Updates on THz Generation Experiments at PITZ

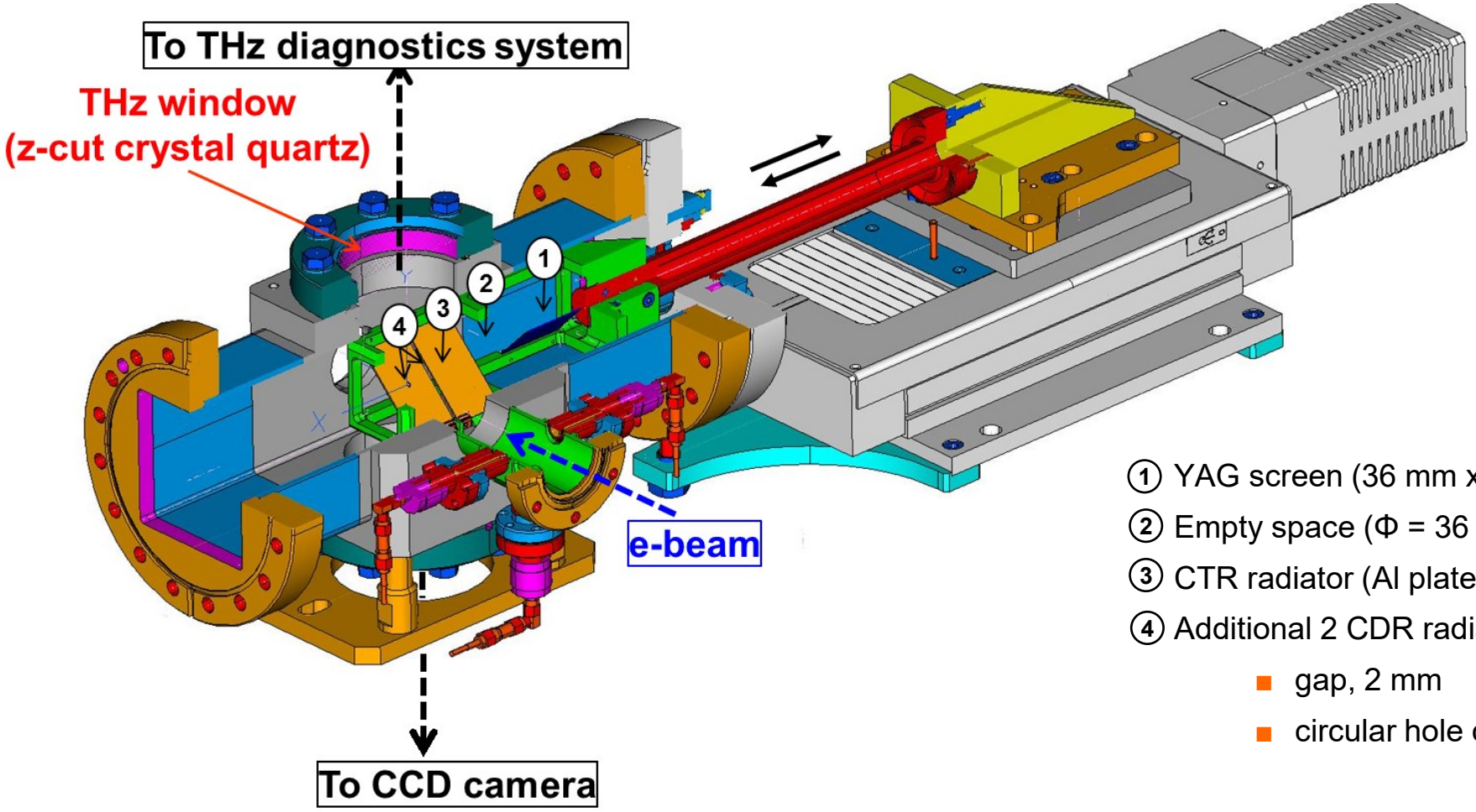
Prach Boonpornprasert

PITZ Physics Seminar
DESY Zeuthen
18.03.2020

Outline

- Review of the THz stations
  - The screen station PST.Scr2
  - THz diagnostics system
- Recent experiments
- Upgrade of the THz diagnostics system

