JGW-G1302026

Cryogenic Payload Modeling: Vibration via Heat Links

Cryogenic Payload Meeting
2013.12.3

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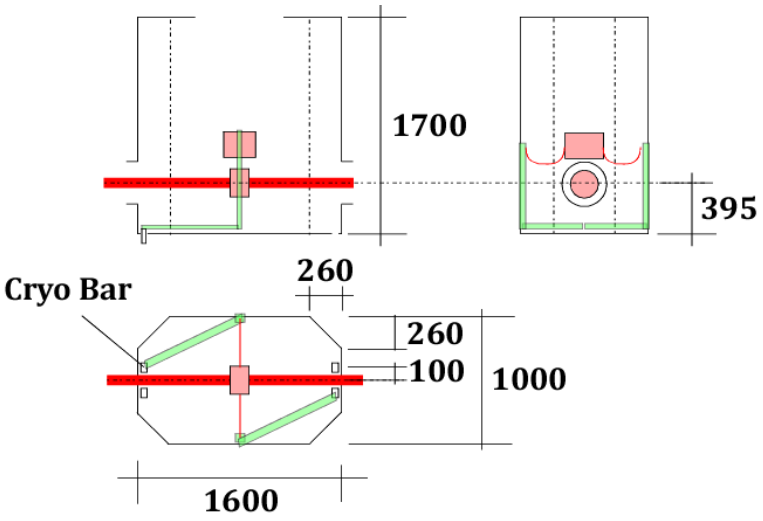
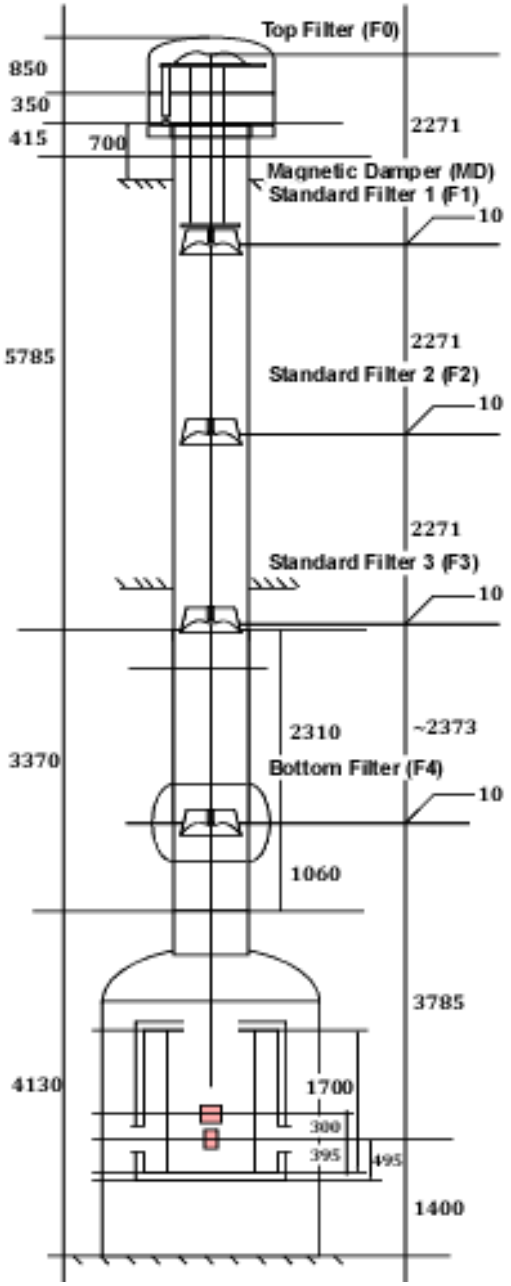
Design Updates

