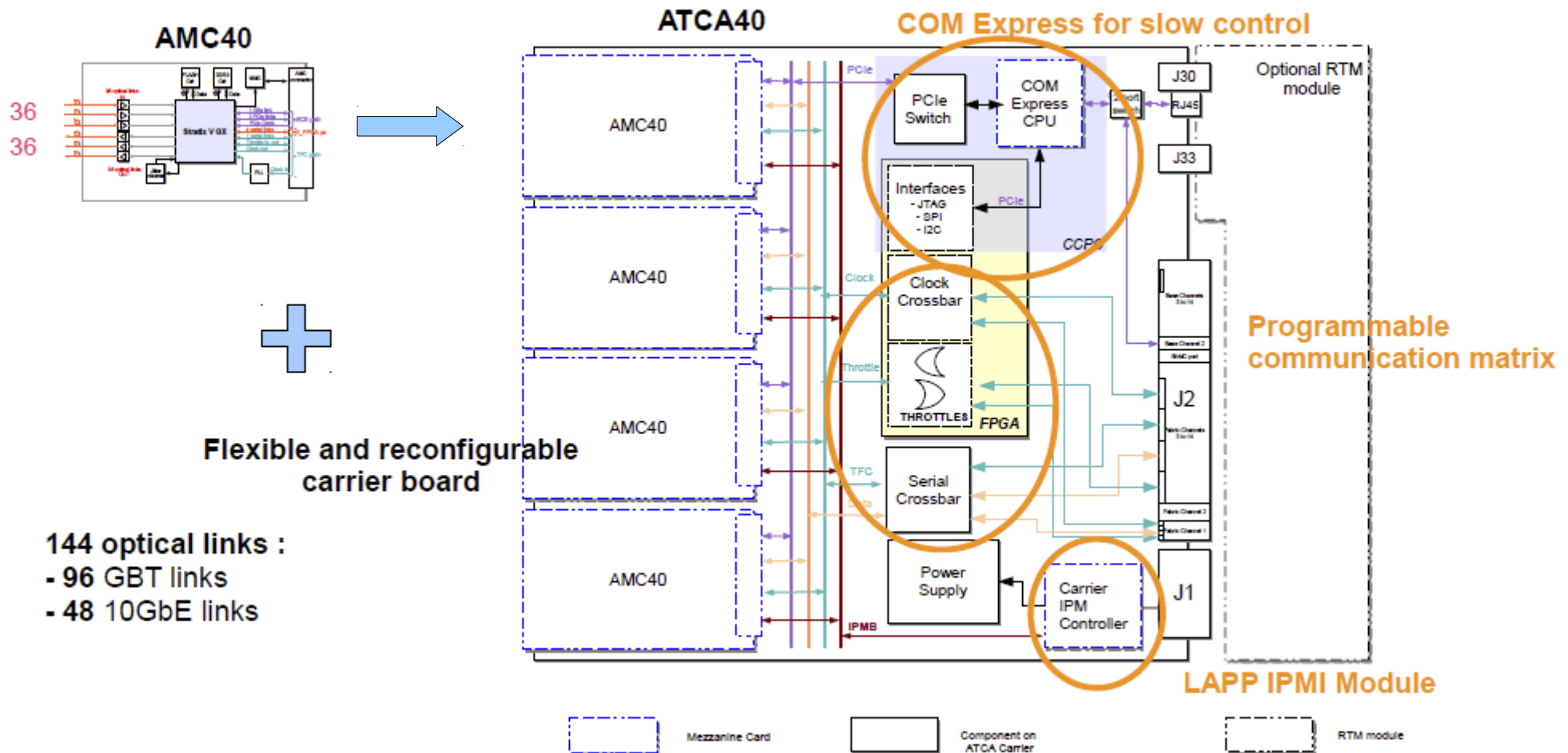# Update on the ATCA/AMC readout cards for LHCb

