university of groningen

kvi - center for advanced radiation technology

Readout of the PANDA Electromagnetic Calorimeter, Status

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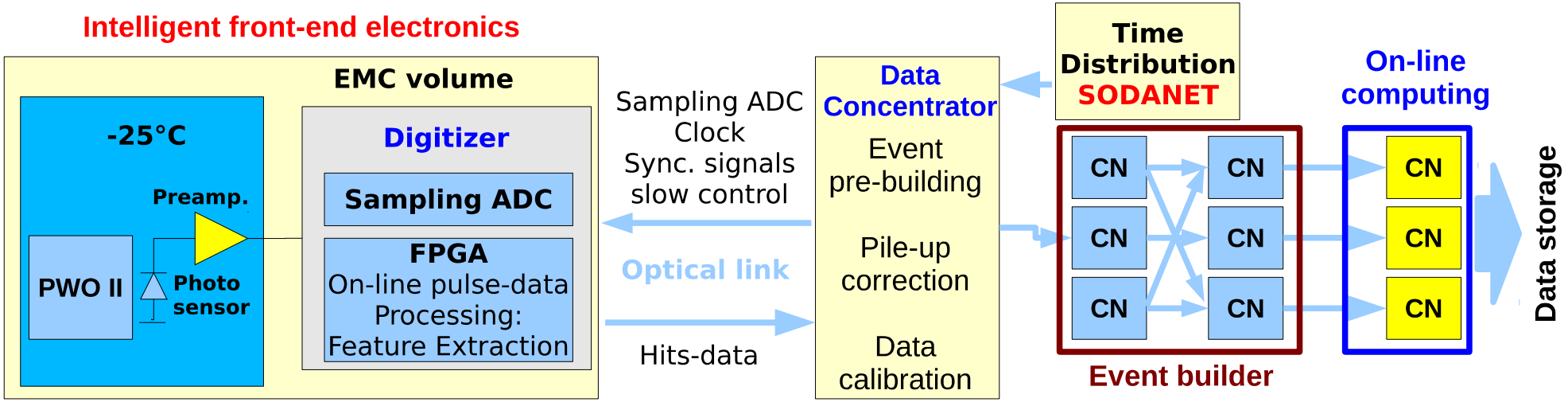
for the PANDA collaboration

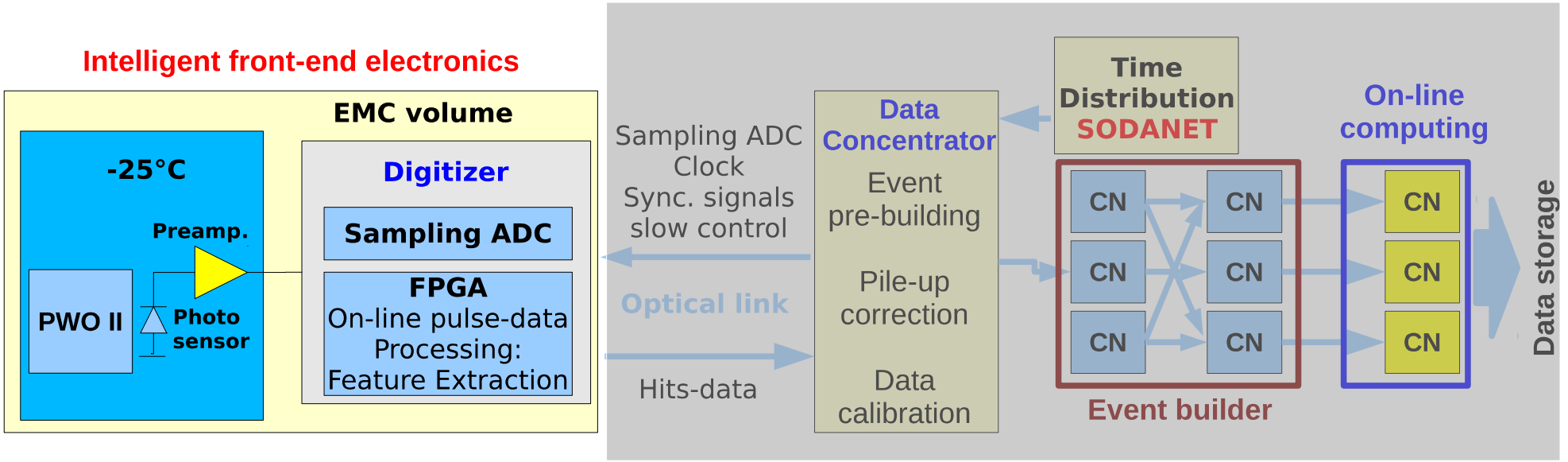
EMC-Readout Scheme



Components of the EMC readout:

- Intelligent front-end: **digitizer**
- Time-distribution system
- Data concentrators
- Burst-building network
- On-line computing

EMC Front-End Electronics

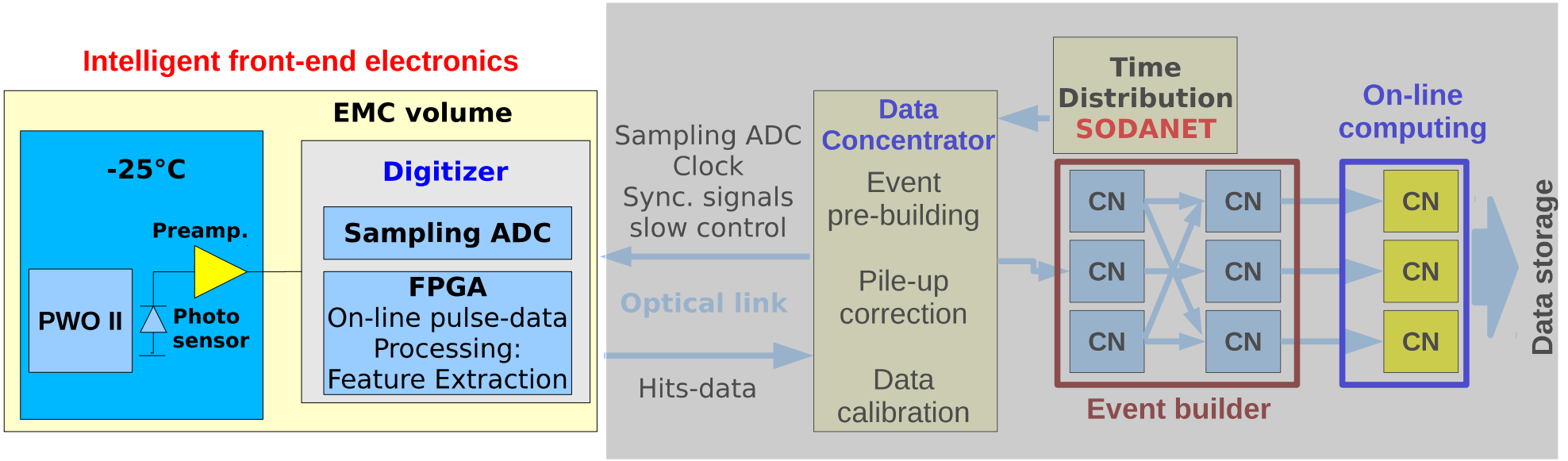


EMC digitizer:

- 64 ADC channels (32 dual-gain readout channels)
- 14 bit resolution
- 80 MHz sampling rate