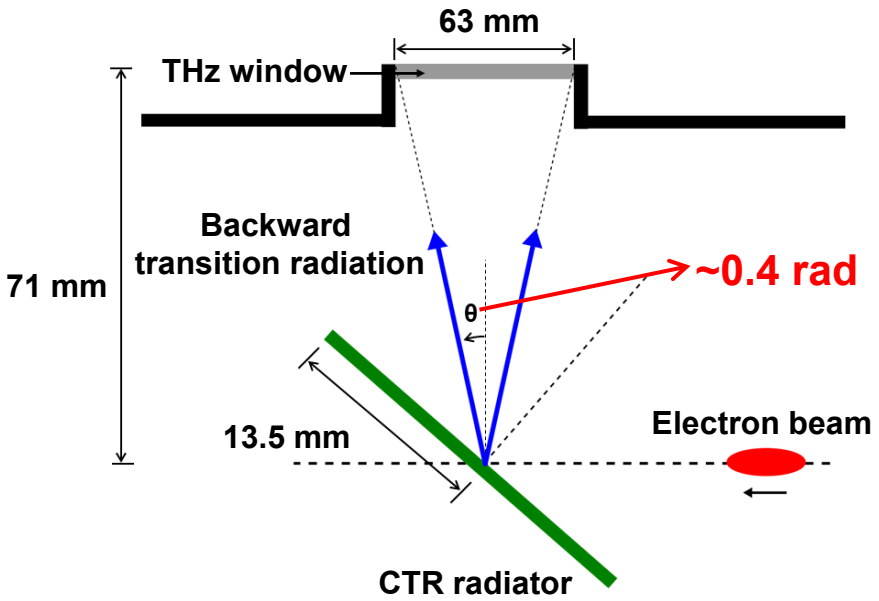
THz Station: PST.Scr2



① YAG screen (36 mm x 55 mm)
② Empty space (Φ = 36 mm)
③ CTR radiator (Al plate, 27mm x 55 mm)
④ Additional 2 CDR radiators
- gap, 2 mm
- circular hole on Al plate, Φ = 2 mm