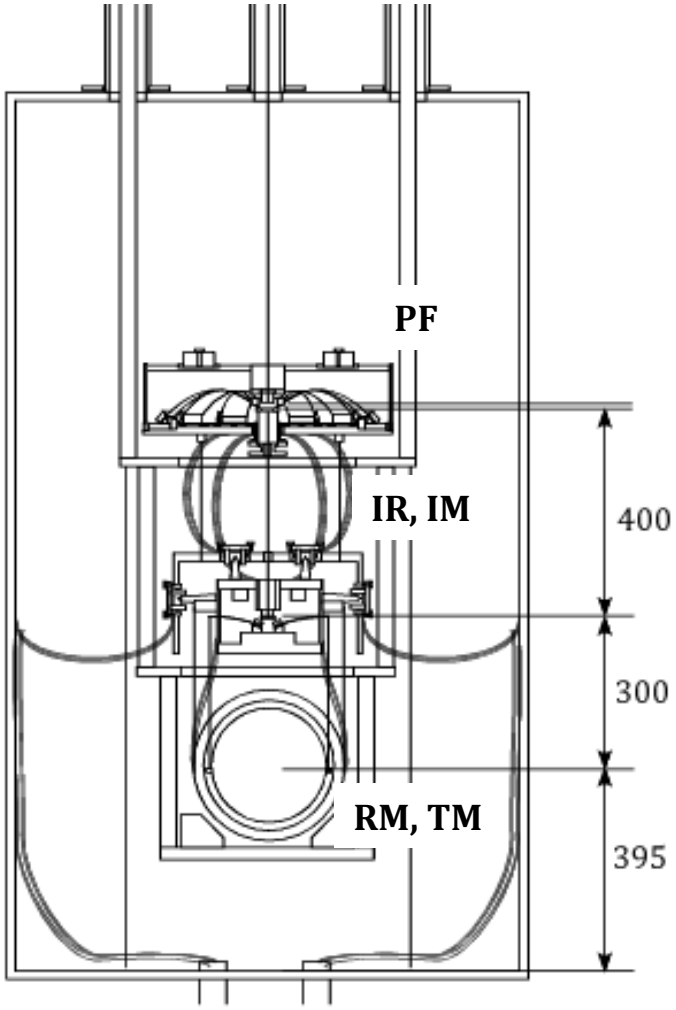
Type-A SAS Dimension

- **References :**
  - Type-A SAS by R. DeSalvo (JGW-D1200904-v3, last update: 2013/04/08)
  - Type-A vacuum chamber (drawing #: VM5926, last update: 2013/06/26)
  - KAGRA cryostat (drawing #: 1KN005806, last update: 2012/07/09)
  - Inner radiation shield (drawing #: 1KN005807, last update: 2012/05/16)





Cryogenic Payload Tentative Parameters



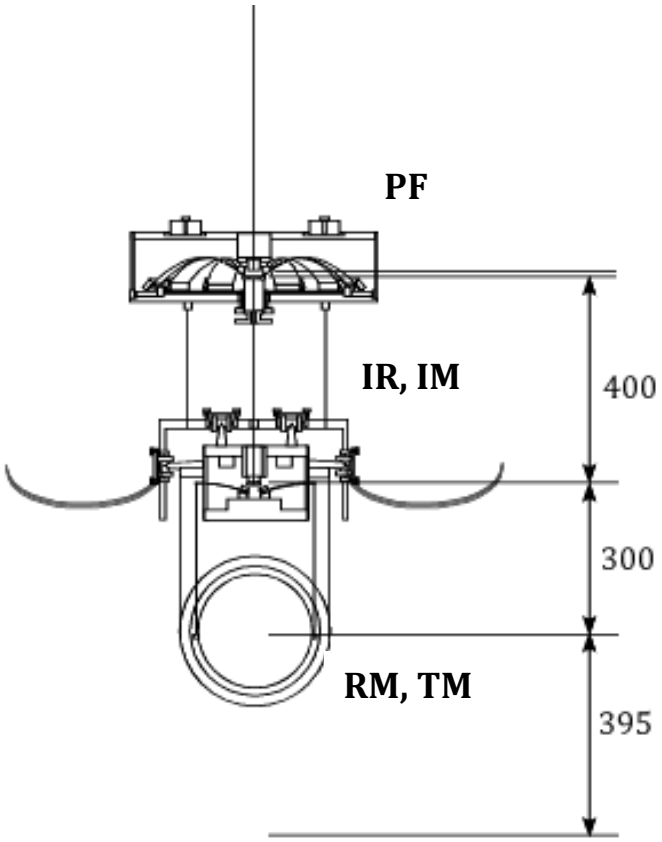
Mass Distribution

Platform	PF	62 kg
Intermediate Recoil Mass	IR	45 kg
Intermediate Mass	IM	53 kg
Recoil Mass	RM	34 kg
Test Mass	TM	23 kg
Total		**217 kg**

Spring Rate

	Q	F_0
GAS Filter at PF-IM	1E3	0.5 Hz
Sapphire springs at IM-TM	1E6	10 Hz

Cryogenic Payload Tentative Parameters



Wire Dimension

	#	L	Φ	σ [MPa]	dx	dy
PF-IM	1	400	1.8	390	-	-
PF-IR	3	230	1.0	220	120	
IM-RM	4	300	0.4	580	25	145
IM-TM	4	300	1.6	28	15	125

