PAUL SCHERRER INSTITUT

PSI

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Next generation data acquisition for the CAMEA instrument

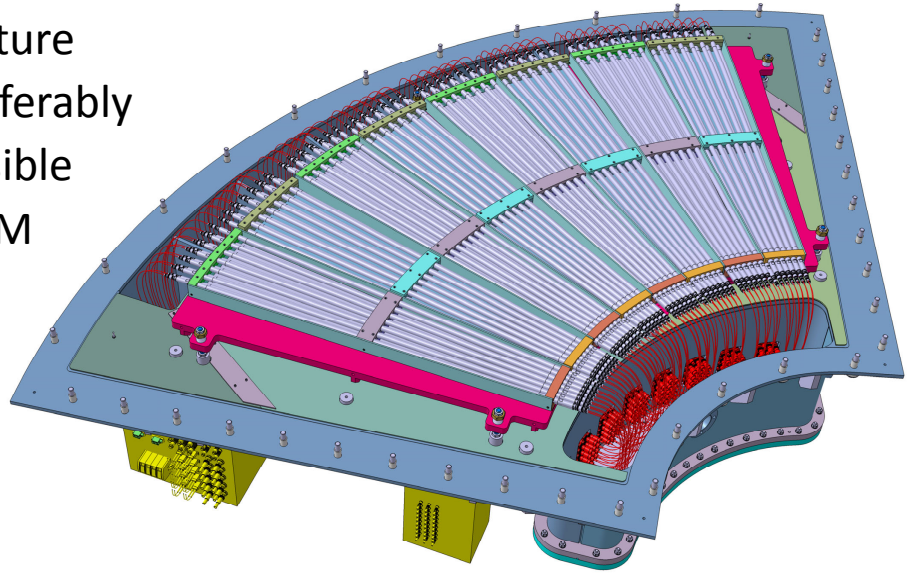
DENIM 2018, 17. September 2018

Contents

- Design drivers
- Frontend electronics concept
- Hardware implementation
- Measurement results
- Conclusion

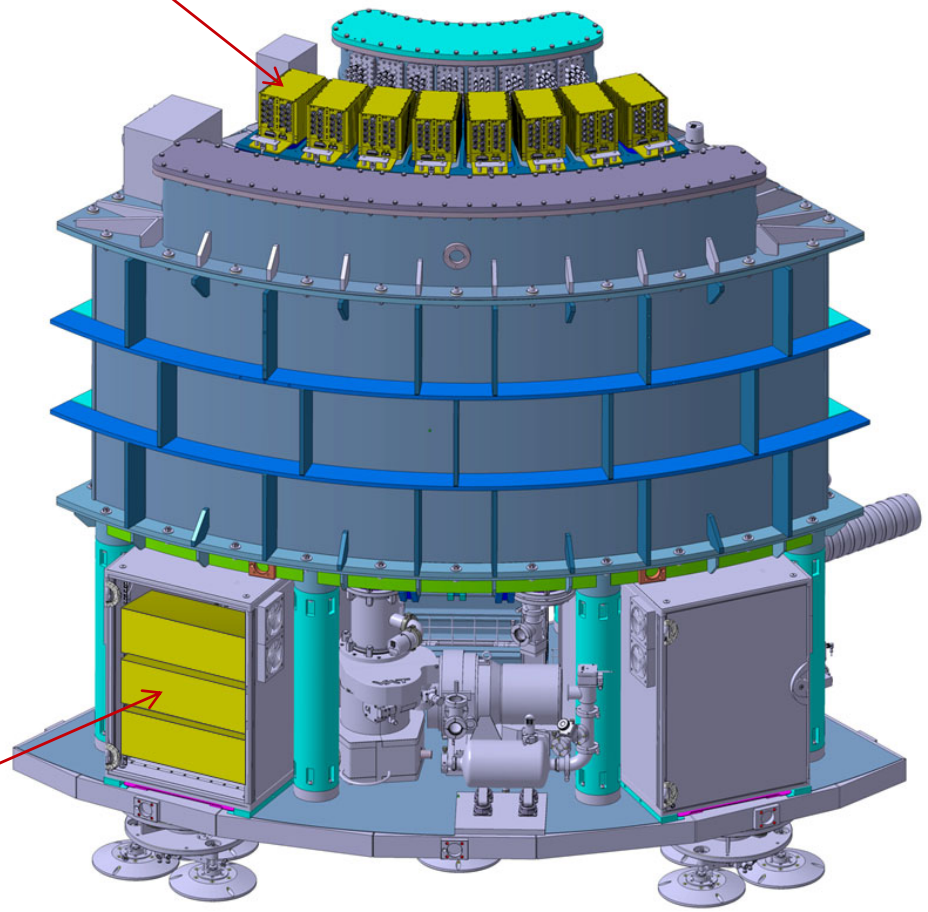
Design drivers for the CAMEA readout electronics

