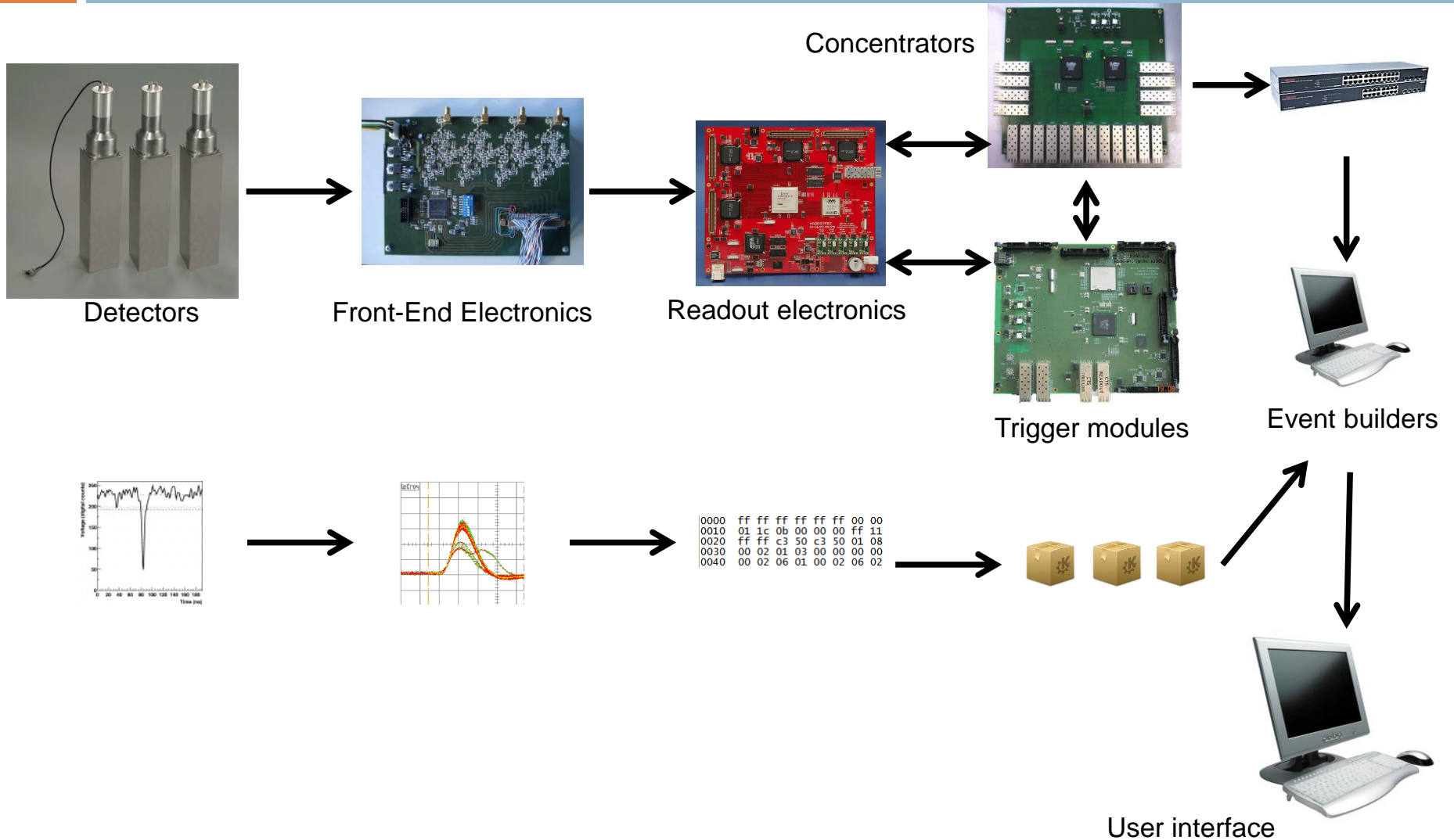


TRIGGER-LESS AND RECONFIGURABLE DATA ACQUISITION SYSTEM FOR POSITRON EMISSION TOMOGRAPHY

Grzegorz Korcyl 2013

Detectors readout



Current electronics – Front End

□ Front End Boards:

- Fast, sharp input signals
- Problem of „time walk”

□ KBv5

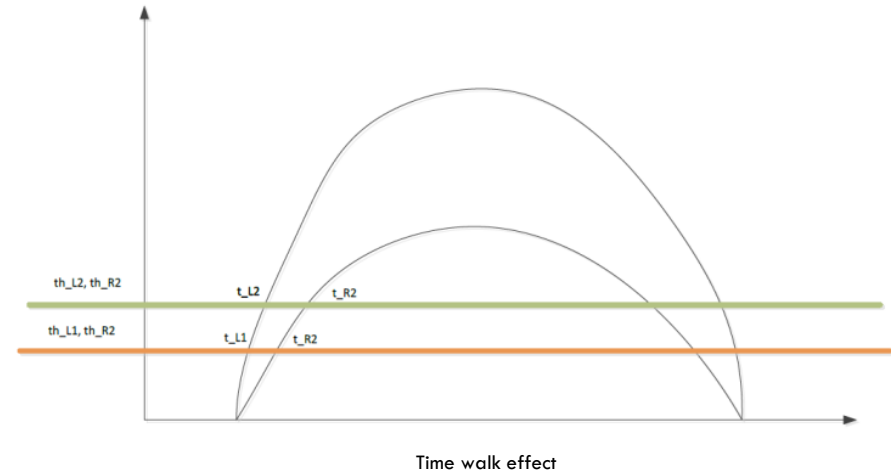
- 4 input channels
- For each:
 - Rise time fast measurement
 - Charge-to-Width measurement
 - Compensation of „time walk”
- Custom format

□ KBv6

- 2 input channels
- For each:
 - Rise time fast measurement at 4 different levels
 - Offline shape recognition
- Custom format

□ KBv7 (under development)

- 3 input channels
- For each:
 - Rise time fast measurement at 4 different levels
 - Charge-to-Width measurement
- VME format



• Some other FEE in development:

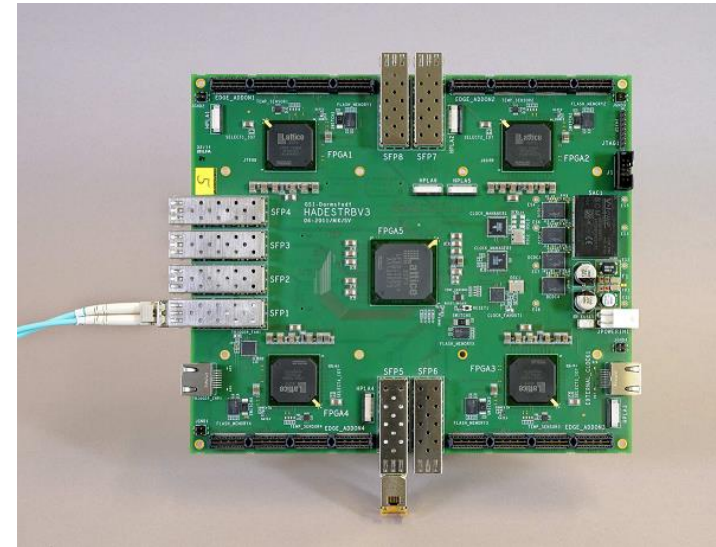
- Marek's frontend
- Mr. Majewski frontend

• Some other FEE from high energy physics experiments:

