xTCA in ATLAS for a possible replacement of VME

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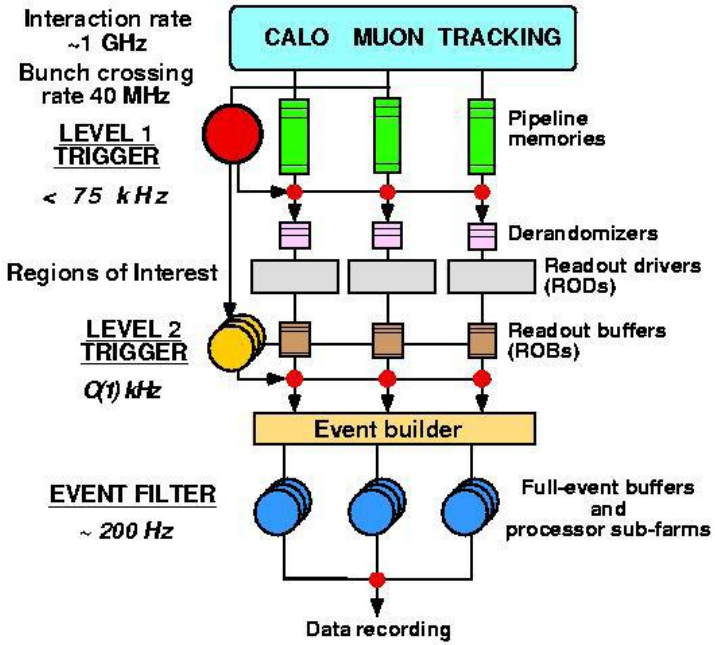
- **A bit of history**
  - Readout architecture
  - Use of VME in ATLAS
  - Is VME not adequate for future systems?
- **Interest in ATCA**
- **Tentative time scale for development and deployment of a new standard**
- **Summary**

Current Readout Architecture

- ReadOut Drivers (ROD) and ReadOut Buffers (ROBIN element of the ROS) separated
  - ROD in VME
  - ROBIN in PCs
  - S-Link in between
- Reasons for separation
  - Easier commissioning
  - Factorisation



VME based RODs

- In normal data taking
  - The VMEbus does not see the data
    - They go through S-Links
  - VMEbus used for configuration, control and monitoring
    - Limited bandwidth
- During special runs (standalone, calibration,...)
  - DAQ software running in the VME crate
  - Trigger rate can be limited

What has been good with VME

- Availability of standardised crates and easy procurement process
  - Easily integrated in the counting room
    - Size, cooling, ...
  - Different flavours although a single protocol
    - Size, power supplies
- Availability of maintenance contract
- Availability of Single Board Computers
  - Family with upgrade capability
  - Standard ATLAS software
    - ROD crate DAQ
- Overall relatively low overhead cost despite the use of high-end crates
  - 840 ChF per slot for a 9U system & 640 ChF per slot for a 6U system
  - Includes bin, fan-tray, power supply and SBC
- About 220 crates in ATLAS

Is VME not adequate for future systems?

- If we keep the same readout architecture and the same functional boundaries
  - VME can still do the job
  - Monitoring tasks could run in PC connected to ROD through ethernet
- However, it's difficult to predict what VME will be in the years 2022–2032 (HL-LHC)
  - First designs in VME beginning of the 80's (previous century)...

What could be a replacement?

