Kick amplitude reduction from dispersion for the OSC in CESR

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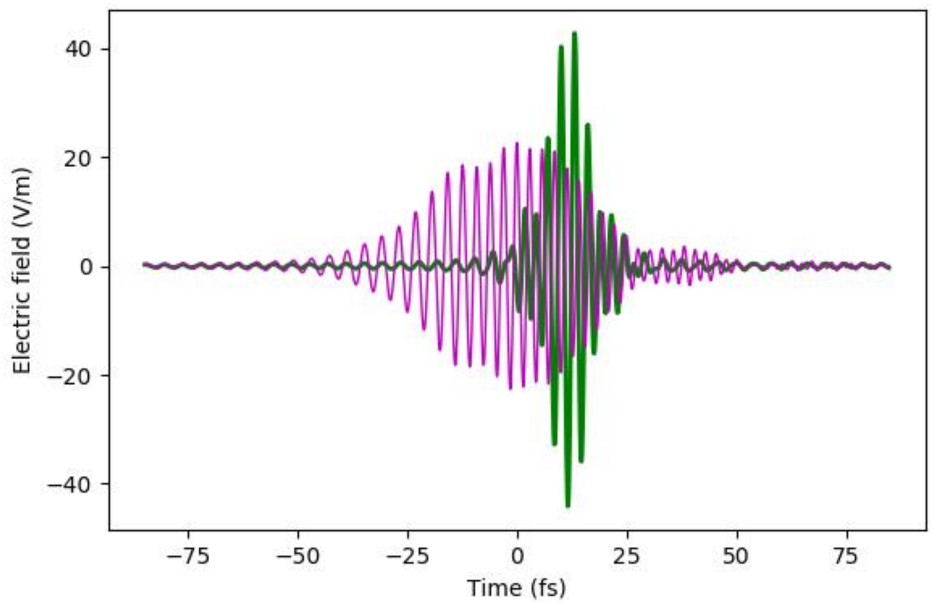
Second order lens dispersion is reducing the field amplitude by ~50% and additionally roughly doubling the pulse length (doubling the number of particles per sample for heating)

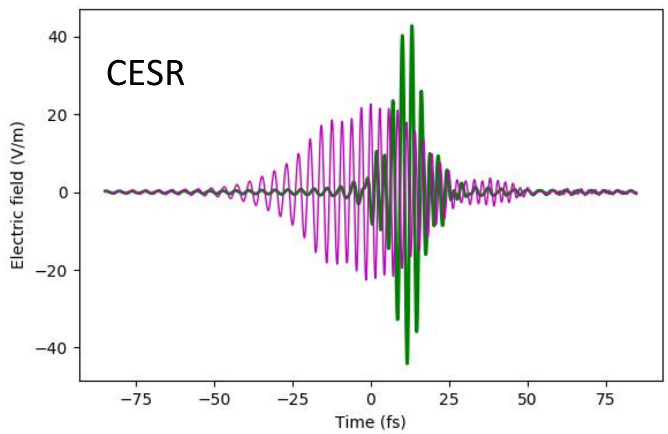


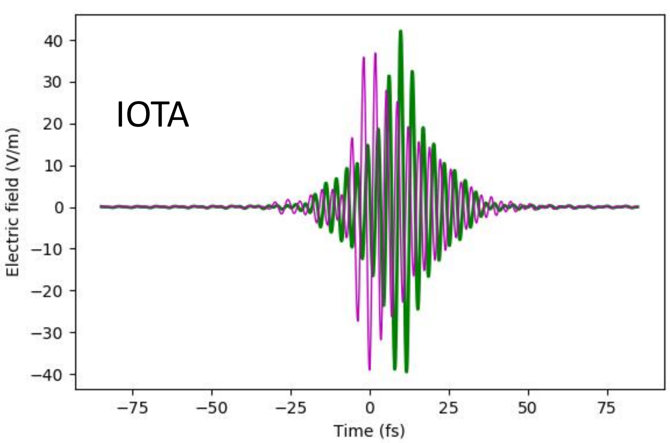
OSC kick amplitude will reduce by a factor of two compared to previous estimates.

Material	n(0.8)	GVD(0.8) (fs^2/mm)	FOM*
quartz	1.45	36.2	80.4
MgF2	**1.38**	**19.7**	**51.8**
CaF2	1.43	27.87	64.8
BaF2	1.47	37.92	80.6

