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Rotary Valve FY 2016 Highlights

P. Fitsos

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Rotary Valve FY 2016 Highlights

The fiscal year started with the Rotary Valve (RV) being reassembled after having crashed in June of 2015. The crash occurred when the RV inner surface contacted the housing. The cause of the crash was never confirmed. No particles were found in the 2.5 thousandths of an inch gap and the filters the helium gas passed through were all clean. There were marks on the bearings that looked like electrostatic discharge as shown below in Figure 1. These marks hadn't been seen before and there were similar discharge marks on some of the ball bearings. Examples of this were found in a literature search of bearing failures. This leads to a possible cause due to this arcing affecting the rotational accuracy of the bearings driving the RV into the housing.

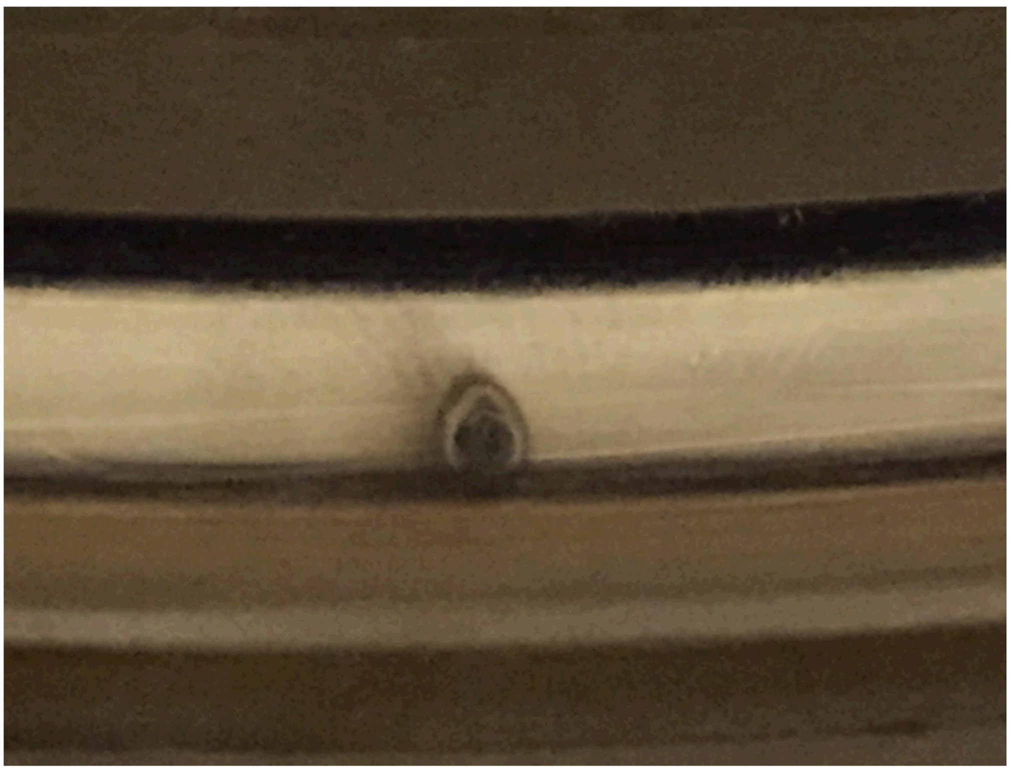

Figure 1: Arcing on the RV's support bearings.

We had another set of NSK bearings that were originally installed when the RV had four bearings. These had been removed when we went to a two-bearing setup. These bearings replaced those with the arcing. They were inspected, cleaned and greased before installation in the RV.

The rotor of the RV and the enclosure walls had been badly scored in the crash. The machining of these surfaces increased the radial gap from 2.5 to 4.3 thousandths of an inch.

The reassembled RV was installed in the Falcon Lab of building 192 instead of re-installing it in the north cave of B192. This improved the accessibility of the RV for testing and data acquisition work. It also avoided conflicts with the Mega Ray project that limited the access to the North Cave. However, an exhaust system and muffler had to be installed on the RV so that we could meet minimum noise standards for the outside yard where the gases exited the building.

During assembly at the machine shop the rotor of the electric motor was damaged when the machinist covered the magnets with tape to protect it during installation. Removing the tape removed a protective plastic layer that kept the magnets from flying off at high speed. A new magnet rotor was order and testing of the RV was kept to slow speeds until the new rotor was installed.

Initial test on the rebuilt RV where done at 100 rpm and rotor deflection as a function of input pressure was measured up to 36 psia using the eddy current sensors. These measurements showed that the RV was stiffer as compared to measurements done in April of 2015 (3.26 psi/um vs 1.7 psi/um). Perhaps this was due to the new bearings and the 30 thousandths preload.