- Readout of 104 position sensitive Helium-3 neutron detector tubes
  – 208 analog acquisition channels
- Dedicated frontend electronics as close as possible to the detector tubes
- Maintain the CAMEA segmentation, i.e., 8 identical frontend boxes each handling 13 tubes
- 2nd Generation DAQ system interfacing to the SINQ computing infrastructure
- Simplify the cable harness, preferably using optical fibers where possible
- Resolution goal: <10 mm FWHM



System overview

CAMEA Frontend Box (8x)



Cable harness

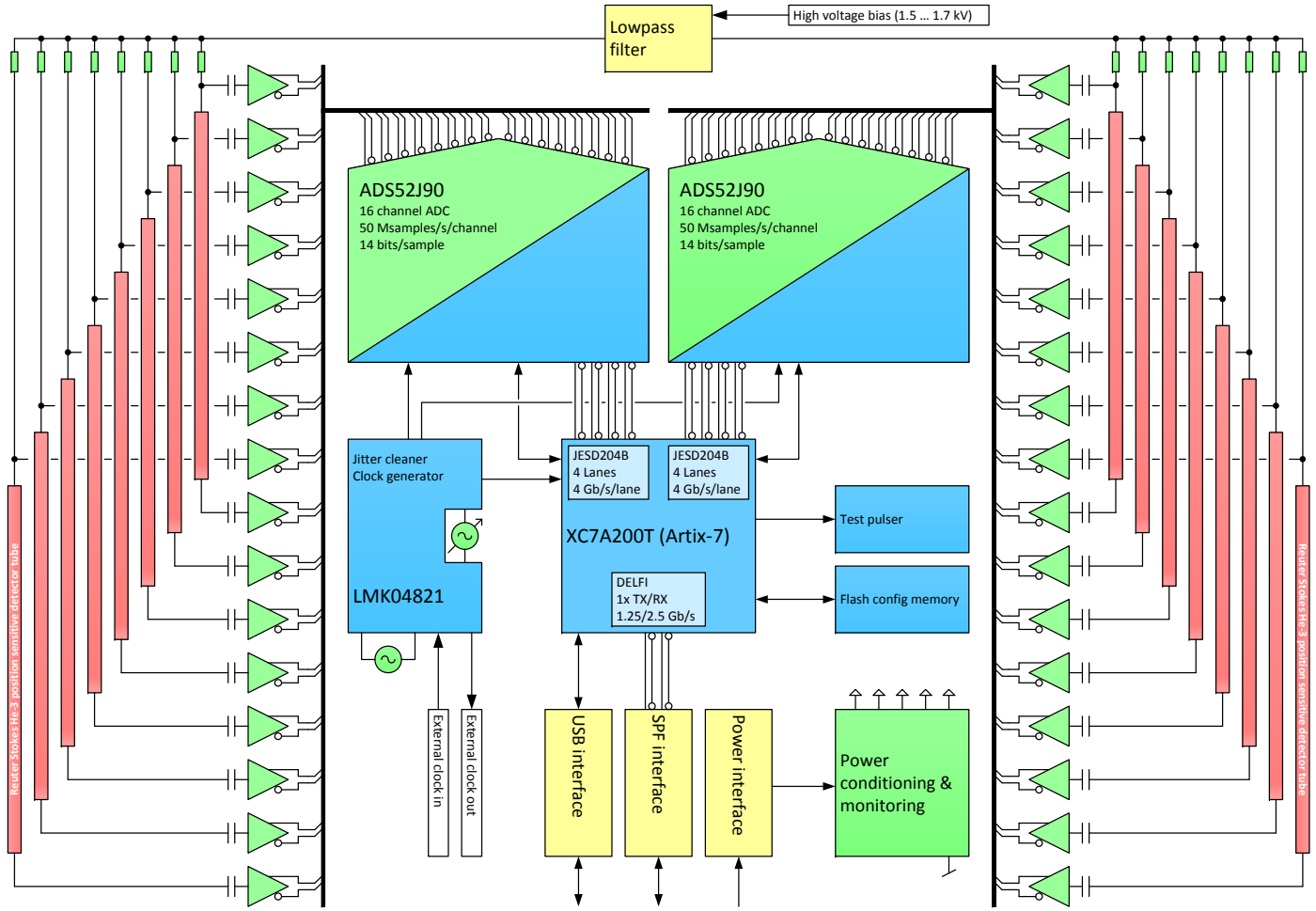
- Frontend box to bottom rack:
  - Low voltage power
  - High voltage bias (8x)
  - Optical gigabit link (8x)
- Bottom rack to SINQ:
  - Line power
  - Optical gigabit link

