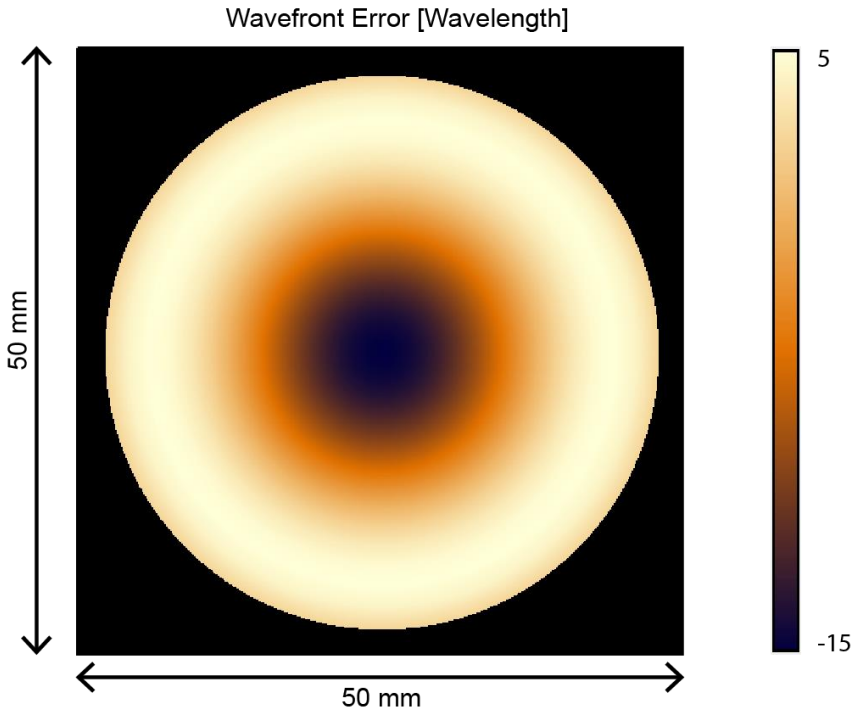
Wavefront Error Detector

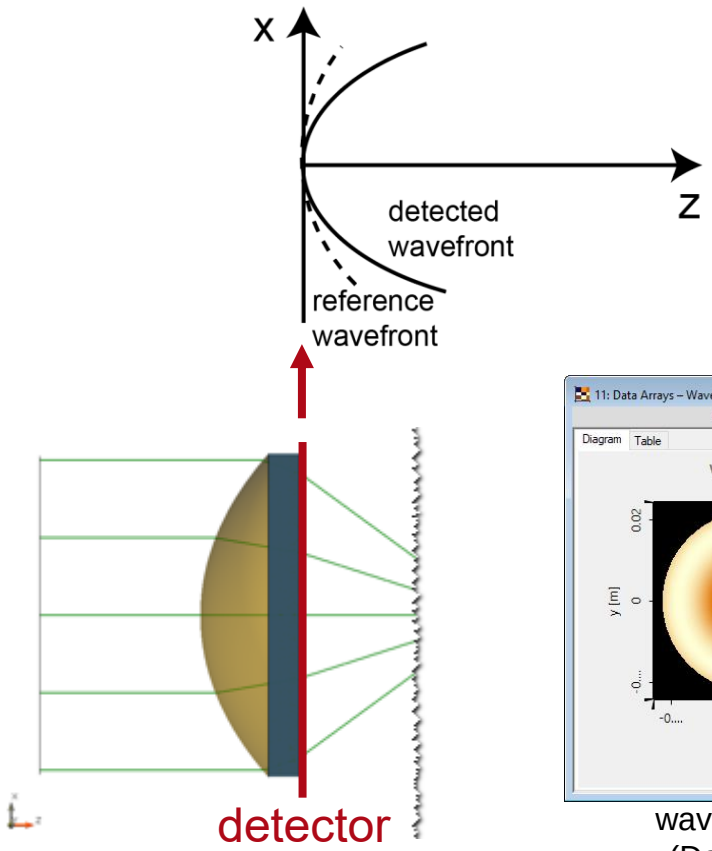
Abstract



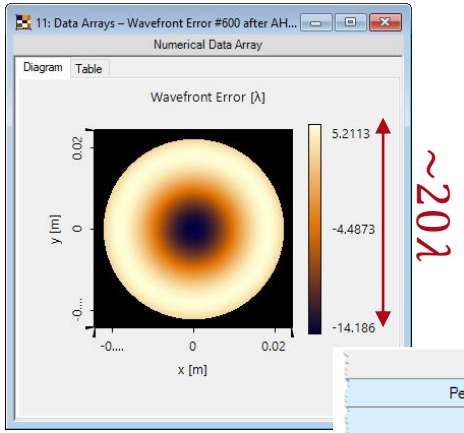
Wavefront error is defined as the difference between the reference wavefront phase, which is a constant phase or spherical phase, and the detected wavefront phase of one optical system. It is a very important criterion for the quality of the system, which can be used as merit functions for parametric optimization. In VirtualLab Fusion, users can detect such errors by using specific detector. This use case shows how to handle a wavefront error detector in VirtualLab Fusion.

