DESY lab talk

Short update on LLRF systems development at DESY

Julien Branlard, for the LLRF team
Low Level RF Workshop 2022
Brugg-Windisch
10.10.2022

Contribution ID 104

HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

DESY.

The European XFEL

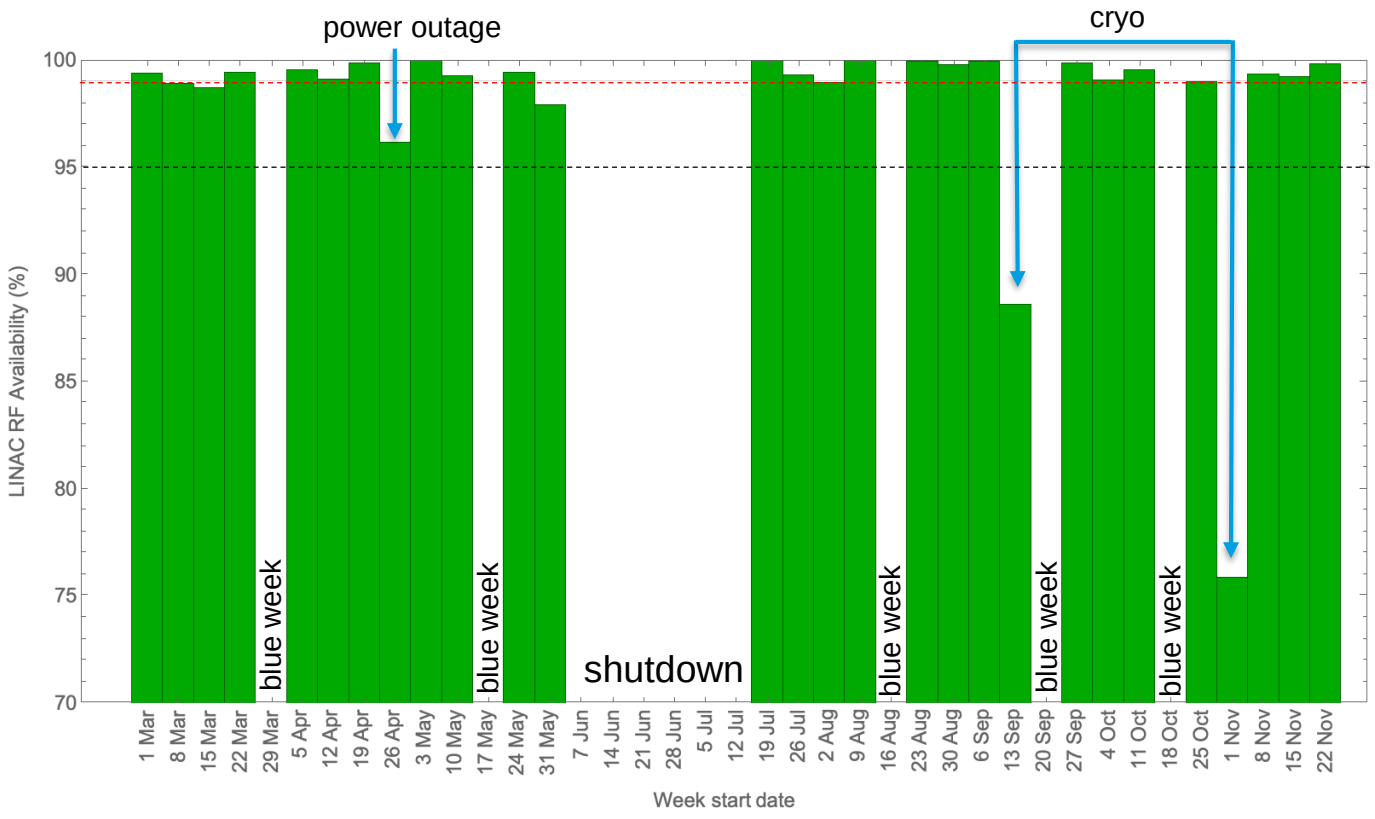
Highlights

- High **availability** (95-99%) and operation statistics

- Flattop → **Beam regions**

- Further development of **beam-based fast FB** (BAM and BCM) arrival time jitter < 6fs

