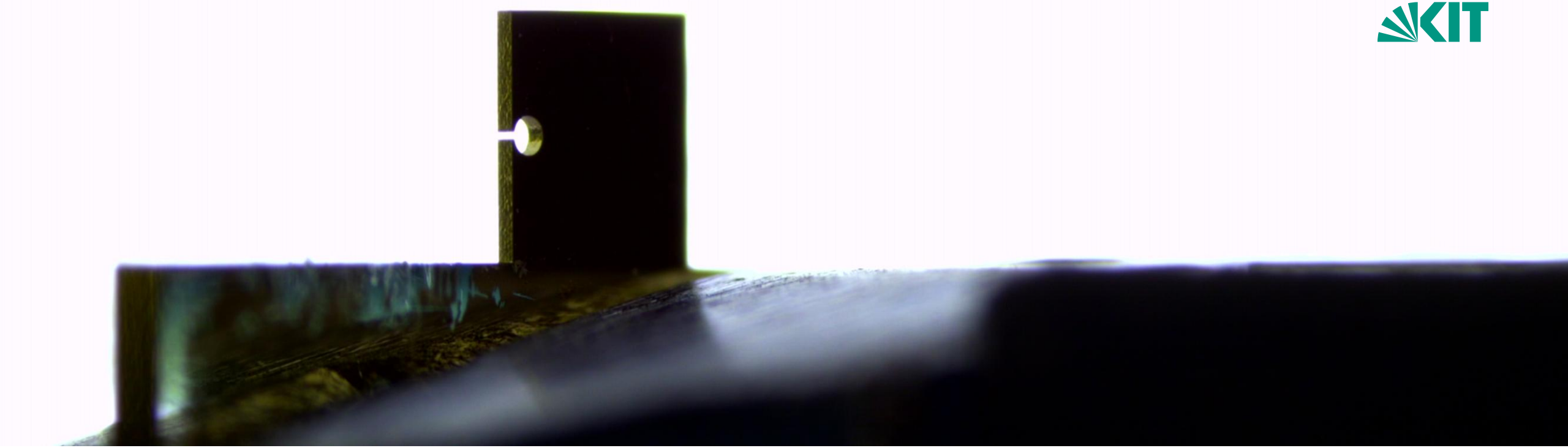


Terahertz Streaking Detection for Longitudinal Bunch Diagnostics at FLUTE

Matthias Nabinger
on behalf of the Compact-TDS collaboration

Karlsruhe Institute of Technology

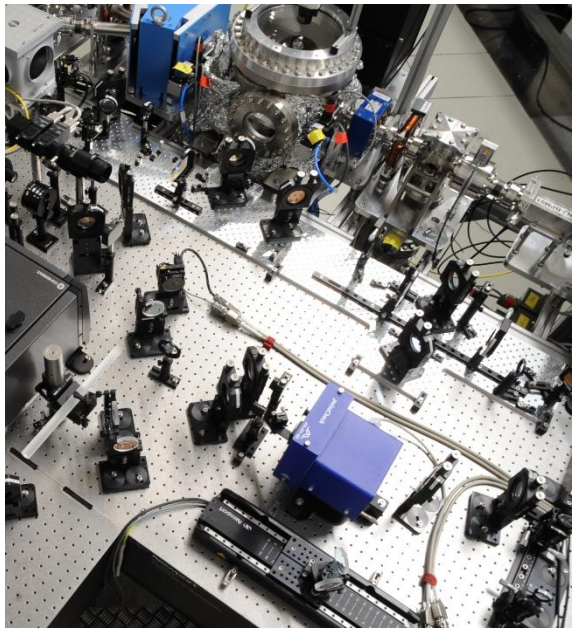
FLUTE

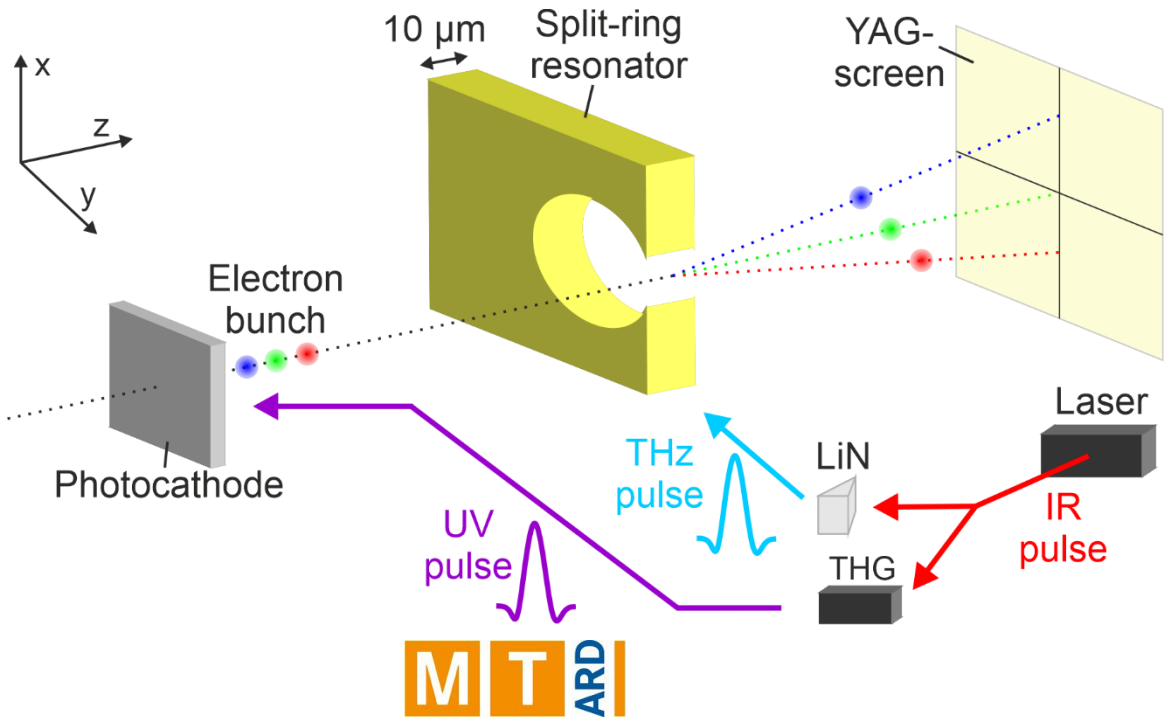
Latest developments in the split-ring resonator experiment at FLUTE

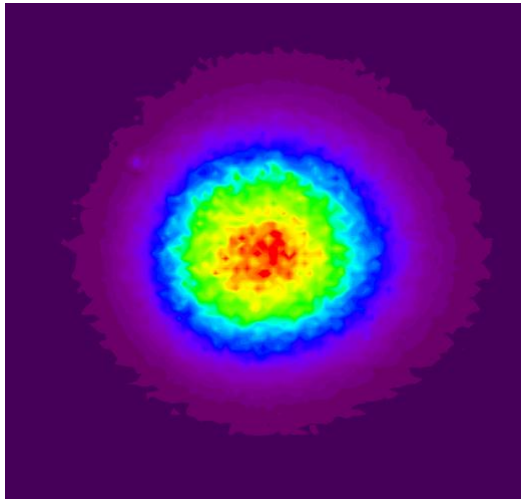
M. Nabinger, M.J. Nasse, T. Schmelzer, N. Smale, J. Schäfer, B. Härer, G. Niehues, S. Funkner, E. Bründermann, R. Ruprecht, A.-S. Müller (KIT, Karlsruhe, Germany)

R. Ischebeck, M. Dehler, M. Moser, V. Schlott (PSI, Villigen, Switzerland)

Z. Ollmann, M. Hayati, T. Feurer (University of Berne, Berne, Switzerland)





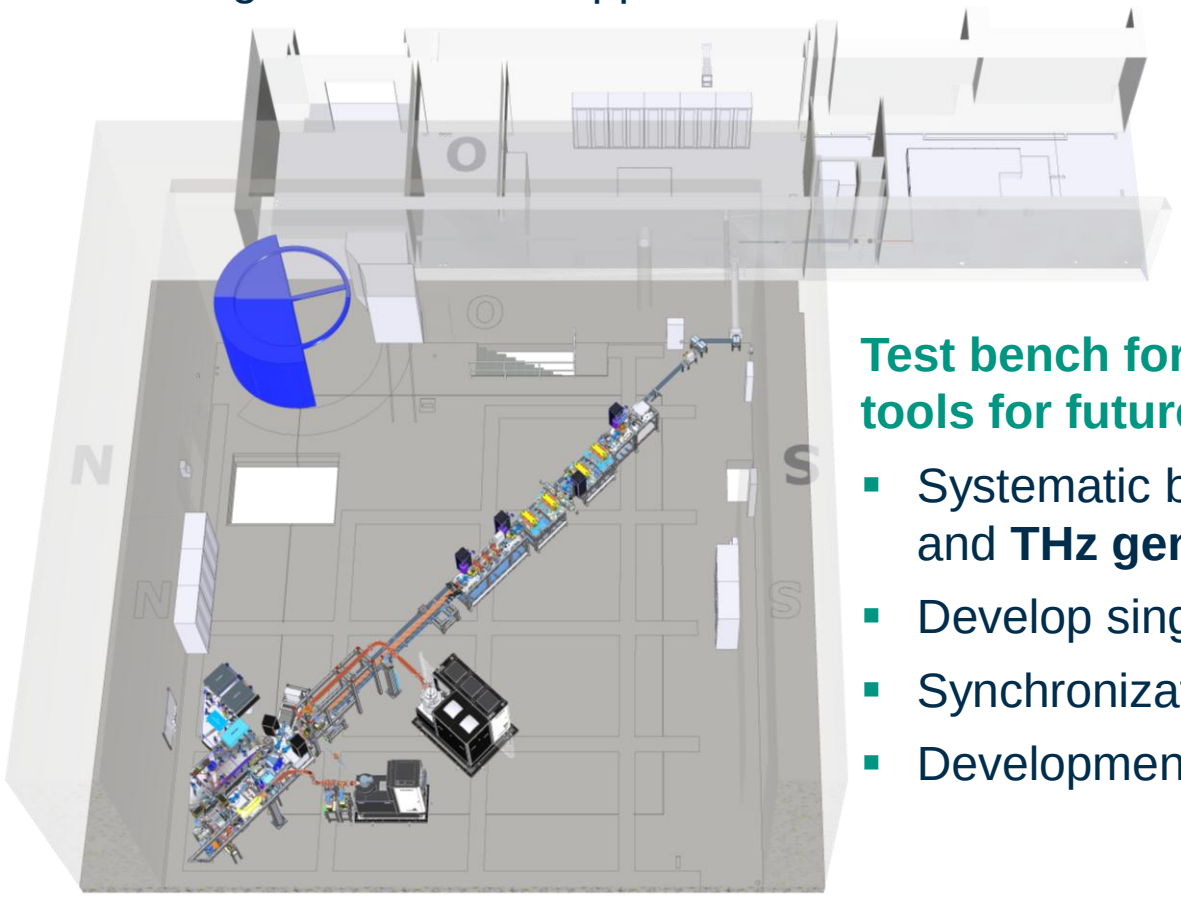


FLUTE: Accelerator Test Facility at KIT

Electron Energy	up to 90 MeV
Repetition Rate	up to 50 Hz
Electron Bunch Charge	up to 1 nC
Electron Bunch Length	down to 1 fs
Spectral Band Coverage	up to 30 THz
THz E-Field Strength	up to 1 GV/m

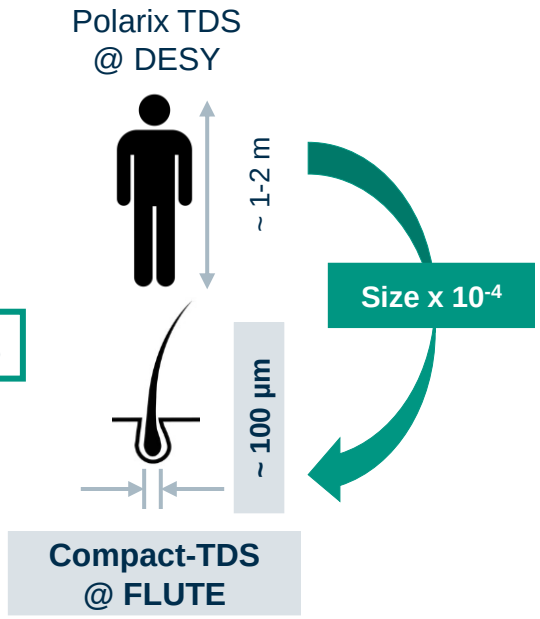
Short-pulse linear accelerator FLUTE

- **Test facility** for accelerator physics
- **THz** generation and applications



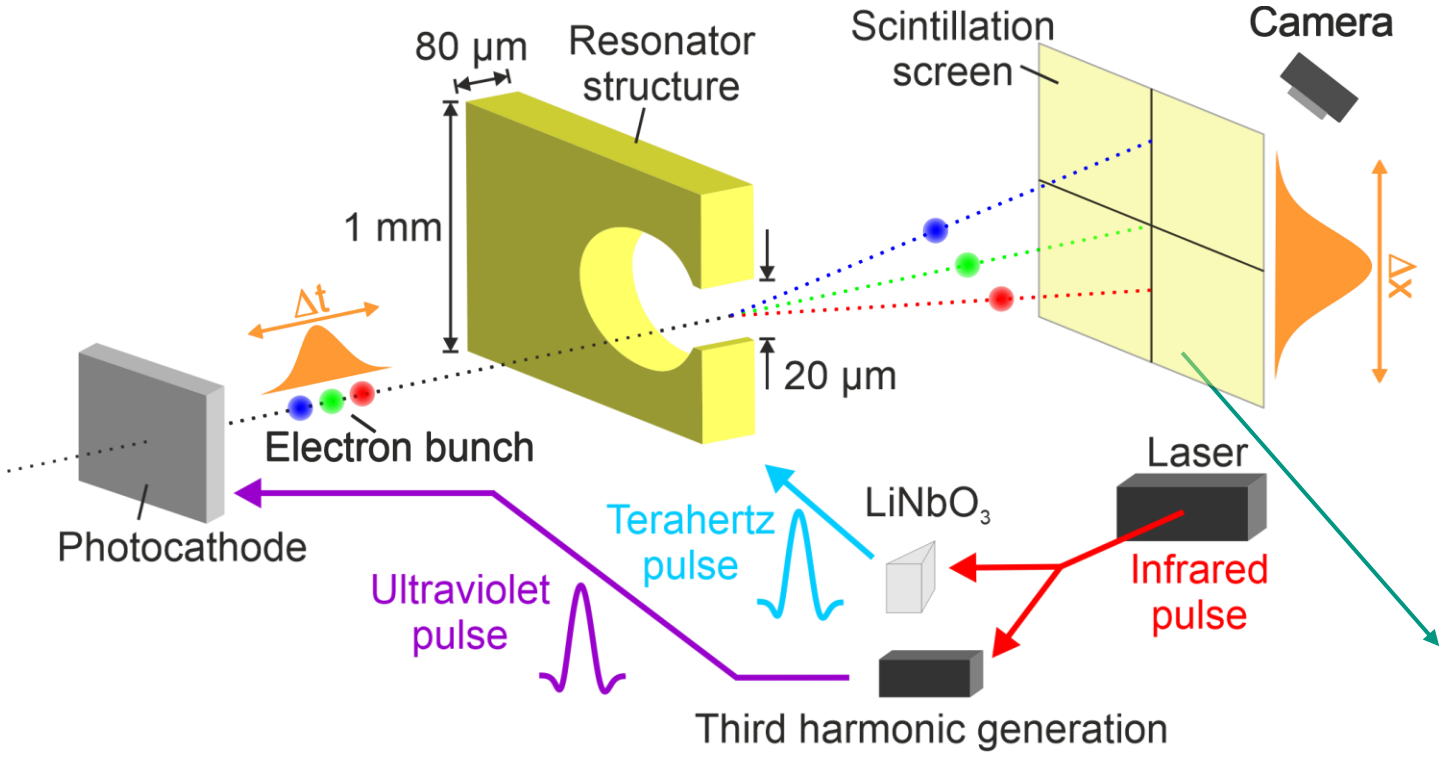
Test bench for new diagnostic methods and tools for future accelerators

