Acousto-Optic Dispersive Filter

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Fastlite
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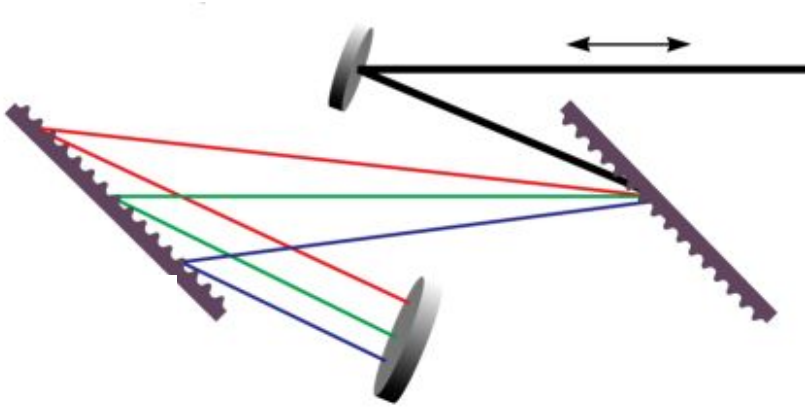
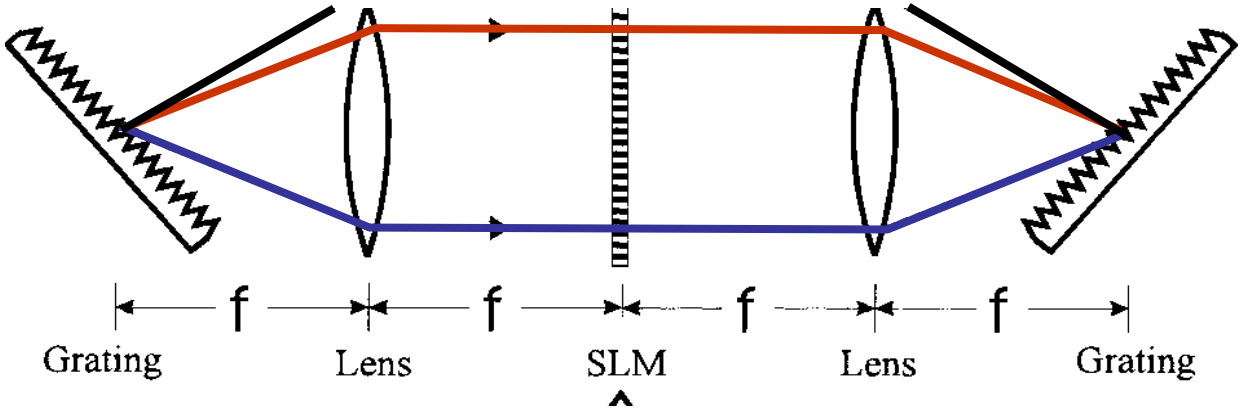
Pulse Shaping I : Spatial Separation

