Status of the Standard Diagnostic Systems of the European XFEL

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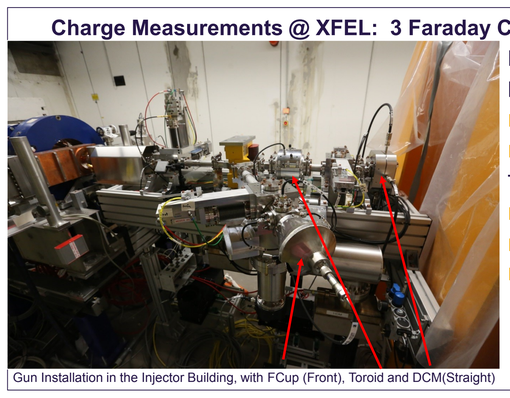
For the E-XFEL Diagnostic Team

Abstract:
The European XFEL, an international X-ray free-electron-laser user facility based on a 17.5 GeV superconducting LINAC, is currently under construction close to the DESY site at Hamburg. The facility is organized as a limited liability company, with shareholders from all participating countries. DESY is in charge of the construction and operation of the accelerator. This contribution will report the status of the standard diagnostic systems of this facility. The design phase has finished for all main systems; most of the components are in production or are already produced. This paper will show details of the main systems, their installation issues and will report on the further time schedule.

Charge Measurements @ XFEL: 3 Faraday Cups, 9 Dark Current Monitors, 26 Toroids



Gun Installation in the Injector Building, with FCup (Front), Toroid and DCM(Straight)

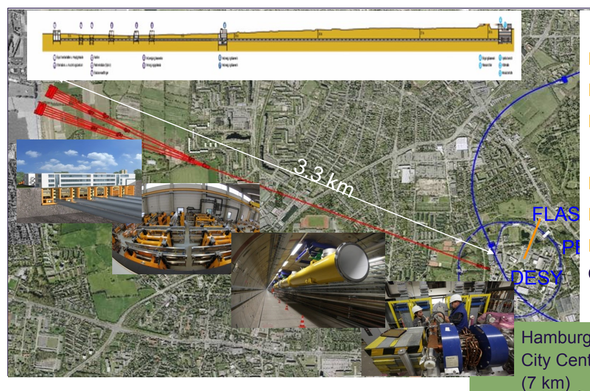
Faraday Cups only at the Gun

Dark Current Monitors(1.3 GHz low Q Cavity):

- Injector, around Chicanes and after Collimation
- Sensitive to few nA DC, and fC Bunches

Toroids:

- based on DESY standard Devices
- Front-End with differential Signals
- µTCA Electronics with Bunch by Bunch FPGA Processing, providing low Latency Transmission, Bunch Pattern and Charge Validation Interlocks.



17.5 GeV Superconducting LINAC

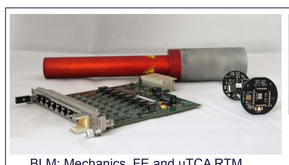
- 2700 bunches per RF pulse
- 10 Hz Rep Rate
- Arbitrary bunch patters

5 Beamlines possible, start with

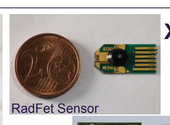
- 2 Hard X-Ray (0.5 Å)
- 1 Soft X-Ray SASE line
- 2 further SASE or spontaneous devices possible

Future Option: 2nd Fan out.

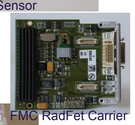
XFEL Beam Loss Monitoring and Dosimetry



BLM: Mechanics, FE and µTCA RTM



RadFet Sensor



FMC RadFet Carrier

XFEL type BLM in FLASH II

µTCA Digital Carrier DAMC02

350 BLMs classical BLMs (Scintilator+PMT)

- µTCA based Electronics (8 Ch/Board)
- Bunch by Bunch Data Processing in FPGA
- Low Latency Interface to MPS

Dosimetry System (about 700 Channels)

- FMC Sensor Carrier with Field Bus for external Sensors.
- Housed by MPS and BPM Hardware
- mGy (internal) and Gy (external) Sensitivity

BPM System supplied by PSI, CEA and DESY as a common In-Kind Contribution

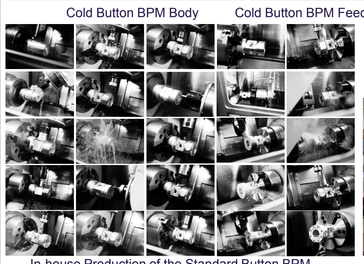
Working Horse: Button BPMs; 297 BPMs; Mechanics DESY; Electronics PSI

