Aeroelastic Prediction Workshop

BSCW Comparison Plots

Notes: These comparisons are utilizing the preliminary data, as submitted prior to the AePW. These are workshop results, not publication results.
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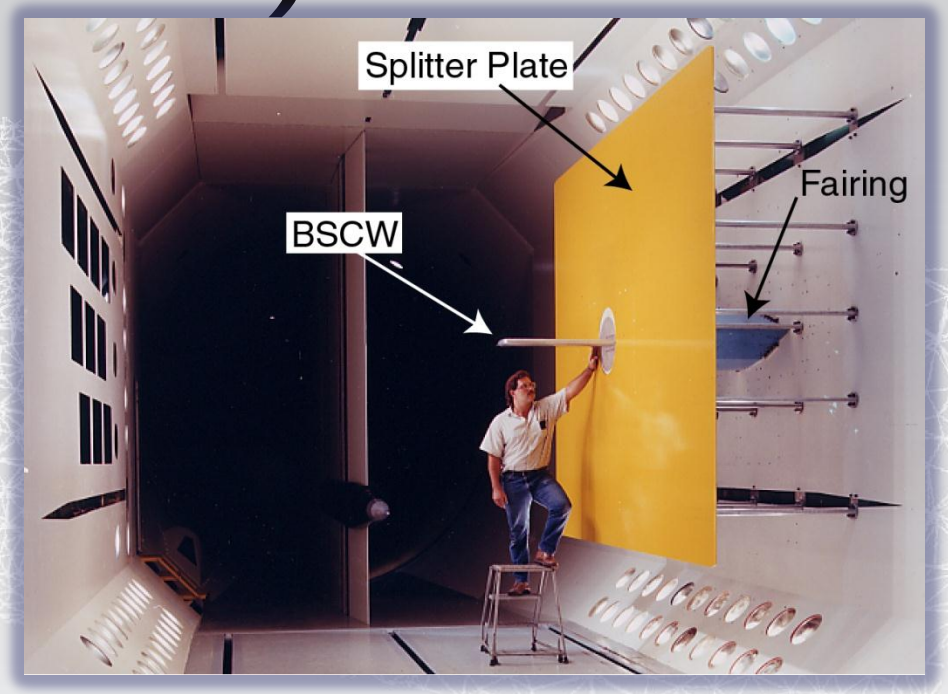
Benchmark Supercritical Wing (BSCW)

- Simple, rectangular wing
- Structure treated as rigid
- Data acquired under mixed attached/separated flow conditions



Known deficiencies:

- Limited number of pressure transducers in experimental data
- Limited number of discrete frequencies of oscillation
- Mach number is at edge of acceptable range for quality pressure data with splitter plate

M=0.85, Re_c=4.49 million, test medium: R-134a

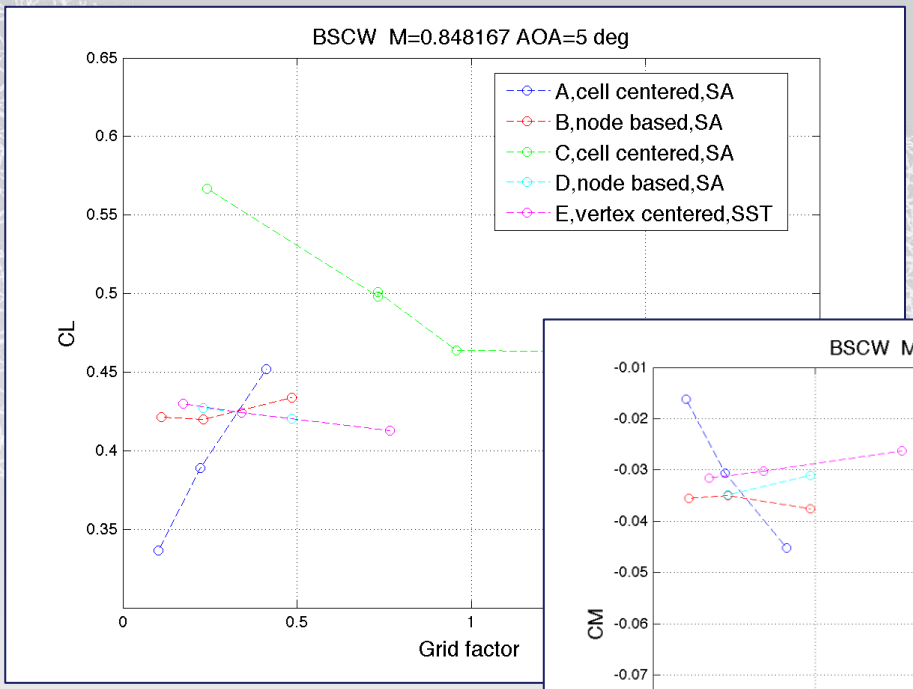
a) Steady Case
   i. $\alpha = 5°$

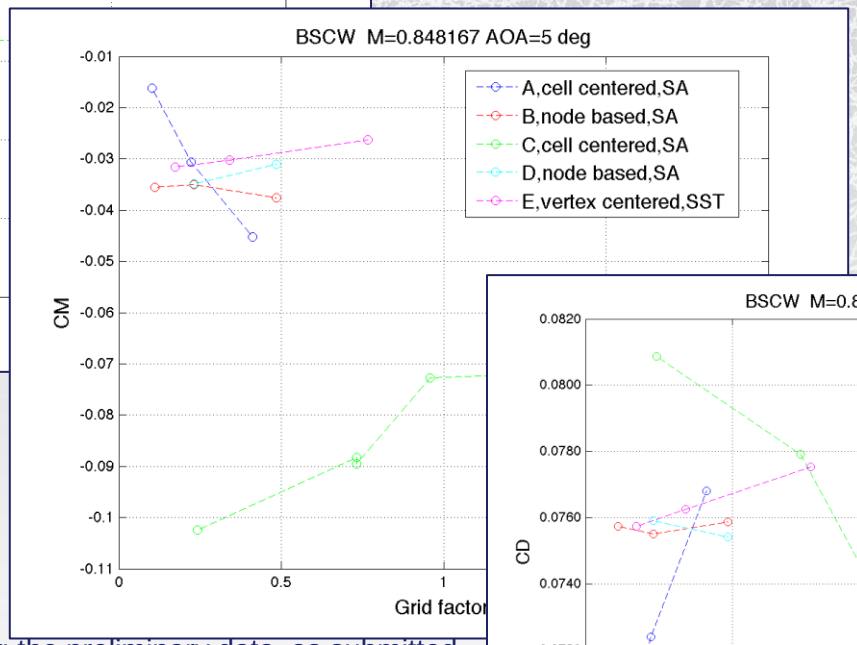
b) Dynamic Cases
   i. $\alpha = 5°$, $\theta = 1°$, f = 1 Hz
   ii. $\alpha = 5°$, $\theta = 1°$, f = 10 Hz

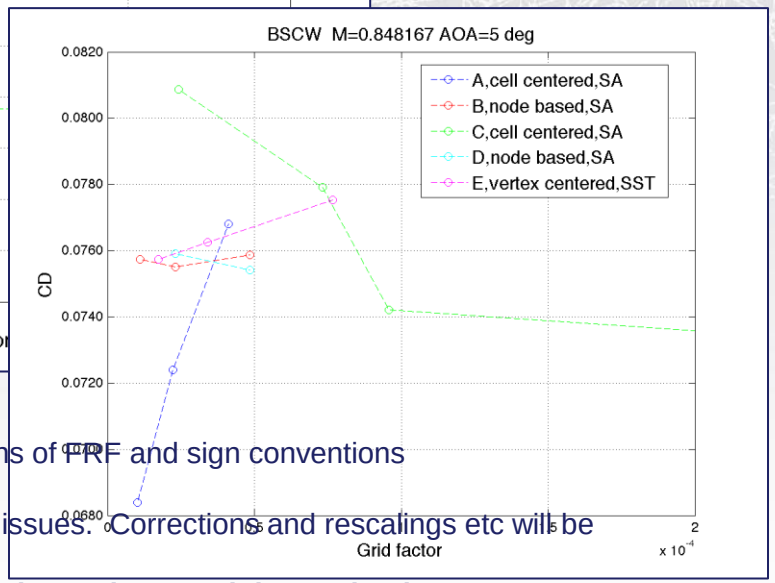
Convergence, spatial

CONFIGURATION	REQUIRED CALCULATIONS			
	GRID CONVERGENCE STUDIES	TIME CONVERGENCE STUDIES	STEADY CALCULATIONS	DYNAMIC CALCULATIONS
Steady-Rigid Cases (RSW, BSCW)	C_L, C_D, C_M vs. $N^{-2/3}$	n/a	• Mean C_p vs. x/c • Means of C_L, C_D, C_M	n/a
Steady-Aeroelastic Cases (HIRENASD)	C_L, C_D, C_M vs. $N^{-2/3}$	n/a	• Mean C_p vs. x/c • Means of C_L, C_D, C_M • Vertical displacement vs. chord • Twist angle vs. span	n/a
Forced Oscillation Cases (all configurations)	• Magnitude and Phase of CL, CD, CM (vs. $N^{-2/3}$ at excitation frequency)	• Magnitude and Phase of C_L, C_D, C_M (vs. Δt at excitation frequency)	n/a	• Magnitude and Phase of C_p vs. x/c at span stations corresponding to transducer locations • Magnitude and Phase of C_L, C_D, C_M at excitation frequency • Time histories of C_p's at a selected span station for two upper- and two lower-surface transducer locations

