

# Ogden Air Logistics Center



**U.S. AIR FORCE**

## Next Generation Crack Growth Predictions - Coupled Finite Element Modeling and Crack Growth

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What happens when you interwork AFGROW 's  
Plug-in capabilities with S Check?



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**BAMF**

**Broad Application for Modeling Failure**

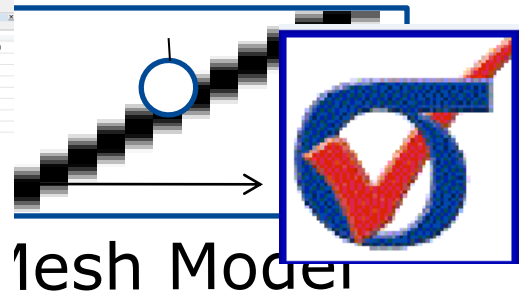
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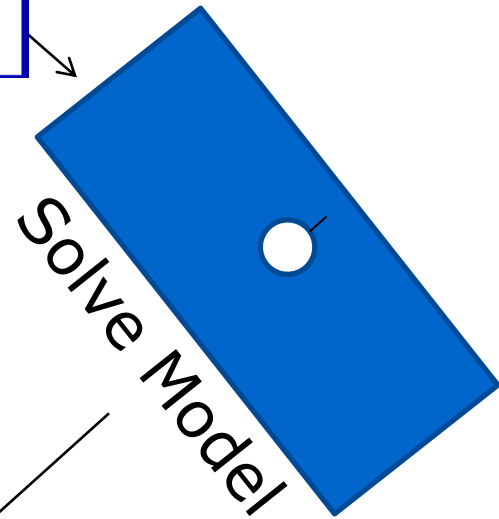
# What does BAMF do for you?



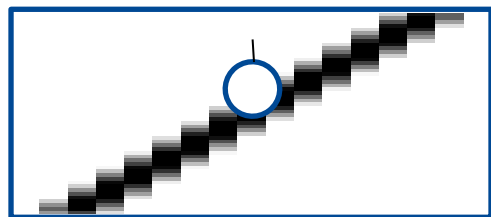
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Mesh Model



Solve Model



Extract Stress Intensities

Import Model

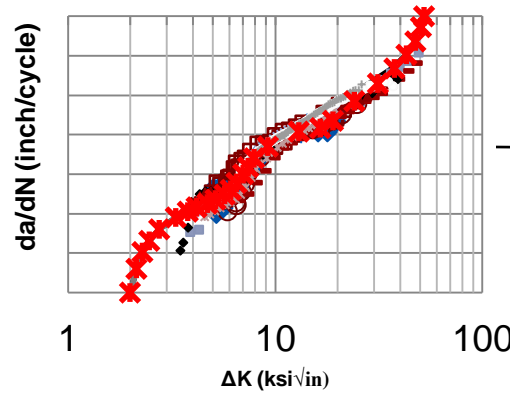


# What does BAMF do for you?



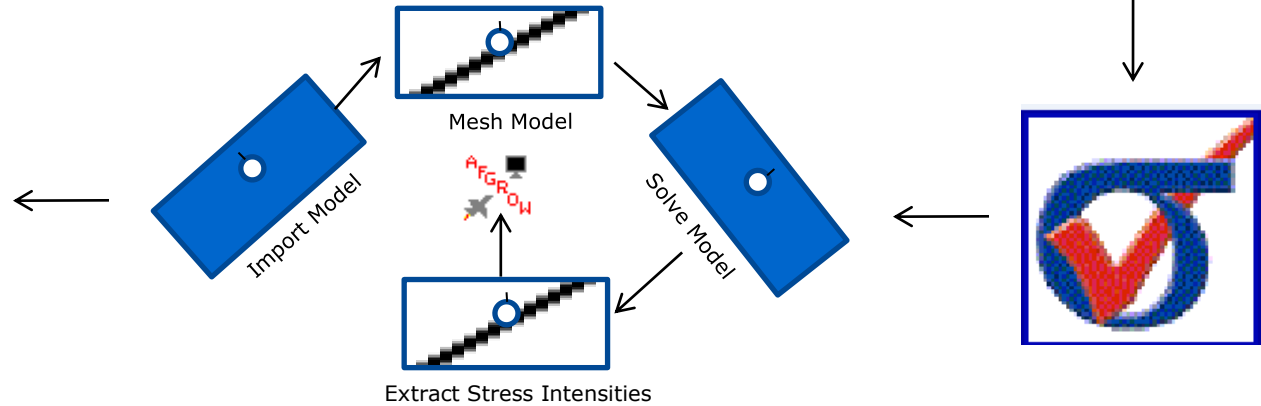
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$$a = K/\sigma$$



