An Introduction to Laser Trimming

A Measurement-Driven Process

PHOTONICS SYSTEMS GROUP

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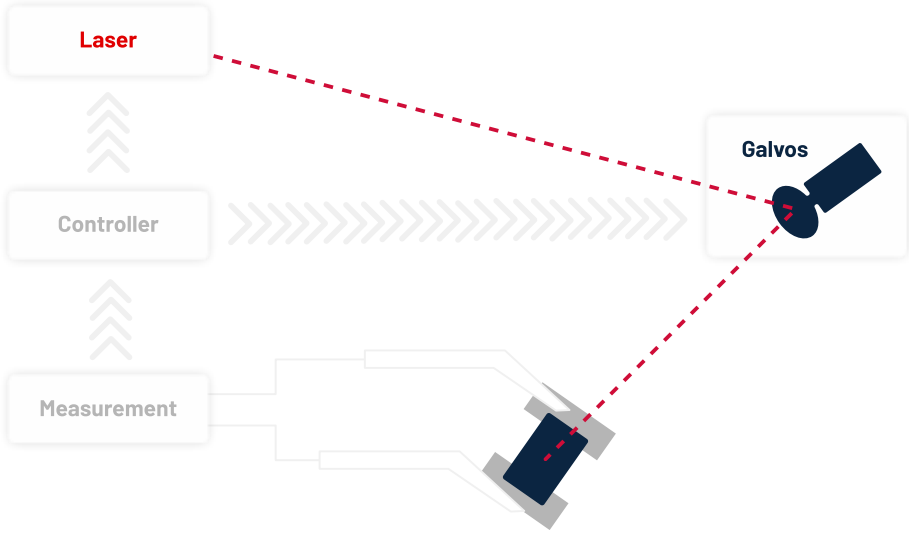
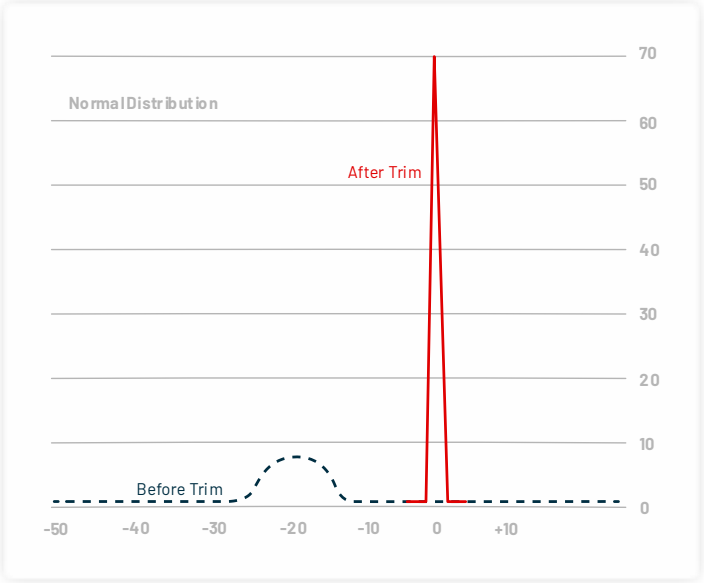
SENSOR & CIRCUIT TRIMMING BASICS

Trimming

- Laser trimming is the process of adjusting the value of a measured parameter by laser manipulation.
- By using a laser beam to cut a resistor while measuring the desired output parameter this parameter can be optimized to a specific range.
- Laser trimming is a fine-tuning step done to optimize the parametric characteristics of a device.





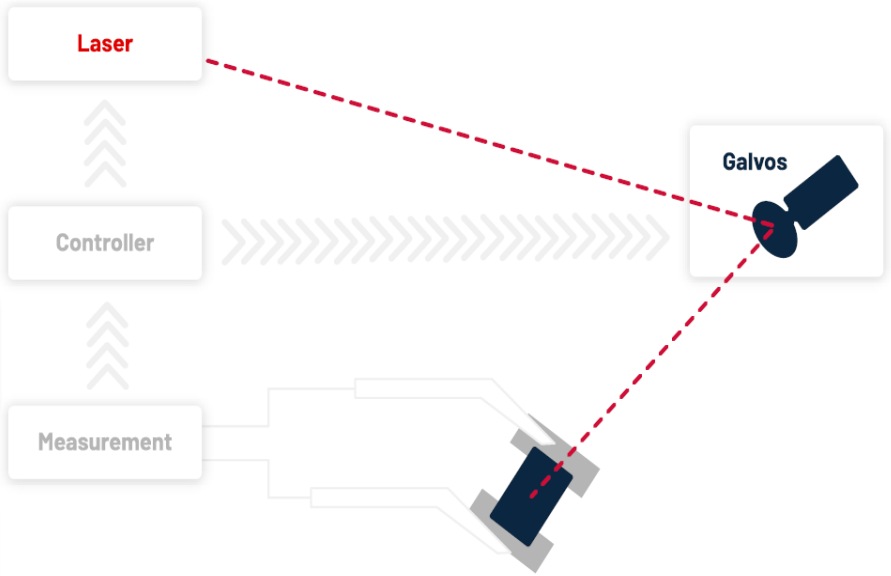
What Determines Laser Trimming Performance?

