PAUL SCHERRER INSTITUT

PSI

KIT Karlsruhe Institute of Technology

Science & Technology Facilities Council

DESY

Working Group Summary

THz Streaking / THz Acceleration / THz Generation

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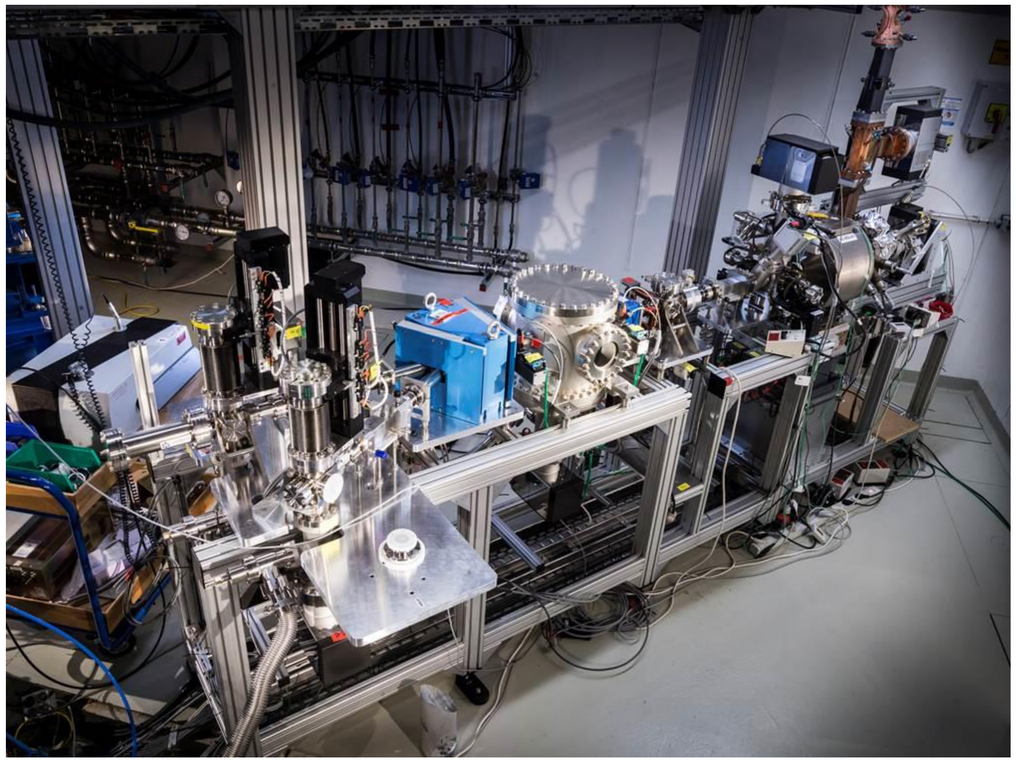
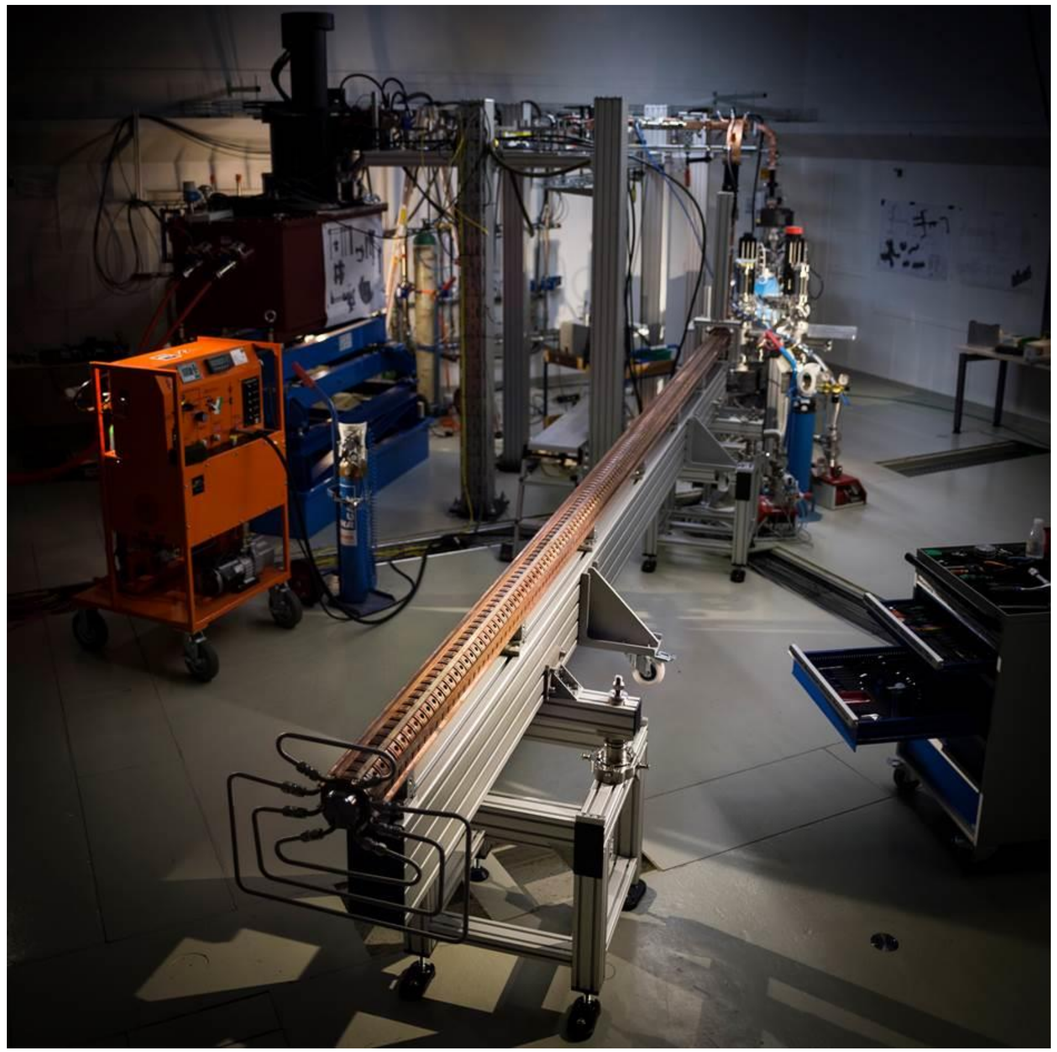
Overview: THz Experiments

