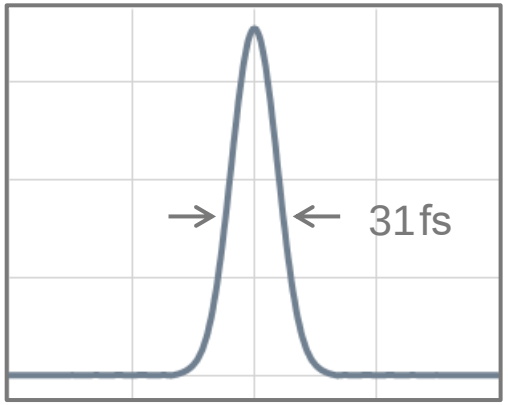
Grating Stretcher for Ultrashort Pulses

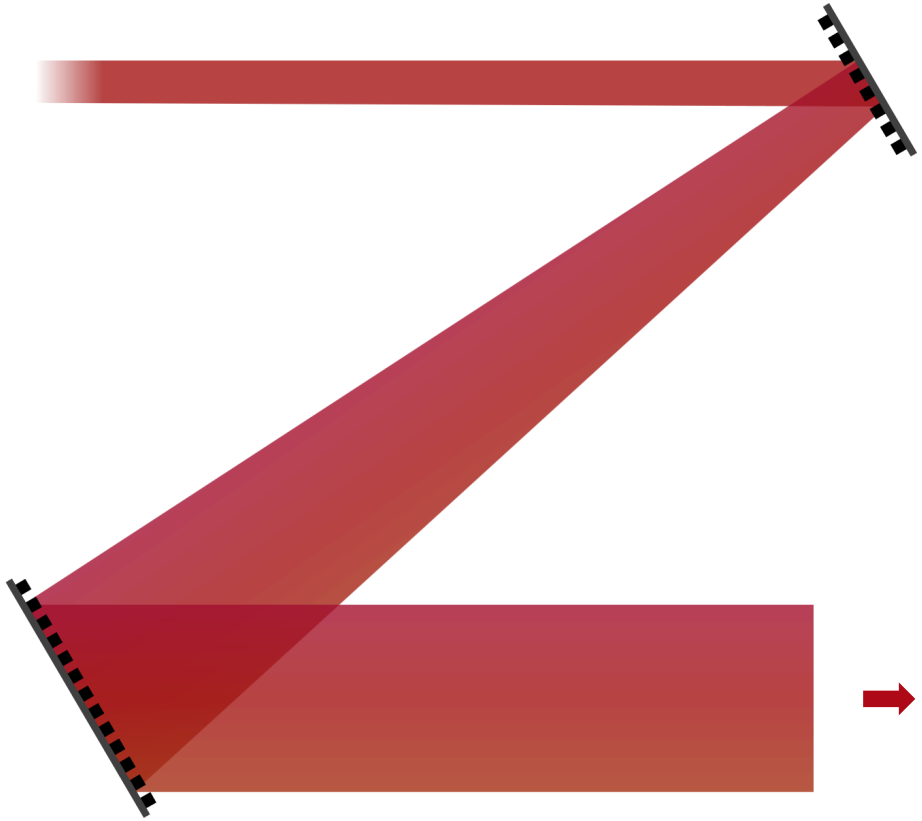
Abstract

The role of ultrashort pulses is growing in modern optical applications. For example, they can be found in the fields of laser material processing, medical imaging, optical communication and so on. Prisms and gratings are typical optical components that are used for manipulating the temporal behavior of optical pulses. In this example, a pulse stretcher consisting of two diffractive gratings are constructed and the pulse broadening effect after propagation through them is demonstrated.

