

Consortium for Innovation in Materials and Manufacturing



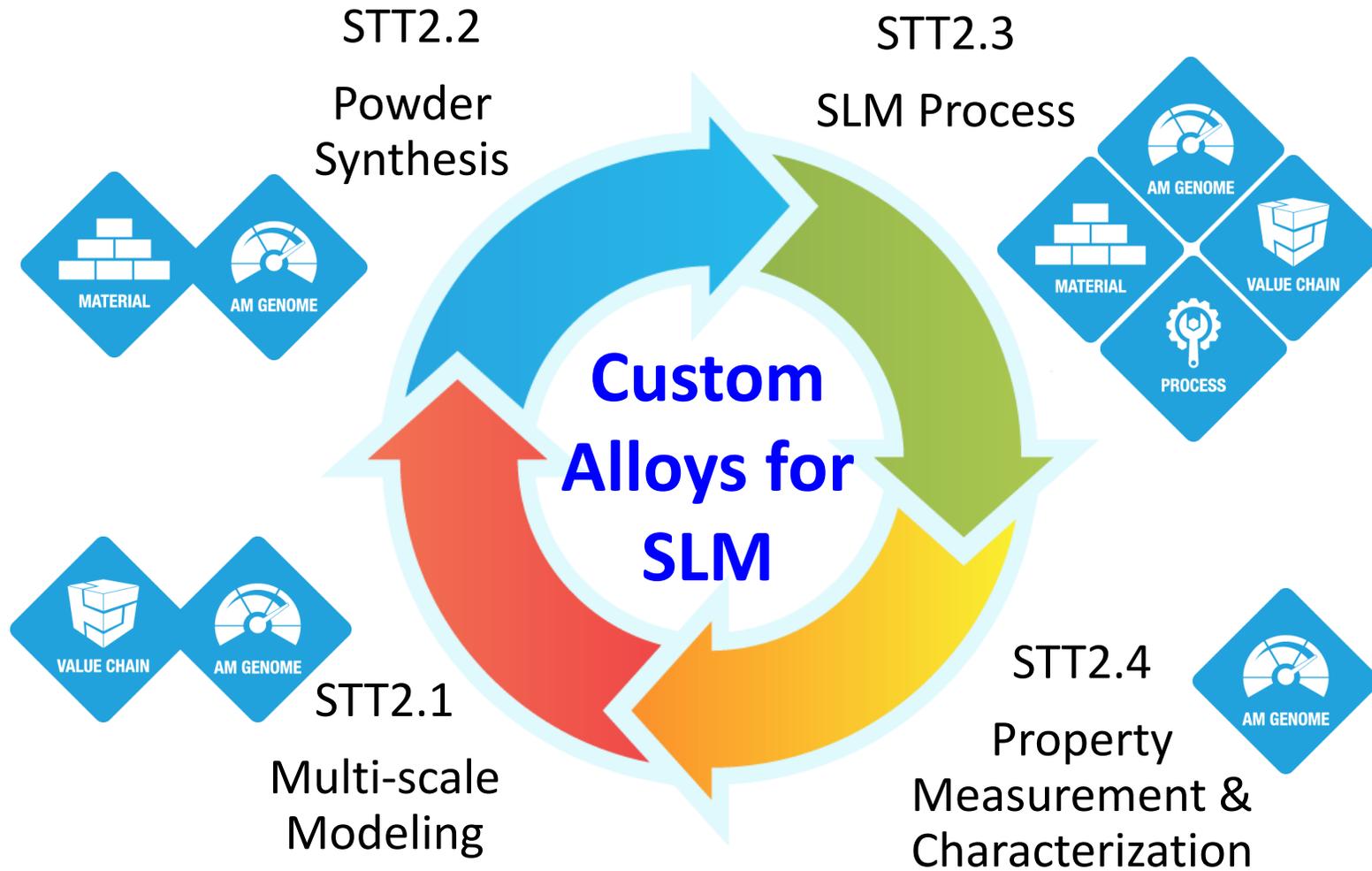
Metal Additive Manufacturing

Selective Laser Melting – Custom Alloys

Arc-Welding – Larger Structures



SST2: Metal Additive Manufacturing



Example: High Entropy Alloys (HEA)

