Summary of activities

(mainly Compact Processing Module…)

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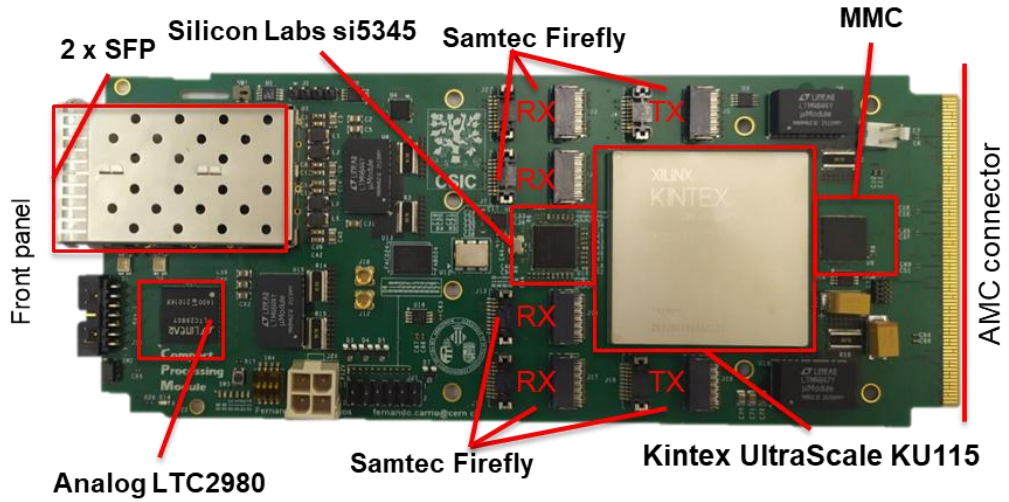
Valencia Tile meeting

Compact Processing Module - Overview

- **Single AMC board** with full-size factor
  - **32 RX channels** via 4 Samtec Firefly
  - **16 TX channels** via 2 Samtec Firefly
  - **Up to 14 channels** via AMC connector
  - **Kintex UltraScale: XCKU115-2FLVA1517E**

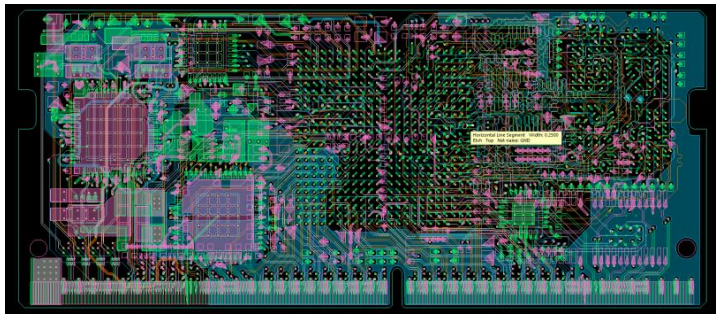
- Procurement status @ Valencia
  - All active components and mechanics for 128 CPMs are on hand (except for a few for v2.3)
  - Received 60% FPGAs for production + 40% procured by South Africa
  - **80% of Firefly modules received**



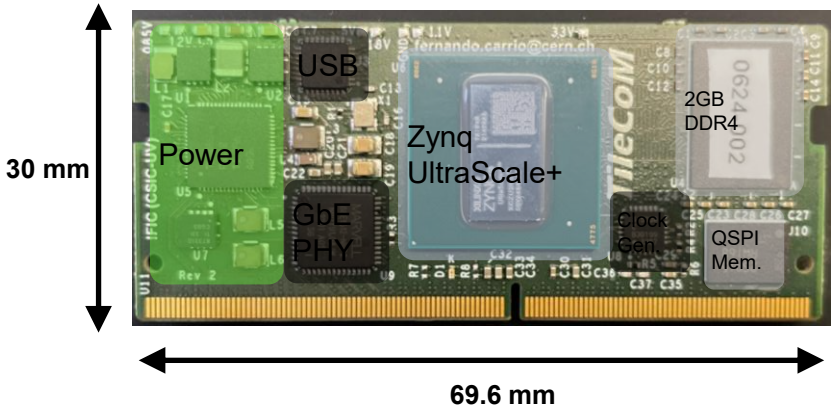
- Received 4 preproduction (v2.3) CPM boards → currently under test
  - Few components not correctly assembled: LEDs and one button
  - Additional batch of 9 CPMs **launched** → complete preproduction + Prometeo
  - Produced 20 PCBs with Panasonic Megtron 6 Halogen Free

