SAE FD&E Residual Stress Committee Update

Spring 2020

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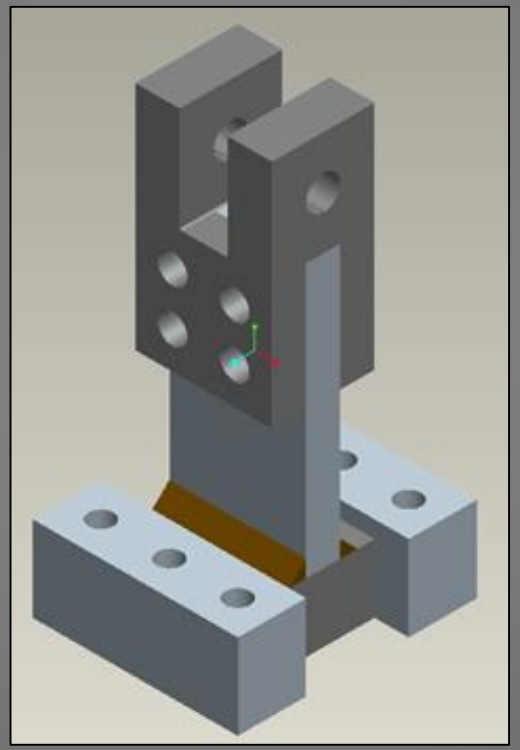
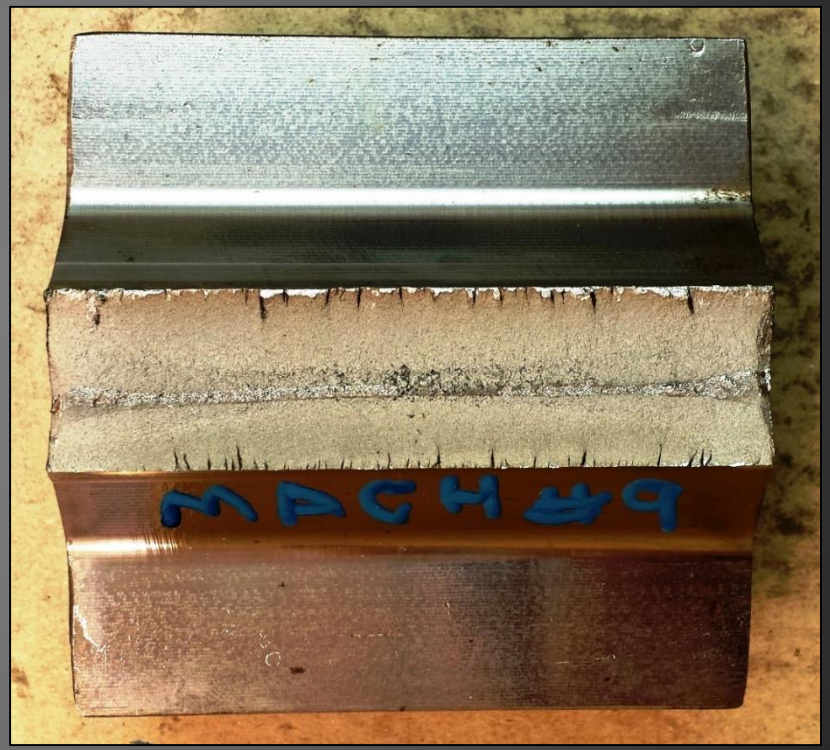
T-Sample Testing (Total Life)

- Predict “Total Life”
- Crack Initiation and Propagation
  - Variable Amplitude
  - Constant Amplitude
- Important Factors
  - Kf
  - Material Properties
  - Stress Field
  - Residual Stress