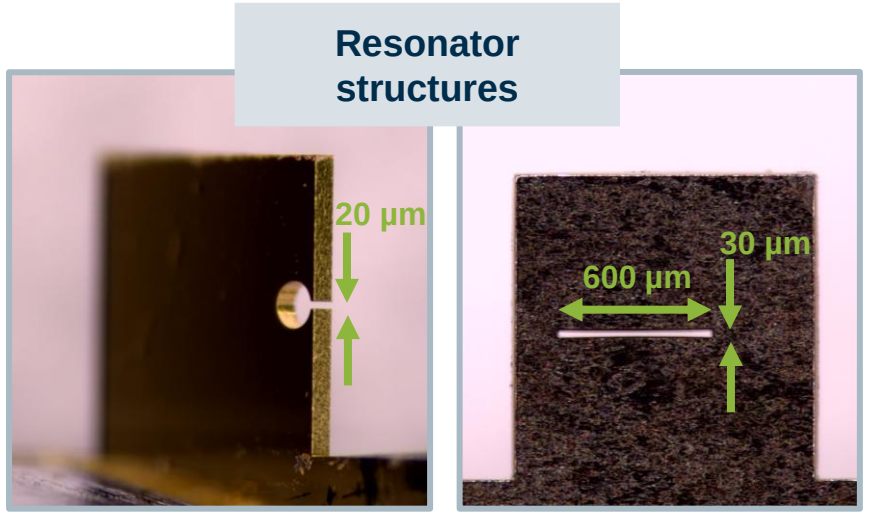
- Systematic bunch compression and **THz generation studies**
- Develop single shot **femtosecond diagnostics**
- Synchronization on a **femtosecond** level
- Development of **AI Control**



Compact femtosecond bunch profile diagnostics

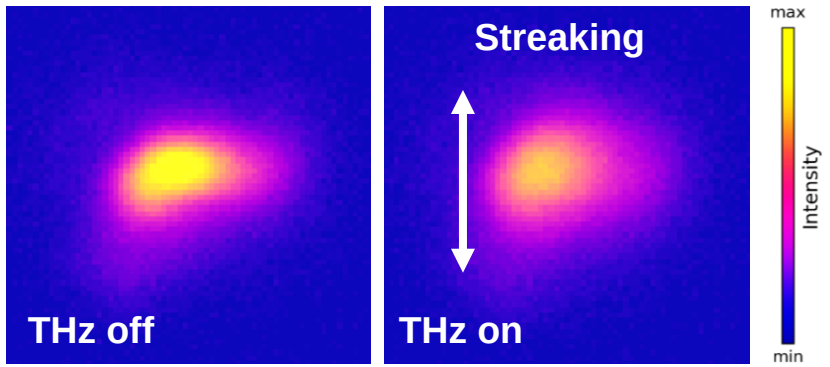
THz-based transverse deflecting system





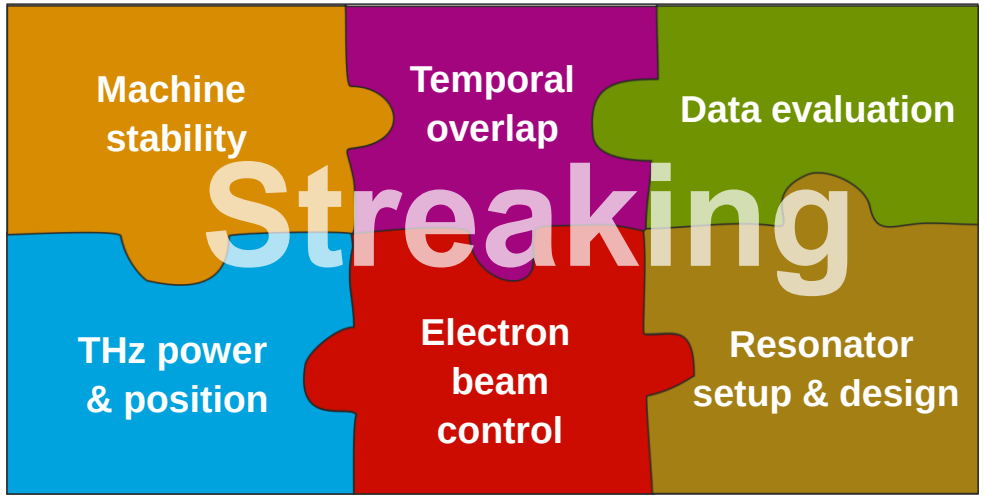
GHz → **THz** + **Resonator** amplification = **Compact & efficient** fs bunch profile measurement

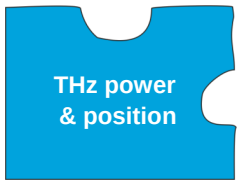
Recently: streaked signal detected!

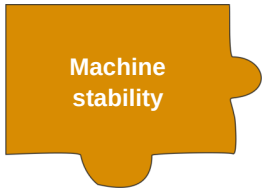


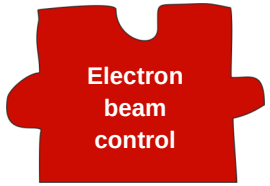
Solving the puzzle...

