Mechanical Q factor measurement of PR3-SAS

Main flow:

1. Excite a resonance at f_0
2. Measure its decay time constant τ

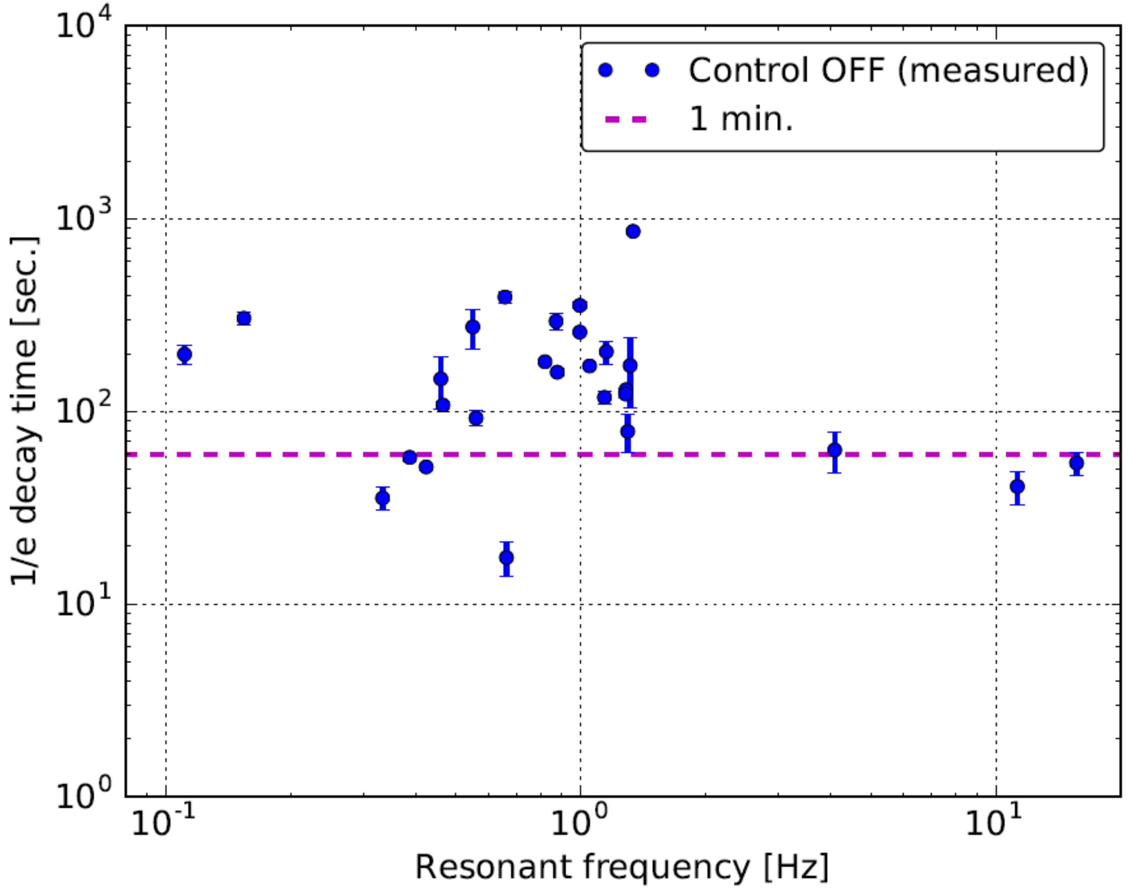
(3. Obtain Q factor using Q = $\pi\, f_0\, \tau$)

