Fluidampr 600701 Damper Design and Validation Testing for 3000GT/Dodge Stealth

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BACKGROUND:

Fluidampr was contacted by James Merriman in order to develop a damper for the Mitsubishi 3000gt/Dodge stealth. The engine currently uses a dual tuned rubber damper, however it was expressed that this damper wasn't protecting the engine to the degree desired. It was requested that the Fluidampr Keeps the OEM sizing, have the ability to mount dry sumps, and remove the rubber failure mode.

DESIGN DECISIONS:

Fluidampr was provided with two rubber dampers in order to aid with the design process. Reviewing the damper Fluidampr decided to put the working mass inside the belt walls of the OEM sized belt ribs. The OEM damper has a weight of approximately 6.6 lbs while the Fluidampr has a weight of 7.4 lbs. Figures 1 and 2 show the Fluidampr design.

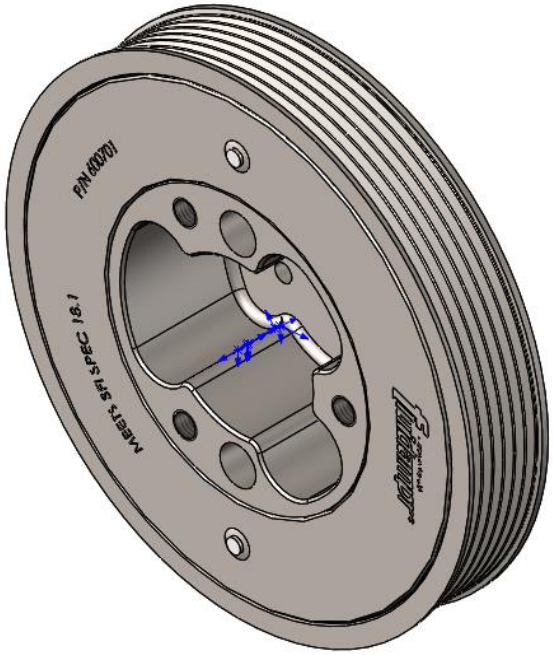

Figure 1

Figure 2

Fluidampr part number 600701 incorporates (2) 13/32 holes for the crank holding tool and (3) 5/16-24 on a 2.75 bolt circle with a 1.90” diameter pilot for dry sump attachment, along with 3 milled out sections to reduce weight. Fluidampr is designed in such a way that it is compliant with SFI spec 18.1 and will include that certification in production engraved on the damper. The damper also includes 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 optimum operating range. For validation testing three variations were manufactured and tested to gain the best idea on

VALIDATION TESTING:

Once the damper prototypes were manufactured validation testing was scheduled. Representatives from Fluidampr traveled to 3SNY in Ronkonkoma New York to conduct in on engine vibration testing. For testing a 1996 3000GT was used. The dampers were outfitted with a bolt on encoder in order to determine which variant provided the best amplitude reduction. Permanent capture thermal

decals were also adhered to the damper. Figures 3 and 4 show the damper with the encoder wheel installed.

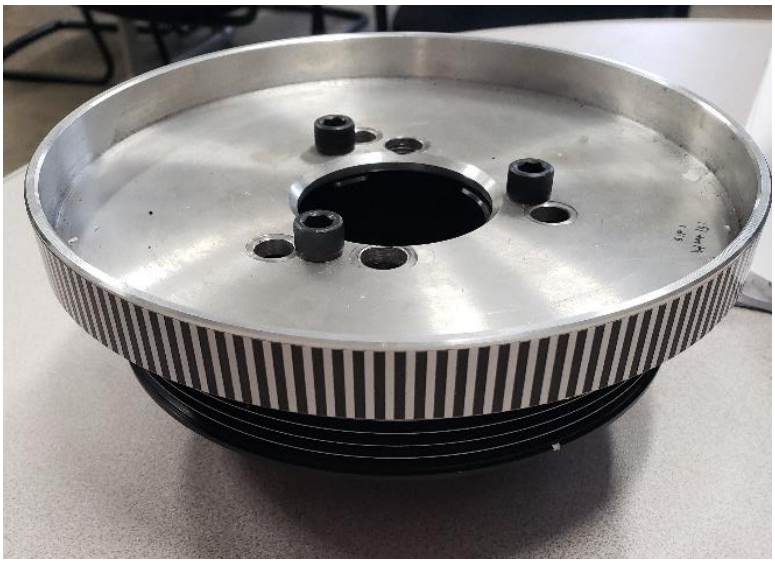

Figure 3

The encoder wheel had 151 pulses per revolution. Each damper tested was run through 2 power pulls, with the car running from approximately 2600 rpm to 7000 rpm. The tests were measured using Fluidampr's Rotec Delta FFT Analyzer. The data examined in this report is the data recorded on the Rotec Delta unit. Thermal properties were monitored as well to ensure that the power levels experienced by the damper were within the damper's safe duty cycle capabilities.

Testing Date: 6/7/2018

Location: 3SNY/Chameleon Tuning

3SNY Representatives Present: David Mennella, Ray Pampena

Fluidampr Representatives Present: Ivan Snyder, Wil Murphy

TESTING DATA:

The first configuration that was tested was the OEM rubber damper that was installed on the engine upon arrival. Once the encoder wheel was attached

and the laser was tested to receive a proper signal two power pulls were conducted. Figure 4 shows the waterfall plot of the first pull performed.

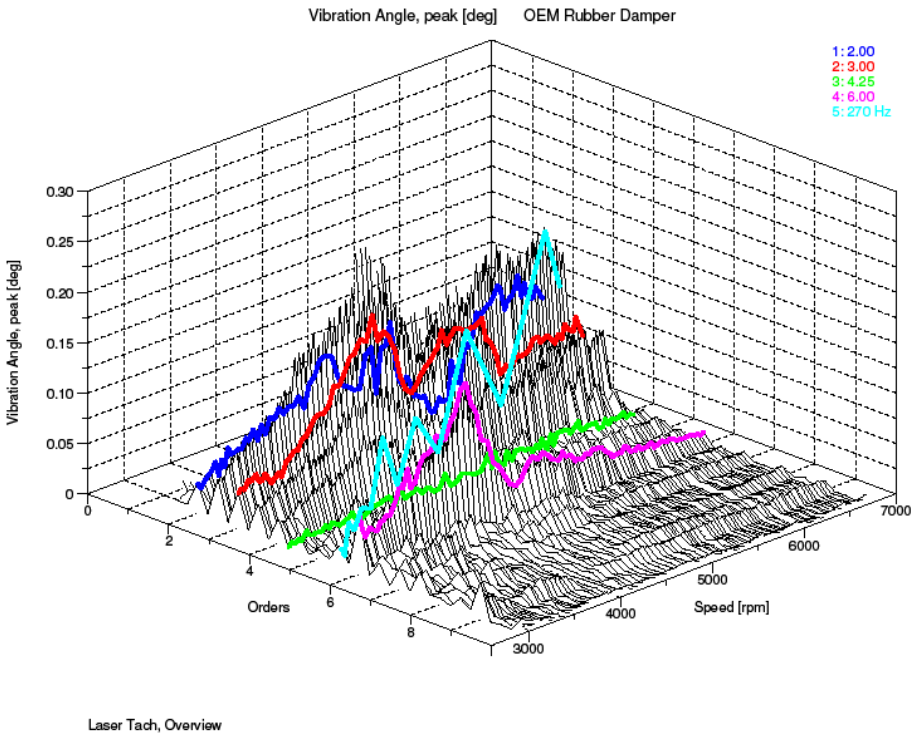

Figure 4

The data exhibited a torsional resonance at 270Hz excited amplitudes across multiple orders. The light blue cursor in figure 5 shows the 270 Hz frequency. The OEM damper was not outfitted with thermal decals.

After the Baseline tests were completed, Fluidampr 600701-600 was installed on the engine. Pulls were completed with the Fluidampr installed. Figure 5 shows the waterfall plot of the Fluidampr 600701-600 damper test.