Facility	SwissFEL Injector	SwissFEL	FLUTE	DC Gun	VELA/CLARA
Location	Villigen	Villigen	Karlsruhe	Manchester	Daresbury
Electrons	330 MeV, q = 10 fC … 200 pC, σ ≲ 1 µm	3.2 GeV, q = 10 fC … 200 pC, σ ≈ 300 nm	7 MeV (42 MeV), q = 50 fC, σ ≈ 10 µm	100 keV, q ≈ 10 fC, σ ≈ 10 µm	5 MeV / 45 MeV, q = 10…100 pC, σ ≈ 10 µm
Interaction chamber, sample alignment	1-d alignment 18 mm x 8 mm ⌀ max. sample size	Quadrupoles and alignment stage in vacuum chamber Chamber size: 2 m x 60 cm	3-d alignment	Solenoids and alignment stage Chamber size: R = 50 cm, H = 50 cm	2 m x 0.5 m
Photons	No laser	Ti:Sa + OPA 2 µm —> ACHIP THz	800 nm —> THG —> Cathode; THz (10 MV/m)	10 mJ Ti:Sa (100 Hz)	1 mJ kHz 1 J 10 Hz 0.5…3 THz
Structures	Double pillar (installed)	SRR Waveguide on grating	Split ring resonator	Dielectric rectangular waveguide Traveling wave	Dielectric rectangular waveguide Traveling wave
Collaboration Opportunities		THz structures	THz (UBe), Sample chamber (PSI)	Structures (PSI)	
Time	now	Installation: middle 2018	Spring 2018	Spring 2018	Fall 2018

FLUTE Phase I: Injector

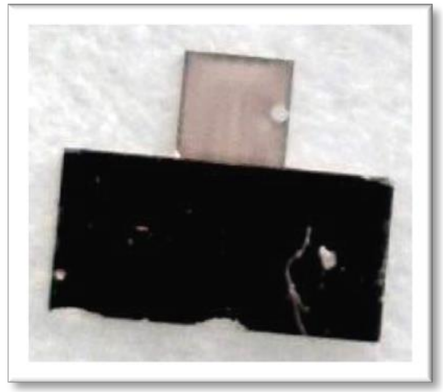
- **Problem with the cathode RF finger in the gun, otherwise ready for gun commissioning**