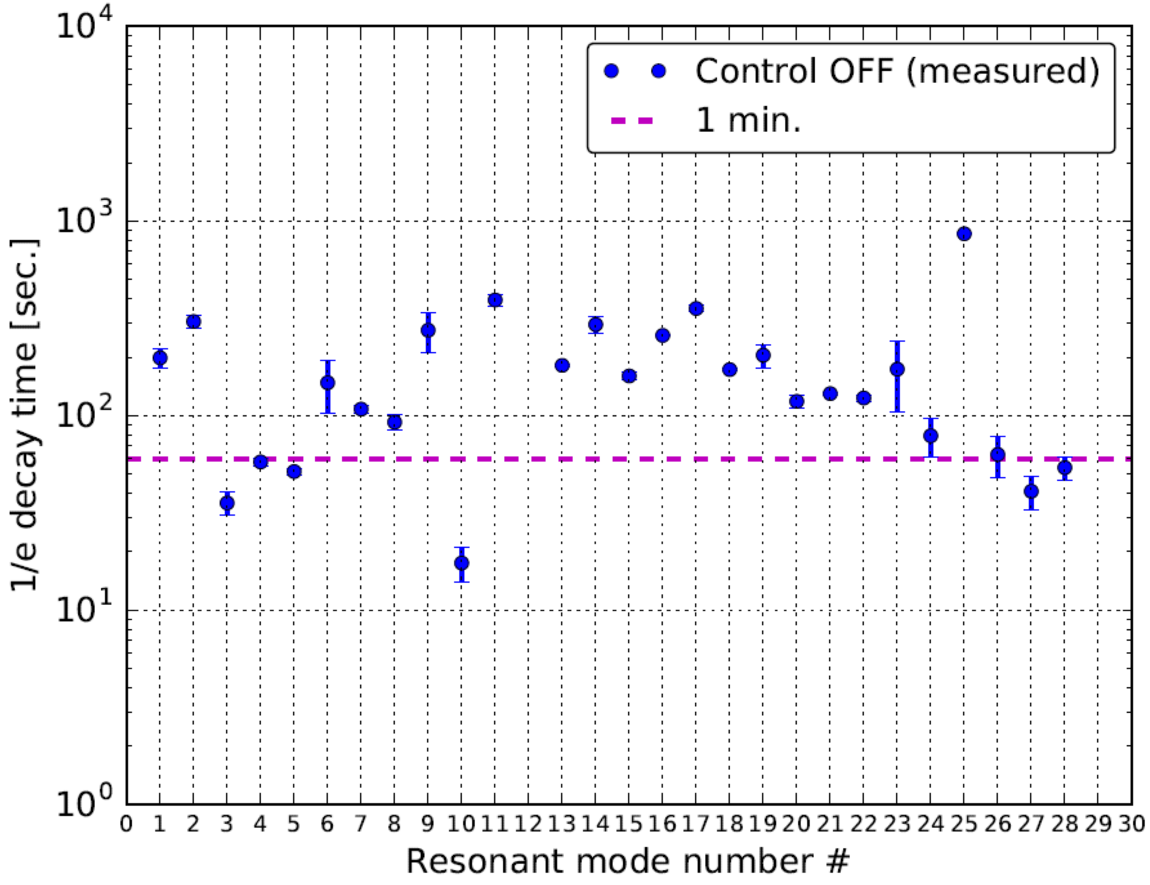
4. Repeat 1-3 for all the measurable resonances

What was done from June 12 to June 23, 2017:

Measuring Q factors *without damping* of PR3-SAS in the chamber in lower frequency region (below 20 Hz).

Result: To be compared with the ones with damping control

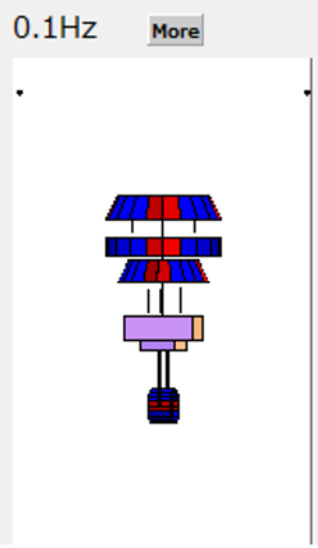




NOTE: #12 was not able to be excited on June 2017. This mode is differential motion by RM and TM in T DoF and thus this mode would not disturb the operation. Then this missing should not be so problematic. (it can be measured somehow though.)

