Longitudinal Diagnostics at FLASH and European XFEL .

Features, upgrades and future plans

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On behalf of the group for beam controls (DESY, MSK)

12th workshop on longitudinal electron bunch diagnostics, Karlsruhe, 12th – 14th Jun. 2023

HELMHOLTZ MT MATTER AND TECHNOLOGIES

FLASH. Free-Electron Laser FLASH

European XFEL

Agenda

1) **Overview : European XFEL**

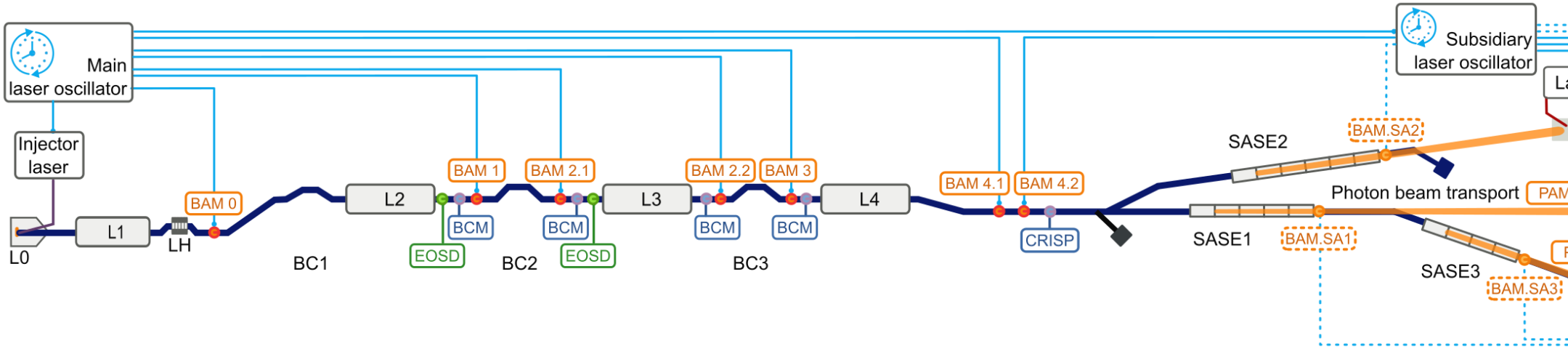
2) **Highlights of longitudinal diagnostics at EuXFEL**
   a) **Intra-train arrival time feedback in standard operation**
   b) **Investigation of seismic effects on arrival time stability**

3) **Overview : FLASH**

4) **Highlights of longitudinal diagnostics at FLASH**
   a) **New EO bunch length diagnostics**
   b) **FLASHforward edge radiation BCM**
   c) **THz beamline + permanent test lab**

Overview European XFEL

Longitudinal Diagnostics at EuXFEL



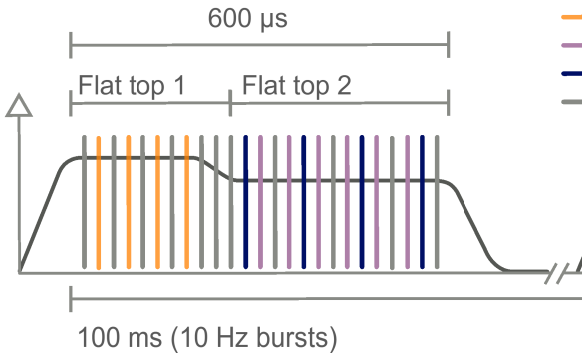
Operated diagnostics

- 7x BAMs
- 1x EOSD
- 4x BCMs
- 1x CRISP
-

New or pending diagnostics

- 1x EOSD
- 3x BAMs

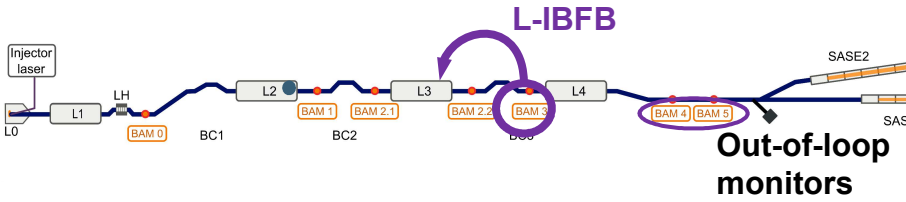
- No. of bunches up to 2700 per train
- bunch spacing down to 220ns
- bunch charges 20pc to 0.5nC
-

