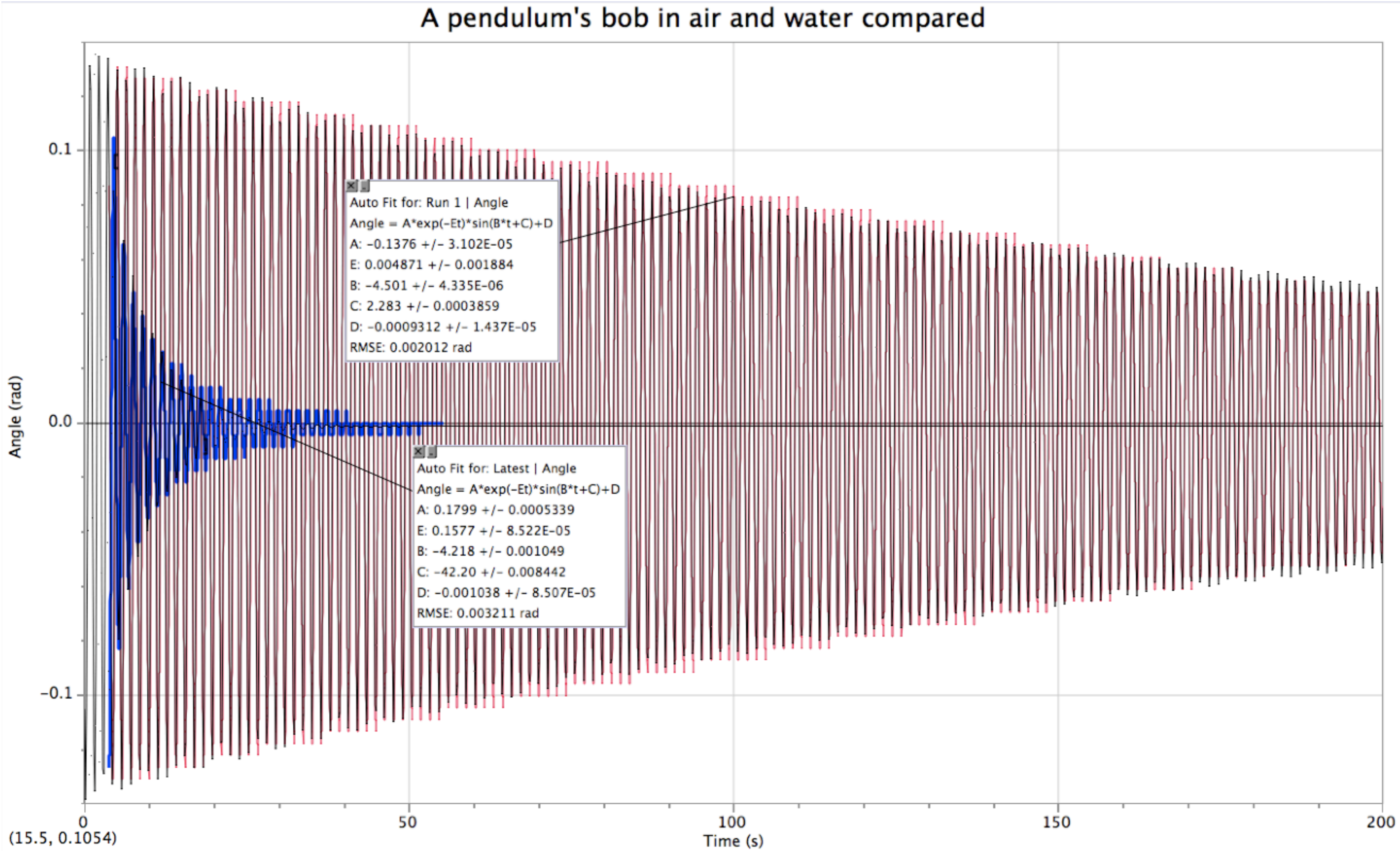