Modeling Task



input pulse
- carrier wavelength 619 nm
- temporal duration 31 fs
- Gaussian spatial profile [collimated]



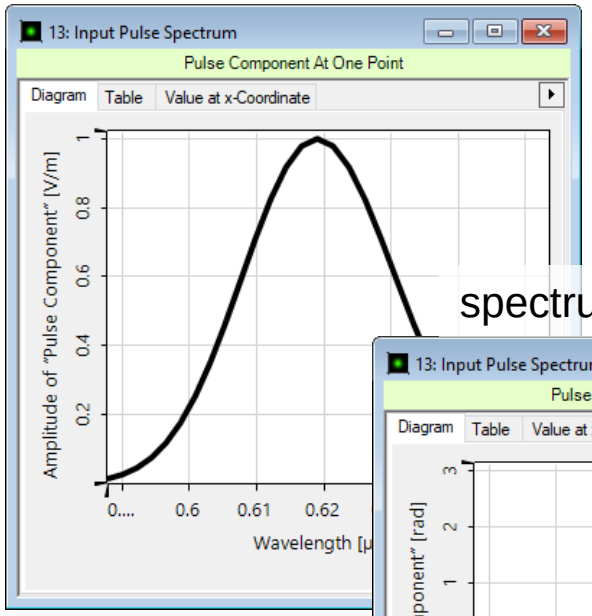
gratings pair
- period 1.667 µm
- rotation angle 30°
- diffraction order R+1
- distance between two gratings 64 mm

How does the two diffraction gratings changes the ultrashort pulse that propagates through them?

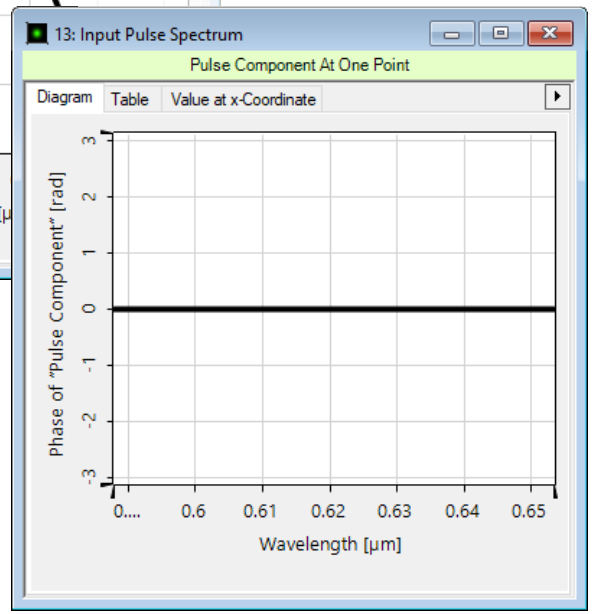
?

Input Pulse in Both Domains

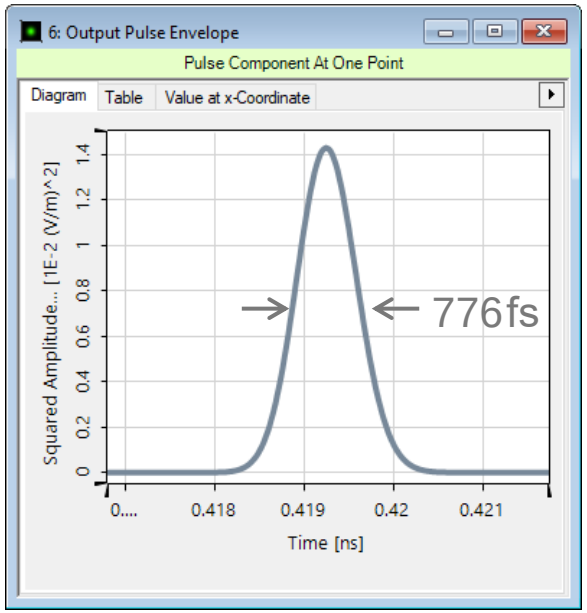
spectrum domain (amplitude)



