

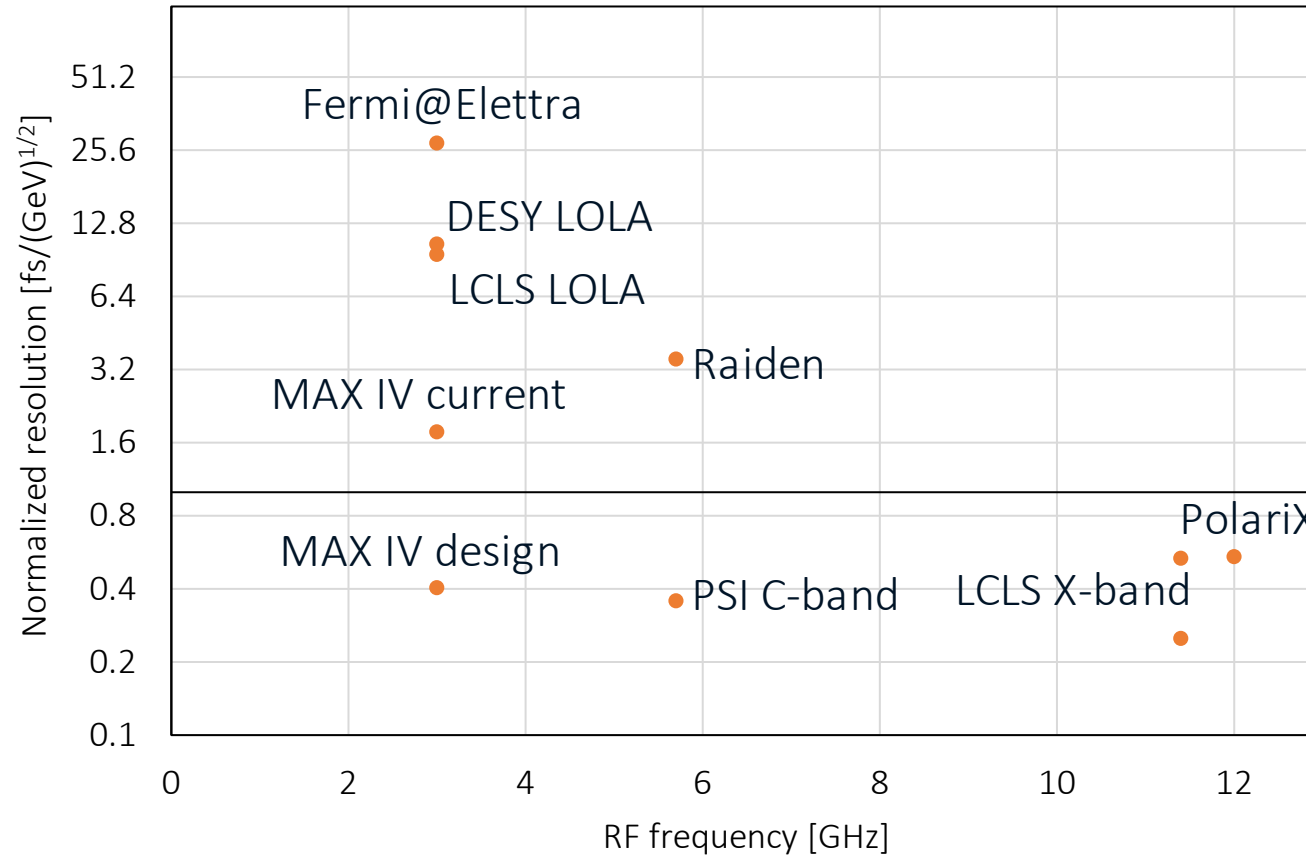
The MAX IV transverse deflecting cavity

IBIC – September 2023

Erik Mansten

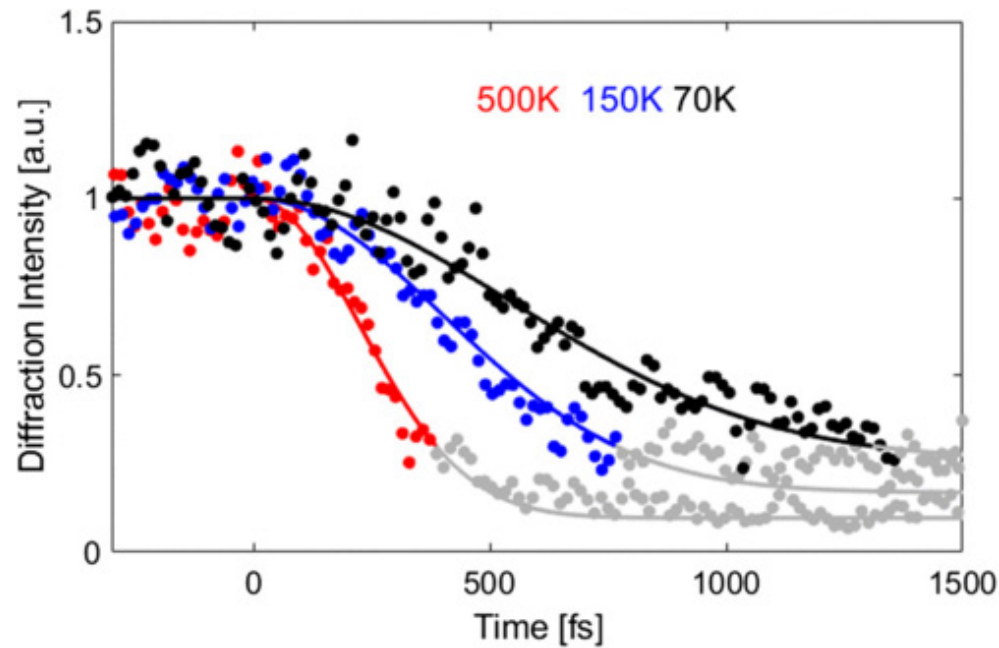
Context – connection to previous work

RF driven deflector performance overview

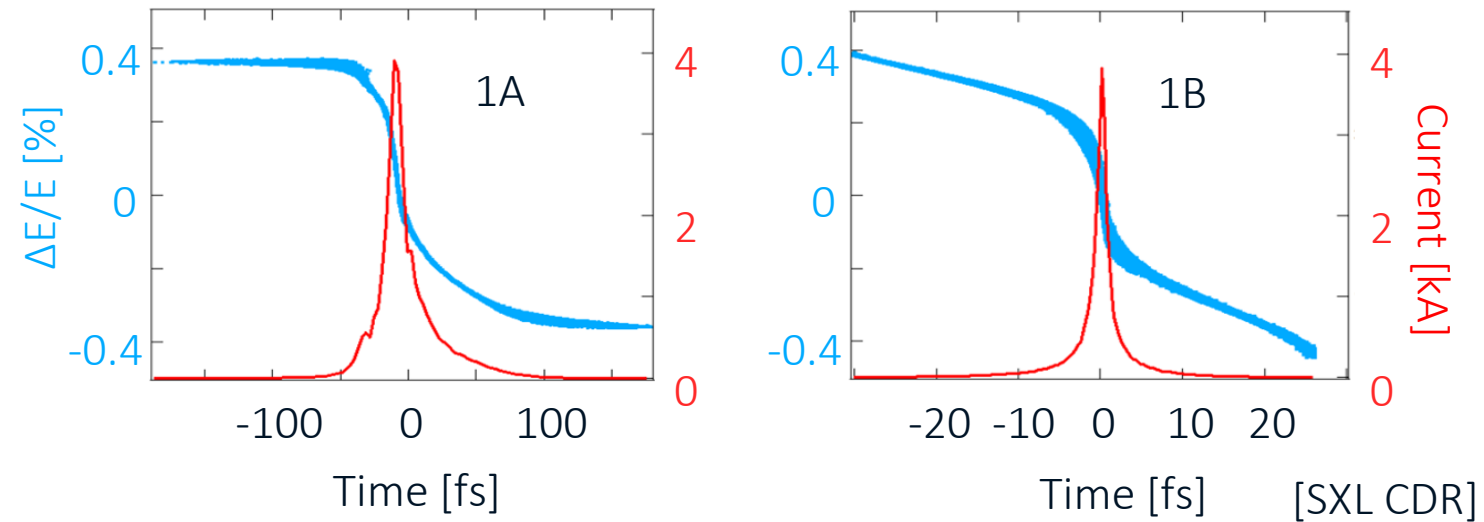


Motivation – longitudinal dia. @ MAX IV

