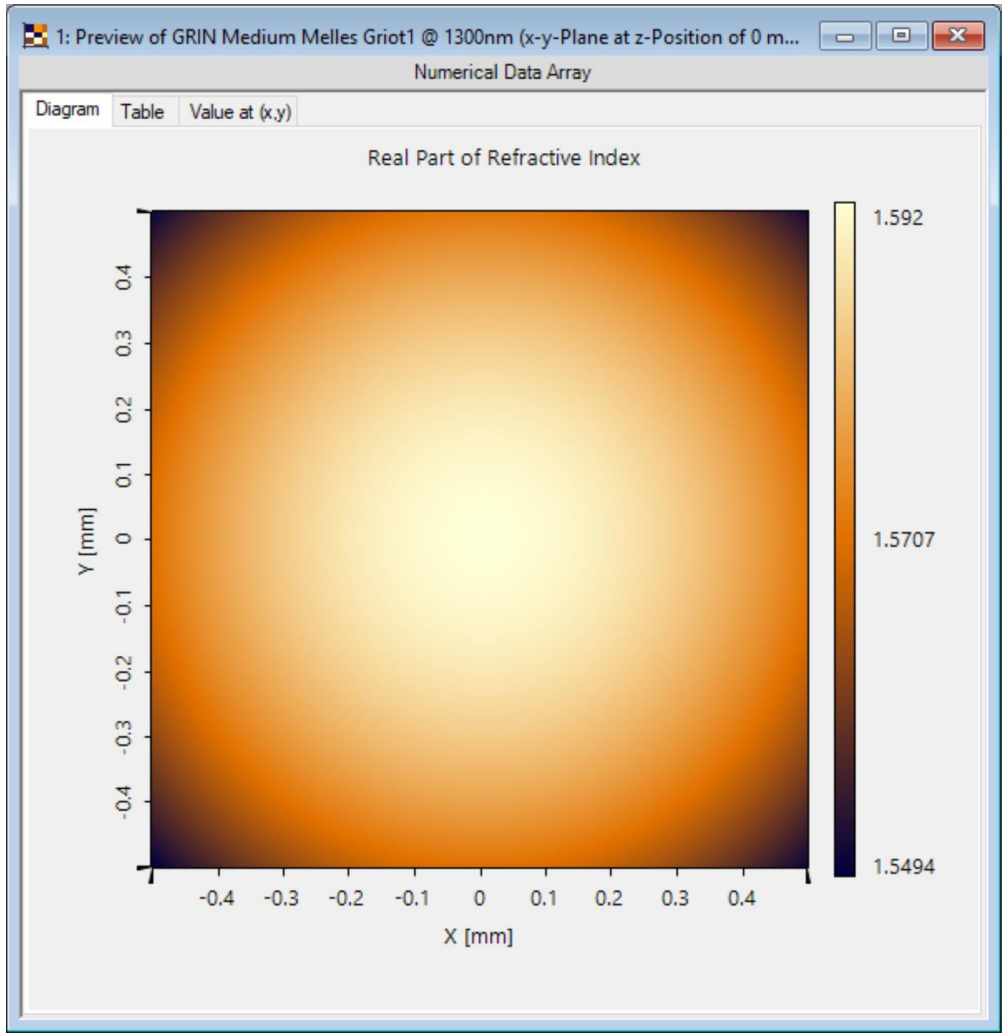
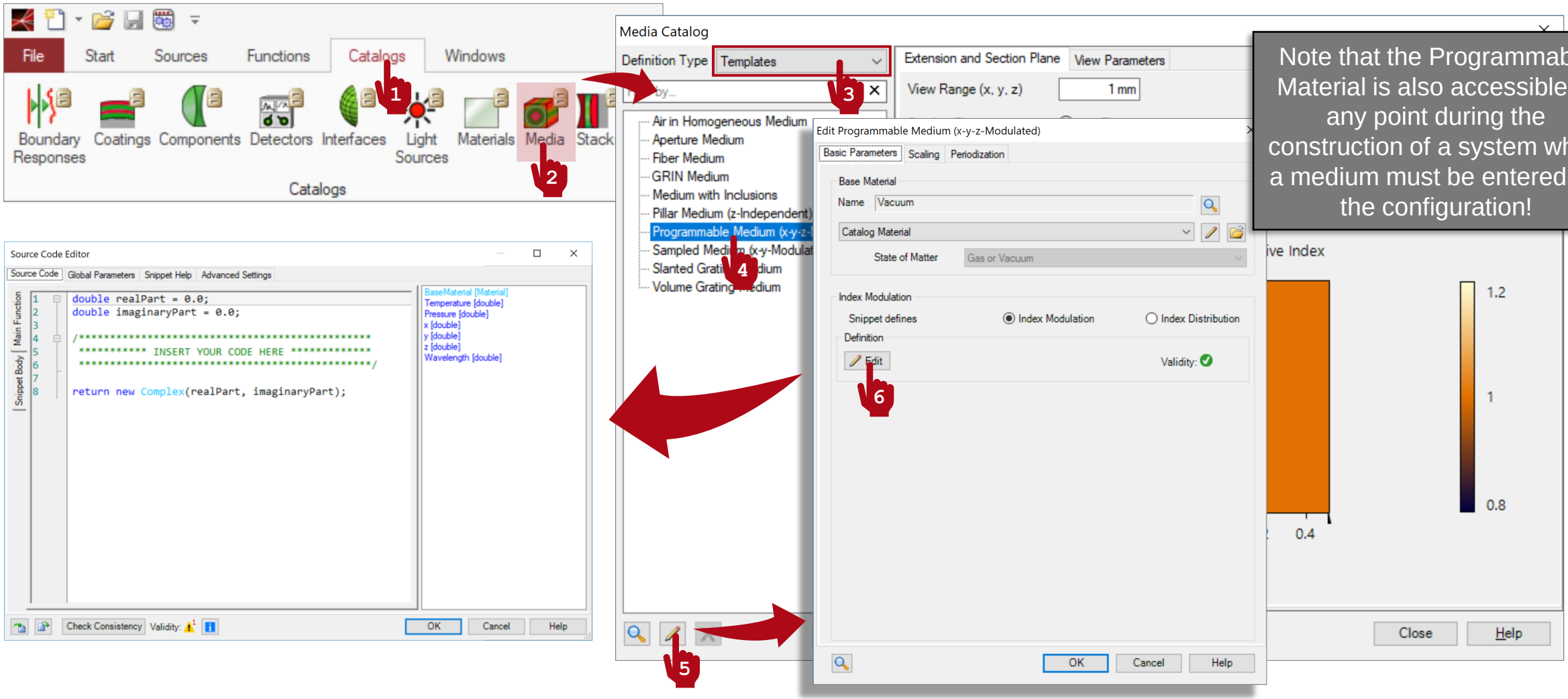
How to Work with the Programmable Medium and Example (Thermal Lens)

