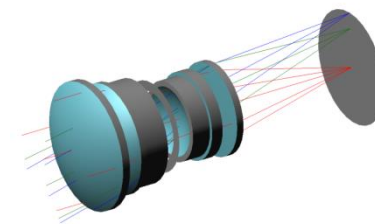
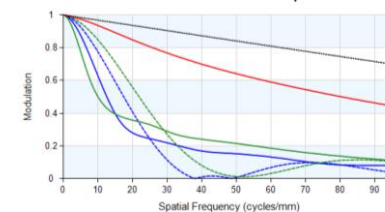
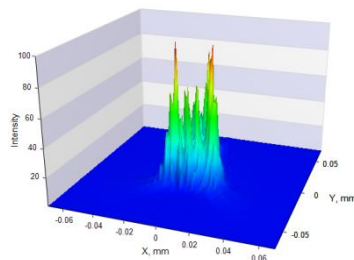


Introduction to CODE V[®] Optical Design and Analysis Software



August 30, 2019

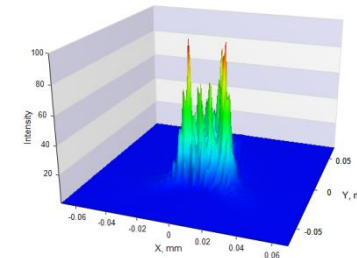
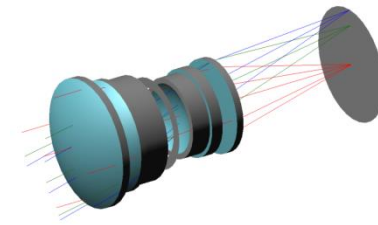
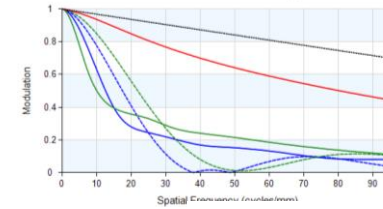
Matt Novak, Ph.D.

novak@synopsys.com



Agenda

- Getting up and running:
 - How to access the latest software and licensing
- Resources to learn CODE V and get help:
 - Customer Support Portal
- Introduce CODE V for optical engineering:
 - Main functions of CODE V design software
 - Entering a lens
 - Common analysis options
 - Optimizing for performance
 - shown by way of a design example in CODE V



How Do I Get CODE V?



CODE V Access for U of A Local and Distance Students

- Recommended Method:

- A floating/network site license is available for CODE V
 - Visit the OSC Site License Page for details on downloading software and using the OSC floating license server
 - <https://wp.optics.arizona.edu/helpdesk/osc-site-licensed-software/>

- Alternative Method if you can't access OSC wireless or VPN:

- Individual licenses are available, too
- See <https://www.synopsys.com/optical-solutions/learn/student-license.html> for further details

Education for CODE V Users

Customer Support Portal and Training



Resources for Learning CODE V

- Various CODE V Help Choices (**HELP** > ...)
- The user area of the OSG website: opticsportal.synopsys.com
 - **Introductory & Advanced Training presentations**
 - CODE V User Group meeting presentations
 - CODE V Webinar recordings
 - Release notes
 - E-news Tips
 - Tech Support FAQs
 - Macro downloads
 - Technical papers

Intro Topics in CODE V Training
Optics 101
Digital Camera
User Interface
Tech Talk
Apertures/Vignetting
Performance Eval.
Optimization
Reflective Systems
Tilts/Decenters
Non-Spherical
Afocal
Zoom
Tolerance Analysis
Macros

Synopsys Optics Portal – Various User Learning Resources

- Training Videos
- Training Presentations
- User Group Presentations
- Glass Catalog Updates

<https://opticsportal.synopsys.com/>



CODE V Support

CODE V® is the comprehensive program for optical design, analysis, and fabrication support of image forming and photonics based systems.