‚Matthias, which puzzle piece was it in the end that solved it?‘

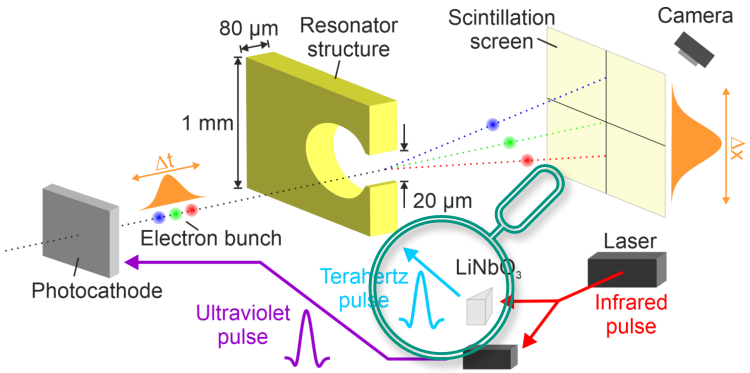


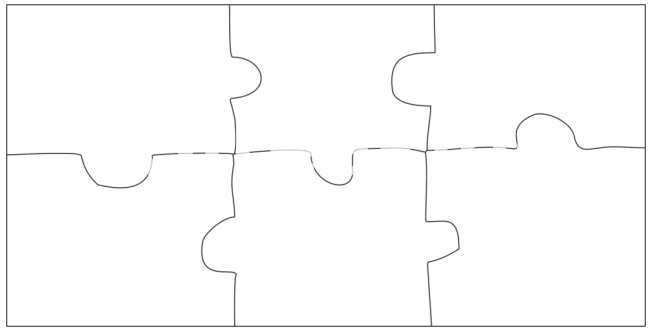




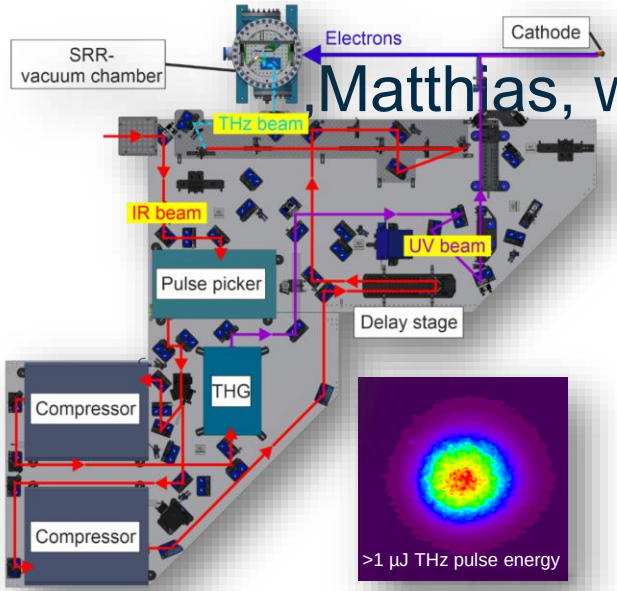


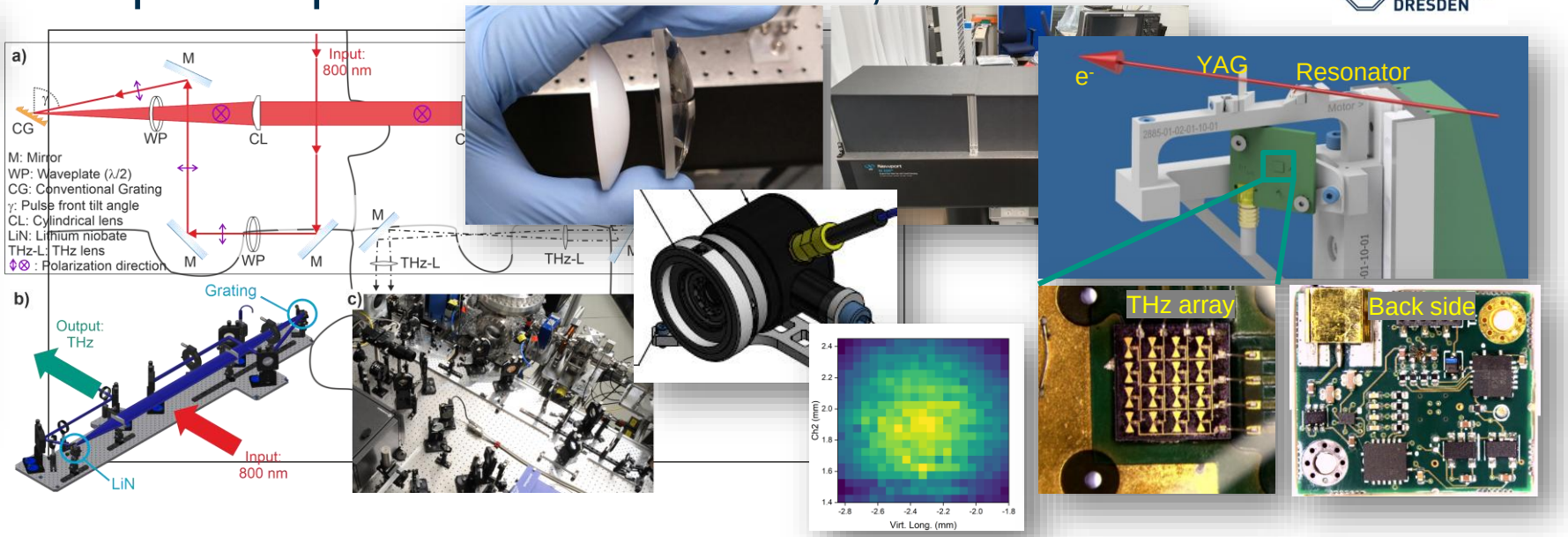
Puzzle piece: THz power & position





„Matthias, which puzzle piece was it in the end, that solved it?“





THz power & position

Machine stability

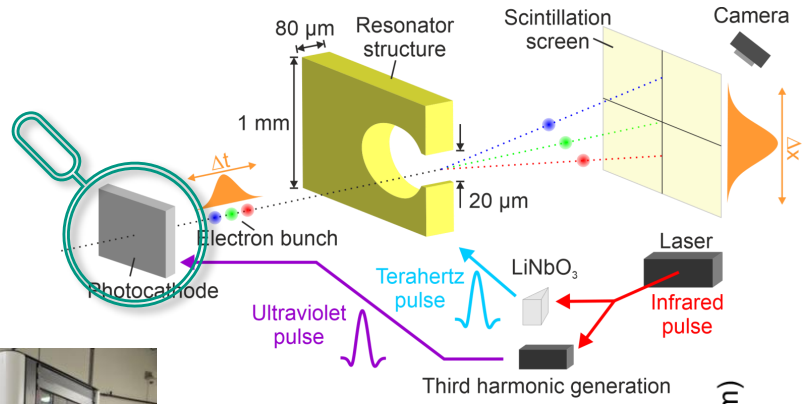
Electron beam control

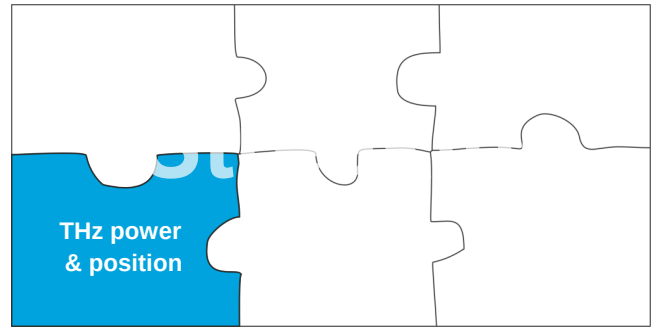
Temporal overlap

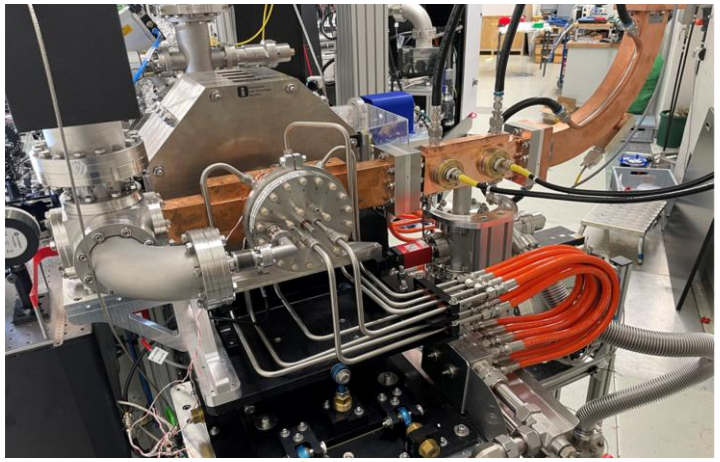
Resonator setup & design

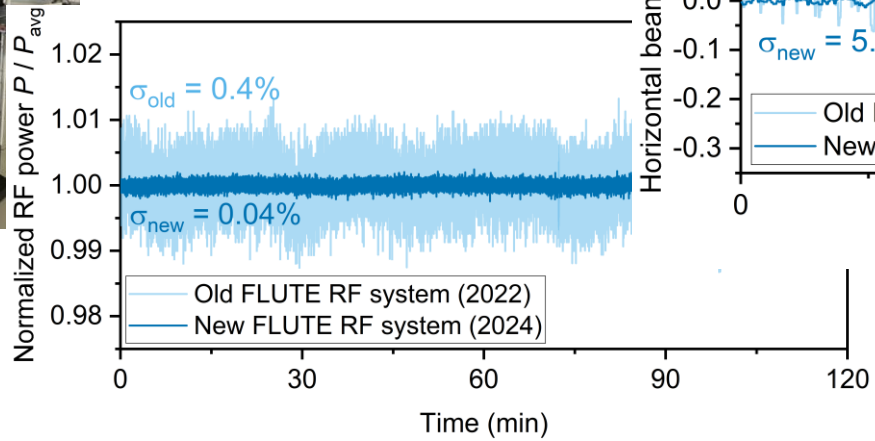
Data evaluation

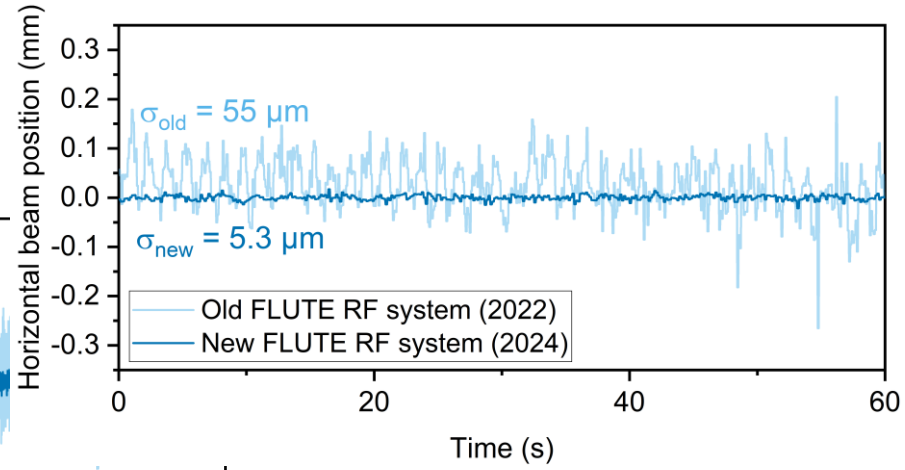
Puzzle piece: Machine stability

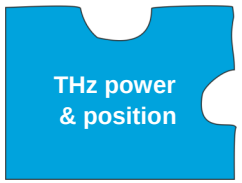


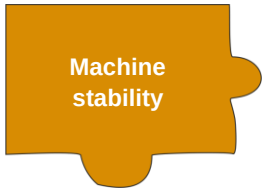


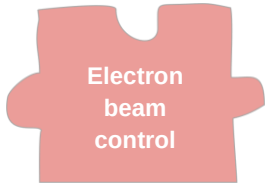


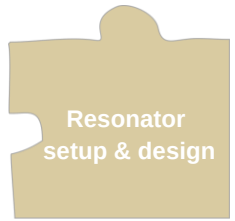




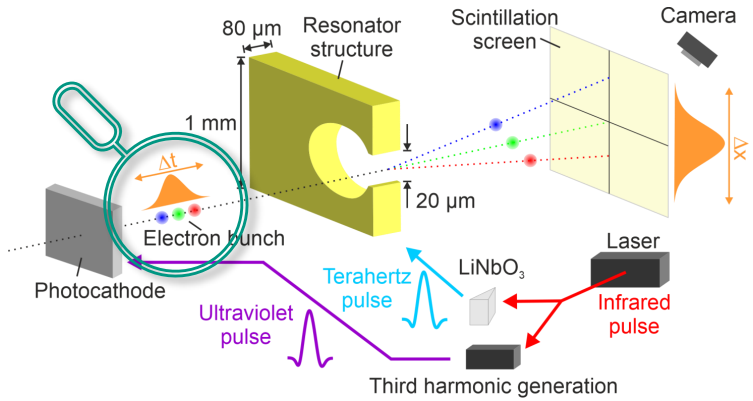


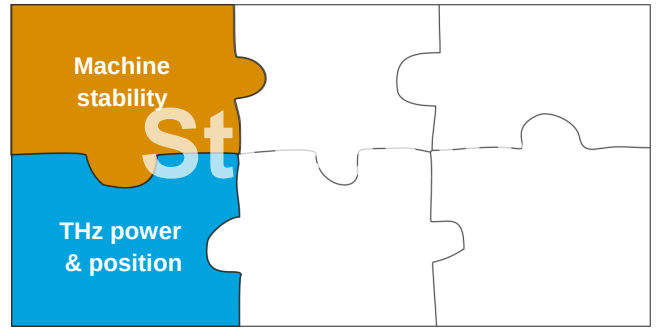


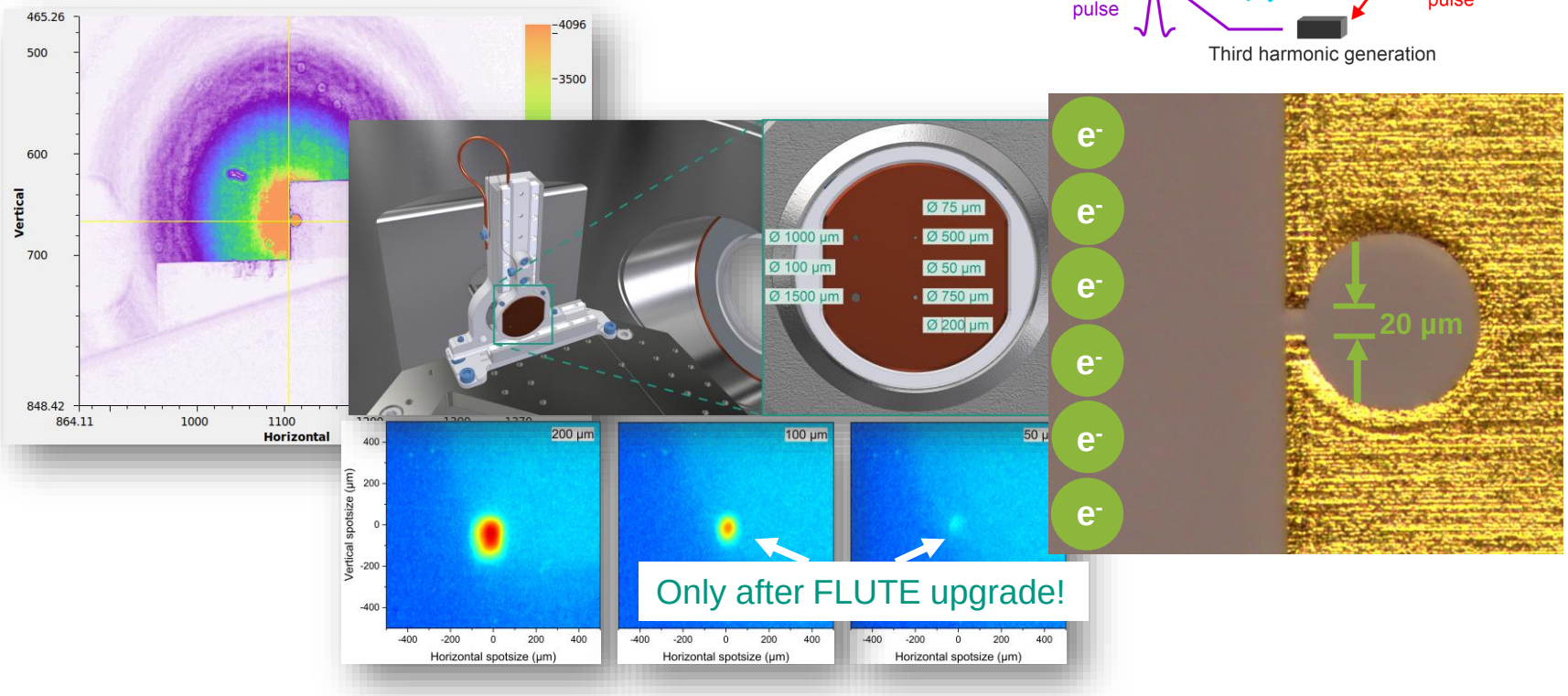


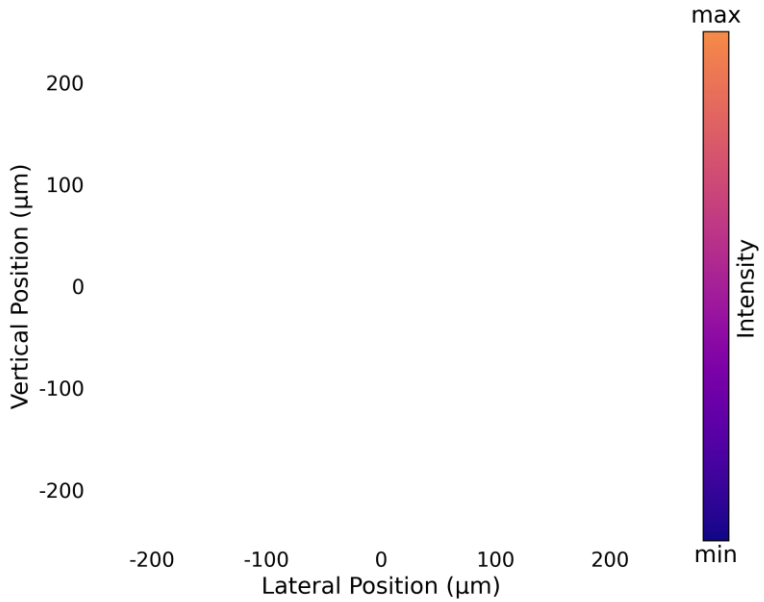


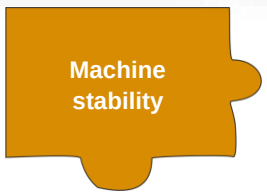
