R35 GTR VR38

ALPHA DAMPER

a single piece damper moving the overhung weight of the rubber absorber behind and inside the OEM sized belt ribs. The Fluidampr design is approximately 9.75lbs., The OEM part was 6.2lbs.

Fluidampr 570901 Damper Design and Validation Testing for Nissan VR38 Engine

June 15, 2018

Engineering Document Number (EDN): 18-0003

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BACKGROUND:

Fluidampr was approached by Nick Norris, Ivan Phipps, and Nathan Cicio from Callies Performance Products, AMS Performance, and Top Speed Motorsports respectively to develop a damper for the Nissan 3.8 L VR 38 engine, used in the GTR. The Engine currently uses a tuned rubber damper, however it was expressed that the rubber was failing. In some high power applications the damper can fail in as little as a few minutes. It was requested that Fluidampr keep the OEM sizing, have the ability to mount dry sumps, and remove the failure mode. Fluidampr was provided with a sample ATI rubber damper as well as a stock damper.

DESIGN DECISIONS:

Fluidampr was provided with two sample dampers to aid in the design process. Reviewing the other dampers Fluidampr decided to make a single piece damper moving the overhung weight of the rubber absorber behind and inside the OEM sized belt ribs. The Fluidampr design is approximately 9.75lbs., The OEM part was 6.2lbs., and the ATI rubber damper is 9.3lbs. Figure 1 and 2 show the Fluidampr design.

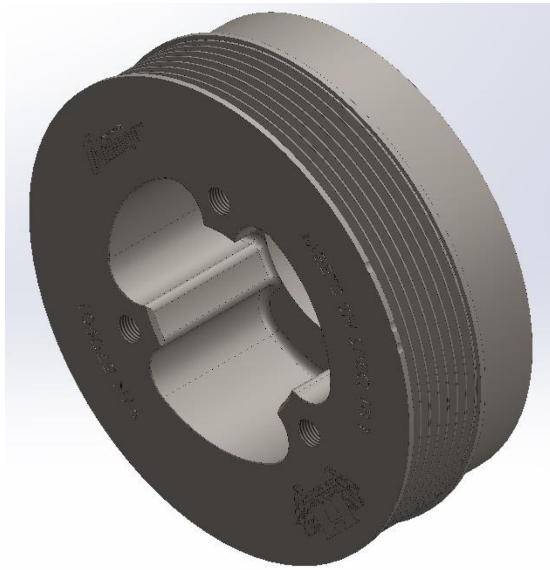

Figure 1

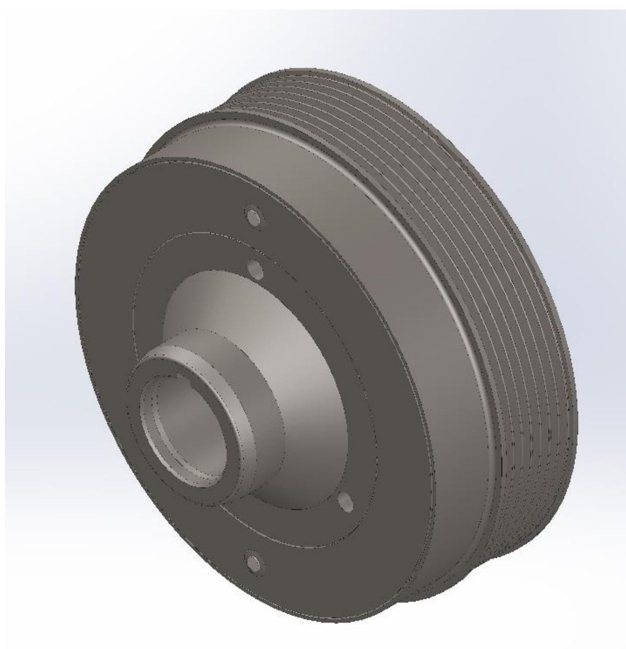

Figure 2

Fluidampr part number 570901 incorporates (3) 3/8-24 threaded holes on a 3.2 inch bolt circle and 2.281 inch pilot for dry sump attachments, along with 3 milled out sections to reduce weight. The tight tolerance of the bore was extended in length so that there is a longer length for press fit on long nose crank shafts. Fluidampr's design is compliant with SFI spec 18.1 and will include that certification in production engraved on the damper. The damper also incorporates high strength and high wear resistance injection molded bearing rings for thrust and radial loads. Variable silicone viscosities were used during the validation testing in order to dial in the dampers optimum operating range. For validation testing three variations were manufactured however only two were tested.

VALIDATION TESTING:

Once the damper prototypes were manufactured validation testing was scheduled. Representatives from Fluidampr traveled to AMS's facility in West Chicago Illinois to conduct on engine vibration testing. For testing a 1700 horsepower modified car was used. The engine was outfitted with an incremental encoder on the free end of the crankshaft to determine which variant provided the best amplitude reduction. Figure 3 shows how the encoder was installed with a Fluidampr on the engine, along with permanent capture thermal decals.

Figure 3

The free end yielded 151 pulses per revolution. Each damper tested was run through 2 power pulls of the car on the dyno running from 1800 rpm to 9000 rpm. The test was measured using Fluidampr's Rotec Delta FFT Analyzer. The data examined in this report is the data recorded on the Rotec Delta analyzer. Thermal conditions were monitored using the permanent capture adhesive decals mentioned earlier. The thermal properties of the damper were monitored in order to determine if the power levels experienced by the damper were within the damper's safe duty cycle capabilities.

Testing Date: 6/7/2018

Location: AMS Performance

AMS Representatives Present: Ivan Phipps

Callies Representatives Present: Nick Norris

Fluidampr Representatives Present: Aaron Neyman, Paul Bennett, Wil Murphy

TESTING DATA:

The first configuration that was tested was the ATI 7" rubber tuned absorber that was installed on the test engine upon arrival. Two power pulls were conducted, after a strip of encoder tape was wrapped on the absorber. Figure 4 shows the waterfall plot of the first pull performed that was measured.

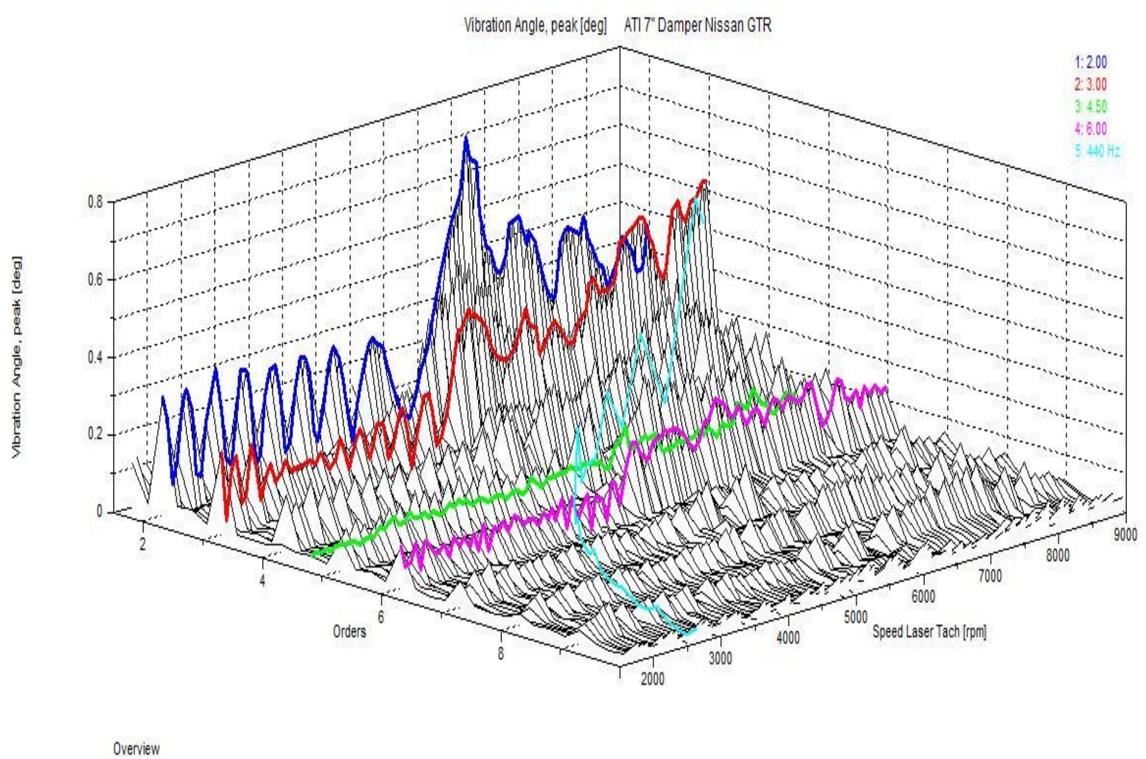

Figure 4

The data exhibited a torsional resonance at 440 Hz. The 440 Hz resonance excited amplitudes in the 3rd, the 4.5 and the 6th orders. The light blue line curser in figure 4 shows the 440 Hz frequency that represented the residual peaks from the tuned rubber damper, outside of the hysteresis range of effectiveness. There was also a higher frequency peak present in the 2nd order from non-sinusoidal motion of pistons and connecting rods. No thermal decals were installed on the baseline damper.