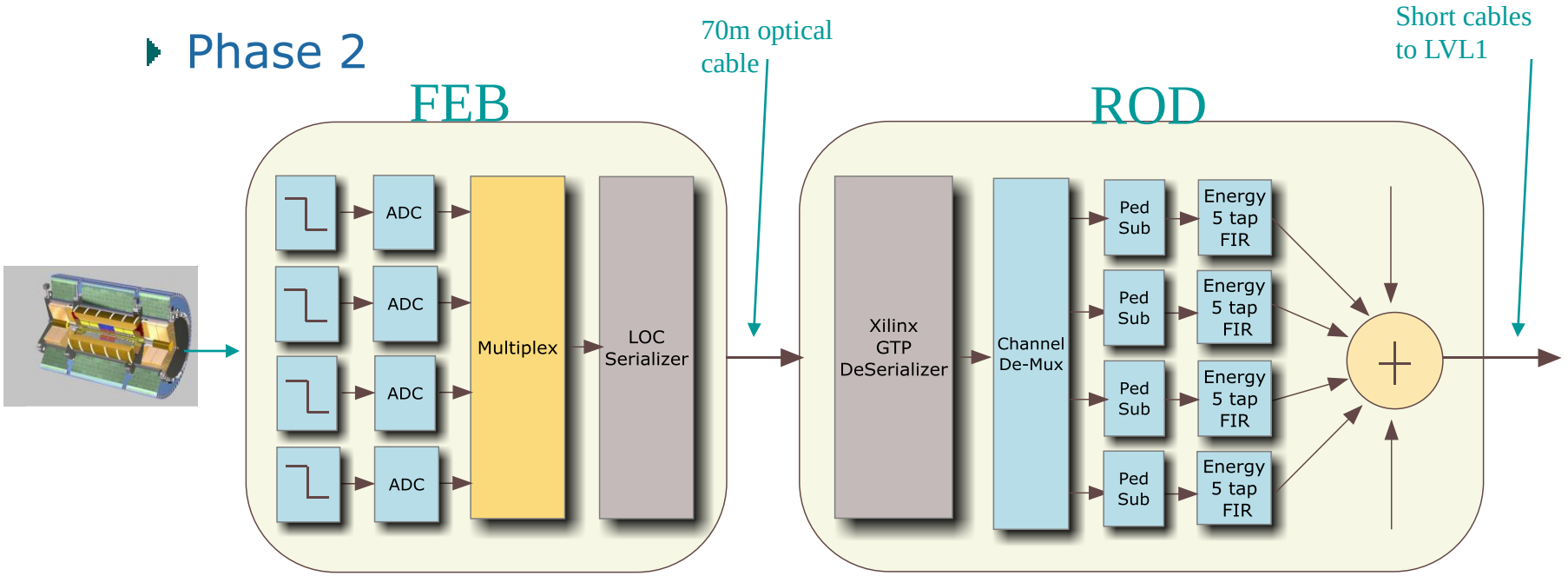
- There are several possibilities
  - VXS as a natural successor of VME
  - ATCA or µTCA
    - Although µTCA seems a bit small wrt our IO problems
  - Direct readout in PCs
    - See for instance A. Kugel's presentation in the IT readout session during the last AUW

      https://indico.cern.ch/sessionDisplay.py?sessionId=30&confId=108365#20111115
  - No standard
    - Define a BIN with Fan Trays and power supplies
    - (GB)Ethernet interfaces on each board
    - Ethernet switches and PCs
    - i.e. a poor man ATCA...

- Currently, most of the developments for long term upgrades in ATLAS are using ATCA

Interest in ATCA (1)

