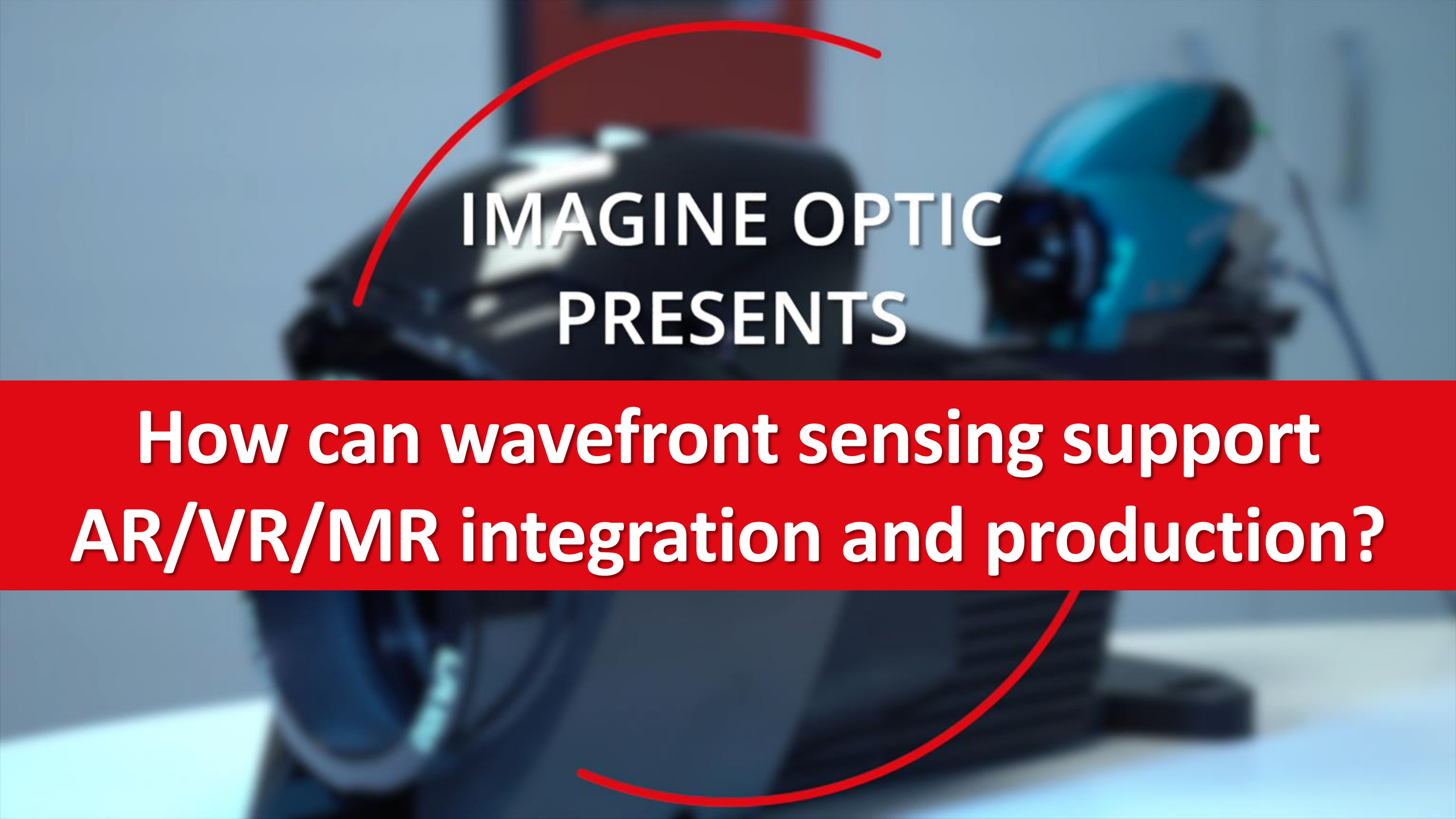
Wavefront sensors and adaptive optics for optical metrology, laser and microscopy

OPTICAL METROLOGY

HIGH-POWER LASERS

BIO-IMAGING

X-EUV



How can wavefront sensing support AR/VR/MR integration and production?

