CASE STUDY:
Improving Surface Finish of Metal Additively Manufactured Inconel 718 Aerospace Components

Case Study Description

This design study was conducted through a collaboration between the Aeronautics Advanced Manufacturing Center (CFAA) of the University of the Basque Country (UPV/EHU), ITP Aero, Renishaw, and Dyndrite. The goal was to improve the surface finish of Inconel 718 (IN718) components, produced via Laser Powder Bed Fusion (LPBF) through segmentation and optimization of process parameters.

Since 2015, the CFAA has advanced LPBF process development for aerospace applications, focusing on improving component quality and process reliability. Working closely with ITP Aero - a leading Spanish aerospace manufacturer - and Renishaw, a global provider of metal AM systems, the research has been guided by the strict standards and demands of aerospace production.

The CFAA operates state-of-the-art Renishaw RenAM 500 systems, which enable automated, high-fidelity component production with real-time monitoring. These systems ensure the repeatable manufacture of high-quality parts. However, reducing surface roughness, especially downskin surfaces on low overhangs, remains a key challenge for aerospace components, both to minimize post-processing and to enhance fatigue performance. Addressing this, CFAA collaborated with Dyndrite to integrate its LPBF Pro software into the workflow.

Dyndrite's LPBF Pro is a production-grade additive CAM platform offering full programmatic, vector-level control. Its unique volumetric segmentation and multi-optic assignment APIs allow engineers to discretize parts, assign multiple parameters per part, and optimize toolpaths and laser strategies. Built on a Python-based recipe framework, LPBF Pro enables the automation of Design of Experiments (DoEs) and serial production. Compatible with all major LPBF OEM formats, including Renishaw systems, it accelerates materials and process development, improves repeatability, and enables data-driven process control from R&D to production.

