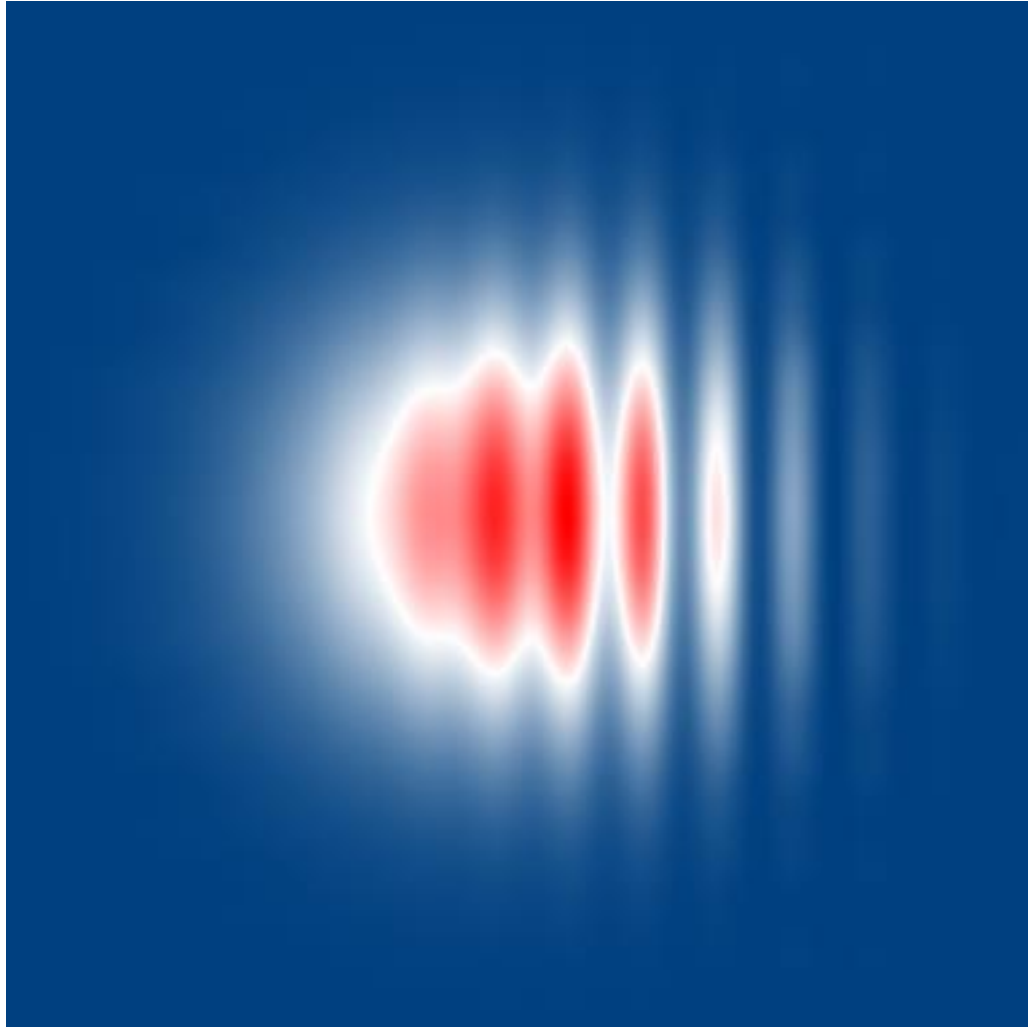


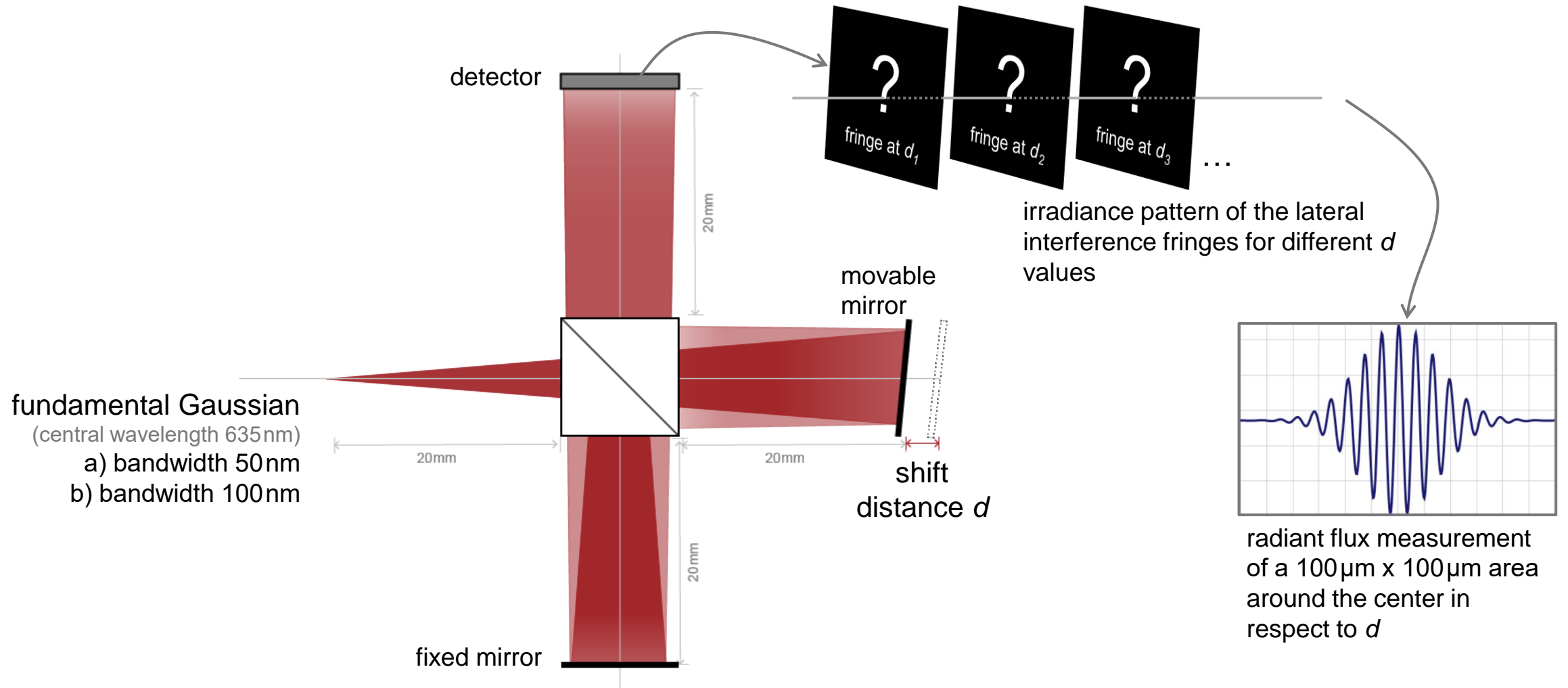
# **Coherence Measurement Using Michelson Interferometer and Fourier Transform Spectroscopy**