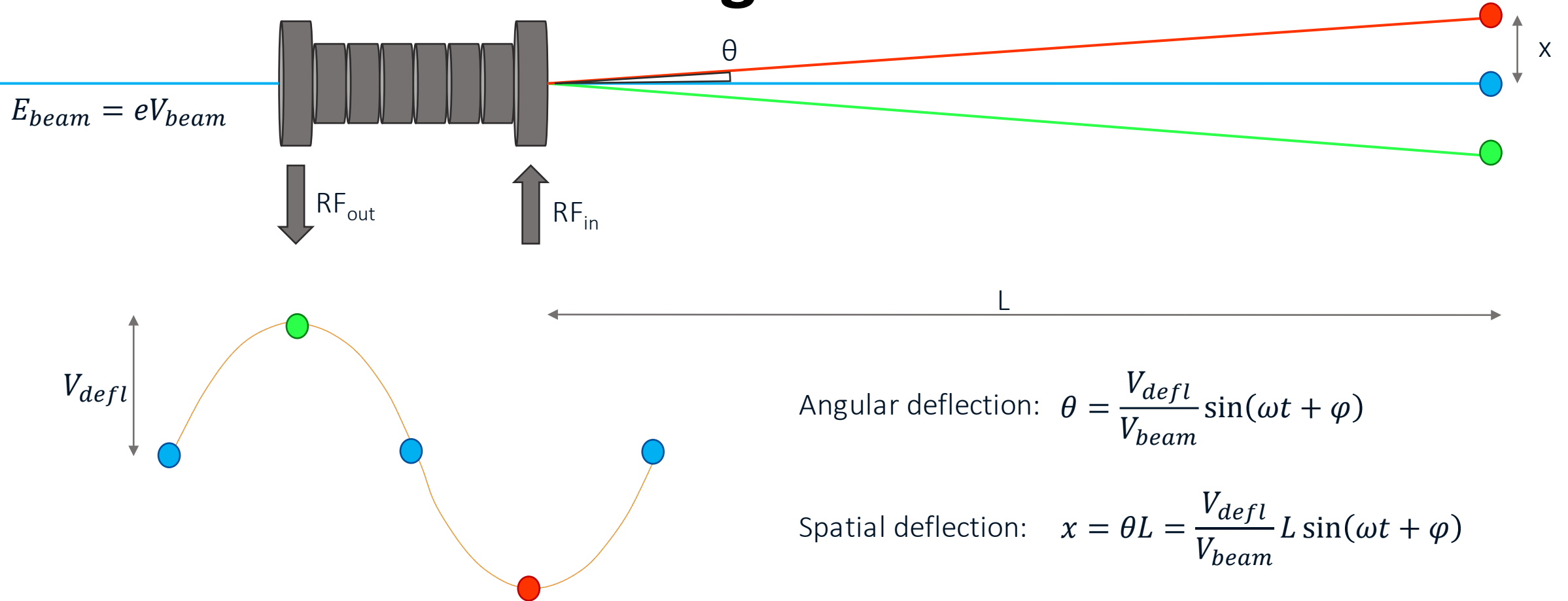
Femtomax pump-probe results



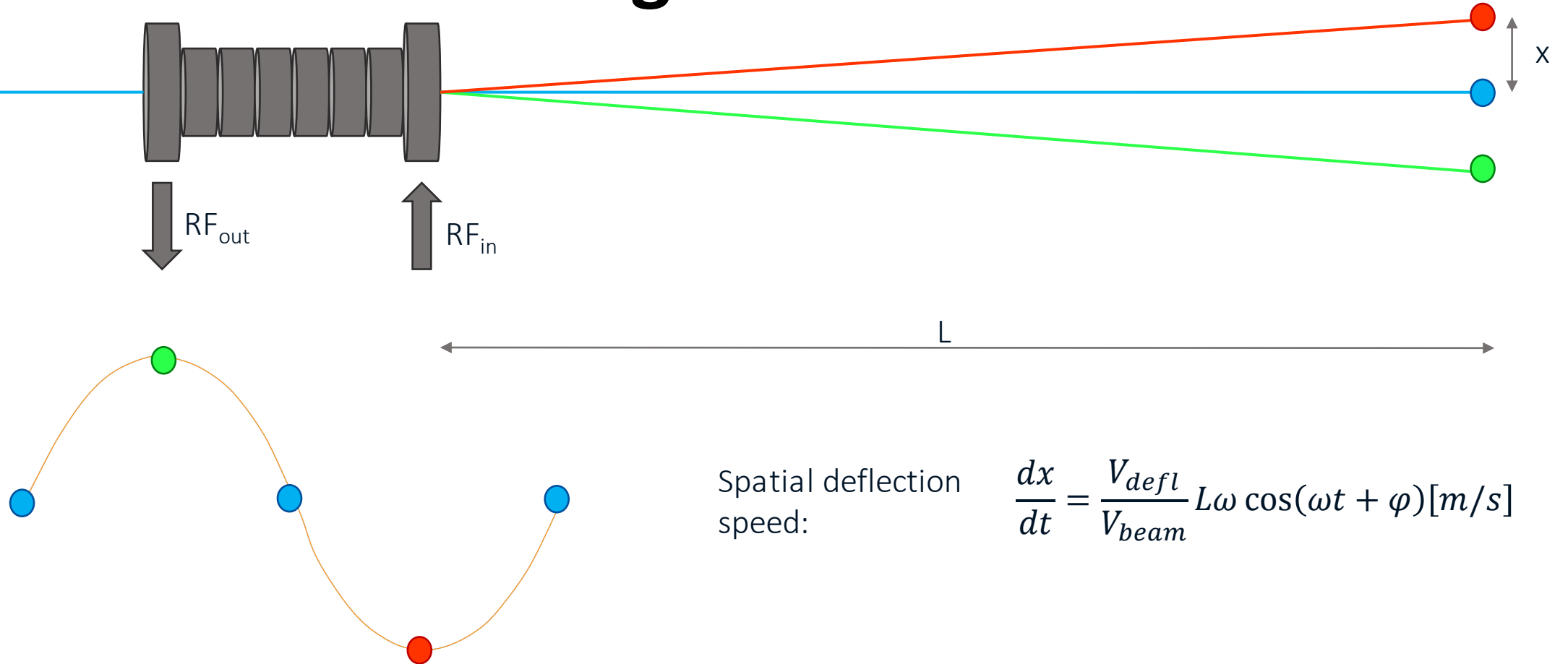
Soft X-ray Laser at MAX IV



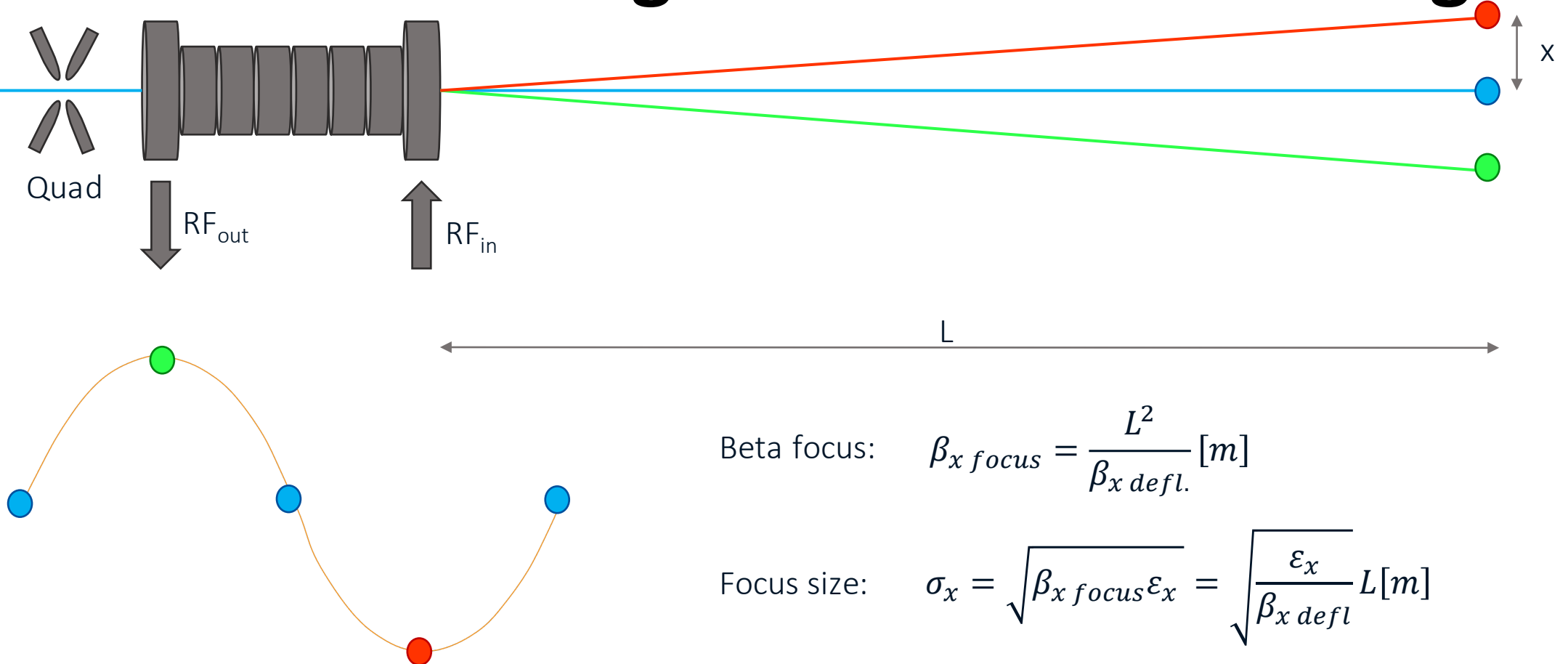
RF deflectors for longitudinal dia. – kick



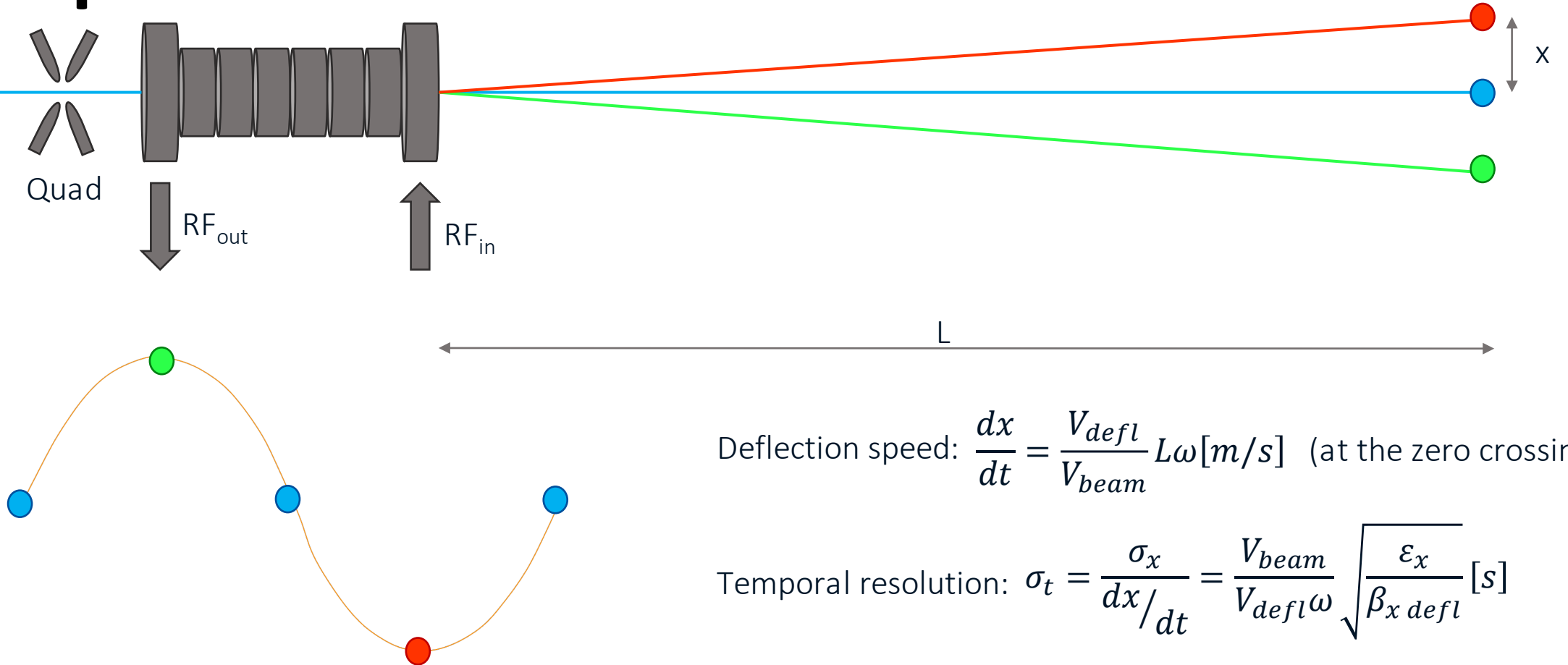
RF deflectors for longitudinal dia. – streak



