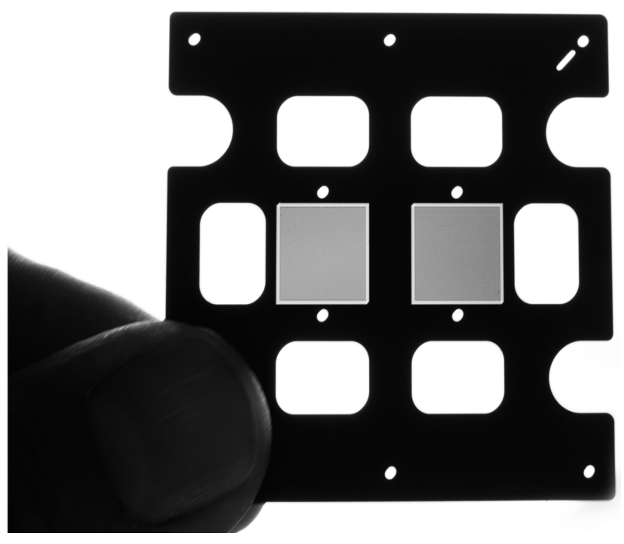
POSTER 01

A comparison of Nano, Pico and Femtosecond laser sources and their manufacturing capabilities in Guide Plate production



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BACKGROUND

The manufacturing capability of state-of-art advanced laser micro-machining systems is a known constraint on the design of Guide Plates for the semiconductor test industry. With the demands from probe card testing presenting greater challenges on hole geometry for probes we are constantly looking at new methods in laser machining.

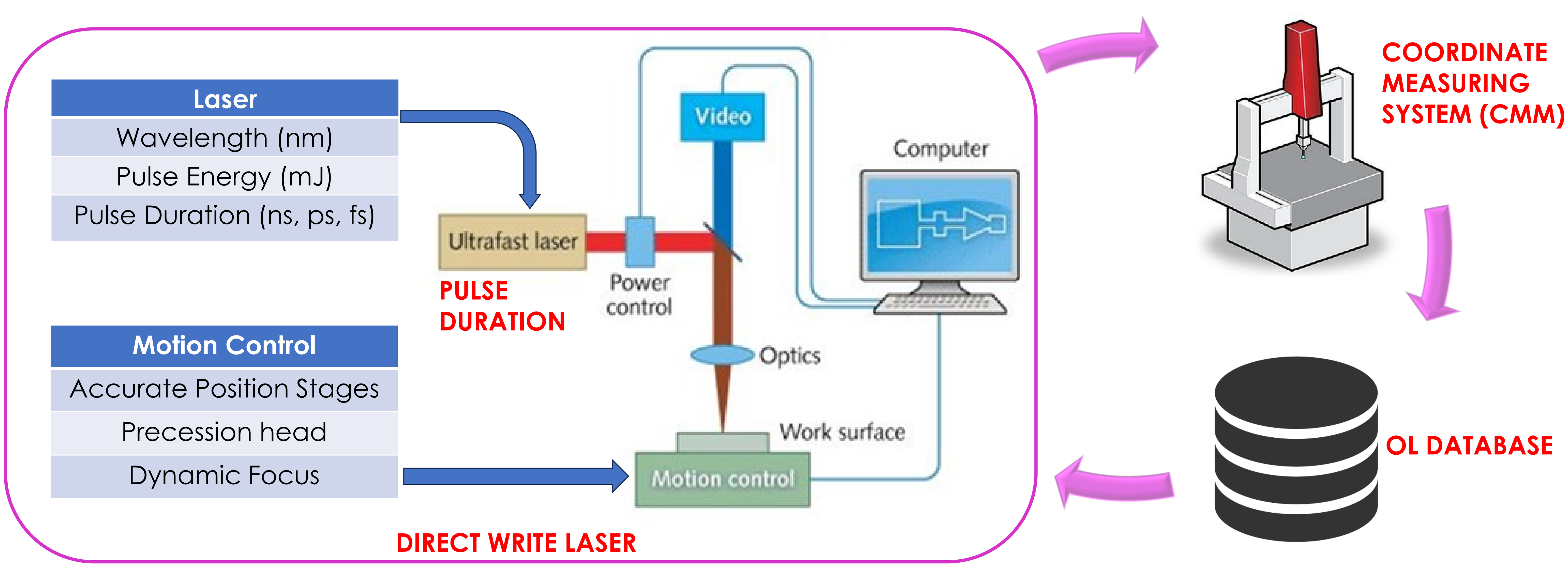
Nanosecond pulse duration lasers are a well-established technology in the manufacture of Guide Plates and are chosen for their stability and high throughput in micromachining.

