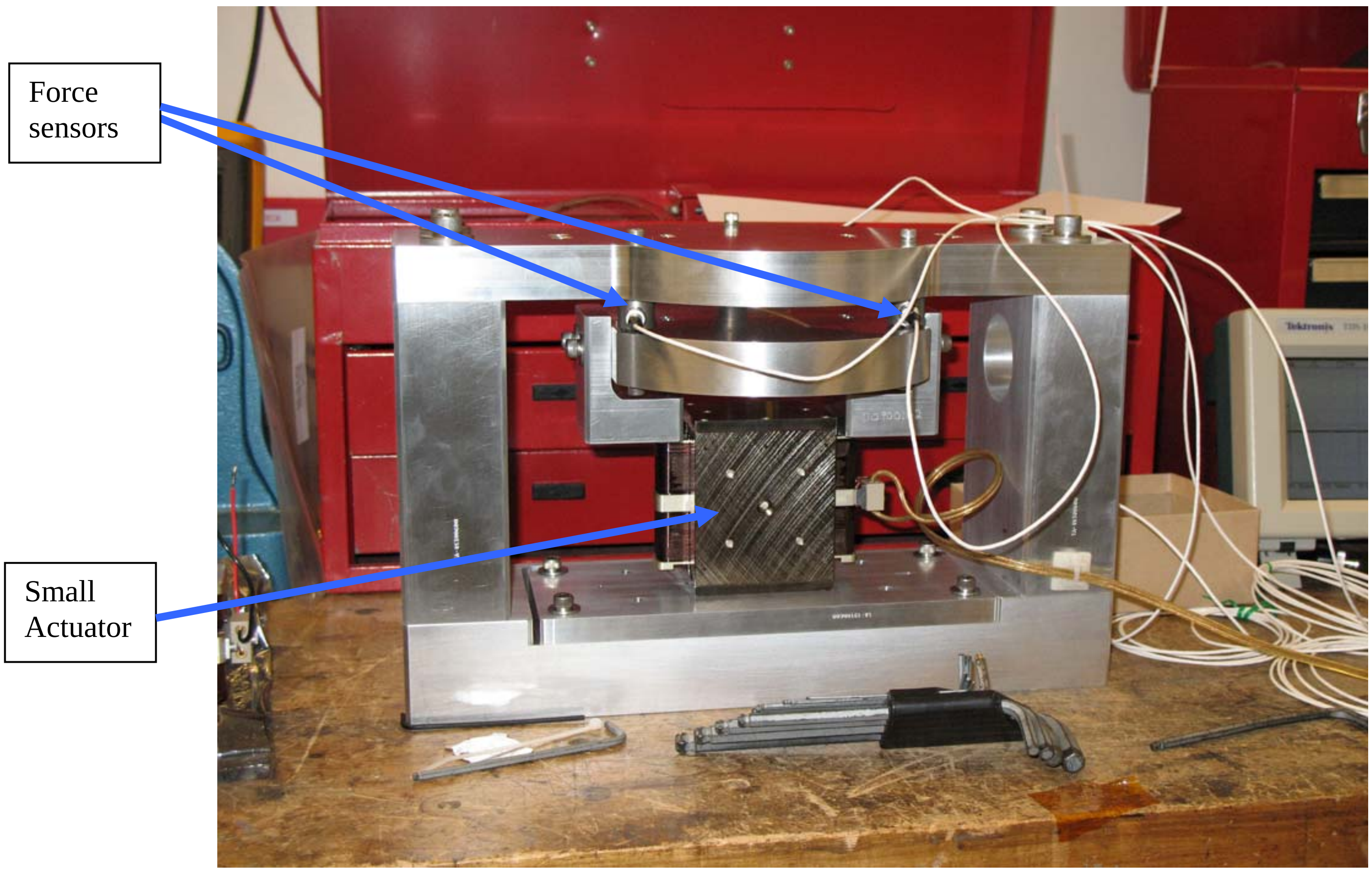
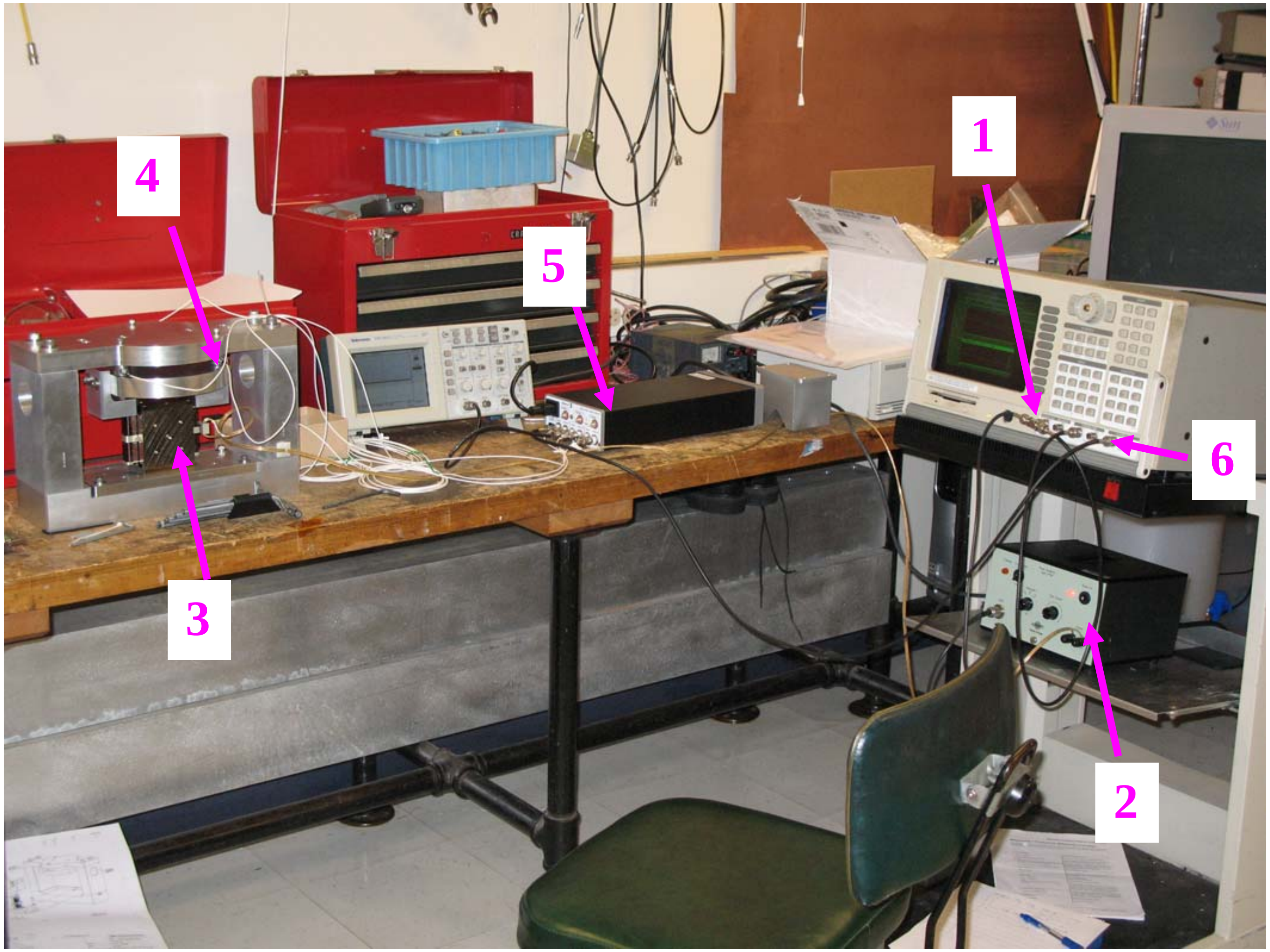
0. Set up Description

