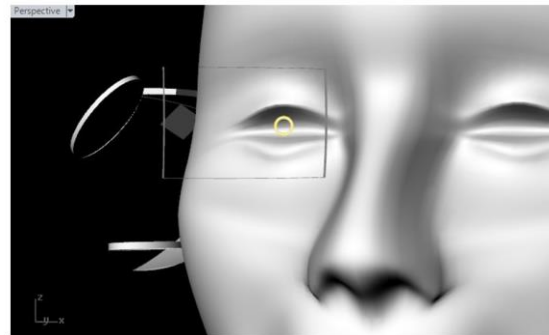
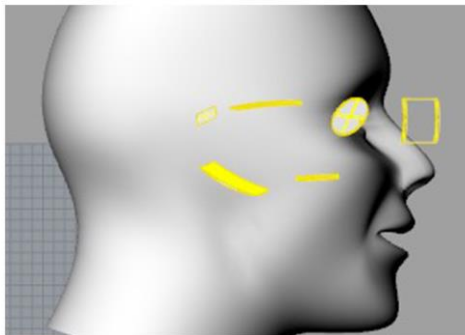
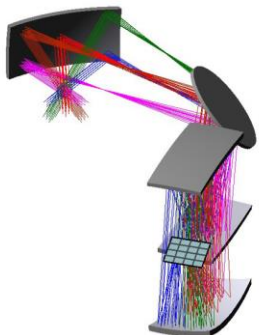


CODE V & LightTools: Design and analysis of AR/VR systems

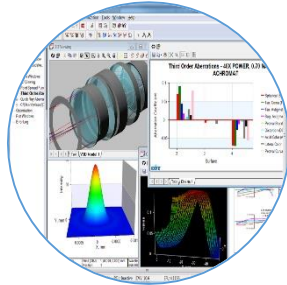
EPIC Online Technology Meeting on Freeform Optics for AR/VR,

Presented by Adrien Manassero, Light Tec, April 29, 2020



LIGHT TEC Activities

—
**Synopsys
 Optical
 Simulation
 Software**
 —



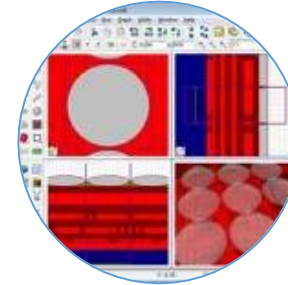
CODE V

Imaging optical design



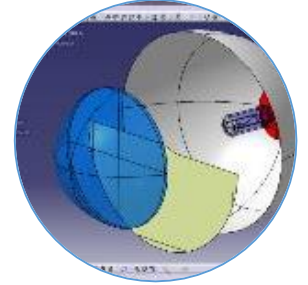
LightTools

Illumination design



Rsoft

Micro & nano optics



LucidShape

Automotive Illumination

—
**Scattering
 Measurement
 Instruments
 Services**
 —



Measurement Service

Scattering measurement



Measurement Instruments

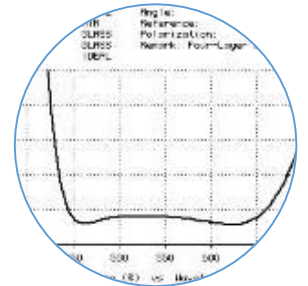
Mini-Diff V2 / Mini-Diff VPro

Reflet 180 S



Engineering & **T**raining

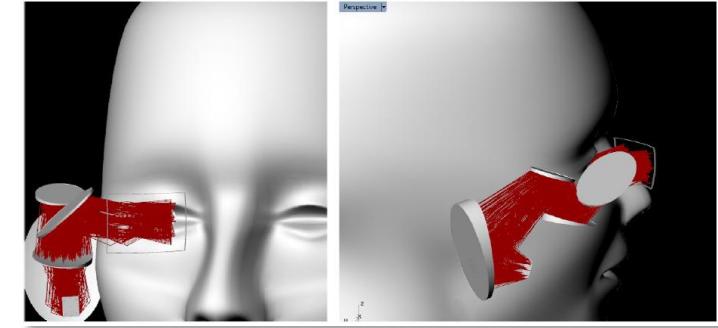
Illumination design &
 Imaging optical design



TF calc

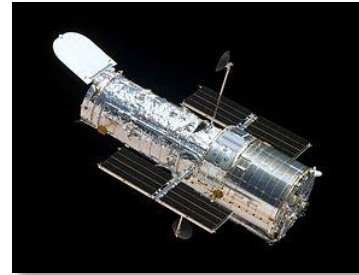
Thin films, analysis,
 optimization

CODE V for Imaging Optics



Imaging systems

- Digital camera lenses & zoom lenses
- IR & UV systems
- Laser scanning systems
- Microlithographic systems
- Projector systems
- Space-borne systems & telescopes
- AR/VR



