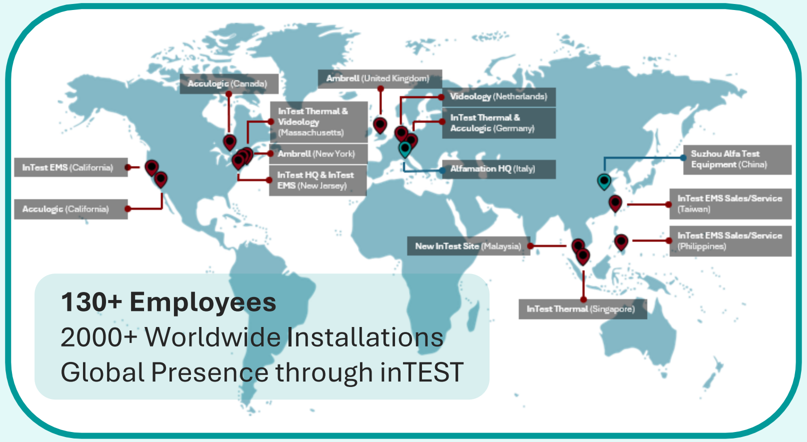
# Micro-Optics Functional Testing for PICs, Datacom and Telecom

Micro-optics
SUMMIT & EXPO
**Amsterdam**
2nd & 3rd December 2024

Sébastien Reithinger
*Technical Leader Opto*

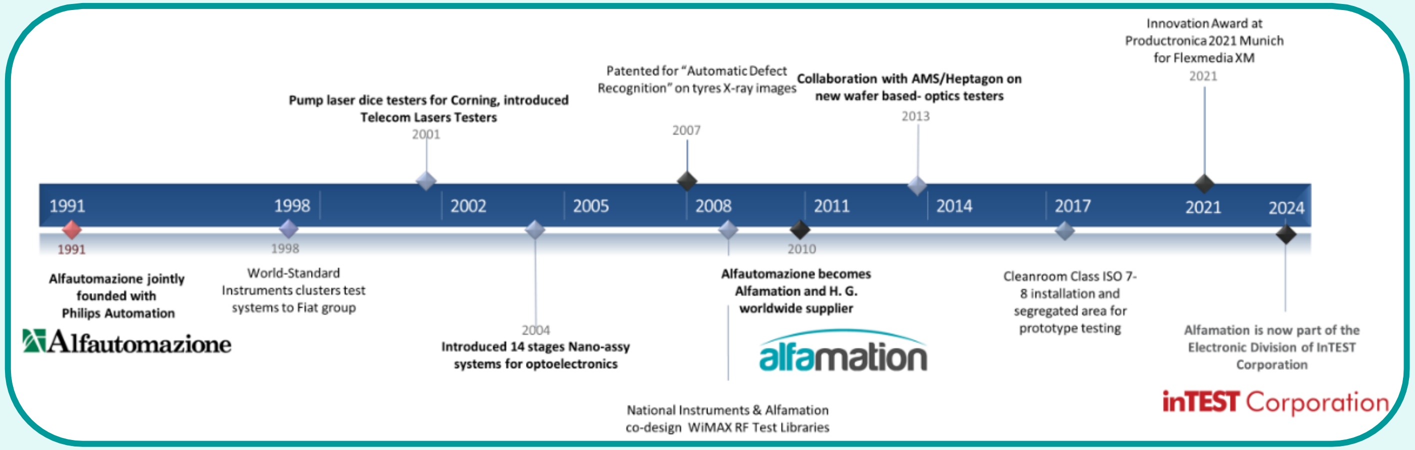
# Alfamation - 33 years of expertise


Headquarters in Lissone (MB)
Italy
Part of inTEST Corp. (NJ USA)
NYSE: **INTT**



**130+ Employees**
2000+ Worldwide Installations
Global Presence through inTEST

- Strong R&D and Engineering
- Expertise in Optics
- Deep knowledge in Image Processing
- Experience in Optoelectronics and Photonics



1991 — **Alfautomazione jointly founded with Philips Automation**

1998 — World-Standard Instruments clusters test systems to Fiat group

2001 — **Pump laser dice testers for Corning, introduced Telecom Lasers Testers**

2004 — **Introduced 14 stages Nano-assy systems for optoelectronics**

2007 — Patented for "Automatic Defect Recognition" on tyres X-ray images

National Instruments & Alfamation co-design WiMAX RF Test Libraries

2010 — **Alfautomazione becomes Alfamation and H. G. worldwide supplier**

2013 — **Collaboration with AMS/Heptagon on new wafer based- optics testers**

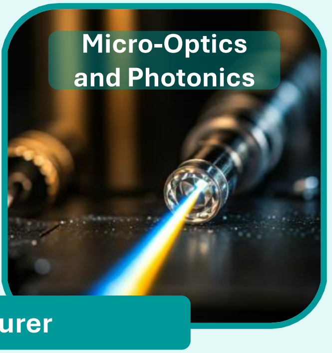
Cleanroom Class ISO 7-8 installation and segregated area for prototype testing