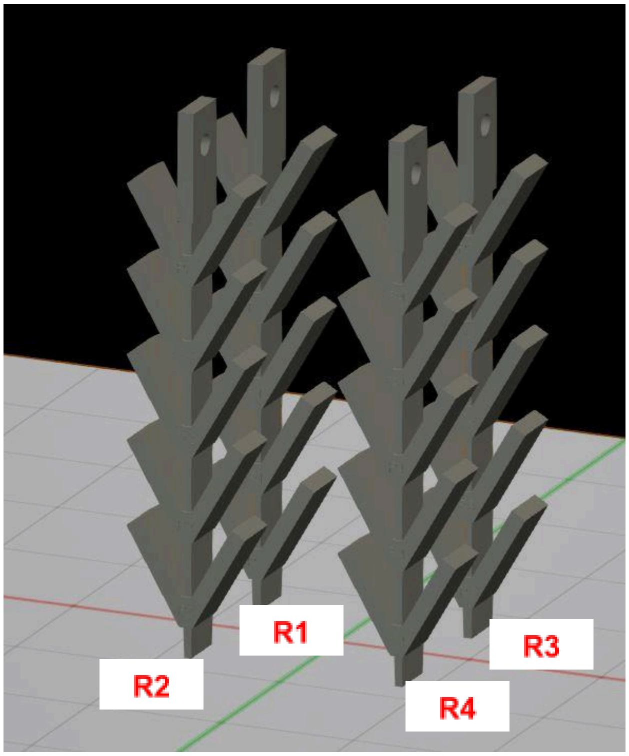
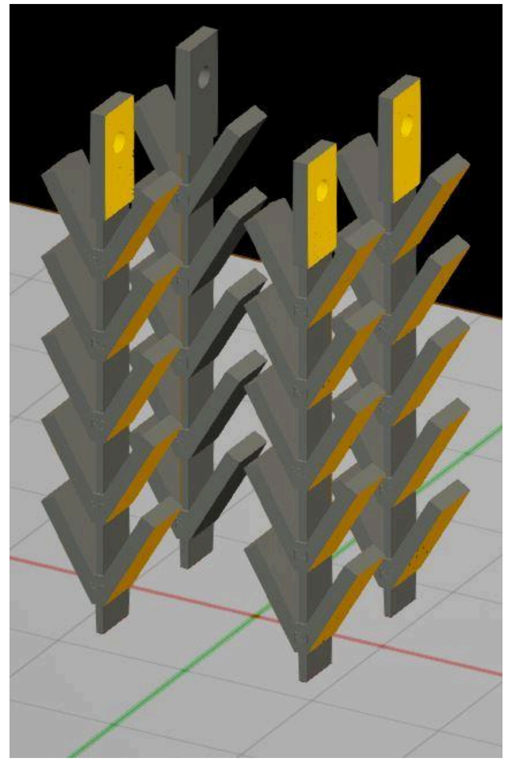
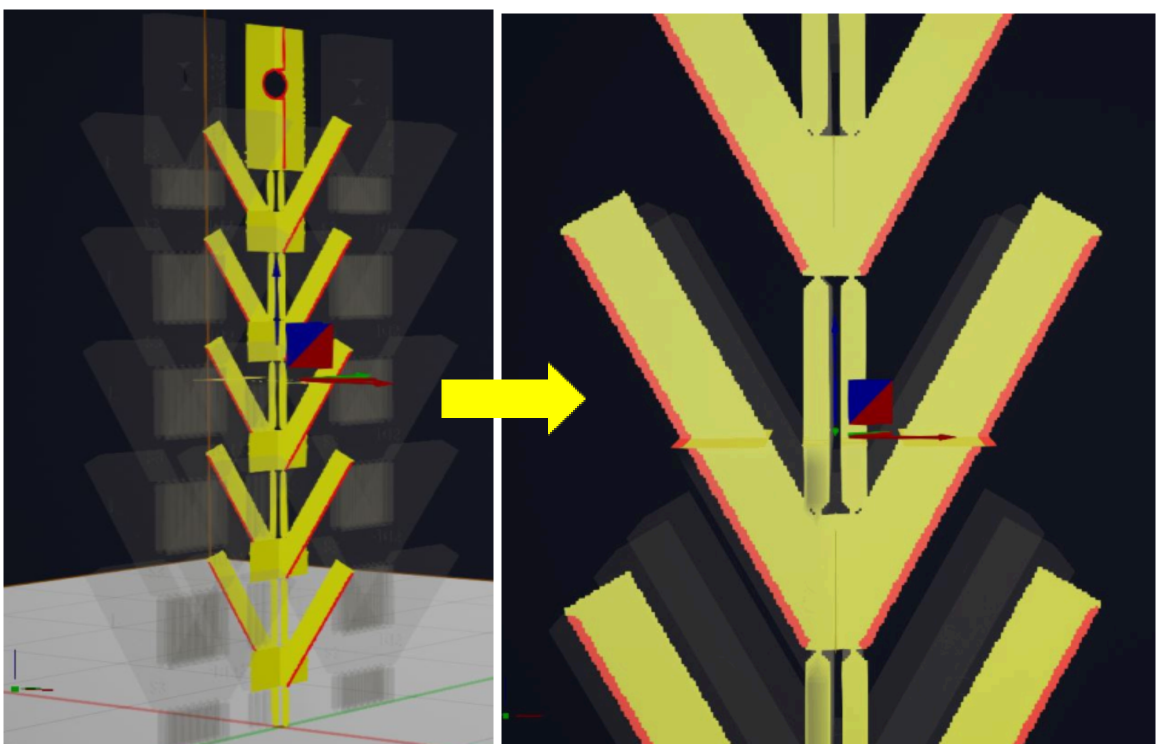
For CFAA, LPBF Pro enables segmentation of components into distinct zones, allowing localized parameter application and optimization. This capability delivers improved surface finish, greater consistency, and enhanced efficiency across complex geometries.

Initial work involved migrating Renishaw's standard IN718 parameters into the Dyndrite environment, then developing optimized build strategies using volumetric segmentation to vary laser speed and power. Four build conditions were evaluated: (R1) Baseline Renishaw parameters implemented in Dyndrite, (R2) Fully optimized Dyndrite strategies, (R3) Standard Renishaw parameters with a simple downskin strategy, and (R4) Renishaw standard parameters with Dyndrite volumetric segmentation. Surface roughness (Sa) improved progressively, from 26.1 µm to 6.8 µm, with the best results achieved under condition R2 .

