Displays Functional Testing

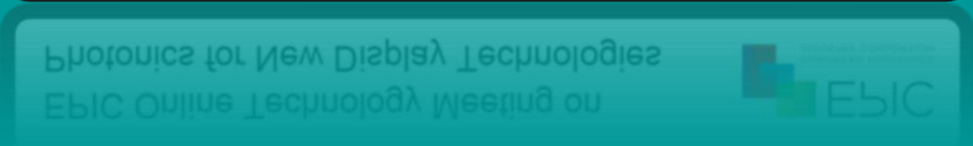Sébastien Reithinger
Technical Leader Opto

9 December 2024. 15:00-17:00 CET

EPIC Online Technology Meeting on
Photonics for New Display Technologies

EPIC
EUROPEAN PHOTONICS
INDUSTRY CONSORTIUM

MEMBER of EPIC

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InTEST Overview

**Headquarters in
Mt. Laurel, New Jersey USA
NYSE: INTT**

**Diversified Global Manufacturer of
Innovative Test and Process
Solutions**

inTEST Corporation Divisions and Brands

Electronic Test Division

inTEST EMS Products

Founded in 1981, inTEST EMS designs, manufactures, and markets test head manipulators, docking and electrical interface products that are used by semiconductor manufacturers to test integrated circuits and wafers.

ACCULOGIC an inTest company

Acculogic designs, manufactures and markets a broad range of systems and instruments for testing electronic devices, electric vehicle batteries, circuit boards and systems. Products include flying probe test systems, functional test systems and others

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Alfamation offers a wide range of products, from individual test modules to complete automated turnkey test systems for design, test, and manufacturing engineers and managers in the automotive, consumer electronics, telecommunications, and medical industries

Environmental Technologies Division

inTEST Thermal Solutions an inTEST Company

inTEST Thermal Solutions (iTS) specializes in the design and manufacture of precision temperature control systems. Our breadth of products and in-house engineering capabilities allow us to be a single-partner-solution for thermal test, process cooling, and cold storage applications. We are recognized globally for our expertise in precise temperature control and simulation of extreme thermal environments, from -185 to +500°C, with rapid transitions or long dwell times. The iTS family includes four product brands: Temptronic, Sigma Systems, Thermonics, and North Sciences.

Confidential

Process Technologies Division

Ambrell INDUCTION HEATING SOLUTIONS

Founded in 1986, Ambrell Corporation, an inTEST Company, is renowned for our application and engineering expertise. Exceptional product quality and outstanding service and support are at the core of our commitment to provide the best customer experience in the industry with operations in the United States and Europe, including the United Kingdom and The Netherlands.

Videology Industrial-Grade Cameras an inTEST Company

Founded in 1995, Videology is a global leader in the design, engineering and manufacturing of industrial-grade embedded video cameras, related systems, software and solutions. For more than 25 years we have been providing performance excellence in a broad spectrum of applications including biomedical devices, life sciences, banking, aerospace, traffic management, photo ID, pipe inspection and more.

3

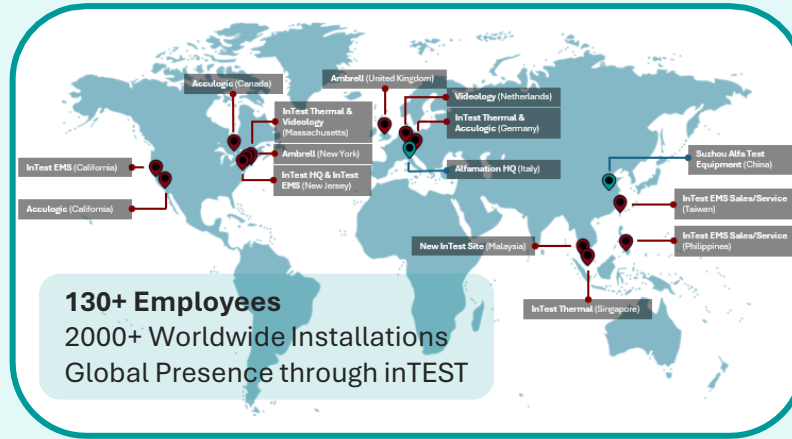|	
Market Capitalization	$162.0 million
Recent Closing Price	$13.32
52 Week Low-High	$10.66 - $27.17
Shares Outstanding	~12.2 million
Institutional Ownership	~63%
Insider Ownership	~5%

