

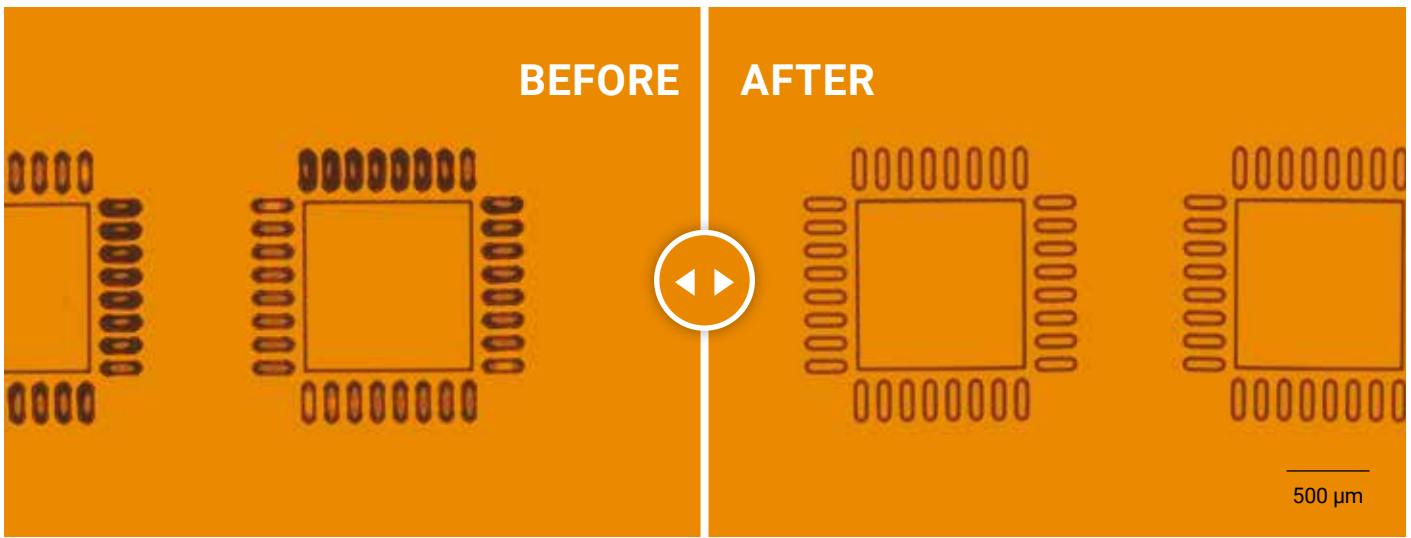


Fig.1. Kapton® surface after laser processing at high scan speed of 500 mm/s - without and with APoD. Cleaner edges, no heat-affected zone, same processing time.

PRODUCT FEATURE

Advanced Pulse-on-Demand

100x* reduced jitter increases precision, throughput and quality

The **Jasper X1** laser comes with an *advanced pulse-on-demand* feature (*Advanced PoD, APoD*), allowing users to trigger pulses with minimized delay between the trigger signal and optical pulse generation (*timing jitter*). *Advanced PoD* provides unmatched precision in processing corners and the highest quality of small features by reducing the *heat-affected zone (HAZ)*. The function maintains constant pulse energy and pulse distance on the material, regardless of fluctuating scan speeds. This results in a maximized productivity and superior quality without HAZ.

Now, users can fully leverage the *position-synchronized output (PSO)* of stages and scanners – a control system that translates the real-time beam velocity into variable trigger frequency, thus providing constant pulse distance. This enables unparalleled precision and quality, even at the highest scan speeds. The only positioning-precision-limiting factor is the accuracy and repeatability of a scanner or stages.

Addressing uncertainty in pulse distribution

When using the laser without APoD, the *timing jitter* depends on a predefined internal pulse repetition frequency and typically ranges between 1 and 10 μ s (1 MHz – 100 kHz). For instance, at a scan speed of 2 m/s,

Perfect for challenging applications

- Sensitive Material Processing:
Reliable results on thin, heat-sensitive substrates
- Flexible Display Fabrication:
Clean, precise cuts with no discoloration or loss of functionality
- Advanced Micromachining:
Perfect for small, integrate features with high-quality edges

Jasper X1
High Power Femtosecond Fiber Laser



Jasper X1 is a 1030 nm high-power femtosecond laser, delivering pulses with energy up to 300 μ J in a burst.

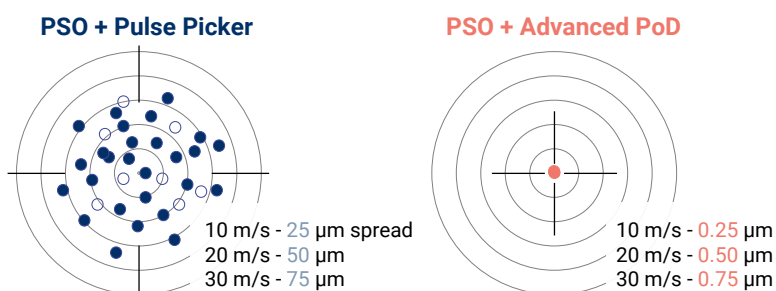


Fig. 2. Jitter visualised as shot dispersion on target. With Pulse Picker (left), positioning error ranges from 25 to 75 μ m with scan speed. Advanced PoD (right) keeps dispersion below 1 μ m in all cases.