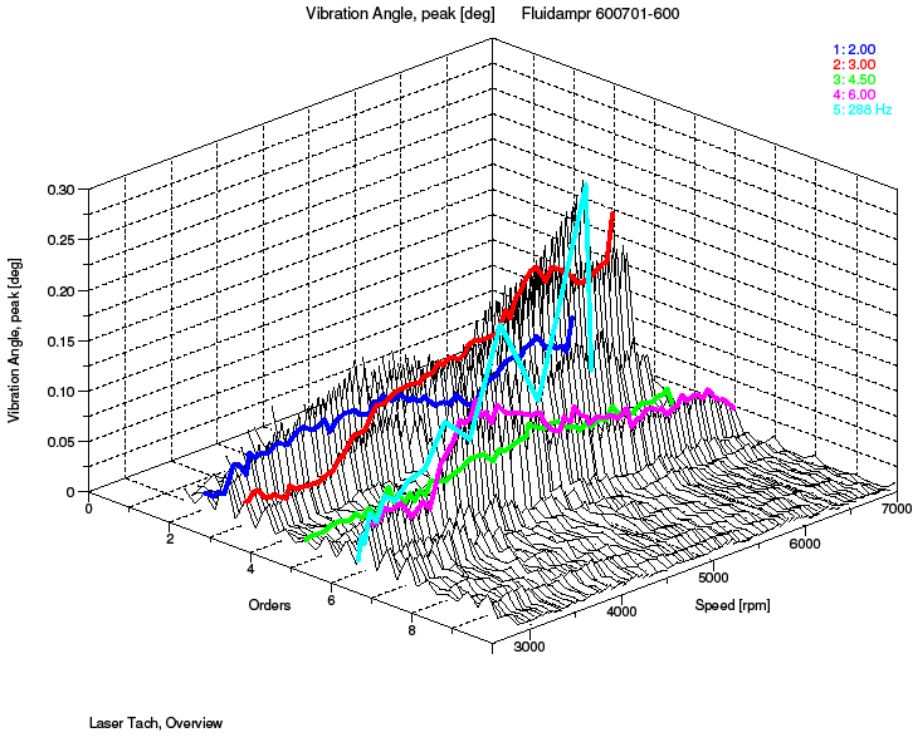

Figure 5

The Fluidampr 600701-600 showed similar excitation orders as the elastomeric damper. One thing to note is that the peak in the 3rd order has been shifted to a higher rpm range and reduced into one singular peak instead of two peaks. There is also a general smoothing in the order amplitudes. This means that as the damper heats up, amplitude peak frequency will not move to Lower RPM ranges.

Next Fluidampr 600701-100 was installed on the engine, with thermal decals. The same power sweeps were performed and measured. Figure 6 shows the waterfall plot overview for Fluidampr 600701-100.

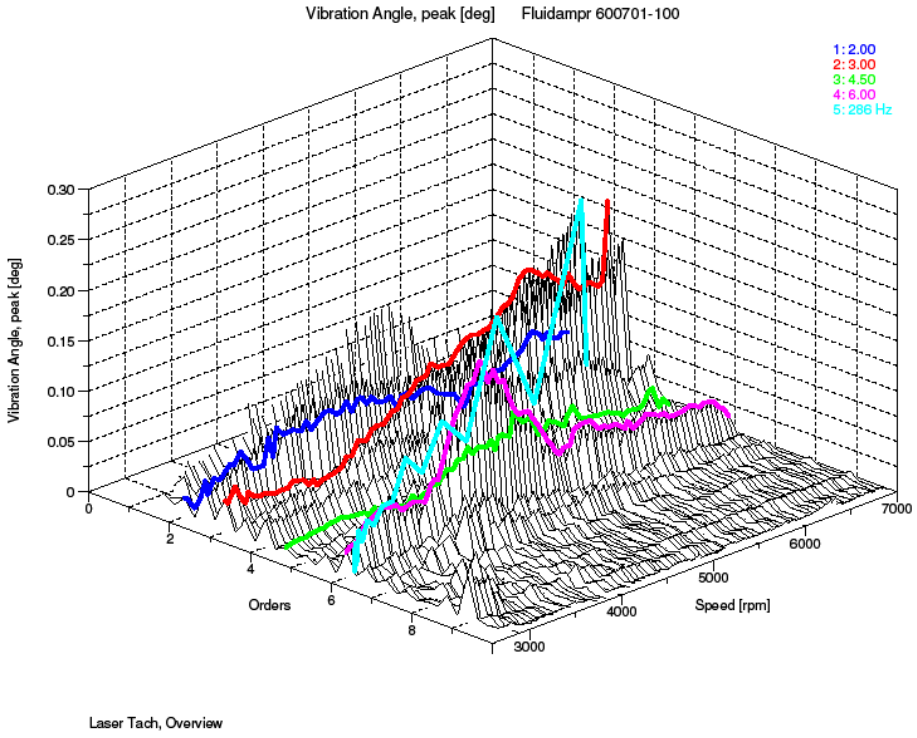

Figure 6

From the waterfall plot it can be see that similar to the Fluidampr 600701-600 the peak has been shifted to a higher frequency. It can also be seen that the peak has a higher amplitude with this variation in silicone.

Lastly the Fluidampr 600701-300 was installed with thermal decals on the engine and the power pulls were performed. Figure 7 shows the waterfall plot of the pull.

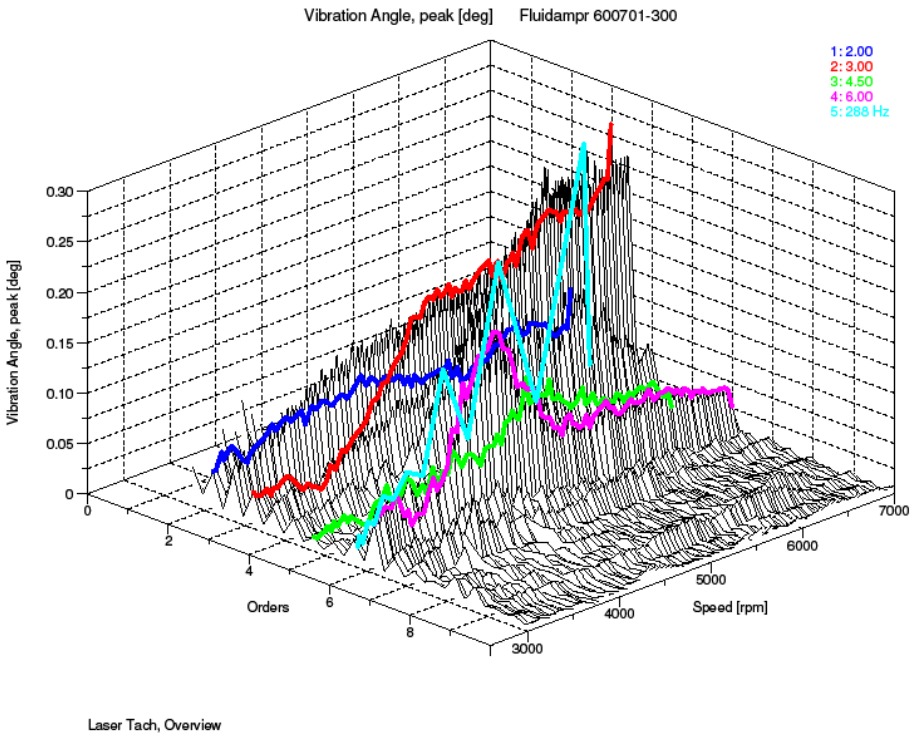

Figure 7

From this graph a shift similar to the other Fluidamprs can be seen, however this damper had the highest vibration amplitude. As far as the thermal capability of the damper is concerned Figures 8 and 9 show the thermal decals on the damper.

Figure 8

Figure 9

From these images it can be seen that the damper in the power pulls only experienced a heat of 125F which is well inside of the dampers operating condition. Figures 10-12 show images of the damper taken with a thermal image camera after the damper had been removed.

