

Technology and Laser Overview

Stefano Concina
Chief Technology Officer



design brilliance / production engineered

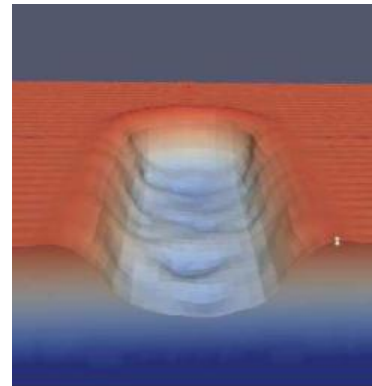
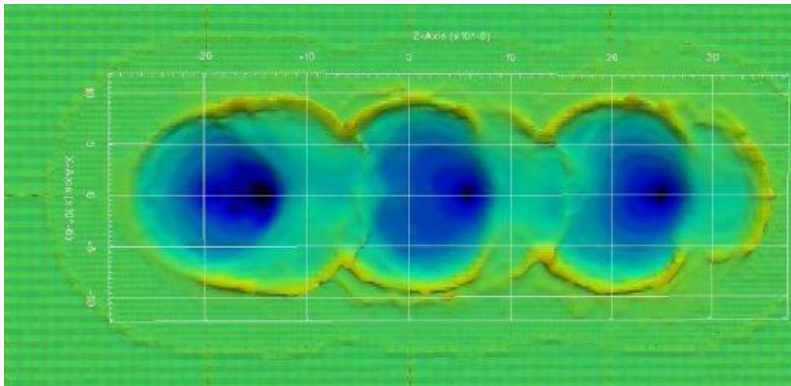
Experts in Transforming Materials with Micron-level Precision

Extensive IP on systems, lasers, processes

High Speed Beam Focusing, Shaping and Manipulation, Coordinated Stage motion, Vision

Drilling, Cutting, Marking, Ablating

Proprietary ESI lasers



Beam Shaping and Positioning

Laser beam needs to be shaped and positioned accurately at very high speeds

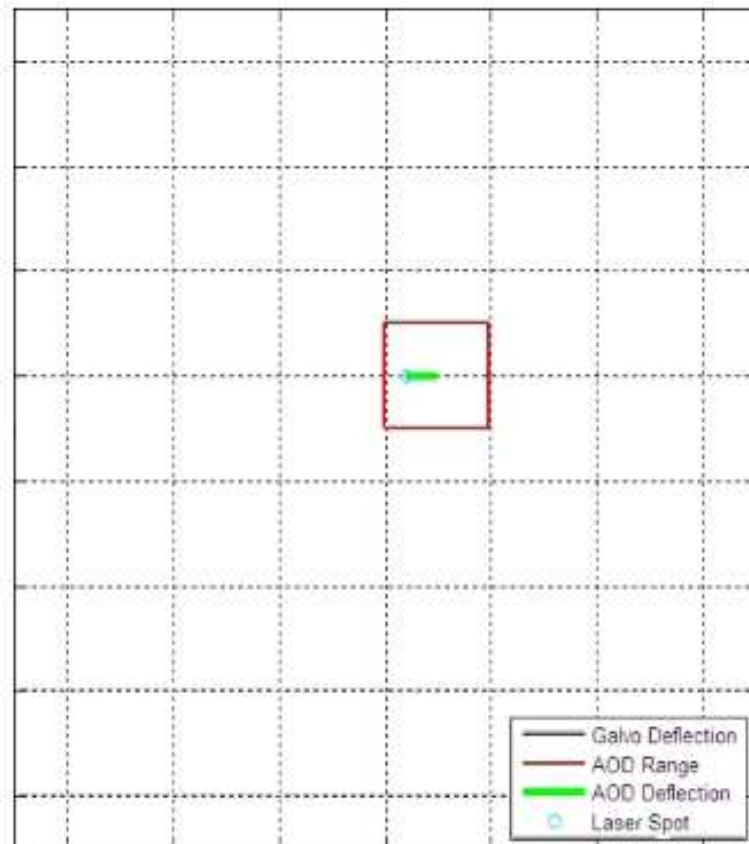
- The sample and the beam are coarsely positioned mechanically in the millisecond (ms) time scale
- Fine positioning occurs in the microsecond (μ s) time scale using optical means
- In one μ s the laser will pulse 80 times!