J.P. Cachemiche, P.Y. Duval, F. Hachon
R. Le Gac, **F. Réthoré**

Outline

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

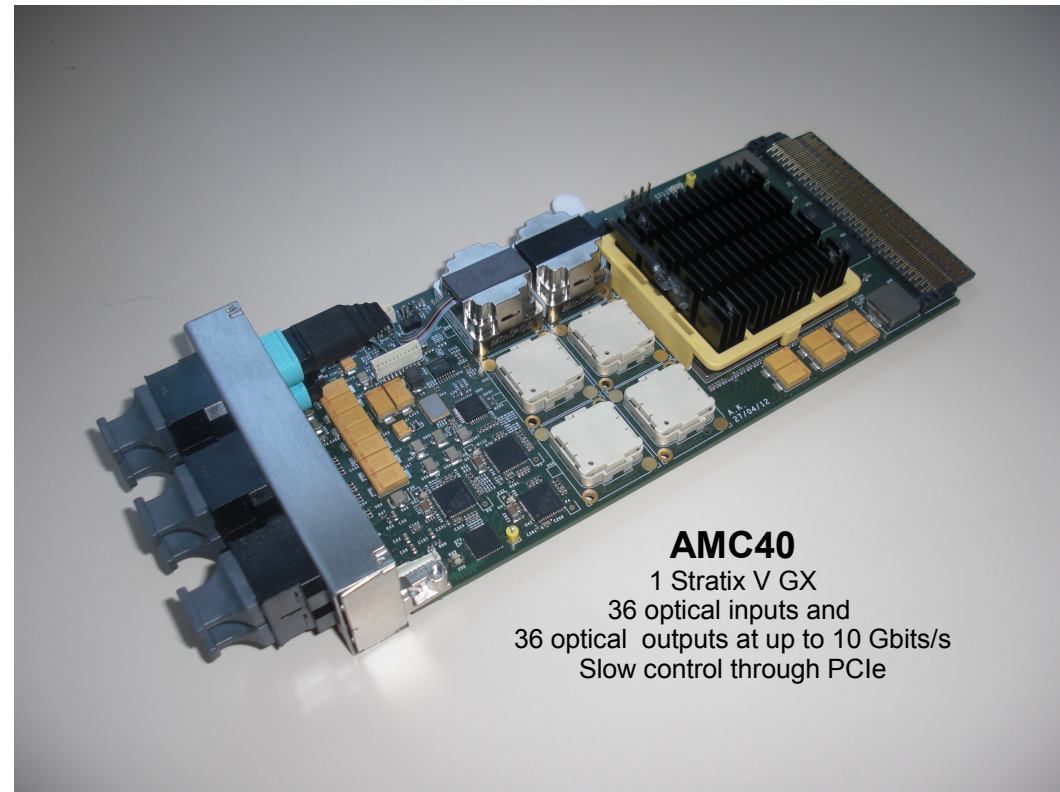# Reminder: Readout Board

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*
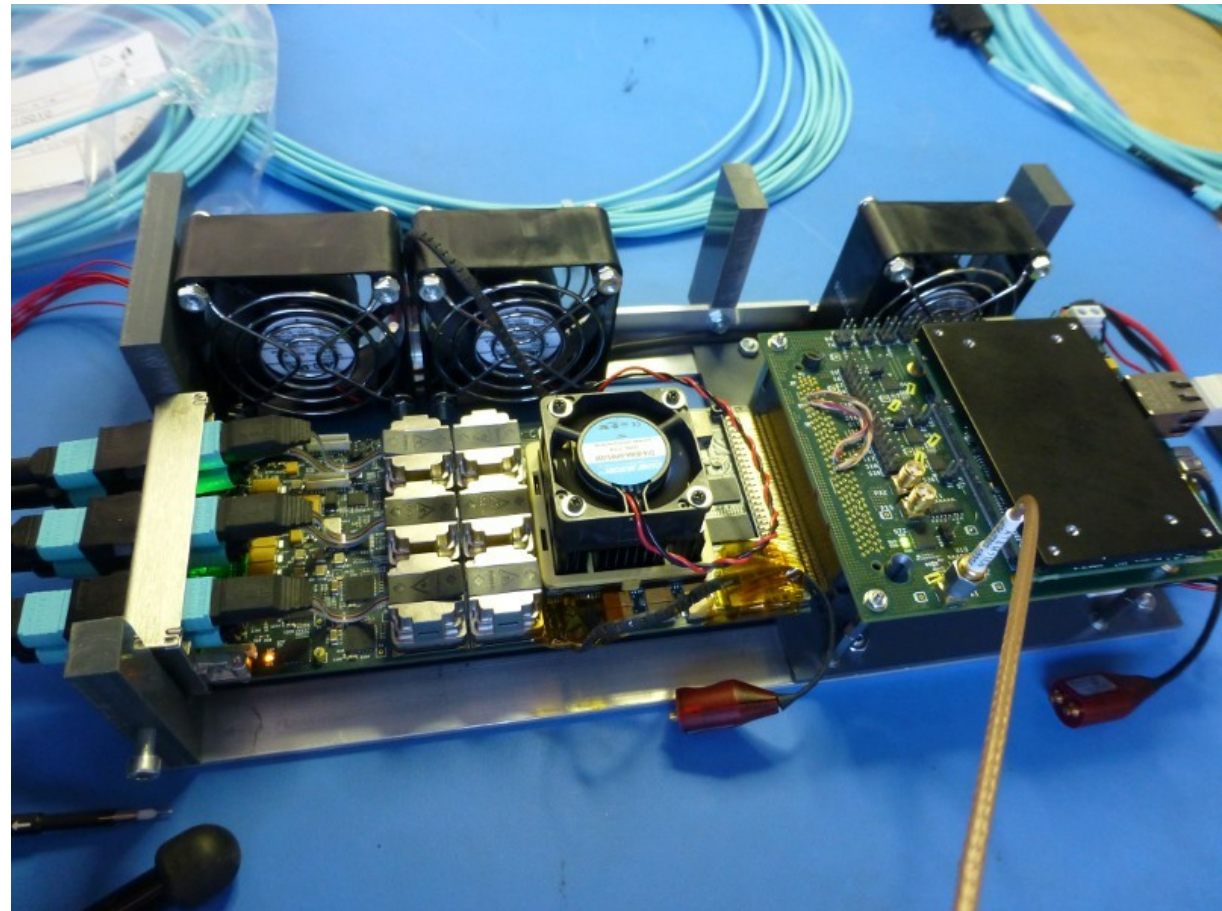- Card received 8 March 2013

AMC40
1 Stratix V GX
36 optical inputs and
