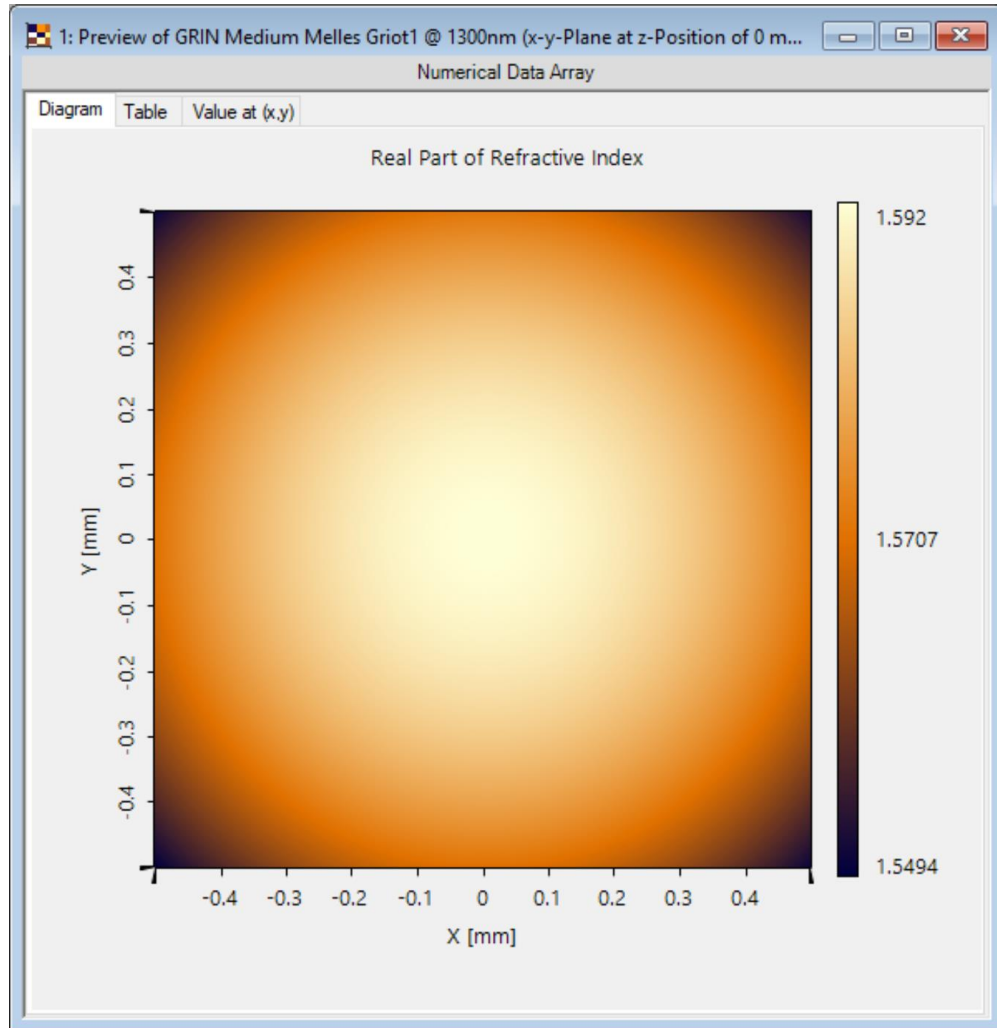


# How to Work with the Programmable Medium and Example (Thermal Lens)

# Abstract



Providing maximum versatility is one of our most fundamental objectives. A key aspect of this aim is to provide a flexible-enough definition mechanism of the refractive index, in order to achieve a realistic characterization of the matter which composes an optical system. In VirtualLab Fusion this role is left to Materials and Media: the first deal with the dependence of the refractive index on wavelength (dispersion), the second group take care of the dependence on position. Here we bring you a tutorial that explains how to program your own custom media.

# Where to Find the Programmable Medium: Catalog

The image shows a software interface with several windows and dialog boxes. Red arrows and numbers 1-6 indicate the steps to find and edit a programmable medium:

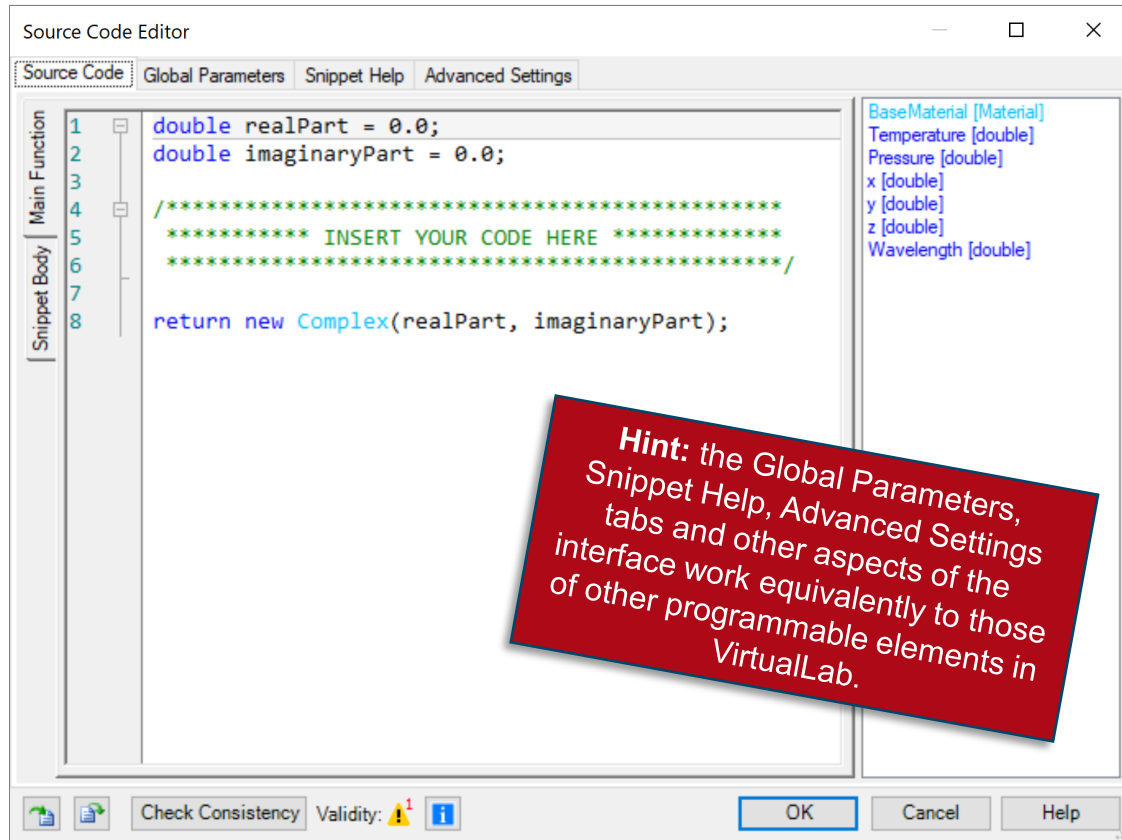
1. Click on the **Catalogs** tab in the top menu bar.
2. Click on the **Media** icon in the Catalogs toolbar.
3. In the **Media Catalog** dialog, click on the **Templates** dropdown menu.
4. In the **Media Catalog** list, click on **Programmable Medium (x-y-z-Modulated)**.
5. In the **Media Catalog** dialog, click on the **Edit** button.
6. In the **Edit Programmable Medium (x-y-z-Modulated)** dialog, click on the **Edit** button in the **Definition** section.

Note that the Programmable Material is also accessible at any point during the construction of a system when a medium must be entered for the configuration!

```
Source Code Editor
Source Code | Global Parameters | Snippet Help | Advanced Settings
1 double realPart = 0.0;
2 double imaginaryPart = 0.0;
3
4 /****** INSERT YOUR CODE HERE *****/
5
6
7
8 return new Complex(realPart, imaginaryPart);

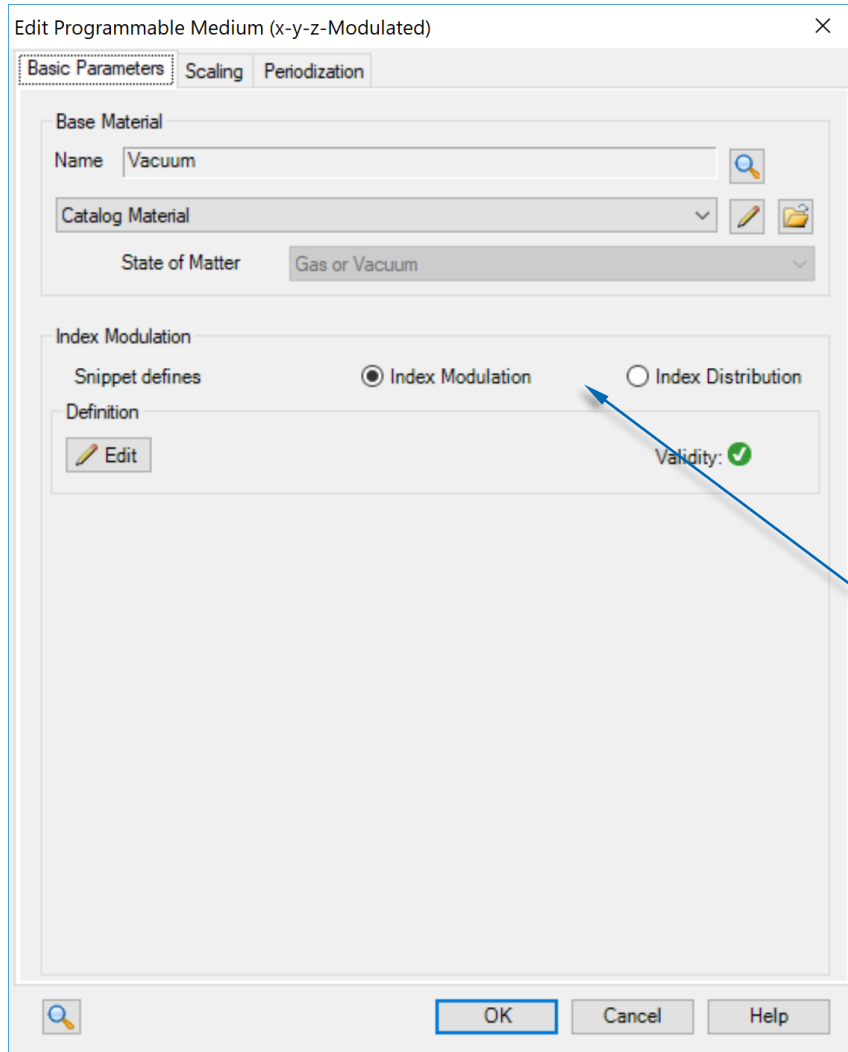
BaseMaterial [Material]
Temperature [double]
Pressure [double]
x [double]
y [double]
z [double]
Wavelength [double]
```

# Writing the Code



- The panel on the right shows a list of available independent parameters.
- **BaseMaterial** refers to the material which is used to define the dispersion (wavelength-dependence) of the refractive index of the medium.
- **Temperature** and **Pressure** are parameters whose value is fixed in the configuration of the optical system.
- **x**, **y** and **z** span the volume of the medium. Any inhomogeneity in the medium will be simulated by programming a function which depends on at least one of these three parameters.
- The parameter **Wavelength** permits the user to access the value of the wavelength.

