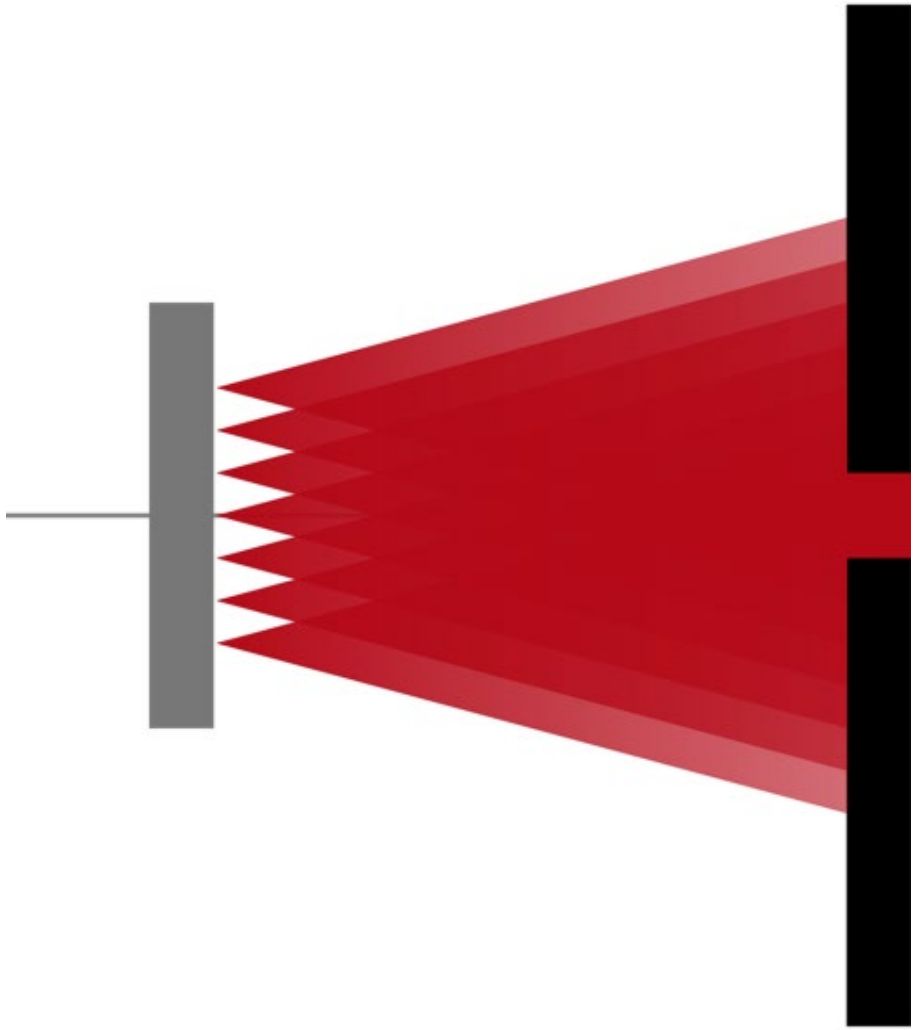
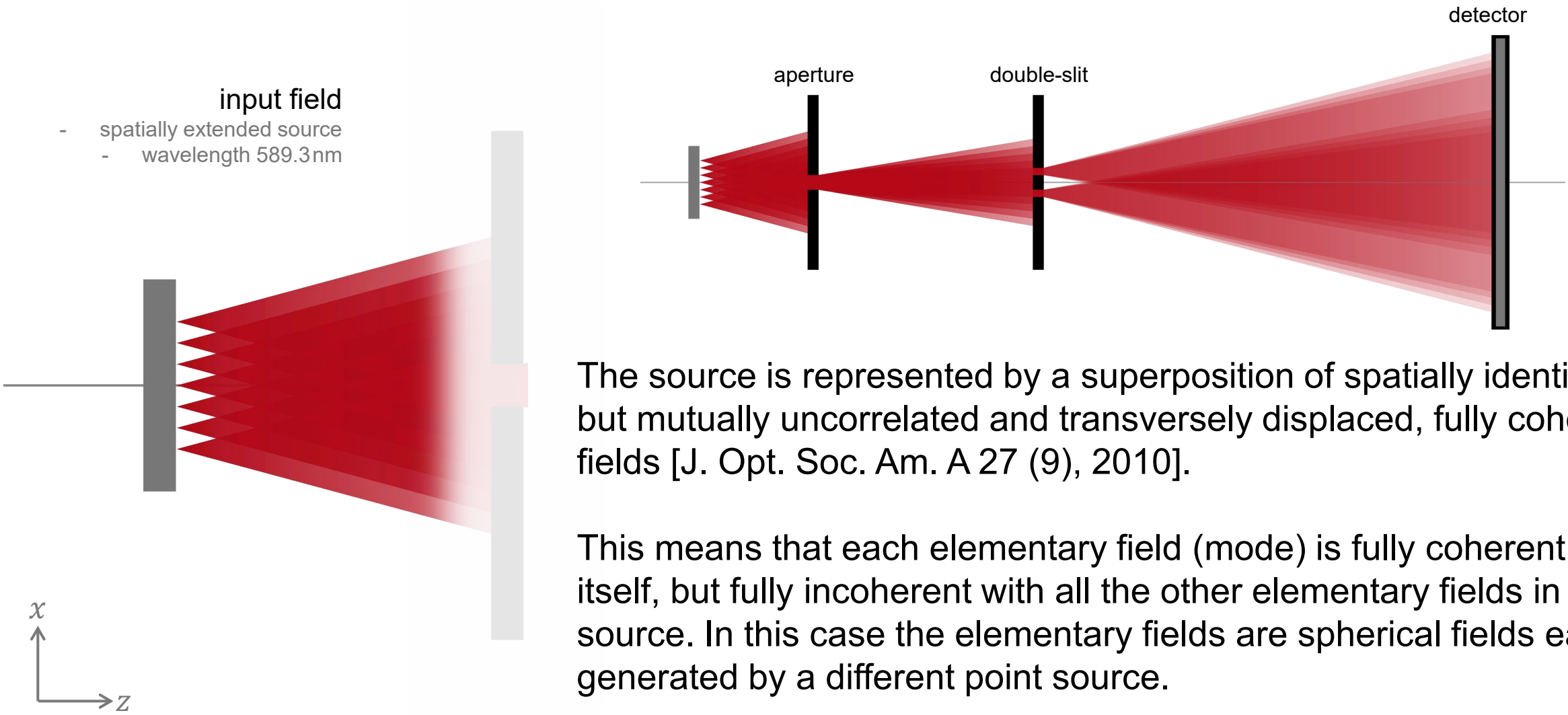
Modeling Spatially Extended Sources with the Shifted Elementary-Field Method

