IOTWeek

Dublin — June 20-23, 2022

Development of a digital twin to achieve enhanced processing efficiency and sustainability

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GLOBAL VISION:

IoT TODAY AND BEYOND

IOTForum

Circular Economy | The Digital Economy | The Digital Transformation of Business

06 Aug 2021

Why digitalization is critical to creating a global circular economy

Application of digital tools for enhancing processing efficiency, sustainability and circularity

- *Process design optimisation*
- *Processing defect identification*

Additive Manufacturing (3D Printing)

Medical Devices – Printed hip and spinal device

Aeronautics - Printed fuel injection nozzle

Additive Manufacturing - Printing system

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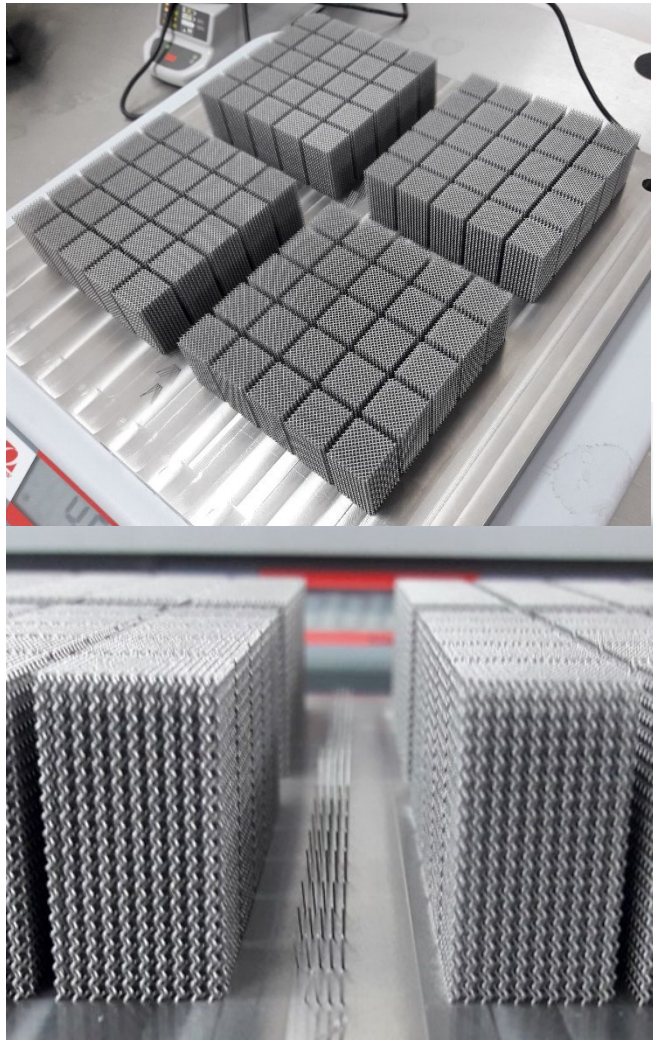
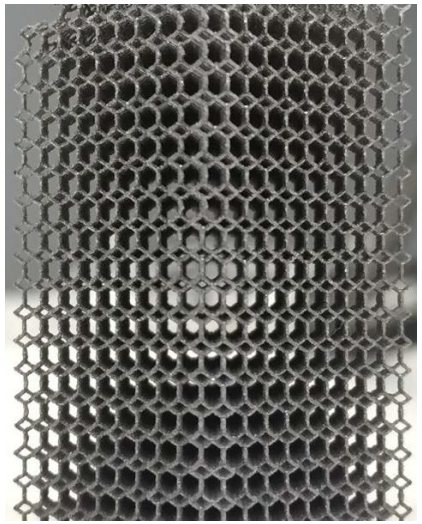
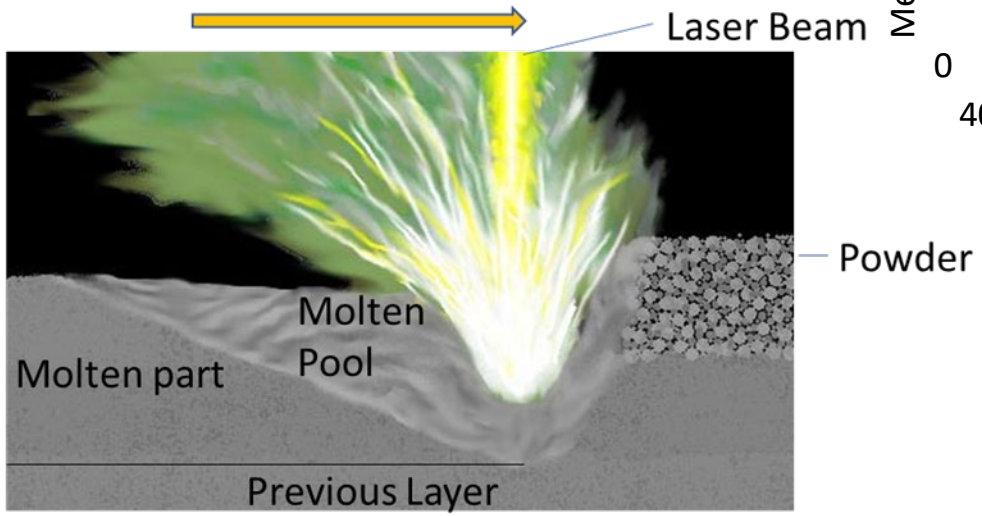
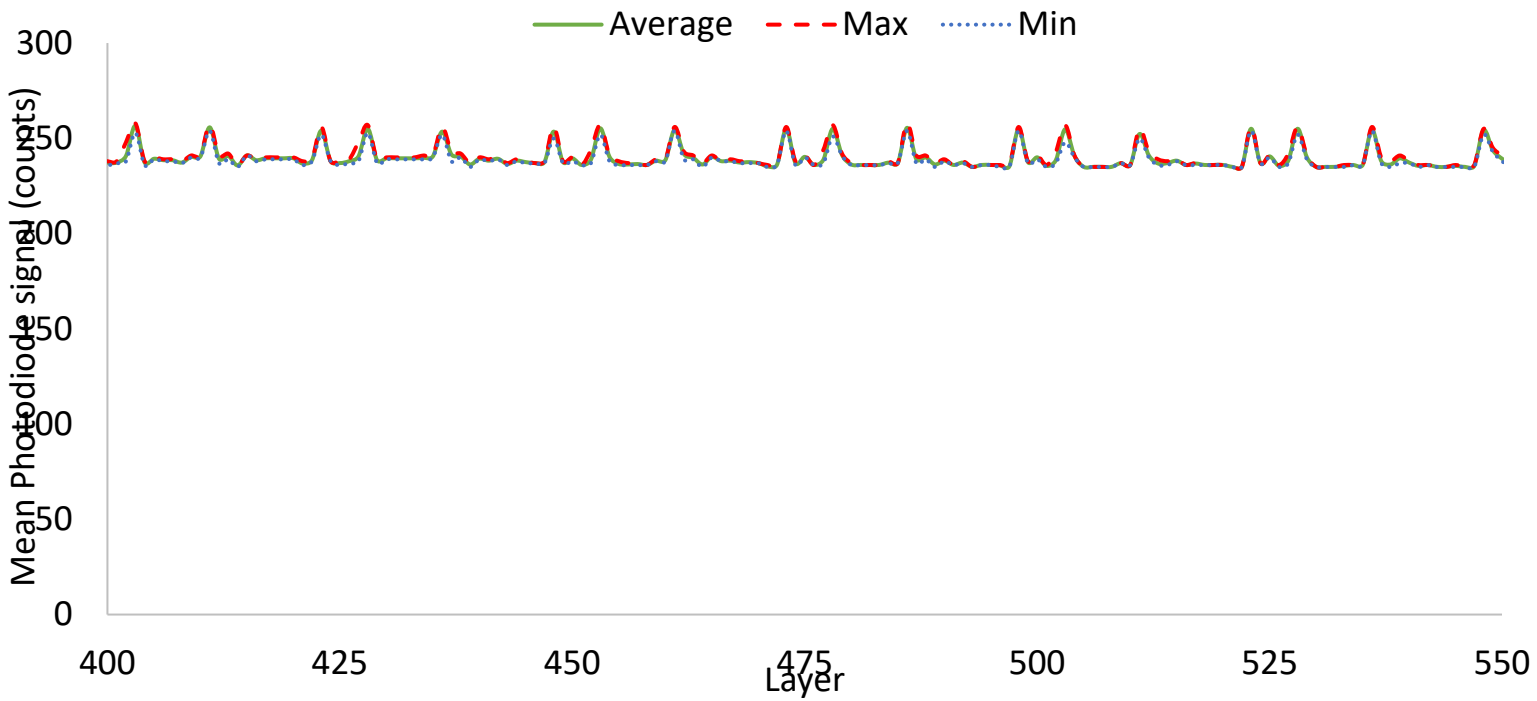