These results demonstrate that advanced software-driven process control - through Dyndrite's LPBF Pro -can deliver substantial improvements in geometric surface finish beyond what is achievable with standard machine parameters. The optimized LPBF strategies are now ready for application by ITP Aero in production environments.

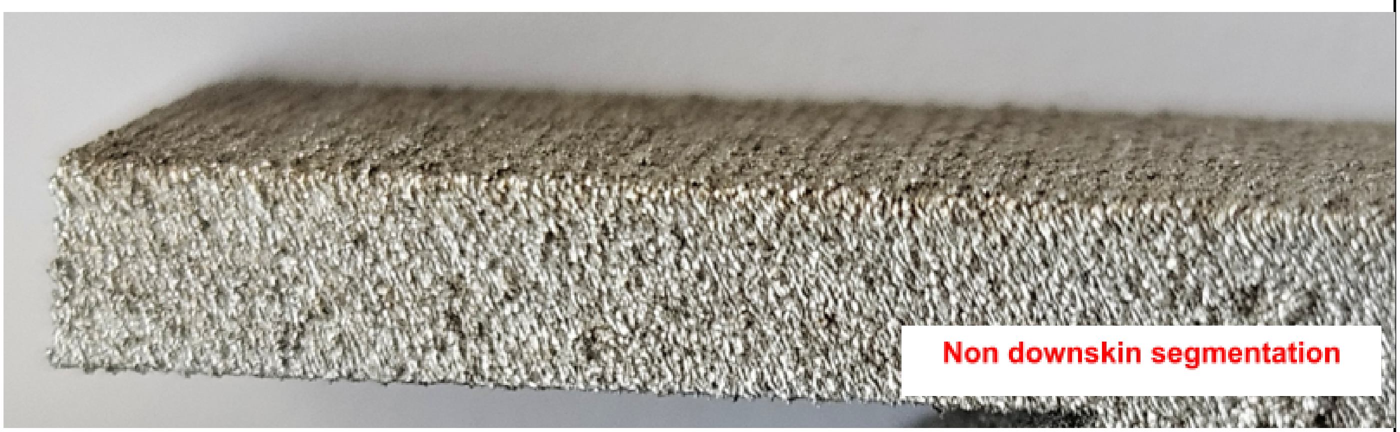
Machine: Renishaw 500s | **Material:** IN718 | **Layer thickness:** 60 µm

Properties	
Machine Manufacturer & model	Renishaw RenAM500S
Maximum build envelope (X × Y × Z)	245 mm × 245 mm × 335 mm
Number of lasers, laser power and type of laser	S (single) 1 × 500 W – ytterbium fibre laser
Beam wavelength	1080 nm
Laser focus diameter	80 µm
Type of Atmosphere	Argon
Laser power / mode	Continuous
Material	Inconel 718 (IN718)
Layer thickness	60 µm
Scanning Strategy	Stripe
Min / Max Laser powers used in study	100 W – 400 W

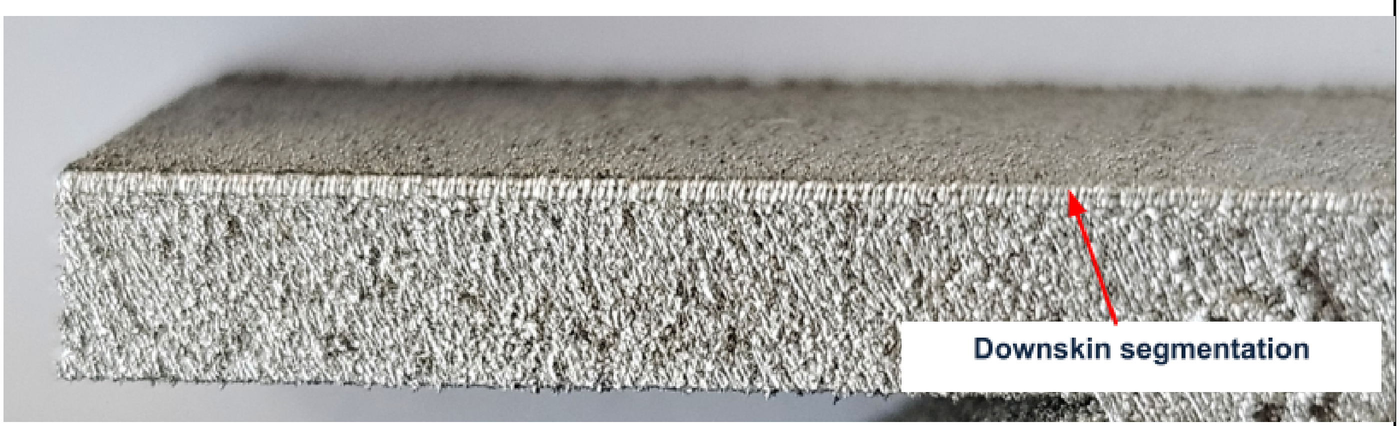
Result Images	
Build Array	 **Test samples**  **Region segmentation**  **Region SDF segmentation**

