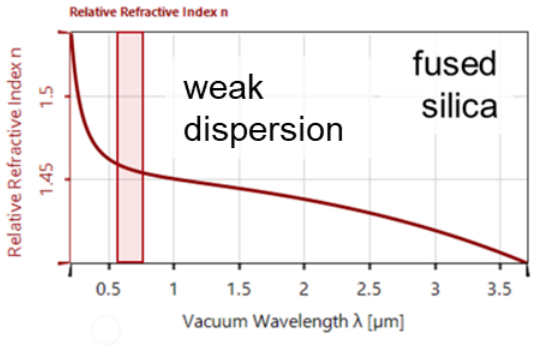
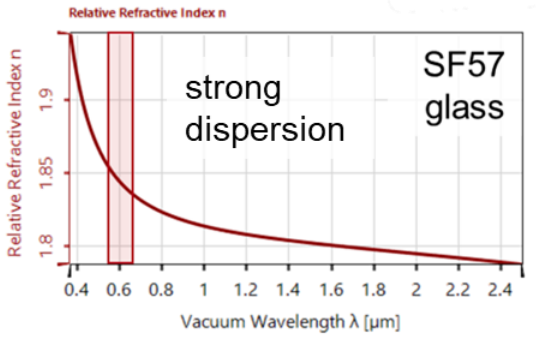
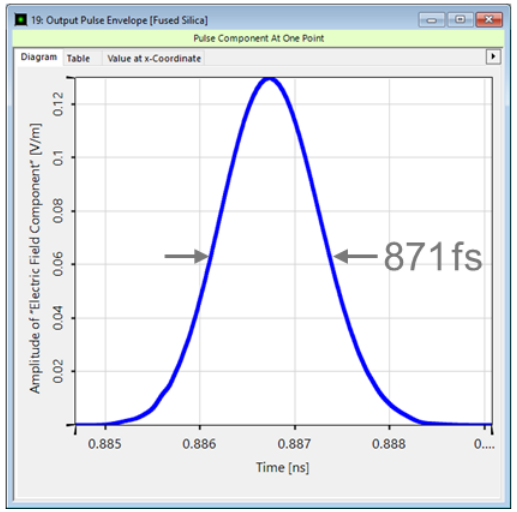
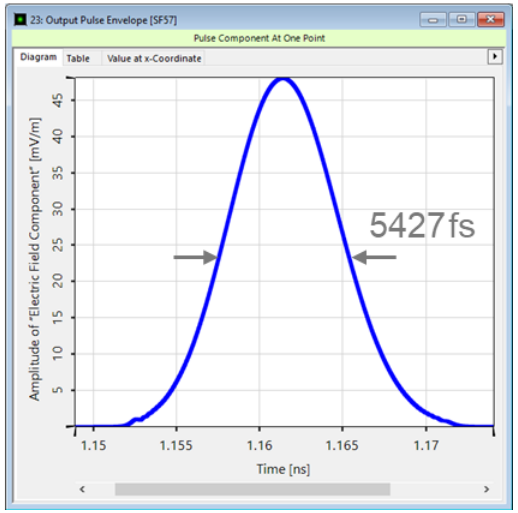
Pulse Broadening in Dispersive Media

Abstract



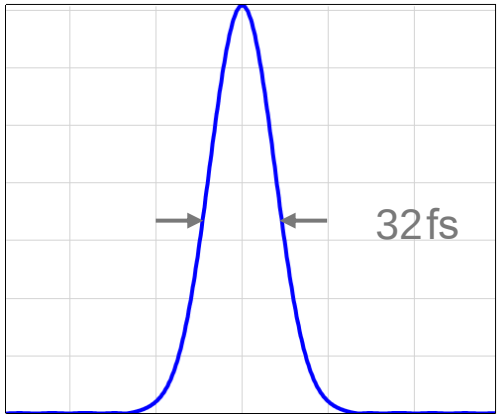






Ultrashort pulses are a promising tool for laser material processing applications. On the one hand, ultrashort pulses often show superiority in e.g. heat control and precision; on the other hand, due to dispersive effects, it can be challenging to maintain the pulse duration after propagation through a complete optical system. In this example, we investigate the relationship between pulse broadening and material dispersion, based on selected examples.