Cold Button BPM Body

Cold Button BPM Feed Through

Standard Button

BPM Assembly in DESY-MDI Cleanroom



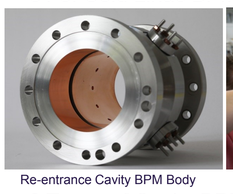
In-house Production of the Standard Button BPM

Girder Assembly in DESY-MVS Cleanroom

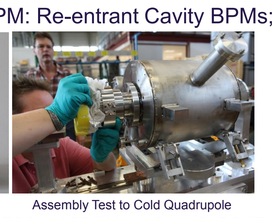
Beam Tests; Resolution

- 30 µm (cold) / 11 µm (warm) @ 20 pC
- 5 µm (cold)/ 3 µm (warm) @ 0.1 -1 nC

31 of Cold Linac BPM: Re-entrant Cavity BPMs; Mechanics and RFFE CEA; Electronics PSI



Re-entrance Cavity BPM Body

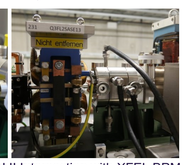


Assembly Test to Cold Quadrupole

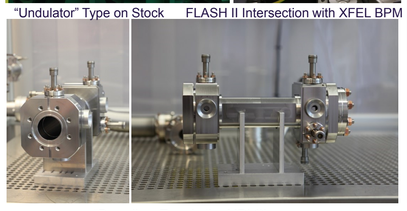
- Re-entrant and Cold Button have same dimensions, and are transparent for module assembly.
- xx µm @ 0.1 -1 nC

2 Types of Cavity BPMs; 103 "Undulator", 26 "Beamline"; Mechanics DESY; Electronics PSI

"Undulator" Type on Stock



FLASH II Intersection with XFEL BPM

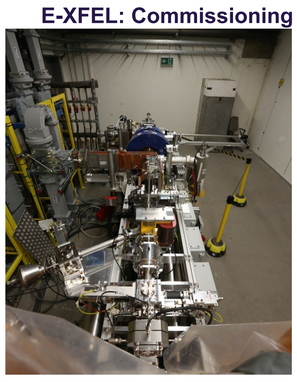


"Beamline" Type in the MDI Cleanroom

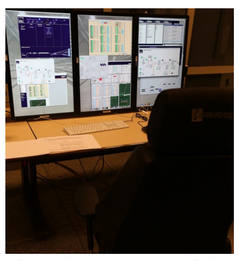
BPM MBU + µTCA FLASH II

- Both types work an 3.3 GHz with similar (low) Q
  -> Same Electronics for Both
- Already commissioned and in Use @ FLASH2
- BPM Resolution:
  Und: 0.5 µm @ 0.1 -1 nC
  11 µm @ 2 pC
  BL: 1 µm @ 0.1 -1 nC

E-XFEL: Commissioning and Schedule



EXFEL RF Gun with first warm section



RF Gun Operation Panels in DESY´s Main Control Room

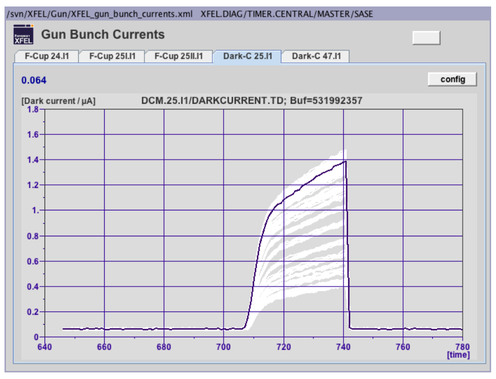
E-XFEL Girder Assembly in MVS Cleanroom

XFEL Schedule

- First Module installed in XTL ☺
- Girder Assembly for Injector and BC started ☺
- Complete Gun Section and start RF -> Sept 14
- First Photoelectrons from Gun -> Oct 14
- Complete Installation of the Injector -> May 15
- LINAC Installation completes, start Cool down -> July 16
- First Beam down the SASE1 Dump -> Dec 16
- First Lasing -> March 16

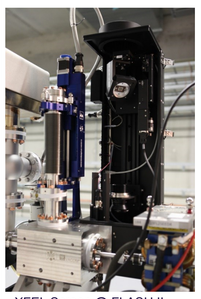
BUT

- Many XFEL Systems are also used for FLASH II ☺
  - Cavity BPMs
  - BLM System
  - Screen System



