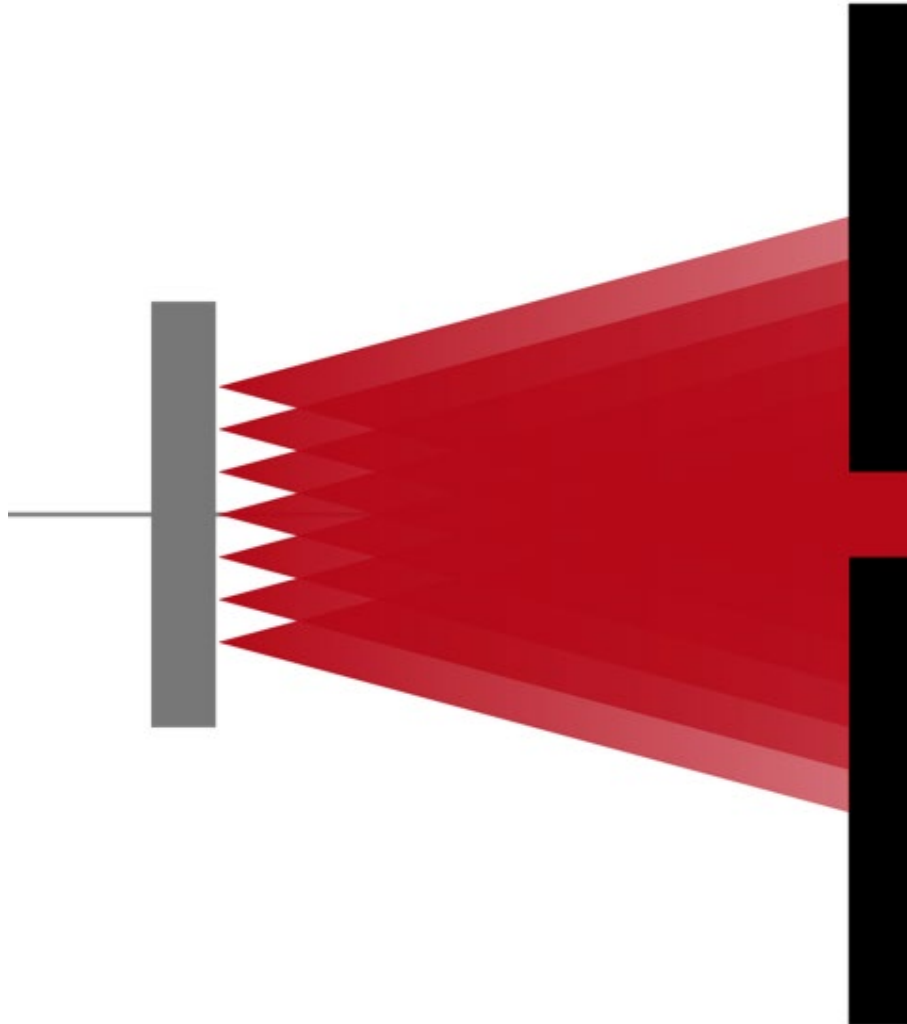


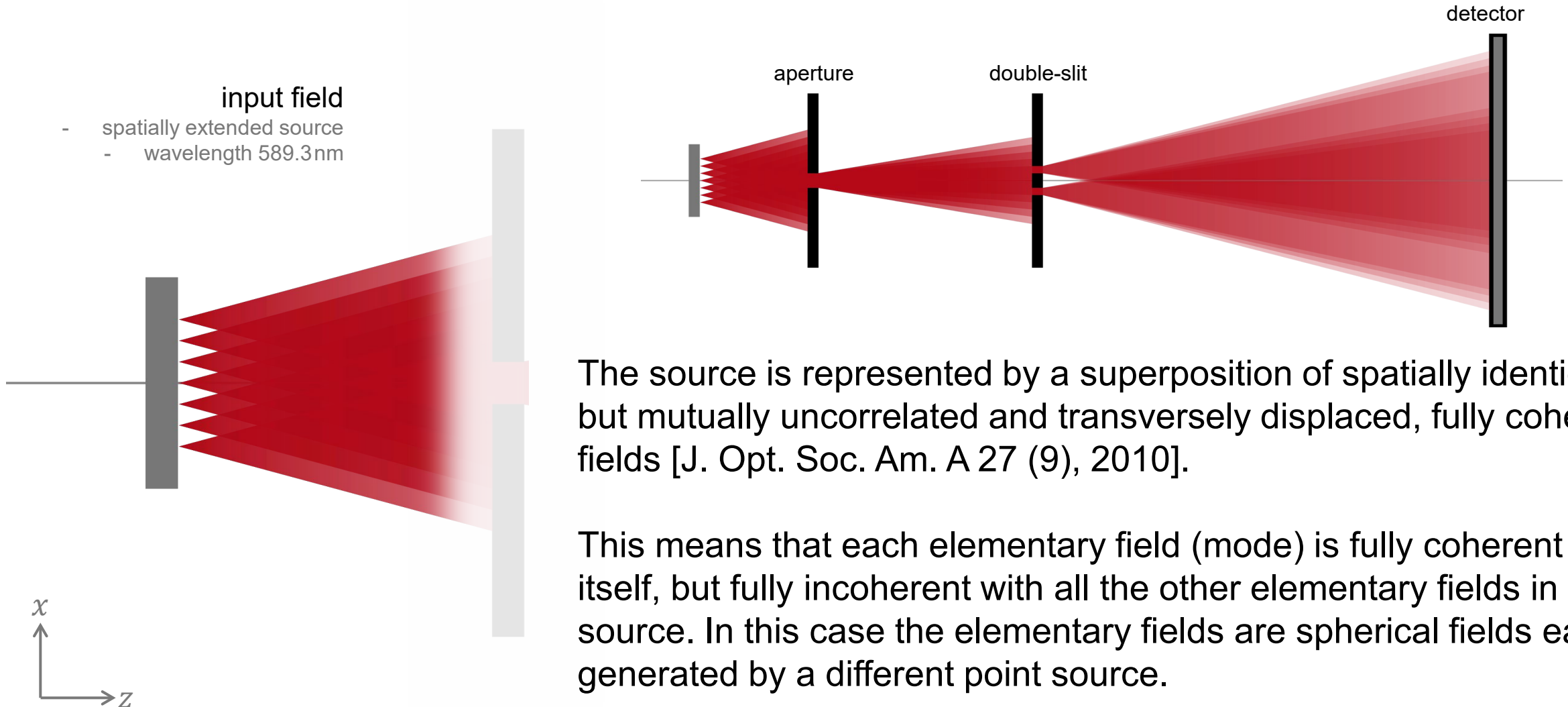
# **Modeling Spatially Extended Sources with the Shifted Elementary-Field Method**

# Abstract



Spatially extended sources appear frequently in practice. They can be modeled using the shifted elementary-field method, reported by Tervo *et al.* [J. Opt. Soc. Am. A 27 (9), 2010]. This use case demonstrates how to realize the shifted elementary-field method in VirtualLab Fusion, to get an accurate model for a spatially extended source, based on Young's interference experiment.

# Shifted Elementary-Field Method



The source is represented by a superposition of spatially identical, but mutually uncorrelated and transversely displaced, fully coherent fields [J. Opt. Soc. Am. A 27 (9), 2010].

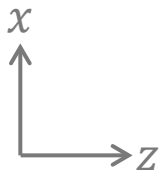
This means that each elementary field (mode) is fully coherent with itself, but fully incoherent with all the other elementary fields in the source. In this case the elementary fields are spherical fields each generated by a different point source.

# Number of Elementary-Fields (Modes)

- input field
- spatially extended source
- wavelength 589.3nm

emitting area

number of modes



- The emitting area is fixed at  $800\mu\text{m}$ . The point source at the edge of this emitting area gives a weak interference pattern, which is negligible.
- The number of elementary fields (modes) should be large enough to achieve convergent and reliable results.
- So before performing the simulation, **we use a one-dimensional (1D) list of point sources along the x axis to check how many modes give convergent fringes along said axis in the detector.**
- To keep the power of the source constant, the power weight of each point source decreases as the number of modes increases.

