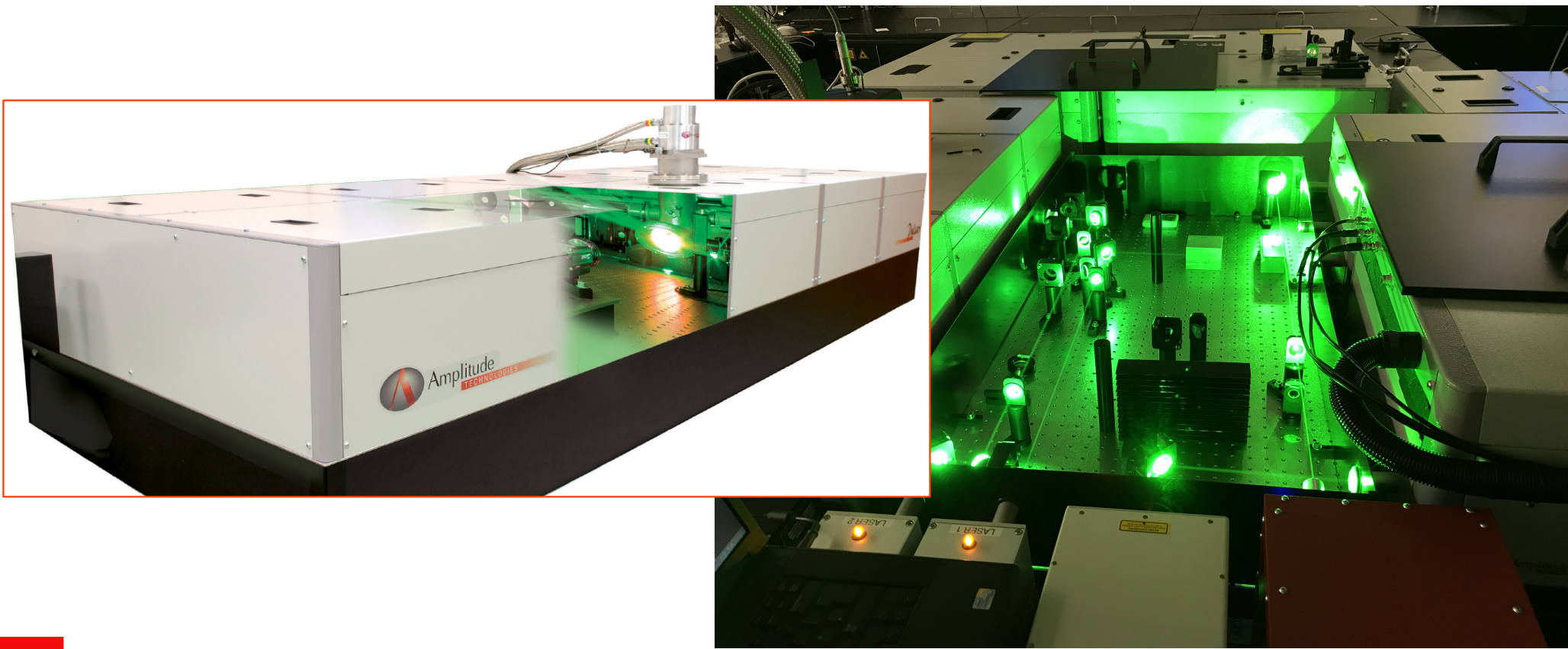


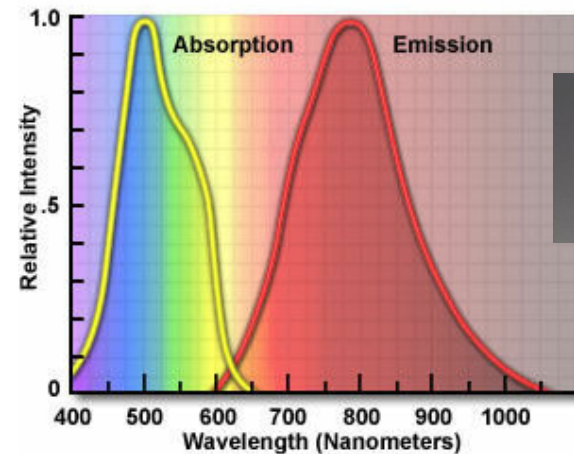
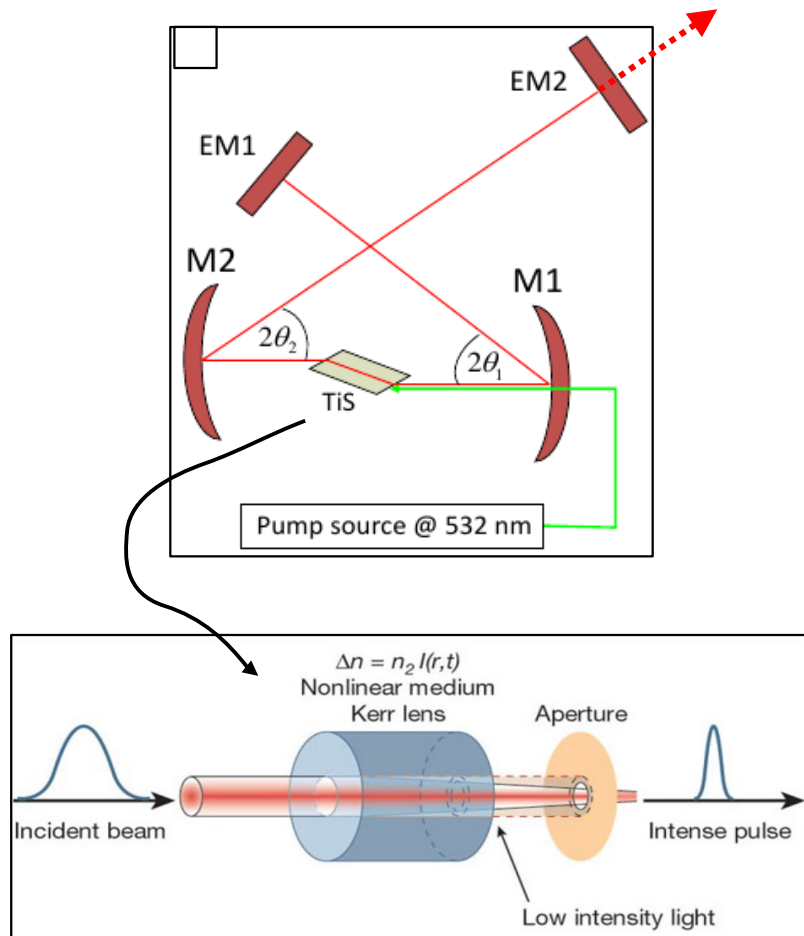


Technical aspects of a multi-step Ti:sapphire-based laser amplifier system

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Laser Engineer @

Ti³⁺ : Al₂O₃ mode-locked femtosecond lasers

Ti:Sa has a very wide emission bandwidth, around 250nm fwhm
- enabling the generation of extremely short optical pulses. $\Delta t \propto \frac{1}{\Delta \omega}$



