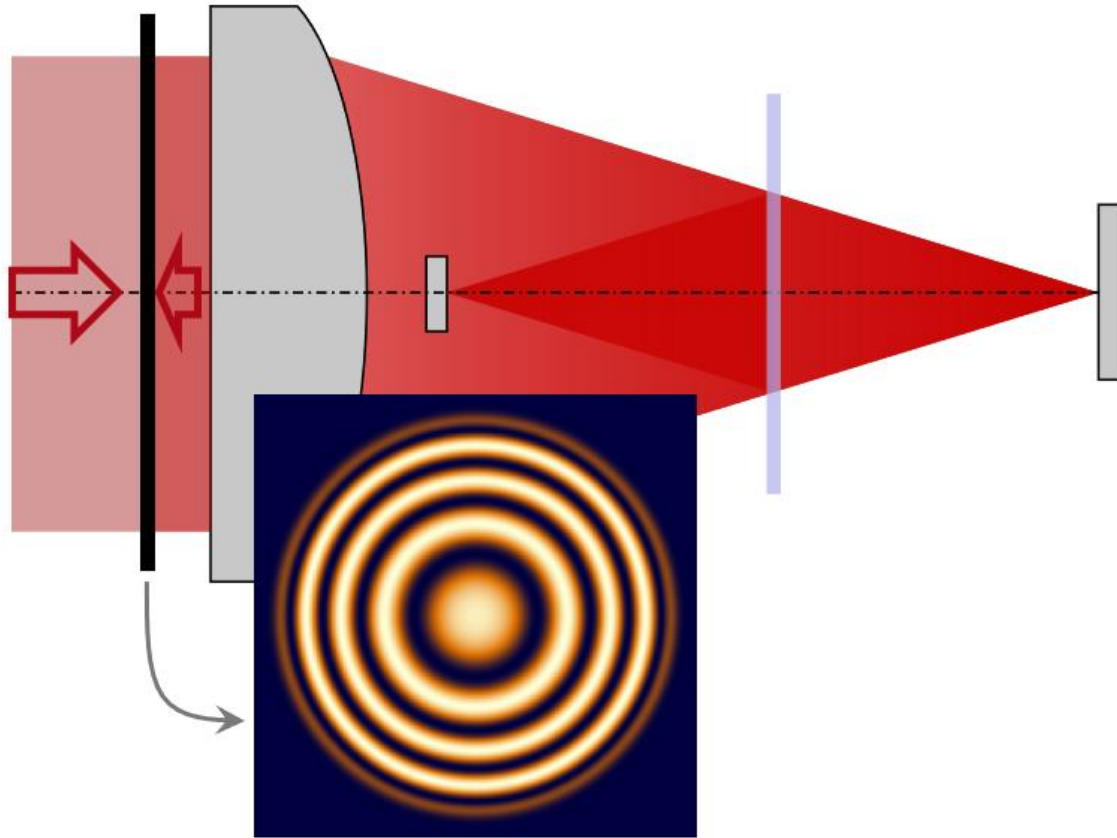


# Simulation of Basic Mirau Interferometer

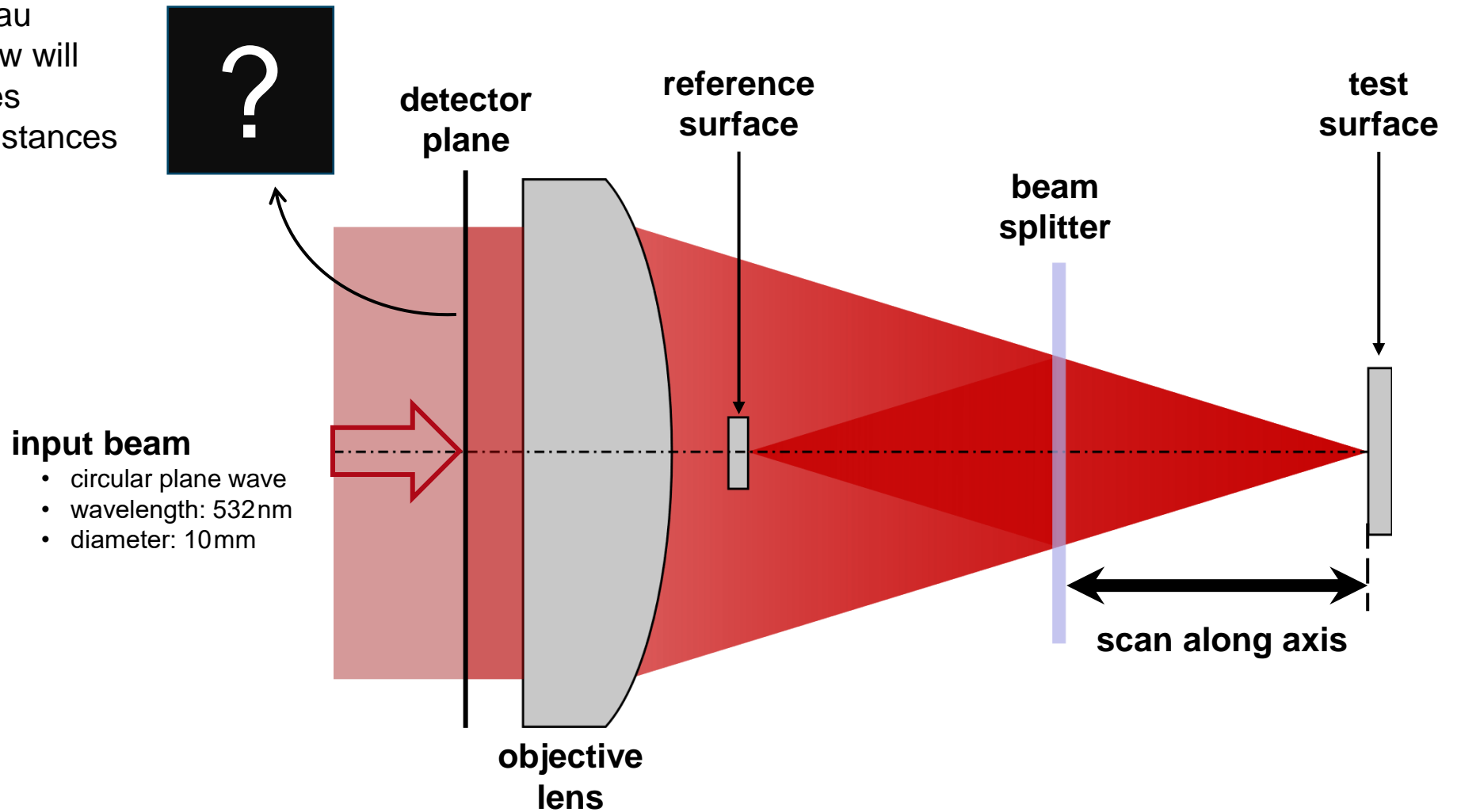
# Abstract



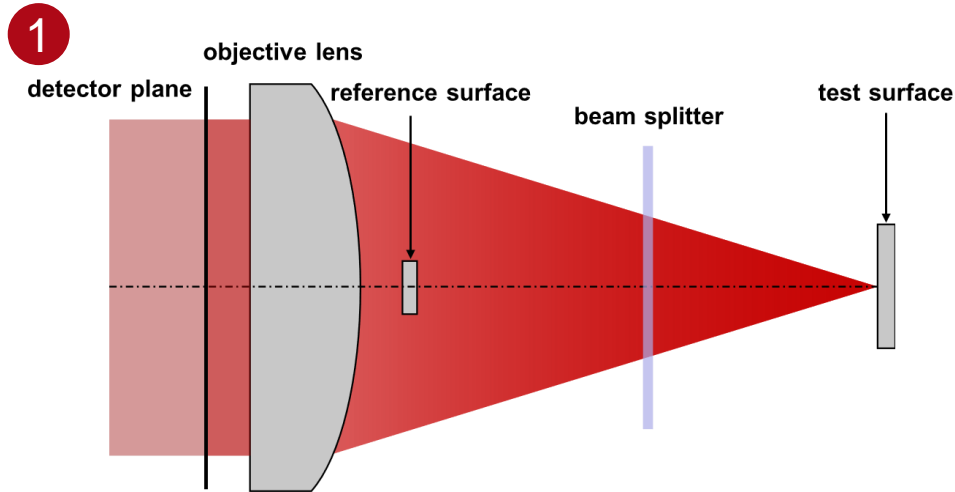
How can a Mirau interferometer be set up in VirtualLab Fusion? This use case demonstrates the modeling via the nonsequential channel configuration and the simulation of the basic functionality. Typical defocus fringes from different test surface positions are evaluated.

# Task Description: Schematic of a Mirau Interferometer

How to model the Mirau interferometer and how will the interference fringes change for different distances of the tested surface?



