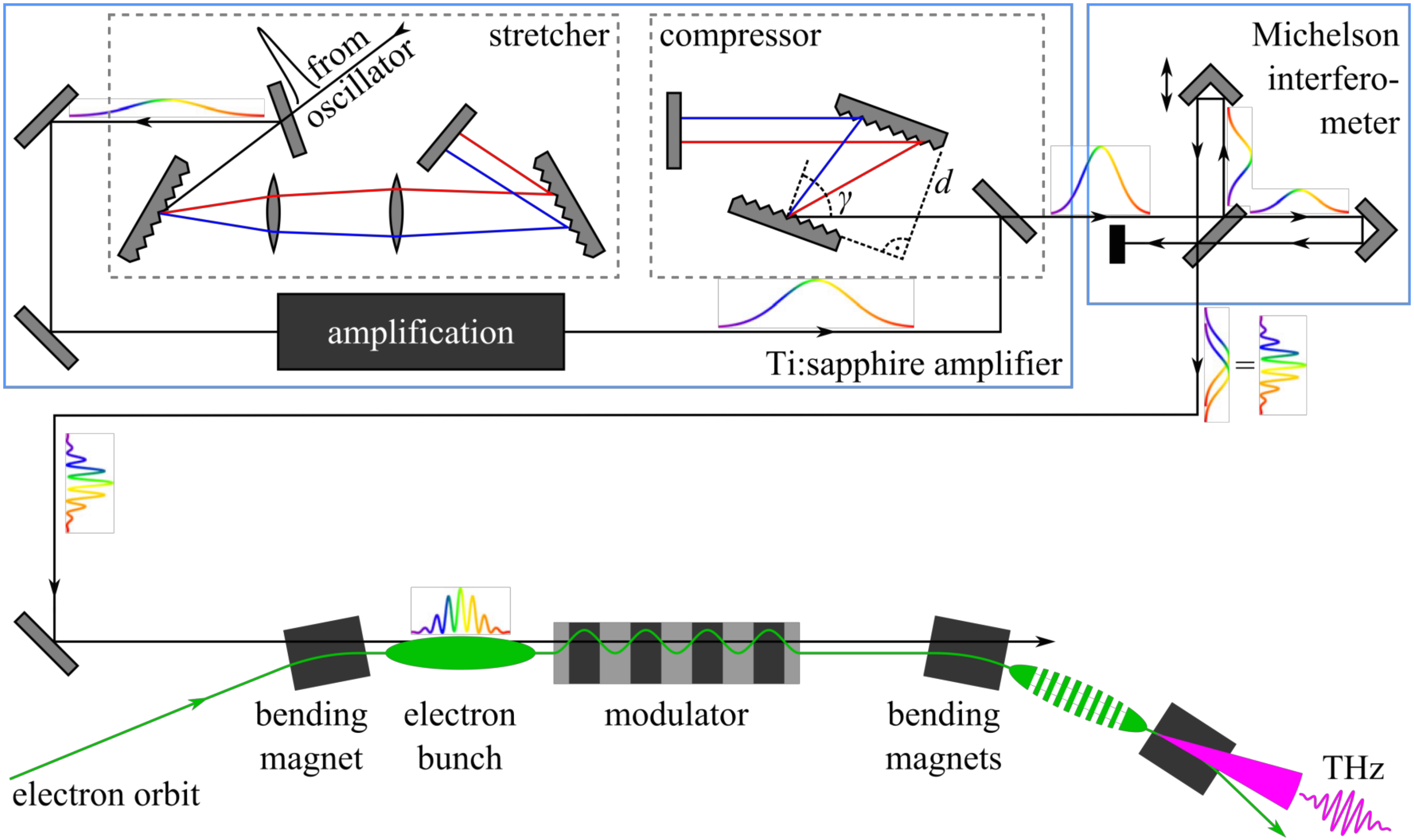
technische universität dortmund

THz detector benchmarking using narrowband THz radiation at DELTA

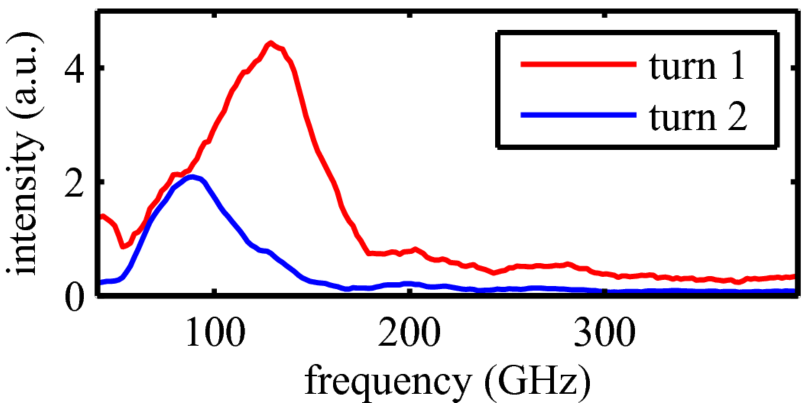
C. Mai et al.
- DELTA -
TU Dortmund University