The actuator JIG has been designed to identify the actuators transfer functions. Both the small and large actuators can be tested. The picture below shows the Jig in the small actuators configuration. The coil pushes on three force sensors mounted in parallel. Those sensors are models Dytran 1053V1, 500mV/Lb, +-10 pds.

The sensors and electronics have been chosen to perform dynamics measurements.



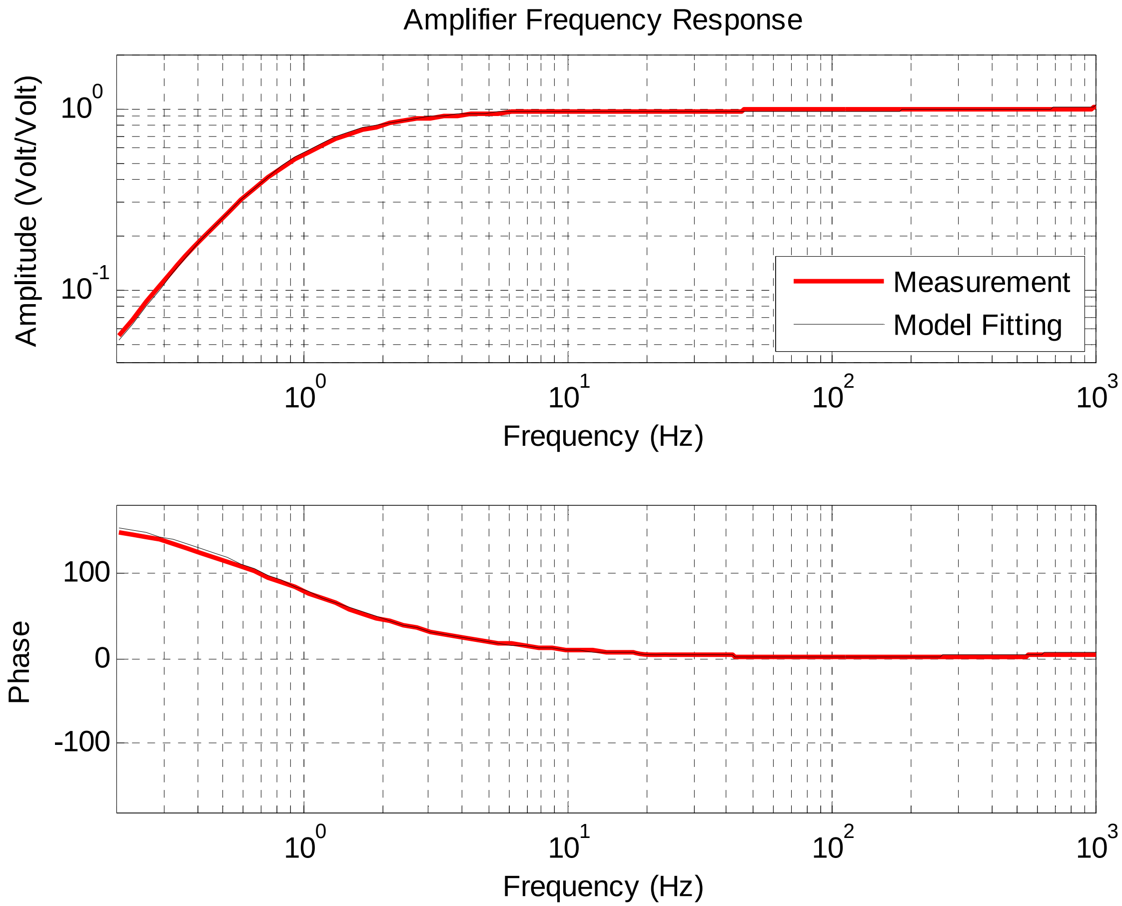
The Stanford Analysis source signal (1) is amplified by the power amplifier Bruel&Kjaer Type 2700 (2). The amplifier drives the actuator (3). The force is measured by the force sensors Dytran 1053V1 (4). The signal is amplified by the conditioner Endvco Model 133 (5). Signal is analyzed by the Stanford analyzer (6).