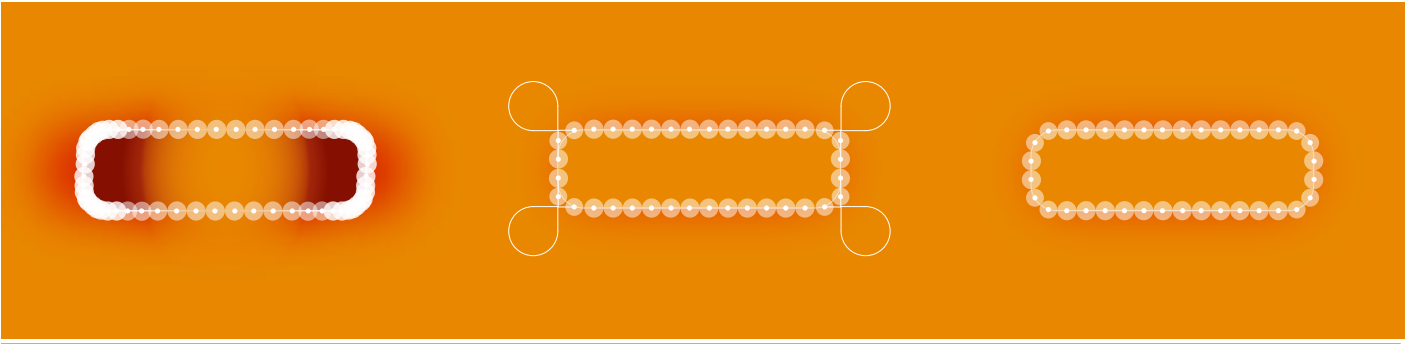


Fig.3. Three approaches to laser motion synchronization: (1) *Free running laser* – constant pulse frequency causes overlap and excessive heating, leading to a visible heat-affected zone; (2) *Skywriting* – additional trajectories increase processing time; (3) *PSO + APoD* – each pulse is precisely synchronized with scanner position, ensuring clean edges and no HAZ.

the pulses are distributed unevenly, with an uncertainty of $\pm 20 \mu\text{m}$, which is significantly worse than the accuracy of modern galvanometric scanners or stages. Moreover, there is a problem with so-called *missing pulses*. This highlights the critical importance of reducing timing jitter.

How Advanced PoD reduces timing jitter

In *Advanced PoD* function, the challenge lies in selecting arbitrary pulses from the oscillator upon request and amplifying them while maintaining consistent pulse energy – an inherently complex task. Addressing this, Fluence's engineers developed a new stabilized-energy mode based on advanced gain control within the laser. This innovation has reduced *timing jitter* to less than 50 ns, enabling unparalleled precision in pulse picking with stabilized pulse energy.

The laser operation is no longer constrained by a fixed base repetition frequency but is instead defined by the requested pulse energy. This allows for an adjustable pulse repetition rate with the resolution of the seeder frequency.

Results: Increased laser duty cycle

With the new feature, the laser duty cycle increases, reducing processing time and eliminating HAZ. Thanks to the new smart laser mode, it is possible to avoid using *skywriting* mode of a scanner, thus increasing the laser duty cycle.

APoD keeps quality at extreme speed and acceleration

High flexibility in pulse triggering is essential for the high dynamics of modern scanners, where beam acceleration exceeds $50\,000 \text{ m/s}^2$. Thanks to APoD functionality, the quality of corners and edges in raster-scanned fields is preserved, even at extreme acceleration or deceleration values and speeds reaching tens of meters per second. *Advanced PoD* is fully compatible with burst mode, pulse-duration tuning, and harmonic generation.

Evaluate the performance of the Fluence Technology lasers (with APoD) on your specific application:

- **challenge our** Ultrafast Laser **Applications Lab** experts with your samples – we'll report back with detailed results,
- **book a demo** system and test it under your own conditions,
- or **select the optimal laser** configuration for your application.

Talk to Fluence Technology to define the best path forward.

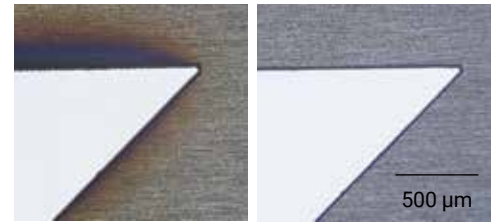


Fig.4. 200 μm -thick stainless steel laser-cut samples. With APoD (right), heat-affected zone (left) is eliminated.

Engineering the Advanced Pulse-on-Demand has unlocked how to:

- drill micro-holes in glass with an aspect ratio $> 25:1$ and densities above 50 mln holes/m^2 – without cracks, chips, or stress,
- micromachine ceramics and oxides with no HAZ, no discoloration, and preserved crystalline structure,
- cut thin metal foils and medical alloys with no melt zone and no need for post-processing,
- texture optical polymers without deformation or carbonization,
- drill and cut sapphire or SiC without cracks,
- place every pulse exactly where it belongs.

*) For standard 200kHz repetition rate