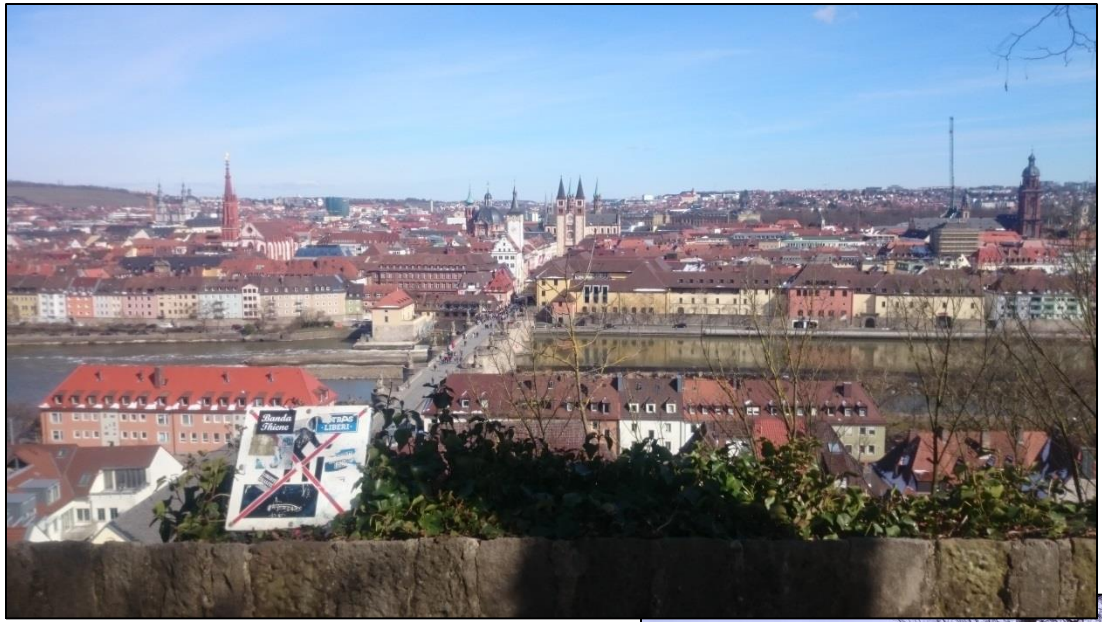
DPG Spring Meeting 2018

Highlights from Würzburg

Osip, Ye & Raffael

Würzburg

Located in northern Bavaria, on the Main River, population ~ 124.000 people



‘Highlights’ from the DPG

Poster Session in the dark

- Three sessions per day, all at the same time
- Poster session in the dark
- Few to non-existent discussions after talks.. ☹

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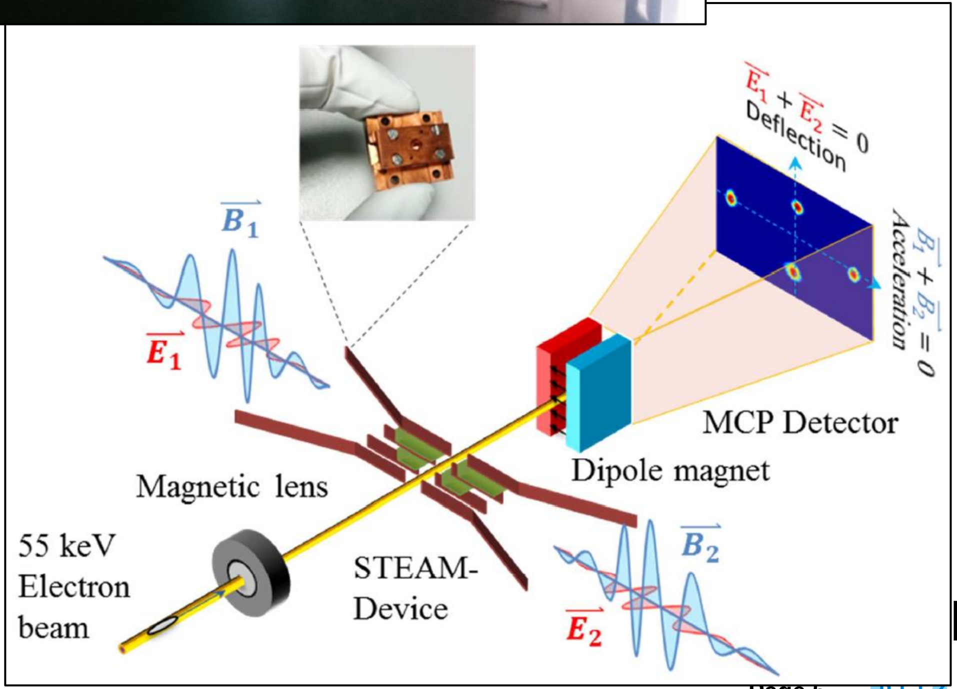
Segmented THz Electron Accelerator & Manipulator (STEAM)