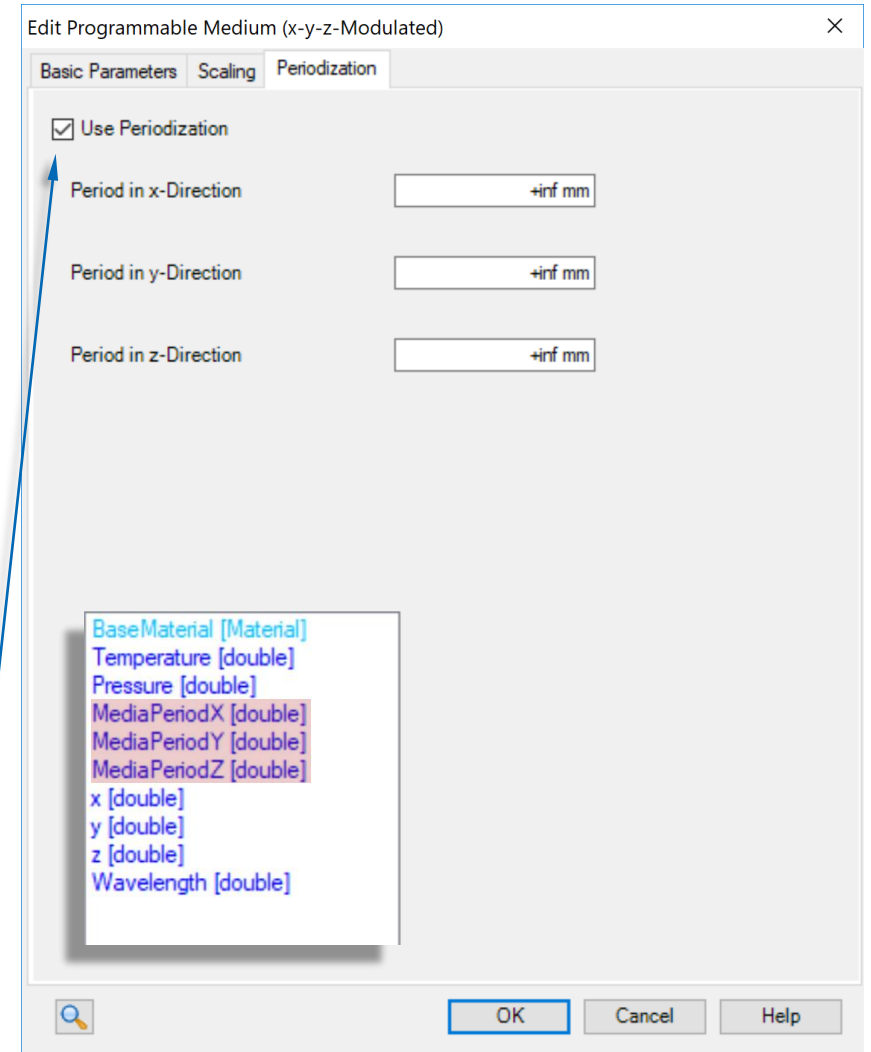
# Base Material, Scaling & Periodization



Change the Base Material (subsequently accessible in the code of the Programmable Medium) here. Use a Material from the Catalog, a constant value of  $n$ , or a custom material!

