# Nonlinear bunch compressors for DALI

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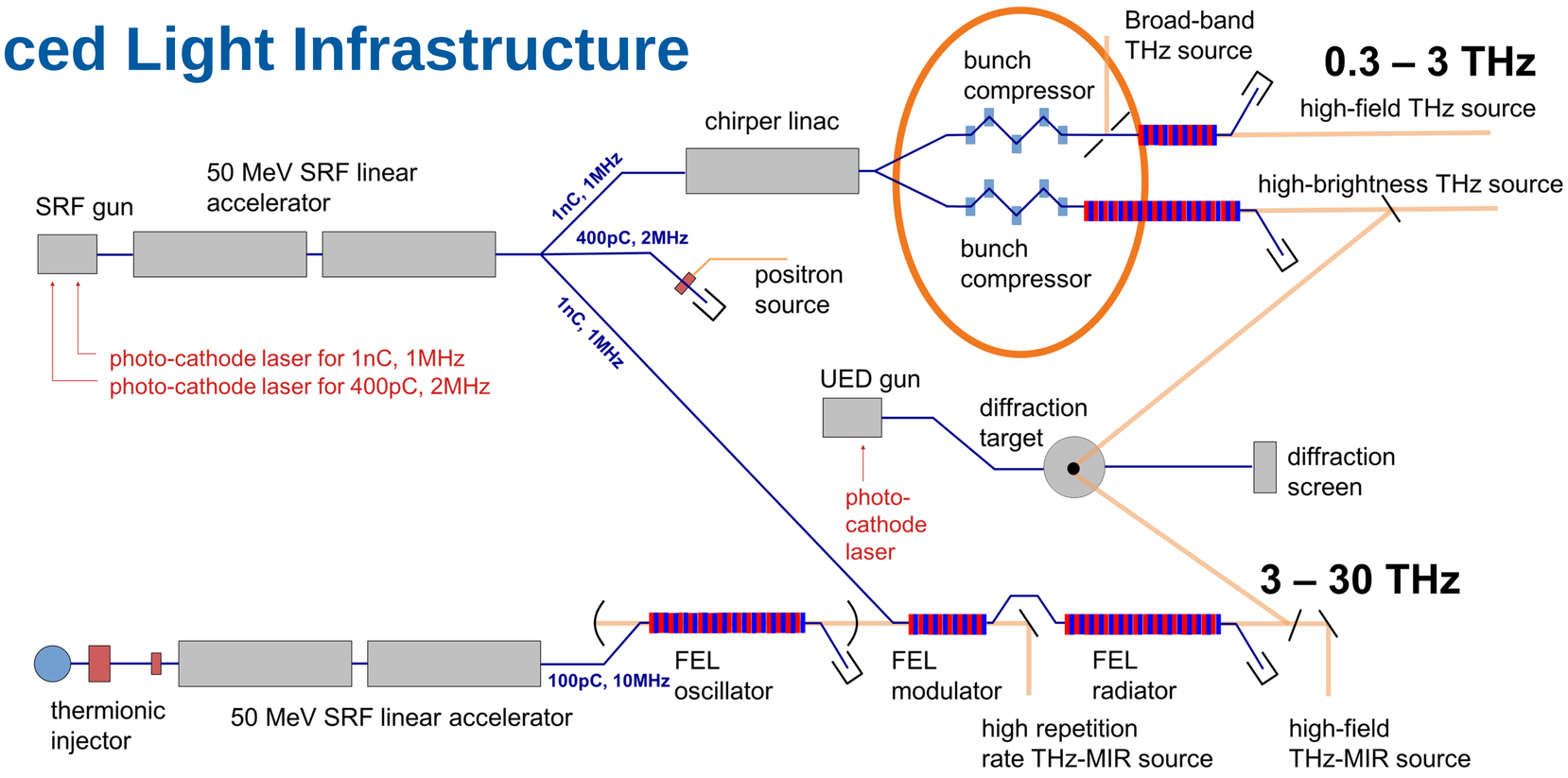
## DALI: Dresden Advanced Light Infrastructure