2021 — Innovation Award at Productronica 2021 Munich for Flexmedia XM

Alfamation is now part of the Electronic Division of InTEST Corporation


**Consumer Electronics**


**Automotive Infotainment**


**Micro-Optics and Photonics**

**Diversified Global Manufacturer**

- RF & Wireless
- Infotainment & Telematics
- 5G and V2X

- Consumer Electronics
- Displays
- PCBA Functional Test

- Audio Amplifier Test
- 32 Simultaneous Audio Channel Testing

## Hyperion™ Common Test Platform

## flexmedia XM

MULTIPLE INSTRUMENTS, ONE FAMILY

- Specialty Test Modules
- Audio-Video Generators/Analyzers
- Camera Simulators
- Ethernet-powered, OS-Agnostic

BATTERY MANAGEMENT PCBA TEST

Single-Site Drawer

Dual-Site Turntable

Dual-Site Drawer

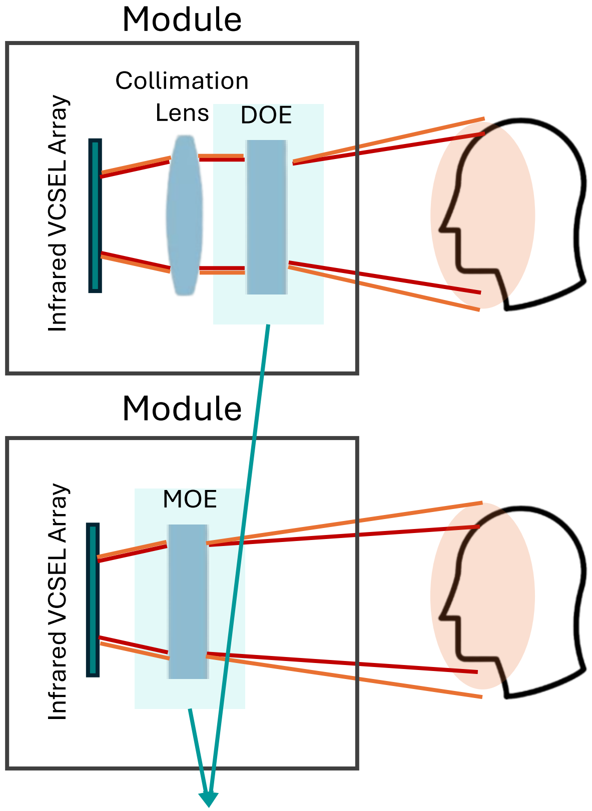
## Pixelshooter™ Automated Display Tester

## WALOT

WAfer-Level-Optics Tester

For High-Volume Manufacturing

# Conoscopy Mode: DOEs and MOEs testing

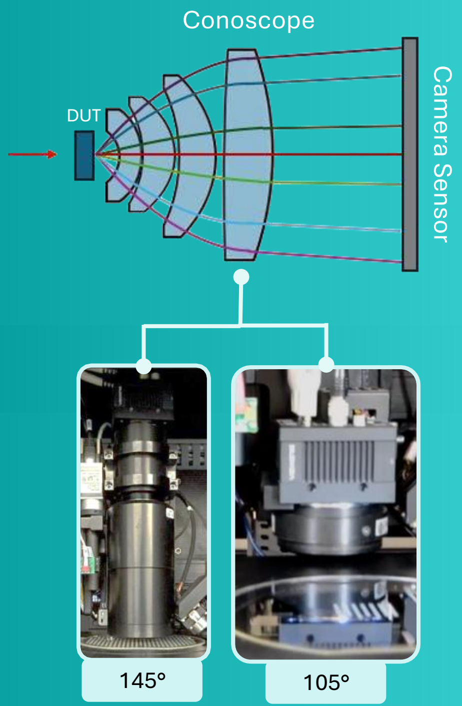


**Tested at Wafer-Level!**

DOEs and MOEs are used for both **Dot Pattern Projection (red)** and **Flood Illumination (orange)** in the face id and gesture recognition procedure.

