



# Integrated test environment for a part of the LHCb calorimeter

TWEPP 2009

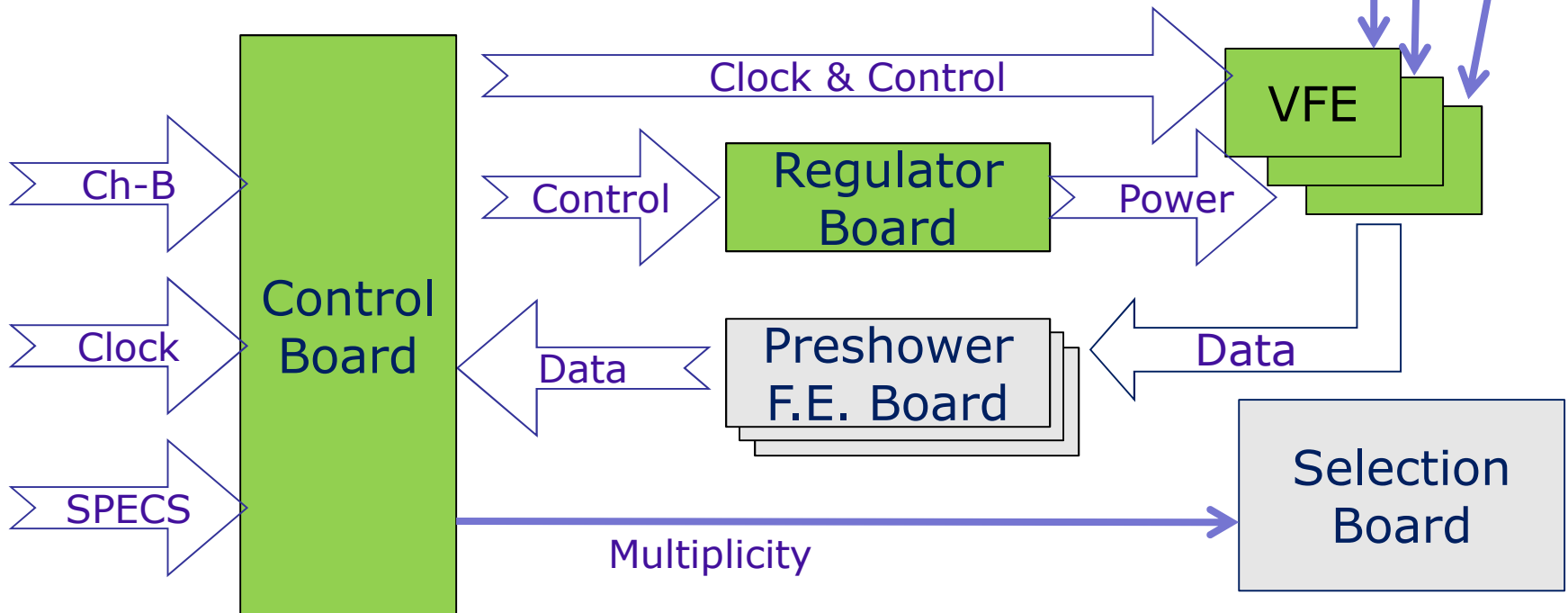
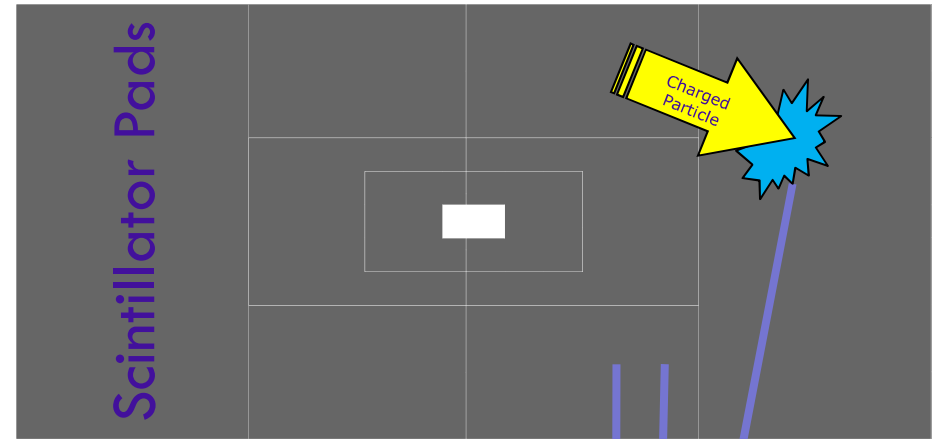
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## PRESENTATION OUTLINE