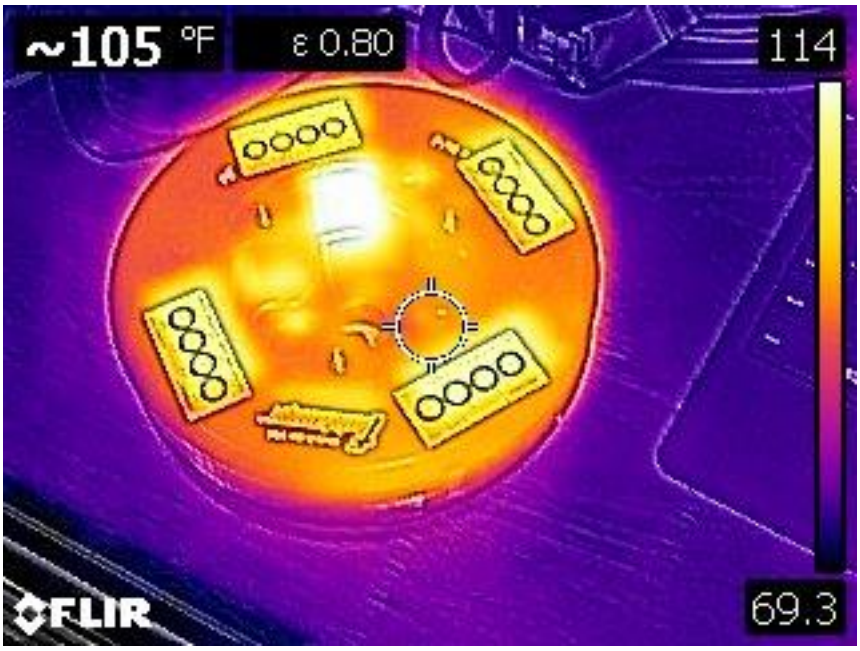

Figure 10

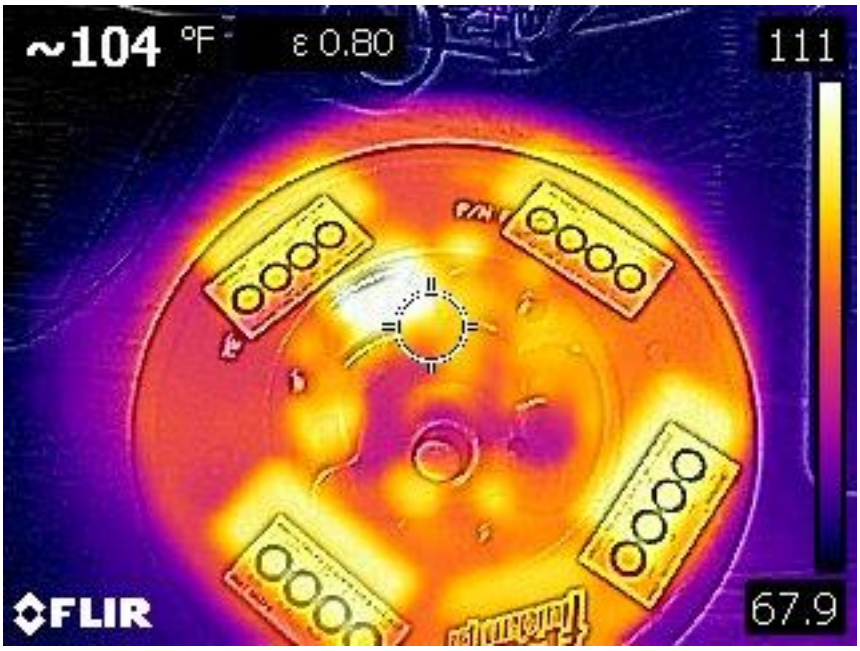

Figure 11

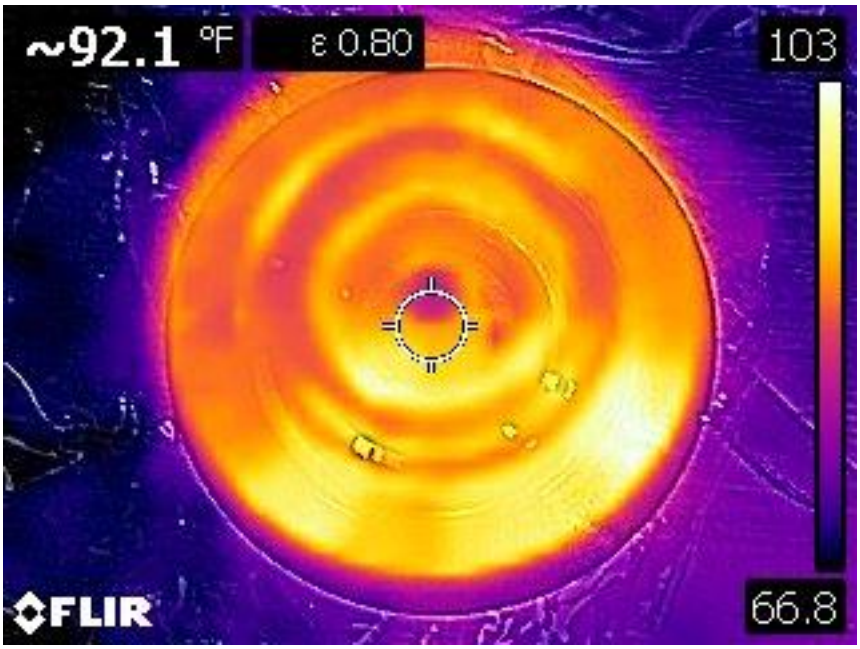

Figure 12

Once again it is seen that the damper is within the acceptable temperature that the damper can operate efficiently and has room as far as temperature and duty cycle are concerned.

COMPARISON AND CONCLUSIONS:

After testing was completed individual orders were extracted in order to compare the data sets more closely. As a note all of the individual orders plots were taken from the 1st speed sweep sets, in order to represent similar operating temperature for each damper. Figure 13 shows the second order comparison for all four of the dampers that were tested.

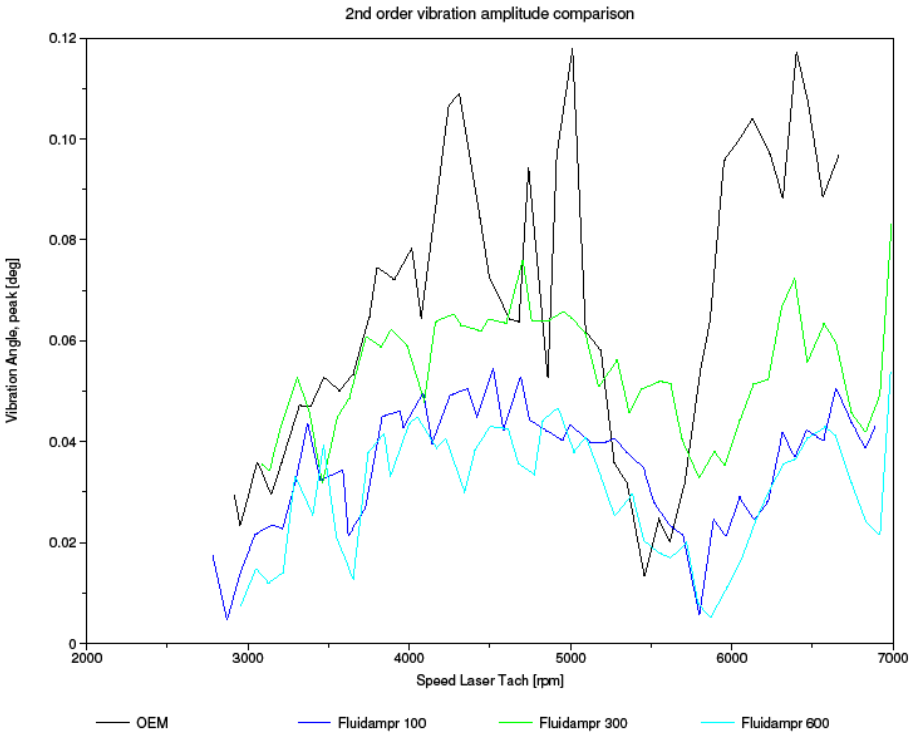

Figure 14

From figure 14 it can be seen that the Fluidampr parts reduce the degree of twist experience by the free end of the crank shaft. Next the 3rd order or the firing order can be seen in Figure 15.

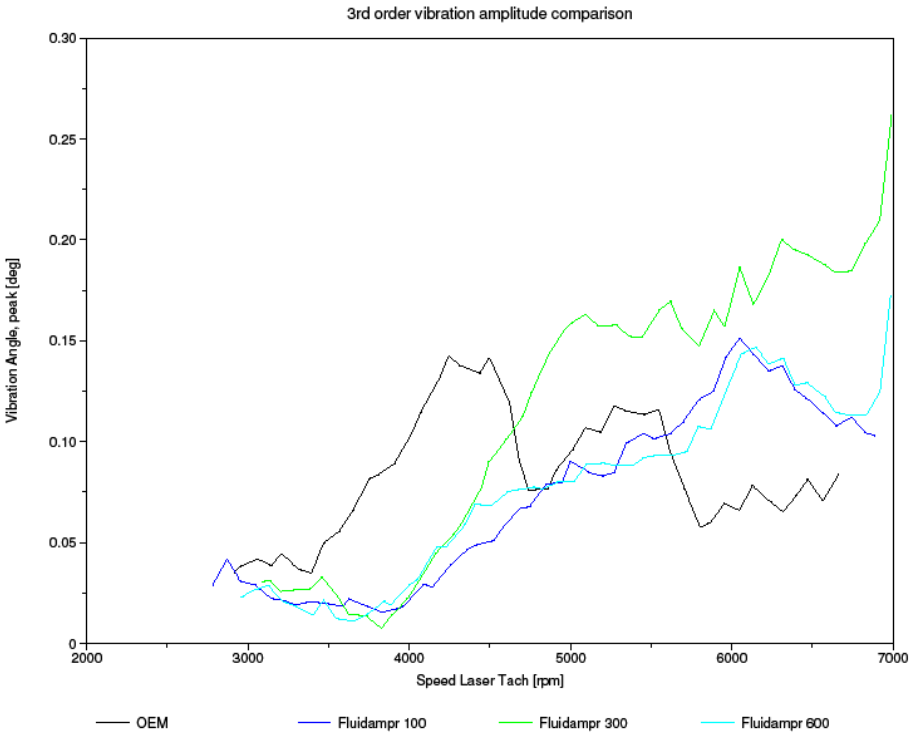

Figure 15

From figure 15 it can be seen that for Fluidampr 600701-100 and 67001-600 the peaks have been shifted higher into the RPM range and that the peaks are no higher than the lower rpm OEM damper peak. Next we will look at the 4.5 order comparison in figure 16.

