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TRB3 - multichannel TDC and DAQ platform

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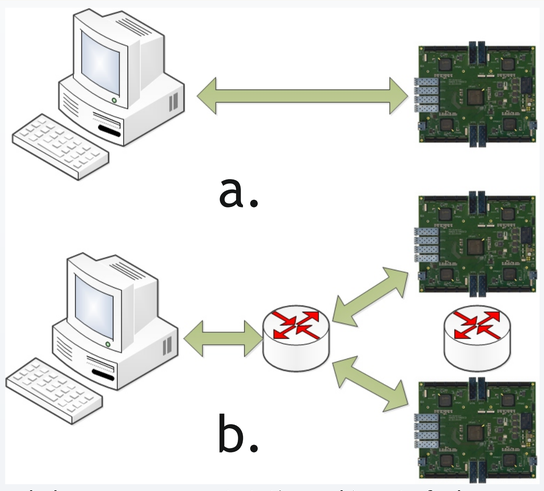
Versatile measurement solution - high precision ADC, QDC, TDC

Trigger Readout Boards v3 as a new solution for any kind of charge or time measurement for modern physic experiments:

- **Hardware features:**
  - Power of 5x Lattice ECP3 150 FPGAs gives a space for implementation of sophisticated measurement mechanisms, DSP algorithms and connectivity features
  - 4x 208-pin QMS connectors: high input/output channel density, act as extension ports for different kind of mezzanine cards providing power and data channels
  - 106-pin Addon board connector on back for even more extendable solution

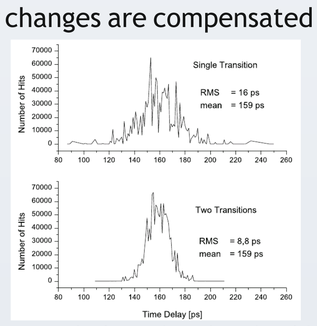
- **FPGA firmware features:**
  - High precision time measurement (~ 14ps RMS) based on FPGA logic, up to 64 channels per FPGA
  - Integrated data acquisition
  - Gigabit Ethernet connectivity together with UDP stack and customizable basic protocols



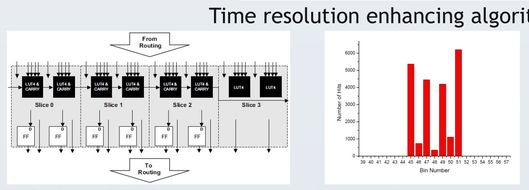
Board usage scenarios: a) stand-alone measurement station or b) part of a larger system

FPGA based Time to Digital Converters

- **4x edge FPGA with TDC design**
- Concept of using FPGA hardware structure to measure time:
  - **Resolution of around 14 ps**
  - **Average binning 30 ps**
  - Multi-hit TDC
  - ~40MHz hit rate per channel
  - Configurable solution
  - **High channel density up to 64** per FPGA (256 per board)
  - LVDS inputs
  - Temperature and power changes are compensated by online calibration mechanism



Time resolution enhancing algorithms

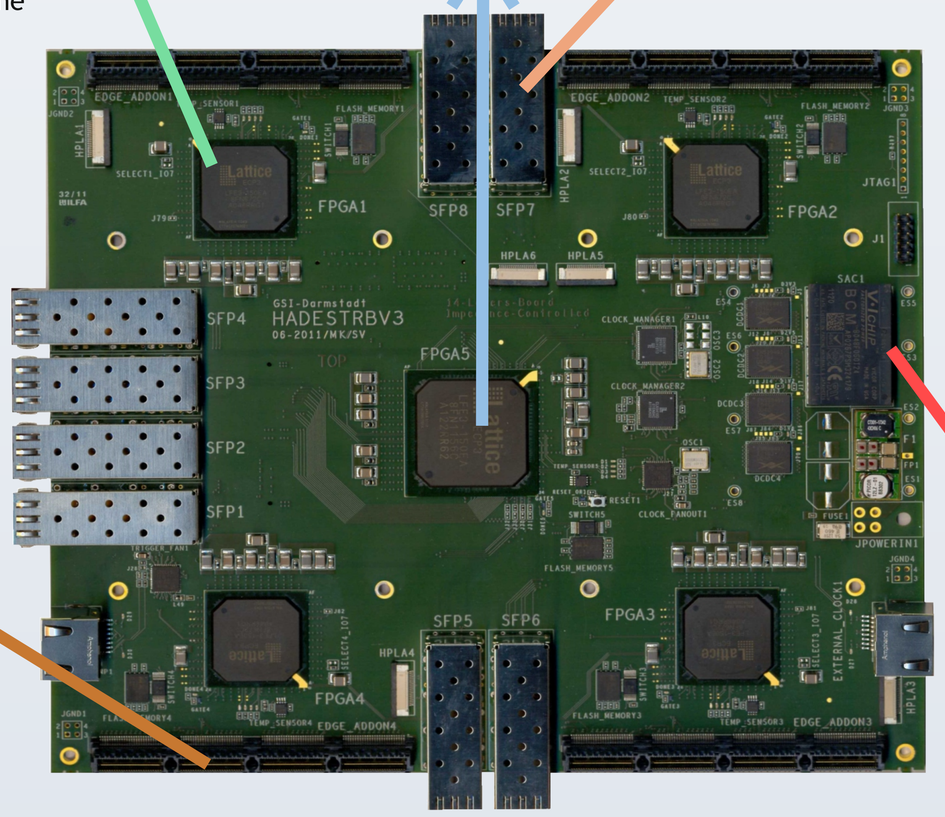


FPGA based TDC concept - use of carry chains

Field Programmable Gate Arrays

- **Main FPGA**
  - High speed LVDS connections to each of the slave FPGAs
  - Connectivity through 8x 3.2Gbps optical links
  - Controls the operation of the board

