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The Prototype Trigger-Less Data Acquisition of the \bar{P} ANDA Experiment

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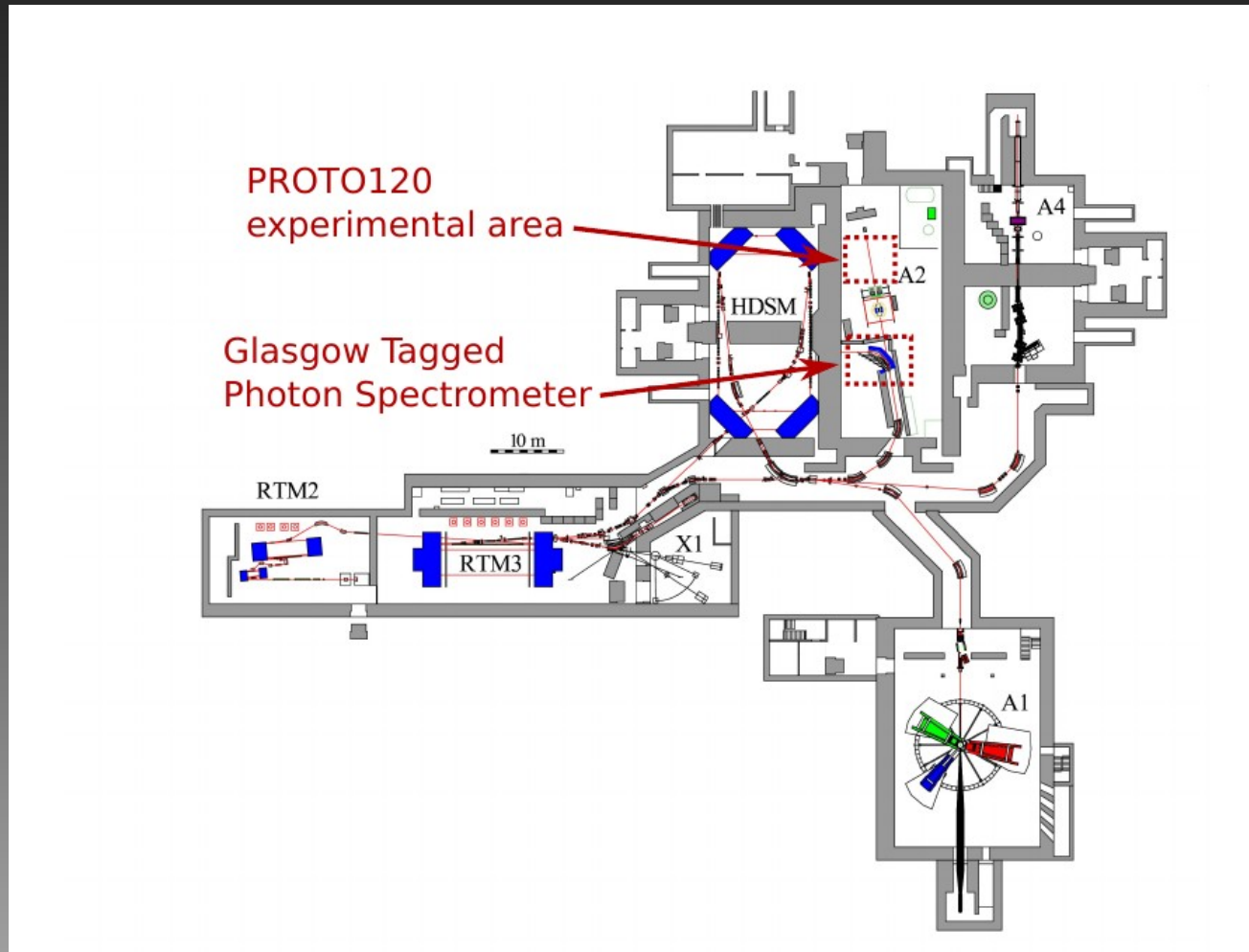


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und Forschung

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Helmholtz Graduate School for Hadron and Ion Research

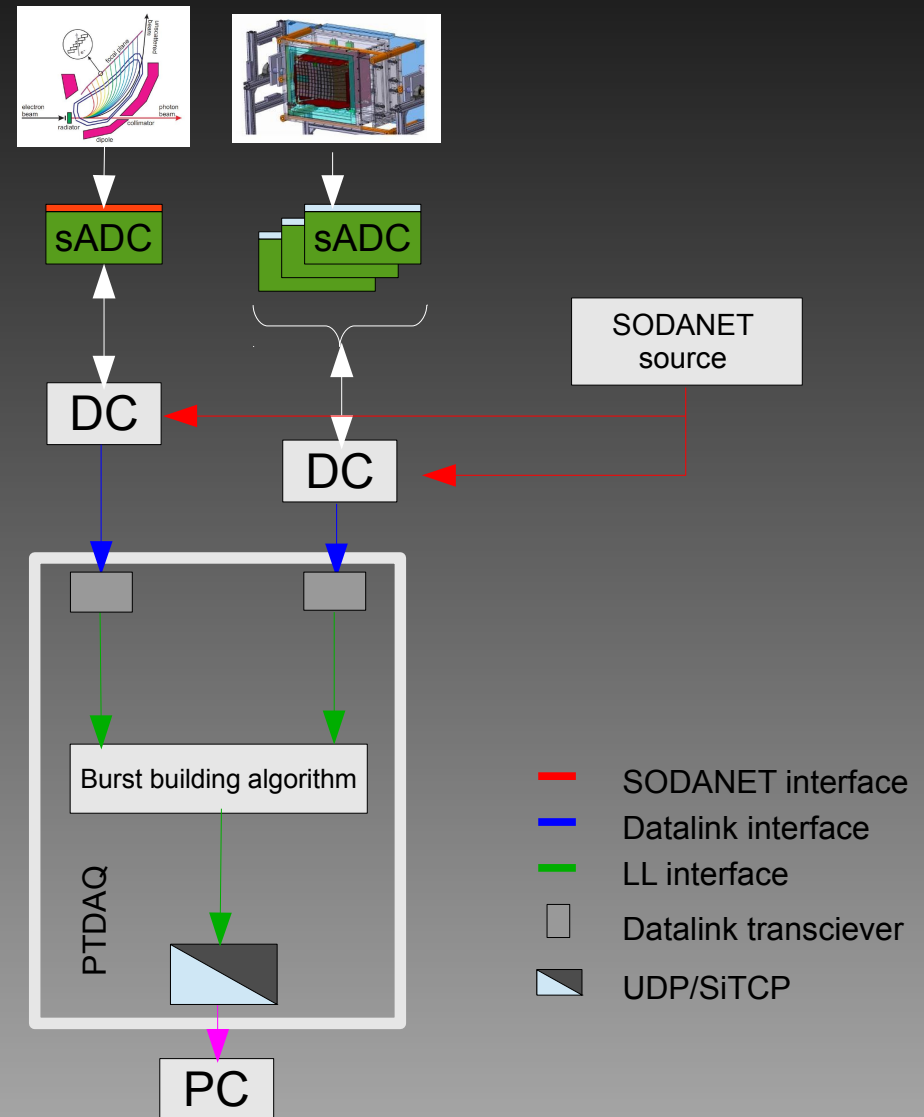
HIC | **FAIR**
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Helmholtz International Center