# Abstract

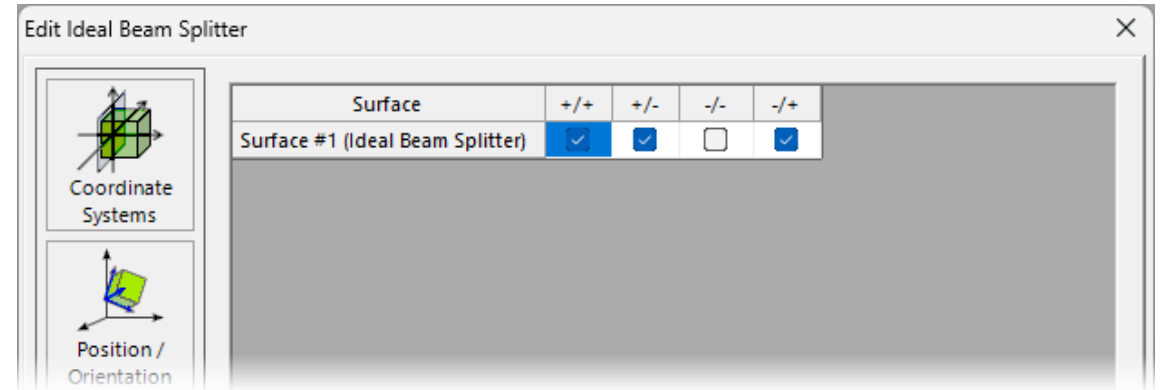
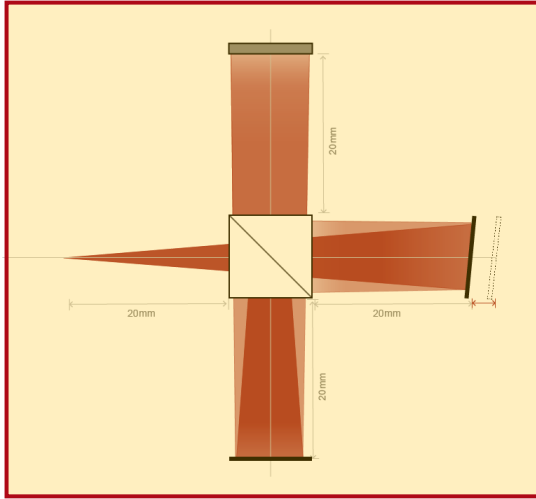


It is known that, in an interferometer, the fringe contrast may depend on the coherence of the light source. For example, in a Michelson interferometer with a source of a certain bandwidth, the interference fringe contrast decreases as the optical path difference between the two arms increases. By measuring the interferogram contrast at different positions of the movable mirror, the coherence length of the source can be concluded. Typical Fourier-transform spectroscopy is usually based on optical setups of this kind.

