The effects of laser beam characteristics in linear energy deposition mechanisms within the quality and dimensions of single tracks within SLM.

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In laser powder-bed-fusion (L-PBF), the energy per unit length applied to the process is typically used as a design parameter to manufacture near full density components layer upon layer. The intensity profile and beam size are important since they define the process power density ($MWcm^{-2}$). The aim in characterising the optimal laser beam conditions is to provide optimal parameters for manufacturing specific part geometries, that could be utilised to establish different power ratings within different regions across the powder bed accordingly. For example, thin walls may be subjected to over melting and distortion if processed at too high powers due to limited heat dissipation, even at optimal energy levels. Even large cross-section geometries with higher heat dissipation capacity may be able to use higher powers and larger laser diameters, to improve build rates with no over melting and no distortion. Characterisation of laser beam properties at varying power ratings is therefore of great importance in order to control minimum thin wall dimensions and maximum build rates of the laser system.

Step one was to conduct laser profiling's at various power ratings and focal lengths, this provided necessary data to characterise the beam profiles and intensity distributions throughout the machines running parameters. This data will be correlated against physical analysis with the same parameters to ensure consistency and repeatability, by generating one-layer single line tracks on the powder bed at varying power ratings, focal lengths and scan speeds.

Measurements where taken at varying focal lengths -10mm to 30mm with 2mm increments at 100W – 1KW in 100W increments. This provided enough data to show how a desired laser beam diameter can be produced at each varying power rating.

In conclusion this data should provide optimal beam properties to meet the desired manufacturing/part characteristics. A method could be produced to precisely generate the necessary power ratings and focal lengths to adjust the laser beam diameter, eventually allowing the system to ensure optimal power and beam properties for the outcome required.