Abstract



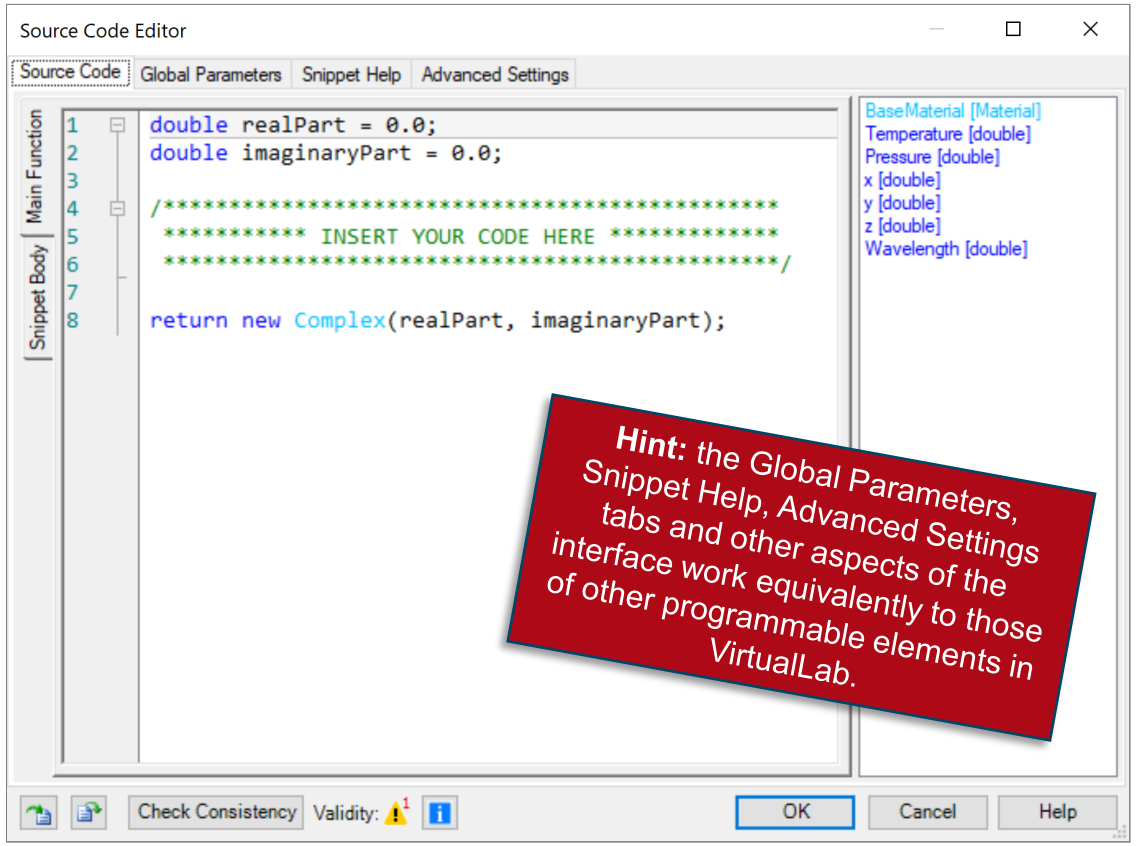
Providing maximum versatility is one of our most fundamental objectives. A key aspect of this aim is to provide a flexible-enough definition mechanism of the refractive index, in order to achieve a realistic characterization of the matter which composes an optical system. In VirtualLab Fusion this role 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



