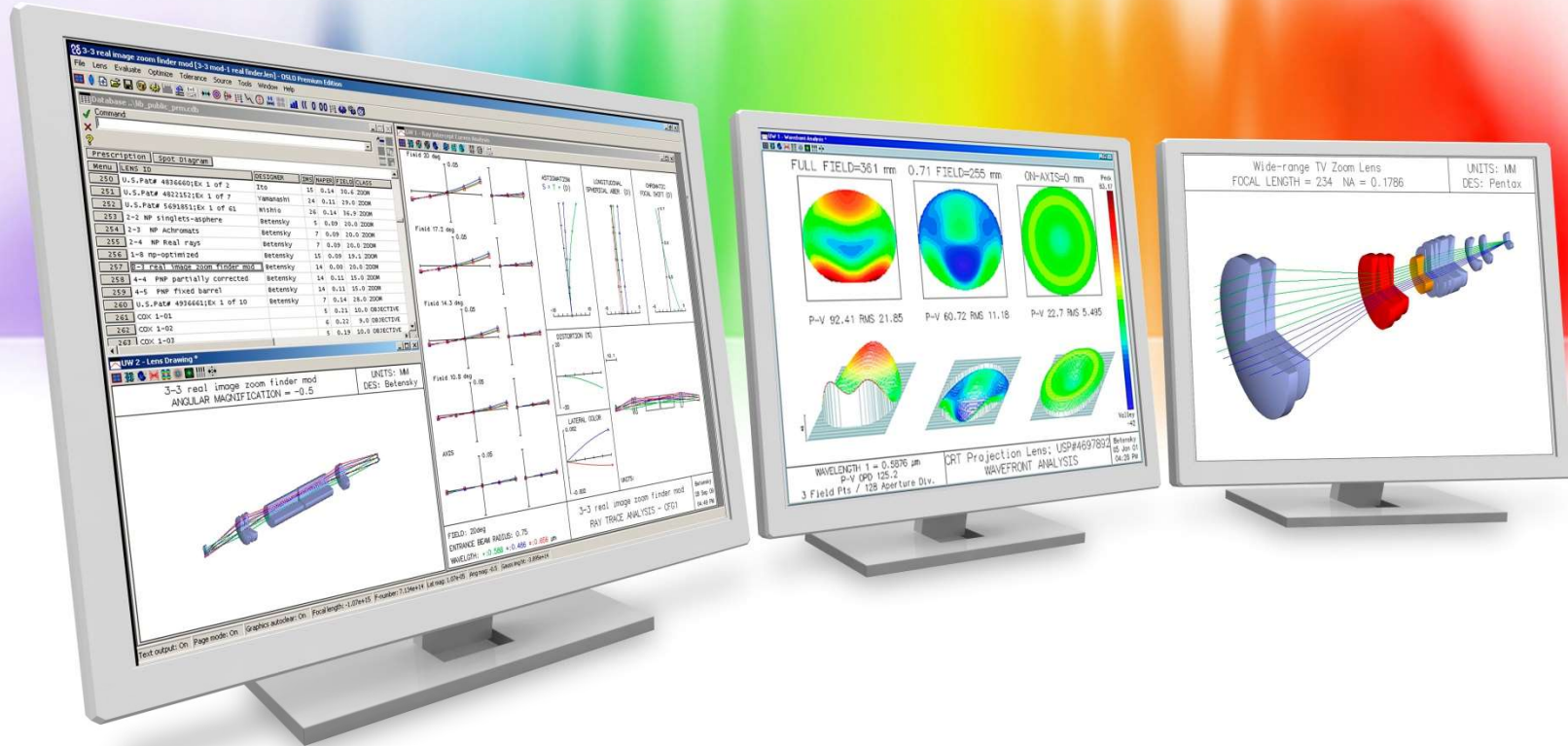


# OSLO



## UA Presentation - Introducing OSLO 7.0

8/23/2017

## 22 OSLO Videos on the Lambda Research Website

**Interface and Overview Videos - <https://www.lambdares.com/su/oslo-videos/>**

- **OSLO Overview** – A high level overview of the interface
- **Understanding and Using the OSLO Check Mark** – Keys to using the accept pending entry and cancel pending entry capability with spreadsheets
- **OSLO Spreadsheet Hierarchy** – Discusses nuances with the spreadsheet hierarchy
- **OSLO Lens Spreadsheet Presentation** – Effective use of the surface data spreadsheet
- **OSLO Top Menu Explanation** – An overview of the graphics windows
- **OSLO Graphics Window** – Details on the graphics window usage and output
- **OSLO Text Window and Command Line** – Text window and command line usage

# OSLO Videos on the Lambda Research Website

## Effective Use, Macro Programming Videos

- **Doublet Optimization Tutorial** – A set of three videos and an interactive tutorial to take a doublet from a blank page through optimization
- **OSLO Catalog Lens Presentation** – Covers effective ways to use catalog lenses
- **OSLO Catalog Lens Tutorial** – An interactive tutorial on using catalog lenses
- **OSLO Text Editors** - Walk-through of the built-in text editors within OSLO
- **OSLO Introduction to Modifying, Supplementing, and Programming** - An introduction to programming in OSLO
- **OSLO Import CCL Into Notepad++** - Importing the CCL Language into Notepad++

## Complete set of OSLO Manuals

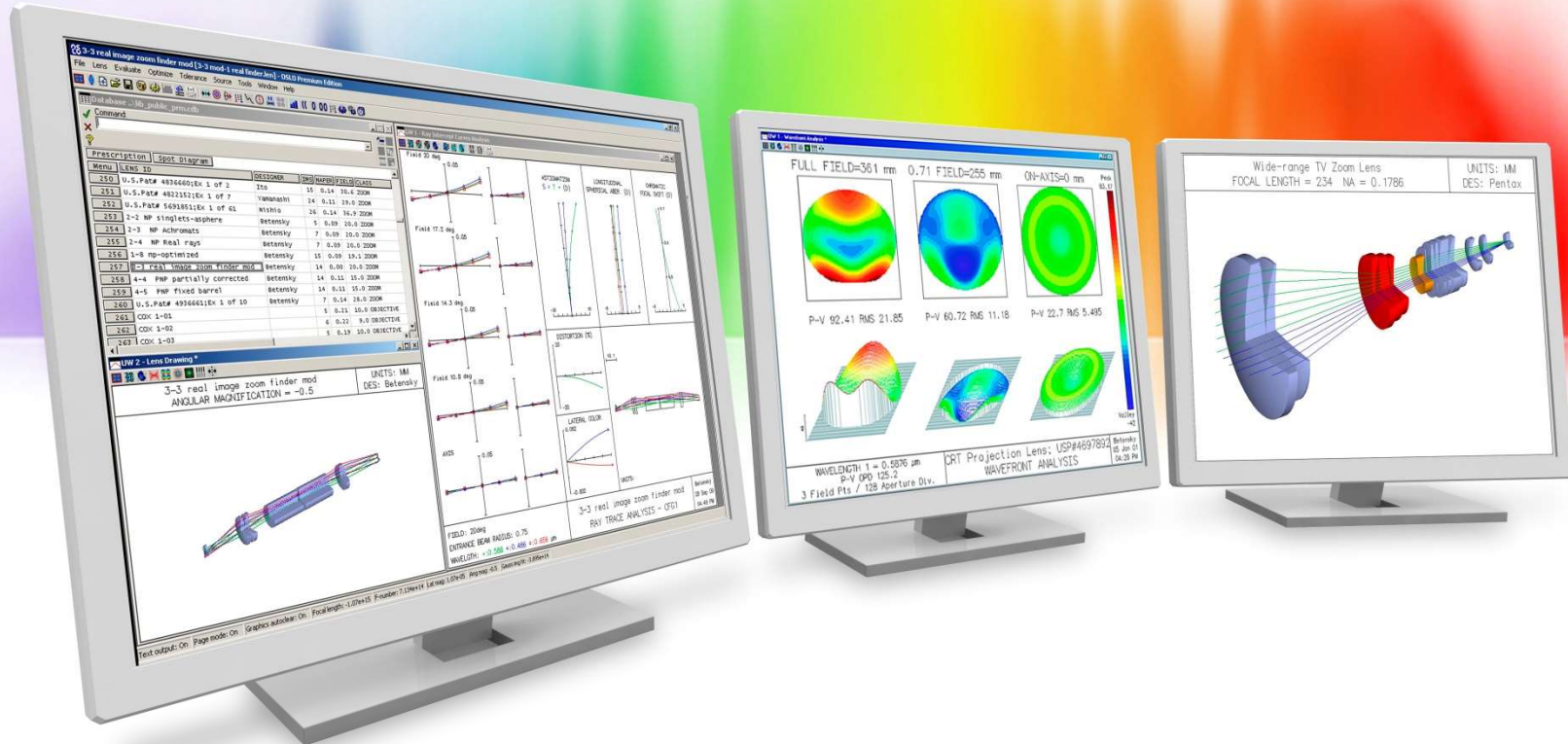
- OSLO User Guide which walks you through step-by-step examples: - [https://www.lambdaresearch.com/wp-content/uploads/support/oslo/oslo\\_releases/OSLOUserGuide.pdf](https://www.lambdaresearch.com/wp-content/uploads/support/oslo/oslo_releases/OSLOUserGuide.pdf)
- OSLO Optics Reference - [https://www.lambdaresearch.com/wp-content/uploads/support/oslo/oslo\\_releases/OSLOOpticsReference.pdf](https://www.lambdaresearch.com/wp-content/uploads/support/oslo/oslo_releases/OSLOOpticsReference.pdf)
- OSLO Programmers Reference - [https://www.lambdaresearch.com/wp-content/uploads/support/oslo/oslo\\_releases/OSLOProgramReference.pdf](https://www.lambdaresearch.com/wp-content/uploads/support/oslo/oslo_releases/OSLOProgramReference.pdf)

# Step by Step Tutorials

The <http://wp.optics.arizona.edu/sasian/opt-517/> folder has multiple step by step tutorials:

- OSLO\_Your\_First\_OSLO\_Session.pdf – Good place to start learning OSLO, introduces you to the interface with a spherical mirror example
- OSLO\_Schmidt\_Camera.pdf – Demonstrates how to use OSLO by designing a Schmidt Camera Objective
- OSLO\_Tutorial\_Classroom\_Demos.pdf
- OSLO\_Tutorial\_Gaussian\_Beam\_and\_Fiber\_Coupling.pdf
- OSLO\_Tutorial\_Landscape\_Lens.pdf
- OSLO\_Tutorial\_Optimization\_OSLO\_Standard\_or\_Premium.pdf

# OSLO



## Introduction

# Introduction

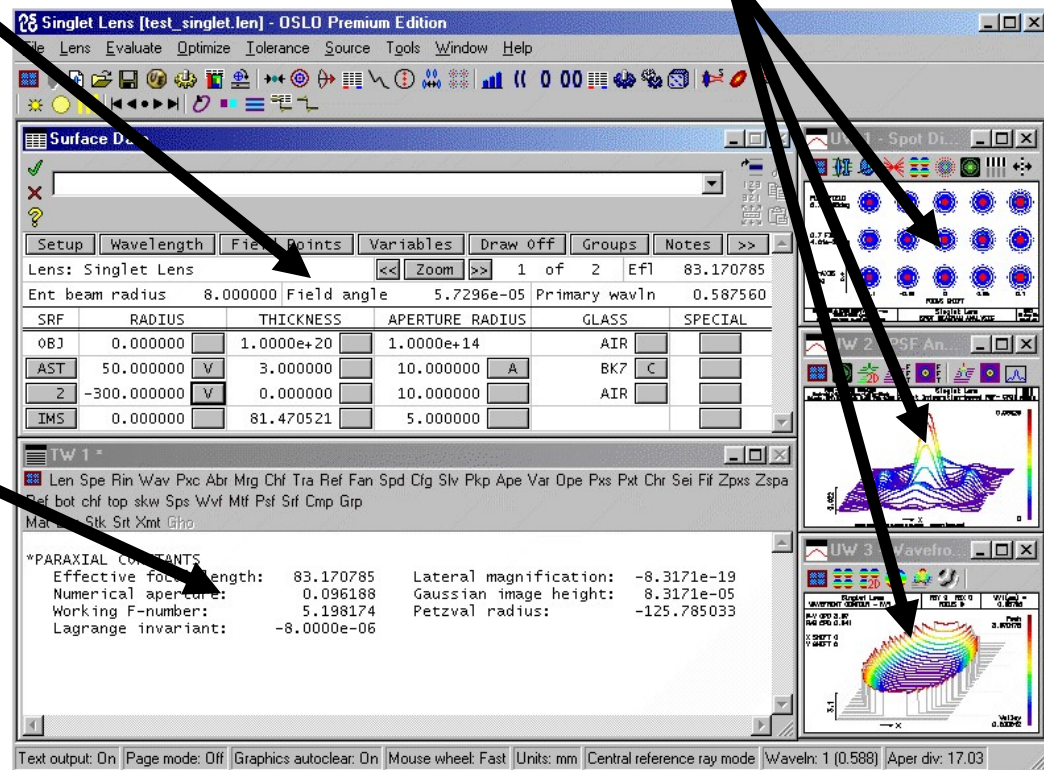
- **User Interface**
  - **Windows Topics**
    - **Menus**
    - **Toolbars**
    - **Main Window Types**
      - **Graphics**
      - **Text**
      - **Spreadsheet**
    - **Other Windows**
      - **Command Line**
      - **Database**
      - **Editors**
      - **Slider Wheel**
      - **Catalog Lens**
      - **Printing**
  - **Setup**
    - **Preferences**
    - **Fonts**
    - **Mouse**
    - **Keyboard**
  - **File and Program Information**

# Main Window Types

- Spreadsheet Window
  - Only one open at a time
  - Latest on top

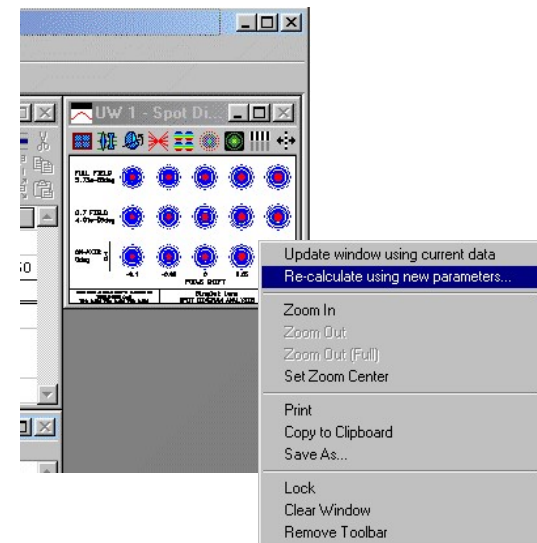
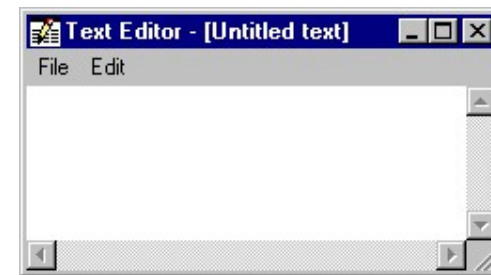
- Graphics Window
  - Up to 32 open at a time
  - Cannot close last

- Text Window
  - Up to 2 open at a time
  - Cannot close last

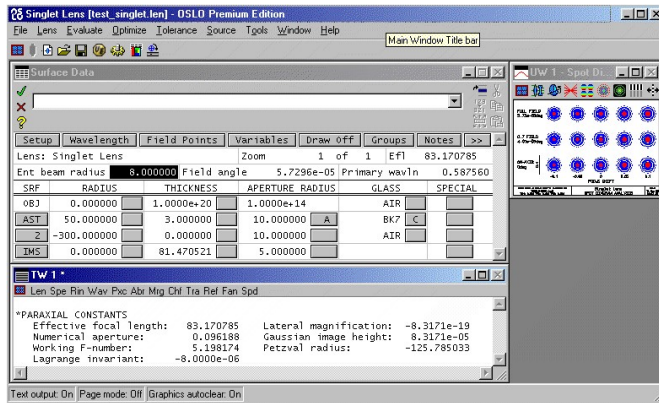


# Menus

- Main Menu Structure
  - Operates similar to Microsoft menus
  - Configured in a\_menu.ccl
- OSLO Editor Menu (not UltraEdit or Notepad++)
  - File & Edit items only
  - Not user configured
- Popup Menu
  - Right-click (not user configured)
  - Attached to SS buttons (not user configured)
  - Attached to toolbars (user configured)



# Main Windows Styles

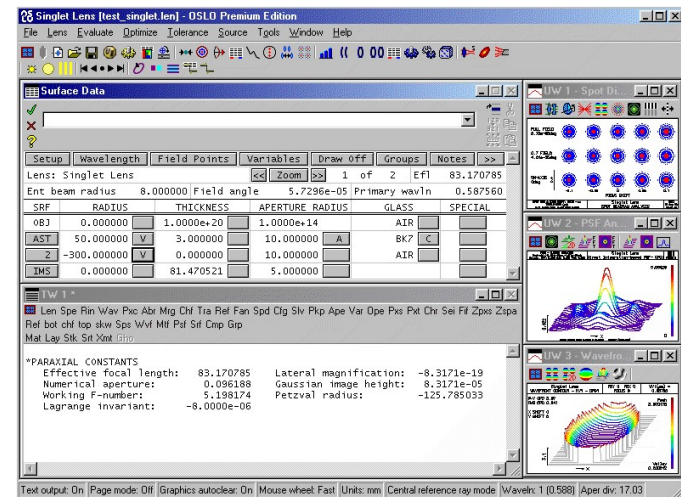


Standard Style

Default display, used for routine tasks

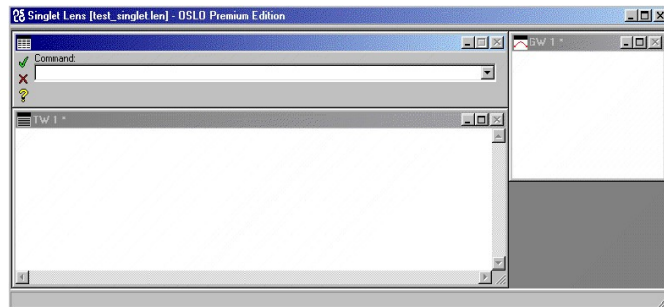
Enhanced Style

Customized from Standard with additional toolbars



Command (Basic) Style

No menus or toolbars, useful for command line input



# Graphics Windows

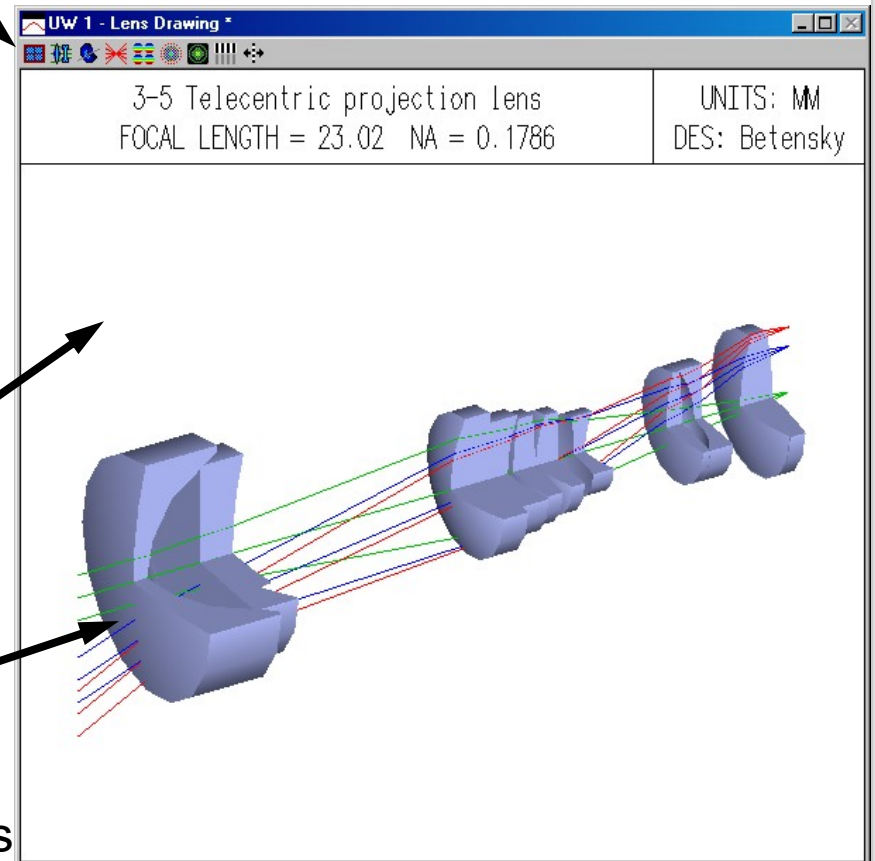
- Up to 32 Windows with Optional Toolbars

- Extensive Vector Graphics

- Clipped viewports
- Zoomable (mouse wheel support)
- Mouse events
- 3D drawing functions
- Fully resizable
- Black or white background
- Right-click support

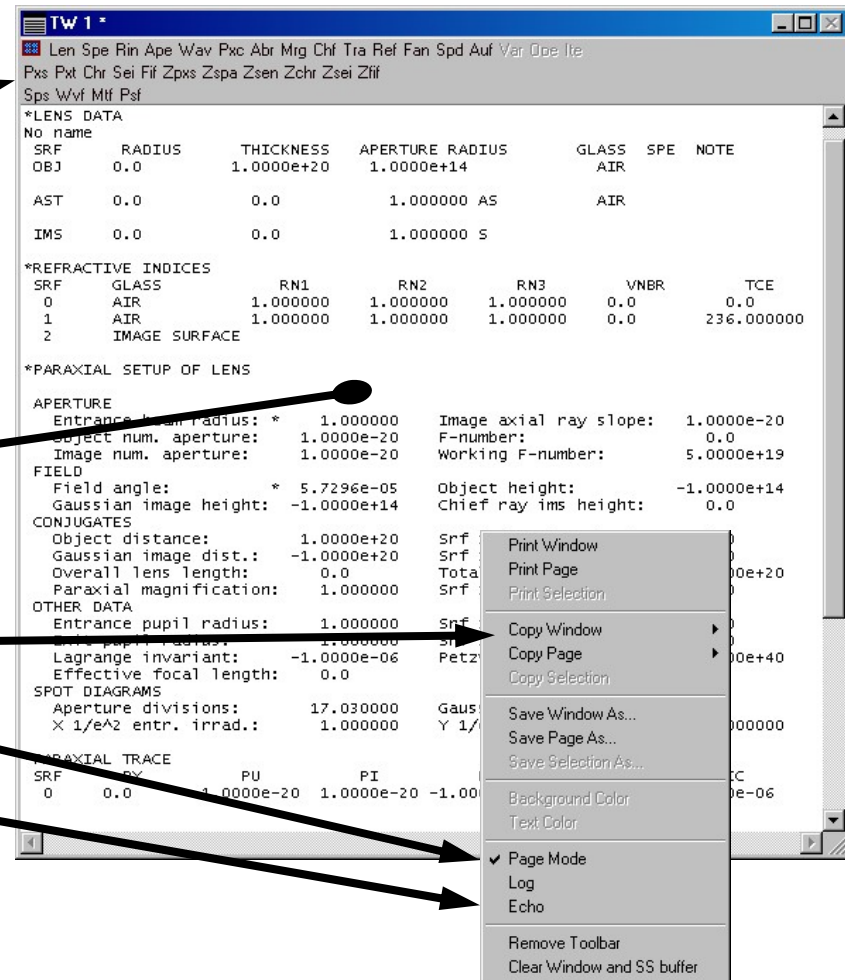
- Limited OpenGL graphics

- Internally generated lens drawings
- Shaded contour plots



# Text Windows

- Up to 2 Text Windows
  - Optional toolbars
  - Variable width, variable height
  - Up to 2000 lines
  - Spreadsheet Buffer Support
  - Right-Click Support
    - Windows Clipboard Support
    - Page or Terminal mode
    - Optional Command Echo
  - Text Output on/off preference



# Spreadsheets (SS)

- Drop Down from Command Line

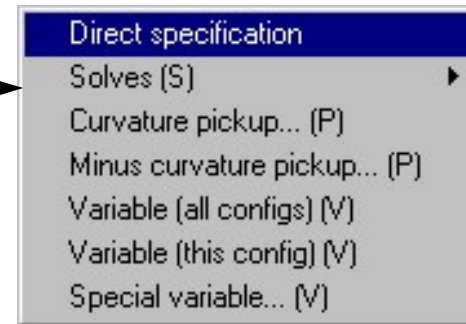
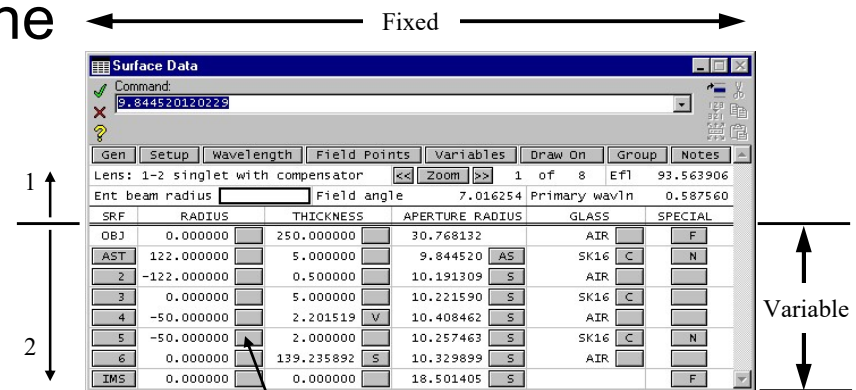
- Fixed width, variable height
- Keyboard or mouse navigation
- Lens data spreadsheet has 2 sections for cell navigation

- Data Entry

- Command line
- List cells
- Button pop-up menus

- Spreadsheets Invoke Other Spreadsheets

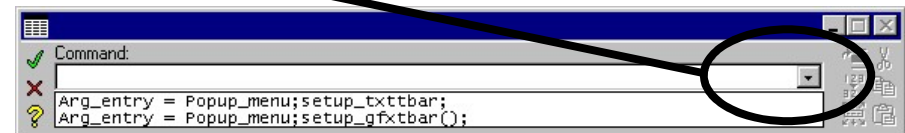
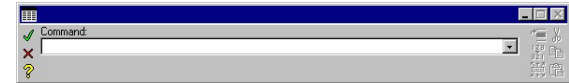
- Multiple spreadsheets organized in a stack on top of each other (FILO)
- Revert feature for lens data



# Command Line

- Command Line is Windows ComboBox

- Max length is 256 characters
- Drop down list is history buffer
  - Click drop down arrow:
  - Press F4 on keyboard
  - Press Ctrl + PageUp
  - Press Ctrl + PageDown



- Windows Cut/Copy/Paste support by right click only
- Keystrokes forwarded from Graphics & Text Windows
- Need to click on command to edit

- Press Enter, Escape or click button:

Enter

Escape

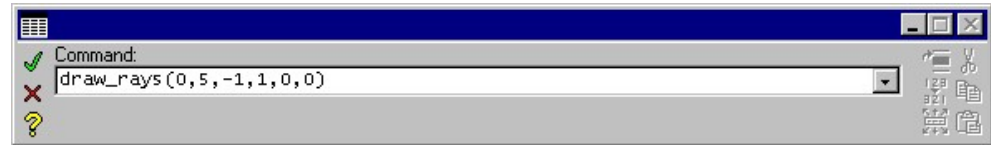
Help



# Command Line Syntax

- C-compatible or free form

- draw\_rays(0,5,-1,1,0,0)
- draw\_rays 0 5 -1 1

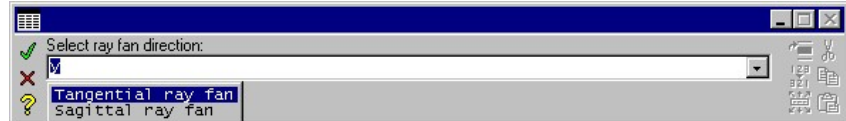
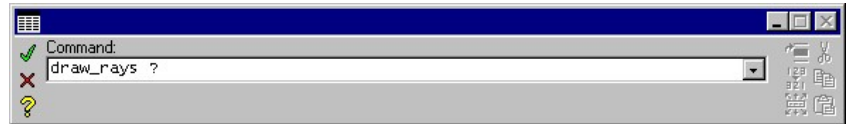


- Long or Short Form

- drr and draw\_rays are the same command (aliased)

- Forced Prompt Operator (?)

