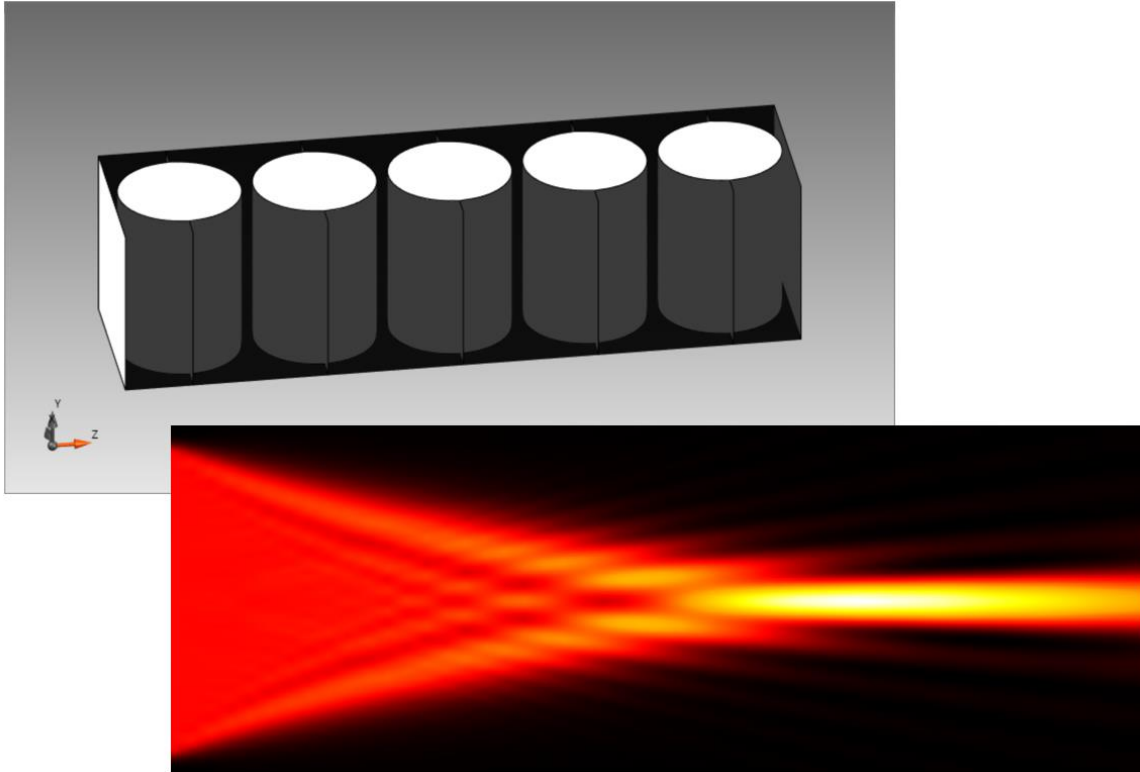


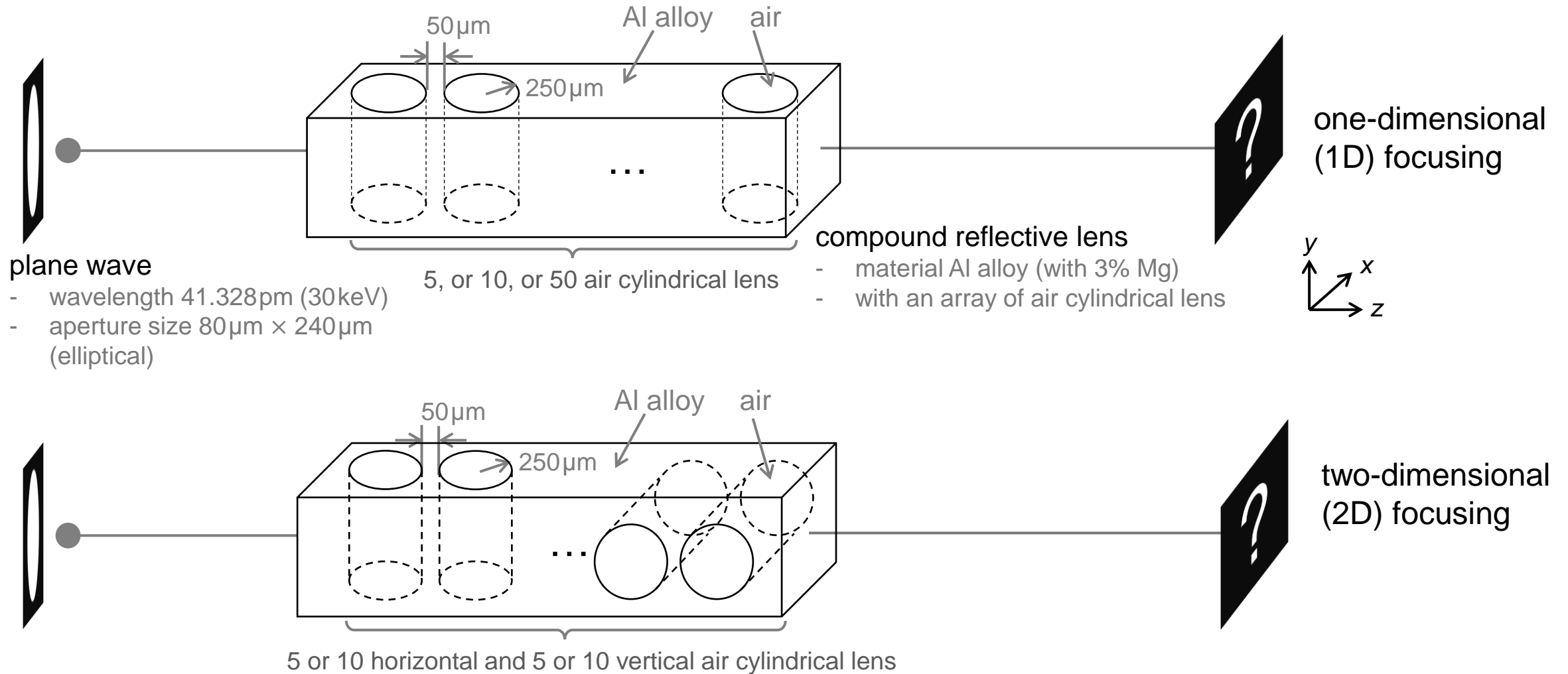
Compound Refractive Lens for X-Ray Focusing

Abstract



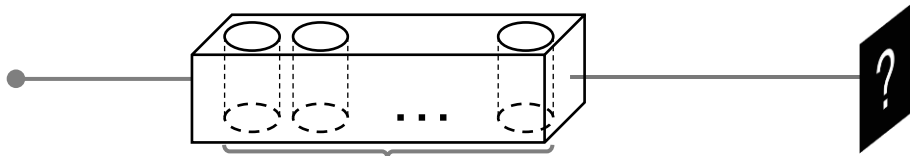
Refraction of x-rays by a single lens is usually small, but a compound lens (consisting of tens or hundreds of individual cylindrical lenses arranged in a linear array) can gradually focus x-rays one- or two-dimensionally. The focal length can be controlled by the number of the lenses, i.e., the more lenses are used, the shorter focal length is achieved. Following the paper of Snigirev *et al.* [Applied optics, 1998, 37(4): 653-662], this use case demonstrates 1D and 2D x-ray focusing by a compound refractive lens in VirtualLab Fusion.