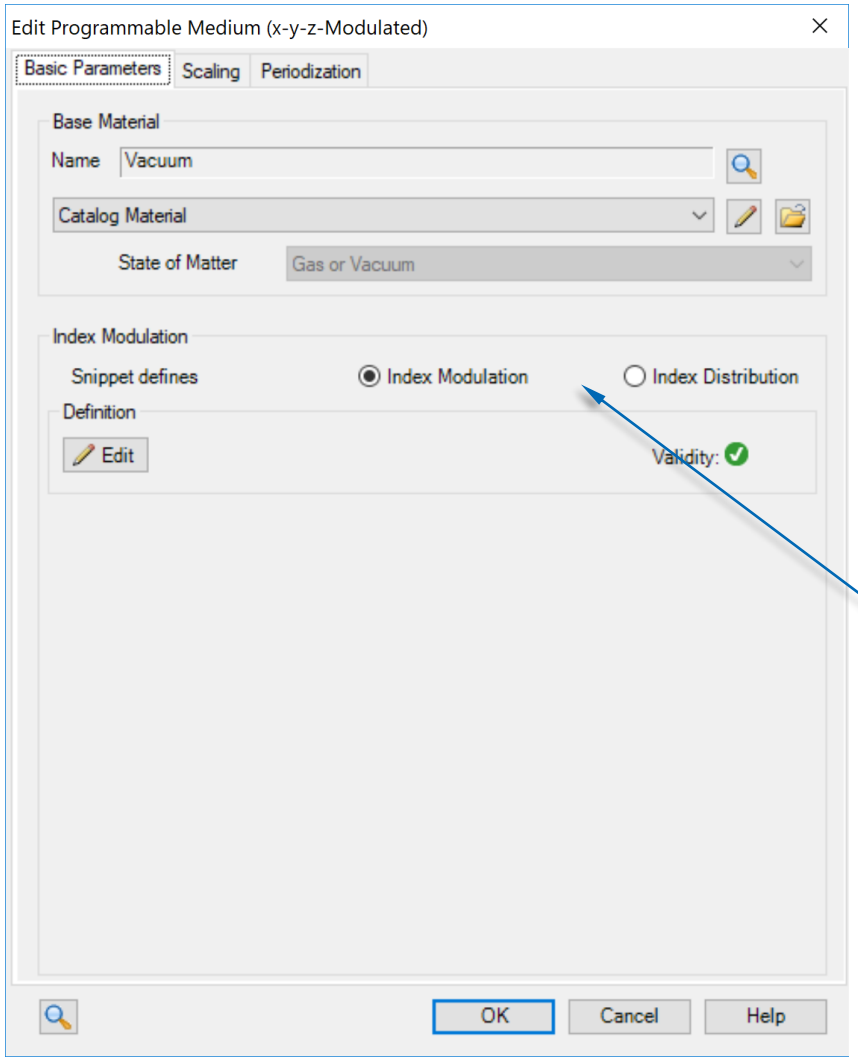
Note that the Programmable Material is also accessible at any point during the construction of a system when a medium must be entered for the configuration!

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.

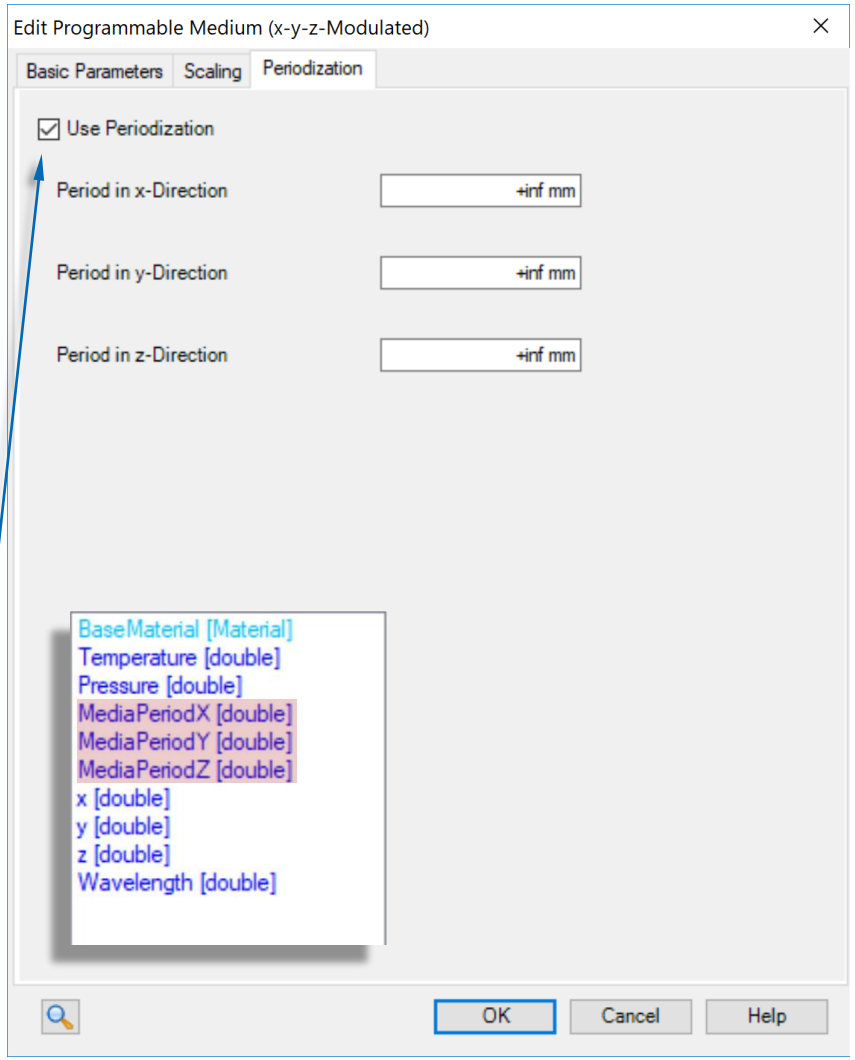
Base Material, Scaling & Periodization



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!