Steady Grid Convergence







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Steady Calculations
C_p vs. x/c

CONFIGURATION	REQUIRED CALCULATIONS			
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Steady-Rigid Cases (RSW, BSCW)	C_L, C_D, C_M vs. $N^{-2/3}$	n/a	• Mean C_p vs. x/c • Means of C_L, C_D, C_M	n/a
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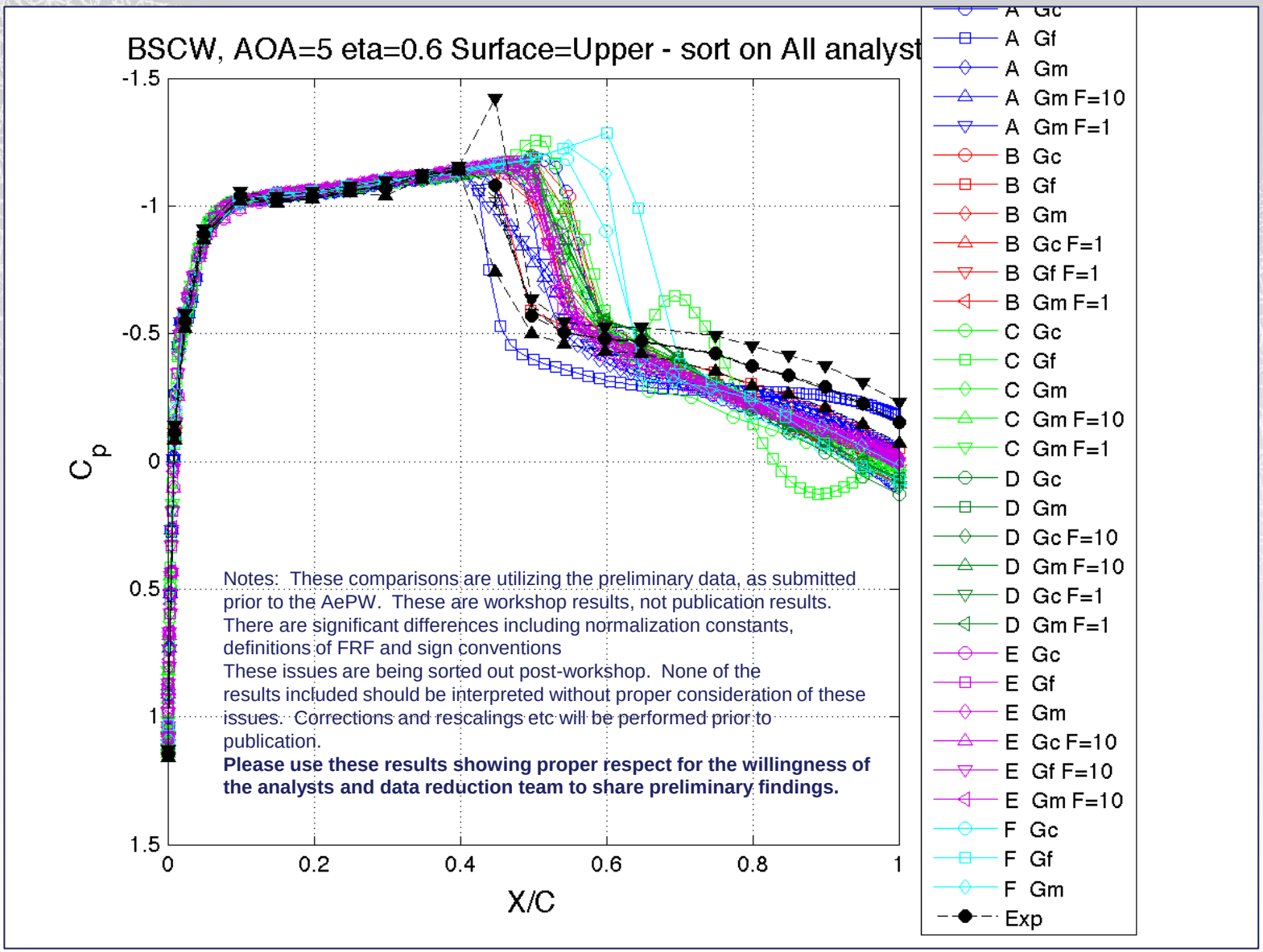
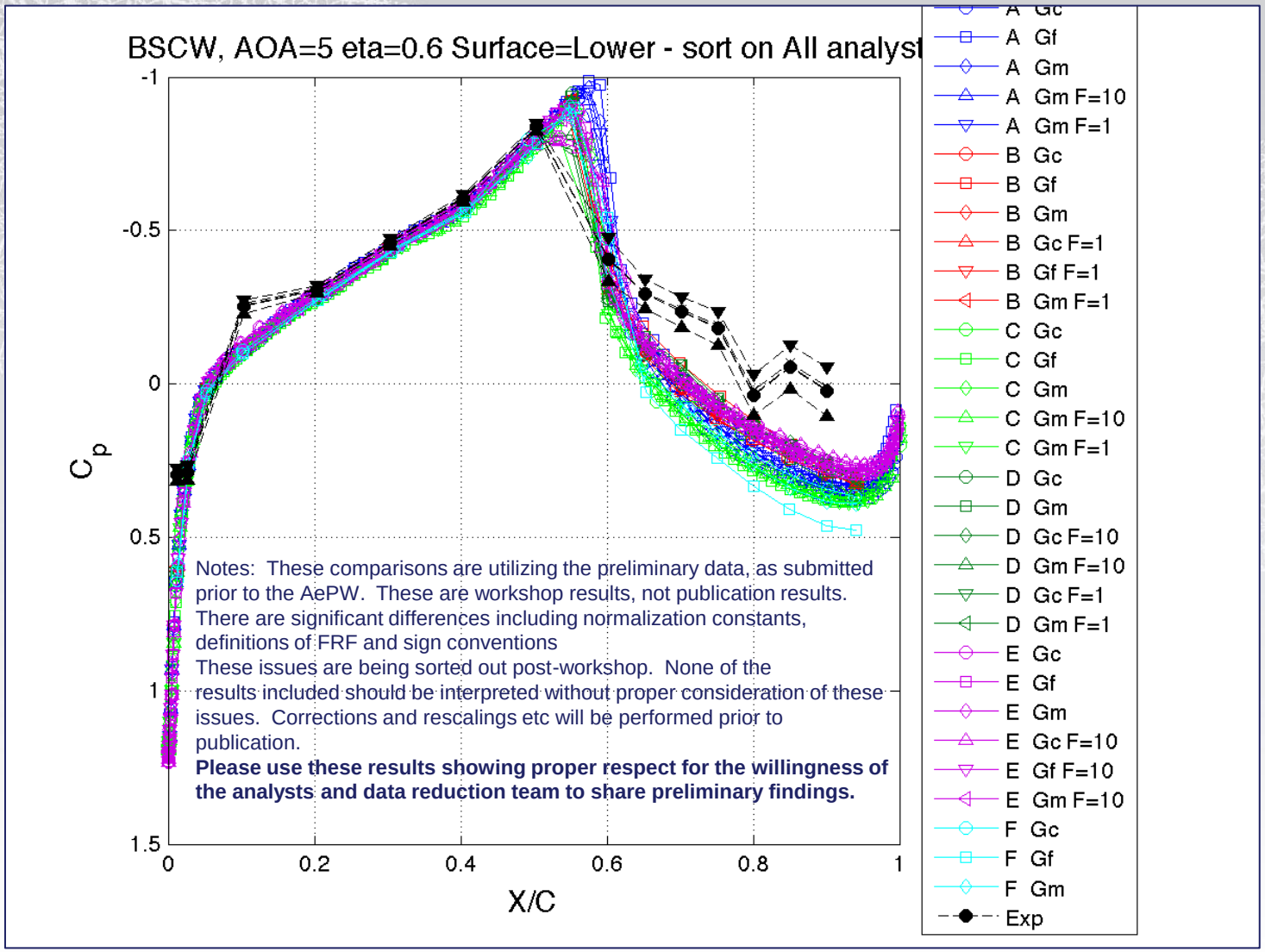
Upper Surface Steady C_p