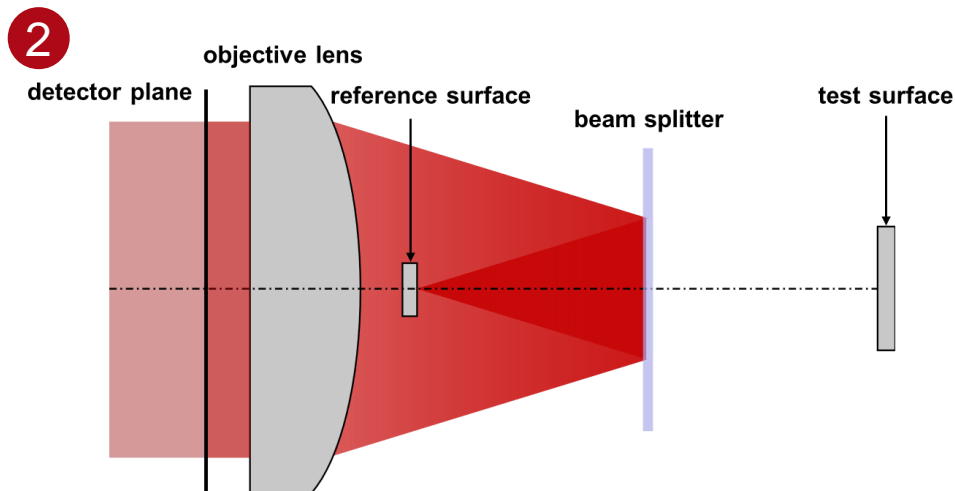
# System Building Blocks & Light Paths



The basic building blocks of the common Mirau interferometer are a microscope objective lens, a reference surface (mirror), a semi-transparent optical element (beam splitter) and the actual test object.

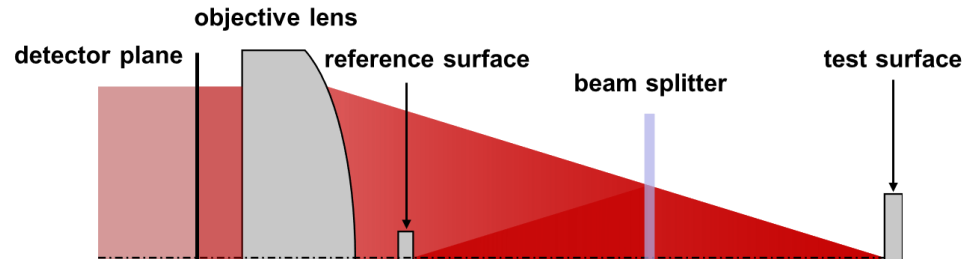
There are two main paths from the source to the detector:

1. One beam passes through the beam splitter, is then reflected by the test surface and goes all the way back to the detector.
2. The other beam is reflected by the beam splitter, focuses on the reference surface, where it is mirrored, again reflected by the splitter and then goes back through the microscope objective till the detector.



By using the *Manual Channel Configuration* mode, it is not necessary to set up these two light paths sequentially (which is also possible within one optical setup).