Galvos position the beam precisely

Controller decides next trim step

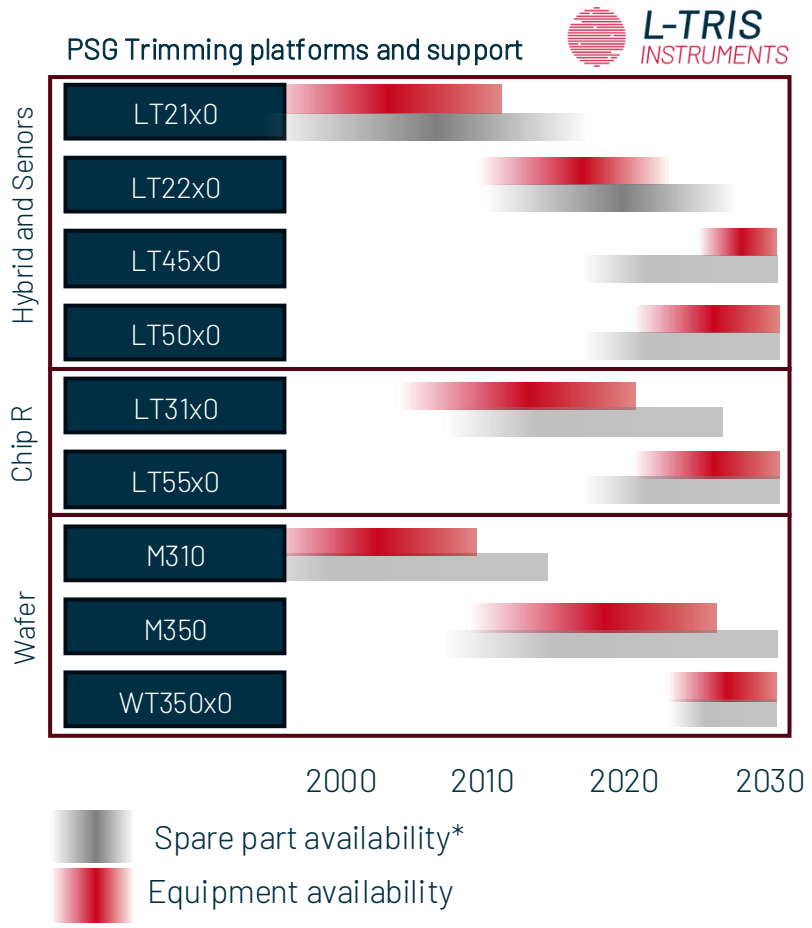
Laser removes material → Value changes

Measurement reads results in real time



- Laser trimming is a closed-loop measurement process
- Final accuracy is driven by measurement and control – not laser power alone
- Measurement stability determines:
  - Achievable tolerance
  - Required guardband
  - Production yield
- System speed defines throughput and machine capacity

