Tuner simulation, assembly and test for the single cavity module

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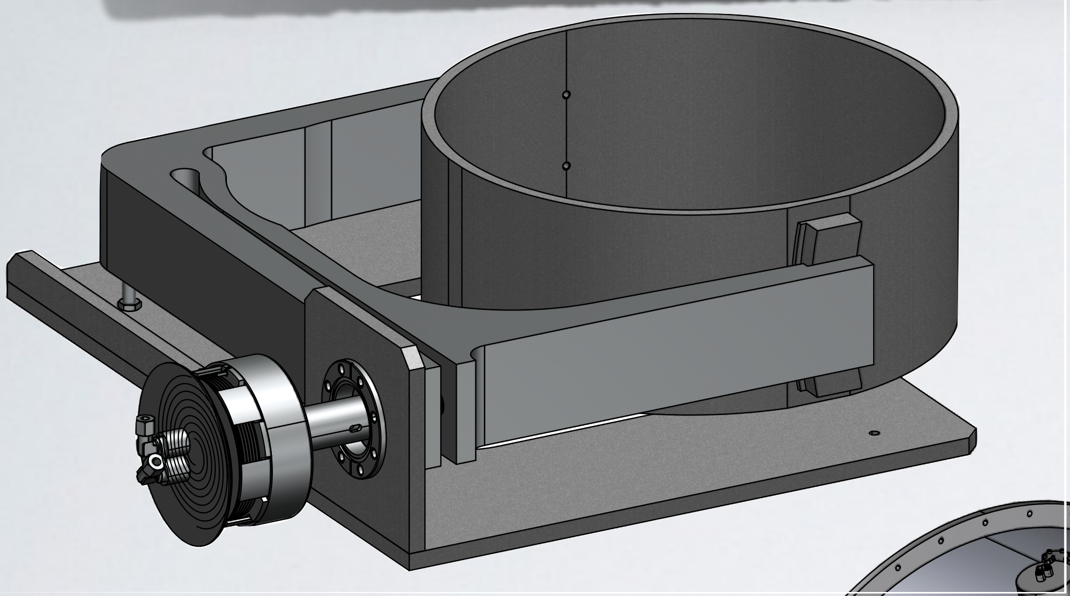
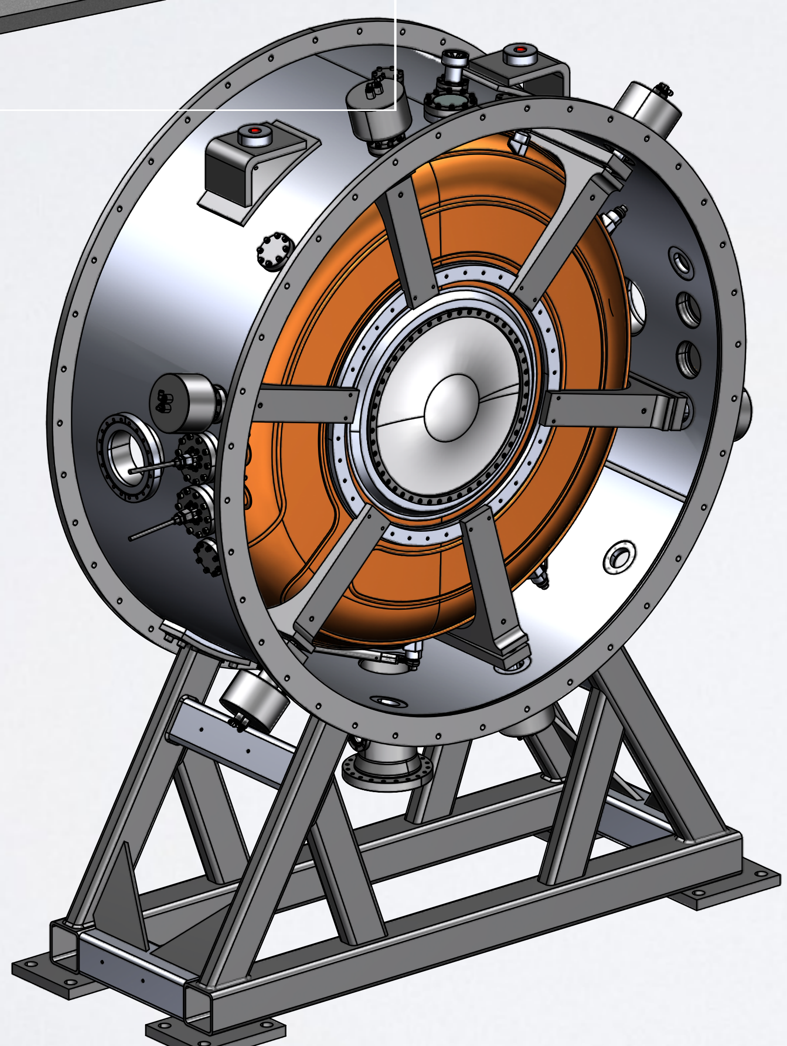
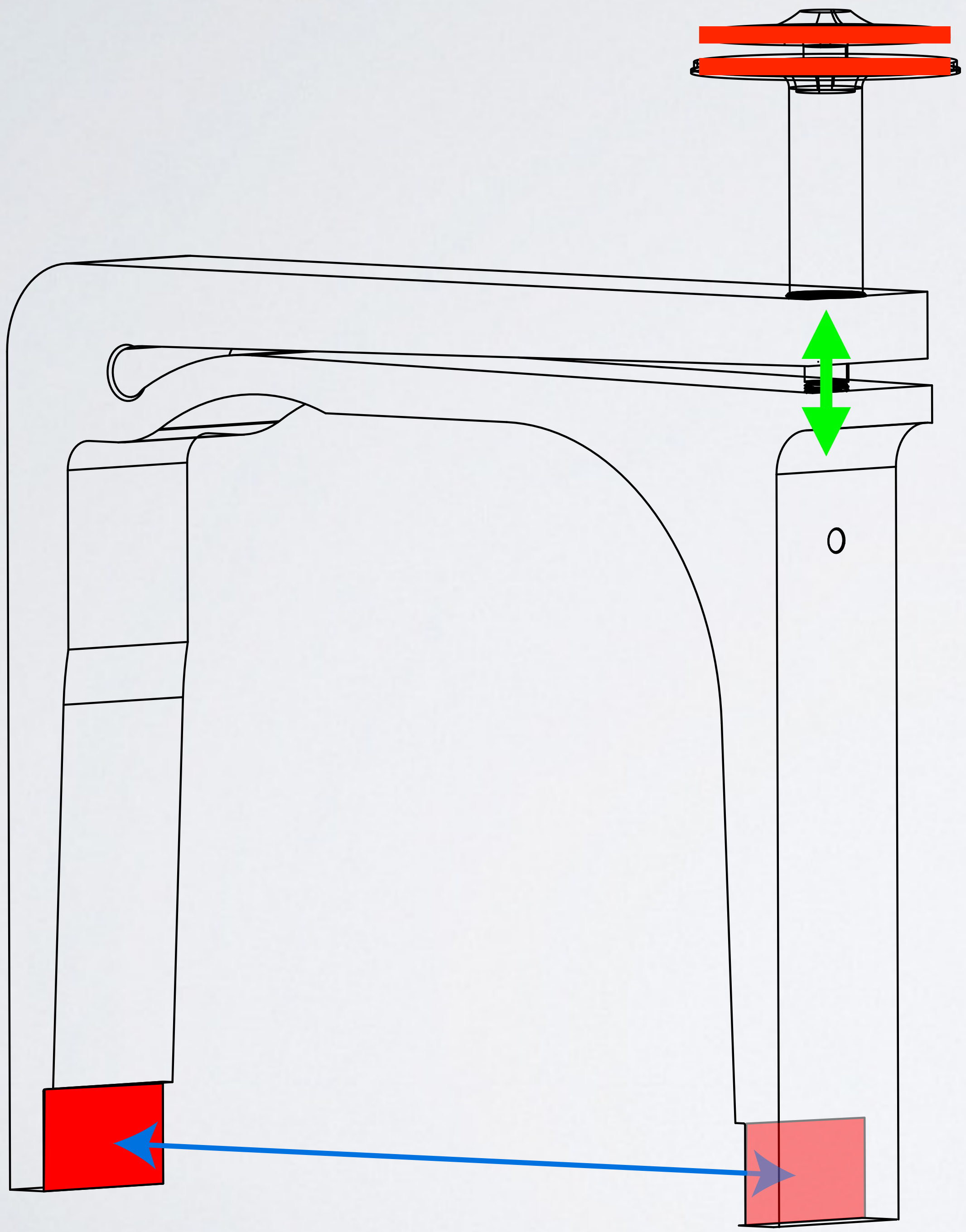
WHERE WE LEFT AT CM 36