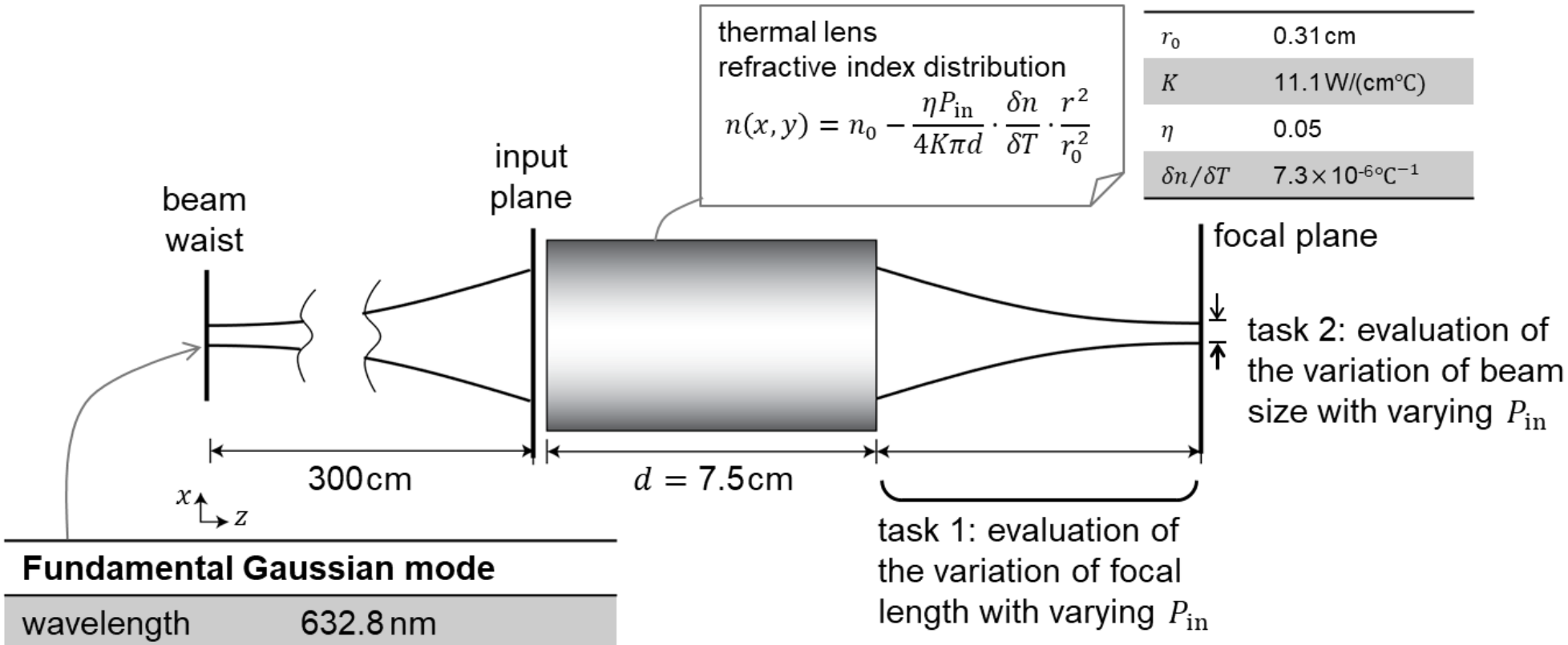
The option Index Modulation adds the value of the refractive index of the Base Material to the value computed by the current snippet. Index Distribution directly defines the value of the refractive index.

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



Programming a Thermal Lens

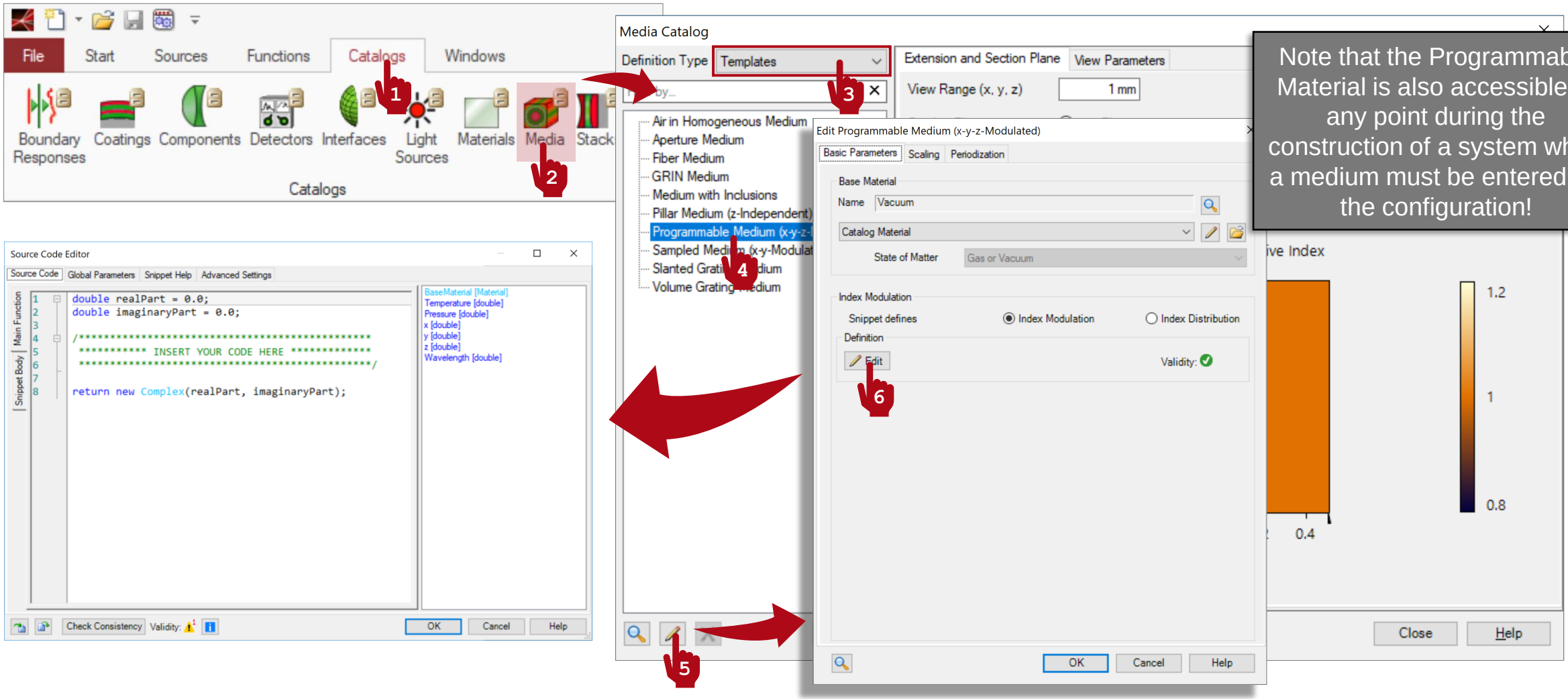
Thermal Lens



r_0	0.31 cm
K	11.1 W/(cm°C)
η	0.05
$\delta n/\delta T$	7.3×10^{-6} °C^{-1}

Fundamental Gaussian mode	
wavelength	632.8 nm
polarization	linear in x-direction
waist radius	760 µm
input power P_{in}	**8 to 20 kW**

