Summary of Rectangular Supercritical Wing (RSW) Analyses

David M. Schuster
NASA Langley Research Center

Aeroelastic Prediction Workshop

April 21-22, 2012

Honolulu, Hawaii

Notes: These comparisons are utilizing the preliminary data, as submitted prior to the AePW. These are workshop results, not publication results. There are significant differences in the geometry used, as well as normalization constants, definitions of FRF and sign conventions These issues are being sorted out post-workshop. None of the results included should be interpreted without proper consideration of these issues. Corrections and rescalings etc will be performed prior to publication.

RSW Data Submissions

Analyst	Organization
Pawel Chwalowski	NASA
Thorsten Hansen	ANSYS Germany GMBH
Dimitri Mavriplis	University of Wyoming
David Schuster	NASA
Daniel Steiling	RUAG Schweiz AG
Sebastian Timme	University of Liverpool

Rectangular Supercritical Wing (RSW)

M=0.825, Re_c=4.0 million, test medium: R-12

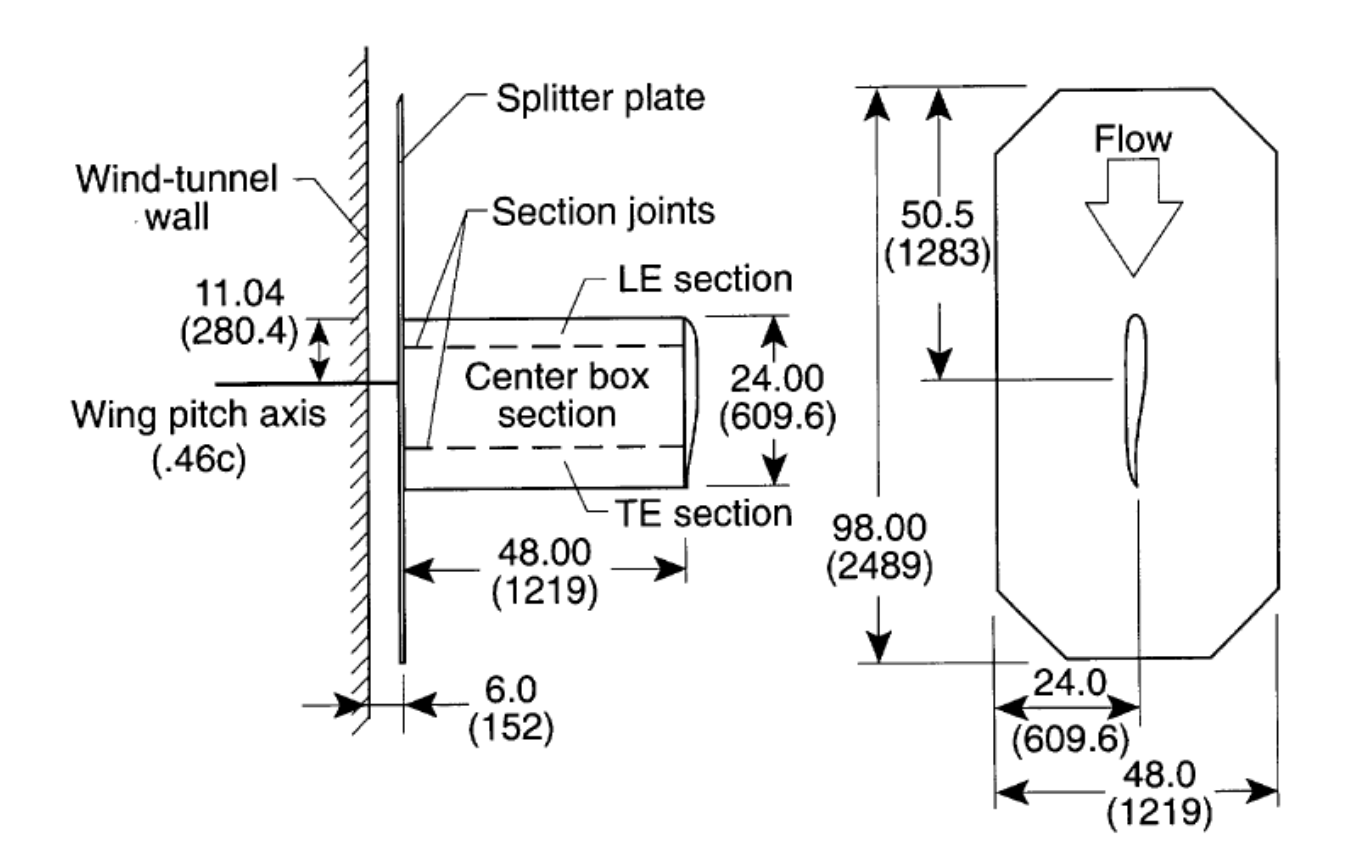
a) Steady Cases
   i. $\alpha = 2°$
   ii. $\alpha = 4°$

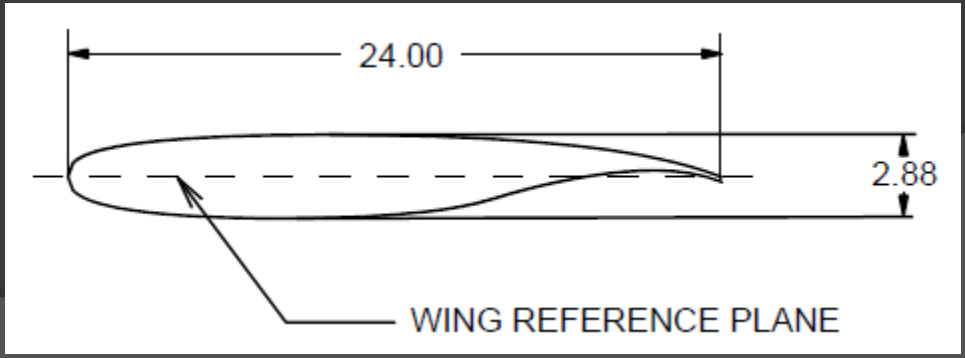
b) Dynamic Cases
   i. $\alpha = 2°$, $\theta = 1.0°$, f = 10 Hz
   ii. $\alpha = 2°$, $\theta = 1.0°$, f = 20 Hz

RSW Modeling Considerations

- Close proximity of splitter plate to wind tunnel sidewall resulted in plate being immersed in tunnel wall boundary layer.
- Study conducted to determine most expedient approach to solve this problem.

RSW Model Layout and Airfoil

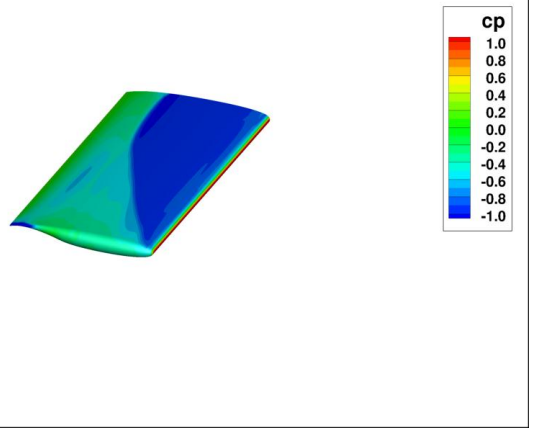




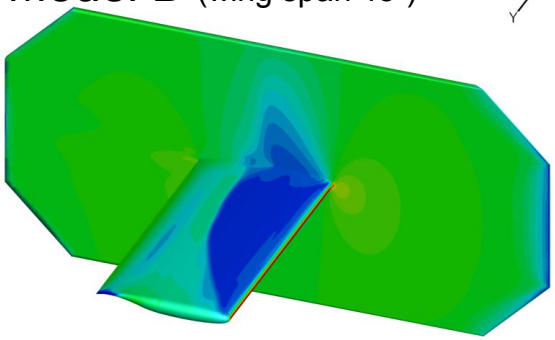
Preliminary RSW Analysis Update

Mach = 0.825, α = 2°, Medium Grid Resolution

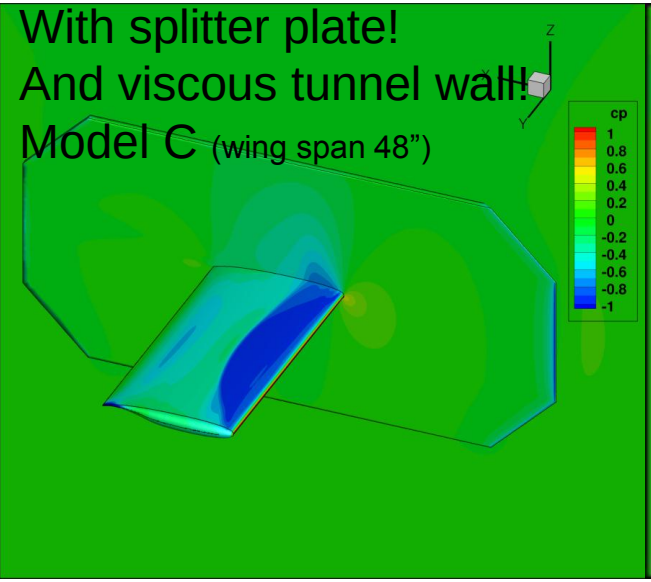
No splitter plate!
Model A (wing span 48”)



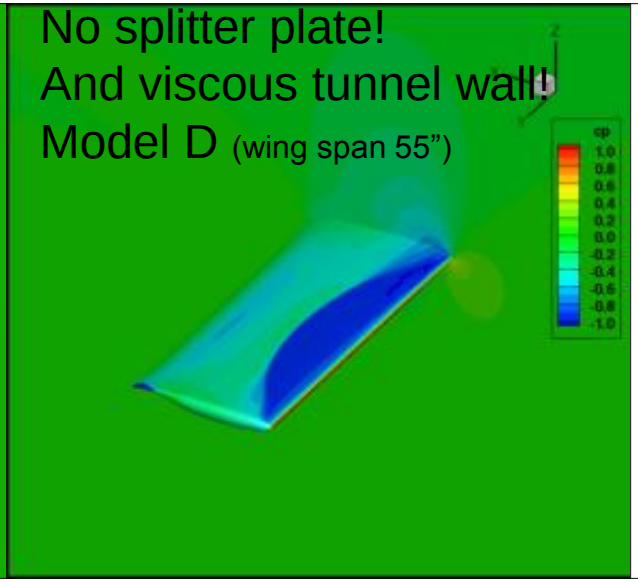
With splitter plate!
Model B (wing span 48”)



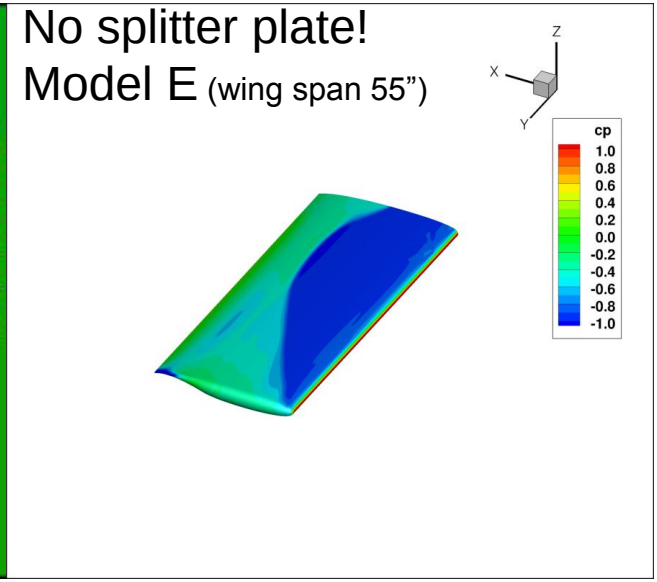
With splitter plate!
And viscous tunnel wall!
Model C (wing span 48”)



No splitter plate!
And viscous tunnel wall!
Model D (wing span 55”)

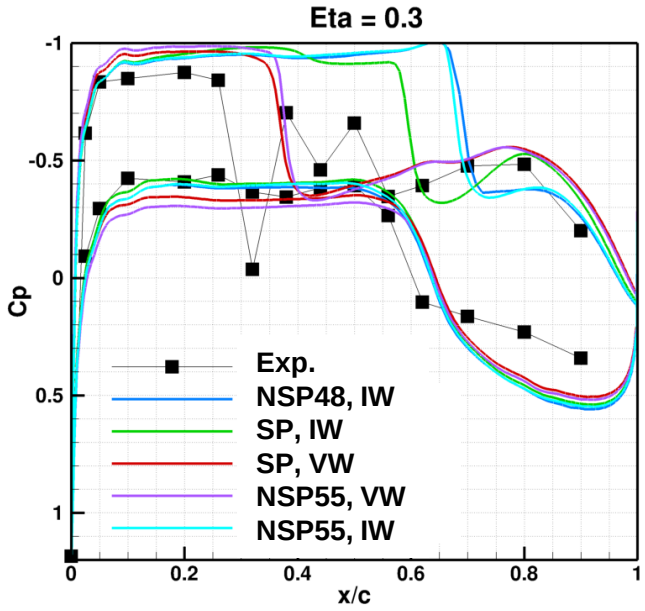


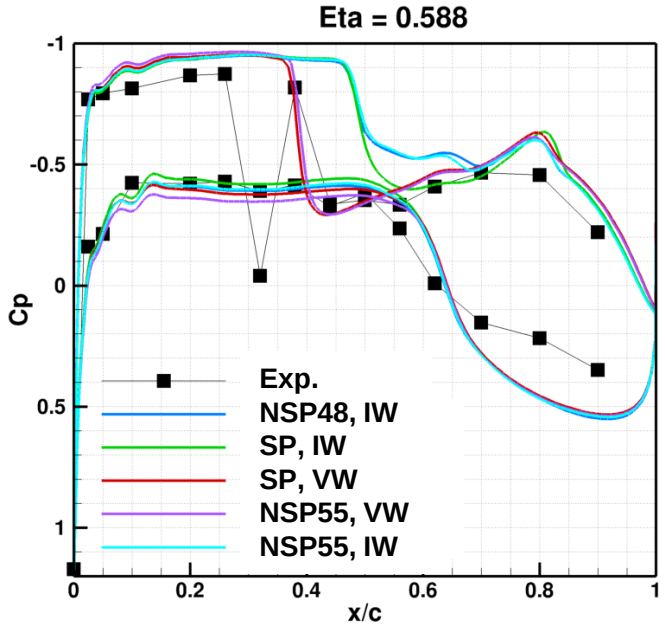
No splitter plate!
Model E (wing span 55”)

