Performance Monitoring of the Barrel Time-of-Flight Super-Module for the PANDA Experiment at FAIR

Svetlana Chesnevskaya

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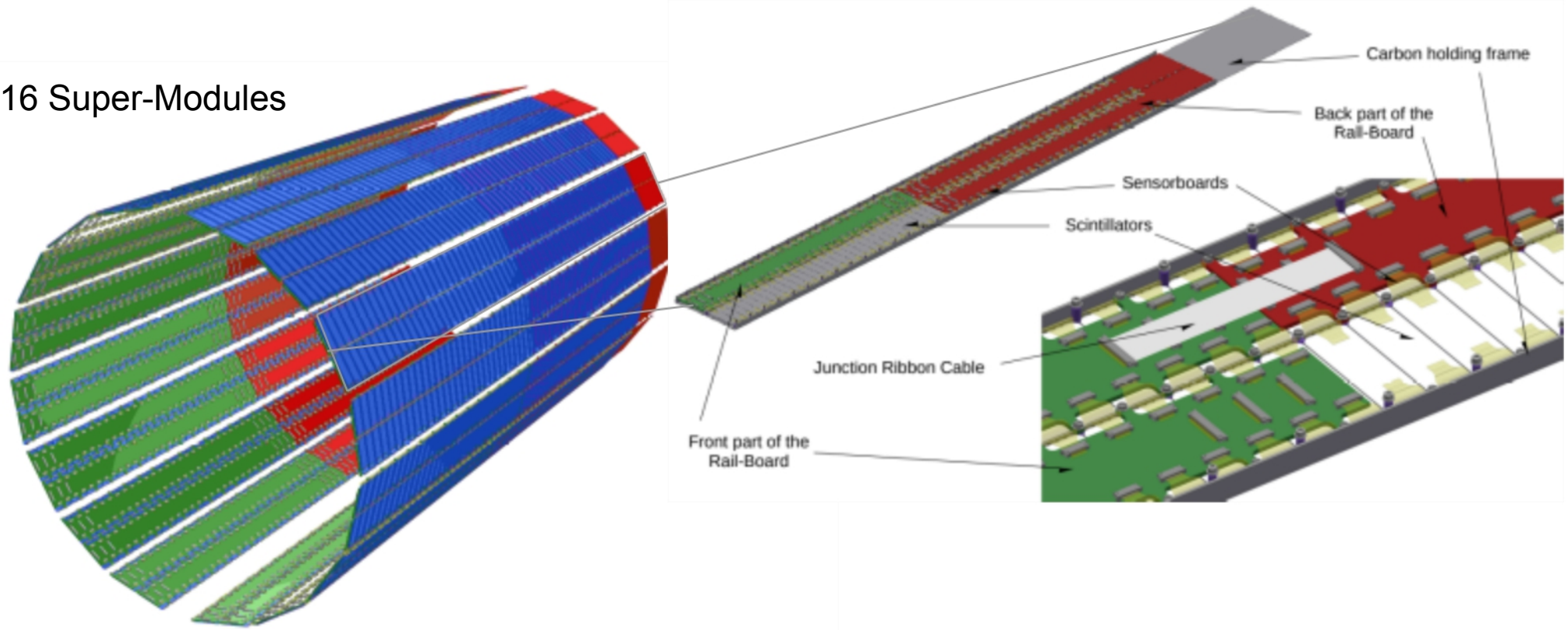
Outline

- $\bar{P}$ANDA Barrel Time-of-Flight (AntiProton Annihilations at Darmstadt)
- Signal Transmission: Rail-Boards (the third iteration)
- Full active B-ToF module
- Performance validation tests
  - Time resolution surface scans
  - Amplitude drop along the board
  - Signal delay along the board & crosstalk measurements

