The Beam Team
Metallurgy, Mechanics, Additive Manufacturing, and Data Science

https://stebnerlabs.me.gatech.edu

Georgia Tech

Who We Are

We are a multi-disciplinary, diverse group of researchers working to advance applicable science and technologies. Our research group name and logo are derived from many of our research programs using the beam lines at synchrotron and neutron facilities around the world.
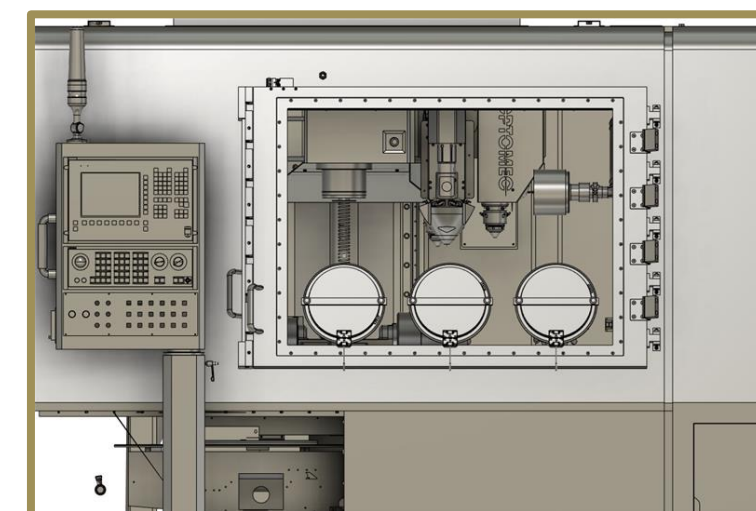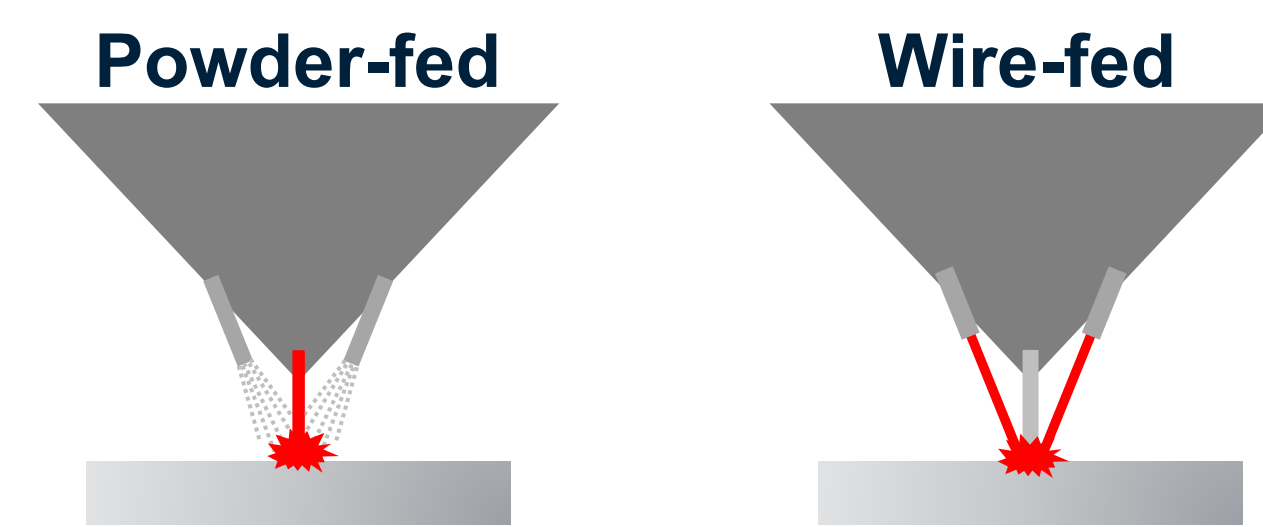
Our Advisor