- Actuators had been tested on a test stand with positive results. All of them were working
- Cavity and tuner were about to be installed in Fermilab CleanRoom

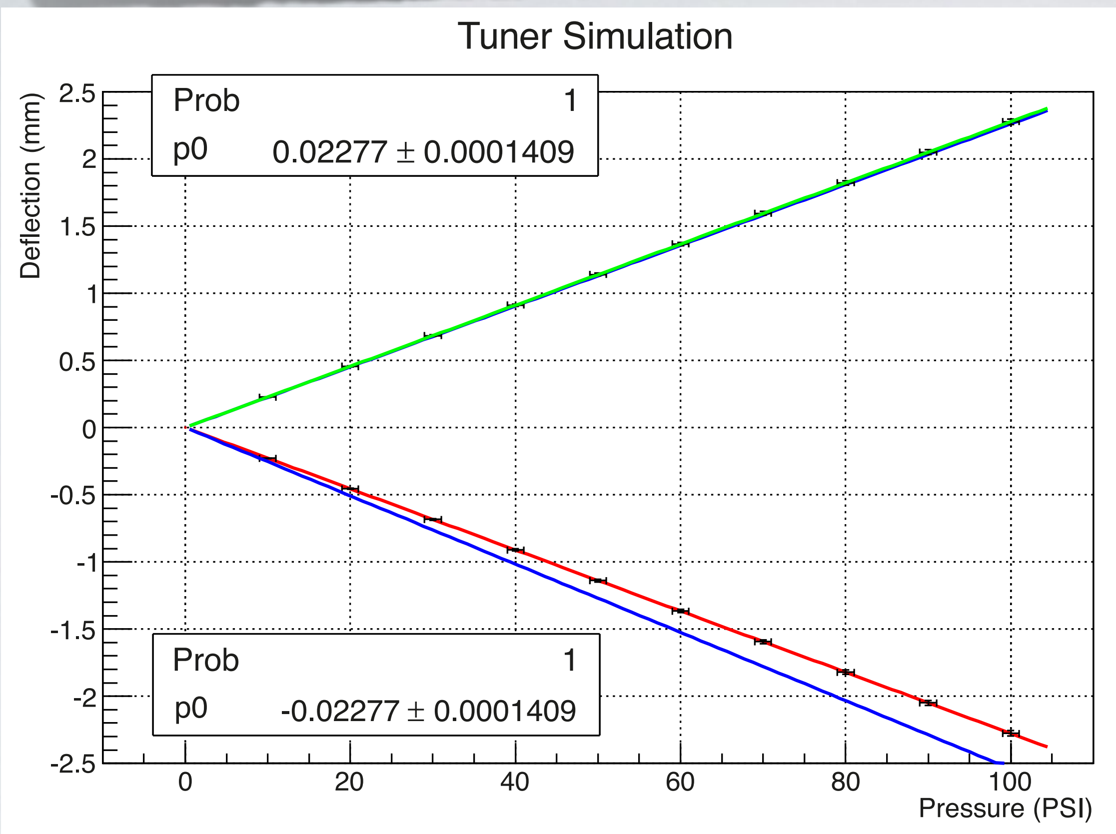
VARIABLES WRAP-UP

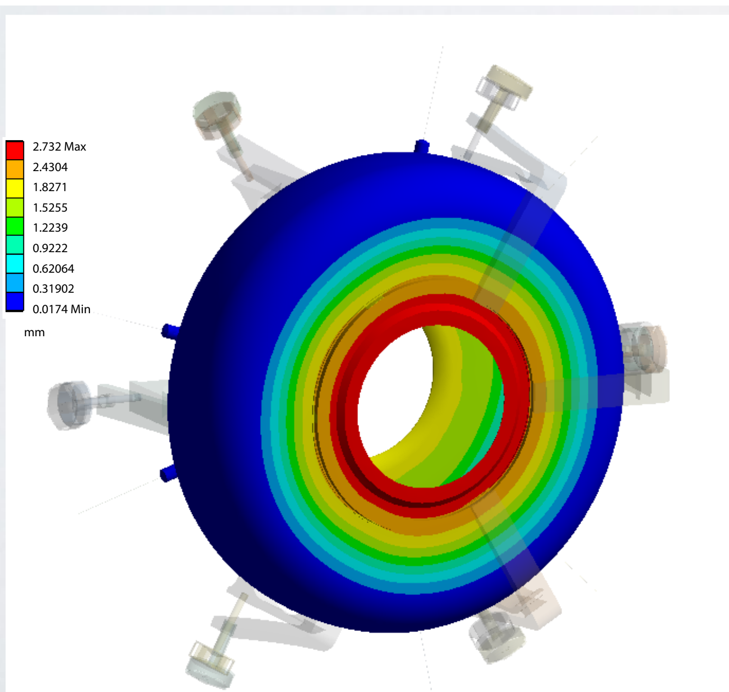


We use the following nomenclature:

- Pressure is positive while squeezing the cavity and negative while stretching the cavity
- Green: Fork Gap variation measured by linear potentiometers (only for testing with no vacuum)
- Blue: Cavity deflection (not measured in this test)
- Frequency and Q: measured by a Network Analyser.

