

HERZAN

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**Acoustic, Vibration, and
EMI Isolation Specialists**

Solutions Guide for Transmission Electron Microscopes

Overview

Transmission electron microscopes (TEMs) are advancing what can be seen on the nanoscale level. Magnifying a sample upwards of one million X requires the quality of data to be precise and the stability of the environment to be absolute.

Environmental stability is Herzan's speciality and has been so for over two decades. Delivering uniquely tailored acoustic, vibration, and EMI isolation solutions for TEMs is why many researchers around the world partner with Herzan to remove noise from their measurements and to optimize their data acquisition process with their TEMs.

TEMs, like the FEI Titan, will receive completely customized solutions based on the environmental noise in the lab, the TEM being supported, the architecture of the lab, and the unique research requirements of the user. There is no technical challenge too complex for Herzan's engineering team, which is why its arrangement of solutions continue to solve the most complex problems a TEM can face.

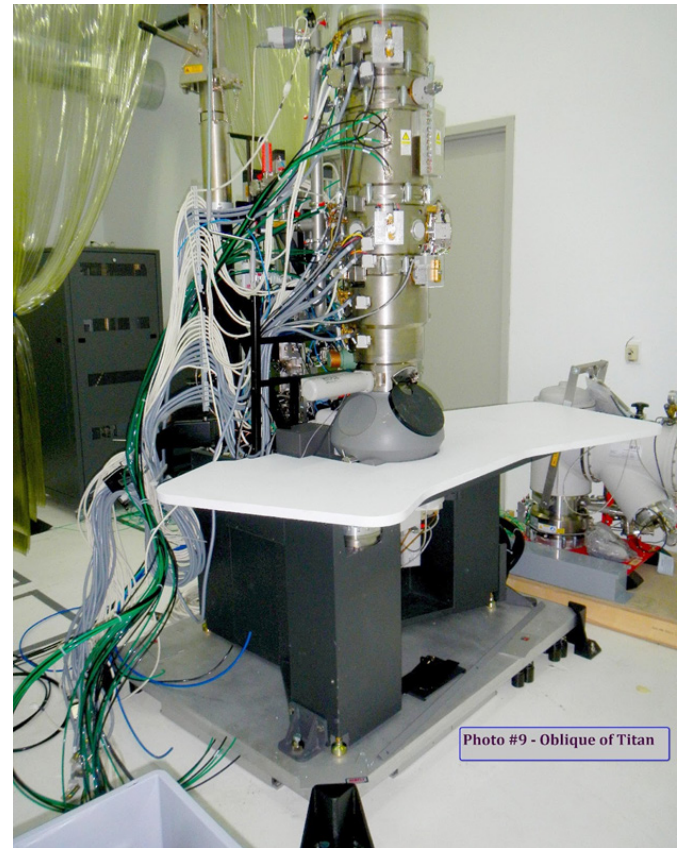


Photo #9 - Oblique of Titan

FEI Titan TEM Supported by A Custom AVI Platform

TEM Problems

- **Vibration Noise** -----> Custom Active Vibration Isolation Platforms
- **Magnetic Fields (AC/DC)** -----> AC/DC Magnetic Field Cancellation System
- **Acoustic Noise** -----> Custom Modular Acoustic Enclosure
- **Unknown Lab Noise** -----> Site Survey Tools/Reports
- **Raised False Floors in Lab** -----> Custom Raised Floor Platforms

Herzan Solutions

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Problem: Vibration Noise

Vibration noise plagues the image quality of TEMs as it creates a jarring or blurring effect to the image itself. Low-frequency vibration noise is particularly an issue as it is often amplified by the internal passive isolators of a TEM or are not being reduced altogether. Low-frequency vibration noise is prevalent where a TEM is installed on an upper floor of a building or the building resonates at a low frequency due to building construction or local noise sources.

While the ideal solution is to move the TEM to a ground floor lab or to remove local noise sources, not all researchers have that luxury. This is why researchers often consider active vibration isolation platforms as a solution since they enable the existing environment to be operational.