Modeling Task

- how to handle a Wavefront Error Detector.



Wavefront phase: The phase distribution in detector plane, which results in one wavefront.
Wavefront error: Deviation between detected and reference wavefront phase.



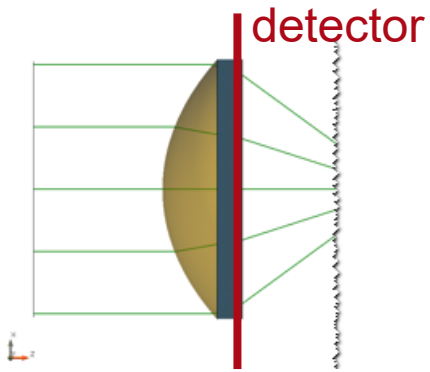
wavefront error
(Data Arrays)

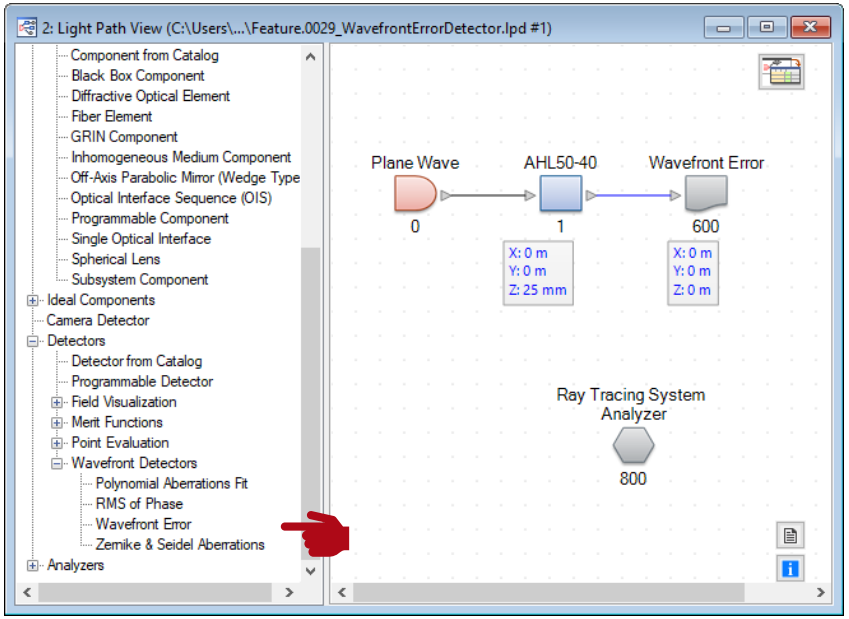
Peak-to-Valley and RMS of wavefront error

Sub - Detector	Result
Peak-to-Valley Wavefront Error [λ]	19.397
RMS [λ] of Wavefront Error	5.5807

System Construction

For illustration purposes, we work with an optical system, which includes a plane wave, an aspherical lens and the wavefront error detector.