- Input buffers to be finalised

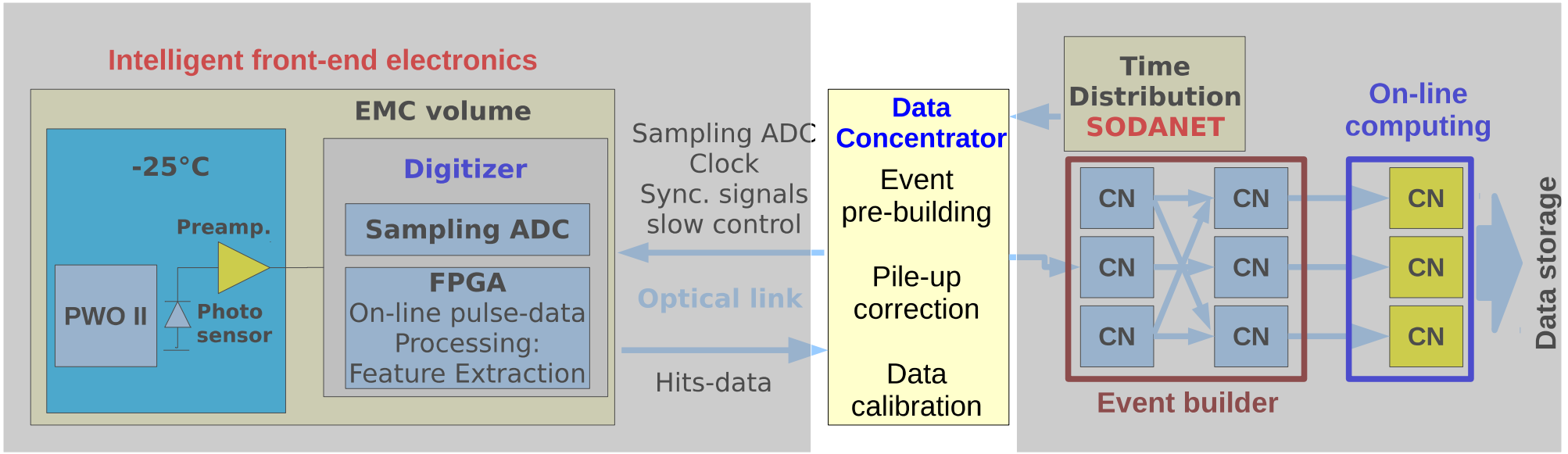
EMC Front-End Electronics



Feature Extraction:

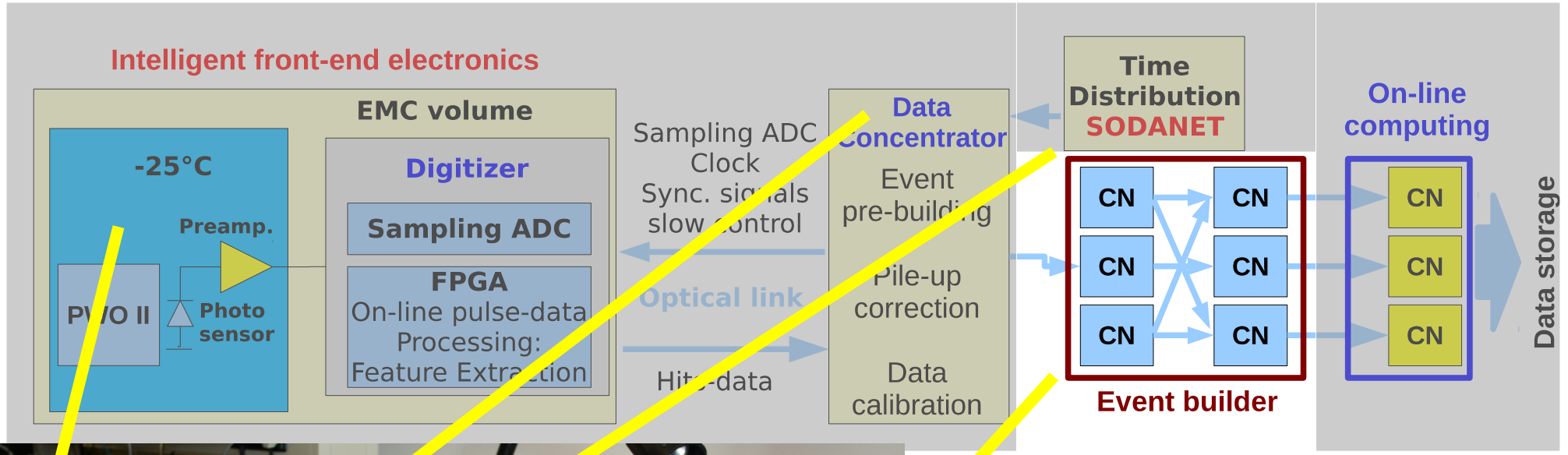
- **MWD filtering** (programmable)
- Base-line follower
- Pulse detection
- Pile-up detection (output waveforms)
- Precise time
- Precise energy
- Diagnostics: Possibility to readout raw ADC data (access to the noise-level measurement)
- **To be done**: self-monitoring for configuration errors, triple redundancy