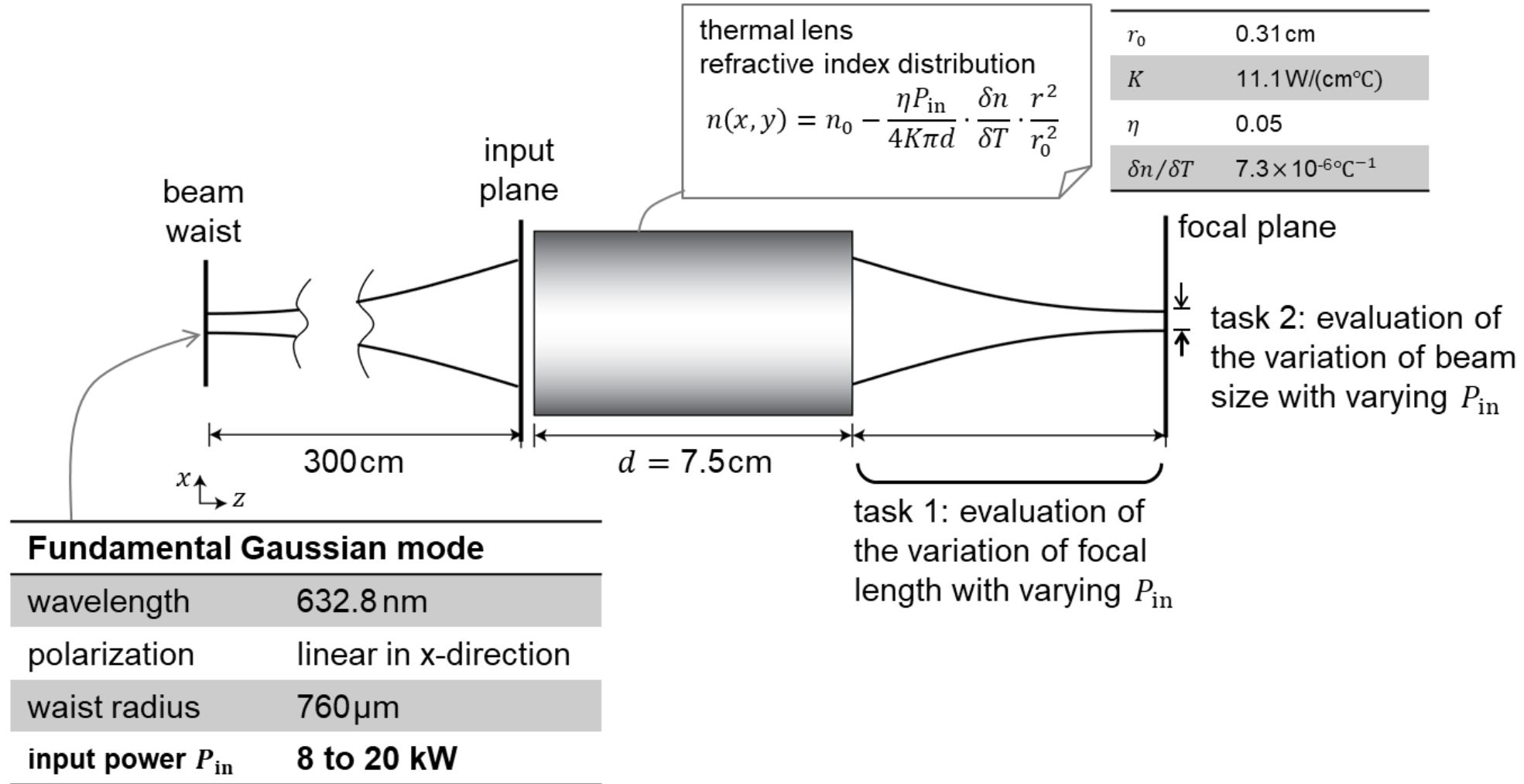
The option Index Modulation adds the value of the refractive index of the Base Material to the value computed by the current snippet. Index Distribution directly defines the value of the refractive index.

Ticking the option Use Periodization activates additional global parameters in the snippet!



# Programming a Thermal Lens

# Thermal Lens



# Where to Find the Programmable Medium: Catalog

1

2

3

4

5

6

Note that the Programmable Material is also accessible at any point during the construction of a system when a medium must be entered for the configuration!

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Source Code Editor
Source Code | Global Parameters | Snippet Help | Advanced Settings
1 double realPart = 0.0;
2 double imaginaryPart = 0.0;
3
4 /****** INSERT YOUR CODE HERE *****/
5
6
7
8 return new Complex(realPart, imaginaryPart);