2023 Revenue $123.3M*
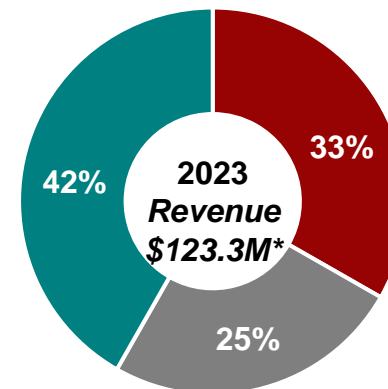
- **Process Technologies** 33%
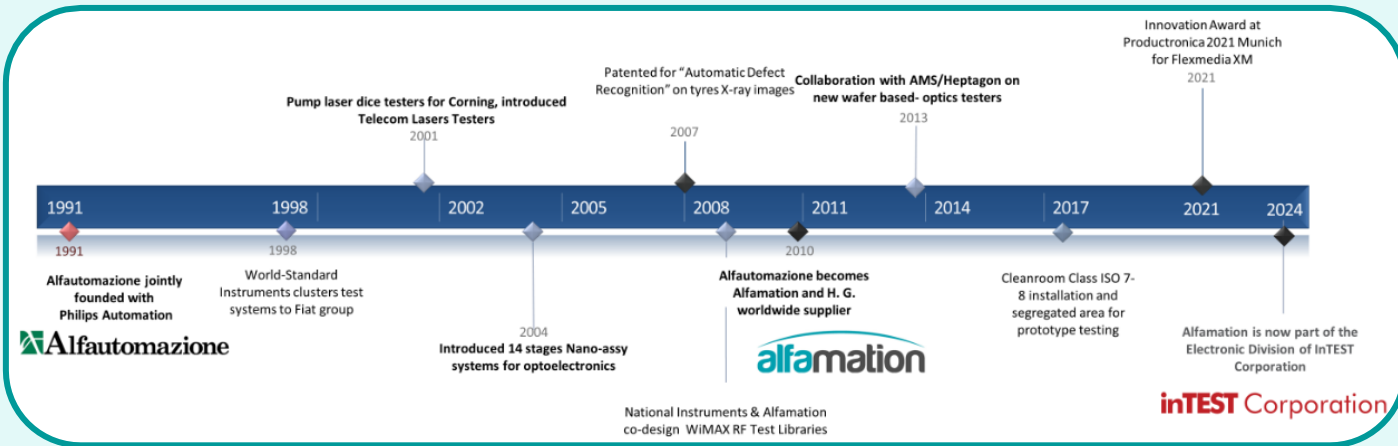- **Environmental Technologies** 25%
- 42%

*Division revenue split is unaudited
Market data as of April 1, 2024, Source: S&P Capital IQ; Shares Outstanding as of March 1, 2024; Ownership as of most recent filing.*

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

Timeline

1991 — Alfautomazione jointly founded with Philips Automation — Alfautomazione

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

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

2002 — 2004 — Introduced 14 stages Nano-assy systems for optoelectronics

National Instruments & Alfamation co-design WiMAX RF Test Libraries

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

2008 — 2010 — Alfautomazione becomes Alfamation and H. G. worldwide supplier — alfamation

2011 — 2013 — Collaboration with AMS/Heptagon on new wafer based- optics testers

2014 — 2017 — Cleanroom Class ISO 7-8 installation and segregated area for prototype testing

2021 — Innovation Award at Productronica 2021 Munich for Flexmedia XM

2024 — Alfamation is now part of the Electronic Division of InTEST Corporation — inTEST Corporation

Market Segments

Consumer Electronics

Automotive Infotainment

Micro-Optics and Photonics

Diversified Global Manufacturer

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- 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

PRODUCTRONICA INNOVATION AWARD WINNER 2021 flexmedia XM

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

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Display Functional Testing
"The Challenge of Ensuring High-Quality Displays"

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Electrical Tests and Firmware Checks