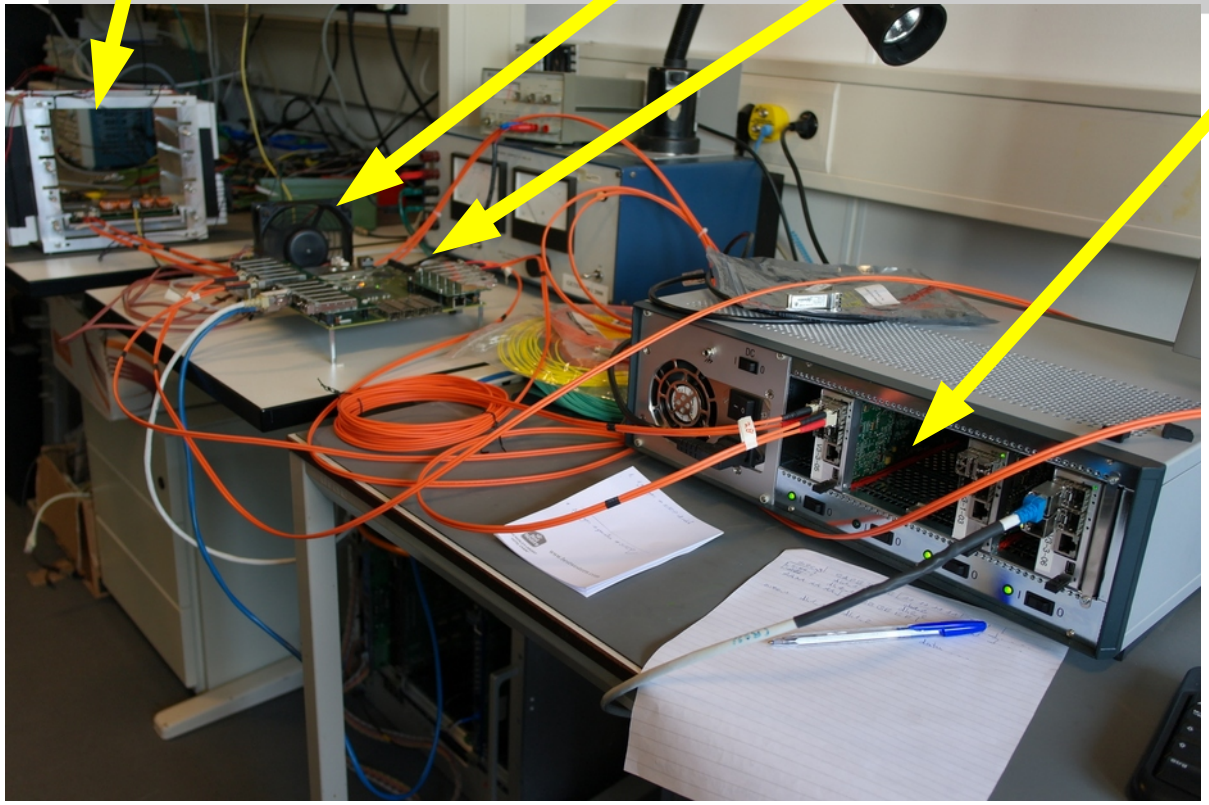
Data Concentrator



- **Data concentrator:**
  - Running on TRB3 and **Xilinx Kintex-7 development** boards
  - Receiving Waveforms and Hit-data over fiber from FEE
  - **Energy calibration for each ADC channel (low and high gain separately)**
  - **Superburst building**
  - Put each Waveform in one Panda data-packet (debugging mode)
  - Send Panda data-packets over fiber to CN UDP translator
  - **Slow Control with SODA-NET**
  - **Combine hits from two digitizers corresponding to the same crystal**
  - Additional features: on-line histogram, data monitoring (hits and waveforms), error detection and counting

Event Building





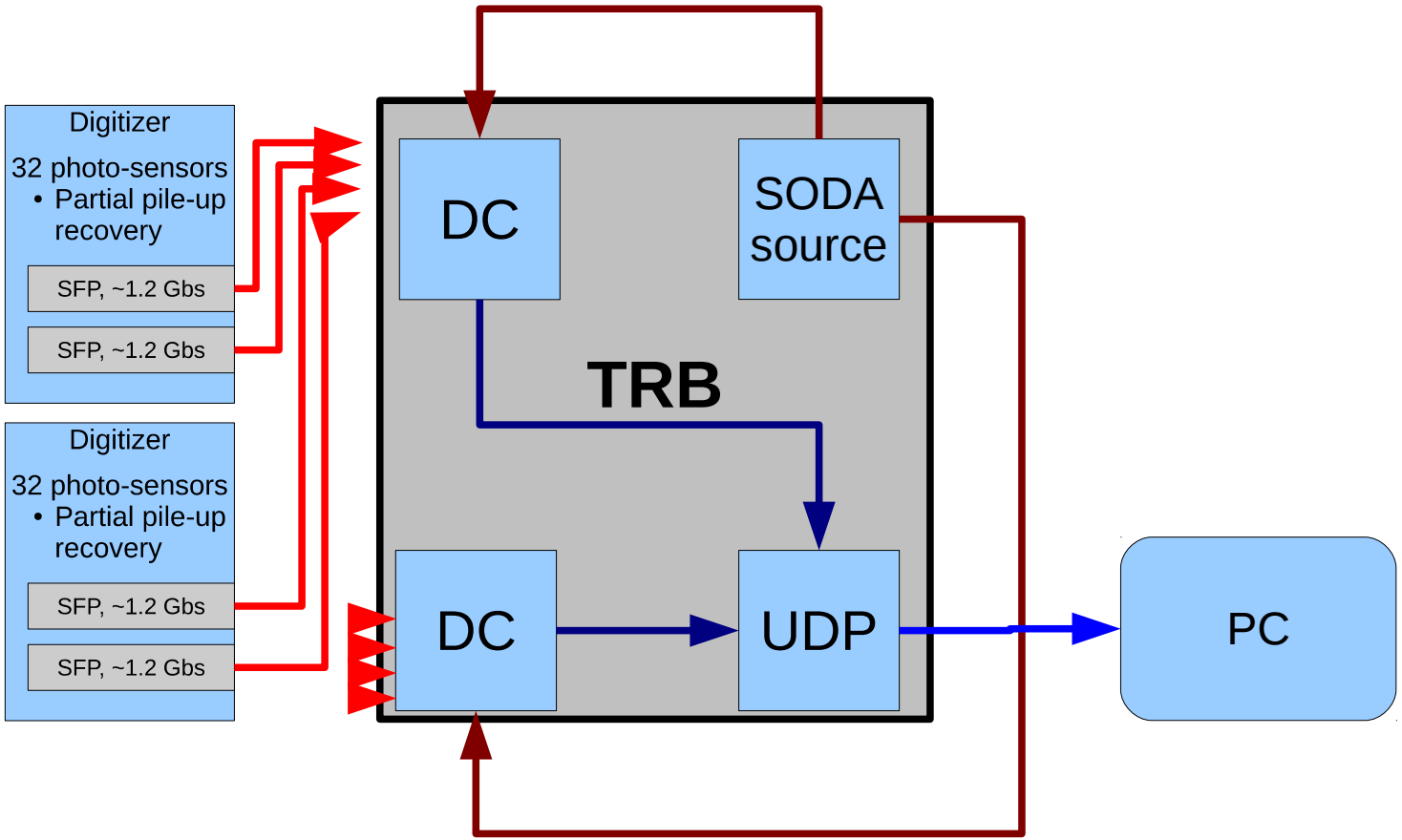
Event builder.

- is implemented on a compute node
- Tested with two EMC data concentrators and two digitizers

Limitations of the test system:

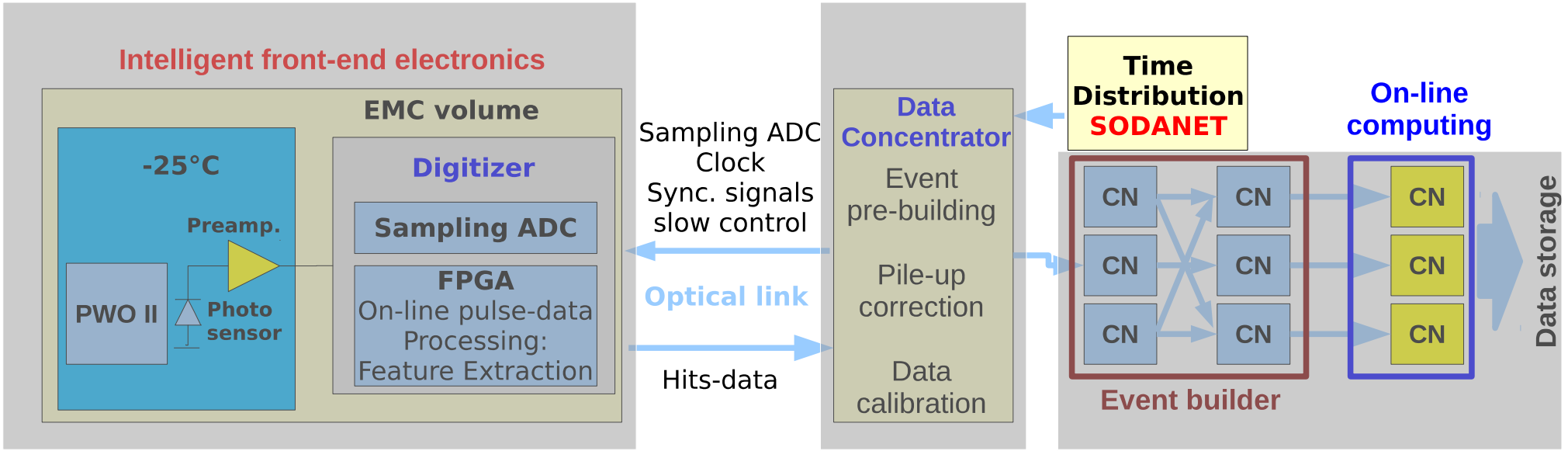
- can accept maximum 8 digitizers
- Limited bandwidth of the serial links (due to TRB3)

