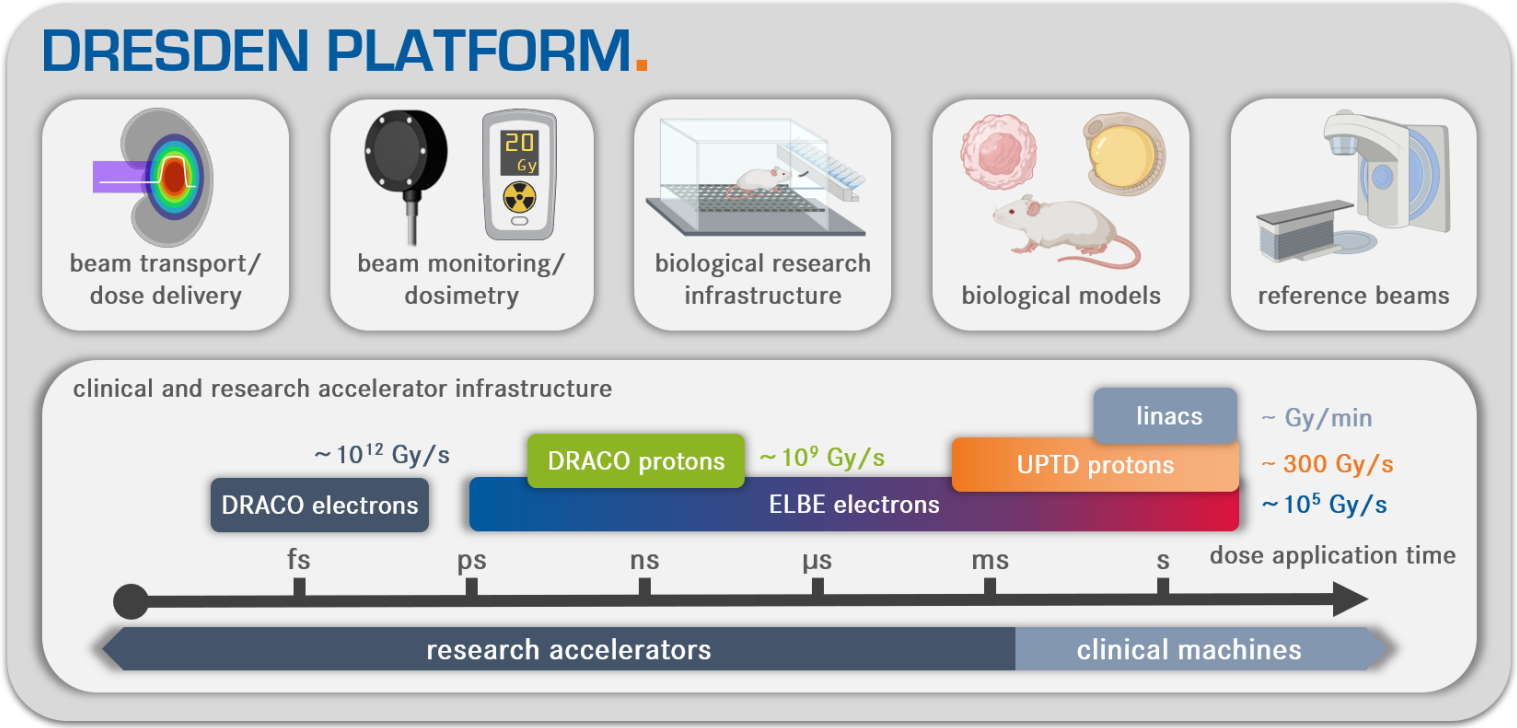
HELMHOLTZ ZENTRUM
DRESDEN ROSSENDORF

HZDR Status Talk ARD-ST3

Michael Kuntzsch

Motivation: Research possibilities at the Dresden platform



- Dresden platform provide broad range of parameters for systematic UHDR studies
  - **Clinical proton cyclotron** and electron Linacs for reference irradiation and dosimetry
  - **ELBE research accelerator** is the most flexible machine regarding time and beam structure
  - **Laser driven accelerators** may provide information of the upper limit of UHDR effects