Modeling Task



input pulse

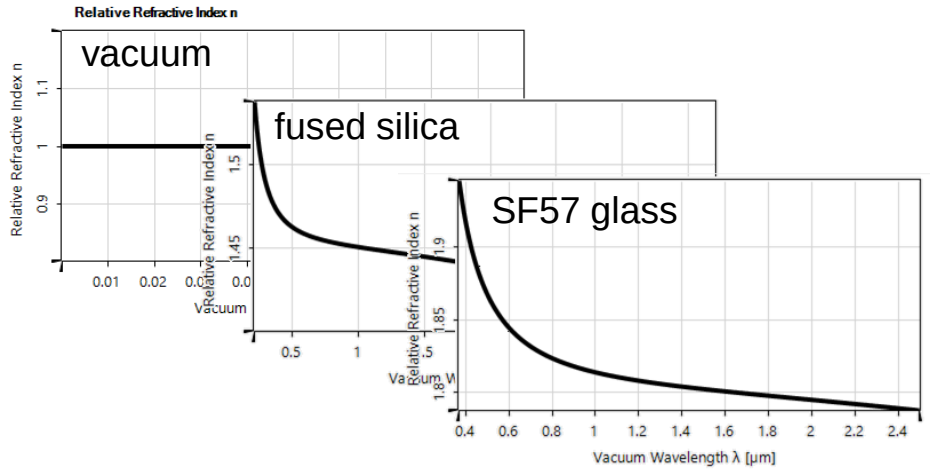
- carrier wavelength 619 nm
- temporal duration 32 fs
- Gaussian spatial profile [collimated]

180 mm

homogeneous media with different dispersion properties

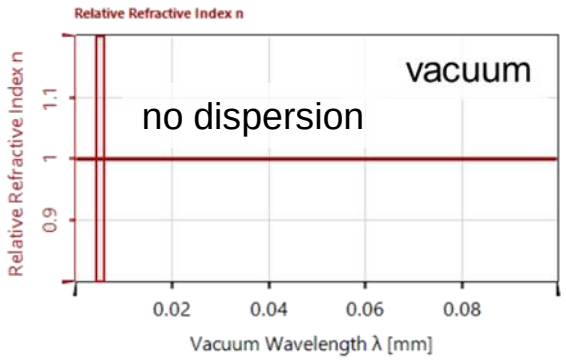
- vacuum
- fused silica
- SF57 glass

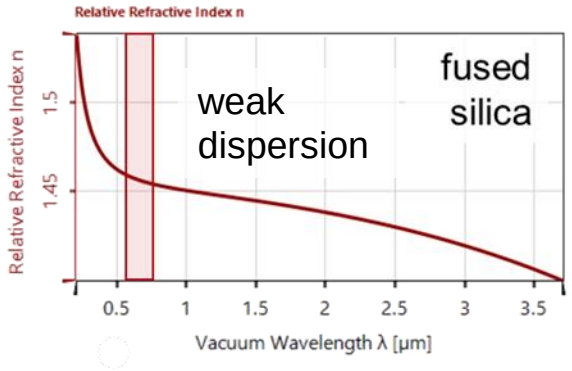
?

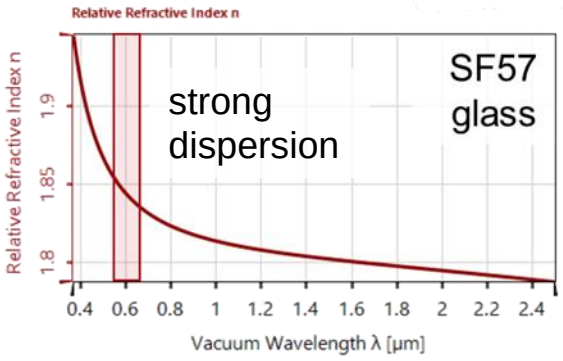


How do the dispersion properties of different media affect the pulse after propagation over a certain distance?