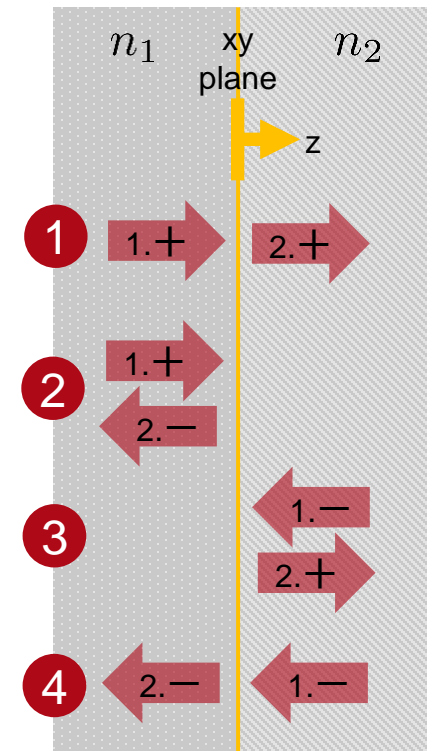
# Idealizations & Channel Control



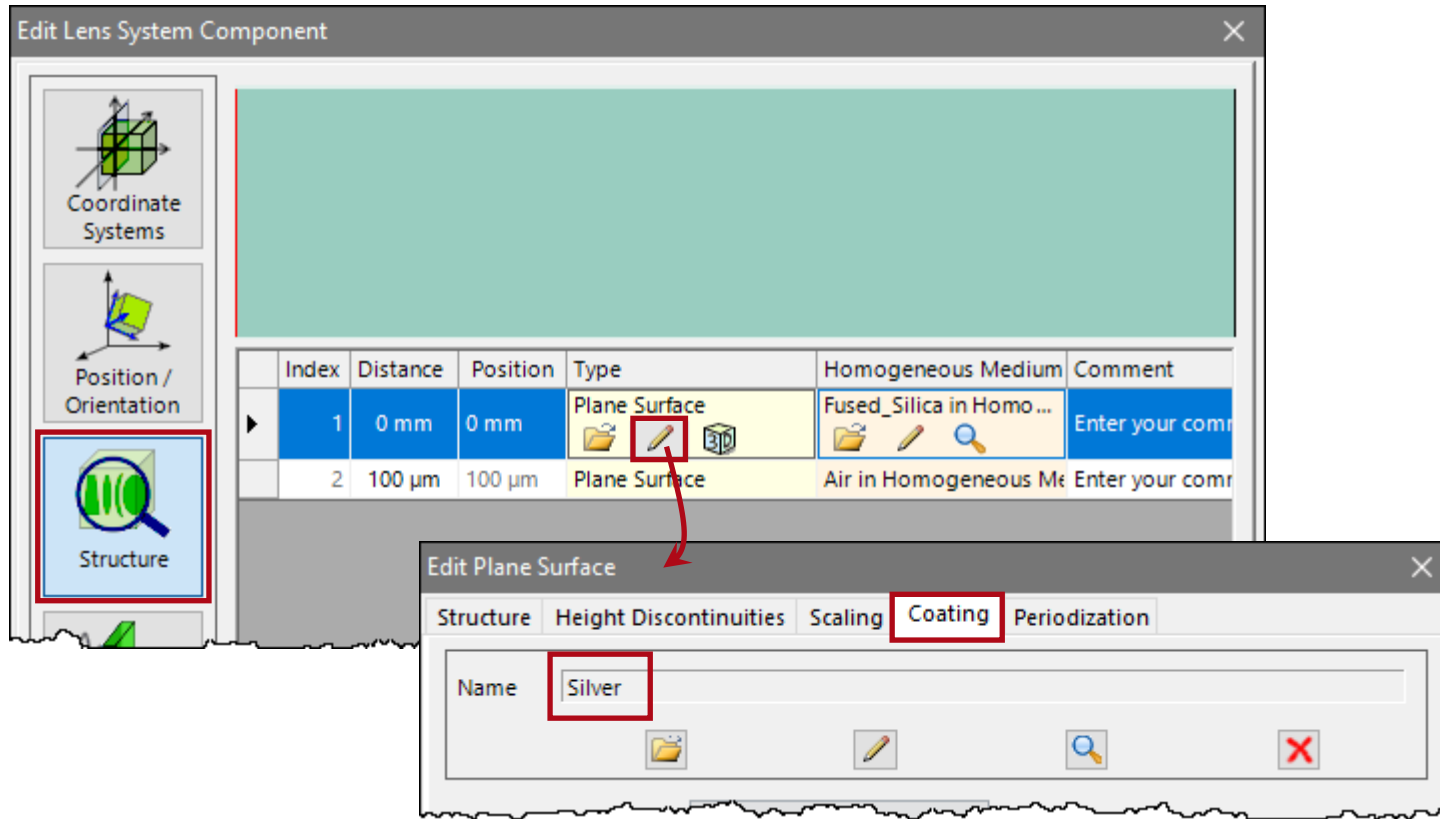
The benefit of simulations is that one can focus on the relevant parts of the system and reduce other effects almost arbitrarily.

1. The microscope objective lens is simulated by an ideal lens.
2. For the semi-transparent plate (beam splitter) a plane-parallel plate made of fused silica is used with a 15.5nm silver coating on its first surface. For neglecting the back reflections on the second surface we used VirtualLab's *Manual Channel Configuration* to switch off these light portions. This way no separate modelling of an anti-reflection (AR) coating is needed.
3. In reality, the small reference surface is attached to a transparent plate. Here we just model a "floating" ideal plane mirror.
4. For the whole field tracing simulation *Modeling Level 1* is used, thus diffraction effects from the truncation of the ideal plane wave are neglected.