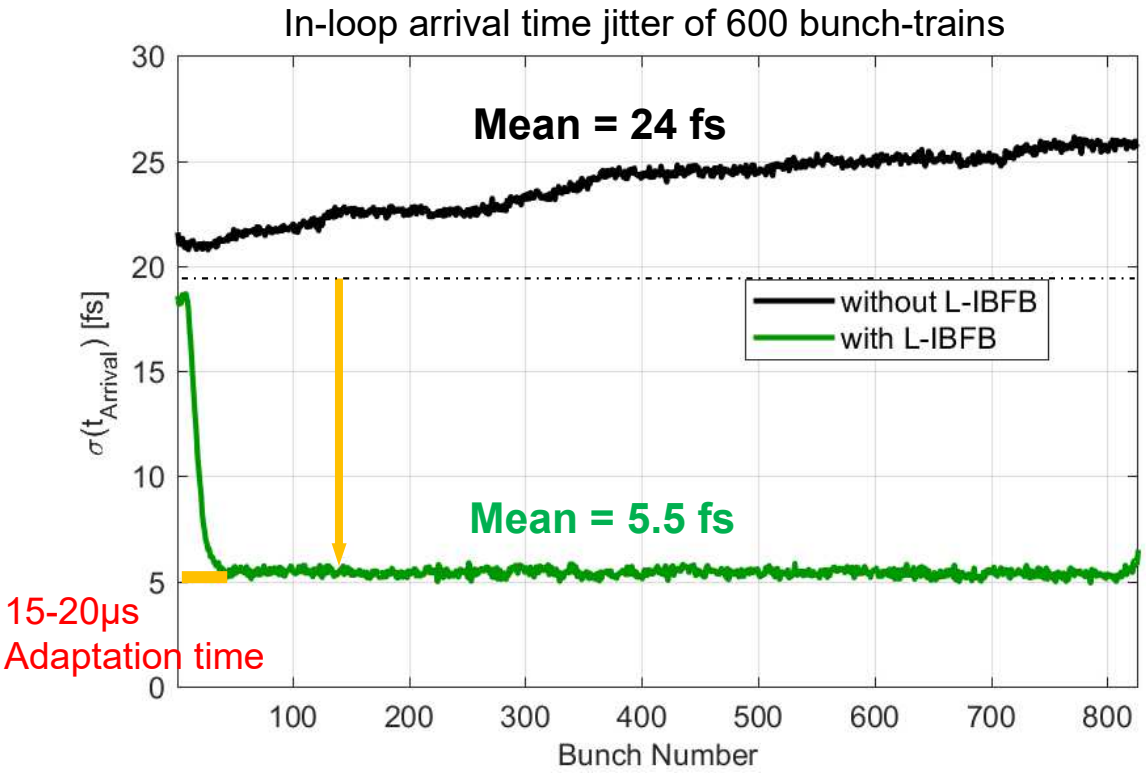


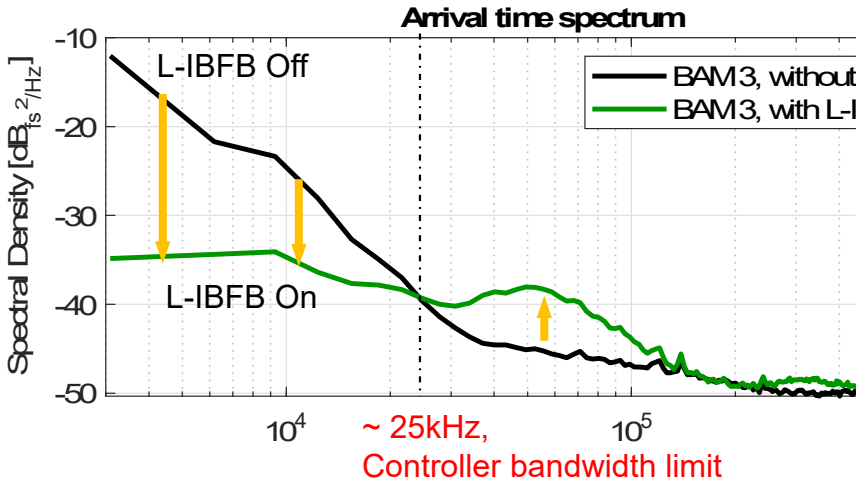
Highlights
of longitudinal diagnostics at EuXFEL