# Modeling Task

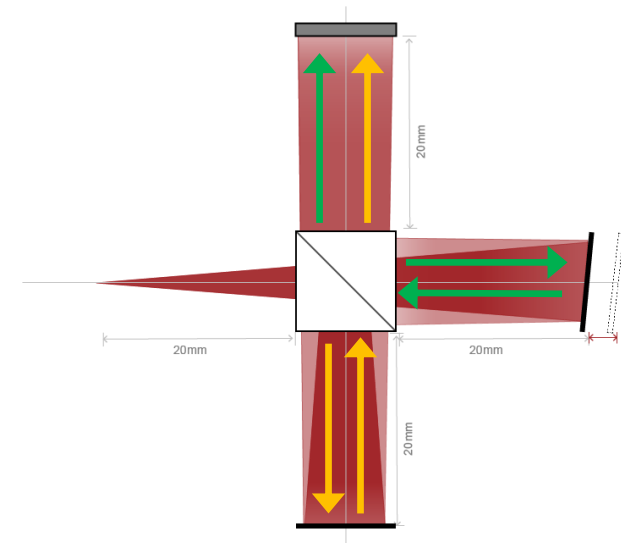


# Non-Sequential Tracing

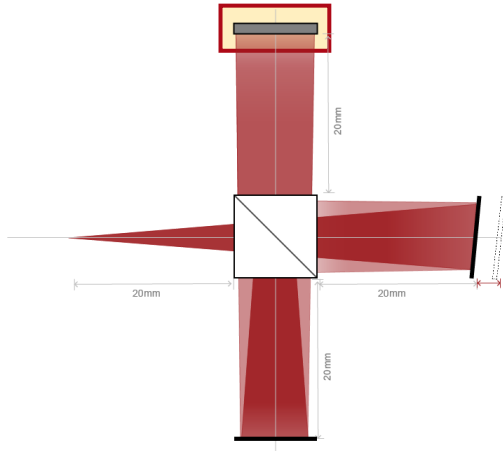


With the channel configuration mode toggle set to *Manual Configuration*, the user can specify, for each surface in the system, which channels to open for the simulation. When the simulation is run, a preliminary analysis of the active light paths will be performed (by the so-called *Light Path Finder*). The field will then be traced along these light paths by the engine, to the detectors present in the system.