→ New Crack Lengths

Insert movie






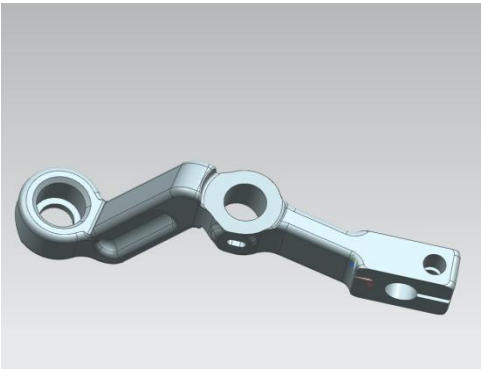
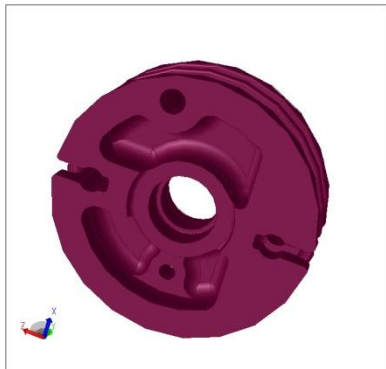
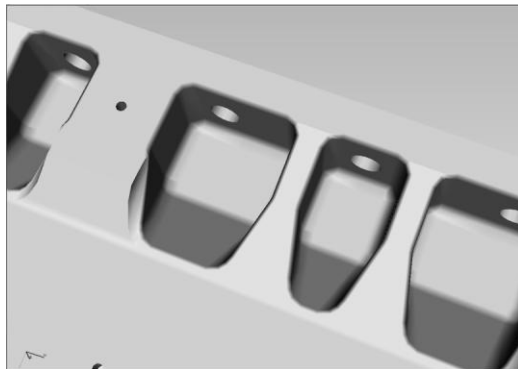
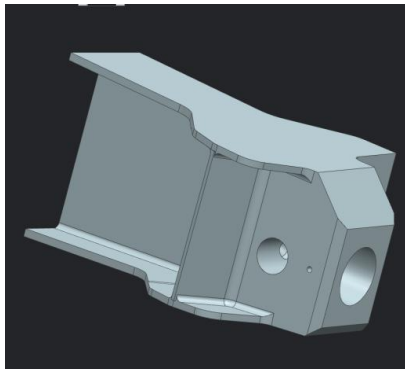


# Building of Code



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-  **Code built in VB2008 Express using AFGROWBetaPlugin (ref Brent Lancaster)**
-  **Development took approximately 6 months (Learning curve for AFGROW/SC commands)**
-  **Hardest part was developing the code and model to account for all possible scenarios of crack growth and model development.**





# Benefits of BAMF



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INFOCON 3 UNCLASSIFIED EPSON Beamer

Form1

Updating elements...