Arriving at Georgia Tech in 2020, Dr. Stebner has built a robust research group with over 20 members and numerous industrial and academic collaborators.
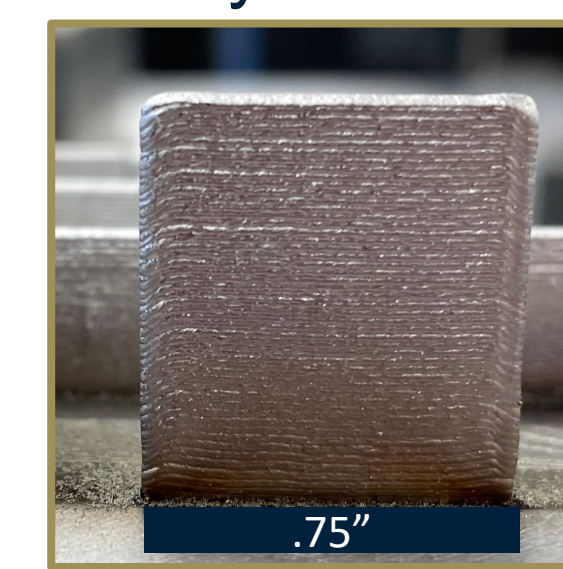
Additive Manufacturing

Optomec MTS 860
- First of its kind
- Hybrid platform
  - LENS DED
  (Powder and Wire fed)
  - 5 Axis CNC Machining
- 4 Powder feeders
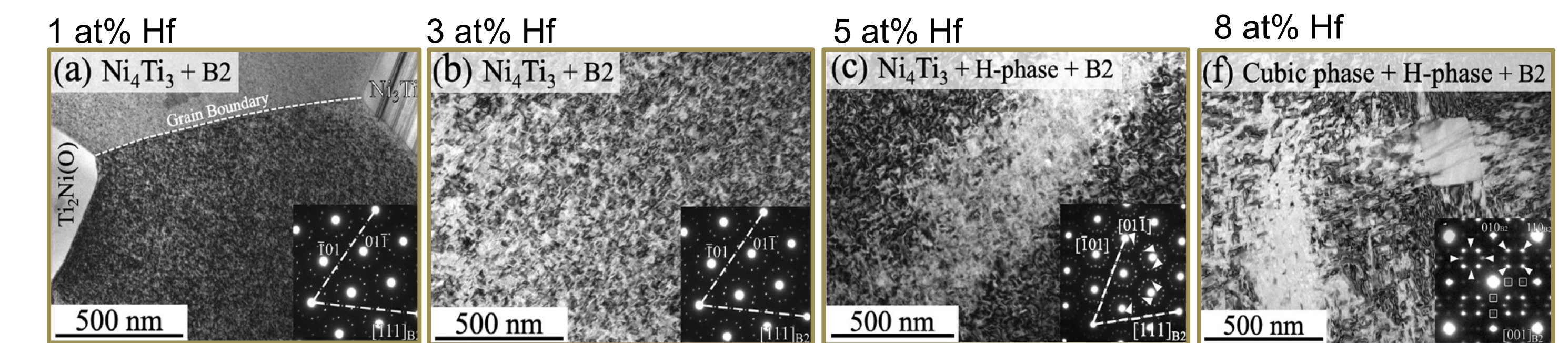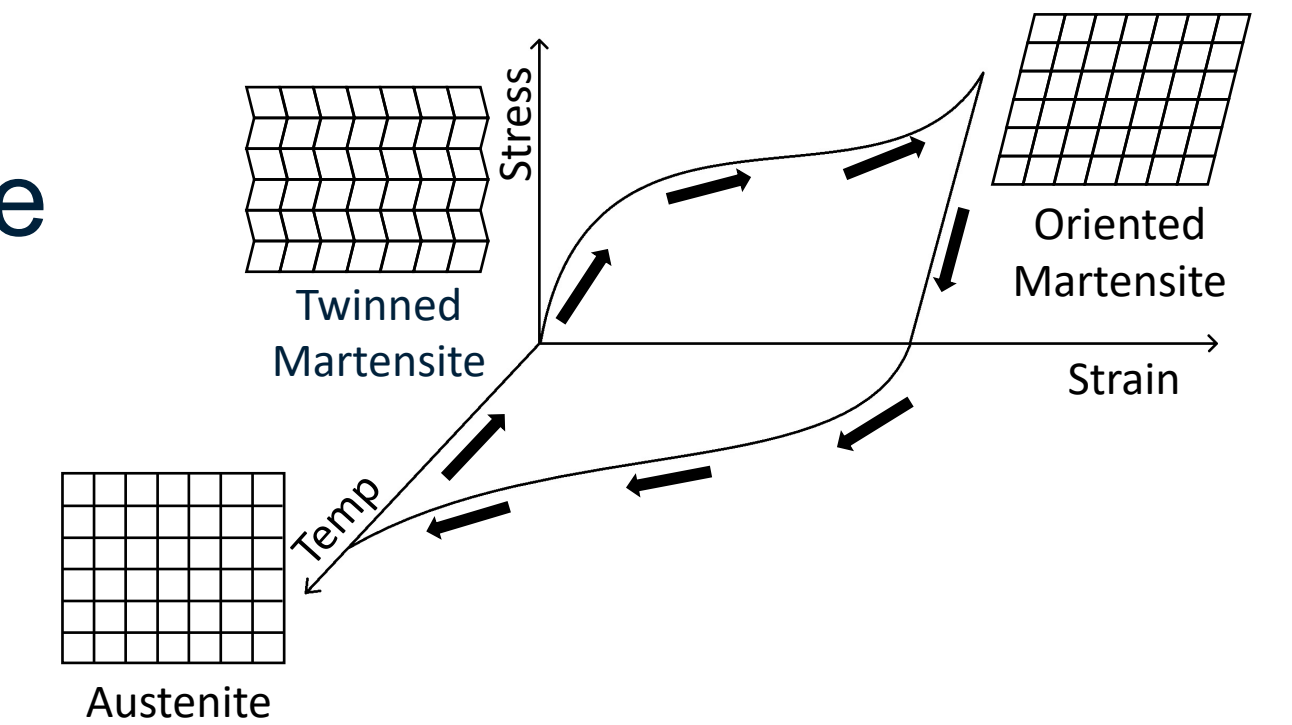- Gradient Materials