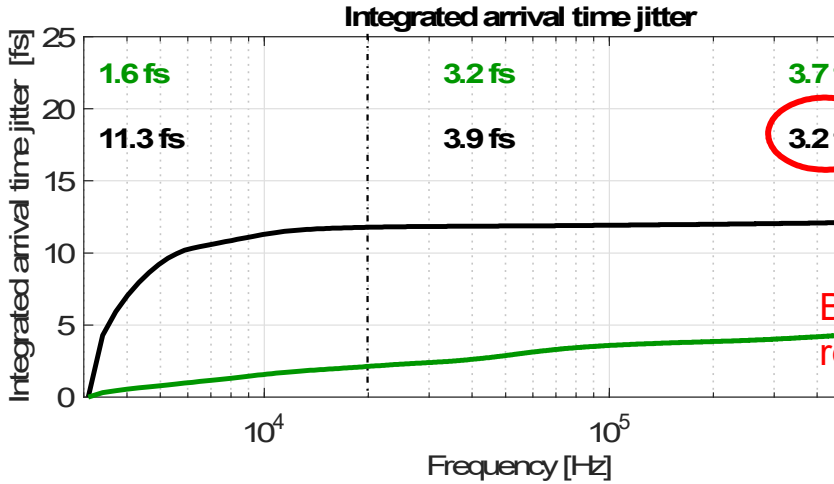
Intra-train arrival time feedback in standard operation

- The L-IBFB uses BAM No. 5 to act on A5 during the RF flat-top
- Reduction of arrival-time jitter to 5.5 fs
- Steady state value reached after 10-15 µs