System Construction

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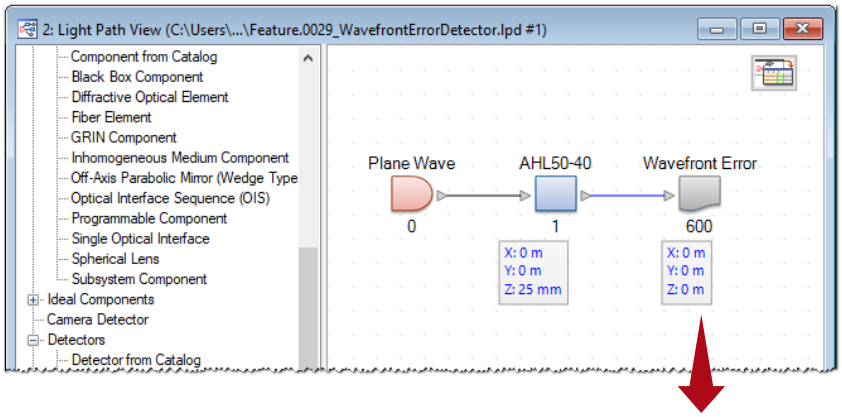
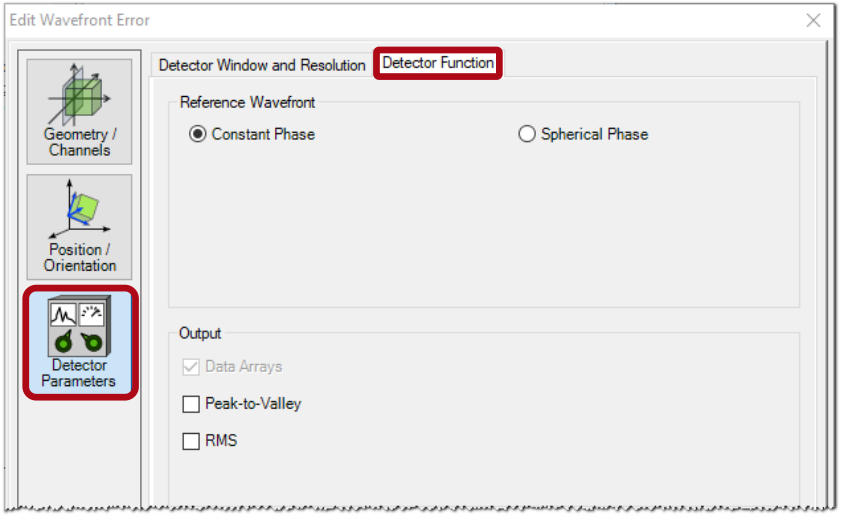
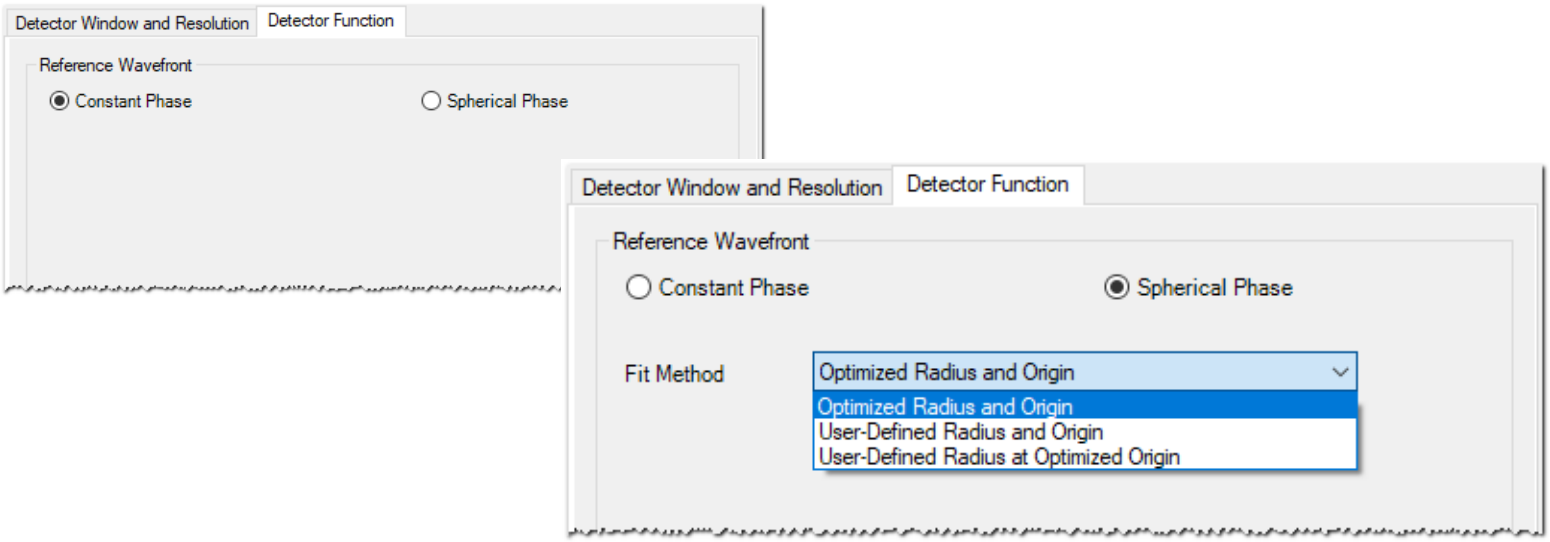