- Name
- Release Notes
- User Group Presentations
- Training Materials
- Training and Demo Videos
- CODE V Documentation Library
- Tech Support FAQs
- Macro and User-Defined Feature Downloads
- Enews and Tips
- Material Downloads
- Technical Papers

Training Courses and User Group Meetings

- Introduction to CODE V:
 - September 24-26, 2019, in Marlborough, MA
- Advanced Topics in CODE V:
 - November 18-20, 2019, in Pasadena, CA
- CODE V User Group Meetings, typically held in June
 - Free, one day meetings
 - Live in Mountain View, CA (San Jose area), Pasadena, CA (Los Angeles area), and Rochester, NY
 - Webinars presented after the live events
 - Topics from 2019
 - CODE V 11.2 New Features
 - CODE V Tips and Tricks
 - Variants of the Offner Relay
 - Design Exploration with Freeform Reflectors
 - Working with Lens Modules in CODE V
 - Modeling Mid-Spatial Frequency Surface Errors Using Beam Propagation



CODE V Introduction – Overview and Demonstration

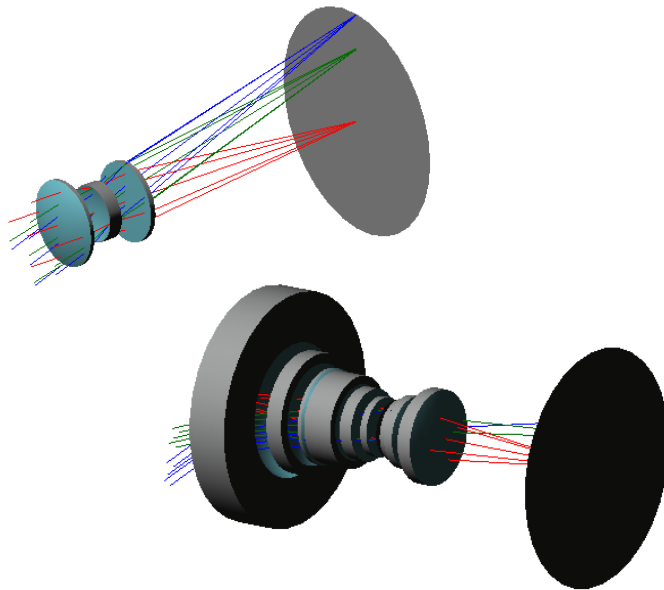


How Can CODE V Help You?

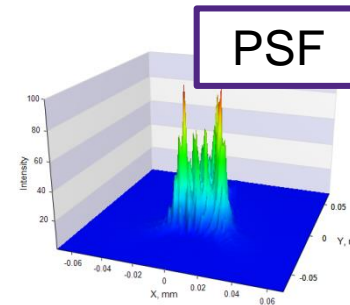
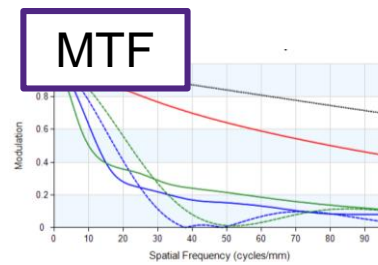
CODE V is a powerful software tool for optical systems...