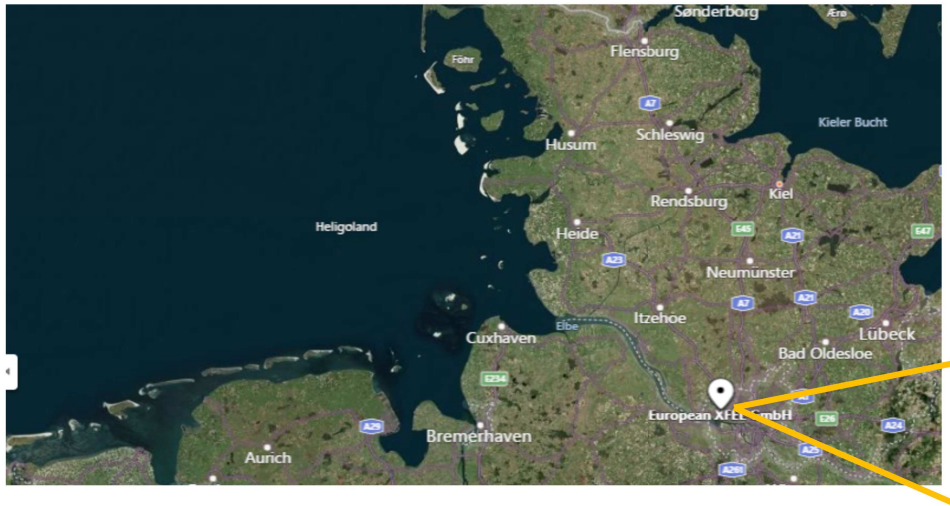


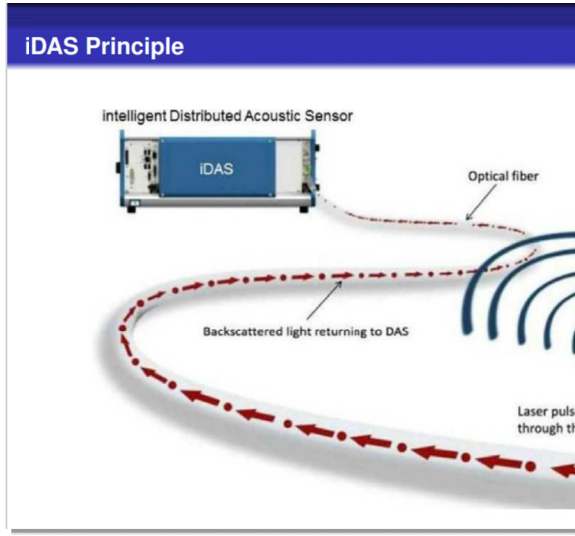


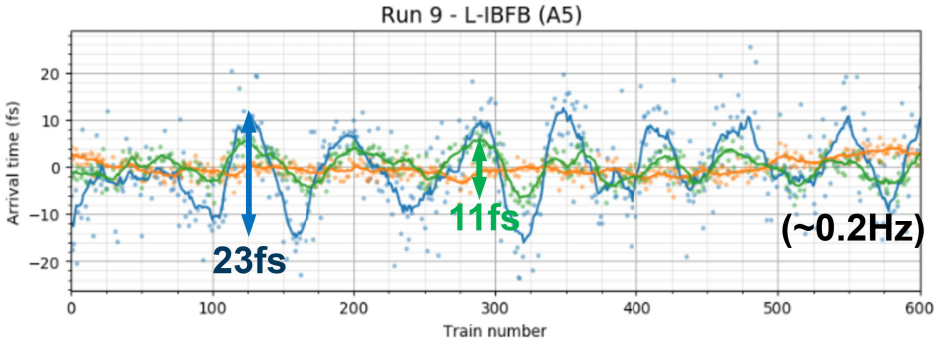


Investigation of seismic effects on arrival time stability

Seismic network for accelerators







- autumn, Oct. 2020

Romain Letrun, Tokushi Sato, Henry Kirkwood, Jayanath Koliyadu
SPB/SFX Instrument, European XFEL
Oct.2020 – Mar. 2021