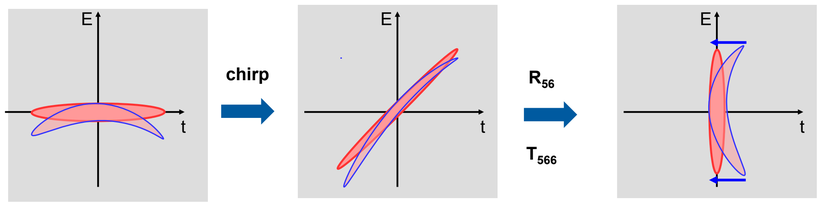
HZDR is planning a successor facility for the ELBE radiation source: DALI, which will include:

- positron source,
- MeV UED instrument,
- optical klystron mid-IR source for 3 to 30 THz, requiring bunch lengths of 10 to 20 wavelengths
- superradiant THz source up to 3 THz

DALI TDR preparations started, construction start scheduled for 2029




## Requirements for compression at superradiant THz source




### Initial beam properties

- Bunch charge: 1 nC
- Slice energy spread: 20 keV
- RMS length: 3 ps

### Acceleration to 50 MeV: Chirp δ 1.7 to 2.5 %

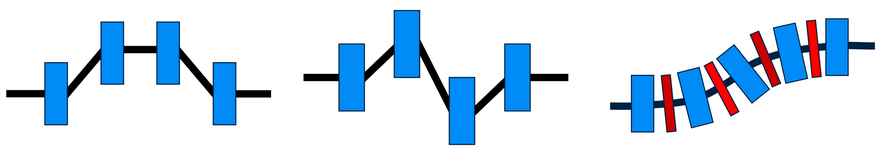
### At superradiant light source

- 70 fs/20 µm RMS length

➢ Compression factor above 40
➢ $|R_{56}| \approx 5$ cm, $T_{566}$ same sign
➢ Consider multistage compression & magnetic compensation of energy non-linearities

### Utilize relative sign of $R_{56}$ & $T_{566}$:

- Chicane: opposite sign
- Arc-like: same sign
- Effects of quadrupoles and higher order magnets