DAQ Chain Test @ MAMI

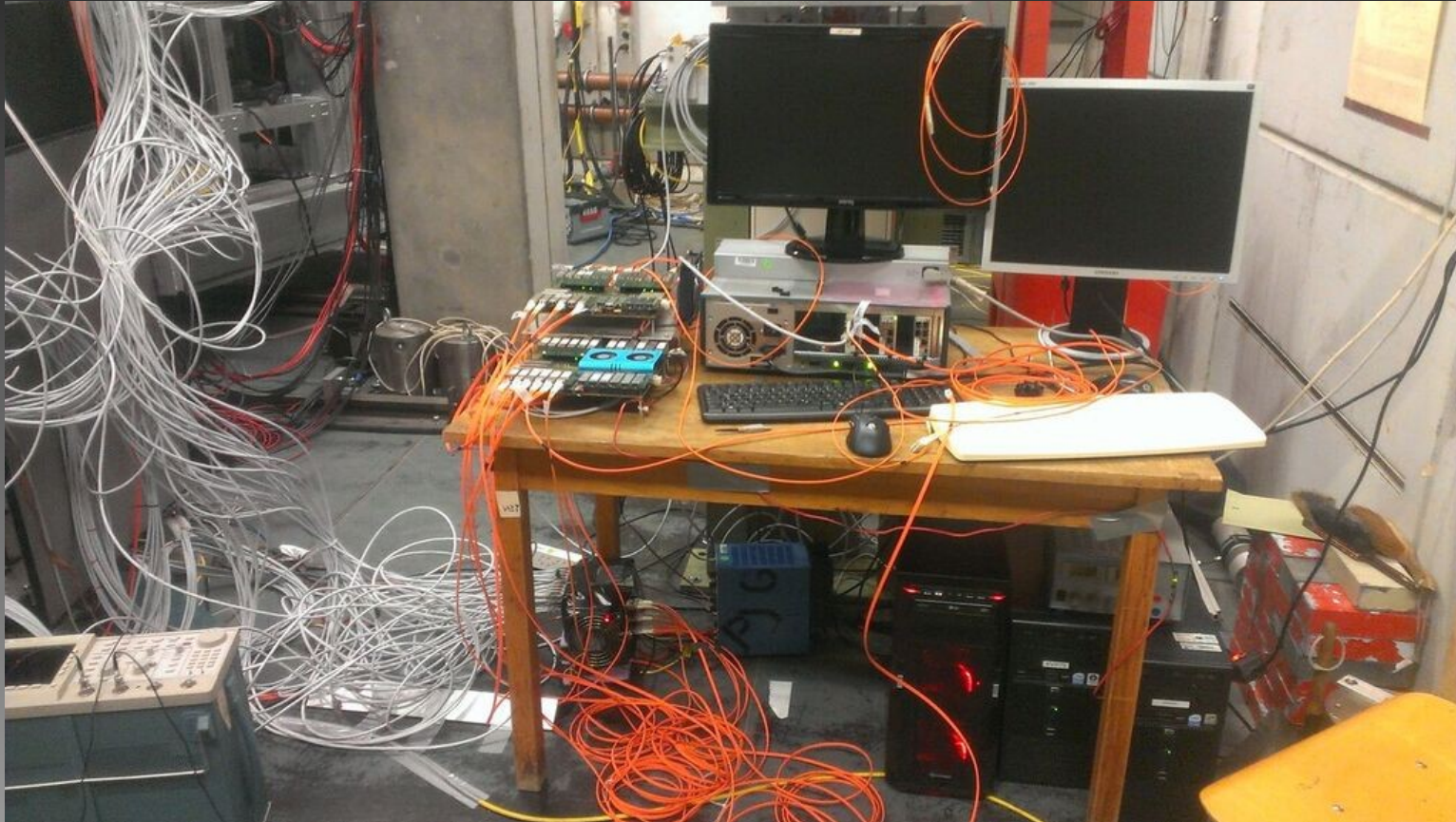


DAQ Chain

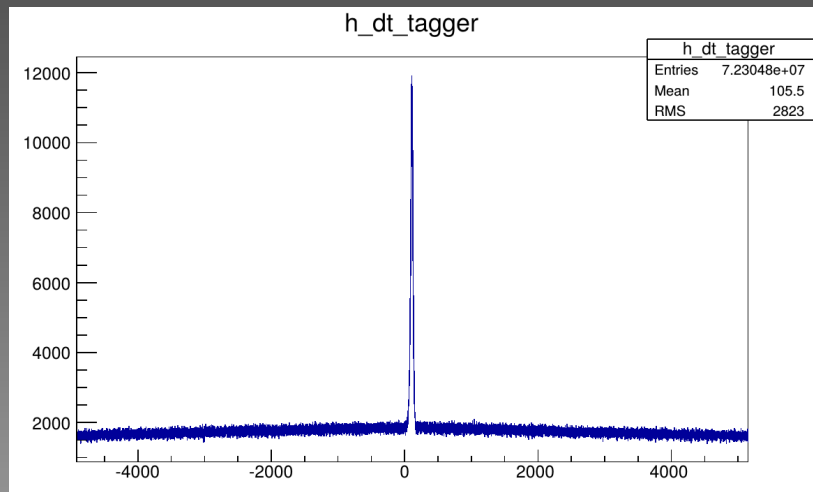
- Detector
 - 48 crystals
 - 16 Tagger channels
- 4 Sampling ADC (Uppsala)
 - Feature extraction mode
- 1 TRBv3
 - 2 Data concentrator
 - 1 SODANET source
- 1 xFP version 3
 - Burst-builder
 - (Filtering)