1 ms is 1/1000 of a second – fast camera shutter speed, 1/3 of fly's wing flap

1 μ s is 1/1000000 of a second – light travels 300m in this time period



Tertiary Beam Positioning



Drawing a square as quickly as possible

- Mechanical beam positioning (galvo) cannot take sharp turns at this speed.
- The optical positioning corrects the position instantly, before the laser pulsates.
- These motions happen seamlessly because they are coordinated.

Process Simulations

Simulation capability to predict laser/material interactions

Can compare lasers quickly, before procuring or designing them!

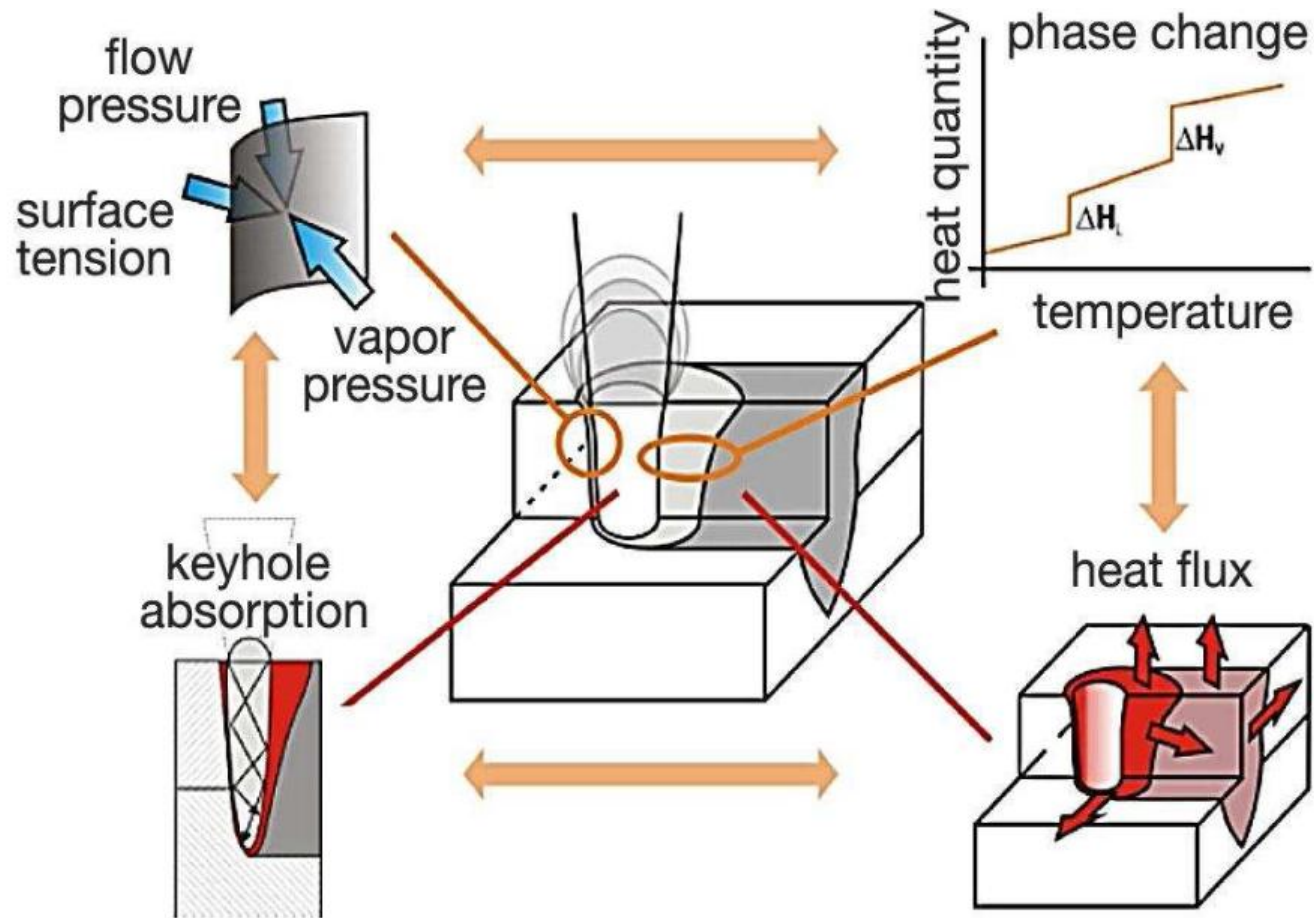
In-house HPC cluster and off-site supercomputer access for faster results