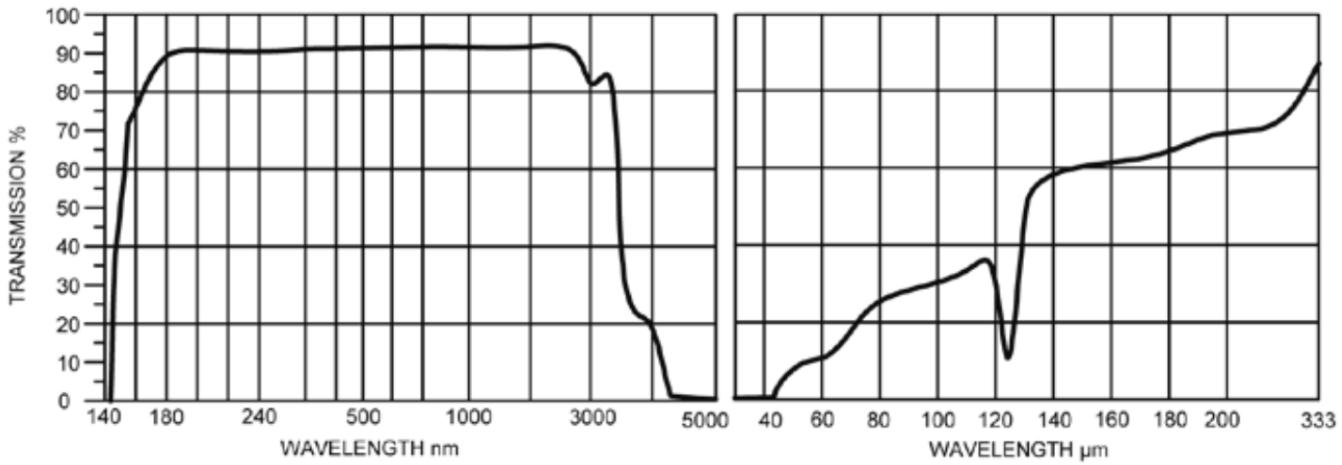
THz Station: PST.Scr2

Acceptance angle



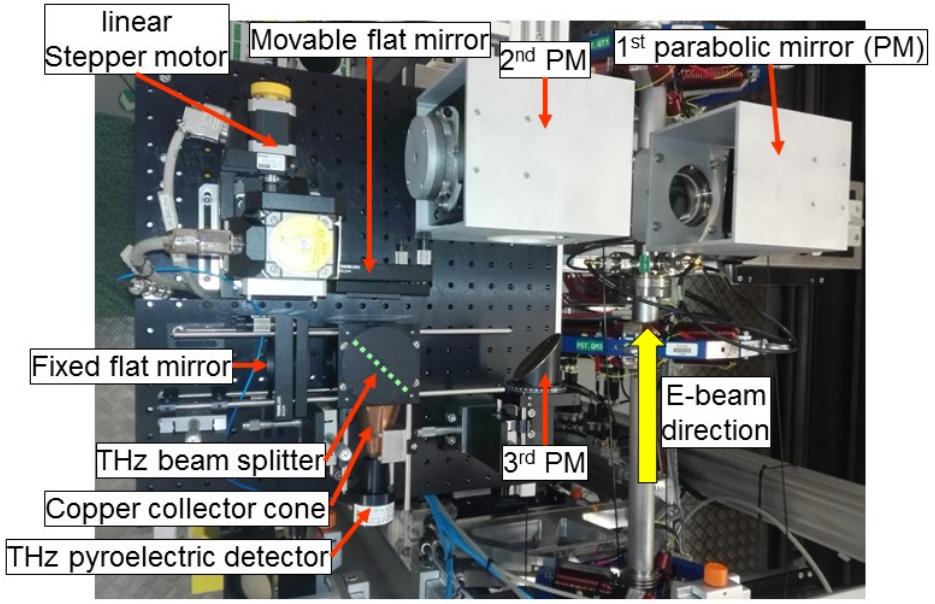
THz window

- Company: Torr Scientific Ltd, UK
- Model: BVPZ64NQZ
- Material: Quartz Natural Z-Cut Zero Length
- Flange type: NW63CF
- Optical thickness: 4.5 mm

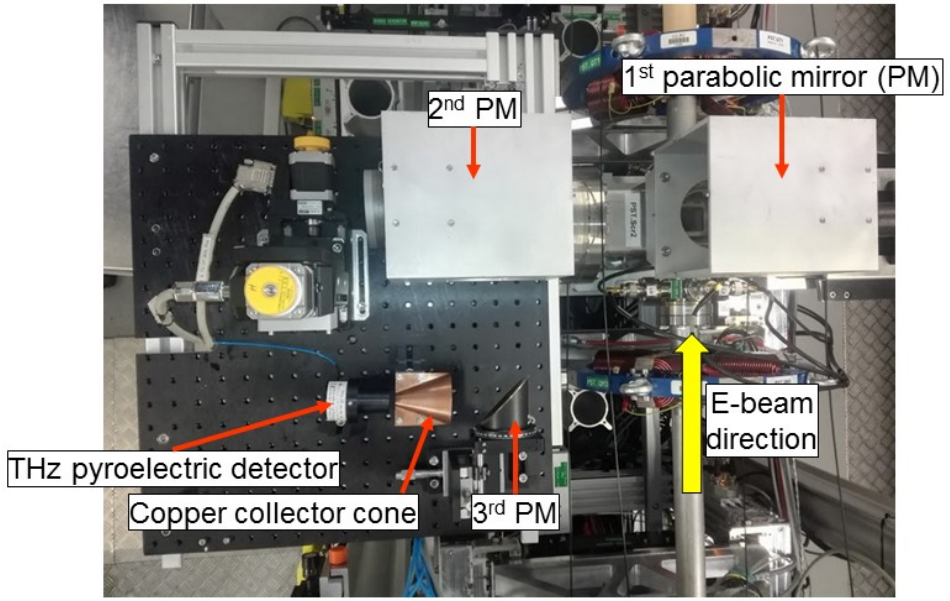


THz Station: THz Diagnostics System

Setup for spectral distribution measurement (Michelson interferometer)