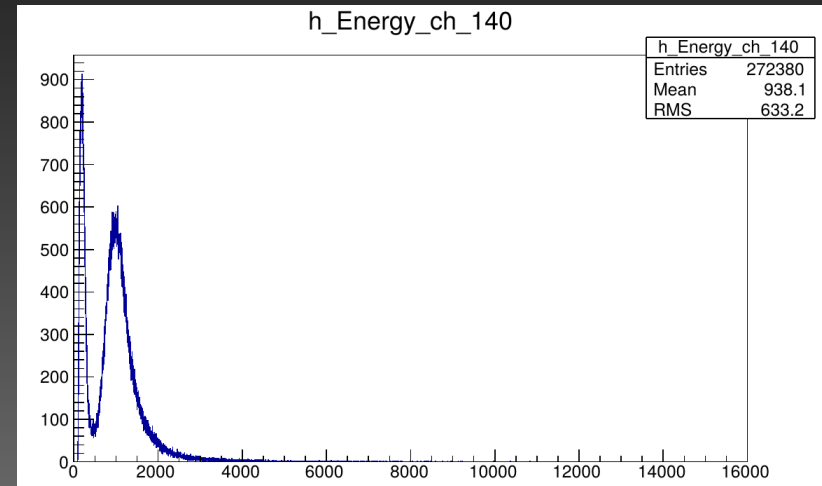
Setup @ MAMI



DAQ Chain Test @ MAMI



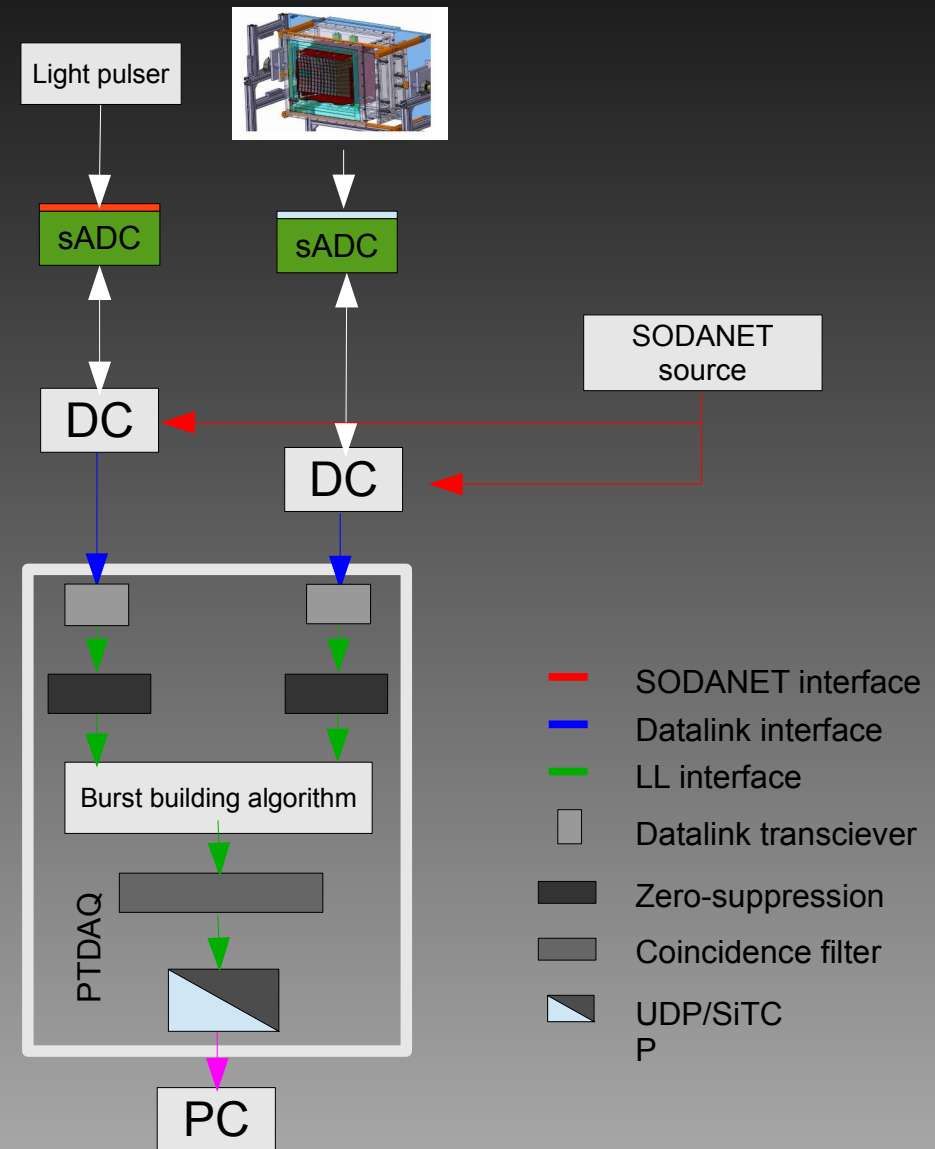
Δt of tagger to proto120



Energy distribution of the central
Crystal in a.u.

PTDAQ Test @ Giessen

- DAQ chain
- Detector
- 2 Pulser
- 2 Sampling ADC (Uppsalla)
 - Feature extraction mode
- 1 TRBv3
 - 2 Data concentrator
 - 1 SODANET source
- 1 xFP version 3
 - Burst-builder
 - Filtering



DAQ Chain Test Results



- First time full DAQ chain in a beam test
- Burst building ✓
 - 88.500.500 bursts at Proto120 test
 - More or less only random events
→ can not be used for comparison
- Zero suppression ✓
- Coincidence measurements ✓