2nd Generation DAQ

Low voltage power supply

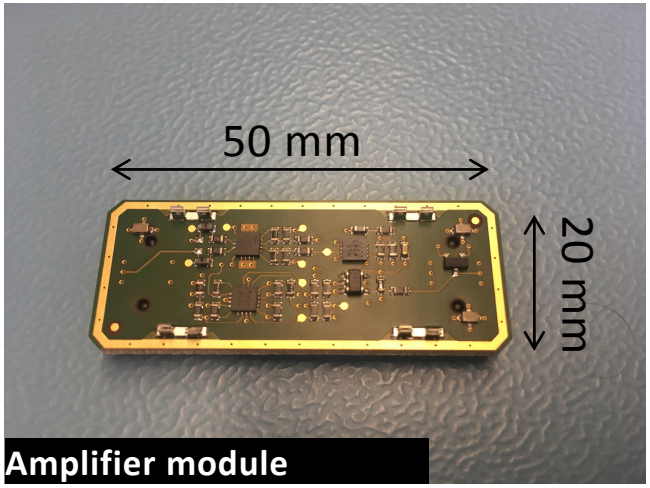
High voltage bias supply

Frontend box concept



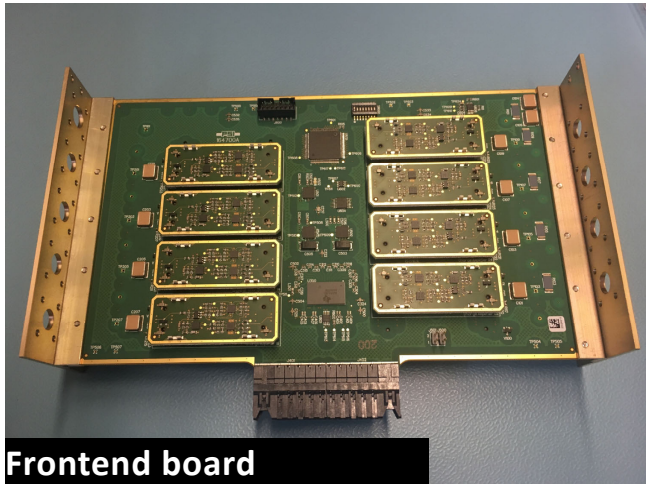
- ADCs sample continuously (50 MSamples/s/channel, 14 bit resolution)
- Data processing in programmable digital hardware
- Neutron event data packet: Tube ID, timestamp, position, charge level