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

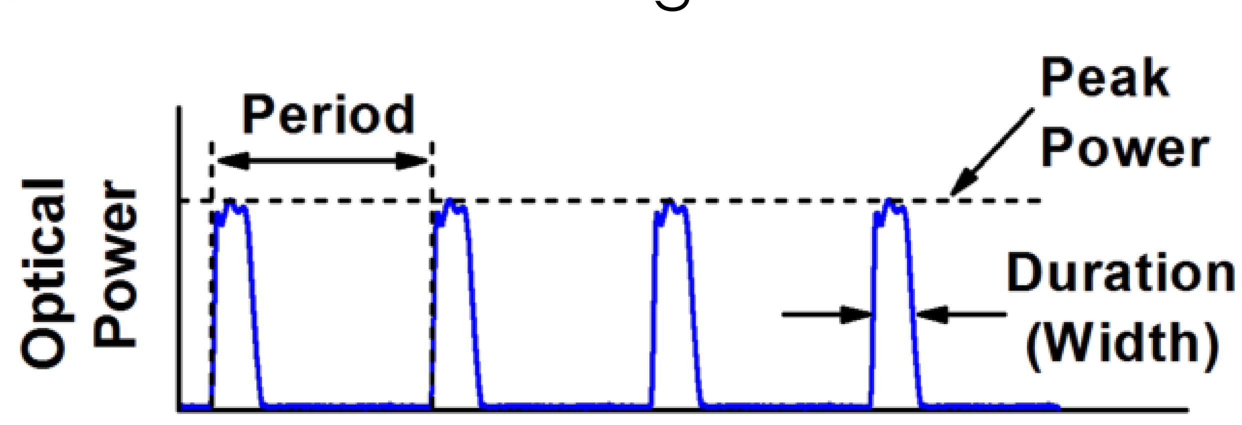
We are comparing the capabilities of Nanosecond, Picosecond and Femtosecond laser sources across defined specifications such as Guide Plate Thickness, hole size/3D shapes and Web thickness between drilled holes.

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.