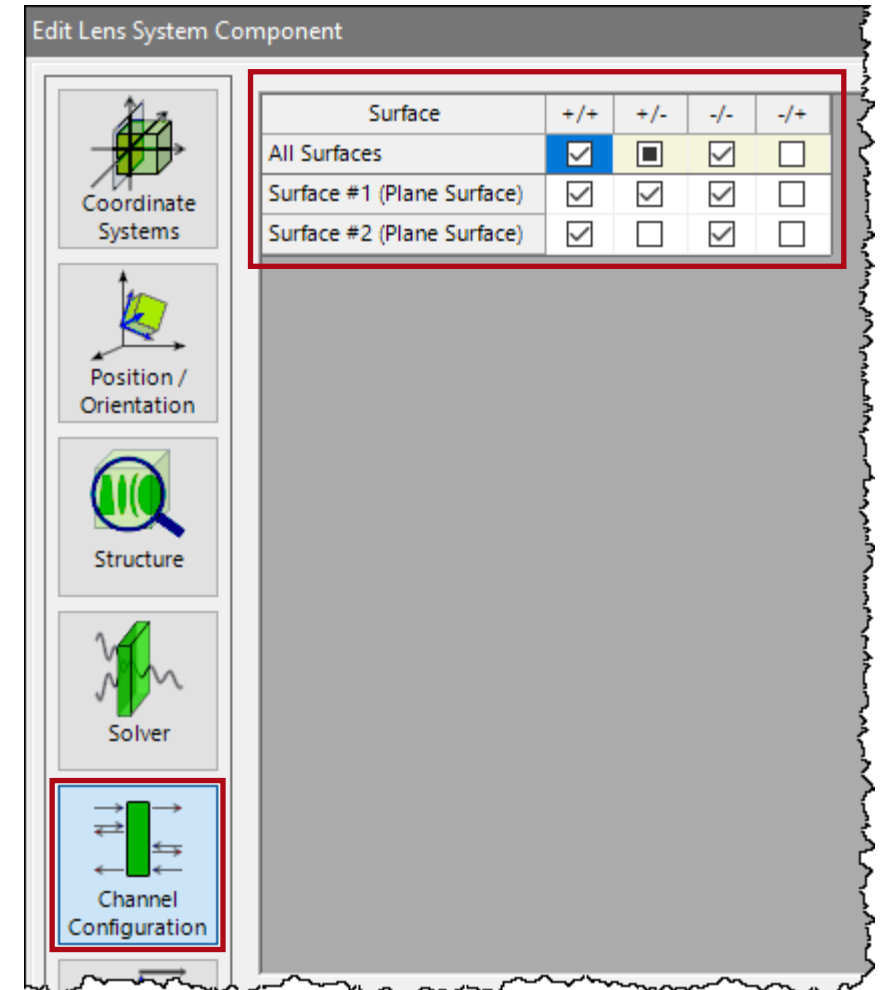
## 4 types of channels



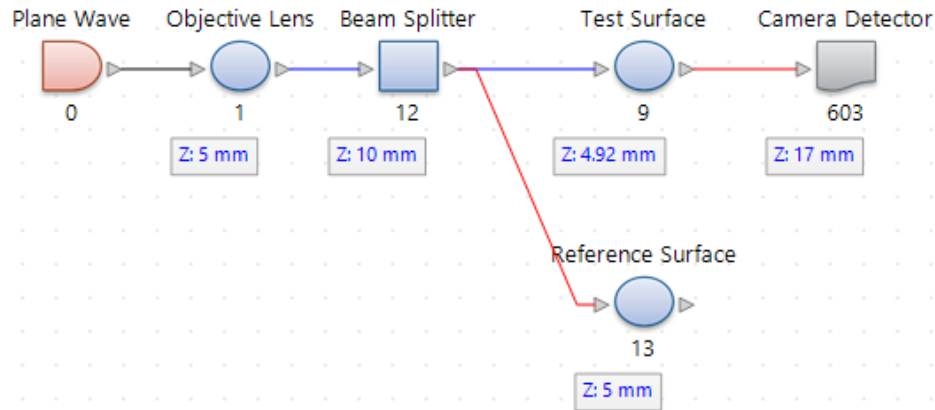
# Semi-Transparent Plate (Beam Splitter) Settings



Typically, partial-transparent plates with different reflectance values are used for the beam splitting, as the more balanced the energy splitting the better the contrast of the interference fringes.

