EPSRC
Engineering and Physical Sciences Research Council

MAPP

Manufacture using Advanced Powder Processes
EPSRC Future Manufacturing Hub

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The University Of Sheffield. Imperial College London NIVERSITY OF LEEDS MANCHESTER 1824 The University of Manchester UNIVERSITY OF OXFORD

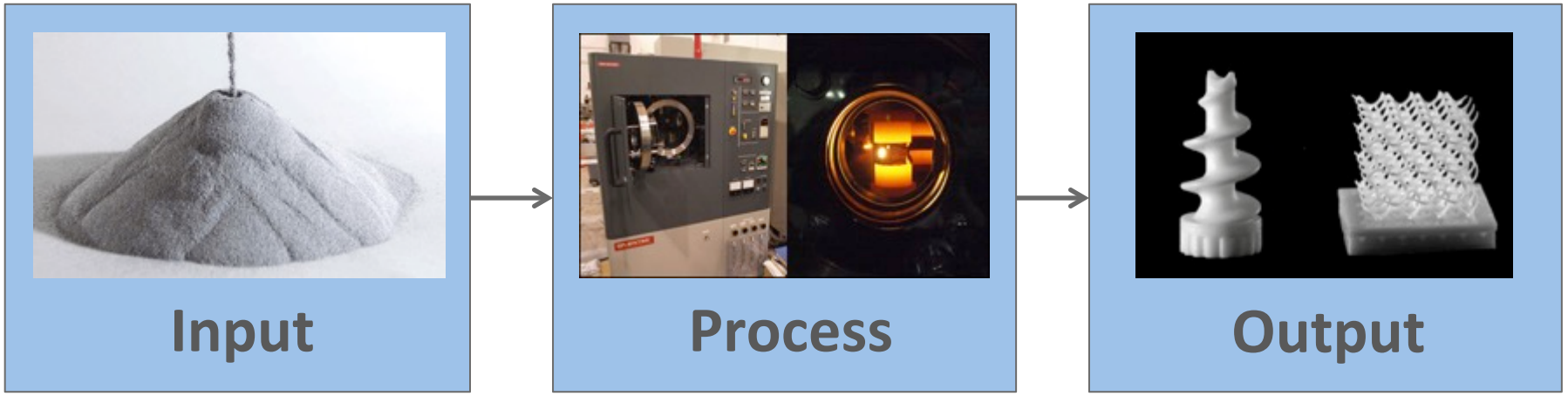
Industry and HVMC Partners

Our Vision

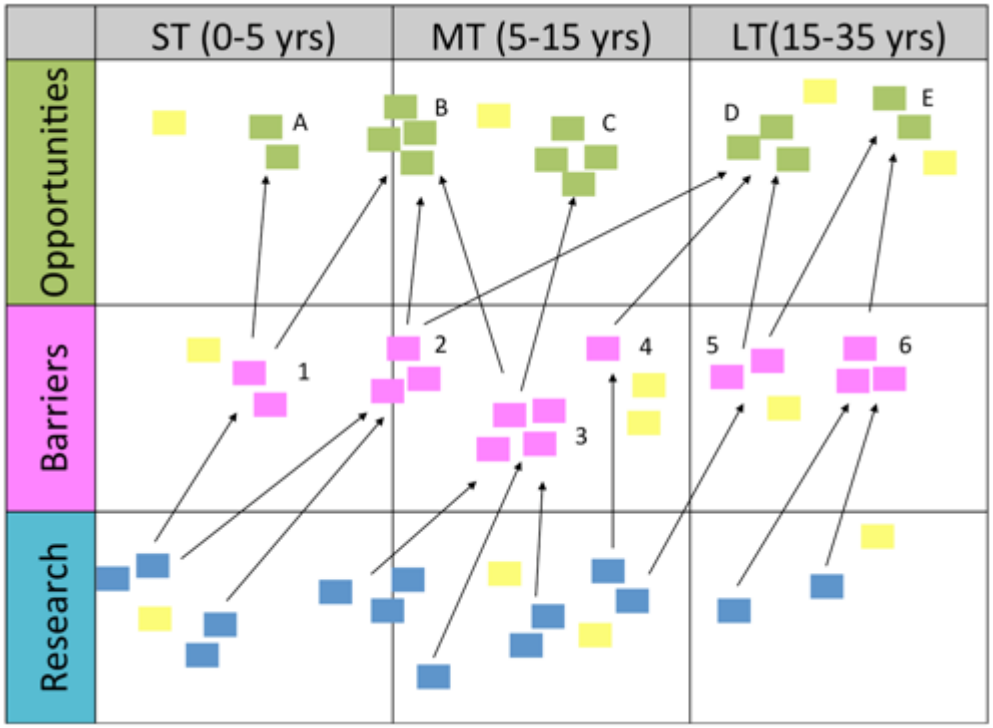
To enable Advanced Powder Processes to deliver on their promise of:

- **Reducing material waste, energy use and costs**
- **Increasing UK industrial productivity**
- **Developing high value and novel product form to provide enhanced in-service performance**