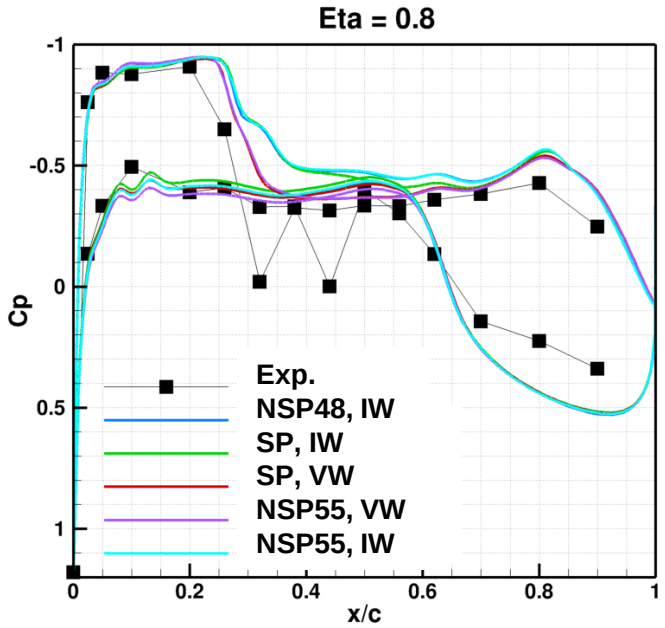


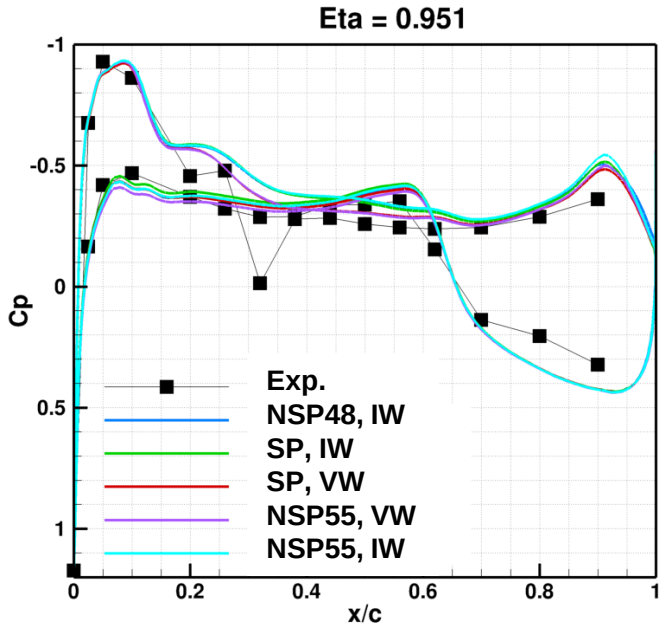
Preliminary RSW Analysis Update

Mach = 0.825, AoA = 2deg, FUN3D vs. Steady Experimental Data





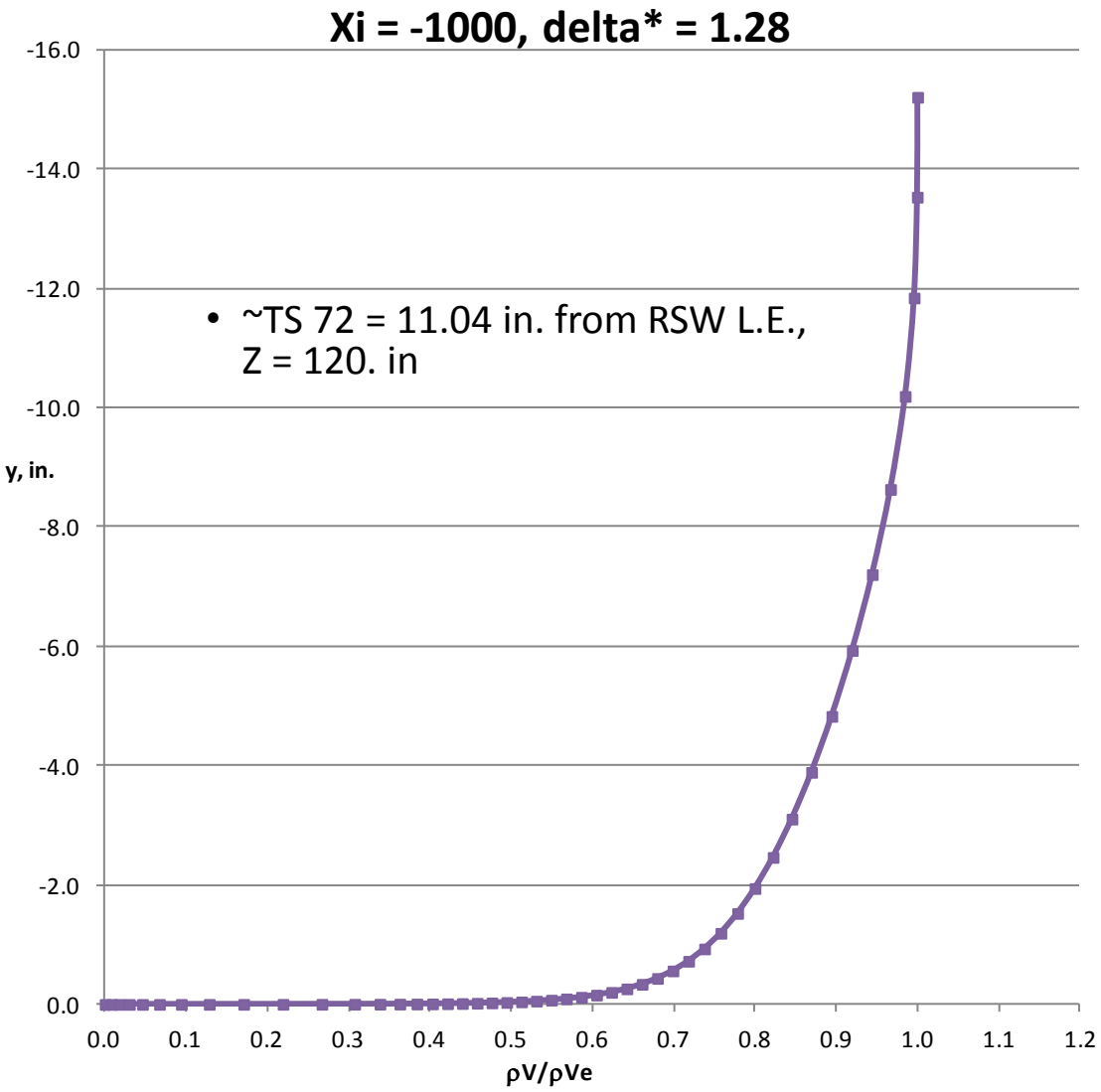




CFL3D Steady Analysis

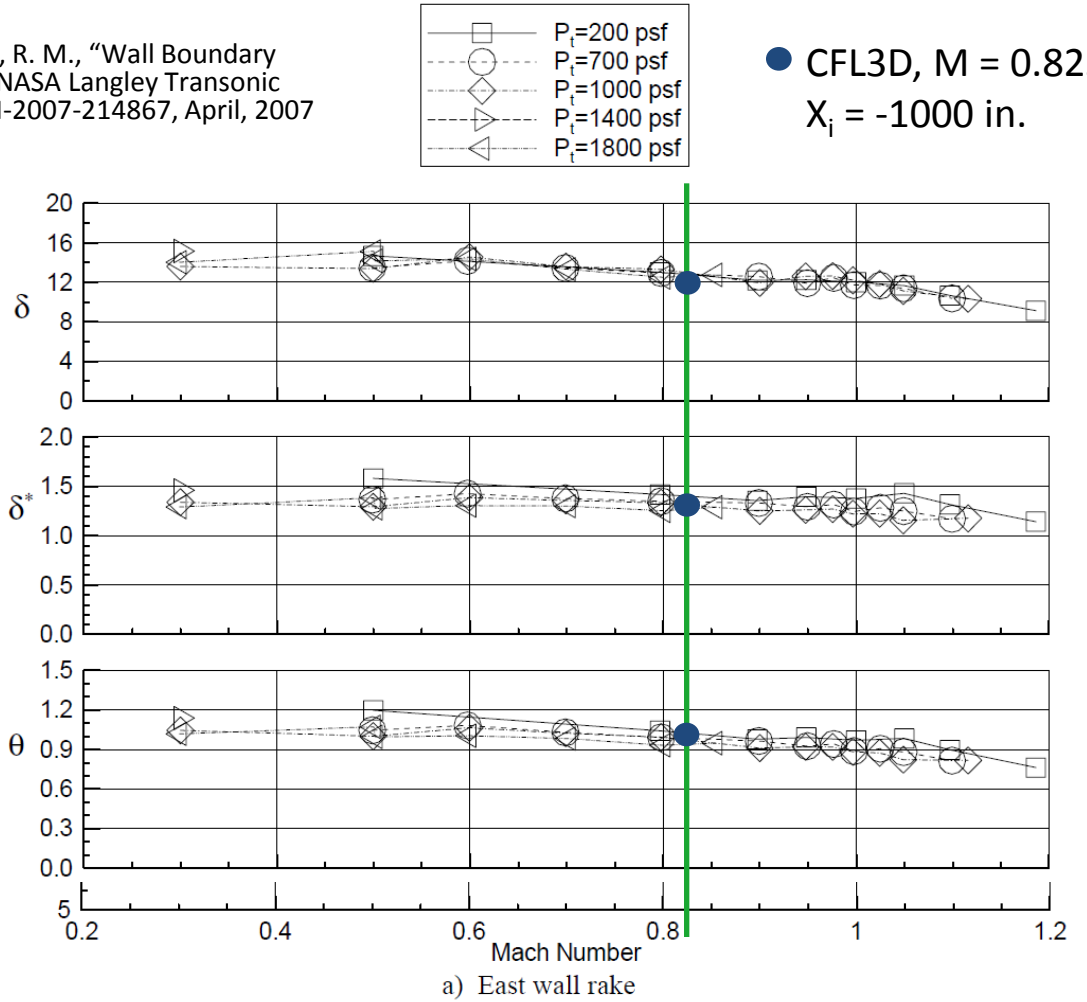
- Single Zone C-H Grid
  - 97 x 255 x 65 = 1,560,576 cells
    - spanwise x streamwise x normal
  - Viscous TDT East Wall.
    - No splitter Plate.
  - Forward grid boundary 1000 in. ahead of wing leading edge.
    - BL measured at TDT TS72 = 11.04 in. aft of RSW leading edge, 120 in. above L.E.

CFL3D Computed BL



TDT East Wall Boundary Layer

- Wieseman, C. D. and Bennett, R. M., "Wall Boundary Layer Measurements for the NASA Langley Transonic Dynamics Tunnel," NASA/TM-2007-214867, April, 2007



a) East wall rake

- CFL3D, M = 0.825, α = 2.00°, X_i = -1000 in.

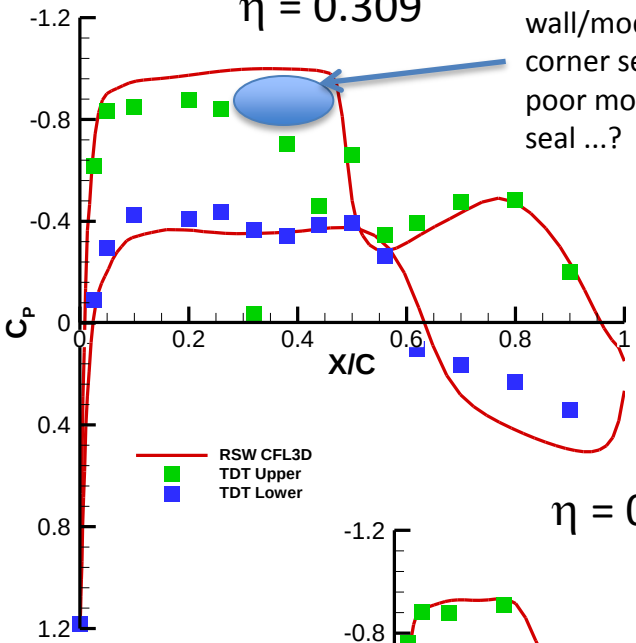
Figure 17. Boundary layer parameters for R-134a, all slots open, TS 72, standard flap settings.

RSW CFL3D Calculation

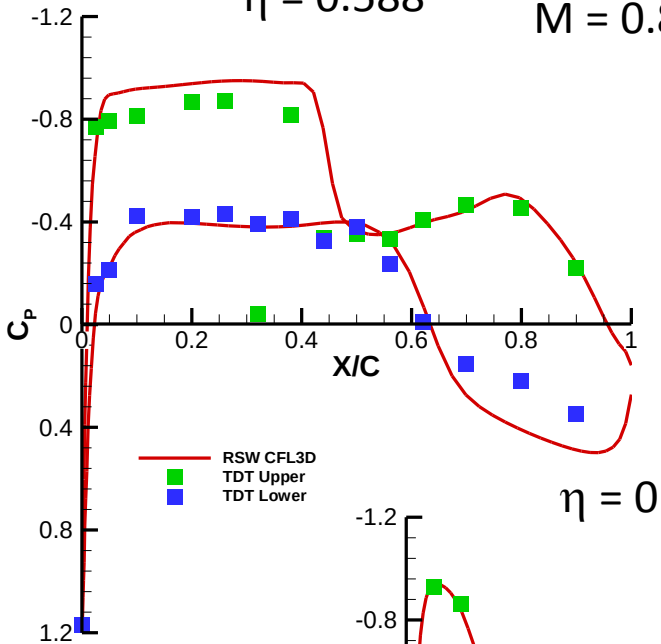
Viscous TDT East Wall
M = 0.825, $\alpha = 2.0^{o}$

$\eta = 0.309$

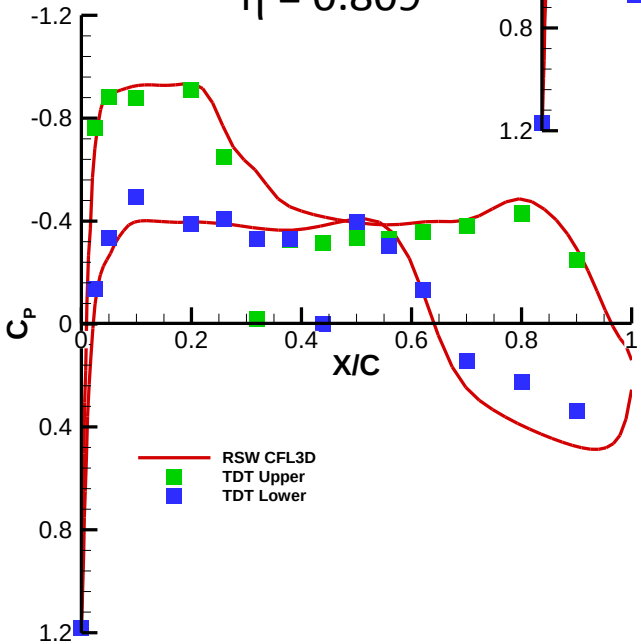
Slot effect, wall/model corner separation, poor model/wall seal ...?



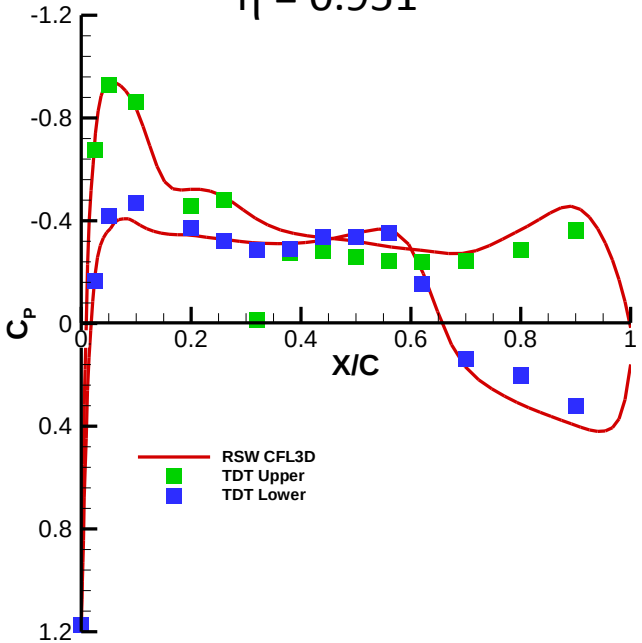
$\eta = 0.588$

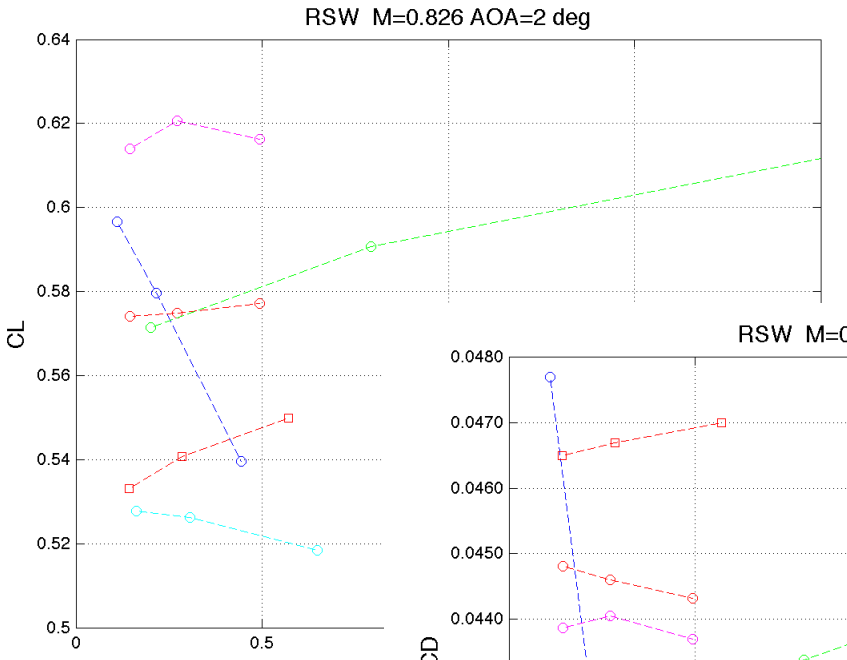


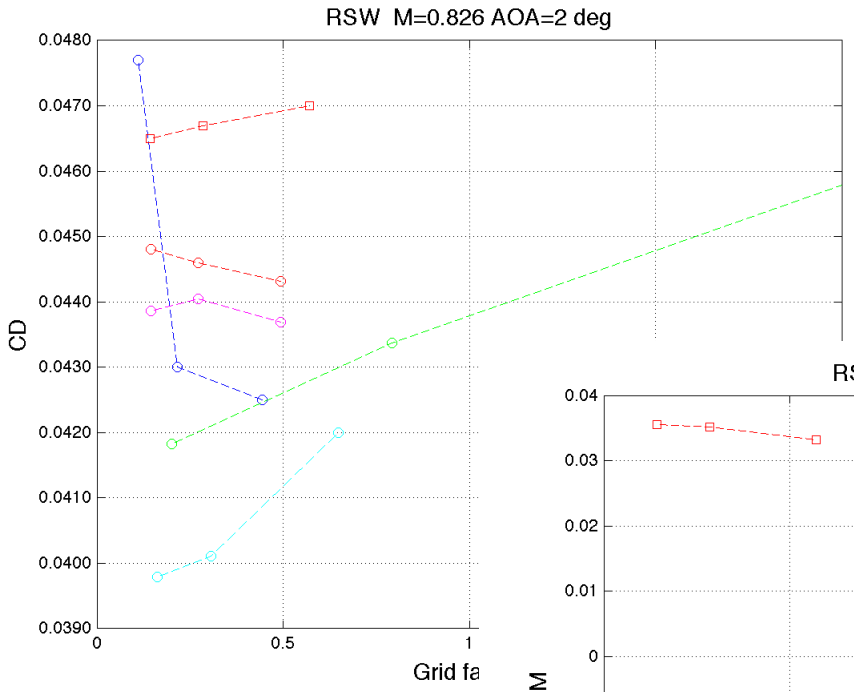
$\eta = 0.809$



$\eta = 0.951$

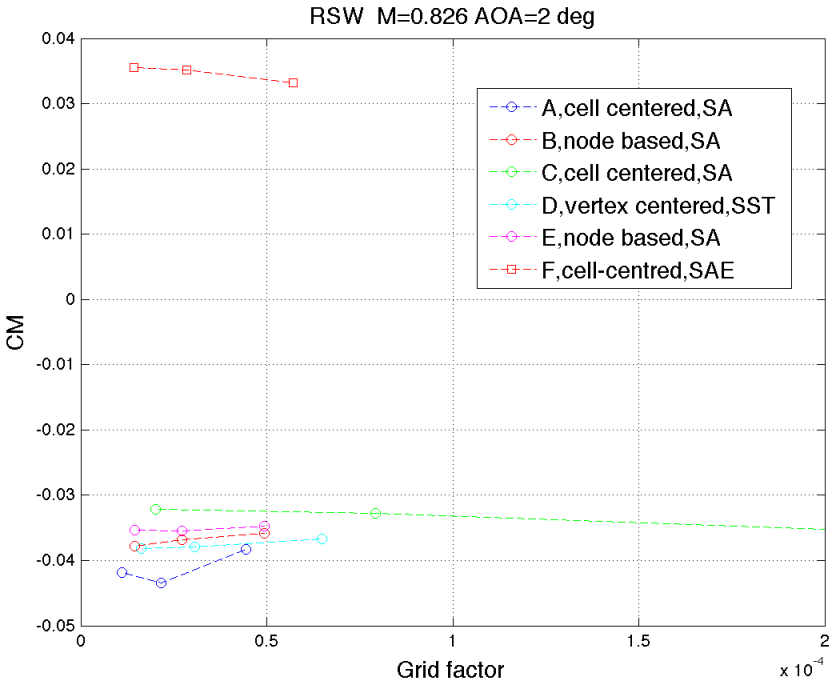




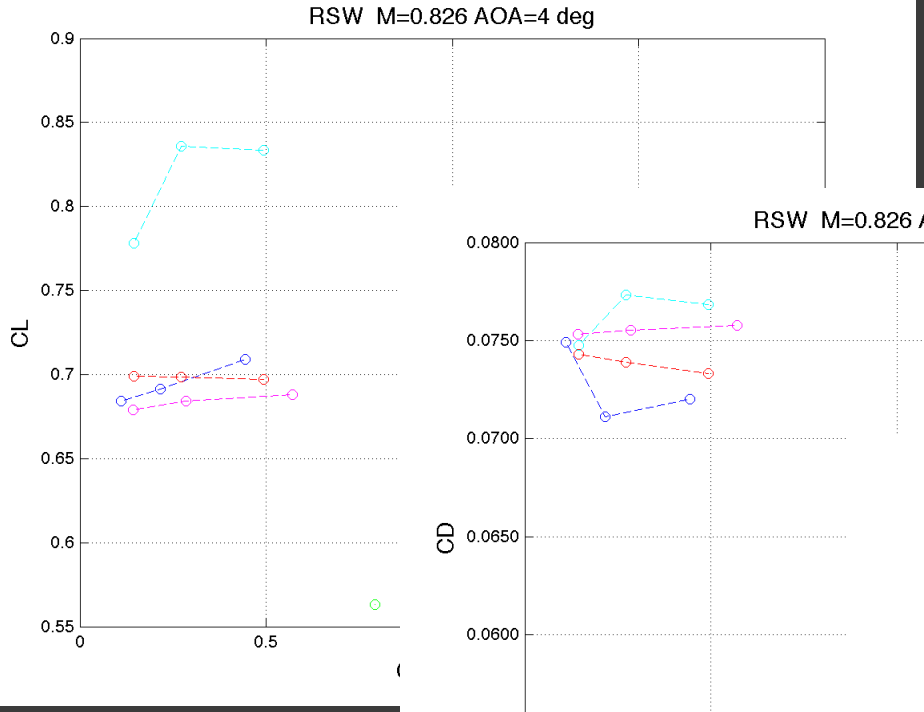


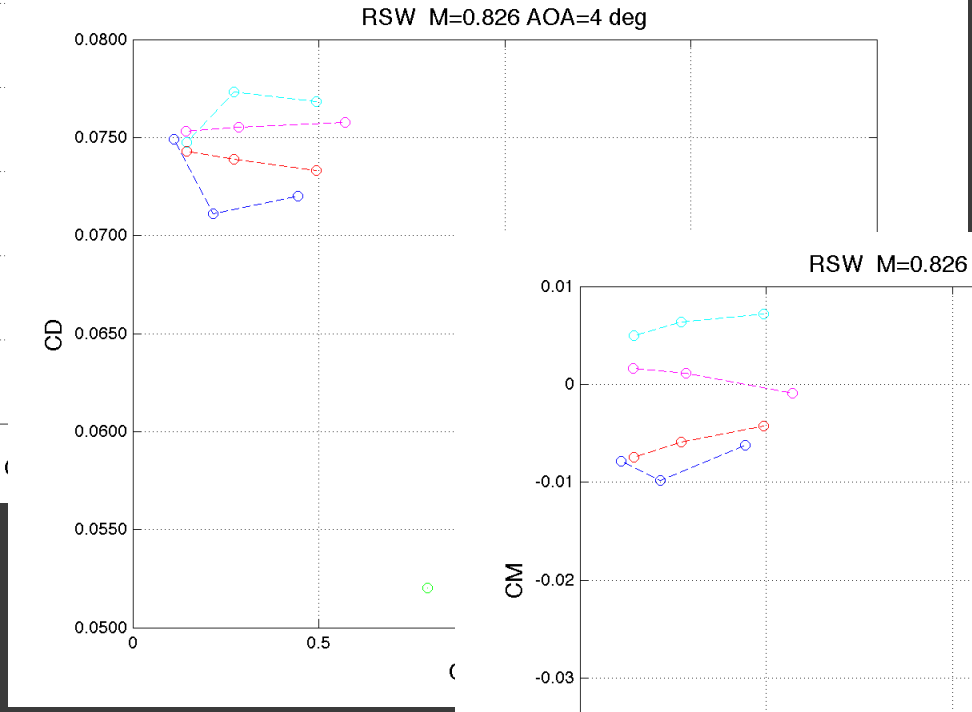
Note: not all analyses utilize the same Normalization parameters and moment reference center.