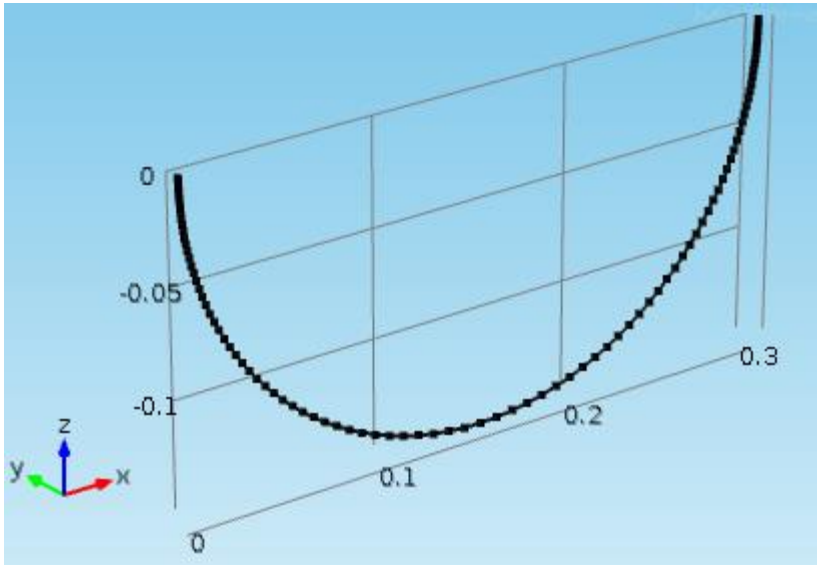
Heat Links

	#	L	R	Φ	Strand #
CB-IR	4	470	150	0.15	45

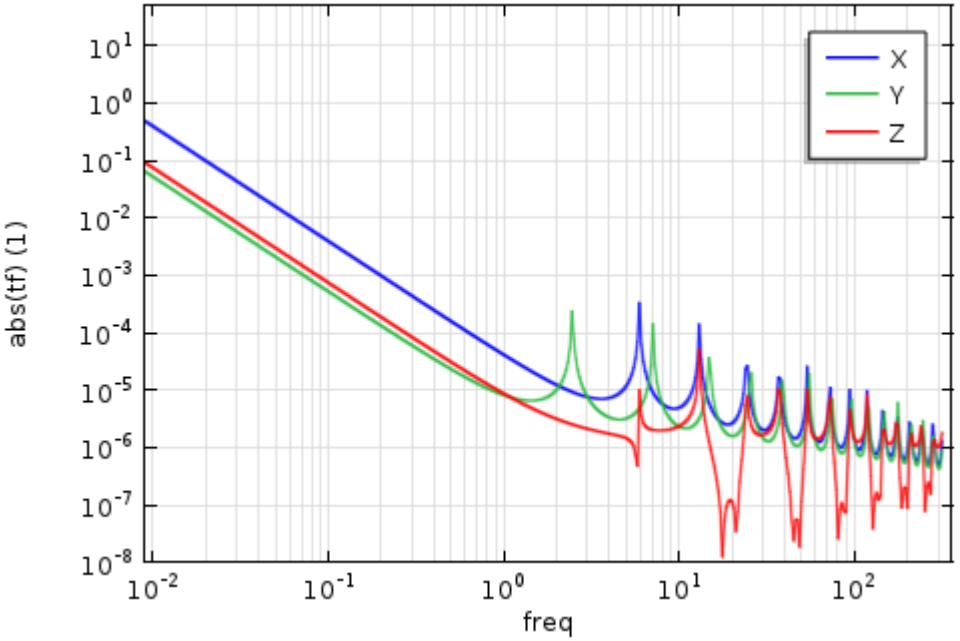
Heat Link Design and Vibration Transmissivity

Conventional heat link design (a=400mm, b=200mm, L=974mm) is not feasible in the limited space of the current cryostat design. Shorter fibers are certainly necessary:

- Pure aluminum (E=70GPa, Loss=1E-2)
- Semi-circular shape with R150, L=470
- Number of fibers: 2x2=4 (symmetric cabling)
- Each fiber consists of 45 strands with Φ0.15



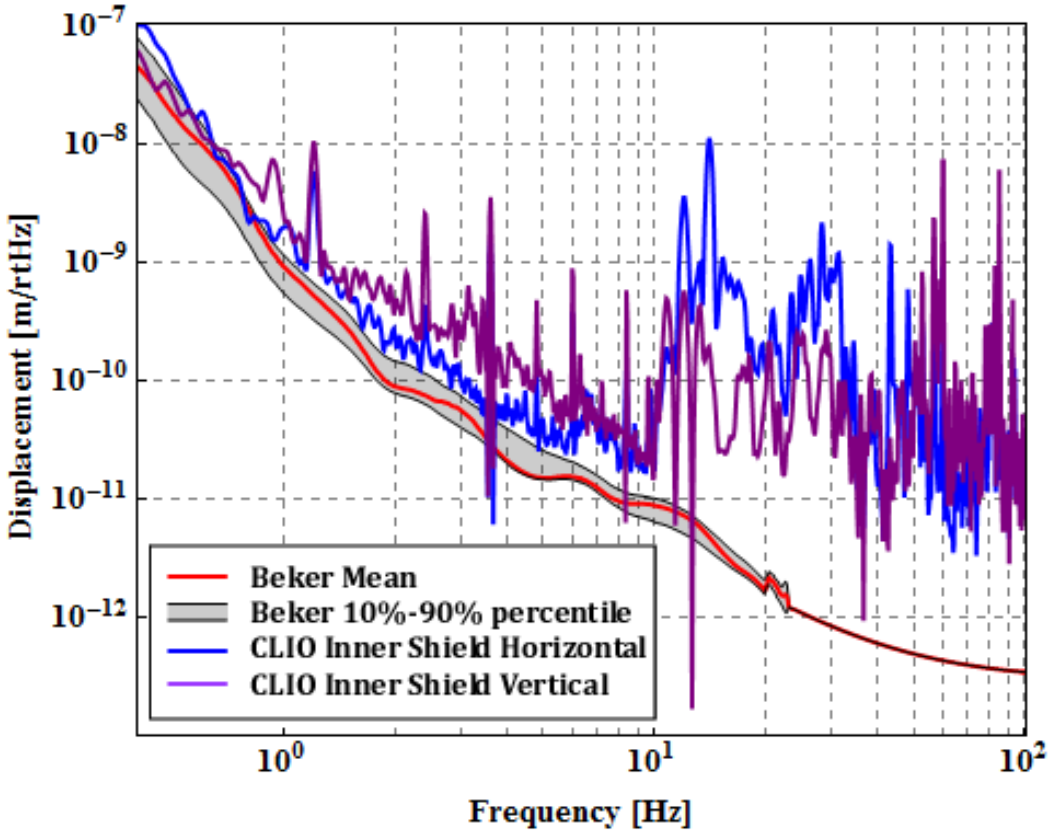
Simulated TF of a strand fiber:
Attached to a 50kg Mass



