EPSRC Centre for Innovative Manufacturing in
LASER-BASED PRODUCTION PROCESSES

Multi Laser Selective Laser Melting

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Introduction

Current build speeds of Selective Laser Melting systems are limited due to mirror scanning speeds and laser throughput. As higher power lasers begin to become economically viable, mirror size will have to increase again decreasing scanning velocity. Large components also suffer from deformation due to residual stresses.

Project Aim: To develop a proof-of-concept high power multiple laser scanning Selective Laser Melting system

Main Objectives:

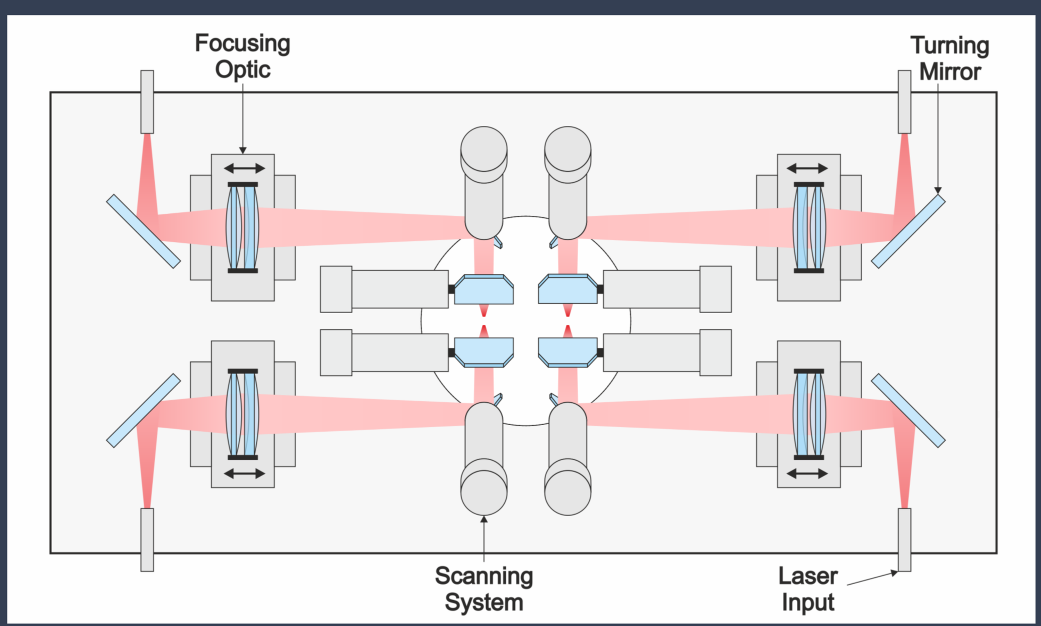
- Increase build rates for SLM systems via the employment of multiple lasers in the scan field
- Develop novel scanning strategies to reduce residual stress in large components
- Investigate different laser operation modes in order to improve surface finish

Optical System

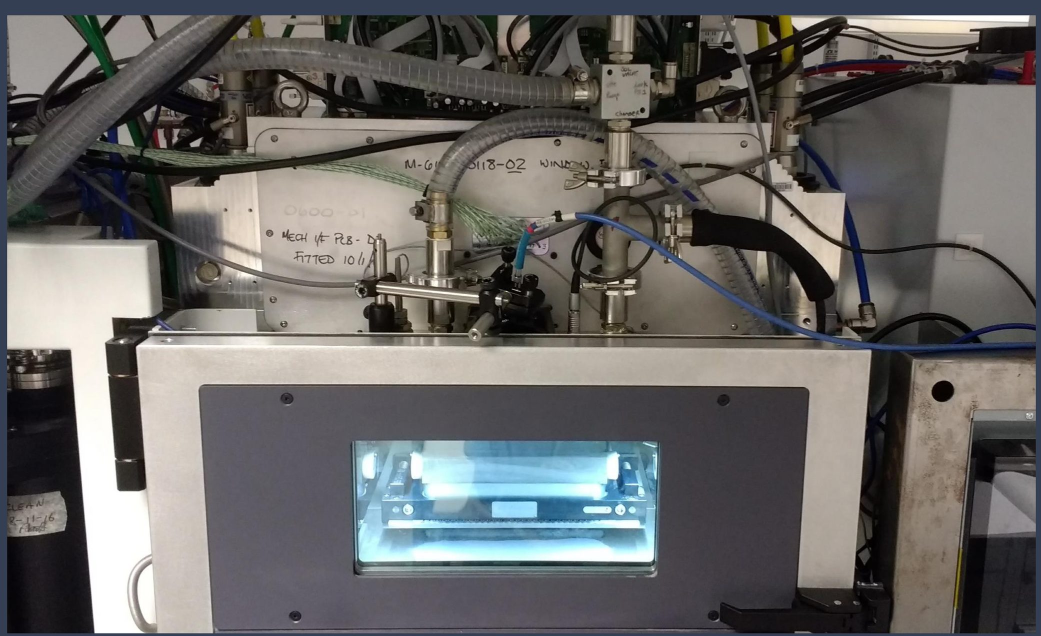
To take advantage of the increased power of the current crop of fibre lasers a prototype optical system has been developed in collaboration with Renishaw and is being used for this project.