Automotive systems

- Projection headlamps
- Positional awareness and
- 360-degree cameras
- HUDs
- LiDAR



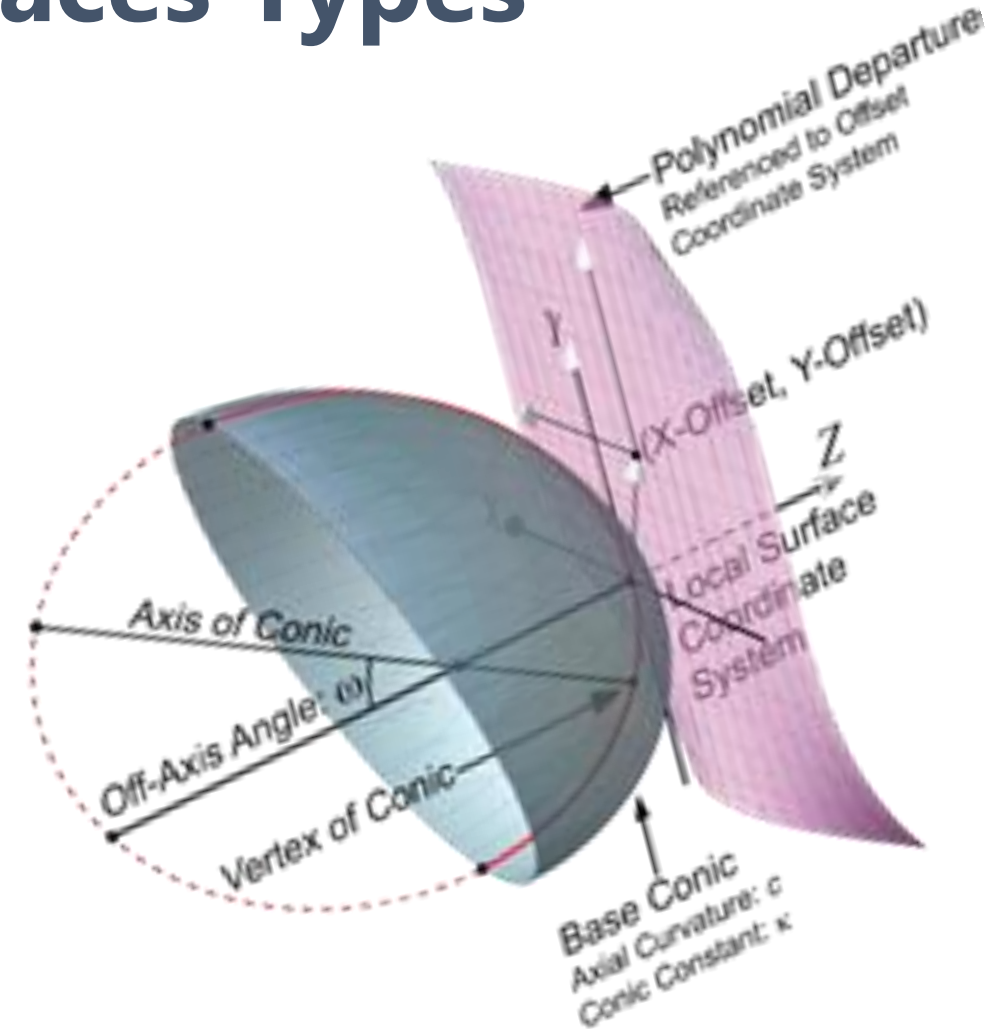
CODE V New Freeform Surfaces Types

Two new surface shapes for freeform design:

- Extended Fringe Zernike surface (SPS ZFE)
- Forbes Q2D (SPS Q2D)

X,Y offset allows decenter of freeform departure

ω parameter allows off-axis angle for surface origin definition



Display Coefficient Symmetry Behavior Currently selected coefficient SPS coefficient C17