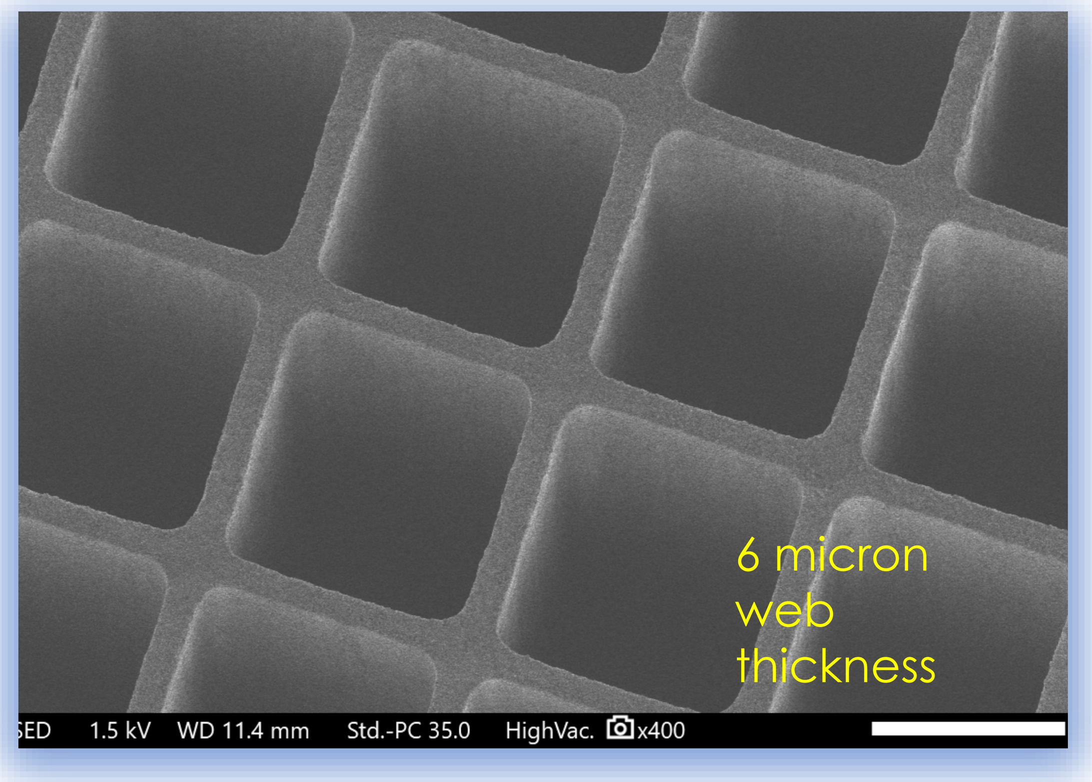


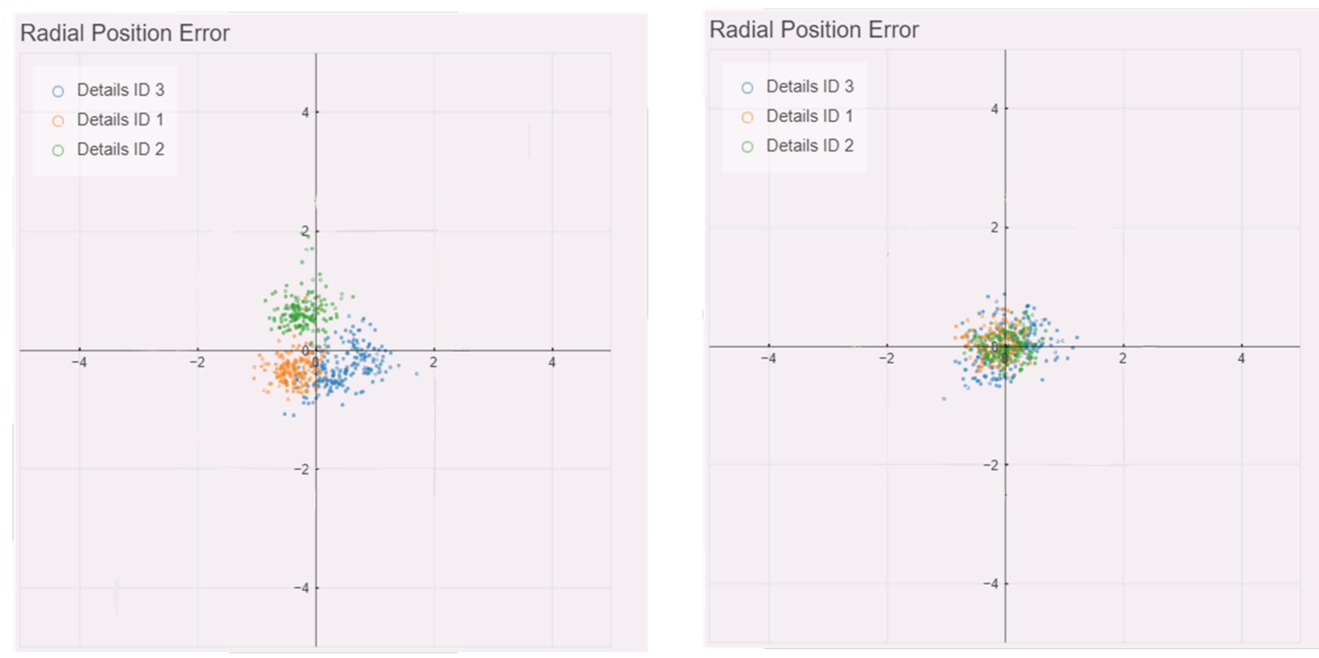
- Nanosecond (ns) Laser Machining (10^{-9} sec)
- Picosecond (ps) Laser Machining (10^{-12} sec)
- Femtosecond (fs) Laser Machining (10^{-15} sec)

