FEM v5.2 for Geri+WS4

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Test mass properties for Geri+WS4

Symmetric mass distribution considered for the wing!

Summary based on Complete Mass Property Test (Geri+WS4)				
mAEWing1 Geri Mass Prop (CB3+WS4)		**Position of Body CG (inch)**		
	Mass (g)	xCG	yCG	zCG
Centerbody	3317.21	-19.40	-0.08	-0.48
Avionics Cover	[52.43]	-9.06	0.00	-2.03
Ballast	[0]	-4.62	0.00	-0.61
Avionics Battery	[70.99]	-20.63	-3.50	-0.85
Propulsion Battery	[548.23]	-19.28	0.00	-0.85
Left Body Flap	[43.99]	-28.06	-7.52	0.14
Right Body Flap	[40.95]	-28.06	7.52	0.14
Left Wing	1392.67	-28.50	-31.99	
Right Wing	1381.11	-28.50	31.99	
Left Winglet	41.84	-42.45	-60.25	-0.21
Right Winglet	40.34	-42.45	60.25	-0.21
Attach Bolts (12)	67.81	-20.22	0.00	-0.16

Test Static Stiffness for WS4

Spar#		Prediction		Test Results	
		EI (N-m^2)	GJ (N-m^2)	EI (N-m^2)	GJ (N-m^2)
Left wing w/ Spar#12					
	Spar	100.41	72.89	**119.30**	**96.08**
	Complete Wing	351.39	1734.85 (Assumes closed shear path)	**359.29**	**299.34**
Right wing w/ Spar#11	Spar	100.41	72.89	**119.47**	**86.18**
	Complete Wing	351.39	1734.85 (Assumes closed shear path)	**304.76**	**261.90**

The asymmetric stiffness distribution is mainly from the stiffness for wing foam+cover!

mAEWing1 FEM updates for Geri+WS4

- Four additional design variables for foam+cover in effective Young's modulus and Shear modulus for inner wing and outer wing
- Total design variables number: 34+4=38
- Include the mode with frequency value 9.2 in FEM update

Mass Properties Comparisons

Centerbody	(Test)	FEM v5.1	FEM v5.2	Diff.
Weight, lbs	7.313	7.323	7.35	0.51%
IXX, lb-in^2	-	53.1	55.60	-
IYY, lb-in^2	-	511.1	497.26	-
XCG location, aft nose, inch	19.40	19.40	19.40	0.0

Centerbody (Geri)

Centerbody	WS4 (Test)	(FEM 5.1)	FEM v5.2	Diff.
Weight, lbs	3.058	3.06	3.06	0.1%
IXX, lb-in^2	1196	1209.8	1221.3	-
IYY, lb-in^2	372.5	366.2	371.2	-
XCG location, aft nose, inch	28.5	28.5	28.5	0.0
YCG location, aft nose, inch	31.99	31.99	31.99	0.0

Wing Set # 4

Centerbody	Geri (Test)	FEM v5.1 (FEM)	FEM v5.2	Diff.
Weight, lbs	13.76	13.77	13.80	0.3%
XCG location, aft nose, inch	23.75	23.76	23.75	0.0
IXX, lb-in^2	9360	9021	9047	-3.3%
IYY, lb-in^2	1578.7	1584	1581	0.1%