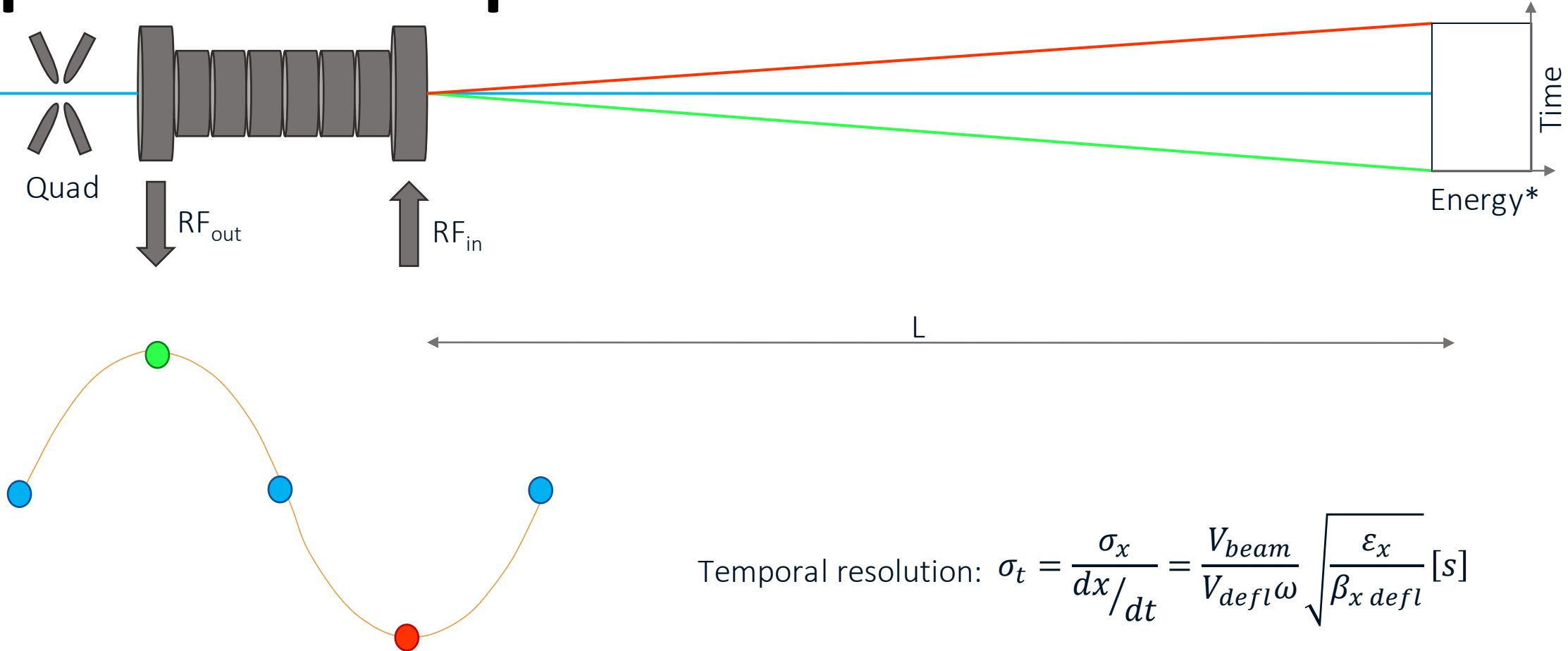
RF deflectors for longitudinal dia. – focusing



Temporal resolution



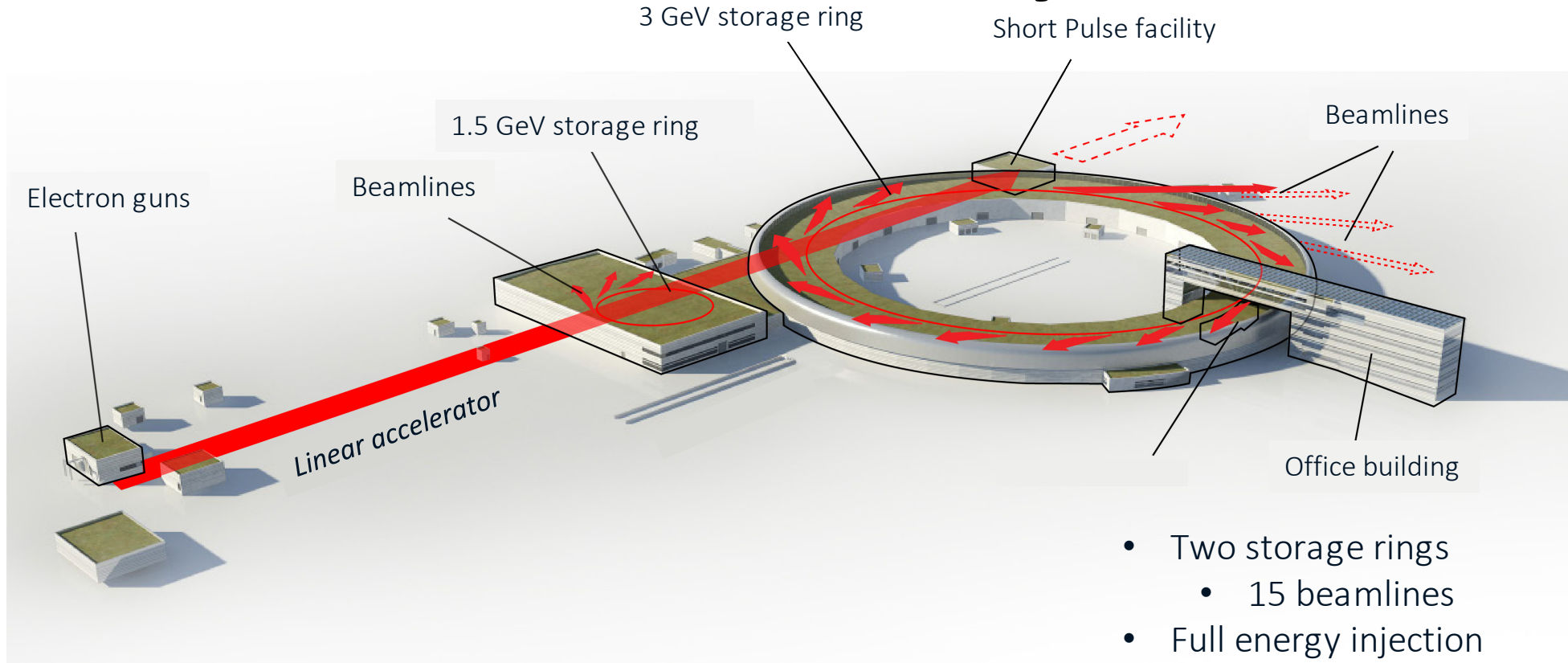
Experimental implementation



Temporal resolution:
$$\sigma_t = \frac{\sigma_x}{dx/dt} = \frac{V_{beam}}{V_{defl}\omega} \sqrt{\frac{\epsilon_x}{\beta_{x defl}}} [s]$$