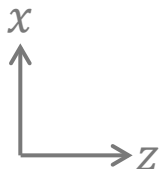
$$\text{weight} = \frac{1.0}{\text{number of modes}}$$

# Configuration of Parameter Variation

- input field
- spatially extended source
- wavelength 589.3 nm

emitting area

number of modes



**optical setup**

select spherical wave as elementary field

**editor of spherical wave**

position of source point on x axis

**Parameter Run**

1	2	*	Object	Category	Parameter	Vary	From	To	Steps	Original Value
					Distance to Input...	<input type="checkbox"/>	-1E+303 mm	1E+303 mm	1	10 mm
					Lateral Offset X	<input checked="" type="checkbox"/>	-400 μm	400 μm	5	0 mm
					Lateral Offset Y	<input type="checkbox"/>	1E+303 mm	1E+303 mm	1	
			"Spherical Wave" #0		Number of Rays X	<input type="checkbox"/>		2E+05	1	31
					Number of Rays Y	<input type="checkbox"/>		2E+05	1	31
					Oversampling Fa...	<input type="checkbox"/>	1E-300	1E+300	1	1

source area is 800 μm

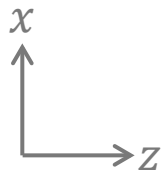
number of modes is 5

# Configuration of Parameter Variation

- input field
- spatially extended source
- wavelength 589.3 nm

emitting area

number of modes



**optical setup**

select spherical wave as elementary field

**editor of spherical wave**

power weight

**Parameter Run**

Object	Category	Parameter	Vary	From	To	Steps	Original Value
		Wavelength	<input type="checkbox"/>	193 nm	50 μm	1	589.3 nm
		Weight	<input checked="" type="checkbox"/>	0	1	5	1
		Polarization Angle	<input type="checkbox"/>		360°	1	0°
		Distance to	<input type="checkbox"/>		1E+303 mm	1	10 mm
		Lateral Offset X	<input checked="" type="checkbox"/>	-400 μm	400 μm	5	0 mm
		Lateral Offset Y	<input type="checkbox"/>	-1E+303 mm	1E+303 mm	1	0 mm

power weight

# Programmable Mode of Parameter Run

## Main Function

```
double[,] parameters = new double[NumberOfParameters,NumberOfIterations];

double weight = 1.0 / NumberOfIterations;
for(int Index = 0;Index < NumberOfIterations;Index++)
{
    //power weight
    parameters[0, Index] = weight;
    //position of point source
    parameters[1, Index] = MinimumValues[1] + (MaximumValues[1] - MinimumValues[1]) / (NumberOfIterations - 1.0) * Index;
}

return parameters;
```

$$\text{weight} = \frac{1.0}{\text{number of modes}}$$

1	2	Object	Category	Parameter	Vary	From	To	Steps	Original Value
				Wavelength	<input type="checkbox"/>	193 nm	50 μm	1	589.3 nm
				Weight	<input checked="" type="checkbox"/>	0	1	5	1
				Polarization Angle	<input type="checkbox"/>	0°	360°	1	
				Distance to Input..	<input type="checkbox"/>	-1E+303 mm	1E+303 mm	1	
				Lateral Offset X	<input checked="" type="checkbox"/>	-400 μm	400 μm	5	0 mm
				Lateral Offset Y	<input type="checkbox"/>	1E+303 mm	1E+303 mm	1	0 mm
		"Spherical Wave" #0		Number of					
				Number of Rays					

# Display of Resulting Fringe along x Axis

5: D:\OneDrive\...\ParameterRun\_5.run\*

**Results**  
Start the parameter run and analyze its results

Go!

Use Already Calculated Results for Next Run

Detector	Subdetector	Combined Output	Iteration Step		
			2	3	4
Varied Parameters	Lateral Offset X ("Spherical...	Data Array	0 $\mu\text{m}$	0 mm	200 $\mu\text{m}$
	Weight ("Spherical Wave"...	Data Array	0.2	0.2	0.2
"Fringe (Camera)" #600 aft...		Animation	s Set	Chromatic Fields Set	Chromatic Fields Set
"Fringes Along X-Axis (Ca...		1D Chromatic	set 1D	Chromatic Fields Set 1D	Chromatic Fields Set 1D

