Study on the Vertical Separation between Suspension Points & Center of Mass
(in Type-B Suspension System, for Recycling Mirrors)

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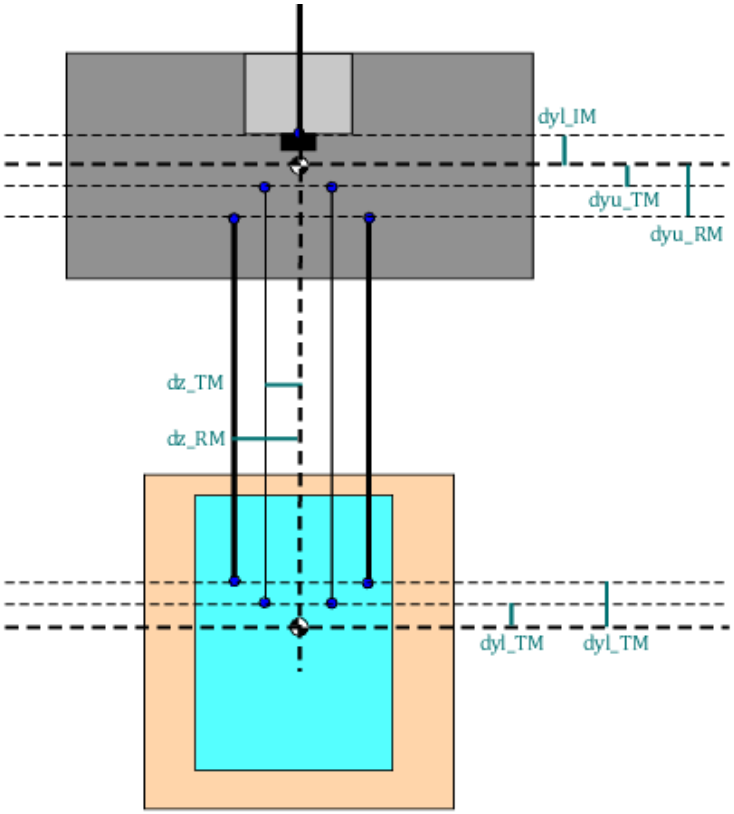
1. Payload Part (IM+RM+Mirror)



Let us define a “default design” :
dyl_IM=3 mm
dyu_TM=dyu_RM=dyl_TM=dyl_TM=0 mm
dz_RM=10 mm, dz_TM=2mm

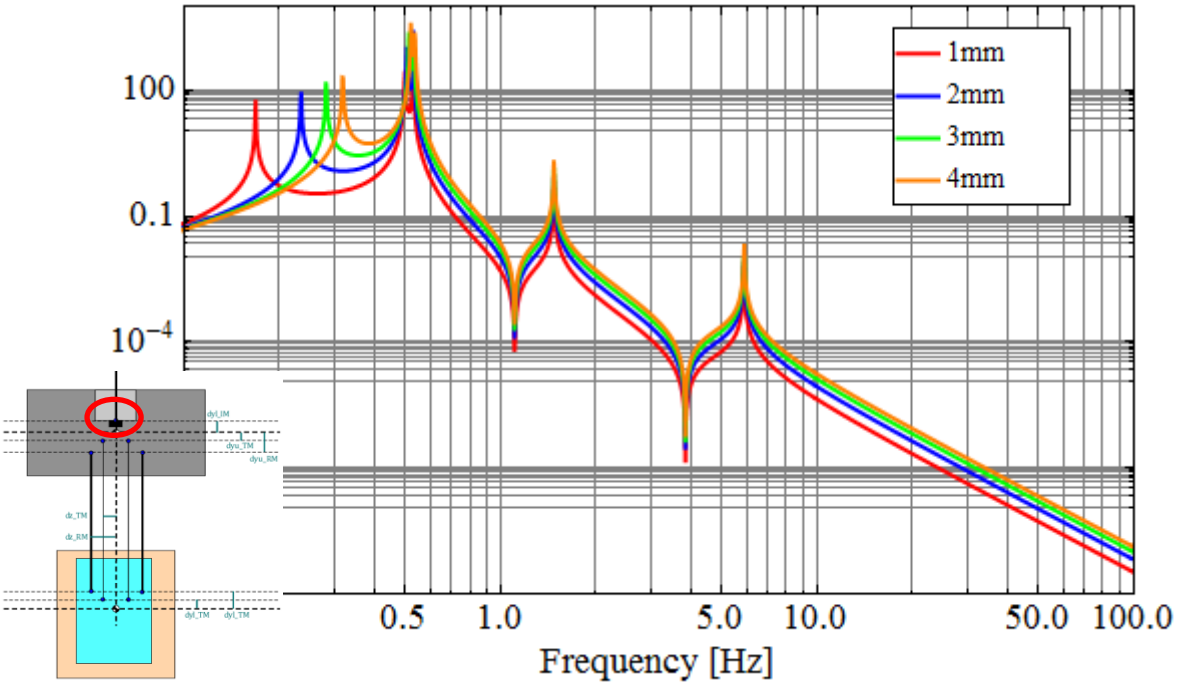
wire thickness (diameters):
dw_IM=0.80 mm, dw_RM=0.60 mm, dw_TM=0.20mm

