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# BAMpF Update 2026

September 16, 2026

# Overview: What is BAMpF?

Broad Application for Multi-point Fatigue


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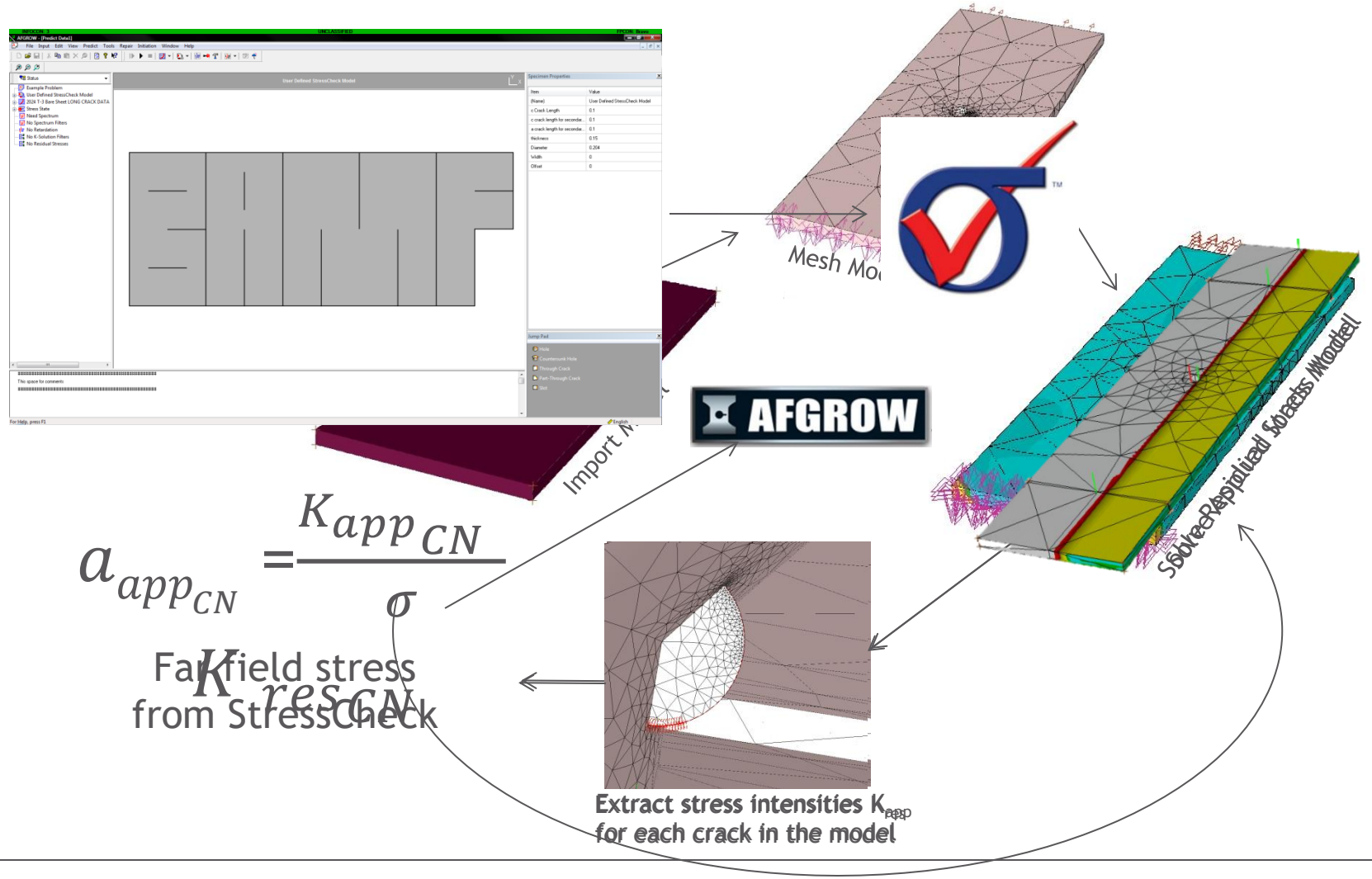
# Overview: BAMpF Process Flow




$$a_{app_{CN}} = \frac{K_{app_{CN}}}{\sigma}$$

Far field stress from StressCheck

$K_{res_{CN}}$



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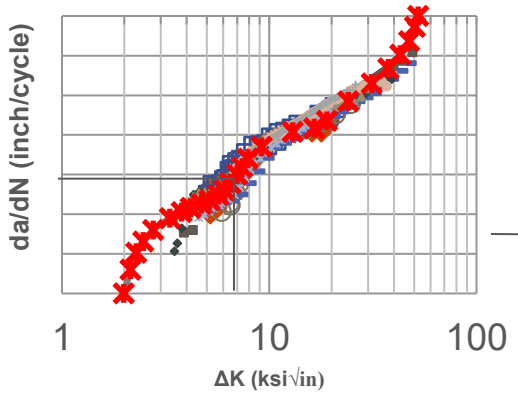
# Overview: BAMpF Process Flow