Eigen mode shapes of PR3 SAS (Type-Bp):

#1



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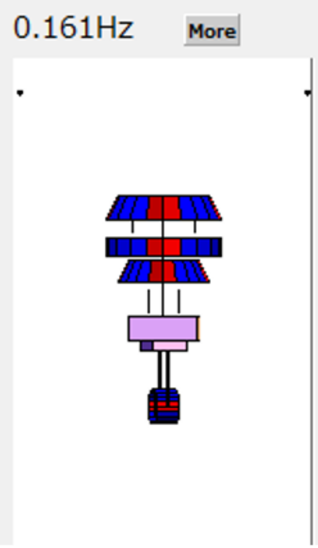

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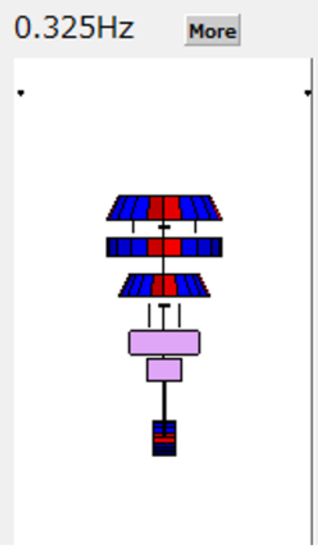

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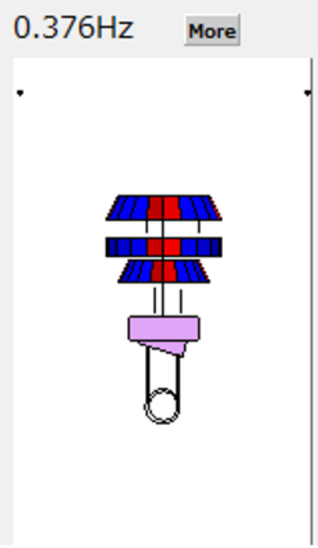

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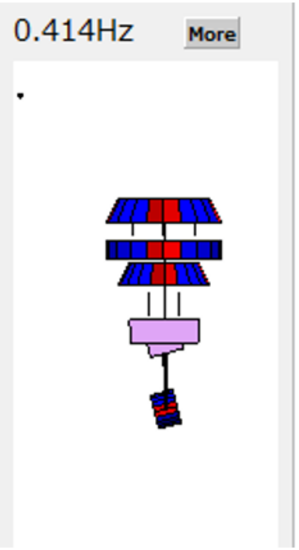
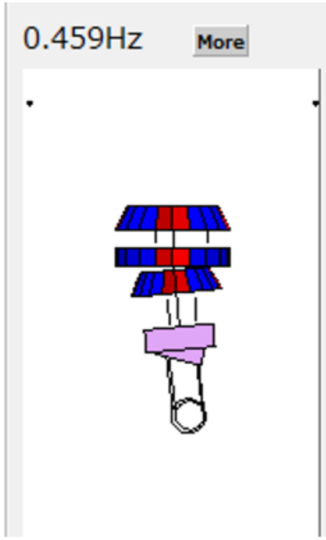


#6



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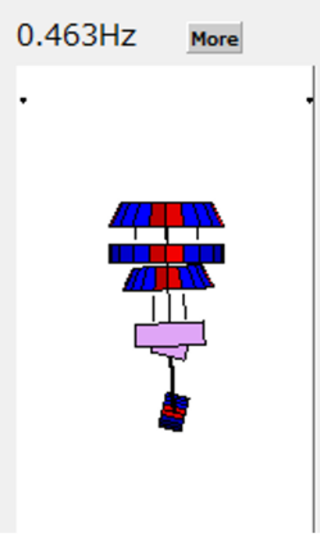