- Voltage Measurement
- Short-Circuit Test
- Current Consumption
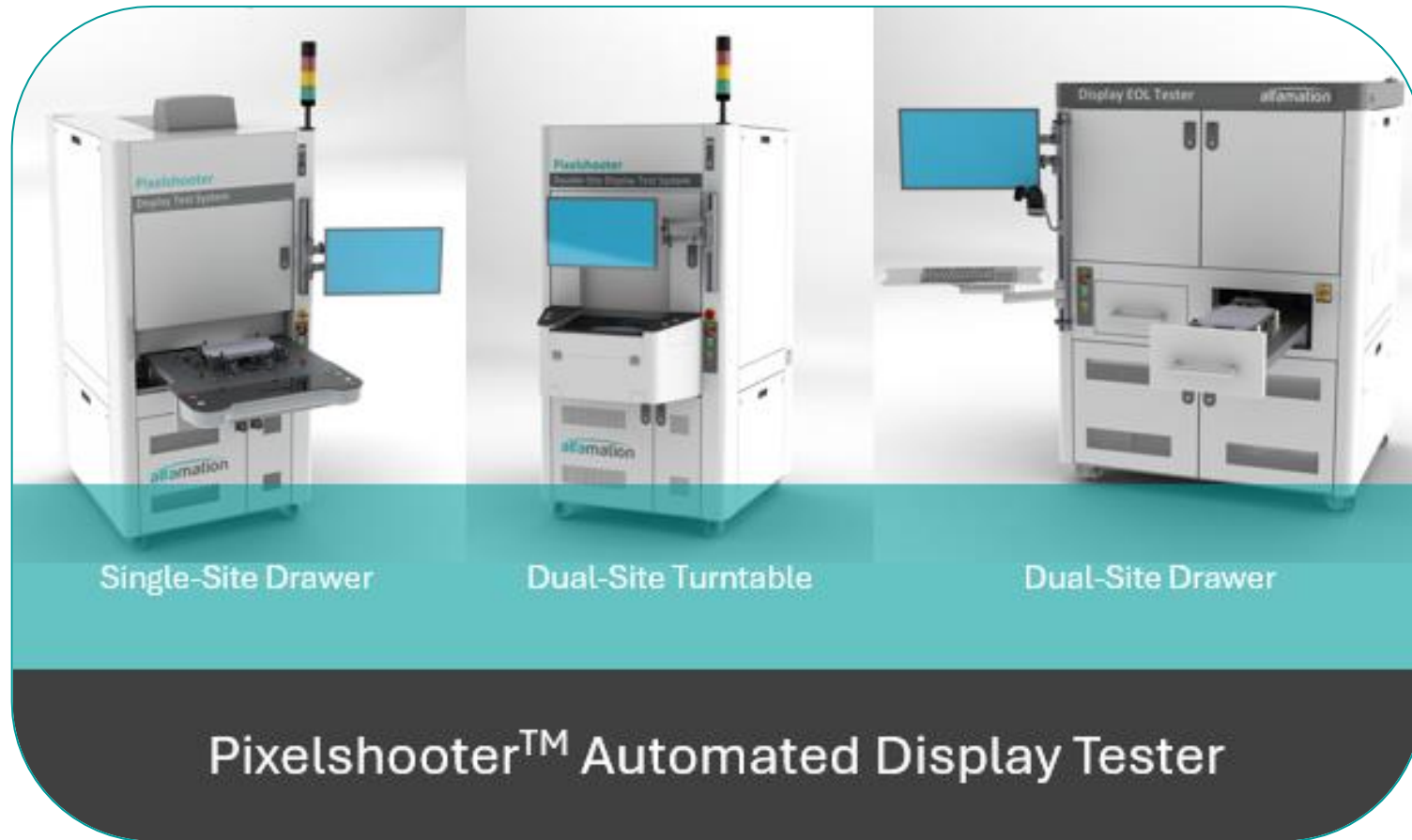- Standby Current
- Current vs Backlight

Optical, Vision and sensors Tests and Calibrations

- Defective Pixels
- Colour Measurements
- Brightness and Contrast
- Gamma
- Uniformity and MURA
- Flicker
- Cosmetic Defects
- Ambient Light Sensor Test

Haptic Tests

- Button Force
- Knob Rotation
- Touch Screen: Single Touch
- Touch Screen: Slide
- Touch Screen: Multi-Touch

All In One Scalable Solution

Single-Site Drawer   Dual-Site Turntable   Dual-Site Drawer

Pixelshooter™ Automated Display Tester

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Pixelshooter™
Double Test Site – Turntable
Case Study – Tester Structure

The following is a high-level representation the structure of **Pixelshooter™ Double Test Site – Turntable:**