$$K_{min_{CN}} = a_{app_{CN}} \sigma_{min} + K_{res_{CN}}$$

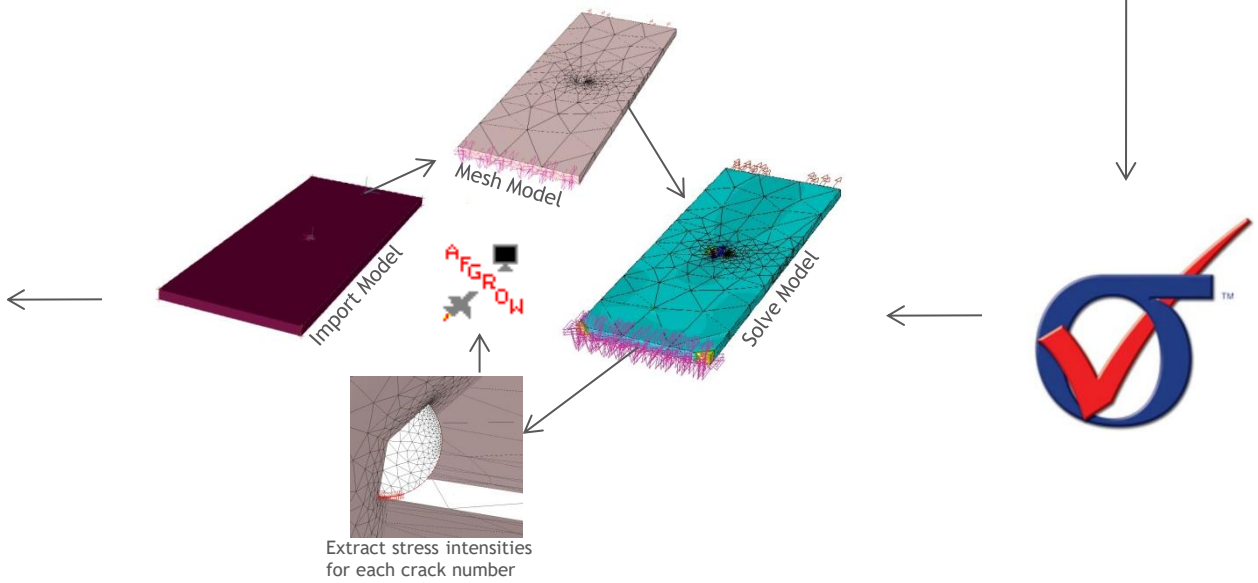
$$K_{max_{CN}} = a_{app_{CN}} \sigma_{max} + K_{res_{CN}}$$

Where $\sigma_{min/max}$ is the AFGROW spectrum stress

$$R_{CN} = K_{min_{CN}} / K_{max_{CN}}$$




→ New Crack Lengths





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# BAMpF Current State

- **Operational with releases of StressCheck™ 12 and AFGROW 5.5**
  - Needs 4 different installations to cover the possibilities of different programs
  - Further releases will no longer support StressCheck ™ 11 and AFGROW 5.4
- **Windows 11/64 bit compatible**
- **Full utilization of StressCheck™ software suite**
  - Complex load cases (via sets)
  - Contact solutions
  - Residual stresses
  - Bearing loads
- **Full utilization of AFGROW crack growth capabilities**
  - Spectrum capabilities
  - Load interaction models
- **Functional API**
  - Updated code with significant enhancements
  - Easy integration with in-house FCG codes
- **USAF Approved Software!**


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# Proposed work from 2025 Workshop

| Feature | Description |
|---|---|
| Multi-Channel Loading | Solve for multiple loading scenarios |
| Integration with other FE tools | Ansys, NX |
| K extrapolation | Extrapolate K to radius of 0 using two different K extractions (Is this needed with new meshing routines?) |
| Multi-Crack Auto-Coalescence | (MCAC) When crack fronts intersect-automatically coalesce cracks |
| **3-D crack growth** | **Crack turning, out of plane crack growth** |
| Crack front splitting | When the crack front splits into multiple cracks |
| Custom Output files | Use a customizable .ini file to allow the user to tailor output files |
| **AFGROW Crashes with Dax** | **When Opening a DAX while plug-in is running AFGROW/BAMpF Crashes** |
| Failure Criteria | Implement some sort of failure criteria, beyond all points reaching K critical (Warner 2022) |
| | |
| | |


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Release date 2027

# BAMpF 8.3 FEATURES


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# Features

- **SIF color plots**
  - Add a BAMpF_KCrit parameter to the stress check model
  - Crack growth evolution plot points will be colored based on the current K value in relation to K Critical
- **Final crack length output**
  - When Afgrow stops the solution the current crack length is output to a csv file
- **Mesh routine specification**
  - Add a BAMpF_MeshIter parameter between 1 and 11 to manually set the mesh routine
- **Surface point correction**
  - Surface point correction has been updated to allow for multi-directional corrections