LASER PULSE DURATION COMPARISONS

Nanosecond Challenges

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

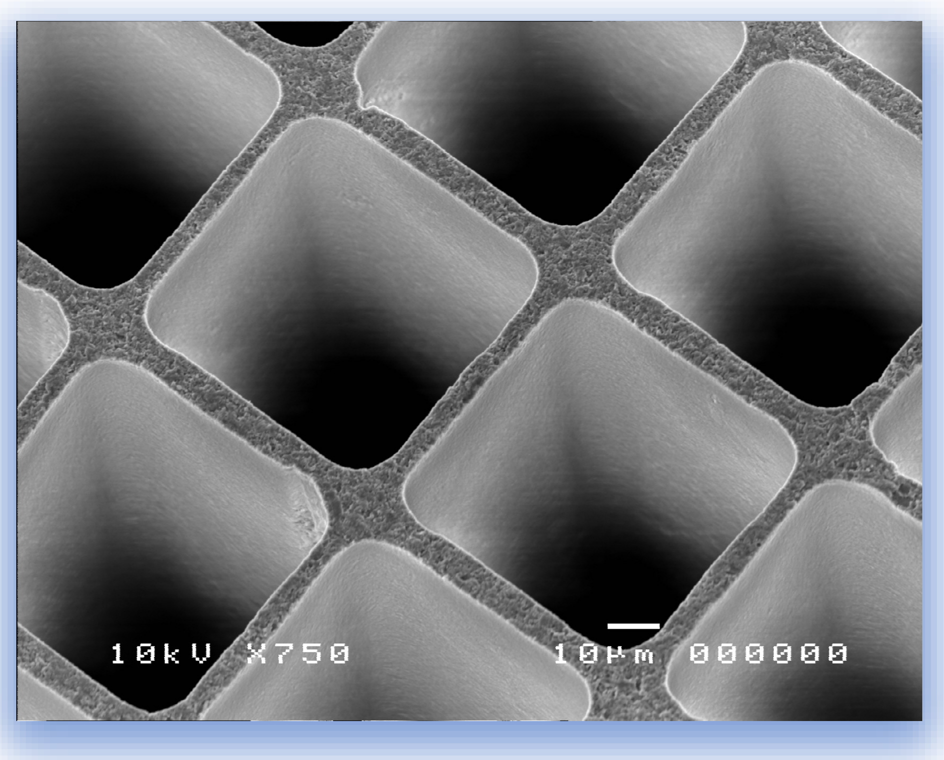