After the baseline tests were completed, Fluidampr 570901-300 was installed and equipped with thermal decals. Pulls were completed on the Fluidampr installed and the car back on the dyno. Figure 5 shows a waterfall plot overview of the vibration measured with the first Fluidampr tests.

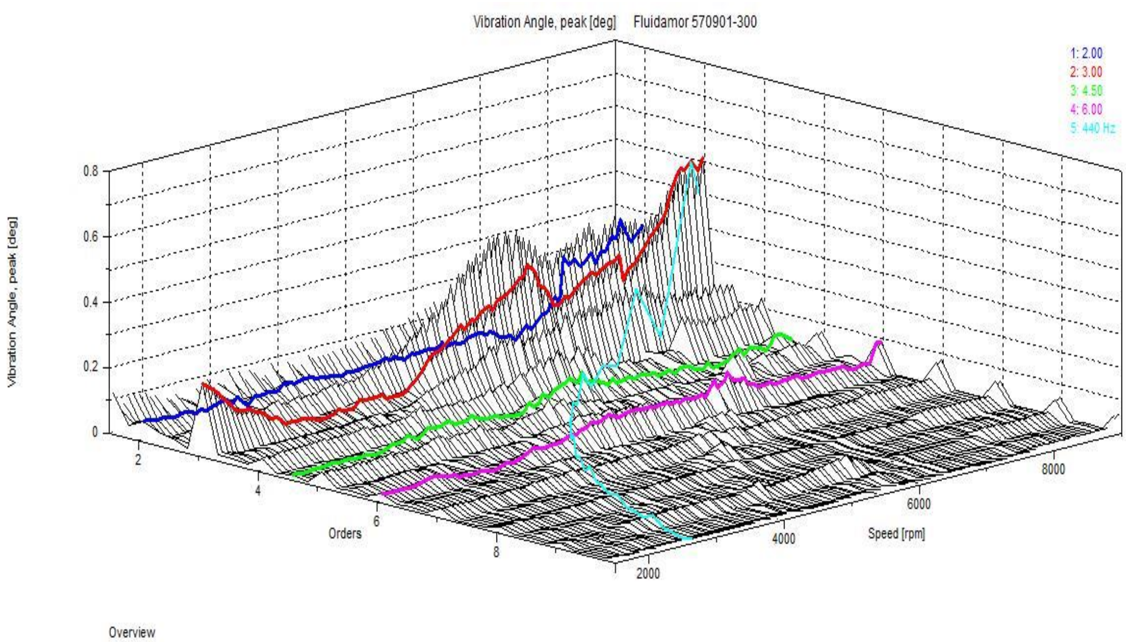

Figure 5

The Fluidampr 570901-300 showed similar order excitations as the elastomeric damper, 2nd and 3rd orders contained the majority of amplitudes. One thing of note is that that for the most part the line cursors show a much smoother line peak to peak as well as a general decrease in amplitudes. This means that as the damper heats up, amplitude peak frequency will not move to lower RPM ranges. The permanent capture stickers showed that through testing the dampers temperature reached between 175°F and 180°F or 79°C and 82°C. Figures 6, 7, 8, and 9 show the permanent capture decals.

Figure 6

Figure 7

Figure 8

Figure 9

Next Fluidampr 570901-600 was fitted with thermal decals and installed on the engine. The same power sweeps were performed and measured. Figure 10 shows the waterfall plot overview for Fluidampr 570901-600.

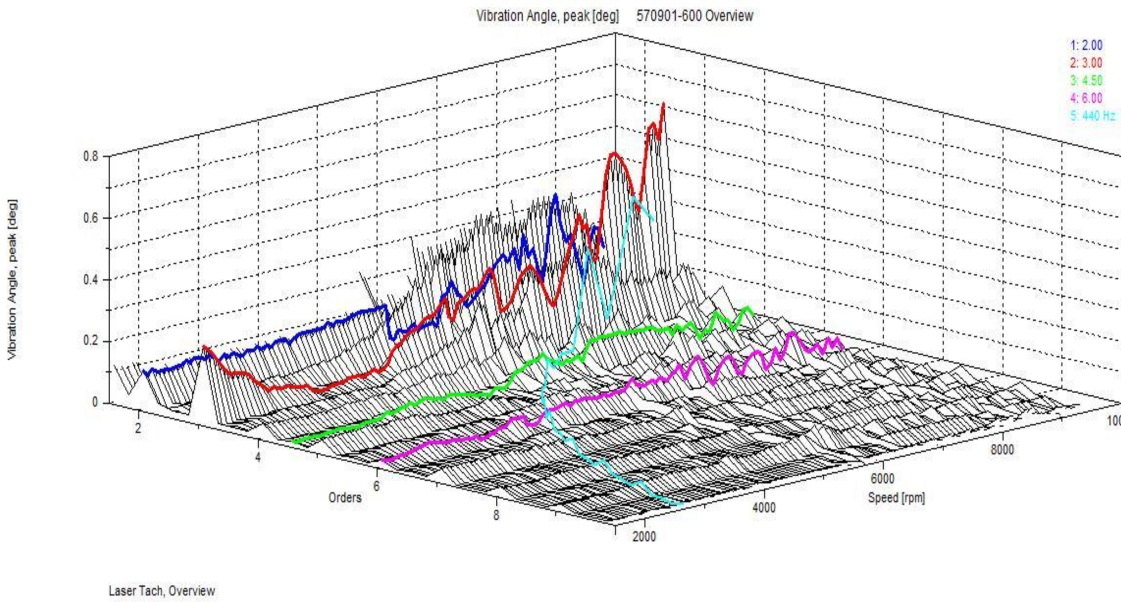

Figure 10

Since the main difference between the two Fluidamprs is the fluid viscosities, resulting in different damping, the same orders are excited. Also it can be seen that the 2nd and 3rd orders contain the majority of the vibrations. There were some amplitude inconsistencies, individual orders will be compared in the next portion of the report. Our data sets from running Fluidampr 570901-600 may have been impacted by a belt fraying earlier in testing and throwing contamination into our high resolution tachometer laser.

COMPARISONS AND CONCLUSIONS:

After the testing was completed, individual orders were extracted in order to compare the data sets more closely. Note: all individual order plots were taken from the 1st speed sweep data sets, in order to represent similar operating temperatures for each damper. Figure 11 shows the 2nd order comparison for all three of the dampers that were tested.

