TRIUMF

Darkside-20k DAQ

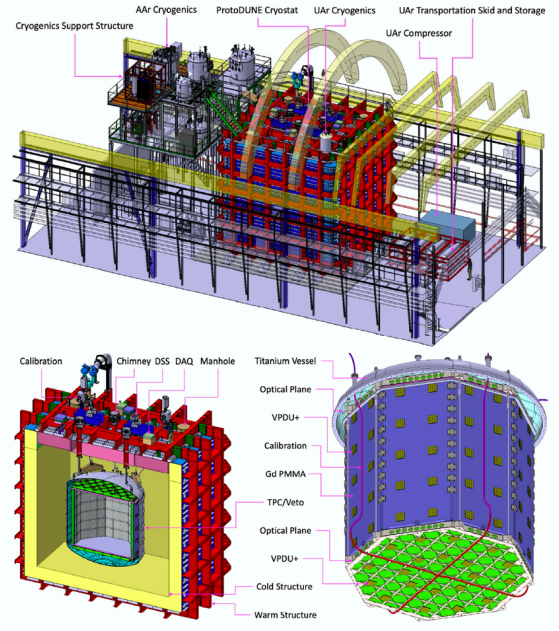
Ben Smith

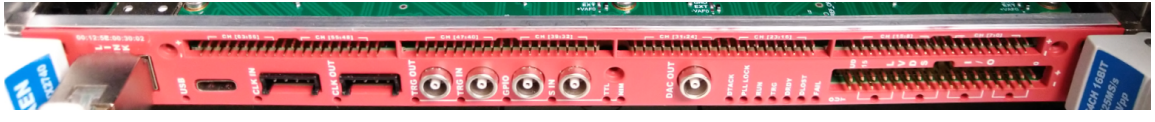
Midas Workshop 2023

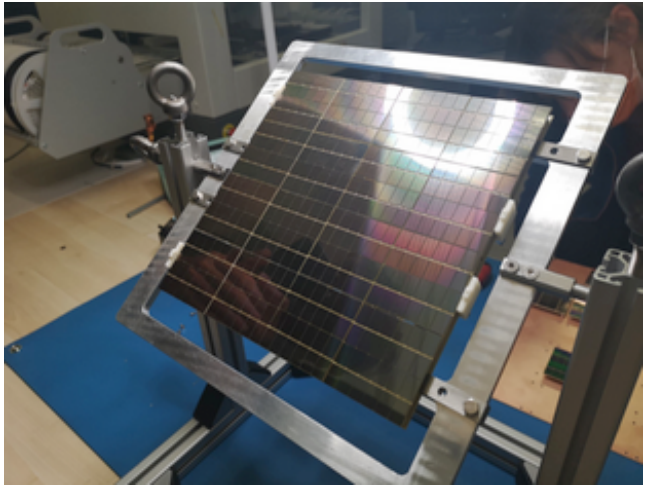
Discovery, accelerated

Darkside-20k

- Liquid argon dark matter search being built in Italy
- Thousands of SiPM channels
- Readout will use dozens of CAEN VX2740 125MS/s digitizers
- 10s of GB/s of data needs reducing to 10s of MB/s







Test facilities vs final experiment

- Lots of SiPM and electronics boards to be tested at cryogenic temperatures
- Currently have 7 test facilities in Europe/Americas
- Developing 2 different DAQs at the same time!
  - Test facilities use 1 or 2 digitizers, low data rates, little online processing
  - Darkside-20k will have dozens of digitizers, many GB/s, and significant online processing

Test facilities

- All running VX2740 digitizers, with some variations for HV/LV control
- Documentation and usable interfaces are critical!
  - Don't want to answer the same question 7 times...
- Using React/node.js for a combined run log interface
  - Python script adds ODB info to a database
  - node.js reads from database
  - Fun to play with, but very different to old-school web dev!