2021 LINAC availability for user runs



Operation Configuration	Time fraction at reduced energy ≤14.5 GeV	Time fraction at high energy >16 GeV
2021	79%	21%
2022	68%	32%

The European XFEL

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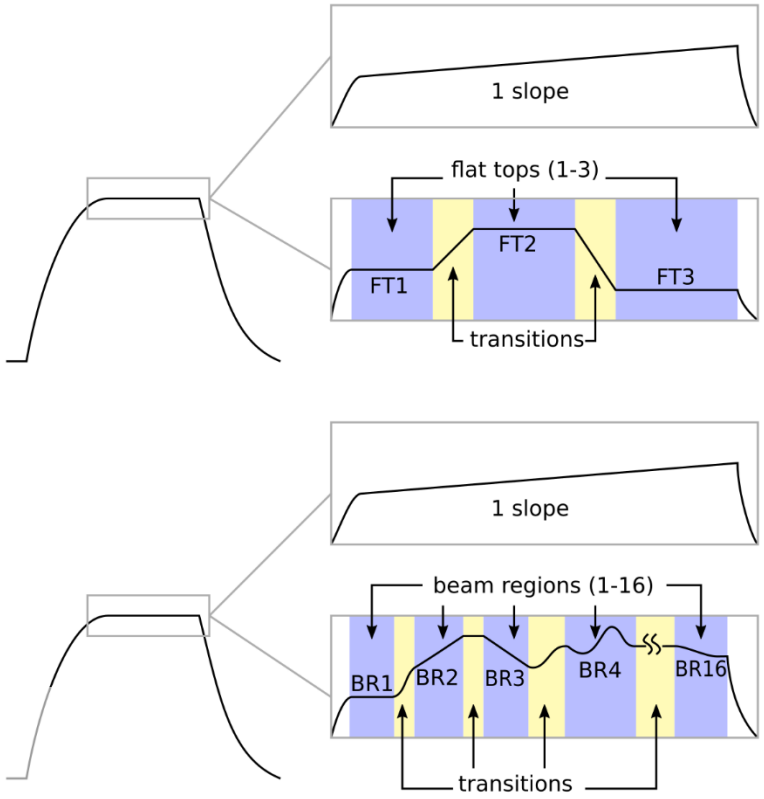
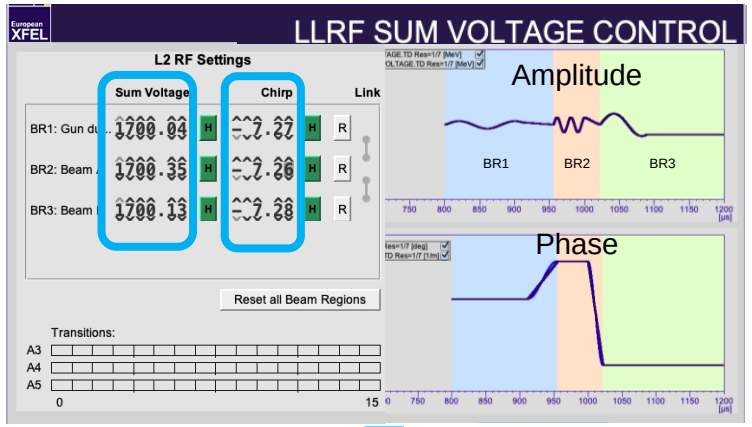
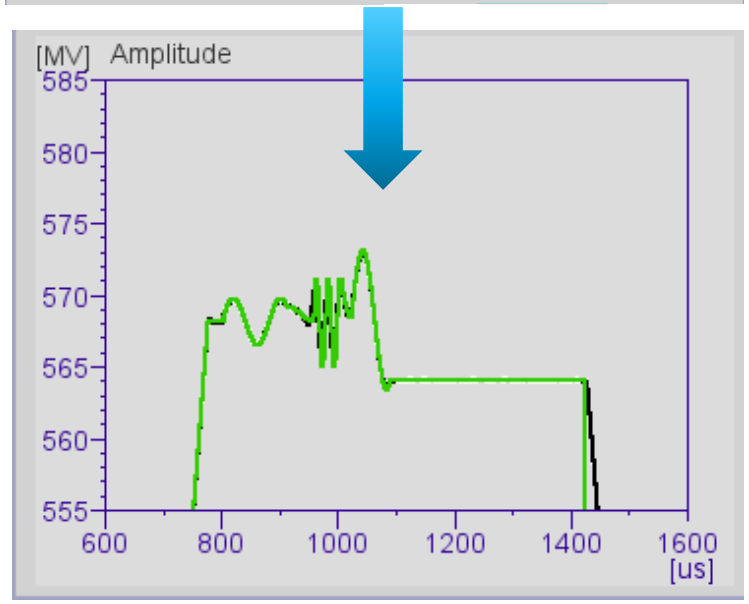