- Introduction
- Real environment
- Former test boards
- Final test board
  - Test capabilities
  - Features
- Conclusions

- LHCb calorimeter
- Future testing needs
  - Reparation needs
  - Non expert tests
  - Integration
  - Usability
    - No need of full laboratory
    - Stability (Software but also Mechanical, loose wires, ...)
  - *Kaizen* (Continued Improvement)
  - Product continuity (FPGA)

- LHCb calorimeter:
  - Power Supply
  - Clock distribution
  - Trigger data flow
  - DAQ data flow



- Data from VFE to PSFEB is composed by 4 LVDS serializers of 21b at 840Mbps each one.
- Data from 7 PSFEB to a single CB is  $7 \times 840\text{Mbps}$ .
- Data from CB to SB is about 1,2Gbps of payload with an optical link.
- Control has I2C bidirectional control as well as a serial synchronous 40MHz channel for time sensitive controls.
- Huge amount of data flows through the system

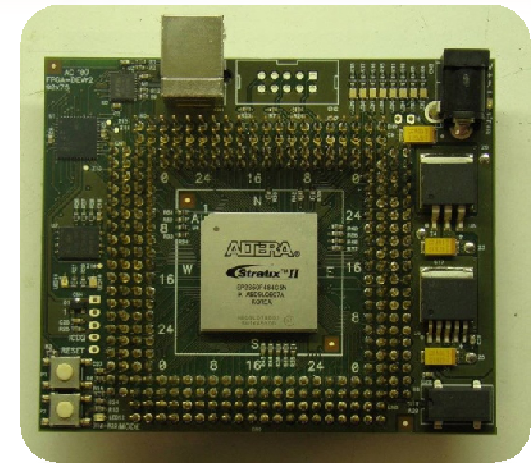
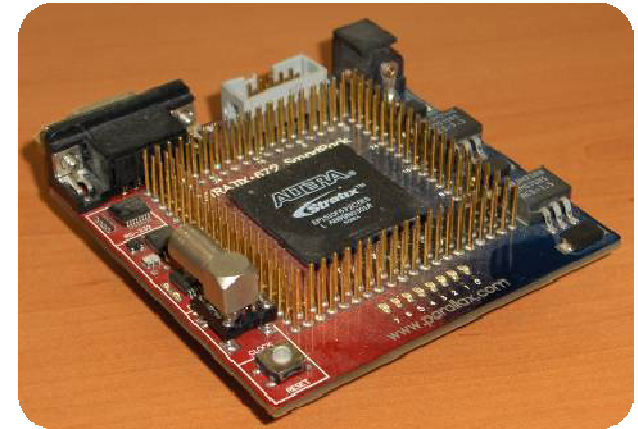
- FPGA Baseline