5 or more elements in equal or near equal atomic percent

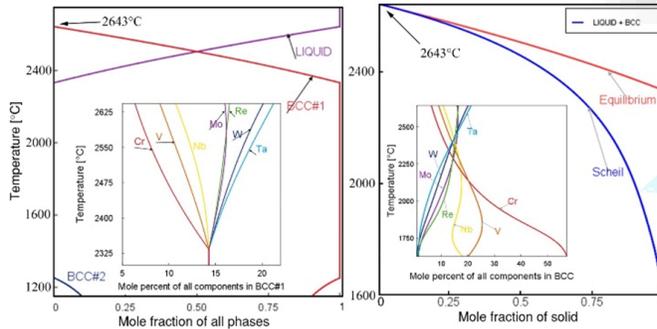
Alloy Making and Qualification



**CrMoNbReTaVW
High Entropy Alloy (HEA)**

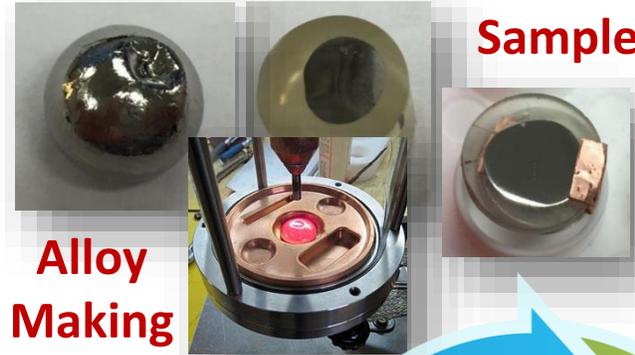
ICME Approach

**Phase Diagram
Calculations
(CALPHAD)**

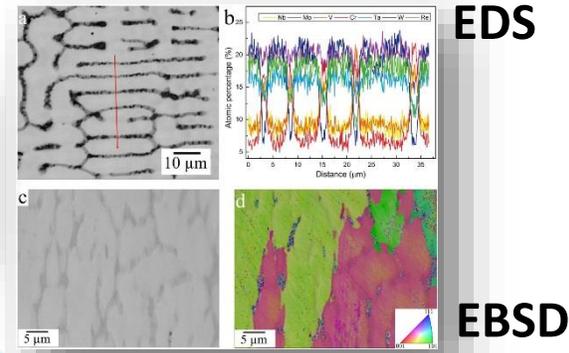


Solidification: Equilibrium

Rapid

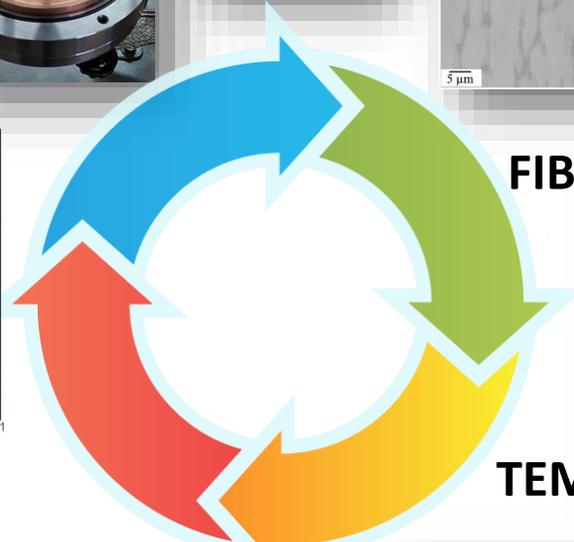


Sample

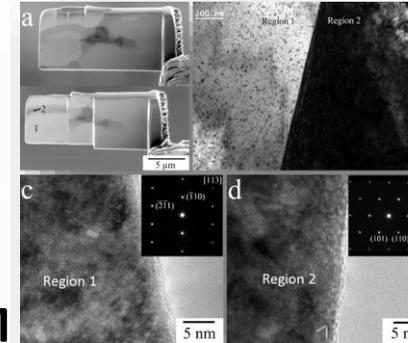


SIF

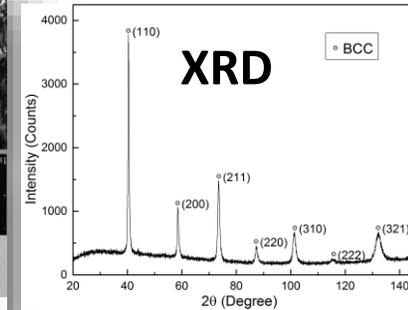
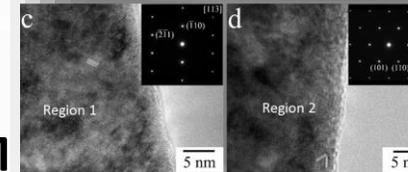
**Composition
Distribution
and Structure**



FIB

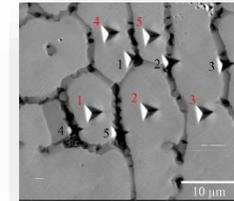
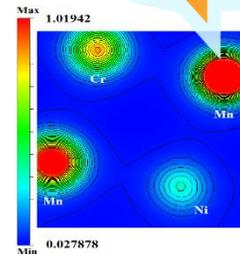


