

## The Decay $\mu \rightarrow eee$

- charged lepton flavour violating decay
- SM including neutrino mixing:  
 $\mathcal{B}_{\mu \rightarrow 3e} \approx 10^{-54}$
- observation: clear sign for **new physics**
- current limit:  $\mathcal{B}_{\mu \rightarrow 3e} \leq 10^{-12}$   
(SINDRUM, 1988)
- aim of the Mu3e experiment:  
 $\mathcal{B}_{\mu \rightarrow 3e} \leq 10^{-16}$

## The Mu3e Experiment

- stopping target experiment at the Paul Scherrer Institute, Switzerland [1]
- compact design to detect particles recurling in magnetic field
- precise spatial and timing measurements:
  - pixel tracker (HV-MAPS): position
  - **scintillating tiles/fibres: timing**

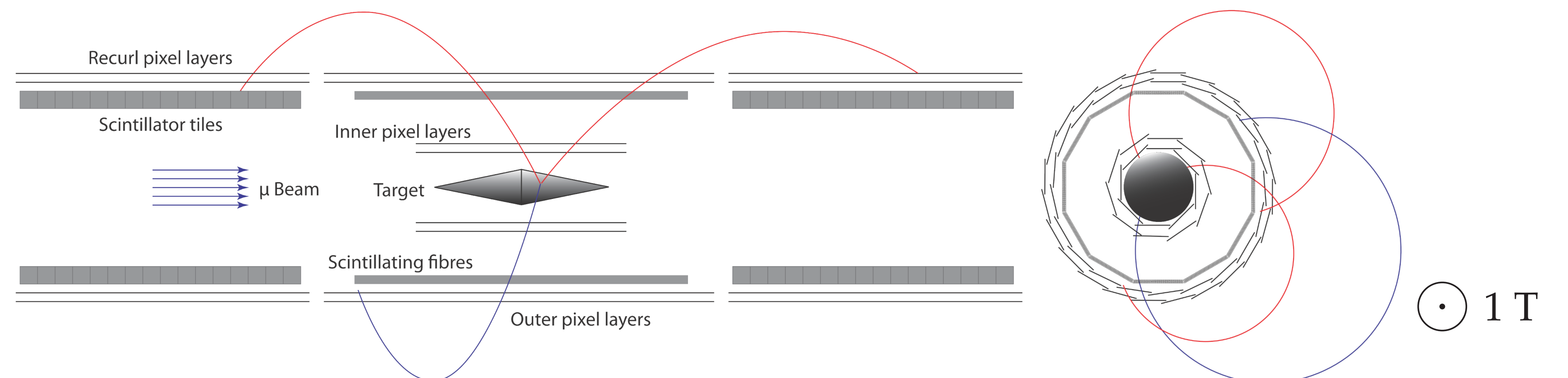


Figure 1: Schematic of the Mu3e experiment.

## The Tile Detector

- suppression of combinatorial background
  - e.g. Michel decays + scattered electron
- requirements: timing resolution < 100 ps at  $\approx 100\%$  efficiency [2]
- to be installed on recurl stations (up- and downstream of target)
- basic detector components:
  - scintillator tiles ( $\approx 6 \times 6 \times 5 \text{ mm}^3$ )
  - silicon photomultipliers (SiPMs)
  - dedicated read-out ASIC MuTRiG