Collaborated with institutions in US and Europe for unmatched capability

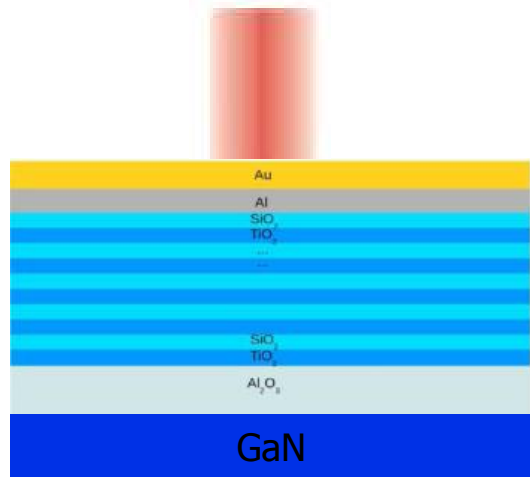
Successfully correlated results with simulation



A Difficult Problem

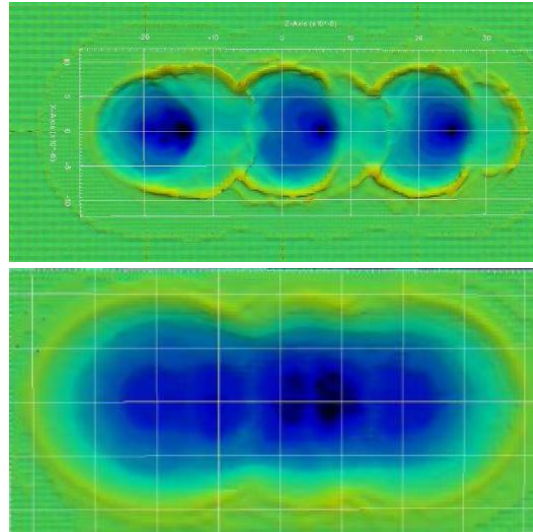


Comparison between Simulation and Experiment

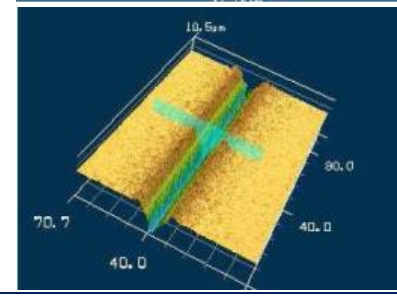
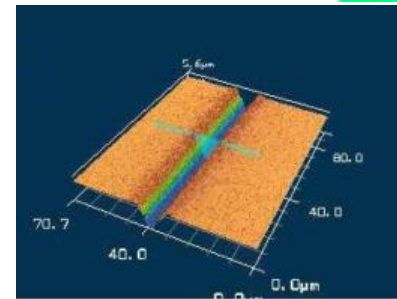
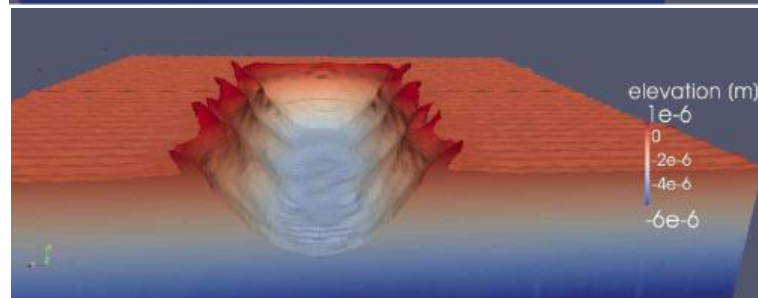
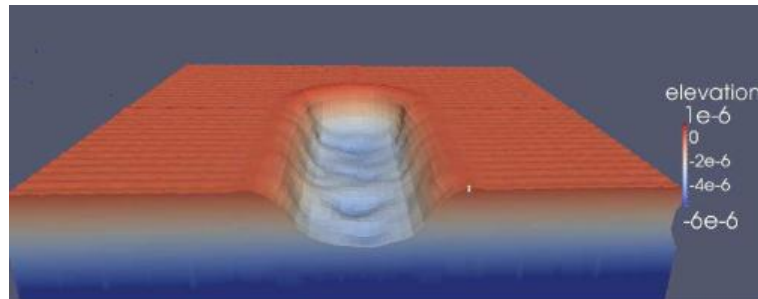
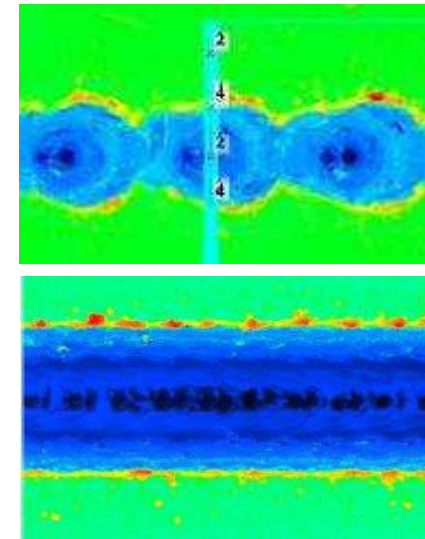