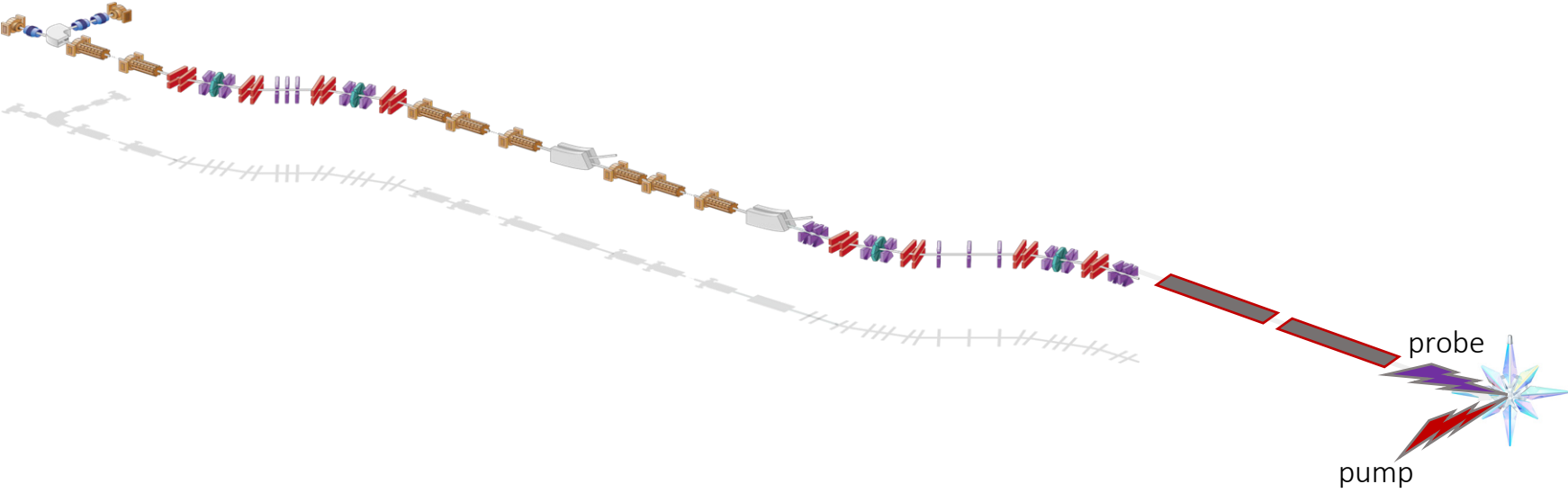
*Requires a spectrometer dipole

Introduction – MAX IV facility



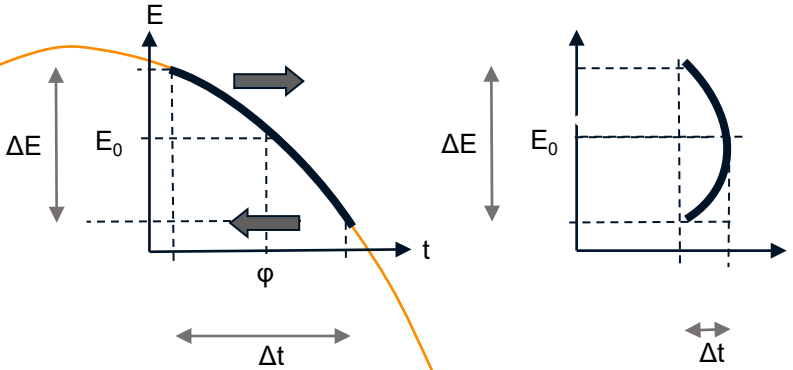
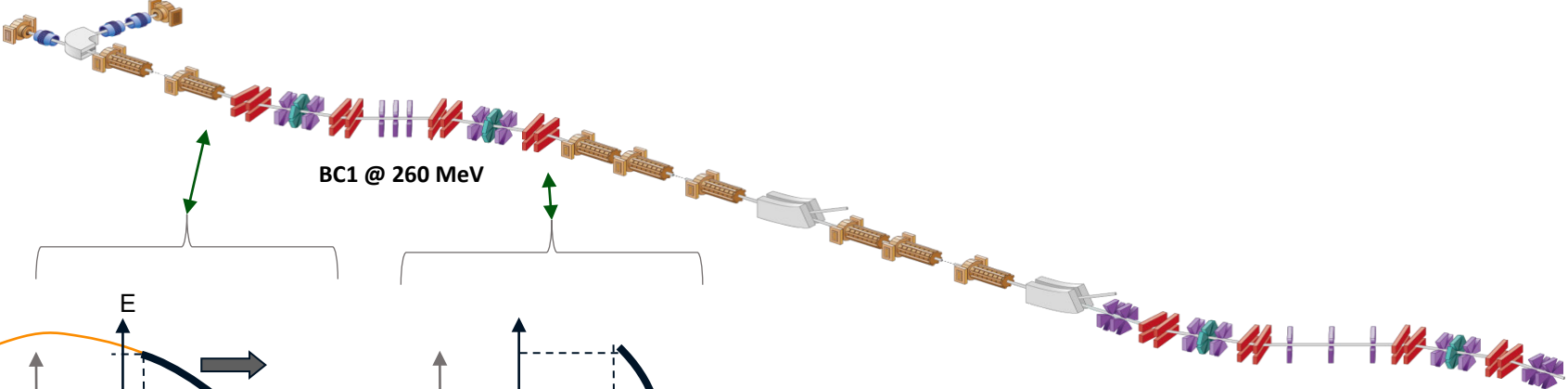
- Two storage rings
 - 15 beamlines
- Full energy injection
- Top-up
- Short Pulse Facility
 - Femtomax beamline

The MAX IV linear accelerator



Compression and linearization

Photo cathode
RF gun

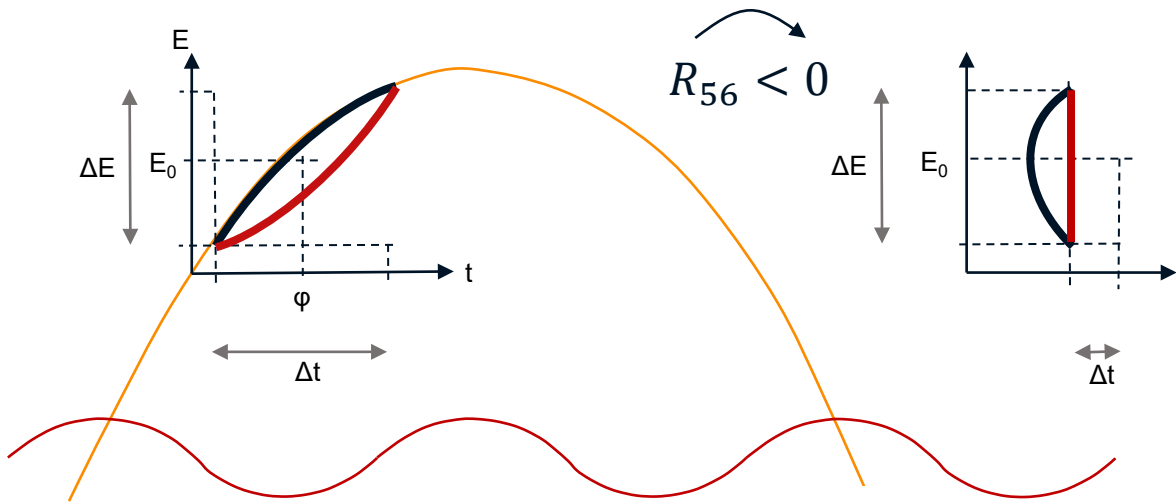


$$\Delta z = R_{56} \left(\frac{\Delta E}{E} \right)$$

BC2 @ 3 GeV

SPF

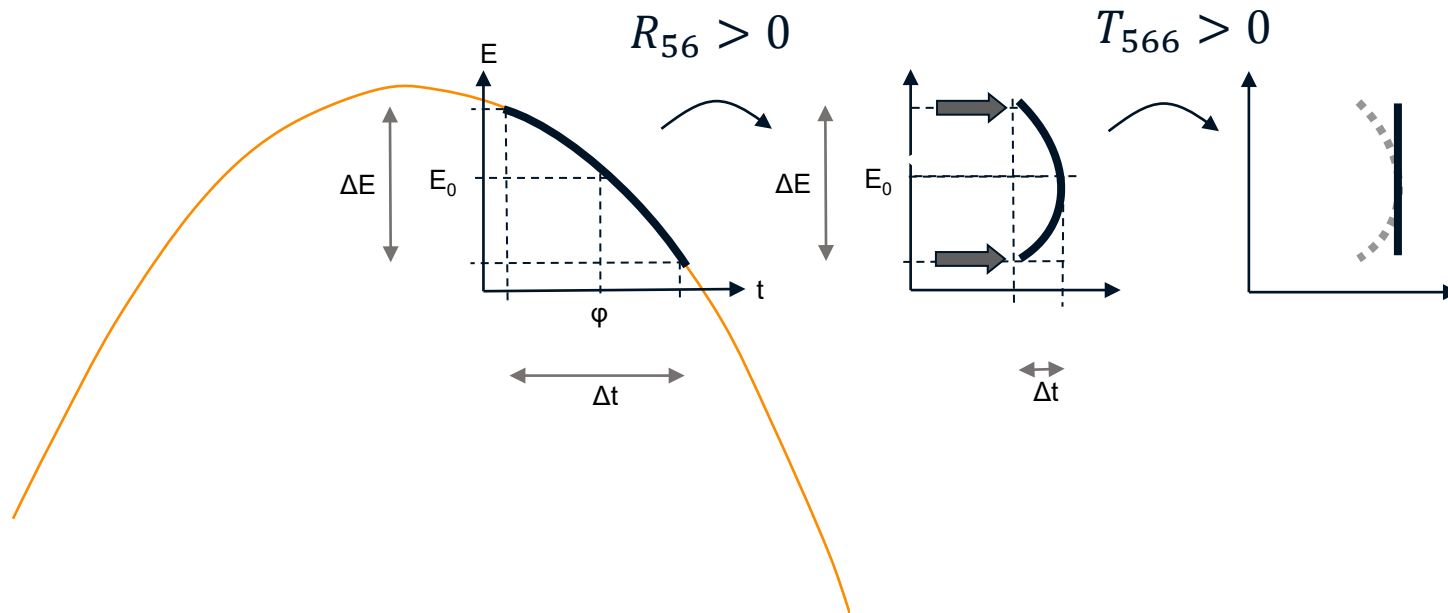
Arc and chicane type compressors



Chicane type bunch compression

- $R_{56} < 0$
- Pre crest acceleration
- $T_{566} > 0$
- Linearize with harmonic cavity
- Harmonic non-linearized tuning

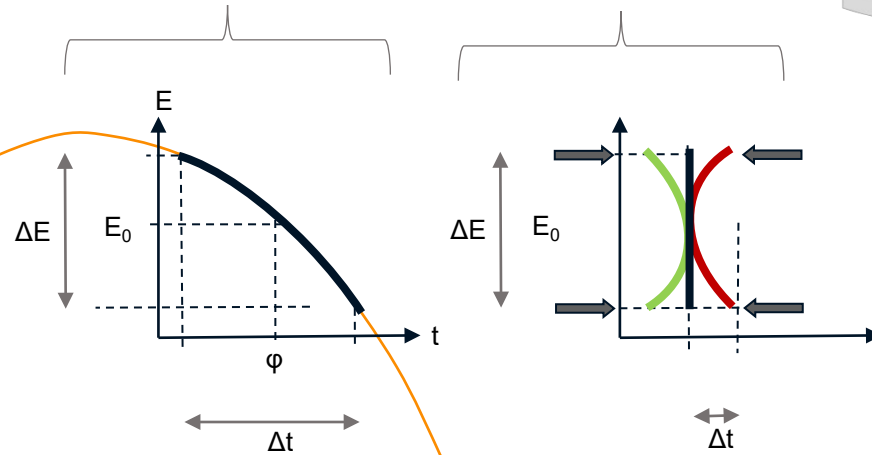
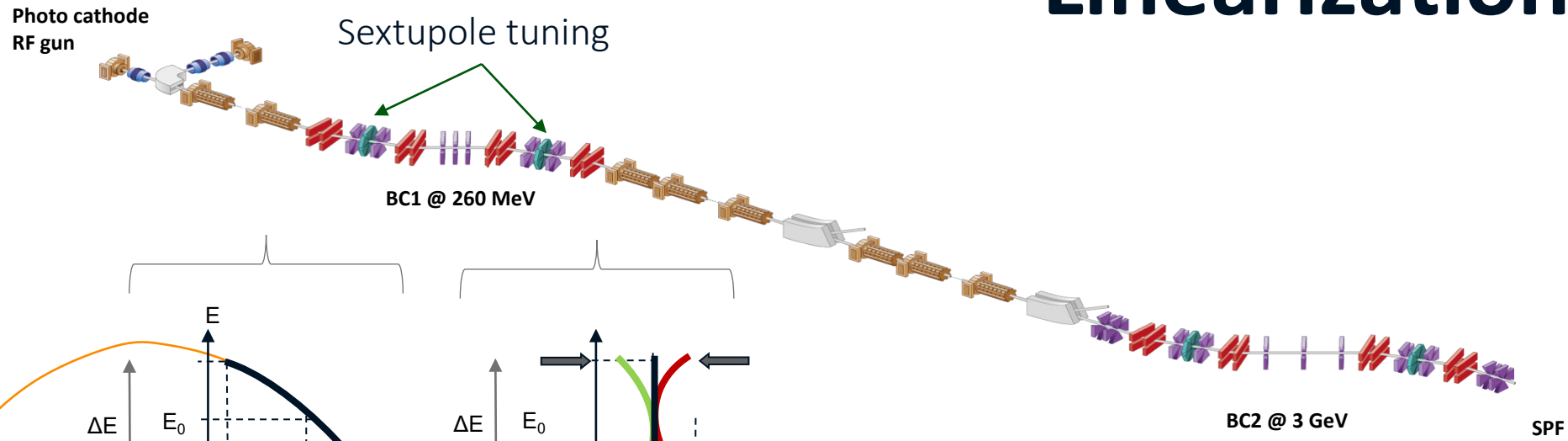
$$\Delta z = R_{56} \left(\frac{\Delta E}{E} \right) + T_{566} \left(\frac{\Delta E}{E} \right)^2$$