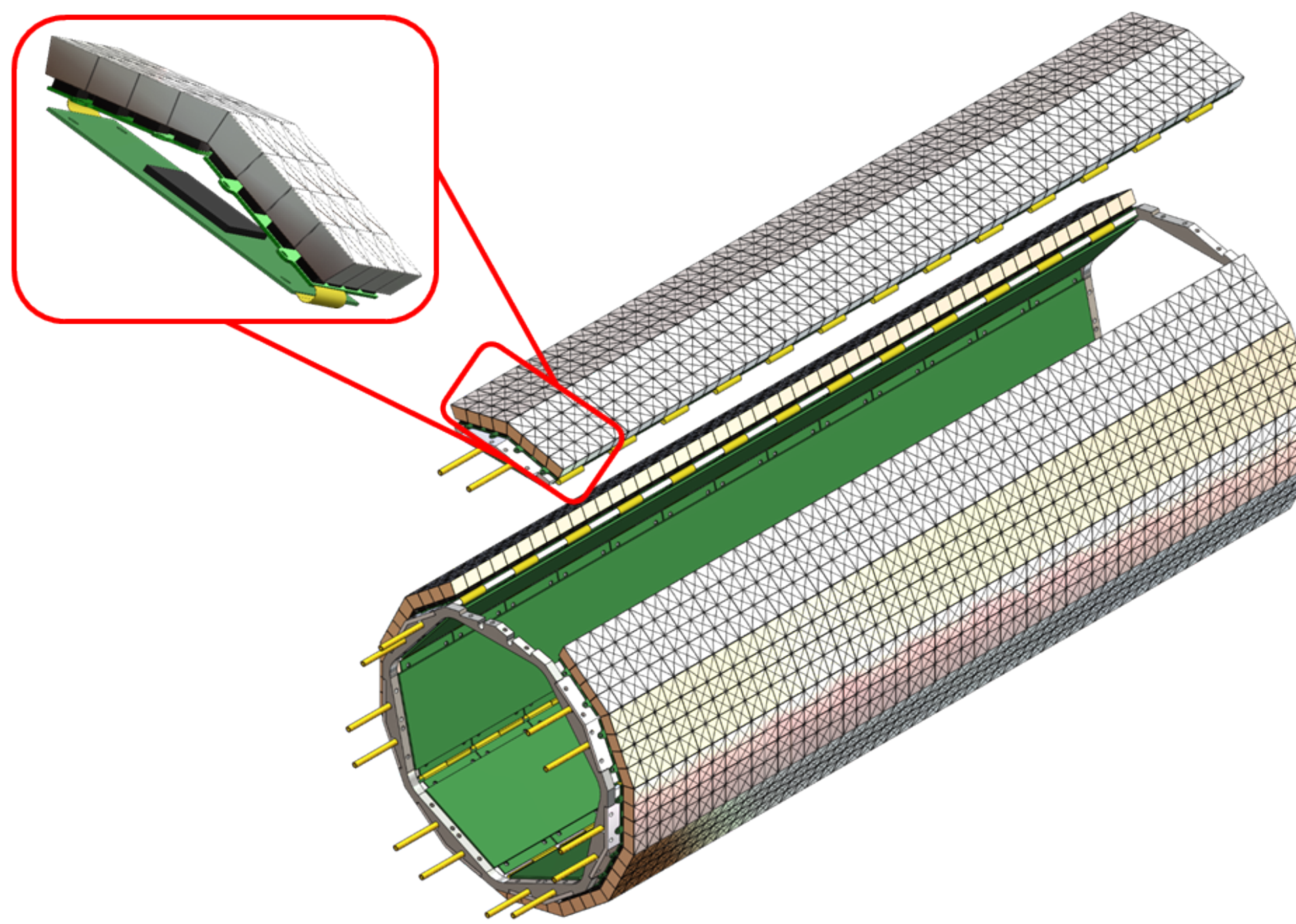


Figure 2: CAD model of a tile detector station.

### modular detector design:

- submodule:
  - 32 tiles and SiPMs
  - one MuTRiG for read-out
- module:
  - 13 submodules on cooling plate
- recurl station:
  - 7 modules assembled on two endrings

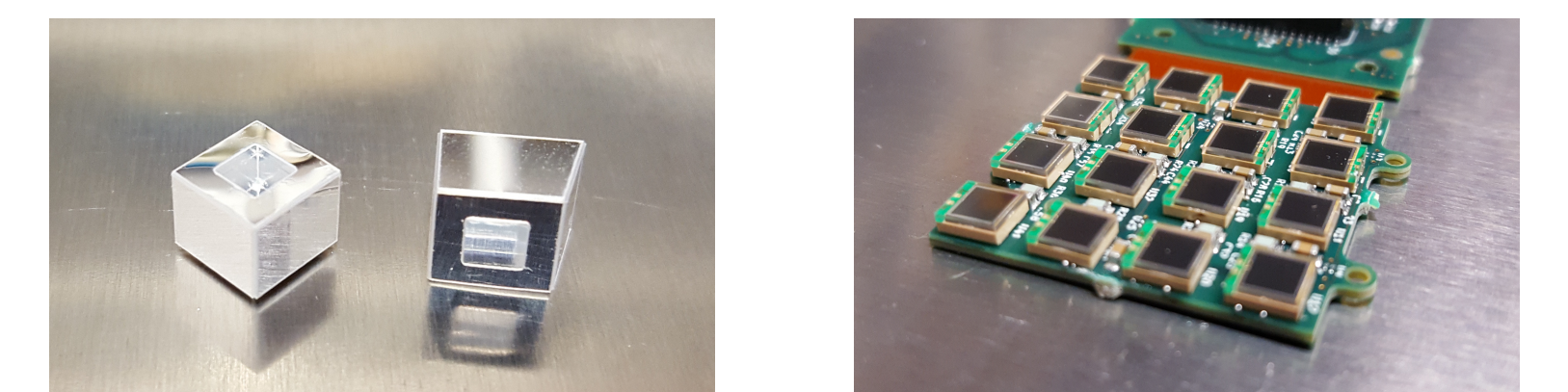


Figure 3: Scintillating tiles and SiPMs.