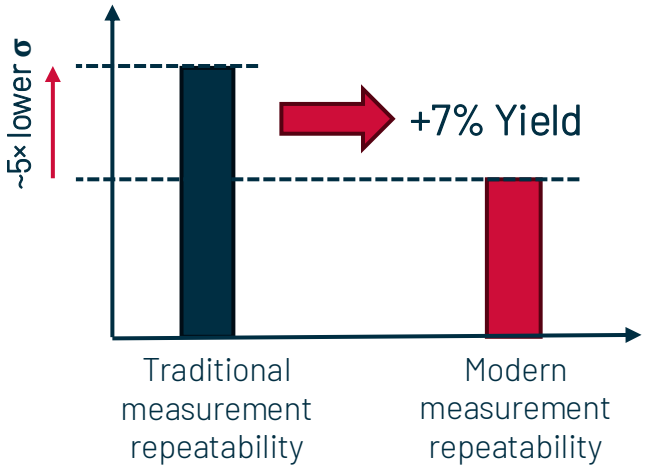
Three Decades of Trimming History



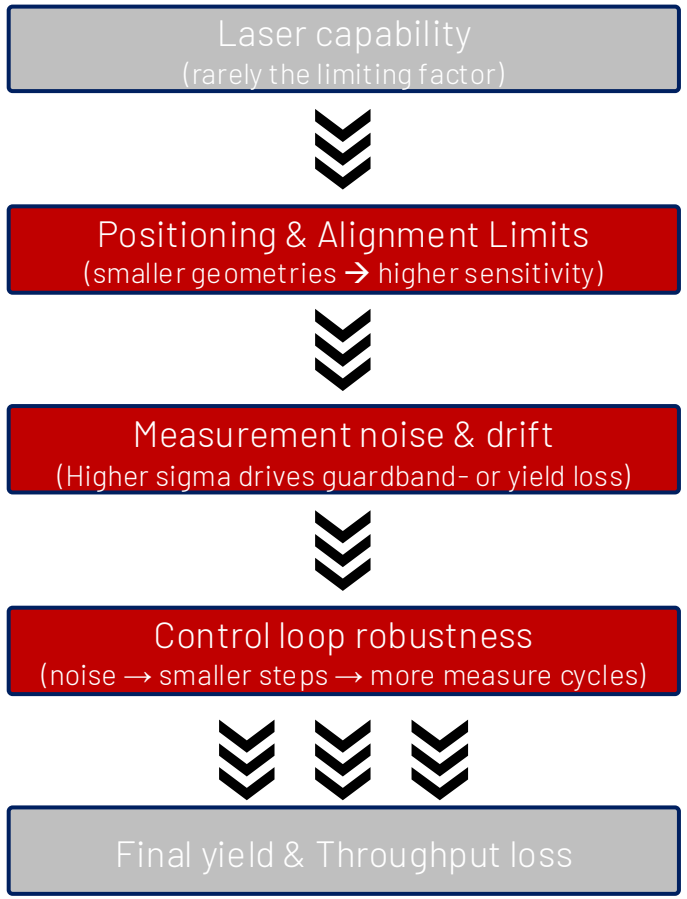
Since 1995 PSG has helped industrialize laser trimming from first-of-kind tools to high-volume production. Transitioning support over multiple machine generations.

The new challenge

- **Automotive grade** requirements for Cpk and traceability
- **Commoditization drives cost-down** and higher throughput and yield expectations
- **Smaller devices** require tighter positioning tolerances and advanced alignment procedures
- **Skilled-labor shortage** requires automation and stable system capabilities