Puzzle piece: Electron beam control

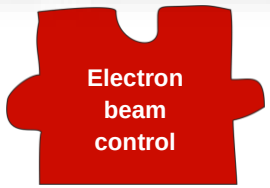


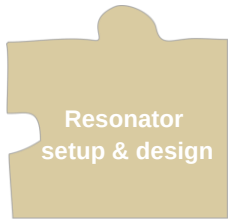




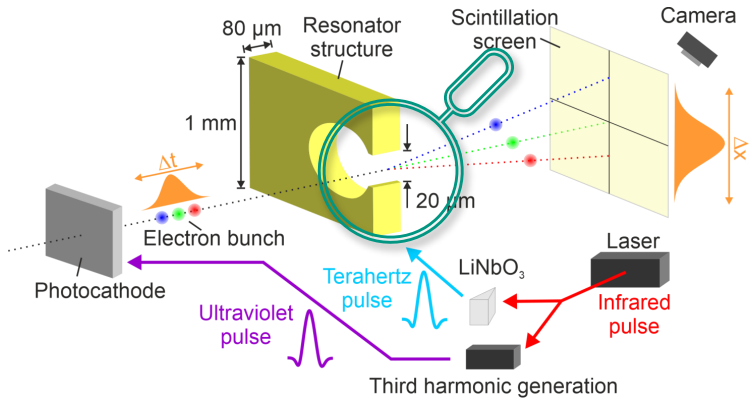


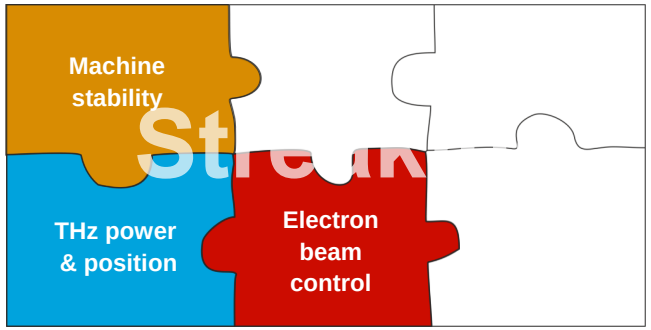


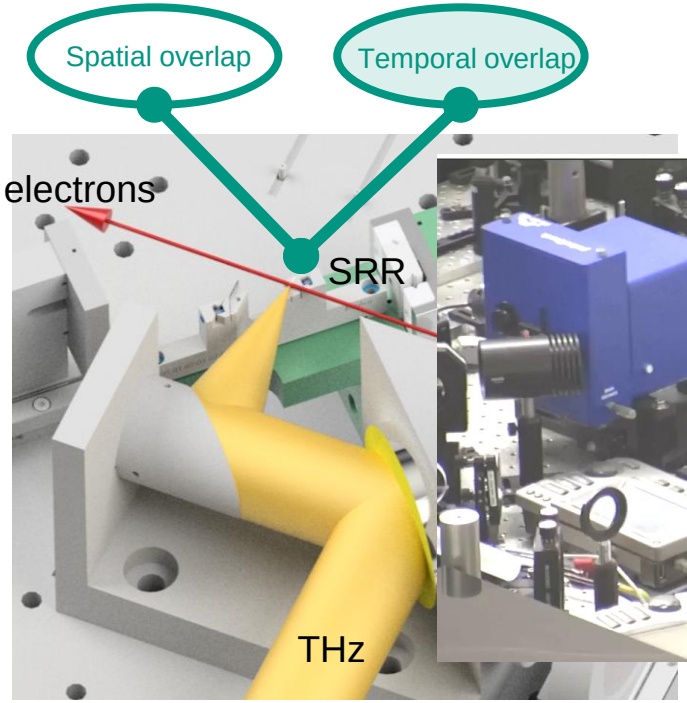


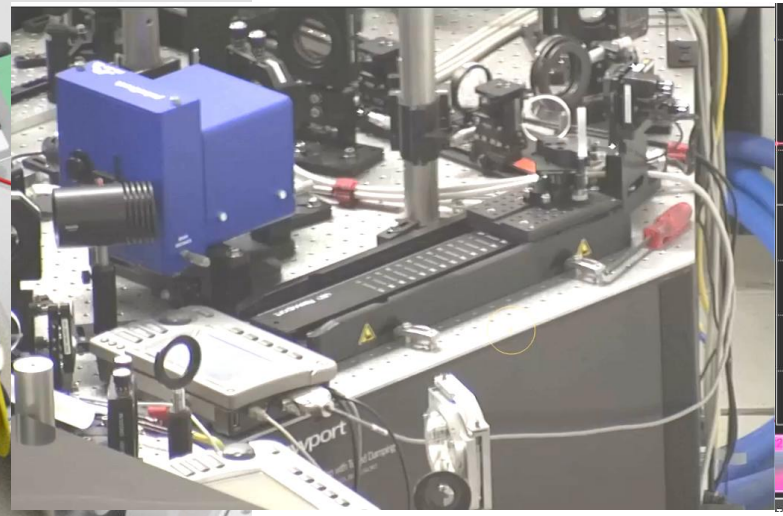


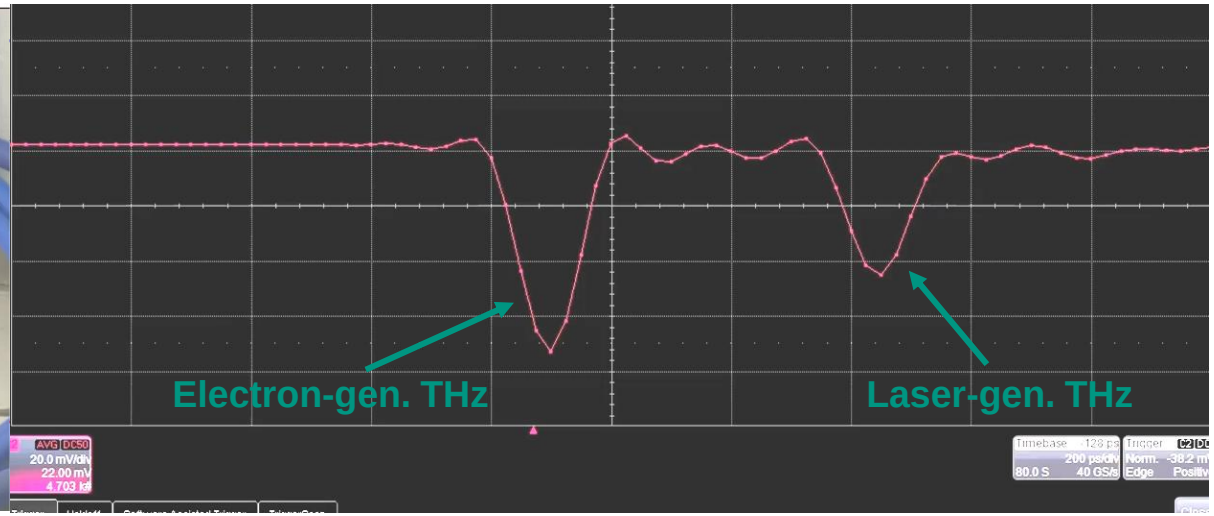
Puzzle piece: Temporal overlap

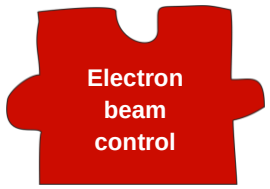


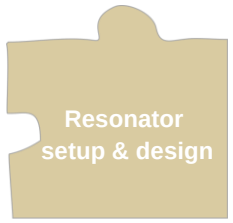




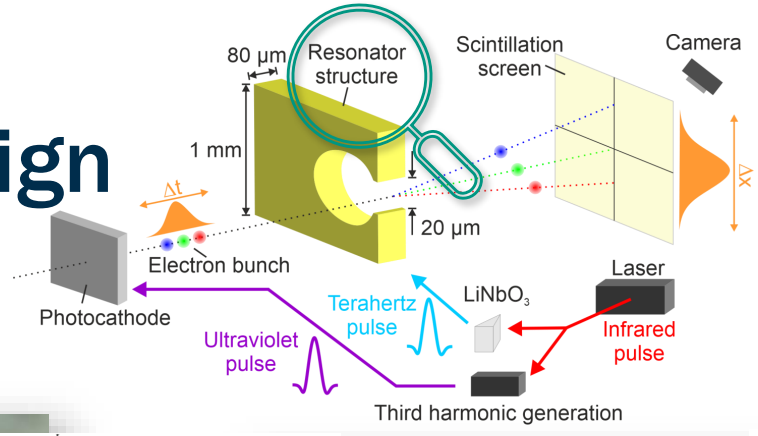


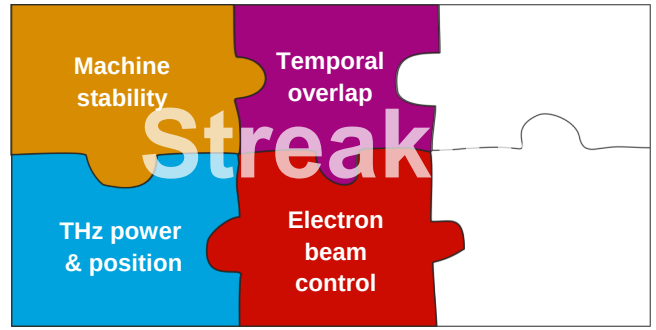


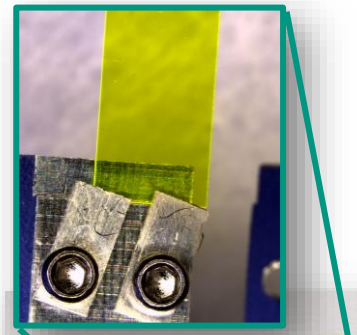


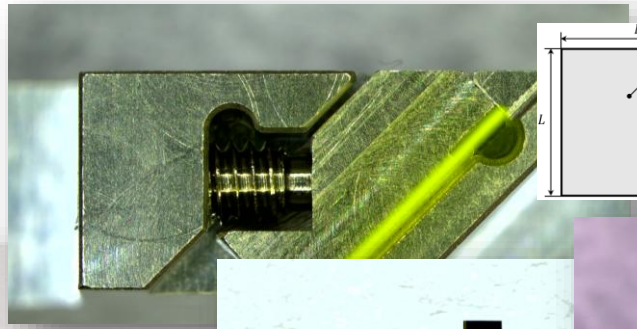


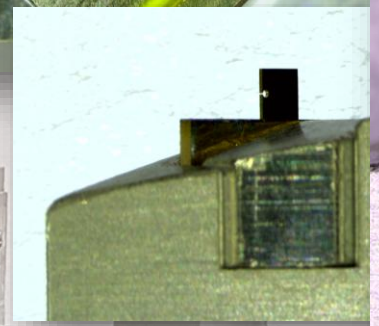
Puzzle piece: Resonator setup & design

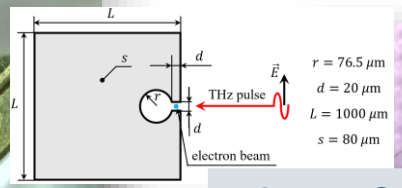




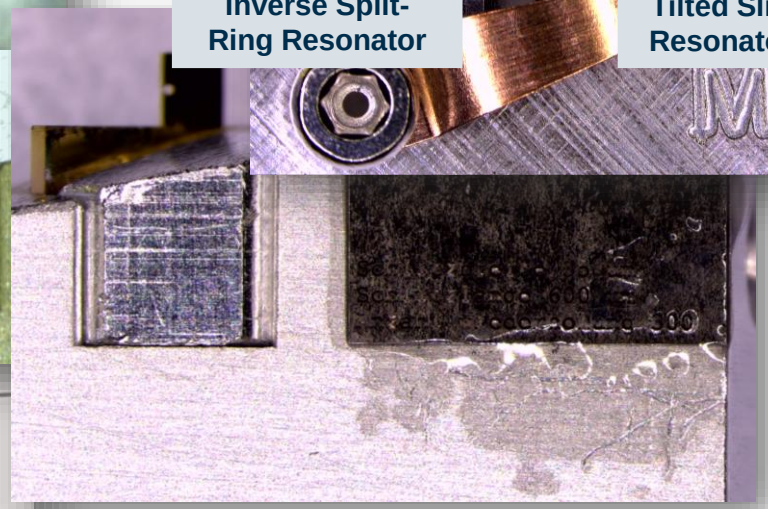


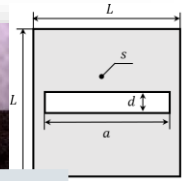




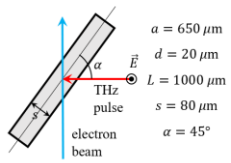


Inverse Split-Ring Resonator





Tilted Slit-Resonator



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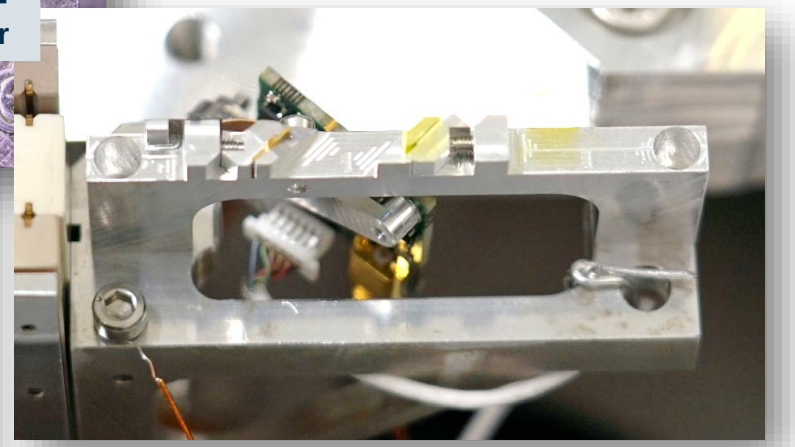
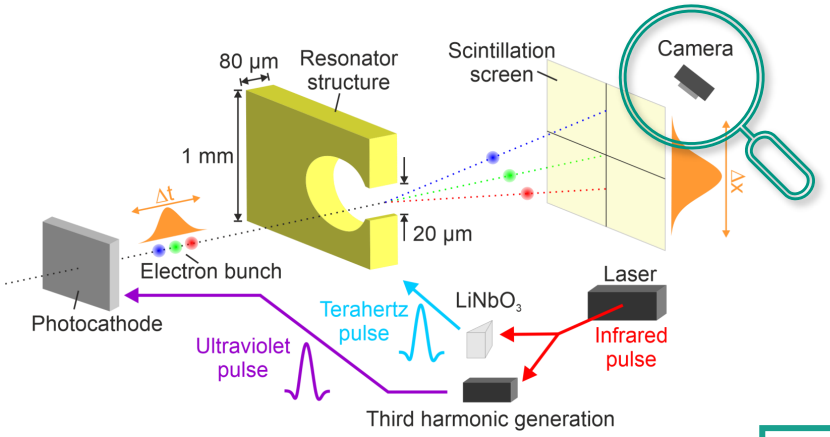


