

POWDER BED FUSION INTERRUPTION STUDY

INTRODUCTION

Laser Powder Bed Fusion (PBF) is an additive manufacturing method used to produce lightweight metal parts in the aerospace industry.

Occasionally, interruptions happen mid-build. When this happens, the current practice is to dispose of the build due to the lack of knowledge of the effect on build quality. **This is a massive waste of time, money, and material.**

This project aims to characterize the effect of interruptions on builds through their mechanical and microstructural properties. This will act as a stepping stone towards more robust standards of acceptability for interrupted builds and offer operators and industries more efficient options.

HOW DO INTERRUPTIONS AFFECT BUILD QUALITY IN PBF?

Aaron Tanaka¹, Kenshin Davitt¹,
Danmar Miraflor¹, Bror Ekdahl²,
Victoria Wagner²,
Christoph Thompson²
Sponsored by Boeing
¹ME, ²MSE



CORE FUNCTIONS

- The aim is to design a build which will allow for the determination of interruption effects through mechanical and microstructural testing.
- The design and testing will leverage the procedures and data from a Round Robin study conducted by UW using the same powder, Ti-6Al-4V, and machine, an EOS M290, to achieve comparable results for validation.

DESIGN AND DEVELOPMENT

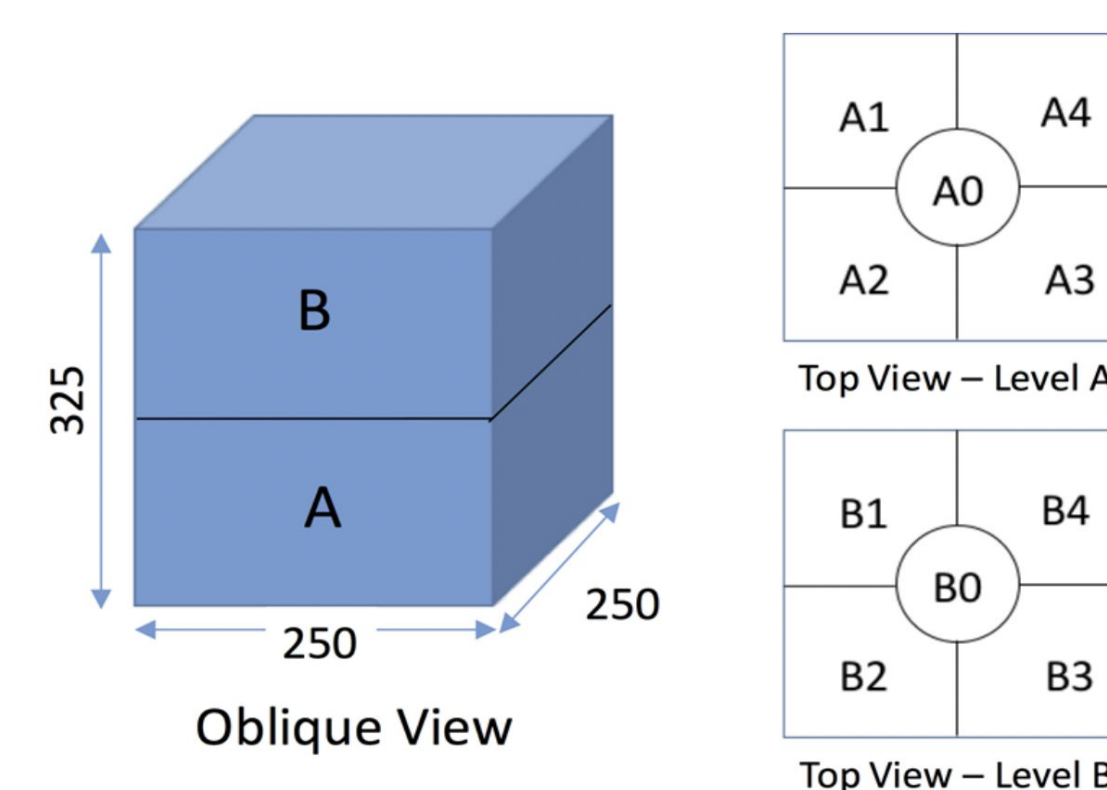


Fig 1. Diagram for build chamber sectioning by region and deck

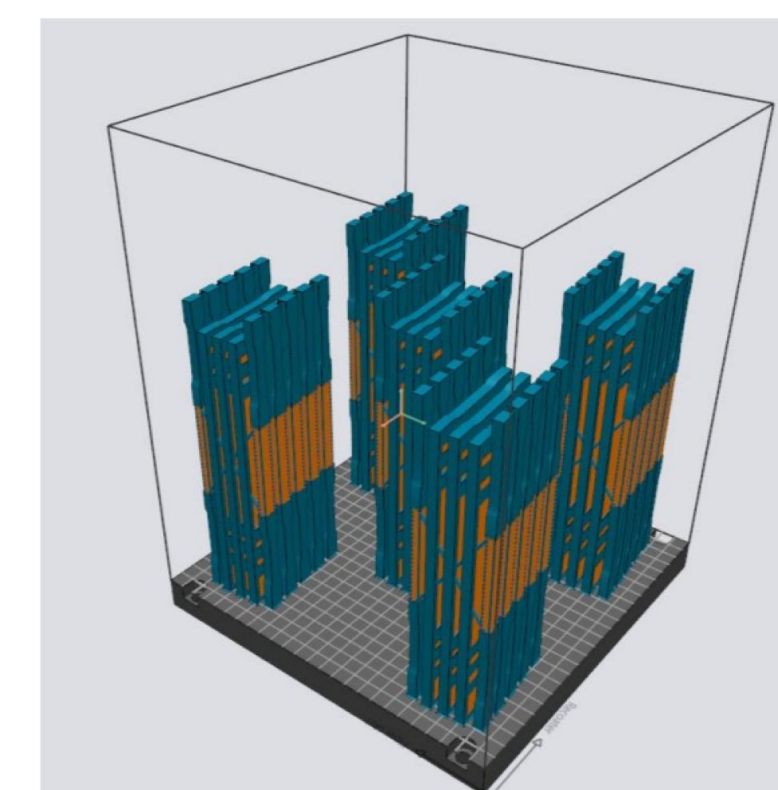


Fig 2. Oblique view of build plate coupon array arrangement

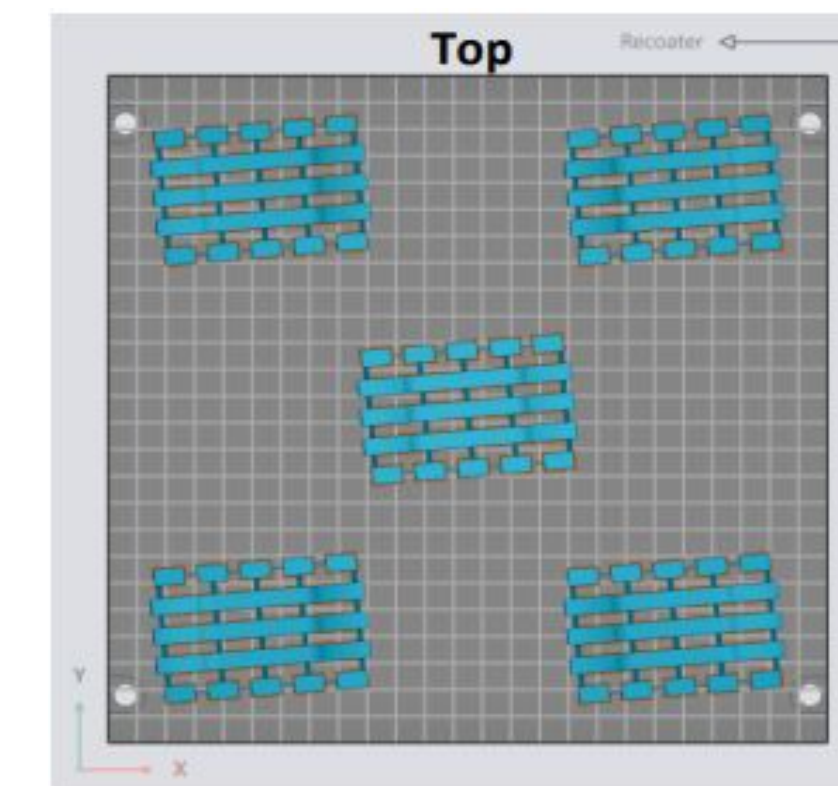


Fig 3. Top view of build plate coupon array arrangement

Prototype/Idea/Diagram

- Utilized coupon array build from UWRR study
- Designed interruption to be an 8-hour pause where gas flow is stopped, and the temperature of the build chamber is allowed to return to ambient.
- Applied the interruption at a layer near the middle of the vertical coupons for each deck