Vibration via Heat Links

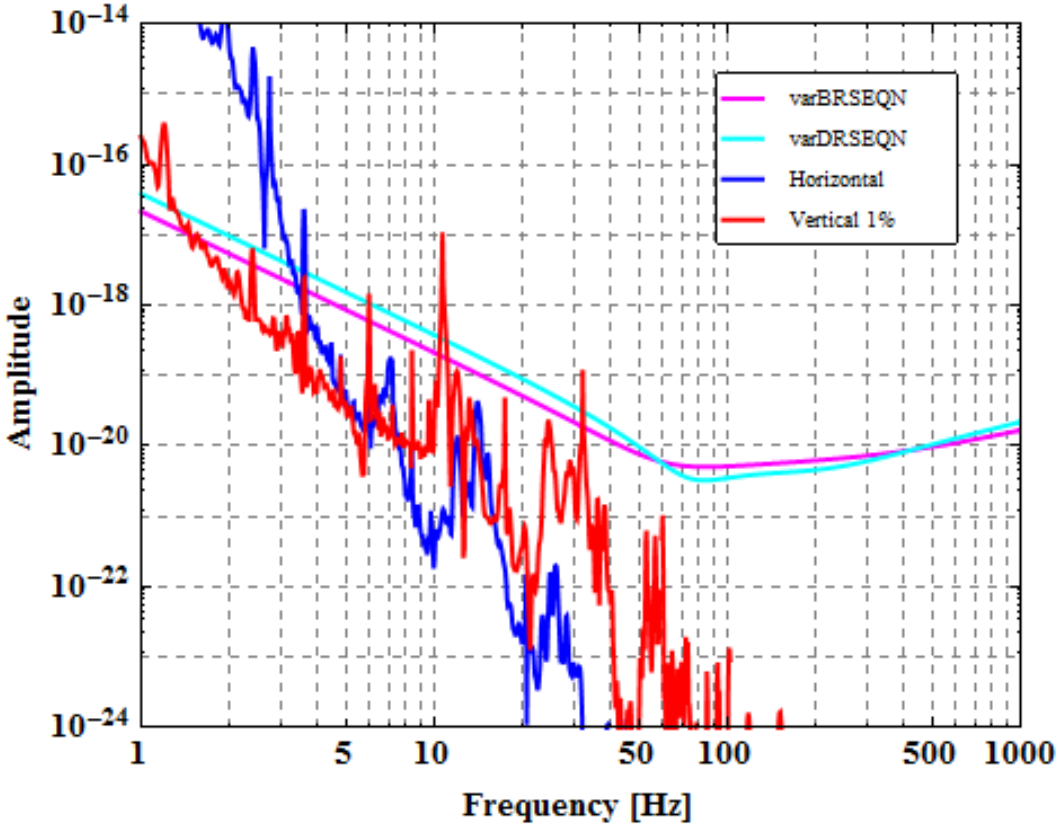
Cryostat Vibration Model

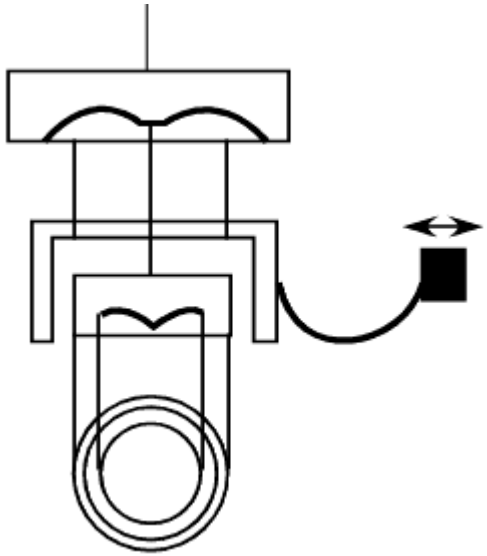
- From CLIO:



Type-B Like Default Design

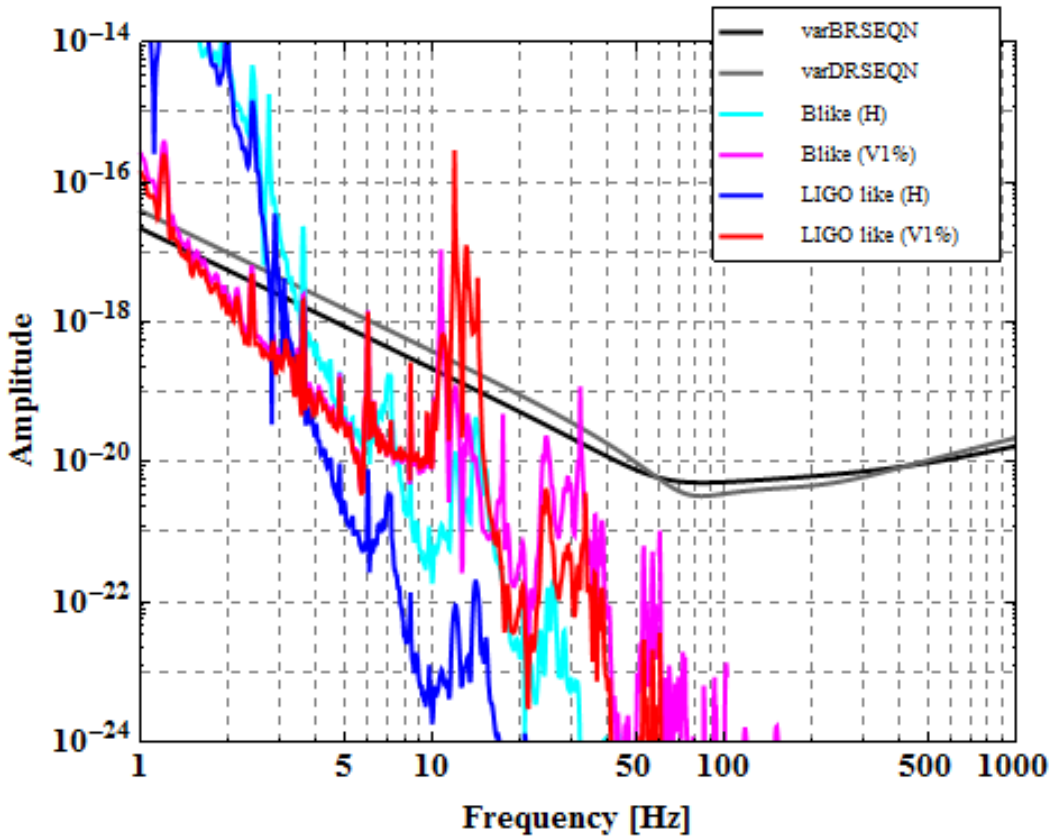
- GAS filter @PF tuned at 0.5 Hz
- Sapphire cantilever with 10 Hz bounce frequency