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.

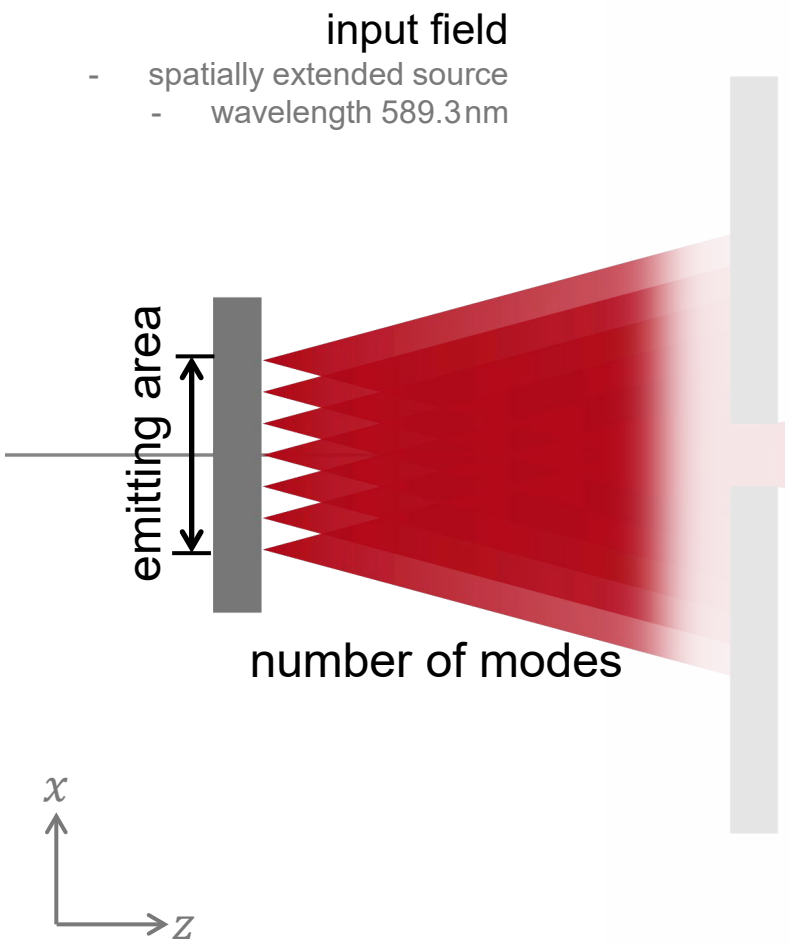
Shifted Elementary-Field Method



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)

