SwissFEL Timing System
First Operational Experience

ICALEPCS’17, Barcelona
SwissFEL Timing Overview

- Provide precise triggering across the facility
- Rep- and beam rate controls
- Distribute operation-critical machine parameters
- Assist machine/beam synchronous DAQ and controls
- Assist Machine Protection System (MPS)
Timing System Overview

- Rep rate **100 Hz**
- Reference clock **142.8 MHz**
- Active delay compensation
Timing System Overview

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Dealing with different form-factors

- VME, PCIe, embedded (FPGA)
- Provide same interface (software configuration, UI)
- Embedded EVR’s increasing -> **non-standard interface must be managed!**

<table>
<thead>
<tr>
<th>Timing device</th>
<th>VME-EVM</th>
<th>VME-EVR</th>
<th>PCIe-EVR</th>
<th>Embedded EVR</th>
</tr>
</thead>
<tbody>
<tr>
<td>In operation 1 year ago</td>
<td>15</td>
<td>8</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>In operation <strong>today</strong></td>
<td>67</td>
<td>142</td>
<td>45</td>
<td><strong>152</strong></td>
</tr>
</tbody>
</table>
Beam Rate Control

• Event rep rate handling is a challenge -> flexible + independent + synchronous
• **Green** is RF with normal trigger -> Acceleration -> Beam **ON**
• **Red** is RF trigger with delayed trigger -> No acceleration -> Beam **OFF**

➢ Continues triggering maintains stable subsystem operation (Laser, RF, etc.)

• Software controlled: operator’s beam rate setting
• Hardware controlled: assist machine protection (beam stopper)
• **Green** is RF with normal trigger -> Acceleration -> Beam **ON**
• **Red** is RF trigger with delayed trigger -> No acceleration -> Beam **OFF**

➢ Continues triggering maintains stable subsystem operation (Laser, RF, etc.)
• Events are synced with internal super-period
• Relative phase of unrelated clocks across subsystems
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Timing Network Diagnostics

- Art of “spaghetti”
• Make it cleaner!
• will nice cabling and labeling help?
• Screw it up!
  ➢ only swap a patch and forget!
• Each node gets its topology id from its parent
• Each parent sends its own id plus ports number to the connected child
• Topology id is updated dynamically
Complex Triggering Application (CTA)

- Generate flexible trigger-and-acquisition patterns (e.g. pump-probe)
- Independent CTA for each end-station -> CTA runs locally + forwards global events
- Upload desired trigger pattern; start pattern playing upon:
  - user’s demand, specified pulse ID, occurrence of a global event
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My thanks go to

- GFA Controls
- Expert groups: LLRF, DI, Laser, ...
- MRF
- Cosylab