$\alpha = 5^0,\ \eta = 0.6$



Lower Surface Steady C_p

$\alpha = 5^0,\ \eta = 0.6$



Dynamic Calculations
Magnitude and Phase of C_p vs. x/c

CONFIGURATION	REQUIRED CALCULATIONS			
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Steady-Rigid Cases (RSW, BSCW)	C_L, C_D, C_M vs. $N^{-2/3}$	n/a	• Mean C_p vs. x/c • Means of C_L, C_D, C_M	n/a
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1 Hz
Dynamic Calculations

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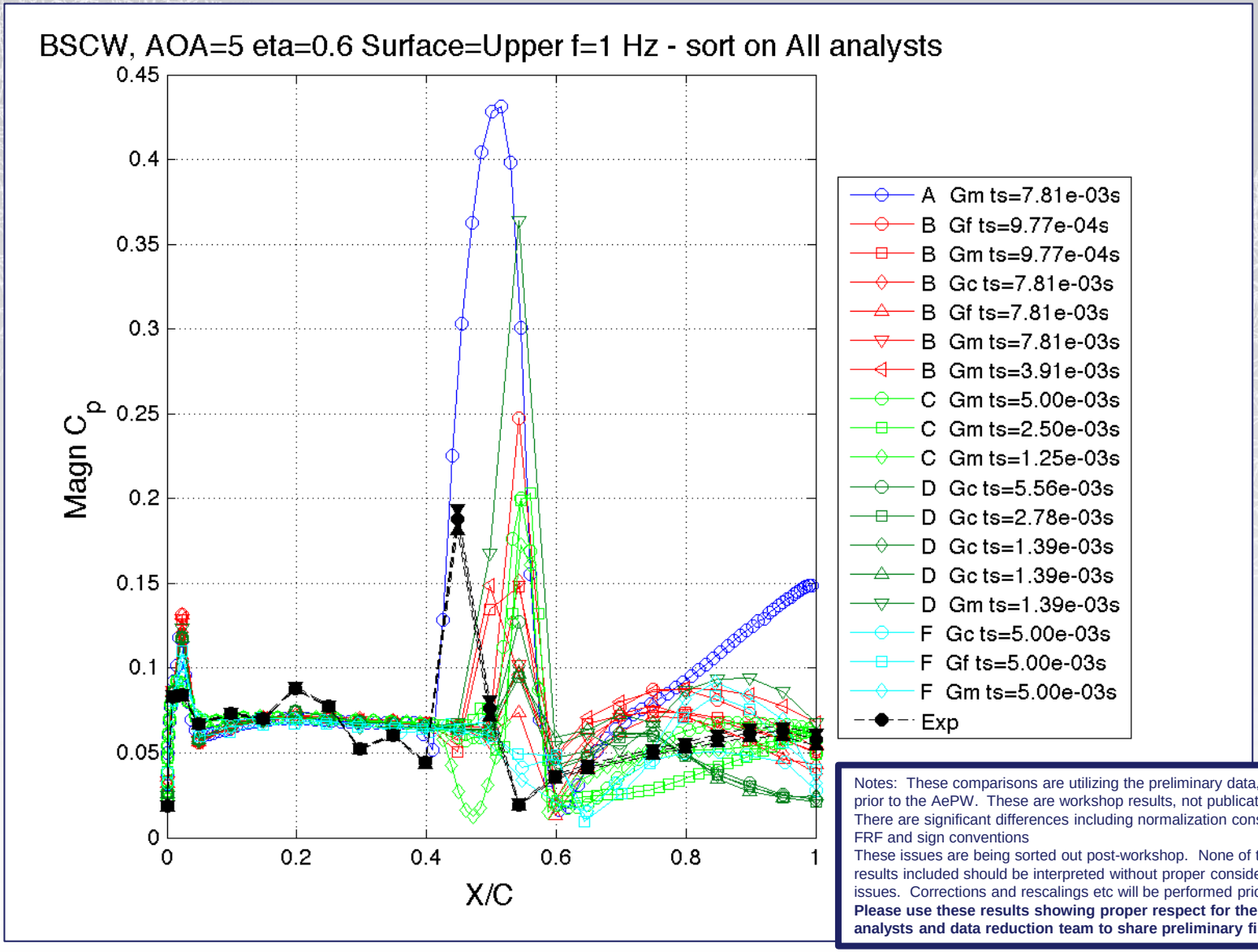
Upper Surface Unsteady C_p Magnitude

$\alpha = 5^0,\ \eta = 0.6,\ f = 1\ Hz$



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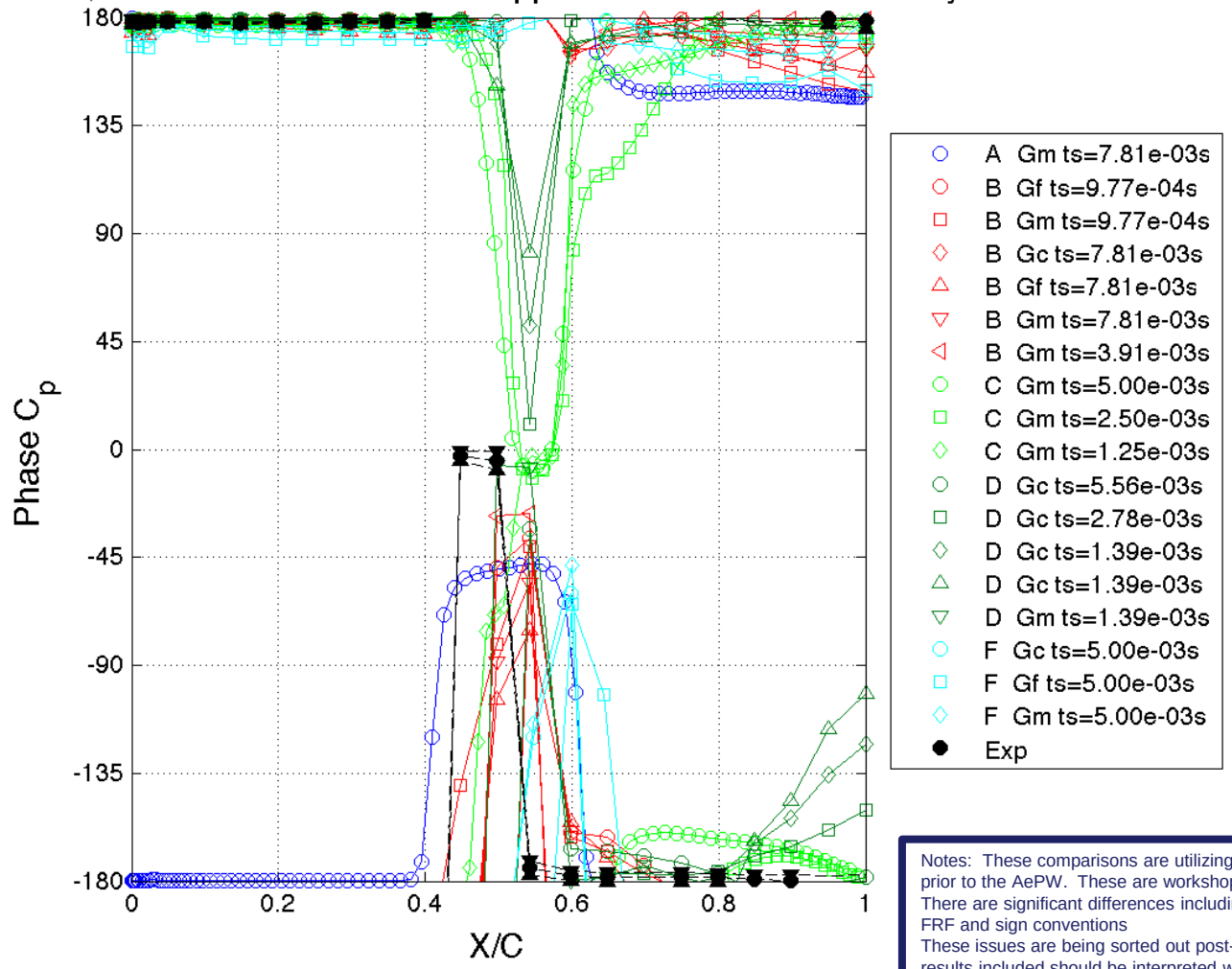
Upper Surface Unsteady C_p Phase