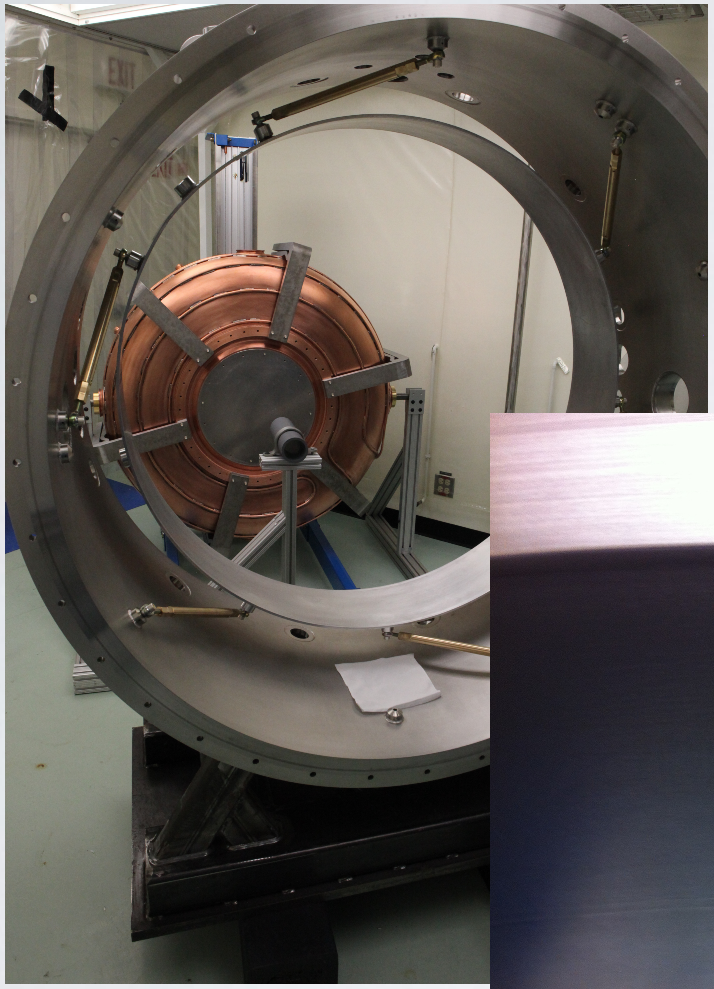
MECHANICAL SIMULATIONS ON TEST STAND

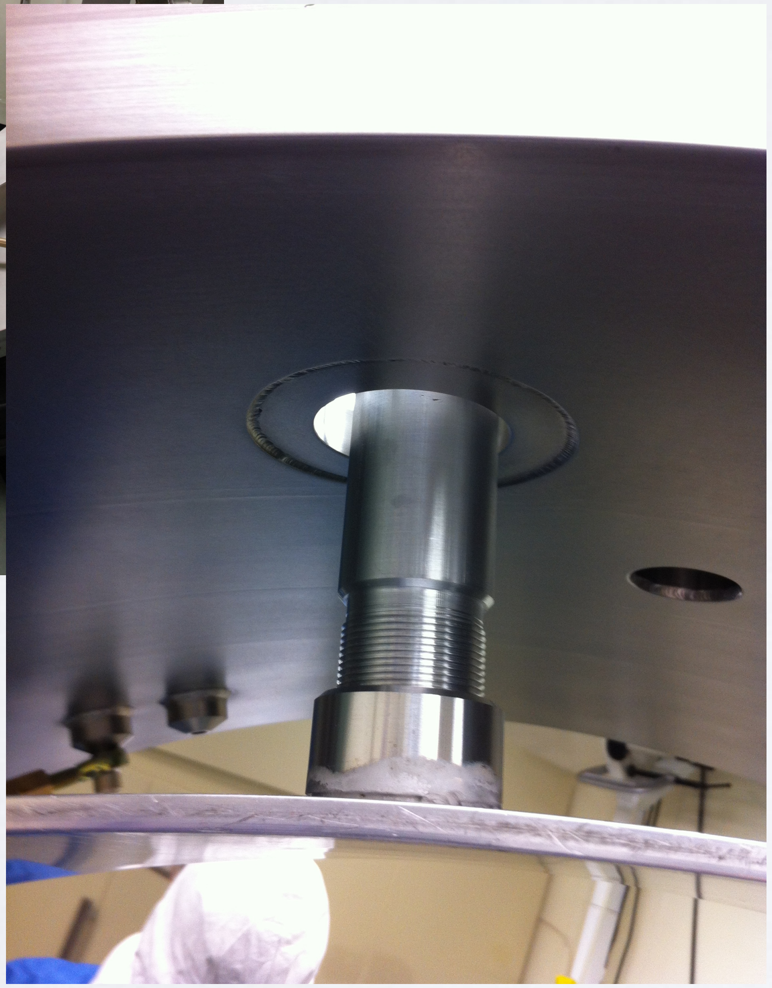




- Good agreement between data (blue) and stretch simulation (green)
- Worse agreement between data (blue) and squeeze simulation (red)
- Simulated data are symmetric for stretch and squeeze mode. Data are not.
- Simulations realised with ANSYS workbench by L. Somaschini, A. Lambert and A. DeMello.

ACTUATOR ASSEMBLY

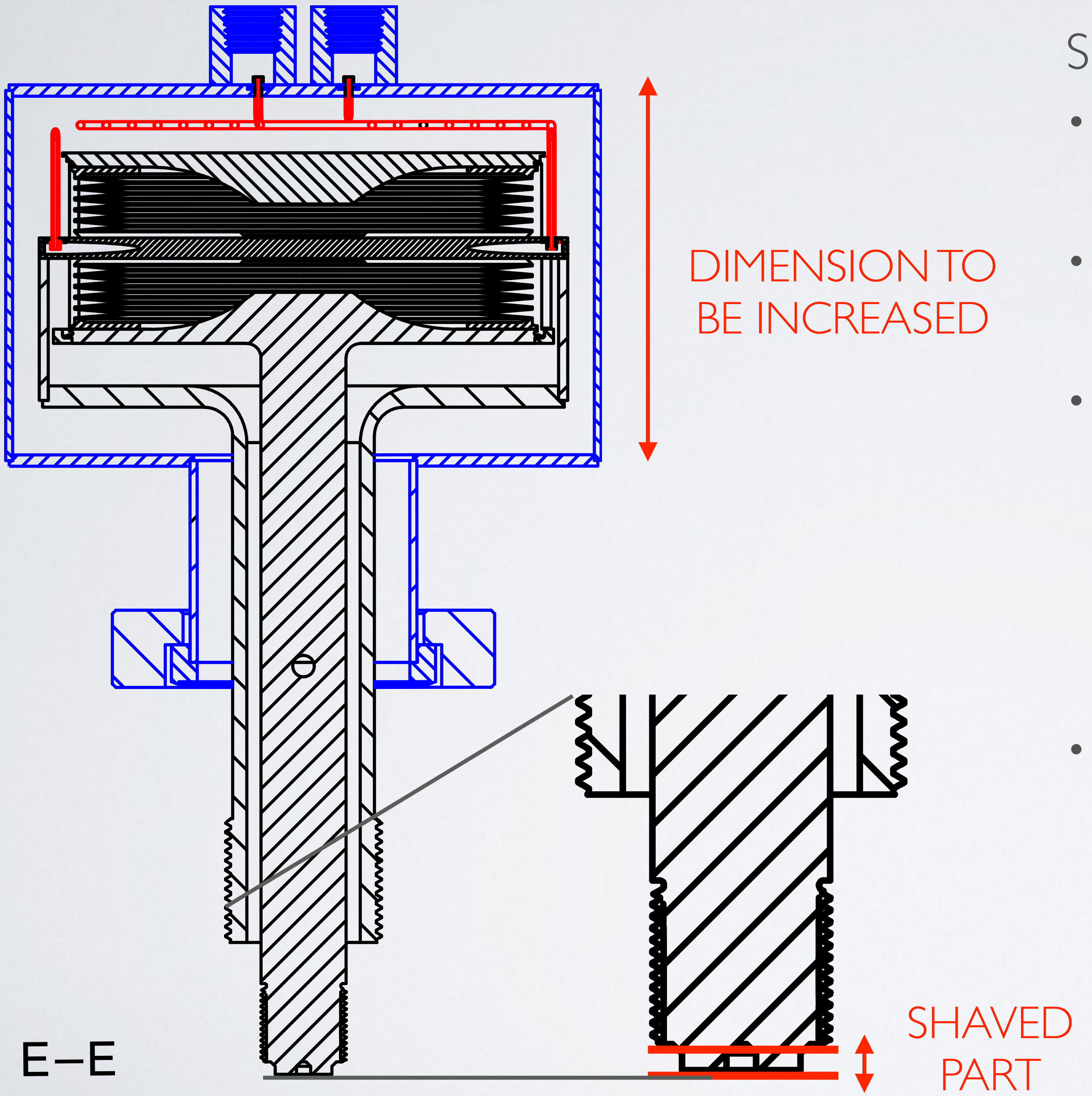




Here are most important results from assembly:

- Cavity has been laser scanned but all forks are machined to provide same gap from pad to pad.
- Stainless Steel shimming is adopted to create proper contact and to facilitate assembly.
- Initial struts position is achieved with a test aluminium hoop and alignment tools