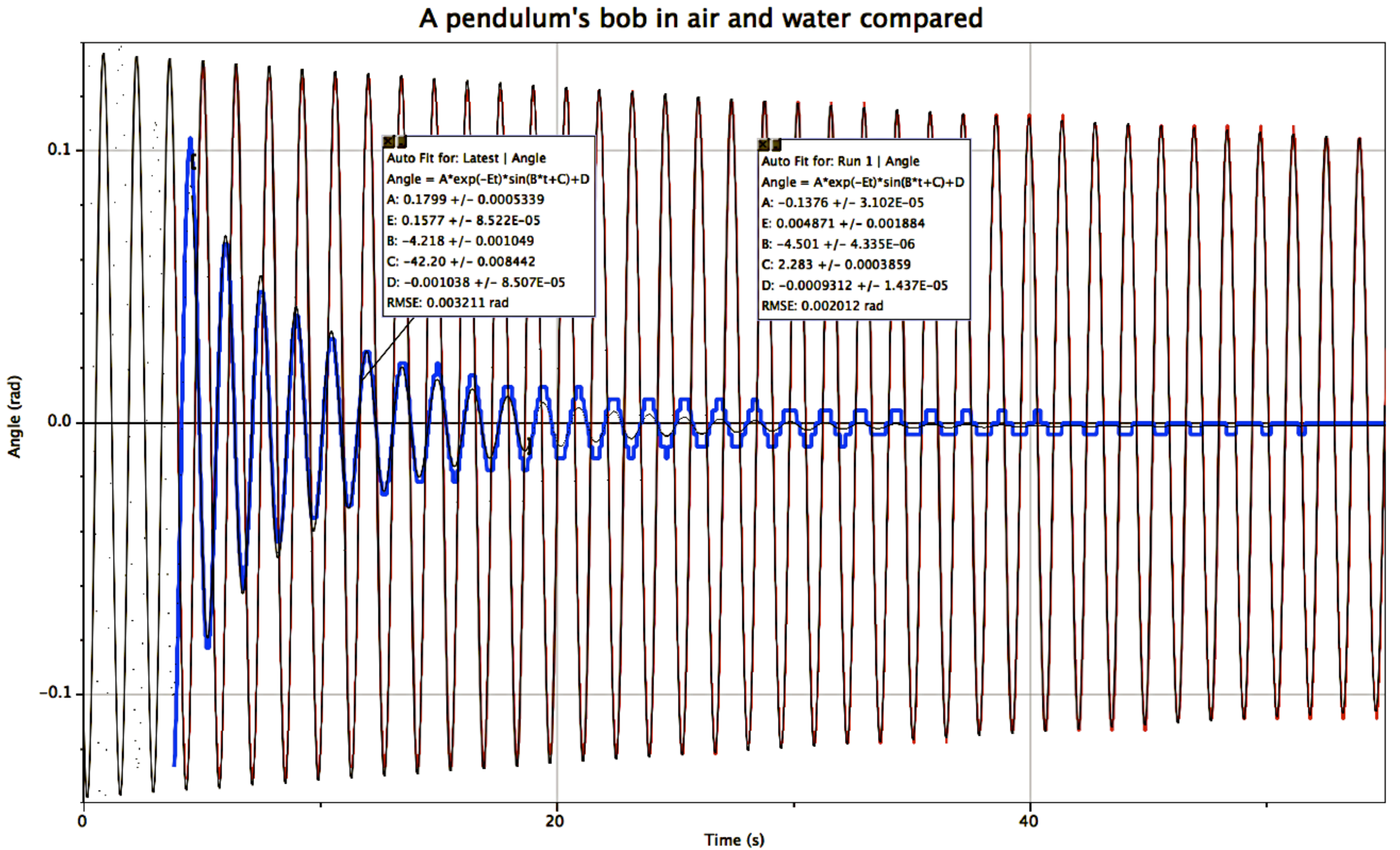
An Exploration of Pendulum Damping