$\alpha = 5^0,\ \eta = 0.6,\ f = 1\ Hz$



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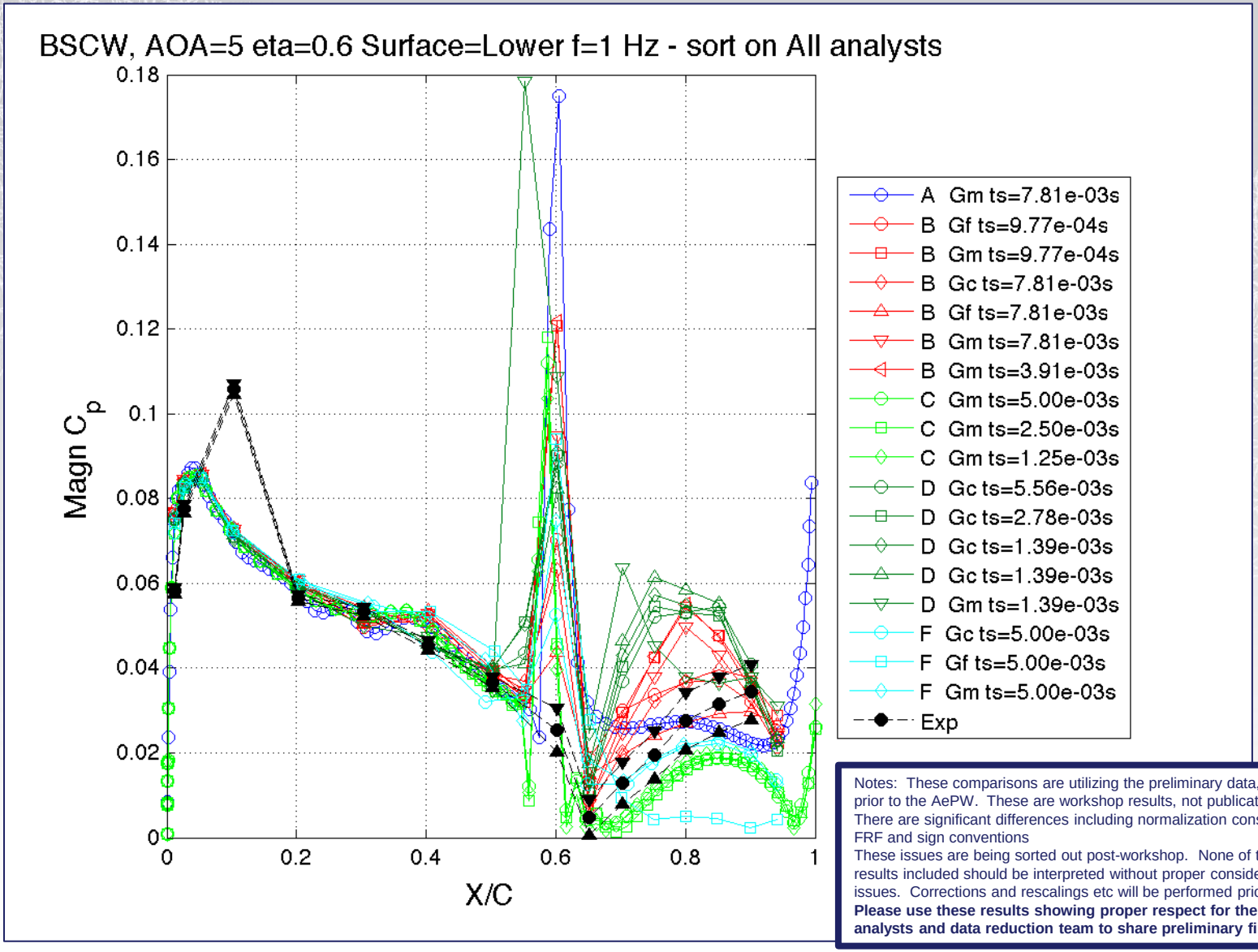
Lower Surface Unsteady C_p Magnitude

$\alpha = 5^0,\ \eta = 0.6,\ f = 1\ Hz$



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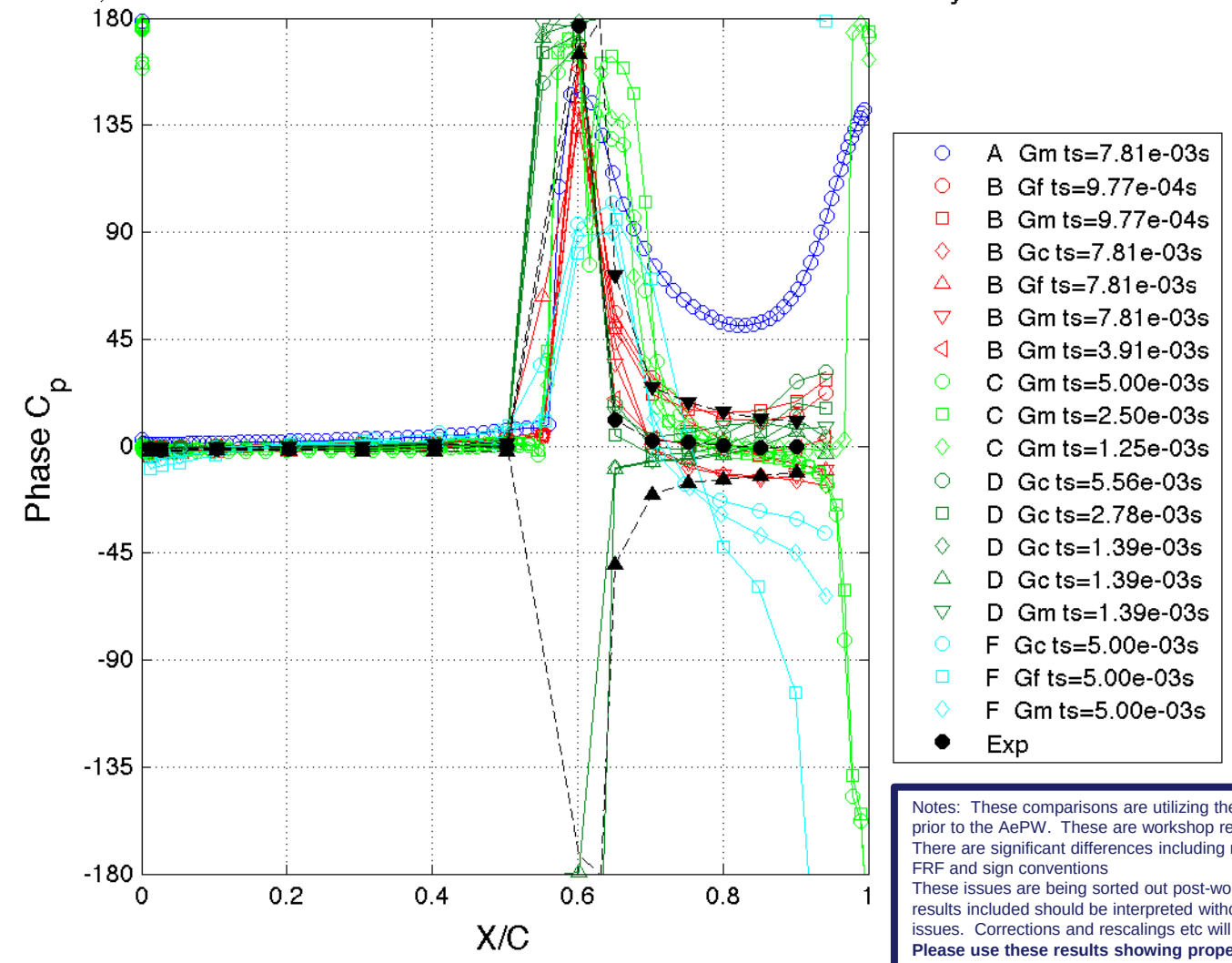
Lower Surface Unsteady C_p Phase