Geri+WS4

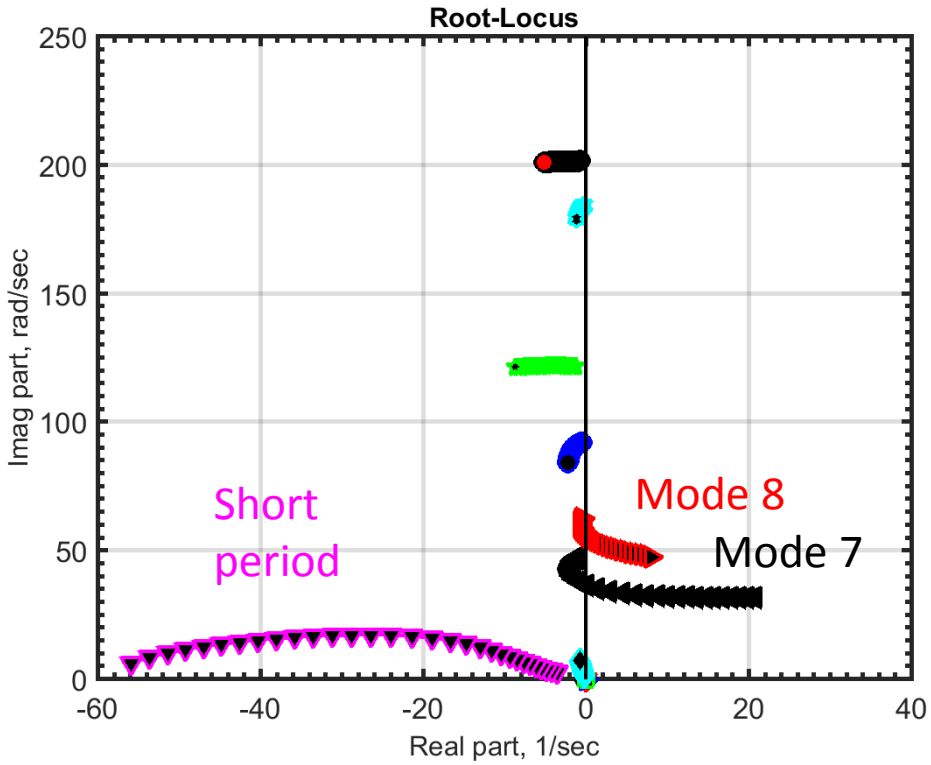
Mode frequencies comparison

Mode Shape*	GVT (Geri+WS4)	FEM v5.1 (Geri+WS4)	FEM v5.2	Diff.
SWB1	7.94	7.95	7.81	-1.64%
AWT1	9.2	12.5	10.0	8.70%
SWT1	16.1	15.9	14.73	-8.51%
AWB1	18.54	18.7	19.72	6.36%
SWB2	31.22	31.5	32.44	3.91%

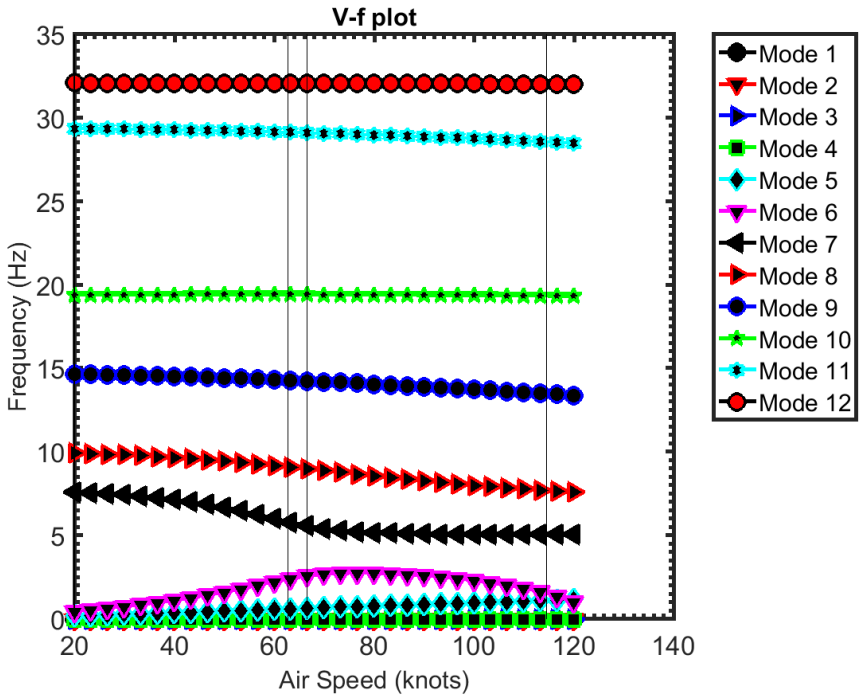
*: Mode shape description is for dominated mode shape