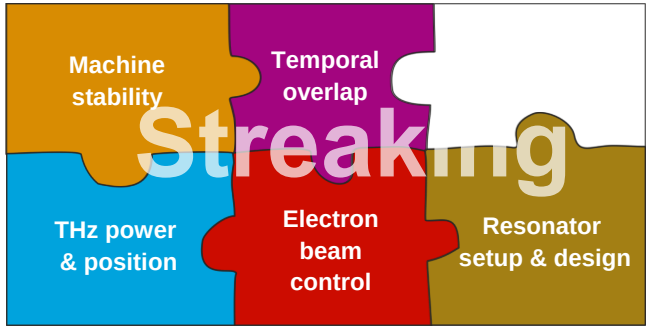
Temporal overlap

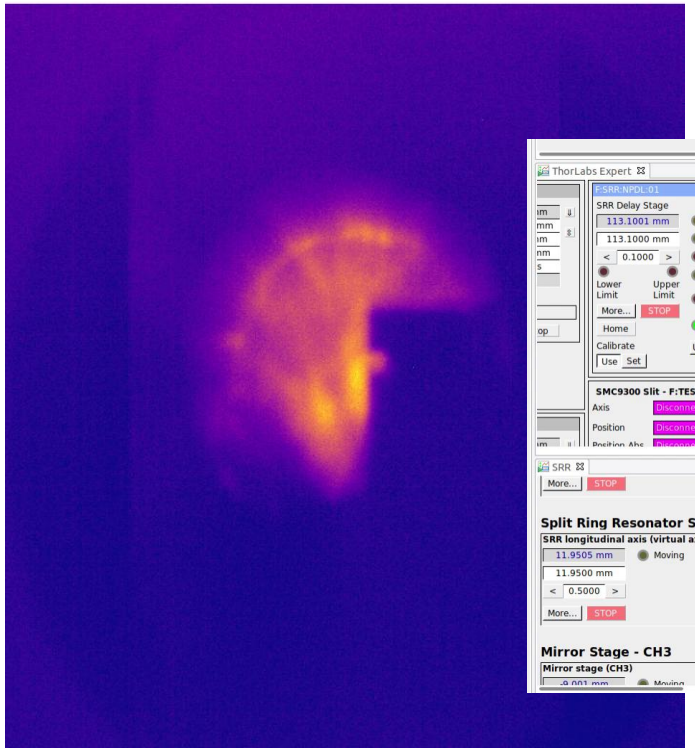
Resonator setup & design

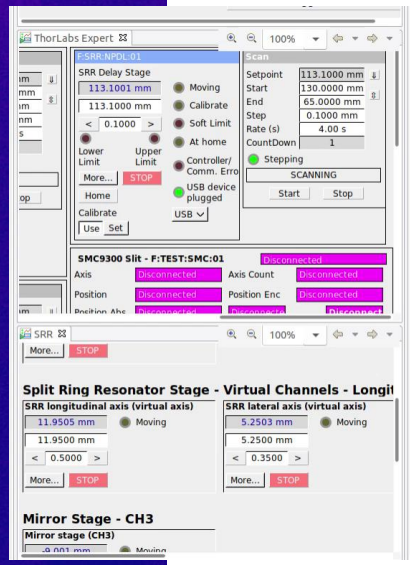
Data evaluation

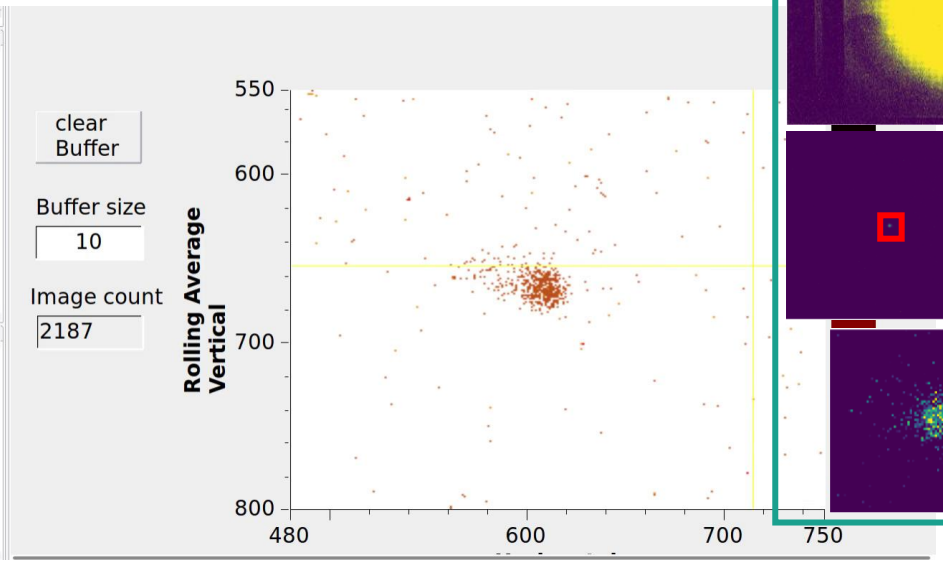
Puzzle piece: Data evaluation

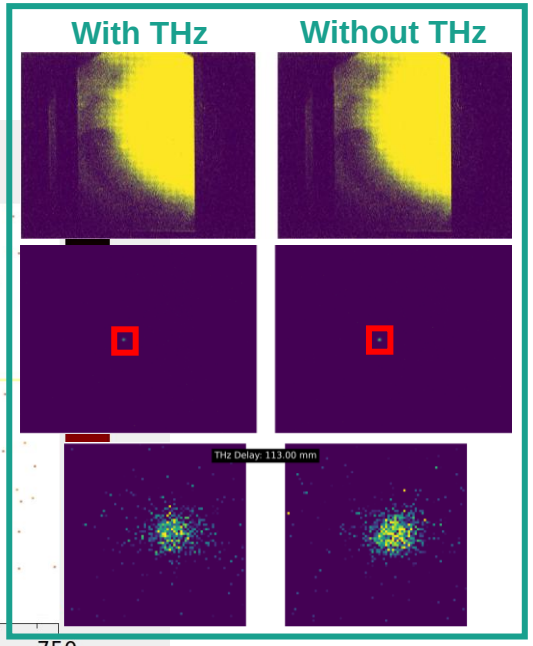










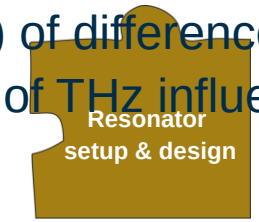


w/ BG

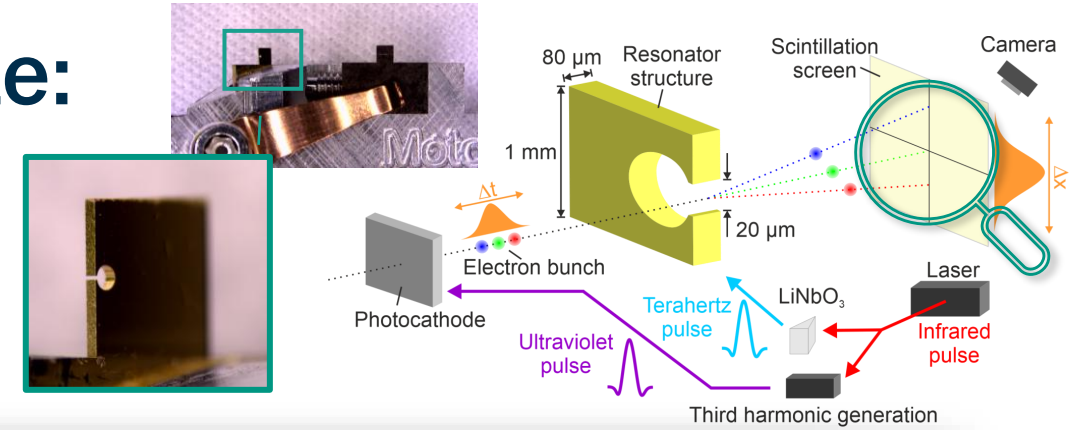
w/o BG

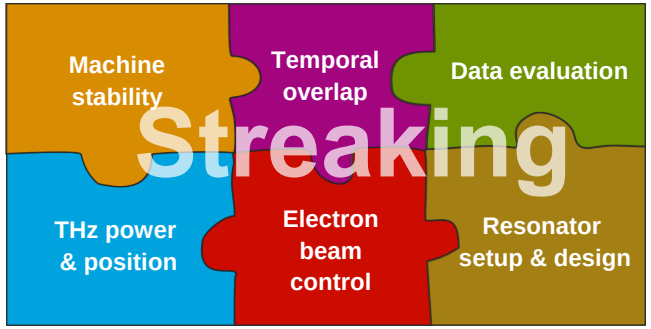
ROI

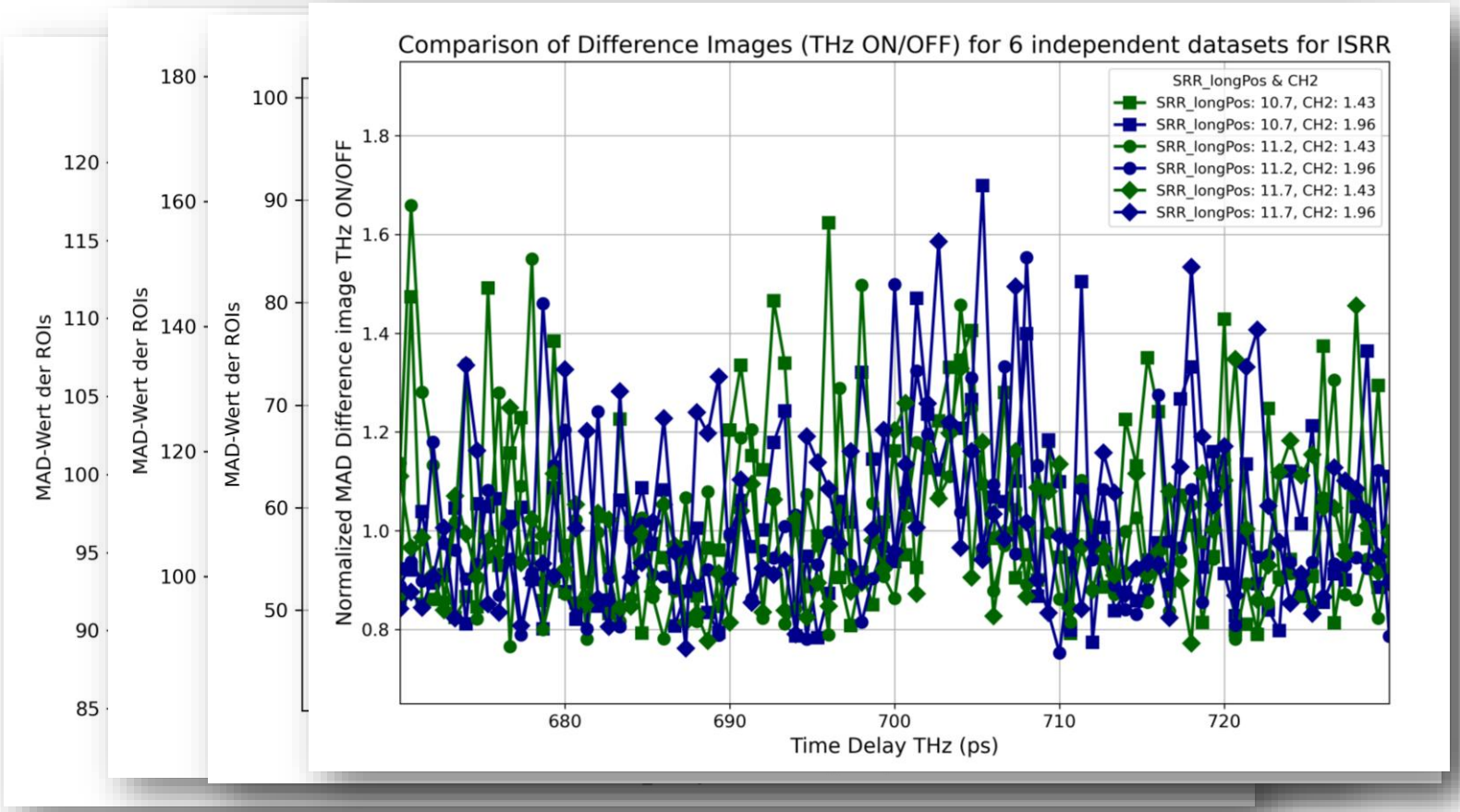
- Calculating mean absolute deviation (MAD) of difference image
- High MAD ➡ Low Similarity ➡ Indication of THz influence

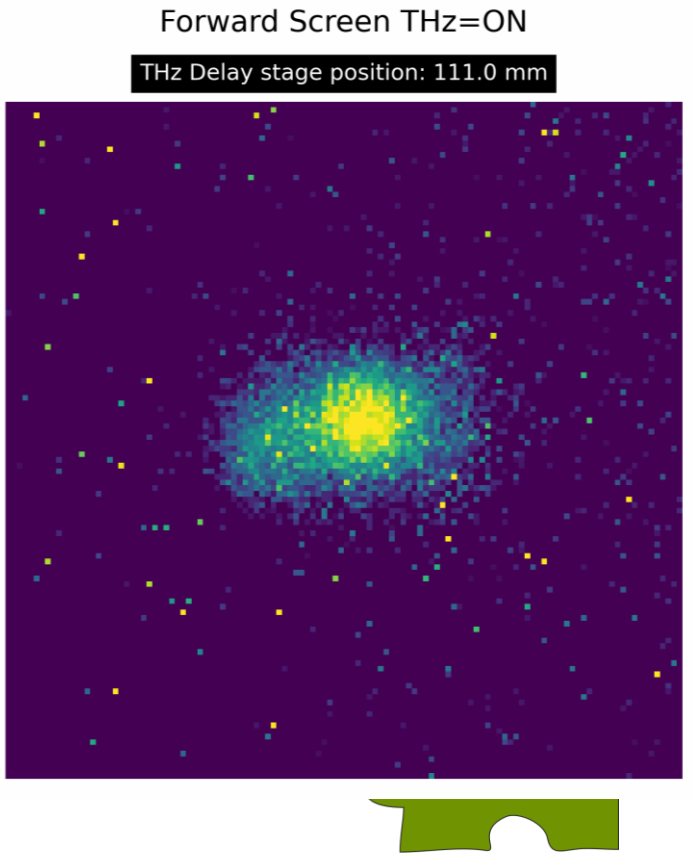


Puzzle complete: Streaking!









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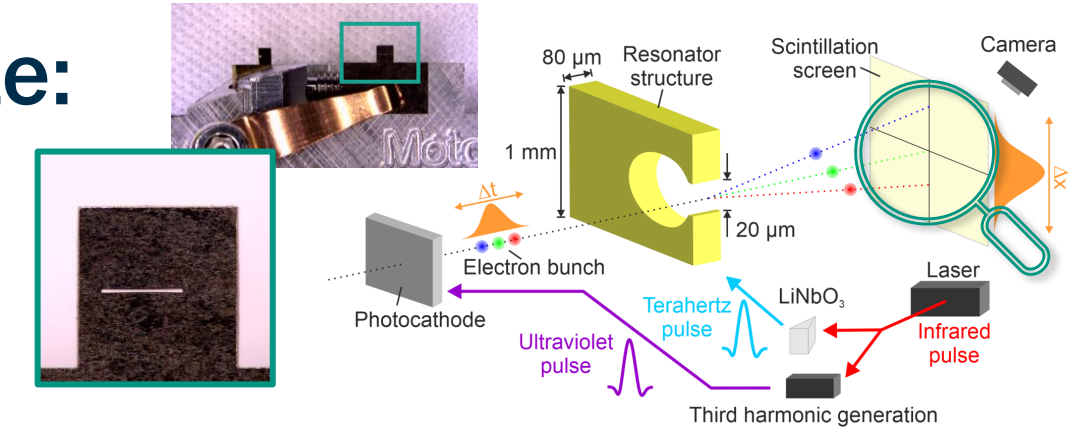

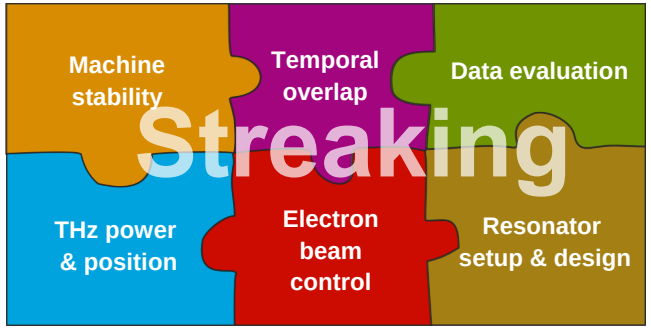

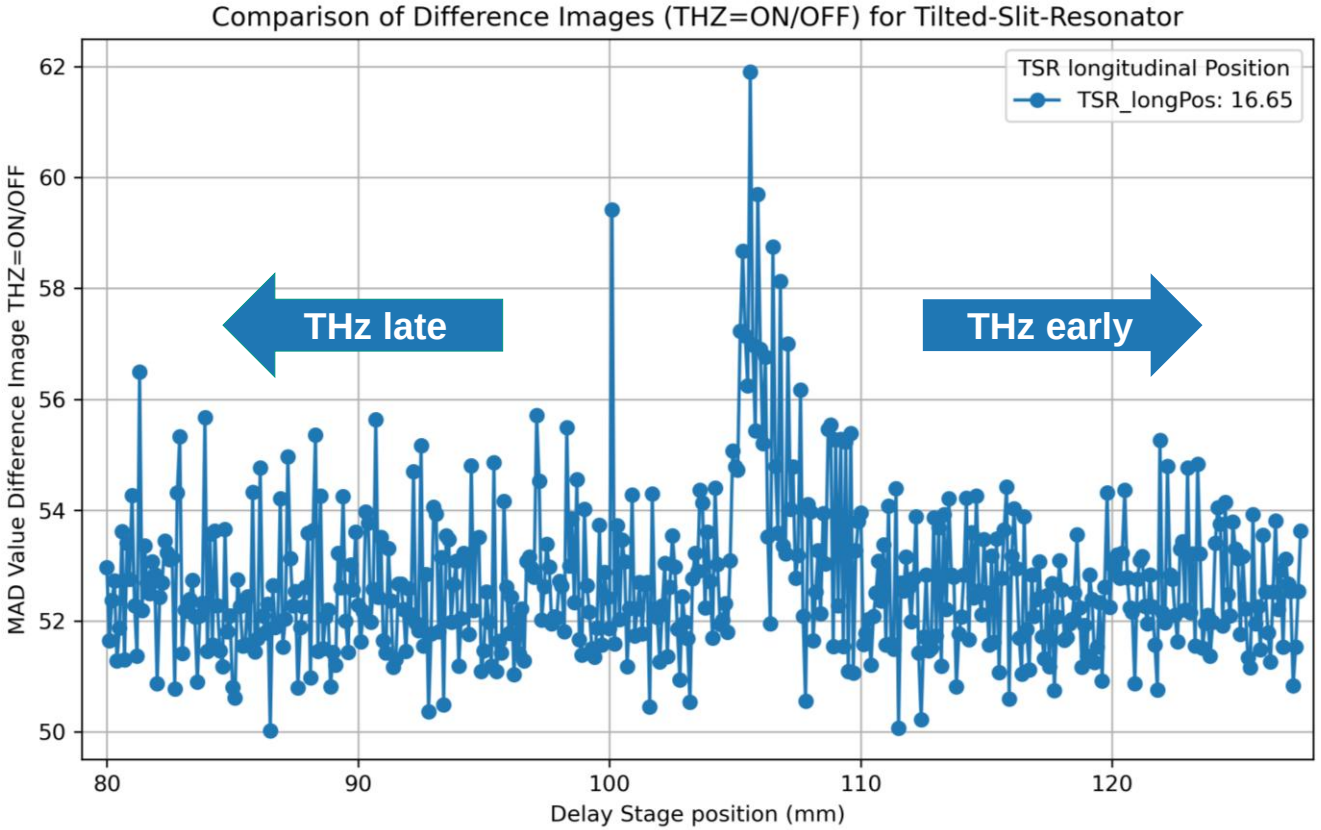

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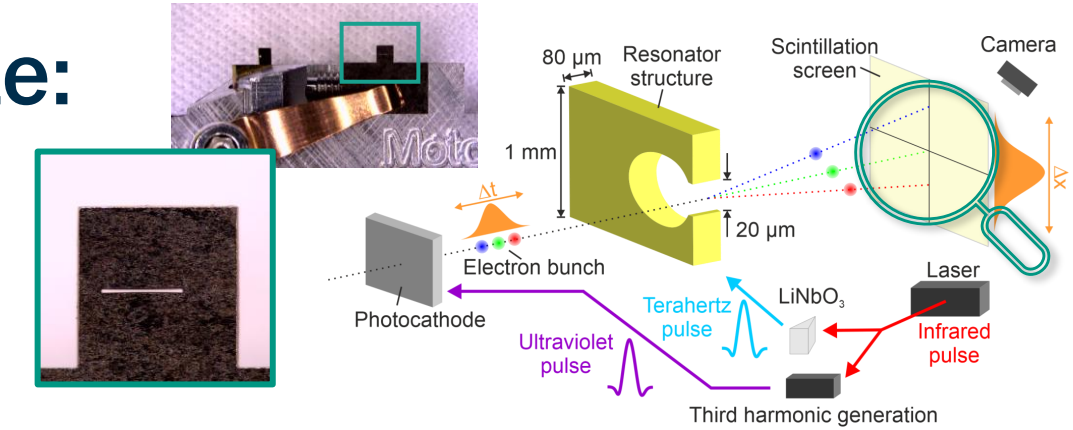

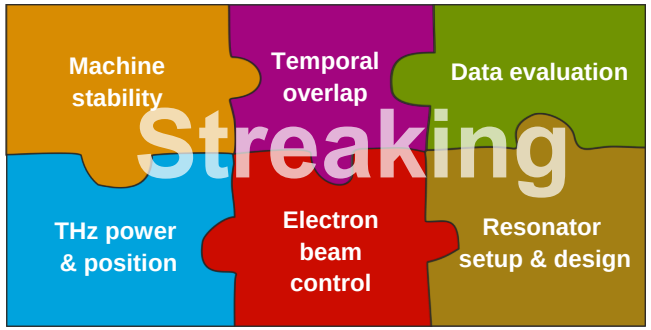

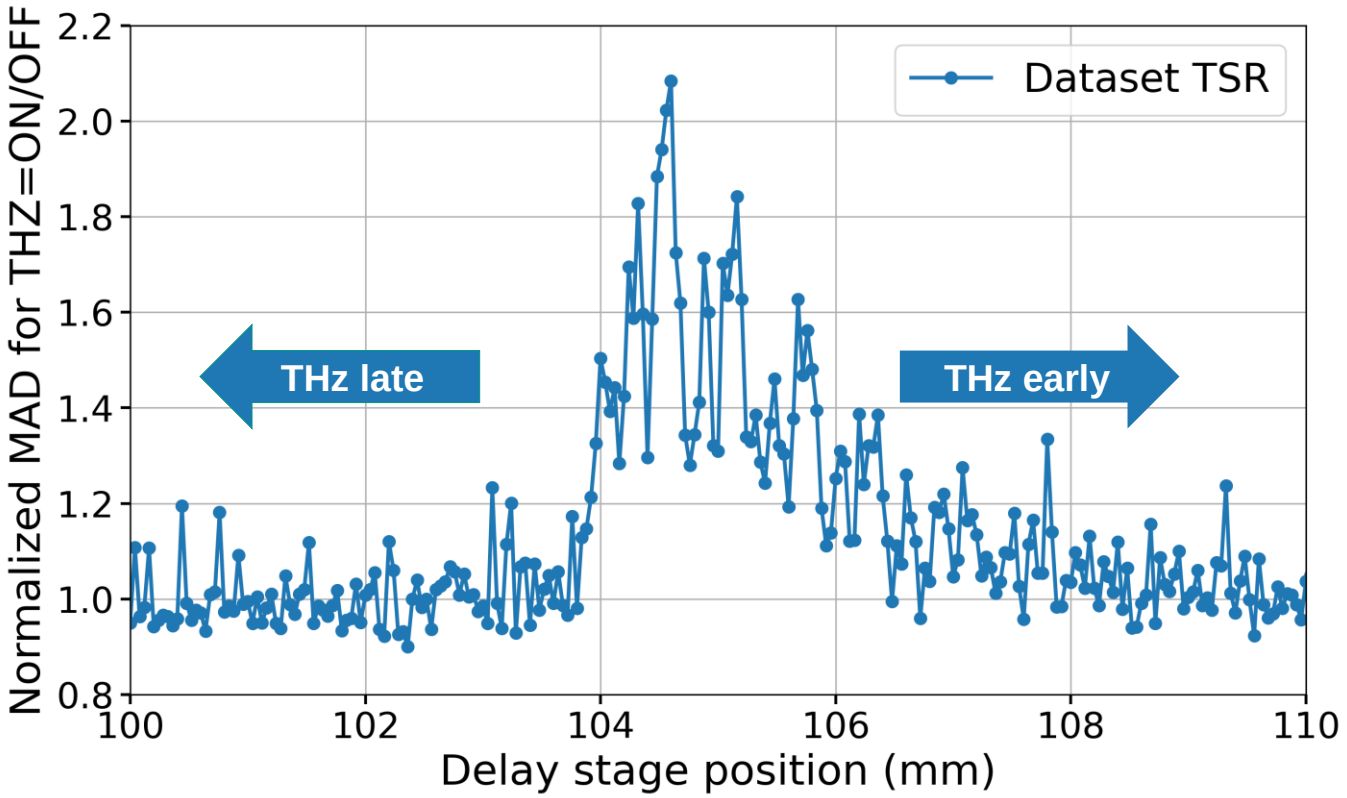

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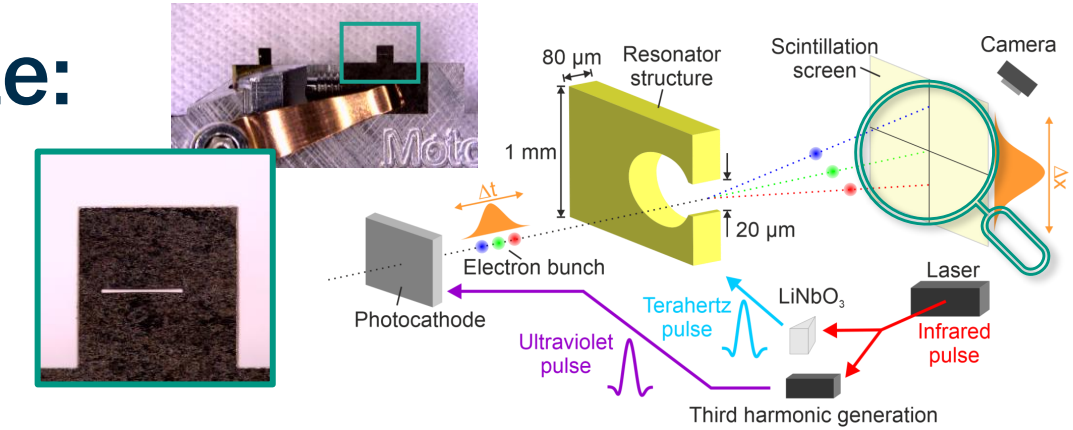

