THz Diagnostics at PITZ

Current Status and Update

Prach Boonpornprasert for THz@PITZ team

Mini-workshop on THz@PITZ, 15.03.2023

Mechanical Designer:
Frieder Müller

HELMHOLTZ

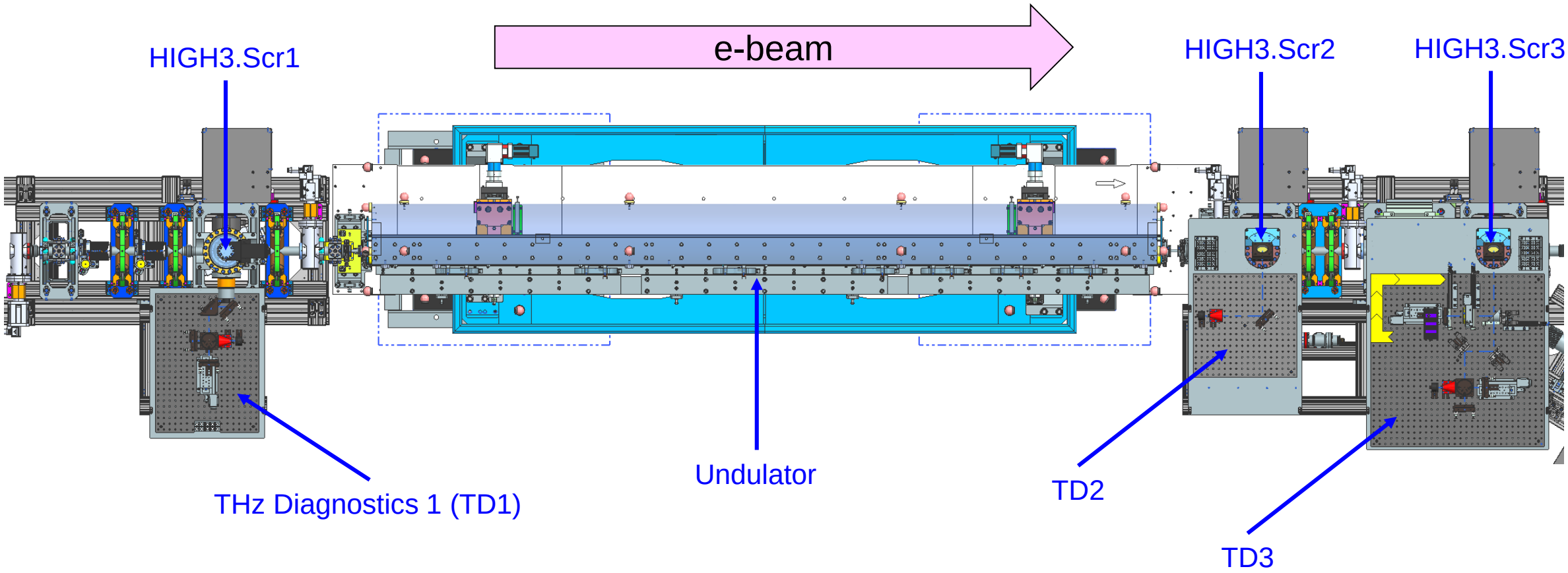
PITZ Photo Injector Test Facility Zeuthen

European XFEL

DESY.

Overview

Top view



Vacuum THz Windows

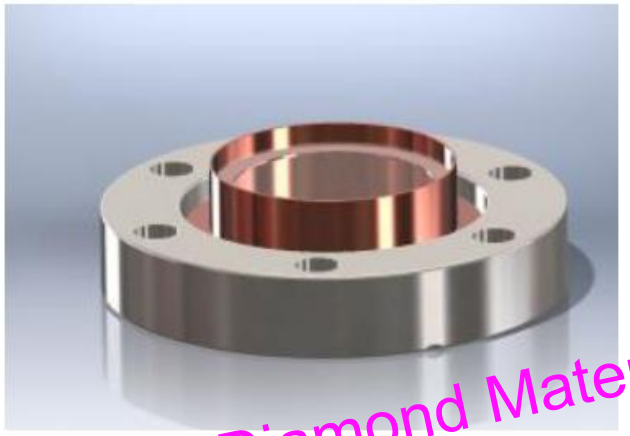
Quartz window @HIGH3.Scr1

64CF Z-Cut Quartz

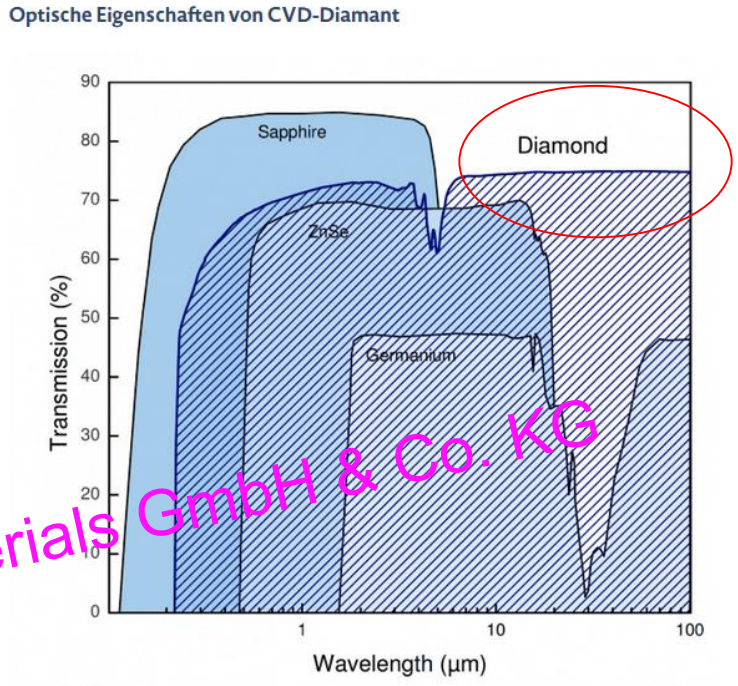
Torr Scientific Ltd

Diamond windows @ HIGH3.Scr2 and HIGH3.Scr3

CVD diamond window



Diamond Materials GmbH & Co. KG



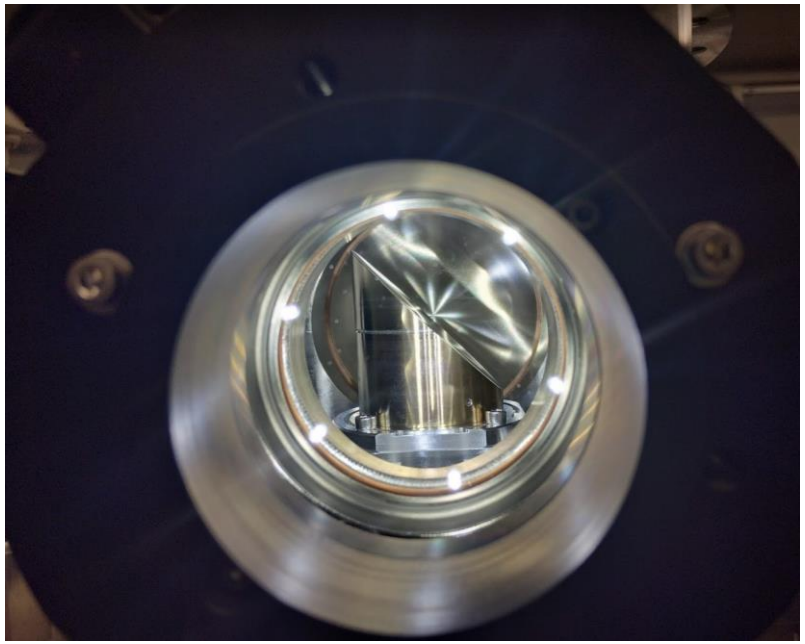
- CVD diamond window, optical quality
- flat faces polished, surface roughness <30 nm RMS,
- Parallelism < 3 arcmin
- wavefront distortion < 2 fringes in double transmission at 633 nm
- thickness 400 µm ± 100 µm
- side faces laser cut
- diameter 24 mm, clear aperture 20 mm.