Arc type bunch compressor

- $R_{56} > 0$
- Post crest acceleration
- $T_{566} > 0$
- Magnetic linearization
- Magnetic non-linear tuning

Linearization tuning



$$\Delta z = R_{56} \left(\frac{\Delta E}{E} \right) + T_{566} \left(\frac{\Delta E}{E} \right)^2$$

Arc type bunch compressor

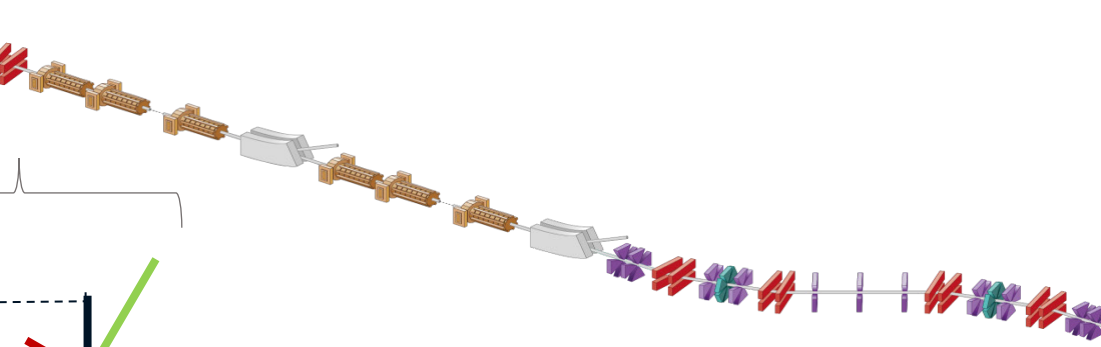
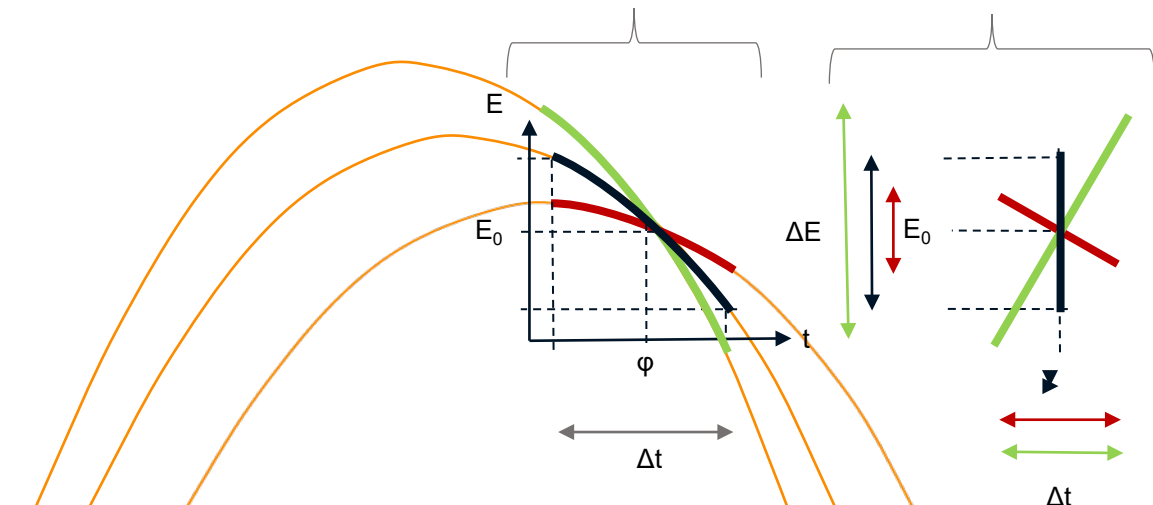
- $R_{56} > 0$
- Post crest acceleration
- $T_{566} > 0$
- Magnetic linearization
- Magnetic non-linear tuning

Compression tuning

Photo cathode
RF gun



BC1 @ 260 MeV



BC2 @ 3 GeV

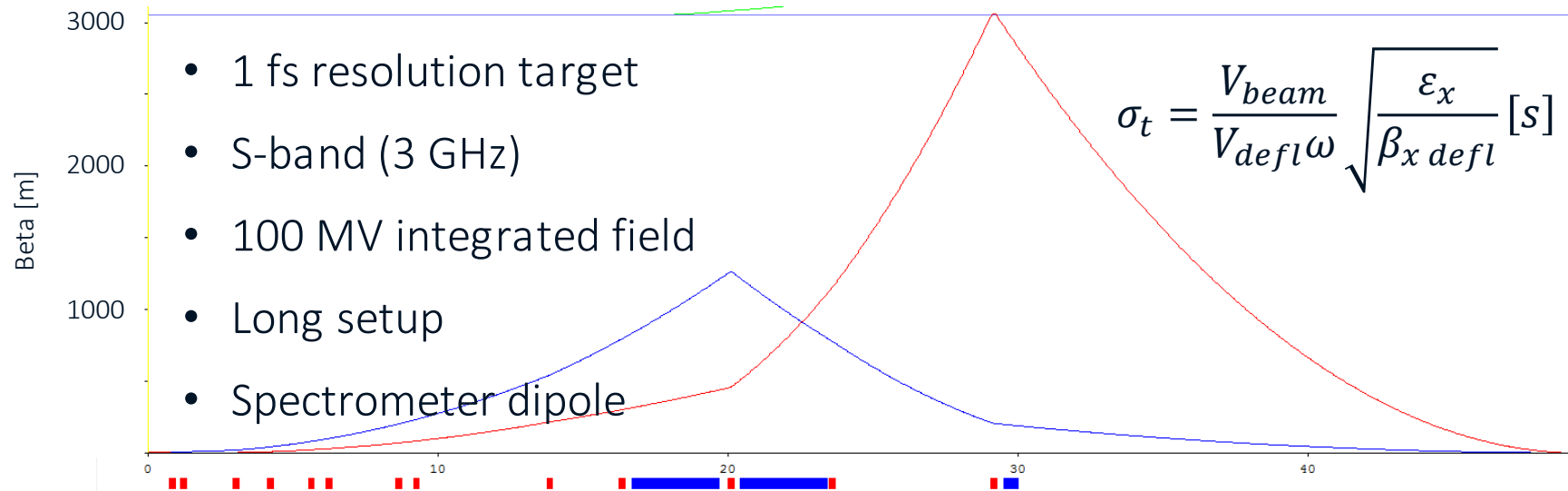
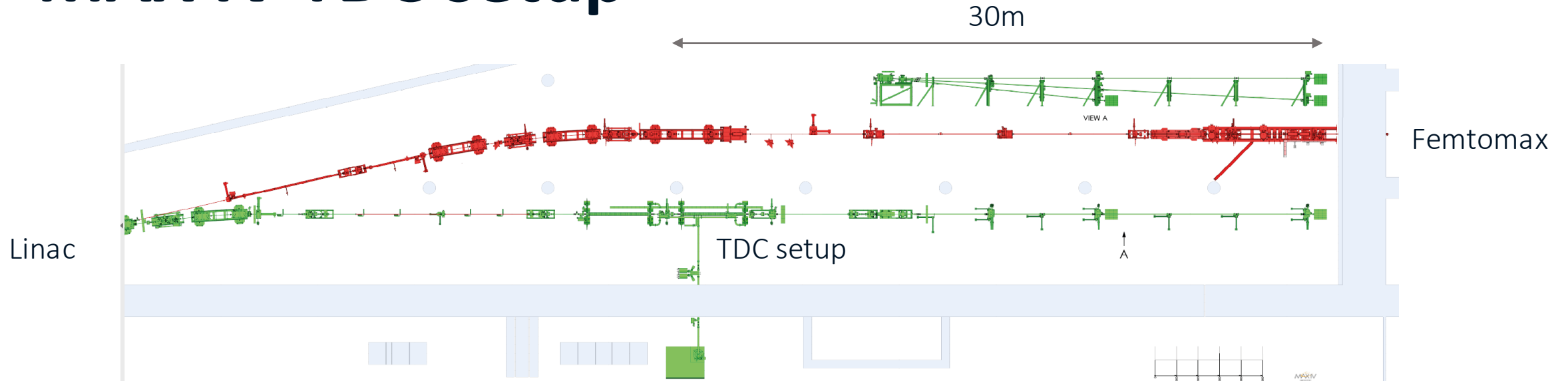
SPF

$$\Delta z = R_{56} \left(\frac{\Delta E}{E} \right) + T_{566} \left(\frac{\Delta E}{E} \right)^2$$

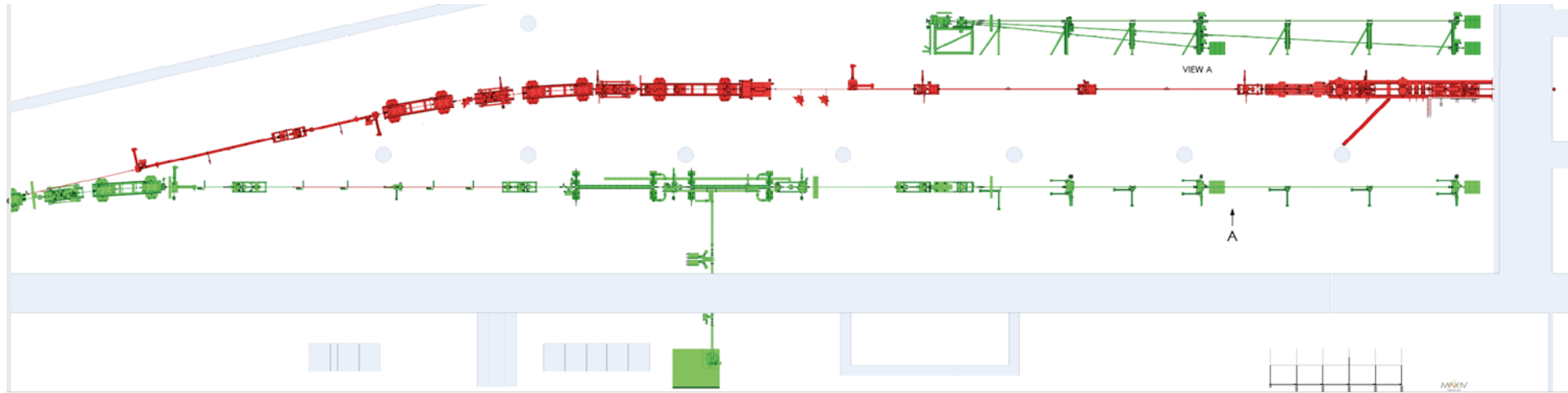
Arc type bunch compressor

- $R_{56} > 0$
- Post crest acceleration
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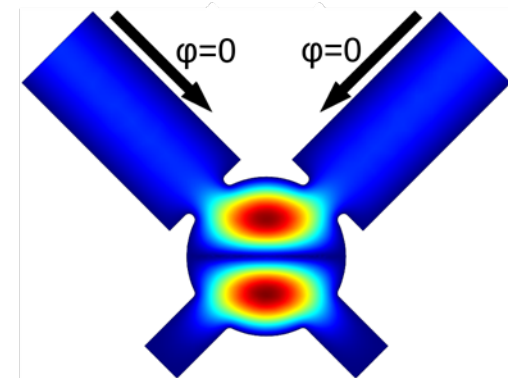
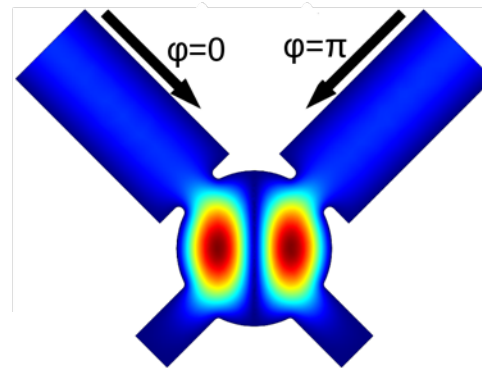
MAX IV TDC setup