Mounted FPGAs: Lattice ECP3 150
- 149k LUTs
- 16x 3.2Gbps SERDES channels
- 6850 Kb SRAM

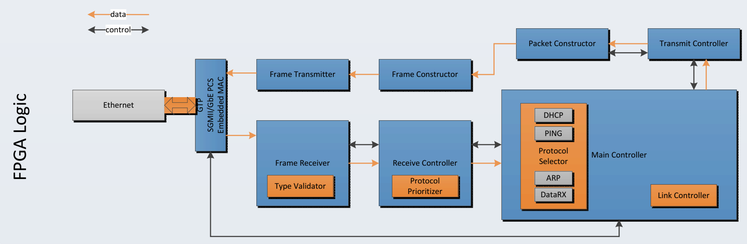


Trigger Readout Board v3

Network Features

- **8x general purpose 3.2 Gbps optical links**
  - Variety of network protocols
  - Connection to larger complex systems

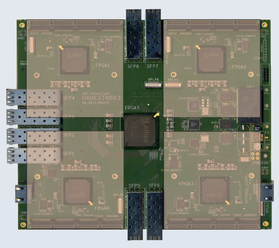
- **Gigabit Ethernet 1000BASE-X enabled links**
  - Transport of collected data
  - Slow control
  - Full Duplex
  - UDP stack implemented as FPGA logic
  - Plug-and-Play design (DHCP, ARP)
  - VLAN functionality
  - Easy custom protocol implementation
  - Jumbo frames



Giagbit Ethernet with higher level protocols FPGA implementation

QMS Connectors

- **208 pin high-speed connector from Samtec**
- Used to transport:
  - timing signals
  - application specific data
  - power
- Slots to connect mezzanine card:
  - up to 4 cards per board
  - different apllications
  - customizable solution



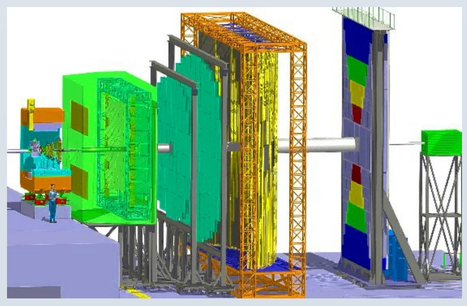
General info

- Power supply: 48V galvanically separated DC/DC
- Board size: 20cm x 23 cm
- 106 pin + power connector on back for AddOn boards
- RJ45 trigger input
- JTAG programming chain
- Flash ROM for each FPGA to store designs for quick boot-up
- External clock input for synchronous systems

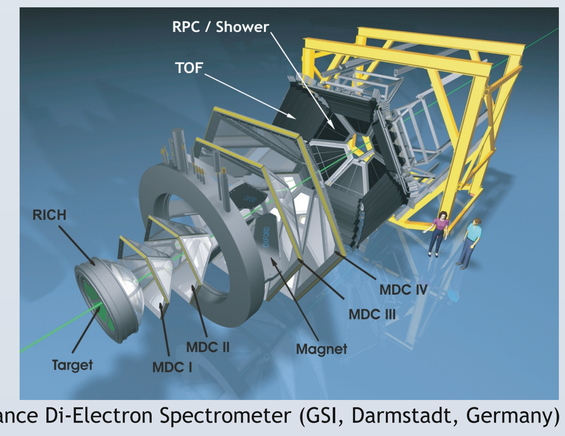
Applications

- **High energy physics experiments:**
  - Designed for any kind of detectors needing precise time measurement like Photomultiplier Tubes or Resistive Plate Chambers
  - Can be used for charge measurement - additional mezzanine Addon boards needed (development in progress)
  - Network HUB - 8x optical links installed on the main board can be extended by Addon boards
  - Trigger system thanks to large number of input channels

- Usage scenarios:
  - The board together with a PC can be used as a stand-alone measurement station
  - Optical links provide connectivity in order to use the board in complex DAQ systems

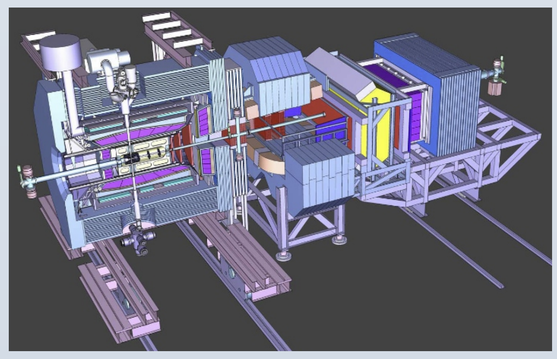


Compressed Baryonic Matter (GSI, Darmstadt, Germany)



High Acceptance Di-Electron Spectrometer (GSI, Darmstadt, Germany)

- **Ongoing projects:**
  - Development of ADC mezzanine Addon board - 4 different approaches will be tested
  - Development of HUB mezzanine Addon board with 6 optical links
  - Integration with HADES Data Acquisition System (GSI, DE) experiment
  - Development of TRBv3 FrontEnd Boards for Barrel DIRC, Disk DIRC and Straw Tube Tracker for PANDA (GSI, DE) experiment
  - Preparation for use in two Positron Emission Tomography projects at JU (Kraków, PL) and LIP (Coimbra, PT)
  - Evaluation of the board for RICH, TOF and MVD detectors readout for CBM experiment (GSI, DE)
  - Many more ...



anti-Proton ANnihilation at DArmstadt (future project at GSI, Darmstadt, Germany)

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