SYNOPSYS®

How to deal with Optical Systems Complexity?

EPIC Online Technology Meeting on Optical Design and Simulations

Emilie VIASNOFF, PhD.
November, 6th 2023

IMPORTANT NOTICE

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AGENDA

- Introduction

- Evolution in Optical Design versus Optics

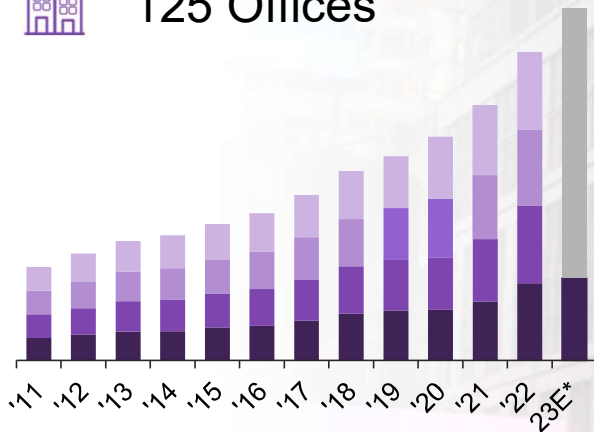- Example of an AR/VR/MR System

- Key Take Aways
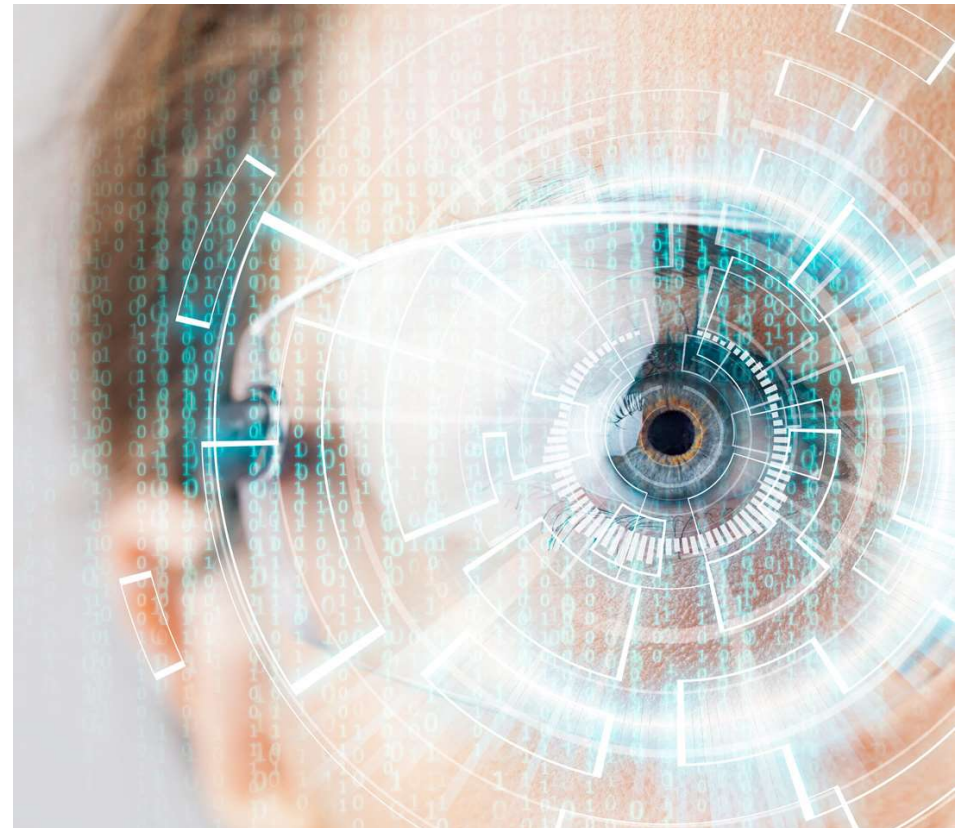
Synopsys – From Silicon To Software

- ~$5.17B Revenue (TTM)
- 19,410 Employees
- 3,380 Patents
- 125 Offices

HAPPY **35**TH ANNIVERSARY!

