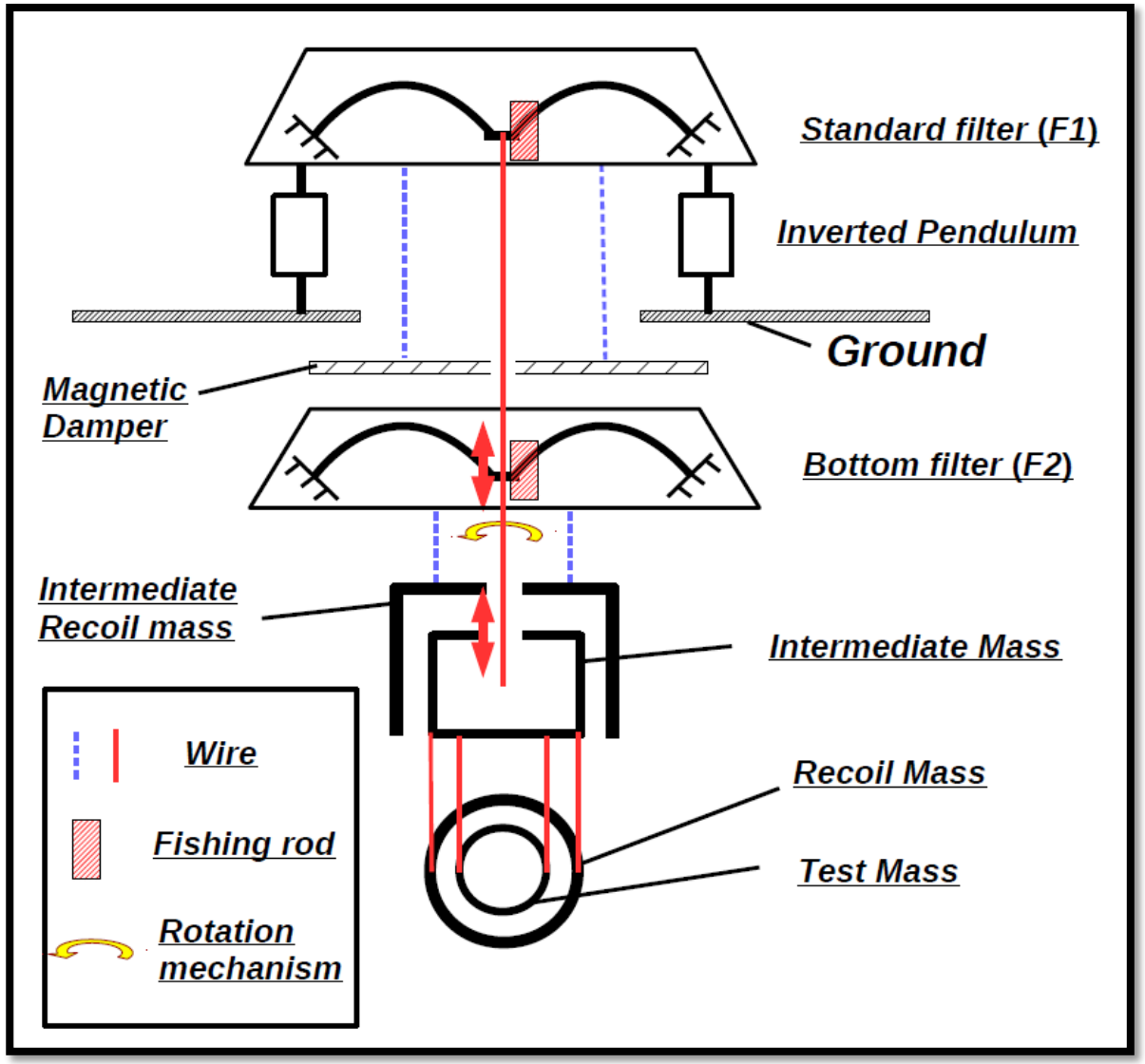
# TypeBp with IP, MD



# Mechanical response

## Calculated by SUMCON (and Simulink)

SUMCON in Mathematica
spension odel structor

SUMCON Version:1.32

About SUMCON | Version Info | Reflesh

New Model | Load Model | Save Model | typeBp_wIP_wMD_160205.m

# TypeBp with IP, MD 160328

Model Construction | Calculation Result | Export Model

## Model Basic Information

**Degrees of Freedom:**

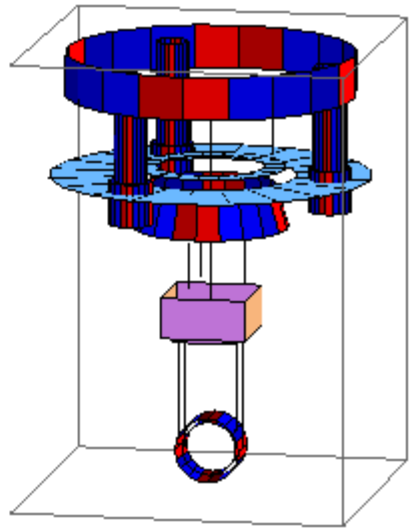
39 State Variables
6 Input Variables
2 Float Variables

**Ground Position:**

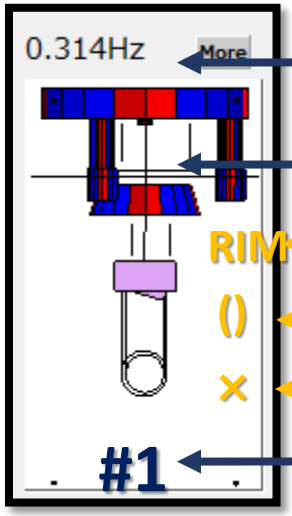
xg → 0. yg → 0. zg → 0. pitchg → 0. yawg → 0. rollg → 0.