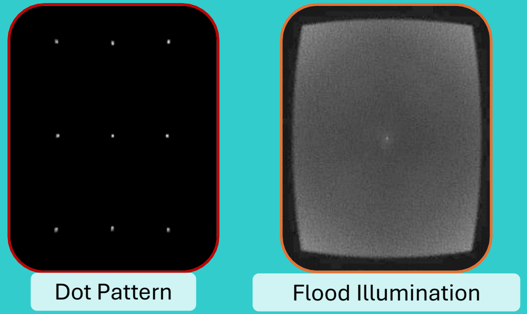
# Conoscopy Mode: Test Principle and Configuration

- **High-resolution camera + Conoscope**
- **High acceptance angle**
- **Angular Map**



Different conoscopes design for different needs!

Acquired Images


Dot Pattern
Flood Illumination

**Test Metrics: Angular Distribution, Transmission Efficiency, Diffraction Efficiency, Uniformity**
**Speed:** Up to **3000 UPH** (Units per hour)
**Stability: Gage R&R < 10%**

**Performance**

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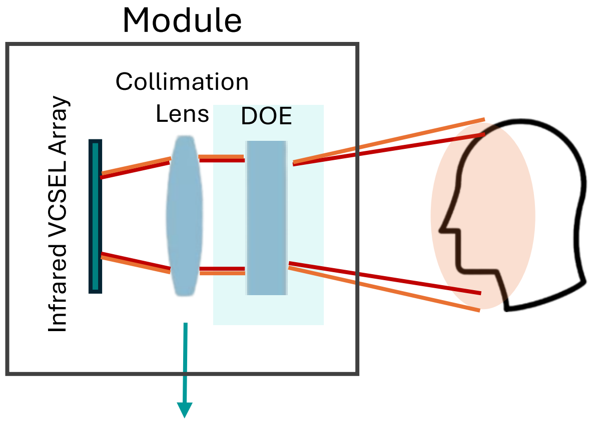
# Collimated Beam Profiling Mode: Collimation Lenses testing

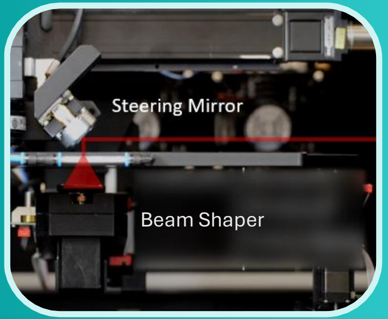
**Collimation Lenses** are components used in a very wide range of applications. In consumer electronics, they are often paired with DOEs for **face ID and gesture recognition**.

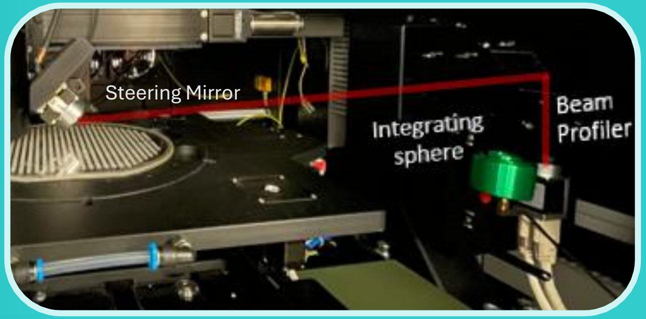


**Tested at Wafer-Level!**

# Collimated Beam Profiling Mode: Test Principle and Configuration

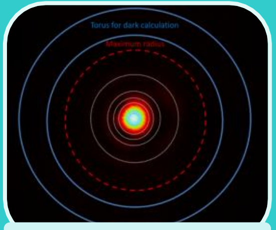
- **Distance sensor** for wafer warpage
- **Focus scan** for best focus and FFL measurement
- **Steering mirror, camera sensor** and **integrating sphere**





**Test Metrics: Spot Size, Transmitted Power, Flange Focal Length, Effective Focal Length**
**Speed:** Up to **1500 UPH** (Units per hour)
**Stability: Gage R&R < 10%**