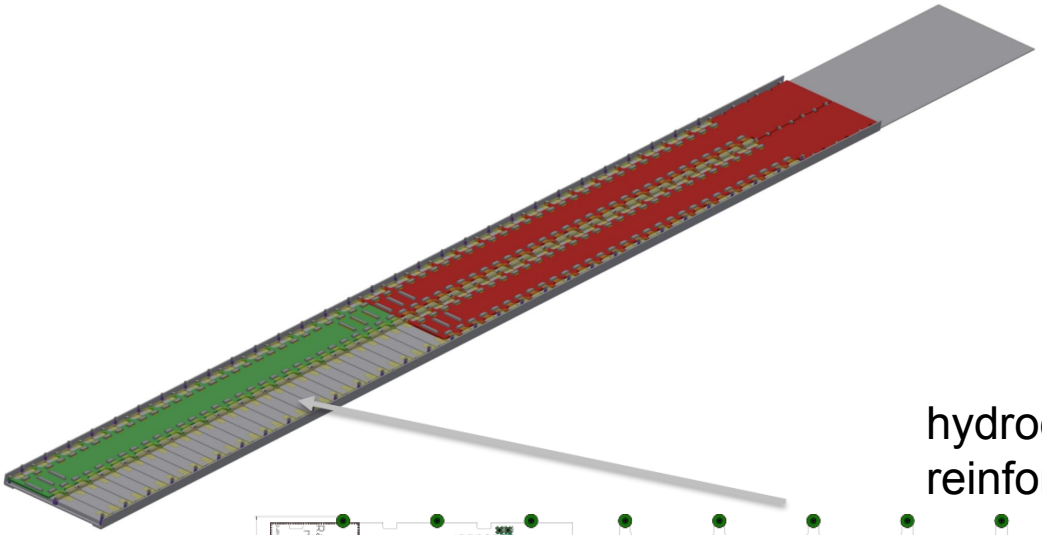
P̄ANDA Barrel Time-of-Flight (AntiProton Annihilations at Darmstadt)

16 Super-Modules



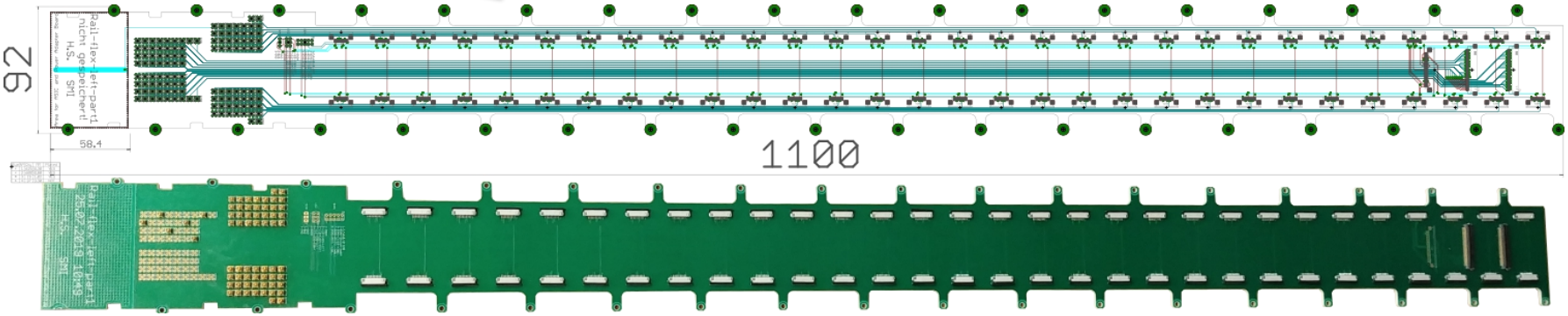
- p̄-p collisions, with momenta ranging from 1.5 GeV/c to 15 GeV/c, on a fixed target to study open questions in hadron physics
- system time resolution of less than 100 ps

Signal Transmission: Rail-Boards (the third iteration)