Two Bobs at end of rod; ring down in air and with one immersed in water



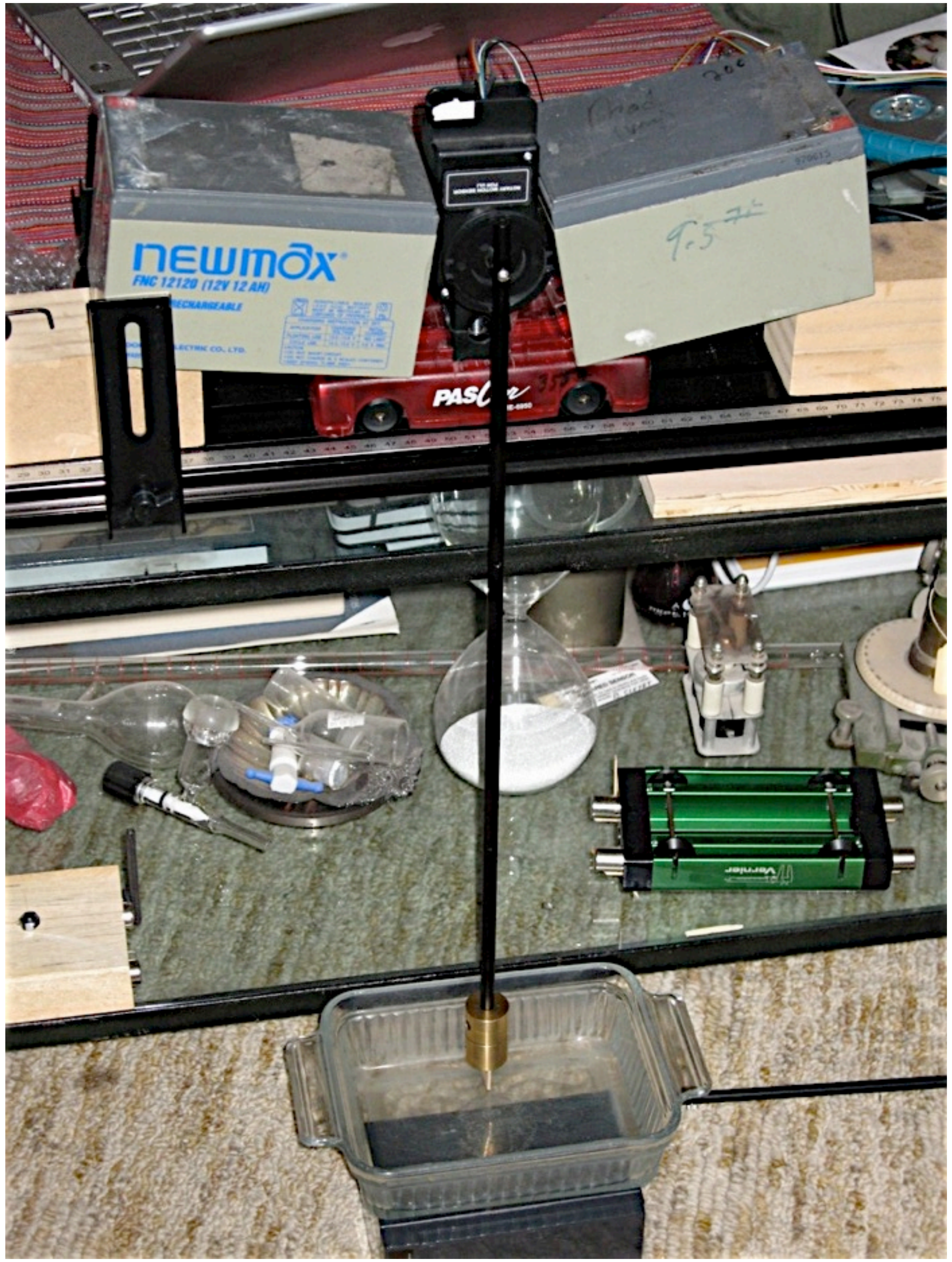
The previous graph expanded

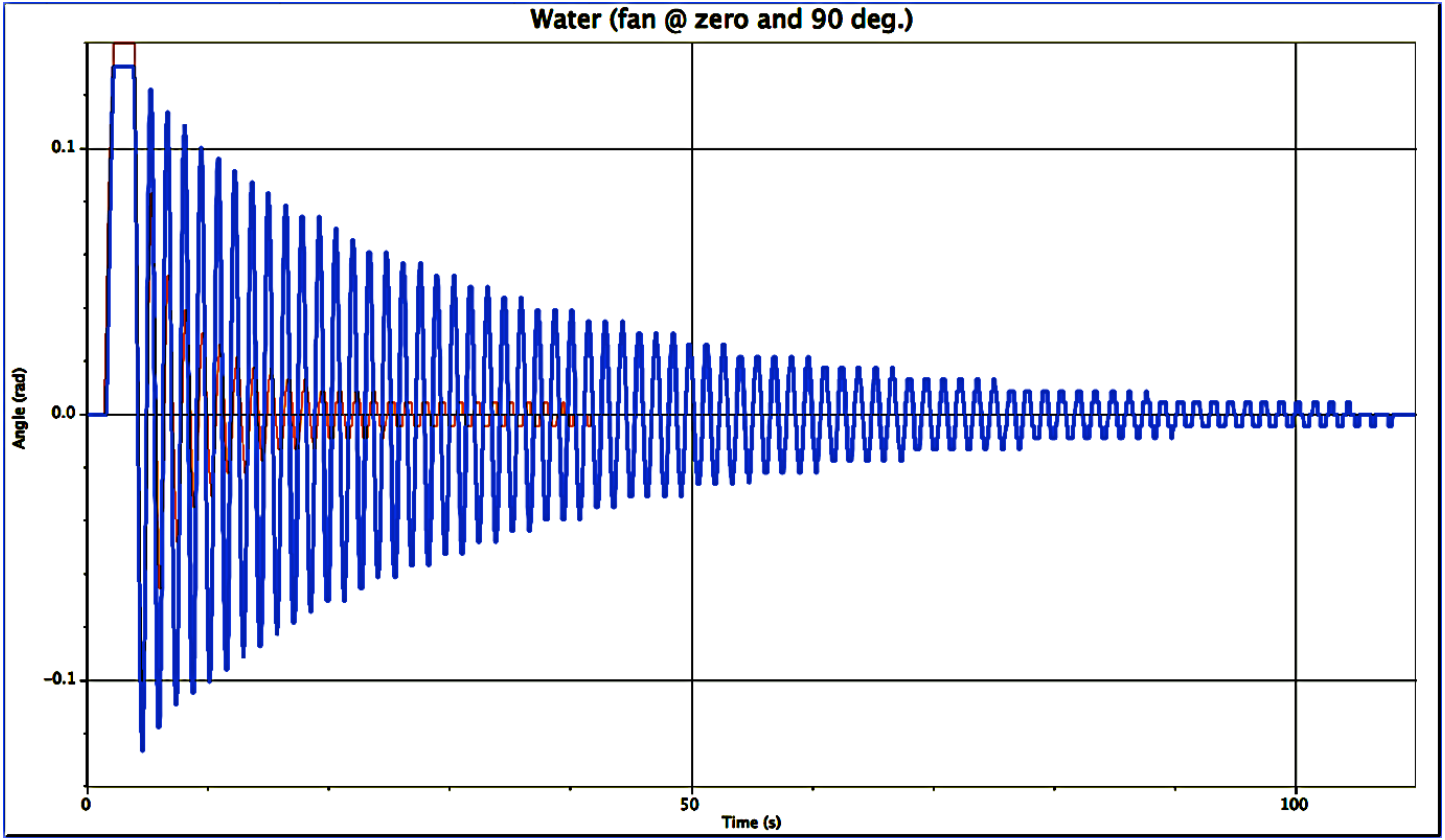