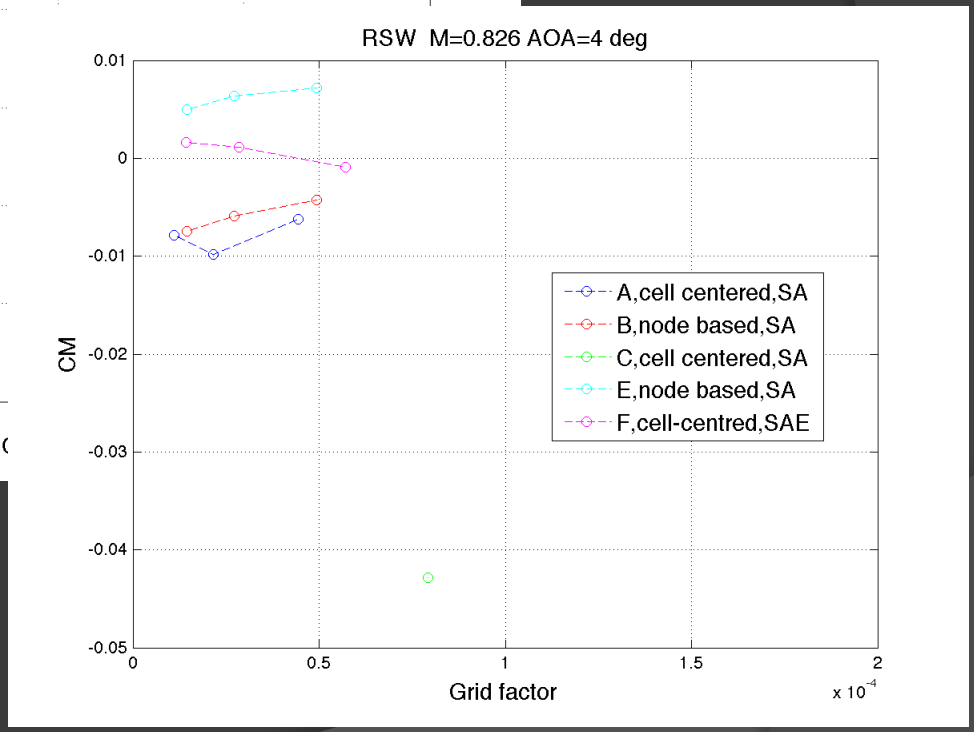
These issues will need to be sorted out in the post-workshop corrections



Note: not all analyses utilize the same Normalization parameters and moment reference center.
These issues will need to be sorted out in the post-workshop corrections



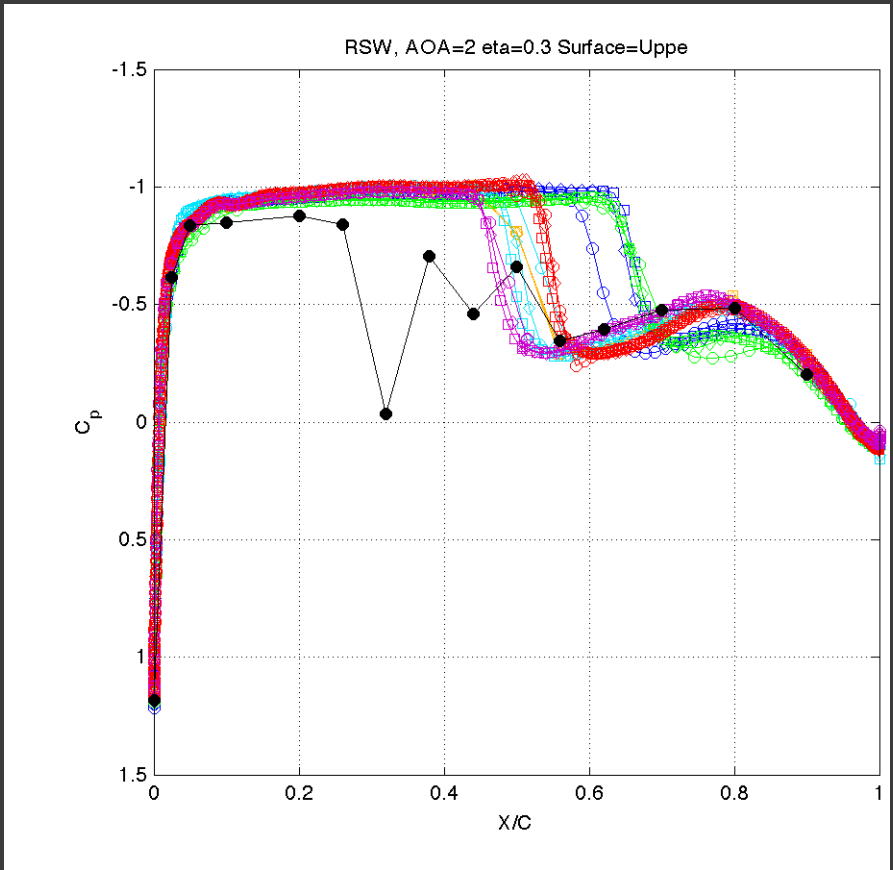


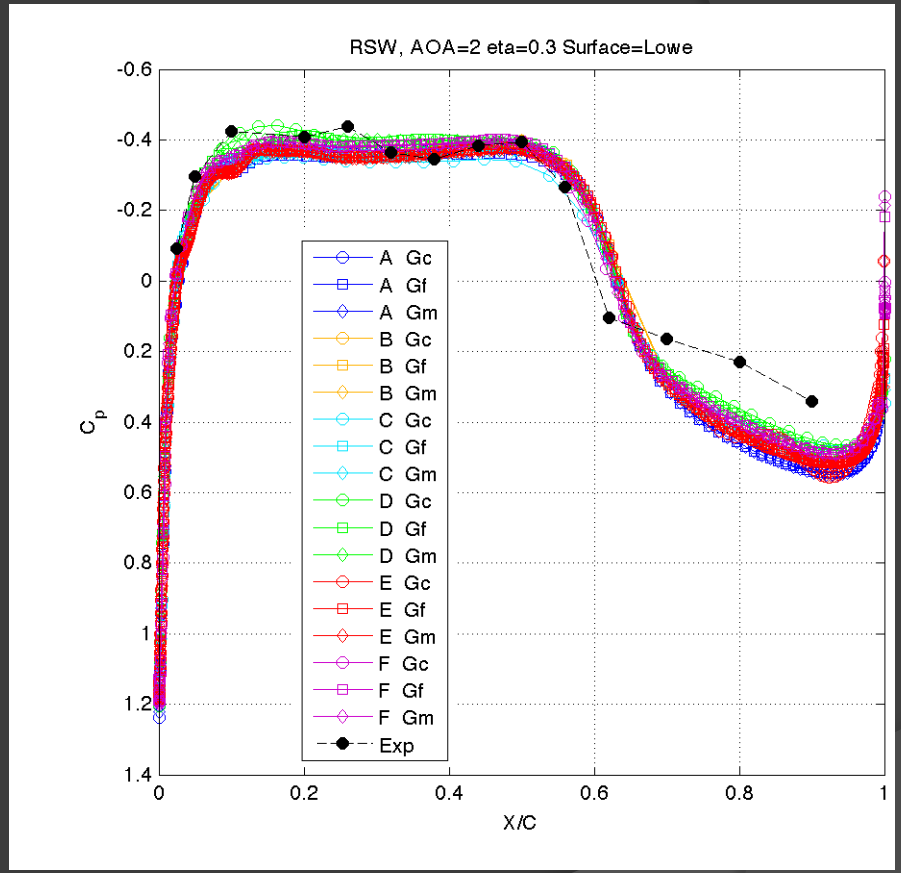


STEADY
$M = 0.825, \alpha = 2^o$

Notes: These comparisons are utilizing the preliminary data, as submitted prior to the AePW. These are workshop results, not publication results. There are significant differences in the geometry used, as well as normalization constants, definitions of FRF and sign conventions These issues are being sorted out post-workshop. None of the results included should be interpreted without proper consideration of these issues. Corrections and rescalings etc will be performed prior to publication.

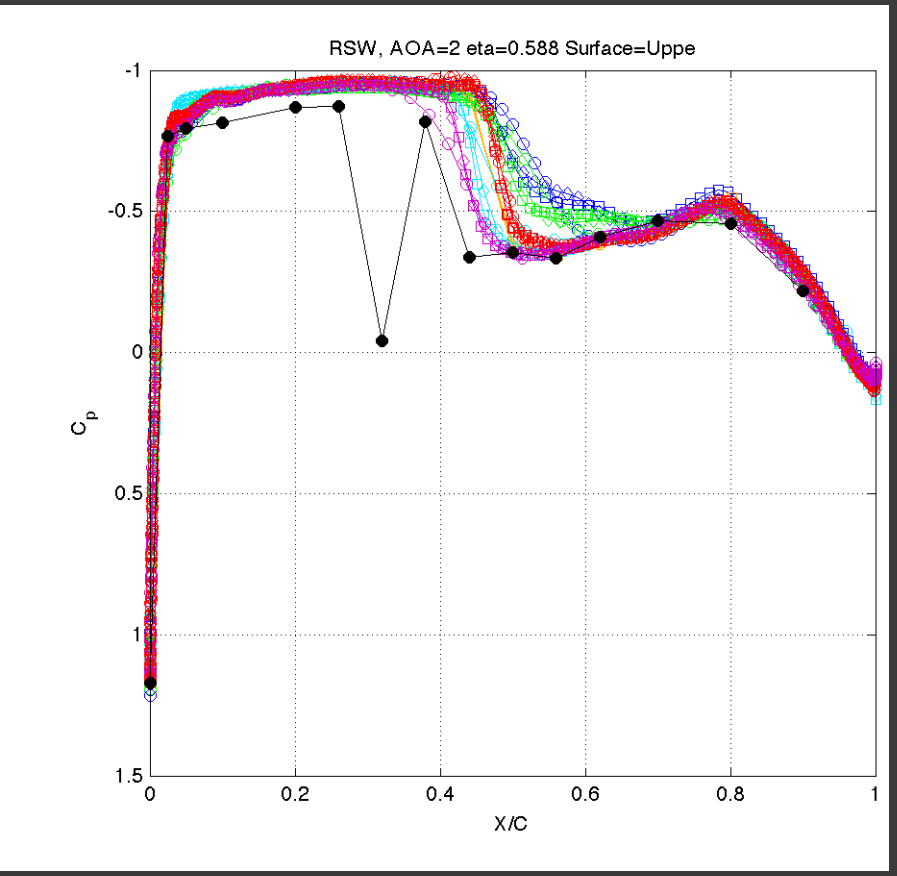
Upper $\eta = 0.309$ Lower

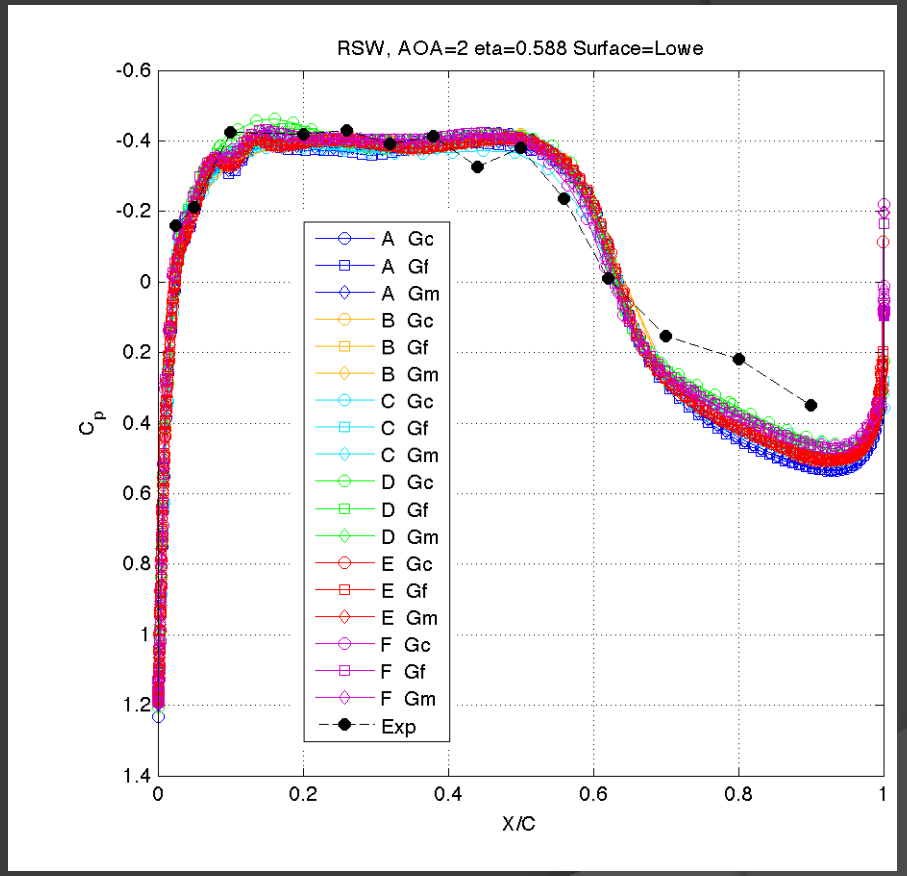




Notes: These comparisons are utilizing the preliminary data, as submitted prior to the AePW. These are workshop results, not publication results.
There are significant differences in the geometry used, as well as normalization constants, definitions of FRF and sign conventions
These issues are being sorted out post-workshop. None of the results included should be interpreted without proper consideration of these issues. Corrections and rescalings etc will be performed prior to publication.

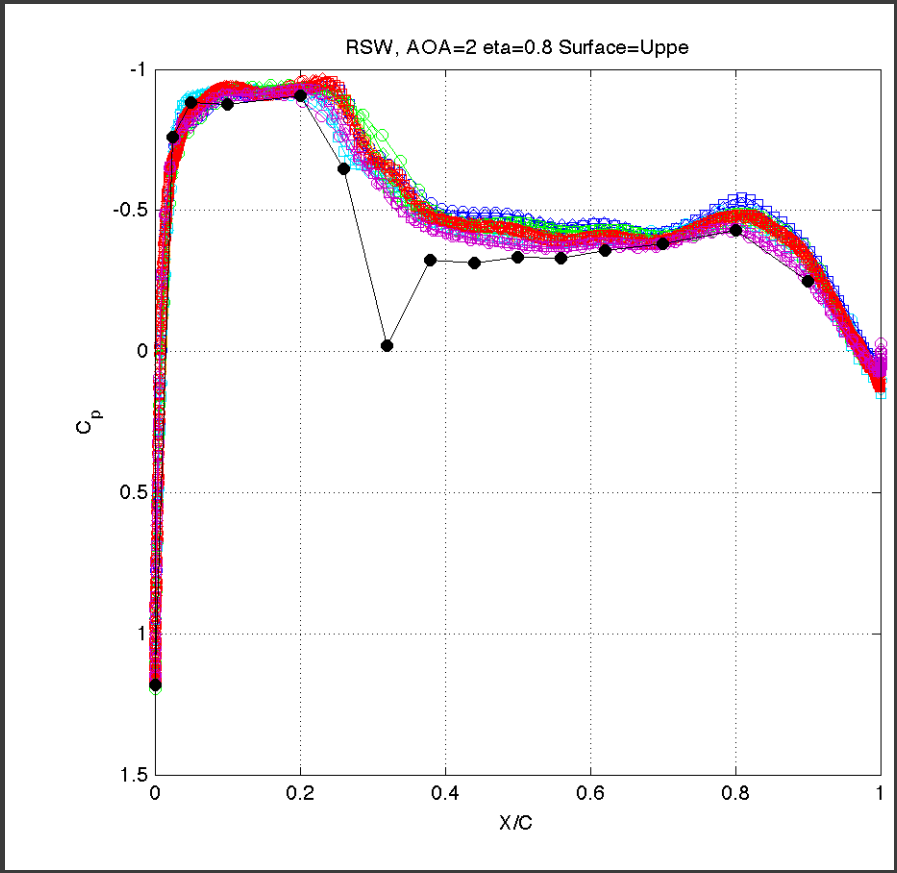
Upper $\eta = 0.588$ Lower

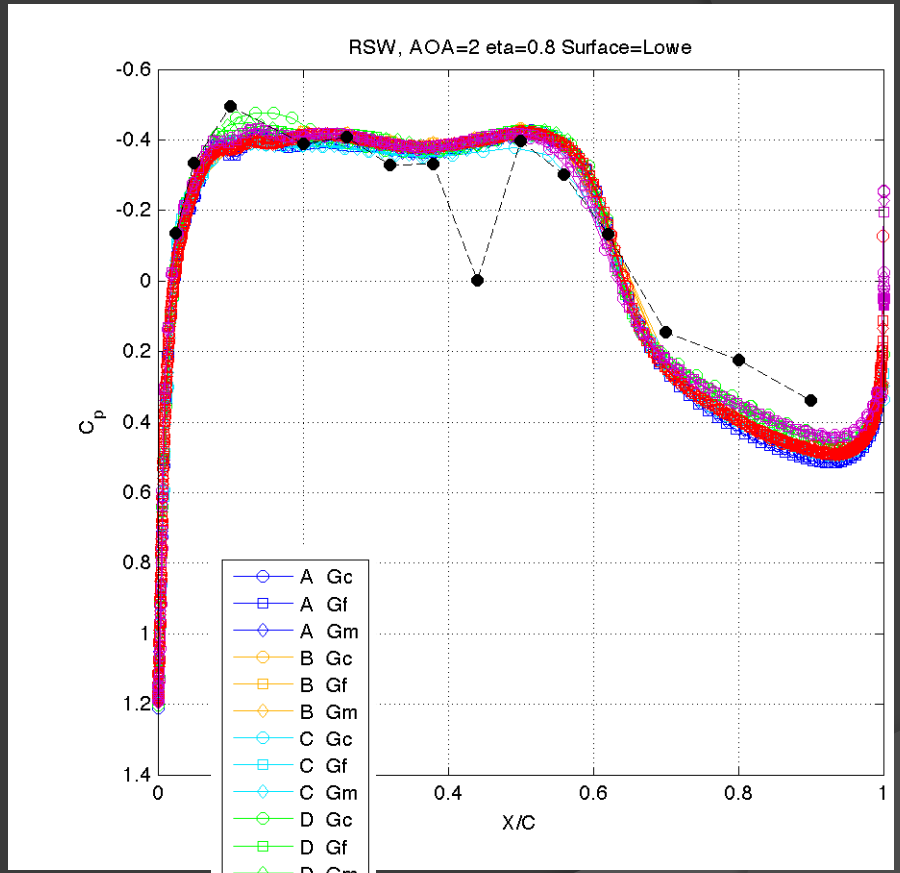




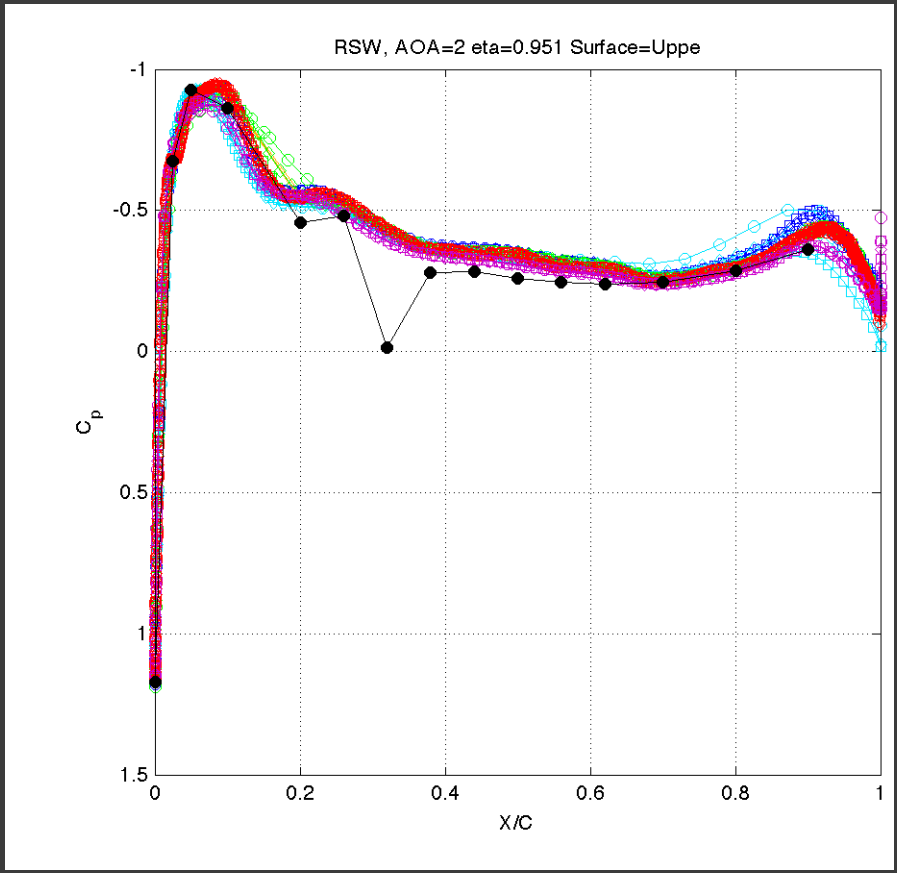
Notes: These comparisons are utilizing the preliminary data, as submitted prior to the AePW. These are workshop results, not publication results.
There are significant differences in the geometry used, as well as normalization constants, definitions of FRF and sign conventions
These issues are being sorted out post-workshop. None of the results included should be interpreted without proper consideration of these issues. Corrections and rescalings etc will be performed prior to publication.