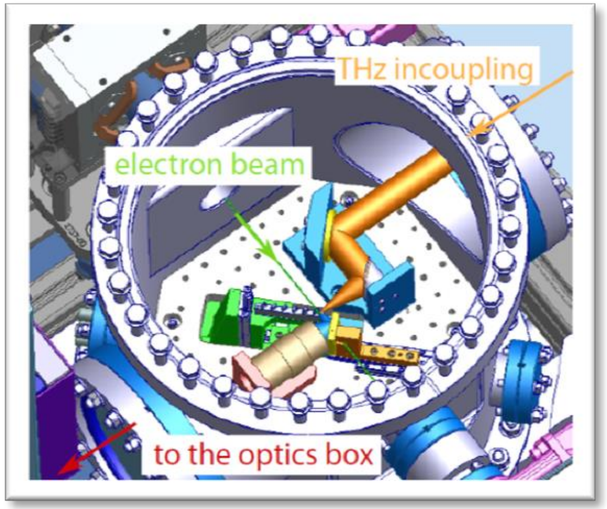


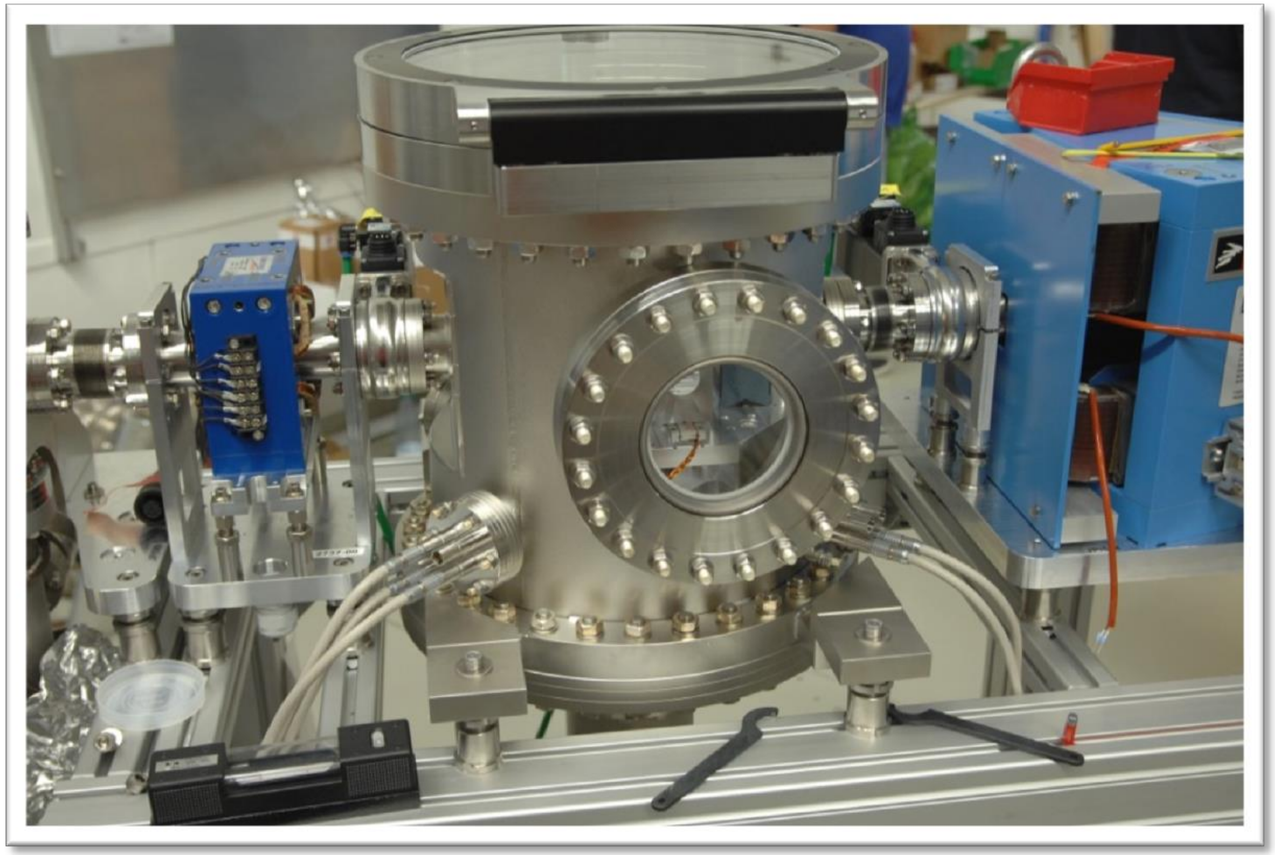


SRR collaboration

- **Vacuum chamber installed at KIT**
- **THz generated with FLUTE laser**
- **SRR structure prototype in lab test**







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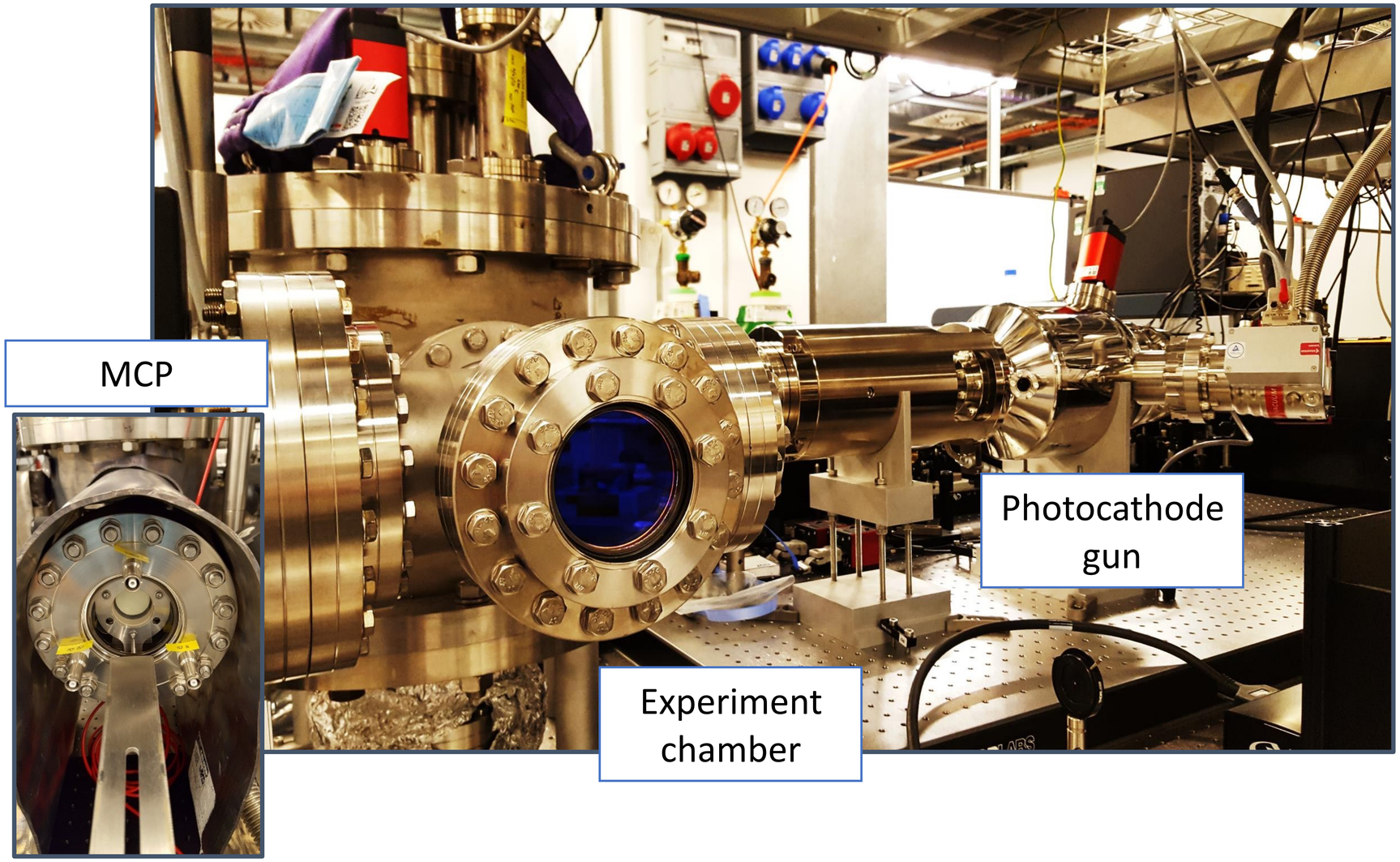
STFC/Manchester: 100 keV gun



- Operational October 2017
- 100 keV, ~10 fC charge
- Solenoid magnets for focussing, spot size: ~100 um
- D = 50 cm circular experiment chamber, including MCP detector
- 10 mJ Ti:Sapp laser: drive photocathode (THG) and THz source
  - S. Mondal (postdoc): working full-time on tuneable narrowband source development

