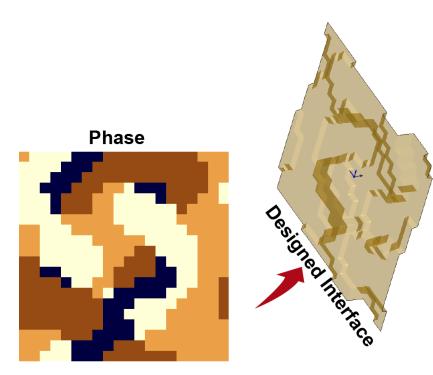


#### **Structure Design**

#### Abstract

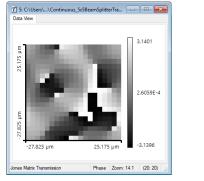


In Virtual ab Fusion the user can design phase functions, which works as beam shaper, beam splitter and diffuser, using the iterative Fourier transformation algorithm. Later these phase function can be converted into a optical structure, which can be a diffractive mirror or a transparent plate. VirtualLab offers a convenient tool to design such an optical structure from a given phase function. This use case shows the usage of the structure design tool.

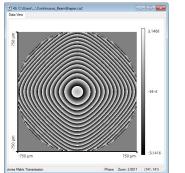
### This Use Case Shows...

how to design an structure (surface height profile) from a phase function

#### phase with dislocations

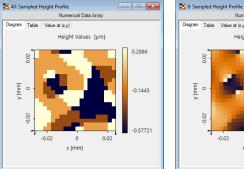


#### phase with $2\pi$ -modulo





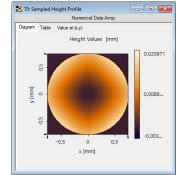
#### quantized structure smooth structure



#### 

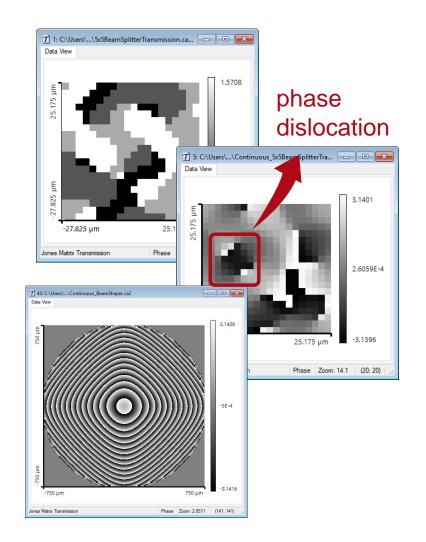
- • ×

#### unwrapped structure



# **System Construction**

- For illustration purpose, we work with
  - phase function with dislocations
    - a quantized one (4-levels)
    - a continuous one
  - a phase function with 2πmodulo



## **Structure Design: Edit Window**

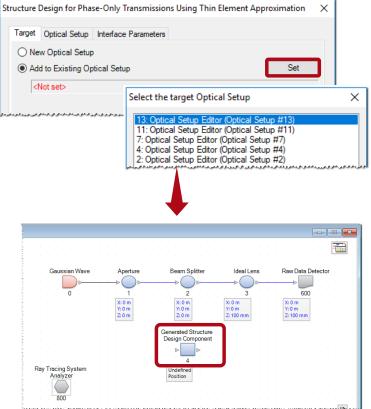
- In the document specific ribbon of transmission function, click Structure Design.
- The designed structure is saved in an *Optical* Setup.

	\5x5BeamSplitter	rTransmission.	ca	• X						
25.175 µm	Ş	5	1	1.5708 -0.7854						
· · •	🔫 i 🖺 🗸 🚔	; 🔜 🐻 i :						Harmo	nic Field	
-27.825	File 🔨 Sta	rt Source	es Funct	ions	Catalogs	Windows	View	Manipulations	Detectors	Design
Matrix Tra	Structure Design		Target Nev	Optical Se v Optical S	etup Interfa	ce Parameters	is Using TI	hin Element App	roximation :	×
							Ok	Cancel	Help	]

## **Edit Window: Target**

Choose the *Optical Setup*, in which the designed interface shall be added.