In-process monitoring during part printing

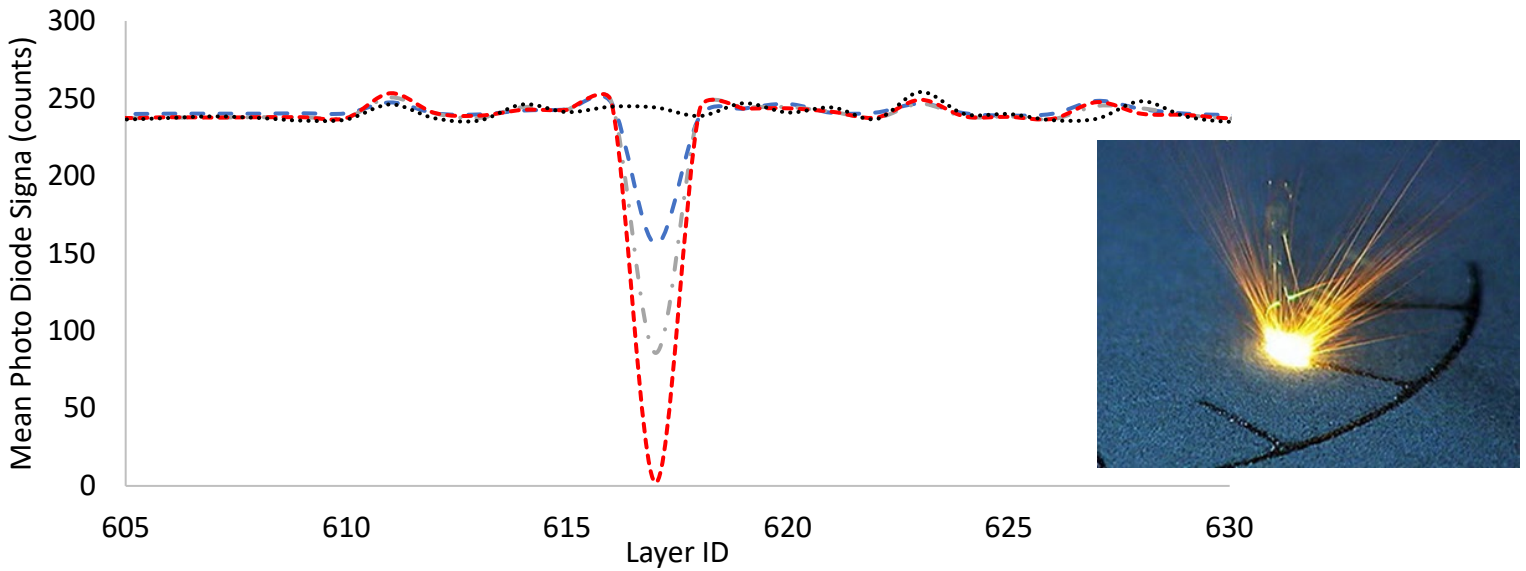




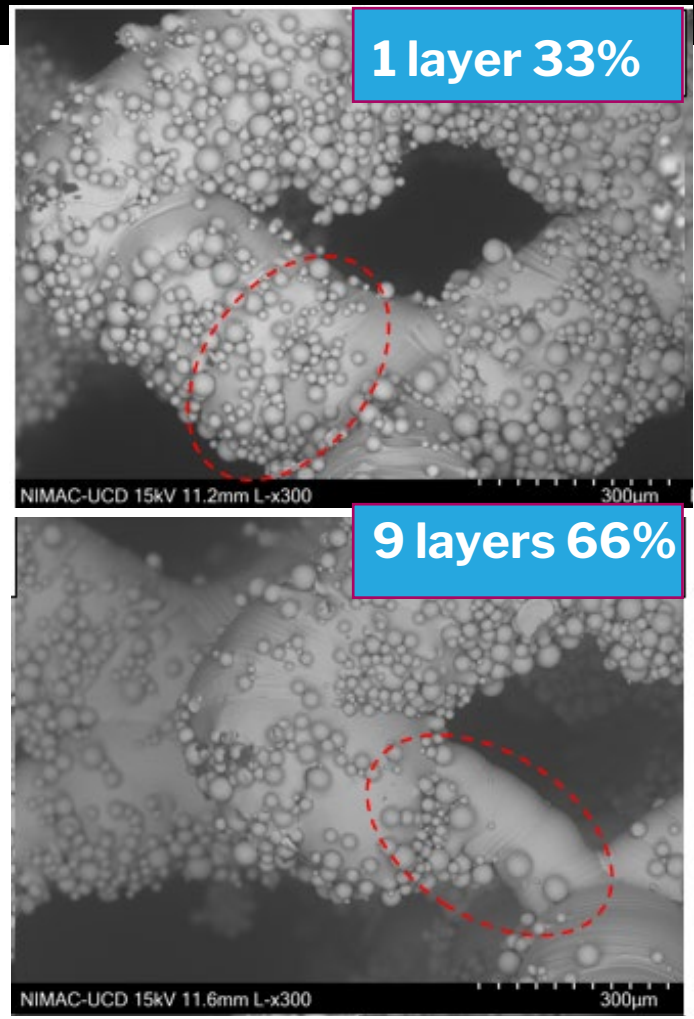


Photodiode signal measurement at each print layer

Influence of laser energy on build parts



Decrease in intensity of photodiode signal with a 33%, 66% and 100% reduction in laser energy at layer 617 (multiple lattice test samples)

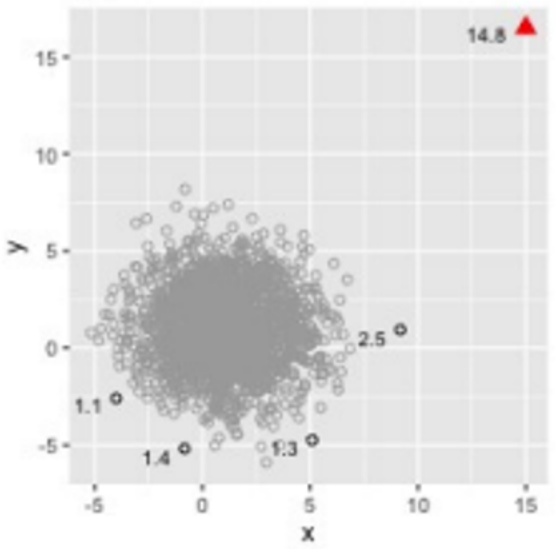


Reduction in the thickness of the lattice struts with decreased laser power (expressed as a %)