Advanced Powder Processes



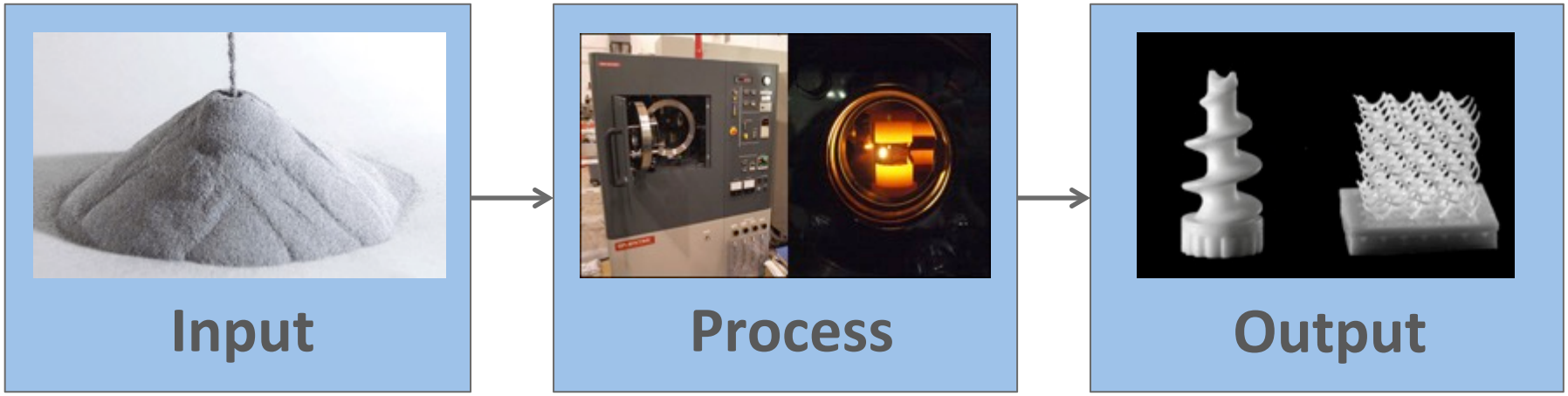
Vision set with industry and HVMC



Challenges and Barriers

- Variability of input material and process outcomes
- Lack of explicit process understanding
- Absence of suitable real-time modelling
- No direct link from processing to in-service performance
- Next generation of engineers and technologists to make this happen

Current situation



Variable

Fixed

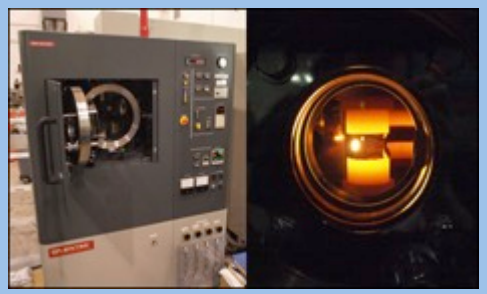
Limited or no monitoring

Variable

With MAPP

Input

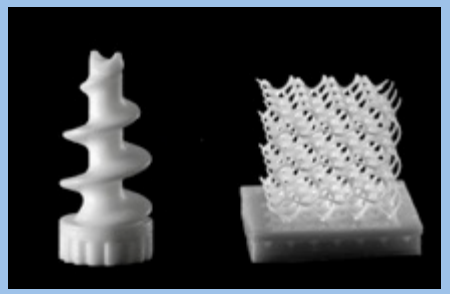
Designed for process



Process

Monitored

Dynamic control via machine learning



Output

Designed

Quality built in

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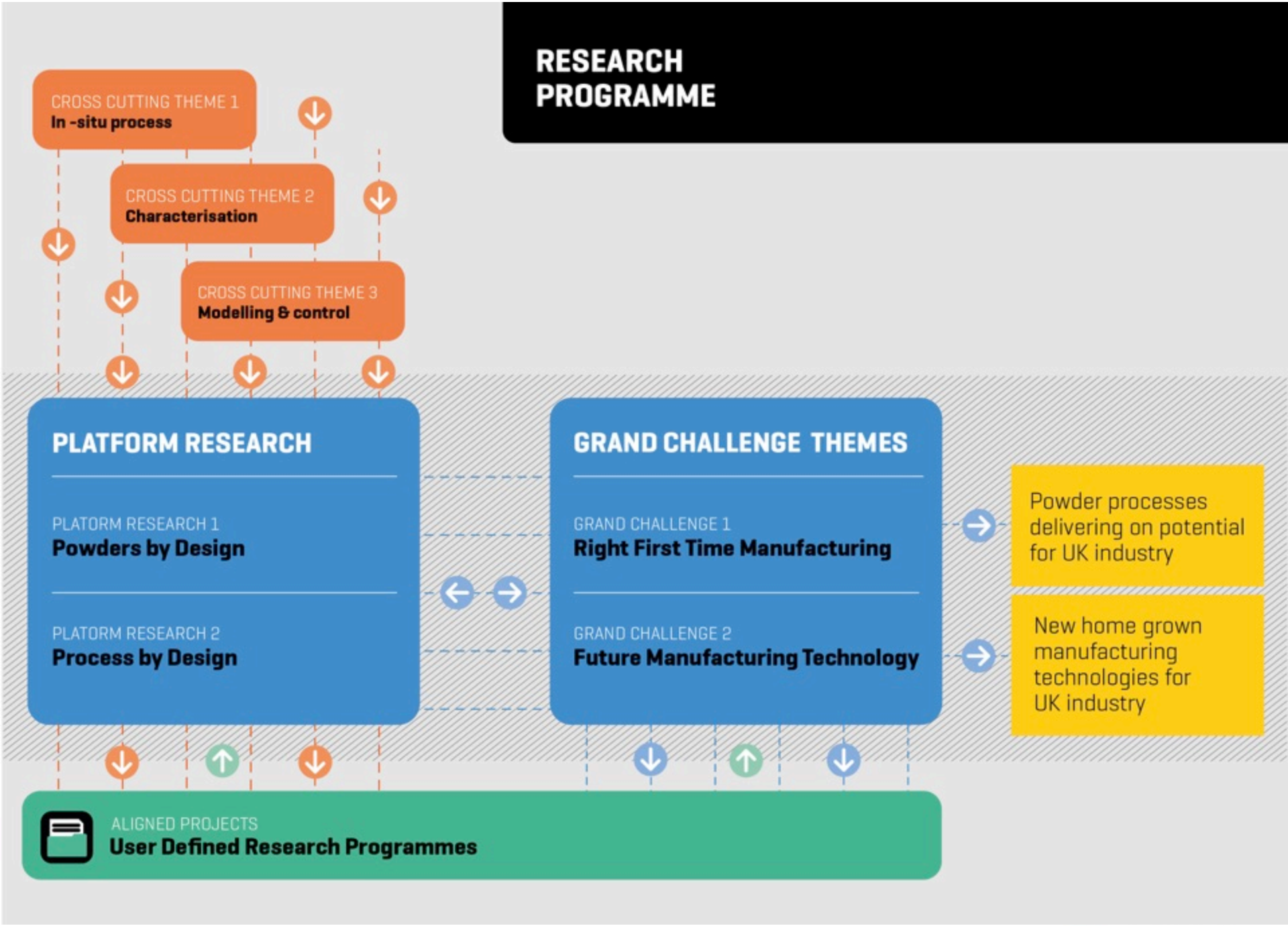
RESEARCH PROGRAMME