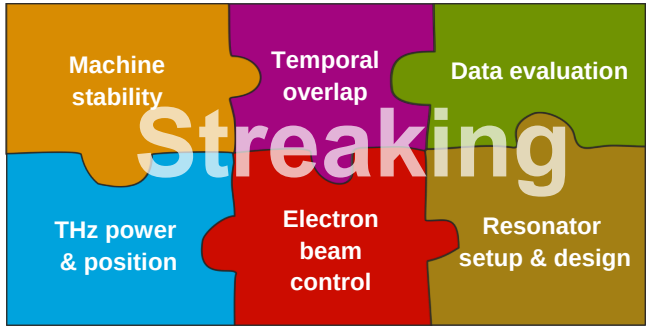

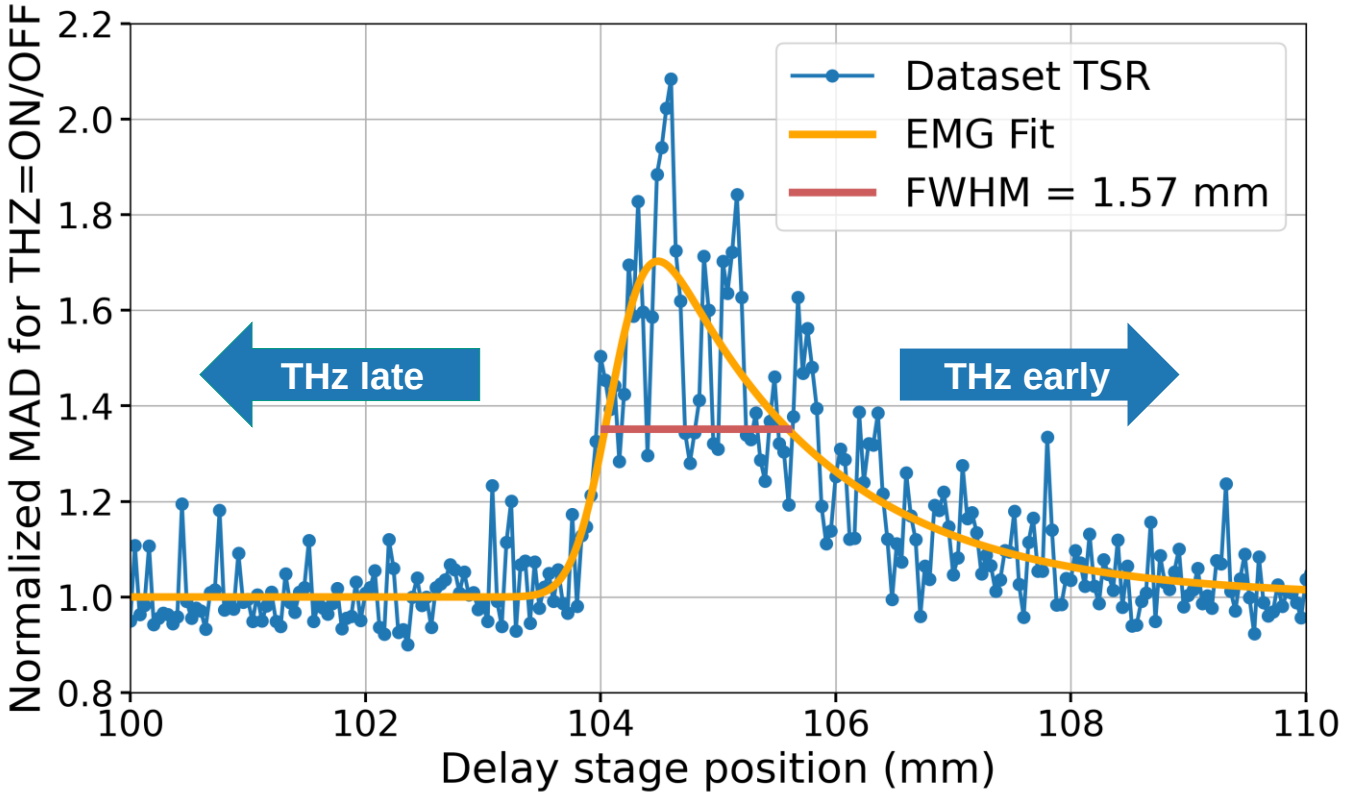

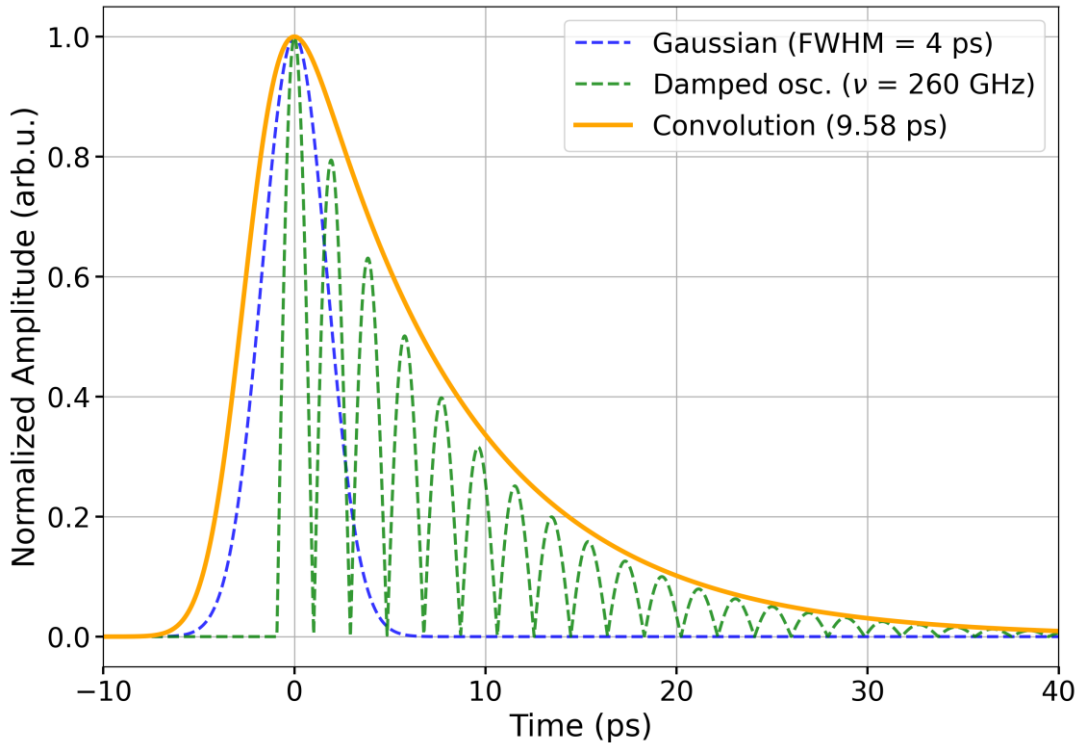

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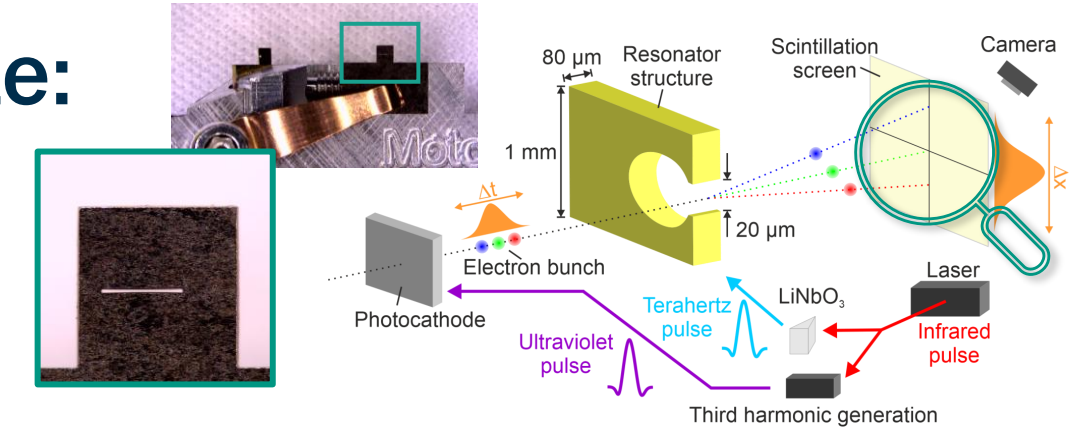