RF design

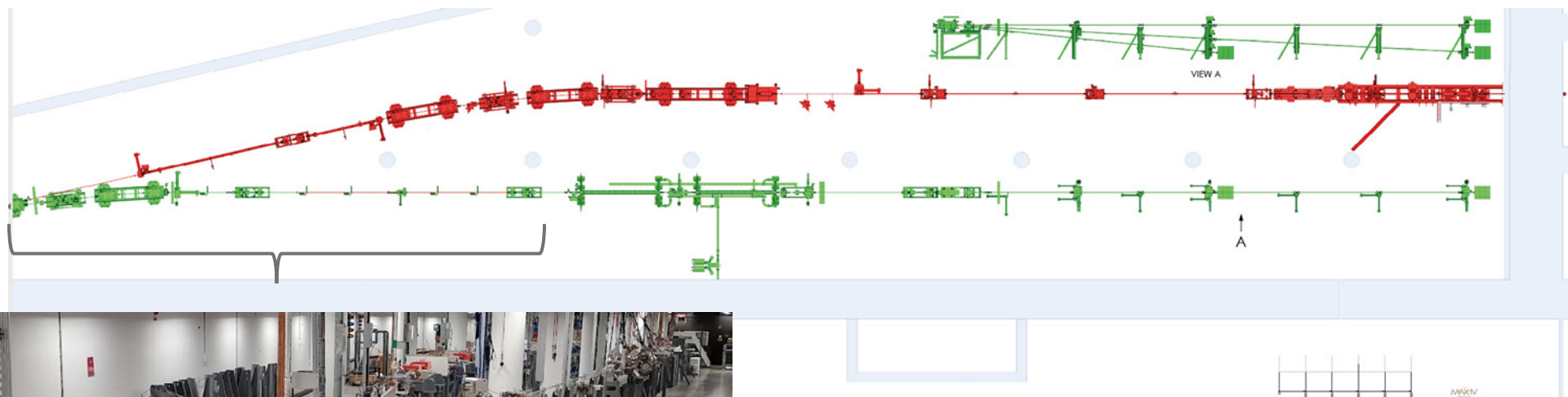


- Scandinova K2 modulator
- SLED RF pulse compressor
- 2 x 3m structures
- Switchable polarization
(phase II)

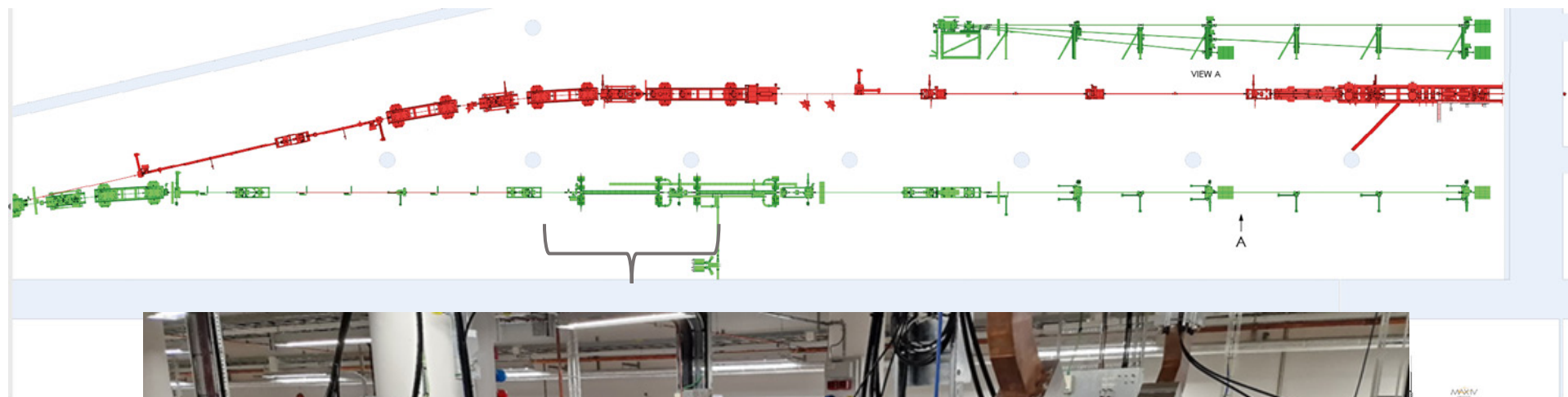


Electric field in the TM_{110} mode

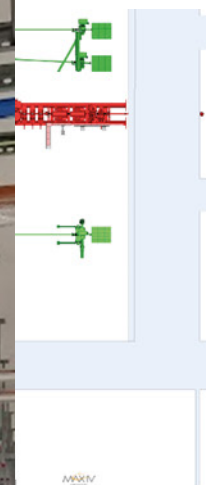
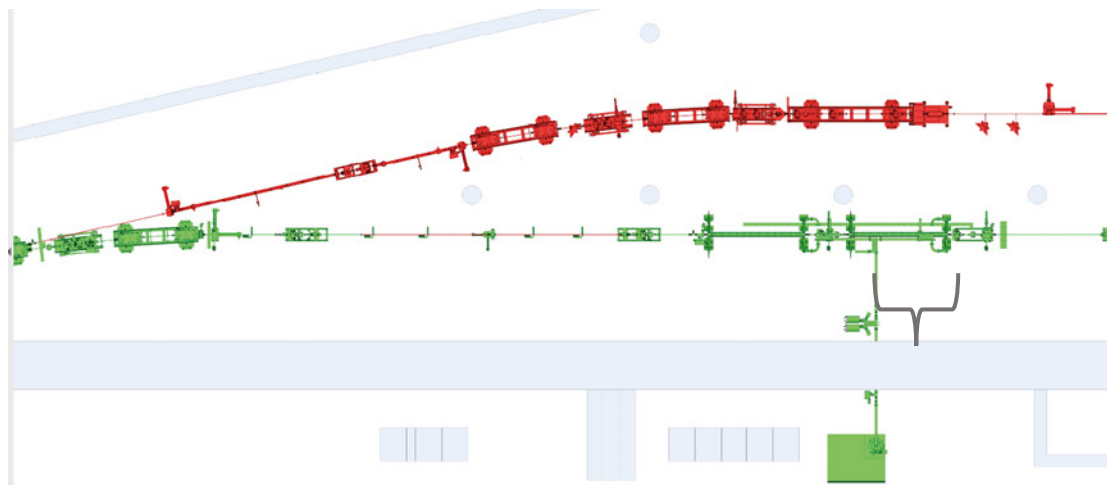
Installation



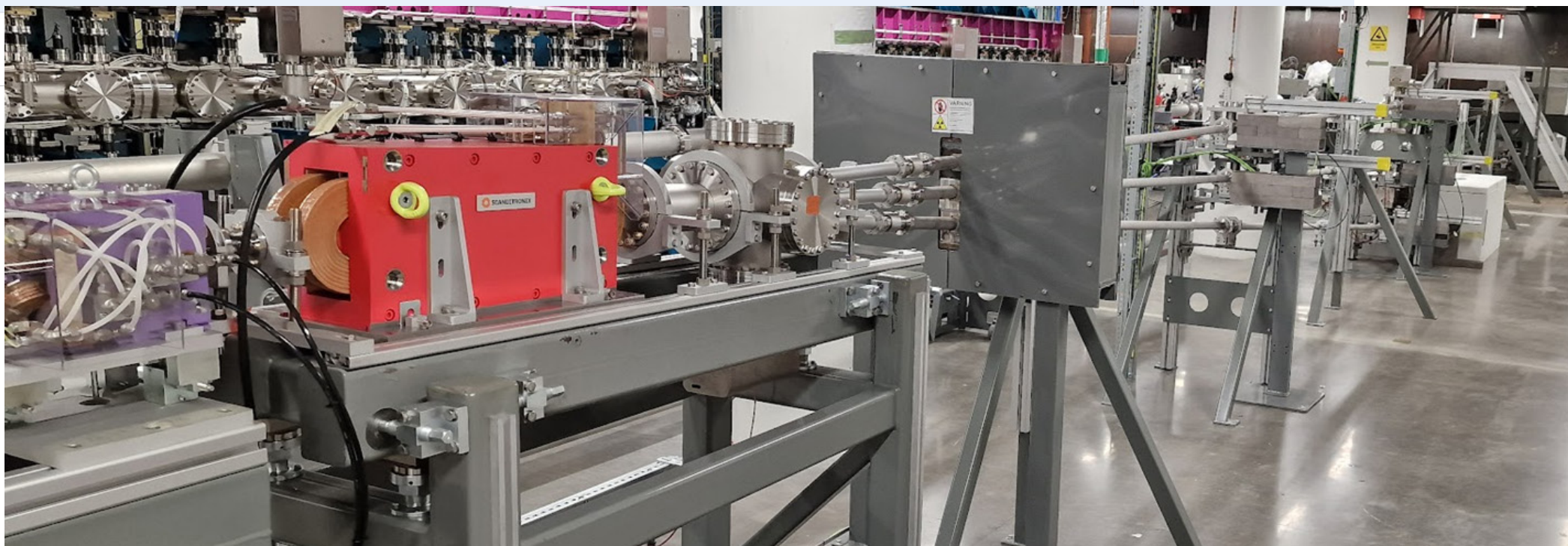
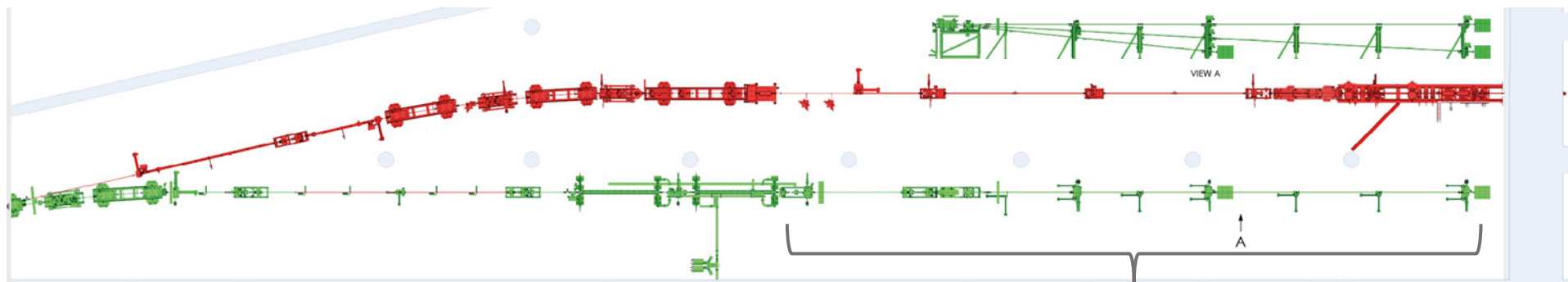
Installation