Modeling Task

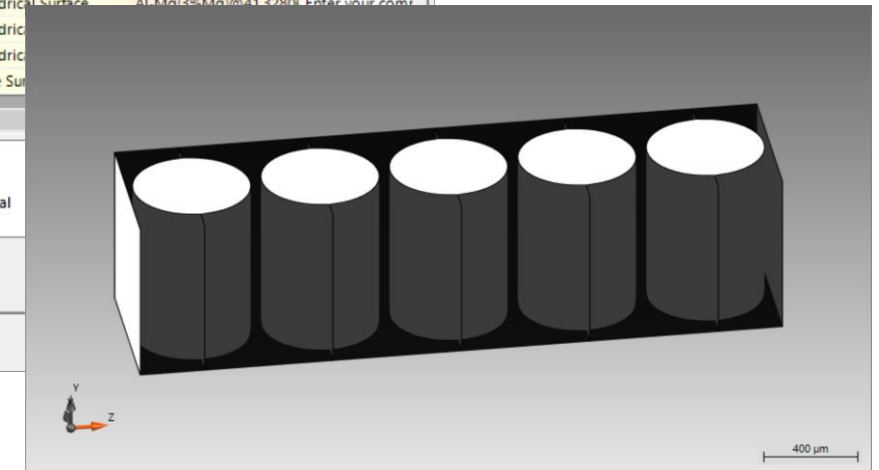
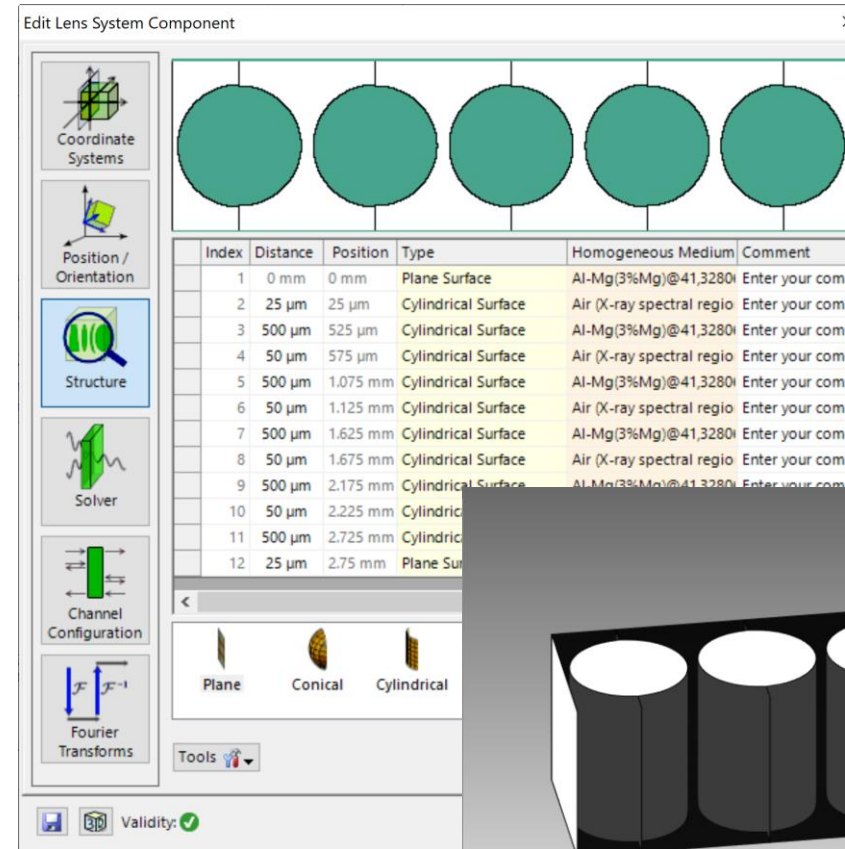


system parameters from Snigirev A, et al. Applied optics, 1998, 37(4): 653-662

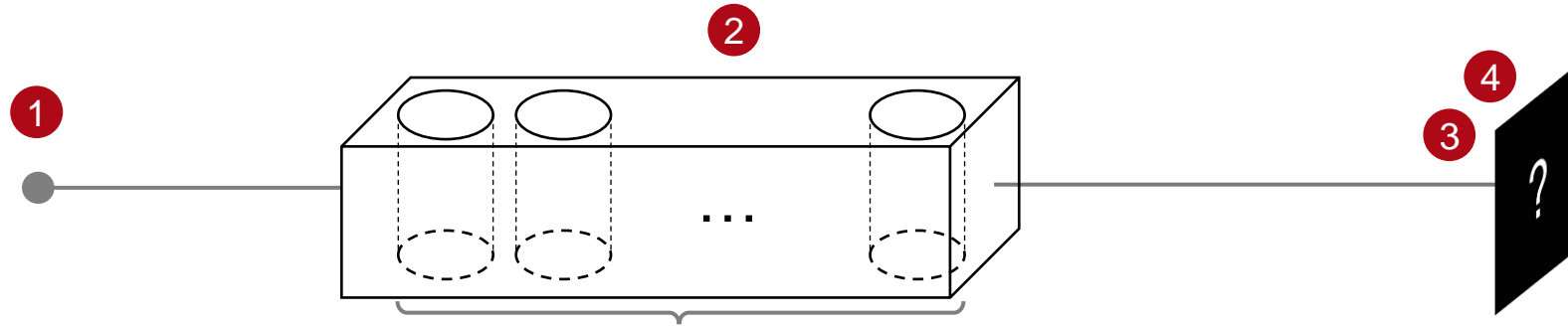
System Building Blocks – Components



- The *Lens System Component* allows the definition of multiple surfaces and the media in between according to the user specifications. By setting two cylindrical surfaces with contrary sign on the *Radius of Curvature* it is possible to generate the cylindrical lenses used in this kind of component.
- This lens modeling is not apt for illumination of the full curvature (including the area where the surface becomes flat). But this is no limitation for this simulation at all, as only a small part of the lens curvature is illuminated.