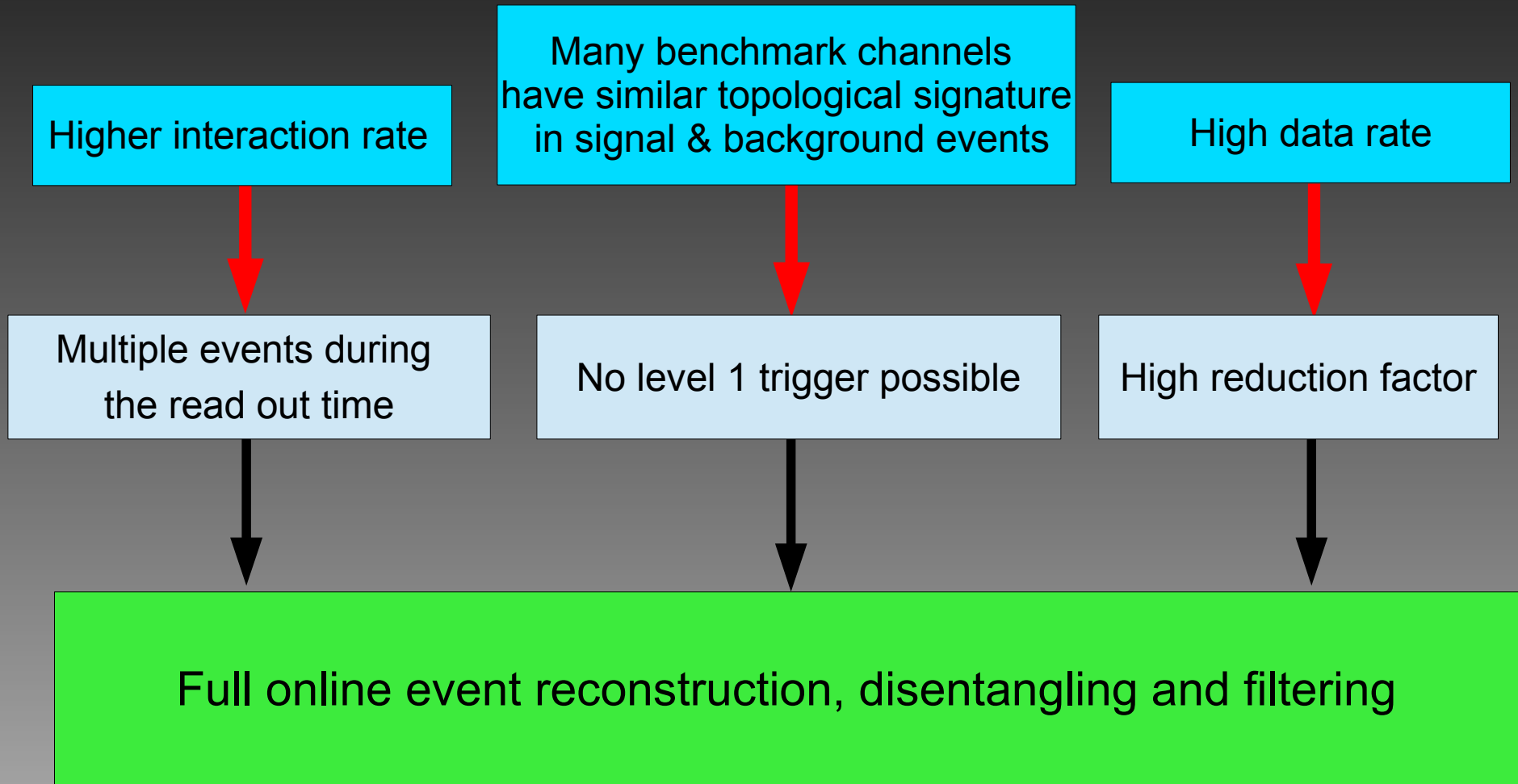


Thanks for your attention

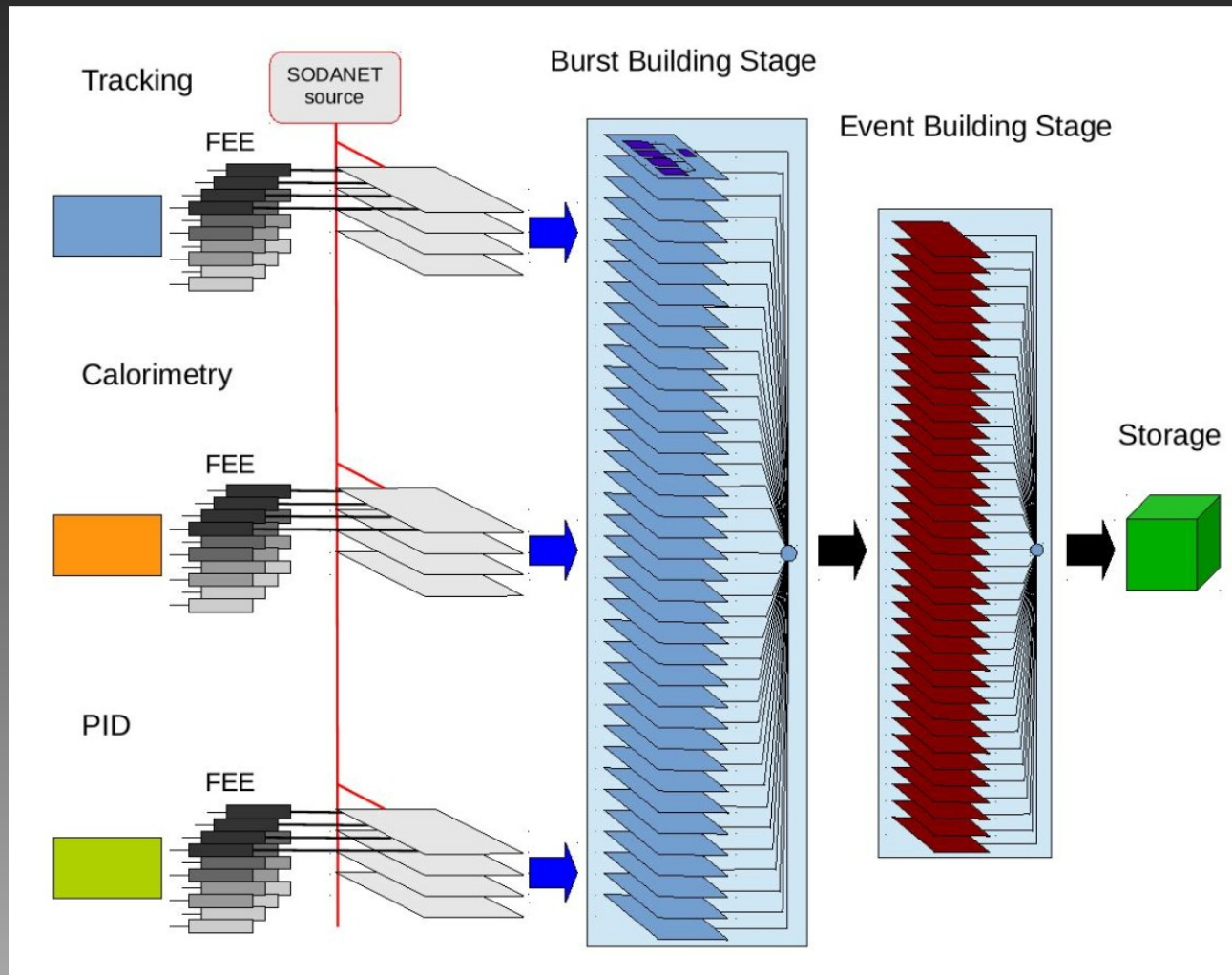


Backup

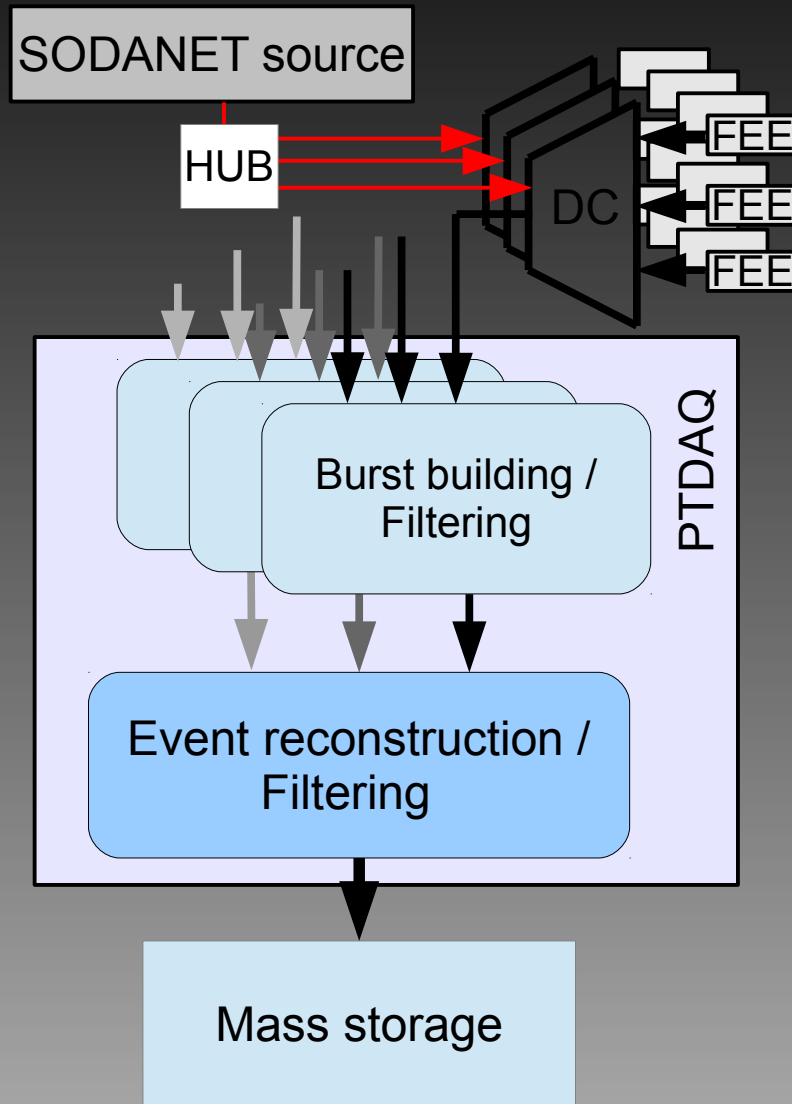
Our Challenge



The PANDA DAQ



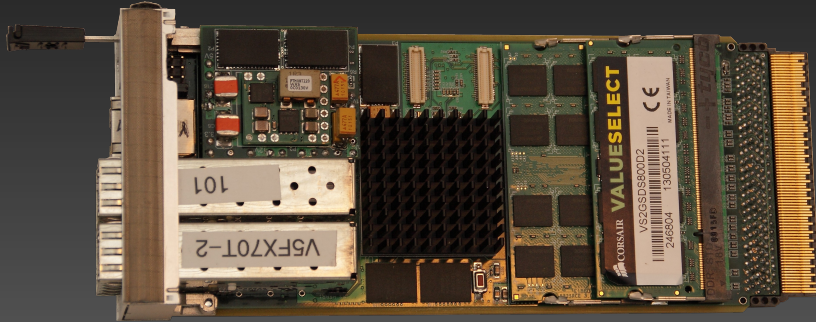
Prototype Trigger-less Data Acquisition (PTDAQ)



Functionality:

- Digitalized data front end electronic synchronized at data concentrator
- Burst building and first filter algorithm
- Event reconstruction and second stage of filter algorithm

Hardware Components



xFP board:

- AMC form factor
- Xilinx Virtex 5FX70T-2
- 2 x 2 GB DDR2
- 4 SFP+ interfaces
 - 6.25 Gbit optical
 - 1 Gb Ethernet



Micro TCA shelf:

- Up to 4 xFP
- Up to 9 data concentrators

Know Cross-Sections of $c\bar{c} \rightarrow p\bar{p}$?