Modeling



Analysis



Optimization

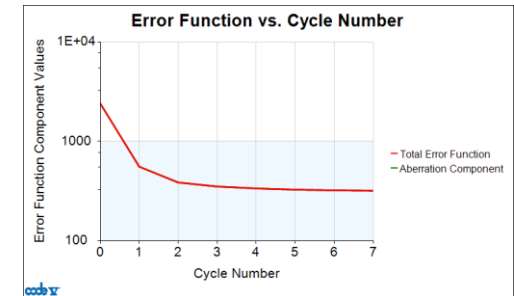
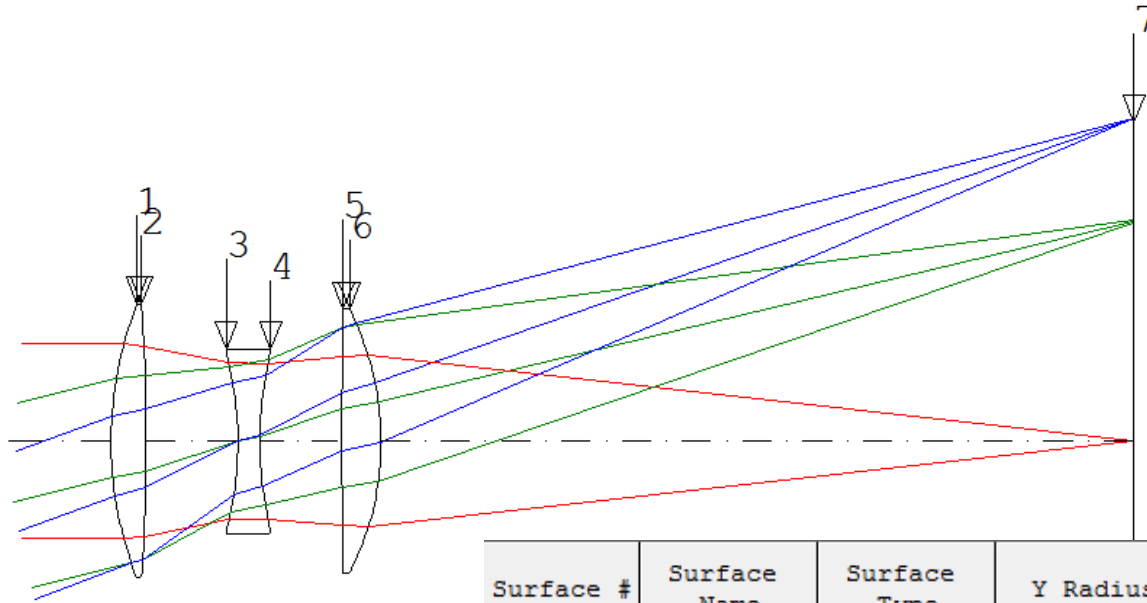


Image Simulation

CODE V is Primarily a Sequential Ray Tracing Program*...