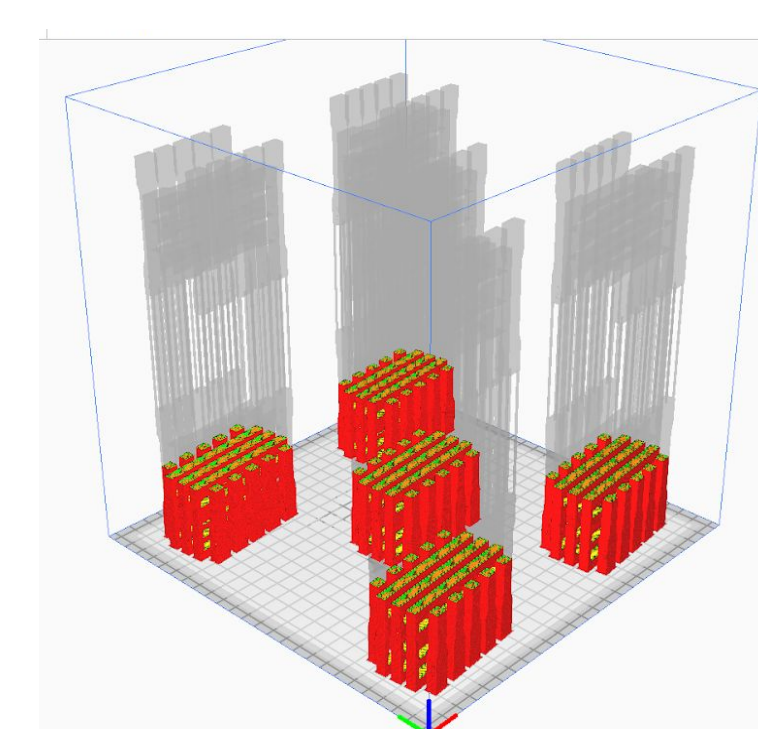
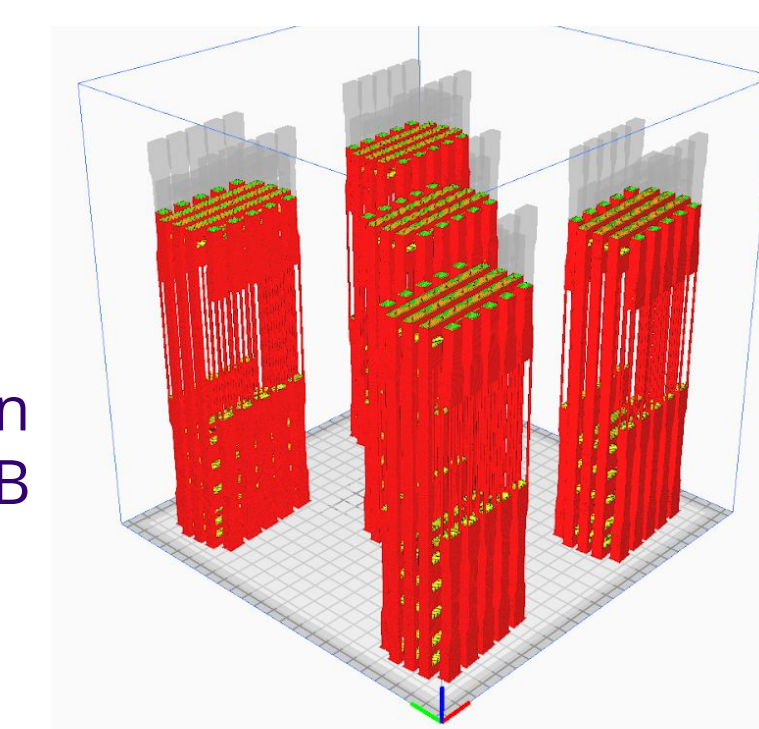