36 optical outputs at up to 10 Gbits/s
Slow control through PCIe

AMC40 test setup

Use of a specially designed AMC_TP (Test Pad) board
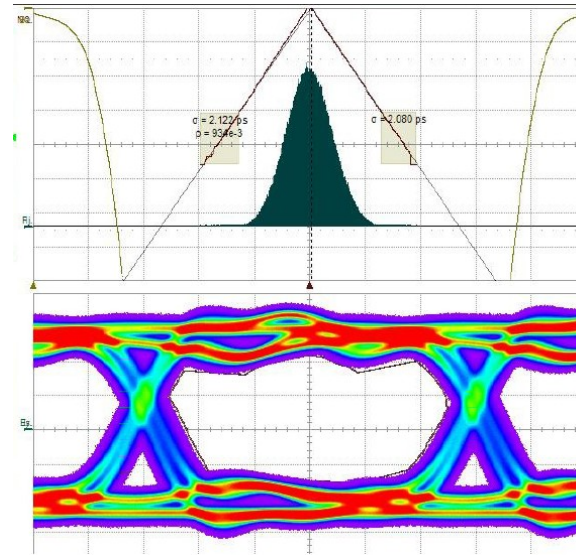
Provides :

- 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

@4,8 Gbit/s :
Total Jitter ≈ 56 pS
Random Jitter ≈ 2,4 pS
Deterministic Jitter ≈ 24 pS
aperture : 0,65 UI@10^{-16}

