A small portable test system for the TileCal Digitizer system

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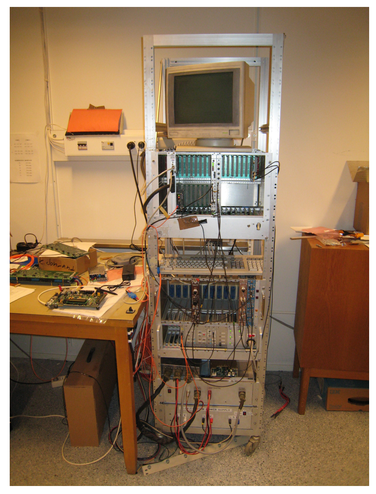
Abstract

The TileCal hadron calorimeter in the ATLAS detector at LHC contains about 2000 digitizer boards, developed and maintained by Stockholm University. A rather complex test system has until now been used to verify the functionality of the boards. However, it was built almost 10 years ago and is now in itself difficult to maintain since it consists of several already obsolete parts. The development of a new simple, reliable and portable test system that could survive the digitizers was therefore initiated. Its components have been chosen to reduce the problem with obsolescence and to allow easy migration to new platforms.

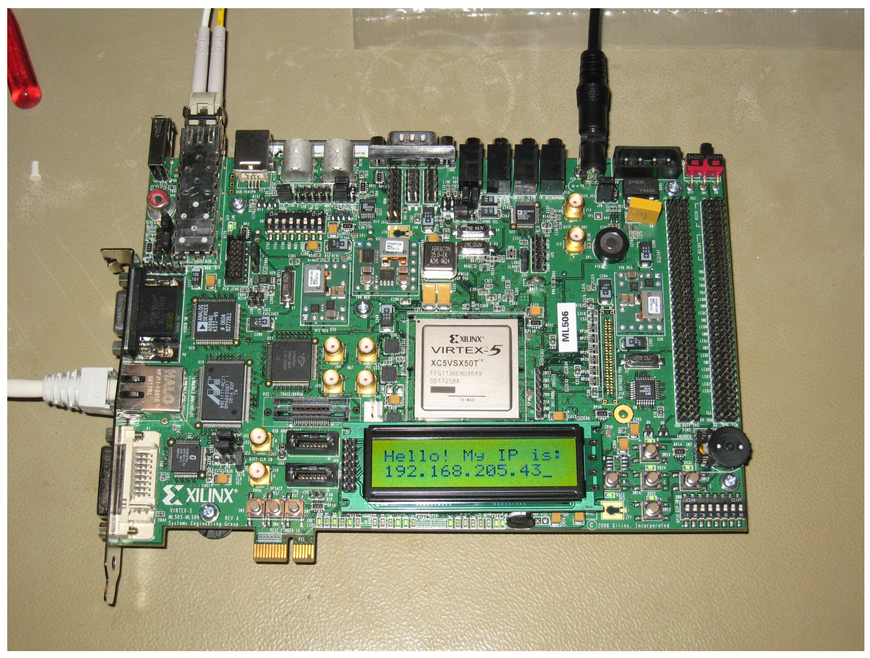
Old system

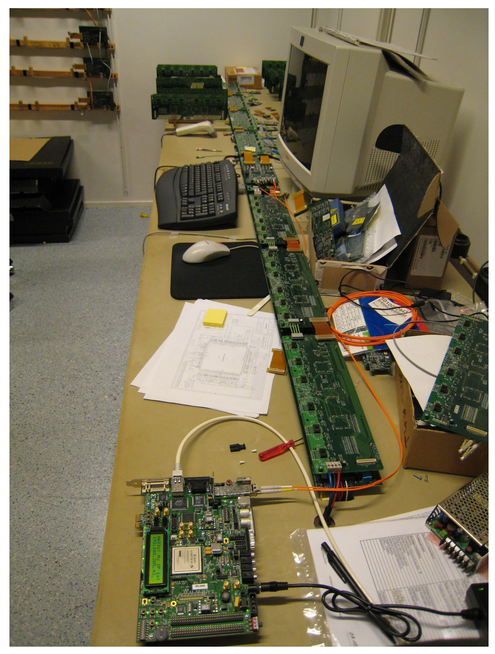
- Far too complex
- Unstable
- Very old and obsolete
  - Impossible to replace in case of break down
- Noisy and power demanding
- Incomplete documentation



New system

- **One single development board replaces the whole previous crate system**
- Based on commercially available components
  - Xilinx ML506 development board
  - Small Form-factor Pluggable (SFP) module
  - A laptop (optional)
- Single SFP module and a GTP in the FPGA for both TTC transmission and G-Link reception
- Easily upgradeable firmware for future improvements
- Embedded system
  - Running standard Linux and the test software
- Communicates with the main computer over Ethernet
- Test software is running in a virtual environment for future compatibility





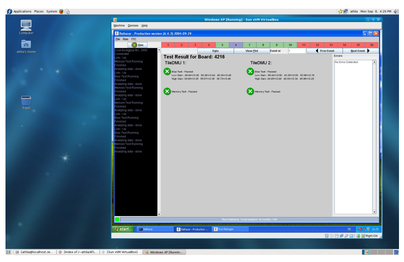
Design Challenges and Solutions

Several design challenges had to be solved to create this system. First the TTC system had to be emulated inside the FPGA to be able to generate signals to the system. A G-Link receiver had to be developed inside the FPGA as well, using the multigigabit transceiver GTP of the Virtex-V. Since the G-Link protocol is different from common protocols used today on the market, some tricks had to be done with the GTP to make it receive the G-Link protocol. A CDR is used to lock the receiver to the source frequency and the G-Link idle pattern is used as a comma character, to make the receiver align to the right bit pattern. The G-Link decoding is then implemented in normal logic cells. Since the board has only one SFP module, both TTC and the G-Link has to share the same resource. The implementation of an embedded system, running Linux, and the porting of the test software to the system was demanding as well.

Long term maintenance

Needs to function during the next 10-15 years

- Needs to be reliable and robust
- The ML506 can easily be replaced in case of failure
  - Upgrading to a newer model would also be possible
- The computer can not be expected to run 15 years
  - Virtualisation ensures easy migration to a new computer while maintaining backward compatibility
  - Eliminates the need for software maintenance



Other applications

The system could be used to test other systems as well in a similar way, requiring only some software development for the board. Even the hardware could be modified if other communication links than TTC and G-Link would be desired.