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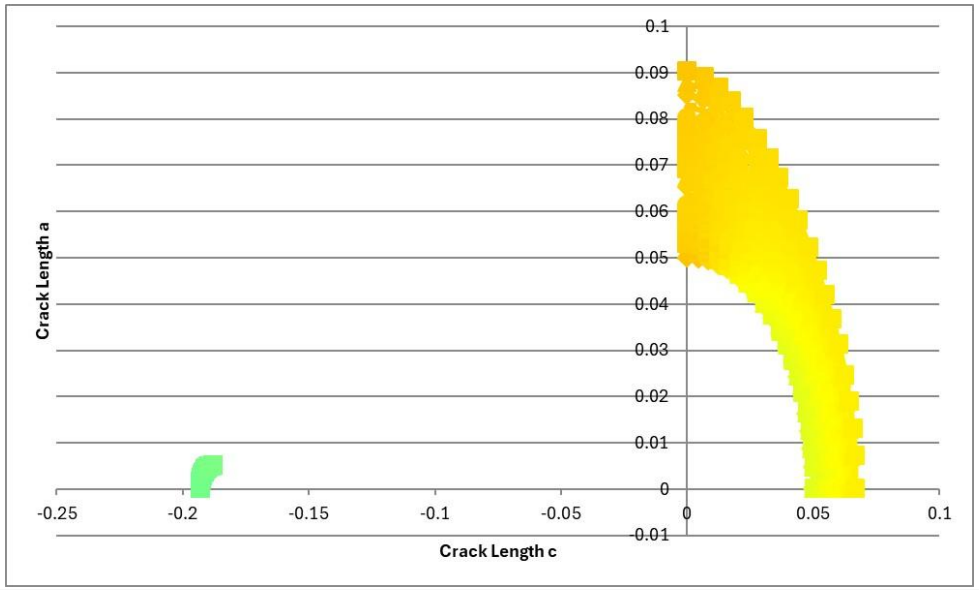
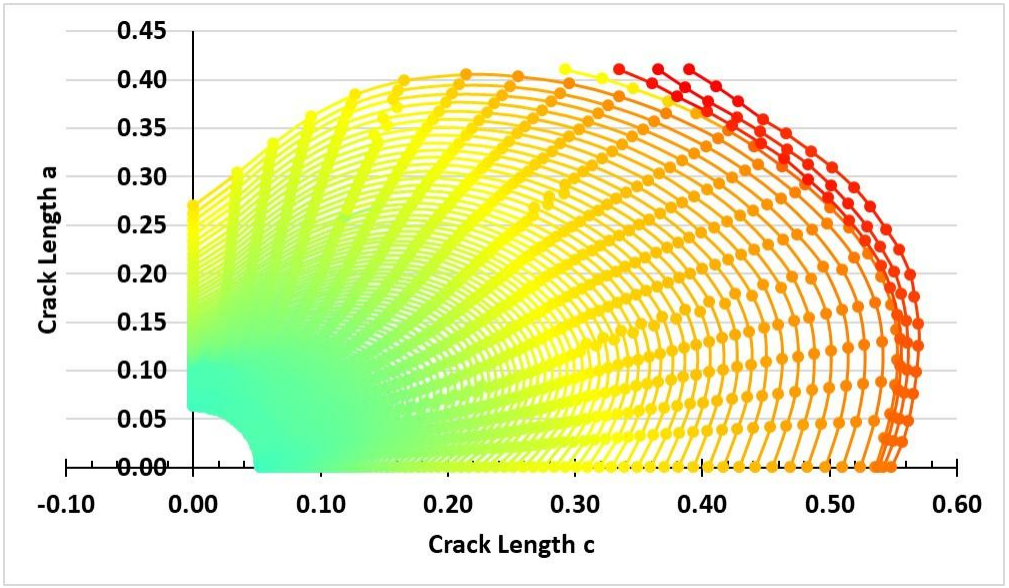
# SIF Color Plots

- **BAMpF_KCrit parameter triggers a SIF color plot**
  - BAMpF will color each point in the crack growth evolution plot based on the ratio of K to Kcrit
  - Once the K value surpasses KCrit, the point will be colored red

| | |
|---|---|
| BLRatio1 | 0.0000e+00 |
| BLLayers1 | 4.0000e+00 |
| BAMpF_KCrit | 3.2000e+01 |
| BAMpF_CSP_Factor1 | 6.5000e-01 |
| BAMpF_CSP_Angle1 | 2.0000e+01 |

$$Point_Color = \mathrm{RGB}\left(\frac{\mathrm{K}}{\mathrm{BAMpF_{KCrit}}}\right)$$





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# Final Crack Length Output

- **When reaching the end of crack growth due to meeting any of the failure or stop conditions BAMpF only recorded the crack length of the crack before failure**
  - Once BAMpF returns control to AFGROW, AFGROW grows the crack and checks any failure conditions
  - The run is stopped before that crack growth can be passed back to BAMpF and recorded
  - A feature was added to record the AFGROW crack growth calculated right before failure
  - A csv file titled FinalCrackLength.csv is saved in the solution directory

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | Crack0 Px | 0.045698 | 0.044814 | 0.036023 | 0.02622 | 0.015985 |
| 2 | Crack0 Py | 0.055197 | 0.05543 | 0.060485 | 0.063398 | 0.063156 |


