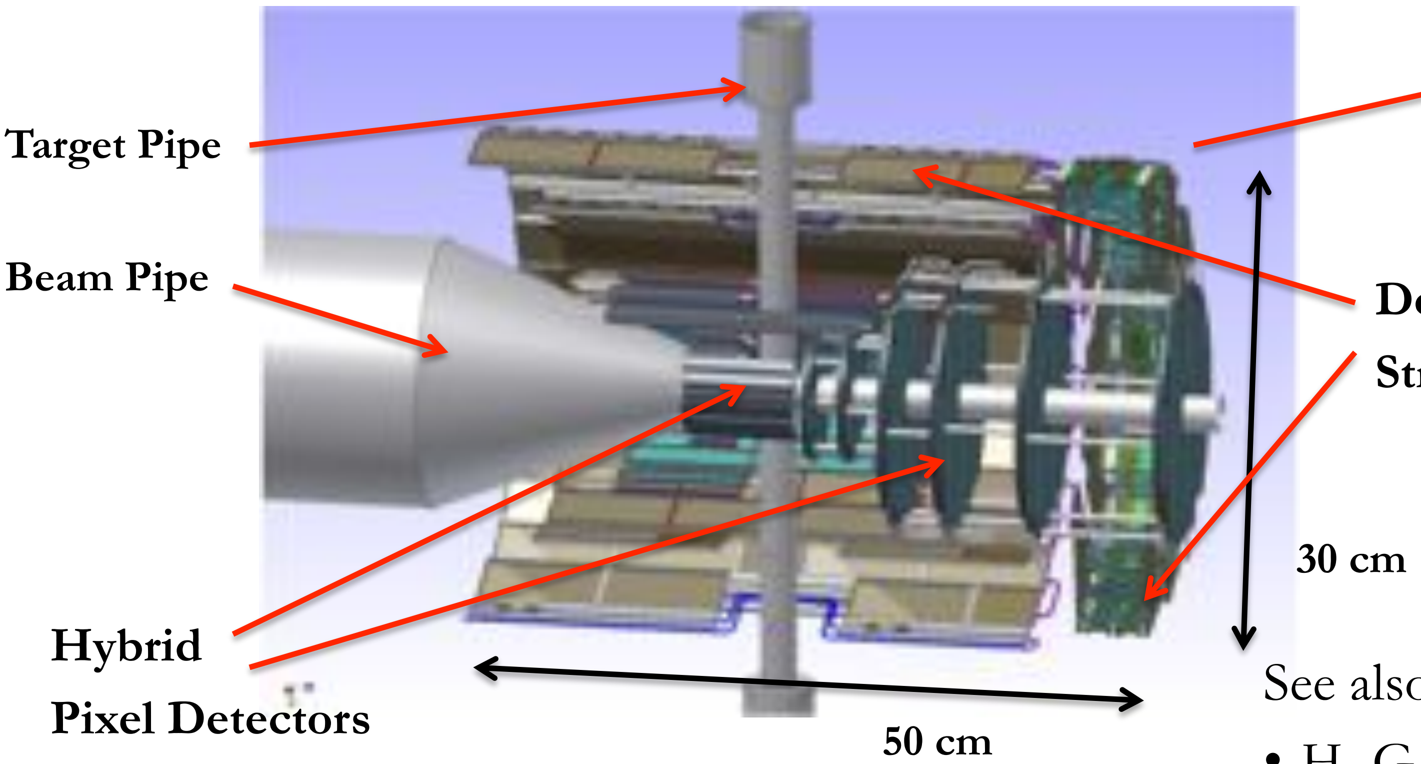
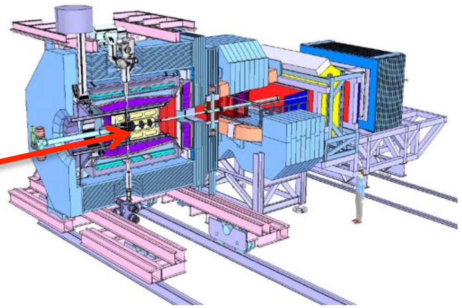
The Micro Vertex Detector

- Vertex reconstruction with high spatial (<100 µm) and time (<6 ns) resolution
- High rate capability ($2 \cdot 10^7$ pbar-p ann./s) and triggerless readout
- Low material budget (<10% radiation length overall) and high radiation tolerance



