

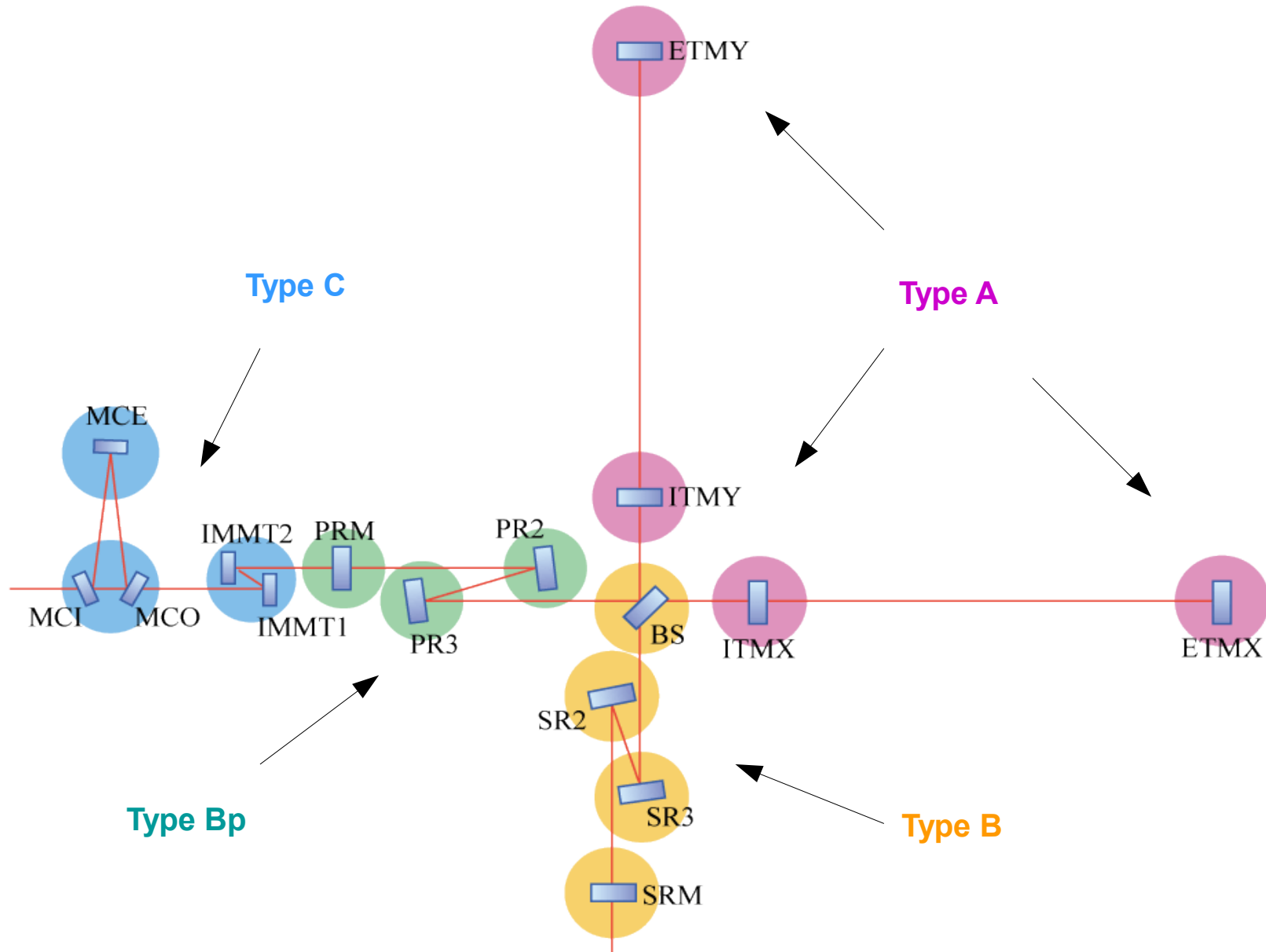


VIS Suspensions and digital system

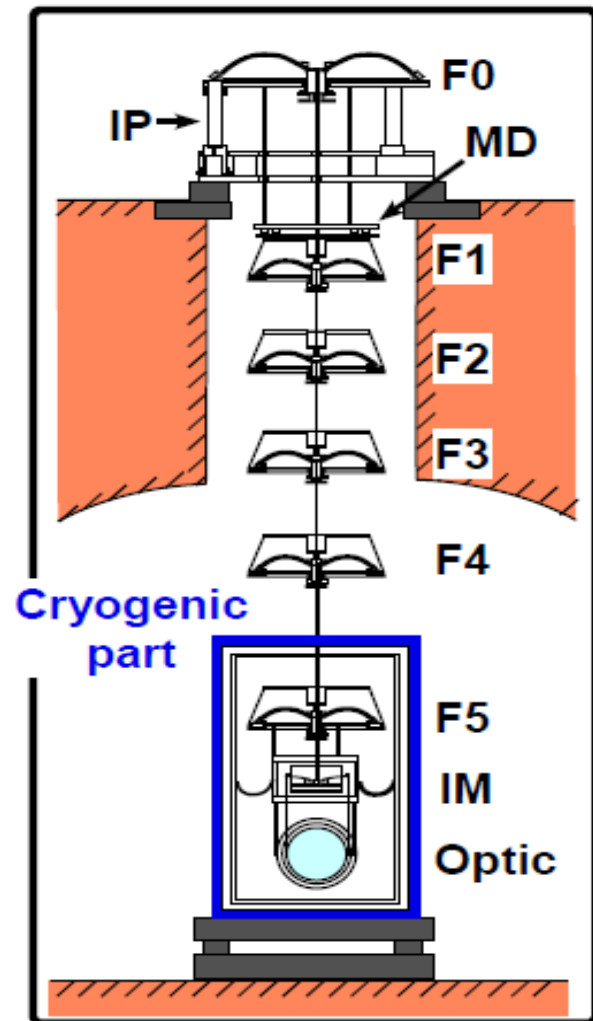
Enzo Tapia
Lecture 1



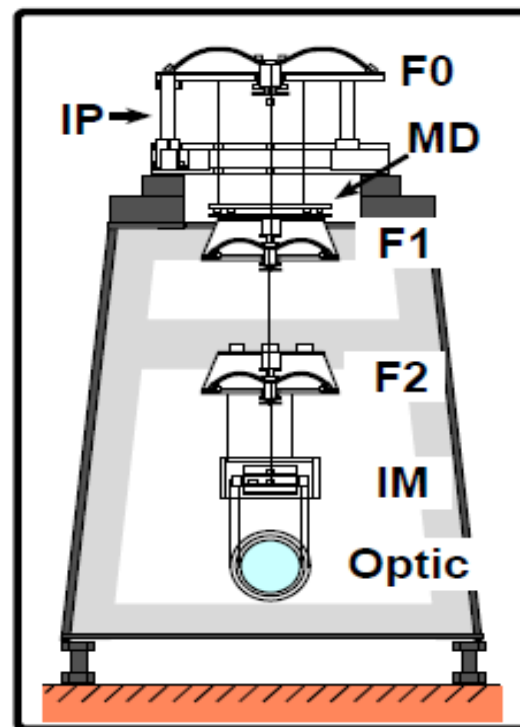
VIS Suspensions



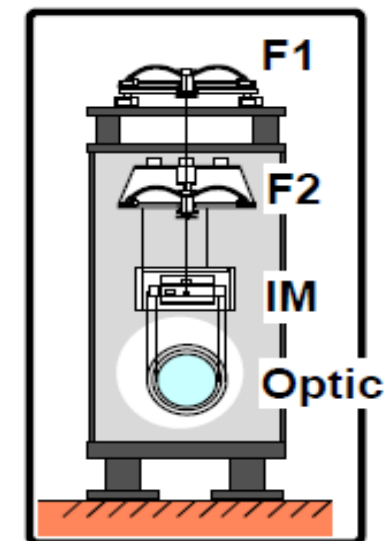
VIS Suspensions



Type-A



Type-B



Type-Bp

Type Bp: PRs

- PR2.
- PR3.
- PRM.

Top Stage

Standard Filter (BF)
Traverser

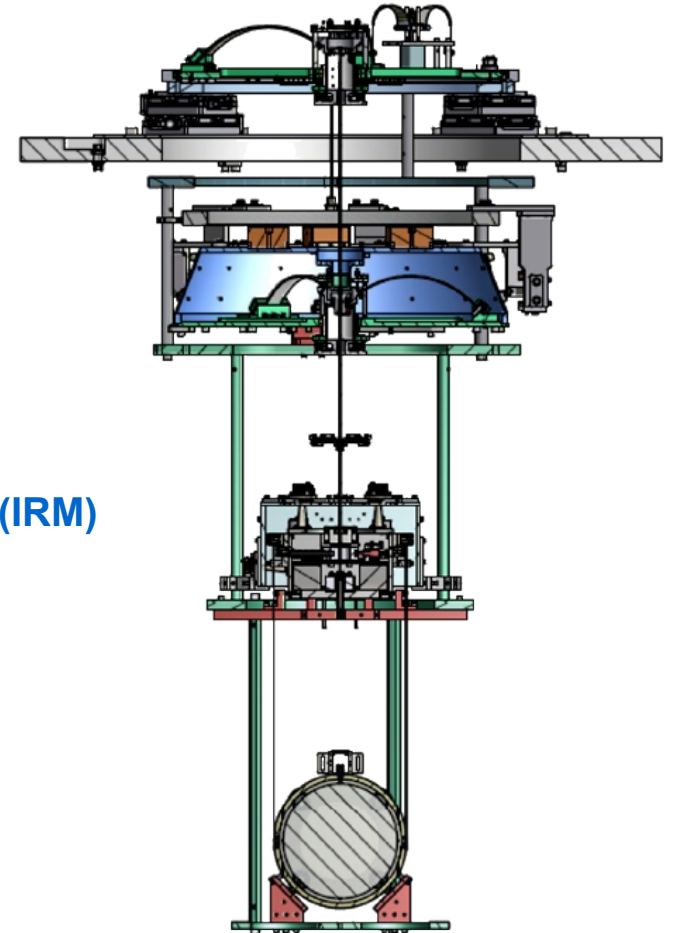
GAS Filter

BF Recoil Mass (BFRM)
Bottom Filter (BF)

Payload

Intermediate Recoil Mass (IRM)
Intermediate Mass (IM)

Recoil Mass (RM)
Optics (SR)



Type B: BS and SRs

- BS
- SR2.
- SR3.
- SRM.

Pre-Isolator

Top Filter (TF)
Filter0 (F0)

Inverted Pendulum (IP)

GAS Filter
chain

Standard Filter (SF)

Bottom Filter (BF)

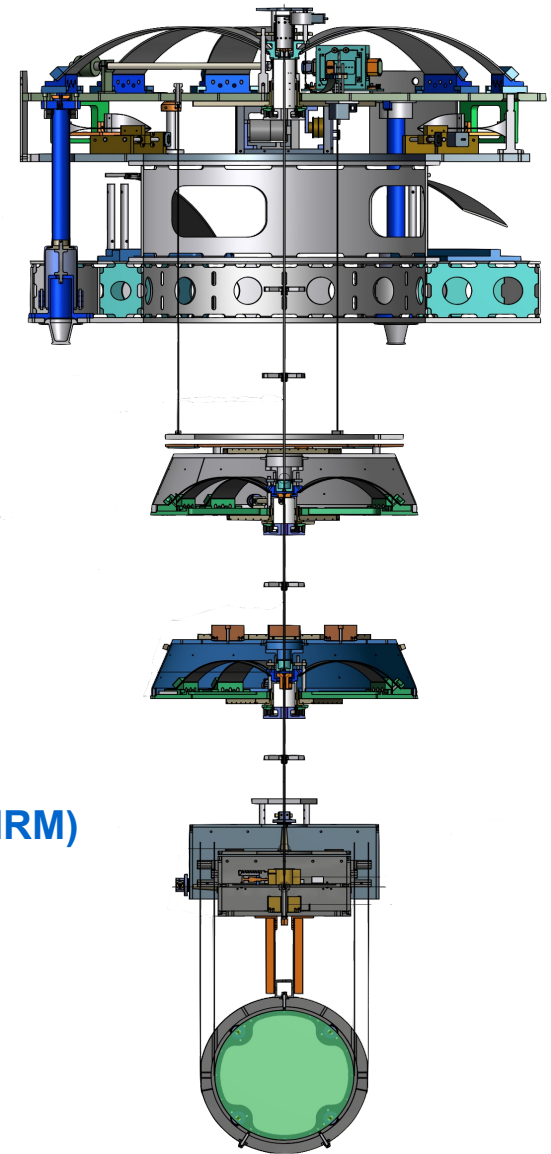
Payload

Intermediate Recoil Mass (IRM)

Intermediate Mass (IM)

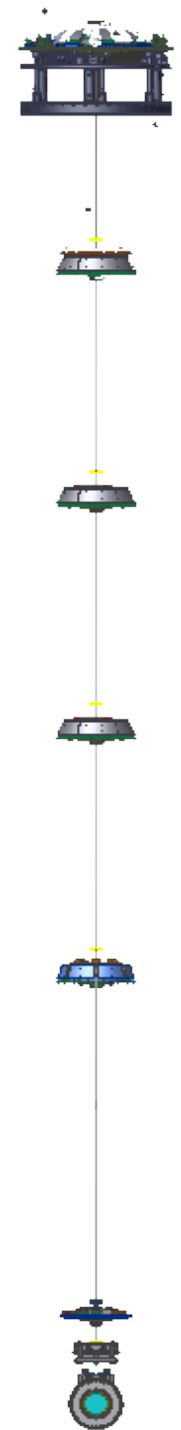
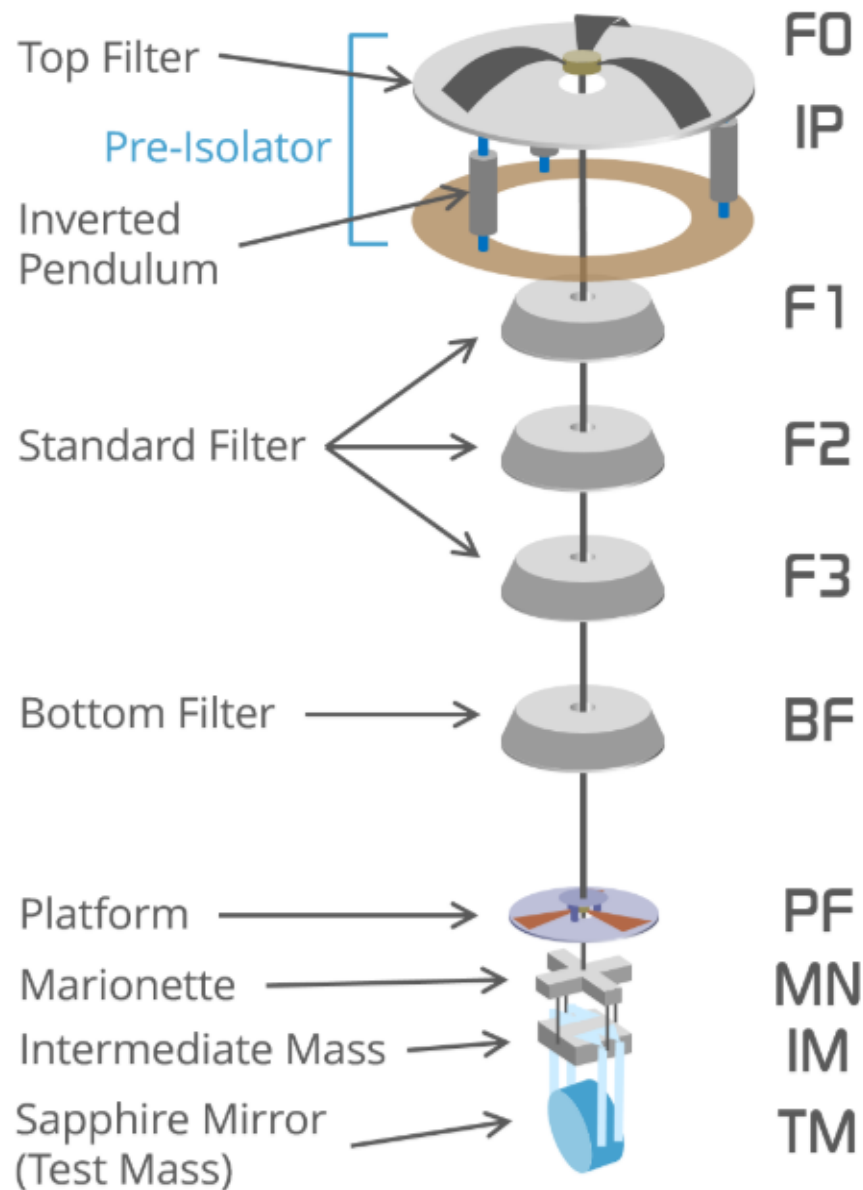
Recoil Mass (RM)