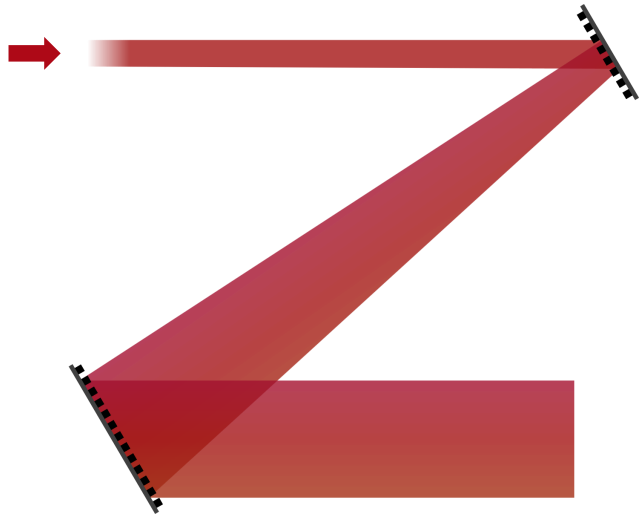
spectrum domain (phase)



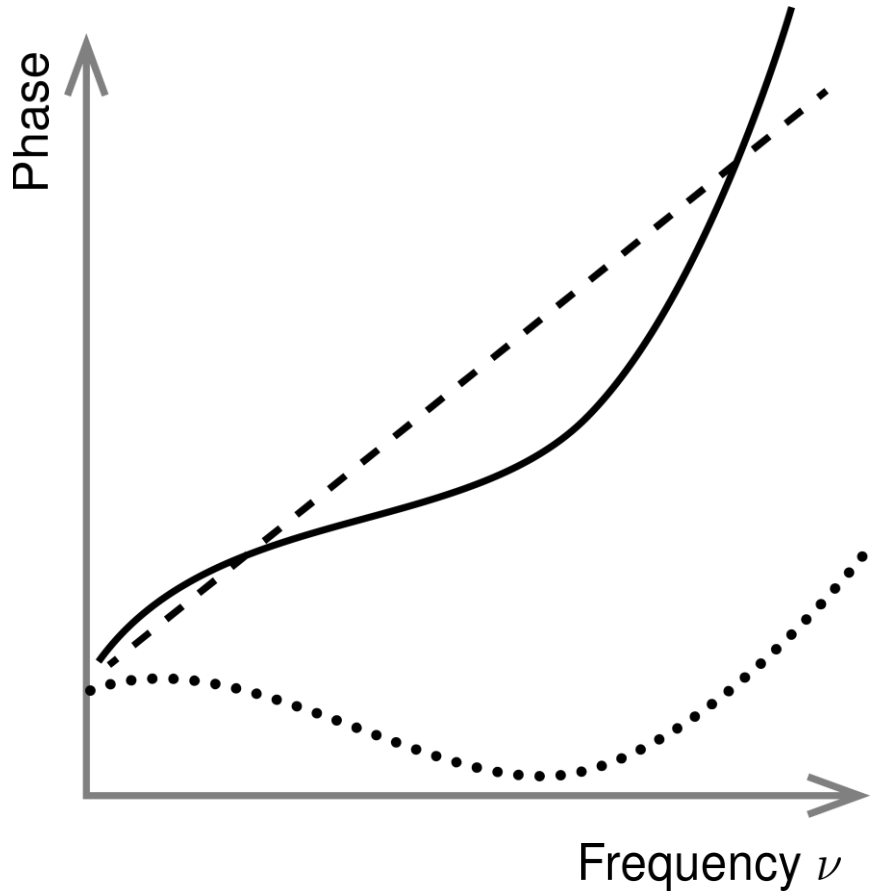
time domain
(squared amplitude)



Nonlinear spectral phase leads to broadening of the temporal pulse envelope.