## The Technical Prototype

- design and equipping of custom flex-print PCBs
- individual tile wrapping with reflective foils to reduce crosstalk
- dedicated gluing tool for tile matrix
- assembly of submodules to cooling structure

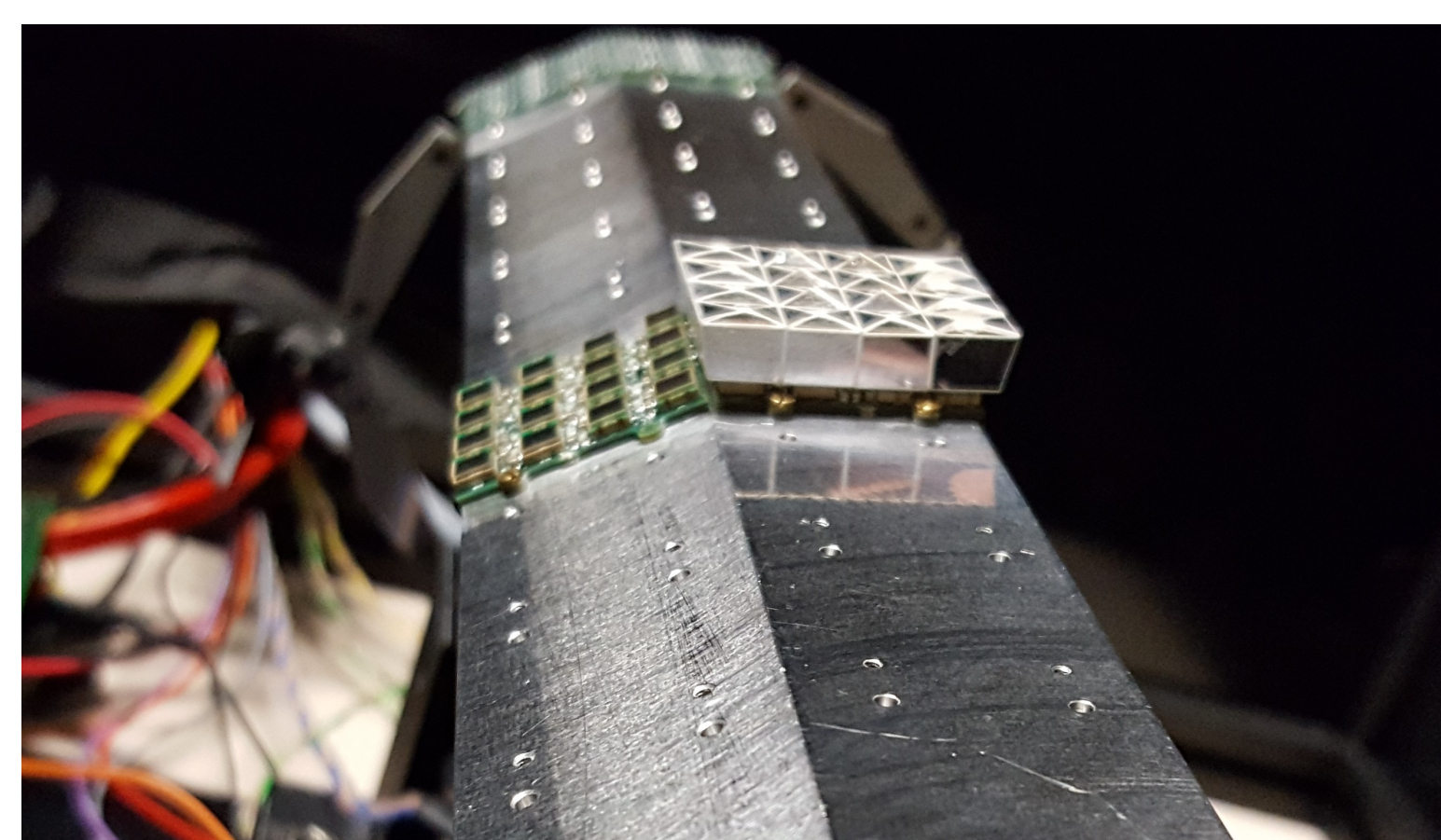


Figure 4: Submodule with assembled tile matrix.