X1: In-Situ Process Monitoring

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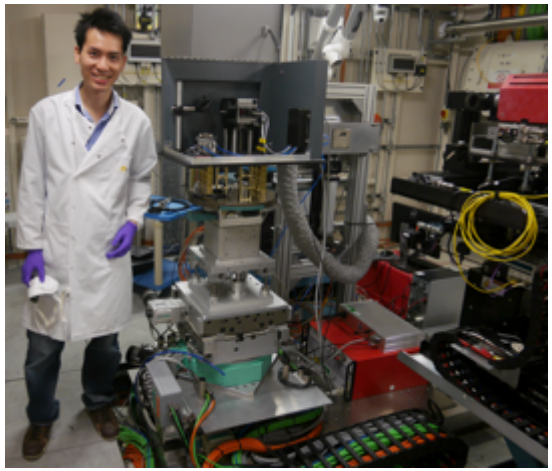
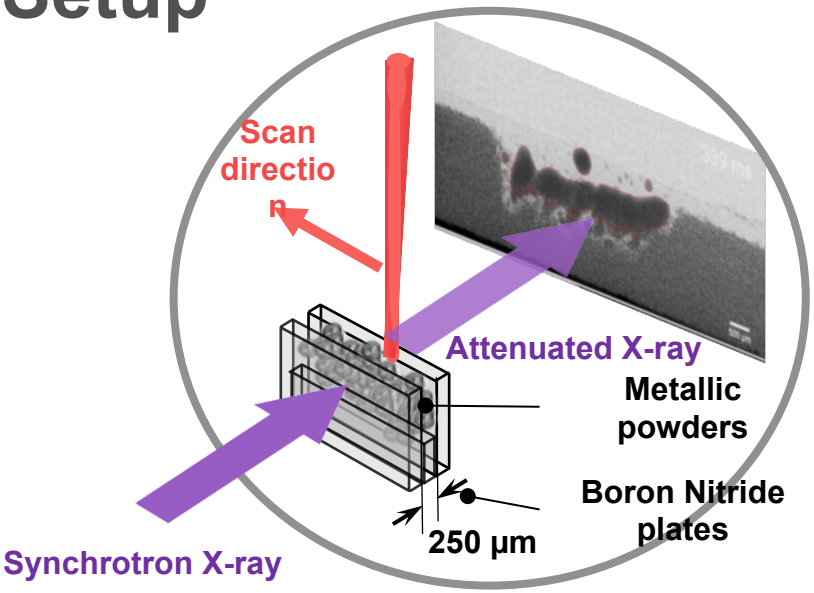
In situ AM Synchrotron Setup