**Equilibrium Point:**

| | | | | | |
|---|---|---|---|---|---|
| xF2 → 0. | yF2 → −0.1444 | zF2 → 0. | pitchF2 → 0. | yawF2 → 0. | rollF2 → 0. |
| xIR → 0. | yIR → −0.647 | zIR → 0. | pitchIR → 0. | yawIR → 0. | rollIR → 0. |
| xIM → 0. | yIM → −0.6977 | zIM → 0. | pitchIM → 0. | yawIM → 0. | rollIM → 0. |
| xRM → 0. | yRM → −1.2847 | zRM → 0. | pitchRM → 0. | yawRM → 0. | rollRM → 0. |
| xTM → 0. | yTM → −1.2848 | zTM → 0. | pitchTM → 0. | yawTM → 0. | rollTM → 0. |
| xF1 → 0. | zF1 → 0. | yawF1 → 0. | xMD → 0. | yMD → 0.0399 | zMD → 0. |
| pitchMD → 0. | yawMD → 0. | rollMD → 0. | hGAS2 → 0.0259 | hGAS1 → −0.0839 | |



# Eigen Mode List




Resonance frequency

Eigen mode shape

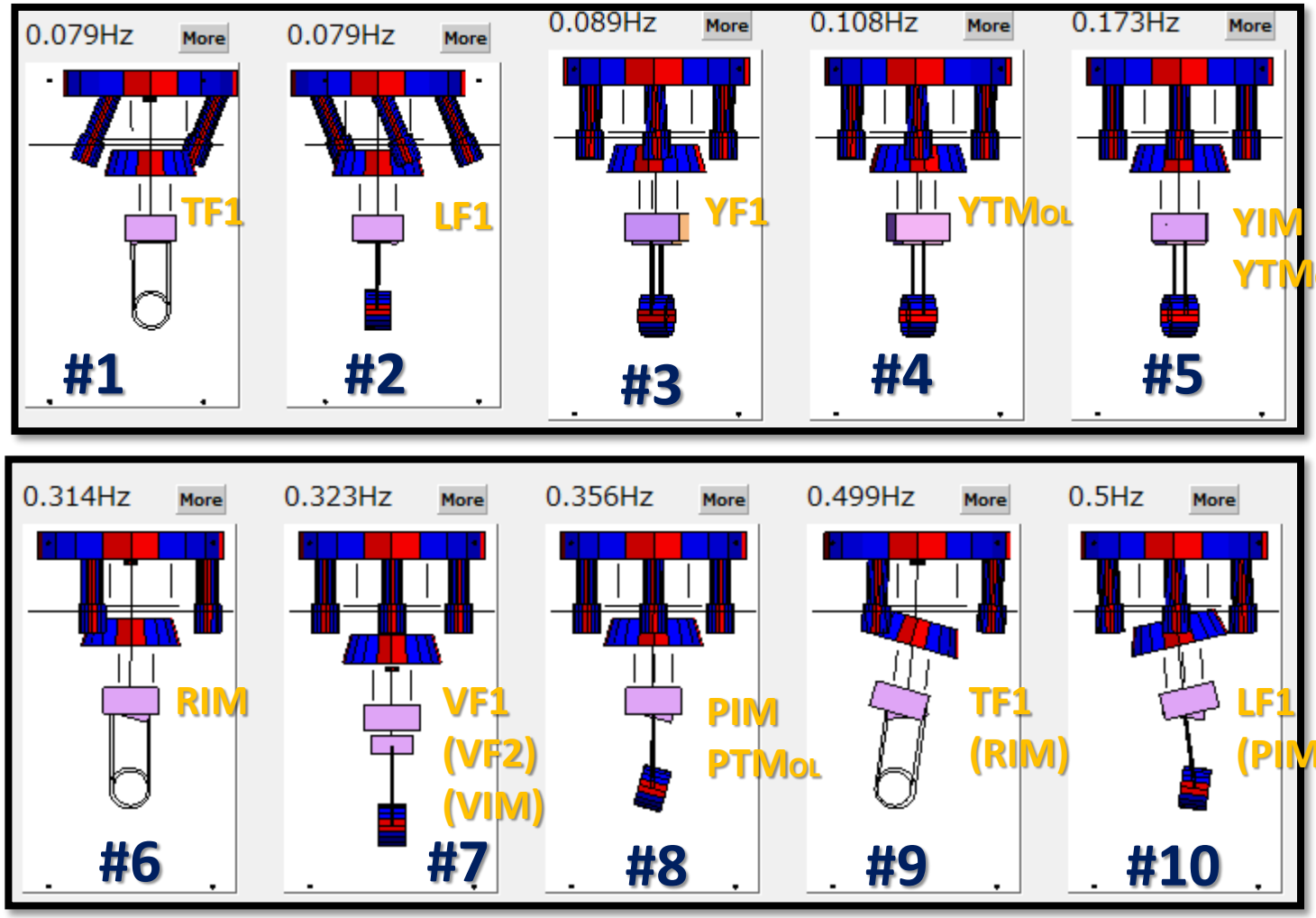
Sensing / Excitation point

Hardly seen/excited

Cannot be seen/excited

Eigen mode number

# Eigen Mode Shape




#1 : TF0

#2 : LF0

#3 : YF0

#4 : YWholeChain

#5 : YPayload

#6 : RPayload

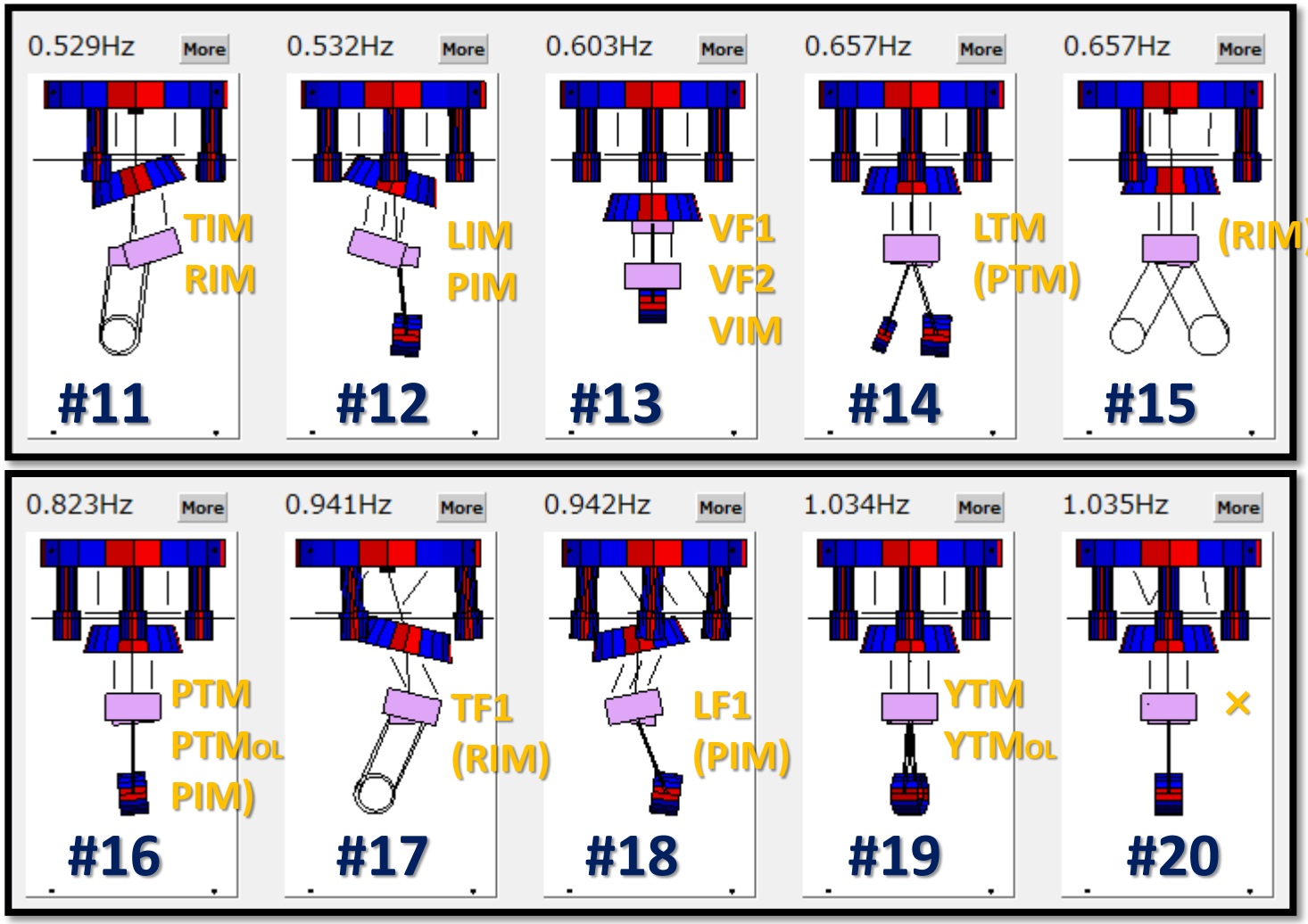
#7 : VPayload

#8 : PPayload