SNPS NasdaqListed

synopsys®

'Leader' In Gartner's Magic Quadrant for Application Security Testing

Broadest IP Portfolio and **#1** Interface, Foundation & Physical IP

#1 Electronic Design Automation Tools and Services

'11 '12 '13 '14 '15 '16 '17 '18 '19 '20 '21 '22 23E*

Data Center HPC / AI | Industrial Automation | Automotive | AR / VR | Government & Aerospace

PROCESS FUNDAMENTALS | Broadest System Design Coverage | DEPLOYED SYSTEM

A Tradition of Excellence and Accuracy in Optical Software

A journey that started in 1963

>2012:
acquisitions of RSOFT and LucidShape
to complete the portfolio with excellent solutions in their fields

1963: ORA
Eng services company

Acquisition by **THE leader in EDA** worldwide

1995: LightTools released

Clients include Bell and Howell, Xerox, KODAK, Panavision, Polaroid, NASA JPL, other **aerospace and defense** contractors and **labs**, and other **commercial companies**

1975: CODE V released
When released, CODE V was an optical design software with never before achieved optical simulation speed and accuracy to serve A&D. In the 90's it became the most used tool **in A&D, and semiconductor optical equipment**

In 1993, the **Hubble optics repair mission** was requiring all contractors to utilize CODE V for the optical design

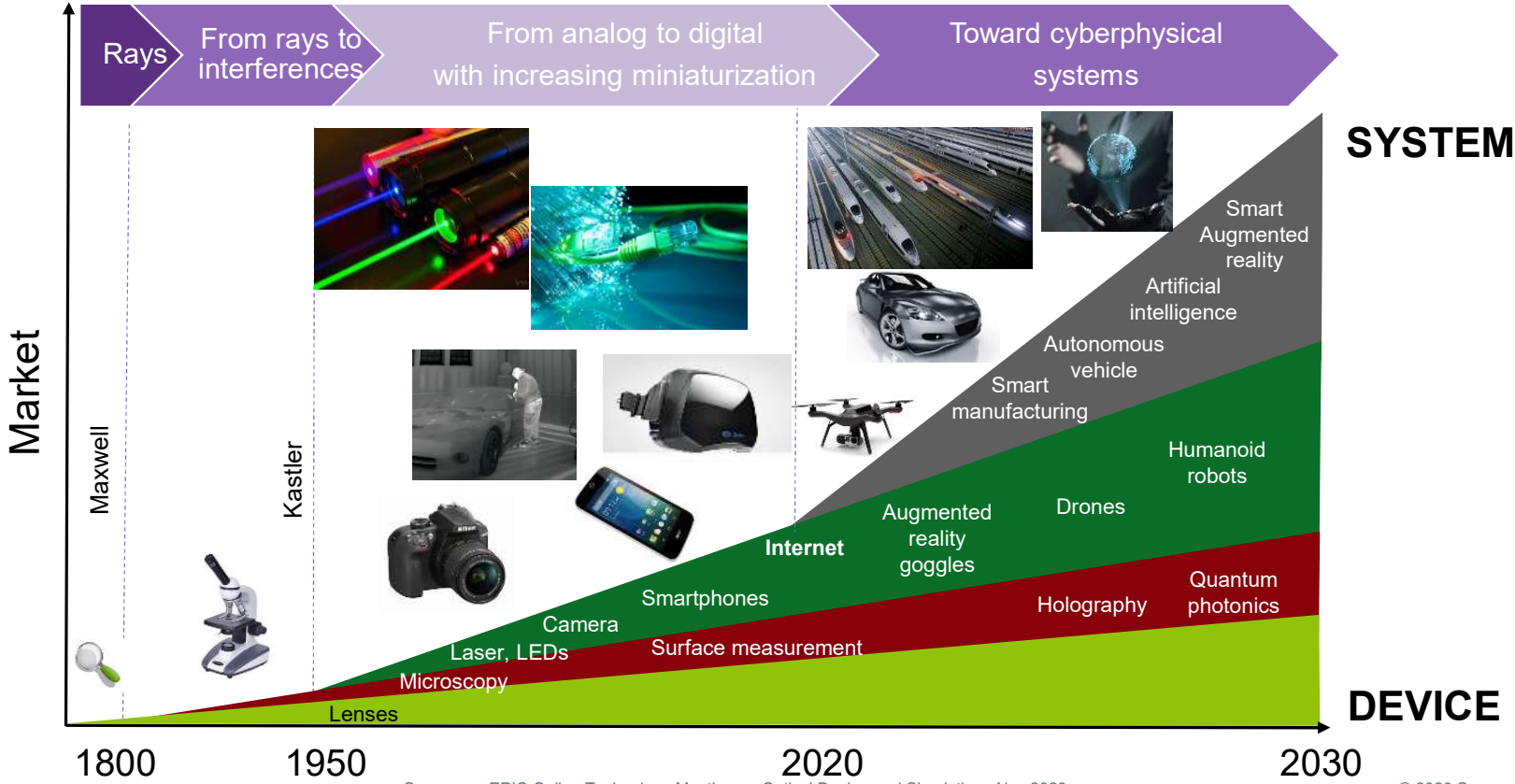The most widely used illumination design tool for general lighting, display and automotive lighting