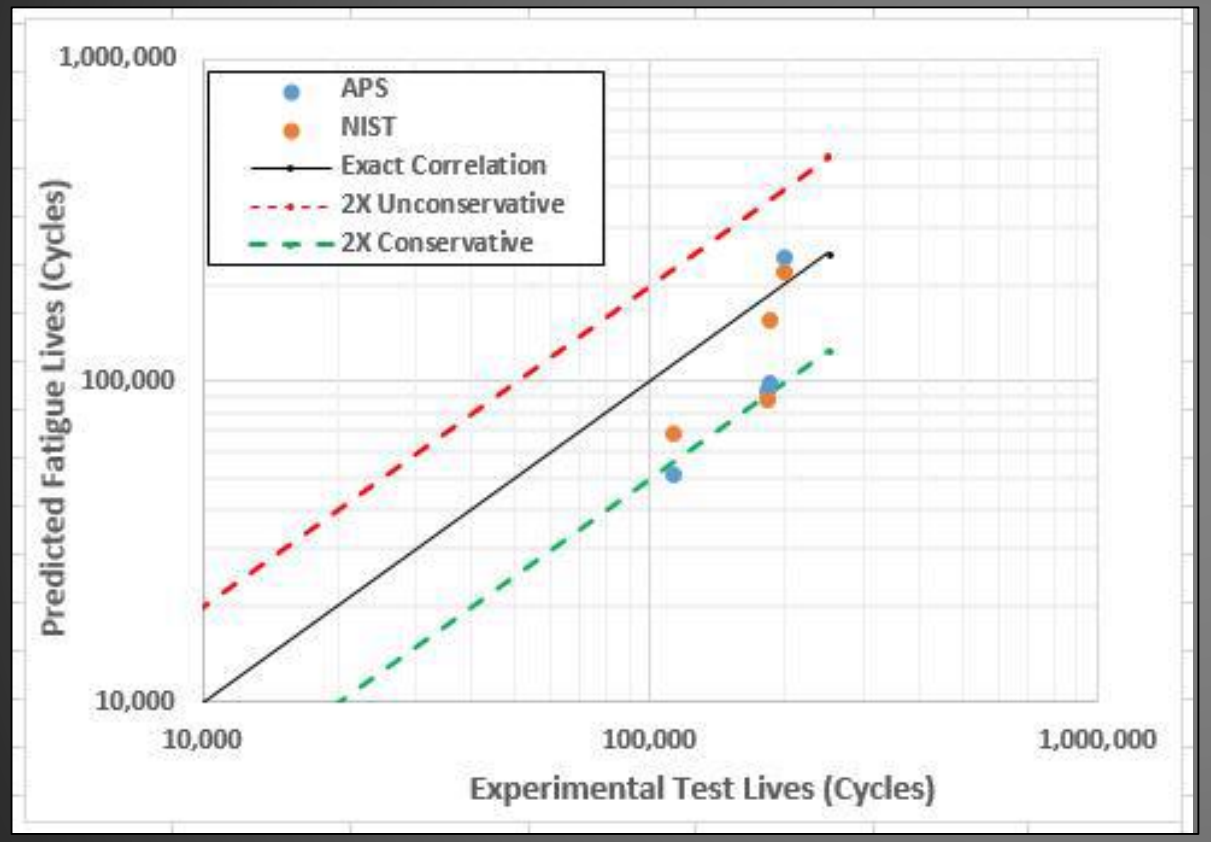
*SAE documentation is available





Testing courtesy of John Deere ADV Center

Importance of Residual Stress



Plot courtesy of Tom Cordes

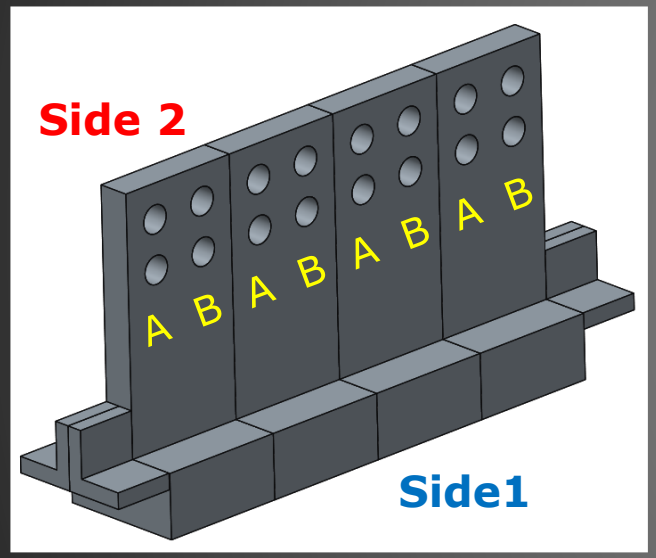
- Two different residual stresses
- NIST shows slightly better correlation
- Both better than no residual stress considered