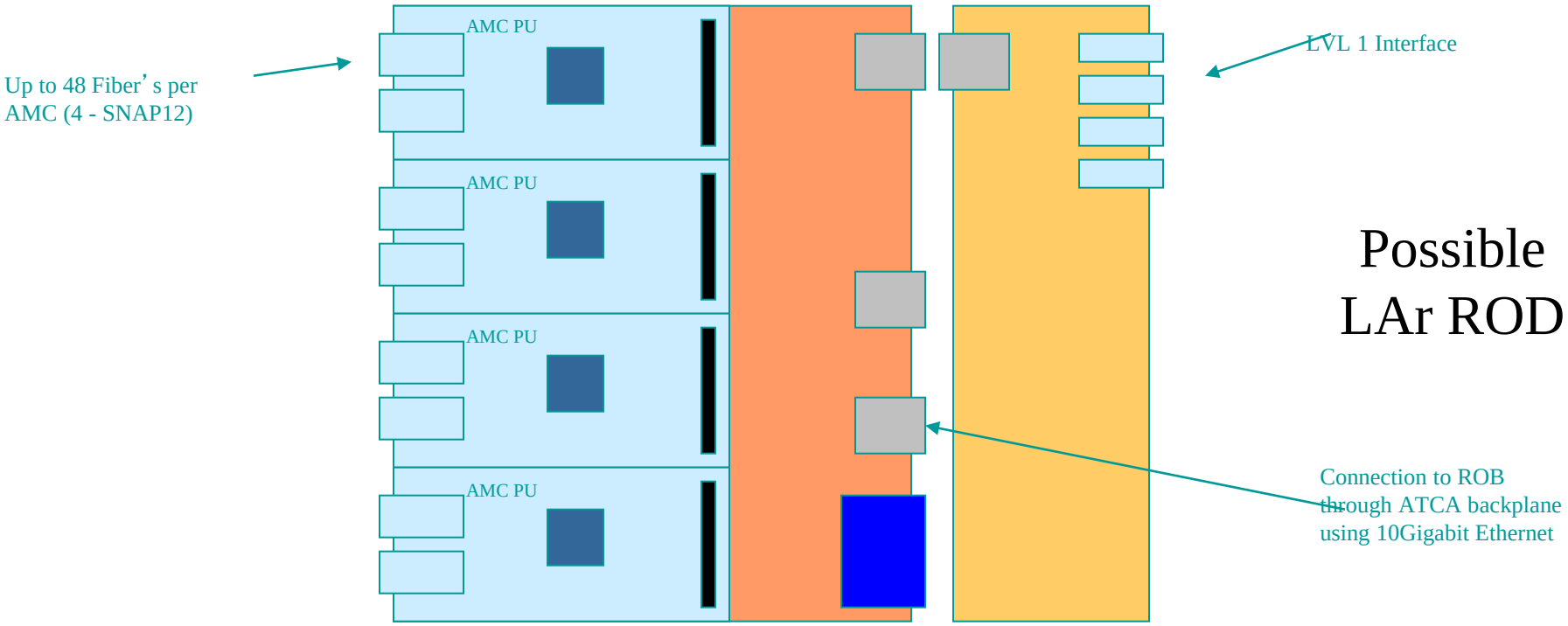
- High speed connections between boards could be very useful for the calorimeters upgrades
  - Phase 2



- In the case of an architecture change with a merge of the ROD and the ROS on the same physical system
  - **Not at all the baseline!**

Why ATCA?

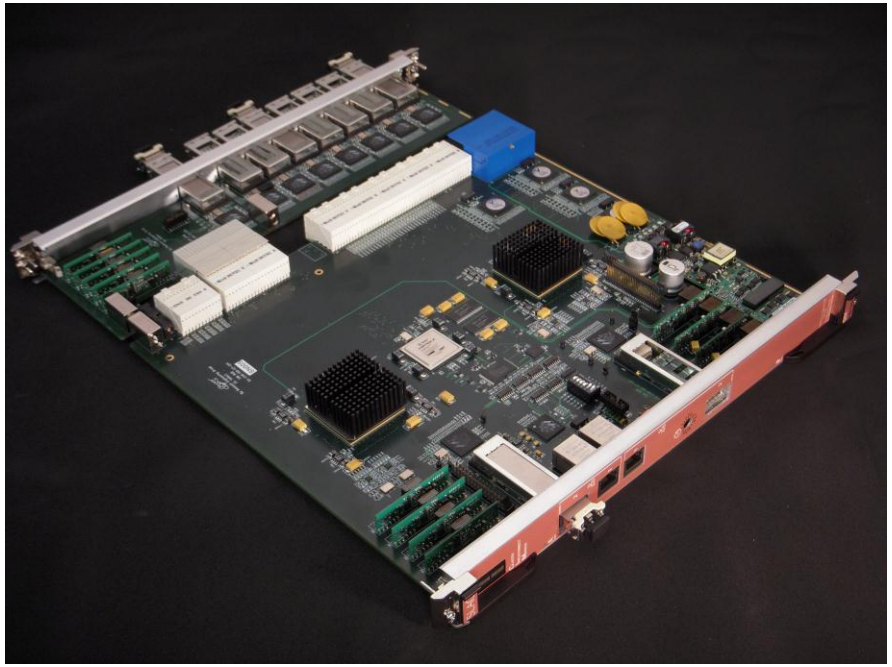
- Need boards large enough to accommodate the I/O