Detector Function: Reference Wavefront

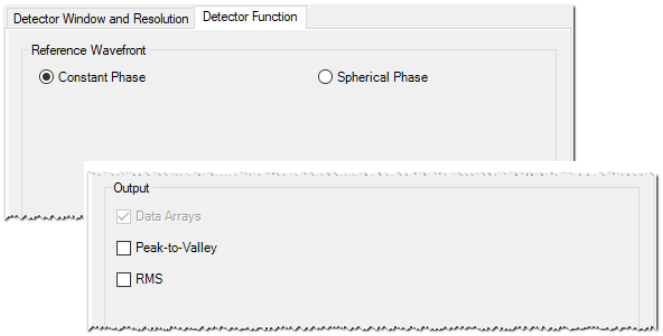
The reference wavefront can be

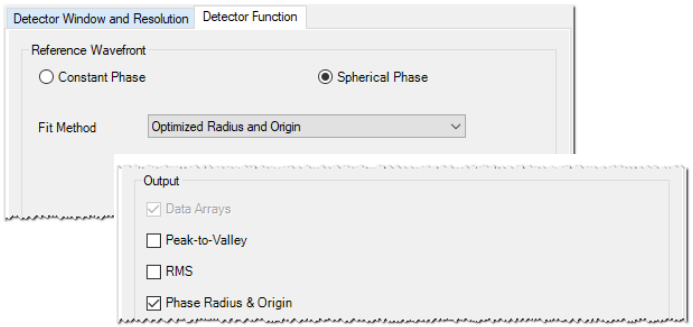
- *Constant Phase* results in planar reference wavefront.
- *Spherical Phase* results in spherical reference wavefront, whose radius and origin can be set by the user or optimized by VirtualLab.

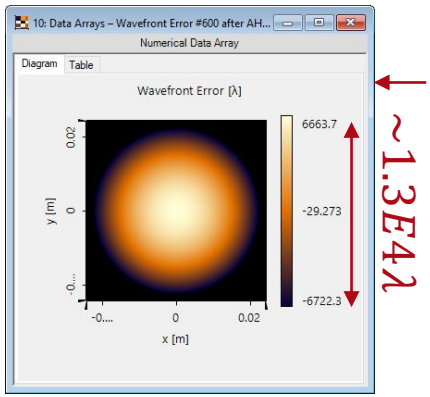


Results: Constant vs Spherical Reference

- Simulation is demonstrated using Ray Tracing.

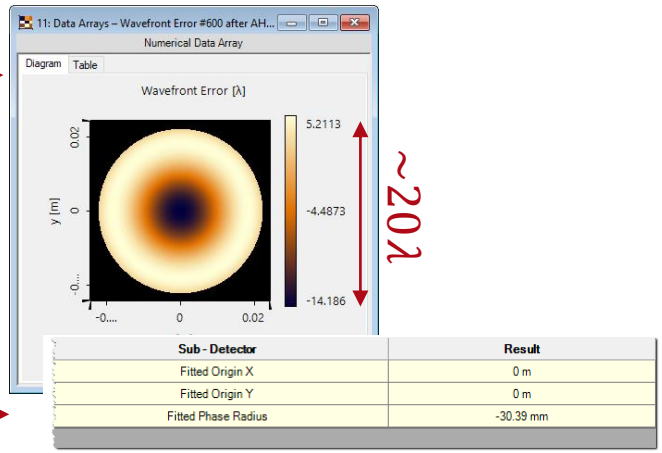






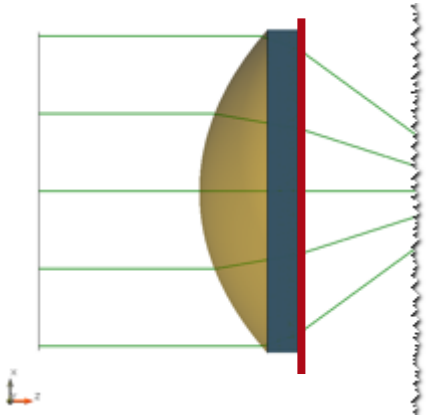
Data Arrays give the distribution of wavefront error in the detector plane.

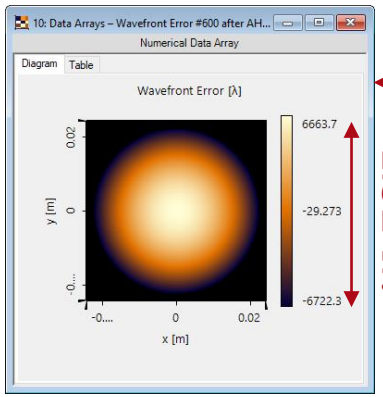
Phase Radius & Origin gives the position of spherical center of the reference spherical wavefront optimized by VirtualLab



Simulation Results: Const. v.s. Spherical

- Simulation is demonstrated using Ray Tracing.
- In this example, the detected wavefront should be spherical. Therefore, when we use *Spherical Phase* as reference, the wavefront error is smaller ($\sim 20\lambda$).

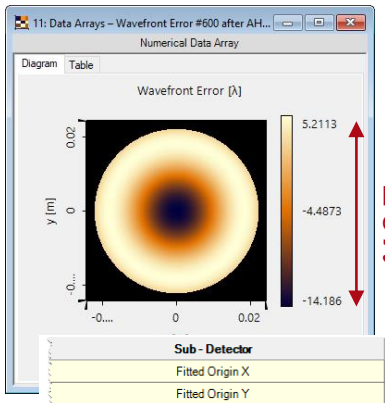




$\sim 1.3E4\lambda$

Data Arrays give the distribution of wavefront error in the detector plane.

