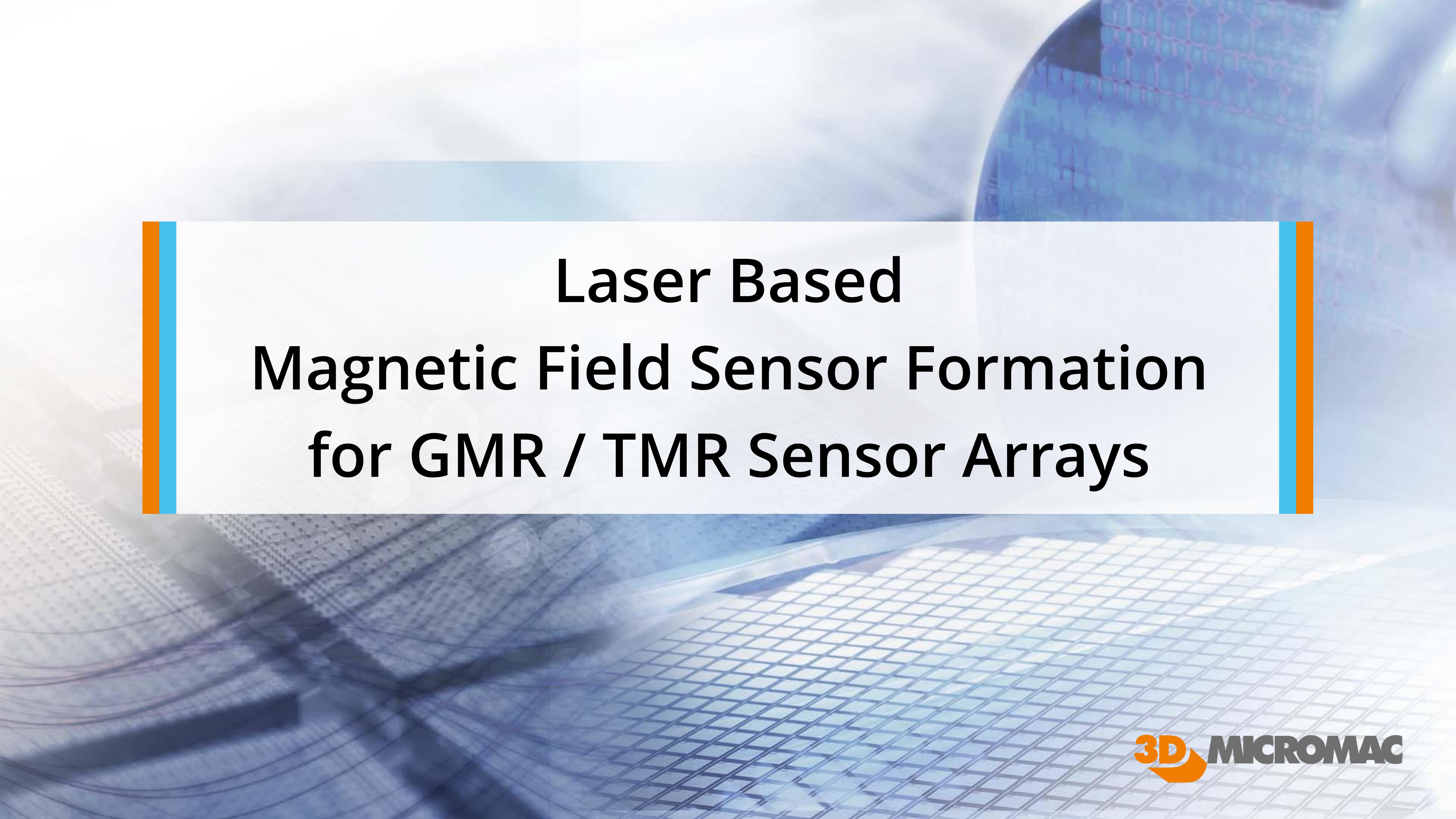


Laser Based
Magnetic Field Sensor Formation
for GMR / TMR Sensor Arrays

3D MICROMAC

Content

3D-Micromac – Micromachining Excellence

We are the leading specialist in laser micromachining.

Our mission:

- **Development and production** of unique process and machine solutions for various high-tech markets
- Customer support **from product development to high-volume production**
- **Enabling** laser micromachining techniques for **new devices**
- Superior production **efficiency** and reliable process **stability**

"Our international customers place great value on future-oriented and user-friendly processes. Our solutions help them increase production efficiency and lower cost".

