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Summary of ECD Results on the Quad Noise Prototype

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1 Introduction

This document summarizes the eddy current damping (ECD) results on the quad noise prototype reaction chain as of April 29, 2009.

The motivation for Sections 3 and 4 is two fold. First, the results from Section 2 showed that damping was on the order of 2 times greater than predicted for most degrees of freedom. Second, the clearance between the magnet and the wall of the copper holes was small enough to limit the ease of installing the copper blocks without causing interference. Thus, tests measuring the components of damping are shown in Section 3 and tests showing the reduction of damping by removing material from the copper blocks are in Section 4.

It is estimated that the copper blocks were all placed such that the magnet depth was consistent to less than $\pm 0.25mm$.

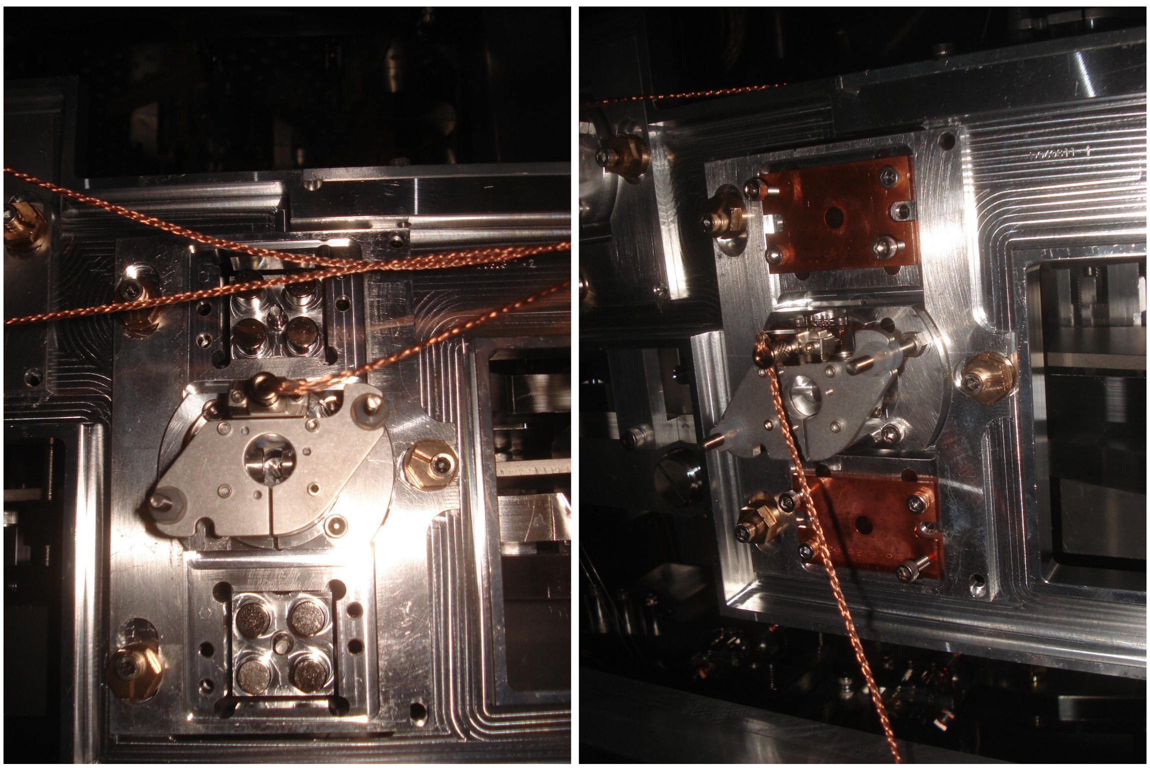

Figure 1: The picture on the left shows an OSEM with no ECD blocks. The damping magnets are visible on the top mass. The right shows an OSEM with ECD blocks around it. Each block sits on the tablecloth and has 4 holes which fit around the magnets.

2 ECD Nominal Results

This section shows the nominal measurements of eddy current damping on the reaction chain. Nominal in this case means that all the copper damping blocks are in place and have the original design dimensions reported in D060317, revision D.