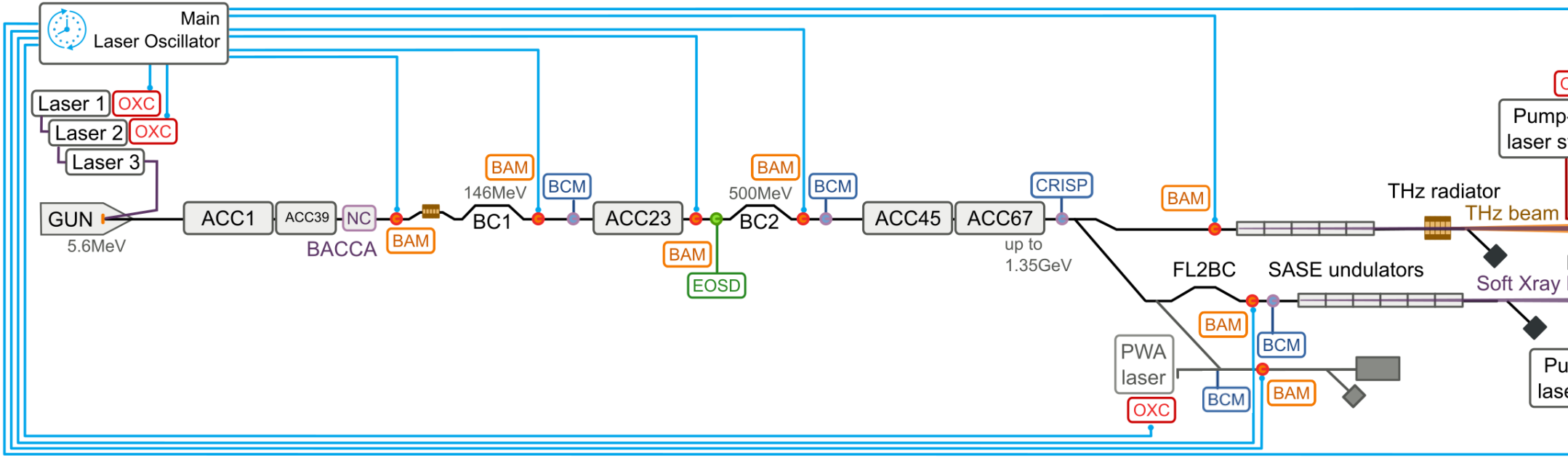
Observed issues with arrival tim

- ca. 5sec period, oscillation bet sensors
  - ❑ Ruled out Main RF fre
  - ❑ Ruled out issues with synchronization
  - ❑ **Origin of error ??**

Poster :
Sources and suppression of arrival time fluctuations (Czwalinna)

Overview
FLASH

Longitudinal Diagnostics at FLASH



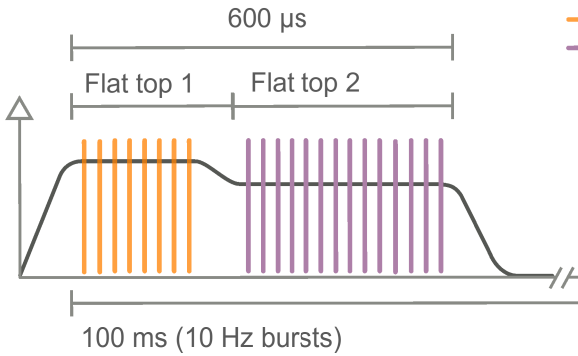
Operated diagnostics (after 2022 shutdown)

- 7x BAMs
- 1x EOSD
- 3x BCMs
- 1x edge radiation BCM
- 1x CRISP

Additional after 2024 shutdown (8/24 to 4/25)

- 2x BCMs
- 1x BAM

- No. of bunches up to 500 per train
- bunch spacing down to 1µs
- bunch charges 10pc to 1nC



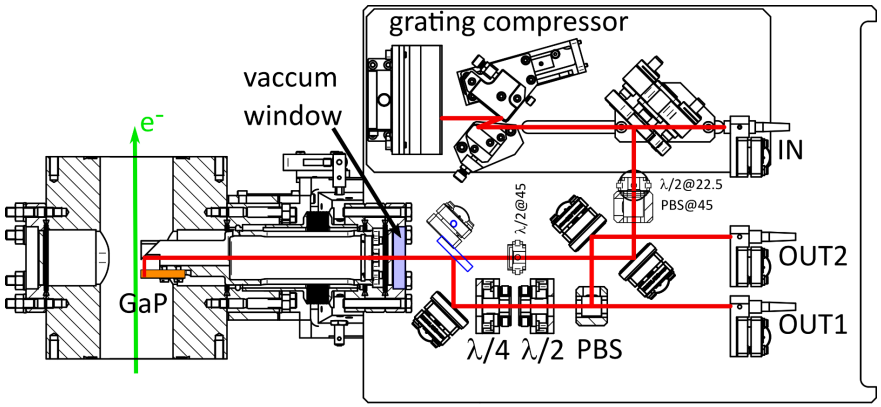
Highlights
of longitudinal diagnostics at FLASH