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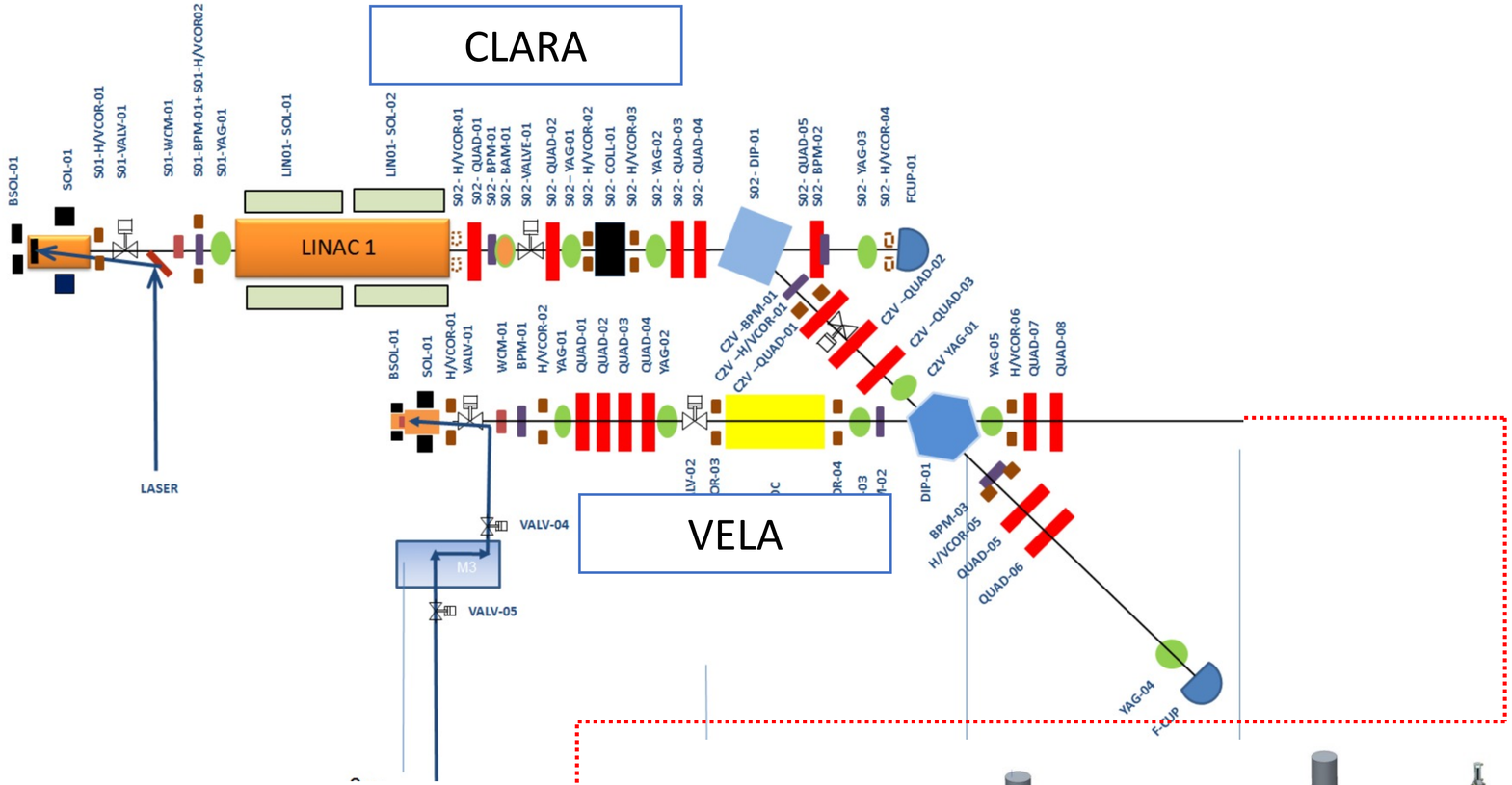
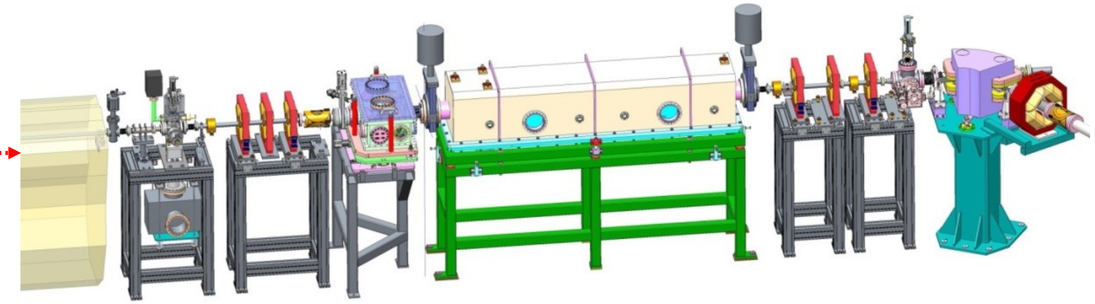
STFC: VELA/CLARA