TEM



**HPC,
Loni**

**Simulations for Alloy Design (DFT, MD)
Electronic Structure and Mechanical
& Thermo-Physical Properties**



**Site-Selective
Indentation Tests:
Hardness, Modulus**

M²TF



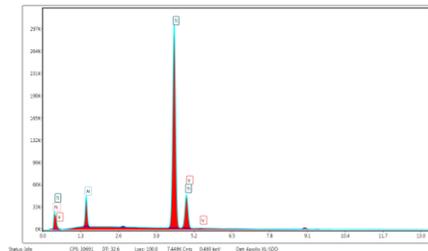
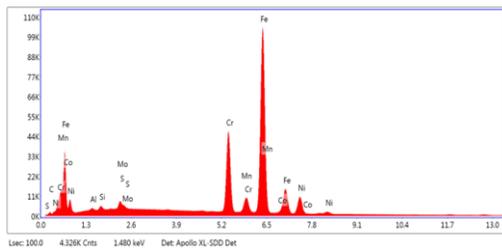
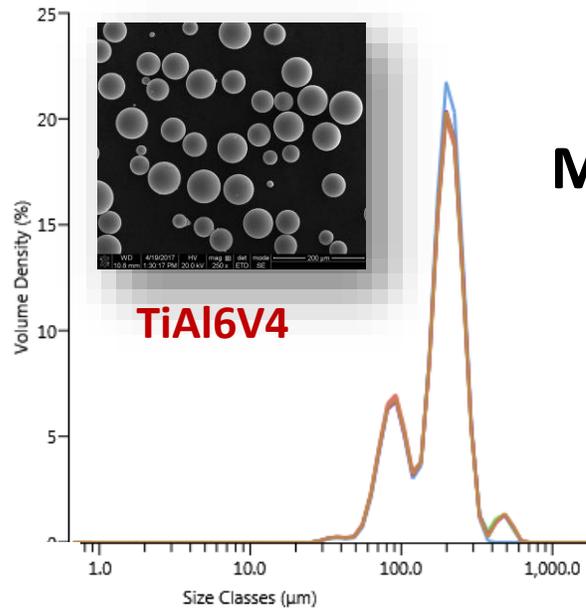
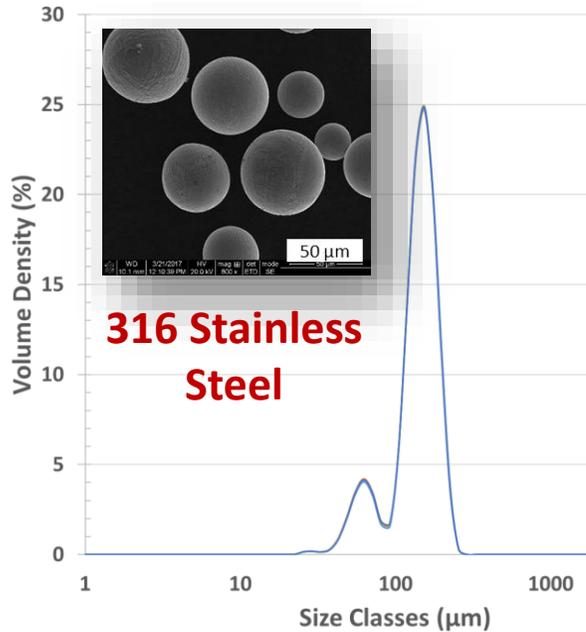
College of
Engineering
Department of
Mechanical & Industrial Engineering

**Groups: Guo, Meng, Sprunger (LSU); Yang (SU);
Mainardi, Ramachandran (LATEch); Derosa (GSU)**

Metal Powder Synthesis for Additive Manufacturing



Powder Composition and Size Characterization



Powder Batch



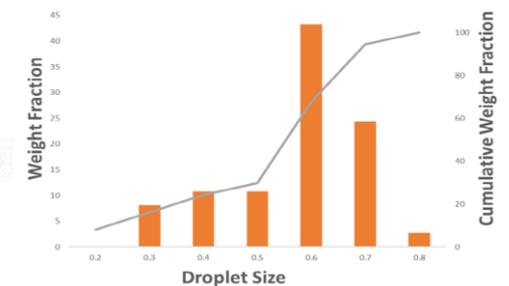
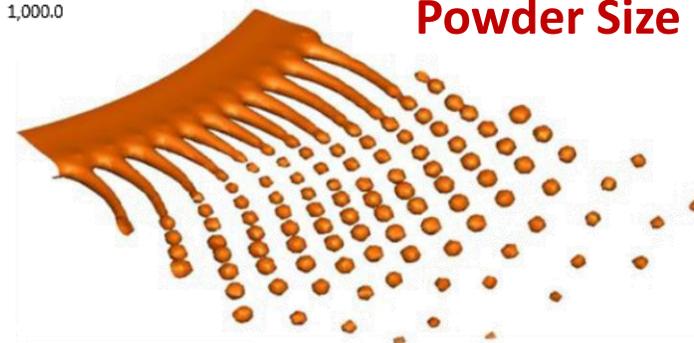
Metal Powder Synthesis