## Channel Setting for Non-Sequential Tracing

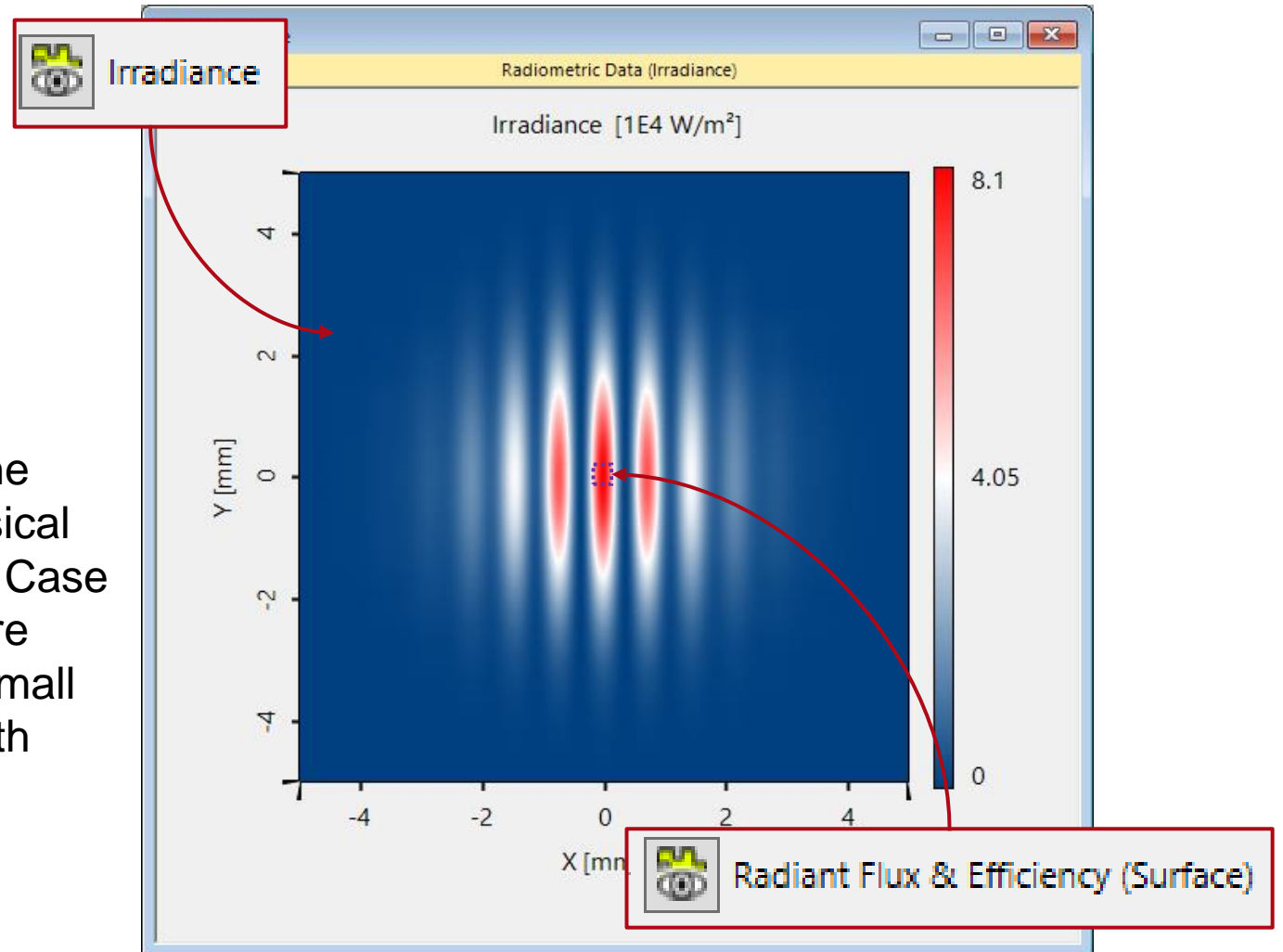


# Detector Add-On

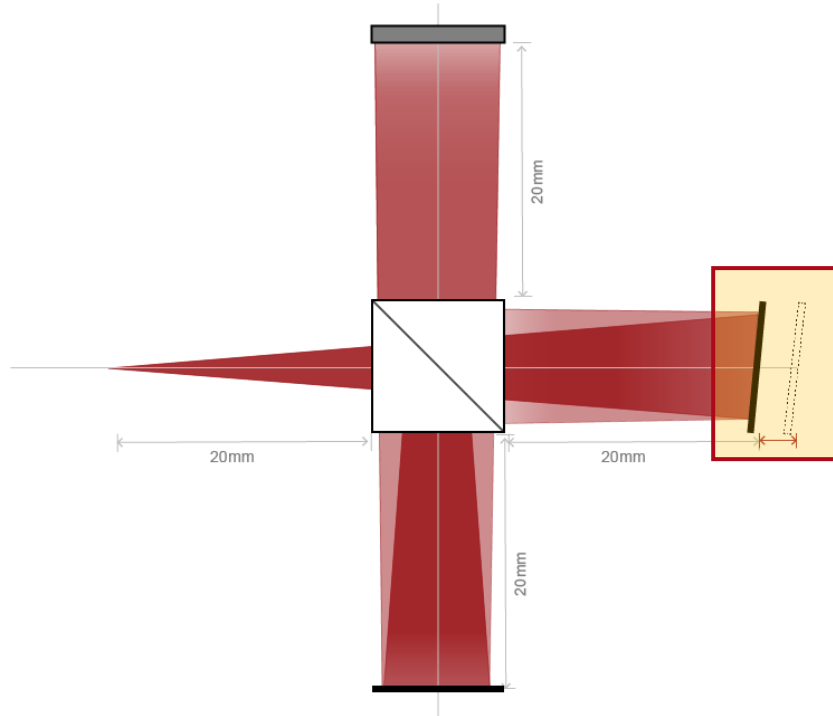


The *Universal Detector* allows the evaluation of the impinging field and the calculation of various physical quantities through so-called *Add-Ons*. In this Use Case specifically we calculate the Irradiance of the entire pattern. We then measure the *Radiant Flux* in a small region around the center to visualize the bandwidth dependency. For more information, see:

[Universal Detector](#)



# Parameter Run



The actual coherence measurement is performed by varying the position of the tilted mirror. Such a variation of parameters can be achieved by a *Parameter Run*.

7: Parameter Run

**Parameter Specification**  
Set up the parameter(s) to be varied.

You can select one or more parameters which shall be varied as well as the resulting number of iterations. Several [modes](#) are available specifying how the parameters are varied per iteration.

Usage Mode: Standard

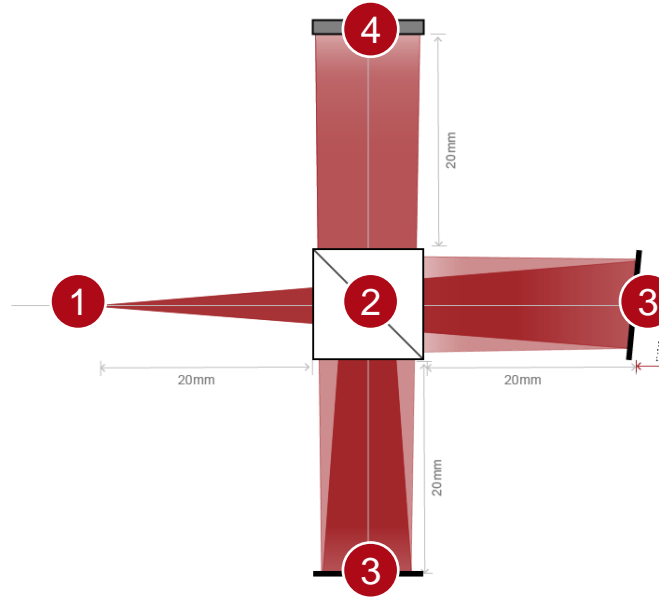
Filter by...  Show Only Varied Parameters

1	2	*	Object	Category	Parameter	Vary	From	To	Steps	Step Size	Original Value
			"Movable Mirror" (# 2)	Basal Po...	Rotation #1 (abou...	<input type="checkbox"/>	-360°	360°	1	720°	0°
				Basal Positioning (Absol...	X	<input type="checkbox"/>	-1E+297 km	1E+297 km	1	2E+297 km	0 mm
					Y	<input type="checkbox"/>	-1E+297 km	1E+297 km	1	2E+297 km	0 mm
					Z	<input type="checkbox"/>	-1E+297 km	1E+297 km	1	2E+297 km	40 mm
				Isolated Positioning	Translation Delta X	<input type="checkbox"/>	-1E+297 km	1E+297 km	1	2E+297 km	0 mm
					Translation Delta Y	<input type="checkbox"/>	-1E+297 km	1E+297 km	1	2E+297 km	0 mm
					Translation Delta Z	<input checked="" type="checkbox"/>	-3 µm	3 µm	121	50 nm	1 µm
				Free Space Propagation (Profile Physical Optics)	Rotation #1 (abou...	<input type="checkbox"/>	-360°	360°	1	720°	0.05°
					Initial Number of...	<input type="checkbox"/>	3	2E+09	1	2E+09	1100
					Control Factor of...	<input type="checkbox"/>	0.1	100	1	99.9	1
					Accuracy Nyquist...	<input type="checkbox"/>	-4	4	1	8	0
					Oversampling Fact...	<input type="checkbox"/>	1E-300	1E+300	1	1E+300	1
			Physical Optics)	PFT Selection Acc...	<input type="checkbox"/>	-2.1475E+09	2.1475E+09	1	4.295E+09	0	
				Sampling Limit to...	<input type="checkbox"/>	11	2E+09	1	2E+09	5792	
				Threshold for Sem...	<input type="checkbox"/>	1E-300	1E+300	1	1E+300	?	