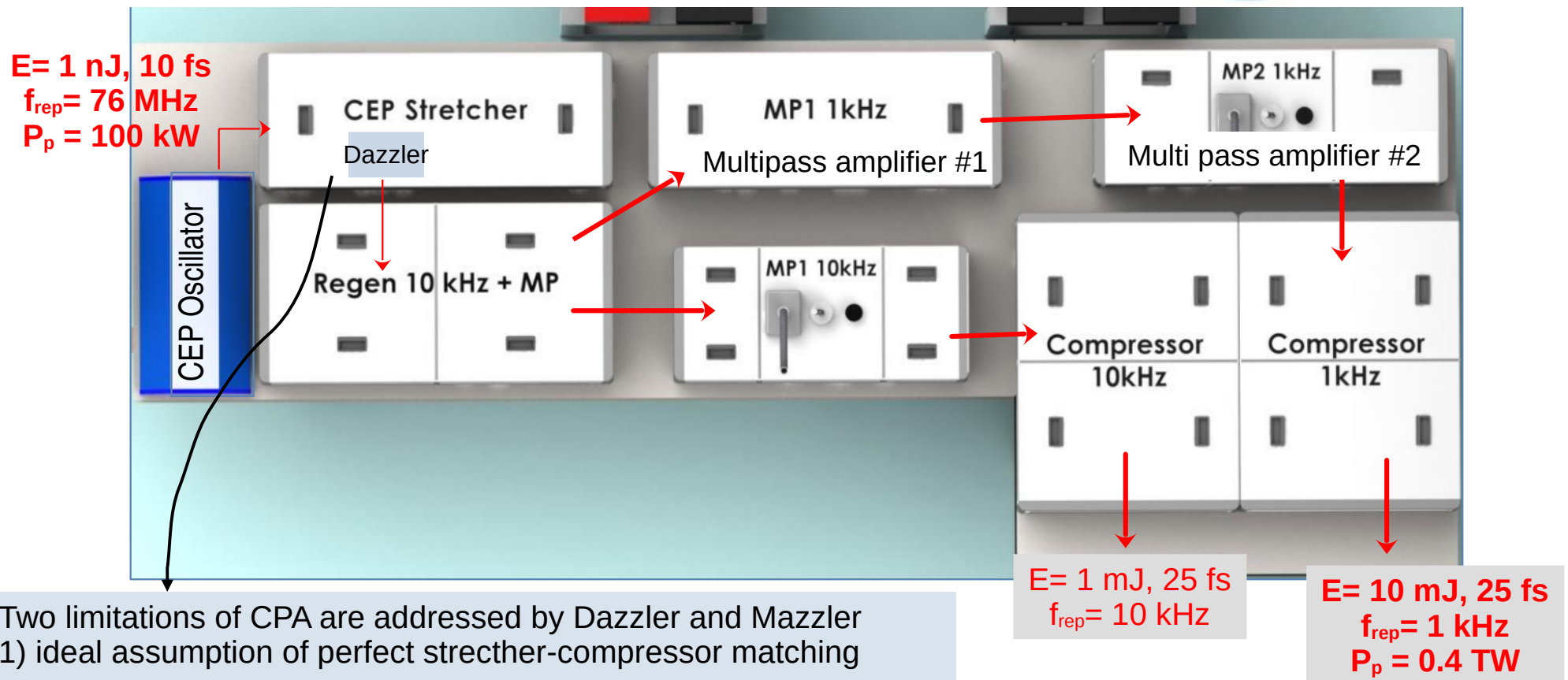
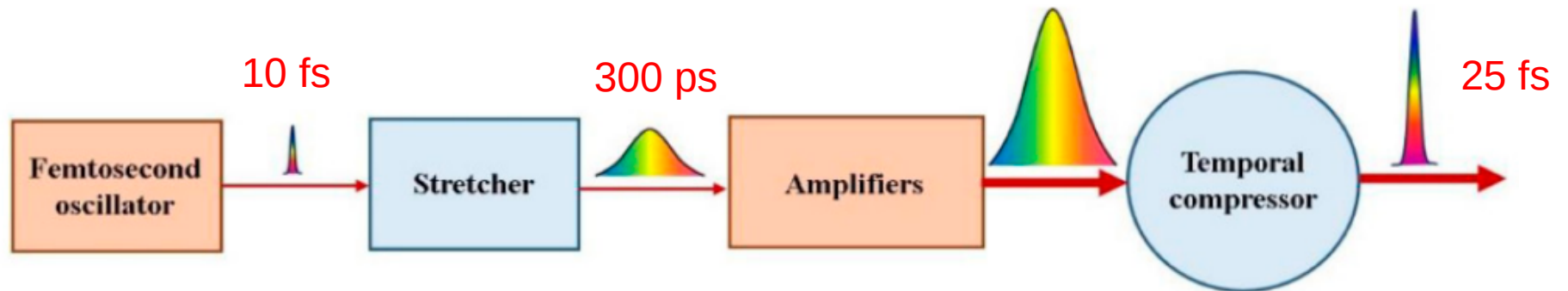
Ti³⁺ : Al₂O₃
0.15 – 0.25%

In the crystal, the accumulated B-integral is a quantity for understanding the optical Kerr effect.

Δn increases, as $n_2 > 0$, the crystal turns into a gradient focusing lens.
The center of the laser beam (high I) focuses more.