Tile Computer-on-Module Hardware

- Custom SoM based on AMD Zynq UltraScale+ ZU2CG device
  - OPC servers for Detector Control System sensors reading
  - Remote front-end FPGA programming
  - CPM and TDAQi JTAG programming and debugging using Virtual Xilinx Cable
  - Acting similar to a SBC, configuration of CPM and front-end electronics
- 4 units of the Preproduction version (v1.3) being/or assembled
  - Expected for this week
- 53 PCBs were produced last December (MOQ).
  - A few will be shipped to SA to test/complete the preproduction in PCB Trax

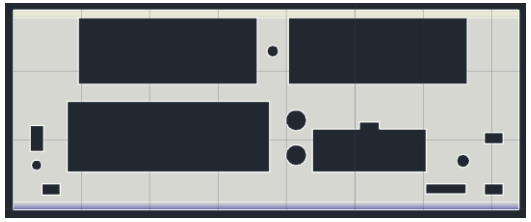


TileCoM v1.3

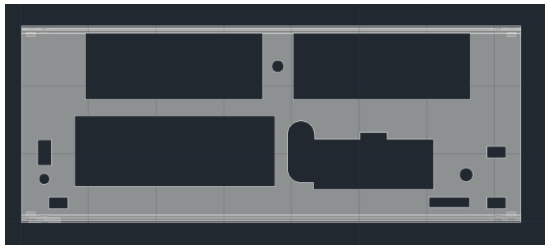


Compact Processing Module - Heatsink Mechanics

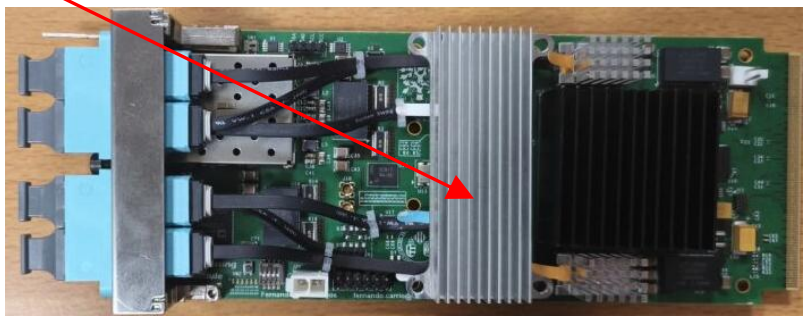
- Front panel design with minor modifications (David in contact with Mechanic workshop)

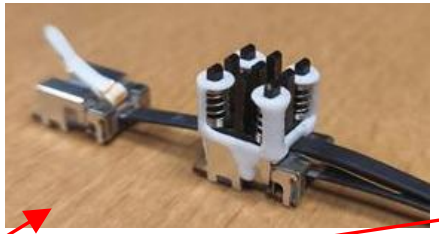


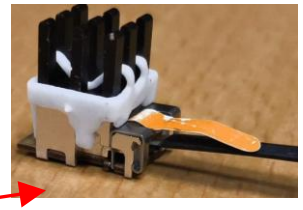
- Strict requirements to keep Firefly operating temperatures below 50°C
- ~~Full heatsink covering Fireflys and/or KU FPGA (v2.1)~~



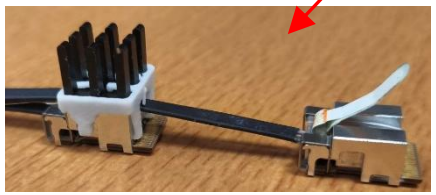
- COTS heatsinks for Firefly TXs(640/640) and FPGA (70/160)
  - **One heatsink covering the 4 Firefly RXs.**
    - Still some risk of applying stress on the PCB + maintenance remains complex