Flange and Mounting
- window solder-sealed into Conflat UHV flange with AuSn solder,
- flange size: standard 2.75 inch Conflat (DIN:DN 40 CF),

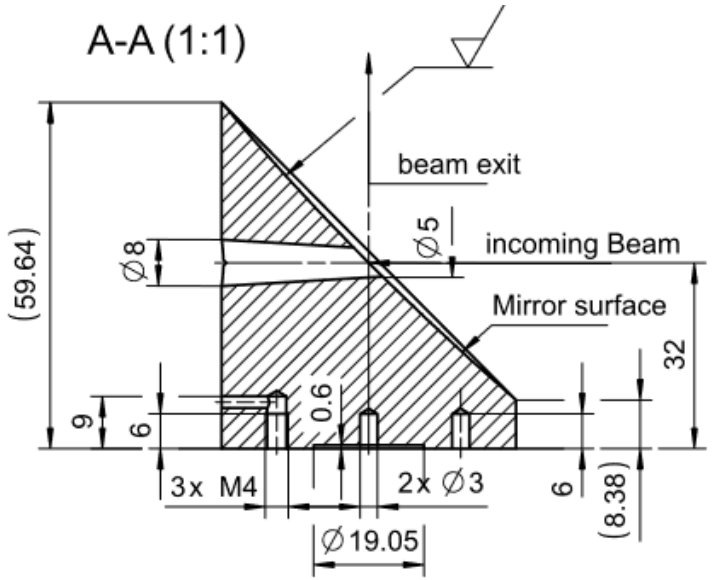
Vacuum THz Mirrors

Manufacturer: LT Ultra-Precision Technology GmbH

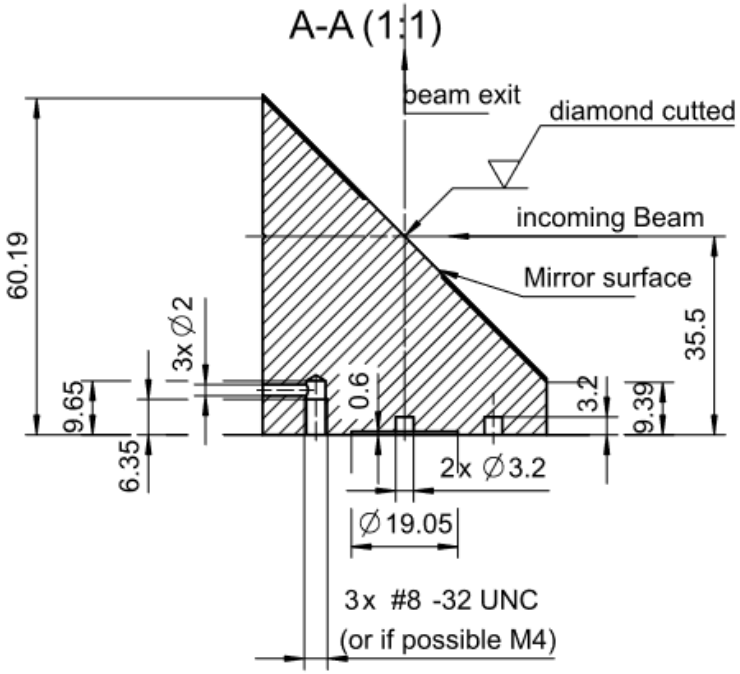
- Vacuum compatible
- Ellipsoidal mirror
- Unprotected gold coating
- Substrate: Aluminum alloy



@HIGH3.Scr2



@HIGH3.Scr3

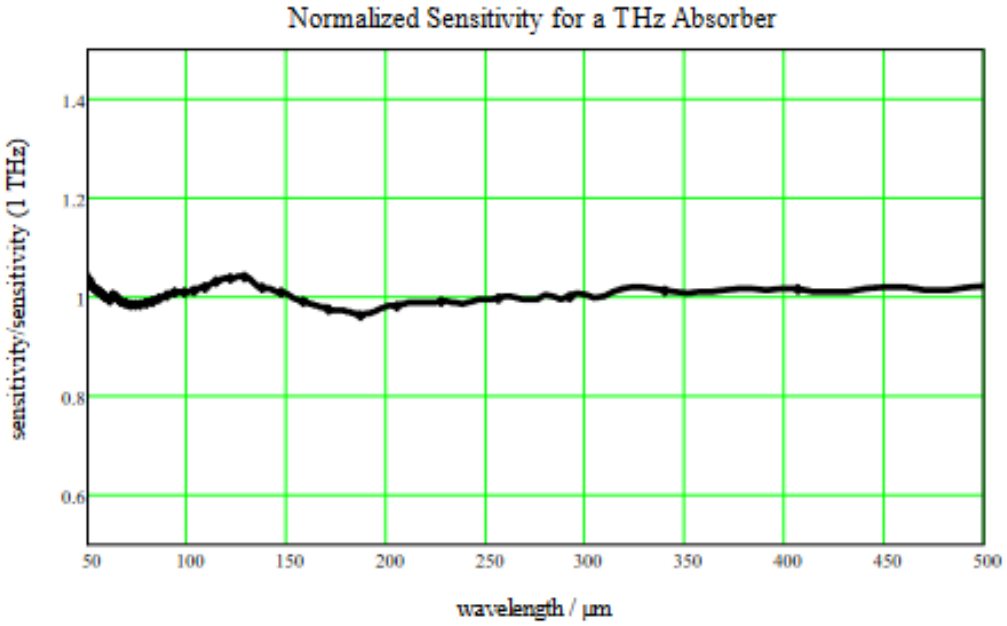


THz Pyroelectric Detectors

Regular and instant supports for PITZ!

Manufacturer: SLT Sensor- und Lasertechnik GmbH, Wildau

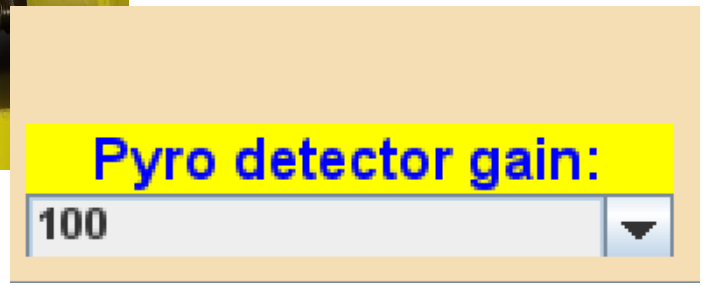
THz10



Voltage Preamplifier (VPA)

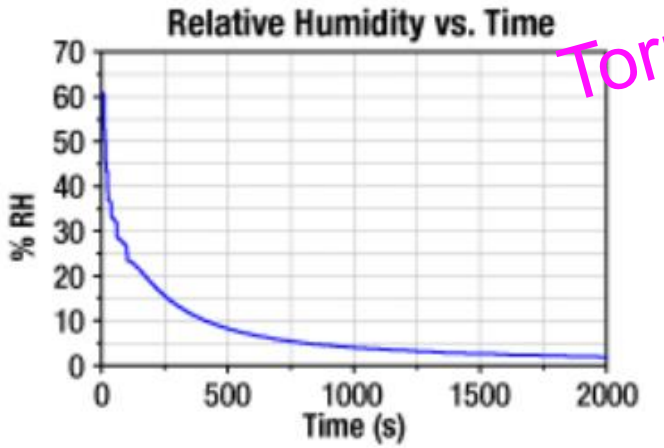
Upgrade to be remote controllable (10.2022+)

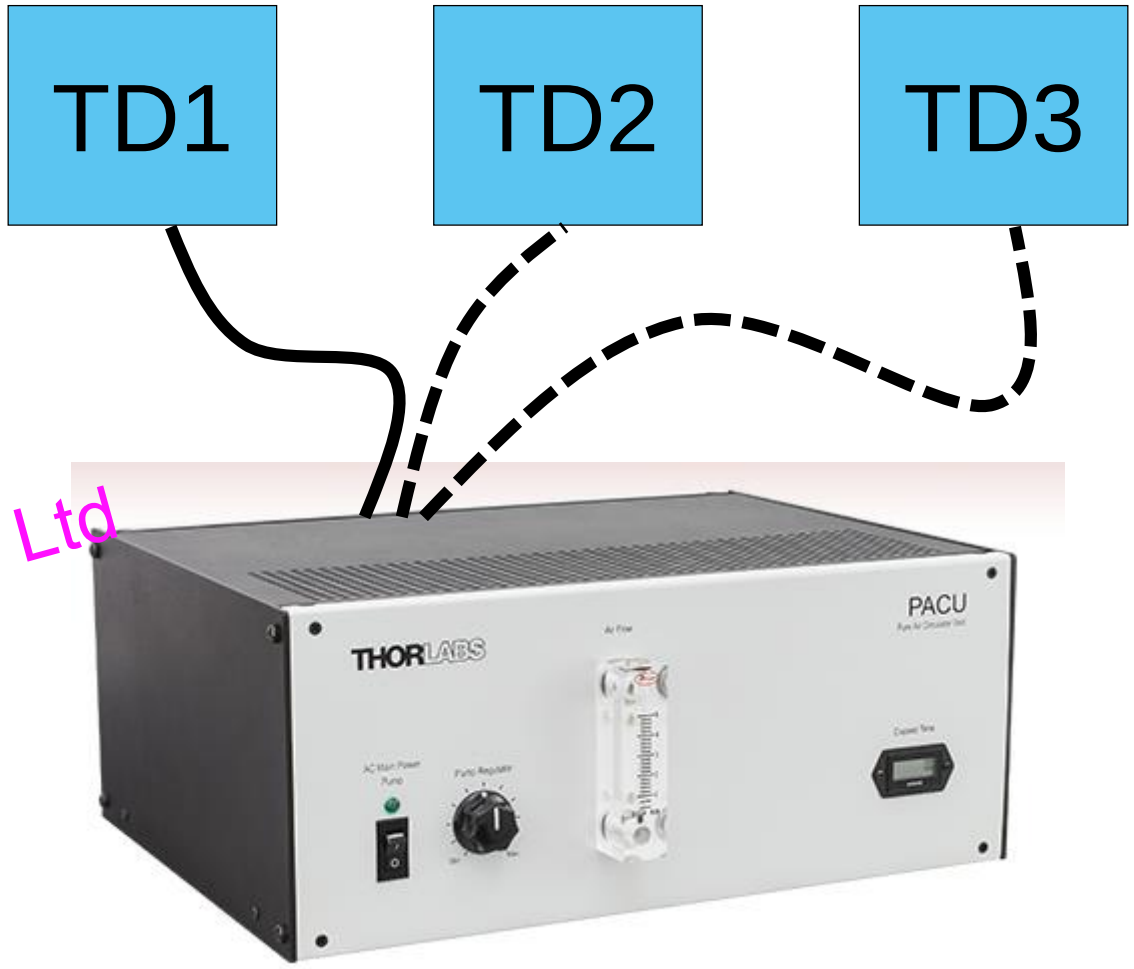
PIZ GUI (DOOCS)