The CFD model of the RV helium side was improved while we were waiting for the new rotor magnet. The beam port geometry was more accurately modeled as shown in Figure 2.

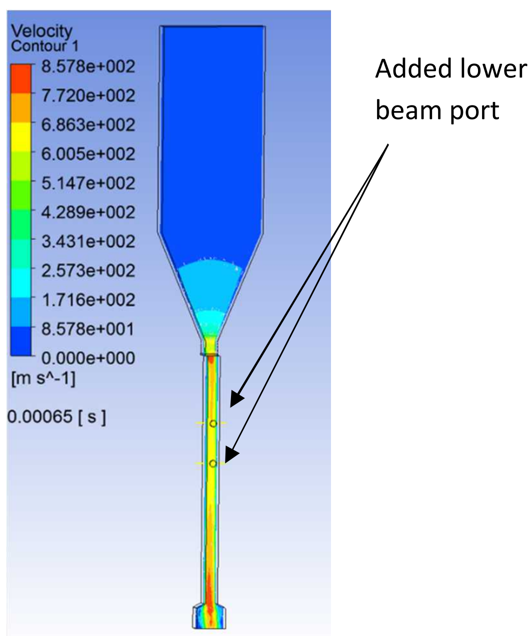

Figure 2: Revised CFD model with two beam ports

Simulations were done at 30, 40 and 50 psia. This revised simulation improved the correlation between measured and predicted as shown in Figure 3

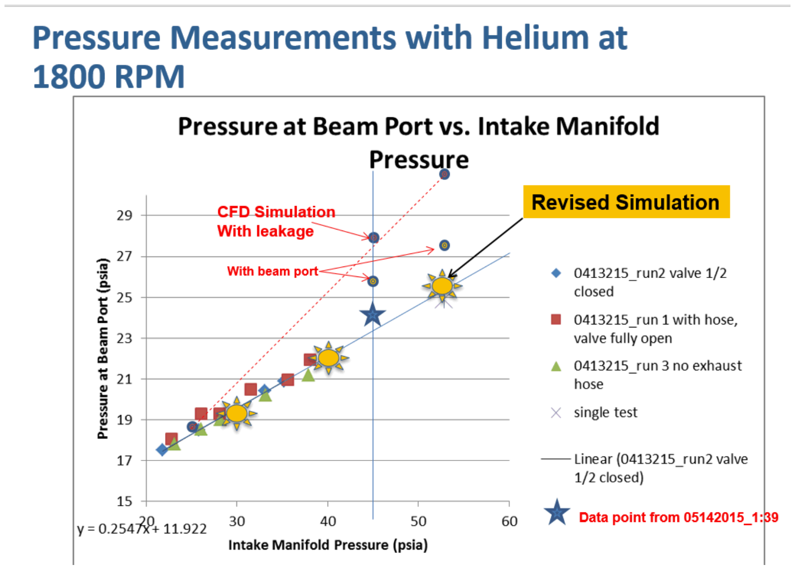

Figure 3: Pressure at the beam port vs. intake pressure. The revised simulation points fell on a line that correlates with experimental results.

The data acquisition system was improved with a new computer and additional DAC cards that increased the number of additional pressure sensors for the RV case and the beam tube. A total of 32 channels are available for future sensors e.g., vacuum gages. More channels could be added with additional DAC cards.

After the installation of the new rotor magnet, the RV was tested at 1800 rpm at low intake manifold pressures. The data point fell on the characteristic curve as shown in Figure 4.

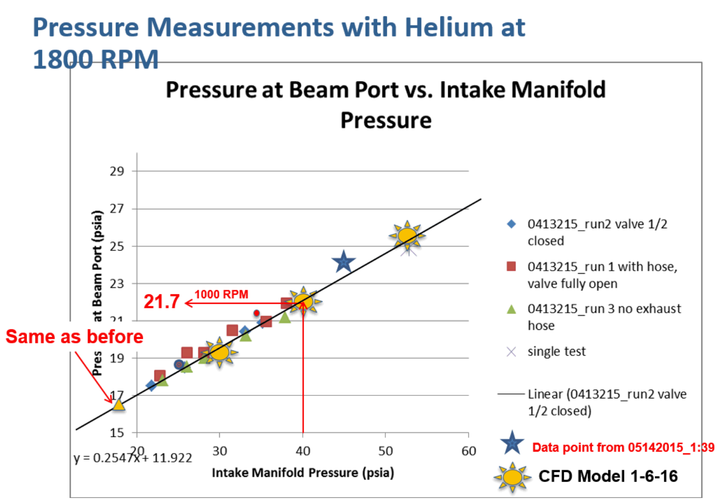

Figure 4: Beam port pressure vs. intake manifold pressure after reassembly of RV.