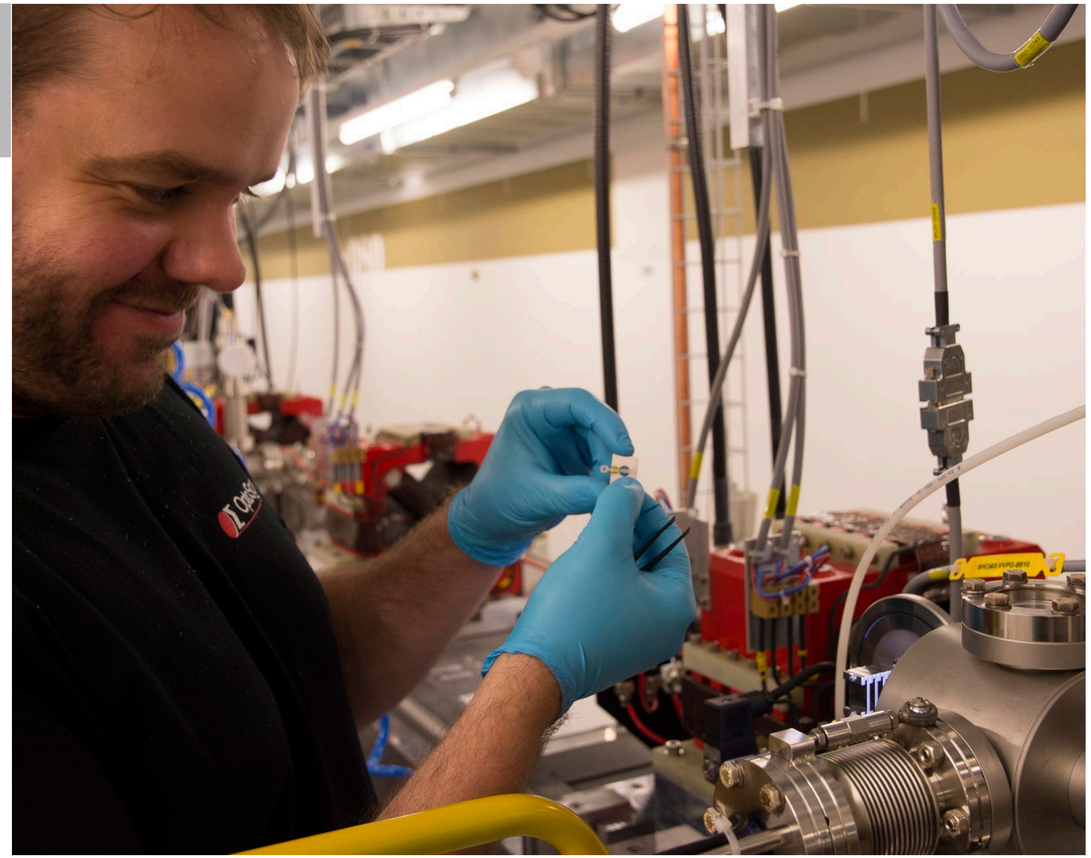


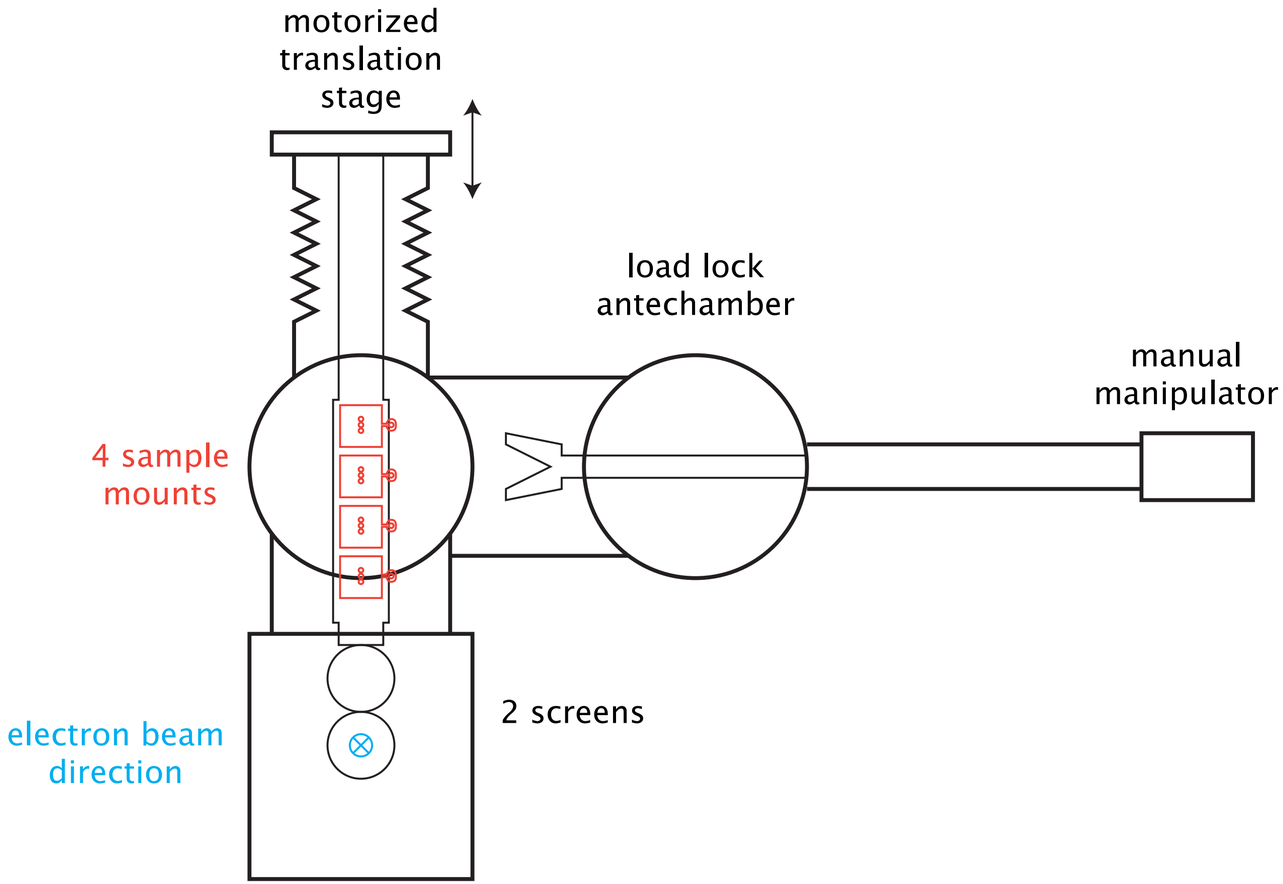
Beam Area 1: user area



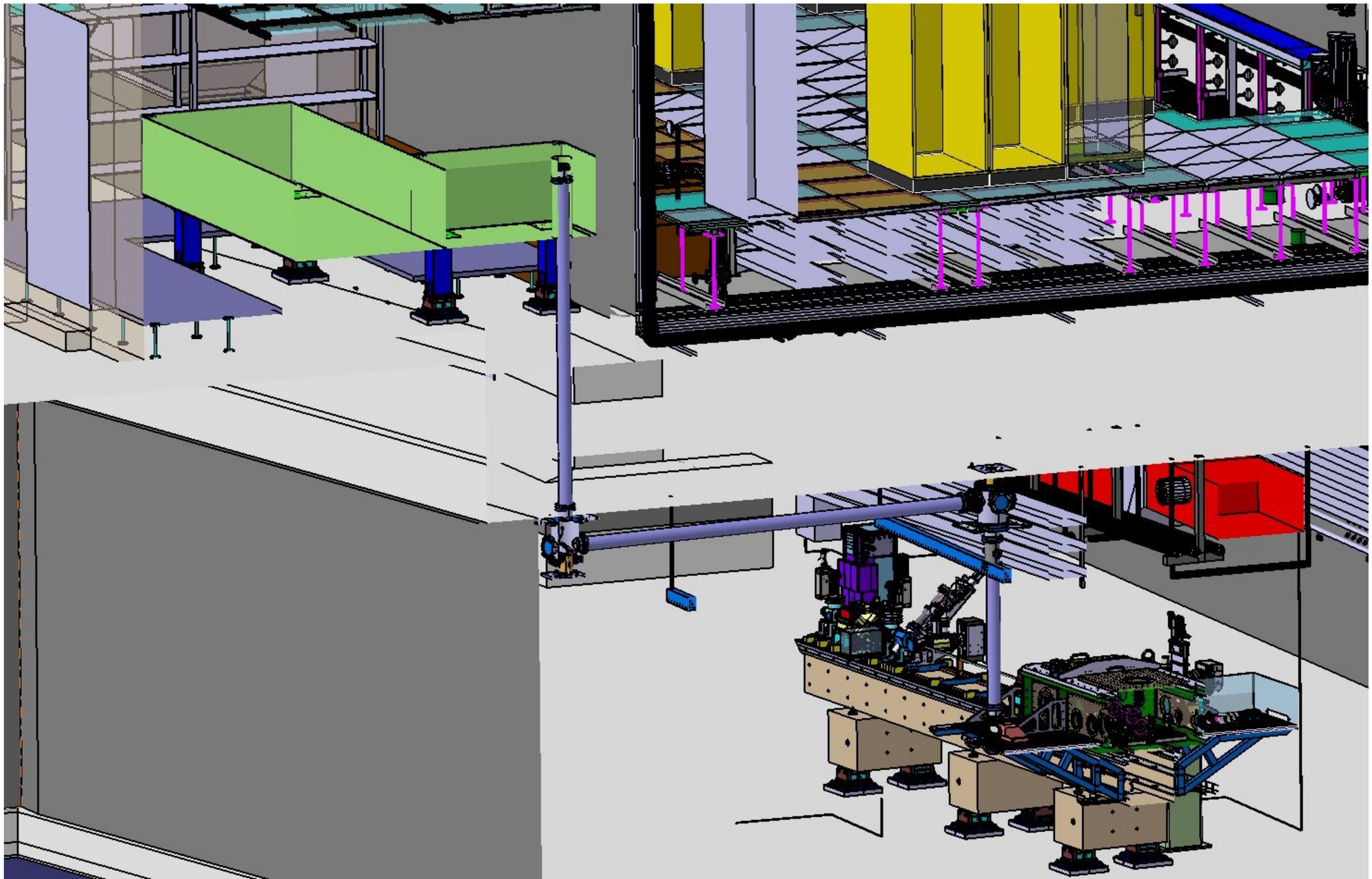
- VELA/CLARA: 5 / 48 MeV
- 10 fC – 100 pC
- Beam delivered to user area including chamber:
  - Quadrupole triplet;
  - 2x0.5 meter experimental chamber;
  - Beam diagnostics including dipole spectrometer after chamber
- Laser light delivered to chamber from LATTE laboratory: 1 mJ @ 1 kHz / 1 J @ 10 Hz