First step was to identify the power amplifier transfer function. Results and model are shown next page.

1. Amplifier Identification

It's a power amplifier Bruel&Kjaer Type 2700. The measured transfer function is shown below. It's fitted with a second order high pass model having two poles at 0.84Hz. The amplifier transfer function will be subtracted from all measurements shown next in this report.

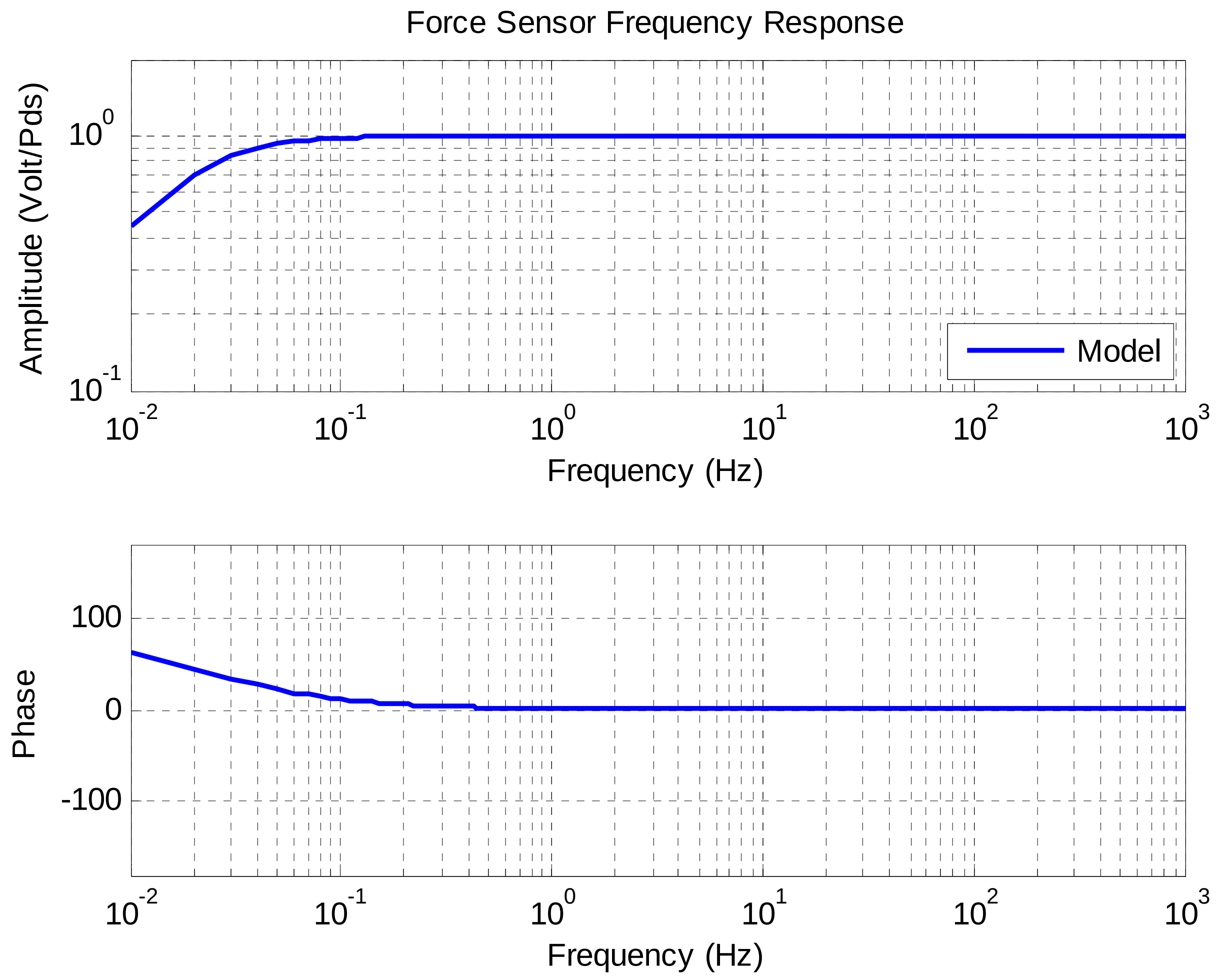


Amplifier Model:

```
p1=0.84;
Ampli=zpk(-2*pi*[0 0 1800],-2*pi*[p1 p1 2500],1.35);
```