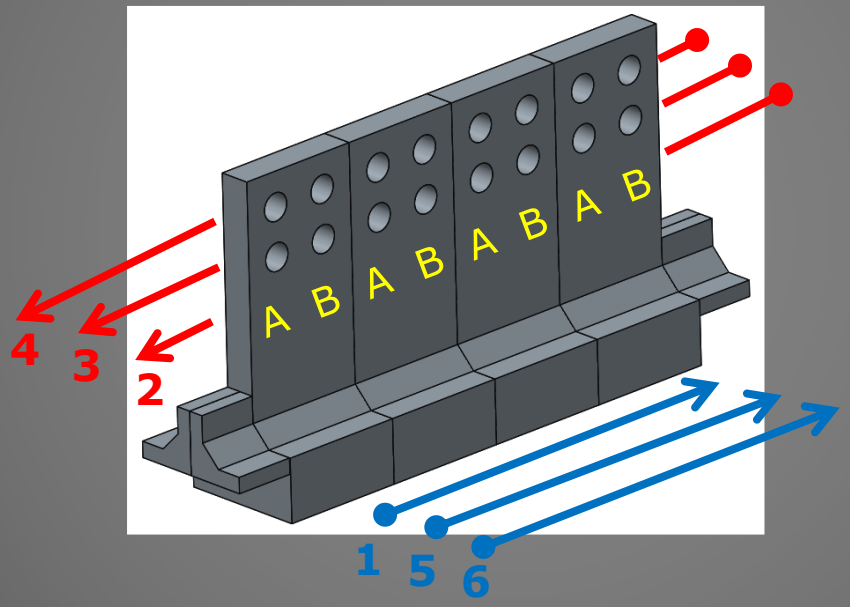
T-Sample Welding Process

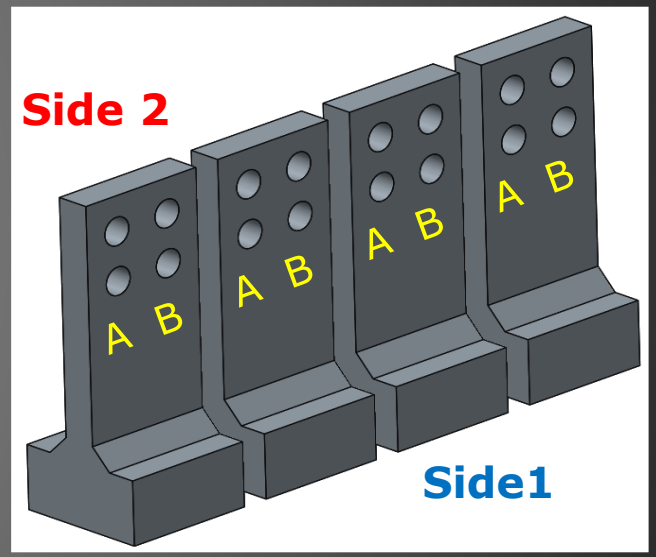
Welding courtesy of John Deere Davenport Works

Parameter/Characteristic	Value
Welding Process	GMAW
Wire Type	Solid
Wire Diameter	0.062 inches
Shielding Gas	90% CO2/ 10% Ar
Base Material	A36
Filler Metal	ER70S-6
Welding Position	45 deg for all weld passes

