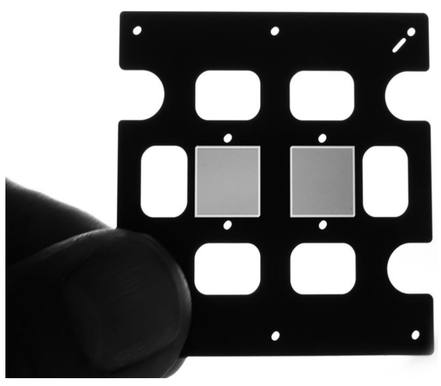
Productivity Enhancements when Drilling Guide Plates for Advanced Vertical Probe Cards

SWTA-24-40

SWTEST
PROBE TODAY, FOR TOMORROW



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OXFORD LASERS

BACKGROUND

The manufacturing capability of state-of-the-art advanced laser micromachining systems is a known constraint on the design of Guide Plates for the semiconductor wafer test industry. With the demands from probe card testing presenting greater challenges on hole geometry for probes, there is a constant need to look at new methods in laser drilling.

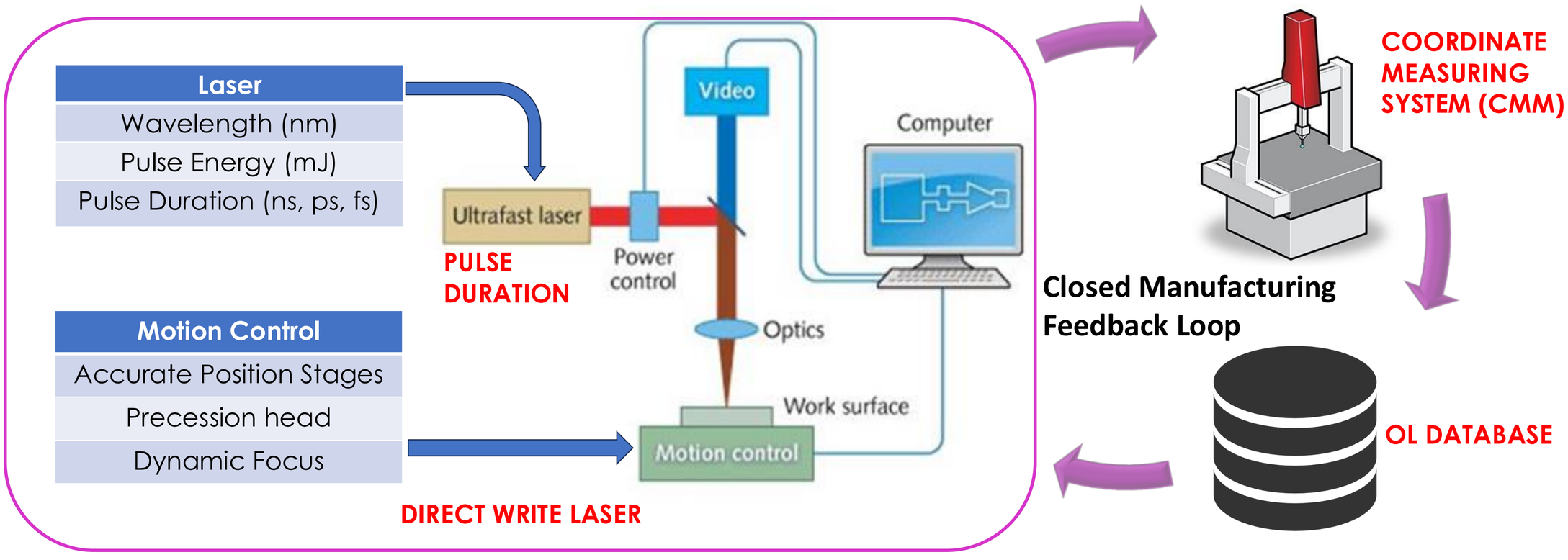
Nanosecond pulse duration lasers are a well-established technology in the manufacture of Guide Plates and are chosen for their stability and high throughput in micromachining.

Ultrafast lasers such as **Picosecond** and **Femtosecond** have been used on most industrial materials providing advantages in challenging materials such as Silicon Nitride.

