Article:

Full field lasers with MetalFab™ systems: The benefits of full scan field v zonal in multi-laser powder bed fusion systems

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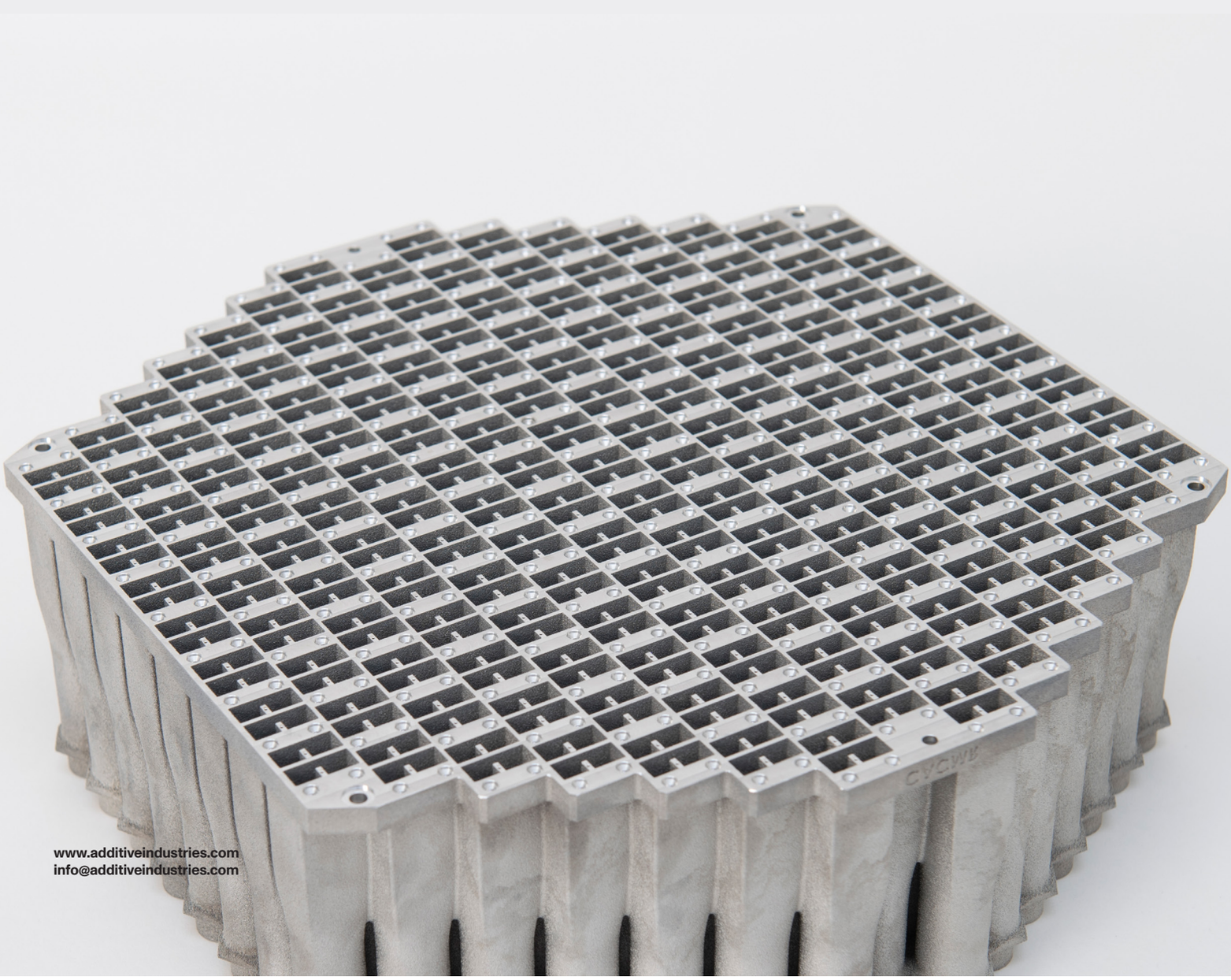

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Full field lasers with MetalFab™ sytems: the benefits of full field v zonal in multi-laser powder bed fusion systems

For large frame metal additive manufacturing systems (build area >400×400mm) there are significant advantages to utilizing multiple lasers to produce parts, but primarily the addition of lasers means faster build rates, higher throughput and ultimately lower part cost. However, integrating additional lasers in a laser powder bed fusion (LPBF) process does not come without technical challenges, since the incorrect assignment and sequencing of these lasers can lead to material quality issues due to condensate and spatter interference. Further to this, inadequate system calibration, control and monitoring can lead to laser to laser misalignment – a particular problem when multiple lasers are working in tandem on a single large part.