You can’t manufacture what you can’t measure

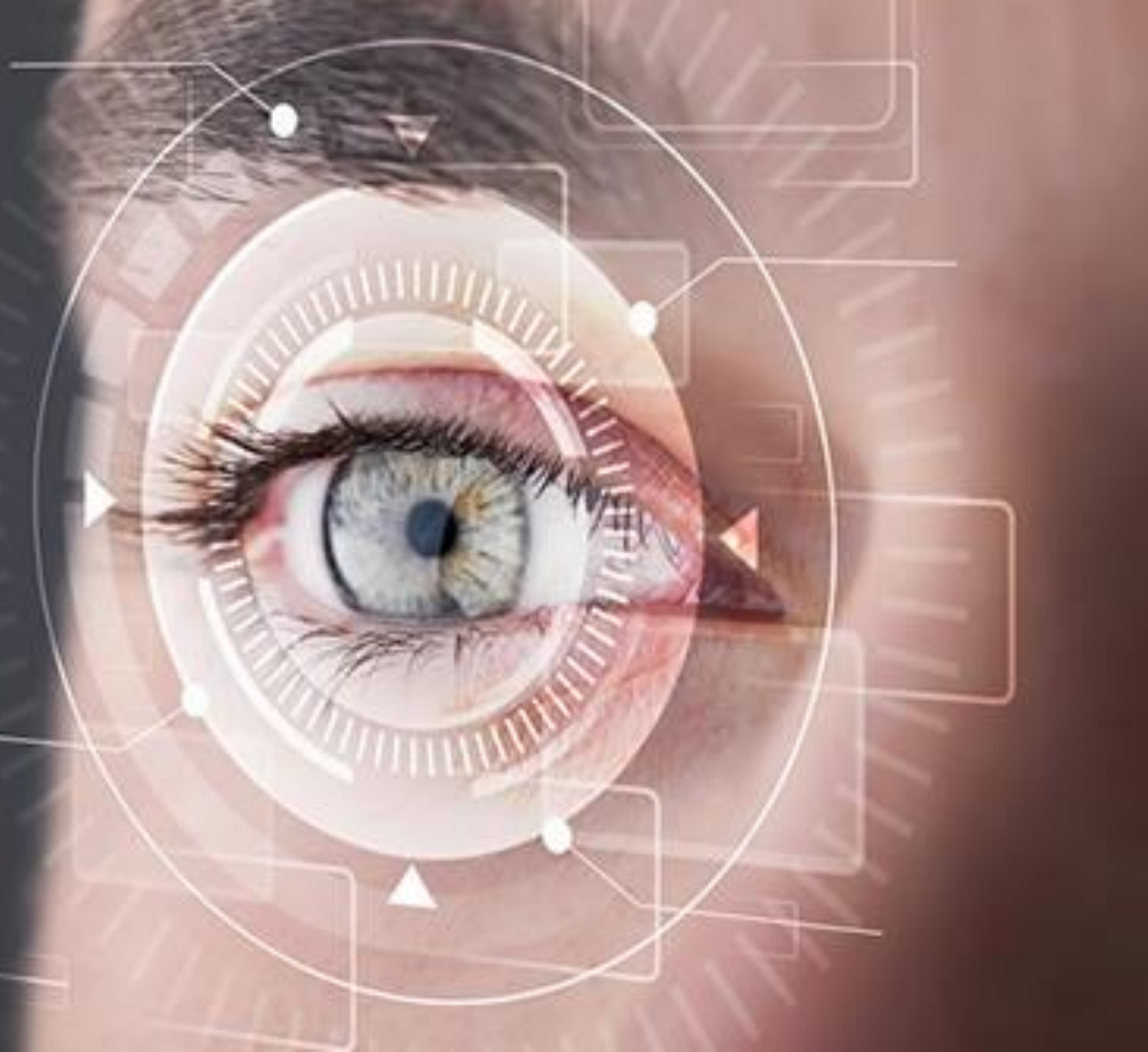
Peter Drucker (?)
management thinker

AR/VR components & systems represent a huge (optical) metrology challenge:

+ Very large dynamic ranges

+ Large aperture: large diam./short focal lengths

+ Complex multi-elements systems:
  - AR/TR coatings
  - Polarization control
  - Embedded features (waveguide, etc.)