3.Camera Group

4.SCARA Robot

5.Robot Tools

1.Test Chamber
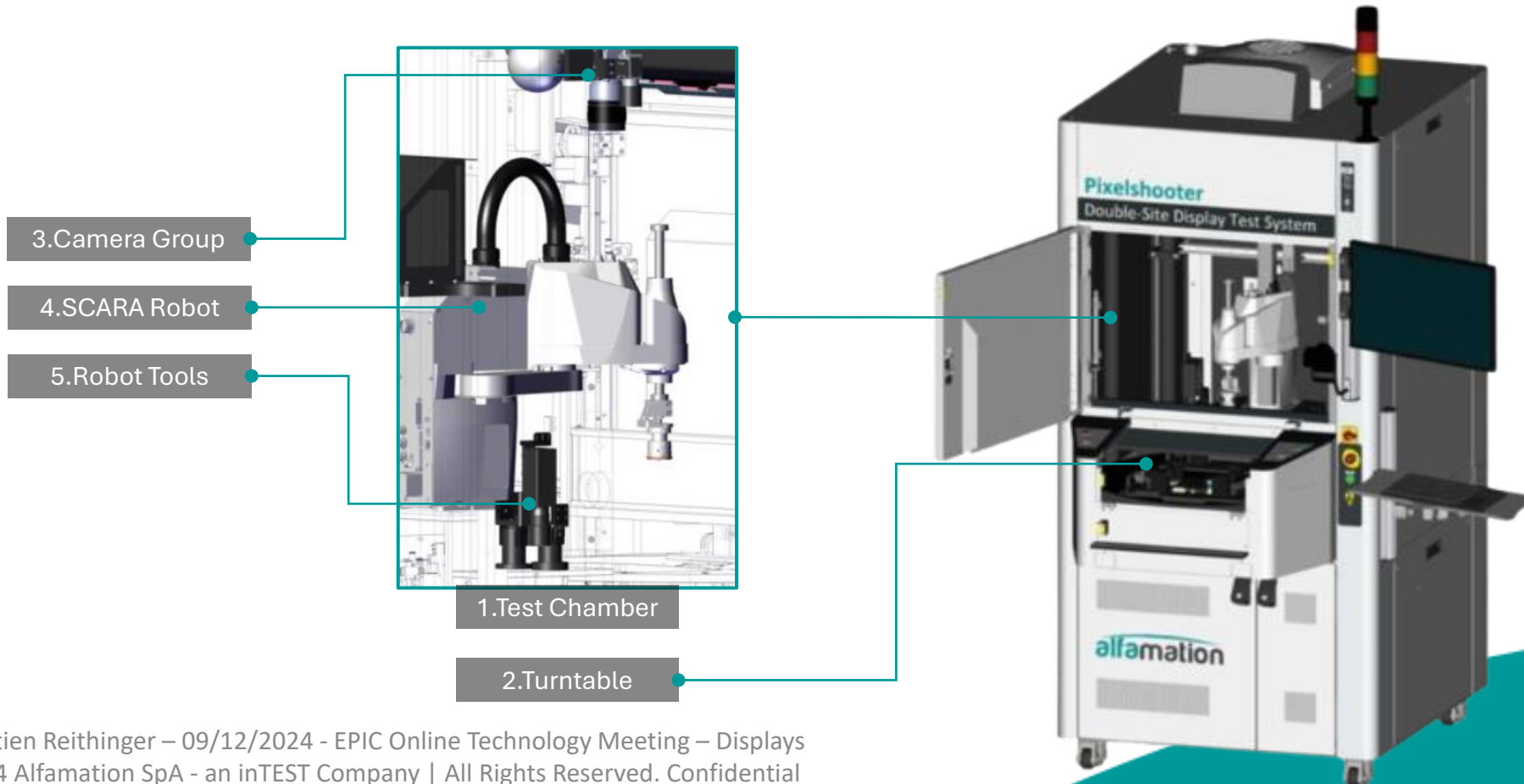
2.Turntable

1. **Test Chamber:** enclose cell where optical, vision and haptic tests are performed
2. **Turntable:** turning table which host the fixture where the DUT is connected and the operator console – it rotates the DUT in and out of the test chamber
3. **Camera Group:** bracket where the high-resolution BW camera and eventually the Colour Camera are mounted
4. **SCARA Robot:** robot which automates the test handling inside the test chamber
5. **Robot Tools:** tools that the robot can equip during the test sequence, such as: rubber finger tools, colorimeters, custom gantries for multi-touch and more
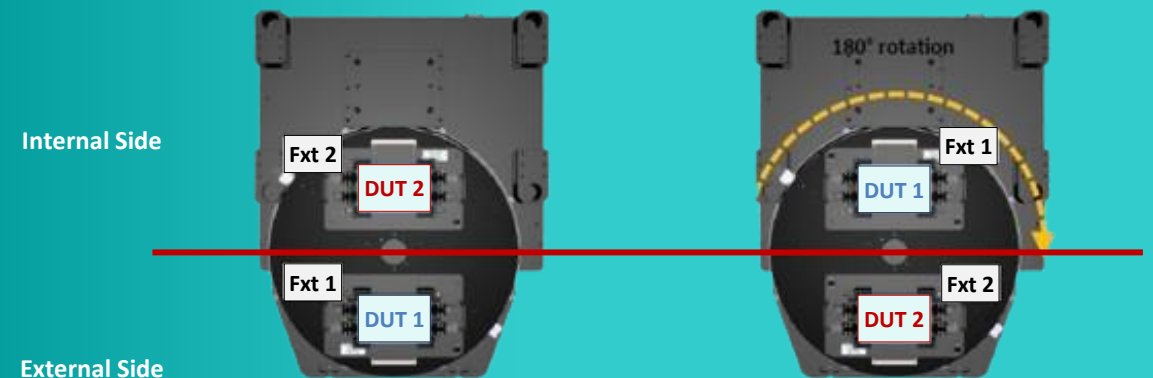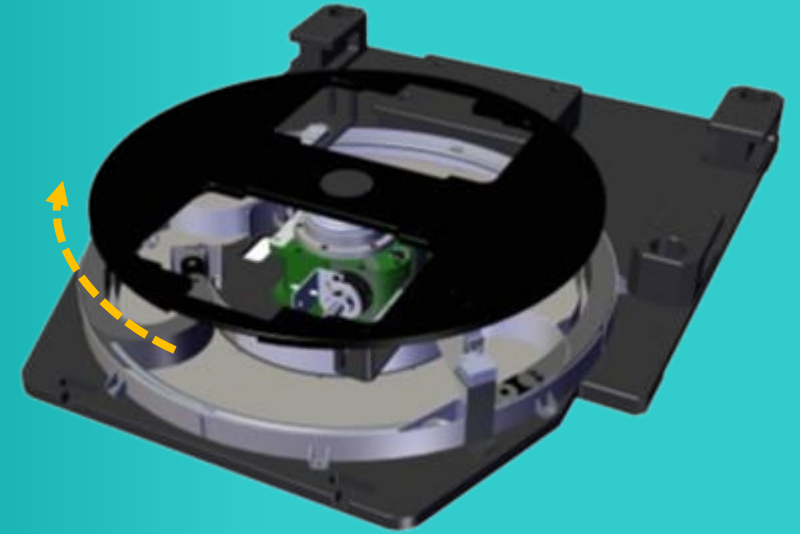
Pixelshooter™
Double Test Site – Turntable
Case Study – Smart Throughput