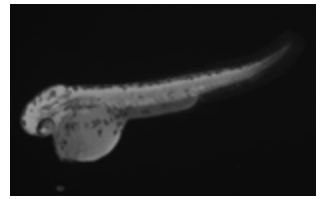
  → Enabling ultra-high dose rate research for different particle beams, pulse structure fractionation, dose, dose rate…

Talk by Elke Beyreuther earlier today

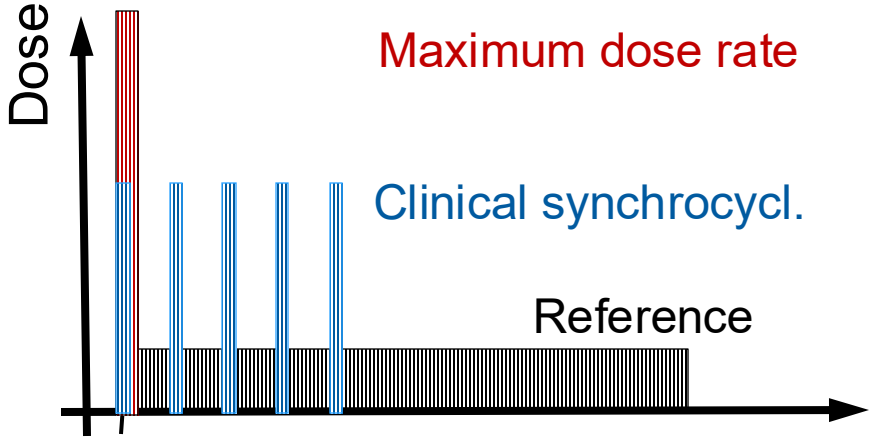
Metzkes-Ng, Beyreuther et al. Scientific Reports 2023

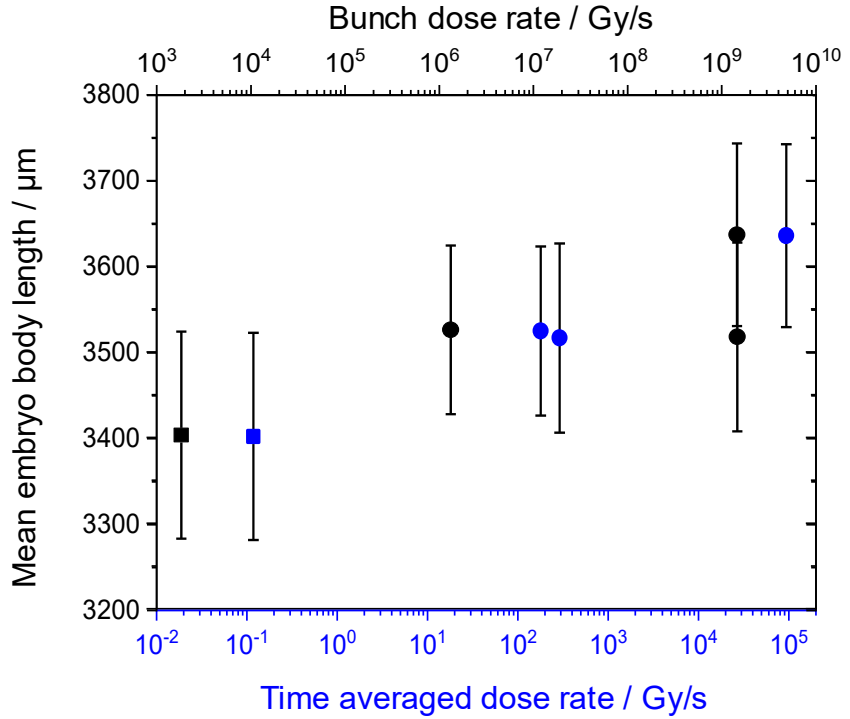
Electron Flash @ the ELBE research electron accelerator

Maximal flexibility in beam parameter setting allow for unique experiments



- Electron energy 20 – 40 MeV
- Flexible pulse time structure, tunable bunch charge
- Bunch frequency of 13 MHz overlaid by macro pulsing