FEI Tecnai TEM Supported By Custom AVI Platform

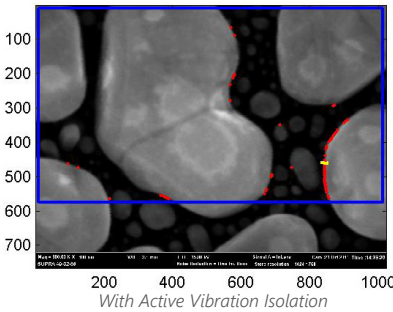
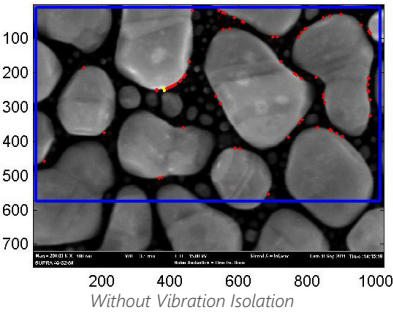
Solution: Custom AVI Platforms

Herzan's active vibration isolation platforms (**AVI Series**) lead the industry in low-frequency vibration isolation. They are utilized by thousands of researchers worldwide to remove disruptive vibration noise from limiting their measurements.

The modular design of the AVI platforms allows them to be easily installed for any research instrument and are particularly effective in supporting TEMs as they have a low profile design (4.5") and scalable load capacity (custom solutions can support up to 10,000 Kg).



Popular TEM Platform: AVI-600M



Performance Comparison Images

A researcher operating an electron microscope (EM) imaged a sample under two unique conditions: **without a vibration isolation system** and **with an AVI platform**. The resulting images demonstrate a significant improvement in image quality and overall measurement clarity when an AVI platform is used to support an EM.

PERFORMANCE HIGHLIGHTS

Product Series	Resonant Frequency	Isolation Starting At	Isolation % at 2.5 Hz	Isolation % at 5 Hz	Isolation % at 10 Hz	Max. Isolation %	Isolation Performance	Active Vibration Isolation Bandwidth
AVI Series	None	1.5 Hz	90%	97%	99%	99.8% at 70 Hz	Greater than 40 dB	Up to 200 Hz
AVI Series with LFS System*	None	0.5 Hz	95%	99%	99.5%	99.8% at 20 Hz	Greater than 55 dB	Up to 200 Hz

*LFS System is a low-frequency upgrade to the AVI Series that can be easily retrofitted into existing systems or integrated into new systems.

Problem: Magnetic Fields (AC/DC)

TEMs operate in ambient magnetic fields comprising of the earth's field and fields radiated by electric machines and power networks. When the ambient field changes, the electron beam in the TEM is deflected, causing loss of resolution and image distortion.



SC-24 System Control Unit

Active cancellation solutions like the Spicer System are often installed to stabilize the environment around the TEM column so that its measurements are not impacted by the fluctuating AC/DC fields.

Solution: Spicer Magnetic Field Cancellation System

Herzan partners with Spicer Consulting to supply industry leading magnetic field cancellation systems that dynamically respond to field changes in the room. These solutions are unique to the customer's environment, contouring to the profile of the room and remaining virtually invisible.

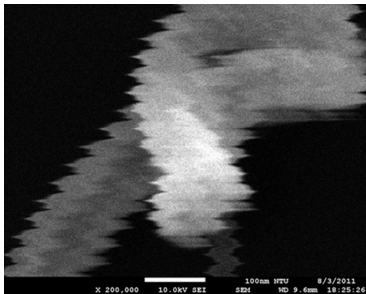


SC22 System Supporting A FEI Titan TEM

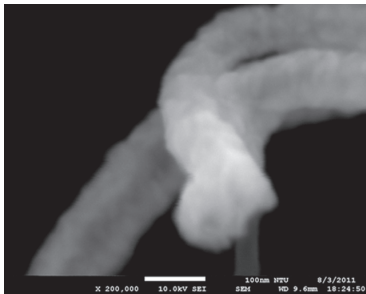
The **SC22 System** cancels AC fields and is considered a more economical solution, while the **SC24 System** cancels AC and DC fields, making it the higher performing solution. Each SC System comprises of the following: a magnetic field control unit, two magnetic field sensors, a mixer, TEM sensor mounts, and three orthogonal axis multicore cables (custom to room size).

Performance Comparison Images

The AC fields created by the power frequencies of local equipment caused the electron microscope's image to blur and receive jagged edges. After the installation of the SC22 System, the distortion in the image significantly improved, enabling the researcher to better understand the collected measurement data and decipher the nuanced details of the sample.



EM Image Without Magnetic Field Cancellation



EM Image With the SC22 Magnetic Field Cancellation System

PERFORMANCE HIGHLIGHTS

Product Series	Fields Cancelled	Field Cancelling Factor	Axes Cancelled	Dynamic Range	Bandwidth
SC22 System	AC Fields	50 at 50/60 Hz	X, Y, and Z	X & Y: 60 mG (6 μ T) pk-pk Z: 35 mG (3.5 μ T) pk-pk	0.5 Hz - 5,000 Hz
SC24 System	AC/DC Fields	> 100 X at 50/60 Hz > 400 X at DC*	X, Y, and Z	X & Y: 4.8 μ T pk-pk Z: 3.3 μ T pk-pk	DC - 5,000 Hz



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Problem: Acoustic Noise

TEMs often contain a structural design that shields against acoustic noise, however, as technologies advance and the need for absolute stability increases, enclosures or other mitigation techniques become necessary. Acoustic noise impacts the TEM image similarly to vibration noise, with the chief difference being acoustic noise can come from many directions and many sources simultaneously.