The **Pixelshooter™ Double Test Site – Turntable** provides a smart solution to increase the throughput without the need of duplicating the entire test cell.

The system comes with **2 Test Sites** (Fixtures) on a **rotating table** as shown in the pictures. On test site is **inside the test cell**, where optical, vision and haptic tests are performed. The other test site is **outside the test cell**, where the DUT startup, electrical tests, firmware configurations and upgrade are performed.

When DUT 1 is loaded, the tester will start to perform the "outside tests"; once done the table automatically rotate DUT1 inside to continue with the "inside tests". Once DUT 1 is inside, it is possible to both **load** DUT 2 and **start the "outside tests" in parallel**.
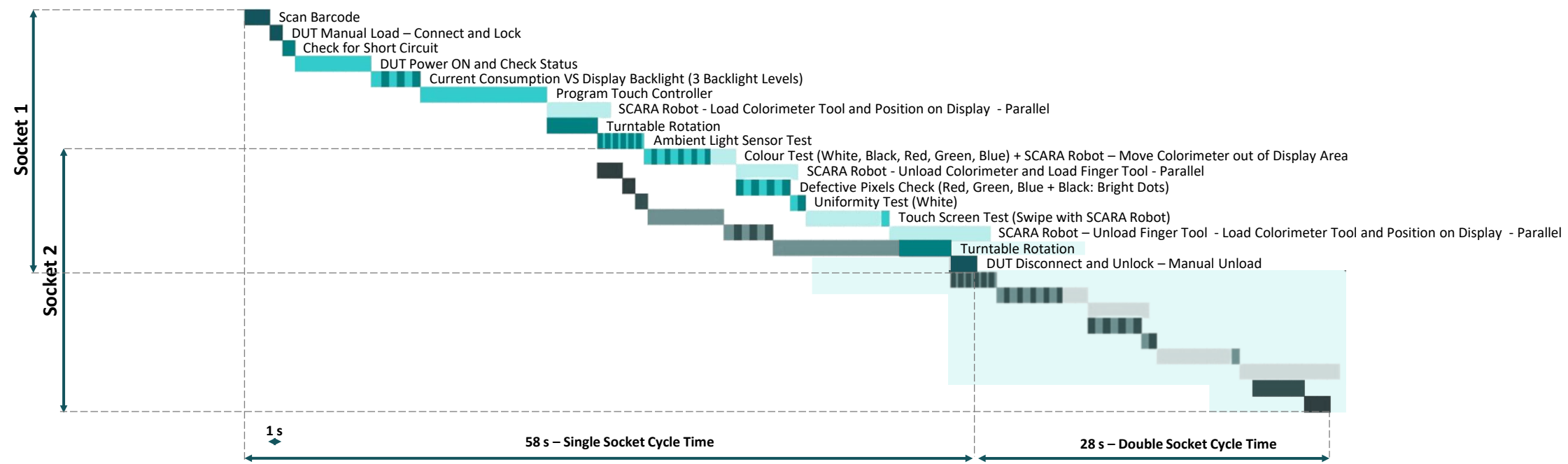
Pixelshooter™
Double Test Site – Turntable
Case Study – Cycle Time

The following is the breakdown of a test cycle performed on **Pixelshooter™ Double Test Site – Turntable**:

Chart labels (top to bottom):
- Scan Barcode
- DUT Manual Load – Connect and Lock
- Check for Short Circuit
- DUT Power ON and Check Status
- Current Consumption VS Display Backlight (3 Backlight Levels)
- Program Touch Controller
- SCARA Robot - Load Colorimeter Tool and Position on Display - Parallel
- Turntable Rotation
- Ambient Light Sensor Test
- Colour Test (White, Black, Red, Green, Blue) + SCARA Robot – Move Colorimeter out of Display Area
- SCARA Robot - Unload Colorimeter and Load Finger Tool - Parallel
- Defective Pixels Check (Red, Green, Blue + Black: Bright Dots)
- Uniformity Test (White)
- Touch Screen Test (Swipe with SCARA Robot)
- SCARA Robot – Unload Finger Tool - Load Colorimeter Tool and Position on Display - Parallel
- Turntable Rotation
- DUT Disconnect and Unlock – Manual Unload