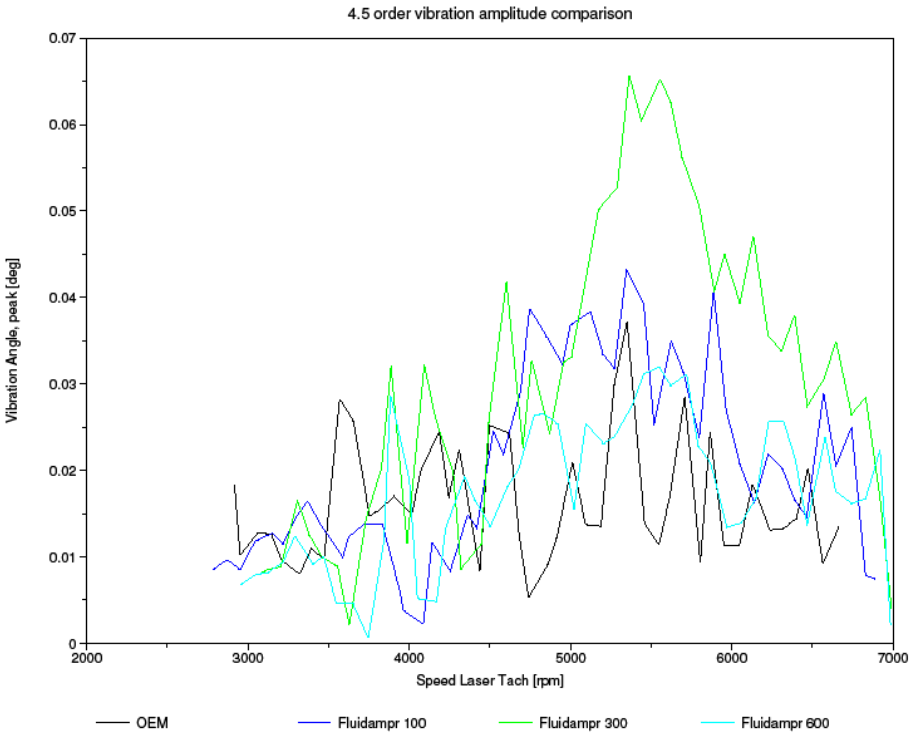

Figure 16

For the 4.5 order the amplitudes are all low, beside the OEM and Fluidampr 600701-600 are near each other across the rpm range. Lastly for independent order amplitudes the 6th order comparison is shown in figure 17.

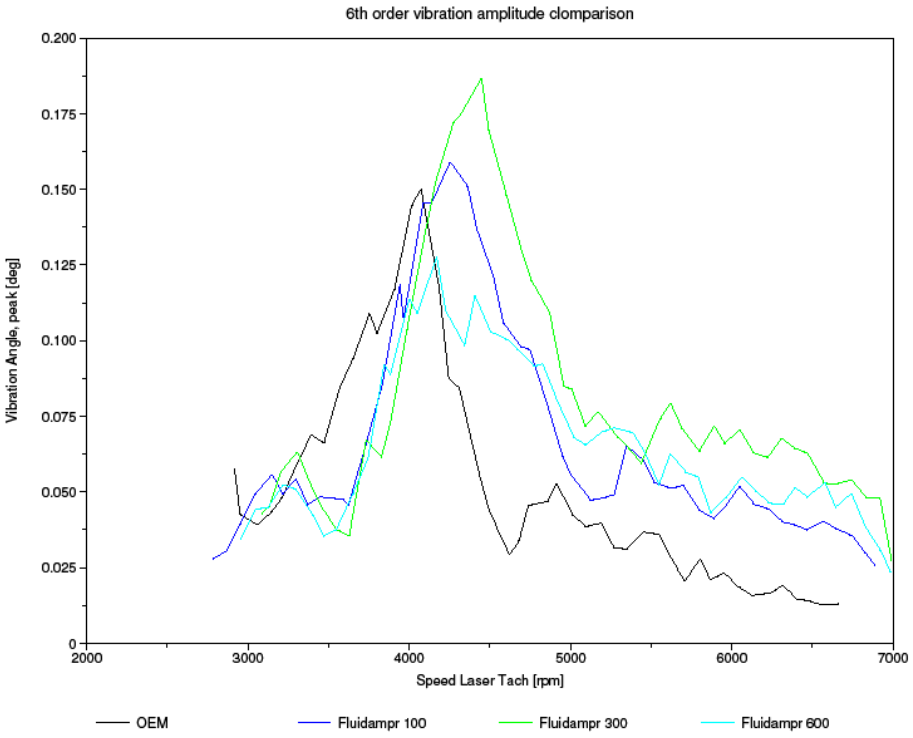

Figure 17

In this order the peak for all of the dampers occurs in roughly the same spot. With all of the major amplitudes have been considered 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 18 shows the 12 order summation comparison for all of the dampers that were tested from 1.5 order through the 12^{th} order.

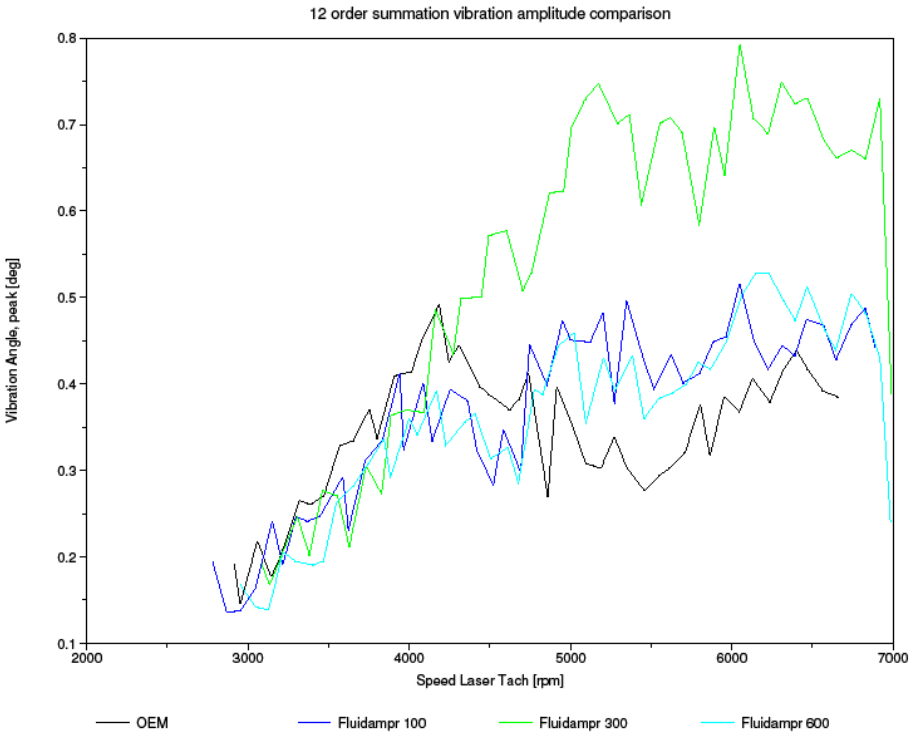

Figure 18

The 12 order summation data showed that the Fluidampr 600701-100 and the 600701-600 dampers are comparable to each other and the OEM unit. The significant difference is that the peak has been shifted into a higher rpm range.

The Fluidampr 600701-600 provided the best amplitude reduction as well as has the most available damping. The Fluidampr also removes the rubber failure mode that the dual tuned damper has. An added benefit to the Fluidampr is that it is SFI compliant and will have that engraved in the production dampers.