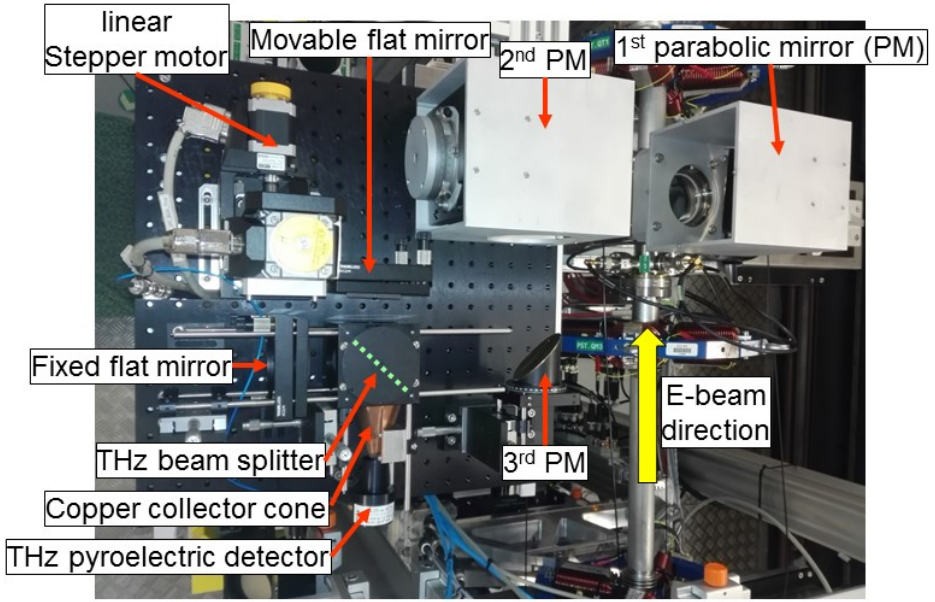


Setup for total pulse energy measurement

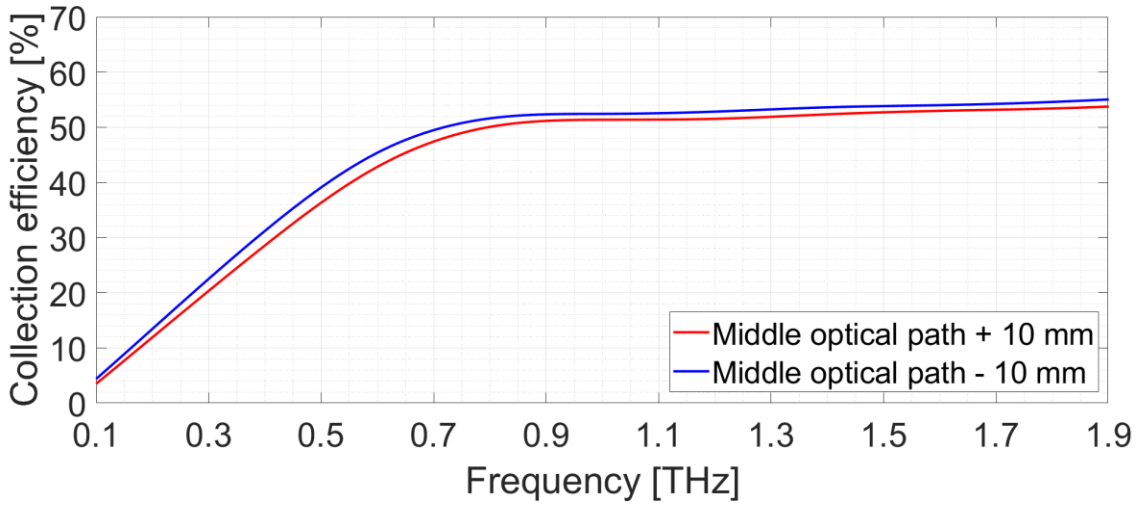


THz Station: THz Diagnostics System

Setup for spectral distribution measurement (Michelson interferometer)



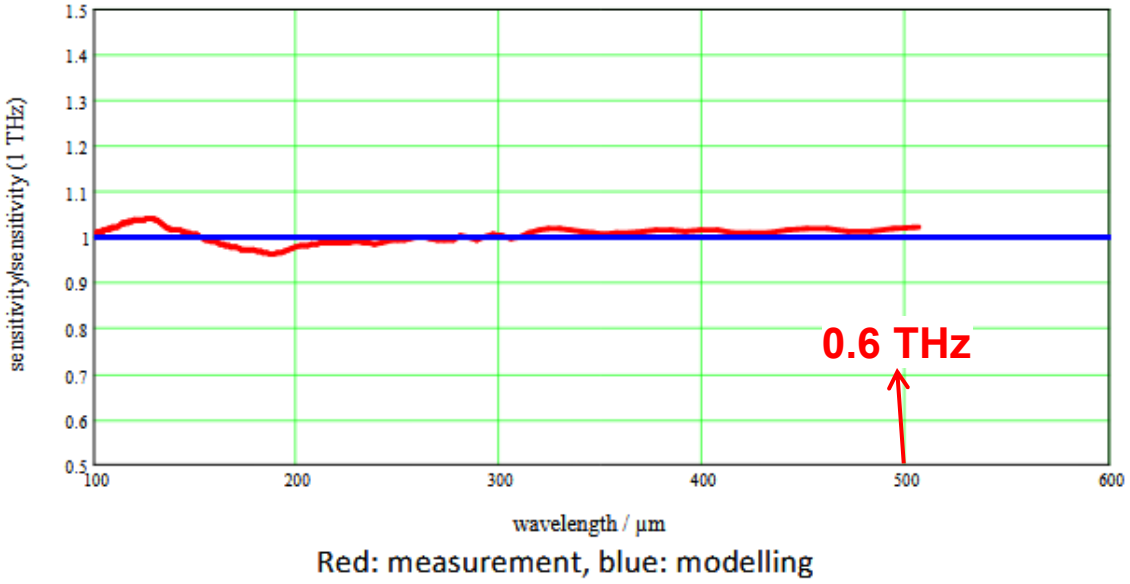
Diffraction loss of this setup (calculated by THzTransport code)