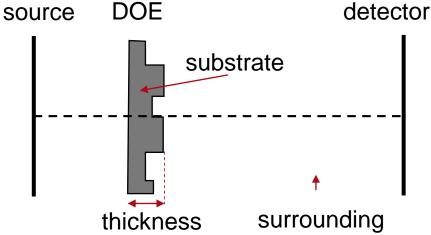
	Design for Pr	nase-Only Tran	nsmiss	ions Usir	ng Thin	Eleme	ent A	ppro	oxim	atior	n >
Target	Optical Setup	p Interface Pa	ramete	ers							
● Ne	w Optical Set	up									
⊖ Ad	d to Existing (	Optical Setup									
رر مر مر	والمحرور والمعنو المدعون		بمرسم	وررمامرين	ببرين	بردين		مومور	ر سی		
14: Opti	cal Setup View	(Optical Setup #	¥13)								
⊡Light So	urces	(Optical Setup #			1011		-		-	_	
⊡Light So ⊷Coordina	urces ate Break	(Optical Setup #		Generated Design (			-		-	-	
⊡ Light So ··· Coordina ··· Compon	urces ate Break	(Optical Setup #		Generated Design C	Compone		-		-	-	
- Light So Coordina Compon Ideal Co Camera	urces ate Break ents mponents Detector	(Optical Setup #					-		-	-	
Light So Coordina Compon Ideal Co Camera Detecto	urces ate Break ents mponents Detector rs	(Optical Setup #		Design C	Compone		-		-	-	
Light So Coordina Compon Ideal Co Camera Detecto	urces ate Break ents mponents Detector rs	(Optical Setup #			Compone 1 ed		-		-	-	
Light So Coordina Compon Compon Ideal Co Camera Detector	urces ate Break ents mponents Detector rs	(Optical Setup #		Design C	Compone 1 ed				-	-	
Light So Coordina Compon Compon Ideal Co Camera Detector	urces ate Break ents mponents Detector rs	(Optical Setup #		Design C	Compone 1 ed					-	
Light So Coordina Compon Ideal Co Camera Detecto	urces ate Break ents mponents Detector rs	(Optical Setup #		Design C	Compone 1 ed						
Light So Coordina Compon Ideal Co Camera Detecto	urces ate Break ents mponents Detector rs	(Optical Setup #		Design C	Compone 1 ed						
⊡ Light So ··· Coordina ··· Compon	urces ate Break ents mponents Detector rs	(Optical Setup #		Design C	Compone 1 ed						



### **Edit Window: Optical Setup**

• Both reflective and transmissive element can be designed.

Structure Design for Phase-Or	nly Transmissions Using Thin Element Approximation	×
Target Optical Setup Inter	face Parameters	
Setup Physical Parameters Substrate Medium Fused Silica in Homoge Medium	Height Profile of Transparent Plate     Height Profile of Transparent Plate     Height Profile of Miror     Surrounding Medium     eneous     Air in Homogeneous Medium     Q View     Edit   Q View	l
Thickness of Substrate Wavelength	1 mm i	
	Ok Cancel Help	



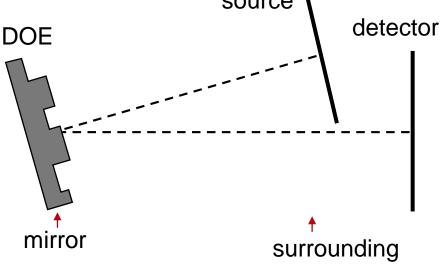
To design transmission DOE, following parameters need to be specified:

- working wavelength
- substrate
- surrounding

### **Edit Window: Optical Setup**

Both reflective and transmissive element can be designed.
source

Structure	Design for Pha	se-Only Transmissio	ns Using Thin Element Appro	ximation $ imes$
Target	Optical Setup	Interface Parameters		
Setup		Height Profile of	Mirror	~
	ical Parameters			
	ibstrate Medium		Surrounding Medium	
	eal Mirror in Hor edium	nogeneous	Air in Homogeneous Medium	
C	🖥 Load 🥒 🖉	Edit Q View	🚰 Load 🥒 Edit 🔍	View
Thic	kness of Substra	ate	1 mm	8
Wav	elength		532 nm	
			Ok Cancel	Help



To design reflection DOE, following parameters need to be specified:

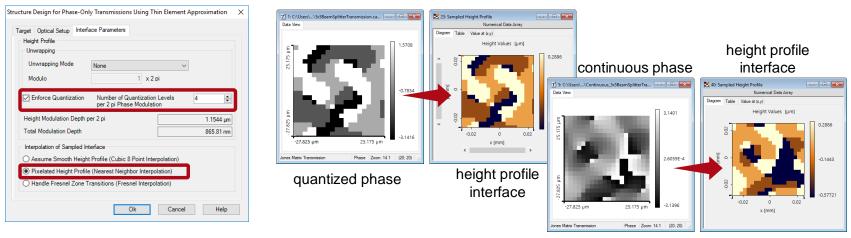
- working wavelength
- surrounding

## **Quantized Interface from Phase with Dislocations**

- Different kinds of interfaces can be generated depending on given phase function and requirements on the surface.
  - phase function with dislocations, both quantized and continuous
    - Unwrapping Mode is None.

