

AM Product Development and Future Research Opportunities



PRESENTED BY

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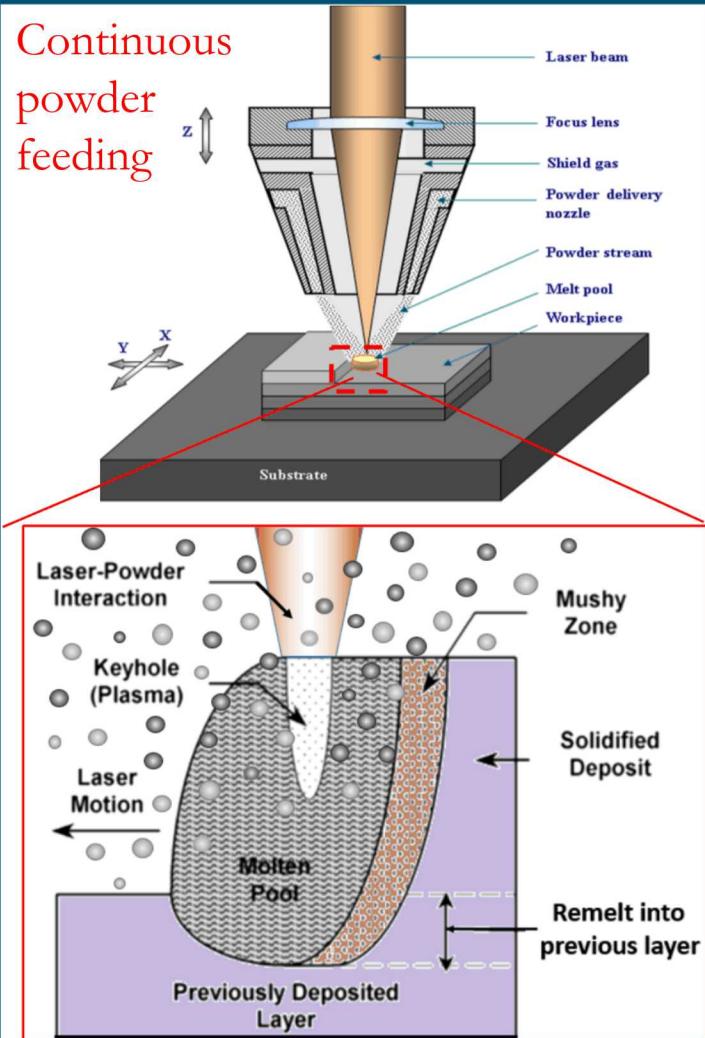
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Content

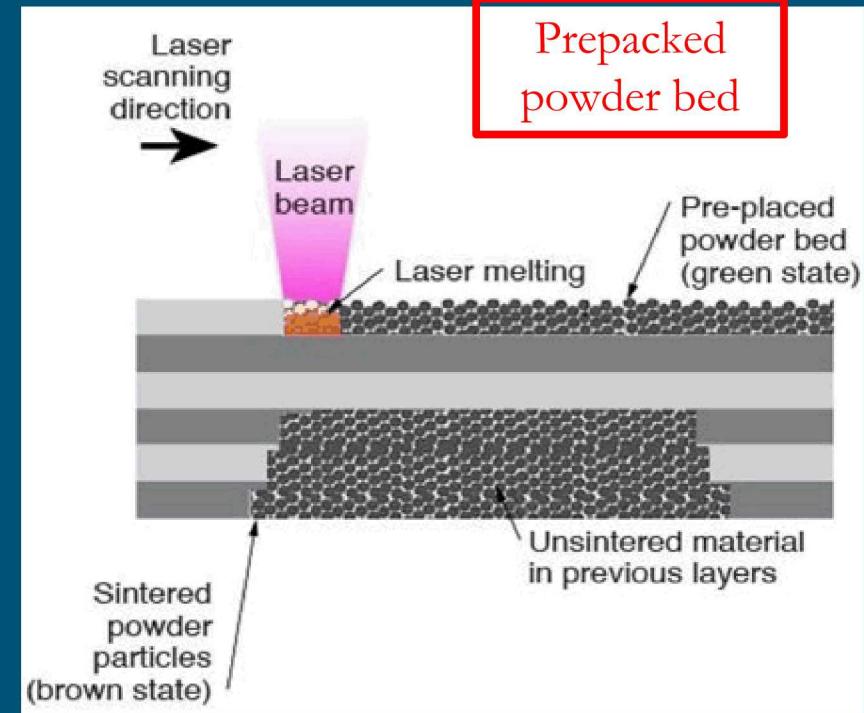
- Baseline Technologies
- Qualification Roadmap
- S&T Maturation Efforts
- Component prototyping
- Future Research Opportunities

