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SuperKEKB Commissioning Detector
BEAST II
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Belle II Collaboration

# VXD BEAST

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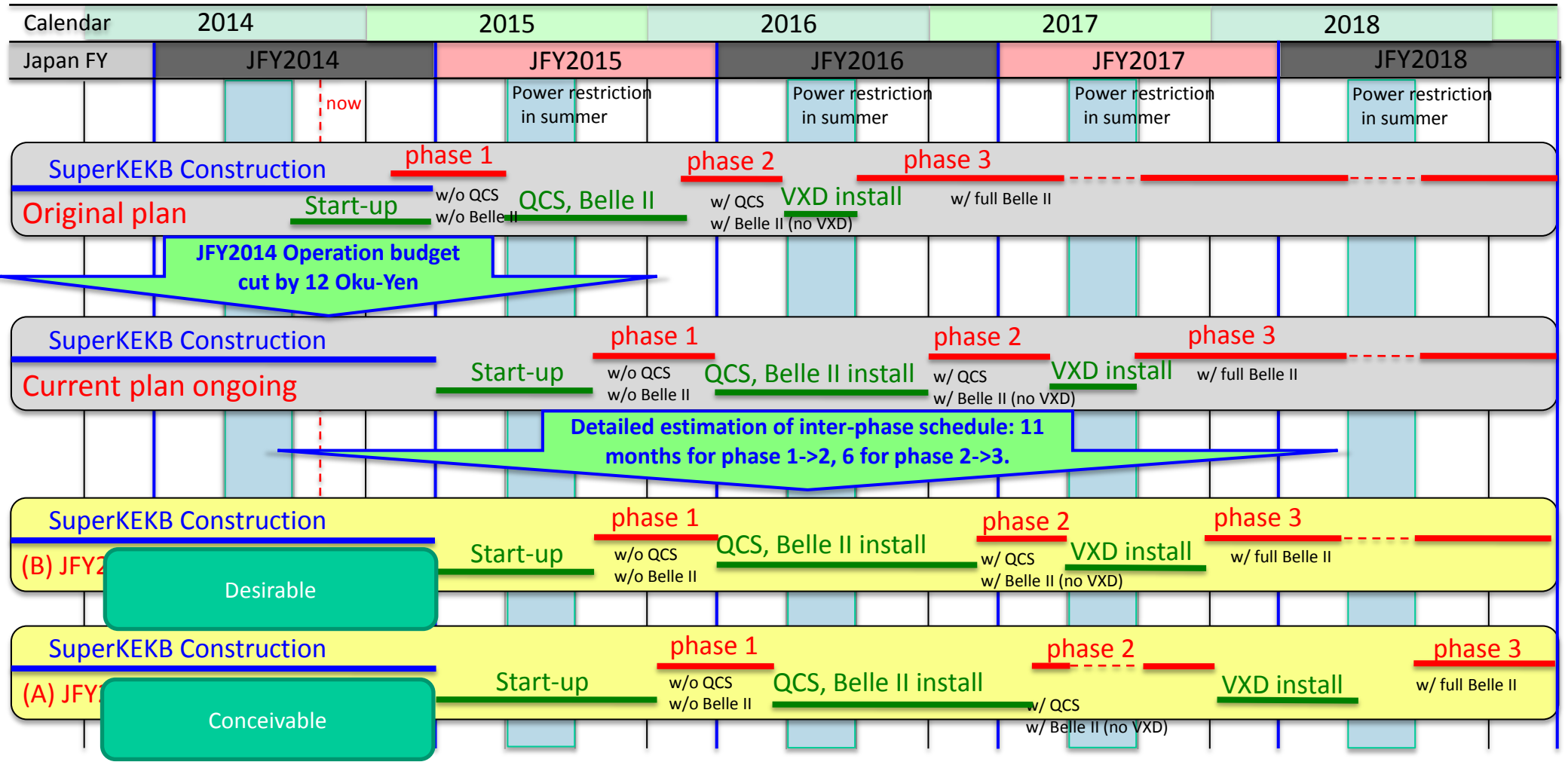
# Schedule




Budget will be clearer in the very end of JFY (?)

# BEAST II Phase 2 Program

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- VXD plans for Phase 2:
  - Belle II on beam line (but VXD)
  - QCS installed
  - Final beam pipe (6.6 µm gold) and heavy metal masks around IP

- Measure individual beam background components: spectrum, rates and time dependence. Determine background status safe for PXD/SVD installation