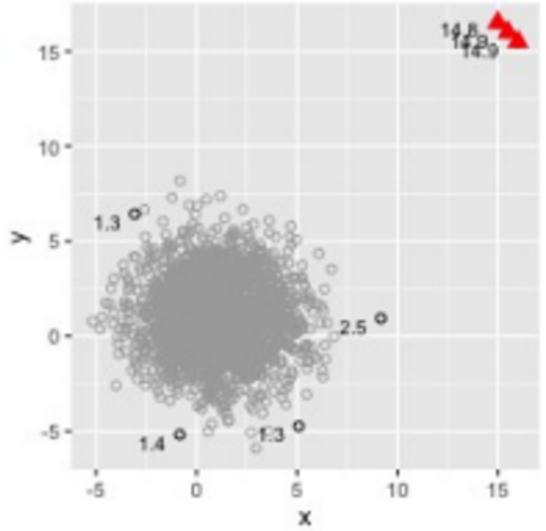
The STRAY algorithm – application to Additive Manufacturing

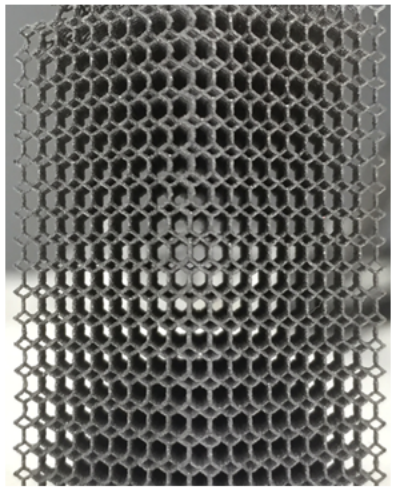
- The Search and TRace AnomalY (STRAY) algorithm calculates **outlier scores** for every point in the dataset
- The algorithm uses **extreme value theory** to calculate an anomalous threshold for these scores

