






LLRF control status at Helmholtz Zentrum Berlin

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HoBiCaT Lab

HZB  BESSY II
Light Source

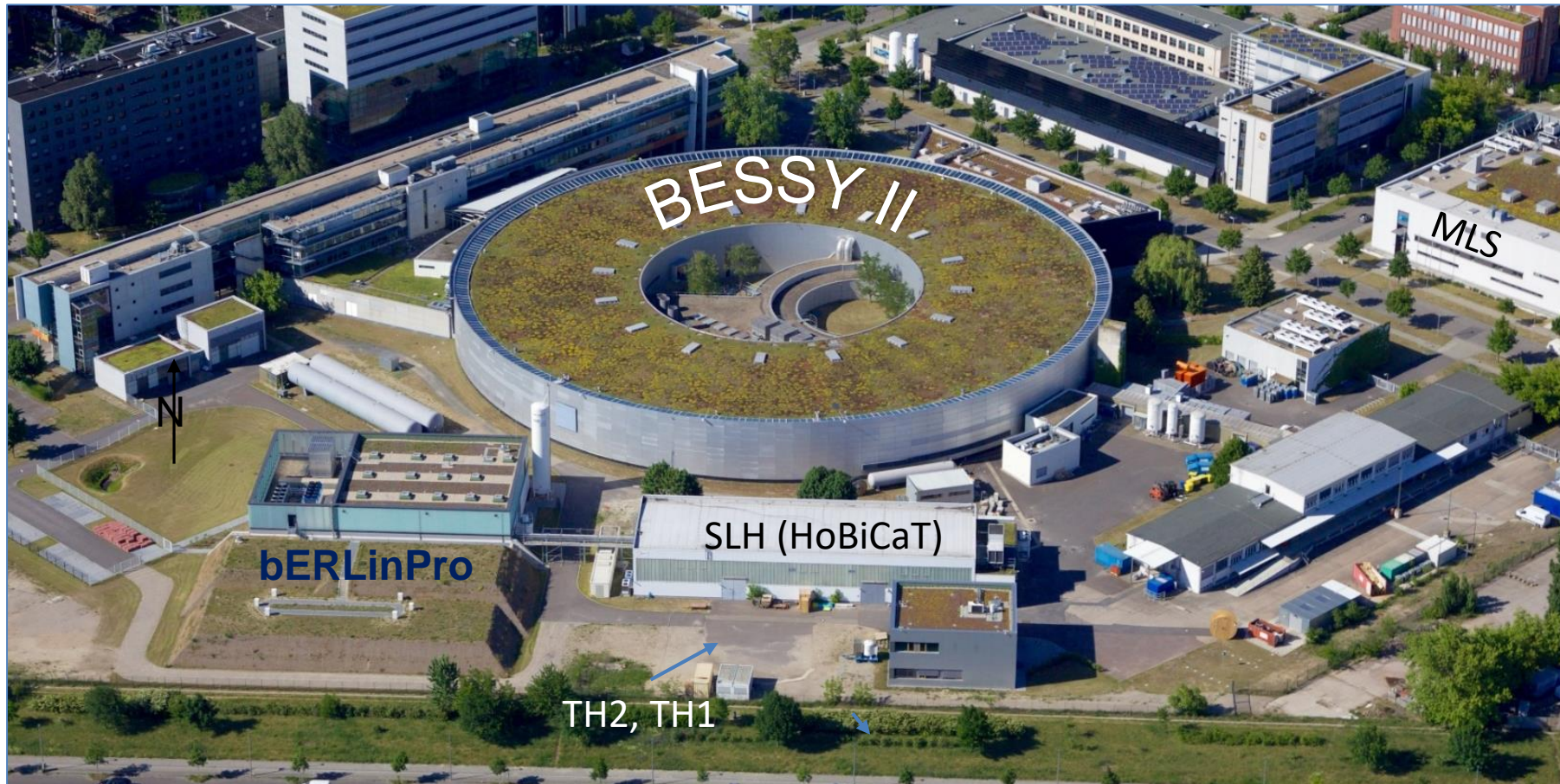
  

Bonus: Metrology Light Source



All of them:

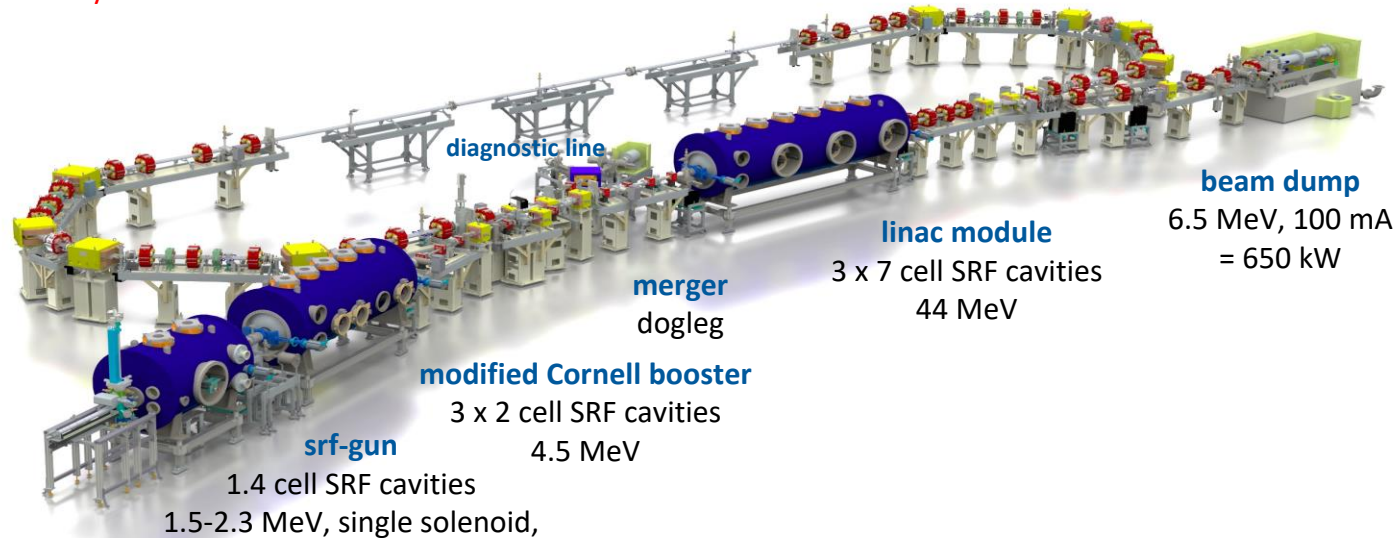
- Single cavity control
- EPICS



bERLinPro: A demonstration facility for ERL science and technology

New developments:

- Beam dynamics and manipulation (merger, recirculator, study beam break-up)
- SRF systems: Photo-injector, high power booster, HOM damped Linac
- Electron source: High repetition laser system high QE cathode development
- Control of beam losses and radiation protection
- High power beam dump
- High power CW RF
- A Cryoplant

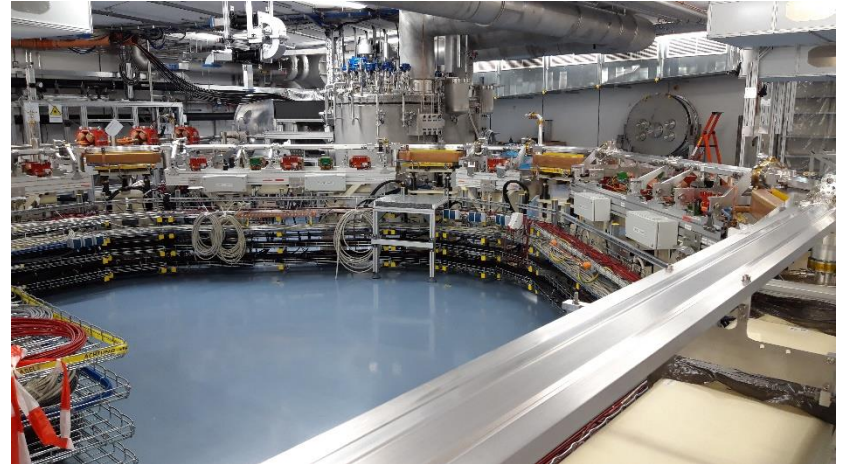


bERLinPro: A demonstration facility for ERL science and technology

- Recirculator vacuum closed
- RF and Cryoplant installed and partially commissioned

But the project officially ended in the beginning of 2021!

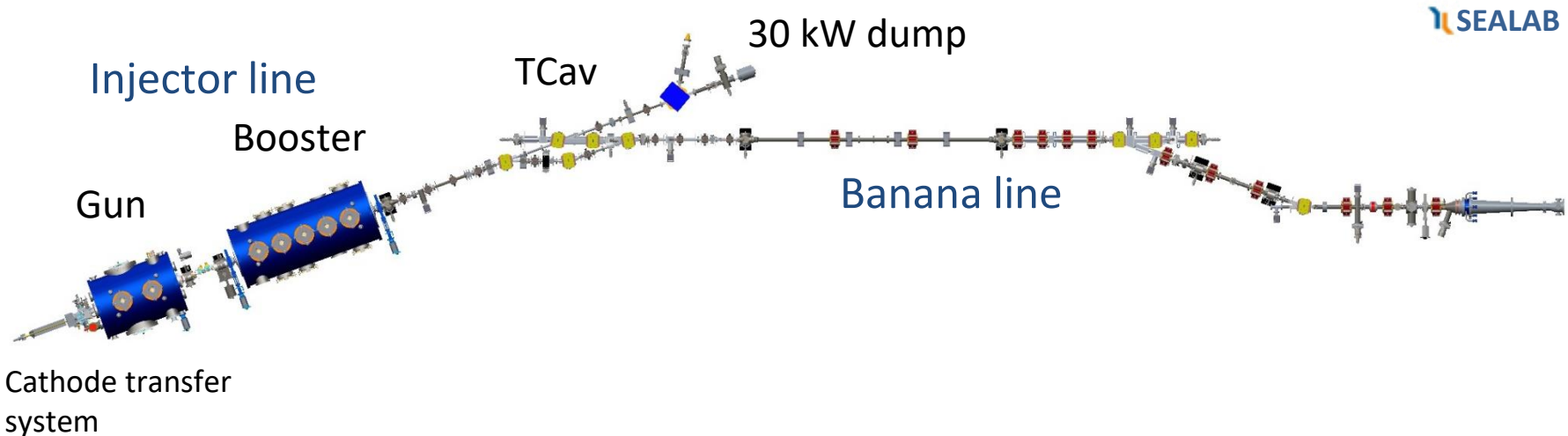
We still need a LINAC Module to be an ERL!



From bERLinPro to SEALAB (Srf Electron Accelerator LABoratory)

We want to open the machine up to internal and external applications:

1. Completion of the injector and banana lines
2. Commissioning Injector with beam
(up to 5 mA, up to 100 pC, up to 6.5 MeV)
3. UED experiment → Aiming for shortest pulses
4. Map the complete attainable phase space for many applications