Output Pulse – Residual Phase over Frequency

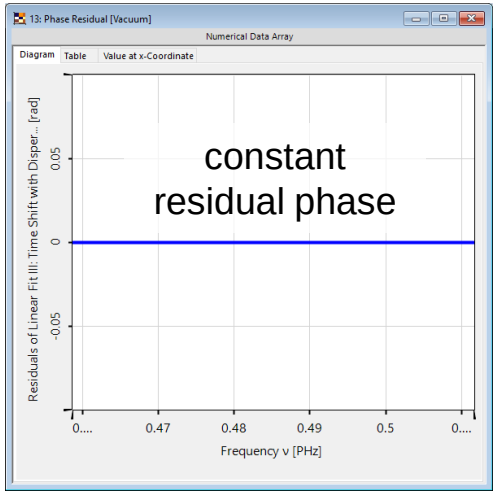




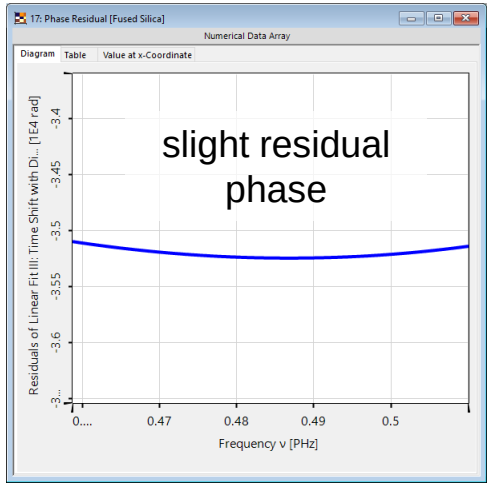


180 mm

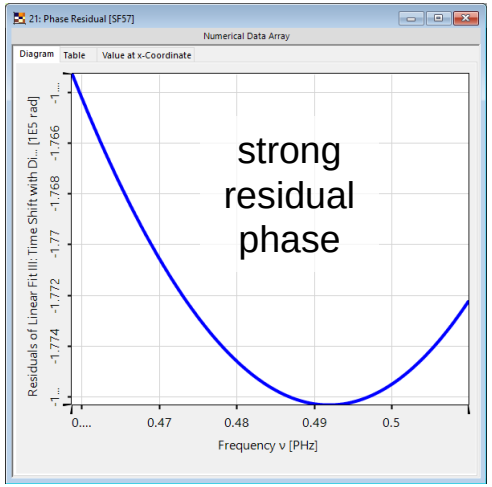
homogeneous media with different dispersions
- vacuum
- fused silica
- SF57 glass