- Study injection background and exercise gated mode operation

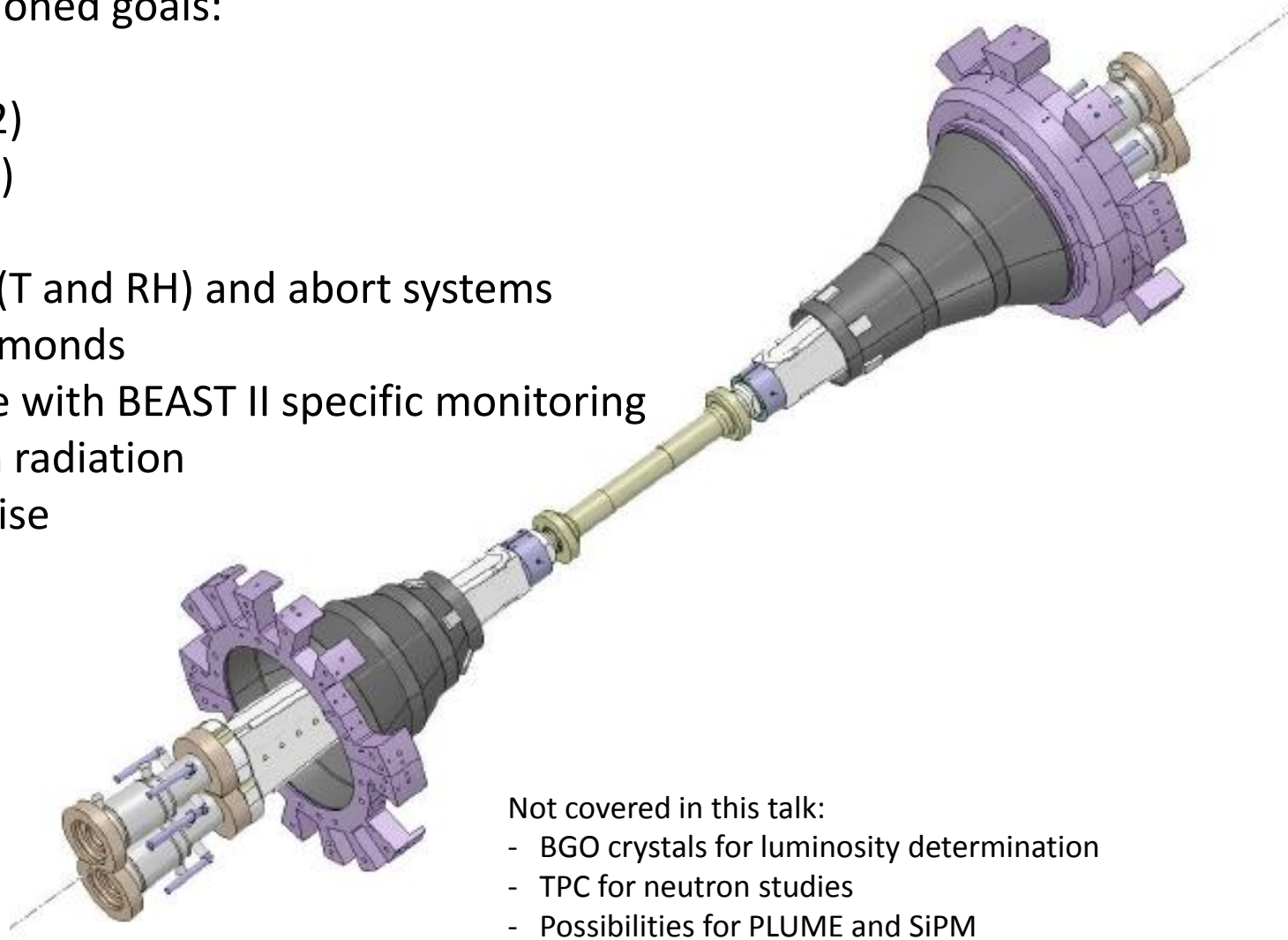
- Ensure VXD services operational: interlocks, beam abort (threshold tuning), radiation and environmental monitoring, cooling system

- System integration with rest of Belle II: full DAQ, Slow Control, tracking, RoI, …

# VXD BEAST Plans

To cover the aforementioned goals:

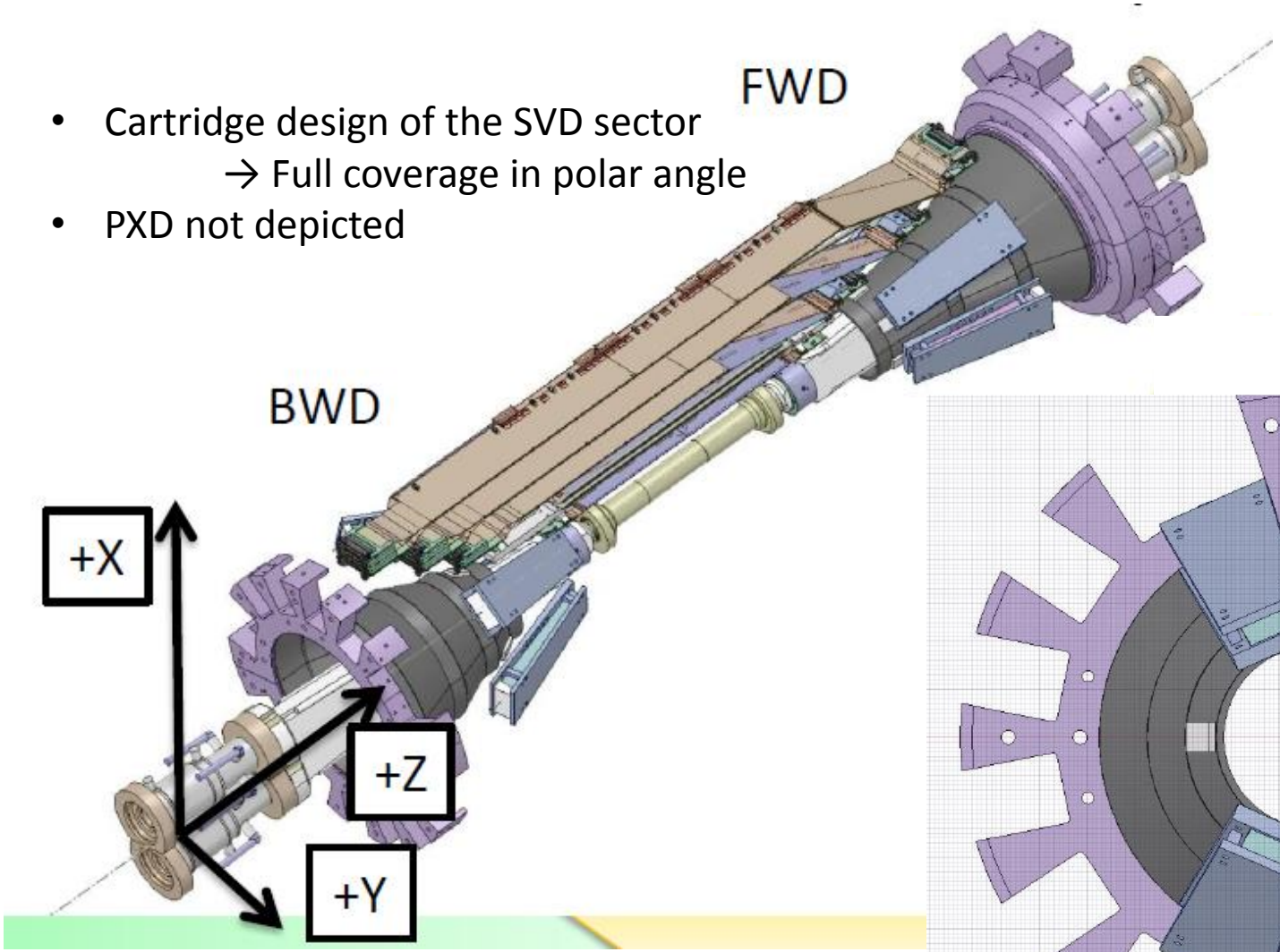
- 2 PXD ladders (L1+L2)
- 4 SVD ladders (L3-L6)
- Services and DAQ
- General monitoring (T and RH) and abort systems
  → FOS and diamonds
- Cover the solid angle with BEAST II specific monitoring
  → Synchrotron radiation
  → Injection noise