Vertical axis: Socket 1, Socket 2

Scale: 1 s

58 s – Single Socket Cycle Time | 28 s – Double Socket Cycle Time

Legend:
- Manual Operations performed by Human Operator
- Tester Operations
- Display Operations (e.g. Power On, Set Brightness/Colour, …)
- SCARA Robot Movements

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Pixelshooter™
Double Test Site – Turntable
Case Study – Spotlight: Ambient Light Sensor Test

Below is reported an example of Ambient Light Sensor Test setup:
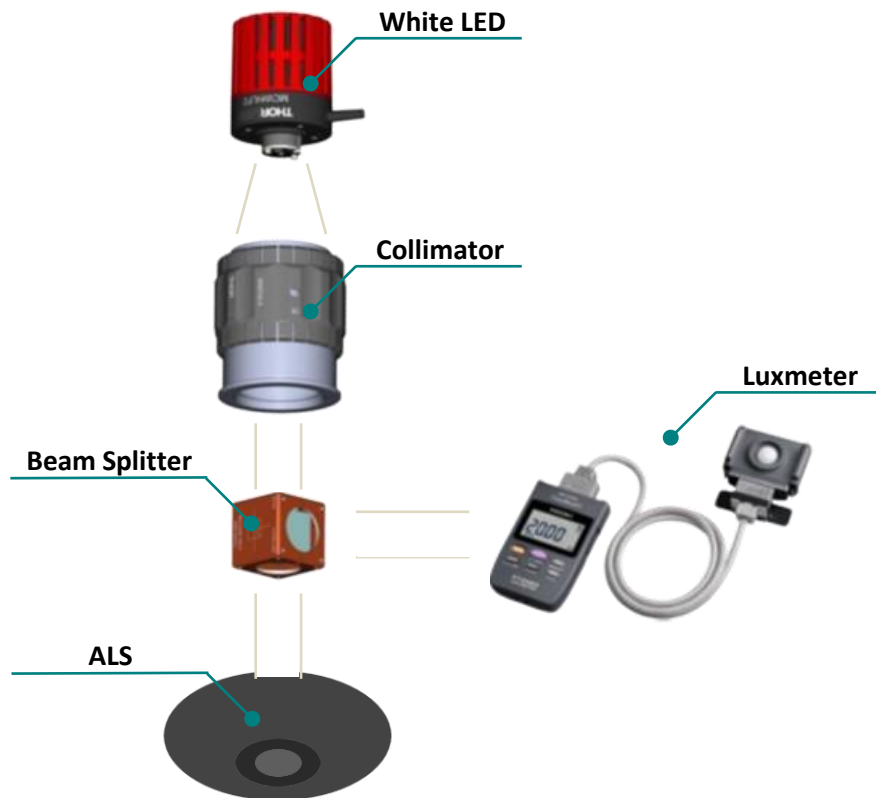
Inside the test cell a **White LED** with known spectral features is coupled to a **Collimator** optics. The resulting collimated beam is deviated on two different path by a **Beam Splitter**: on path leads to a **Luxmeter**, the other one leads to the **Ambient Light Sensor** on the DUT.

The Luxmeter is used to **calibrate the illumination intensity** that gets to the ALS: this way the system can deliver known illumination levels to ALS and characterize the response read from the device accordingly.

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Case Study – Spotlight: Defective Pixels Check

Below is reported an example of Defective Pixels Check analysis:
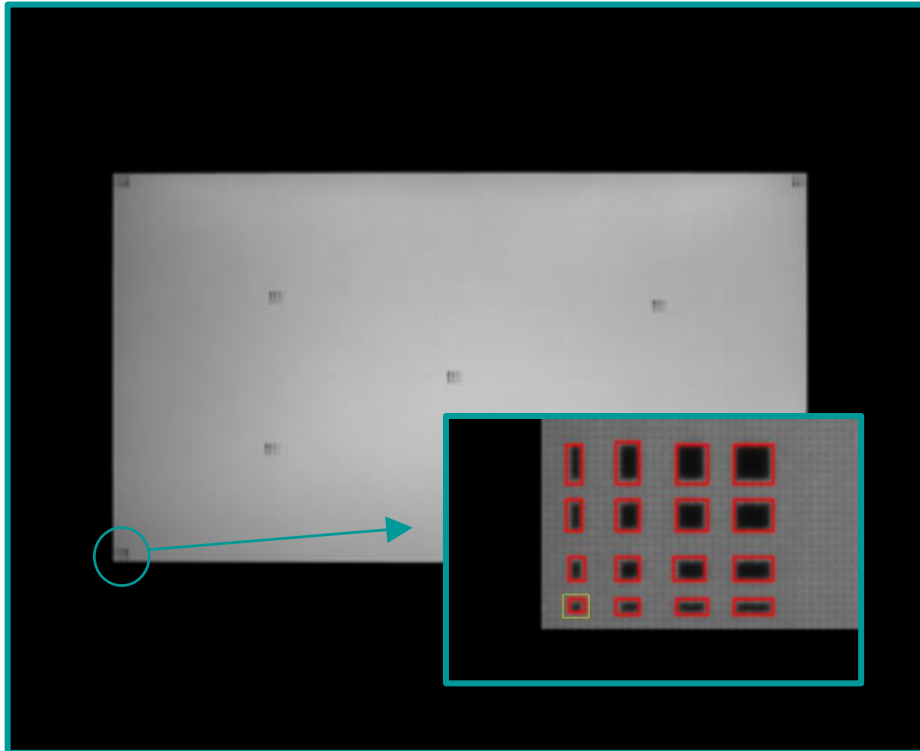
The **High-Resolution Camera** within the test cell allows perform **defective pixels** checks (electrical failures) **down to the single subpixel**. Multiple algorithm options are implemented to detect defects under different conditions.
It is possible to classify the resulting defects in terms of position, dimensions and aspect ratio.
The same algorithms are applied to find **bright dots** on black images.