Rays trace from surface 1 -> surface 2 ->.... -> Image



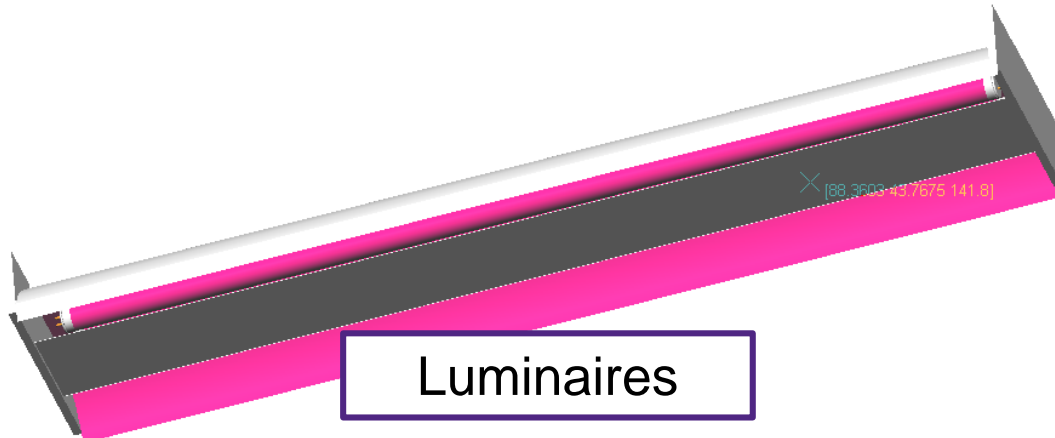
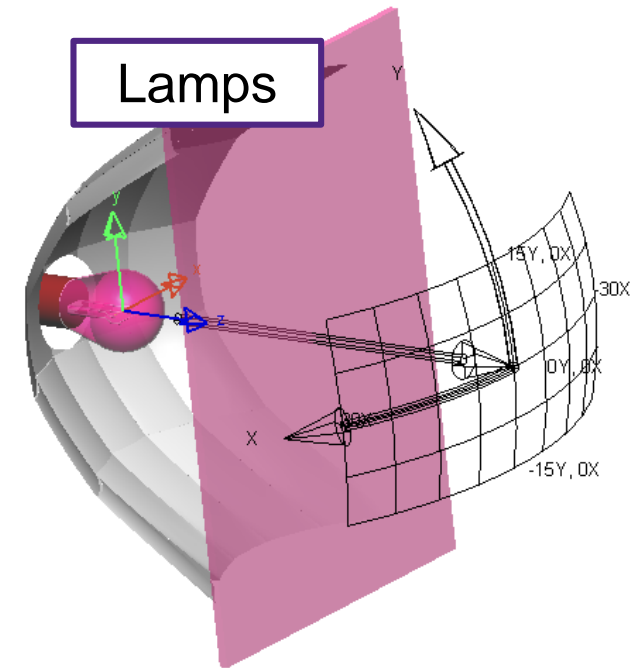
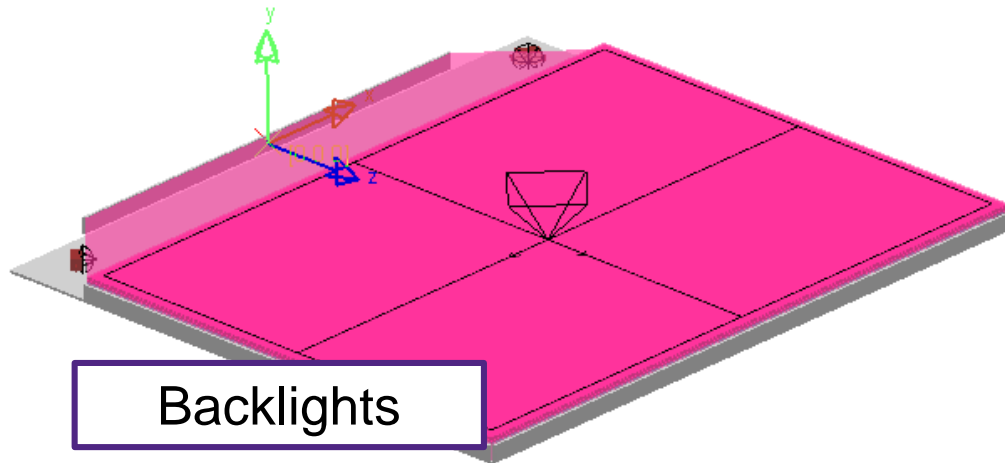
Generally used for imaging systems

Surface #	Surface Name	Surface Type	Y Radius	Thickness	Glass	Refract Mode	Y Semi-Aperture
Object			Infinity	Infinity			0
1			21.4814	2.0000	SK16_SCH		7.0000
2			-124.1000	5.2600			6.8124
Stop			-19.1000	1.2500	F4_HOYA		4.4892
4			22.0000	4.6900			4.6320
5			328.9000	2.2500	SK16_SCH		6.5000
6			-16.7000	43.0505 S			6.7462
Image			Infinity	0.0289 V			18.4699

*Can be used in non-sequential mode...not the focus today

...Rather than a Non-Sequential Ray Tracing Program

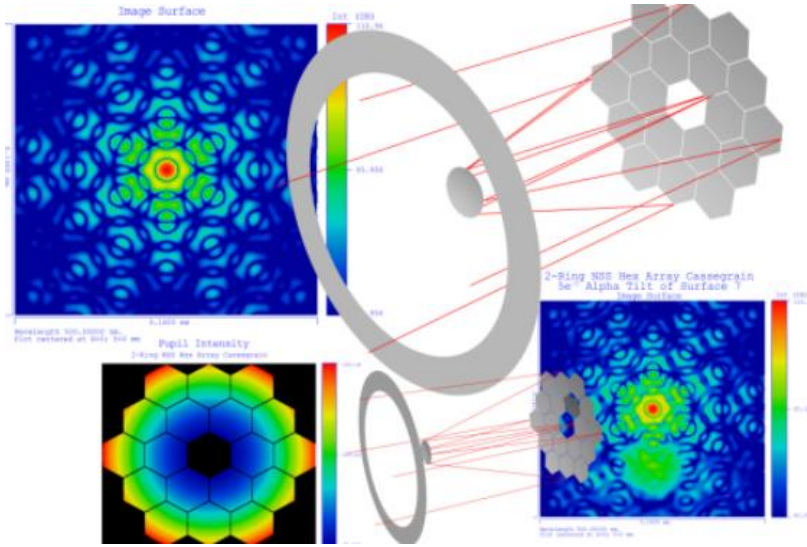
Rays start from source(s) -> bounce around geometry -> Create illumination pattern on receiver(s)