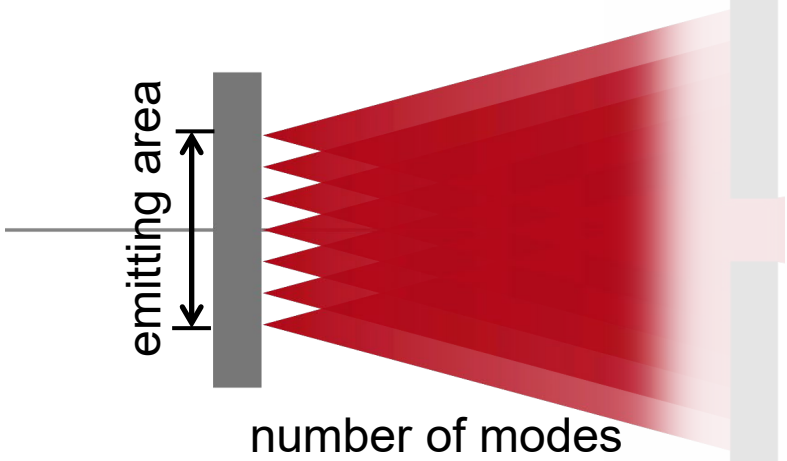


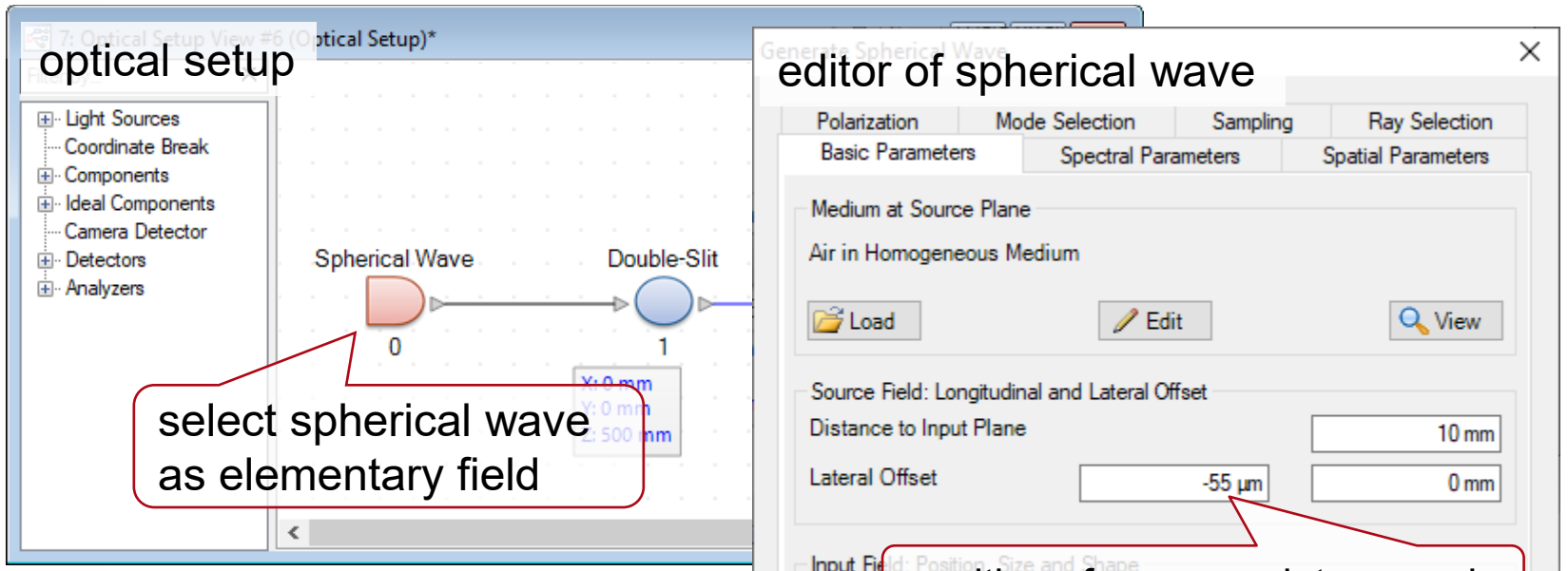
- The emitting area is fixed at 800µm. The point source at the edge of this emitting area gives a weak interference pattern, which is negligible.
- The number of elementary fields (modes) should be large enough to achieve convergent and reliable results.
- So before performing the simulation, **we use 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.