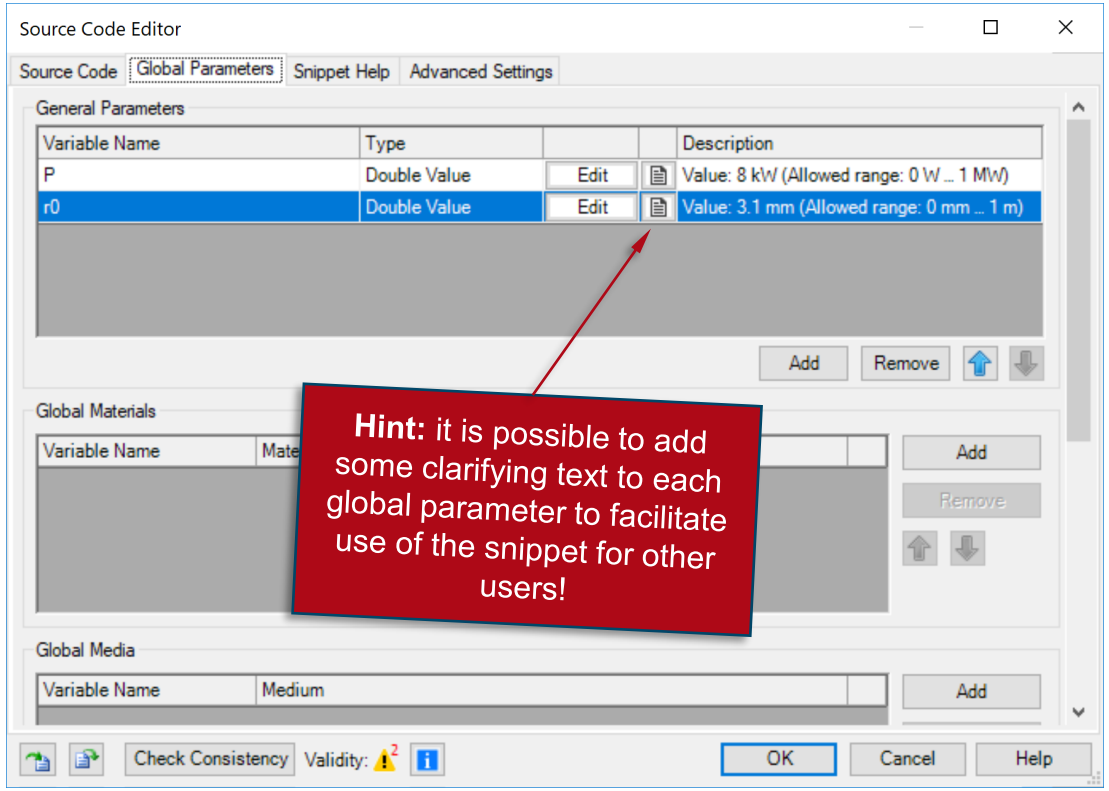
Where to Find the Programmable Medium: Catalog



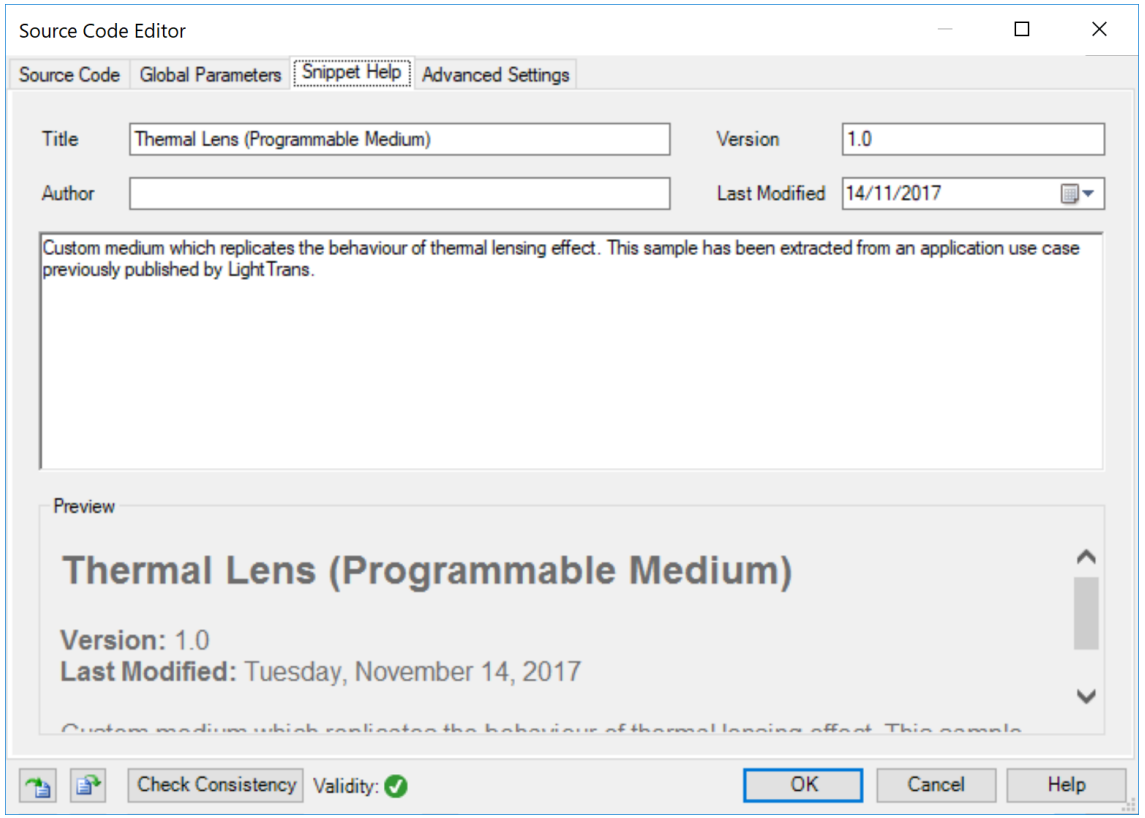
Note that the Programmable Material is also accessible at any point during the construction of a system when a medium must be entered for the configuration!