Grating Compressor

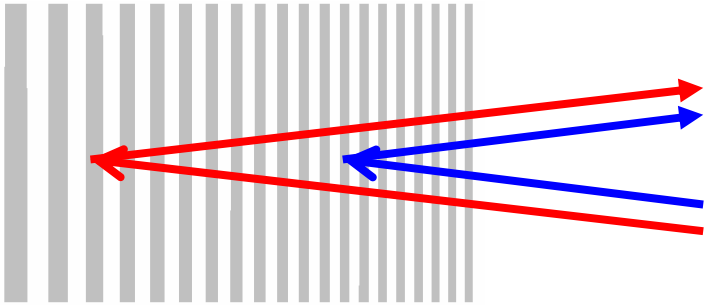


Programmable Shaper

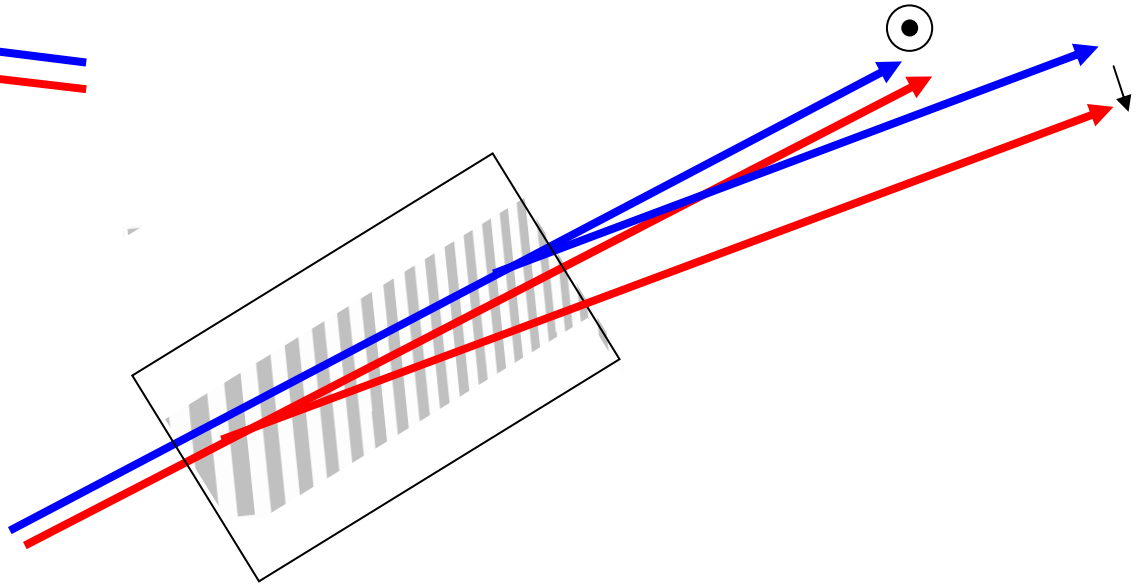


Pulse Shaping II :
Diffraction by aperiodic structure

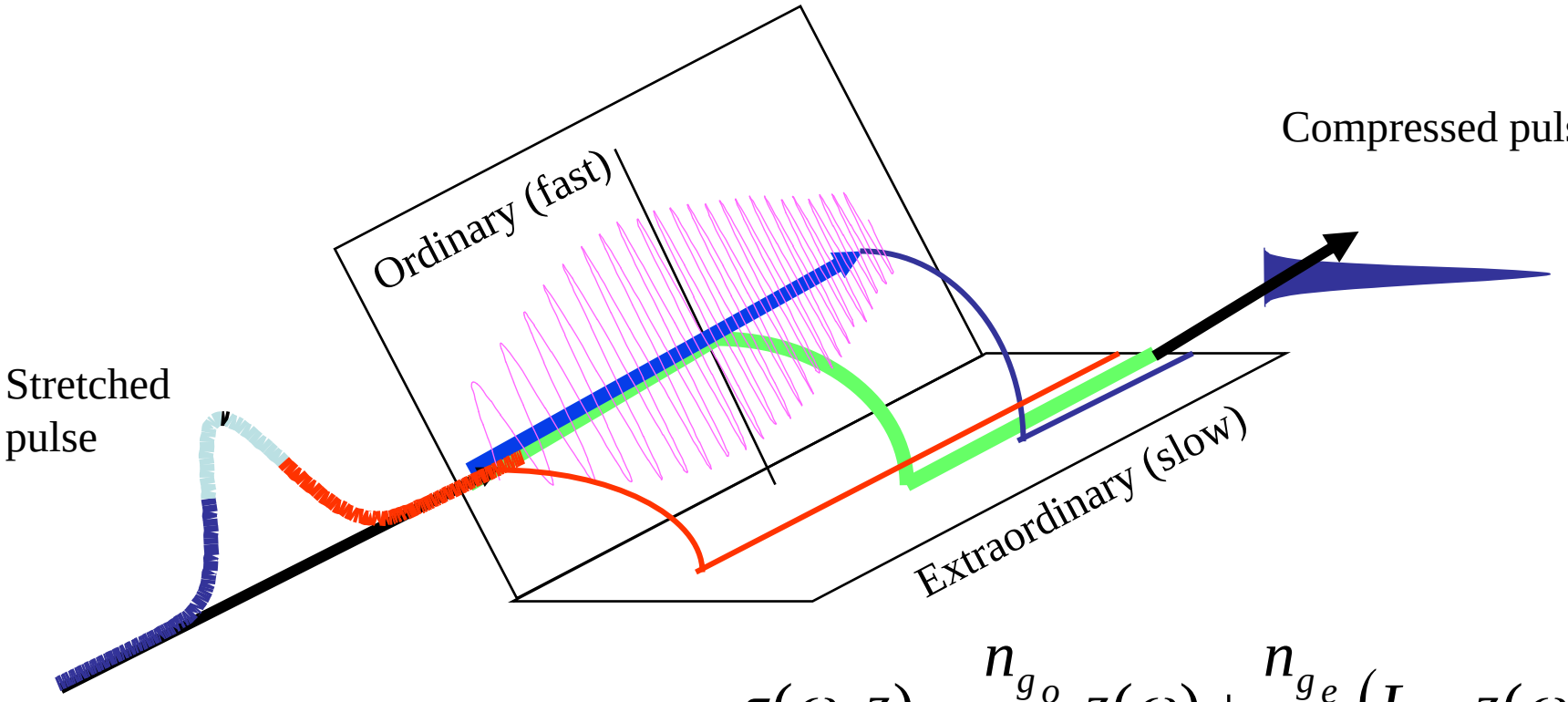