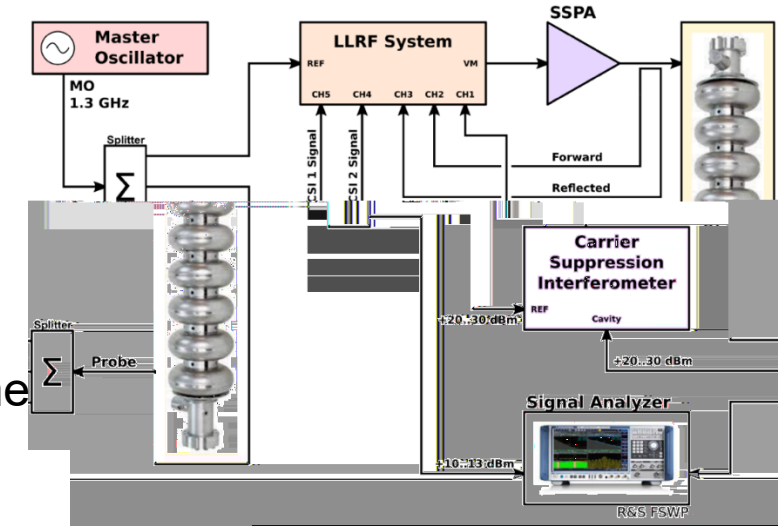


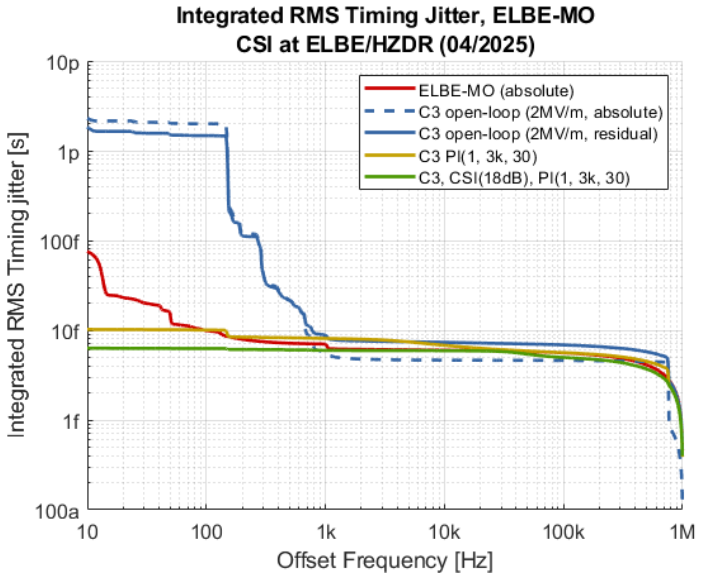
Pawelke et al.: Radiother Oncol (2021) 158
Karsch et al.: Radiother Oncol (2022) 173
Jansen et al. Med Phys 2021; Radiother Oncol 2022
Horst et al.: Radiother Oncol (2024) 194

- Zebrafish embryo model:
  - Helps to identify relevant parameters for studies with higher order organisms (mice)
  - “Simple” model

Carrier-Suppression-Interferometer (CSI)

- attosecond resolution RF detector
- development by DESY
- second test at ELBE facility
- RMS timing jitter of 6 fs with CSI
- system limited by AM noise of old ELBE MO, new MO to come

