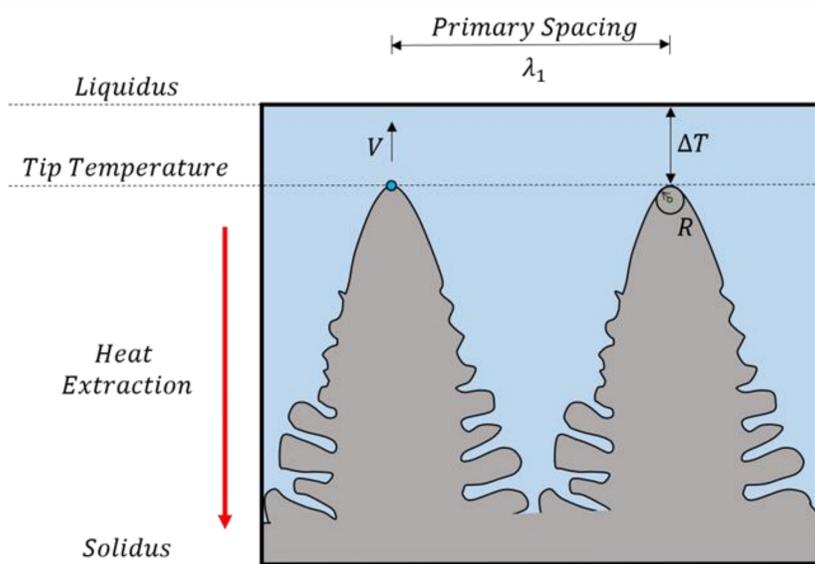


## Single Crystals

Single crystals are a continuous unbroken solid crystal lattice with no grain boundaries. They find a wide range of applications, from semi-conductors, optoelectronics, to applications in aerospace engines where high-temperature creep and fatigue resistance are required. Perfect single crystals of practical size are exceedingly rare in nature and difficult to produce in a laboratory, albeit, they can be made under precisely controlled conditions.

## Dendritic Solidification Structures

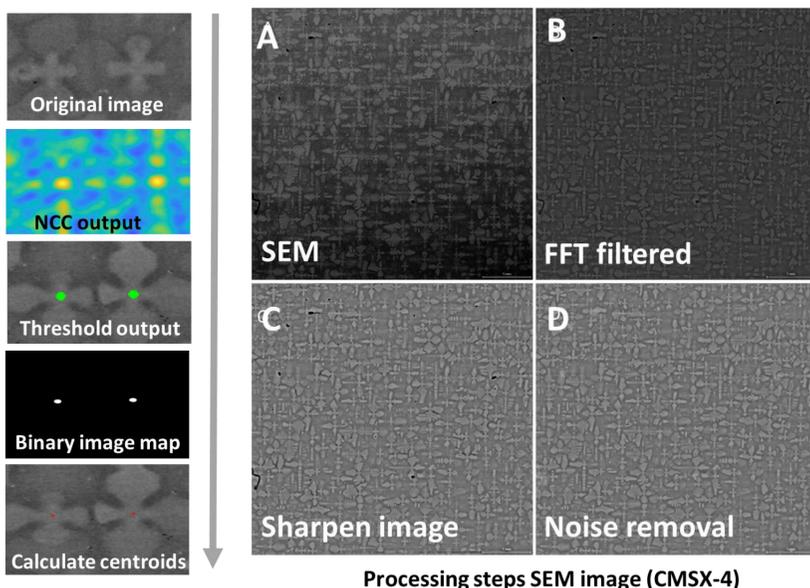
During solidification, dendrites are the predominant structure and form with a solute profile significantly different to the nominal solute content of the alloy. The primary spacing controls the segregation process and determines the distribution of inhomogenities in the material; thus, influencing the final mechanical properties.



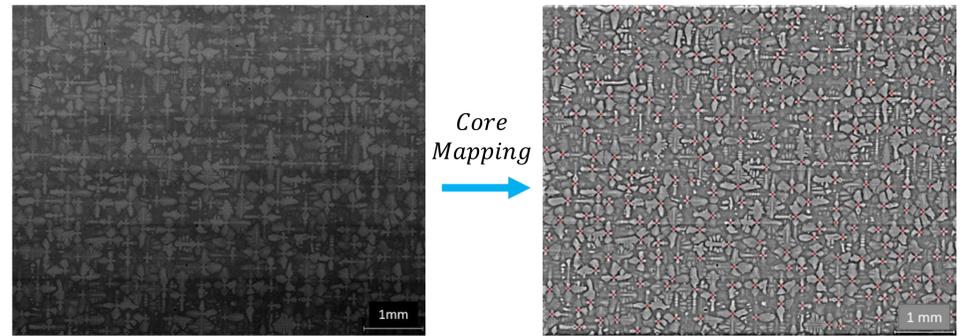
## The Focus

The aim of this work is to develop a new methodology for assessing primary spacing variation over a bulk microstructure in a manner that is accurate, rapid, and automatic. The purpose is to elucidate unknown relationships between primary spacing disorder, local dendritic packing and the bulk process variables. This is achieved by: 1) determining dendritic cores automatically and 2) developing an algorithm to determine locally interacting neighbours.

