CLIC-ACM

Acquisition and Control System

B. Bielawski ¹  F. Locci ¹  S. Magnoni ¹

¹CERN, Geneva, Switzerland
Beams Department, Controls Group

ICALEPCS’13
San Francisco, 10th October 2013
1 CLIC Overview
   ■ The Layout
   ■ CLIC in Numbers

2 Requirements
   ■ Physical Constrains of the CLIC-ACM
   ■ Requested Acquisition and Control Channels

3 Solution
   ■ Data Transfer and Synchronization
   ■ Network Topology
   ■ Reliability and Availability

4 Summary
CLIC in Numbers

Two Beam Module (TBM)
A basic building block of CLIC — a compact integration containing all the components required to accelerate the beam.

Acquisition and Control Module (ACM)
A device providing timing, data acquisition and control to the TBM module (Alignment, Stabilization, Power, Vacuum, Cooling, ...), communicates with Front End Computers (FECs) installed in alcoves.

Some numbers describing CLIC:
- 2 main beam linacs (each 1.5 TeV),
- 24 sectors (\sim 880 m long) per linac,
- 440 TBM\&s and ACM\&s per sector,
- 21000+ TBM\&s and ACM\&s in total,
- 50 Hz repetition rate.
Physical Constrains of the CLIC-ACM

- Power consumption $\leq 50$ W,
- TIDs 100–1000 Gy per year,
- Limited space to place the ACM, possible placements:
  - left — hard to access, short cables,
  - under — hard to access, short cables, risk of flooding, collides with the Drive Beam support system,
  - middle — easy access, short cables, risk of physical damage,
  - right — easy access but very long cables.
### Requested Acquisition and Control Channels

#### Requested:

<table>
<thead>
<tr>
<th>Type of channel</th>
<th># of ch.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fast ADC (200 MS/s, 14 b)</td>
<td>28</td>
</tr>
<tr>
<td>Slow ADC (10 kS/s+, 16 b)</td>
<td>55</td>
</tr>
<tr>
<td>Raw DIO</td>
<td>110</td>
</tr>
<tr>
<td>Serial IO (RS232/485)</td>
<td>18</td>
</tr>
<tr>
<td>Slow DAC (10 kS/s+, 16 b)</td>
<td>24</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>300+</strong></td>
</tr>
</tbody>
</table>

#### Additional:

- Original signals: 300
- Spare signals (50%): 150
- Critical signals: + 50
- **Total**: = 500

---

The diagram shows the time progression of various monitoring and control systems, including Beam Loss Monitors, Wakefield Monitors, Beam Position Monitors, Main Beam Quad Stabilisation, Main Beam Quad Power, Prealignment, and the interlock points. The legend identifies the types of signals and control actions involved.
Solution — Data Transfer and Synchronization

GBT

A CERN project aiming at delivering reliable rad-hard devices and protocol for timing and data acquisition.

Features:

- 3.2 Gb/s (40 ch, 80 Mb/s each),
- build-in e-link switch,
- radiation resistant (up to 3 kGy),
- clock recovery (40 MHz),
- guaranteed fixed latency,
- low power consumption — 2 W.
Solution — Network Topology

Three network topologies have been taken into account.

<table>
<thead>
<tr>
<th>Topology</th>
<th>Cost 1</th>
<th>FECs</th>
<th>Timing</th>
<th>Bandwidth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Star</td>
<td>Medium</td>
<td>N</td>
<td>Easy</td>
<td>B</td>
</tr>
<tr>
<td>Ring 8^2</td>
<td>High</td>
<td>N/8</td>
<td>Medium</td>
<td>B/8</td>
</tr>
<tr>
<td>Ring 16^2</td>
<td>Low</td>
<td>N/16</td>
<td>Hard</td>
<td>B/16</td>
</tr>
</tbody>
</table>

^1 With 8/16 devices in the ring

^2 Cost estimations and image courtesy of Simao Machado, CERN
Solution — Reliability and Availability

Critical Signals

Signals which are necessary for Machine Protection and not receiving results from these channels will cause immediate machine stop.

Two ways to increase reliability of acquisition of critical signals:
- acquiring critical signals in adjacent ACMs,
- connecting adjacent ACMs to separate networks.
Summary

Current plans for the CLIC Control System include:

▶ the ACM capable for acquiring/controlling over 500 channels,
▶ use of the GBT chip providing timing and communication,
▶ Double Star network topology with interleaving for increased reliability,

Future plans:

▶ making more precise simulations of radiation in the tunnel,
▶ ACM placement selection,
▶ selection of technology for acquisition cards in the ACM.

Finally:

▶ Design and development of the ACM and all the boards installed inside.
Questions & Answers