Optics (SR)



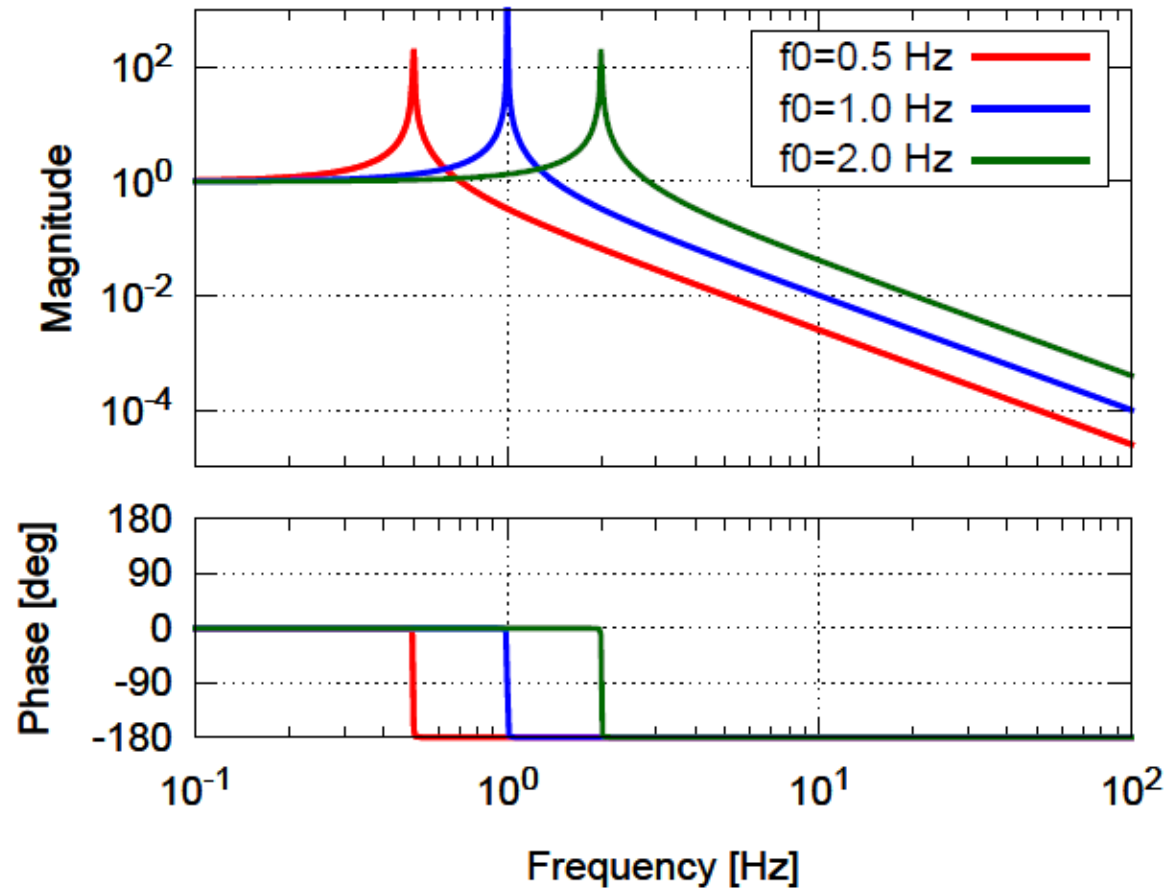
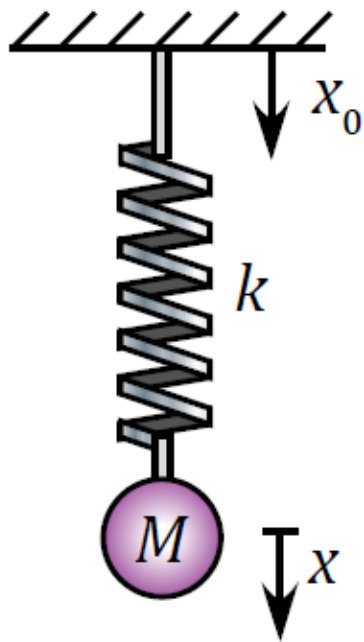
Type A: ITM and ETM

- ITMX.
- ITMY.
- ETMX.
- ETMY.



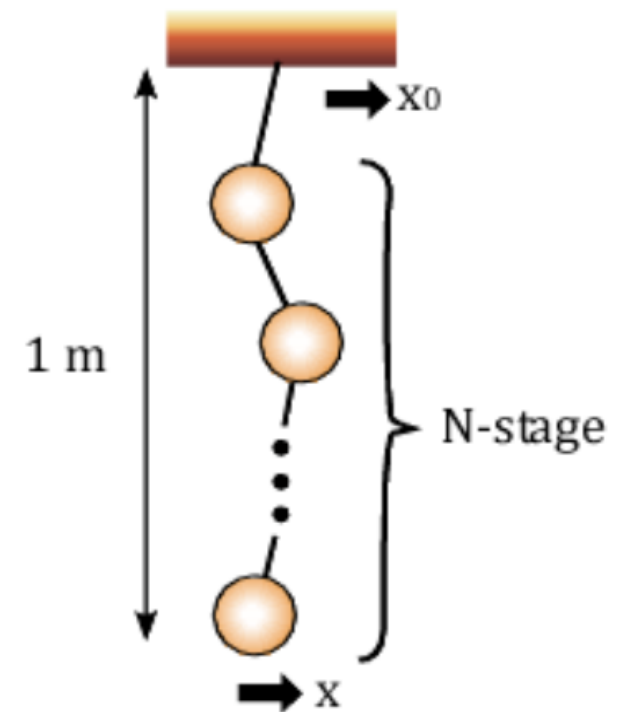
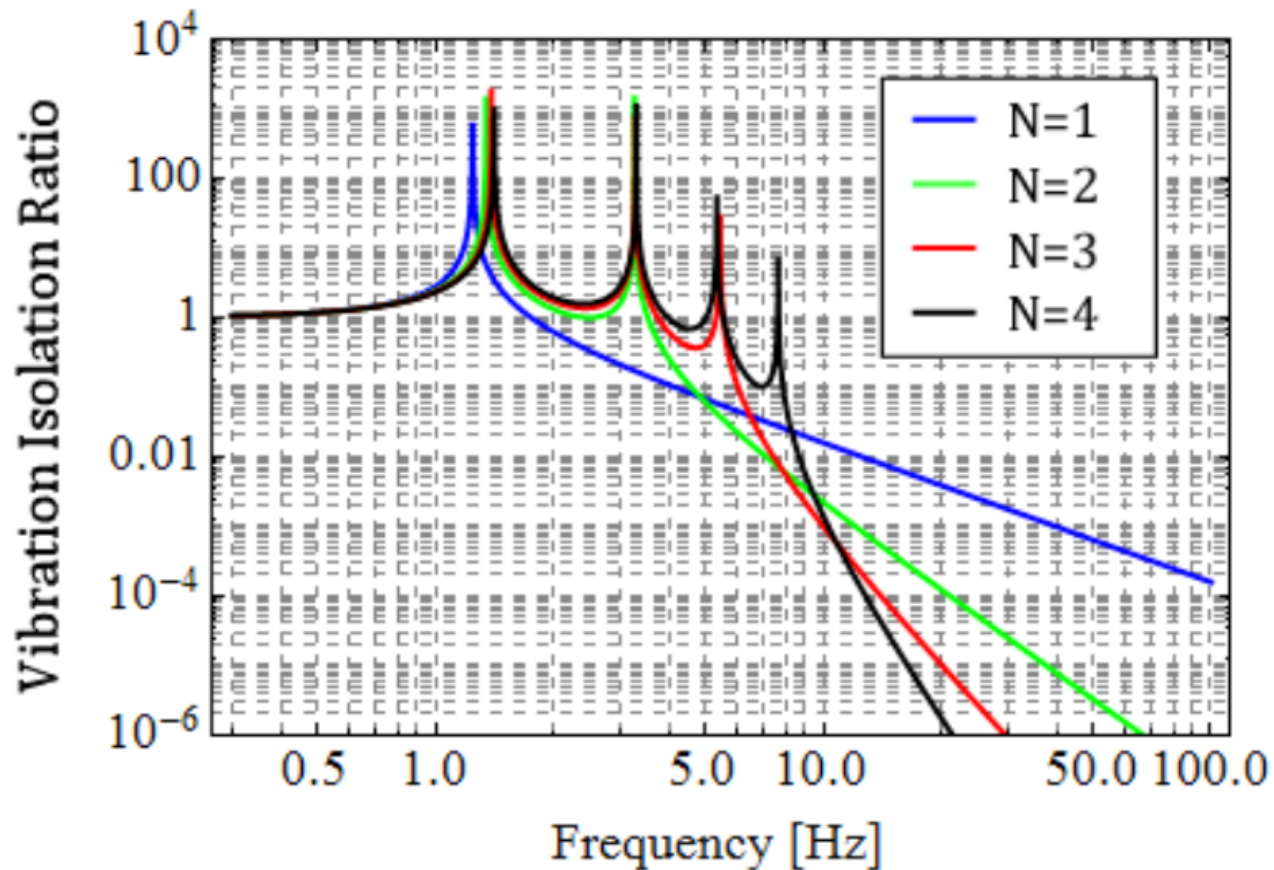
Vibration Isolation 1

The isolation can be done using pendulums and springs.

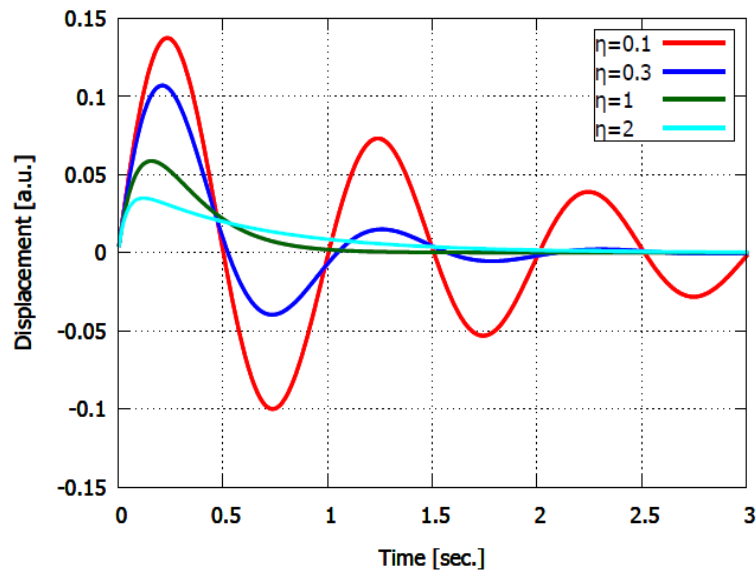


Vibration Isolation 2

The isolation can be done using pendulums and springs.



Vibration Isolation 3

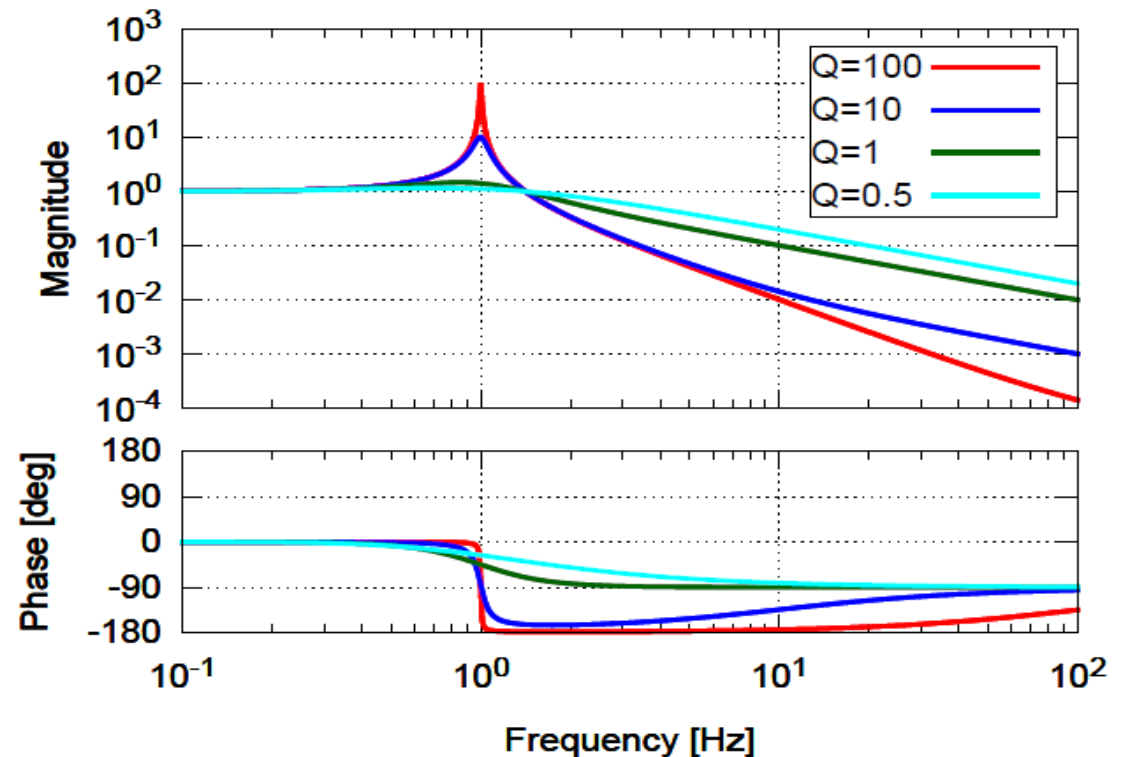


- Viscuous damping with different damping factors (ratio).

