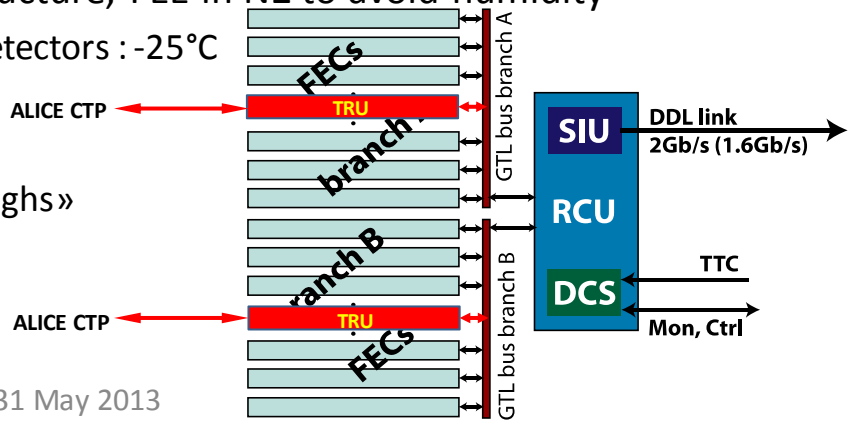
PHOS Upgrade – how to cope with 50 kHz PbPb interction rate

- LoI was submitted in 2012 – main points:
  - Physics: improve capability for measuring prompt thermal radioation by better discrimination against hadrons (mainly anti-neutrons) using TOF cuts;
    - **Q: should the PHOS TDR contain a (short) paragraph on the physics arguments? Seems that the physics arguments will be covered in introductory chapter (?)**
  - Read-out: replace current GTL bus system with point-to-point (P2P) links;
    - Increase R/O bandwidth for higher interaction rate
  - Proposal to build new FEE cards (FECs) with integrated TOF electronics
    - However, this option has been abandoned due to insufficient engineering resources;
    - An alternative under consideration is to add a TOF daughter card to the FEC. However, such an add-on to the FEC must be prototyped and verified, and again there is the question of engineering resources within the LS2 time horizon.
- **Bottom line: PHOS will use common ALICE solutions wherever possible!**

PHOS: current topology and characteristics

- PHOS detector: 4 modules x 3594 PbW crystals with APD photodetectors
- The FEE/Trigger data/trigger/CTRL topology is the same as for EMCal/DCal
- Per PHOS module: 4 RCUs x 2 R/O branches = 8 branches
  - RCU: TPC type, F/W configurable for TPC or PHOS
  - Branch: 14 FEE cards (FECs) + 1 Trigger Region Unit (TRU), interconnected by GTL bus
  - FEE card: 64 x 10-bit ALTRO channels, currently 64 samples at 10 MHz
    - ALTRO bus max R/O bandwidth = 260 MB/s
    - Setup time for one channel readout = 475 ns
    - 25 ns to read out one 40 bit word
    - «Black event» 64 samples x 10 bits per event give 16 · 40 bit data words
      - FEC readout time = setup[64 · 475] · readout[64 · 16 · 25] = 30400 ns + 25600 ns ≈ 56 µs
      - Branch readout time = 14 · 56 ≈ 784 µs
      - Module readout time ≈ 784 µs, all branches can be read out in parallell
    - Branch readout with ALTRO sparse data scan: ≈30µs + readout of non-empty FECs
  - TRU: the 1120 bits hit pattern can be read out as a «fake» ALTRO buffer
- Special: detector module mechanics is gas tight structure, FEE in N2 to avoid humidity
  - Operating temperture for PbW crystals and photodetectors : -25°C
  - RCU is placed on the module bottom plate
  - All power and data signals routed through the module bottom plate with gas-tight «feed-throughs»