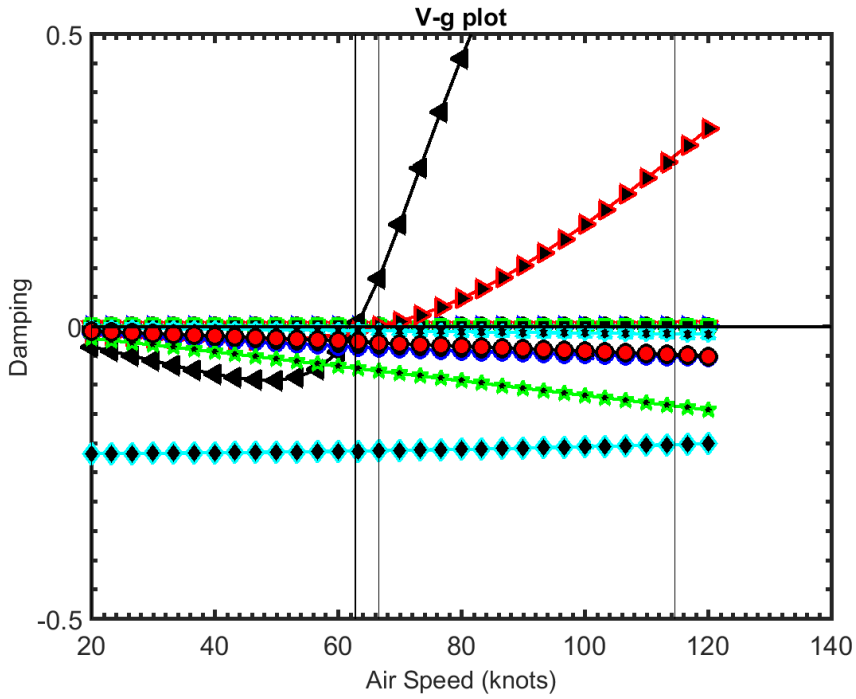
Flutter results (1/2)

Genuine Mode	Flutter speed, knots	Flutter frequency, Hz
Mode 7 (SWB1)	62.8 (32.3m/s)	5.8
Mode 8	66.7 (34.3m/s)	9.0