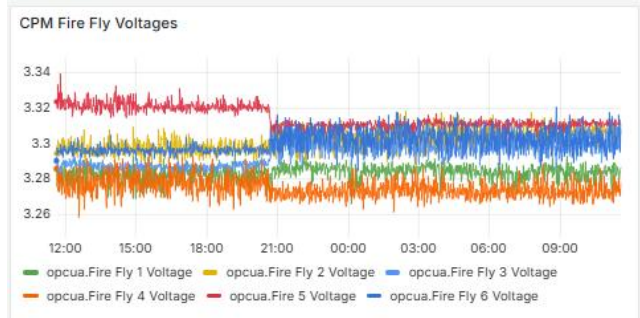


  - **Custom plastic clip for independent heatsinks**
    - No mechanical stress, easy maintenance
    - Thermal performance acceptable
    - Made in PA16 (Nylon)
    - Being tested in 175

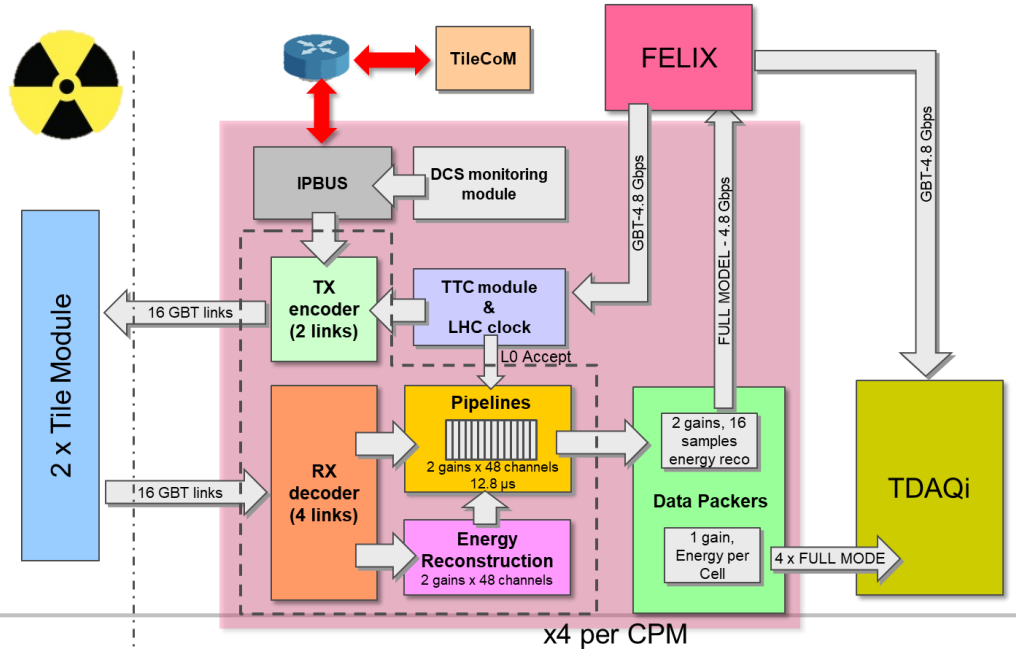


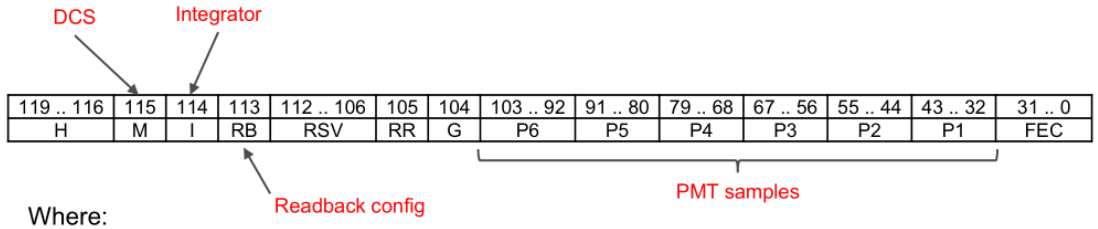
FW: Compact Processing Module

- Most functionalities in place and validated during test beams, VST and Demonstrator
  - 2 link @ 4.8 Gbps to FELIX: TTC and Readout + 1 GbE for IPbus communication
    - LTI - FULL MODE (9.6 Gbps) implemented -> tested with BNL-155!
  - 28 x links to DaughterBoards (4.8/9.6Gbps): **GBT with FEC and new data format**
  - 4 x links @ 9.6 Gbps to TDAQi: FULL mode
  - Remote programming via IPbus for both CPM and DaughterBoards
  - Block to detect corruption in the data samples to be added (stuck bits, spikes, etc)
  - Firmware updates for the DCS readings → Brenton as part of his Master thesis