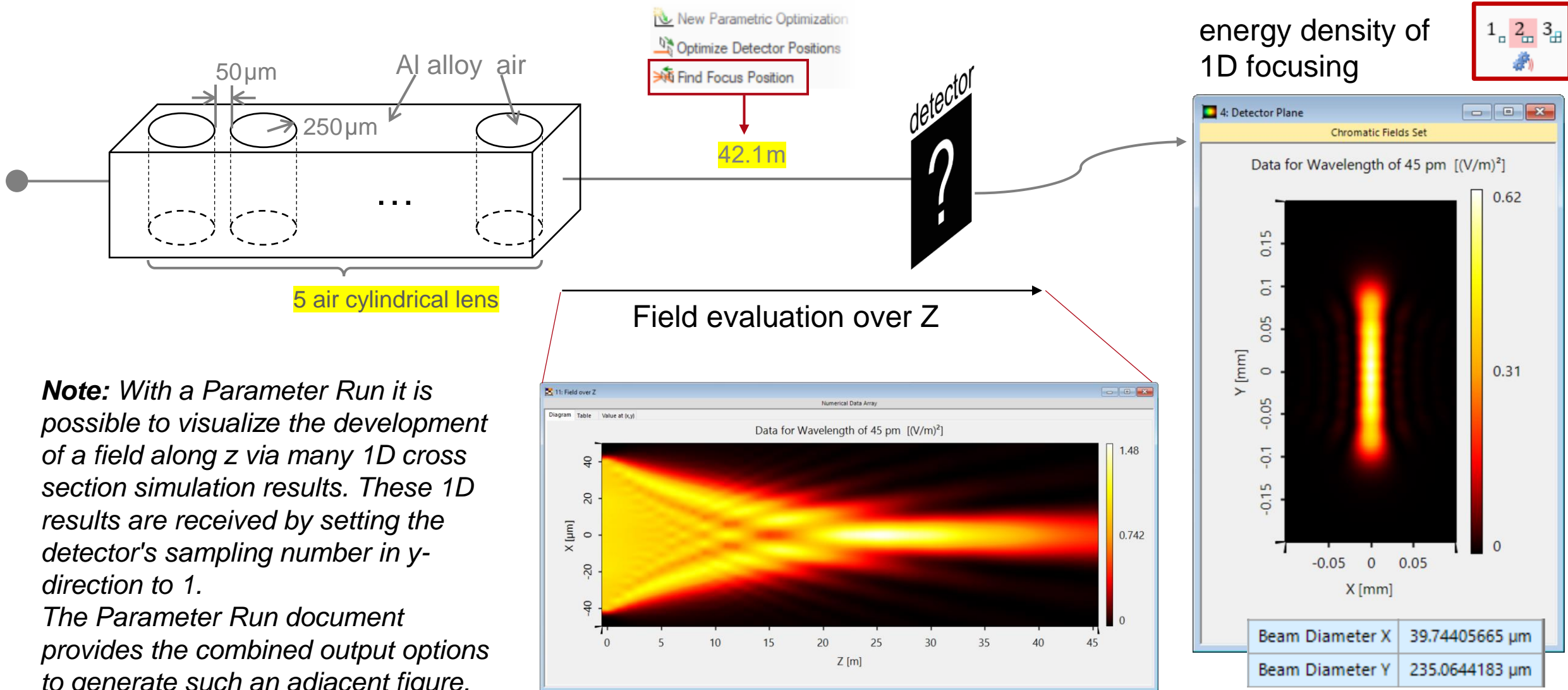
Summary – Components...