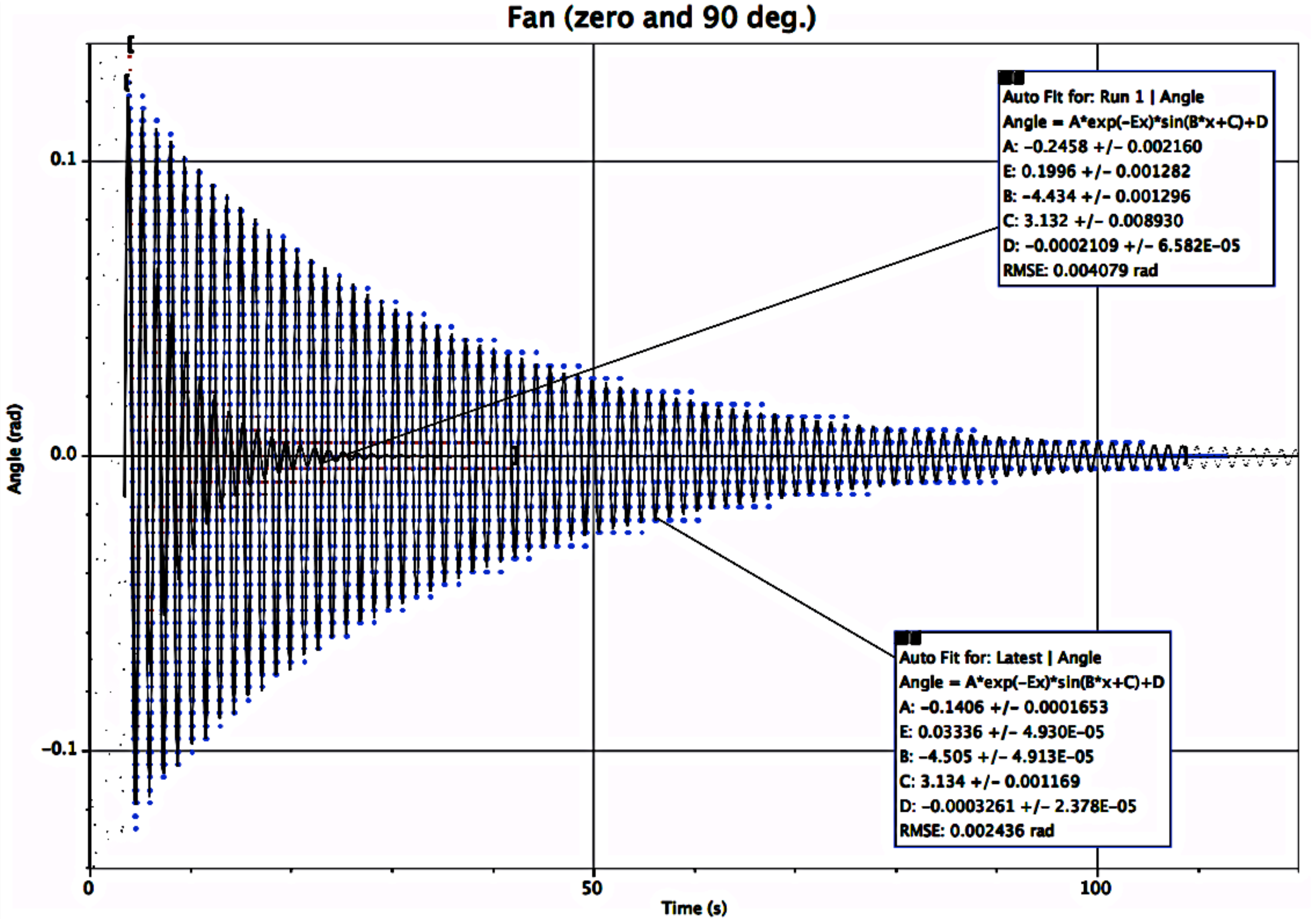
Problem: How much of the lengthened period is due to the damping and how much to the buoyancy?
I hadn't yet found the answer, so I modified the apparatus!