o Crack Length 0.05 o Beta 1.79  
o Crack Length 0.05 o Beta 2.1011

c	Kc	a	Ke	ct
0.05	7084	0.05	8327	0

**K extraction a=0.05 c=0.05**

Copy Data to Excel Abort AFGROW Run

**running Kc extraction**

Y X

BAMF

BAMF

BAMF




BAMF

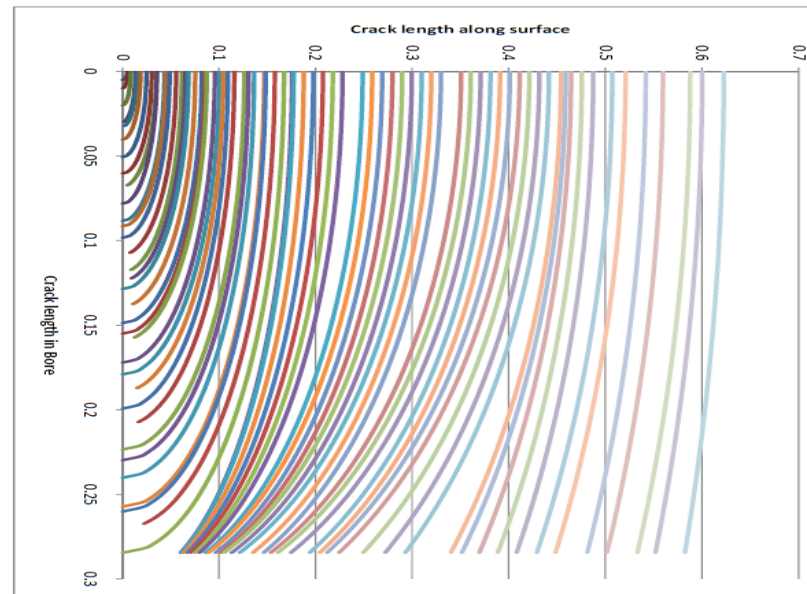
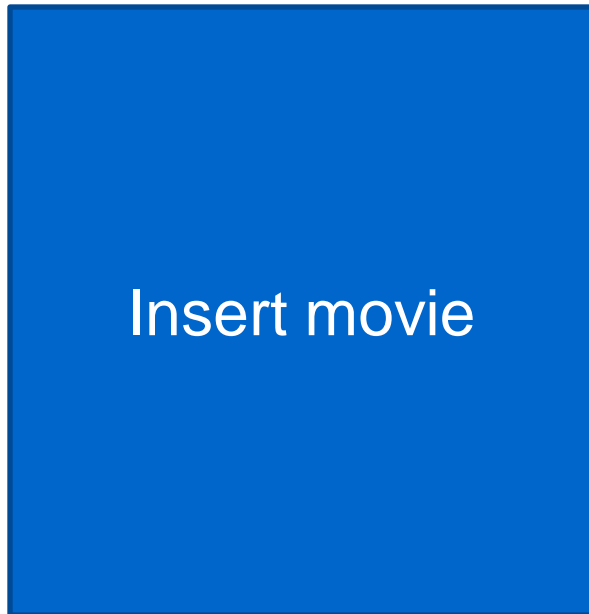


# More Features of BAMF



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-  Allows for a/c to be constant or variable
-  Graphics to help understand how stress is redistributed in the part as the crack grows
-  Graphic that shows the beach marks as the crack grew through the part





# Building a BAMF Model in StressCheck



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## Keys to not making the model fail

- Have me build your model!
- Sets, Sets, Sets
  - CRACKFACE; CRACKFRONT; AUTOMESH; NUCLEATION; THICKNESS
- Define BCs as Sets
- View for stress plot defined as “Stress”
- Plot parameters for stress plot saved as Stress
- Saved with No Mesh
- Currently Save as OffsetHole.sci



# Variability in Validation of BAMF Solutions



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**Building of FEA Model (StressCheck)**

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**Selection of Ka and Kc from StressCheck Extractions**

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**Determining “Far Field Stress”**