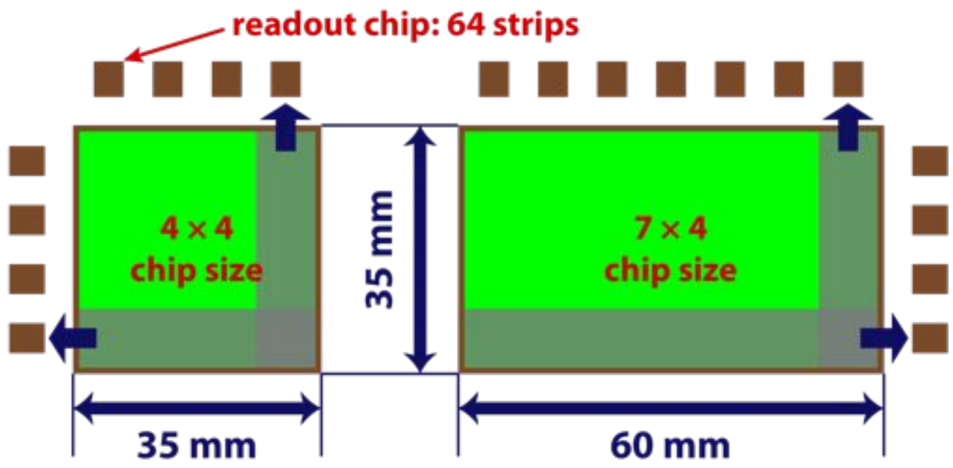


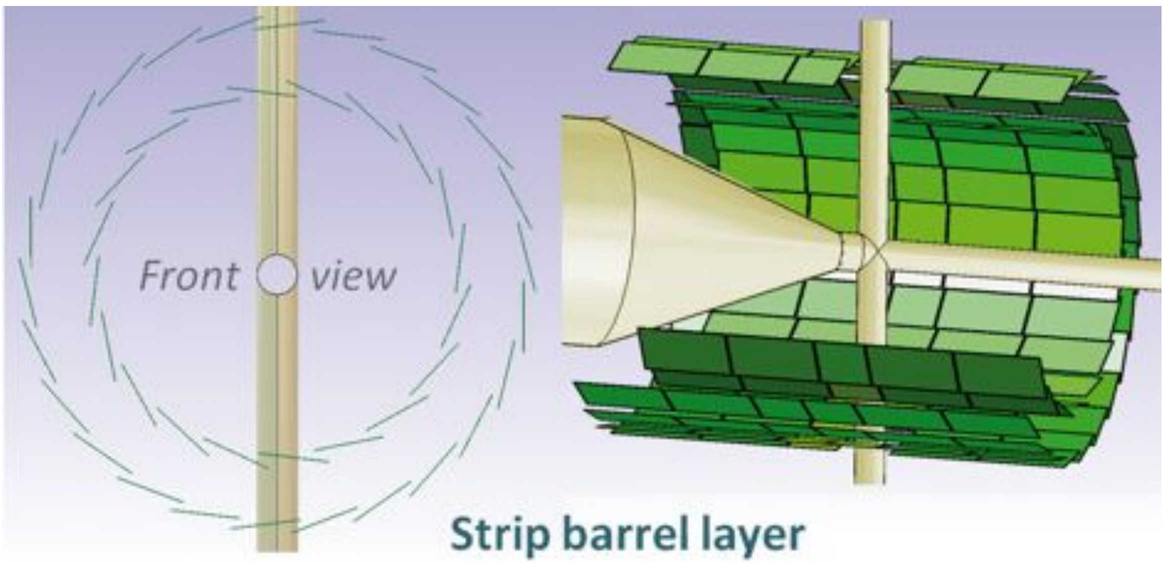
See also:

- H.-G. Zaunick, HK34.2
- D. Deermann, HK46.91

Strip Barrels – Design Concept

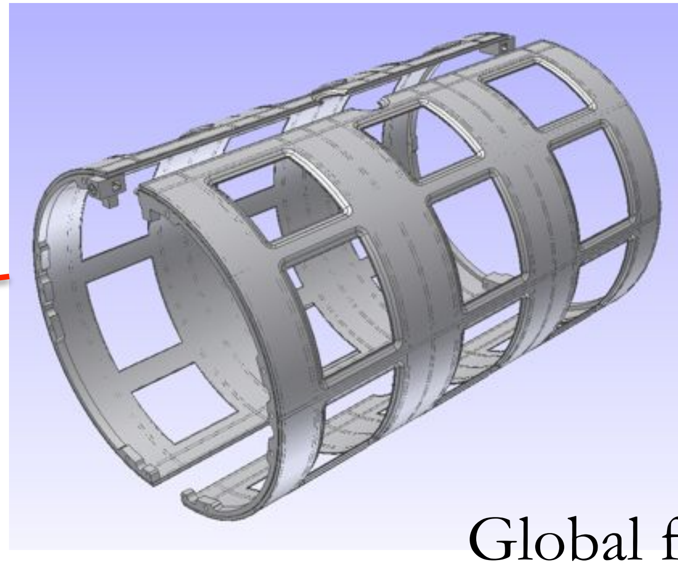
- Rectangular (512 × 896 channels) and squared (512 × 512 channels) sensors
- Stereo angle: 90°, strip pitch 65 µm
- Readout every second strip
- Two barrels at r = 92 and 125 mm
- 4 – 6 sensors on each of the 46 staves (248 sensors in total)



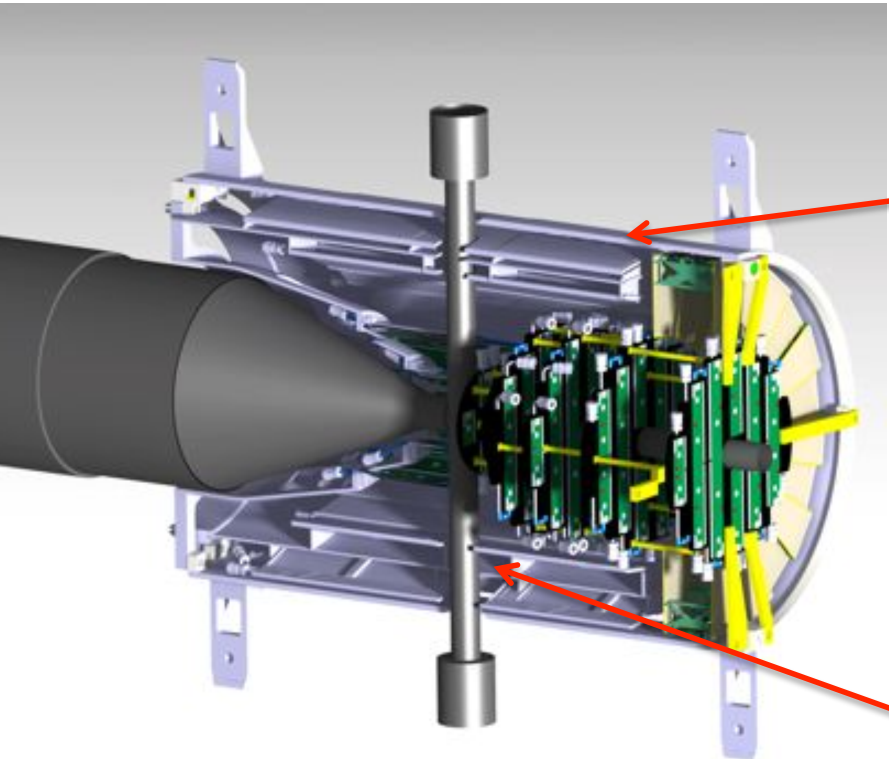


- Coverage: 0.422 m^2
  (70% of the full MVD)
- 162k channels
- ~2500 readout chips
- ~700 W power consumption
- Barrel 3: 20 staves 28 cm long
- Barrel 4: 26 staves 31 cm long