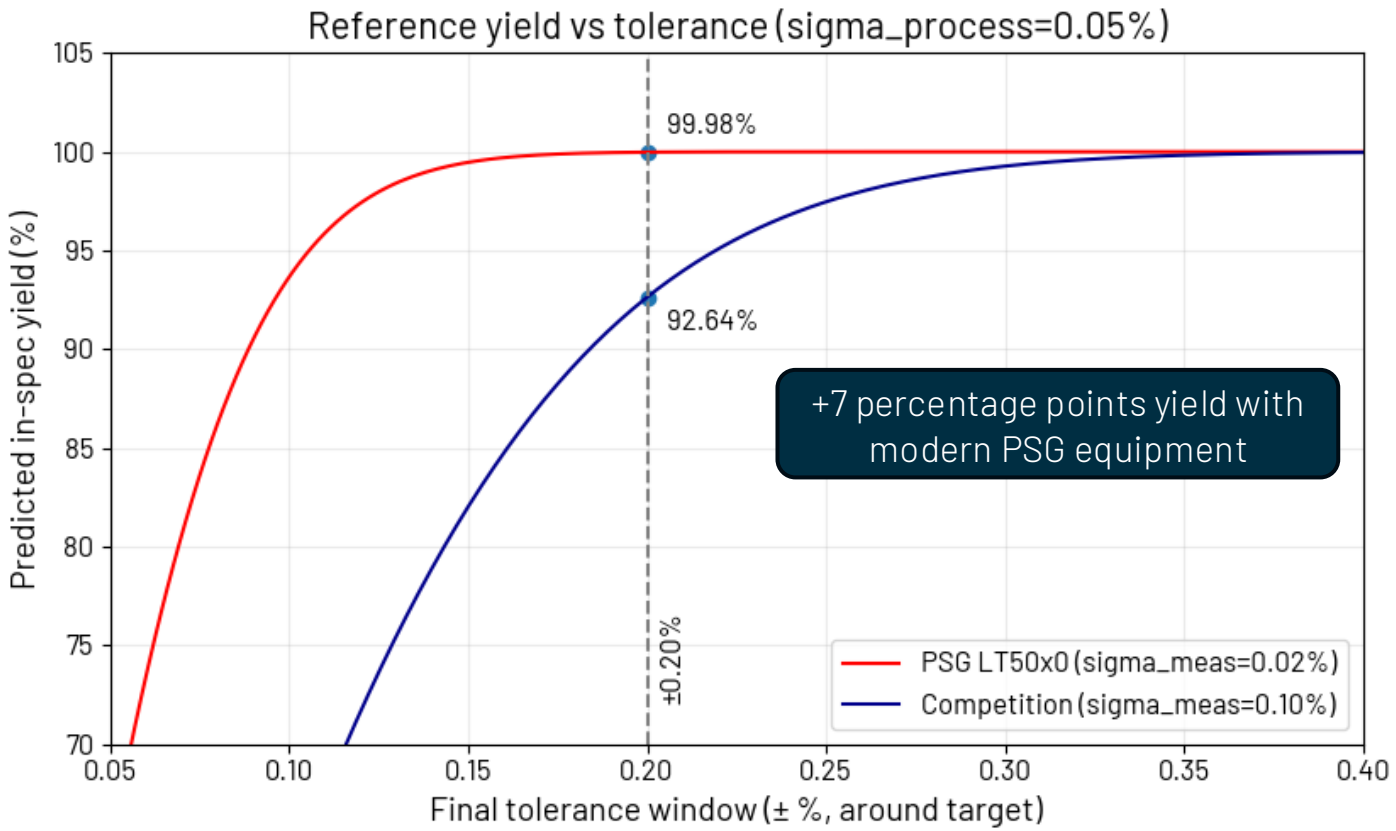


Where Trimming Performance Is Typically Lost



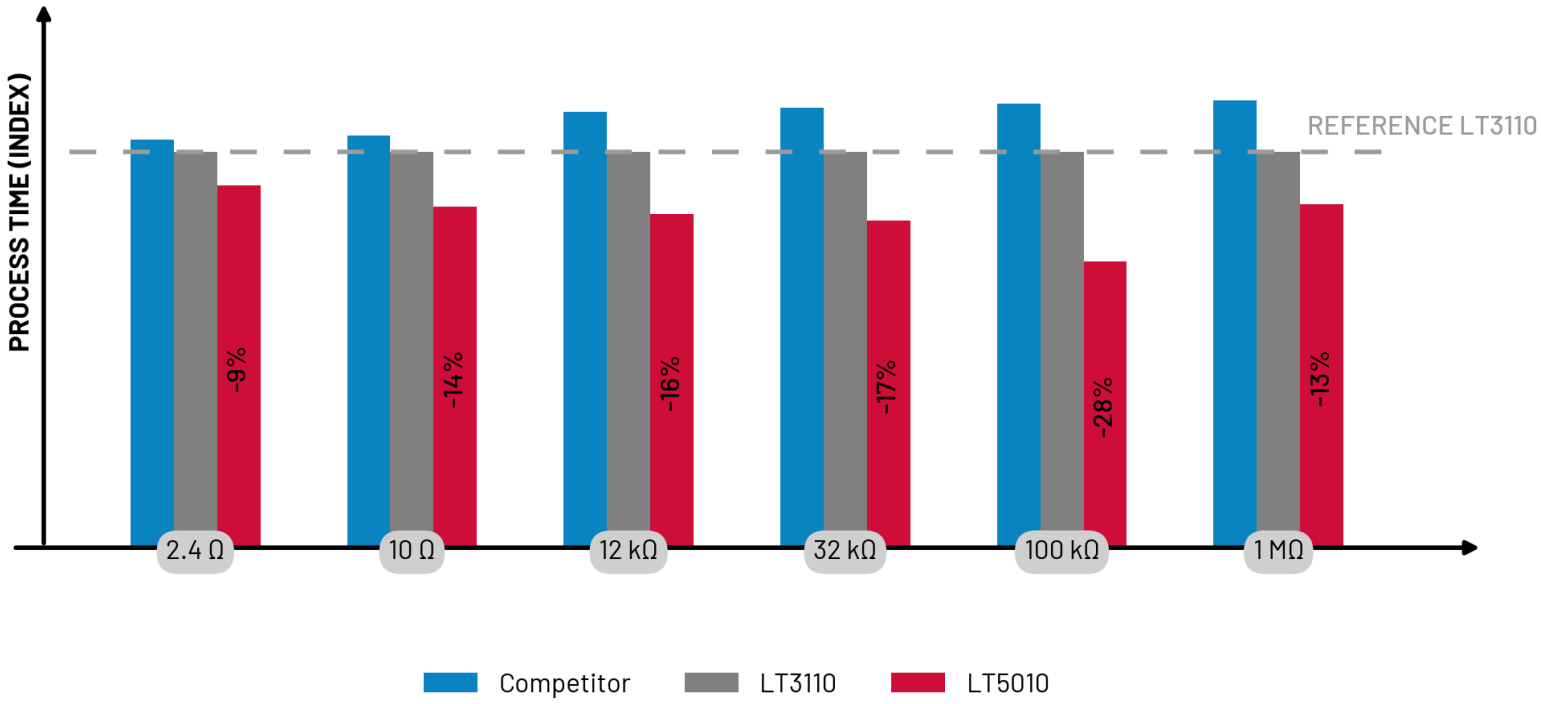
- Most trimming losses occur in measurement and control
- Higher measurement sigma increases needed guardband and scrap
- Control loop noise forces smaller trim steps and more verification measurements
- Alignment accuracy protects functional and safety-critical geometries

Lower Measurement Sigma = Higher Yield



- Tighter measurement distribution
  → **higher production yield**
- Future requirements will evolve
  → **Modular, modern platforms keep you ready (investment security)**
- Stable and repeatable measurements
  → **Less fine tuning and operator dependency**