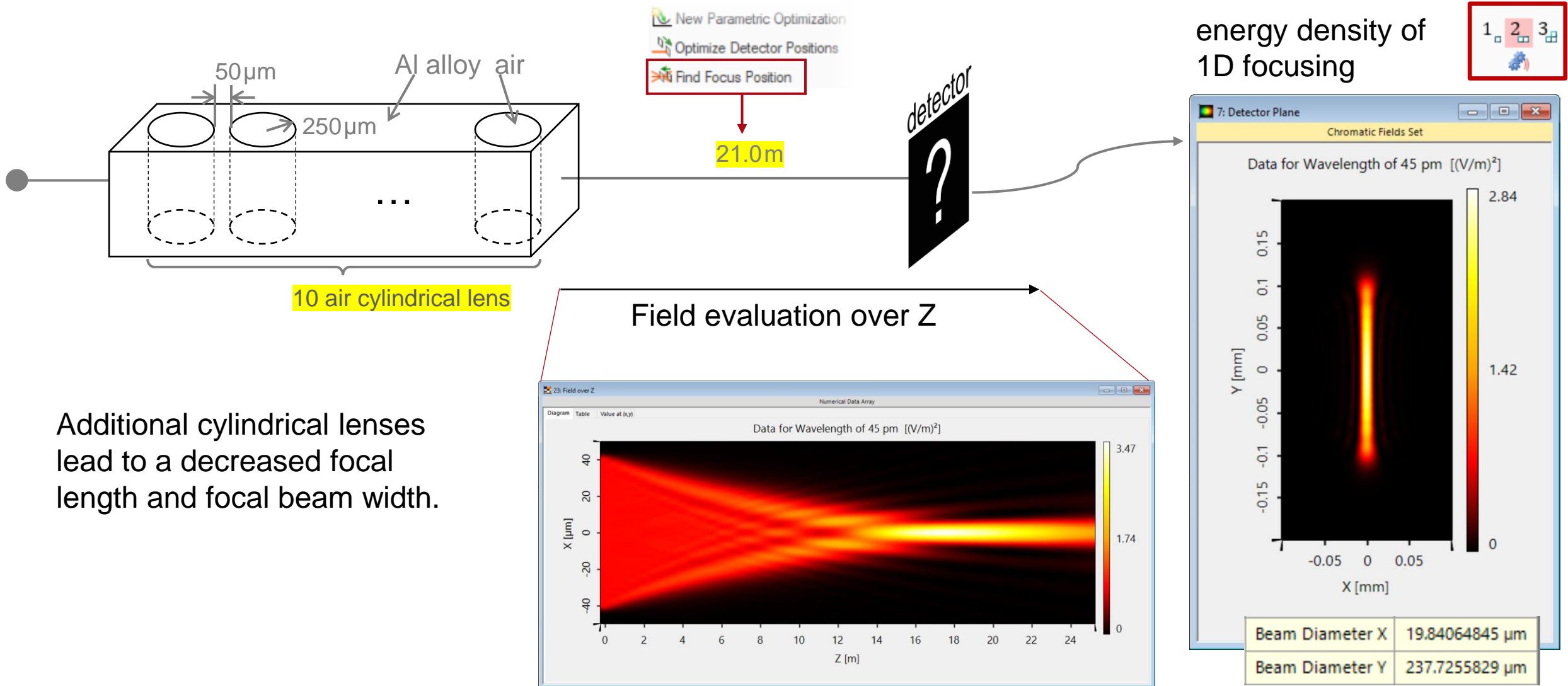
... of Optical System	... in VirtualLab Fusion	Model/Solver
1. Source	<i>Plane Wave Source</i>	Truncated Ideal Plane Wave
2. Compound lens	<i>Lens System Component</i>	Local Plane Interface Approximation (LPIA)
3. Detector	<i>Spot Size Detector</i>	Second-Momentum theory
4. Detector	<i>Camera Detector</i>	Energy density