Baseline Technologies

3-D LENS



(3-D EPBF) 3-D LPBF

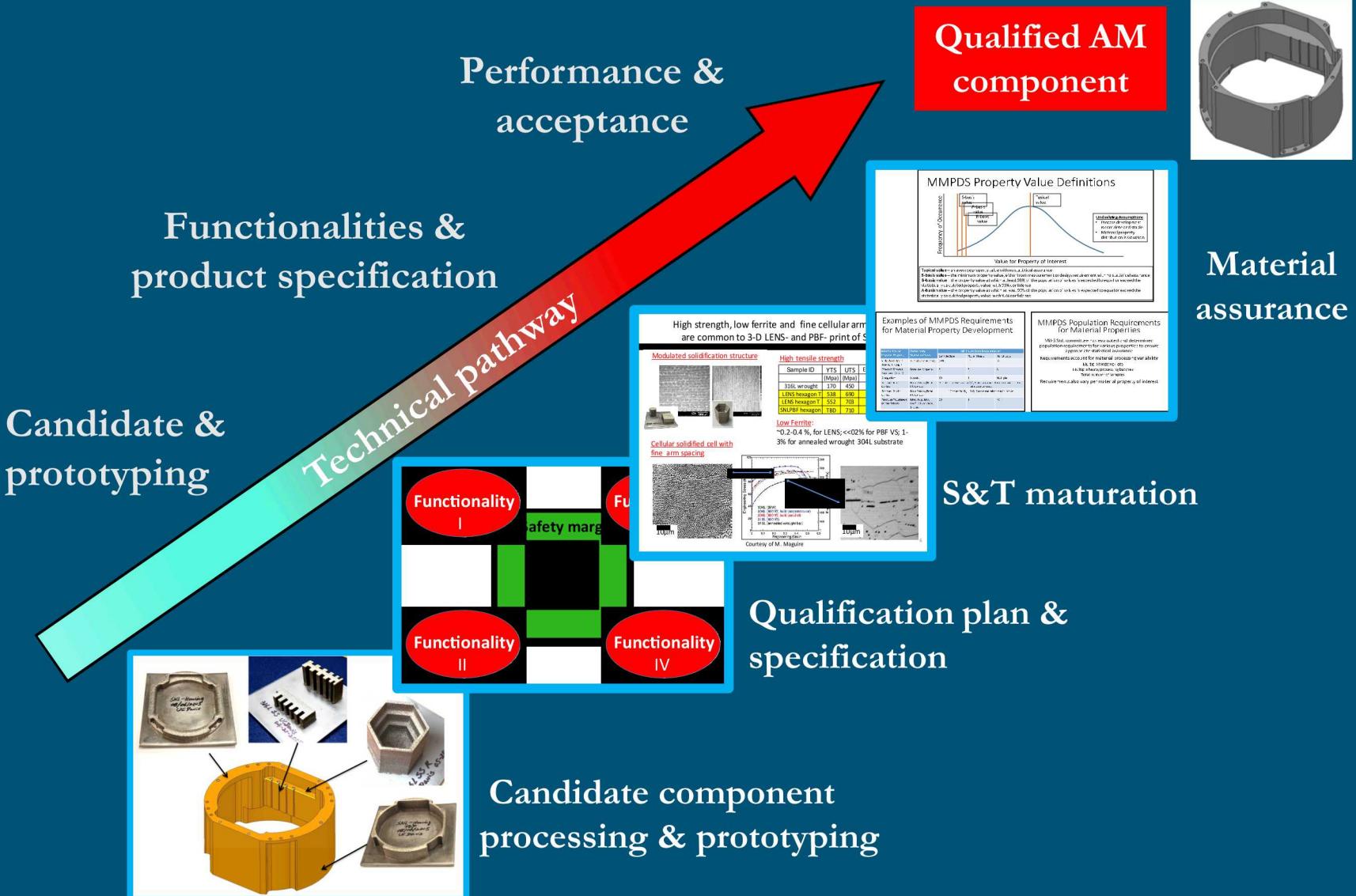


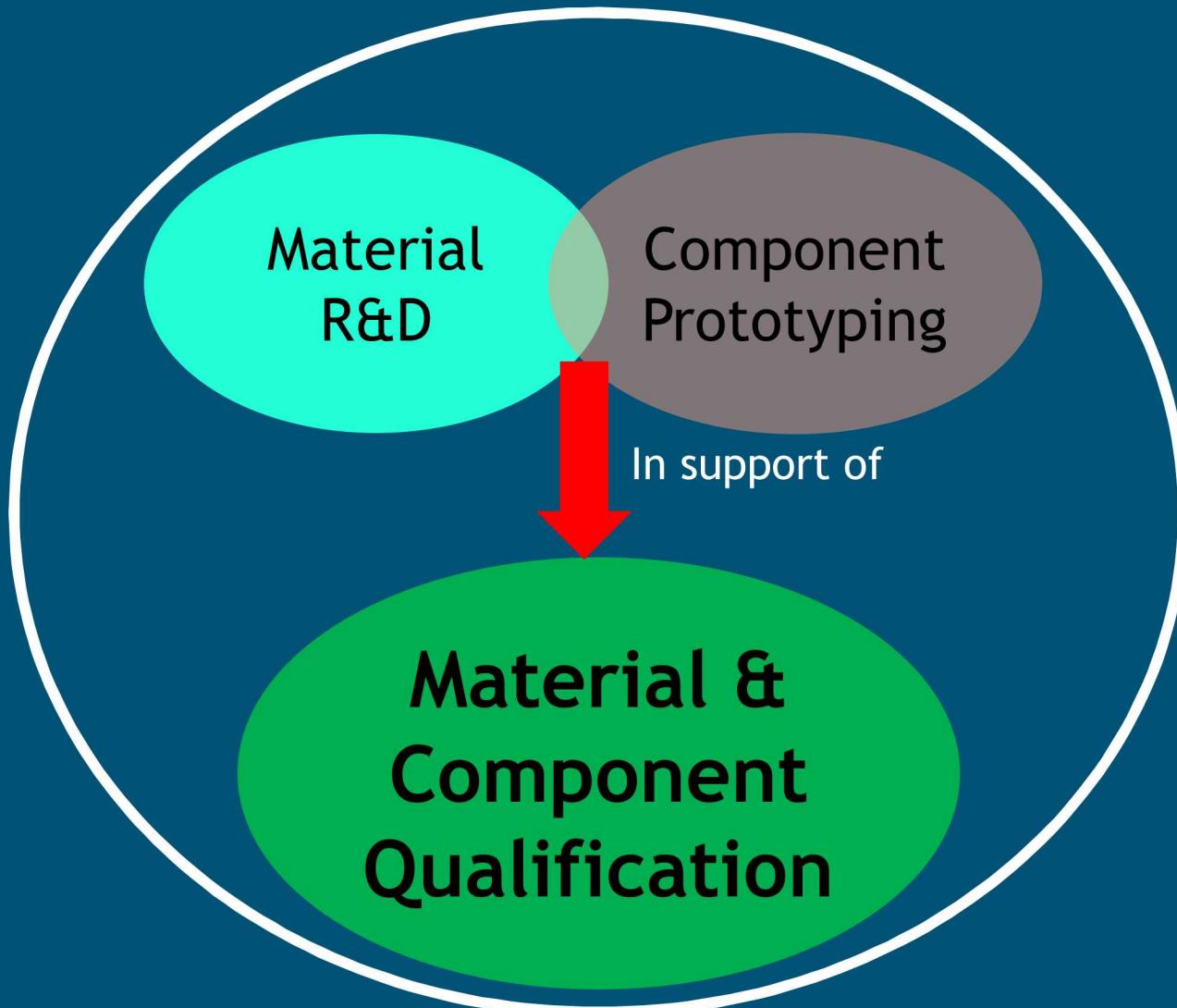
Common printing steps