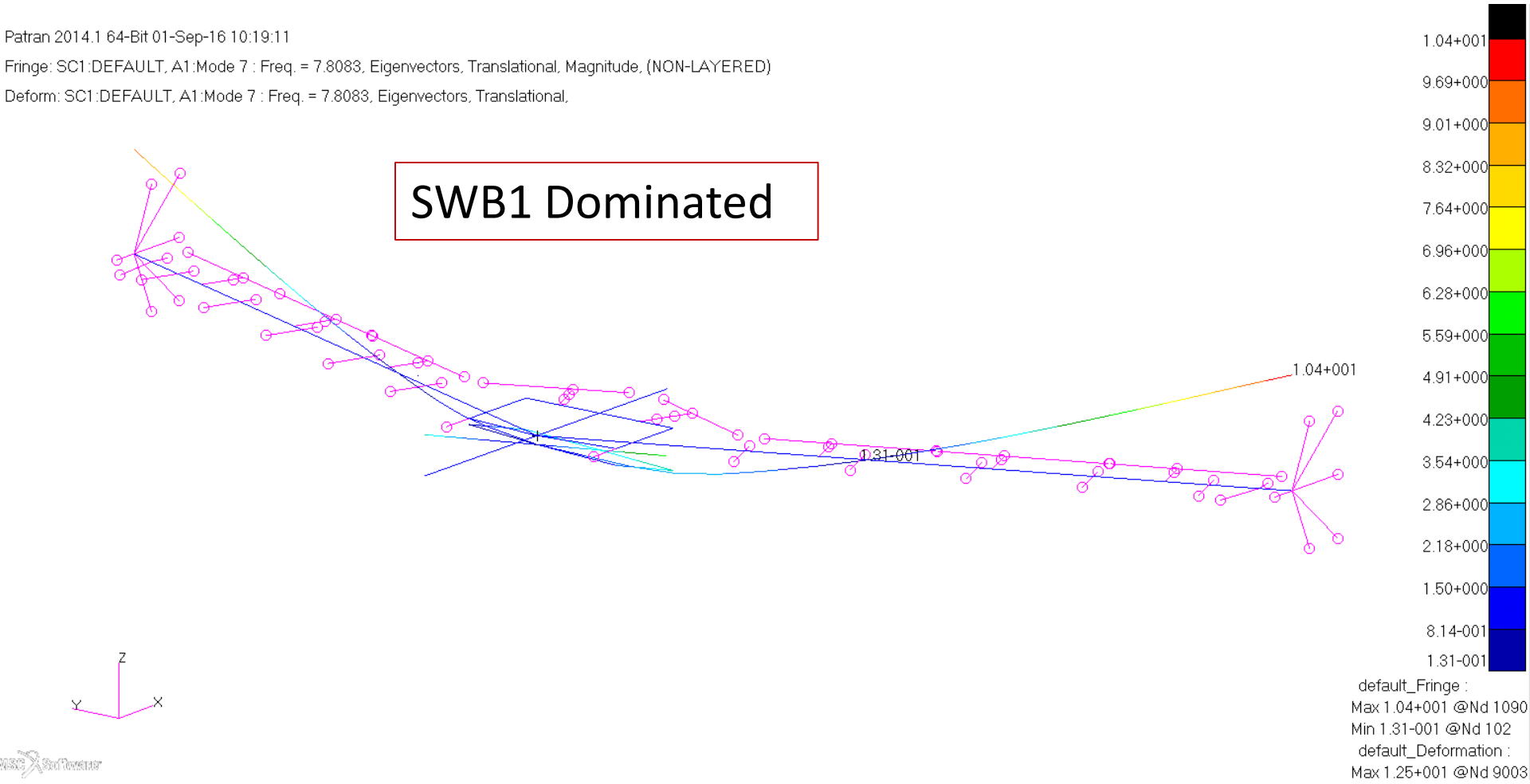


Flutter results (2/2)





Mode Shape


Patran 2014.1 64-Bit 01-Sep-16 10:19:11
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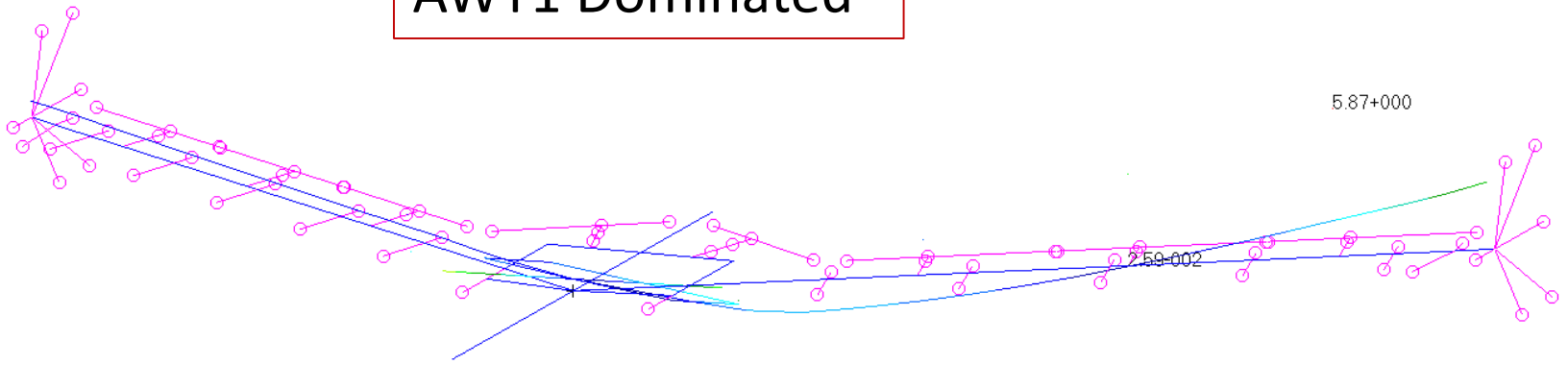
Deform: SC1:DEFAULT, A1:Mode 7 : Freq. = 7.8083, Eigenvectors, Translational,
SWB1 Dominated
1.04+001
1.31-001
1.04+001
9.69+000
9.01+000
8.32+000
7.64+000
6.96+000
6.28+000
5.59+000
4.91+000
4.23+000
3.54+000
2.86+000
2.18+000
1.50+000
8.14-001
1.31-001
default_Fringe :
Max 1.04+001 @Nd 1090
Min 1.31-001 @Nd 102
default_Deformation :
Max 1.25+001 @Nd 9003
Z
Y
X