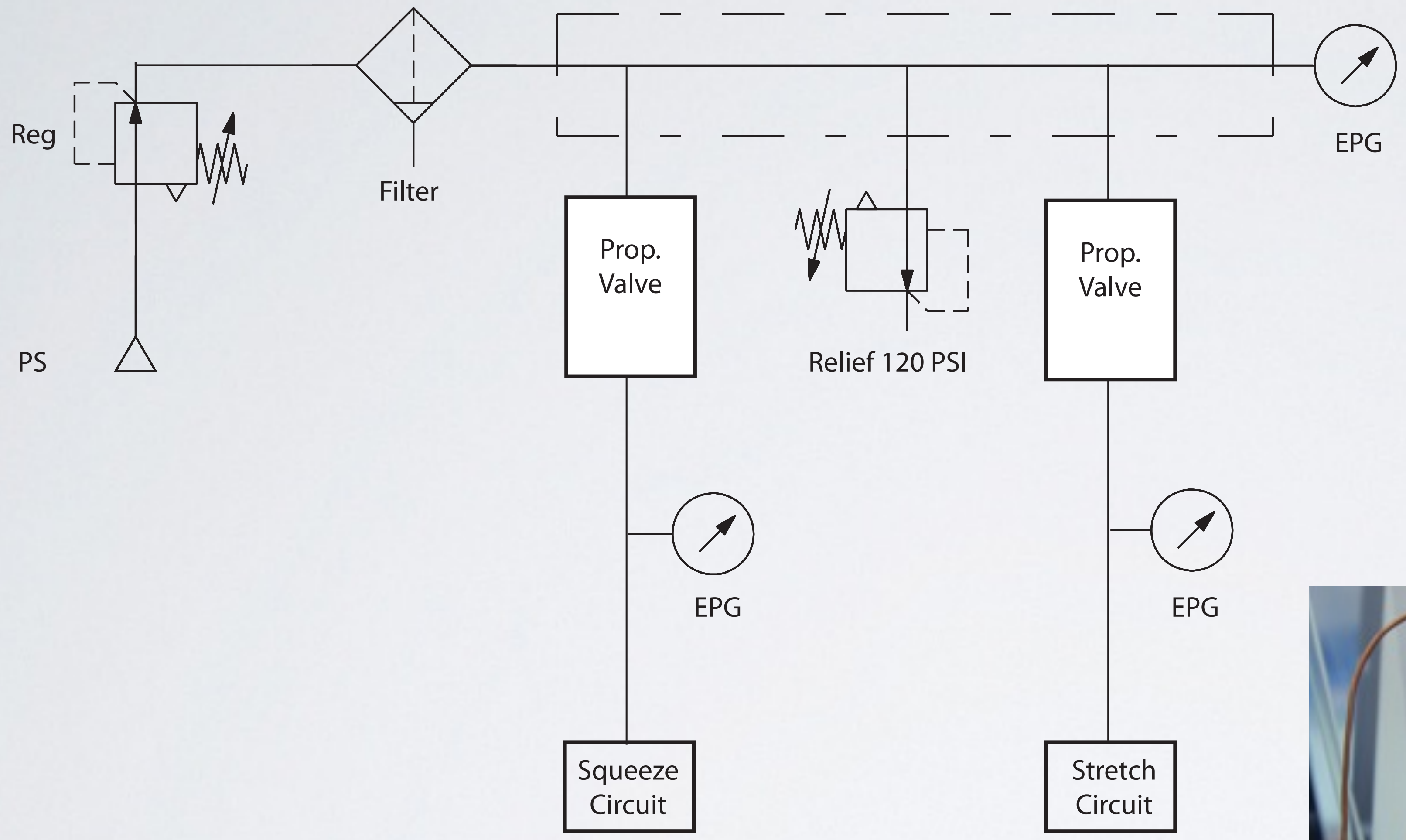
ACTUATOR ASSEMBLY



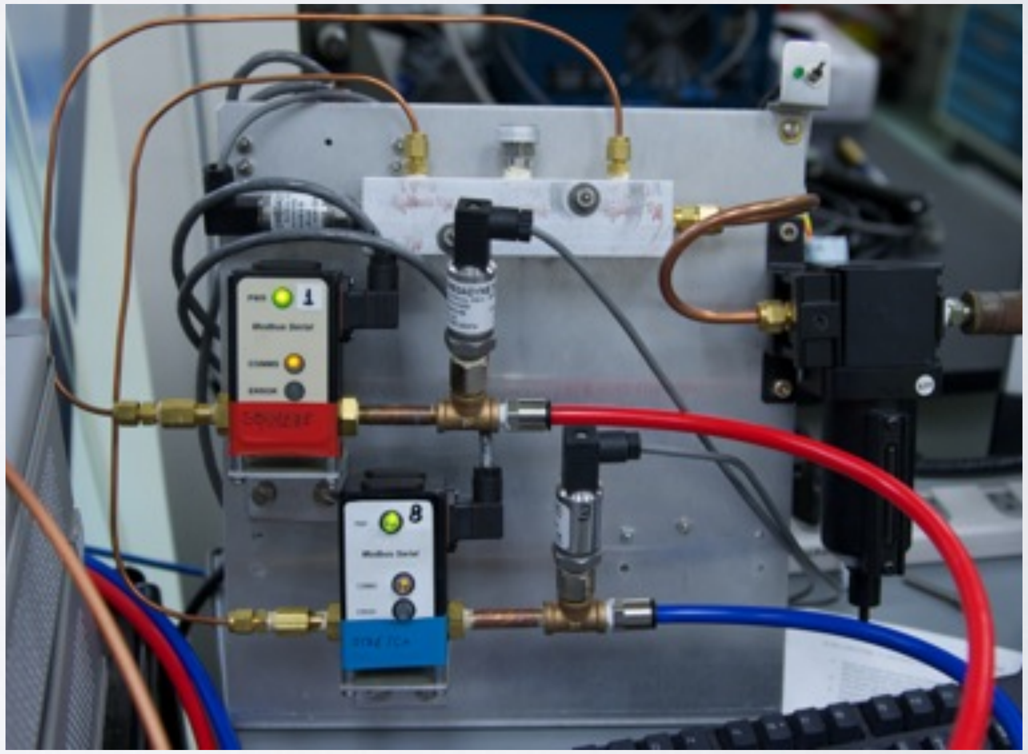
Some issues occurred:

- 4 Actuator bellows couldn't be screwed because they were too short.
- Issue was solved by shaving the bottom of corresponding actuators.
- Radial play allowed by bellows is very small because of small vacuum can dimensions. The main constraint in this comes from the presence of Coupling Coil.
- It was suggested to A. DeMello to consider an enlarged vacuum can for all actuators not interacting with coupling coils. This will allow for a MUCH easier installation.