Simulation Results

1D-Simulation: 5 Cylindrical Lens

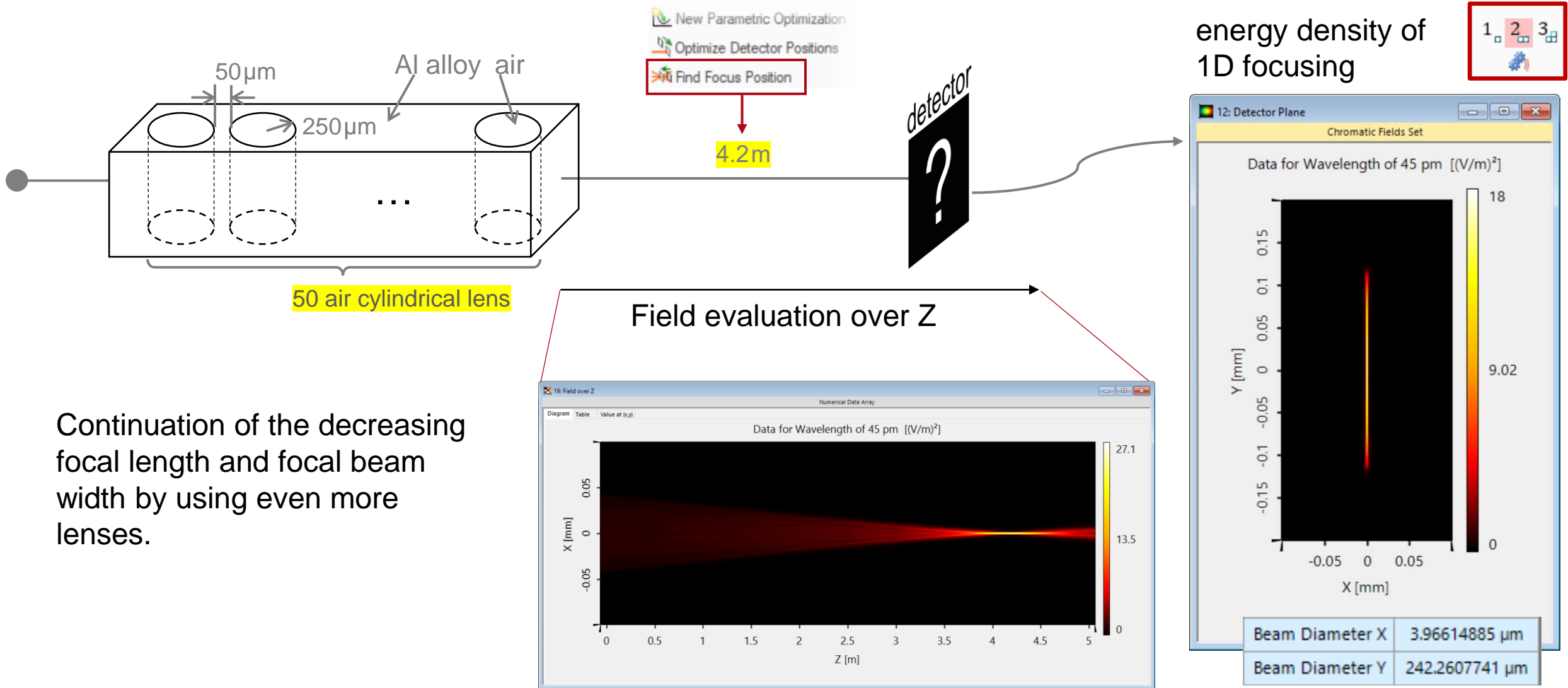


1D-Simulation: 10 Cylindrical Lens

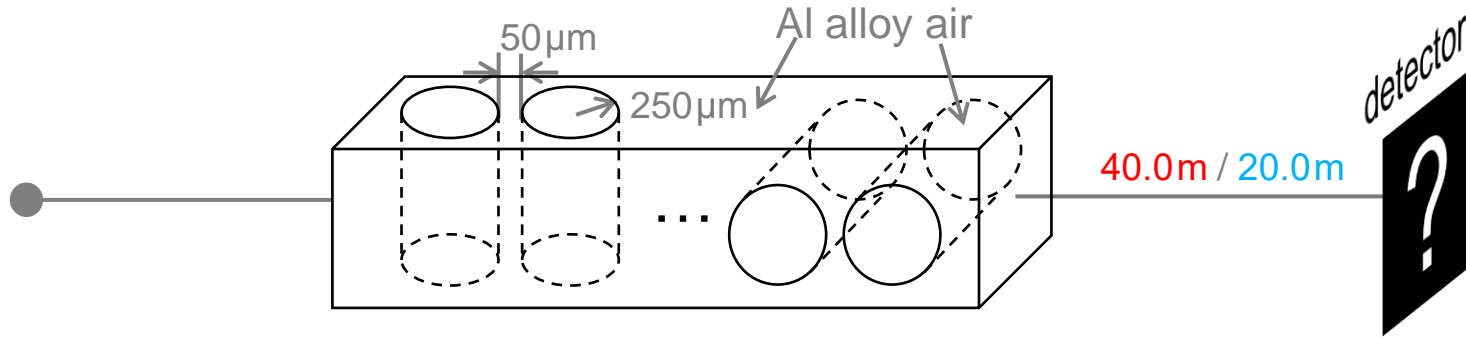


Additional cylindrical lenses lead to a decreased focal length and focal beam width.