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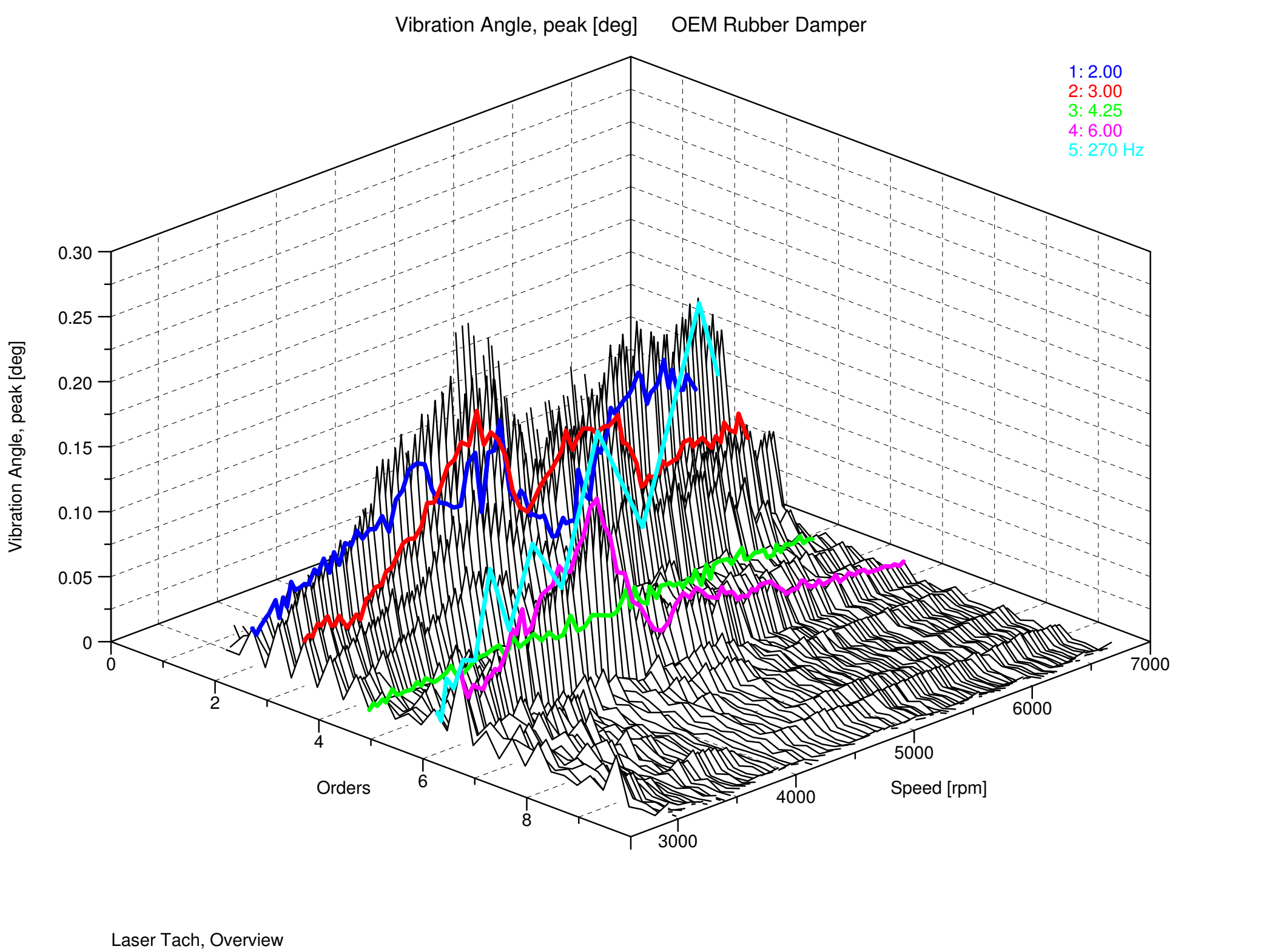
Vibration Solutions Specialist