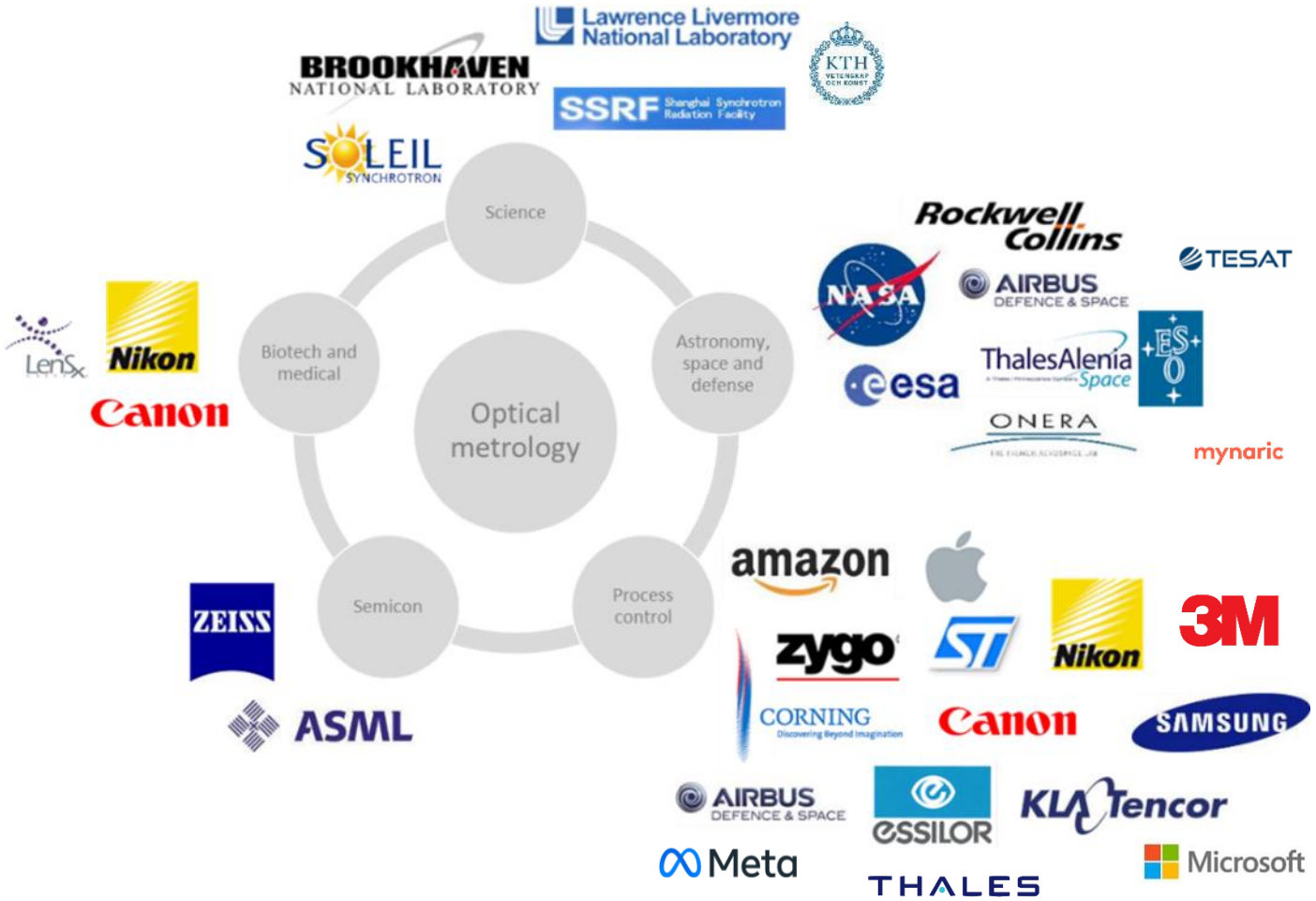


Company

+ Founded in **1996**, development and manufacturing of **wavefront sensing** & **adaptive optics**
+ **55** employees, **6.5 M€** revenue
+ 35+ patents granted
+ > **2000 sensors** worldwide…
+ > **200 Adaptive optics** systems with Mirao52e for ophthalmology and microscopy and
  > **70 adaptive optics** systems with ILAO & ILAO Star for high-power lasers in > 10 countries

Company


Paris (Headquarter)
Bordeaux
Beijing
San Francisco
Boston
Barcelone
Systematic
Paris Region Digital Ecosystem
Route des Lasers
THE PLACE TO BE
EPIC
Photonics
France
ASTech
FO-RS
Freeform Optics
Research and solutions
SPIE
OSA
afaq
ISO 9001
Qualité