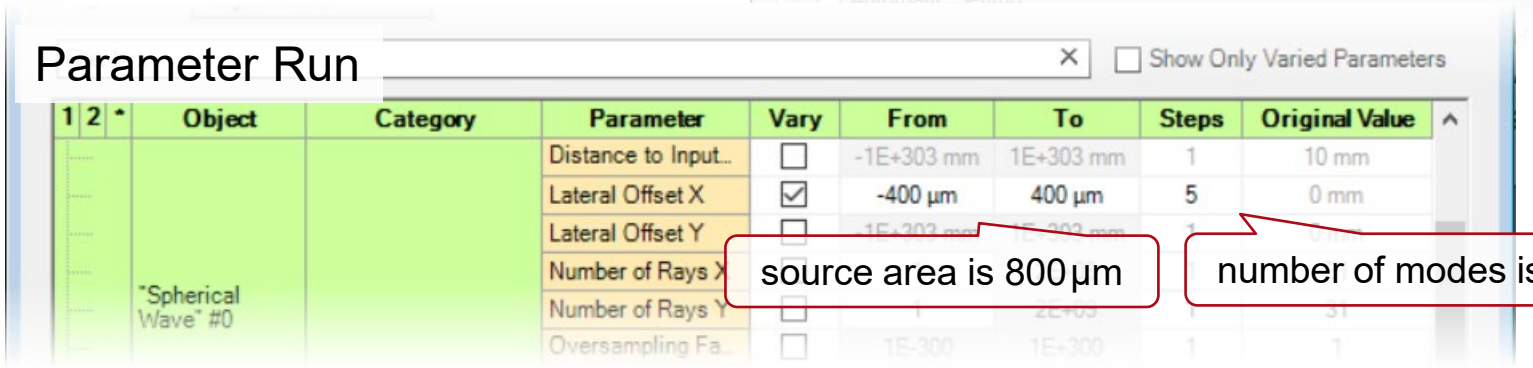
$$\text{weight} = \frac{1.0}{\text{number of modes}}$$