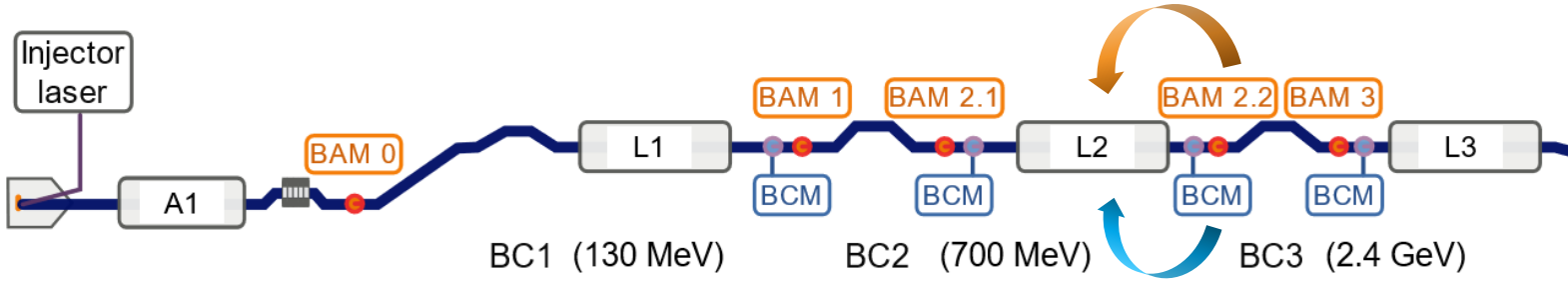


Marco Diomede (#34) Talk on Tuesday

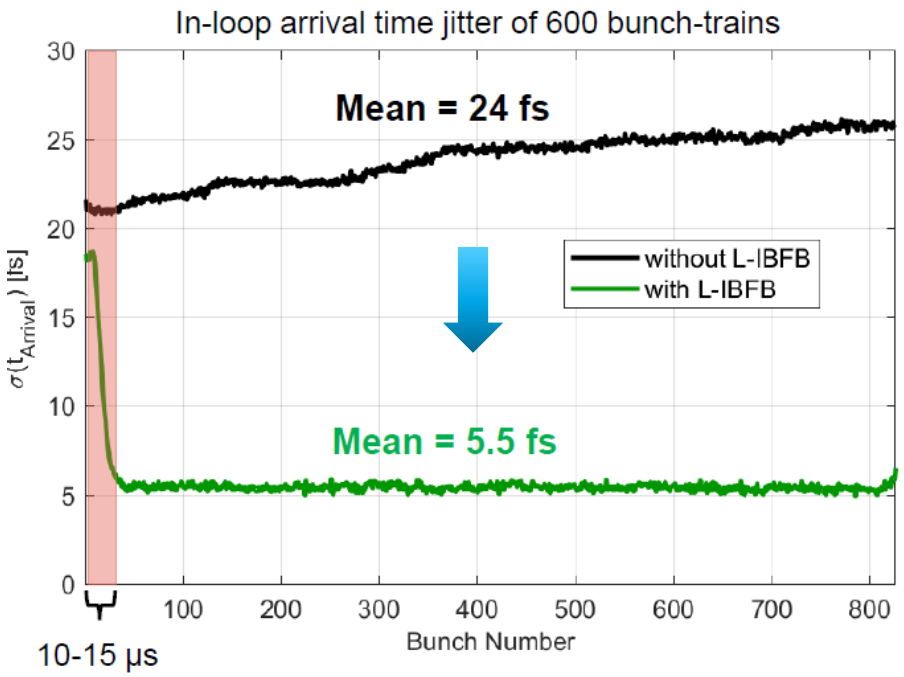
The European XFEL

Highlights

- High **availability** (95-99%) and operation statistics



- Flattop → **Beam regions**



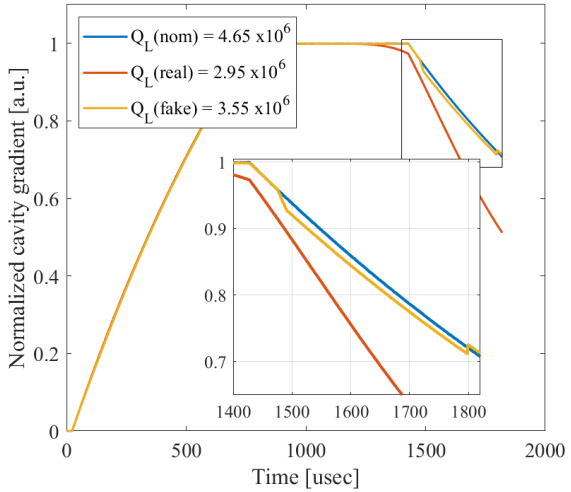
- Further development of **beam-based fast FB** (BAM and BCM) arrival time jitter < 6fs

Björn Lautenschlager (#35) Talk on Thursday

The European XFEL

Machine Learning for particle accelerators

- Make use of **machine learning** to improve diagnostics (i.e. quench detect)



Can ML help distinguish “REAL” from “FAKE” quenches ?

	TP	TN	FP	FN	a
QDS	55	56	10	3	~90%
GLR	55	65	1	3	~97%

improved accuracy

Julien Branlard (#23) Talk on Monday

- FPGA-based **HW acceleration of ML algorithms**

White Paper

Comparing FPGA RTL to HLS C/C++ using a Networking Example

Gianluca Martino (#5) Talk on Monday

FLASH upgrade

End of 1 year shutdown

FLASH
Free-Electron Laser in Hamburg

- Energy increase (**exchange of 2 cryomodules**) new bunch compressors and laser heater
- LLRF **upgrade**

➡ Christian Schmidt (#27) Poster on Wednesday

- New **master oscillator** (in collaboration with ise)