wire length:
lw_IM=lw_RM=lw_TM=500 mm

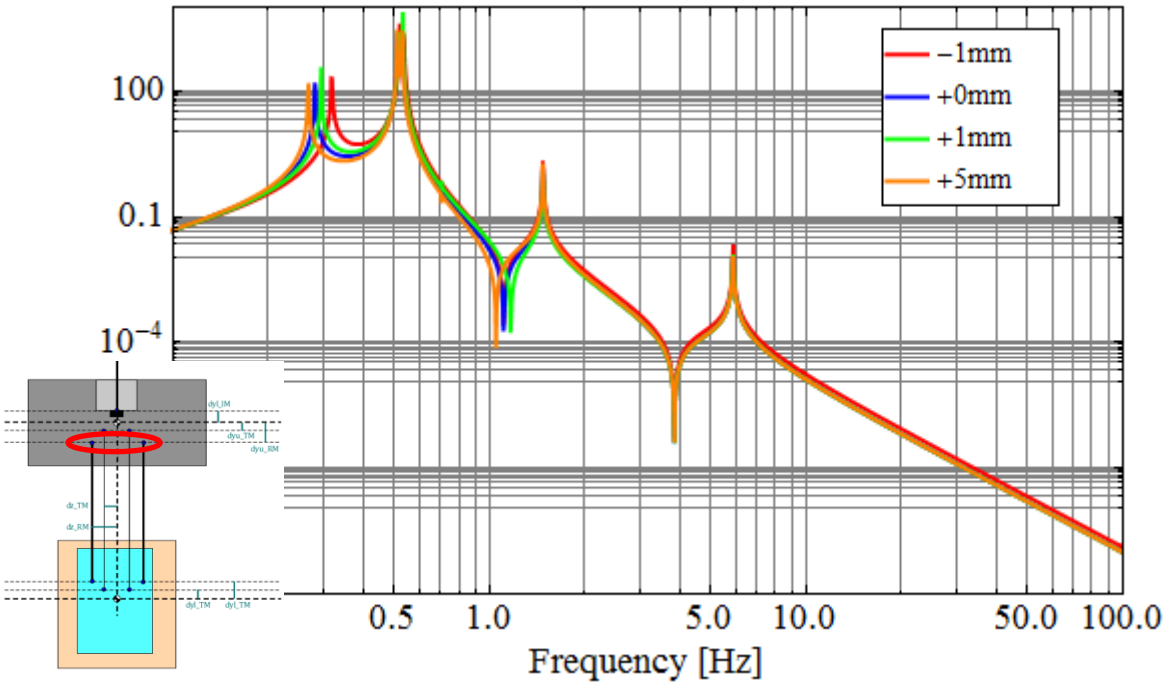
Note that, bending elasticity of a wire is not taken into account.
(i.e. suspension point = bending point of the wire)

The following plots are the transfer functions, from the top motion (in horizontal direction) to the mirror pitch motion (z_ground → tx_mirror).

