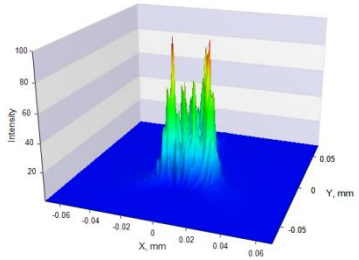
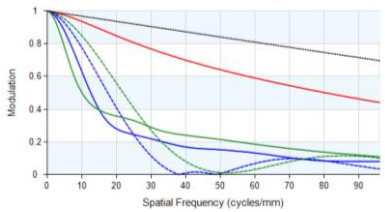
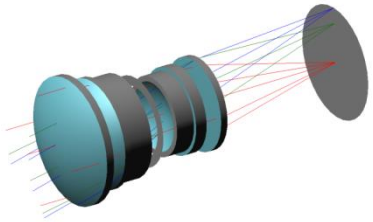
Introduction to CODE V® Optical Design and Analysis Software







August 30, 2019

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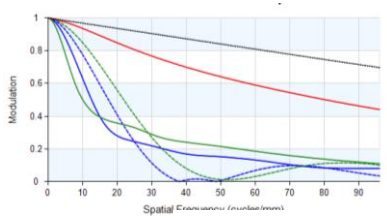
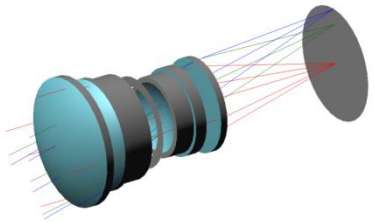
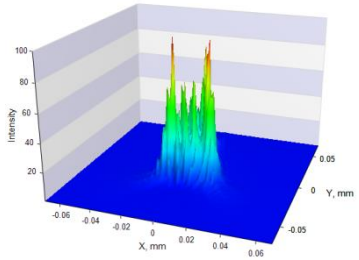
Agenda

- 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/

Training Courses and User Group Meetings

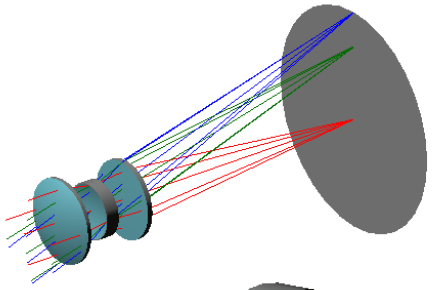
- Introduction to CODE V:
  - September 24-26, 2019, in Marlborough, MA
- Advanced Topics in CODE V:
  - November 18-20, 2019, in Pasadena, CA
- CODE V User Group Meetings, typically held in June
  - Free, one day meetings
    - Live in Mountain View, CA (San Jose area), Pasadena, CA (Los Angeles area), 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

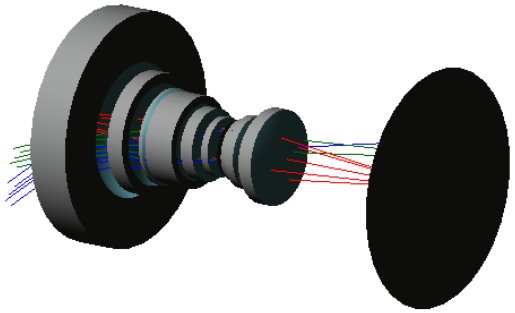
CODE V Introduction – Overview and Demonstration

How Can CODE V Help You?

CODE V is a powerful software tool for optical systems…

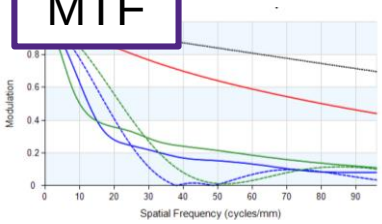
Modeling





Analysis

MTF



PSF

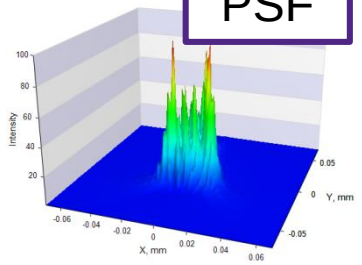
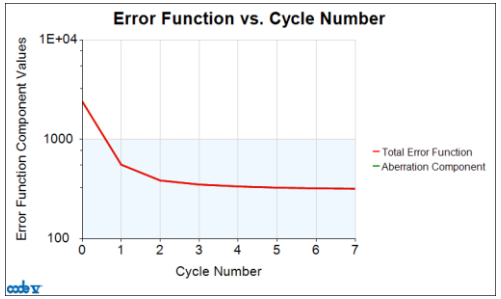