Key features include:

- Integrated 4 channel laser optical module with independent scanning control
- Complete 250 x 250 mm scan field overlap by each laser channel
- Non F-Theta lens based focusing system Flat field focusing achieved by a custom designed dynamic focusing unit
- View port on each channel to allow for in-process sensing systems
- Modified Renishaw AM250 chassis in a modular form to allow for ease of reconfiguration
- Current laser configuration: 4x 0.5 kW



Multi-laser optical configuration



Optical module fitted to donor chassis

Scanning Strategies

Two independent beam examples:

A – Individual part assigned a laser module

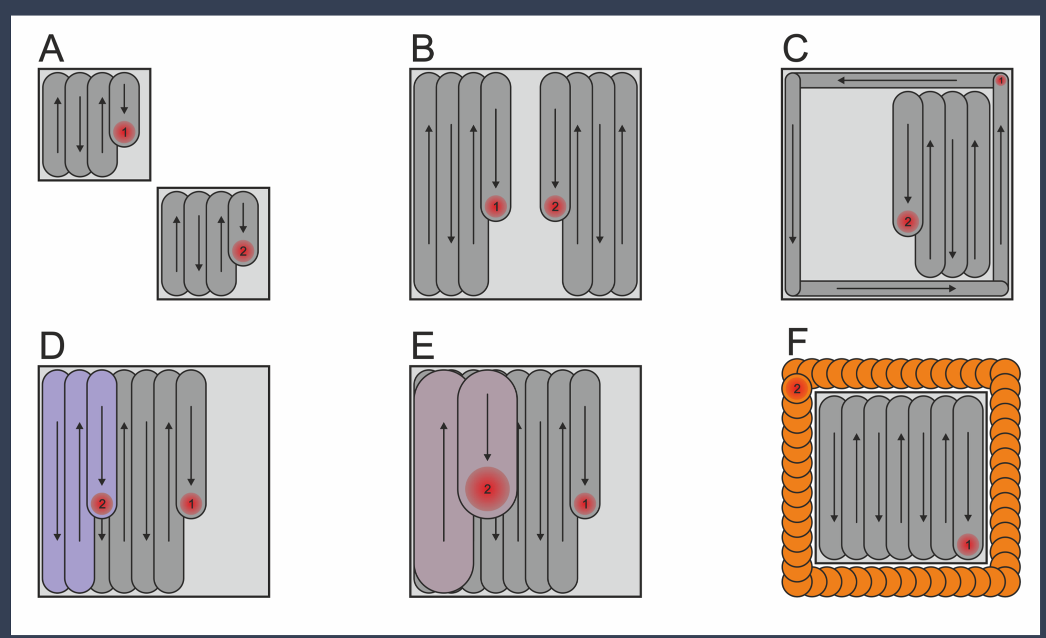
B – Each laser module scans a different area of a single part slice