2. Force sensor

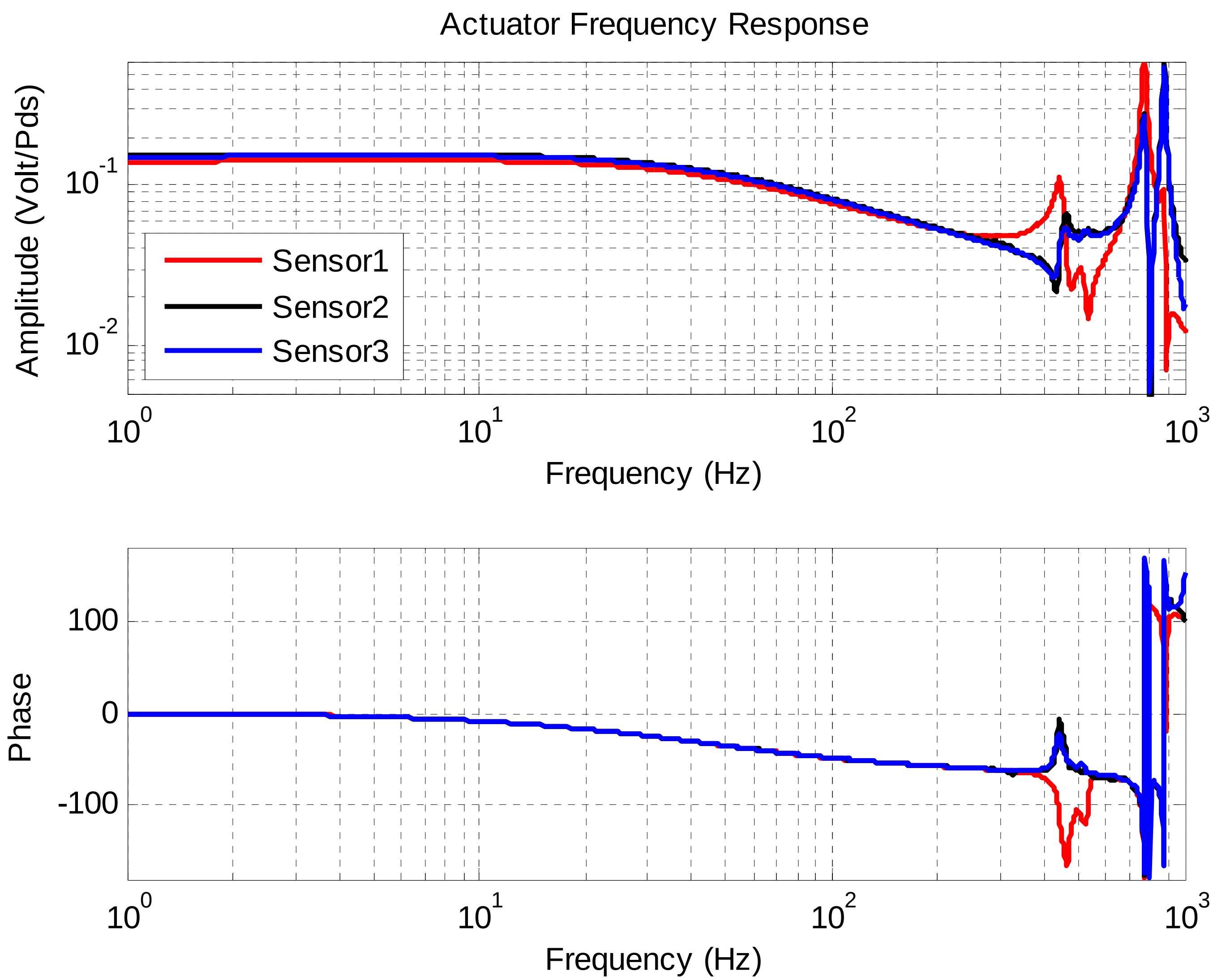
The force sensors are models Dytran 1053V1. Their data sheet gives a time constant of 50s. We assume it behaves like a first order high pass with a pole at 20mHz like shown on the plot below. The sensor transfer function will be subtracted from all measurements shown next in this report.




```
p1=0.02;
Sensor=zpk(-2*pi*[0],-2*pi*[p1],1);
```