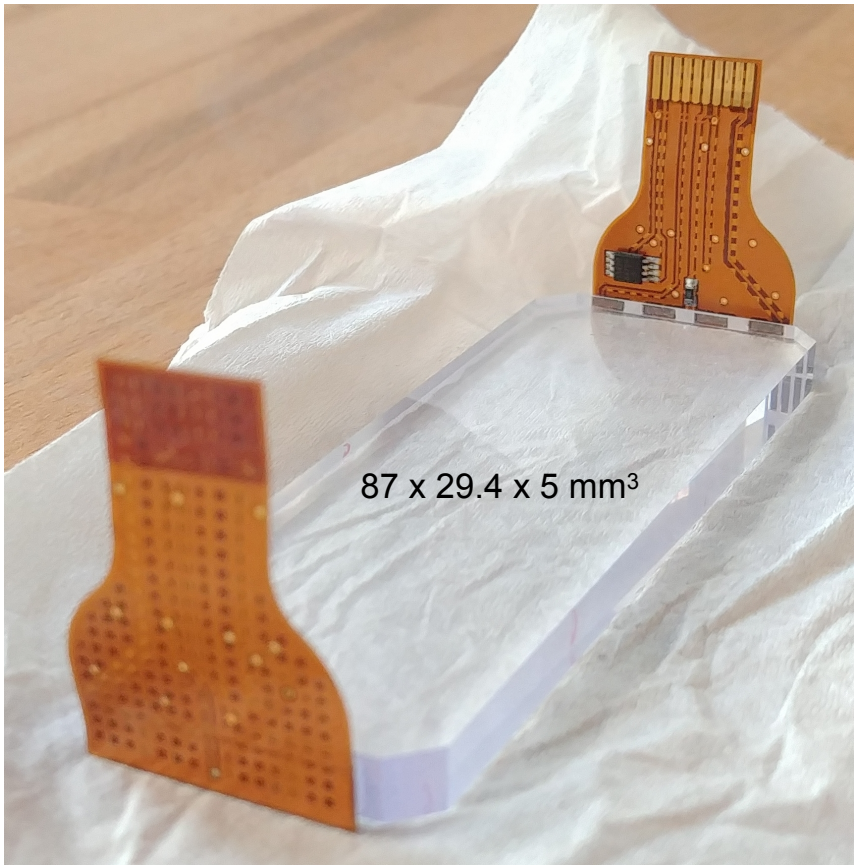
x 4

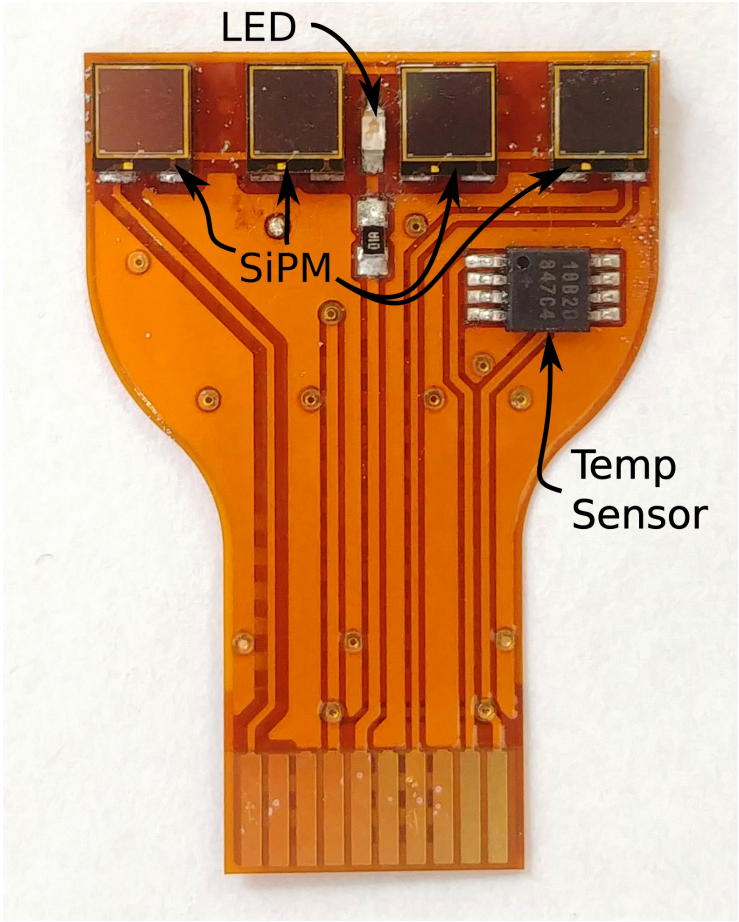
hydrocarbon-based material filled with ceramics and reinforced with glass fibers (RogersCorp)