2010: acquisition by Synopsys

SYNOPSYS®

Our customers today include **A&D**, still, and we extended to **consumer** with cameras, displays and AR/VR, **automotive** with headlamps, HUD, and sensors, and **medical**

Some History

→ Optics & Photonics are getting from the device level to the system level

Major Trends in Four Domains

Our Driver

- Consumer Optical systems

This Photo by Unknown Author is licensed under CC BY-NC-ND

- Automotive Optical systems

This Photo by Unknown Author is licensed under CC BY-NC-ND

- AR/VR/MR Optical Systems

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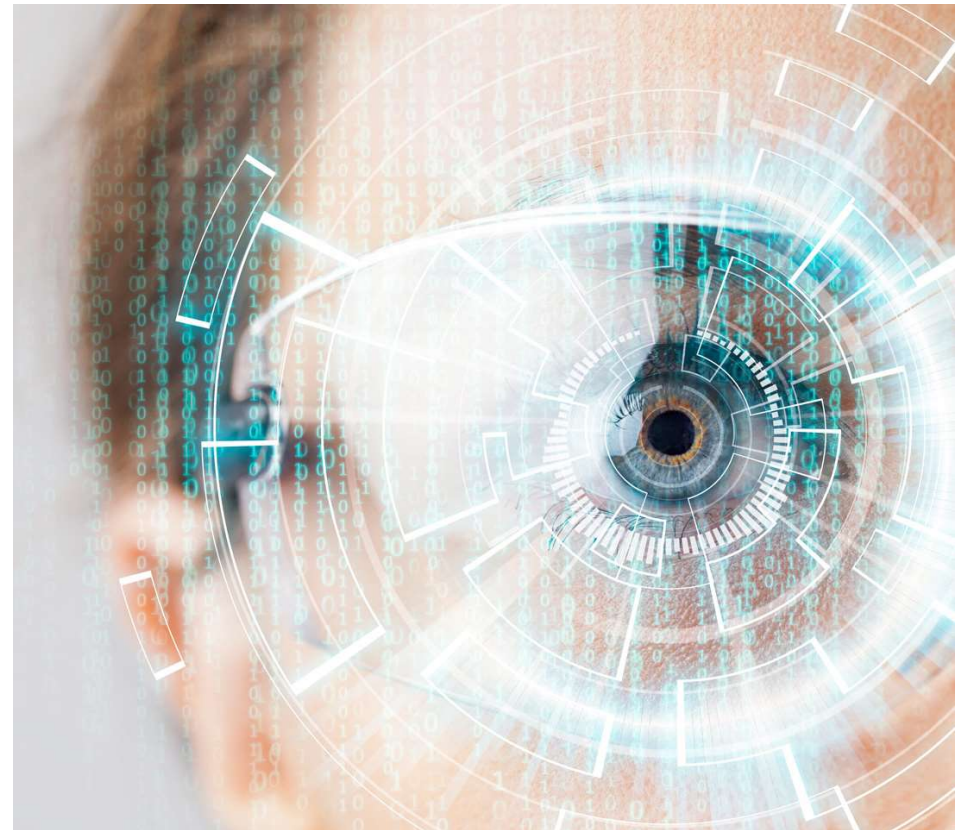- A&D Optical systems
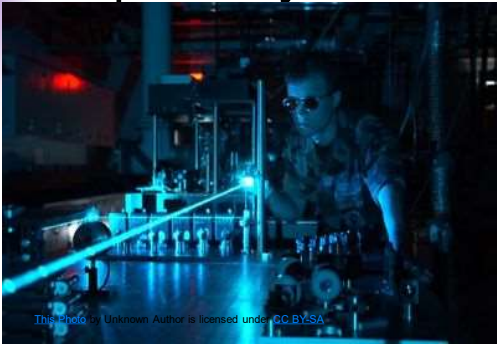
This Photo by Unknown Author is licensed under CC BY-SA