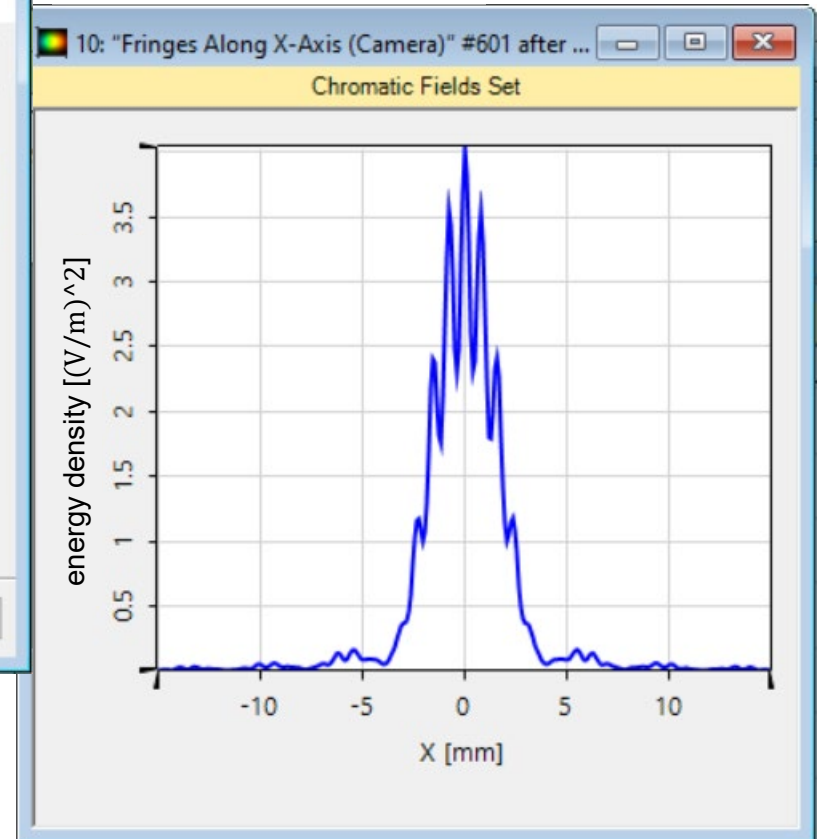
select the row

display the resulting fringe

Create Output from Selection

< Back Next > Show ▾

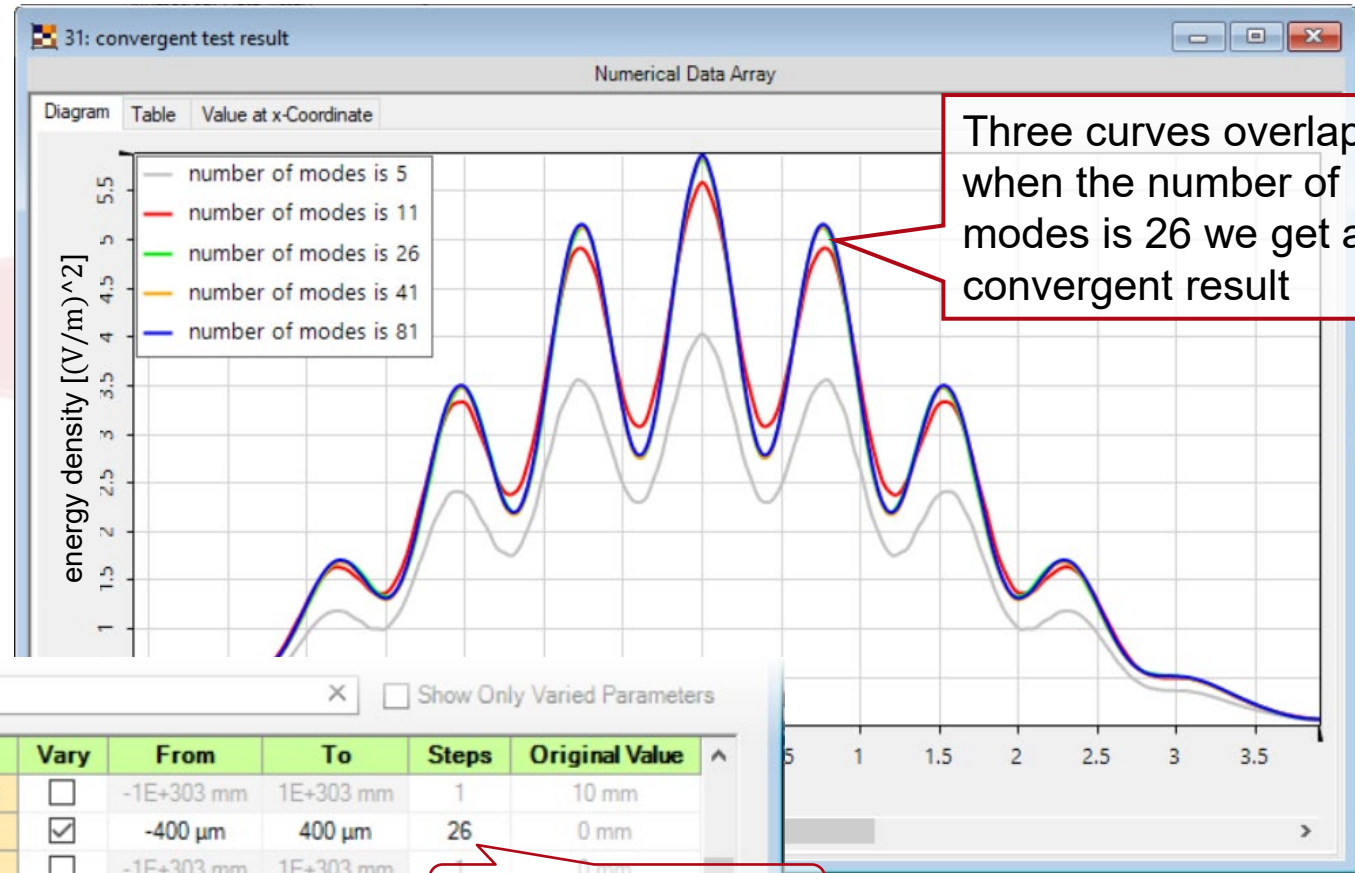
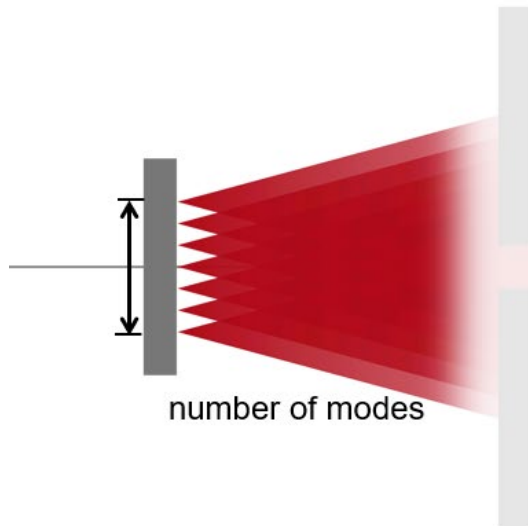
fringe along x axis



superposition of energy density from different point sources



# Fringes with Different Number of Modes



## Parameter Run

1	2	*	Object	Category	Parameter	Vary	From	To	Steps	Original Value
			"Spherical Wave" #0		Distance to Input...	<input type="checkbox"/>	-1E+303 mm	1E+303 mm	1	10 mm
				Lateral Offset X	<input checked="" type="checkbox"/>	-400 μm	400 μm	26	0 mm	
				Lateral Offset Y	<input type="checkbox"/>	-1E+303 mm	1E+303 mm	1	0 mm	
				Number of Rays X	<input type="checkbox"/>	1	2E+09	1	31	
				Number of Rays Y	<input type="checkbox"/>	1	2E+09	1	31	
				Oversampling Fa...	<input type="checkbox"/>	1E-300	1E+300	1	1	

number of modes

# Document Information

---

title	Modeling Spatially Extended Sources with the Shifted Elementary-Field Method
document code	IFO.0019
version	1.1
edition	VirtualLab Fusion Basic
software version	2020.2 (Build 2.22)
category	Feature Use Case
further reading	<ul style="list-style-type: none"><li>- <a href="#"><u>Application of the Programmable Mode of a Parameter Run</u></a></li><li>- <a href="#"><u>Young's Interferometer Experiment</u></a></li></ul>