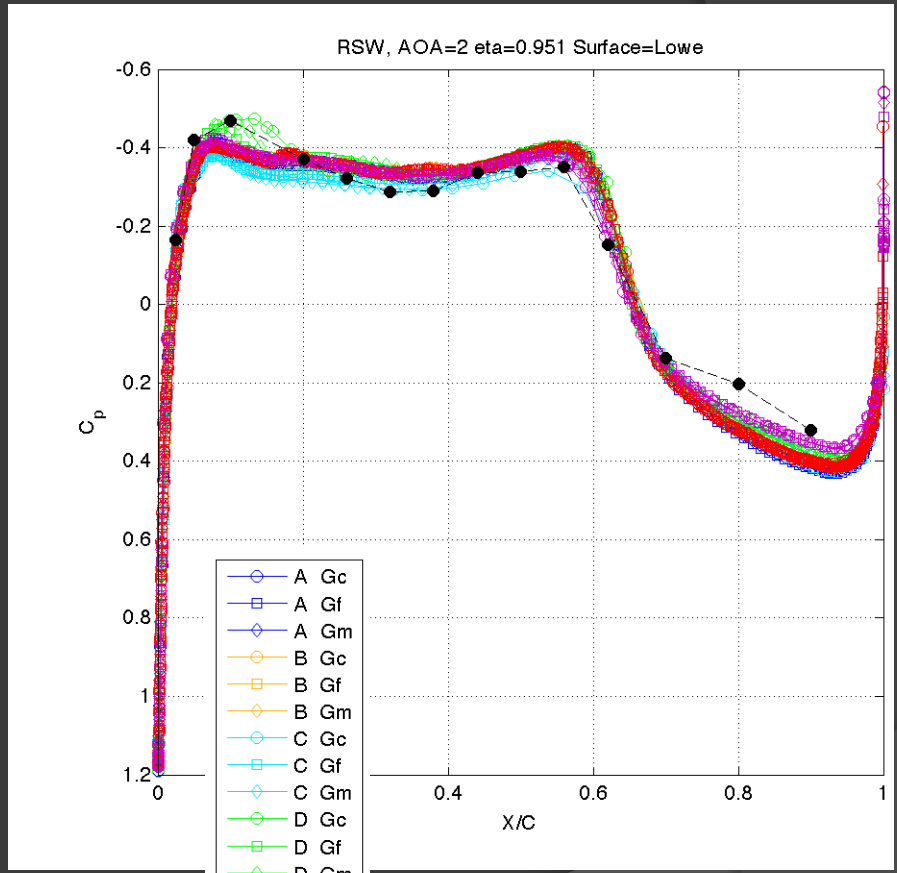
Upper $\eta = 0.809$ Lower





Upper $\eta = 0.951$ Lower

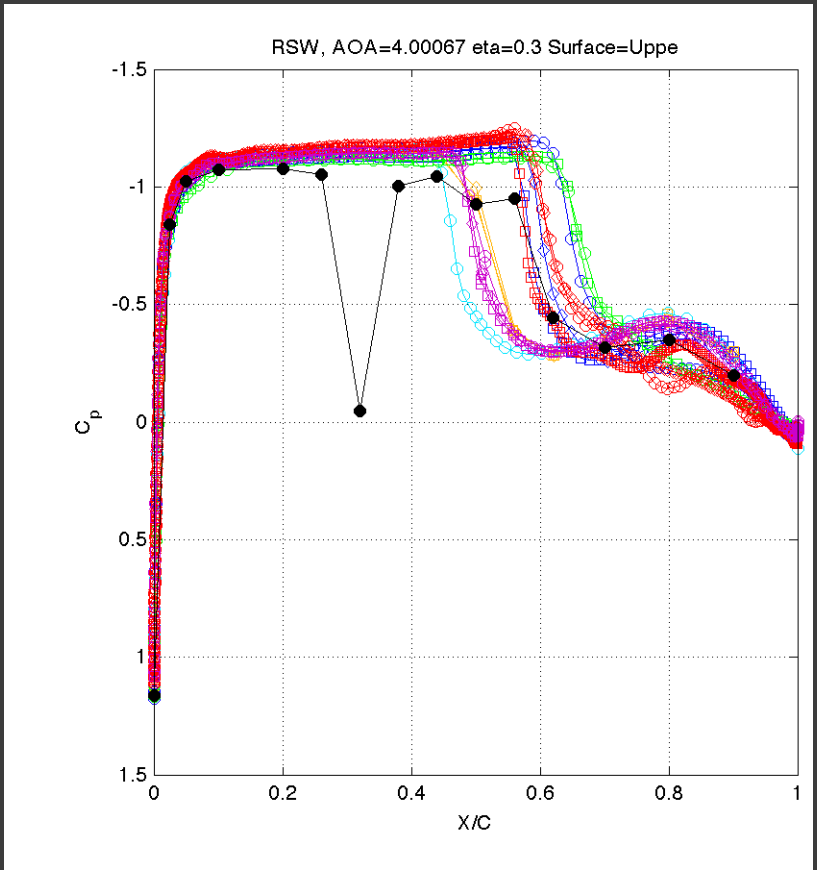


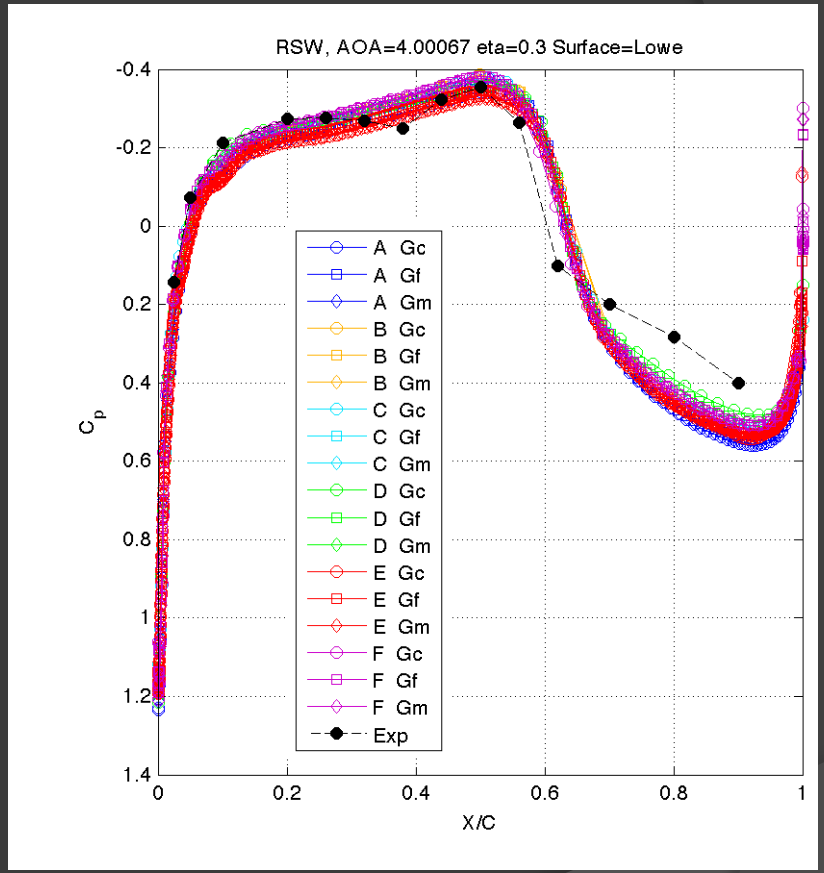


STEADY
M = 0.825, α =4^o

Notes: These comparisons are utilizing the preliminary data, as submitted prior to the AePW. These are workshop results, not publication results.
There are significant differences in the geometry used, as well as normalization constants, definitions of FRF and sign conventions
These issues are being sorted out post-workshop. None of the results included should be interpreted without proper consideration of these issues. Corrections and rescalings etc will be performed prior to publication.

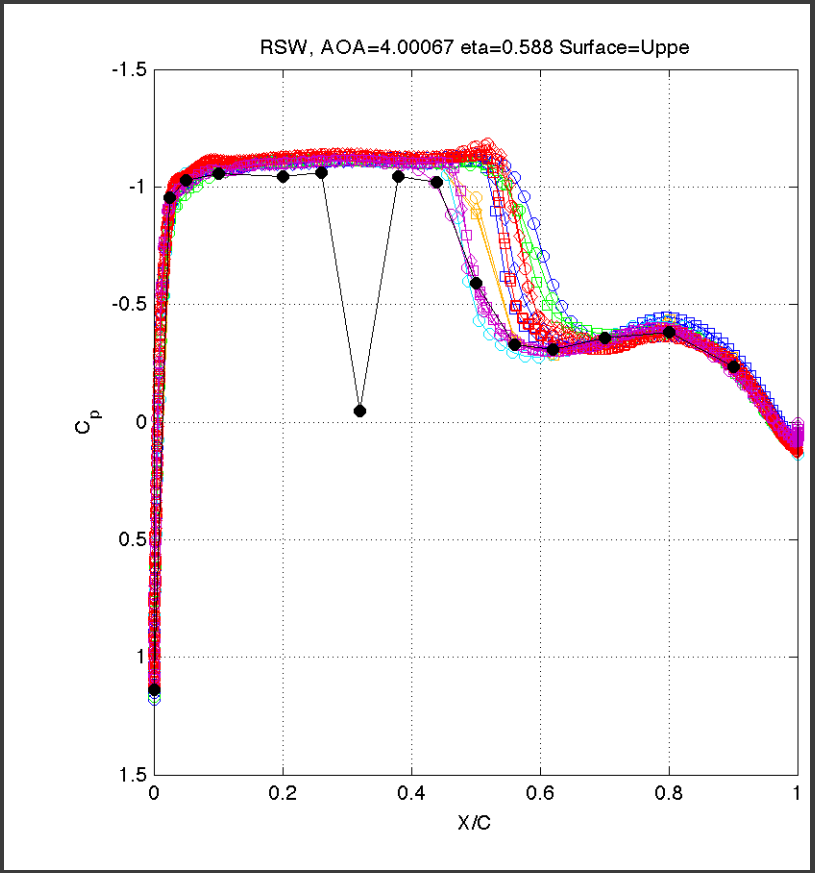
Upper $\eta = 0.309$ Lower

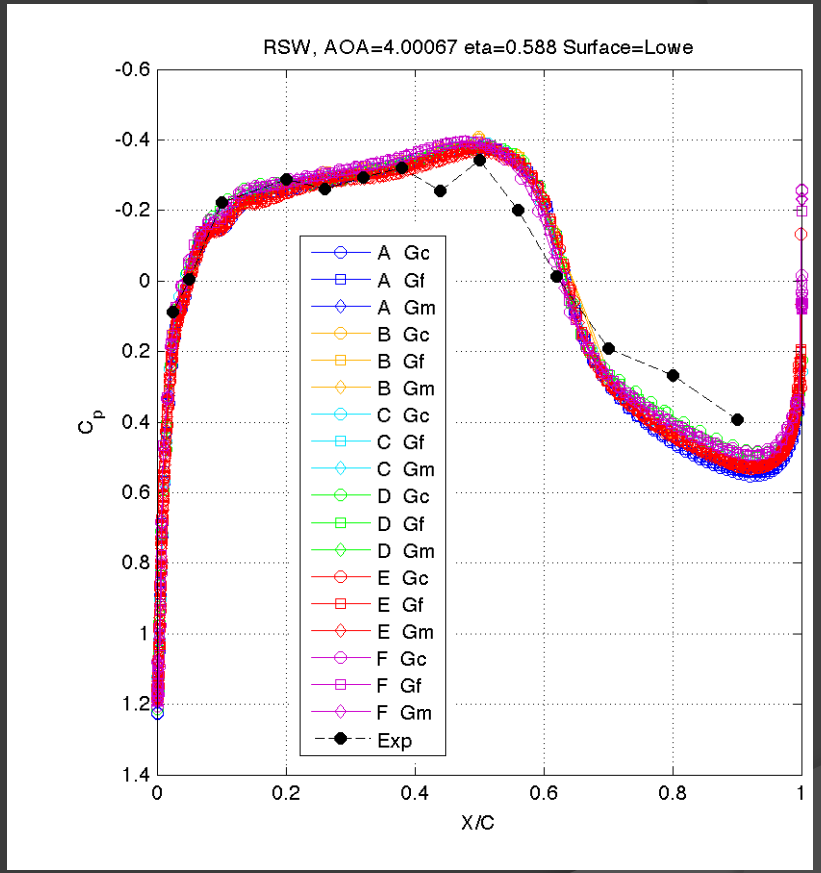




Notes: These comparisons are utilizing the preliminary data, as submitted prior to the AePW. These are workshop results, not publication results.
There are significant differences in the geometry used, as well as normalization constants, definitions of FRF and sign conventions
These issues are being sorted out post-workshop. None of the results included should be interpreted without proper consideration of these issues. Corrections and rescalings etc will be performed prior to publication.

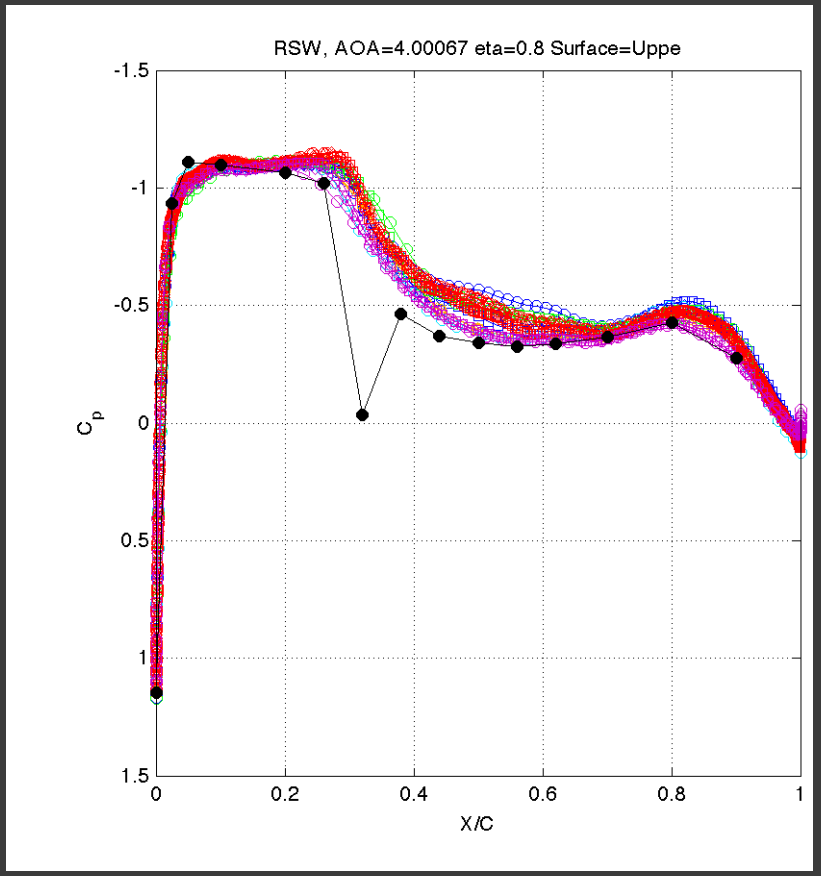
Upper $\eta = 0.588$ Lower

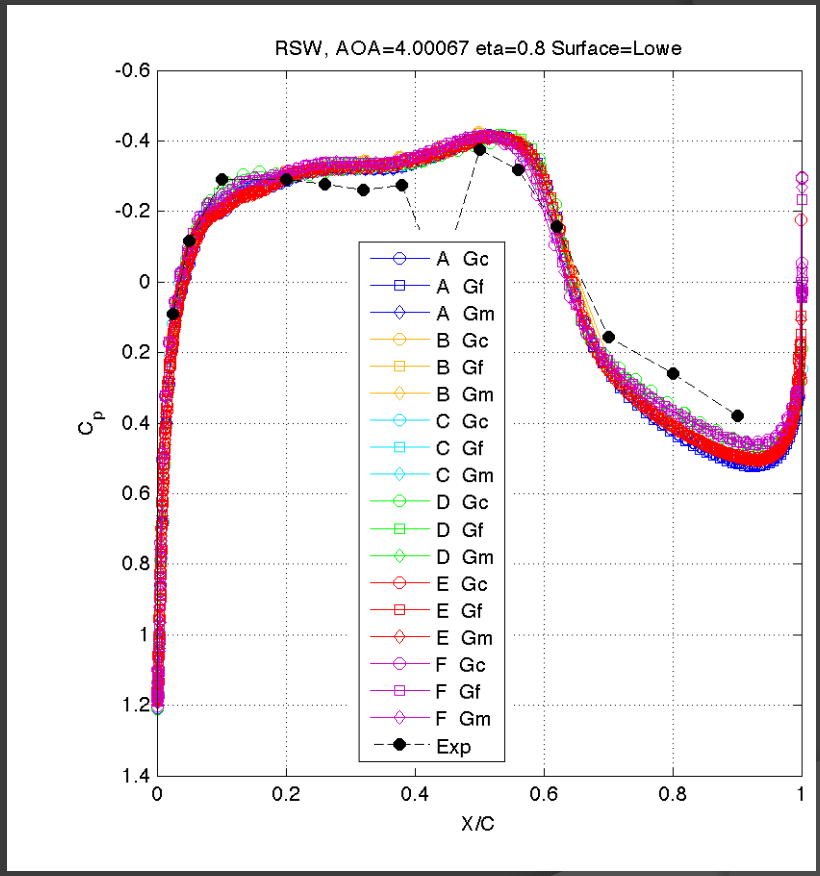




Notes: These comparisons are utilizing the preliminary data, as submitted prior to the AePW. These are workshop results, not publication results.
There are significant differences in the geometry used, as well as normalization constants, definitions of FRF and sign conventions
These issues are being sorted out post-workshop. None of the results included should be interpreted without proper consideration of these issues. Corrections and rescalings etc will be performed prior to publication.

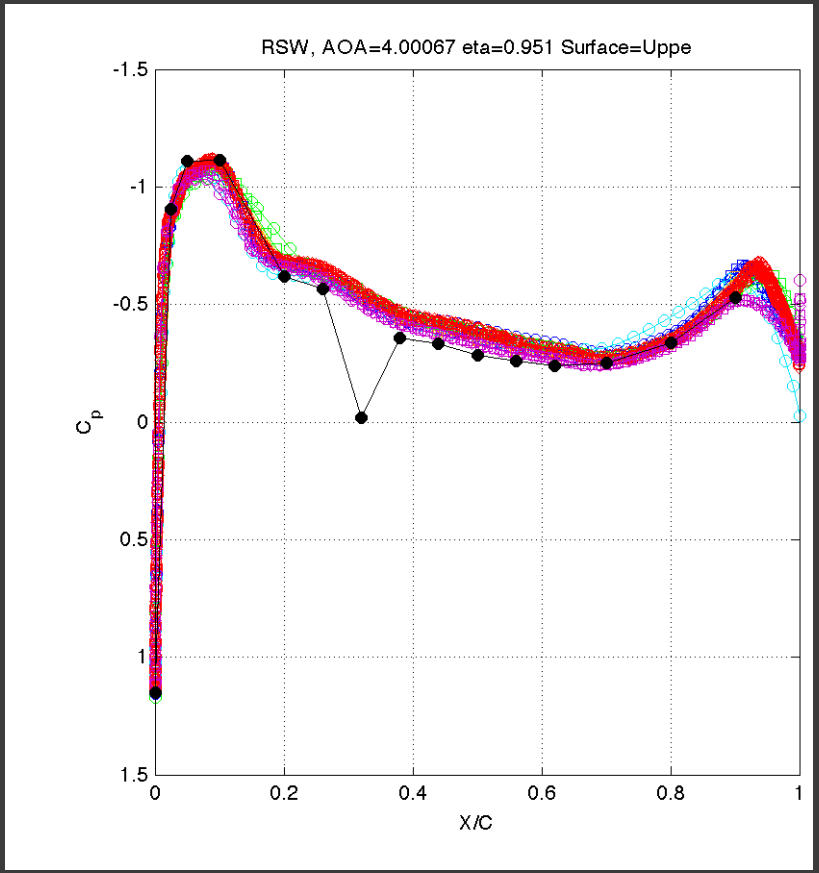
Upper $\eta = 0.809$ Lower

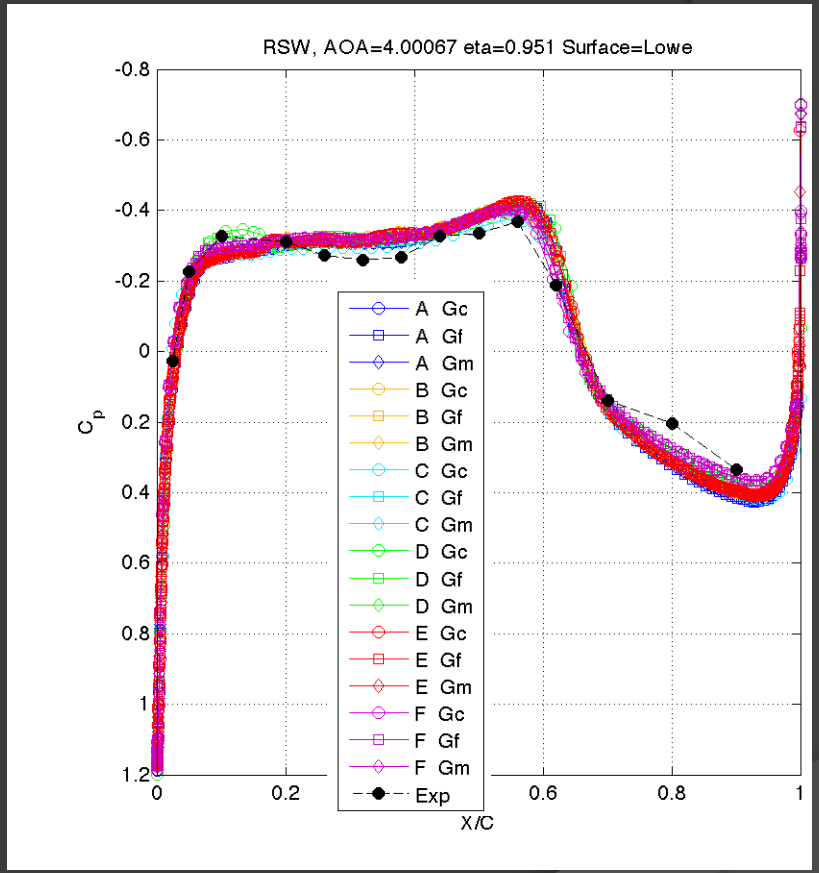




Notes: These comparisons are utilizing the preliminary data, as submitted prior to the AePW. These are workshop results, not publication results.
There are significant differences in the geometry used, as well as normalization constants, definitions of FRF and sign conventions
These issues are being sorted out post-workshop. None of the results included should be interpreted without proper consideration of these issues. Corrections and rescalings etc will be performed prior to publication.