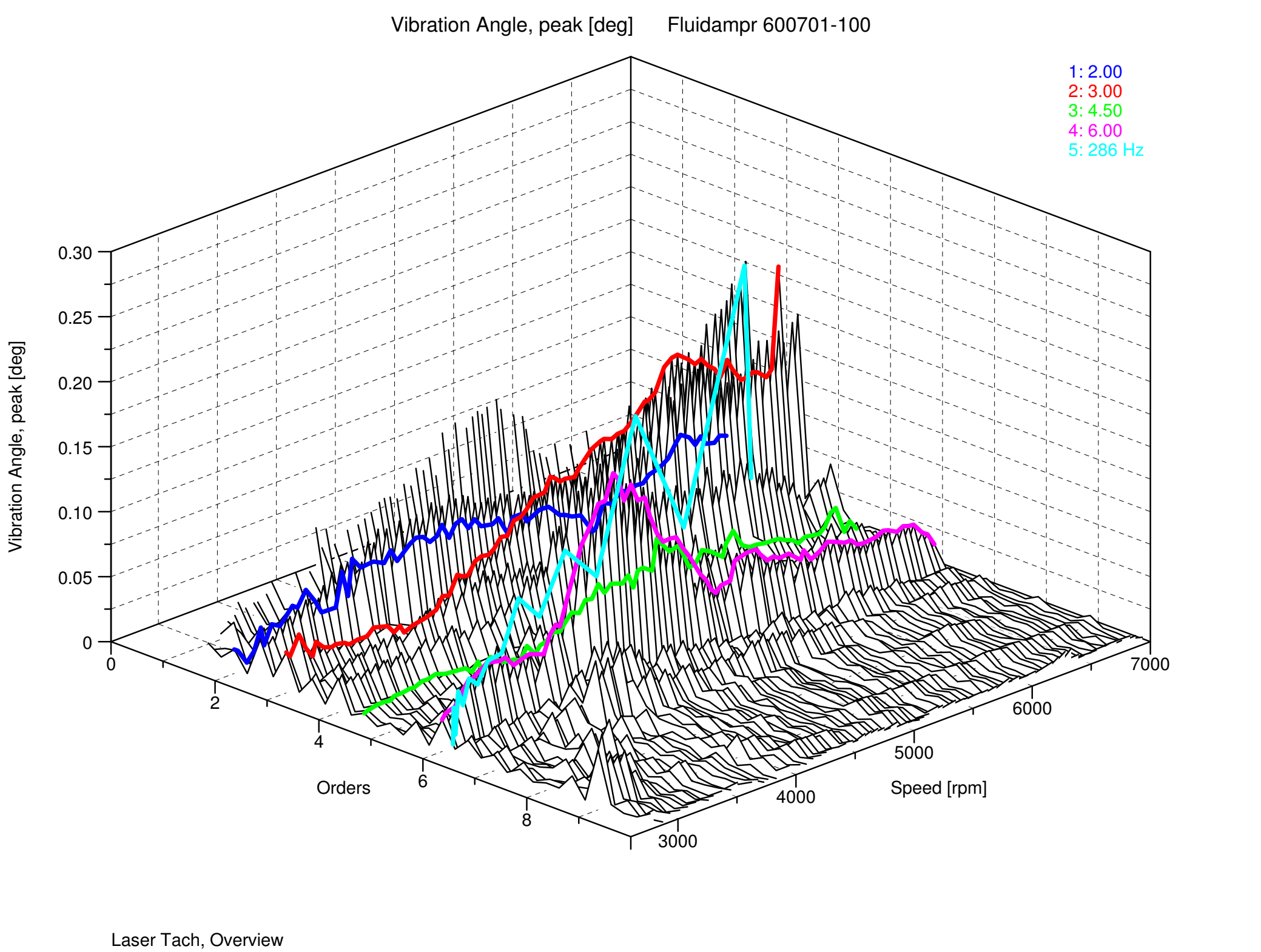
Fluidampr

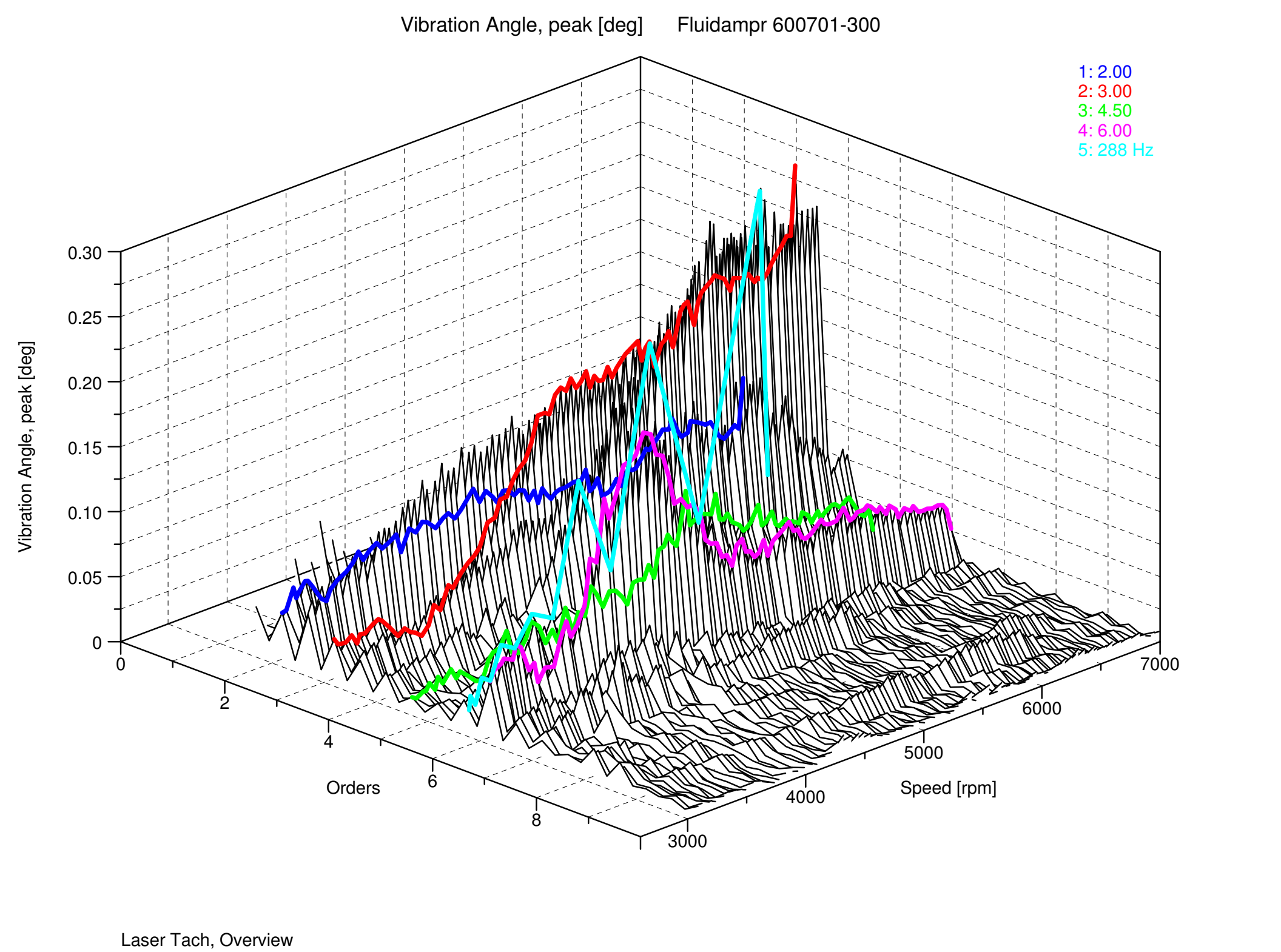
Vibratech TVD

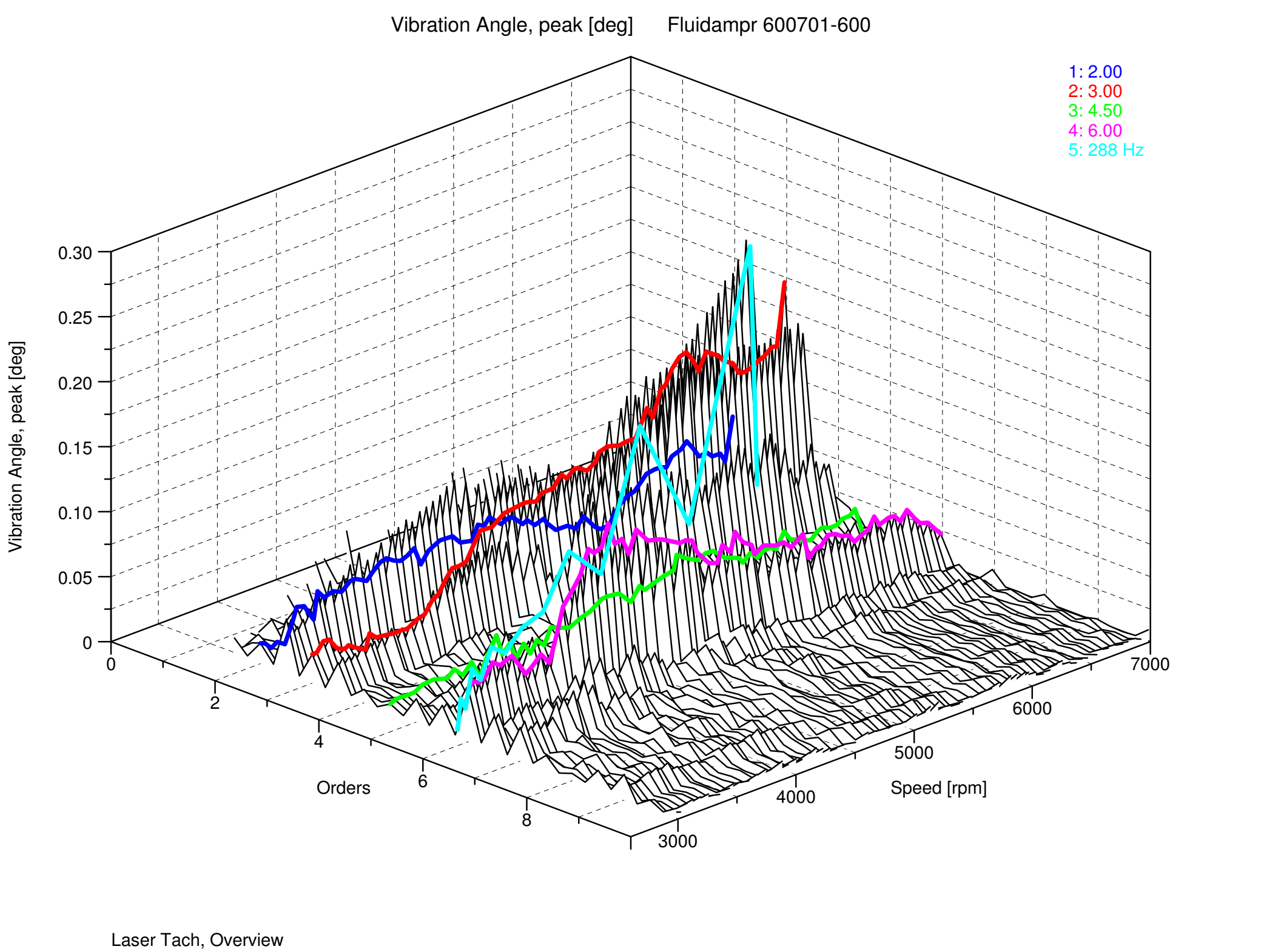
Date: 11/28/2018

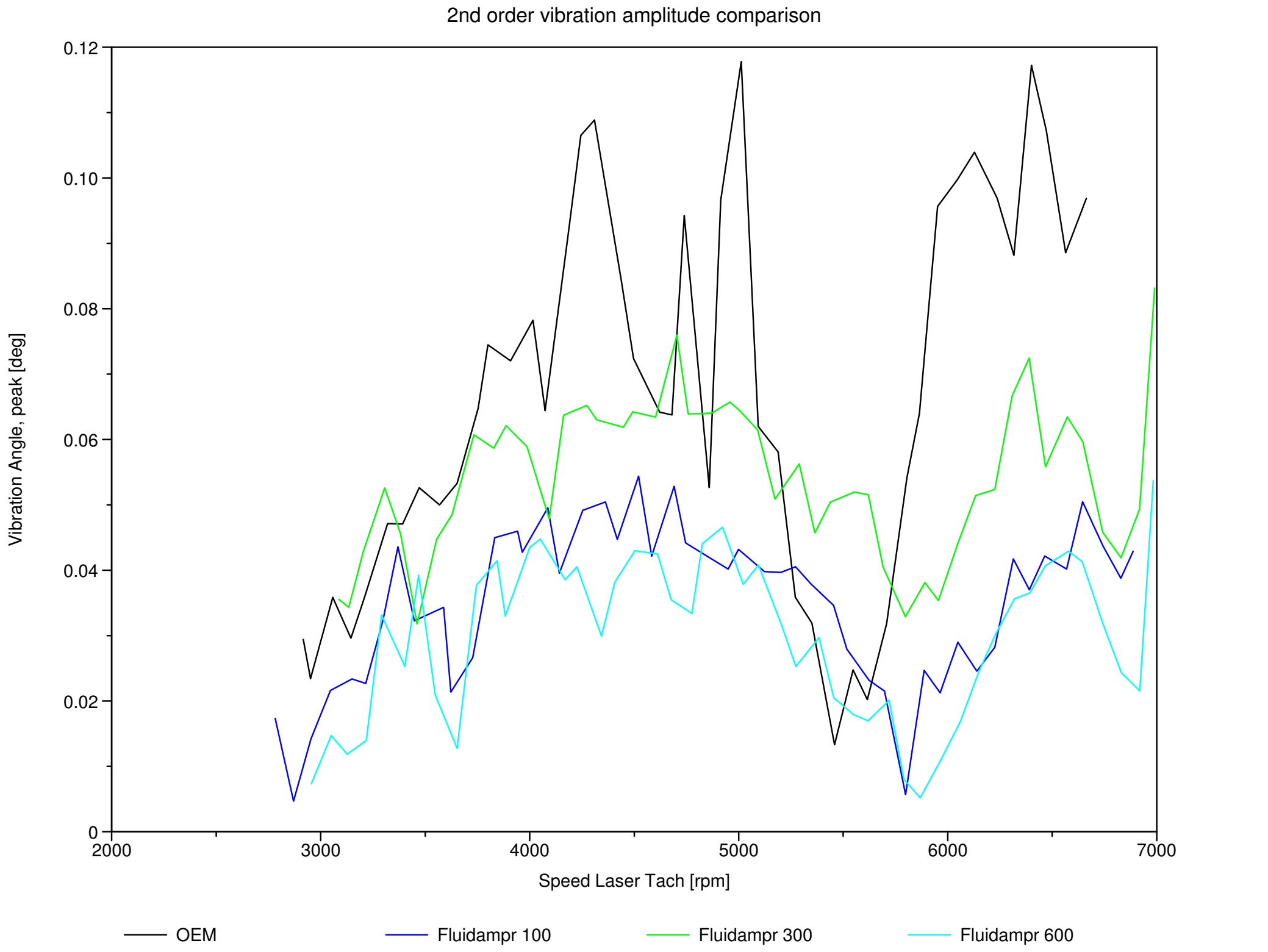
APPENDIX

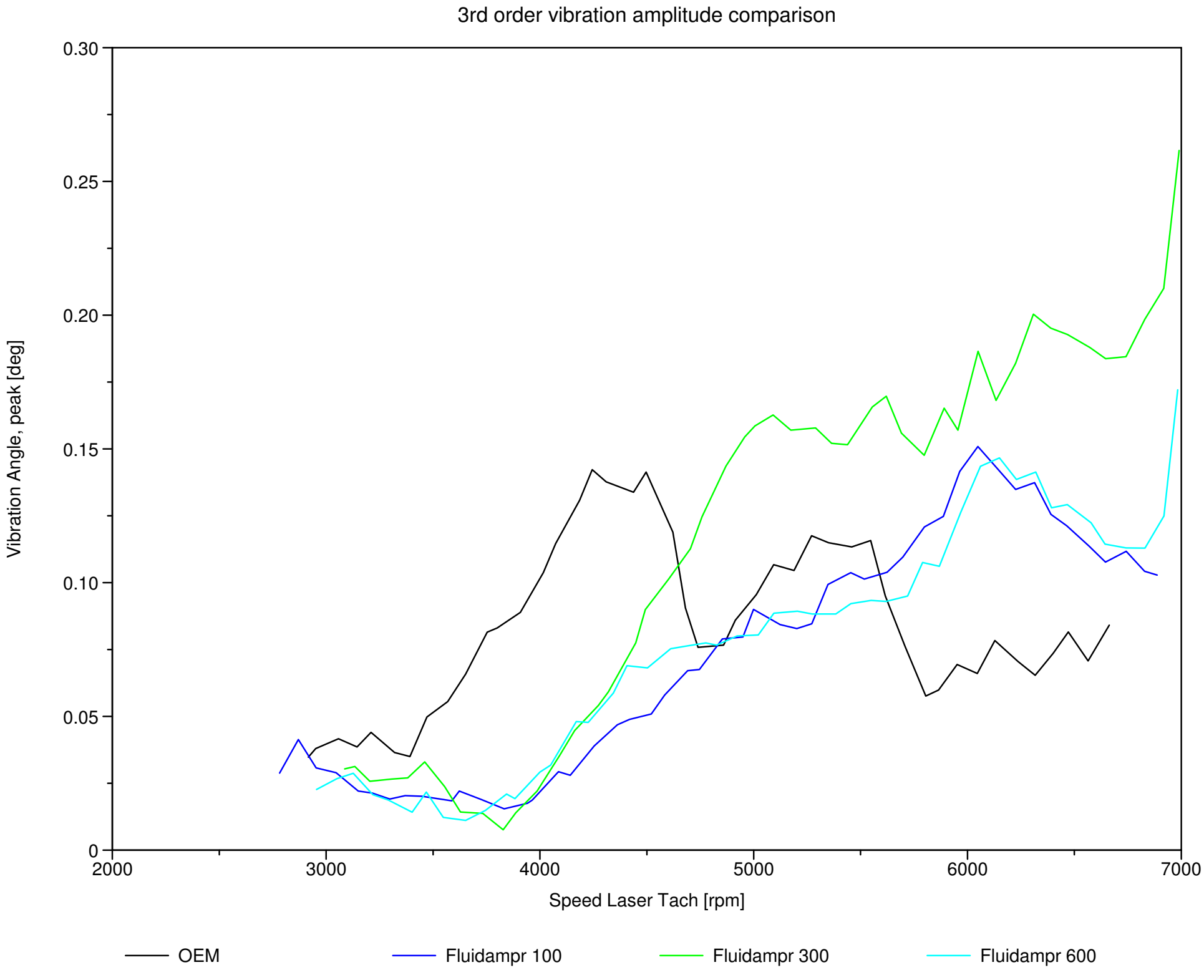

Vibration Angle, peak [deg]
OEM Rubber Damper
1: 2.00
2: 3.00
3: 4.25
4: 6.00
5: 270 Hz
Vibration Angle, peak [deg]