Zonal Scan Field Lasers

Typically most large frame LPBF systems utilize a zonal scan field approach as it is not possible for all lasers to cover the entire build area. In this case, the build area is split into zones that each laser can reach (its scan field) and are designated based on the build plate size and shape, and optical design. In this system architecture, overlapping zones (stitching zones) are created to enable large parts to be produced covering the entire build area (see fig.1).

This approach creates compromises because laser efficiency cannot always be balanced efficiently for many parts when high quality and integrity is needed, leading to laser redundancy time.

Also, as it is often not possible for a single laser to scan the outer contours (borders) of a part external stitch lines are visible and a physical deviation/step can be present - this is further exacerbated when laser to laser calibration is not optimal.

Further to this, part quality can be compromised due to interference with gas flow (particularly with quadrant based zonal scan fields) and this often leads to a requirement to further reduce laser efficiency, or face poor part quality and defects.

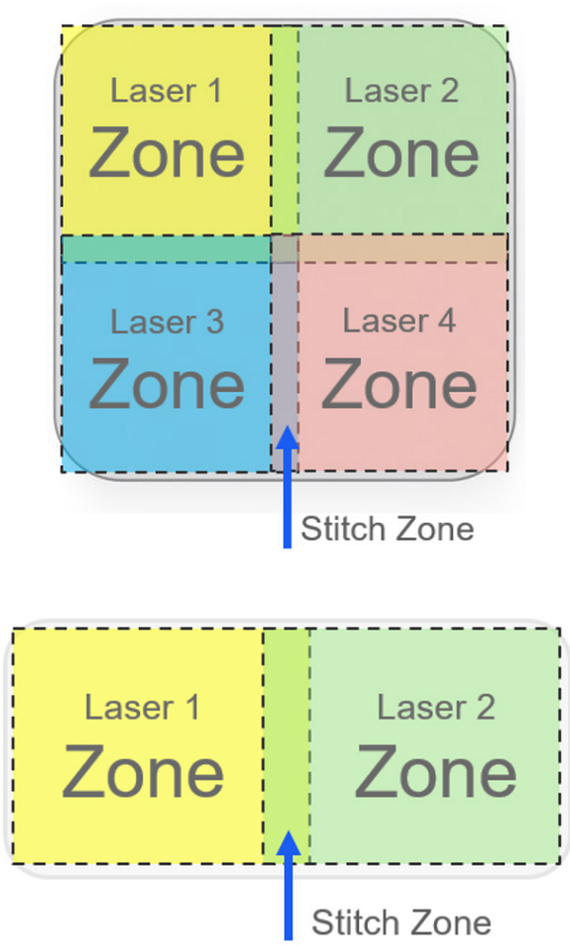

Fig 1: Typical large multi-laser system architectures with zonal scan fields

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MetalFab™ Full Field Lasers

All MetalFab systems utilize a full scan field capability for all lasers, regardless of how many lasers are fitted to the system (see fig.2) which can be 1,2,3 or 4. This means that each laser can reach the entire area of the 420 x420mm build area, and therefore in combination with Additive Industries automated and highly accurate laser-to-laser alignment there is no compromise required between quality and productivity – laser efficiency can be maintained at a very high rate (>90%) with no risk of interference regardless of part geometry or build layout.

With the laminar gas flow design, 'swim lane' laser assignment methodologies ensure the highest quality parts with the highest laser efficiency, whether a manual laser assignment approach is employed for full build batches of serial production parts or the Additive Industries Dynamic Laser Assignment (DLA) software tool is used to assign multiple lasers balancing optimal quality with optimal efficiency. Further to this for large parts, the outer contours can be scanned with a single laser meaning no visible stitch lines are present.