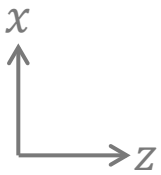
Configuration of Parameter Variation

input field
- spatially extended source
  - wavelength 589.3 nm









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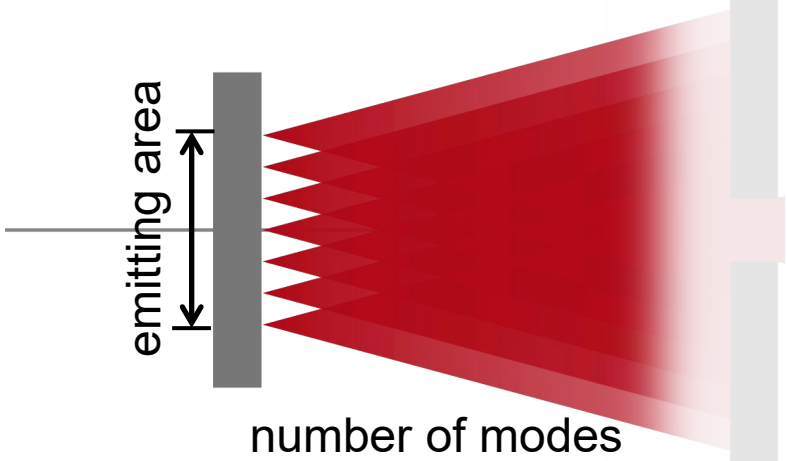
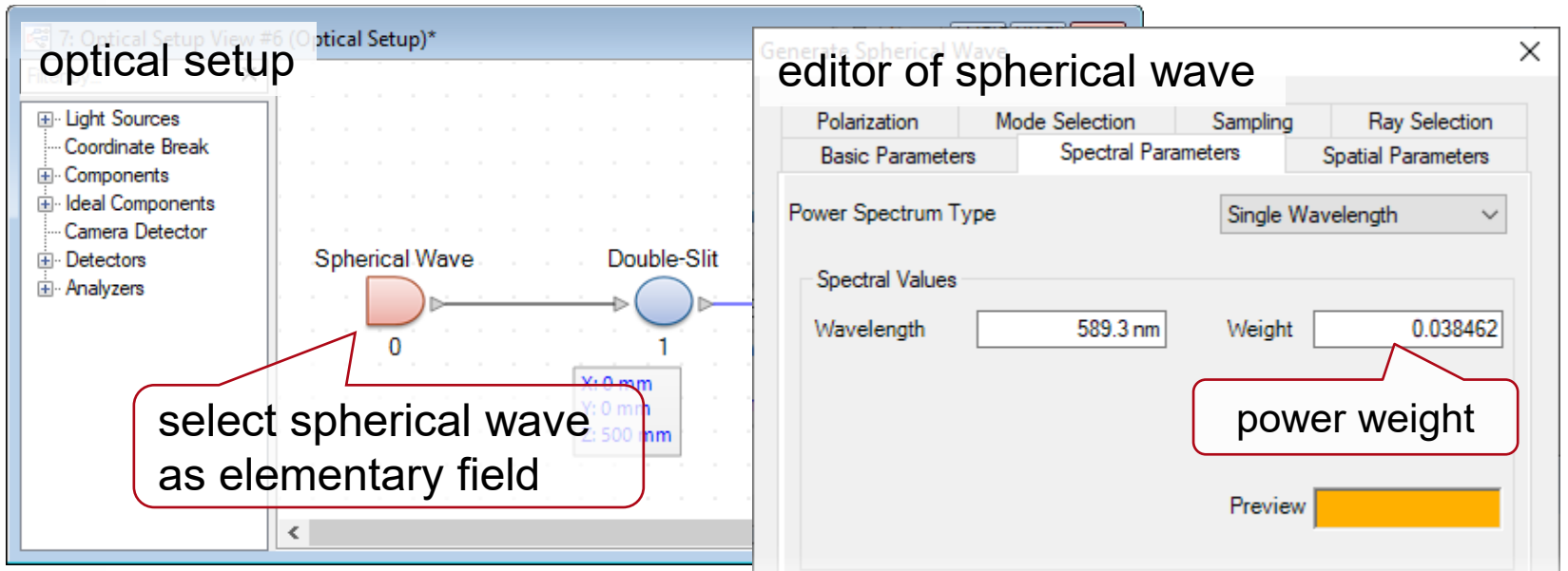
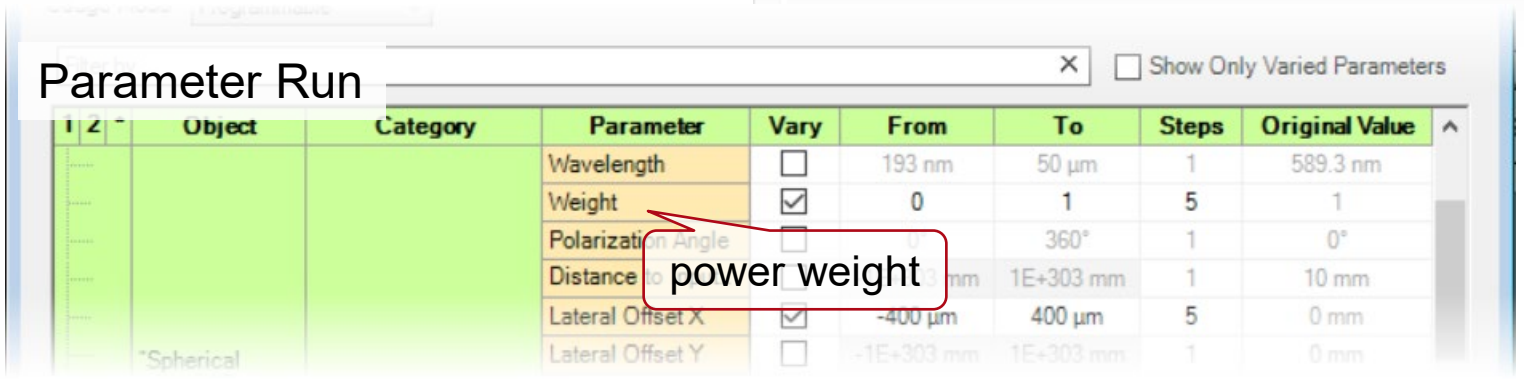
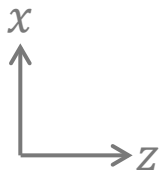