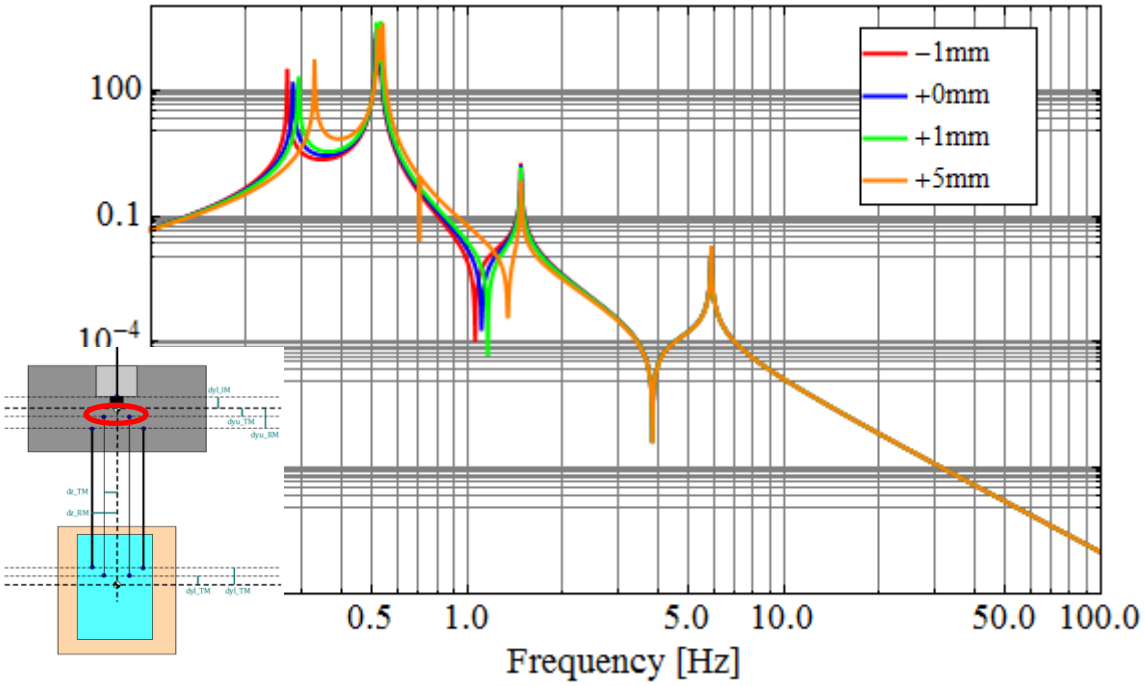
(1) dyl_IM dependence



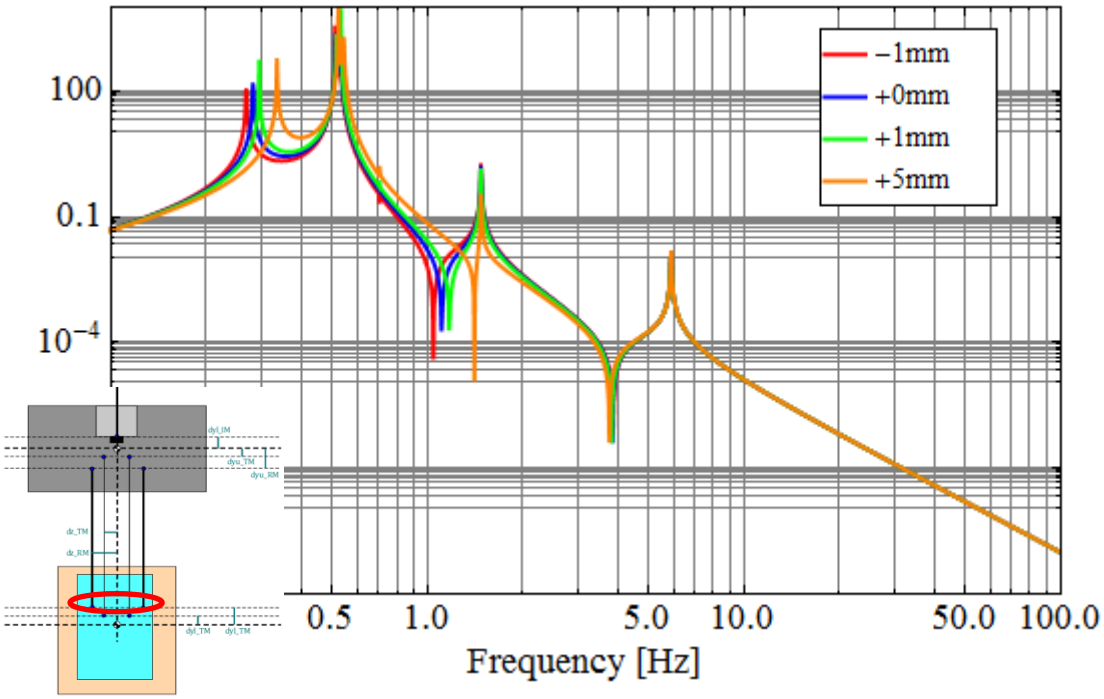
(2) dyu_RM dependence



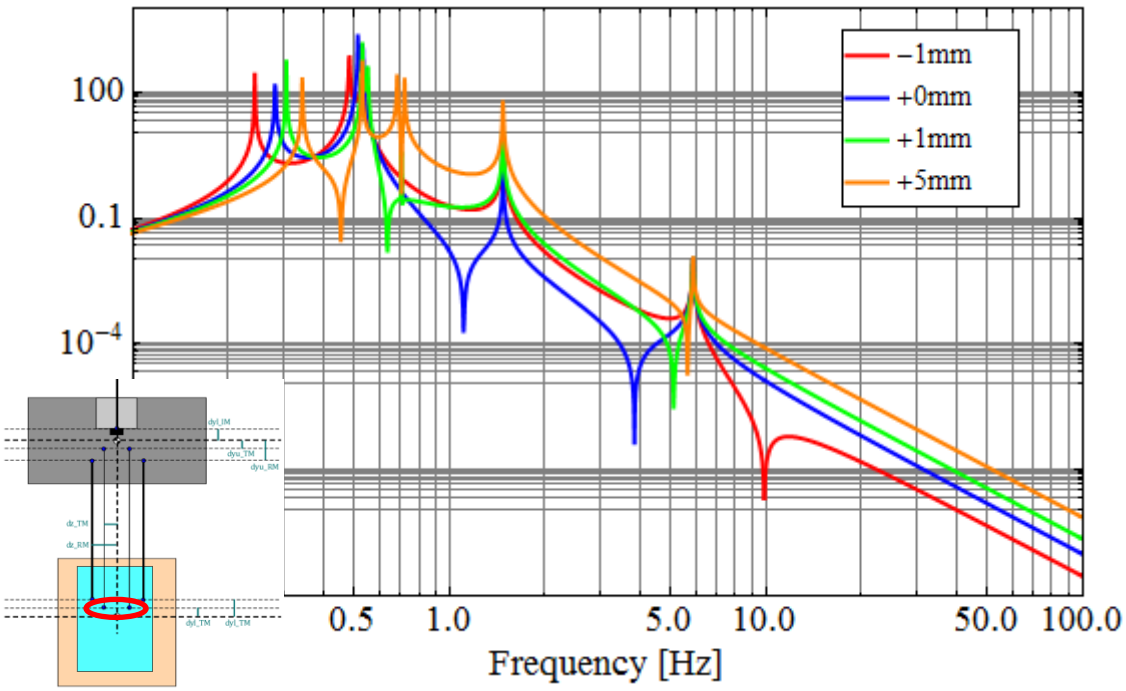
(3) dyu_TM dependence