- Originally Parallax Board with Stratix EP1S25F672C6

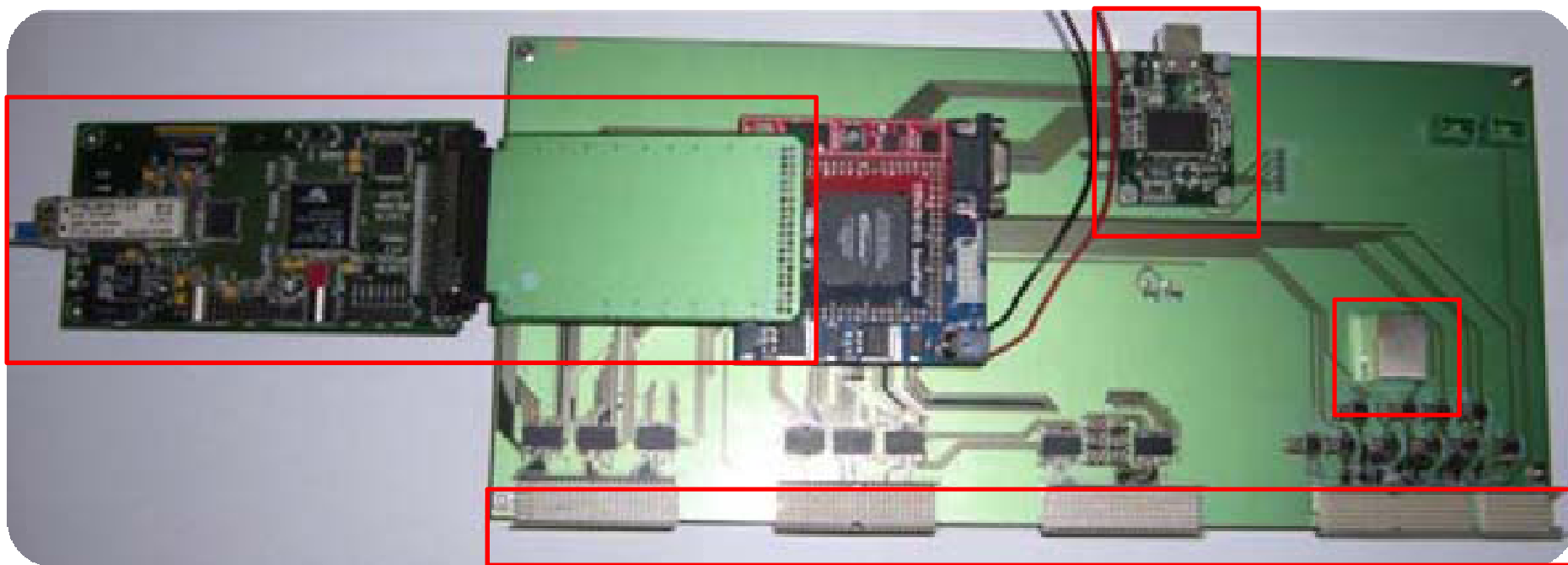
- Nice solution for prototyping & tests (Discontinued by vendor)
- Good form factor

- Extended design done by our group

- Same philosophy
- USB instead of RS232, usable not only for programming.
- Aprox. Double of pins
- Backwards compatible
- More powerful Stratix II EP2S60F484C5



- Control Board
  - Data from the backplane (PSFEB -> CB)
  - SPECS from the backplane
  - Optical Link Receiver
  - USB interface with a mezzanine by Bitwise Systems

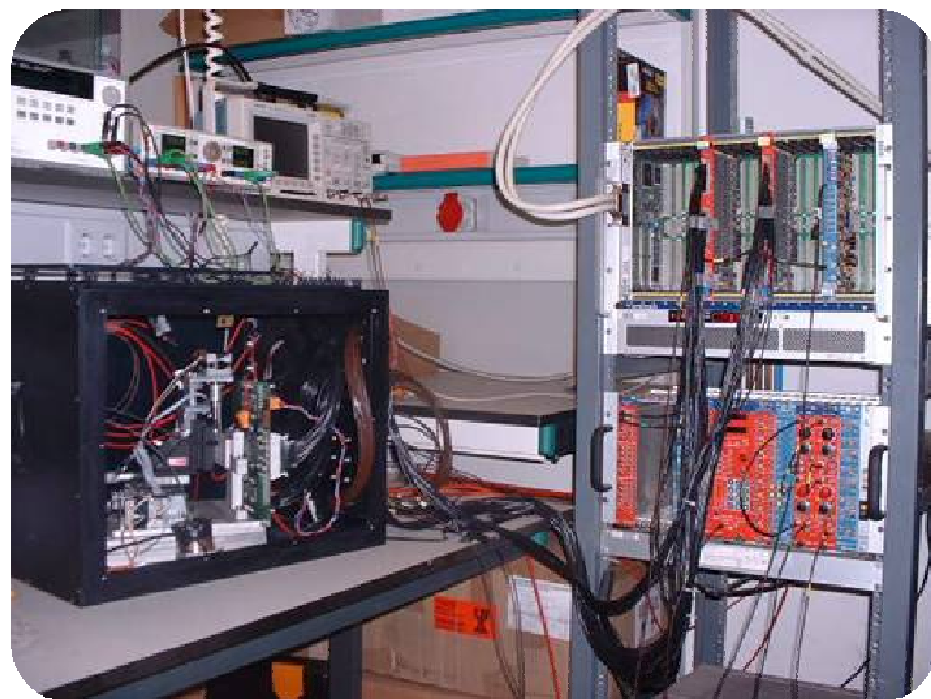


- Very Front End
  - Digital Part
    - PreShower Front End Board reception
    - Control of the VFE can be driven from the Control Board or from test board
    - Connection through real LDVS cable ensures maximum realism
    - USB interface with a mezzanine by Bitwise Systems
    - Can also work with the Photo Multiplier test environment to test the analogical part