Alloy Stock



Spinning Electrode Melt Simulations

Powder Size Distribution Prediction



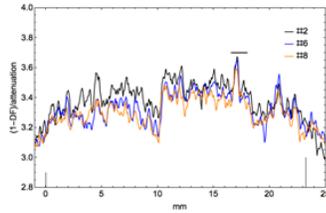
SLM Process Studies for Alloy Powders



CAMD

Diagnostics Coupled To Mechanical Testing

X-Ray and Neutron Scattering



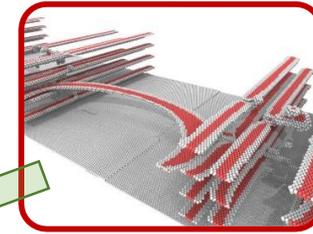
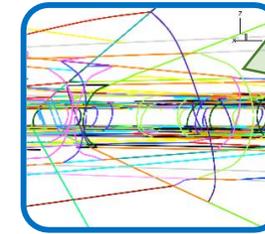
Materials Behavior & Structure



M²TF



Dislocation Dynamics



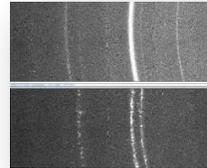
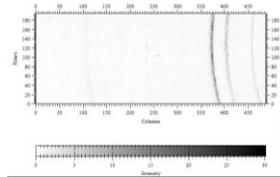
MD Simulation

Life-time Prediction

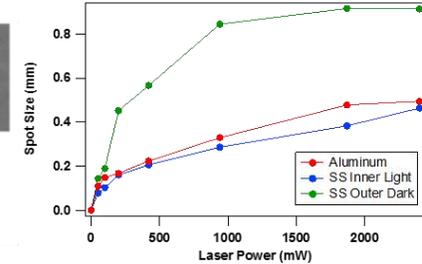
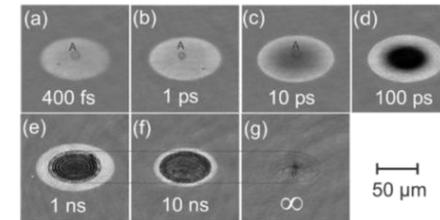
HPC, Loni

In-situ synchrotron XRD of SLM process

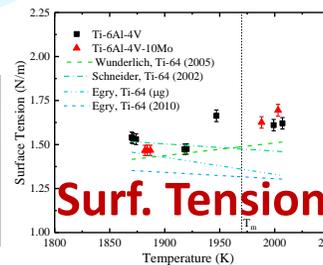
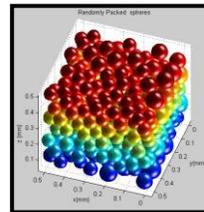
Alloy Phase Evolution During SLM



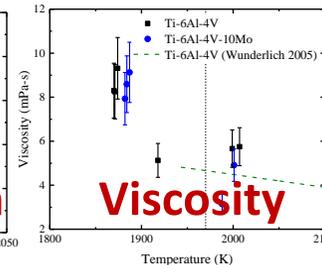
Laser-Material Interaction Experiment



Laser-Powder-Bed Interaction Simulation



Surf. Tension



Viscosity

NASA Collaboration NASA MSFC

ESL Melt Property Measurement



College of Engineering
Department of Mechanical & Industrial Engineering

Groups: Guo, Meng, Sprunger, Shao, Haber, Butler (LSU); Raush (ULL); Genov (LATech)

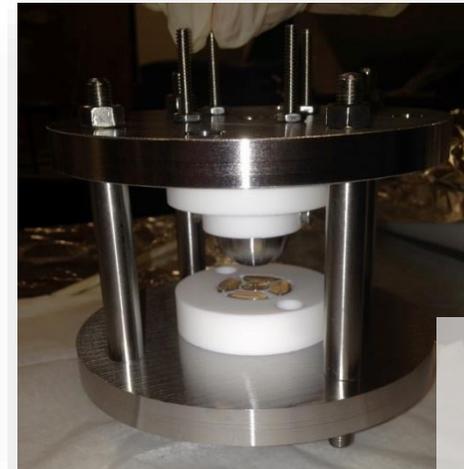
Electrostatic Levitation (ESL) for Metal/Alloy Melt Property Measurement