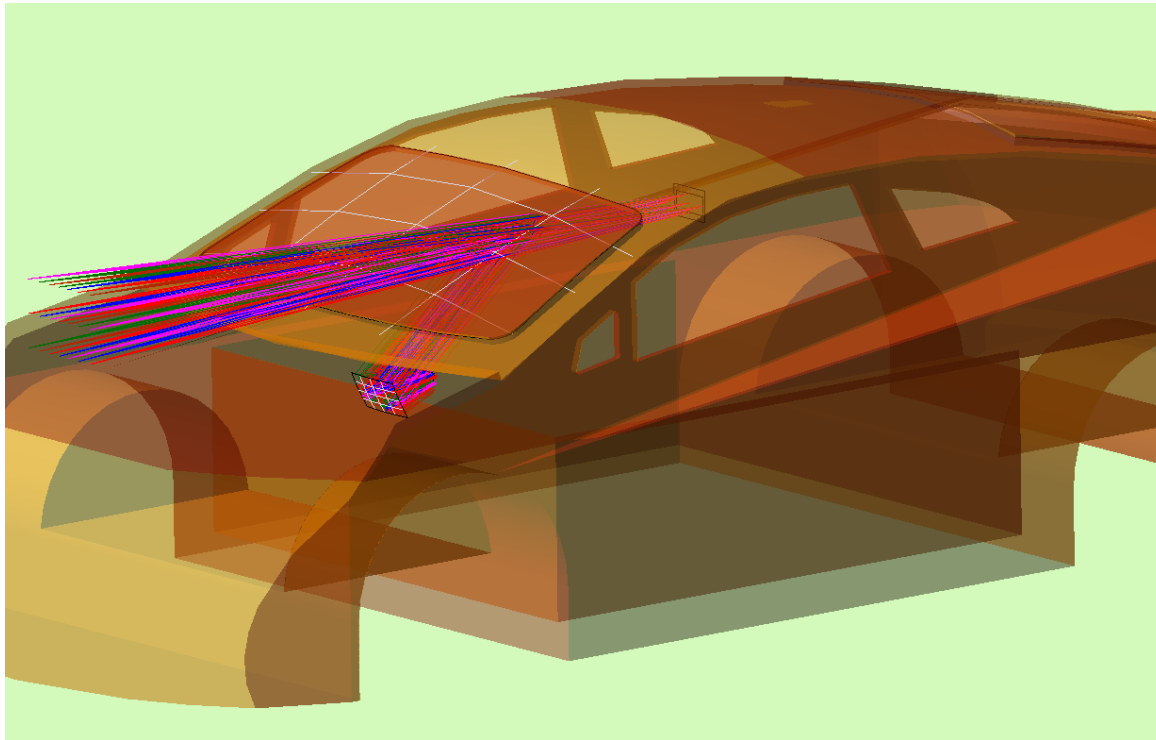
Non-zero coefficient(s) that do not meet the symmetry condition are highlighted

Max Radial Order	sin(5t)	sin(4t)	sin(3t)	sin(2t)	sin(t)	Azimuth Independent	cos(t)	cos(2t)	cos(3t)	cos(4t)	cos(5t)
R**0 (Piston)						0.00000					
R**1 (Tilt)					0.00000		0.00000				
R**2 (Power)				0.00000		0.00000		0.00000			
R**3			-2.00789e-014 V		8.73994e-015 V		0.00000		0.00000		
R**4		0.00000		0.00000		-0.00080 V		-8.05397e-007 V		6.31456e-008 V	
R**5	0.00000		0.00000		4.80013e-015 V		0.00000		0.00000		0.00000
R**6		0.00000		0.00000		-5.28051e-006 V		4.78632e-007 V		0.00000	
R**7	0.00000		0.00000		0.00000		0.00000		0.00000		0.00000
R**8		0.00000		0.00000		0.00000		0.00000		0.00000	
R**9	0.00000		0.00000		0.00000		0.00000		0.00000		0.00000
R**10		0.00000		0.00000		0.00000		0.00000		0.00000	