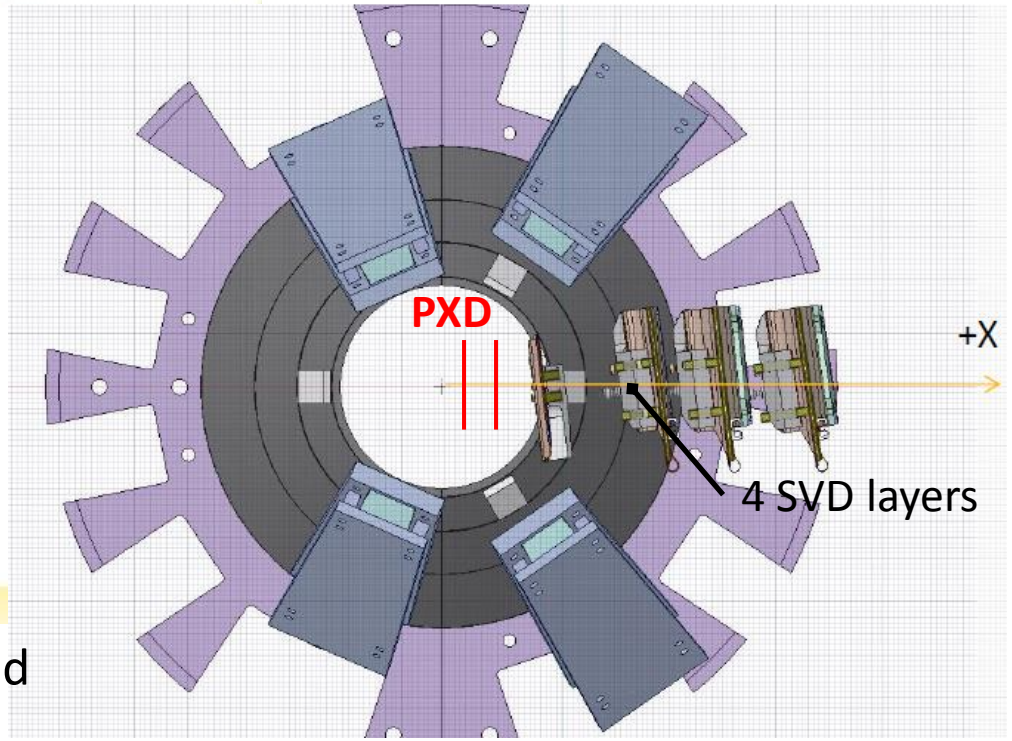
Not covered in this talk:
- BGO crystals for luminosity determination
- TPC for neutron studies
- Possibilities for PLUME and SiPM

# VXD Geometry

- Cartridge design of the SVD sector
  → Full coverage in polar angle
- PXD not depicted




Highest background sensitivity AND largest overlap in the accelerator plane (+X)




→ Still, additional instrumentation needed

# Strasbourg BEAST pre-Meeting

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Strasbourg pre-meeting:

- 12th and 13th January 2015 in Munich
- HLL, Strasbourg, MPI, Bonn; DESY and KEK (via SeeVogh)

→ Global VXD scheme during Phase 2 and next steps

→ Possibilities for PLUME in Phase 2 (J. Baudot *et al*.)

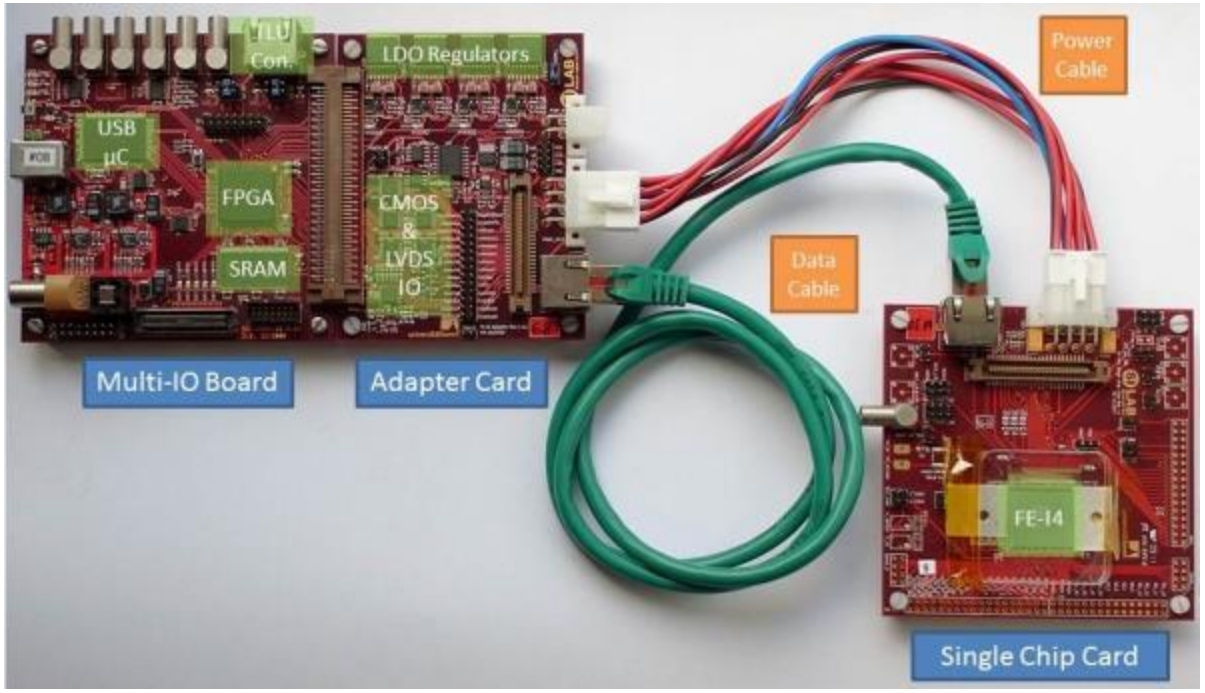
→ Possibilities for plastic scintillators and SiPM in Phase 2 (F. Simon *et al*.)