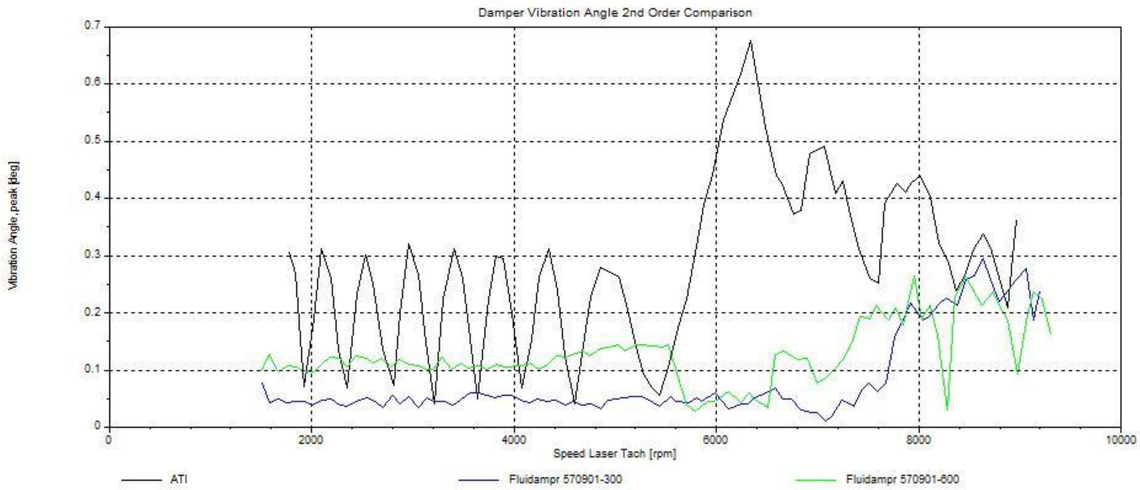

Figure 11

The data sets show how much smoother the engine vibrations are with a Fluidampr installed. There was a vibration peak at approximately 6200 RPM with the tuned rubber absorber that appears to be minimized with the Fluidamprs. The Fluidamprs showed amplitude reduction compared to the tuned rubber absorber. The next order that was examined was the 3rd order, or the firing order for the engine. This order contained the majority of the stressed crankshaft amplitudes due to the nature of how the vibration is driven by the firing. Figure 12 shows the comparison chart for the three dampers tested.

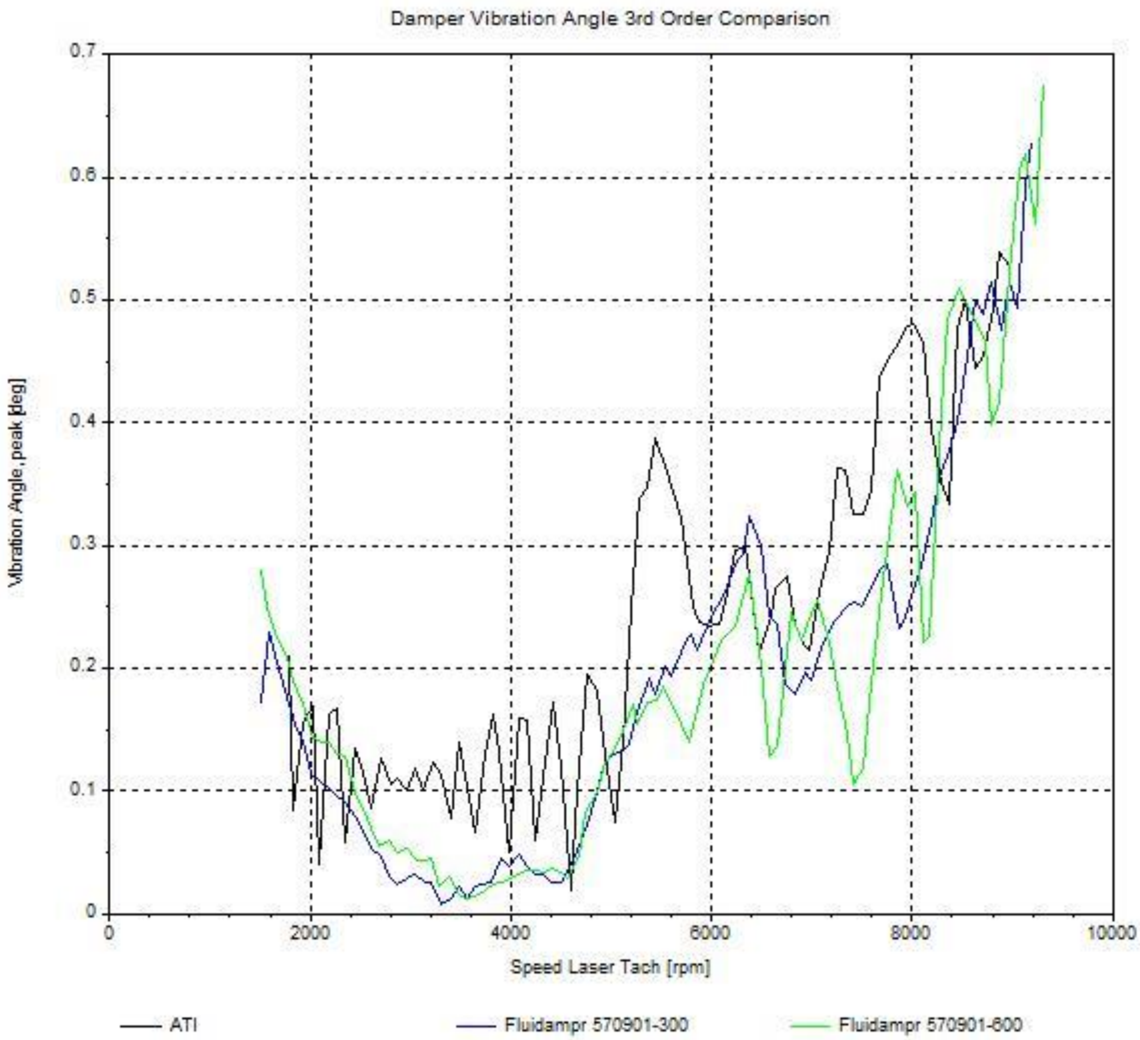

Figure 12

The vibration amplitudes of the Fluidampr, green and blue lines, are in general lower in amplitude but follow a similar path to the tuned rubber damper. The ATI tuned rubber absorber has a peak amplitude at 5500 rpm, both Fluidamprs on the other hand experienced a lower amplitude peak at 6300 rpm. Additional charts showing the 4.5 and 6th order harmonic comparisons are included in the appendix portion of this report.

After the major amplitude orders were examined, a 12 order summation was calculated (direct summation) and compared in order to get a clear overview of the harmonic and high order content measured. Figure 13 shows the 12 order comparison for all of the dampers tested from 1.5 order through the 12th order.