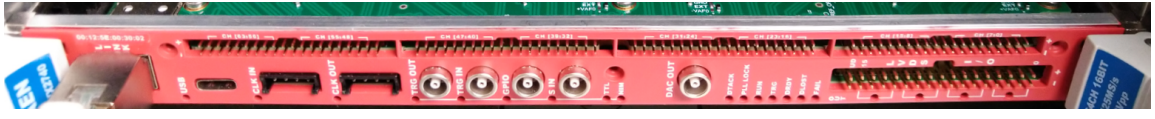
Gennaro Tortone @ INFN-Napoli

CAEN power supplies

- I've written a flexible midas frontend for CAEN power supply systems (e.g. SY5527)
- Automatically discovers which modules are installed, and the capability of those modules
  - E.g. number of channels, if parameters in uA or mA...
  - Adjusts ODB structure accordingly
- Custom webpage included

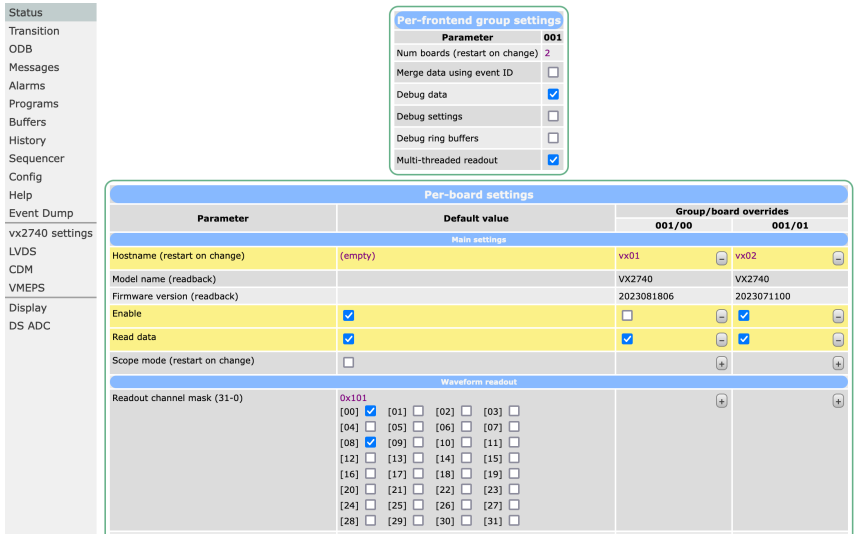
VX2740 digitizers

- 64 channels, 125MS/s
- Comes with standard firmware, but user can customise!
- VME form factor, but data readout via ethernet or USB
- CAEN provide library for configuration / data readout
- We have a midas frontend for it



VX2740 configuration

- Most digitizers will have the same configuration (except for a couple of things)
- I made a "/VX2740 defaults" directory in ODB
- Per-board differences are stored in /Equipment/VX2740_003/Settings/Board01/<param> etc.
  - Only contains keys for settings that are overridden!
- ODB is much smaller and quicker to edit



VX2740 custom firmware

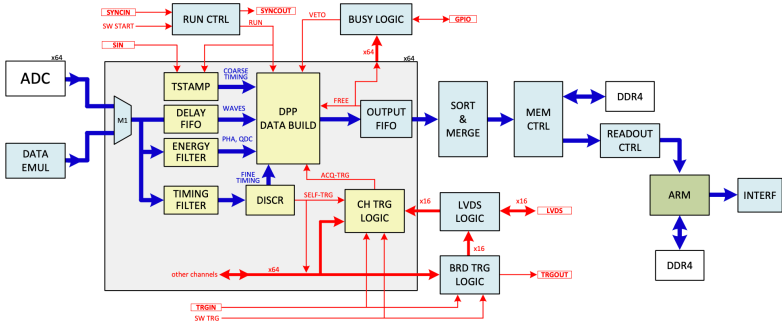


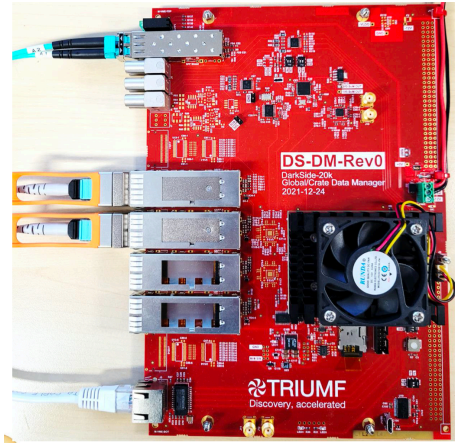
Fig. 3.1: Block Diagram of the DDP firmware