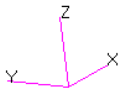
Patran 2014.1 64-Bit 01-Sep-16 13:33:53

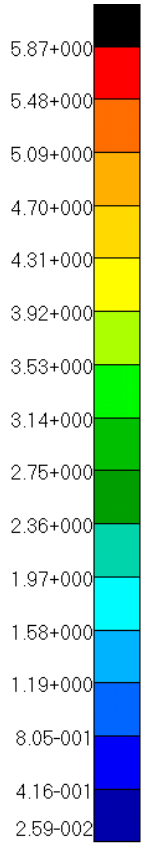
Fringe: SC1:DEFAULT, A1:Mode 8 : Freq. = 10.041, Eigenvectors, Translational, Magnitude, (NON-LAYERED)

Deform: SC1:DEFAULT, A1:Mode 8 : Freq. = 10.041, Eigenvectors, Translational,

AWT1 Dominated







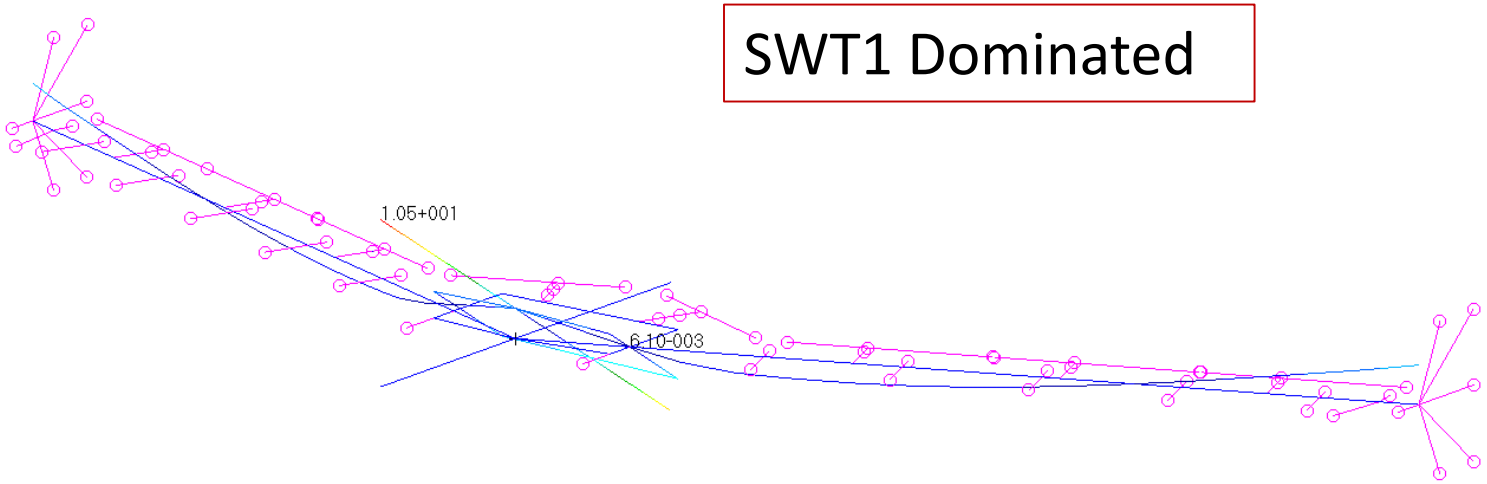
default_Fringe :
Max 5.87+000 @Nd 10014
Min 2.59-002 @Nd 1050
default_Deformation :
Max 7.30+000 @Nd 10004

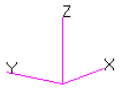
Patran 2014.1 64-Bit 01-Sep-16 10:20:14

Fringe: SC1:DEFAULT, A1:Mode 9 : Freq. = 14.725, Eigenvectors, Translational, Magnitude, (NON-LAYERED)