PNEUMATIC CONTROL

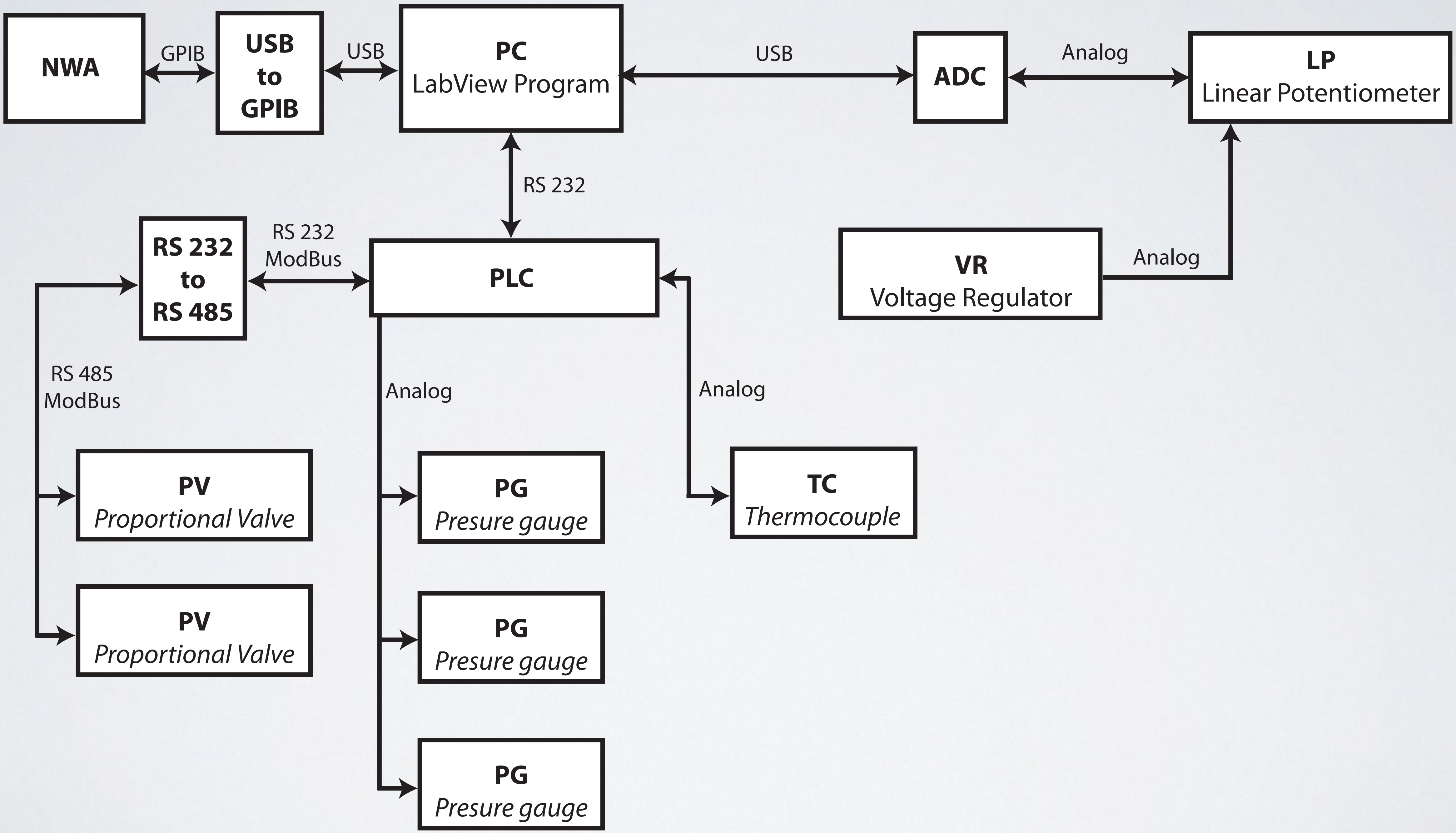


- All connection now realised with copper and radiation compatible sealant
- REMEMBER that prop. valves are NOT radiation compatible