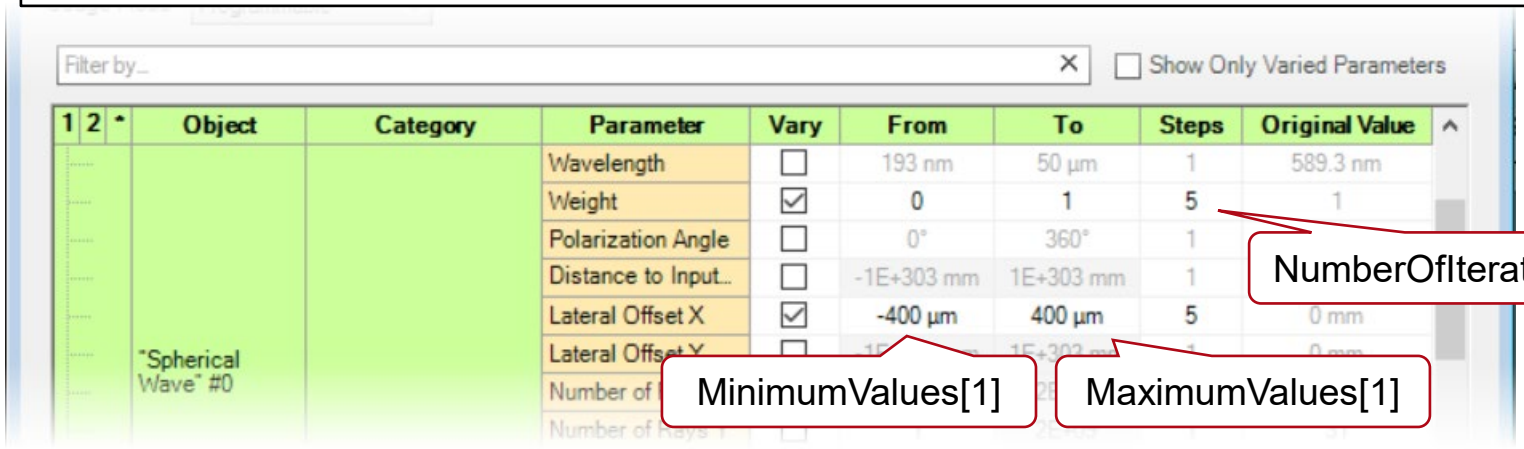


Programmable Mode of Parameter Run

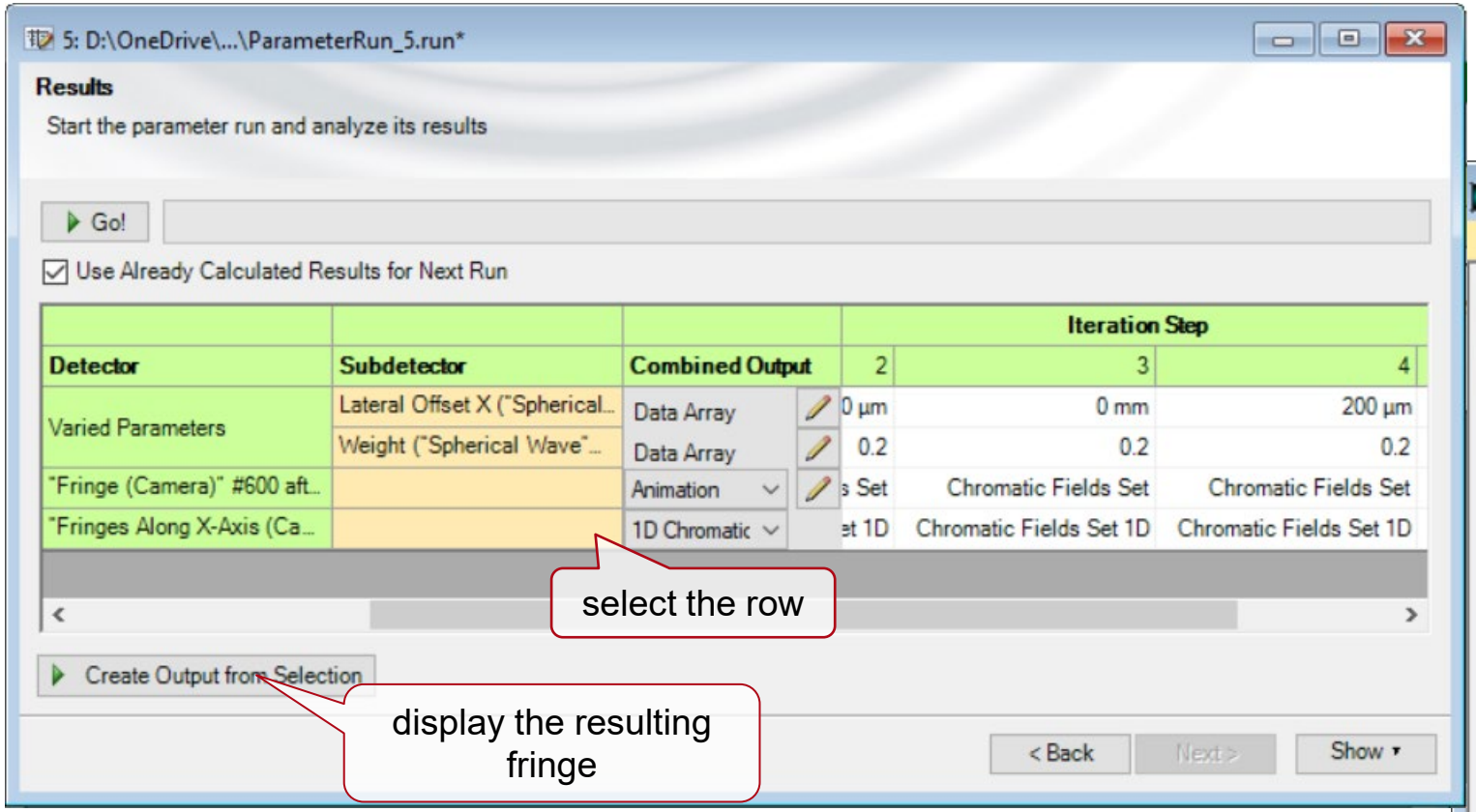
Main Function

```
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;
```