Uwe Wagner, CEO

3D-Micromac – The Specialist in Laser Micromachining

Key Facts

» Founded in **2002**

» 180 employees

» Based in **Chemnitz, Germany**

» Branch offices in US and Taiwan

Services

» **Feasibility studies & process development** in-house

» Production of limited lots and ramp-up production

» **Worldwide** sales & service network

Machine Base

> 600 installations worldwide

> 50 systems in semi industry

> 150 systems in glass/display

> 30 systems in microdiagnostics

> 110 systems in photovoltaics

> 30 systems in roll-to-roll production

Target Markets & Products

» Semiconductor

» Glass & Display

» Microdiagnostic

» Photovoltaic

Motivation for Laser xMR

Growing Demand for Magnet Sensor Devices

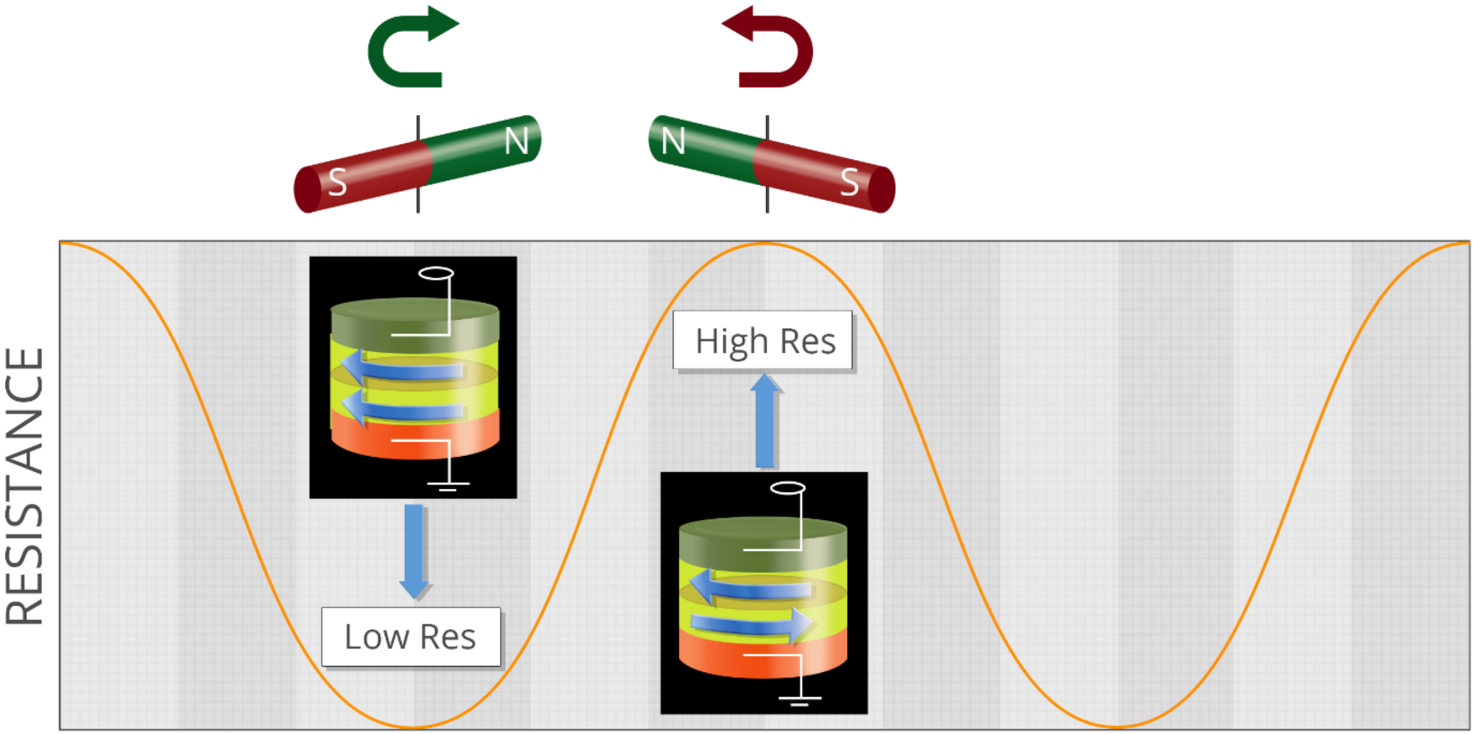
… driven by …

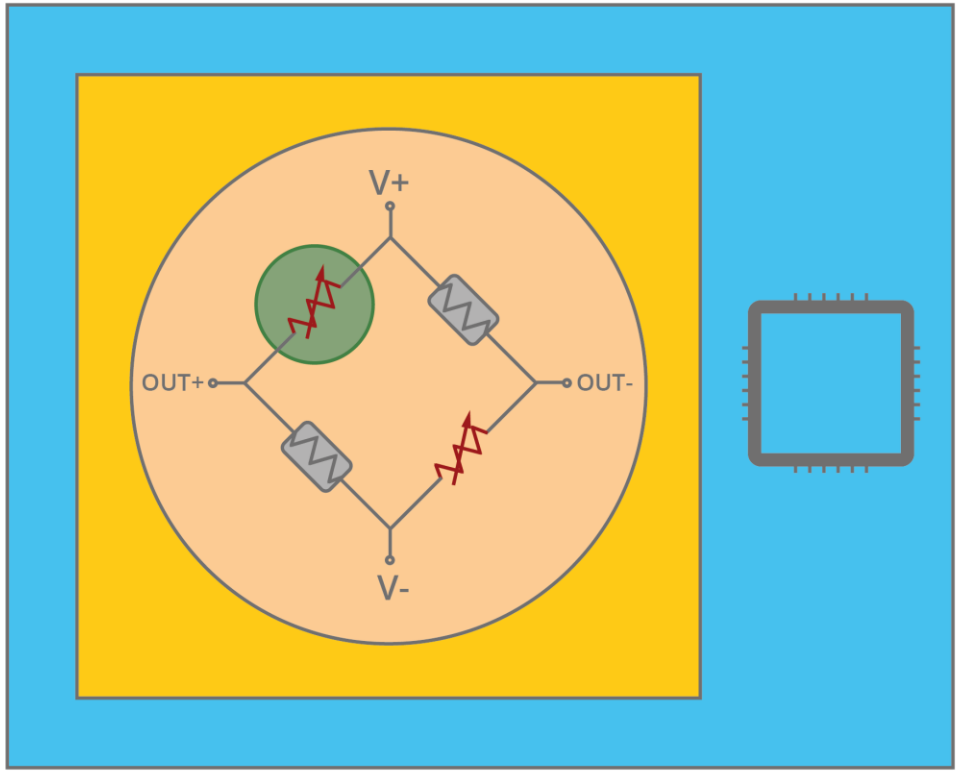
1. **Sensors for IoT**
   - Integrated rotation sensors
   - e-compass
2. **Appliance**
   - Brushless DC motor angle sensor
   - Position sensors
3. **Automotive**
   - Power steering angle control
   - Electronic throttle control
   - Brushless DC motor angle sensor
4. **Mobile devices**
   - e-compass

Magnetic Orientation Sensor Systems

Aim: Build very sensitive magnetic orientation sensor chips

→ Using GMR or TMR (Giant or Tunneling Magneto-Resistance) sensors
→ Using a Wheatstone bridge circuit