0.30
0.25
0.20
0.15
0.10
0.05
0
0
2
4
6
8
Orders
3000
4000
5000
6000
7000
Speed [rpm]
Laser Tach, Overview

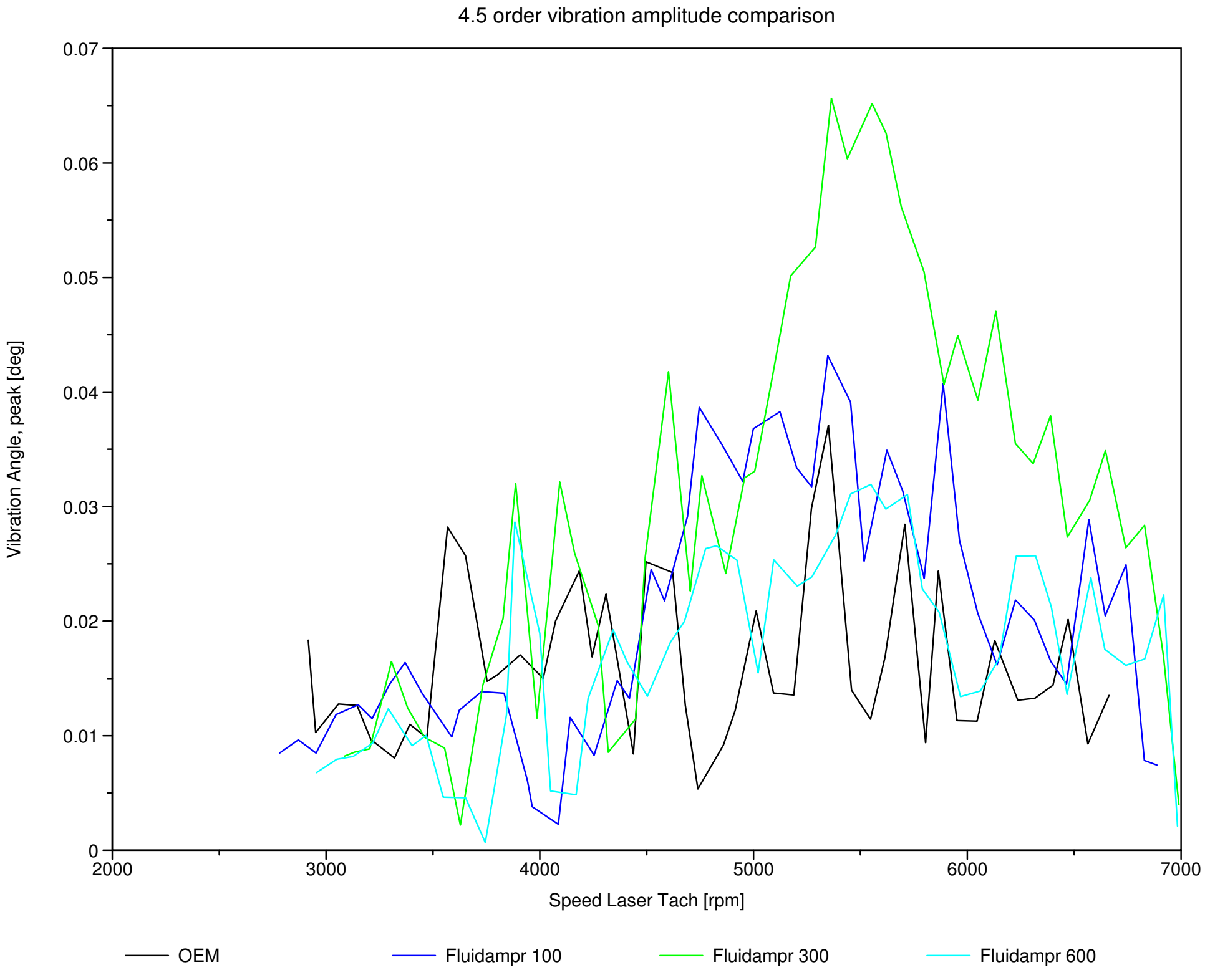

Vibration Angle, peak [deg]
Fluidampr 600701-100
1: 2.00
2: 3.00
3: 4.50
4: 6.00
5: 286 Hz
Vibration Angle, peak [deg]
0.30
0.25
0.20
0.15
0.10
0.05
0
0
2
4
6
8
Orders
3000
4000
5000
6000
7000
Speed [rpm]
Laser Tach, Overview