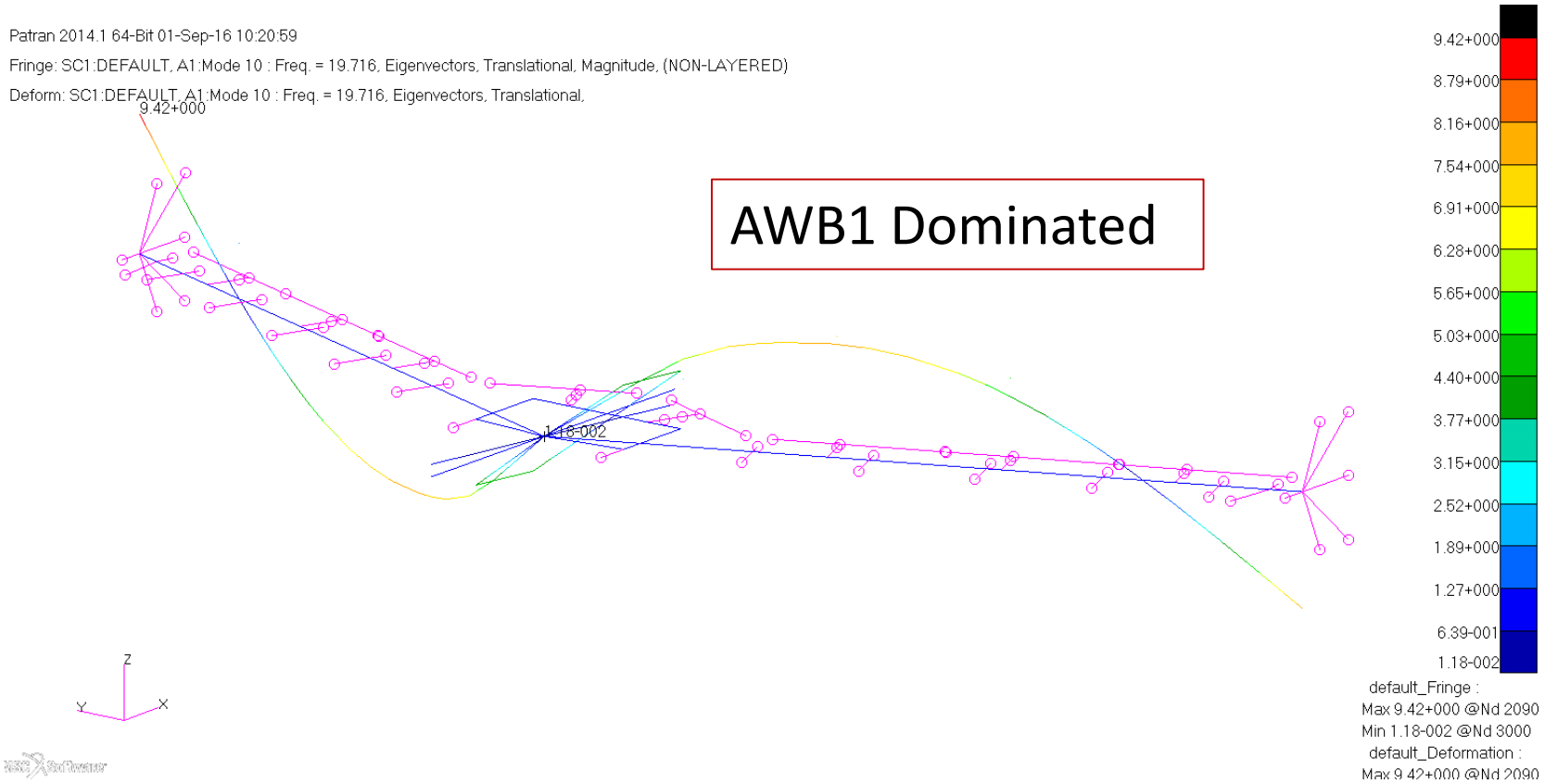
Deform: SC1:DEFAULT, A1:Mode 9 : Freq. = 14.725, Eigenvectors, Translational,

SWT1 Dominated





default_Fringe :
Max 1.05+001 @Nd 3001
Min 6.10-003 @Nd 1010
default_Deformation :
Max 1.05+001 @Nd 3001