Analysis of Phase over Frequency



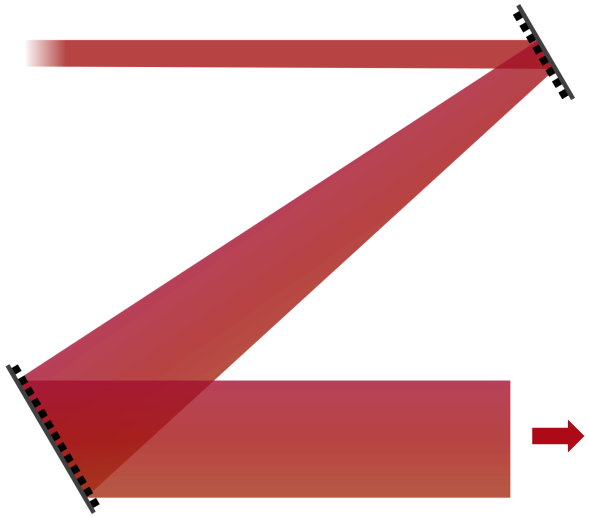
complete phase

linear fit phase

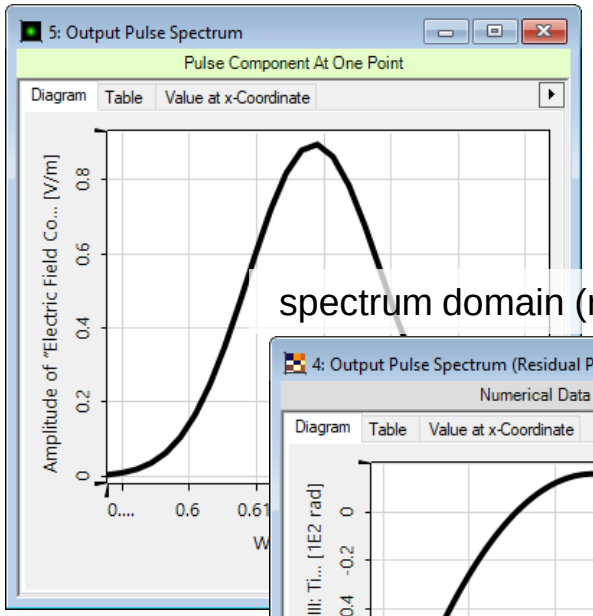
residual phase
(complete phase – linear fit phase)

- Complete phase v.s. frequency can be analyzed at a given spatial position.
- A linear fitting of phase over frequency gives information on temporal shift.
- The residual phase (extracting linear fit from complete phase) determines the temporal pulse profile.