…connects the Front End Electronics (FEE) to the detector elements while providing mechanical support

Full active B-ToF module





B-ToF module:

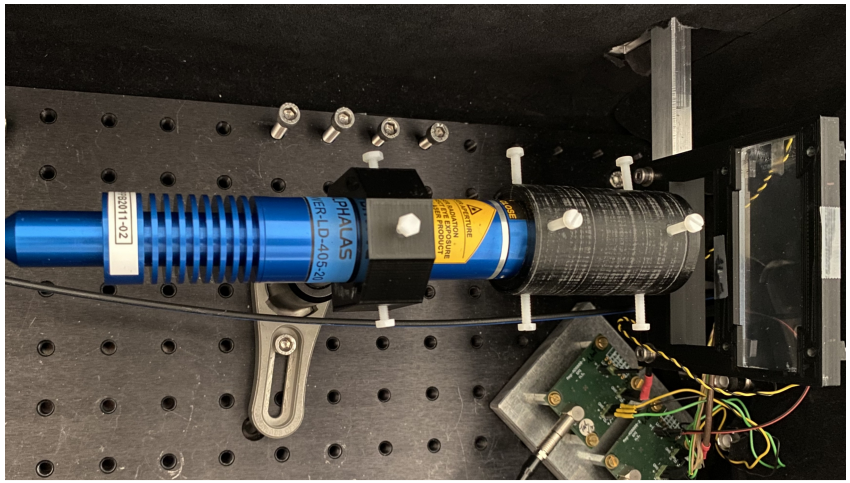
- scintillator tile (EJ-232)
- 2 flexible sensor boards (2 channels)

Flexible Sensor Board:

- 4 SiPMs in series
- Temp sensor
- LED to monitor the detector performance

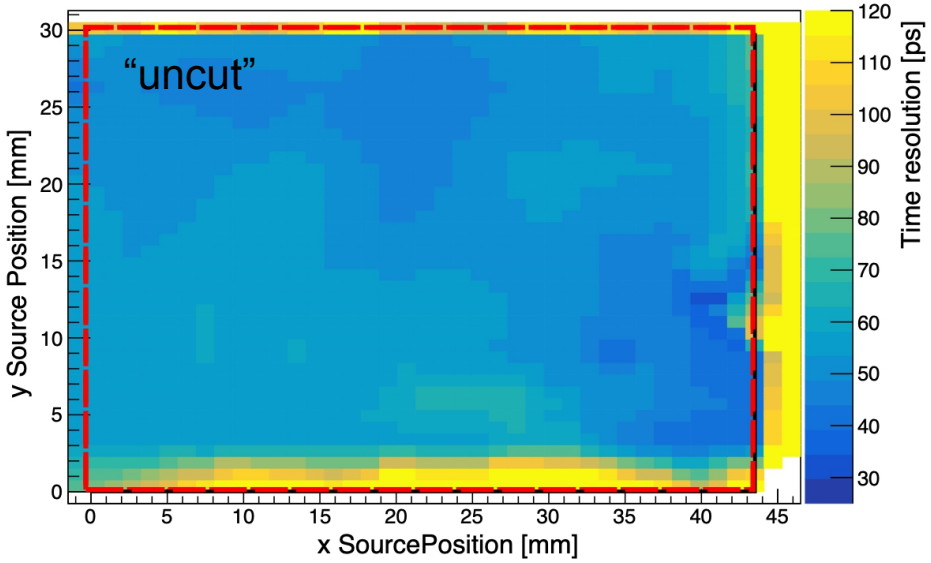
Performance validation tests

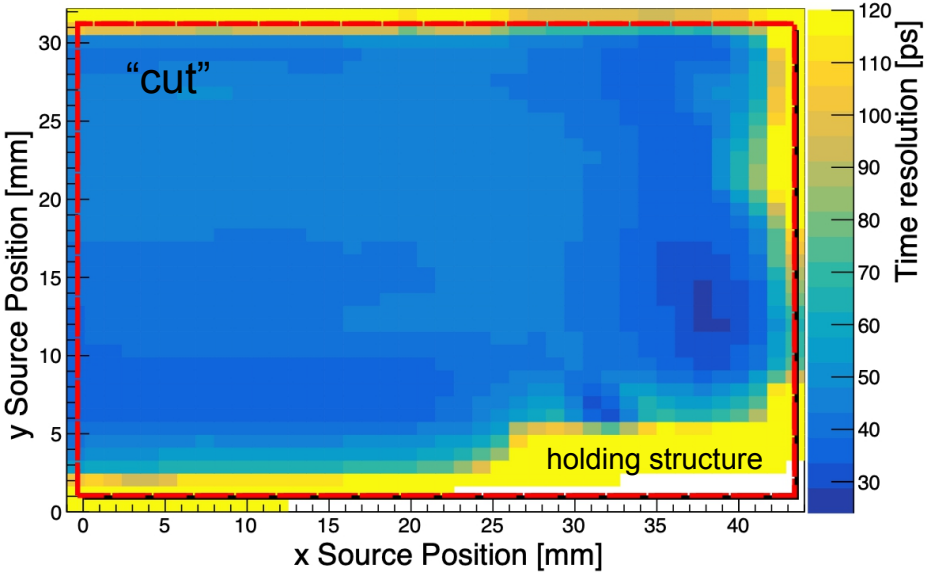
Time resolution surface scans



Test setup for comparative measurements:

- the ALPHALAS PICOPOWER^{TM} laser emits a beam (∅ = 3 mm) onto the scintillator surface
- the amplified signals are measured with an oscilloscope

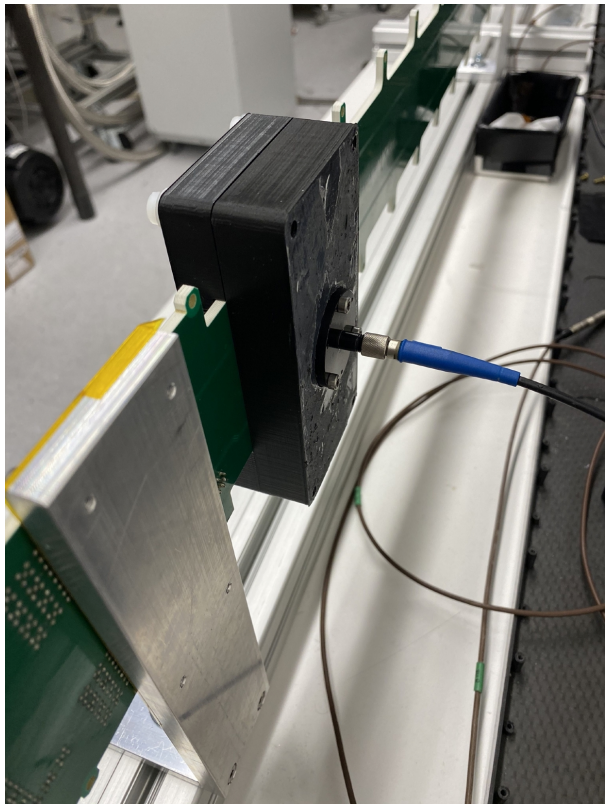




The overall average time resolution of both scintillators is much better than the design goal: **53.1 ± 4.3 ps** for "uncut" scintillator and **41.5 ± 5.1 ps** for "cut" scintillator.