✔ **GBT optical links**

- Loopback test at 4.8 Gbits/s
  over 10 meters of OM3 optical fiber
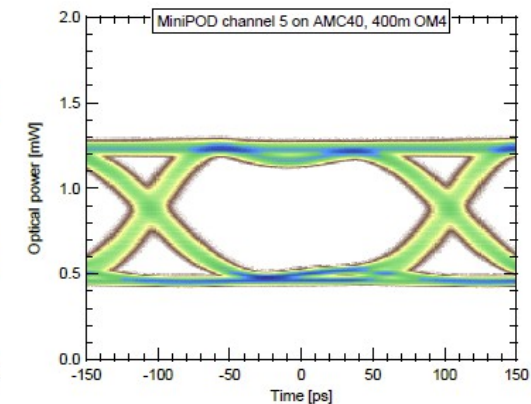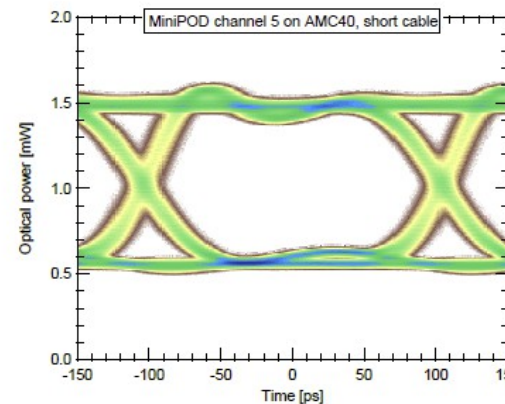 ➜ *Bit Error Rate better than 10^{-16}*

- Test OK at 4.8 Gbits/s **over 400 meters of OM4 fiber with Versatile Link prototype** (tested at CERN December/2012)
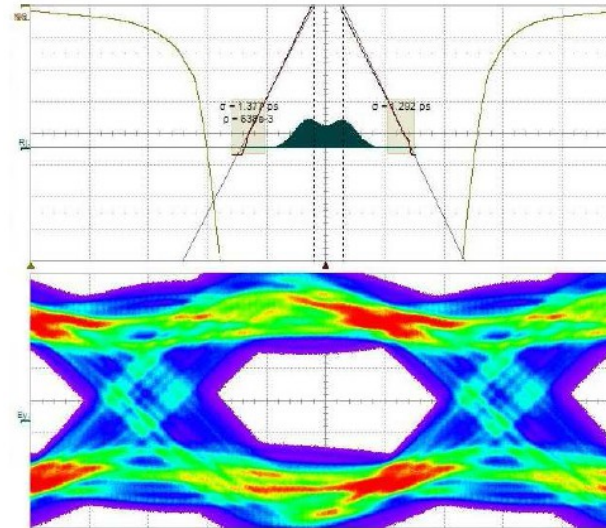 ➜ *Margin better than 9.5 dB*
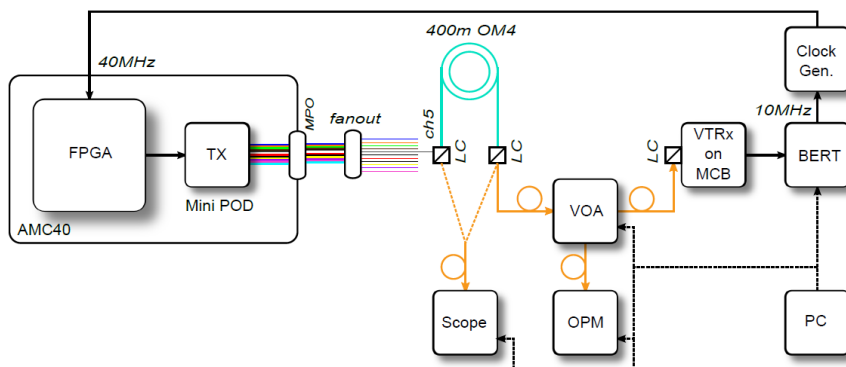
Downlink test setup

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}*

Measurements at 10.3125 Gbit/s :
Total Jitter   ≈ 55 pS
Random Jitter   ≈ 0.93 pS
Deterministic Jitter ≈ 42 pS
aperture : 0,42 UI@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 10^{-15}*
   ➡ *Margin better than 10dB*