- Only 6 known cross-sections in $c\bar{c}$
 - η_c ; J/ψ ; $\chi_{c0}(1P)$; $\chi_{c1}(1P)$; $\chi_{c2}(1P)$; $\psi(2S)$
 - More than 30 resonances
 - including X, Y, Z
- Important Knowledge for \bar{P} ANDA
 - Input for simulations

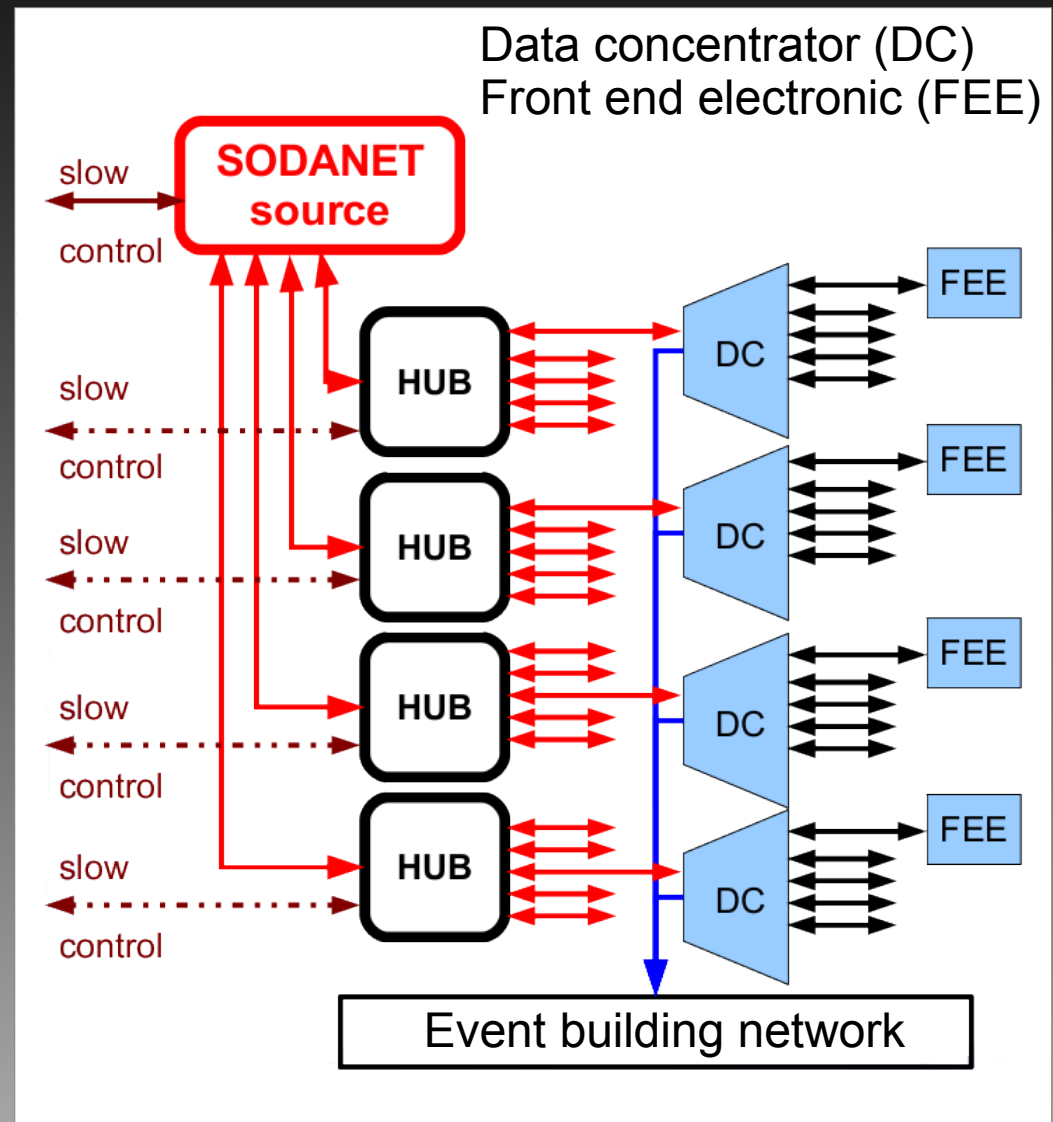
Synchronization of Data Acquisition

Functionality:

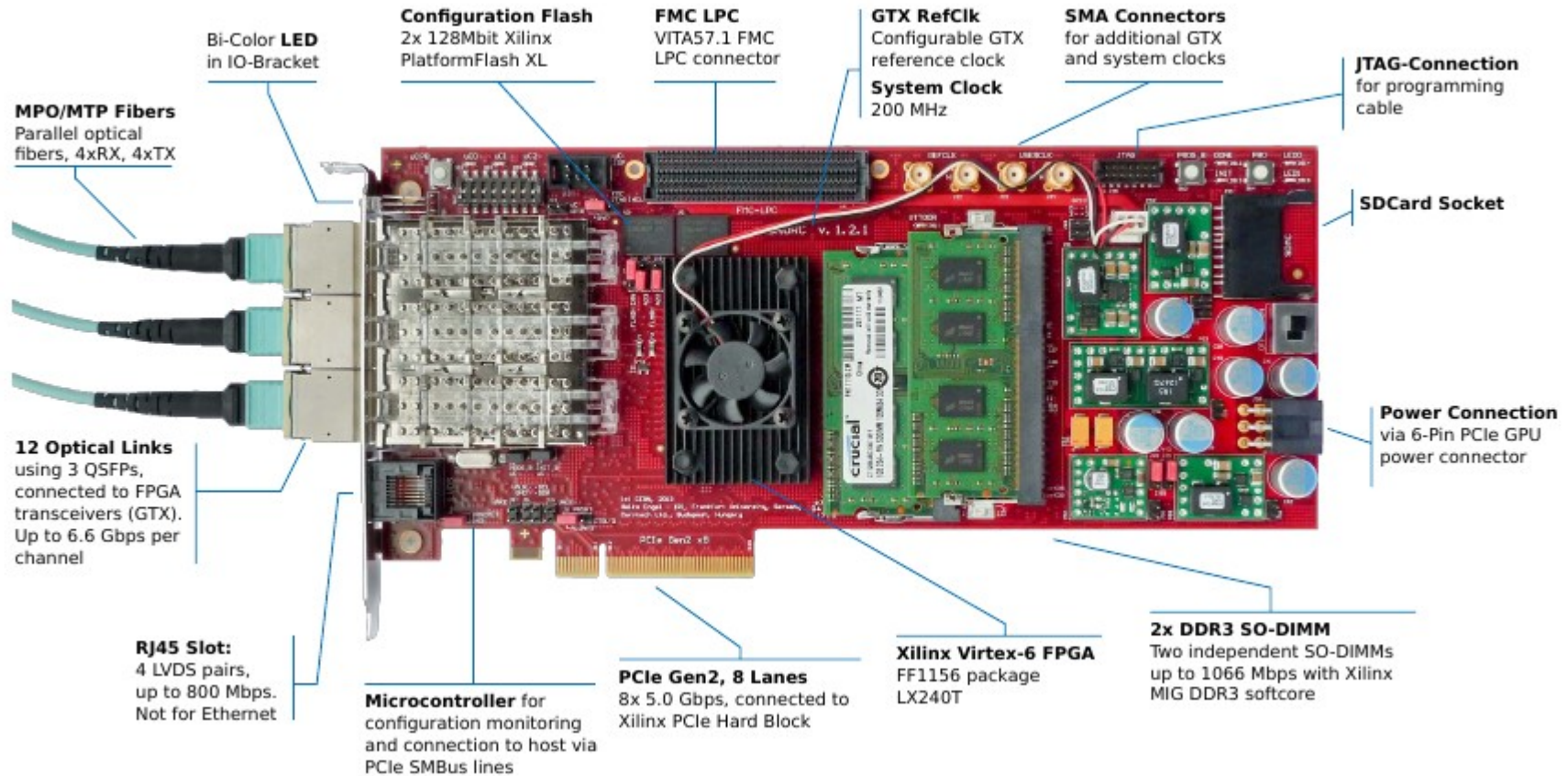
- Distribution of clock
 - Time stamp
- Distribution of synchronization commands
 - Start, stop, calibration
- Signal distributed over optical fiber
- Measurement of a signal propagation time
- Distribution of detector configuration data
- Slow control

SODANET link:

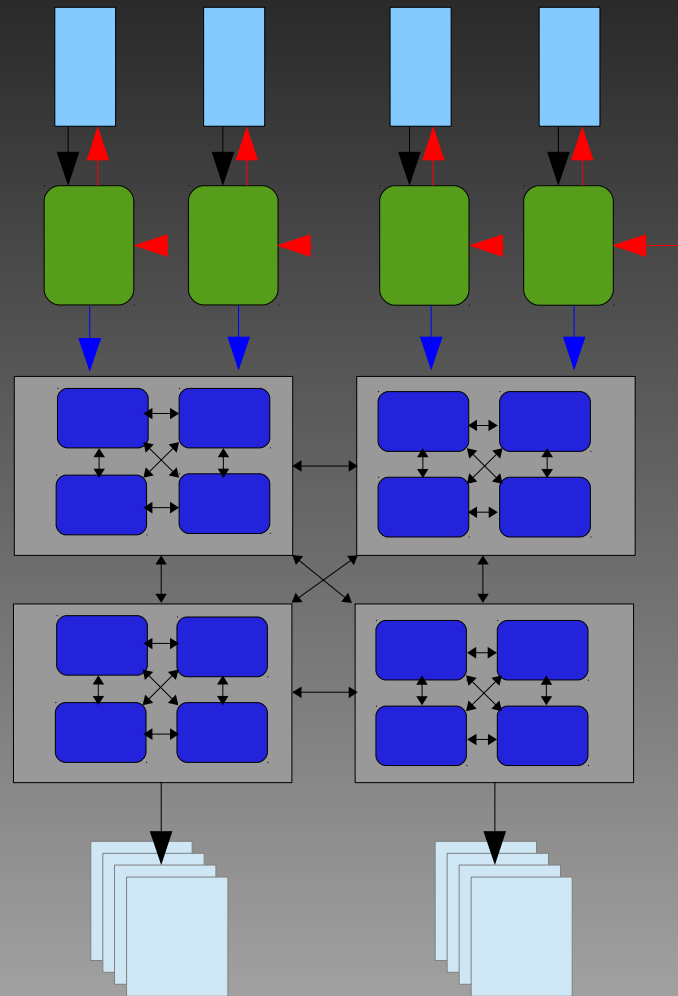
- Bidirectional
 - Source → data concentrator:
 - Synchronization
 - Front end electronic configuration
 - Data concentrator → source:
 - Slow control, used for time calibration



C-RORC Overview



Burst Building Network



Front End Electronic (FEE)

Data Concentrator (DC)

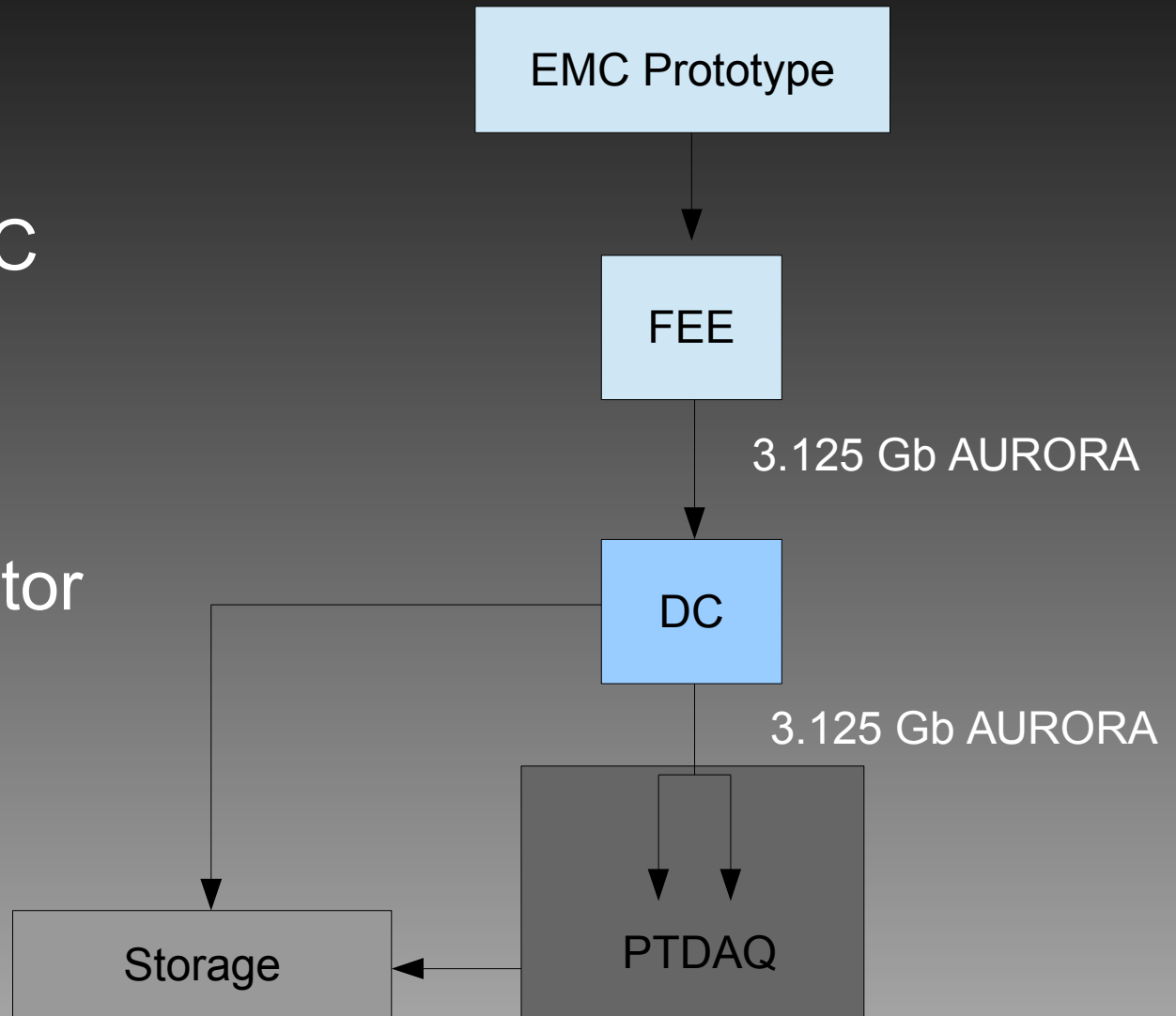
1. Level Event Building

2. Level Event Building

Further filtering

MAMI Test Setup

- DAQ chain
 - 1 Sampling ADC
 - Pile-up mode
- 1 xFP version 2
 - Data concentrator
- 1 xFP version 3
 - Burst-builder



Additional Hardware Components



TRBv3



Sampling ADC (Uppsalla)

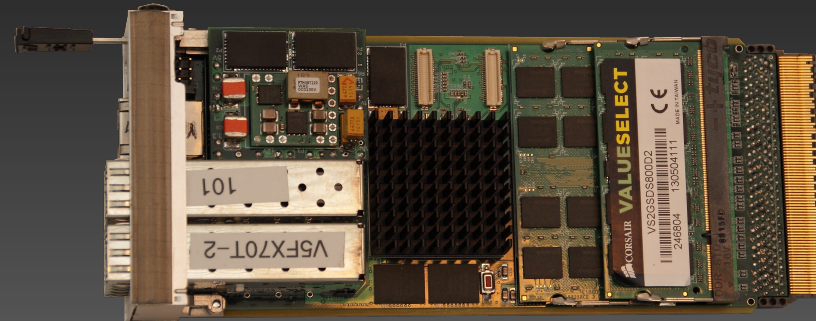
- Version 2012
- 32-ch, 14-bit
- 80 MSPS
- Virtex-6

Used Hardware



Sampling ADC (Uppsalla)