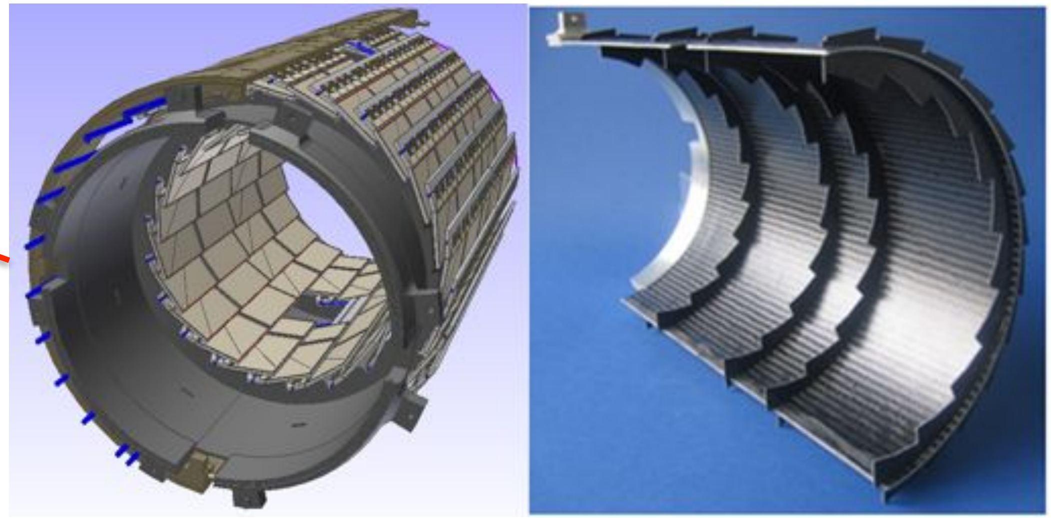
Strip Barrels – Mechanical Integration



Global frame



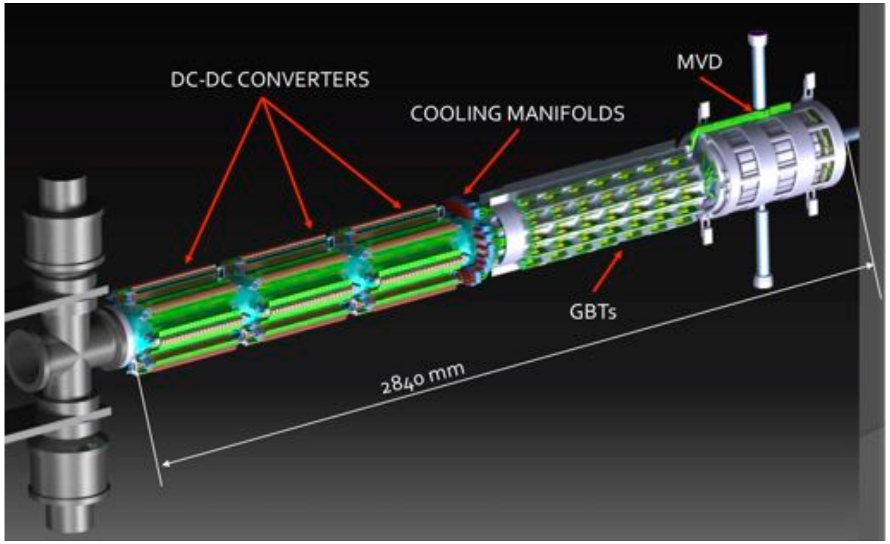
Complete half-detector



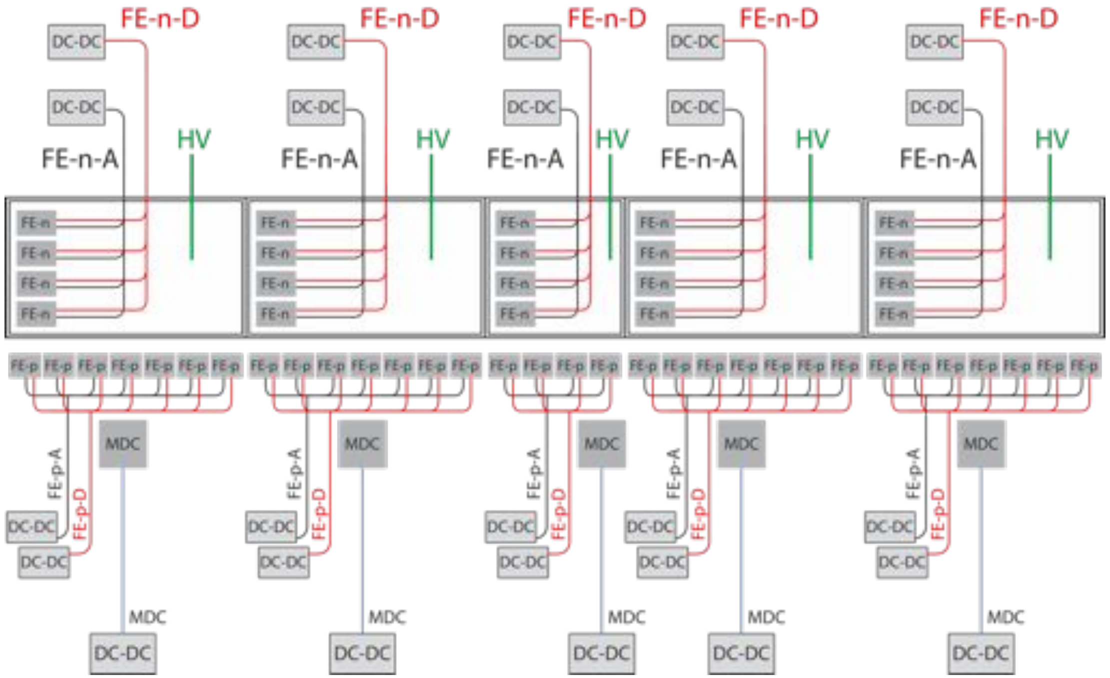
Strip barrels support

Strip Barrels – Powering

- DC-DC powering operating in B=2T
- 5 power domains per sensor
- up to 60 power supply cables per strip barrel stave (up to 4 m long)
- ~1500 converters for barrels + disks (+600 for pixel detector)
- MVD services routing is a crucial issue