- *Powder melting*
- *Molten metal fusion*
- *Molten metal solidification*

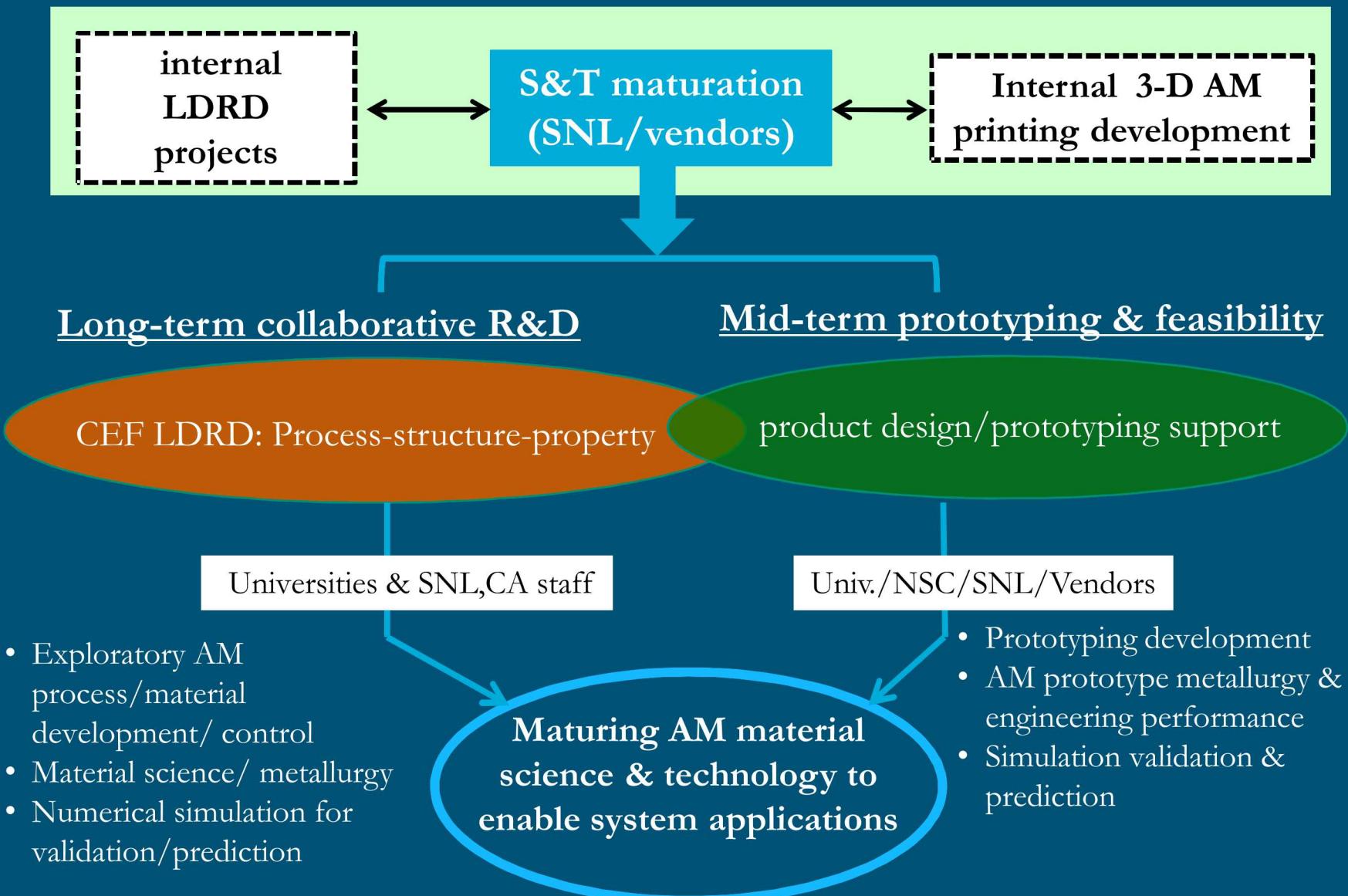
Accompanies by
metallurgical
reaction

Metal AM Component Qualification Roadmap





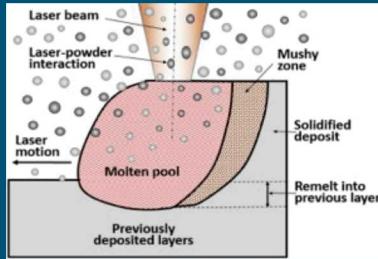
Existing SNL,CA programs and potential UC collaboration