I added a fan instead of immersing the bob

I rotate the rod 90 degrees to obtain maximum damping. But there is still the problem of a slight variable immersion with displacement.



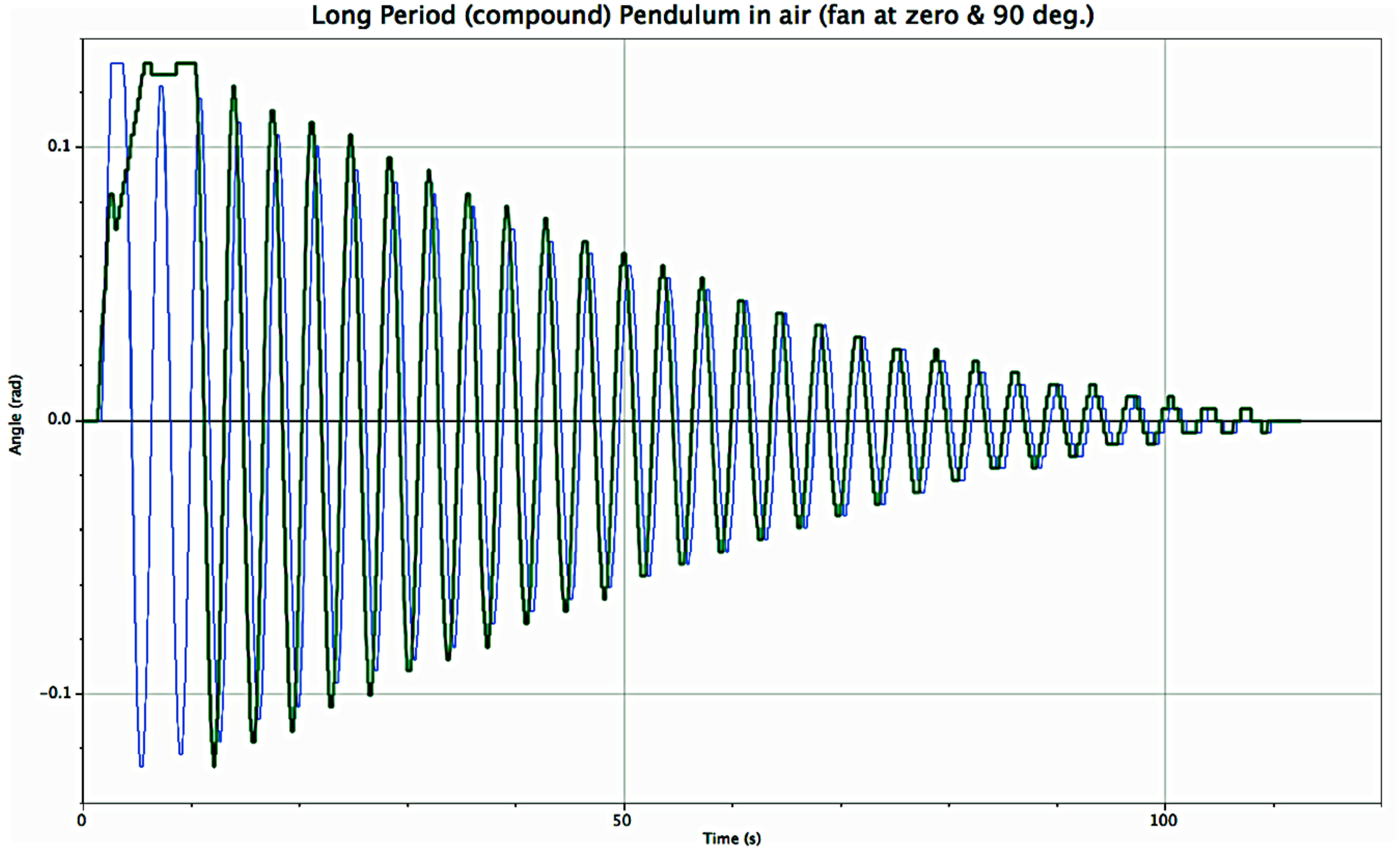

Water (fan @ zero and 90 deg.)
Angle (rad)
0.1
0.0
-0.1
0
50
100
Time (s)