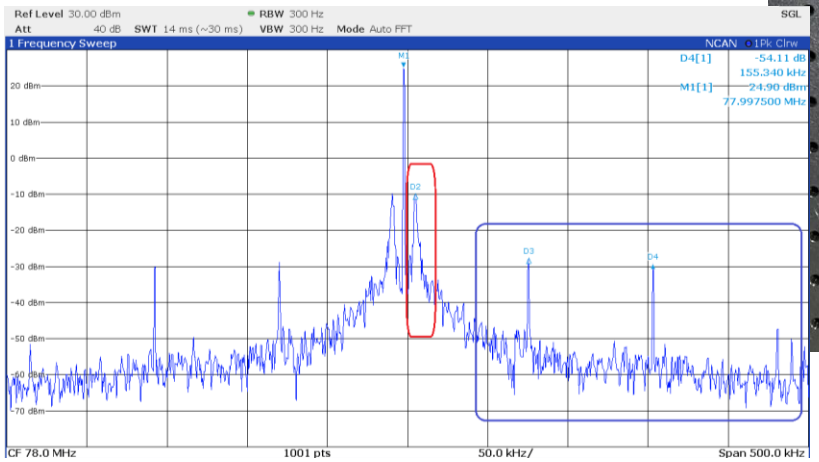




See talk by Matthias Hoffmann on Thursday

New Synchronization Optical Master Oscillator

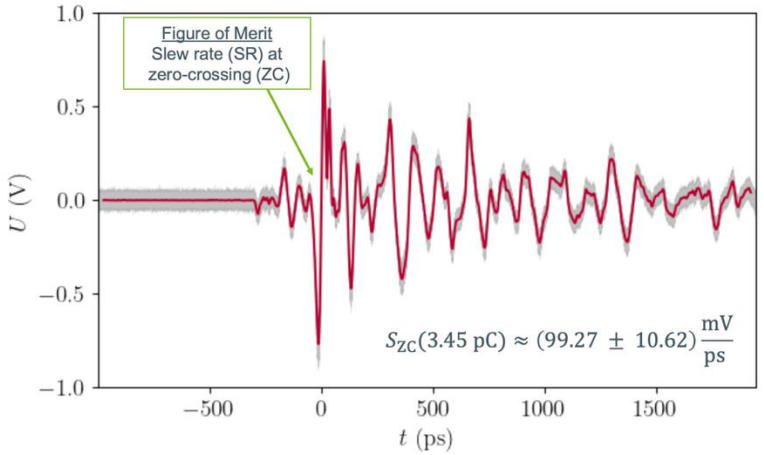
- New system from Menhir purchased
- excellent laser performance
- only 156 MHz system available
- pulse picker needed to split the beam into two 78 MHz beams
- pulse picker driver introduces noise
- home build solution on the way

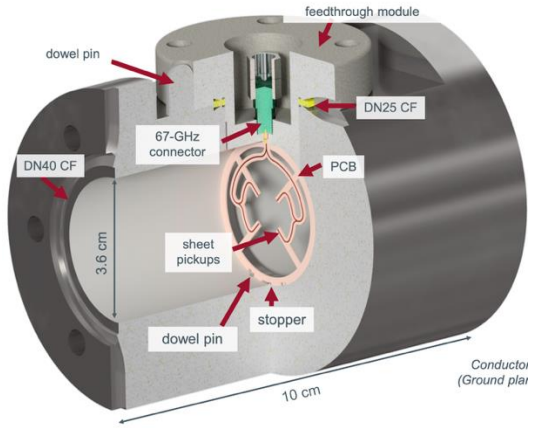


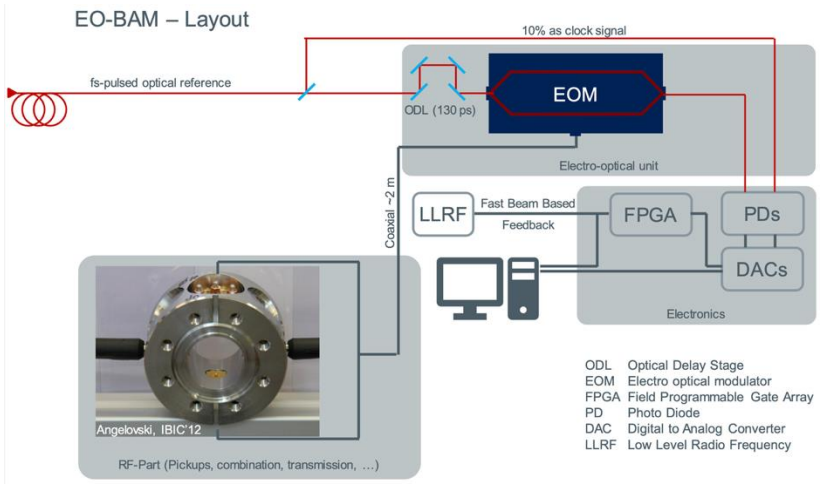
See poster by Mohammed Salman on Thursday