Diamond Light Source



In situ AM on Beamline I12

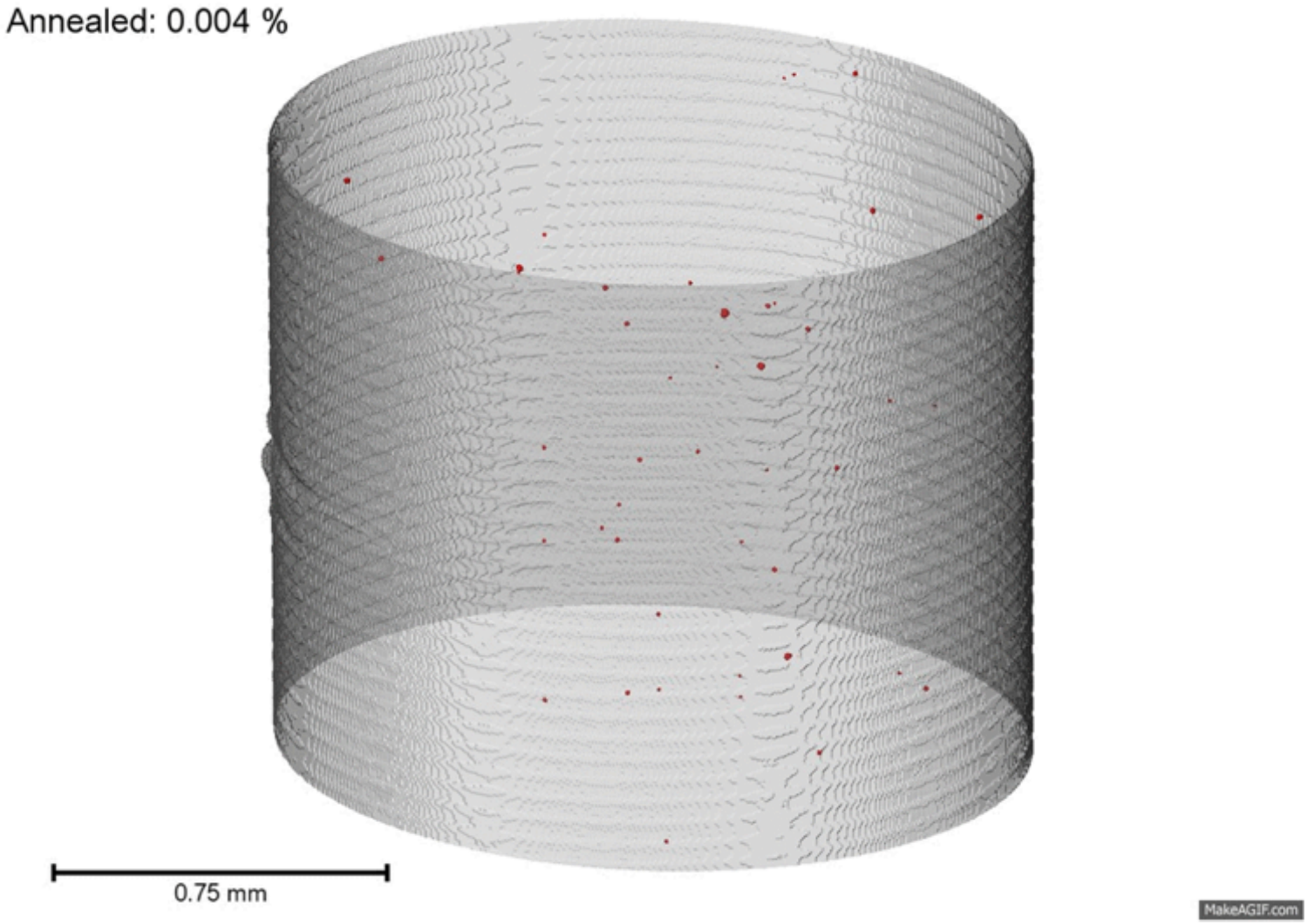


Leung, Lee, Towrie et al,
Funding EPSRC (RCaH&MAPP), FP7

diamond EPSRC Engineering and Physical Sciences Research Council MAPP AMAZE Research Complex at Harwell