Result Images

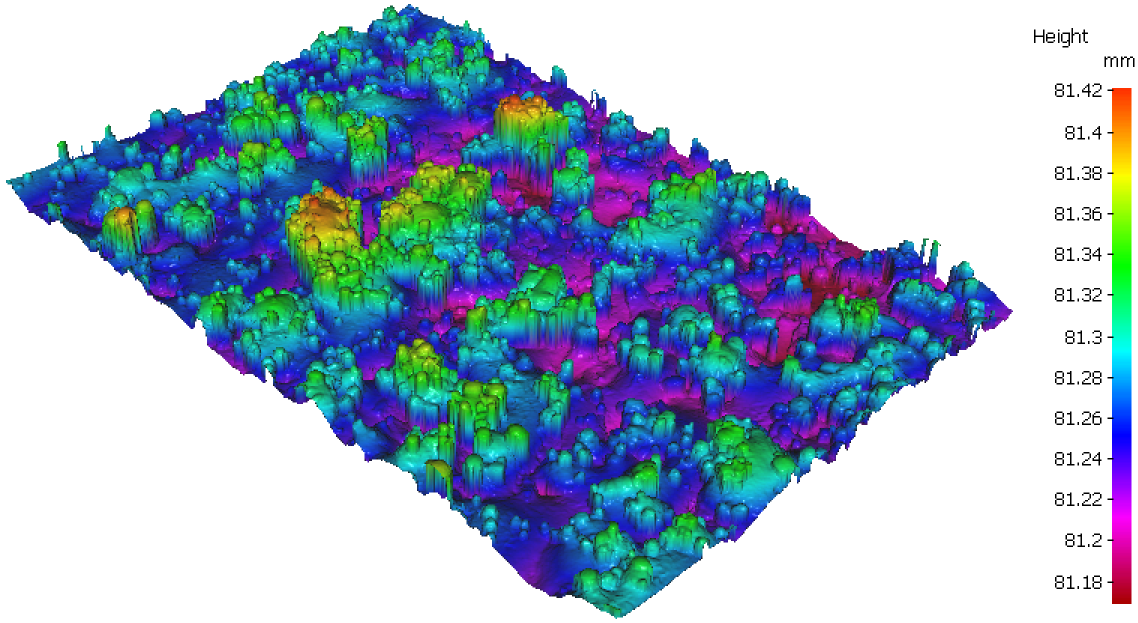
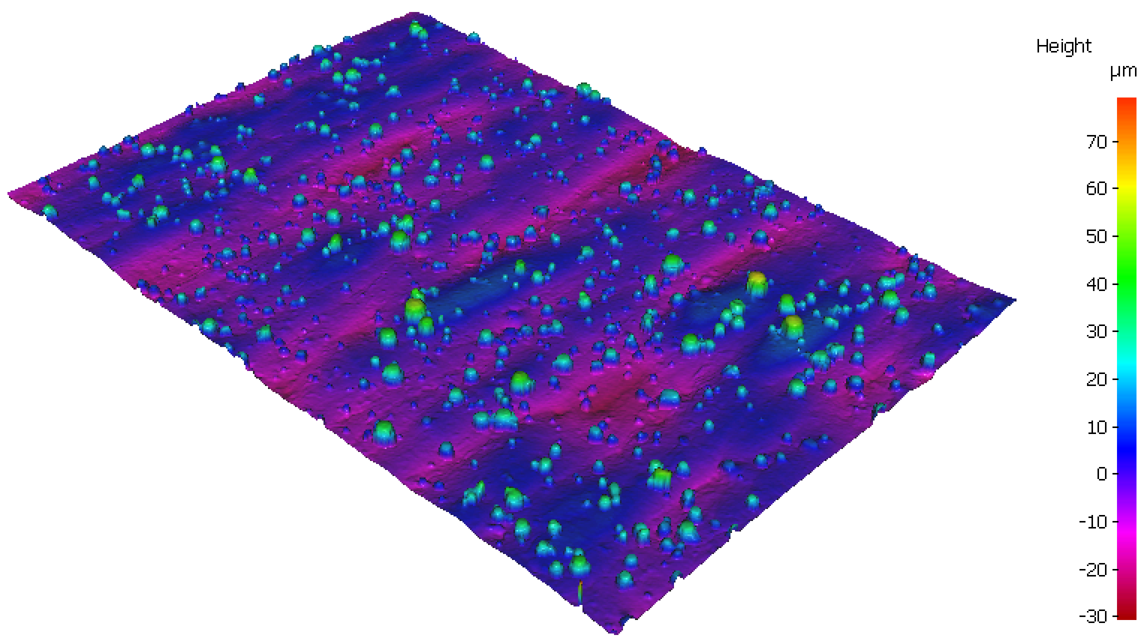
R1 R2 R3 R4