< Back    Next >    Show ▾

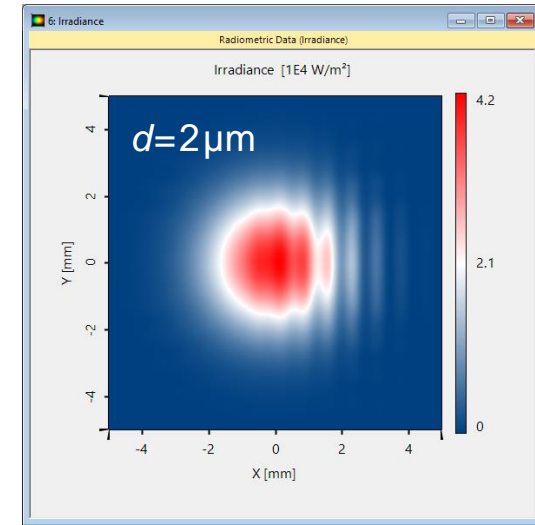
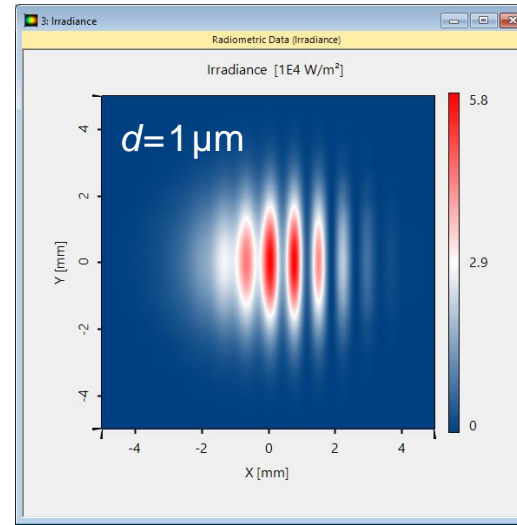
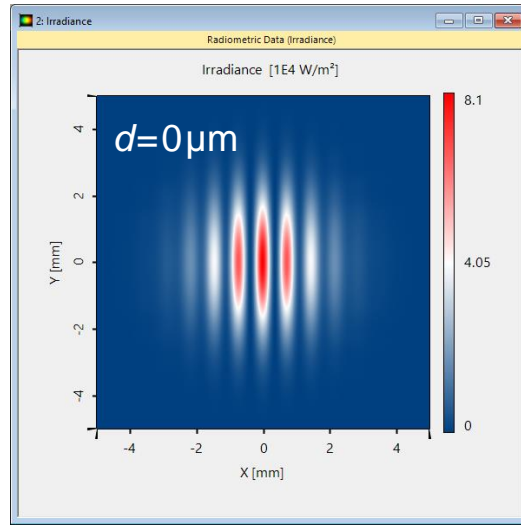
*Usage of the Parameter Run Document*

# Summary – Components...

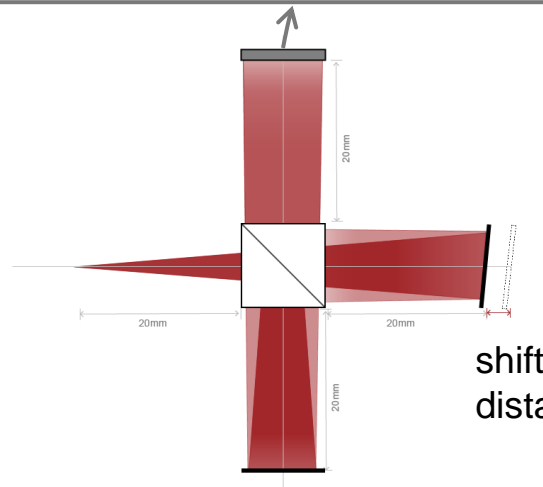


... of Optical System	... in VirtualLab Fusion	Model/Solver/Detected Value
1. Source	Gaussian Wave	spatial Gaussian formula
2. Beam Splitter	Ideal Beam Splitter	transmission function
3. Mirror	Ideal Mirror	Local Plane Interface Approximation
6. Detector	Universal Detector	Irradiance/radiant flux