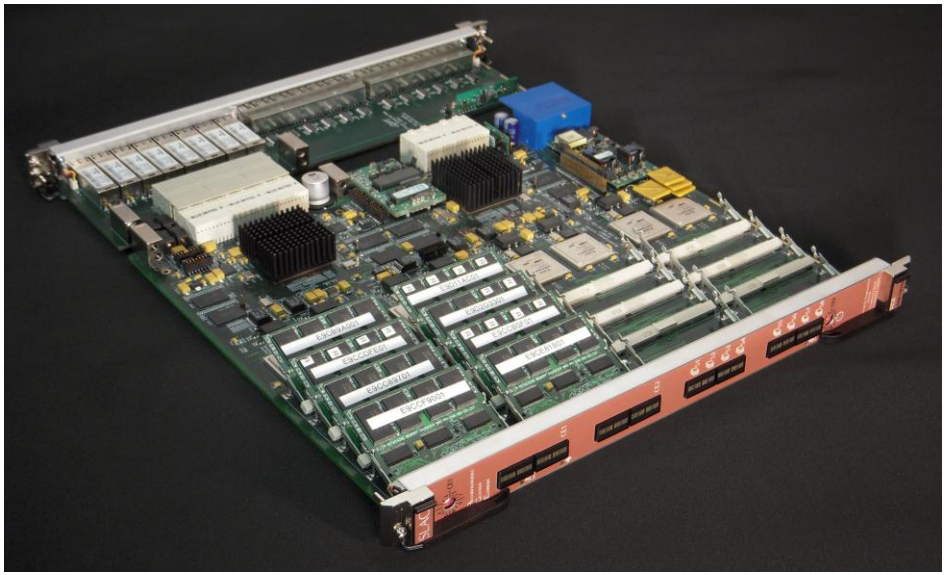


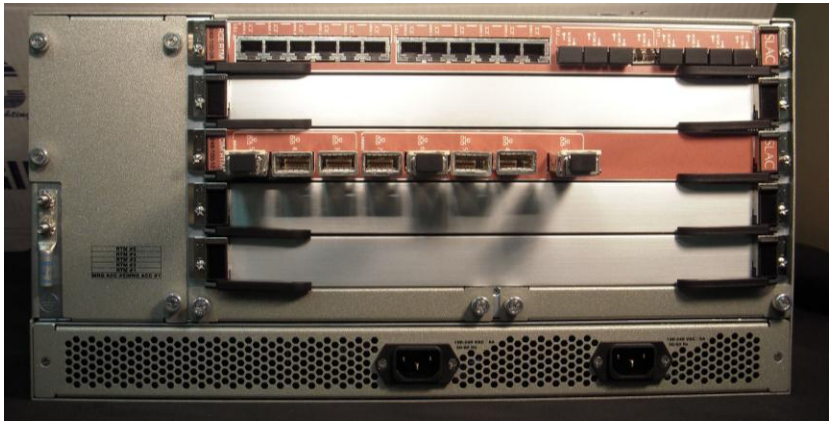
On-going Projects (1)

- Developments at SLAC
  - Presented several times, e.g.
    - http://indico.cern.ch/event/twepp10
    - http://indico.cern.ch/event/ACES2011
- TTC included in new generations
- First system used for reading out the new IBL0 pixel layer
  - Although the new ROD for IBL will be in VME