## Thermal Studies

- implementation of prototype design in CAD software
- finite-element simulation of heat flux to investigate cooling system
  - single ASIC as heat source
  - simulation inputs from prototype measurements
- good agreement of simulation and data

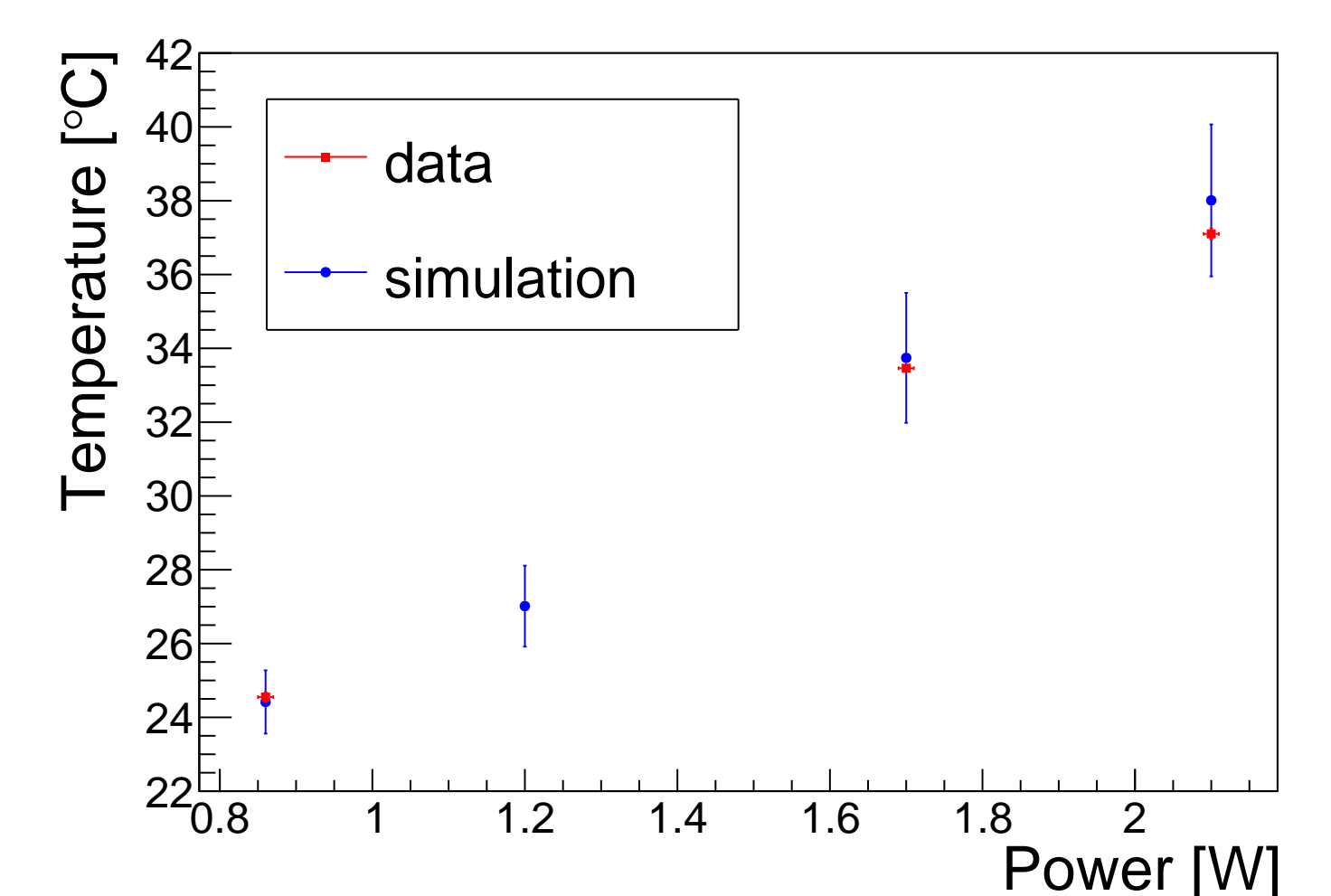


Figure 6: Comparison of data and simulation.

