

# Electronics Lessons Learned from GE1/1

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# Outline

## 1. OptoHybrid

- 1.1 Modifications while in production
- 1.2 Failures at QC7
- 1.3 Keep the OHs clean
- 1.4 VTRx failures

## 2. GEB issues

- 2.1 Soldering
- 2.2 Flatness
- 2.3 Cleanliness
- 2.4 Packaging

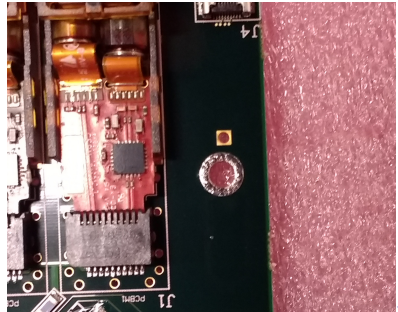
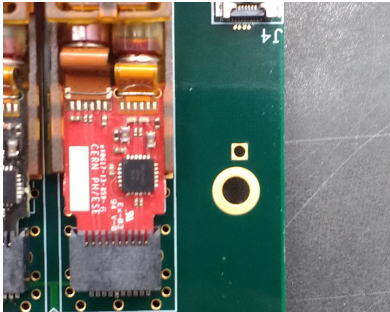
## 3. Test procedure

- 3.1 *Sbit rate vs THR\_ARM\_DAC*
- 3.2 Keep track of the components
- 3.3 Plan for failures

## 4. Conclusion

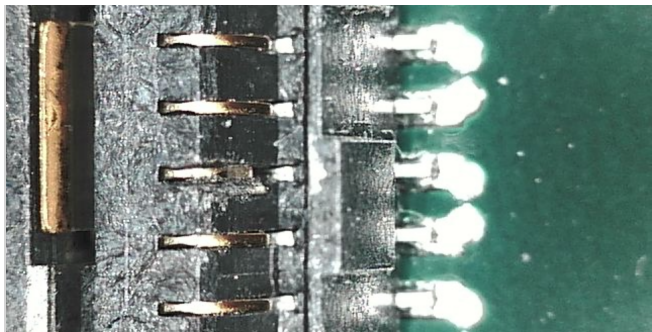
# Modifications while in production

1. Cover with solder the gold plated pad touching the tin-plated brass standoffs:
  - ▶ Prevent galvanic corrosion
  - ▶ By hand on already produced OH (CERN SMD lab)
  - ▶ At production for newly produced OH
2. Improve temperature sensors:
  - ▶ PT100 do not match the SCA ADC characteristics
  - ▶ Replace the PT100 with PT1000
  - ▶ Add a precise resistor for SCA current source calibration
  - ▶ End up with 3 OH versions (stored in DB)



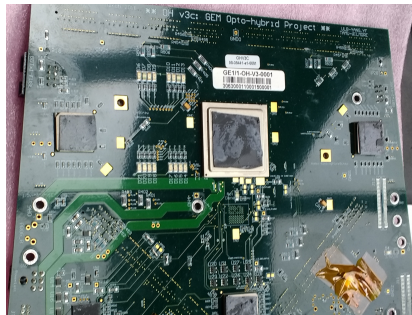
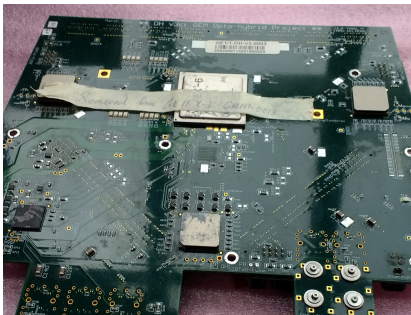
## Failures at QC7

- ▶ More than 15 OHs have been returned to ULB
- ▶ 3 were found with broken SAMTEC pins
- ▶ 4 have a serial number lower than 10 (and need reworking)
- ▶ Other OHs have been repaired, tested and returned to CERN
  - ▶ Not all OHs have been found misbehaving; back in production



# Keep the OHs clean

- ▶ OHs were not cleaned before shipment from CERN to ULB
- ▶ Thermal paste everywhere:
  - ▶ In the SAMTEC connectors
  - ▶ Under the BGA packages
  - ▶ Inside the VTR<sub>x</sub>/VTT<sub>x</sub>
- ▶ Unnecessary stress experienced during cleaning
- ▶ Also clean with compressed air before assembly



# VTRx failures

Various symptoms:

- ▶ GBTx loosing lock
- ▶ VFAT loosing synchronisation
- ▶ Unreliable OH FPGA communication

