



# **MicroTCA Evaluation and Developments in the CERN PH-ESE Group**

**MTCA Workshop for Industry and Research  
DESY, 11. December 2012**

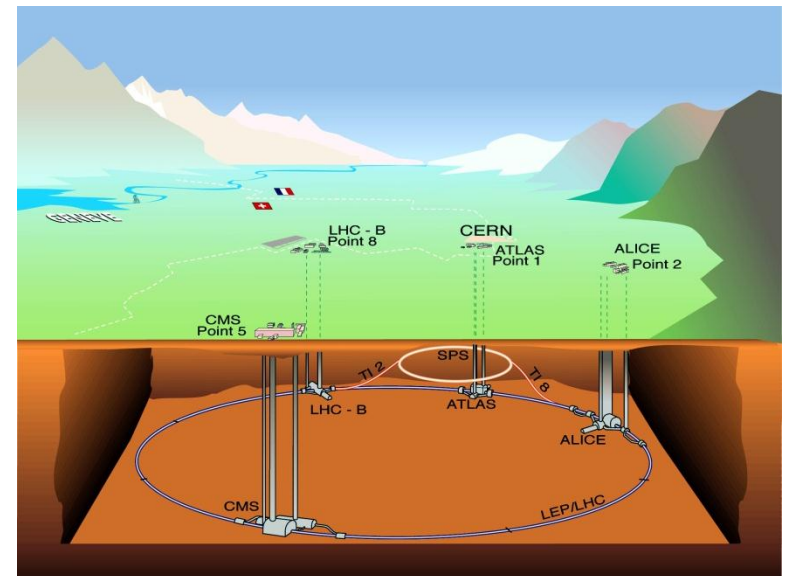
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# Outline

- **Introduction**
- **CERN PH-ESE MicroTCA evaluation project**
  - Evaluation of commercial MicroTCA equipment
  - MicroTCA developments
    - MMC mezzanine
    - AMC and RTM load modules
  - MicroTCA power supply testing
- **Gigabit Link Interface Board (GLIB)**
  - Architecture
  - Hardware
  - Applications & status
- **Summary**

# Introduction

- Major upgrades of the LHC experiments at CERN are foreseen over >10 years
  - Aligned with LHC upgrade long shutdowns: 2013/14, 2018, 2023
- Off-detector electronics of the LHC experiments mostly based on VME
  - Working very reliably
  - “Old” technology and doubts about long-term availability
- Experiments planning to use MicroTCA & ATCA for upgrades of their back-end electronics
  - MicroTCA: CMS
  - ATCA: LHCb & ATLAS
- xTCA advantages
  - Choice of form factors
  - Backplane bandwidth and protocols
  - Cooling and power supply
  - Redundancy (PSU, cooling)
  - Infrastructure monitoring features
- MicroTCA and ATCA developments already on-going at CERN and collaborating institutes
- Accelerator sector is also investigating MicroTCA
  - Front-end controller upgrade and linear collider project (CLIC)



# xTCA Evaluation Project

- **Electronic Systems for Experiments (PH-ESE) group at CERN**
  - Custom electronics design services for the experiments
  - Centralized services and support for modular electronics, instrumentation and power supplies
- **MicroTCA evaluation project in CERN PH-ESE group launched in 2011**
  - Technical evaluation of components for MicroTCA and MTCA.4 systems
  - Development of tools (H/W and S/W) for the testing of commercial components
  - Conduct market surveys
  - Report results (e.g. to the [xTCA Interest Group](#))
- **Recently expanded the evaluation project to also include ATCA**
- **Focus is on xTCA infrastructure components**
  - Shelves and power supplies (electrical and cooling performance)
  - Shelf management
- **Keep close contact with the xTCA development projects in the experiments**
- **Longer term goal**
  - Try to standardize MicroTCA and ATCA shelves and power supplies at CERN
    - Could be difficult because many options (backplanes, cooling, RTMs, power supply, ...)
  - Define acceptance test procedures
  - Provide centralized support for these items

# Commercial MicroTCA Equipment

- **Equipment acquired & evaluated**
  - Vadatech 12 slot MicroTCA shelf (VT892)
  - Schroff 6 slot MTCA.4 shelf
  - Kontron MCH (with PCIe switch)
  - NAT MCH (with PCIe switch)
  - Kontron processor AMC (AM5030)
  - Concurrent Technologies processor AMC (AM310)
  - ELMA AMC load module
  - ESD ADIO-24 AMC
  - Polaris Networks xTCA tester S/W
- **Evaluation results**
  - Built up working systems using components from different vendors
  - Successfully integrated in-house designed AMC modules
  - Developed MicroTCA expertise in the section and disseminated results via the xTCA interest group
  - Many (mostly minor) interoperability problems encountered (IPMI related)
  - Components providing the same function (e.g. shelf or MCH) can have very different features and user interfaces (S/W)
  - Many options and possible customizations
    - Cooling, PSUs, data transfer protocols, backplane topology, ...