SM01C converter (CERN development), soon FEAST

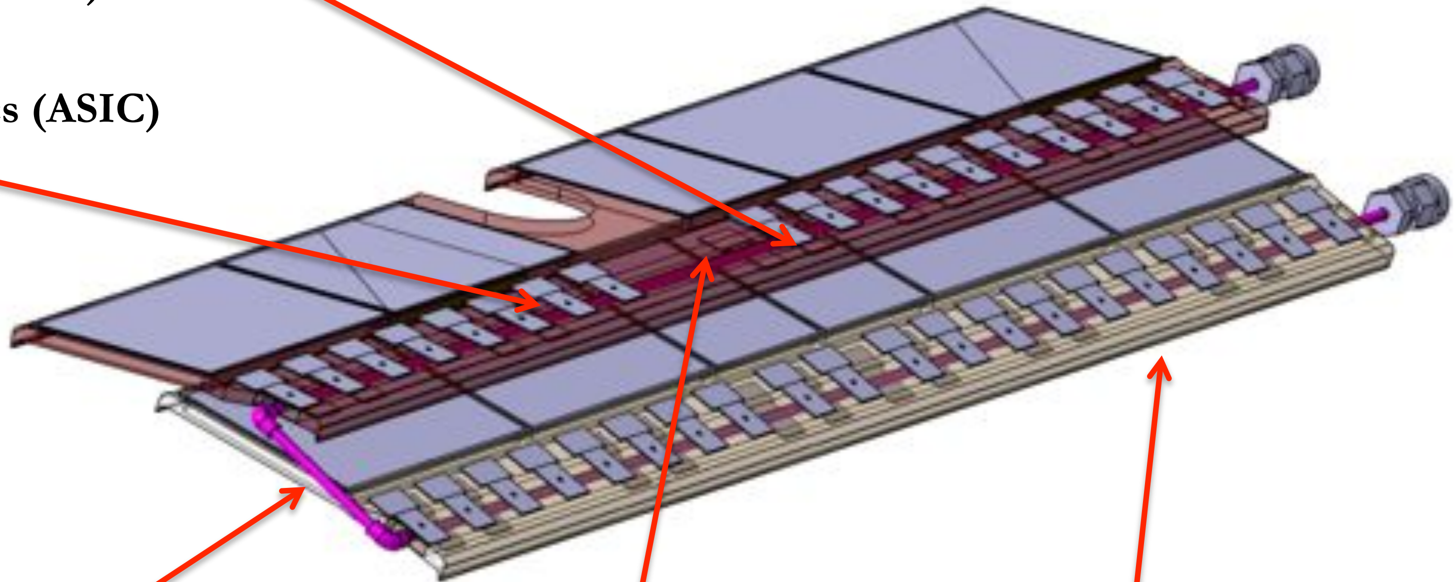


Strip Module – Stave Design I

Strip supermodule:

Module controller (ASIC)

Front-end electronics (ASIC)



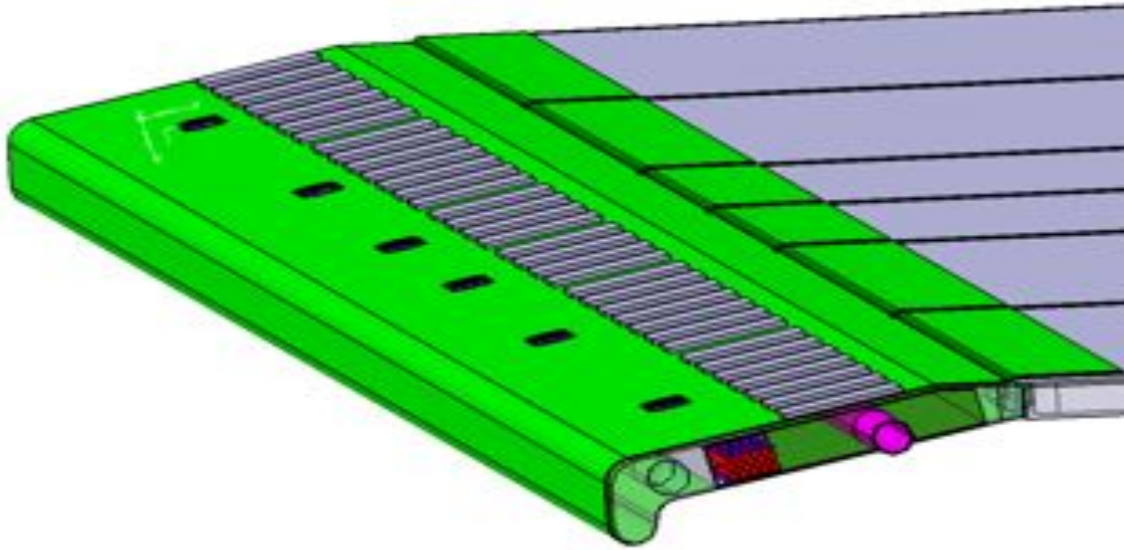
Cooling loop between two adjacent staves