Traced to VTRx failures:

- ▶ 4 on 3 OHs back from CERN
- ▶ 2 at ULB after a few minutes/hours
- ▶ 1 replaced at CERN

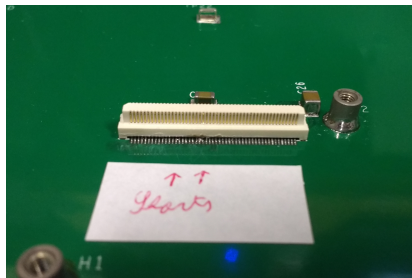
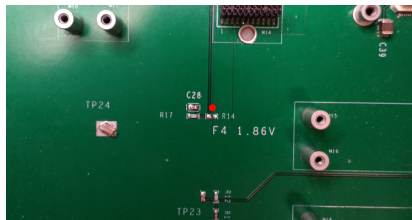
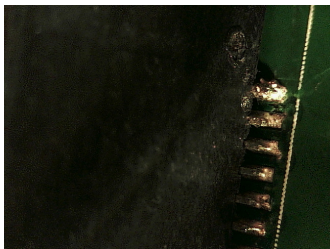
Different modes of failures:

- ▶ 1 VTRx failed on the Tx (*IDLE* state)
- ▶ 2 VTRx's failed on the Rx (*waitDESLock* state)
- ▶ 1 VTRx drawing 0.1 A less than expected

# GEB issues

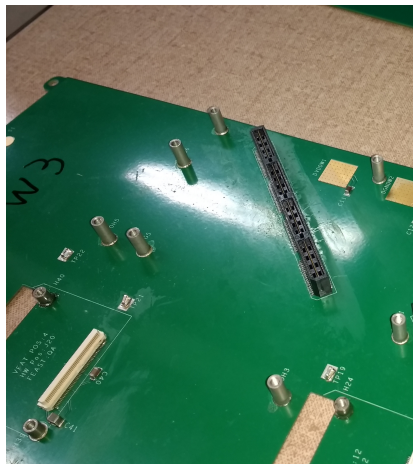
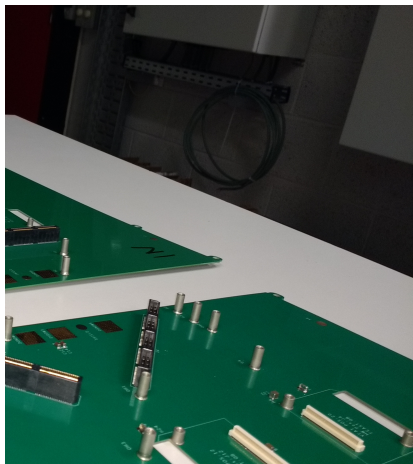
- ▶ Only a few (2-3) returned from CERN
- ▶ But many rejected at ULB
- ▶ Longest component to repair and test
- ▶ Large variety of issues with batch-to-batch variation
- ▶ More thorough tests should be performed at production:
  - ▶ PRBS patterns on the data lines
  - ▶ Test the powering with DC/DC FEAST-like

# Soldering





# Flatness and cleanliness



# Packaging

- ▶ GEBs damaged by:
  - ▶ Too light packaging
  - ▶ Too tight packaging
- ▶ Each batch is sent with different packaging:
  - ▶ Difficult to re-pack components
  - ▶ Standardization would be appreciated

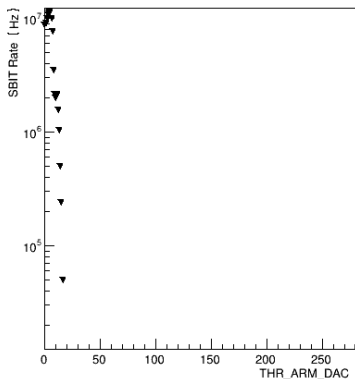


## Test procedure

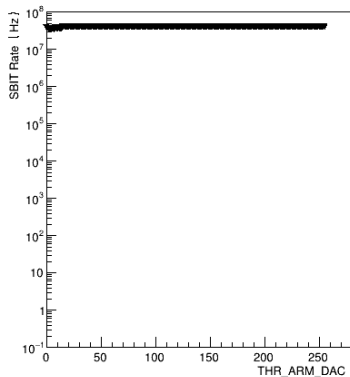
- ▶ Visual inspection of both GEB and OH
- ▶ GEB flatness measurement
- ▶ Consolidation of the standoffs and check each of them at a defined torque
- ▶ GEB cleaning, particularly the connectors, with flux-cleaner, isopropyl alcohol and compressed air
- ▶ Checking the LV with FEASTs
- ▶ Full electronics assembly
- ▶ QC7 test without VFAT analogue channel tests
- ▶ Complete Sbit test (Sbit rate measurement + fast Sbit mapping)
- ▶ Overnight test for connectivity stability (GBTx lock and VFAT synchronisation)