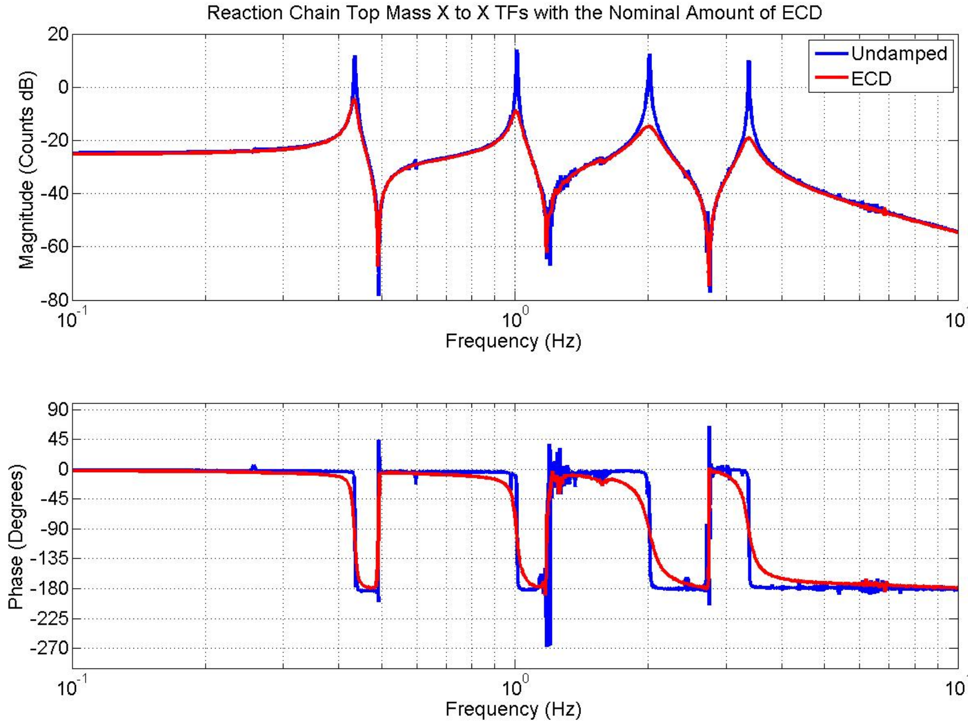

Figure 2: Reaction chain nominal ECD in the x direction. The blue curve is the undamped response, the red curve is the damped response.

3 Yaw transverse and longitudinal ECD

This section illustrates the amount of damping with differing configurations of the ECD blocks in order to independently observe the components of damping from longitudinal and transverse motion of the magnets in the blocks. Yaw was chosen for these measurements because this degree of freedom is the most uncoupled from all the others and was the most likely to provide 'pure' longitudinal and transverse motion of the magnets. Z could be used by the same argument, but it was guessed that the electrostatic drive and OSEM cabling would have less effect on yaw than z. Additionally z often shows some coupling to pitch (note: some pitch peaks can be seen on the blue curve of Figure 4).

Longitudinal motion refers to the magnets moving in and out of the holes in the copper blocks. Transverse motion refers to magnets moving side-to-side in the copper holes.

The motivation for this section is that the results from section 2 showed that damping was roughly two times greater than expected. Previous modeling of ECD only considered damping from longitudinal motion of the magnets. Thus it was suspected that transverse motion of the magnets may contribute significant damping as well.

Figure 8 shows that damping is roughly equal due to both the transverse and longitudinal motion of the magnets. It appears that transverse damping may even be slightly greater. This could explain the mysterious factor of 2 observed before.