Strasbourg pre-meeting:
https://indico.mpp.mpg.de/conferenceDisplay.py?confId=3240

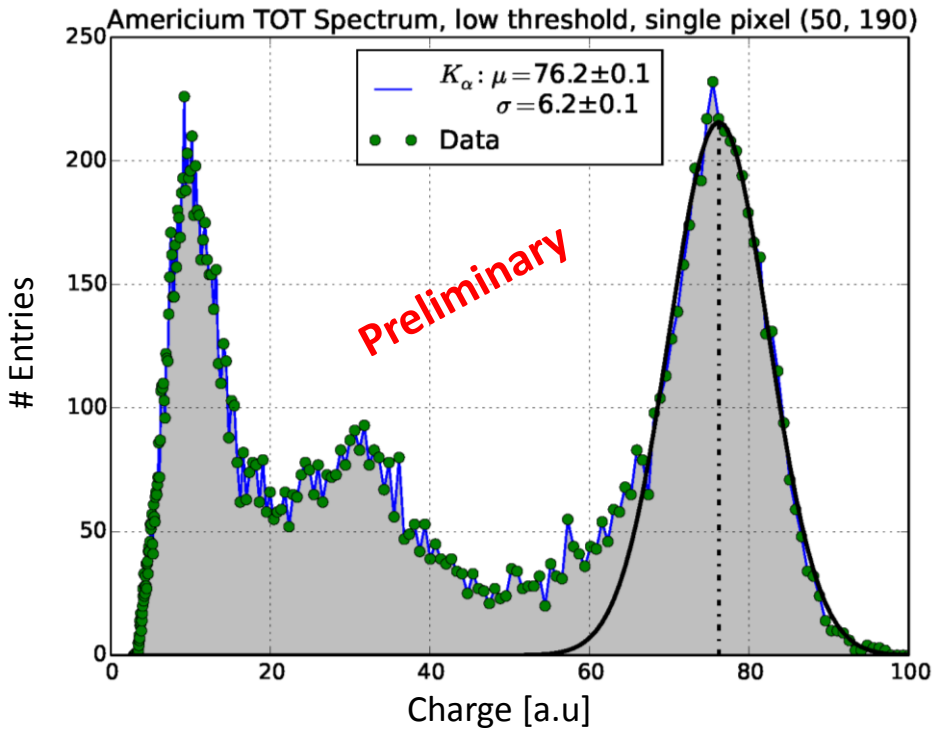
# FE-I4 Based Option

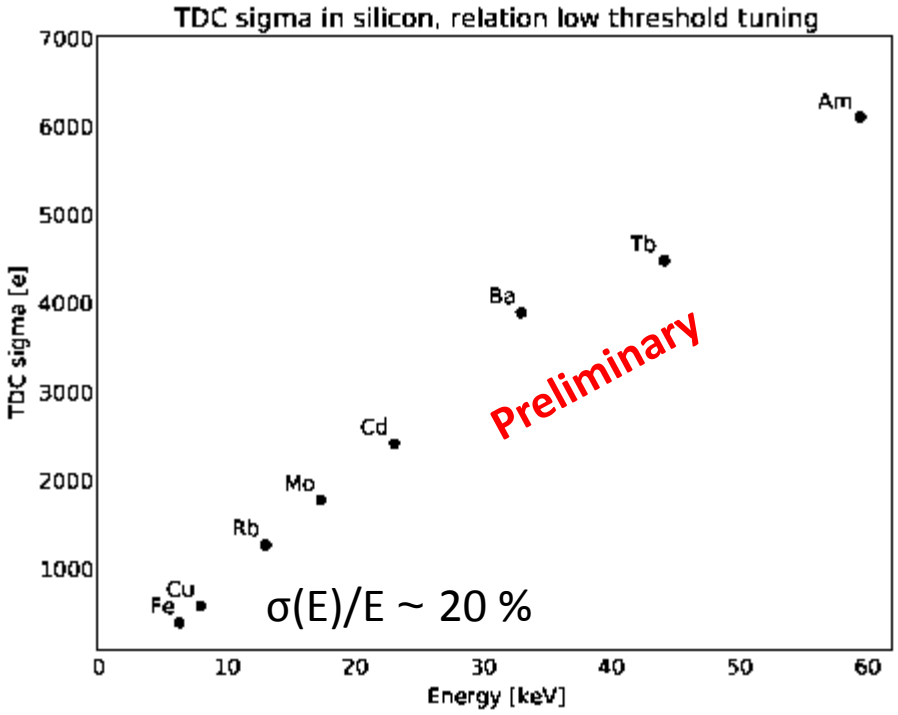
Hybrid planar sensor FE-I4 based

- Pixel size: 50 x 250 µm$^2$
- Radiation tolerance: 300 Mrad
- Hit-trigger association resolution: 25 ns




# Energy Calibration




→ FE-I4 (ATLAS-IBL): Fast, adequate energy resolution and minimizes system related problems (radiation hardness and long cables)