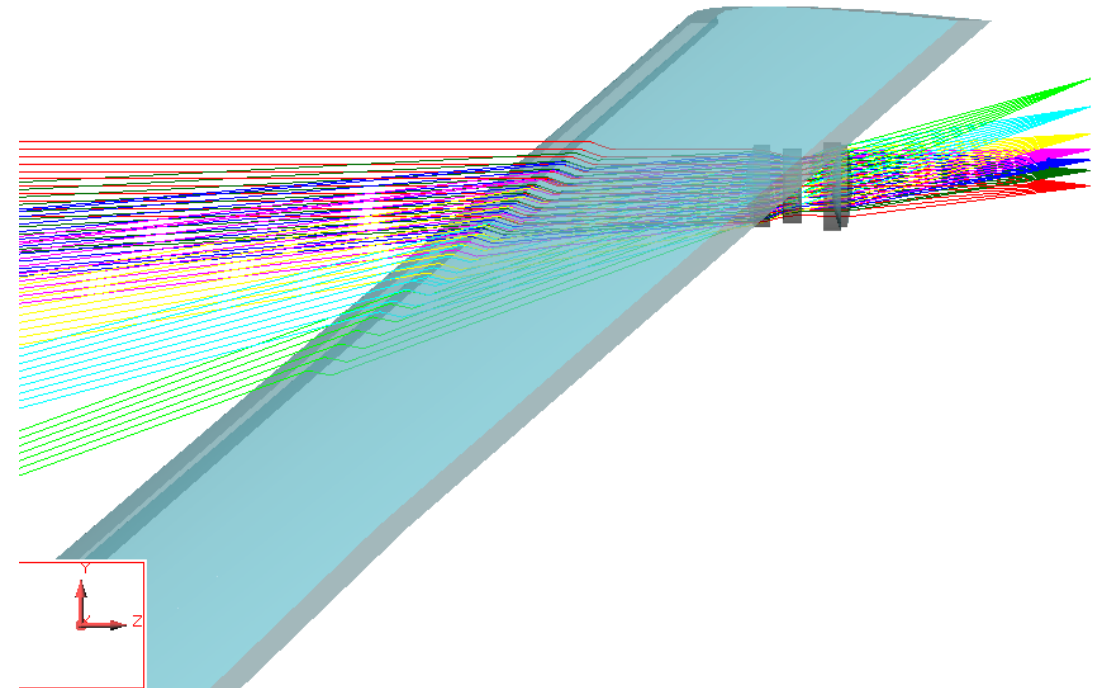
CODE V CAD Import

- Possibility to import of CAD objects for visualization and ray tracing

CAD used for visualization (car frame)

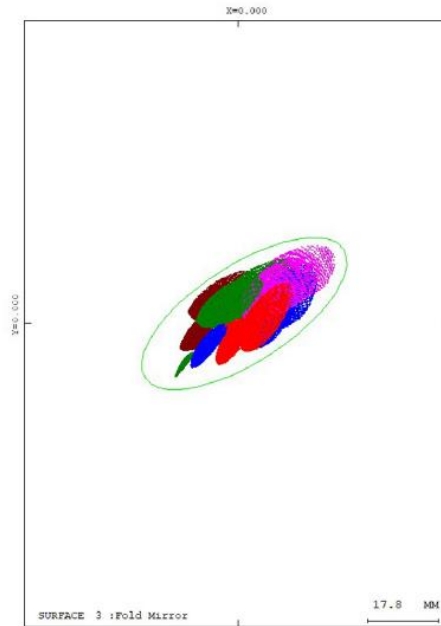


CAD used for Ray tracing (windshield)

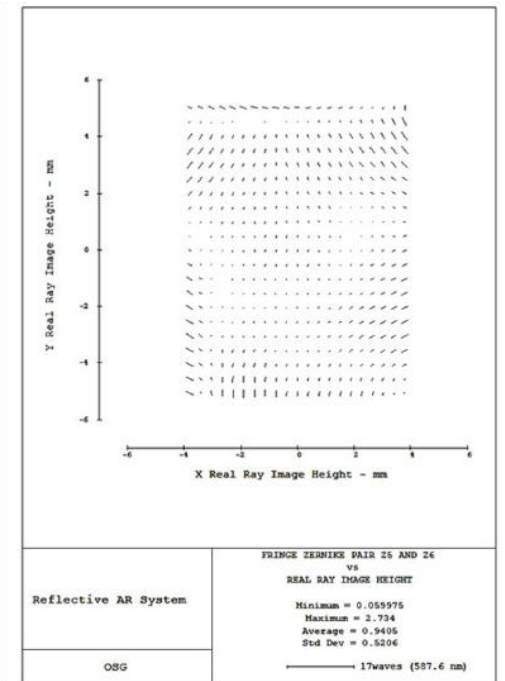
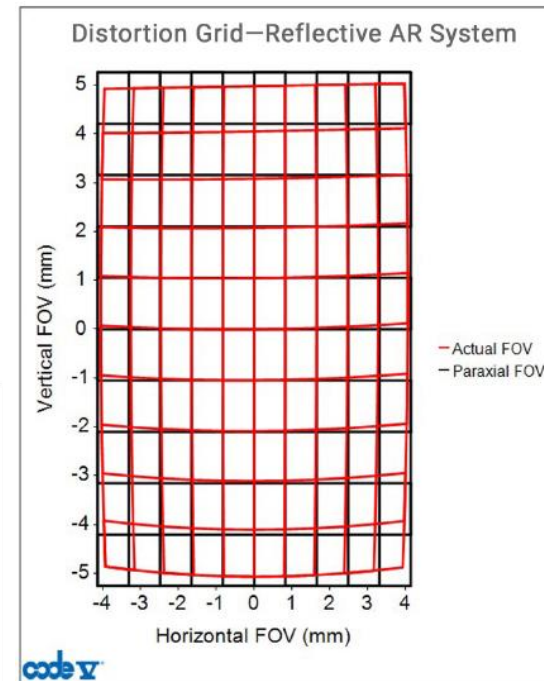