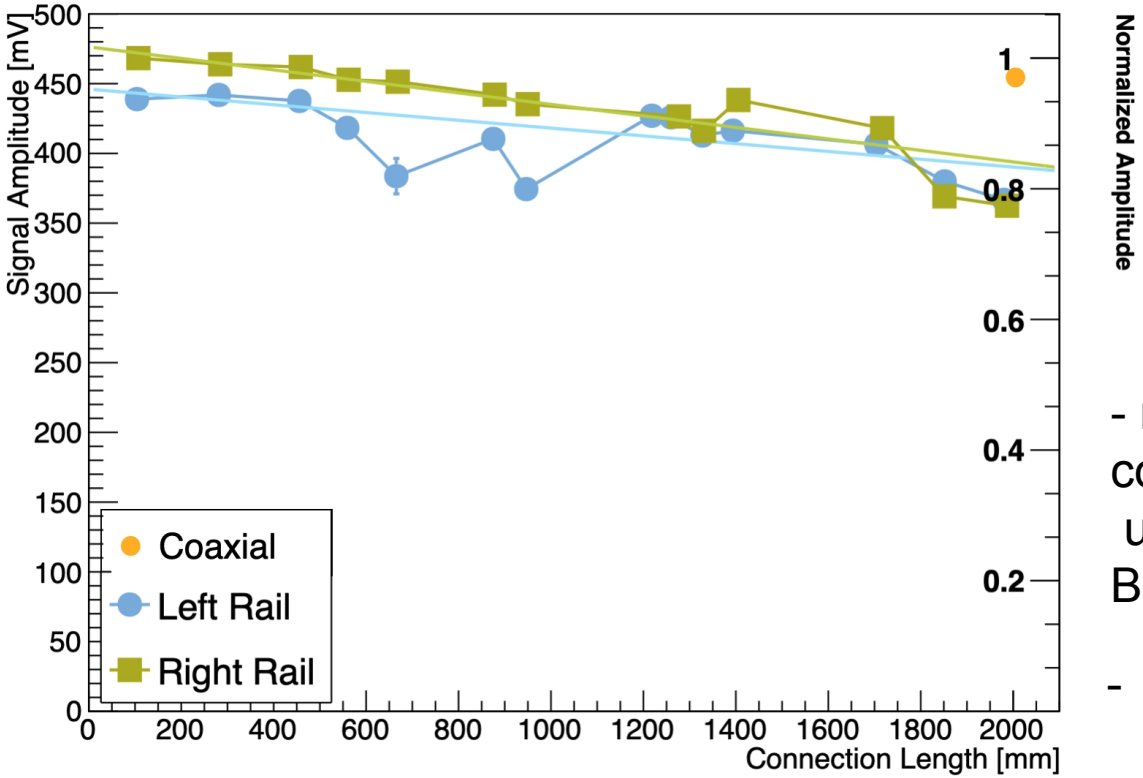
Performance validation tests

Amplitude drop along the board



Experimental setup:

- a black box is attached to the Rail-Board with a B-ToF module inside
- the light pulse is transmitted through a fiber onto the scintillator
- the whole arrangement is moved from one slot to another



- measured drop of up to 23% for an internal connection of 2 m length - expected to be up to 27.5% (50% drop for previous Rail-Board versions)

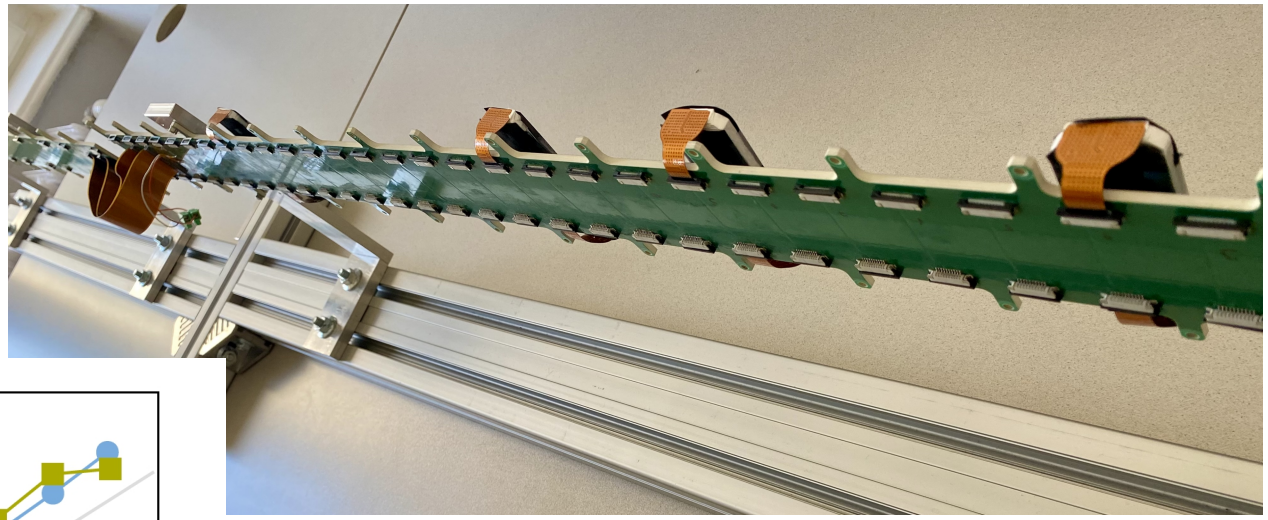
- the orange dot: the result (2% loss) for a standard 2m coaxial cable (50CA)