Worst visual sample (condition R1) - - Renishaw parameters



Best visual sample (condition R2) - Fully optimized Dyndrite

Result Images	
Worst surface texture (condition R1)	 **Sa = ~32.0 µm**
Best surface texture (condition R2)	 **Sa = ~7.0 µm**

<table>
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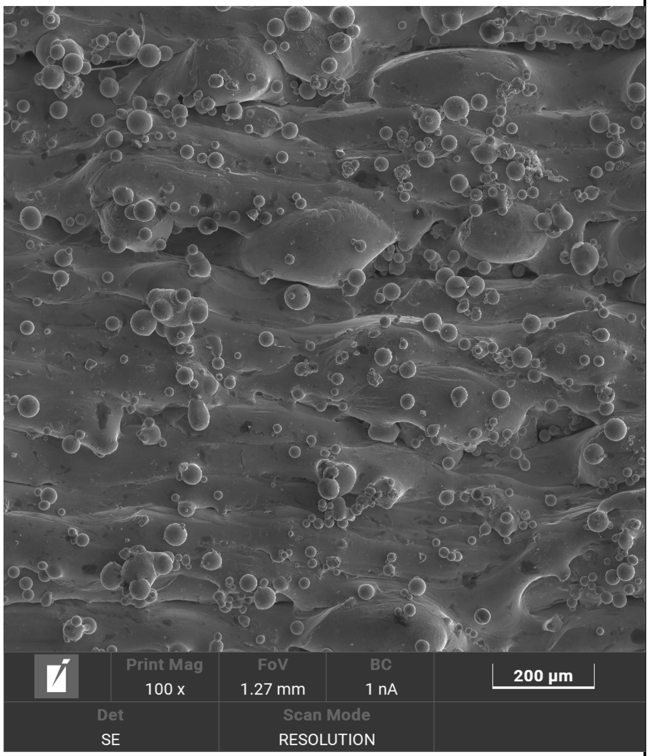
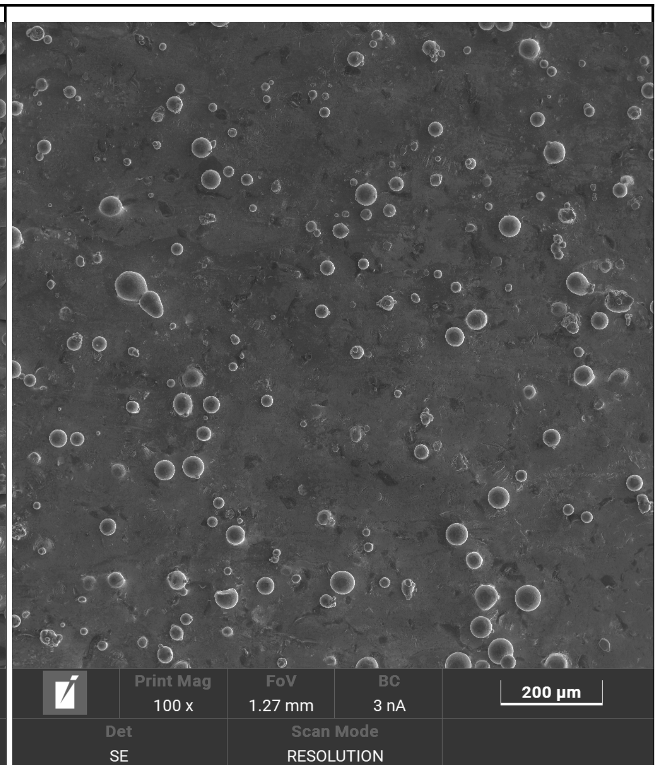
<td>SEM Images