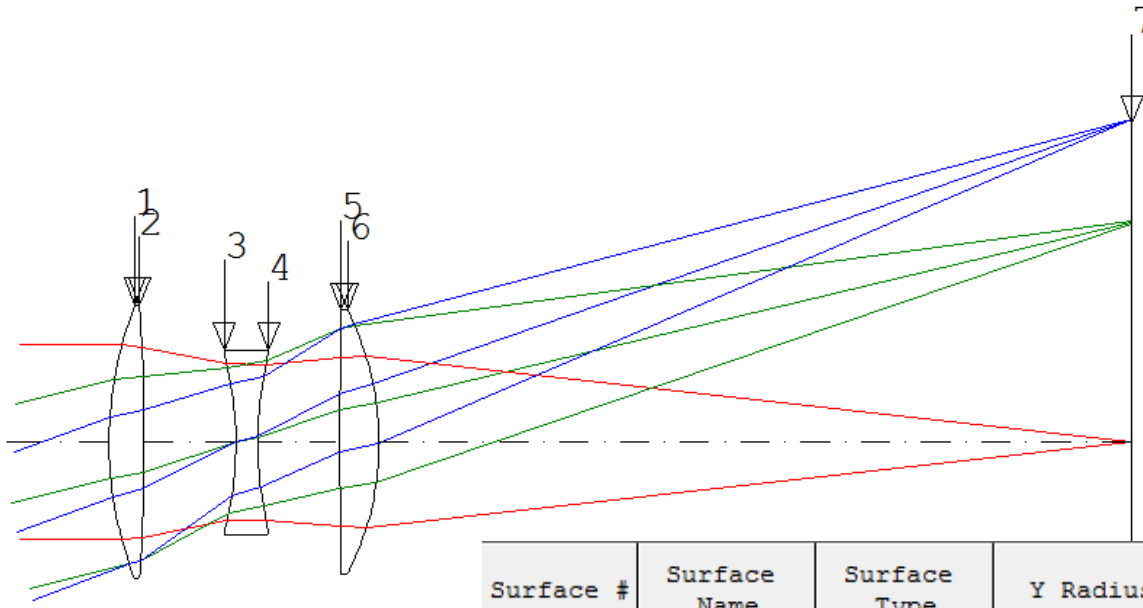
Image Simulation

Optimization



CODE V is Primarily a Sequential Ray Tracing Program*…

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



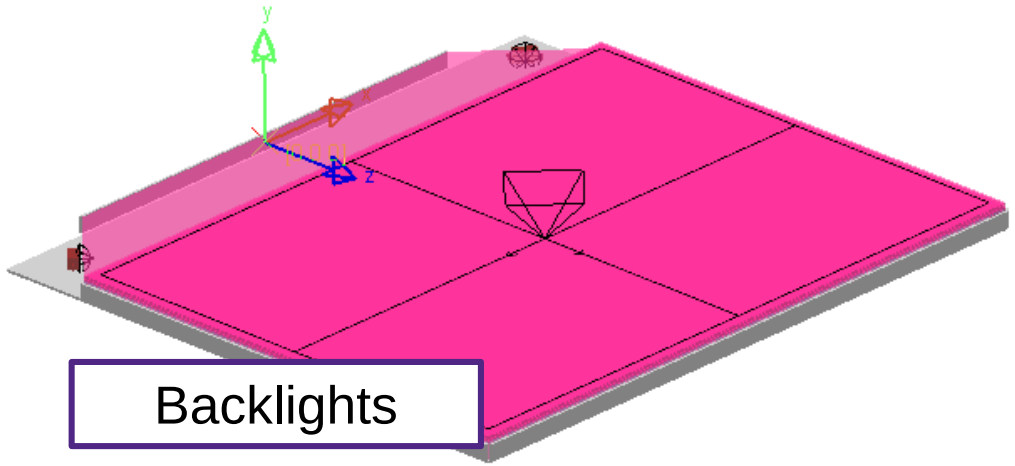
Generally used for imaging systems