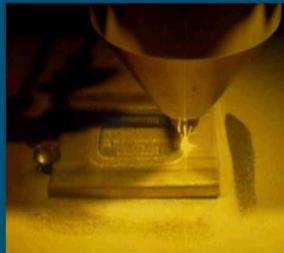
S&T Maturation Efforts

Process- & prototyping

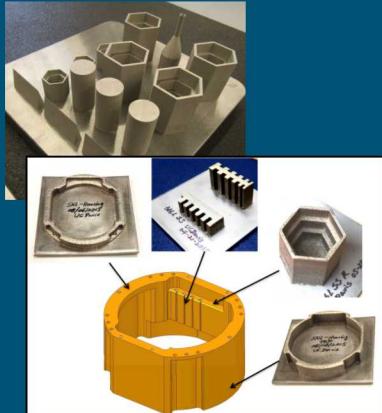
Laser-material interaction



Process optimization

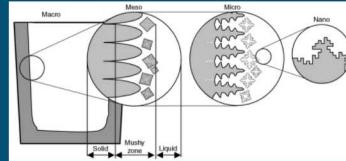


Prototyping feasibility

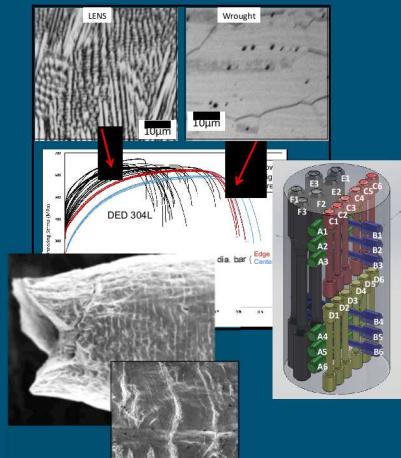


Material science

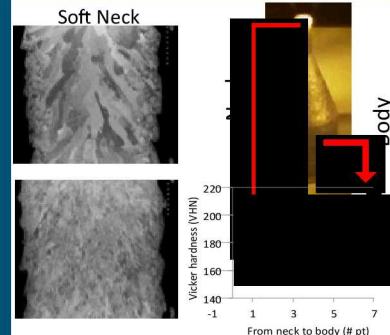
Solidification basis



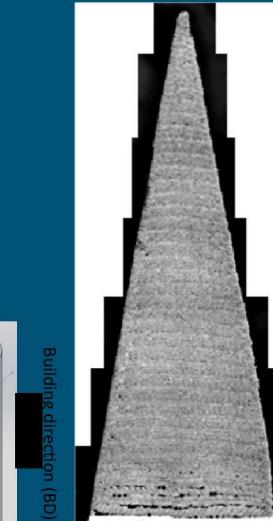
Mechanical behavior



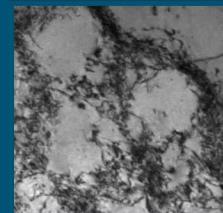
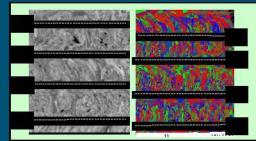
Thermal transport



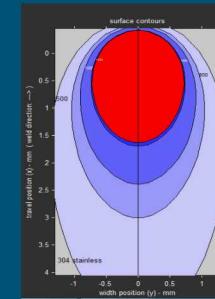
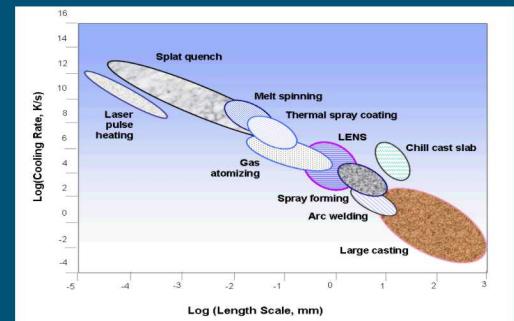
Geometry & structural defect