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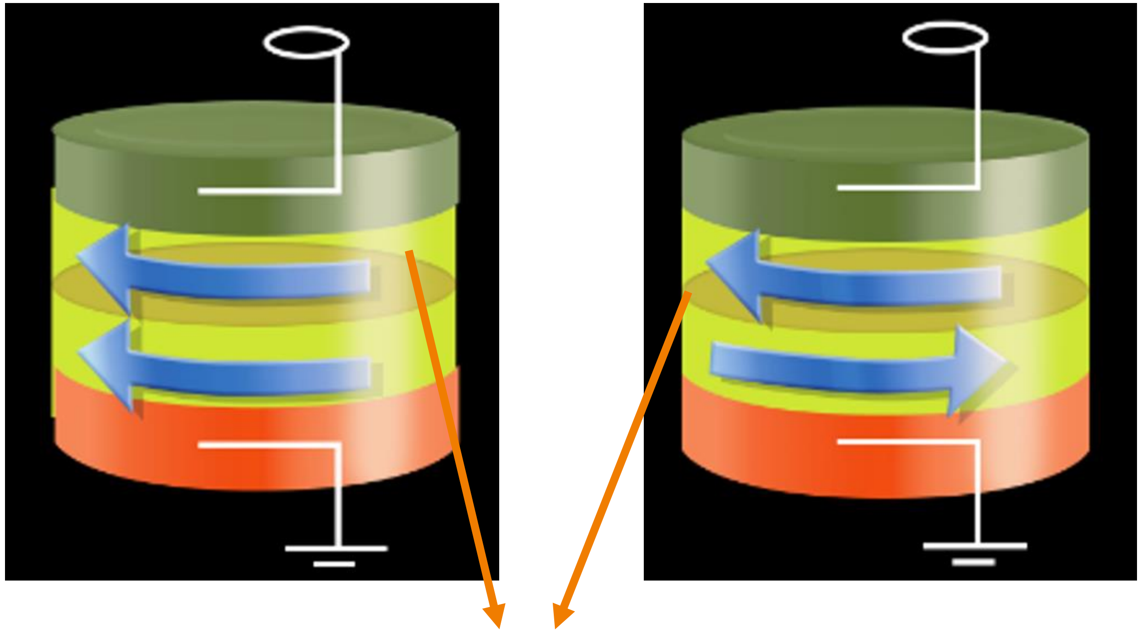
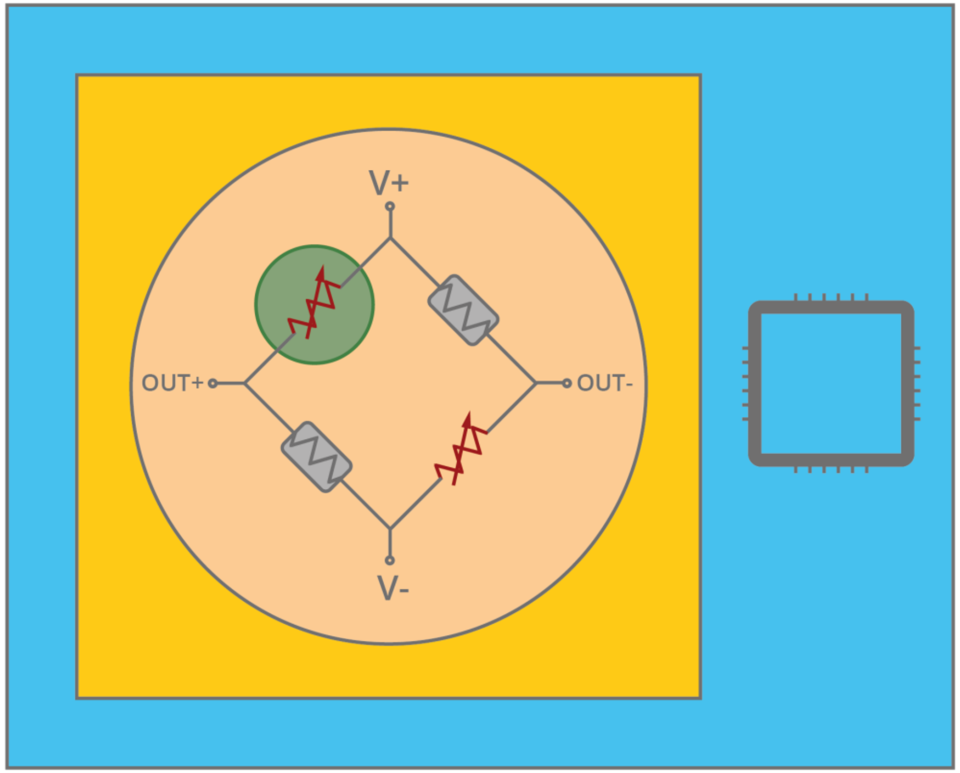
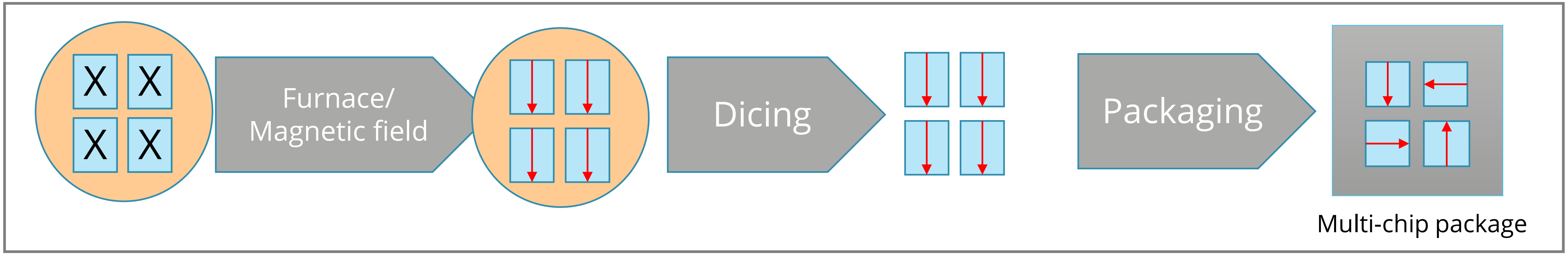