Material cross-section

Simulation



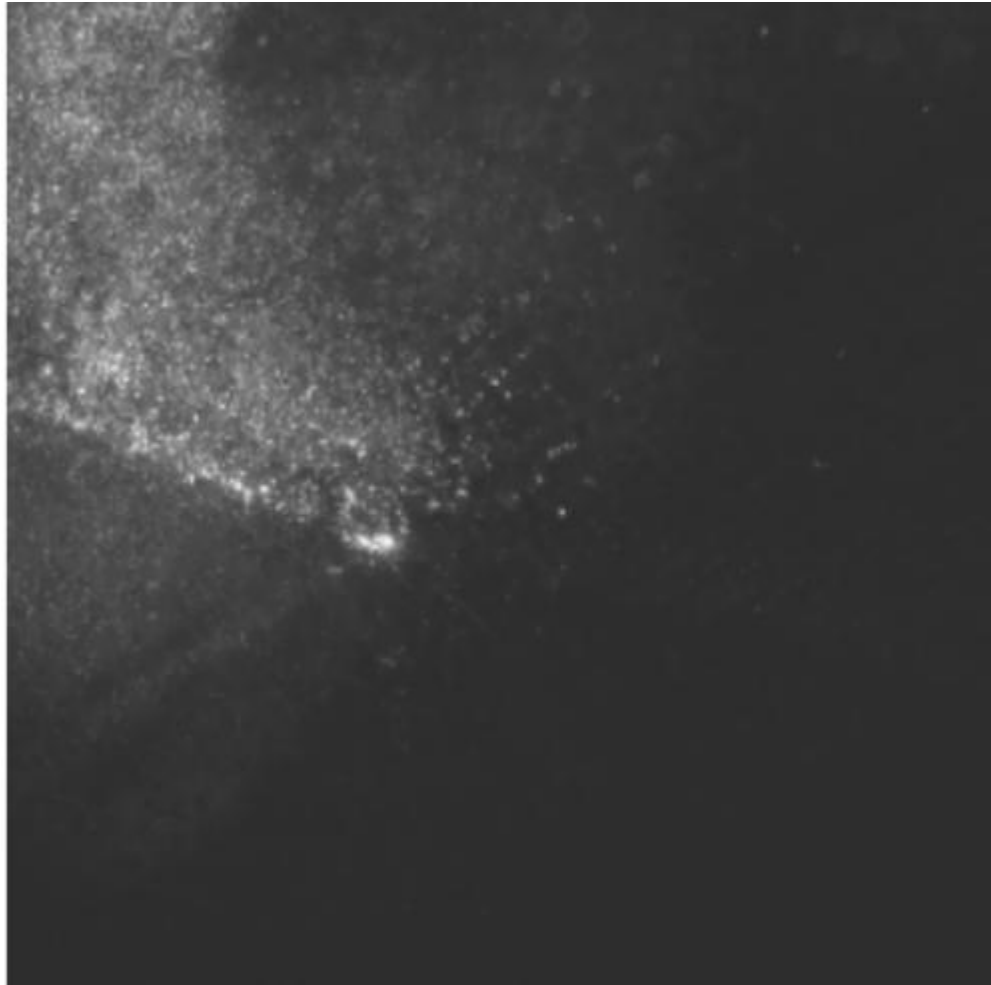
Experiment @ ESI



good process

not-so-good process

Technology Enables Competitive Advantage



10 μ s per frame
Green laser cutting
silicon

Faster time to solution
with a better result

Lowers total cost of
ownership

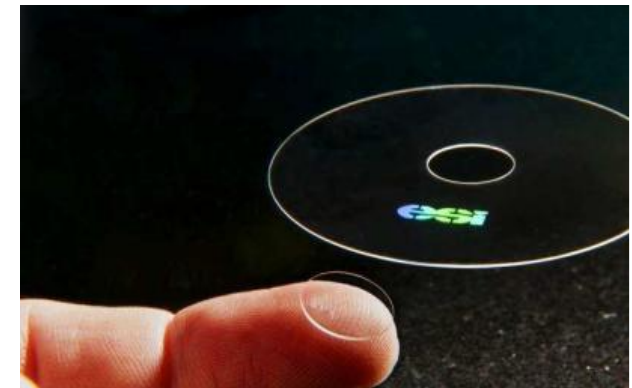
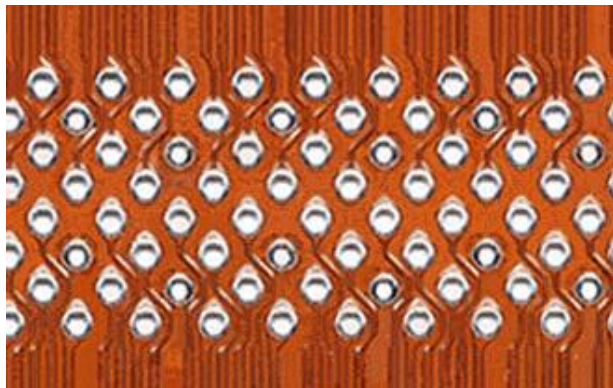
Leveraging ESI Laser Technology

Advanced lasers to support specialized applications (not commodity)

Fiber, UV, Ultrafast, Tailored Pulse

Built for specific materials, performance, cost

For drilling, marking, and cutting



ESI Laser Business Division Benefits

Ownership and control of the most critical component of our platforms

Optimized design criteria for performance, reliability and total cost of ownership

Aligned to ESI customer applications served by IPD and CPD divisions

Capturing more of the value chain, including the repair life-cycle



Adoption Update

Seeded all ESI applications labs with multiple prototype and Alpha units

First laser shipped with ESI systems this summer. Prototyped, tested, shipped in quantity in 7 months.

More systems shipping in the next 3-6 months with ESI lasers

We expect to shift the ESI purchasing to 50% internal lasers within three years.