- ? Causes prompts for all missing arguments

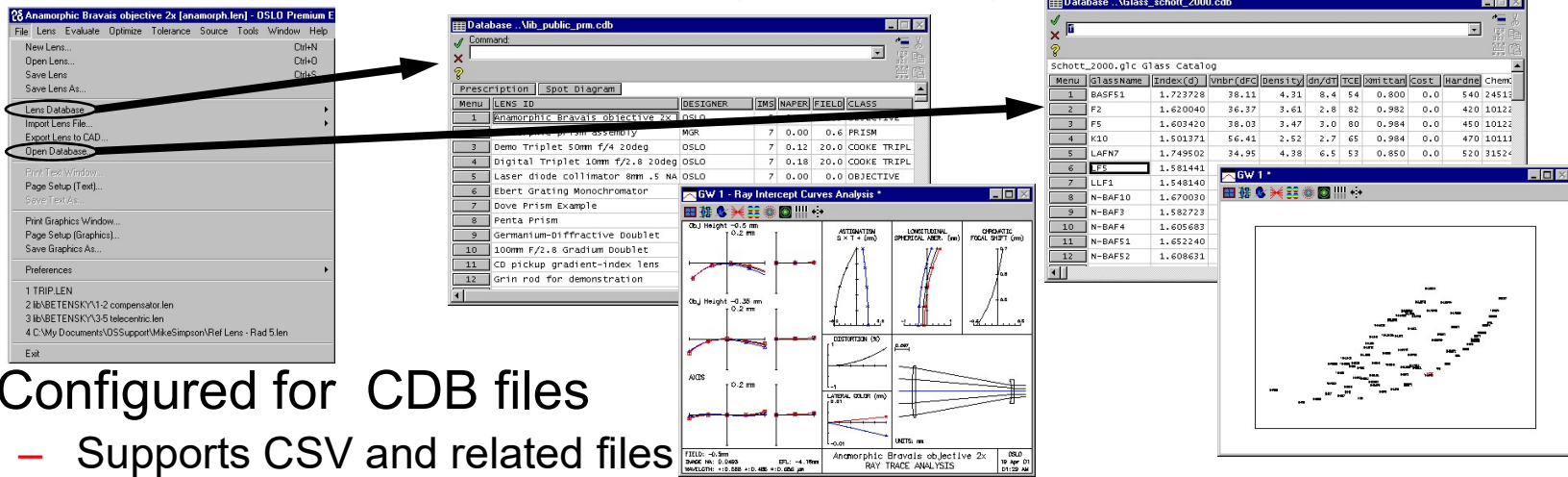


- Calculator Mode

- 2 + 2 ENTER produces “Result = 4” message
- SmartCells distinguish between commands and values
- Named registers - OSLO Lens data (RD, TH, ..etc.)
- Symbolic input: a=PI; 2\*PI

# Databases – Lens and Glass

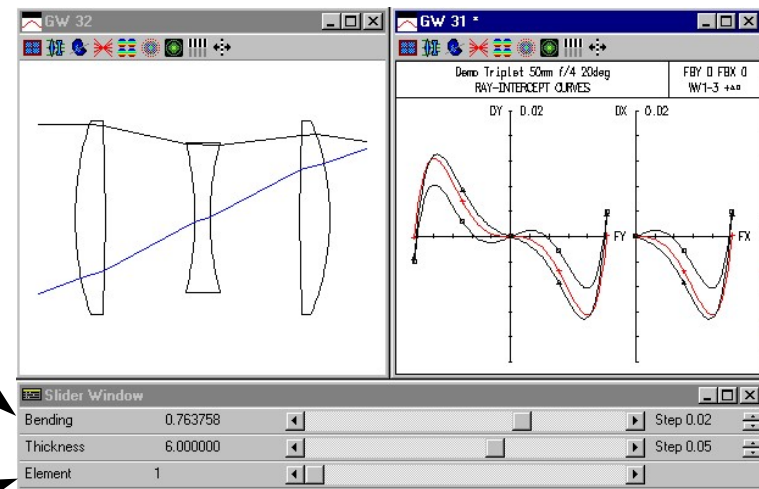
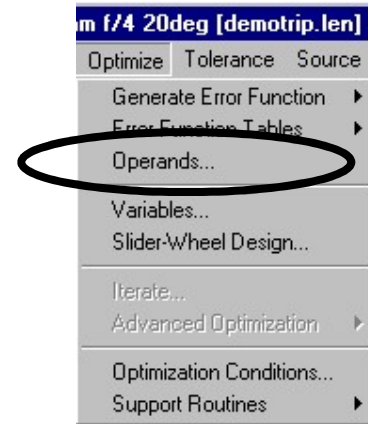
- User configured SS for 2D array data entry



- Configured for CDB files
  - Supports CSV and related files
  - Over 1000 lens designs available including examples from Warren Smith, Arthur Cox, Ellis Betensky and Bruce Walker
- New Features
  - Fixed width, horizontal scrolling
  - User programmable with callback buttons
  - Limited keyboard support
  - List support

# Slider Wheel Window

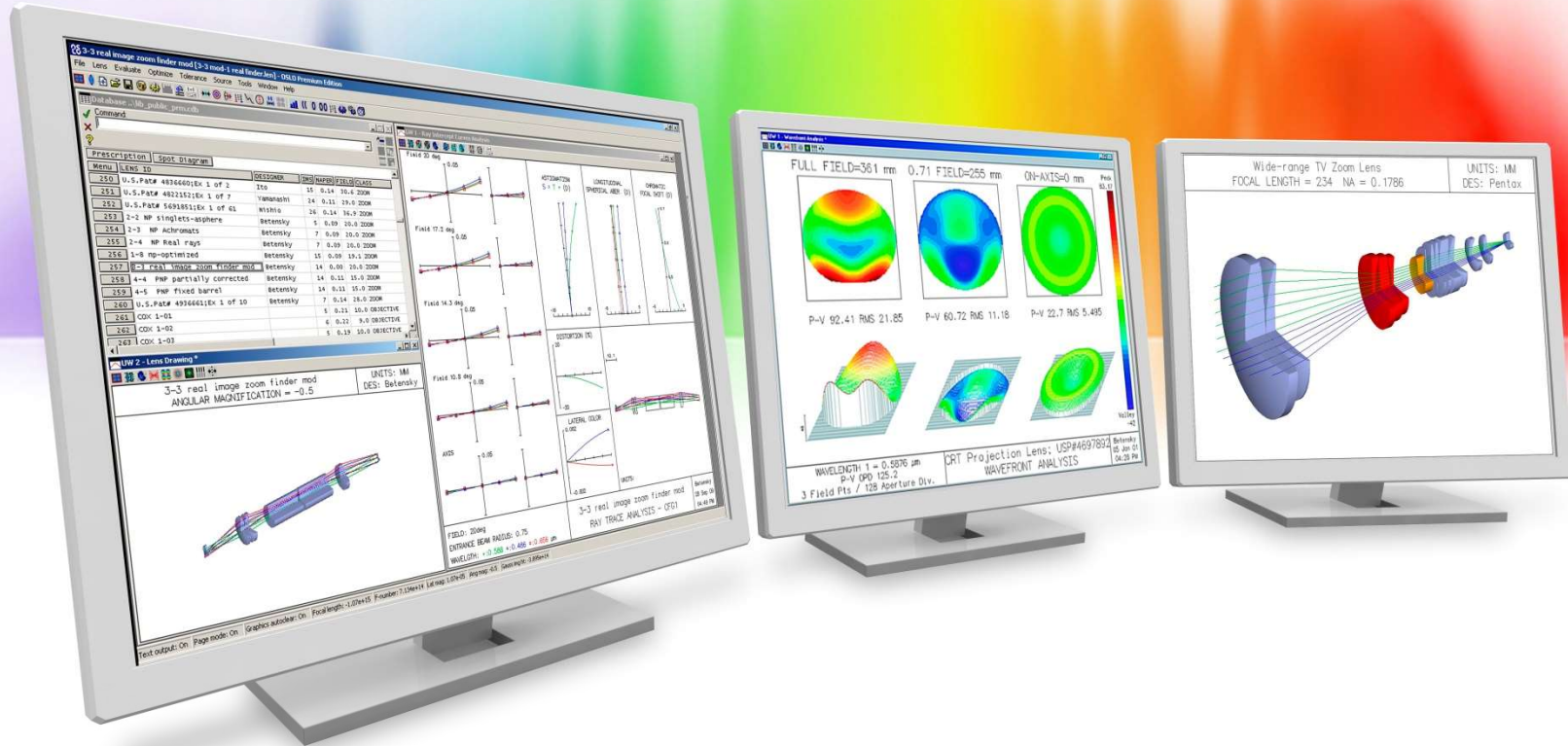
- Special Window for 32 Sliders
  - Combined with data entry spreadsheet
  - Supports mouse wheel
  - Variable range for real data
  - User programmable
  - Integer, Real, Real Fixed, and List data types



Real

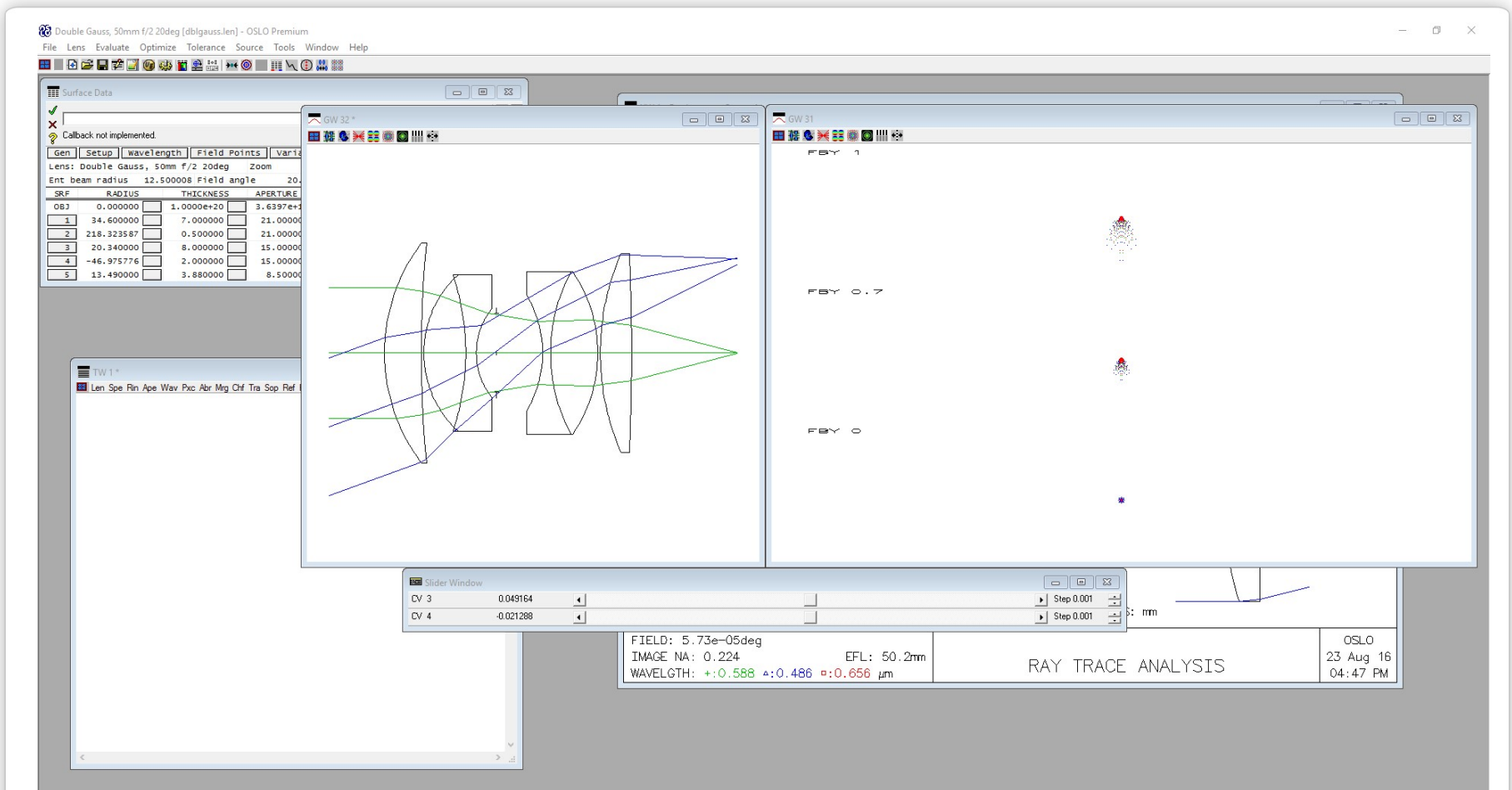
Integer

# OSLO



## Interactive Doublet Demonstration using sliders

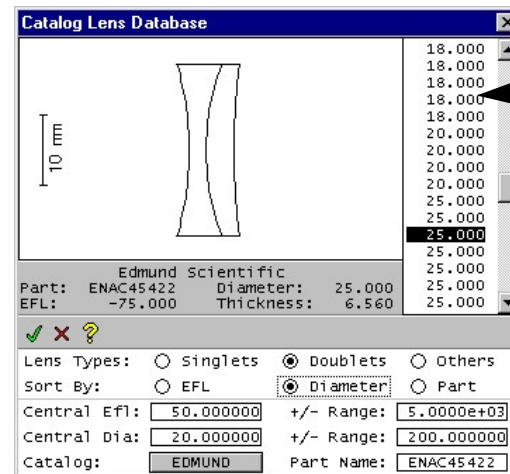
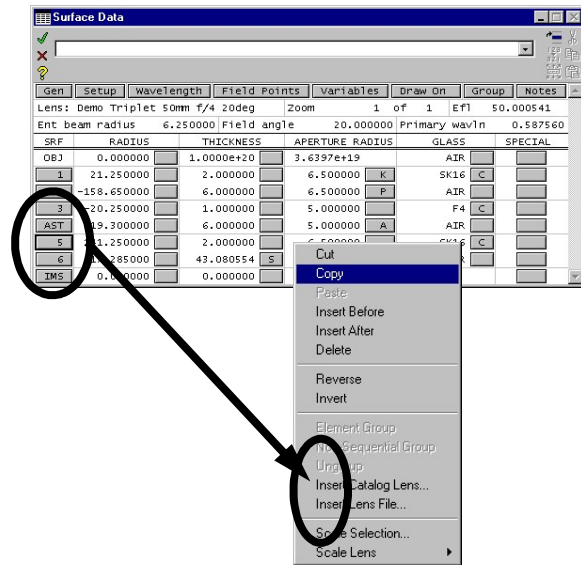
# Sliders



Multiple sliders can be attached to multiple variables with two displays showing the effects of changing the variables as the sliders are manipulated

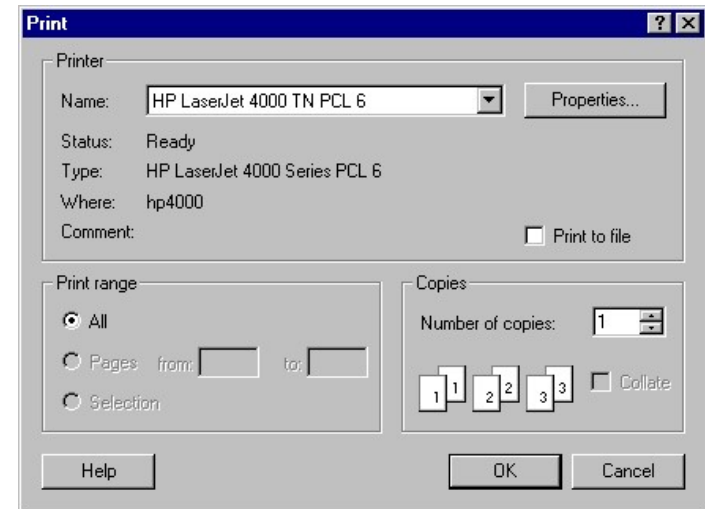
# Catalog Lens Window

- Graphical Database for Stock Lenses
  - Scrollable lens list
  - Automatic drawing of lenses
  - Database sorting for focal length, diameter & part number
  - Range selection
  - User configurable

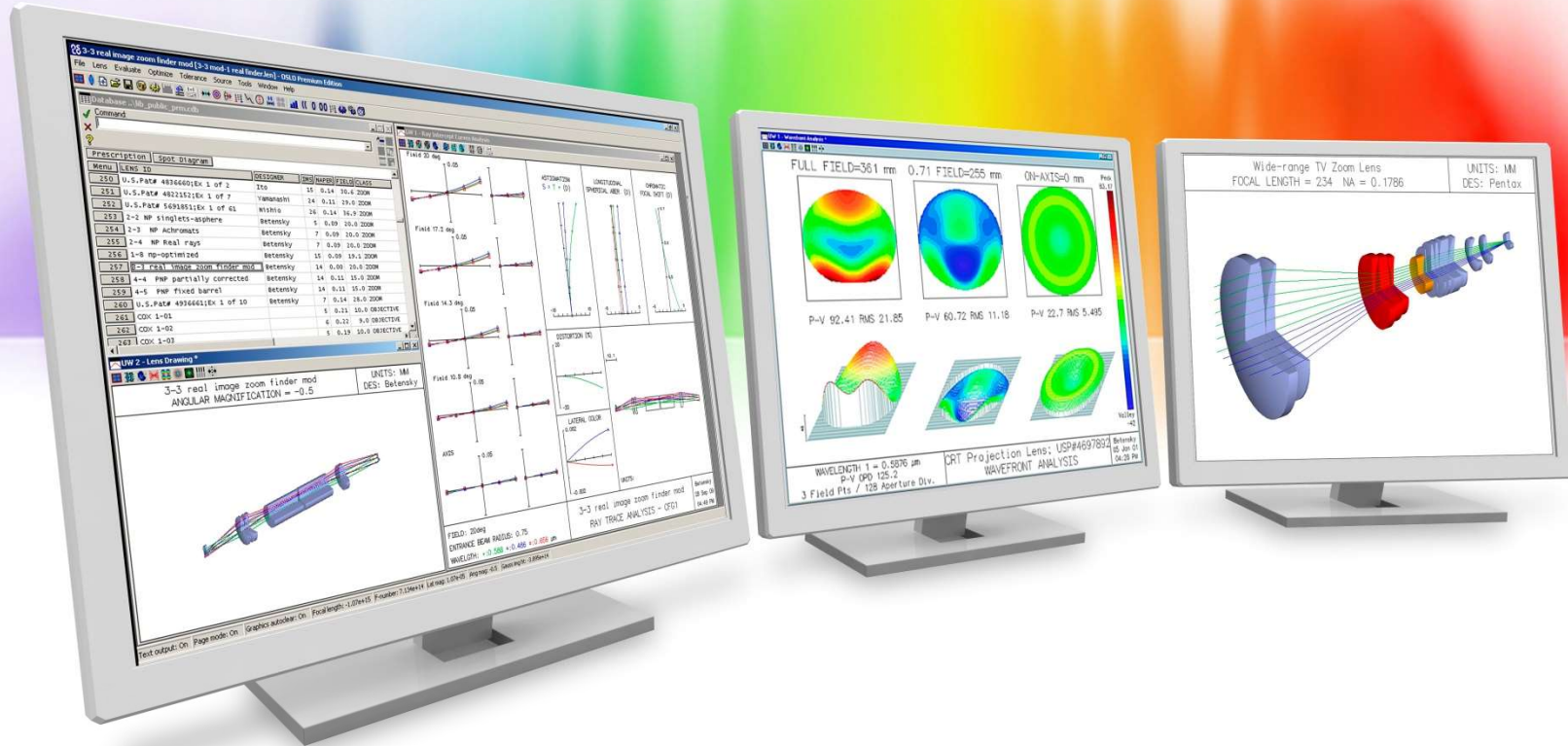


# Printing

- Uses Standard Windows Drivers
  - Standard printer selection dialog box
  - Standard page selection dialog box
- HPGL Graphics Output
- Other Protocols Supported Through Windows
  - \*.wmf, \*.emf files
  - \*.bmp files for OpenGL output
  - Limited postscript support through Windows
- Lambda Research does not provide device support

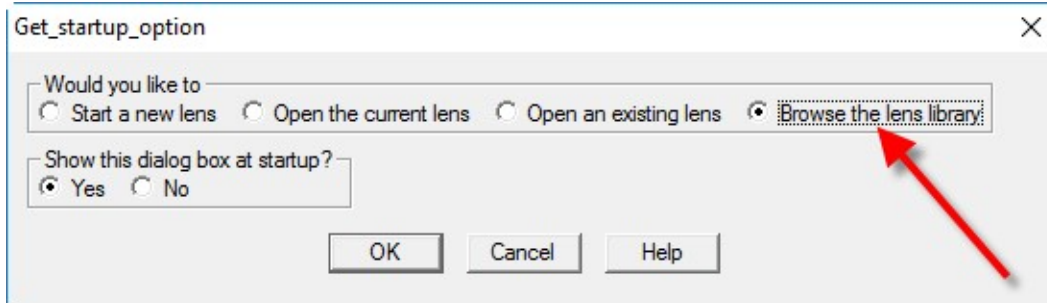


# OSLO



## Lens Library Demonstration

# Using the Browse Lens Library – over 800 optical systems



OSLO Premium  
 File Lens Evaluate Optimize Tolerance Source Tools Window Help

Database: .lib\_public\_prm.cdb

Command:

Prescription | Spot Diagram

Menu	LENS ID	DESIGNER	IMS	NAPER	FIELD	CLASS
1	Anamorphic Bravais objective 2x	OSLO	5	0.05	-2.9	OBJECTIVE
2	Anamorphic prism assembly	MGR	7	0.00	0.6	PRISM
3	Demo Triplet 50mm f/4 20deg	OSLO	7	0.12	20.0	COOKE TRIPL
4	Laser diode collimator 8mm .5 NA	OSLO	7	0.00	0.0	OBJECTIVE
5	Ebert Grating Monochromator	OSLO	4	0.14	-0.0	DIFFRACTIV*
6	Grin rod for demonstration	OSLO	3	0.29	30.0	ROD
7	Hubble space telescope	OSLO	4	0.02	0.1	TELESCOPE
8	IR Fisheye Lens	T.Jamieson	10	0.71	45.0	I.R. FISHE*
9	Laser communications system	OSLO	8	0.25	0.0	OBJECTIVE
10	He-ne f/2 doublet focusing lens	OSLO	5	0.25	0.0	OBJECTIVE
11	Magnifying glass 5X	OSLO	4	0.10	2.5	OBJECTIVE
12	Mono quartet 100mm f/3.15den	OSLO	9	0.17	15.0	OBJECTIVE

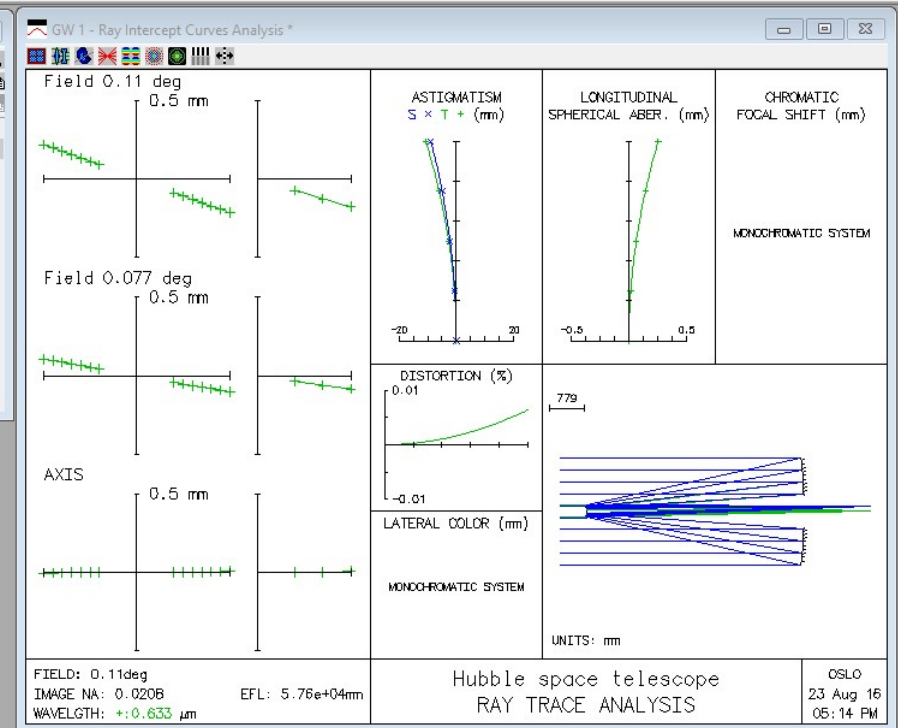
TW 1\*

Len Spe Rin Ape Wav Pxc Abr Mrg Chf Tra Sop Ref Fan Spd Auf Var One file

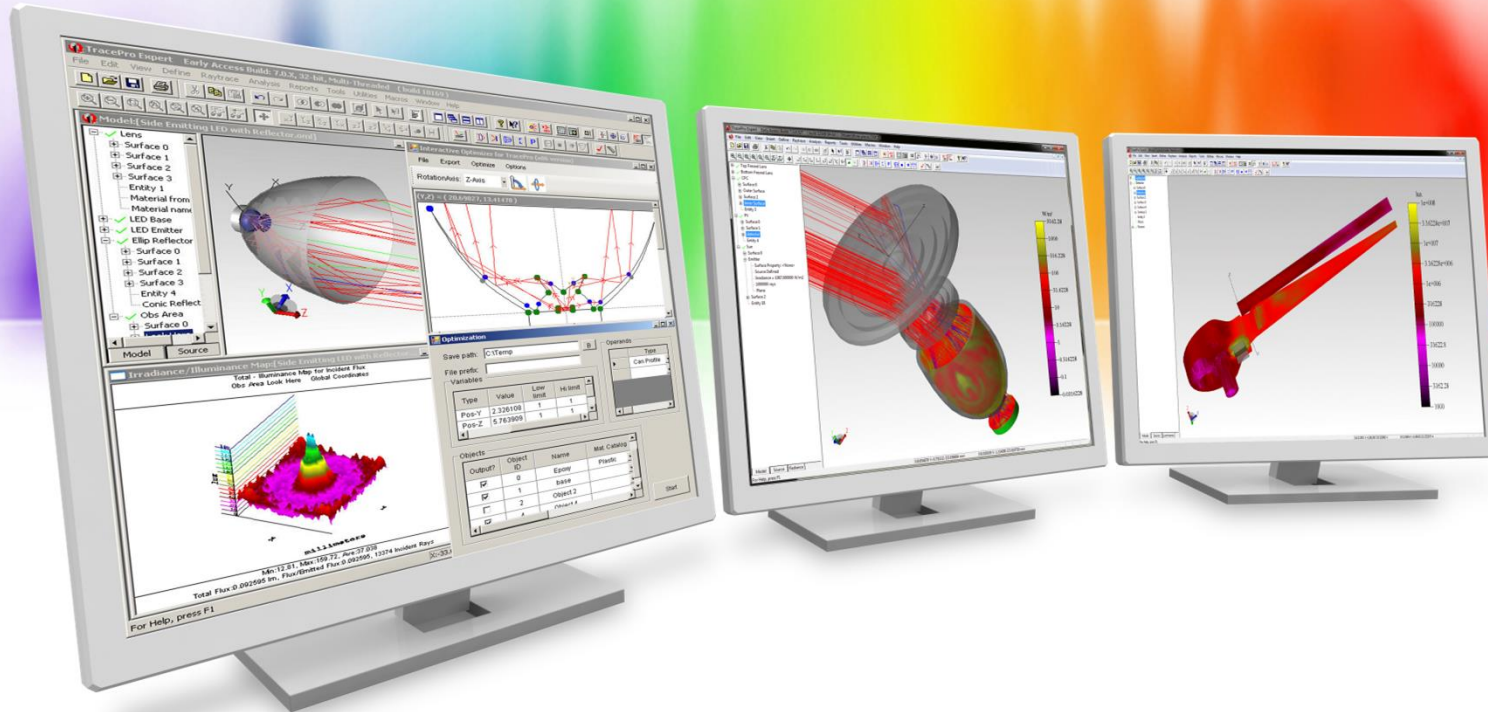
LENS DATA

Hubble space telescope

SRF	RADIUS	THICKNESS	APERTURE RADIUS	GLASS	SPE	NOTE
OBJ	--	1.0000e+20	1.9199e+17	AIR		
1	--	4.9061e+03	1.2094e+03	SX	AIR	*
AST	-1.1040e+04	-4.9061e+03	1.2000e+03	AX	REFL_HATCH	*
3	-1.3580e+03	6.4059e+03	150.000000		REFL_HATCH	*
IMS	--	--	110.578590	S		



# OSLO



## INTERACTIVE CATALOG LENS DEMONSTRATION

# Open OSLO → File New → Select Catalog Lens

The image shows two windows from the OSLO software. The 'File new' window has 'New file name' set to 'untitled' and 'File type' set to 'Catalog lens'. The 'Catalog Lens Database' window shows a list of lenses with '50.000' selected in the EFL column. The 'Surface Data' window shows a context menu open over the 'AST' surface, with 'Insert Catalog Lens...' selected.

**File new**

New file name: untitled

File type:  Custom lens  Catalog lens  Perfect lens

Number of surfaces: 1

1.000000 Focal length of perfect lens

0.000000 Magnification

0.050000 Image numerical aperture

No name [untitled.len] - OSLO Premium

File Lens Evaluate Optimize Tolerance Source Tools Window Help

**Surface Data**

Select spreadsheet option: cat

Gen Setup Wavelength Field Points Variables Draw Off Group Notes

Lens: No name Zoom 1 of 1 EFL 1.0000e+4

Ent beam radius 1.000000 Field angle 5.7296e-05 Primary wavln 0.587560

SRF	RADIUS	THICKNESS	APERTURE_RADIUS	GLASS	SPECIAL
OBJ	0.000000	1.0000e+20	1.0000e+14	AIR	
AST	0.000000	0.000000	0.000000	AS	

click on SS and select Insert Catalog Lens

Context menu options: Cut, Copy, Paste, Insert Before, Insert After, Delete, Reverse, Invert, Element Group, Non-Sequential Group, Ungroup, **Insert Catalog Lens...**, Insert Lens File..., Scale Selection..., Scale Lens

**Catalog Lens Database**

Part: MGO1LSX017 Diameter: 22.500

EFL: 50.000 Thickness: 4.080

Lens Types:  Singlets  Cem Dblts  Others

Sort By:  EFL  Diameter  Part

Central Efl: 50.000000 +/- Range: 5.0000e+03

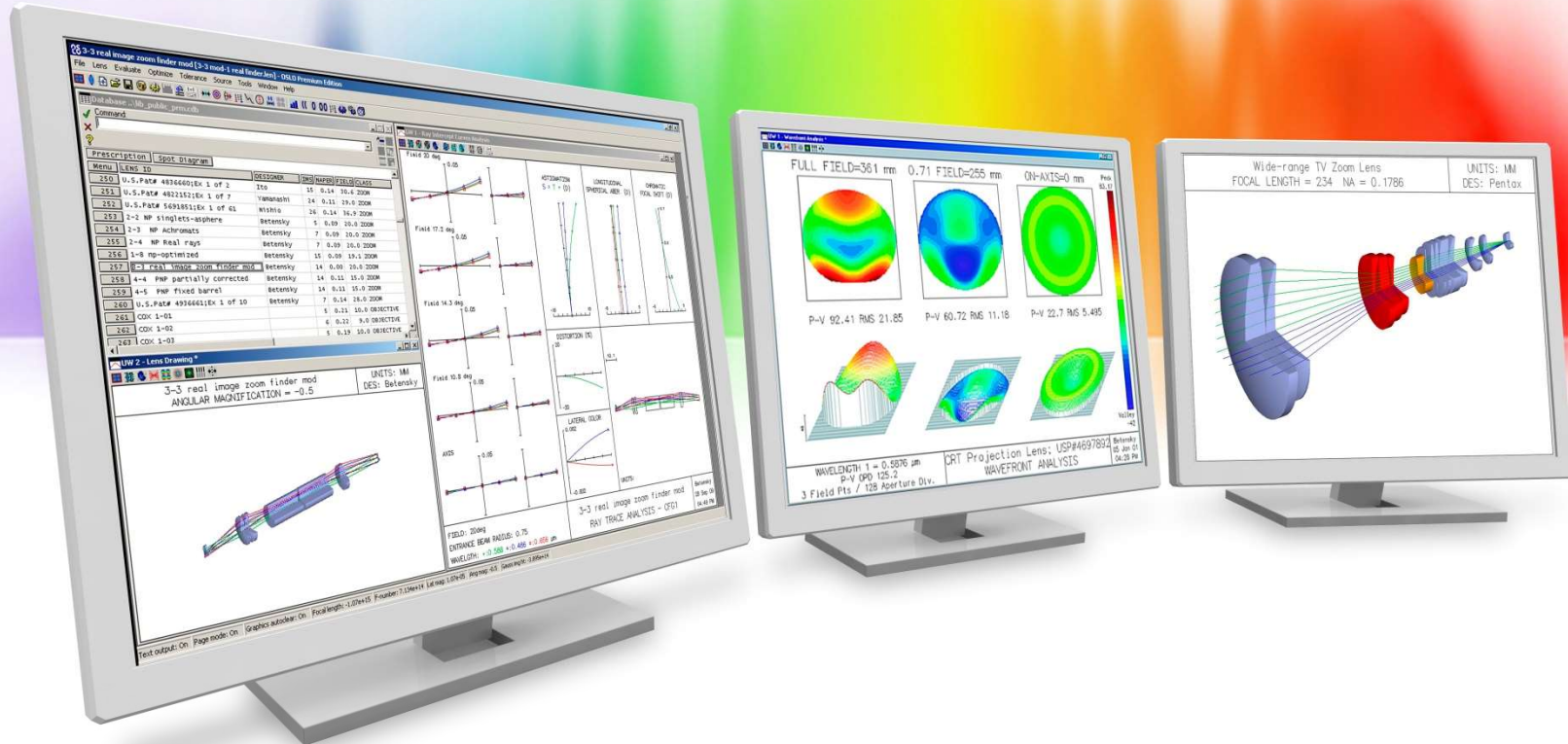
Central Dia: 20.000000 +/- Range: 200.000000

Catalog: MELLES\_SPH Part Name: MGO1LSX017

Two methods to open the catalogs of lenses in OSLO.

- 1- File New and Select Catalog Lens
- 2 – Open a new lens, right click on any surface column and select Insert Catalog lens

# OSLO



## Introduction to Command Line, Setup and Preferences

# Introduction

- Installation
- **User Interface**
  - **Windows Topics**
    - **Menus**
    - **Toolbars**
    - **Main Window Types**
      - **Graphics**
      - **Text**
      - **Spreadsheet**
    - **Other Windows**
      - **Command Line**
      - **Database**
      - **Editors**
      - **Slider Wheel**
      - **Catalog Lens**
      - **Printing**
  - **Setup**
    - Preferences
    - Fonts
    - Mouse
    - Keyboard
- File and Program Information

# Introduction

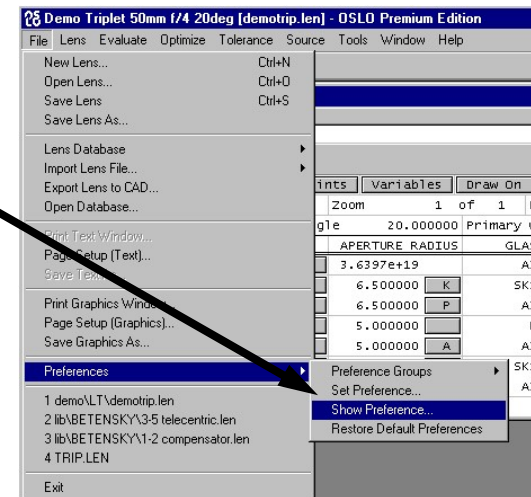
- Installation
- User Interface
  - Windows Topics
    - Menus
    - Toolbars
    - Main Window Types
      - Graphics
      - Text
      - Spreadsheet
    - Other Windows
      - Command Line
      - Database
      - Editors
      - Slider Wheel
      - Catalog Lens
      - Printing

## – Setup

- **Preferences**
  - **Fonts**
  - **Mouse**
  - **Keyboard**
- File and Program Information

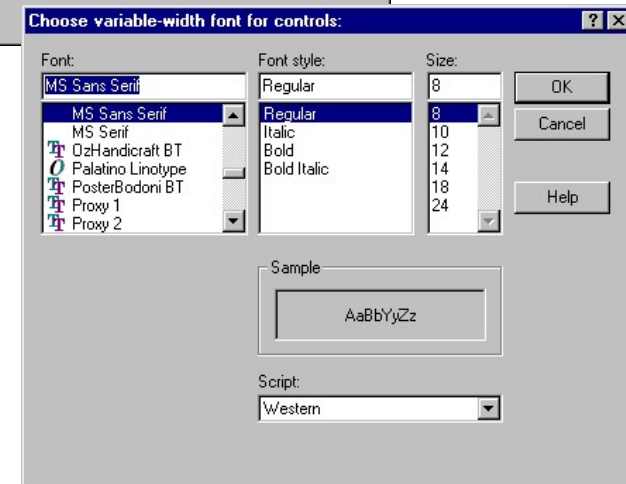
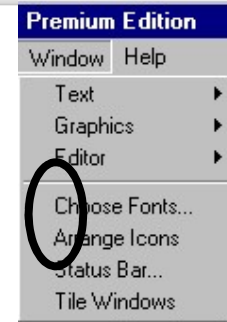
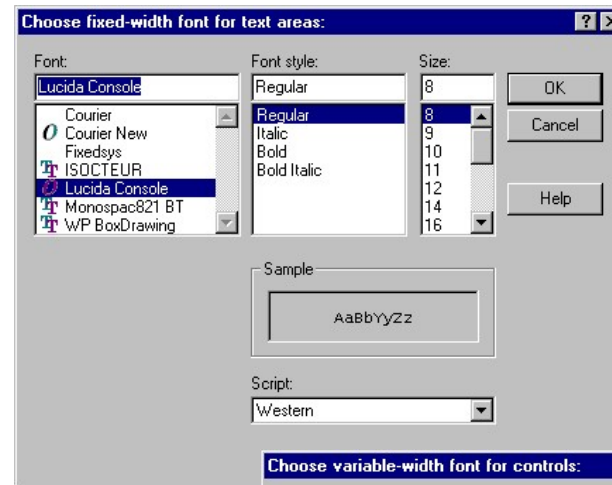
# Preferences

- Determines Program Parameters
- To Show Preferences:
  - See File>>Preferences>>Show Preferences
  - Type shp on the Command Line
- To Set Preferences:
  - See File>>Preferences>>Set Preferences
  - Type stp on the Command Line
- Values include int\_pref, real\_pref, ...etc.
- Saved in .../private/oslo.ini
- Look up “Preferences” in on-line help for complete list



# Fonts

- Need fixed and variable spaced fonts
- Fixed Fonts
  - Spreadsheets, text output
  - Maintains columns
- Variable Fonts
  - Messages, prompts
  - More readable
- Change using OSLO menu item Windows>>Choose Fonts
  - Note: 2 dialogs open sequentially. Try,
    - Variable: MS Sans Serif - 8pt or
    - Fixed: Lucinda Console - 8pt
  - Don't use > 10pt (formatting problems)



# Mouse

- Left click selects
- Right click pops up context menu
- Double click updates graphics
- Drag
  - Zooms graphics (Marquee box)
  - Selects range in spreadsheet, text output
- Shift-click changes input mode in spreadsheet
- Wheel zooms graphics, scrolls SS and sliders
- Slow mouse wheel preference(slmw)
  - 1 event/notch when on, 3 (typical) when off

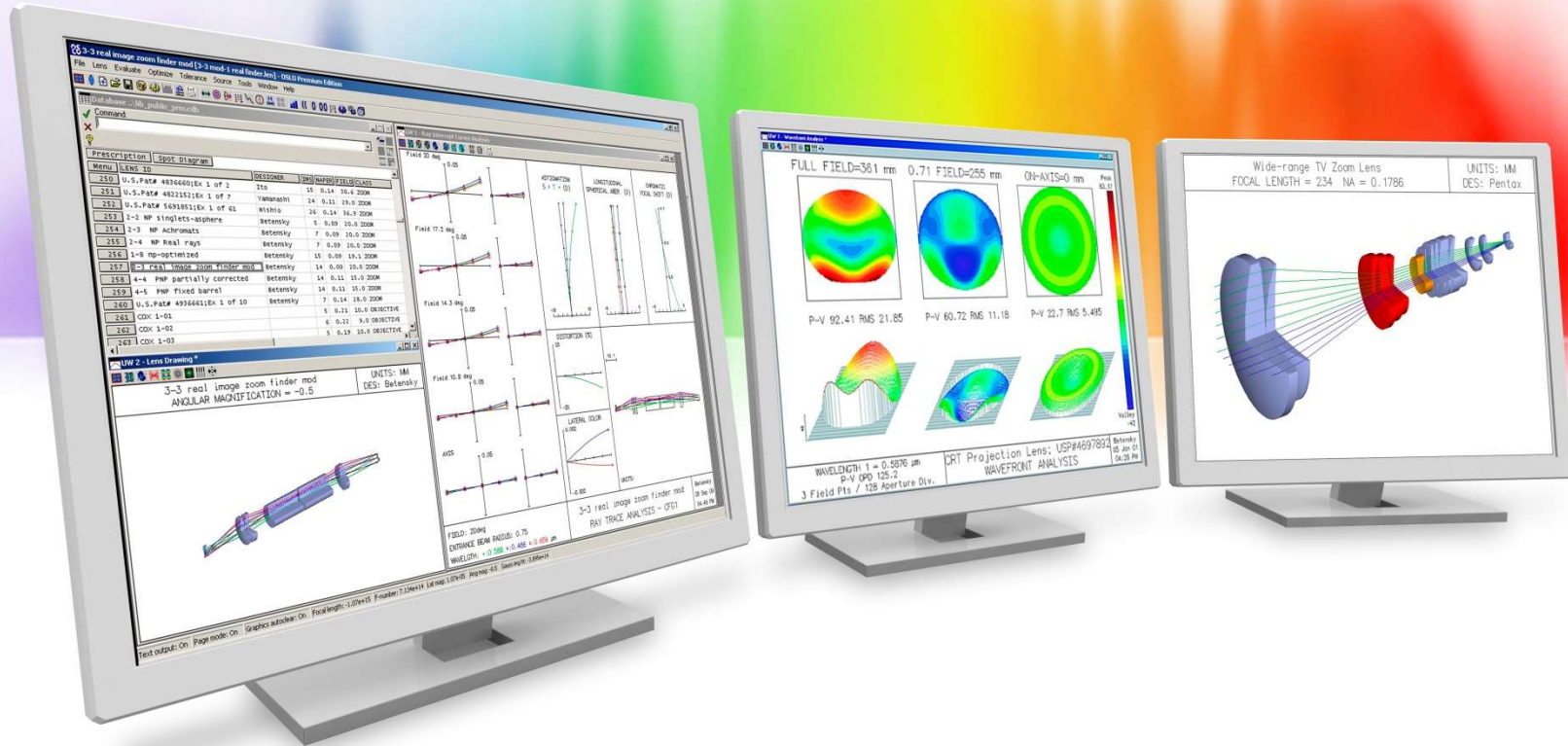
## Keyboard - Shortcuts

- Text keystrokes sent to Command Line:
- CTRL + Arrows: zoom graphics
- SHIFT + Arrows: select text output
- CTRL + PageUp/PageDown: scrolls history up/down
- TAB & SHIFT TAB navigates dialogs and spreadsheets
- Keyboard arrows navigate SS but don't cross fixed boundary
- Windows intercepts some keystrokes (e.g. F4)
- Define special keystrokes as “accelerators”
  - See “Other Accelerators” menu in a\_menu.ccl

## Status Bar

- Visibility set by preference shsb
- Choose Menu item:  
Window>> Configure Status Bar to set items
- Items are pre-programmed for CCL
  - Select pre-programmed items from the list
  - Use Set\_Preference (stp) command to set value
    - Strcpy(Astr, "My item")
    - stp(sb04, Astr)
    - "My item appears in field 4 of status bar.