Welding Process Animation

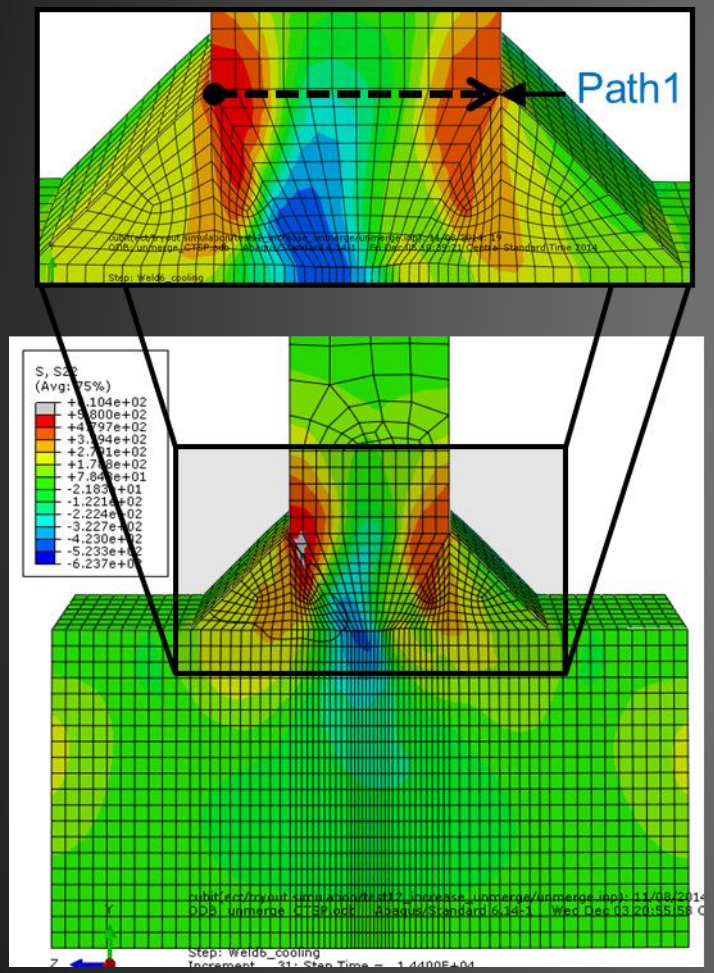


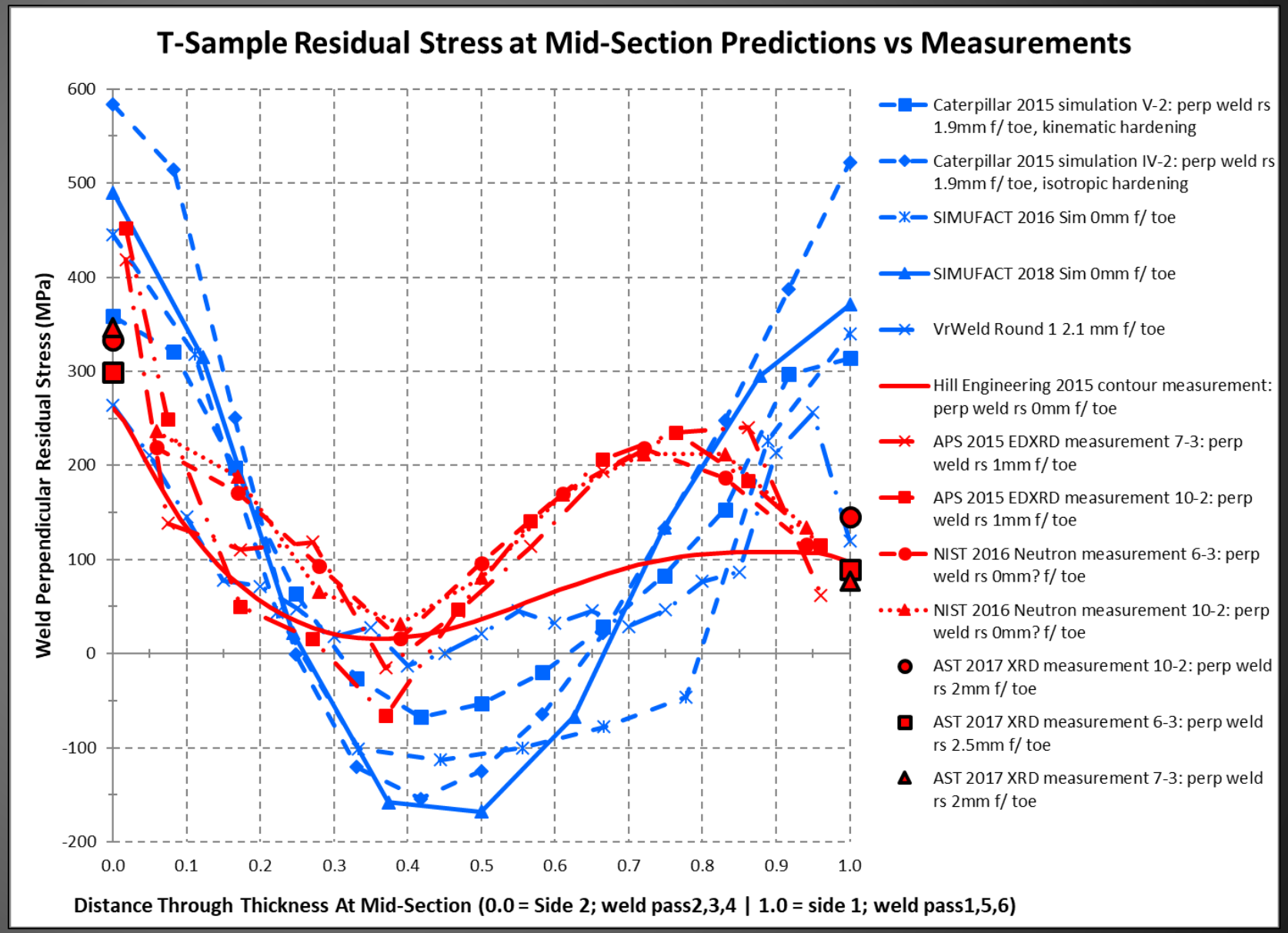




Simulation courtesy of CAT Technical Center