# Old Design

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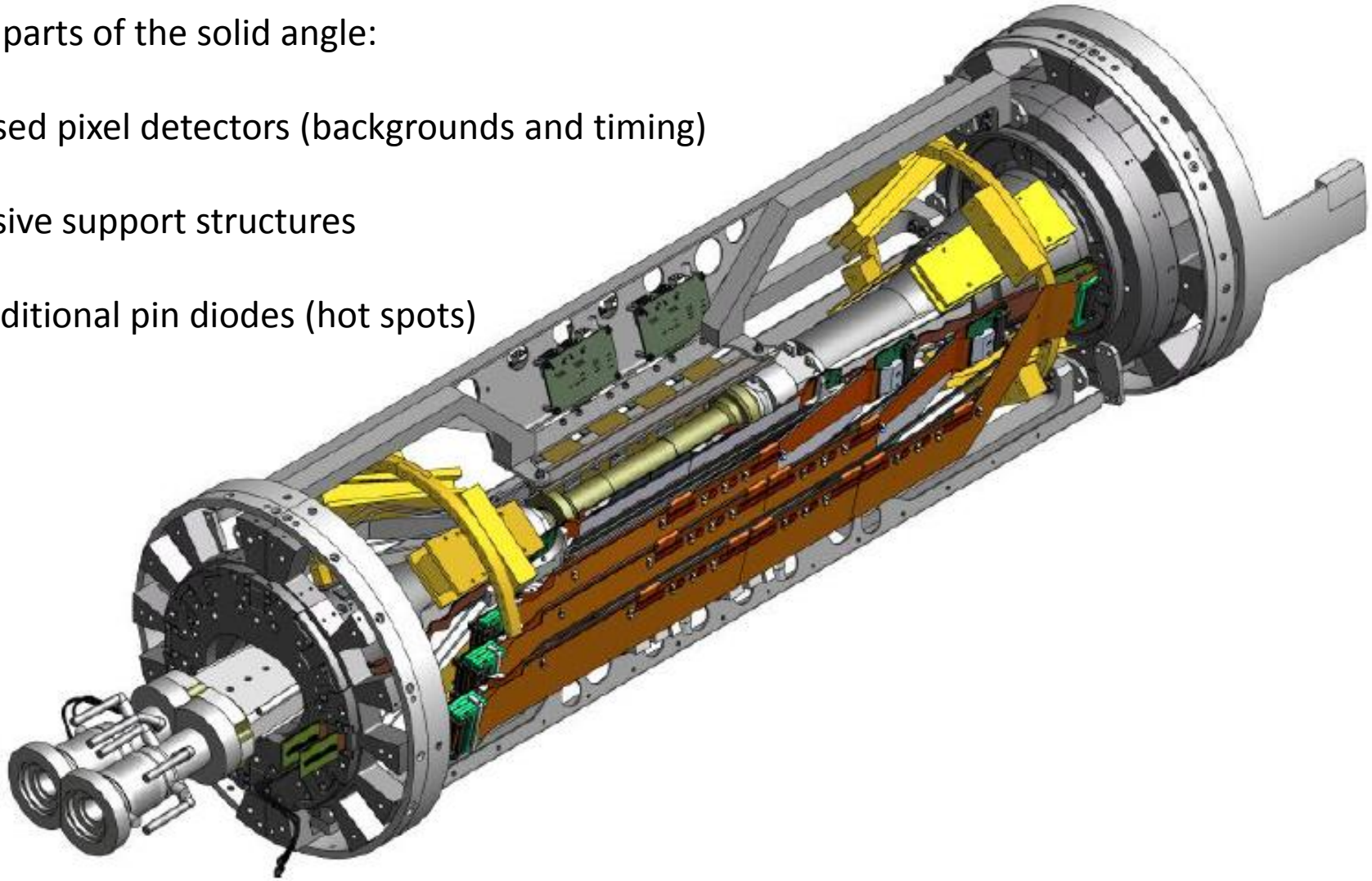
Instrument parts of the solid angle:

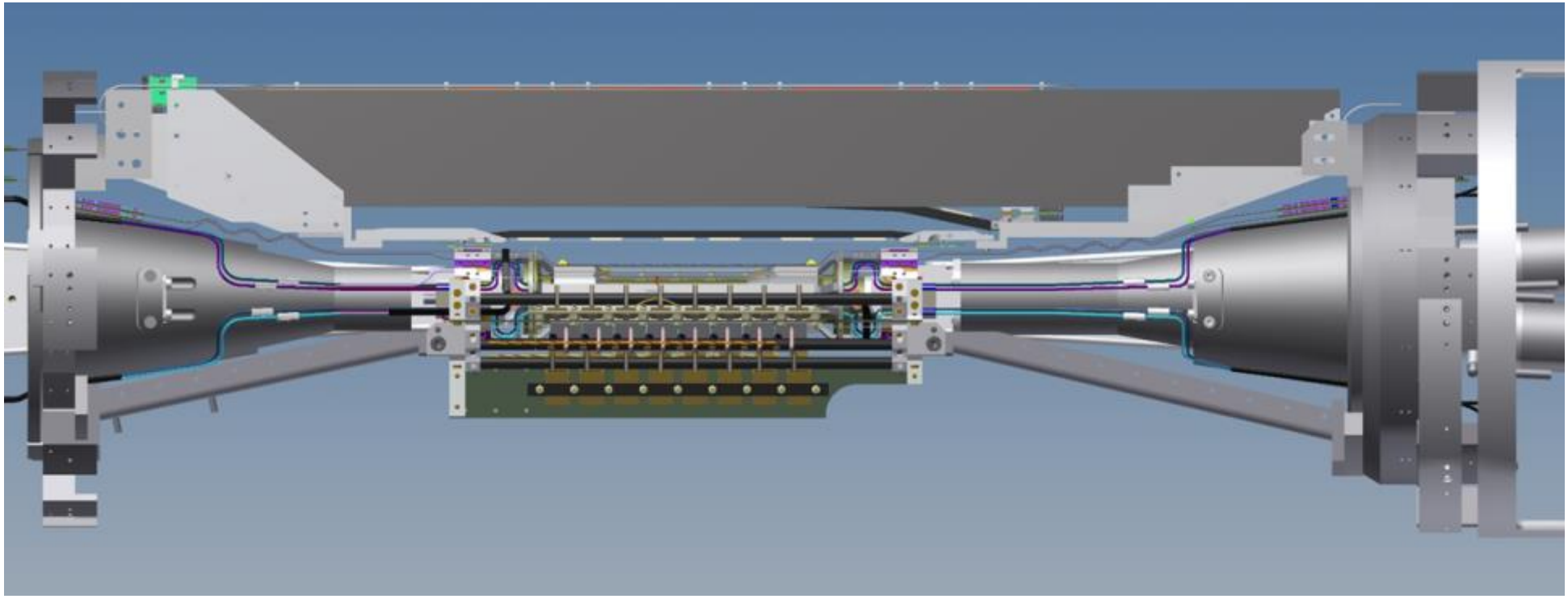
- FE-I4 based pixel detectors (backgrounds and timing)

→ Too massive support structures

Missing: Additional pin diodes (hot spots)



# Redesign Support Structures



- Redesign of support structures: Lighter, as required
- Design still evolving: further material reduction (kapton)
- Cooling needed, but no optimal solution found yet
- BGO crystals may see still too much material in front