Chirped Mirror
Dielectric Structure



AOPDF
Acoustic Wave

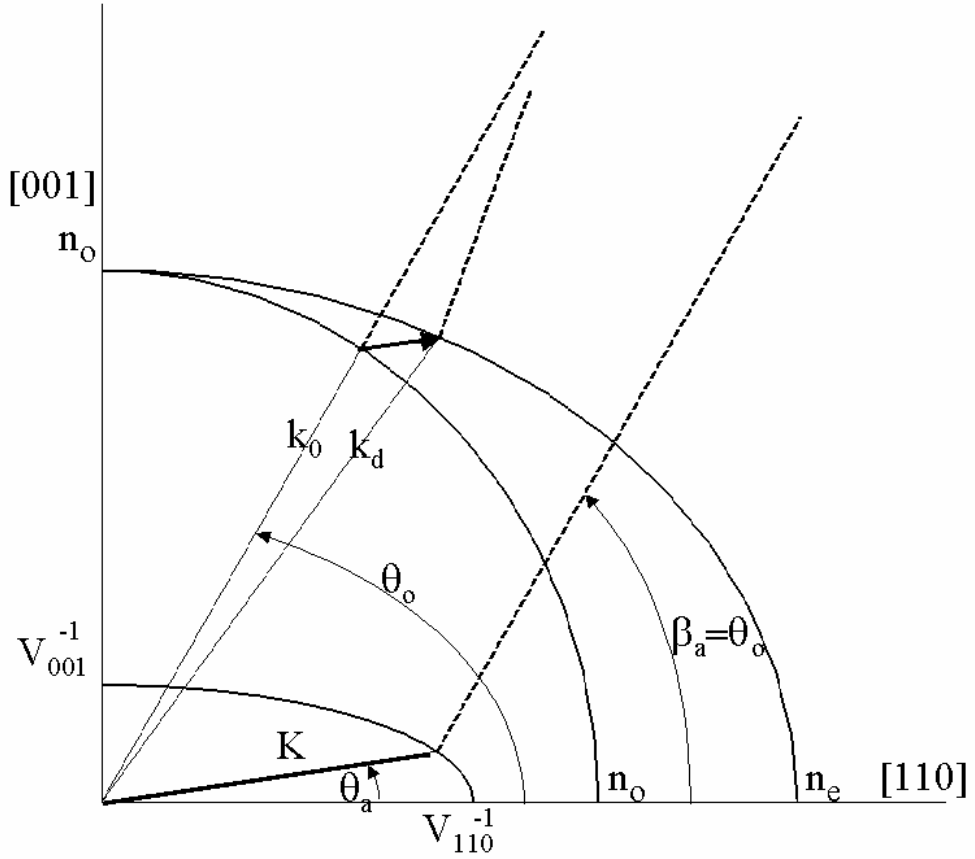


Semi-quantitative Understanding
Delay vs frequency control



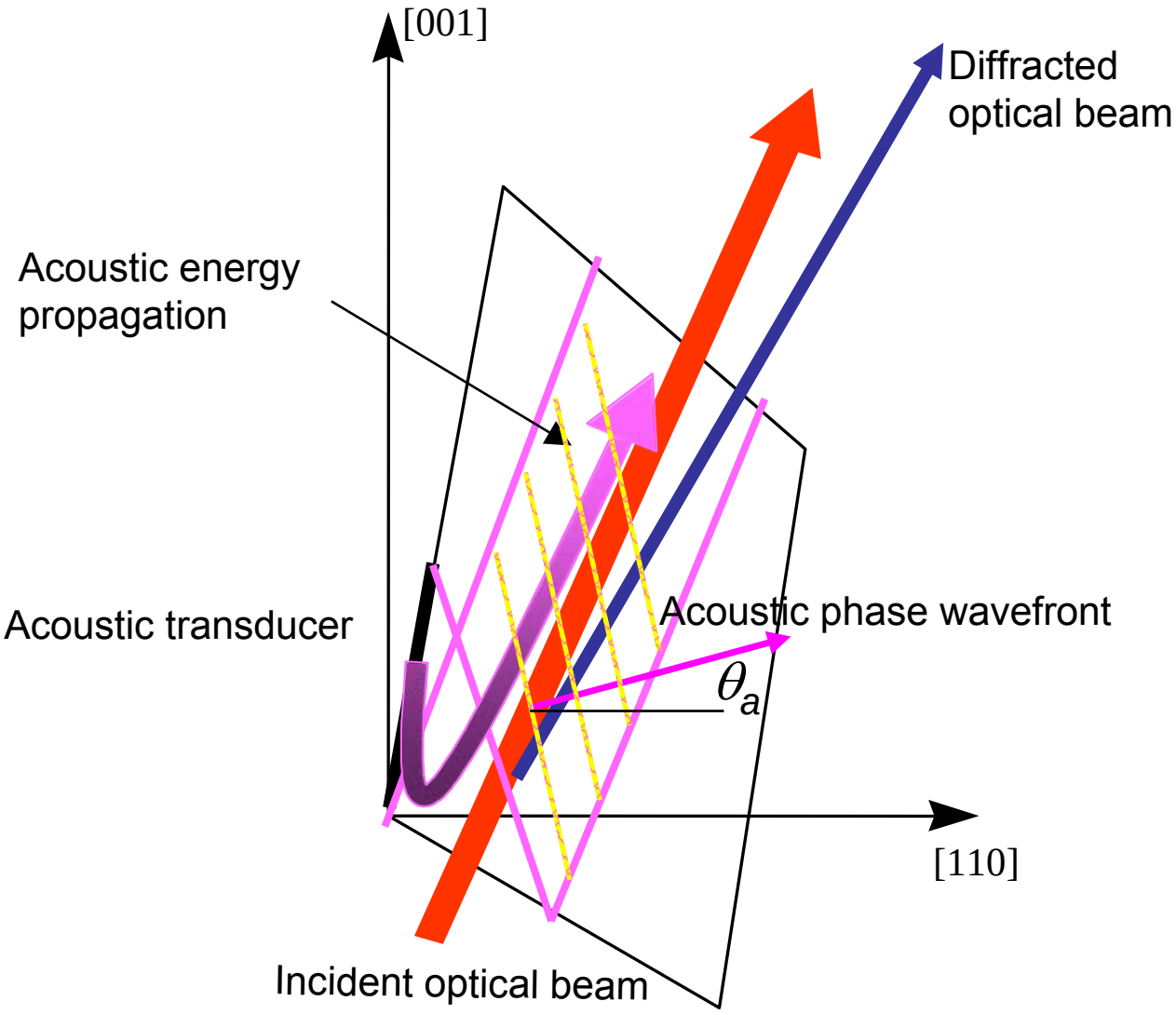
