

— ATHANASSIOS KALIUDIS

s Langer

Physics degree needed? Nope! USP made simple

So, you think you need a physics degree to machine parts with ultrashort pulsed lasers? Not any more! Pulsar Photonics has made it as easy as CNC machining.

The machine operator carefully positions a blank approx. 20 x 30 cm in size in the working area of the RDX 500 microprocessing machine, and the vacuum chuck applies gentle suction to fix the blank in place. The machine's motorized axis system can position parts with an accuracy of 300 nm and repetition accuracy of ± 100 nanometers, and it aligns the blank so that the built-in camera system can see its top-left corner.

Next, the operator launches the software assistant and hands control over to the program. The software scans the blank's registration marks to determine its precise alignment and ensures it is in exactly the right position, because even the tiniest deviations can have major repercussions on a micrometer scale. The software assistant carries out whatever adjustments are required without any input from the operator – and the [TruMicro 2030](#) ultrashort pulsed laser from TRUMPF starts doing its job.

— Reducing complexity

The user-friendly software assistant was developed by Pulsar Photonics GmbH, which was founded in 2013 as a spin-off from the Fraunhofer Institute for Laser Technology ILT. The company specializes in building systems for laser micromachining, focusing in particular on ultrashort pulsed lasers. It develops suitable systems technology for each customer, and offers tailored application development and contract manufacturing services. Founders and managing directors Joachim Ryll, Stephan Eifel and Jens Holtkamp knew right from the start that ultrashort pulsed laser technology would never gain widespread acceptance unless they could get simplify matters.

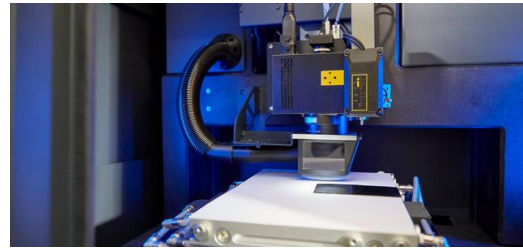
So, when a request came in from a manufacturer of high-power electronic systems, they seized the opportunity to show how even the most complex manufacturing methods can be simplified if you know enough about the processes involved. Ryll explains: "When it comes to producing components for high-power electronic systems, you might have a machine operator



who specializes in each individual stage of component production, but we can't expect them to be an expert in every machine in the entire process."



The Photonic Elements machine control software displays the ablation geometry executed during the process. (Picture: Claus Langer)



The motorized processing head of the RDX 500 consists of a galvanometer scanner with a vision system, a precision probe, and a laterally mounted extraction system. (Picture: Claus Langer)



Part of the visual inspection involves documenting homogeneous ablation. The ablation zone is dark and shows the plastic surface. The key to successful machining is to ablate the gaps cleanly to provide electrical insulation between the conductive tracks. (Picture: Claus Langer)



Joachim Ryll founded Pulsar Photonics GmbH in 2013 together with Stephan Eifel and Jens Holtkamp. (Picture: Claus Langer)

The customer wanted a compact machine system with a fast, high-precision processing technique to facilitate the laser machining of printed circuit boards (PCBs). One of the key requirements was that the process needed to be user-friendly – something of a challenge when you are performing micro drilling, laser ablation and precision cutting in a single operation on both the front and back of the PCB!

The blank used to make the PCB consists of a copper-plastic-copper composite. One example of the specified machining processes involves turning the blank into 50 PCBs for high-frequency electronic systems known as interposers. Each interposer measures five by five millimeters and is subsequently used to adapt the tiny conductive tracks of an integrated circuit to PCB fabrication technology.

In the first step, a TruMicro 2030 with a pulse duration of 900 femtoseconds drills plated-through holes, or "via holes," in the blank. These holes act as interlayer connections, enabling the conductor paths to extend in three dimensions across multiple layers. At the same time, they serve as a means of fixing the integrated circuit in place on the PCB.

» **"We knew that ultrashort pulsed laser technology would never gain widespread acceptance unless we got rid of the complexity."**

Joachim Ryll, CEO Pulsar Photonics

In the next step, the laser uses ablation to create fine conductive tracks in the copper. The USP laser takes advantage of a technique known as cold ablation to ensure that the inner plastic layer of the blank is not damaged in this process. The laser also offers the required level of precision. This is important because failing to properly ablate the gaps between the conductive tracks could result in a flow of electricity that would impair the entire unit. Finally, the component is flipped onto its back. The camera detects the registration marks and the system once again automatically aligns the component to enable the laser to machine the other side of the blank.

At the end of this process, the TruMicro 2030 cuts the individual circuit boards out of the base plate. Conventional methods of manufacturing printed circuit boards generally employ longer pulsed nanosecond lasers. "That wasn't an option for our customer because it didn't meet the requirement for high resolution. The only way to reliably produce conductive tracks up