The image shows a device displaying a flat green background.
Defects with different dimensions and aspect ratios are simulated in different areas of display.
The system manages to detect defects down to the single subpixels **even close to the borders of the device**.

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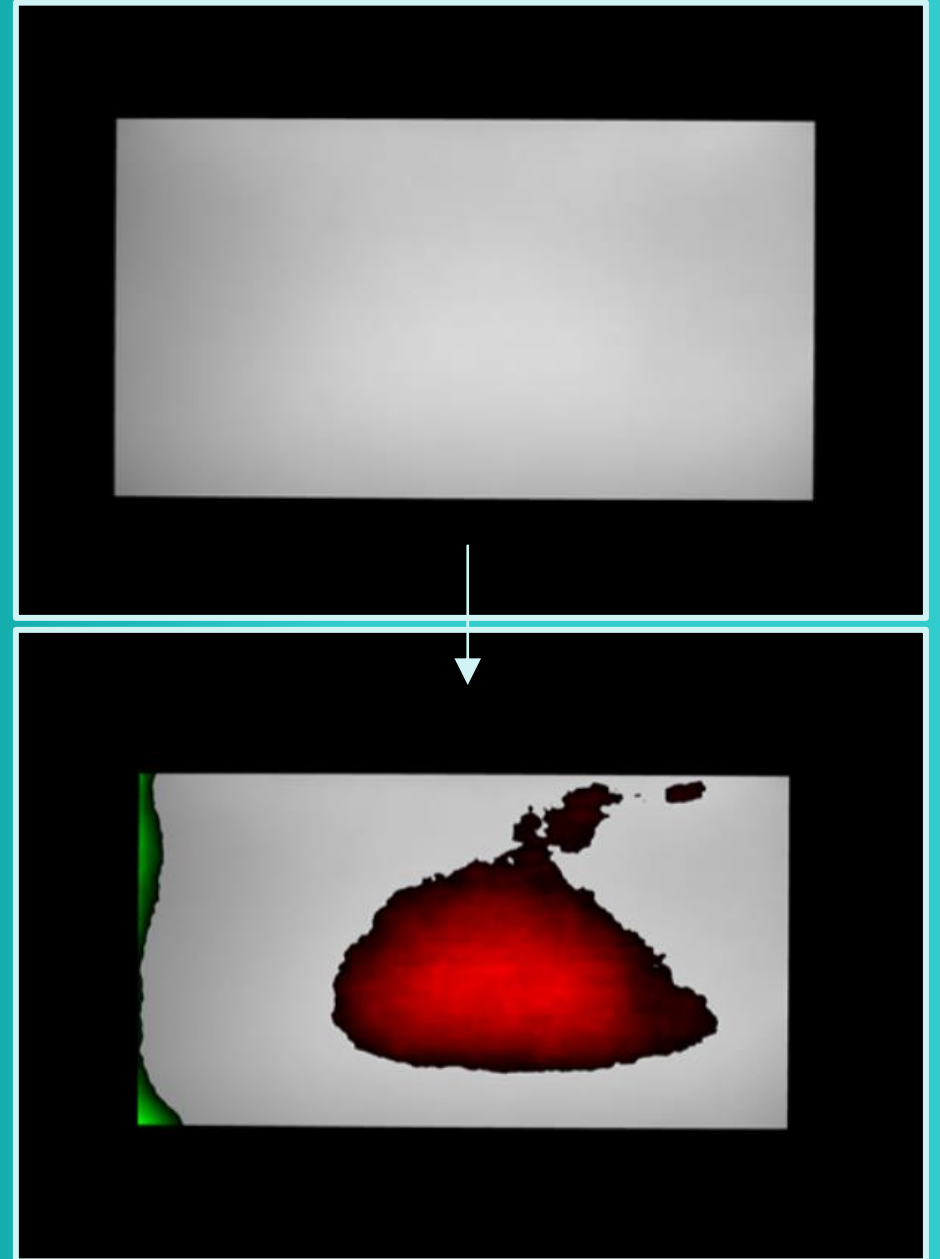an inTEST Company