# OSLO

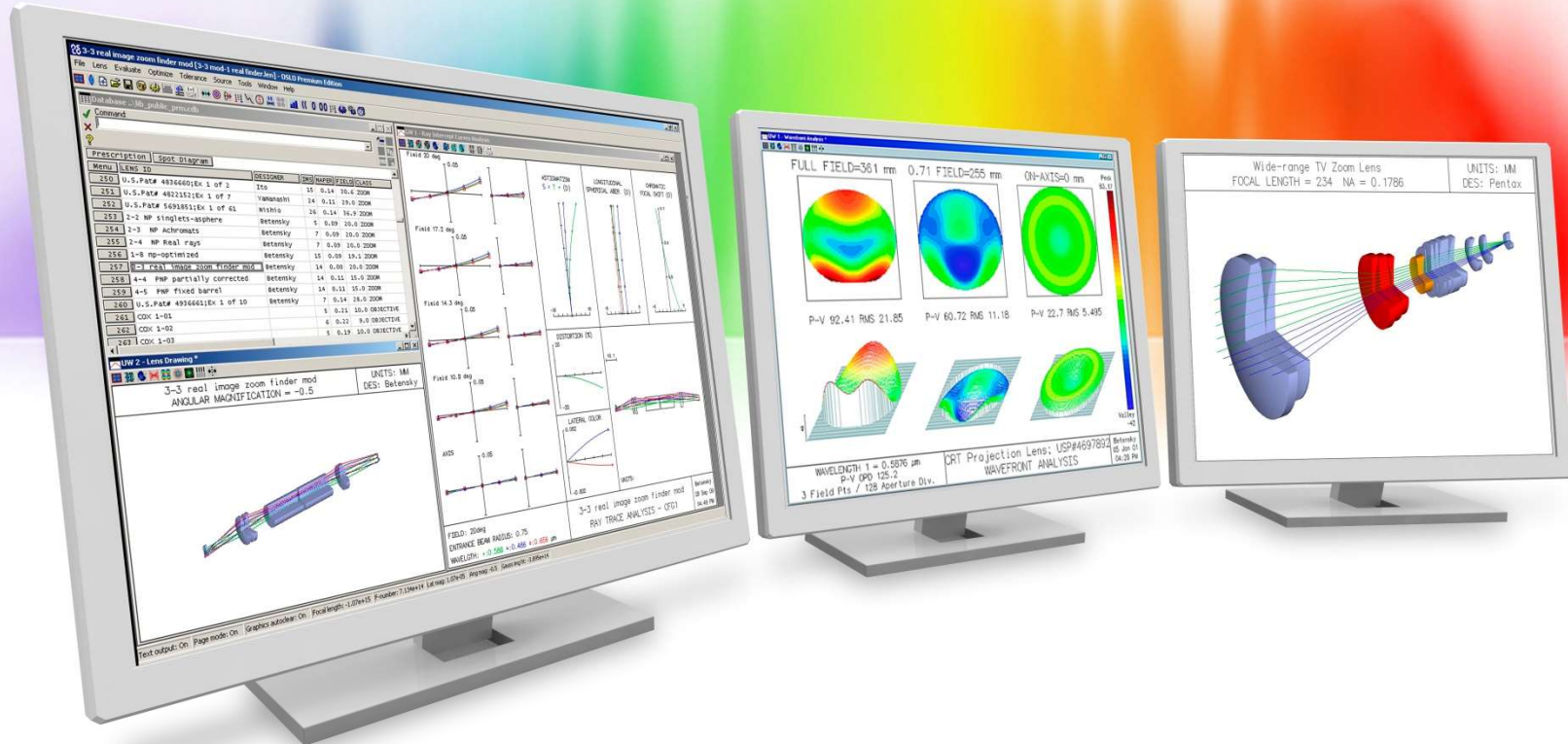


## Interactive Triplet Demonstration

For use in UA Opti 517 Class – All rights reserved -Lambda Research Corporation



# OSLO

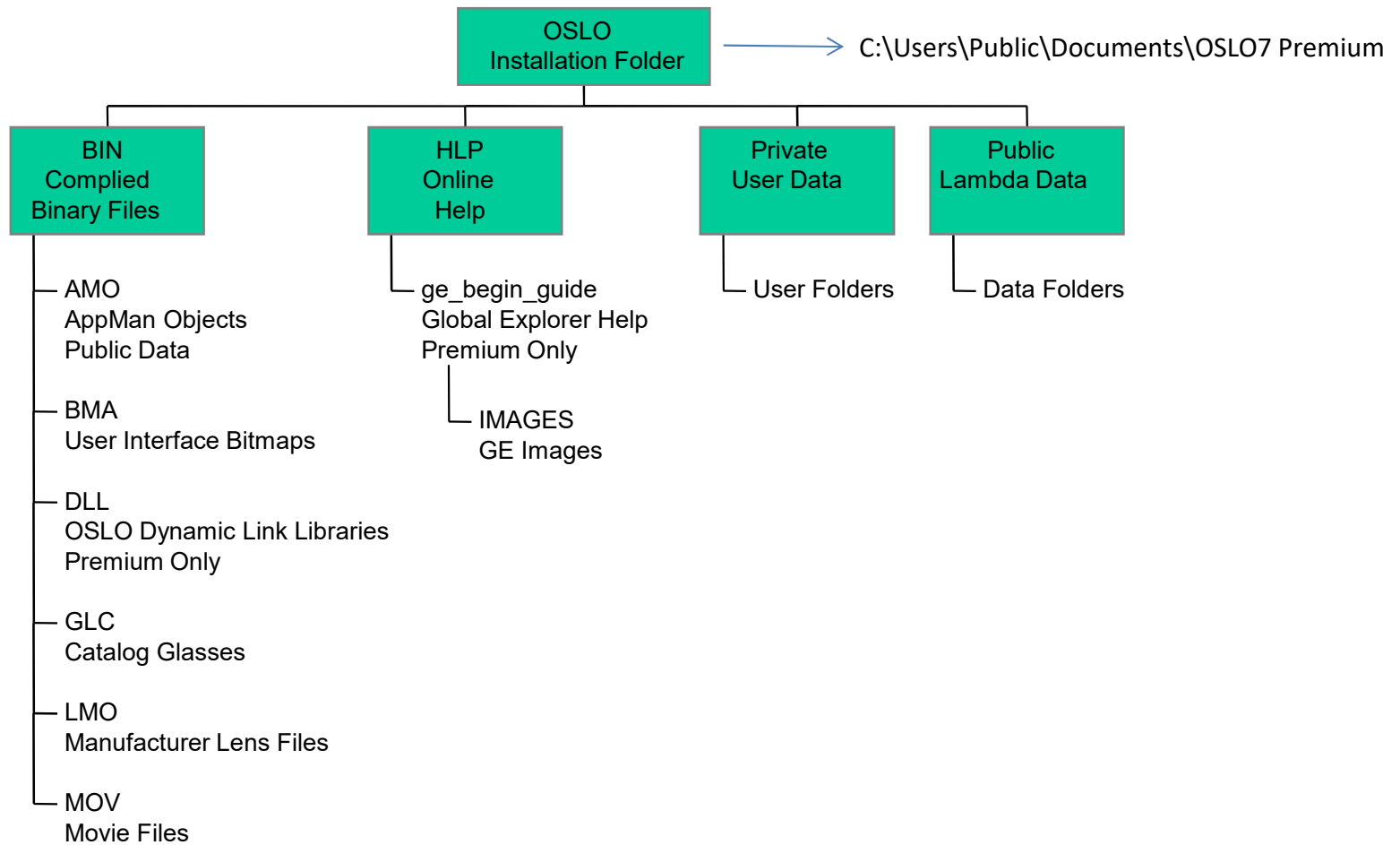


## Introduction to the OSLO File System

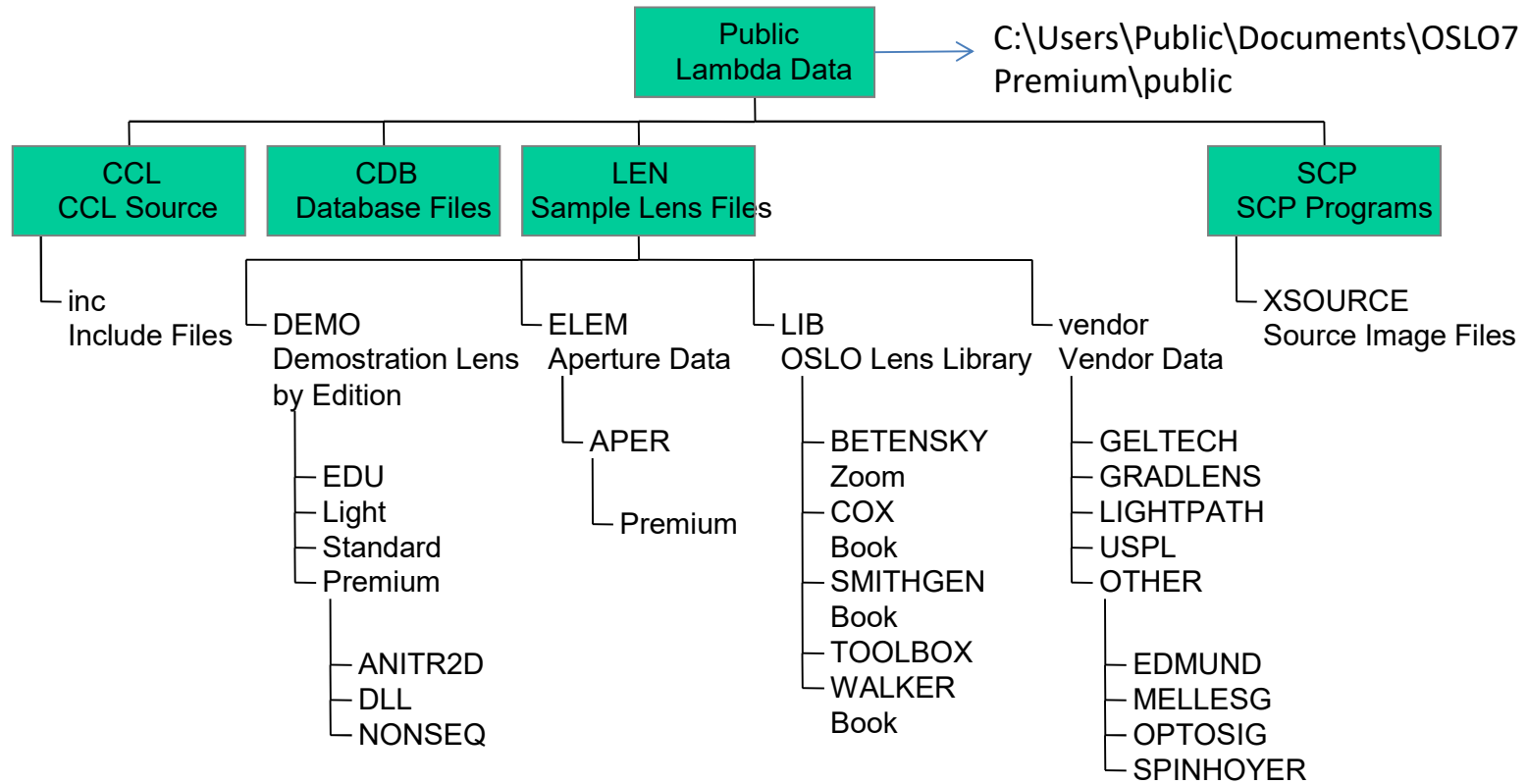
# Introduction

- Installation
- User Interface
- **File and Program Information**
  - **OSLO File System**
    - OLSO File Hierarchy
    - LEN/OSL Files
    - **CCL/CCX Files**
    - CC Source Code Files
    - SCP Files
    - CDB Files
    - Other OSLO Files
    - Import/Export Files
  - **OSLO Functional Flow**

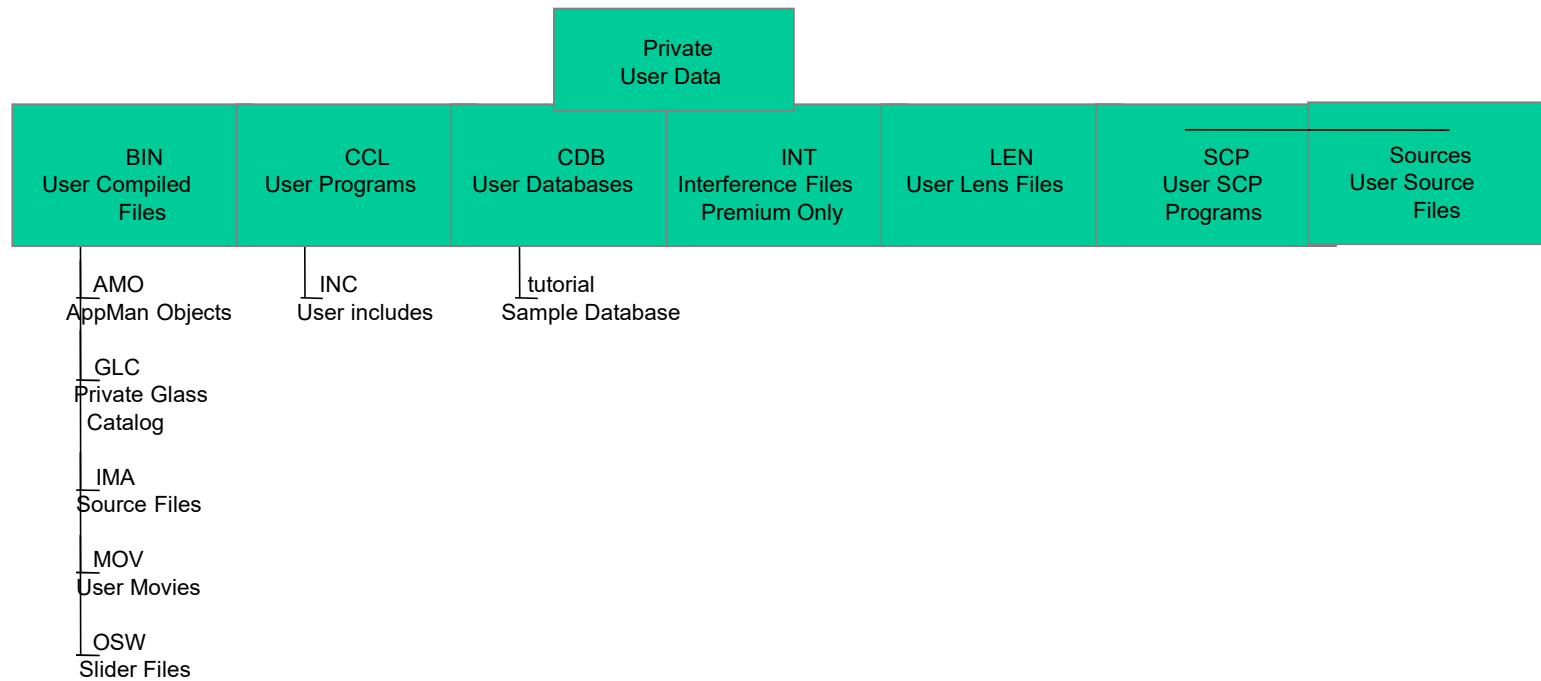
# OSLO File Hierarchy



# Public Folders

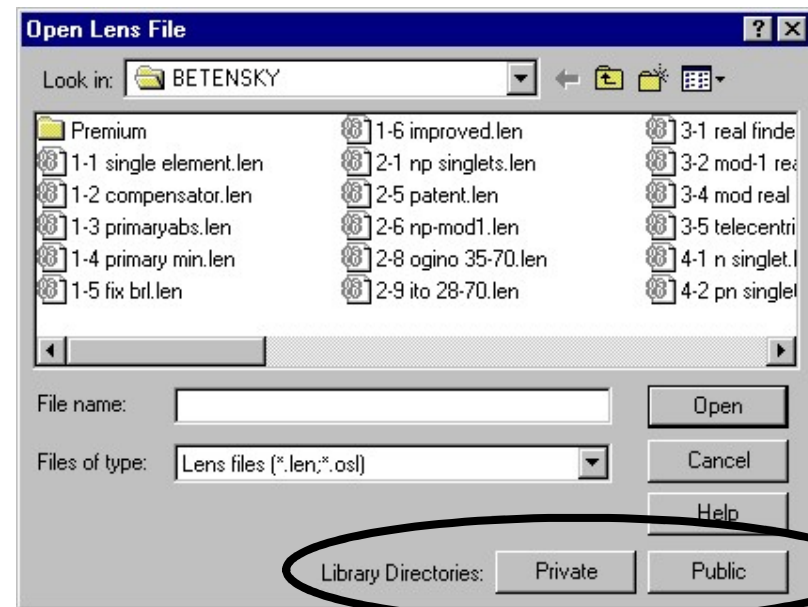


# Private Folders



# OSLO File System

- Public and Private Directories
  - Public Files marked “read-only”
  - Private set by OSDATA environment variable in win.ini
  - Also uses “current” LENS and TEXT directories
- Special File Types
  - LEN or OSL  
(set under *preferences*)
  - SCP
  - CCL
  - CDB
- Uses Modified Windows Dialog Box:



## LEN/OSL Files

- LEN is current format
- Text files containing optical prescriptions by listing commands
  - //OSLO header line
  - LEN NEW ...more lines... END (lens surface data)
  - CFG NEW ...more lines... END (multi-configuration data)
  - Miscellaneous data lines (operating conditions)
  - VAR NEW ...more lines... END (optimization variable data)
  - RST NEW ...more lines... END (rayset data)
  - OPE NEW ...more lines... END (optimization operand data)
- Use literal or symbolic data
- Insert one lens into another

## CCL/CCX Files (1)

- CCL: Compiled Command Language Similar to Java
- File Name not significant
  - Scanccl.ccl used from the command line locates commands
  - File prefix groups commands
- All CCL Files Compiled to \*.AMO
  - AMO: AppMan Object file
- Automatically Compiled with OSLO Editor
- Incremental Compile/Link
- “Private Files” Outrank “Public Files” in Usage Order
- Use \*.CCX for In-Process Files

## CCL/CCX Files (2)

- File Locations of Special CCL Commands
  - Argument definitions & globals: `a_global.ccl`
  - Strings: `a_string.ccl`
  - Lists: `a_list.ccl`
  - Menus: `a_menu.ccl`
  - Toolbars: `.../inc/a_toolbar.h`

# SCP Files

- SCP: Star Command Procedure
  - Not as efficient nor as powerful as CCL
  - SCP is meant to be used to create simple scripts
  - SCP is a subset of CCL
- Search Order
  - Cmdname:filename
  - Current file, if specified
  - Default.scp
- File Format

```
*cmdname
ccl command line statement;
ccl command line statement;
- etc. -

*cmdname
ccl command line statement;
ccl command line statement;

- etc. -
```

# CDB Files

- Compatible with Excel, ...etc.
- Used for OSLO Lens Library, Source Database
- Edited with OSLO database spreadsheet
- Format is “Delimited Data” (\*.CSV, \*.TAB) with a Readable Header:

```
,=lbc...cdb6%4d%9.3f%9.1f%9.3f%-6.6ts%9.1f%12.6f  
BK7=1.5168,SILICA=1.45846 \tlex_6,,,,,,,,,  
  
LensID,Radius1,Thickness,Radius2,Glass,Diameter,Focal Length  
  
1,25.95,4,0,BK7,20,0.0  
  
2,-184,2,184,SILICA,30,0.0  
  
3,21.577,6.9,-21.577,BK7,20,0.0  
  
...more lines...
```

## Other OSLO Files

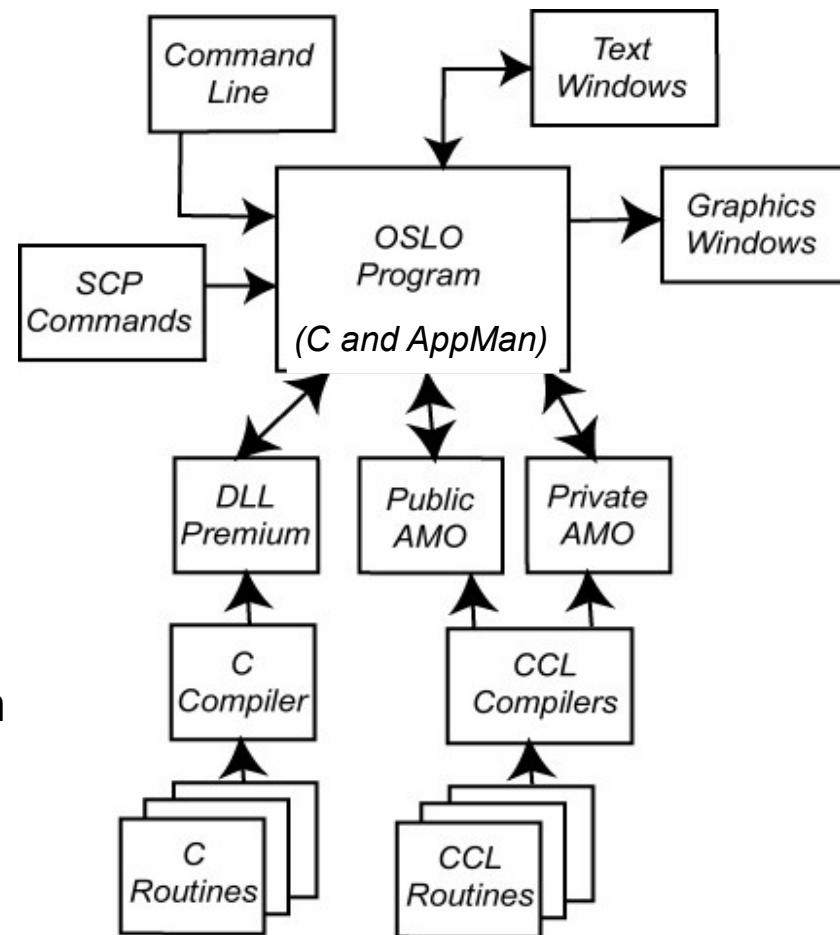
- \*.GLC: Glass Data
- \*.LMO: Lens Module (catalog lens)
- \*.TGL: Test Glass
- \*.OMD: Coating Material Data
- \*.OCD: Coating Prescription Data
- \*.MOV: Movie
- \*.INT: Interferogram
- \*.AMO: Appman Object Code

# Import/Export Files

- Import Data From
  - Code V (\*.SEQ)
  - GENII (\*.LNS, \*.LEN)
  - Sigma (\*.DAT, \*.LNS, \*.LEN)
  - Zemax (\*.ZMX)
- Export to CAD
  - IGES (\*.IGS)
  - DXF (\*.DXF - 3D only) Tested with AutoCad & Design Cad
  - IGES support for Mastercam (COM Opticam format)
  - STEP – All Surface Types

# OSLO Functional Flow

- OSLO is built on CCL
- OSLOxxxx.exe (all versions of OSLO):
  - Include library routines (from C)
  - Loads compiled CCL routines (from AMO files) for execution

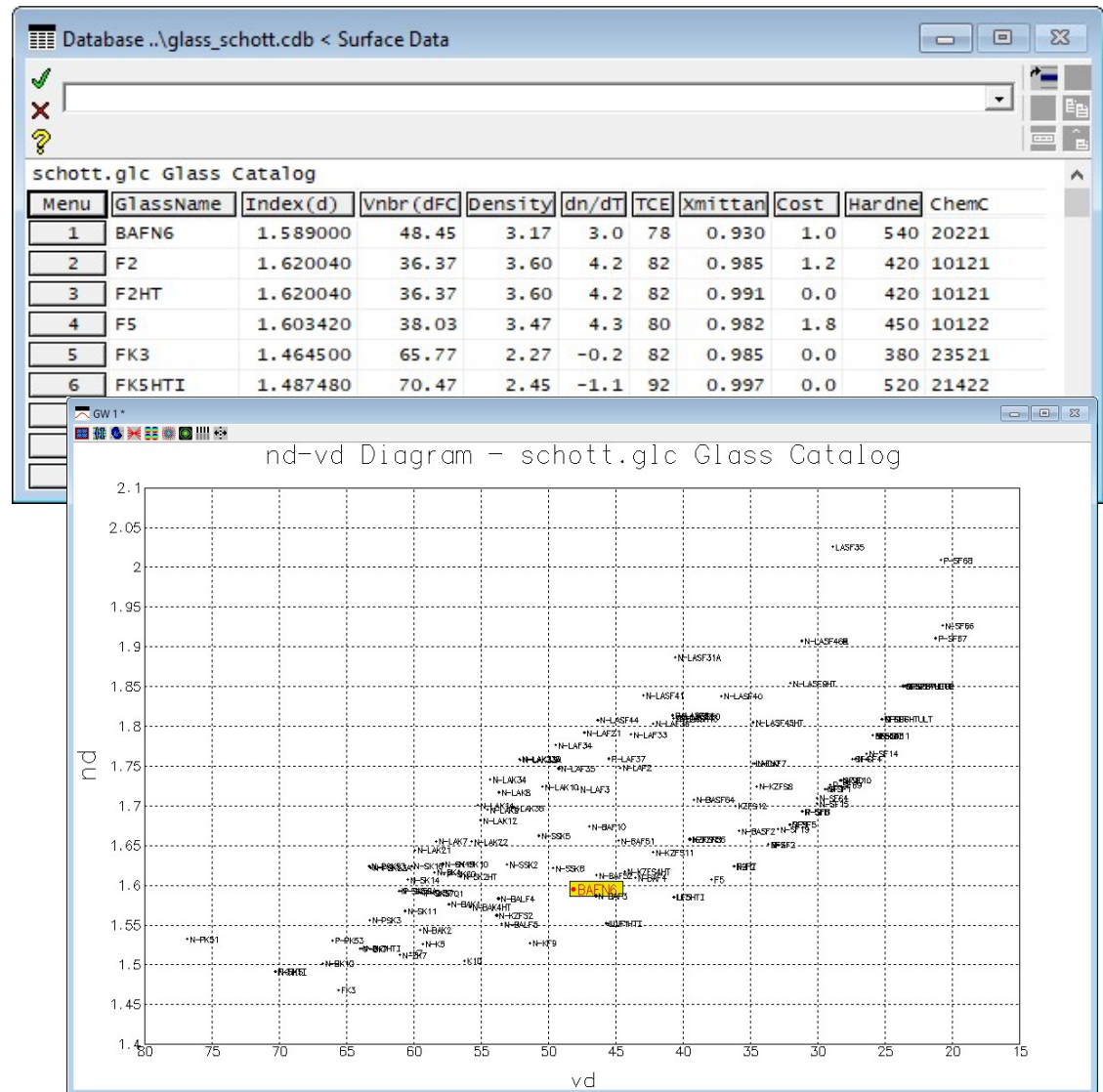


# Lens Drawing

- Drawing Conditions
  - Location of drawings, space for ray trajectories
  - Appearance (rings, spokes, apertures, mirror hatching)
  - Rays to show (object points, fans, etc)
  - Rays are not same as field point set or ray set
- Drawing Types
  - Plan View (Strictly 2D, not a projection)
  - Wire Frame (3D, uses color for surfaces)
  - Hidden Line (also incorrectly called solid model)
  - Shaded (Uses OpenGL)
- Zoom Drawing
  - Shows all positions

# Glass Database

- Use glass database to help choose appropriate glasses
  - Draws glass map
  - Sort on any glass data
- Be wary of glass availability
  - Glasses in center of map not necessarily cheapest
  - Vendors working on new glasses
- Temperature and thermal expansion data included