- Accelerating, streaking, compressing & compression in one
- Superposition of electric and cancellation of magnetic fields or superposition of magnetic and cancellation of electric fields
- Phase-matching inside STEAM device by insertion of dielectric slabs



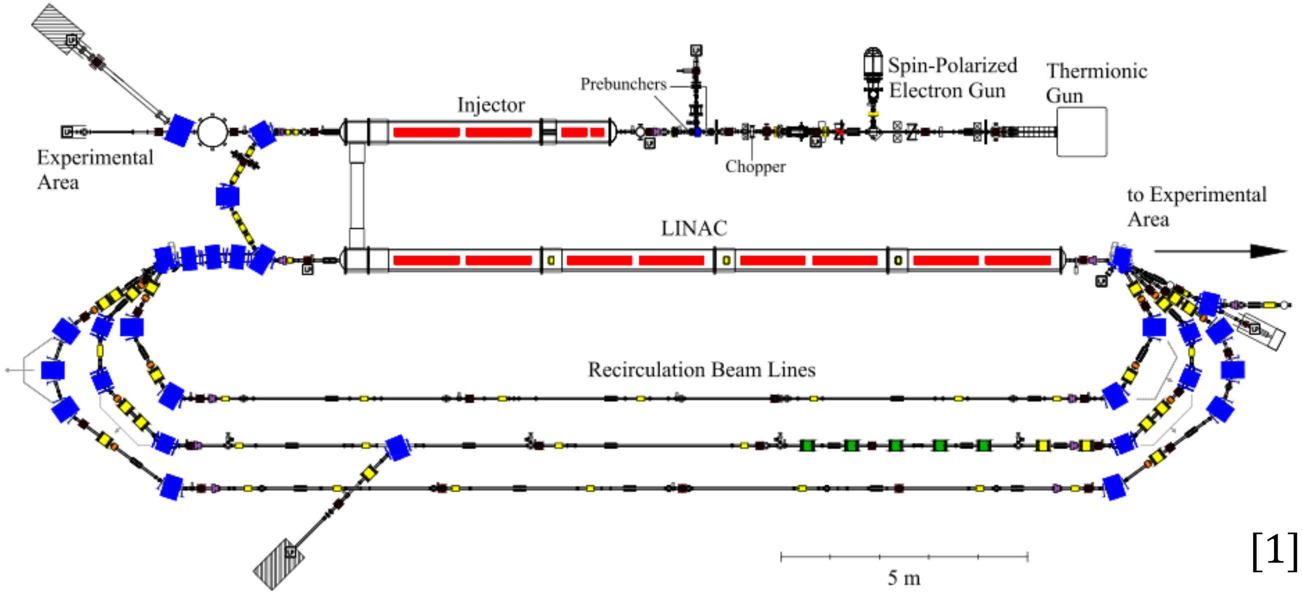
[1]

[1] D. Zhang, CFEL, DESY.