➡ Maciej Urbanski (#45) Talk on Monday

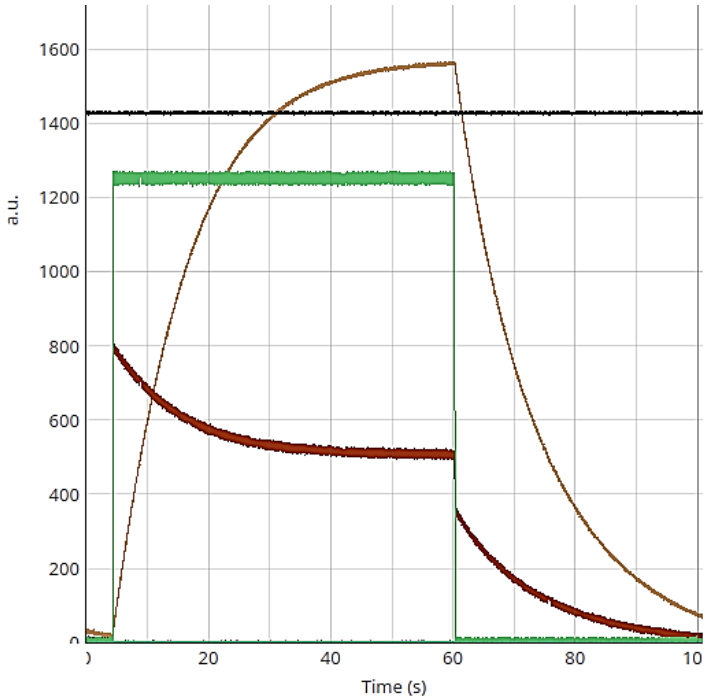
TEST facilities

… and other “smaller” facilities

- REGAE and other NRF systems
  - **New FW for higher sampling ADC** (125 → 250 MSPS)

Michael Buechler (#65) Poster on Wednesday

- Cavity VTS (analog → **MTCA.4 SEL system**)



March 2022
SEL test with a 1.3 GHz SRF cavity with a coupling of Q_L = 5e10

- Coupler processing test stand
- Klystron test stand
- CW tests stands (1.3 GHz and 3.9 GHz)
- FALCO : NRF gun conditioning test stand
- SRF gun test stand
- …

Cagil Guemues (#77) Poster on Wednesday

FUTURE facilities

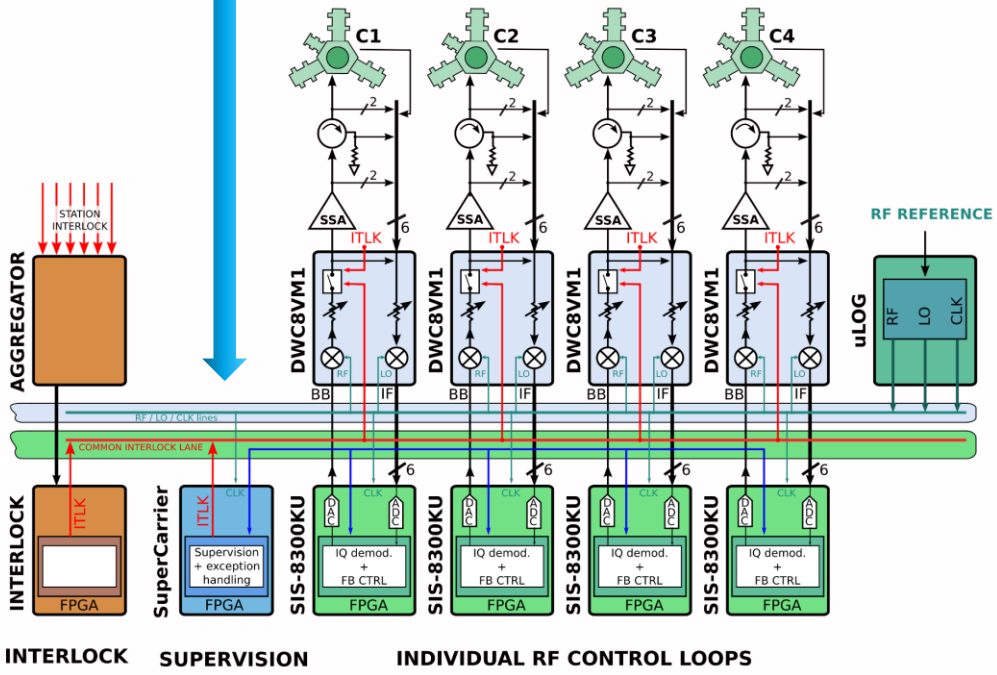
~ 5 years

- **PETRA IV upgrade**
  - Achieve 10keV X-ray energies (approaching diffraction limit)
  - Ideal source for 3D X-ray microscopy on nanometer scale

- Entire machine upgrade
- Including new LLRF (MicroTCA-based)
- 24 cavities at 500 MHz
- 24 cavities at 1.5 GHz
- **Develop trip compensation concept**
- 500 MHz test stand in operation

"supervisor" to redistribute RF if one loop trips

4x single regulation loops



Matthias Hoffmann (#25) Poster on Wednesday

COLLABORATIONS

with partner (Helmholtz) and external labs

HELMHOLTZ
RESEARCH FOR GRAND CHALLENGES

- **Open source FW**
  - FW **framework** code available on **GitLab**
  - **Board Support Package** also available for selected boards on **GitLab** https://gitlab.desy.de/fpgafw/fwk

Lukasz Butkowski (#114) Speed Talk on Wed.