Powder-fed   **Wire-fed**

Capabilities
- Working with materials that are difficult to traditionally manufacture.
  - Difficult to form materials
  - Reactive materials

Pure Molybdenum Wall

.75"

Alloy Development

Shape Memory Alloys (SMAs)
- Alloys that can exhibit remarkable plasticity and thermally activated shape recovery.

- NiTiHf
  - High strength and wear resistance
  - Hf affects transformation temperature
 - How can we tailor these alloys for specific applications?

1 at% Hf | 3 at% Hf | 5 at% Hf | 8 at% Hf

(a) $Ni_4Ti_3 + B2$ (b) $Ni_4Ti_3 + B2$ (c) $Ni_4Ti_3 + H\text{-phase} + B2$ (f) Cubic phase + H-phase + B2

500 nm | 500 nm | 500 nm | 500 nm

https://doi.org/10.1007/s40830-020-00296-w

- NiTiMo
  - Relatively unstudied ternary alloy
  - Possible applications in high temperature actuators and medical devices.

200µm

20µm
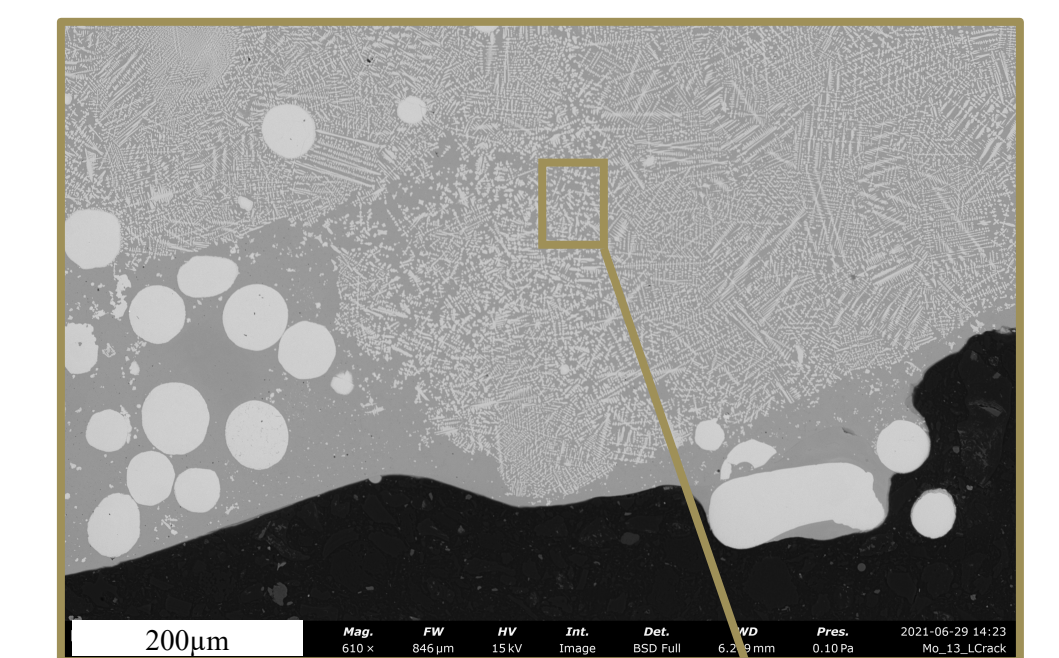
High Performance Structural Materials
- Molybdenum
  - Melting point of 2600°C
  - Can we use this metal for hypersonic flight? Possibly for nuclear fuel shielding?