Microstructure & Anisotropy



Numerical modeling

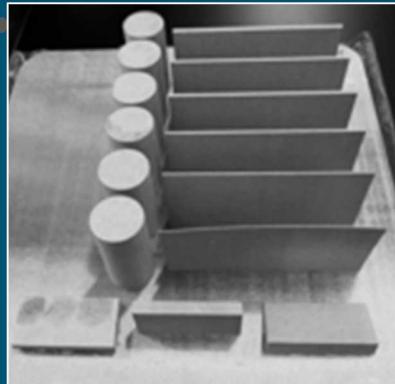


External collaborations

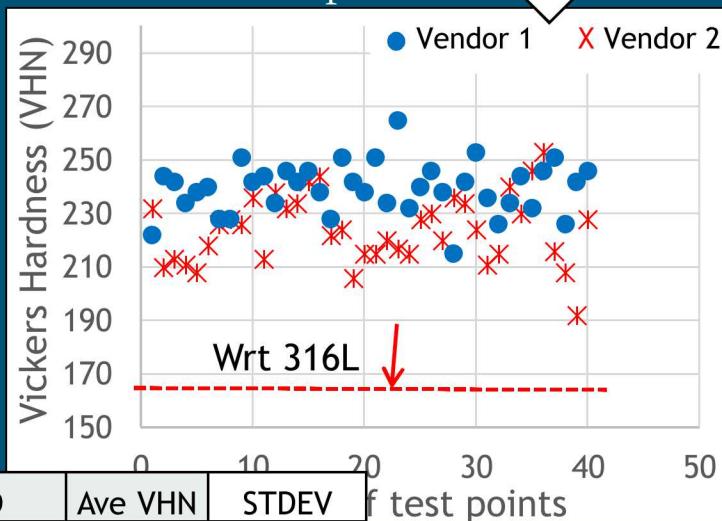
- UC Davis/Irvine: LENS Prototyping
- UC Berkeley: Microstructure-solidification
- Stanford: Thermal transport & process control & modeling(TBD)
- NSC: AM prototyping
- PolarOnyx: Femtosecond AM printing,

S&T Maturation Efforts

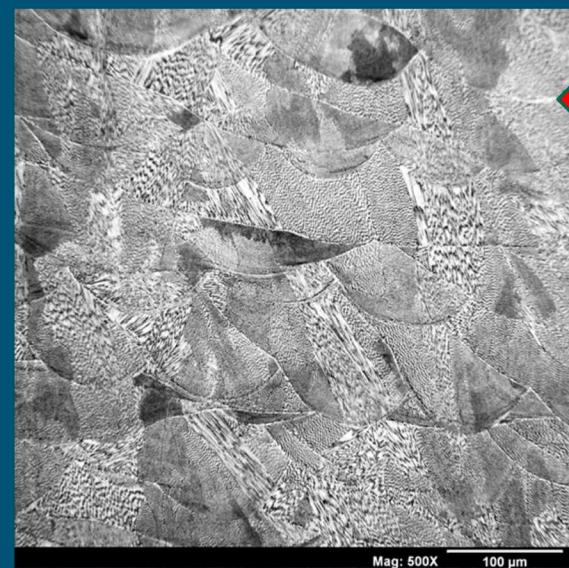
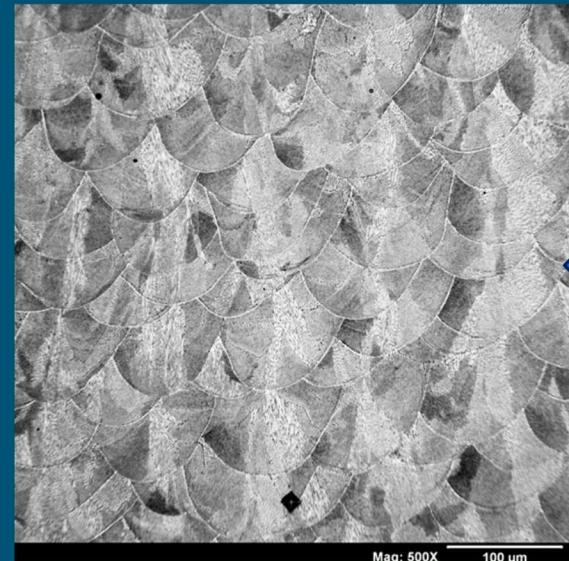
3-D LPBF 316L product possess high & uniform strength but is printer hardware dependent