$\alpha = 5^0,\ \eta = 0.6,\ f = 1\ Hz$



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10 Hz
Dynamic Calculations

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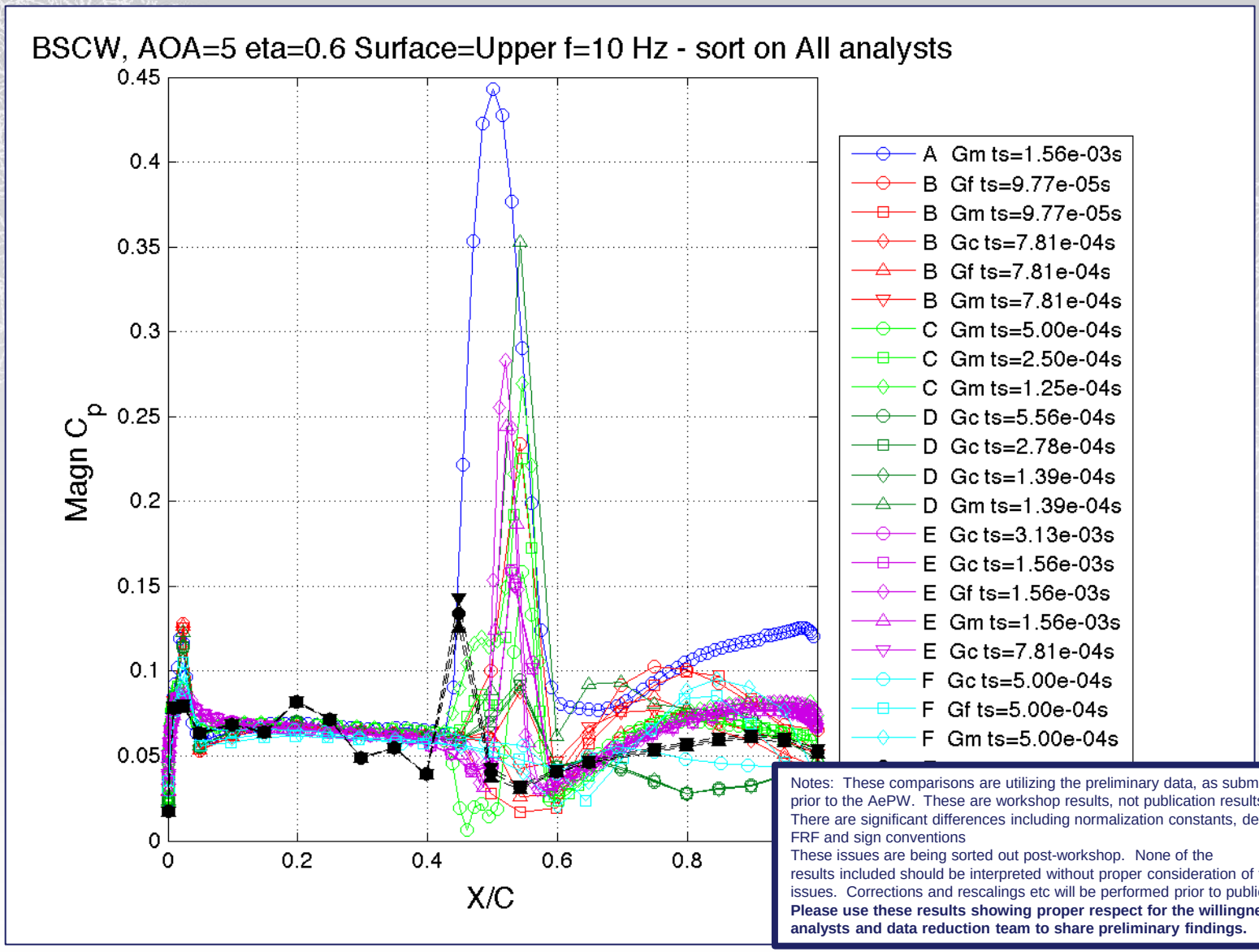
Upper Surface Unsteady C_p Magnitude

$\alpha = 5^0,\ \eta = 0.6,\ f = 10\ Hz$



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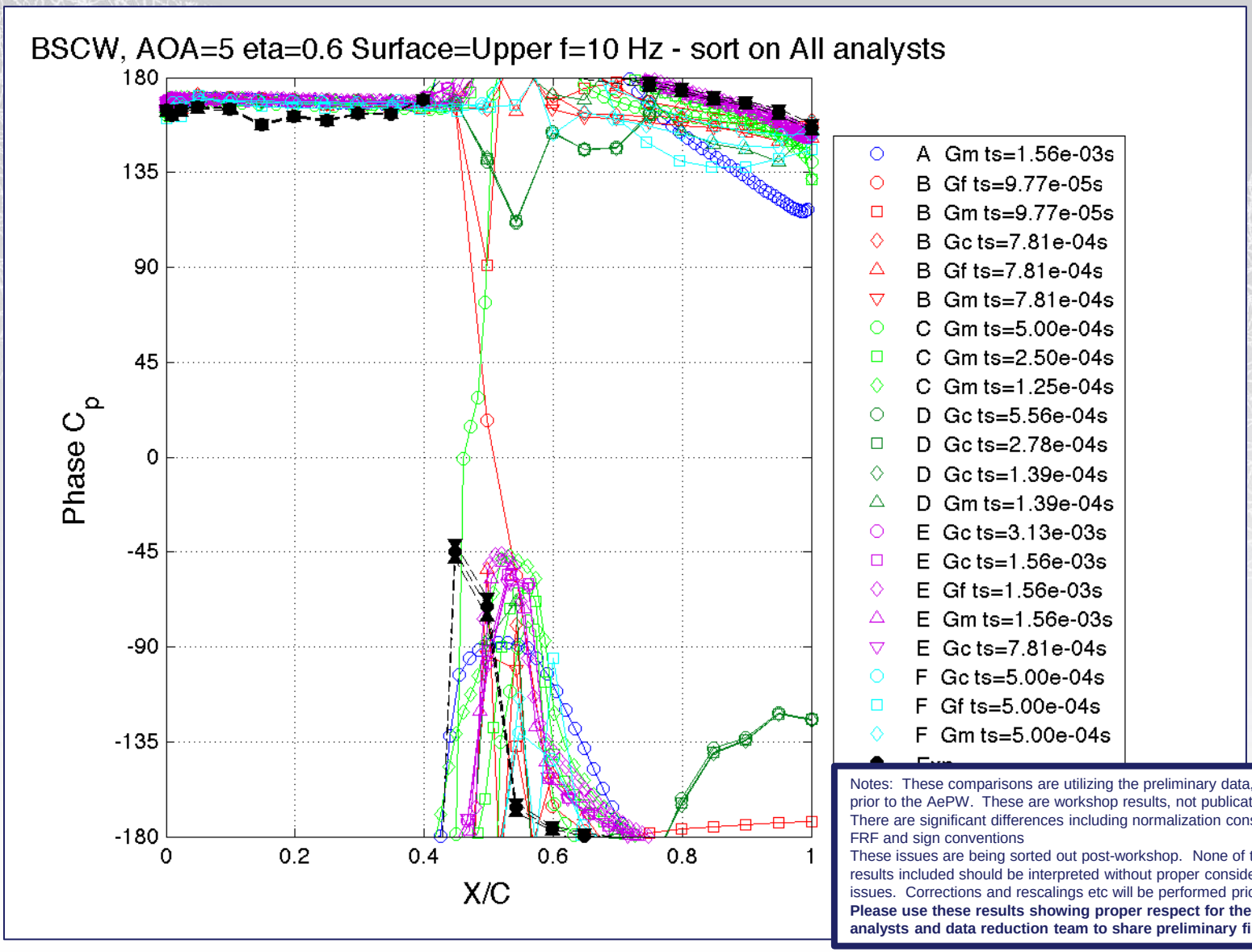
Upper Surface Unsteady C_p Phase

$\alpha = 5^0,\ \eta = 0.6,\ f = 10\ Hz$



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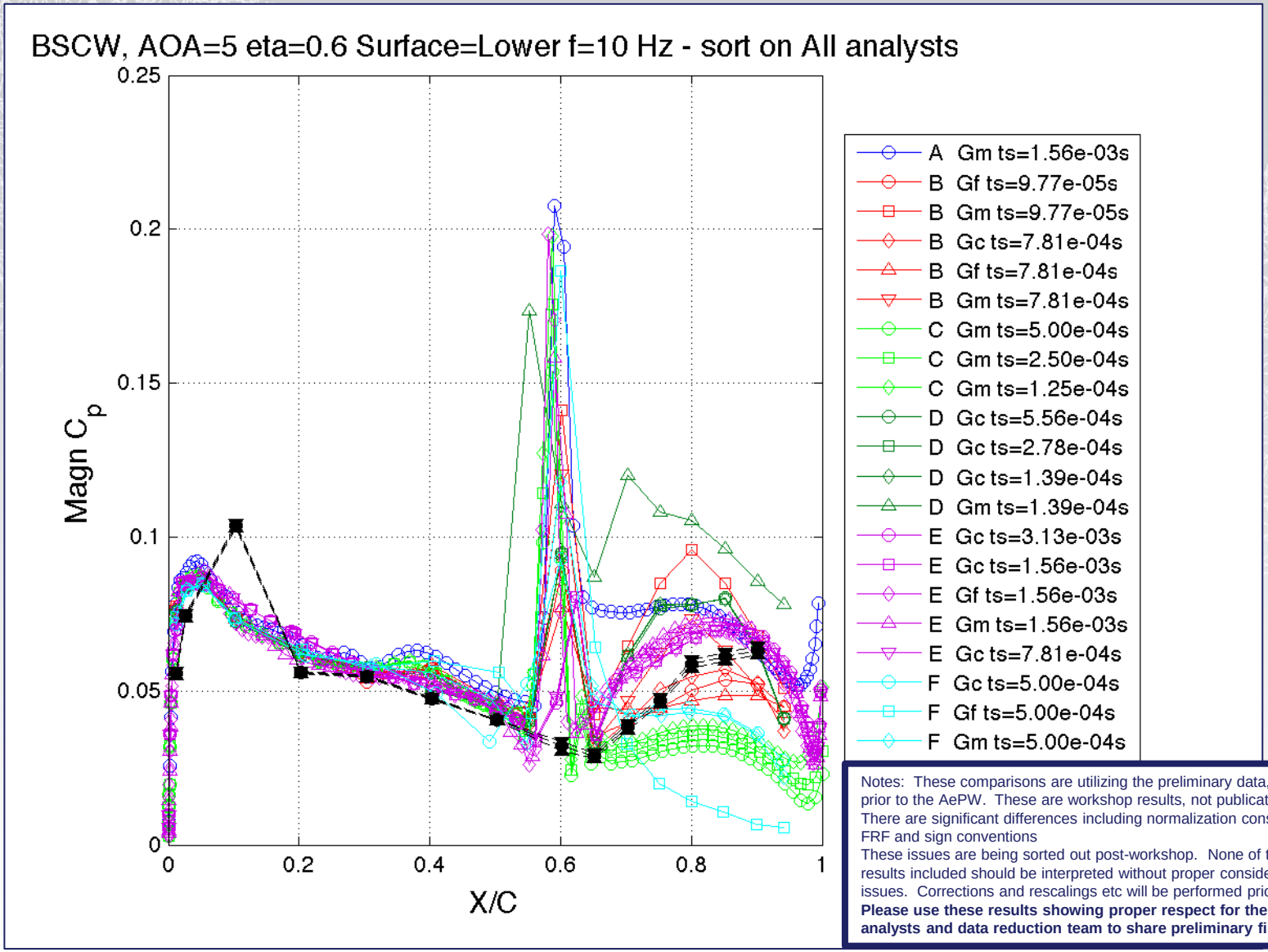
Lower Surface Unsteady C_p Magnitude