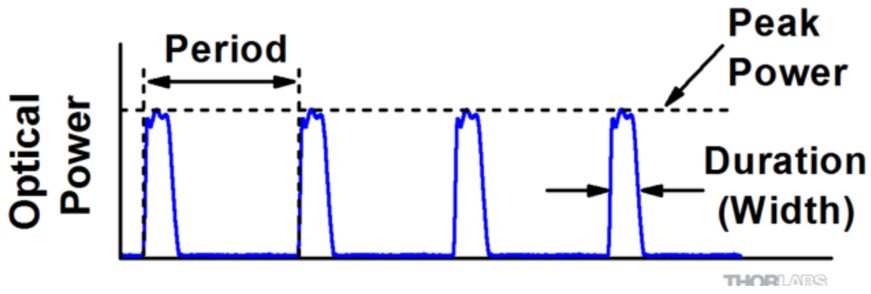
We are comparing the capabilities of Nanosecond, Picosecond and Femtosecond laser sources across defined specifications such as Guide Plate Thickness, hole size/3D shapes and Web thickness between drilled holes.

HOW GUIDE PLATE LASER DRILLING WORKS

A typical business Integrated facility such as OL incorporate laser drilling tools, advanced metrology, and automated process optimisation. The complete cycle of this process is shown below:



Pulse duration is the time during which the laser emits energy to the work surface. The shorter the pulse the lower the heat into the material whilst drilling, but there are challenges such as greater optical non-linearities.



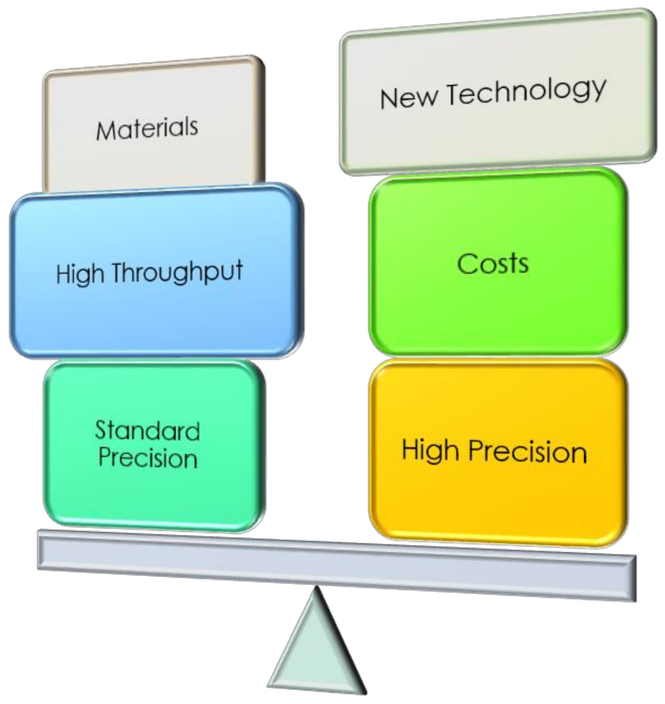
- Nanosecond (ns) Laser Machining (10^{-9} sec)
- Picosecond (ps) Laser Machining (10^{-12} sec)
- Femtosecond (fs) Laser Machining (10^{-15} sec)

PRODUCTIVITY IMPROVEMENTS TO DELIVER ADVANCED GUIDE PLATES

There are two particular attributes to improve the productivity of the manufacture of guides plates:

1. *The selection of the correct laser drilling tool to match the exact specifications of the required design of Guide Plate*