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# Mesh Routine Selection

- Added a parameter BAMpF_MeshIter to StressCheck
  - 1 to 7 corresponds to AddAutoMeshSimCrackFront (New meshing routine)
  - 8 to 11 corresponds to AddAutoMeshSimBoundaryLayer (Legacy meshing routine)
- User can decide to start at a certain mesh to avoid problematic meshes

| AddAutoMeshSimBoundaryLayer | | |
|---|---|---|
| # | Mixed Mesh | Shrink to Fit |
| 8 | True | False |
| 9 | True | True |
| 10 | False | True |
| 11 | False | False |

| AddAutoMeshSimCrackFront | | | |
|---|---|---|---|
| # | Mixed Mesh | Integration Layer | Grade Toward End |
| 1 | True | True | True |
| 2 | True | True | False |
| 3 | True | False | True |
| 4 | False | True | True |
| 5 | True | False | False |
| 6 | False | True | False |
| 7 | False | False | False |


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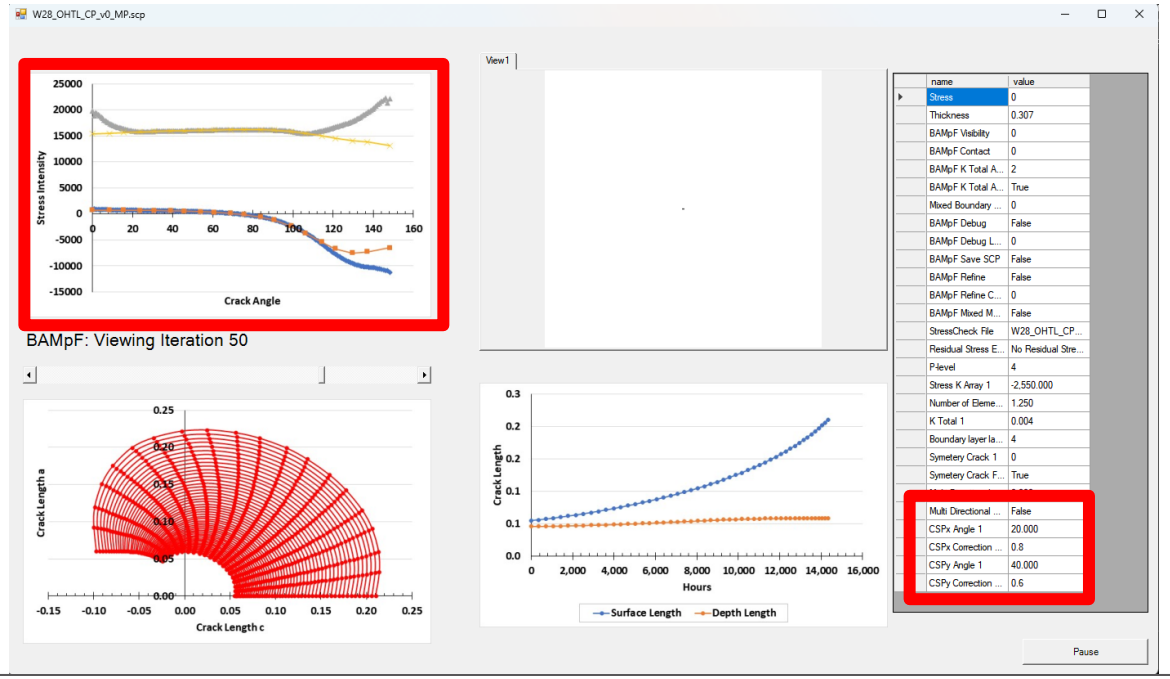
# Surface Point Correction

- **To enable different surface point correction in multiple directions**
  - Delete BAMpF_CSP_Factor1 and BAMpF_CSP_Angle1 (This will override everything)
  - Create BAMpF_CSPx_Factor1, BAMpF_CSPy_Factor1, BAMpF_CSPx_Angle1, BAMpF_CSPy_Angle1
  - Updates can be seen in SIF plot and table
  - When cracks break through thickness the X direction factor will be used for corrections to both the top and bottom surface





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# BAMpF 8.2 BUGS


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# Bug Fixes

- **Retardation parameter fix**
  - Fixed output of parameter files
- **Midpoint fix in curved/sloped models (In Progress)**
  - Fixed crack face detaching from the model
- **180 degree long crack fix on short cracks**
  - Fixed incorrect smoothing operation
- **ApplicationBB stack overflow issues during solve**
  - Reverted programing object that was causing errors


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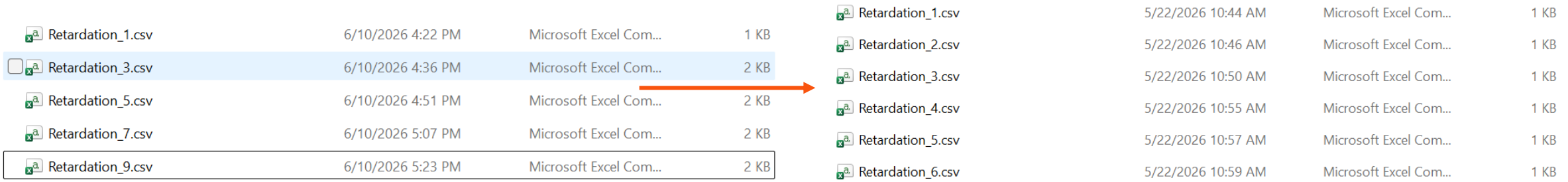
# Retardation Parameter Output Fix

- **When restarting a run for an iteration that is not a multiple of the number of cracks, BAMpF would crash**
  - The retardation parameters were incrementing by the number of cracks in the model rather than by iteration
  - When reading previous data the parameters would not exist causing BAMpF to crash
- **The numbering was fixed and the crash no longer occurs**