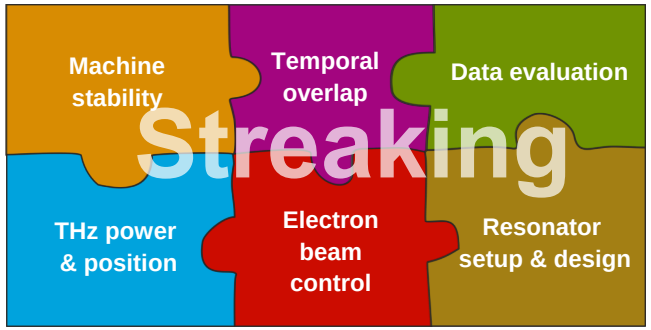

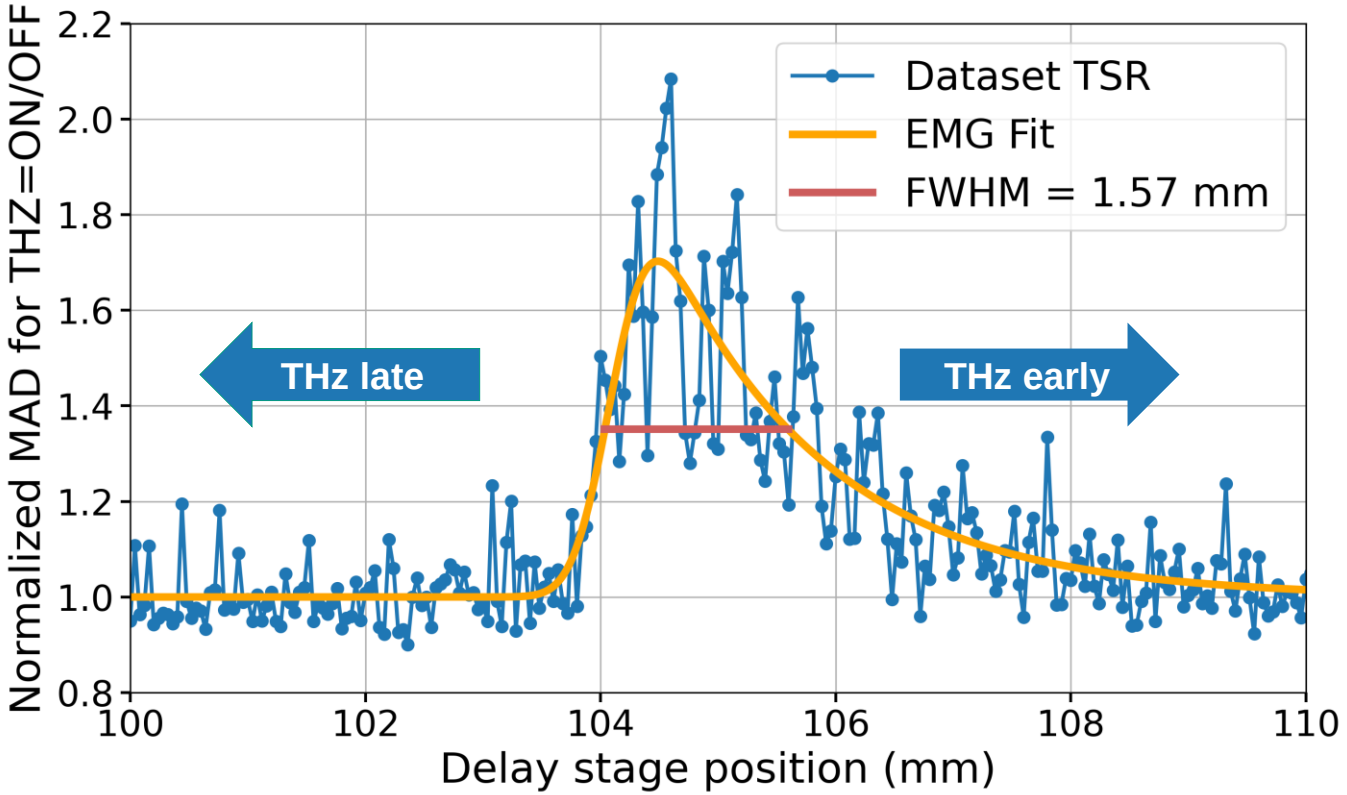

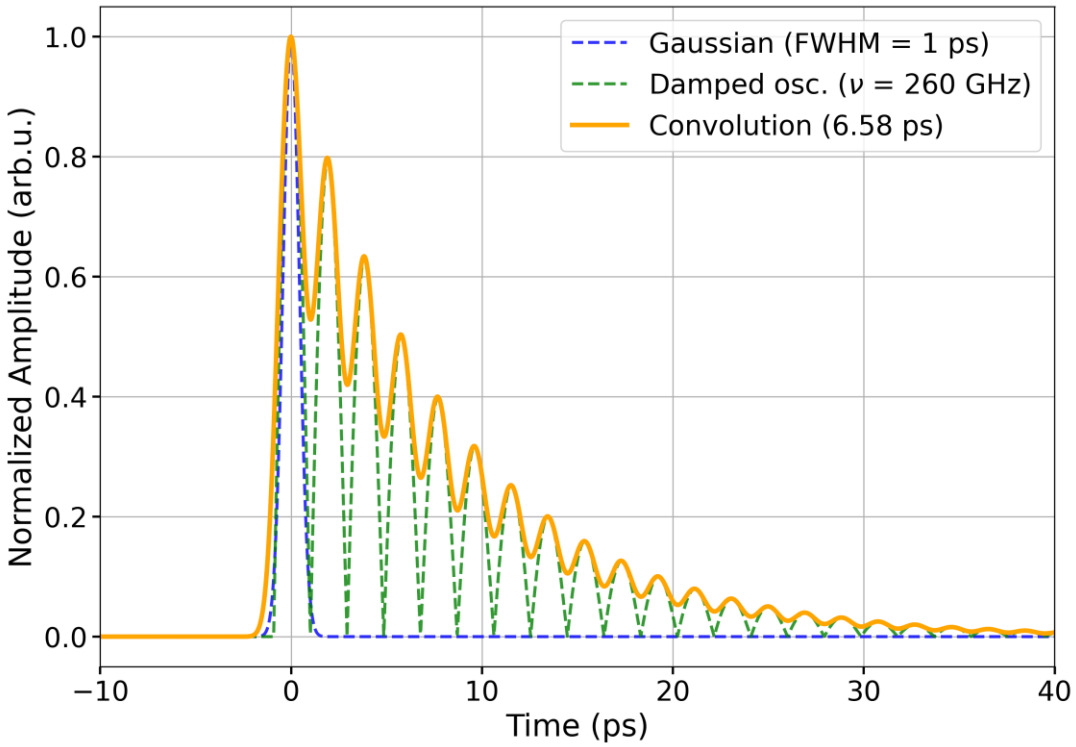

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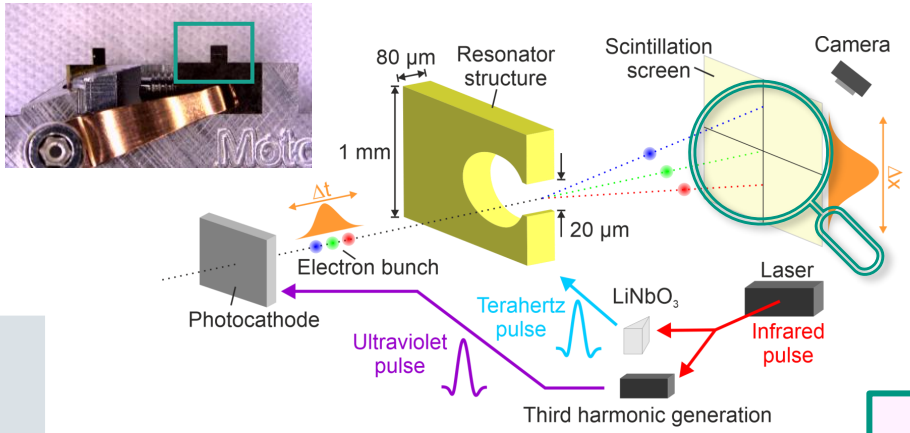

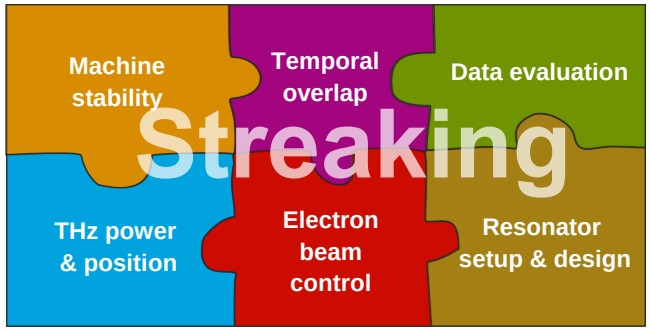

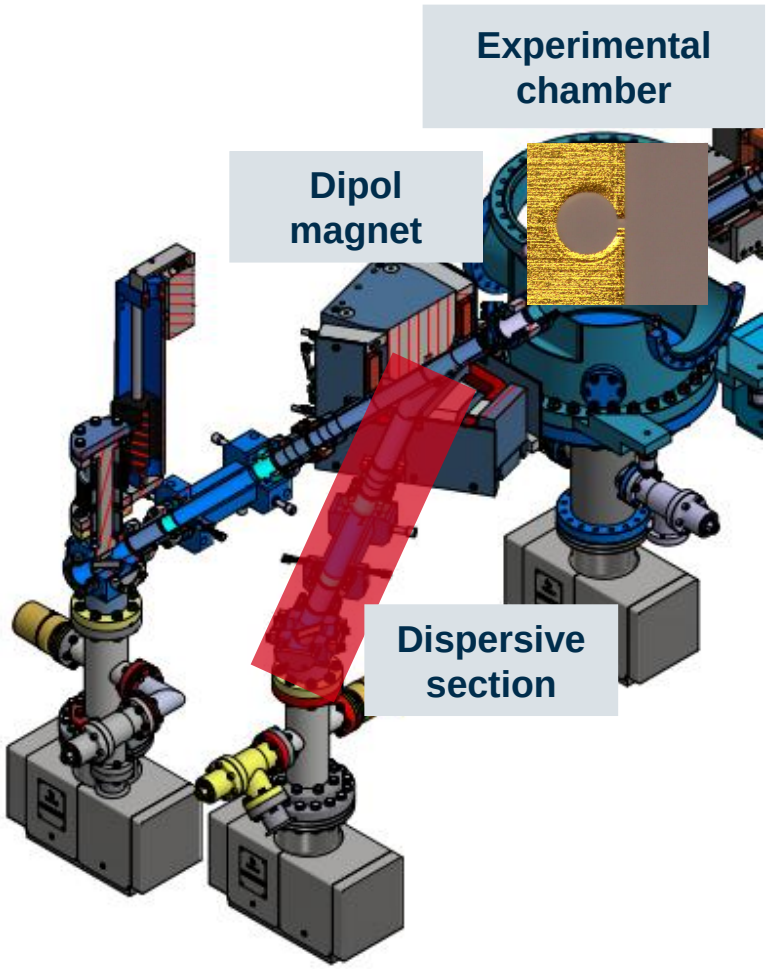

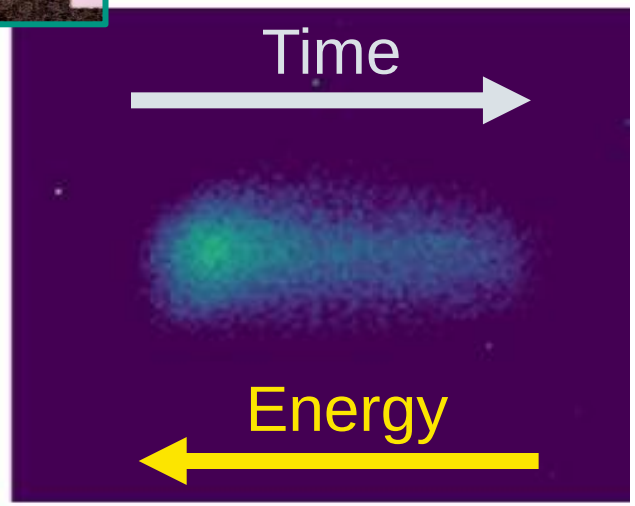

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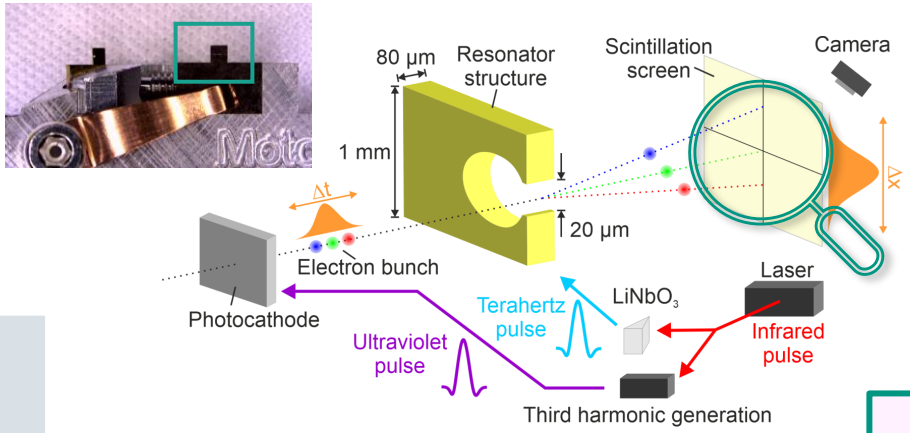

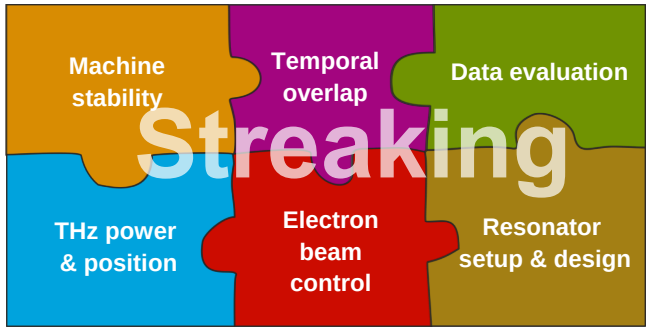

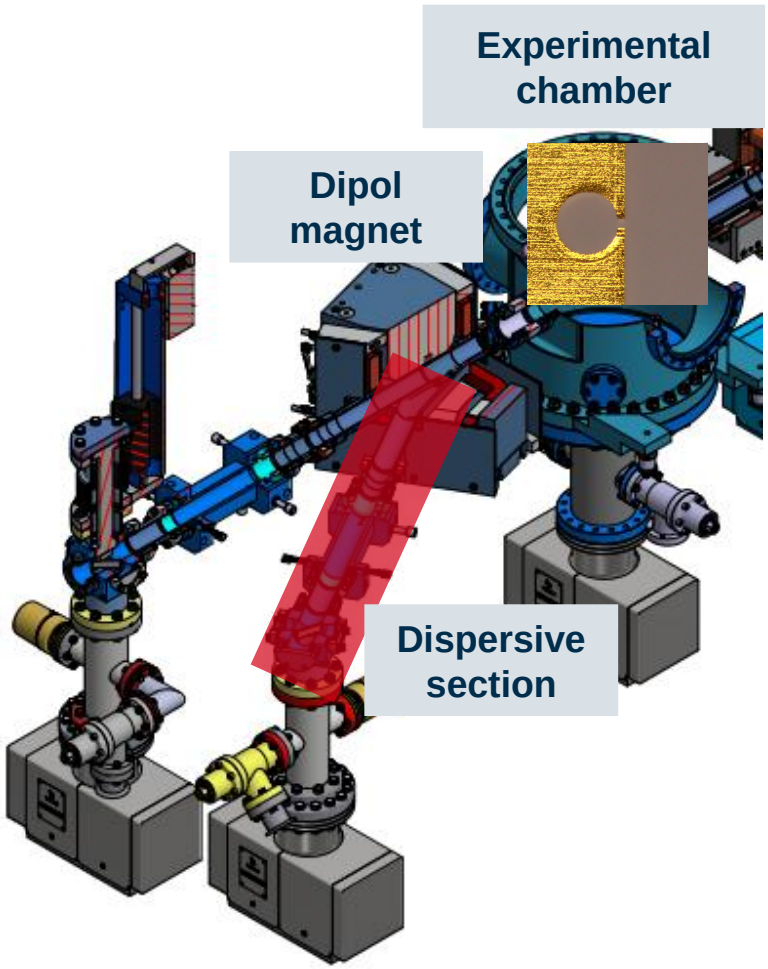

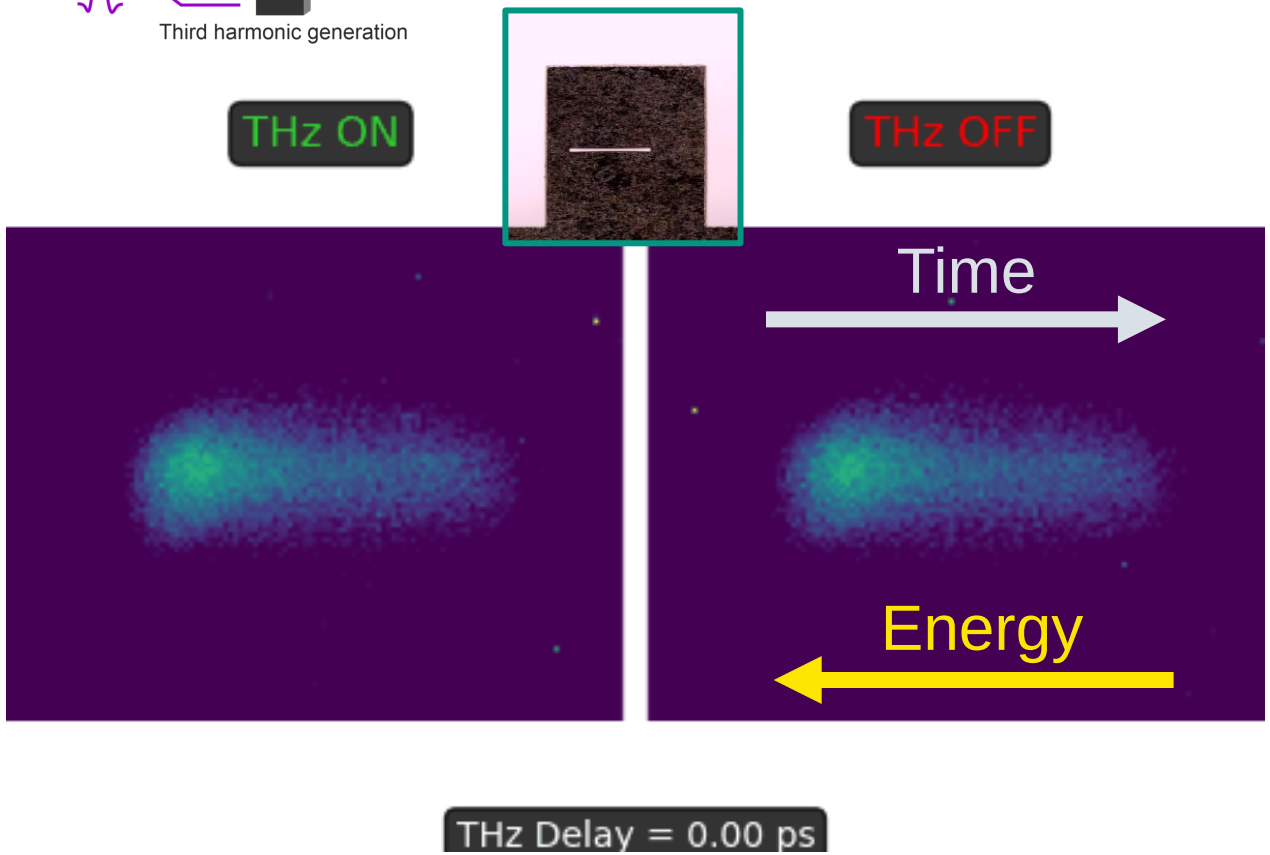

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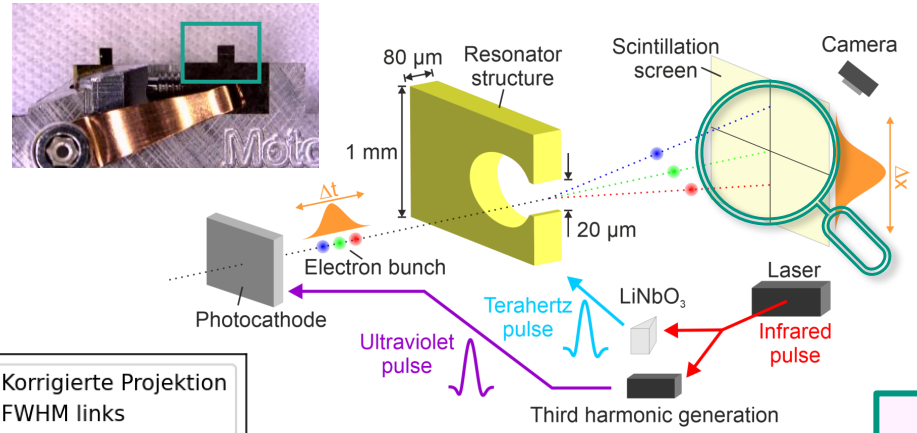