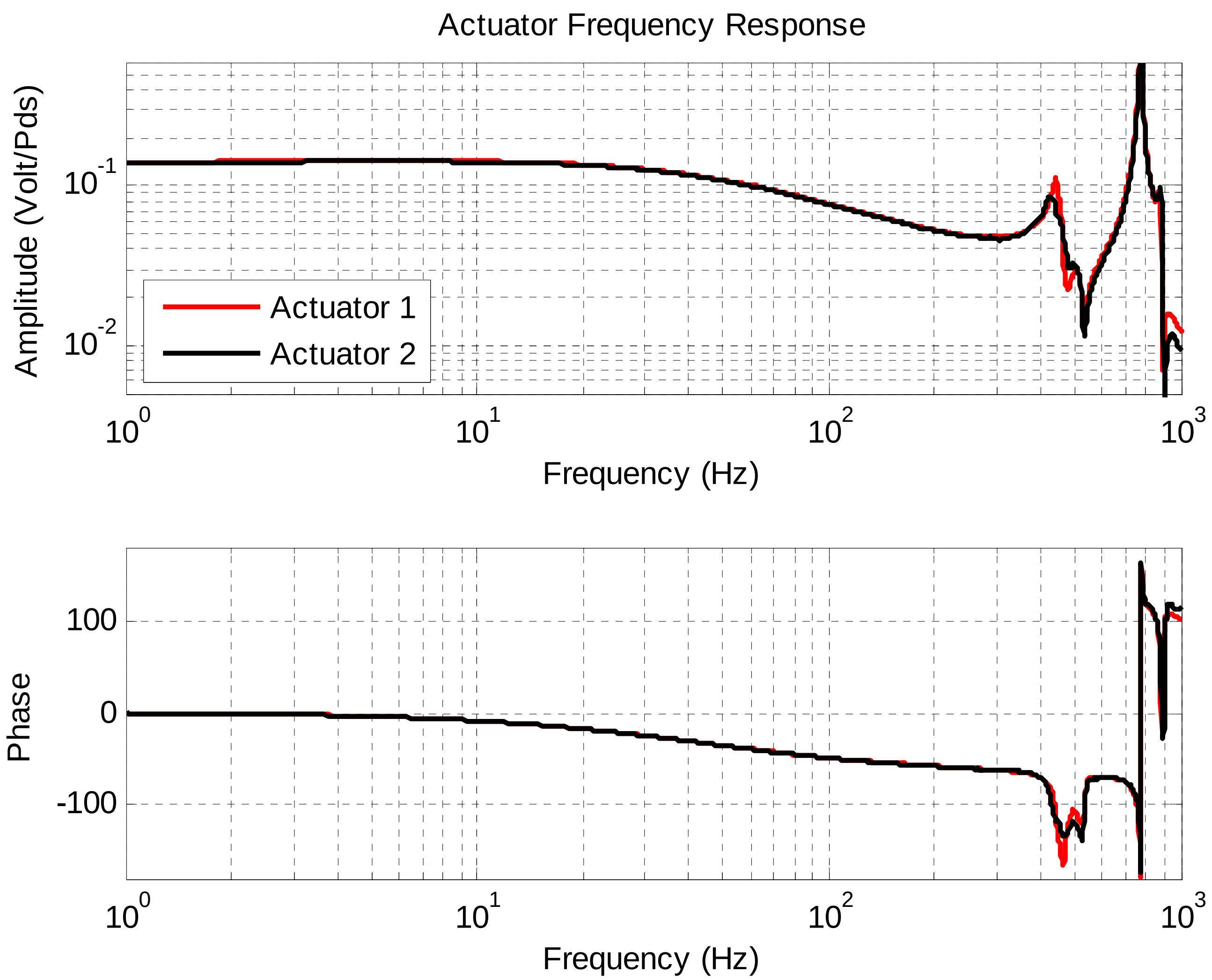
3. Small Actuator Frequency response – Sensors comparison

To insure a good iso-static connection, the Jig uses three sensors in parallel. The plot below shows that for a given input, all three sensors have very similar results up to 300Hz. Above 300Hz, the transfer functions are dominated by the Jig resonances.



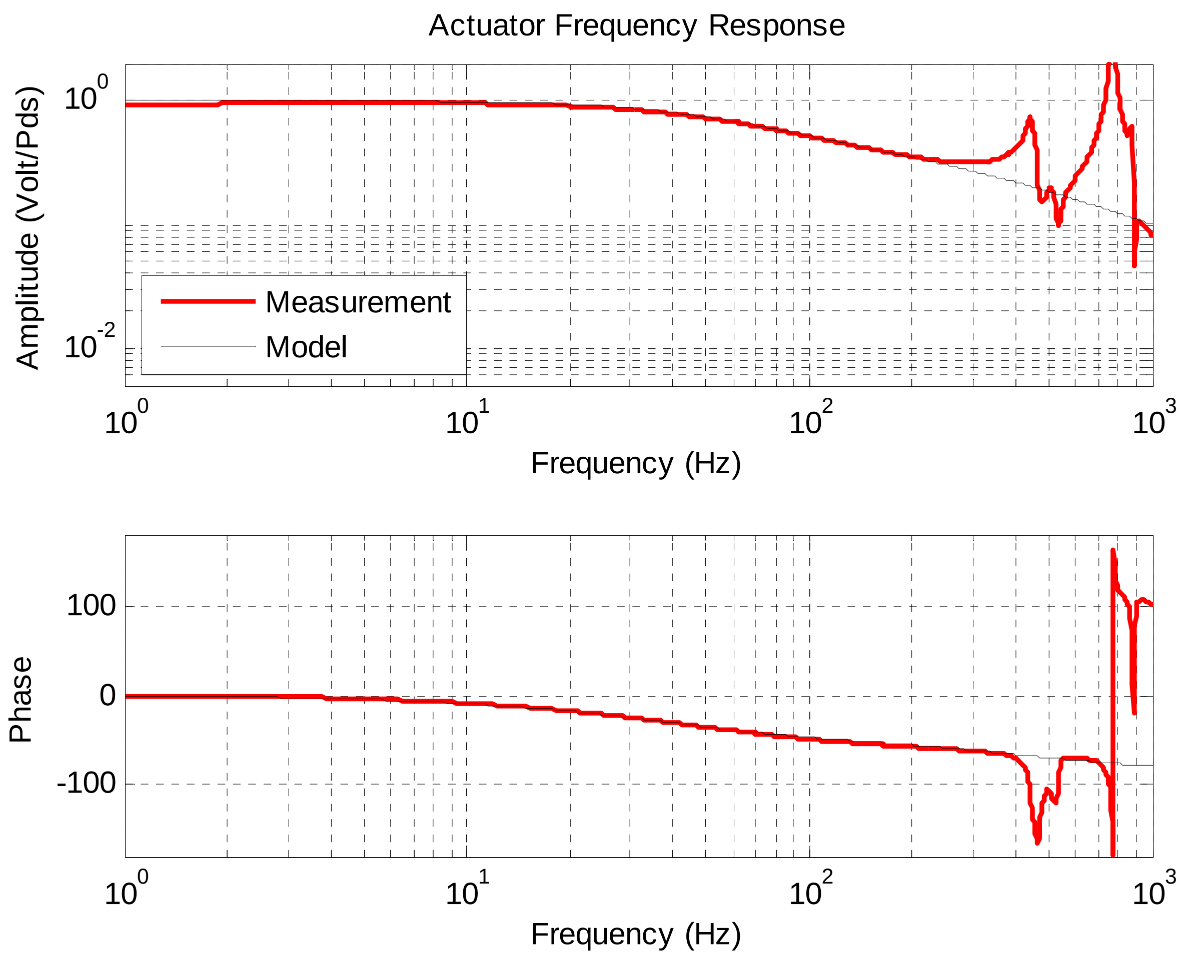
4. Small Actuator Frequency response – Actuators comparison

The responses of two different actuators are compared on the plot below. The actuators transfer functions are quasi-identical. Next actuators purchased will be tested to check the consistency from one set to another.