Unique Technologies

Rod-Type fiber lasers

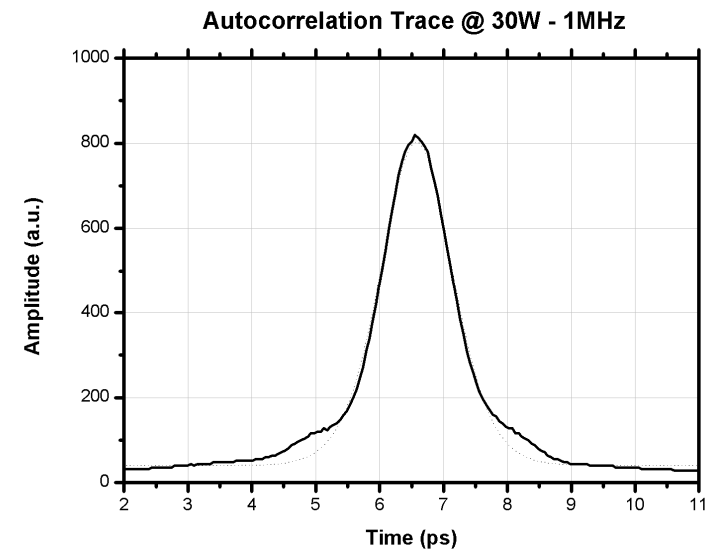
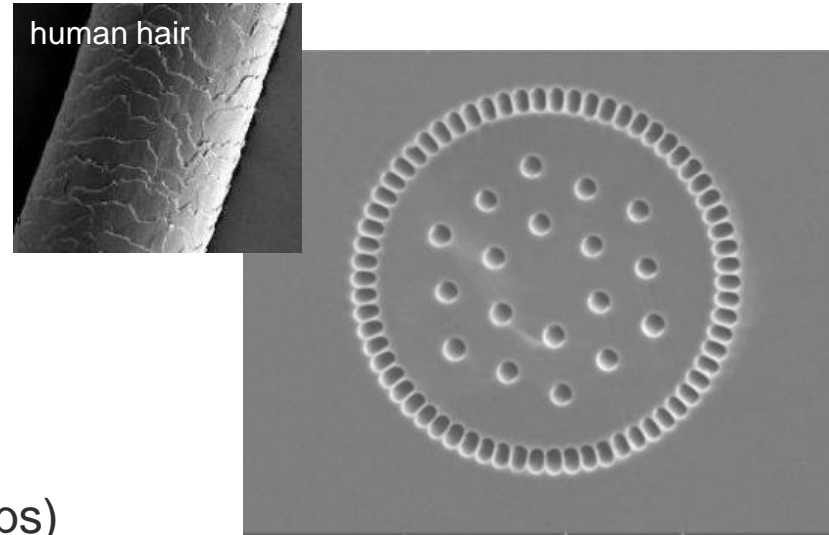
- Holey Fiber
- Capable of very high power