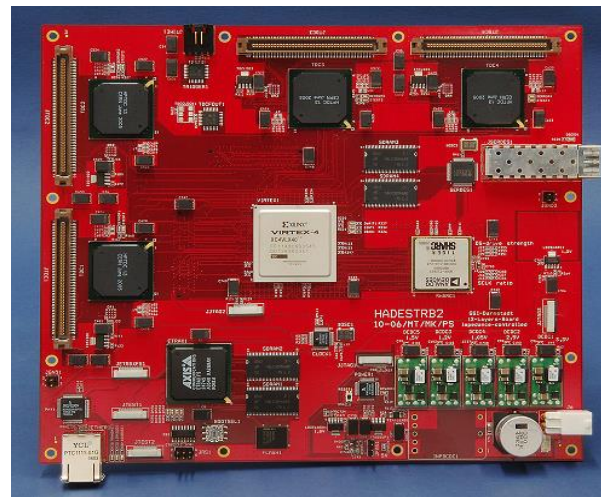
- NINO board
- PADIVA board

Current electronics

- 5x Lattice ECP3 150 FPGAs
 - ▣ 4 edge devices
 - ▣ 1 central
 - ▣ Flash ROMs for each
- 8x 3.2Gbps optical links
- 4x 208pin QMS connectors
 - ▣ Small Addons
- 1x 106pin connector
 - ▣ Large Addon
- Hardware trigger input



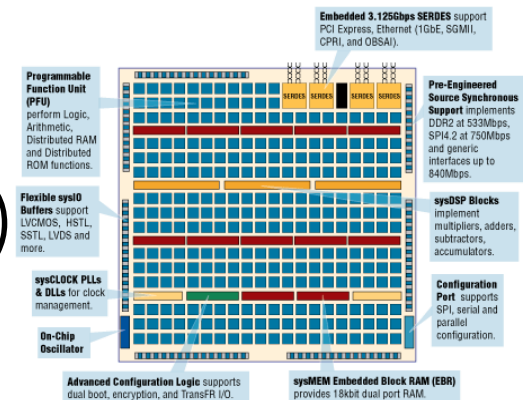
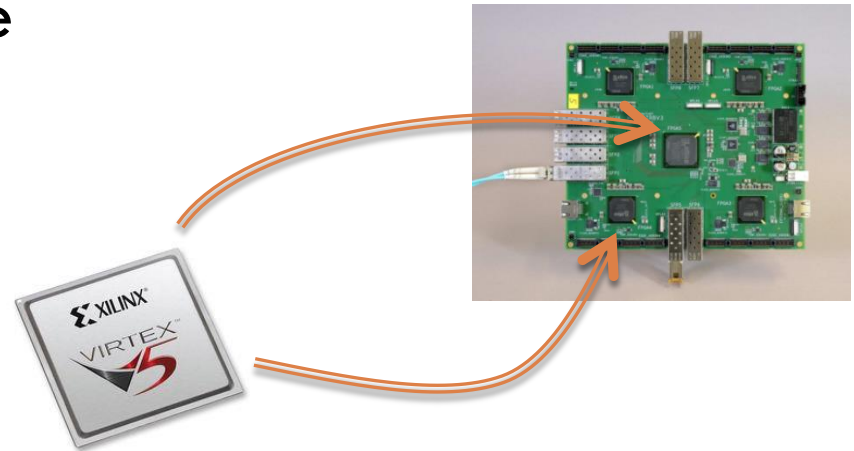
TRBv3