Vickers hardness profile



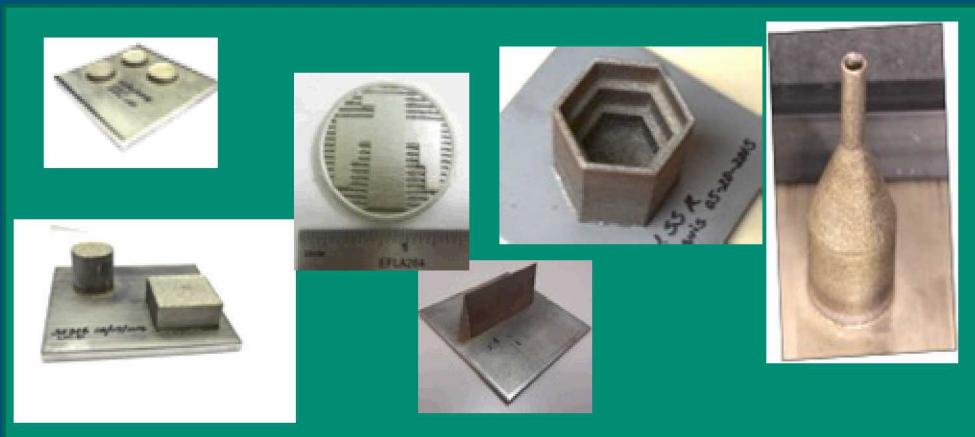
Sample ID	Ave VHN	STDEV
V-2 316L (LPBF)	223	12.8
V-1 316L (LPBF)	239	9.6
316L (wrt ref)	165	<9.0



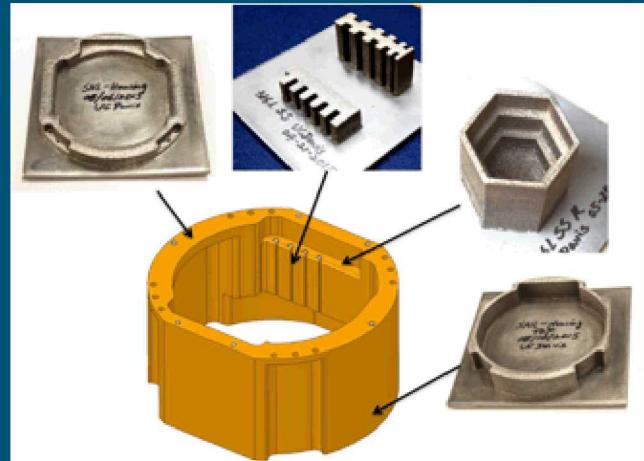
Coarse solidified grains & columnar cells yield softer material

316L LENS- / LPBF- S&T maturation and prototyping

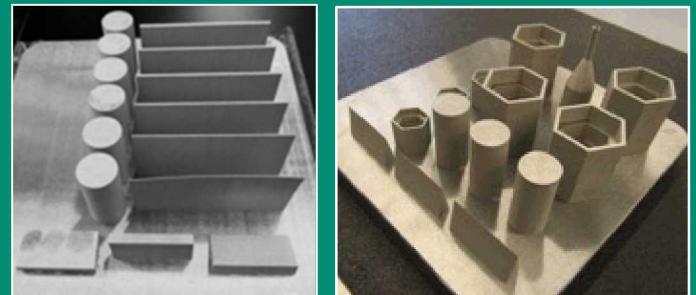
3-D LENS prototypes



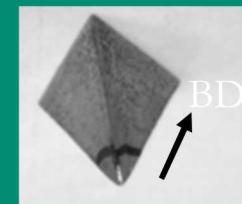
A&E housing prototype



3-D LPBF prototypes



Novel LPBF pyramid (Femtosecond)



High angle overhang,
PolarOnyx

Material Assurance

↓ *Integrate*

AM processing
(Development/control/
optimization)

↔
↓
Modeling and simulation
(Predictive capabilities)

Materials testing and
characterization
(Structure & properties)