Unmatched Trimming Speed – More Output per Machine

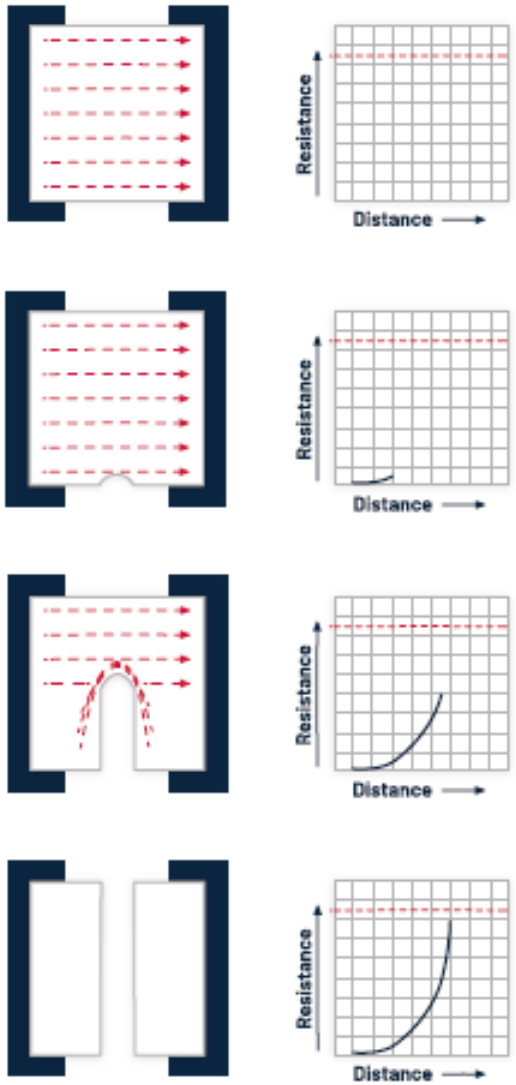


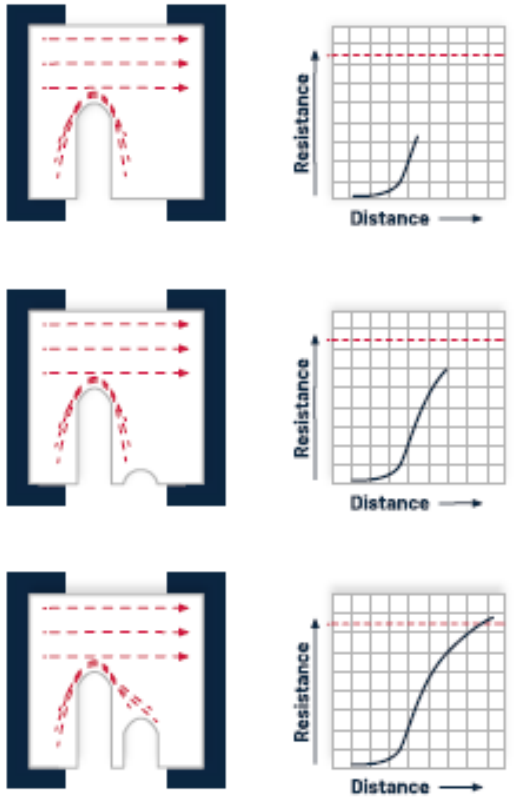
Comparison based on identical, conservative trim parameters (apples-to-apples). Higher speeds are achievable with parameter optimization.

- **Modern lasers perform at higher trimming speeds** across the full resistance range
- **Fair benchmark** under identical baseline parameters
- **higher output per machine** or cycle-time reserve or tighter specs
- Parameter optimization can unlock additional throughput
- **Direct impact on cost per part**

SENSOR & CIRCUIT TRIMMING

Current Flow





SENSOR & CIRCUIT TRIMMING

Resistance Change Profiles

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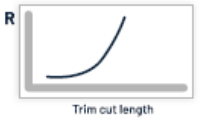
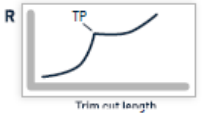
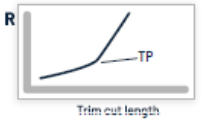
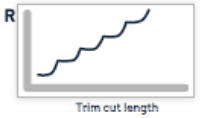
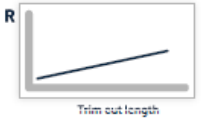
	Trim cut type	Trim sensitivity
P cut or plunge cut: Fast but minimum precision.		
D cut or double plunge cut: High precision, generating a low count of new squares (sheet resistance, 3.2).		
L cut: High precision, generating multiple new squares with the horizontal cut line.		
M cut or serpentine cut: Large increase in R value possible, while maintaining high precision.		
Shave cut or scan cut: Provides high voltage insulation at the cost of speed.		
Customized cuts: Our new LT50X0 trimmer generation provides fully customizable trim cuts. Whatever you can imagine might suit your application, can be created on our systems.		

Figure 13: Resistance increase profiles of various trim cuts.