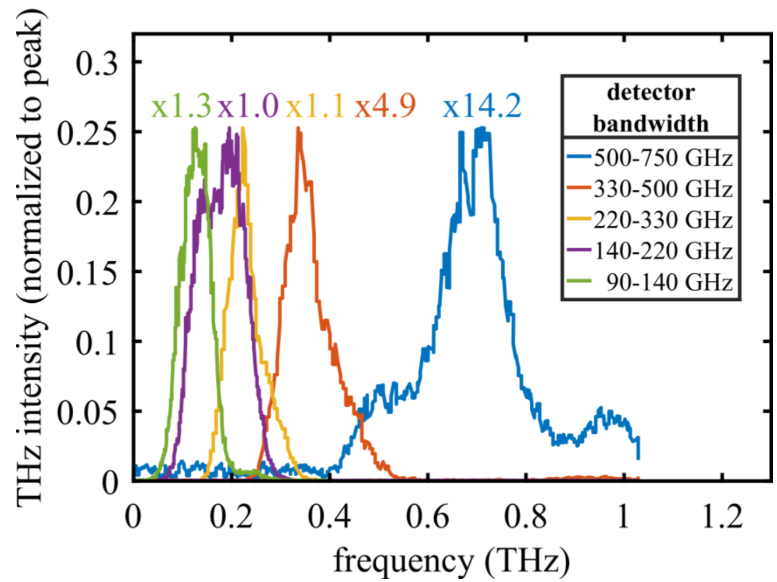
DORTMUND

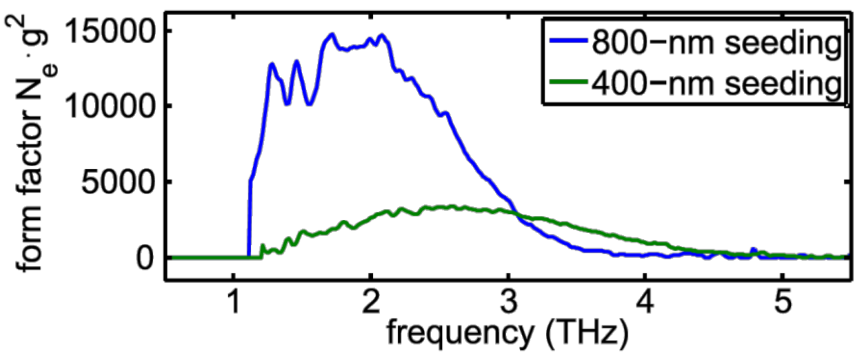
Generation of narrowband THz radiation

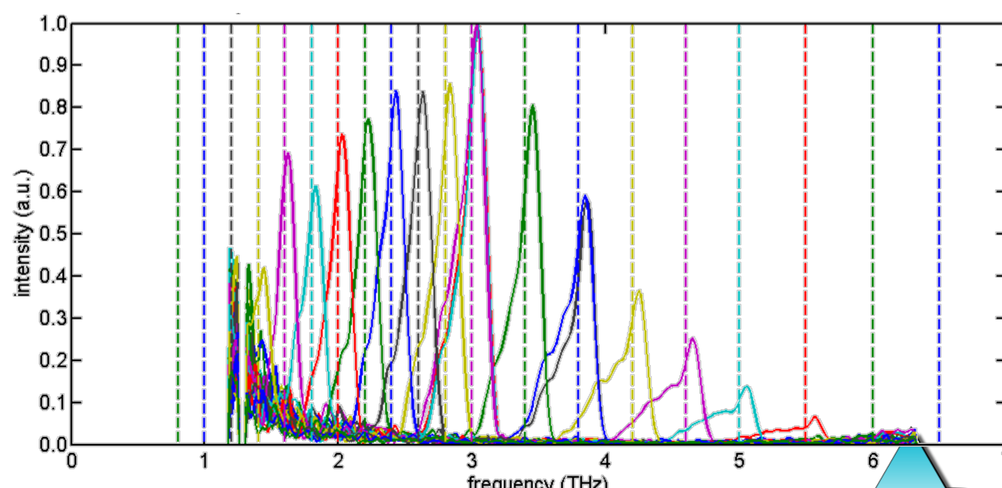


Broadband and Narrowband radiation

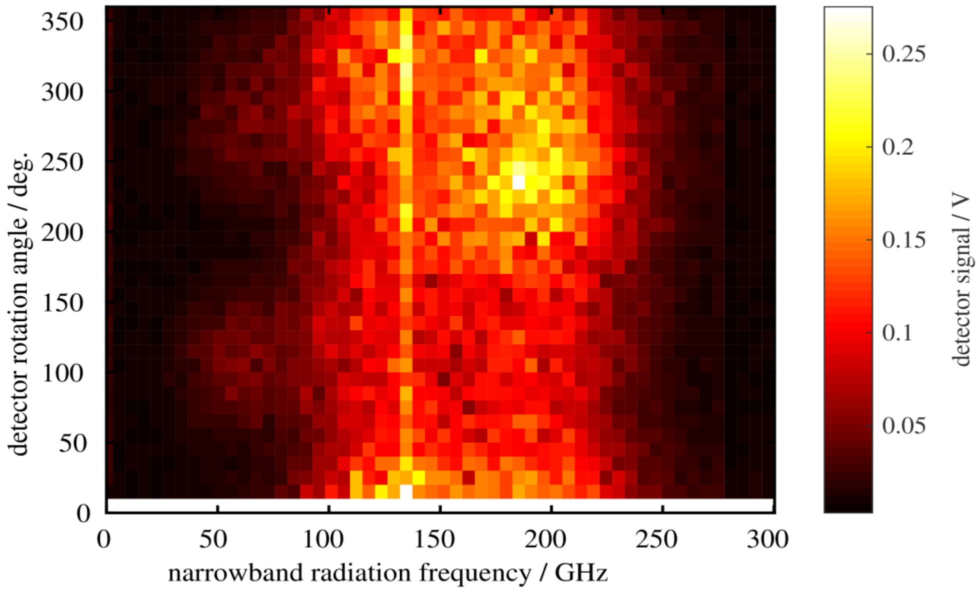




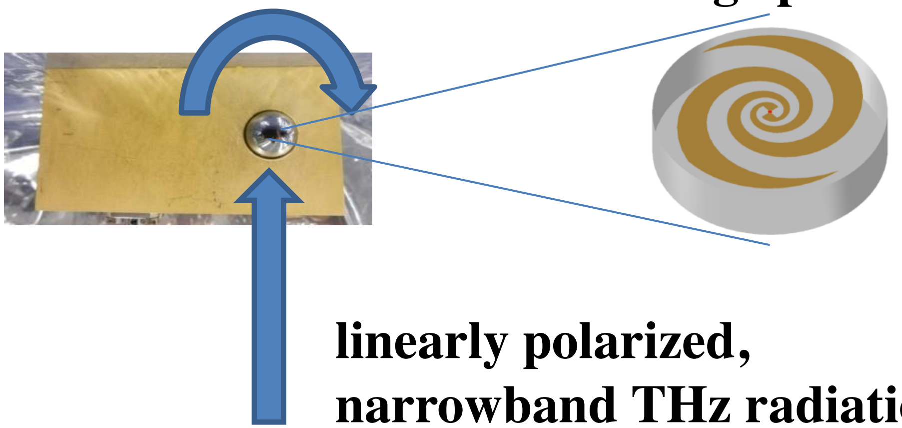




Frequency-dependent Polarization Characterization



rotation of THz detector to change polarization angle



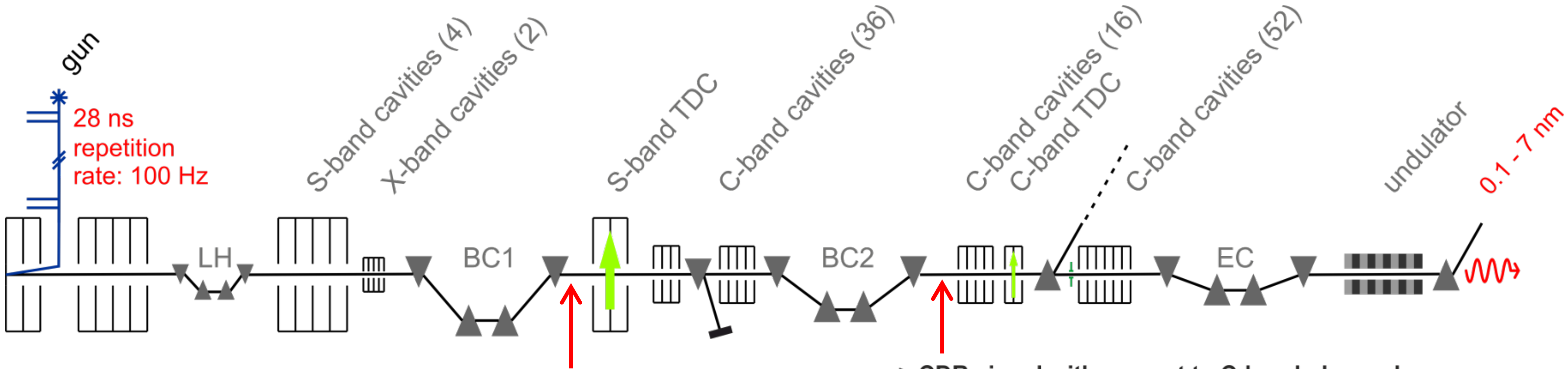
linearly polarized,
narrowband THz radiation (10% BW)
under variation of central frequency

PAUL SCHERRER INSTITUT

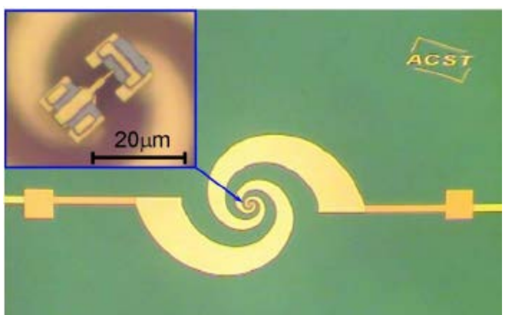
Commissioning results of BCM/CDR at SwissFEL

F. Frei, R. Ischebeck (PSI)

21.6.2018



A1) How does the incoming polarisation of THz radiation affect the signal from a log-sprial antenna based detector?

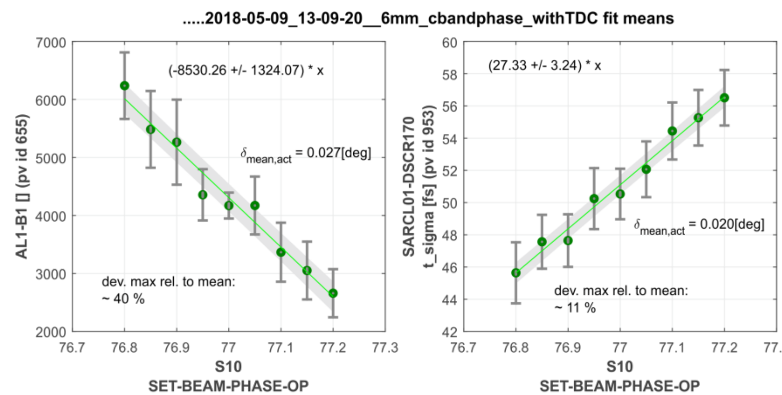


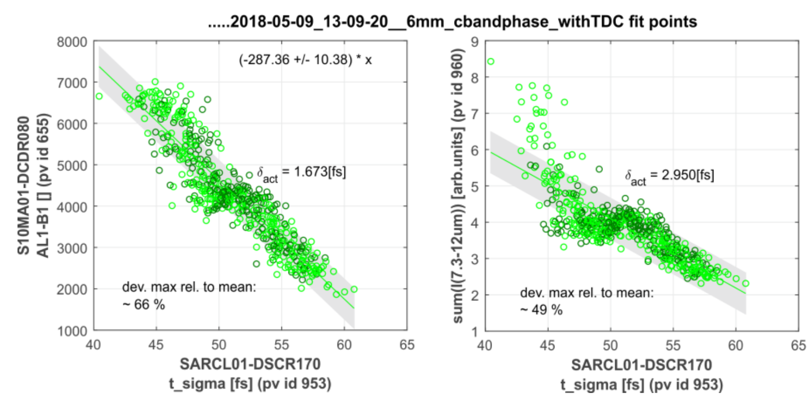
Picture by ACST.

A2) «Damage»-Test of narrow band Schottky detector from TU Dresden.

B1) During last commissioning shift, we measured on a large scale, 3.9% resolution in bunch length change.