From concept to hardware 1/2



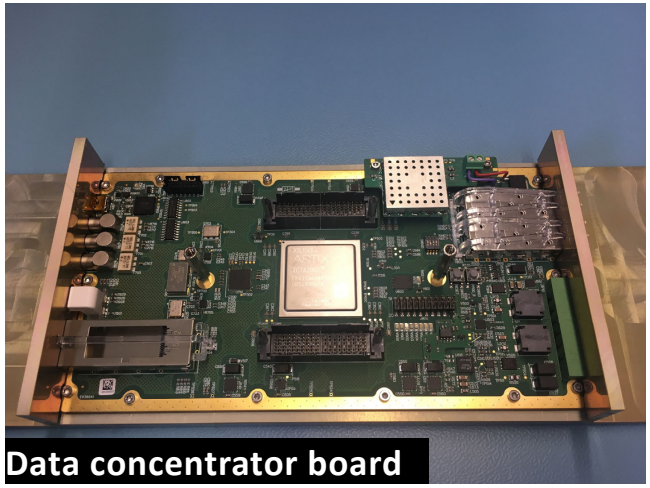
Amplifier module

- Amplification
- Pulse shaping
- Signal conditioning for ADC


Frontend board

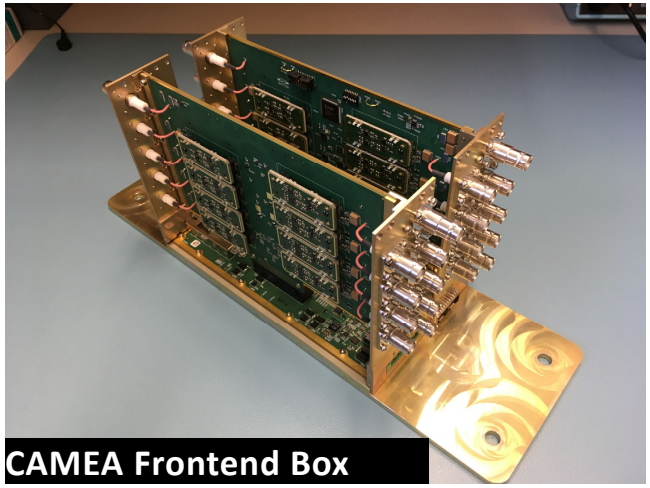
- Carrier board for up to 16 amplifier modules
- A/D conversion
- High voltage injection
- Test pulse injection

From concept to hardware 2/2



Data concentrator board

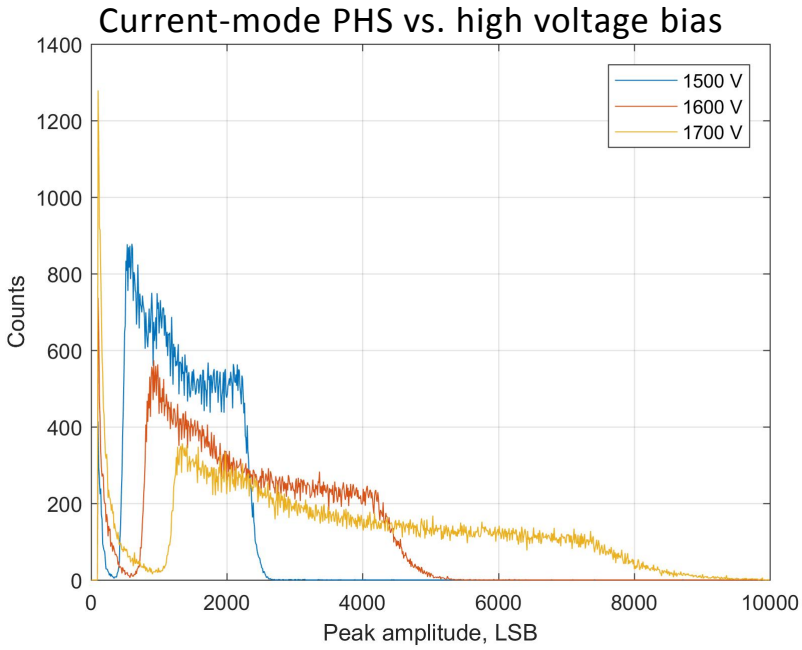
- Carrier board for 2 frontend boards
- Pulse processing
- Power conditioning
- Clock generation & distribution
- Fiber optical interfaces (2 x SFP, QSFP)