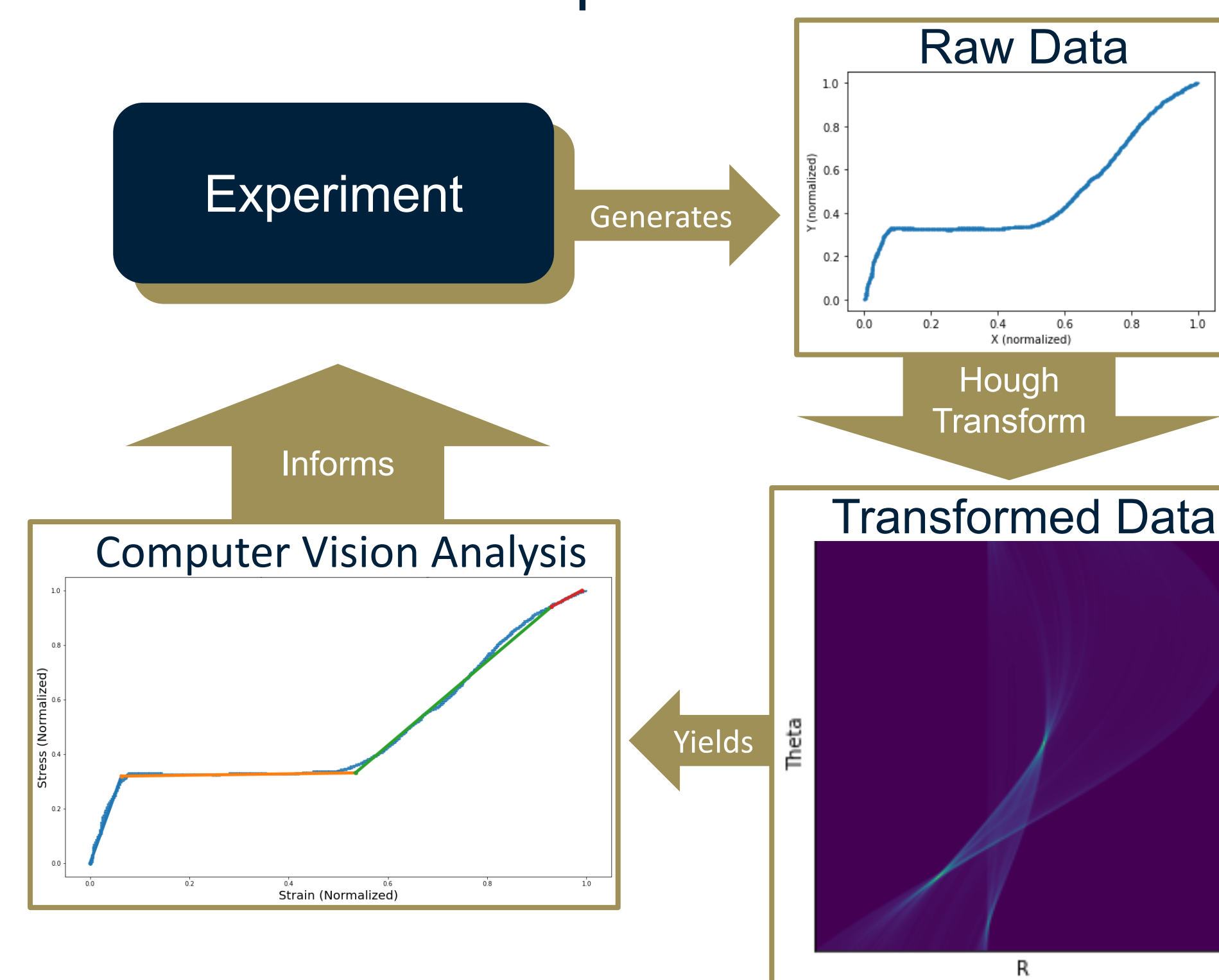200 µm
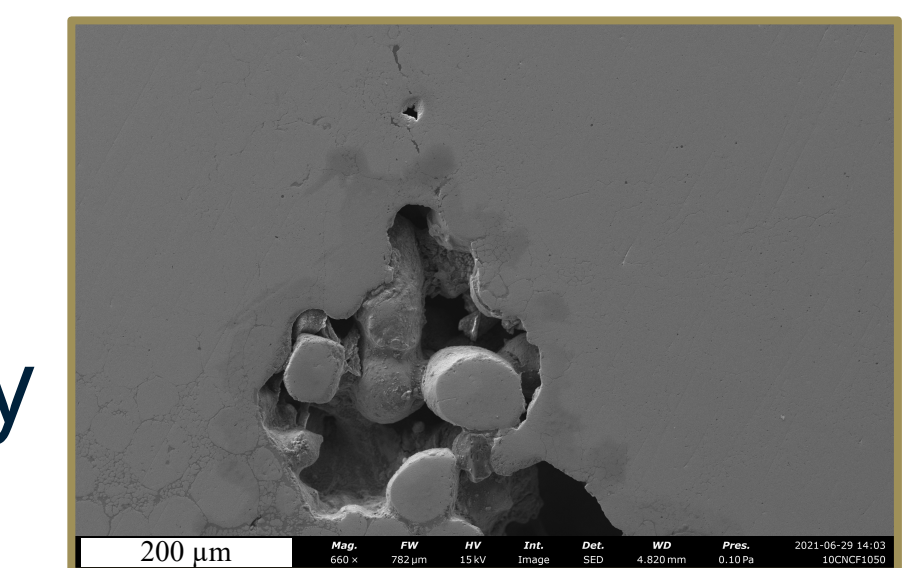
- Dislocation Cell Structures
  - IN718 displays dislocation cells when additively manufactured
  - Has similar mechanical benefits as small grain size without drawbacks
  - How will these structures respond to heat treatment?
  - Can we design them into other metals such as NiTiHf?