Pure Air Circulator Unit (Thorlabs)

PACU™ Specifications	
Air Flow	
Flow Rate[a]	0.6 to 4.5 L/min
Flow Meter Range	0.6 to 5 L/min
Compatible Air Temperature Range	5 - 40 °C

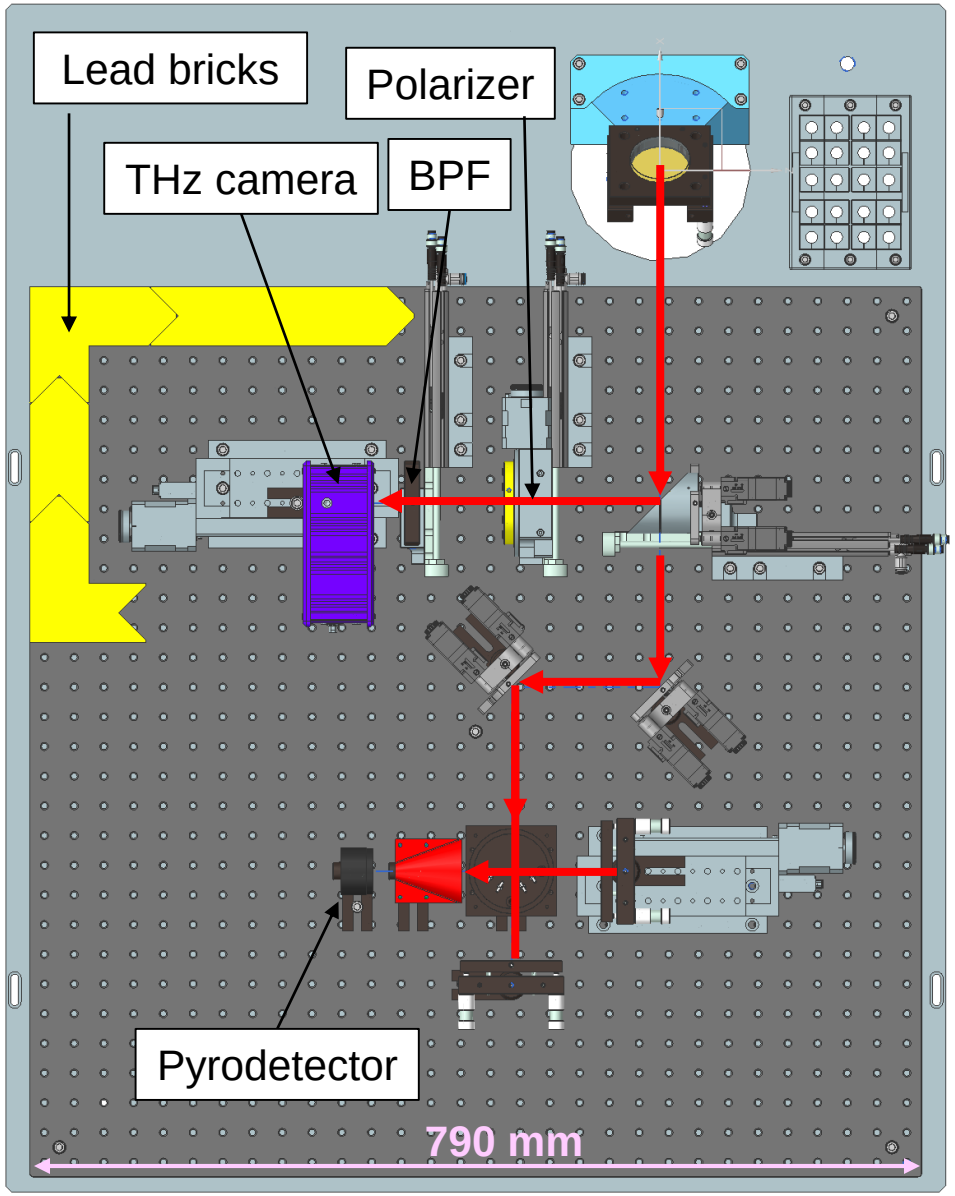




Torr Scientific Ltd

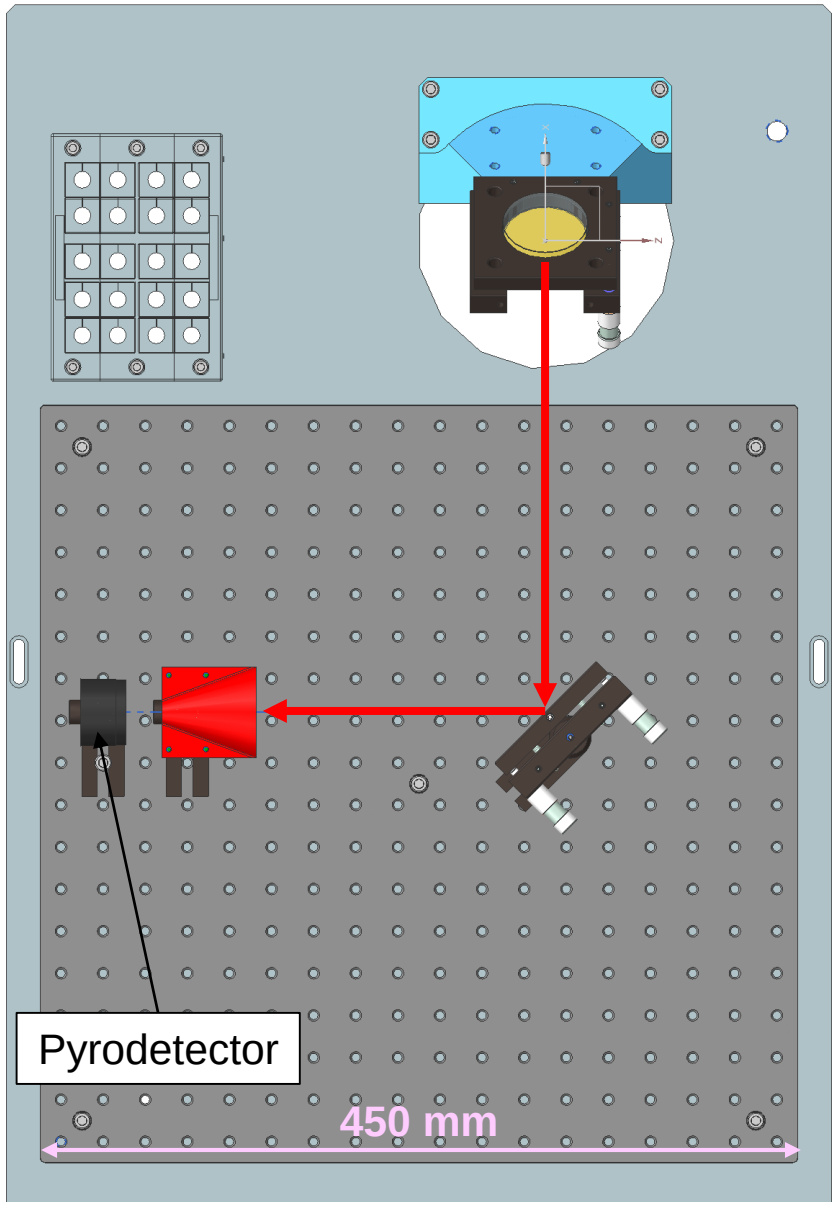
TD3 (for Undulator Radiation, FEL)