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Case Study – Spotlight: Uniformity

Here is reported an example of Uniformity analysis:

The **High-Resolution Camera** within the test cell allows perform **uniformity** analysis. The algorithm is able **to detect global non-uniform areas** within the display's active area.
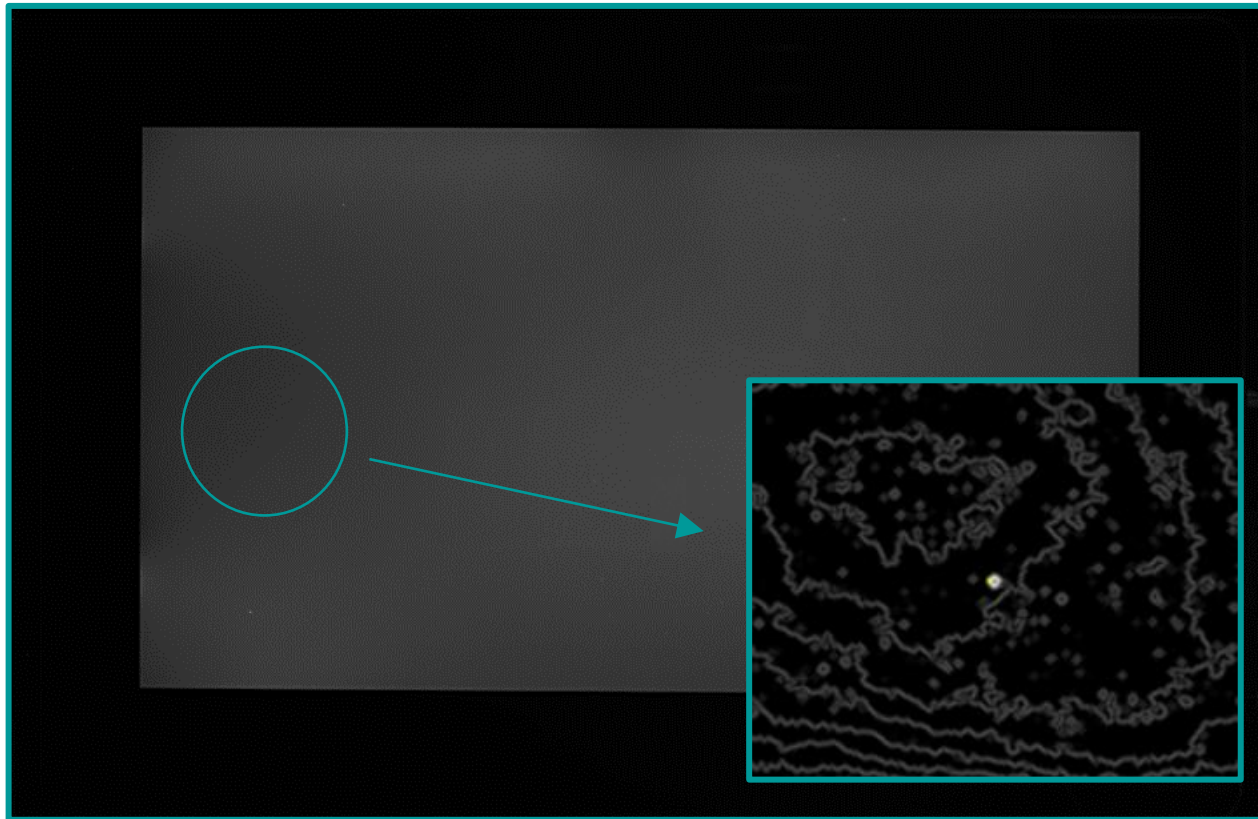
The image shows a device displaying a flat white background. The area where the range of maximum brightness values are detected is highlighted in red, while the region where the range of minimum values are detected is highlighted in green.
In this case **the weaker brightness region is on one side of the display**: this is a very **common trait of defective displays** and can be **easily detected by this test system**.

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Case Study – Spotlight: MURA

Below is reported an example of MURA analysis:

The **High-Resolution Camera** within the test cell allows perform **MURA** analysis. The algorithm is able to detect local non-uniformities within the display's active area.

The image shows a device displaying a flat black background. The MURA analysis shows the local variations in the panel brightness by computing a gradient.
Local defects are recognized as bright areas in the gradient image as the one showed on the image.

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Keeping Pace With Displays Technology Evolutions

— What can **You** do for **Alfamation**?

  — **test challenge: uLED display, OLED, AR/VR, HUD, Holographic.**

  — **test methods** and **instruments**

— What can **Alfamation** do for **You**?

  — **Innovative mindset.**

  — **Strong engineering team**

  — **Wide range of proven platforms, providing comfortable bases for new test development.**

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Let's Discuss

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