THz Station: THz Diagnostics System

THz detector

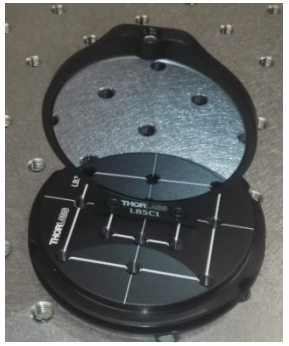
- Company: SLT, Wildau
- Model: THz20
- Type: Pyroelectric detector



Red: measurement, blue: modelling

THz beam splitter

- Company: Tydex, Russia
- Model: BS-HRFZ-Si-D50.8-T3.5
- Material: High Resistivity Float Zone Silicon (HRFZ-Si)



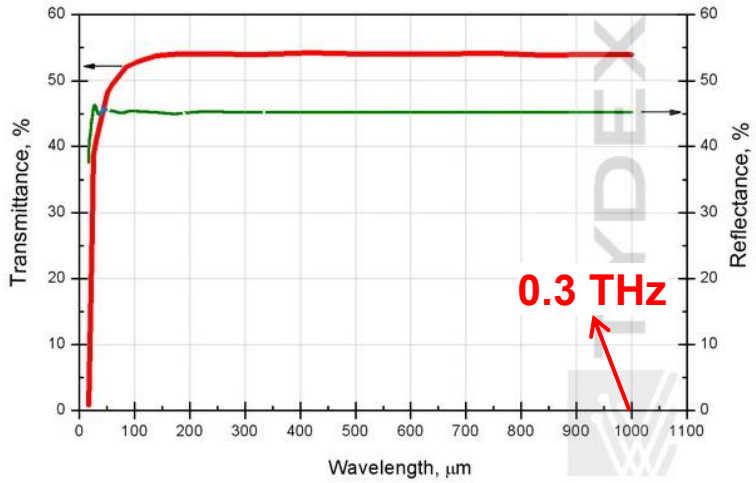


Fig. 1. Transmission and reflection of HRFZ-Si 5.0 mm-thick sample in THz range.

THz Station: THz Diagnostics System

THz detector: conversion from output voltage to energy

F_{calib} = calibration factor from company = $58.4\ V/W$
G = amplification conversion factor (gain) = $10^8\ V/A$
G_{VPA} = gain of voltage preamplifier = 1000
C_{det} = detector capacity = 3.34 nF
C_{cab} = cable capacity = 100 pF
$S_{current}$ = current sensitivity
$S_{voltage}$ = voltage sensitivity
$V_{measured}$ = measured voltage from the scope
$E_{measured}$ = measured enegy per pulse
NoP = number of pulses

$$S_{current} = \frac{F_{calib}}{G} = \frac{58.4\ V/W}{10^8\ V/A} = 0.584\ \mu A/W$$

$$S_{voltage} = \frac{S_{current}}{C_{det}+C_{cab}} = \frac{0.584\ \mu A/W}{3.44\ nF} = 170\ V/J$$

$$\frac{A/W}{F} = \frac{A.s/J}{A.s/V} = \frac{V}{J}$$

$$E_{measured} = \left(\frac{V_{measured}}{S_{voltage}}\right) * \left(\frac{1}{NoP}\right) * \left(\frac{1}{G_{VPA}}\right)$$