    - Deployment in P1 by Brenton: Ipbus → IS → pBeast
  - Several firmware updates to extend debugging capabilities



DCS readings via IPbus





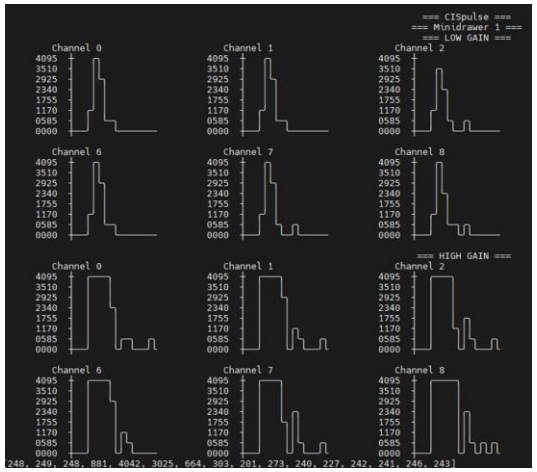
Where:

- H: GBT header.
- M: DCS & monitoring data.
- I: Integrator data.
- RB. Read back commands.
- RSV: Reserved bits.
- RR: Reset Request from the Daughterboard.
- G: FEB gain. 0 is low gain and 1 high gain.
- Px: PMT samples.
- FEC: Forward Error Correction.

BW assigned	Assigned bits	Description/ max requirement
80 Mbps	4	GBT header → Used as returned BCR
80 Mbps	1	DCS monitoring data. It includes a maximum of 100 sensors * 10 Hz * 32-bit words for monitoring of temperature sensors, voltages and currents.
80 Mbps	1	Integrator data. It includes a maximum of 6 PMTs * 200 Hz * 32-bit words
80 Mbps	1	Read back of MB and DB registers
80 Mbps	1	Reset Request from the DB
80 Mbps	1	High and Low gain identifier
5.760 Gbps	72	PMT readout data
2.56 Gbps	32	Forward Error Correction