ATCA40 main features

ATCA40 prototype

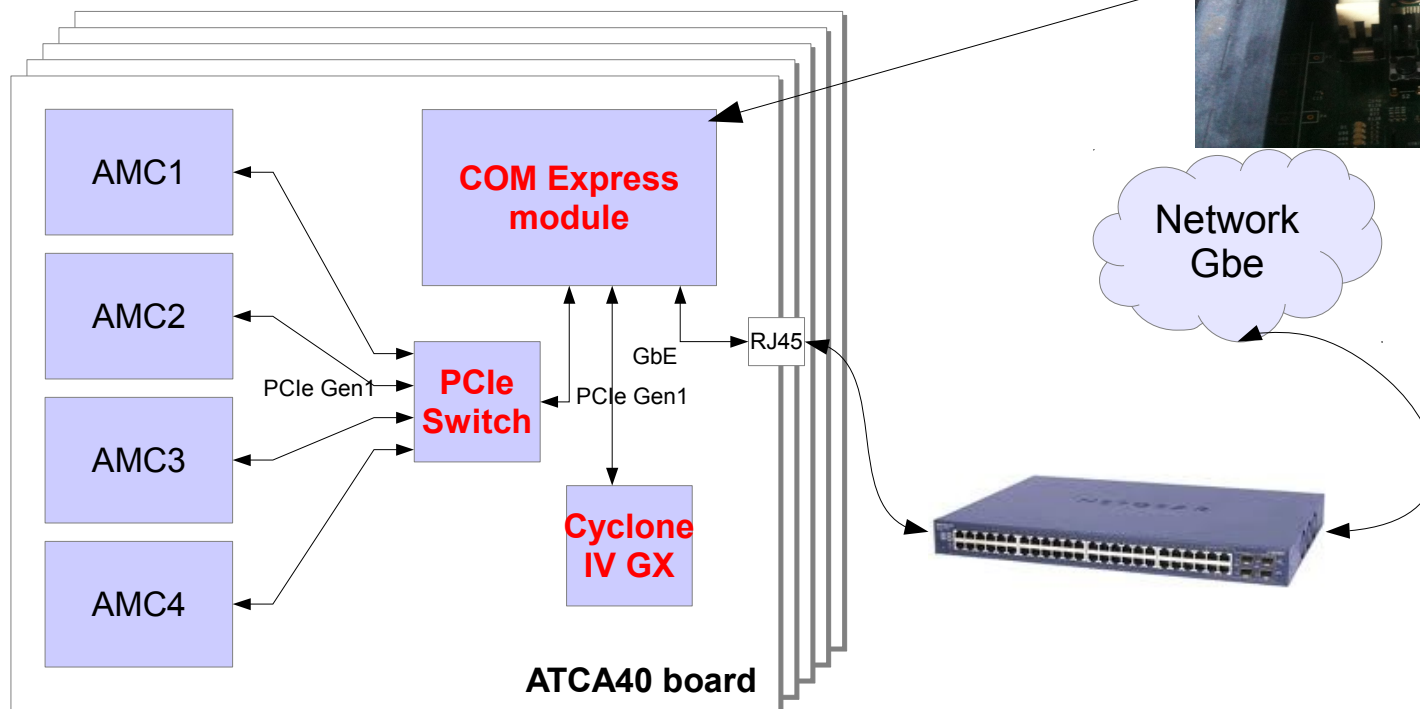**2 boards produced