The Virtual European XFEL Accelerator

Development, test and integration of high level software at the European XFEL

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Introduction

Can **not** talk about:

- **the European XFEL**
  (see MOA3O02, MOPGF101, ...)

- **the FLASH facility**
  (see MOC3O07, ICALEPCS2007 TOAA04, ...)

- **the control system**
  (see ICALEPCS2009 MOD004, ...
Outline

- **The Idea** - Motivation
- **Where we’ve grown up** - From FLASH to XFEL
- **The core of the Control System Architecture** - The DAQ (Data Acquisition System)
- **The Virtual XFEL** - damned let’s have a look
The Idea / Motivation

- The European XFEL is a **large scale** machine
- **Tight time schedule** for commissioning and time up to first lasing
- **Lessons learned** at other facilities:

  Need to have **all** software **ready** for the **commissioning**

  Set up **interdisciplinary team** from multiple DESY groups to **provide high level software**

  Test and thereby **approve** foreseen **control system architecture works**
The European XFEL is a **large scale** machine

**Tight time schedule** for commissioning and time up

**Lessons learned** at other facilities:

- Need to have **all software ready** for the commissioning
- Set up **interdisciplinary team** from multiple DESY groups to provide high level software
- Test and thereby **approve** foreseen control system architecture works
FLASH is the little brother of XFEL
- Control System: DOOCS/TINE
- Front-end Hardware: VME, µTCA
- Timing System
- Machine Protection System
- Multi-Beam-Line Operation
- ...

FLASH is the test bed for software to be used at XFEL, but …

XFEL is 10 times as big!
From FLASH to XFEL

FLASH ~ 30 crates producing < 100 Mbyte/s
XFEL ~ 200 crates producing >> 100 Mbyte/s

→ High data rates require data reduction
→ Synchronize data from various sources
→ Have to think more in physics entities

⇒ The Data Acquisition System (DAQ)
The Data Acquisition System

1. Calculate orbit for given optic

2. Write orbit to BPM server

3. Send orbit data to DAQ/orbit server

4. Display orbit + modify by bump program

5. Write new currents

6. New currents to optic server

Orbit display, bumps

Orbit

DAQ

BPM

Optic

Magnet Server
The Virtual European XFEL Accelerator

The virtual XFEL
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The virtual XFEL – Orbit
The Virtual European XFEL Accelerator

The virtual XFEL – Orbit

[Image of orbit data from Orbit ML Server]
The Virtual European XFEL Accelerator

The virtual XFEL – Orbit

Virtual XFEL Overview

Orbit from Orbit ML Server

Data on Table

Horizontal

Vertical

BASB1

BASB2

BASB1

BASB2

BASB1

BASB2
The virtual XFEL – Orbit

Virtual XFEL Overview

Orbit from Orbit ML Server

Horizontal

Vertical

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The virtual XFEL – Orbit

[Graphs showing virtual XFEL orbit data]
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The virtual XFEL – Orbit

Virtual XFEL Overview

Orbit from Orbit ML Server

Horizontal

Vertical

SASE1

SASE2

SASE1

SASE2
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The virtual XFEL – Data throughput

Virtual XFEL Overview
The virtual XFEL – Data throughput
The Virtual European XFEL Accelerator

The virtual XFEL – Timing
The virtual XFEL – **Timing**
The virtual XFEL – Bunch pattern handling

Virtual XFEL Overview

Legend:
- Server, Process, Display...
- Action/Script
- Read, Write
- Responsible server
- Action connection
- Inactive / not in use
- Monitor link

Currently playing:
- Suka
- Josef
- Koral
- Lee
- Olaf
- Peter
- Raymond
- Sanna
- T跛
- Timm
- Weick
- All

DAQ

Energy Gain Server

Transport ML Server

Orbit Server

Optic Server

Magnet Server

Magnet Energizer

Power Supply Server

Timing Server

LLRF Controller

Tomasi Server

BPM Server

F3M
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The virtual XFEL – Bunch pattern handling
The virtual XFEL – Bunch pattern handling
The virtual XFEL – Bunch pattern handling
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The virtual XFEL – Bunch pattern handling
The virtual XFEL – LLRF

Virtual XFEL Overview

DAQ

Energy Gap Server  Tuning Server  Orbit Server

Optic Server

Magnet Server

Power Supply Server

F3M

Timing Server  LLRF Controller  Tuning Server  BPM Server

Grid & Trend Display  Grid Display  Bump Tool  Sequencer  Magnet Display

Legend

Server, Process, Display...
Active/Script
Fault
Remote server
Active connection
In-active / not assigned
Monitor link

Currently playing

Saku  Josif  Nical  Lina  Cobi  Radio  Raimond  Jukka  Timo  Veli
All

RPC LRPC  Watchdog  MainTaskbar
The Virtual European XFEL Accelerator

The virtual XFEL – LLRF

Virtual XFEL Overview

XFEL Energy Overview

Server

Legend

- Server, Pipes, Display...
- Active/Script
- Online/Offline
- Inactive
- Inactive/Offline
- Active
- Online
- Active/Offline
- Inactive/Offline
- Active
- Online
- Active/Offline
- Inactive/Offline

Currently playing

- Baba
- Josef
- Ingrid
- Lers
- Olaf
- Jana
- Jacek
- Rose
- Stanislav
- Tamas
- Tim
- Volker
- Weco
- All

Draw All

Click on section a to display its energy profile

146.1 MeV
706.2 MeV
2789.2 MeV
15277.3 MeV

Print
The Virtual European XFEL Accelerator

The virtual XFEL – LLRF

Virtual XFEL Overview

XFEL Energy Overview

Click on section to display its energy profile

Show all

146.5 MeV
78.1 MeV
130.3 MeV
1464.5 MeV
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The virtual XFEL – LLRF
The Virtual European XFEL Accelerator

**Summary**

- The VXFEL **allowed** us to:
  - Test the **network** and **data throughput**
  - Tests of the **Timing System** and **Bunch Pattern Handling**
  - Is a test bed for all **High Level Software**
  - Test **naming conventions** and prepare server **configurations**
  - **Port** software from the VXFEL **1:1** to the XFEL
  - Develop and test **display concepts and displays**
  - ...

- The VXFEL **does not** or only partly allow to:
  - Test **hardware**
  - Do **physical simulations**
Summary

- **Started as** pure test for data throughput
- **Turned out to be vital tool** for testing much more aspects of the software
- Even further proved to be an essential tool for development of GUIs
- Allows to some extend physics experiments

→ VXFEL got it's dedicated hardware and will be kept running!

Thank you for your attention!