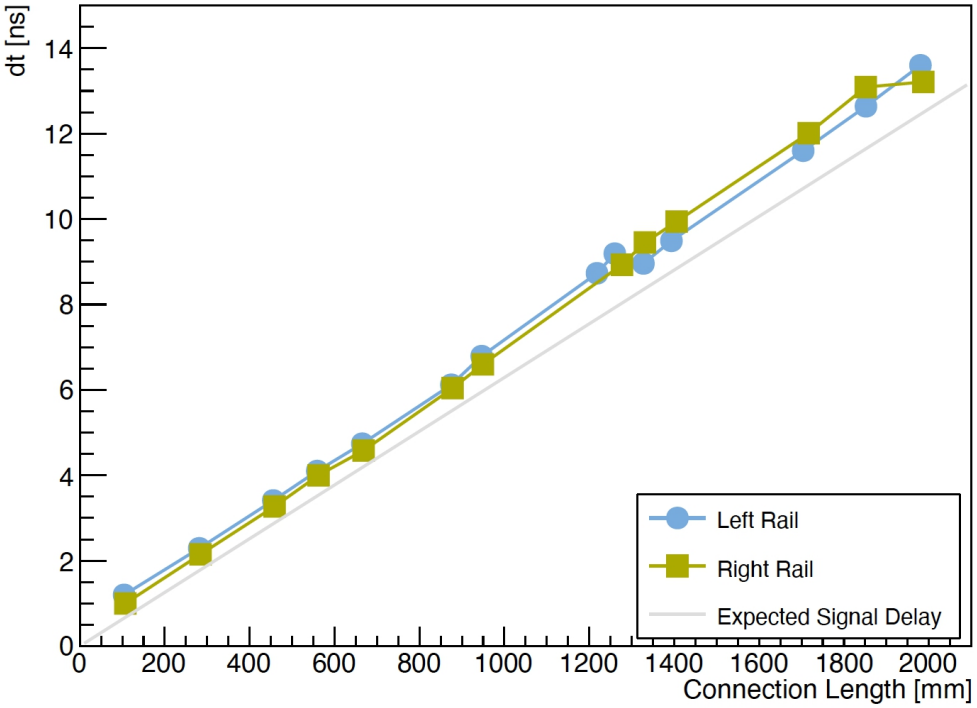
Performance validation tests

Signal delay along the board & crosstalk measurements

Experimental setup:

- the 3rd generation Rail-Board with 4 full active BToF modules
- the modules are protected from light (Teflon film and black paper)





The longer the electrical connection line – the longer the time delay between detector hit and time stamp in the electronics.

Time differences between the signals from the left (blue) and the right SiPM arrays (green) & the reference signal (laser trigger):

- the speed a signal travels through a copper connection is ~ 16.3 cm/ns
- the measured speed estimated to be ~ 15.1 cm/ns