BaseMaterial [Material]
Temperature [double]
Pressure [double]
x [double]
y [double]
z [double]
Wavelength [double]
```

Media Catalog

Definition Type: Templates

Extension and Section Plane: View Parameters

View Range (x, y, z): 1 mm

- ... Air in Homogeneous Medium
- ... Aperture Medium
- ... Fiber Medium
- ... GRIN Medium
- ... Medium with Inclusions
- ... Pillar Medium (z-Independent)
- ... Programmable Medium (x-y-z-Modulated)
- ... Sampled Medium (x-y-Modulated)
- ... Slanted Grating Medium
- ... Volume Grating Medium

Edit Programmable Medium (x-y-z-Modulated)

Basic Parameters | Scaling | Periodization

Base Material

Name: Vacuum

Catalog Material

State of Matter: Gas or Vacuum

Index Modulation

Snippet defines:  Index Modulation  Index Distribution

Definition

Edit

Validity: ✓

Refractive Index

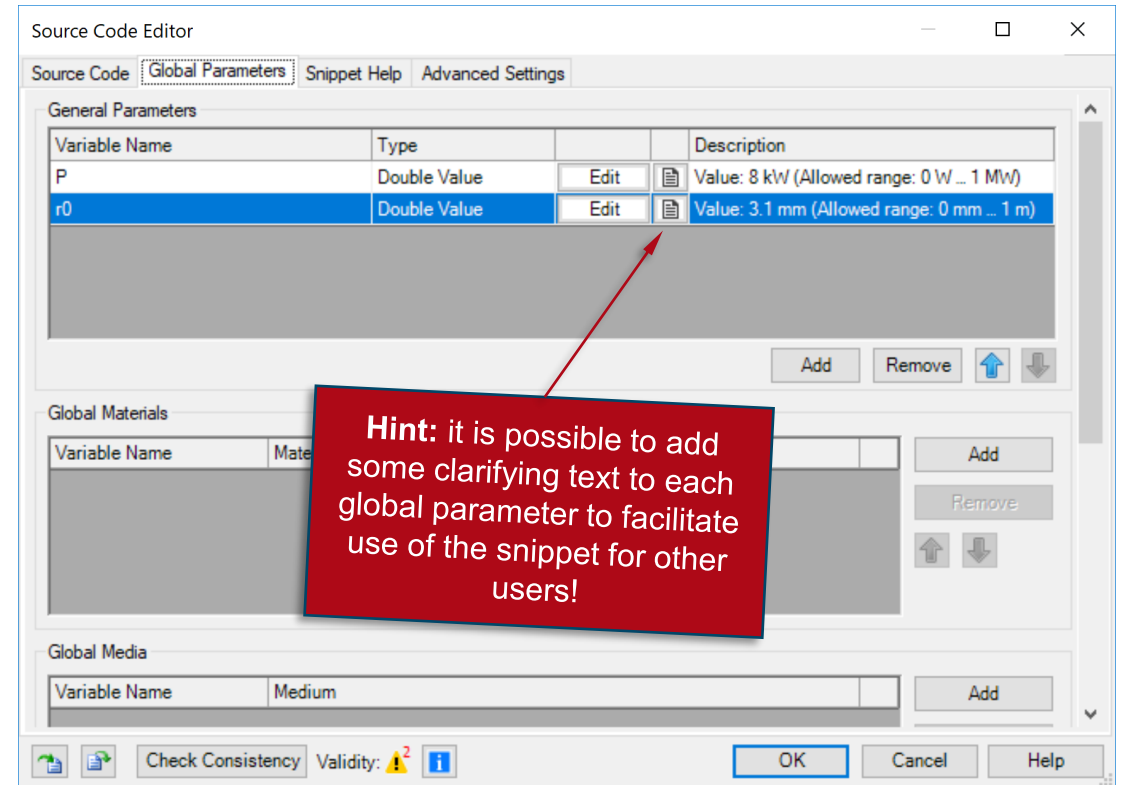
0.4 1 1.2

Close Help

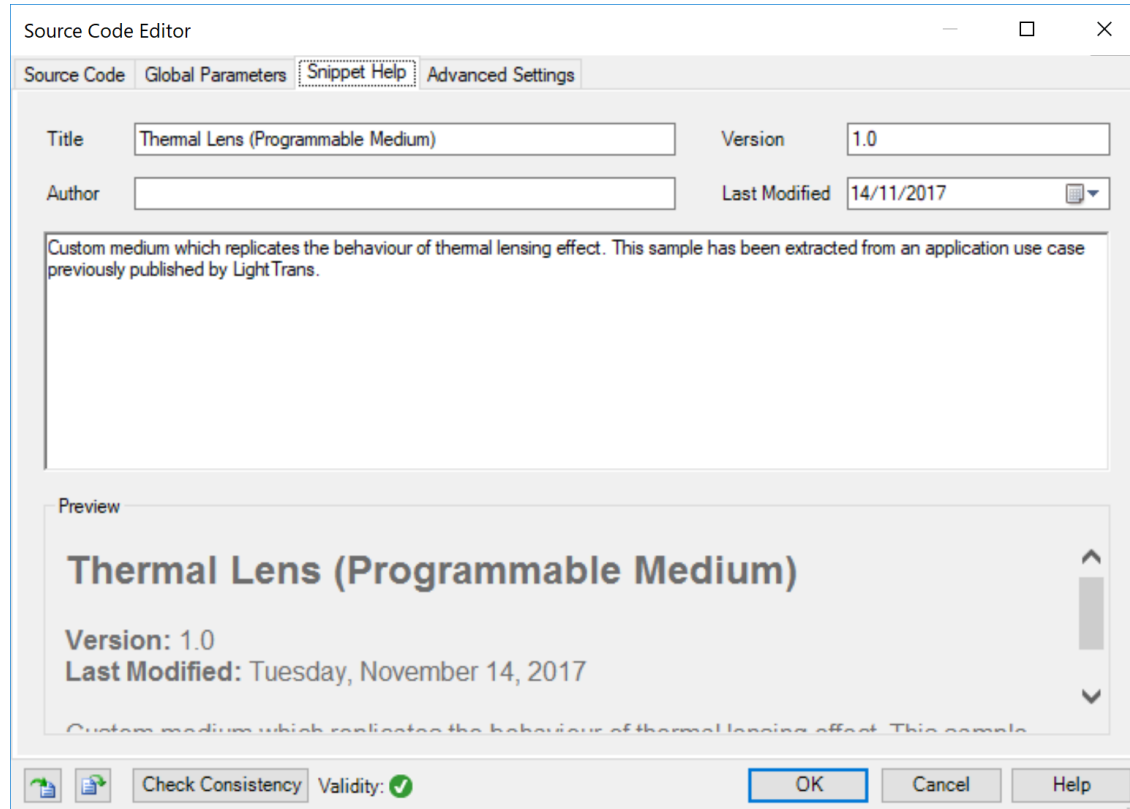


# Programmable Medium: Global Parameters

- Once you have triggered open the Edit dialogue, go to the Global Parameters tab.
- There, Add and Edit two global parameters:
  - **double** P = 8 kW (0W, 1MW): the input power of the laser.
  - **double** r0 = 3.1mm (0mm, 1m): r<sub>0</sub> in the equation (see slide with basic theory).