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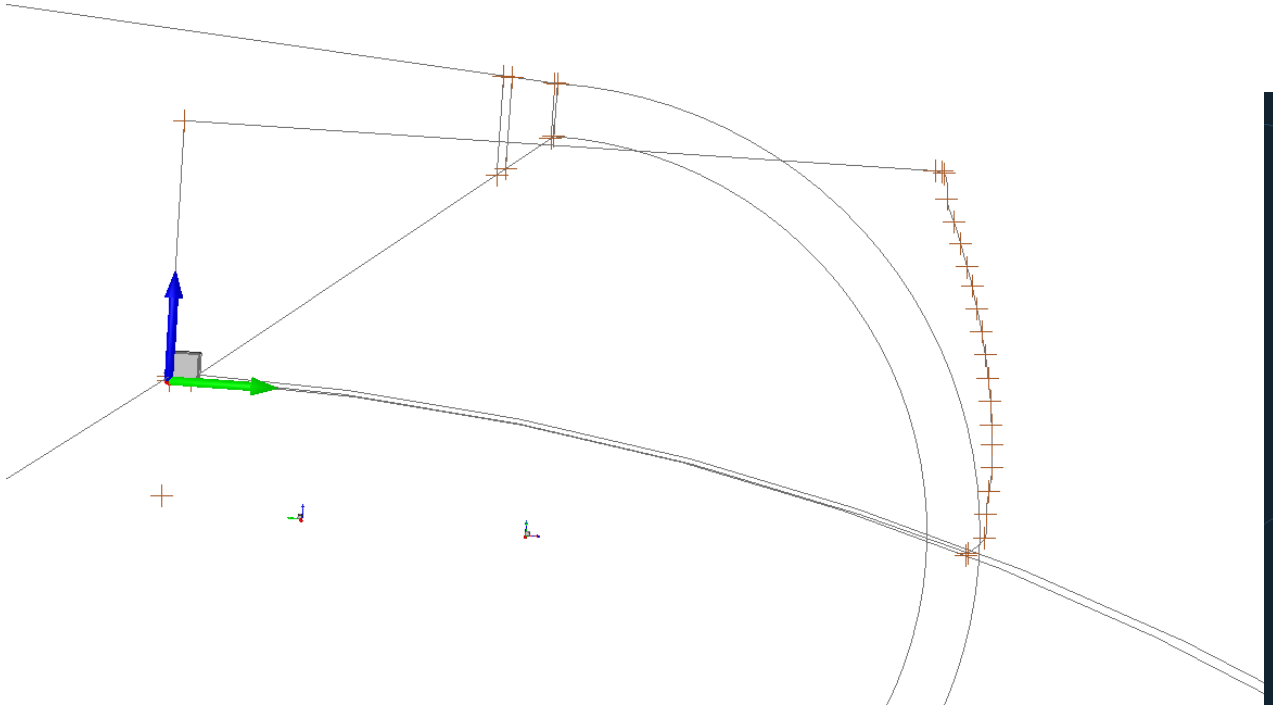
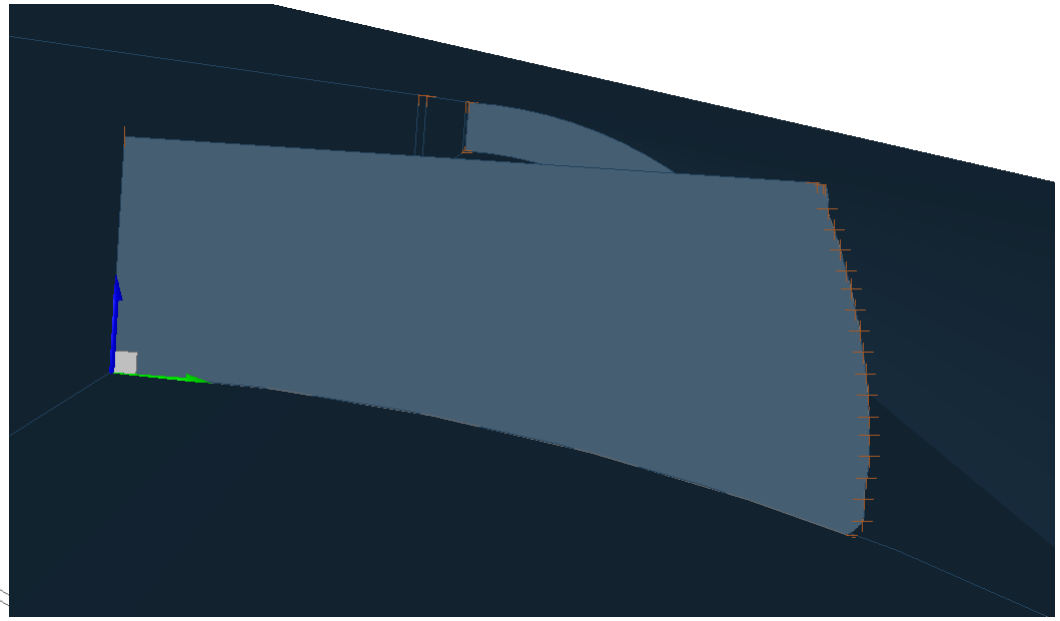
# Midpoint Bug