In collaboration with NASA
Marshall Space Flight Center



J. Raush working with NASA MSFC ESL team



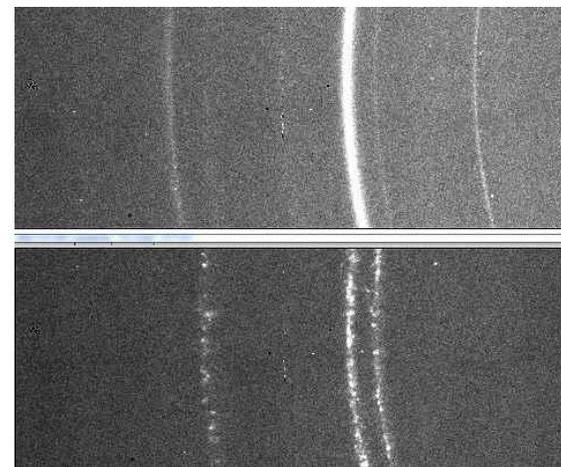
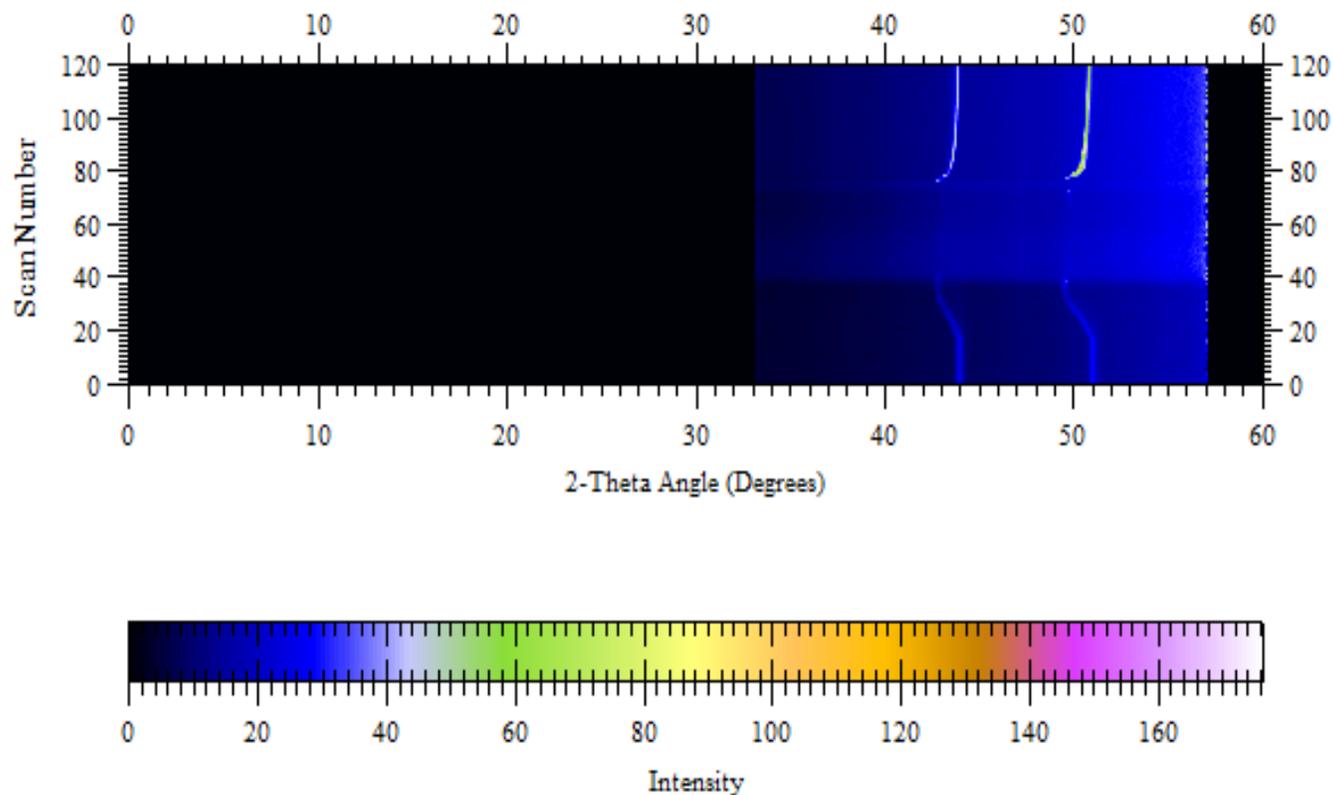
ESL System



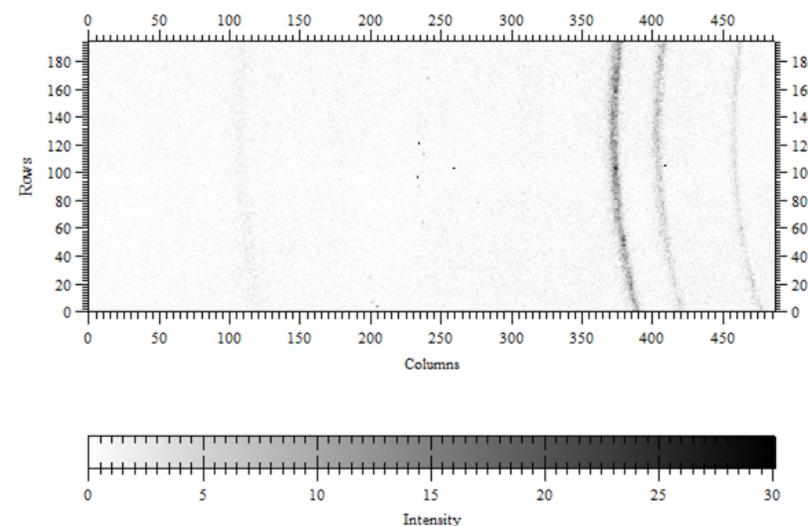
College of
Engineering
Department of
Mechanical & Industrial Engineering