## Towards the Full Tile Detector

### detector integration:

- limited space for tile detector in experimental cage
  - re-design of tile detector geometry
  - implemented in CAD model
- new prototype planned

### preparations for large-scale production:

- improvement of gluing/wrapping tools
- simplified submodule assembly to reduce damage risks
- testing and QA scheme

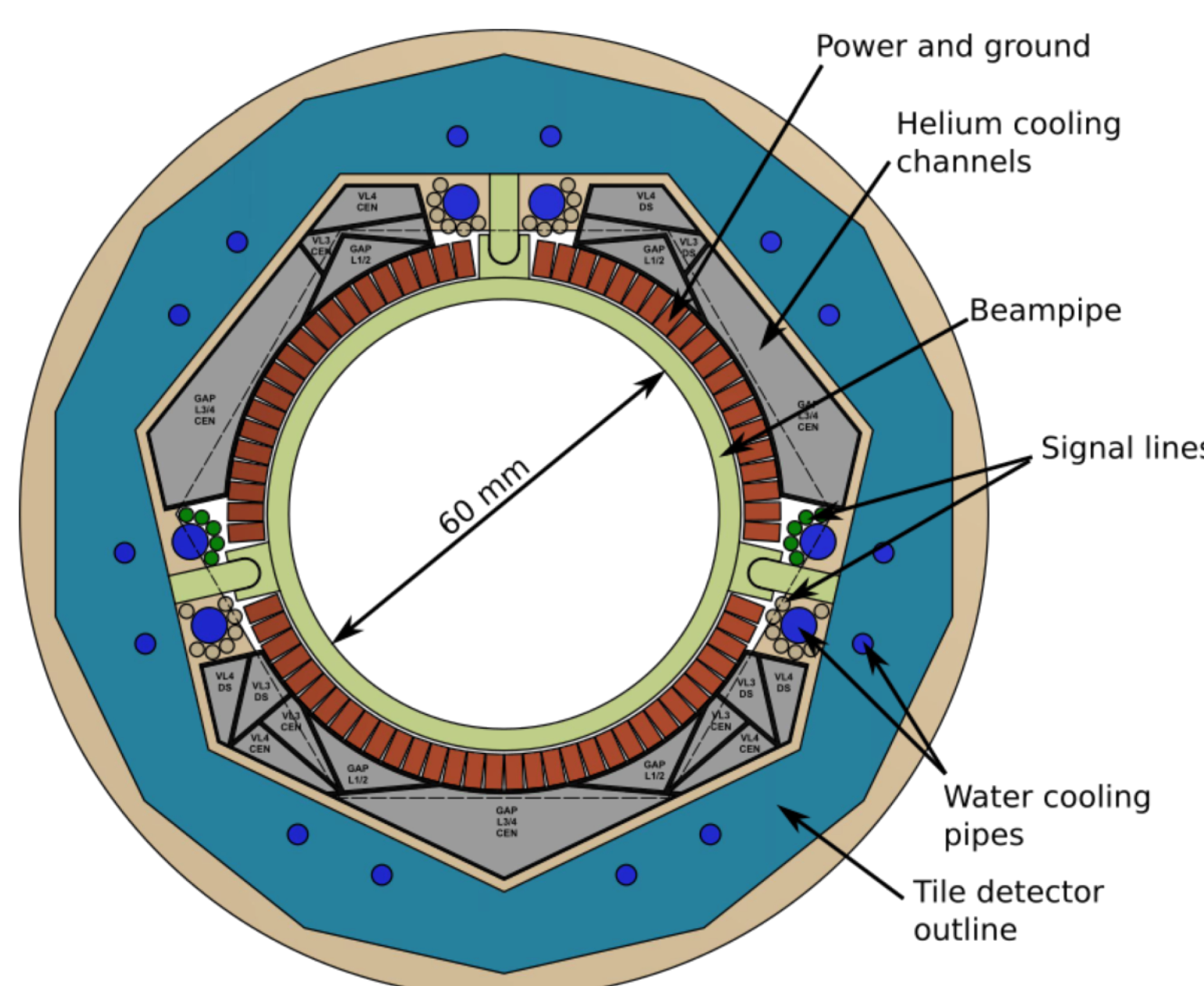


Figure 5: Cross-section of the Mu3e experiment including foreseen services.

## References

- [1] A. Blondel et al. *Letter of Intent for an Experiment to Search for the Decay  $\mu \rightarrow eee$* , 2012
- [2] Patrick Eckert. *The Mu3e tile detector*, PhD thesis, Heidelberg University, 2015