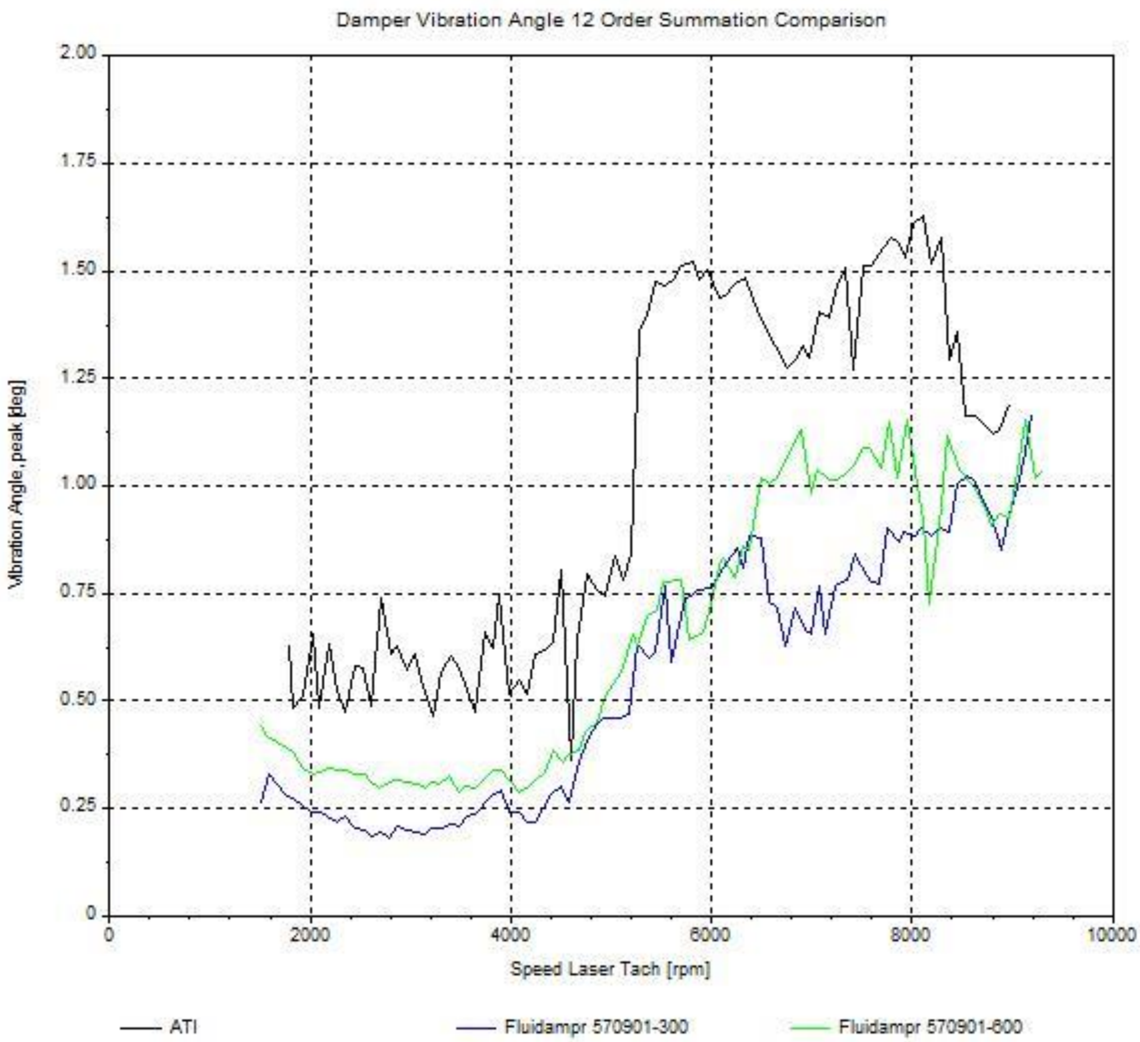

Figure 13

The 12 order summation data showed that the two Fluidampr dampers tested were quite comparable with respect to vibration amplitudes experienced by the engine. Figure 14 also shows that the Fluidampr reduced the amplitudes of the vibrations when all orders are considered. With the vibration damping in mind we can see the impact on torque and horsepower. Figure 14 depicts the engine performance in horsepower and torque.

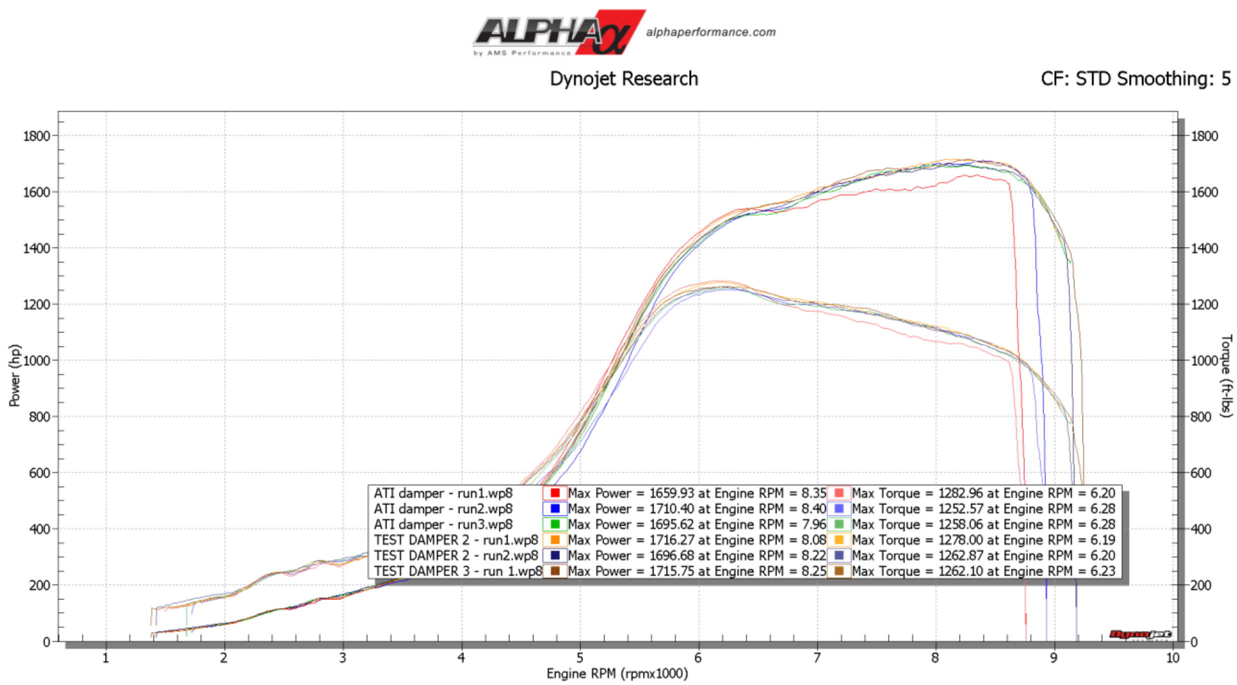

Figure 14

It can be seen from the chart that all of the test runs, excluding the first run, all hold similar power levels with both Fluidamprs showing minor increases in performance. With a decrese in vibrational losses the engine gains marginal horsepower and torque performance. The first run is of the engine for the first time on the dyno for the day, the engine was cold and hadn't fully warmed up, resulting in a data set that is unlike the other sets. Fluidampr didn't capture the first run with the Rotec unit for vibration analysis, but rather the second ATI run and on were captured.

The Fluidampr 570901-600 provided an amplitude reduction as well as having the most damping. The Fluidampr also showed enough heat to indicate that the damper was operating efficiently (170 – 180 F) but still had plenty of room to spare as far as temperature and duty cycle was concerned, meaning that higher horsepower and higher heat applications will not overload the damper thermally. While the Fluidampr is 9.75lbs in your hand, while in operation the crank feels only approximately 2/3 of that mass, or 6.5 lbs. Fluidampr brings the mass in closer to the crankshaft snout in an envelope similar to the OEM, reducing the chance of bending in the crankshaft. For all of these reasons Fluidampr will move to use 570901-600 variation in full production under the part number 570901.

Prepared by: Wil Murphy

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Vibration Solutions Specialist