Phase Radius & Origin gives the position of spherical center of the reference spherical wavefront optimized by VirtualLab

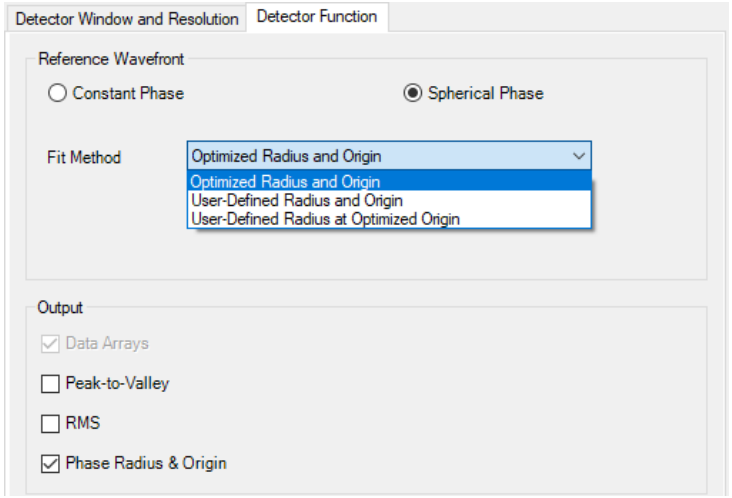


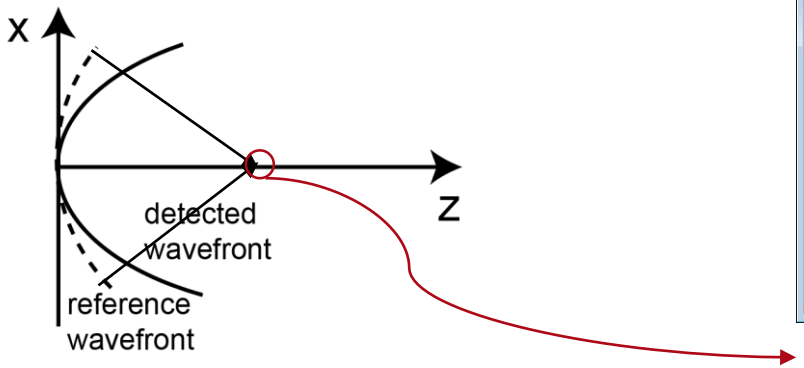
$\sim 20\lambda$

Sub - Detector	Result
Fitted Origin X	0 m
Fitted Origin Y	0 m
Fitted Phase Radius	-30.39 mm

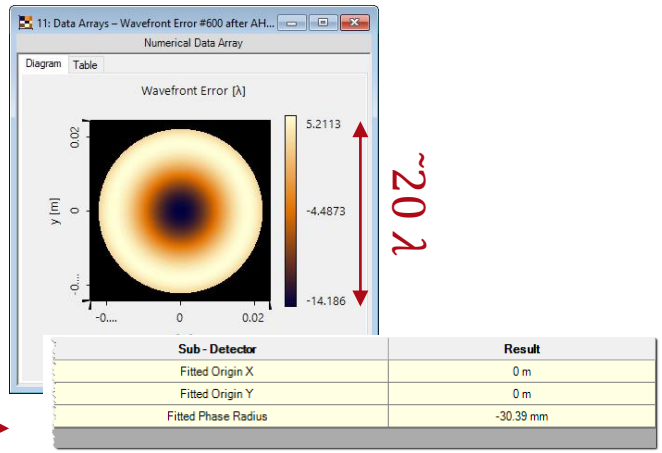
Spherical Phase: Fit Method

- Fit Method
  - *Optimized Radius and Origin*: The reference spherical wavefront is optimized/fitted from detected wavefront. The position of spherical center is shown when *Phase Radius & Origin* is checked.