- Use the button with the small “notes” icon to add some explanation to your custom global parameters.

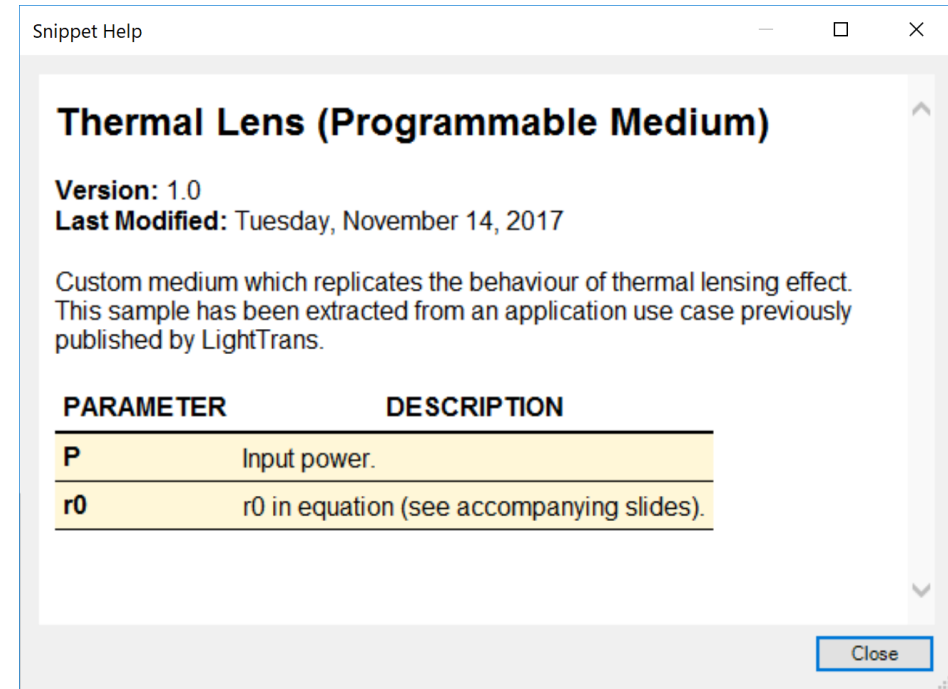
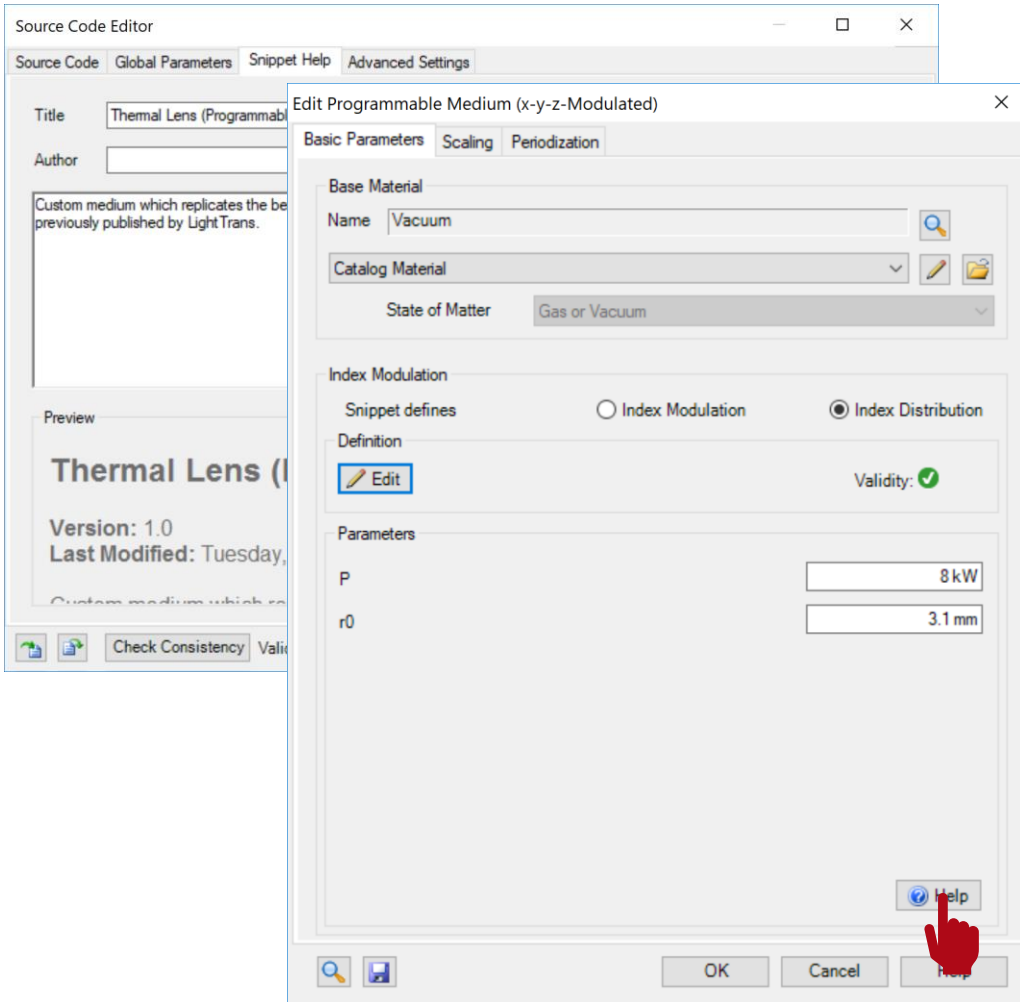


# Programmable Medium: Snippet Help

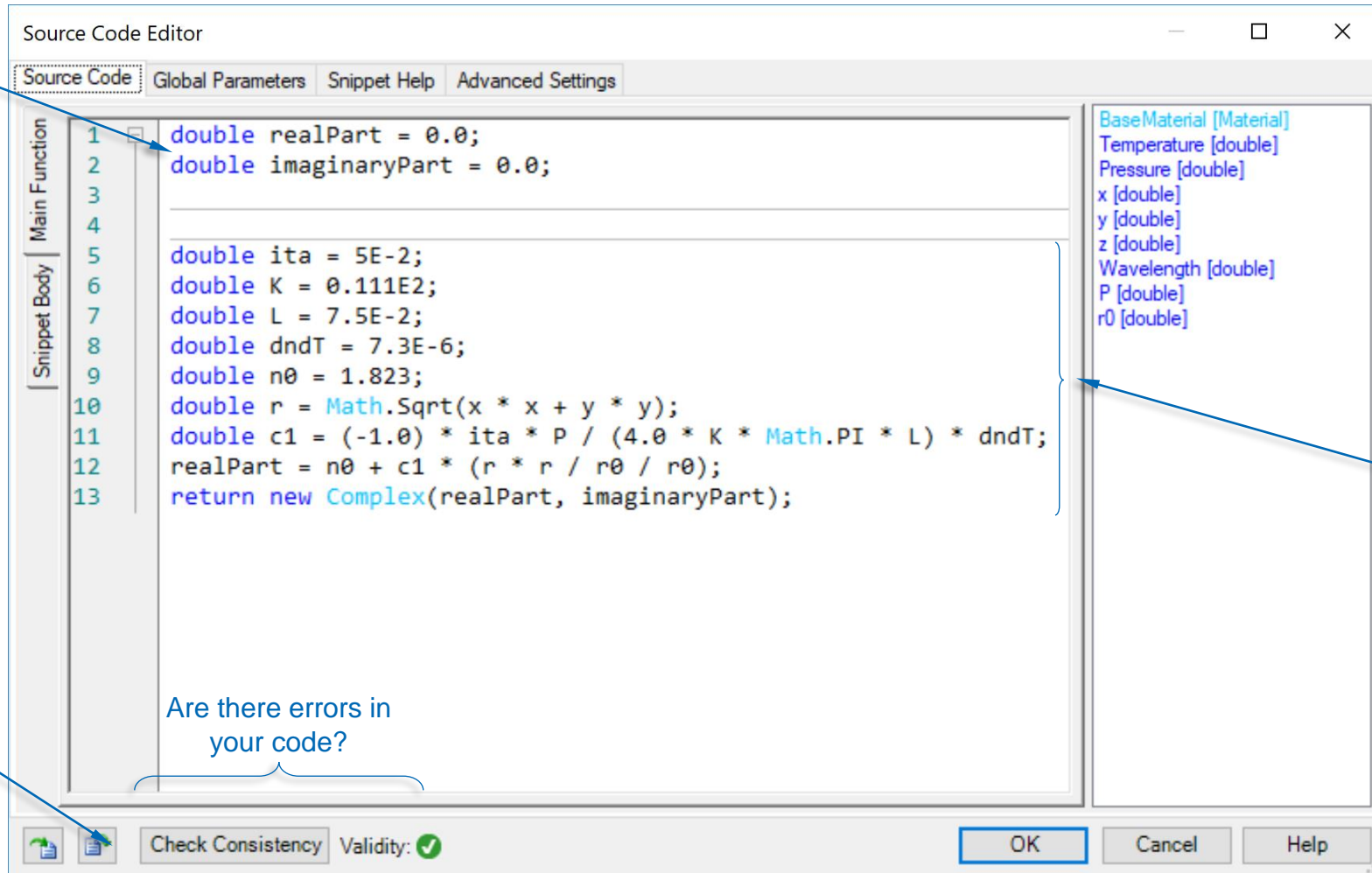


- **Optional:** you can use the Snippet Help tab to write instructions, clarifications, and some metadata associated to your snippet.
- This option is very helpful to keep track of your progress with a programmable element.
- It is especially useful when the programmable element is later disseminated to be handled by other users!

# Programmable Medium: Snippet Help



# Programmable Medium: Writing the Code (1)



Declare output

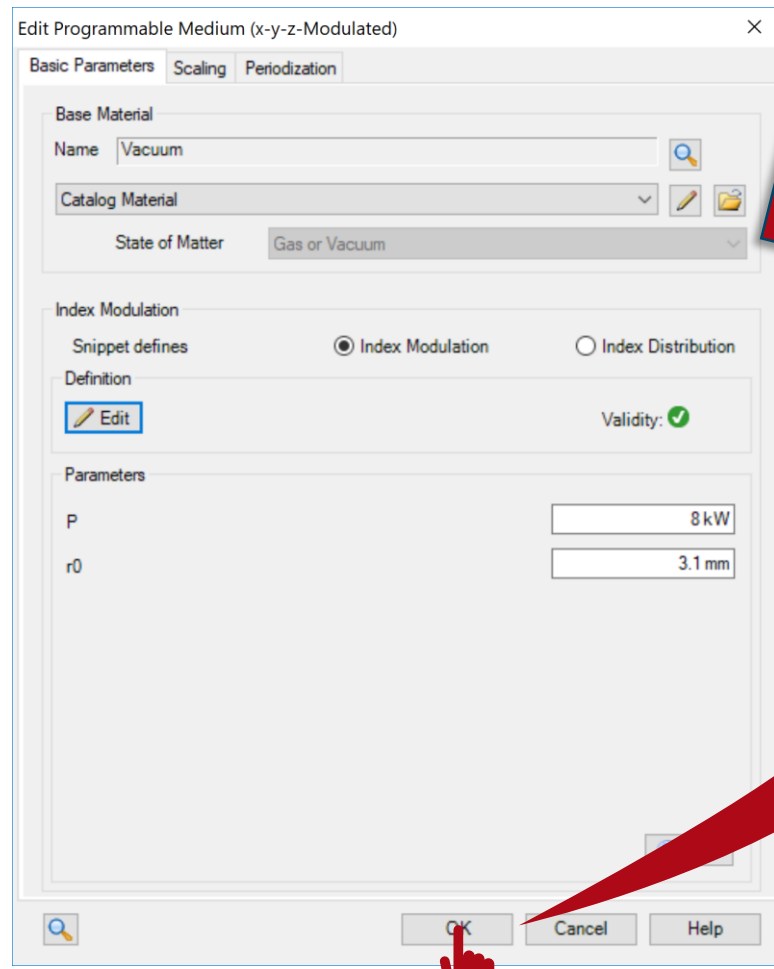
Default global parameters/variables

Global parameters defined by user in Global Parameters tab

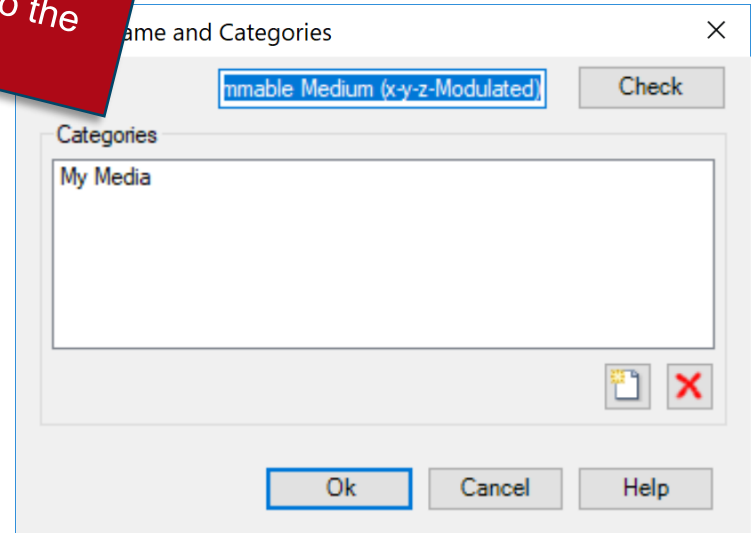
Eq.

Export Snippet to save your work!

# Save the Custom Medium to the Catalog



**Hint:** if you used the Catalog to define your custom medium, you will be automatically prompted to save your work to the catalog



# Output

Edit Programmable Medium (x-y-z-Modulated)

Basic Parameters | Scaling | Periodization

Base Material  