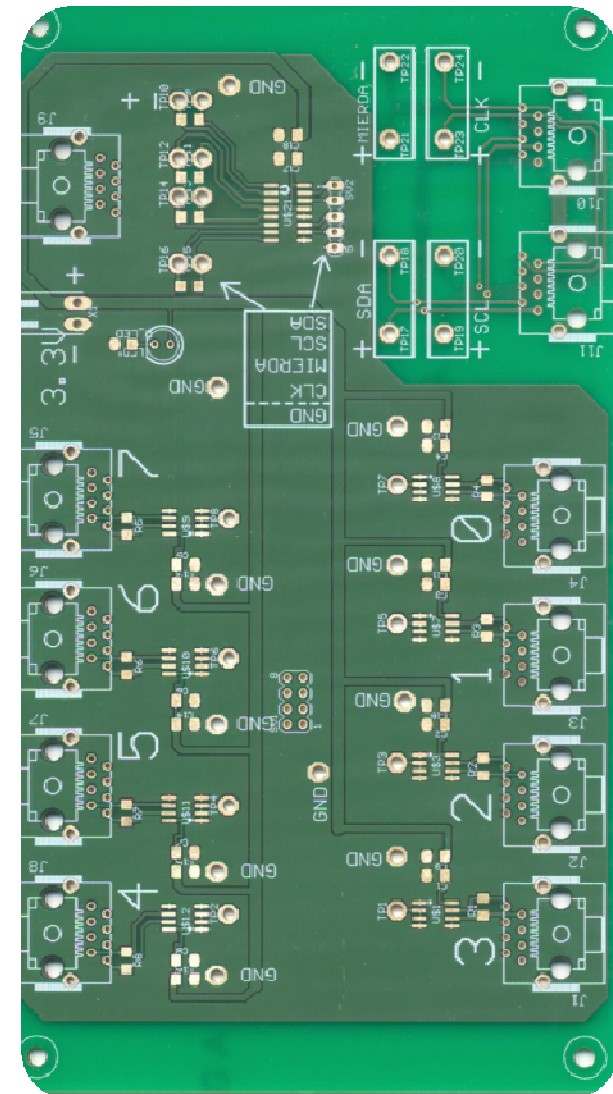


- Very Front End
  - Analogical Part
    - High voltage power supply for the PMTs
    - Dark box to test with controlled light
    - Motorized optical fiber emits pulsed light on the desired channel of the PMT
    - Also diffuse pulsed light is available
    - Motor control is done by a computer while triggering of light pulses is done by the VFE's test board that also collects the resulting data