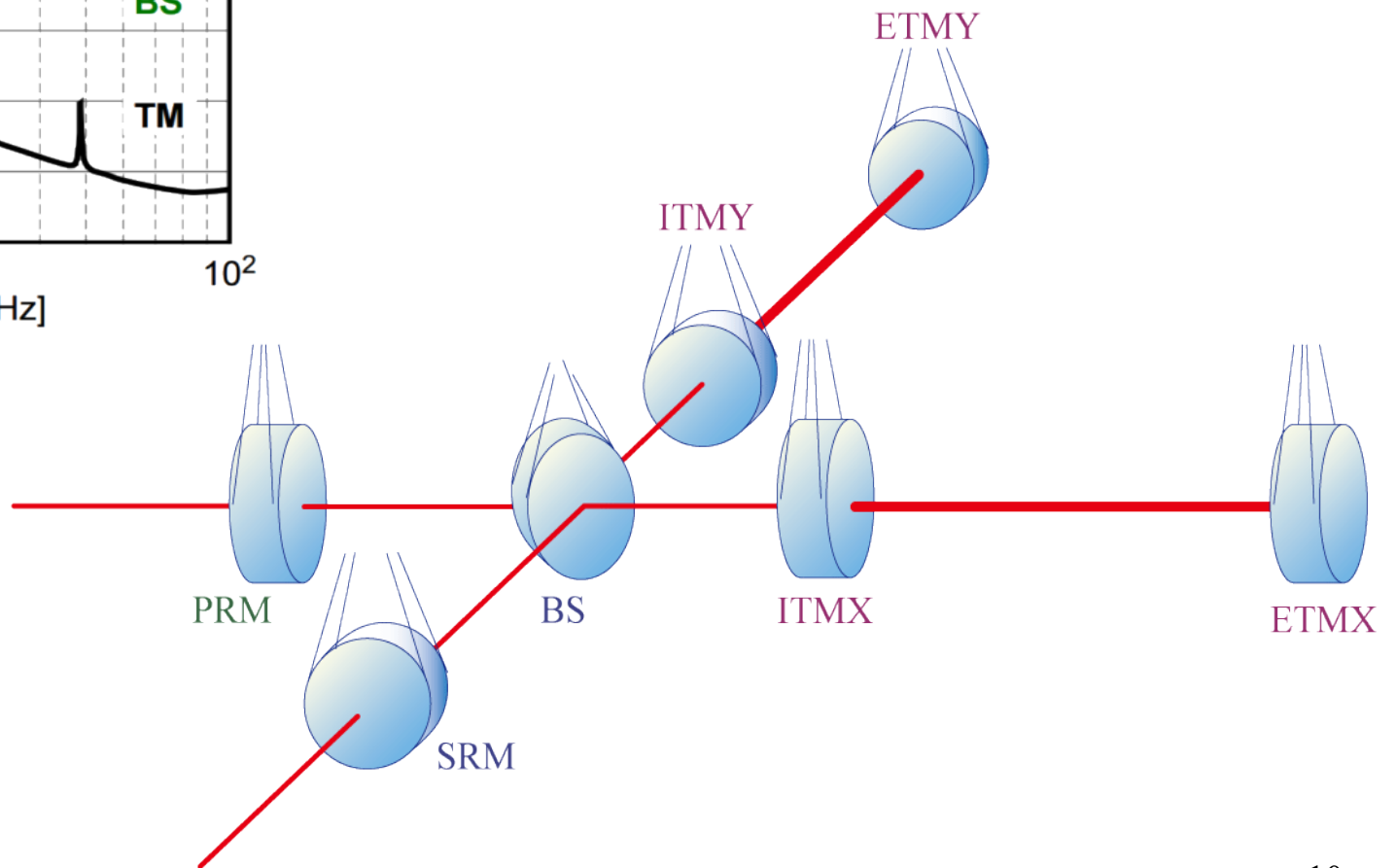
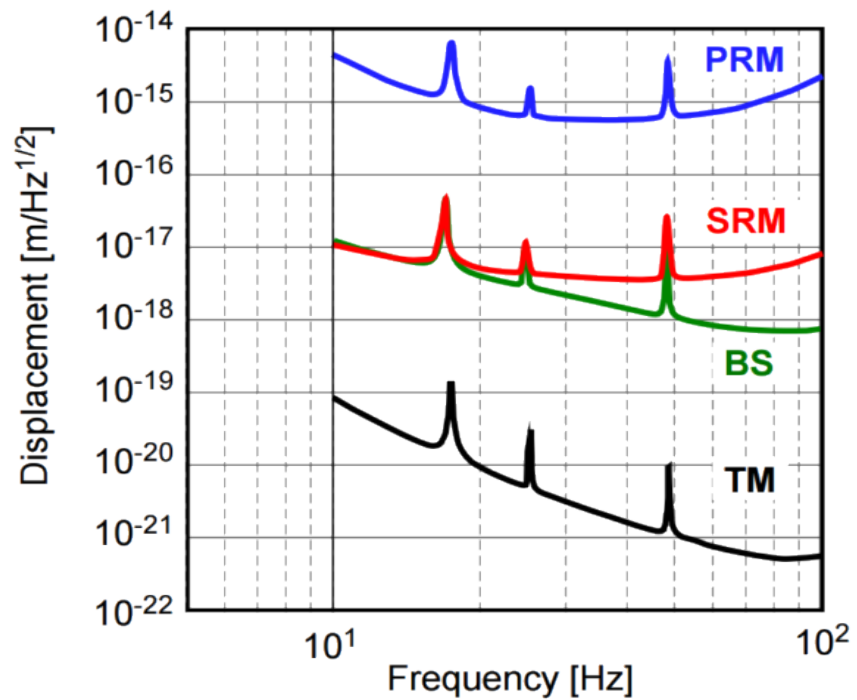
γ : Damping coefficient.

$\eta = \gamma / 2M\omega_0$: Damping ratio.

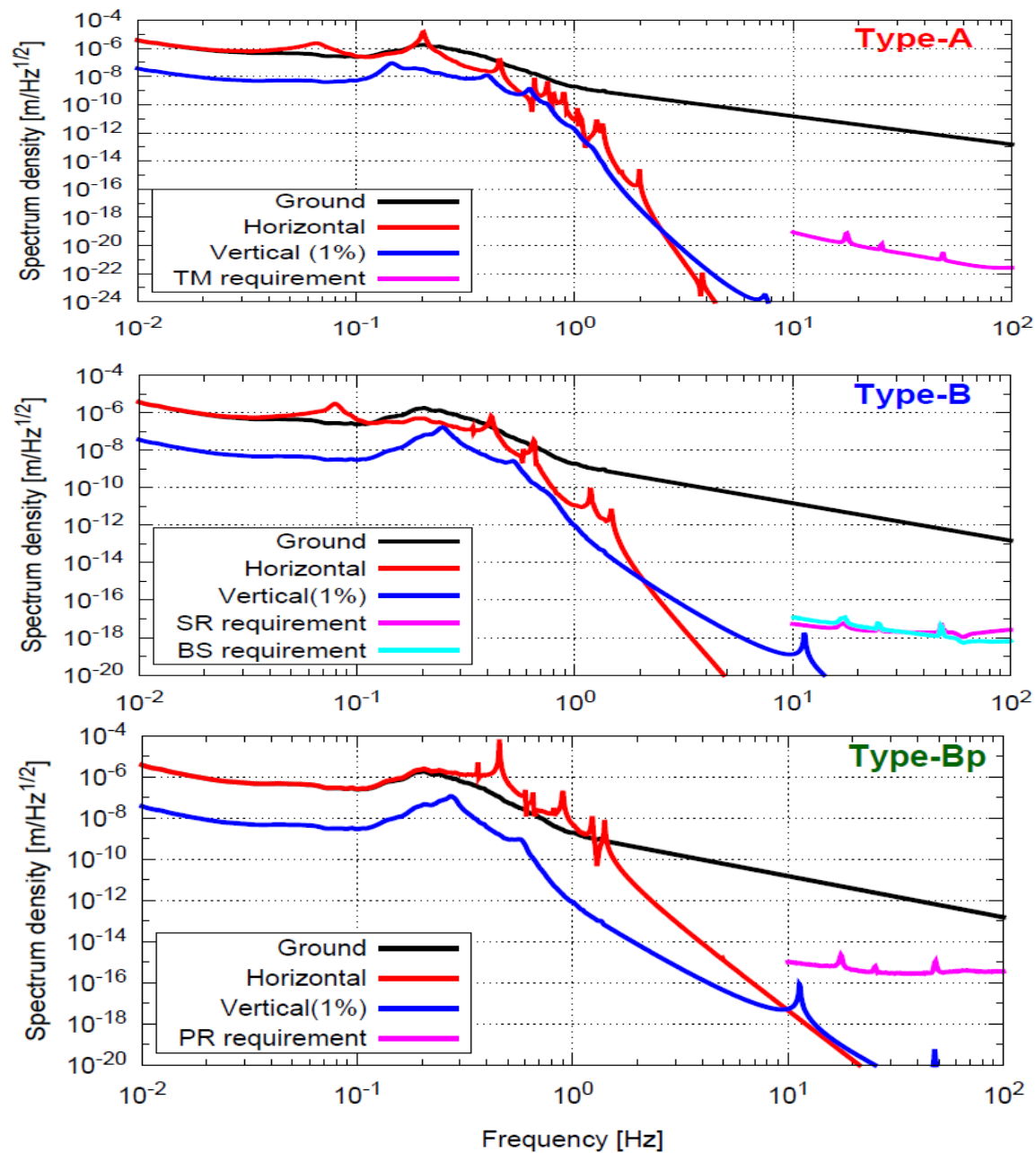
$Q = \frac{1}{2\eta}$: Quality factor.



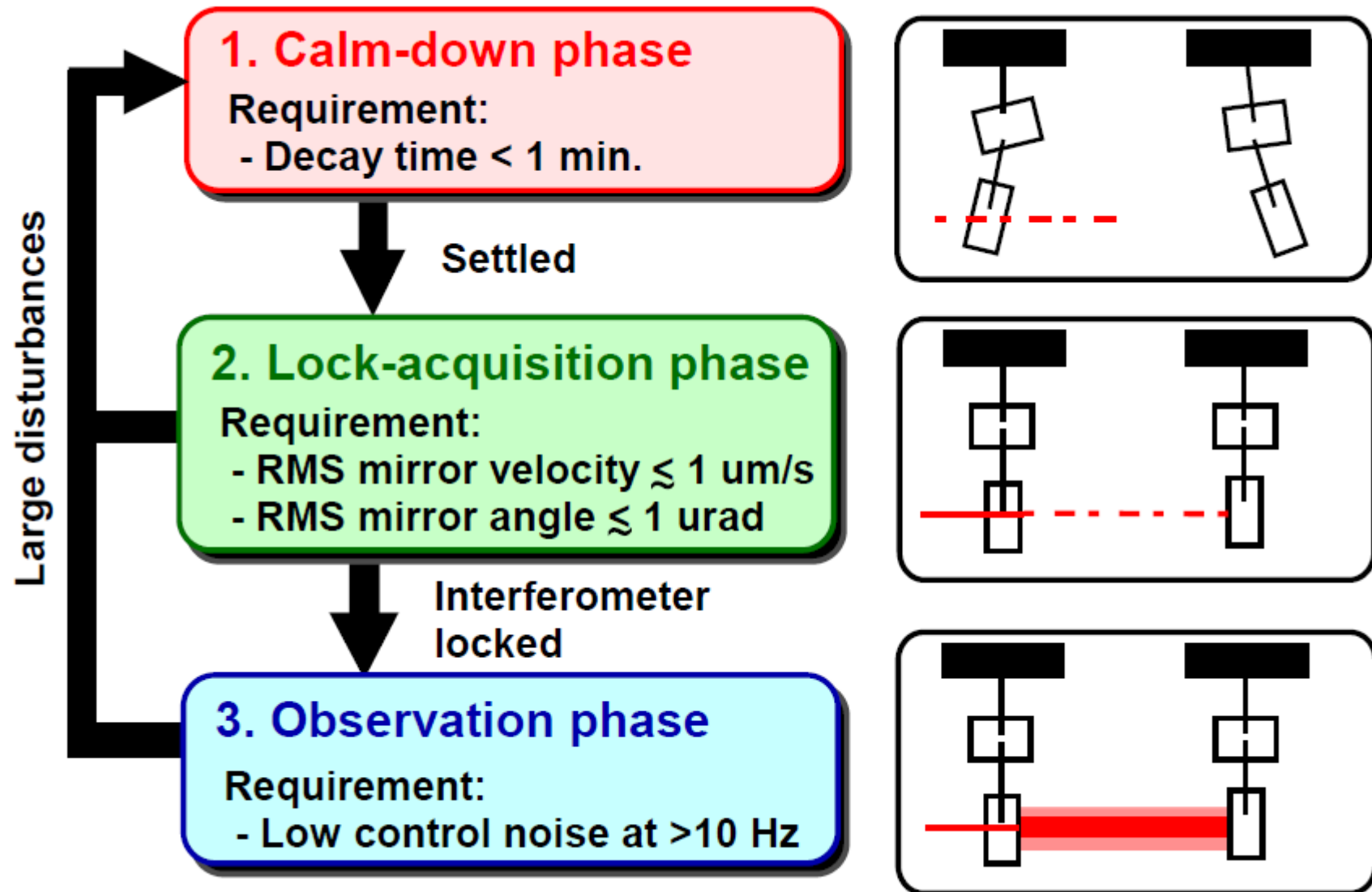
Requirements 1



Requirements 2



Requirements 3



Type B: Sensors and Actuators

- BS
- SR2.
- SR3.
- SRM.

Pre-Isolator

Top Filter (TF)
Filter0 (F0)

Inverted Pendulum (IP)

GAS Filter
chain

Standard Filter (SF)

Bottom Filter (BF)

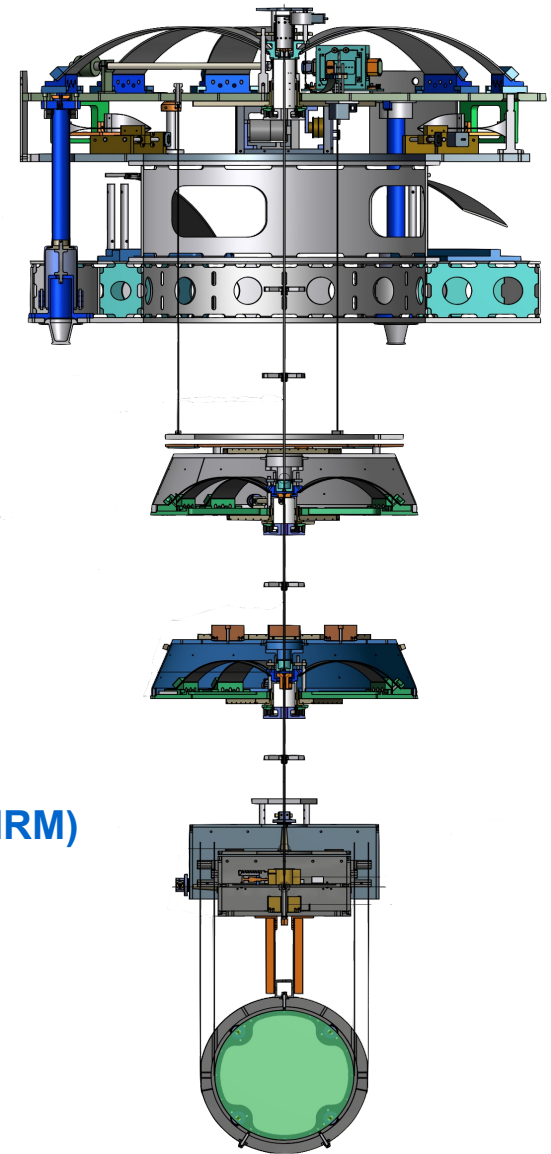
Payload

Intermediate Recoil Mass (IRM)