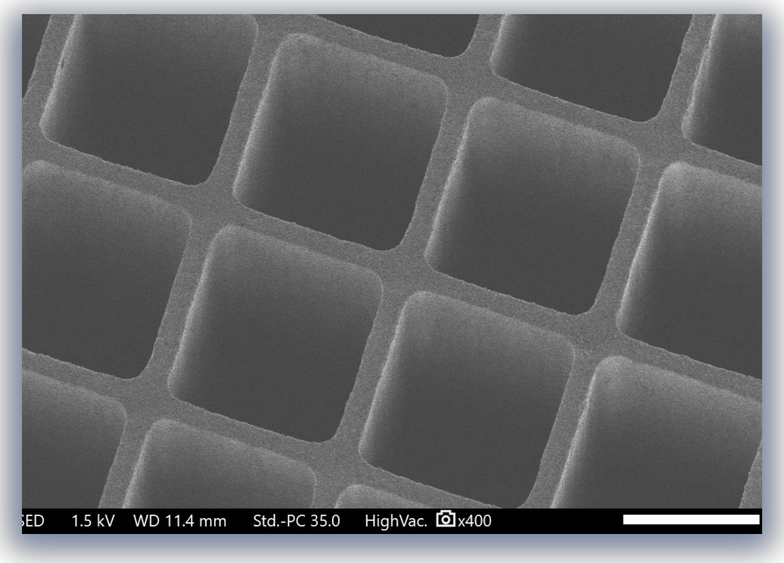
2. *A well-tailored feedback loop between guide plate design, selected laser tool and comprehensive metrology using Machine Learning and proprietary software*



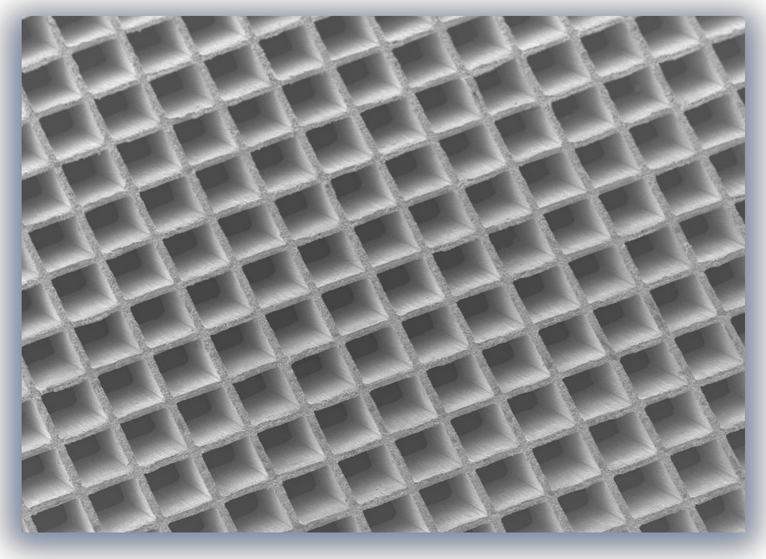
The selection of the suitable laser drilling methods are shown here:

Nanosecond Challenges

Problem – Laser heat accumulation management required to achieve tight webbing
Solution – Tailor laser drill recipes with applied metrology

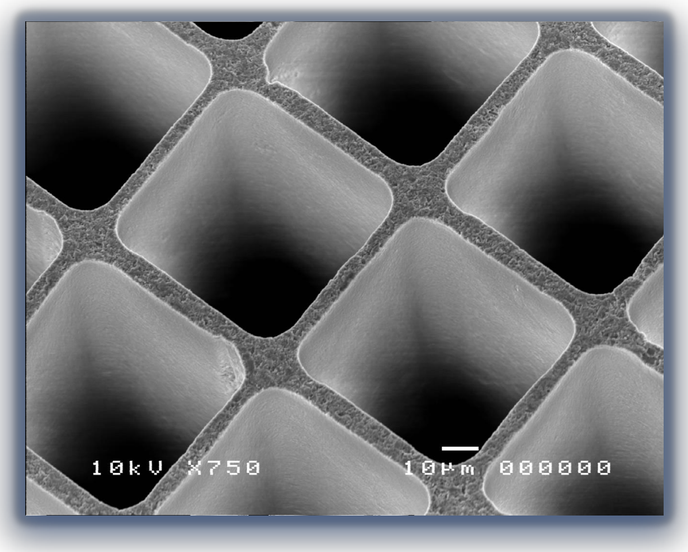


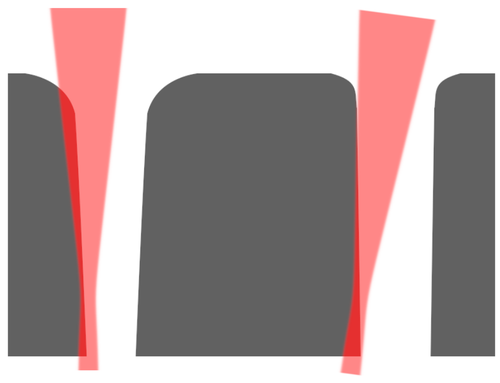
Nanosecond lasers can provide high throughput holes for production giving features such as Web 6 µm