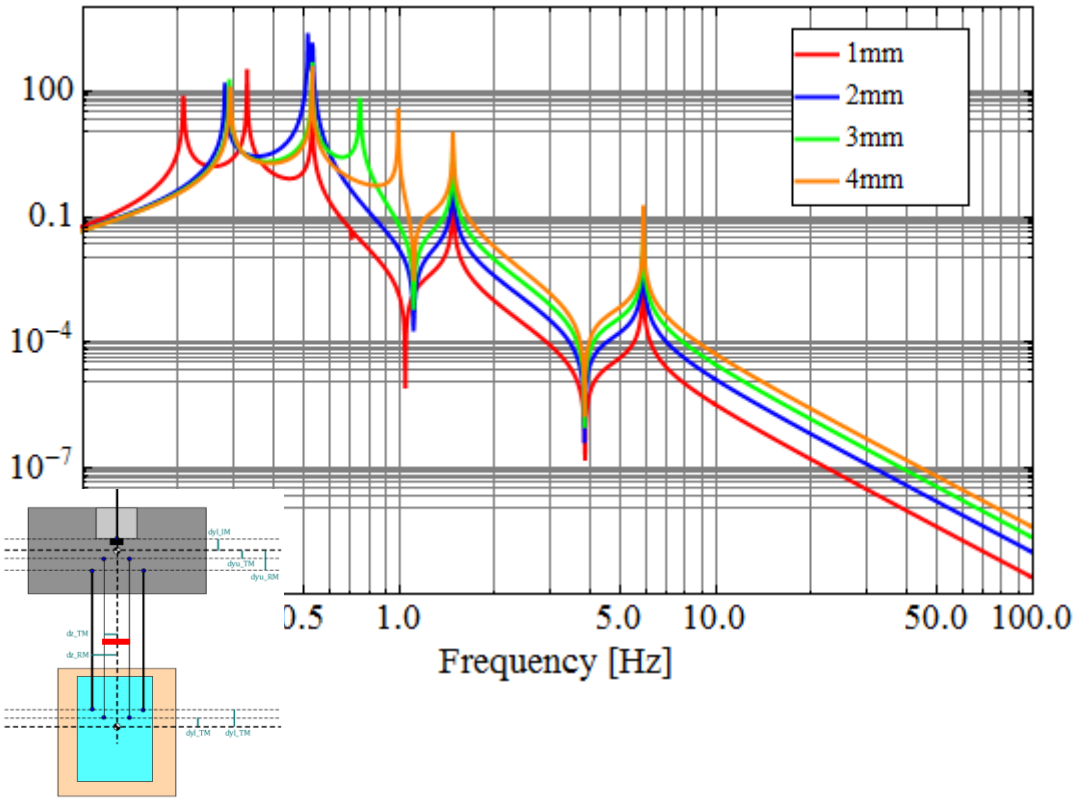
(4)dyl_RM dependence



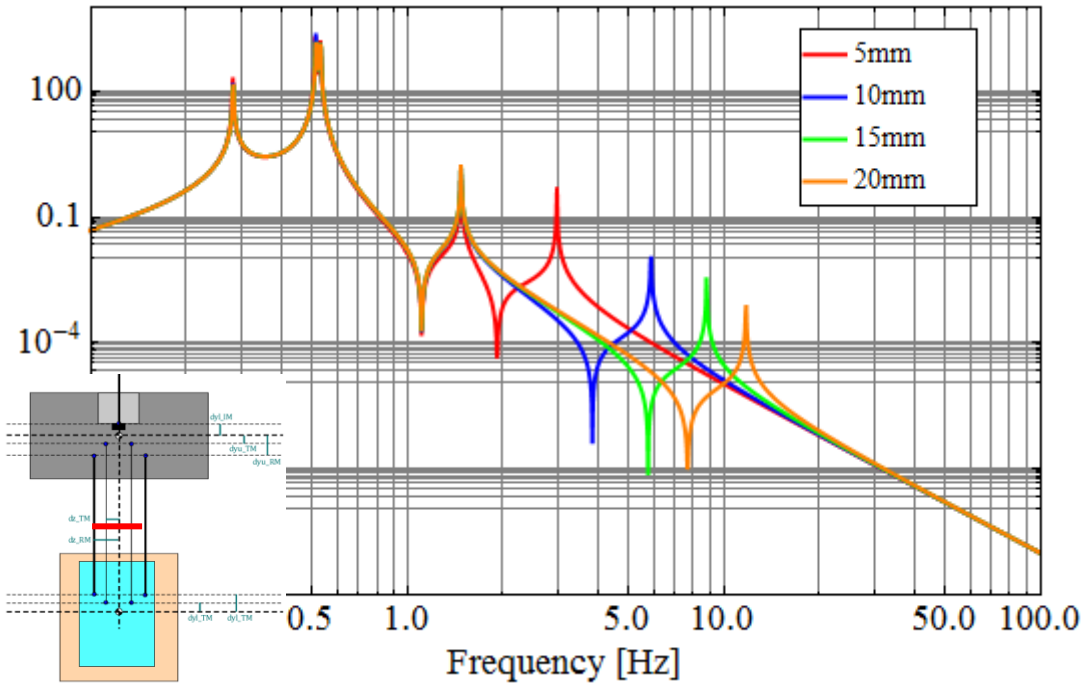
(5)dyl_TM dependence



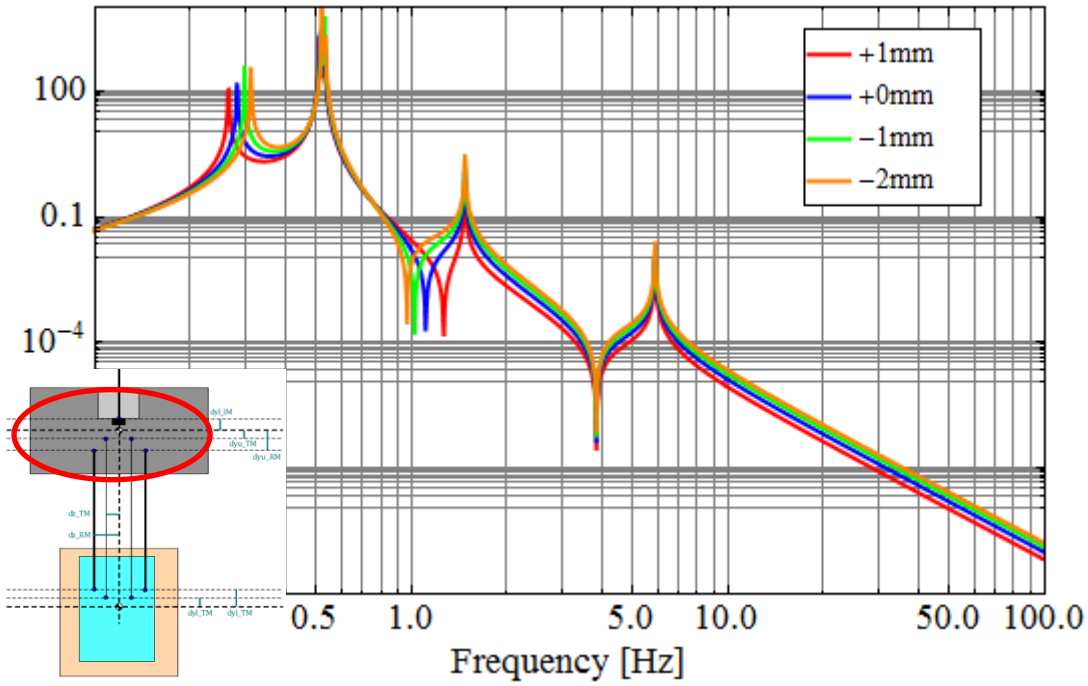
(6) dz_TM dependence