Example: NoP = 20 pulses, $V_{measured}$ = 1 mV

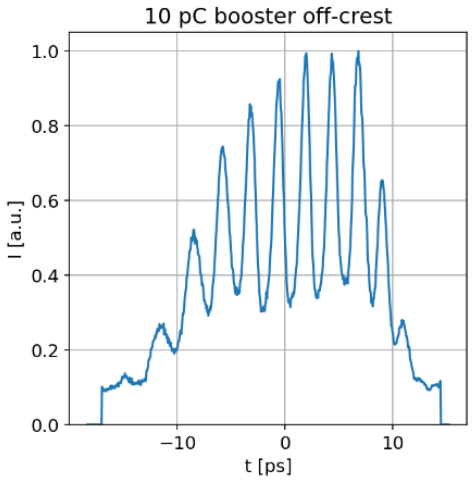
➔ $E_{measured} = \left(\frac{1\ mV}{170\ V/J}\right) * \left(\frac{1}{20}\right) * \left(\frac{1}{1000}\right) = 0.294\ nJ$

Recent Experiments

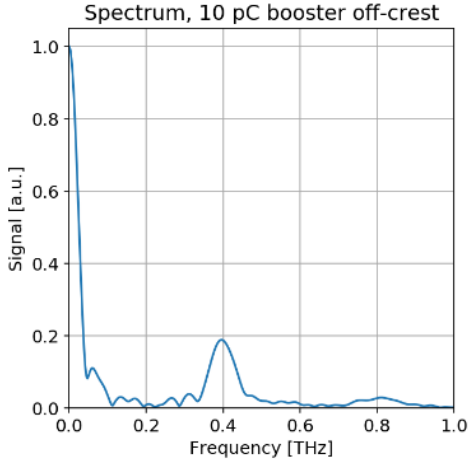
Measurements of (C)TR generated by a modulated beam (March 2020)

Highlight results were presented by G. Georgiev in PPS 05.03.2020 (rehearsal for ~~DPG 2020~~)

- Laser: Modulation using Lyot filters, BSA = 2.5 mm
- Beam: Q_{bunch} = 500 pC and 1 nC
- $P_{z,gun}$ ~ 6.7 MeV/c, $P_{z,booster}$ ~ 20.7 MeV/c

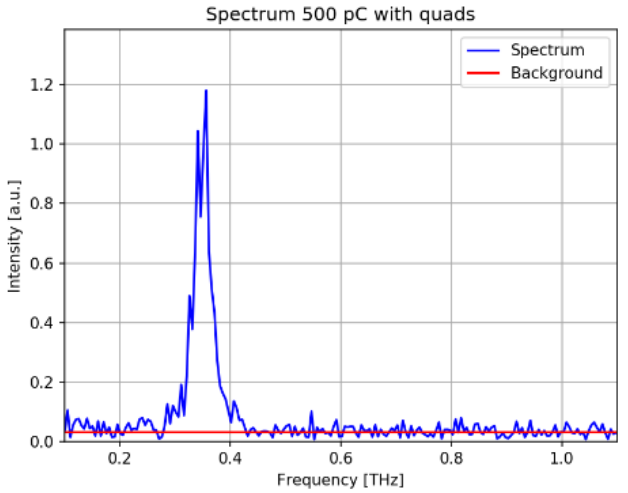


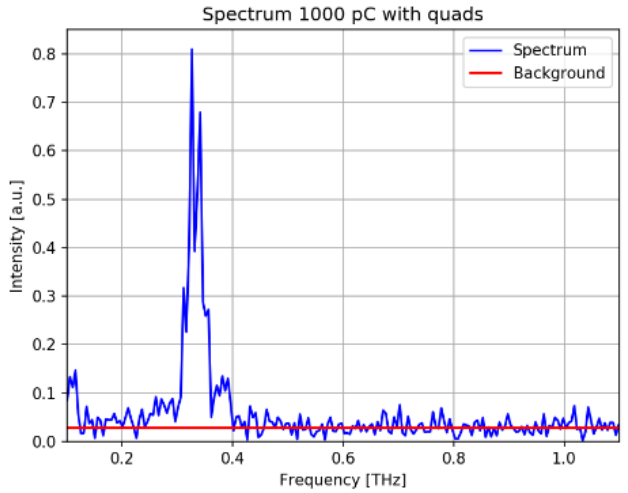
Current profile of a 10 pC modulated beam measured by the booster off-crest method