$$\tau(\omega, z) = \frac{n_{g_o}}{c} z(\omega) + \frac{n_{g_e}}{c} \left(L - z(\omega) \right)$$

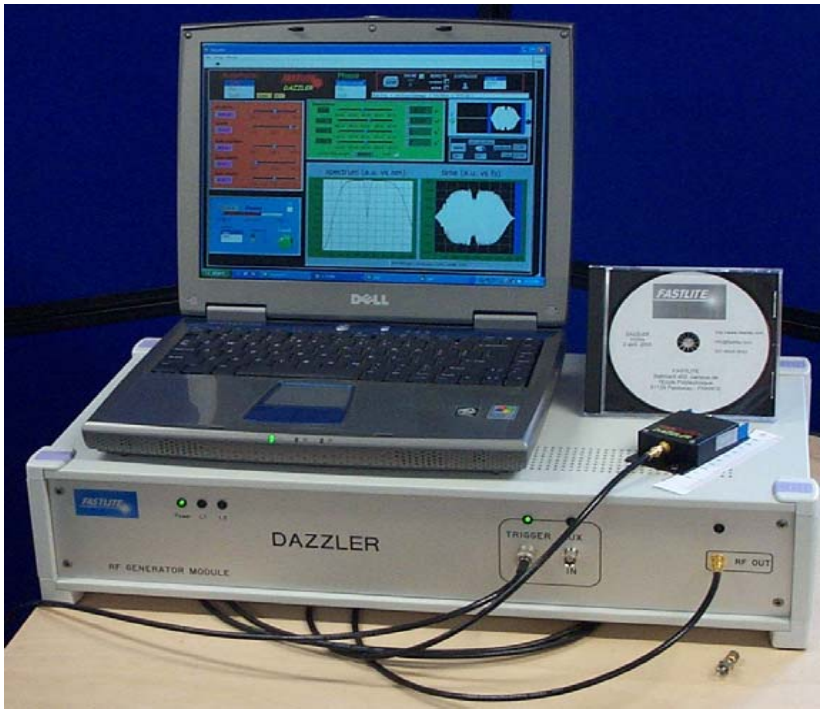
Quantitative Point of Vue
K-Conservation + Phase transfer