vacuum



fused silica

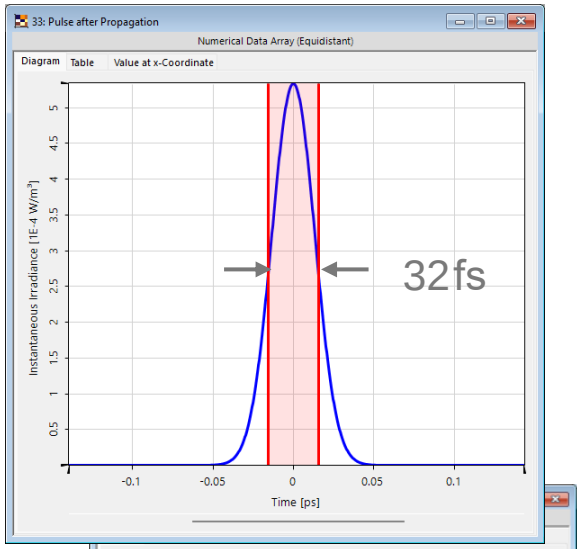


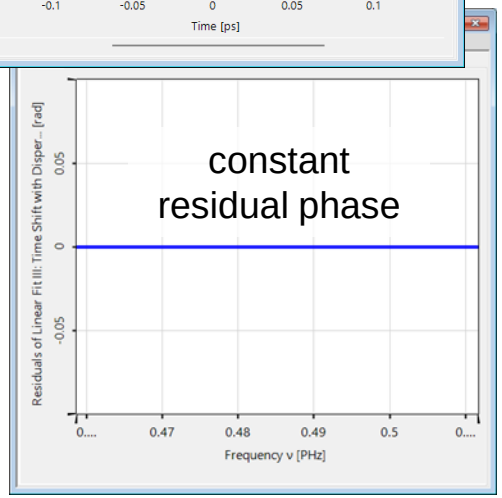
SF57 glass

Output Pulse – Pulse Duration

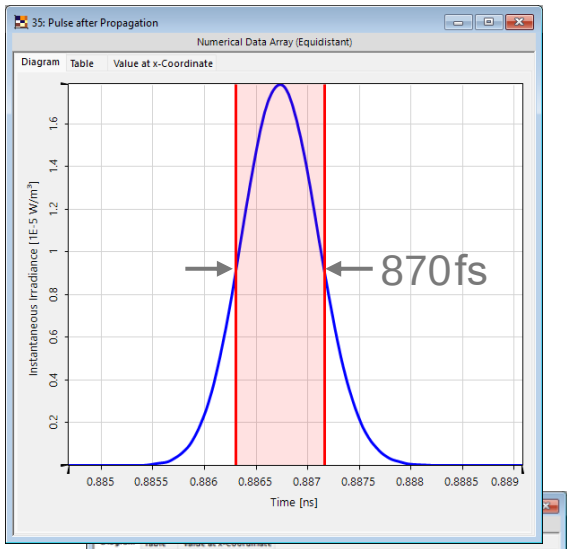
180 mm

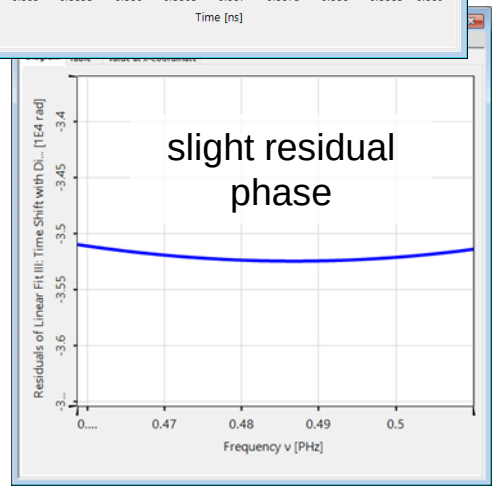
homogeneous media with different dispersions
- vacuum
- fused silica
- SF57 glass