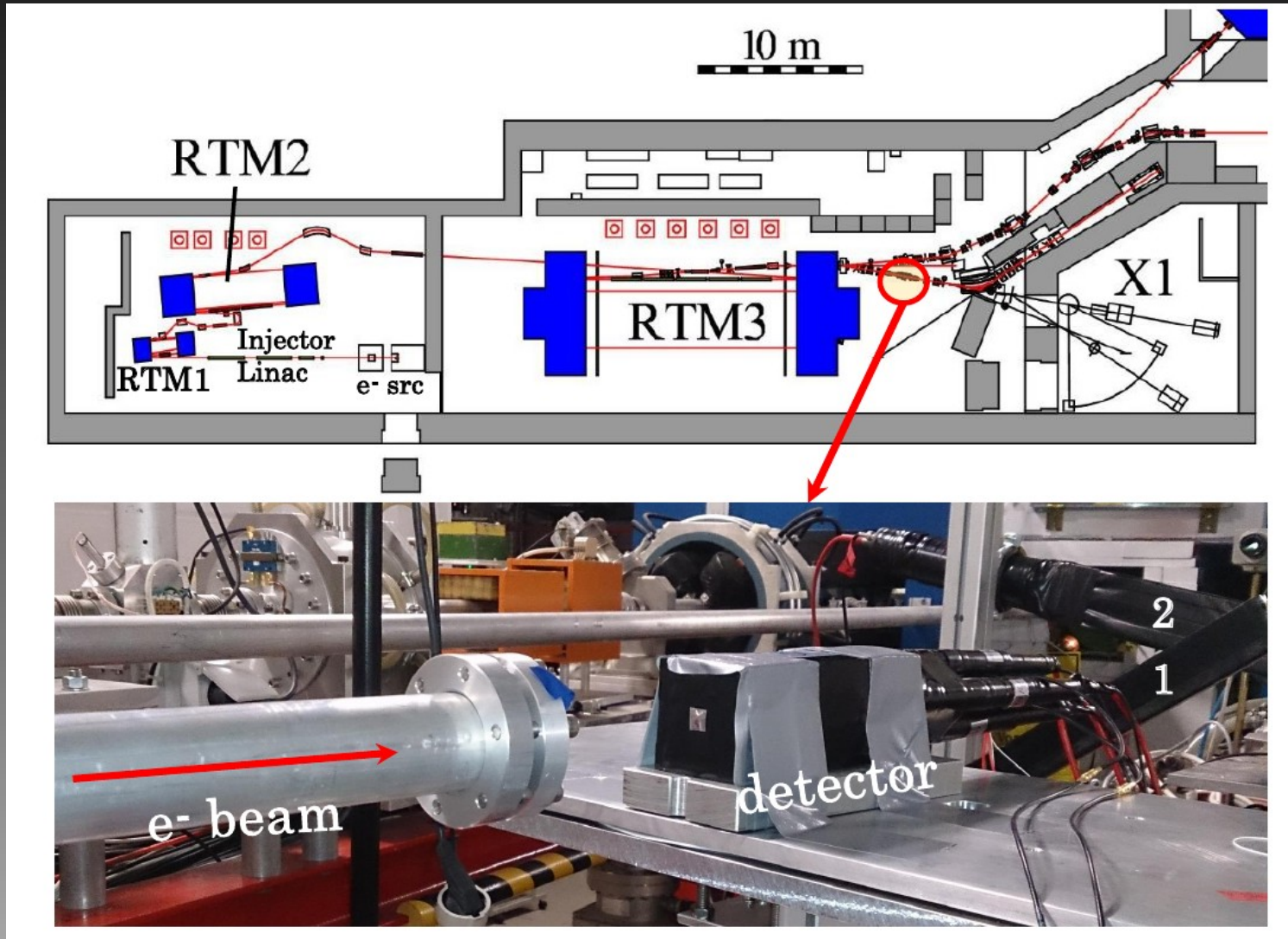
- Version 2011
- 16-ch, 14-bit
- 125 MSPS
- Virtex-5LX50



xFP board:

- AMC form factor
- Xilinx Virtex 5FX70T-2
- 2 x 2 GB DDR2
- 4 SFP+ interfaces
 - 6.25 Gbit optical
- 1 Gb Ethernet

MAMI Test Location



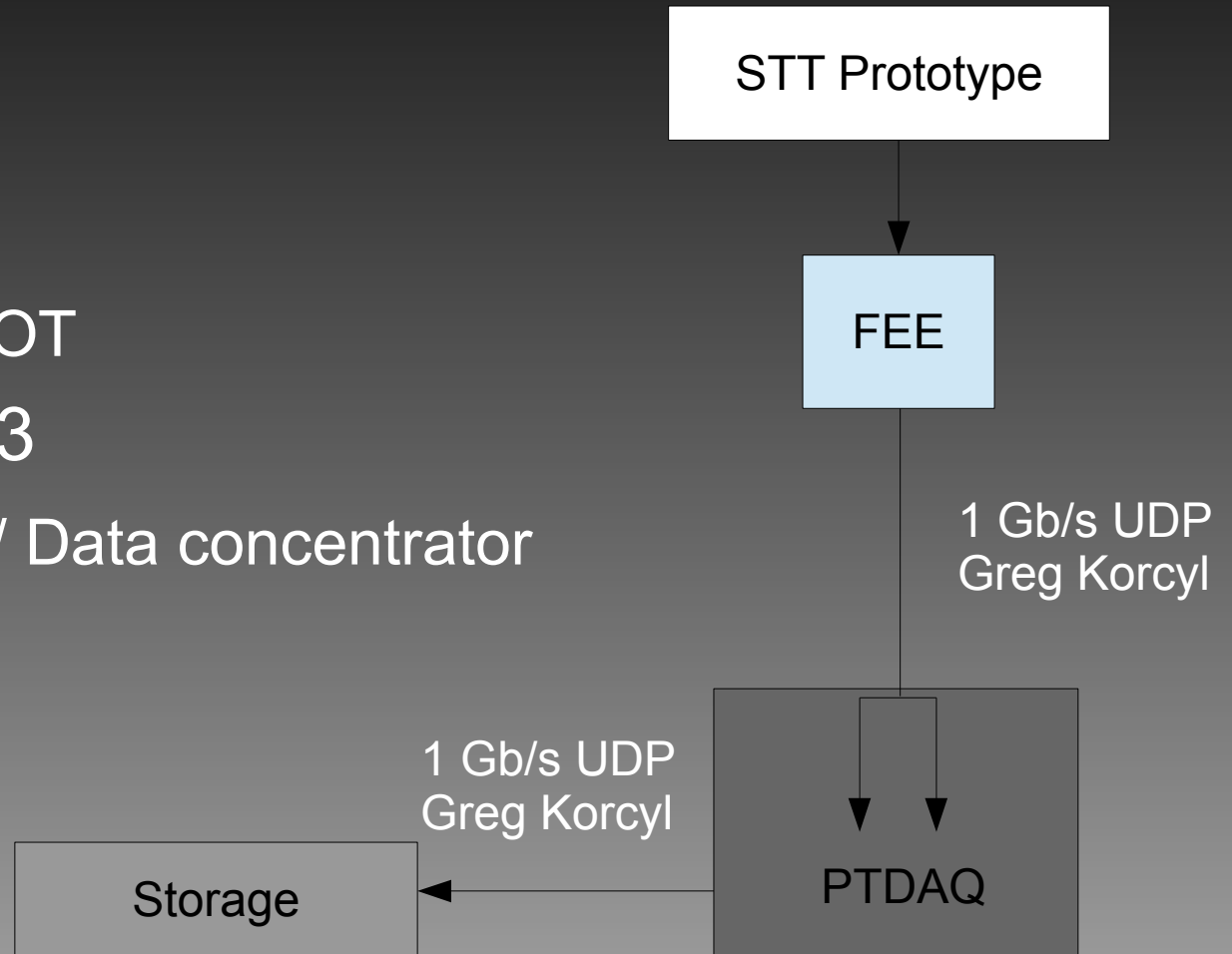
MAMI Test Results



- Stable Connection between DC and xFP
 - 2-Input burst building successful
 - For $\sim 15 * 10^6$ Stable events
 - Event size ~ 700 Byte
 - Data rate of ~ 1 Gbit/s