GEN-I RCE board + RTM

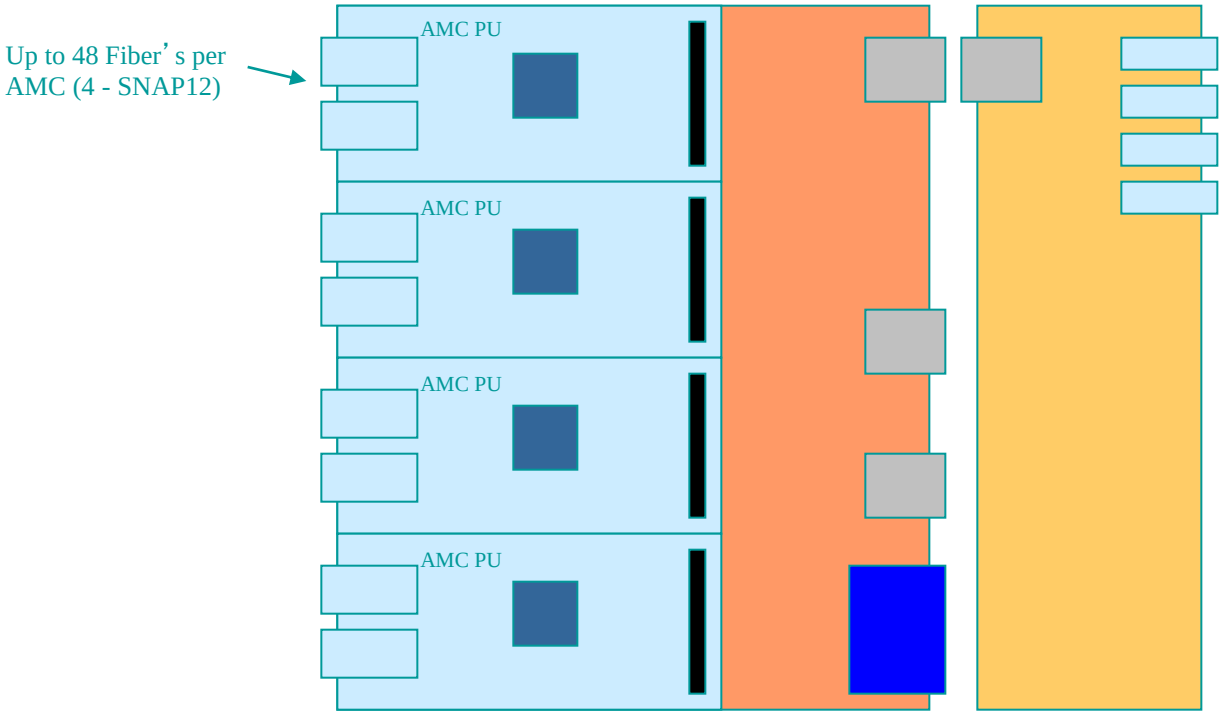






On-going Projects (2)