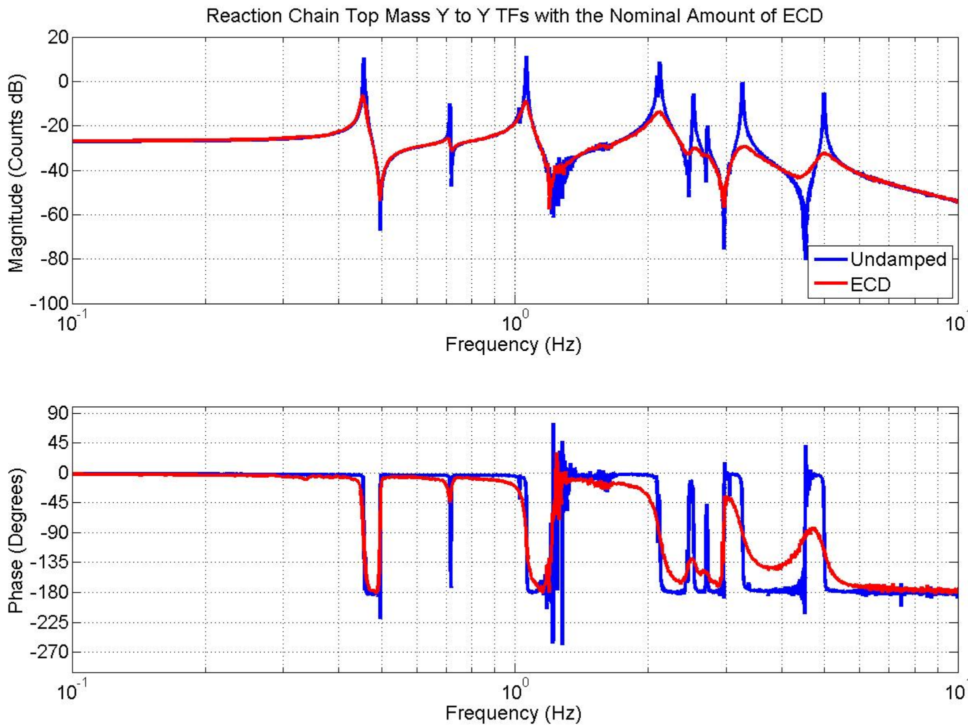

Figure 3: Reaction chain nominal ECD in the y direction. The blue curve is the undamped response, the red curve is the damped response.

4 Increasing the Diameter of the Copper Block Hole

To reduce the amount of damping and simultaneously increase the clearance around the magnets, the holes of in the copper blocks were milled out from 12 mm to 12.7 mm (0.5 inches). 12.7 mm was chosen because it was the most relevant mill size immediately available in the LASTI machine shop.

Longitudinal and transverse yaw ECD damping results are shown in Figures 9 and 10. A test of the full combined damping with the new hole diameter was not done because new copper blocks were drilled out for this test and three out of eight of them turned out to be on the high end of their tolerance in length and width and consequently were too tight to fit onto the reaction chain. The results obtained nonetheless provide a lot of insight.