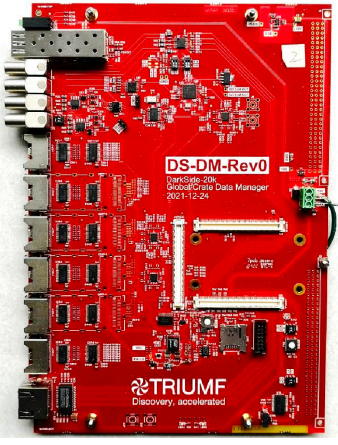
- We can implement parts of the VX2740 firmware
  - One FPGA runs both CAEN part and user part
  - c.f. V2495 where there are two separate FPGAs and a bus
- CAEN side of the firmware is a black box
  - We've been beta-testing it; close to being complete
  - Must compile on CAEN's servers; build takes a while
- For Darkside, TRIUMF have implemented
  - FIR filter and custom trigger logic
  - Communication with Crate Data Manager via LVDS lines

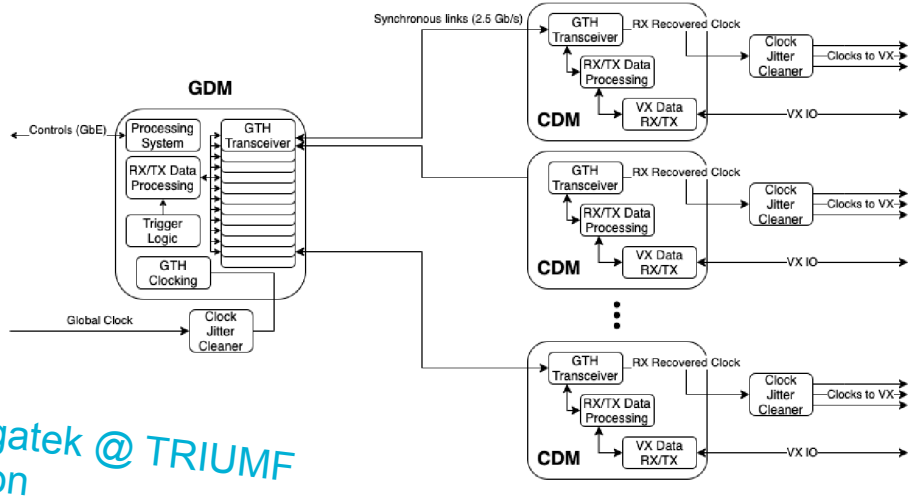
Yair Linn @ TRIUMF
Sam de Jong @ UVic

Crate/Global Data Managers (CDM/GDM)

- Multi-digitizer synchronisation
- Custom hardware by TRIUMF
- Reads full detector state via LVDS for optional global trigger
- Clock distribution
  - GPS timestamps and 62.5MHz clock
- Injects triggers for "end of time slice" and "unbiased data"