Readout Configuration with Single TRB DC



Single TRB board allows to read out up to 8 digitizers at low hit-rate

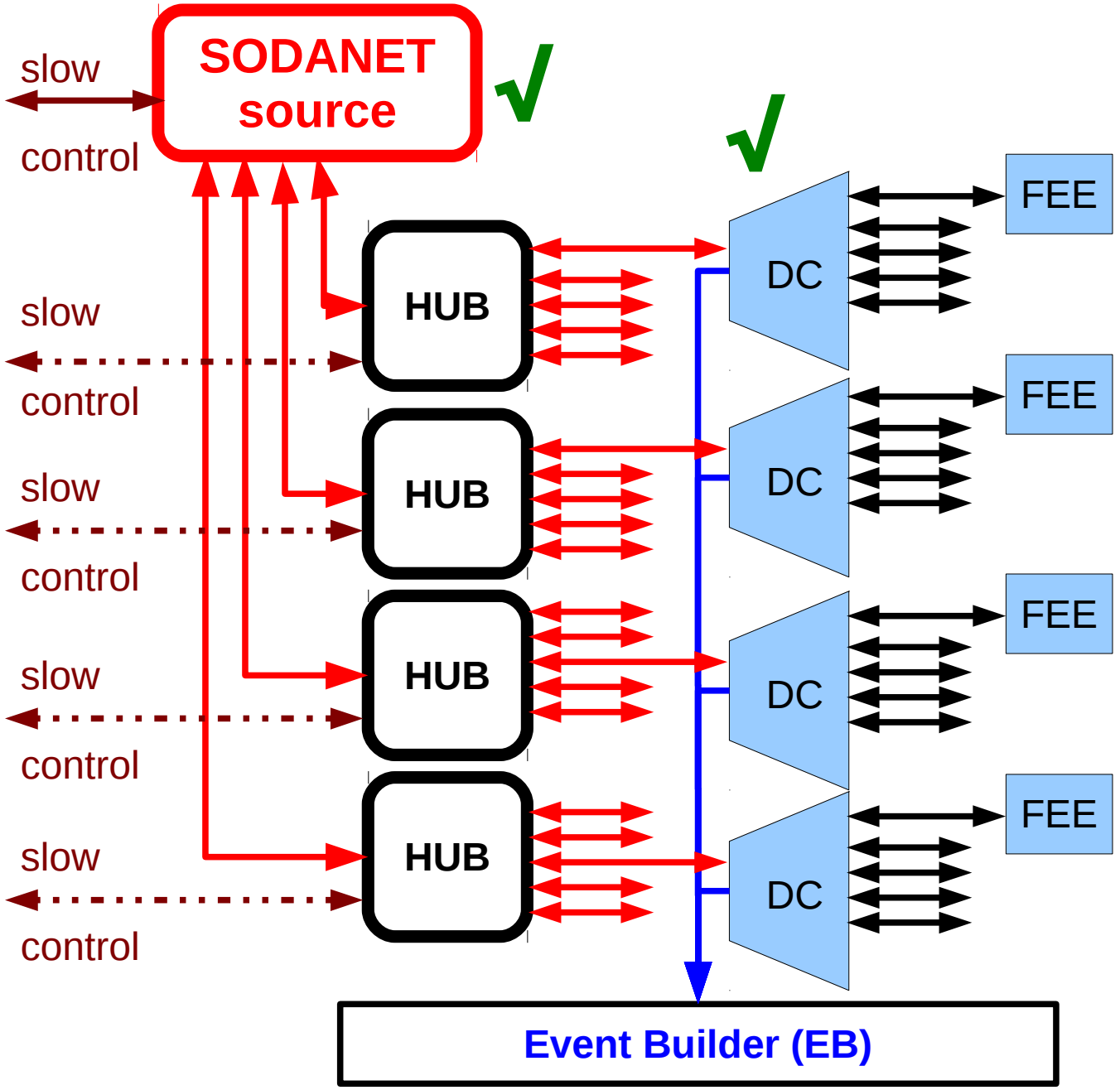
Time Distribution



SODANET provides:

- synchronization of the FEE
- Continuous monitoring of the Data Concentrator (**DC**) or FEE functionality
- Initial rough (~10ns) time calibration of the propagation time of the synchronization signal
- Transfer of a slow-control (FEE configuration/status) information

SODANET Topology



SODANET link:

- Bidirectional
- Synchronous (only in one direction)
- Transfer:
  - source → DC: synchronization information and FEE configuration
  - DC → source: slow control, used for time calibration

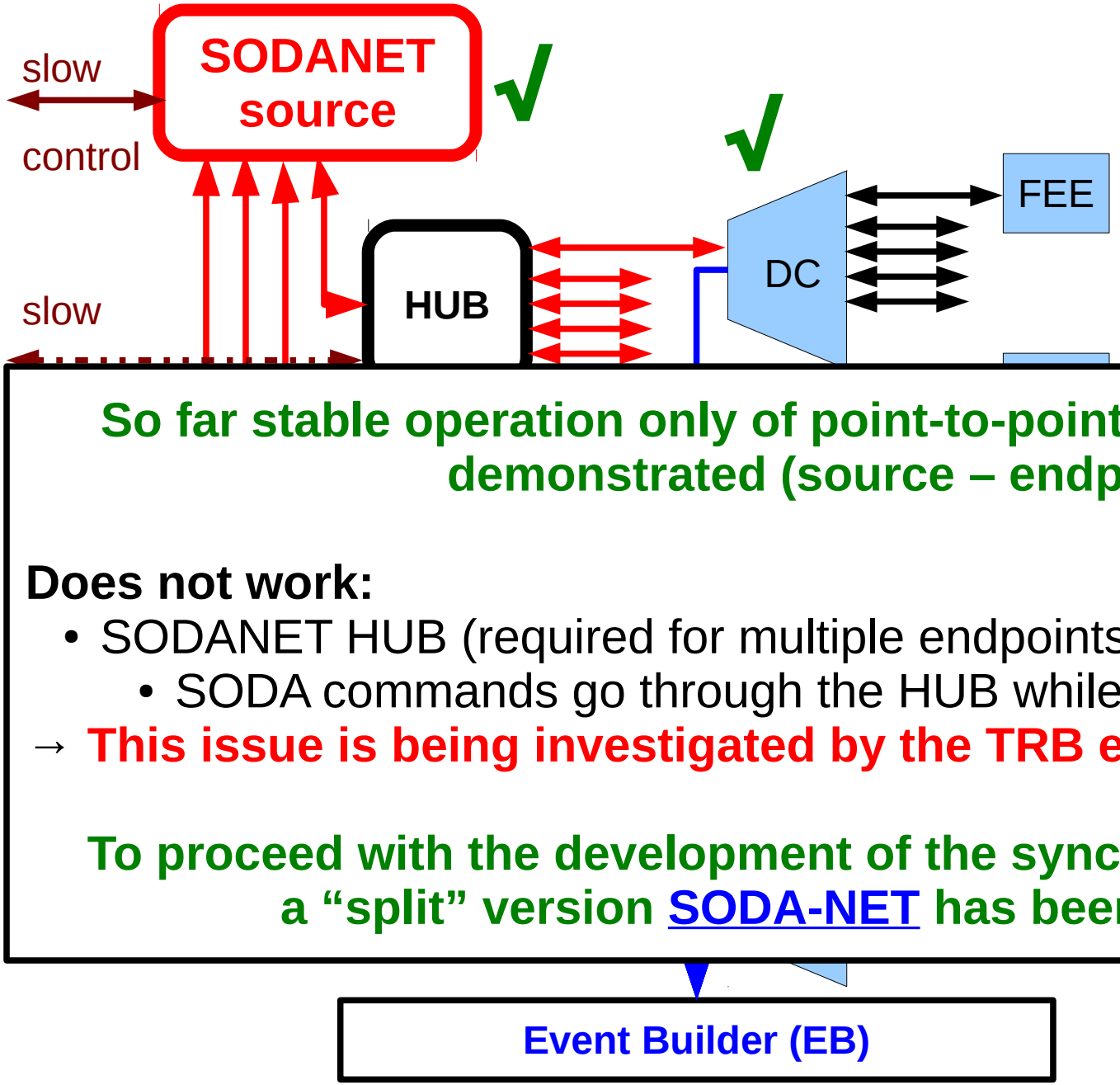
Data link (DC → EB):