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_0 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.

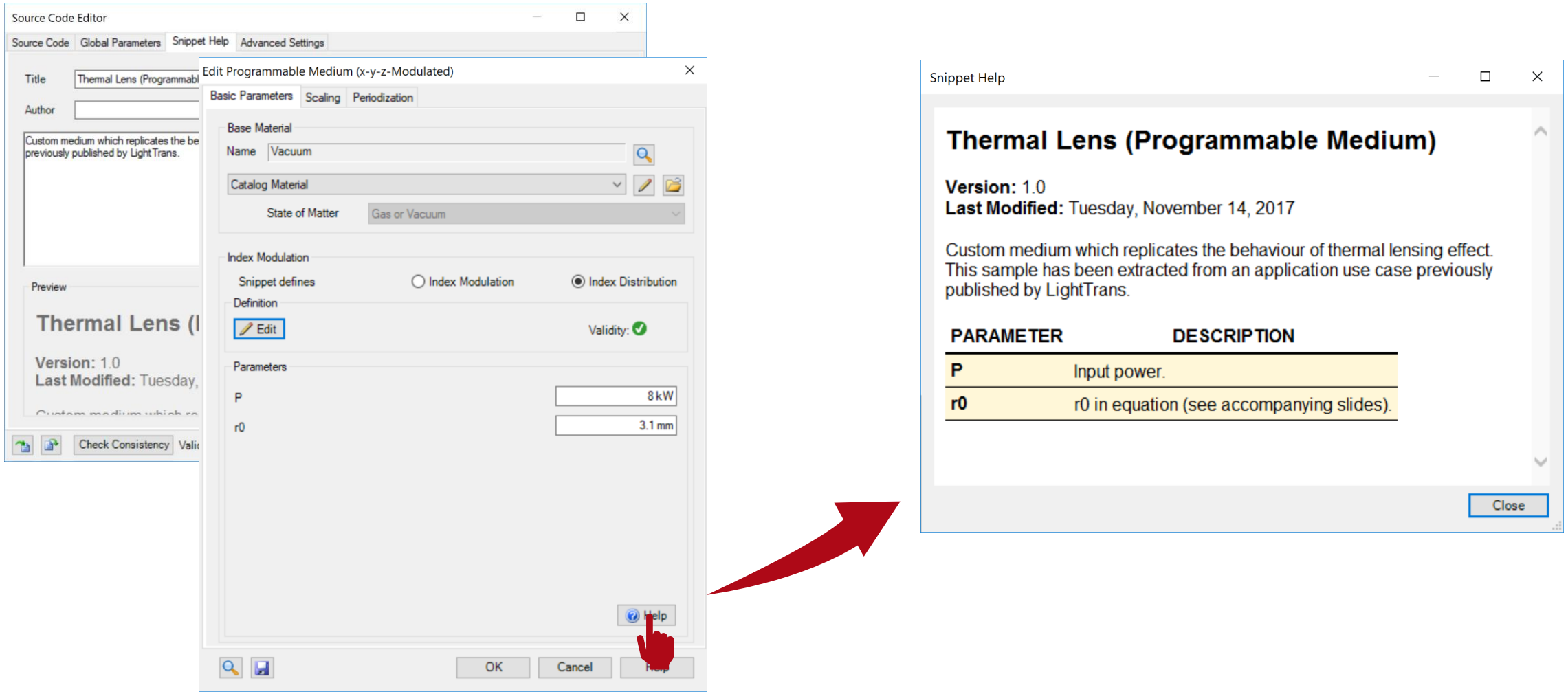


Programmable Medium: Snippet Help

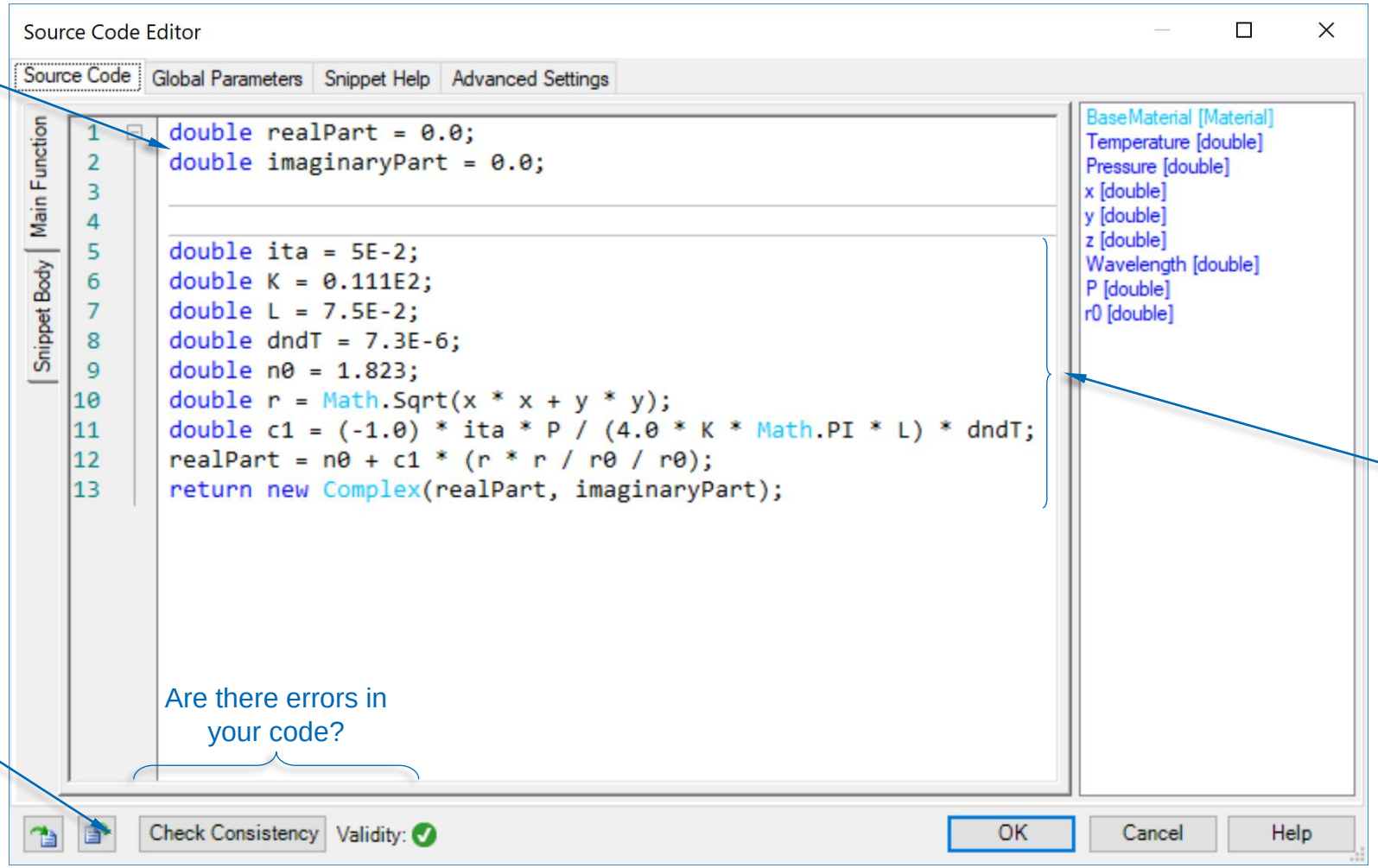


- **Optional:** you can use the Snippet Help tab to write instructions, clarifications, and some metadata associated to your snippet.
- This option is very helpful to keep track of your progress with a programmable element.