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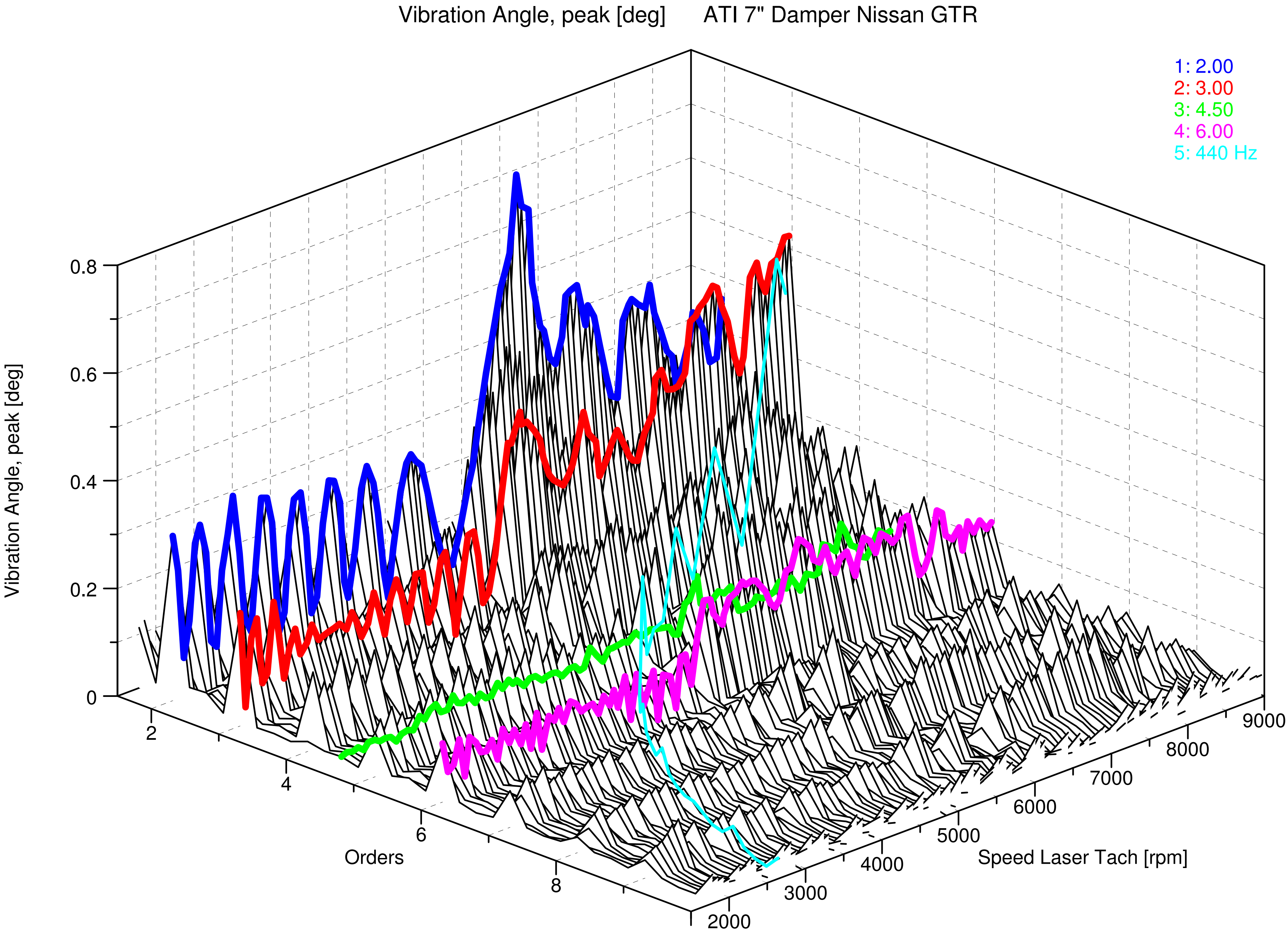
Vibratech TVD

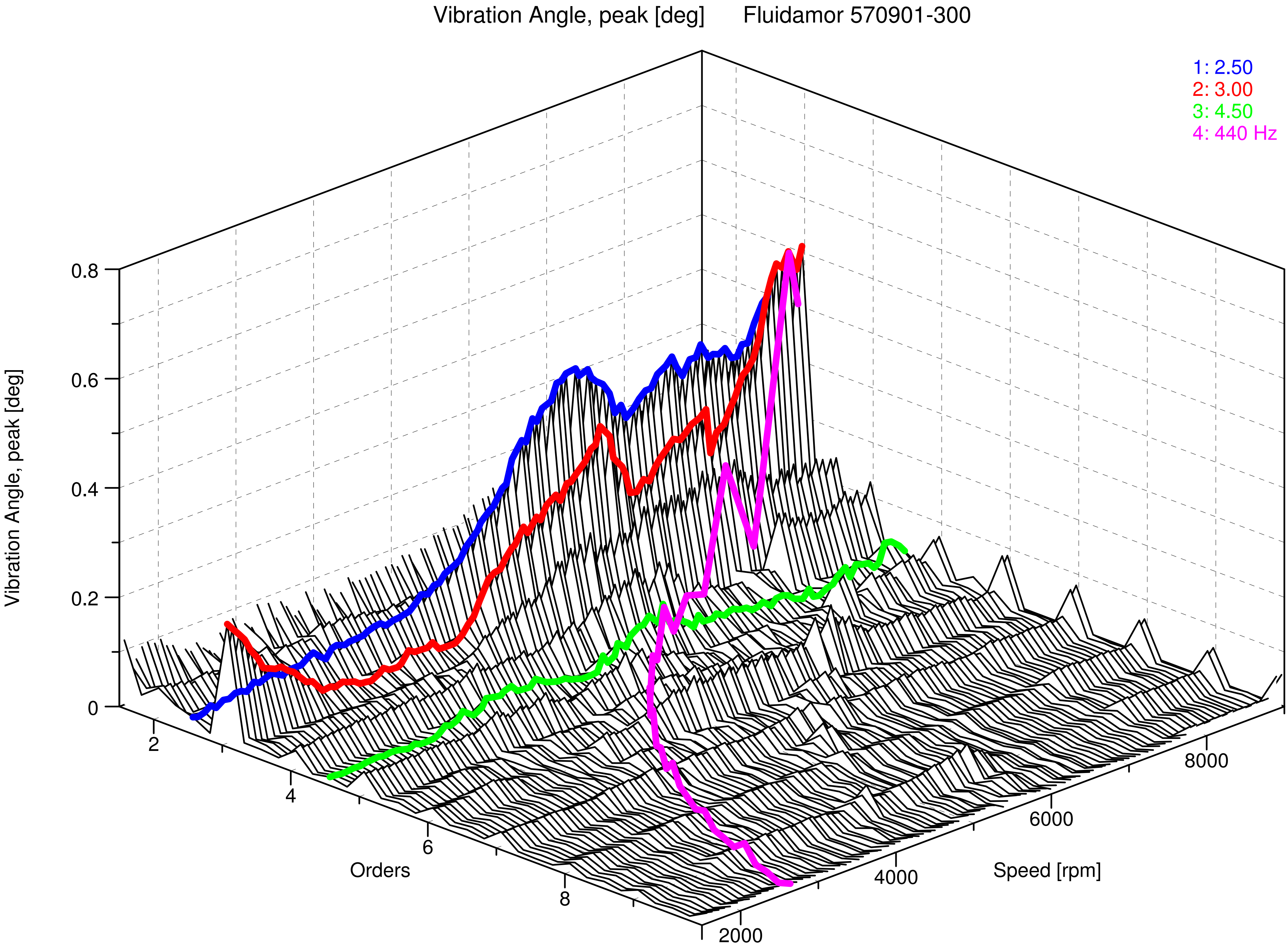
Date: 6/28/2018

APPENDIX



Vibration Angle, peak [deg]
ATI 7" Damper Nissan GTR
1: 2.00
2: 3.00
3: 4.50
4: 6.00
5: 440 Hz
Vibration Angle, peak [deg]
0.8
0.6
0.4
0.2
0
2
4
6
8
Orders
2000
3000
4000
5000
6000
7000
8000
9000
Speed Laser Tach [rpm]