# Additional Equipment

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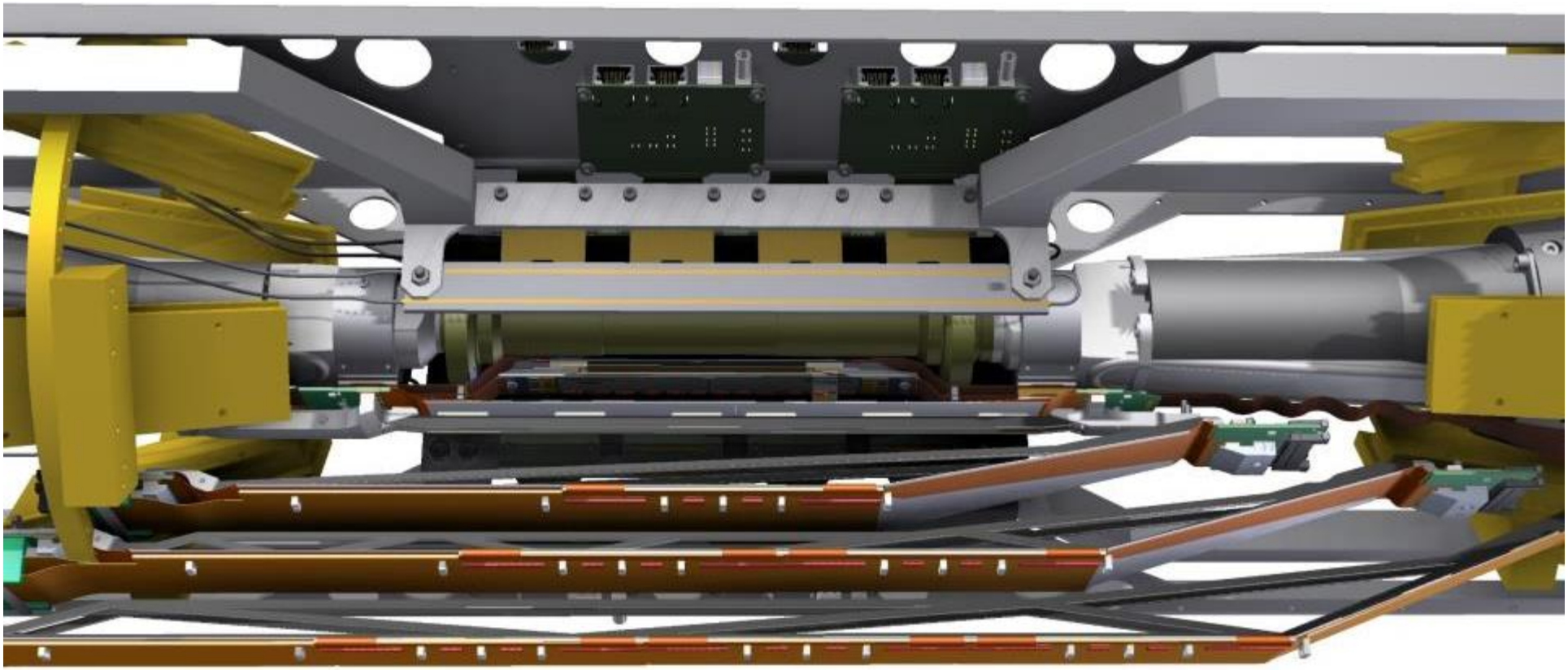
→ FE-I4: Cover 90° , 180° , 270° in ϕ, full acceptance in θ
→ SiPM: Cover 135° , 225° in ϕ

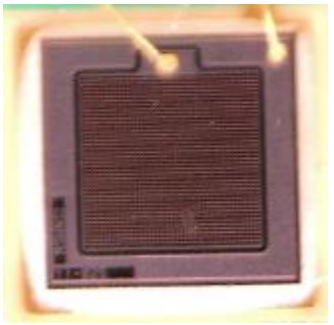


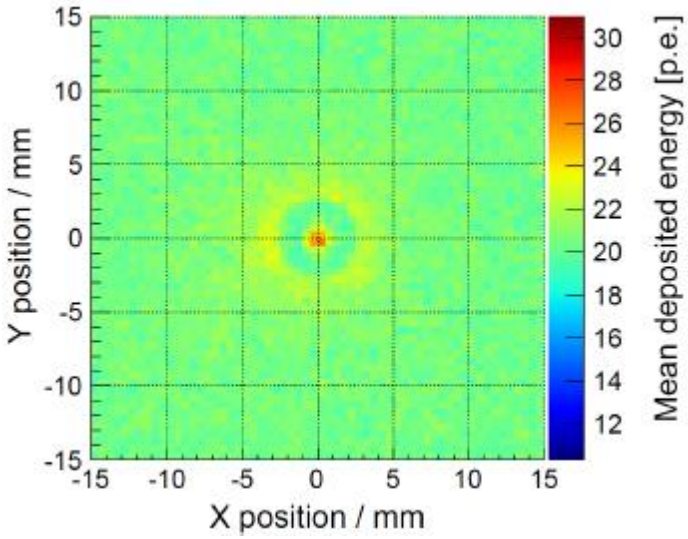
# Scintillators with SiPM Readout

- Plastic scintillators with SiPM. Ultrafast (800 ps sampling time) and suited for noise injection studies

- System developed for the HCAL (CALICE) of ILC → Not optimal yet for our application.