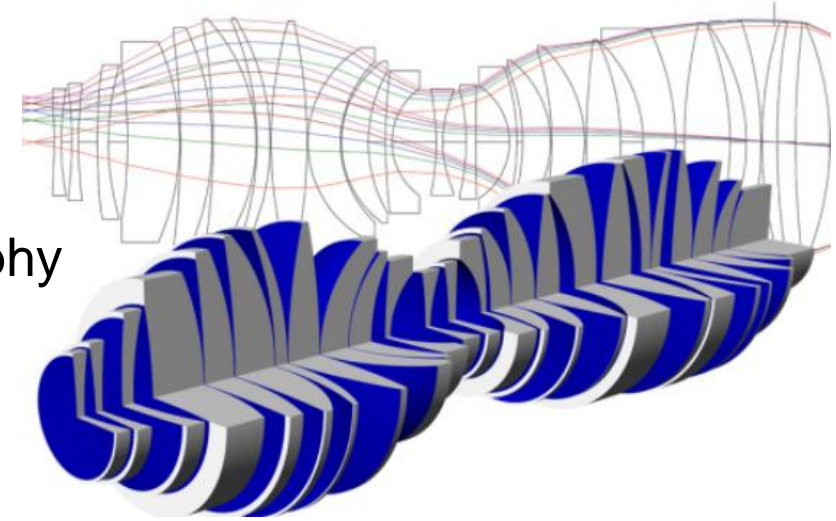
Used for illumination systems, stray light, etc.
Images from LightTools®