- LAr calorimeter goal: 150 Tbps total system

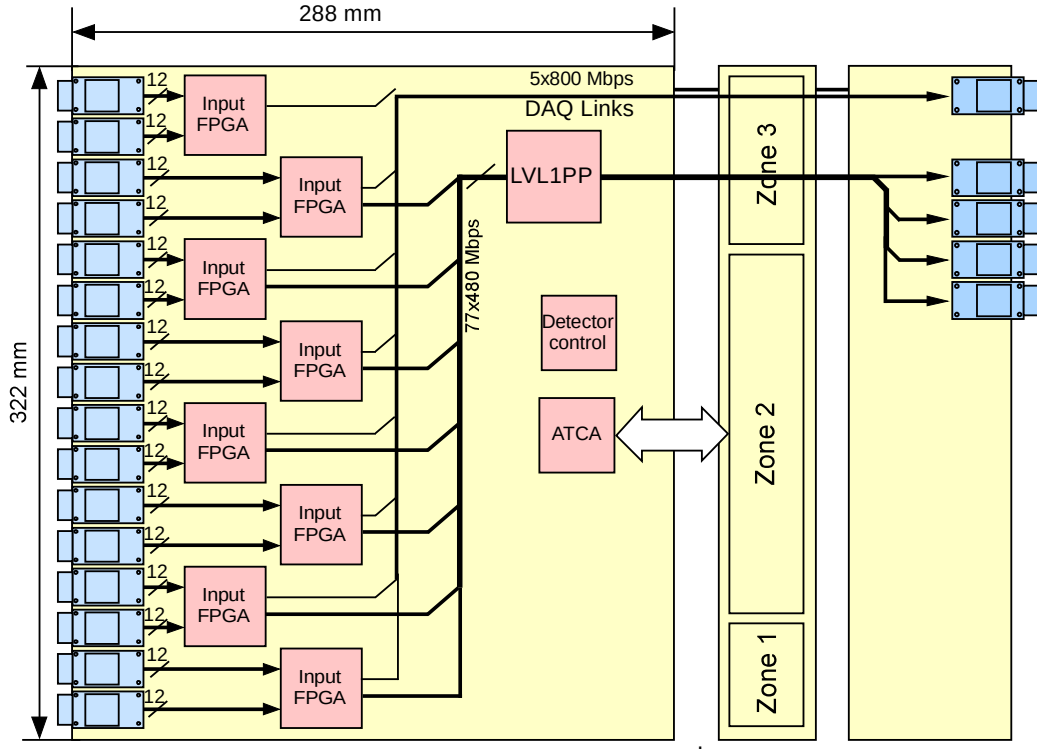


- AMC cards for the Processing Units
- ATCA Carrier board as mother board
- Controller mezzanine

On-going Projects (3)

- Tile Calorimeter
  - Development of mezzanines
  - Optical link card with SNAP12
  - GBT receiver
  - sROD Demo being designed

