OPEN POSSIBILITIES.

Attenuating Acoustic Effects on HDD Performance

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Attenuating Acoustic Effects on HDD Performance

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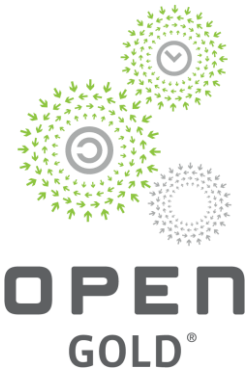

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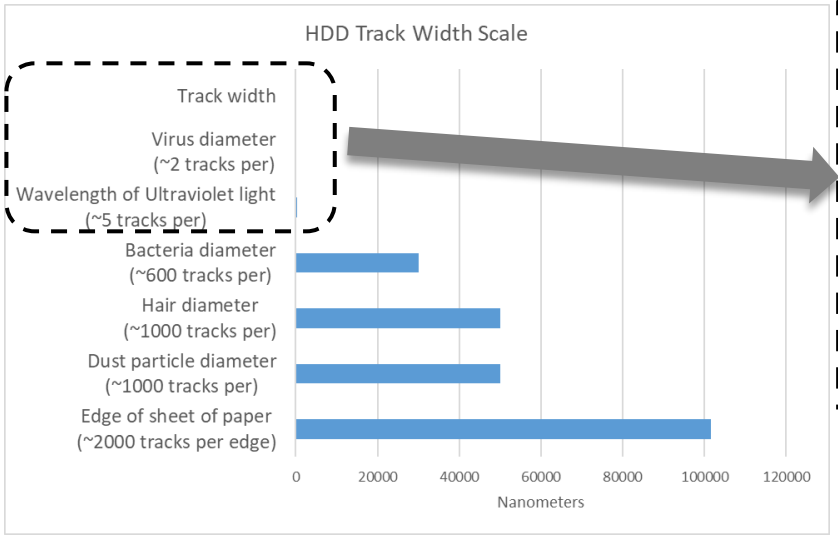
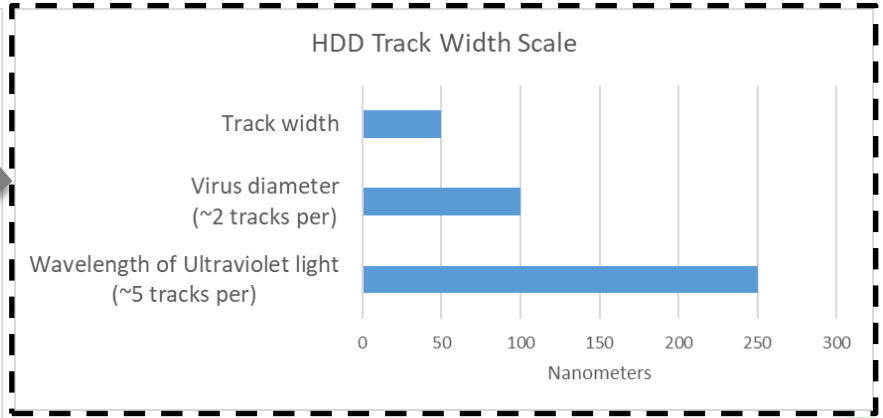
Background

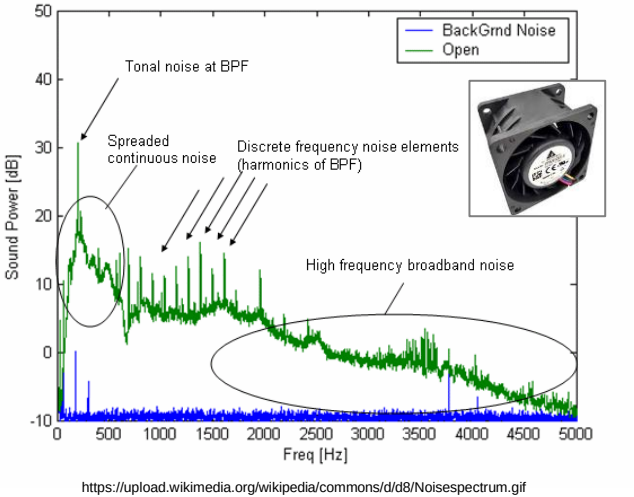
- As the hard disk drive areal density increases (increasing tracks per inch), the ability of the HDD servo system to filter out external vibrations becomes increasingly difficult. Today's HDDs are approximately 500,000 TPIs (Tracks Per Inch).