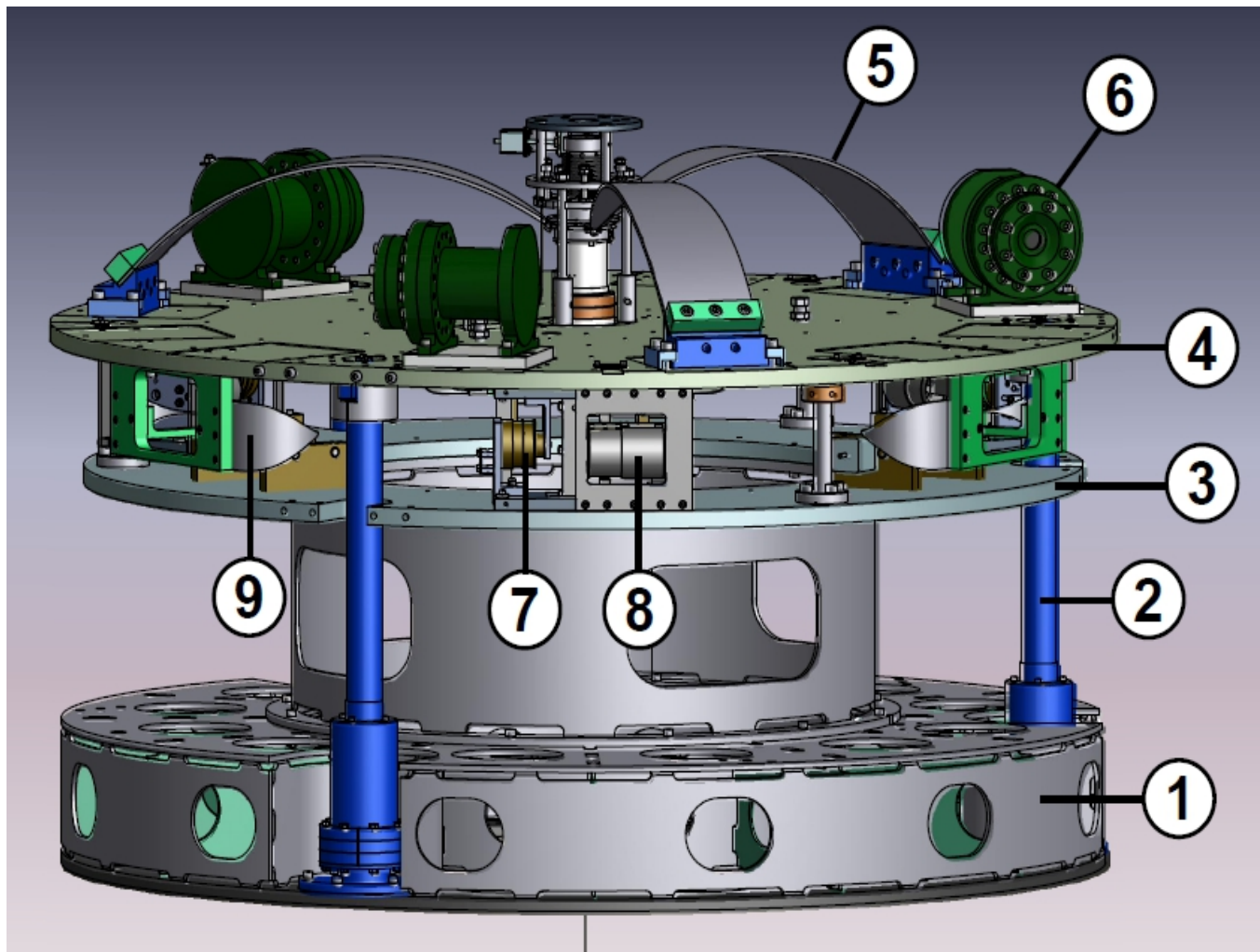
Intermediate Mass (IM)

Recoil Mass (RM)

Optics (SR)

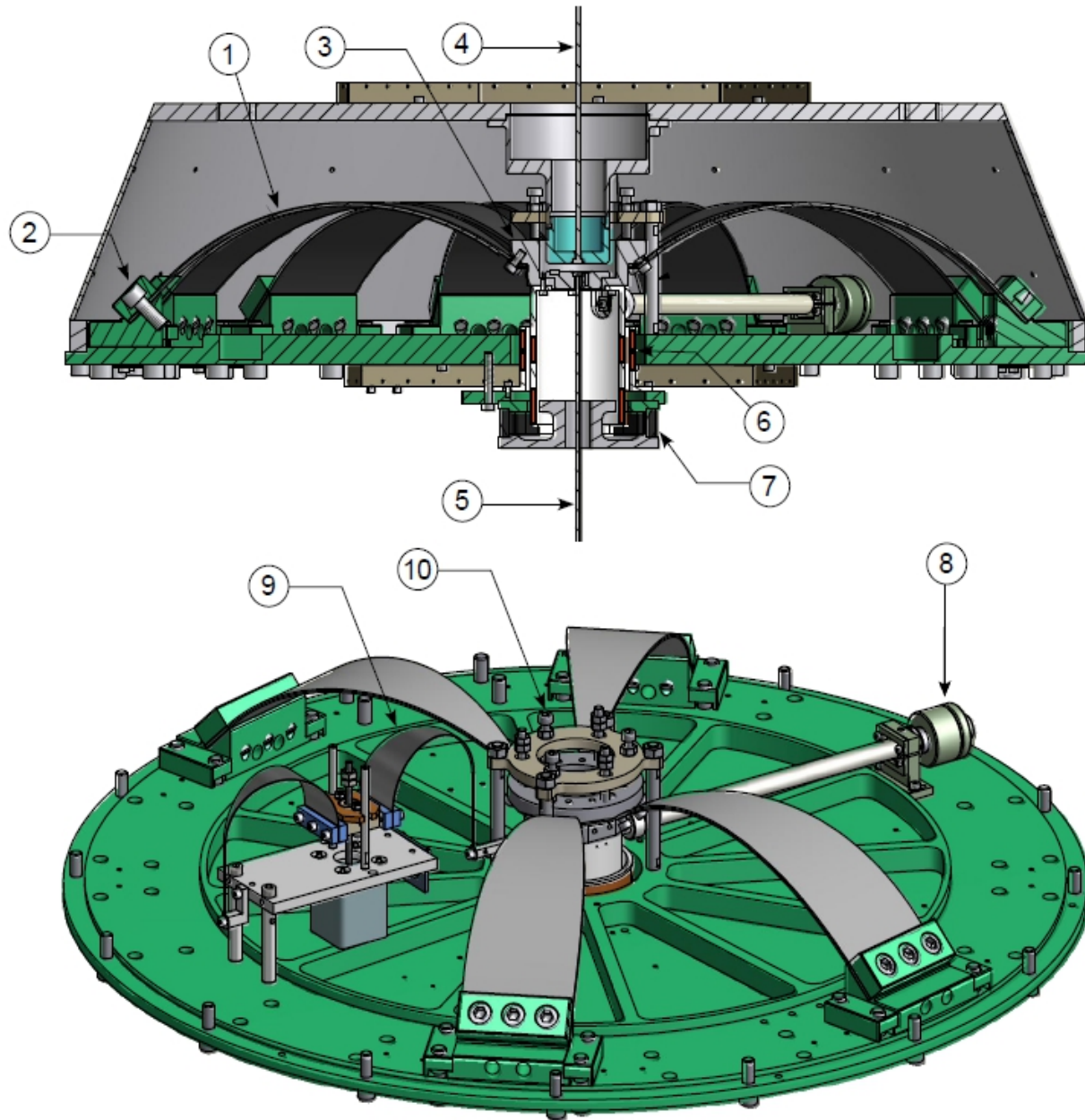


Preisolator



- (1) Base ring.
- (2) Inverted pendulum (IP) leg.
- (3) Base upper level (For Stepper Motors and LVDT sensors) connected to base ring.
- (4) Table isolated by the IPs in horizontal motion (L,T and Y).
- (5) GAS (Geometric antispring) blade of the top filter (F0).
- (6) Geophone.
- (7) Horizontal Linear Variable Differential Transducer (LVDT).
- (8) Coil-magnet actuator.
- (9) Horizontal Fishing rod with stepper motor.

GAS (Geometric anti-spring) filter



(1) Blades.

(2) Blade attachment to the base.

(3) Keystone.

(4) Upper rod supporting the weight to the GAS filter and the mass below it.

(5) Lower rod connected to the lower stage (It moves the Keystone).

(6) LVDT (it measures the displacement of the Keystone).

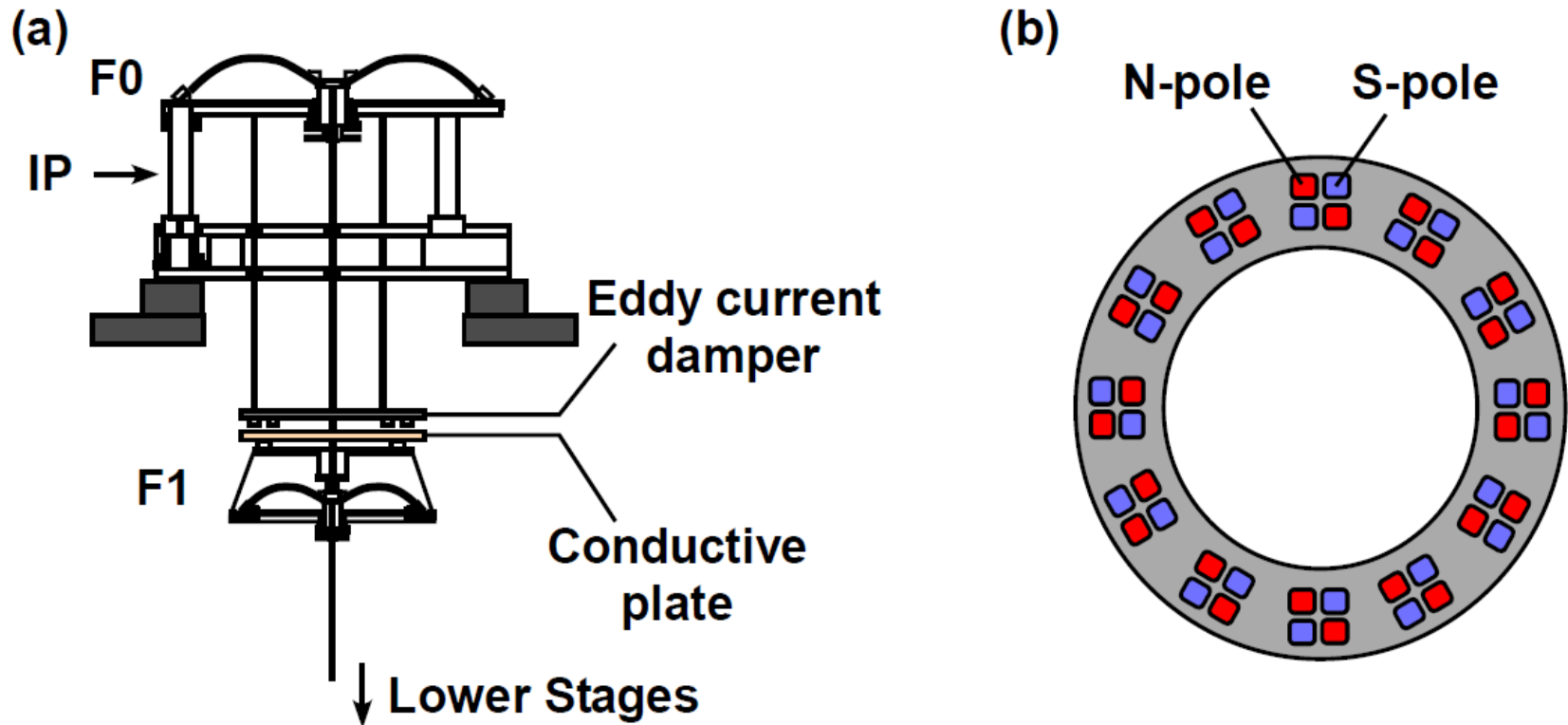
(7) Coil magnet actuator.

(8) Magic wand (to improve the saturation value of isolation)

(9) Fishing rod (to move the Keystone).

(10) Locking system screws.

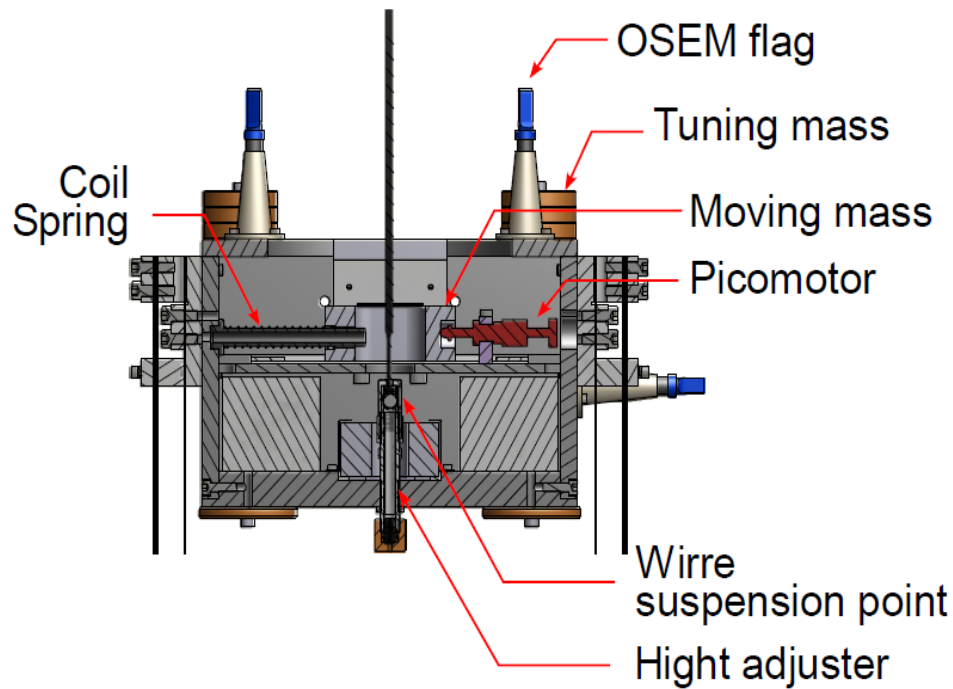
Eddy current damper



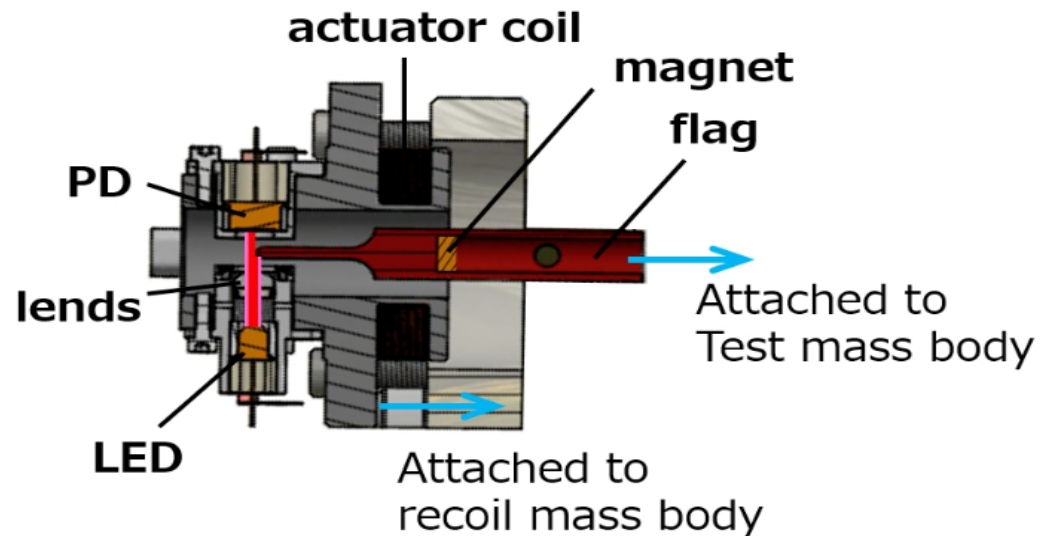
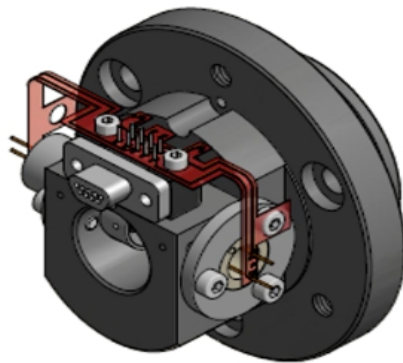
The yaw motions have high quality factors, so they will have a long decay time.

Torsion modes are passively damped by the eddy current damper.