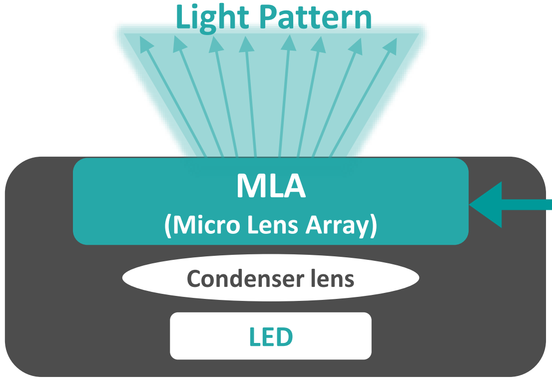
**Performance**



Spot on Beam Profiler

# Light Pattern Projector Testing

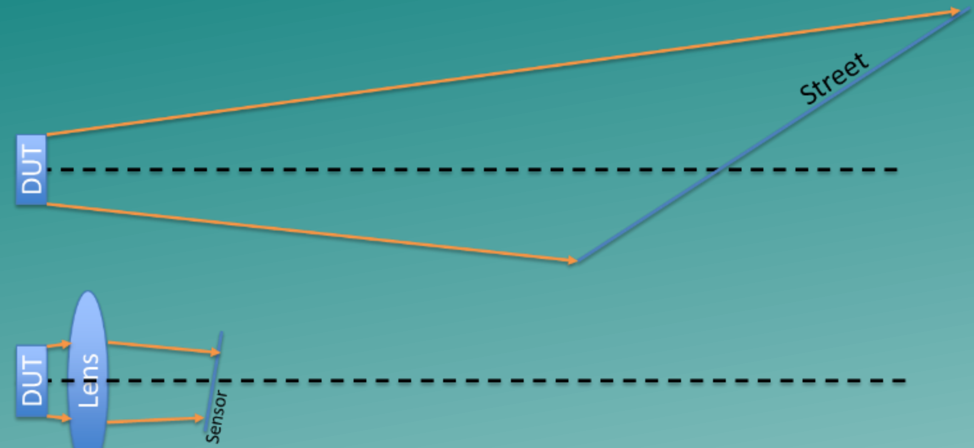
**Automotive**
Light Pattern Projection

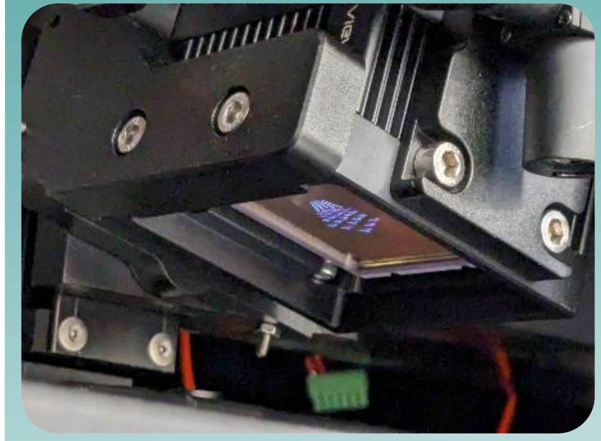


**Tested at wafer-level**

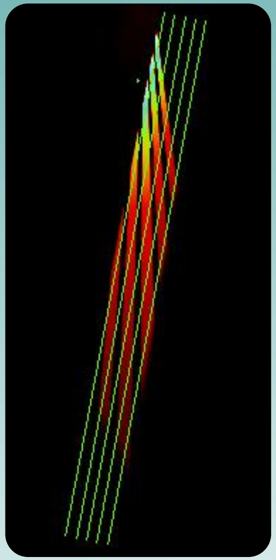
## Performance

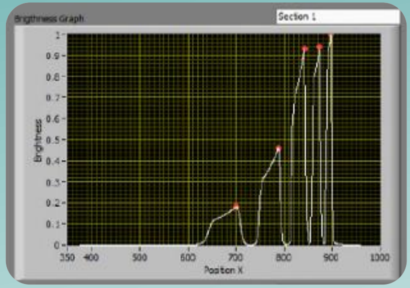
**Test Metrics:** Dimensions, Sharpness, Brightness, Ghosts.
**Automated setup flexibility**
Up to **2500 UPH**
**Gage R&R < 10%**
**Sub-mm resolution** on target image surface





Projected Image on Rotated Sensor





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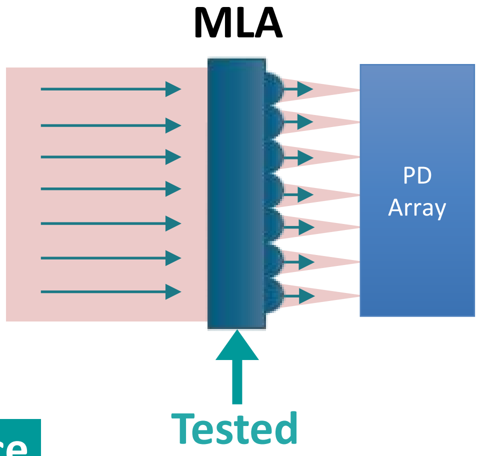
# Coupling Optics Testing