Fig 4. Model of interruption design on Deck A

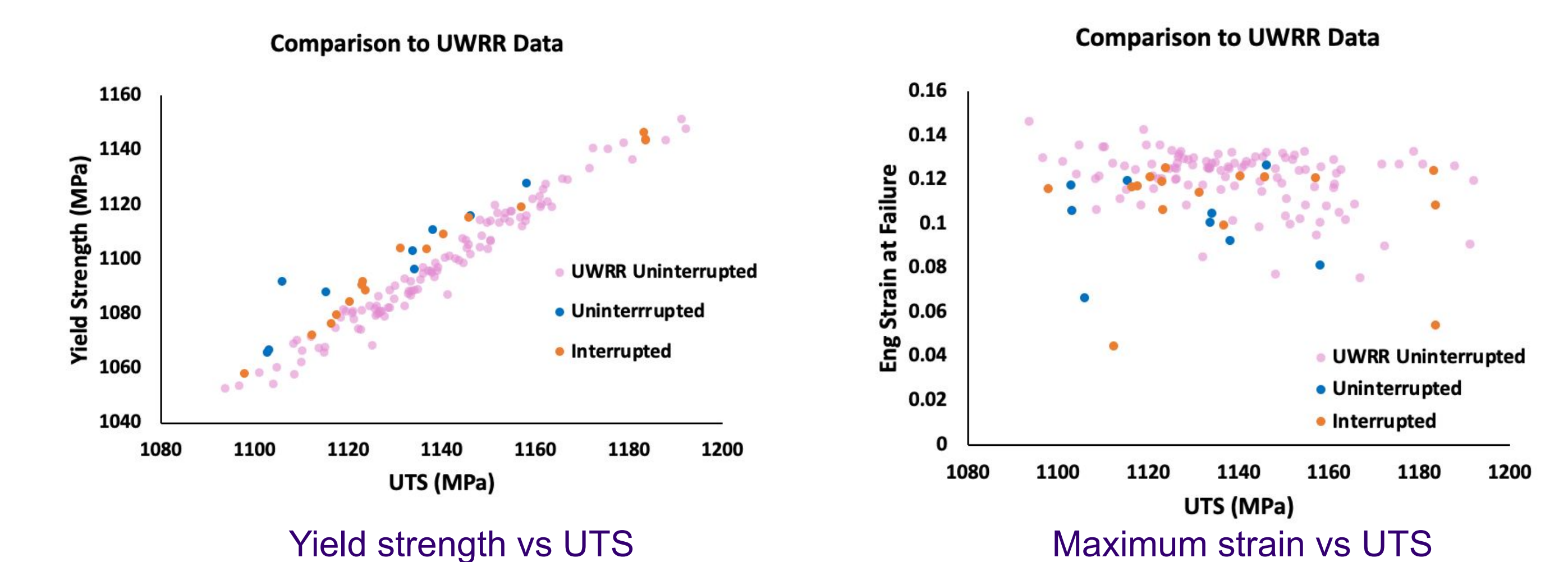
Fig 5. Model of interruption design on Deck B



METHOD

- Two builds were printed, one is the control, and the other is the interruption build.
- Each build is composed of five regions, each containing 95 coupons, for a total of 190 per build.
- Coupons machined using UWRR procedure
- Tensile testing completed using an Instron 5585H
- SEM microstructure analysis
- Fractography using optical microscopy

RESULTS/VALIDATION



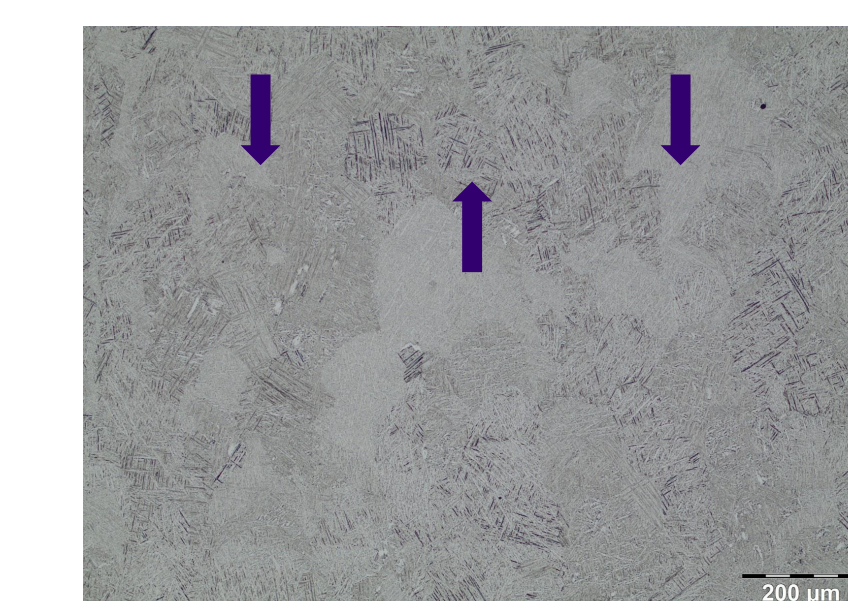
Tensile data supports a theory that a pause interruption **does not** negatively affect the mechanical properties of the material

Tensile Results	Control	Interrupted
	1111 MPa	1102 MPa

Microstructure analysis shows no significant change in microstructure due to the interruption.



Control coupon



Interrupted coupon



Fracture Surface

CONCLUSION & FUTURE WORK

- Strengths of design: Utilizing Round Robin procedure, consistency of data, thorough microscopy tests
- Weaknesses of design: Low number of test samples resulting in weak statistical significance
- Future recommendations include: fatigue studies, variation of interruption type, variation of interruption location
- The data used in this study will act as a stepping stone for future research and certification to enable the acceptance of interrupted parts in the aerospace industry.

Acknowledgements: Dwayne Arola, Stacey Huang, Ramulu Mamidala, Reid Schur, Patrick Buffington, Cory Cunningham

Mechanical Engineering Capstone Exposition: June 2nd 2022, Husky Union Building, University of Washington, Seattle