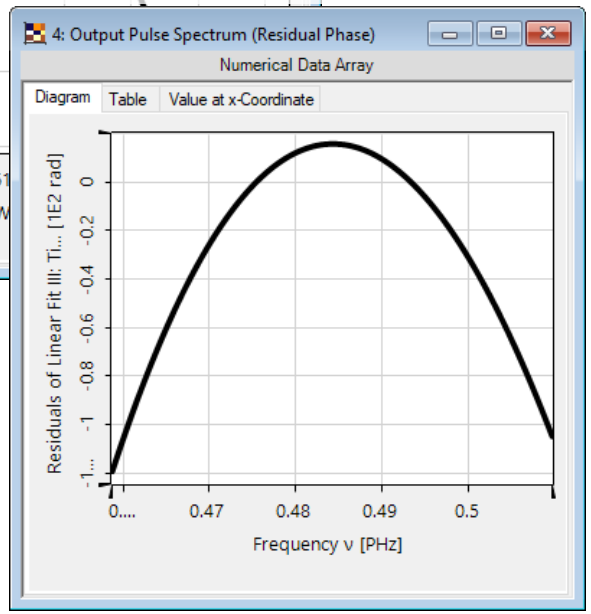
Output Pulse in Both Domains



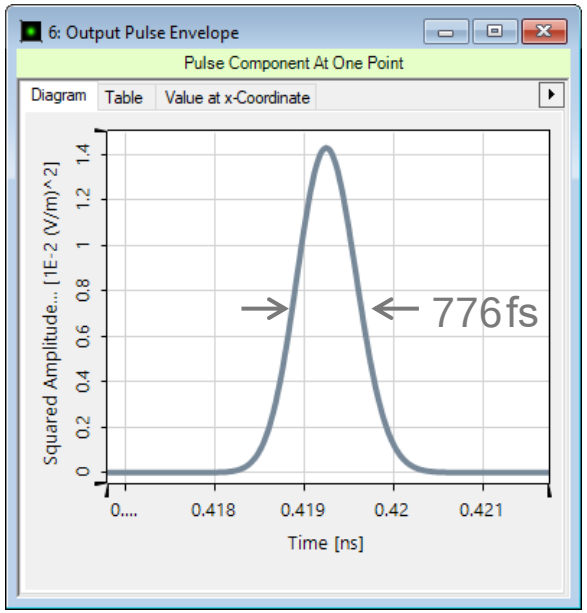
spectrum domain (amplitude)



spectrum domain (residual phase)

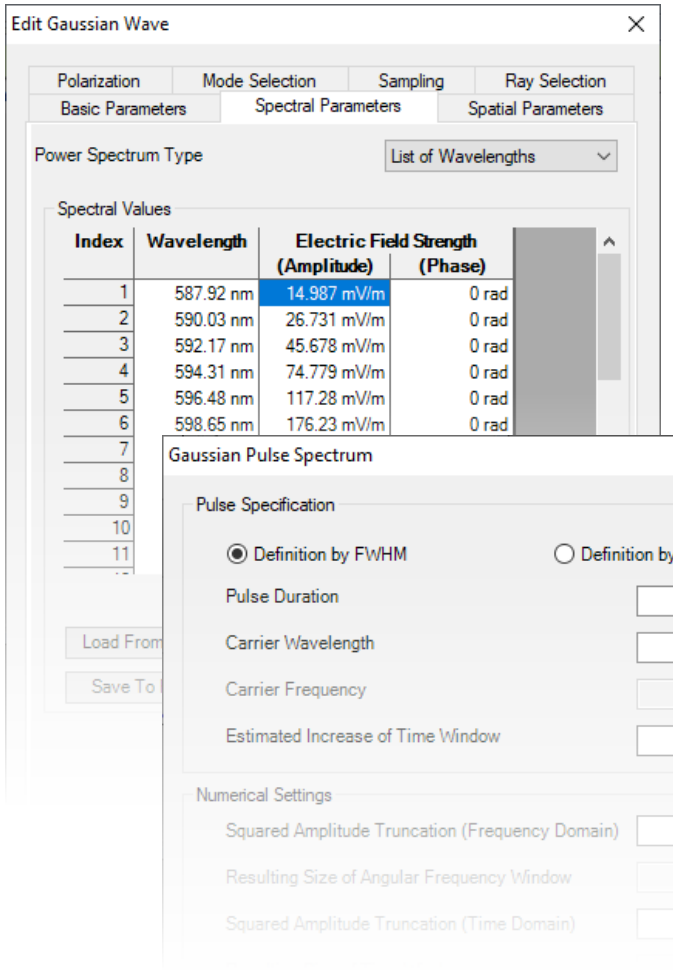


time domain
(squared amplitude)