#9 : TPendulum

#10 : LPendulum

# Eigen Mode Shape




#11 : RF2

#12 : PF2

#13 : GAS

#14 : LTM

#15 : TTM

#16 : PTM

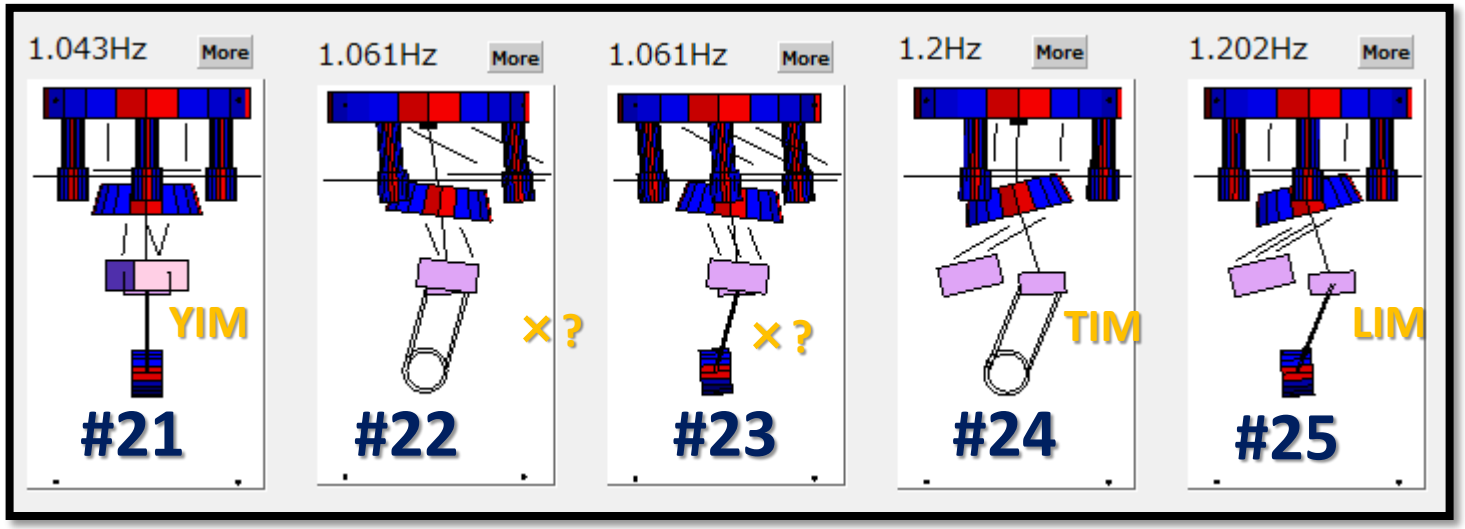
#17 : TPendulum

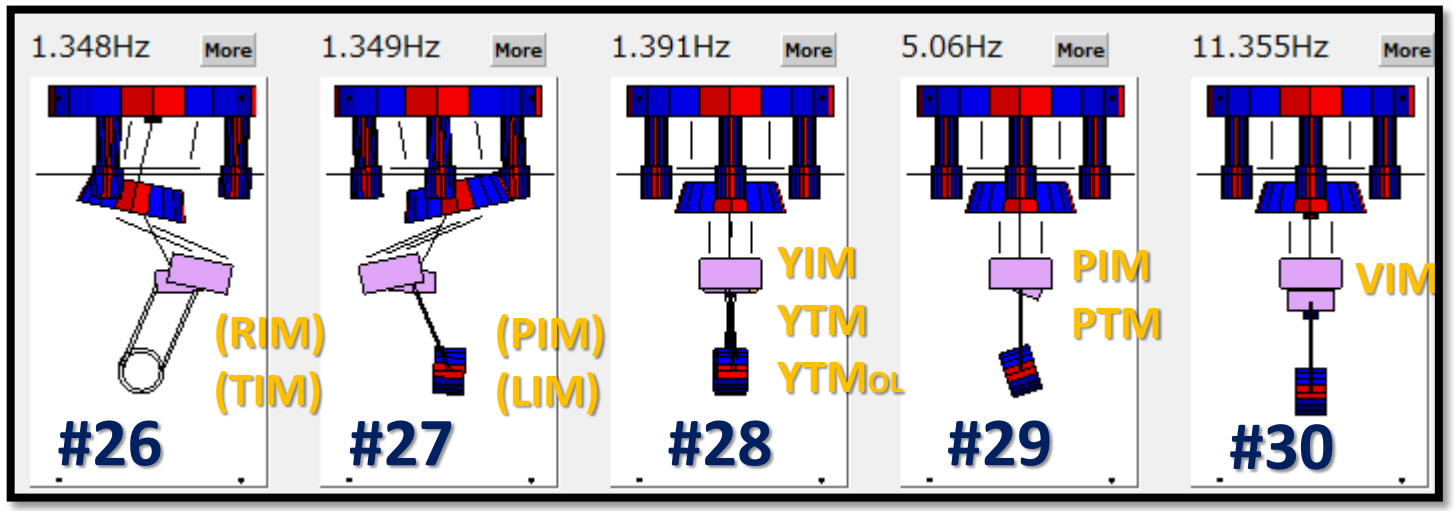
#18 : LPendulum

#19 : YTM, YRM
(YTM, -YRM)

#20 : YMD

# Eigen Mode Shape




[#21 : YIR]

[#22 : TMD]

[#23 : LMD]

[#24 : TIR]

[#25 : LIR]

[#26 : TPendulum]

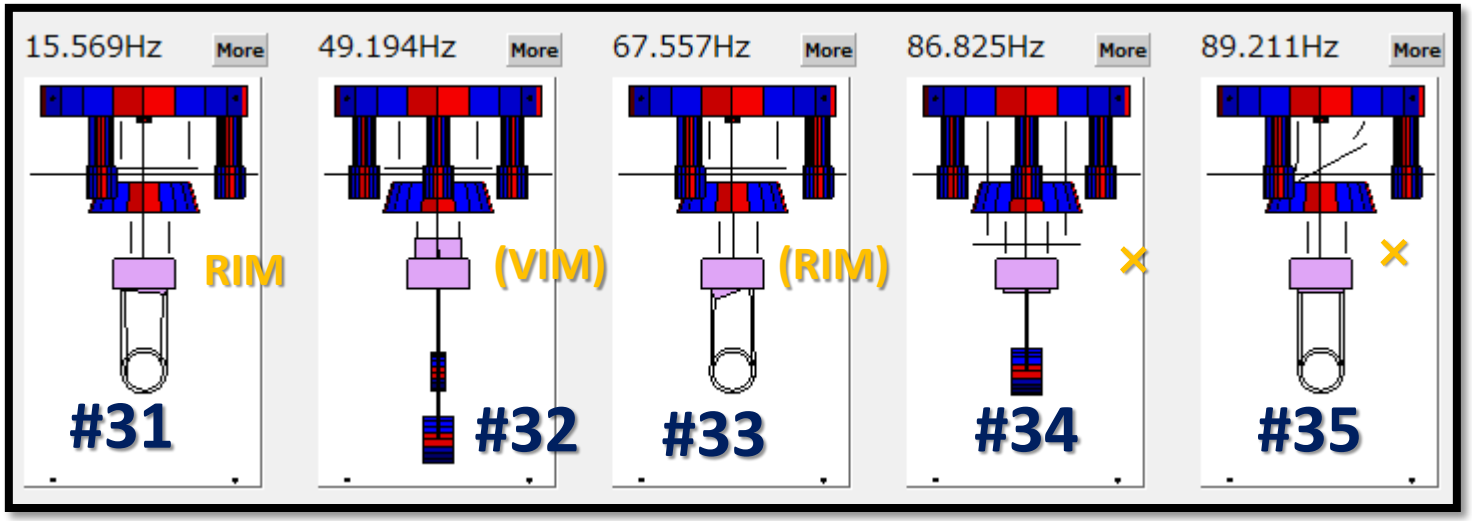
[#27 : LPendulum]

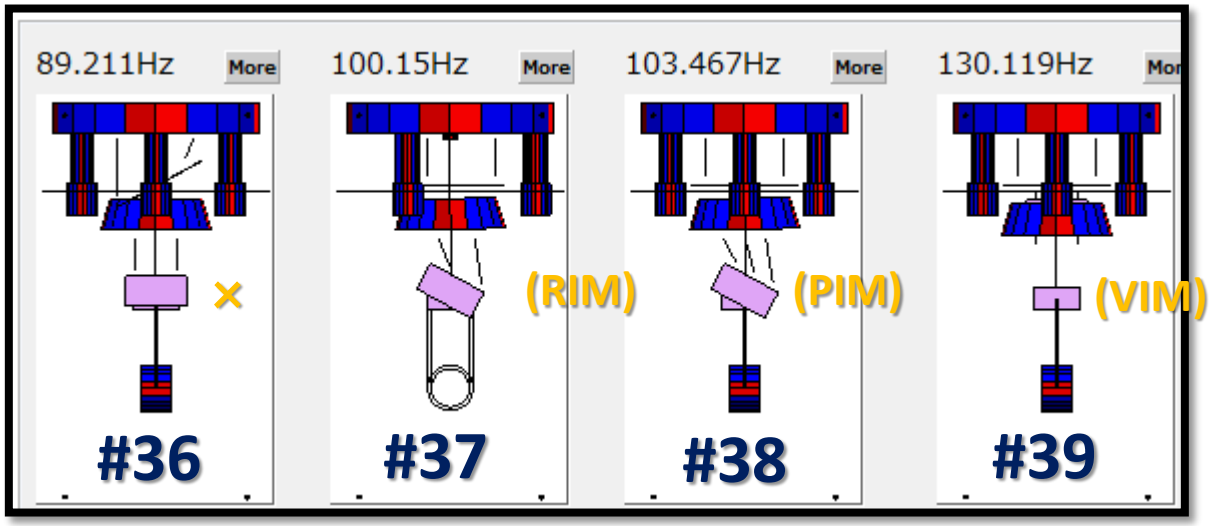
[#28 : YTM]