## Sbit rate vs THR\_ARM\_DAC

- ▶ Precious diagnostic tool
- ▶ Difficult to interpret the results
- ▶ Should write manual or a automatized software tool

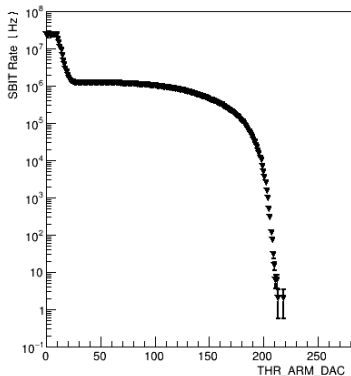


Good Sbits line

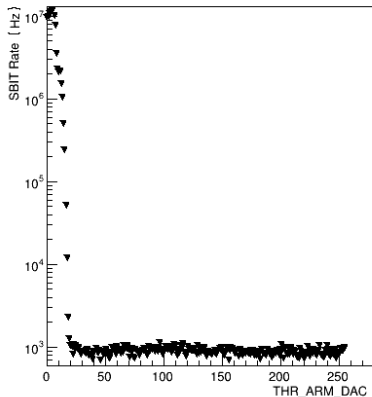


Disconnected/broken Sbits line

## Sbit rate vs THR\_ARM\_DAC - more examples



Noise in the frontend



Issue with the OH FW (now fixed)

# Keep track of the components

- ▶ Receiving a component for debugging without its history is challenging
- ▶ Work has been invested to integrate the electronics components and tests into the GEM DB
- ▶ GE1/1 components are being uploaded
- ▶ Plan it in time; takes time to converge with the DB experts

OptoHybrid [GE1/1-OH-V3-0090]

ID	48180
Serial Number:	GE1/1-OH-V3-0090
Barcode:	3063000110001500090
Inserted at:	16-SEP-19 10.00.13.000000 PM EUROPE/ZURICH
Inserted by:	CMS_GEM_PRTTYPE_MUON_WRITER
Manufacturer name:	Page Electronica
Location:	ULB

Parent Component:

Child parts:

- GBT: X-GBT-0903
- GBT: X-GBT-0902
- GBT: X-GBT-0901
- FPGA: X-FPGA-0090

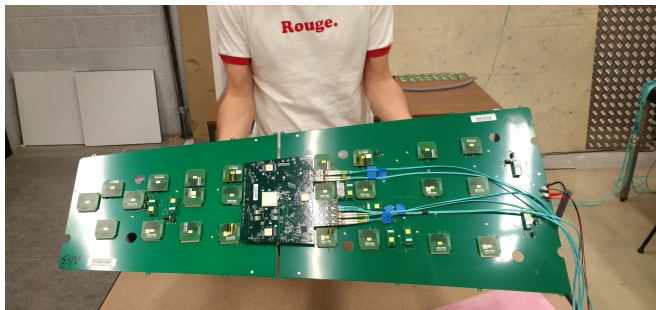
# Plan for failures



- ▶ Allow to test 6 electronics sets "simultaneously"
- ▶ Crucial to increase the throughput
- ▶ Coordination required for access to the CTP7
- ▶ Re-used testings components can also fail:
  - ▶ FEASTs
  - ▶ VFATs

## Two parts design

- ▶ Two pairs of SAMTEC connectors with complex geometry
- ▶ Difficulties to mount the OptoHybrid on the two GEBs
- ▶ Alignment (and cleanliness once again) are crucial
- ▶ Should minimize the mechanical stress on the SAMTEC connectors
- ▶ The 3 components can easily be handled alone once assembled





# Conclusion

- ▶ Keep all components clean, particularly the connectors
- ▶ Plan for non-working components and debugging
- ▶ Better quality control for GEBs at production
- ▶ Expect components to die during QC (VFAT, FEASTs)
- ▶ Plan the GEM DB in time in order to keep track of the components
  
- ▶ Need to share in a systematic way our experience with GE2/1
  
- ▶ Presented only the problems, but the GE1/1 electronics is working well overall