Summary of the LLRF activities within the recent FLASH upgrade.

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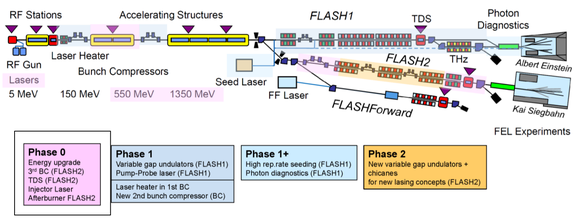
Abstract

The FLASH facility is currently re-commissioned after an almost 10-month shutdown for the FLASH2020+ project. Within this period several subsystems of the machine have been renovated or completely rebuild. One of the major tasks was the exchange of the accelerating modules ACC2 and ACC3 to European XFEL type cryomodules. Furthermore, the master oscillator which successfully operated for 15 years has been completely exchanged. Both demanded major re-cabling and adaptation of the interfaces to the existing infrastructure. A summary of the LLRF activities and experiences of the re-commissioning work is presented.

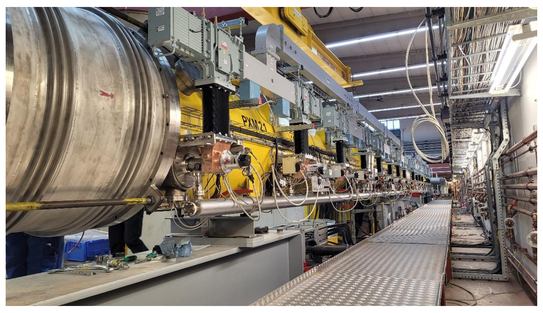
FLASH energy upgrade 2022+

- Energy upgrade to 1.35 GeV
- Injector upgrade
  - Laser heater installation in first BC
  - Optimized layout of the 2nd BC
- Cryo modification for 0.5bar operation
- …



Exchange of the cryomodules ACC2 and ACC3

- New XFEL type modules higher gradient with significantly better performance
  - Upgrade of the waveguide distribution system with optimized RF power distribution
  - Upgrade of the related sub-systems such as LLRF
- Piezo and phase shifters, fully complementary to XFEL
- New RF cabling required

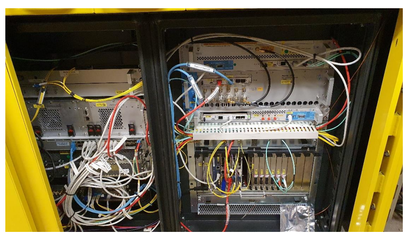


Installation of new CM for ACC2 and ACC3

https://flash.desy.de/

Summary of LLRF system changes

- Improved reliability
  - Critical components ar connected to UPS
  - Moved active ethernet components out of the tunnel
    - ▶ Modified patch panels and communication routing
- Improved performance
  - Installation of the re-synchronization device REFM-opt
  - Connection to new cooling water systems 8 →18degC
- Improved unification with XFEL
  - Integration of the machine protection system
  - Server and firmware upgrade
  - Exchanged external PS modules for 19" components
- Preventive maintenance
  - Patched upconverter module
  - Inspected / cleaned filters, checked fans
  - Overall cabinet cleanup

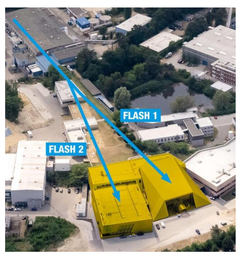


Clean-up and modification of LLRF racks installed in the accelerator tunnel

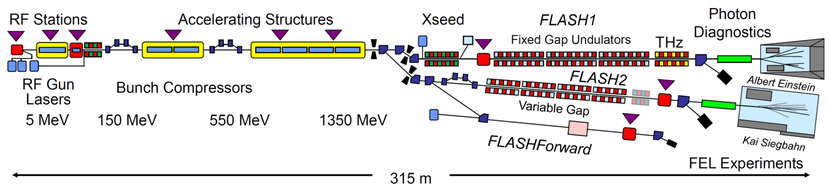
FLASH facility

Free-Electron **LAS**er in **H**amburg

- SASE FEL, 4.2 – 52nm
- 10Hz RF pulse rep rate
  - 1.3GHz + 3.9 GHz RF
- Regular dual beamline operation within one RF pulse FLASH 1&2

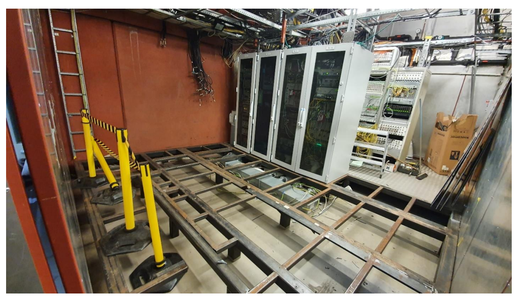


FLASH site and accelerator view



Master Oscillator upgrade

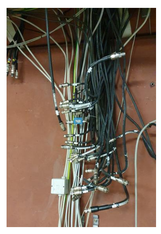
- Complete disable of the old master oscillator, component storage
- Installation and Commissioning of temporal MO during shutdown
- Clean up and preparation of the new cabinet space
- Installation and commissioning of the new rack infrastructure
  - Mains, cooling, IT, ..
- Installation and commissioning of the new MO components
  - Module integration
  - Cabling internal /external
- Switching from temporal to new MO

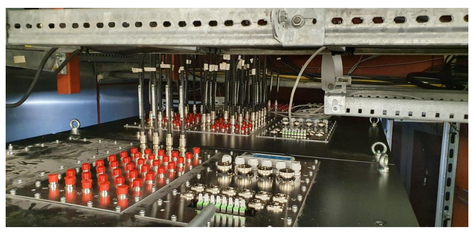


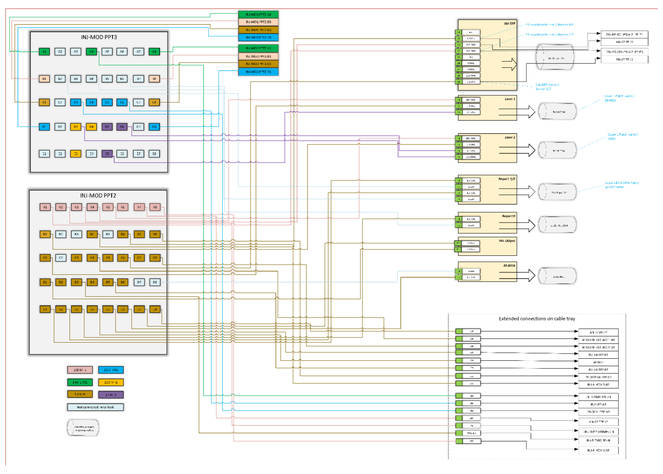
Upgrade of the reference distribution system

- Cleanup obsolete RF distribution cables from old installation
- Modification of the existing RF distribution cables
  - Extension, re-routing
  - Documentation!
- Setup new clients
- Characterization and commissioning of all links
- Improve sub-distribution cabling
  - clean-up obsolete modules

Now we have a complete documentation of all reference distribution clients !
→ Important for next upgrades







Summary and future work

- New MO installation and clean-up of the reference distribution
- LLRF system unification and adaptation to the new installed CM

- Final upgrade from the last VME system to uTCA
- CPU upgrade of current systems, KLM installation
- Optimization of the reference distribution system

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MSK. Maschine Strahlkontrollen

FLASH Free-Electron Laser in Hamburg