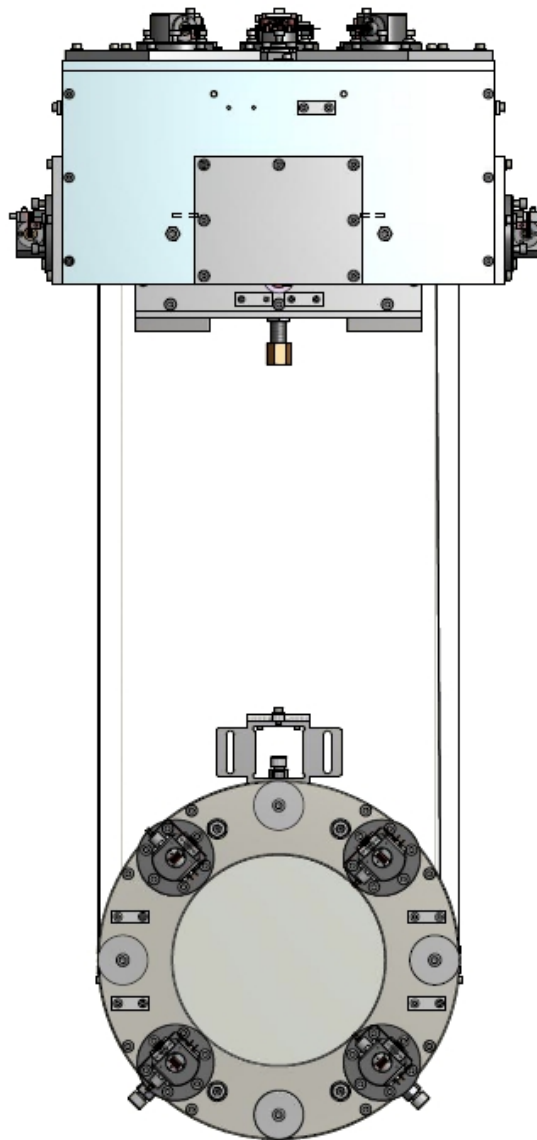
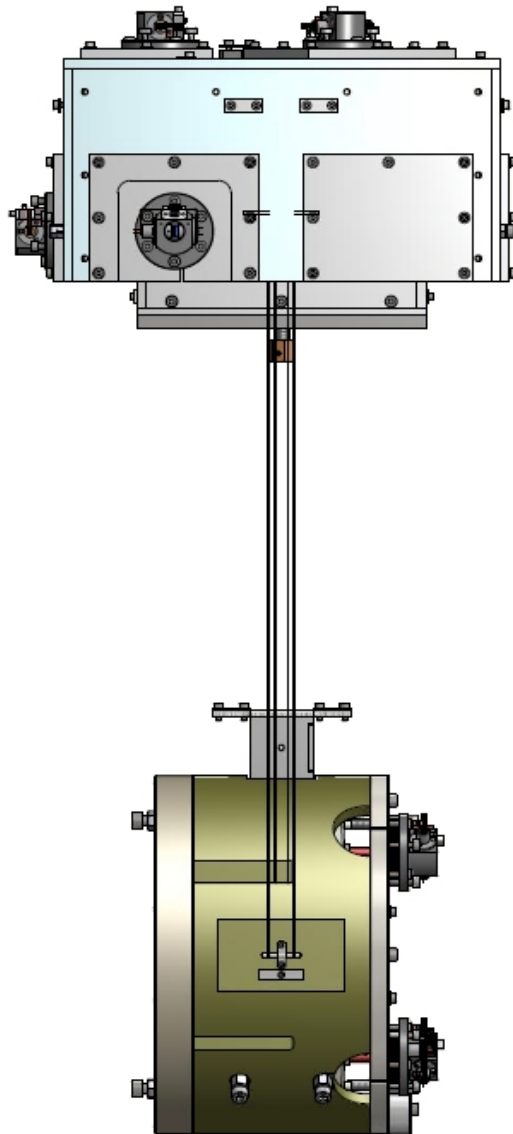
IM stage and OSEMs



OSEM: Optical Sensor and Electro Magnetic actuator.



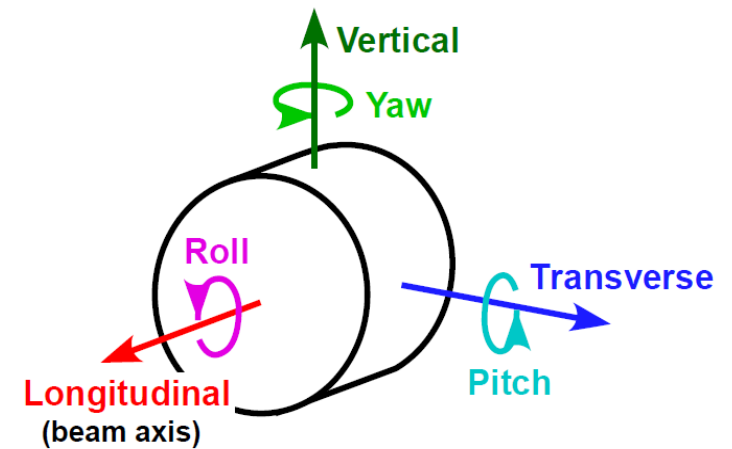
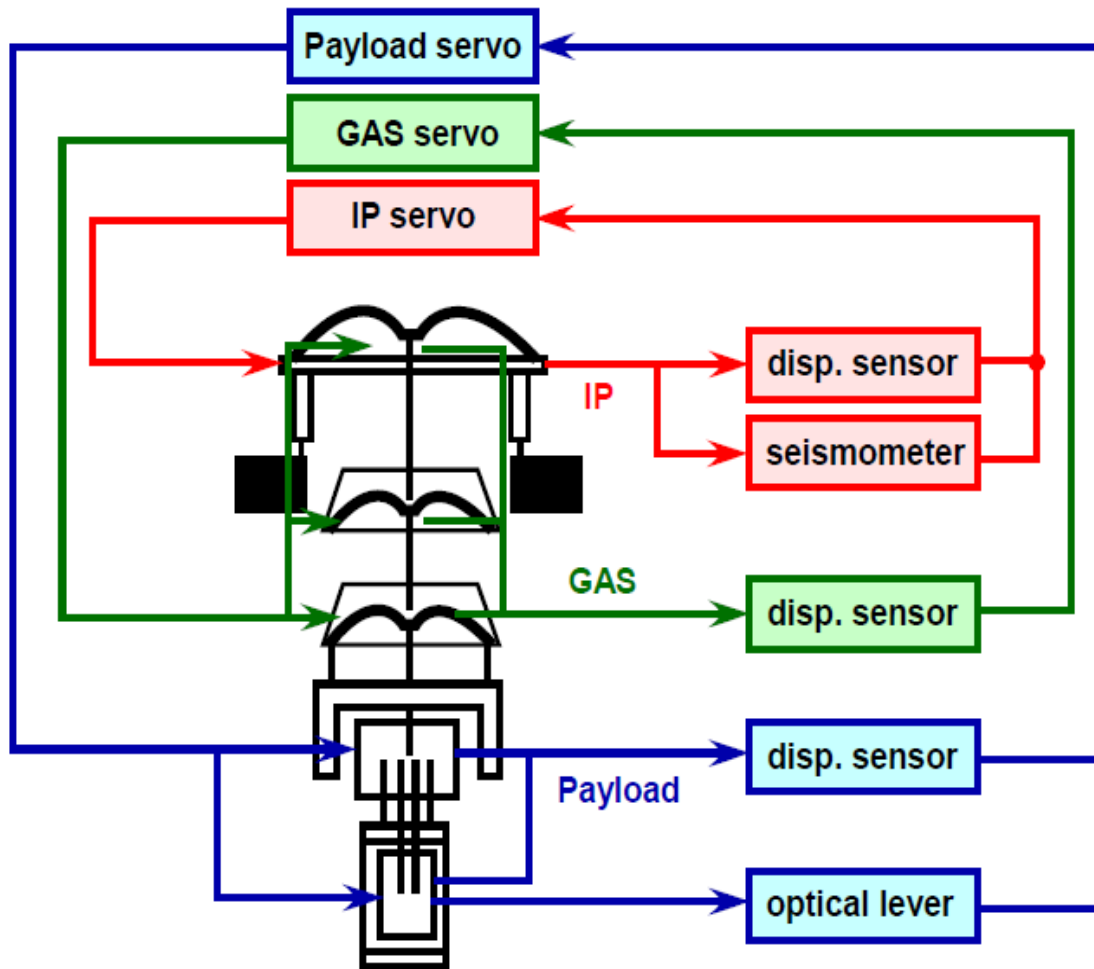
IM OSEMs and TM coil actuators



**6 OSEMs at the IM stage
(Sensor and actuator).**

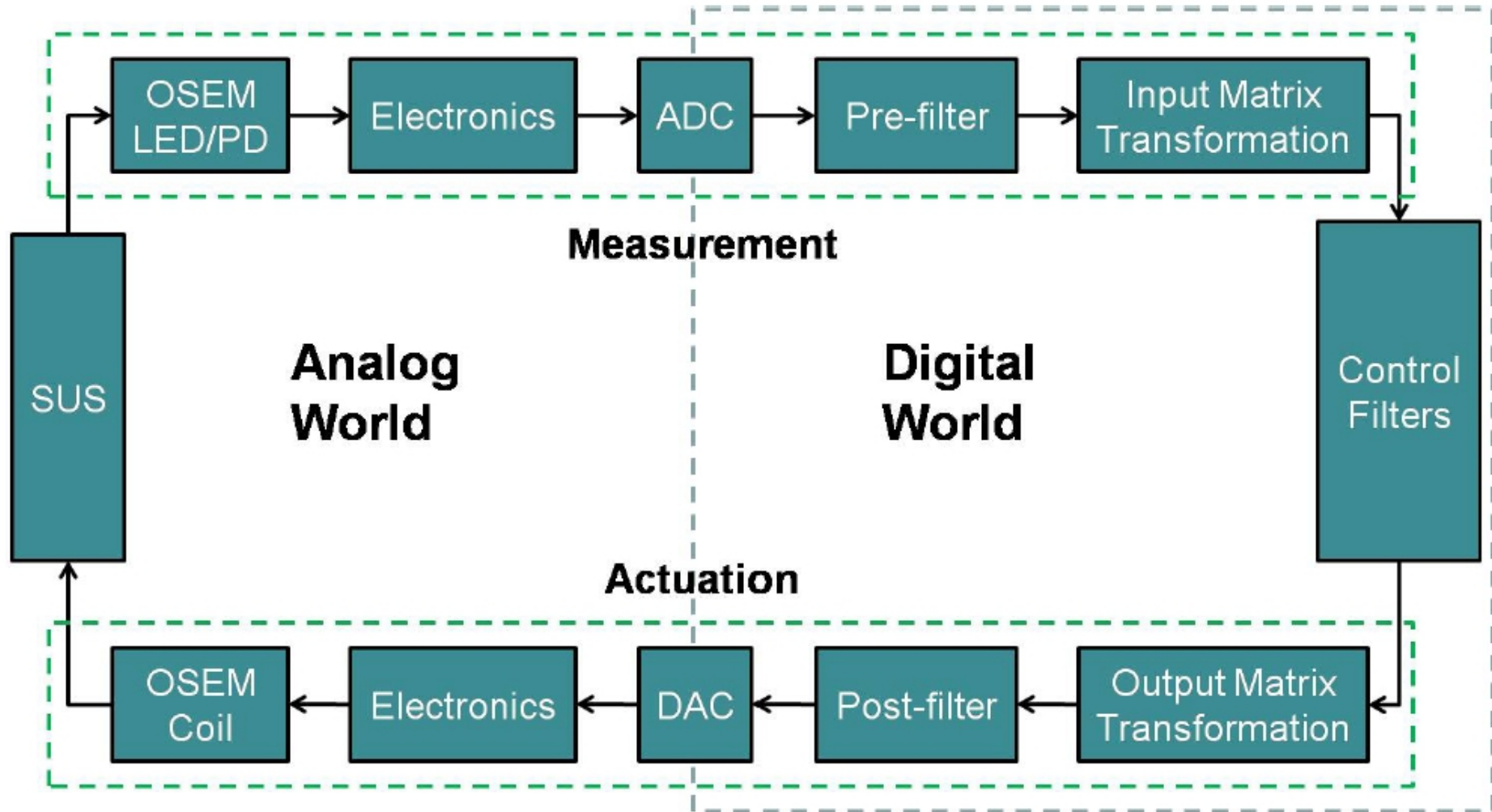
**4 Coil actuators
at the Optics stage.**

Sensors and servo filters

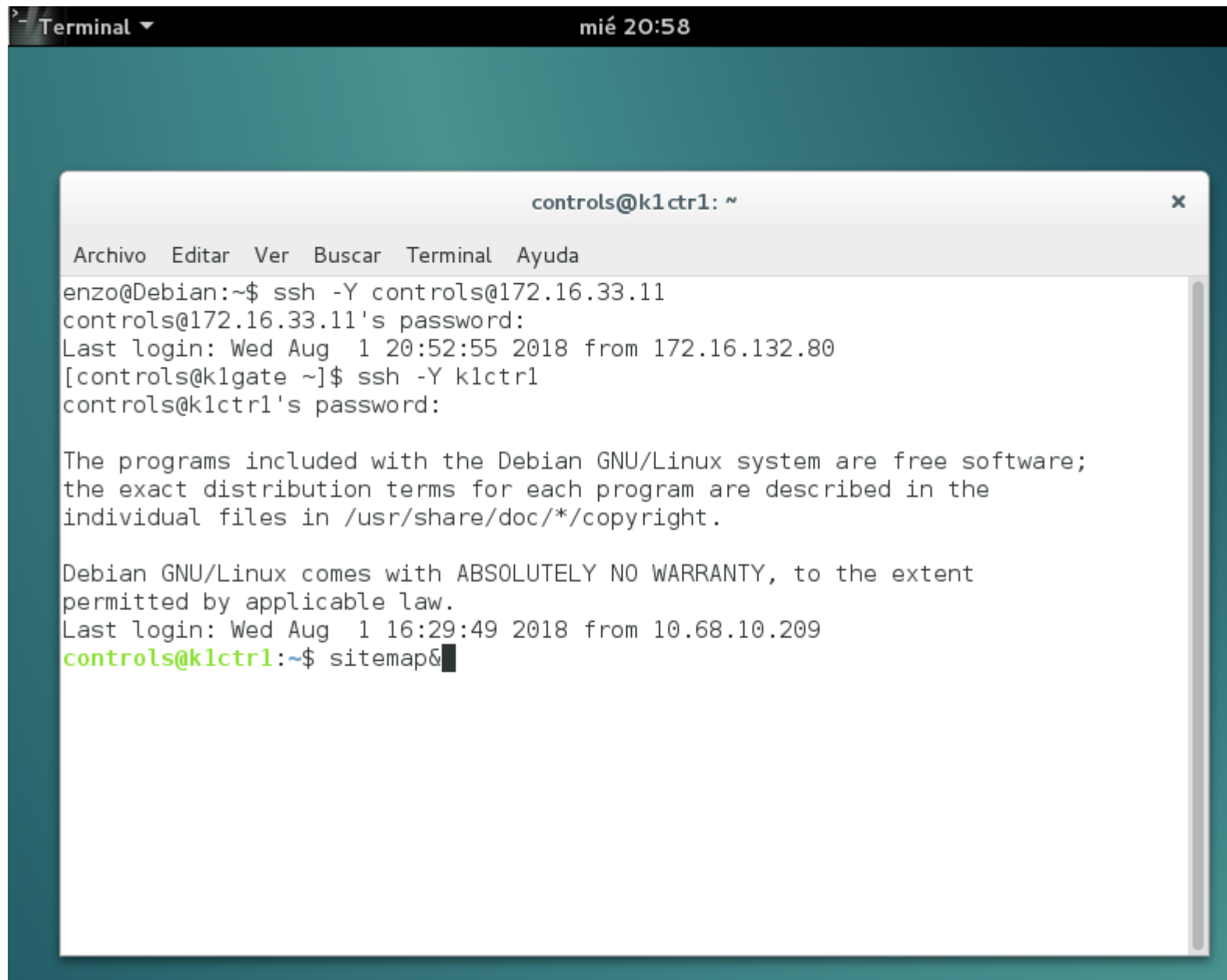


Axes definition.