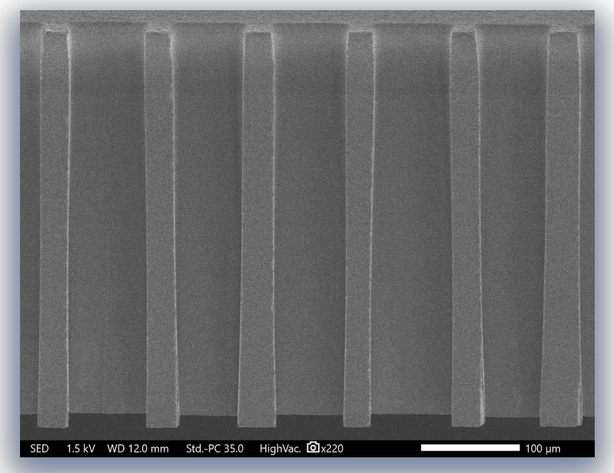
Picosecond Challenges

Problem – High Precision but generally insufficient laser pulse energy to control taper
Solution – Use with angled precession drill head





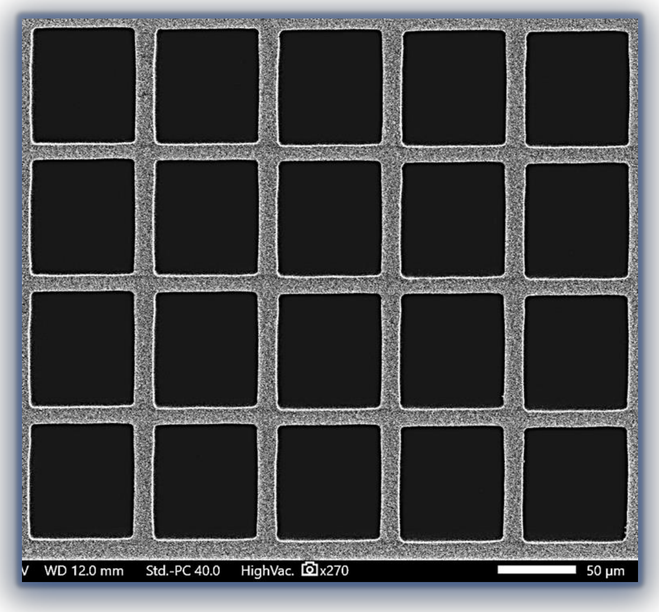
Direct Head Angled Head



Precise Taper Control

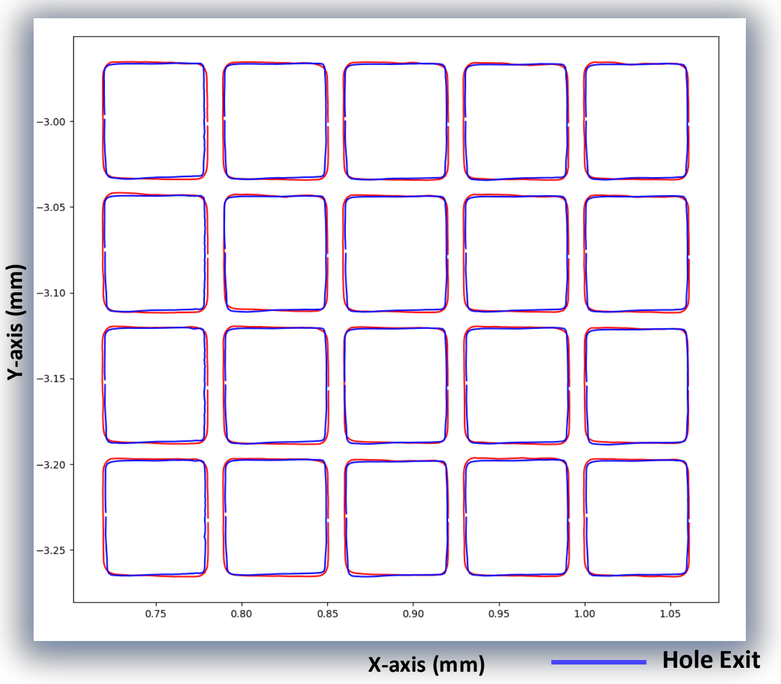
Femtosecond Challenges

Problem – Insufficient laser pulse energy to drill; and debris build up inside the bore hole.
Solution – Use with angled precession drill head and gas assist