Cathode transfer
system

- CW Single cavity control + Tuner's Motor Control + Tuner's Piezo Control

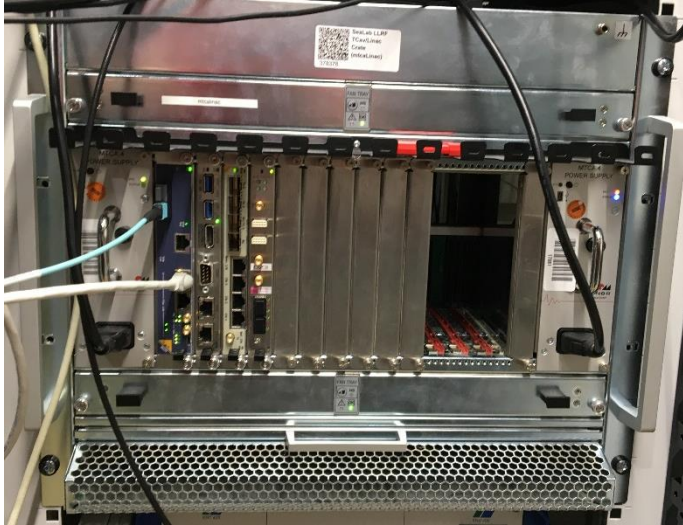


Injector crate: photoinjector + 3x booster:

- 4 pairs of SIS8300-L2+DWC8VM1; FMC25+MD22+PZT4
- X2-timer + x2-timer-RTM
- NAT-MCH (with PCI uplink) + MCH-RTM
- RF backplane + DRTM-LOG1300
- ADIO24 for MPS interfacing
- External CPU



- CW Single cavity control + Tuner's Motor Control + Tuner's Piezo Control



Linac crate: TCAV + reserved slots for Linac:

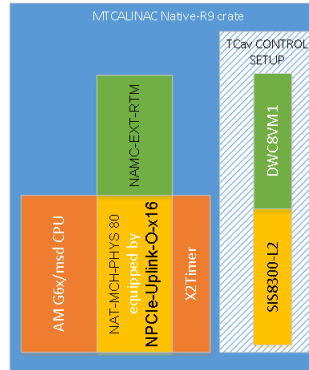
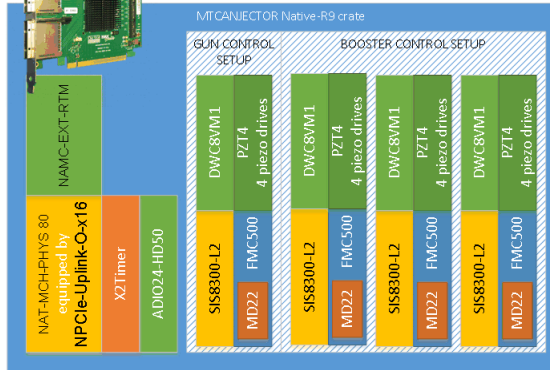
- 1 pairs of SIS8300-L2+DWC8VM1
- X2-timer + x2-timer-RTM
- NAT-MCH (with PCI uplink) + MCH-RTM
- RF backplane + DRTM-LOG1300
- AMC CPU