## Automatic Dendritic Core Detection



## Packing Patterns and Primary Spacing

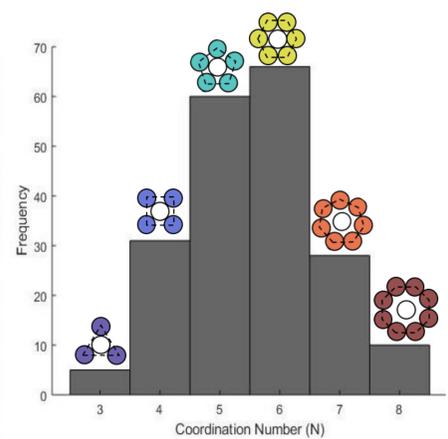
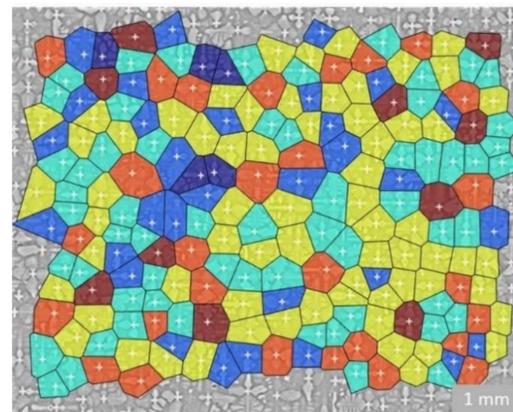


Unique Packing Term for Each  $N$

$$R_{SLPS} = \bar{\lambda}_{Local} + (K_{SLPS} \lambda_{\sigma Array})$$

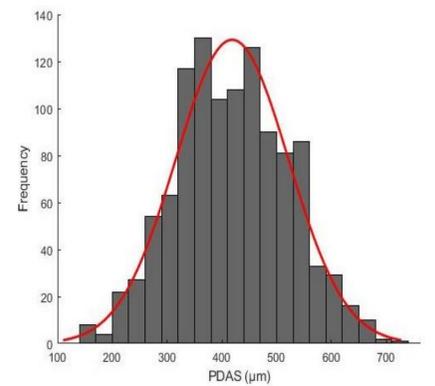
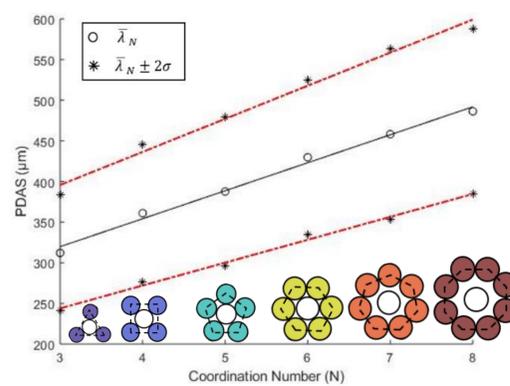
$$K_{SLPS} = \frac{2\lambda}{a} \sqrt{\tan\left(\frac{\pi}{N}\right)}$$

Local dendritic packing mapping



Hexagonal Packing Most Numerous

Relationship between local packing and local primary spacing



Smooth Gaussian Accuracy

Increasing Scale

## Outcomes

- 1) Dendritic cores mapped close to 100% accuracy.
- 2) Local primary spacing determined with classic gaussian fit.
- 3) Packing patterns can determine local primary spacing.
- 4) Hexagonal,  $N_6$ , packing most frequent formed.
- 5) Local primary spacing increases with increase in nearest interacting neighbours (coordination number,  $N$ )
- 6)  $N_6$  packing has similar average local primary spacing to that of the bulk array.

## Acknowledgements

J.S. and B.N. wish to acknowledge EPSRC CDT (Grant No: EP/L016206/1) in Innovative Metal Processing for providing PhD studentships for this study and Rolls-Royce Plc for providing financial support.