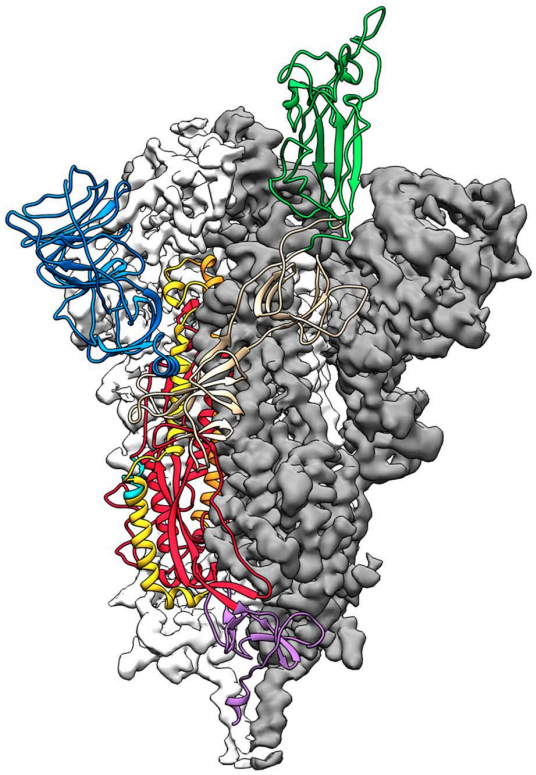
Case Study

TMC Equipment Supports First Look At Coronavirus Structure



This is a 3D atomic scale map, or molecular structure, of the 2019-nCoV spike protein. The protein takes on two different shapes, called conformations—one before it infects a host cell, and another during infection. This structure represents the protein before it infects a cell, called the prefusion conformation. Credit: Jason McLellan/Univ. of Texas at Austin[1]

SITUATION

On February 19, 2020 researchers at the University of Texas at Austin and the National Institutes of Health announced they had created the first 3D molecular structure of the part of the 2019 novel coronavirus[1] that attaches to and infects human cells. This was an essential milestone for the development of vaccines and other countermeasures.

In order to create the atomic-scale 3D models, the researchers utilized two Thermo Fisher Scientific Cryogenic Transmission Electron Microscopes (Cryo-TEMs) – a Krios and a Talos - equipped with Gatan K3™ single electron counting direct detection cameras[2].

The Sauer Structural Biology lab that houses the Cryo-TEMs is a part of the Faulkner Nanoscience and Technology Building, centrally located on the UT Austin campus, roughly one mile from the I-35 highway; heavy nearby traffic is a common source of excessive floor vibration. Predictably, the survey performed early in the planning stage determined the vibration at very low frequencies exceeded the requirements for one of the microscopes.

In addition, AC magnetic field levels were above the instrument specifications, which is common in a multi-use facility. Nearby elevator activity would occasionally cause a shift in quasi-DC fields, again exceeding the manufacturers specifications for the TEMs as well as the Gatan K3 cameras.

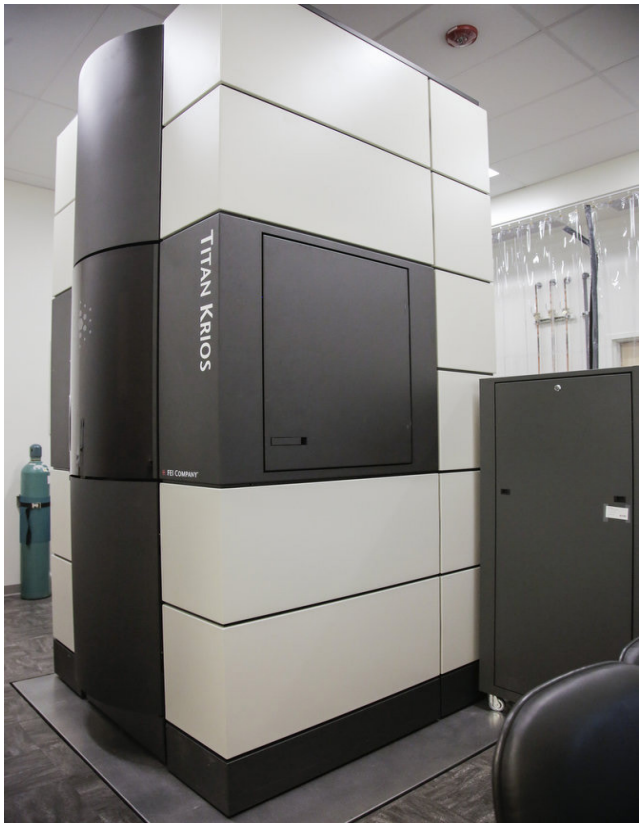


Figure 1: Typical set up of a Kryos TEM on a STACIS Quiet Island.