A further benefit of this system architecture is that if in unforeseen circumstances one or more lasers are not operational, the available lasers can continue to produce parts accessing the entire build area, ensuring continuous part production is not compromised.

Fig 2: Full field lasers on MetalFab systems

Full Field v Zonal Lasers - Practical Example

As the MetalFab full scan field capability enables all lasers to operate as one across the entire build area, regardless of the geometry type and position on the base plate it is possible to achieve high laser efficiency consistently through every layer of a build, however the geometry/scan layer changes and moves throughout its height. This can be shown clearly in the below worked example, where a large aerospace duct is being manufactured. Due to its size and shape, it must be positioned to start on the base plate in the front right corner, and then grows diagonally to its final position in the back left corner (see fig. 3).

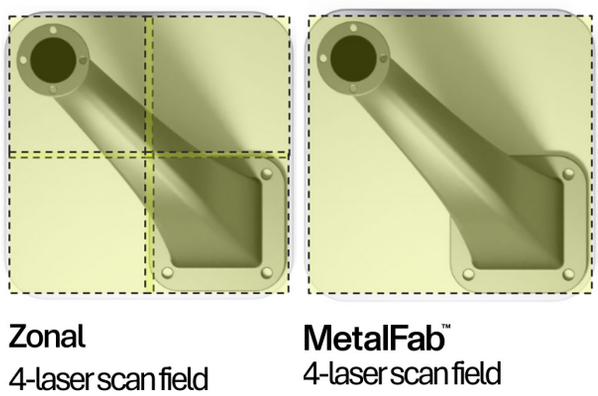
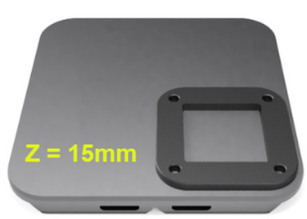


Fig 3: Aerospace duct orientated on plate - zonal v full field scan fields overlayed

In this example a 4-laser MetalFab system is used and it is possible to assign the lasers using the DLA software tool to achieve a consistent laser efficiency of >95% (percentage of time per layer that all 4 lasers are firing) throughout every layer of the 400mm tall build, with no stitch lines since outer borders are always scanned with a single laser. Conversely with a 4-laser quadrant based zonal scan field system, for the majority of the build it is only possible to utilize a single laser, leading to laser efficiency as low as 25%. This is shown in the images below (fig.4), where comparative laser efficiency is shown at various build heights.



- Zonal Efficiency = 25%
- MetalFab Efficiency = **>95%**

- Zonal Efficiency = <30%
- MetalFab Efficiency = **>95%**

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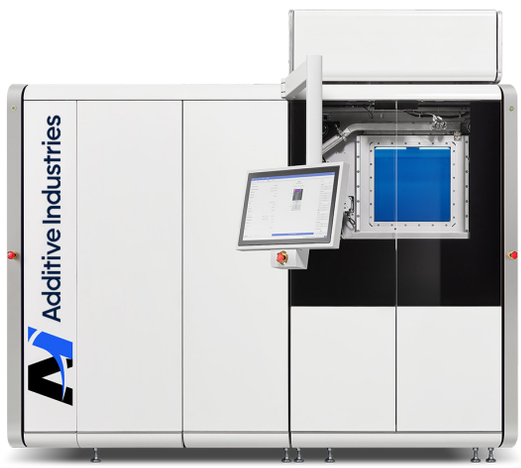
Fig 4: Comparison of zonal v full filed laser efficiency in 4 laser systems

Summary

Full scan field capability is a significant benefit for multi-laser systems, and the MetalFab is unique in this feature when compared to other large LPBF systems with build area greater then 400×400mm. It allows for better material quality and less potential defects, higher laser efficiency and improved surface quality as no visible border stitching is present on large parts. With these factors in mind, it ensures that the investment in a multi-laser system is utilized to the very maximum it can be, enabling the most cost effective process.



MetalFab G2 Core system with 4 x full field 500W lasers

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