Examples of Trim Cuts

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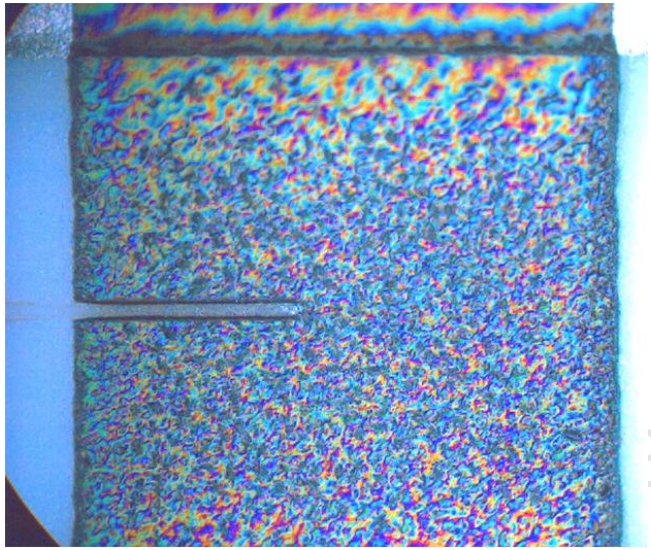
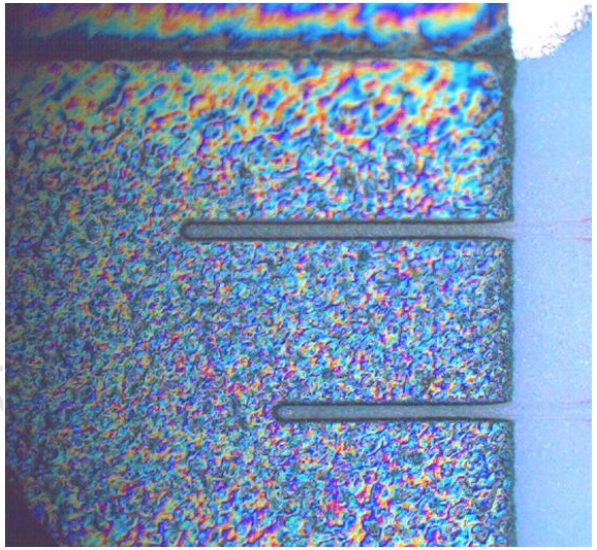
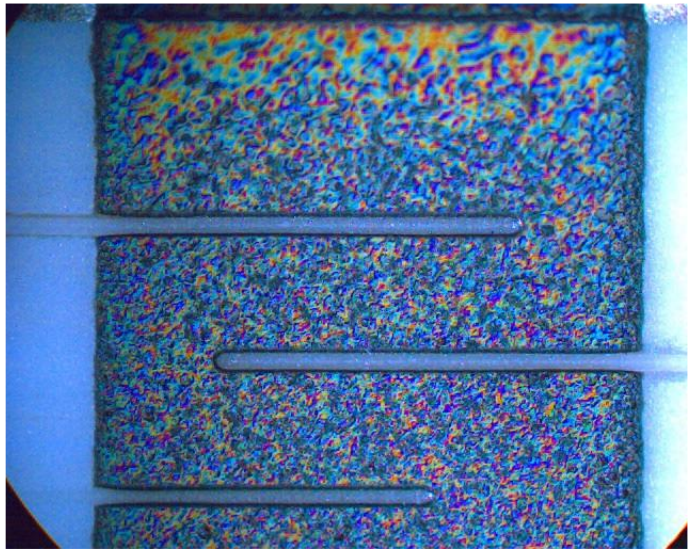
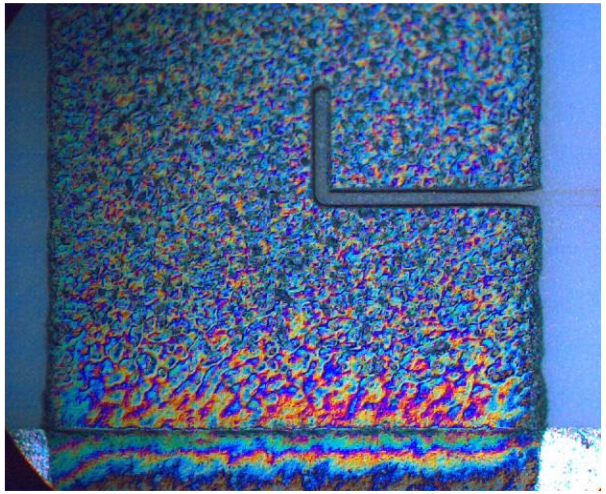
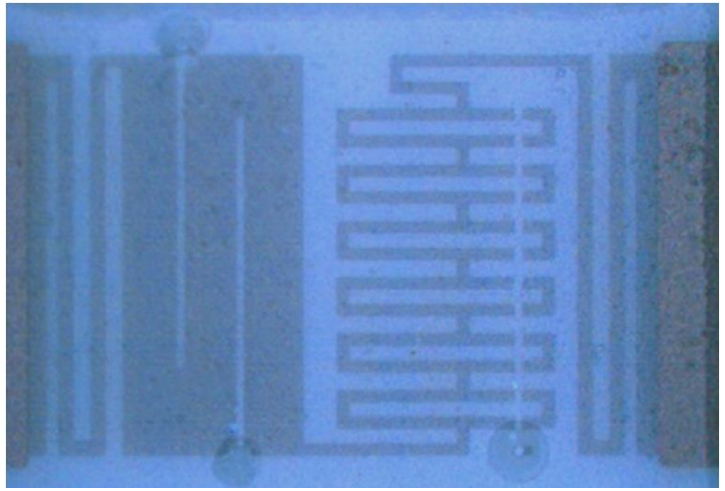
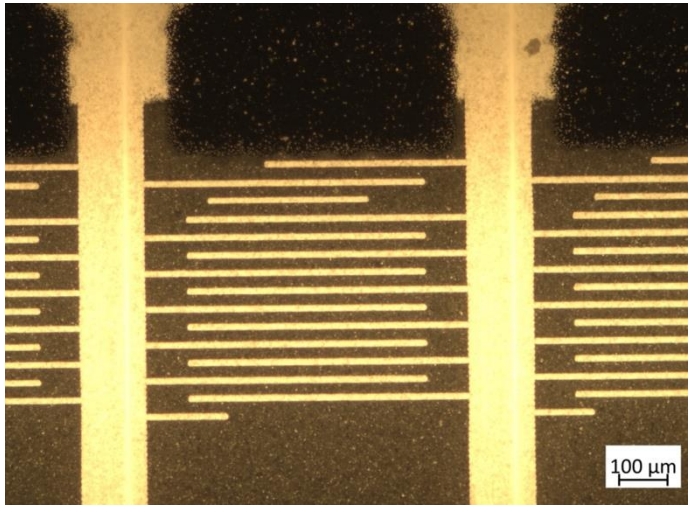