The RV beam tube was connected to a vacuum cell experiment for reducing the beam line pressure to a vacuum. The initial layout is shown conceptually in Figure 5. Two scroll pumps and a screw pump (not shown) were used to pump out the cells and the beam line.

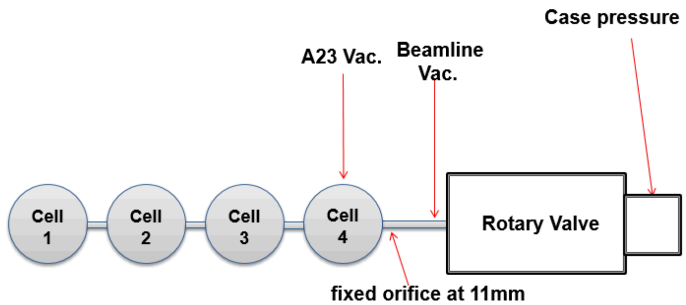

Figure 5: Conceptual layout of a vacuum cell experiment for reducing beam line pressure to a vacuum.

Experiments were made at 1800 rpm and at various intake manifold pressures to see how much of a vacuum could be pulled in the beamline. For example, Figure 6 shows an intake manifold pressure of nominally 50 psia and a corresponding beamline pressure that was reduced to a vacuum of about 130 Torr and cell 4 to 110 Torr.

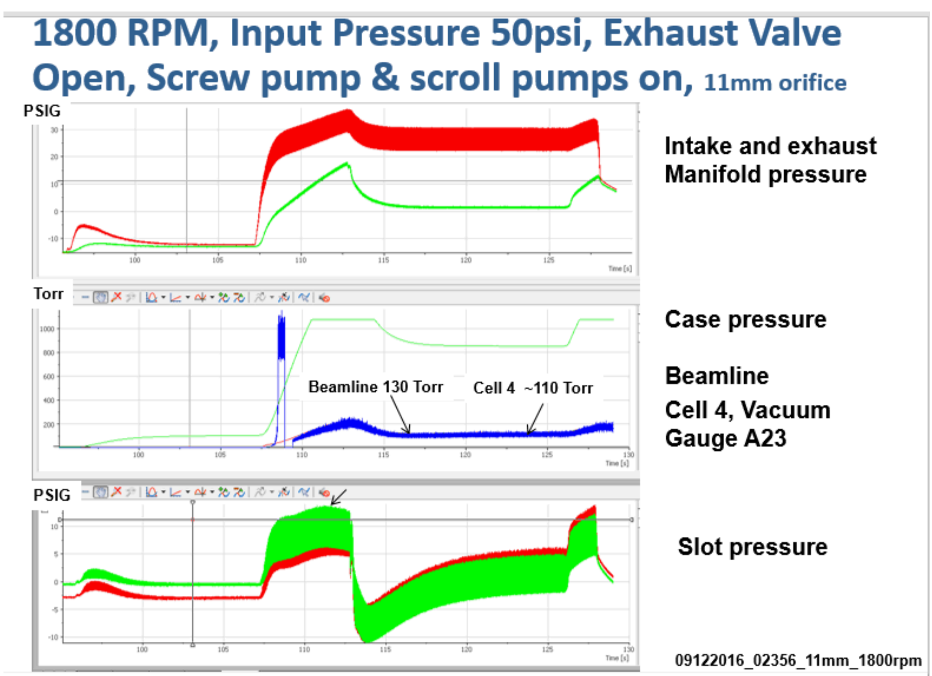

Figure 6: Pressure and vacuum plots of the RV at 1800 rpm.

Also, shown in Figure 6 is the RV case and slot or beam port pressure. As the beamline valve is opened at about 114 seconds, the case pressure drops, the vacuum gages in the beamline and cell 4 begin to record a vacuum. The slot pressure is reduced dramatically and then rises to about 5psi as shown on the bottom plot of Figure 6. These steady state values are shown in Figure 7 as "New data", over a range of intake manifold pressures.