IN718 with dislocation cells

GB

GB

GB

2 µm
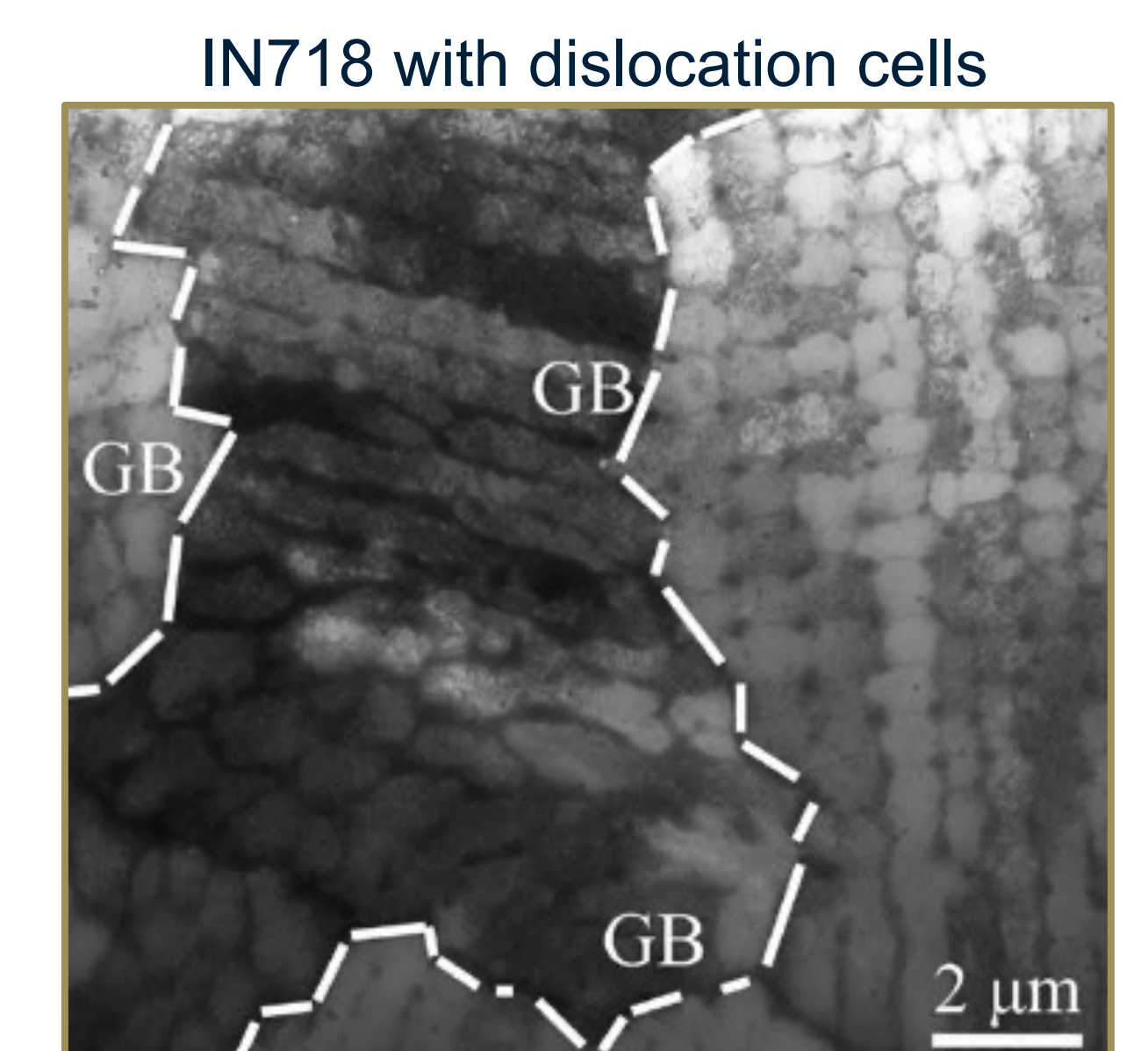
Data Science

Automation of Data Extraction
- Can we analyze large data sets automatically with machine vision and mathematical transforms?
- If so, can we build a larger framework to automate experiments?