- Unidirectional Ethernet

Link DC ↔ FEE:

- Bidirectional, synchronous
- Protocol up to subsystem

SODANET Topology



SODANET link:

- Bidirectional
- Synchronous (only in one direction)
- Transfer:
  - source → DC:
- synchronous
- Protocol up to subsystem

So far stable operation only of point-to-point SODANET link was demonstrated (source – endpoint)

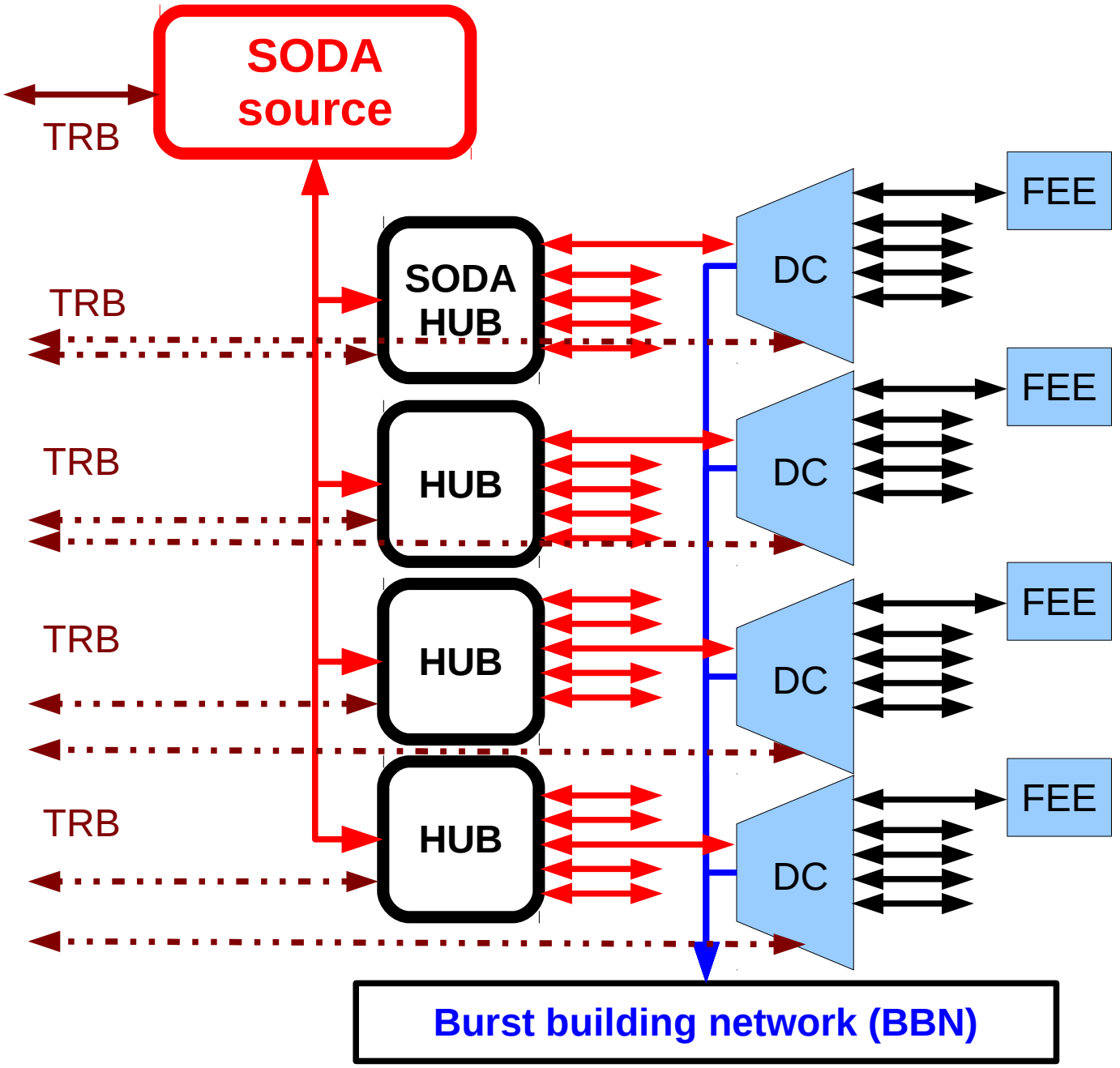
Does not work:

- SODANET HUB (required for multiple endpoints):
  - SODA commands go through the HUB while the TRB hub is hanging

→ **This issue is being investigated by the TRB expert (Jan Michel)**

To proceed with the development of the synchronization protocol a "split" version SODA-NET has been developed

SODA-NET



SODA link:

- Bidirectional
- Synchronous (only in one direction)
- Transfer:
  - source → DC: synchronization information
  - DC → source: slow control, used for time calibration

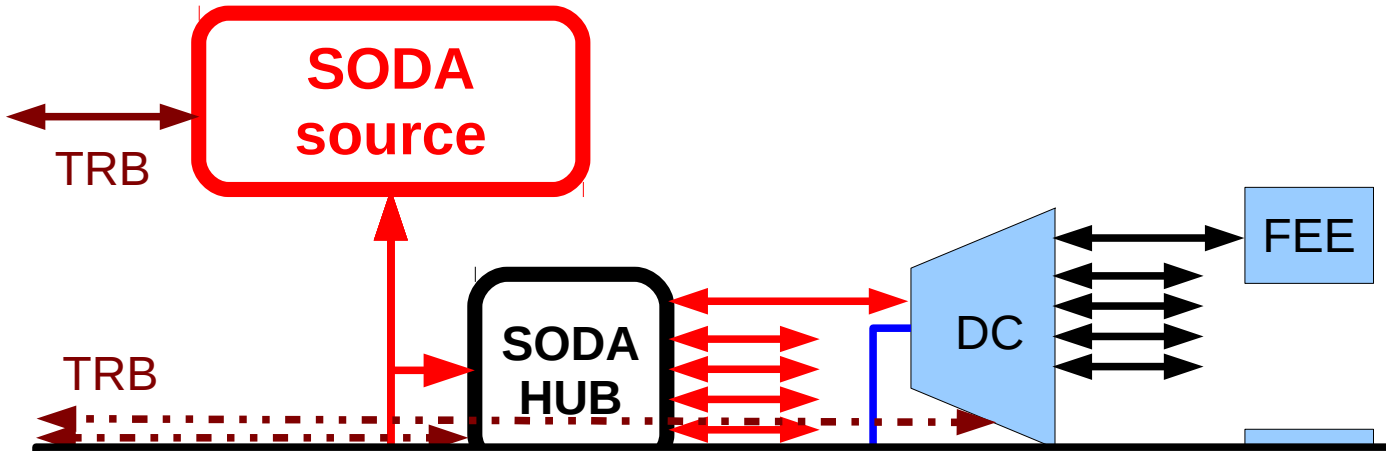
Data link (DC → BBN):