‘Highlights’ from the DPG

First ERL Operation of S-DALINAC

- It works! (First time in Germany)
- Phase change by moving magnets + beam pipe
- Phase has to be changed by ~ 126 deg, reason unknown



[1]

[1] M. Arnold, PhD Thesis 2016, TU Darmstadt.

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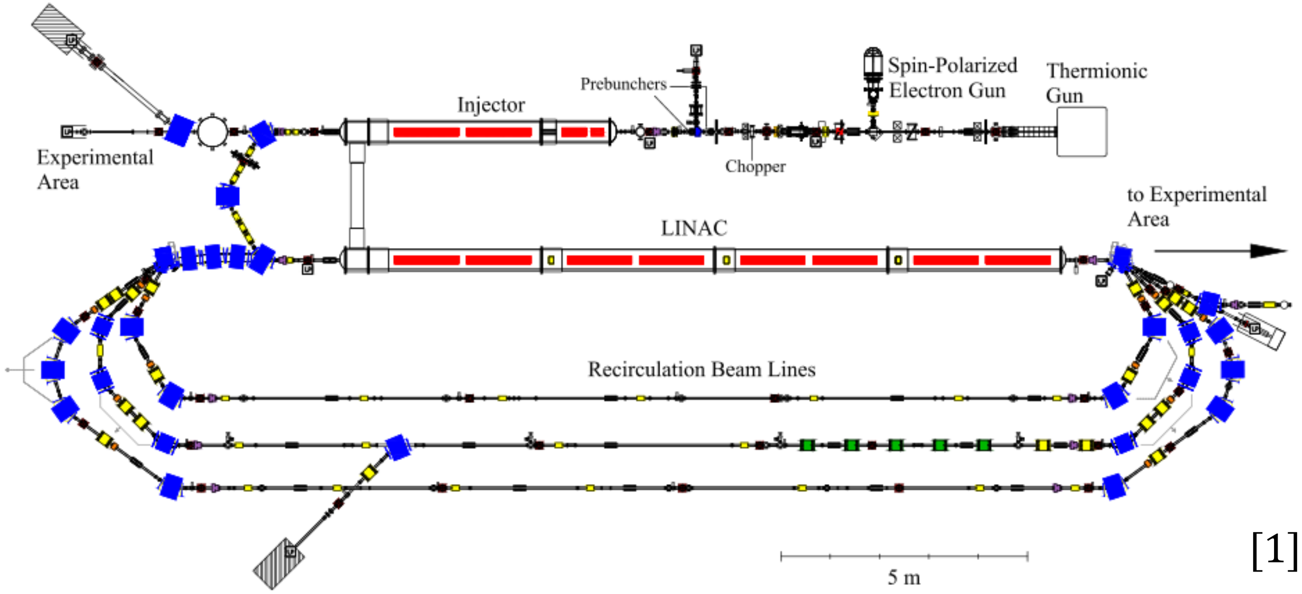
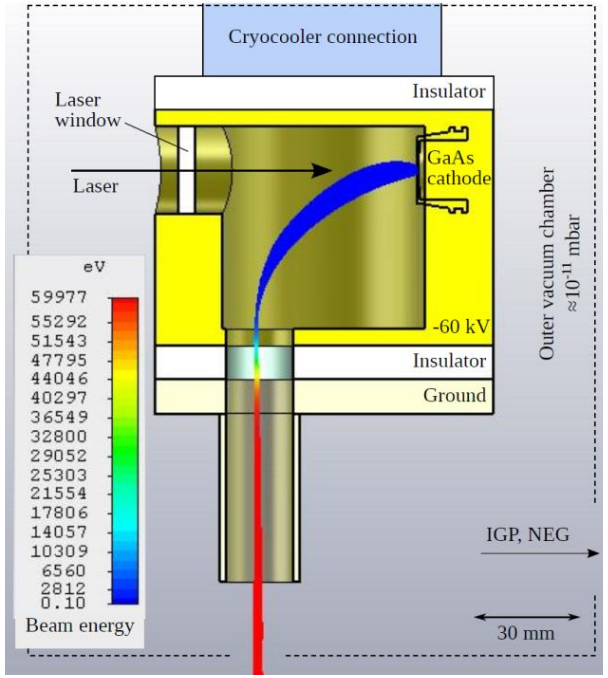