[#29 : PIM, PRM]

[#30 : VTM]

# Eigen Mode Shape




#31 : RTM

#32 : VRM

#33 : RIM, RRM
(RIM, -RRM)

#34 : VMD

#35 : RMD

#36 : PMD

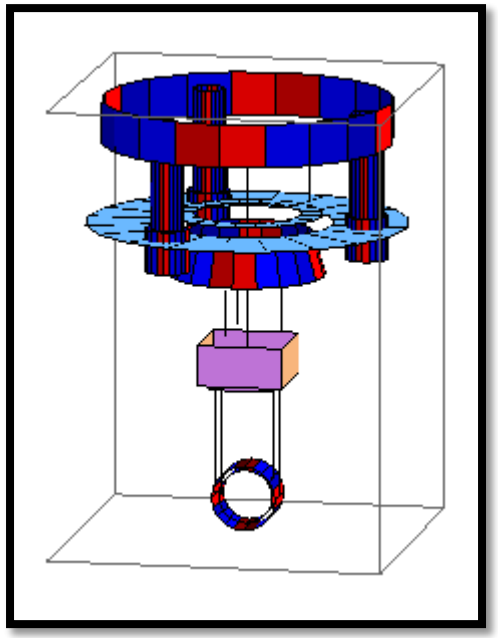
#37 : RIR

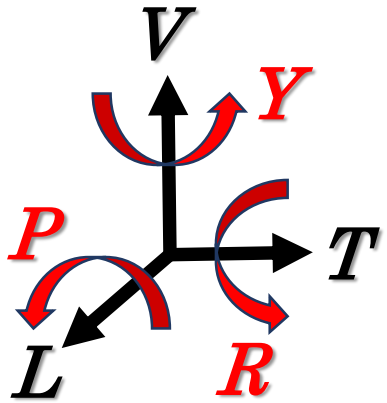
#38 : PIR

#39 : VIR

# Force Transfer Functions

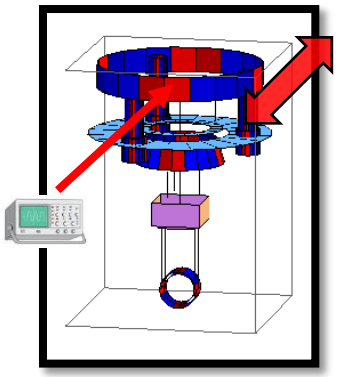
## (, which can be measured, with No ctrl)