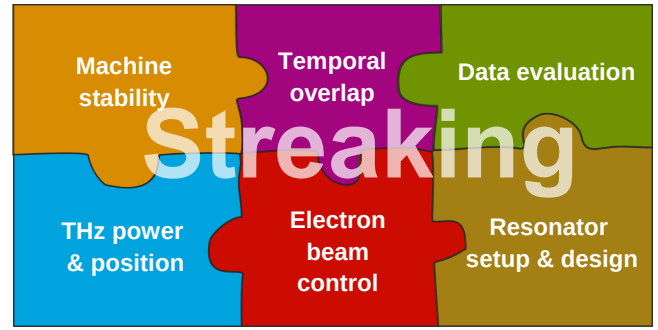

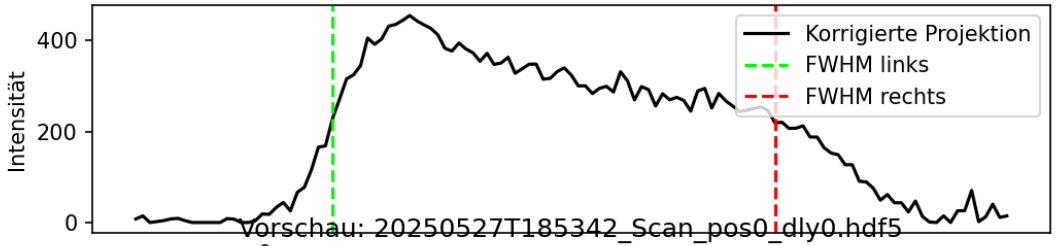

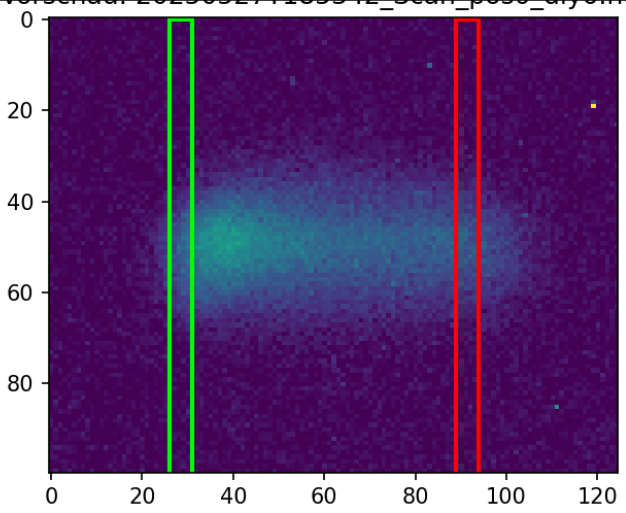

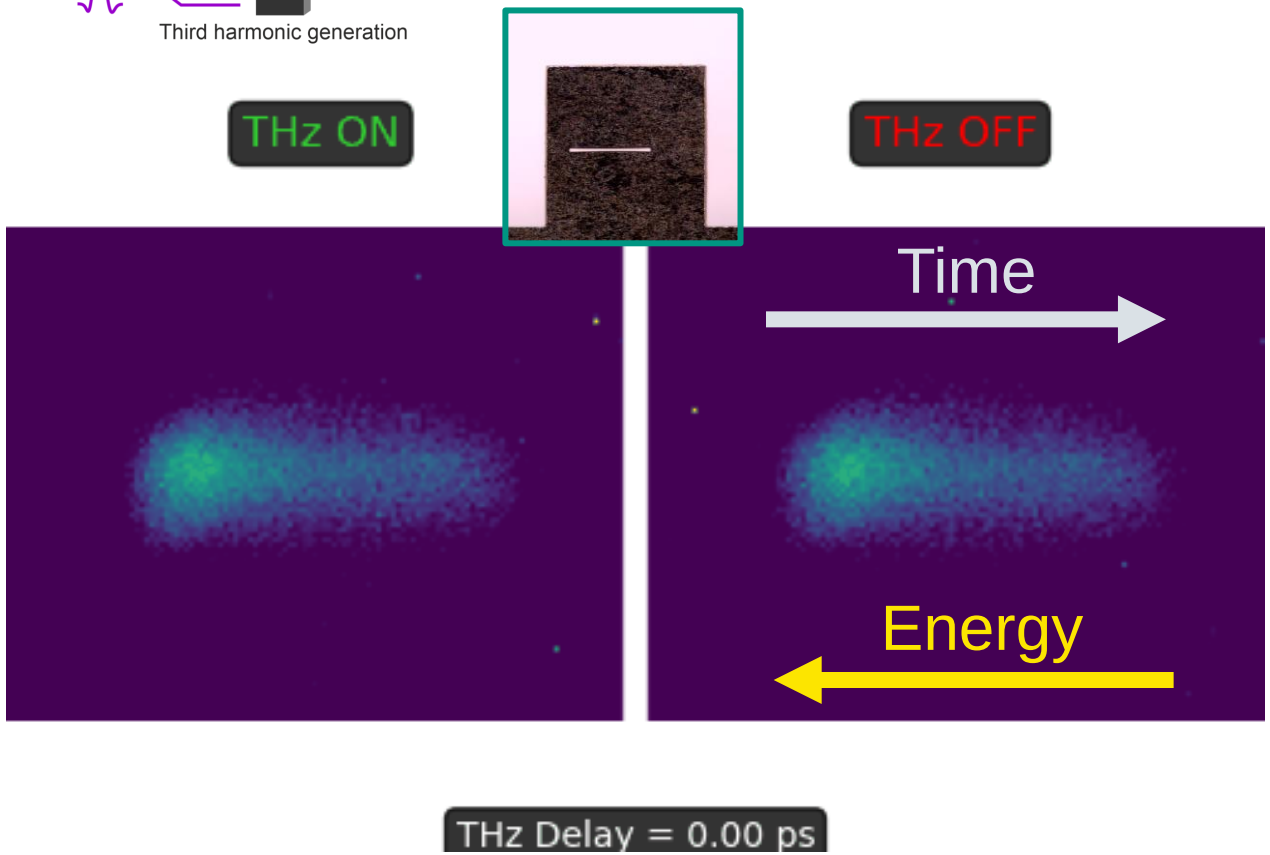

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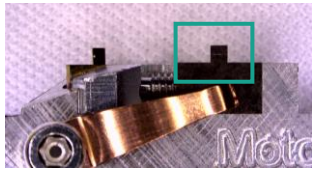
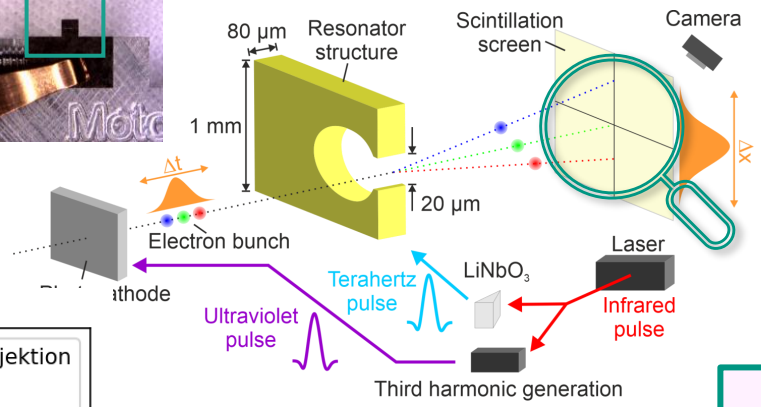
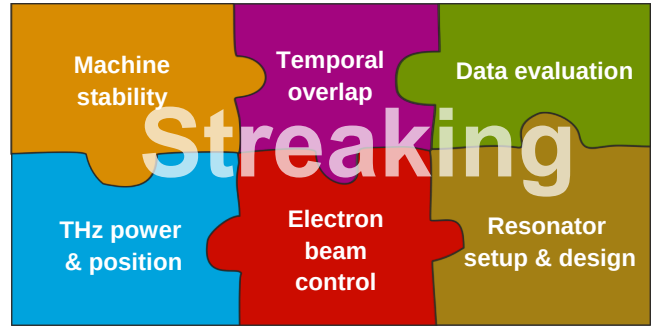
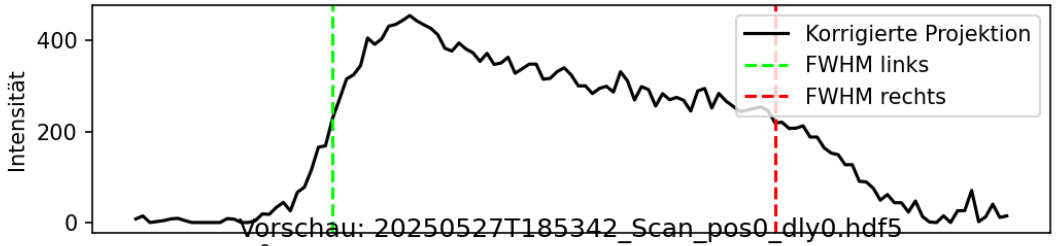
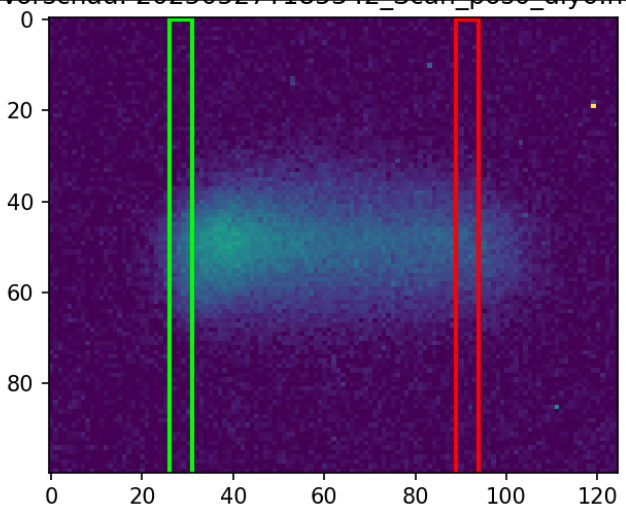
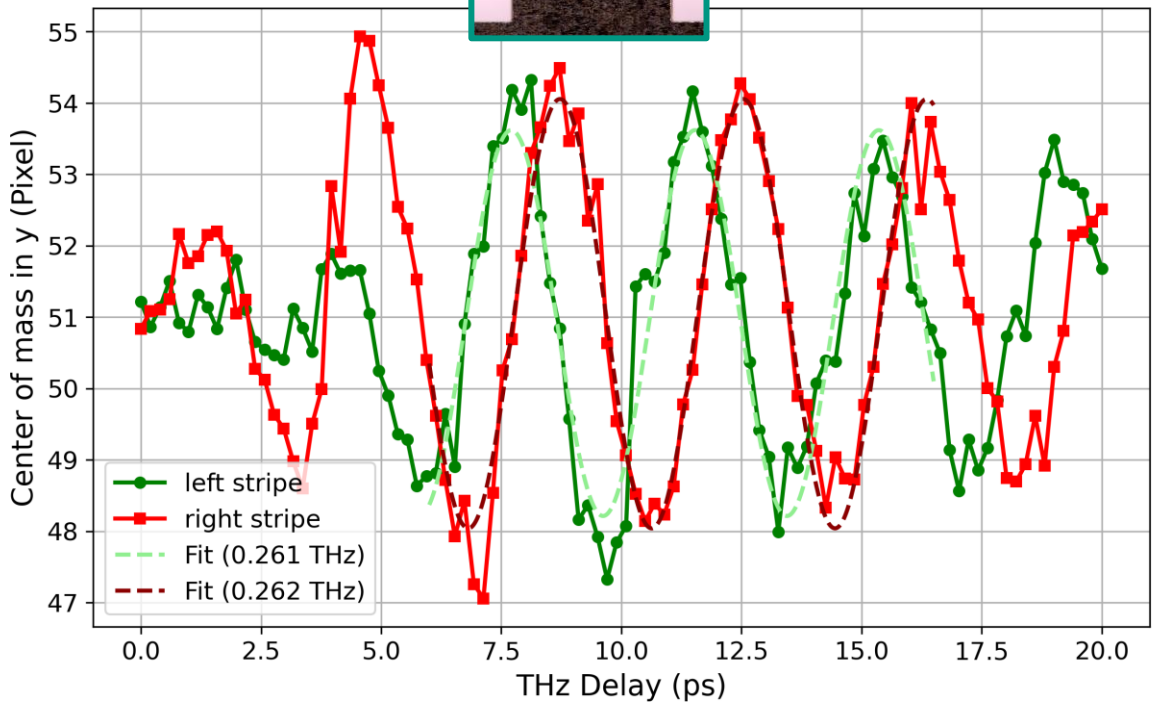










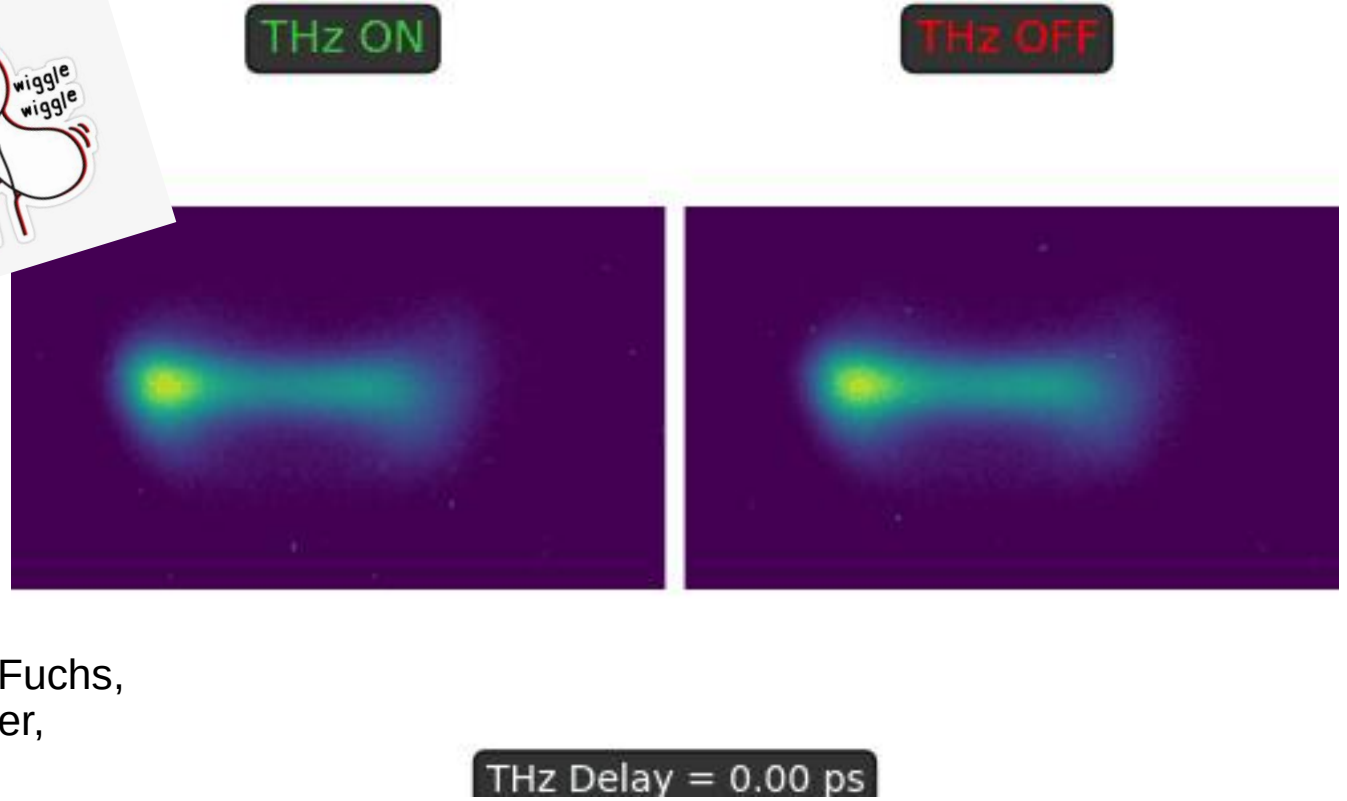


Preliminary + assumptions:

FLUTE electron bunch length → τ_{bunch} = 3 ps (FWHM)

Matthias Nabinger
Doctoral researcher

Contact: matthias.nabinger@kit.edu



Thank you for your attention!

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