New BAM Pickup measurements at ELBE

- New BAM Pickup Design goal: <10 fs resolution for charge < 1 pC
- 67 GHz Demonstrator tested at ELBE
- 1.4 m of V-cable (high attenuation)
- Final version with EOM integrated





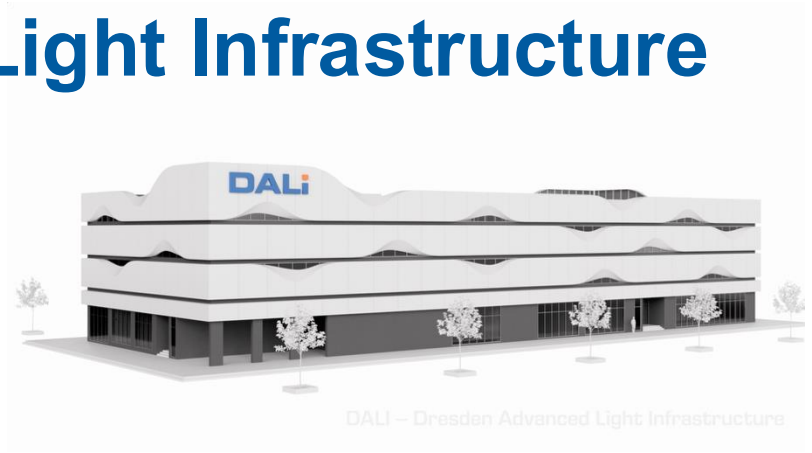


See poster by Bernhard Scheible on Thursday

DALI – Dresden Advanced Light Infrastructure

MIR accelerator

- 50 MeV, 100 pC, 10 MHz, 1 mA
- 10 - 120 µm (2.5 – 30 THz)

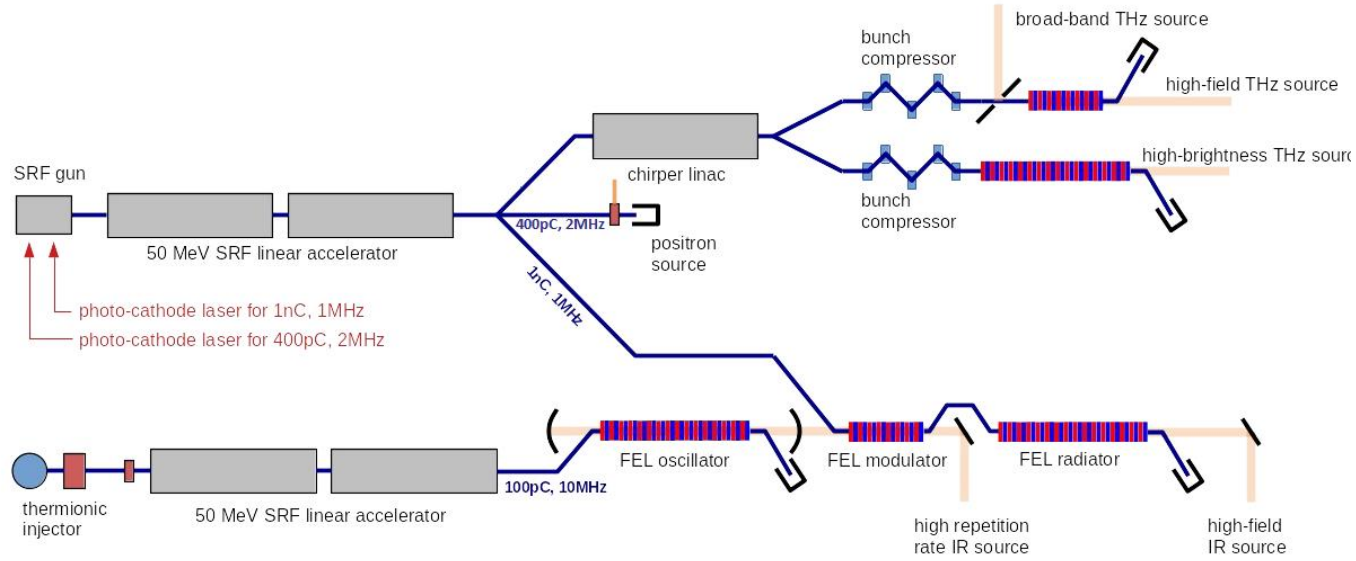


THz / Positron accelerator

- 50 MeV, 1 nC, 100 kHz…1 MHz, 1 mA
- 10 µm – 3 mm (0.1 – 30 THz)