100X</td>
<td>

SEM (condition R1) - Renishaw parameters</td>
<td>

SEM (condition R2) - Fully optimized Dyndrite</td>
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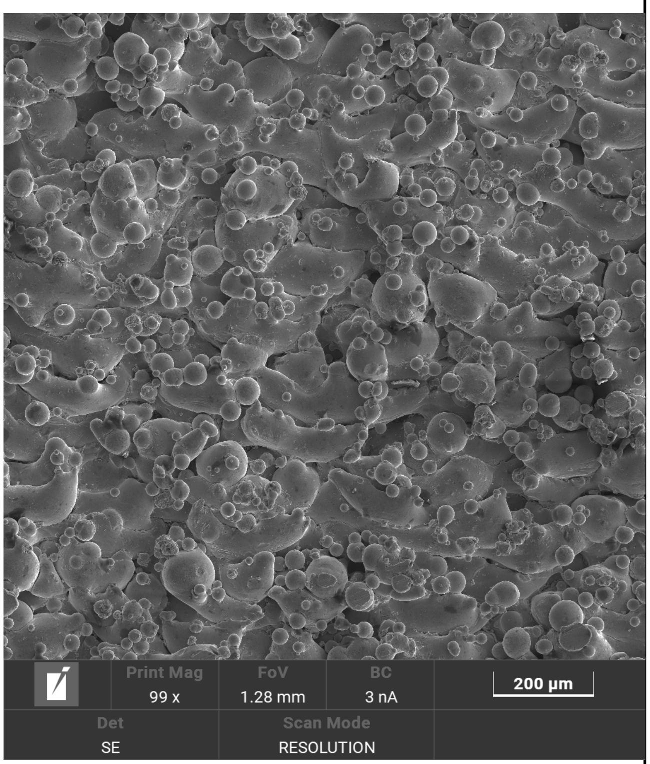
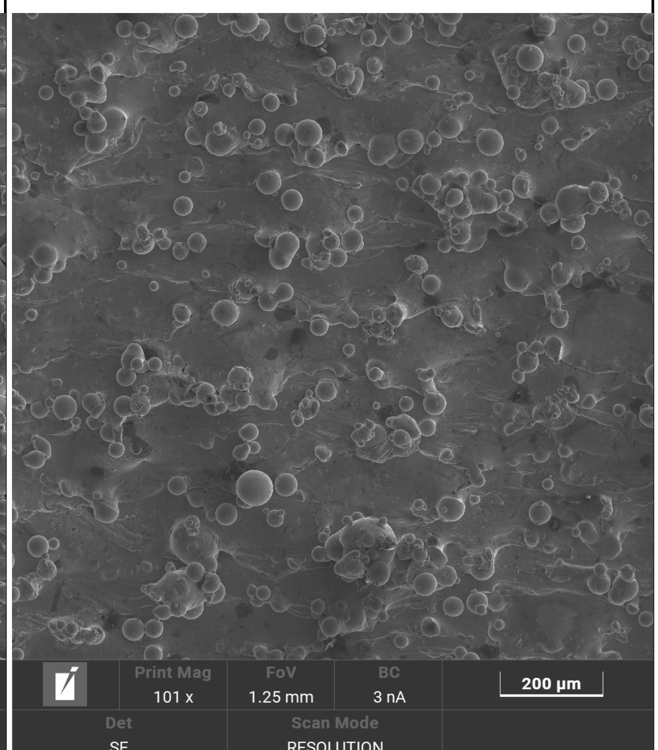
<td>