- Expected to be ready by spring 2023
- Enclosed system, A pure air circulator unit is used for air purification and humidity reduction.
- THz diagnostics
  - Pulse energy using pyroelectric detectors
  - Transverse profile using a THz camera
  - Polarization using a THz polarizer
  - THz spectrum using a Michelson interferometer
- Diamond vacuum window
- ~1.8 m transport in vacuum, 1-1.5 m transport in air
- Focusing by using 90° off-axis ellipsoidal and parabolic mirrors
- 3 pneumatic actuators, 3 motorized mirror adjusters, 2 motorized linear stages



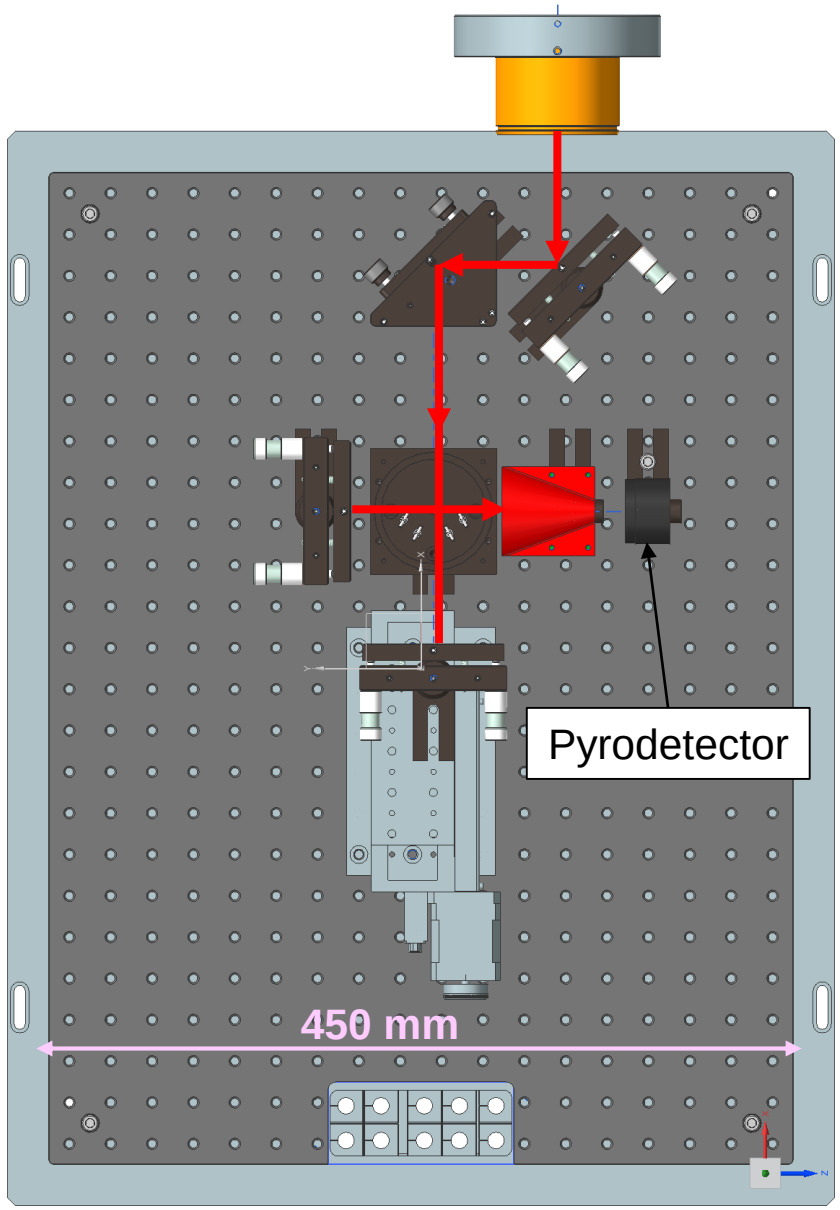
TD2 (for Undulator Radiation, FEL)

- Expected to be ready by spring 2023
- Enclosed system, A pure air circulator unit is used for air purification and humidity reduction.
- THz diagnostics
  - Pulse energy using pyroelectric detector
- Diamond vacuum window
- ~0.8 m transport in vacuum, ~0.5 m transport in air
- Focusing by using 90° off-axis ellipsoidal mirror

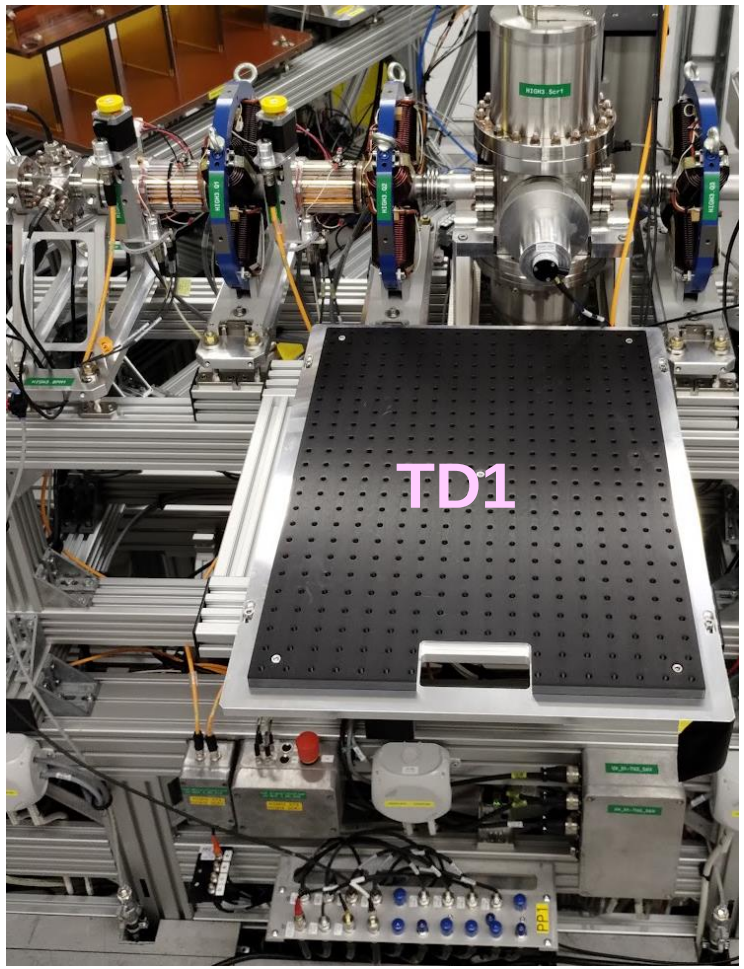


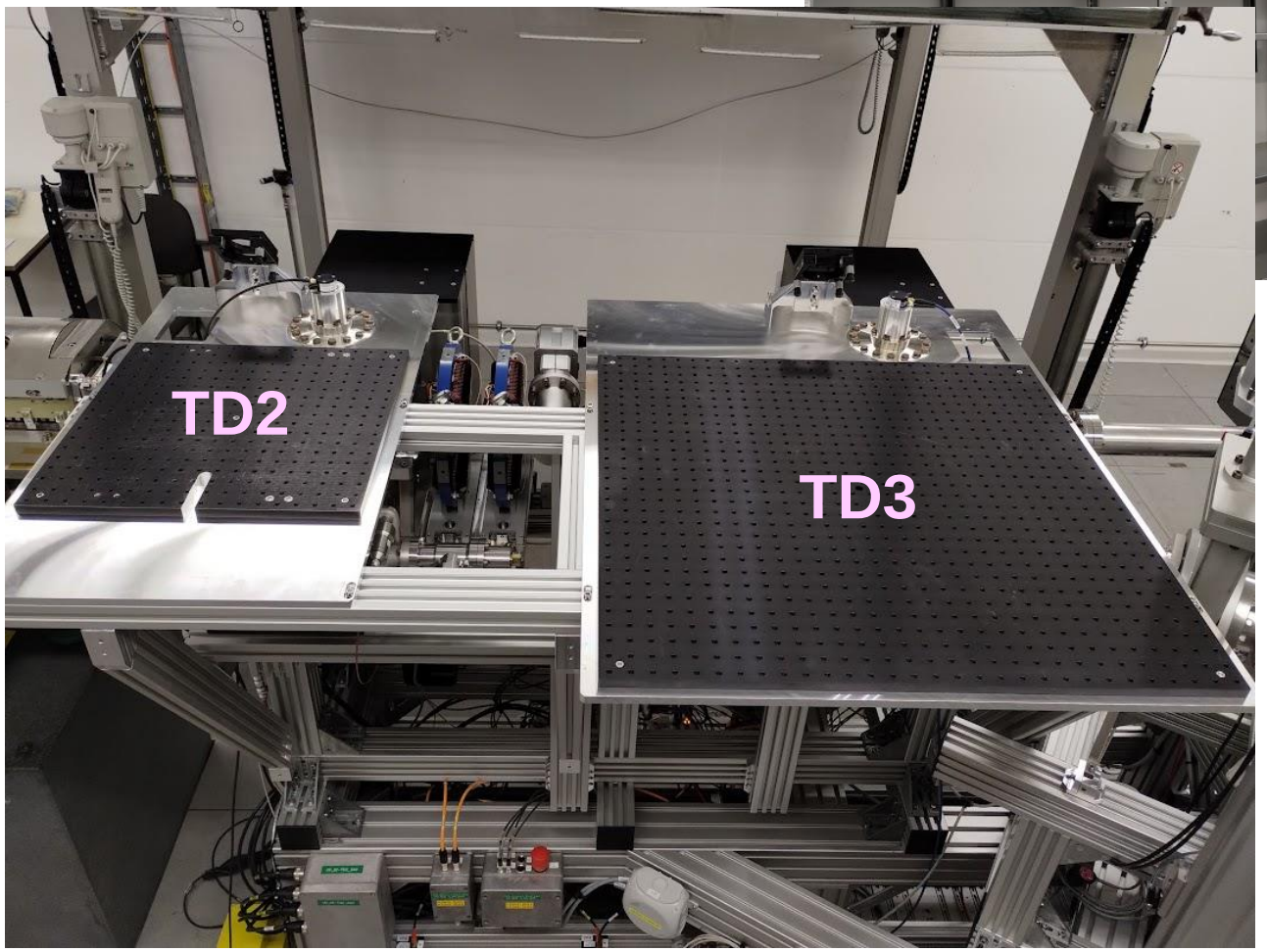
TD1 (for Transition Radiation)