Fan (zero and 90 deg.)
Angle (rad)
0.1
0.0
−0.1
0
50
100
Time (s)
Auto Fit for: Run 1 | Angle
Angle = A*exp(−Ex)*sin(B*x+C)+D
A: −0.2458 +/− 0.002160
E: 0.1996 +/− 0.001282
B: −4.434 +/− 0.001296
C: 3.132 +/− 0.008930
D: −0.0002109 +/− 6.582E−05
RMSE: 0.004079 rad
Auto Fit for: Latest | Angle
Angle = A*exp(−Ex)*sin(B*x+C)+D
A: −0.1406 +/− 0.0001653
E: 0.03336 +/− 4.930E−05
B: −4.505 +/− 4.913E−05
C: 3.134 +/− 0.001169
D: −0.0003261 +/− 2.378E−05
RMSE: 0.002436 rad

Note the periods and damping constants compared:

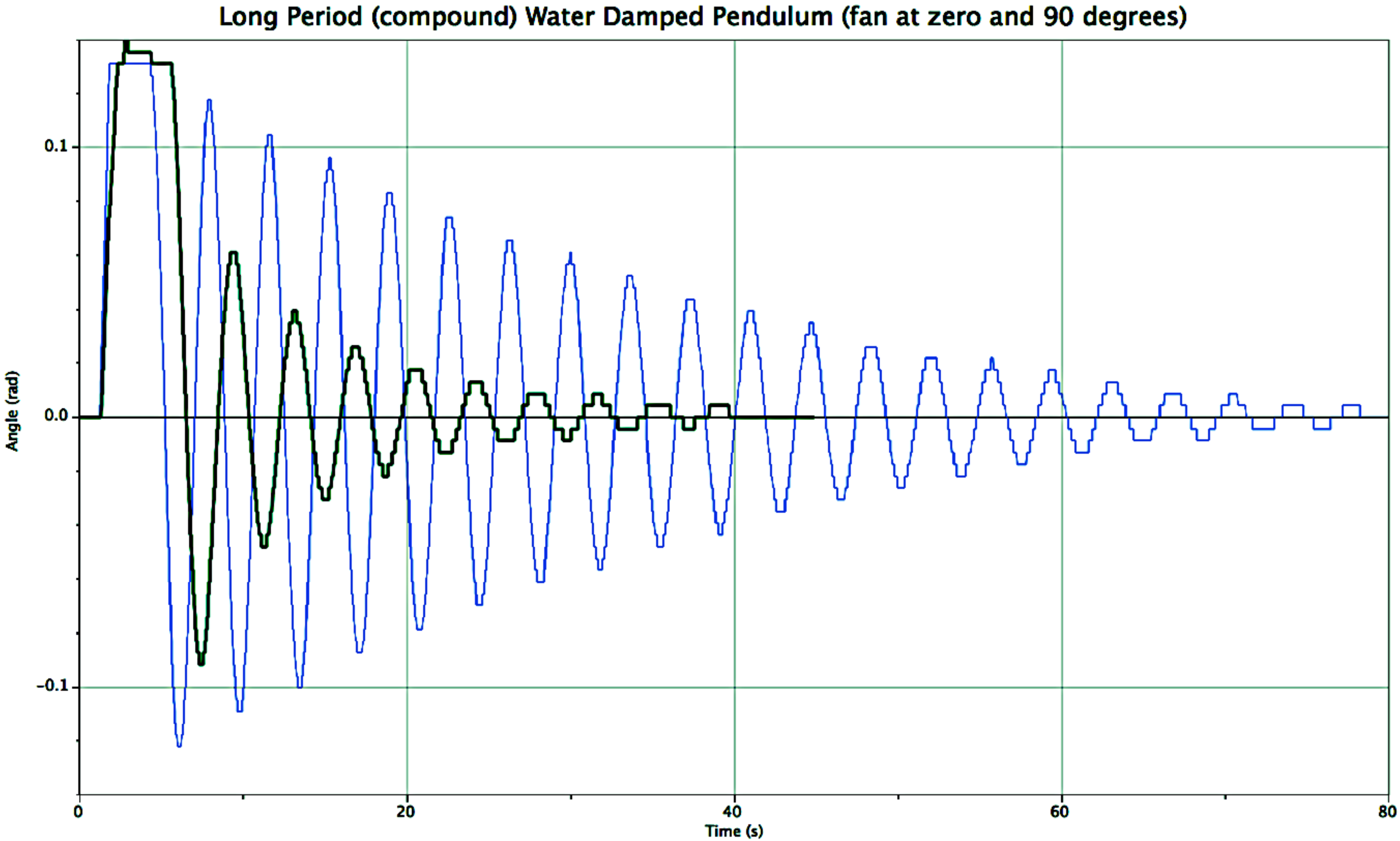
Bob immersed: 2Pi f damping constant	Air 4.501/s 0.000487	Water 4.218/s 0.1577
Fan angle (in water) 2Pi f damping constant	90 4.505 0.0334	0 deg. 4.434/s 0.1996