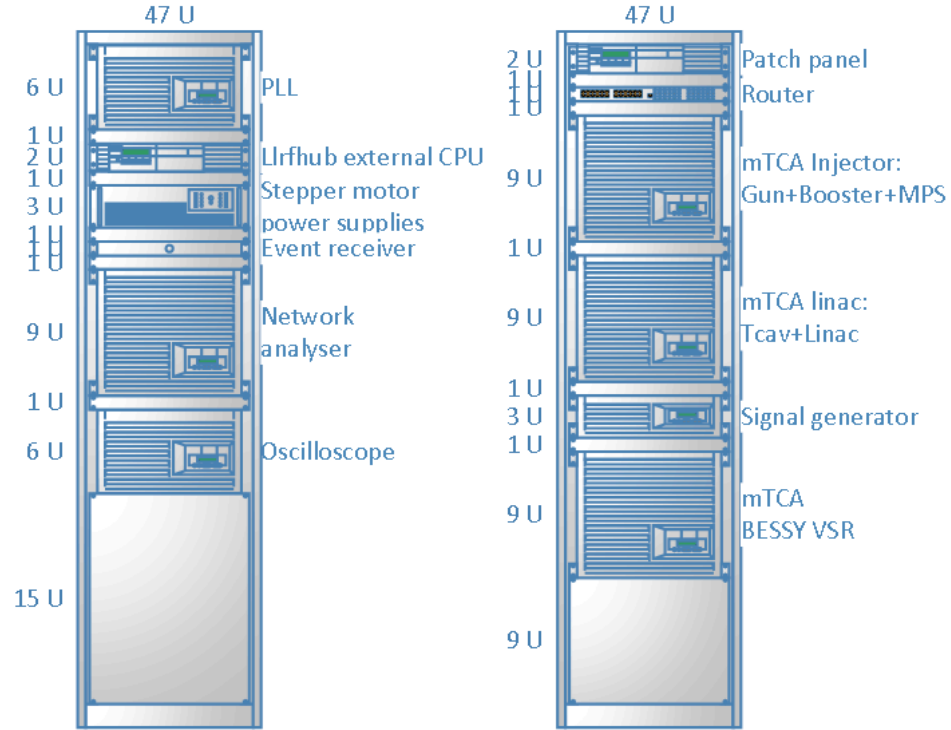
PLX PCIe NIC x8 Uplink



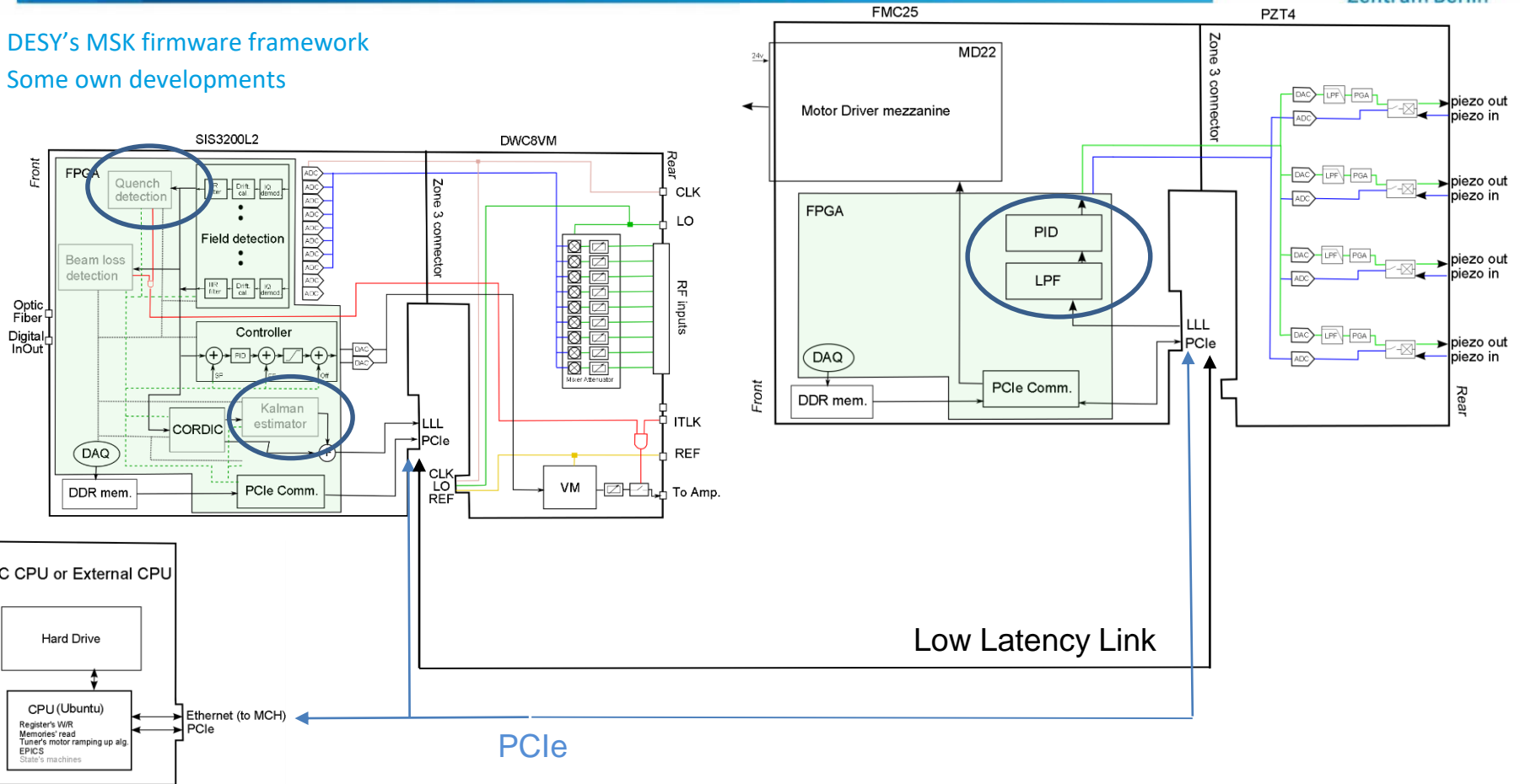
Optical interface



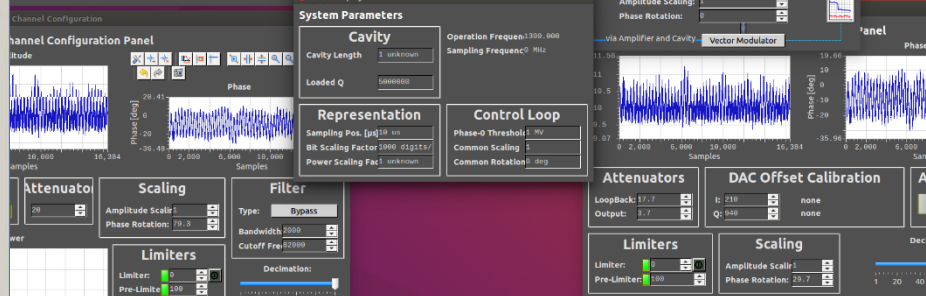
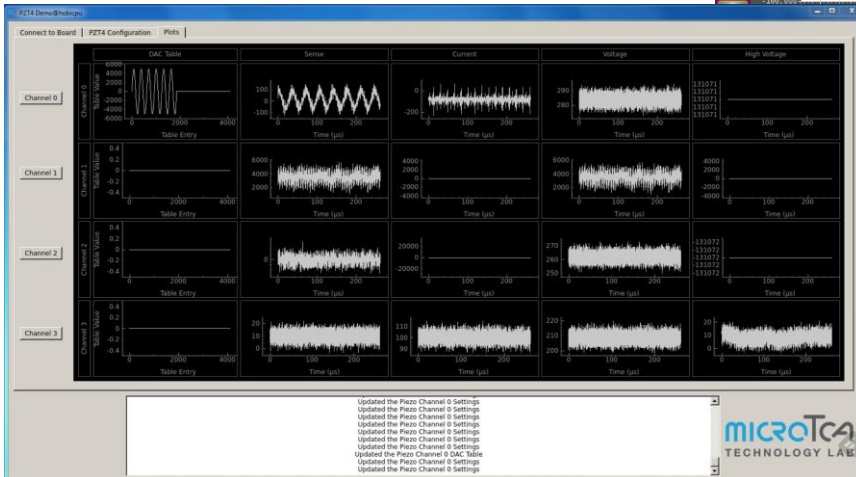
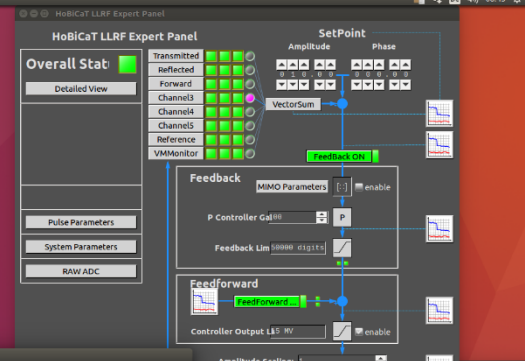
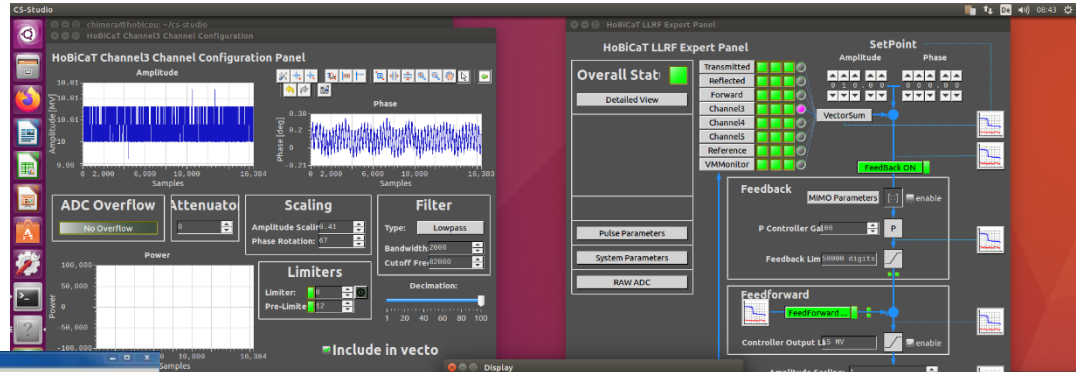
The cabinets equipment in the SeaLab RF Hall