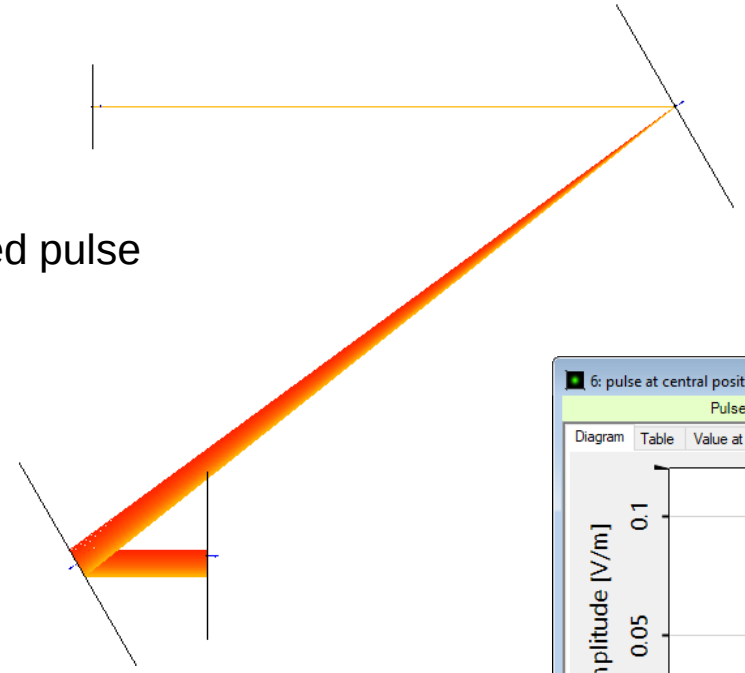


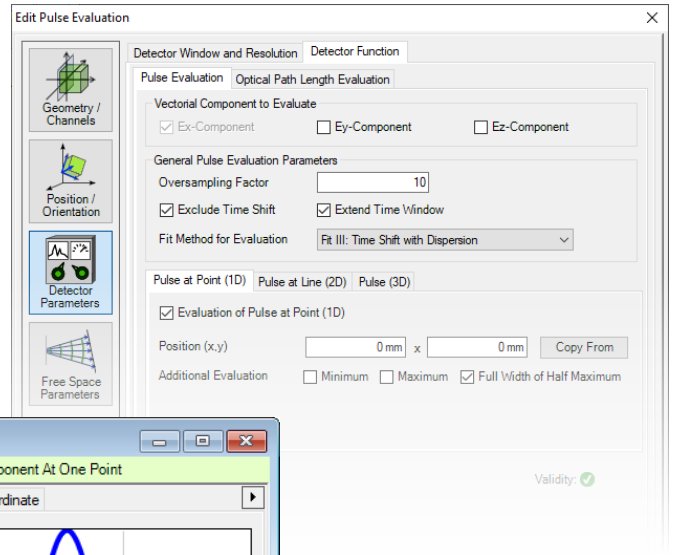
Higher-order spectral phase leads to broadening of the temporal pulse envelope.