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**Material File (AFGROW)**

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**Failure Criteria**

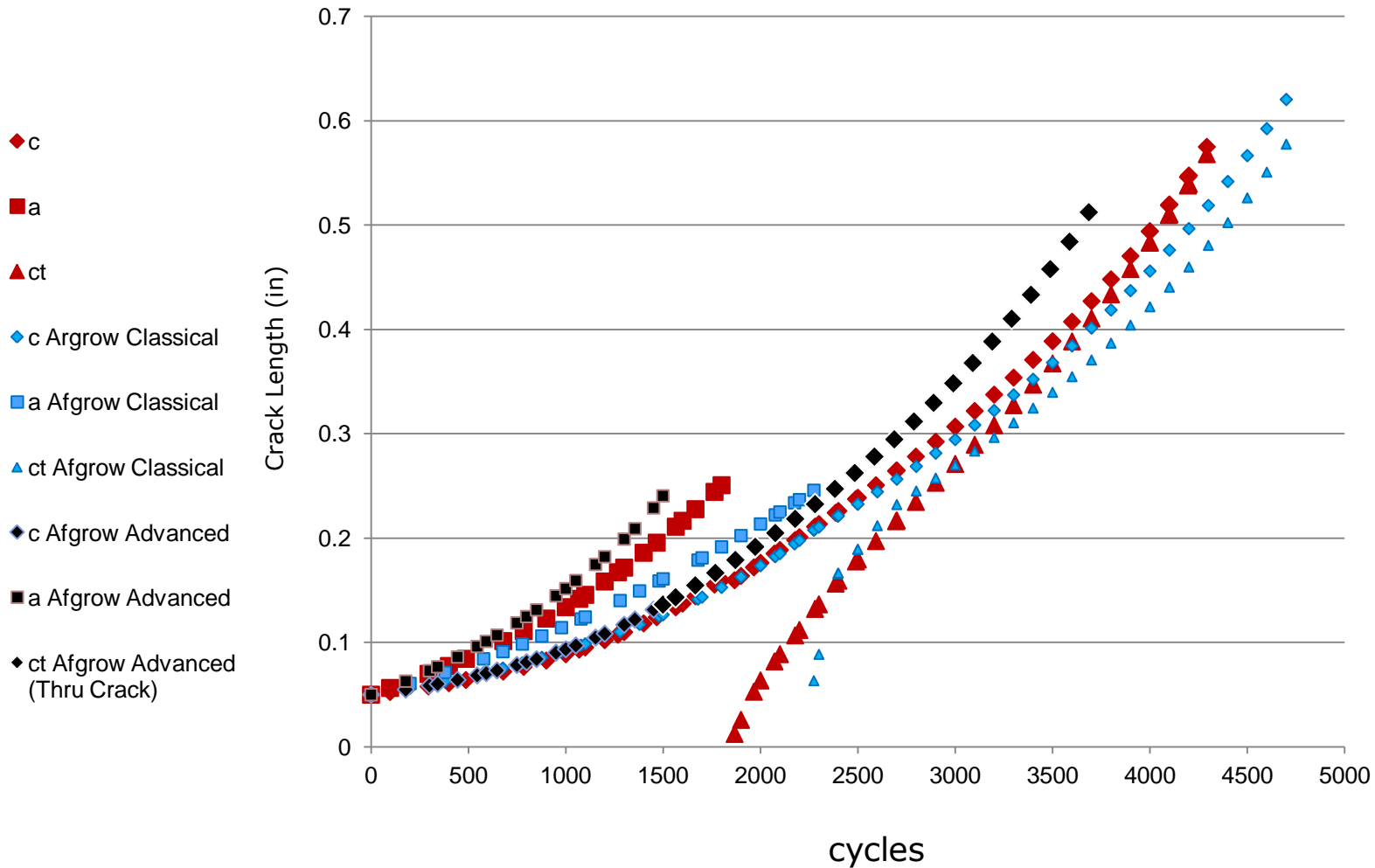


# Comparison to AFGROW

$B=2$   $W=5$   $t=0.25$   $D=0.25$   
Const Ampl SMF 30



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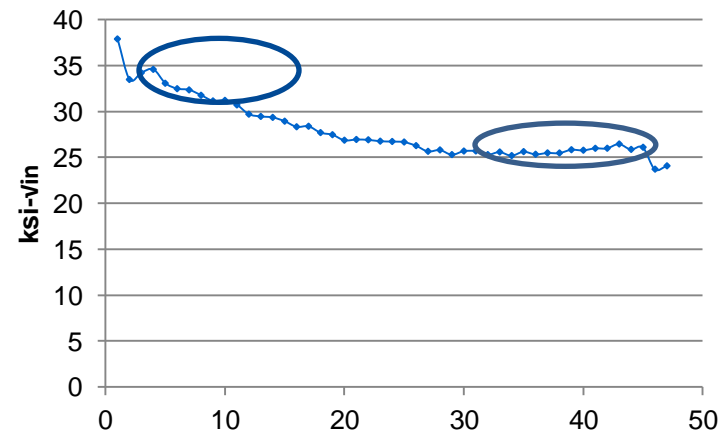
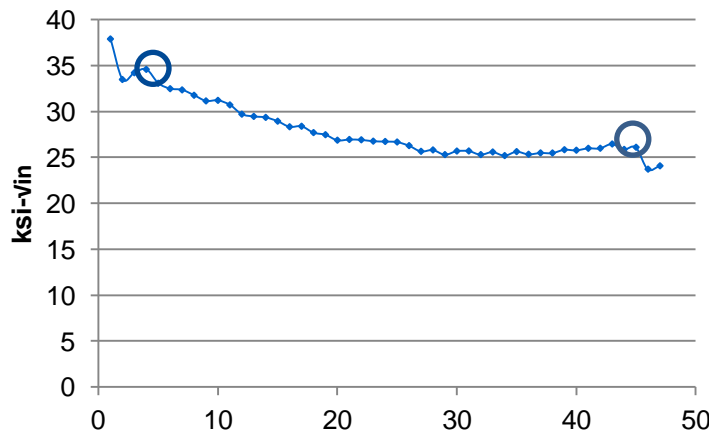