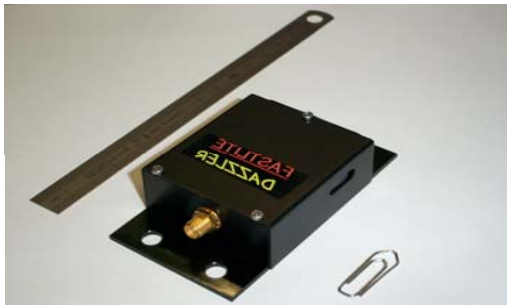


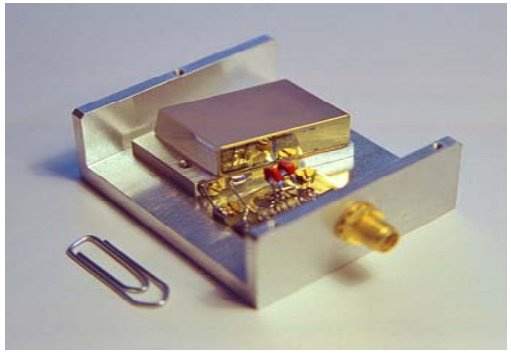
$$E_{out}(t) \propto S(t/\alpha) \otimes E_{in}(t) \quad \text{où} \quad \alpha = \frac{f_{ac}}{f_{opt}} \approx 10^{-7} \quad \Rightarrow \quad E_{out}(\omega) \propto S(\alpha\omega) E_{in}(\omega)$$

Dazzler™


[001]
Diffracted
optical beam
Acoustic energy
propagation
Acoustic transducer
Acoustic phase wavefront
θ_a
[110]
Incident optical beam


DELL
FASTLITE
DAZZLER
RF GENERATOR MODULE
TRIGGER
IN
RF OUT


FASTLITE
DAZZLER

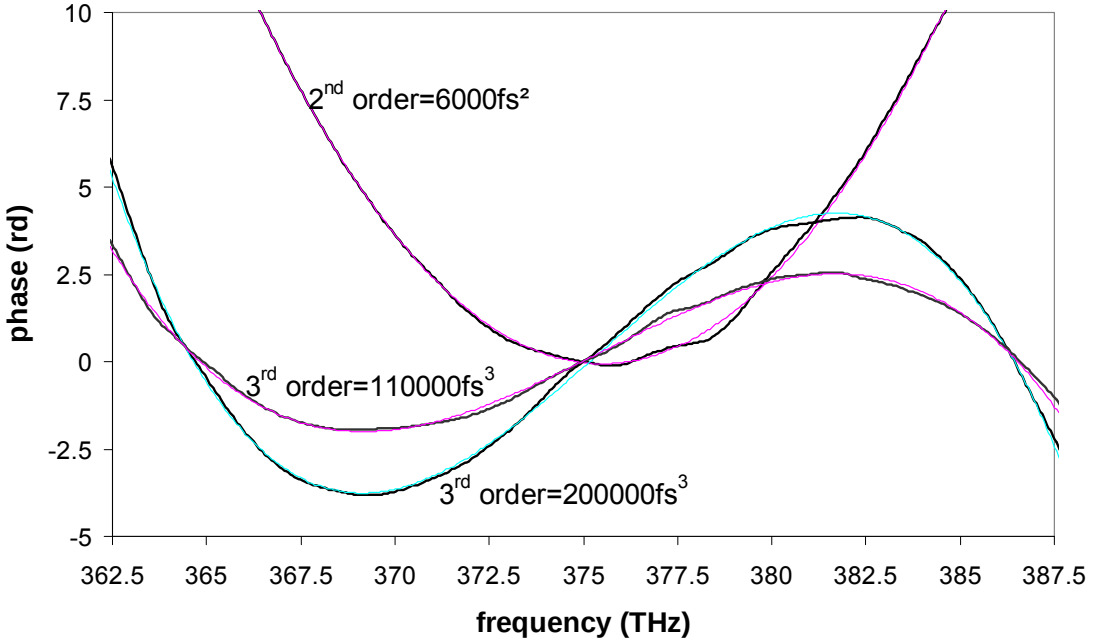


Materials

	Window (μm)	Optical index/biref $n_{0/}$ /dn	Velocity of sound V(m/s)	Density ρ	Acousto-optic coeff. p	M (mm^2/GW)
MgF_2	0.11 - 7.5	1.4/0.01	2830	3.18	0.05	0.3
α-Quartz	0.15 - 4.5	1.6/0.01	3360	2.65	0.06	0.6
KDP	0.20 - 1.7	1.5/0.05	1650	2.34	0.07	6
$Te0_2$	0.35 - 4.5	2.2/0.15	615	5.99	0.09	800
Hg_2Cl_2	0.38 - 28	2.0/0.60	347	7.19	0.056	1030

Pros and Cons
Aopdf vs LCD

- Simple
- Stable
- Quantitative
- Power limitations
- Rep. Rate considerations



Spectral Resolution

- Number of independent points
- BT product
- Examples

Spatial LCD

K*N

K<0.5 N~512

BT=256

Diffraction Dazzler

T=6 ps

B=10%(@800nm)

BT = 225

Throughput Efficiency

- Examples

Spatial LCD

Grating^2*LCD

70%

Diffraction Dazzler

Band : 100nm (@800nm)

30% to 80%

Power Limitations

- Thick usely highly non linear material
  - Typical limit is 30 microjoules in Dazzler at 500 to 800 nm
  - Expressed in Energy not Power due to self dispersion
  - LCD pulse shaper can do one to two orders of magnitude better.