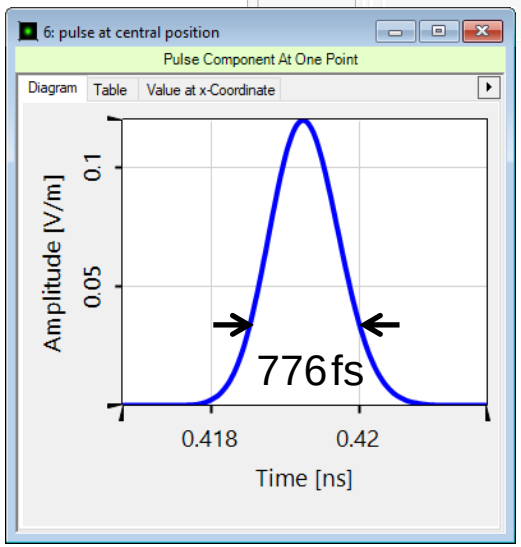
Peek into VirtualLab Fusion



customized pulse spectrum



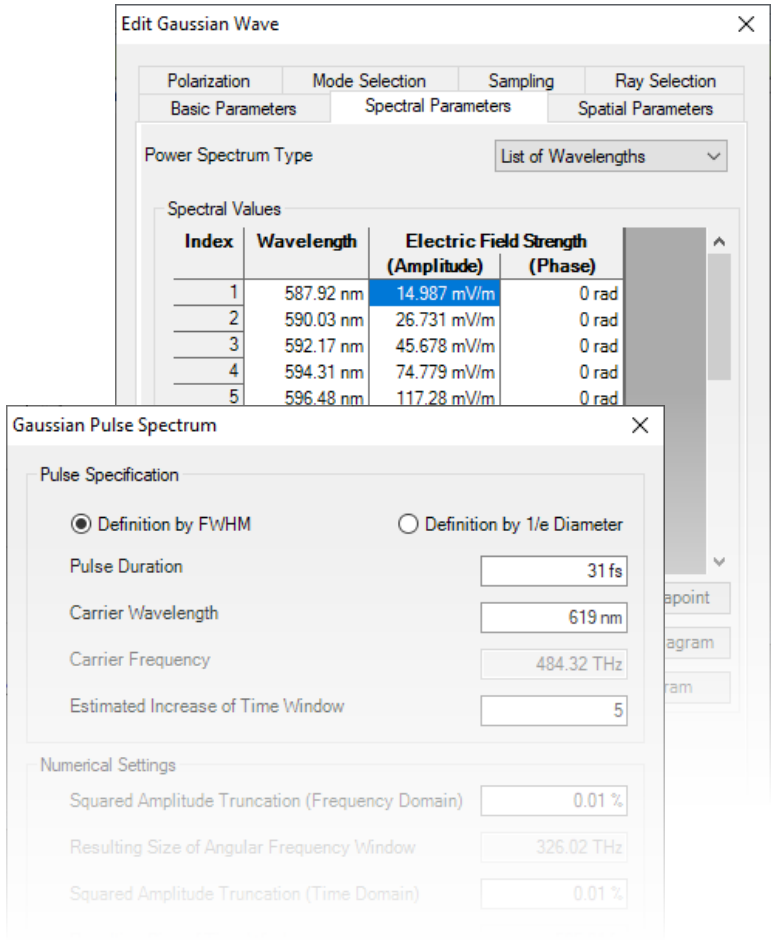




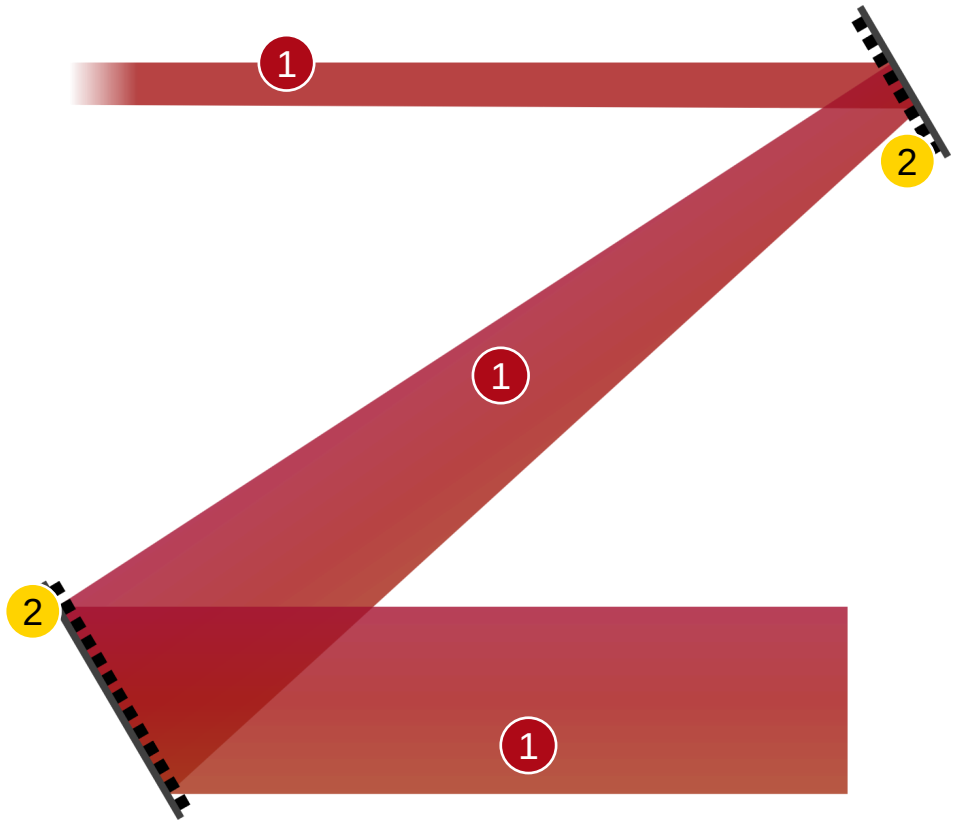
pulse evaluation detector

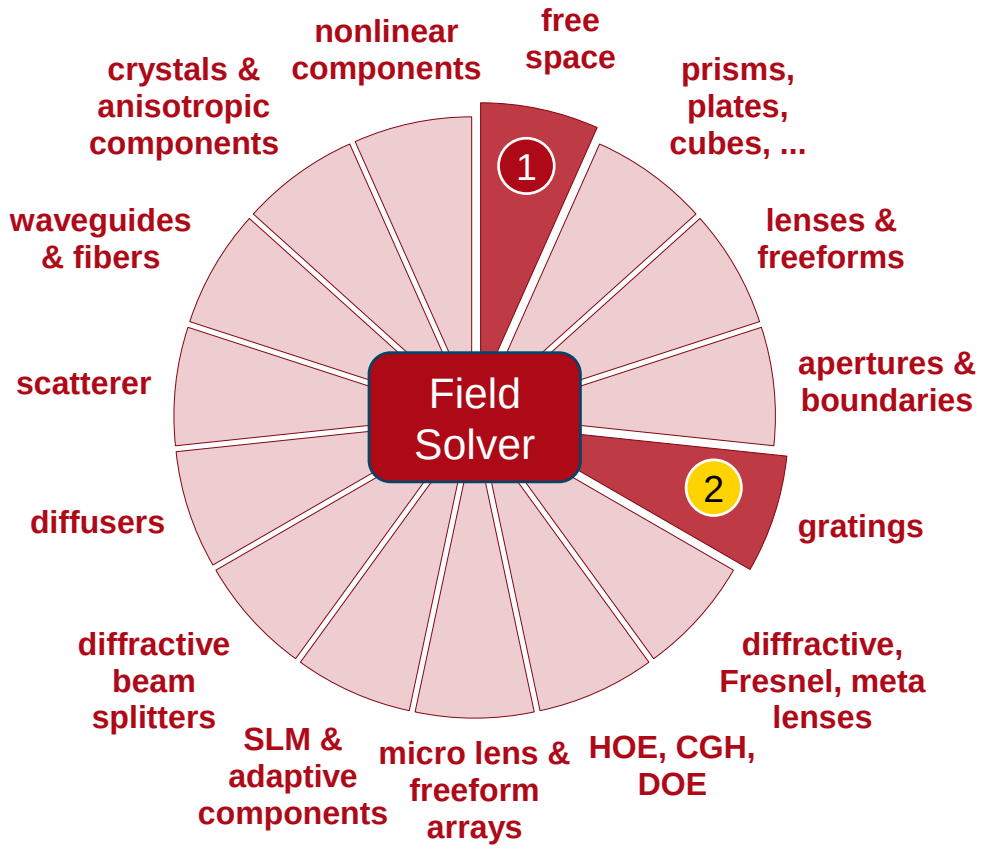
Workflow in VirtualLab Fusion

- Set up input Gaussian field
  - Basic Source Models [Tutorial Video]
- Set up an ideal grating and select the working diffraction order
- Select and set up the pulse evaluation detector



VirtualLab Fusion Technologies





idealized component

Document Information

title	Grating Stretcher for Ultrashort Pulses
document code	USP.0002
document version	1.1
software version	2023.1 (Build 1.556)
software edition	VirtualLab Fusion Basic
category	Feature Use Case
further reading	• Focusing of Femtosecond Pulse by using a High-NA Off-Axis Parabolic Mirror • Pulse Focusing with High-NA Lens • Pulse Broadening in Dispersive Media