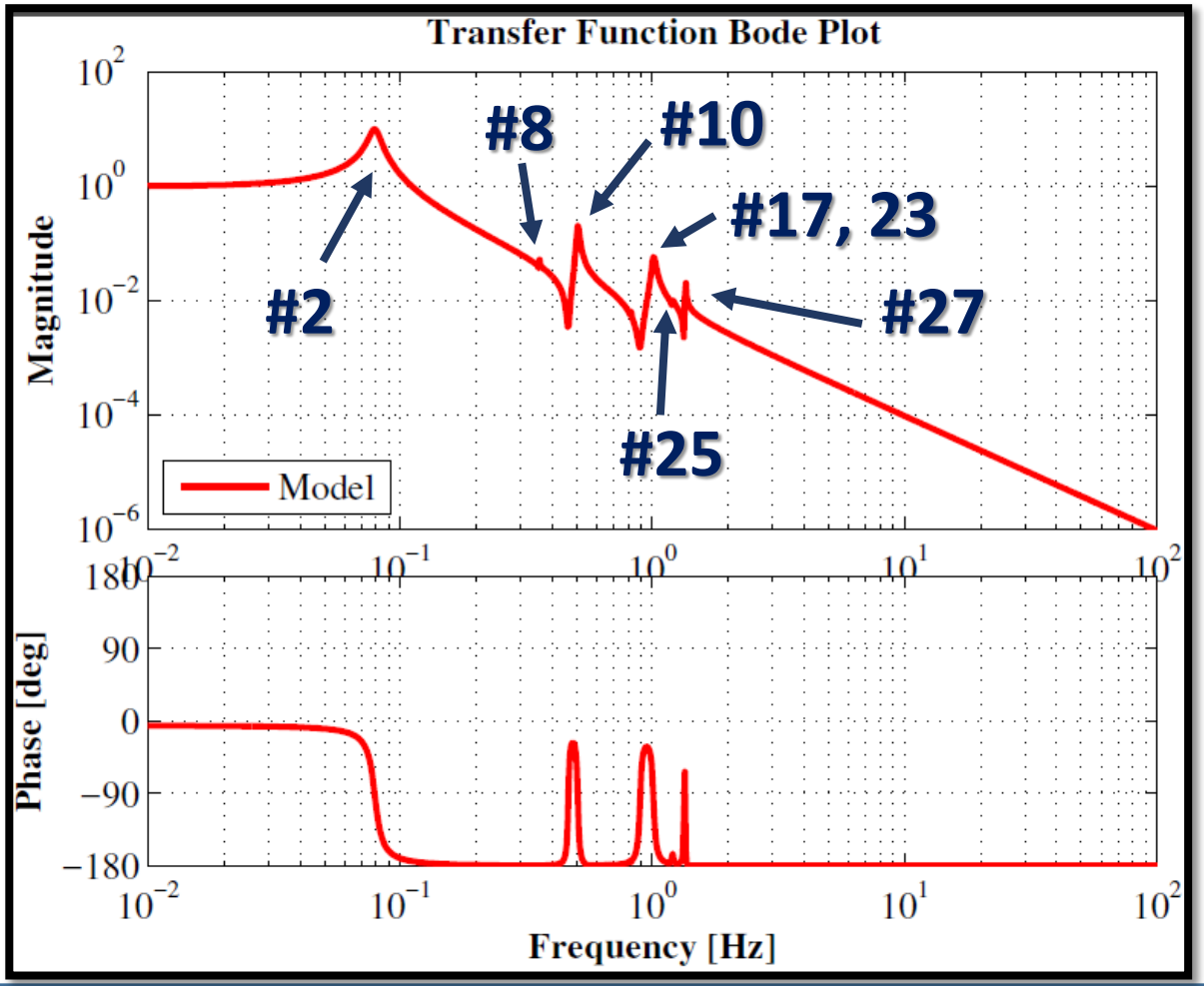




# Force Transfer Function

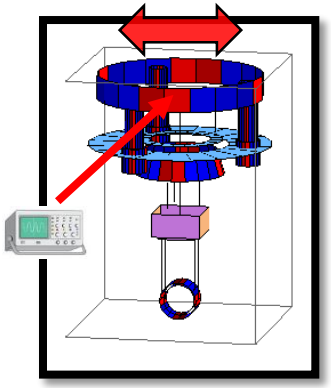
## LVDT_LF1 / actLF1

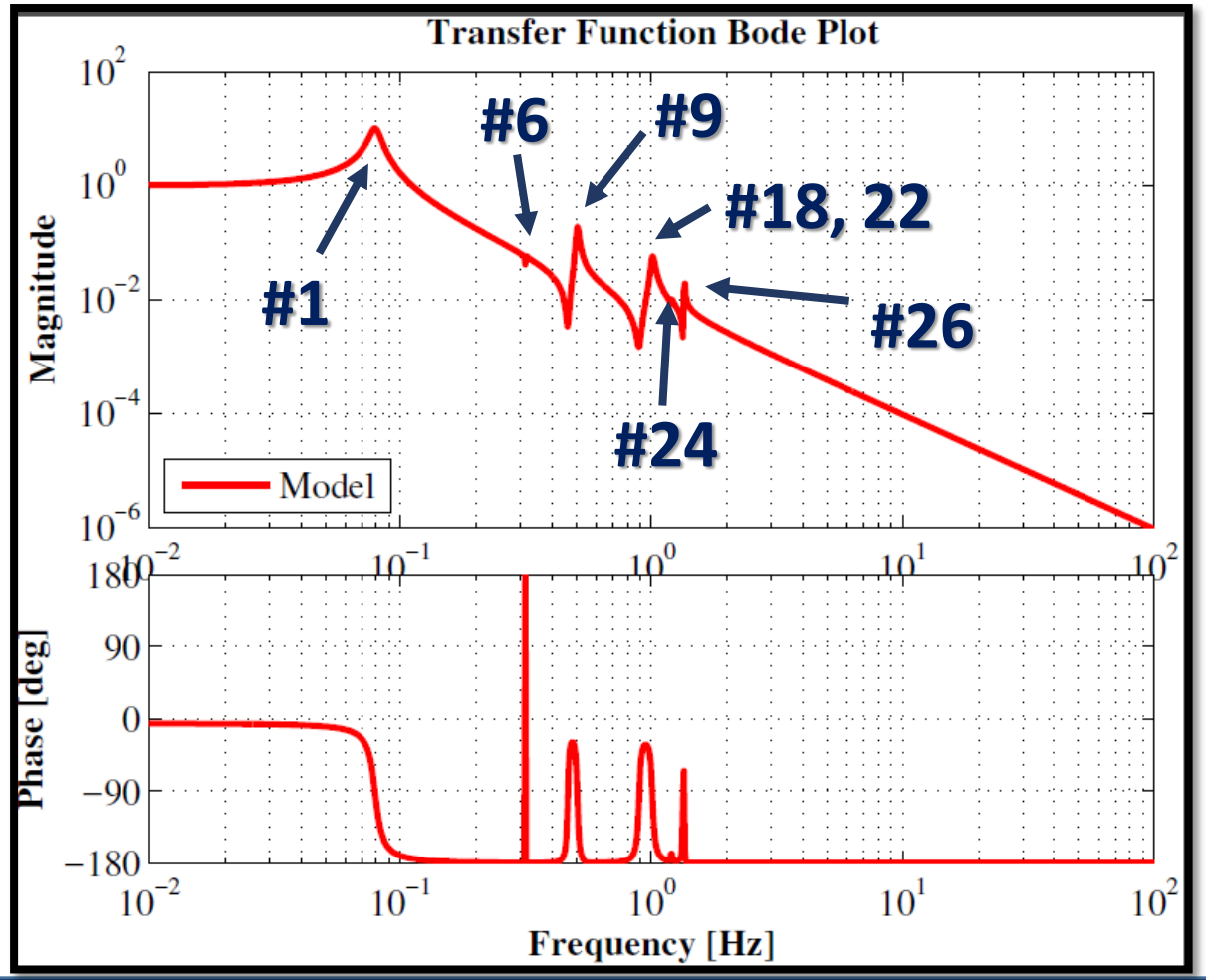