- DESY's MSK firmware framework
- Some own developments



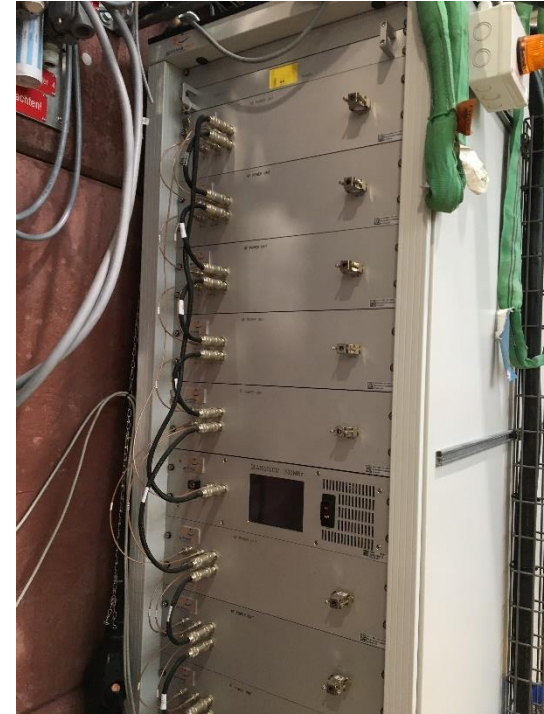
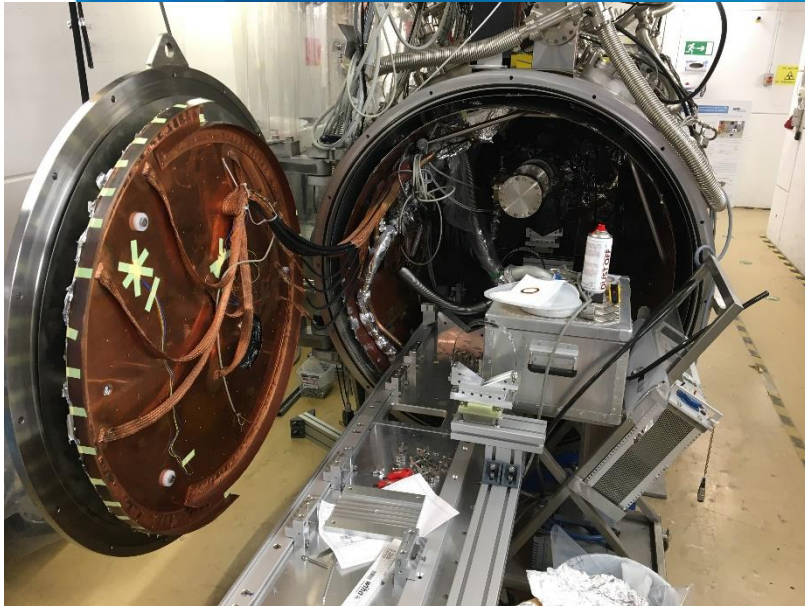
- LLRF Server + ChimeraTK adapter for EPICS



- Piezo and motor control still to be developed. Currently using Python GUI by Cagil Gümüş (DESY)

Horizontal Bi Cavity Test Stand (HoBiCaT)

- Testing cryomodule
- 15KW 1.3GHz SSA (and brand new 1.5GHz)
- Fully dressed TESLA cavity
- mTCA crate

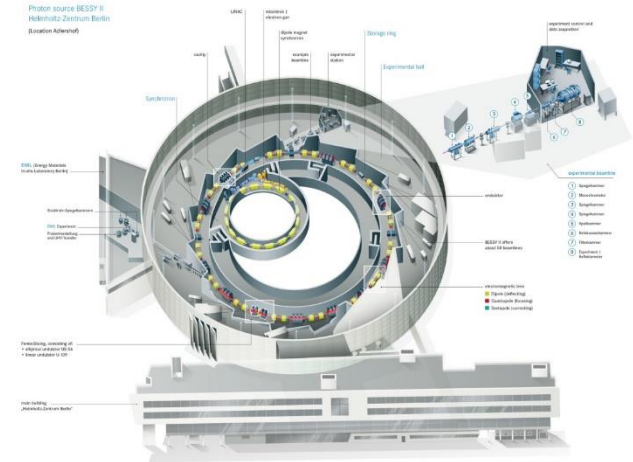


- The SR BESSY II is a 1.7 GeV synchrotron radiation source operating since 1998
- BESSY II emits extremely brilliant photon focused on soft X-rays (PETRA III: hard X-rays)
- Pioneer in offering low α operation (short pulses) with a community of user performing dynamic measurements in „functional materials“