Installation



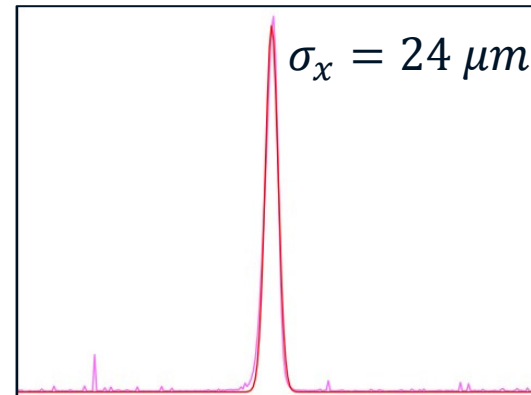
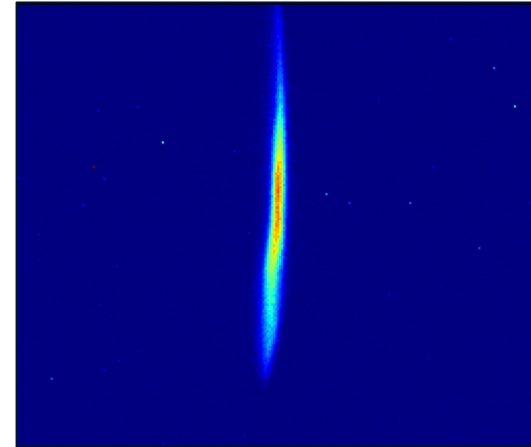
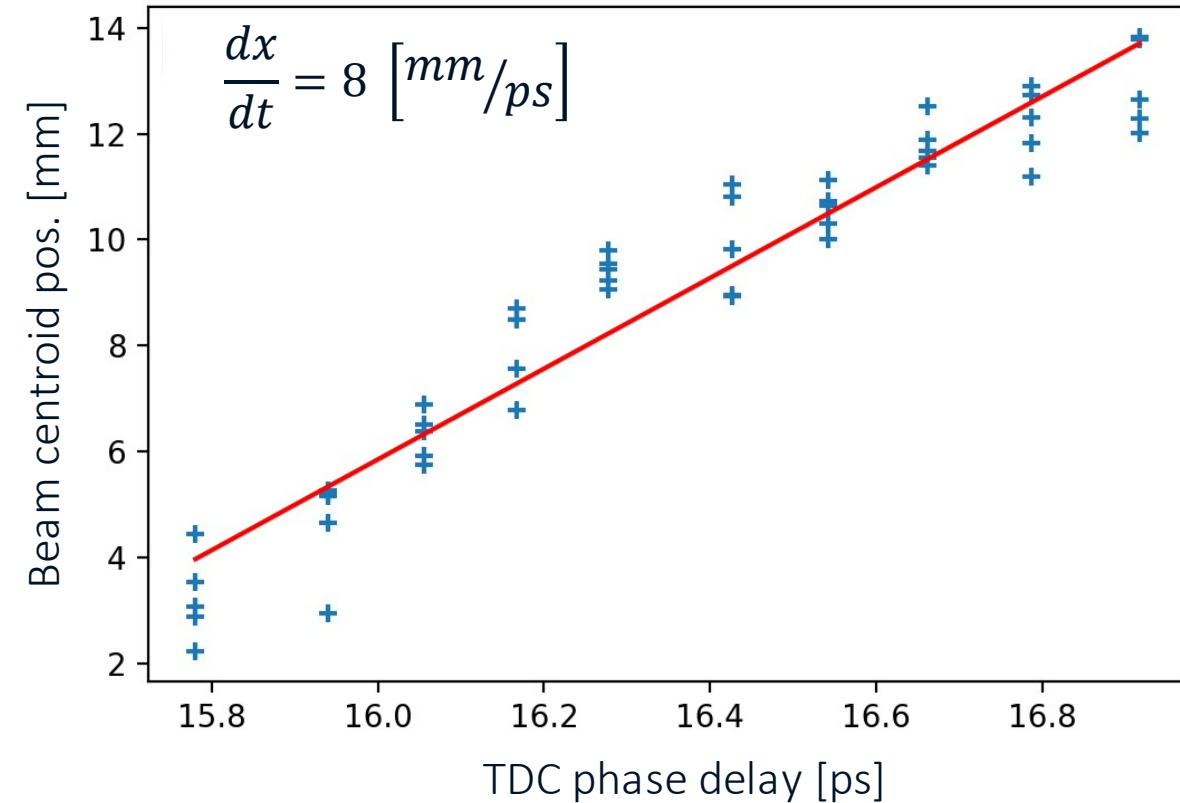
Installation



Beam commissioning results

- Temporal resolution measurement
- Compression scans
- Linearization scans

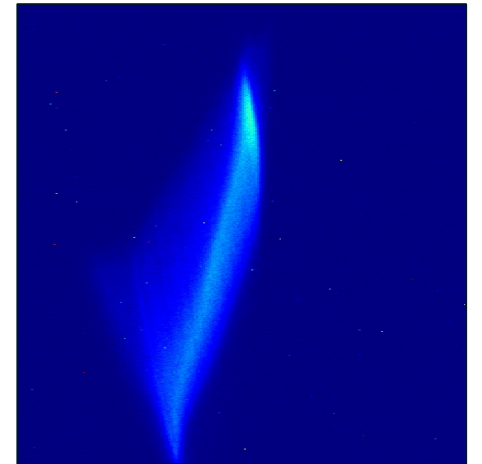
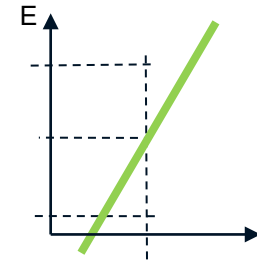
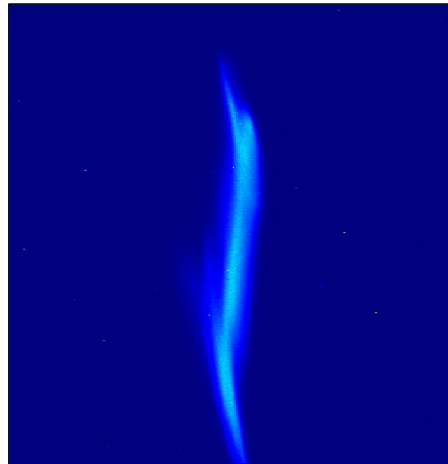
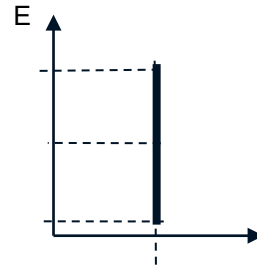
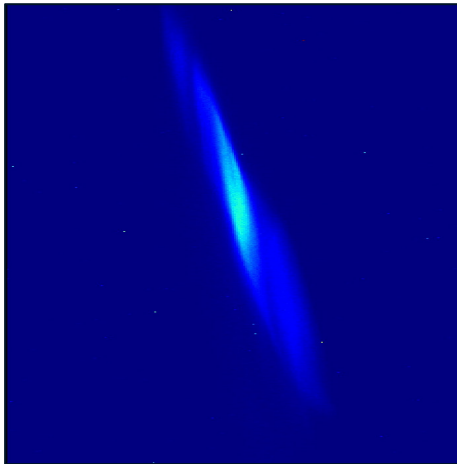
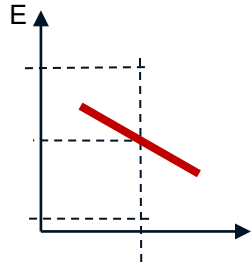
Temporal resolution