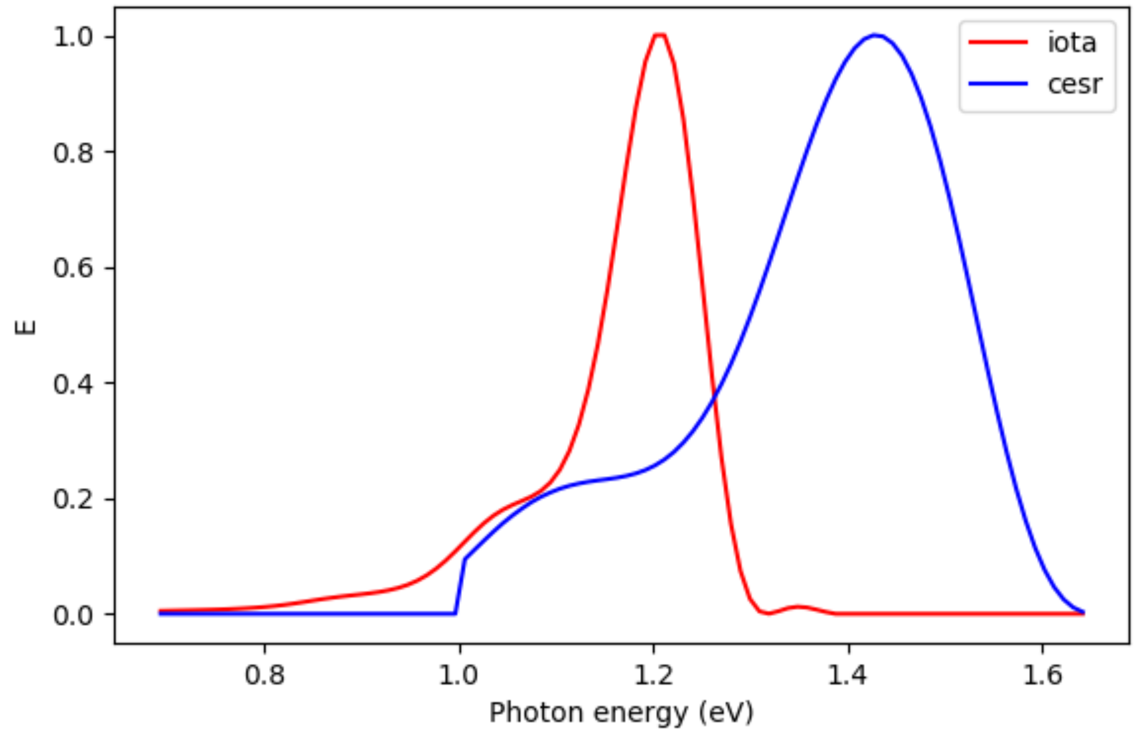
*FOM=GVD/(n-1). Glasses with smaller n require more thickness. FOM is used to find the best glass.

Dispersion effects: CESR vs IOTA





Note I equalized the glass thickness for IOTA and CESR case . In reality IOTA has ~1/4th the glass thickness of CESR.



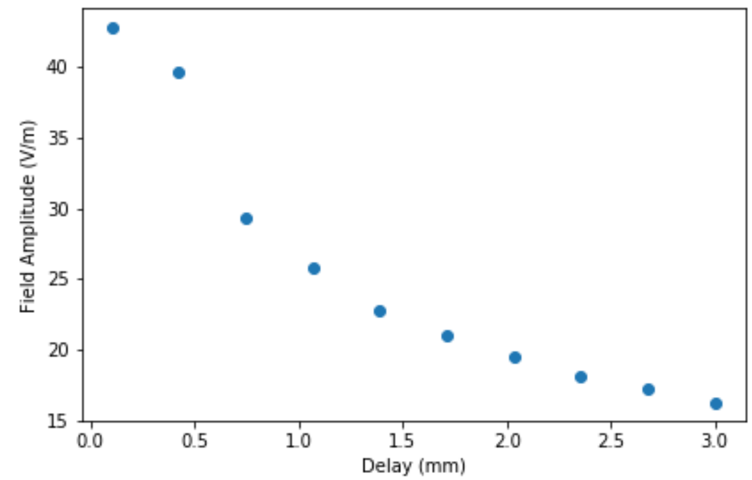
OSC in CESR operates over a larger bandwidth and is therefore more sensitive to lens dispersion.

Any ways to compensate using refractive optics?

2 mm optical delay is generous for a passive OSC system. Suppose we reduced the required glass thickness?

$$\lambda_u + \lambda_x = \frac{k_o M_{56}}{2\tau_s}\frac{\Delta\mathcal{E}}{U_s}$$

This is a bad approach since reducing glass thickness implies reducing M_{56} and so damping rate.



What if we simultaneously reduce M_{56} and λ so that both cooling ranges and total damping is constant?

At first this looks more promising. Unfortunately the GVD of most (all?) grows rapidly with decreasing wavelength in mid-IR/visible spectrum. This approach would leave some room to optimize our current configuration but will not bring us near the original (no dispersion) field amplitude/damping rates.

Material	n(0.5)	GVD(0.5) (fs^2/mm)	FOM
quartz	1.46	71.5	155
MgF2	1.38	37.5	98.6
CaF2	1.44	50.52	115
BaF2	1.48	67.12	140

Any ways to compensate using reflective optics?

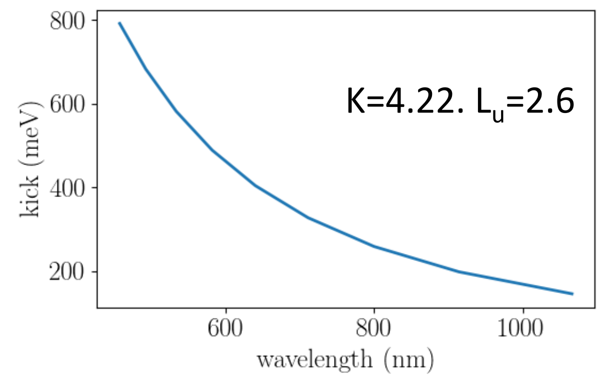
Suppose we use a “mirror-chicane” to provide the delay?
Curved mirror can provide focusing. Fine adjustment of mirror positions can be used for longitudinal timing.

Possible Pros
Eliminates dispersion. This not only helps with the fundamental but also may allow simultaneously cooling with higher harmonics. A thin low-pass filter can be used for the case of cooling with only the fundamental.

Initial demonstration can be done with smaller wavelength M_{56} yielding overall faster damping rates. Note by reducing M_{56} the dispersion invariant in the chicane center can be reduced giving a smaller eq. emittance prior to cooling.

If mirror-chicane can be made adjustable on the order of ~mm we can adjust M_{56} at fixed wavelength and observe changes to the cooling range.

We can even consider an advanced demonstration of the OSC where M_{56} is dynamically increased as the beam is cooled.



Definite Cons:
Will requiring rethinking vacuum chamber. It does not seem possible to create a mirror-chicane constrained to present optics chambers.

Still need to consider details of mirror-chicane for feasibility.