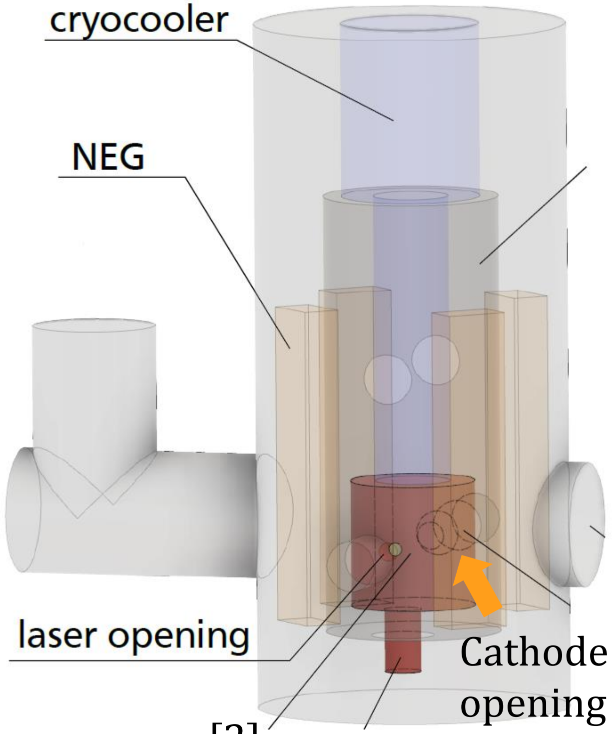
[1]

Cooled GaAs cathodes at S-DALINAC

- Polarized electrons (> 40 %)
- Electrostatic acceleration
- Frequency-tripled Ti:Sapphire Laser as photocathode laser



[2]



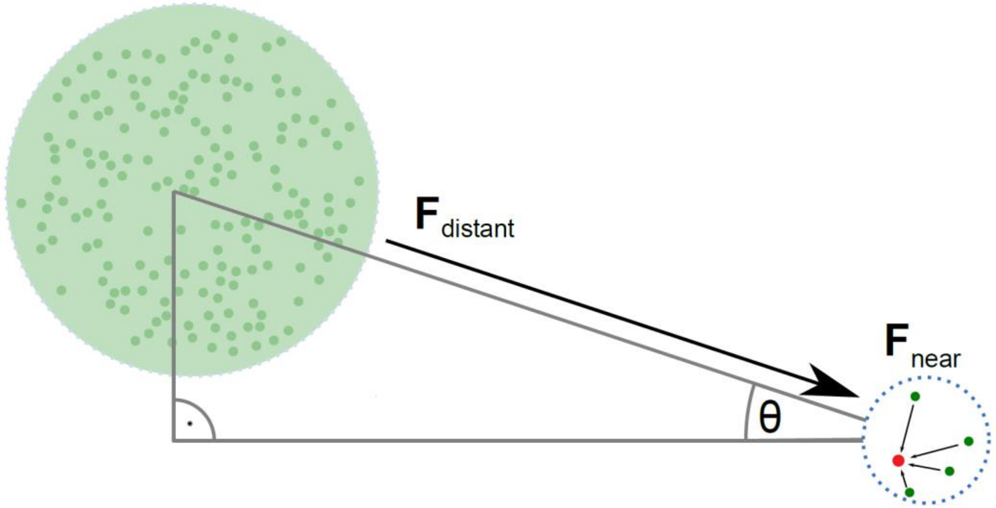
[2]

[1] M. Arnold, PhD Thesis 2016, TU Darmstadt. [2] T. Eggert, TU Darmstadt.