Performance validation tests

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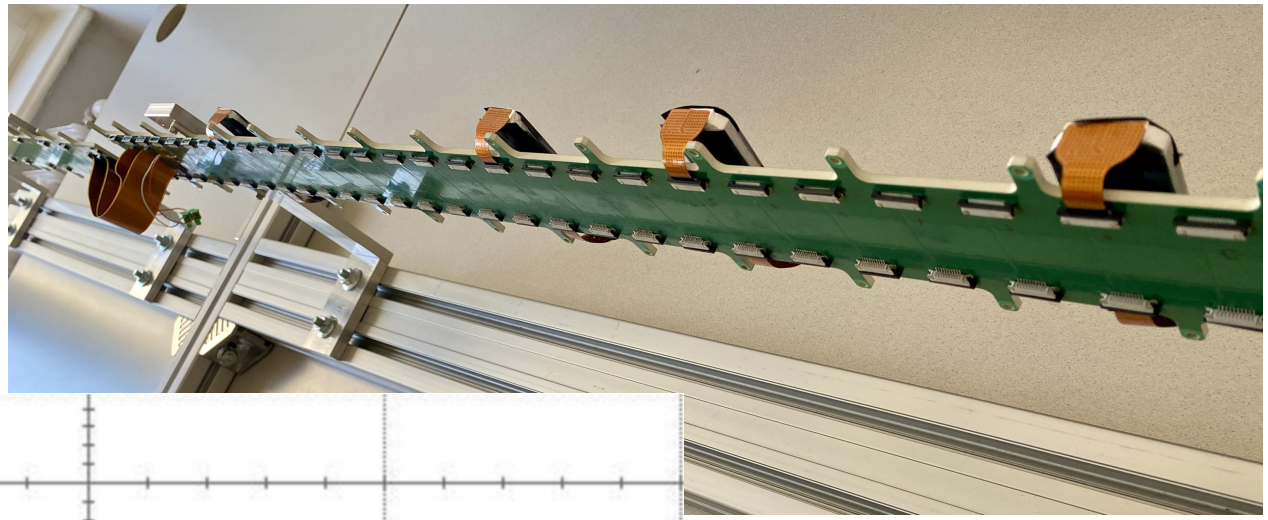

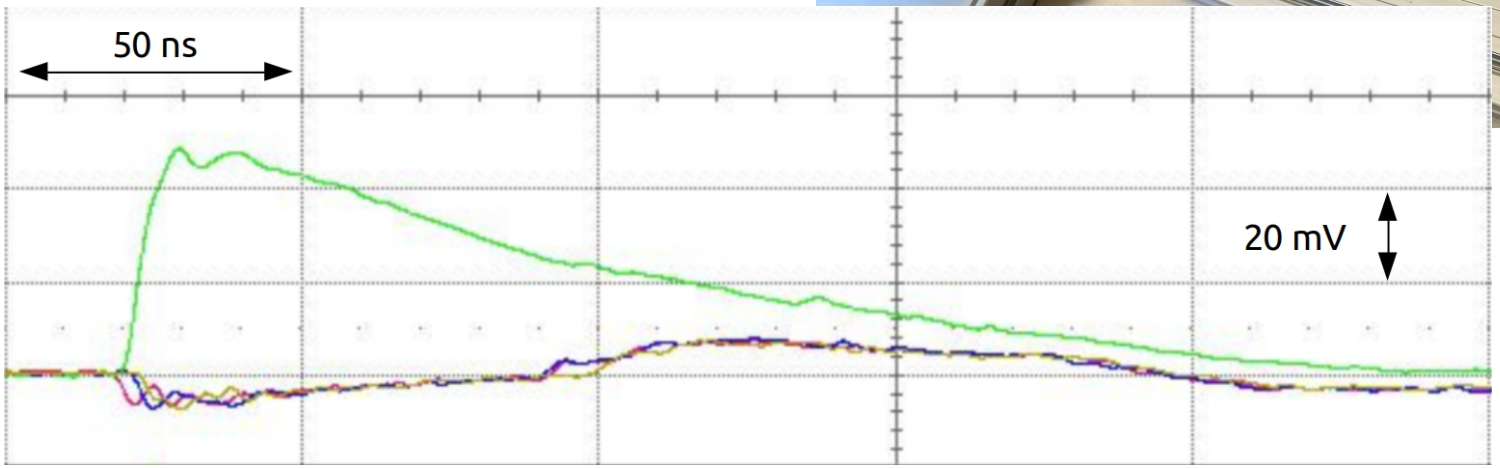

An example of one of the strongest crosstalk detected: FEXT ~ 25 dB

Measured far-end crosstalk (FEXT): aggressor signal (green) and 3 victim signals. All four lines are located in one layer.

Thank you for your attention