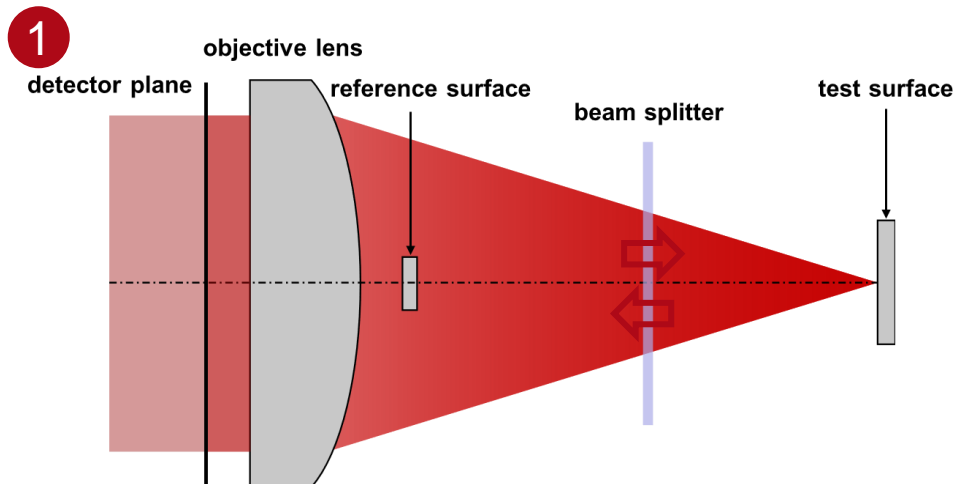


# System Building Block – Light Path #1



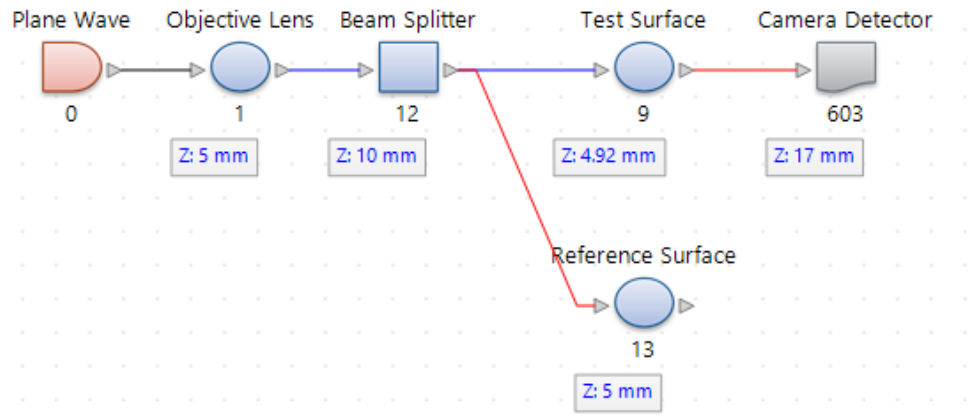
## Light Going Through the Semi-Transparent Plate

- The test surface is positioned in the focal region of the objective lens.
- Channel +/+ and -/- are open for both surfaces of the semi-transparent plate to allow the light from the source and the light reflected from the test surface to pass through.



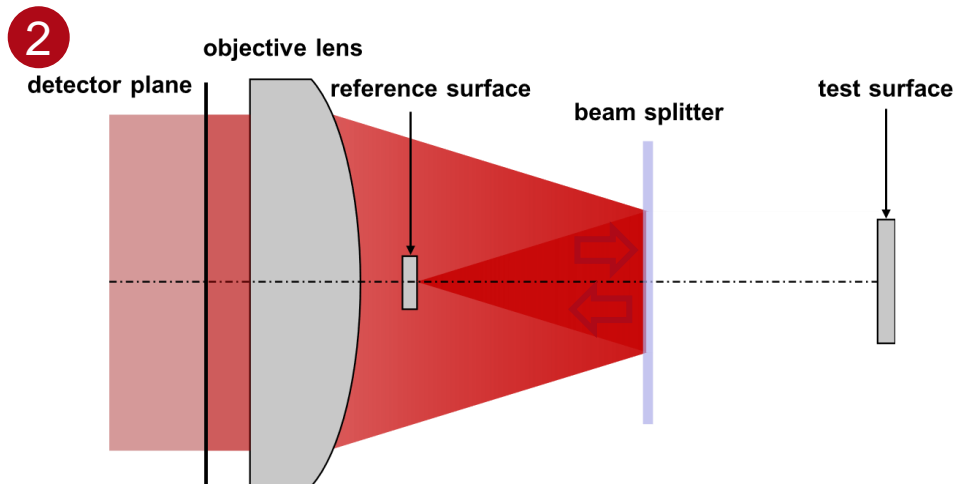
Surface	+/+	+/-	-/-	-/+
All Surfaces	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Surface #1 (Plane Surface)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Surface #2 (Plane Surface)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