# Selection of K



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- Selection of K's is not a trivial manner!
- As aspect ratio changes the concentration of points along the curve change (Zach and Cordell)
- Current method is aimed at attempting to capture the local max and local min
- Number of points can be changed in the VB code to change the aggressiveness of the model



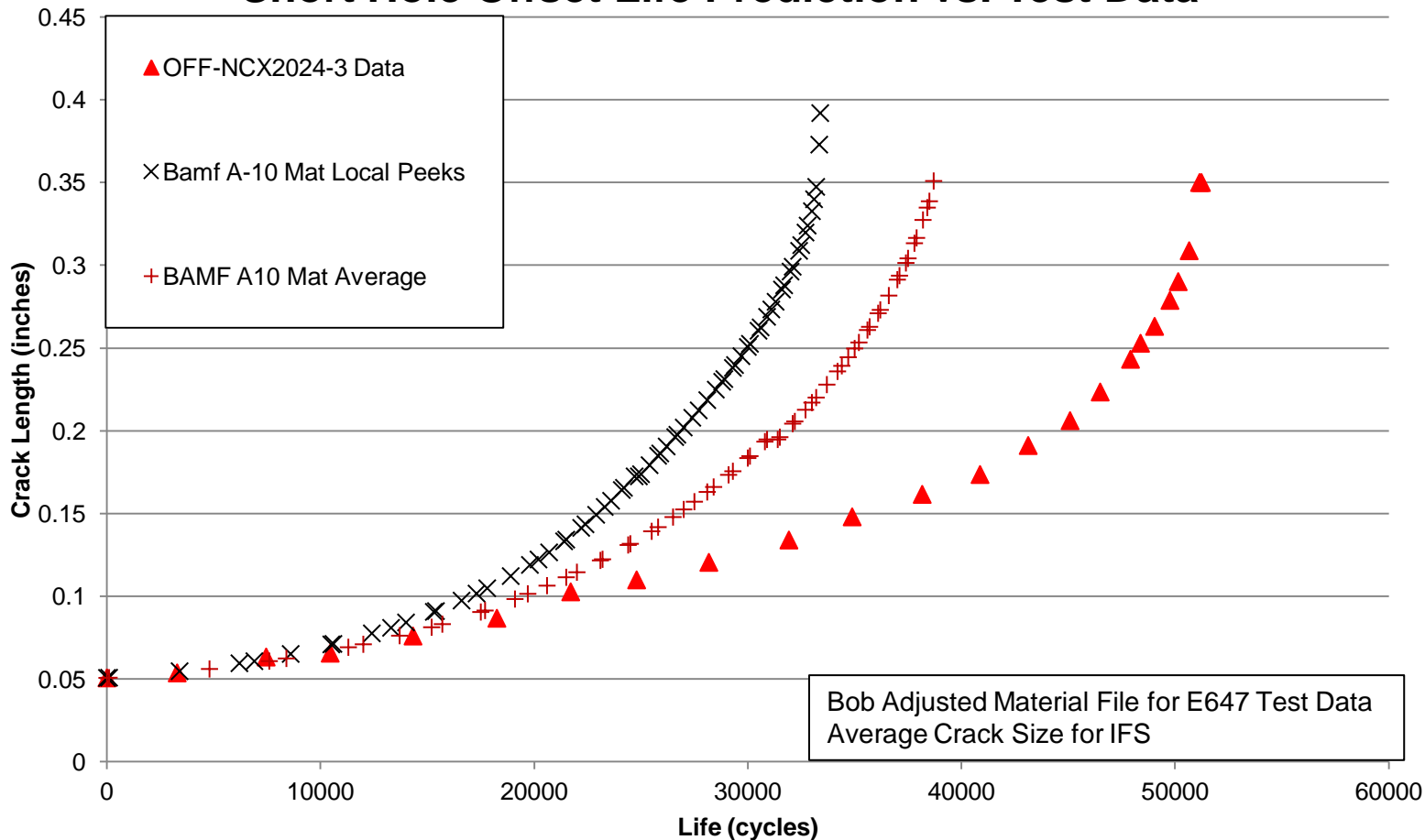


# Selection of K



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## Short Hole Offset Life Prediction vs. Test Data





# Material File Selections



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- **Subtle Differences in the  $Da/DN$  curve can drastically change the shape of the curve**
- **Not BAMF dependent but worth noting when matching data to test results**