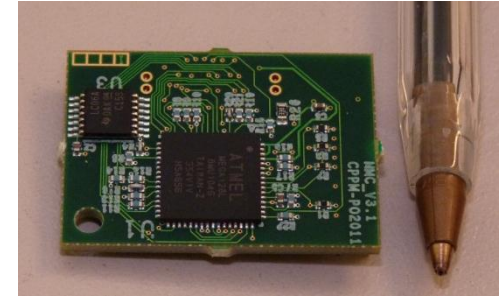
Vadatech shelf



Schroff shelf

# MMC & Tester AMC Development

- **MMC hardware**
  - Based on design from CPPM/Marseille
  - Small production made (<100)
  - Used on AMCs developed in-house
  - Distributed to external users
  - Plan to also turn into reference design for integration directly on an AMC module
  - Proposed as a standard for AMC designs in ATLAS
- **MMC software**
  - Based on code received from DESY
  - Clean split between generic and module specific code
  - RTM support tested with MMC tester and RTM load module
  - Code available in CERN SVN repository
- **MMC tester AMC**
  - MMC debugging & S/W development
  - On-board sensors, LEDs and test points
  - RTM emulation



MMC mezzanine

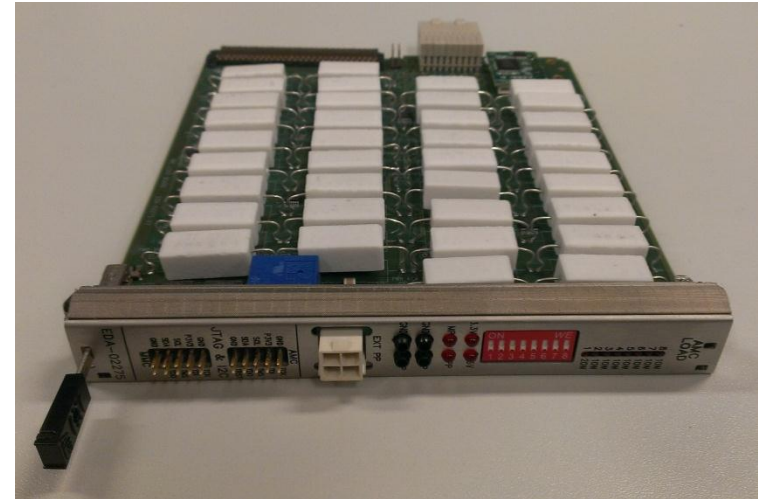


MMC test AMC

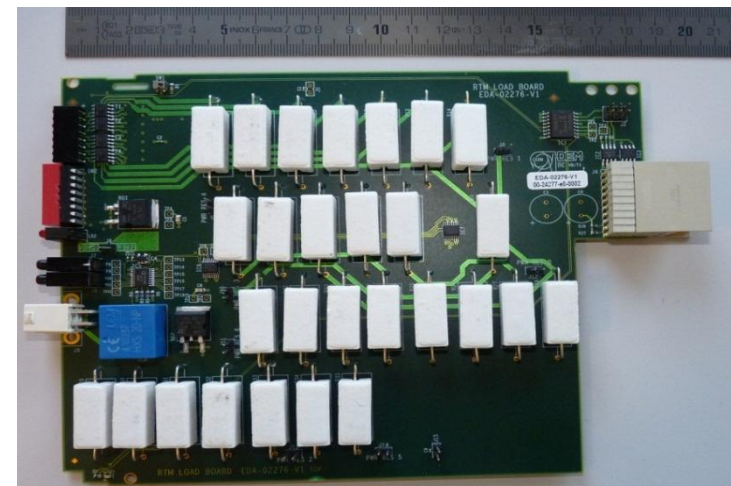


# AMC & RTM Load Development

- AMC and RTM load modules developed in-house
  - Based on switched resistive loads
  - Control via MMC or front-panel
  - Temperature monitoring to evaluate cooling performance
- Produced enough modules to fully populate and load a 12 slot MicroTCA shelf
- Enables comprehensive power supply and cooling performance measurements