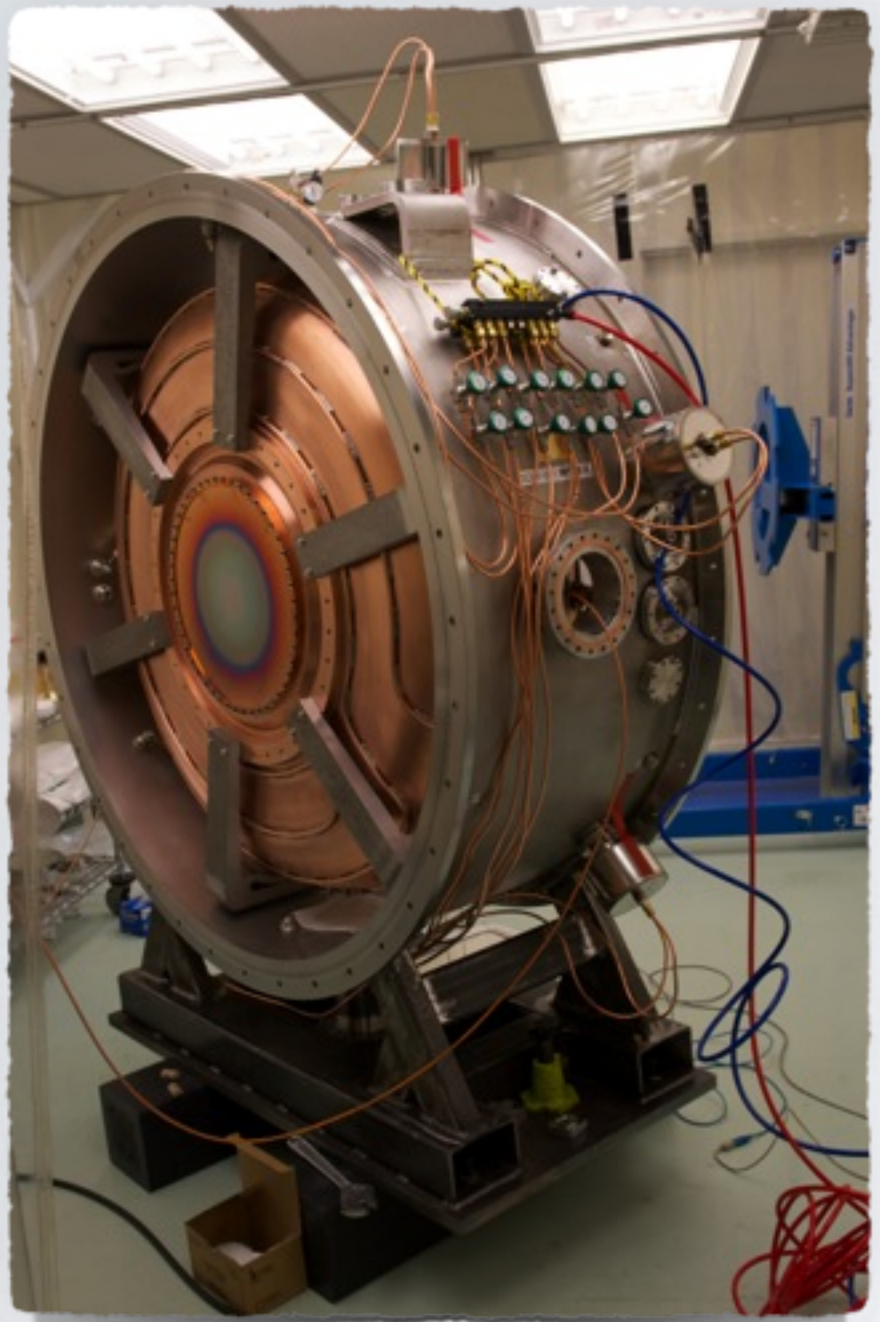


- Newly installed pressure gauges provide redundancy on pressure measurement

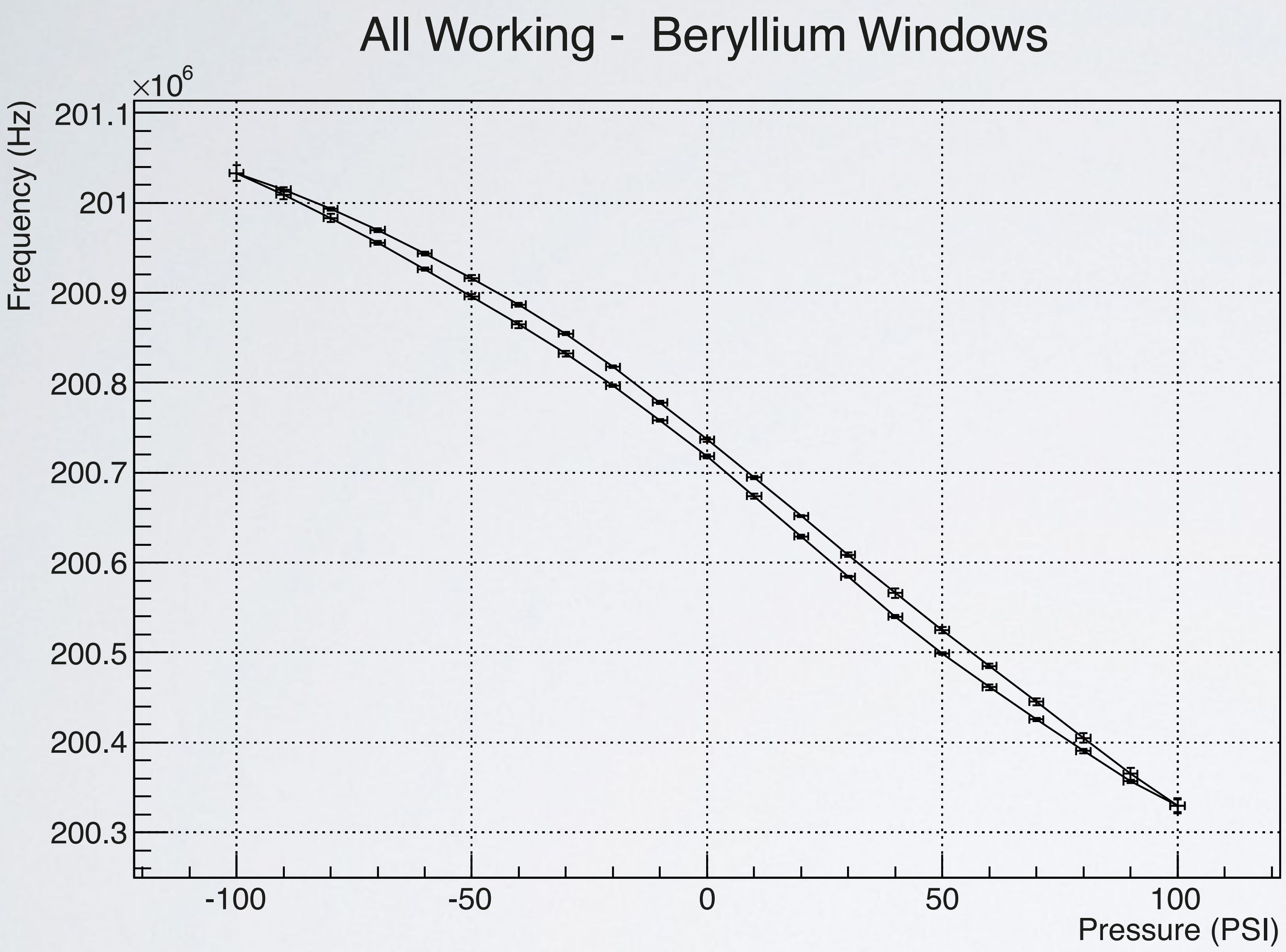
ELECTRONIC CONTROL



DURING ASSEMBLY



TRANSFER FUNCTION

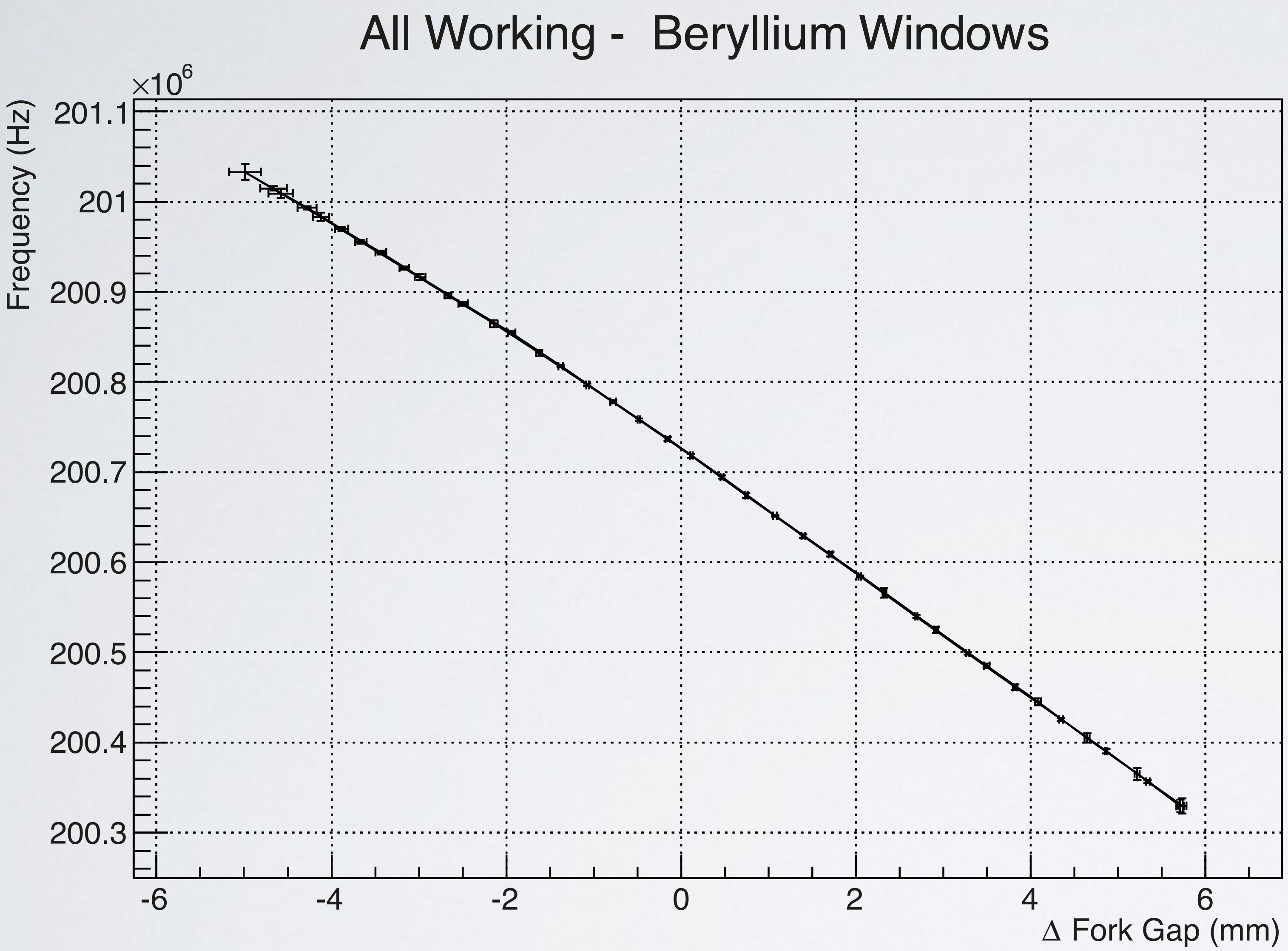


Resonant Frequency	200.727±0.009MHz
Maximum Frequency (@-100PSI)	201.033±0.003MHz
Minimum Frequency (@100PSI)	200.329±0.002MHz
Q	41820 ± 1045

- Q is lower than design one, but similar to prototype cavity
- Remarkable hysteresis cycle: (20 KHz)
- Tendency to saturation at negative pressures

Feedback loop under construction at FNAL by Dave Peterson. This curve is used as starting point to define gain and loop logic.