One layer needs to be pinned ➔ magnetic field + heat



Sophisticated Production Today

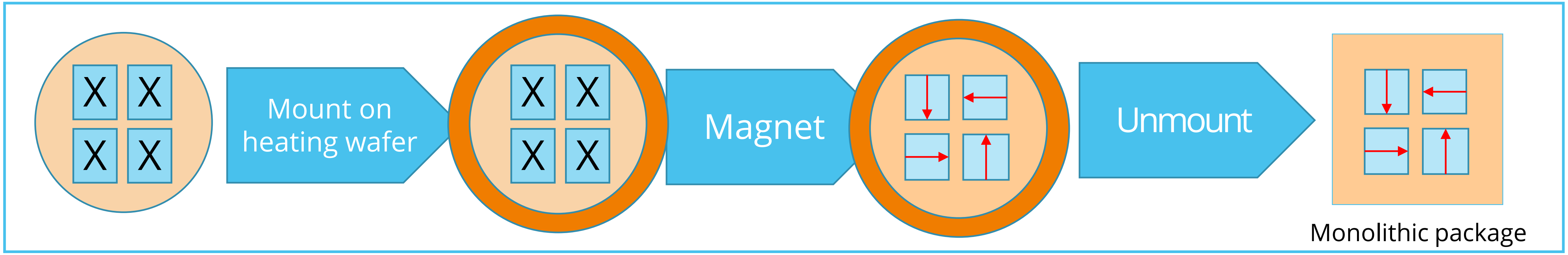


Furnace/
Magnetic field

Dicing

Packaging

Multi-chip package



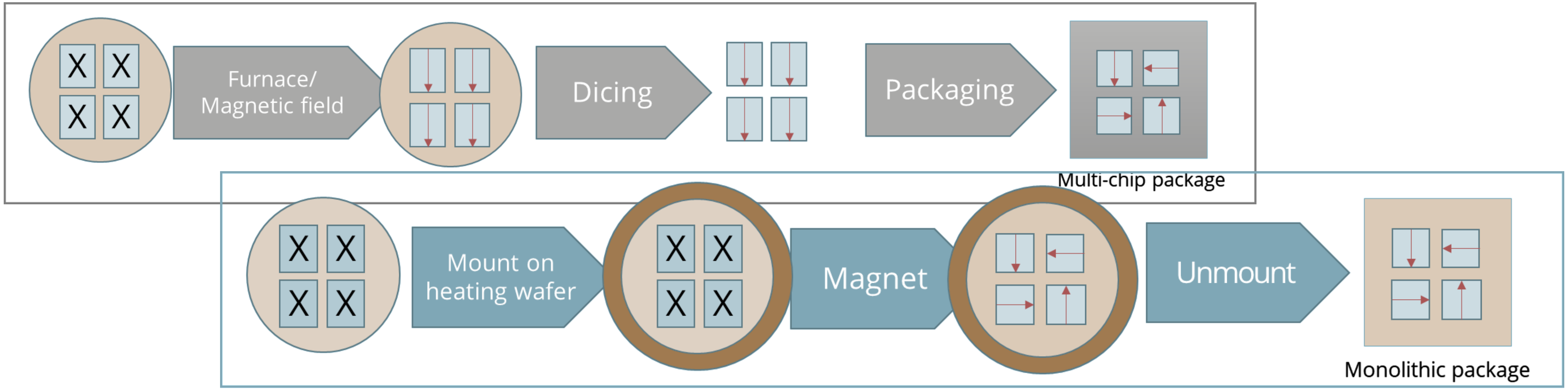
Mount on
heating wafer

Magnet

Unmount

Monolithic package

Sophisticated Production Today



Furnace/ Magnetic field

Dicing

Packaging

Multi-chip package

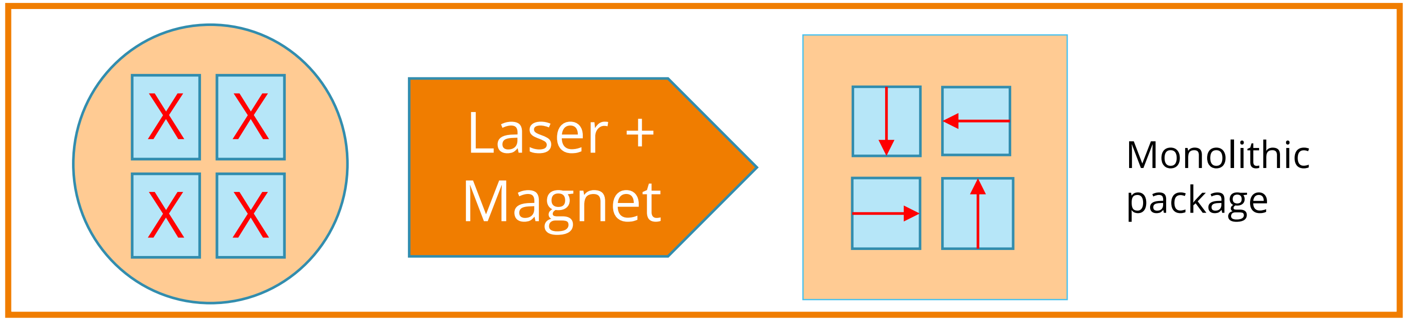
Mount on heating wafer

Magnet

Unmount

Monolithic package

NEW: Our solution



Laser + Magnet

Monolithic package

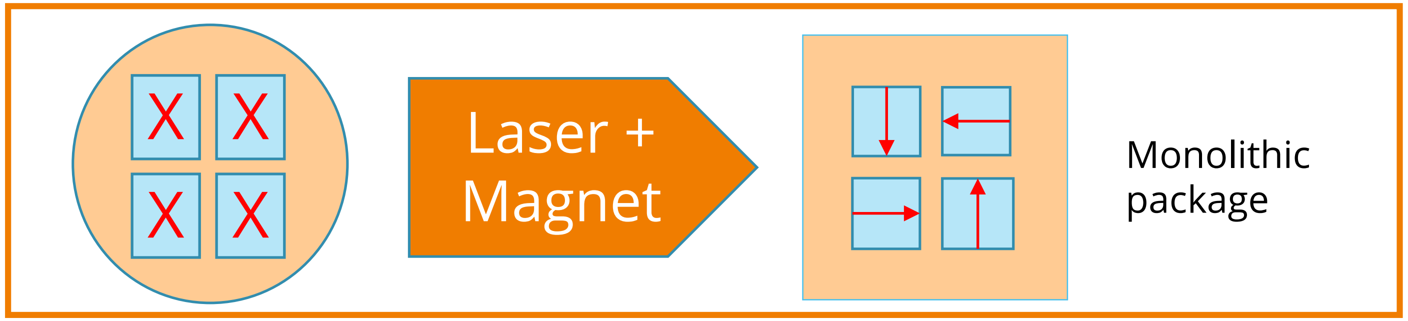
Principle of Laser Pinning

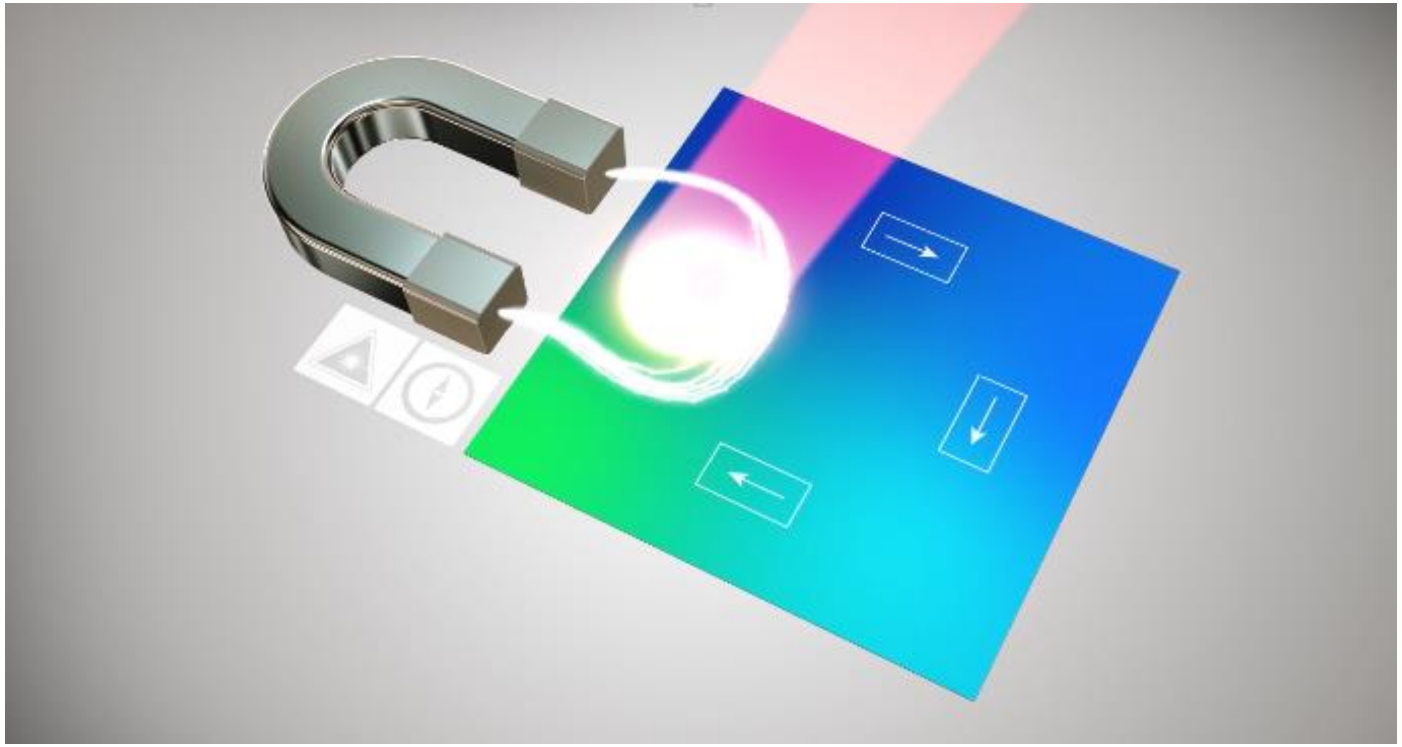
Process description:

- Strong magnet is positioned over the sensor field
- Laser shoots "through" the magnet and heats up the sensor field