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

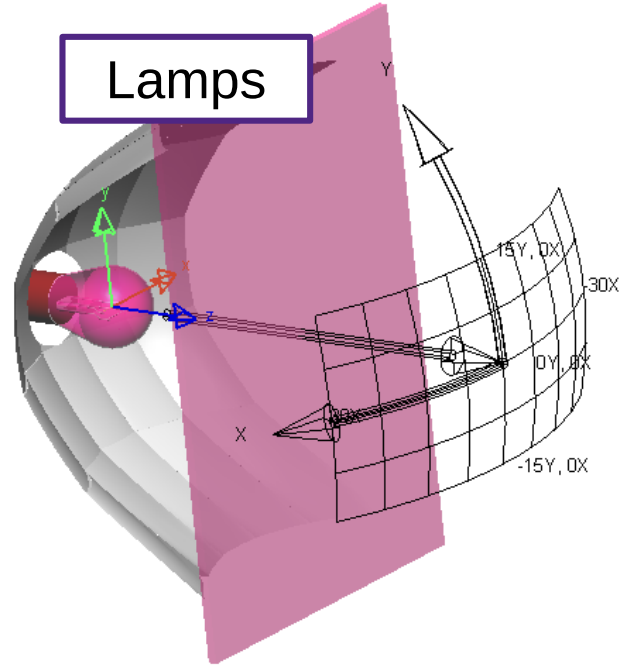
*Can be used in non-sequential mode…not the focus today

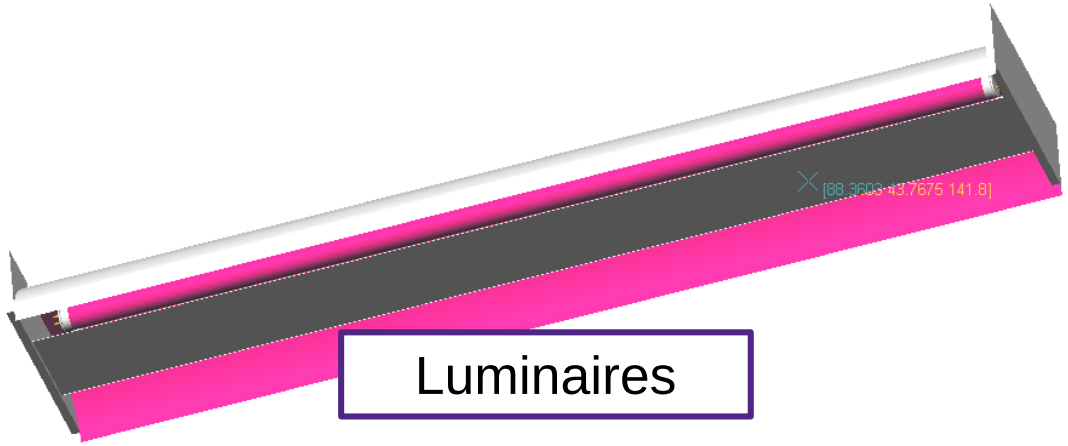
…Rather than a Non-Sequential Ray Tracing Program