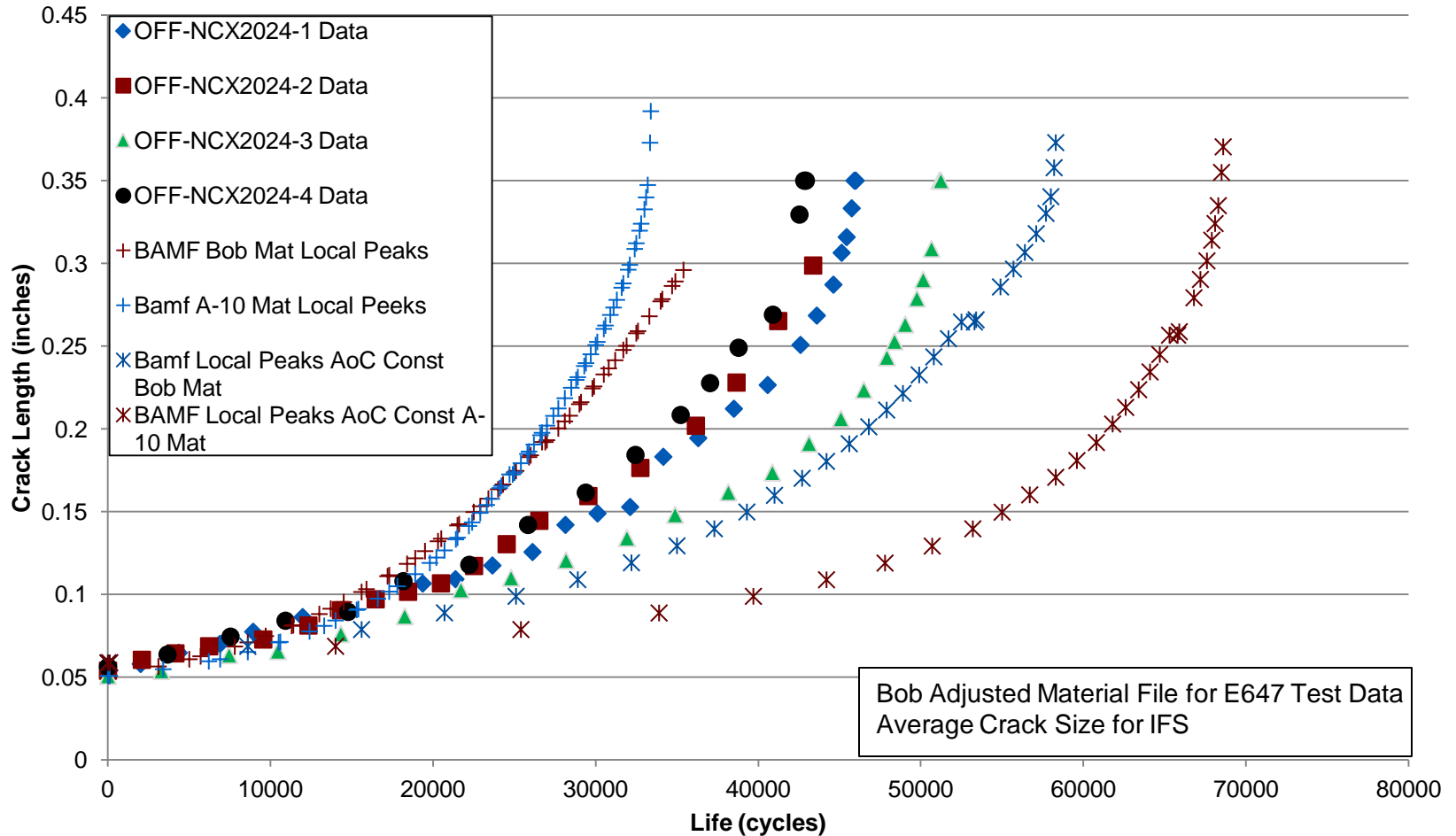


# Material File Selections



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## Short Hole Offset Life Prediction vs. Test Data





# Discussion of things to be worked on



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- **Through thickness failure**
- **Failure criteria**
- **Transition into obscure geometries**
- **Dealing with small crack lengths  $<0.05$  in**
  - **Sets (THICKNESS)**
  - **AFGROW 5%**
- **Mesh refinement tools (Local Curve refinement)**
- **Multi-cracks that are not in the global planes**