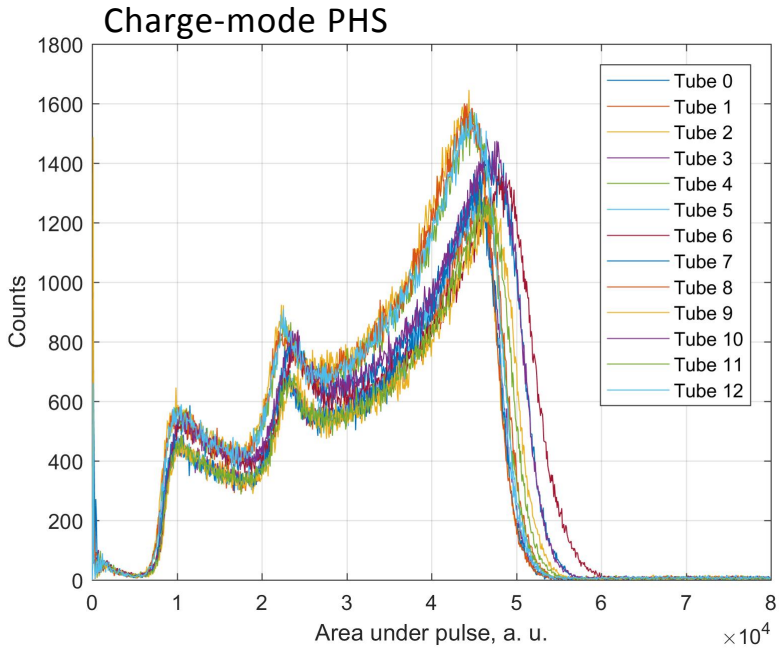


CAMEA Frontend Box

- Passively cooled via housing
- Power consumption approx. 25 W

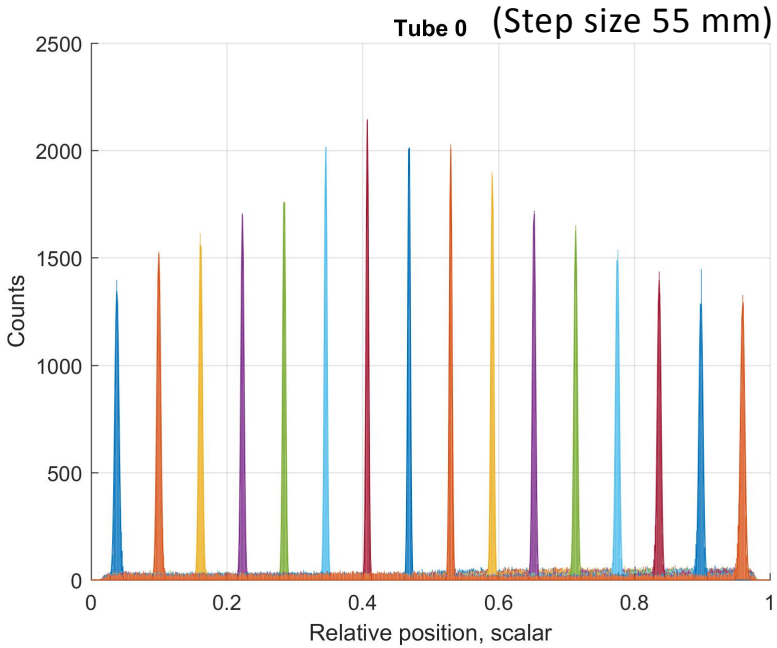
Measurement results 1/2

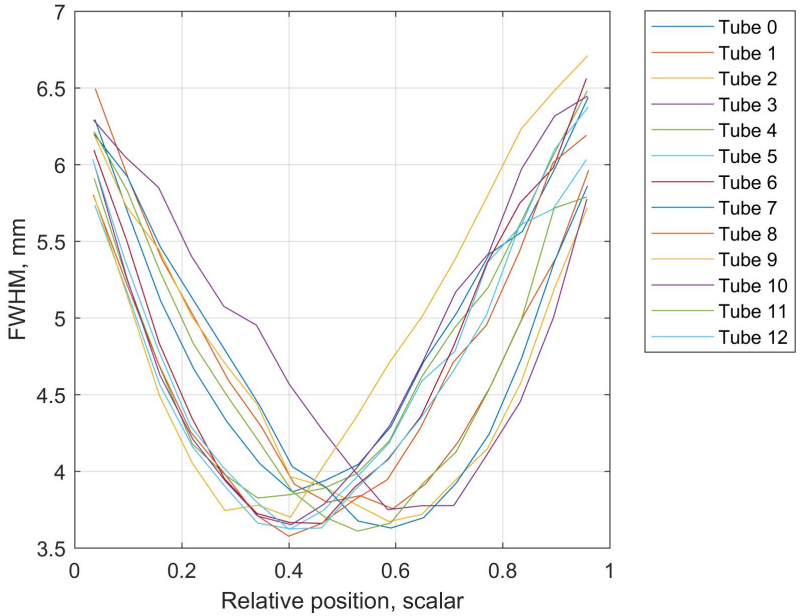




- Current-mode and charge-mode Pulse height Spectra (PHS) can be measured simultaneously
- Current-mode: Find trigger condition
- Charge-mode: Verify tube health, gamma discrimination

Measurement results 2/2





- Full Width at Half Maximum (FWHM) approximately 5 mm
- Resolution can be traded against sensitivity in post-processing by increasing the gamma discrimination level

We developed a new data acquisition system for the CAMEA instrument consisting of…

