

## Photonic production chains - AI methods and shaped light for laser material processing

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Photonic production chains represent a transformative approach to manufacturing, leveraging the unique properties lasers for material processing. The integration of artificial intelligence (AI) into these processes further enhances efficiency and adaptability, paving the way for more intricate designs and optimized production outcomes. This became even clearer in the context of battery and e-mobility applications.

AI-driven methods in photonic production chains enable real-time monitoring, adaptive control, and predictive maintenance of laser systems. By analyzing vast amounts of data from the manufacturing process, AI can dynamically adjust laser parameters such as power, pulse duration, and beam shape, ensuring optimal performance and reducing material waste. Machine learning algorithms also facilitate defect detection and quality assurance, making the process more reliable and less dependent on manual intervention.

Shaped light, a technique involving the manipulation of laser beam profiles, plays a critical role in enhancing the precision and versatility of laser material processing. By customizing the intensity distribution of the laser beam, shaped light allows for more controlled energy deposition, enabling the processing of a wide range of materials with varying properties. This capability is particularly useful in applications such as micro-machining, additive manufacturing, and surface texturing, where precision is paramount.

The combination of AI methods and shaped light in photonic production chains leads to a highly adaptable and intelligent manufacturing system. This integration not only improves the accuracy and speed of production but also opens new possibilities for creating advanced materials and components. This presentation for iLAS 2025 will provide an insight into Precitec's activities in recent years, being able to more than concept proof the advantages of these individual approaches, but also their combination.