Nevertheless BESSY II has passed its half life and needs to be renewed to be competitive among other light sources



BESSY-III



- New SSA amplifiers in operation since 2015
- Old analogue units → Noise limiting device, no spare units
- 1 Petra-type cavity in the booster
- 4 HOM-damped cavities in SR

HOM damped EU-Cavities

Copper 500 MHz

SR → Give back energy lost to the beam



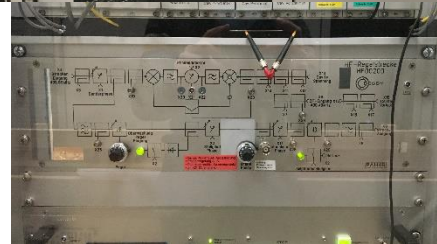
80kW 500MHz SSA



Petra-type cavity (5-cell)

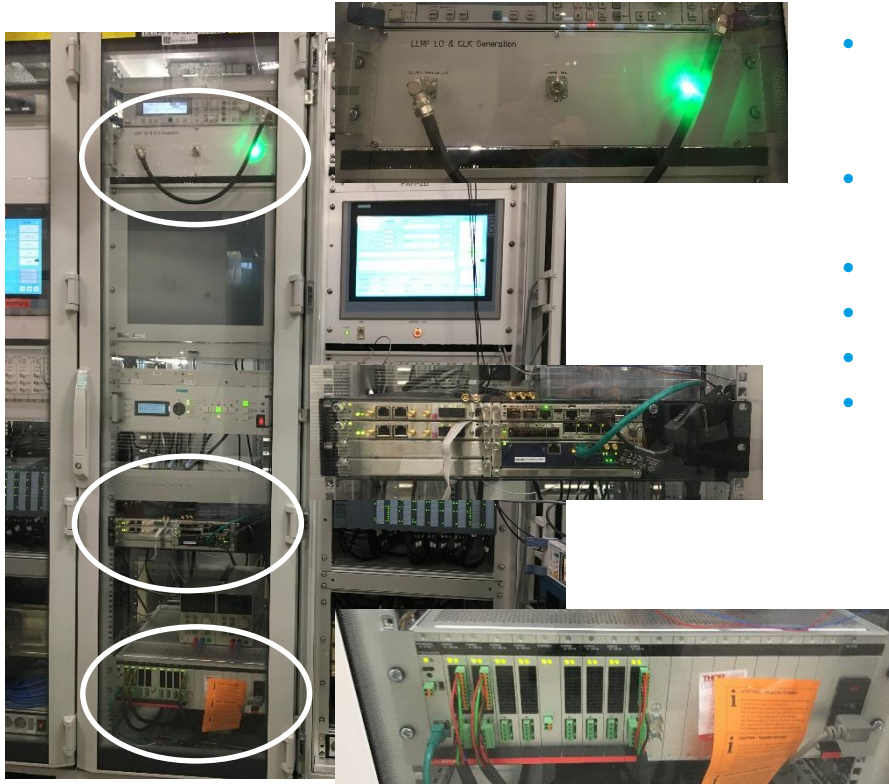
Copper 500 MHz

Booster → Acceleration



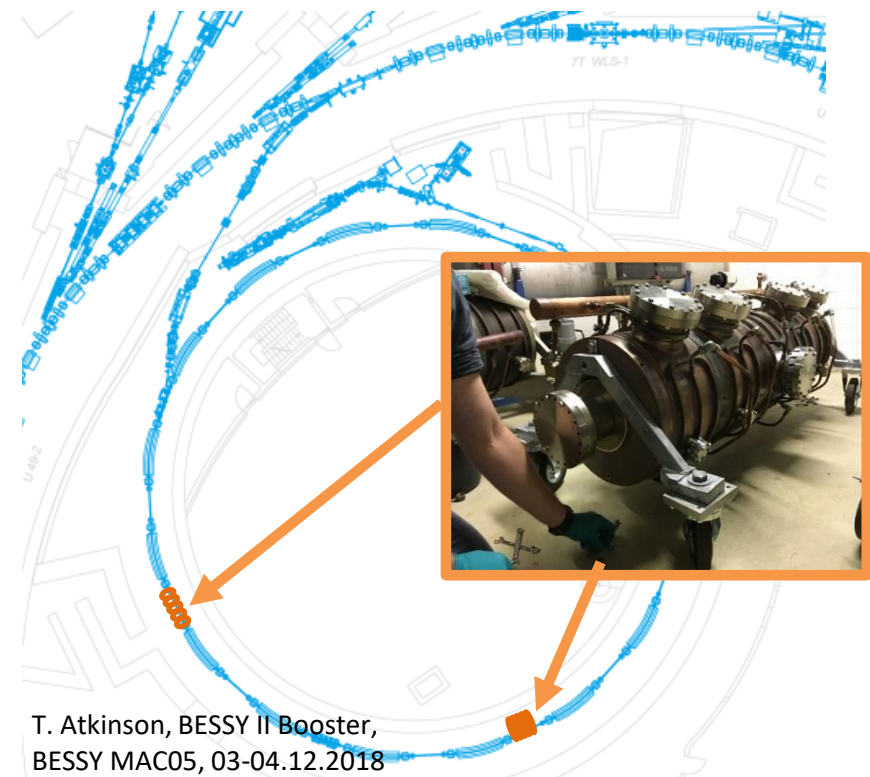
Analogue LLRF

- Two new Petra-type cavities in the booster ring + SSAs → Shorter injected beam
- New mTCA.4 single cavity LLRF control