> CDR signal with respect to C-band phase change:
(9 C-band stations on beam)

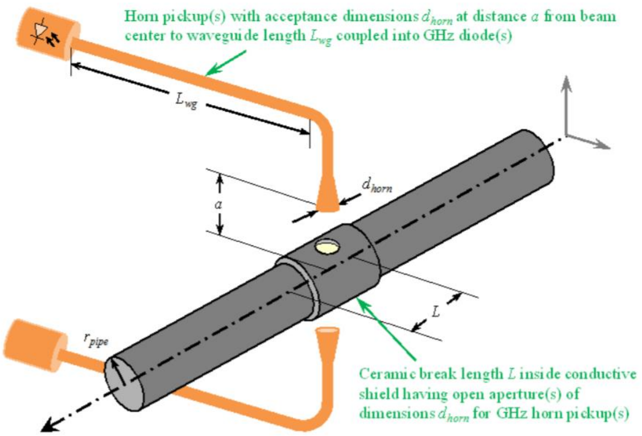


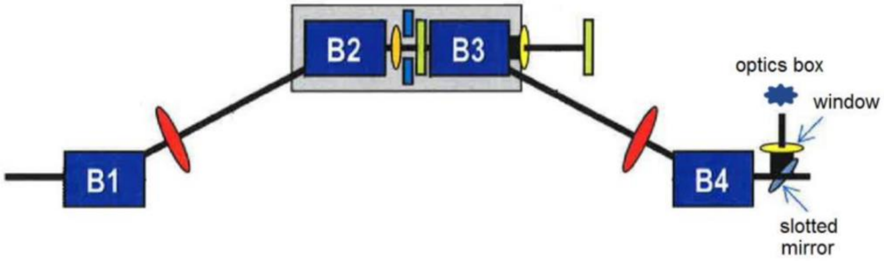


Bunch length monitors for the LCLS-II superconducting linac

Detectors for single-shot bunch length monitors and feedback systems:

- GHz rectifying diodes for long bunches (0.5 ~ 4 ps) by extracting coherent-enhanced ceramic gap radiation in BC1
- Pyro detectors for short bunches (10 – 250 fs) by extracting coherent-enhanced edge or synchrotron radiation in BC2
- Considerations for high repetition rate and high average power dissipation





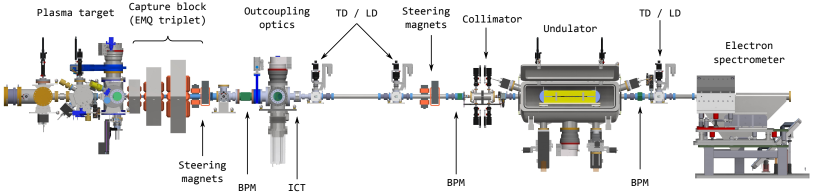
Coherent Radiation Spectroscopy For Single-Shot Longitudinal Diagnostics of Ultra-Short Electron Bunches

Konstantin Kruchinin, Dariusz Kocoń and Alexander Molodozhentsev

ELI-Beamlines
Institute of Physics of the Czech Academy of Science
Czech Republic

Introduction

ELI “LUIS” beamline



Goals:

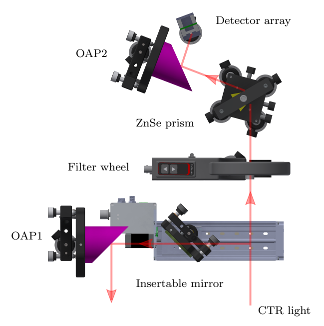
- Ultimately - demonstrate FEL based on LWFA.
- First step - produce spontaneous undulator radiation in 2 – 6 nm range suitable for user experiments
- Manipulate longitudinal phase space to reach beam parameters required for FEL

Motivation:

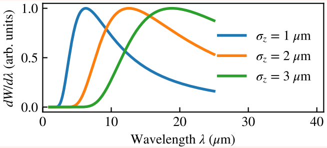
- Length of the LWFA produced bunch is less than $\lambda_p/4$ (typically 10 fs or less)
- Conventional methods are not single shot or don't have enough resolution
- Retrieve bunch longitudinal profile from coherent radiation (TR/DR/SPR) spectrum by single-shot FIR spectroscopy based on dispersive prism

Concept

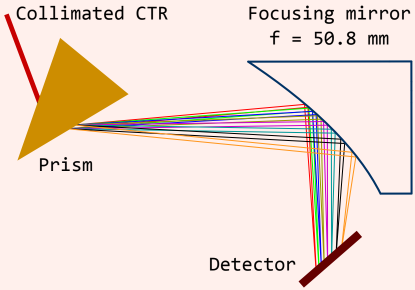
Experimental setup



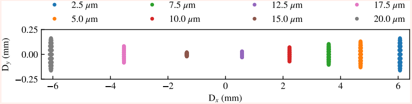
CTR spectrum



Simulations



Simulated spot diagram on the detector sensor for various wavelengths



THz-Spectrometer at European XFEL

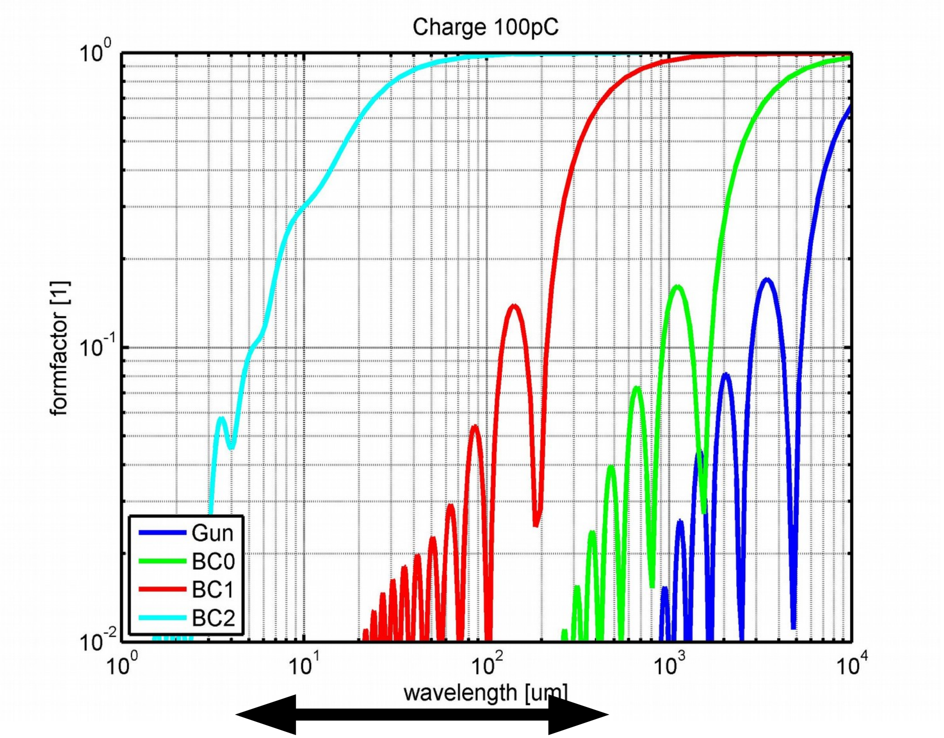
8th Topical Workshop on Longitudinal Diagnostics

Lockmann, Nils
Hamburg, 25-27.6.2018

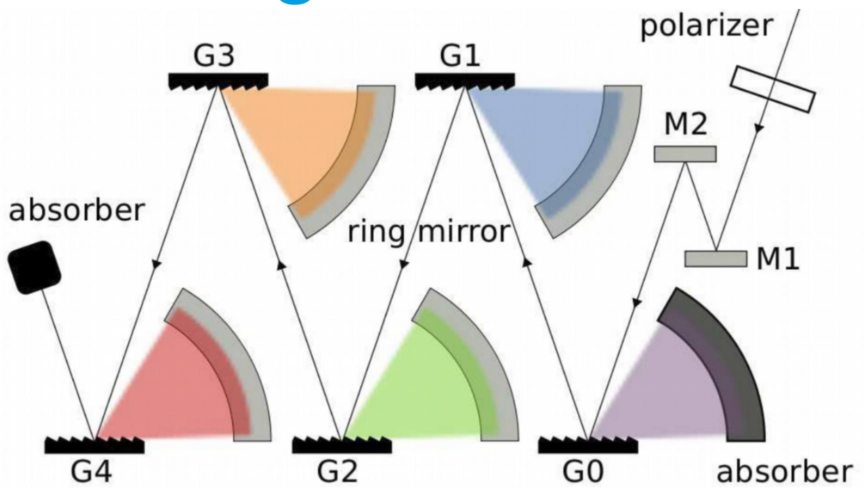
HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

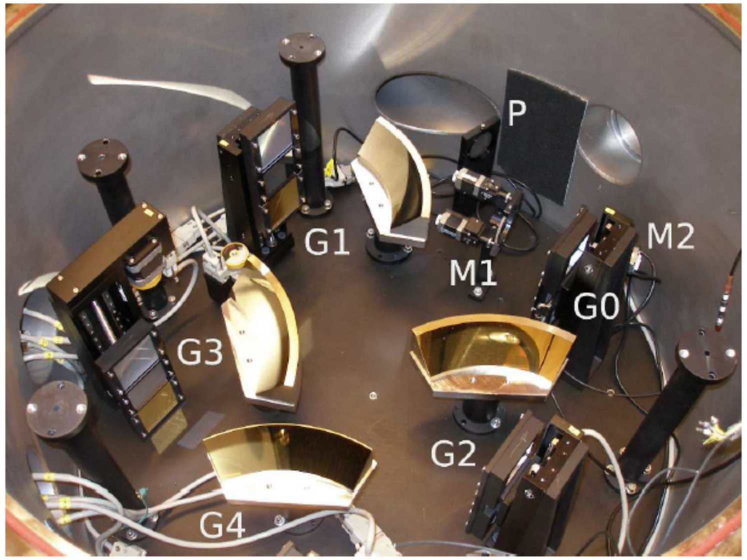
DESY.