- Laser pulse only at sensor field area, using a adjustable laser field dimension → no heating of nearby electronic
- On the fly processing → high throughput possible

Laser parameter:

- Wavelength: 1064 nm
- Pulse length: adjustable in ns range



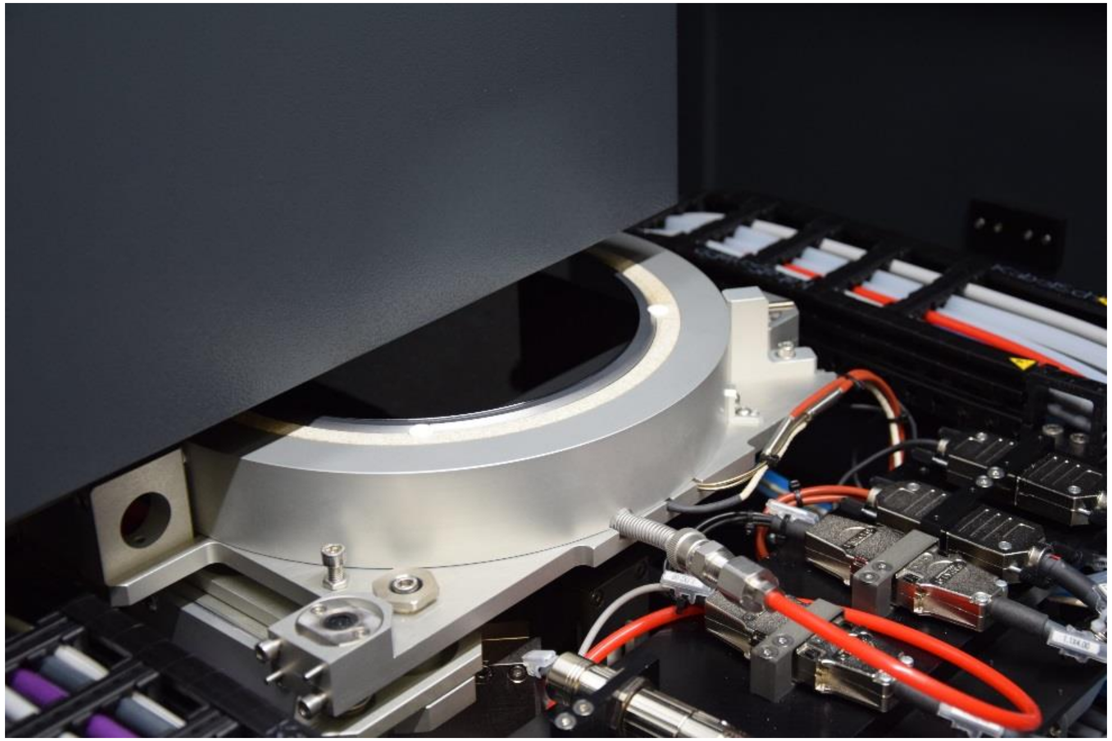


microVEGA™ xMR

Setting new standards for magnet sensor production

microVEGA™ xMR at a Glance

- High performance laser annealing system
- Standard working area for 300 mm wafer
- Novel solid state laser based process
- Integrated process control
- Automatic wafer handling



Inside microVEGA™ xMR

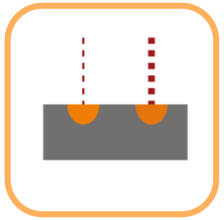
Throughput estimation* (very product specific):

- 520,000 sensors per hour (a customer sample)

*depending on sensor and wafer design

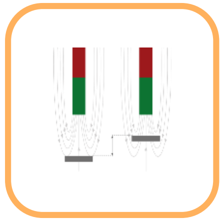
Wafer - Parameter - Fitting

The following parameters can be changed by recipe:



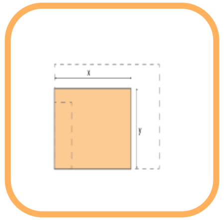
Laser pulse energy

Variation of laser power



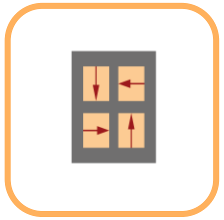
Magnetic flux

Up to **0.65 Tesla**
Variable by height of the magnet



Sensor dimensions

Rectangular shapes changeable by recipe:
10 µm x 10 µm to **300 µm x 300 µm**

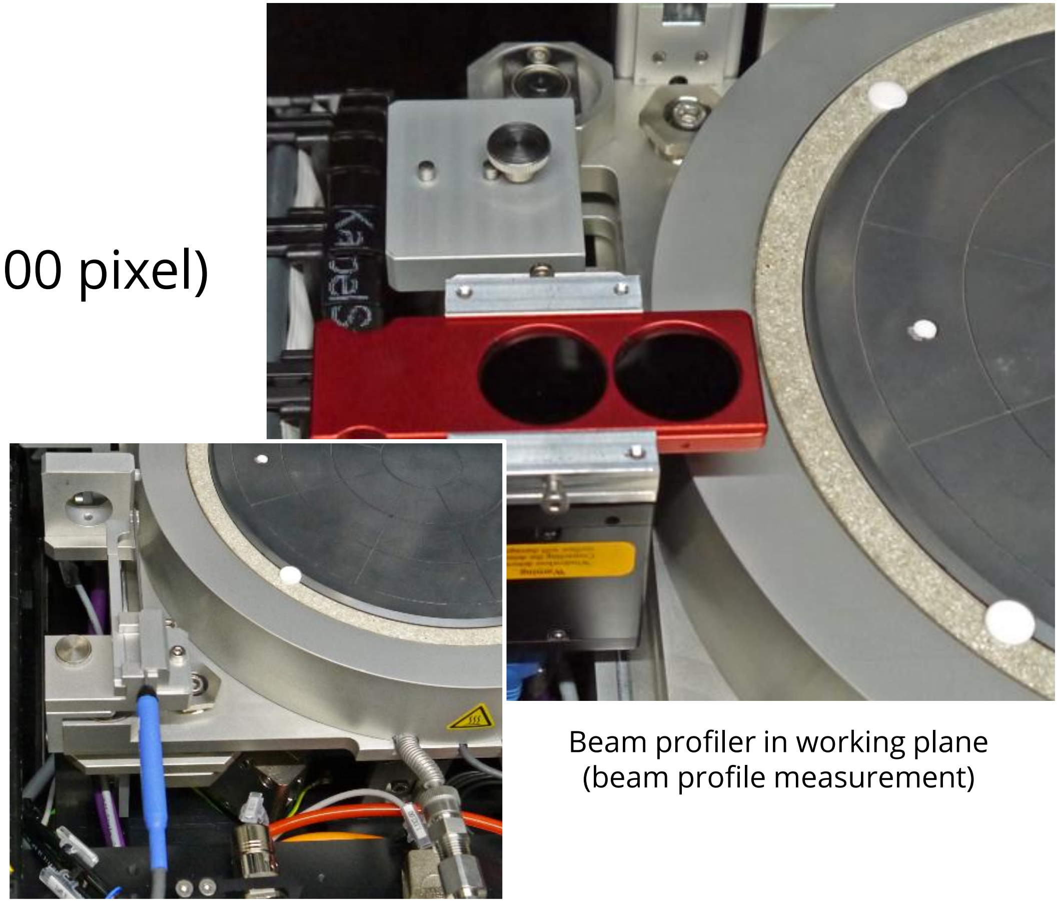


Orientation

Rotatable by **360°**
Accuracy: ± 0.01°

Magnet Sensor Processing - Sensor and Process Control

- Energy sensor at laser exit
- Power sensor at chuck level
- Beam analyzer at wafer level or laser exit
  (free positioning, high resolution cam 1,600 x 1,200 pixel)
- Gauss-meter integrated
- All relevant data are saved in log files



Beam profiler in working plane
(beam profile measurement)

Gauss meter probe

Production Example: Crocus Technology

microVEGA™ xMR installed at Crocus Technology

- Used for programming monolithic TMR magnetic sensors
- Following quality assessment results are shown

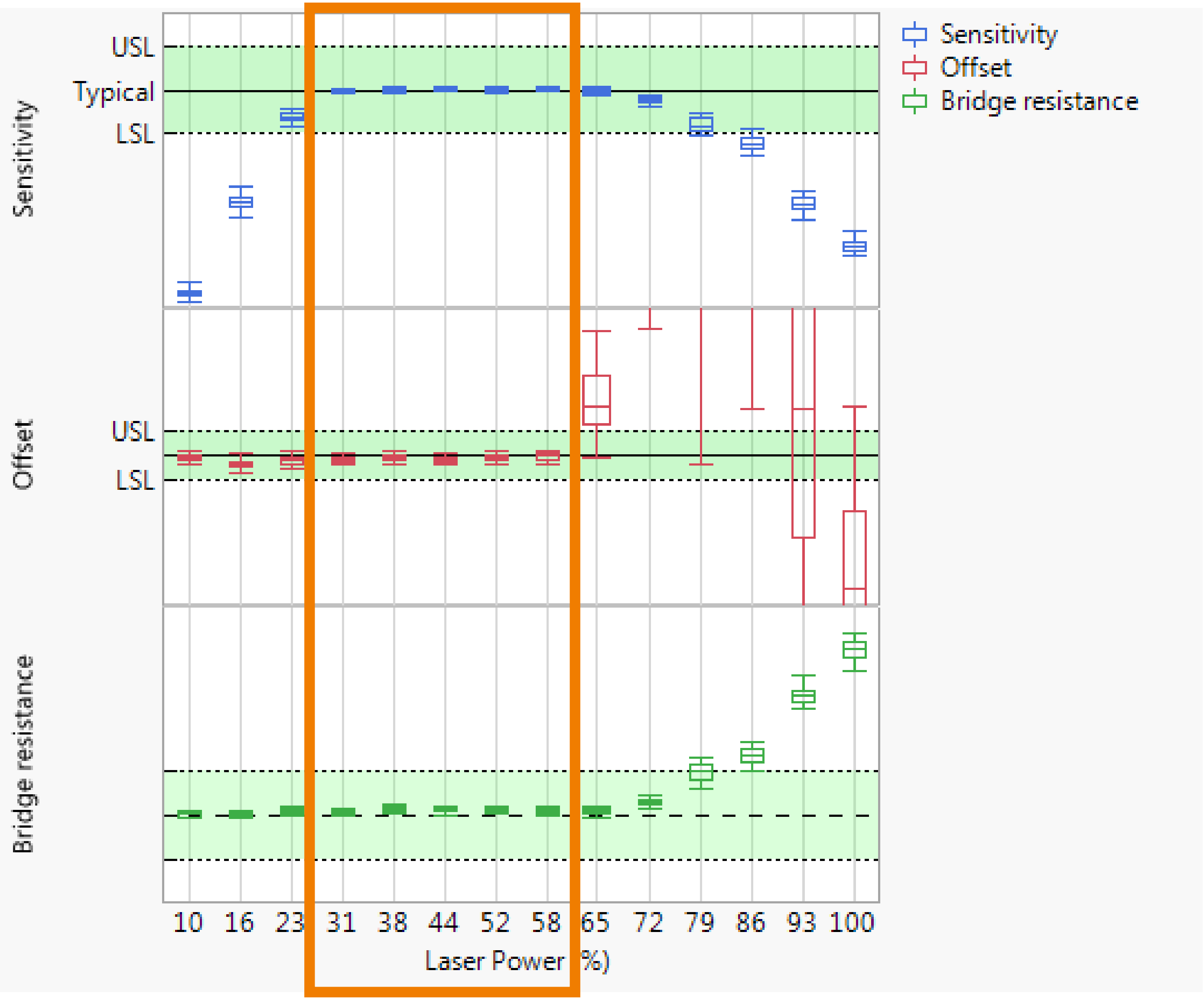
Detailed quality assessment results available on request!