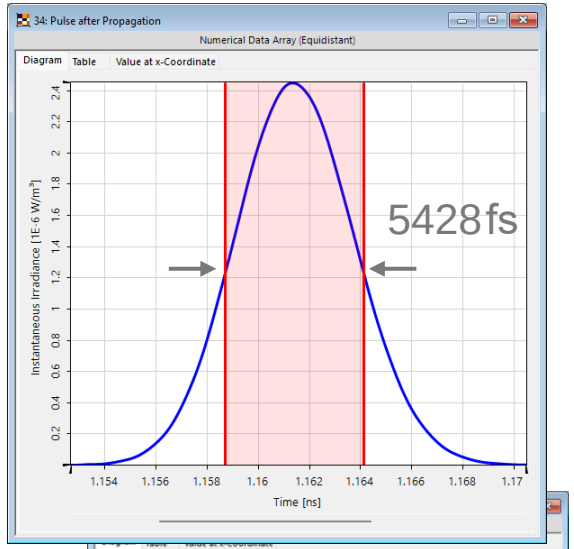


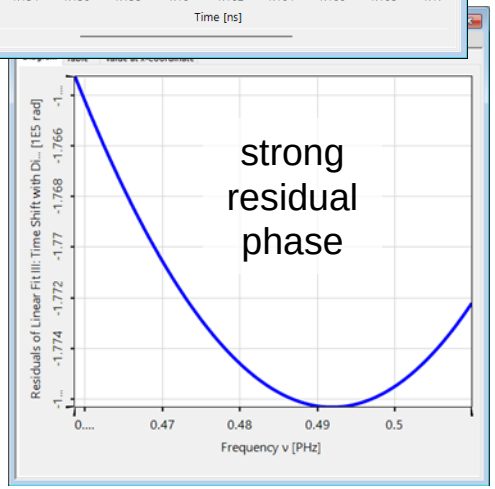
vacuum





fused silica





SF57 glass

Workflows

LP Mode Source

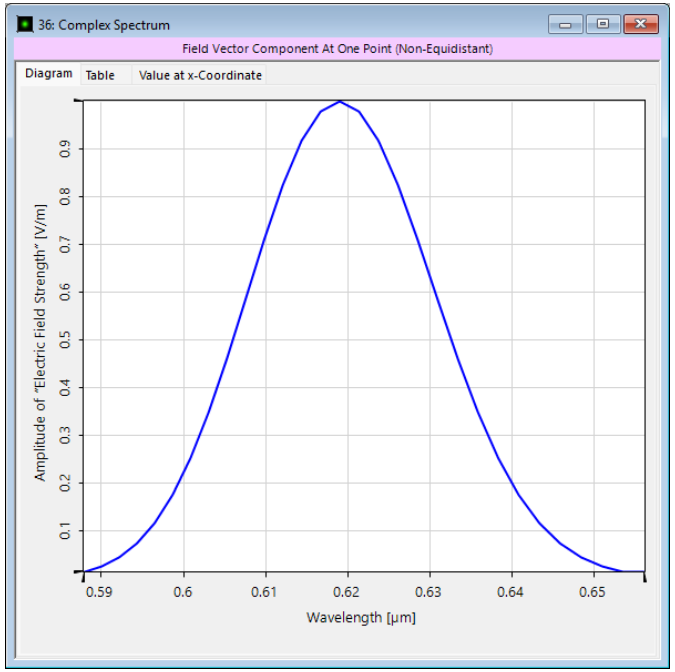
Source selection

System setup

Detector selection

Getting it done in VirtualLab Fusion:

- Gaussian Source
- Include Spectrum into Source



Gaussian spectrum

System Setup

Source selection

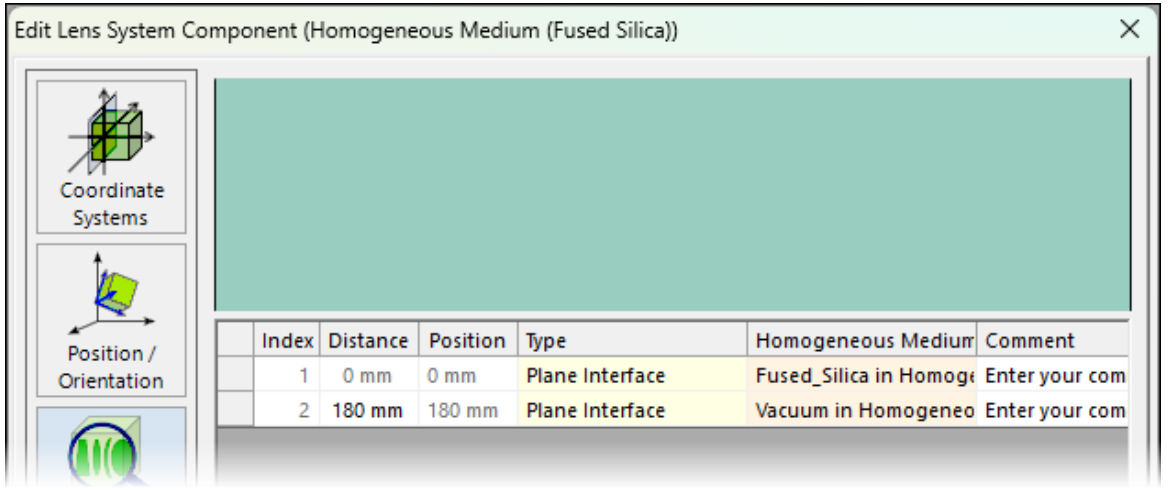
System setup

Detector selection

Getting it done in VirtualLab Fusion:

- Construct a Glass Block through two plane interfaces

	vacuum	fused silica	SF57
n@588nm	1	1.4585	1.8466
n@653nm	1	1.4565	1.8369
Δn(588~653nm)	0	2.0×10^{-3}	9.1×10^{-3}



Detector Selection

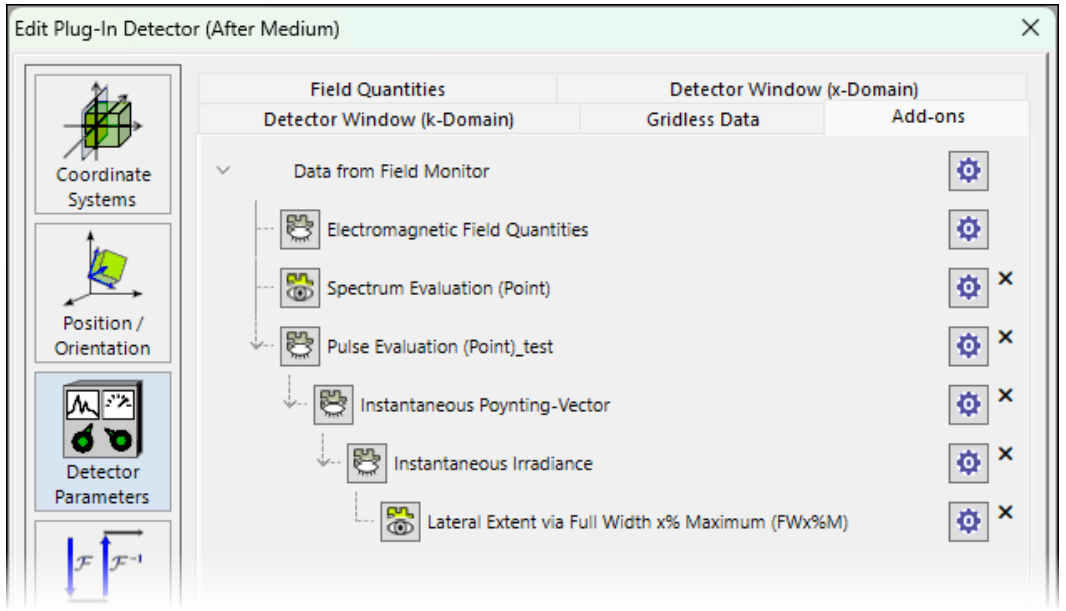
Source selection

System setup

Detector selection

Getting it done in VirtualLab Fusion:

- Pulse Evaluation



Document Information

Title	Pulse Broadening in Dispersive Media
Document code	USC.0132
Publication date	08.07.2025
Required packages	-
Software version	2025.1 (Build 1.172)*
Category	Use Case
Further reading	- Focusing of Femtosecond Pulse by using a High-NA Off-Axis Parabolic Mirror - Pulse Focusing with High-NA Lens - Grating Stretcher for Ultrashort Pulses

** The files attached to this document require the specific version or later.*