UED

- 4 MeV, 10 fC … 100 fC

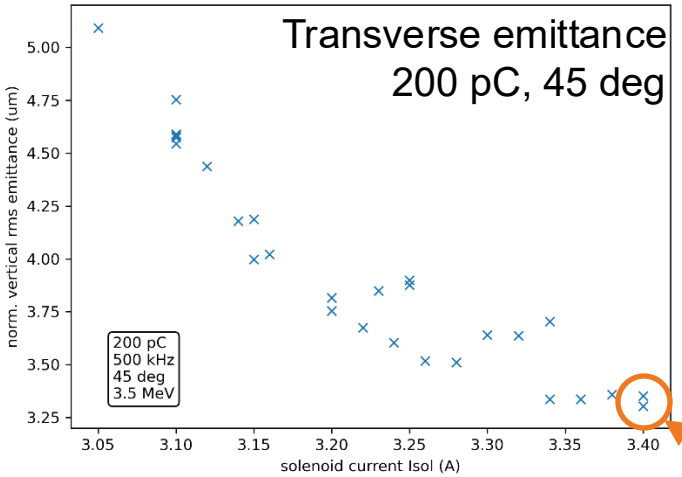


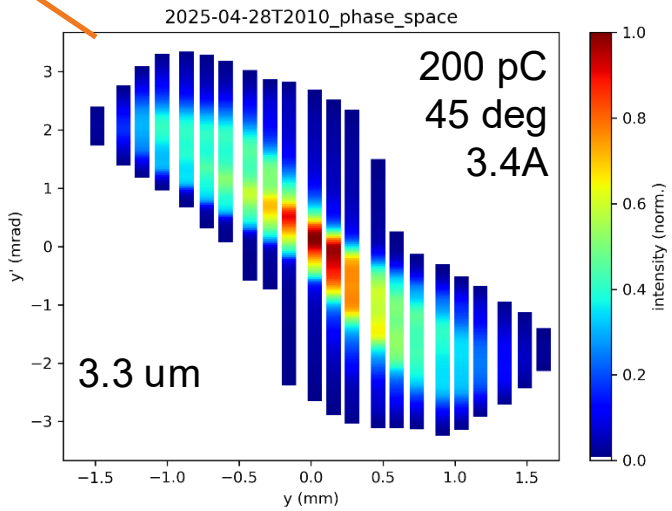
- CDR finished in 2023
- very positive feedback from FIS commission
- strongly supported by Matter program reviewers

Transverse emittance measurements at ELBE

Measurements of the transverse emittance for 200 pC bunch charge at the ELBE SRF gun

- SRF Gun at ELBE
  - For ELBE THz source (TELBE) operation
  - Typ. with 200 pC
    - Up to 1 nC for DALI planned
  - TELBE optimization using
    - Laser-to-RF phase
    - Solenoid strength





- Transverse emittance measurements
  - Beam characterization in diagnostics beamline
  - Single-slit scan
  - Redevelopment of image analysis
  - Beam dynamics studies ongoing

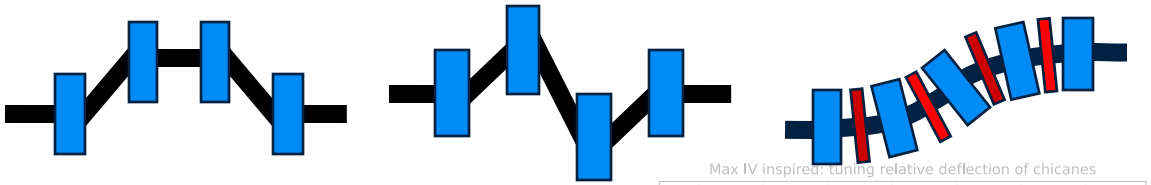
See poster by Raffael Niemczyk on Thursday