‘Highlights’ from the DPG

3D Space Charge Tracking

- Using fast multipole methods
- Bundle distant electrons to effective SC force
- Code still under construction
- Example run was 6 times faster than ASTRA, deviation was < 0.5 %



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[1] S. Schmid, TU Darmstadt.

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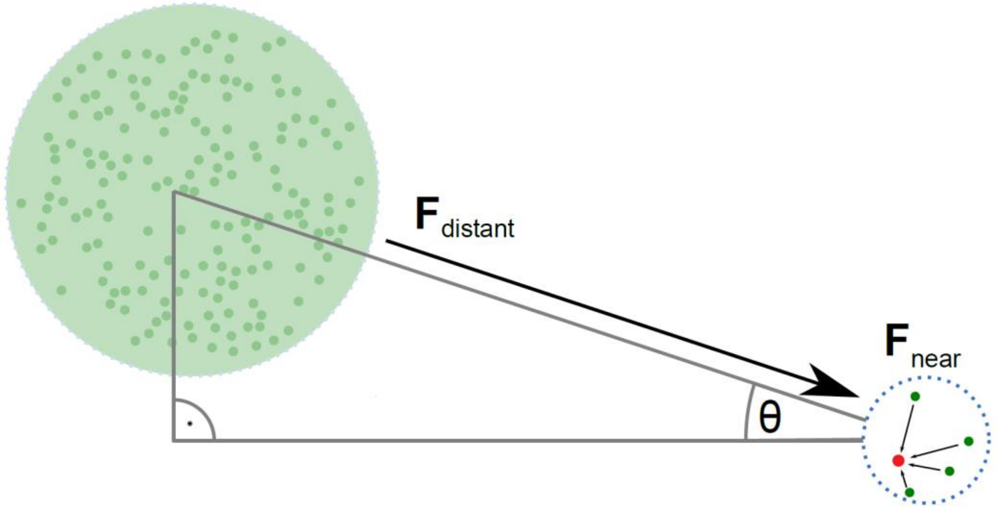


[1]

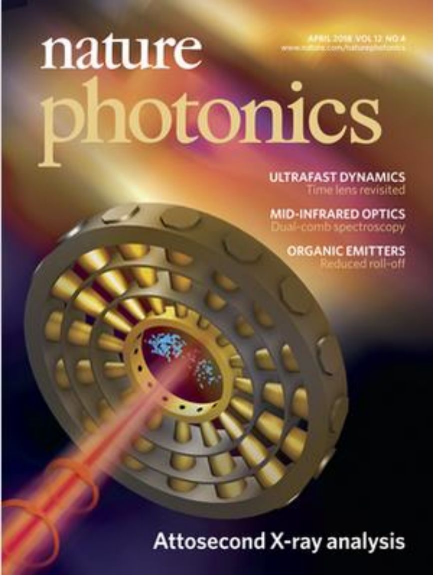
Single-Shot emittance measurements at LUX

- Quadrupole Scan, but…
- Quadrupole strength ***k*** depends on momentum
- Emittance (assumed to be) equal for all momenta
- Emittance from Spectrum: Beam size vs energy

[2]

They weren’t sharing slides…

[1] S. Schmid, TU Darmstadt. [2] L. Hübner, CFEL, University Hamburg.