Jülich Connection Test

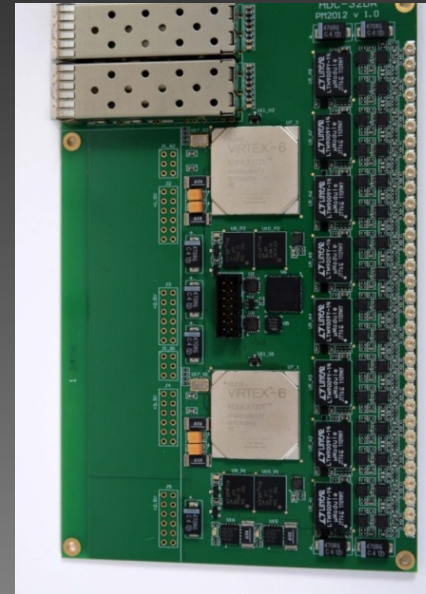
- DAQ chain:
 - 1 TRBv3
 - FEE board /TOT
 - 1 xFP version 3
 - Burst-builder / Data concentrator



Groningen SODAnet Connection Test

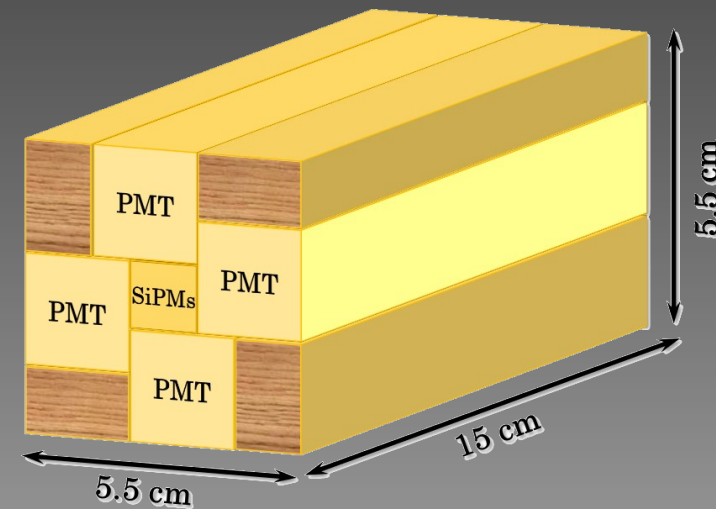
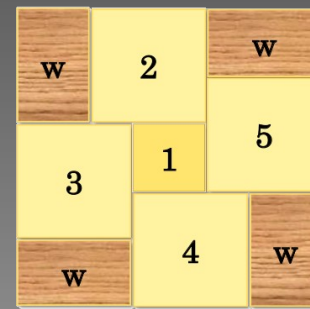
Sampling ADC (Uppsalla)

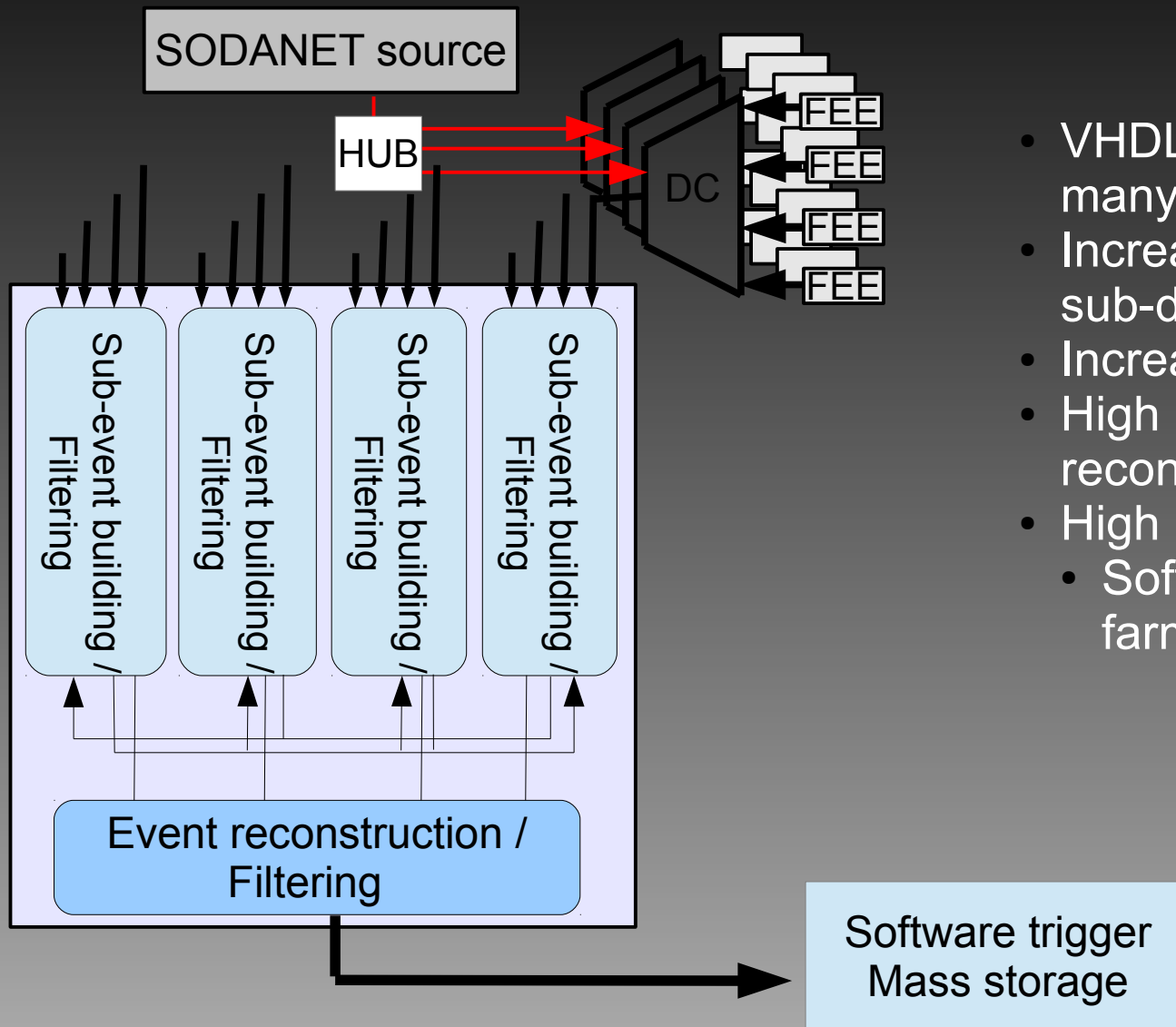
- Version 2012
- 32-ch, 14-bit
- 80 MSPS
- Virtex-6



MAMI Test Setup

- Beam parameter:
 - 210 MeV electrons
 - 0.003 - 2 MHz event rate
- Detector:
 - 1 mini PWO crystal
 - 2 HAMAMATSU SI-PM
 - 4 $\overline{\text{PANDA}}$ crystals





- VHDL code can be used without many changes
- Increased number of inputs per sub-detector
- Increase the possible data rate
- High performance event reconstruction
- High level event filtering
 - Software trigger on a sever farm or GPUs

The PANDA DAQ



- Freely streaming data :“Trigger - less”
- No hardware triggers
- Event filtering
- Autonomous FEE, sampling ADCs with local feature extraction
- Time-stamping (SODA)
- Data fragments can be correlated for event building
- Caveat: the high-rate capability implies overlapping events !!!
- average time between two events can be smaller than typical detector timescales
- This “pile-up” has to be treated and disentangled
- Real-time event selection in this environment is very challenging and requires a lot of studies