↓ *Discover*

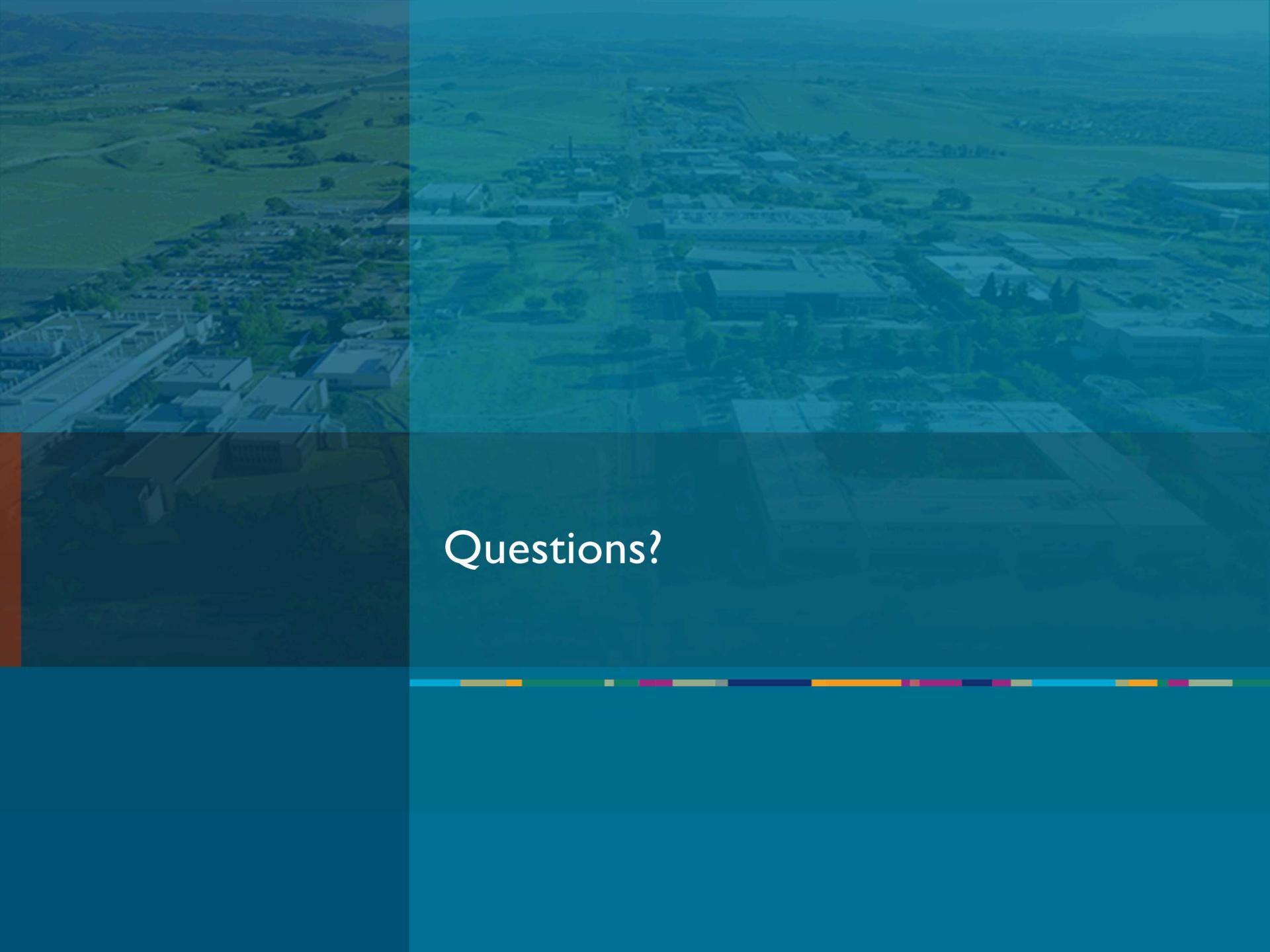
- Process-structure-property- relationships
- Geometry/precision & limitation/manufacturing constraints
- Materials properties control and defect mitigation

↓ *Enable*

Science-based AM system engineering

Future Research Opportunities

- Anisotropic topology optimizing software that accounts for print strategy or mass/volume optimization
- Develop software package to convert STL files to parametric CAD files
- Development of high z material AM components
- Material properties characterization (fatigue, environmental corrosion, tensile hardness, etc.)
- Develop inspection methods for unique topology optimized parts
- Develop an understanding of how voids and imperfections affect topology optimized parts.



Questions?