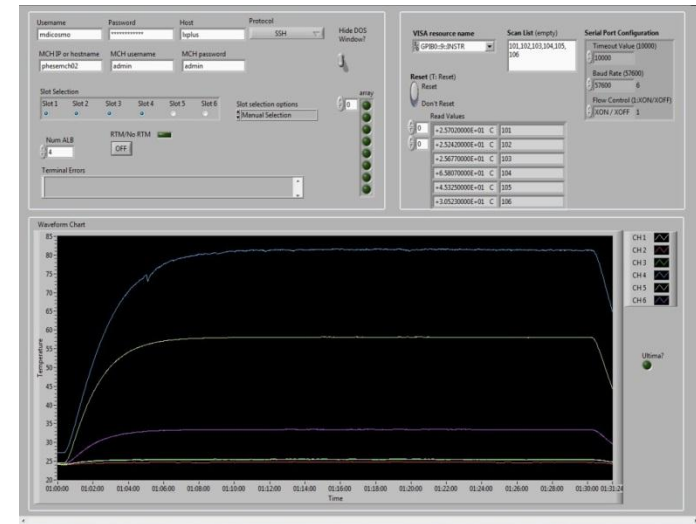
AMC load board



RTM load board

# MicroTCA Power Supply Testing

- **Electrical tests**
  - Static load tests: payload voltage versus load
  - Dynamic load tests: payload voltage for load step
  - Payload voltage ripple
  - PSU efficiency test
- **Thermal tests**
  - On-board temperature gradient
  - Slot temperature variation
- **Labview GUI to control load modules and acquire measurement results developed**
- **Initial tests with Schroff 6-slot MTCA.4 shelf**
  - Small voltage variation under load and ripple
  - Efficiency ~85%
- **Tests with 12-slot Vadatech shelf on-going**
  - No RTM support
  - Requires 2 power modules under full load (12 x 80W) and external AC/DC supply