Upper $\eta = 0.951$ Lower





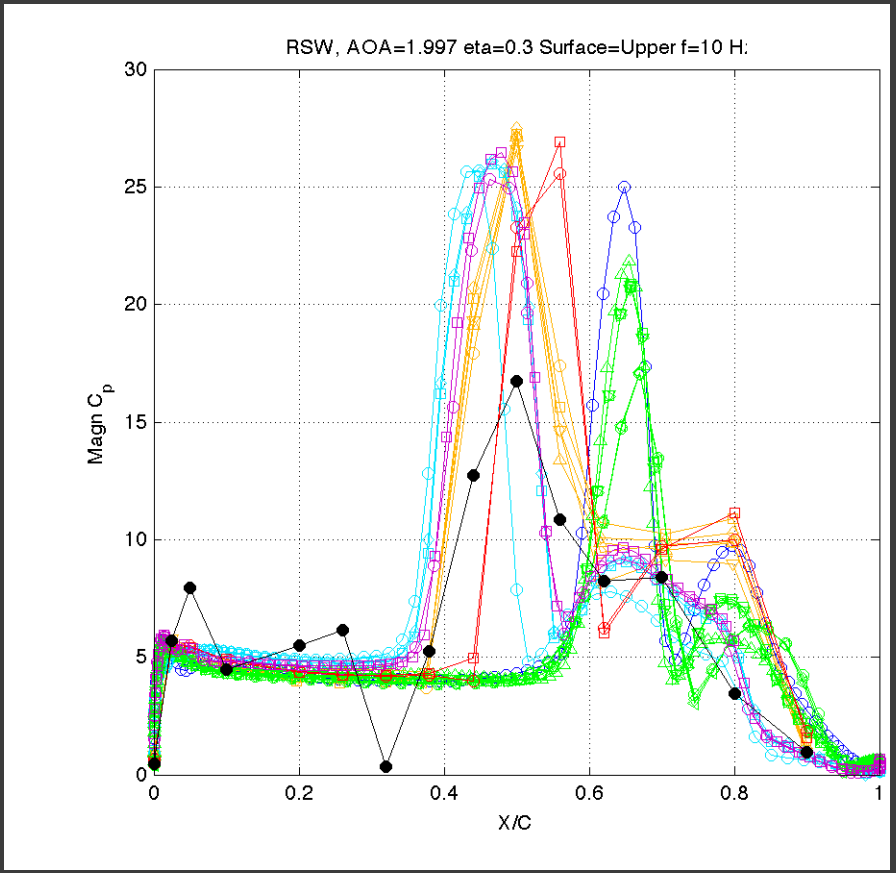
Notes: These comparisons are utilizing the preliminary data, as submitted prior to the AePW. These are workshop results, not publication results.
There are significant differences in the geometry used, as well as normalization constants, definitions of FRF and sign conventions
These issues are being sorted out post-workshop. None of the results included should be interpreted without proper consideration of these issues. Corrections and rescalings etc will be performed prior to publication.

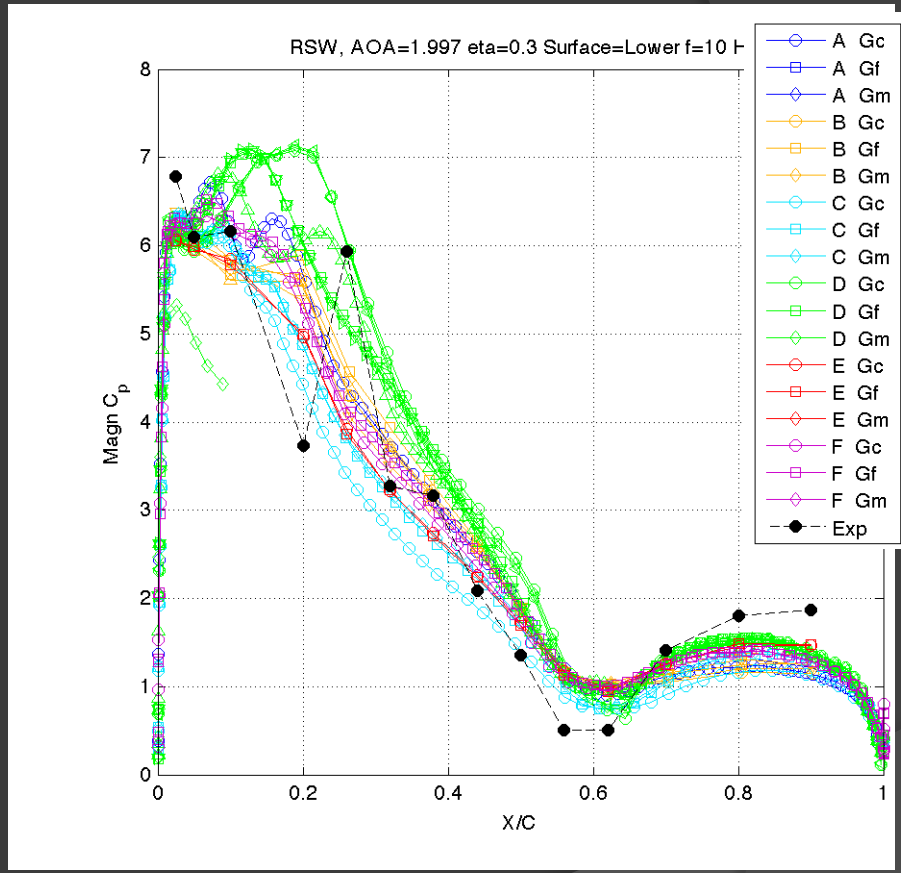
UNSTEADY

$M = 0.825, \alpha = 2^o, \theta = 1^o, f$=10 Hz.

Notes: These comparisons are utilizing the preliminary data, as submitted prior to the AePW. These are workshop results, not publication results.
There are significant differences in the geometry used, as well as normalization constants, definitions of FRF and sign conventions
These issues are being sorted out post-workshop. None of the results included should be interpreted without proper consideration of these issues. Corrections and rescalings etc will be performed prior to publication.

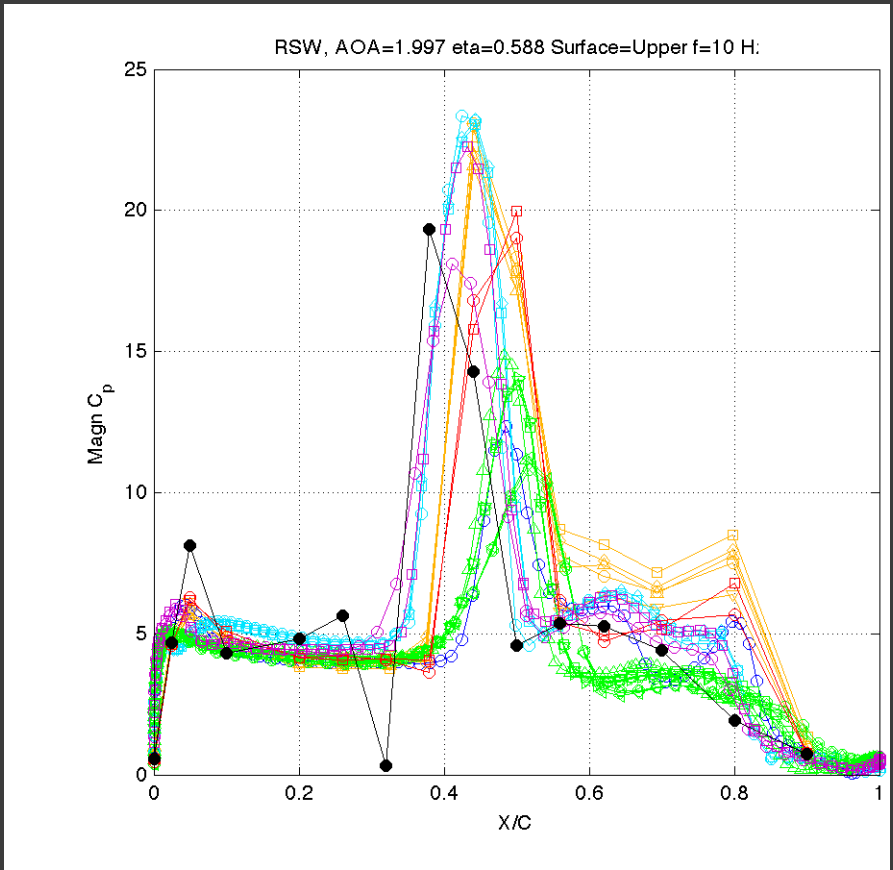
Upper $\eta = 0.309$ Lower

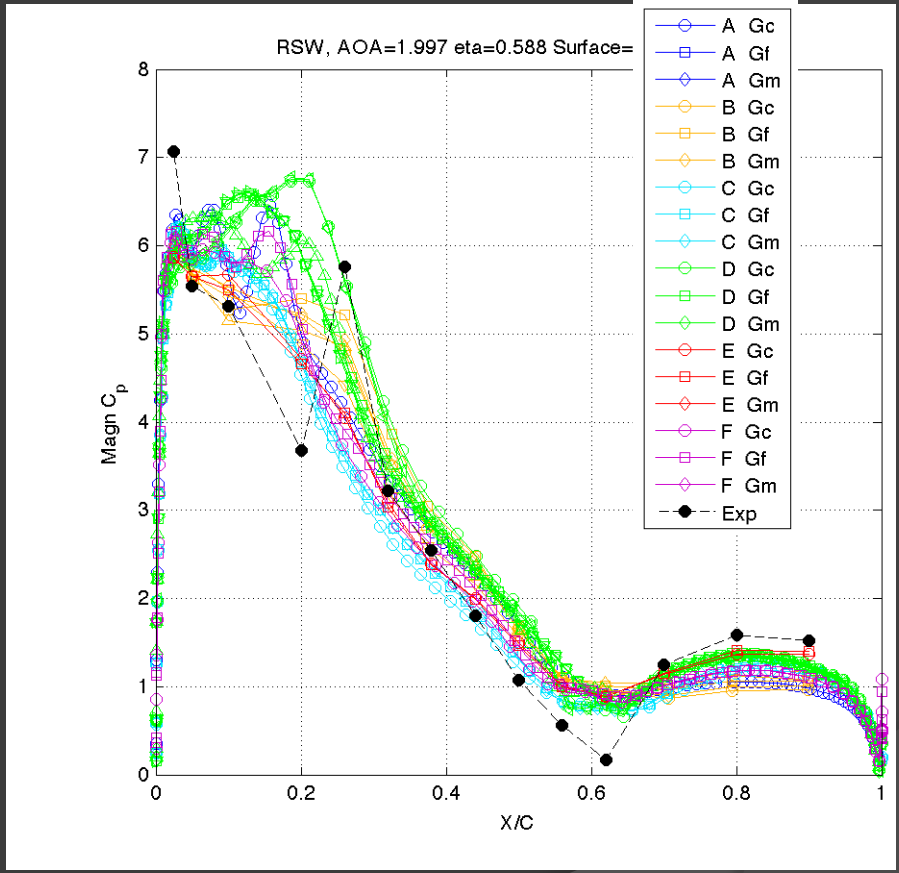




Notes: These comparisons are utilizing the preliminary data, as submitted prior to the AePW. These are workshop results, not publication results.
There are significant differences in the geometry used, as well as normalization constants, definitions of FRF and sign conventions
These issues are being sorted out post-workshop. None of the results included should be interpreted without proper consideration of these issues. Corrections and rescalings etc will be performed prior to publication.

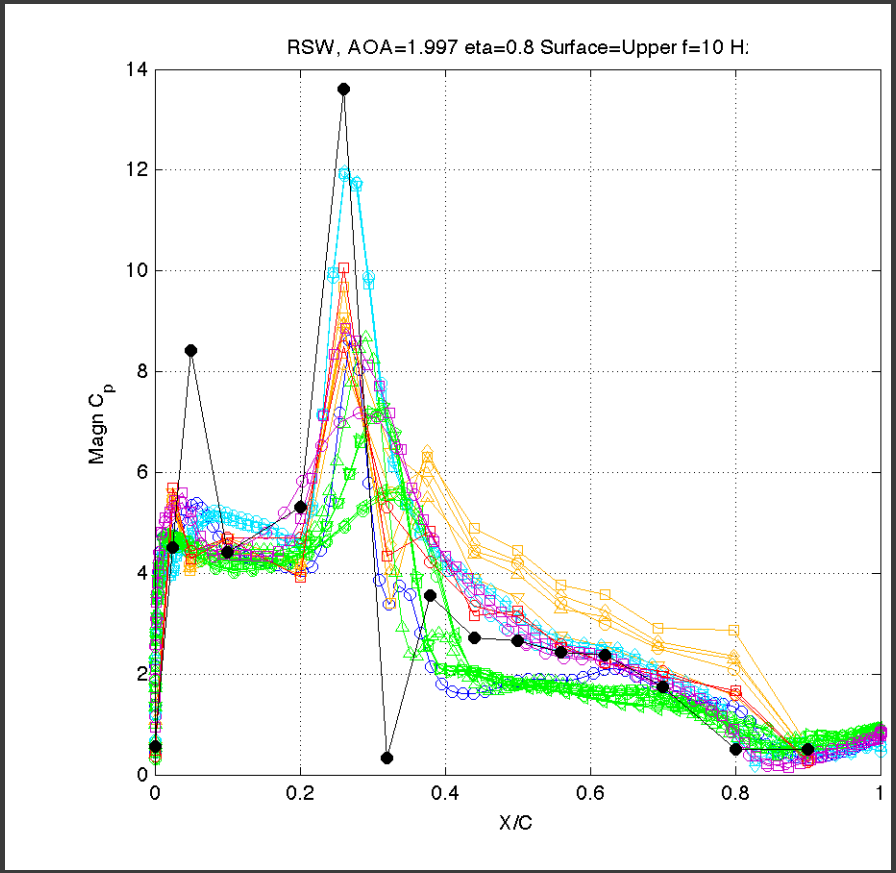
Upper $\eta = 0.588$ Lower

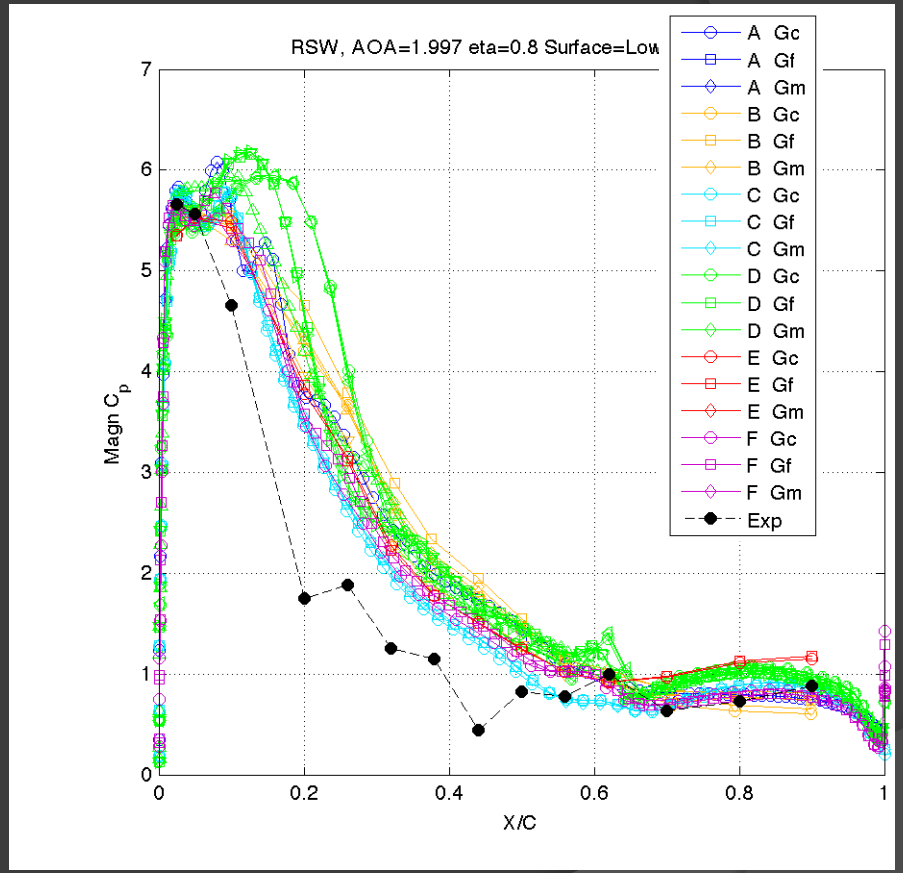




Notes: These comparisons are utilizing the preliminary data, as submitted prior to the AePW. These are workshop results, not publication results.
There are significant differences in the geometry used, as well as normalization constants, definitions of FRF and sign conventions
These issues are being sorted out post-workshop. None of the results included should be interpreted without proper consideration of these issues. Corrections and rescalings etc will be performed prior to publication.

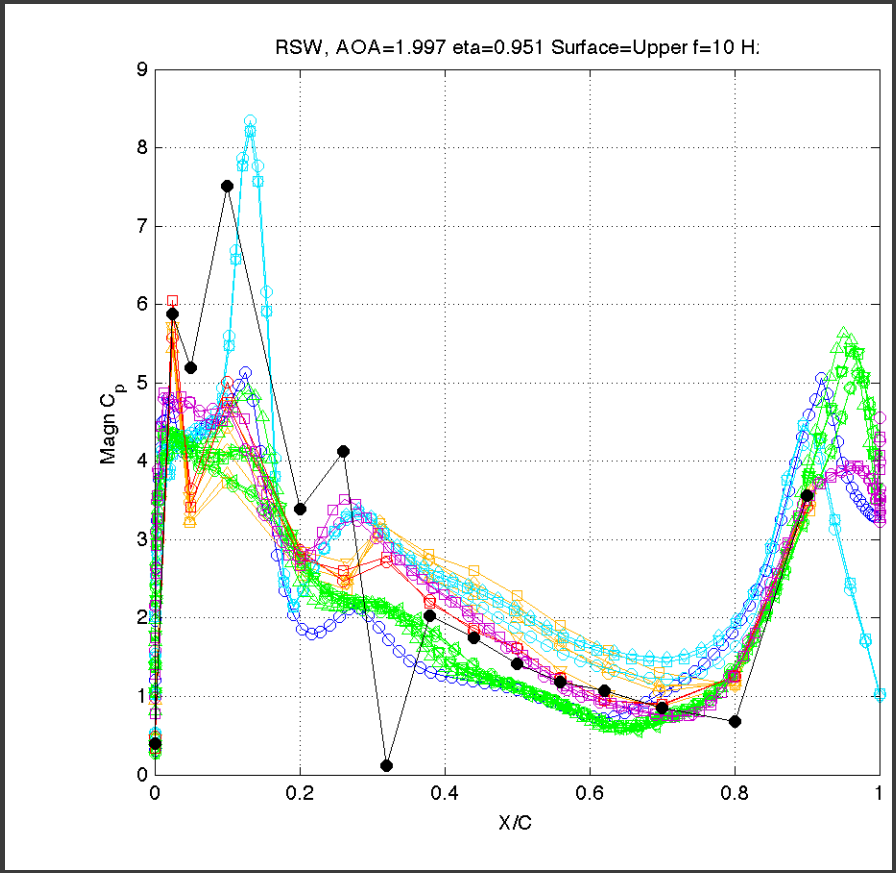
Upper $\eta = 0.809$ Lower

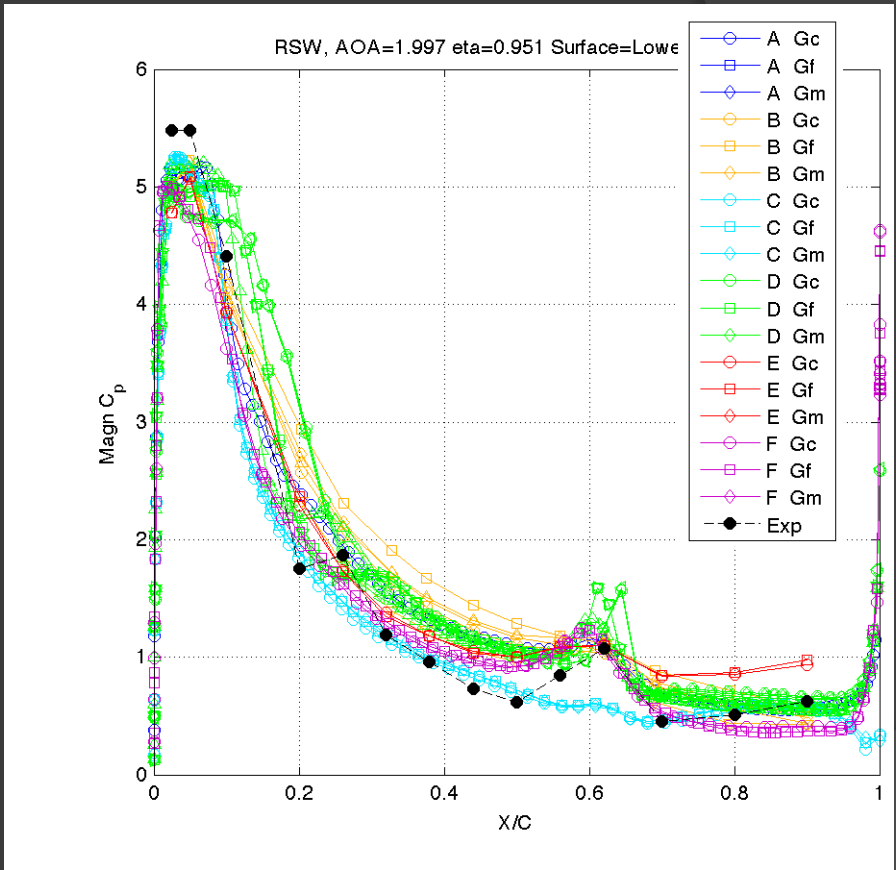




Notes: These comparisons are utilizing the preliminary data, as submitted prior to the AePW. These are workshop results, not publication results.
There are significant differences in the geometry used, as well as normalization constants, definitions of FRF and sign conventions
These issues are being sorted out post-workshop. None of the results included should be interpreted without proper consideration of these issues. Corrections and rescalings etc will be performed prior to publication.