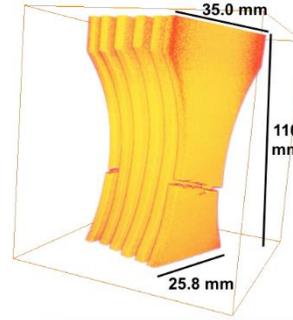
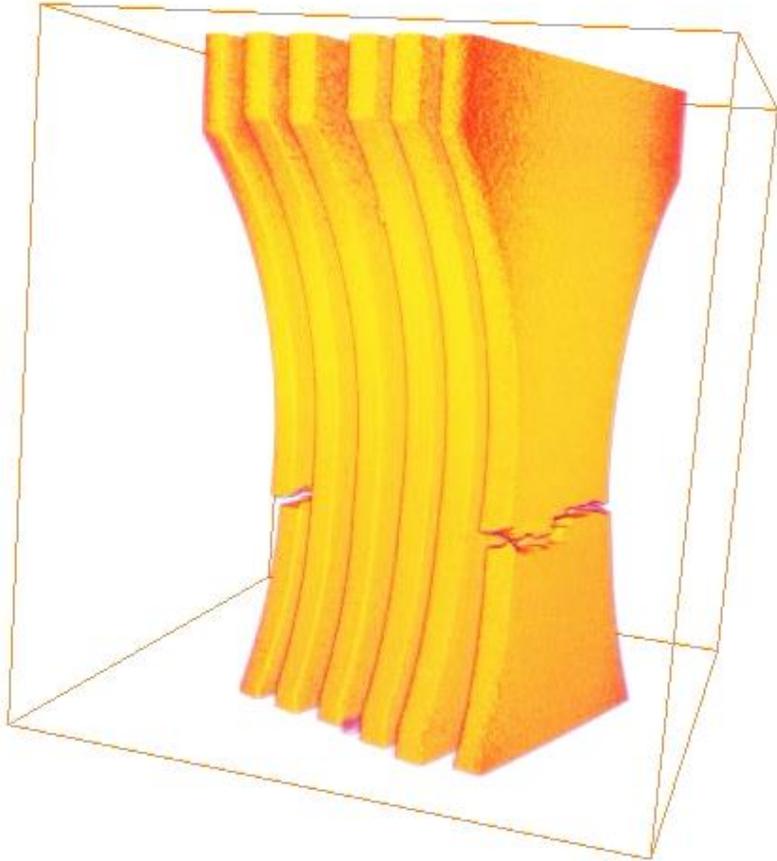
Faculty: Johnathan Raush (ULL), Wenjin Meng,
Shengmin Guo, Phil Sprunger

In-situ study of high entropy alloy phase evolution under laser heating using synchrotron XRD

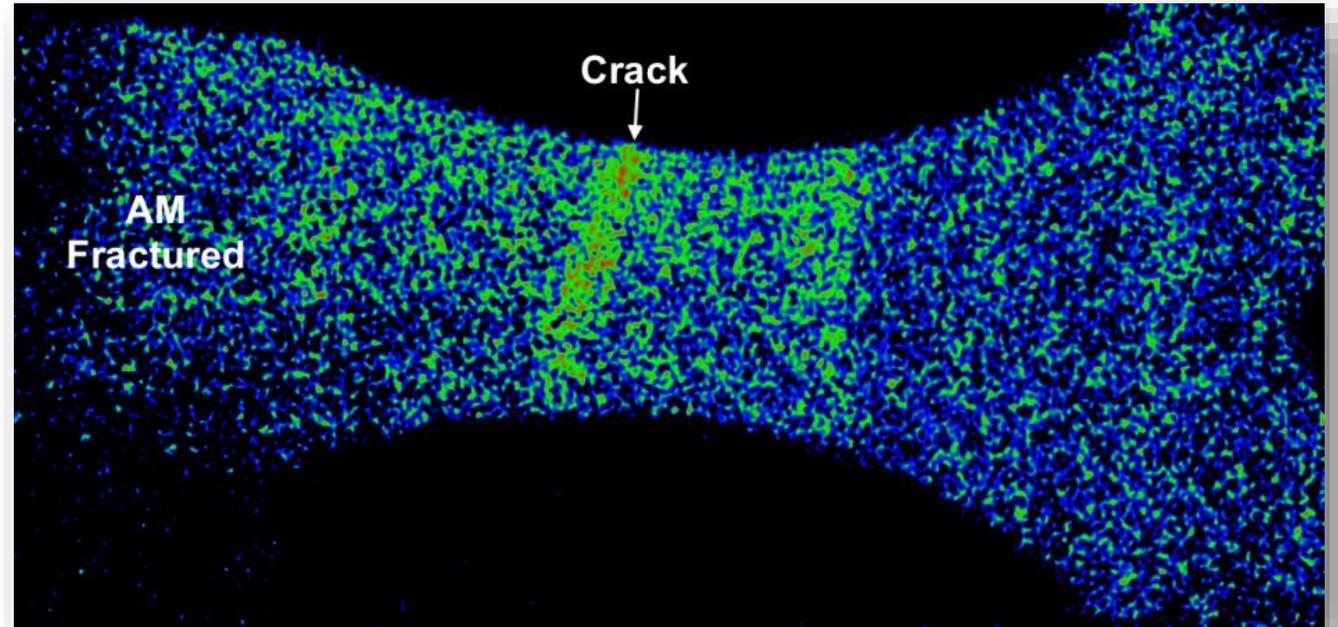


**LSU
CAMD**





Neutron Interferometry Detection of Early Crack Formation in Fatigued Additively Manufactured SS316



