

Llsec

Powder Nozzle Qualification Device

The measuring system Llsec (short for "light section") generates a laser light section, which analyses all relevant powder nozzle characteristics for many Direct Energy Deposition (DED) processes, directly before the process starts. This ensures faultless operation.

Motivation

In modern industrial component production, reproducibility of processes and precise knowledge of all relevant process parameters provide the basis for efficient and cost effective component manufacturing. While in subtractive processes such as milling, the tool calibration prior to process start corresponds to the state of the art, in laser powder DED processes it is a fundamental problem to determine the exact position and extent of the Tool Center Point (TCP). As a compact stand-alone measuring device, Llsec can be used within all common laser powder DED machines.

Use Cases

Industry

As a significantly process-influencing piece of hardware, the condition of the powder nozzle must be checked and evaluated regularly in order to carry out reproducible processes.

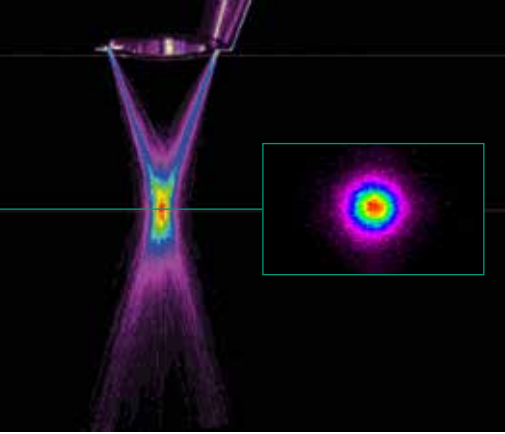
Research and Development

The development of new nozzles for increasingly demanding processes is a great challenge that can only be adequately tested with suitable measurement technology. Statements must also be made about the influence of the process parameters on the shape of the powder cone, for example, to determine the degree of powder utilisation.

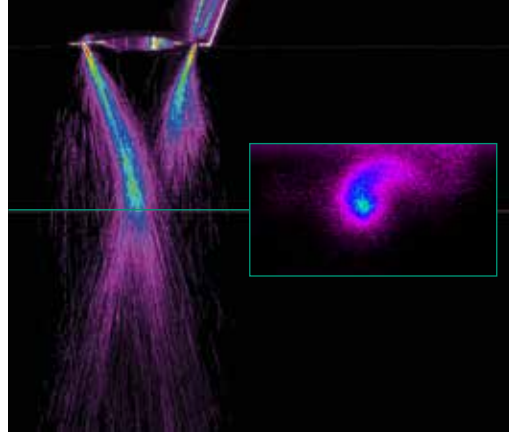
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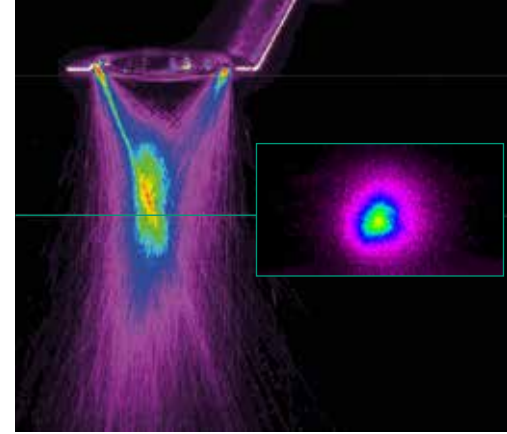
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Intact Nozzle – Standard Process
COAX14 nozzle with standard process parameters and 316l steel powder.



Nozzle after Collision
COAX14 nozzle after a collision within the machine during a 5-axis process.



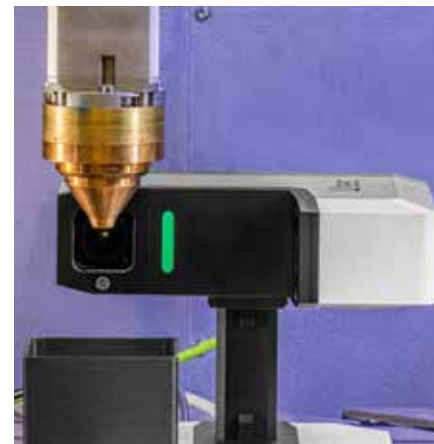
Intact Nozzle with Internal Clogging
COAXpowerline nozzle which was partially clogged by moist powder.

Measuring Principle

The laser light section method divides the powder jet into a definable number of measuring planes. The precise knowledge of its position allows a three-dimensional image of the powder jet to be created. Analysis algorithms developed at Fraunhofer IWS, in conjunction with the corresponding software, calculate all relevant nozzle parameters, such as the exact position and expansion of the powder focus. Llsec enables fast and easy quantitative analysis of all relevant measurement parameters by aligning the captured image information with mathematical functions. This results in optimum comparability of different measurements.

Analysis of Measurement Data

Based on the acquired image data, an analysis algorithm reliably detects the position of the powder focus, the spot of the highest powder density within the powder jet. The comparison of the real with the theoretical focus position allows a direct statement about the further usability of the nozzle. The analysis of the shape and characteristics of the powder jet at several relevant measuring points also allows a quantitative assessment of the nozzle quality. Not only the wear of the nozzle can be observed, but also the service life increases significantly. Transferring the focus position as TCP to the machine control reduces tool change time and significantly increases the process reproducibility. In addition, Llsec ensures a better process understanding and less effort for parameter studies: In this way, the various influences of the feed parameters on the powder cone characteristics can be investigated.



Standard setup for measuring a powder nozzle using Llsec.

Technical Data

Height/width/depth	Llsec: 150 mm x 210 mm x 60 mm Llsec XL: 200 mm x 210 mm x 60 mm
Diameter of nozzle tip	Llsec: 0–20 mm Llsec XL: 0–40 mm
Weight	1 kg
Measuring range	50 x 50 mm ²
Measuring resolution	X/Z (image): 30.6 µm/Px Y (minimum distance of layers): 50 µm
Power supply	Power over Ethernet (PoE) 12 V
Communication	1 Gbit/s Ethernet
Protection class	IP54
Laser protection class	3B
Required PC	Windows 7 or newer, 64 bit, Net-Framework 4.7, 5 GB free memory, SSD
Control	Manually by the user or via MQTT interface of the Llsec software