PSI: Experiment in the SwissFEL Injector



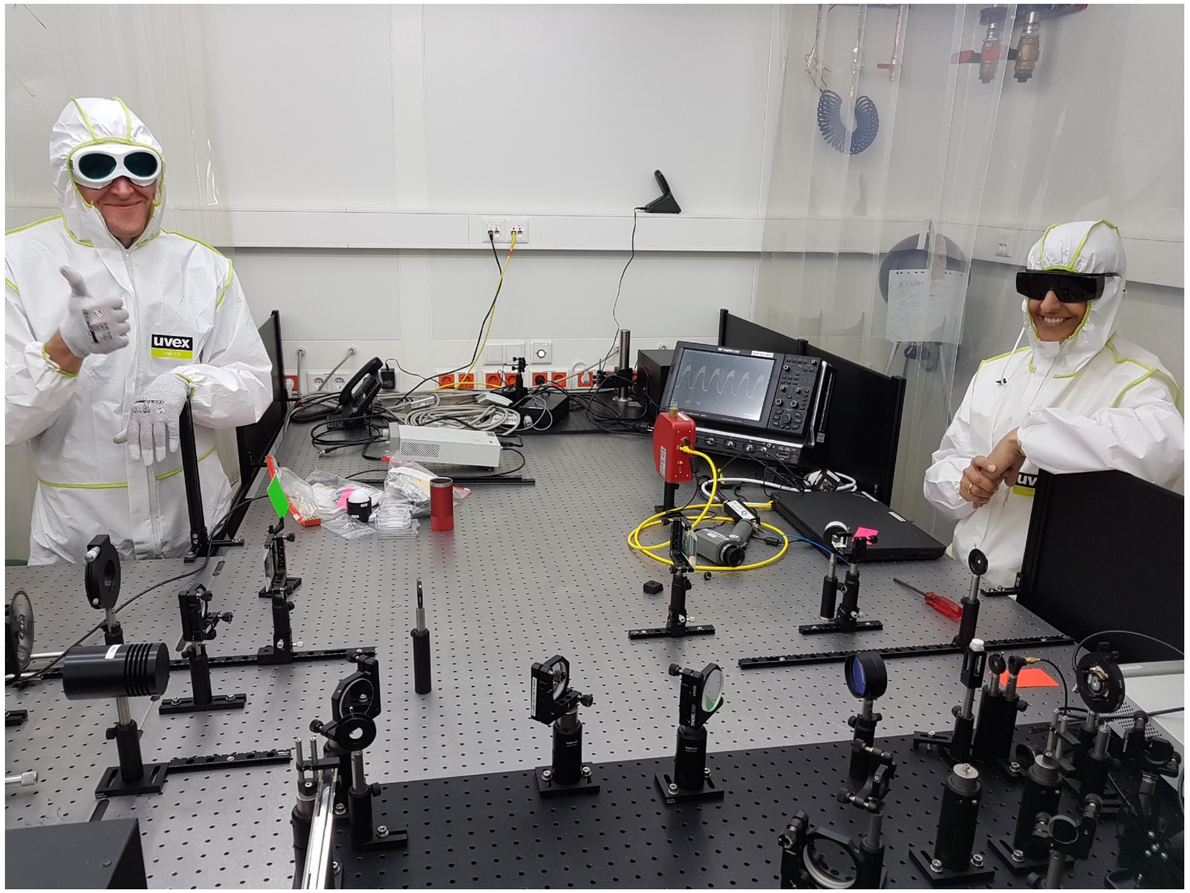


Experimental Chamber in SwissFEL/ATHOS



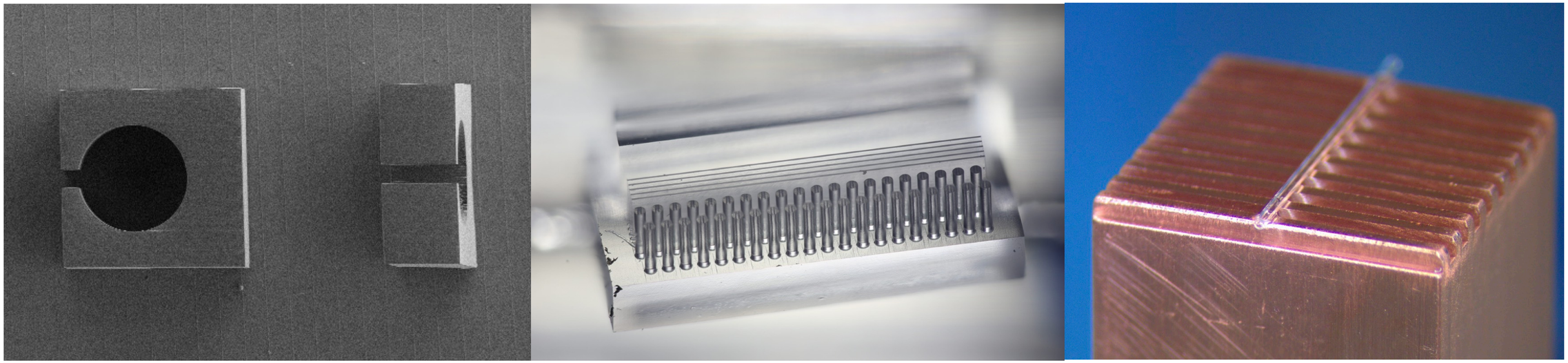
Joint Interest / Collaboration Opportunity: THz Generation

- Easy: few-cycle pulses <—> large bandwidth
- Multi-Cycle THz generation could allow for more efficient coupling
- Efforts underway at Daresbury (Shyamal)
- THz pulse shaping (Ed)
- THz pulse properties: input for design process



Joint Interest / Collaboration Opportunity: Structure Manufacturing

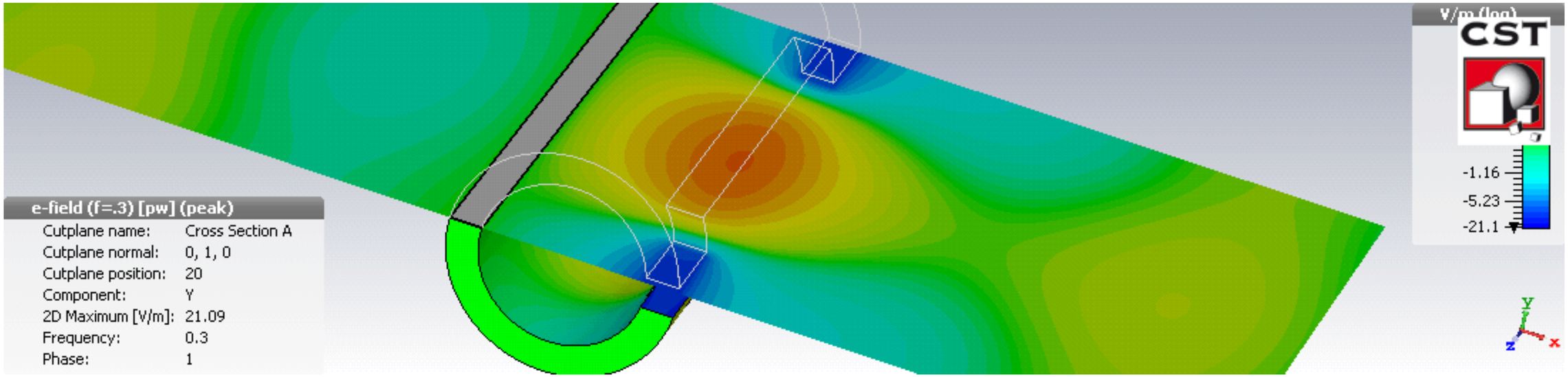
- Metallic, dielectric and combined structures:



- Future work:
  - Structures for sub-relativistic beams (for example, $\beta = 0.55$)
  - Graphene plasmon structures?

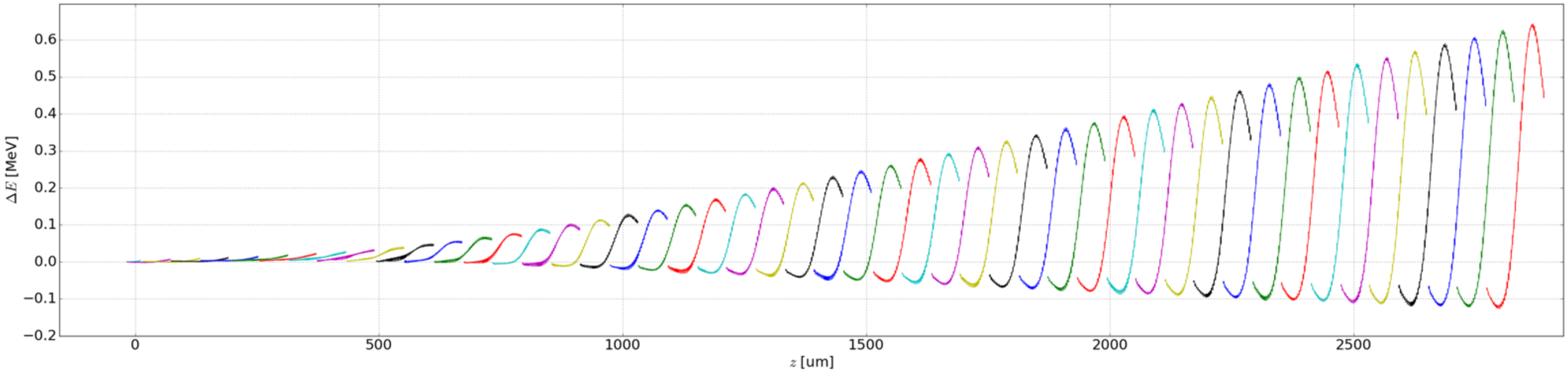
Joint Interest / Collaboration Opportunity: Modeling