Ultrafast pulse widths

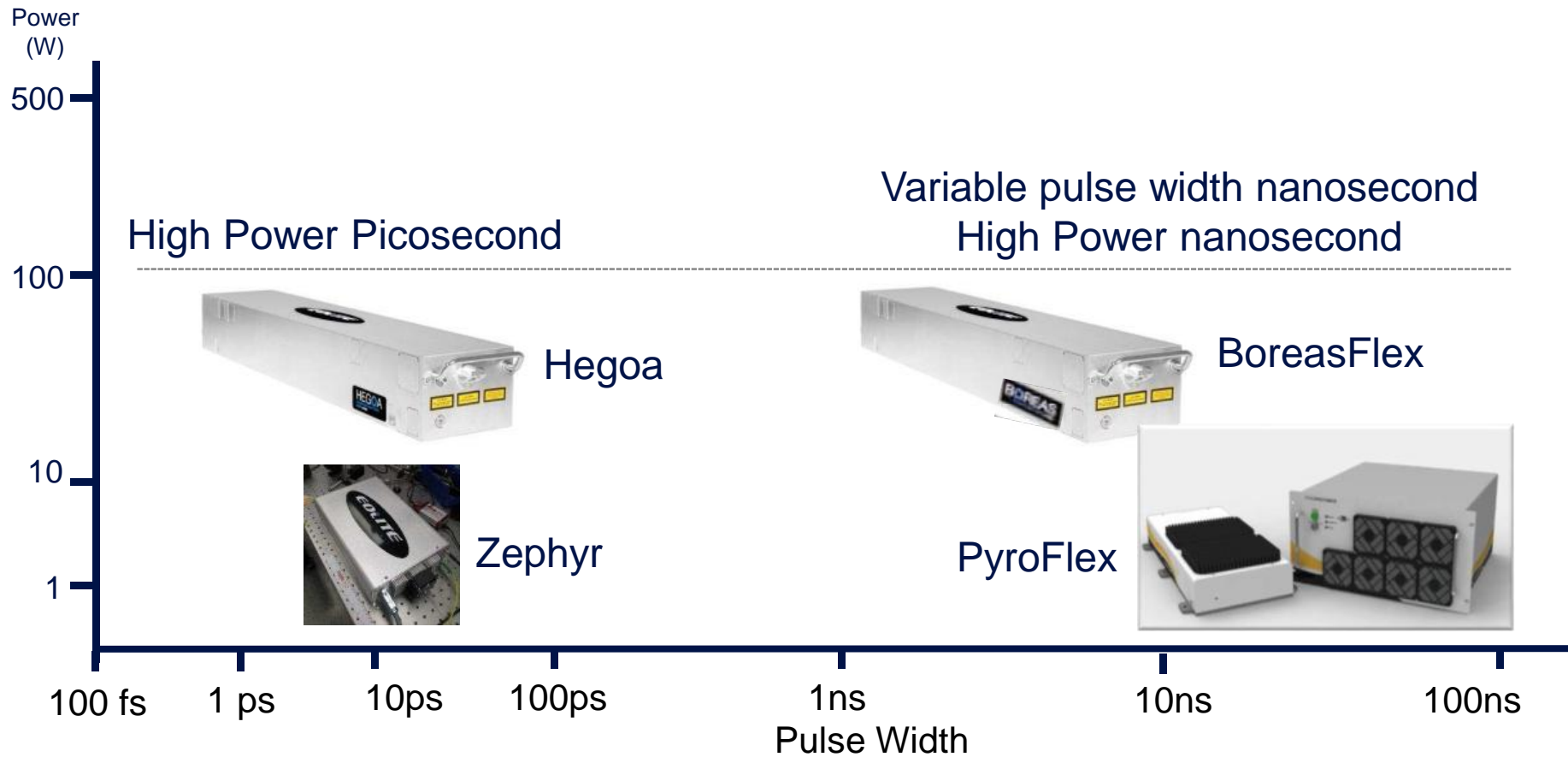
- Down to 1 trillionth of a second (1 ps)
- Light travels 0.3mm in this time period