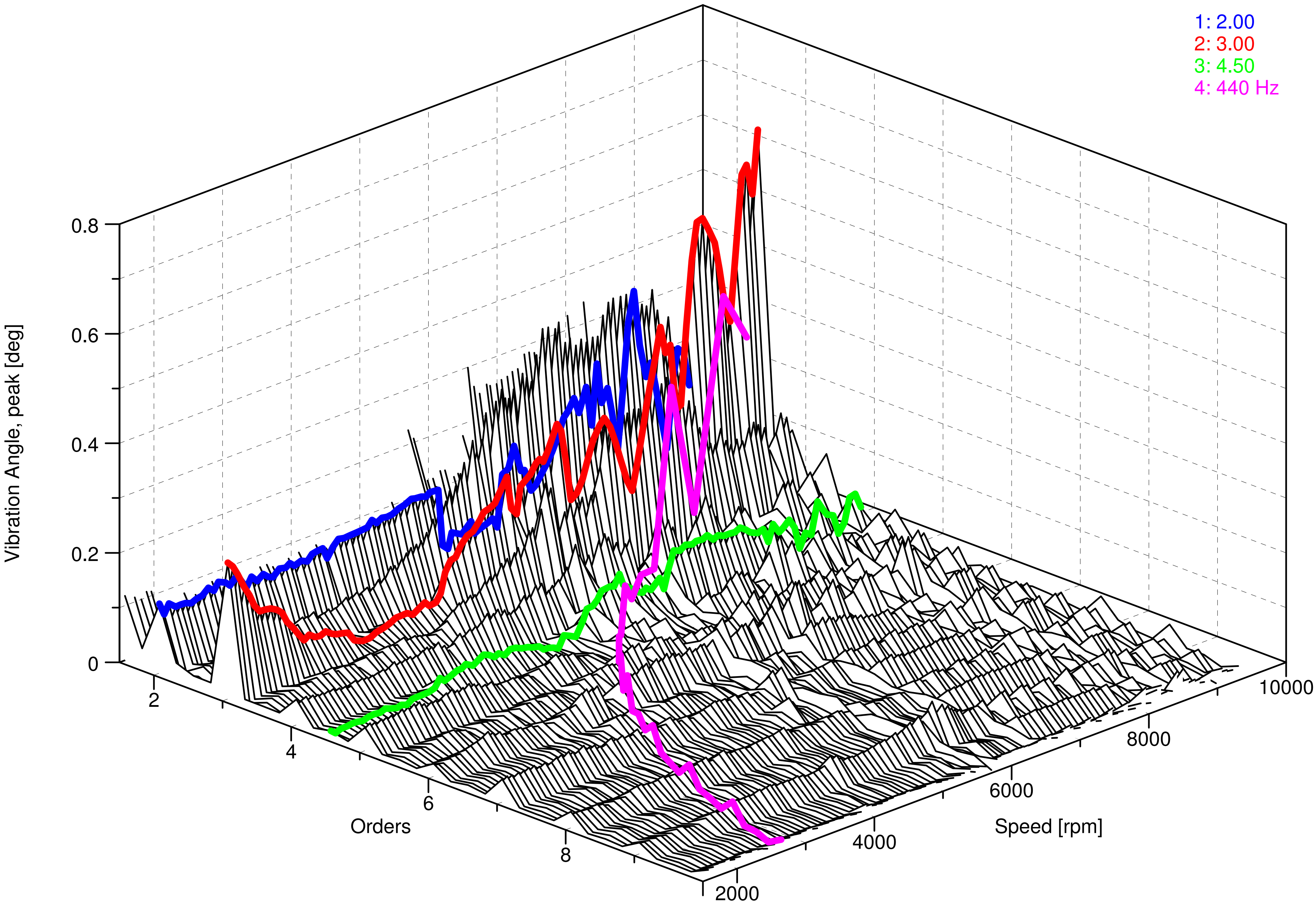
Overview



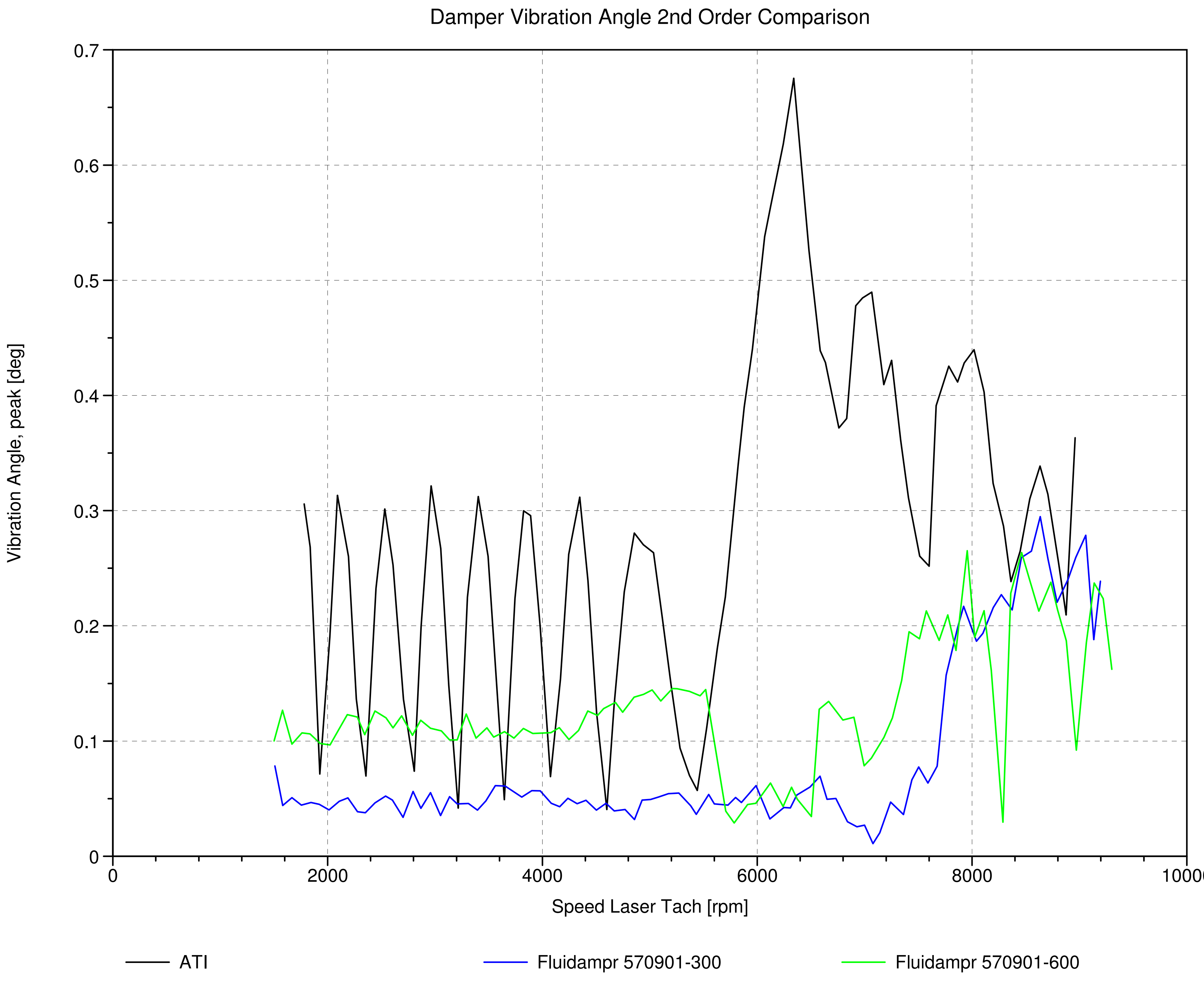
Vibration Angle, peak [deg]
Fluidamor 570901-300
1: 2.50
2: 3.00
3: 4.50
4: 440 Hz
0.8
0.6
0.4
0.2
0
Vibration Angle, peak [deg]
2
4
6
8
Orders
2000
4000
6000
8000
Speed [rpm]