Ti:Sa based multi-step amplifier system

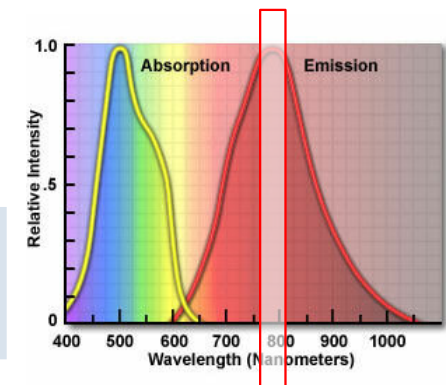
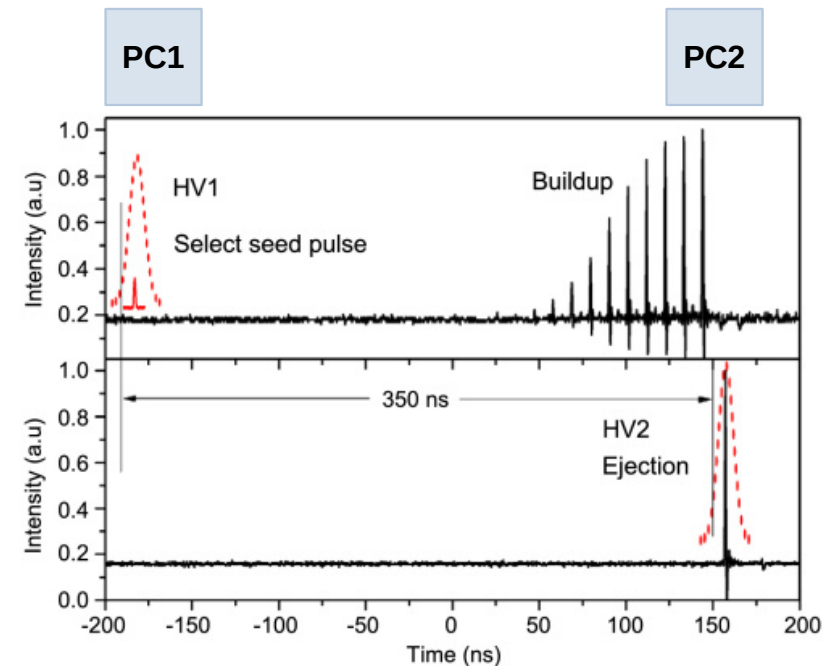
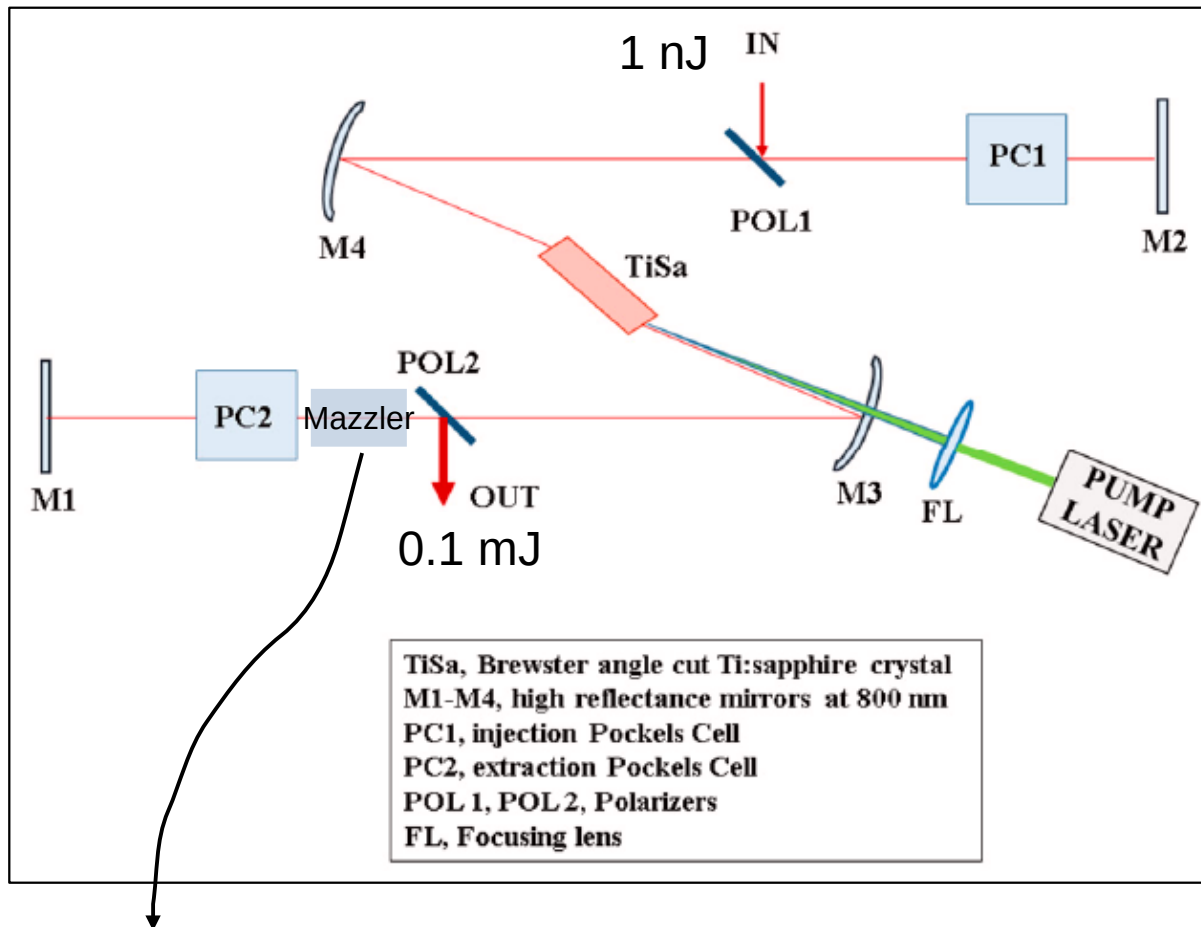
Method: chirped-pulse amplification (CPA)