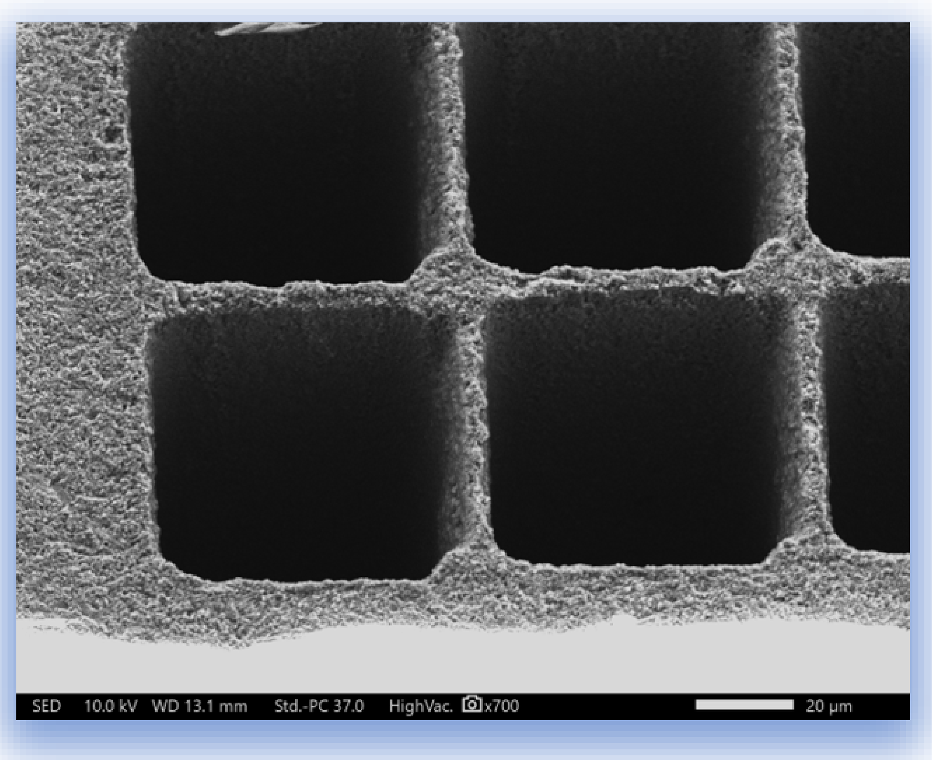


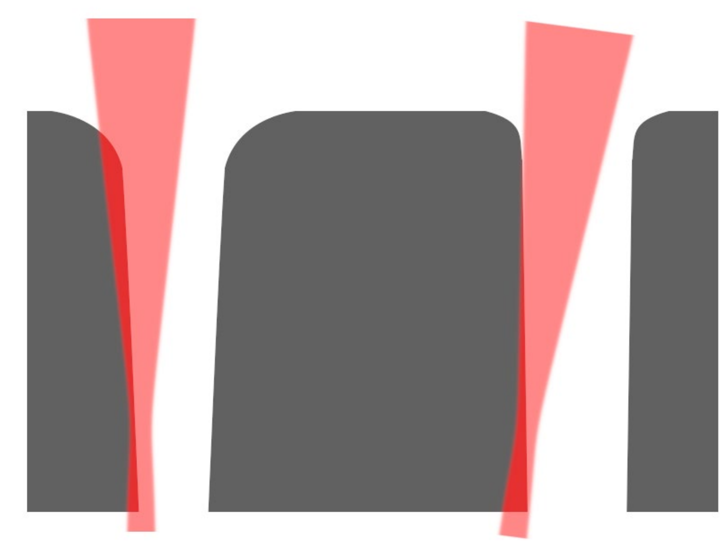
Dimensions in Microns

Picosecond Challenges

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