Contact us on:
www.lasersensorformation.com

Variation of Laser Power

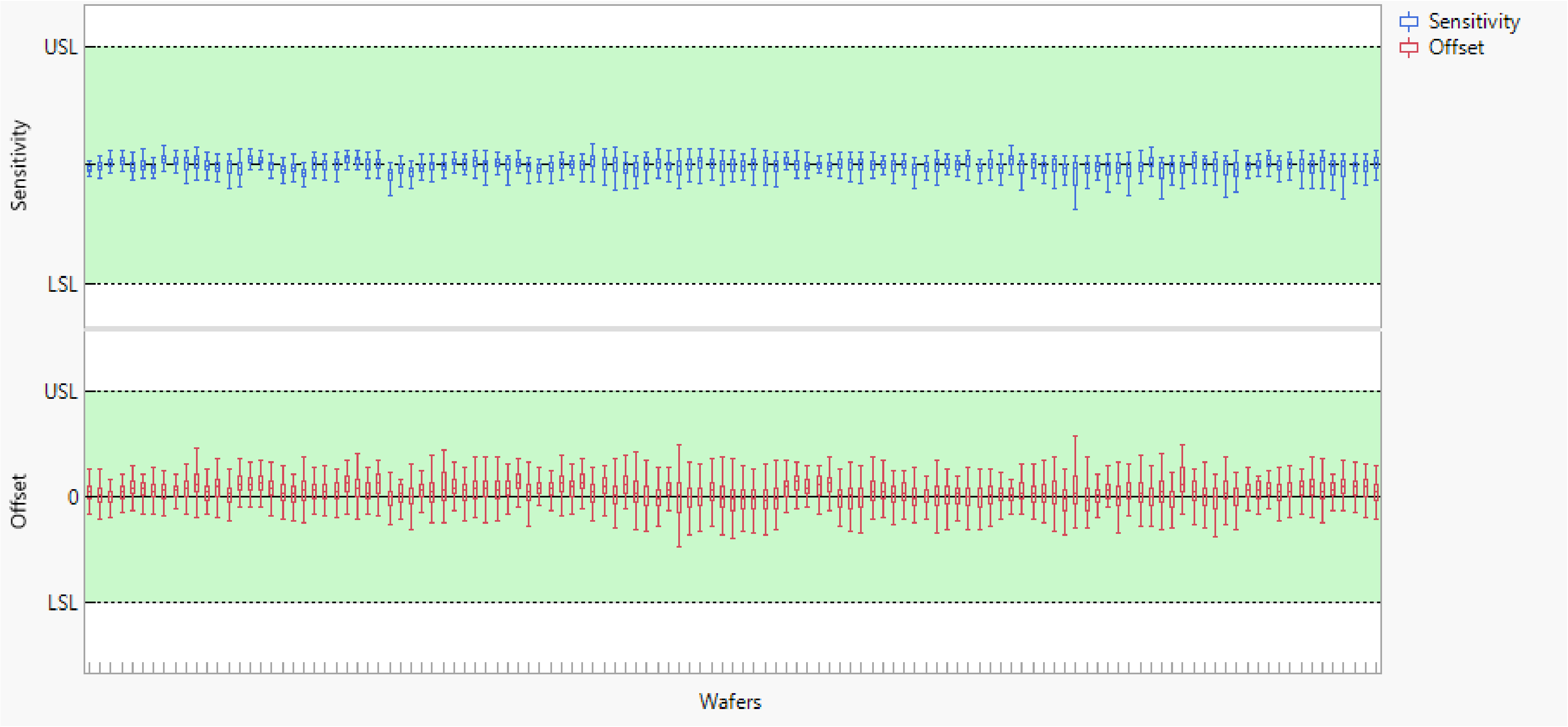
- Variation of the laser power of each single laser pulse
- Each 100 devices across one wafer
- Analysis of
  - Sensitivity → maximum sensitivity is the quality criteria
  - Offset → mismatches between sensor branches
  - Bridge resistance → overall indicator of sensor structural integrity

✓ High pinning quality
✓ High reproducibility from device to device
✓ Large laser power range