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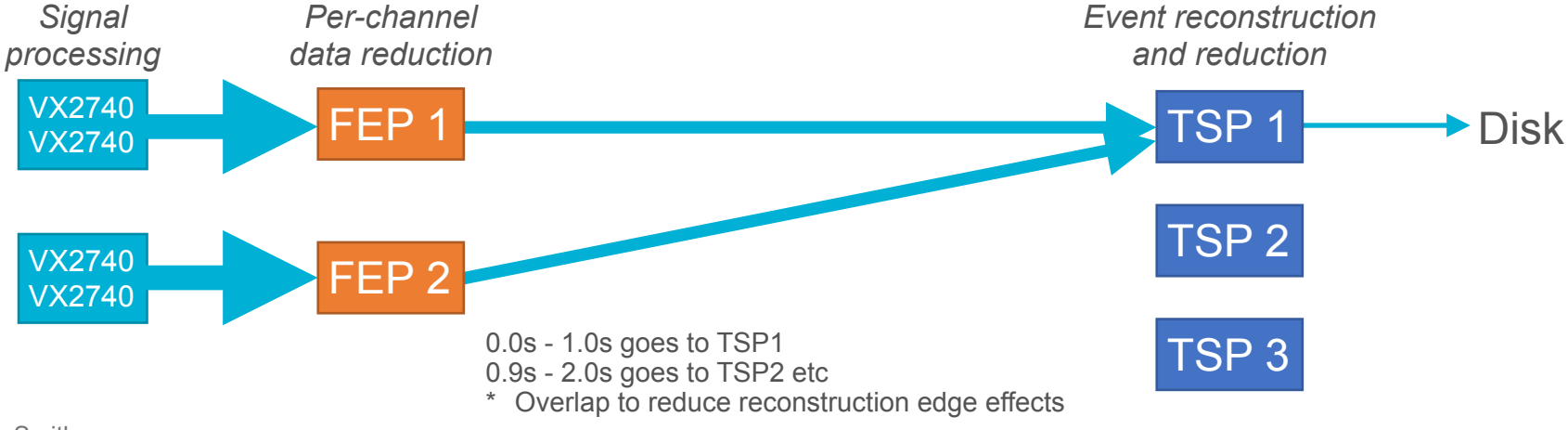
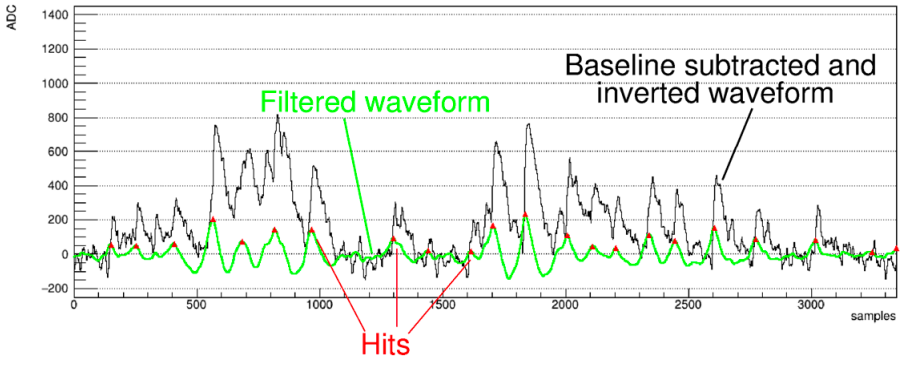
Konstantin Olchanski, Peter Margatek @ TRIUMF
Sam de Jong @ UVic, Ian Johnson

Online data processing

- Triggerless architecture - lots of data to handle!
- Front End Processors read digitizers
- All data for 1s interval sent to a Time Slice Processor
- Will have dozens of FEP and TSP nodes