## Coupling Optics



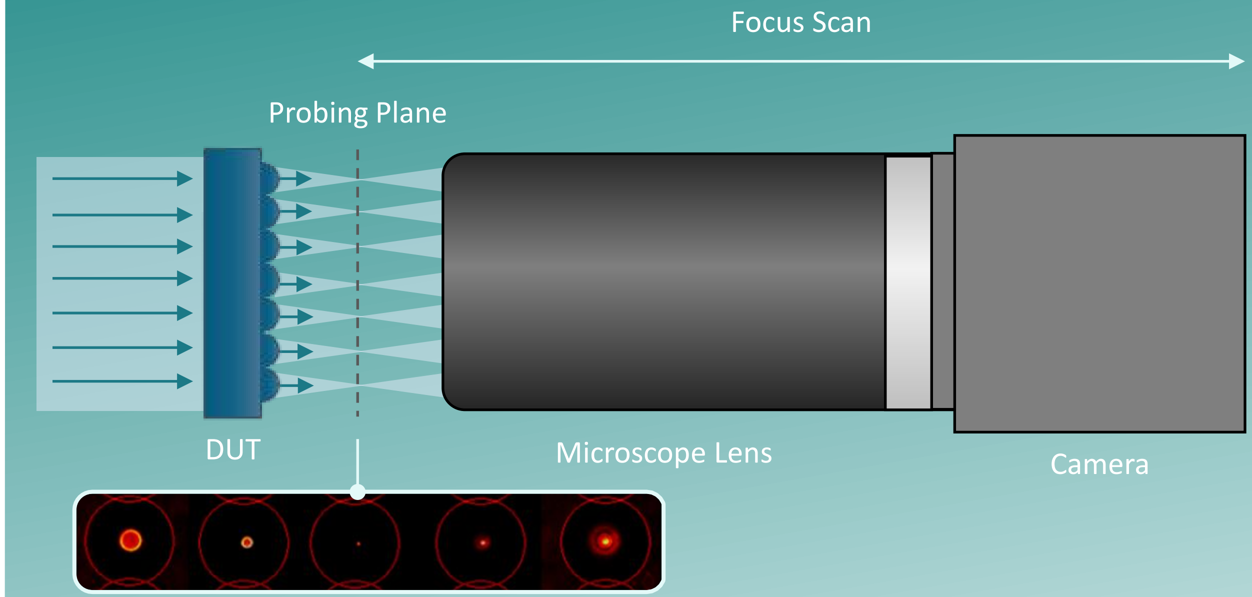
## Performance

**Metrics:** Uniformity, Flange Focal Length, Efficiency,…

Up to **1500 UPH**

**Gage R&R < 10%**

**Z Scan resolution < 5 um**



Micro-Optics Functional Testing for PICs, Datacom and Telecom

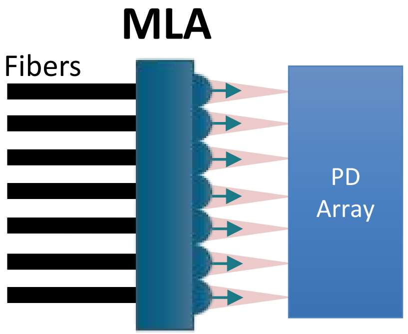
# The Challenge

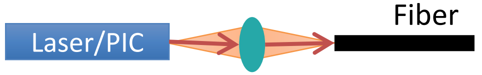
# Functional Testing vs Morphological Inspection

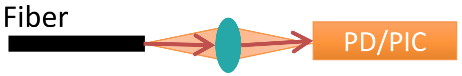
| | Morphological inspection | Functional testing |
|---|---|---|
| **Method** | Verifying shapes and dimensions:<br>Radius of curvature, thickness, diameter,… | Verifying function:<br>coupling efficiency, focal length,… |
| **Pro** | • Standard equipment's available.<br>• Covering wide range of DUT without retooling | • Direct evaluation of DUT performance.<br>• Test limits tuned for final application |
| **Cons** | • Setting test limits on shapes could be an overkill w.r.t. the function.<br>• Does not translate directly to DUT function | • Need retooling and flexibility to cover a wide range of DUT. |

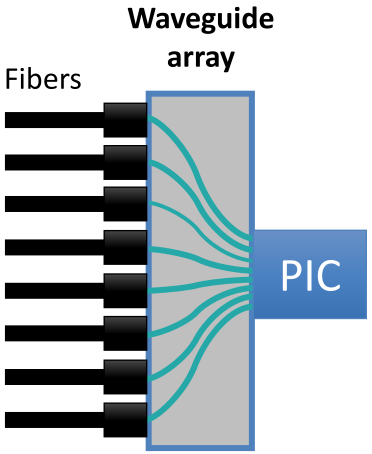
# Functional Tester Has to Adapt

- Many parameters to adapt to:
  - Design Wavelength
  - Input / output channels layout (linear, single, matrix)
  - Lens diameters
  - Lens pitch
  - Beam divergences: collimated? NA?