Repetition Rate

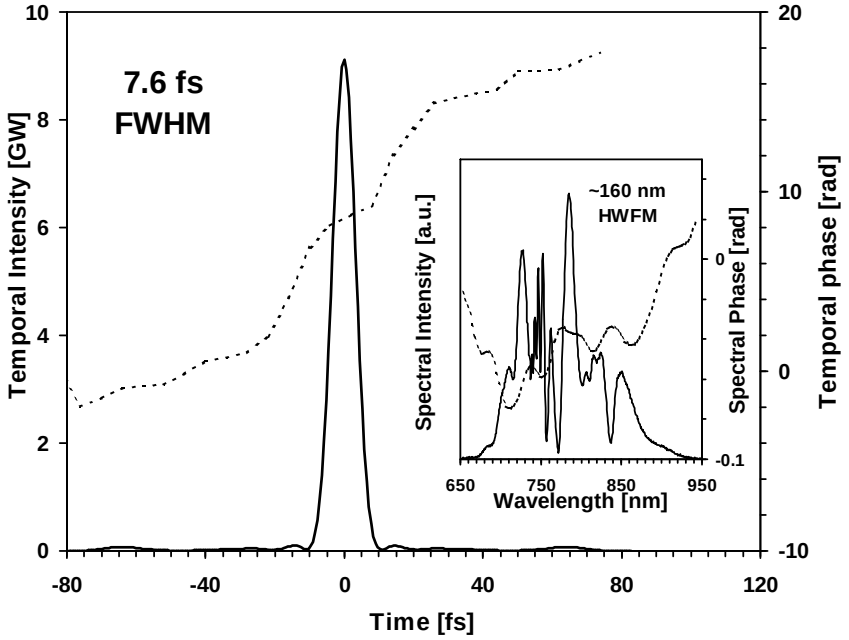
- Propagation time tens of microseconds
- High rate pulses ->
  - Partially diffracted pulses
    - Limit duty cycle (e.g. 50%)
  - Pulses with different self dispersion
    - Limit bandwidth (e.g. 10 nm)

    - Regardless good two photon imaging with oscillators has been obtained
    - GVD scanning experiments

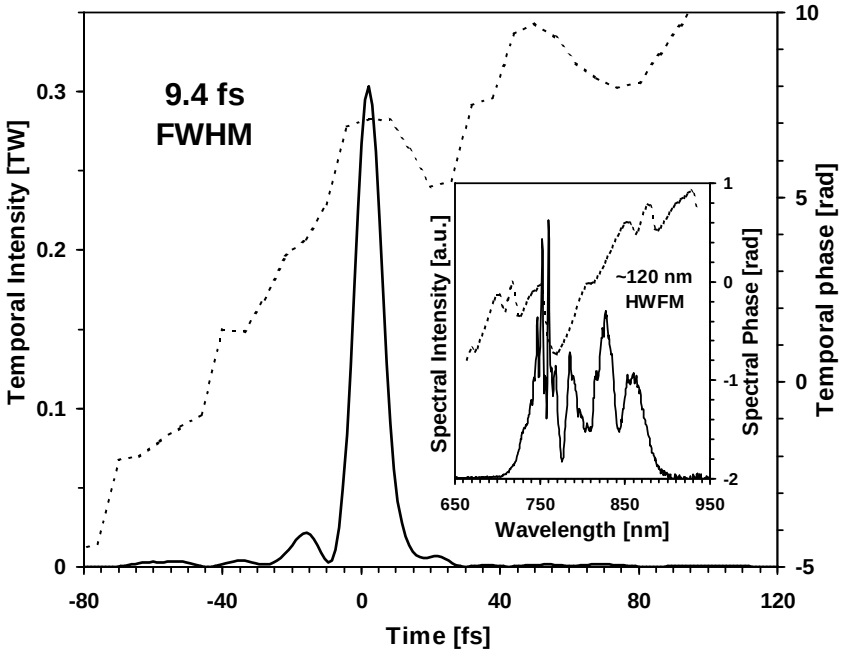
Sub 10fsec Amplifiers: Post compensation (TU WIEN)