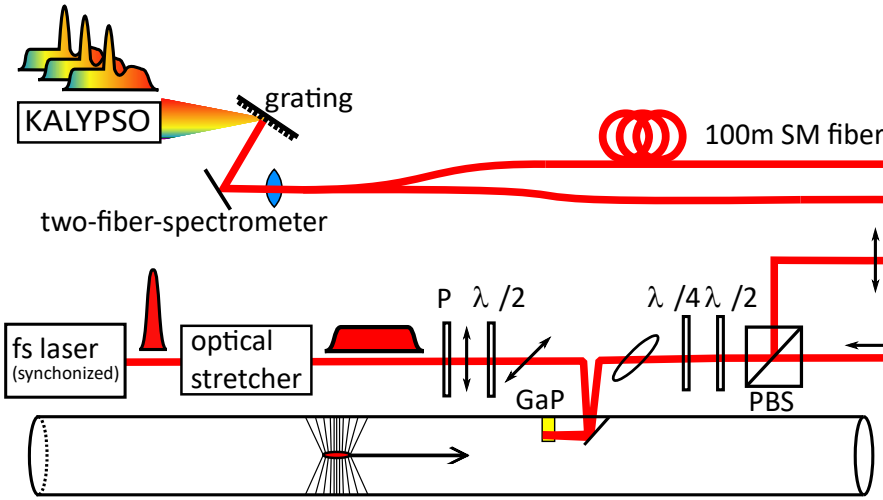
New EO bunch length diagnostics

DEOS: Diversity Electro-Optic Sampling

High temporal resolution and long time window with Spectral decoding

New design **optimized for novel electro-optic detection scheme:**





- **New optics design** to prevent polarization distortion from metallic mirrors (see also Quentin's poster)
- Further optics upgrades to test
-