- Expected to be ready by spring 2023
- Enclosed system, A pure air circulator unit is used for air purification and humidity reduction.
- THz diagnostics
  - Pulse energy using pyroelectric detector
  - THz spectrum using a Michelson interferometer
- Quartz vacuum window
- ~0.2 m transport in vacuum, ~0.5 m transport in air
- Focusing by using 90° off-axis ellipsoidal and parabolic mirrors
- 1 motorized linear stage



Construction Status (13.03.2023)



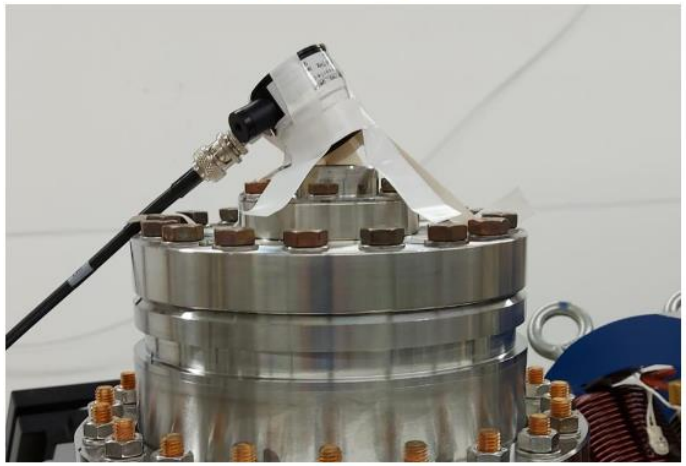


Quick Solution for THz diagnostics