Labview GUI



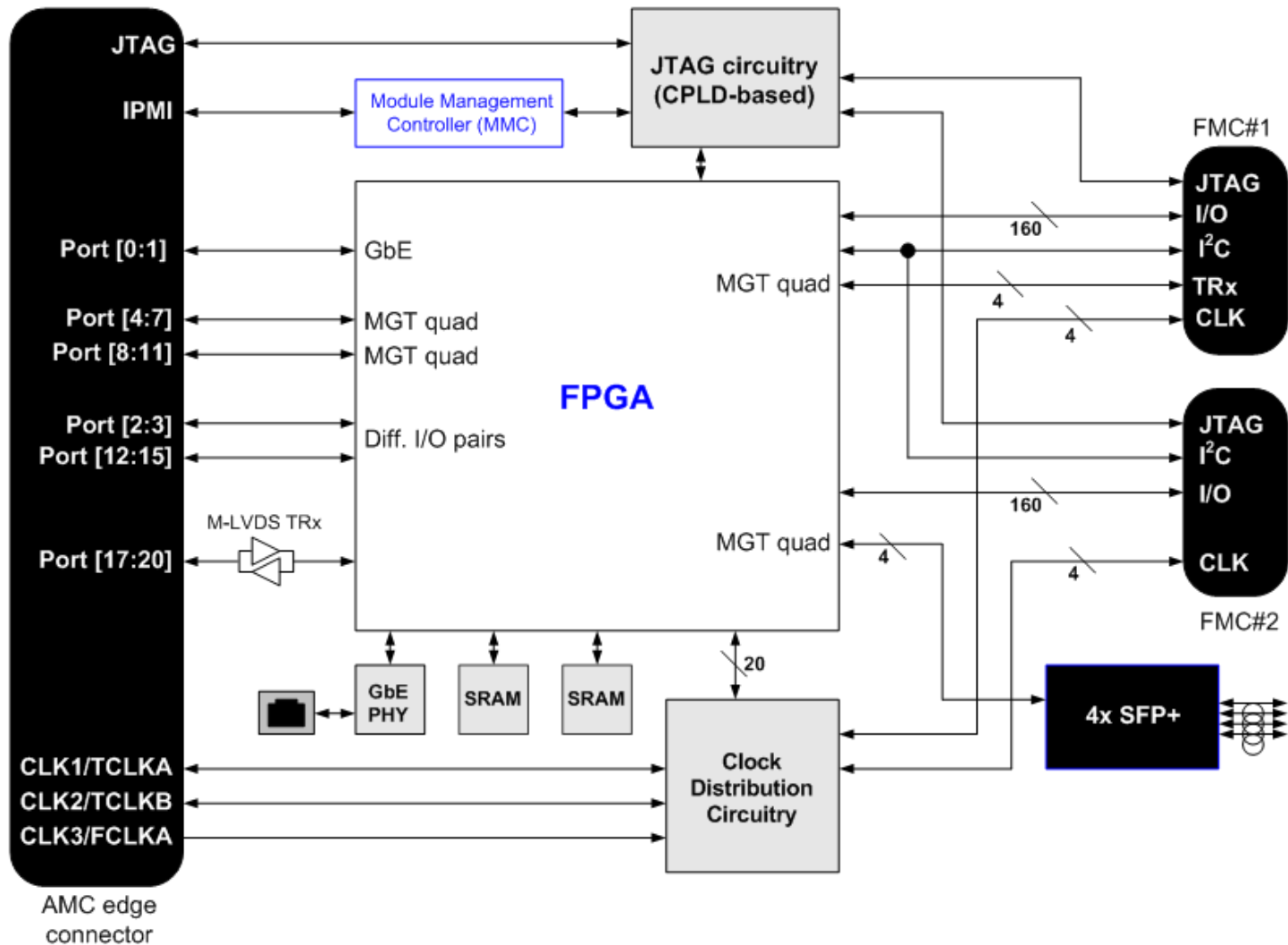
Test setup with Vadatech shelf



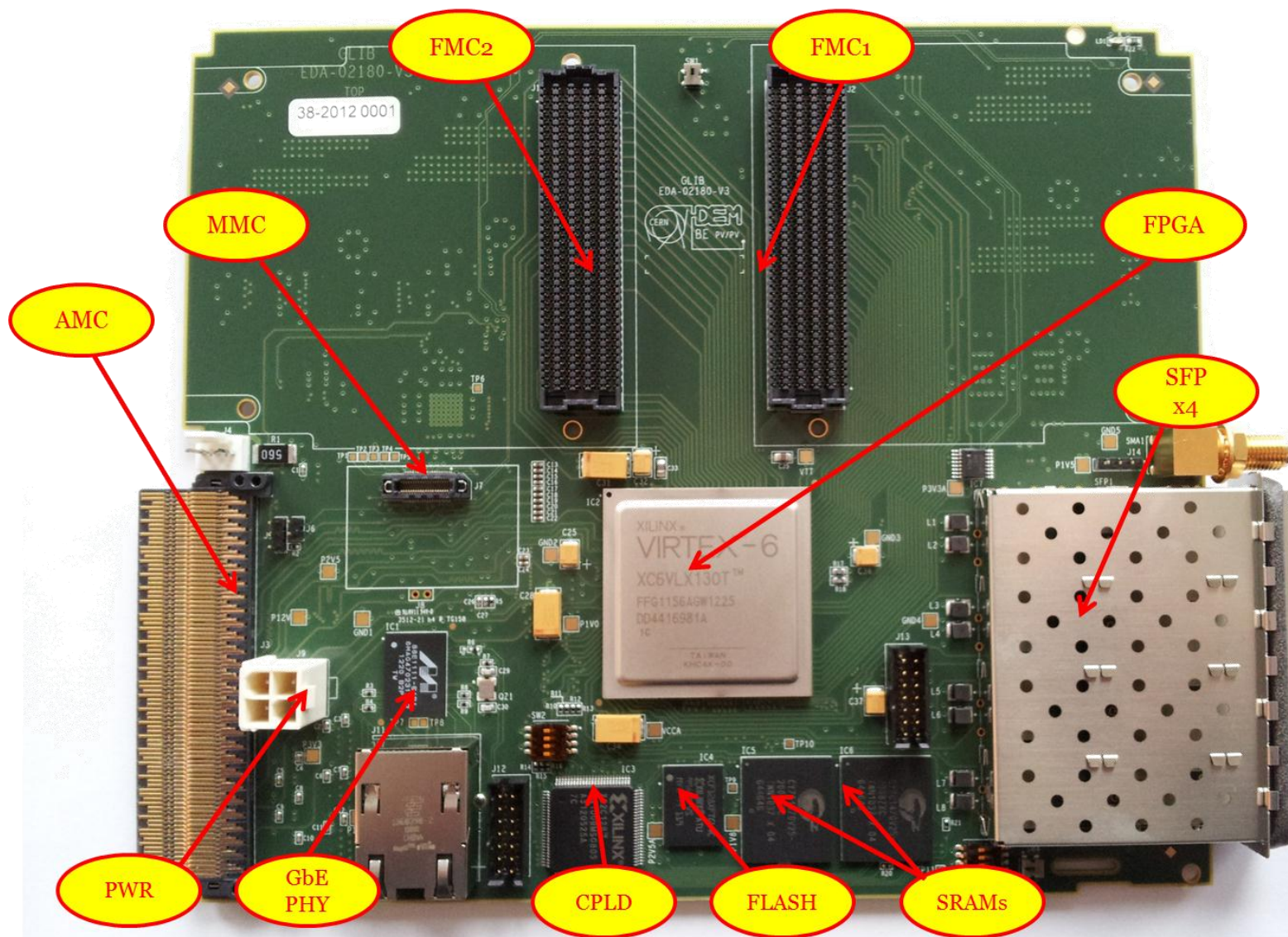
# Gigabit Link Interface Board (GLIB)