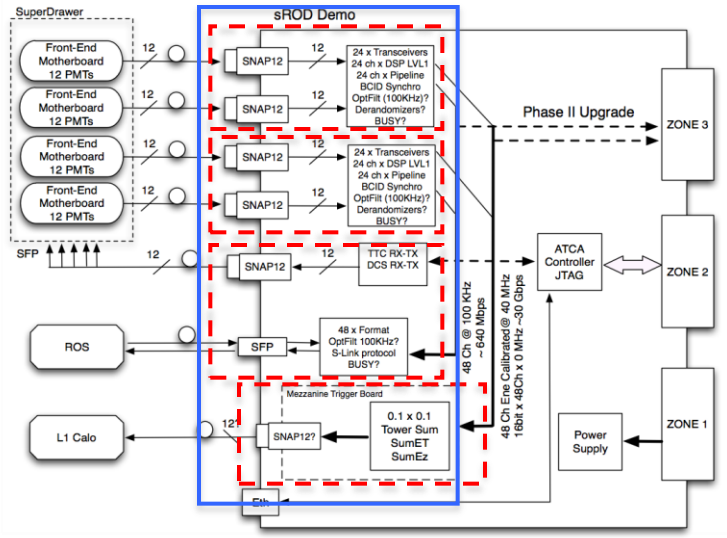
    See last AUW agenda

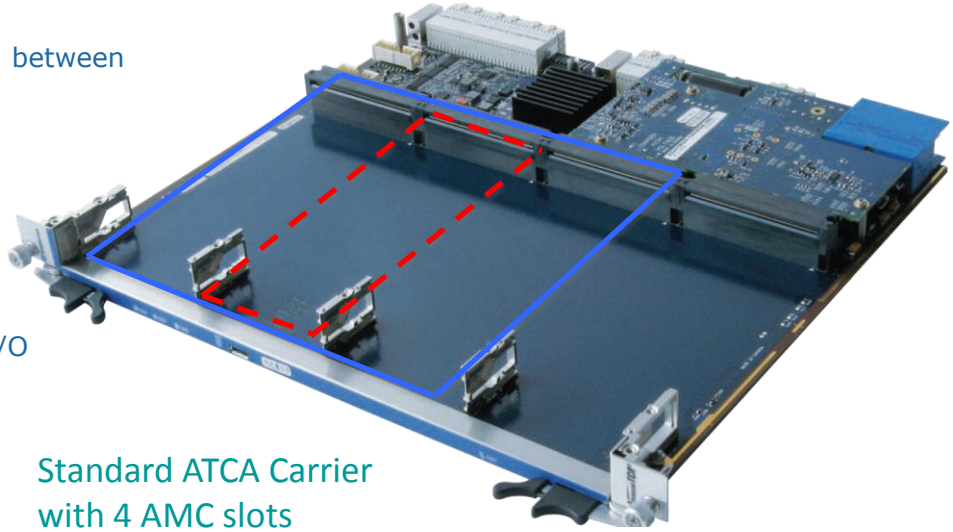


From Alberto Valero
Stanford Atlas Upgrade week

Options for sRODdemo

- A) Complete design of the ATCA board
  - CONS:
    - We don't have experience with ATCA. Short term
  - PROS:
    - Gain experience. Full custom
- B) Design 3 AMC cards for a commercial ATCA-Carrier
  - PROS:
    - ATCA interface and power provided by the carrier
    - Design AMC with main functionalities
    - AMC board might be used in MobiDick 4'
  - CONS: Data transfer between AMC slots: bandwidth and latency
- **C) Design 3 in 1 AMC**
  - PROS:
    - Same as before but no problem with communication between AMCs
  - CONS:
    - Not sure it is possible due to mechanical constraints
- D) Design RTM for ATCA-Carrier
  - PROS:
    - Design a custom RTM with main functionalities and I/O
  - CONS:
    - Reduced space
    - Very similar to design an ATCA custom board (A)





Standard ATCA Carrier with 4 AMC slots

From Alberto Valero
Stanford Atlas Upgrade week

The AMC sRODdemo board

- We are evaluated the possibility of using double or triple AMC
  - The goal is to have a density of channels similar to what we will have in the final sROD
  - The pre-placement of components shows that double size is enought
- FMC boards for expansion: Data transmission, clock management unit
  - FMC boards allows us to test different approaches for communication with L1Calo and ROS systems.
- One of the main concern is the L0/L1 Calo PP latency:
  - Possible direct transmission from reception FPGA (pipelines)