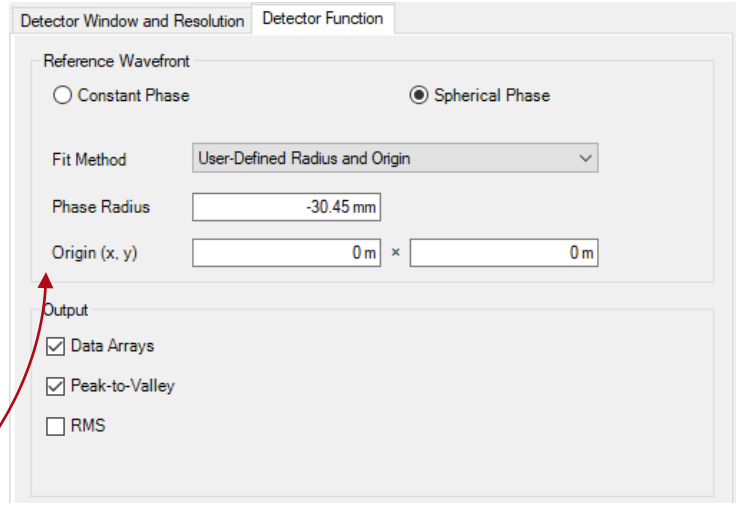
wavefront error

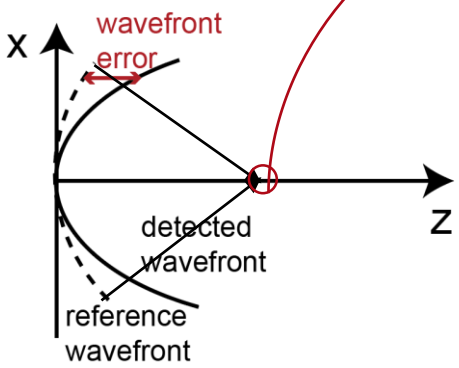


phase radius and origin

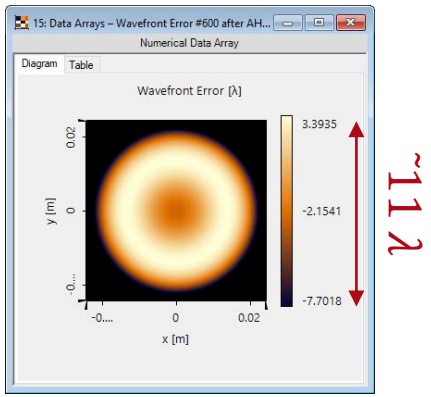
Spherical Phase: Fit Method

- Fit Method
  - Optimized Radius and Origin
  - *User-Defined Radius and Origin*: The position of sperical center of the reference wavefront, i.e. radius and x,y coordinates are given by the user.





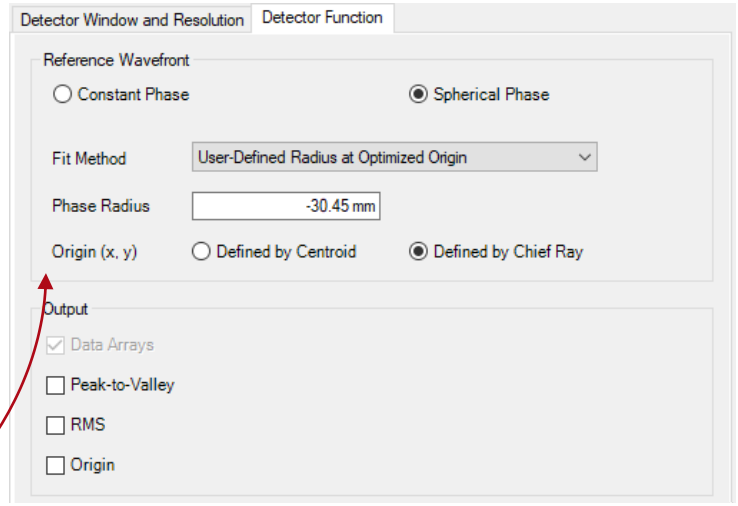
wavefront error

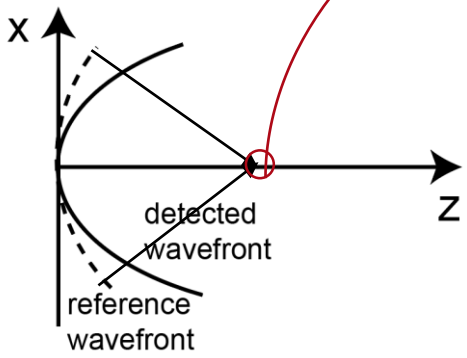


~11 λ

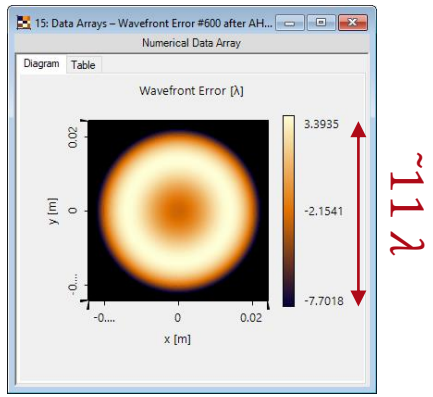
Spherical Phase: Fit Method

- Fit Method
  - Optimized Radius and Origin
  - User-Defined Radius and Origin
  - *User-Defined Radius at Optimized Origin*: x,y coordinates are optimized by the VirtualLab.