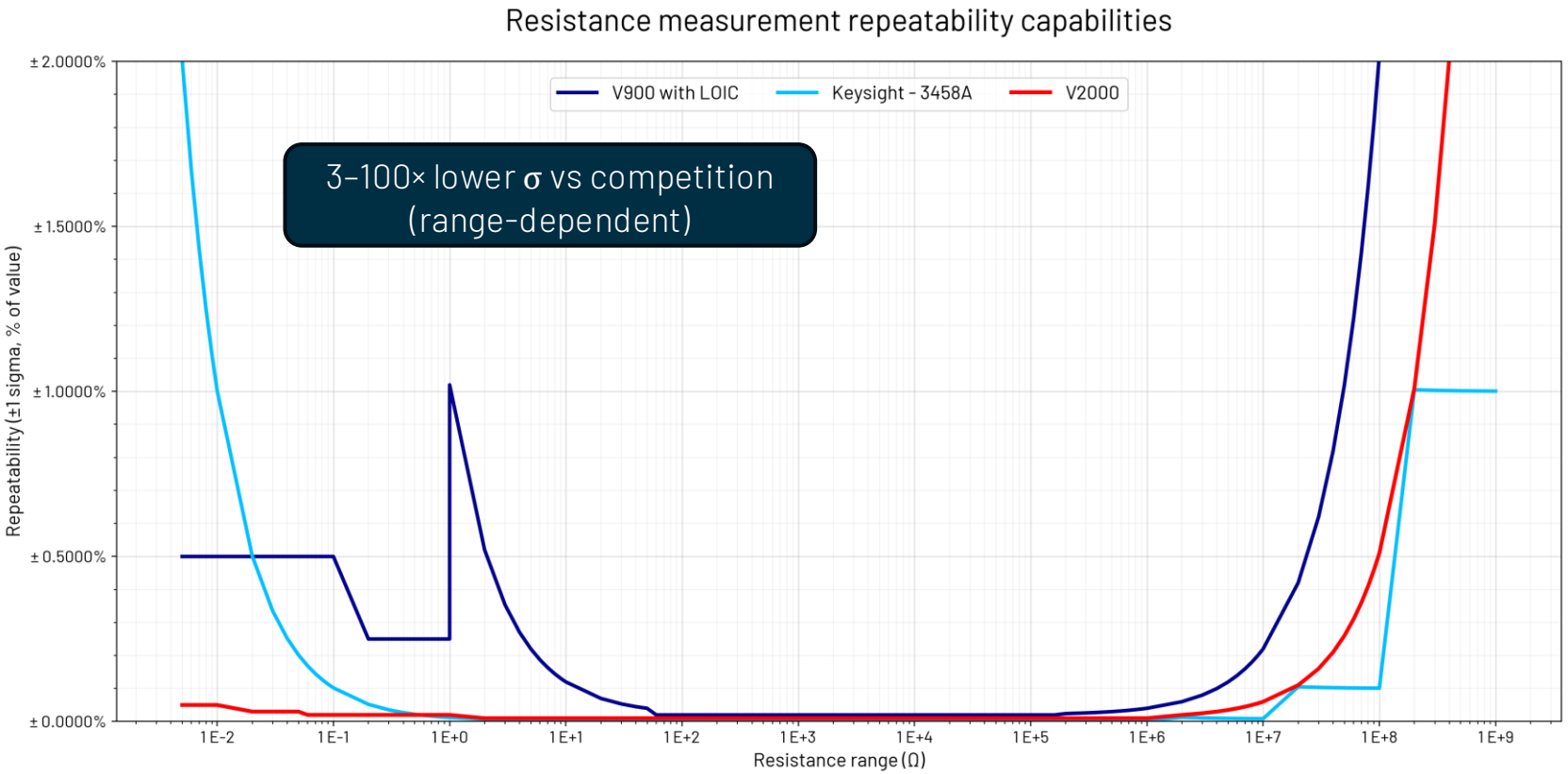








Measurement System V2000 – The Benchmark in Resistance Measurement



Repeatability shown as % of value (1σ), measured under identical conditions.

- **High-precision, force/sense current, force/sense voltage,** multi-measurement unit
- **Outperforms industry standards and bench instruments** in repeatability and speed across the full range
- **0.005 Ω – 1 GΩ** with active guarding **(up to 250 mA)**
- **Current-nulling bridge** support
- **Up to 10x** Kelvin 3x24 crosspoint matrix cards
- No additional measurement devices needed . V2000 fits it all
- Optional **internal reference resistor card** for advanced process control

L-TRIS INSTRUMENTS

The PSG Trimmer Lineup

Circuit Trim and Chip Trimmer Product Lines

- Chip Resistor Trimming
- Sensor trimming
- Hybrid and analog module trimming
- Low- and High Volume production-grade automation available

Wafer Trim and Fusing Product Lines

- Mixed-signal wafer trimming
- Fuse cutting / link blowing
- Production-grade wafer handling and automation available
- Ready for high-volume semiconductor manufacturing

Circuit Trim Performance Overview

	LT4500	LT4510	LT5000	LT5010	LT5020	LT5030
Laser type	ns IR	ns GR	ns IR	ns GR	ps GR	ps IR
Typical substrate size	max. 200x200mm	max. 200x200mm	max. 200x200mm	max. 200x200mm	max. 200x200mm	max. 200x200mm
Measurement range	10 Ω to 1MΩ	10 Ω to 1MΩ	5mΩ to 1GΩ	5mΩ to 1GΩ	5mΩ to 1GΩ	5mΩ to 1GΩ
Measurement Modes	Force Current	Force Current	Force Current Force Voltage Bridge	Force Current Force Voltage Bridge	Force Current Force Voltage Bridge	Force Current Force Voltage Bridge
Modes	Passive Trim	Passive Trim	Passive Trim Active Trim	Passive Trim Active Trim	Passive Trim Active Trim	Passive Trim Active Trim