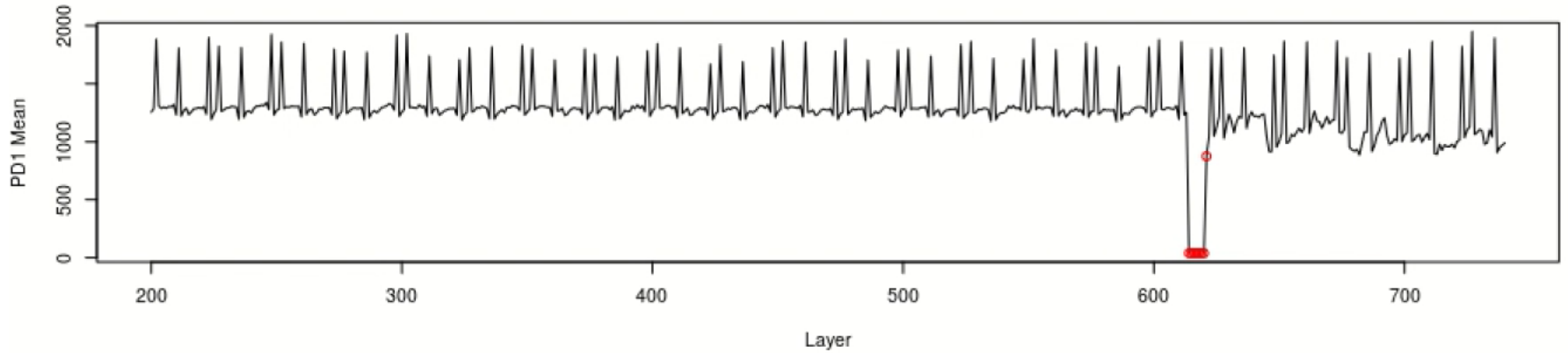
NN distances marked



Maximum gap marked

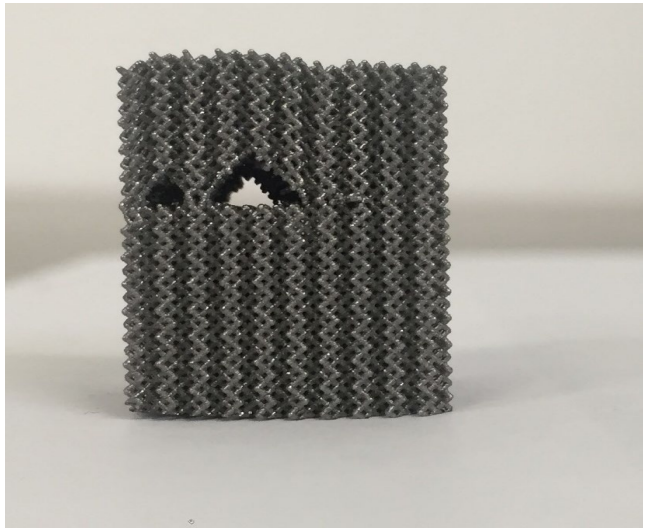




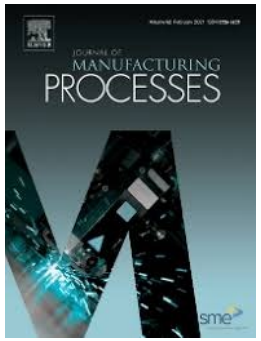


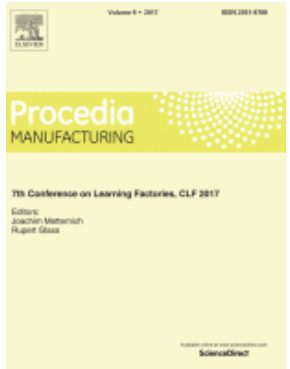
In-process sensor data obtained during the additive manufacturing process

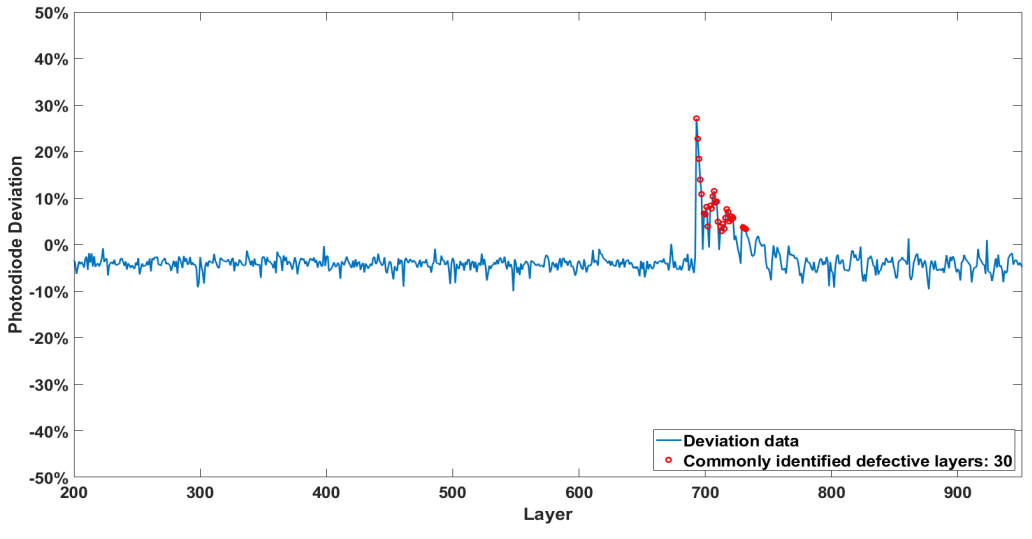
Data Analytics - anomaly detection approaches