Background

- Vibrations can come from operational vibrations, drive to drive interactions, nearby equipment and many other sources
- Acoustics from Air Moving Devices (AMDs) operating at high speeds have become a much bigger factor in the performance of HDDs



https://upload.wikimedia.org/wikipedia/commons/d/d8/Noisespectrum.gif

- Current HDD technology and mechanics allow for error rejection below 2kHz
- AMDs can create excitations up to 20kHz with tones at blade pass frequencies

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Axial Fan Acoustics

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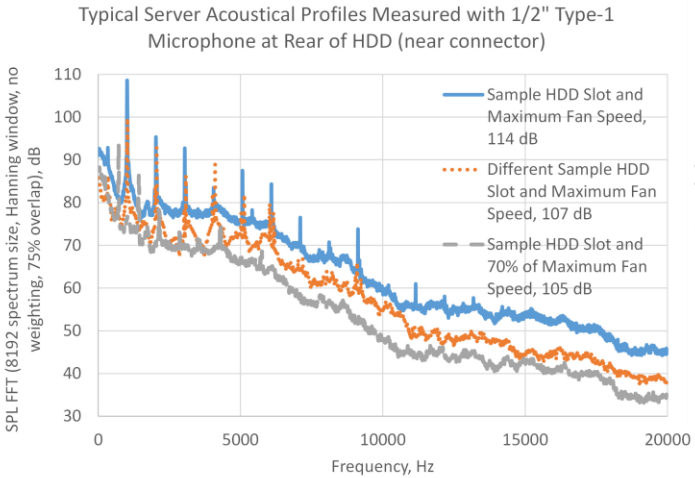
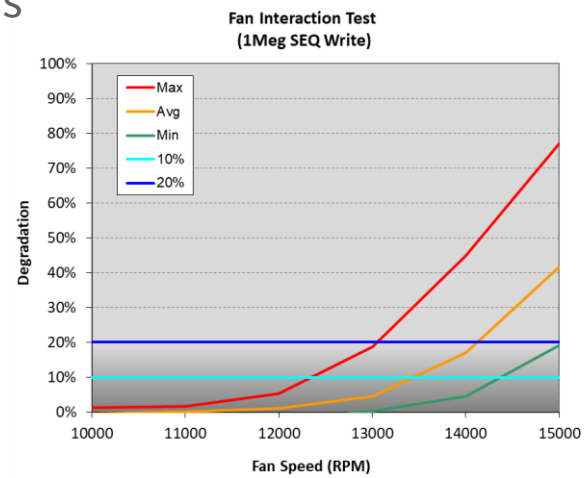
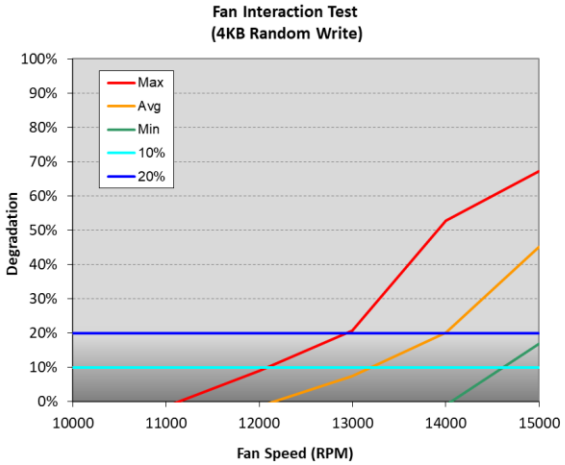
- The trend toward higher AMD speeds in storage systems can significantly affect the drive performance due to the high acoustic transmission from the AMDs