Positioning accuracy	±10µm	±10µm	±5µm	±5µm	±5µm	±5µm
External Measurement devices	No	No	GPIB, ATI	GPIB, ATI	GPIB, ATI	GPIB, ATI
Add. Features	• Matrix Cards • Ref Board • Substrate and Die alignment	• Matrix Cards • Ref Board • Substrate and Die alignment	• Matrix Cards • Ref Board • Substrate, Reticle and Die alignment • Theta axis • Active Guard (250mA) • Analog aux lines for external references	• Matrix Cards • Ref Board • Substrate, Reticle and Die alignment • Theta axis • Active Guard (250mA) • Analog aux lines for external references	• Matrix Cards • Ref Board • Substrate, Reticle and Die alignment • Theta axis • Active Guard (250mA) • Analog aux lines for external references	• Matrix Cards • Ref Board • Substrate, Reticle and Die alignment • Theta axis • Active Guard (250mA) • Analog aux lines for external references

Chip Resistor Trim Performance Overview

	LT5500	LT5510	LT5520
Laser type	ns IR (ThickFilm)	ns GR (ThinFilm)	ps GR (ThinFilm)
Typical substrate size	50x60mm 60x70mm	50x60mm 60x70mm	50x60mm 60x70mm
Measurement range	5mΩ to 1GΩ	5mΩ to 1GΩ	5mΩ to 1GΩ
Measurement Modes	Force Current Bridge	Force Current Bridge	Force Current Bridge
Modes	Passive Trim	Passive Trim	Passive Trim
Positioning accuracy	±5µm	±5µm	±5µm
External Measurement devices	No	No	No
Add. Features	• Matrix Cards • Ref Board • Substrate and Reticle alignment • Theta axis • Active Guard (250mA)	• Matrix Cards • Ref Board • Substrate and Reticle alignment • Theta axis • Active Guard (250mA)	• Matrix Cards • Ref Board • Substrate and Reticle alignment • Theta axis • Active Guard (250mA)

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Thank you for your time!

Improving trimming performance through precision measurement, speed, and platform stability

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