Dealing with System Complexity and Optimization

AGENDA

- Introduction

- Evolution in Optical Design versus Optics

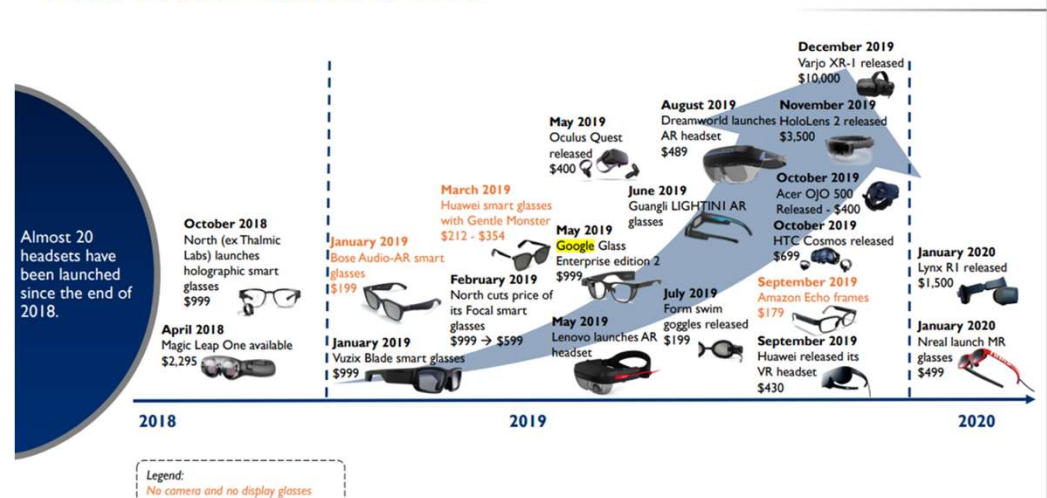- Example of an AR/VR/MR System

- Key Take Aways

AR|VR|MR

→ An emerging application with cutting-edge challenges and system-level constraints

- AR/VR systems are a **collection of complex components**: displays using microLEDs, HOE/DOE, sensors for head tracking, eye tracking, gesture tracking

- There is still a long way to go despite **extraordinary investments** and many important industry players

WHAT'S NEW – PRODUCT LEVEL

Almost 20 headsets have been launched since the end of 2018.

April 2018 Magic Leap One available $2,295

October 2018 North (ex Thalmic Labs) launches holographic smart glasses $999

January 2019 Bose Audio-AR smart glasses $199

January 2019 Vuzix Blade smart glasses $999

February 2019 North cuts price of its Focal smart glasses $999 → $599

March 2019 Huawei smart glasses with Gentle Monster $212 - $354

May 2019 Lenovo launches AR headset

May 2019 Google Glass Enterprise edition 2 $999

May 2019 Oculus Quest released $400

June 2019 Guangli LIGHTINI AR glasses

July 2019 Form swim goggles released $199

August 2019 Dreamworld launches AR headset $489

September 2019 Amazon Echo frames $179

September 2019 Huawei released its VR headset $430

October 2019 Acer OJO 500 Released - $400

October 2019 HTC Cosmos released $699

November 2019 HoloLens 2 released $3,500

December 2019 Varjo XR-1 released $10,000

January 2020 Lynx R1 released $1,500

January 2020 Nreal launch MR glasses $499

2018   2019   2020

Legend: No camera and no display glasses

- According to IDTechEx, "Software is nearly there, hardware has many hurdles to overcome."
  - **Optics:** Bottleneck with combiner & compact camera optics
  - **Display:** Issues with resolution & full color
  - **Sensors:** Emerging technologies in eye tracking and time of flight cameras

Dealing with Disruptive AR|VR|MR Systems

- **For great AR|VR|MR systems, you need:**
  - A great chip, AI enabled
  - A great optics, fully optimized
  - A great microdisplay, providing great images
  - Great cameras, leveraging metalenses