# Element Drawing

- ISO 10110 Compatible
  - Tabular format
  - Default SS shows ISO standard values
- Enter Data, Drawing automatically produced
  - Tolerances
  - Fabrication data
- Singlets Only
- Portrait Format Preferred

# Evaluation Setup

- Set Current Object Point
  - Automatically traces reference ray
  - Use caution in interpreting, not always used
- Set Current Wavelength
  - Used for analysis as default, indicated if not 1
- Set Current Configuration
  - Sets configuration for analysis
- Autofocus
  - Adds shift to image surface
- General Conditions

# General Conditions

- Evaluation mode, Aberration mode
- Units, OPD in waves
- Ray aiming type, Ray aiming mode
- Wavefront reference sphere position
- Symmetry State, Aperture checking
- Solves in alternate configurations
- Zernike polynomial reference axis
- Global reference surface for ray data
- Evaluation z-axis
- Source astigmatic distance
- Temperature, Pressure
- Use equal image space ray increments
- Polarization Ray Trace, Calculate diffraction efficiency

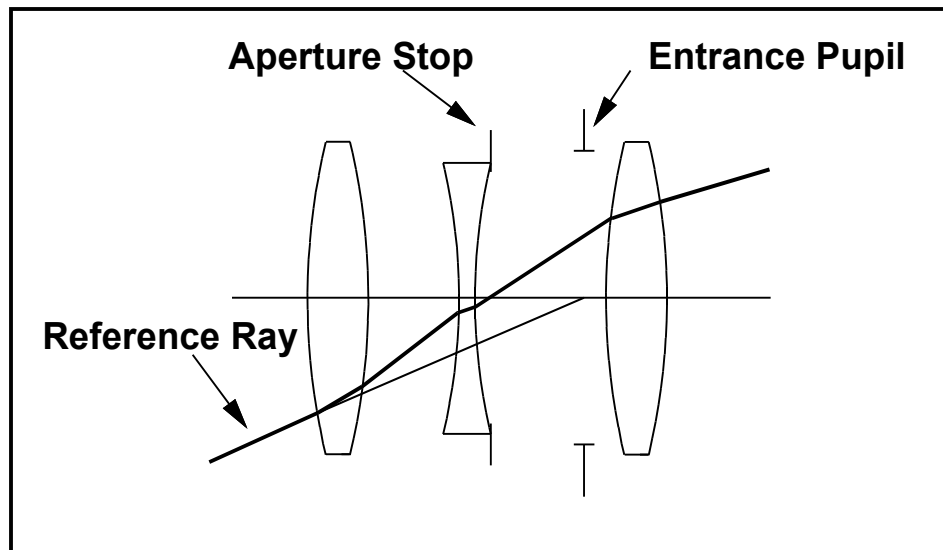
# Paraxial Analysis

- Paraxial Constants
  - Pxc, Pxs commands
- Paraxial Ray Trace
  - Pxt (in either XZ or YZ plane)
- Zoom Setup
  - Data for all zoom positions

# Aberrations

- Aberration Coefficients
  - 3<sup>rd</sup>, 5<sup>th</sup>, 7<sup>th</sup> SA
  - Seidel Pupil aberrations
  - Buchdahl Fifth-Order
    - M1 – M12
    - Intrinsic/Transferred contributions
  - 3<sup>rd</sup> order axial gradient contributions
  - Transverse, Angular, Unconverted, Wavefront (3<sup>rd</sup>)
- Zernike Coefficients
- Zoom Group Sensitivity
- Aldis Theorem Contributions

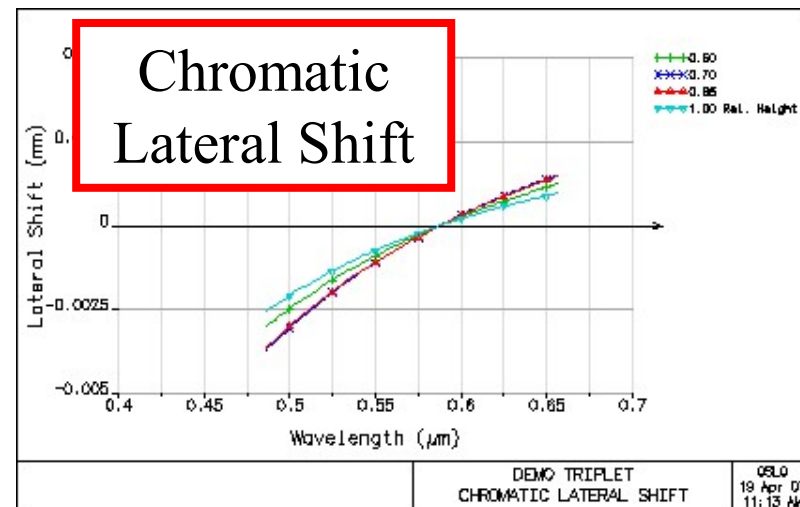
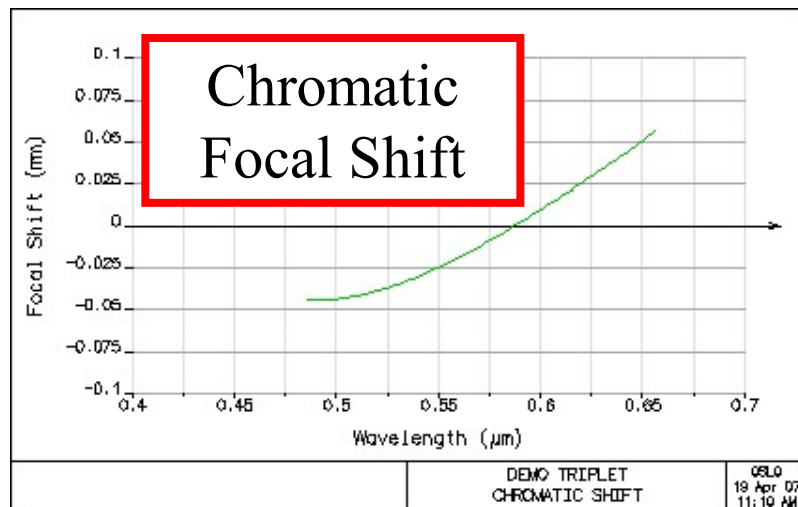
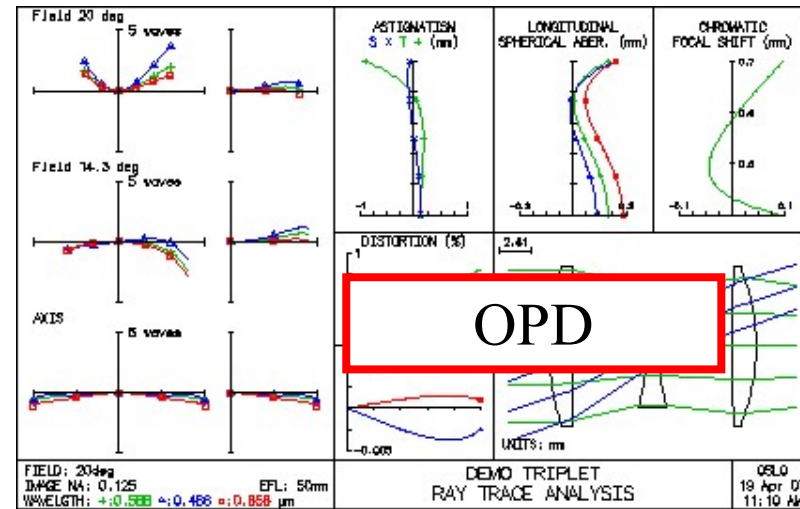
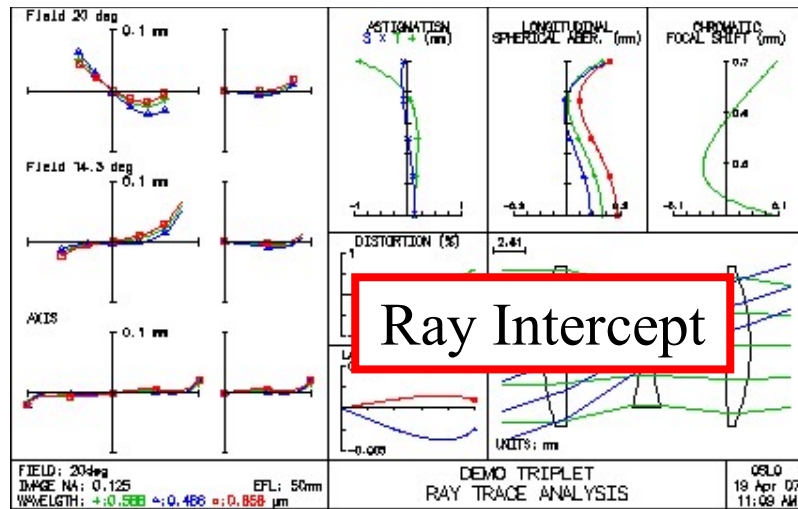
# Reference Ray Definition



# Image Evaluation

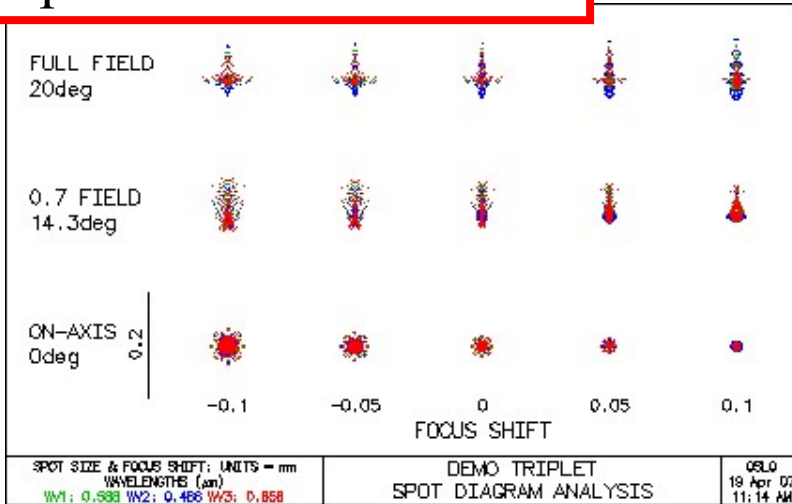
- Ray Analysis
- Spot Diagrams
- Wavefront Analysis
- Point Spread Function
- Modulation Transfer Function
- Through-Focus MTF
- Slider Wheel Interaction with any Analysis

# Ray Analysis Examples

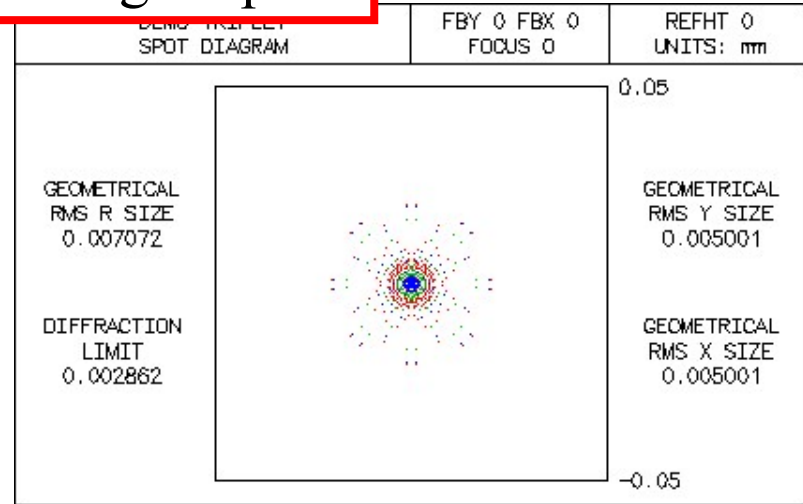


# Spot Diagram Example

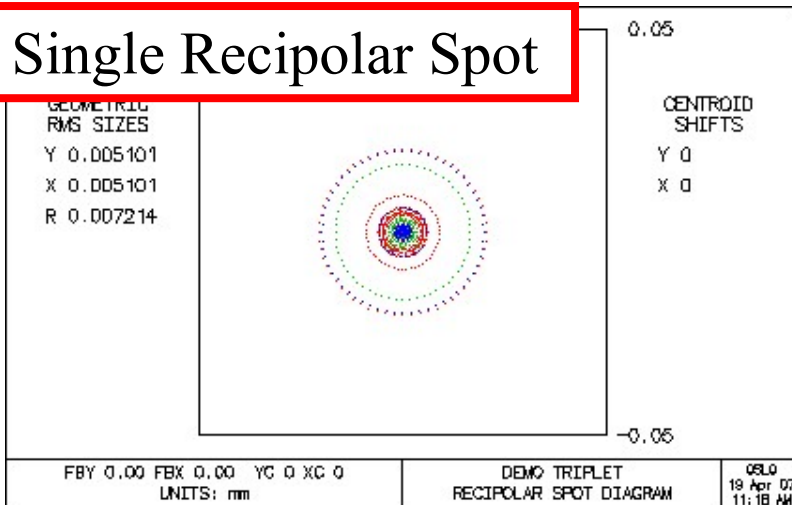
## Spot vs. Field & Focus



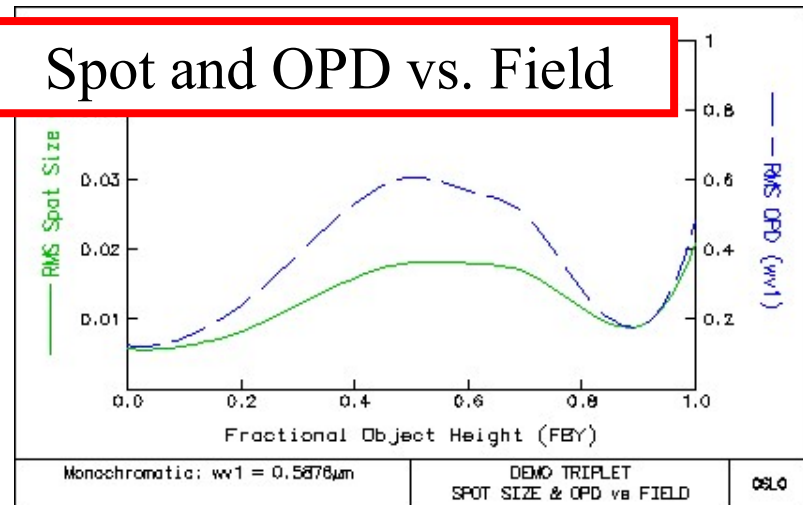
## Single Spot



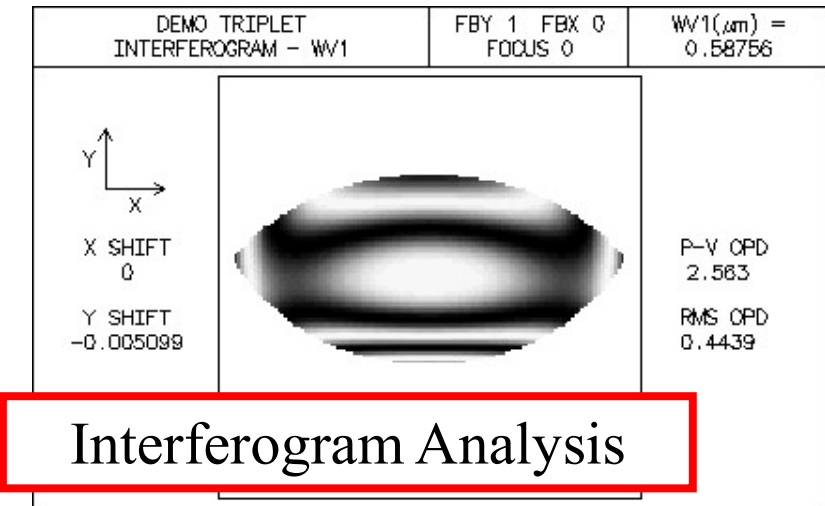
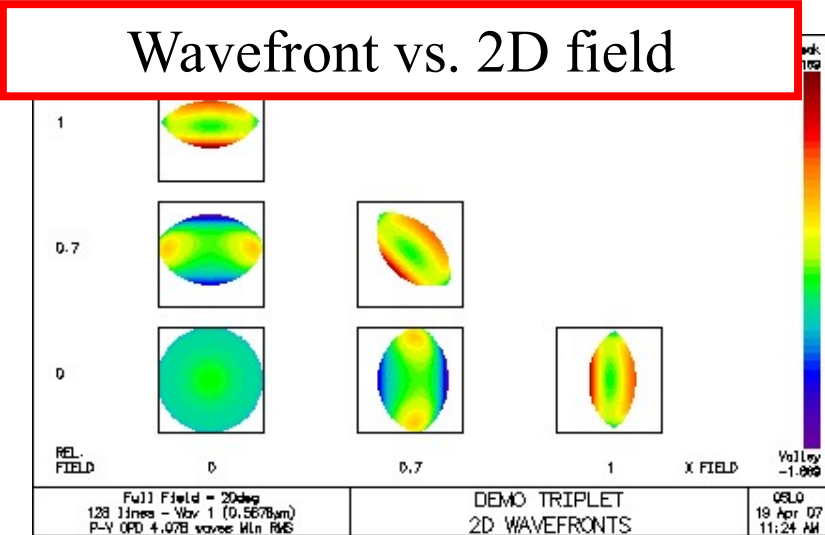
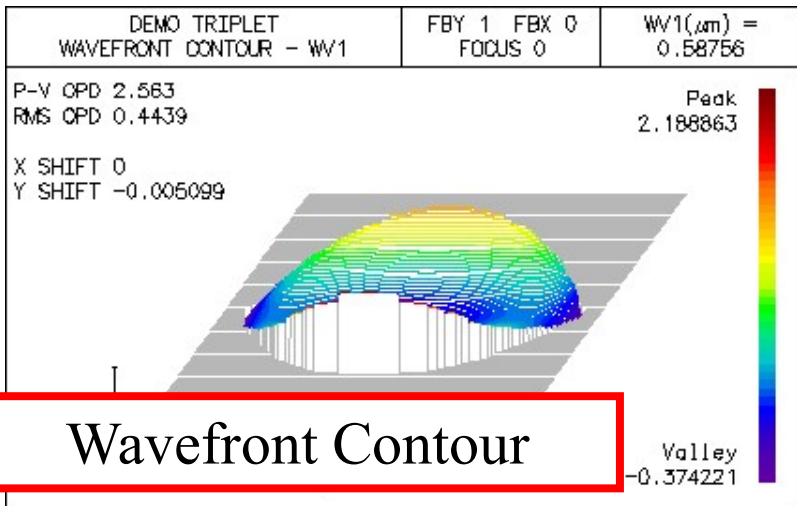
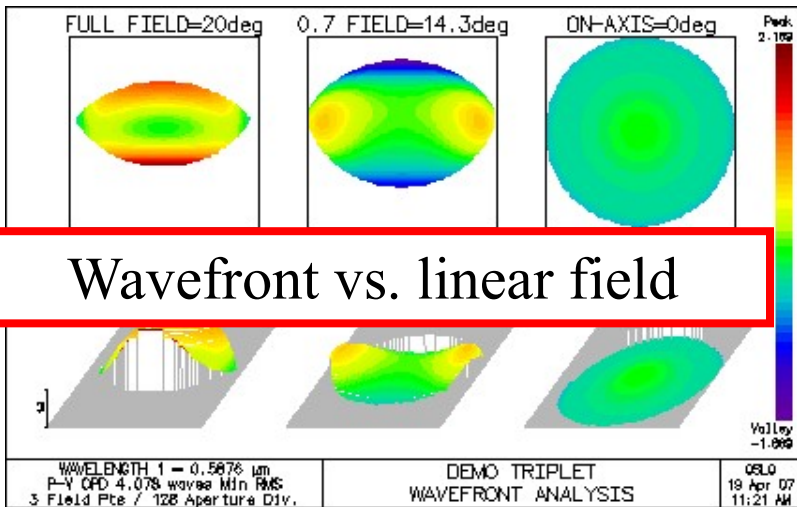
## Single Recipolar Spot



## Spot and OPD vs. Field

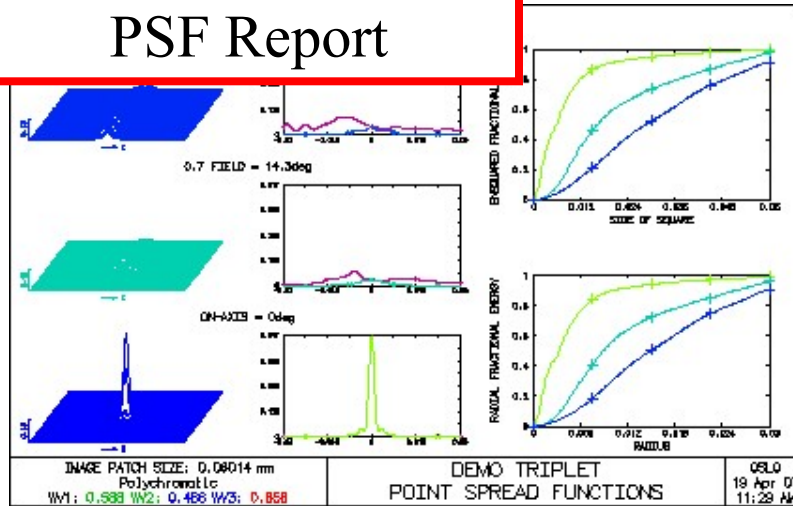


# Wavefront Analysis Examples

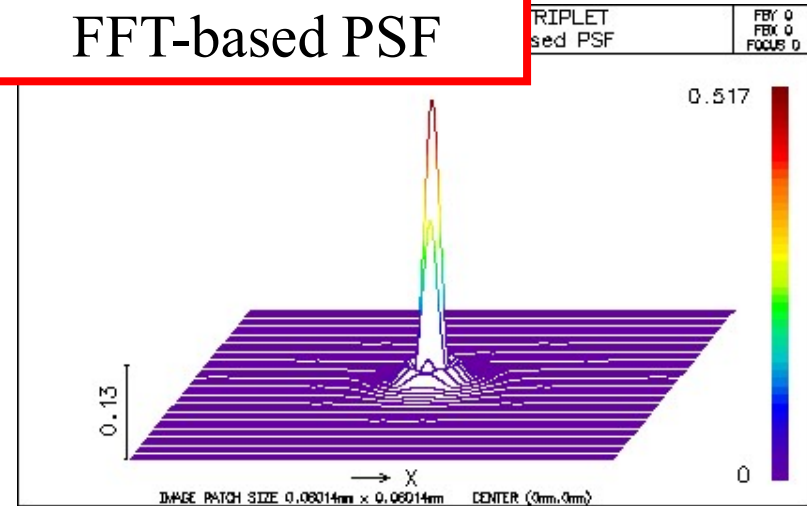


# Point Spread Function Examples

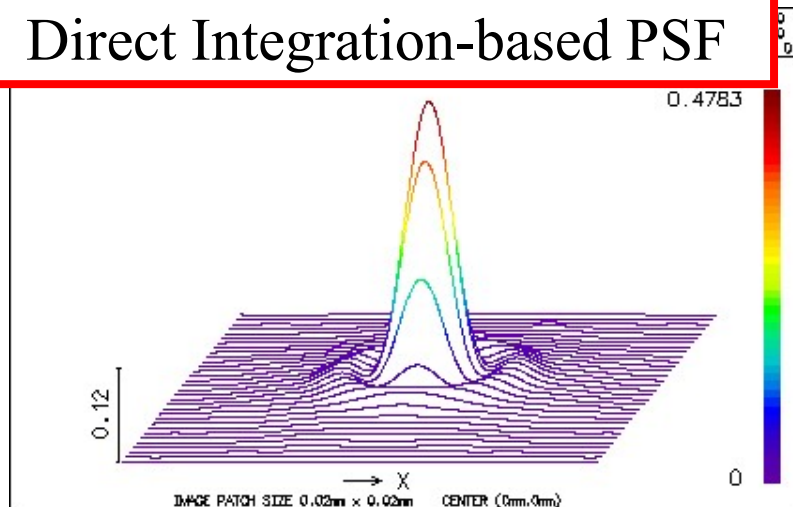
## PSF Report



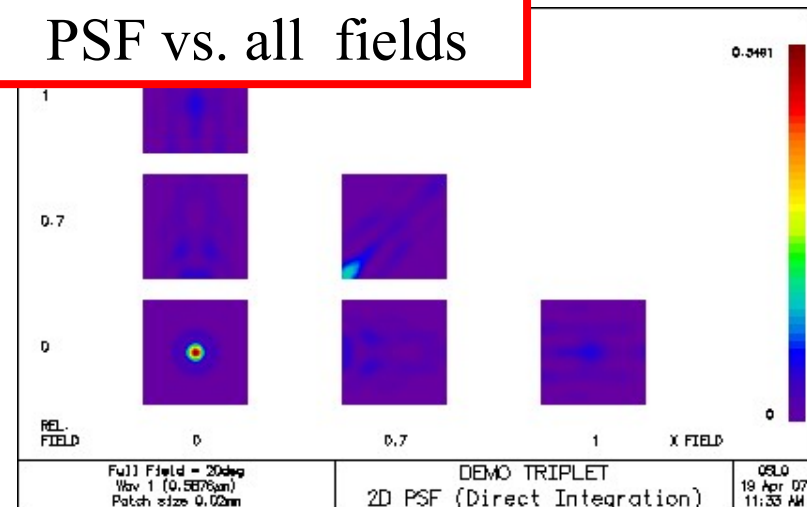
## FFT-based PSF



## Direct Integration-based PSF

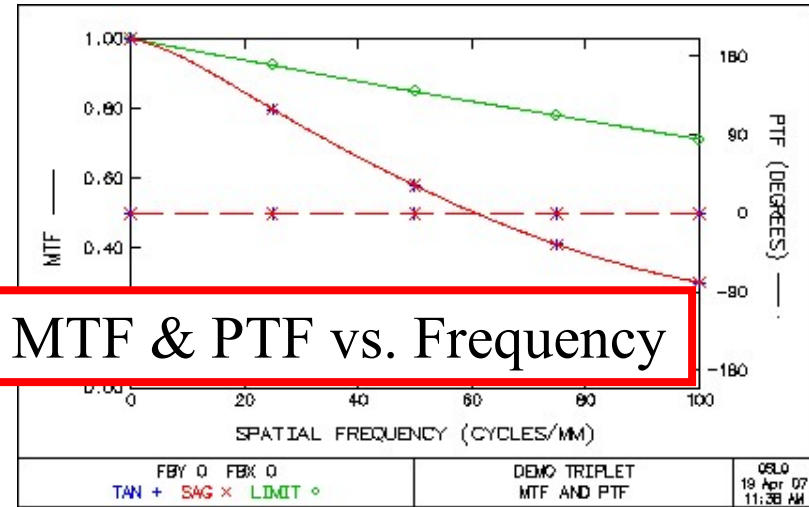
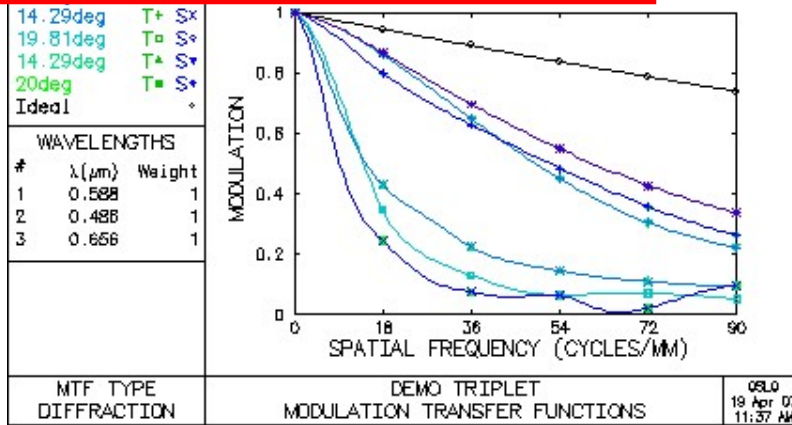