5. Small Actuator Frequency response – Model fitting

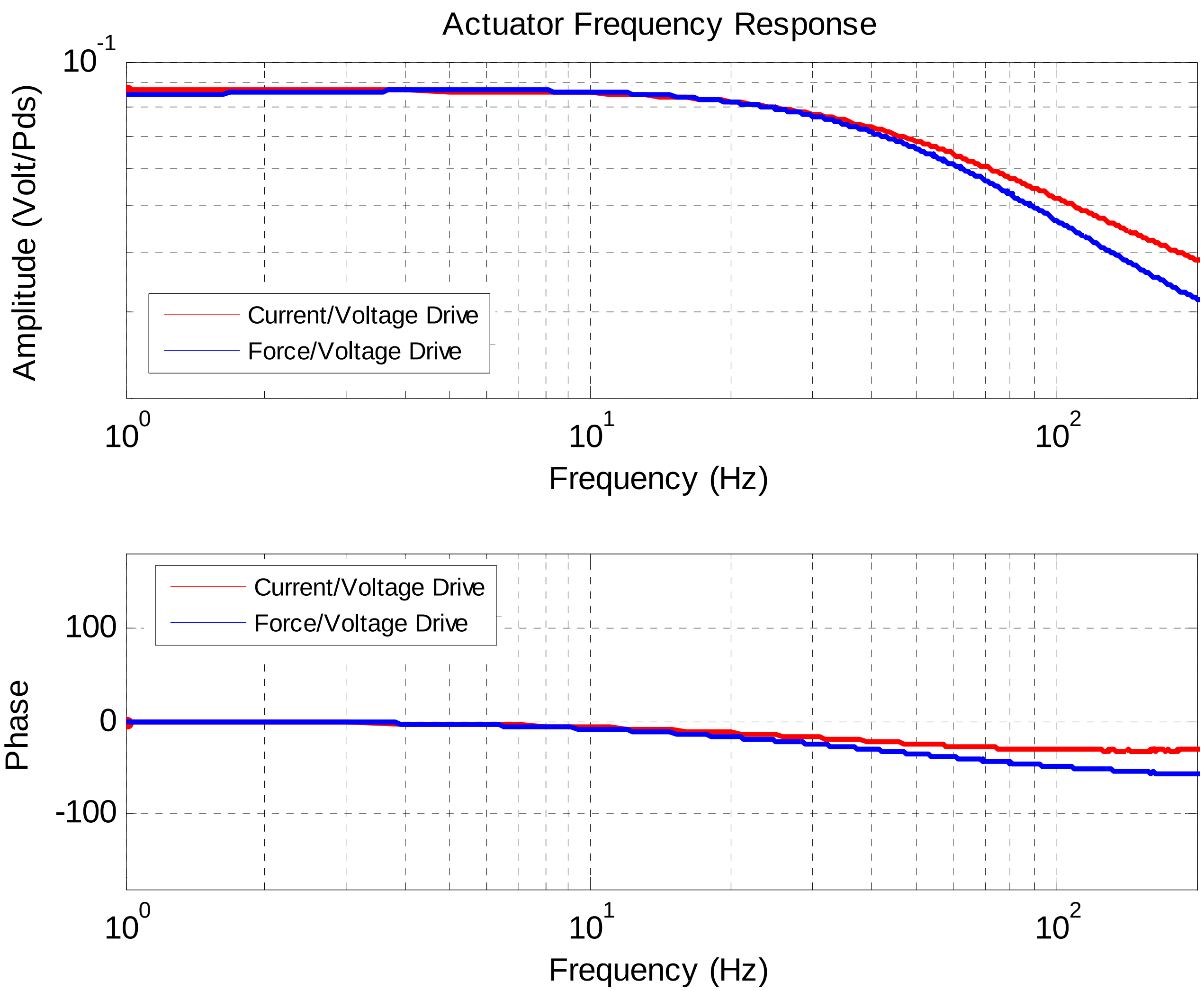
On the plot below, a model of the actuator transfer functions is proposed and compared to the measurement. The small actuators have a first pole at 50Hz. The phase is -25deg at 30Hz.




```
p1=50; p2=290;
z1=140;
Act=zpk(-2*pi*[z1],-2*pi*[p1 p2],2*pi*p1*p2/z1);
```