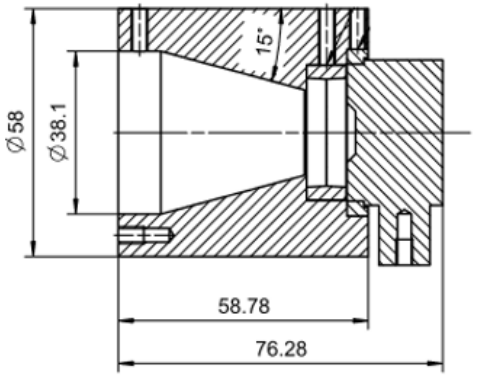
Have been used since July 2022

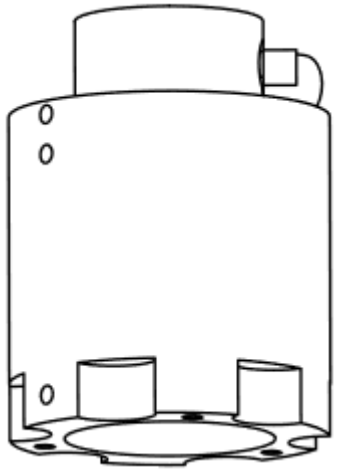
23.07.2022

25.07.2022



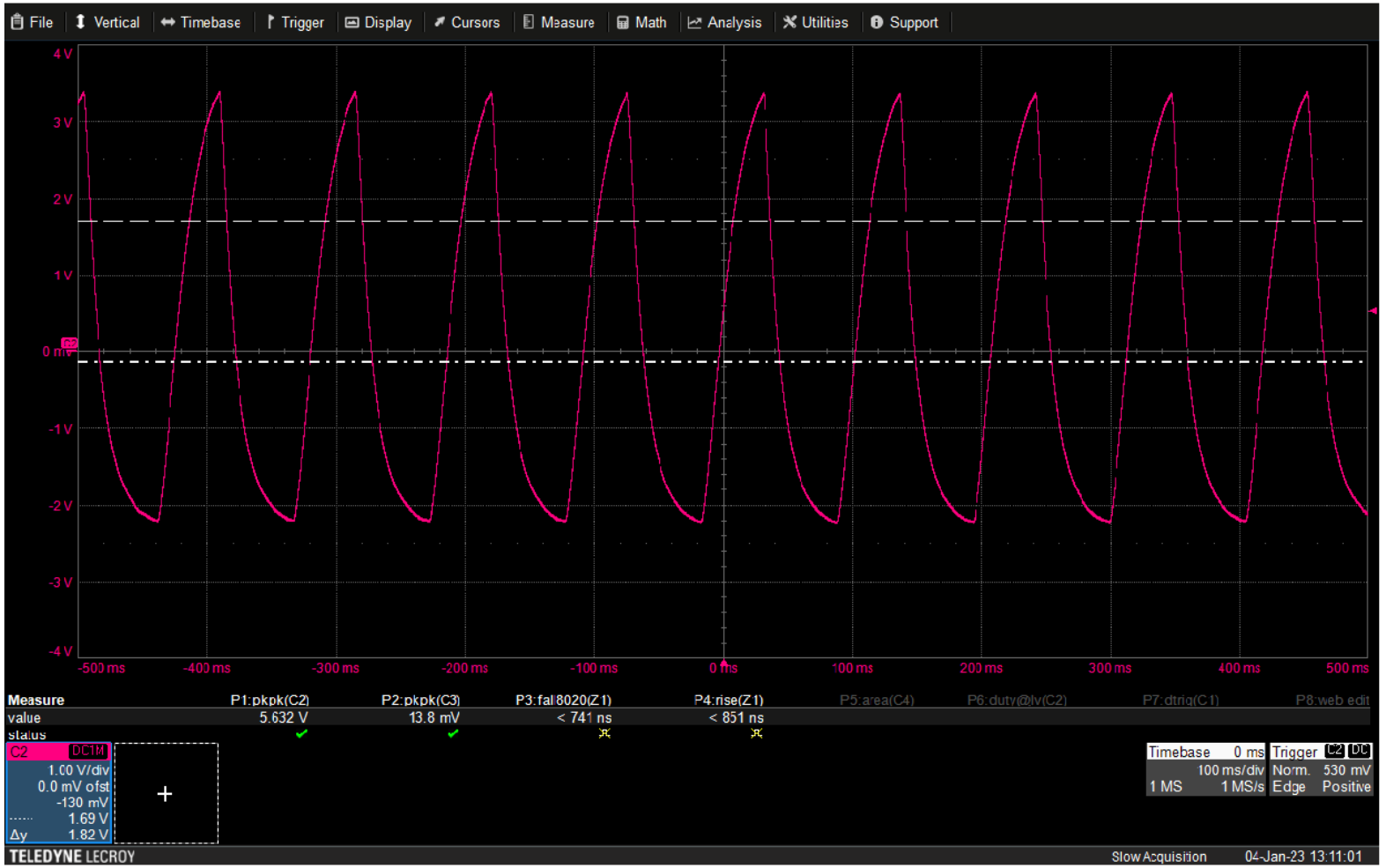
26.07.2022+





Detector Check in Tunnel with an External IR Source

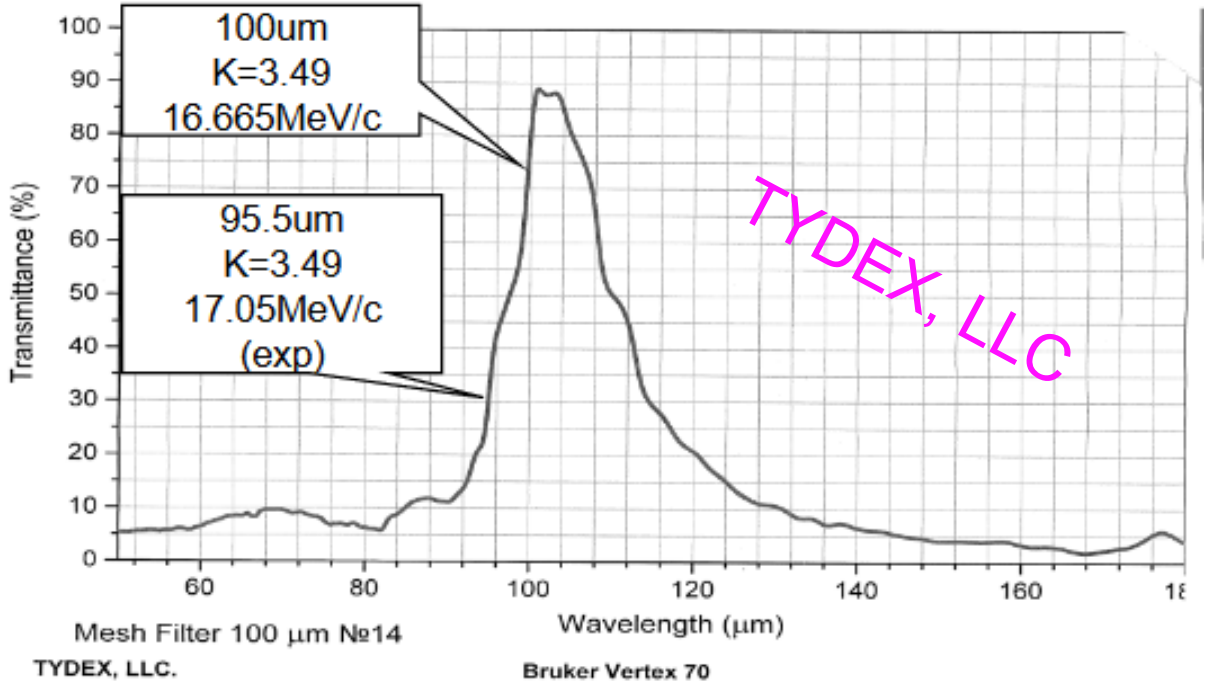
12.08.2022 17:39 M. Krasilnikov, K.Lange **Pyrodetectors quick check in tunnel with an IR (~2um) source -> setup**



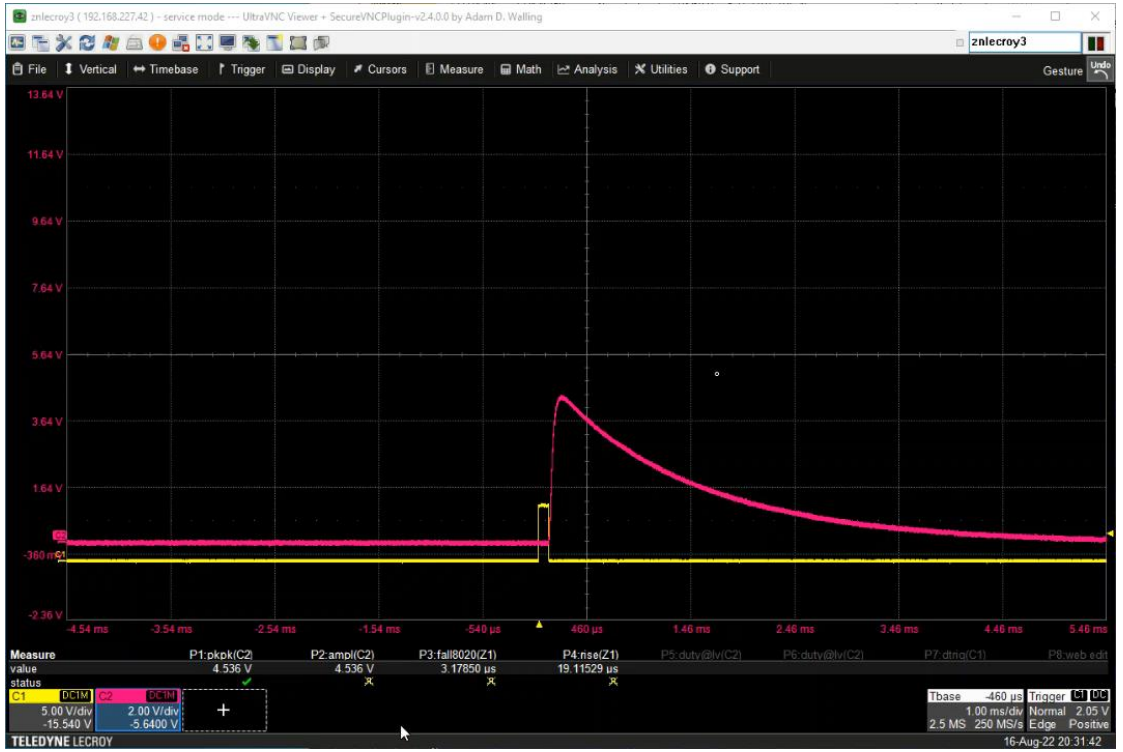
Band-Pass Filter

Fresh BPF

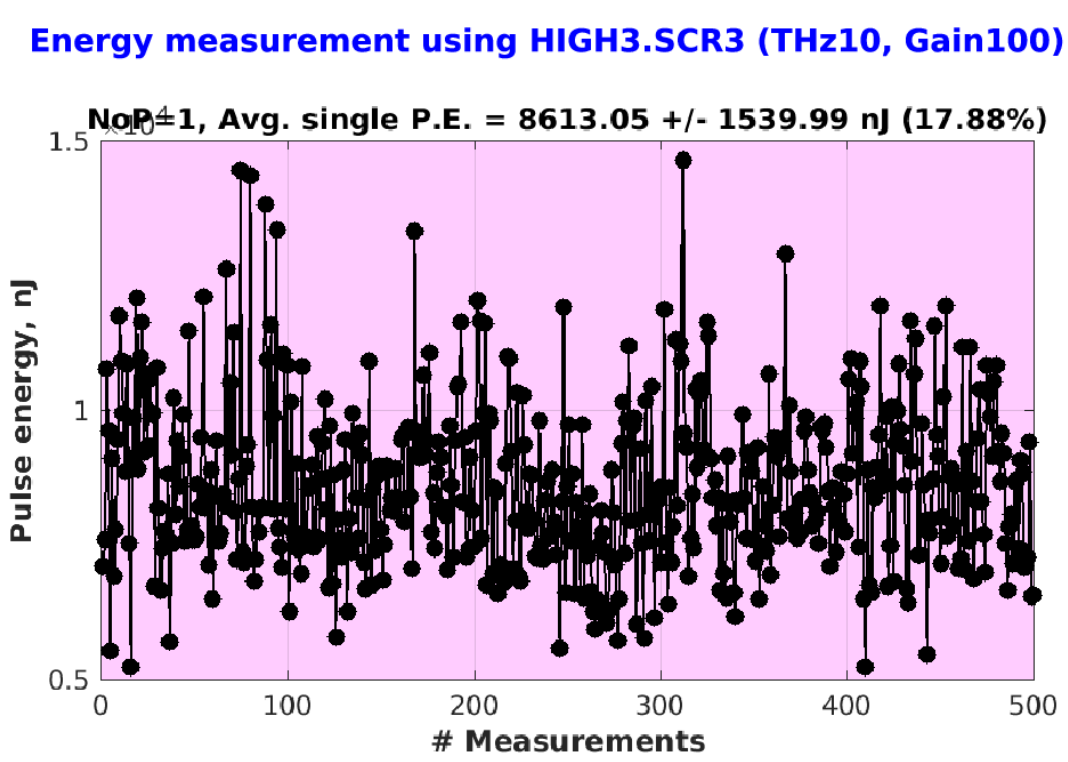
After used for several months (12.2022)