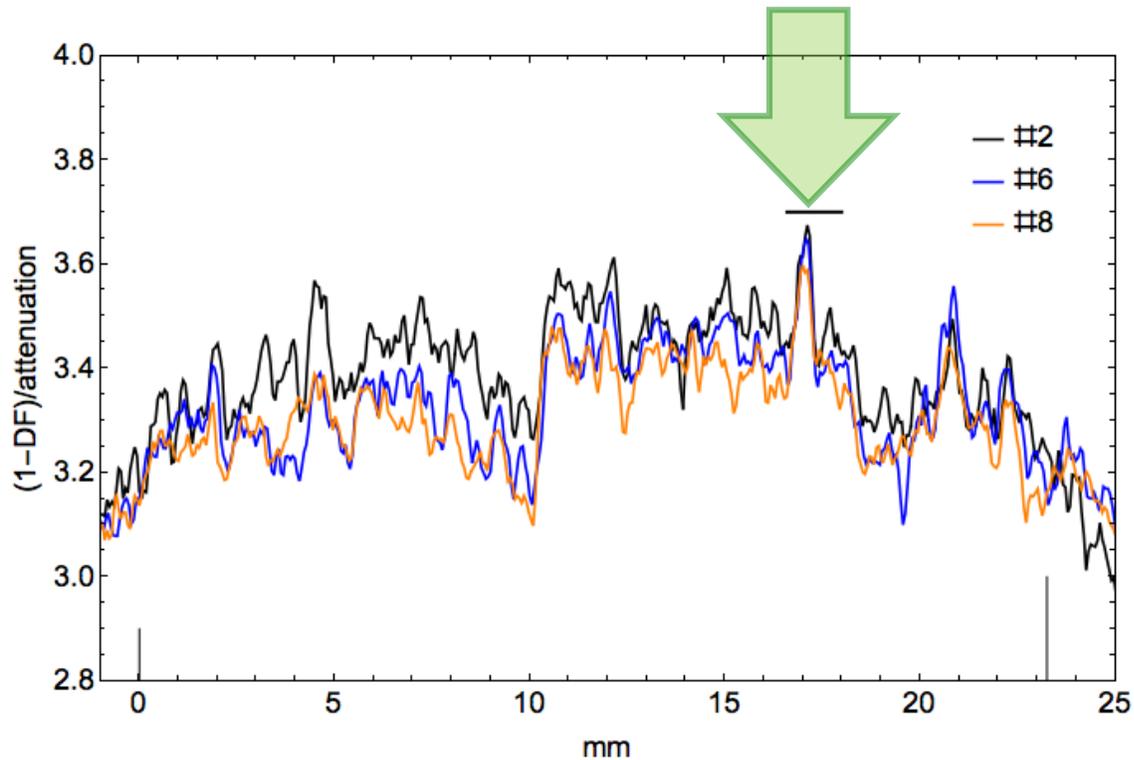
Collaboration with **NIST** and **Helmholtz Zentrum Berlin für Materialien und Energie (HZB)**

Butler, Khonsari and Guo Groups

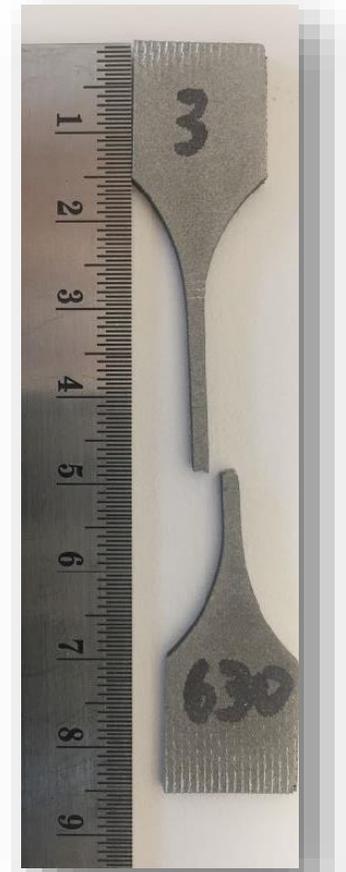
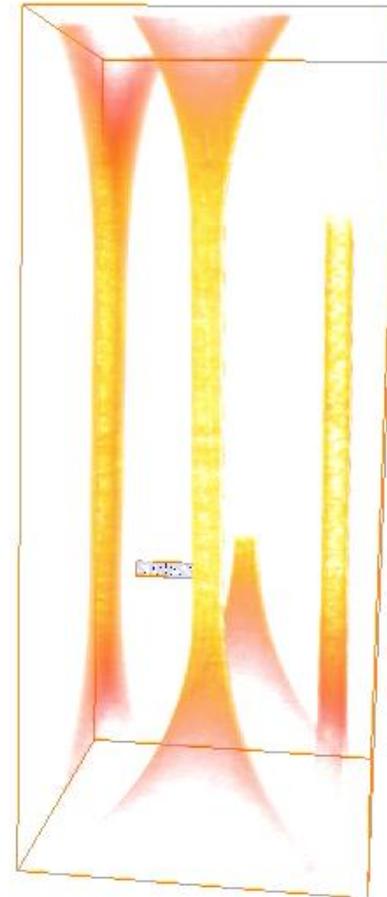
SLM Process Sample Mechanical Test With Neutron Scattering Diagnostics