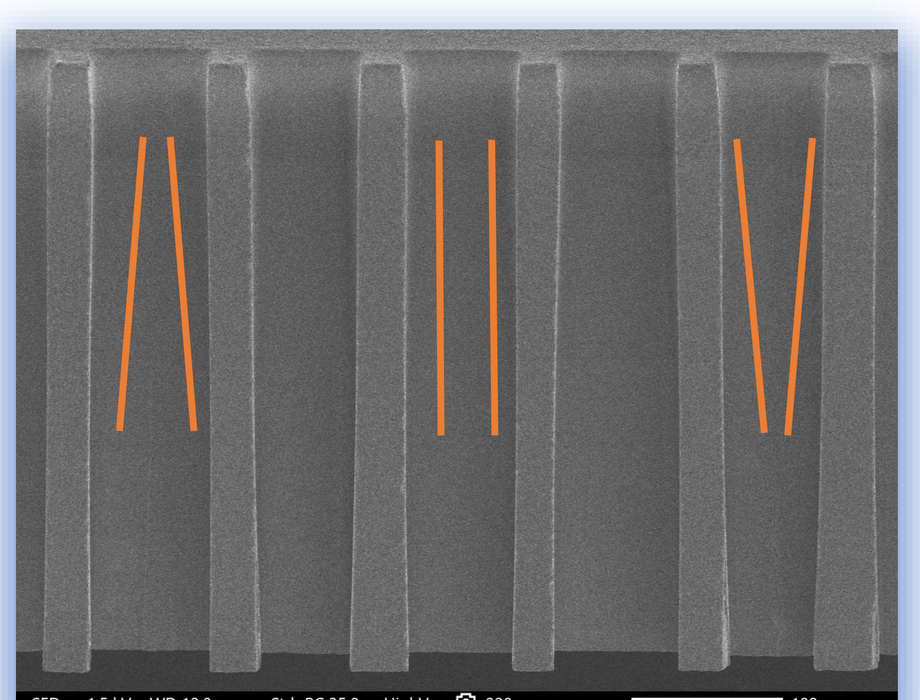


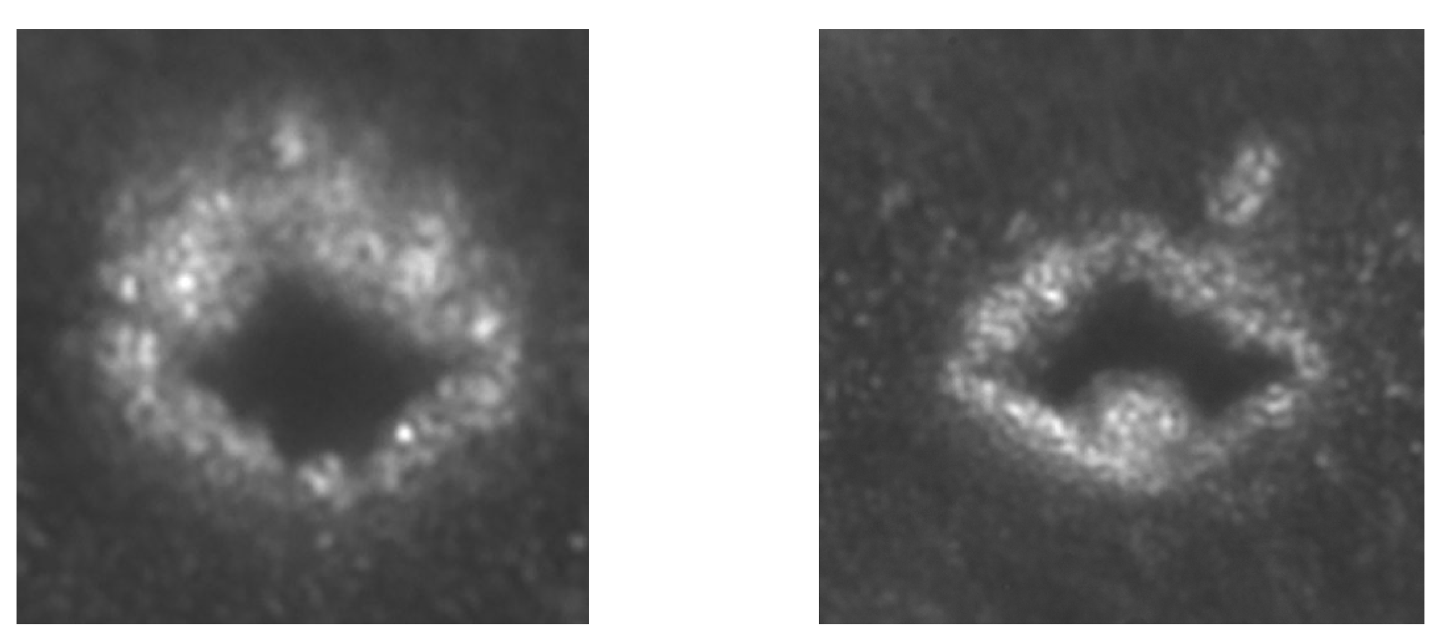


Direct Head Angled Head

Femtosecond Challenges

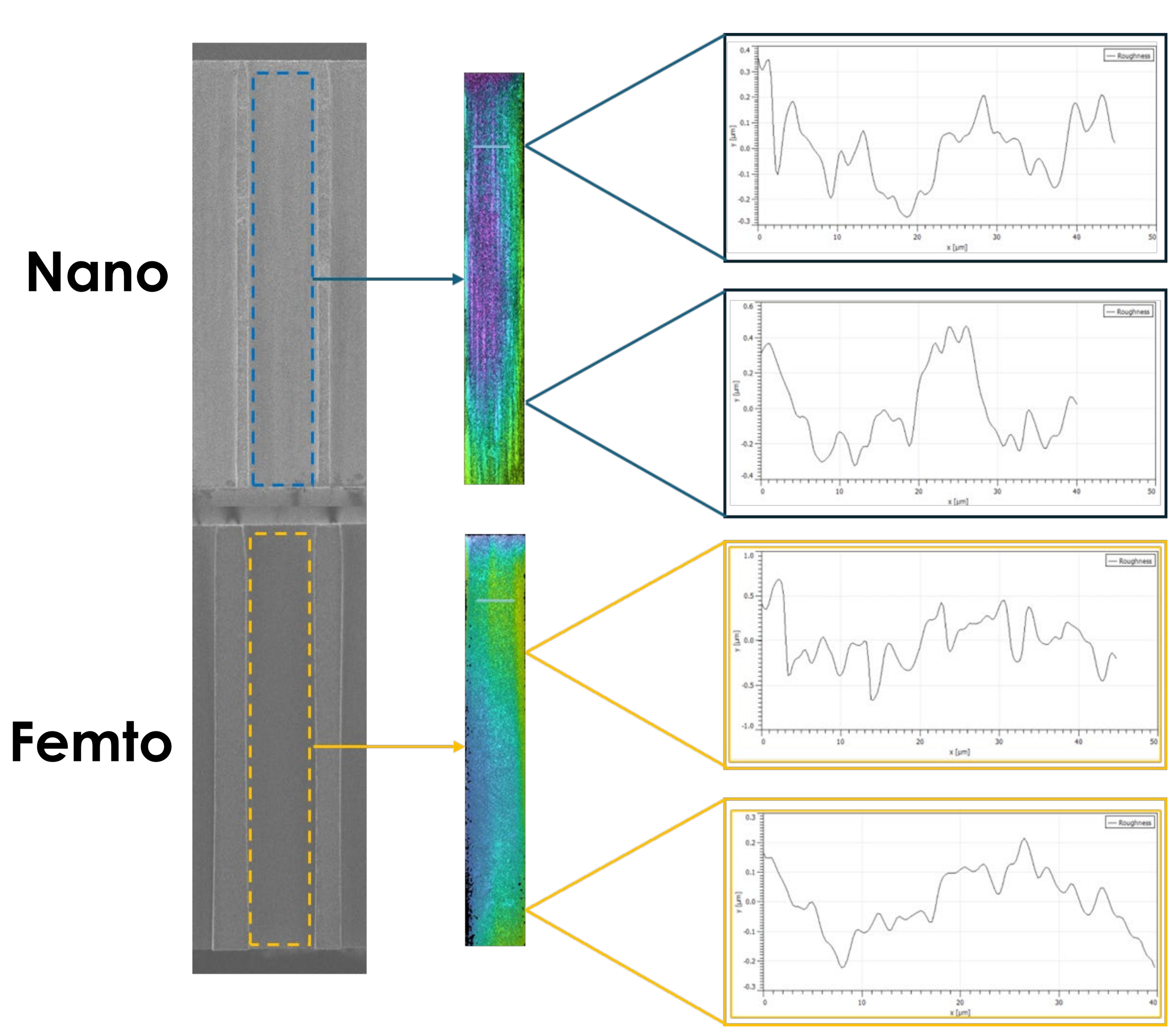
Problem – Insufficient laser pulse energy to drill and debris build up inside the bore hole.
Solution – Use with angled precession drill head and gas assist