# Force Transfer Function

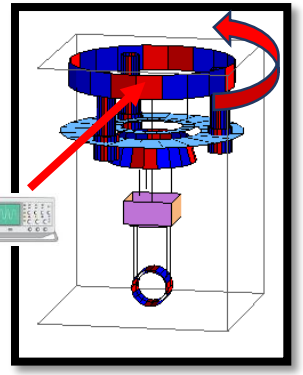
## LVDT_TF1 / actTF1

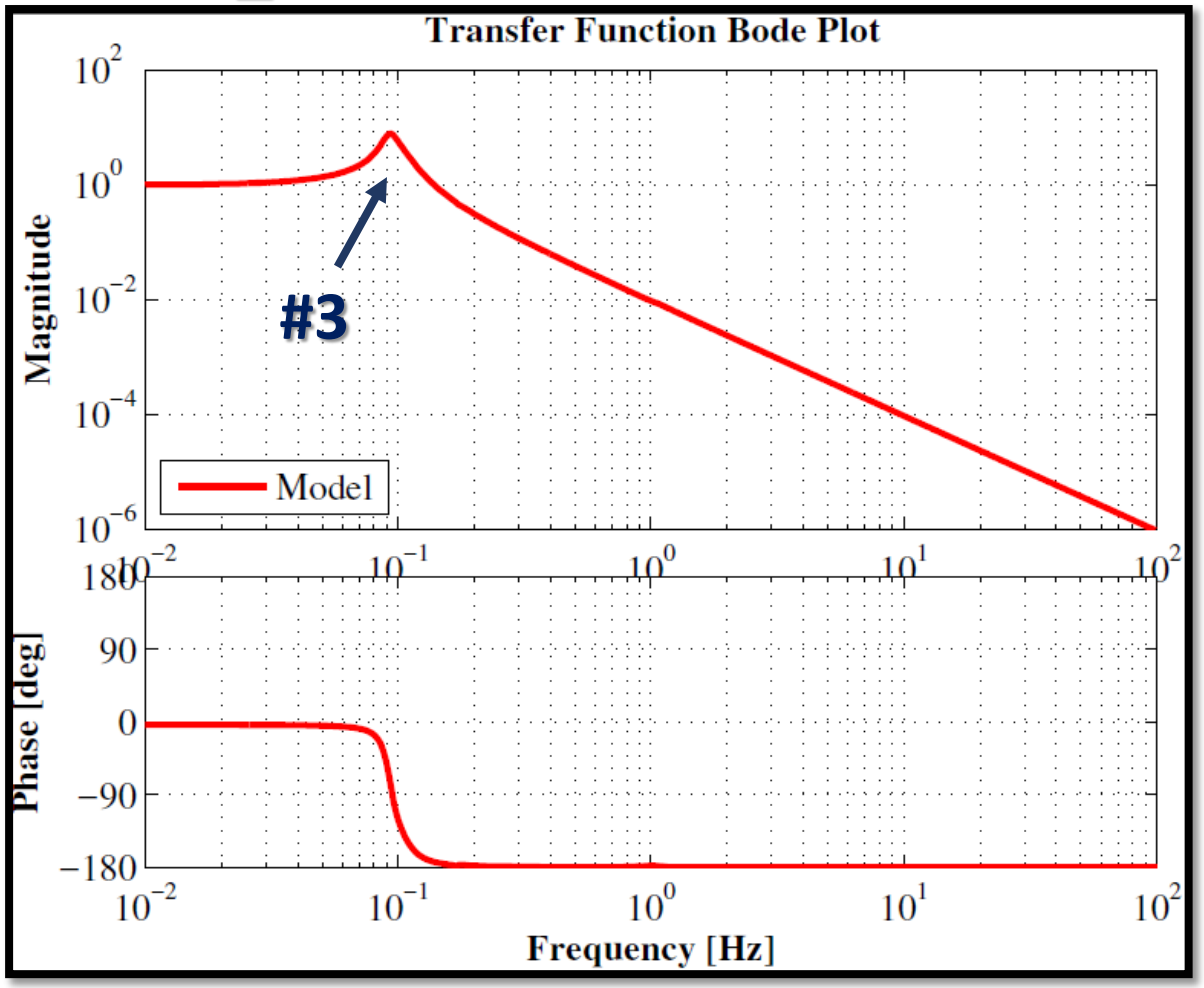




# Force Transfer Function

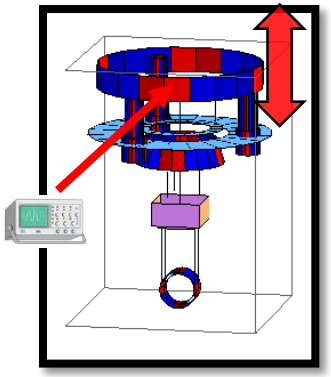