CODE V is Used in a Range of Demanding Applications

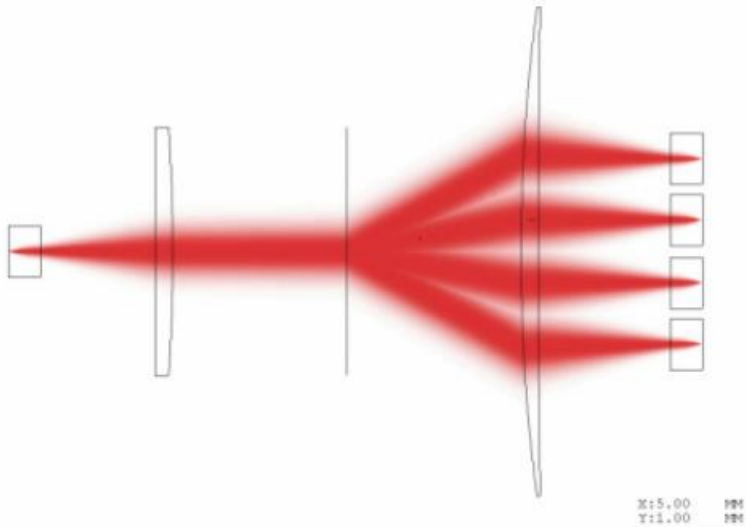
Segmented
Mirror
Telescope



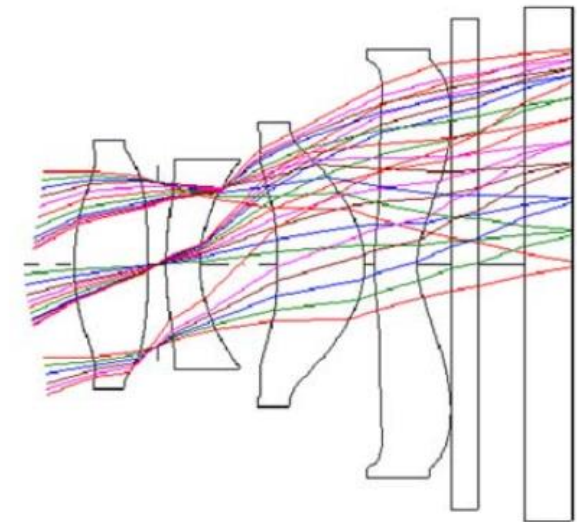
Microlithography
Lens



1x4 Diffractive
Fiber Coupler



Cell Phone
Camera



CODE V General Interface Elements

Title Bar

Toolbars

Menu Bar

LDM Spreadsheet

Interactive 3D Visualization window

Navigation Toolbar

SpecBuilder™ Window

Command Window

Command Line

Tabbed Output Window

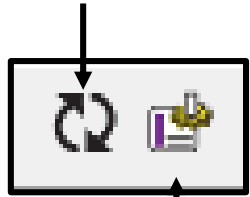
Status Bar

Surface #	Y Radius	Thickness	Glass	Refract Mode	Y Semi-App
Object	Infinity	Infinity			
1	97.0855	5.9643	SF5_SCHOTT		23.94
2	817.6942	0.3016			22.27
3	99.7747	1.4911	SK16_SCHOT		20.04
4	18.9654	31.7168			15.34
5	38.6103	4.4732	SK16_SCHOT		7.23
6	-92.0898	0.1508			6.39
7	20.6876	4.3623	SK16_SCHOT		5.93
8	56.1479	1.3602			5.01
Stop	Infinity	1.4228			4.81
10	-23.8203	0.6317	F1_SCHOTT		4.64

Label	Name	Goal Mode	Target	Value
<input checked="" type="checkbox"/>	Spectral Range			
<input checked="" type="checkbox"/>	Short Wavelength (um): individual values o	display only	0.4861	
<input checked="" type="checkbox"/>	Long Wavelength (um): individual values ov	display only	0.6563	
<input checked="" type="checkbox"/>			0.5000	
<input checked="" type="checkbox"/>			0.0000	
<input checked="" type="checkbox"/>			0.0126	
<input checked="" type="checkbox"/>			0.0000	
<input checked="" type="checkbox"/>			0.3113	
<input checked="" type="checkbox"/>			0.9035	
<input checked="" type="checkbox"/>			0.0000, 0.	

CODE V Tabbed Output Windows for Data Organization

Execute



Modify Settings

Beam Synthesis Propagation

Input Beam | Output | Pre-Analysis | Propagation Controls | Output Grid Definitions/Time Estimate

Title

Generate 2D charts

	Output Quantity	Start Surface	End Surface	Start Zoom	End Zoom	Near/Far	Template Name
1	Intensity	Image	Image	1 - Ball len	1 - Ball len	Near Field	Default
2	Phase	2	2	1 - Ball len	1 - Ball len	Near Field	Default

Monochromatic
Unnormalized
Thresholds: Phase = 0.010 and Output (dB) = -50.000
Accuracy control: Standard

Output Controls ...

Cross-sectional Slice Plots ...

Beamlet Footprint Plots ...

Gaussian Beam Fit Table ...