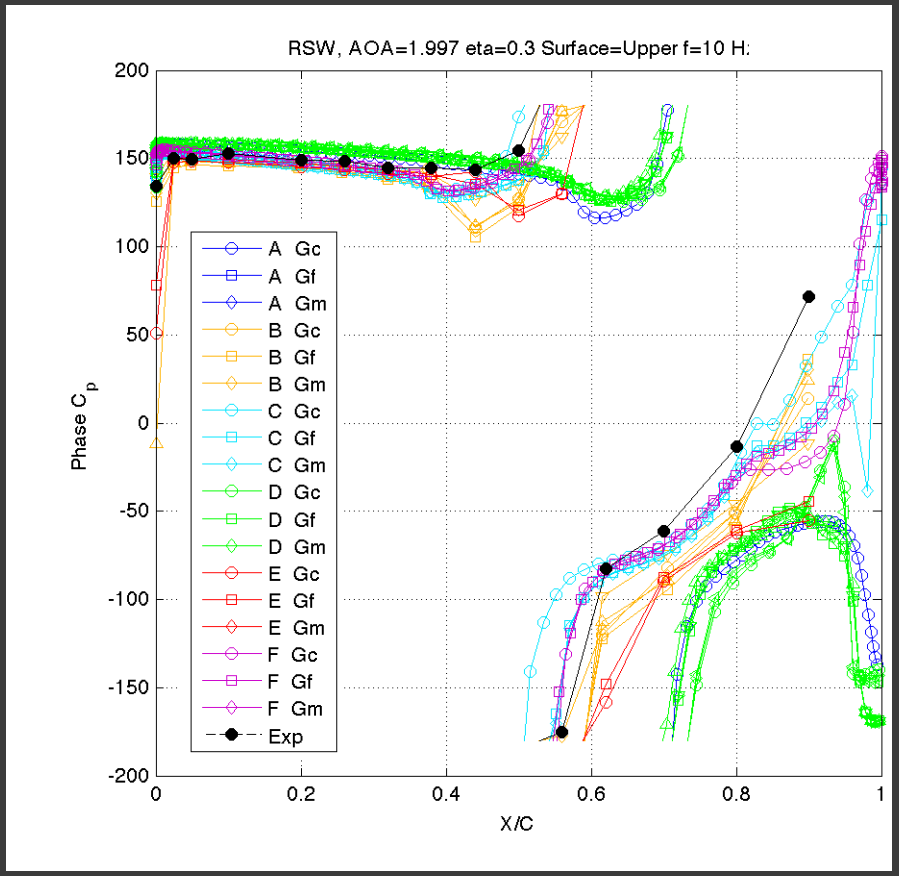
Upper $\eta = 0.951$ Lower

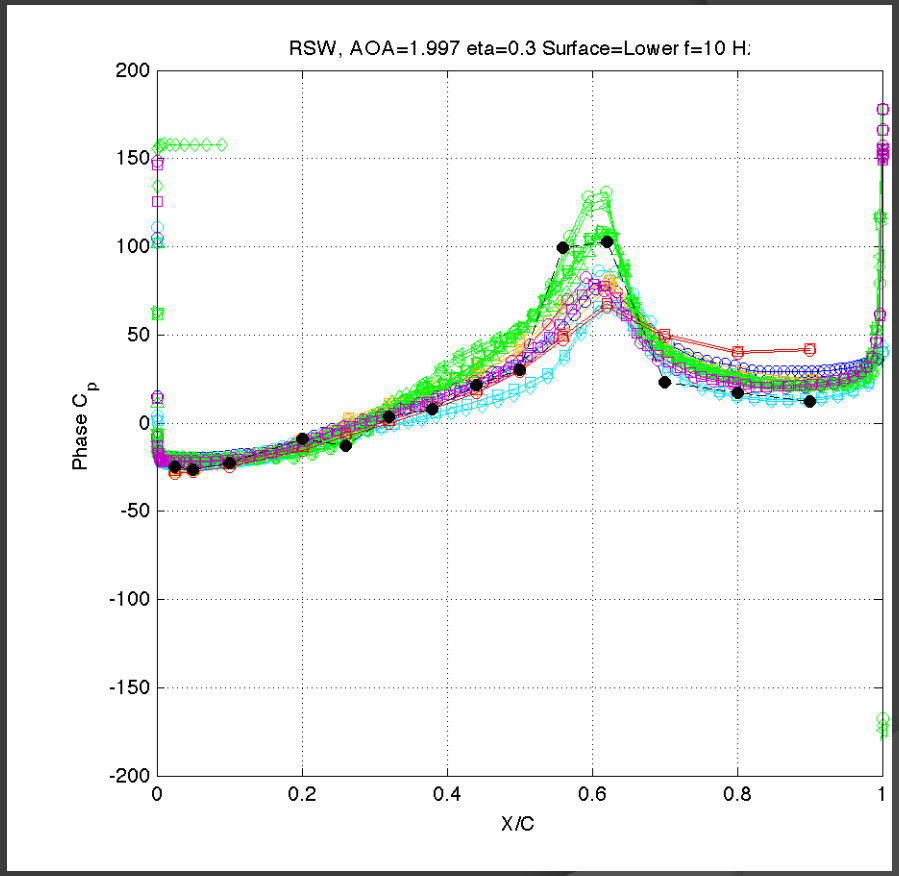




Notes: These comparisons are utilizing the preliminary data, as submitted prior to the AePW. These are workshop results, not publication results.
There are significant differences in the geometry used, as well as normalization constants, definitions of FRF and sign conventions
These issues are being sorted out post-workshop. None of the results included should be interpreted without proper consideration of these issues. Corrections and rescalings etc will be performed prior to publication.

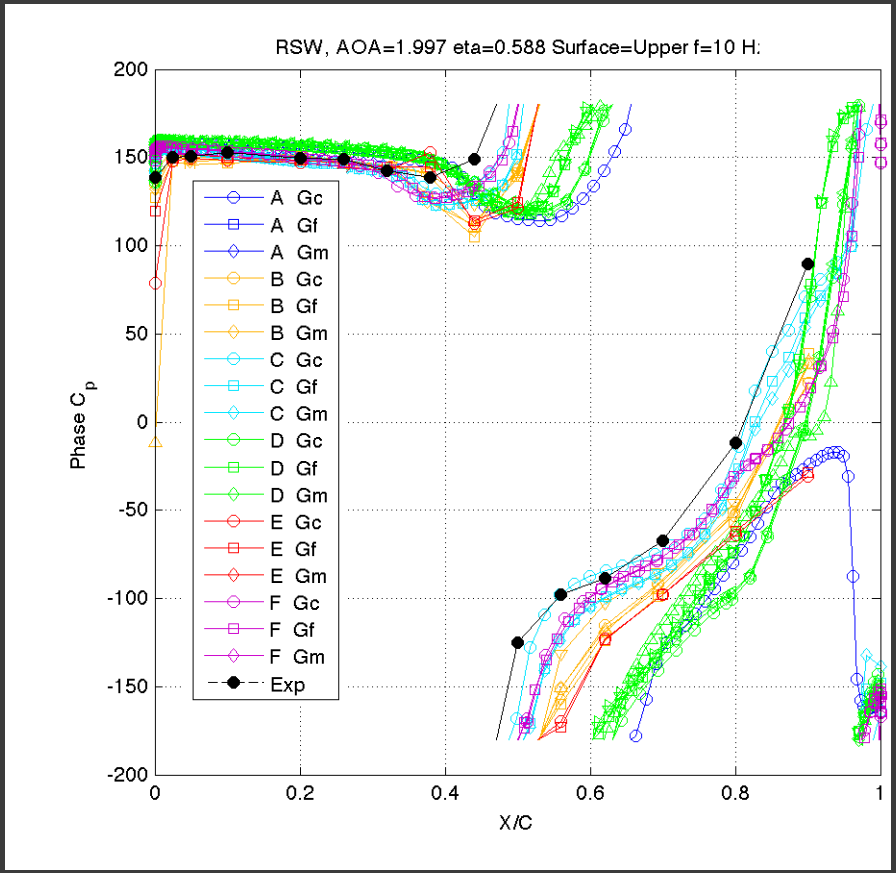
Upper $\eta = 0.309$ Lower

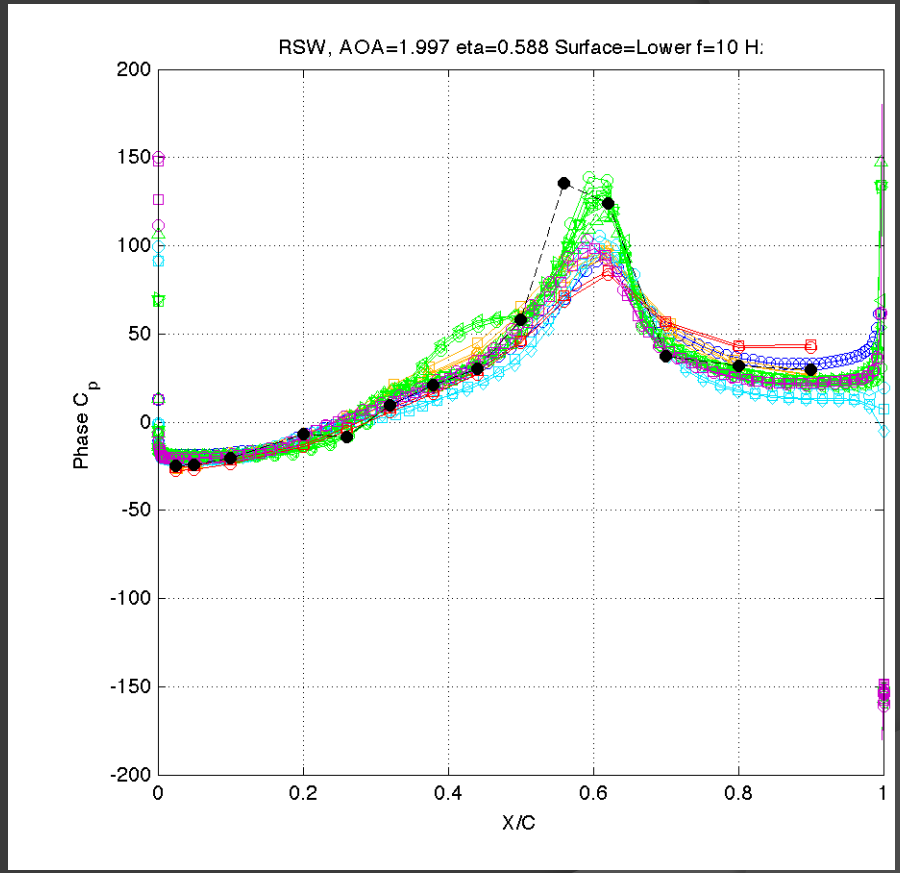




Notes: These comparisons are utilizing the preliminary data, as submitted prior to the AePW. These are workshop results, not publication results.
There are significant differences in the geometry used, as well as normalization constants, definitions of FRF and sign conventions
These issues are being sorted out post-workshop. None of the results included should be interpreted without proper consideration of these issues. Corrections and rescalings etc will be performed prior to publication.

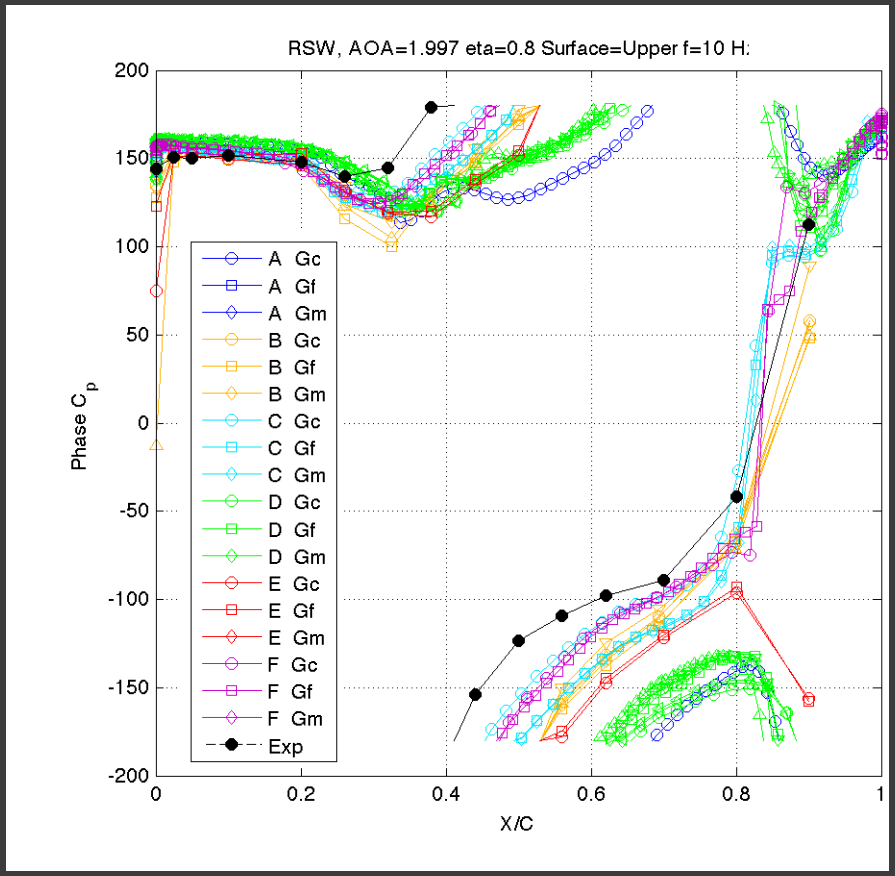
Upper $\eta = 0.588$ Lower

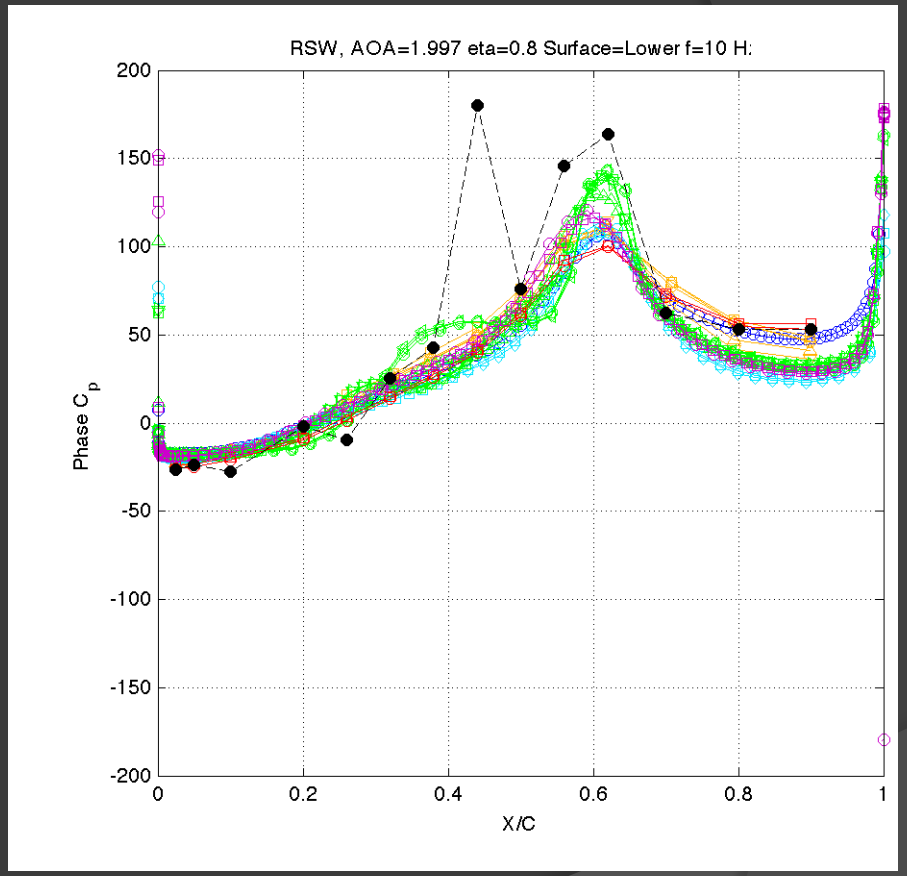




Notes: These comparisons are utilizing the preliminary data, as submitted prior to the AePW. These are workshop results, not publication results.
There are significant differences in the geometry used, as well as normalization constants, definitions of FRF and sign conventions
These issues are being sorted out post-workshop. None of the results included should be interpreted without proper consideration of these issues. Corrections and rescalings etc will be performed prior to publication.

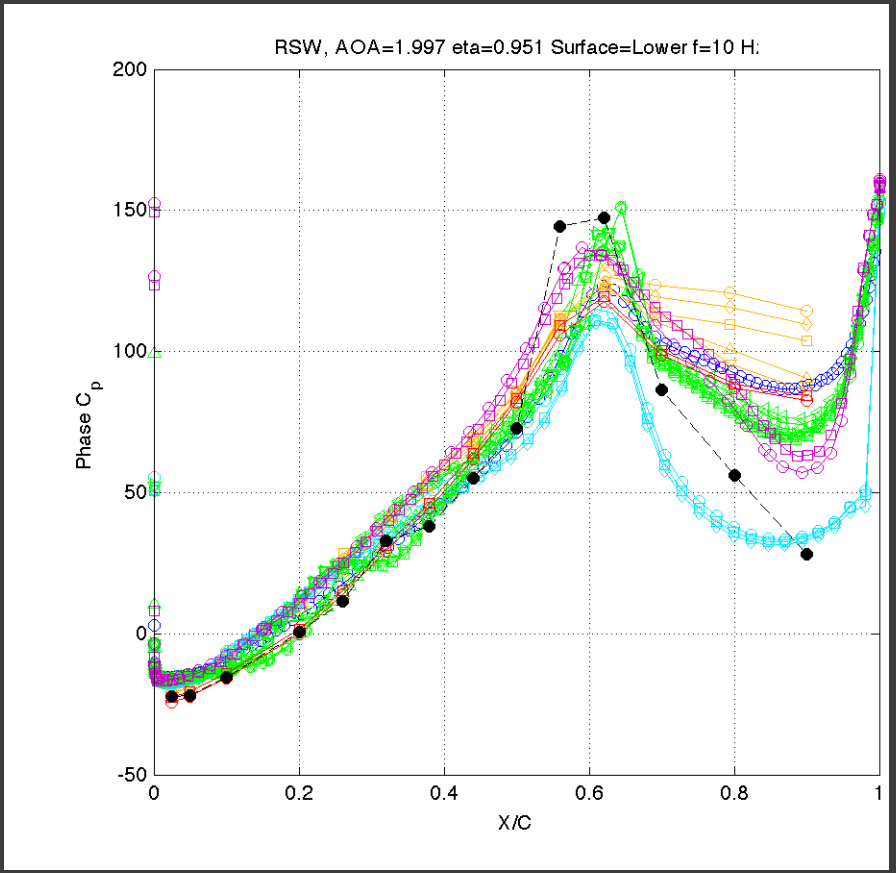
Upper $\eta = 0.809$ Lower

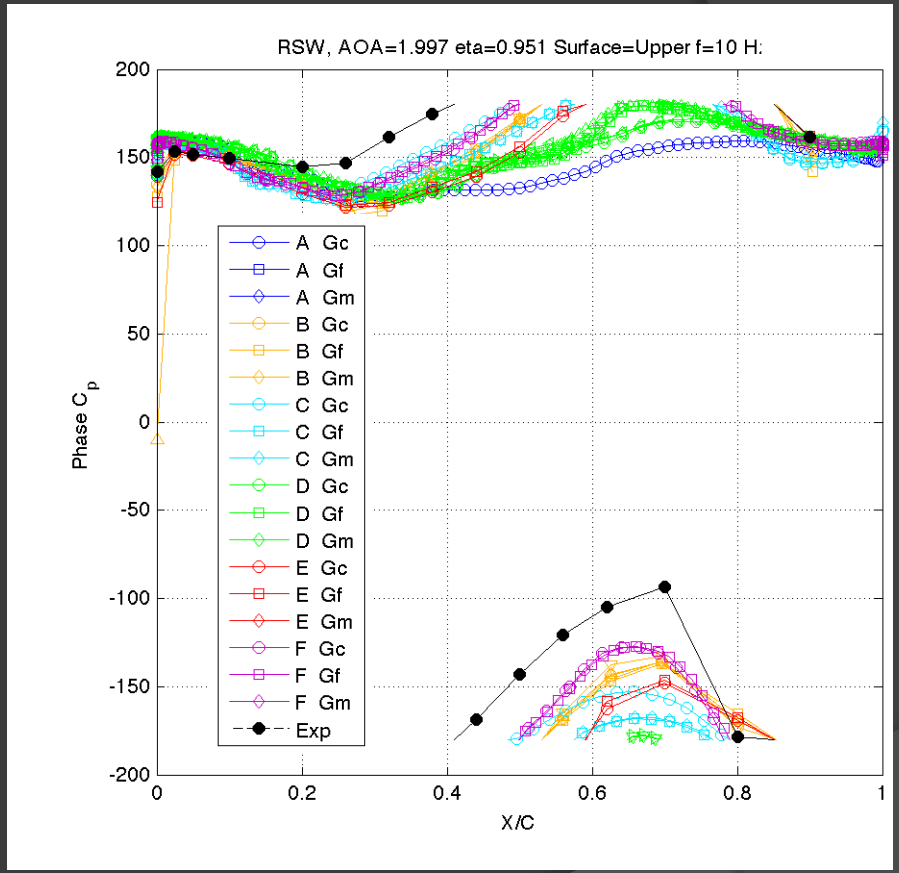




Notes: These comparisons are utilizing the preliminary data, as submitted prior to the AePW. These are workshop results, not publication results.
There are significant differences in the geometry used, as well as normalization constants, definitions of FRF and sign conventions
These issues are being sorted out post-workshop. None of the results included should be interpreted without proper consideration of these issues. Corrections and rescalings etc will be performed prior to publication.