## PSF vs. all fields

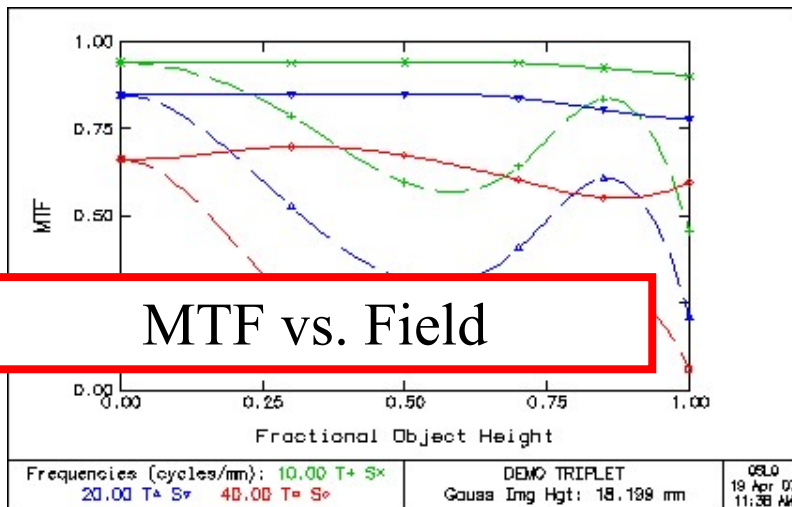


# Modulation Transfer Function Examples

## Through Frequency MTF

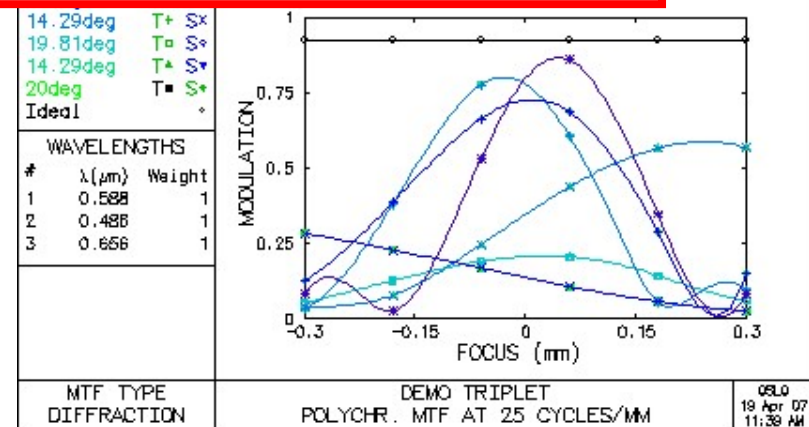


## MTF & PTF vs. Frequency

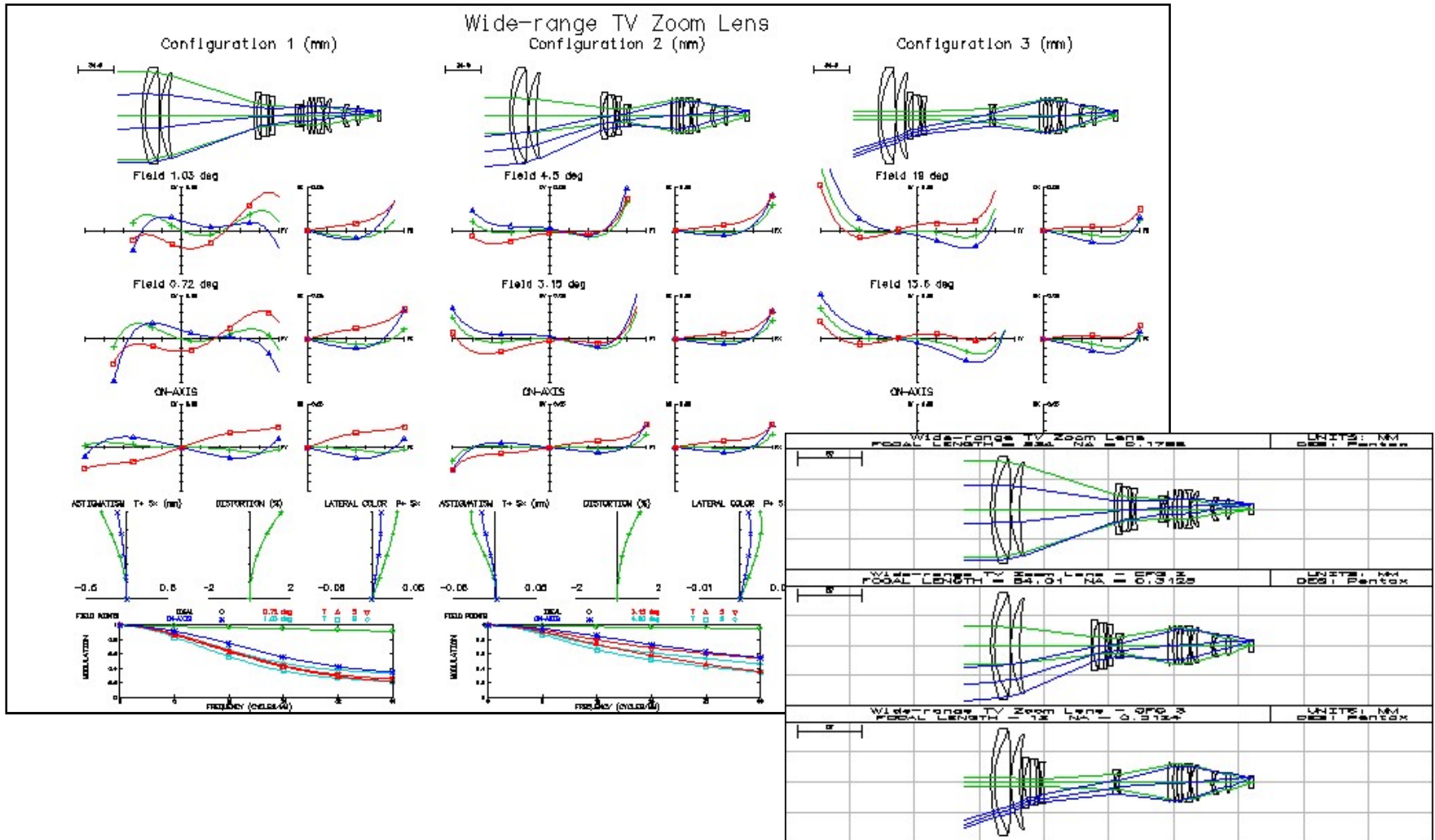


## MTF vs. Field

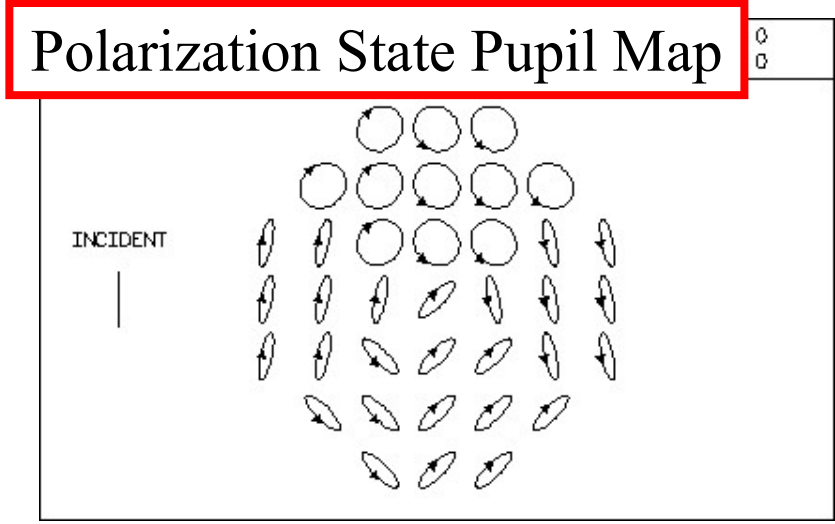
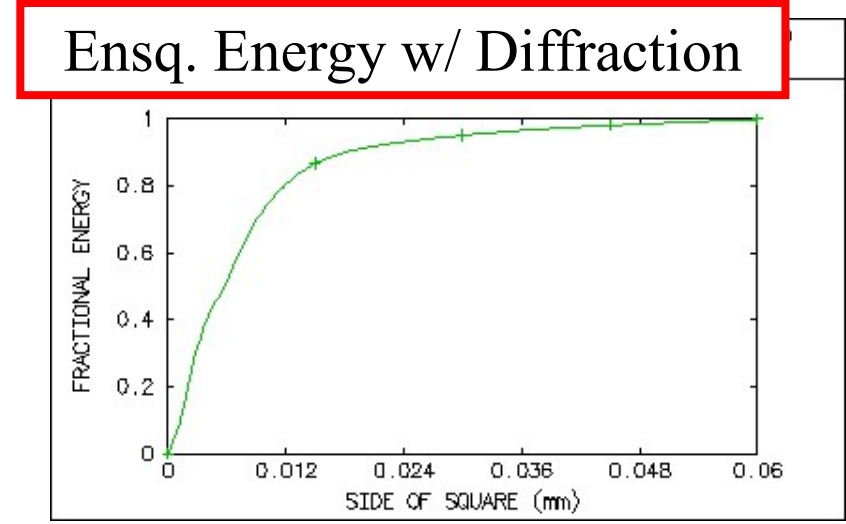
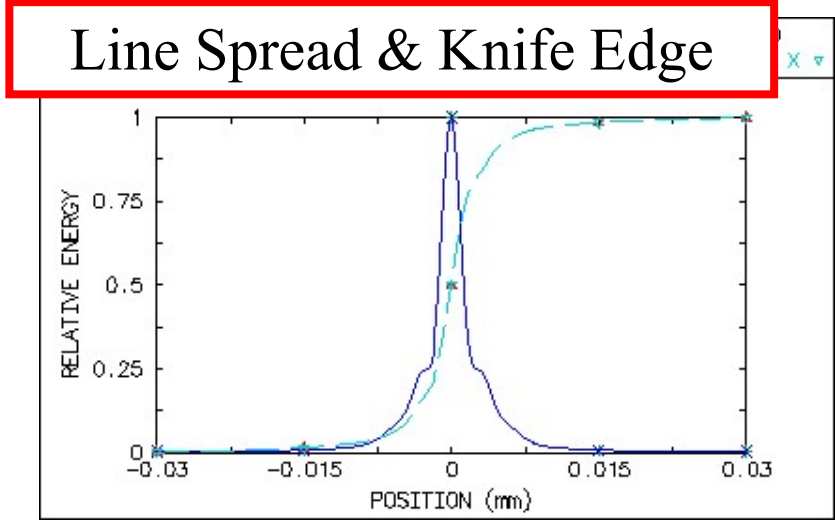
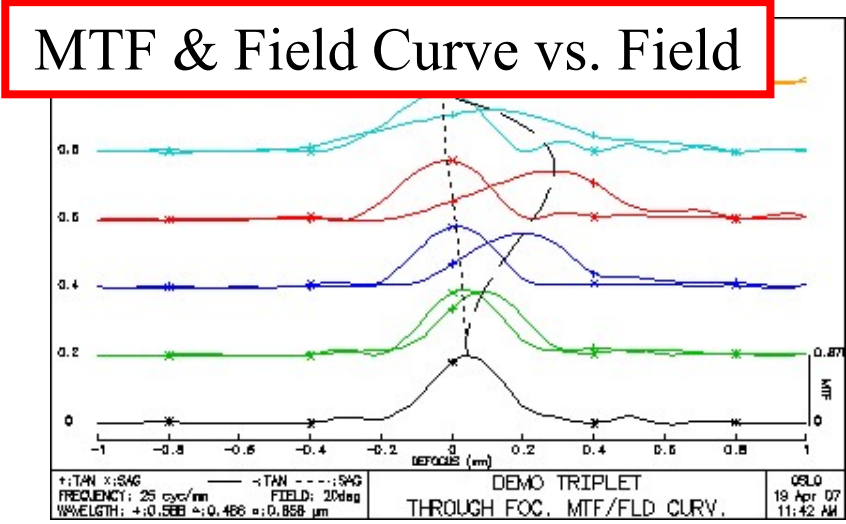
## Through Focus MTF



# Zoom Lens Analyses



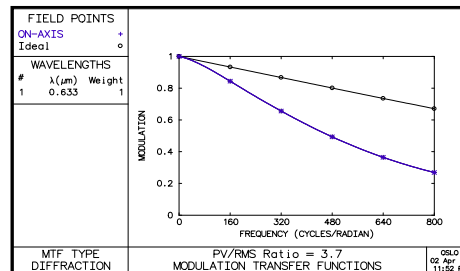
# Other Analyses



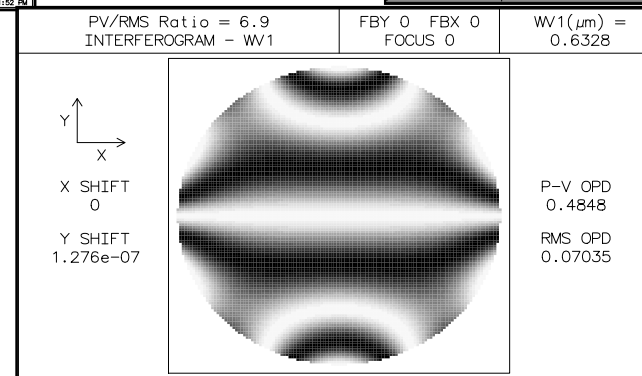
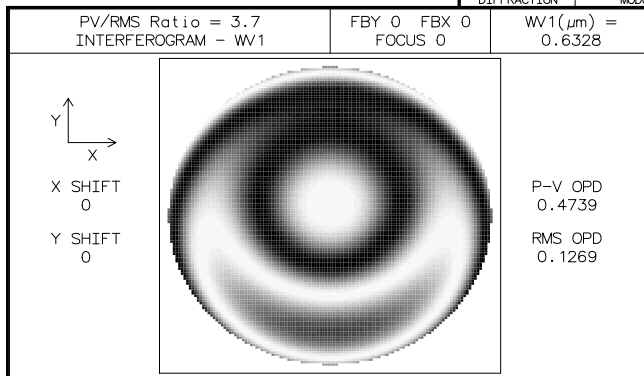
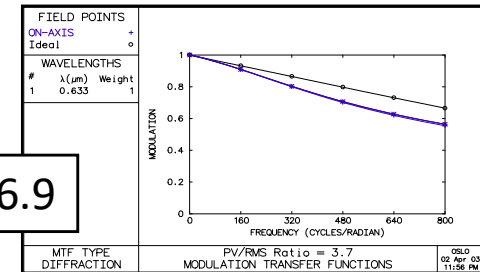
# System Evaluation

- Analysis Method Consistent with
  - Design Criteria
  - Measurement
- Be Wary of Measurement and Spec “Equivalents”
  - Tolerance budget calculated in RMS wavefront
  - Final system measured in RMS wavefront
  - System MTF

PV/RMS Ratio 3.7



PV/RMS Ratio 6.9



Similar RMS Wavefronts can have drastically different PV and MTF

# Slider Wheel Interaction with any Analysis

The image displays two windows from an optical design software interface, illustrating the interaction between analysis results and user-adjustable parameters.

**Top Window (GW 32 and GW 31):** Shows a ray diagram of a lens system (GW 32) and a corresponding ray analysis plot (GW 31). The ray diagram shows light rays passing through a lens system. The ray analysis plot shows the ray paths and their intersections.

**Slider Window (Top):** A control panel for adjusting parameters. It includes the following data:

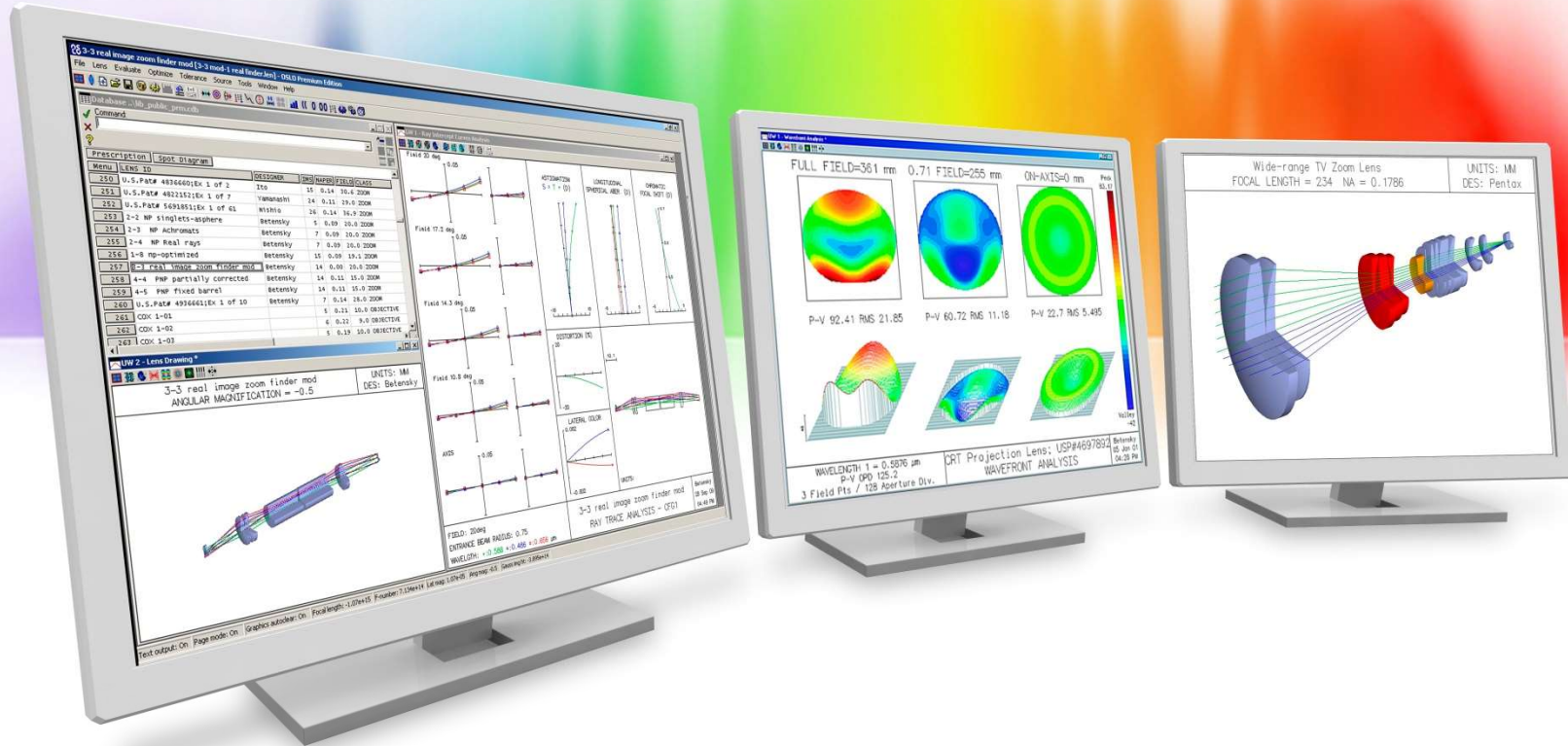
Parameter	Value	Step
CV 1	0.047059	Step 0.001
TH 1	2.000000	Step 0.1
CV 2	-0.006303	Step 0.001
TH 2	6.000000	Step 0.1
CV 3	-0.049383	Step 0.001

**Bottom Window (UW 32 - Ray Analysis):** Shows a detailed ray analysis plot for a 100mm F/2.8 Gradient Doublet. The plot displays ray-intercept curves for different rays (F1, F2, F3, F4) and their intersections (FX, FY). The plot includes the following data:

Parameter	Value
Offset in Blank	4.000000
Element Thickness	3.000000

The plot also shows a graph of Refractive Index vs. Z (mm) for the lens elements, with values ranging from 1.67 to 1.74 over a distance of 0.0000 to 12.1000 mm.

