Digital Readout Board for CMS and TOTEM
Precision Proton Spectrometer timing upgrade project
CT-PPS as part of the upgrade programs adds tracking and timing detectors in the very forward region on both sides of CMS in LHC tunnel

Used new cylindrical Roman Pot
Detectors and Readout

- Equipped with diamond and ultra-fast silicon detectors (UFSD) for timing measurements

- New readout and timing systems based on
  - Digitizer Readout Board
Main Functions

- Receive front-end data of the timing detectors
- Reformat the data packets
- Transmit them to DAQ through optical data links
- Distributes the control information to the front-end hybrids
- Collects different detector and board parameters.

Components

- Digitizer Board
  - Core is rad-hard FPGA SmartFusion2 M2S150-FC1152 from Microsemi Co.
- Mezzanines
  - HPTDC
  - SAMPIC
  - GOH for data transfer
  - USB for test and debug
Digital Readout Board (2)

Components

- Digitizer Board
- GOHs
- Adapter
- USB for lab tests
- Readout Box

- HPTDC
- SAMPIC
Digital Readout Board (3)

Digitizer Board

2 x SAMPIC mezzanines

HPTDC

2 x GOH
Digital Readout Board (4)

Readout Box

TOTEM Readout and Clock Boxes
Sector 56
Digital Readout Board (6)

**Basic Blocks**

- I2C Interface for Control
- Connector for HPTDCs Mezzanine + DAC TRSH
- Connectors for SAMPIC Mezzanines + Flash EPROM
- Power Distribution
- FPGA SoC M2S150-FCG1152 MICROSEMI
- Clock and Commands Distribution
- GOHs
- POH
- QuickUSB Mezzanine
- JTAG Port

Gueorgui ANTCHEV - CERN/INRNE-BAS
Firmware for HPTDC (Diamonds detectors)

- Built as hierarchical structure using VHDL and Verilog
- Equal basic blocks are implemented for the 4 HPTDC mezzanines
- Devised around two functional units - the control loop and the data path
- The control loop implements an I2C slave which is connected to the CCU
- The I2C communication is used to receive the configuration bits of the HPTDCs and control the Digital Readout Board operation
- The HPTDCs are then configured by a JTAG master also implemented in the control loop
Control, Programming and Readout
Software (1)

Basic blocks

- Slow control library for read/write operations on all I2C devices
- API for configuration purposes, for changing the thresholds of the NINO discriminator chips, and for controlling the settings of the PLL25
- Control a parallel interface, which is used to reset and change the laser intensity of the GOH.
- Integrated within the CMS xDAQ platform for the development of distributed data acquisition systems
Software (2)

- **Functionalities of Digitizer Board:**
  - Portability: VME or μTCA interfaces;
  - Write/Reading a single register;
  - FPGA Control (Microsemi SmartFusion2);
  - Setup/configuration (HPTDC, NINO, PLLs and QPLL);
  - CCU25 slow control ring configuration;
  - Reset procedure (HPTDC, CCU25, GOH, POH and crate);
  - Write/Reading (FPGA FIFO);
  - Scan all devices (I2C);
  - Diodes configuration (GOH and POH);
  - NINO board threshold setup;
  - Versioning control (firmware and software);
  - Enable/Disable Optical clock;
  - CCU25 JTAG programming;
  - Slow control SAMPIC interface under development.
  - Interface with CMS DAQ: receiving SOAP commands for detector state configuration (or recovering).
Software (XDAQ13/14 or python GUI):
Digital Readout Board successfully build

Covers several requirements

Readout the detectors from different technology

First version installed in 2016 for diamond detectors

Second version with SAMPIC for UFSD to be installed next month