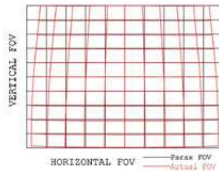- Let's see why you need a Simulation Platform to design and test this complex system
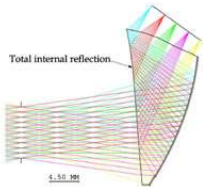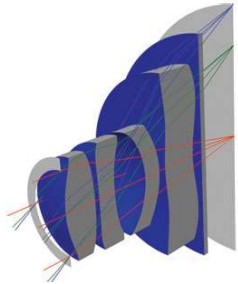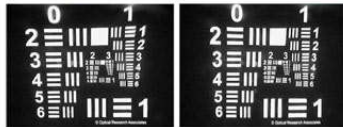
Optical Solutions with a Focus on AR|VR|MR

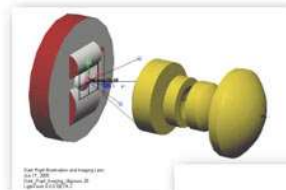## IMAGING
With CODE V®

cameras

Freeform prism

Lens and freeform prism optimization, analysis including image simulation, tolerancing and fabrication support
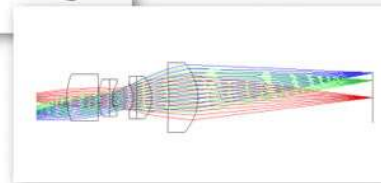
ILLUMINATION
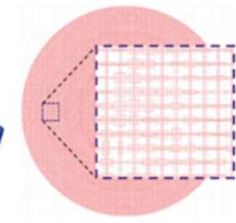### With LightTools®

cameras

Light sources

Straylight analysis, light source simulation, optimization, Virtual prototyping, and visualization

PHOTONIC DEVICE
With RSoft Photonic Device Tool®

metalenses

microLED displays
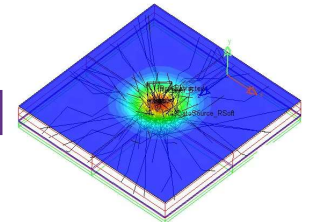
Waveguide combiners
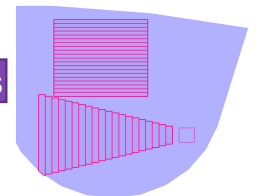
Simulation and design of passive and active photonic devices

An Overview of Synopsys Optical Platform

Design | **Applications**

Synopsys Optical Platform

CODE V | **LightTools** | **RSOFT**

OSF/seq | BSDF

S S L

LucidShape family

**SmartStart Libraries (SSL): BSDF, volume
Materials measurements Services
Instruments: REFLET/MiniDiff**

Multi-threads, distributed computing or GPU enabled
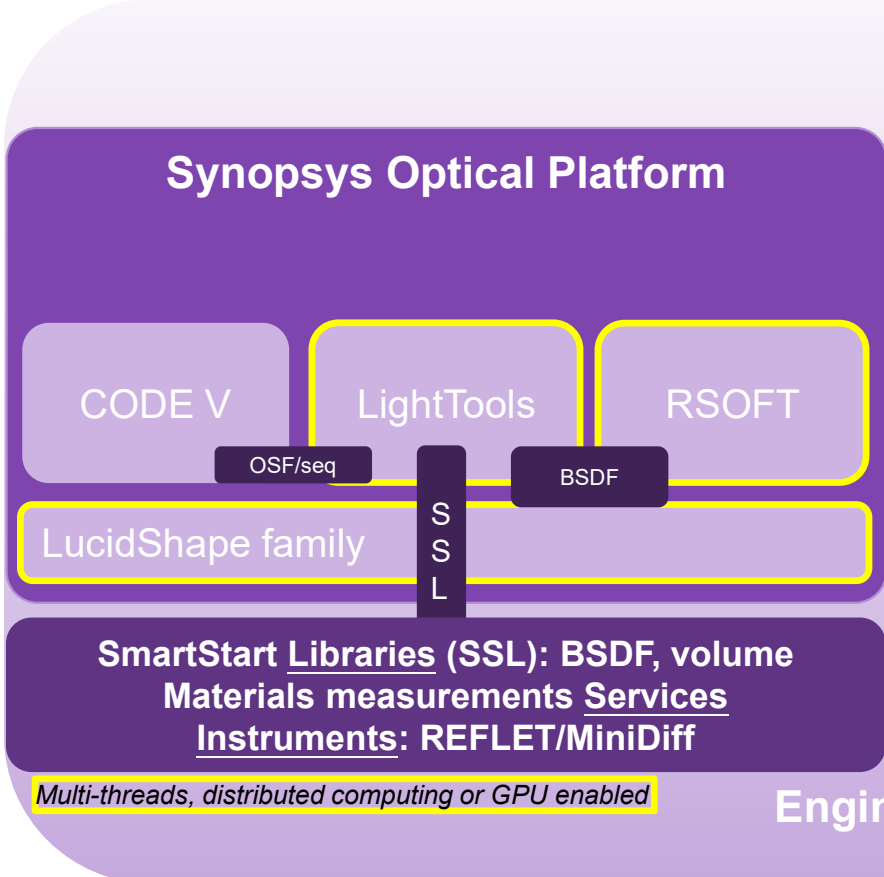
Engineering Services