in December 2012**
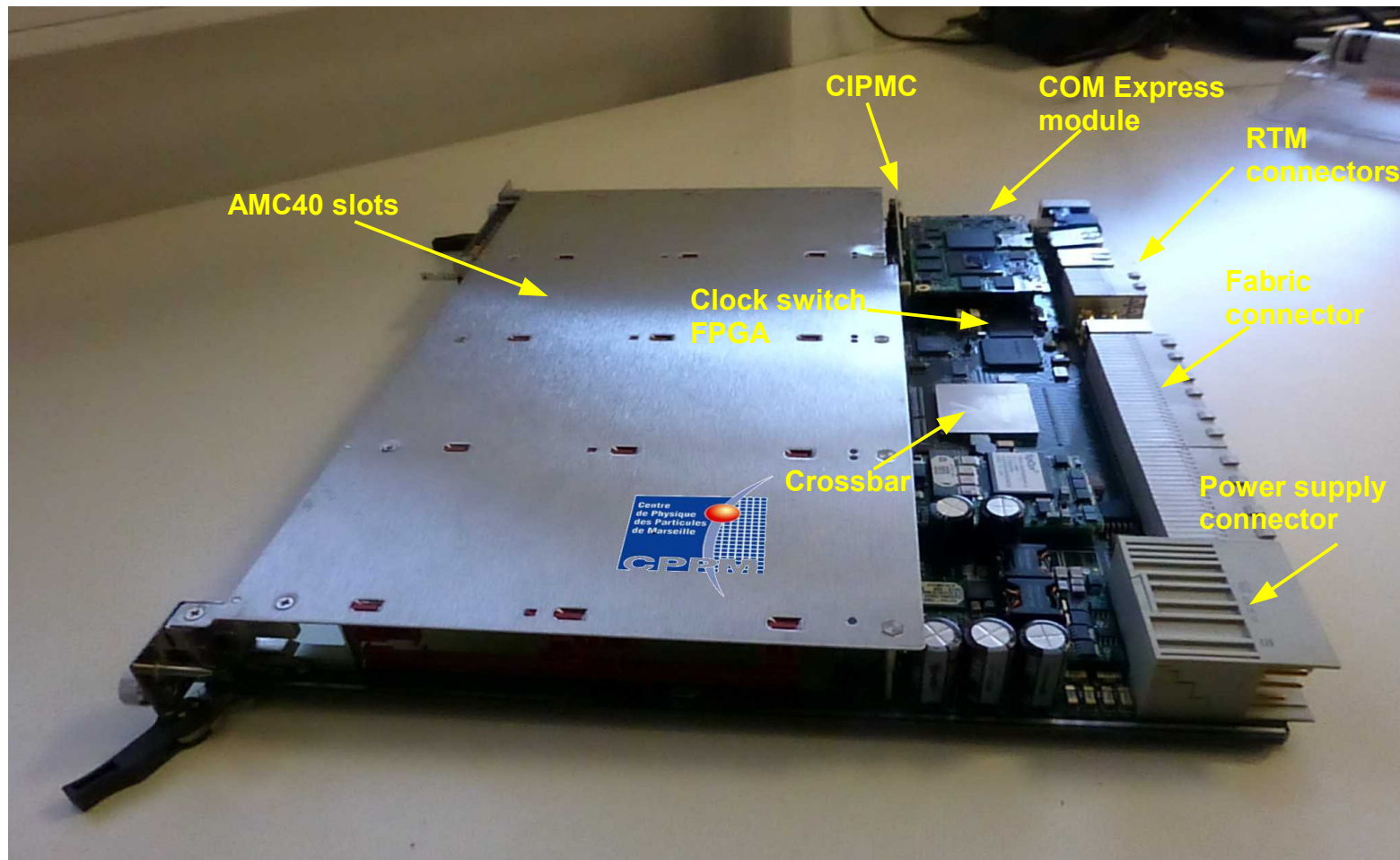
Slow control: GbE & PCIe on ATCA40