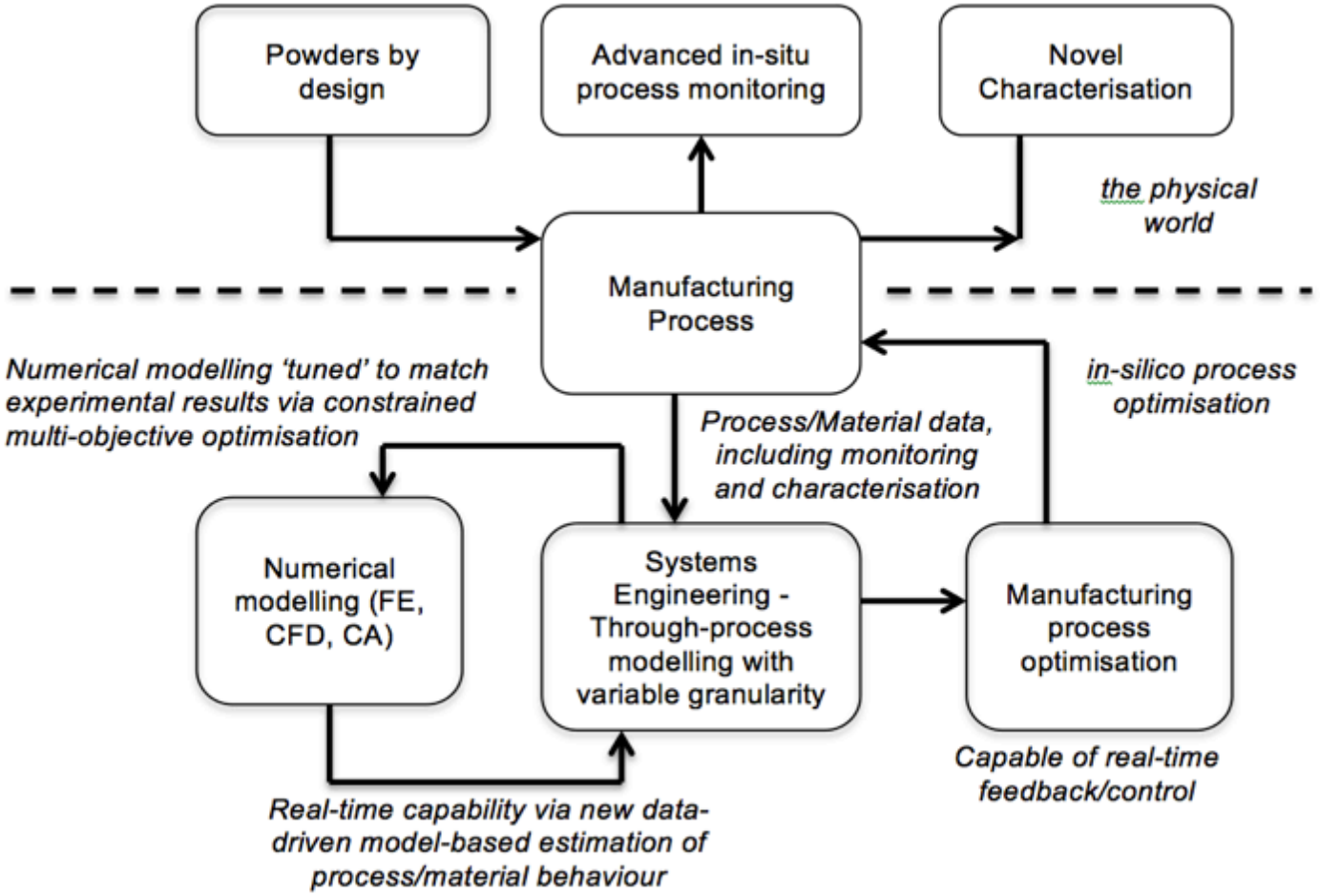
X2: Characterisation

Advanced X-Ray Tomography



X3: Modelling and Control

Hybrid Modelling Approach used in MAPP



GC1: Right First Time Manufacturing

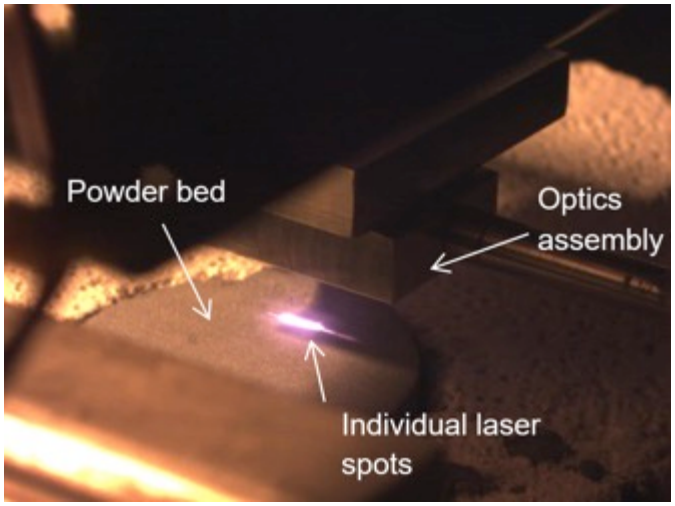
Large-volume High Speed Sintering machine

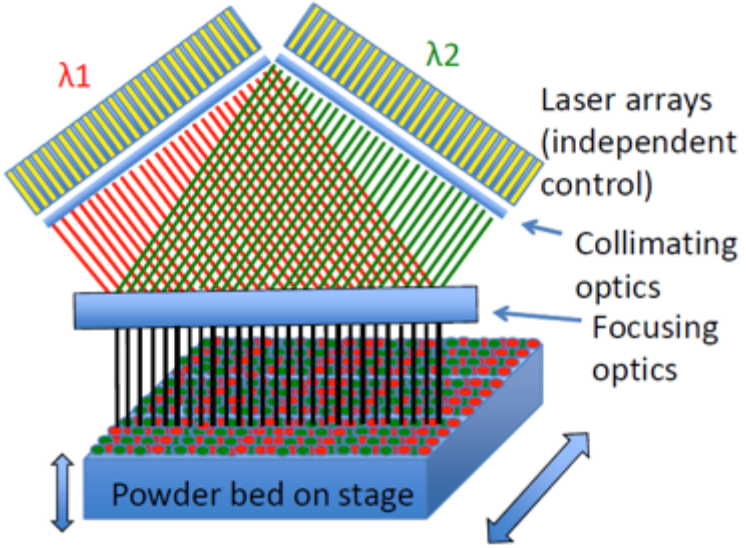
- 2 year, ~£1million, EPSRC-funded collaboration between University of Sheffield and the Advanced Manufacturing Research Centre (AMRC)
- Design and manufacture a High Speed Sintering capable of competing with Injection Moulding production rates
  - Overall build volume of 1630 x 855 x 760 mm
  - Production rates of <1 second per part (75 x 10 x 2mm part dimensions)
  - Next Phase in MAPP