- In some models we were seeing the crack face stop affecting the entire surface in a curved model after breakthrough



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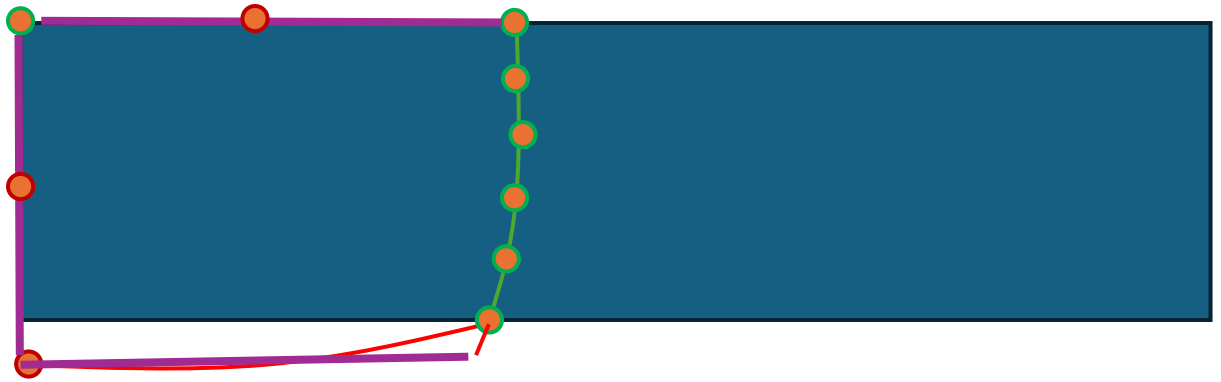
# BAMpF 2025: Out of Body Spline Programmatic Fix

- ❑ Models should be created with mid points (C1PMx1, C1PMy1) and (C1PMx1, C1PMy1)
- ❑ 2 point line connect this to the origin and  the first and last point in the model
- ❑ When a point goes outside the bounds of the model, BAMpF will shift the points as shown
- ❑ Model Builder will automatically create these midpoints
- ❑ Previous models can still be utilized in the new BAMpF but will run into the failure issue

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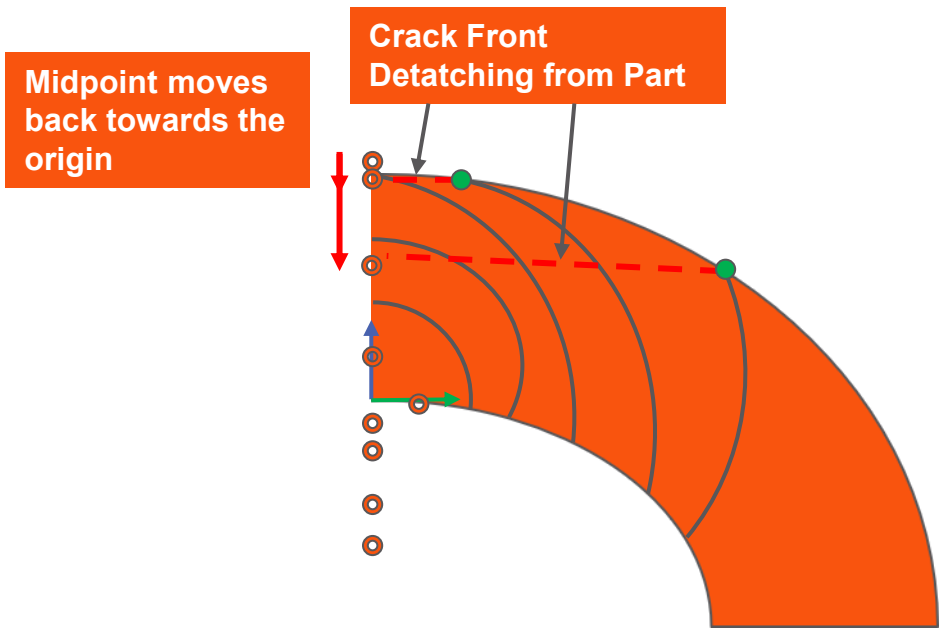
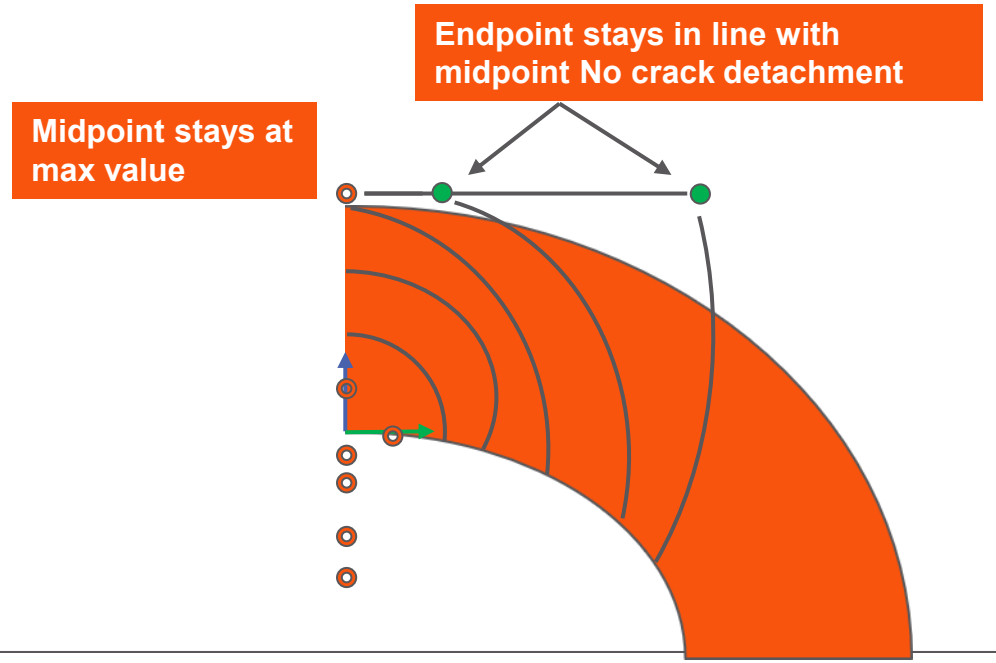
# Midpoint Fix (In Progress)