The tops were supported by 8 custom 1,200 mm high posts outfitted with TMC Gimbal Piston isolators with a total payload capacity of 3,600 kg. The post system was equipped with base plates and one row of upper tie bars. The base plates allow the posts to be bolted and secured to the concrete floor. The upper row of tie bars significantly stiffens up the tall construction and enables good isolation performance in both the vertical and horizontal directions. The height of the custom posts and the 300 mm thick optical top add up to the standard working height of 900 mm above the raised floor.

To rectify these environmental disturbances, TMC installed a STACIS Quiet Island active floor vibration cancellation system in the floor under the Talos and Mag-NetX active magnetic field cancellation systems for each TEM.

The room floor was designed to be compatible with the Quiet Island concept allowing the TEM to be installed without being raised above floor level. As shown in Figure 2, the STACIS Quiet Island, with a unique piezoelectric vibration cancellation technology, suppresses the floor vibration from above Vibration Criterion level D to below level F[3].

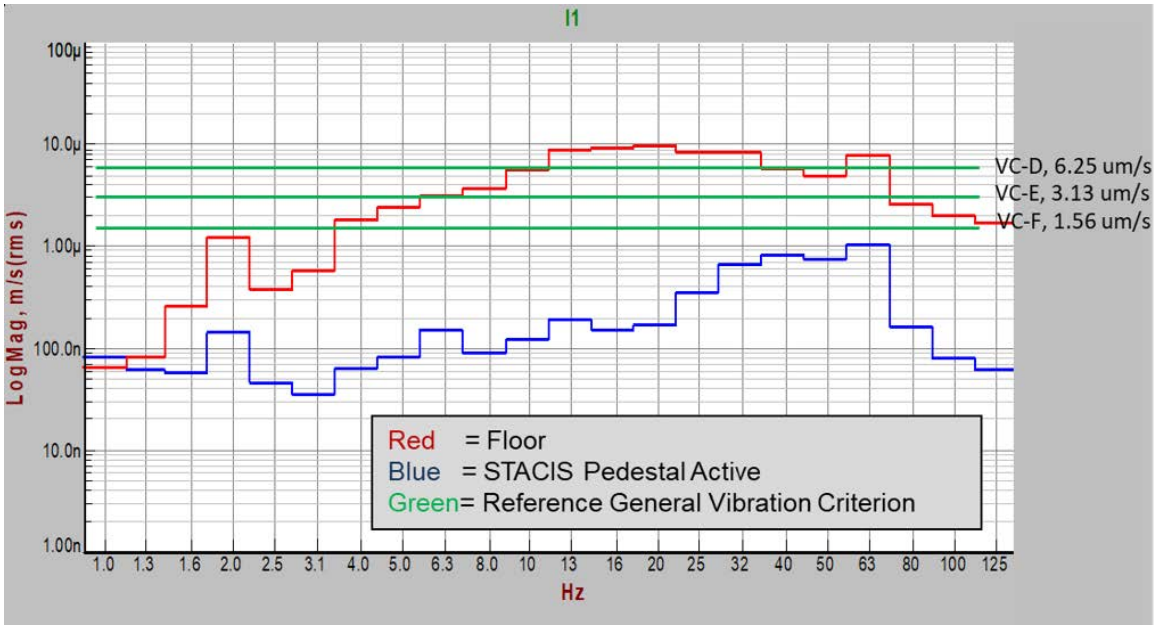


Figure 2: Actual room floor vibration measurements at the site under the Talos.

TMC's detailed familiarity with Thermo Fisher Cryo-TEMs enabled the Mag-NetX systems' Helmholtz coils to be integrated into the TEMs' enclosures, making effective use of the valuable space in the room. The enclosure-mounted active field cancellation system provides roughly 100x suppression of magnetic fields at the sensor (see Figure 4). The Mag-NetX controller and GUI can also be used to continuously monitor fields (attenuated fields, or in "open-loop") and provide data in terms of field strength over time (see Figure 3), or plotted against frequency.