- It is especially useful when the programmable element is later disseminated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

Programmable Medium: Snippet Help



Programmable Medium: Writing the Code (1)



Declare output

Default global parameters/variables

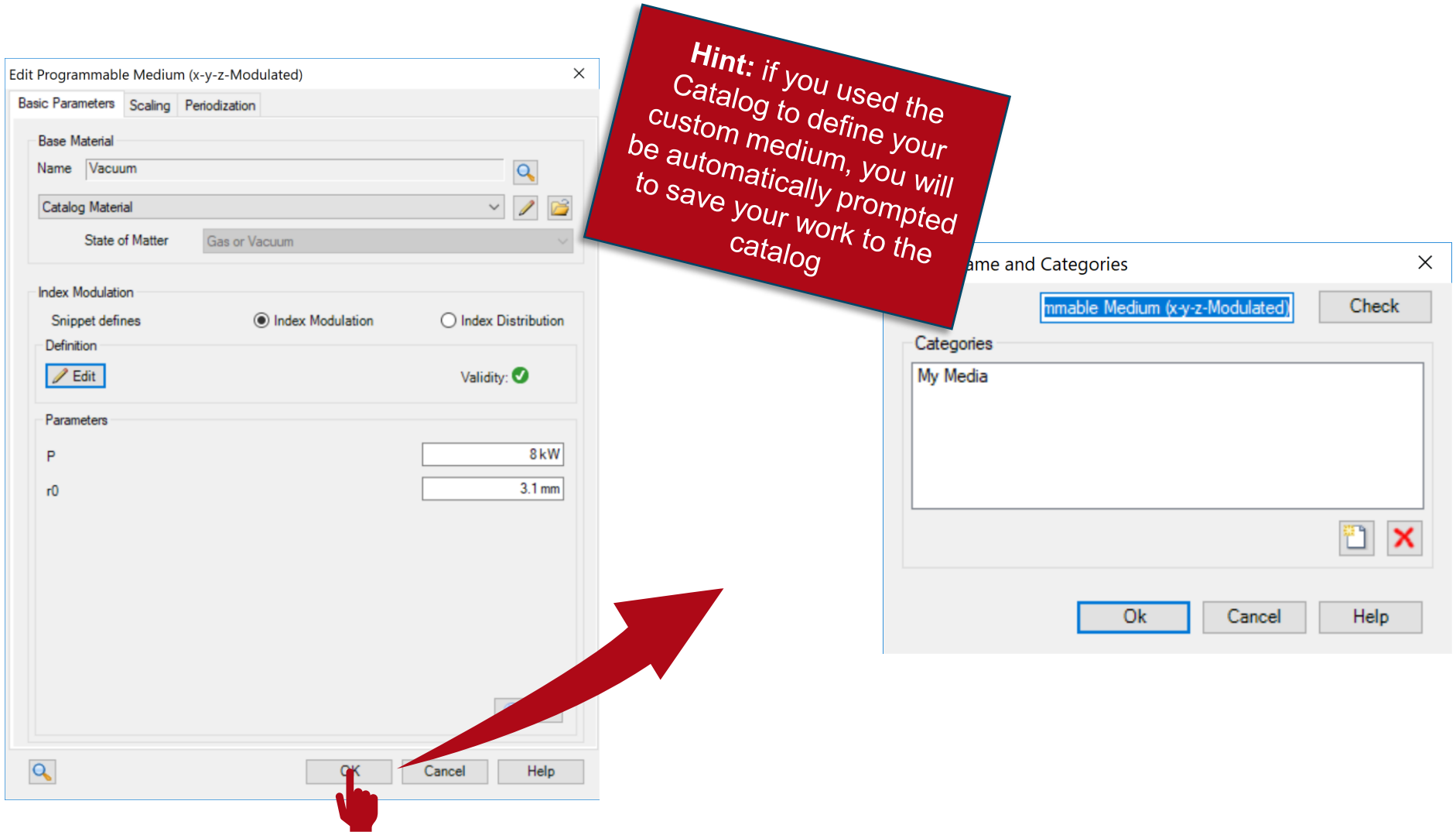
Global parameters defined by user in Global Parameters tab