COM Express Module

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

PCIe to Cyclone IV : Direct link from "COM Express module"
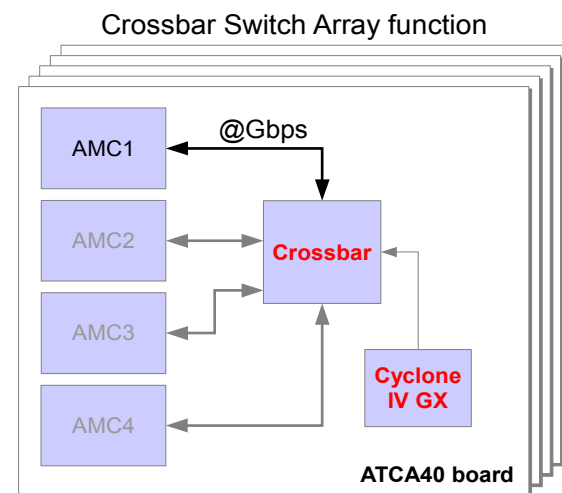**PCIe to Stratix V :** on AMC40 board through local PCIe switch

Serial links on ATCA40
(loop-back AMC1 slot)

Crossbar Switch Array function
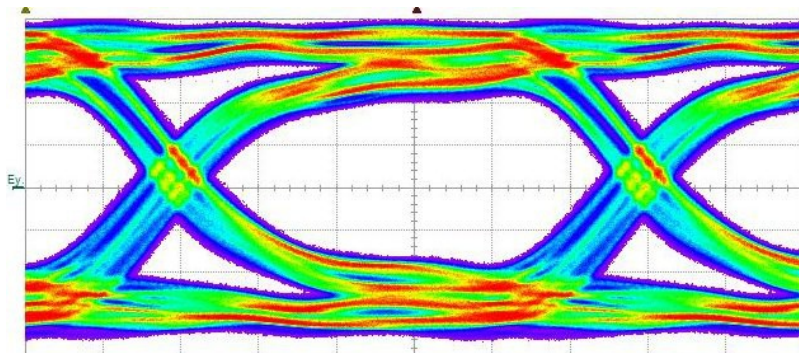

Crosspoint programming from Cyclone IV GX

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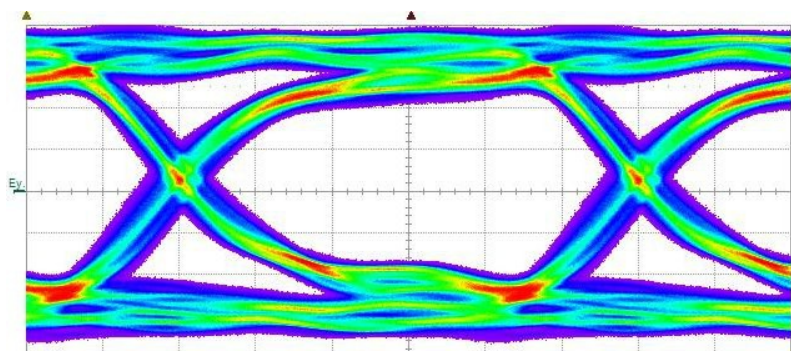between Stratix V GX AMC40 through crossbar**

➡ *BER better than 10^{-16}*

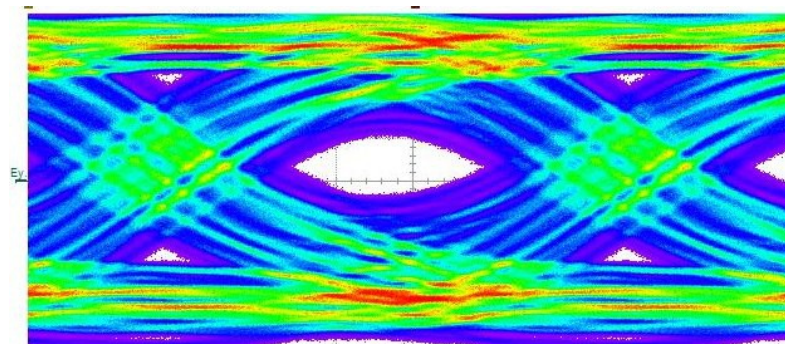*** Serial links ATCA to ATCA not yet tested (3.2 Gbits/s)**