- Unidirectional

Link DC ↔ FEE:

- Bidirectional, synchronous
- Protocol up to subsystem

SODA-NET



SODA link:

- Bidirectional
- Synchronous (only in one direction)
- Transfer:
  - source → DC:

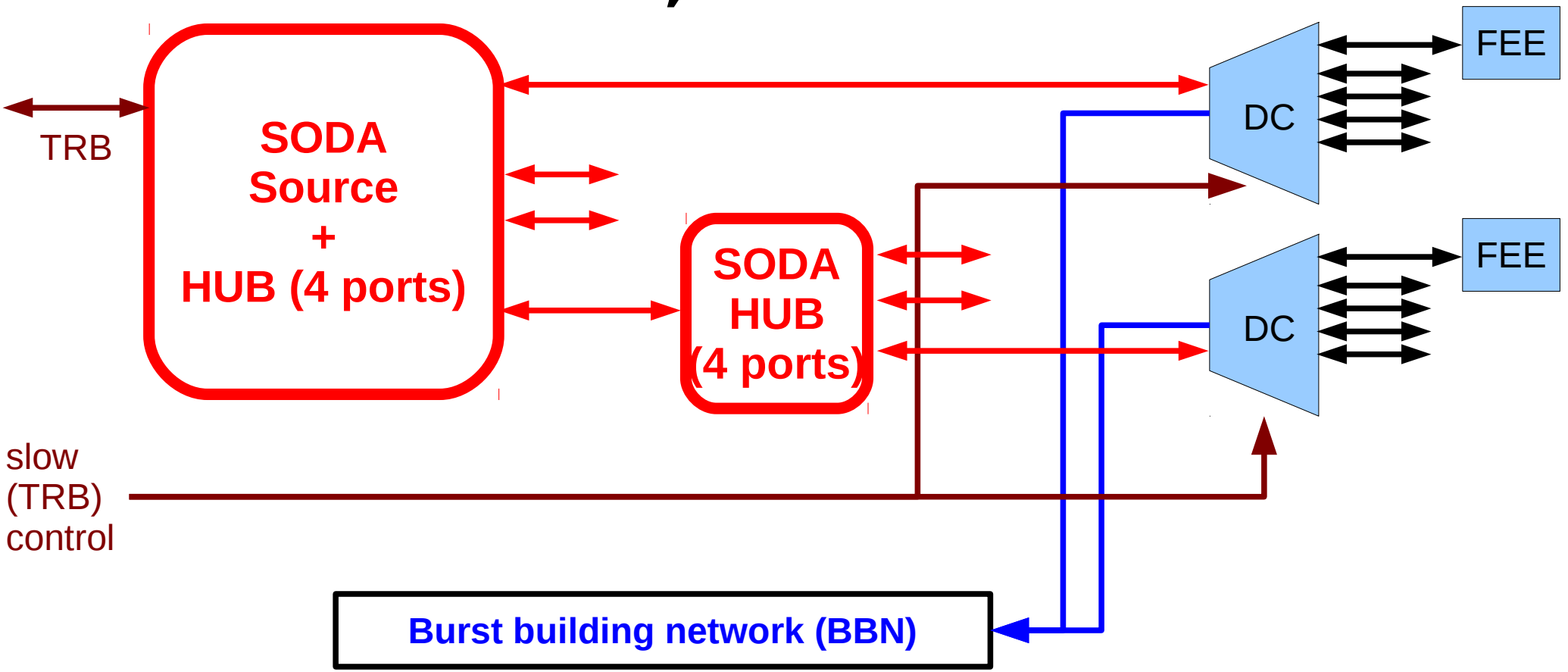
SODA-NET allows:

- To test performance of the time-distribution network in terms of jitter, scalability of the system
- To develop data concentrator firmware (migration from SODA-NET to SODANET is straightforward)
- To build complex readout systems with multiple DC/FEE modules

subsystem

Burst building network (BBN)

SODA-NET, Current Status

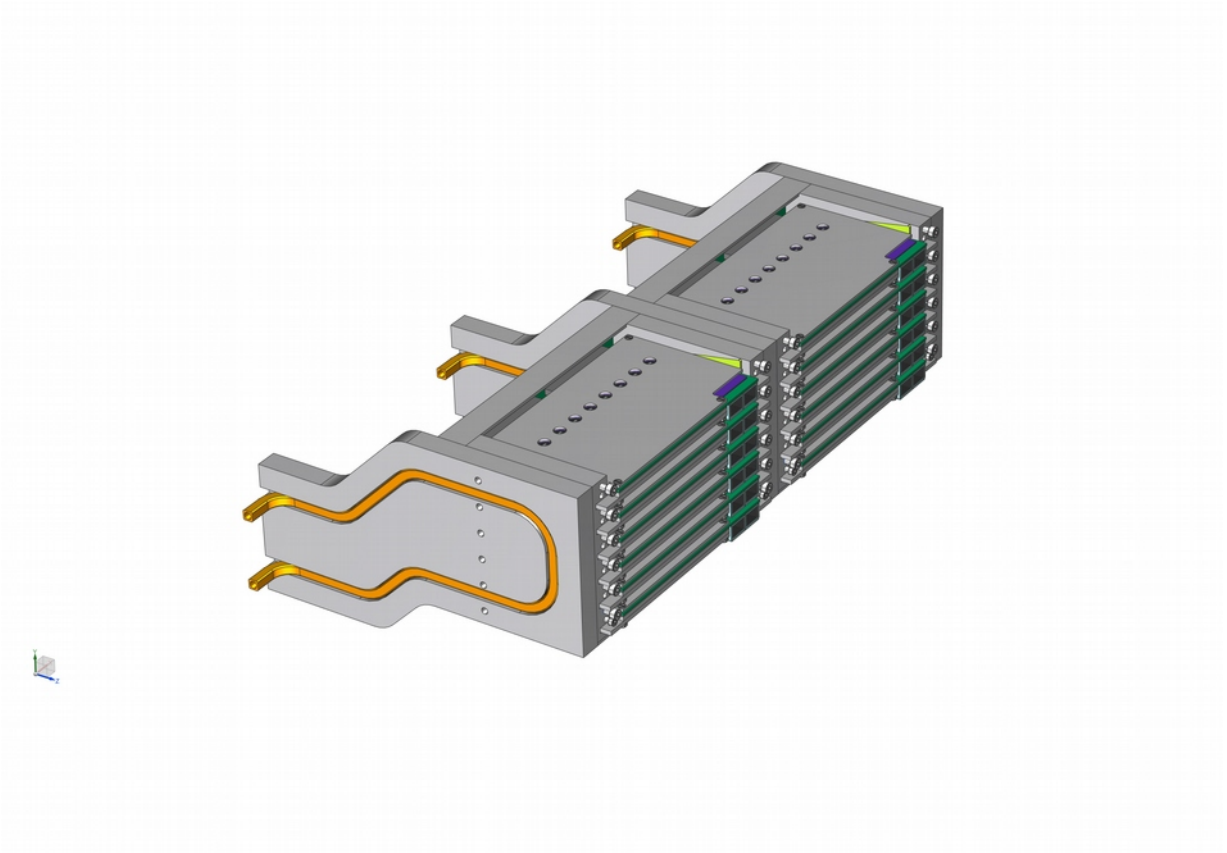


Prototype of the system with all components (two TRB boards and two EMC digitizers) operates stable: first tests are successful.