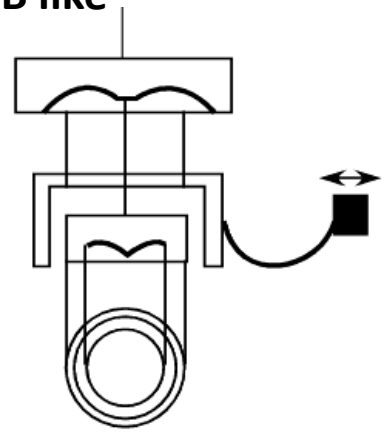


Type-B Like V.S. LIGO Like

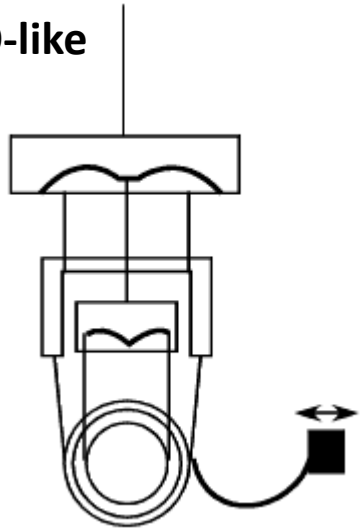
- Anyway vertical noise is harmful…



Type-B like

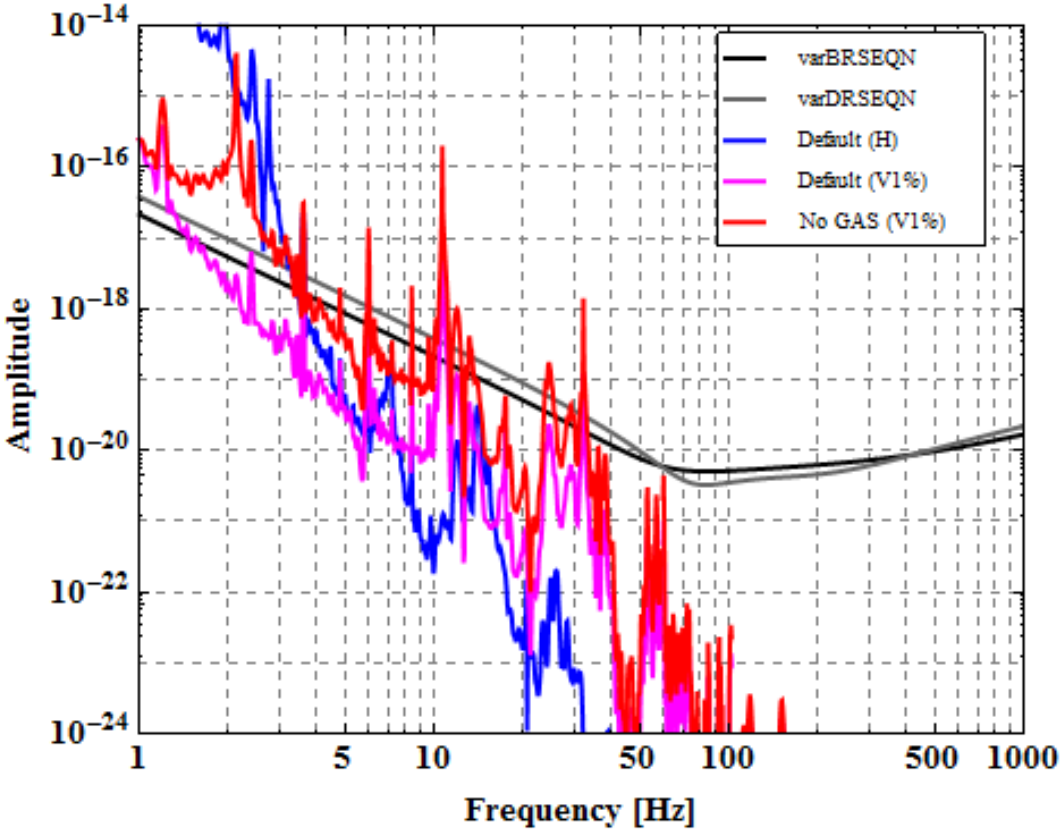


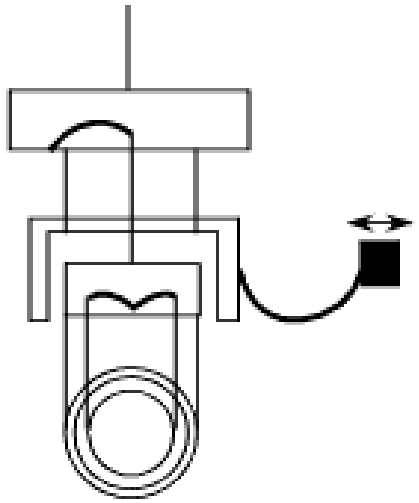
LIGO-like



Type-B Like NO GAS

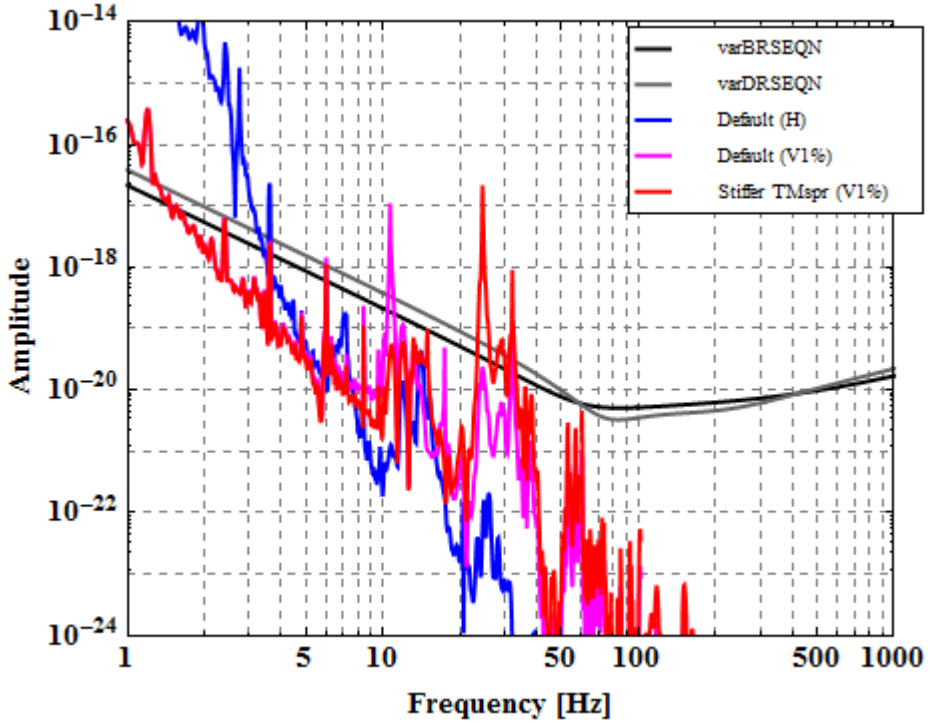
- Normal Spirng @PF tuned at **1.5 Hz**
- Worse attenuation around 10 Hz…