Experiment — Generates → Raw Data

Hough Transform

Transformed Data

Yields

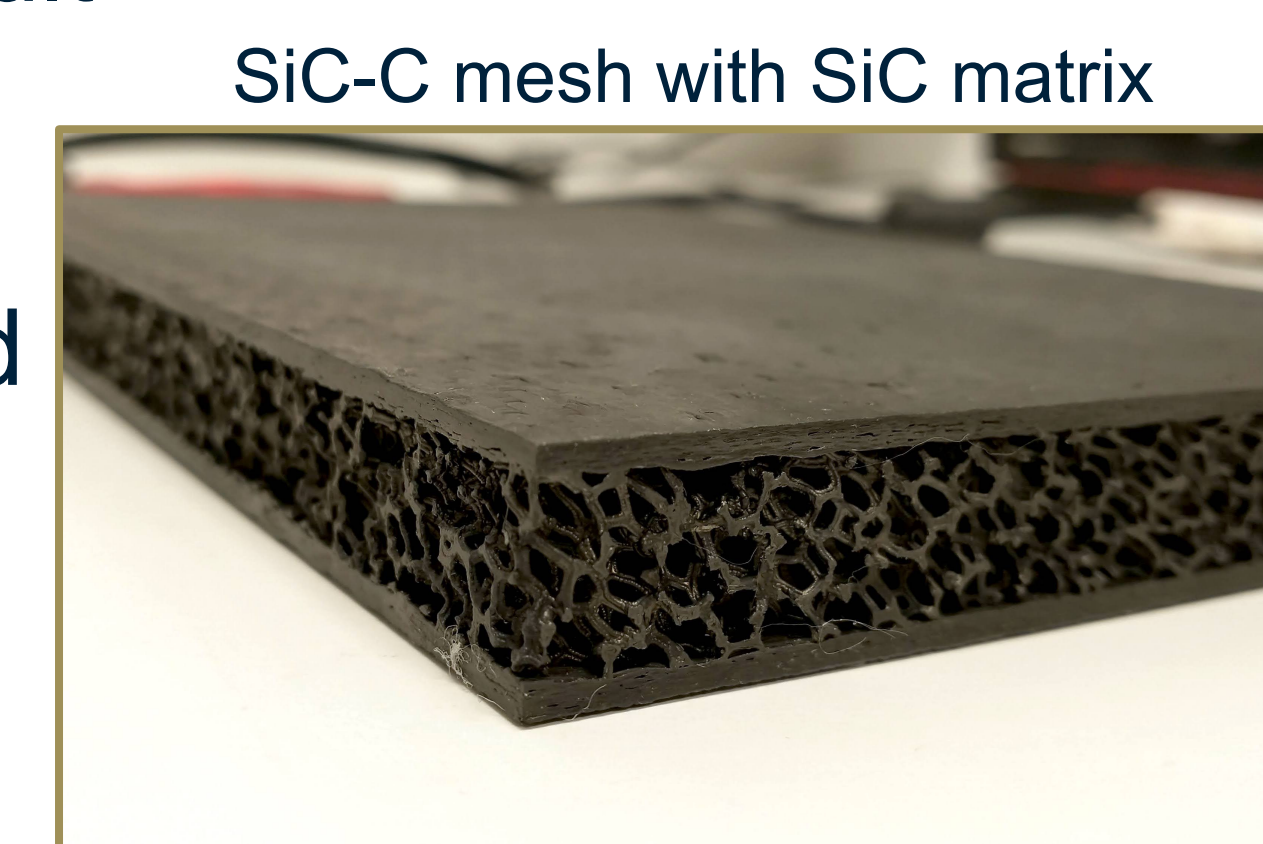Computer Vision Analysis

Inms

Mechanics

6D Yield Hypersurfaces
- Used 6D techniques to improve yield surface calibration
- Developed new criteria to capture greater degrees of anisotropy and asymmetry
- Proposed new standards for experimentally measuring yield behavior