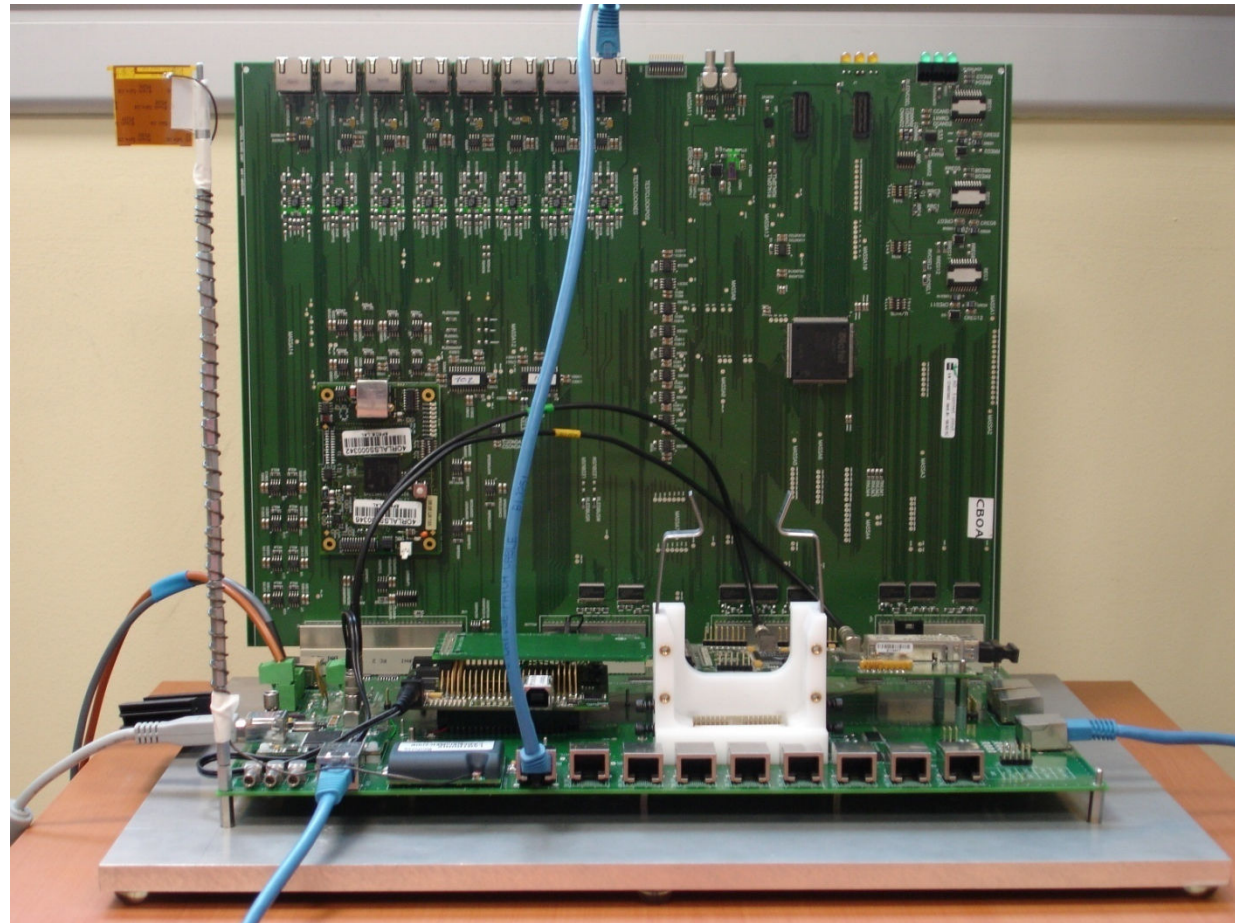
- Link supervision

- Clock distribution very important for our system, it defines integration time. Must be easily checkable.
- Communication between the VFE/RB and the CB is done by an ad-hoc I2C with only two pairs. Focus of doubts, also tested.
- Able to supervise signal shapes and communications.
- Able to substitute a VFE and view what would it receive.
- Able to check relative phases of the 8 clocks available on a CB.