(7) dz_RM dependence



(8) Vertical position of CoM of IM

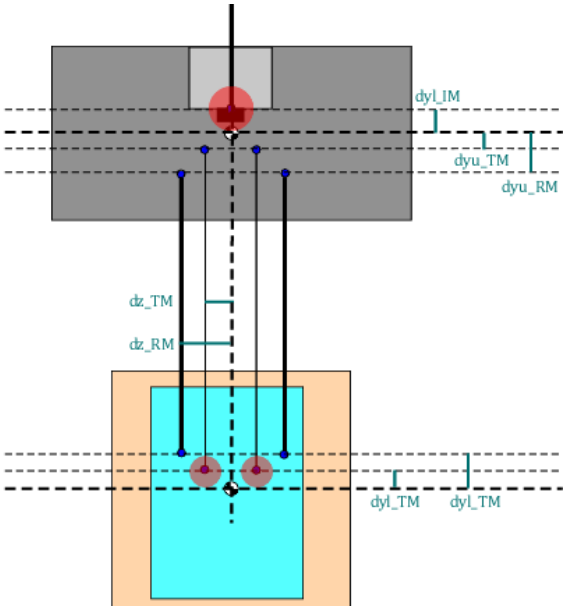


Discussion

Sensitive parts to the longitudinal-pitch transfer function are:

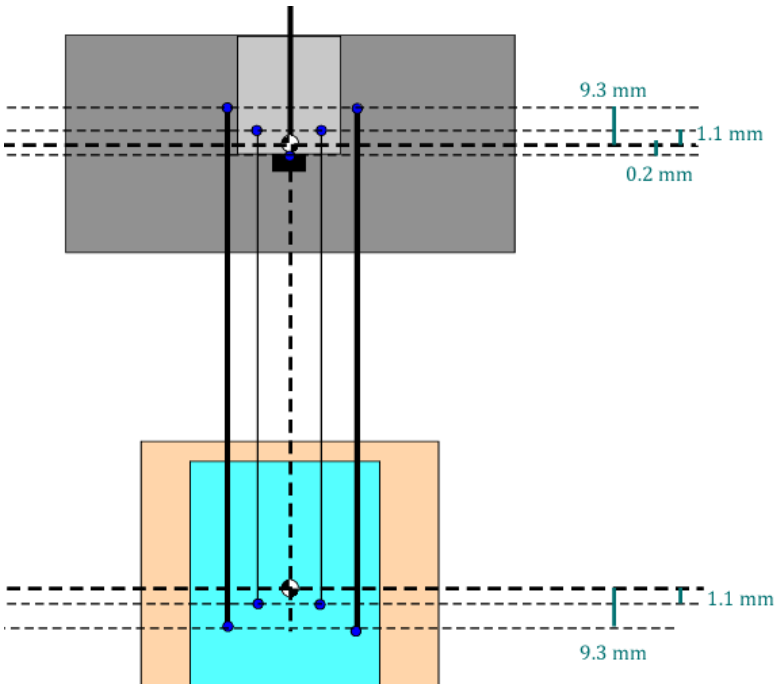
* Upper suspension point @ IM
* Suspension points @ Mirror

These parts must be carefully designed and tuned.

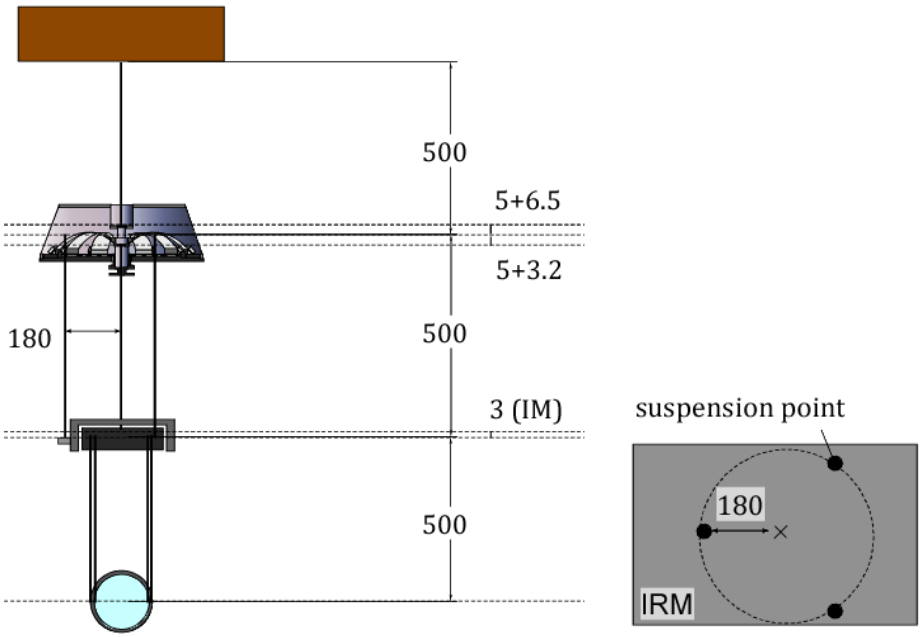


Due to the elasticity of wires, the suspension point and the effective bending point were separated by Sqrt[EI/T]. (E: Young's modulus, I: second moment of area, T: tension) After this compensation, the default design will be:

dyl_IM=-0.2 mm
dyu_TM=dyl_TM =-1.1mm
dyu_RM=dyl_TM=-9.3 mm



2. IRM suspension



Default design:

dyl_F2=11.5 mm, dyu_IM=8.2mm, dyl_IM=3.0 mm,

dyu_IRM=dyl_IRM =0 mm

(Note: suspension point = bending point of the wire)