# OSLO



## Analysis, Operands and Optimization

# Popular Analysis Options

	Includes Diffraction?
● Wavefront diagrams	No
● Spot diagrams	No
● Ray diagrams	No
– Transverse Ray	
– Longitudinal ray	
● Point Spread Function (PSF)	Yes
– Line Spread Function (LSF)	
● Modulation Transfer Function (MTF)	Yes
– Square wave response	
● Encircled Energy	Maybe
– Ensquared Energy	

# Optimization Components

## Required:

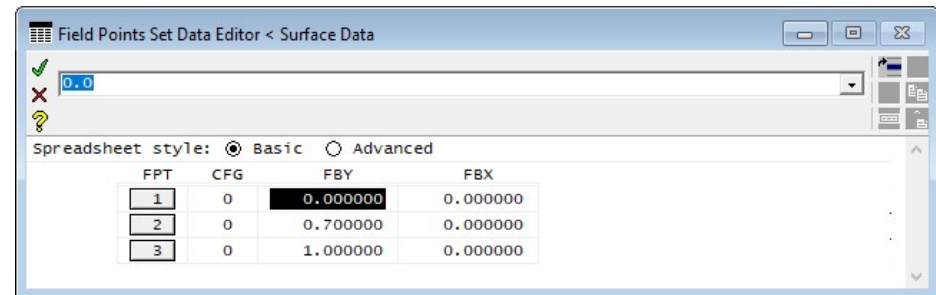
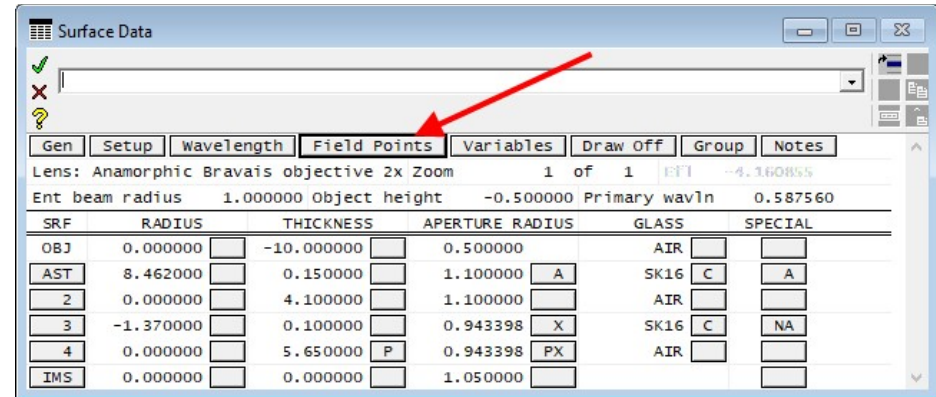
- Error Function (operand set)
  - Create OCM operand set (Light and user defined)
  - Create “built in” or “direct entry” operand set
- Variables
- Optimize
  - OSLO allows you to choose optimization engine: Local or Global

## Optional:

- Vignetting Factors
- Data Tables
  - Field point set
  - Ray table (pupil point set)
  - Spot diagram set

# Field Points

- Define Object and Aperture for Optimization
- Object Points Vary With Zoom Position
  - Cfg 0 means global specification
  - Cfg  $n$  active in zoom position  $n$  only
- Aperture Varies With Vignetting
  - Vignetting varies with apertures
  - Use apset and vig cmds
- Drawing Field Points are not Evaluation Field Points



# Ray Set (Pupil Set)

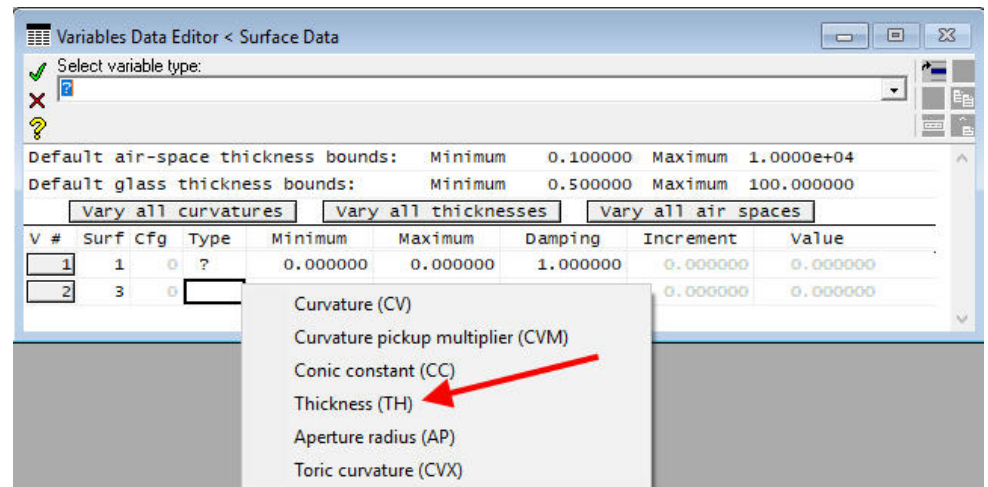
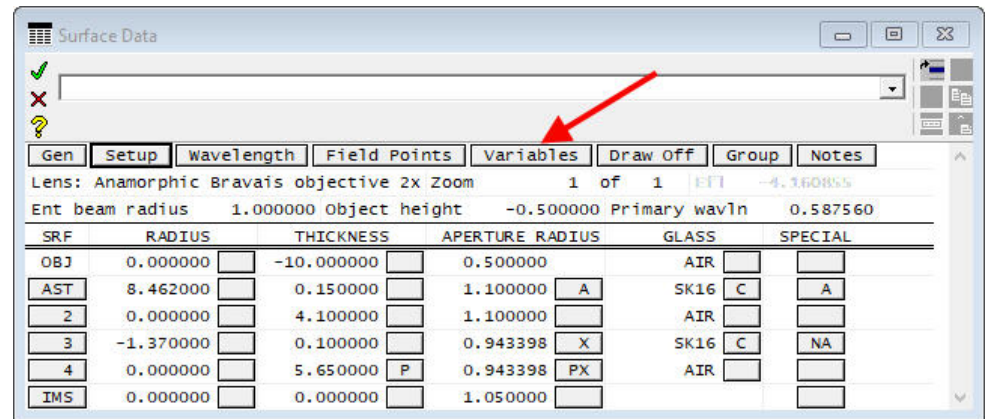
- Specifies Rays Used in Optimization
- Ray Set Can Be Assigned to Any Field Point
- Can Specify Either Ordinary or Reference Ray
- FY, FX Are Vignetted Fractional Coordinates
- Weight Not Used

# Spot Diagram Set

- Needed for MTF or WVF operands
- Specifies
  - Field point
  - Aperture divisions
  - First wavelength & number of wavelengths

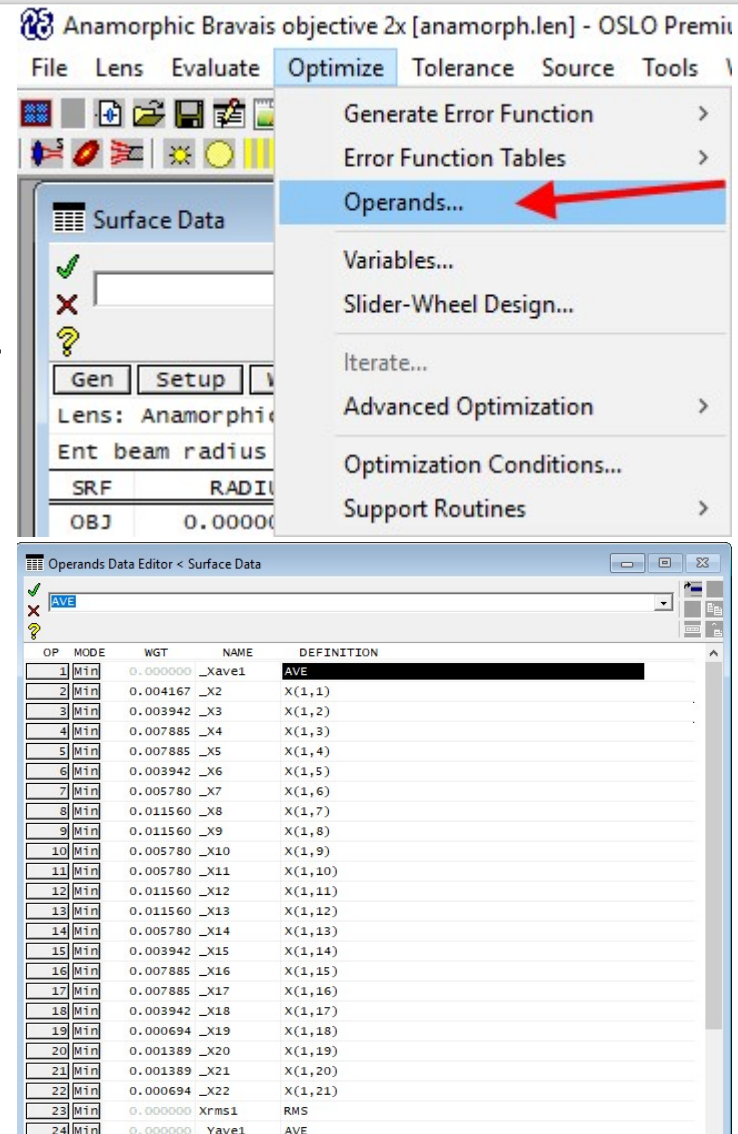
# Variables

- Set up in Lens SS or Variables SS
  - Lens SS restricted to common items
  - Variables SS pops up list of allowed variables
- Thickness defaults in SS
- Other defaults in optimization conditions
- Don't touch variable damping
- Can set values of variables in SS
  - Can also use vb command from the command line



# Operands Spreadsheet

- Enters or Edits Error Function Manually
- Minimize or Constraint Mode
- Weight
  - 0.0 means calculate but don't add to ERF
- Name
  - Used for identification only, leading \_ means don't display
- Definition
  - Component <op> Component
  - <op> is +, -, \*, /, >, <
- Target always 0.0



# Generate Error Functions (Item under Optimize menu)

## MENU OPTION

- Singlet
- Cemented Doublet
- OSLO (RMS Spot Size/Wavefront)
- GENII (Gray's Method)
- Aberration Operands
- Ray Operands
- Generate Field Points

## OPERAND CREATED

- OCM+Special Action
- OCM+Special Action
- Direct Entry Operands
- OCM Method/Direct Entry
- OCM Method
- OCM Method
- Does not create operands

# OSLO Error Function

- Evaluates RMS Spot Size or Wavefront
- Based on Forbes' Quadrature Methods
- User chooses number of rings and spokes
- Additional options:
  - D minus D chromatic operands
  - Square Grid (like Code V)
  - Edge Thickness operands
  - Distortion operands
  - Add to current error function
  - Custom weighting for field and wavelength
  - Symmetry override
- Available in Standard and Premium Only

# Aberration (OCM) Operands

- Sets up 21 First, Third, Fifth-Order Operands
- Delete Unwanted Operands for final Erf
- Results in OCM's
- Good for simple systems (no tilts, etc)
- Opcb\_abs callback (in optim\_callbacks.ccl)

# Ray OCM Operands

- Error Function for On-axis and 1 Off-axis Field
- Oprays\_template Generates 21 Ray Operands
- Arguments Are Off-axis Field Point and Vignetting
- Delete the Operands You Don't Want
- Opcb\_rays Callback (in Optim\_callbacks.Ccl)
- Learn more about ray operands by typing Ray Operands in Help

[OSLO Help Overview](#) - [Optimization](#) - [Generating an Error Function](#)

## Ray Operands

*"oprays\_template" command*

*Default menu item: Optimize>>Generate Error Function>>Ray Operand Template*

The [oprays\\_template](#) CCL command may be used to generate an error function based on data computed for rays computed from 2 field points. The way it works is to generate a template error function containing all the operands that are evaluated by the `opcb_rays` callback. You build your own error function by deleting the operands that you don't want, either manually using the operands spreadsheet, or programatically such as is done in the [cemdoublet\\_erf](#) error function generator. The available operands are as follows.

Operand	Name	OCM#
On-axis fractional beam radius	AXIS_FYMAX	OCM1
Fractional height of off-axis object	OFAX_FOB	OCM2
Lower FY for off-axis object point	OFAX_FYMIN	OCM3
Upper FY for off-axis object point	OFAX_FYMAX	OCM4
FX for off-axis object point skew ray	OFAX_FX	OCM5
Paraxial axial ray height	PY	OCM6
Paraxial axial ray slope	PU	OCM7
Paraxial chief ray height	PYC	OCM8
Paraxial chief ray slope	PUC	OCM9
Effective focal length	EFL	OCM10
axis focus shift	AXIS_FOCUS	OCM11
axis FY zone dy	AXIS_ZDY	OCM12
axis FY zone opd	XIS_ZOPD	OCM13
axis FY zone dmd	AXIS_ZDMD	OCM14
axis FY zone osc	AXIS_ZOSC	OCM15

# Operands Spreadsheet

- The operands set is a user-constructed measure of the performance of a lens. The operands set consists of a number of operand definitions that measure various physical and optical properties of a lens system; these quantities are combined into a single figure of merit called the error function (or merit function).
- The *Number* of the operand is displayed in the first column of the spreadsheet, on a row button. The operand number is used to refer to this entry in some commands.

# Operands Spreadsheet Continued:

Each operands set entry consists of four fields:

- **Definition (see list of available [components](#))**

Operand definitions are of the form  $A$ ,  $A+B$ ,  $A-B$ ,  $A*B$ ,  $A/B$ ,  $A**B$ ,  $A>B$ , or  $A<B$ , where  $A$  and  $B$  represent [components](#). The operators "+", "-", "\*", "/", and "\*\*" represent addition, subtraction, multiplication, division, and exponentiation, respectively. The operators "<" and ">" are used to form "one-sided" operands that have zero value when the expressed relation is true, and have a value equal to the difference between the components when the relation is false. For example, the operand with definition " $-0.005<SA3$ " will have zero value if  $SA3$  is greater (algebraically) than  $-0.005$ , but it will be active with a value of  $-0.005-SA3$  if  $SA3$  is less than  $-0.005$ . Conversely, the operand definition " $0.005>SA3$ " will be inactive if  $SA3$  is less than  $0.005$ , but it will be active with a value of  $0.005-SA3$  if  $SA3$  is greater than  $0.005$ .

The first component of an operand may be preceded by a minus sign, but the second component may not be preceded by a minus sign. For example, the operand definition " $-0.005<SA3$ " is legal, but the (algebraically equivalent) definition " $SA3>-0.005$ " is not legal.

# Operands Spreadsheet Continued:

- **Mode** (OSLO Standard and OSLO Premium only)

The **Minimize** or **Constraint** mode is selected by activating the mode cell by clicking on it; this toggles the mode back and forth between its two possible values. The optimization algorithm attempts to find exact solutions for the constraint operands, through the technique of Lagrange multipliers. The program attempts to find values of the variables such that all of the constraint operands have zero value. Note that there must be at least as many variables as constraint operands for constraint optimization to be possible. Constraint operands are often used to maintain certain conditions of the lens (e.g., f-number) exactly. The minimize-mode operands are used to form the error function proper. The optimization algorithm attempts to minimize the weighted root-mean-square value of the minimize-mode operands, while satisfying any constraint operands.

- **Weight** (Minimize mode only)

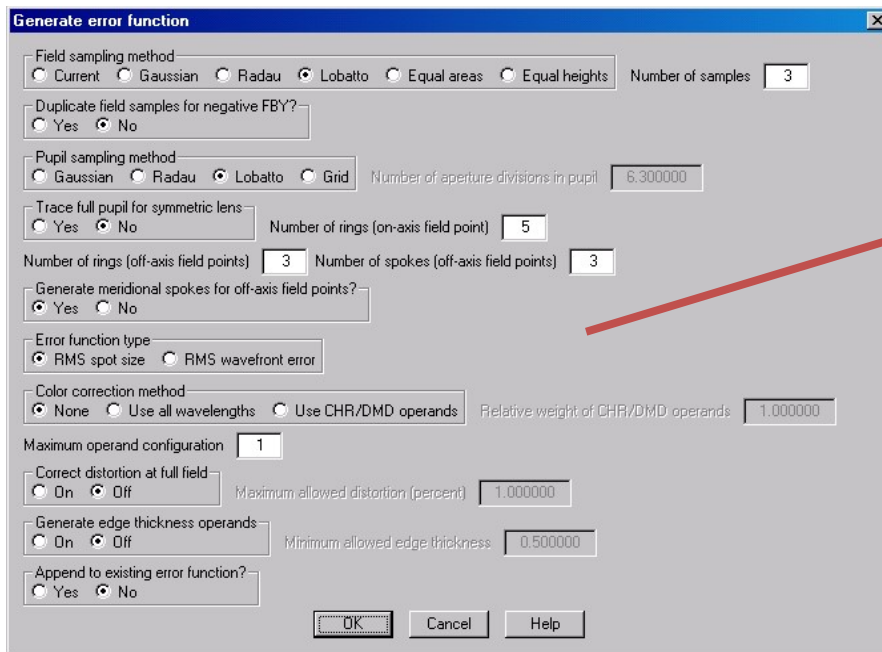
Determines the relative importance of an operand in the error function. The default weight is 1.

- **Name**

An operand name, which may be up to ten characters long, is optional. If the name begins with an underscore, "\_", the operand is a "hidden" operand; that is, it is not listed by the [operands print](#) command unless the "all" option is specified. Note that AVE operands and operands between AVE operands and RMS operands are also "hidden."

# Generate Error Function → OSLO Spot Size/Wavefront

- Ray based error function with direct editing
- Add to operand set as needed to control system during optimization.

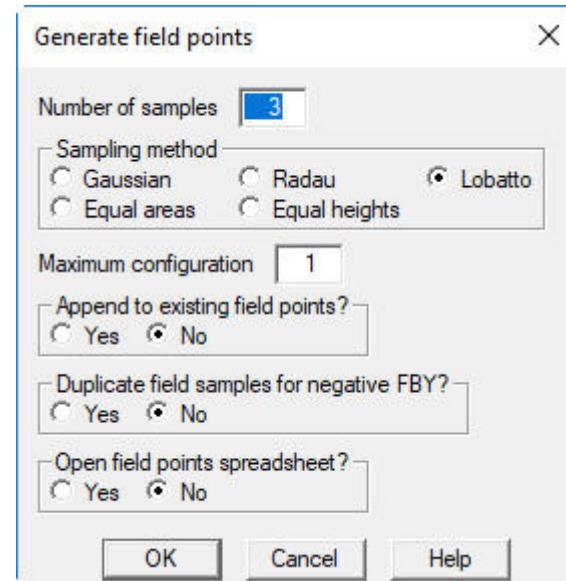


**Operands Data Editor < Surface Data**

OP	MODE	WGT	NAME	DEFINITION
1	Min	0.000000	_Yave1	AVE_
2	Min	0.008333	_Y2	Y(1,1)*0.707107
3	Min	0.047309	_Y3	Y(1,2)*0.707107
4	Min	0.069357	_Y4	Y(1,3)*0.707107
5	Min	0.069357	_Y5	Y(1,4)*0.707107
6	Min	0.047309	_Y6	Y(1,5)*0.707107
7	Min	0.008333	_Y7	Y(1,6)*0.707107
8	Min	0.000000	Yrms1	RMS
9	Min	0.000000	_Xave2	AVE
10	Min	0.041667	_X10	X(2,7)
11	Min	0.034722	_X11	X(2,8)
12	Min	0.069444	_X12	X(2,9)
13	Min	0.069444	_X13	X(2,10)
14	Min	0.034722	_X14	X(2,11)
15	Min	0.034722	_X15	X(2,12)
16	Min	0.069444	_X16	X(2,13)
17	Min	0.069444	_X17	X(2,14)
18	Min	0.034722	_X18	X(2,15)
19	Min	0.006944	_X19	X(2,16)
20	Min	0.013889	_X20	X(2,17)
21	Min	0.013889	_X21	X(2,18)
22	Min	0.006944	_X22	X(2,19)
23	Min	0.000000	Xrms2	RMS
24	Min	0.000000	_Yave2	AVE
25	Min	0.041667	_DY25	Y(2,7)-024
26	Min	0.034722	_DY26	Y(2,8)-024
27	Min	0.069444	_DY27	Y(2,9)-024
28	Min	0.069444	_DY28	Y(2,10)-024
29	Min	0.034722	_DY29	Y(2,11)-024

# Generate Field Points

- Sets up Field Point Set Automatically
- Use Quadrature or Grid Methods
- Accommodates Zoom Systems
- Append or Overwrite Current Set
- Menu Option Does Not Create Operand Set



Field Points Set Data Editor < Surface Data

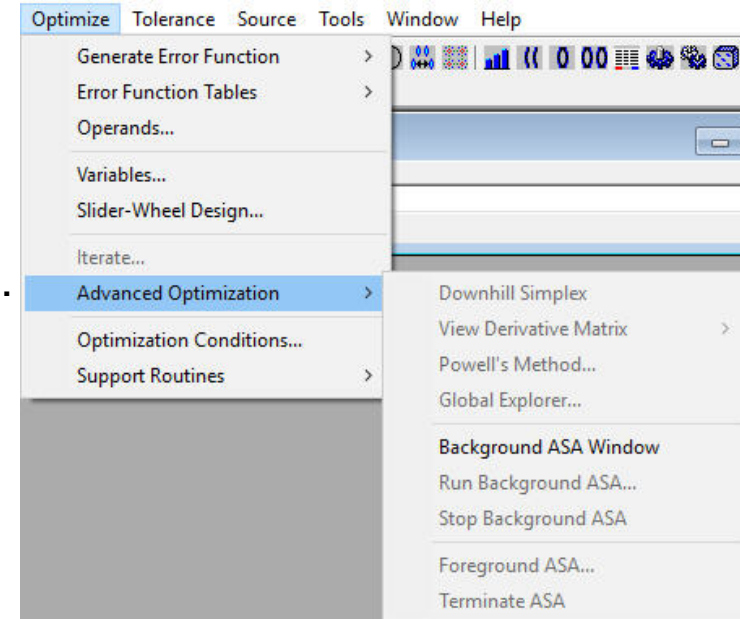
0.0

Spreadsheet style:  Basic  Advanced

FPT	CFG	FBY	FBX
1	0	0.000000	0.000000
2	0	0.700000	0.000000
3	0	1.000000	0.000000

# Optimization Conditions

- Specify parameters to optimization methods
  - Specify CCL Routines if Required
  - Damped Least Squares
    - Damping factor, Solution Tolerance, etc.
  - OSLO Error Function
    - Weighting terms
  - ASA parameters
    - Cooling rate, termination condition, etc.
  - Miscellaneous
    - Infinite reference sphere, ERF printing convention, etc.



# Optimization Methods

- Damped Least Squares
- Downhill Simplex
- Powell's Method
- Adaptive Simulated Annealing (ASA)
- Global Explorer

# Damped Least Squares

- The Gold Standard for Local Optimization
- Minimizes a Function Subject to Constraints
- Uses Derivatives of ERF Wrt Variables
- Optional Lagrange Multipliers for Constraints
- Damping Controls Stability
- Subject to Stagnation

# Simplex (Nelder-Mead)

- Simple Non-Derivative Method
- Slow, Stable, OK for Simple Problems
- Included mostly for Curiosity
- See Numerical Recipes (Press, et.al.)

# Powell's Method

- Non-derivative Local Method
- Finds Conjugate Directions
- Slow, Stable
- Has Worked (Sometimes) Where DLS Fails
- See Numerical Recipes for Discussion

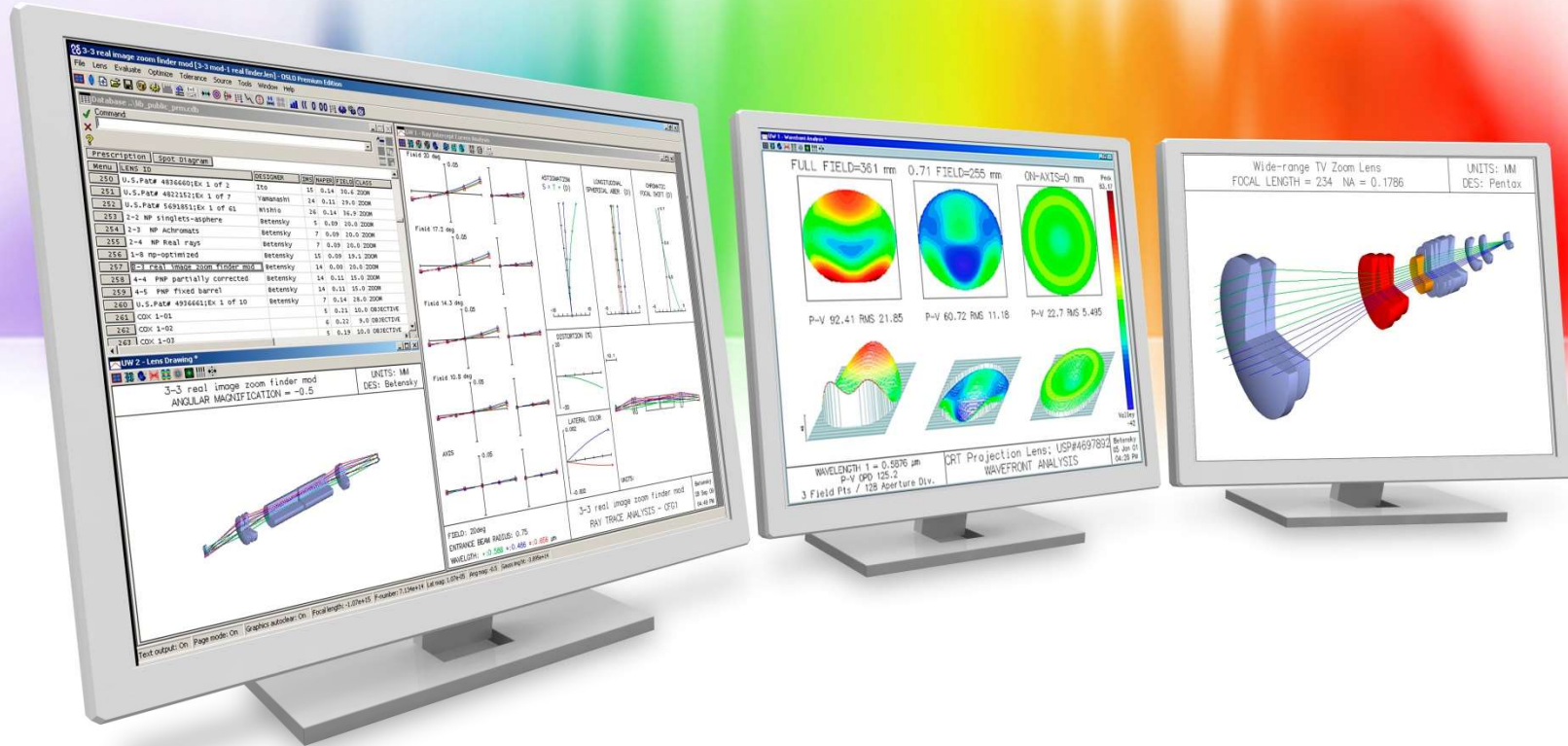
# Global Explorer

- Multiple Solution Generator
- Damped Least Squares With Escape Function
- Much Faster Than ASA
- Global Exploration, Not Global Optimization
- Developed by Ishikki, Et.Al.