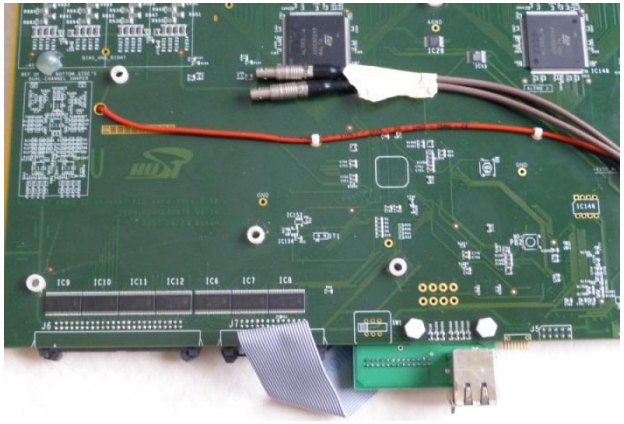


PHOS: LS2 electronics upgrade

- **Baseline: keep current FEE cards, upgrade TRUs to EMCal/Dcal version**
  - **Therefore: no continous readout, local trigger generation**
  - Replace GTL bussed readout with P2P links
    - Number of links per module = 120 (112 FECs + 8 TRUs)
    - Type and functionality: TBD. (EMCal/DCal has an implementation, the Bergen are working on an implementation for TPC, see following pages). Whatever the choice, must co-exist with CRU.
- DAQ / Control : Common Readout Unit (CRU)
  - Q: how to interfaceP2P links to CRU? Electrical / fibre / protocol?
  - Q: or can one use several CRUs per module with X number of P2P inputs?
  - Q: or should one foresee a PHOS specific MPX between P2P links and CRC(s)?
    - If so, can PHOS/EMCal/DCal have a common solution? EMCal/Dcal P2P now based on H. Muller design.
  - Q: what about trigger ?
- PHOS specific CRU capabilities:
  - Suppression: none
  - Data formatting: probably none
  - Trigger selection: none (assuming that PHOS can send L0 / L1 decisions to CTP as now
- CRU Project: see TB 25 April and also file «CRU_Project_23May2013.pdf»
- Other:
  - L0/L1 decisions from all TRUs are OR'ed in a «TOR» unit for single L0/L1 signals to CTP
  - A BUSY Box controls the BUSY time of the PHOS

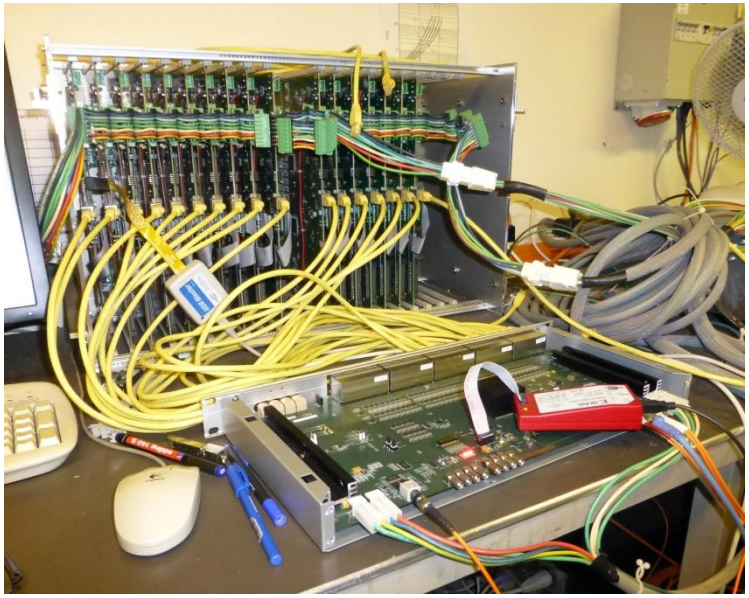
EMCal/Dcal Scalable Readout P2P

The EMCal P2P adapter mounted on a PHOS FEC is shown below. Before answering Werner I had a phone discussion with Hans Muller, who indicated that a modification of the PHOS FEC could be necessary, possibly also for the TRU.



However, to route 120 link cables through the PHOS bottom plate is (probably) out of the question, and there is (probably) not space inside PHOS for the SRU units.

Photo on the right shows setup in the EMCal lab.
A 1U SRU unit has 40 P2P inputs, which means that 3 units would be needed for a PHOS module.



GBT system

- Point-to-point topology
- Bidirectional link 3.2 Gbit/sec
- Three logical channels: DAQ, DCS, Timing and Trigger