Form Factor and Spectrometer Design

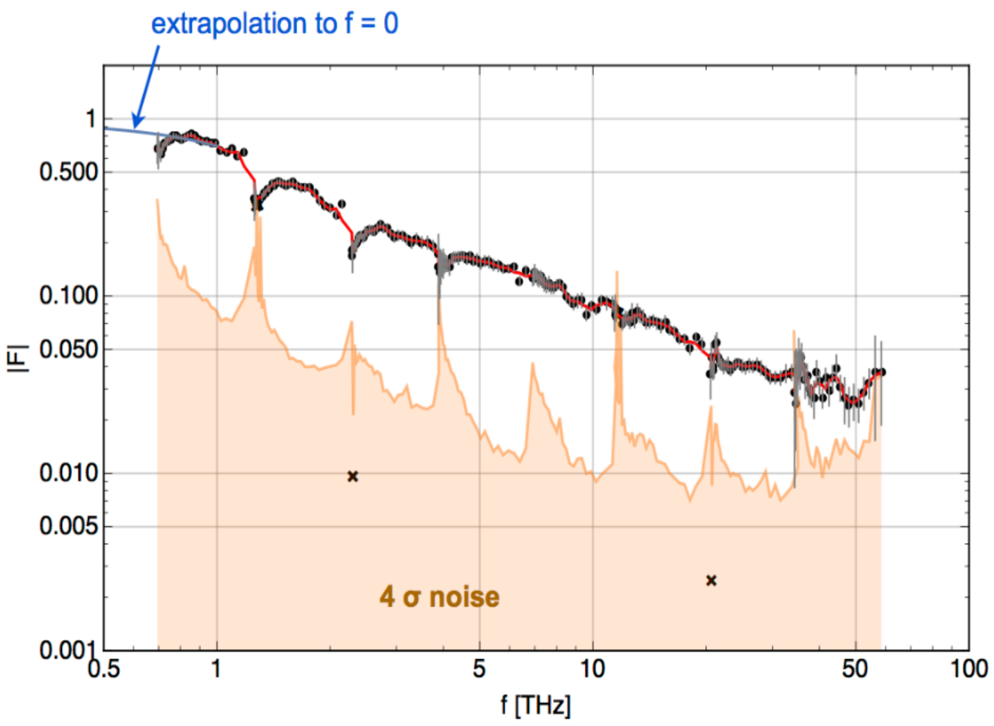


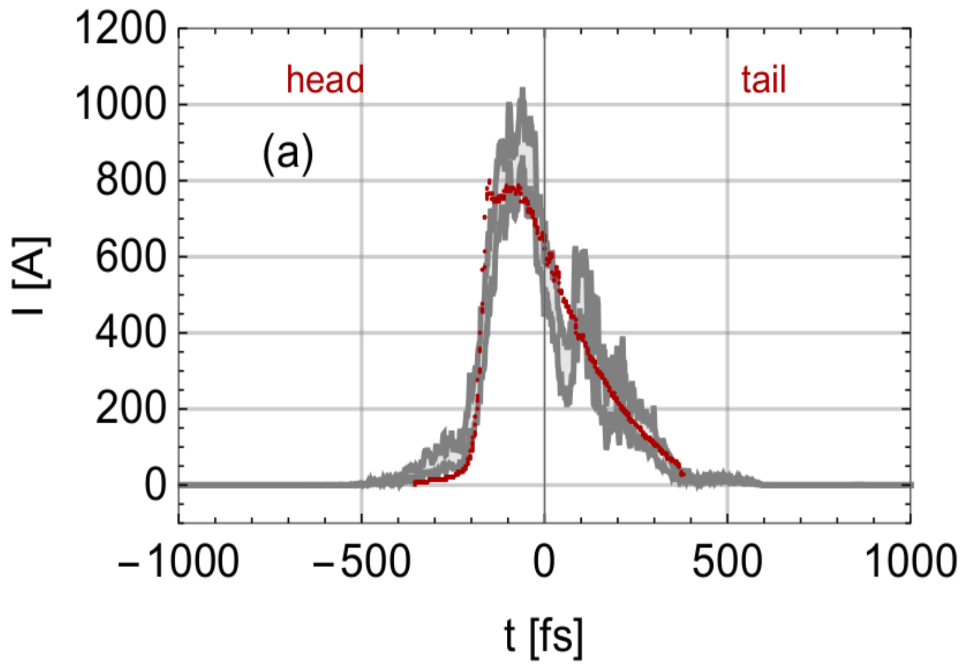
Spectrometer Range



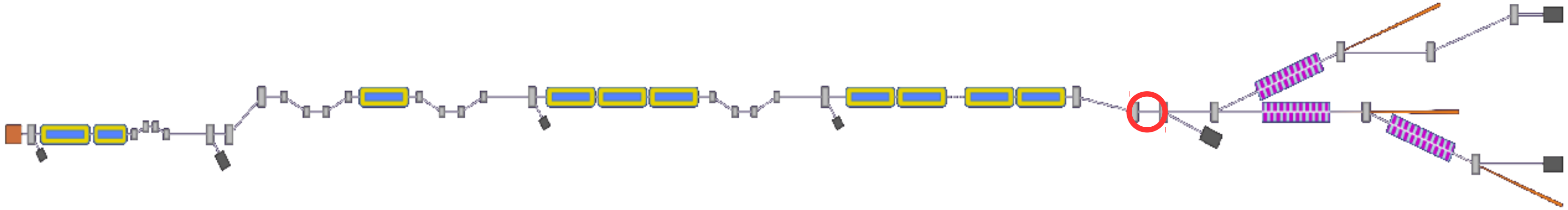


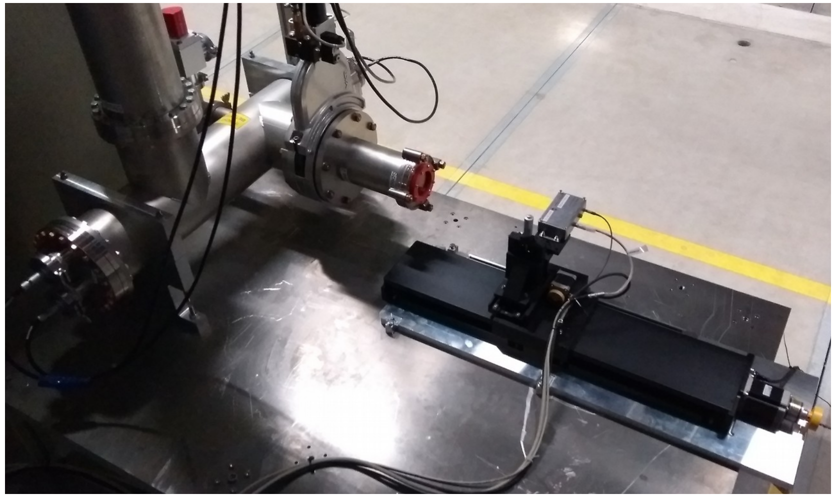
Examples from FLASH

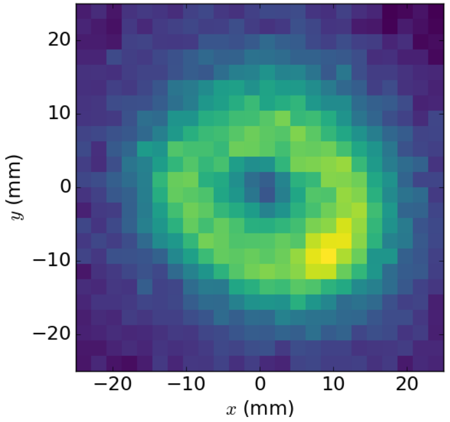


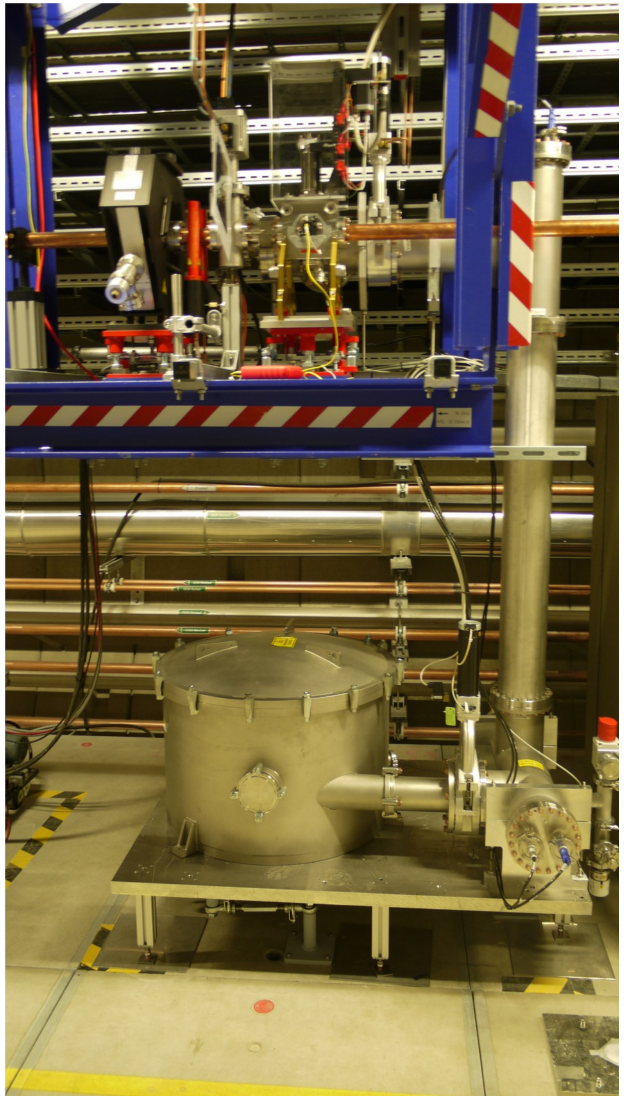


Beamline Installation and Commissioning









Dr.-Ing. Niels Neumann
Chair for RF and Photonics Engineering

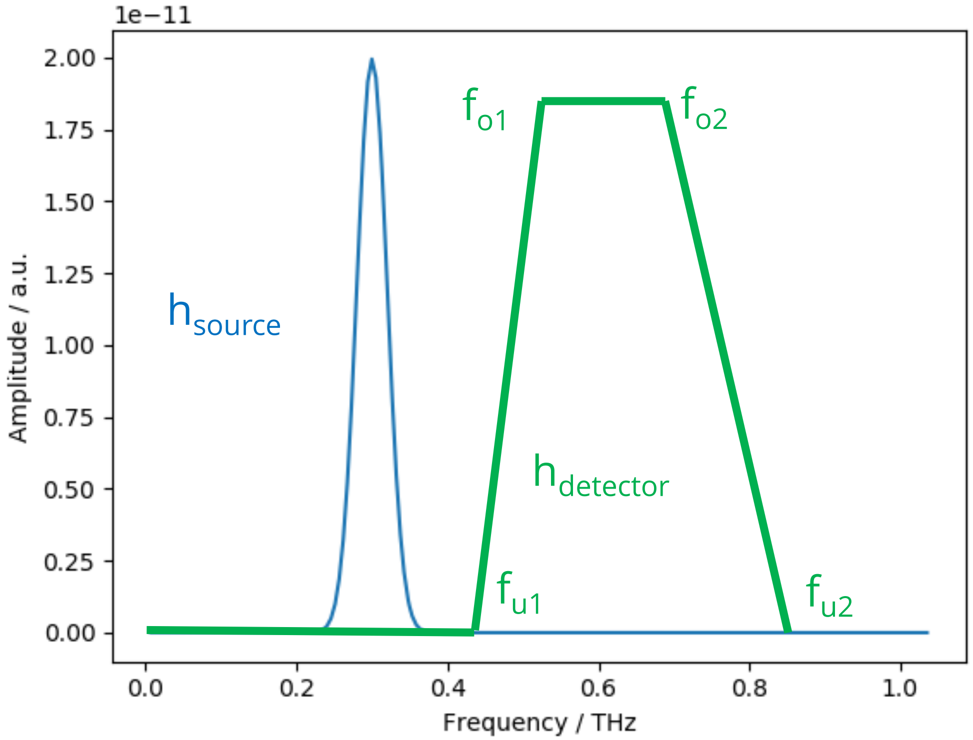
THz detector and DELTA THz source frequency behavior

8th Topical Workshop on Longitudinal Diagnostics for FELs
Hamburg, 25.-27.06.2018