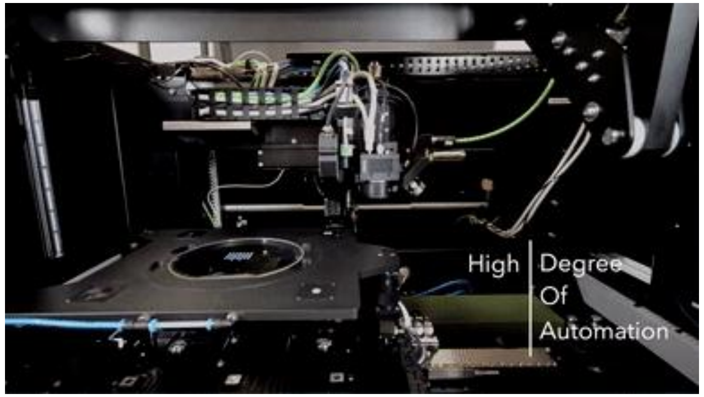




Micro-Optics Functional Testing for PICs, Datacom and Telecom

# Tackling the challenge

# What makes a good ATE ? (**A**utomated **T**est **E**quipment)



## High Throughput

- Optimized test sequence
    - Parallel processes
    - **Batch sequencing**
- Built-in step-by-step test time analyzer

## Test Reliability

- **Automated calibration sequences**
- Golden units monitoring
- Built-in statistical tools

## Cost optimization

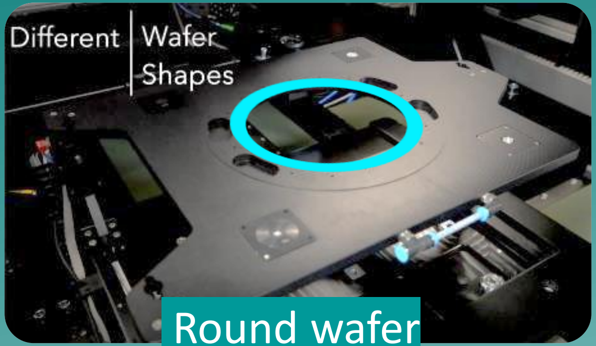
- **Sweet spot** among:
    - Instruments perf
    - Testing scope
    - Testing time
    - Test flexibility
- Standard base platform
    - **Common base components and spare parts**

## Cleanroom Friendly

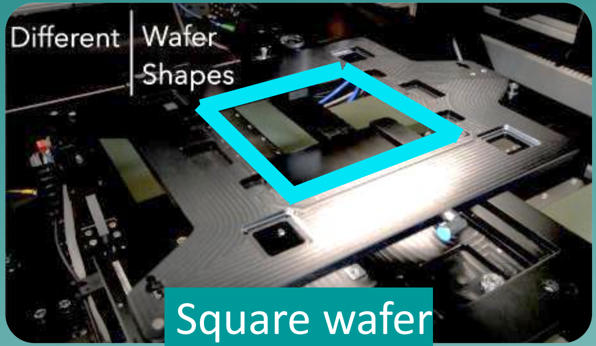
- **Low operator workload**
    - **Automated serial number reading and alignment**
    - **Robotized wafer loading**
- **Reduced footprint**
- Cleanroom compatible
- Network integration

# Flexible Setup

- Various Wafers **sizes**, **shapes** and **thickness**
- Wafer fixing :
  - Vacuum
  - Clamping
- Beam shaping of LED or Laser, with controlled:
  - Polarisation
  - Divergence
  - Intensity profile
  - Active area size and shape.