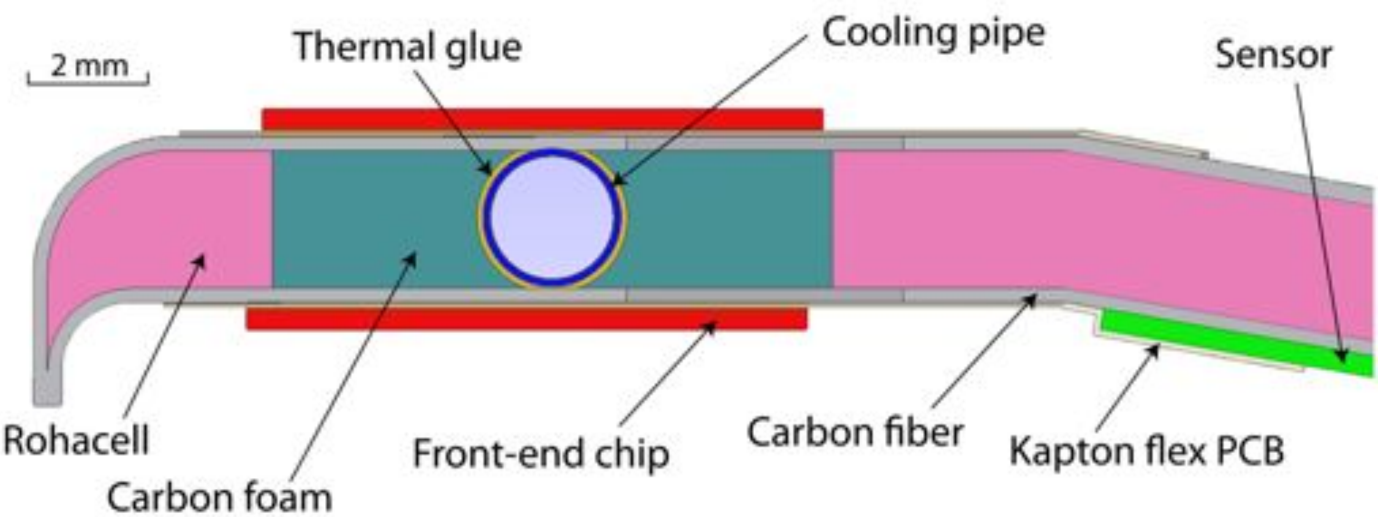
Hybrid PCB

Composite stave with embedded cooling pipe

Strip Module – Stave Design II

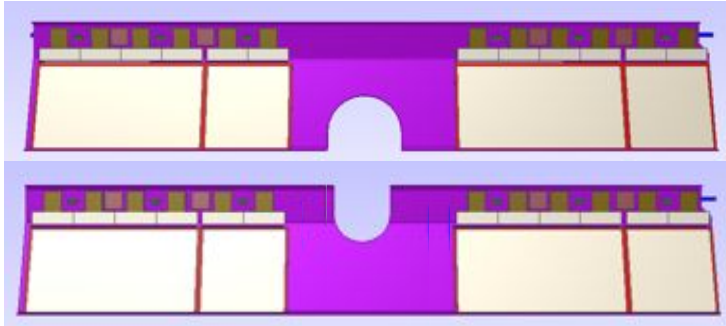
- Sandwich structure of carbon fiber (200 μm) and foam (2 mm)
- Up to 18 W dissipated on one stave → active water cooling
- Embedded cooling pipe in nickel-cobalt alloy (2 mm diameter, 80 μm wall thickness)
- Carbon foam (POCO HTC) in the area around the cooling pipe



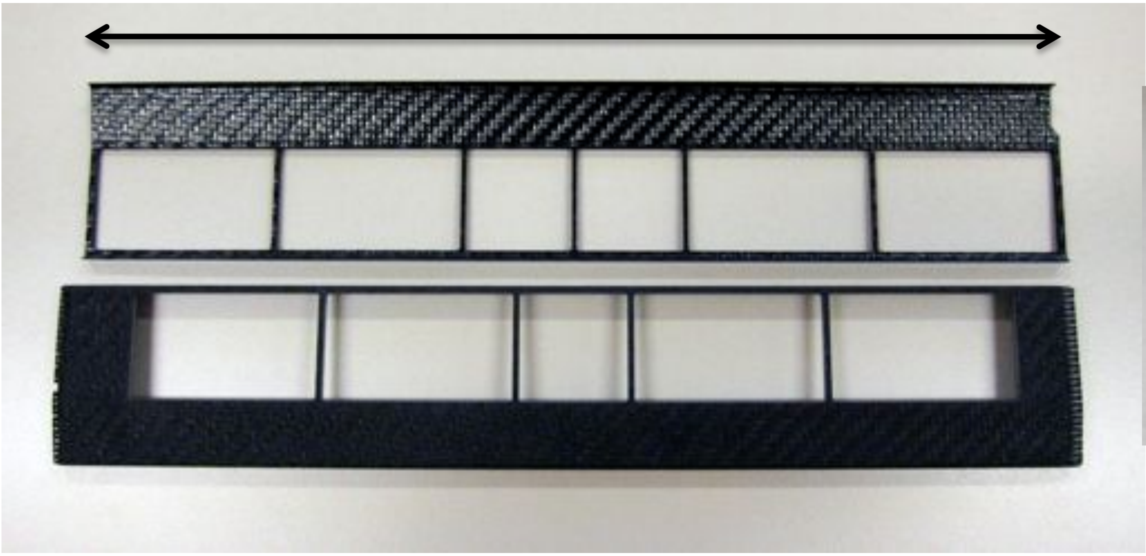


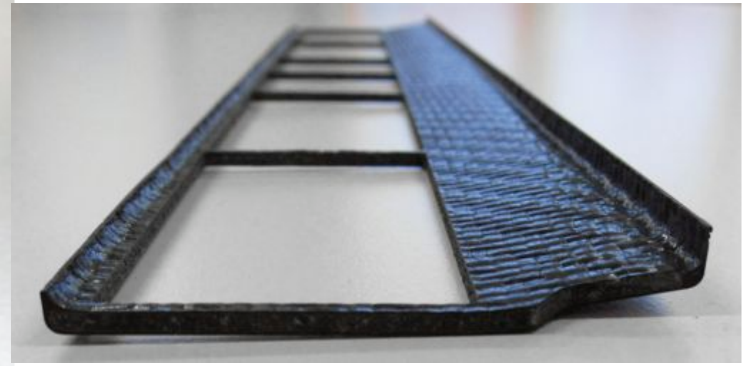
Strip Module – Stave Design III

- Design in collaboration with ZEA-1, Jülich
- Large cutouts for the sensors
- Special design for top/bottom staves around the target pipe
- 6 different designs in total