Solutions: Consulting Services or Custom Acoustic Enclosures

Herzan has supported acoustically sensitive applications for over twenty years, providing consultative engineering services and custom designed acoustic enclosures based on the individual requirements of the researcher.

Consulting Services

Building an acoustic enclosure can be challenging in certain lab environments due to limited space available or poor temperature regulation. These limitations require alternative recommendations to reduce the noise profile of the room, which is Herzan's speciality. We offer solutions to address the local noise in the room, including:

- Damping or Relocating Noise Generating Equipment
- Baffling Air-Flow Away from TEM
- Recommending Architectural Changes to the Room to Improve Local Sound Damping
- And More

TEM Acoustic Enclosures

Herzan's legacy supporting sensitive instruments with uniquely tailored acoustic enclosures directly benefits TEM users who find acoustic noise routinely disrupts the quality and clarity of their images. All design, engineering, and manufacturing work is performed at Herzan's facility in California, which allows TEM users the opportunity to completely specialize and upgrade a TEM acoustic enclosure that fits the individual needs of their TEM and research.

Majority of TEM acoustic enclosures are modular, meaning they comprise of individual, interlocking panels that are built around the TEM. Each panel is layered with variable density material and includes all of the necessary features required for optimal usability of the TEM and maximum acoustic isolation.



Modular Acoustic Enclosure Designed for Compact Electron Microscope



Segmented Acoustic Enclosure Designed for Large Electron Microscope



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Problem: Unknown Lab Noise

Environmental noise is often the limiting factor in receiving desirable measurement results from TEMs. Measuring and analyzing environmental noise before the installation of a TEM is not only required by most manufacturers, it enables the user to save time, money, and resources by preparing the installation location appropriately for their upcoming instrument.

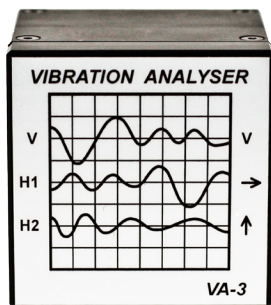
Solutions: Site Survey Tools/Reports

Herzan offers solutions and services to help researchers better understand their environment, including tools to measure all types of noise (the WaveCatcher) and services to provide researchers with a comprehensive report that measures and identifies disruptive noise sources and the resulting solutions to mitigate that noise.

The WaveCatcher site survey tool helps researchers understand their environment by providing comprehensive site surveys. The WaveCatcher is designed to deliver intuitive and intelligent environmental measurements by using an array of vibration, acoustic, and EMI sensors (depicted below).



WaveCatcher Carrying Case



Triple Axis Vibration Sensor



Single Axis Vibration Sensor



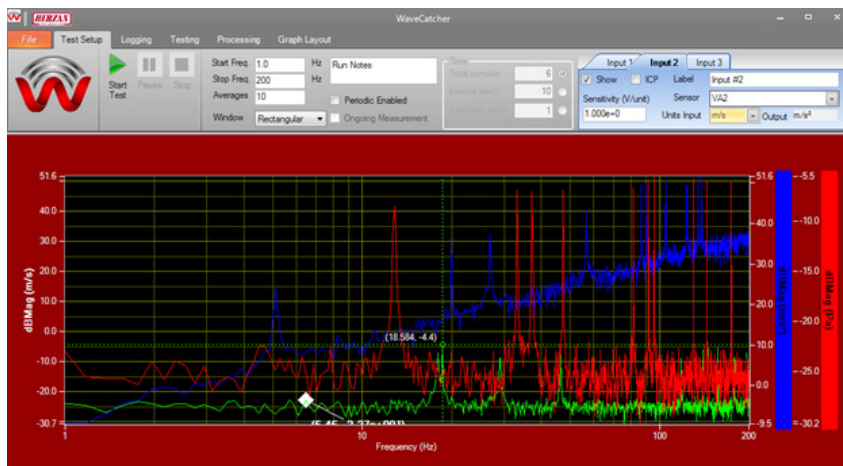
Acoustic Microphone



Triple Axis EMI Sensor (AC/DC Fields)

The WaveCatcher And TEMs

Researchers often utilize the WaveCatcher prior to a TEM being installed so they can better understand what environmental mitigation solutions are required. Herzan provides the WaveCatcher as a tool available to researchers or lab managers, or uses the WaveCatcher to perform a site survey, where a report will be generated to highlight what (if any) noise needs to be isolated.