Overview

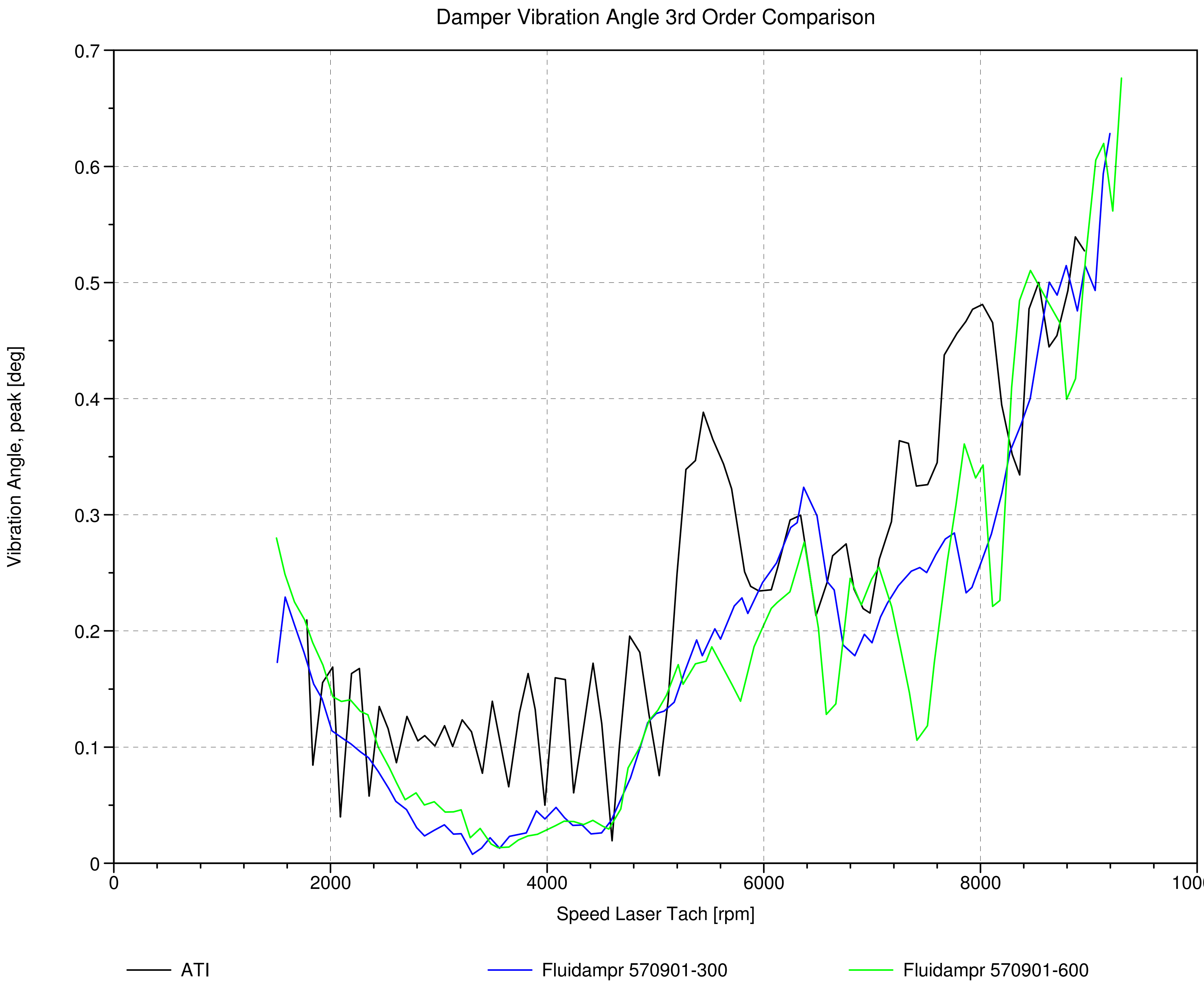
Vibration Angle, peak [deg]   570901-600 Overview