Effect of No Gas/Gas assist

Laser Drilled Borehole Wall Roughness



Confocal microscope measurements reveal the surface roughness at the borehole entrance is higher than the exit for both Nano and Femtosecond drilling.

Roughness:

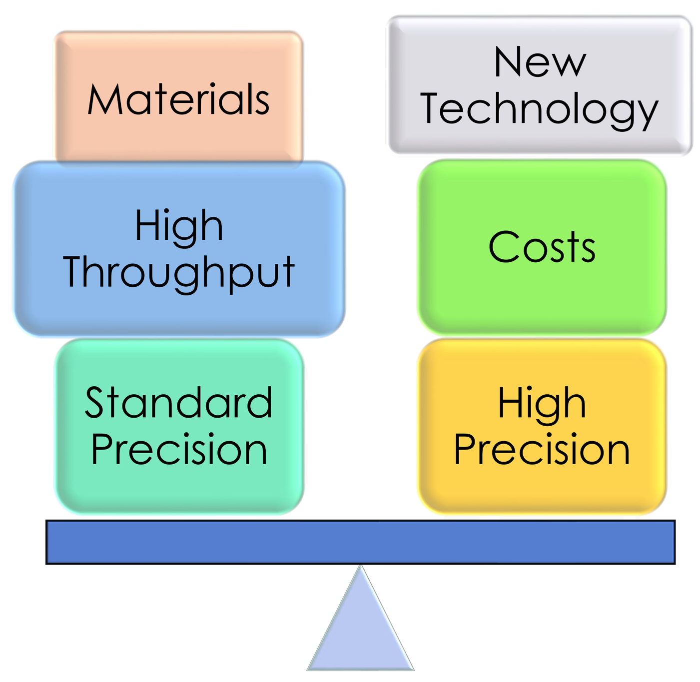
- Femto Entrance: 185 nm
- Femto Exit: 87 nm
- Nano Entrance: 217 nm
- Nano Exit: 112 nm

Area Surface Roughness across the entire borehole:

- Femto: 546 nm
- Nano: 447 nm

IN SUMMARY

1. There are a significant amount of complexities when considering the type of pulse duration laser for the exact guide plate design. We have demonstrated that in order to provide a reliable and repeatable ceramic product there needs to be a range of 'tools' at the supplier's disposal.



2. If there is careful consideration on ALL Guide Plate specifications we are able to match the optimal laser pulse duration depending on probe card design, specifications and throughput requirements from the customer.

Table highlighting different laser pulse duration performance depending on material and web thickness.

Laser Pulse Duration	Material Thickness (mil)	Web Thickness (µm)	Process Complexity
NANOSECOND	<18	<10	Low
	>18	<10	Medium
	<18	>10	Low
	>18	>10	Low
PICOSECOND	<18	<10	Low
	18-30	<10	Medium
	>30	<10	High
	<18	>10	Low
	18-30	>10	Medium
	>30	>10	High
FEMTOSECOND	<18	<10	Low
	>18	<10	Very High
	<18	>10	Medium
	>18	>10	Very High

FURTHER WORK

The increasing availability of ultra short pulsed laser technology will help manufacturers reduce the complexities of efficient Guide Plate production. Further research and development to provide a simplified manufacturing capability to the probe card designers and ultimately an easier way to test next generation chips is something we will discuss in future presentations.

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