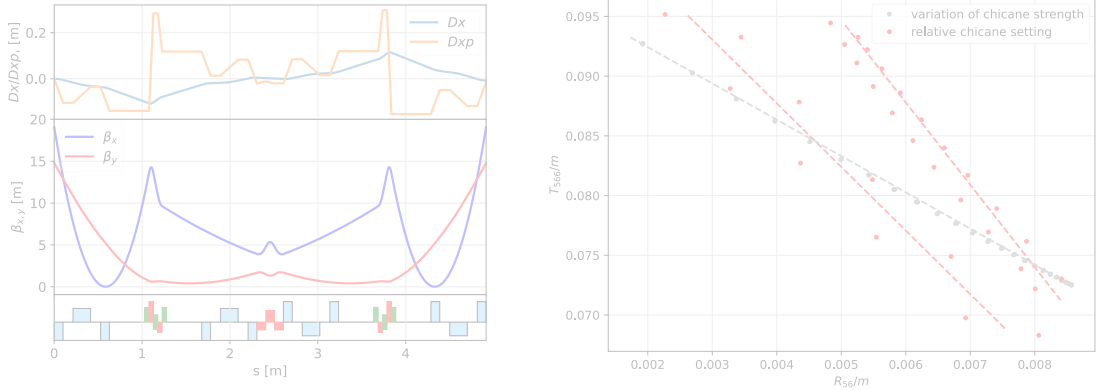
Nonlinear bunch compressors for DALI

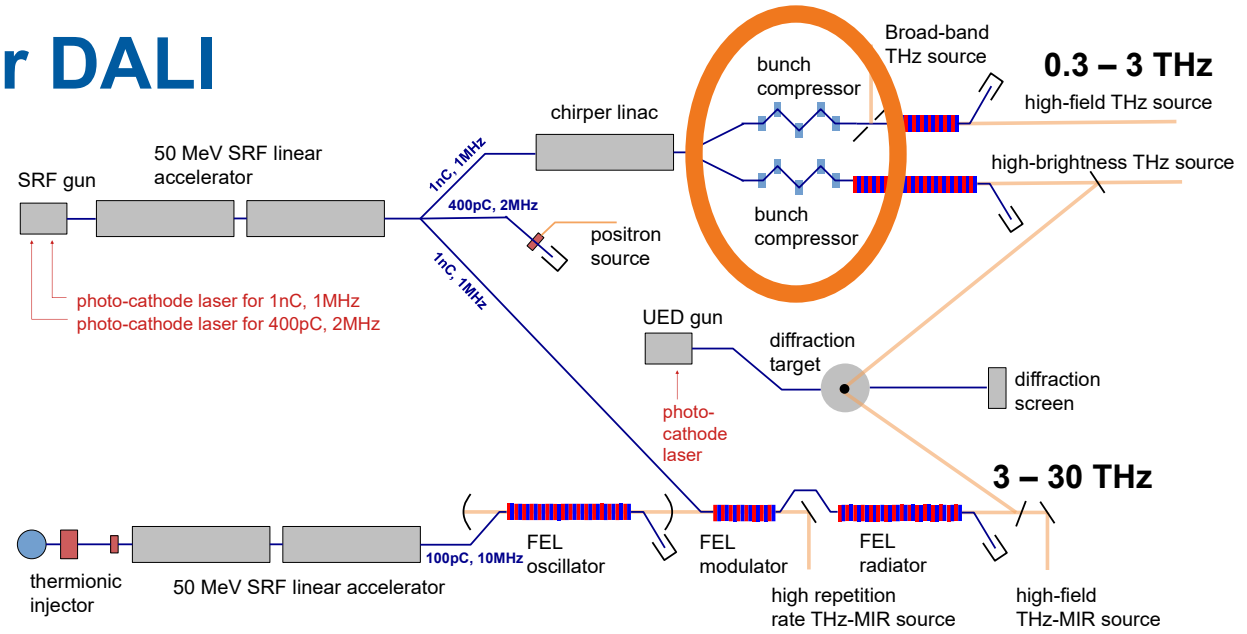
THz sources require short bunches for superradiant emission