New Criterion vs Old
1%
5%
10%
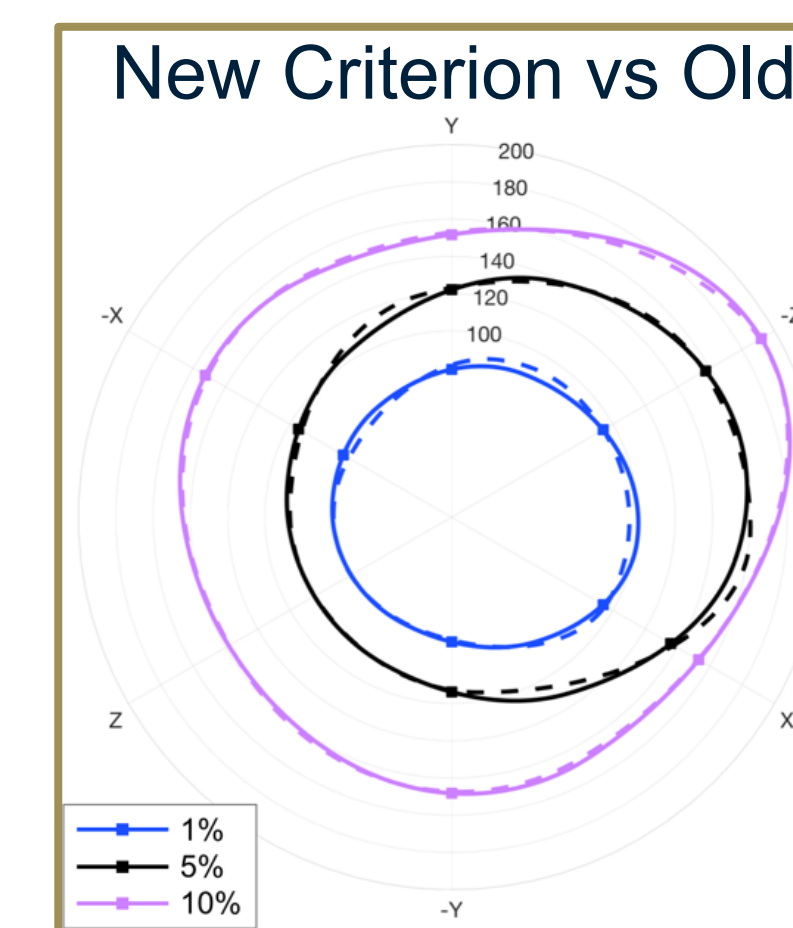
Non-Destructive Evaluation (NDE) of High-Temperature Ceramic Parts
- Parts can be expensive and difficult to produce
- Can we use machine learning to analyze several types of NDE and form a baseline to enable ultrasonic testing for inexpensive and quick part analysis?

SiC-C mesh with SiC matrix