# System Building Block – Light Path #2



## Light Being Reflected by the Semi-Transparent Plate

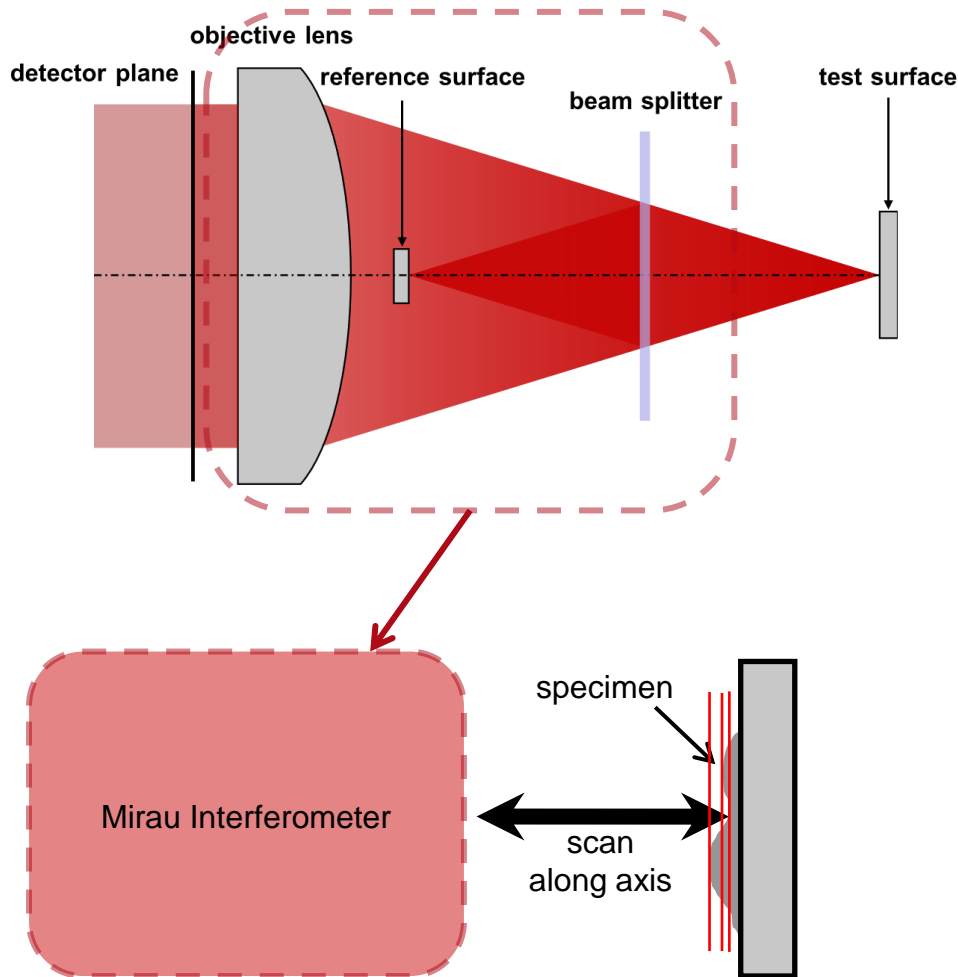
- For the reflecting light path of the beam splitter, the +/- channel has to be activated.



Surface	+/+	+/-	-/-	-/+
All Surfaces	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Surface #1 (Plane Surface)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Surface #2 (Plane Surface)	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