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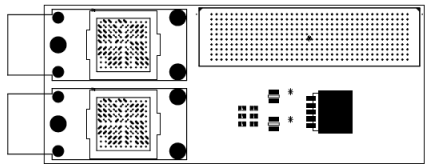
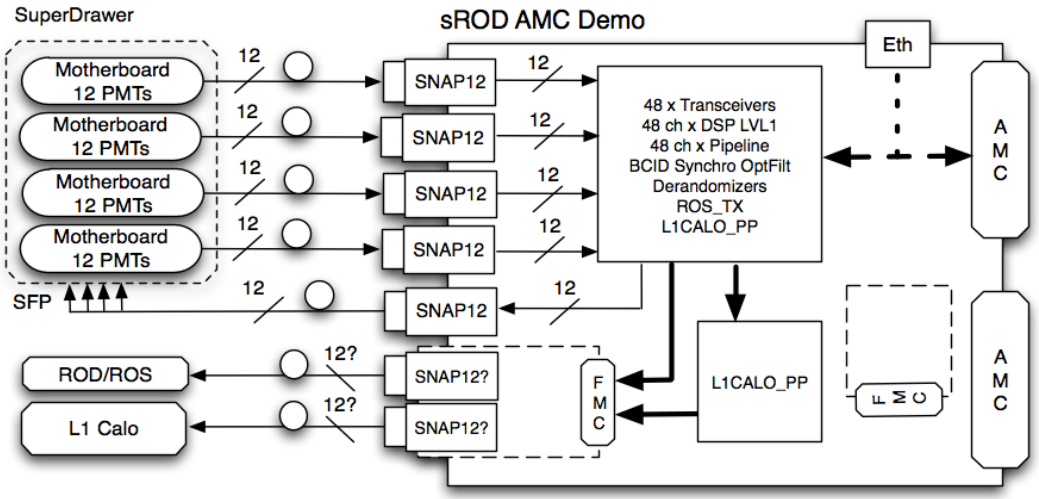
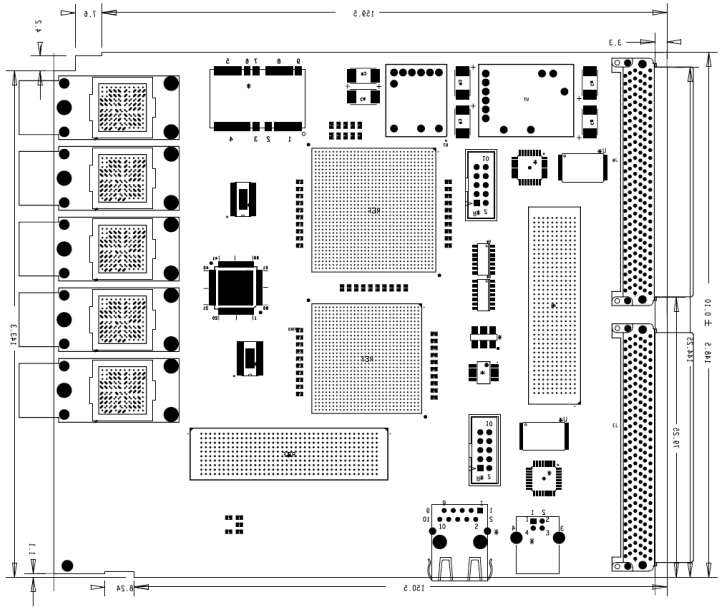
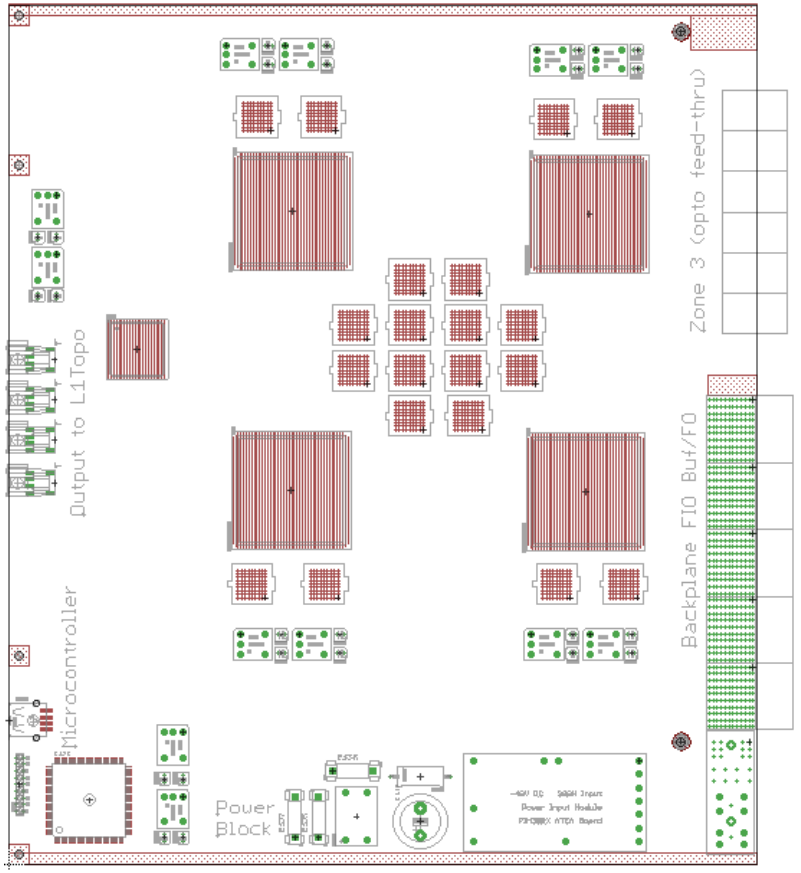






On-going Projects (4)

- Level-1 calorimeter upgrades for Phase 1



- Fast Track Trigger (FTK)
  - Phase 1 at the latest

Wish list

- Whatever the selected new standard will be we'll need the following:
  - Integration in the existing infrastructure
    - Cooling with vertical air-flow
    - Compatibility with the main power distribution
  - Common family of crates (as done for VME)
    - Not too many variants
  - Controller (Shelf manager & control software, embedded CPU?)
  - Purchasing and maintenance contracts

I.e. the same kind of support we have today with VME

Tentative Schedule

- Large change in off-detector electronics not before Phase-1 (2018 or so) and mainly for Phase-2
- Decision on which platform is to be used to be done this year
- Availability of standard elements (crates, etc.) for deployment 1–2 years after(?)

What's going on

- A task force with representative of each sub-systems + TDAQ to define a replacement is being put in place
  - Expected conclusion (decision) at the end of the year
- When a standard is selected, define the main characteristics of the system we wish
  - Power, Cooling, Possible special use of the backplane (e.g. for TTC distribution),...
  - Procurement organisation
    - If ATCA is selected one could have common requirements with other experiments (e.g. LHCb)
    - Very much willing similar service as for the VME