Overview of the SwissFEL Project at PSI

Markus Janousch for Controls and the SwissFEL teams of PSI
Overview and Location

1st construction phase
2013-16

- Injector
  - 0.35 GeV
- BC1 Linac
  - 2.0 GeV
- BC2 Linac
  - 3.0 GeV

2nd construction phase
2018-19

- Linac 1
  - 2.6-3.4 GeV
- Linac 2
  - 2.1-5.8 GeV
- Linac 3
  - 3.0 GeV

Athos 0.7-7nm
Aramis 0.1-0.7 nm

The SwissFEL Building Site

The two passages for wild game crossing.

On the first floor the RFmodulators and other supply systems are situated.

Photon Beamlines, Experiments and Preparation Laboratories
ARAMIS Undulators

Linear Accelerator

PSI campus
Swiss Light Source
Central Control Room

Situation of SwissFEL next to PSI campus
Key Parameters

**Overall Length**
- 720 m

**Total electrical power**
- 5.2 MW

**Maximum electron beam energy**
- 5.8 GeV

**Number of FEL lines**
- 2

**Wavelength**
- 1 - 7 Å, 7 - 70 Å

**Repetition Rate**
- 100 Hz

**Aramis 1Å**
- Charge per Bunch
  - 200 pC
  - 10 pC
- Bunch length
  - 25 fs
  - 6 fs
- Peak Brightness
  - $7 \cdot 10^{32}$ ph/s/mm²/mrad²/0.1%
  - $1 \cdot 10^{32}$ ph/s/mm²/mrad²/0.1%
- Number of Photons
  - $73 \cdot 10^9$
  - $1.7 \cdot 10^9$

**Long Pulses**
- 200 pC
- 25 fs
- $7 \cdot 10^{32}$ ph/s/mm²/mrad²/0.1%

**Short Pulses**
- 10 pC
- 6 fs
- $1 \cdot 10^{32}$ ph/s/mm²/mrad²/0.1%
1st construction phase
2013-16

- Injector
- Linac 1
- Linac 2

- BC1
- BC2

0.35 GeV
2.0 GeV
3.0 GeV

2nd construction phase
2018-19

- Linac 1
- Linac 2
- Linac 3

- BC1
- BC2

2.1-5.8 GeV
2.6-3.4 GeV
0.35 GeV
0.1*0.7 nm
0.35 GeV
2.0 GeV
3.0 GeV
2.1-5.8 GeV
2.6-3.4 GeV
0.35 GeV
0.1*0.7 nm
0.35 GeV
2.0 GeV
3.0 GeV
2.1-5.8 GeV
2.6-3.4 GeV
0.35 GeV
0.1*0.7 nm

Aramis 0.1-0.7 nm
Athos 0.7-7 nm

Overview and Schedule
Network (provided by Central IT)

- 100 Gbit between SwissFEL, Control Room, and Computing Centers
- LAN, 10 Gbit SwissFEL, special devices
- WLAN in tunnel
7-Slot VME Crates provided by Trenew

- Dual power supplies in parallel operation
- Cooling from side to side for improved airflow
- Plug-in power supplies, fan units, air filter etc. for easy maintenance
- Integrated crate monitoring with Ethernet connection (I²C)
Co-developed by Controls, LLRF, and IOxOS Technologies SA in Switzerland.

6 U VME64x single board computer (Freescale Power PC P2020 dual core, Xilinx Virtex-6 central and Spartan-6 IO FPGAs).

**Extension slots**
2 XMC, 1 PMC, 2 FMC mezzanine

**Operating system**
Linux RT

The board of choice for fast D/A signal processing, timing, Power-Supply control and connection to EtherCAT-Systems.
Timing and Event System from MRF

- Reference clock runs at 142.8 MHz
- 5 ps RMS jitter
- Sequence reprogrammable within 10 ms (10 Hz)

**Event Sequencing:**

100 Hz synchronized with mains

New version of mrfioc2-driver developed with help of Cosylab. Also for PCIe.
Motion Controllers

PowerBRICK LV IMS PSI based on Delta Tau’s PowerPMAC.

PCle timing card from MRF integrated.

For coordinated and synchronized movements.

MDrive from Schneider-Electric

Ethernet communication interface

Incremental, SSI, and BISS encoders. A few special systems have to be supported.

New support of motorRecord for PowerPMAC written with help of Cosylab.
Camera Support

Cameras are used for
- Electron beam diagnostics
- Lasers
- Photon beam diagnostics
- Experiments

- MS Windows based system
- Timing system (MRF) included
- Fast analysis of data with 100 Hz
- Dedicated storage for 5 cameras running simultaneously.
Serial and Low Demand Systems

Serial and slow signals do not need VME

**WAGO system**
- Slow digital I/O
- Slow analog I/O
- Temperature measurement with low accuracy
- Connected with Ethernet to an EPICS softIOC

http://www.wago.us/

**MOXA Serial Server**
- 16 serial ports
  - (configurable RS232, RS485, RS422)
- Runs Linux and EPICS softIOC on the device

http://www.moxa.com/product/NPort_6650.htm
Beam Synchronous and High Volume DAQ

Based on EVR or FPGA decoding of events.

CA or JSON for configuration

Streaming of data with ZMQ

Storage of data in HDF5 format

Collected 20 TByte of camera data (Gigafrost) and 40 TByte of reconstructed data in 1 hr at TOMCAT (1Tb/min) beam line of SLS last month.
Summary

• The hardware is available and has been tested. It is ready to be installed starting this summer.
• Many other new technologies are being developed and used and will be reported on a next meeting

https://www.youtube.com/watch?v=6BtvzgYvrgk