31.3 cm

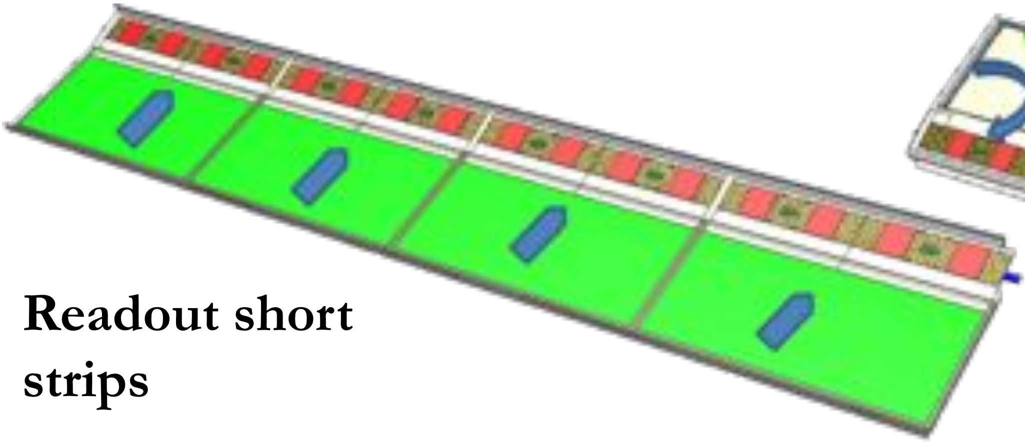




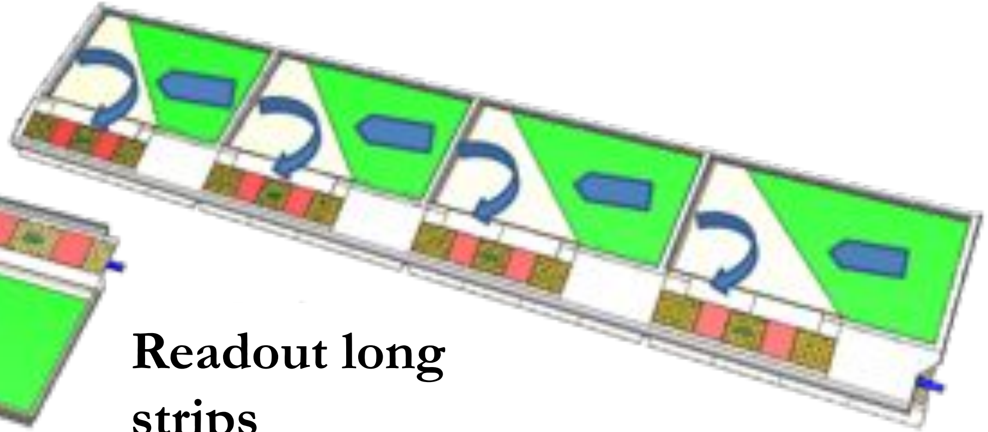
~6 cm

- Thermal tests to validate the cooling system are ongoing

Strip Module – Hybrid Bus I

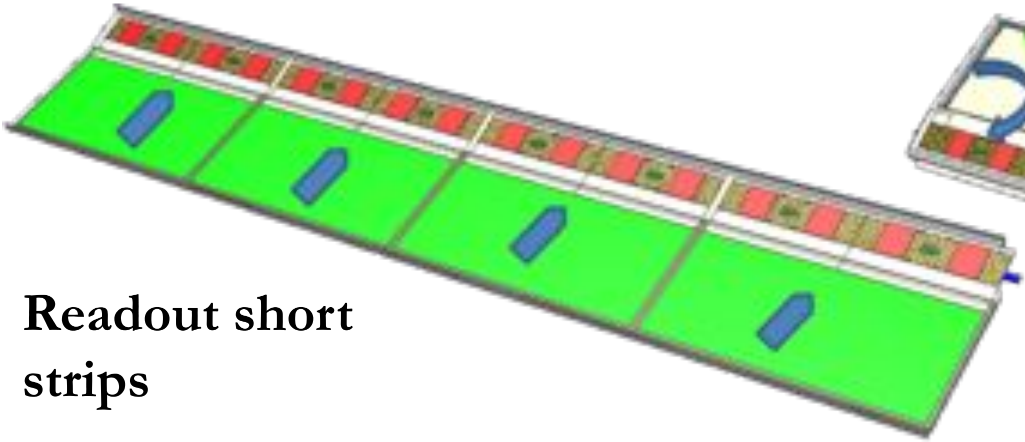


Readout short strips

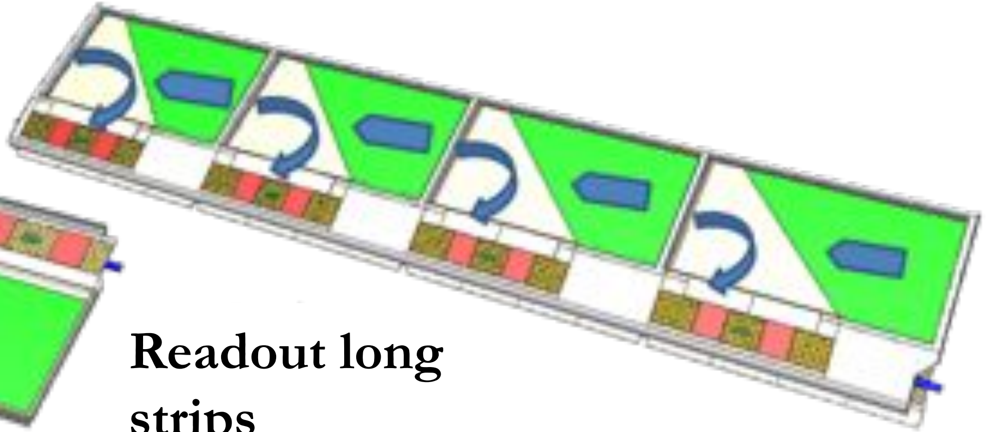