Neutron Scattering Diagnostics Coupled To Mechanical Testing

Normalized dark-field in tomography on half-life sample runs has feature corresponding to location of eventual failure



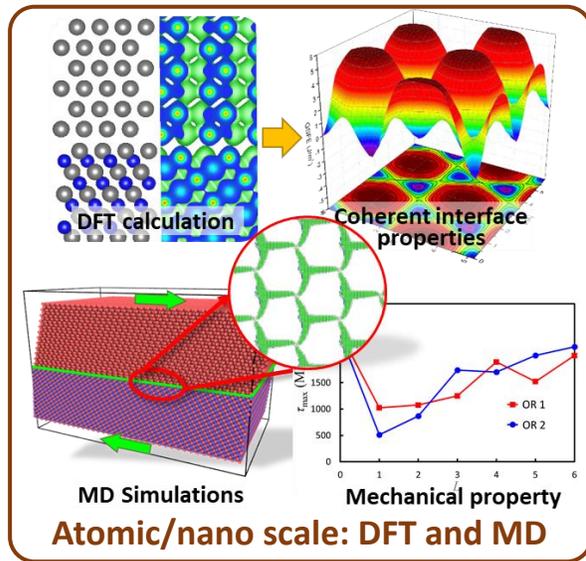
Materials Behavior & Structure



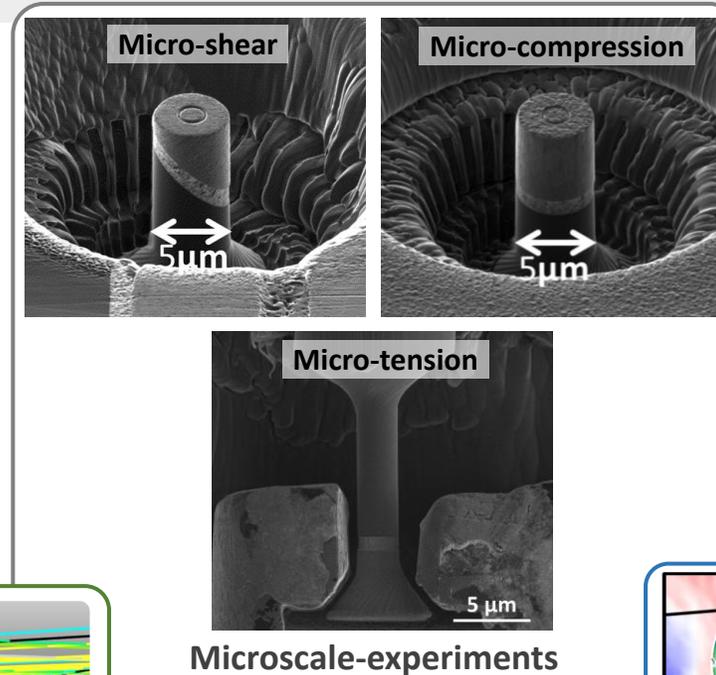
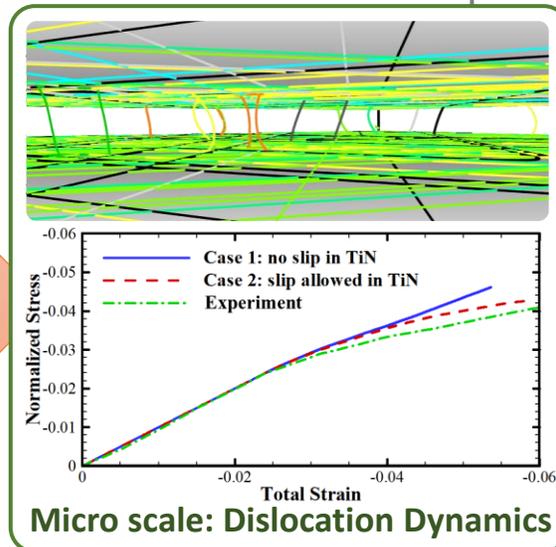
Integrated Multiscale Studies

An integrated multiscale experimentation and simulation approach to evaluate and predict mechanical properties of additive manufactured materials

Multiscale Simulation Cascade



Information passing



Experiment

Validation

Information passing