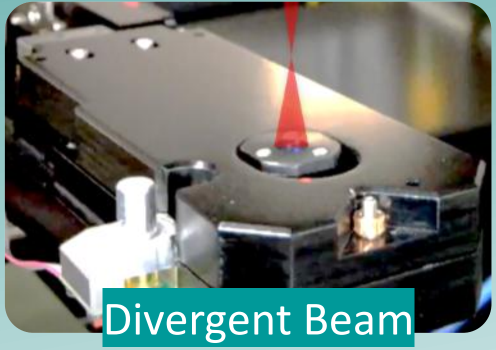


Round wafer



Square wafer

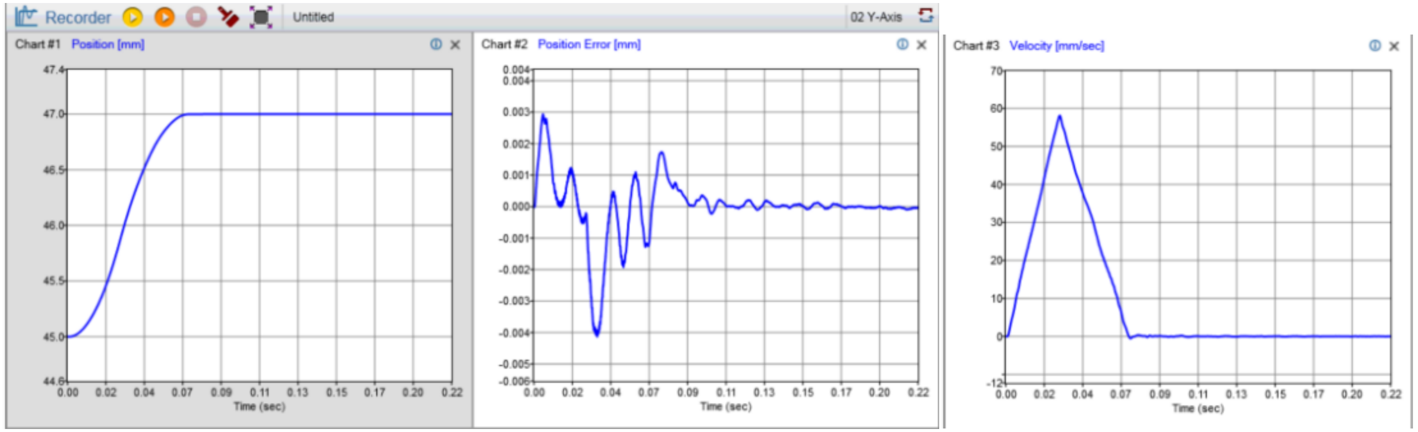

Collimated Beam

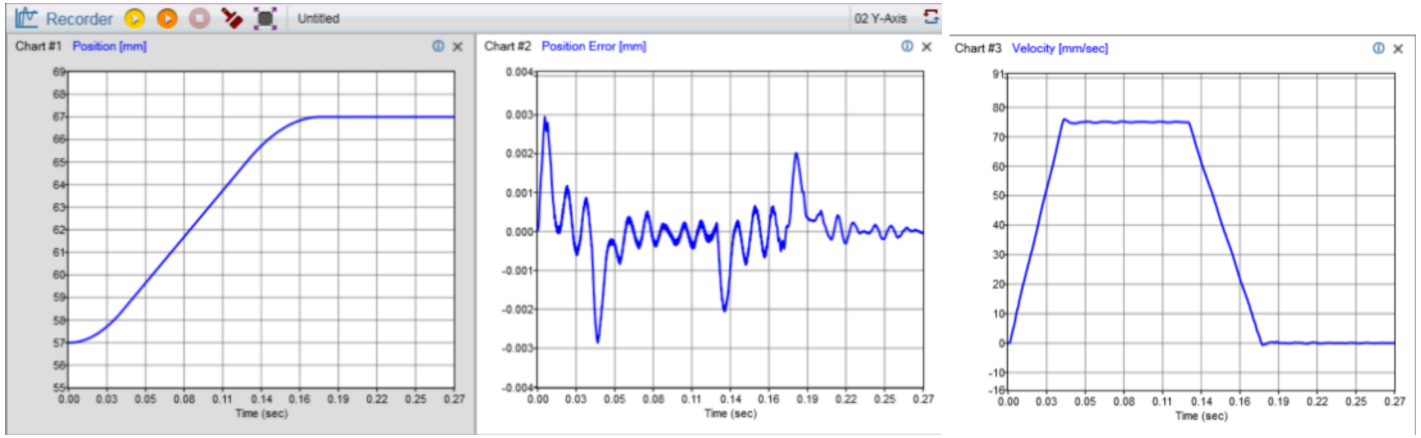

Divergent Beam

# DUT-to-DUT Wafer stepping in less than 200ms

| Step size | Stepping time (Settling within 300nm) |
|---|---|
| 2 mm | 90 ms |

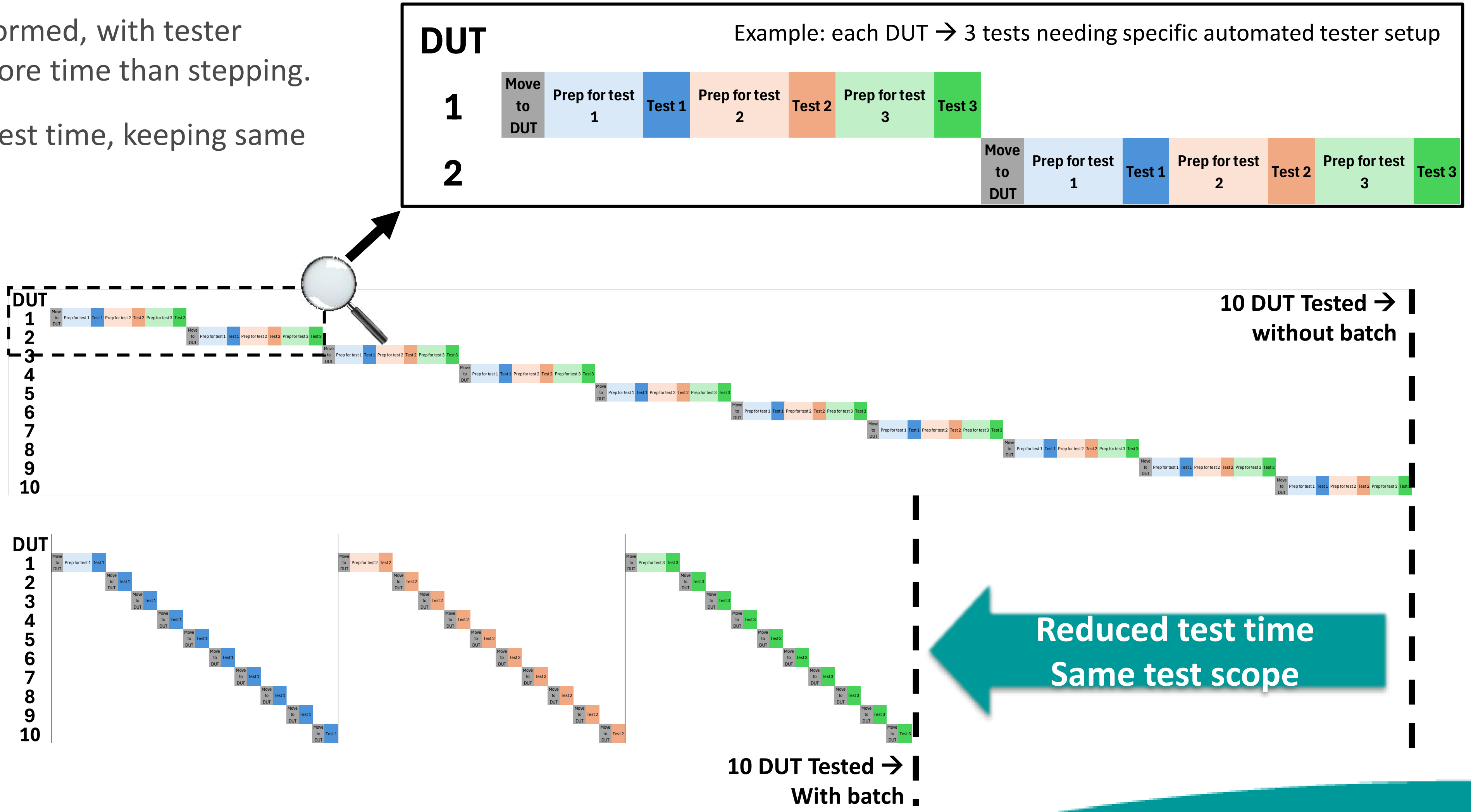
| Step size | Stepping time (Settling within 300nm) |
|---|---|
| 10 mm | 200 ms |





# Time optimization strategy for complex test scopes

- When several tests are performed, with tester setup for each test taking more time than stepping.
- Batch Testing helps reduce test time, keeping same test scope.