CODE V diagnostic tools for AR/VR

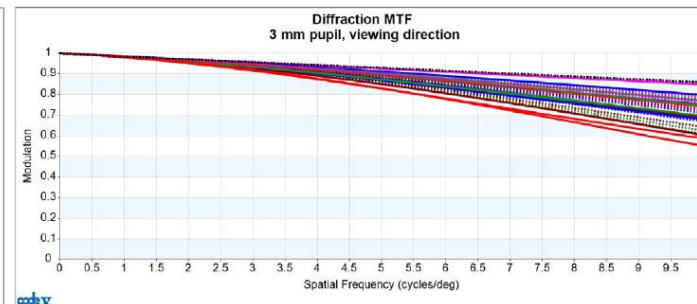
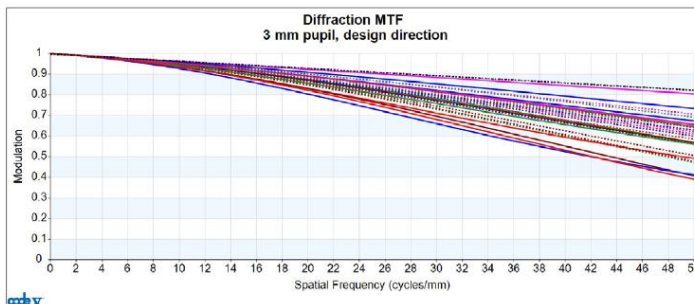
- 3D Viewing
- Distortion Grid Analysis
- Field Map Analysis
- Diffraction Image Simulation
- Footprint Plot
- MTF Analysis



Footprint analysis



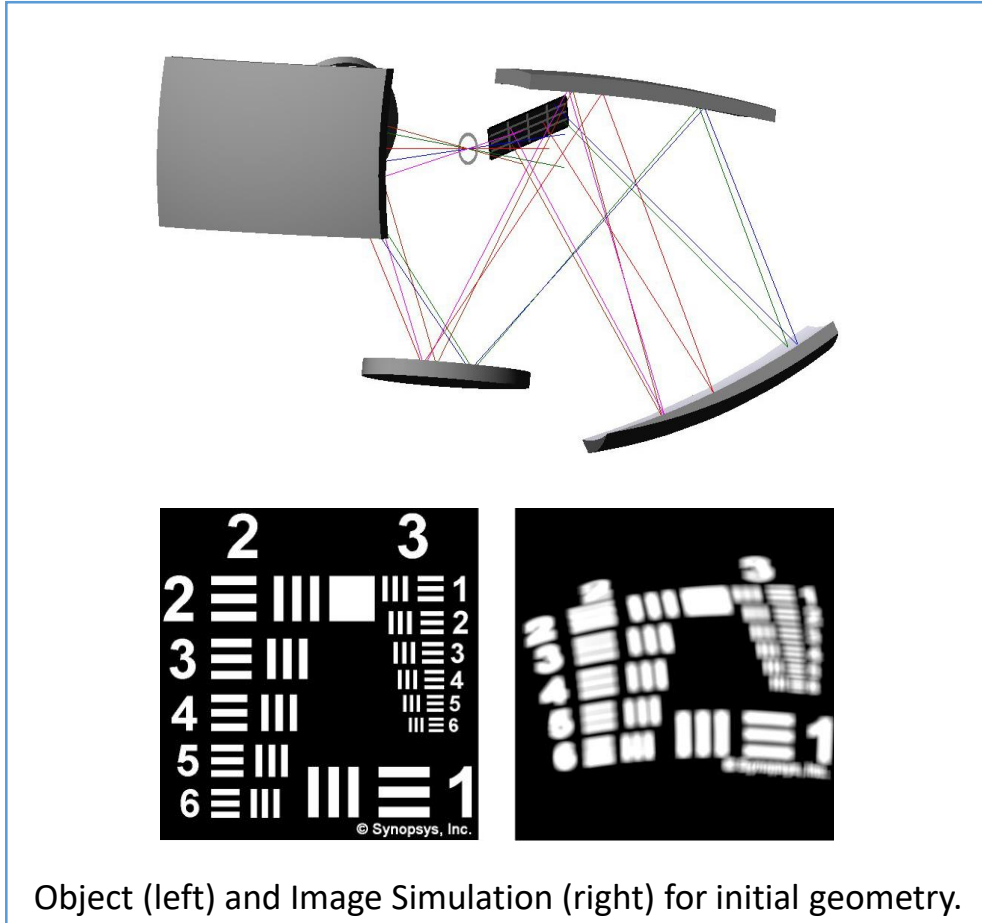
Distortion Grid and Field Map Analysis for AR reflective imaging system