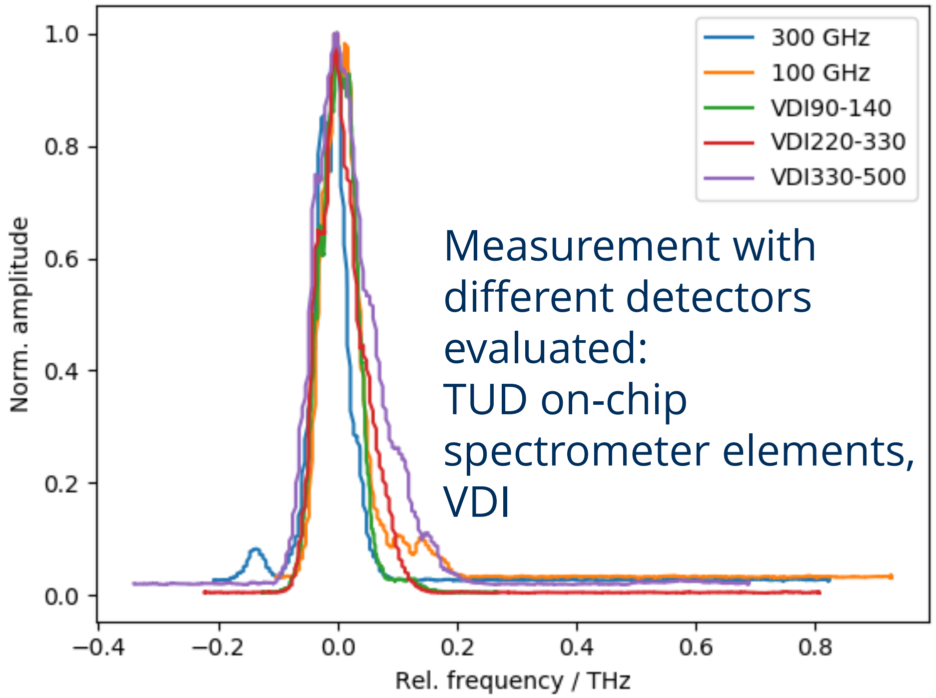
Approach

Measured detector behavior is convolution between spectral characteristics of THz source and THz detector: at each frequency integral power of spectrum filtered with detector spectral response

$$y_{detector}(f) = \int_{-\infty}^{\infty} h_{source}(f', f = f_c) \cdot h_{detector}(f') \mathrm{d}f'$$

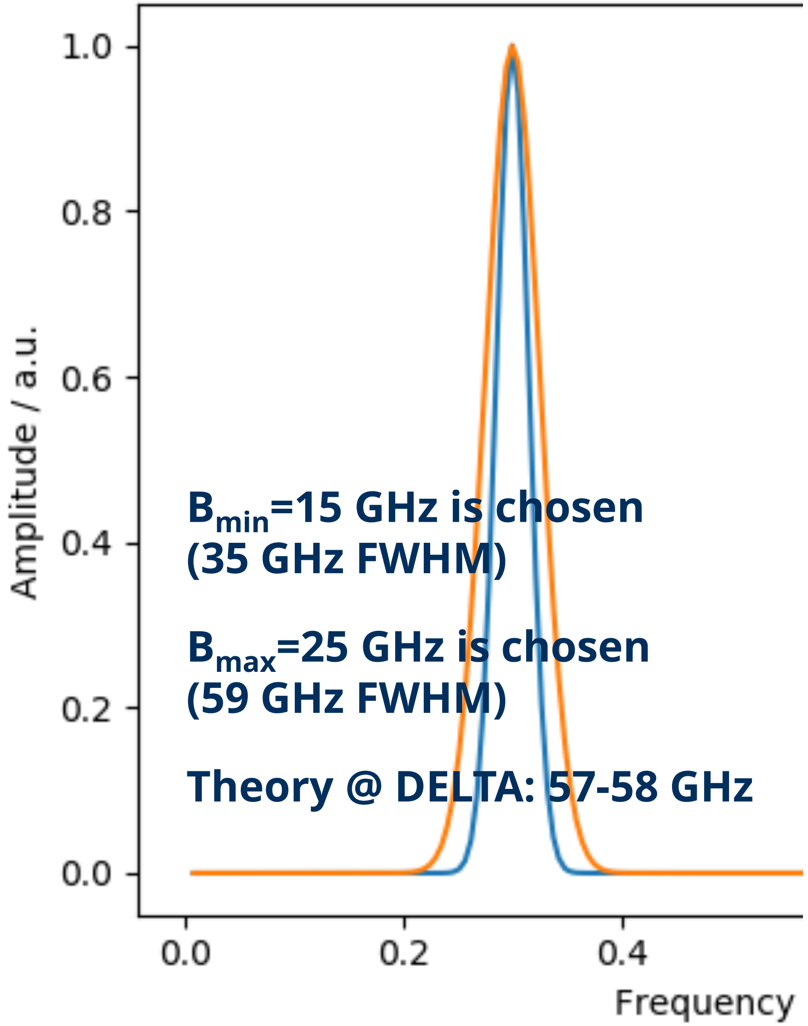


Estimation of h_{source}:
min. bandwidth: „step“ detector behavior assumed, i.e. detector slope much steeper than source slope
max. bandwidth: „dirac“ detector behavior assumed → measured spectrum equals DELTA source spectrum