$\alpha = 5^0,\ \eta = 0.6,\ f = 10\ Hz$



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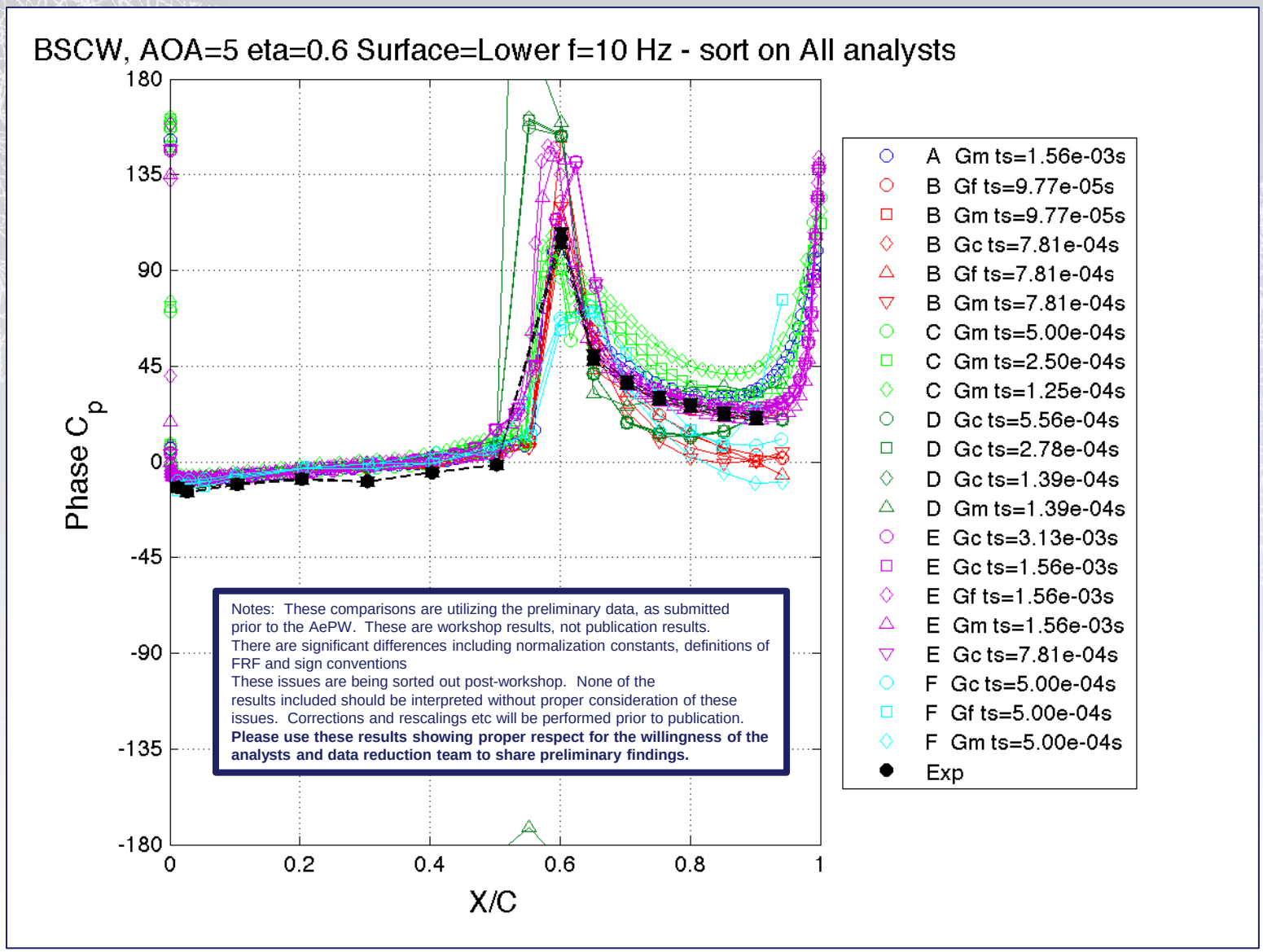
Lower Surface Unsteady C_p Phase

$\alpha = 5^0,\ \eta = 0.6,\ f = 10\ Hz$



All Magnitude Data

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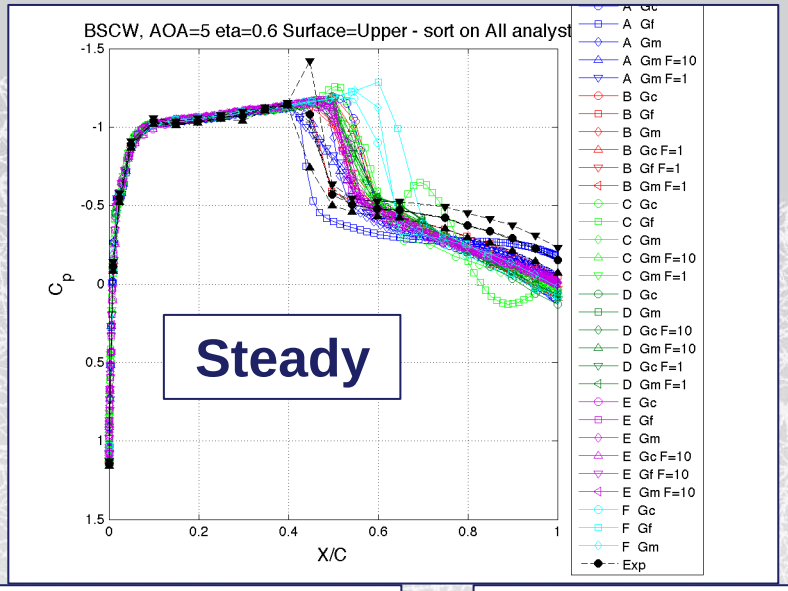
Comparison results, Upper surface



