Status of the THz-Streaking Experiment with Split Ring Resonators at FLUTE

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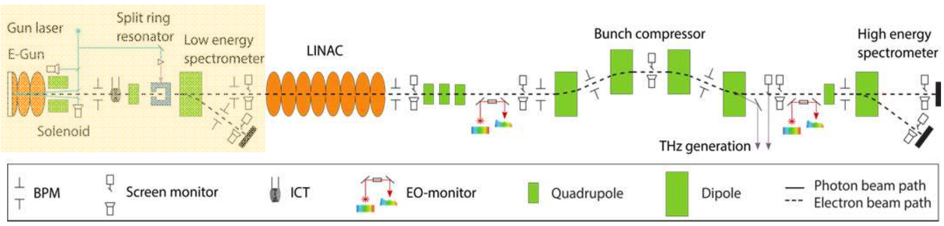
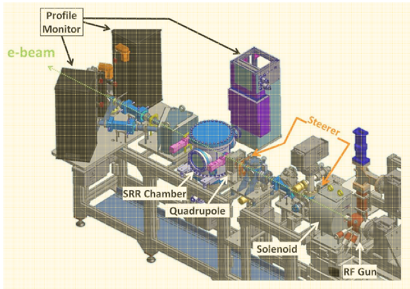
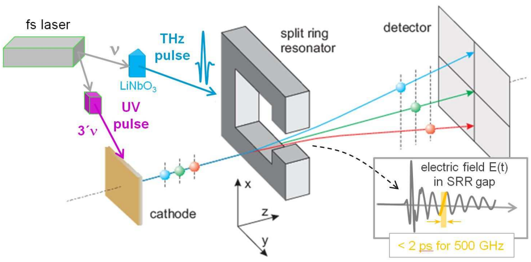
The SRR Experiment at the FLUTE Test Facility





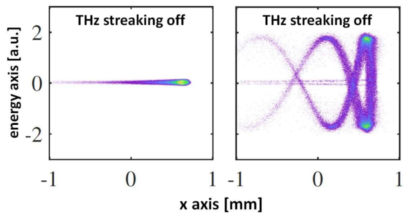
Principle of THz-Streaking with Split Ring Resonators



Temporal Resolution (similar to RF deflectors)

$$\frac{\sigma_{y0}}{cS} = \frac{\sqrt{\varepsilon_y}}{\sqrt{\beta(s_0)}}\,\frac{1}{\sin(\Delta\Psi_{s_0\to s_1})}\,\frac{E}{eV}\,\frac{1}{2\pi f} \quad \Rightarrow \quad \frac{\sigma_{y0}}{cS} \sim 2\ \text{fs}$$

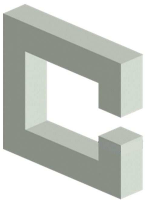
- FLUTE beam energy: E = 7 MeV
- SRR gap (deflecting) voltage: V = 12 kV
- SRR resonance frequency: f = 300 GHz
- β-function (@ SRR): $\beta(s_0)$ = 1 m
- bunch charge: Q = 50 fC
- emittance: ε_y = 3 nm
- phase advance SRR / screen: 90°



ASTRA Simulations

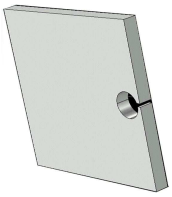
for conservatively assumed kick strength of 5keV/c (considering e.g. losses in the THz beam transport) clearly visible streaking image on FLUTE low energy spectrometer screen (FLUTE bunch length is 2 ps)

Split Ring Resonator Design Optimization



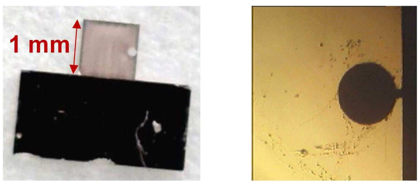
"classical SRR"

20 µm x 20 µm x 20 µm gap dimensions



"manufacturing SRR design"

20 µm x 20 µm x 80 µm gap dimensions
milled and drilled out of a solid plate
increased interaction region for larger kick strength

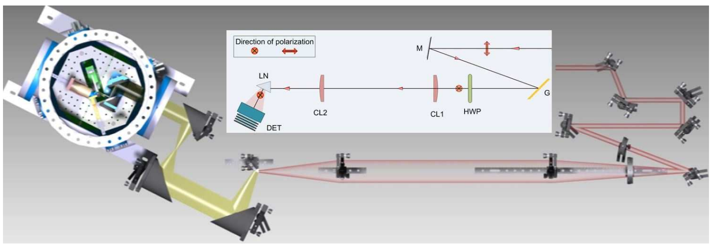


images of SRR for FLUTE experiment

manufactured from glass with gold coating
avoids charging up and heating by halo electrons or accidental hit by main beam

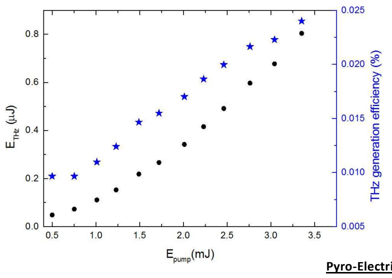
THz Pulse Generation and Characterization

Layout of the THz Pulse Generation (red beam path) and THz Beam Transport to SRR in Vacuum Chamber (yellow beam path)



Legend of symbols: M: dielectric mirror; G: reflection grating; HWP: l/2 retardation plate; CL1: plane convex cylindrical lens (f = 421 mm); CL2: plane convex cylindrical lens (f = 250 mm); LN MgO doped stoichiometric $LiNbO_3$ prism

THz Pulse Energy and Conversion Efficiency (pump: FLUTE gun laser)



- Optical rectification in $LiNbO_3$ crystal with FLUTE gun laser pulses (6mJ @ 800 nm, 35 fs (FWHM) @ 1 kHz)
- Conversion efficiency of 0.024% results in maximum THz pulse energy of 80 µJ for 3.35 mJ pump laser energy
- 4f imaging system provides THz spot dimensions of 0.92 mm (horizontal) and 1.15 mm (vertical)
- Maximum THz field strength of 14 MV/m can be reached at the location of the SRR in the experimental chamber

Pyro-Electric Camera Image of THz Beam Profile