UV wavelength

- Core ESI expertise
- Good process match to most materials

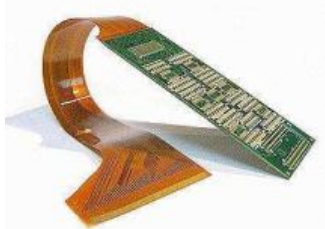


Covering a Wide Range of Microfabrication Needs



Addressing Key Microfabrication Markets & Applications

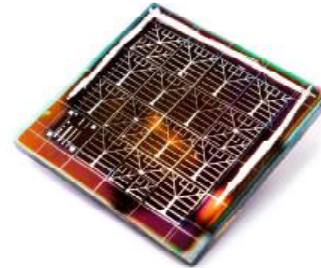
Complex Laminates



Flex Circuit Via Drilling



Advanced Interconnect



Thin Film Scribing

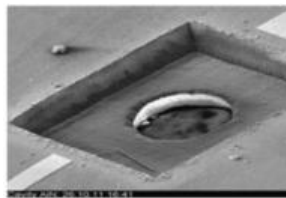


ITO Patterning

Brittle Materials



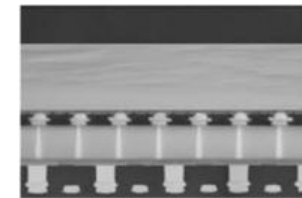
Glass Processing



Ceramic Dicing

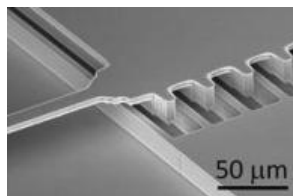


LED Scribing



Thin Film Scribing

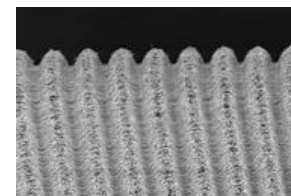
Metals



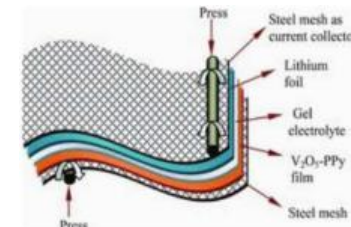
Metal Microfabrication



Core Hole Drilling



Surface Texturing



Battery Foil Singulation

Applying Our Technology for Competitive Advantage

Unique IP in systems and lasers

World leading high-performance beam shaping and positioning

In-house laser designs provides cost and performance advantages