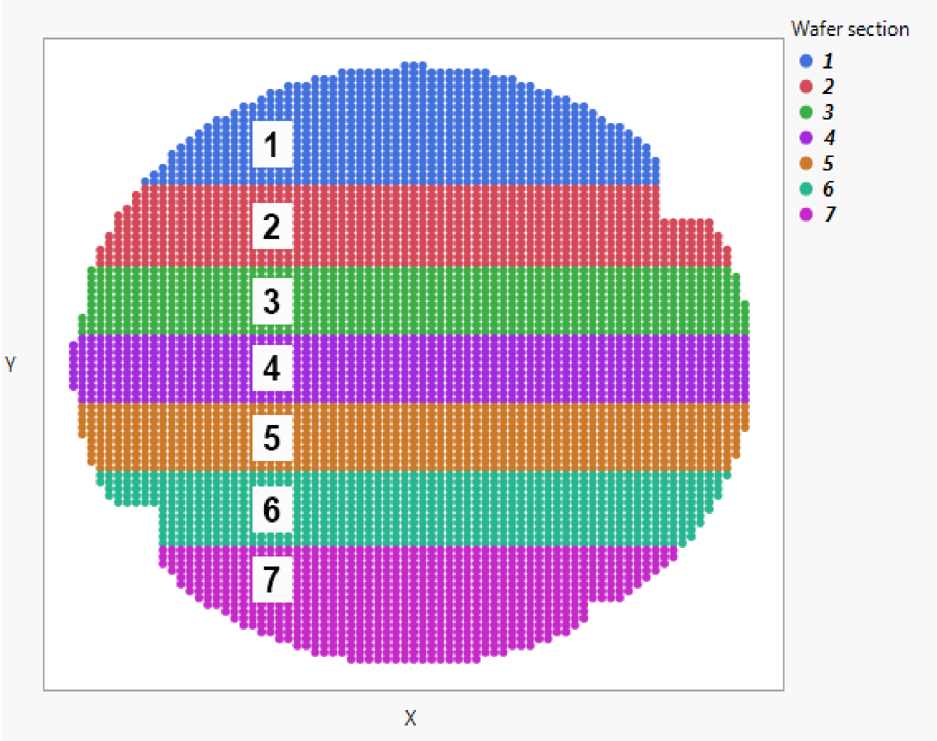
Wafer-to-wafer Reproducibility

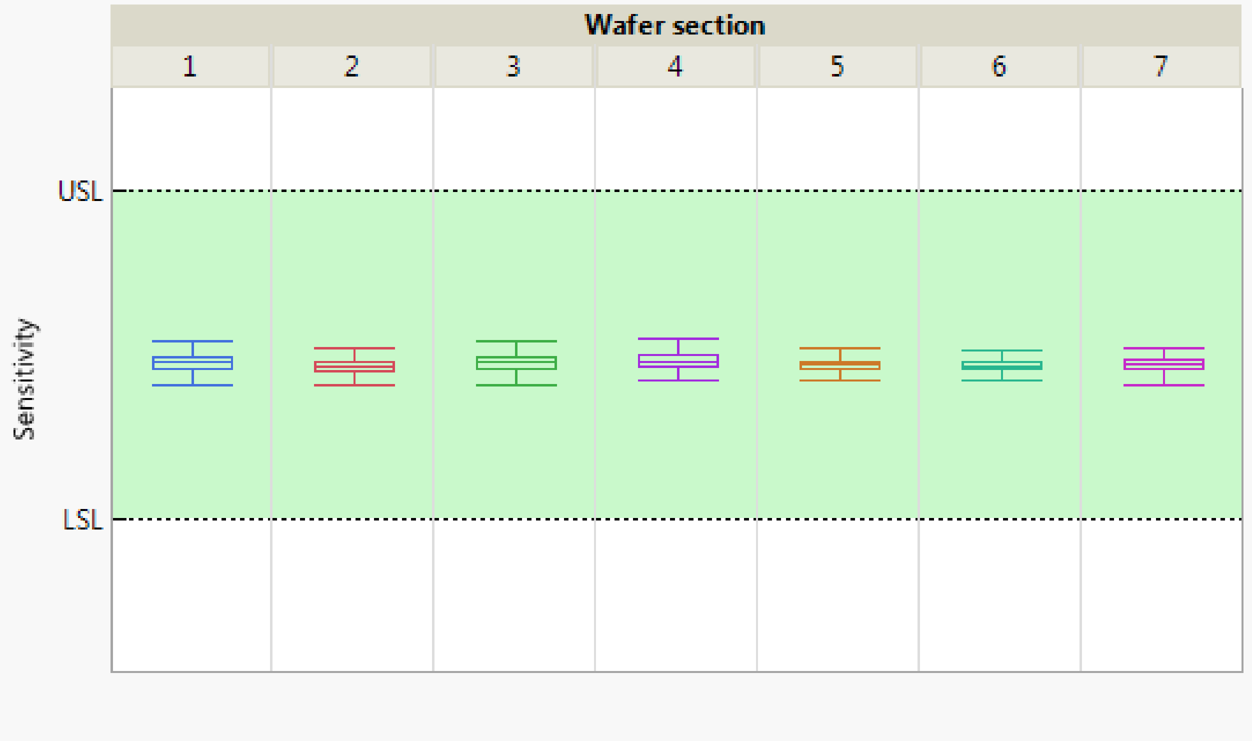
- Sensitivity and offset across wafer
- Sample size: 120 wafers



✓ Sensitivity uniformity below 2%
✓ Demonstrated for 120 wafers

Homogeneity over one Wafer





- Sensitivity evaluation over one wafer
- Evaluation of equal number of sensors in 7 lines
- Laser processing horizontal line by line

✓ highly reproducible median sensitivity
✓ narrow and reproducible sensitivity distributions

microVEGA™ xMR – Summary

- **Cost-efficient production** of monolithically integrated sensor chips in just one production step
- Very high energy homogeneity - resulting in **improved sensor quality**
- Enables the **production of smaller sensors**
- Unique selectivity and maximum precision for **more devices per wafer** or **new sensor designs**
- High temperature gradient allows sensor location directly **next to read-out electronics**
- **Easily adjustment** of the magnetic orientation, sensor position and sensor dimension
- **New sensor designs** on monolithic packages possible
- High precision and high repeatability is **proven in production**

microVEGA™ xMR

3D-Micromac – What We Offer For Sensor Field Formation

- **Machine Solutions** - Our laser systems deliver leading edge processes with superior production efficiency.

- **Process development** - We fully support our customers in the qualification of product ideas as well as in the development of stable laser processes for production facilities.

- **Contract manufacturing** - With our unique process expertise we manufacture high-quality components as contract manufacturing service for you.

- **After-Sales Service** - Our qualified service team is available around the clock and worldwide, offering fast and reliable service.

Thank you for your attention!

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