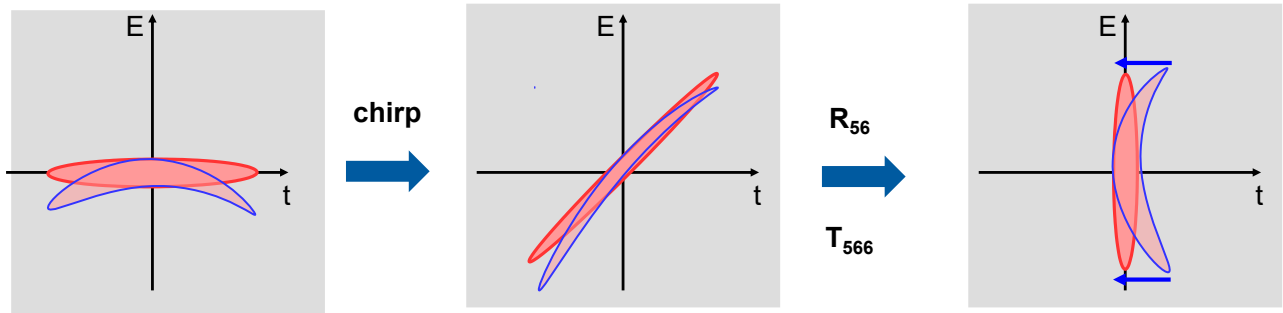
- compression by > 40, possible due to low energy spread of SRF gun
- target pulse duration 70 fs rms

candidate for tunable bunch compressor presented





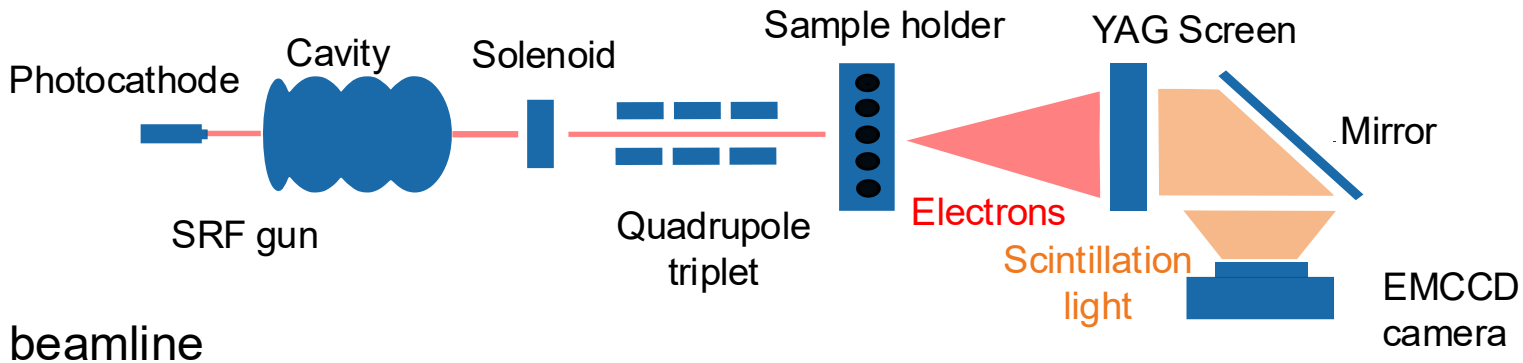




See poster by Arthur Delan on Friday

Ultrafast Electron Scattering

Activities at HZDR & with partners



- DALI
  - **THz** sources
  - **Positron** source
  - **MeV Ultrafast electron scattering** beamline

- Test of ELBE SRF Gun
  - Check performance for UED applications
  - Funding granted, hardware purchase started

- Coordination with user community
  - Bundling efforts with HZB & DESY
  - User workshop at HZB

See poster by Louis Stein Thursday

Thank you.