Upper $\eta = 0.951$ Lower

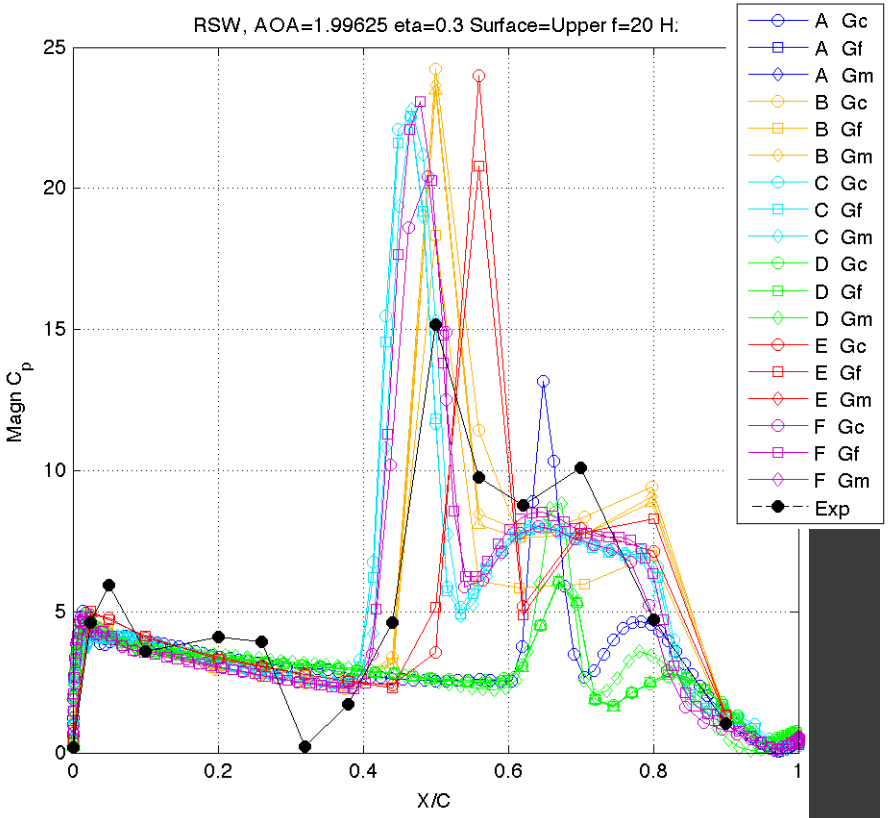


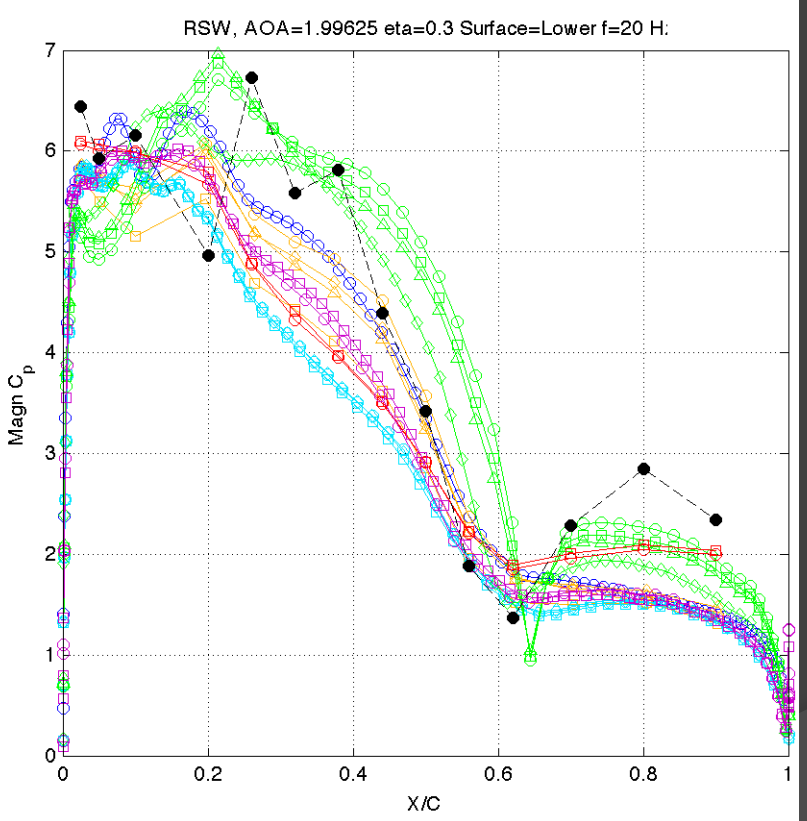


Notes: These comparisons are utilizing the preliminary data, as submitted prior to the AePW. These are workshop results, not publication results.
There are significant differences in the geometry used, as well as normalization constants, definitions of FRF and sign conventions
These issues are being sorted out post-workshop. None of the results included should be interpreted without proper consideration of these issues. Corrections and rescalings etc will be performed prior to publication.

UNSTEADY f=20 Hz

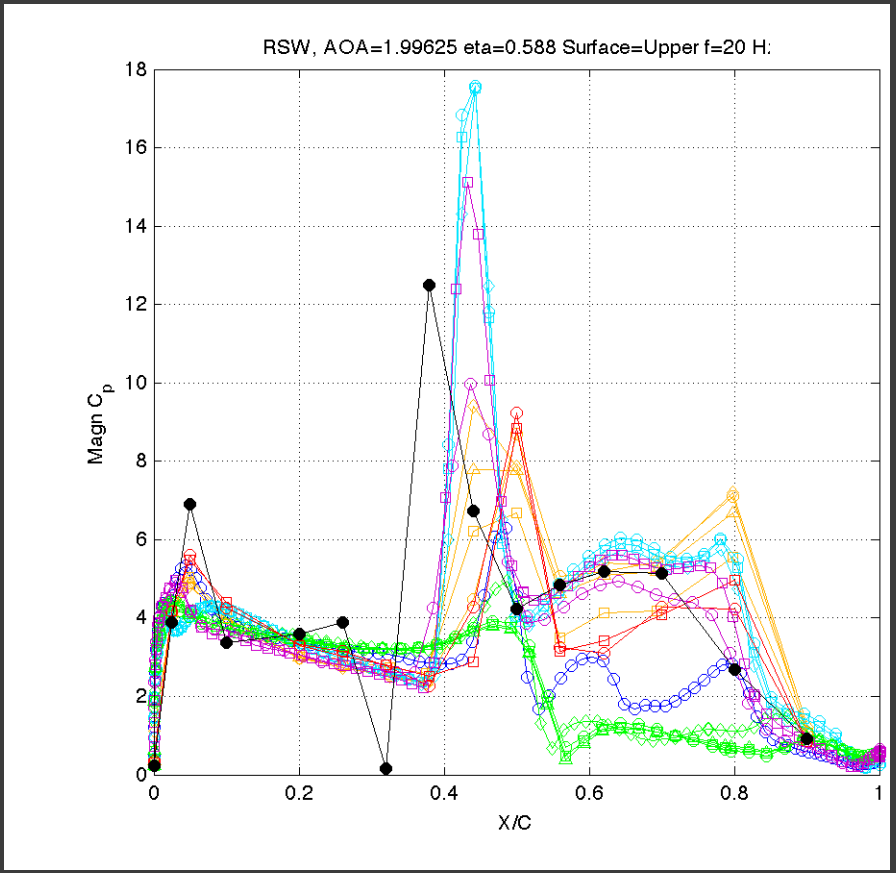
Upper $\eta = 0.309$ Lower

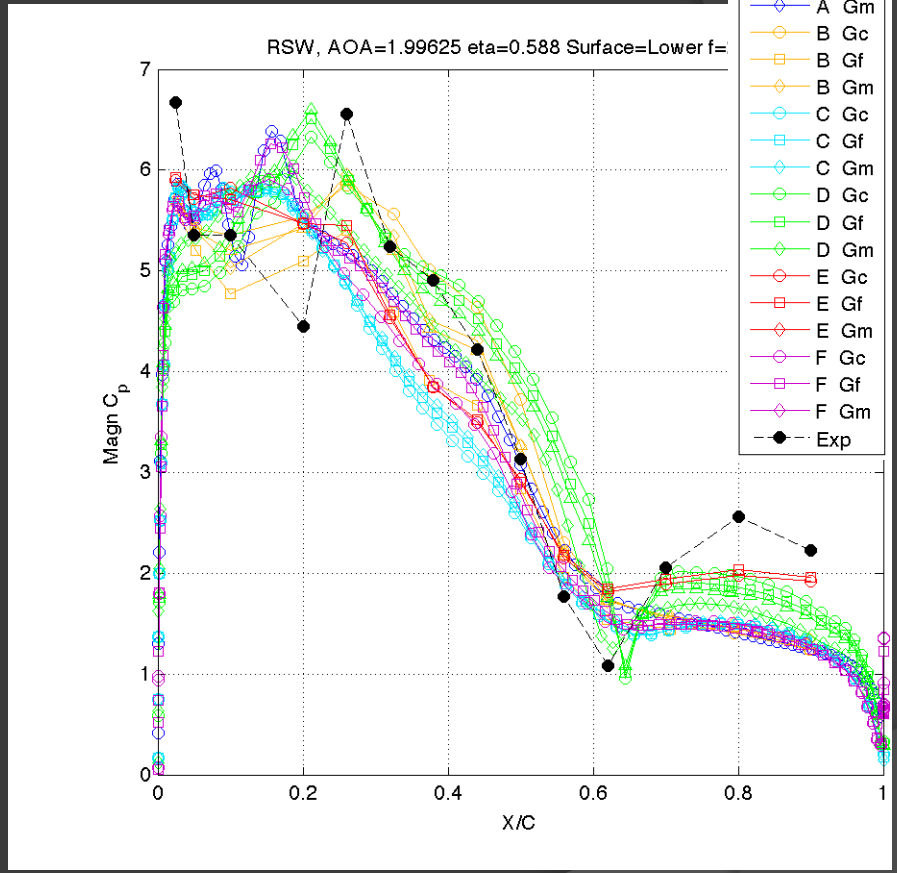




Notes: These comparisons are utilizing the preliminary data, as submitted prior to the AePW. These are workshop results, not publication results.
There are significant differences in the geometry used, as well as normalization constants, definitions of FRF and sign conventions
These issues are being sorted out post-workshop. None of the results included should be interpreted without proper consideration of these issues. Corrections and rescalings etc will be performed prior to publication.

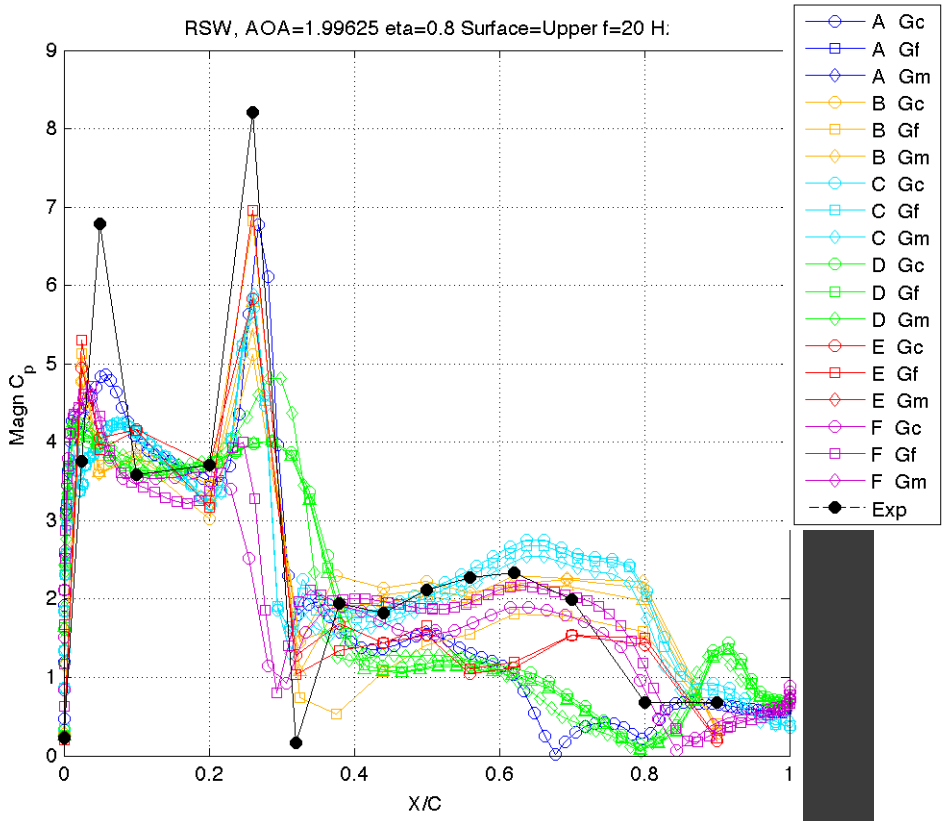
Upper $\eta = 0.588$ Lower

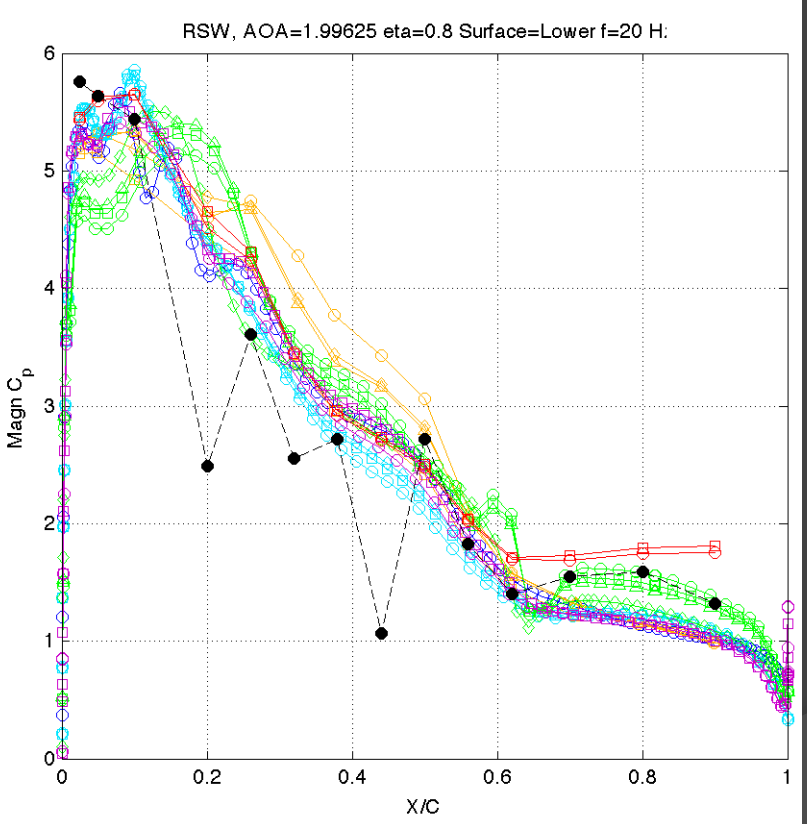




Notes: These comparisons are utilizing the preliminary data, as submitted prior to the AePW. These are workshop results, not publication results.
There are significant differences in the geometry used, as well as normalization constants, definitions of FRF and sign conventions
These issues are being sorted out post-workshop. None of the results included should be interpreted without proper consideration of these issues. Corrections and rescalings etc will be performed prior to publication.

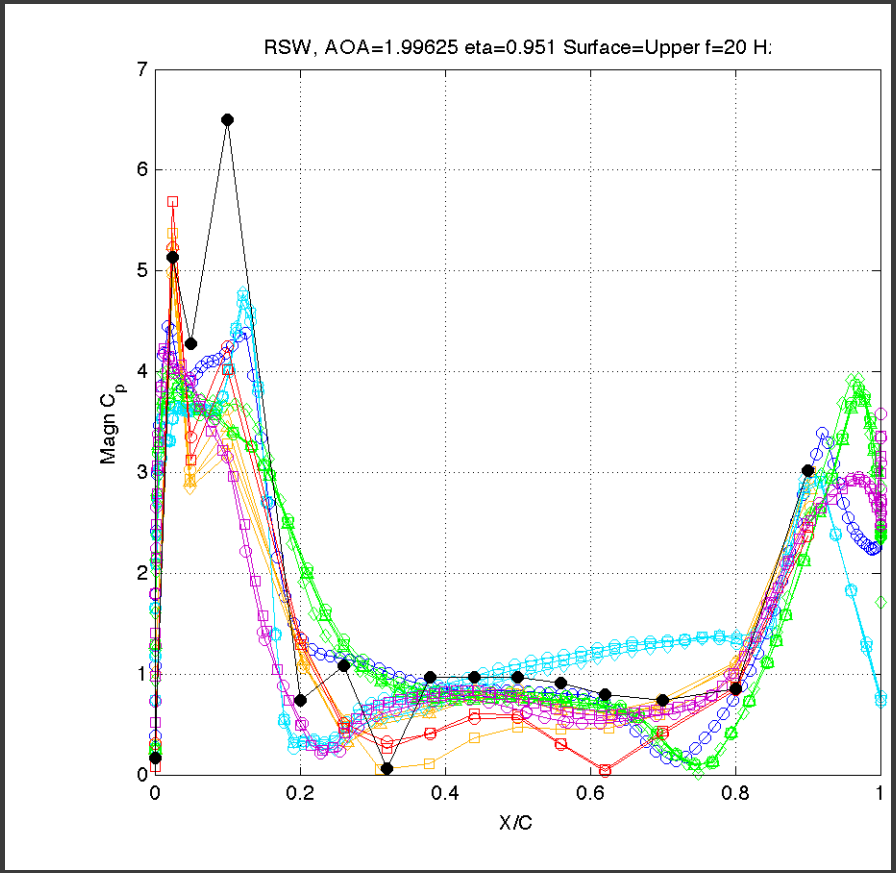
Upper $\eta = 0.809$ Lower

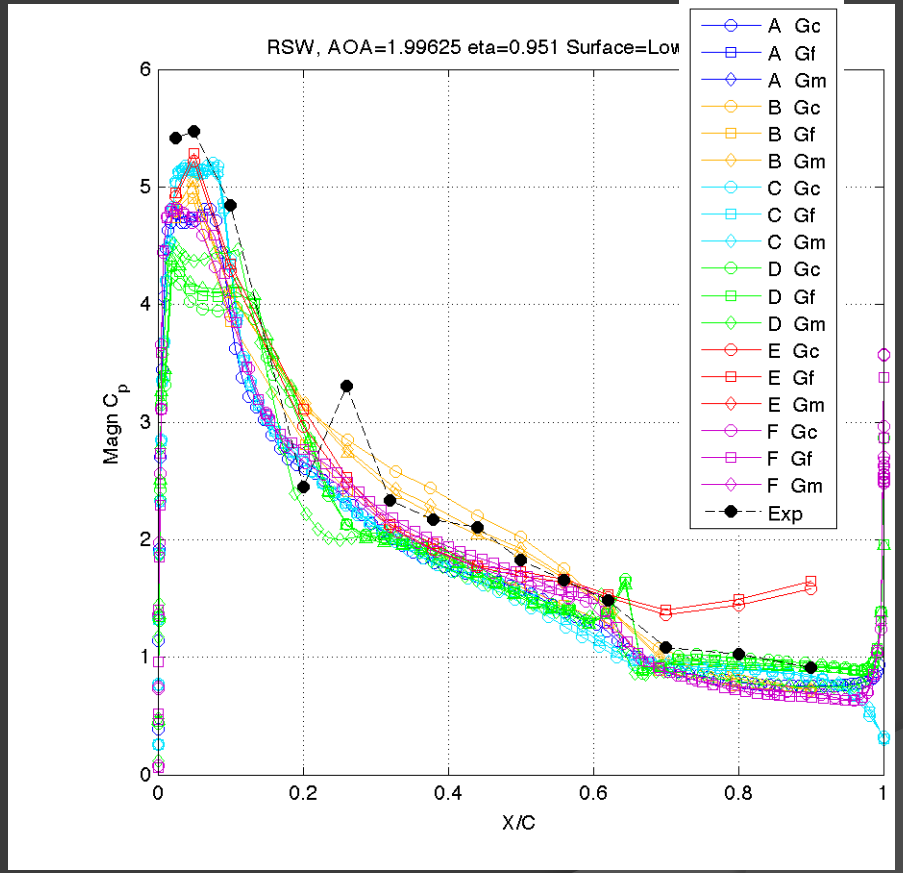




Notes: These comparisons are utilizing the preliminary data, as submitted prior to the AePW. These are workshop results, not publication results.
There are significant differences in the geometry used, as well as normalization constants, definitions of FRF and sign conventions
These issues are being sorted out post-workshop. None of the results included should be interpreted without proper consideration of these issues. Corrections and rescalings etc will be performed prior to publication.