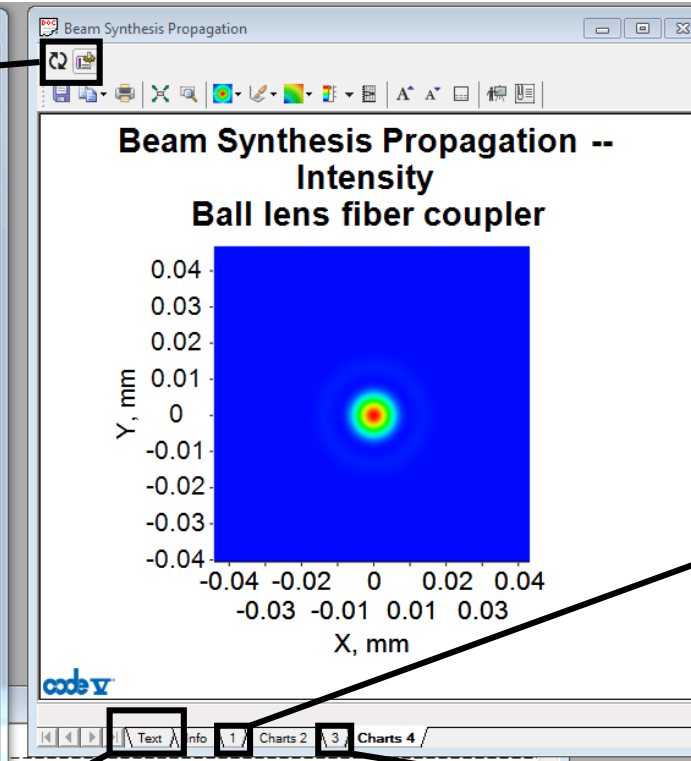
Save Data to Buffer ...

Save Beamlet Set...

Save/Load Settings...

OK Cancel Help

Input Dialog



Tabbed Graphical Output

Beam Synthesis Propagation : 12:...

Beamlet footprint at reference wavelength

Ball lens fiber coupler

Beam Synthesis Propagation : 12:46:34...

Beamlet Intensity

Displacement from fiber center at (0,0) = (0, 0) mm

SURF NUM	GRID LOC	THRESH	X-RAD (mm)	Y-RAD (mm)	X-SHIFT (mm)	Y-SHIFT (mm)	ROTATION ANGLE (deg.)	PEAK INTENSITY
1	Near	0.135300	0.286124	0.286124	-0.000000	0.000000	0.000000	7.802700e+000
2	Near	0.135300	0.284417	0.284417	-0.000000	0.000000	0.000000	7.963051e+000
3	Near	0.135300	0.006609	0.006609	-0.000000	0.000000	0.000000	1.272476e+004

Text Output

Demonstration of Optical Design in CODE V

Compact Aspheric Camera Based on Tessar Photographic Lens



Optical Design - *Automatic Design* - in CODE V

- A key CODE V strength is the effectiveness of its optimization algorithms
 - In particular, the ability to control constraints exactly is a very powerful tool for designers
- CODE V optimization is easy to use, requiring minimal input in many cases
 - This is achieved through the use of intelligent defaults
- If needed, the **Automatic Design** feature is flexible and allows control of many optimization details

CODE V Design Example

Compact Camera Lens for Aerial Drone Imagery, Visible Spectrum

- Image sensor approximates 4:3 Camera Format
Sensitive area 17.3 x 13 mm (full diagonal 21.6-mm)
- Objective Lens
Focal length Fixed, 25.0 mm
Design Semi-Field of View 25° (for 11.6 mm semi-diagonal and 25 mm EFL) – oversize design image
f/number Fixed aperture, *f*/2.5
Overall Length 30 mm (less than)
Sharpness Average of Radial & Tangential MTF