# Lateral Interference Fringes – 50 nm Bandwidth



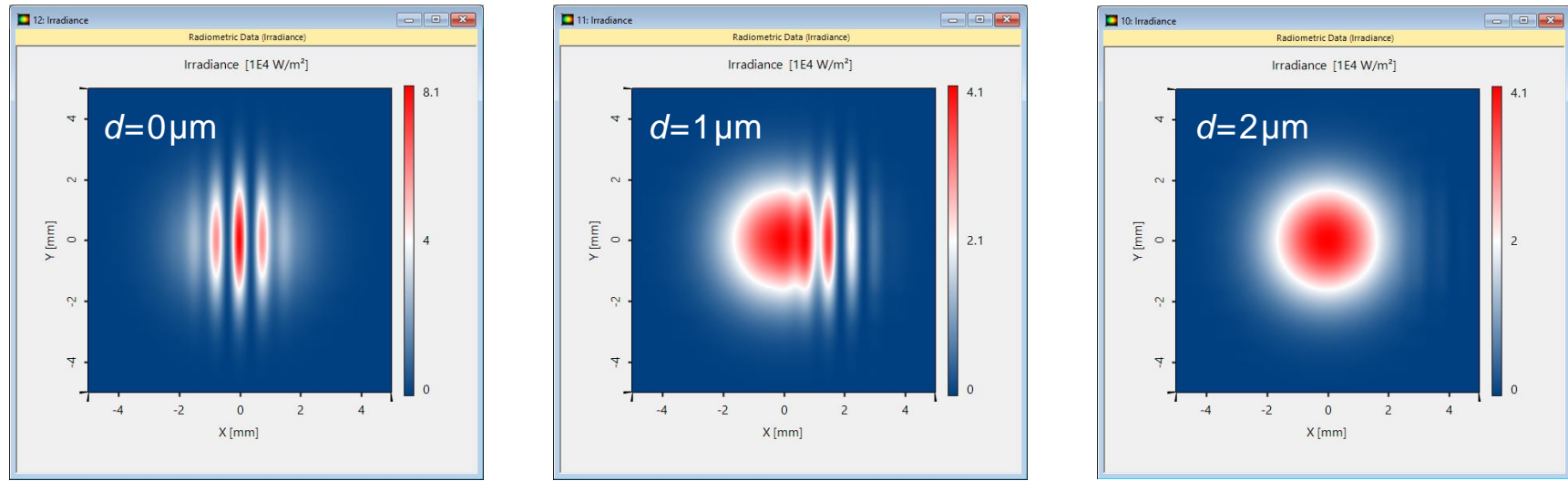
fundamental Gaussian  
(central wavelength 635nm)  
a) bandwidth 50nm



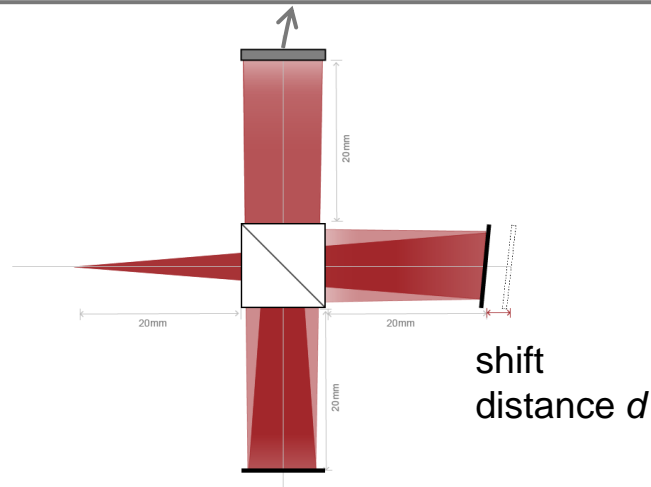
The interference pattern is only visible when the two arms are the same length, with the contrast of the fringes decreasing as the path difference increases. The region where the fringes remain visible represents the *coherence length*. The asymmetry is caused by the mirror tilt.