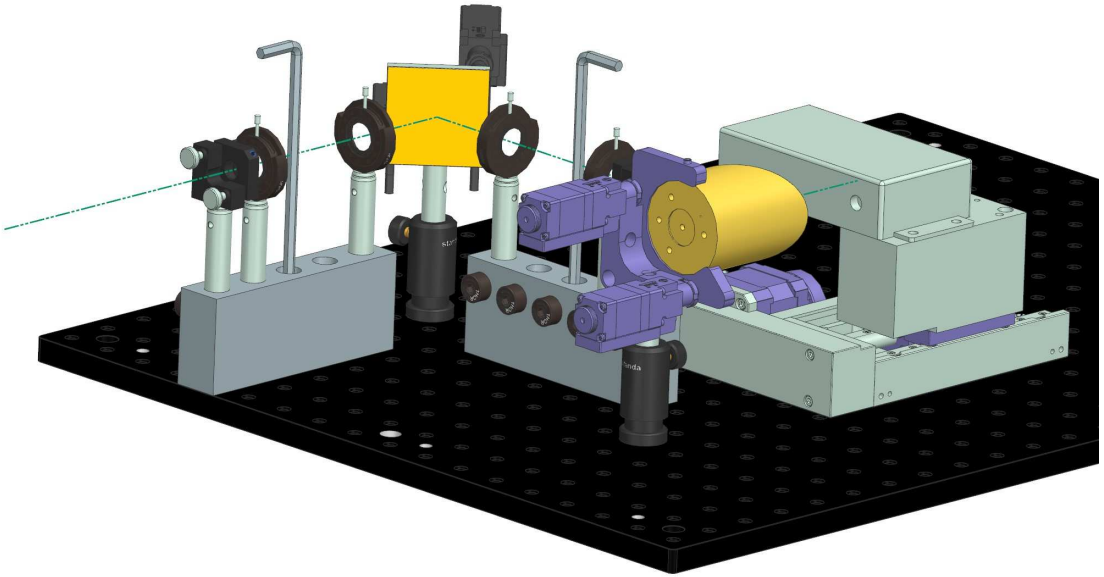
- **New detection schemes** to test
-

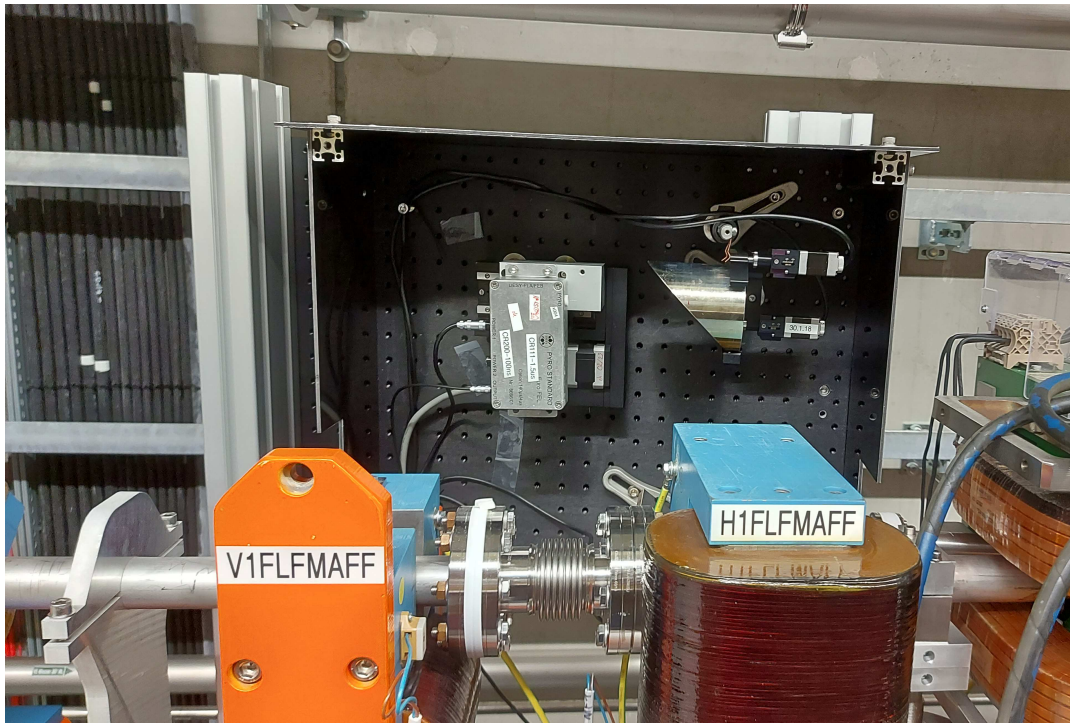
Aiming for reliable operation AND new developments.

FLASHforward edge radiation BCM

A simlified version of the BCM for the FLASHforward plasma acceleration beamline

- no screen, but edge radiation from a dipole
- only one channel
- ready for comissionig (next weekend)