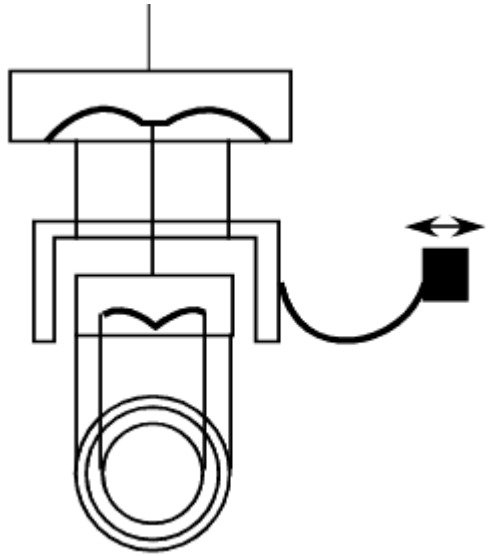




Type-B Like, Stiffer TM Spring

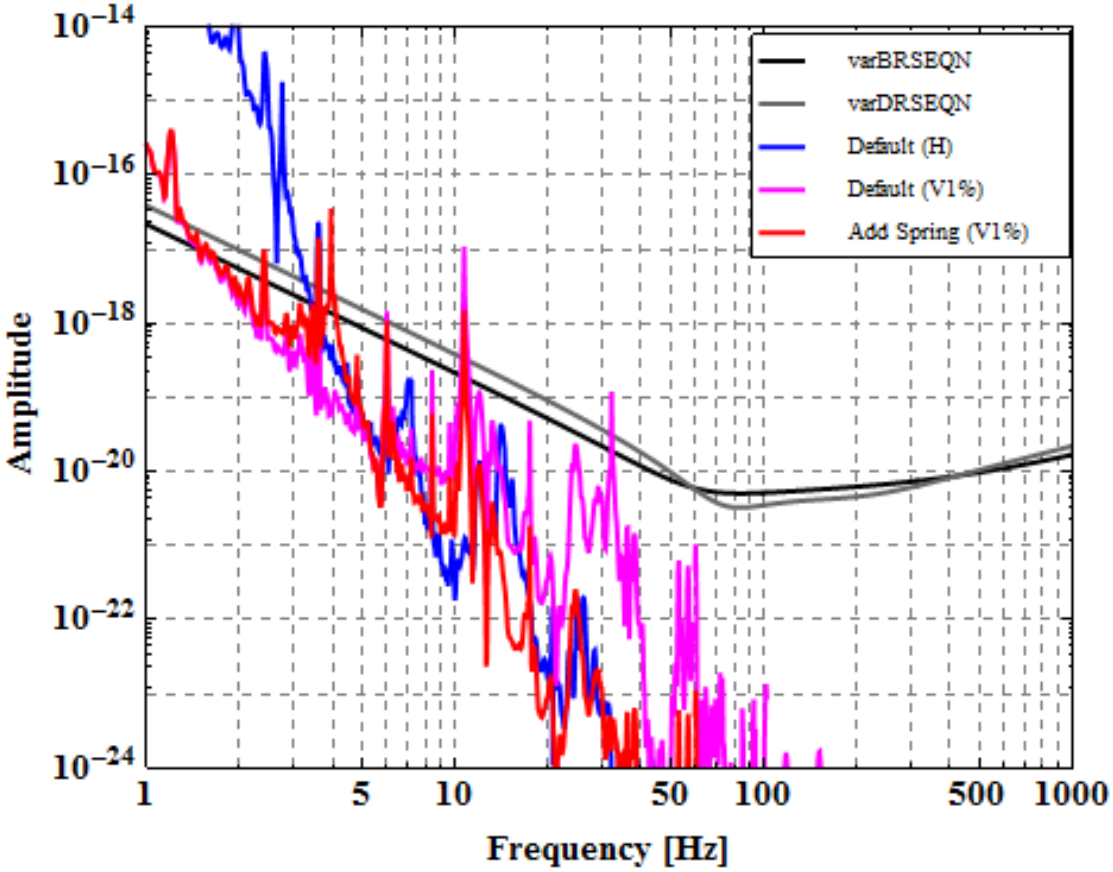
- Sapphire cantilever with **20 Hz** bounce frequency
- Get worse >20 Hz

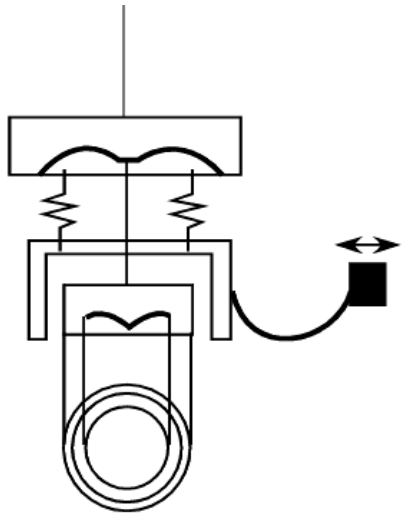