Imaging systems

Displays,
incl. AR/VR

ADAS

Aerospace
& Defense

Our Design and Simulation Workflow for Waveguide AR Glasses

A parametric BSDF as the link between RSoft and LightTools

1 Specification & Layout

2 Grating Design

3 System Performance

4 System Optimization

BSDF

Determine spec. and layout base on the requirements

RSoft DiffractMOD/ RSoft FullWAVE along with MOST Optimizer

LightTools simulation and analysis with RSoft BSDF

LightTools optimize the parameters including RSoft BSDF

An Overview of Synopsys Optical Platform

Design | **Simulations** | **Applications**

Synopsys Optical Platform

CODE V | **LightTools** | **RSOFT**

OSF/seq

BSDF

LucidShape family

S S L

SmartStart Libraries (SSL): BSDF, volume Materials measurements Services Instruments: REFLET/MiniDiff

Multi-threads, distributed computing or GPU enabled

Various formats

Visualization

Image Simulations

Virtual Environment LucidDrive

Engineering Services

Imaging systems

Displays, incl. AR/VR

ADAS

Aerospace & Defense

SYNOPSYS®

Co-Simulate the Image Quality
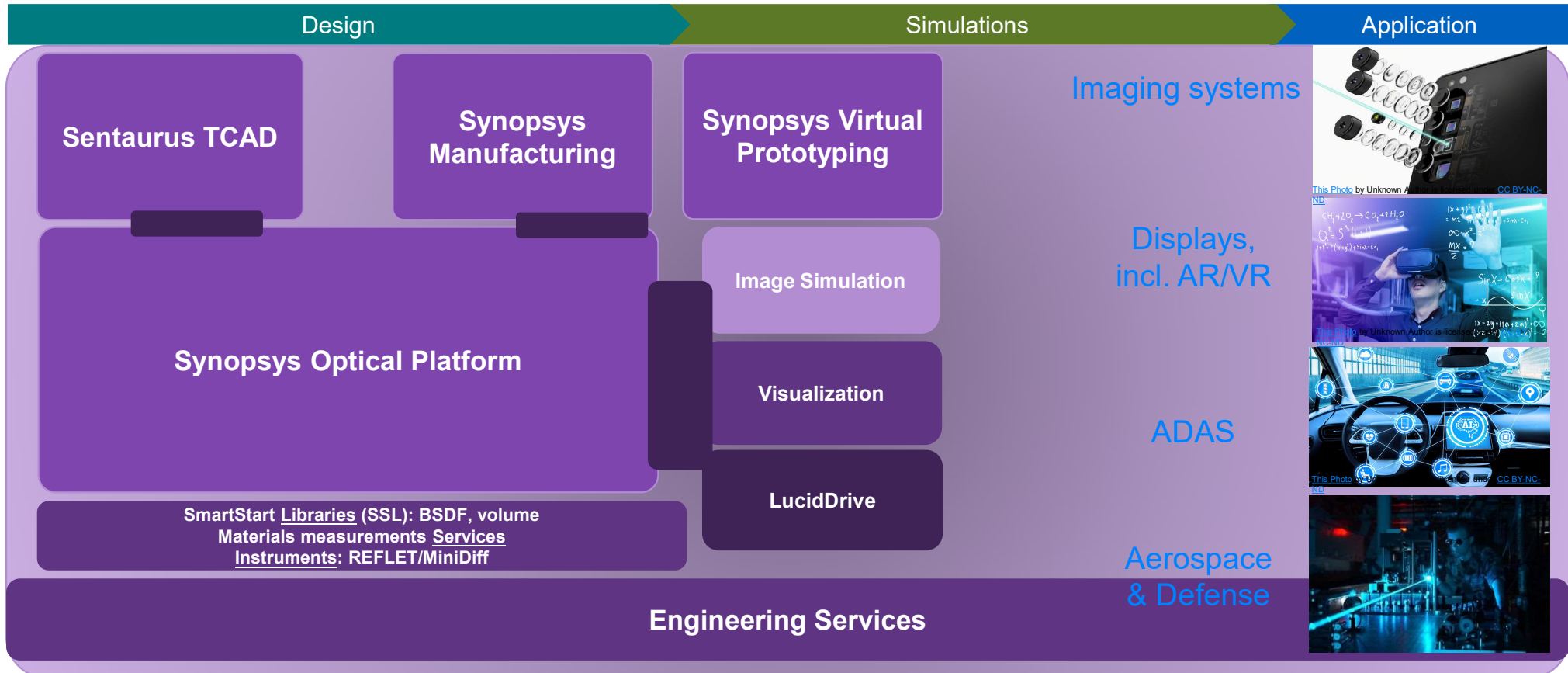→ **Setting the interoperability stage for ultra-small and smart cameras**