Oscill. → PreAmp. → Hollow fiber → Dazzler → Ampli. →

Before last amplification



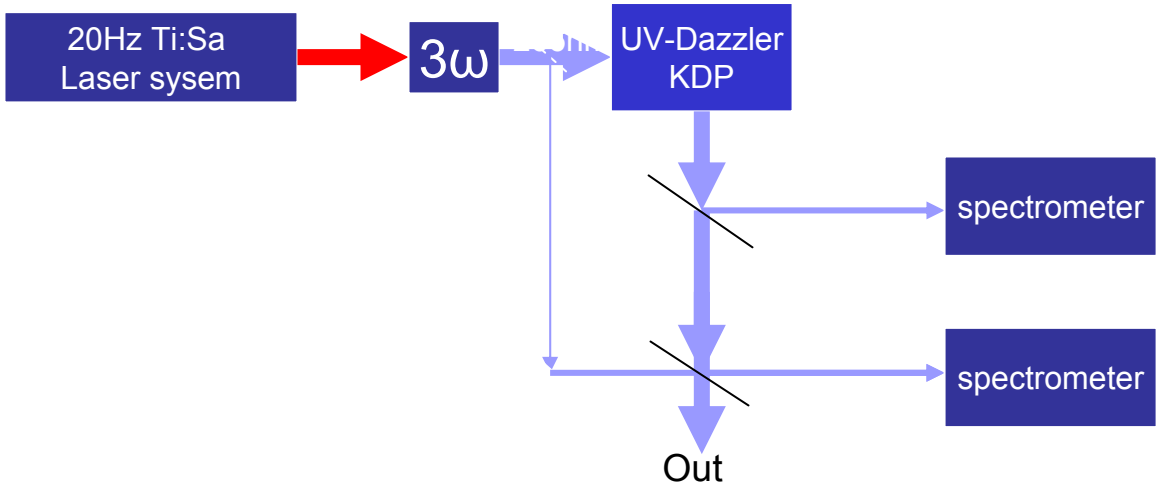
After last amplification



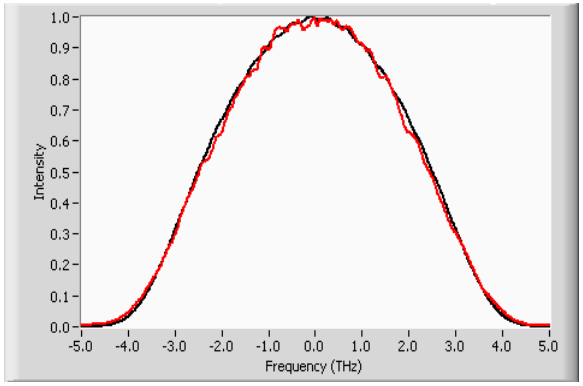
J.Seres et al. « Sub-10-femtosecond, terawatt-scale Ti:sapphire laser system »
Optics Letters, **28,** 19**,** p.1832-1834, (October 1,2003)