Name: Vacuum  
Catalog Material  
State of Matter: Gas or Vacuum

Index Modulation  
Snippet defines: Index Modulation  
Definition: Edit  
Parameters: P, r0

Preview for Programmable Medium (x-y-z-Modulated)

Extension and Section Plane | View Parameters

View Range (x, y, z): 1 mm 1 mm 1 mm

Section Plane:  x-y-Plane  z-x-Plane  z-y-Plane

z-Position of Section Plane: 0 mm

Diagram | Table

Real Part of Refractive Index

Y [mm]: -0.4, -0.2, 0, 0.2, 0.4

X [mm]: -0.4, -0.2, 0, 0.2, 0.4

Close Help

Preview for Programmable Medium (x-y-z-Modulated)

Extension and Section Plane | View Parameters

View Range (x, y, z): 1 mm 1 mm 1 mm

Section Plane:  x-y-Plane  z-x-Plane  z-y-Plane

z-Position of Section Plane: 0 mm

Diagram | Table

Y	X				
	-500 $\mu\text{m}$	-490 $\mu\text{m}$	-480 $\mu\text{m}$	-470 $\mu\text{m}$	-460 $\mu\text{m}$
500 $\mu\text{m}$	2.8	2.8	2.8	2.8	2.8
490 $\mu\text{m}$	2.8	2.8	2.8	2.8	2.8
480 $\mu\text{m}$	2.8	2.8	2.8	2.8	2.8
470 $\mu\text{m}$	2.8	2.8	2.8	2.8	2.8
460 $\mu\text{m}$	2.8	2.8	2.8	2.8	2.8
450 $\mu\text{m}$	2.8	2.8	2.8	2.8	2.8
440 $\mu\text{m}$	2.8	2.8	2.8	2.8	2.8
430 $\mu\text{m}$	2.8	2.8	2.8	2.8	2.8
420 $\mu\text{m}$	2.8	2.8	2.8	2.8	2.8
410 $\mu\text{m}$	2.8	2.8	2.8	2.8	2.8