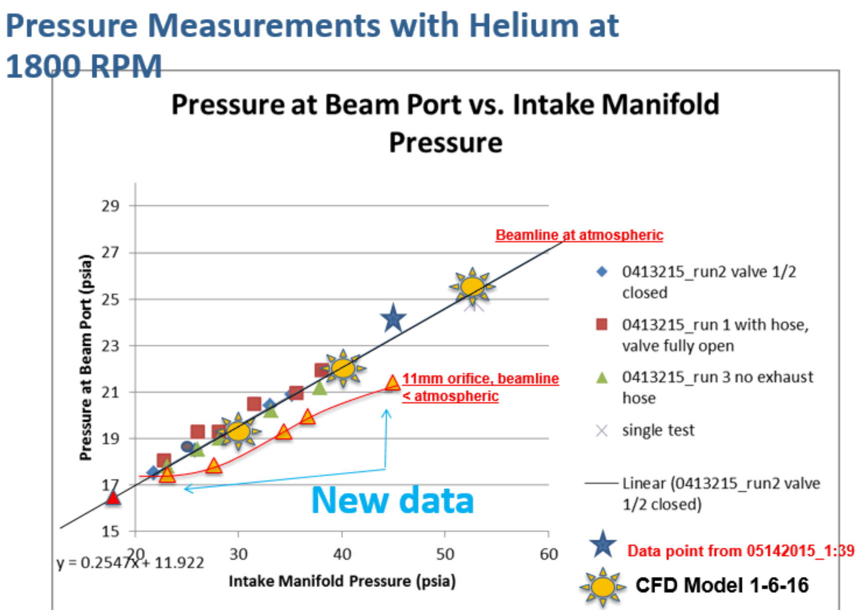

Figure 7: Familiar beam port vs. intake manifold plot but with new data from experiments attempting to create a vacuum in the beamline.

The rotor in the RV moves back and forth as first the intake manifold valve is opened, and then the beamline valve is opened and closed as shown in bottom plot of Figure 8.

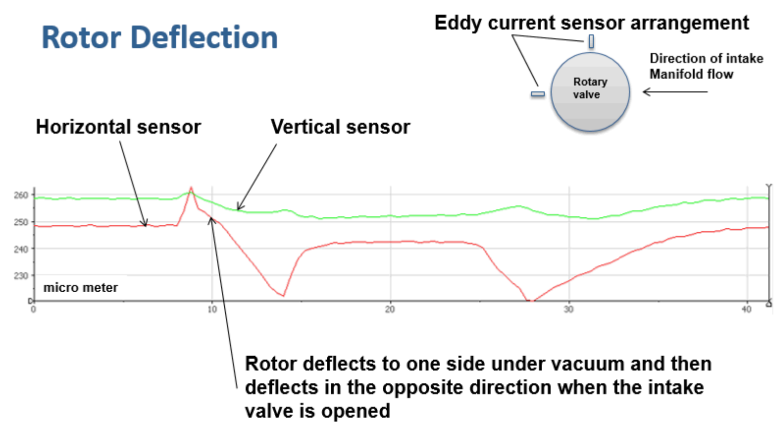

Figure 8: Rotor deflection at 40 psi when the beamline and intake valves are opened.

We plan to reduce the rotor motion by installing an insert on the argon side of the RV so that an opposing argon gas can help and steady the motion of the rotor as the helium intake valve is opened.   Figure 9 shows the insert that was designed and fabricated this fiscal year.

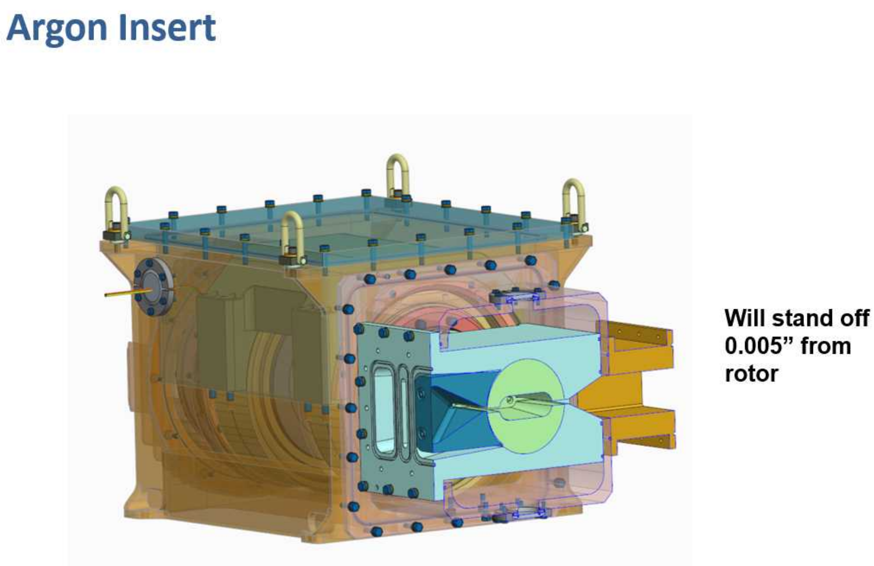

Figure 9: Argon insert.

Reducing the motion of the rotor will give us confidence in increasing the helium intake manifold pressures without driving the rotor into its enclosure. The higher intake pressures will most likely be needed to combat the reduction in beam port or slot pressure that come with trying to pull a vacuum in the beamline as is shown in Figure 7.