# Lateral Interference Fringes – 100 nm Bandwidth

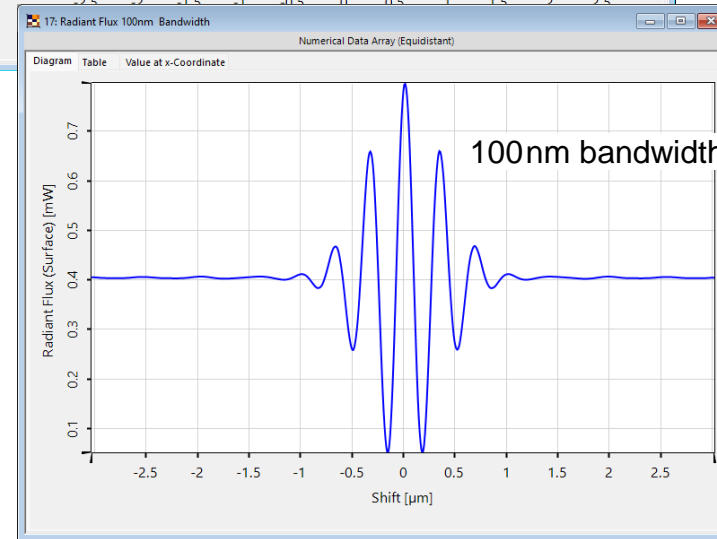
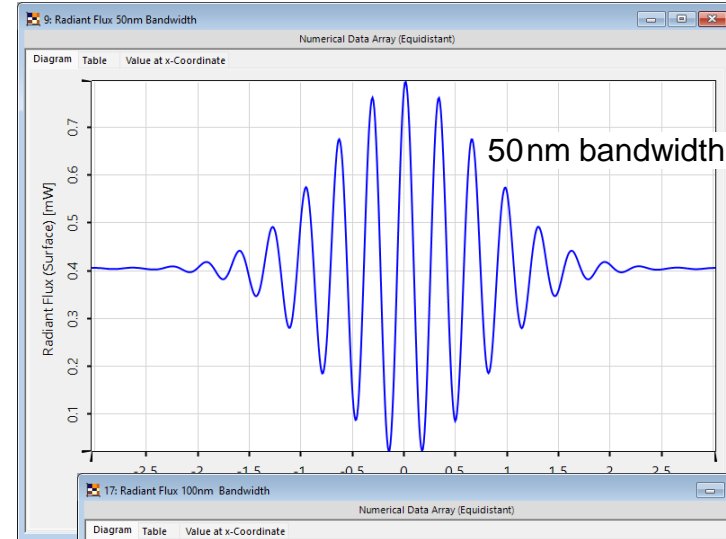
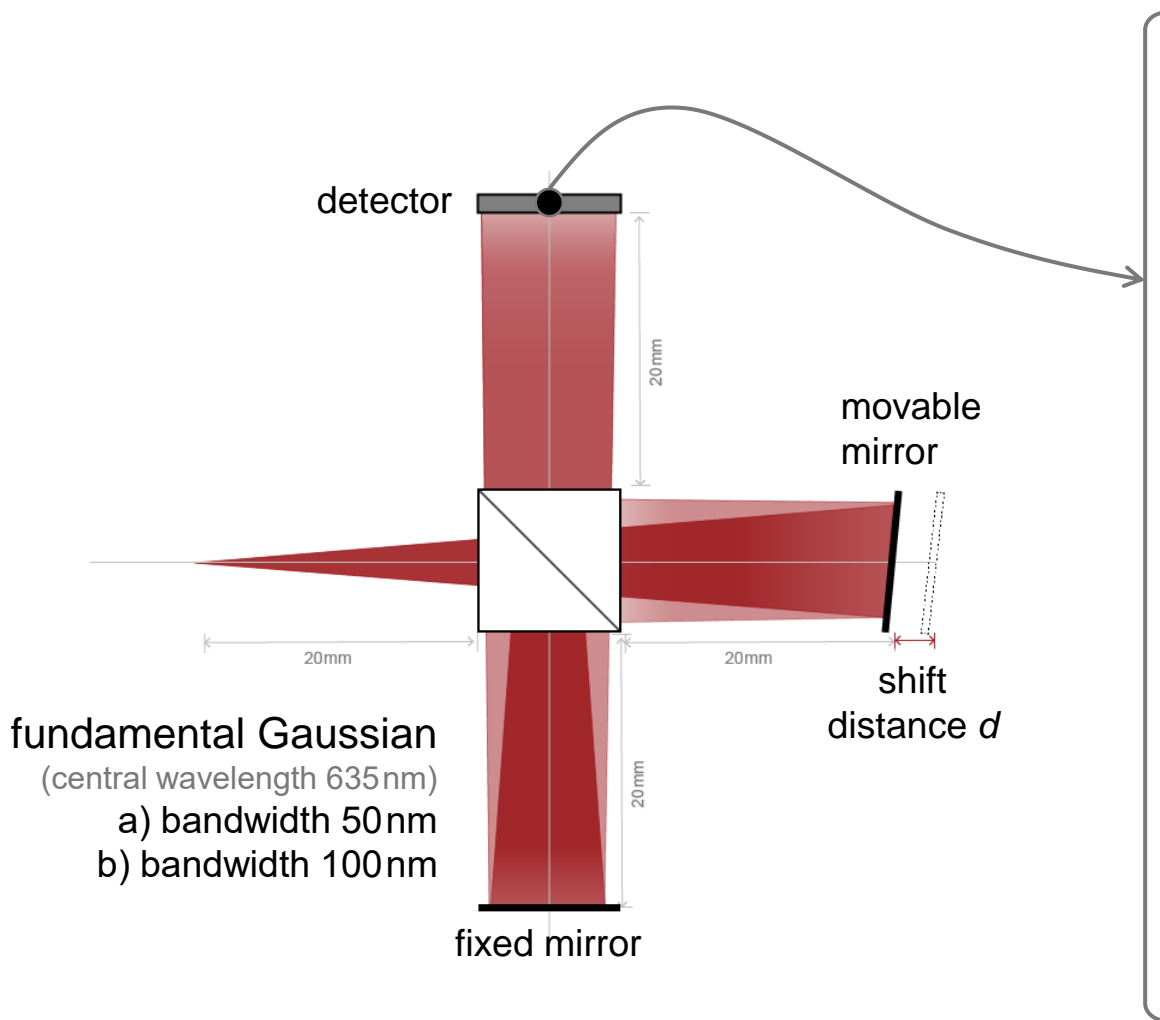