Measurement with different detectors evaluated:
TUD on-chip spectrometer elements, VDI

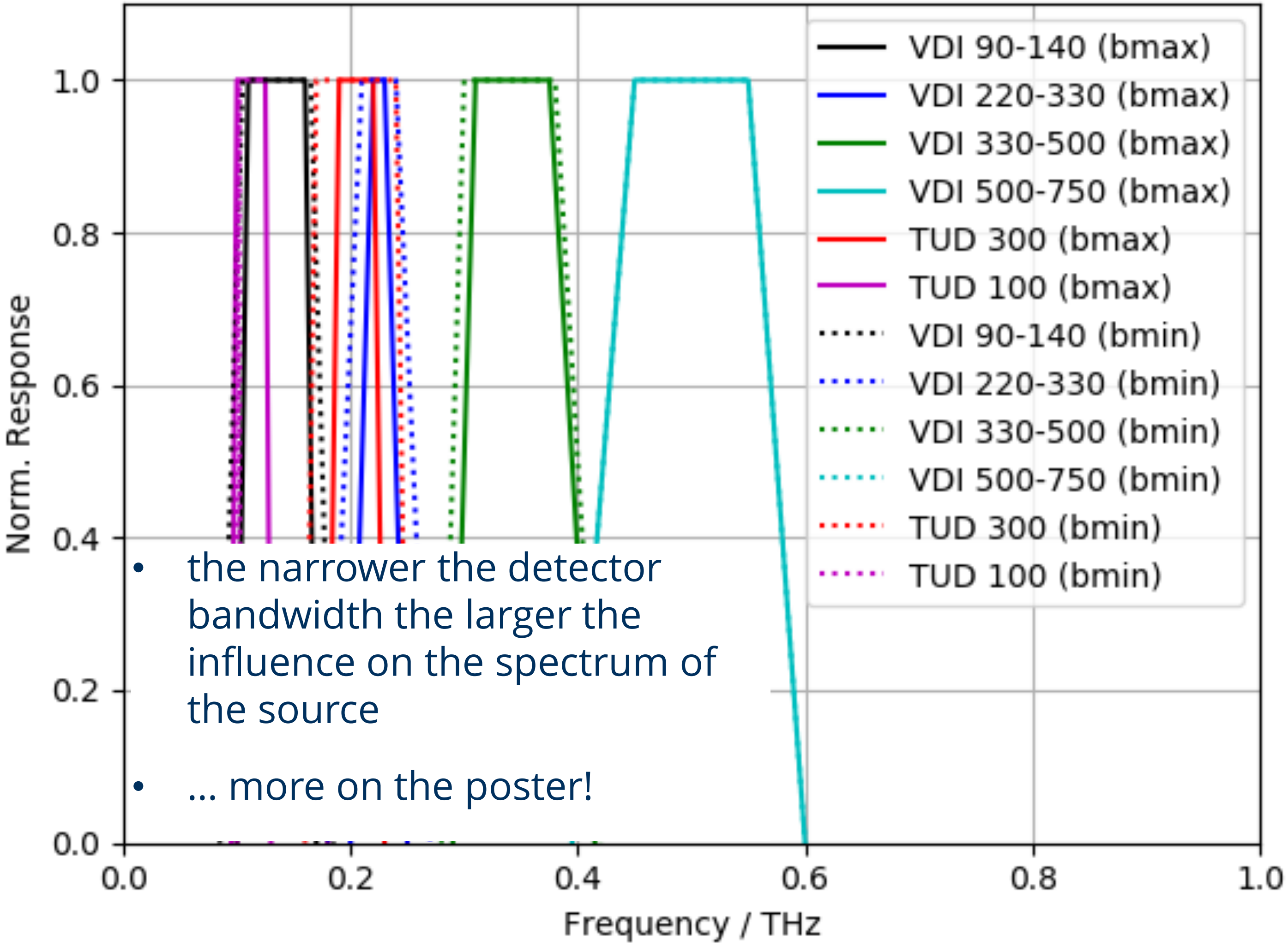
...some results



B_{min}=15 GHz is chosen
(35 GHz FWHM)

B_{max}=25 GHz is chosen
(59 GHz FWHM)

Theory @ DELTA: 57-58 GHz



- the narrower the detector bandwidth the larger the influence on the spectrum of the source
- ... more on the poster!

High Frequency Technology

Technische Hochschule Mittelhessen

Fachbereich Informationstechnik – Elektrotechnik – Mechatronik

8th Topical Workshop on Longitudinal Diagnostics for FELs

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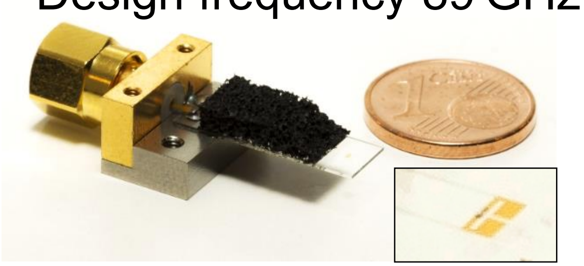
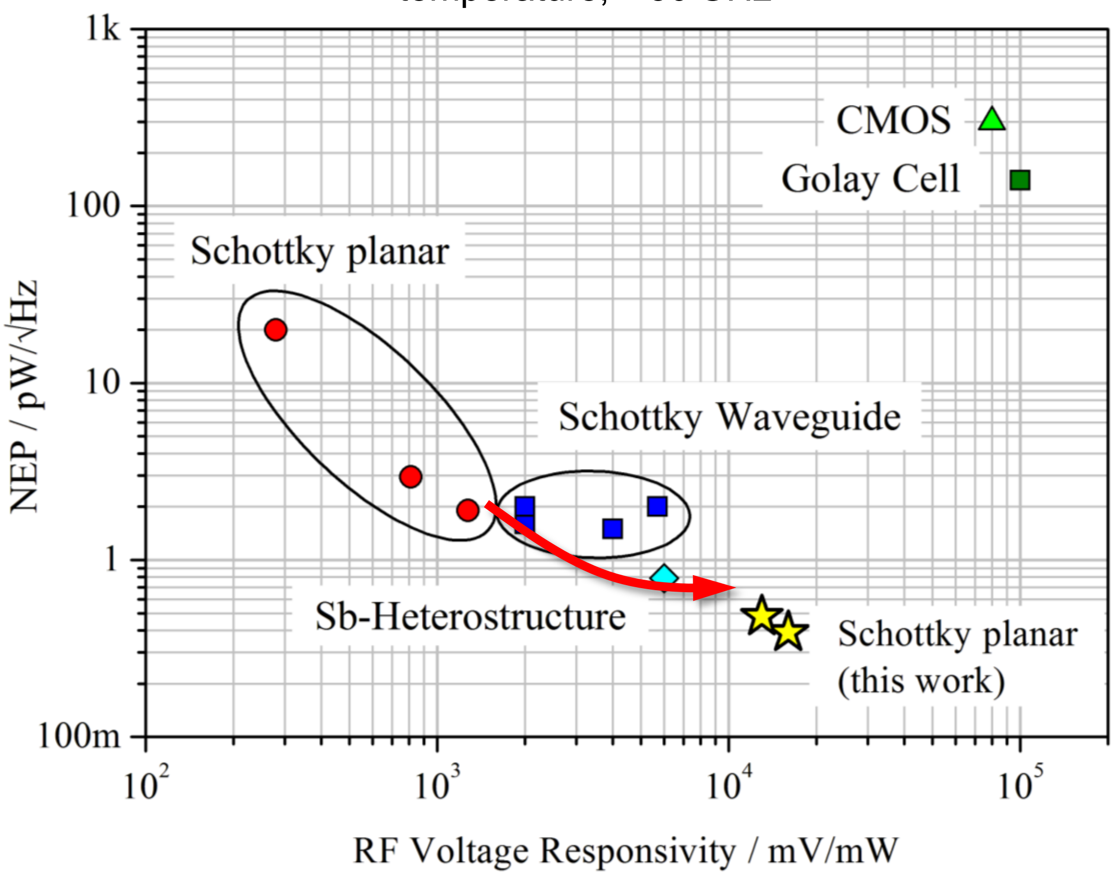
Highly Responsive Detector