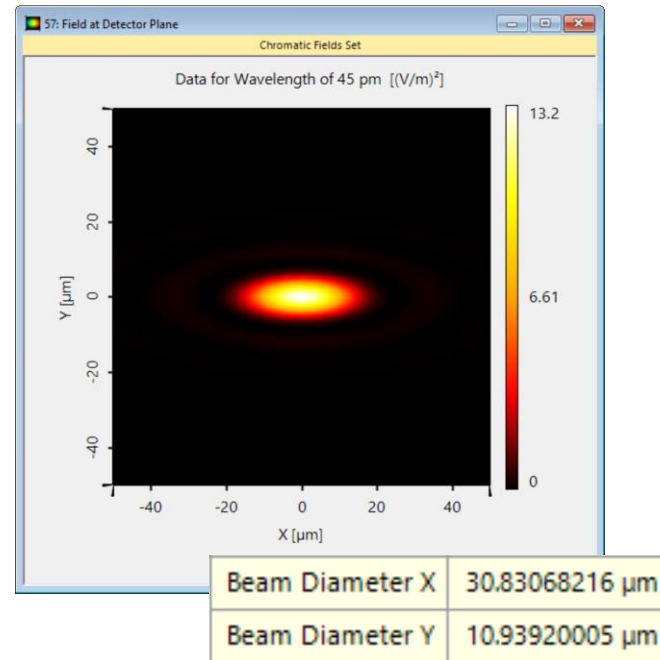
1D-Simulation: 50 Cylindrical Lens



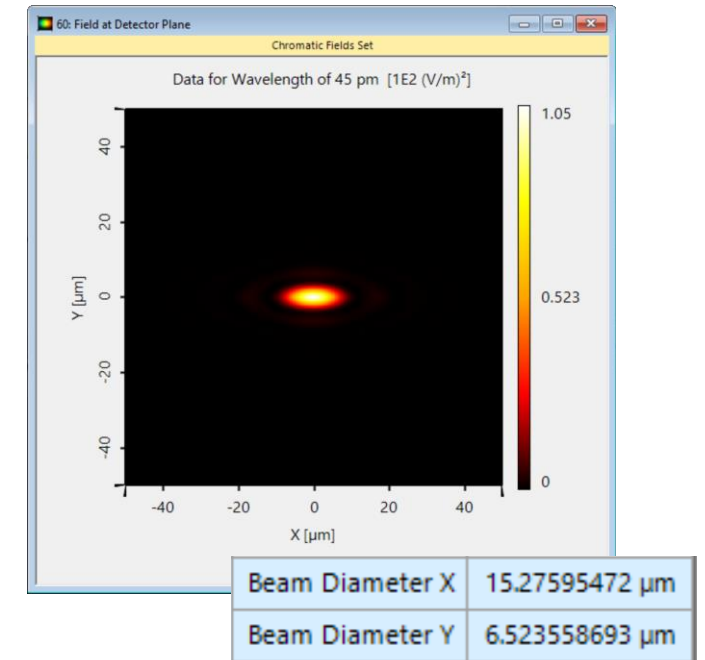
2D-Simulation: 5 Cylindrical Lens



- To focus the x-ray beam in both x- and y-direction the compound lens can be built up by an horizontally (H) and vertically oriented cylindrical lenses.
- Here we simulated an equal number of both types.