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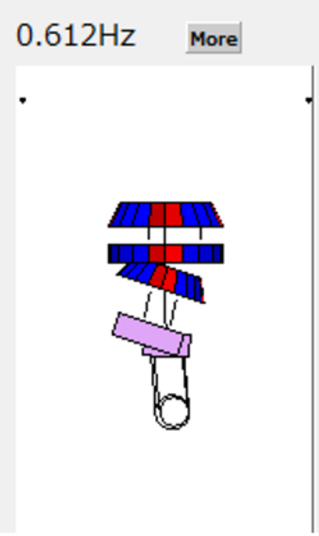
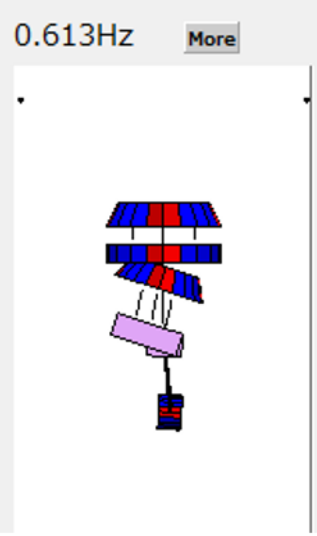
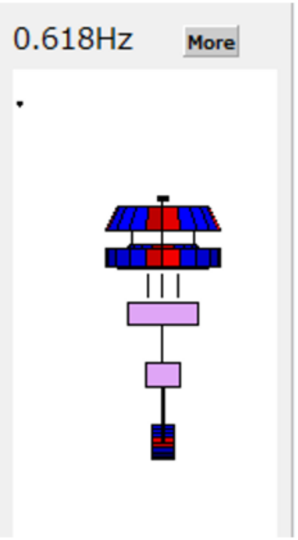
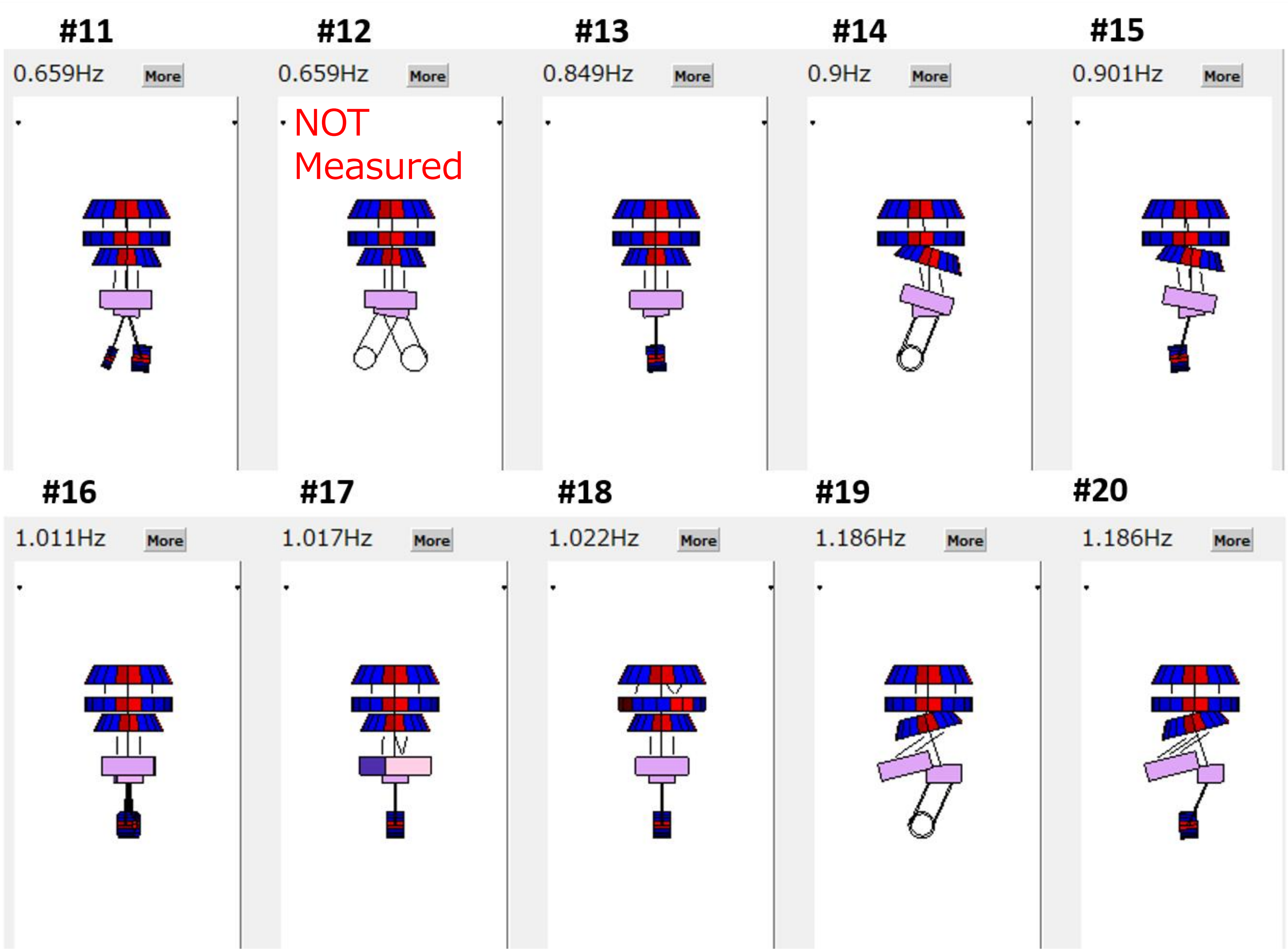