Lawrence Livermore
National Laboratory
BROOKHAVEN
NATIONAL LABORATORY
SSRF
Shanghai Synchrotron
Radiation Facility
KTH
SOLEIL
SYNCHROTRON
Science
Biotech and
medical
Optical
metrology
Astronomy,
space and
defense
Semicon
Process
control
Rockwell
Collins
TESAT
NASA
AIRBUS
DEFENCE & SPACE
ThalesAlenia
Space
ESO
esa
ONERA
mynaric
LensX
Nikon
Canon
ZEISS
ASML
amazon
zygo
Nikon
3M
CORNING
Discovering Beyond Imagination
Canon
SAMSUNG
AIRBUS
DEFENCE & SPACE
ESSILOR
KLA Tencor
Meta
THALES
Microsoft

Wavefront sensing

(Shack-Hartmann) Wavefront sensing is a metrology technique that provides quantitative metrics on:

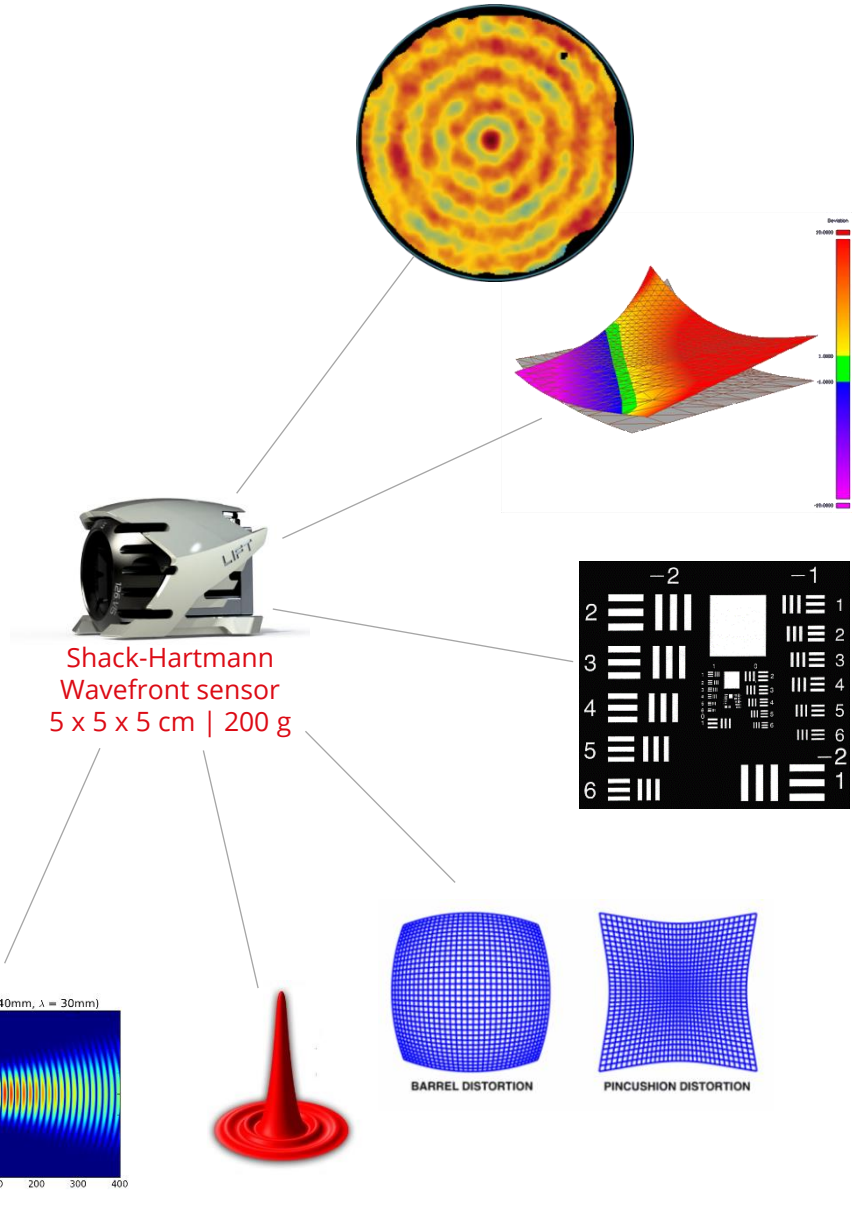
Optical quality

+ Transmitted wavefront error
+ Surface shape / surface deviation
+ MTF
+ Distortion