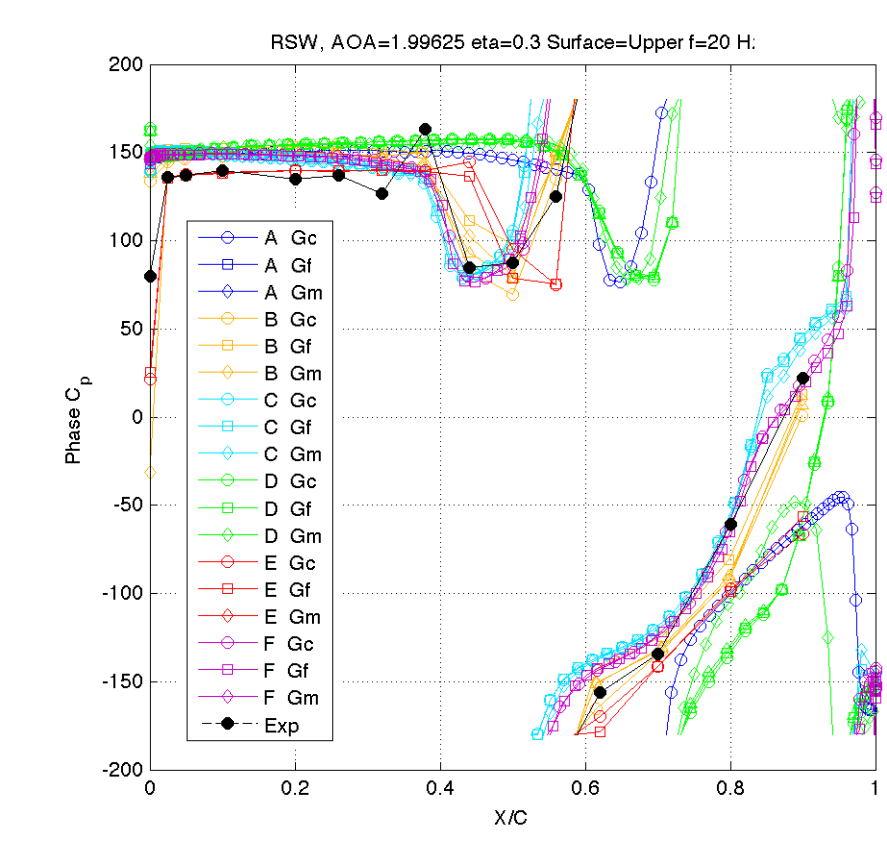
Upper $\eta = 0.951$ Lower

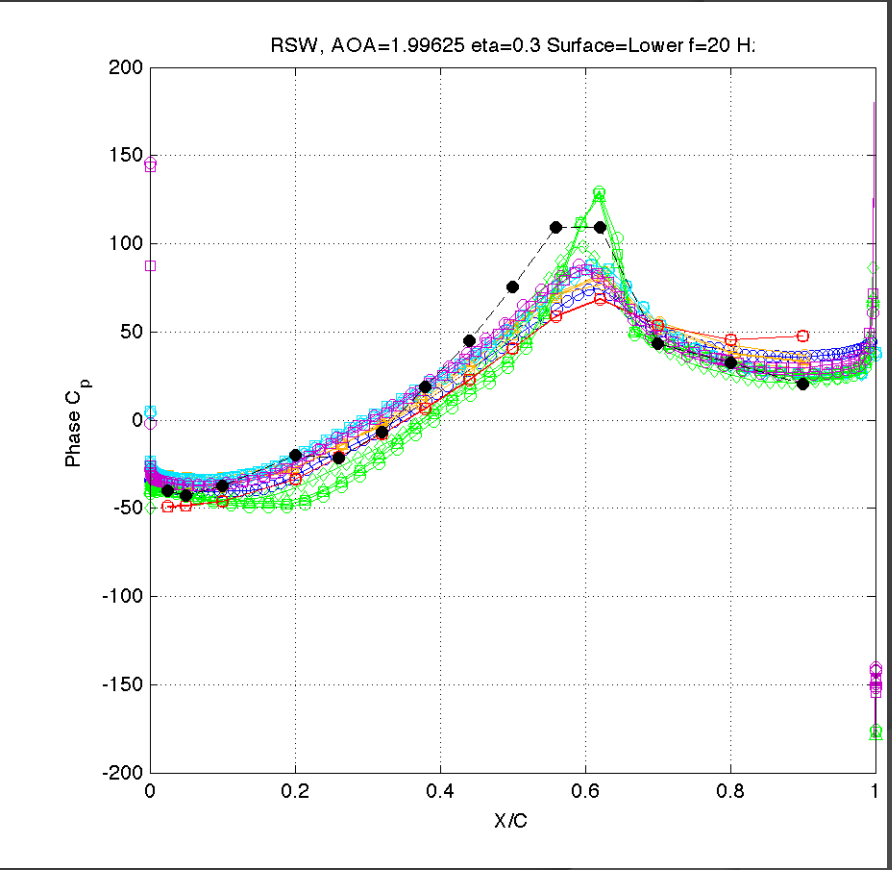




Notes: These comparisons are utilizing the preliminary data, as submitted prior to the AePW. These are workshop results, not publication results.
There are significant differences in the geometry used, as well as normalization constants, definitions of FRF and sign conventions
These issues are being sorted out post-workshop. None of the results included should be interpreted without proper consideration of these issues. Corrections and rescalings etc will be performed prior to publication.

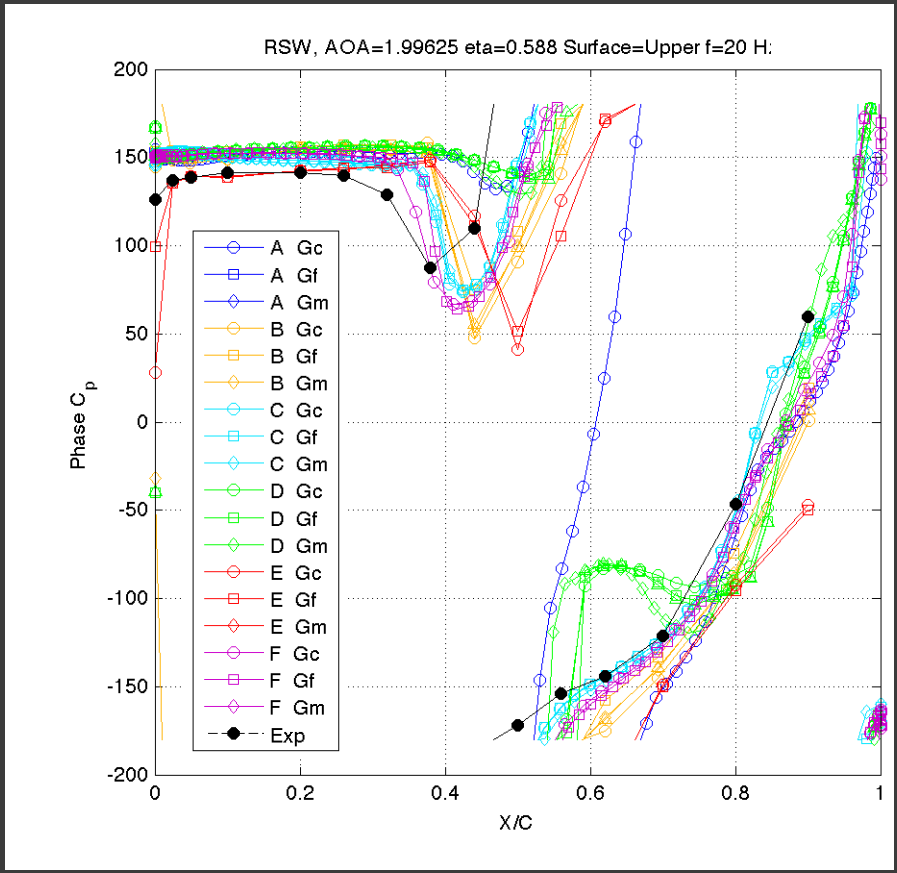
Upper $\eta = 0.309$ Lower

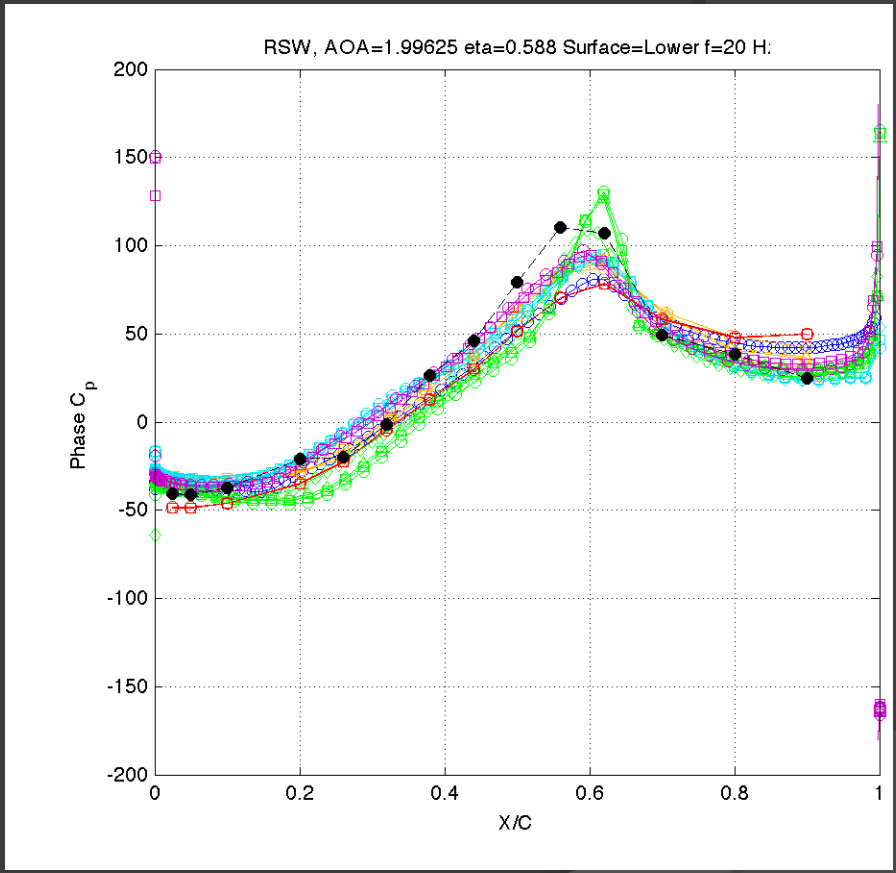




Notes: These comparisons are utilizing the preliminary data, as submitted prior to the AePW. These are workshop results, not publication results.
There are significant differences in the geometry used, as well as normalization constants, definitions of FRF and sign conventions
These issues are being sorted out post-workshop. None of the results included should be interpreted without proper consideration of these issues. Corrections and rescalings etc will be performed prior to publication.

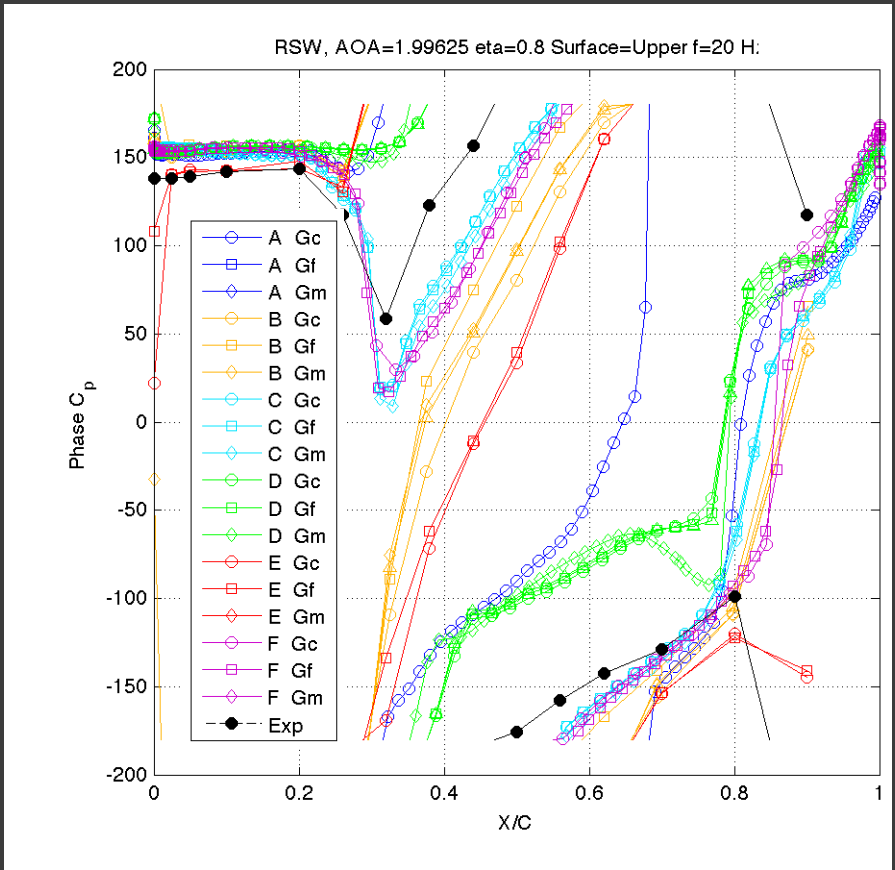
Upper $\eta = 0.588$ Lower

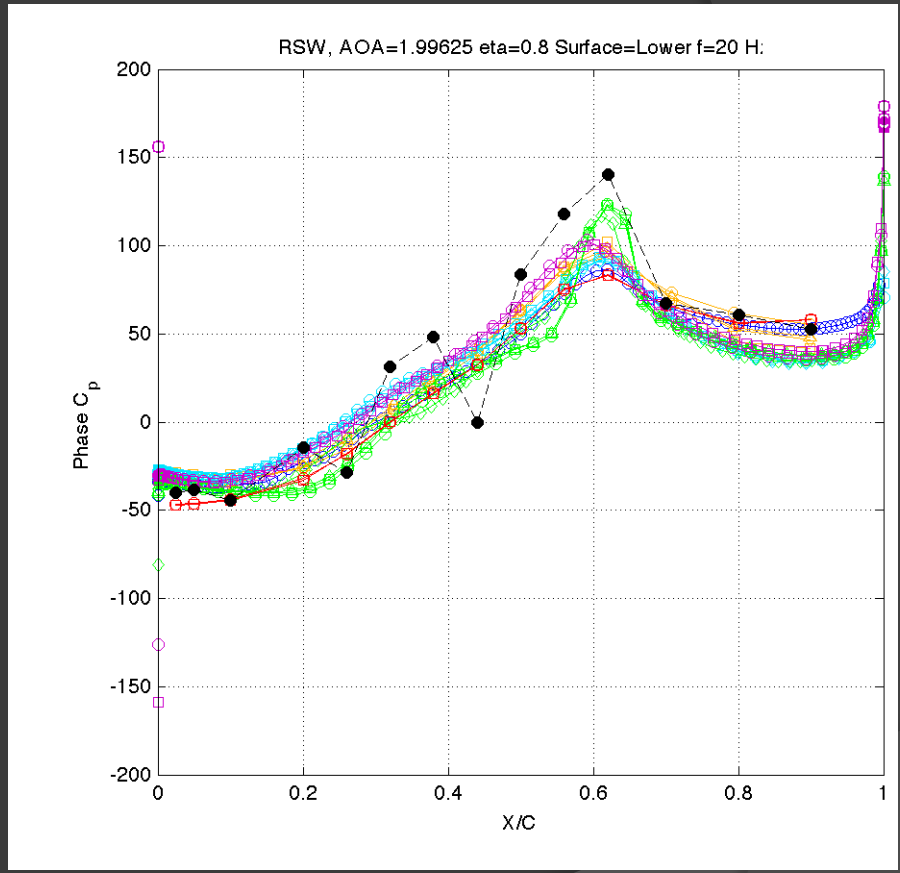




Notes: These comparisons are utilizing the preliminary data, as submitted prior to the AePW. These are workshop results, not publication results.
There are significant differences in the geometry used, as well as normalization constants, definitions of FRF and sign conventions
These issues are being sorted out post-workshop. None of the results included should be interpreted without proper consideration of these issues. Corrections and rescalings etc will be performed prior to publication.

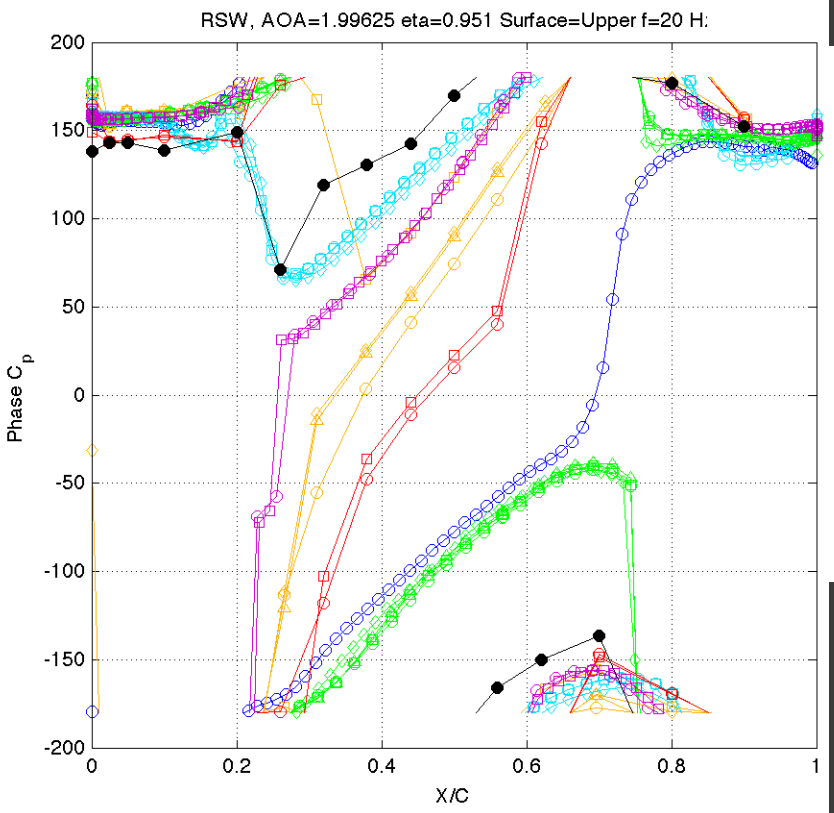
Upper $\eta = 0.809$ Lower

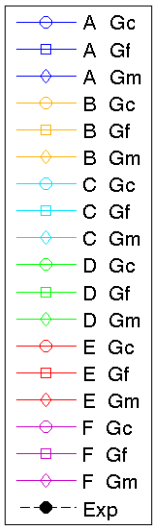


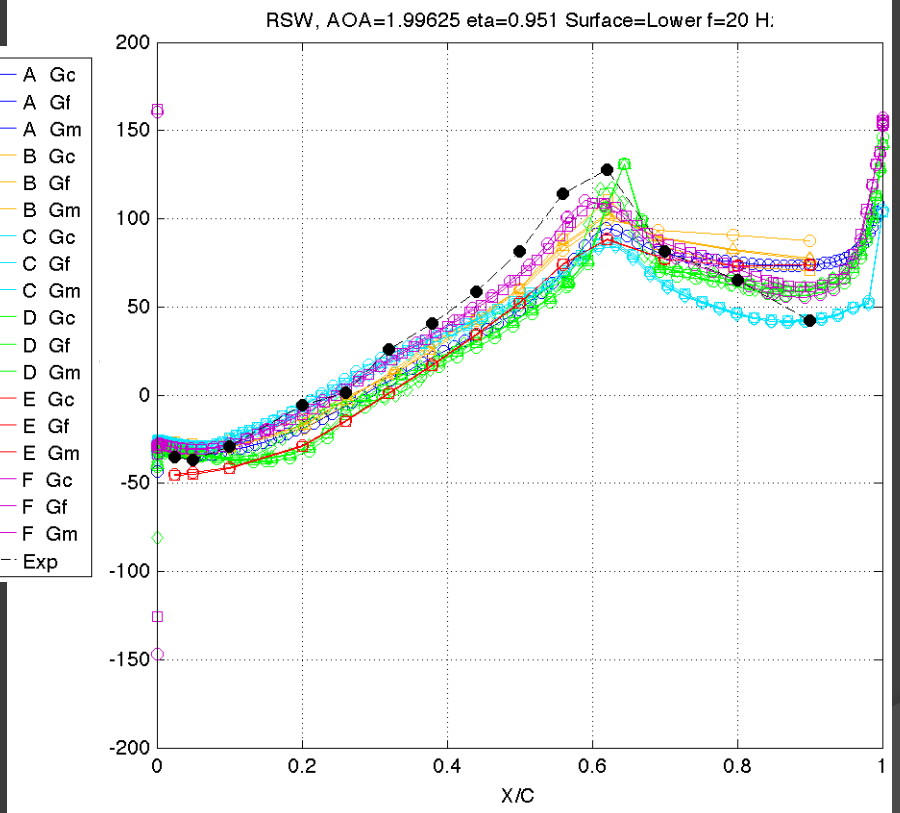


Notes: These comparisons are utilizing the preliminary data, as submitted prior to the AePW. These are workshop results, not publication results.
There are significant differences in the geometry used, as well as normalization constants, definitions of FRF and sign conventions
These issues are being sorted out post-workshop. None of the results included should be interpreted without proper consideration of these issues. Corrections and rescalings etc will be performed prior to publication.

Upper $\eta = 0.951$ Lower







Notes: These comparisons are utilizing the preliminary data, as submitted prior to the AePW. These are workshop results, not publication results.
There are significant differences in the geometry used, as well as normalization constants, definitions of FRF and sign conventions
These issues are being sorted out post-workshop. None of the results included should be interpreted without proper consideration of these issues. Corrections and rescalings etc will be performed prior to publication.