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



Backlights



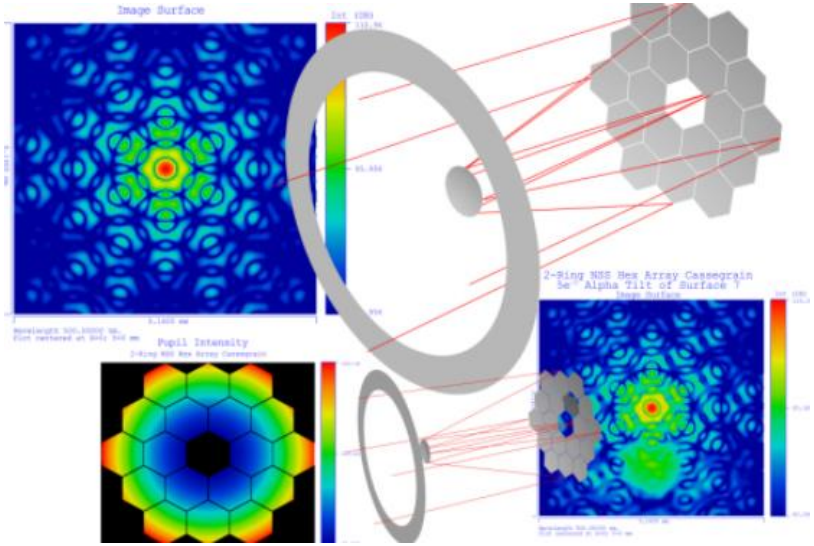


Luminaires

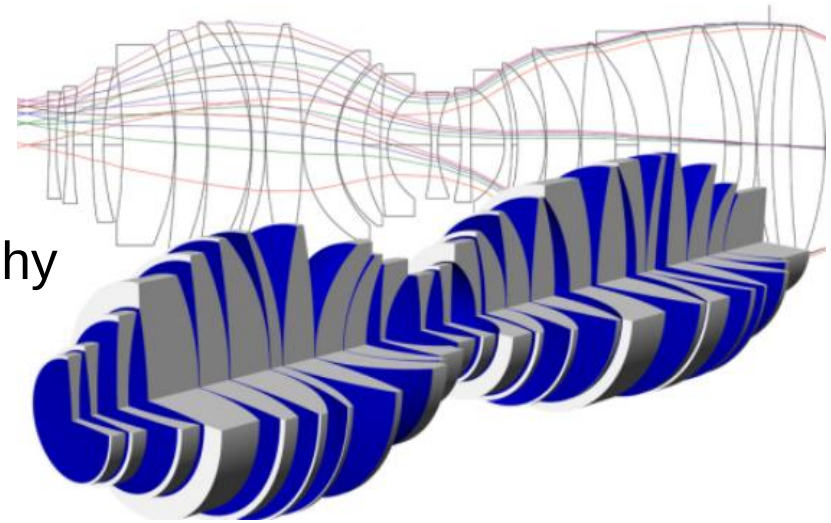
Used for illumination systems, stray light, etc.
Images from LightTools®