Mounting / adjusting / optimizing

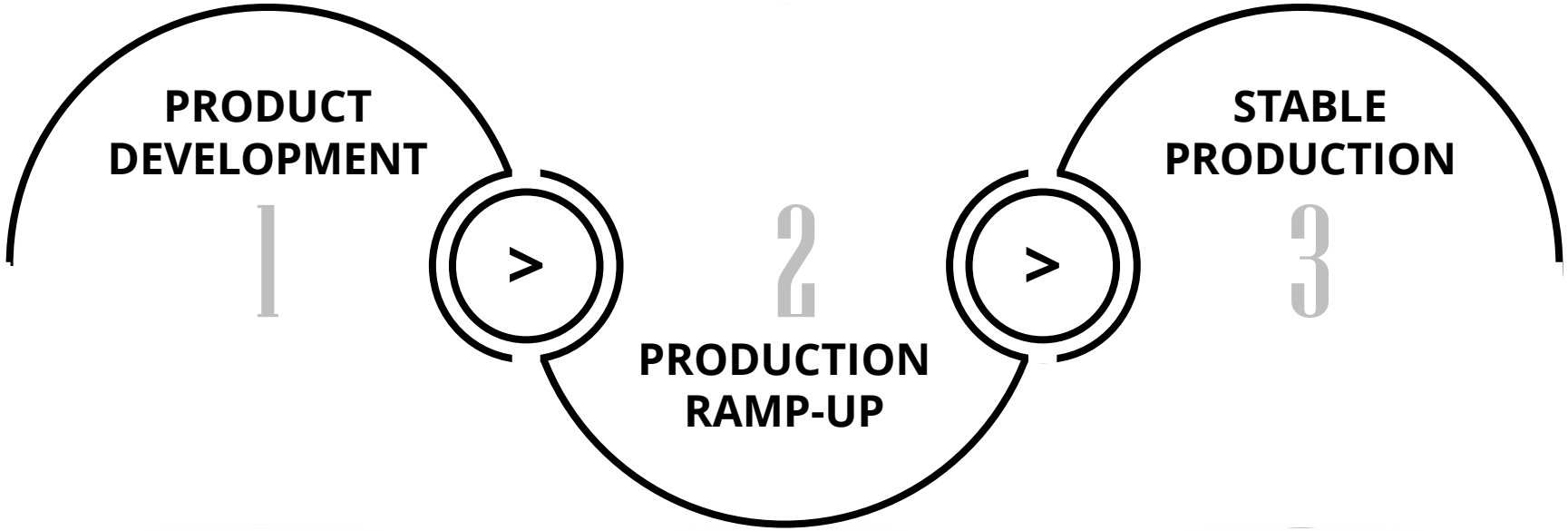
+ Optical alignment in live
+ Knowledge on source of errors

Laser diagnostic
Adaptive optics control



Wavefront sensing for AR/VR/MR integration & production

Product development process



Use & needs for optical metrology	+ Validation of th. models + Optimization of designs + Evaluation of proto performances	+ Transitioning from R&D to production + Development and tuning of production tools + Validation of pre-serie	+ Routine QC + Drift, wear + ISO std. assurance

Wavefront sensing for AR/VR/MR

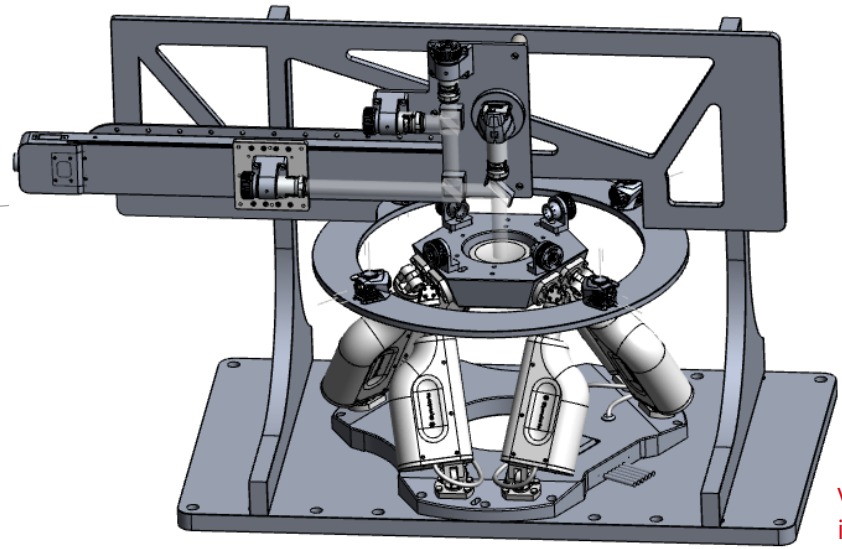
PRODUCT DEVELOPMENT

+ Technical challenge is in general **very high** (complex and new)
  → Use of standard (existing) metrology solutions w/ specific implementation to adapt for specificity of samples
  → Development of new solution