- **Open source SW**
  - ChimeraTK **framework** source on **GitHub** https://github.com/ChimeraTK/
  - Servers available under **LGPL-3 license** GNU General Public License v3.0
  - Server **source code on Gitlab** https://gitlab.desy.de/msk-sw

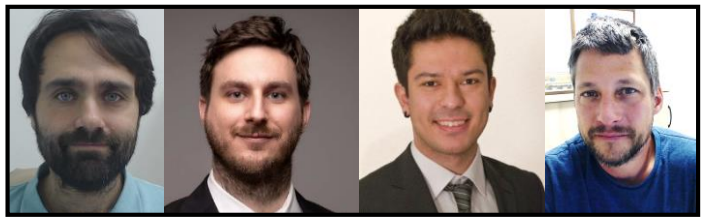
- **EPICS** for **LLRF servers**

Patrick Nonn (#18) Poster on Wednesday

COLLABORATIONS

with partner (Helmholtz) and external labs

- **Collaboration with SLAC (USA)**
  (LLRF employees to LCLS-II commissioning)



Development of a **narrow band active noise compensation** (NANC) at LCLS-II

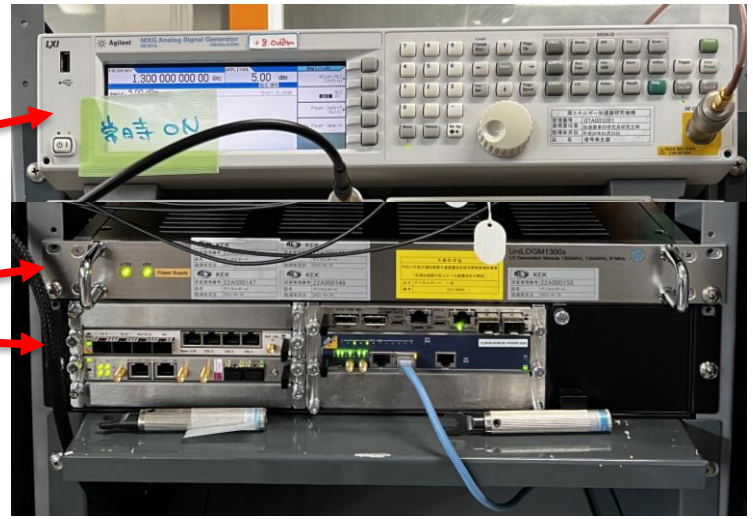
➡ Andrea Bellandi (#91) Poster on Wed.

- Discussion for **collaboration with SCK CEN**
  MYRRHA (front end for ADS in Belgium)

- **Collaboration with KEK (Japan)**
  (Cavity VTS with digital SEL)

(see KEK lab talk)