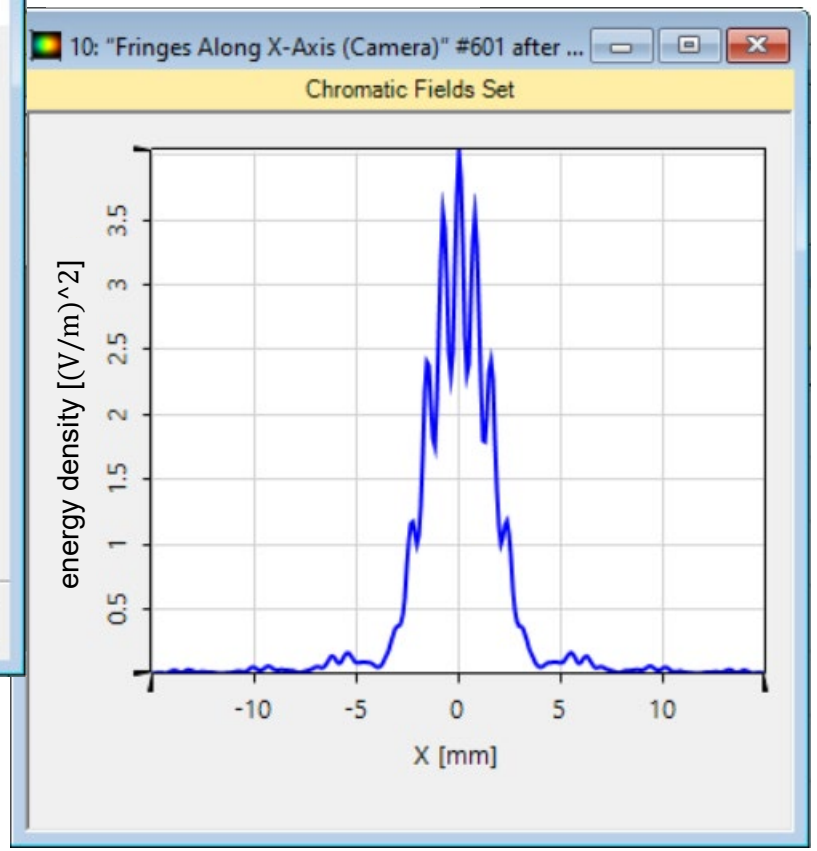
$$\text{weight} = \frac{1.0}{\text{number of modes}}$$