Analog-Digital diagram



KAGRA sitemap 1



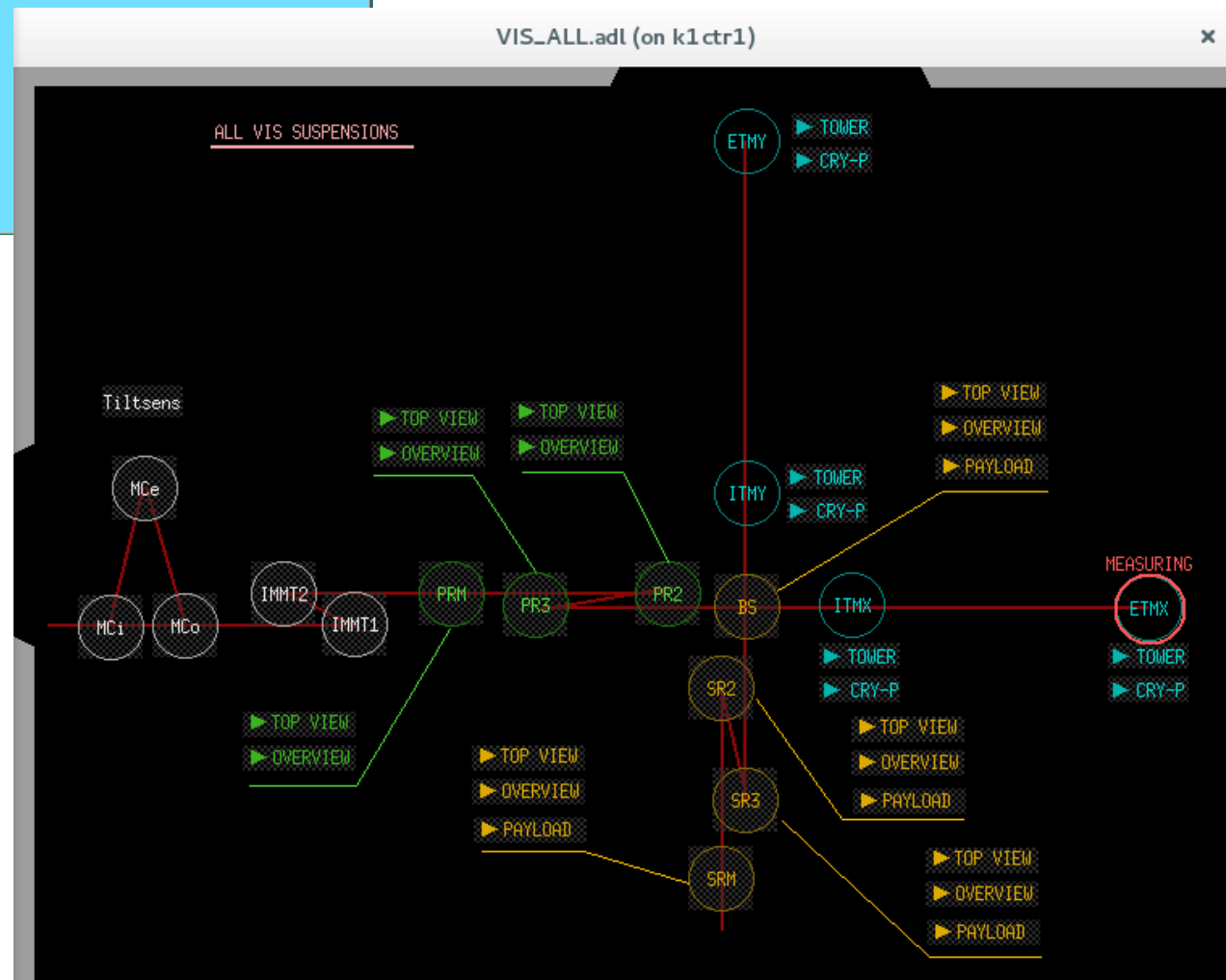
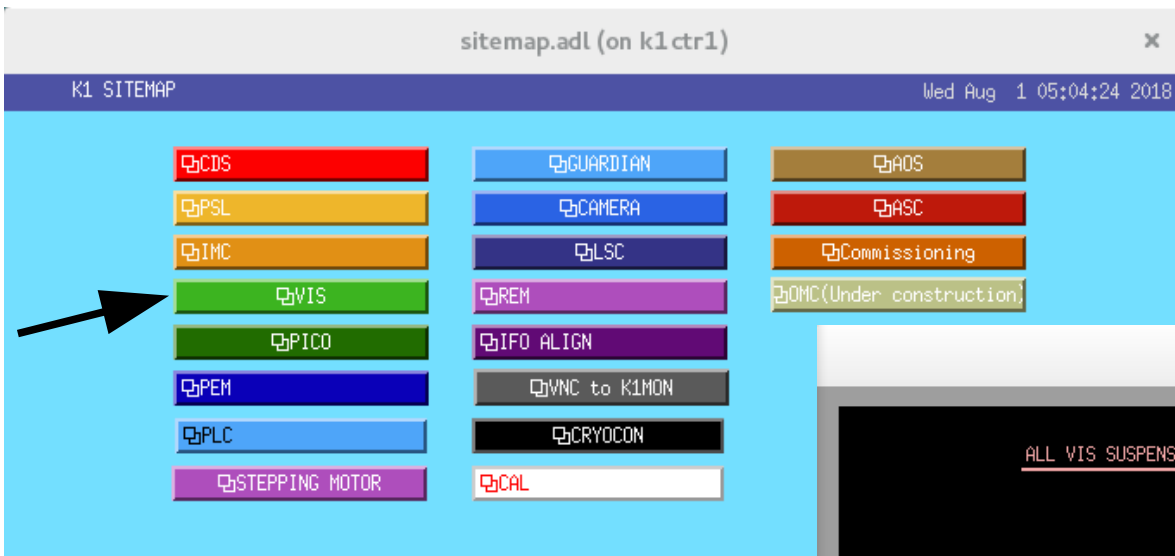
The screenshot shows a terminal window titled "Terminal" with a clock showing "mié 20:58". Inside the terminal, a sub-window titled "controls@klctrl: ~" is open. The sub-window has a menu bar with "Archivo", "Editar", "Ver", "Buscar", "Terminal", and "Ayuda". The terminal output shows the following sequence of commands and responses:

```
enzo@Debian:~$ ssh -Y controls@172.16.33.11
controls@172.16.33.11's password:
Last login: Wed Aug  1 20:52:55 2018 from 172.16.132.80
[controls@klgate ~]$ ssh -Y klctrl
controls@klctrl's password:

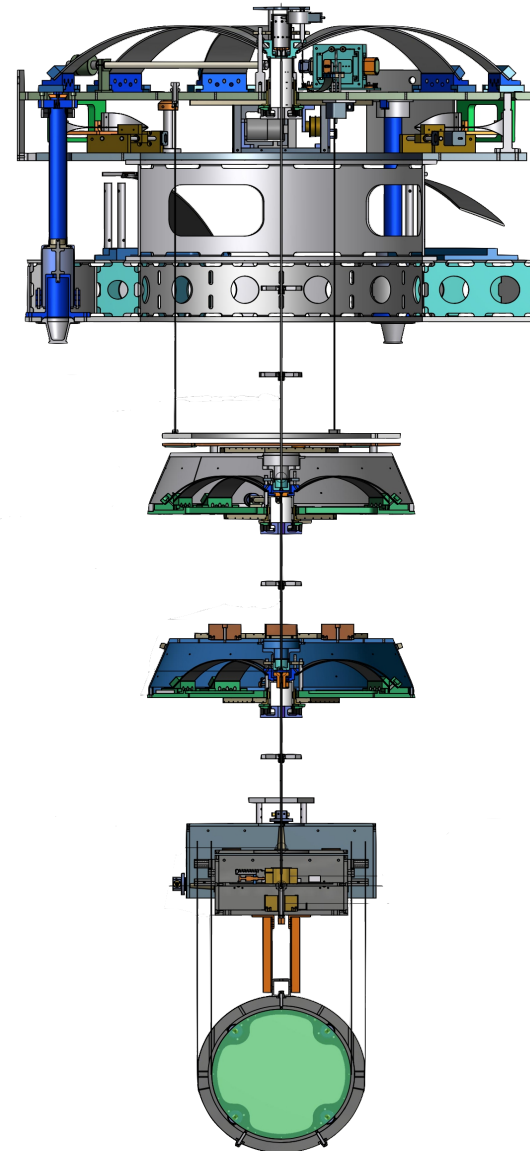
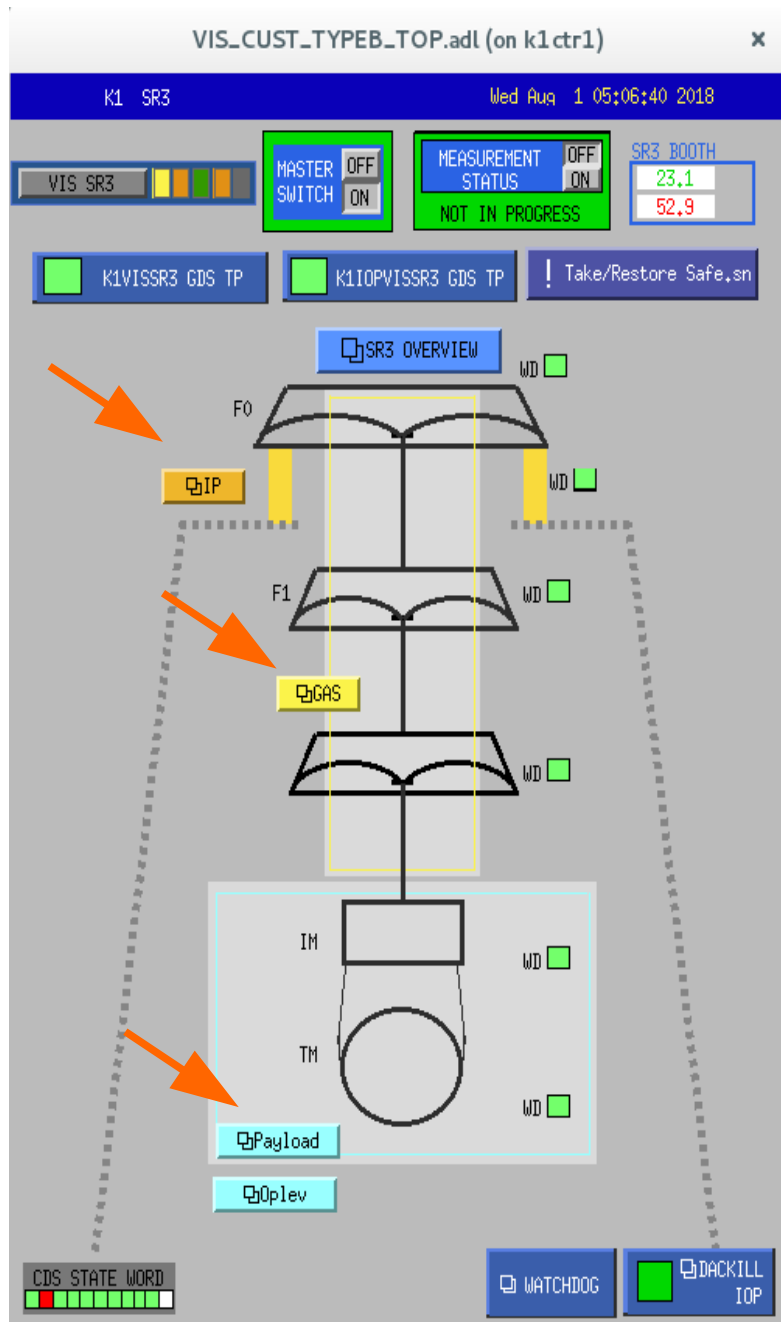
The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
Last login: Wed Aug  1 16:29:49 2018 from 10.68.10.209
controls@klctrl:~$ sitemap&
```