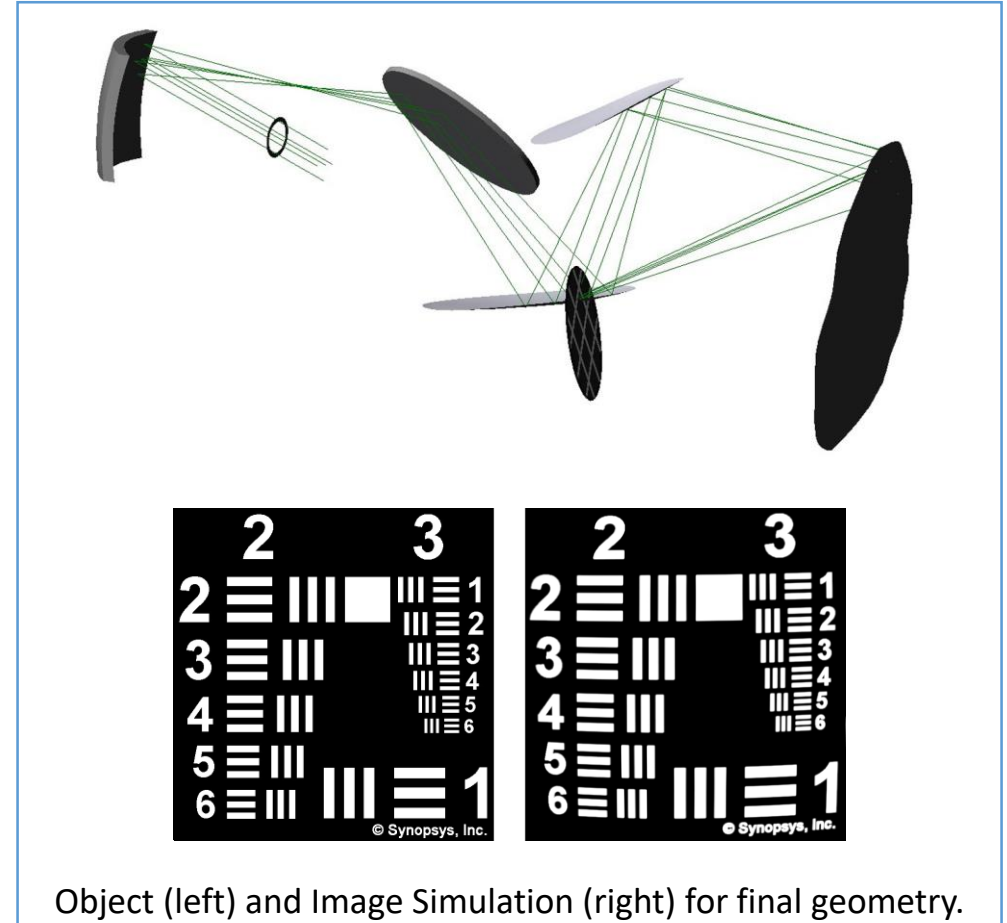
Instantaneous pupil MTF for reverse (design) direction (left) and visual use orientation (right)

CODE V Optimization

Before Optimization



After Optimization

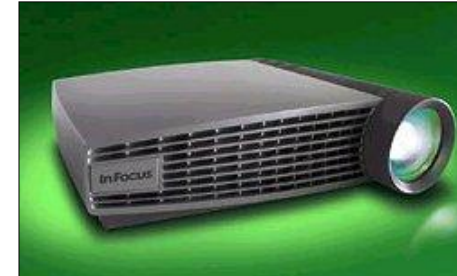


CODE V
Optimization
In 19 cycles

LightTools for Illumination Optics

General illumination

- Projectors
- Flat panel display backlighting
- Stray light analysis
- Luminaire design
- LED sources and packaging
- Lightpipes
- Machine vision
- Medical and Bio-medical devices