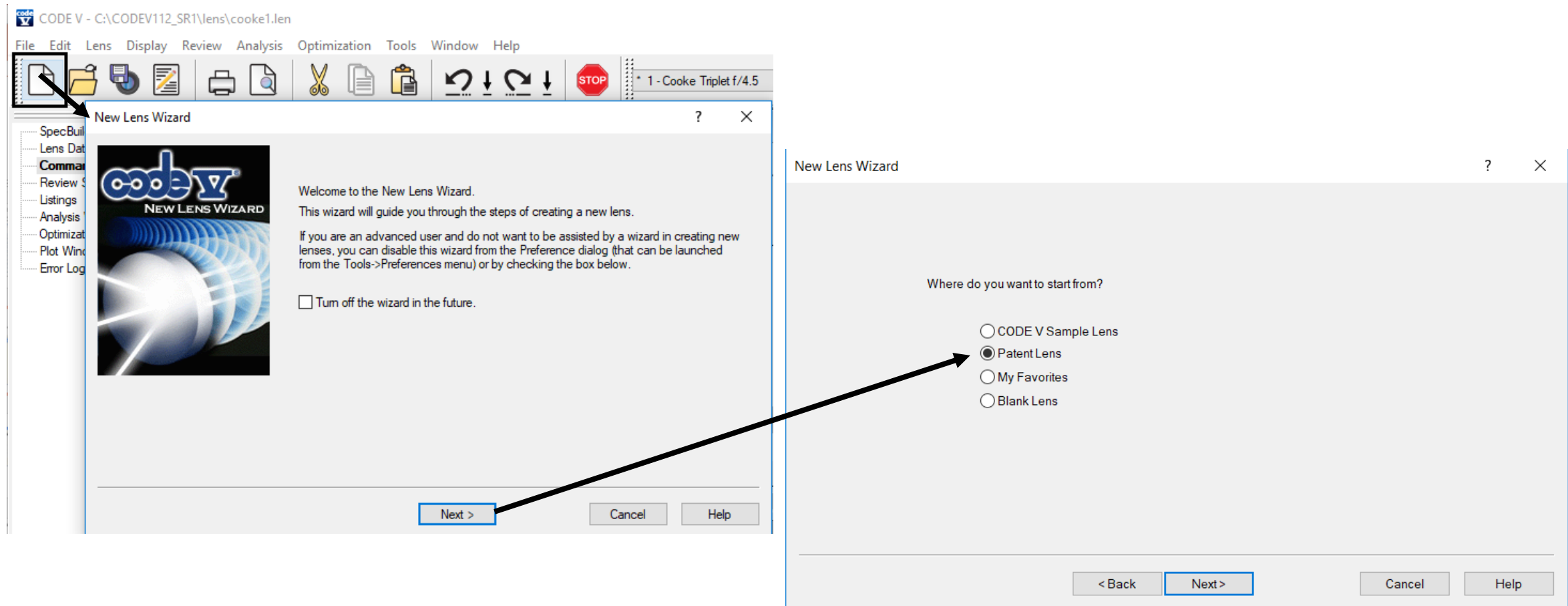
Observation frequency: 20 lp/mm	> 40% average of Radial & Tangential MTF
---------------------------------	--

Vignetting

Relative illumination > 60%

Getting A Starting Lens

- **New Lens Wizard** can open a blank lens, several sample or patent lenses
- Choose a patent lens to start the example now in CODE V



CODE V Documentation Library – Complete Help Resource

Help

- CODE V Help F1
- Contents and Index
- What's This? Help SHIFT+F1
- CODE V Documentation Library**
- Synopsys OSG On the Web >
- Tip of the Day...
- About CODE V...

CODE V Documentation Library

Version 11.2

Welcome to the CODE V documentation library. This page contains links to printable PDFs of the most current CODE V documentation. To use this page:

- Click a title to display the document (Adobe Acrobat Reader must be your default PDF viewer)
- Hover your cursor over a title to view the document description
- Click the search button to search all documents for a particular word or phrase

[Search All Documents](#)

What's New

- Release Notes

Reference Manuals

- Setup and Operation
- Lens System Setup
- Multilayer Design
- Lens Data Transformation and Visualization
- SpecBuilder
- Optimization
- Tolerancing
- Diagnostic Analysis
- Geometrical Analysis
- Diffraction Analysis
- Beam Propagation and Coupling Efficiency
- Fabrication Support
- Systems Analysis
- Macro-PLUS
- Application Programming Interface

How-to Guides

- Test Drive
- Introductory User's Guide
- Photonics Modeling Guide

Other Documentation

- SpecBuilder Quick Start Card
- Prompting Guide (Command Line)
- Troubleshooting Guide
- Glossary of Optical Terminology

Customer Portal

- Feature Videos
- Training Course Notes
- CODE V Main Support Page

- Command and Subject Index for CODE V Reference Manuals

Welcome to CODE V!