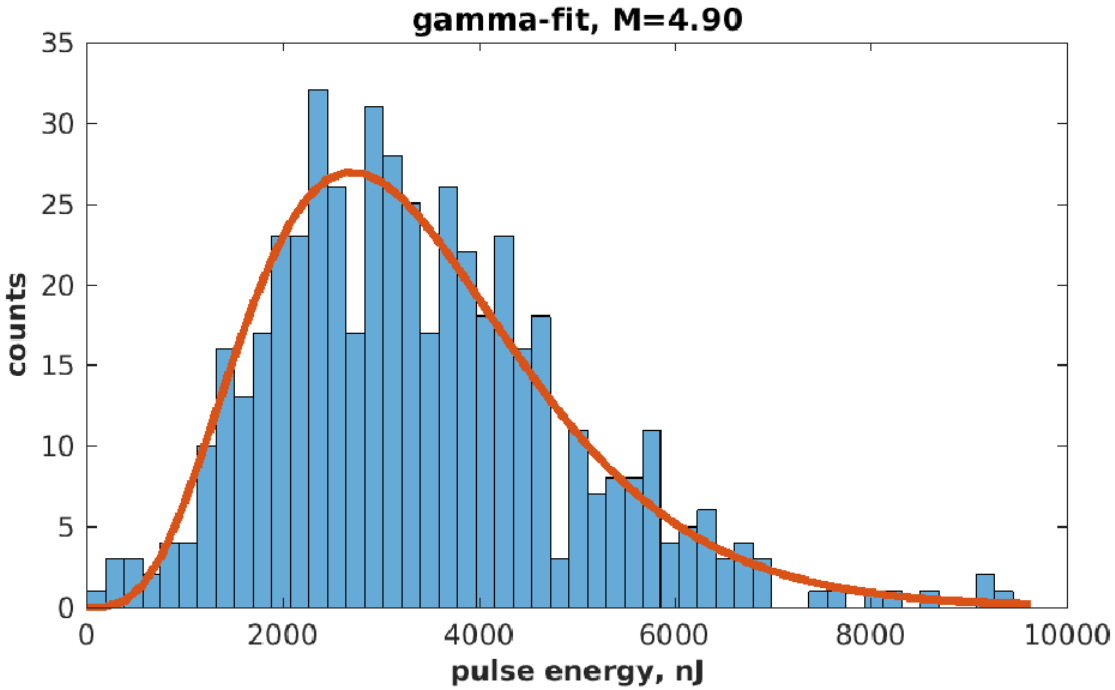


Examples of Measured Waveforms (FEL, Pyrodetectors)



Example of Statistical Measurement





Number of measurement 500, delay time 0.20 sec

Data saved to /doocs/measure/THz/2022/PulseEnergy/2022/20221012N/THzPE_0406.mat

Brainstorming Meeting on Time-resolved THz diagnostics for THz@PITZ

Online (Zoom) meeting, Tuesday, 5.10.2021

https://confluence.desy.de/x/s5eiDQ

Participant List

- Mikhail Krasilnikov , DESY
- Frank Stephan , DESY
- Prach Boonpornprasert , DESY
- Anusorn Lueangaramwong , DESY
- Andreas Hoffmann , DESY
- Georgi Georgiev , DESY
- James David Good , DESY
- Raffael Niemczyk , DESY
- Tobias Weilbach , DESY
- Xiangkun Li , DESY
- Grygorii Vashchenko , DESY
- Pavel Evtushenko, HZDR
- Sergey Kovalev, HZDR
- Sascha Preu, TU Darmstadt
- Nicholas Matlis, CFEL

Meeting Agenda

Speakers	Topics
M. Krasilnikov	Short PITZ (THz@PITZ) overview/introduction
T. Weilbach	THz@PITZ realization/status
P. Boonpornprasert	Planned THz diagnostics
X.-K. Li	THz pulse characteristics from start-to-end simulations of THz SASE FEL
G. Georgiev	Stability improvements expected from seeding
N. Matlis	Single-shot EOS measurements of THz pulses
S. Preu	Ultrafast Detectors for High Power THz Facilities
J. Good	Available laser infrastructure at PITZ
G. Vashchenko	Timing/synchronization system at PITZ
Discussion on realization of the time-resolved THz pulse diagnostics at PITZ	
Next steps	
Closing Remarks	

Summary

- Construction work on THz diagnostics for THz@PITZ is ongoing, expected to be finished by Spring 2023
- A quick Solution to measured THz directly from the windows has been used since July 2022.
- Brainstorming Meeting on Time-resolved THz diagnostics for THz@PITZ took place on 05.21.2021