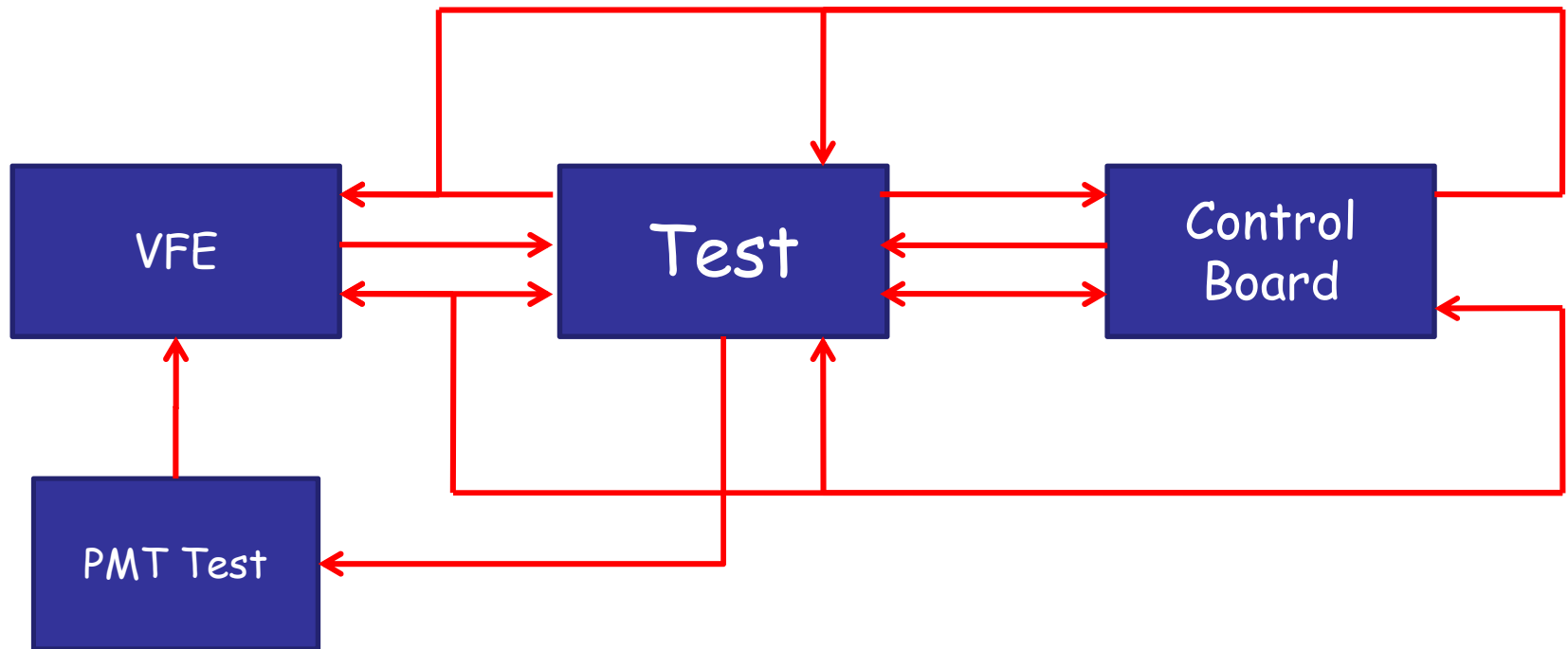


- Mixing real detector with "emulated" parts
  - Test for the data cabling with LVDS pattern
    - With real datapath
    - With test board instead of PSFEB
  - Test for analogical noise and offset
    - With real datapath
    - With test board instead of PSFEB
  - Test for the control cabling
    - With real datapath
    - With test board instead of CB
    - With scope
  - All of them very useful to isolate problems and try to solve them.

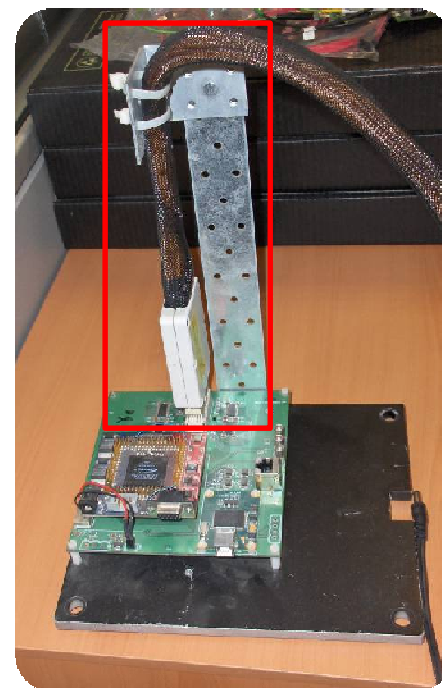
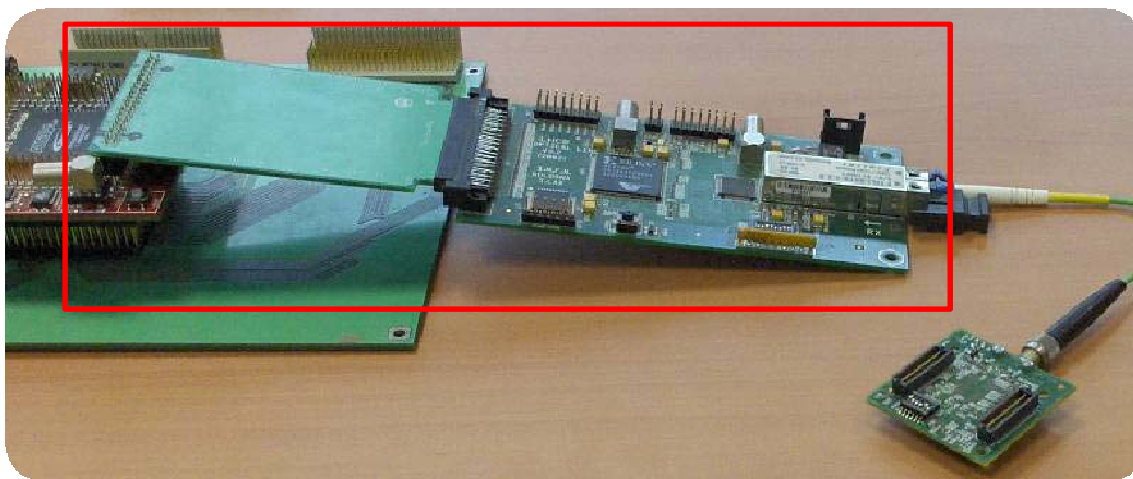
- USB
- Ethernet
- WiFi
- LVDS Data
- Control Cables
- Optical
- Power
- PMTs env.
- Spy