fundamental Gaussian  
(central wavelength 635nm)  
b) bandwidth: 100nm



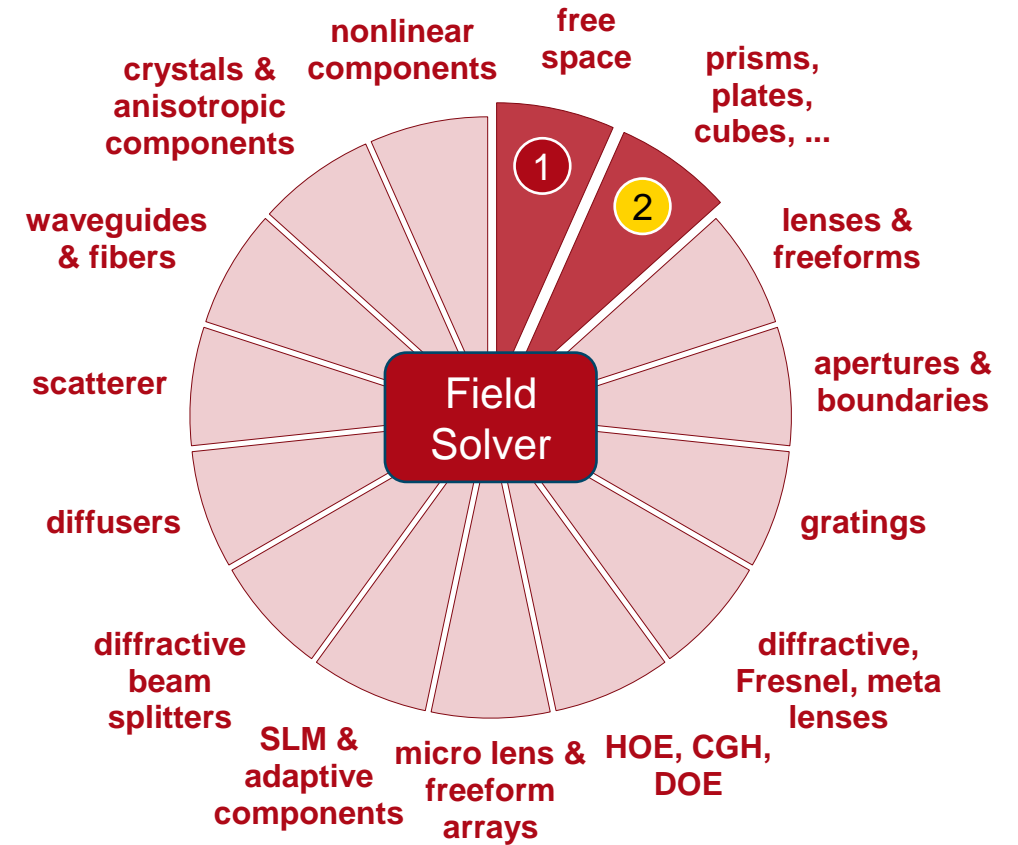
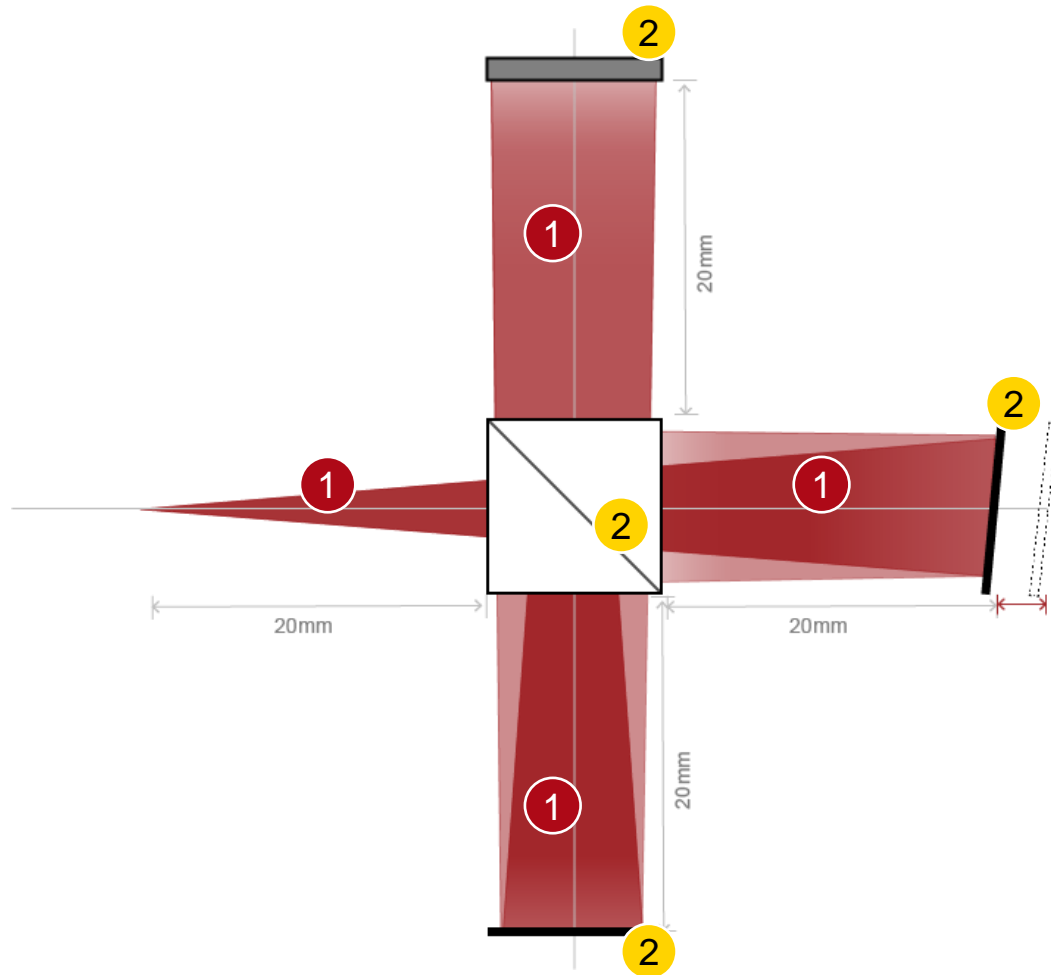
Broader spectral bandwidth leads to a shorter coherent length; therefore the interference fringe starts to vanish sooner in comparison to the case with narrower bandwidth.

# Radiant Flux Measurements of the On-Axis Point



When measuring the radiant flux on axis the coherence length can be directly visualized. It is quite clear that it is inversely proportional to the bandwidth of the incoming light.

# VirtualLab Fusion Technologies



# idealized component

# Document Information

title	Coherence Measurement and Fourier Transform Spectroscopy
document code	IFO.0002
version	1.1
edition	VirtualLab Fusion Basic
software version	2023.1 (Build 1.556)
category	Application Use Case
further reading	<ul style="list-style-type: none"><li>• <a href="#"><u>Laser-Based Michelson Interferometer and Interference Fringe Exploration</u></a></li><li>• <a href="#"><u>Mach-Zehnder Interferometer</u></a></li><li>• <a href="#"><u>Fizeau Interferometer for Optical Testing</u></a></li></ul>