Direct UV pulse shaping : UV-AOPDF KDP

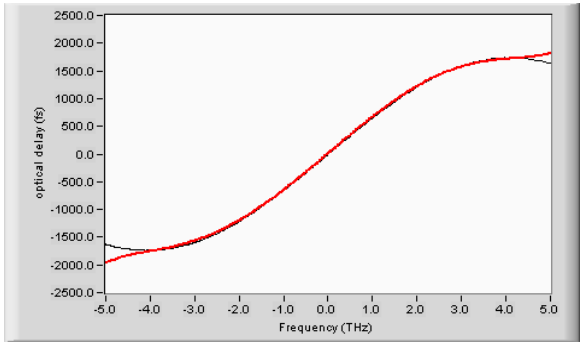
Experimental results

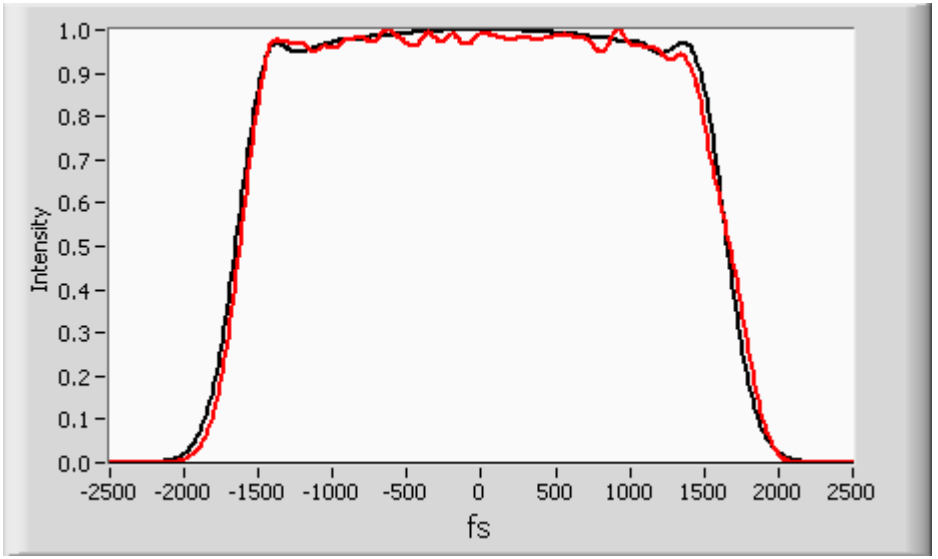


Amplitude

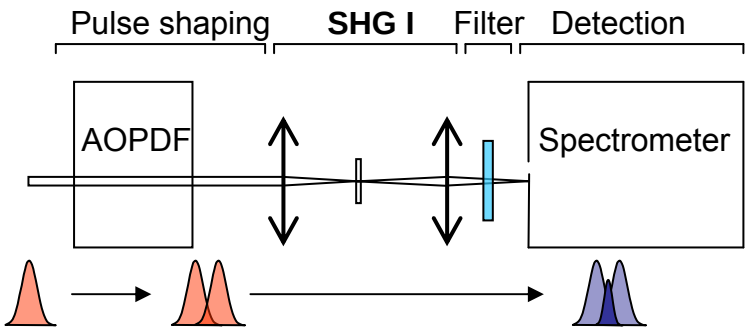


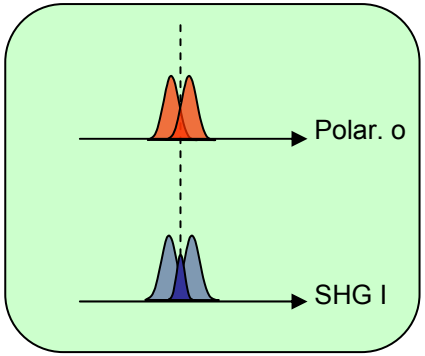
Delay





Interferometric Configuration

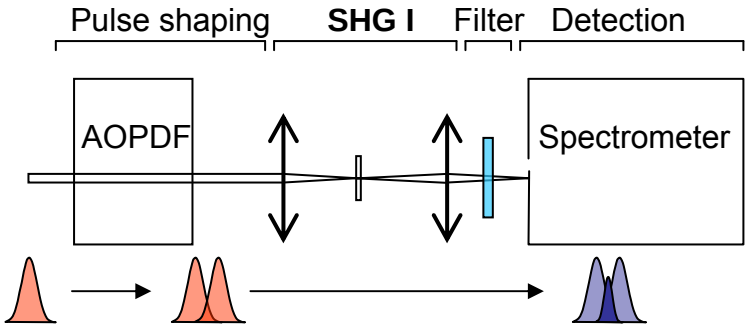


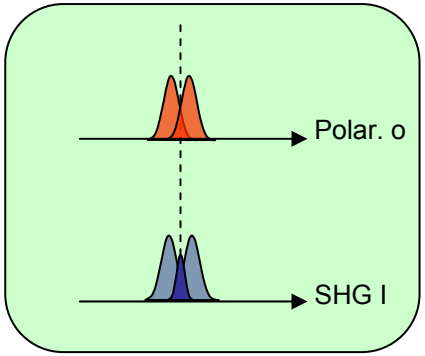


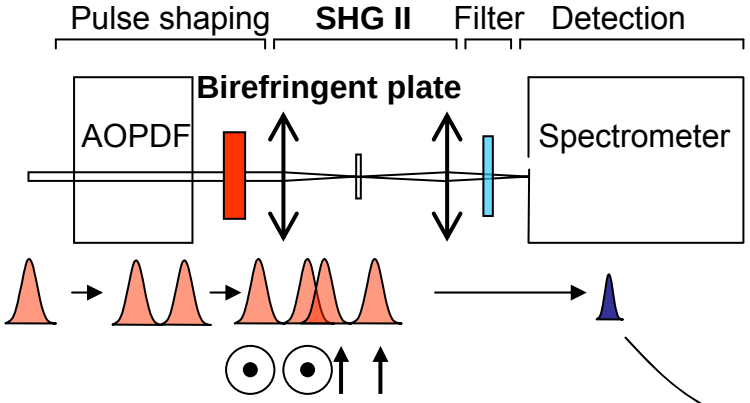
Interferometric and not intensimetric

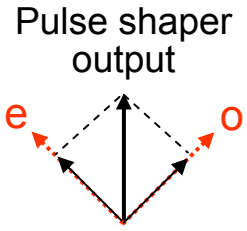
Intensimetric Configuration

- Trick: polarization multiplexing and type II SHG









Birefringent and SHG crystals axes