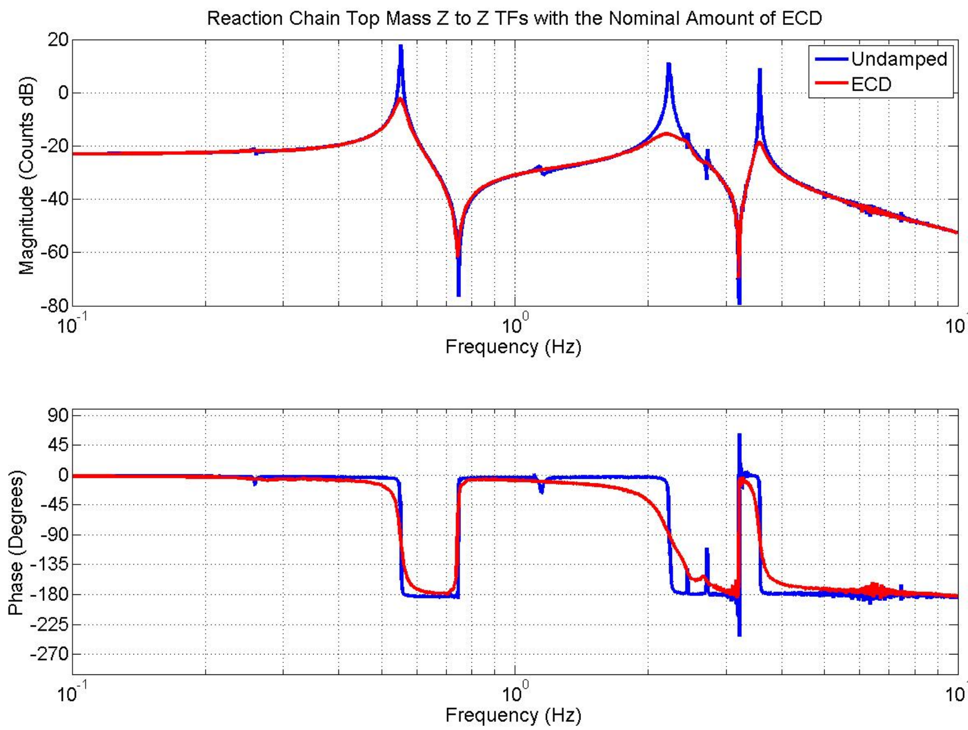

Figure 4: Reaction chain nominal ECD in the Z direction. The blue curve is the undamped response, the red curve is the damped response.

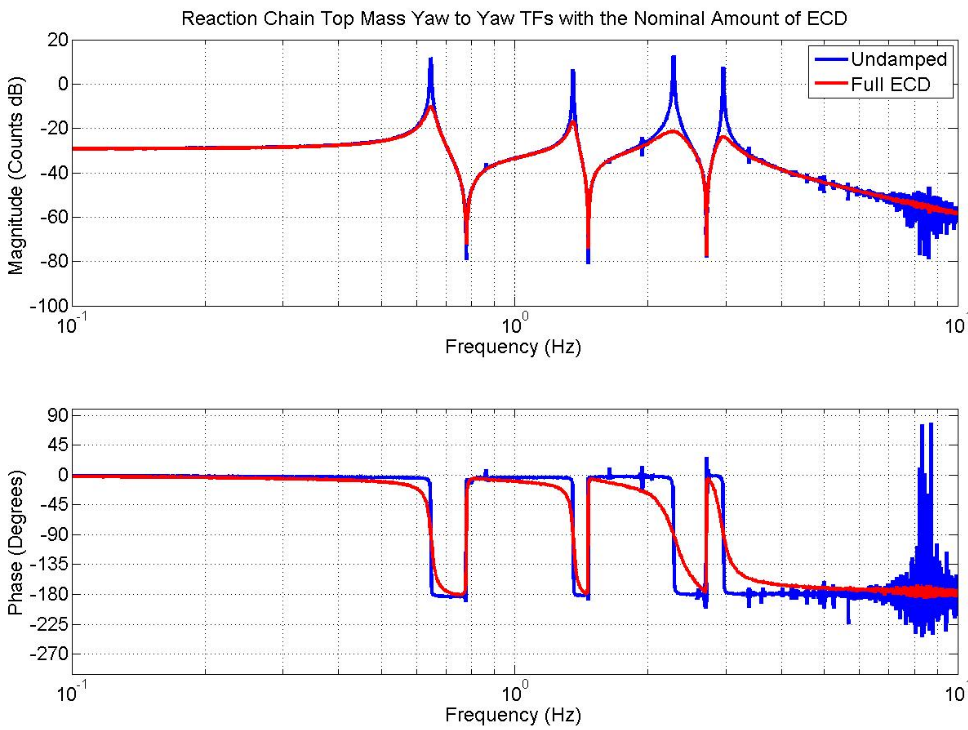

Figure 5: Reaction chain nominal ECD in the yaw direction. The blue curve is the undamped response, the red curve is the damped response.

