Suspension Tests for the Quartz Bar Shipping Crates

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This note presents test results of the air-spring suspension system installed on the transport crates for safe truck shipping of the quartz bars of the electron-ion collider's detection of internally reflected Cerenkov light (DIRC) detector.

Eight wooden crates will be used for the safe shipment of eight aluminum barboxes, each containing 48 quartz bars, from SLAC National Accelerator Facility to Jefferson Lab. An interior suspension system has been designed for each crate that has eight air-springs oriented vertically to cushion the bottom of the crate's interior basket, and four air-springs oriented horizontally for transverse damping, Fig. 1.

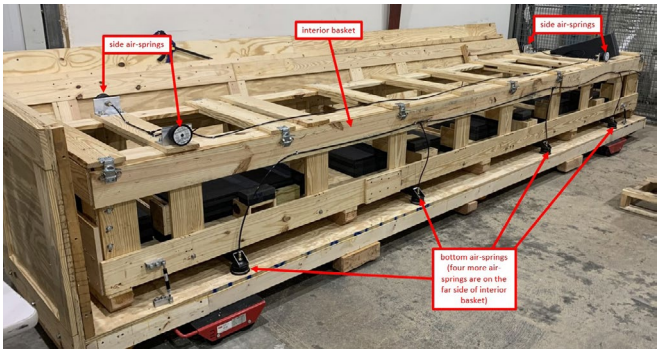

FIG. 1 Crate without mock-up barbox or accelerometers. The crate's exterior sides were removed to show the air-springs.

To determine the air pressure for the 12 air-springs that would keep the g-forces on the barboxes in the *x, y,* and *z* directions ≤ 1 g, tests on a mock-up barbox, whose structural dimensions and weight are identical to the actual barbox, were performed on the air-springs with ten USB accelerometers, which record the g-forces at their locations, Fig. 2.

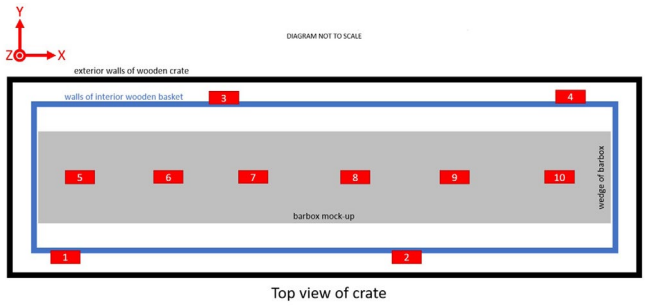

FIG. 2 Location of USB accelerometers for the test. The coordinate system is shown in the top left corner.

To begin the test, the air-springs were pressurized to 25 psi, data acquisition for the accelerometers was then started, the test crate was sealed, the crate was transported with a forklift from the lab and placed on a flatbed truck, and the truck was driven on the road.

Upon returning to the lab, the pressure in all air-springs was increased to 30 psi and the truck was driven the same circuit. Finally, the crate was removed from the flatbed truck, its lid removed, and the accelerometer data acquisition stopped. Table 1 is a timeline of events from the test day.

Approximate time	Event
11:45	DAQ started, setting pressure of bottom air springs to 25 psi
11:50	Installing interior basket cover
12:00	Installing exterior crate lid
12:15	Setting side air spring pressure to 25 psi
12:20	Staging crate to load on flatbed truck
13:00	Loading crate on flatbed truck with forklift
13:21	Truck turned on
13:23	Truck starts driving for first test run
13:40	Truck returns to JLab, set pressures of all air springs to 30 psi
13:45	Truck leaves for second test run
14:00	Truck returns to JLab
14:30	Removing crate from truck with forklift
14:50	Crate opened, DAQ stopped

Table I. Timeline of events.

Data from each accelerometer was plotted to view the g-forces experienced throughout the test. Figure 3 shows the plots generated for accelerometer #8. Analysis of the plots shows that the duration and magnitude of the g-forces experienced during loading were less than the g-forces experienced when the flatbed truck was started, as can be seen by the portions of data that are noisier from about 13:25–13:40 (shown by the vertical red lines) and from 13:45–14:00 (shown by the vertical blue lines).

While g-forces for the 25-psi and the 30-psi tests along the *x* and *y* axes were within ±1 g of the sensors' baseline reading, the g-forces along *z* were almost five times greater.

The tests show that the air-spring pressure of 25 psi damped the forces slightly better than the air-spring pressure of 30 psi—shown by the absolute minimum g-forces along the *z*-axis.

The tests will be repeated before the return trip from SLAC to Jefferson Lab with the actual crates on the transport trucks.

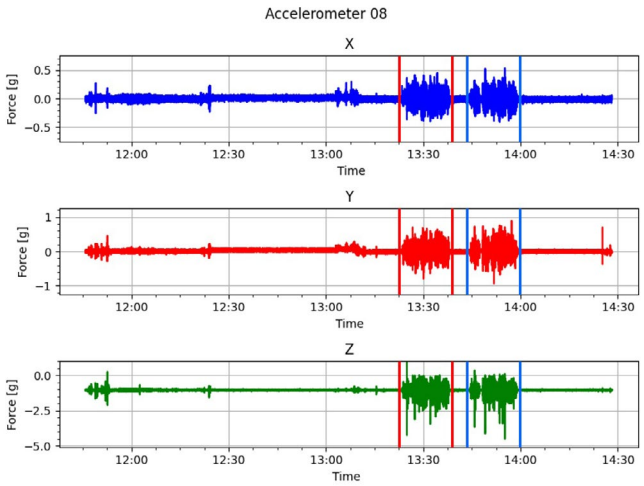

FIG. 3. The section from about 13:40—13:45, between the two noisy portions, is when the truck had returned to JLab and was turned off while the pressure in the air-springs was increased.

It is expected that the overall g-forces experienced by the accelerometers should be less since the shipping trucks have an air-ride suspension system that will help dampen the g-forces, whereas the flatbed truck has a standard leaf-spring style suspension.