- **Features**
  - Mid/full-size double-width AMC
  - 4 on-board SFP+ transceiver modules
  - I/O extension via 2 FMC slots (HPC)
    - Commercial or in-house developed FMC mezzanines
  - Virtex-6 FPGA (XC6VLX130T)
  - Flexible clock distribution
  - Copper GbE PHY for bench-top operation
  - 2 on-board 72 Mb SRAM chips
  - Control via Ethernet or PCIe
- **Applications**
  - Flexible FPGA-based module for high speed optical links in high energy physics experiments
  - Optical link evaluation in the laboratory
  - Control, triggering and data acquisition in beam or irradiation tests
  - Bench-top setup or in MicroTCA crate

# GLIB Architecture

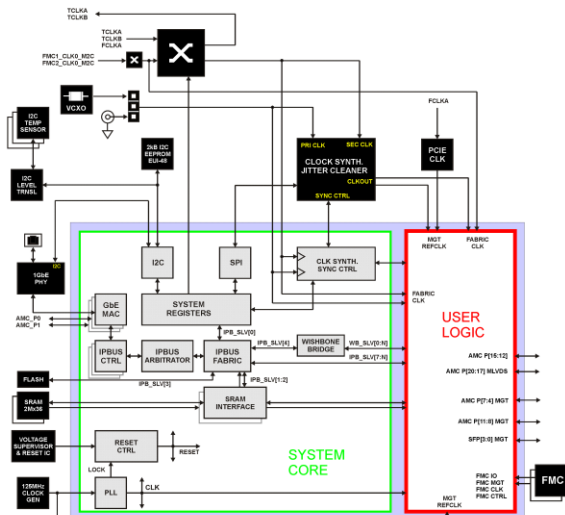


# GLIB Hardware

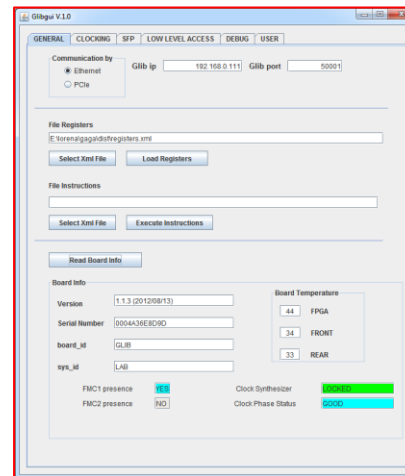


# GLIB Ancillary Developments

- **Firmware**
  - Common firmware framework developed
  - Clean separation between common and user specific parts
- **GLIB GUI**
  - Java based graphical front-end to control and monitor the common GLIB configuration and status registers
- **TTC FMC**
  - Interface to the Trigger, Timing and Control (system) of the LHC experiments
  - Optical input and Clock & Data Recovery (CDR), protocol in GLIB FPGA