"Hard Disk Drive Performance Degradation Susceptibility to Acoustics", ASHRAE Technical Committee 9.9 White Paper, 2019

Background

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AMD speeds are increasing due to

- Higher enclosure densities (higher flow impedance)
- Higher power CPUs in application servers
- Trend toward higher data center temperatures to optimize Total Cost of Ownership (TCO)

Causes of Fan Noise

Excitation forces generated by the fans are the result of:

- mechanical components interacting and coupling with the chassis
- broadband fan noise (including noise emanating from the fan motor and air stream turbulence)
- spikes or tones called blade pass frequencies - These tones are caused when the fan impeller rotates past a nearby stationary object (finger guard, static vanes, etc.) and are a function of the number of fan blades, the rotational speed of the impeller and the geometry and distance of the stationary object

Possible Acoustic Reduction

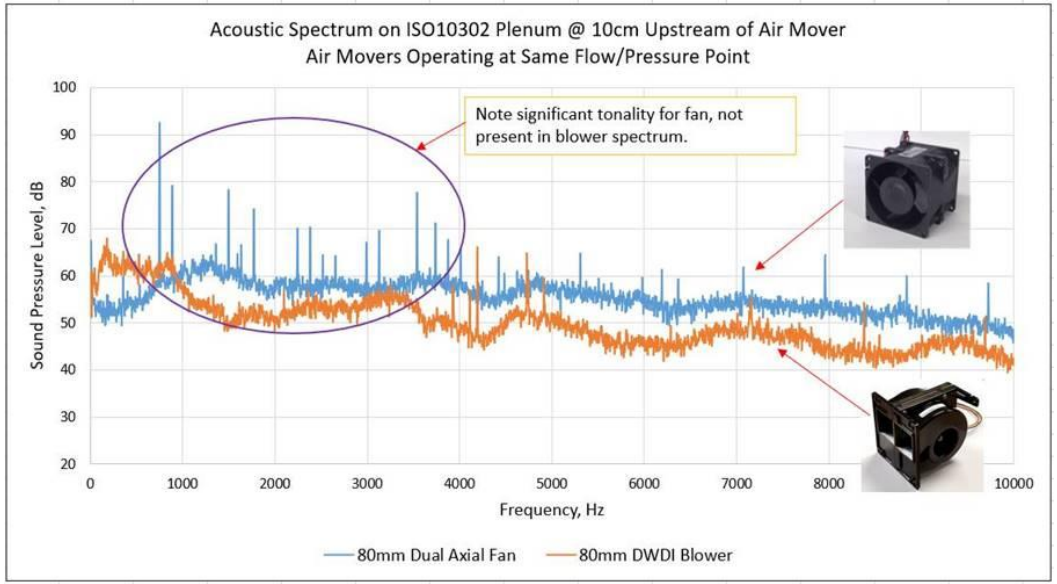
Blowers

- Blowers can be significantly quieter than axial fans (6 and 15 dB lower respectively on average) – (*https://www.electronics-cooling.com/2019/03/managing-cooling-fan-noise-in-product-design/*).

- Blowers have lower tonality than axial fans because the work to move the air is shared amongst many more blades and their wakes only hit a single relatively radiused blower cutoff in the housing geometry.

DWDI Blower Reduces Acoustics

- The DWDI (Double Width Double Inlet) blower from the Boyd Corporation has lower broadband noise and significantly less tonality than an equivalent axial fan