400 $\mu\text{m}$	2.8	2.8	2.8	2.8	2.8
390 $\mu\text{m}$	2.8	2.8	2.8	2.8	2.8
380 $\mu\text{m}$	2.8	2.8	2.8	2.8	2.8
370 $\mu\text{m}$	2.8	2.8	2.8	2.8	2.8
360 $\mu\text{m}$	2.8	2.8	2.8	2.8	2.8
350 $\mu\text{m}$	2.8	2.8	2.8	2.8	2.8
340 $\mu\text{m}$	2.8	2.8	2.8	2.8	2.8
330 $\mu\text{m}$	2.8	2.8	2.8	2.8	2.8
320 $\mu\text{m}$	2.8	2.8	2.8	2.8	2.8

Close Help

# Test the Code!

## Main Function

```
// Declare output:
double realPart = 0.0;
double imaginaryPart = 0.0;

// Implement equation from theory:
double ita = 5E-2;
double K = 0.111E2;
double L = 7.5E-2;
double dndT = 7.3E-6;
double n0 = 1.823;
double r = Math.Sqrt(x * x + y * y);
double c1 = (-1.0) * ita * P / (4.0 * K * Math.PI * L) * dndT;
realPart = n0 + c1 * (r * r / r0 / r0);

// Return output:
return new Complex(realPart, imaginaryPart);
```

# Document Information

title	How to Work with the Programmable Medium and Example (Thermal Lens)
document code	CZT.0104
version	1.0
toolbox(es)	Starter Toolbox
VL version used for simulations	7.4.0.49
category	Feature Use Case
further reading	<ul style="list-style-type: none"><li>- <a href="#">How to Work with the Programmable Material and Example (Linear Dependence)</a></li><li>- <a href="#">Gaussian Beam Focused by a Thermal Lens</a></li></ul>