Tips:

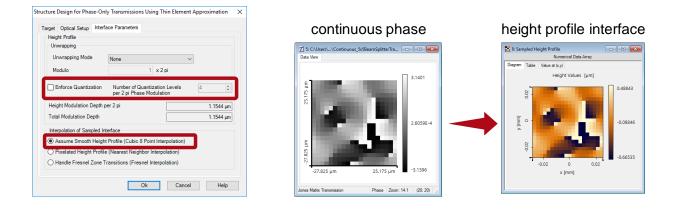
• If quantized interface is required, *Enforce Quantization* is checked and number of level is given. *Pixelated Height Profile* is ALWAYS checked for quantized structure.



 $\frac{\text{Total Modulation Depth}}{\text{Modulation Depth per 2 } pi} = \frac{N-1}{N}$ , with N denoting number of quantization level.

## **Smooth Interface from Phase with Dislocations**

- Different kinds of interfaces can be generated depending on given phase function and requirements on the surface.
  - phase function with dislocations, both quantized and continuous
    - Unwrapping Mode is None.
    - If quantized interface is required, Enforce Quantization is checked and number of level is given. Pixelated Height Profile is ALWAYS checked for quantized structure.
    - If continuous interface is designed, Assume Smooth Height Profile is ALWAYS checked

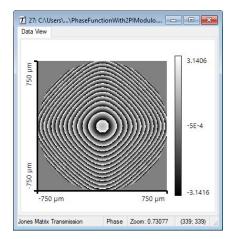


#### **Interface from a Wrapped Phase**

- This phase function contains jumps to 2π steps (2πmodulo). Depend on the requirement of structure, different Unwrapping Modes can be used.
  - None: no unwrapping.
  - *Partial*: unwrap the phase into  $2\pi$ -,  $4\pi$ -,... N  $\cdot 2\pi$ -modulo.

Number of Quantizat per 2 pi Phase Modul	
er 2 pi	1.1544 µm
	1.1544 µm
erface	
Profile (Cubic 8 Point Ir	nterpolation)
(Nearest Neighbor Inte	rpolation)
ransitions (Fresnel Inter	rpolation)
	per 2 pi Phase Modu er 2 pi erface Profile (Cubic 8 Point In (Nearest Neighbor Inte

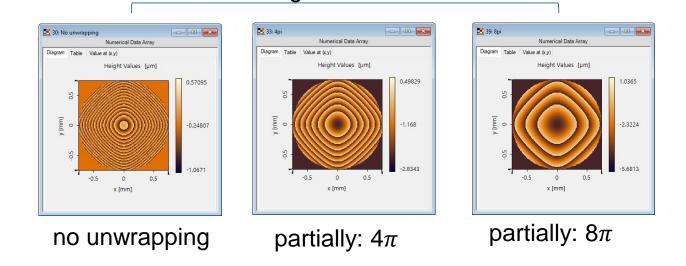
Interpolation Handle Fresnel Zone Transitions is recommended. This is a special interpolation which avoids interpolation artifacts at the Fresnel jumps.



#### Phase with $2\pi$ -modulo

## Wrapped and Partially Unwrapped Interface

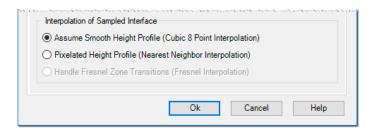
- This phase function contains jumps to 2π steps (2πmodulo). Depend on the requirement of structure, different Unwrapping Modes can be used.
  - None: no unwrapping.
  - *Partial*: unwrap the phase into  $2\pi$ -,  $4\pi$ -,... N  $\cdot 2\pi$ -modulo.



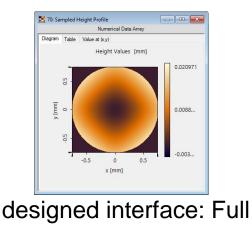
designed interface

# **Fully Unwrapped Interface**

- This phase function contains jumps to 2π steps (2πmodulo). Depend on the requirement of structure, different Unwrapping Modes can be used.
  - None: no unwrapping.
  - Partially: unwrap the phase into  $2\pi$ -,  $4\pi$ -,... N· $2\pi$ -modulo.
  - Full: completely unwrap



Interpolation *Assume Smooth Height Profile* is recommended.



#### **Document Information**

title	Structure Design
version	1.0
VL version used for simulations	7.3.0.50
category	Feature Use Case