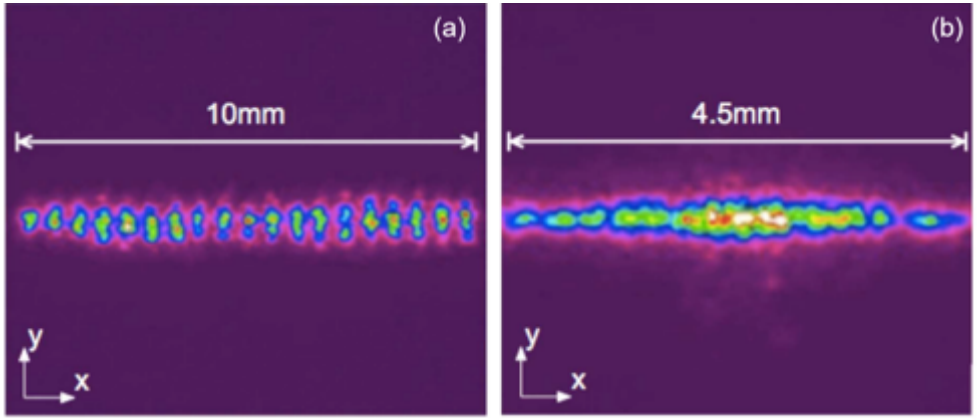
GC2: Future Manufacturing Technologies

Diode Area Melting

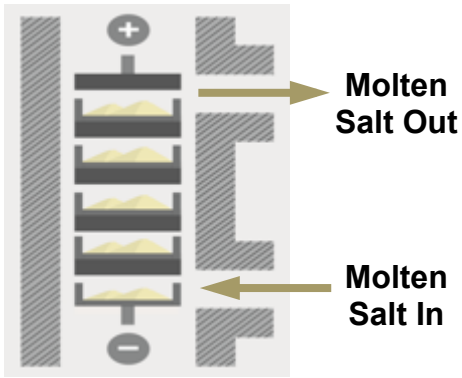
- **Highly scalable approach, using laser modules with higher wall-plug efficiency compared to traditional fiber lasers**
- **Potential to instantaneously switch laser bar wavelength enabling the processing of different materials including polymers**
- **Laser spot overlap and focus can be adjusted to provide efficient optical pre-heat and component stress reduction**