Eq.

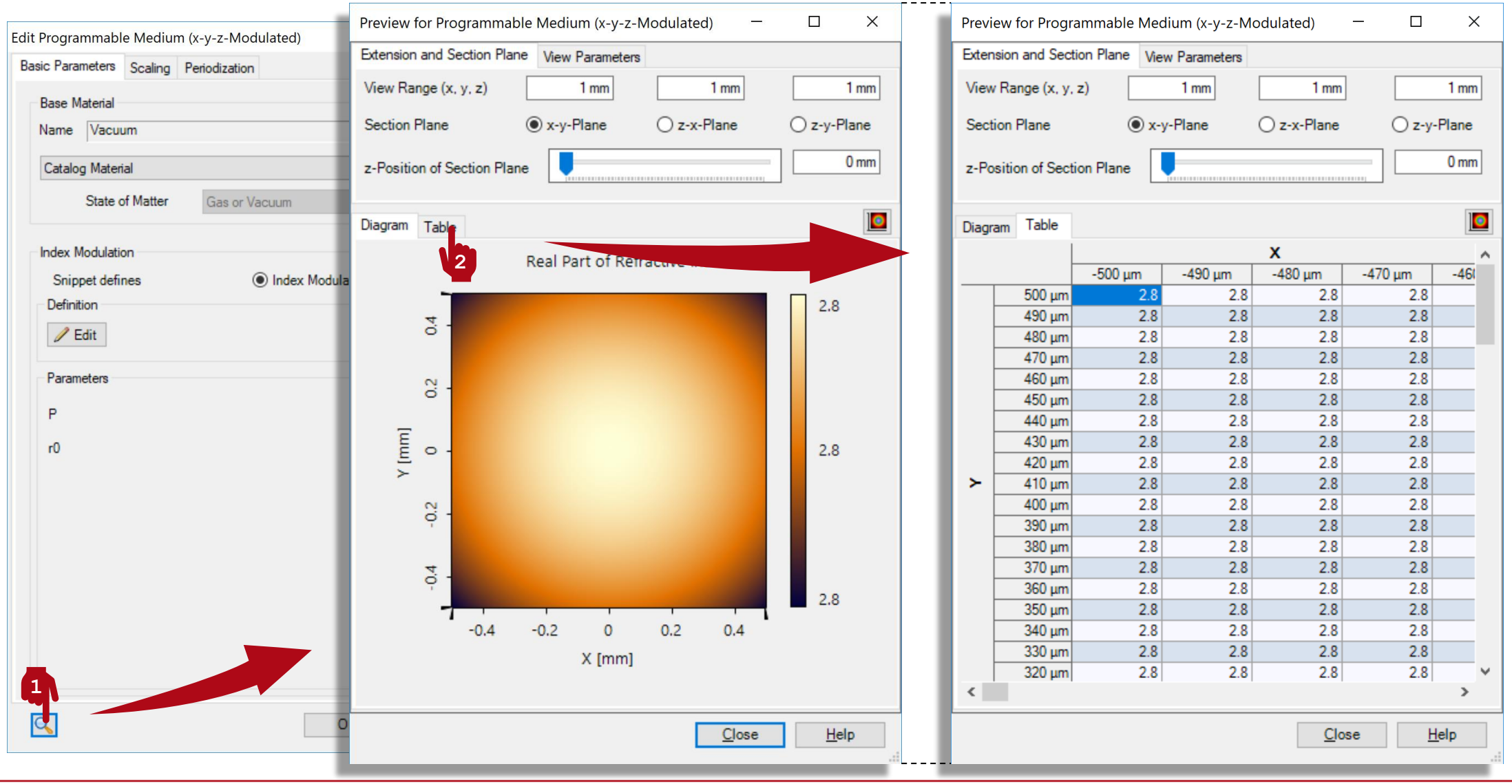
Export Snippet to save your work!

Are there errors in your code?

Save the Custom Medium 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 Modula
Definition
Edit
Parameters
P
r0
1
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
2
Real Part of Refractive
2.8
2.8
2.8
Y [mm]
0.4
0.2
0
-0.2
-0.4
-0.4
-0.2
0
0.2
0.4
X [mm]
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
X
-500 µm
-490 µm
-480 µm
-470 µm
500 µm
490 µm
480 µm
470 µm
460 µm
450 µm
440 µm
430 µm
420 µm
410 µm
400 µm
390 µm
380 µm
370 µm
360 µm
350 µm
340 µm
330 µm
320 µm
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	- How to Work with the Programmable Material and Example (Linear Dependence) - Gaussian Beam Focused by a Thermal Lens