# Adaptive Simulated Annealing

- True Global Optimization
- Who Wants It?
- Also Used Multiple Solution Generator (Msg)
  - Combined With DLS Local Optimization
- Features Uniform Search
- Most Efficient Global Method Available
- Developed by Forbes and Jones

# OSLO



## Introducing the New Features in OSLO 7

# Improvements and New Features in OSLO 7

## Improvements in OSLO 7

- Improved STEP File Exporter
- Improved Zemax<sup>®</sup>/OpticStudio<sup>®</sup> importer
- Improved Code V<sup>®</sup> importer
- Feature Improvements
  - Asymmetric Aspheres include base conic (OSLO Premium only)
  - Help > Check for Updates
  - Help > License
  - Updated glass catalogs

## New Features in OSLO 7

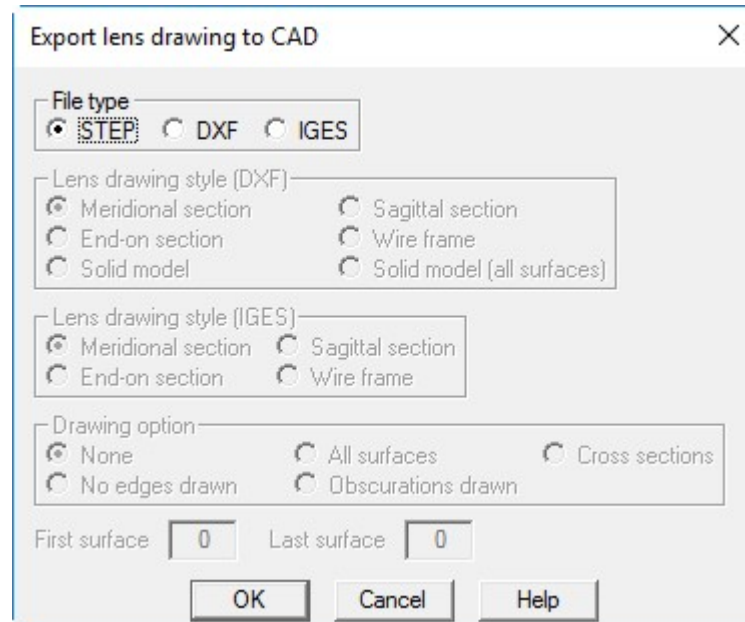
- New licensing using CodeMeter

## New Videos for OSLO 7

## New Examples Page on Website and Updated Manuals

# Improved STEP Export

- File→Export Lens to CAD
  - Now Exports Conics, Aspheres, and almost all lens types both for centered and decentered systems



# STEP Export from the Shafer 5 Mirror system and then imported into TracePro as a STEP file

Shafer Five-Mirror Objective [shafer5mirr.len] - OSLO Premium Early Access Build: 7.0.0.17016  
File Lens Evaluate Optimize Tolerance Source Tools Window Help

Surface Data

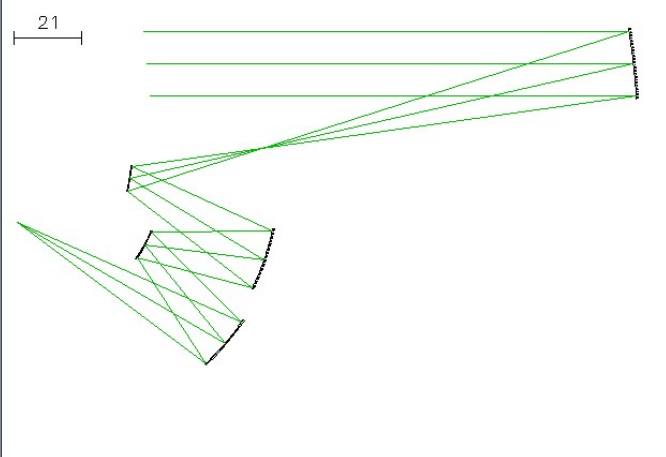
Command:

Coordinates: Tilt and bend

Gen	Setup	wavelength	Field Points	Variables	Draw Off	Group	Notes
Lens: Shafer Five-Mirror Objective Zoom 1 of 1 ET 1 90.33492%							
Ent beam radius 10.000000 Field angle 1.000000 Primary wavln 10.000000							
SRF	RADIUS	THICKNESS	APERTURE RADIUS	GLASS	SPECIAL		
OBJ	0.000000	1.0000e+20	1.7455e+18	AIR			
1	-239.500000	-160.200000	11.000000	REFL_HATCH		C	
2	-228.900000	48.690000	4.000000	REFL_HATCH		C	
3	-75.940000	-37.240000	10.000000	REFL_HATCH		C	
AST	-39.810000	39.240000	5.000000	A		C	
5	-78.720000	-74.500000	9.000000	REFL_HATCH		C	
IMS	0.000000	0.000000	1.576320	S		C	

UW 1 - Lens Drawing \*

Shafer Five-Mirror Objective      UNITS: CM  
OPTICAL SYSTEM LAYOUT      DES: D. Shafer

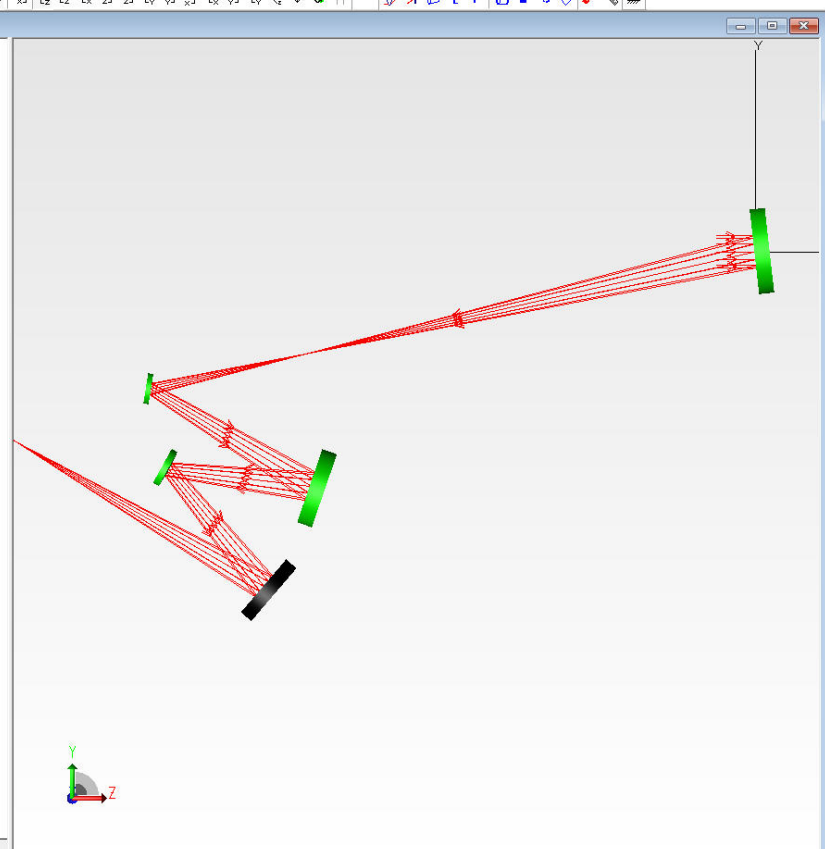


TracePro Expert

File Edit View Geometry Define Raytrace Optimize Analysis Reports Tools Utilities Macros Window Help

Model[shafer5mirr.oml]

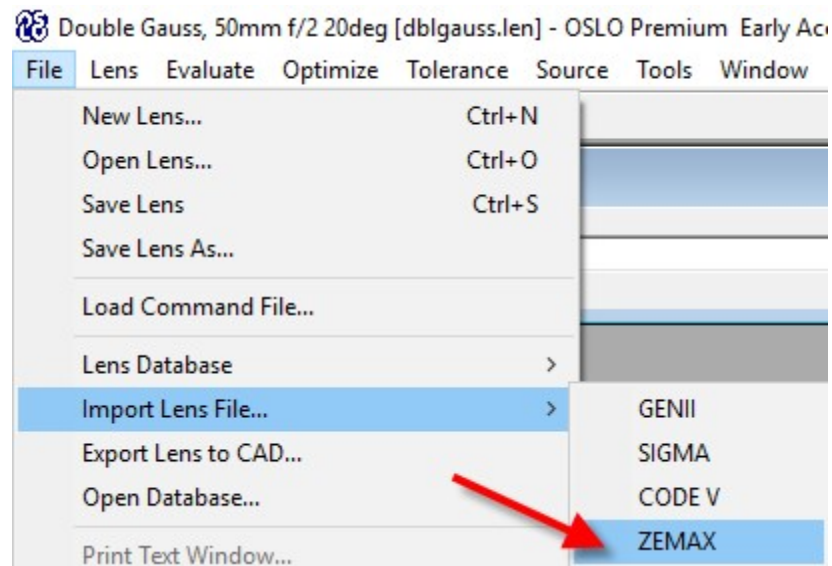
- OSLO Lens 1 REFL\_HATCH
- OSLO Lens 2 REFL\_HATCH
- OSLO Lens 3 REFL\_HATCH
- OSLO Lens 4 REFL\_HATCH
- OSLO Lens 5 REFL\_HATCH



Model Source Radiance

# Improved Zemax/OpticStudio Importer

- File→Import Lens File→Zemax
  - Will attempt to import every Zemax commands and will report any problems on import to the text window. Older importer would stop on the first non-recognized command.



# Steps to use Zemax/OpticStudio Importer

- Step 1 – Close the Surface Data Spreadsheet

- Step 2 – File→Import Lens File→Zemax

- Step 3 – Look in the

Text window for error

Messages

- Step 4 – Check the graphic

windows to make sure that

all rays passed through the

System

- Step 5 – Check that

Apertures are set correctly

The screenshot displays the Zemax/OpticStudio software interface. The main window is titled "Surface Data" and contains a table with columns for Gen, Setup, wavelength, Field Points, Variables, Draw On, Group, and Notes. Below the table is a detailed lens specification including Ent beam radius, Field angle, Primary wavln, and various surface parameters (SRF, RADIUS, THICKNESS, APERTURE\_RADIUS, GLASS, SPECIAL).

Overlaid on the main window are two smaller windows:

- Text Window (TW 1):** Displays the "LENS INPUT" data. It contains parameters such as LID, UNI, EBR, WVF\_REF\_SPM\_POS, Exit pup1, WVLNS, and several surface definitions (SRF 0, 1, 2, 3, 4, 5) with their respective radii, thicknesses, and aperture radii. Two red arrows point to error messages in this window: "MNR command (marginal ray normal solve) not supported by OSLO" and "MNR command (marginal ray normal solve) not supported by OSLO".
- Autodraw Window:** Shows a schematic diagram of the lens system. It includes the text "DEMO SHOWS APLANATIC SOLVE", "FOCAL LENGTH = 0.8196 NA = 0.868", and "UNITS: MM DES: OSLO". A scale bar indicates a length of 1.08 mm.

# Second Example using Zemax/OpticStudio Importer

- Step 1 – Close the Surface Data Spreadsheet
- Step 2 – File→Import Lens File→Zemax

[Untitled lens] - OSLO Premium Early Access Build: 7.0.0.17016  
 File Lens Evaluate Optimize Tolerance Source Tools Window Help

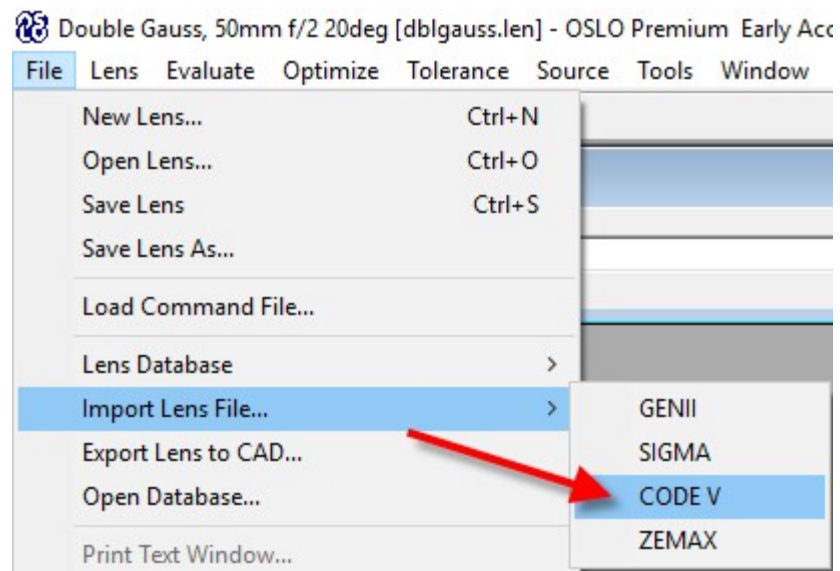
The screenshot displays the OSLO Premium interface with three main windows:

- Surface Data:** A spreadsheet showing lens parameters for a 'THREE GLASS APOCHROMAT'. The zoom is 1 of 1 with an effective focal length (Efl) of 100.000000 mm. The entrance beam radius is 5.000000 mm and the field angle is 5.7296e-05. The primary wavelength is 0.546000 mm.
- Autodraw:** A schematic diagram of the lens system. It shows a 2.02 mm object on the left. The lens is labeled 'THREE GLASS APOCHROMAT' with a focal length of 100 mm and a numerical aperture (NA) of 0.05. The units are in millimeters (MM) and the design is for OSLO.
- TW 1\* (Lens Input):** A list of lens surfaces and their properties:
 

SRF	TH	CV	TH	GLA	SRF	CV	TH	GLA
0:	--	--	1.0000e+20		1:	1		
AST					1:	0.011051	1.000000	
1:					2:	0.000670	1.000000	
CV					GLA			
TH					SRF			
GLA					3:	0.042660	2.000000	
SRF					CV			
2:					TH			
CV					GLA			
TH					SRF			
GLA					4:	-0.015855	98.827642	
SRF					CV			
3:					TH			
CV					SRF			
TH					5:	--	--	
GLA					CV			
SRF					TH			
4:					END			5
CV								
TH								
GLA								
SRF								
5:								
CV								
TH								
GLA								
SRF								
END								

# Improved CodeV Importer

- File→Import Lens File→CodeV
  - Will attempt to import every CodeV command and will report any problems on import to the text



# Steps to use CodeV Importer

- Step 1 – Close the Surface Data Spreadsheet

- Step 2 – File→Import Lens File→CodeV

- Step 3 – Look in the

Text window for error

Messages

- Step 4 – Check the graph

Windows to make sure that

all rays passed through the

System

- Step 5 – Check that

Apertures are set correctly

The screenshot displays the CodeV software interface with three main windows:

- Surface Data:** A spreadsheet showing lens parameters for a 'Double Gauss' lens. The table below summarizes the data:

SRF	RADIUS	THICKNESS	APERTURE RADIUS	GLASS	SPECIAL
OBJ	0.000000	9.9394e+11	2.4782e+11	AIR	
1	57.449765	8.746658	38.120801	BK7	S
2	188.460067	0.298182	34.709485	AIR	C
3	34.887272	12.424230	34.561622	SK1	C
4	0.000000	3.776966	26.078721	F15	C
5	21.469207	15.107864	21.469207	AIR	
AST	0.000000	12.921199	16.847167	AS	
7	-27.034908	3.776966	20.726960	F15	C
8	0.000000	10.833928	22.522299	SK16	C
9	-34.986743	0.298182	27.620069	AIR	
10	586.740491	6.858175	27.701678	SK16	C
11	-63.115214	63.137622	28.738683	AIR	
IMS	0.000000	0.000000	26.432710	S	

- UW 1 - Lens Drawing:** A graphical representation of the lens system. It shows a central lens element with a focal length of 104.1 mm and a numerical aperture (NA) of 0.2401. A scale bar indicates a length of 15.4 mm. Light rays are shown passing through the lens system.
- TW 1\* - LENS INPUT:** A text window displaying the lens input data, including surface numbers, radii, thicknesses, and glass types. It also shows update variables for various parameters like V1, V2, V3, V4, and V5.

# Second Example using CodeV Importer

- Step 1 – Close the Surface Data Spreadsheet
- Step 2 – File→Import Lens File→CodeV

[Untitled lens] - OSLO Premium Early Access Build: 7.0.0.17016  
 File Lens Evaluate Optimize Tolerance Source Tools Window Help

Surface Data

75.0

Gen Setup wavelength Field Points Variables Draw Off Group Notes

Lens: Cassegrain Ritchey-Chretien Zoom 1 of 1 Ef1 1.7521e+03  
 Ent beam radius 75.000000 Field angle 0.600000 Primary wavln 0.632800

SRF	RADIUS	THICKNESS	APERTURE RADIUS	GLASS	SPECIAL
OBJ	0.000000	1.0000e+10	1.0472e+08	AIR	
AST	-742.857200	-260.000000	75.000000	AS	REFLECT A
2	-290.232796	471.717084	22.500000		REFLECT A
3	-55.229670	7.500000	16.901850	S	SF11 C
4	-118.498104	5.000000	17.832237	S	AIR
IMS	0.000000	-0.016718	18.347856	S	

TW1\*

Len Spe Rin Ape Wav Pxc Abr Mrg Chf Tra Sop Ref Fan Spd Auf Var Que Ite

STORED GLASS UNKNOWN

STORED GLASS UNKNOWN  
 Reading C:\Users\Public\Documents\OSLO7 Premium Early Access\private\bin\g1c\private.g1c  
 Writing C:\Users\Public\Documents\OSLO7 Premium Early Access\private\cdb\glass\_private.cdb

\*LENS INPUT

```

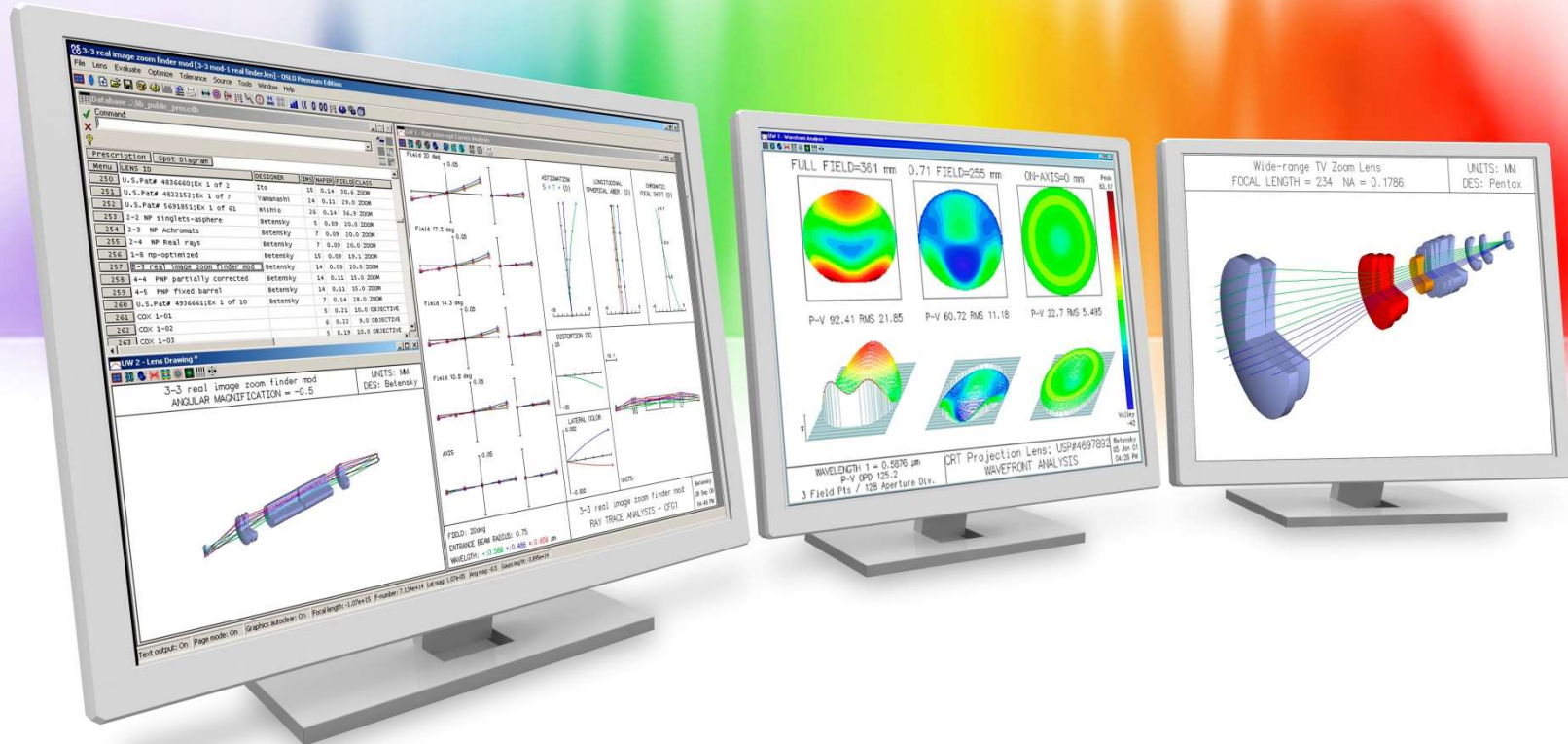
SRF 0:
SNO2
Cassegrain Ritchey-Chretien
LID: Cassegrain Ritchey-Chretien
EBR 75.000000
UNI mm
UNI mm
WAVLNS 0.632800
WW1 1.000000
ANG 0.600000
SRF 0: --
RD --
TH 1.0000e+10
GLA AIR
SRF 1:
RD -742.857200
TH -260.000000
IN GLA()
GLA REFLECT
AST 1
*** Command CON not recognized ***
CC -1.046192
SRF 2:
AP 75.000000
SRF 2:
RD -290.232796
TH 471.717084
IN GLA()
GLA REFLECT
*** Command CON not recognized ***
CC -2.915001
AP 22.500000
SRF 3:
RD -55.229670
TH 7.500000
IN GLA()
GLA SF11
SRF 4:
RD -118.498104
TH 5.000000
IN GLA()
GLA AIR
SRF 5:
RD --
TH -0.016718
GLA AIR
END 5

```

UW 1 - Lens Drawing \*

Cassegrain Ritchey-Chretien UNITS: MM  
 FOCAL LENGTH = 1752 NA = 0.04281 DES: OSLO

# OSLO



## OSLO 7.1 Global Explorer 2 Demonstration

# Global Explorer Two Operands setup by Angle CCL

- You can use the Angle CCL that comes with Ge2 to automatically setup the chief and marginal rays to setup the Global Explorer optimization parameters. After invoking the Angle CCL the operands are changed and reported in the text window as shown at right and the Minimum RMS Error is shown at the bottom giving us a starting error for the default system.

```
TW1*
Len Spe Rin Ape Wav Pxc Abr Mrg Chf Tra Sop Ref Fan Spd Auf Var Ope lte

*** Selected On-Axis Fpt ***
FPT  CFG  FBY  FBX  FY1  FY2  FX1  FX2
1    0  0.00  0.00 -1.00000  1.00000  -1.00000  1.00000
*** Selected On-Axis Ray ***
Ray  TYP  FY  FX
R 5  Ordinary  1.00000  0.00000

*** Selected Off-Axis Fpt ***
FPT  CFG  FBY  FBX  FY1  FY2  FX1  FX2
3    0  1.00  0.00 -0.80000  0.80000  -0.80000  0.80000
*** Selected Off-Axis Ray ***
Ray  TYP  FY  FX
R 5  Ordinary  1.00000  0.00000
R 11 Ordinary  0.00000  1.00000
R 12 Ordinary -1.00000  0.00000

>> ope

*OPERANDS
OP  MODE  WGT  NAME  VALUE  %CNTRB  DEFINITION
0 50  M  4.8000e-11  ANG_Rms_1  25.499454  0.00  RMS
0 51  M  --  Bot_Limit  --  --  O50>0.0
0 52  M  1.0000e+03  Top_Limit  --  --  O50<90.0
0 59  M  0.250000  Yrms1  0.028588  0.21  RMS
0 68  M  0.500000  Xrms2  0.201845  20.47  RMS
0 77  M  0.500000  Yrms2  0.287626  41.57  RMS
0 86  M  0.125000  Xrms3  0.277410  9.67  RMS
0 95  M  0.125000  Yrms3  0.454192  25.92  RMS
0 102 M  0.125000  CHRrms1  0.041813  0.22  RMS
0 111 M  0.500000  CHRrms2  0.038057  0.73  RMS
0 120 M  0.125000  CHRrms3  0.028267  0.10  RMS
0 124 M  --  --  7.070081  --  PL(4,20,1,5)+PL(4,20,1,6)
0 131 M  --  --  6.322051  --  PL(4,21,1,5)+PL(4,21,1,6)
0 135 M  10.000000  --  -0.010533  1.12  PU+0.142875
MIN RMS ERROR: 0.009374
```

# GE2 Results using Angle than Ge2 commands

- You can use Global Explorer and the new Global Explorer 2 optimization routine coming in OSLO 7.1 to do global optimization. These optimization routines search global solution space for multiple solutions based on user criteria. For a triplet design, we asked GE2 to search solution space to minimize an angular merit function. The 9 solutions are shown at left.