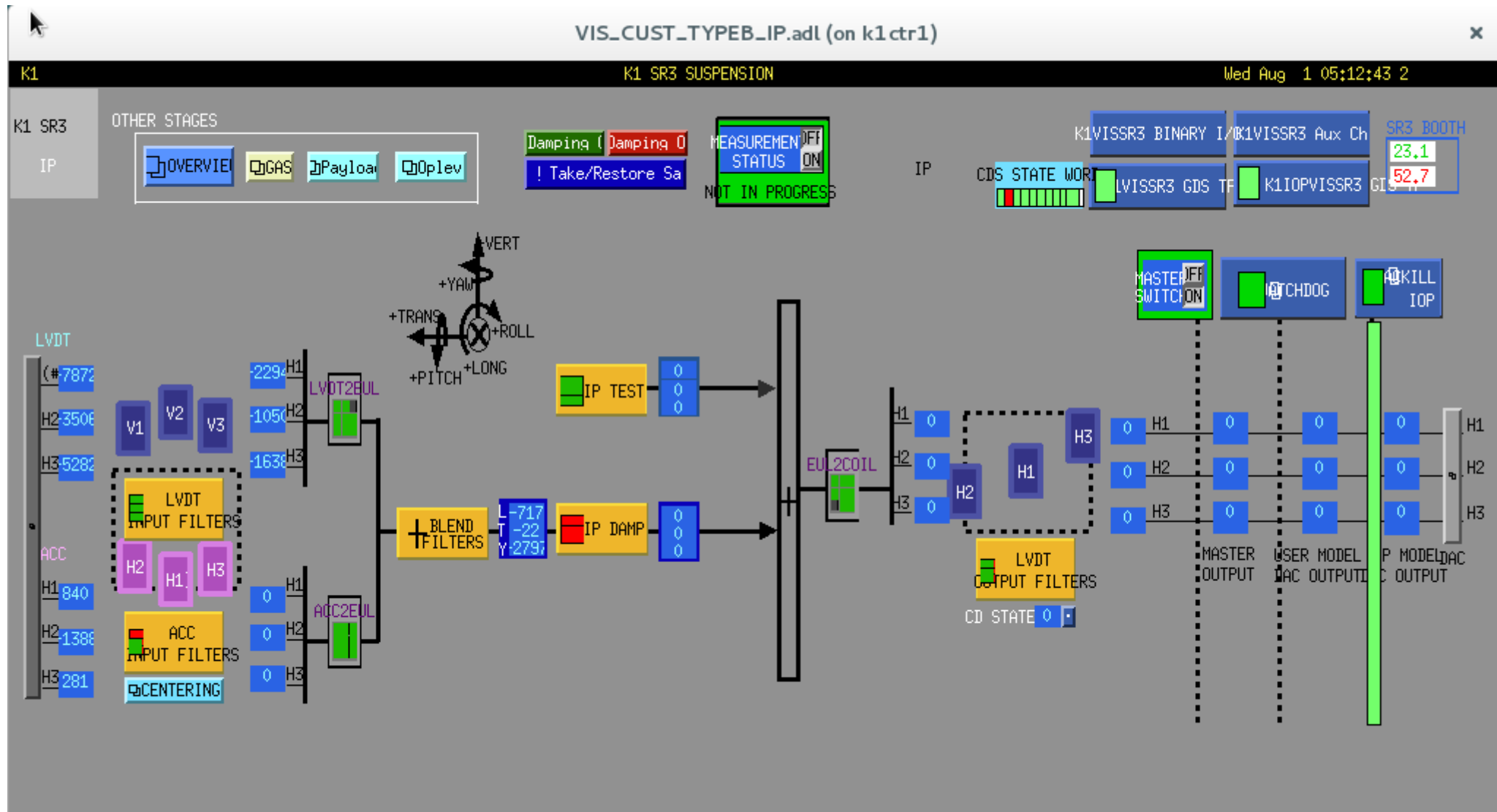
KAGRA sitemap 2



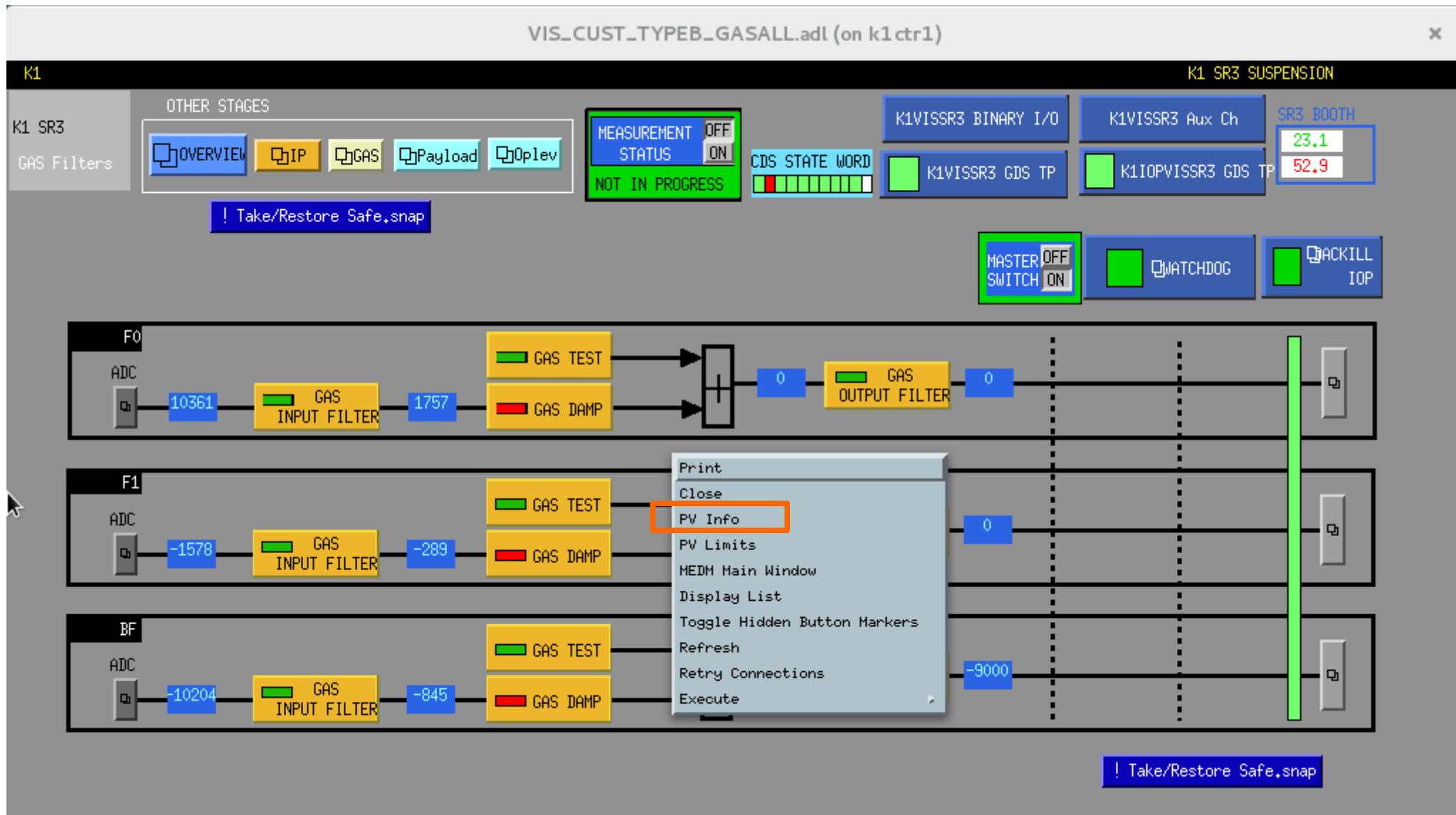
KAGRA SR3 Suspension 1



KAGRA SR3 Suspension 2 (Preisolator)

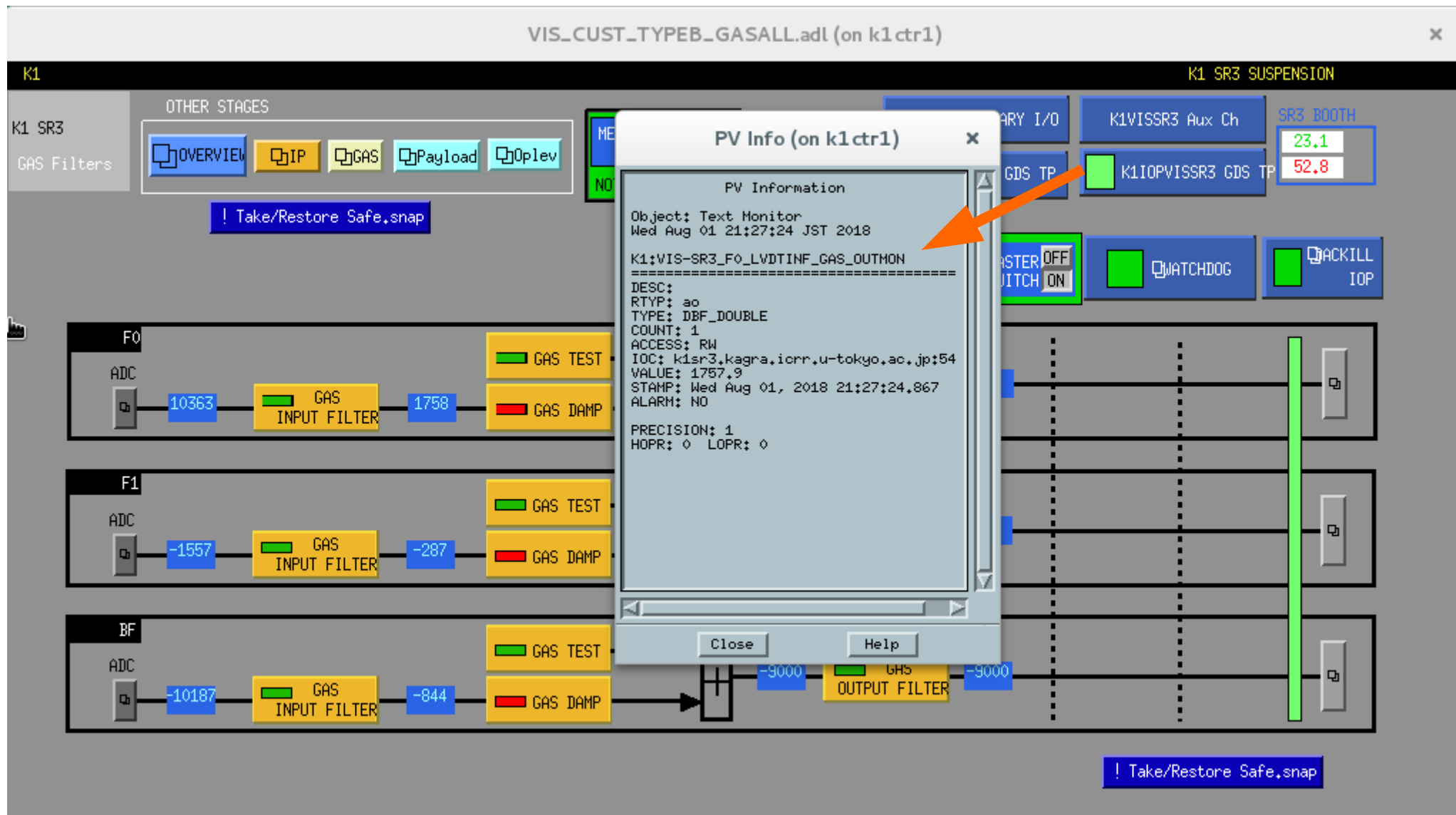


KAGRA SR3 Suspension 3 (GAS)



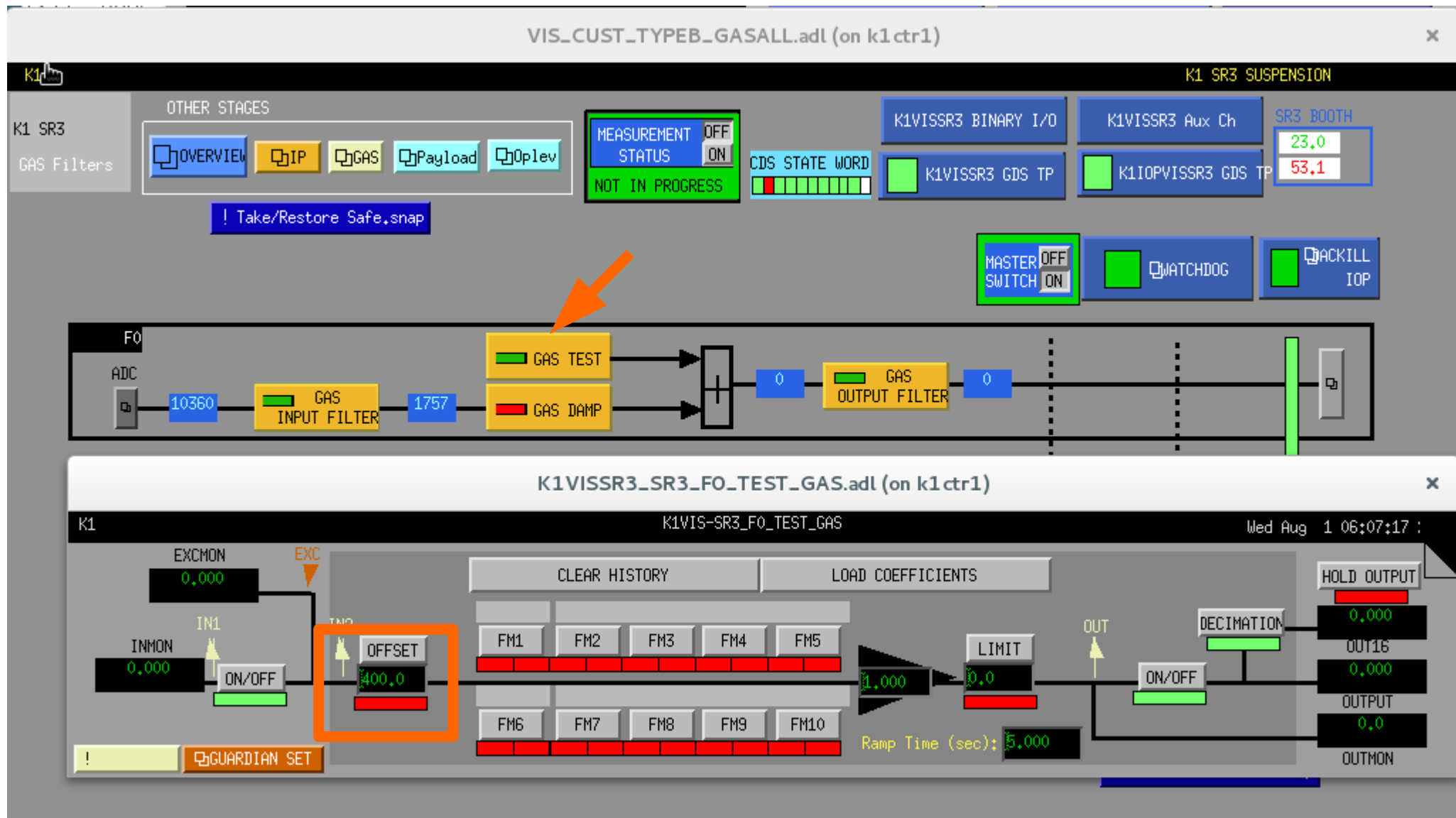
Right click > PV Info

KAGRA SR3 Suspension 4 (GAS)



Right click > PV Info > Name of the variables. (K1:VIS-SR3_...)

KAGRA SR3 Suspension 5 (GAS)



Set excitation or perturbation to one DoF.

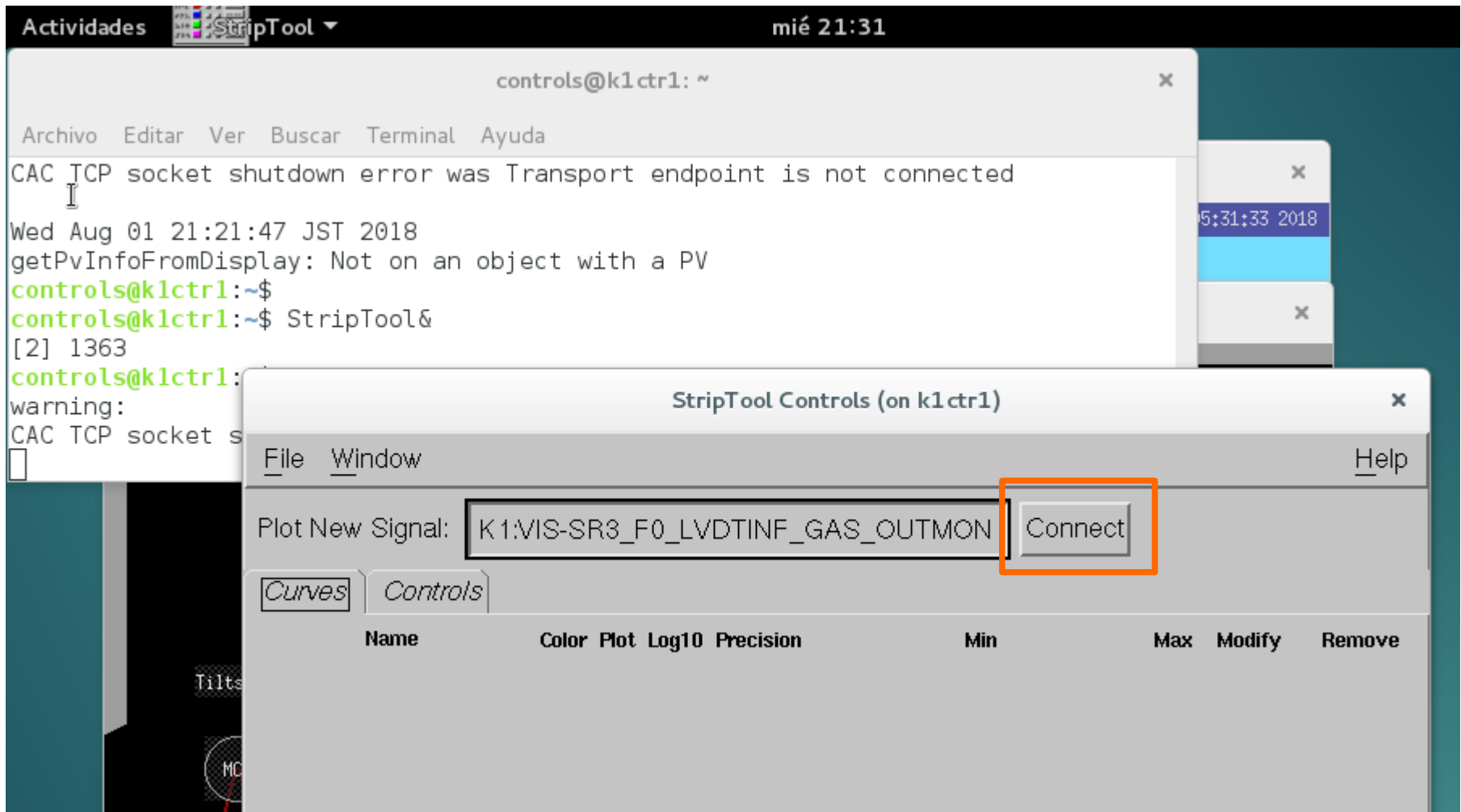
KAGRA SR3 Suspension (IM)

Will be shown in control room.

KAGRA SR3 Suspension (Overview)

Will be shown in control room.