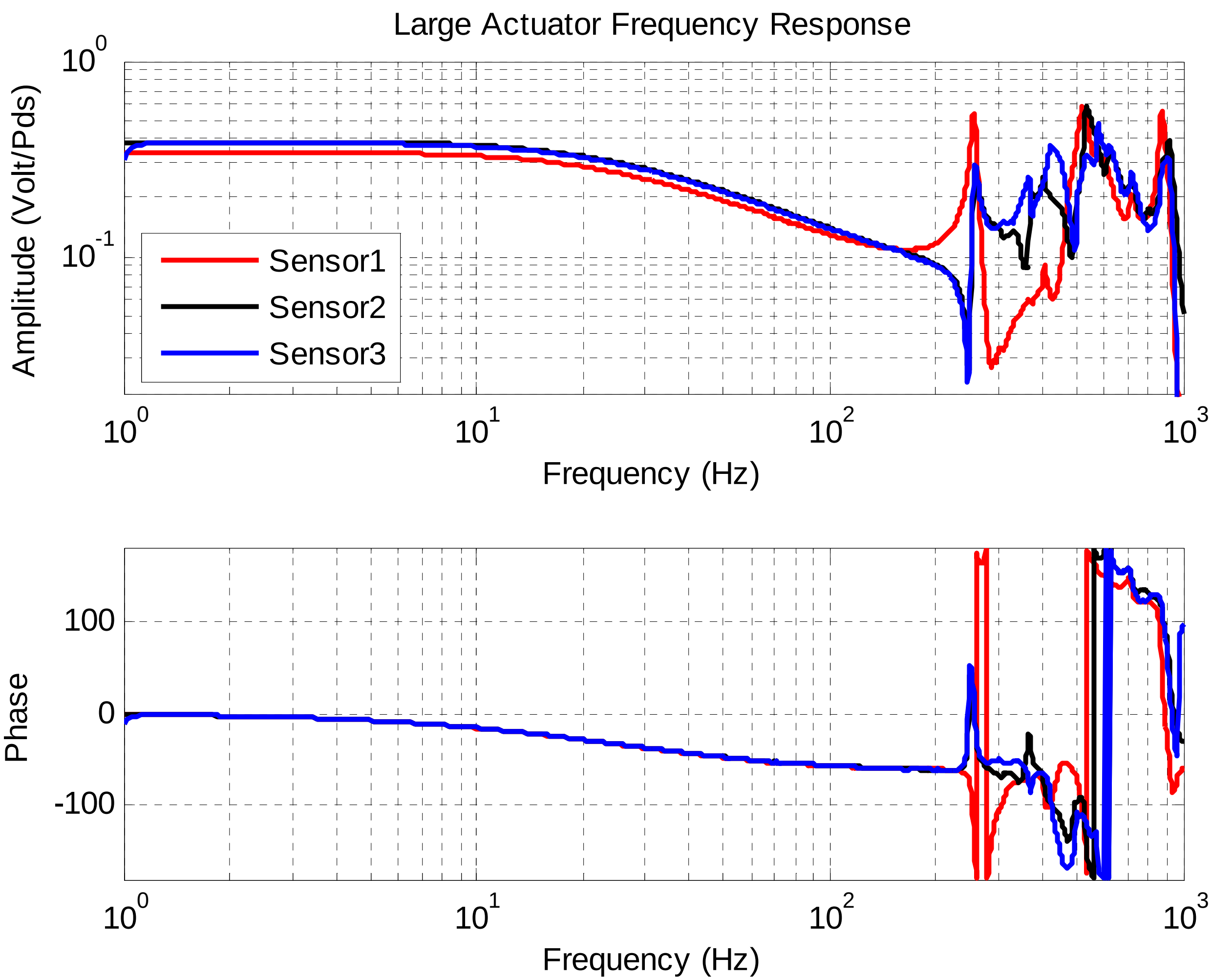
6. Small Actuator: Current over Force comparison

The plot bellows compare the “Current/Voltage drive” in the coil and the “Force/Voltage drive”. It shows that the Force/Current relationship is frequency dependent.



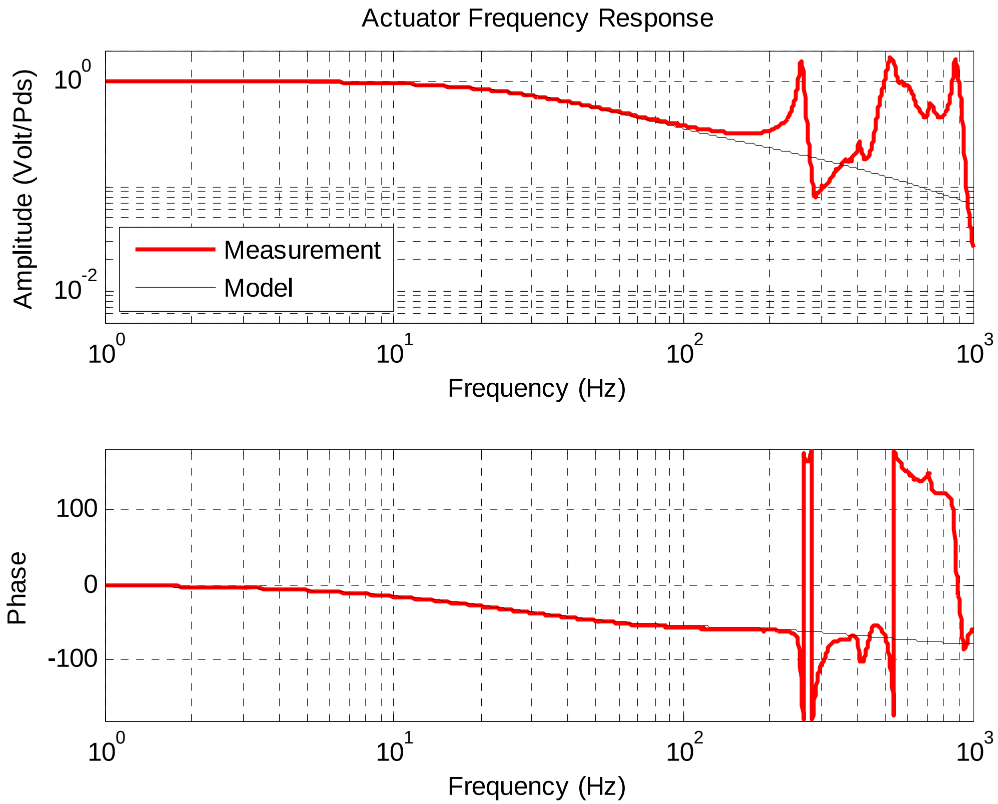
7. Large Actuator Frequency response – Sensors comparison

Like for the small actuators, the three sensors gives similar responses when the large actuator is driven.