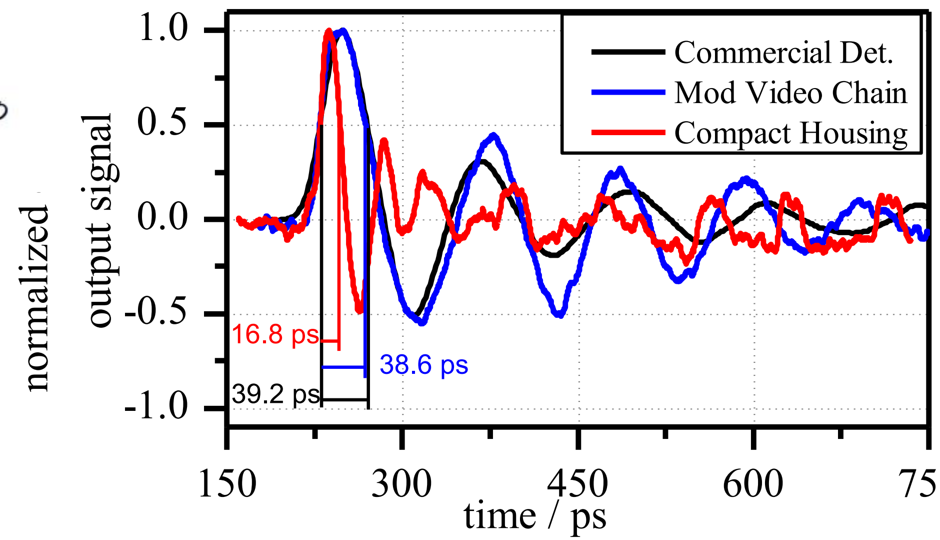
- Aim for considerable improvement to other published results:
  - γ_{RF} > 10 000 mV/mW
  - NEP < 1 pW/√Hz
- ACST zero-bias Schottky diode
- Compact design without amplifier or lenses
- Design frequency 89 GHz



Measurement results, ambient temperature, > 50 GHz



Quasi Optical Detector Module with Improved video chain



RF Bandwidth 50GHz – 2 THz

Video Bandwidth 40 GHz

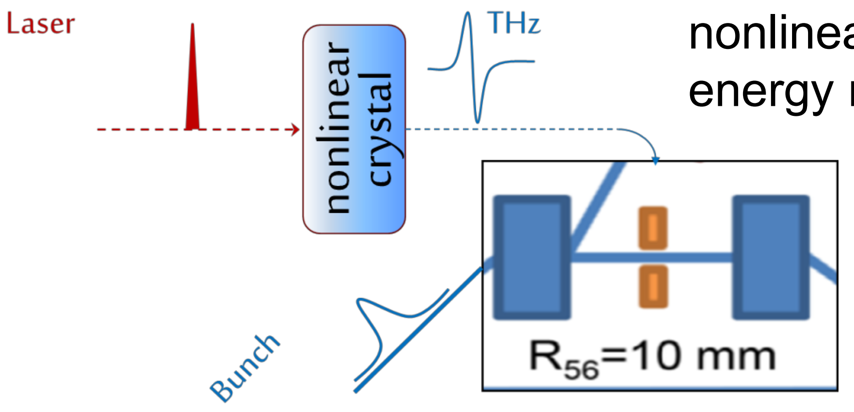
Intrinsic response time of less than 16.8 ps for short collimated THz pulses at 1.315 THz.

A. Penirschke et al., „Compact quasi-optical Schottky detector with fast voltage response“, Infrared, Millimeter, and Terahertz waves (IRMMW-THz), 2014 39th International Conference on, Year: 2014, Pages: 1 - 2, DOI: 10.1109/IRMMW-THz.2014.6956027

Minimization of the Electron Bunch Arrival-Time Jitter between Femtosecond Laser Pulses and Electron Bunches for Laser-driven Plasma Wakefield Accelerators

- Synchronization of the electron bunch and of the laser in the range of **few** femtoseconds
- Development of a new shot to shot feedback system with a time resolution ≤ 1 fs

Generation of Terahertz (THz) pulses by optical rectification of high energy laser pulses in a nonlinear crystal to
energy modulate electron bunches



Aim:
- Understanding of the influence of the optical properties on the THz generation
- Investigation of periodically poled lithium niobate

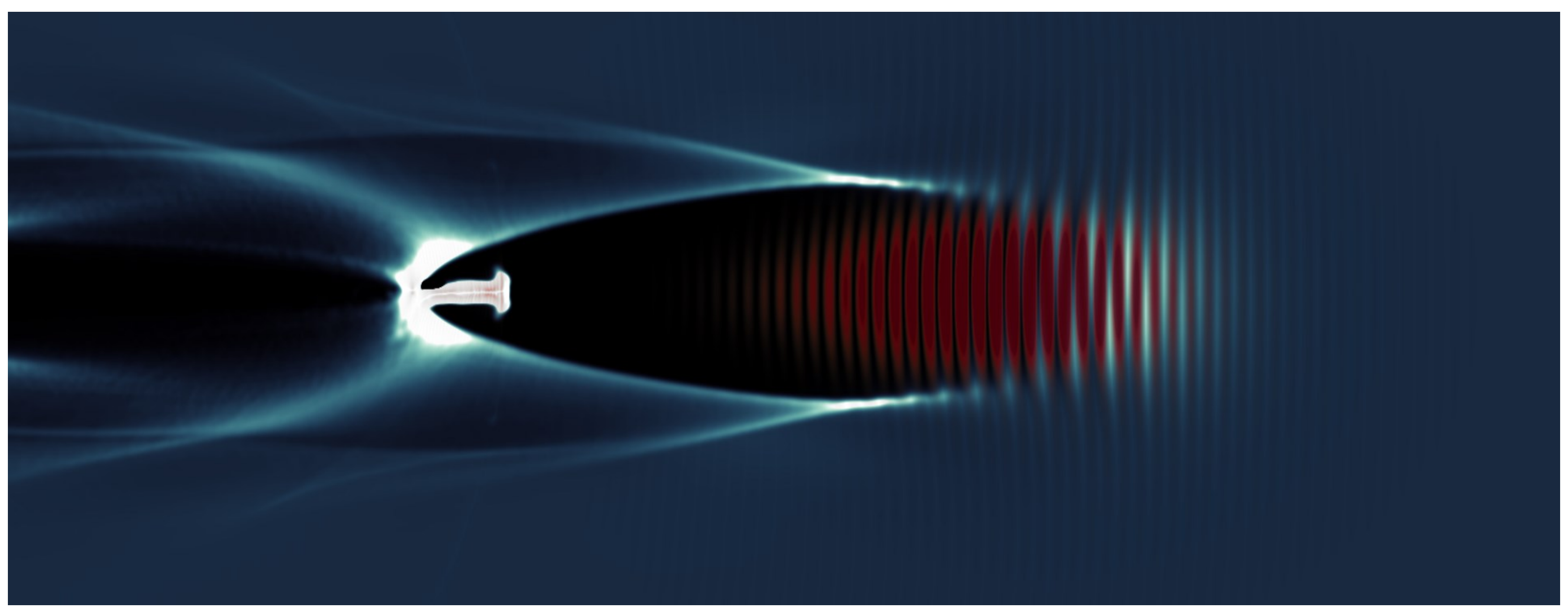
Commissioning Status of the VIS-MIR Transition Radiation Spectrometer at DESY

Paul Winkler
FLA, DESY and CFEL, UHH
paul.winkler@desy.de
fla.desy.de

FLASHForward▸▸
Future-oriented wakefield-accelerator research and development at FLASH