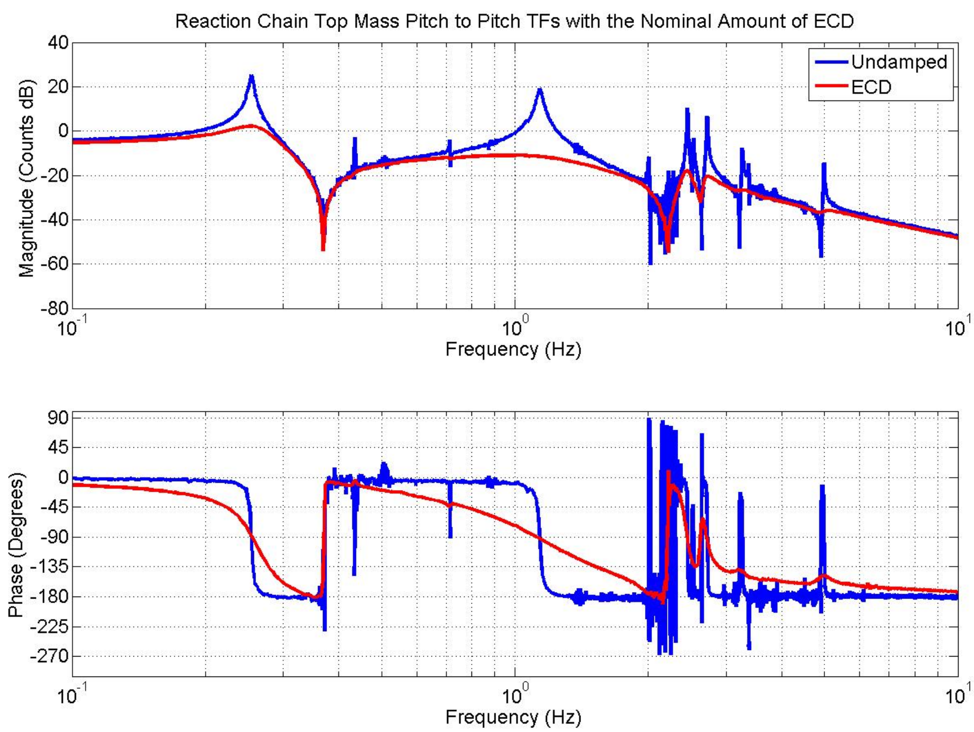

Figure 6: Reaction chain nominal ECD in the pitch direction. The blue curve is the undamped response, the red curve is the damped response.

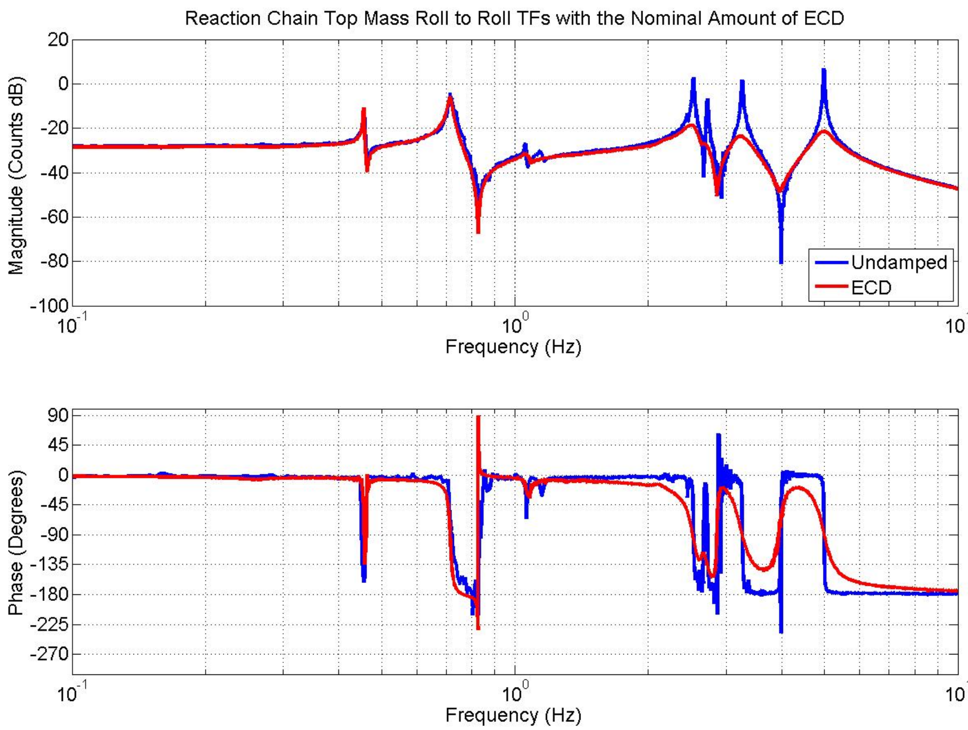

Figure 7: Reaction chain nominal ECD in the roll direction. The blue curve is the undamped response, the red curve is the damped response.