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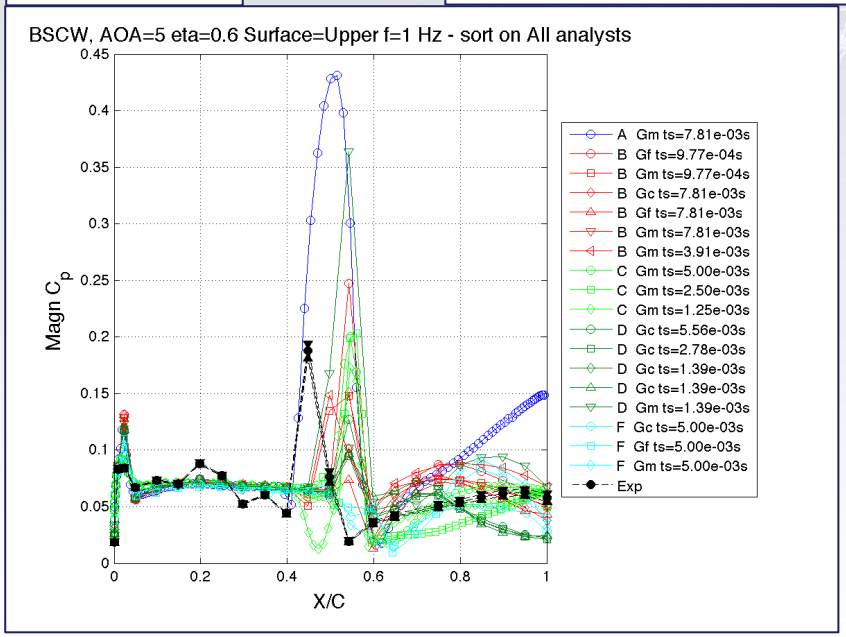
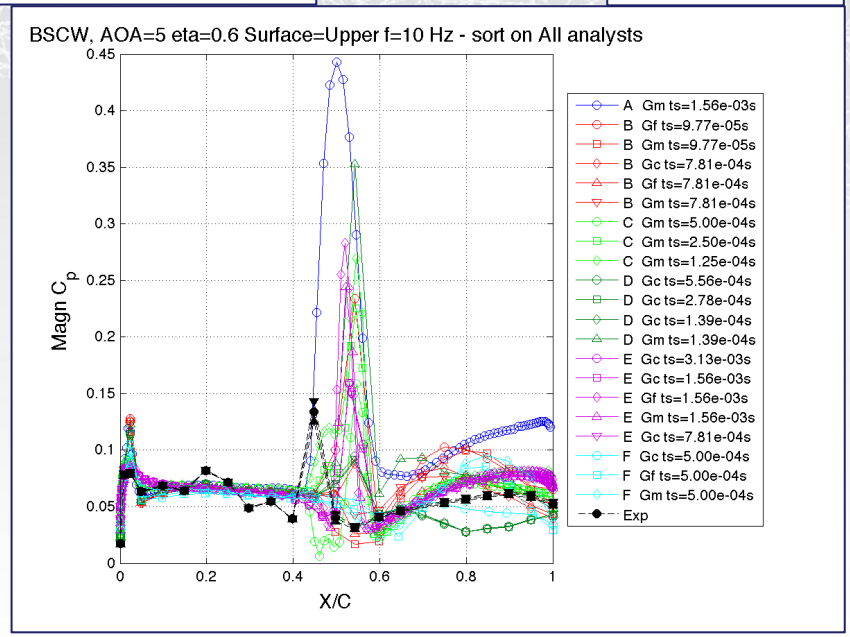
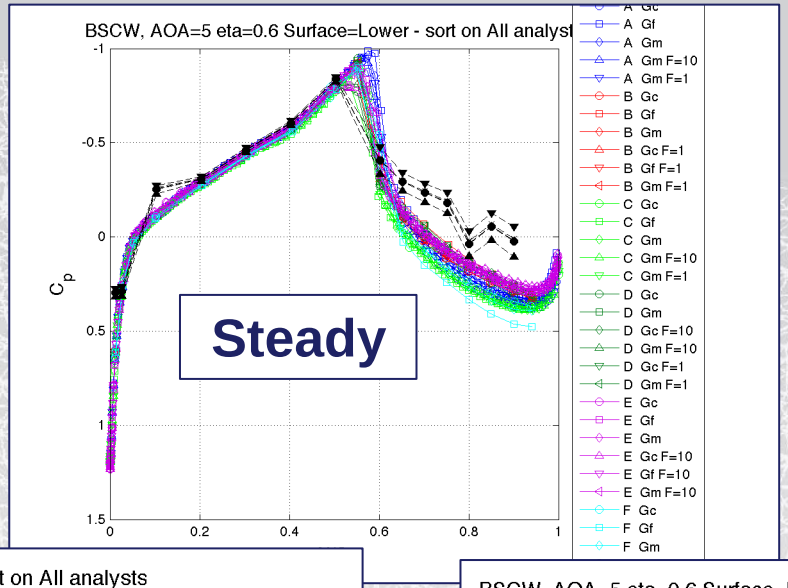
1 Hz



10 Hz



Comparison results, Lower surface



Steady

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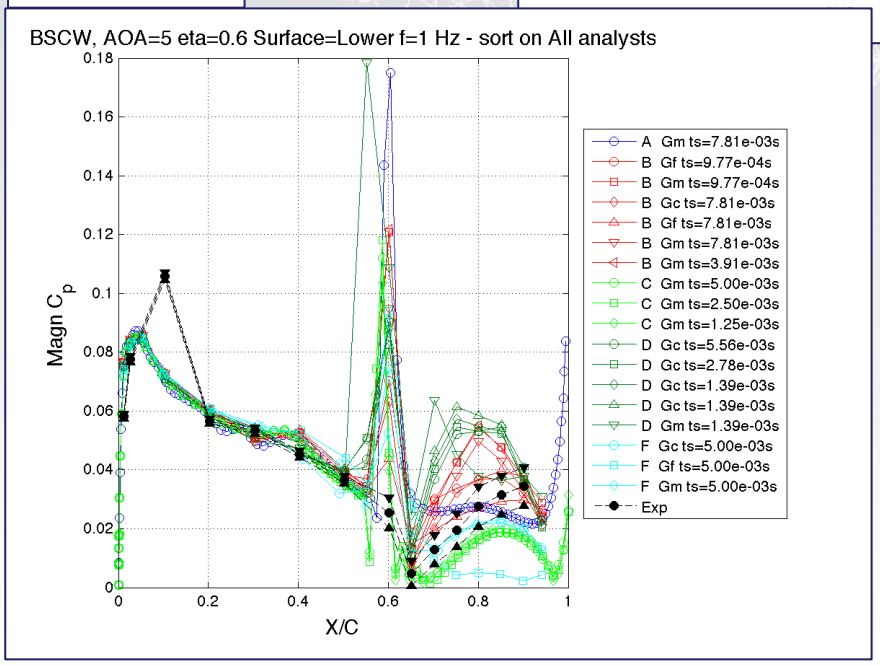
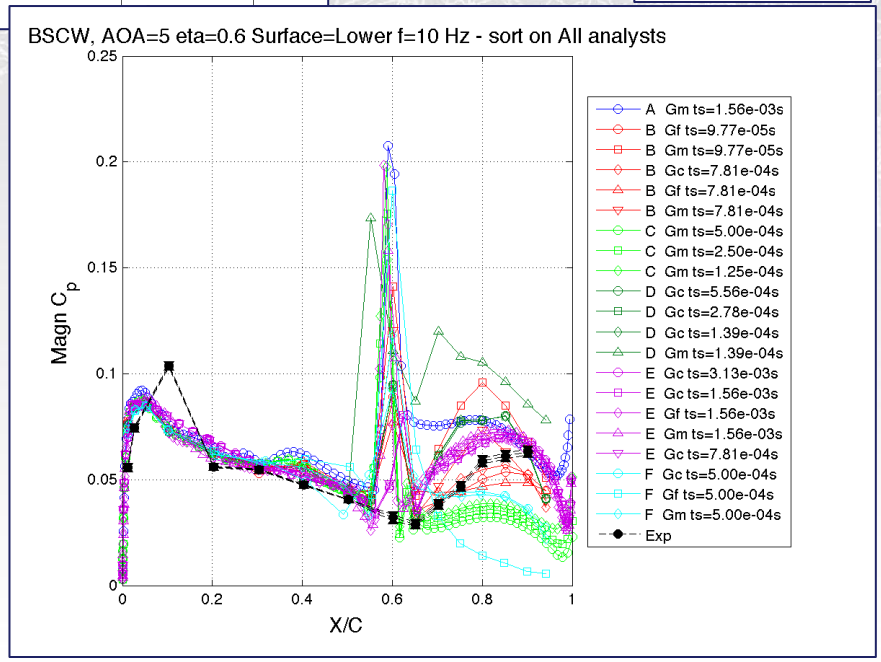
1 Hz



10 Hz



Comparison Data Matrix

CONFIGURATION	REQUIRED CALCULATIONS			
	GRID CONVERGENCE STUDIES	TIME CONVERGENCE STUDIES	STEADY CALCULATIONS	DYNAMIC CALCULATIONS
Steady-Rigid Cases (RSW, BSCW)	C_L, C_D, C_M vs. $N^{-2/3}$ ✓	n/a	• Mean C_p vs. x/c ✓ • Means of C_L, C_D, C_M ✓	n/a
Steady-Aeroelastic Cases (HIRENASD)	C_L, C_D, C_M vs. $N^{-2/3}$ ✓	n/a	• Mean C_p vs. x/c ✓ • Means of C_L, C_D, C_M ✓ • Vertical displacement vs. chord ✓ • Twist angle vs. span ✓	n/a
Forced Oscillation Cases (all configurations)	• Magnitude and Phase of C_L, C_D, C_M vs. $N^{-2/3}$ at excitation frequency ✓	• Magnitude and Phase of C_L, C_D, C_M vs. Δt at excitation frequency ✓	n/a	• Magnitude and Phase of C_p vs. x/c at span stations corresponding to transducer locations ✓ • Magnitude and Phase of C_L, C_D, C_M at excitation frequency ✓ • Time histories of C_p's at a selected span station for two upper- and two lower-surface transducer locations