TRBv2

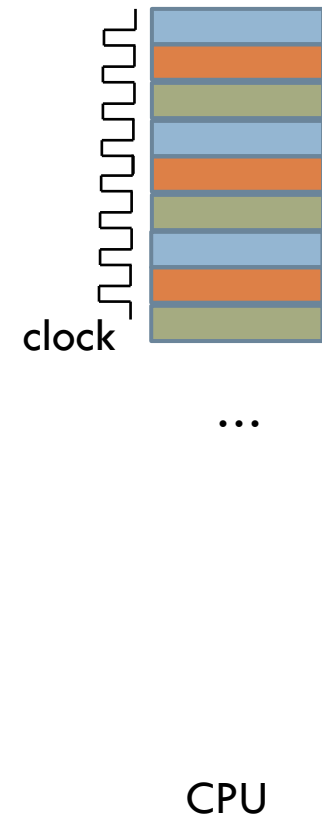
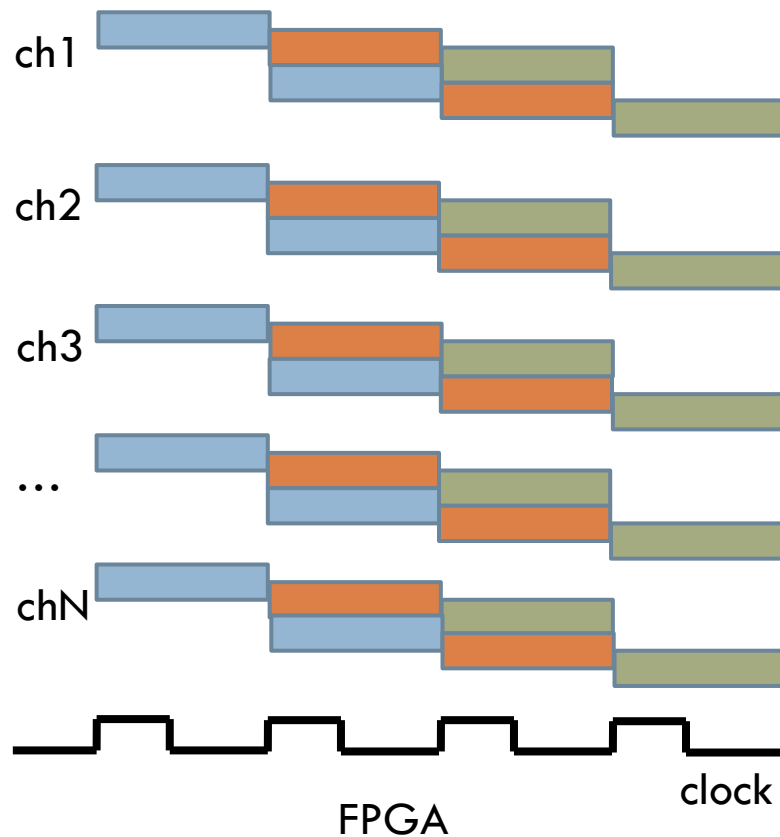
Reconfigurable electronics

- Programmable logic device
- Reconfigurable by the user
- Parallel processing
- Real-time processing
- Hardware features:
 - ▣ Memory blocks
 - ▣ Communication ports
 - ▣ Digital Signal Processing units
- CPU solutions (MicroBlaze, LatticeMico)
- SoC – FPGA combined with CPU



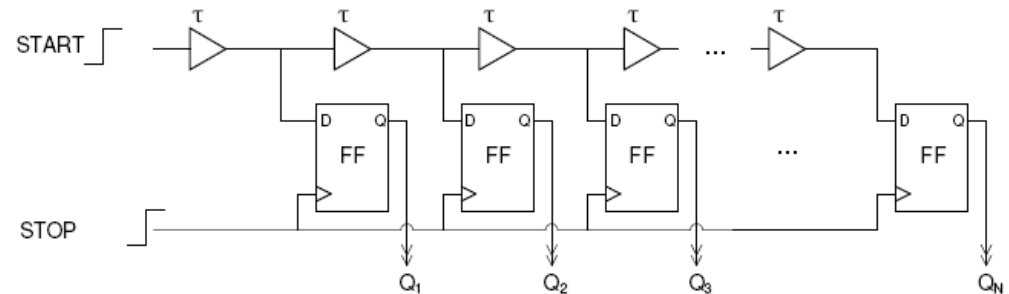
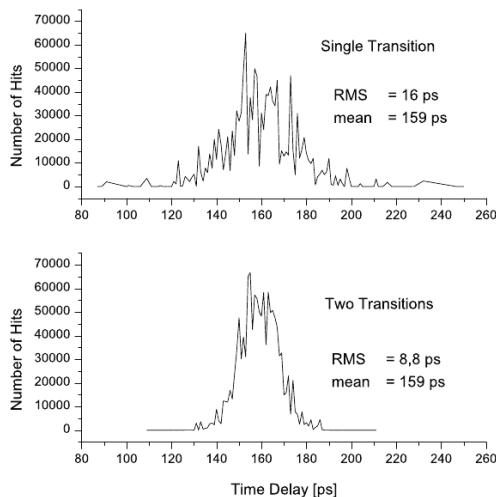
Reconfigurable electronics