Segmented THz electron accelerator and manipulator (STEAM)

Dongfang Zhang, Arya Fallahi, et al.
Group of Prof. Franz X. Kärtner, CFEL, DESY

Laser based acceleration: intrinsic synchronization; compact structure; strong driving fields

Novel accelerator concepts

Dielectric Laser Accelerators (DLA) ← **THz-based Accelerators** → **Laser Plasma Accelerators (LPA)**

Micron-scale structure → high requirement for alignment and control
Bunch charge < 1 fC

Mm-scale structure → traditional tech.
Moderate bunch charge (pCs)
Compactness + low cost + strong driving fields

Suffering from instabilities
Difficult in controlling injector and low rep. rate
(High acceleration gradient ~100GV/m)

↓

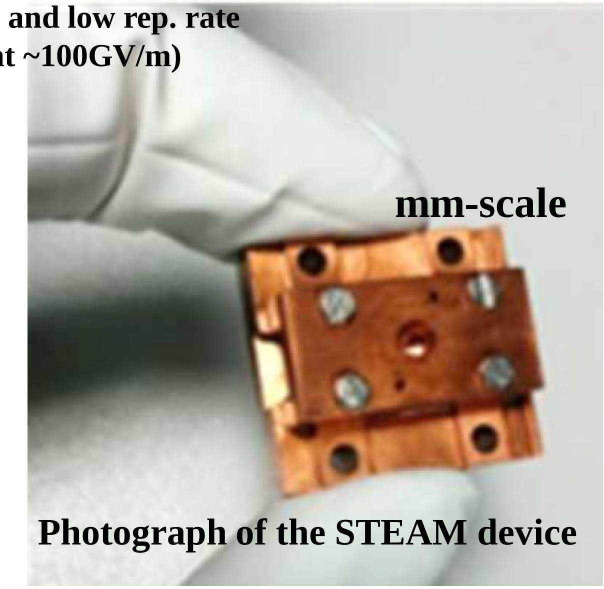
Limited by lack of highly energetic THz sources