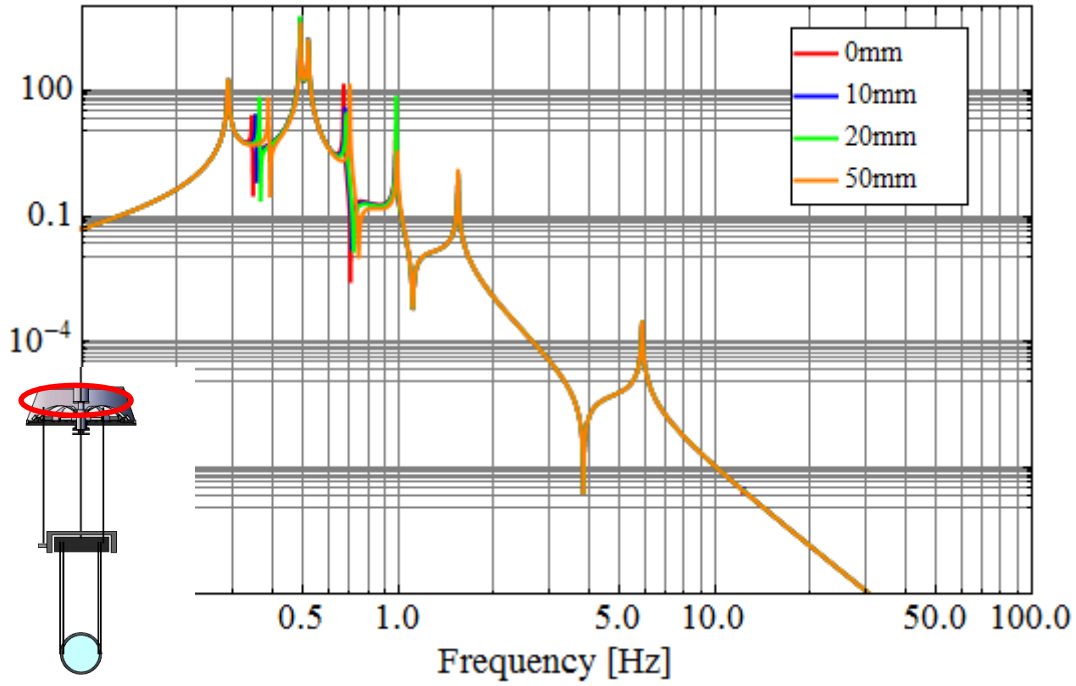
IRM is suspended by three wires.

The horizontal distance between a wire and the center of IRM is 18 cm.

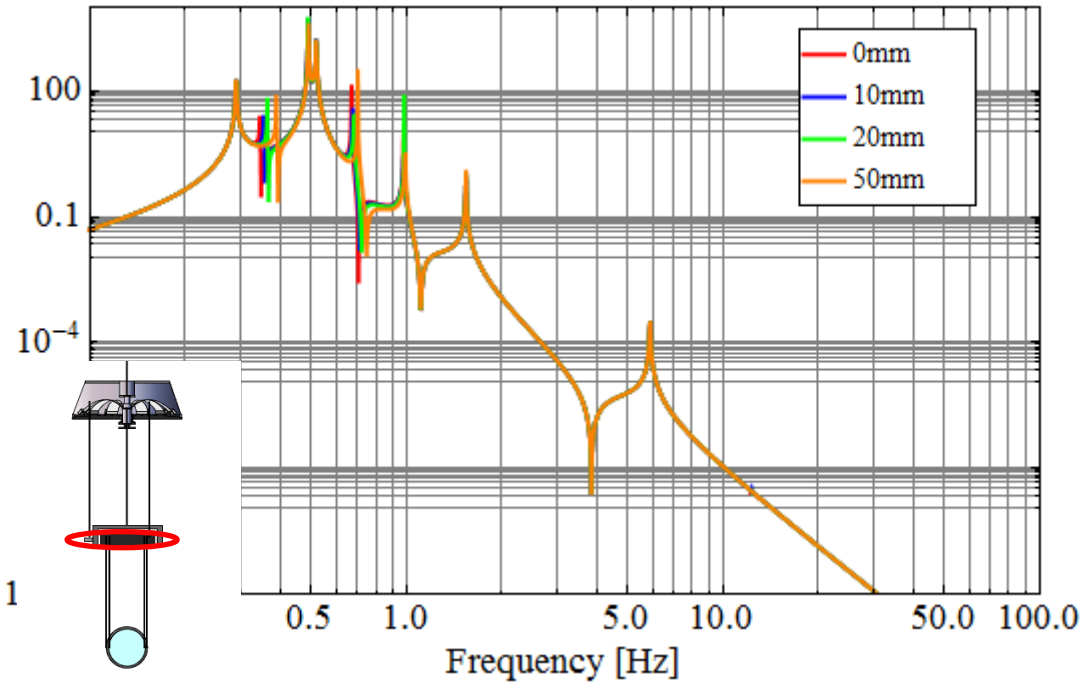
(In the top view, the suspension points are on the corners of a regular triangle)

The following plots are the transfer functions, from the top motion (in horizontal direction) to the mirror pitch motion (z_ground → tx_mirror).