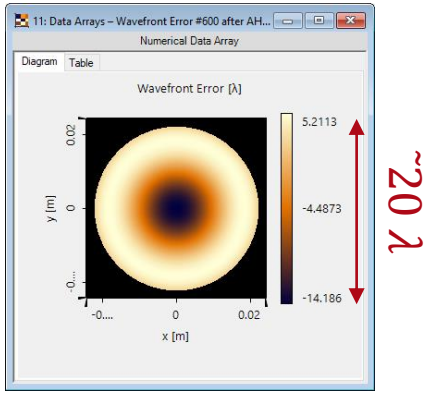
wavefront error

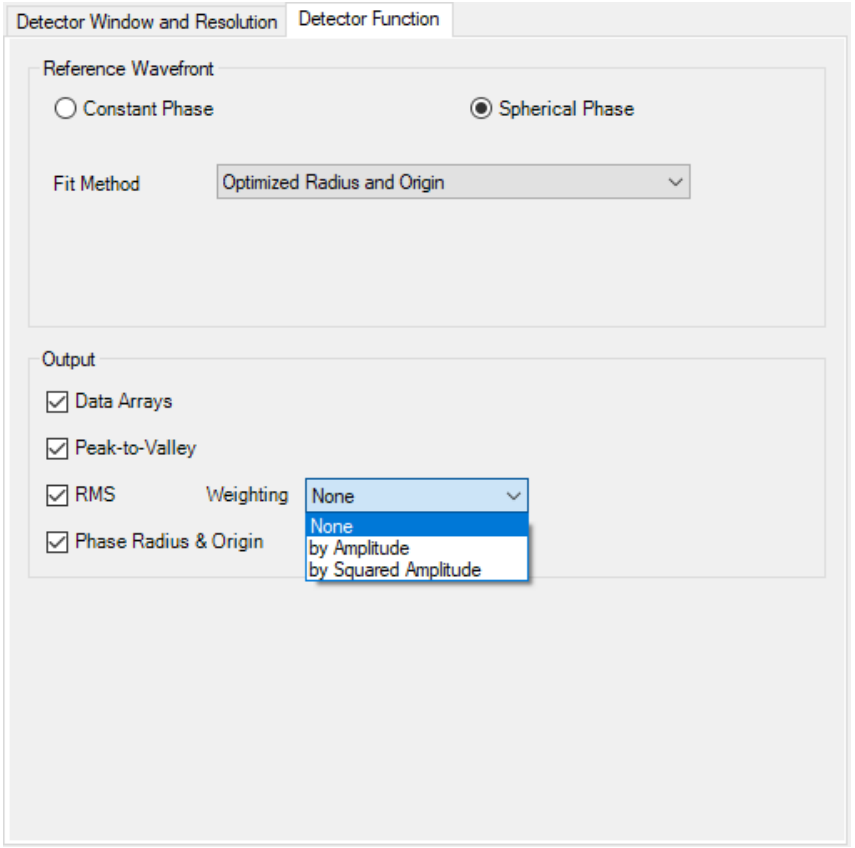


Detector Function: Output

- Output:
  - *Data Arrays* give the distribution of wavefront error in the detector plane.