T-Sample Residual Stress

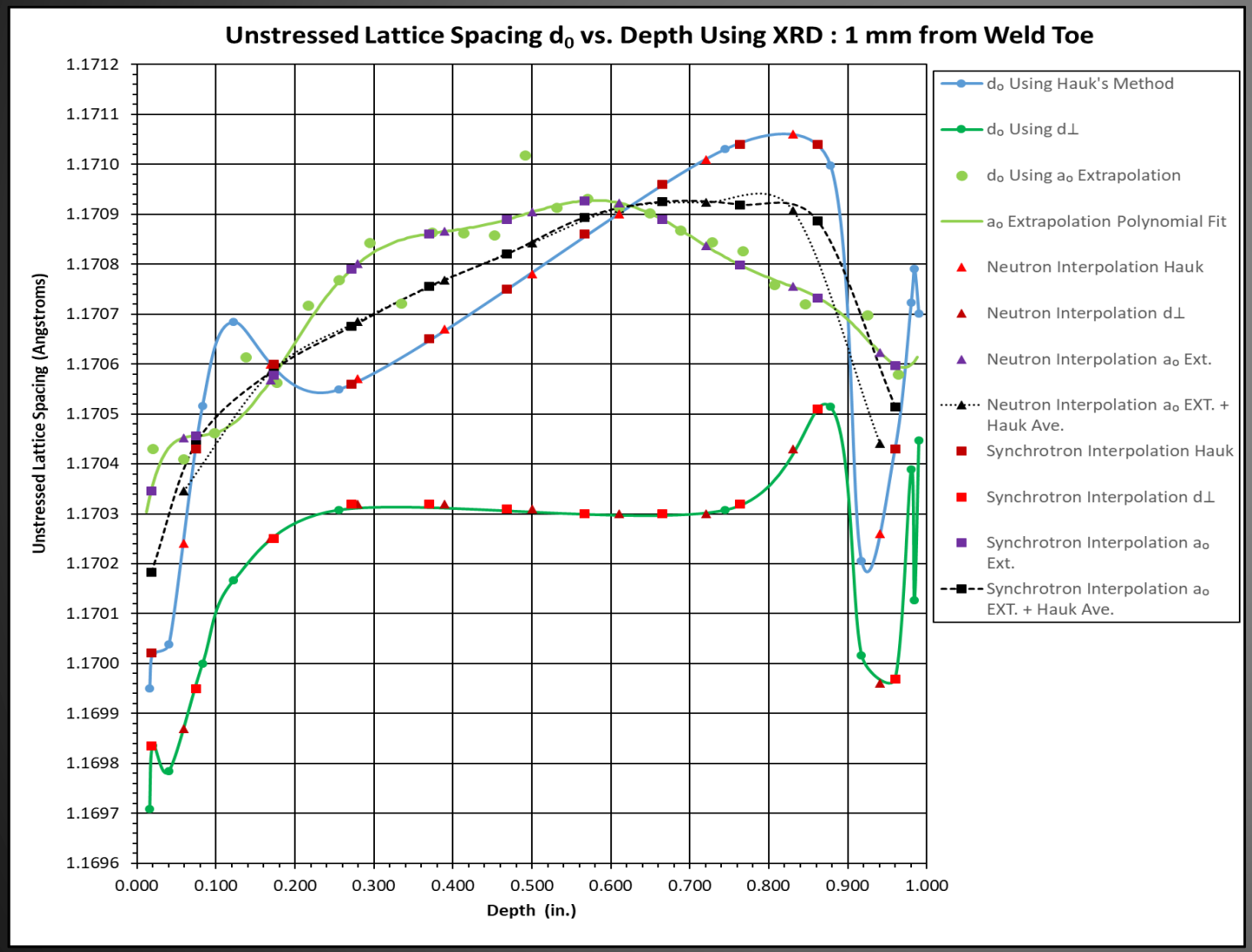




Residual Stress Correlation

- Measurements and predictions have reasonable group correlation