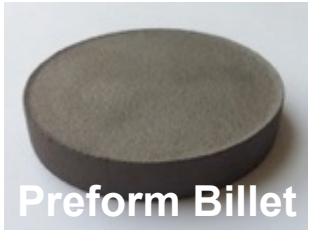


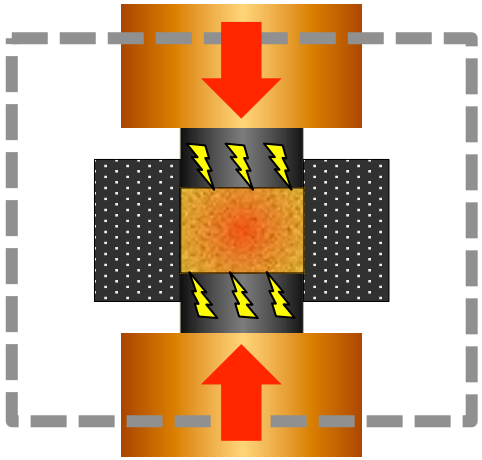


FastForge - SPS

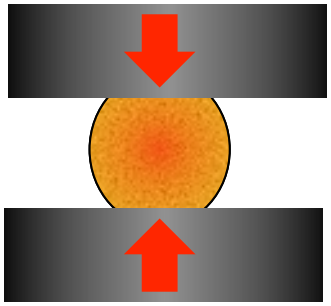


Metalysis Process





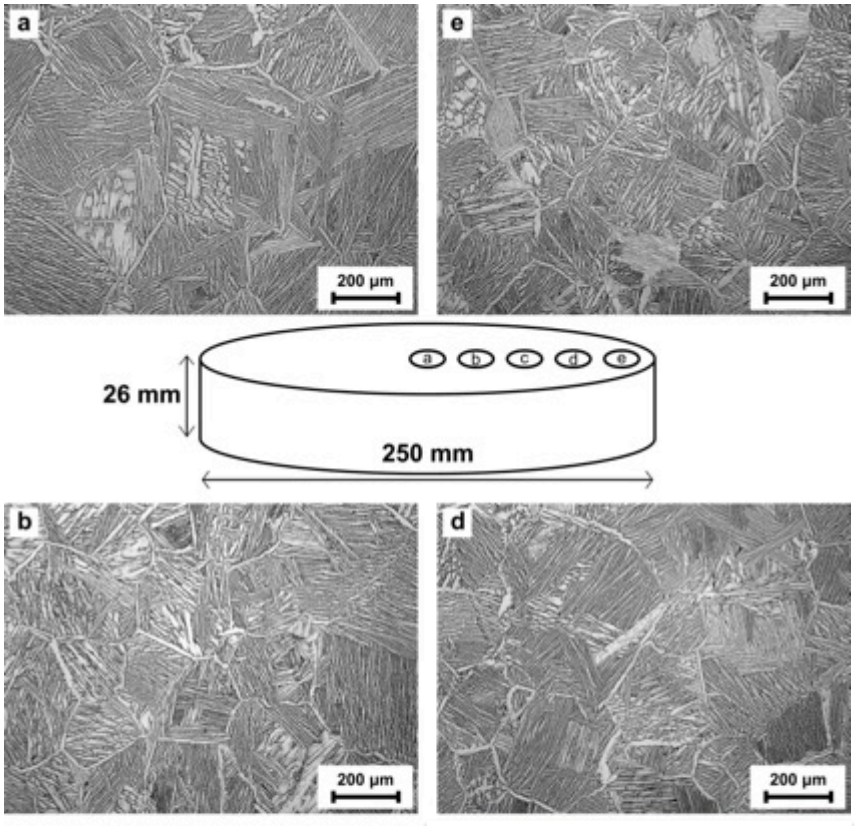
Spark Plasma Sintering

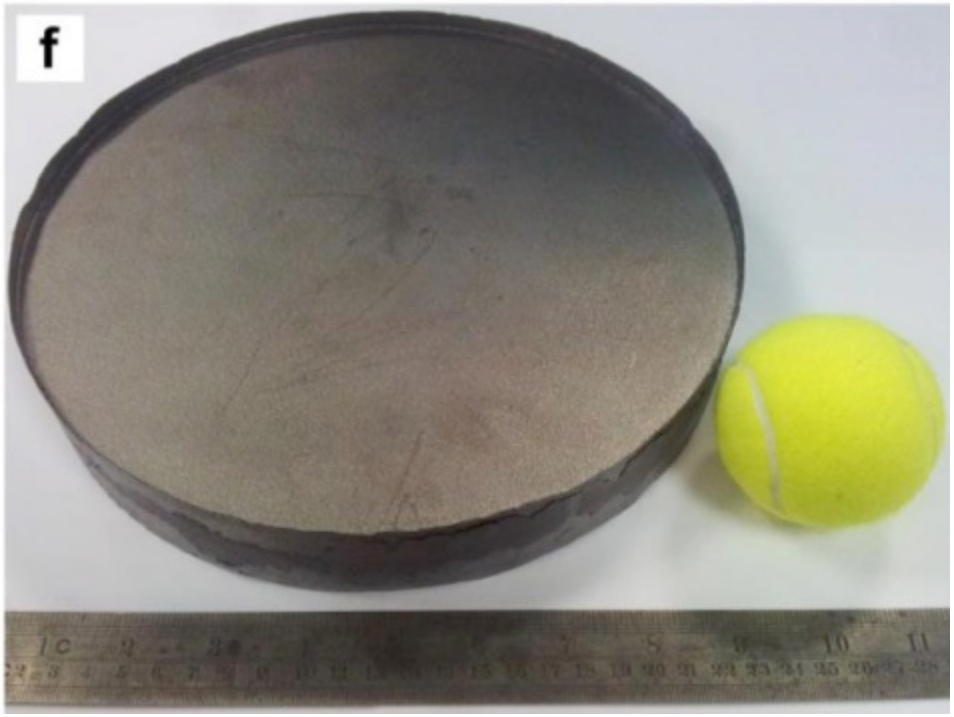


"One-Step" Forge

Forged Product

FastForge - SPS





"Spark Plasma Sintering of Commercial and Development Titanium Alloy Powders"

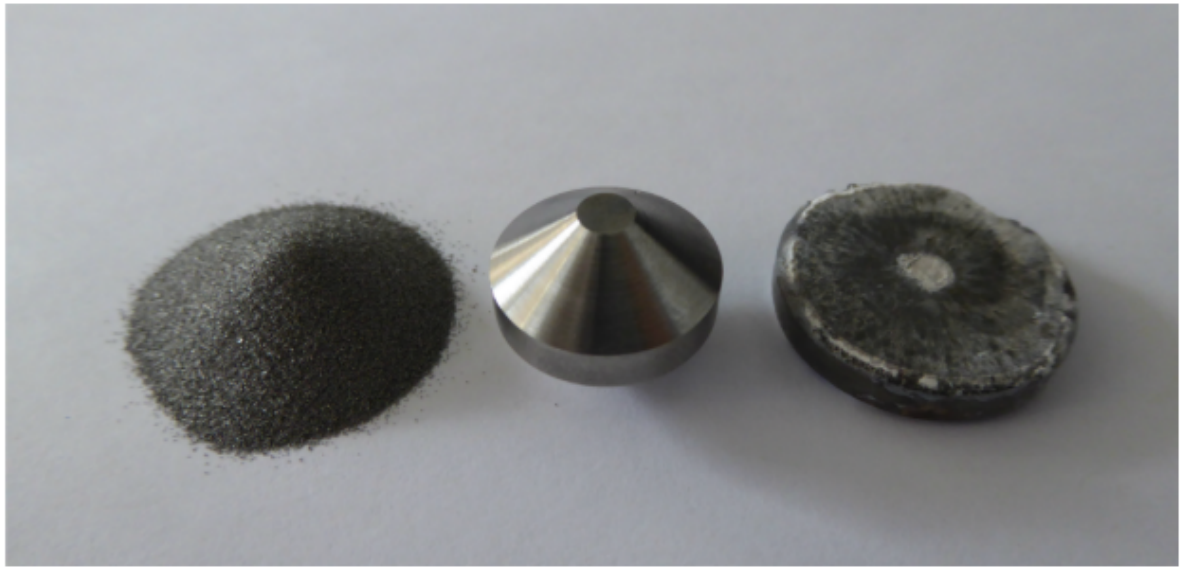
N.S. Weston, F. Derguti, A. Tudball, M. Jackson

Journal of Materials Science, *in print* (2015)

DOI: 10.1007/s10853-015-9029-6

FASTForge to deliver cheaper aerospace titanium

Posted on **29 Nov 2016** by **Jonny Williamson**



L to R: Titanium powder obtained from rutile sand, Field Assist Sintered double cone preform, then pancake forging - image courtesy of FastForge.

A consortium comprising the world's leader in aircraft landing gear, a leading specialist metals producer and two of the UK's leading universities is working on FastForge, a project aimed at the production of aerospace-grade titanium at a third of the current price.

The partners working on the FASTForge project include Safran Landing Systems (formerly Messier-Bugatti-Dowty); Metalysis; the University of Strathclyde's Advanced Forming Research Centre (AFRC), and the University of Sheffield.