- Previously, the midpoints were set to the same x or y value as the endpoints by but stay on the original x or y axis
- In a curved model, tracking with the endpoints caused the crack to re-enter the model
- We modified the midpoints so they do not move back towards the origin and the endpoints were modified to stay at their max value with the midpoints





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# Current Problems

- The end points can get far enough from the first interior points that the exterior spline will be longer than the interior spline
- In these unique geometries, this spline will cause modeling problems that were fixed last year
- We are working on a method to mitigate this issue while keeping the crack face from detaching while also not running into spline errors


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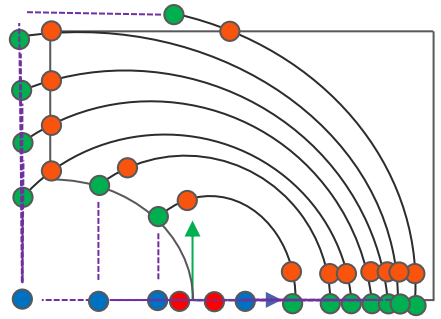
# Midpoint Fix – Proposed Solution

- ❑ Add two extra midpoints to the model
- ❑ These extra midpoints will allow the original midpoints to follow behind the endpoints to keep the external spline short
- ❑ When the endpoints of the crack start growing along a surface back towards the origin, the extra midpoints will replace the original midpoints while the original midpoints follow the endpoints

Midpoint
Extra Midpoint
EndPoint
First Interior Point
Two Point Line
Crack Spline

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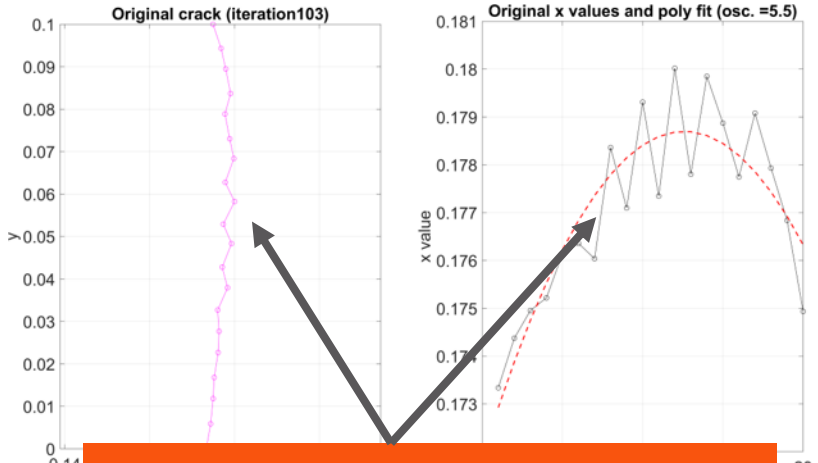
# 180 Degree Crack Oscillation Bug

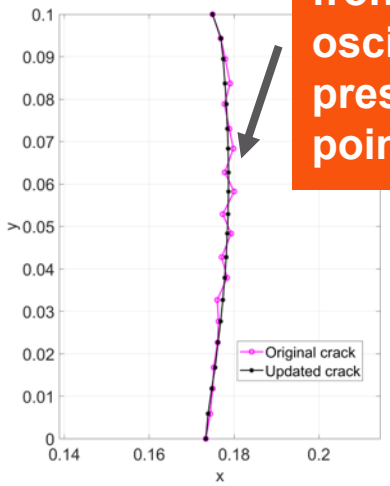
- BAMpF includes a feature where it does a quadratic polynomial fit to long through cracks that are starting to oscillate due to small changes in delta K
- The check BAMpF was using to check for through cracks treated some small 180 degree cracks as though they were through cracks and started re-fitting cracks with 2 or more oscillations which is every 180 degree crack with pinning at the surface