Longitudinal Bunch Diagnostic

for plasma accelerated beams

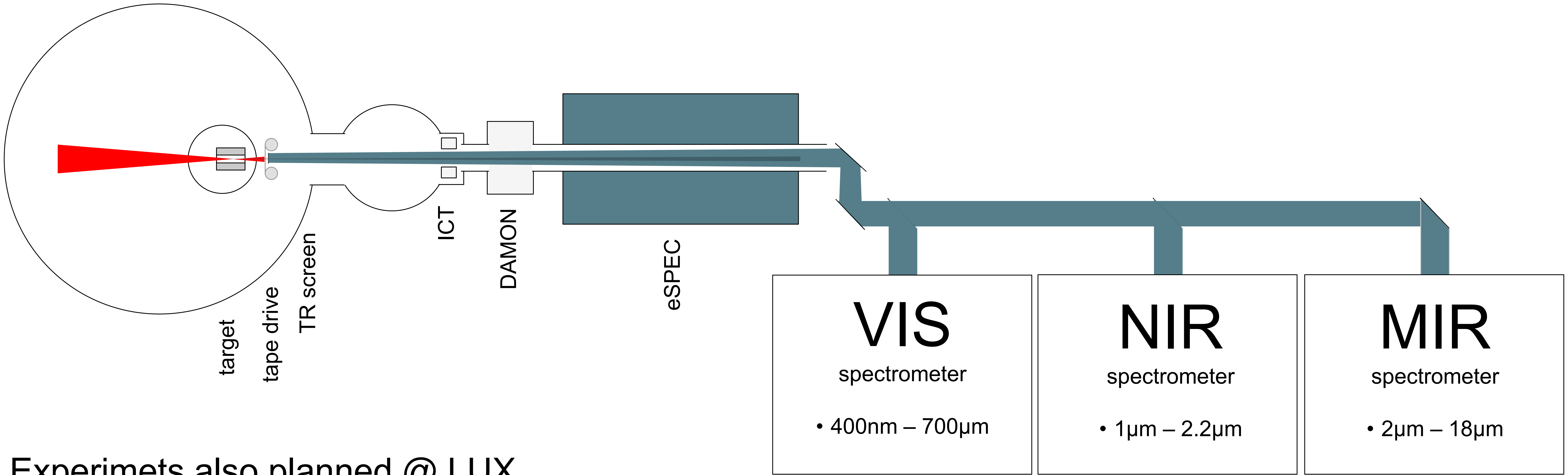


PIC simulation of a Laser pulse travveling through a plasma by S. Jalas

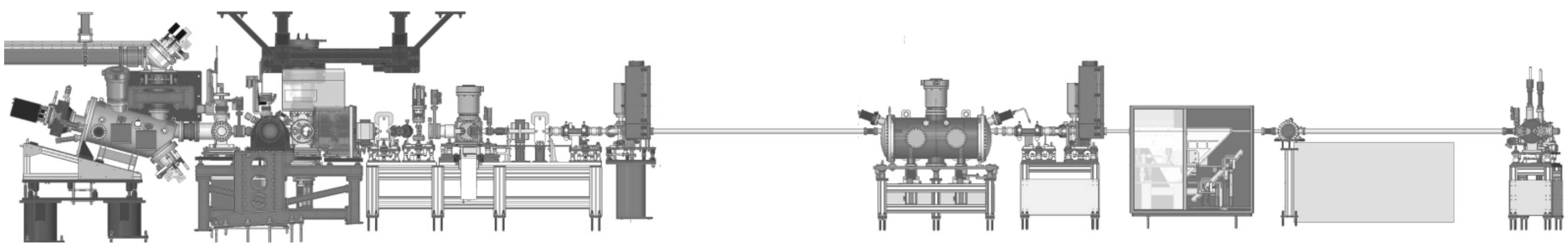
features of LWFA / PWA

- small initial beam emittances ~10 nm
- very short e-bunches ~1 - 10 fs
- 50 MeV – 500 MeV
- 10 pC – 1 nC
- energy spread 1% – 10%
- divergence 0.5 mrad – 10 mrad

TR @FLA

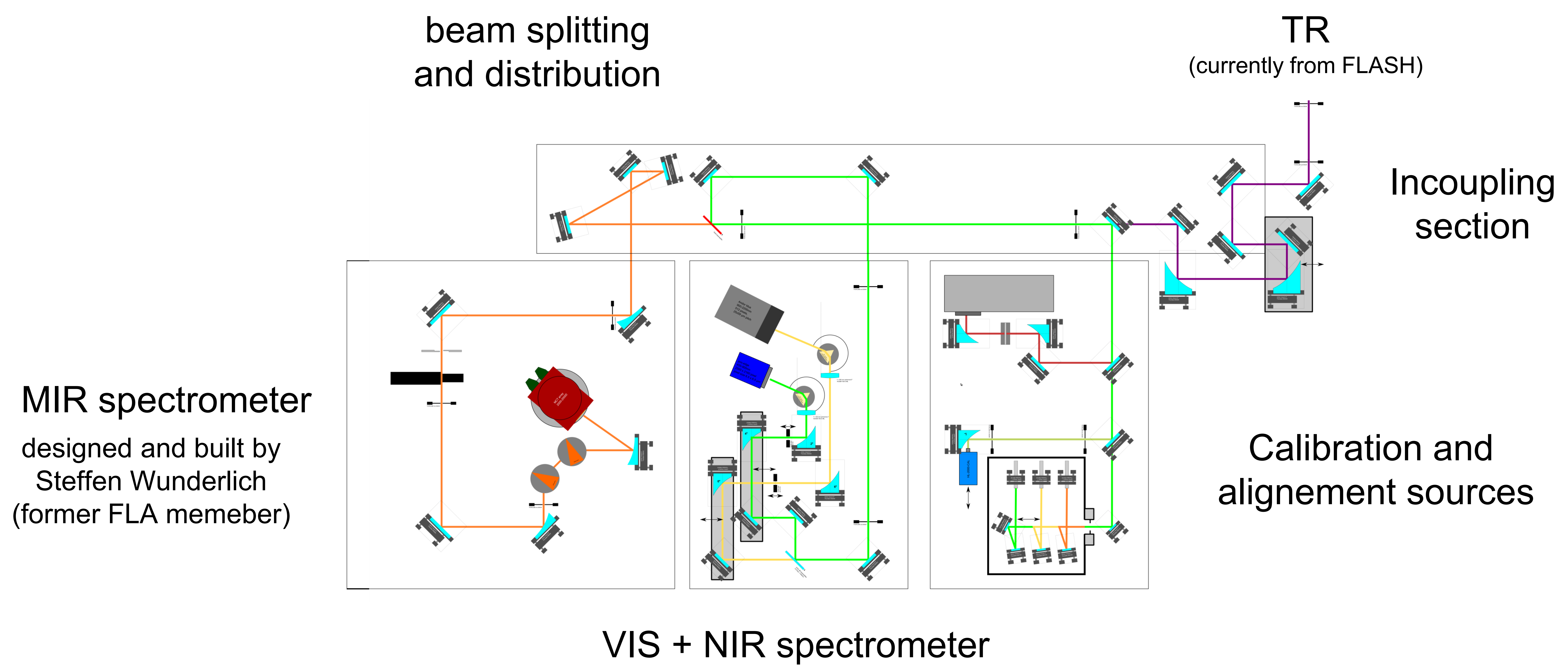


Experimets also planned @ LUX



Spectromter Design

With helpful discussion and design Tipps from:
Omid Zarini and Arie Irman (HZDR)



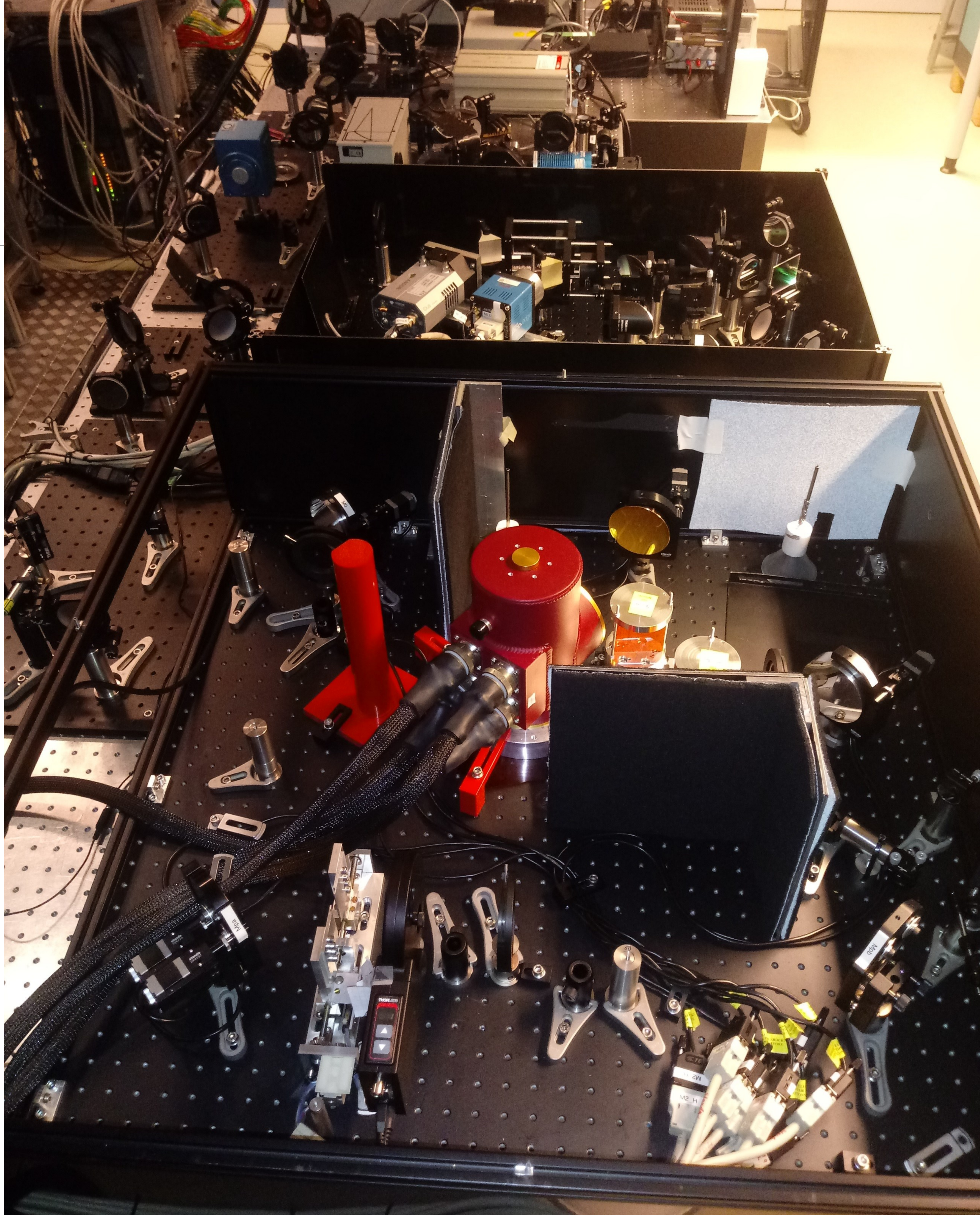
The Spectrometers

Goal

- single shot bunch length detection
- 1 pC sensitivity

Status

- relative calibration between spectrometers
- get data acquisition into control system



Thank you for the Attention
and see you at the posters