Web 6 µm
Corner Radii <4 µm
Zero Taper

Hole Profile Repeatability

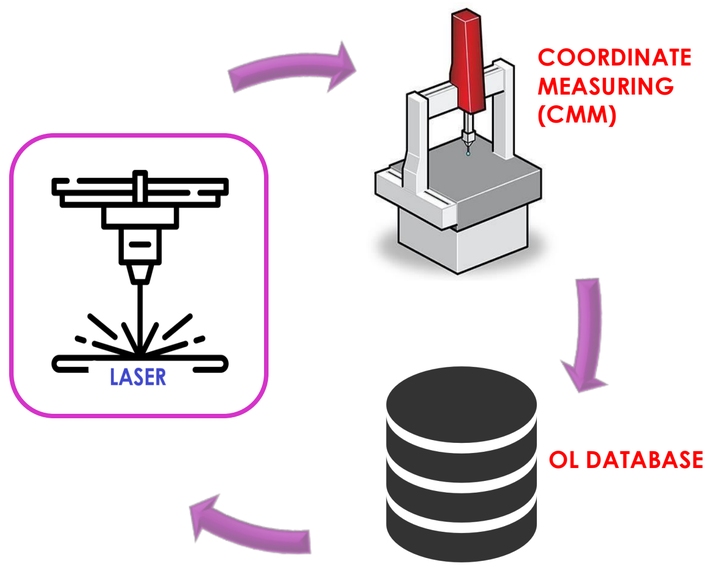


WHY IS A PRODUCTION FEEDBACK LOOP IMPORTANT FOR A PROBE CARD?

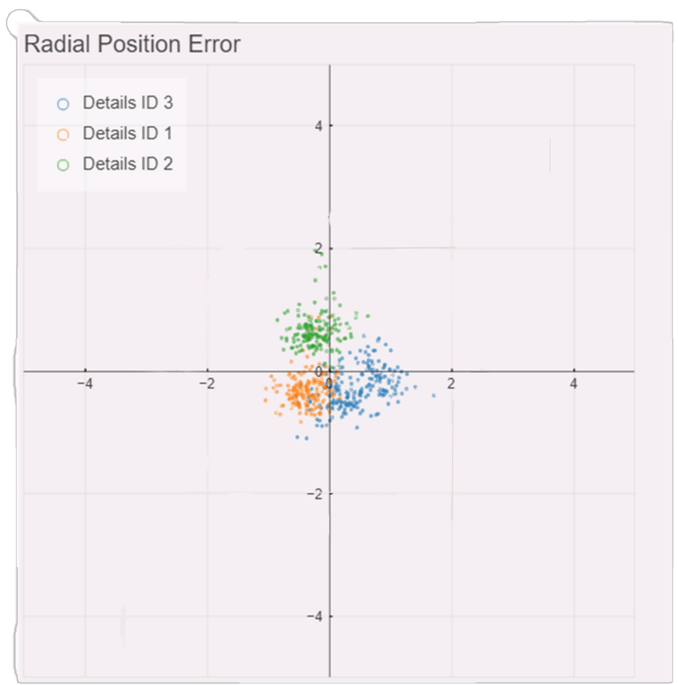
When Oxford Lasers receive a new Guide Plate design from a customer there are a significant number of complexities that are considered.

- We have seen that selection of the correct laser is integral to the quality of the final Guide Plate
- But what about consistency?