CODE V is Used in a Range of Demanding Applications

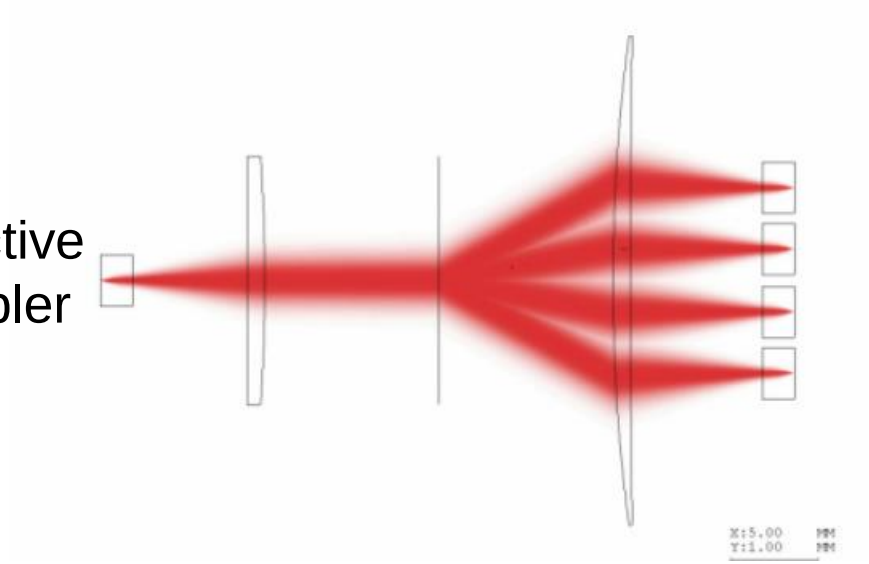
Segmented Mirror Telescope



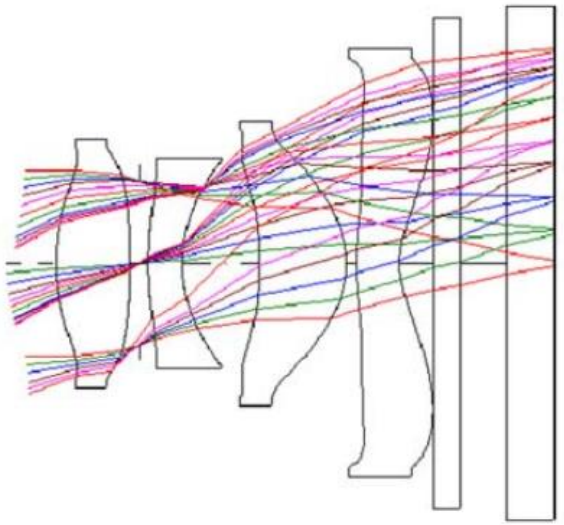
Microlithography Lens



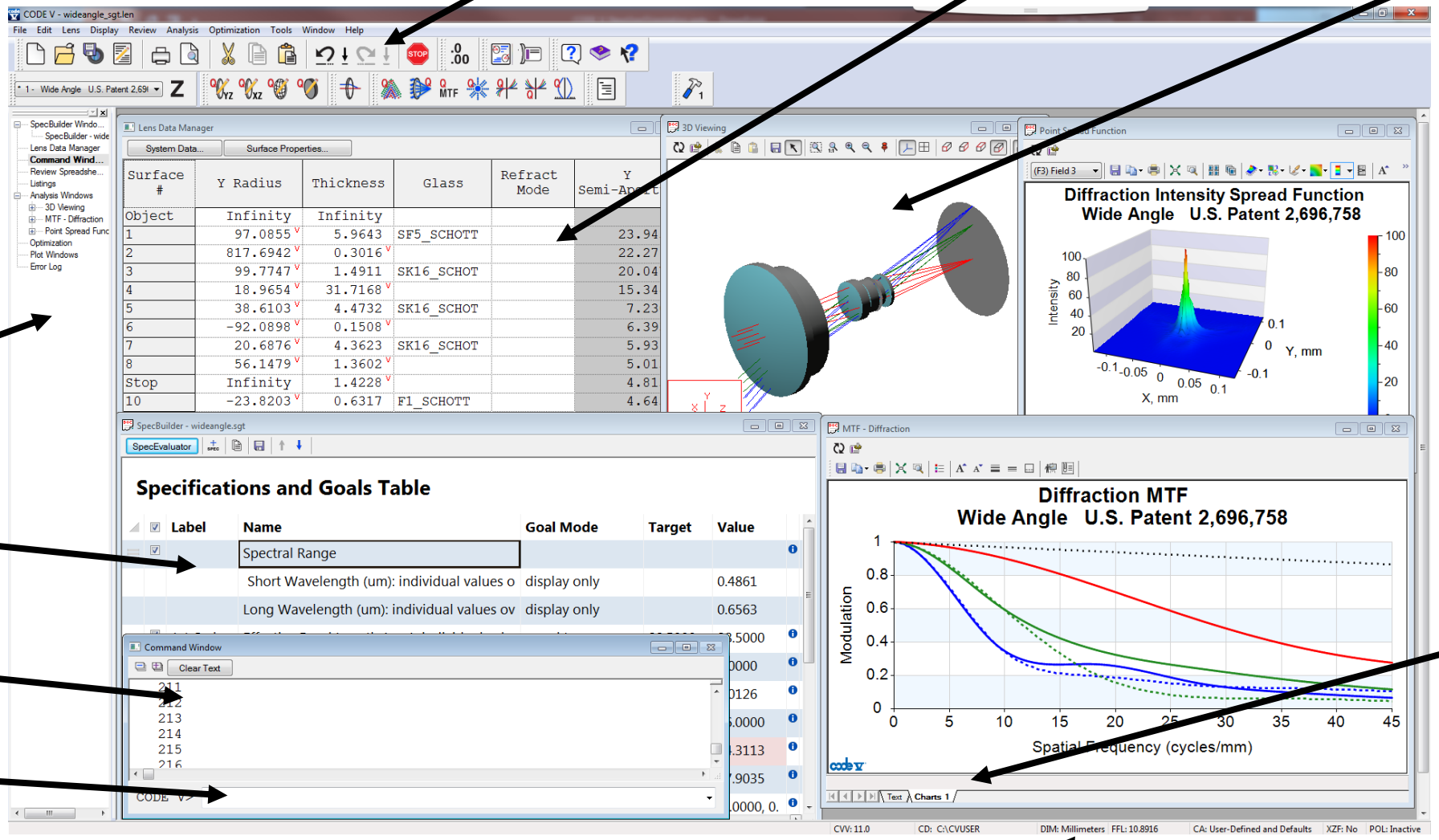
1x4 Diffractive Fiber Coupler



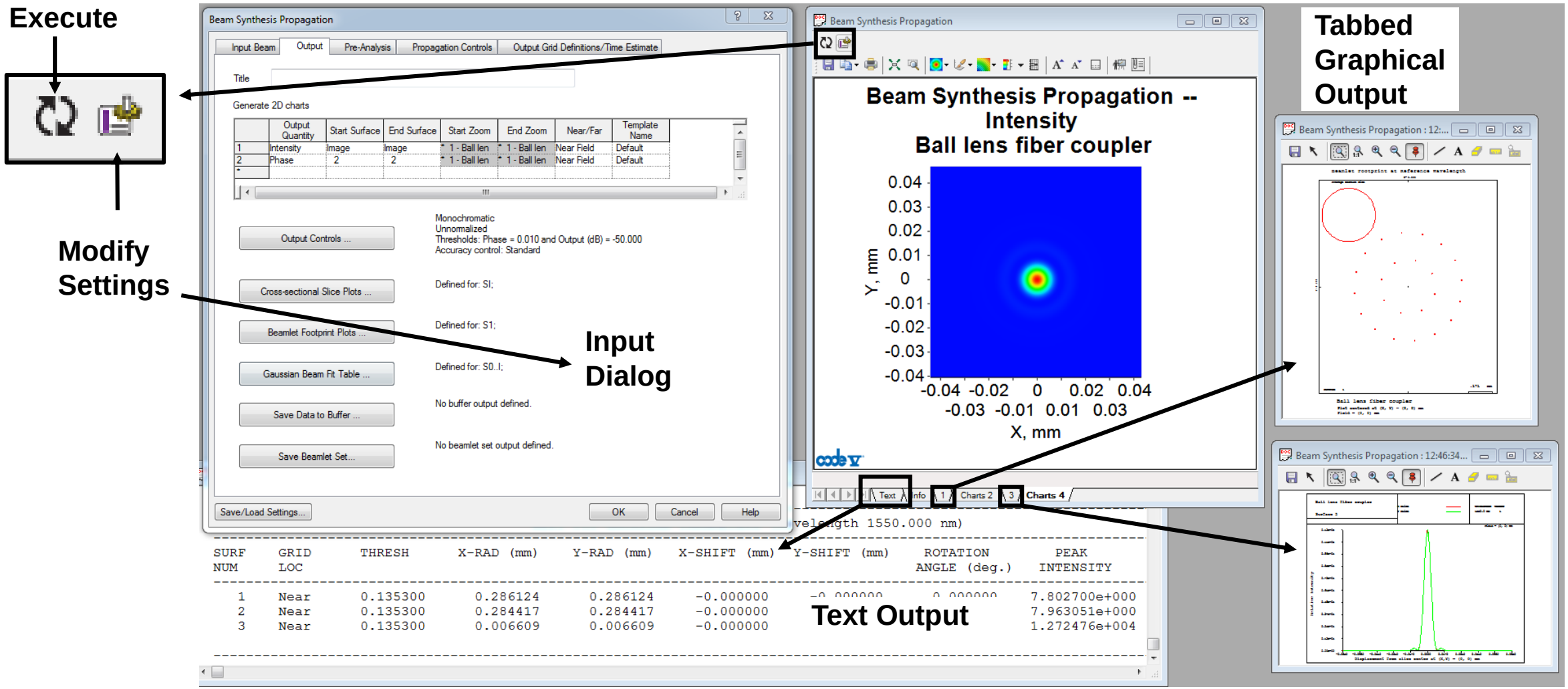
Cell Phone Camera