TRANSFER FUNCTION

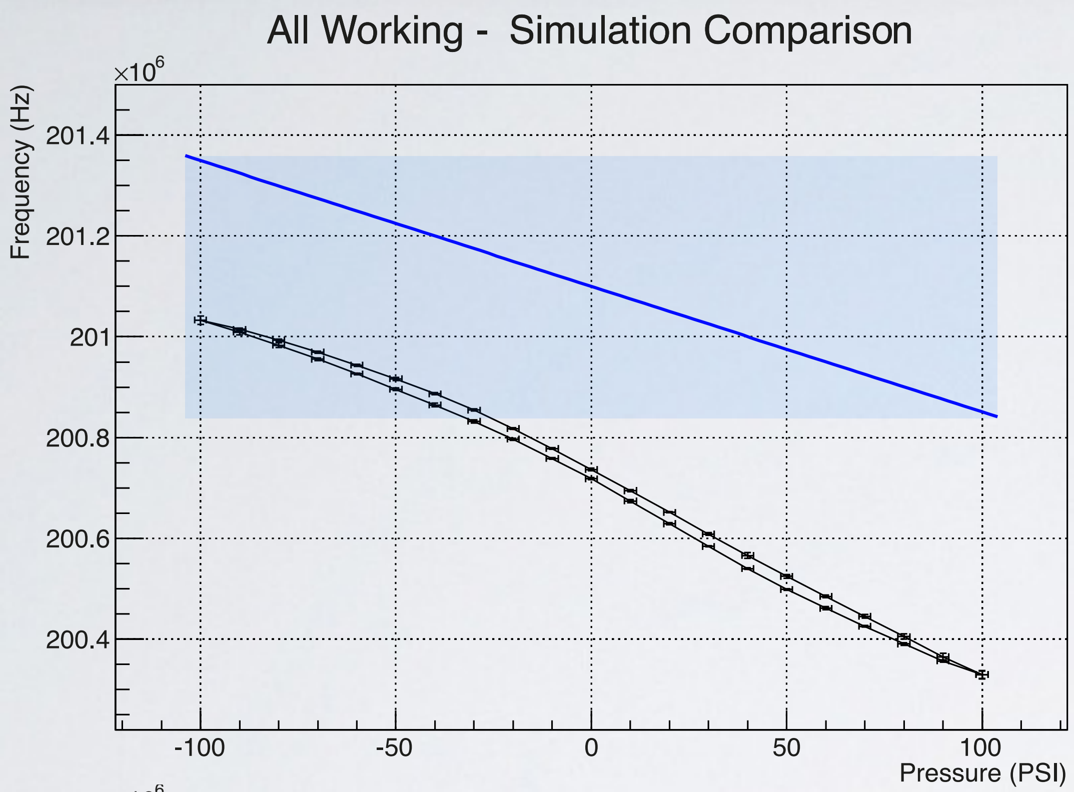


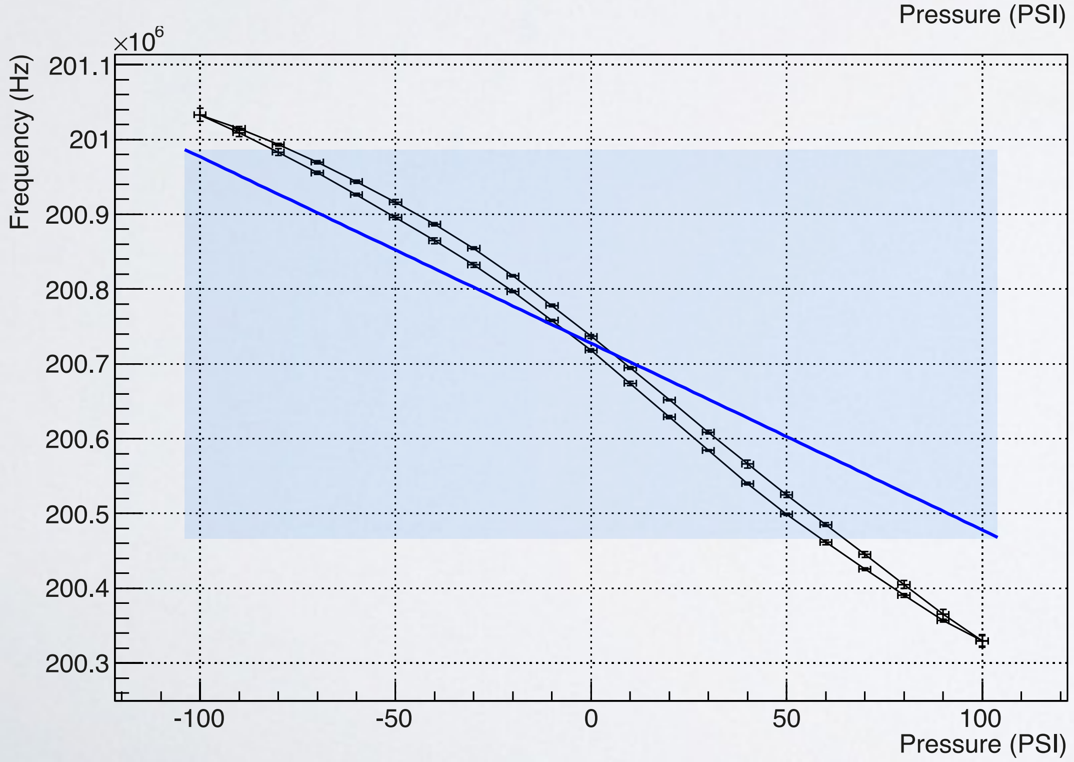
New curve as a function of fork gap variation (relative piston movement)

- No hysteresis
- No tendency to saturation

Non-linearities are not caused by forks!!!

TRANSFER FUNCTION





Differences between simulations and data in:

- Resonant frequency
- Tuning range

	Measurements	Simulations
Resonant Frequency	200.727±0.009MHz	202.100 MHz
Tuning Range	704 ± 4 KHz	500 KHz

SIMULATIONS IMPROVEMENTS

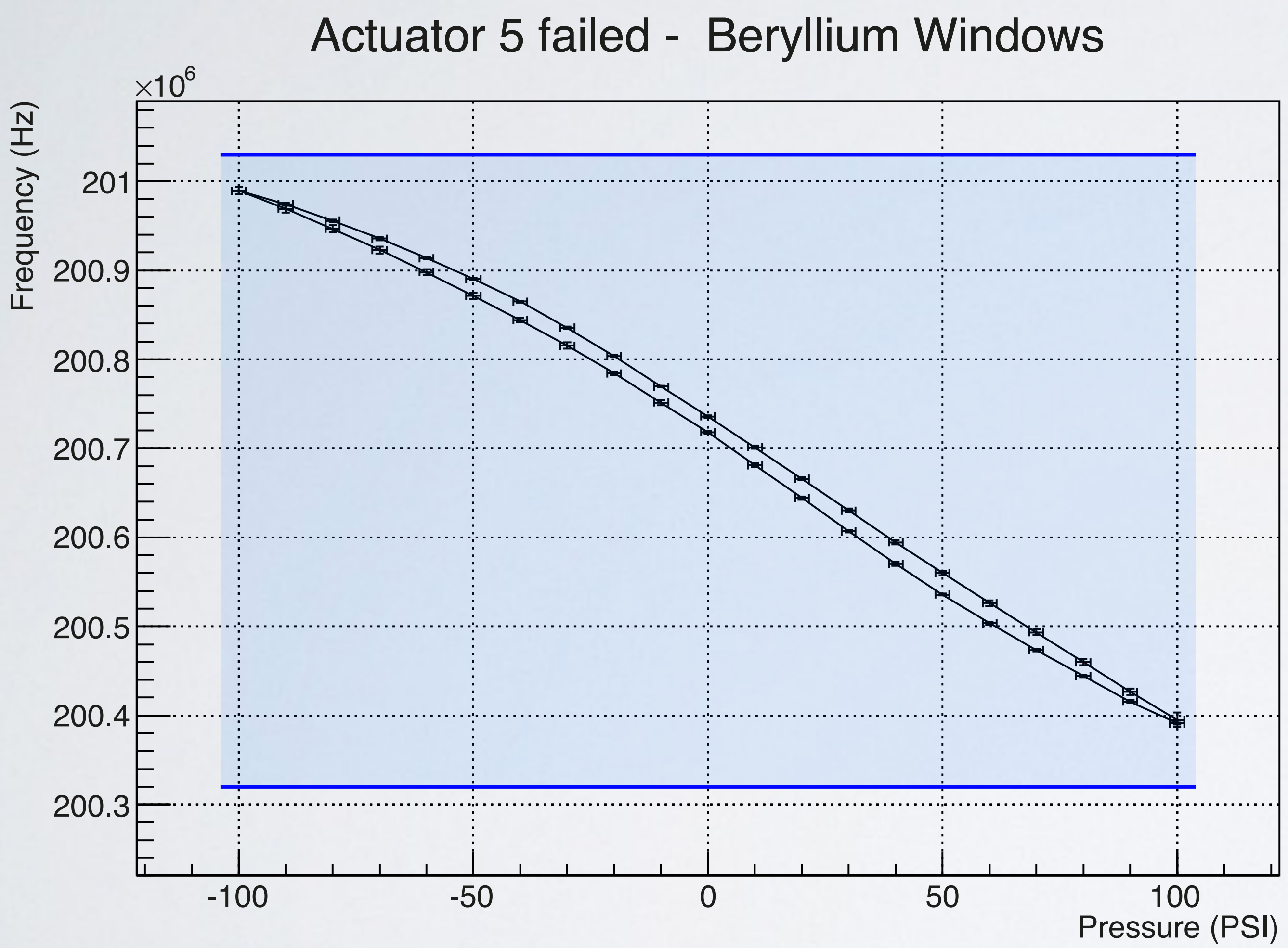
Possible simulations improvements:

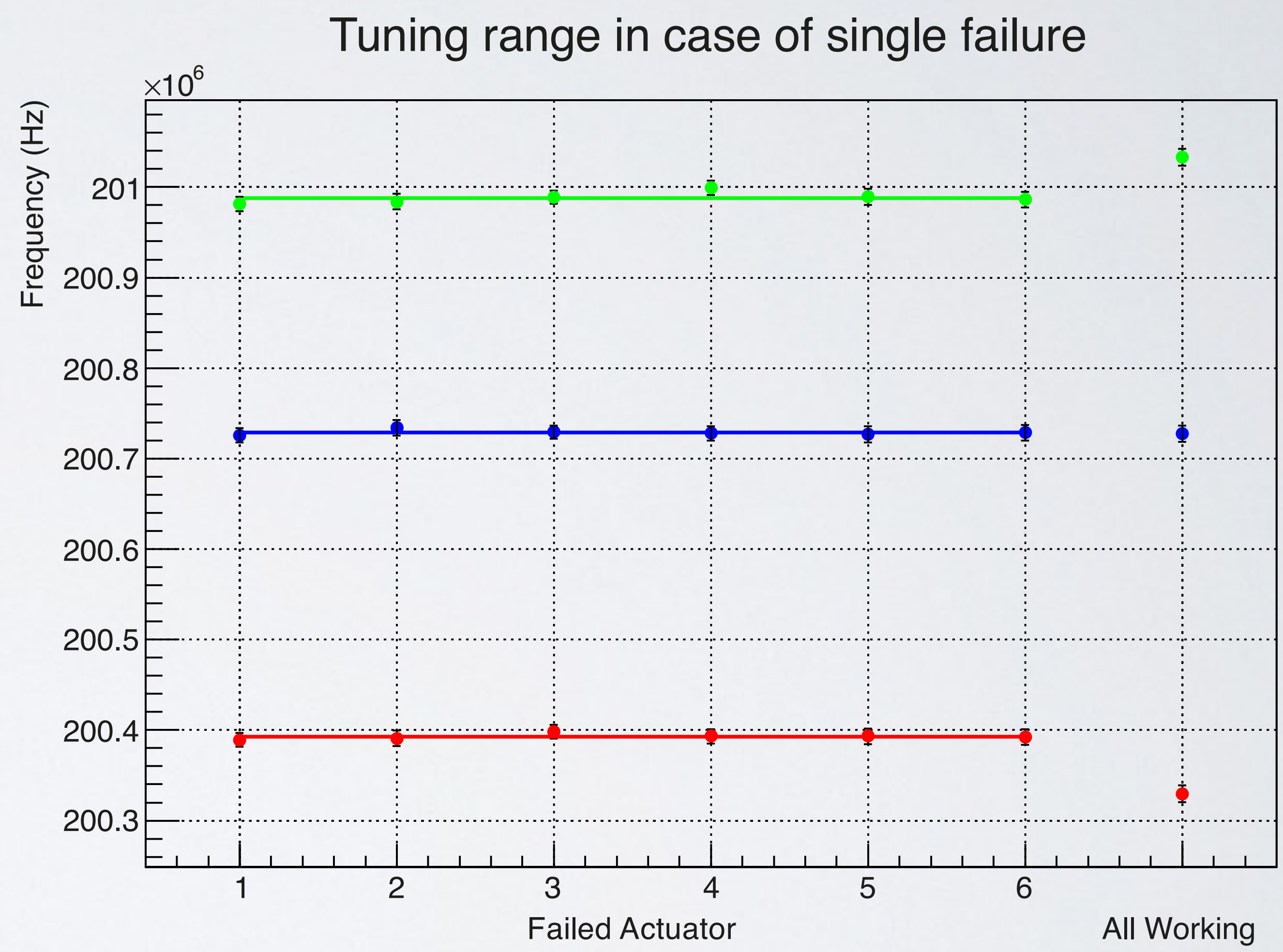
- Different simulations (L. Somaschini, A. Lambert, S. Virostek) gave the same result, which is incompatible with data.
- Troubles could come from the model:
    - No side ports in the model
    - No cooling lines in the model
    - Simplified geometry for beryllium windows

- Limited simulation time due to high overbooking for ANSYS multiphysics licence.

IN CASE OF FAILURE

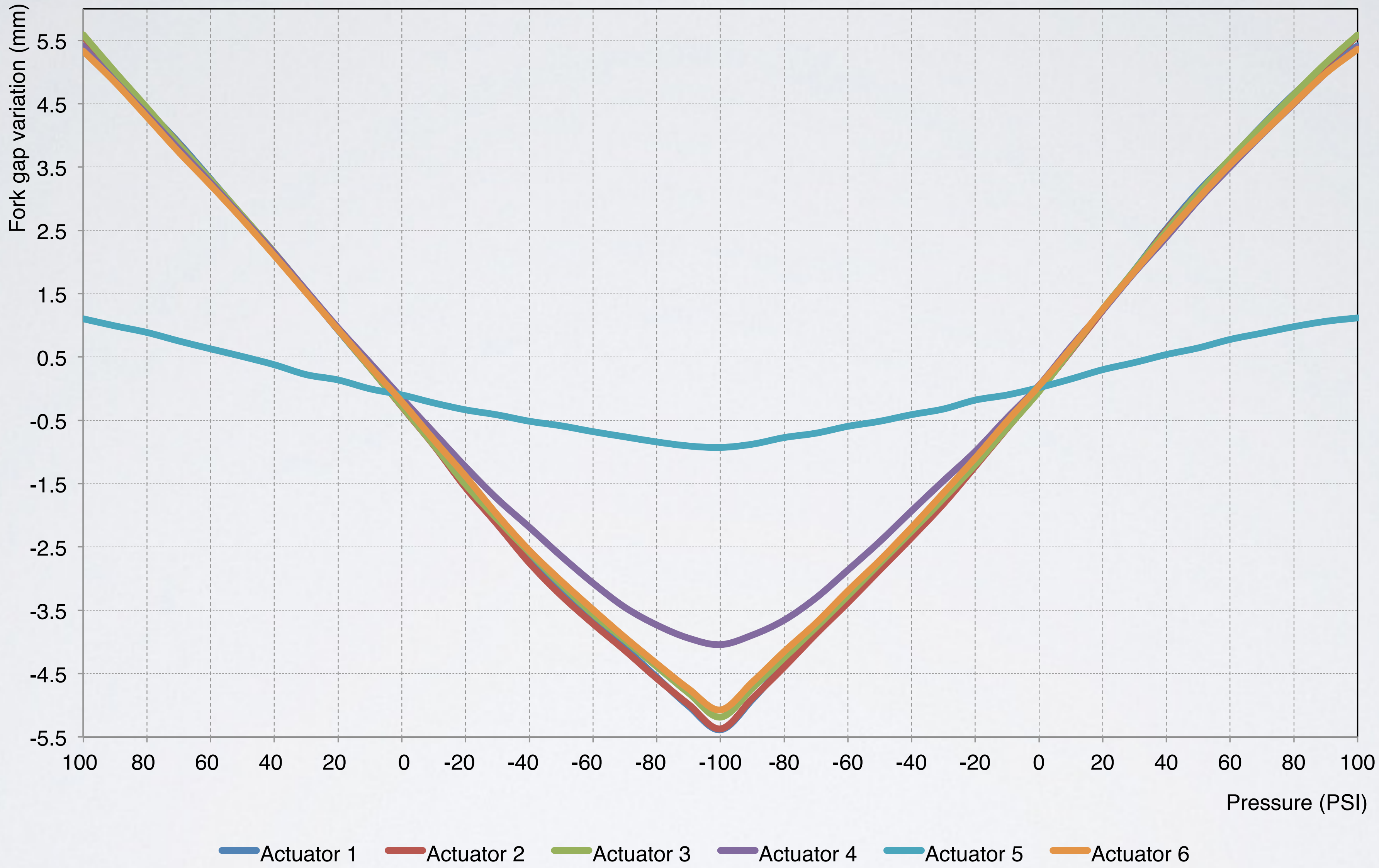
Air supply cut to ONE actuator at a time





System is sill working with a tuning range reduced of 100 KHz, independently of the failed actuator. AJ DeMello says that more than one failed actuator can result in plastic deformation of the cavity

IN CASE OF FAILURE



When actuator 5 fails (air leak failure) its actuator shaft is still moved by the action of other 5 working actuators

CONCLUSIONS

Many positive results:

- Proper functionality of all components
- Validation of mechanical simulations
- System proved to be reliable
- System working also in case of single actuator failure
- Obtained a calibration curve for the feedback loop

CONCLUSIONS

Some negative aspects:

- Discrepancy between RF simulations and measurements
- Small tuning speed (1 PSI/s, 3 KHz/s)
  - High pneumatic volume (required by radiation incompatibility of prop. valves)
  - Small air flow in proportional valves (only 1/8")

Next step:

- High power test with feedback loop

Thanks for your attention