8. Large Actuator Frequency response – Model Fitting

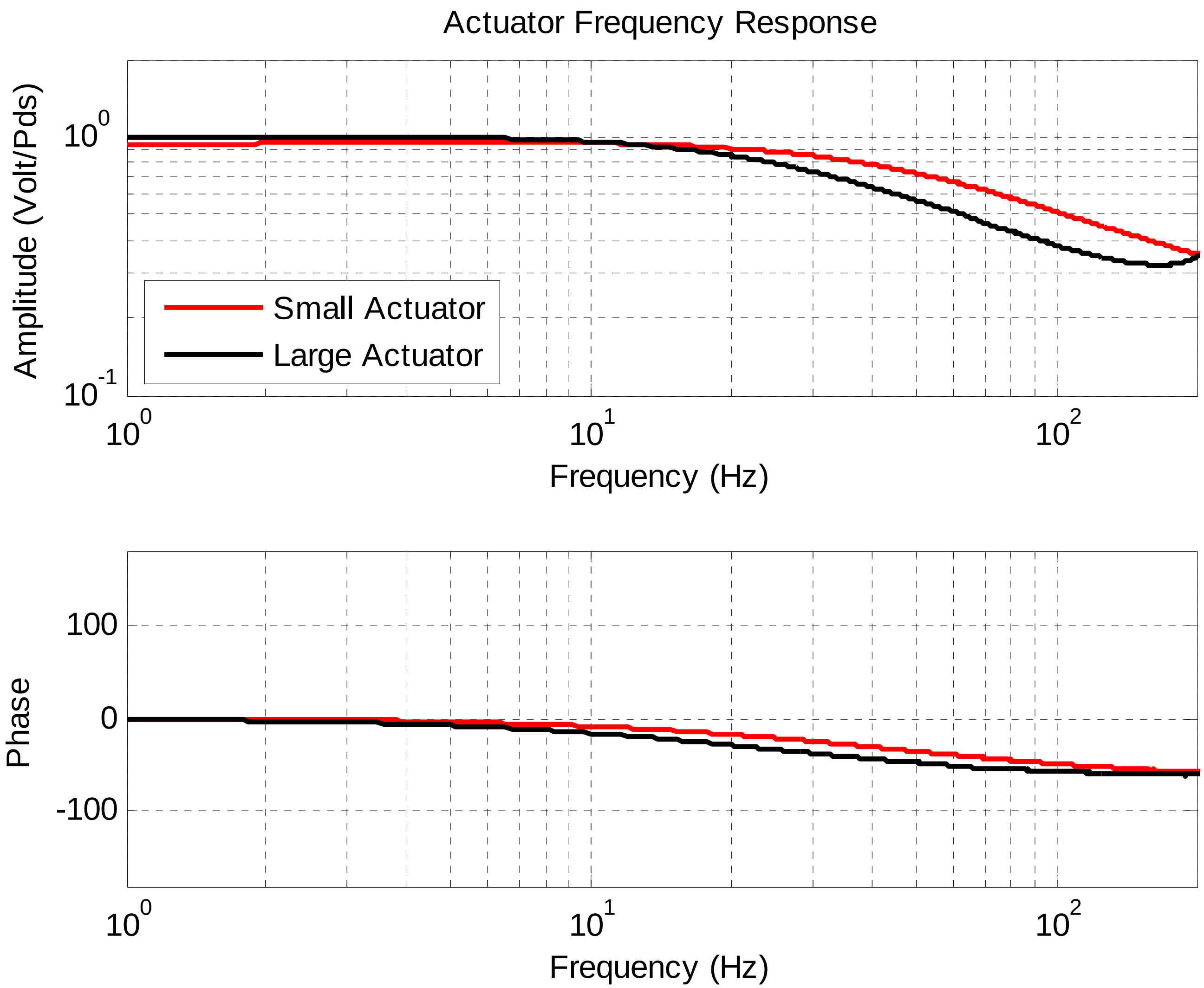
The large actuator response is fitted with a model having a first pole at 32Hz. The phase is -37deg at 30Hz.




```
p1=32; p2=300;
z1=136;
Act=zpk(-2*pi*[z1],-2*pi*[p1 p2],2*pi*p1*p2/z1);
```

9. Small/Large Actuator Comparison

The plot bellows compares the small and large actuators transfer functions.



Conclusion

- The actuators transfer functions have been identified. They confirm the "Current/Drive" measurements who show that the actuators have low frequencies poles and zeros.

- The large actuators have a first pole at 32Hz. The small ones have a first pole at 50Hz.

- Compensation filters will be implemented on the output of the front end. The purpose is to account accurately for those poles and zeros. This will make the ISI transfer function much closer of an ideal 1/f^2, -180deg around the unit gain frequency, which is a systematic way to simplify the amount of control design work to be done.