Readout long strips

Strip Module – Hybrid Bus I



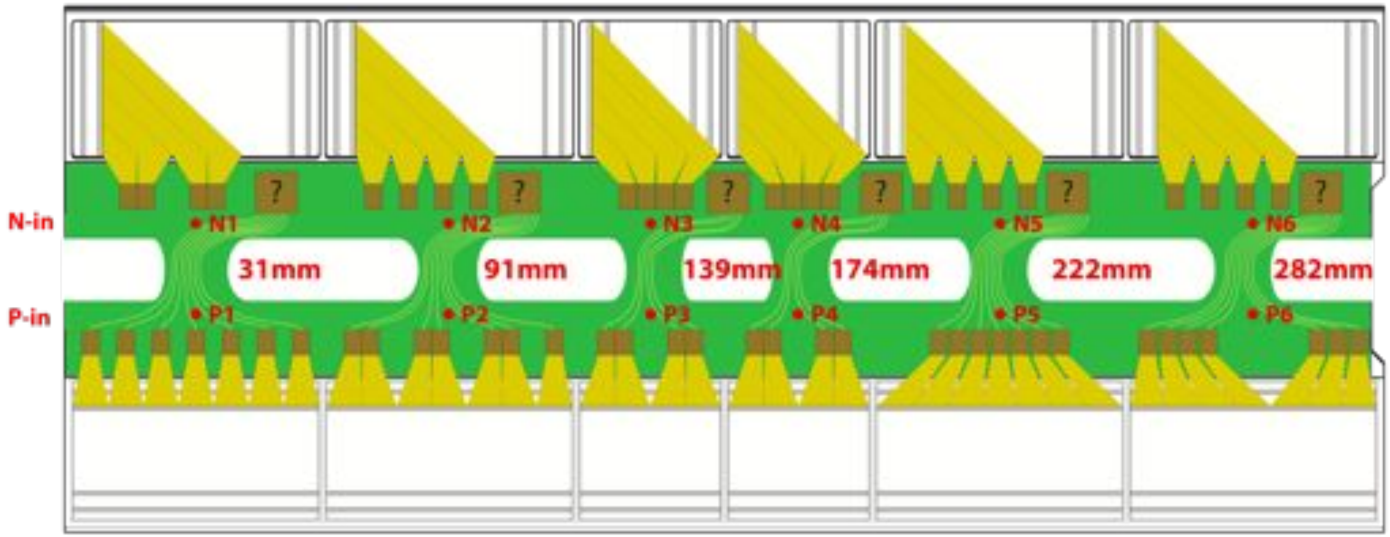
Readout short strips



Readout long strips

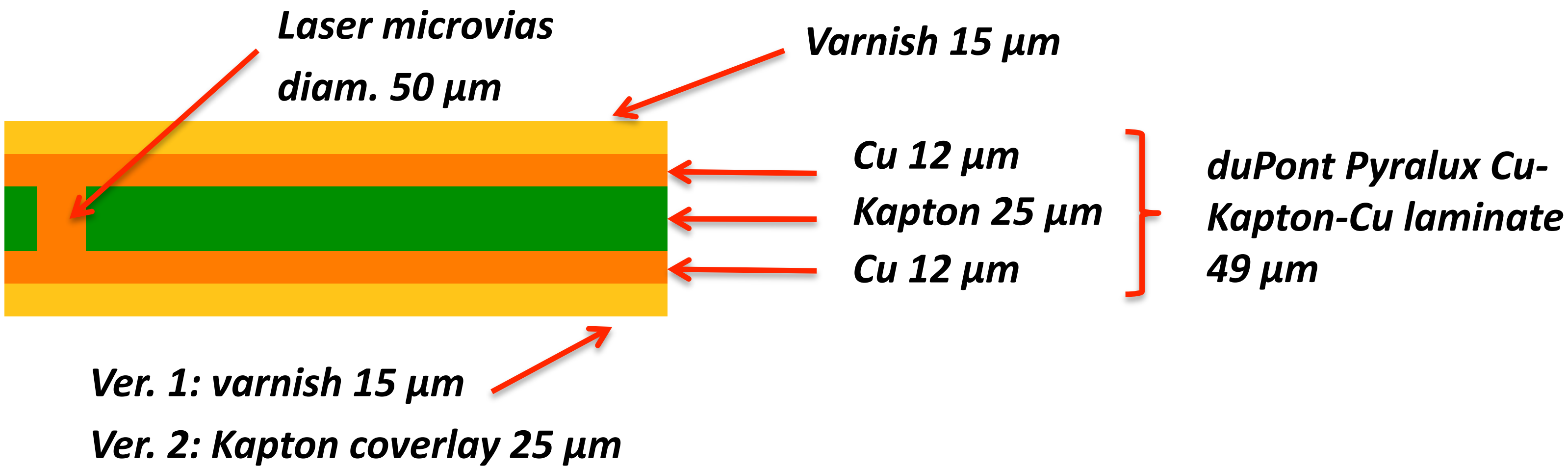
- Connects the sensor and the front-end chips, adapting the pitch
- Distributes I/O signals and power to the chips