Type-B Like + V Spring for IRM

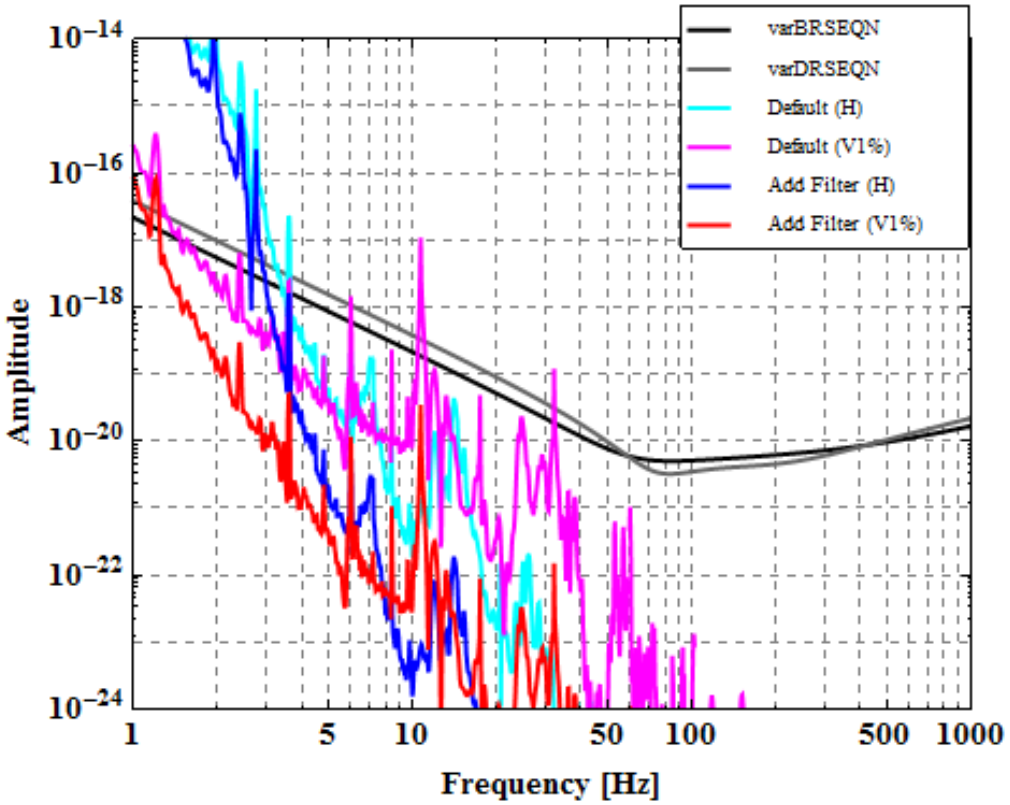
- Adding springs for IR suspension with 3 Hz resonant freq
- Better attenuation above 10 Hz
- **Difficulty in assembly: How to compensate large drift after cooling??**