- System operated successfully in many test beam campaigns
  → Final choice of plastic scintillator, SiPM and readout electronics will be made to satisfy the Phase 2 requirements





# Updated Geometry

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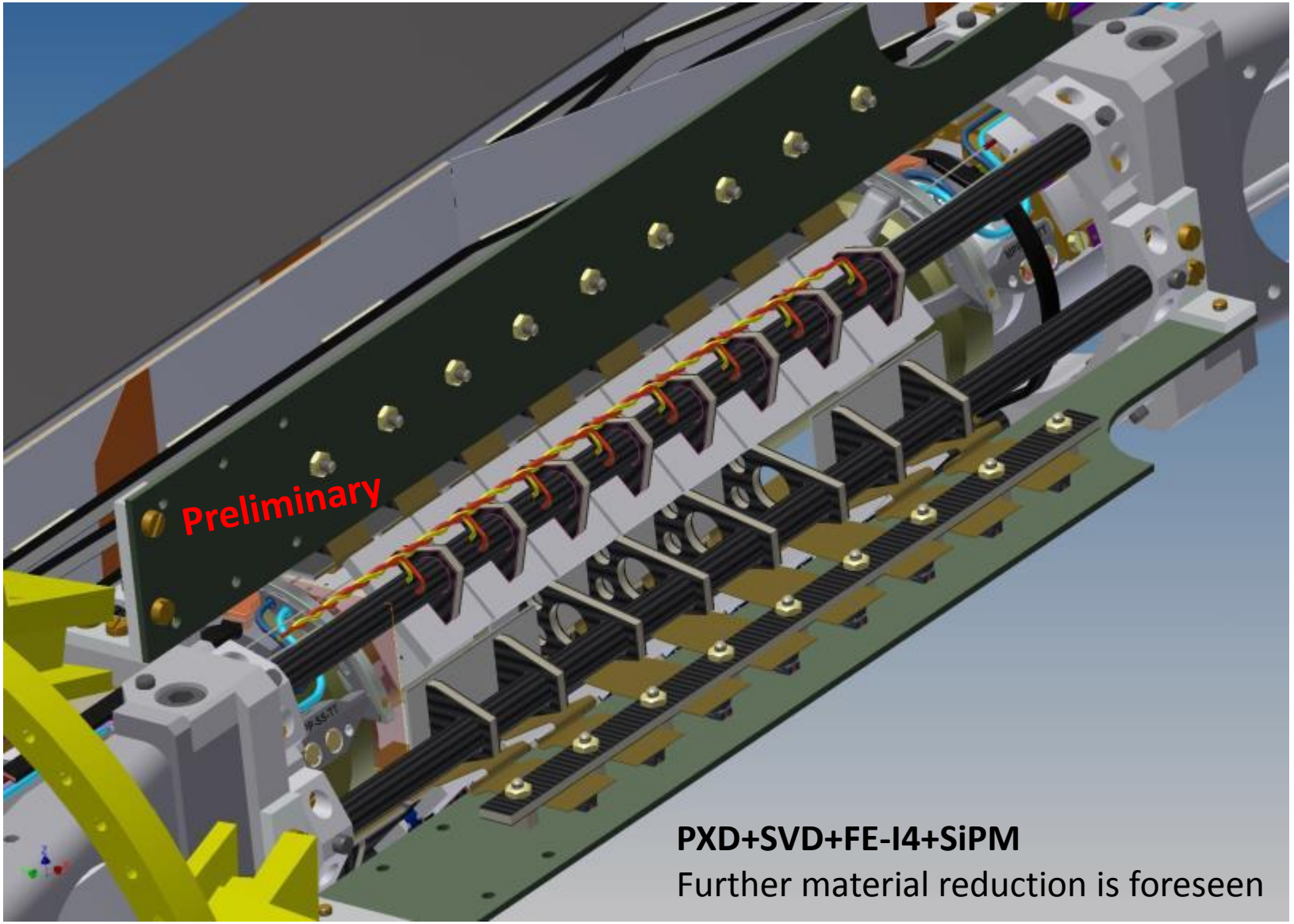
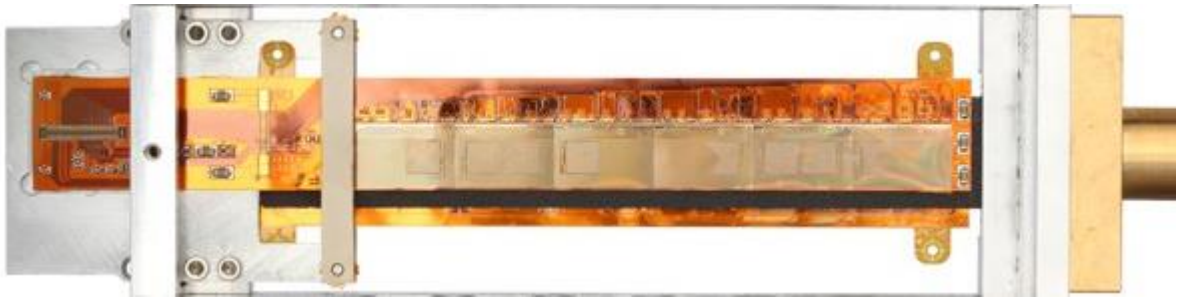
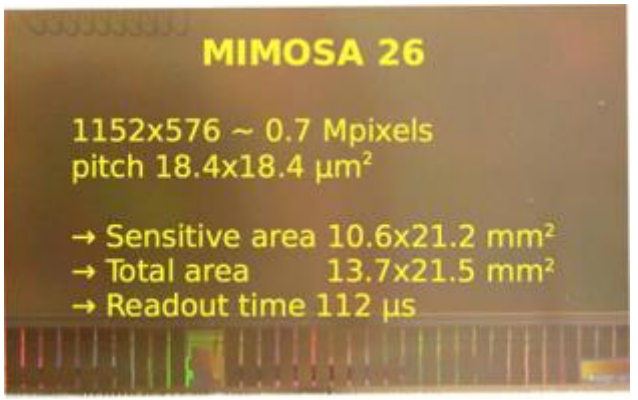
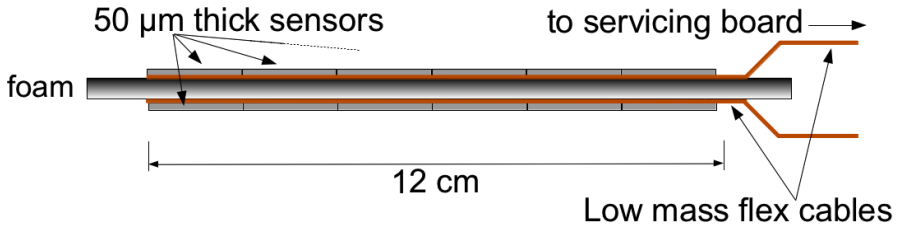
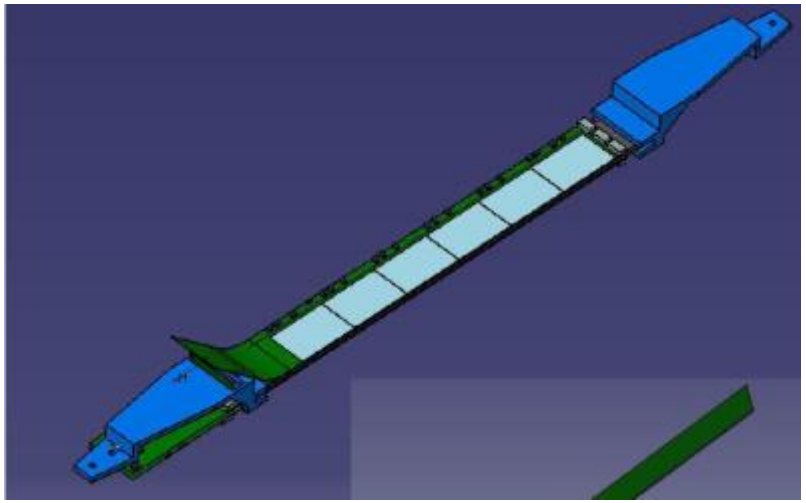