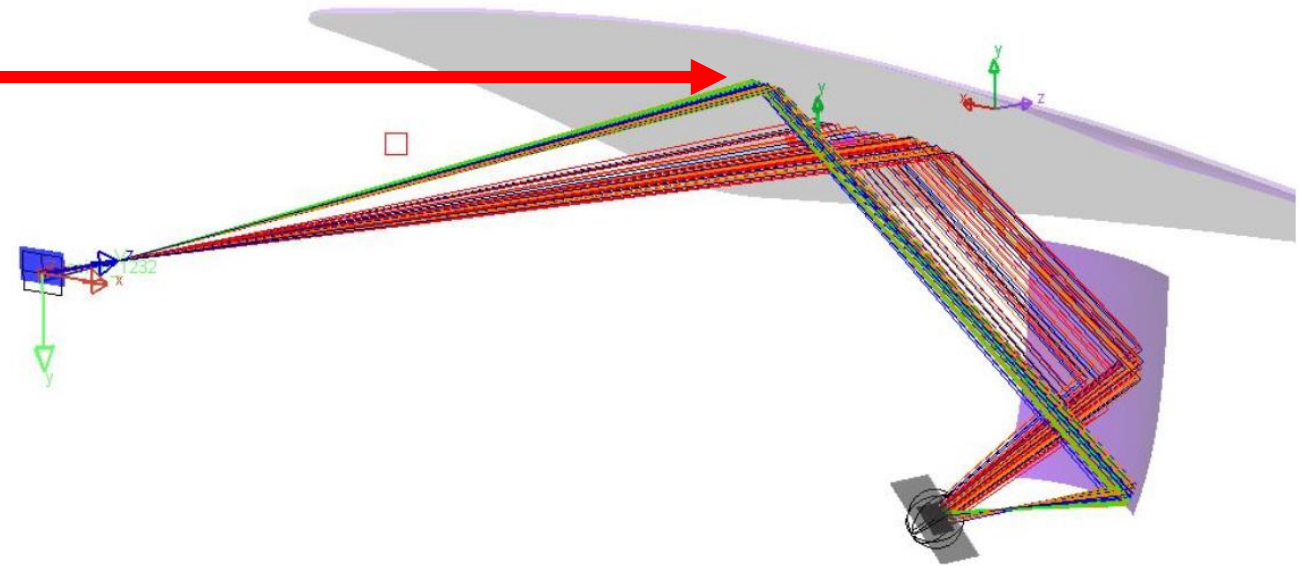
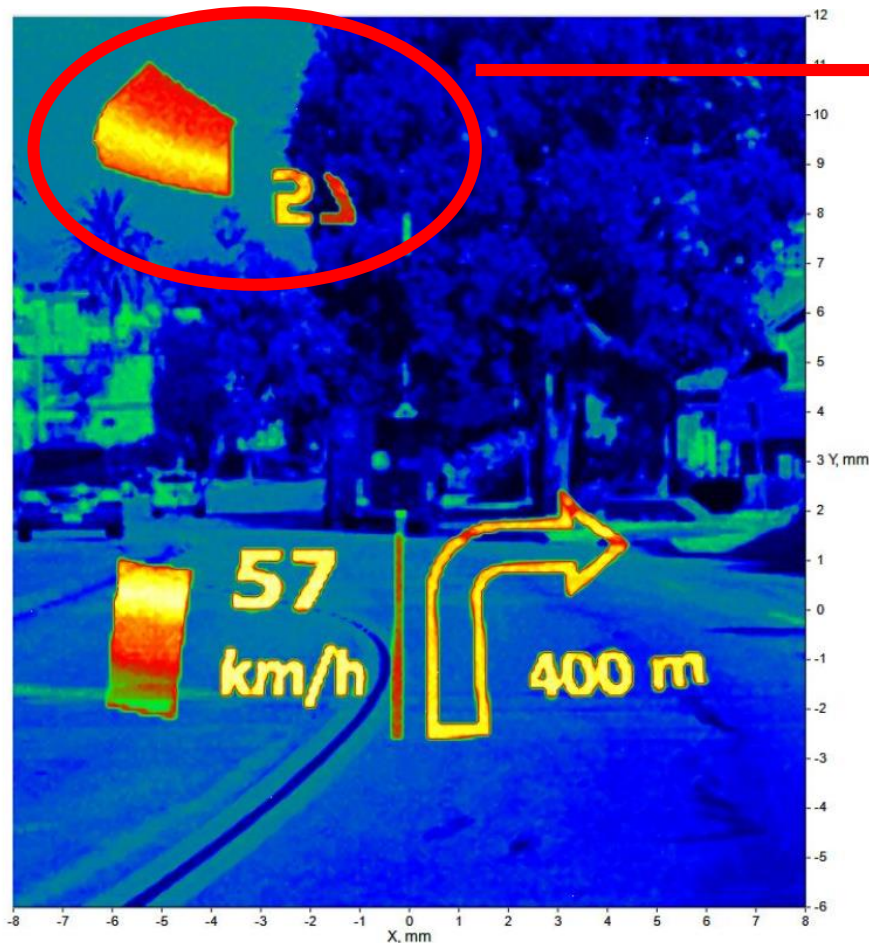


Automotive

- Instrument clusters
- Interior lights
- Switches, controls
- Sensors, detectors
- HUDs