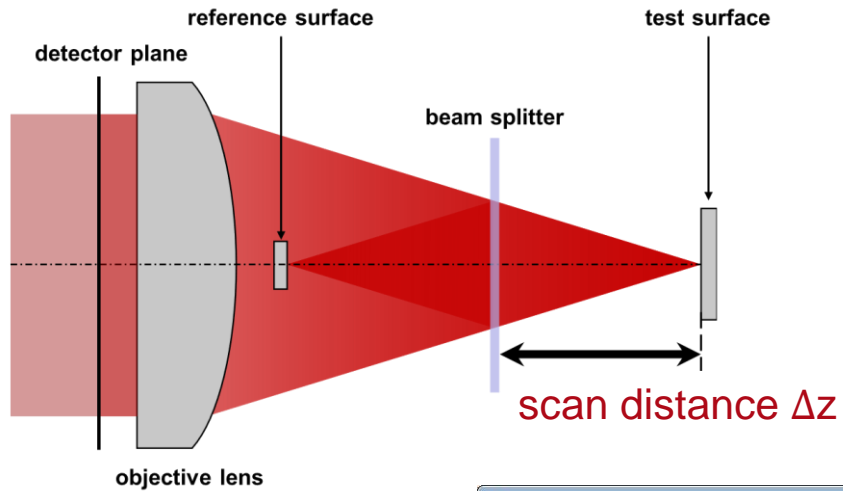


# System Building Block – Test & Reference Surface

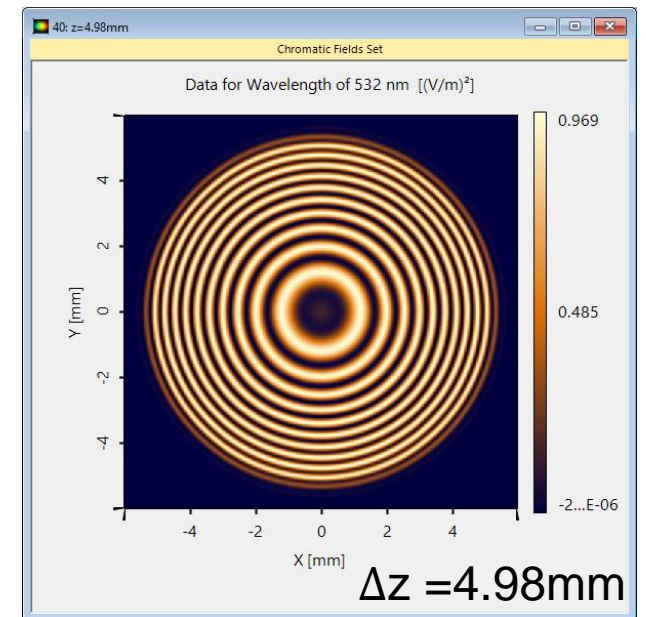
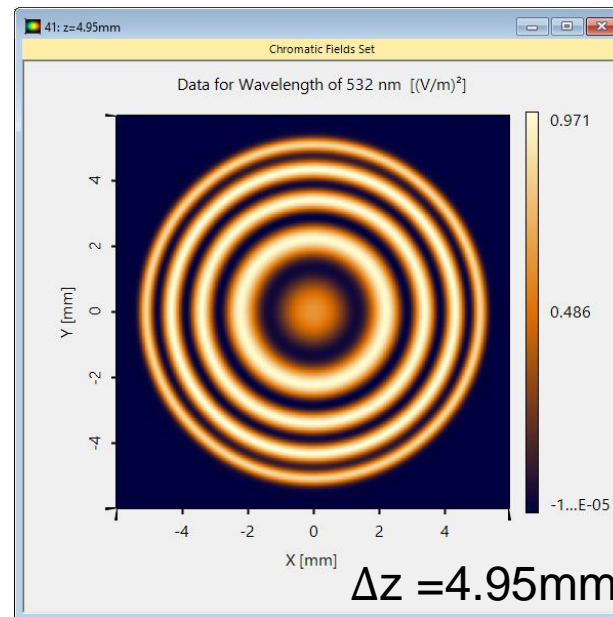
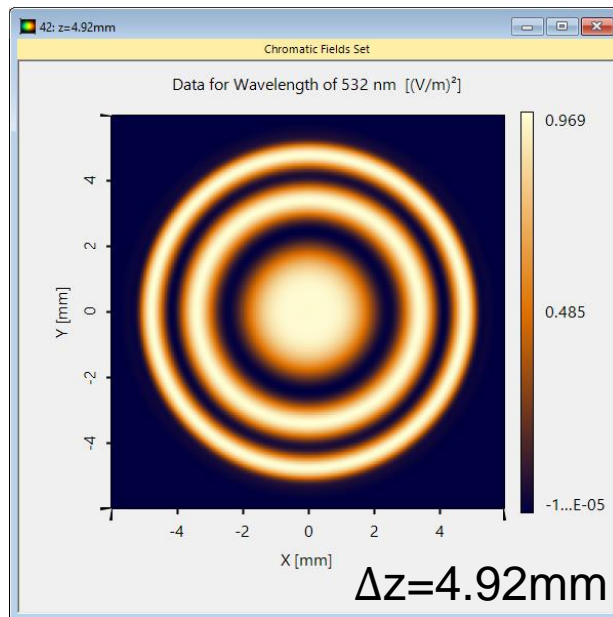


- In this simulation, the reference and test surfaces are modeled by ideal mirrors.  
*(That is why the best splitting ratio for the semi-transparent plate is 50:50 which is approximately achieved with the 15.5nm silver coating.)*
- A real specimen is placed on the test surface and by scanning the Mirau interferometer in the axial direction, the different interference pattern can be used to calculate the height.
- The size of the reference surface should be small enough to avoid central obscuration, but larger than the size of the focal spot.

# Simulation Results – Interference Fringes



- The fringes at three different positions of the Mirau interferometer are shown below.
- The interference fringes is affected by how far the test surface is out of focus. Larger defocus values introduce stronger spherical phase change in the test path, resulting in denser interference fringes.



# Document Information

title	Simulation of Basic Mirau Interferometer
document code	IFO.0020
document version	1.0
software edition	VirtualLab Fusion Basic
software version	2021.1 (Build 1.180)
category	Application Use Case
further reading	<ul style="list-style-type: none"><li>- <a href="#"><u>Young's Interference Experiment</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>