Courtesy M. Omet

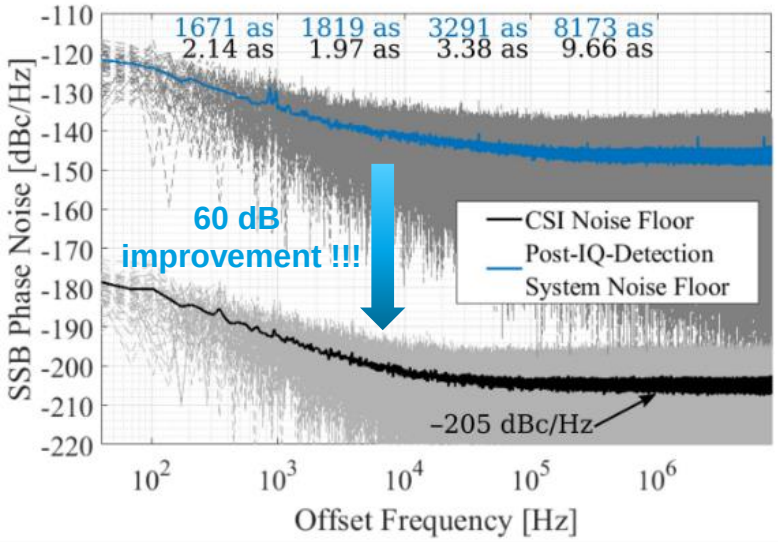


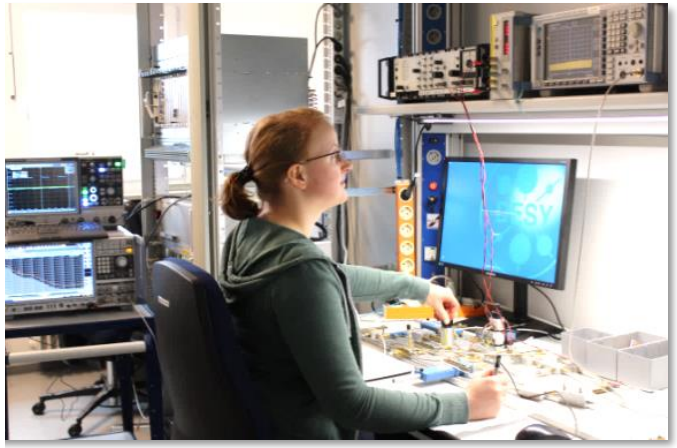
Continuing R&D

Master, PhD students and PostDocs

- **Attosecond field detection**
  Carrier Suppression Interferometer (CSI)

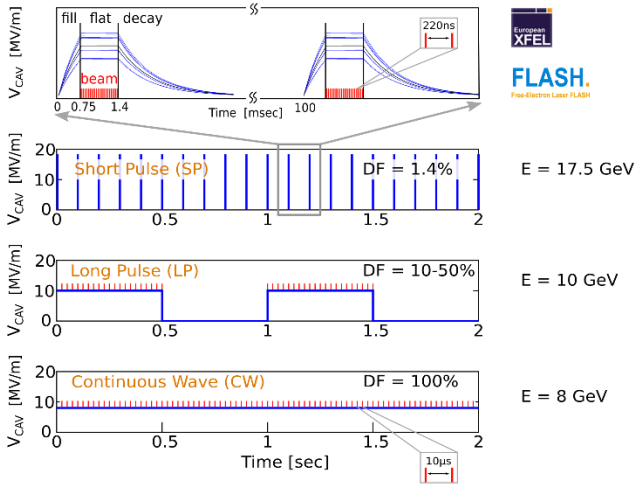
➡ Uros Mavric (#41) Invited Talk on Wednesday





Reference:
L. Springer et al., “Phase Noise Measurement for L-Band Application at Attosecond Resolution”, in IEEE Transactions on Instrumentation and Measurement, vol. 71, pp.1-7, 2022

- **CW / LP EuXFEL** (continuous wave / long pulse upgrade of the European XFEL)
  - Mini workshop Nov. 2-3 2022



Thank you

2 weeks ago : LLRF team back in the control room !!!

End of 1 year shutdown : FLASH tuning after cool down

Contact

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List of DESY contributions

- DESY lab talk (104)
- CSI (41)
- FLASH2020 MO upgrade (45)
- L-IBFB (35)
- LLRF EPICS (18)
- FLASH shutdown (27)
- Update of XFEL LLRF (34)
- PETRA IV LLRF (25)
- SEL in MTCA (77)
- Machine learning quench detect (23)
- FPGA HW accelerator for ML (5)
- NANC (LCLS-II) (91)
- Fast FB for REGAE (65)