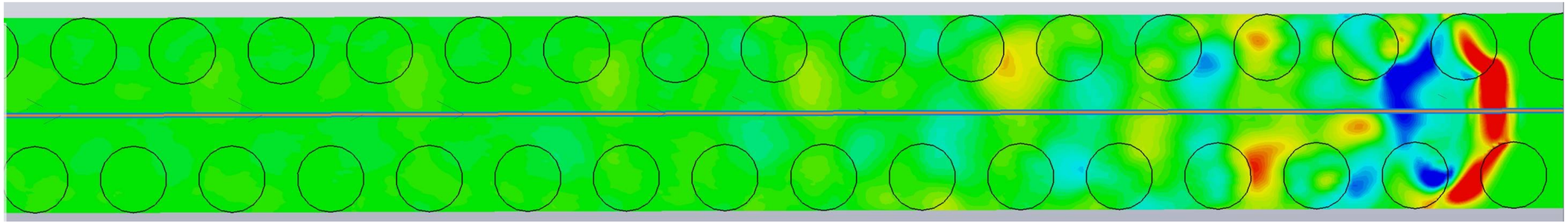
- Use CST for particle tracking
- Extensive experience at PSI (Xiaoyu, Micha & Benedikt)
- Modeling of electron beam before and after the structure (Minjie)
- THz transport (Vincent)
- Simulation of the generation of THz (Ed)



Joint Interest / Collaboration Opportunity: Beam Loading / Wake Fields

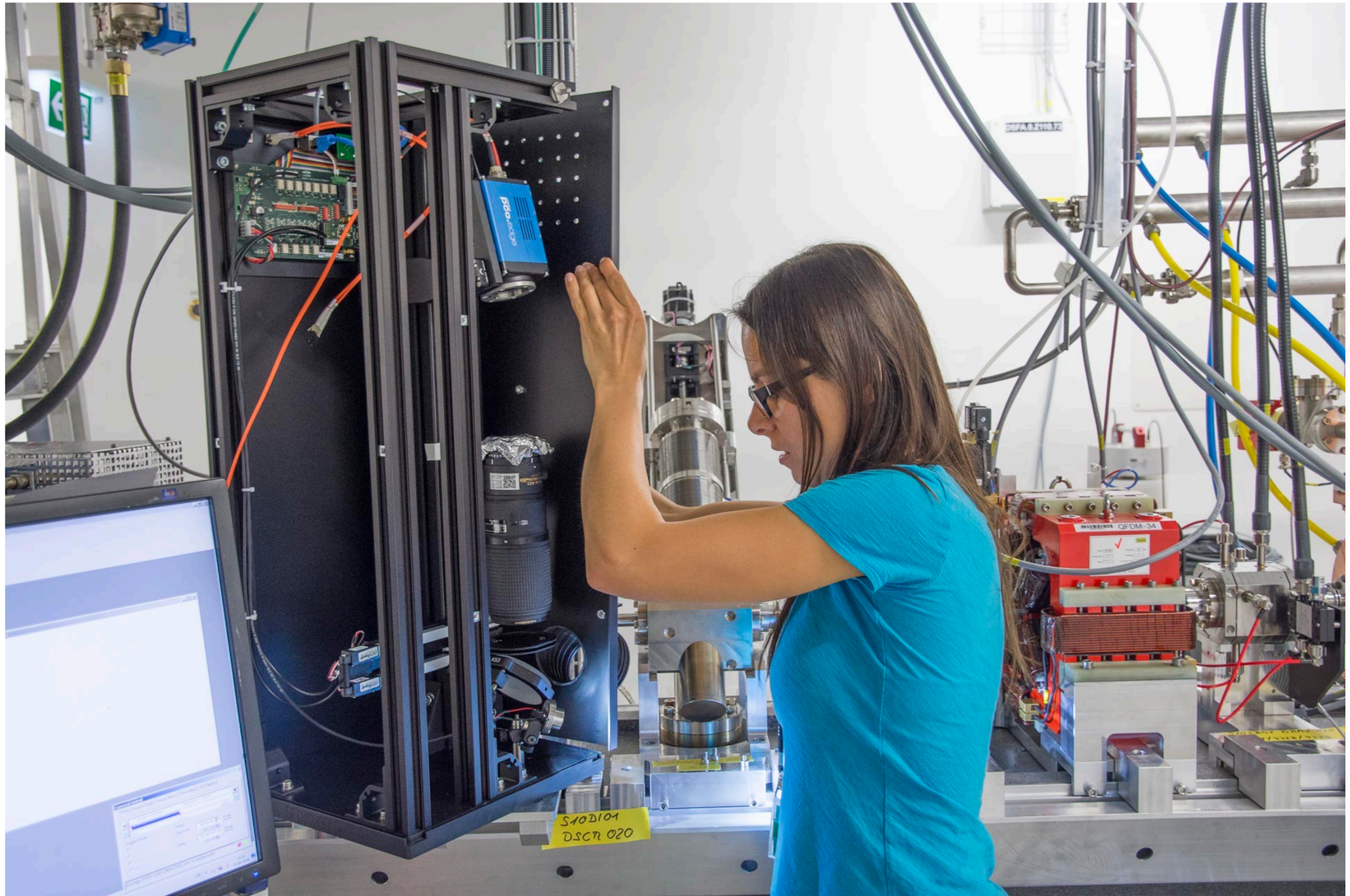
- Modeling of wake fields inside double pillar structure (Benedikt)
- Experiments planned for SwissFEL (Eugenio)
- THz generation in waveguide structures with electron beams (Liangliang & Anni)
- Experiments in SwissFEL





Joint Interest / Collaboration Opportunity: Electron Detection

- Collaboration KIT—PSI



Joint Interest / Collaboration Opportunity: Synchronization

- Collaboration KIT—DESY for RF-Laser synchronization
- Synchronization between THz and FEL pulses

Joint Interest / Collaboration Opportunity: Joint Experiments

Joint Interest / Collaboration Opportunity: Joint Measurements

- THz near field measurements: UBe
- Measurements with electron beams: Daresbury, KIT, PSI, …

Complementary diagnostics

- KIT: EO monitor (for long bunches: ~100 fs)
- PSI: RF deflector, photon pulse length (THz streak camera)
- CLARA: EO (tentative)