Patran 2014.1 64-Bit 01-Sep-16 10:20:59
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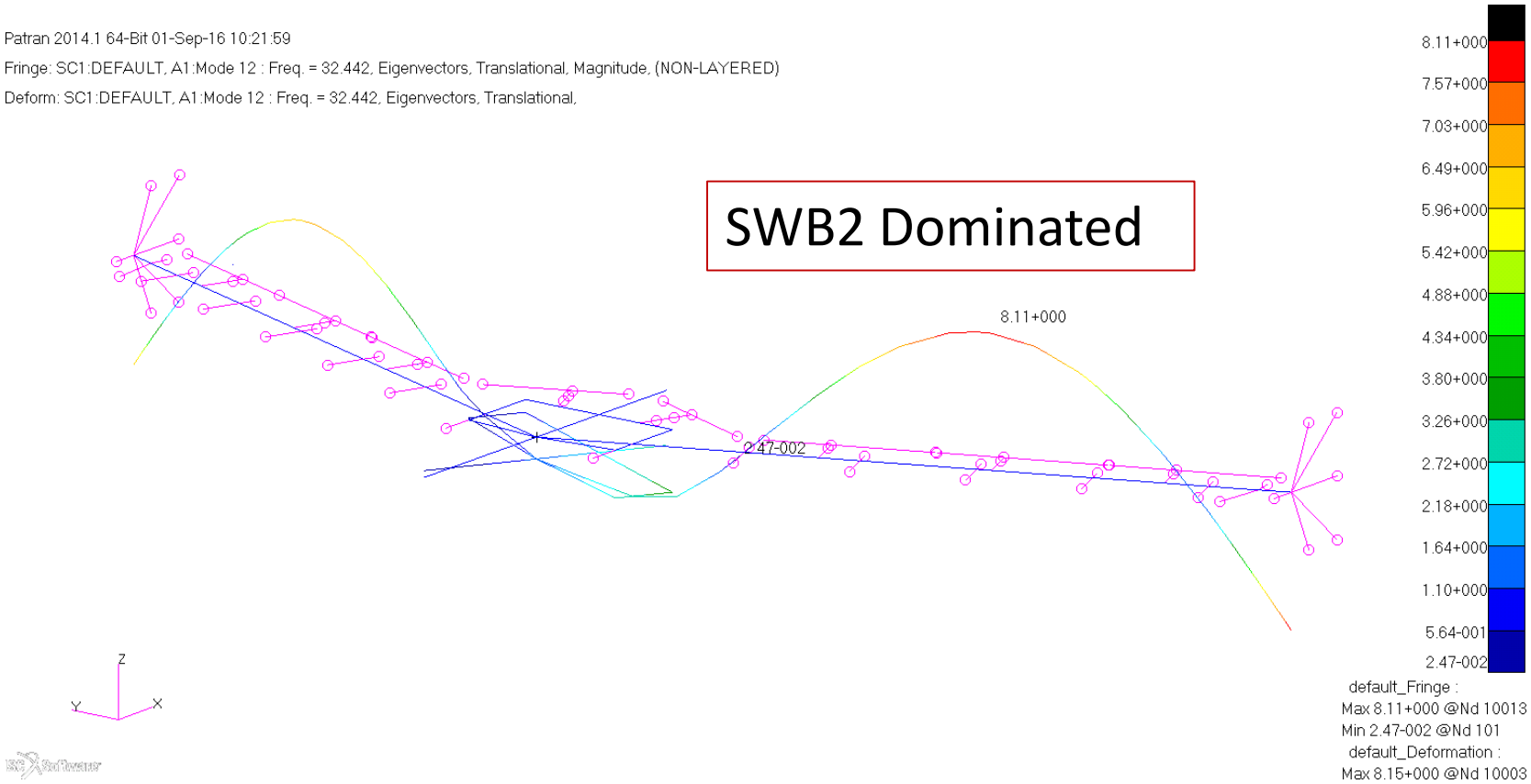
Deform: SC1:DEFAULT, A1:Mode 10 : Freq. = 19.716, Eigenvectors, Translational,
9.42+000
1.18-002
AWB1 Dominated
9.42+000
8.79+000
8.16+000
7.54+000
6.91+000
6.28+000
5.65+000
5.03+000
4.40+000
3.77+000
3.15+000
2.52+000
1.89+000
1.27+000
6.39-001
1.18-002
default_Fringe :
Max 9.42+000 @Nd 2090
Min 1.18-002 @Nd 3000
default_Deformation :
Max 9.42+000 @Nd 2090
Z
Y
X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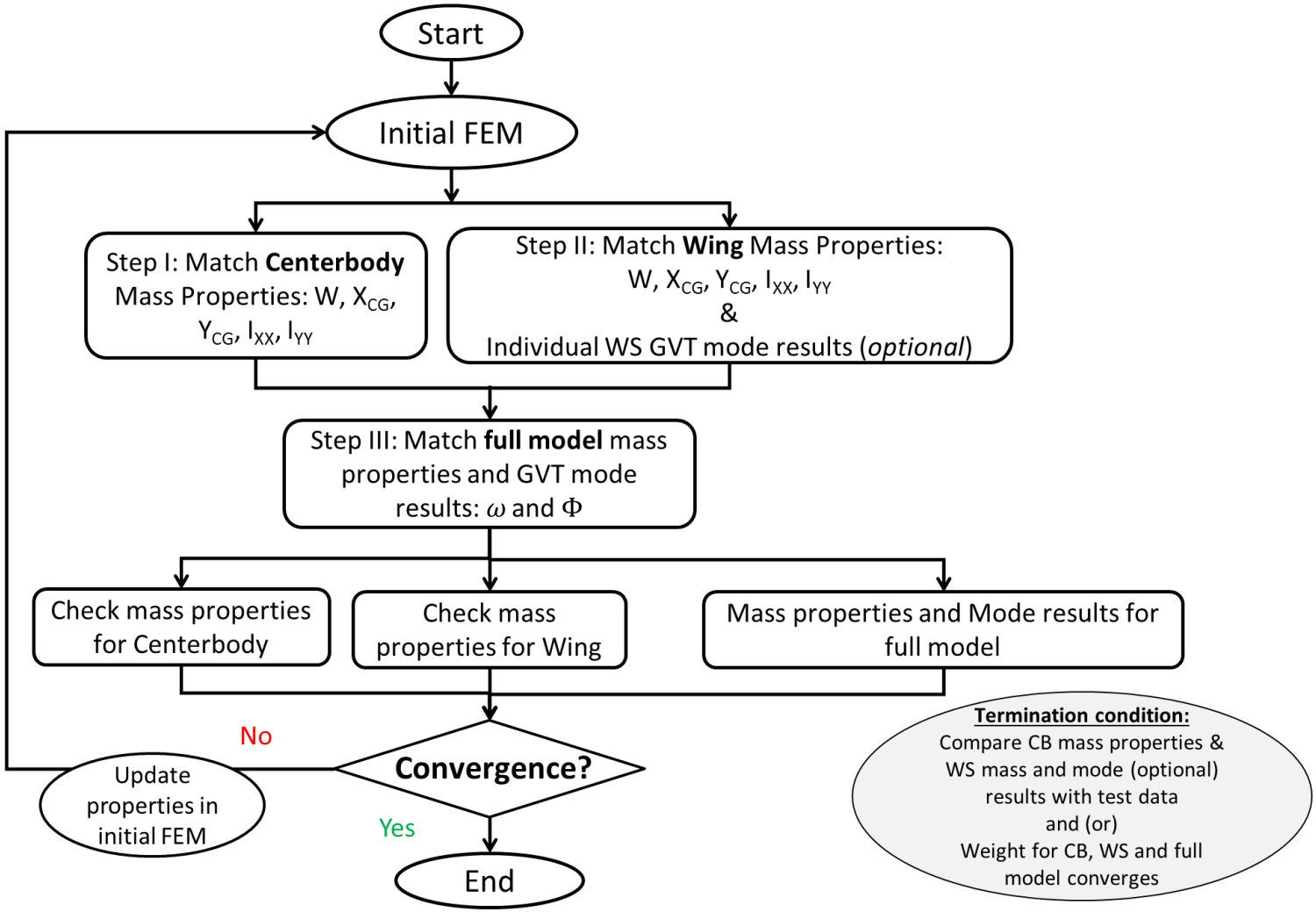
Deform: SC1:DEFAULT, A1:Mode 12 : Freq. = 32.442, Eigenvectors, Translational,
SWB2 Dominated
8.11+000
2.47-002
8.11+000
7.57+000
7.03+000
6.49+000
5.96+000
5.42+000
4.88+000
4.34+000
3.80+000
3.26+000
2.72+000
2.18+000
1.64+000
1.10+000
5.64-001
2.47-002
default_Fringe :
Max 8.11+000 @Nd 10013
Min 2.47-002 @Nd 101
default_Deformation :
Max 8.15+000 @Nd 10003
Z
Y
X

Summary

- Good comparisons in mode results and mass properties of FEM v5.2 with test article's data
- Good comparison of BFF speed of FEM v5.2 with previous Skoll test speed (30m/s)
- FEM v5.2 could be used for flutter analysis or possible flutter suppression analysis

FEM updating flowchart



Iteration history