Regenerative amplifier

The initially weak pulse is made stronger by passing it multiple times through the crystal placed in an optical resonator together with electro-optical switches: Pockels cells and polarisers.

The amplification factor up to 1 million.

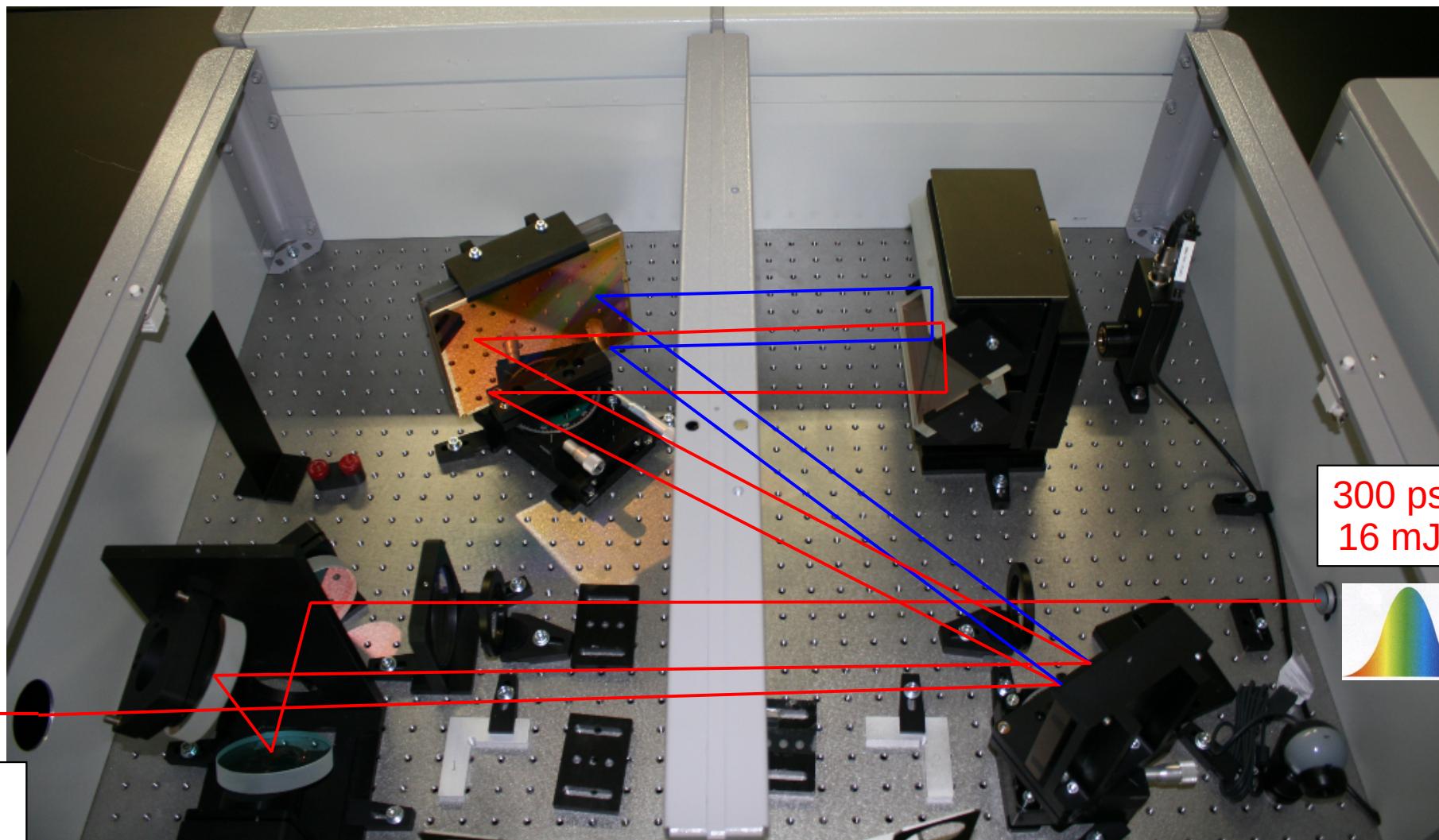


Two limitations of CPA are addressed by Dazzler and Mazzler

2) Ti:sa gain spectrum is non uniform, Mazzler compensates the narrowing gain

Grating compressor

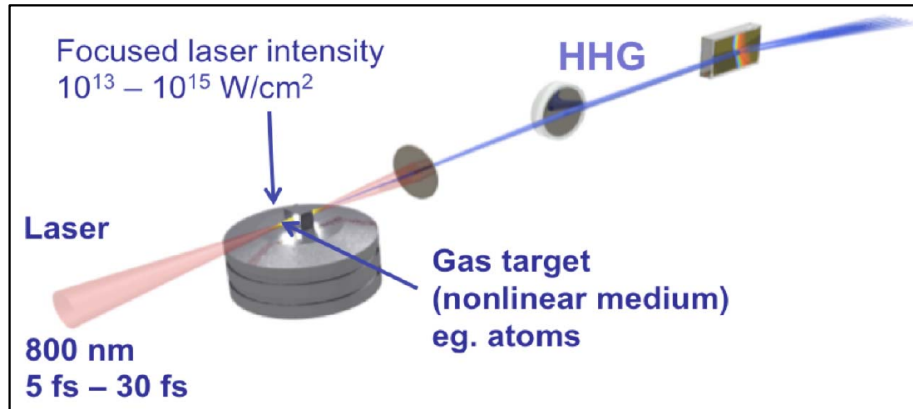
reverses the stretching process by synchronising the temporally separated wavelengths.



Positive GVD added for shorter wavelengths, they catch up the longer wavelengths.

Ultrashort pulses are vulnerable

It is crucial to maintain their quality from the source to the experiment.



We need the short pulse and aberration-free focus at the experiment.

Issue / Distortion	Characterization methods	Mitigation / Avoidance
Temporal chirp	Spider, Frog, d-scan, autocorrelator	Fs-enhanced optics, chirped mirrors, Dazzler
Spatial chirp	Far-field imaging, wavefront sensor	Precise alignment of diffractive optics
Astigmatism	Beam caustics measurement	Precise alignment of diffractive/reflective optics
CEO instability	f-2f interferometer, stereo-ATI	Stable oscillator design, active feedback loops
Self focusing	Beam profile monitoring, Z-scan technique	Lower the B-integral by using large beam diameters
Energy instability	Photodiode or power meter tracking	Jitter-free electronics, stable pump lasers
Pointing stability	Position sensitive detectors	Active beam stabilization systems, mechanical and thermal isolation