C – Internal area scanned by one system, boundary by the second

D – Post layer scan heating to alleviate residual stress

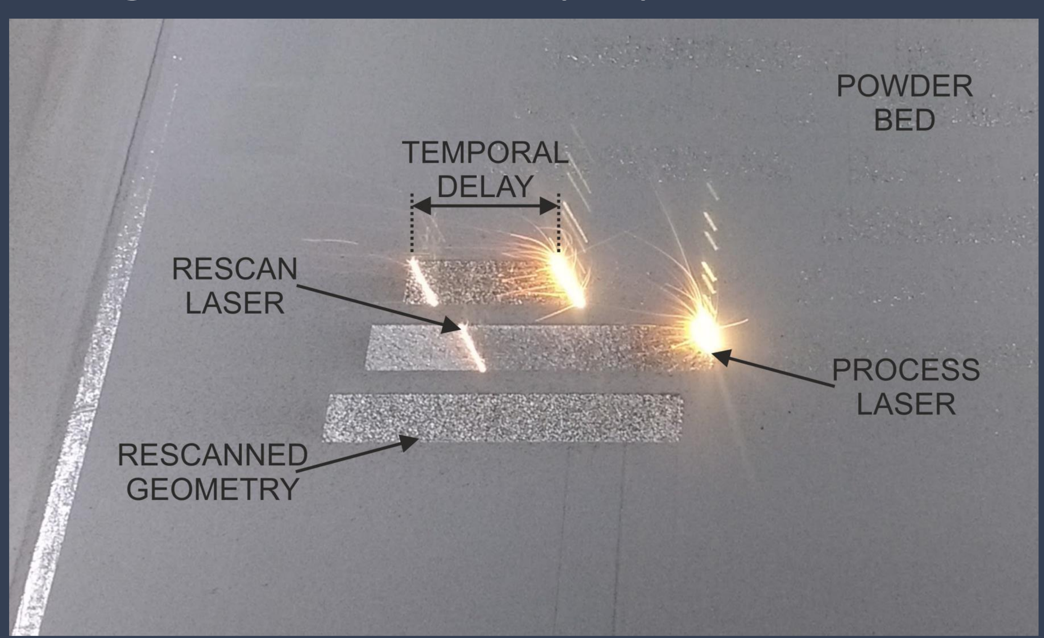
E – Post melt scan with differing beam characteristics

F – Boundary scan with pulsed source to modify surface features



Achievable scanning strategies

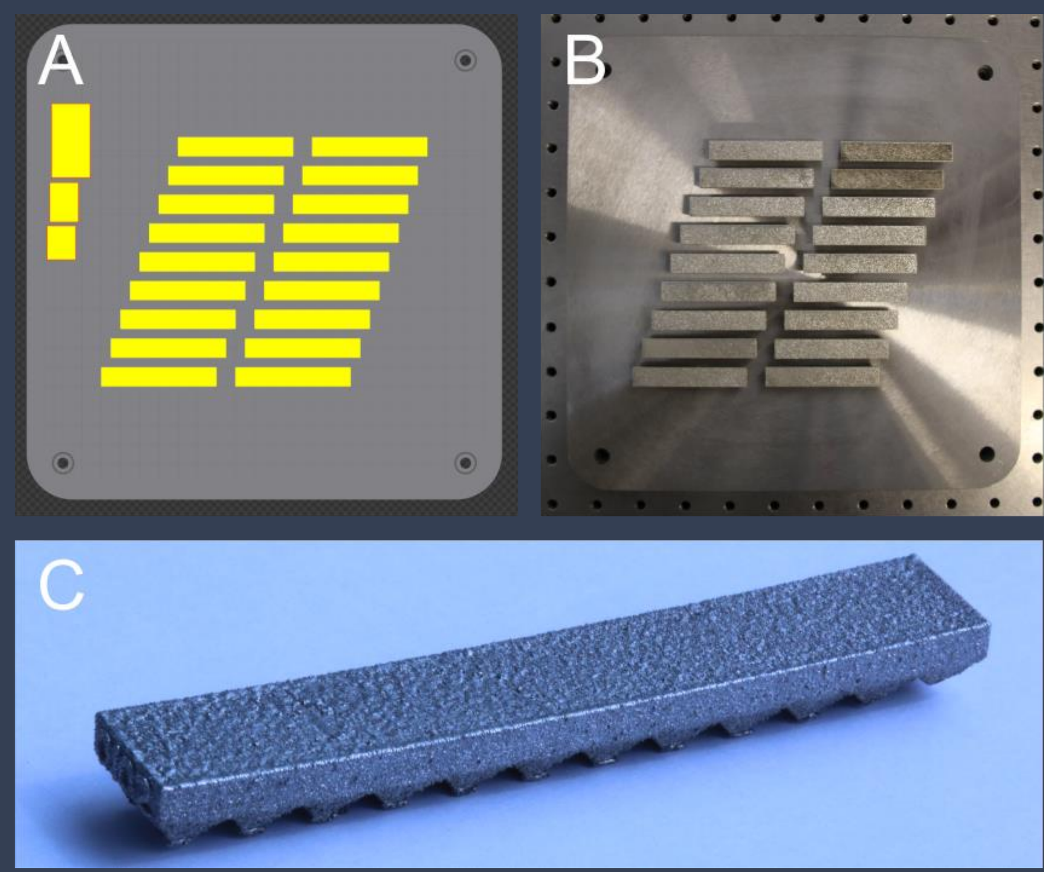
The reduction of residual stress within SLM manufactured components is of upmost importance. In larger components residual stresses lead to build failure, part cracking and loss of dimensional accuracy. In-process heat treatment is possible via modified scanning strategies using the additional laser sources. Limited re-melting occurs due to a change in material bulk properties.