First Electrons from the E-XFEL Gun (Dark current, 9.09.2014)

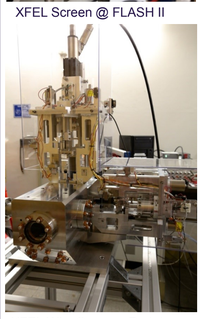
Beam Size Measurements @ EXFEL



XFEL Screen @ FLASH II

Screens:

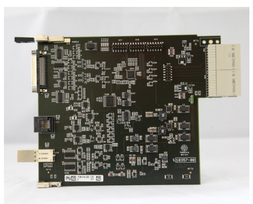
- All using LySo scintillating Targets
- 12,9 x 9,6 mm Chip CMOS Camera
- 14 Simple Screens: View under 45° , about 1:4 Scale
- 37 Screens
  - Target perpendicular to the Beam -> COTR reflected back
  - 1:1 (1:2) Scale, optics using the Scheimpflug Principle
- 12 Off-Axis Screens
  - Same, but with additional Off Axis Target
  - Measure Bunches kicked out of the long Bunch Train by a Kicker



XFEL Wire Scanner Prototype

Wire- Scanners:

- 12 Stations in Groups of 3 (determine ε, α, β without any optics change)
- Fast Scanners running 1 m/s on Trigger
- separated hor. and vert. Scanners
- use Linear Motors and µTCA Controls



XFEL Wire Scanner Prototype RTM

ACKNOWLEDGMENT

This paper gives an overview over work done within the standard diagnostic work package. Therefore it represents the contributions of the many people of the project team. The author would like to thank all contributors to this work package as well as all the people in the E-XFEL project helping to get entire machine ready for installation and commissioning.

REFERENCES

[1] The European XFEL, Technical Design Report, http://www.xfel.eu/documents/technical_documents
[2] S. Schreiber et al., "First Lasing at FLASH2", FEL 2014, Basel
[3] M. Hüning, "Status of the European XFEL", IPAC 2013, Shanghai
[4] B. Keil et al., "The European XFEL beam position monitor system", IPAC 2010, Kyoto
[5] A. Kaukher et al., "XFEL Beam Loss Monitor System", IBIC 2012, Newport News
[6] MTCA.4, www.picmg.org, 2014
[7] C. Simon et al., "Production Process for the XFEL Re-Entrant Cavity BPM", IBIC 2014, Monterey
[8] S. Vilcins et al., "Mechanical Design of Cryogenic Vacuum Feedthroughs for X-FEL Button BPM's" , IBIC 2014, Monterey
[9] D. Lipka et al., "Button BPM Development for the European XFEL", DIPAC 2011, Hamburg
[10] D. Treyer et al., "Design and Beam Test Results of Button BPMs for the European XFEL BPM Electronics", IBIC 2013, Oxford
[11] D. Lipka et al., "BPMs from Design to real Measurement", IPAC 2014, Dresden
[12] B. Keil et al., "Design Status of the European X-FEL Transverse Intra Bunch Train Feedback", IBIC 2012, Tsukuba
[13] N. Baboi et al., "Commissioning of the FLASH2 Electron Beam Diagnostics in Respect to its use at the European XFEL", IBIC 2014, Monterey
[14] D. Lipka, "FLASH Undulator BPM Commissioning and Beam Characterization Results", IBIC 2014, Monterey
[15] M. Stadler et al., "Low-Q Cavity BPM Electronics for E-XFEL, FLASH-II and SwissFEL", IBIC 2014, Monterey
[16] D. Lipka et al., "Dark Current Monitor for the European XFEL", DIPAC 2011, Hamburg
[17] M. Werner et al., "A Toroid Based Bunch Charge Monitor System with Machine Protection Features for FLASH and XFEL", IBIC 2014, Monterey
[18] C. Wiebers et al., "Scintillating Screen Monitors for Transverse Electron Beam Profile Diagnostics at the European XFEL", IBIC 2013, Oxford
[19] T. Lensch, "Wire Scanner Installation into the MicroTCA Environment for the European XFEL", IBIC 2014, Monterey
[20] D. Nölle et al., "Test and Measurements with the Embedded Radiation-Monitor-System Prototype for Dosimetry at the European XFEL", IPAC 2012, New Orleans

Pictures: http://adweb.desy.de/~dnoelle/XfelMeetsPhotoshop
http:/xfel.desy.de/pictures