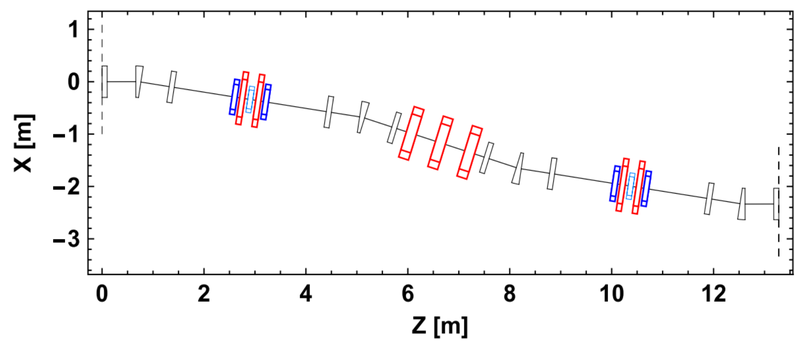


## A tunable compressor option

**Flexibility to match curvature caused by chirp and other sources**

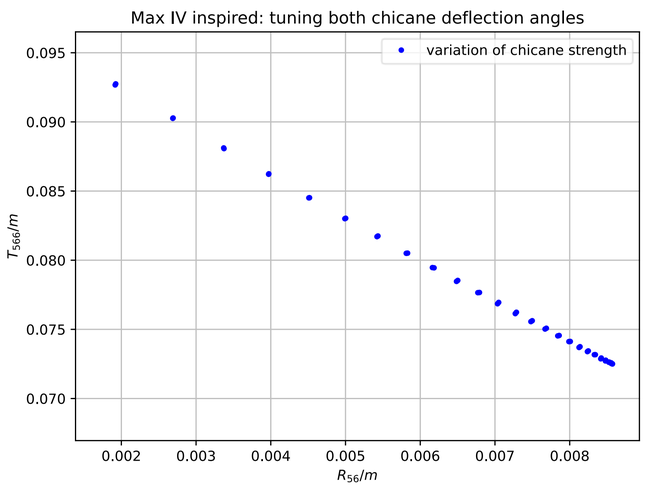
Max IV bunch compressor:

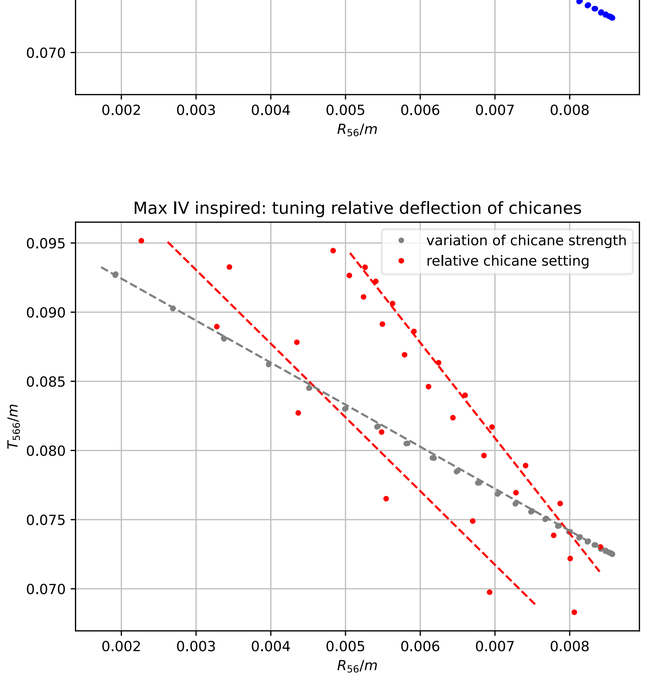
- highly tunable
- studies on adaptation for DALI are ongoing

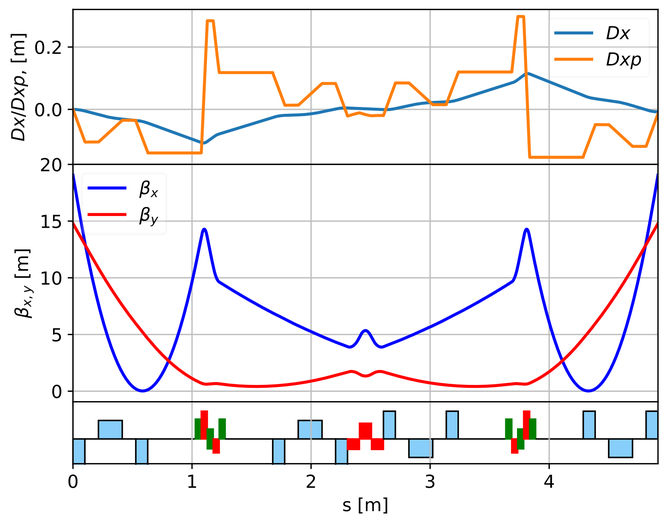



Max IV layout of the inter storage ring bunch compressor
black: dipoles, red: quadrupoles

DOI: 10.1103/PhysRevAccelBeams.23.100701




Right: beam optics of DALI design candidate inspired by Max IV

Left: achromatic tuning range using two degrees of freedom

Even without sextupoles the ratio of $R_{56}$ and $T_{566}$ is tunable using 3 degrees of freedom: 2 chicanes and a high dispersion quadrupole

Simulations show required $T_{566}$ and $R_{56}$ are of same sign regardless of sign of chirp

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