□ Parallel - pipelined processing



Current Electronics - TRBv3

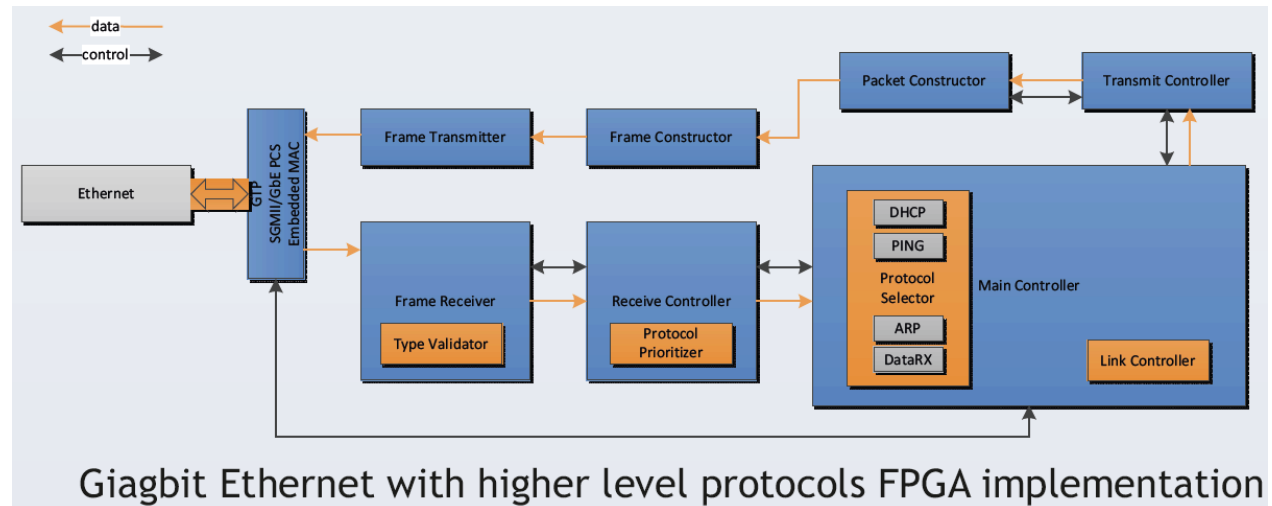
- Use of the internal structure of the chip to create delay chains
- Highly configurable TDC solution
 - ▣ Number of channels \leftrightarrow single channel resolution
 - ▣ A lot of methods to improve resolution



Current Electronics - TRBv3

□ Gigabit Ethernet link – Data Readout, Slow Control

- Full Duplex
- 118 MBps
- Basic protocols (IP, UDP, ARP, DHCP, ICMP, Custom)
- Autonegotiation + network address acquisition
- VLAN
- Jumbo frames
- Address filtering



Current electronics - Triggering

□ Trigger board (in development) :

- „Snapshot” of detectors status

- „Triggerless system”