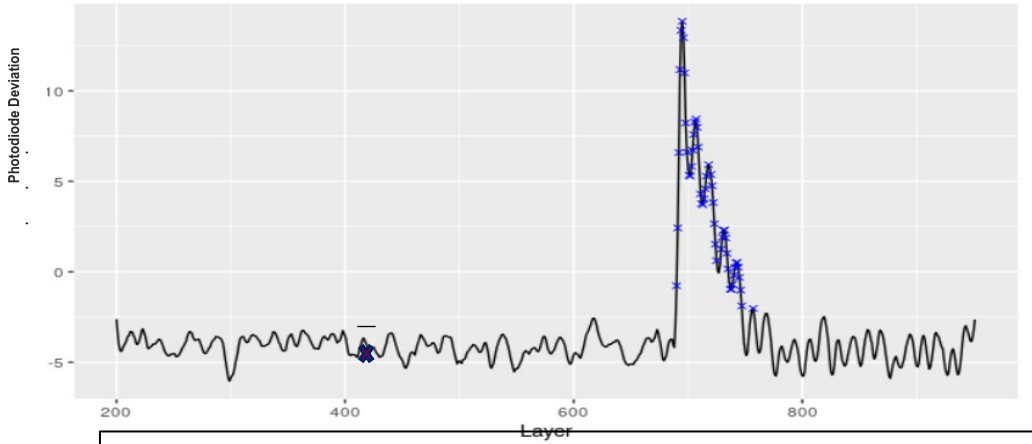
2 mm defect in a printed alloy lattice structure







Generalized Extreme Studentized Deviate (GESD) approach – 31 layers defective



STReam AnomalY (STRAY) algorithm- 51 layers defective

Photodiode signal with print layer

Recommender System

Additive Manufacturing Processing conditions

Human operator

Recommender system

Quality Information previous runs / current run

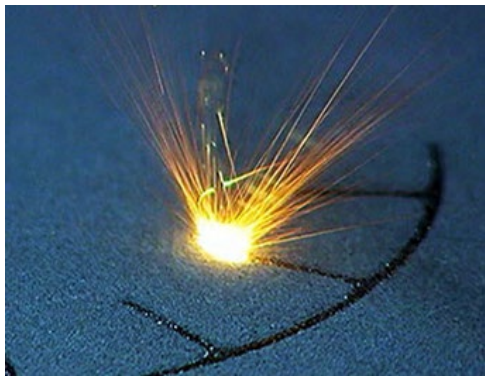
Material

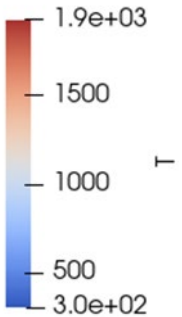
In-Process Data

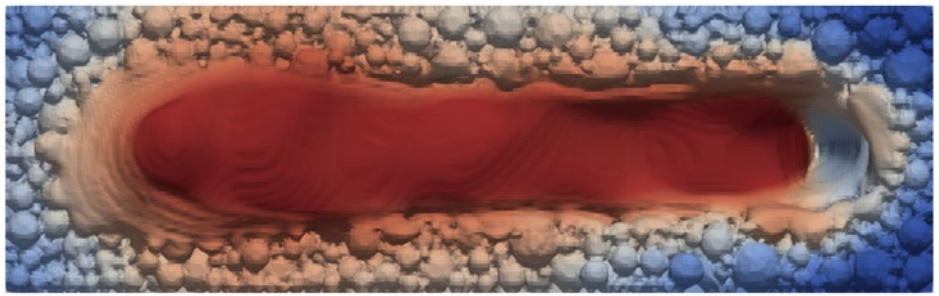
Printed Part characterisation

Materials Modelling Data

Part Design (CAD)







Recommender System -process digital twin

- Strong correlation between in-process data and final part performance
- Rapid feedback to operator (<20 Sec.)
- Selection of data analysis approach
- Incorporation of data from previous studies also modelling data
- System continually updated (digital twin)