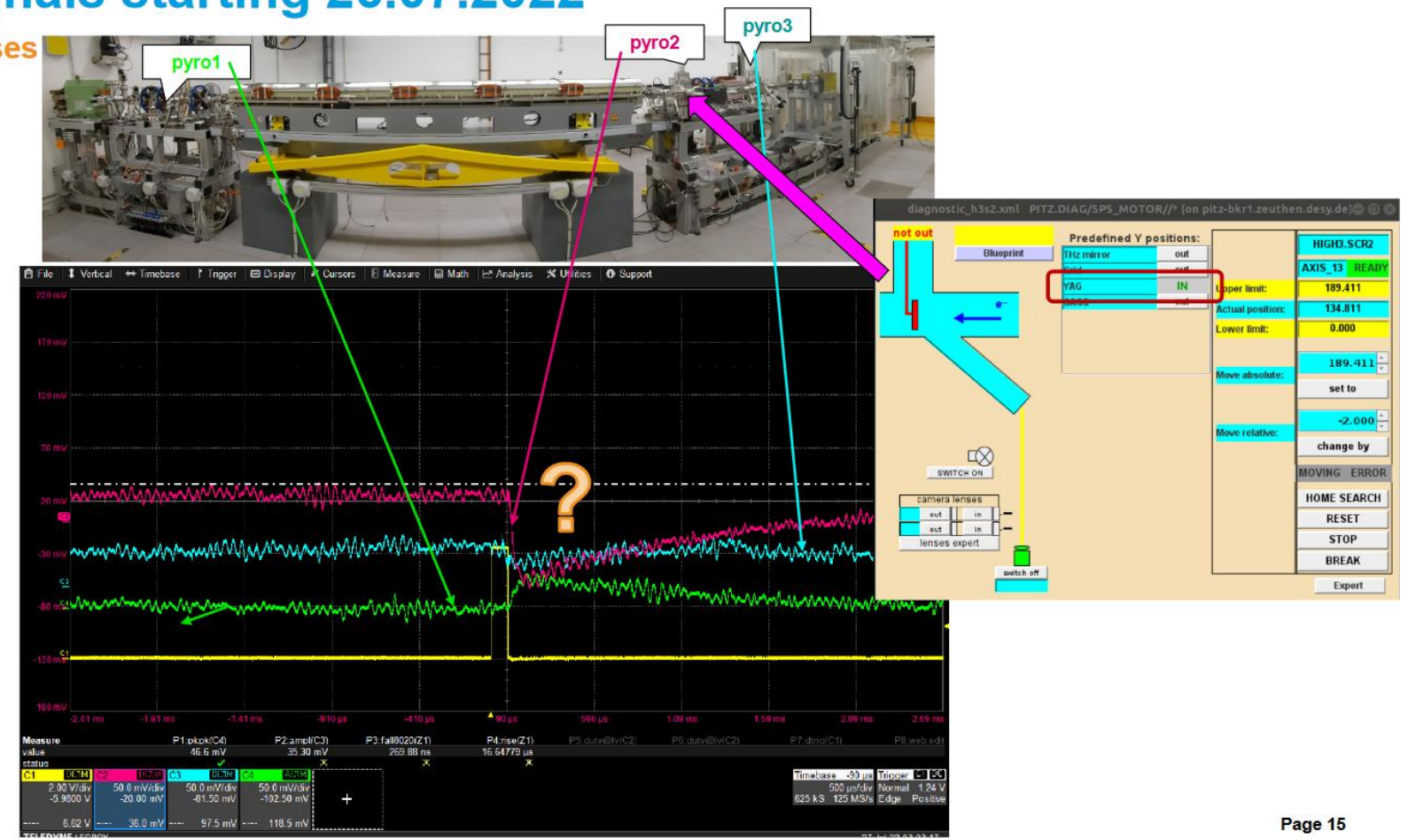
Backup

Problem: Negative peak from pyrodetectors

Problem: Negative peak from pyrodetectors

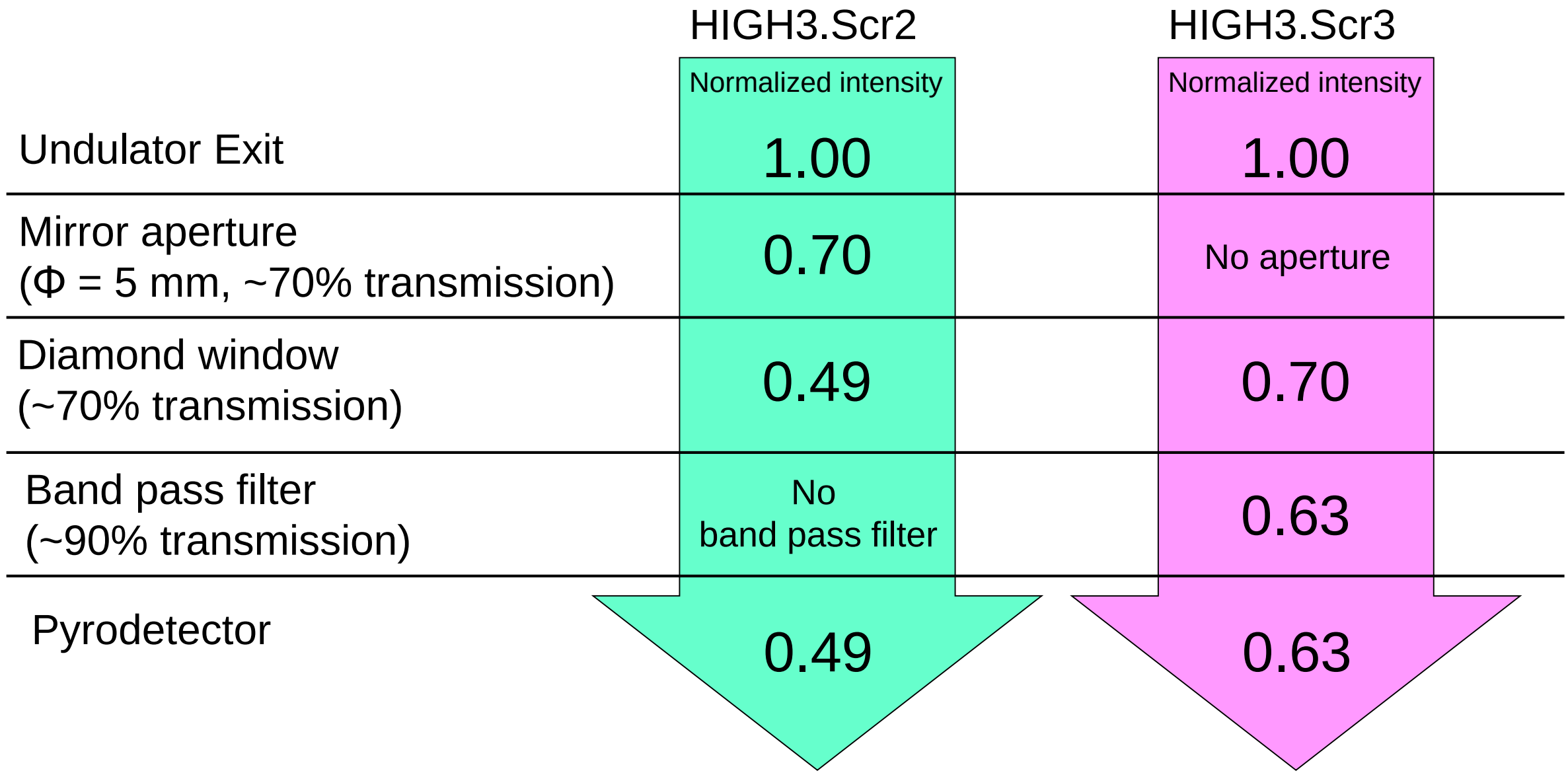
Pyro-signals starting 26.07.2022

500pC, 20pulses



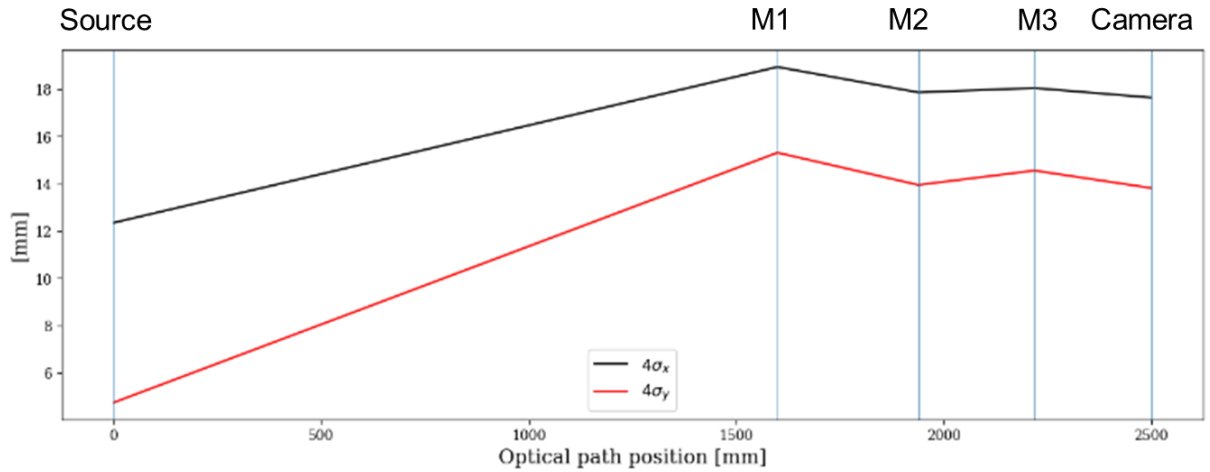
DESY.

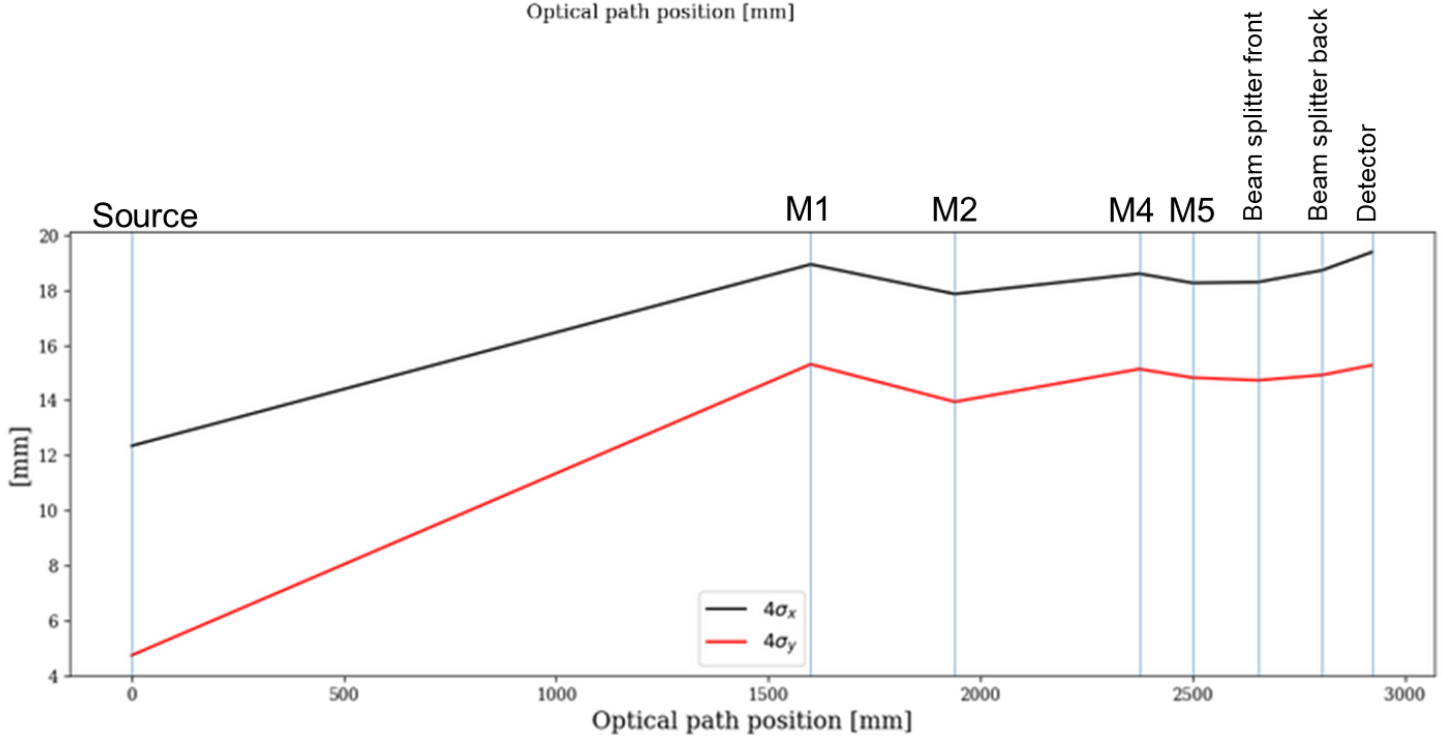
FEL Radiation Loss Estimation for λ_{FEL} = 100 µm



HIGH3.Scr3: simulated photon beam envelope

Tool: LightPipe





HIGH3.Scr3: simulated photon beam envelope (long path)

Tool: LightPipe