Software tools

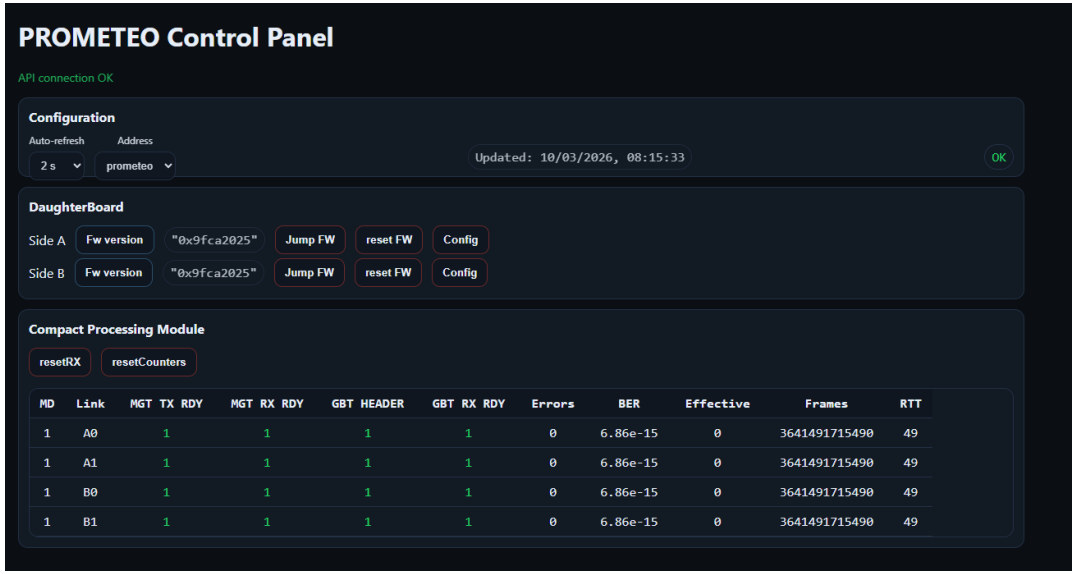
- Software ecosystem continuosly evolving and growing up: Demonstrator, Prometeo, Vertical Slice Tests
- Online libraries for the CPM: TROOPER libraries https://gitlab.cern.ch/fcarrio/tropper-libraries/-/tree/master
  - C++ libraries for TDAQ, also compiled as *.so* python libraries. Cmake, Make
- PrometeoPy application using them: https://gitlab.cern.ch/fcarrio/prometeopy



PrometeoASCII with Trooper libraries

Grafana@ testbeam using pBeast + IS

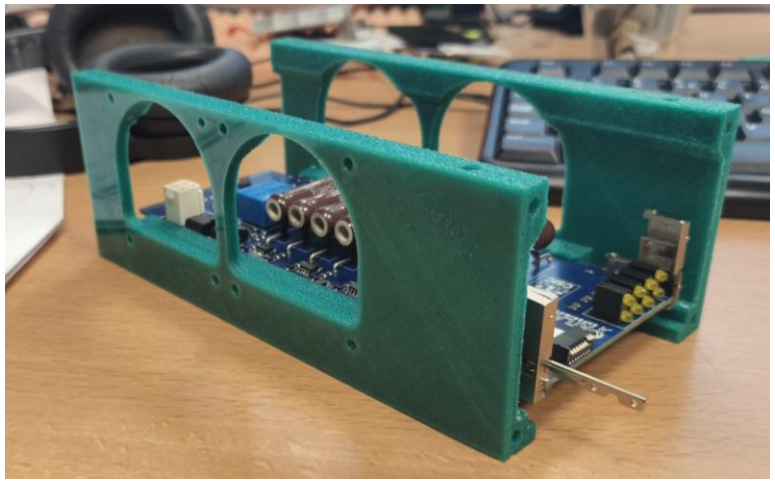
- Preliminary software for DCS monitoring for the Demonstrator (Filipe, Brenton, Mpho)
  - Publishing into ATLAS IS -> pBEAST -> Grafana
  - OPC UA developments in parallel for Phase -II
- Control Prometeo Web panel
  - Control and monitoring of links
  - Fw loading and initialization