 - Periodic trigger signal

- Optical connections to each TRB

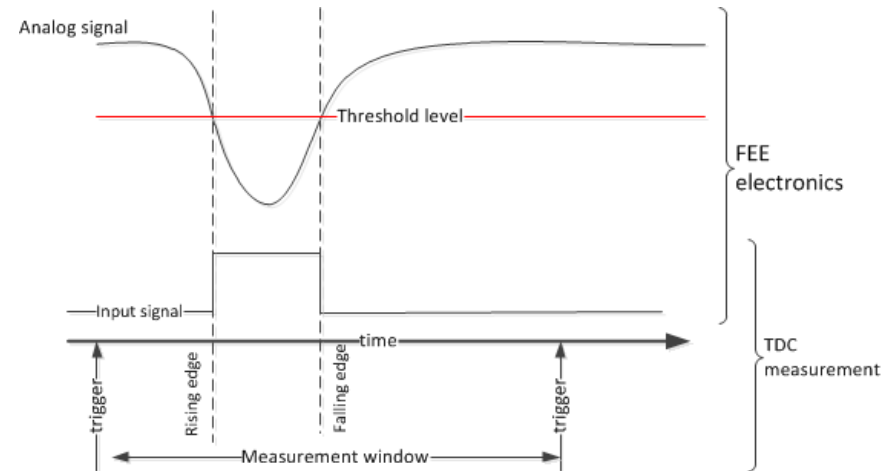
 - Trigger signal distribution

 - Event tag distribution

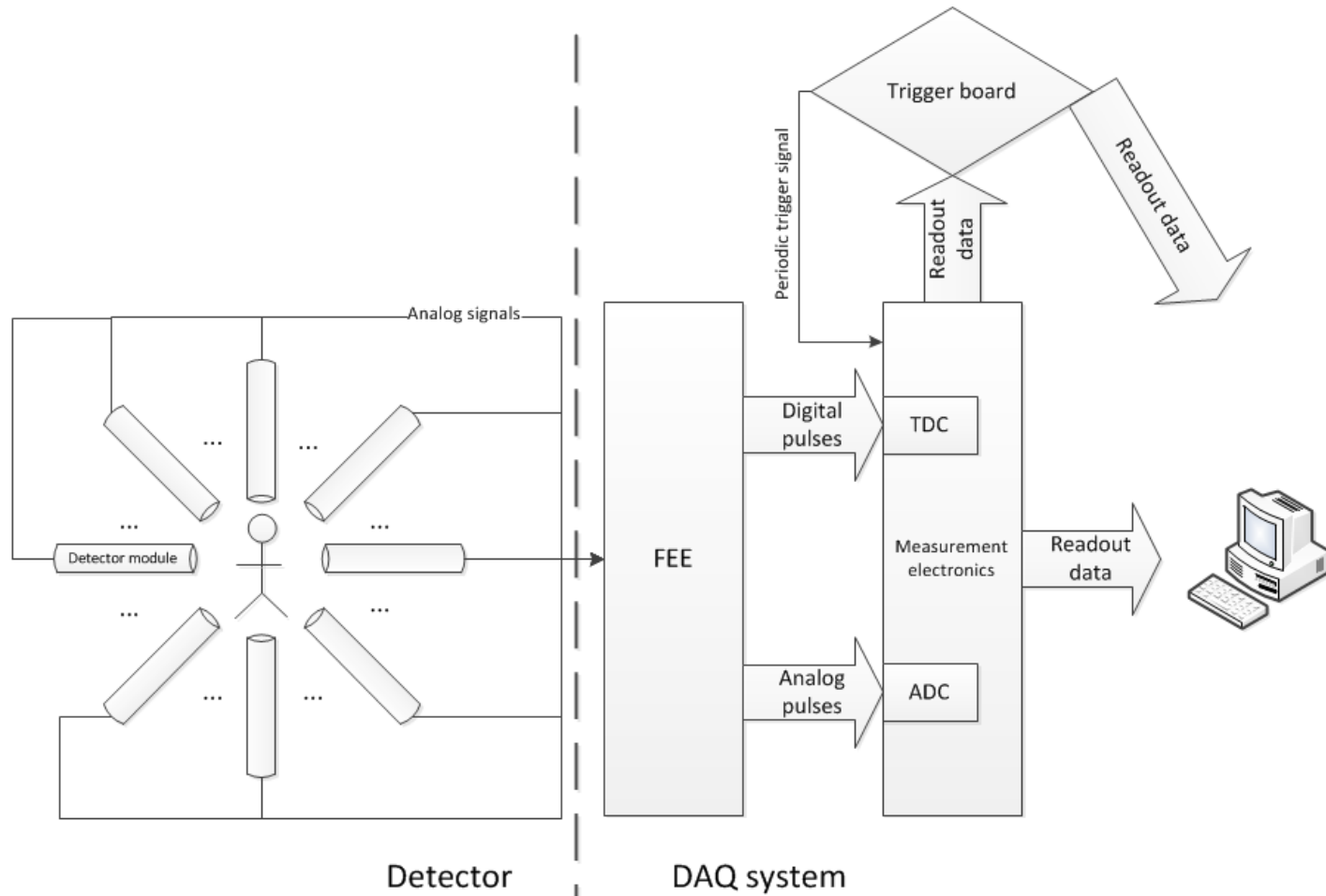
 - Data readout

- Data concentrator

 - Can perform online filtering/analysis



Current electronics

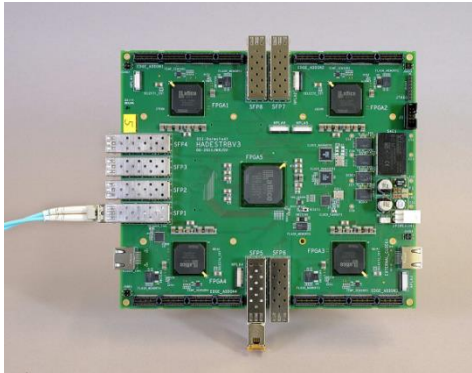


Prototype setup

Backplane
240 channels



16x FEE
3
channels



Software

- Slow control
 - ▣ Number of scripts to setup and start acquisition
 - Enclosed in GUI by Silvermedia
- Data collection – event building
 - ▣ Standard event builder
 - ▣ DABC event building plugin
- Unpacking – translation from HEX to meaningful format
 - ▣ Lightweight unpacker
 - ▣ GO4 module
 - ▣ Both produce ROOT tree structure
- Online monitoring
 - ▣ Histograms display in GUI by Silvermedia
 - ▣ GO4 GUI

Software

The screenshot displays a Windows desktop environment with a software application titled "PET_general - Microsoft PowerPoint" running. The application window shows a file browser on the left with a tree view of folders including "Workspace", "Analysis", "Histograms", "TRB0", "TDC0", "Ch0", "Ch1", "Ch2", "Ch3", "Ch4", "Ch5", "Ch6", and "Ch7". The main area contains three panels:

- Panel7: [TDC0_Channels]** displays "TDC0 TDC channels 00:54:25 2013-07-05 Analysis/Histograms/TDC0/TDC0_Channels".
- Panel8: [TDC0_UndetectedHits]** displays "TDC0 Undetected hits in TDC channels 00:54:25 2013-07-05 Analysis/Histograms/TDC0/TDC0_UndetectedHits".