$$\sigma_t = \frac{\sigma_x}{dx/dt}$$
$$= 3 \text{ fs}$$

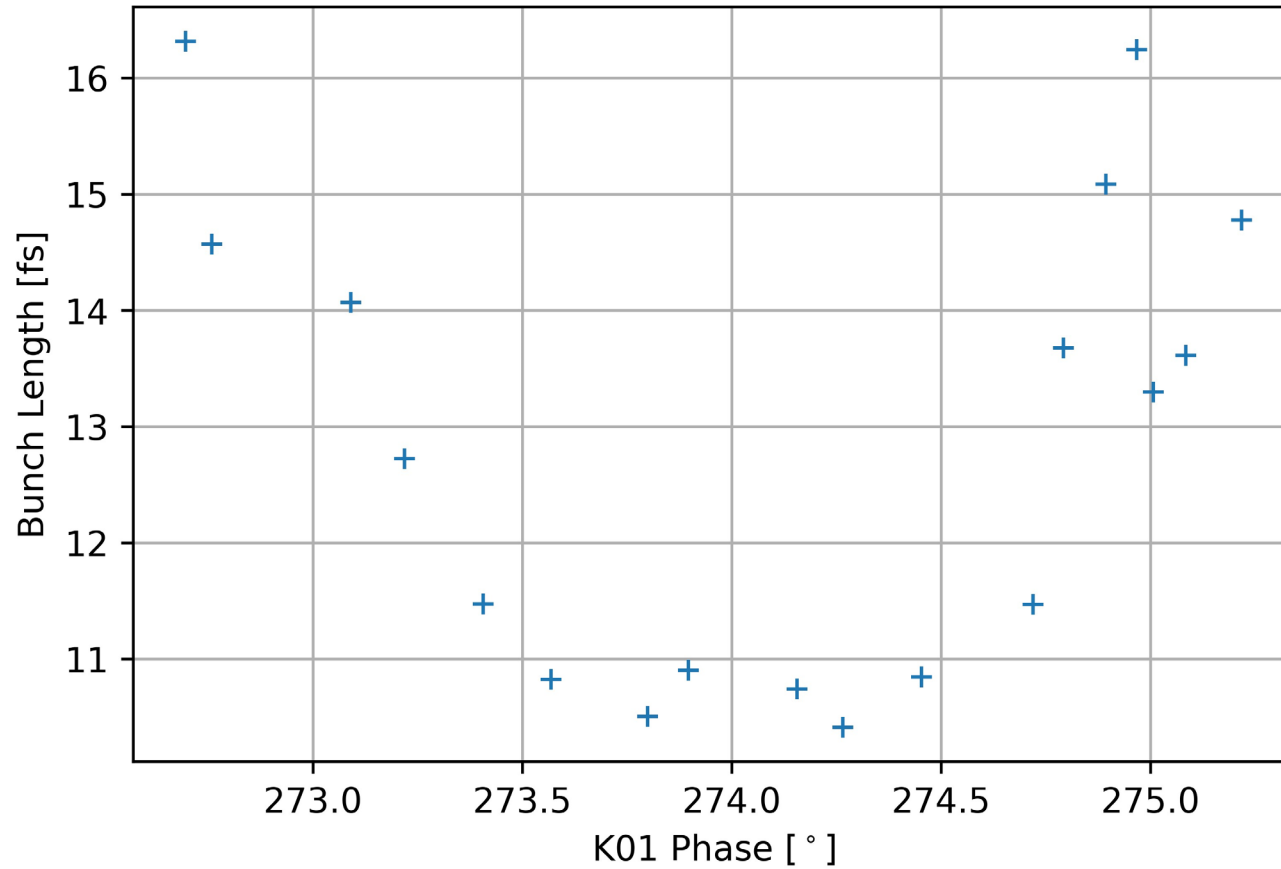
Johan Lundquist

Compression scan



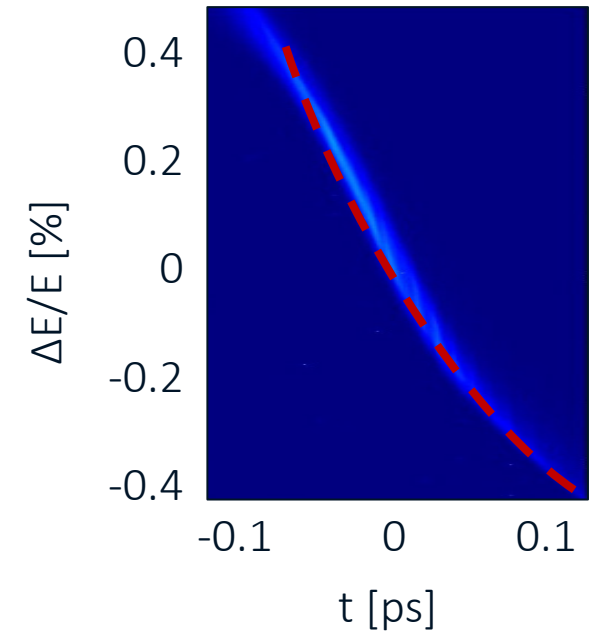
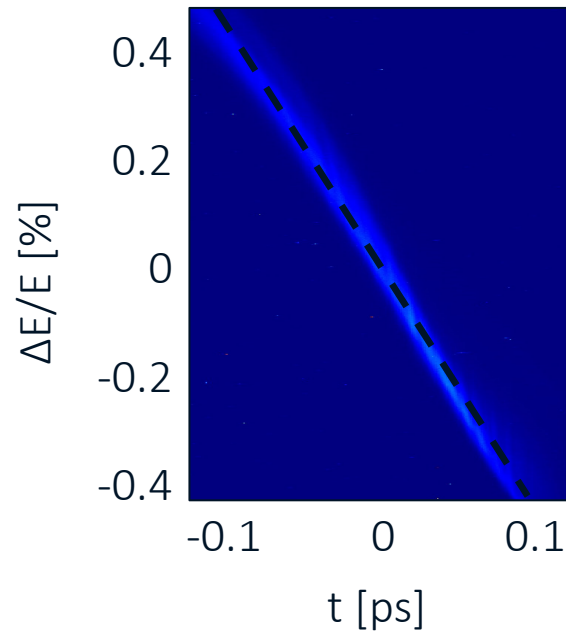
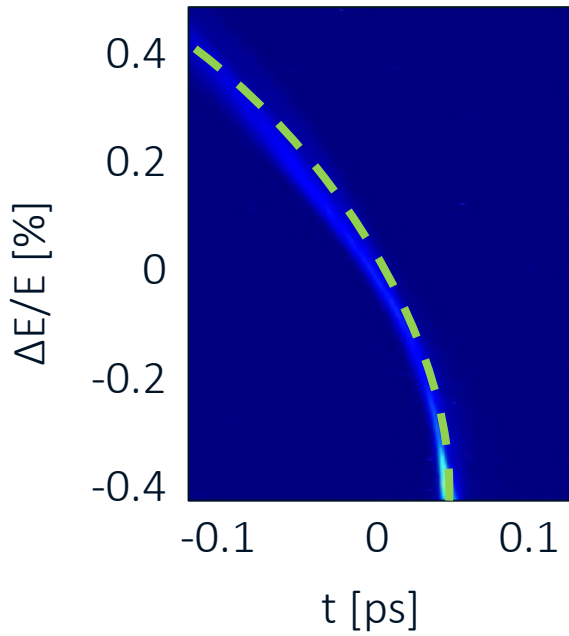
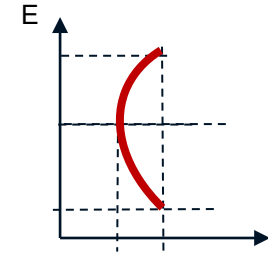
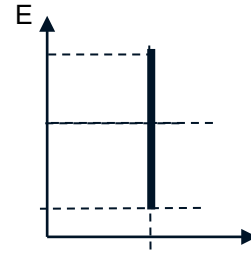
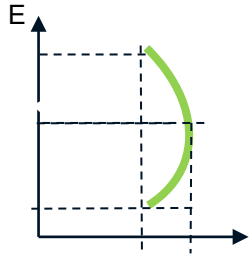
Johan Lundquist

Compression scan

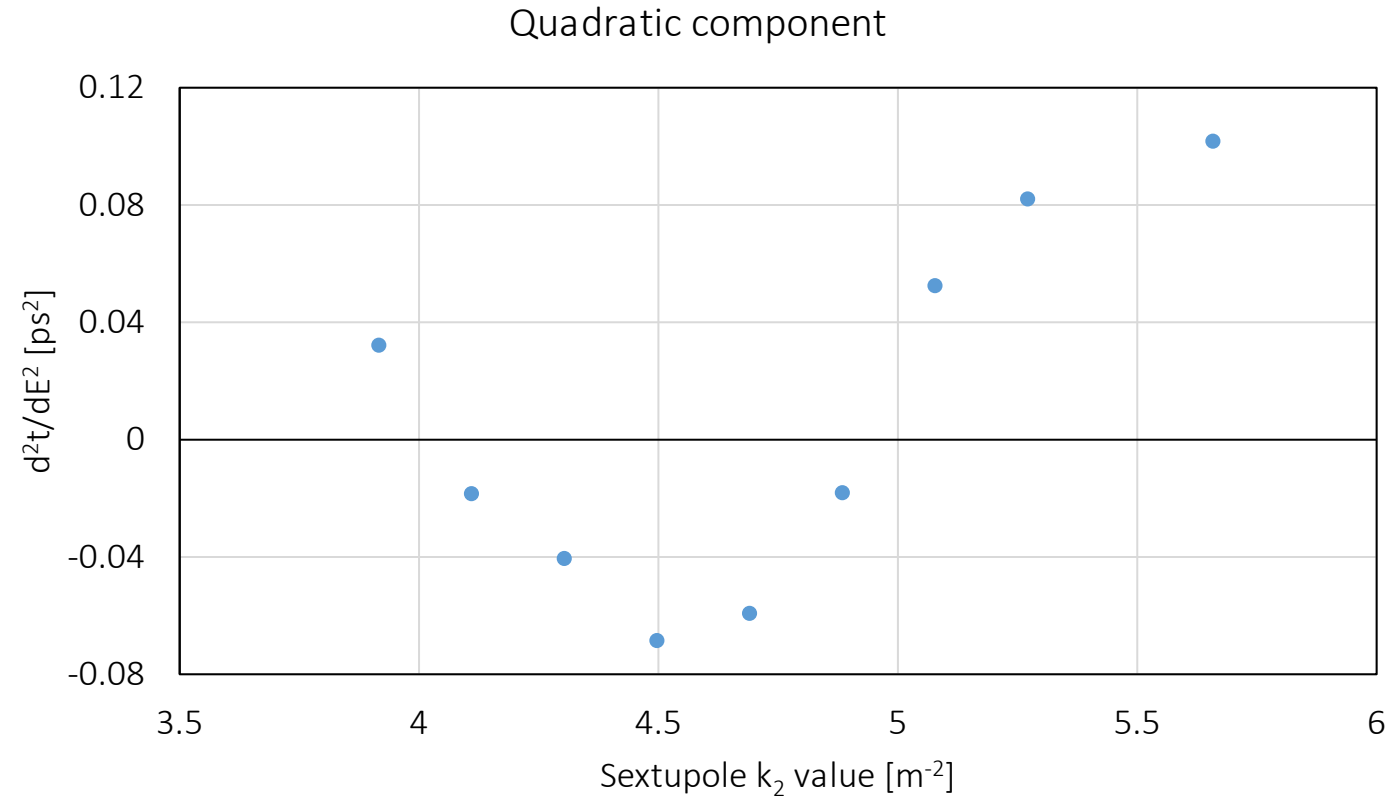


Johan Lundquist

Linearization scan



Linearization scan



Johan Lundquist

TDC challenges and outlook

- 3 fs \rightarrow < 1 fs
 - Current streak 8 mm/ps
 - Target 30 mm/ps
 - Increase RF power
 - Bakout
 - SLED tuning
 - Current unstreaked beam focus 55 μm (FWHM)
 - Target below 30 μm
- Slice Twiss parameter scans
- Phase shifter to turn polarization