Display of Resulting Fringe along *x* Axis

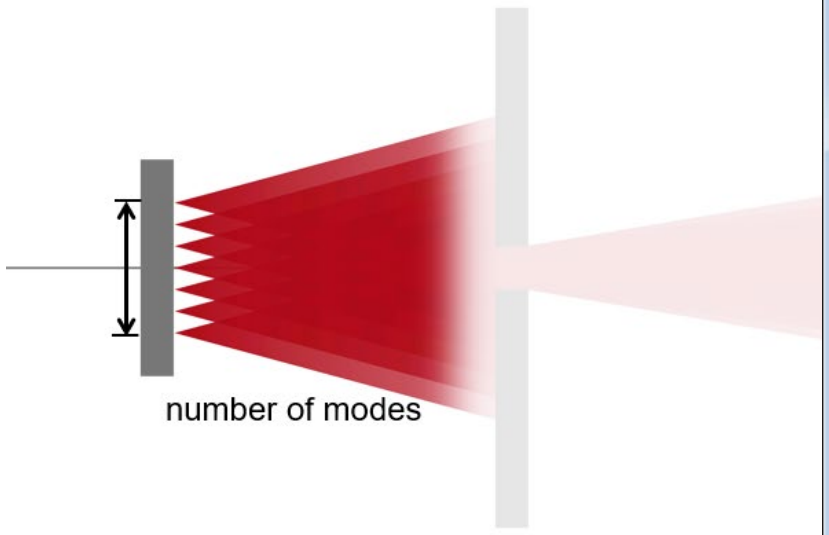


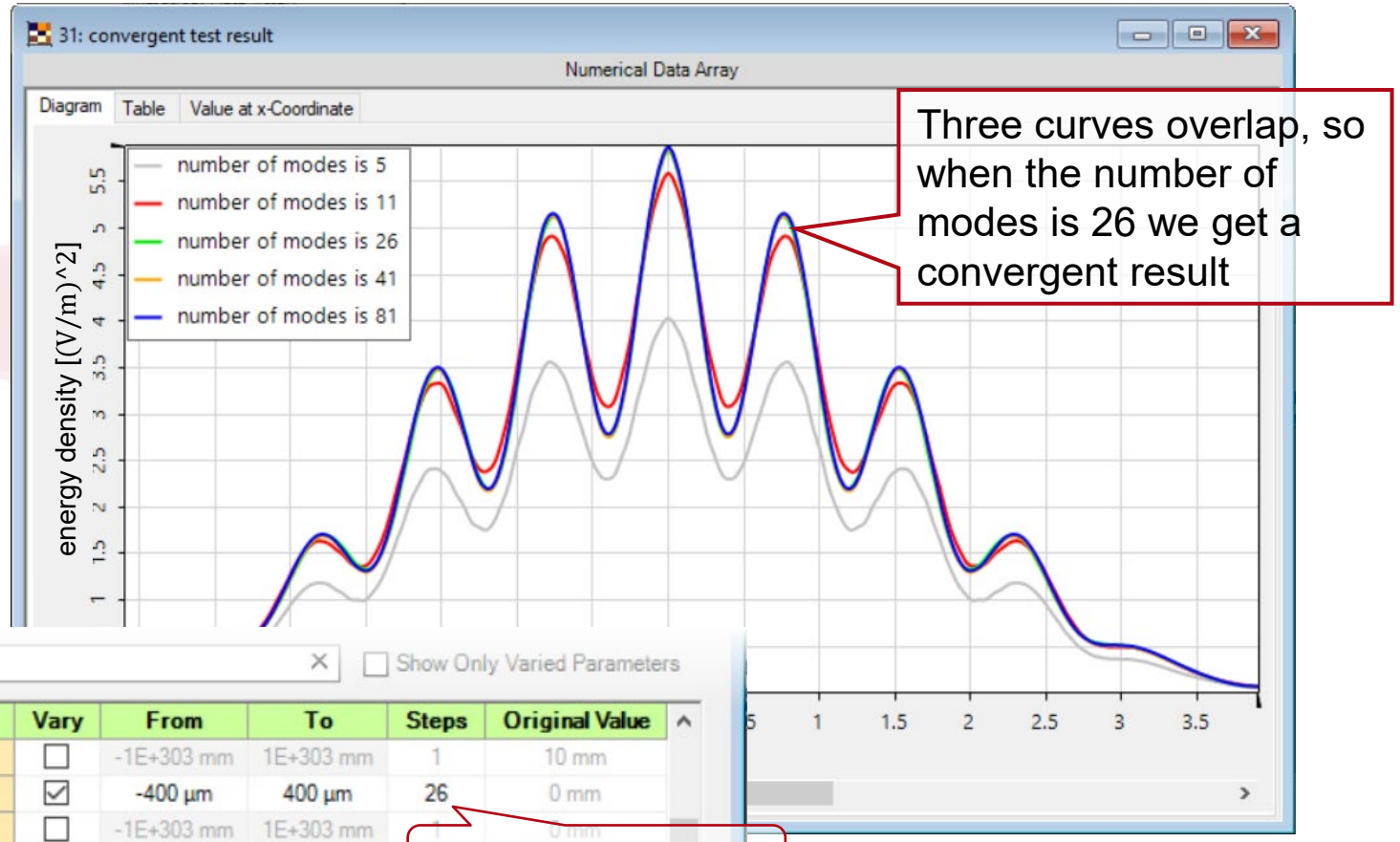
fringe along *x* axis



superposition of energy density from different point sources

Fringes with Different Number of Modes





Three curves overlap, so when the number of modes is 26 we get a convergent result

Parameter Run

Show Only Varied Parameters

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

number of modes

Document Information

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document code	IFO.0019
version	1.1
edition	VirtualLab Fusion Basic
software version	2020.2 (Build 2.22)
category	Feature Use Case
further reading	- Application of the Programmable Mode of a Parameter Run - Young's Interferometer Experiment