- 12-slot crates expected next year:
 - Redundant PU and MCH (user machine)
 - Possible to retrofit an RF backplane
- External LO generation: same frequencies as PETRA and REGAE. Future upgrade? (U. Mavric later today)
- SIS8300-KU + DWC8VM1
- AMC CPU running LLRF server (ChimeraTK)
- Temporary X2-timer. BESSY-II will use MRF
- Phytron controller for cavity tuners (EPICS)

- Radiation permit expected in summer 2022
- Spare cavity in test stand



T. Atkinson, BESSY II Booster,
BESSY MAC05, 03-04.12.2018

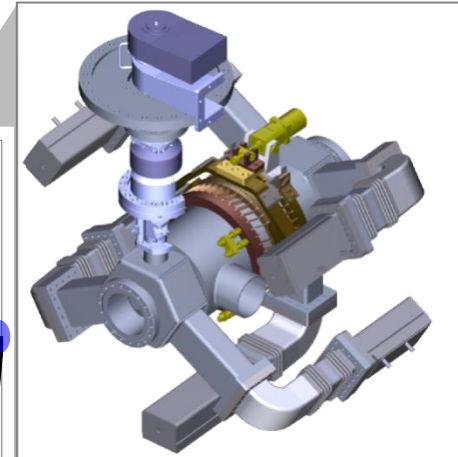
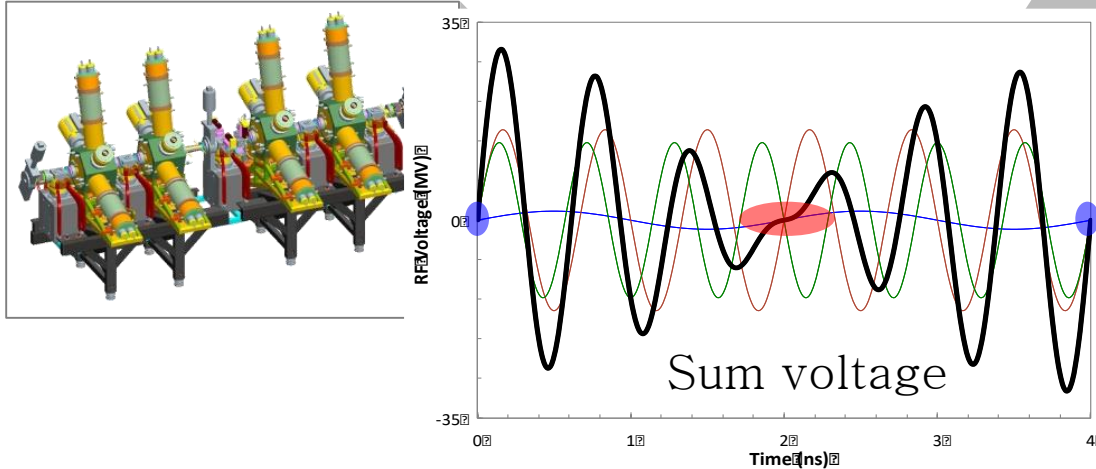


- Short pulses operation is a BESSY-II strong field but:
 - Lower beam current (flux reduced by 100)
 - Different machine optics → 1 week/year

$$\sigma \propto \sqrt{\alpha \dot{V}_{\text{rf}}}$$

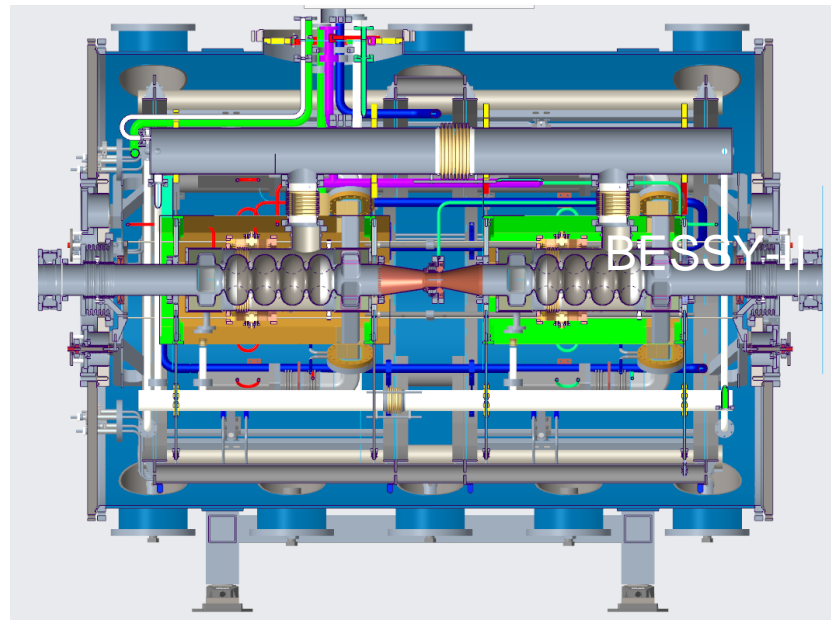
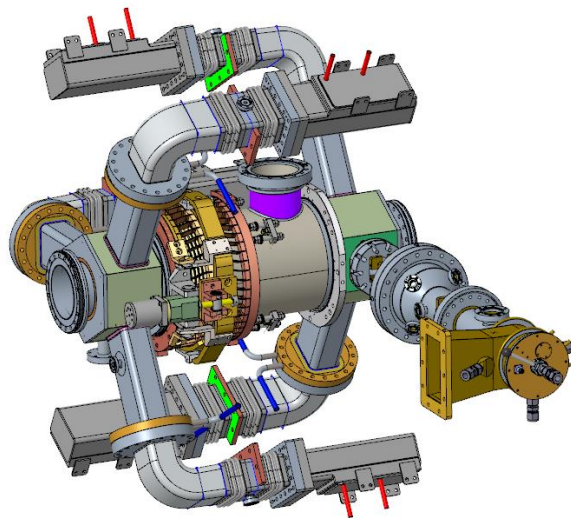
← Machine optics
← Hardware (RF cavities)