- Panel9: [TDC0_Errors]** displays "TDC0 Errors in TDC channels 00:54:27 2013-07-05 Analysis/Histograms/TDC0/TDC0_Errors".

The log window at the bottom shows the following entries:

Date	Time	Type	Description
05.07.13	00:54:09	Warning	End of event source TUserSource: localtools/hid/etraxp014.te13172155959.hid - End of input file localtools/hid/etraxp014.te13172155959.hid
05.07.13	00:54:09	Info	AnalysisClient UserClient-cerber-22621 has STOPPED analysis processing.
05.07.13	00:54:05	Info	Analysis nameslist was requested from client current
05.07.13	00:54:03	Info	Analysis MyAnalysis event classes were initialized.
05.07.13	00:54:03	Info	Analysis nameslist was requested from client current

The system tray shows the current date and time as 2013-07-05 00:57:40, and the taskbar includes icons for "Go4 v4.5.5", "LSC isp (VMD)", "Unpacker", "localhost", "System Monitor", "File Explorer", "Reveal Analy", and "eth1 (not top)".

Conclusions

- The entire readout chain is working and verified
- Hardware for the prototype:
 - TRBv3 is ready
 - FEE in development (previous versions under tests)
 - VME crate, fans, cables are being ordered
- Software for slow control
 - Basic scrips
 - Nice GUI under development
- Analysis software
 - 2 solutions:
 - Standard:
 - Event building verified
 - Lightweight unpacker verified
 - DABC and GO4:
 - Under verification