#9

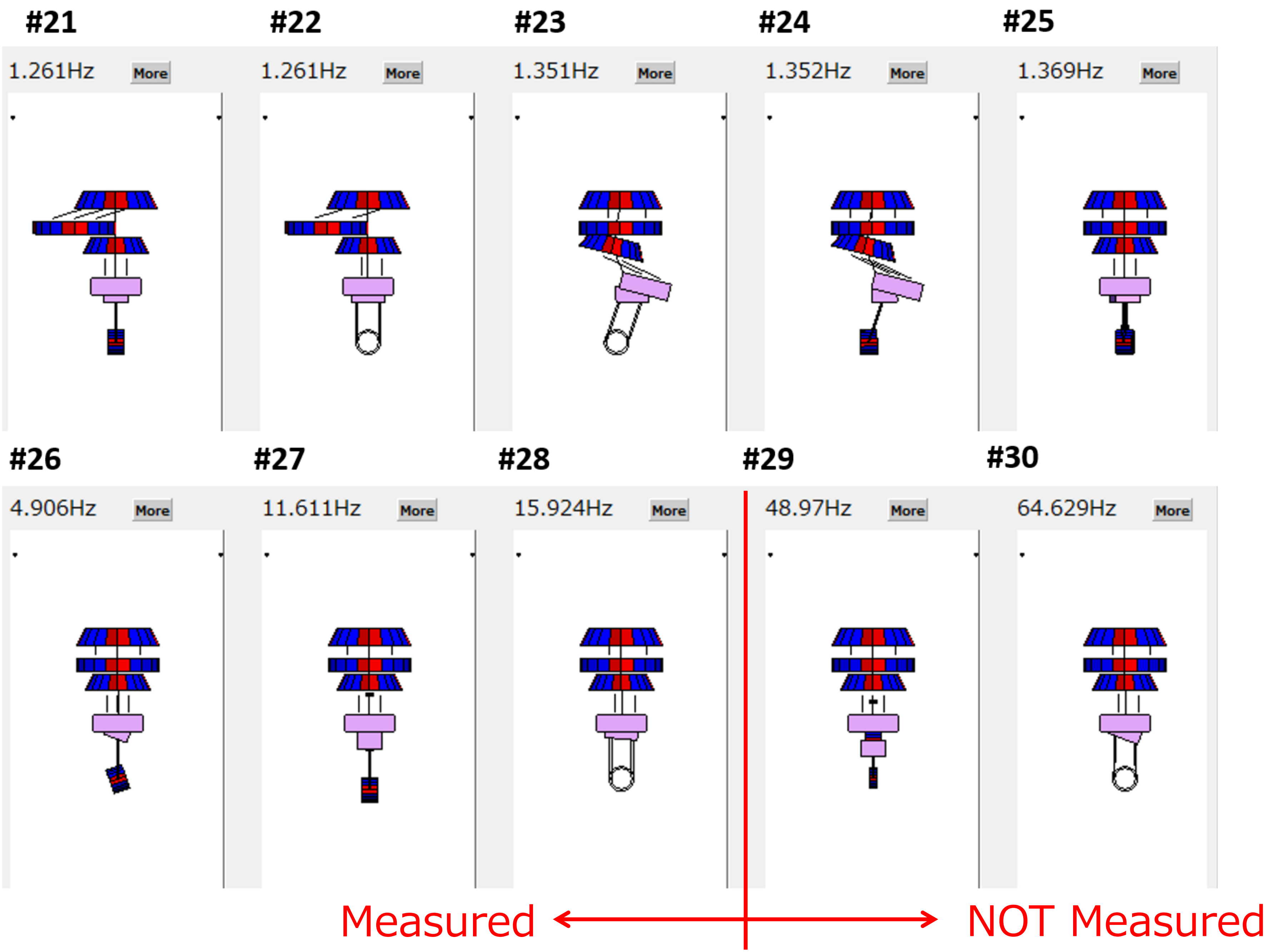


#10



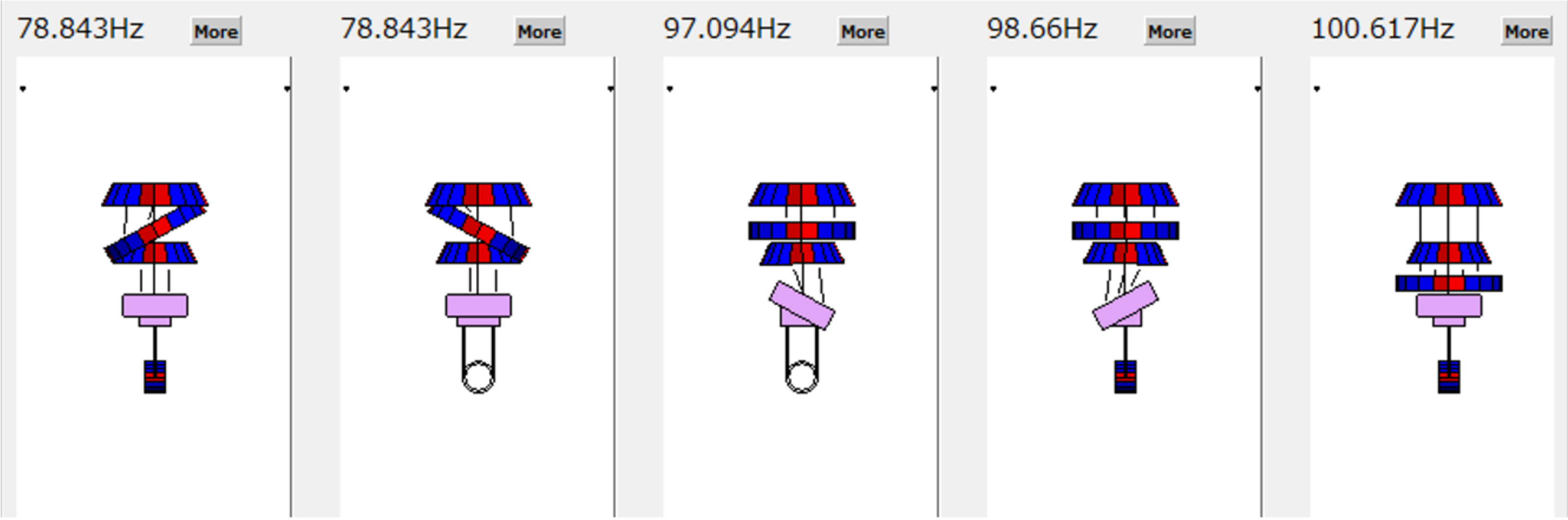


#11
0.659Hz
More
#12
0.659Hz
More
NOT Measured
#13
0.849Hz
More
#14
0.9Hz
More
#15
0.901Hz
More
#16
1.011Hz
More
#17
1.017Hz
More
#18
1.022Hz
More
#19
1.186Hz
More
#20
1.186Hz
More

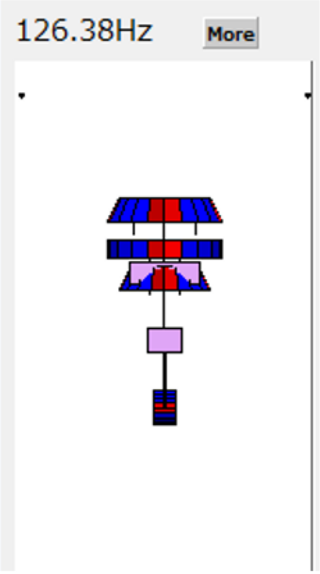

#21
1.261Hz
More
#22
1.261Hz
More
#23
1.351Hz
More
#24
1.352Hz
More
#25
1.369Hz
More
#26
4.906Hz
More
#27
11.611Hz
More
#28
15.924Hz
More
#29
48.97Hz
More
#30
64.629Hz
More
Measured
NOT Measured