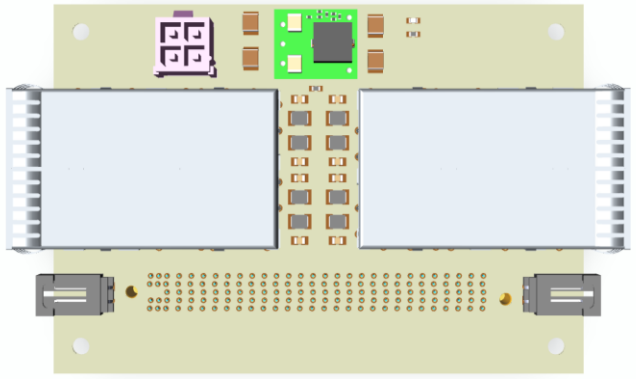


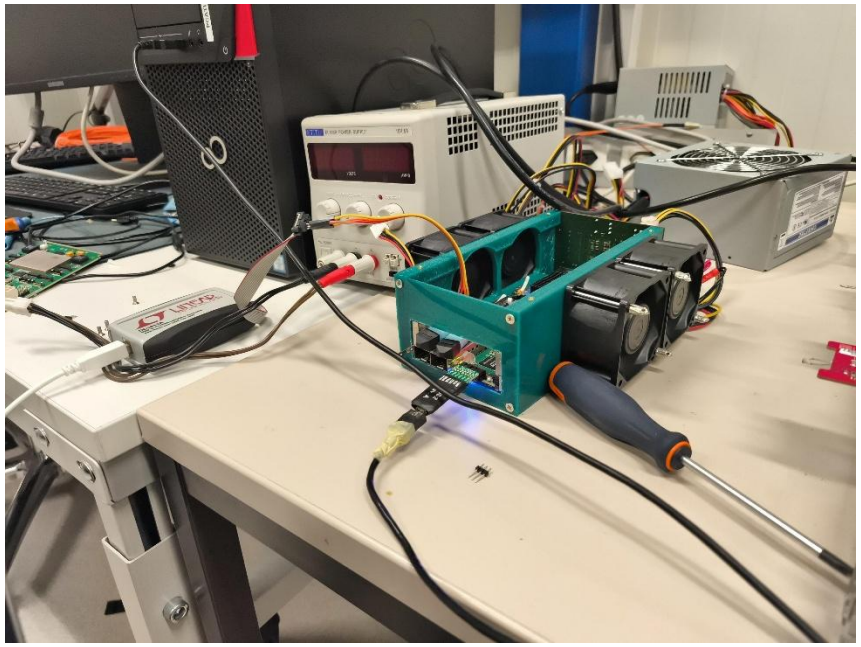
Control Prometeo Web panel

Miscelaneous: Hardware developments for production tests

- 3D support for on-table test benches + Ethernet backplane -> Fully working
  - Support with built-in guidelines
  - Four 60 mm x 60 mm fans screwed into the support
  - Backplane with 4 SFP and providing power to CPM and fans