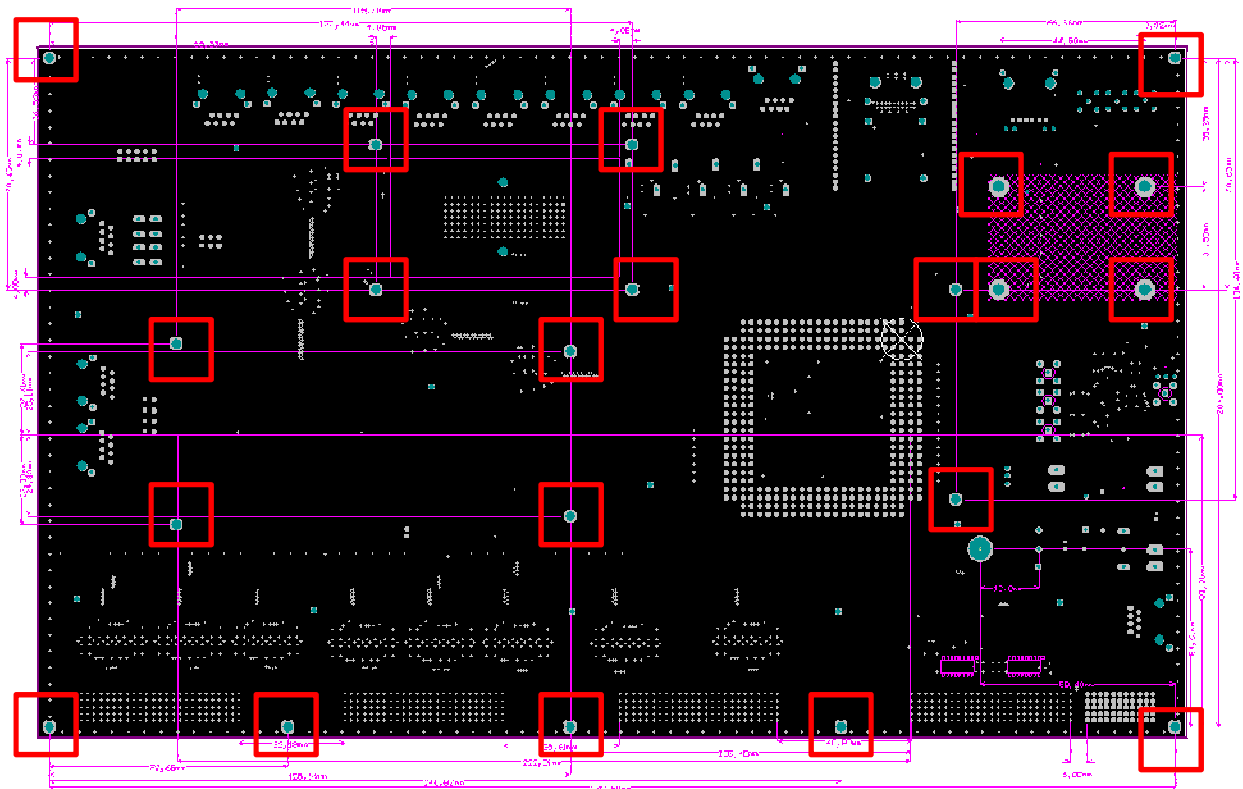
- Test capabilities



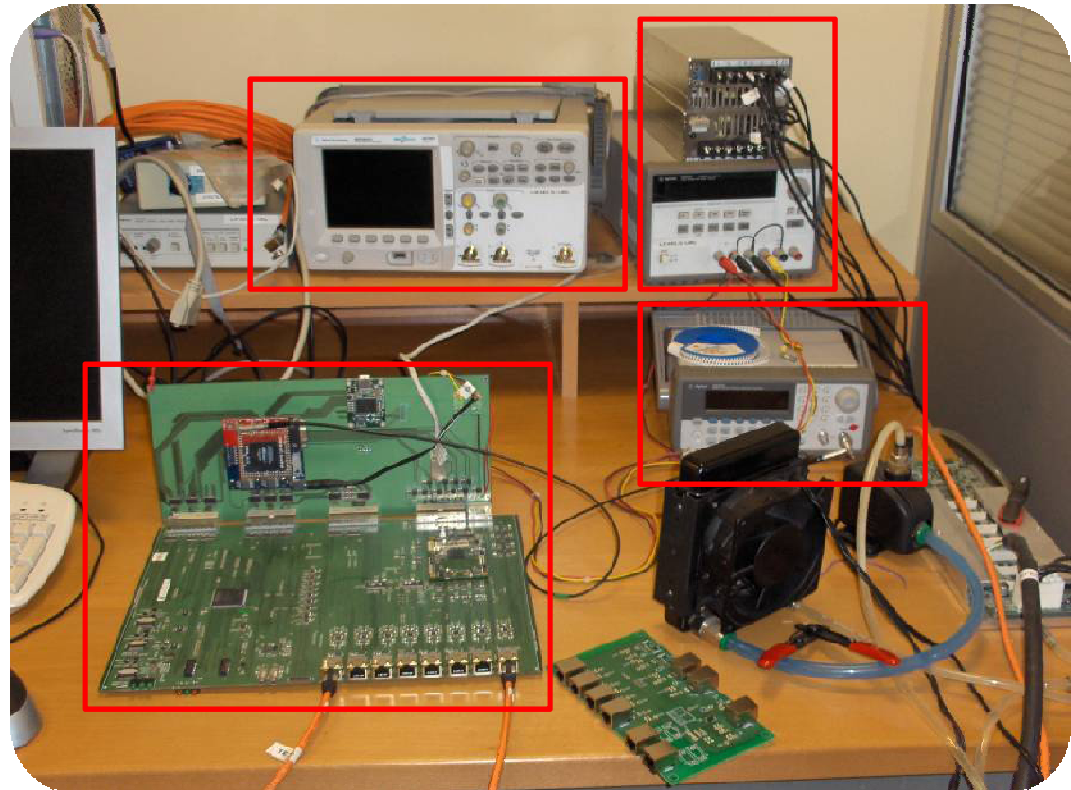
- Features
  - Mechanical resistance
    - One must not expect careful manipulation by an average user.
    - Old one had clear mechanical flaws.
    - Common in systems designed during prototyping tests. (Loose wires,...)



- Mechanical resistance
  - 21 screws,
  - 10mm aluminium plate
  - Good fixation of optical link
  - Good fixation of LVDS cable

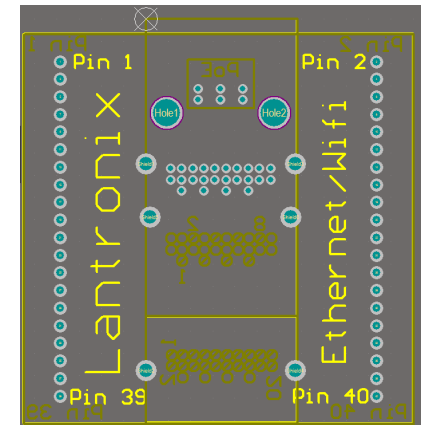


- Less laboratory dependant
  - Power
  - Clock
  - Scope
  - Special SW on PC
- Now:
  - Clock generator
  - Power Regulator
  - No SW needed\*





- Better interface:
  - USB
  - Ethernet/WiFi (compatible with various models with integrated web server)
- Portable:
  - O.S. Independent (No drivers)
  - No applications
  - Always Updated software
- Usable:
  - Remotely operated (expert at home, ALARA reasons, etc)



- Ready for future tests and reparations
- System suitable for average user
  - Usable
  - Stable
  - Intended for average user
- Better interface
  - Ethernet is a great advantage
- More test possibilities
  - New data paths not available before
- Less lab dependant
- Solved problems learned by using testing boards