- Image simulation can help us understand optical performance

- Use CODE V
  - Design the lens to meet optical performance requirements
  - Perform a ghost analysis to look for particularly difficult surface pairs
  - Export to LightTools for mount design and flare analysis

- Use LightTools
  - Import the lens file from CODE V
  - Design the lens mount
  - Assign the optical properties to the surfaces of the mount, lens and detector
  - Insert a source
  - Run multiple Monte-Carlo simulations to analyze flare and ghost images

- **CODE V IMS analysis can understand image quality**
- **LightTools stray light simulation can check ghost image from lens and flare caused by mechanism and sensor**
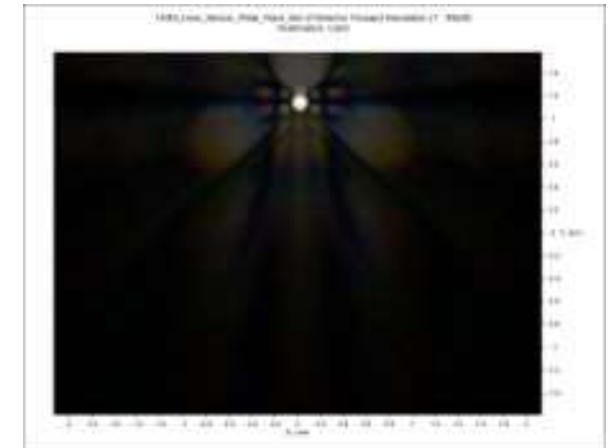
An Overview of Synopsys Optical Platform

One Optical Solutions Platform tied into the Synopsys ecosystem

Design	Simulations	Application

Sentaurus TCAD

Synopsys Manufacturing

Synopsys Virtual Prototyping

Synopsys Optical Platform

Image Simulation

Visualization

LucidDrive

SmartStart Libraries (SSL): BSDF, volume
Materials measurements Services
Instruments: REFLET/MiniDiff

Engineering Services

Imaging systems

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Displays, incl. AR/VR

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ADAS

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Aerospace & Defense

Design Through Manufacturing Simulation

Simulation flow quantifies manufacturing impact on device performance

Free-form meta-atoms
500 nm

Lithography

Etch

Process Explorer simulates the etch process

Device Testing

RSoft analyzes the simulated device performance

Sentaurus Lithography simulating a 193 dry 0.93 NA positive tone resist process

Correction

Proteus applied OPC or ILT with a **Sentaurus Lithography** model

Design

MetaOptic Designer, RSoft, And LightTools to optimize meta optics using inverse design techniques

Metalenses are subject to patterning effects such as shape, shifted size, sidewall angle and pillar size

Key Takeaways

- **Optics evolved to more complex systems**
- **Especially in consumer applications (cameras, AR/VR/MR), ADAS and A&D**

- **Designing these optical systems needs a paradigm shift toward comprehensive simulations platforms**

- **Synopsys has a comprehensive portfolio to design, optimize and test, end-to-end, optical systems**
  - Our optical design platform for multi-scale simulations tied to Synopsys electronics platform
  - Beyond optics, go at the system-level with more simulations

Thank You

Questions?

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