3.2 Gbits/s
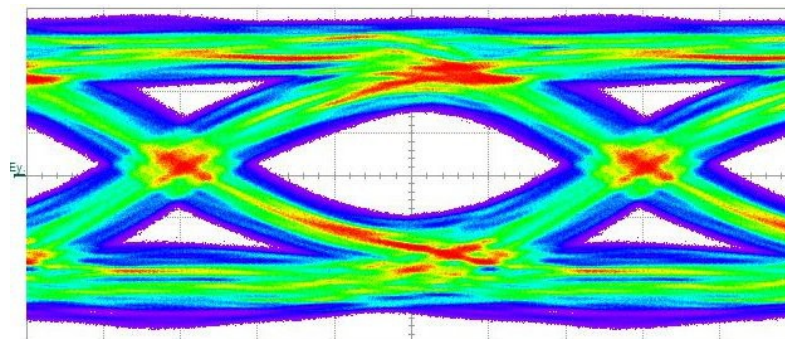

▲ **No pre-emphasis** : Eye width = 0.73 UI

With pre-emphasis : Eye width = 0.74 UI

6.4 Gbits/s

No pre-emphasis : Eye width = 0.19 UI
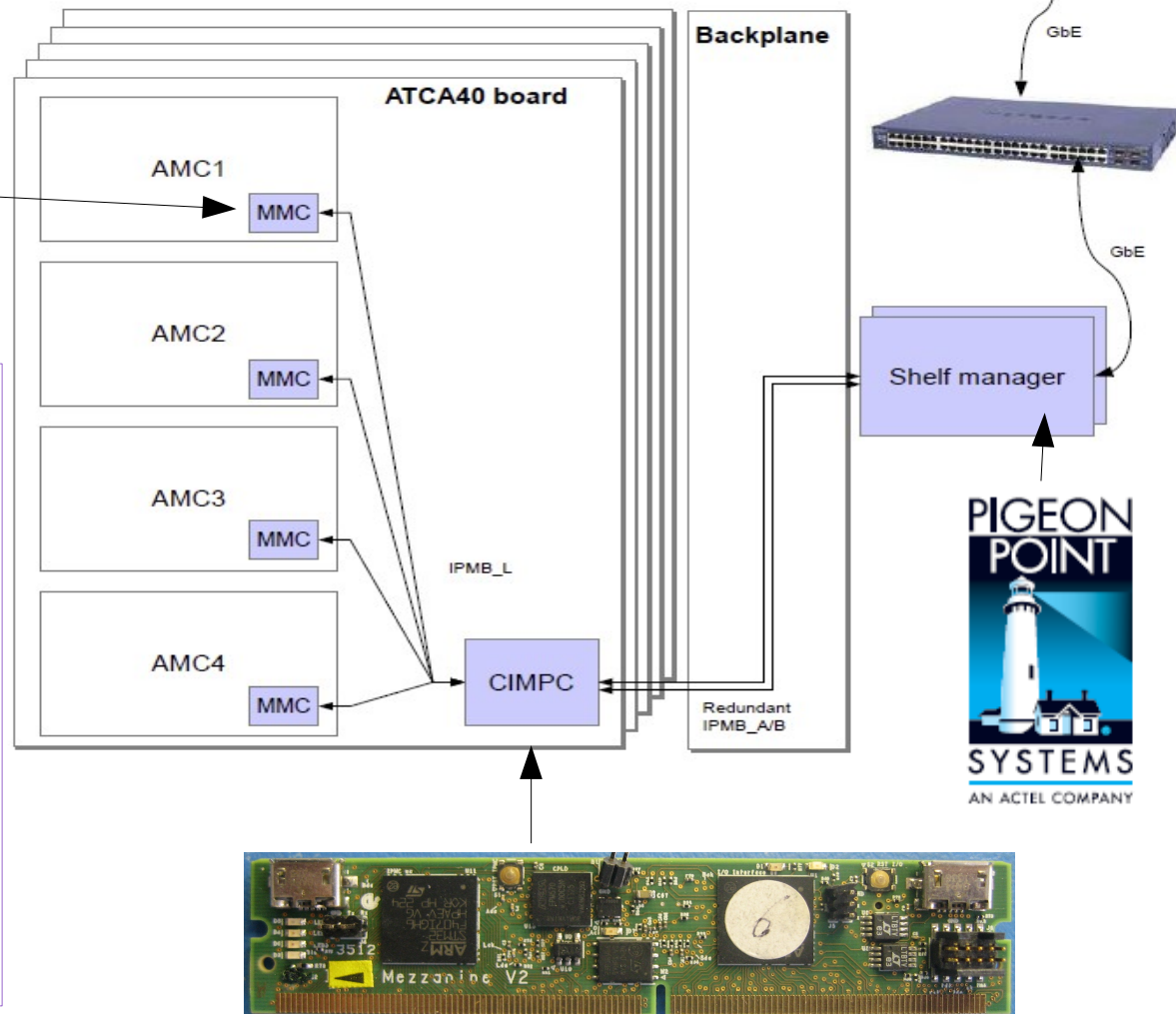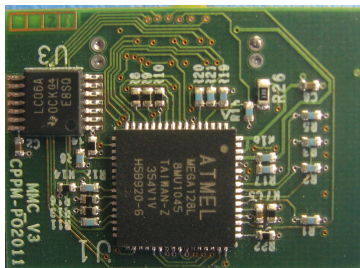

▲ **With pre-emphasis** : Eye width = 0.47 UI

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)*