NOT Measured

#31 #32 #33 #34 #35



#36

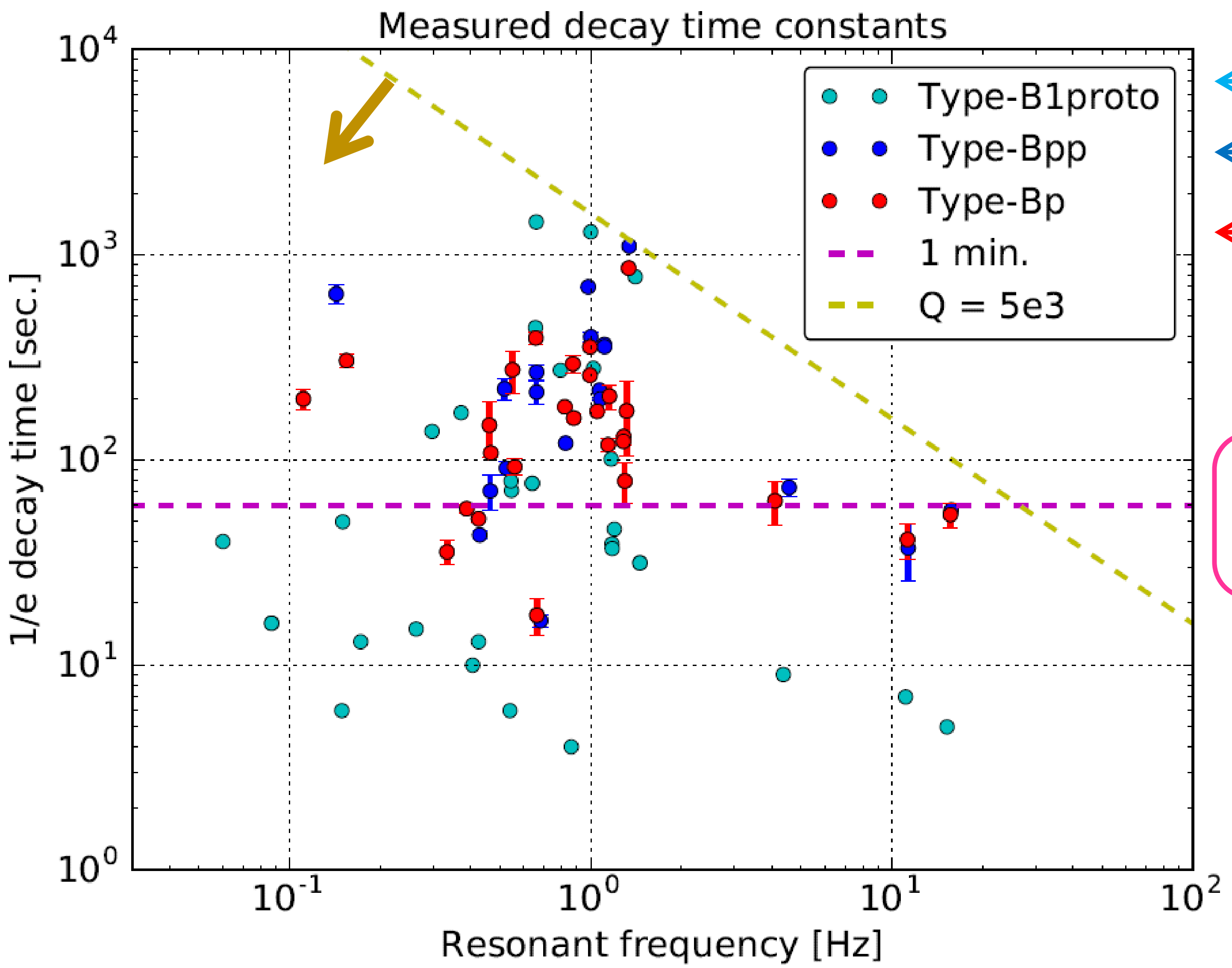


Since these higher-resonant-frequency-modes are so difficult to be excited and also the decay time constants of these modes are expected originally smaller. Thus we do not take care of them for the time being.

Mechanical Q factors of KAGRA-SAS:

Type-Bp vs. Type-Bp’ vs. Type-B1proto

Maximum Q *without damping* seems to be ~ 5e3 for KAGRA-SAS.



Suspension by T. Seki.

iKAGRA PR3 Suspension

bKAGRA PR3 Suspension

1 min: Requirement
in the damping control phase

Note:
Type-B1 proto & Type-Bpp
were in vacuum,
on the other hand,
Type-Bp was in air.

Back ups:

Preparation:

1. Measure forced transfer functions
   in order to know which the appropriate actuator is.

2. Calculate eigen-mode-shapes & their resonant frequencies
   using 3D-rigid-body model.

3. Implement damping filters
   in order to complete this measurement smoothly.

Measurement:

1. Open “dv” for watching oscillation of related DoFs.

2. Open 2 windows of “diaggui” for excitation & for measurement.

3. Set excitation amplitude, frequency, and time
   in diaggui for excitation.

4. Input excitation and
   after confirming the resonance is excited enough by looking at dv,
   turn off the excitation then start measurement of the decay signal.

5. Fit the measured data by following formula:

$$f(t) = A \exp\left(-\frac{t}{\tau_e}\right) \sin\left(2\pi f_0 t\right) + x_0,$$

When it was difficult to excite only one resonant mode and a beating signal is measured, the signals can be fitted by a double decay sine wave function:

$$f(t) = A_1 \exp\left(-\frac{t}{\tau_{e,1}}\right) \sin\left(2\pi f_1 t\right) + A_2 \exp\left(-\frac{t}{\tau_{e,2}}\right) \sin\left(2\pi f_2 t\right) + x_0$$