↓ ← **Laser based method**

High power, GV/m THz fields possible

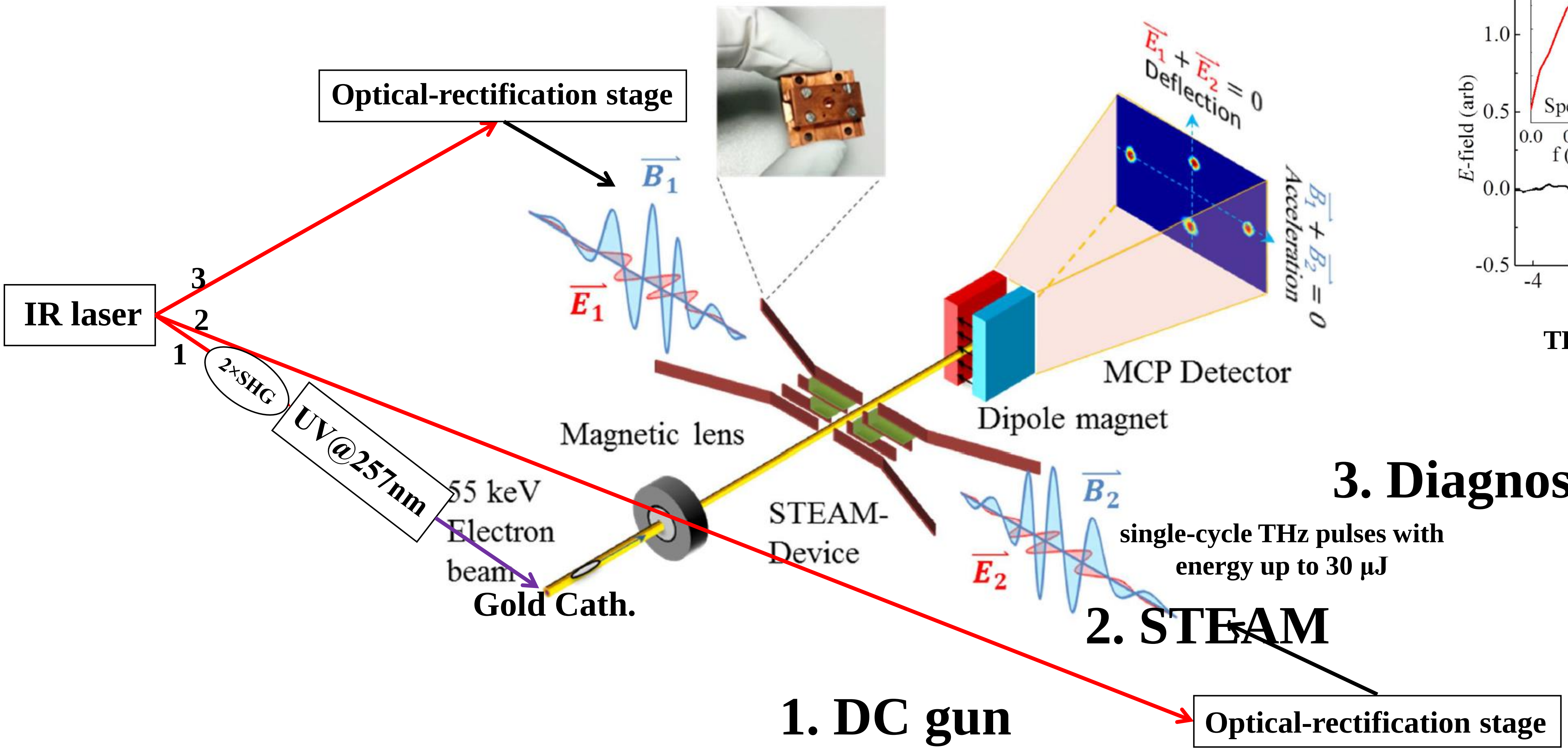
↓

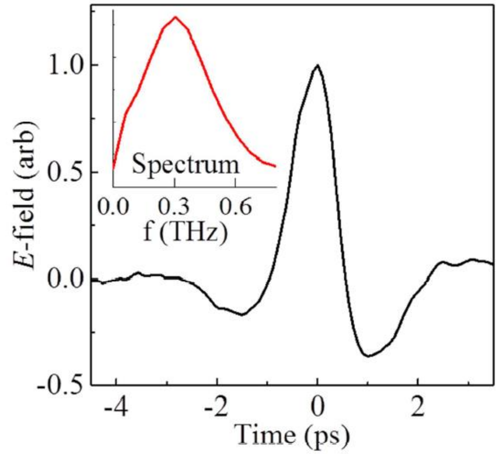
Design of laser driven THz-based compact electron gun



Photograph of the STEAM device

Two counter-propagating THz beams interacting with the 55 keV electron beam inside the segmented THz waveguide structure





THz pulse waveform

Transverse pumping and segmented structure for phase-matching the electron-THz interaction for non-relativistic beams ("high-gradient photogun")

Mode Switch	Experiments of STEAM using 2×6 µJ of THz energy			
	Mode	**Function**	**Performance**	**Realization**
By tuning the relative delay of the two THz pulses and the electrons (controlled by motorized stages acting on the respective IR pump beams)	**"E-mode"** **(with canceled B)**	Acceleration	**50 MV/m (average)**	**Control of electron-THz interaction:** **Segmentation** → multiple layers of varying thickness (+ e- velocity)→dephasing **Insertion of dielectric slabs** of variable length → delay THz
		Compression	**1ps to 100 fs**	**Velocity bunching** → compression or stretching For measurement of compression, **a second STEAM** device used as streaker
		Focusing	focusing strength of **up to 2 kT/m** (comparable to active plasma lenses)	**Panofsky-Wenzel theorem** Focusing configuration → decompression condition Defocusing configuration → compression condition
	"B-mode" **(with canceled E)**	Streaking	streaking gradients in excess of **140 µrad/fs** temporal resolution **below 10 fs**	**Use zero crossing of the THz B-field**

Laser parameters:

(i) 4 mJ, 1030 nm Yb:KYW laser operating at 1 kHz
(ii) 40 mJ, 1020 nm Yb:YLF laser operating at 10 Hz

Simulations showing

MeV electron beams with up to **10 pC** of charge possible by increasing number of layers and THz pulse energies to **mJ** level