Proposal for the full hybrid layout

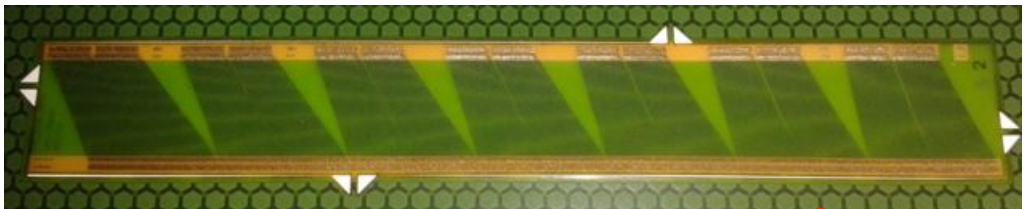


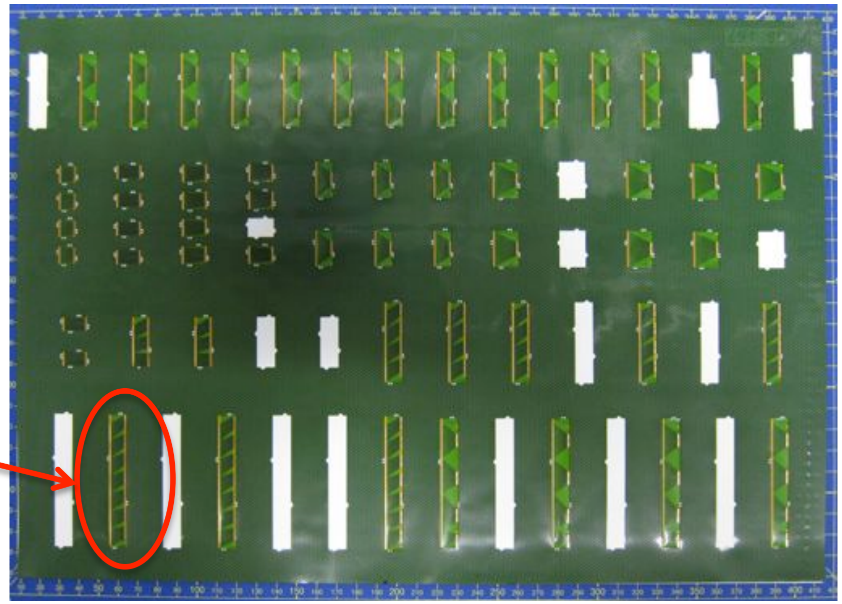
Strip Module – Hybrid Bus II

- First prototypes with flexible technology: flex pitch-adapters



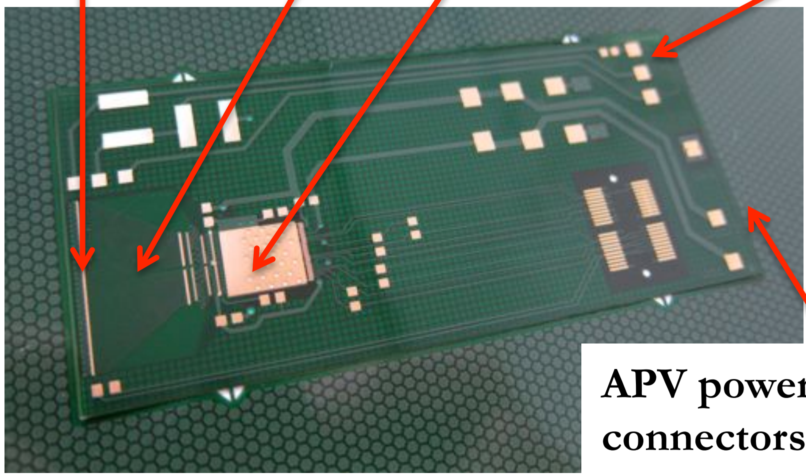
Flex pitch-adapter prototype

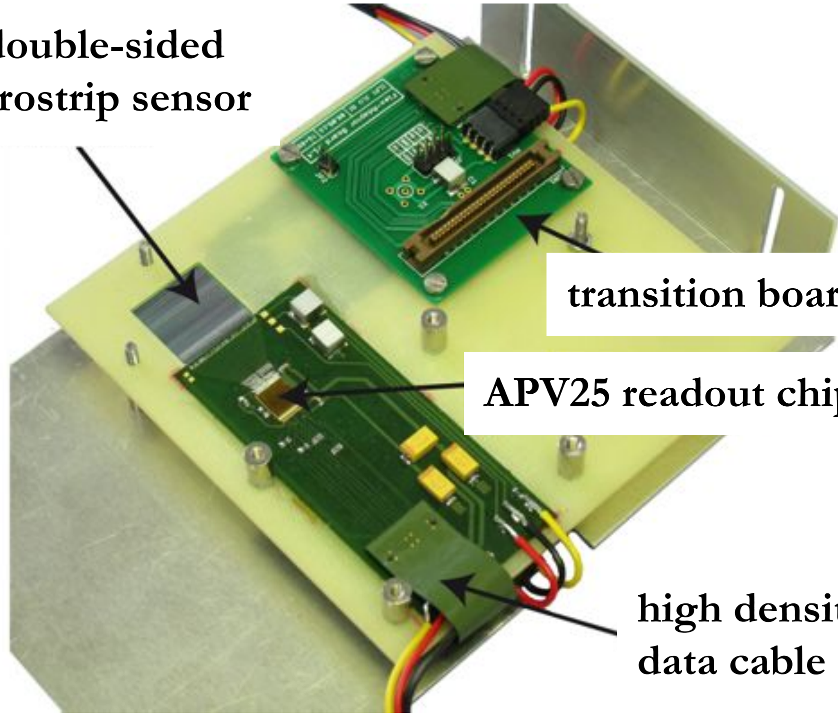




Strip Module – Hybrid Bus III

- Reduced-scale prototype with APV25 readout chip produced





Summary & Outlook

- **The general design of the PANDA MVD is finalized.**

- **Development and validation of components is ongoing:**
  - Carbon fiber stave prototypes under study;
  - Flex pitch adapters and small-scale PCB produced and tested successfully.

- **Some future steps:**
  - Design and test of a full-scale hybrid;
  - Validation of the stave cooling system.

Thank you for your attention!

GEFÖRDERT VOM
Bundesministerium für Bildung und Forschung

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MVD panda

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