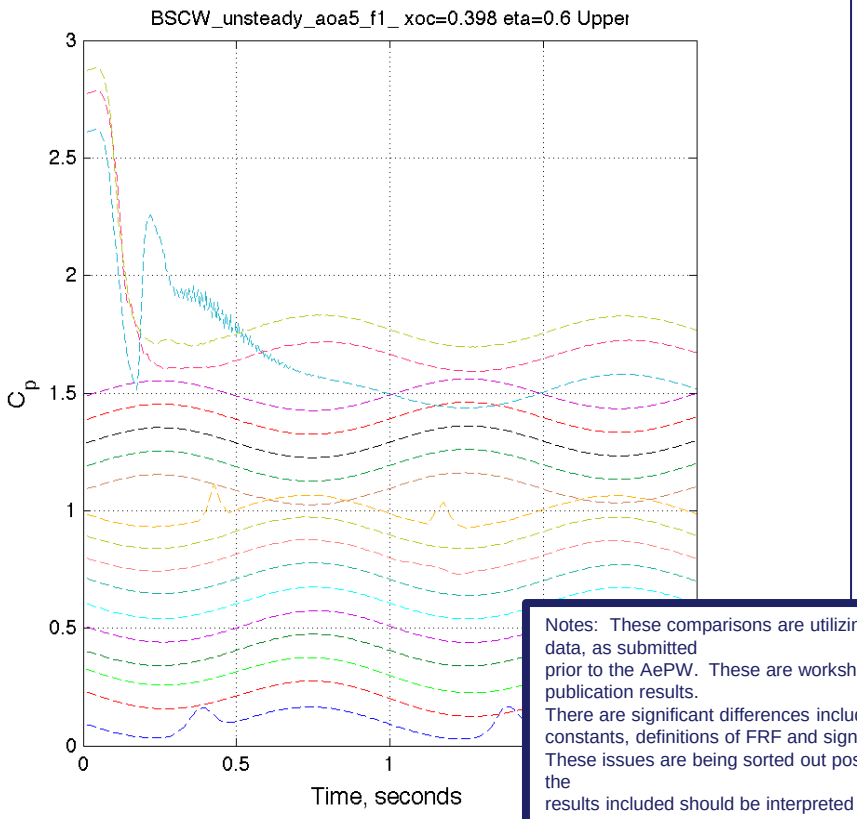
Time History Plots

Approximately 2 Cycles

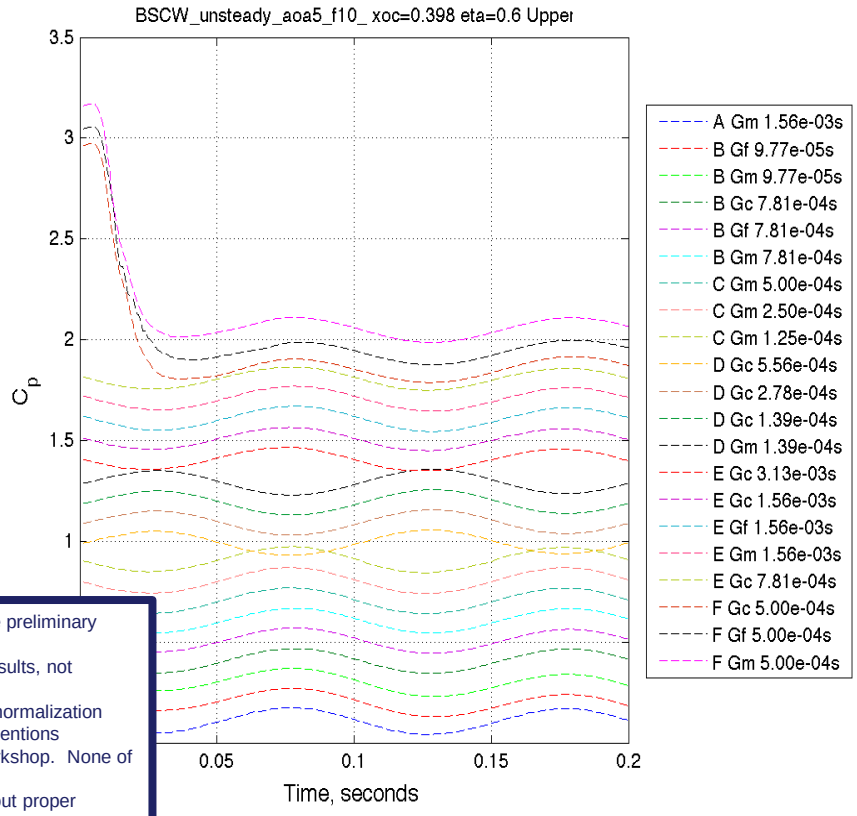
x/c = 0.398, η = 0.6

Note:
Some analysts submitted time histories with initial Transients removed.
Others, on request, submitted their data with initial transients included in the data set for examining the effects on data anlayses

F = 1 Hz



F = 10 Hz



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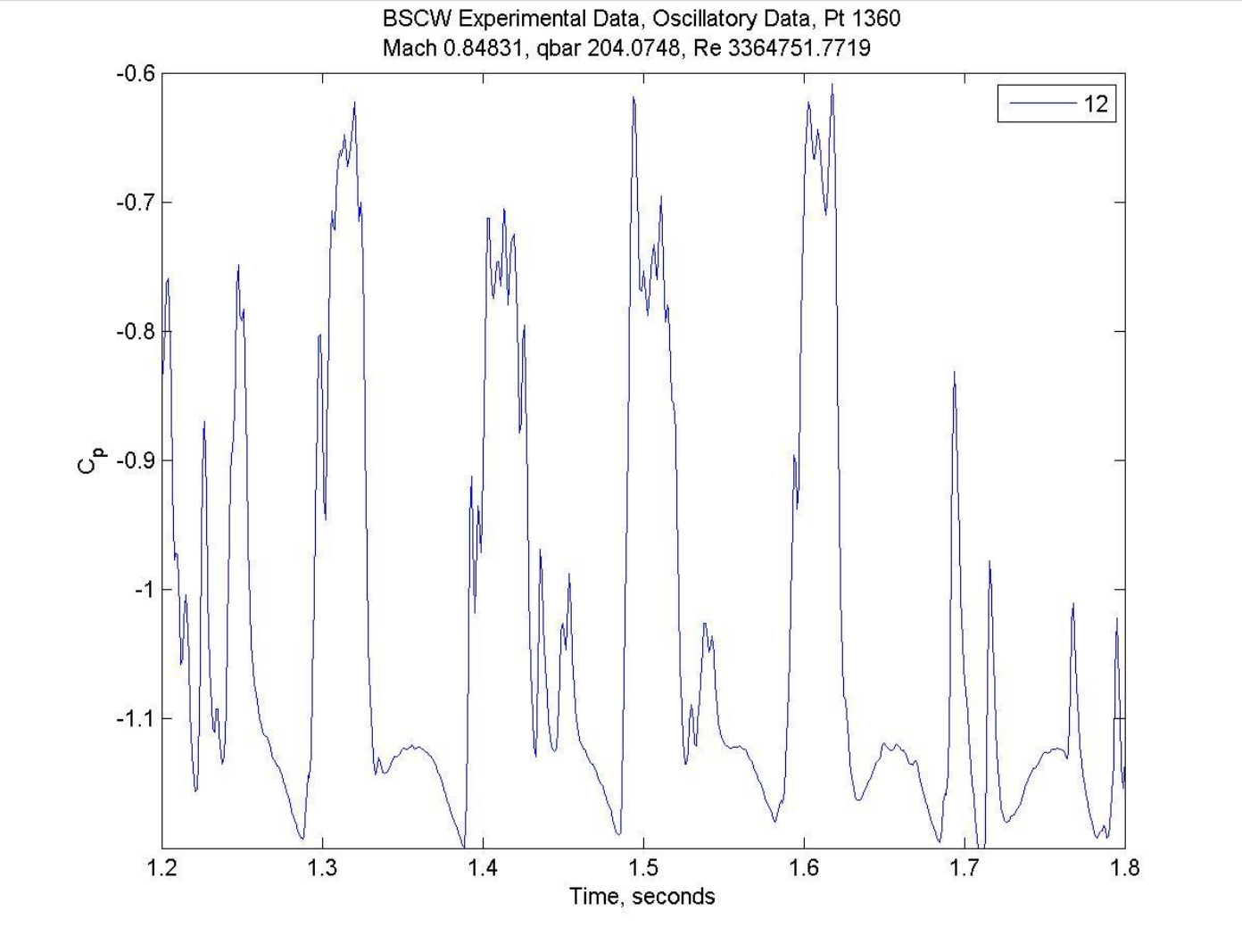

Ceiling behavior as in the steady case
Excitation frequency in evidence for half cycles

Excursion of shock across transducer (past transducer towards leading edge)
Occurs principally during the first ½ cycle of excitation shown