Existing 500 MHz



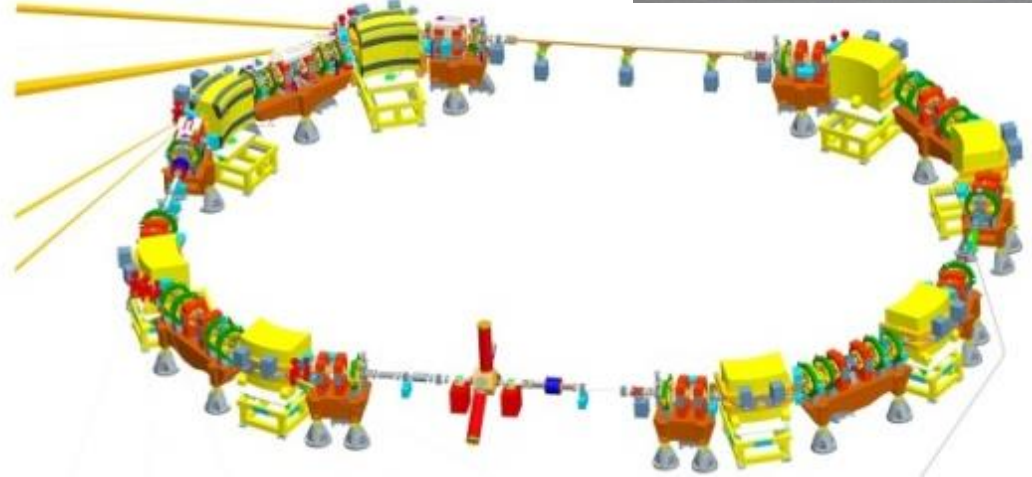
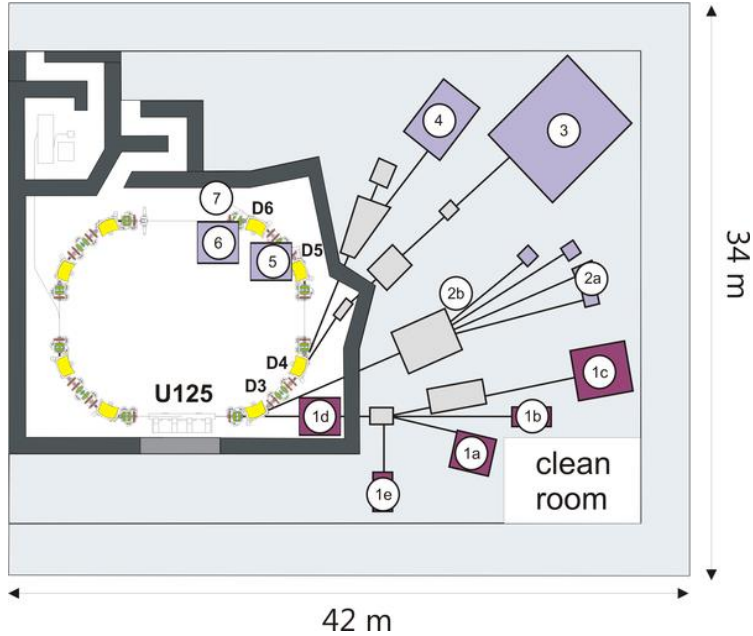
- Two-tone high-voltage CW SRF for innovative bunch-length manipulation
- Beating RF system provides two different buckets for short and long bunches spaced by 2 ns.

- VSR-DEMO as first step: test a cryomodule at SEALAB bunker
 - 2 SRF cavities @ 1.5GHz
- Similar LLRF concept as for bERLinPro but:
 - SIS8300-KU instead of L2
 - DAMC-FMC2ZUP instead of FMC25
 - DRTM-LOG1500 (in development → See Uros' talk)



Metrology Light Source

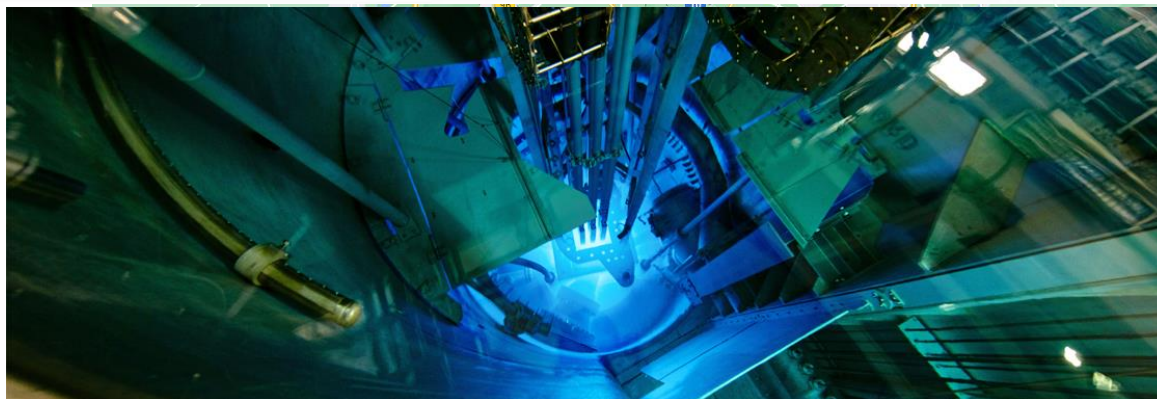
- Owned by Physikalisch-Technische Bundesanstalt (PTB), operated by HZB
- Same analogue LLRF as in BESSY-II. To be replaced, as well.



Thanks for your attention!

Our research at a glance

- Photon Science
- Photovoltaics
- Solar Fuels / Catalysis
- Electrochemical energy storage
- Quantum and Functional Materials
- Accelerator Research



Mit Flävisen
und Seeburger
Grämlandschaft

BER II Neutron Source (Decommissioned)



Lise Meitner Campus (Wannsee)



Proton Cyclotron for Eye Tumor Therapy