After completion of the tests with a small-scale system, larger system is required for scalability tests (>ten TRB board)

All subsystems should start using the SODA-NET

Design of the Crates for EMC Digitizers (fw Endcap)

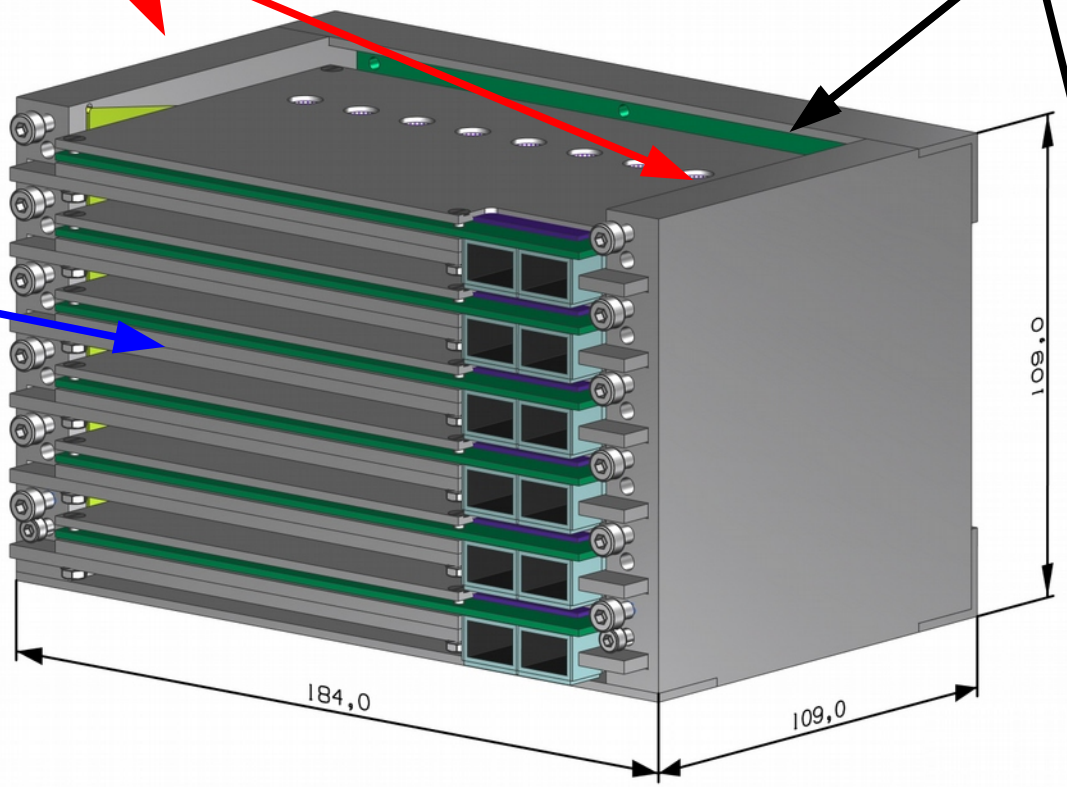


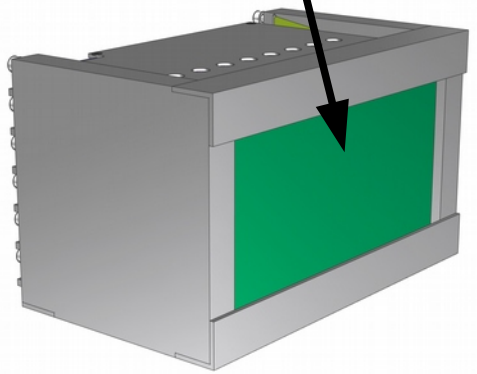
Crate for 6 Digitizers

Walls with clamping structures for good thermal contact

Backplane PCB

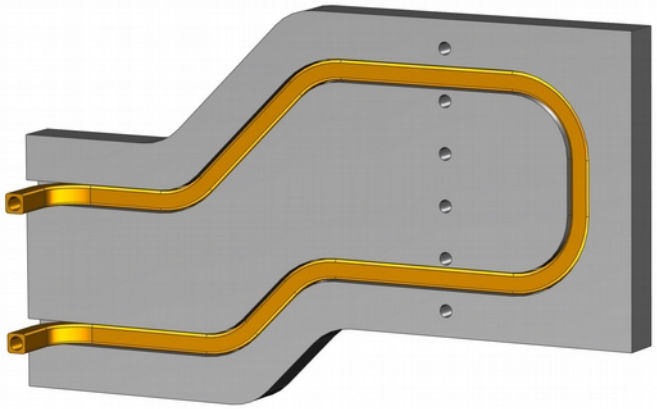
Digitizers with cooling envelop





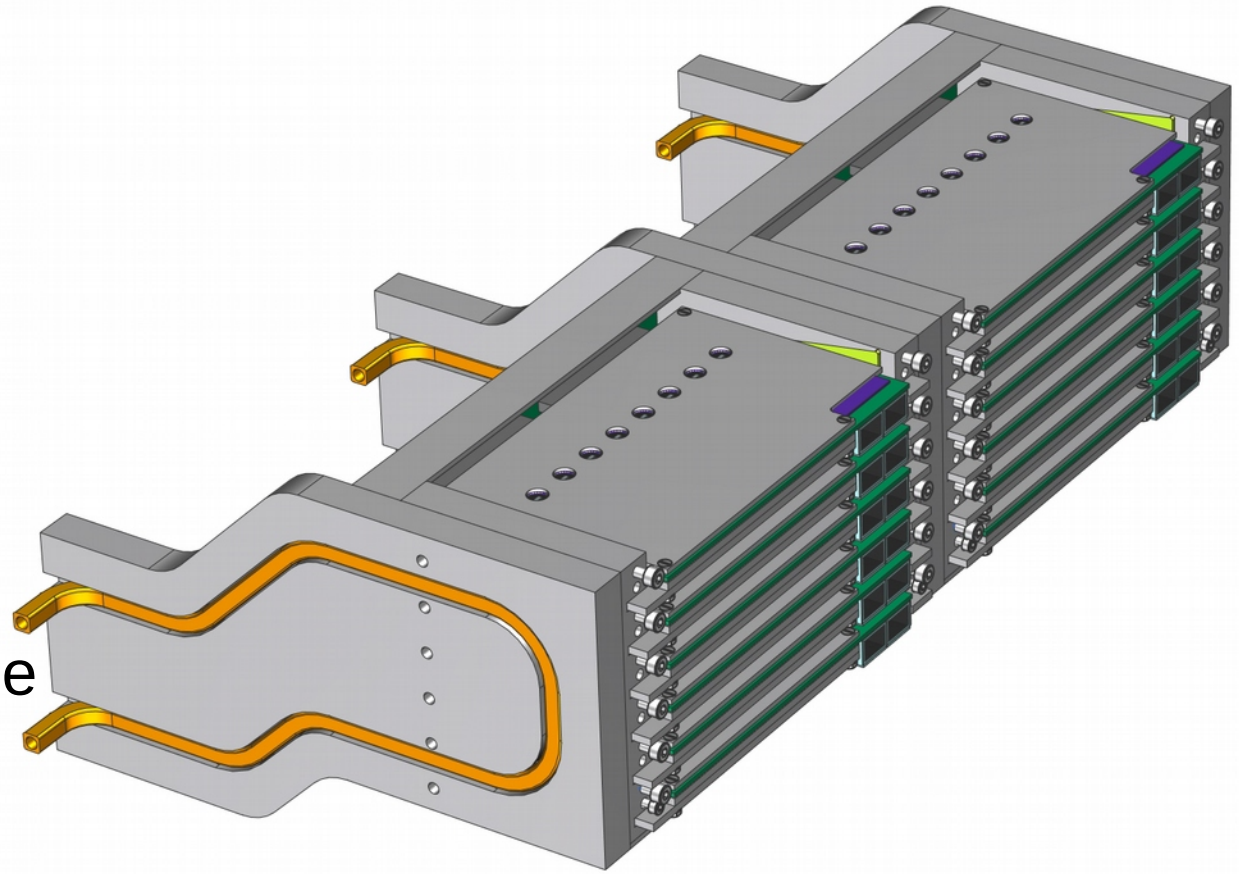
Cooling envelops were made and testes with a prototype crate