In-process rescanning of test geometries

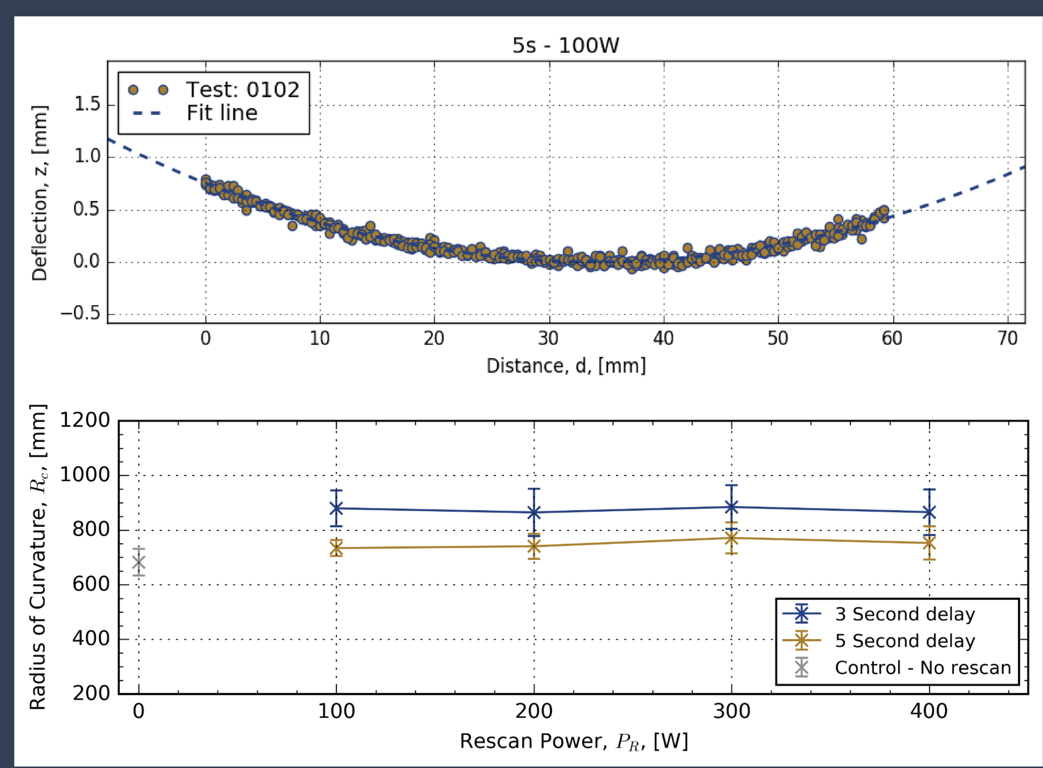
Residual Stress Measurement

This has been assessed via the manufacture of deflection cut-off samples with varying rescan powers and temporal delays. Test geometries are built directly onto a build substrate, in Inconel 718, and then removed.



A: Laser scan pattern with decoy (delay) parts; B - As-built geometries; C - Cut-off geometry

The top surface is then measured via laser triangulation. The data is used to calculate a radius of curvature via a least squares fit method. An increase in magnitude demonstrates a reduction in residual stress.



Upper: Test sample data with curve fit. Lower: Curvature plot for varying delay and powers

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