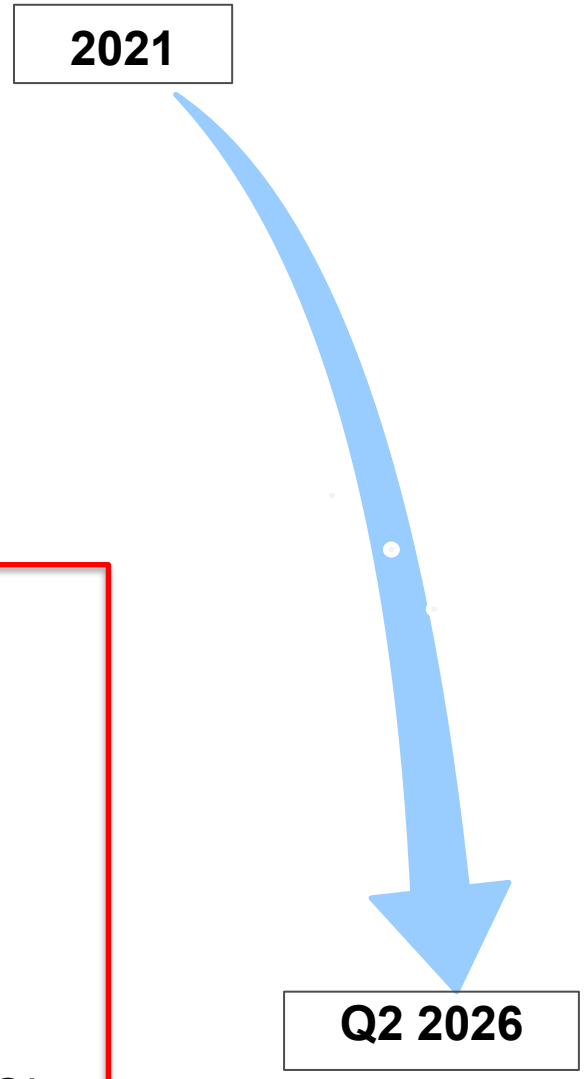






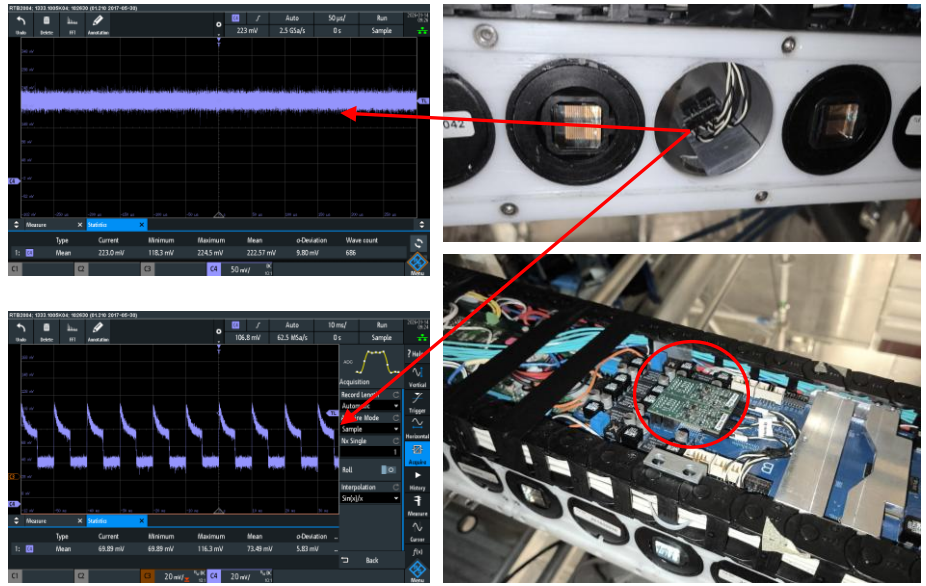
Plan towards the PRR

- PDR and FDR designs fully validated
  - All designs largely frozen before FDR, with no major issues identified
- Initial integration tests between CPM, Carrier, TDAQi
  - Home institutes, test beam area, Demonstrator
  - *GbE connection with TileCoM not fully validated in the carrier*
- Thermal tests completed in 2023 in SR1
    - Full system validated under worst-case thermal conditions
- Firmware and software quite advanced
- PreProduction of boards
  - TileCoM, GbE switch → Ongoing Valencia/SouthAfrica
  - ATCA carrier boards → VLC, 4 boards almost validated
  - Compact Processing Modules → VLC, 4 units under test
    - 9 more to be assembled in February/March
- Preproduction validation at home institutes during Q4'25-Q2'26
  - Definition and description of acceptance and validation tests
  - Functionality and stress tests to be done
- Additional integration tests at CERN: CPM + Carrier + TileCoM + TDAQi



Bonus

- Environmental sensors installed in the Demonstrator as a candidate system for Phase-II
  - System controlled from Daughterboard GPIO pins and readout using XADC
  - Analog signal conditioning for temperature (PT100) and humidity (polymer) using INA333
  - Sealicon FGDOS for TID + Dickson bridge to charge it (20V)
    - Two sensors: 0-10 Gy and 0-50 Gy with 8-bit resolution
  - 2 sensor boards equipped in MD4, where probes has been installed in PMT hole 44
- Control of I2C and SPI lines from remote CPM via IPbus
  - Propagation signals via GBT protocol over fiber at 4.8 Gbps
  - 2 × SPI interfaces and 2 × I2C interfaces
  - LED trigger with LEMO
  - Fully working now