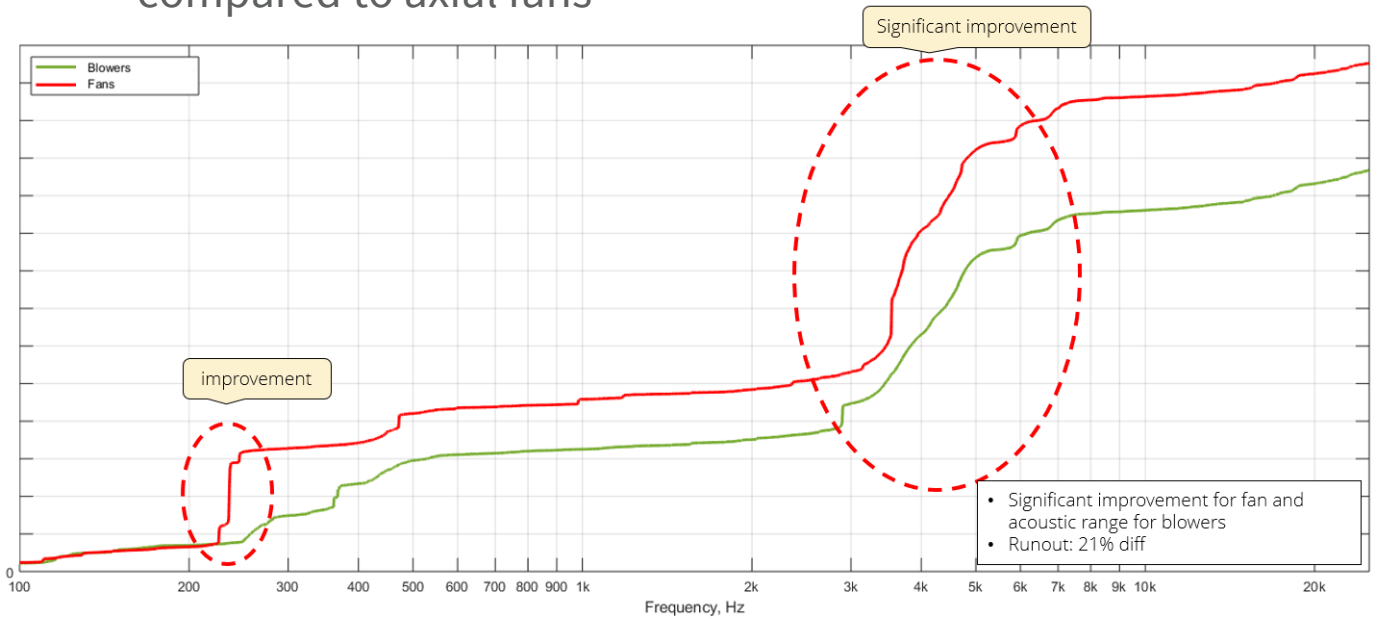
NOTE: The DWDI blower was not optimized for the system it was tested in. An optimized DWDI blower could have even better acoustics.

DWDI Blower vs Axial Fan Comparison

- A single high density storage enclosure was used
- HDD runout testing completed with axial fans and with blowers
- The DWDI blower speed was determined by maintaining the same pressure drop through the system as created by the axial fans

Blower vs Axial Fan Test Results

- Measured ~20% improvement of track runout with blowers compared to axial fans



Track runout –

- Runout, in general, is a slight error in a rotating tool, such as being off-center or not exactly round.
- HDD track runout is a combination of repeatable runout (RRO), like a track not being exactly centered around the motor, and non-repeatable runout (NRRO), i.e., vibration that causes a head to be bumped from staying in a data track.

Conclusions

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- HDDs are affected by external vibrations and AMD acoustics are becoming a bigger factor in HDD performance
- Higher power application servers, high density enclosure designs and higher data center ambient temperatures are increasing AMD speeds
- Reducing vibrations to the HDDs will significantly improve HDD performance
- DWDI blowers produce significantly less “noise” than axial fans and can be one of the ways in which enclosure designers can improve HDD performance

Acknowledgements

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- Charlie Morris, Principal Engineer, Seagate Technology
- Kevin Van Pelt, Principal Engineer, Seagate Technology

Pictures

https://www.jkmoving.com/app/uploads/2021/06/0025-JK-Moving-at-DataBridge-Sites-20210323_650x450_acf_cropped-3.jpg
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Call to Action

- Storage development community needs to design systems with reduced environmental vibration to support continued development of high-capacity HDDs by incorporating innovative, cost-effective mechanisms for cooling HDD storage systems to reduce the impact of acoustic sound pressure as a disturbance

- Utilize OCP's HDD acoustic surrogate to measure the acoustic profile of cooling solutions in the HDD system

- Participate in the HDD Vibration Storage subgroup

Open Discussion