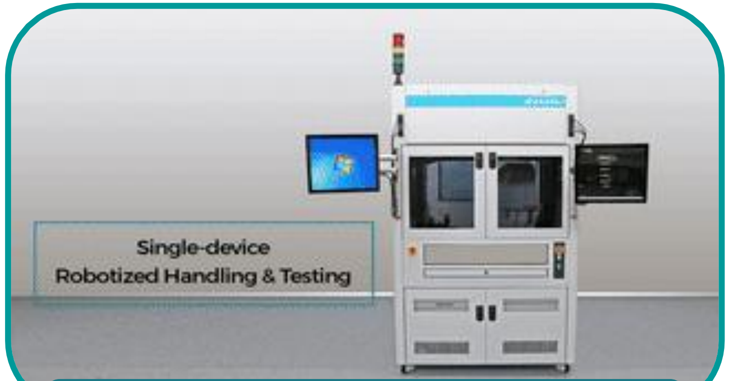
**Without Batch Testing**

**With Batch Testing**

# Collaborations

## testing micro-optics and assembled modules

- **Alfamation** is Looking for:
  - **test methods and instruments**, to be integrated.
  - **micro-optics and photonics test challenges.**
- **Alfamation,** by leveraging its strong engineering expertise, can:
  - Supply Innovative Automated Test Equipment
  - Develop new test methods
  - **Not only at wafer-level !** →



**Automated P&P Platform for Assembled Module Testing**

**Manual Loading Test Platform for Assembled Module Testing**

# VISIT US AT OUR BOOTH!

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