+ Metrology performed by **experts**, highly skilled / trained resources
+ Usually iterative process
+ **Time budget** allocated is very **large**
+ Environment is controlled and optimal

+ Evaluate/validate the metrology means used for the next phases

Off-the-shelf solutions



Very large dynamic range implementations

Specific metrology developments

Wavefront sensing for AR/VR/MR

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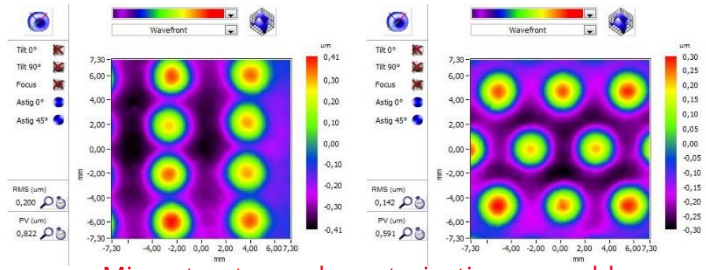
PRODUCTION RAMP-UP

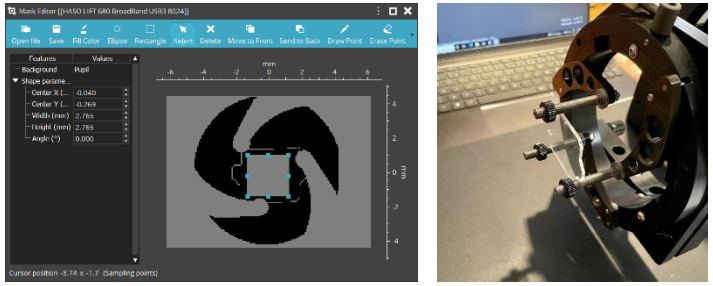
+ Similar tech. challenge (same kind of technical requirements), but **benefit from previous phase**)
+ Metrology on a different kind of object: for example on mold (shape control and deviation from mold to object molded)

+ Broadly similar

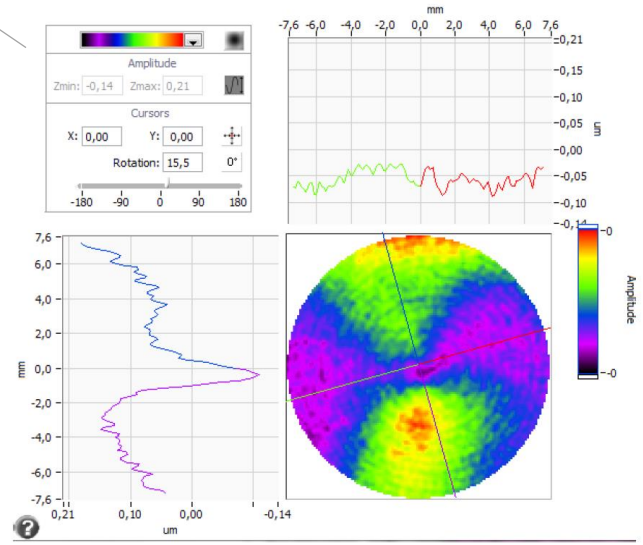
+ Define the metrology means used in stable production