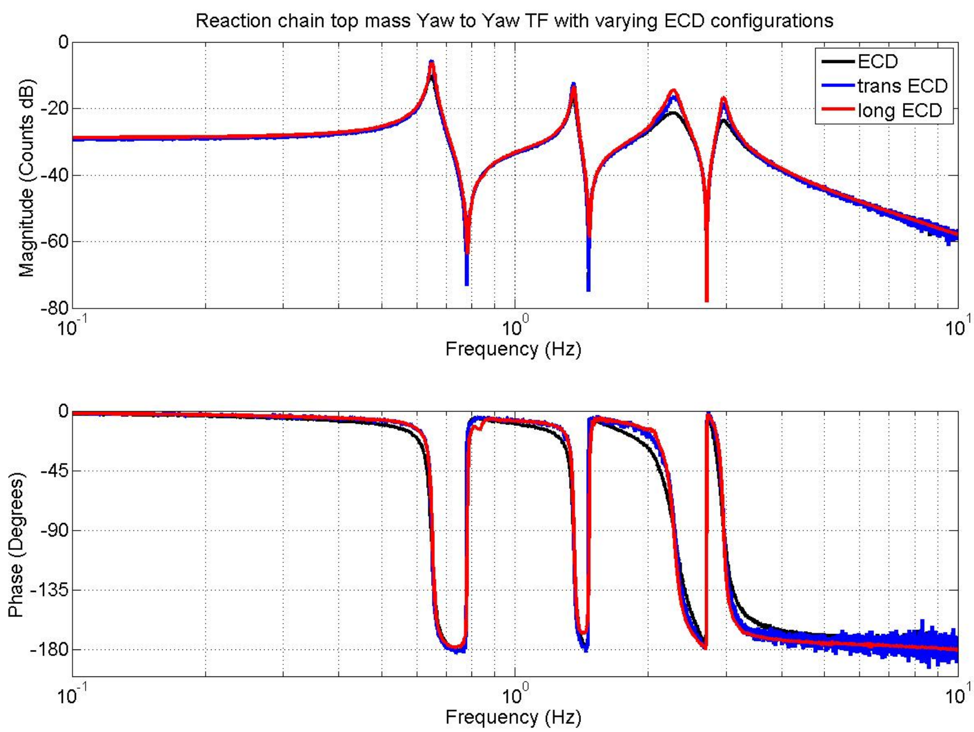

Figure 8: Reaction chain damping in yaw direction with varying ECD configurations. The black curve is the previous full ECD response, the blue curve is transverse ECD response, and the red curve is the longitudinal ECD response.