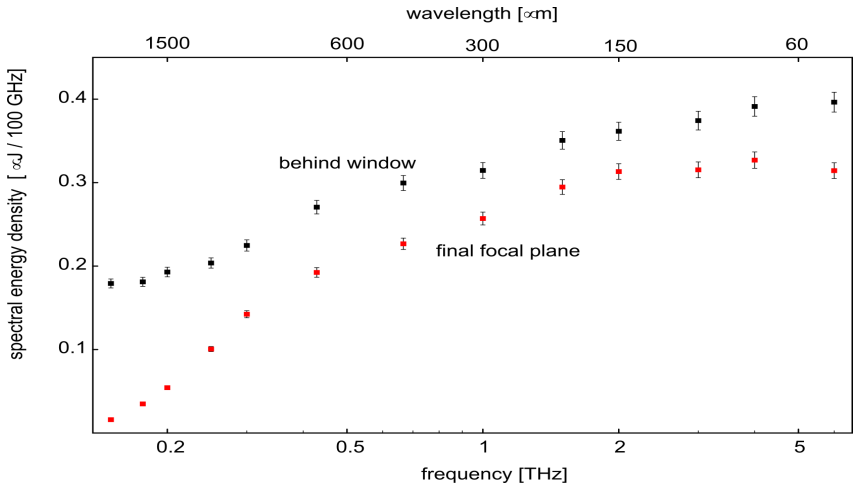


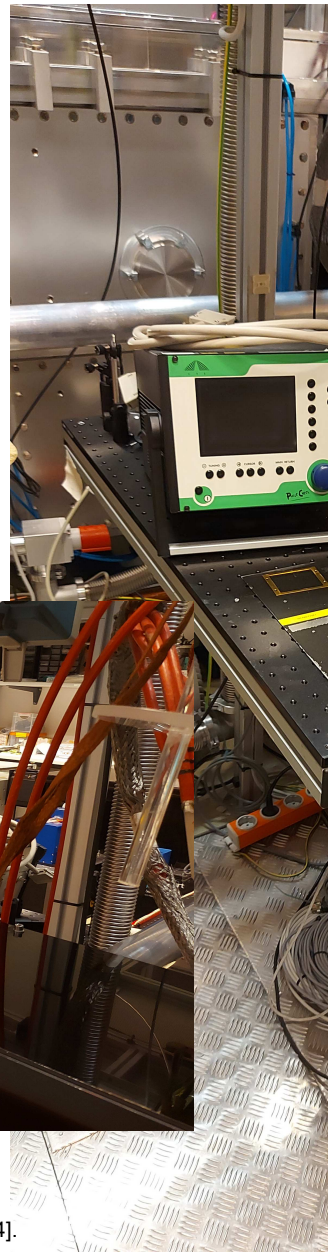
THz beamline + permanent test lab

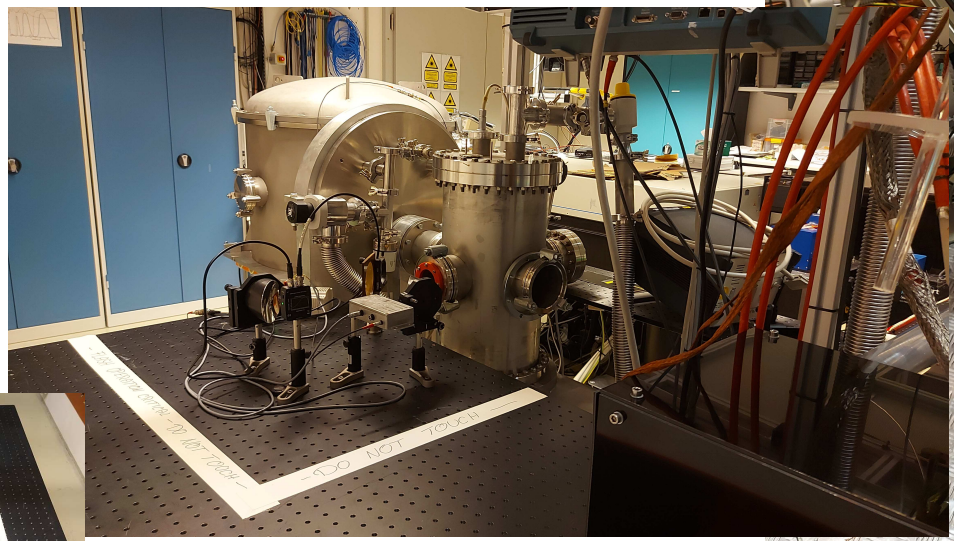
At FLASH1 the
Coherent Diffraction Radiation Beamline
is available again for diagnostics and tests!

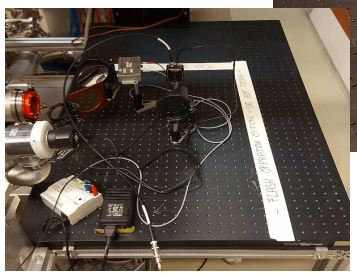
- Two posts with **breadboard**s
  - 75cm x 120cm
  - 25cm x 75cm
  - third port for CRISP
- **100 GHz to 10 THz**
- About **300nJ/ per 100 GHz bw**
- Shared room with laser plasma experiments,

Contact:
Nils Lockmann, Bernd Steffen









More details : S. Casalbuoni, B. Schmidt, P. Schmueser, B. Steffen
Far-infrared transition and diffraction radiation. II:
The THz beamline at the VUV-FEL linac [DESY-TESLA-FEL-2006-04].

Thank you .

Acknowledgements

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- MFL, DESY group for FLASH operation
- Université de Lille,
  Institute Physique des Lasers Atomes et Molécule
  (now even with an official collaboration agreement and a joined PhD position!)

Bund
für Bi
und F

DESY.

UH

GFZ
Helmholtz Centre
POTSDAM

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FLASH.
Free-Electron Laser FLASH

PhLAM
Physique des Lasers
Atomes et Molécules