Microstructures characterization on mold

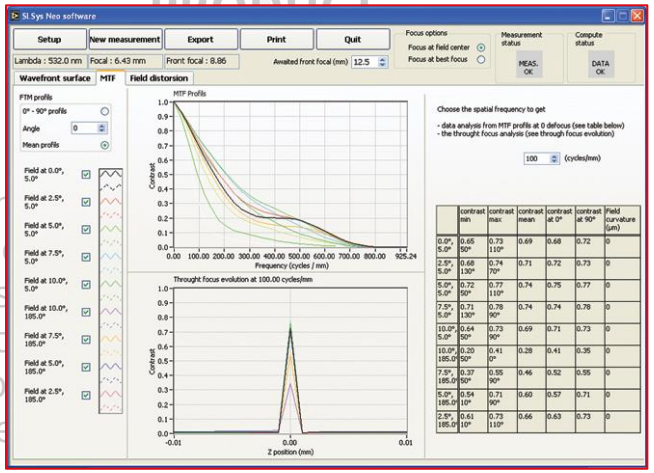


Mold development vs molded object analysis

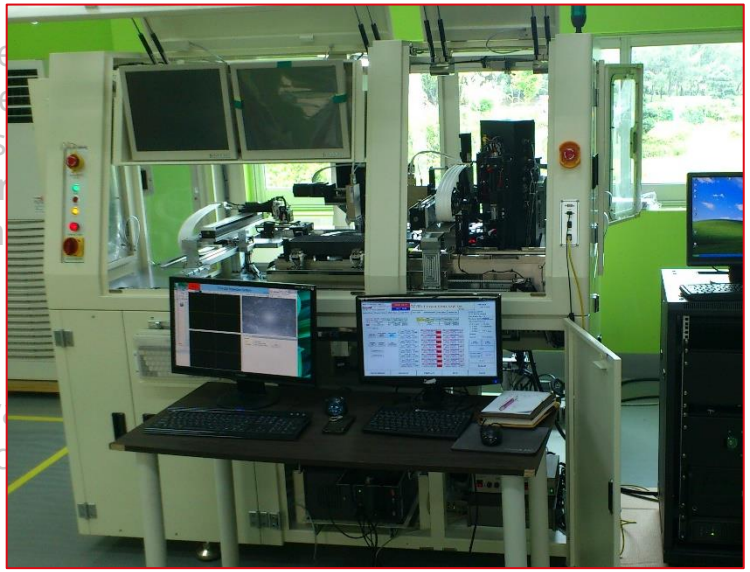


Mold polishing quality testing

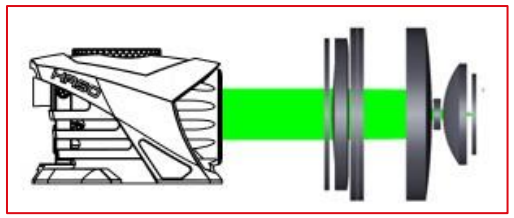
Wavefront sensing for AR/VR/MR



Automated test bench for MTF measurement



Automated test bench for focus measurement



Metrology of VR system in user working conditions

Procès-verbal de mesure de [redacted]

Informations générales

Date :

Opérateur :

Commentaire :

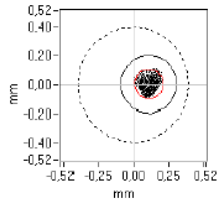
Référence visière : Numéro de série :

Numéro de série : [redacted]

Informations des colles utilisées			Respect des temps d'attente		
Type de colle					
Numéro de lot			Etape 1	Etape 2	Etape 3
Date d'ouverture		OK/KO	OK/KO	OK/KO	OK/KO
Date de péremption		OK/KO			

Résultats

	Mesuré	Tolérance (<)	Sanction
Décentrage X (mm)			
Décentrage Y (mm)			
Défocalisation (mm)			
P.V de déformation (µm)			OK/KO
Décentrage total (mm)			OK/KO
Diamètre de tâche (mm)			OK/KO



Tolérance de centrage
Tolérance de taille
Taille mesurée
Impacts

CONFORME / NON CONFORME

Référence : Yxxxxxxx Rev : xx

Notes :

Bonding under live optical metrology

3 STABLE PRODUCTION

+ Measurement can **eventually** be **much simpler** than in the first two stages
  → Use same technology (because already validated)
  → Different implementation
+ Measurements according to **ISO standards**

Fully in production environment:
+ Easy to use by any operators
+ Fast (systematic or sampling)
+ At line
+ Robustness to vibrations
+ Automation: SDKs for software integration in
+ Reactive technical support

Wrap up

xR: technically complex application
=> first challenge to address

Necessary **transitioning through phases** to get to production:
=> Technology supports these phases
=> Technology adapts so that we can inherit from dev. & knowledge acquired

Requirements change through phases
and can eventually simplify in production…
…or not!

Wrap up

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rporcar@imagine-optic.com

Pleased to provide more information
Happy to perform **tests on your samples**

Support information