SEM (condition R3) - Renishaw standard parameters with simple downskin</td>
<td>

SEM (condition R4) - Renishaw standard parameters with Dyndrite volumetric segmentation</td>
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</table>

Conclusions

This work has been carried out in close cooperation with ITP Aero, who defined the technical requirements and provided expertise to guide the expected outcomes of the study. The research also relied on Renishaw's advanced additive manufacturing systems, which ensured high process reliability and supplied the baseline parameters used as a starting point. In addition, Dyndrite's LPBF Pro software was integrated into the workflow, enabling advanced programming and zone-based parameter optimization within the build process.

Starting from well-established standard process parameters, the objective of this Design of Experiments was to identify optimized parameters for improved downskin surface finish on low overhang geometries, in the specified material. This was achieved through a systematic variation of laser power and scan speed (see Figure 1).

The study demonstrates the relevance of process parameters in the surface finishing and quality of additively manufactured parts. It provides a valuable foundation for further refinement, showing that by extending the DoE methodology, additional improvements can be achieved across a range of geometries—such as support-free low overhangs, thin walls, lattice structures, and flow channels—and across different part families or specific components, using both multi-laser and single-laser systems.

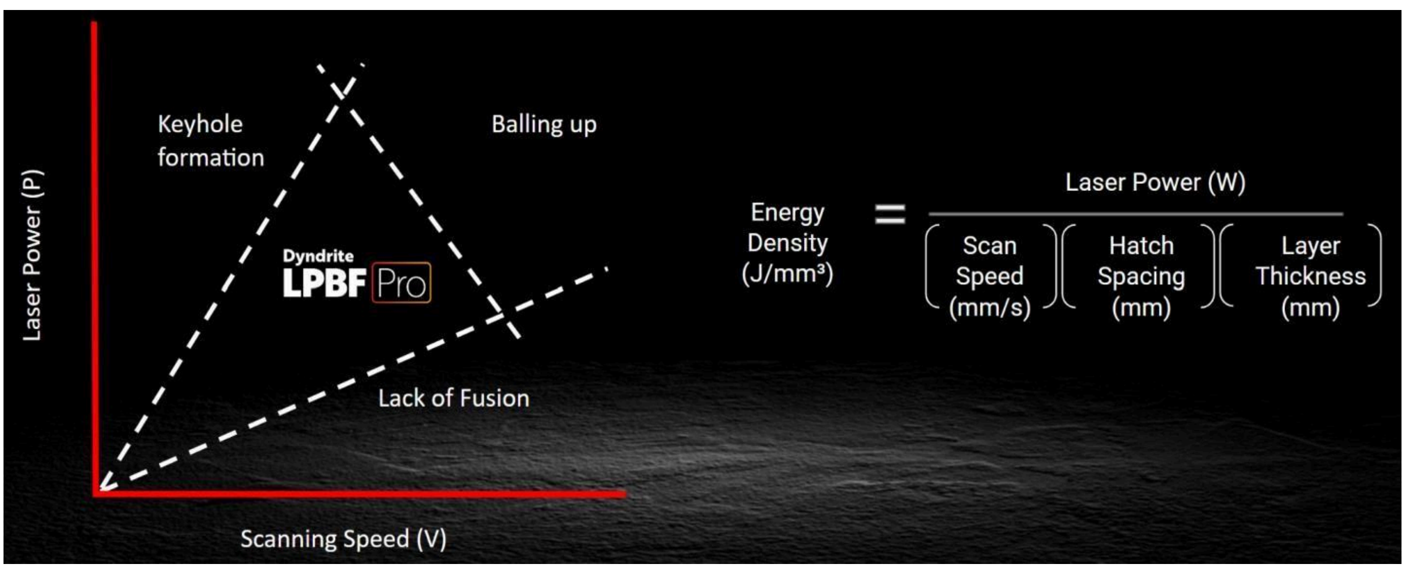

Figure 1: Dyndrite LPBF Pro process parameter control

Follow up

If you'd like access to the Dyndrite build recipe used to create this build, or wish to speak with a member of our Applications Team about optimizing your LPBF parts and processes, please contact us at support@dyndrite.com, or complete the inquiry form here.