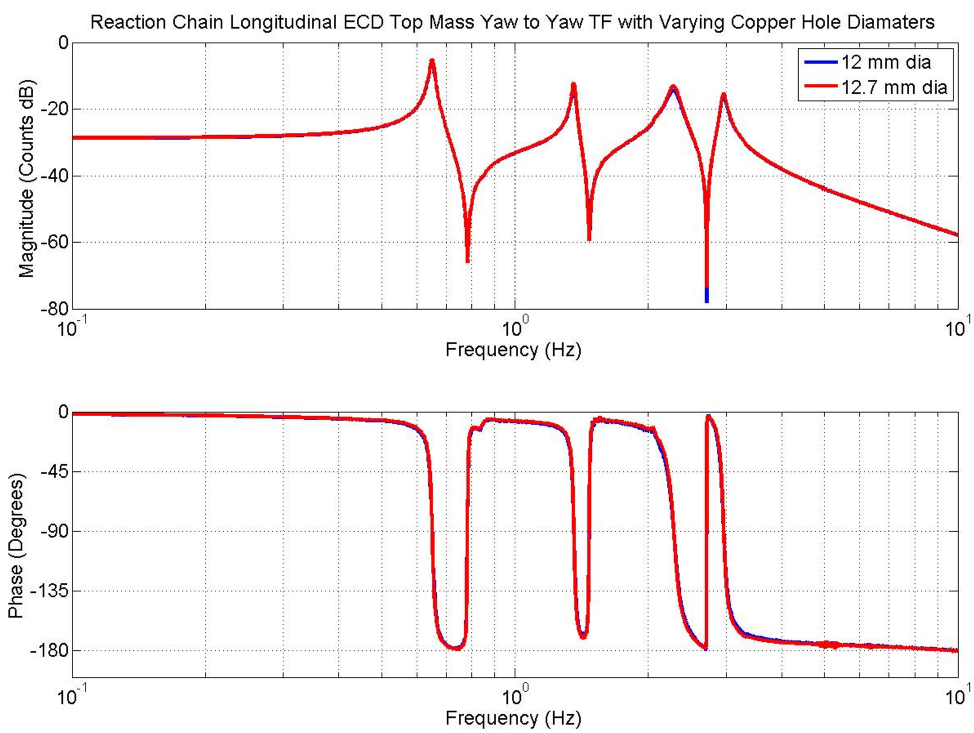

Figure 9: Reaction chain longitudinal ECD in yaw direction. The blue curve is the previous full longitudinal ECD response with 12 mm diameter holes. The red curve is a repeat of this measurement with 12.7 mm diameter holes.

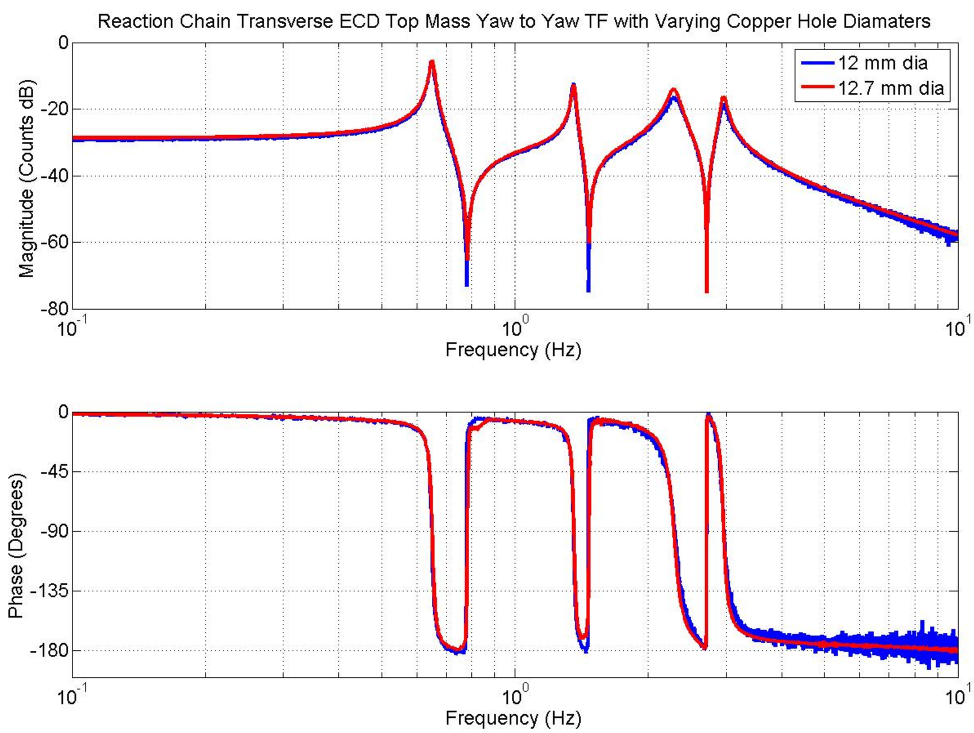

Figure 10: Reaction chain transverse ECD in yaw direction. The blue curve is the previous full transverse ECD response with 12 mm diameter holes. The red curve is a repeat of this measurement with 12.7 mm diameter holes.