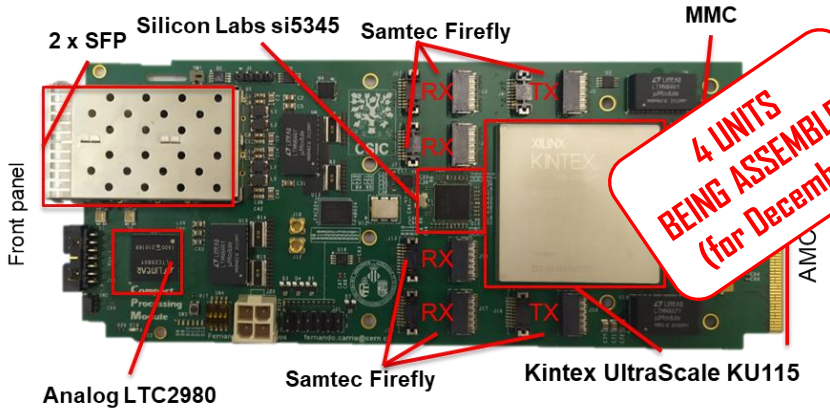
TileSensor board v1.0

Tile GBTx board

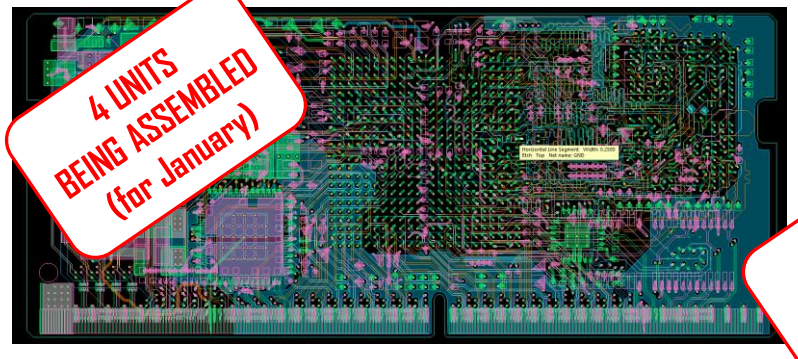
BACKUP

HW: Hardware developments

- Revision 2.3 of the CPM
  - Single AMC board with full-size form factor
  - 6 x Samtec Firefly
  - XCKU115-2FLVA1517E

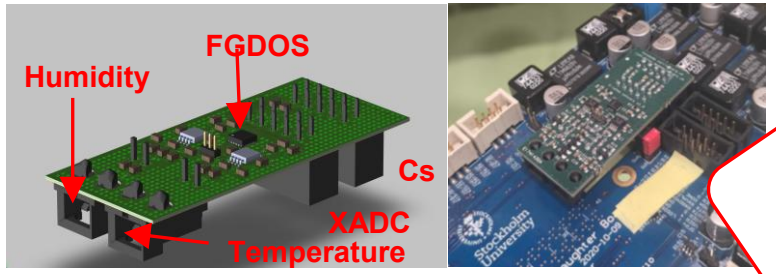


- Rev 1.3 of the TileCoM
  - SODIMM-240pin: 6.7 cm x 3 cm
  - 10 layers, 1 mm thickness, with 251 components



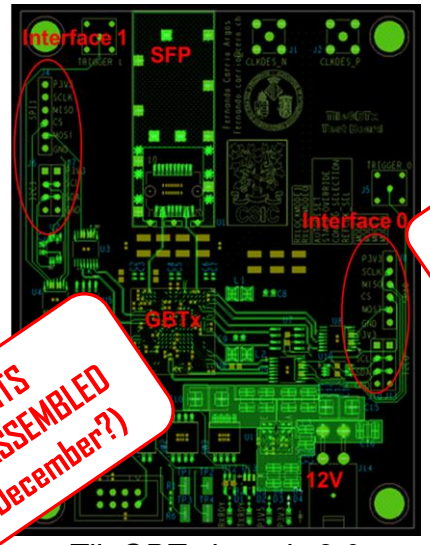
TileCoM v1.3

- Sensing environment conditions inside the TileCal modules
  - Analog signal conditioning for temperature (PT100) and humidity (polymer) using INA333 + Total Ionazing Dose (TID) sensor



TileSensor board v1.0

- Optical GBT-GPIO expander
  - Remote control of the HV and LED drivers from CPM



TileGBTx board v2.0

- Plastic support for on-table test benches + Ethernet backplane
  - Support with built-in guidelines
  - Four 60 mm x 60 mm fans
  - Backplane with 4 SFP and power distribution