# PLUME





- MIMOSA-26 (2008)
  - AMS 0.35 µm
  - Sensitive layer: 15 µm thick
- MISTRAL (2015) (t.b.c.)
  - TowerJazz 0.18 µm

# Strasbourg BEAST pre-Meeting

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- PLUME: Thin and highly granular sensors but ‘slow’ (M26, Mistral).

Might be useful in certain Θ locations to complement the PXD+SVD modules.

Additional locations far from the IP under investigation: hot spots inside the QCS (?)

- Plastic scintillators with SiPM. Seem to be a nice counterpart of PLUME.
- Technical feasibility to be demonstrated: Rad. Hardness, cable length, …
- Simulations are mandatory: Rates, energies, detector geometry and optimal placement. Synergy with machine group is needed!

# Open Questions

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- Data acquisition system and trigger distribution. Event building. Timing (800 ps – 115 μs)

- Level of integration with Belle II other subdetector systems

- How to disentangle the different types of backgrounds?

- How to determine the VETO width in the PXD?

- How to determine the thresholds (radiation, temperature, humidity)?

- How to ensure a tight VXD volume?

- Additional humidity sensors filling the chamber? How to define cold/warm dry volumes?

- Alignment constants update rate? Stability of the primary vertex?

- Do we need a L-shape profile with a FOS to measure BP vibrations?

- …

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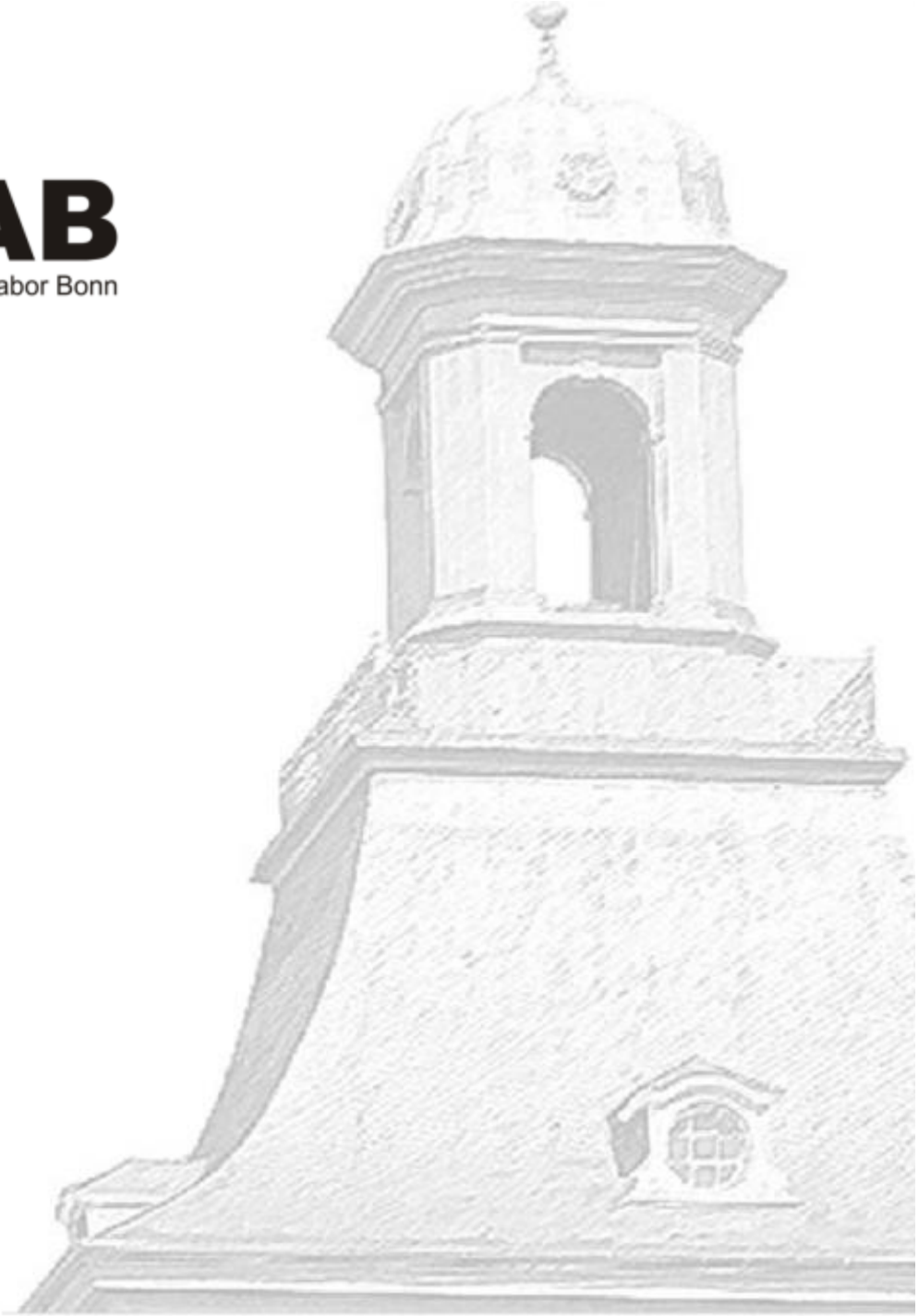

# Thank you

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