Update on the ATCA/AMC readout cards for LHCb

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Outline

- Reminder: Readout Boards
- Main features for:
  - AMC40 board
  - ATCA40 board
- Summary
Reminder: Readout Board

Flexible and reconfigurable carrier board

144 optical links:
- 96 GBT links
- 48 10GbE links

Diagram showing the configuration of the readout board with various components and connections.
AMC40 main features
AMC40 boards history

First prototype AMC_V0

- Based on Stratix V GX Engineering Sample
- Card received in June 2012
- Issues on PCIe not correctable on initial version

Second prototype AMC_V1

- Based on Stratix V GX Production version
- Same design as AMC40_V0:
  ➪ few bugs fixed
  ➪ new stackup to avoid potential crosstalks issues
- Card received 8 March 2013
AMC40 test setup

Use of a specially designed AMC_TP (Test Pad) board

Provides:

- Power supply
- Clock input
- Serial links loopback on AMC connector
- Same COM express module (CCPC) as ATCA40 to control the board through PCIe
Optical links at 4.8 Gbits/s - AMC40

✔ GBT optical links
- Loopback test at 4.8 Gbits/s over 10 meters of OM3 optical fiber
  ➔ Bit Error Rate better than $10^{-16}$

- Test OK at 4.8 Gbits/s over 400 meters of OM4 fiber with Versatile Link prototype (tested at CERN December/2012)
  ➔ Margin better than 9.5 dB
Optical links at 10 Gbits/s  – AMC40

✔ 10 GbE optical links
  - Test OK at 10.3125 Gbits/s over 10 meters of OM3 optical fiber
    ➤ Bit Error Rate better than $10^{-16}$
  - Test OK at 10.3125 Gbits/s minipod loopback over 400 meters of OM4 fiber
    (tested at CERN December/2012)
    ➤ 6 hours test without error → BER < $4.6 \times 10^{-15}$
    ➤ Margin better than 10dB
ATCA40 main features
**ATCA40 prototype**

2 boards produced in December 2012
Slow control: GbE & PCIe on ATCA40

COM Express Module

- Modified Scientific Linux kernel version 6.2 - Remote booting through GbE Ethernet network (~120s)

PCle to Cyclone IV: Direct link from “COM Express module”
PCle to Stratix V: on AMC40 board through local PCIe switch
Serial links on ATCA40 (loop-back AMC1 slot)

Crosspoint programming from Cyclone IV GX

3.2 Gbits/s (TFC) and 6.4 Gbits/s (X-FPGA) loopback link between Stratix V GX AMC40 through crossbar

\[ \text{BER better than } 10^{-16} \]

* Serial links ATCA to ATCA not yet tested (3.2 Gbits/s)

<table>
<thead>
<tr>
<th>Speed</th>
<th>No pre-emphasis</th>
<th>With pre-emphasis</th>
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<tbody>
<tr>
<td>3.2 Gbits/s</td>
<td>Eye width = 0.73 UI</td>
<td>Eye width = 0.74 UI</td>
</tr>
<tr>
<td>6.4 Gbits/s</td>
<td>Eye width = 0.19 UI</td>
<td>Eye width = 0.47 UI</td>
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IPM interfaces on ATCA40

MMC: Design is fully embedded on the AMC40 board
CPPM & P. Vischoudis and V. Bobillier (CERN)

Software (IPMI – PICMG 3.0):

MMC (DESY & CPPM):
- Operational & tested (μTCA)

CIPMC (LAPP) to:
- Shelf Manger (Pigeon Point Solution): Operational & Tested with ATCA40.
- MMC: In progress (Sept 2013)

CIPMC: based on a development made by the LAPP for ATLAS
Summary

- **AMC40:**
  - Generic board dedicated to the High speed serial links
    - 10GbE & 4.8Gbit/s (GBT)(optical links)
    - 6.4 Gbit/s & 3.2 Gbit/s (internal links)
    - Embedded MMC functionality

- **ATCA40:**
  - ATCA carrier for AMC boards – Communication matrix
    - High speed link routing function (crossbar)
    - Slow control (GbE & PCIe protocols)
    - Full IPM interface (ATCA carrier application)