(1) dyu_IRM dependence

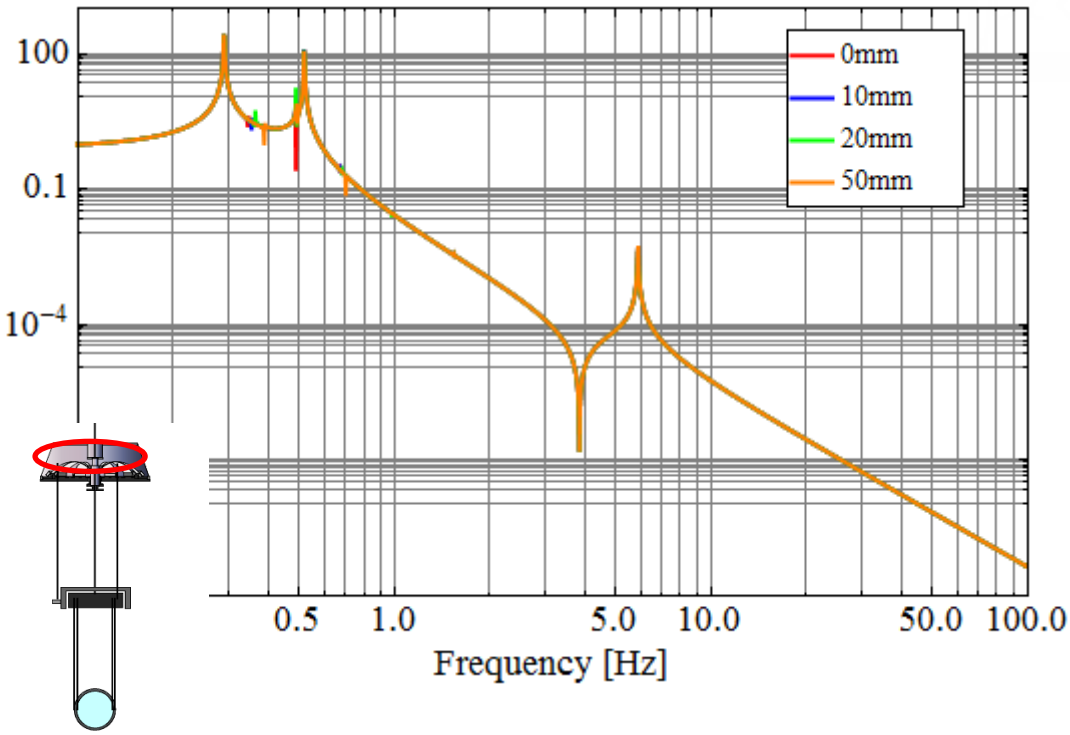


(2) dyl_IRM dependence

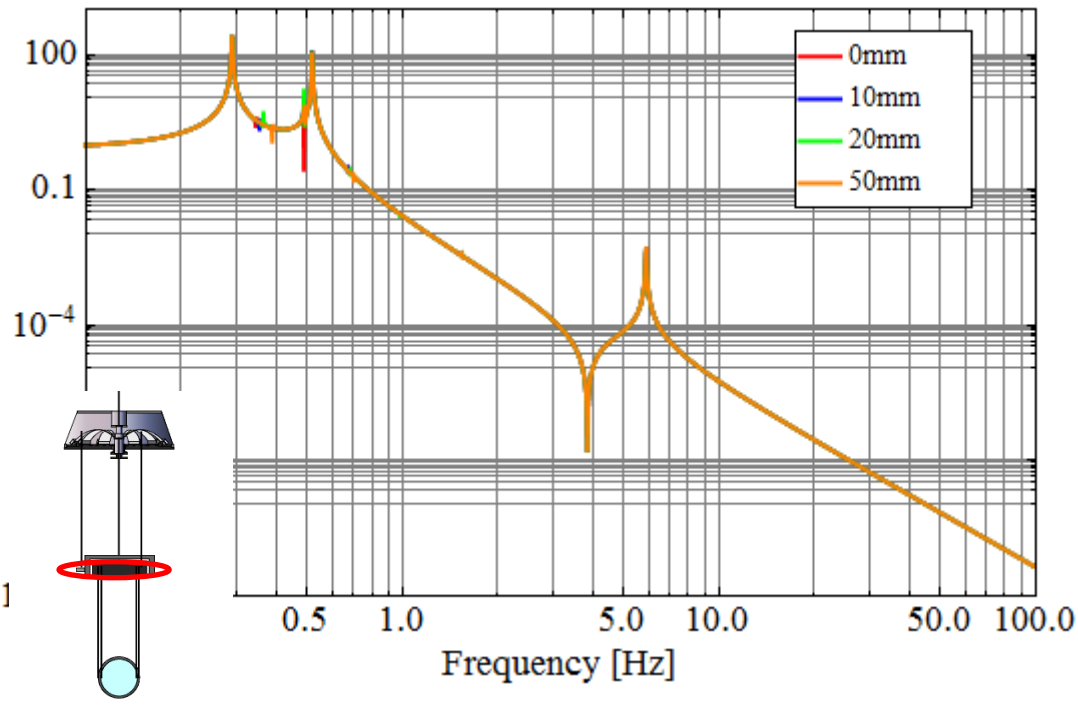


The following plots are the frequency response of the mirror pitch motion, when torque is exerted to IM from actuators on IRM (Tx_IM - Tx_IRM → tx_mirror).

(3) dyu_IRM dependence



(2) dyl_IRM dependence



Discussion

Changes in vertical positions of the suspension points on the IRM suspension do not change the frequency response of the system.

3. GAS Filters