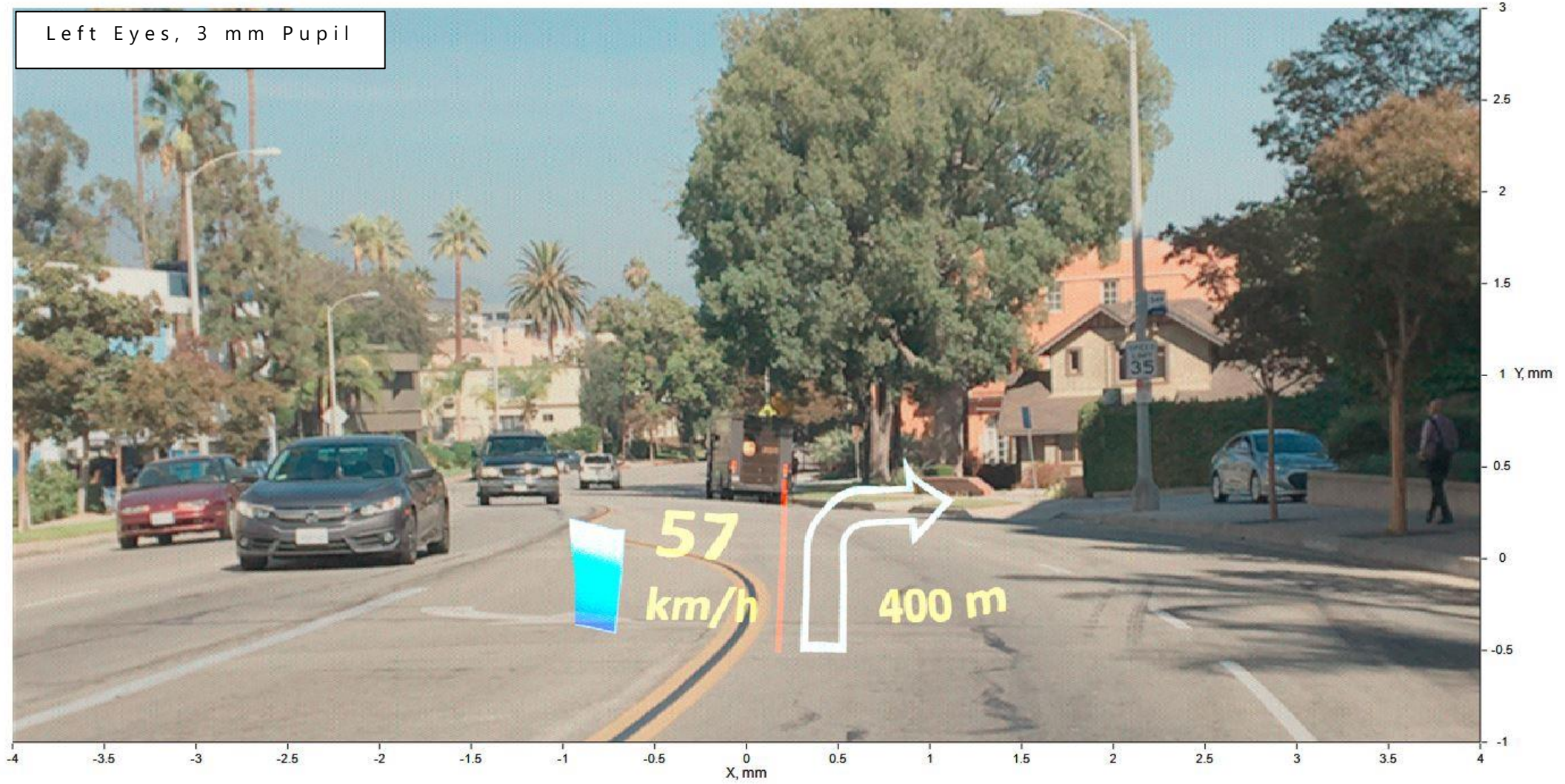


LightTools: Stray light analysis



LightTools helped uncover and fix a problem with the reflector aperture allowing stray illumination to reach the eyebox for the viewer

LightTools: Photorealistic Rendering

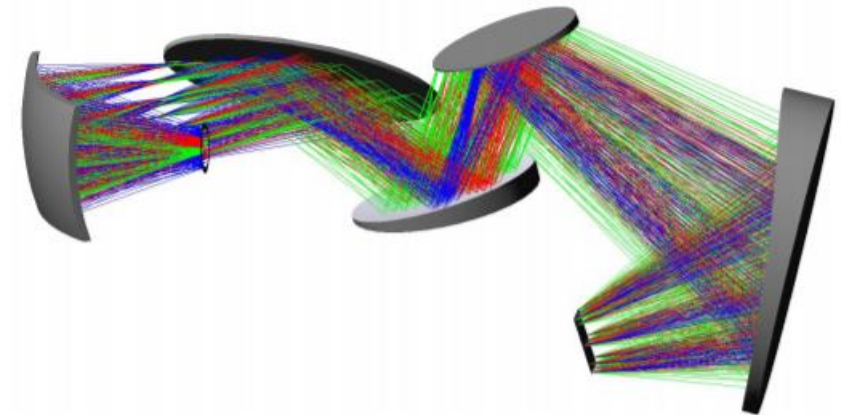


Summary

- CODE V is a strong tool to analyze and optimize an imaging optical system
- CODE V has new features to follow the needs and the expectation from the market
- LightTools is a powerful tool for radiometric analyses and visual rendering of your design
- Using both software packages together make use of the full depth of their capabilities to achieve a superior design



Final CAD software package front view (left) and side view (right) with nominal adult male wearer



3D CAD Export view of final optimized AR system

THANK YOU