Cooling of the Crates



Crates will be mounted between cooling plates, which are simultaneously supporting structures

- Water pipes for several cooling plates can be connected in series
- Usage of a single copper pipe pressed/welded into the cooling plates would increase robustness of the system



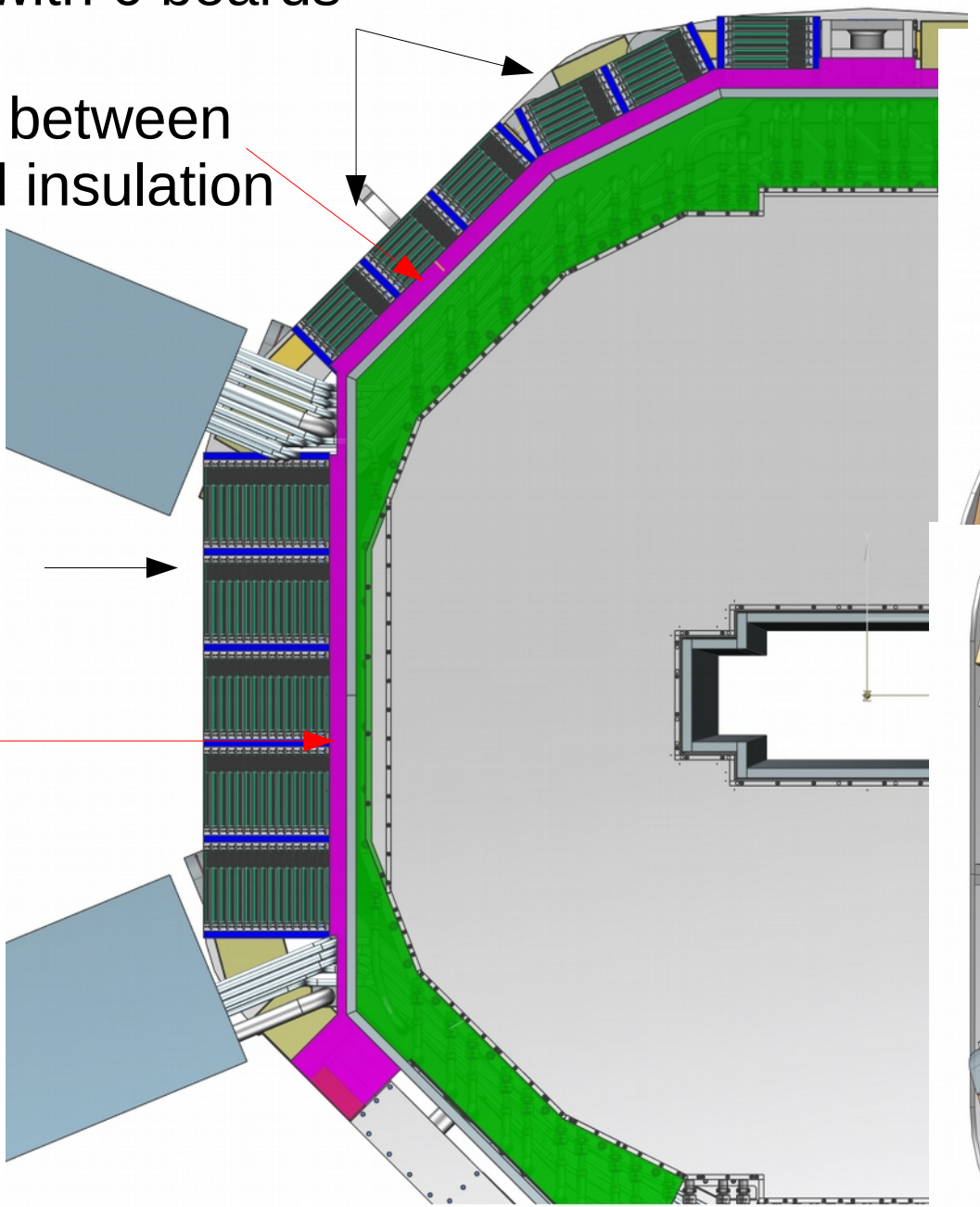
Placement of the Crates

6 crates with 6 boards

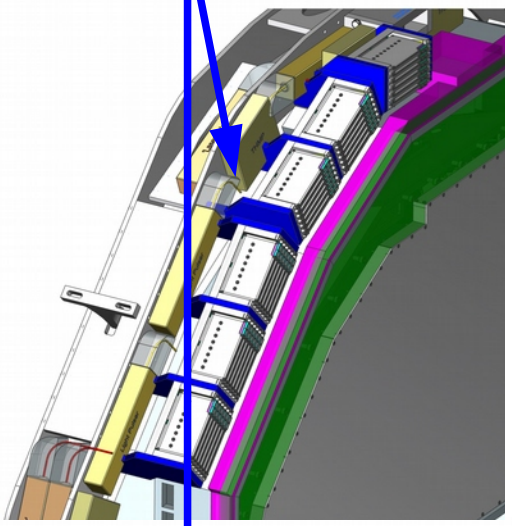
Distance between crate and insulation 40mm

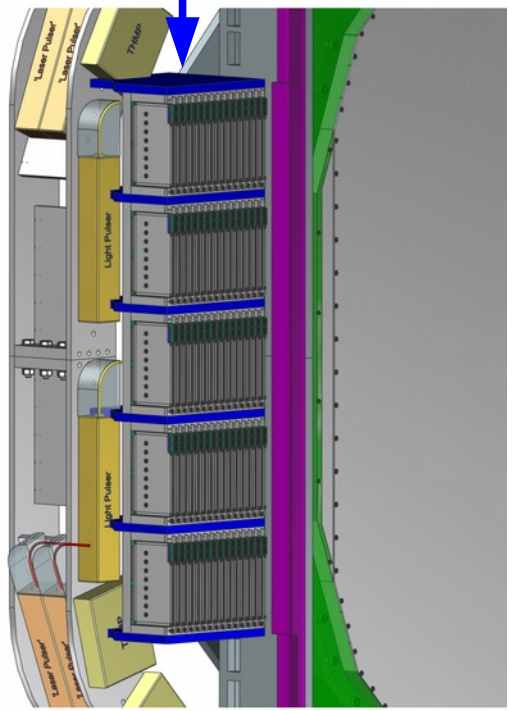
5 Crates with 15 boards

Distance between crate and insulation 35mm



Cooling plates





Summary

- **The EMC readout prototype is ready for larger-systems tests**
  → require more available hardware

- **SODA-NET is ready for implementation for ALL PANDA subsystems**

- **Crates for EMC digitizers (fw end-cap) are designed;** still to be designed:
  - Backplane PCB
  - Power supply