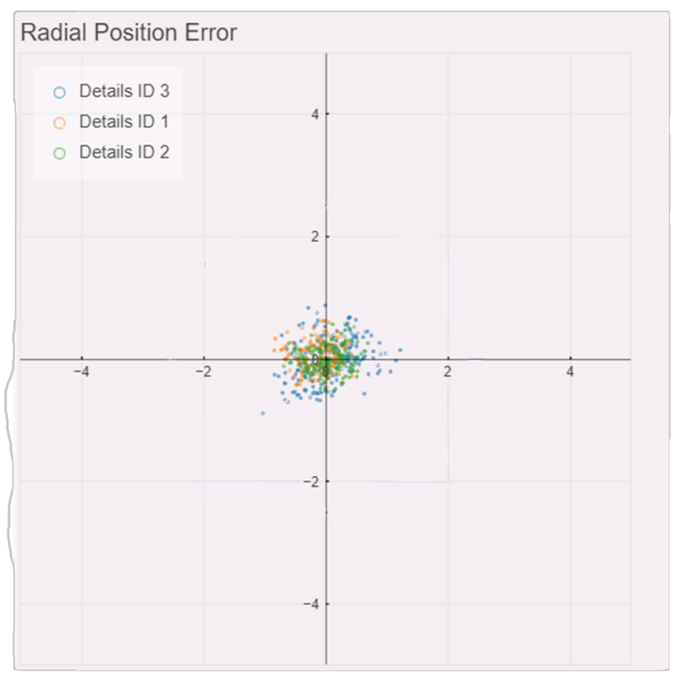
  Number of holes per plate can now go beyond 100,000 vias and this can prove problematic in a drilling environment
- To combat this, selecting one area of metrology positional error of the individual holes, we can use historical data to improve the outcome
- The closed feedback loop between Laser source, Measuring system and OL Database provides the Probe Card customer with an optimised Guide Plate



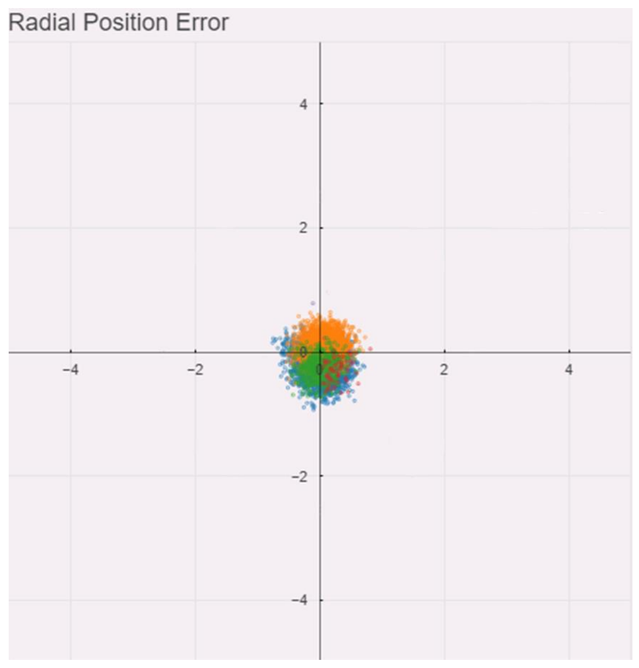
An Example Showing Positional Error Improvements after Machine Learning Feedback



Measurement Data from Test Plate showing positional error spread

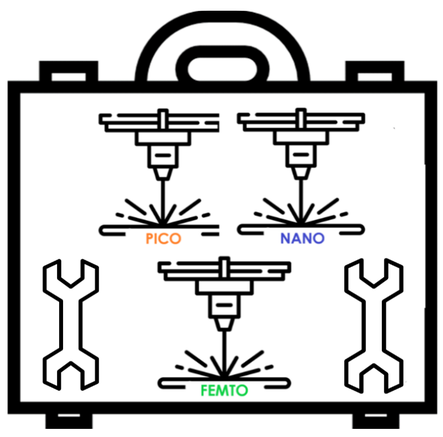


Data using feedback into system closing positional error spread



Final output Production Plate Data giving much improved accuracy

We have demonstrated that to provide a reliable and repeatable ceramic product there needs to be a range of 'tools' at the supplier's disposal.



FURTHER WORK

- New technology in material science for Guide Plates and increasingly compressed delivery times is pushing R & D into efficiencies that require intelligent drilling
- Developing this combination of machine learning and modular selective laser drilling will provide the Probe Card industry with a Guide Plate that will adapt to the new deliverables

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