Firmware



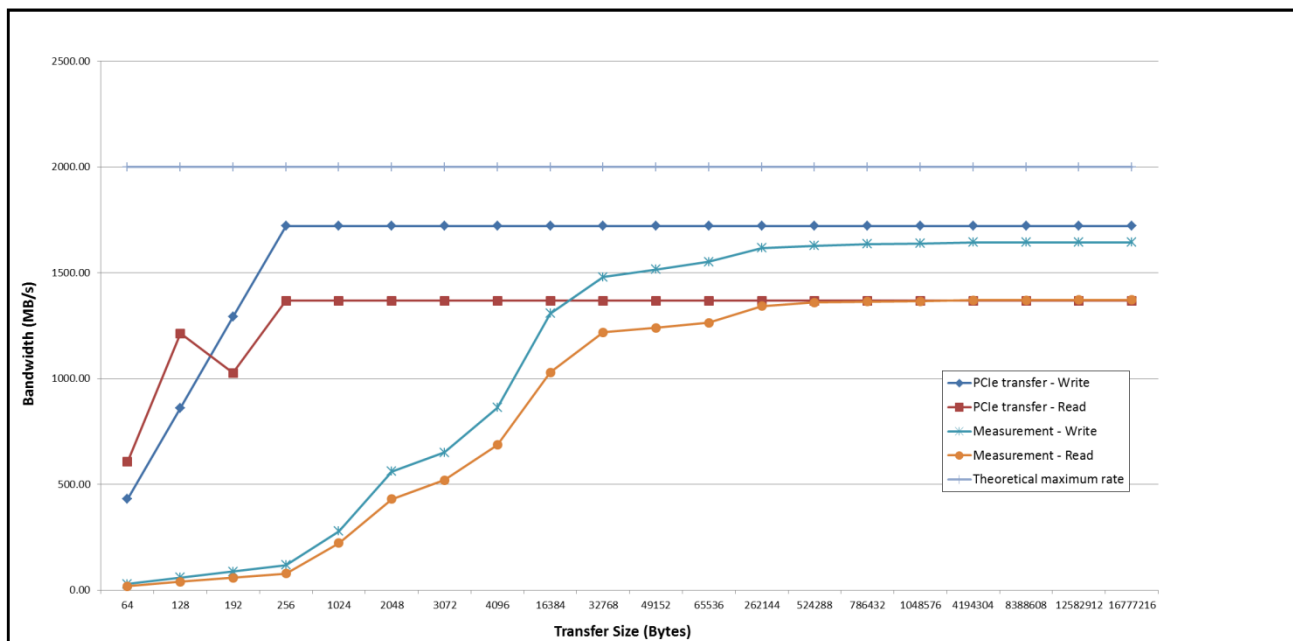
GUI



TTC FMC

# GLIB Status

- Production version fully tested and working
- ~50 modules produced and partly distributed to outside users
- Strong interest from all LHC experiments
  - Users in CMS, ATLAS, LHCb & ALICE
- Used to interface to the radiation-hard optical link and ASIC chipset (GBT) developed for the LHC experiment upgrades
- PCIe GEN2 x4 DMA bandwidth measurements in MicroTCA shelf
  - Kontron processor AMC <-> MCH <-> GLIB AMC





# Summary

- **xTCA evaluation project on-going in the CERN PH-ESE group**
  - Focus on infrastructure components
  - Shelves and power supplies (electrical & cooling performance)
  - Shelf and module management
- **Commercial MicroTCA equipment acquired and evaluated**
  - Shelves, MCH, power modules, processors AMCs
- **MMC mezzanine card and controller software available**
- **AMC and RTM load modules developed for power supply tests**
- **Comprehensive MicroTCA power supply tests on-going**
- **Recently expanded project to include ATCA**
- **Future plans for MicroTCA**
  - Continue evaluation program
  - Attempt to standardize MicroTCA and ATCA shelves and power supplies at CERN
- **GLIB AMC**
  - Flexible FPGA based module for optical link applications in HEP experiments
  - Double-width, mid/full-size AMC, expandable through 2 FMC sockets
- **Strong interest from the experiments**
- **Production modules available**
- **Custom designed FMC modules available**
- **Development framework available (firmware, software, GUI)**