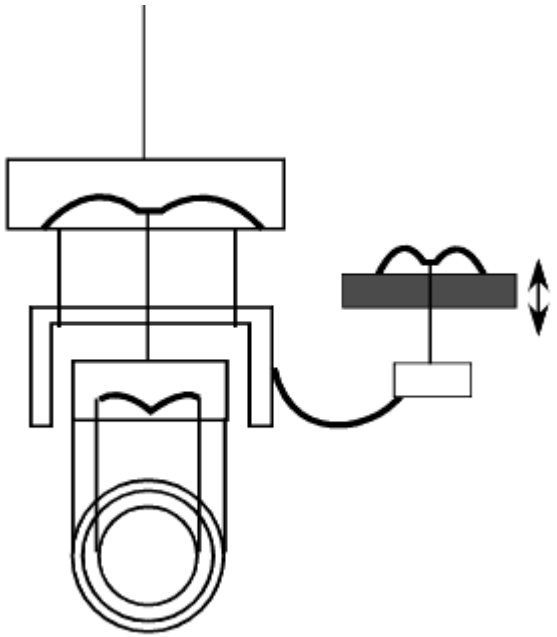




Type-B Like + 1 More Filtering

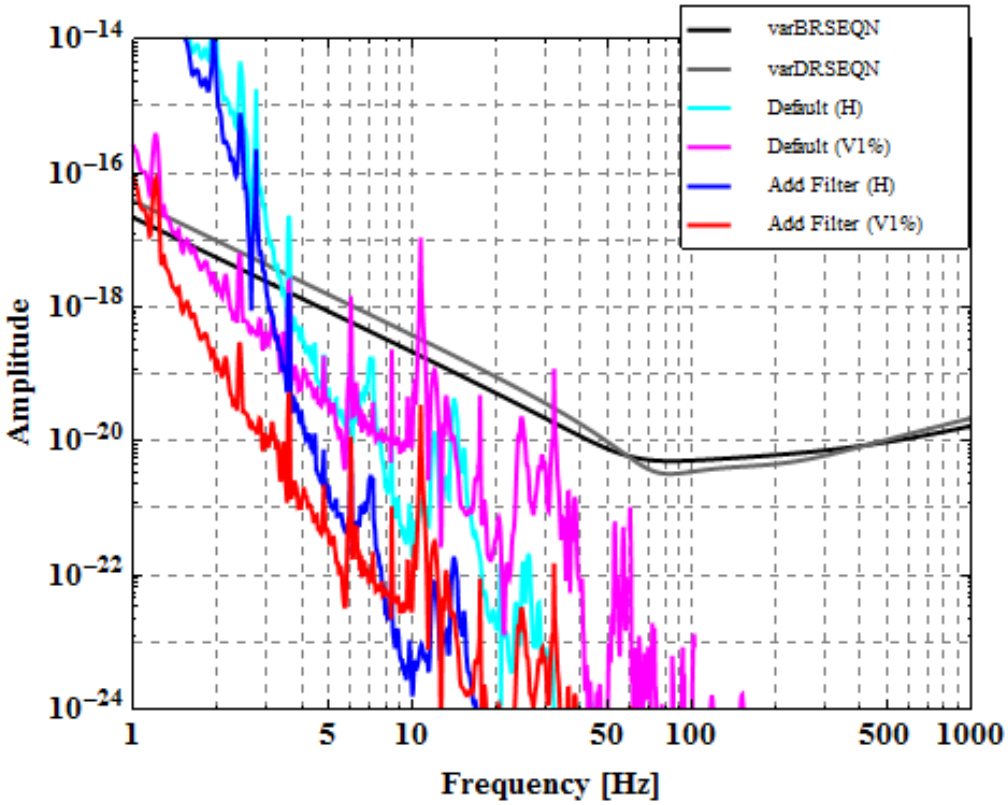
- GAS filtering (tuned at 0.5 Hz) in front of the suspension
- Certainly the vibration is attenuated by additional filter

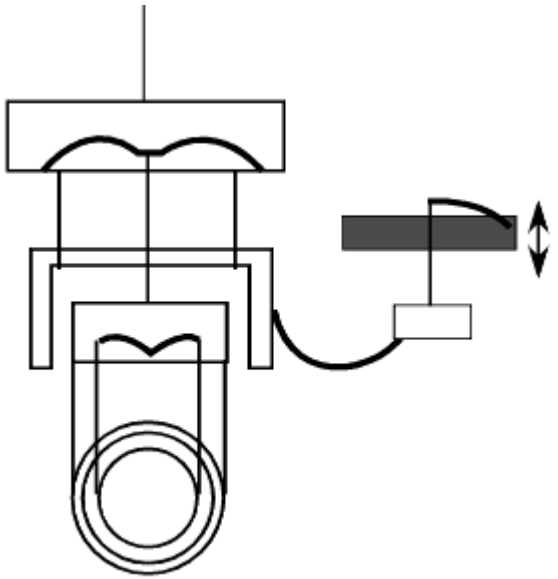




Type-B Like + 1 More Filtering (2 Hz)

- Normal Spring (resonance at 2 Hz) in front of the suspension
- Even 2 Hz spring helps a lot.





TO BE INVESTIGATED

- Effect of heat links between masses
- Optimization of heat link geometry