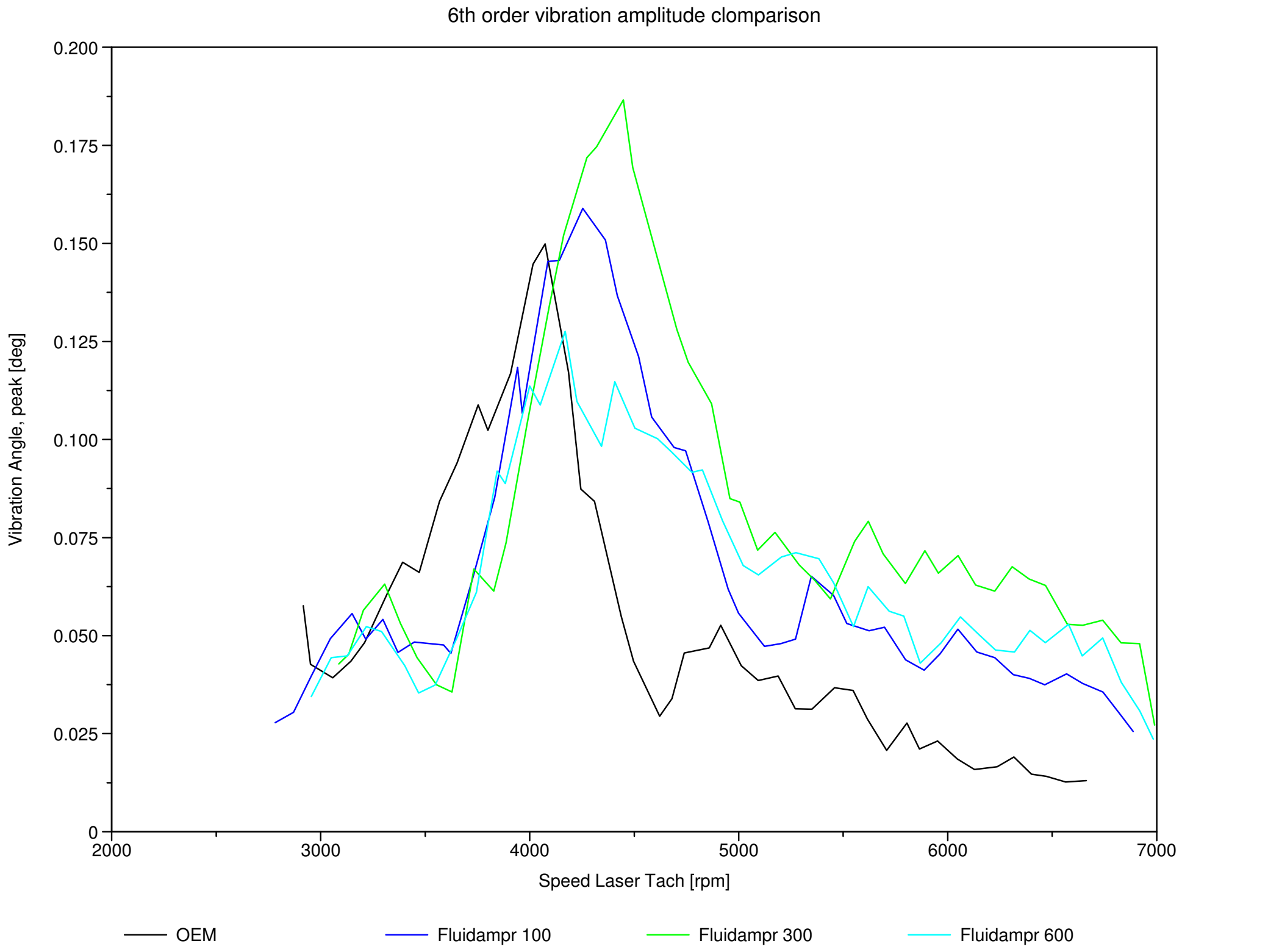

Vibration Angle, peak [deg]
Fluidampr 600701-300
1: 2.00
2: 3.00
3: 4.50
4: 6.00
5: 288 Hz
Vibration Angle, peak [deg]
0.30
0.25
0.20
0.15
0.10
0.05
0
0
2
4
6
8
Orders
3000
4000
5000
6000
7000
Speed [rpm]
Laser Tach, Overview

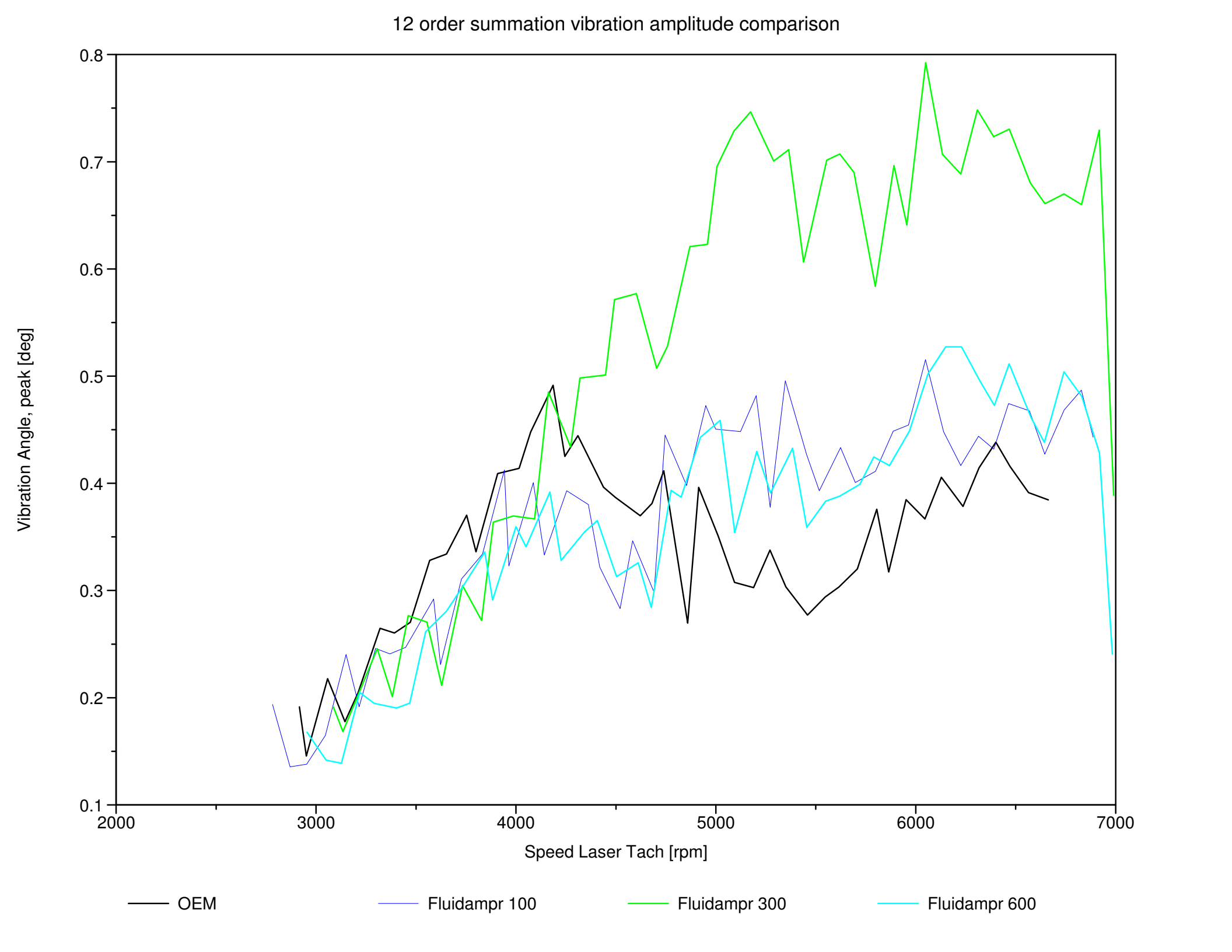

Vibration Angle, peak [deg]
Fluidampr 600701-600
1: 2.00
2: 3.00
3: 4.50
4: 6.00
5: 288 Hz
Vibration Angle, peak [deg]
0.30
0.25
0.20
0.15
0.10
0.05
0
0
2
4
6
8
Orders
3000
4000
5000
6000
7000
Speed [rpm]
Laser Tach, Overview


2nd order vibration amplitude comparison
Vibration Angle, peak [deg]
0.12
0.10
0.08
0.06
0.04
0.02
0
2000
3000
4000
5000
6000
7000
Speed Laser Tach [rpm]
OEM
Fluidampr 100
Fluidampr 300
Fluidampr 600


3rd order vibration amplitude comparison
Vibration Angle, peak [deg]
0.30
0.25
0.20
0.15
0.10
0.05
0
2000
3000
4000
5000
6000
7000
Speed Laser Tach [rpm]
OEM
Fluidampr 100
Fluidampr 300
Fluidampr 600


4.5 order vibration amplitude comparison
Vibration Angle, peak [deg]
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
2000
3000
4000
5000
6000
7000
Speed Laser Tach [rpm]
OEM
Fluidampr 100
Fluidampr 300
Fluidampr 600


6th order vibration amplitude clomparison
0.200
0.175
0.150
0.125
0.100
0.075
0.050
0.025
0
Vibration Angle, peak [deg]
2000
3000
4000
5000
6000
7000
Speed Laser Tach [rpm]
OEM
Fluidampr 100
Fluidampr 300
Fluidampr 600


12 order summation vibration amplitude comparison
Vibration Angle, peak [deg]
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
2000
3000
4000
5000
6000
7000
Speed Laser Tach [rpm]
OEM
Fluidampr 100
Fluidampr 300
Fluidampr 600