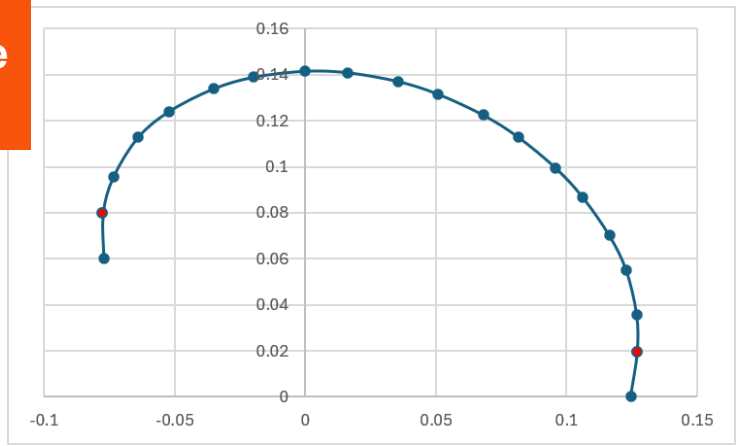


Original crack front (oscillatory)




Updated crack front removes oscillations and preserves surface points

180 degree crack with 2 oscilations (Inflection points in orange)

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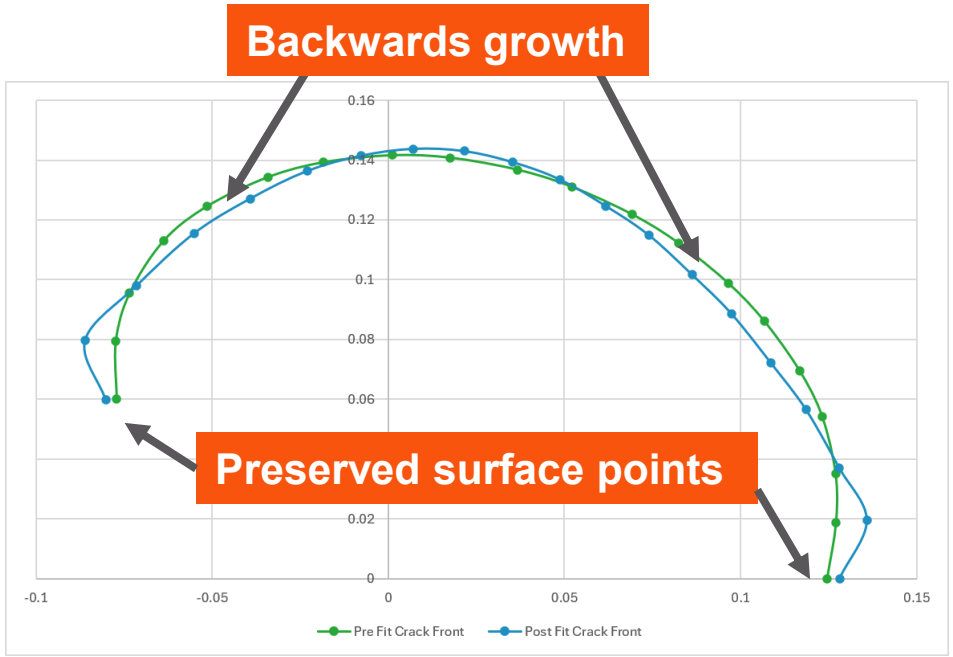
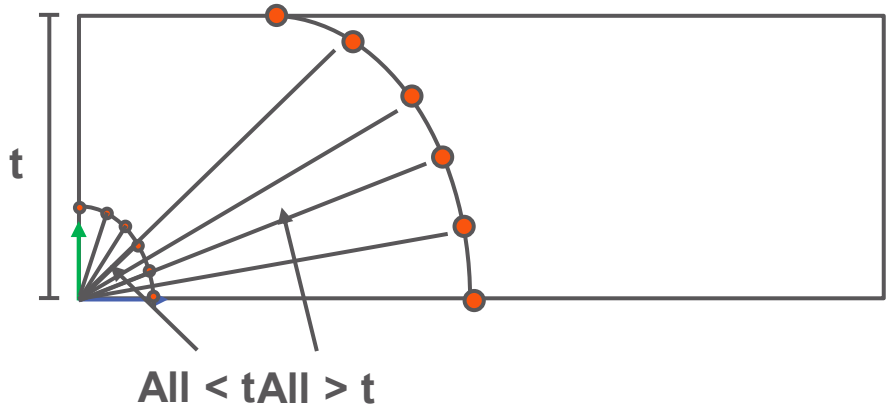
# 180 Degree Crack Oscillation Bug

- The small 180 degree cracks aren't approximated by quadratic functions so the crack front is far different from previous iterations and can show backwards growth in places
- The surface point preservation causes unusual shapes at the endpoints
- To prevent this oscillation smoothing, we implemented a check so that it will only occur if every point in the crack front is farther from the origin than the part thickness





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# ApplicationBB Stack Overflow

- Previously we started using a new StressCheck object (StressCheckApplicationBB) to remove some GUI flickering and to speed up the solution time
- As of StressCheck 12.1 this dll encountered an error in some complex models crashing BAMpF with a stack overflow error
- To mitigate this issue, we reverted back to using the StressCheckApplication object which adds approximately 10% to the solution time but does not encounter the stack overflow error in complex models


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# BAMpF PROPOSED FEATURES


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# Proposed Feature List for 2026

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| Multi-Channel Loading | Solve for multiple loading scenarios |
| Integration with other FE tools | Ansys, NX |
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