WaveCatcher Software Interface (Version 3.0+)



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Problem: Raised False Floors In Lab

Due to the complexity and sophistication of TEMs, labs are often designed around their unique requirements so the operation is seamless and efficient. One common requirement is to include a false floor, which allows equipment, cabling, and other items to be placed underneath the false floor, creating an aesthetically appealing lab space.

The false floor creates challenges for vibration isolation platforms, as they need to be recessed underneath the floor, while being of equal height to the false floor cavity. Additionally, if a TEM has an acoustic enclosure, the enclosure needs to be raised equal height to the TEM, preventing clearance issues and height concerns within the lab.

Solutions: Custom Raised Floor Platforms

Herzan's engineering, design, and production teams collaborate to create unique sub-floor platforms to ensure the vibration isolation platform and TEM enclosure (if included) are of equal height to the floor itself. Each sub-floor platform represents the unique requirements of the TEM and its accompanying hardware, taking into consideration clearance requirements, seismic restraint specifications, dimension limitations and more.

This collaborative effort with the user and the architectural firm building the room is a common design process for Herzan's engineering team and can be easily adapted to any lab design or format.



AVI Platform and Support Frame Supporting A TEM's HT Tank In A Lab with A Raised Floor



The images above represent a successful recessed floor platform for a TEM vibration isolation platform, TEM acoustic enclosure, and TEM HT Tank vibration isolation platform.



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Custom AVI-600 Platform and Support Frame
Supporting a FEI Krios TEM and Acoustic Enclosure

References: Herzan TEM Solutions

Herzan has been proud to support many world-renowned institutions to optimize their TEM by removing disruptive environmental noise. These solutions have led to many happy users who are willing to share their experience with the AVI Series, Spicer Systems, and other supporting products made available from Herzan.

If you have questions on whether Herzan can resolve your noise problem, feel free to contact one of the references below for an objective overview on their experience working with Herzan and the solutions provided. They will be able to share unique features of their environment and how those features were addressed through the partnership with Herzan.

Additional References Are Available



AVI-400S-3 Supporting A FEI Titan 80-300 KV TEM

ACE came to Herzan sharing the need to isolate low-frequency vibrations from their lab housing a FEI Titan 80-300 KV TEM. Herzan designed a custom AVI platform to match the exact profile of the TEM. This custom AVI platform helped Rajesh's TEM meet specification and greatly improve its imaging, despite being located near several freeways.

Company: Advanced Circuit Engineers
End User: Rajesh Jain
Email: rajesh@advancedcircuitengineers.com
Phone: (408) 719-1617
TEM Supported: FEI Titan 80-300 KV
Herzan Solution: AVI-400S-3 MP



AVI-600S-4 Supporting A FEI Krios G2 TEM

CSHL came to Herzan sharing the need to isolate low-frequency vibrations and AC/DC fields from their lab designed for a FEI Krios G2 TEM. The lab had a raised floor requiring sub-floor platforms for the TEM, TEM enclosure, and HT Tank. The solutions provided helped CSHL's TEM install exactly to the profile of the lab, ensuring the TEM and TEM enclosure were raised equally, eliminating clearance concerns inside the enclosure. The HT Tank also received a vibration isolation platform due to its rigid connection to the TEM.

Company: Cold Spring Harbor Laboratory (CSHL)
End User: Dennis Thomas
Email: thomas@cshl.edu
Phone: (516) 367-5909
TEM Supported: FEI Krios G2 TEM
Herzan Solution (Vibrations): AVI-600S-4 + AVI-400S MP
Herzan Solution (AC/DC Fields): SC-24 Spicer System



AVI-600S-3 Supporting A FEI CM-100 TEM

TSS came to Herzan sharing the need to isolate a refurbished FEI CM-100 TEM on an upper floor of a building. The vibration noise was considerable, and they needed a low-profile platform effective at cancelling low-frequency vibration noise. Herzan custom designed an AVI Platform to match the profile of the TEM, enabling the TEM to meet specification and run optimally.

Company: TSS Microscopy (TSS)
End User: Matt Weschler
Email: matt@tssmicroscopy.com
Phone: (408) 719-1617
TEM Supported: FEI CM-100 TEM
Herzan Solution: AVI-600S-3 MP