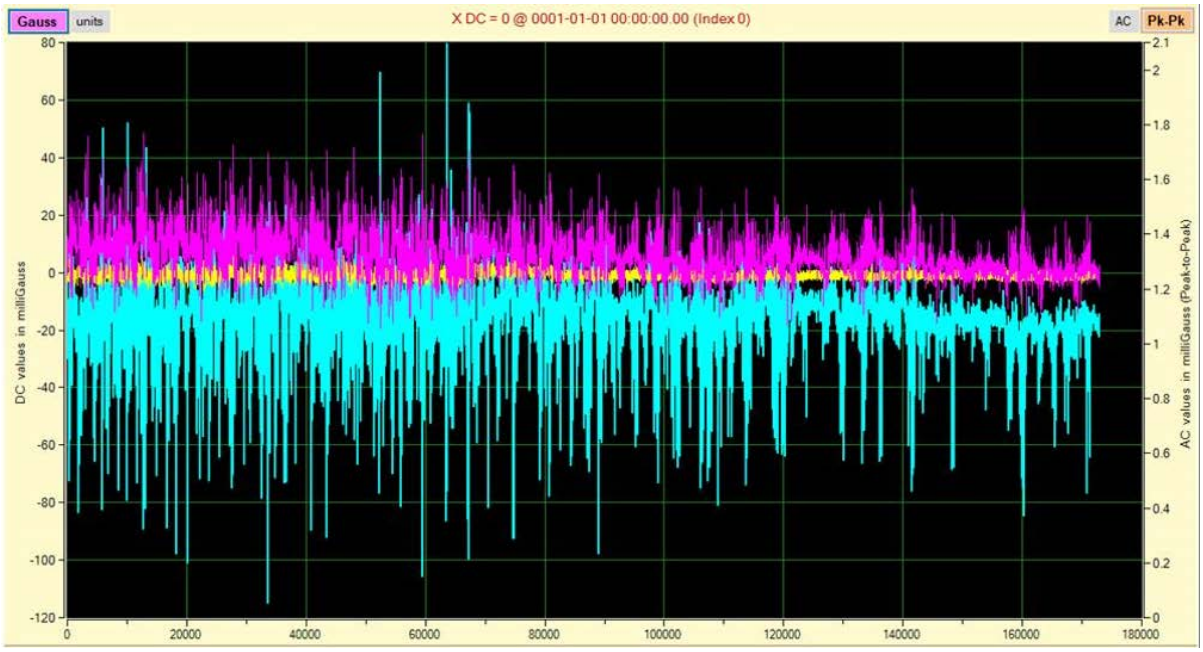


Figure 3: TMC's Mag-NetX system can be used to continuously monitor the fields. This allows the user to monitor for changes in the environment throughout the day. This is an example of a recording over a period of 9.5 hours at a different city location before the system was powered on.

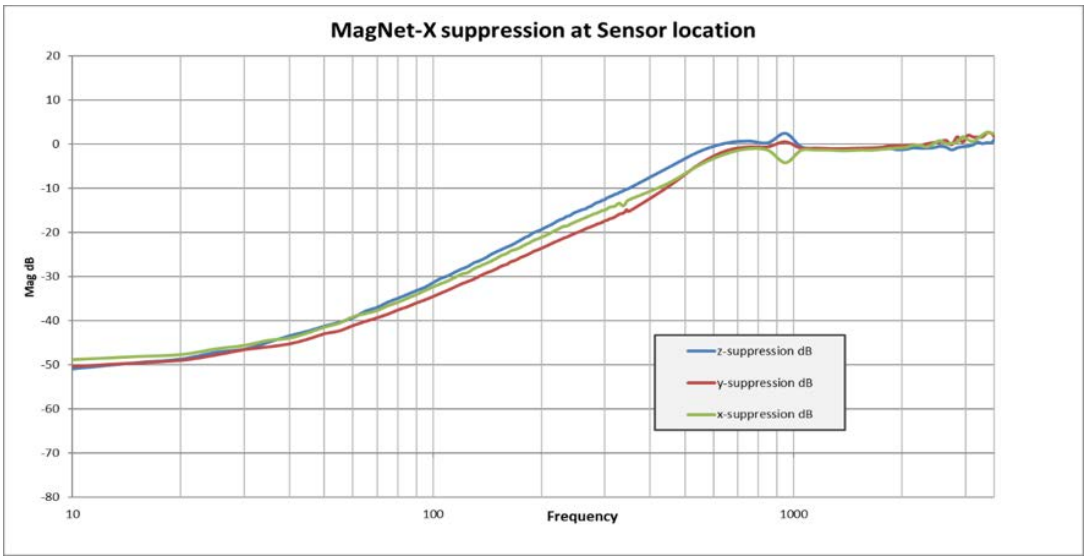


Figure 4: Actual measurements of magnetic field suppression at the sensor location (usually close to the microscope's stage)

TMC's technology and experience led to the advanced solutions needed to meet the demands of these high performing microscopes and cameras in challenging environments.

TMC's modular design approach allows us to combine standard components and design concepts in customized engineered solutions to fit the unique geometry of Cryo-EMs.

"Because of the pump and transmitter downstairs, the initial site survey for our facility didn't pass. So we purchased the STACIS and Mag-NetX from TMC to counteract the vibration and EMI issues. The microscopes work pretty well after the installation of these two items, and is very stable because of the cancellation of vibration and extra EMI".

Aguang Dai, PhD, Lab Manager at the Sauer Structural Biology Laboratory at the University of Texas at Austin

References:

[1] Breakthrough in Coronavirus Research Results in New Map to Support Vaccine Design", Feb 19, 2020,
[2] K3 Camera page on Gatan website
[3] Evolving criteria for research facilities: I – Vibration, Colin Gordon Associates, SPIE Conference 5933: Buildings for Nanoscale Research and Beyond, 2005