Front End Processor



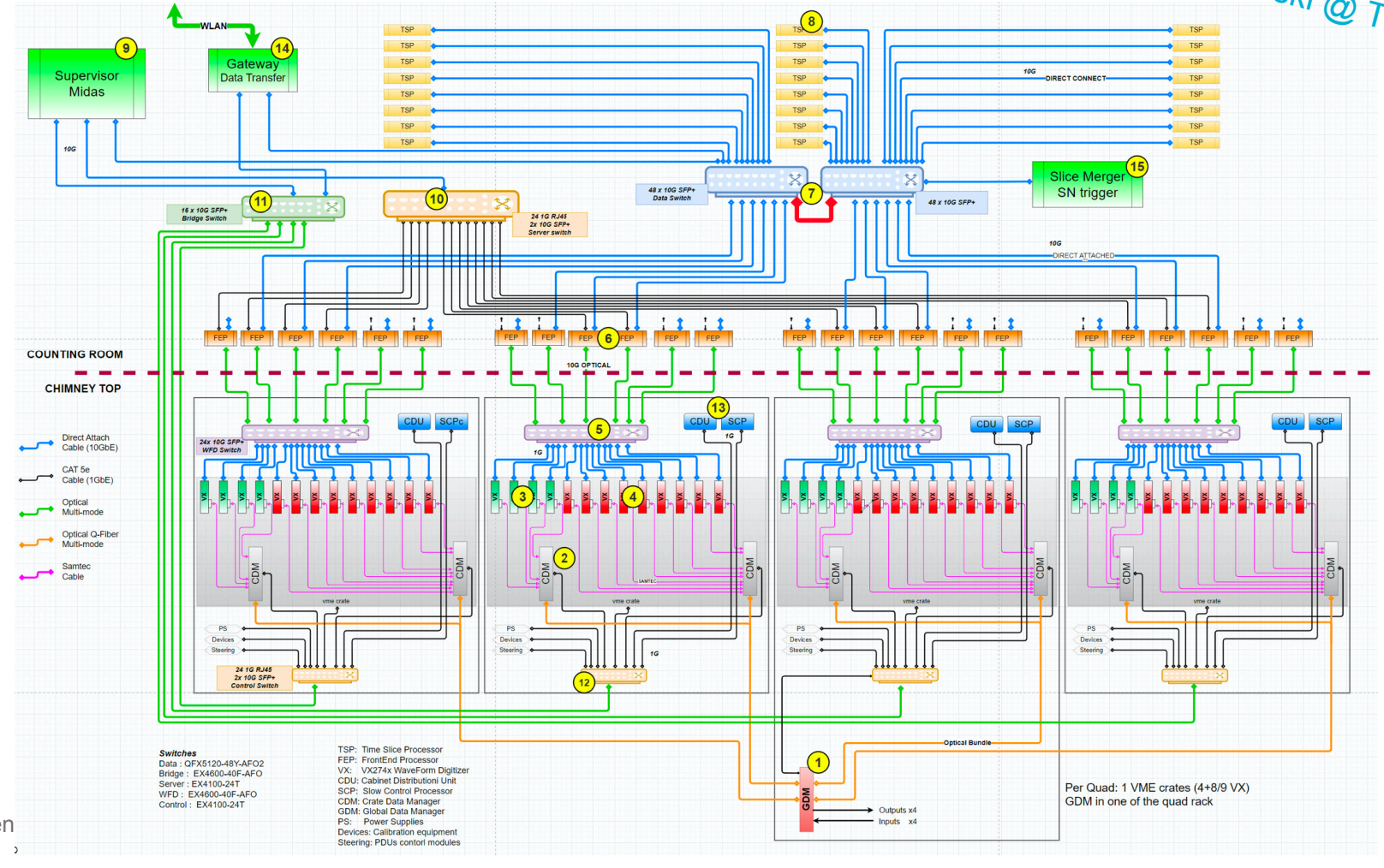
- Performs hit-finding and data reduction for 2 boards
- Multithreaded (std::thread, std::deque<std::shared_ptr>)
  - 1 per board for reading waveforms into a queue
  - 1 per board for processing data (into another queue)
  - 1 for accumulating data from all boards into slices
  - 1 per slice for sending data to TSPs
- Data sent to TSPs via TCP/IP sockets, not midas buffers
- A Pool Manager tells FEPs where to send each slice

Time Slice Processor

- Has access to 1s of data from entire detector
- Can do further data reduction, event reconstruction etc
- If we have 50 TSPs, can spend up to 50s analysing each 1s of data (on average)
- Sends final data to a supernova trigger
- Sends summary stats back to the Pool Manager
- Likely to NOT be midas clients
  - Pool Manager is a midas client and will forward ODB settings and run transitions to TSPs

Final network

Pierre-Andre Amaudruz and
Konstantin Olchanski @ TRIUMF



Summary

- Using midas for most things in DS-20k DAQ
- Not planning to use midas for:
  - Data flow between FEPs and TSPs (direct sockets)
  - Time slice processors (don't want 50+ clients)
  - Slow control (that group want to use a full SCADA system)
  - Test facility run log (fun to play with React/node.js)
- Question:
  - What tools do people use for managing large numbers of servers (Ansible, Foreman, Puppet, manually...)?