… dedicated frontend boxes,

… multi-purpose 2nd Generation DAQ unit,

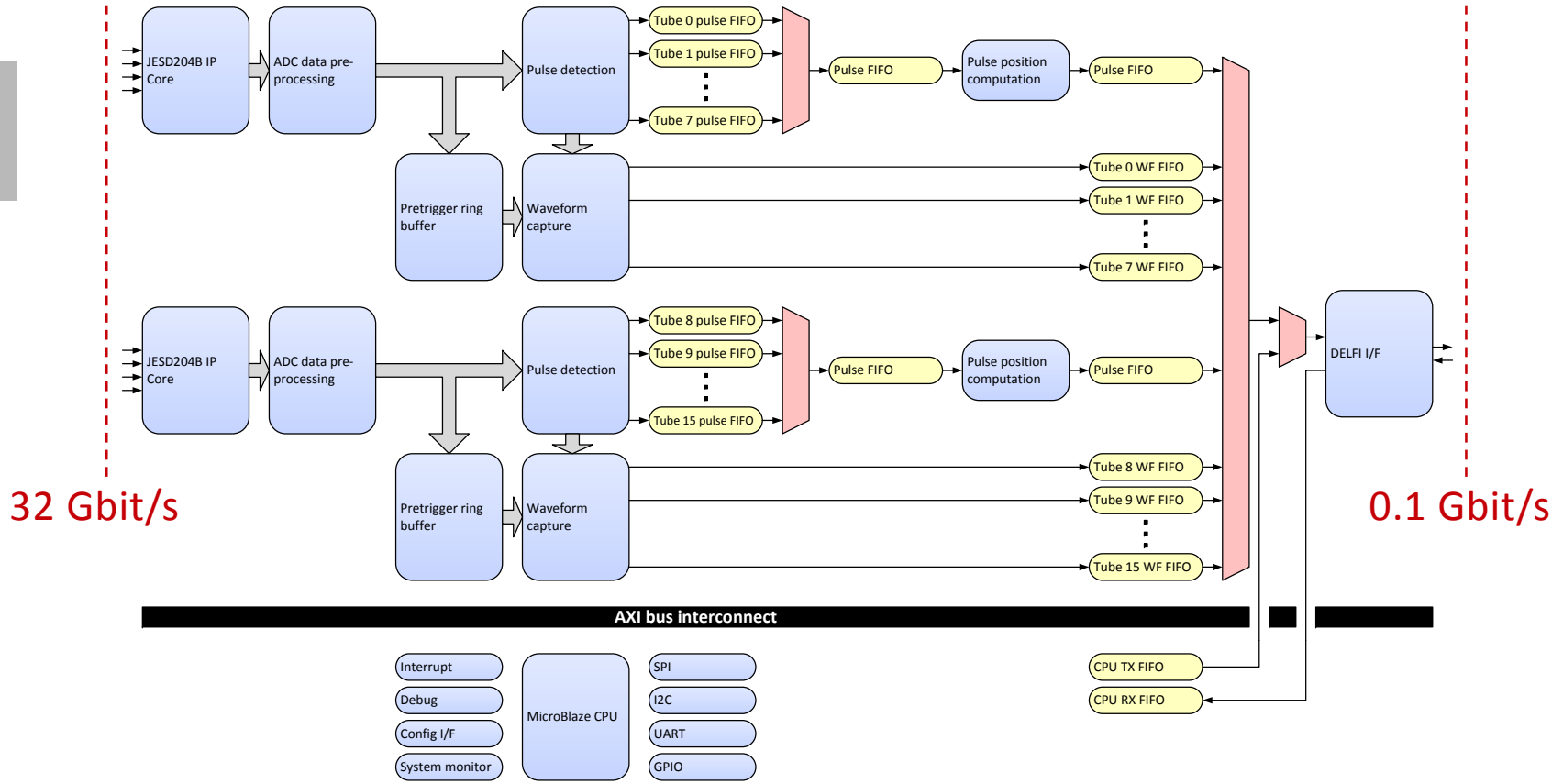
… serialized optical fiber interfaces.

First CAMEA results autumn 2018!

My thanks go to

- Urs Greuter
- Gerd Theidel
- The CAMEA project team

FPGA pulse processing



DELFI: Deterministic Event Latency Fiber Interface

- Deterministic latency for high-priority event messages
- Small footprint in FPGA