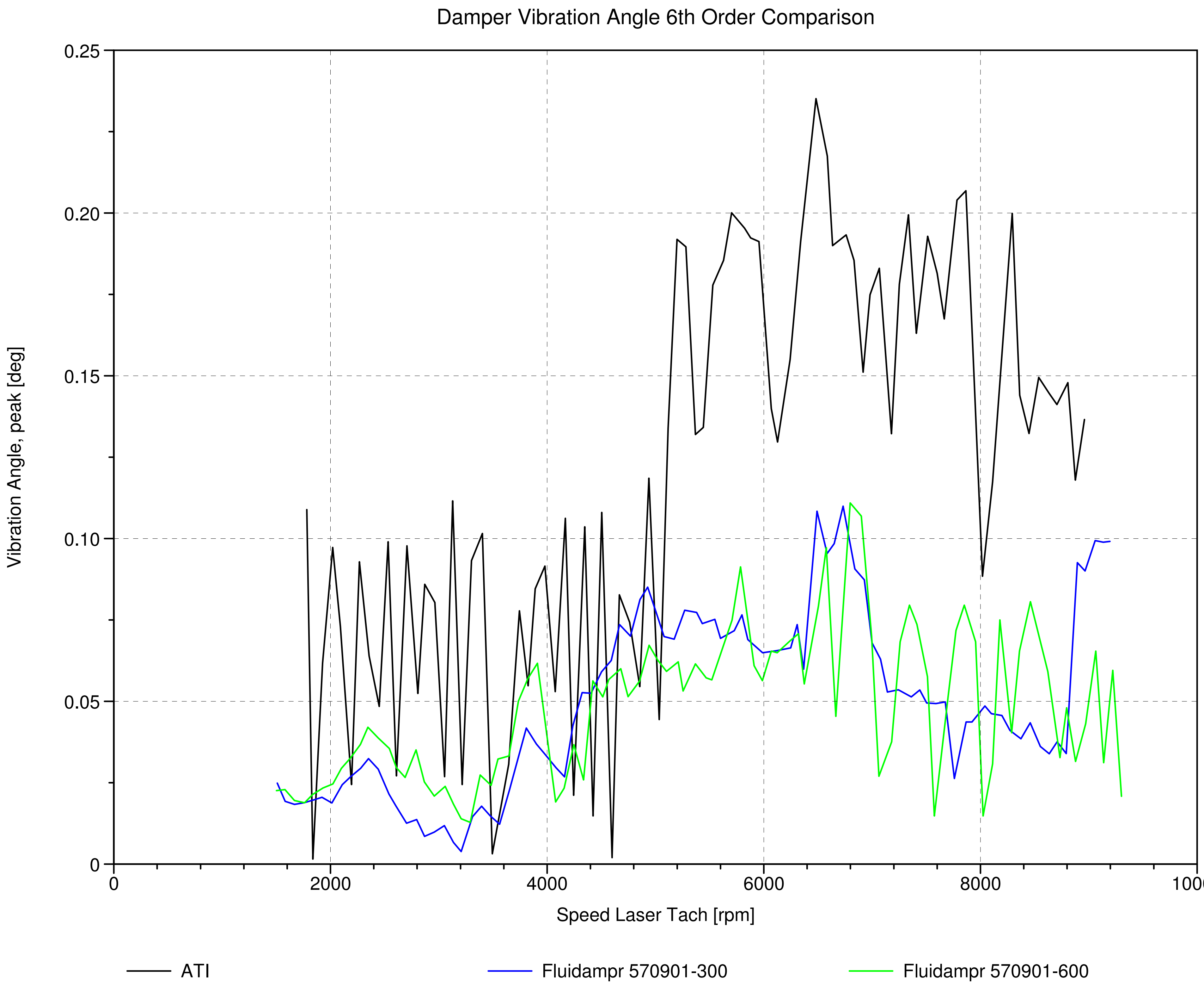
Laser Tach, Overview

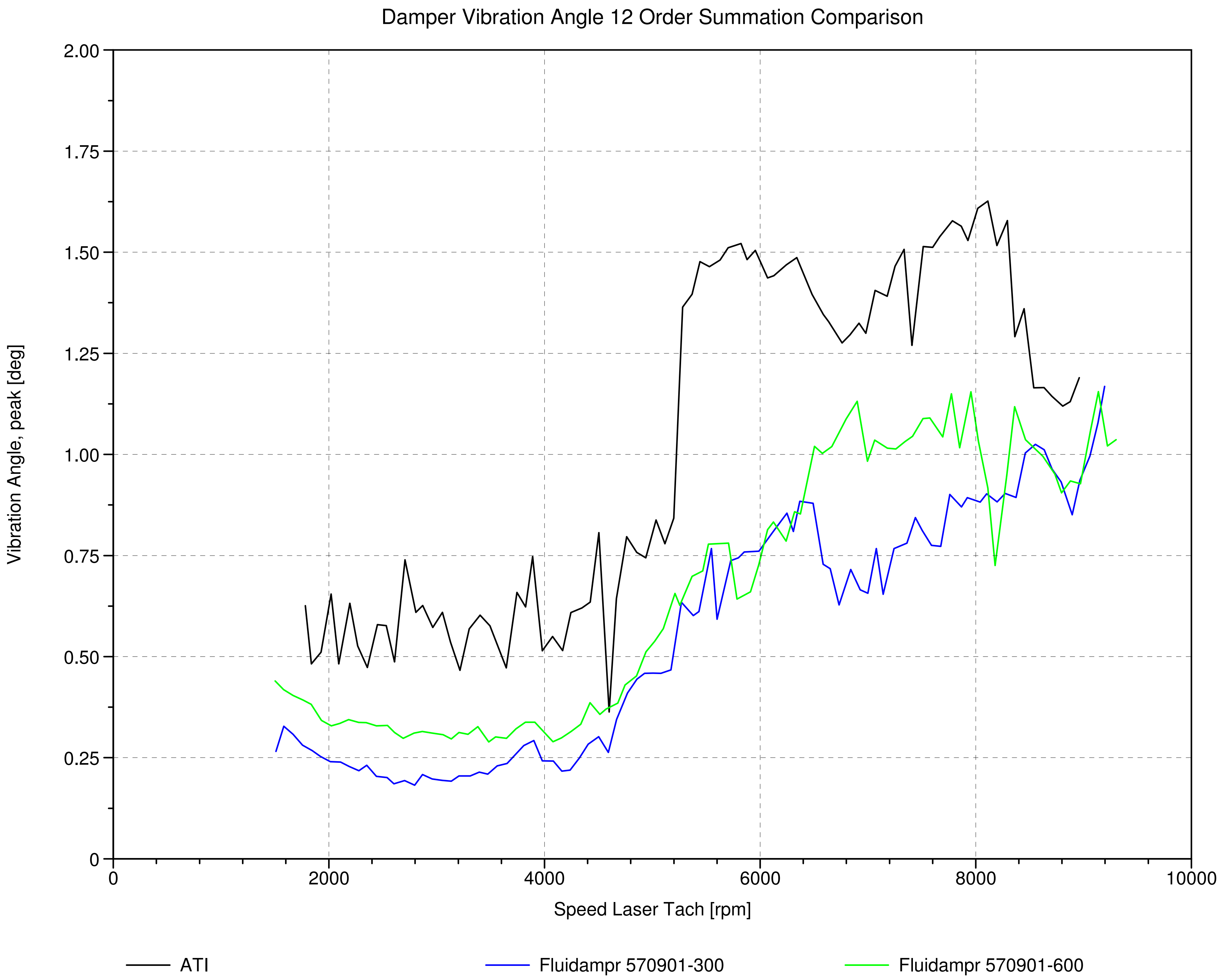


Damper Vibration Angle 2nd Order Comparison
Vibration Angle, peak [deg]
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
2000
4000
6000
8000
10000
Speed Laser Tach [rpm]
ATI
Fluidampr 570901-300
Fluidampr 570901-600

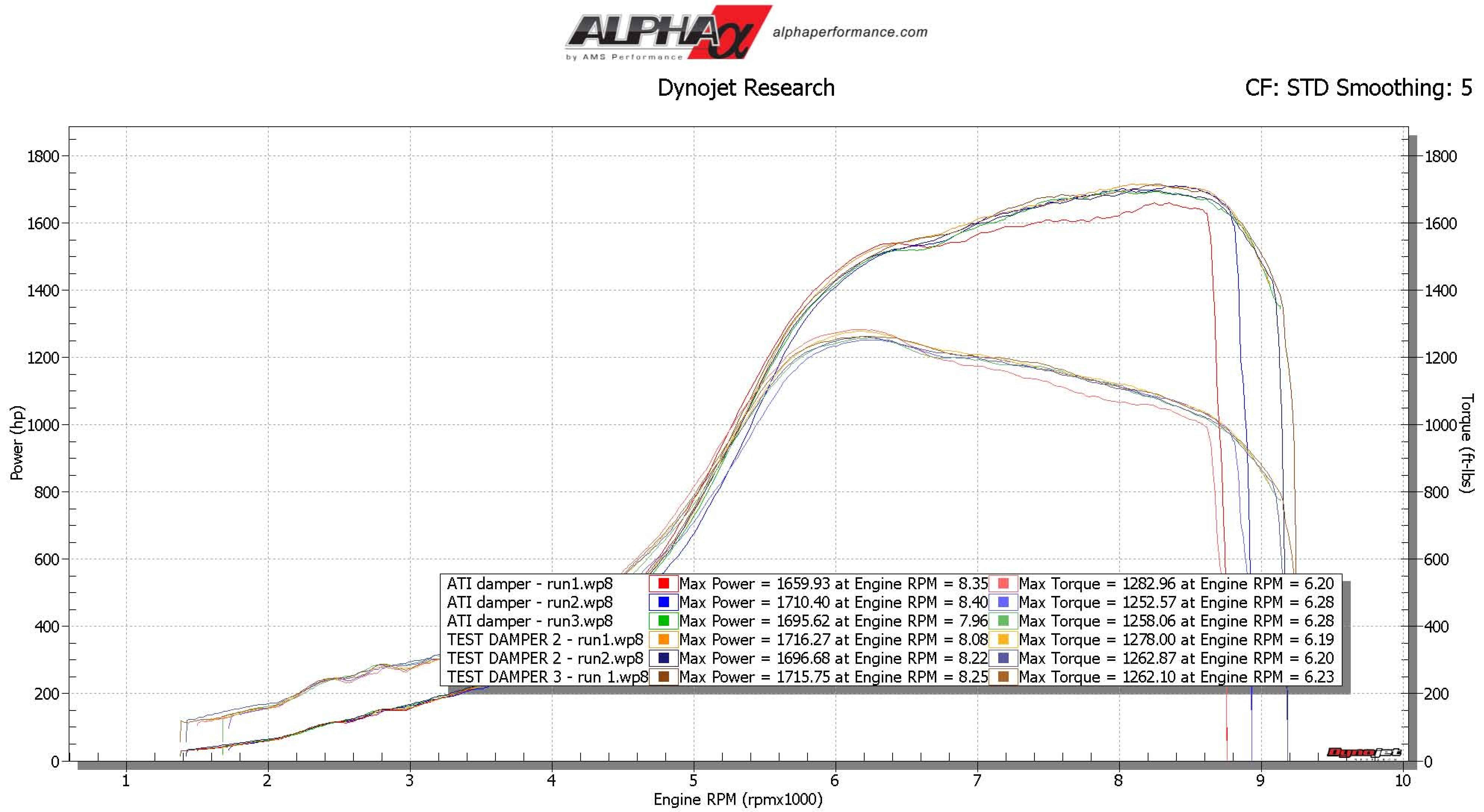


Damper Vibration Angle 3rd Order Comparison
Vibration Angle, peak [deg]
Speed Laser Tach [rpm]
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0
2000
4000
6000
8000
10000
ATI
Fluidampr 570901-300
Fluidampr 570901-600


Damper Vibration Angle 6th Order Comparison
Vibration Angle, peak [deg]
0.25
0.20
0.15
0.10
0.05
0
0
2000
4000
6000
8000
10000
Speed Laser Tach [rpm]
ATI
Fluidampr 570901-300
Fluidampr 570901-600



Damper Vibration Angle 12 Order Summation Comparison
Vibration Angle, peak [deg]
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0
0
2000
4000
6000
8000
10000
Speed Laser Tach [rpm]
ATI
Fluidampr 570901-300
Fluidampr 570901-600



ALPHA
by AMS Performance
alphaperformance.com
Dynojet Research
CF: STD Smoothing: 5
Power (hp)
Torque (ft-lbs)
Engine RPM (rpmx1000)
ATI damper - run1.wp8 Max Power = 1659.93 at Engine RPM = 8.35 Max Torque = 1282.96 at Engine RPM = 6.20
ATI damper - run2.wp8 Max Power = 1710.40 at Engine RPM = 8.40 Max Torque = 1252.57 at Engine RPM = 6.28
ATI damper - run3.wp8 Max Power = 1695.62 at Engine RPM = 7.96 Max Torque = 1258.06 at Engine RPM = 6.28
TEST DAMPER 2 - run1.wp8 Max Power = 1716.27 at Engine RPM = 8.08 Max Torque = 1278.00 at Engine RPM = 6.19
TEST DAMPER 2 - run2.wp8 Max Power = 1696.68 at Engine RPM = 8.22 Max Torque = 1262.87 at Engine RPM = 6.20
TEST DAMPER 3 - run 1.wp8 Max Power = 1715.75 at Engine RPM = 8.25 Max Torque = 1262.10 at Engine RPM = 6.23
Dynojet