- Beginning half correlates better
- Most simulations over-predict the ends

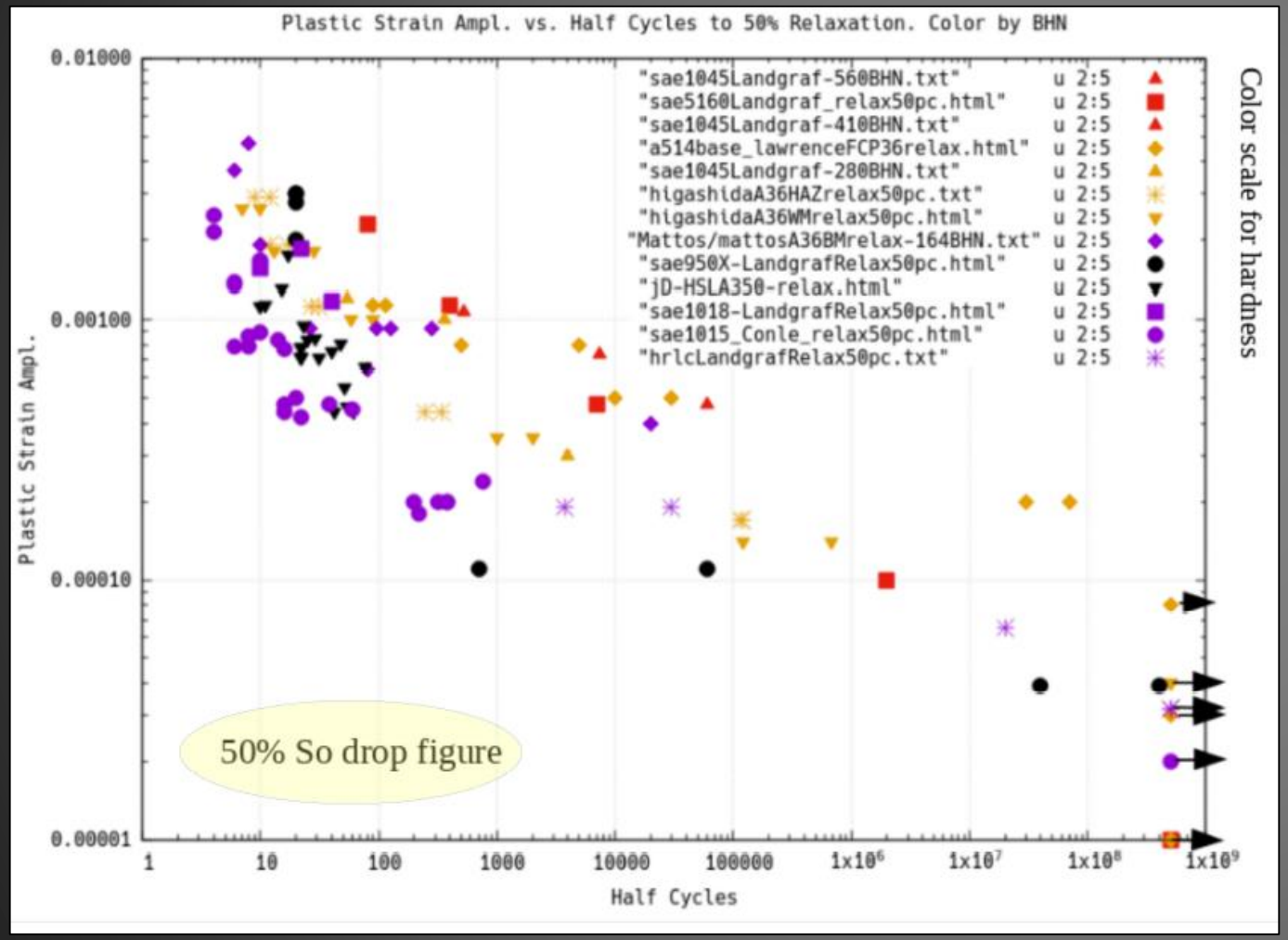
Correlation of Measurement vs Predicted Residual Stress