The spectral distribution derived from FT

Case	Peak [a.u.]	Peak w/o bkg	Freq. [THz]
500 pC @ Imin	0,627	0,593	0,356
500 pC @ Imin-20A + quads	1,18	1,15	0,356
1 nC @ Imin	0,546	0,511	0,324
1 nC @ Imin-20A + quads	0,809	0,781	0,326

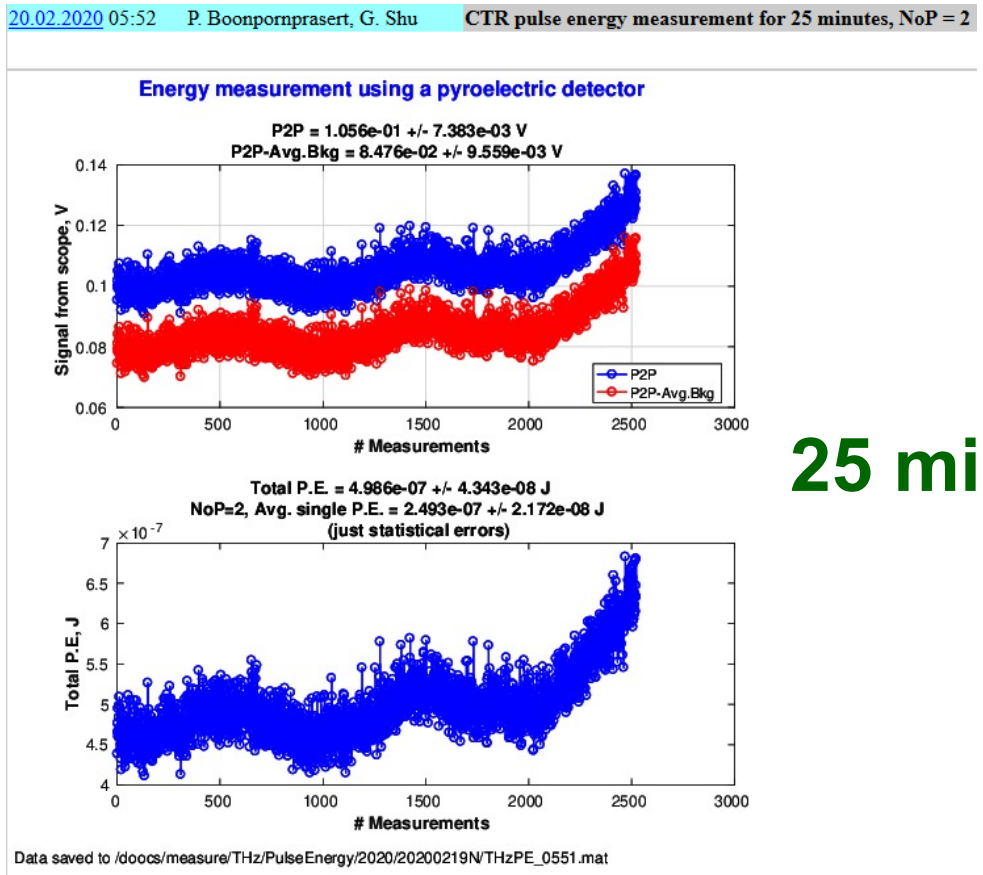




Recent Experiments

Difficulties

- Optical alignments ➔ Upgrade the diagnostics system
- Slow signal fluctuations from the pyroelectric detector were observed. A possible cause is some components were heated. ➔ To be investigated by a thermometer.