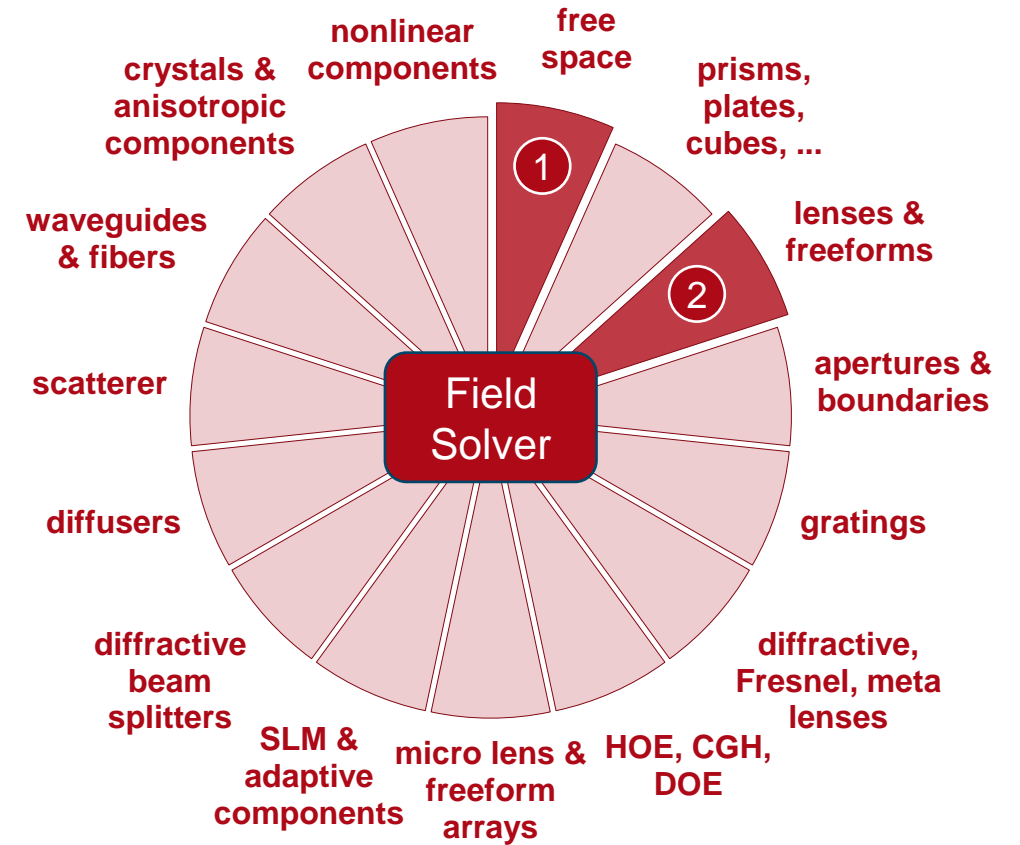
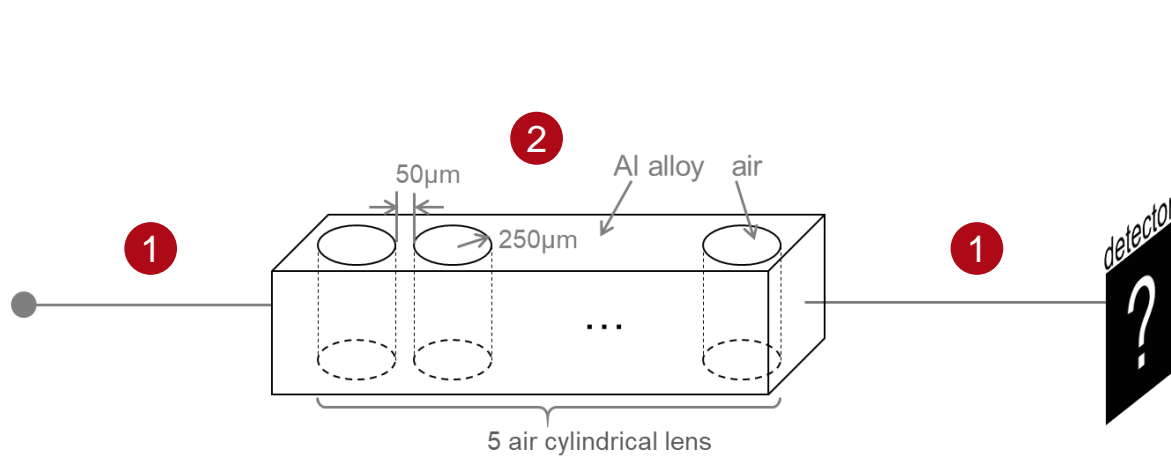


5 (H) and 5 (V) air cylindrical lens



10 (H) and 10 (V) air cylindrical lens

VirtualLab Fusion Technologies



Document Information

title	Compound Refractive Lens for X-Ray Focusing
document code	XRAY.0004
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edition	VirtualLab Fusion Basic
software version	2021.1 (Build 1.180)
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further reading	<ul style="list-style-type: none">- Single Grating Interferometer for X-Ray Imaging- Grazing-Incidence Focusing Mirrors for X-Ray Beams