wavefront error

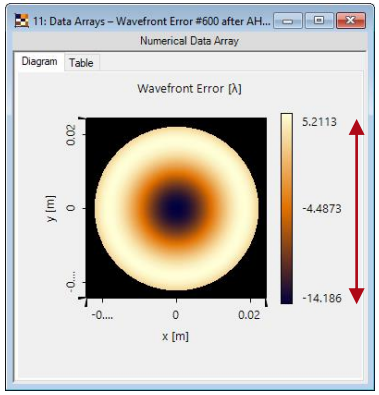


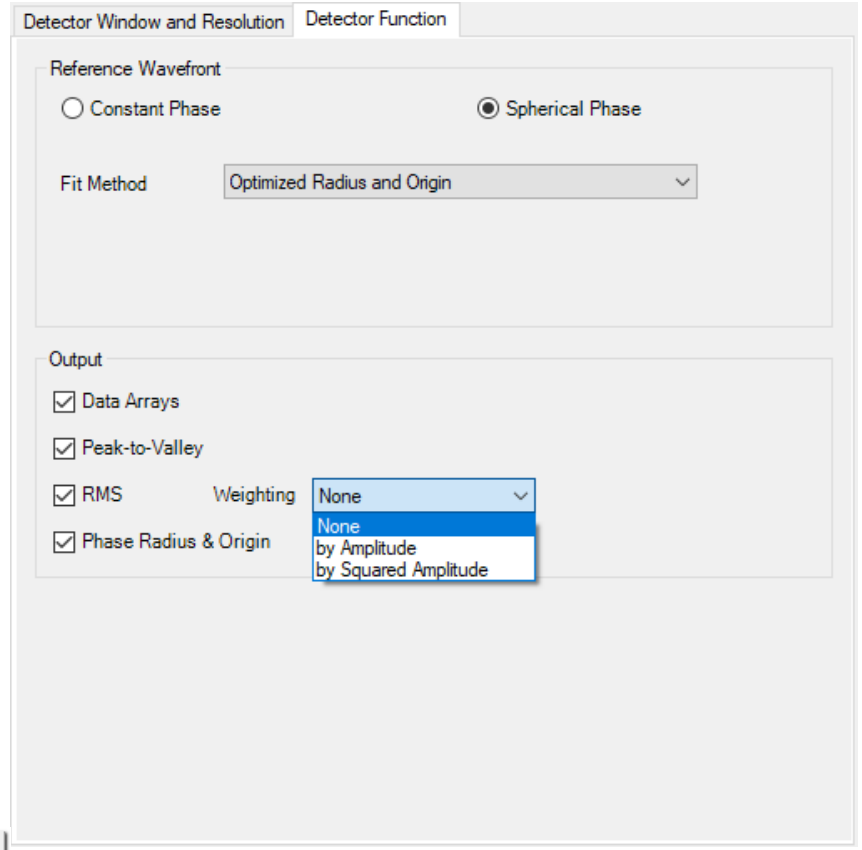


Detector Function: Output

- Output:
  - Data Arrays
  - *Peak-to-Valley*: maximum value minus minimum value of wavefront error.

wavefront error

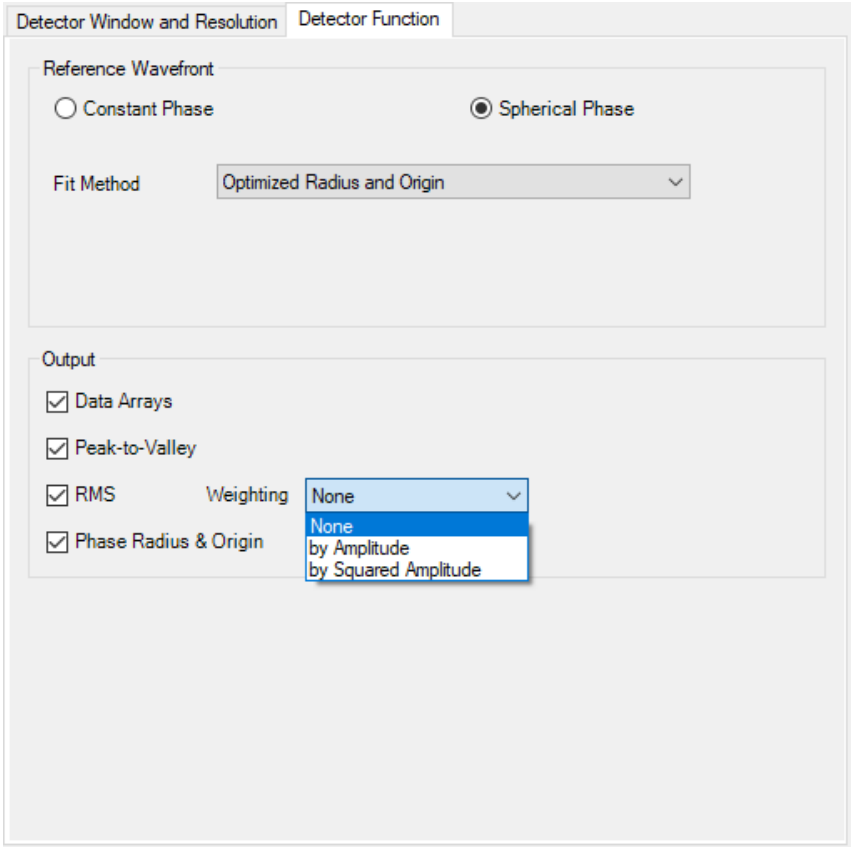




Sub - Detector	Result
Peak-to-Valley Wavefront Error [λ]	19.397

Detector Function: Output

- Output:
  - Data Arrays
  - Peak-to-Valley
  - *RMS*: The roof mean square of the wavefront error. User can either apply a *Weighting by Amplitude* or *by Squared Amplitude* to avoid phase from almost dark regions.



Weighting	RMS [λ]
None	5.5824
by Amplitude	5.5816
by Squ. Ampl.	5.5807

small differences due to almost uniform amplitude at detector position

Document Information

title	Wavefront Error Detector
version	1.0
VL version used for simulations	7.0.3.4
category	Feature Use Case