Long period (compound) pendulum

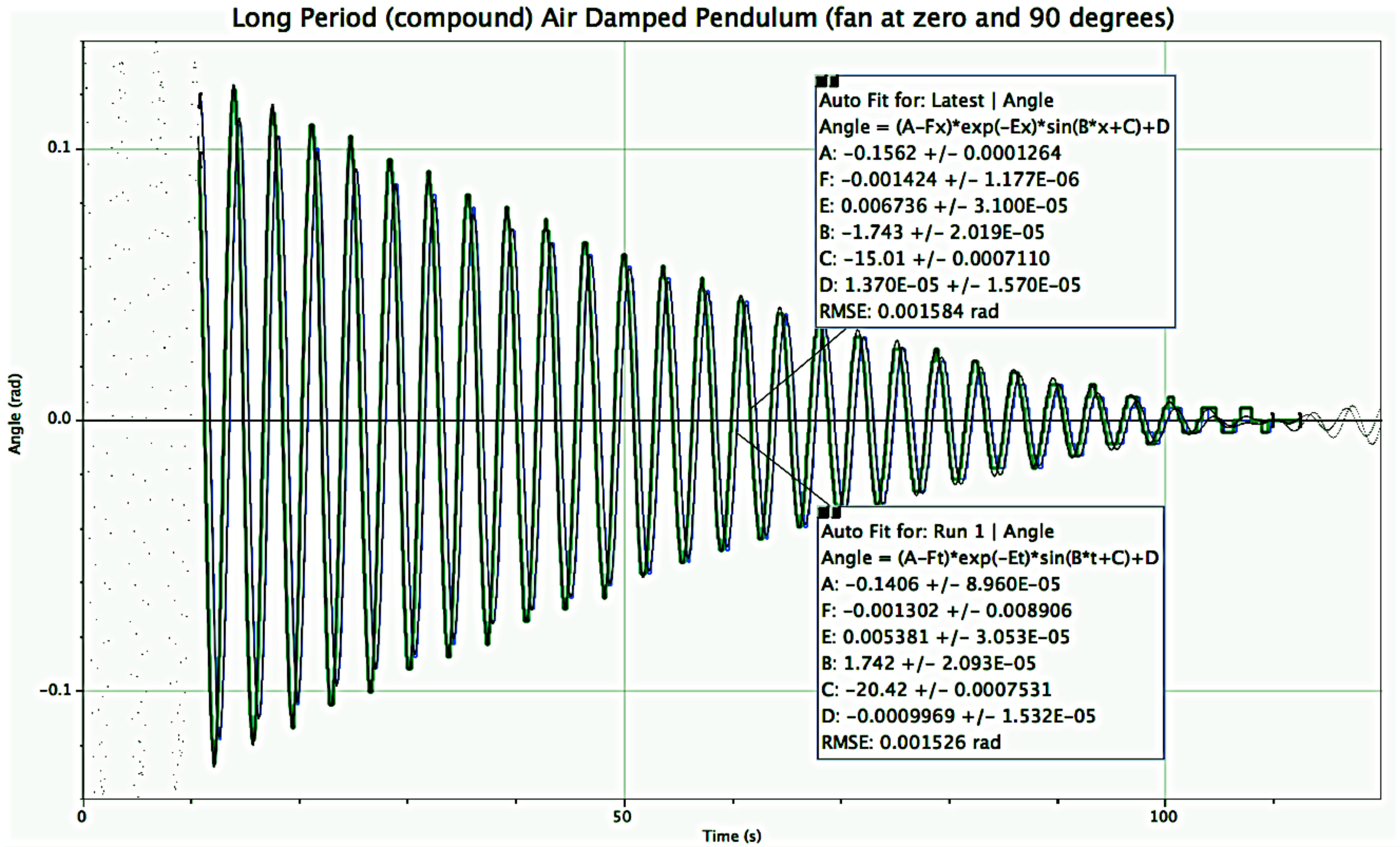


Long Period (compound) Pendulum in air (fan at zero & 90 deg.)
Angle (rad)
0.1
0.0
-0.1
0
50
100
Time (s)