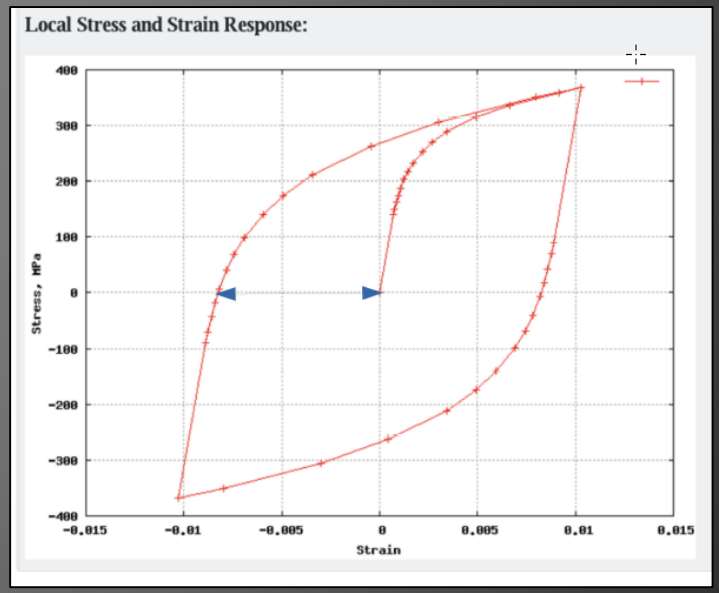
- Improve diffraction measurement
  - Currently use constant D_0
  - Correct for D_0 changes through thickness
- ProtoXRD provided D_0 vs thickness
  - Hauk's Method
  - D-Perpendicular
  - Powder diffractometer

Data/Figures courtesy of ProtoXRD (James Pineault)

Residual Stress Relaxation Testing



- 24kN load causes plastic strain amplitude of 0.007
- This loop would cause 50% reduction in residual stress in less than 10 cycles



Figures courtesy of Al Conle

Future Work

- Correct measured residual stresses with D_0 versus depth data
  - Work with Thomas G. from NIST for neutron data
  - Work with Justin/APS for EDD data
- Fatigue testing samples with modified residual stress
  - Relieved and compressive
  - Predictive work to support testing- Dan L.
- Residual stress relaxation testing
- Contact me if interested in being involved

Questions

Thank you!

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