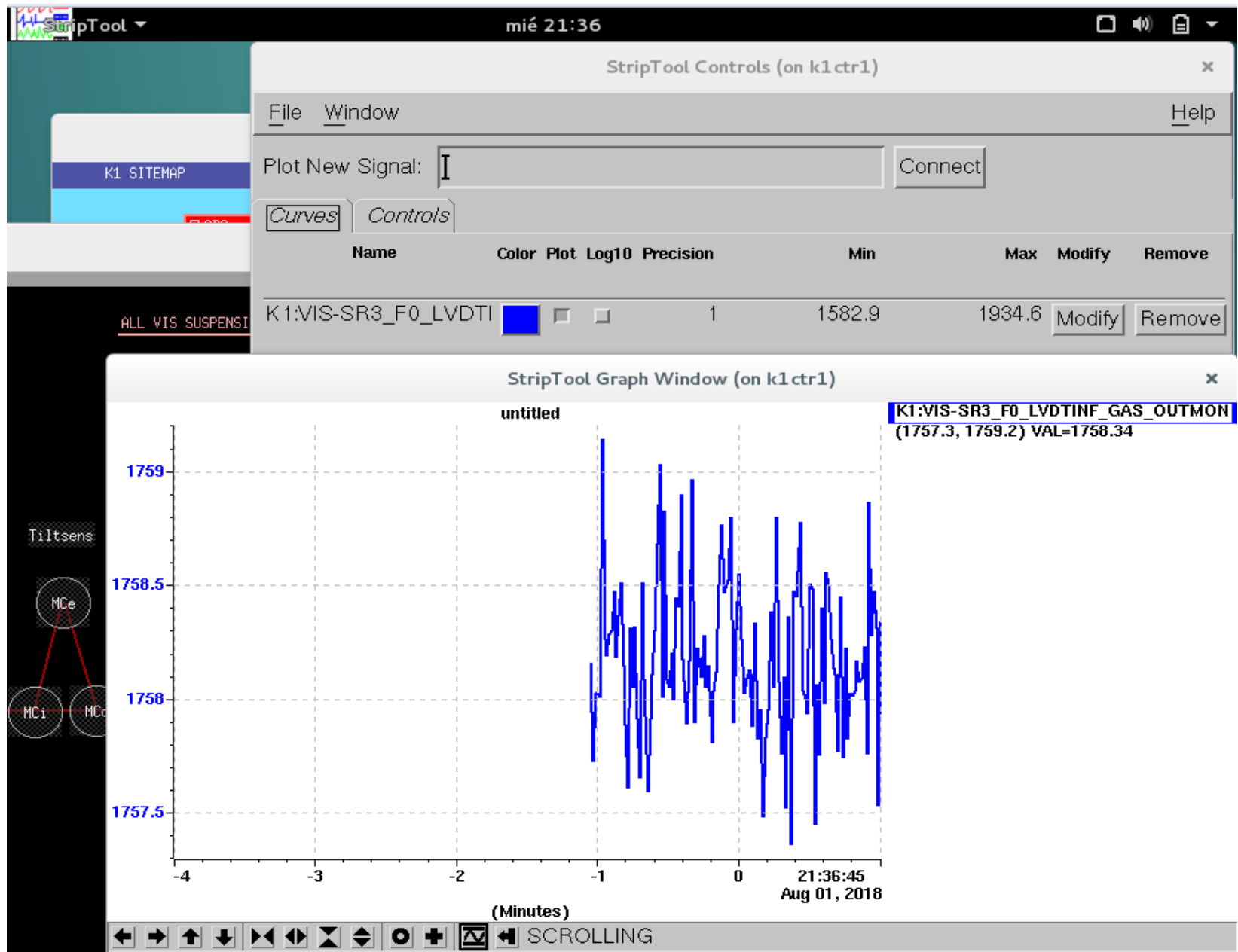
StripTool 1



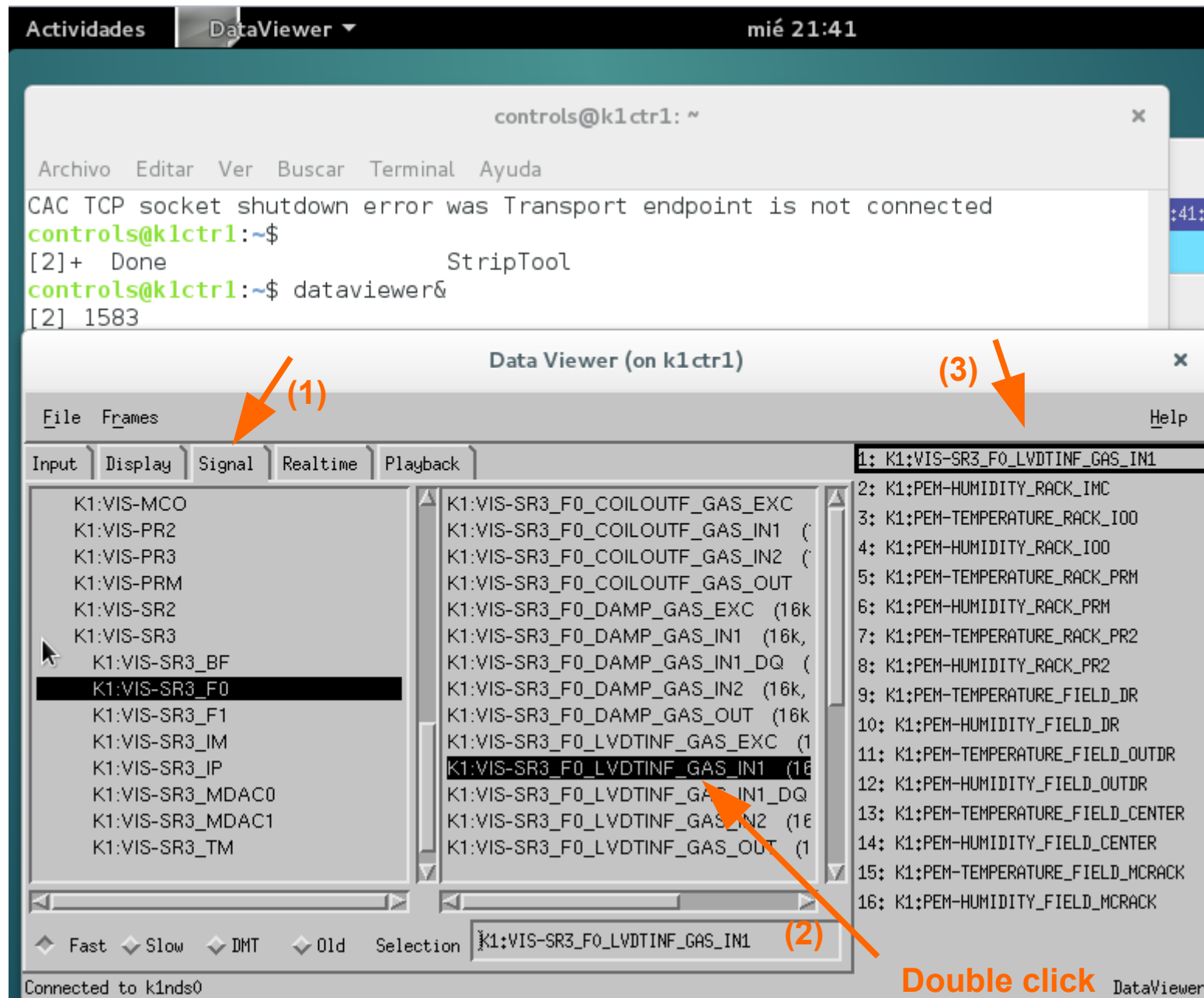
Terminal > StripTool& > Write or copy the name of the variable.

For slow signals mostly. <https://epics.anl.gov/EpicsDocumentation/ExtensionsManuals/StripTool/StripTool.html>

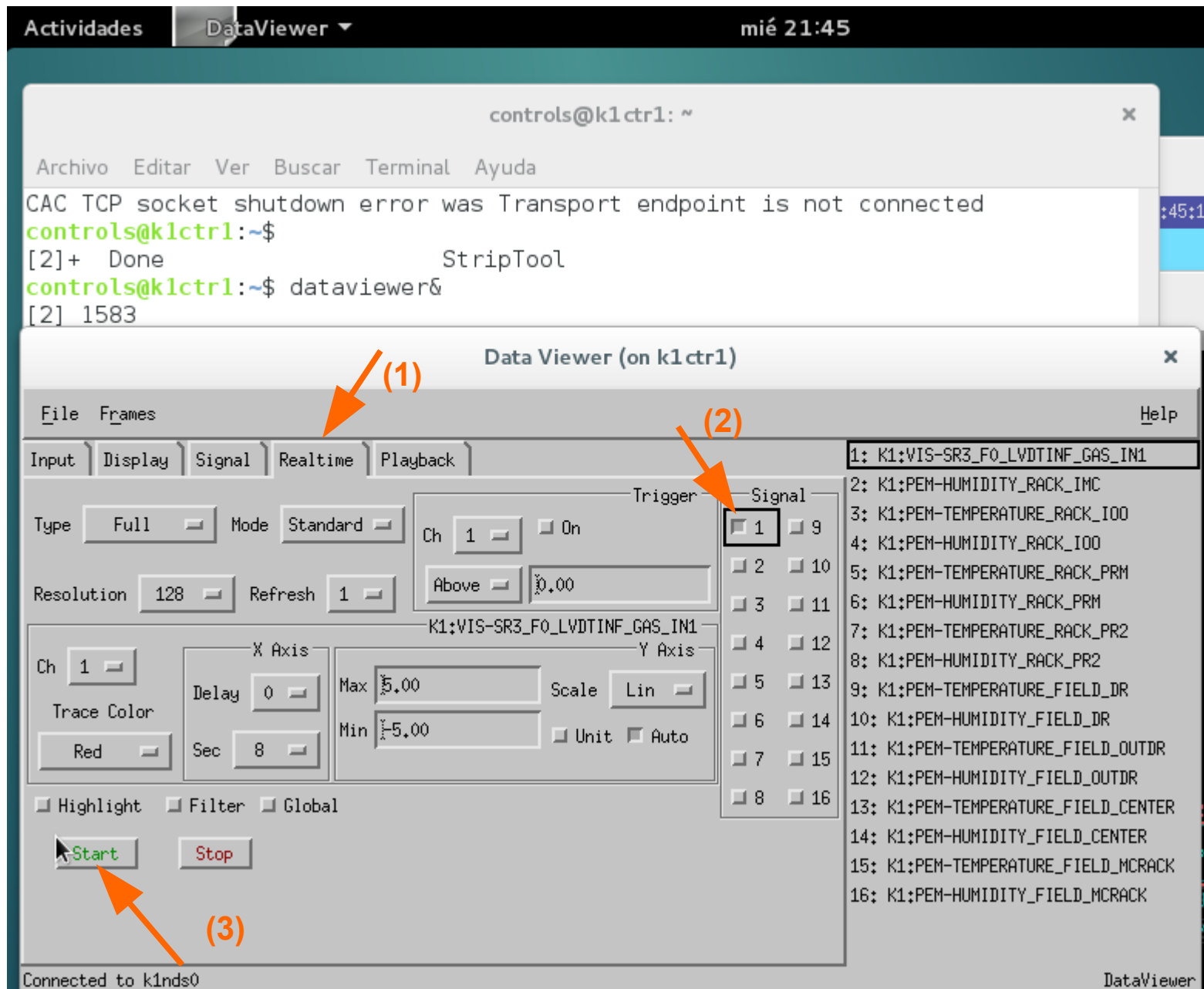
StripTool 2

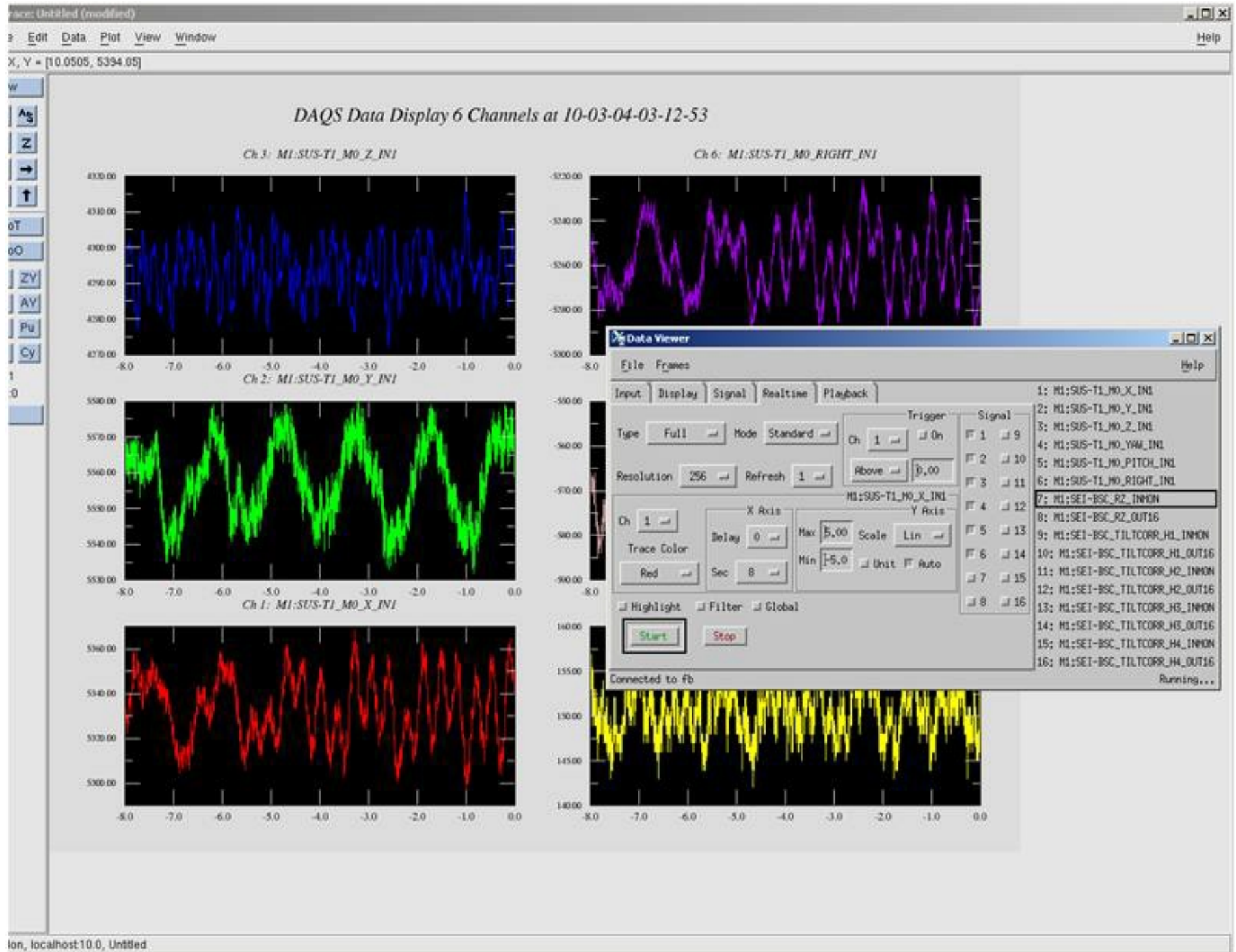


Dataviewer 1: tool to plot and view real time data.



Dataviewer 2: tool to plot and view real time data.





Task

- (1) Apply one ramp function to one of the DoF in the SR3. Some ~hundreds of counts of amplitude.**
- (2) Measure the excitation and the displacement of that DoF.**
- (3) Apply one “Step” function (1 [s] ramp). And measure natural frequency of that DoF.**
- (4) Estimate Q factor.**

Plan for next weeks:

- **GAS Filters details.**
- **OSEMs details.**
- **FFT, Windowing, Aliasing, Leakage, ...**
- **Use of diaggui.**
- **Transfer Functions (TF).**
- **...**

Suggestions?

- **Not too fast.**
- **SUMCON (simulation tool).**
- **Why blades in the GAS filters and not springs?.**
- **Do not use acronyms.**
- **...**

- **A study of low frequency vibration isolation system for Large Scale Gravitational Wave Detectors. T. Tsekuguchi.**

<https://gwdoc.icrr.u-tokyo.ac.jp/cgi-bin/DocDB/ShowDocument?docid=4155>

- **Seismic attenuation for Advanced Virgo. Vibration isolation for the external injection bench. M. Blom.**

http://gwwiki.icrr.u-tokyo.ac.jp/JGWwiki/KAGRA/Subgroups/VIS/Introduction?action=AttachFile&do=view&target=thesis_M_Blom.pdf

- **Electronics Setup and testing LIGO. B. Shapiro.**

<http://gwwiki.icrr.u-tokyo.ac.jp/JGWwiki/KAGRA/Subgroups/VIS/Introduction?action=AttachFile&do=view&target=Electronic+Setup+and+Testing+of+aLIGO+Suspensions.pdf>

- **You can also get this and more pdf files on the KAGRA wiki page:**
- <http://gwwiki.icrr.u-tokyo.ac.jp/JGWwiki/KAGRA/Subgroups/VIS/Introduction>