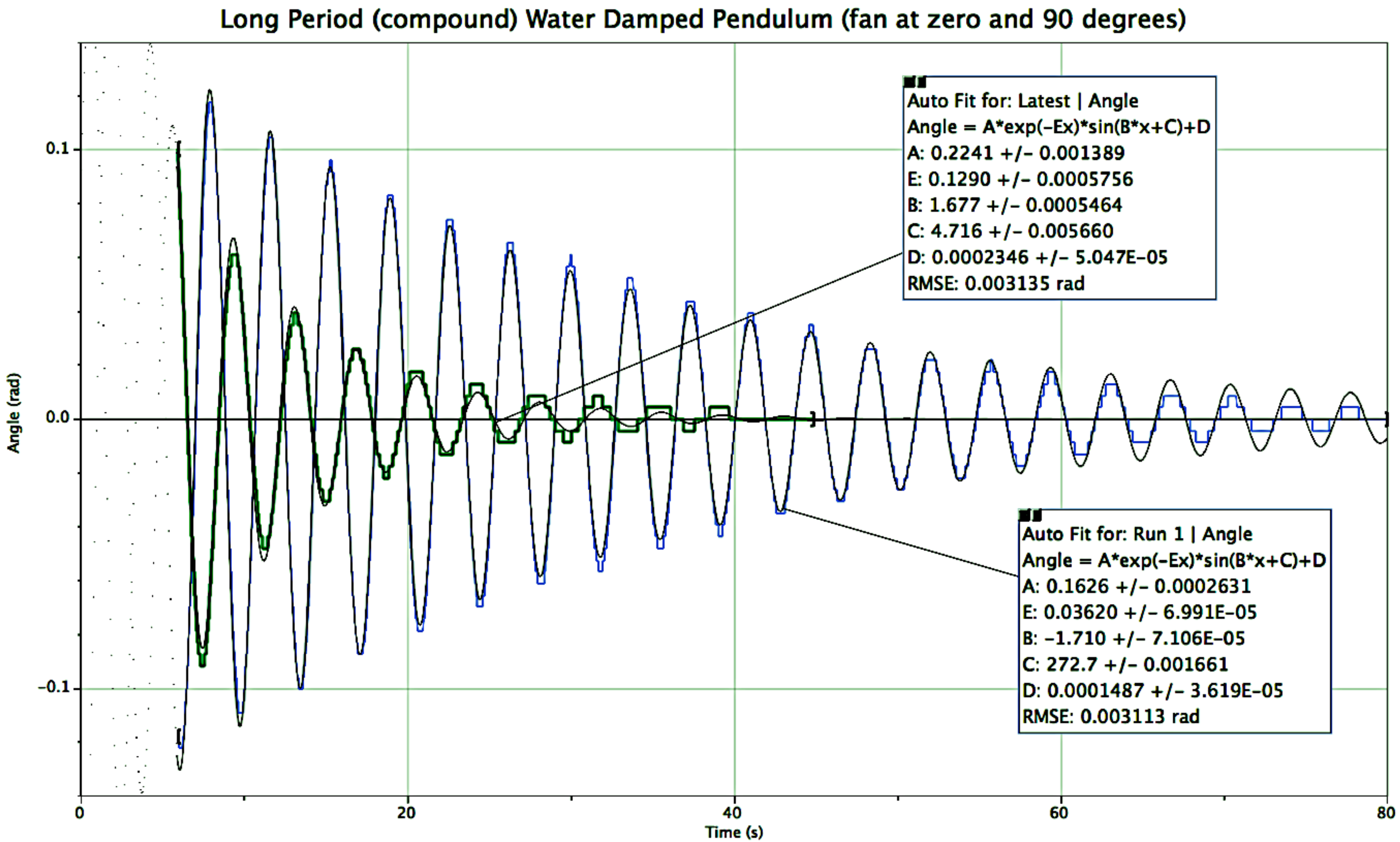
And:


Long Period (compound) Water Damped Pendulum (fan at zero and 90 degrees)
Angle (rad)
0.1
0.0
-0.1
0
20
40
60
80
Time (s)

To obtain "reasonable" fits a Coulomb factor required



Dominant damping is viscous.



And the table:

Damping	Water
0 deg. 2Pi f Damping constant	1.677/s 0.129
90 deg. 2Pi f Damping constant	1.710/s 0.0362