CODE V General Interface Elements



CODE V Tabbed Output Windows for Data Organization



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

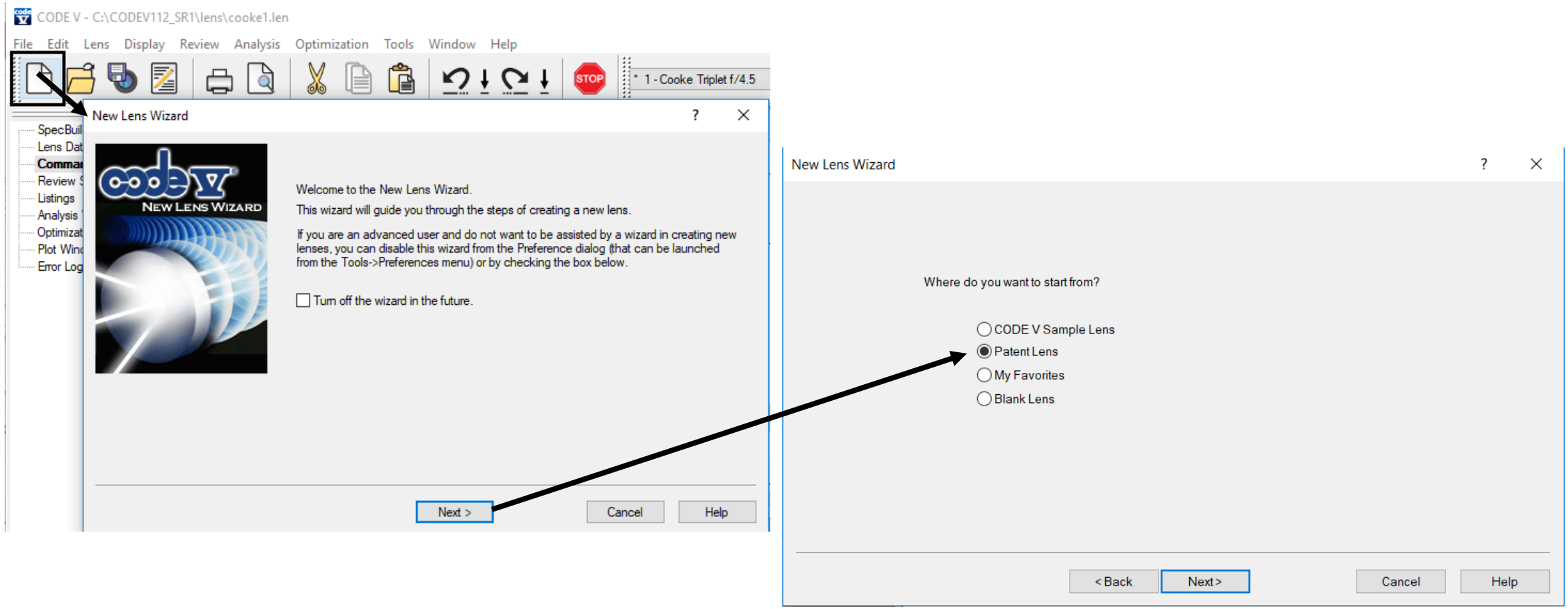
Focal length	Fixed, 25.0 mm
Design Semi-Field of View	25° (for 11.6 mm semi-diagonal and 25 mm EFL) – oversize design image
f/number	Fixed aperture, f/2.5
Overall Length	30 mm (less than)
Sharpness	Average of Radial & Tangential MTF

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

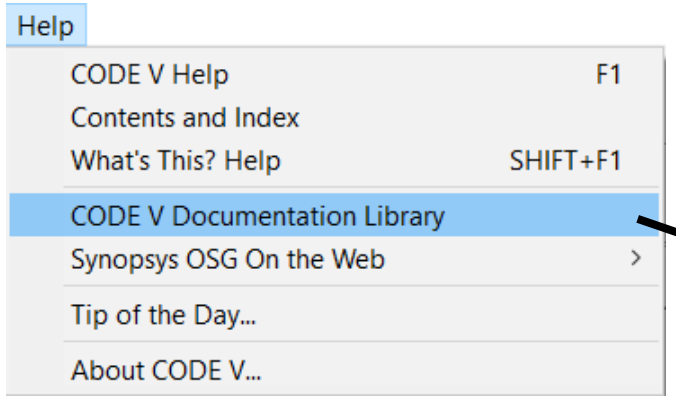
Vignetting	Relative illumination > 60%

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



Welcome to CODE V!