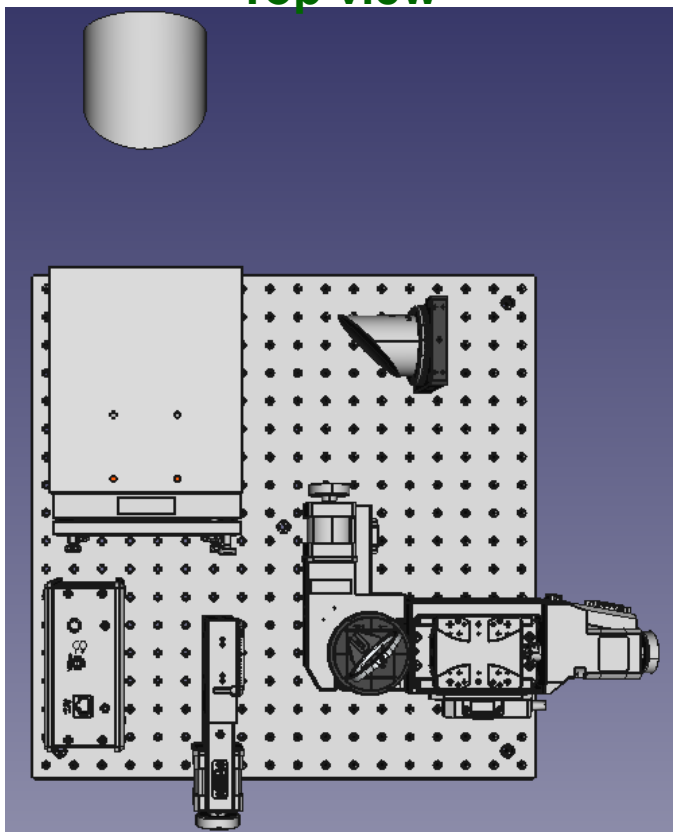


25 minutes

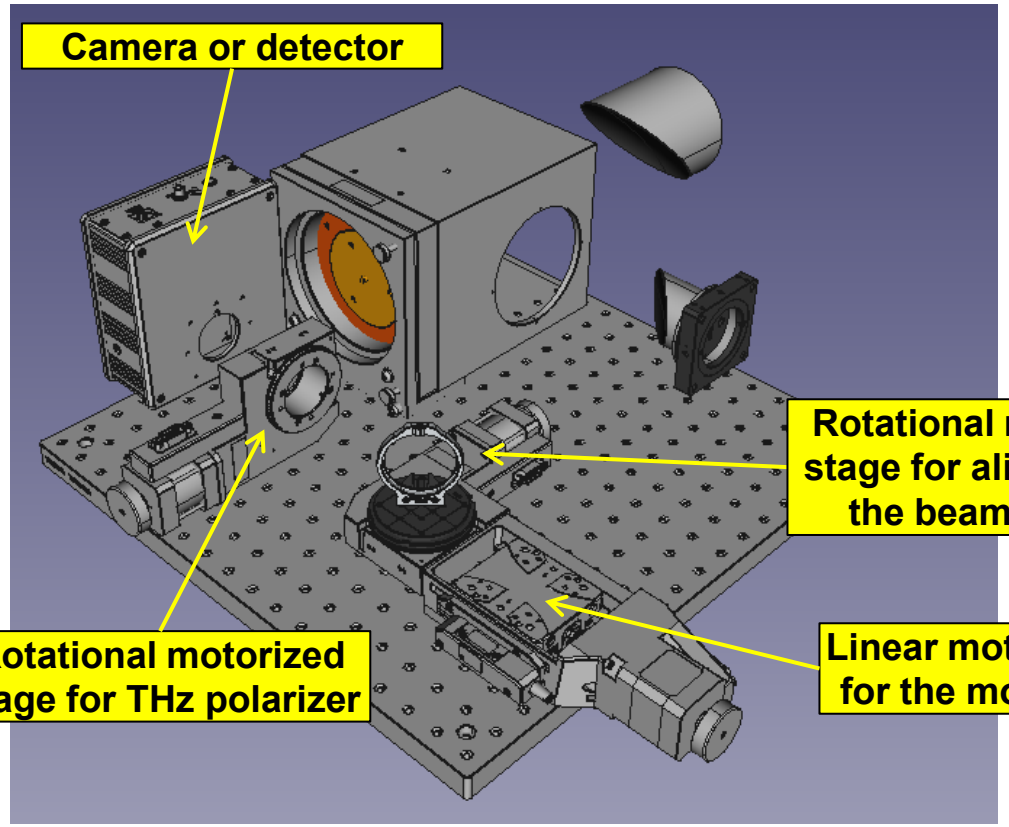
Upgrade of the THz Diagnostics System

- Consider of using THz band-pass filters.
- Equip with more remote control motorized stages ➔ design is ongoing (H. Shaker).

Top view



Isometric view



Summary and Outlook

- Details of the CTR/CDR station are reviewed.
- Highlight experimental results were already presented by G. Georgiev in PPS 05.03.2020.
- Upgrade of the THz diagnostics system is ongoing.

To be done

- CTR measurements using a THz camera
- CTR/CDR polarization measurements
- Investigation of signal fluctuation from the detector
- Test of THz window
- Detailed calculations of THz radiation transport
- …