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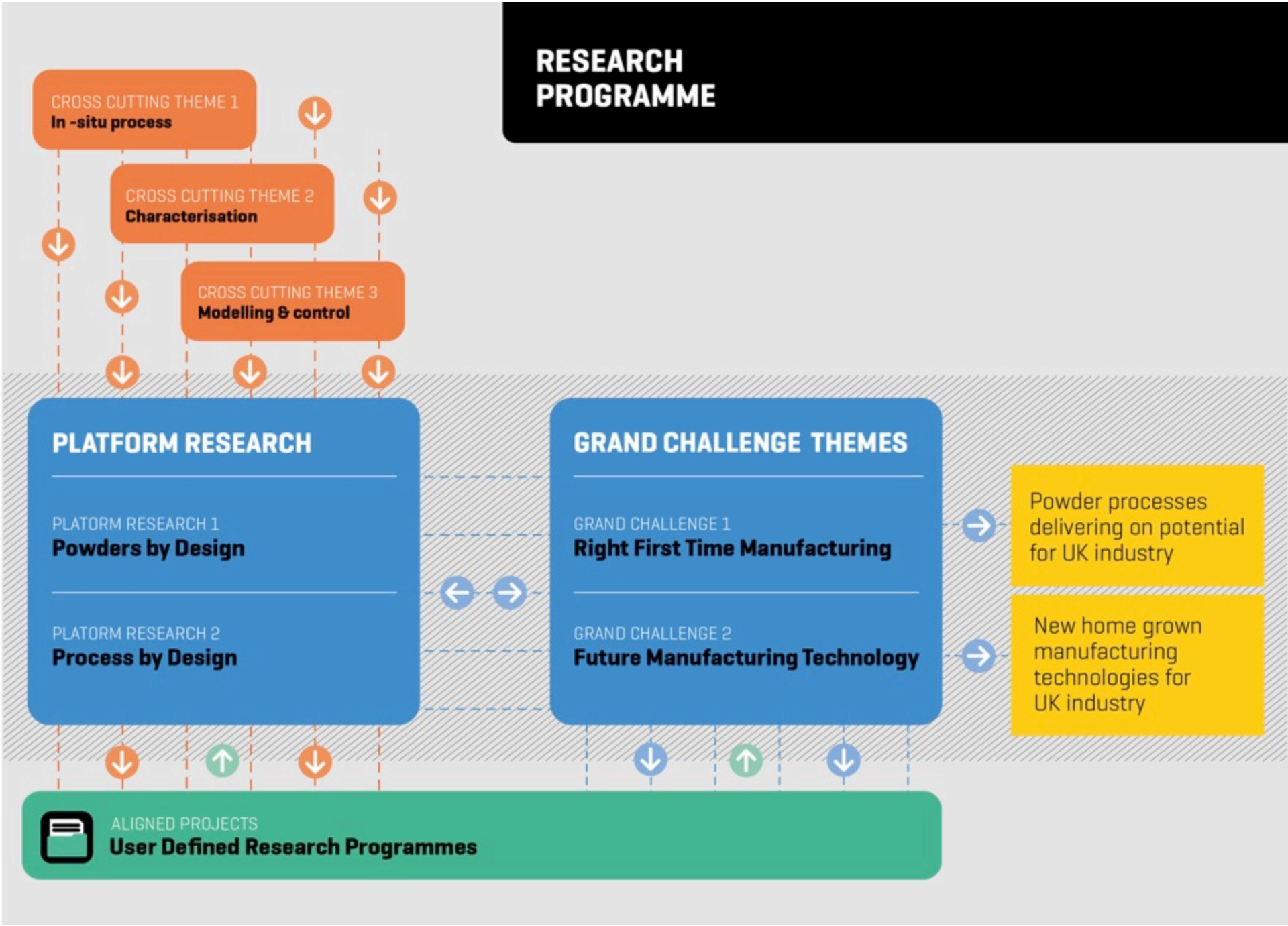

Today's Talks

- Powders and Additive Manufacturing for Aerospace applications'
  - *Rob Sharman, Global Head of Additive Manufacturing, GKN Aerospace*

- 'X-ray synchrotron imaging of additive manufacturing: from metrology to process control'
  - *Peter Lee, University of Manchester & Research Complex at Harwell* (X1, X2 P2)

- *'*Manufacturing with Powders at Johnson Matthey'
  - *Alison Wagland, Johnson Matthey*

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Today's Talks

- Powder dynamics in additive layer manufacturing processes'
  - *Andrew Bayly, University of Leeds* (P1)

- 'Metal AM from the perspective of the powder'
  - *Phil Carroll, Chief Executive Officer, LPW Technology*

- 'Prevention is better than cure'
  - *Iain Todd, MAPP Director, University of Sheffield* (P2, X1-3)

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Why MAPP? Why now?

The combination of and advances in:

- **machine learning with physically based modelling**
- **materials processing with advanced in-situ & ex-situ characterisation**

MAPP will create new, connected, intelligent cyber-physical manufacturing environments to achieve "right first time" product manufacture from powders.

Rolls-Royce GKN AEROSPACE Johnson Matthey SAFRAN Messier-Bugatti-Dowty WEIR MAHER

RENISHAW apply innovation™ XAAR Morgan Advanced Materials elementsix METALYSIS freemantechnology EASTMAN

AFRC The University Of Sheffield. Advanced Manufacturing Research Centre cpi CATAPULT High Value Manufacturing mtc Manufacturing Technology Centre NUCLEAR AMRC WMG THE UNIVERSITY OF WARWICK ZEISS LPW PSI

BOEING