MicroTCA.4 LLRF system installation for the Eu-XFEL

Installation overview

Julien Branlard, for the LLRF team
XFEL MicroTCA.4 LLRF installation
Talk overview

> The European XFEL
  - overview
  - from cavity to linac

> The MicroTCA.4 LLRF system
  - in a table…
  - system description
  - core modules
  - crate occupation

> Installation challenges
  - inventory
  - storage
  - test
  - installation

> Outlook
The European X-ray Free Electron Laser

- 17.5 GeV light source user facility
- TESLA superconducting 1.3GHz RF cavities
- 1.4 msec pulses at 10 Hz
- e- beam 1.35 mA nom. - 4.5 mA max
- 2016: construction / commissioning
- 2017: first user operation
The European XFEL

https://www.youtube.com/watch?v=p3G90p4glQA

Photo: Dirk Noelle
The European XFEL
from cavity to linac

INJECTOR | LINAC1 | LINAC2 | LINAC3

- Cavity
- Cryomodule
- Linac

1m 10m 2km

CM1 CM2 CM3 CM4

LLRF master KLYSTRON LLRF slave

Photo: Nobu Toge
Photo: Dirk Noelle
Photo: irfu.cea.fr
LLRF system description

- AMC: Advanced Mezzanine Card
- RTM: Rear Transition Module
- 12 slots, hot swap
- Redundant power supply
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MicroTCA.4 LLRF digitizer: **SIS8300**
- 10 ch. Digitizer, 16 bits, 165 MSPS max
- Virtex VI
- Application firmware block diagram:
**LLRF MicroTCA.4 core modules**

- **MicroTCA.4 LLRF controller: TCK7**
  - Kintex VII
  - 12.5 Gbps throughput
  - 8x SPF+ on front panel
  - Application firmware block diagram:

Reference:
LLRF MicroTCA.4 core modules

> uRFB with uLOG

Input: Reference RF signal (REFER)
Generation of local oscillator (LO)
Generation of clocks (CLK)
Distribution of REFER, LOG, CLK

LO = 21 RF stations
⇒ 42 crates equipped with uRFB + uLOG
### LLRF crate occupation - FRONT

#### MASTER

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<tr>
<th>UPM</th>
<th>MCH</th>
<th>CPU</th>
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<th>DAMC02</th>
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#### SLAVE

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- **UPM**: Universal Port Module
- **MCH**: Main Control Hardware
- **CPU**: Central Processing Unit
- **X2TIMER**: Second Timer
- **DAMC02**: Damc02
- **TCK7**: Tck7
- **SIS**: Digitizers (SIS8300)
- **Machine protection (DAMC2)**
- **Main controller (TCK7)**
- **Timing**
- **Power module**
- **CPU**
- **MCH**

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**Julien Branlard** | LLRF installation for the European XFEL | 7.12.2016 | Page 11
LLRF crate occupation - REAR

- **uLOG** (Reference, CLK, LO)
- **Down converters**
- **Vector modulator**
- **Machine protection**
- **Timing**
- **Power module**

**MASTER**

- **uLOG**
  - D
  - W
  - C
  - B
  - P

**SLAVE**

- **uLOG**
  - D
  - W
  - C
  - B
  - P

**Diagram**
LLRF standard system for an RF station

- 2x 9U 12 slot crates (Pentair)
- 4x 1kW power supply (Wiener)
- 2x MCH 80-lane PHYS (NAT)
- 2x CPU quad core (Concurrent)
- 2x timer AMC module (NAT)
- 2x timer RTM module (NAT)
- 2x DAMC2 (DESY)
- 2x MPS-RTM (DESY)
- 2x TCK7 (Vadatech)
- 1x VM (DESY)
- 1x CLKFT (DESY)
- 13x SIS8300 digitizers (Struck)
- 13x DWC1300 down converter (Struck)
- 2x uLOG (DESY/Dynamique)

50 MicroTCA.4 components / RF station

x 26 RF stations
+ non-standard RF stations
+ test setup
+ spares

> 2000 components
Installation challenges / highlights

Device inventory

Storage
Installation challenges / highlights

Test instructions

Test reports

Deutsches Elektronen-Synchrotron

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Test results: PASSED

Test statistics

- Tests passed: Can be used.
- Hardware has been modified: Only install if you know what you are doing.
- Tests not passed: Restricted usage. Only install if you know.
- Module is broken: DO NOT INSTALL.
Installation challenges / highlights

1. Crate inspection
2. RTM backplane inspection
3. MCH settings configuration
4. Module insertion
5. Check inventory labelling
6. Check successful device test
7. Ethernet registration (MCH, CPU, ADM)
8. DESY inventory
9. Operating system installation
10. BIOS settings configuration
11. Driver installation (JTAG, LLRF),
12. Tool installation (MATLAB, LINUX)
13. Check FRU information
14. Firmware programming
15. Server installation
16. Basic platform checks
17. System verification
18. Screws, fillers
19. Ready for rack installation

Dedicated crate assembly room
Schedule

MicroTCA installation
2015: 3 mo / 6 crates
2016: 1 mo / 6 crates

Complete installation:
CS3: 250 days
CS4-CS6: 150 days
CS7: 100 days
Conclusion and outlook

➢ Installation phase is over

➢ Time for warm commissioning is over
  
  Cool down started yesterday!

➢ Planning for cold commissioning

➢ Repairs, maintenance, upgrades, etc…
Questions?

Thank you
for your attention!