## LVDT_YF1 / actYF1

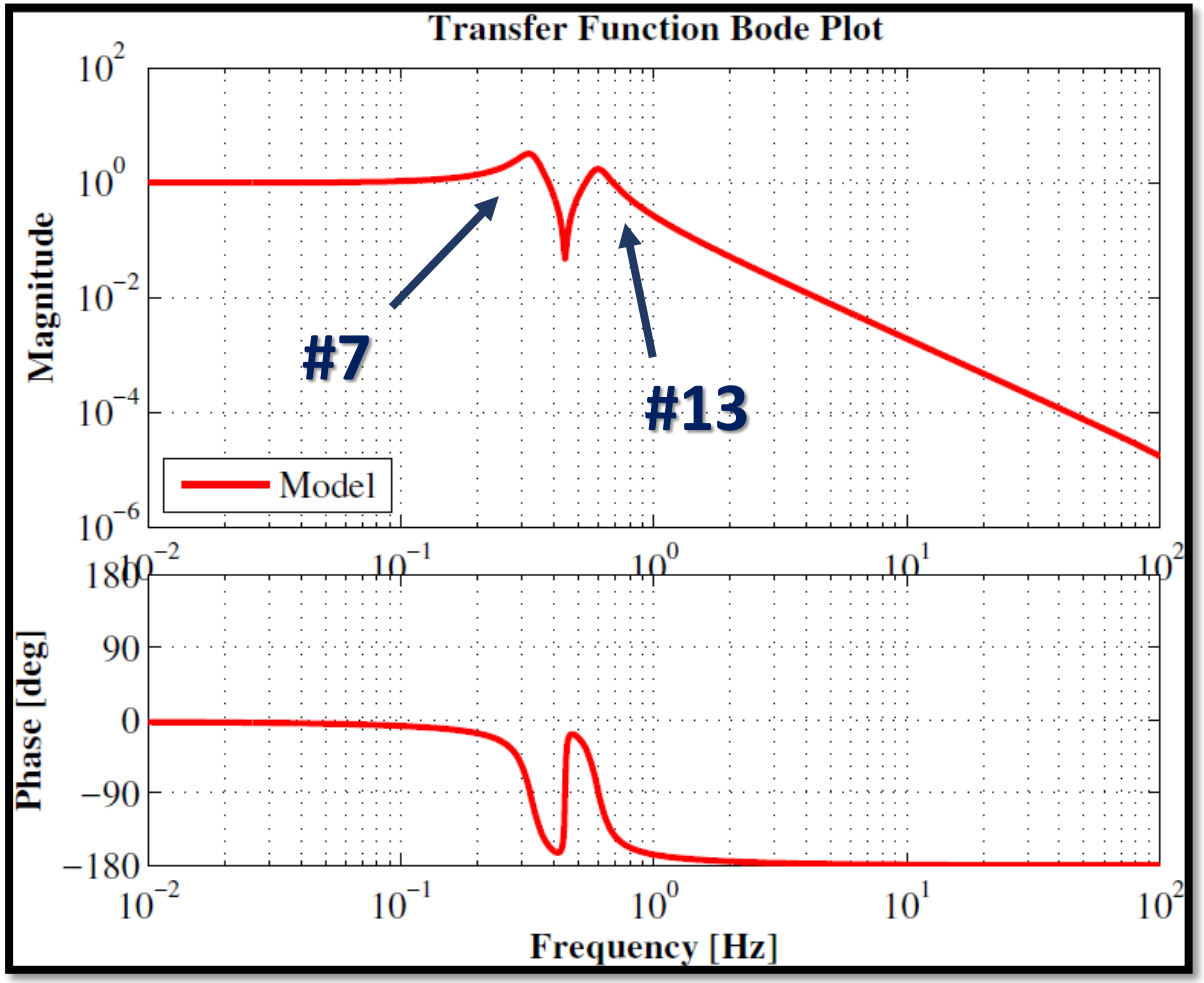




# Force Transfer Function

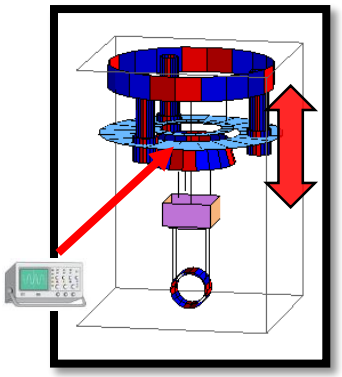
## LVDT_VF1 / actVF1

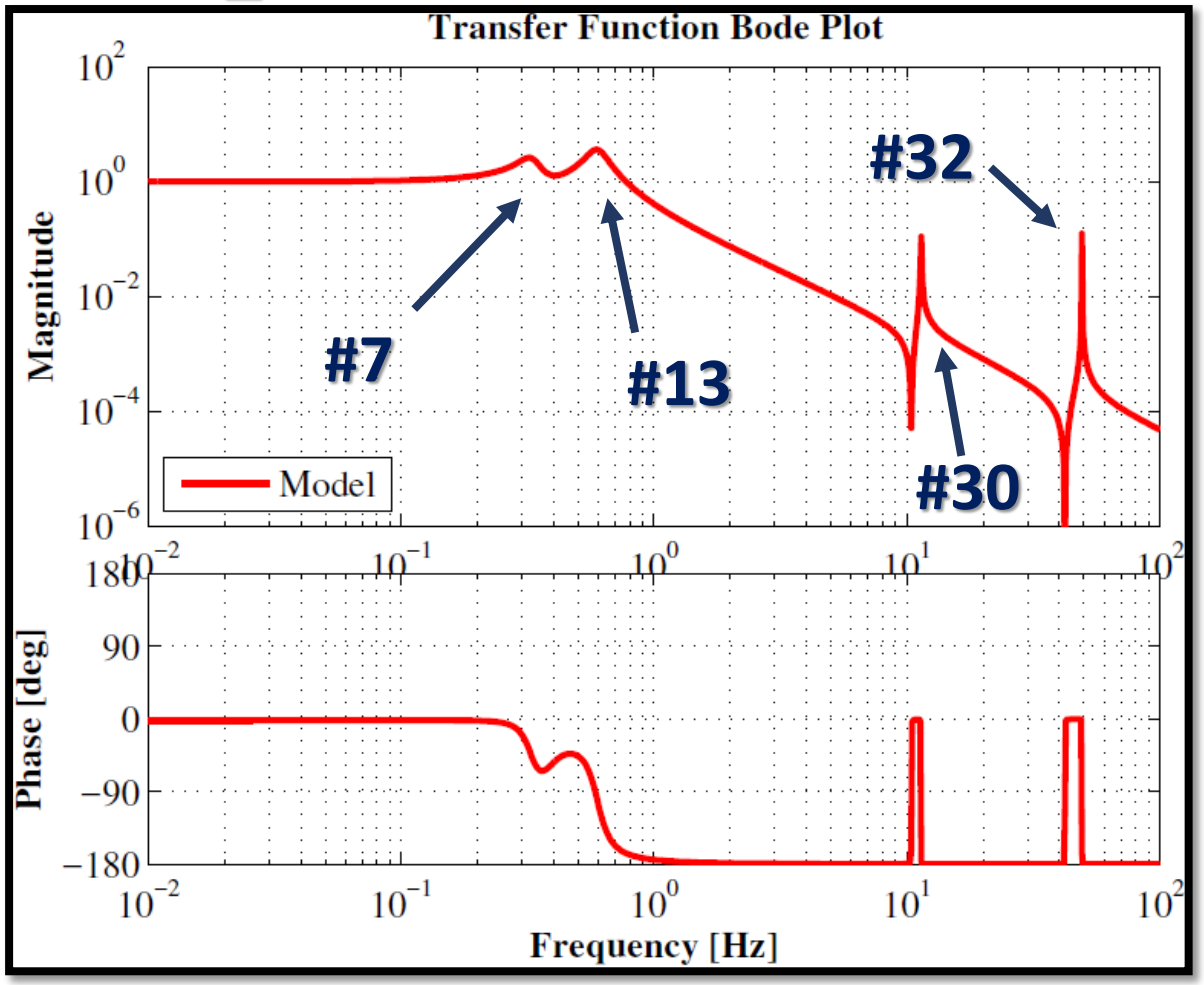




# Force Transfer Function

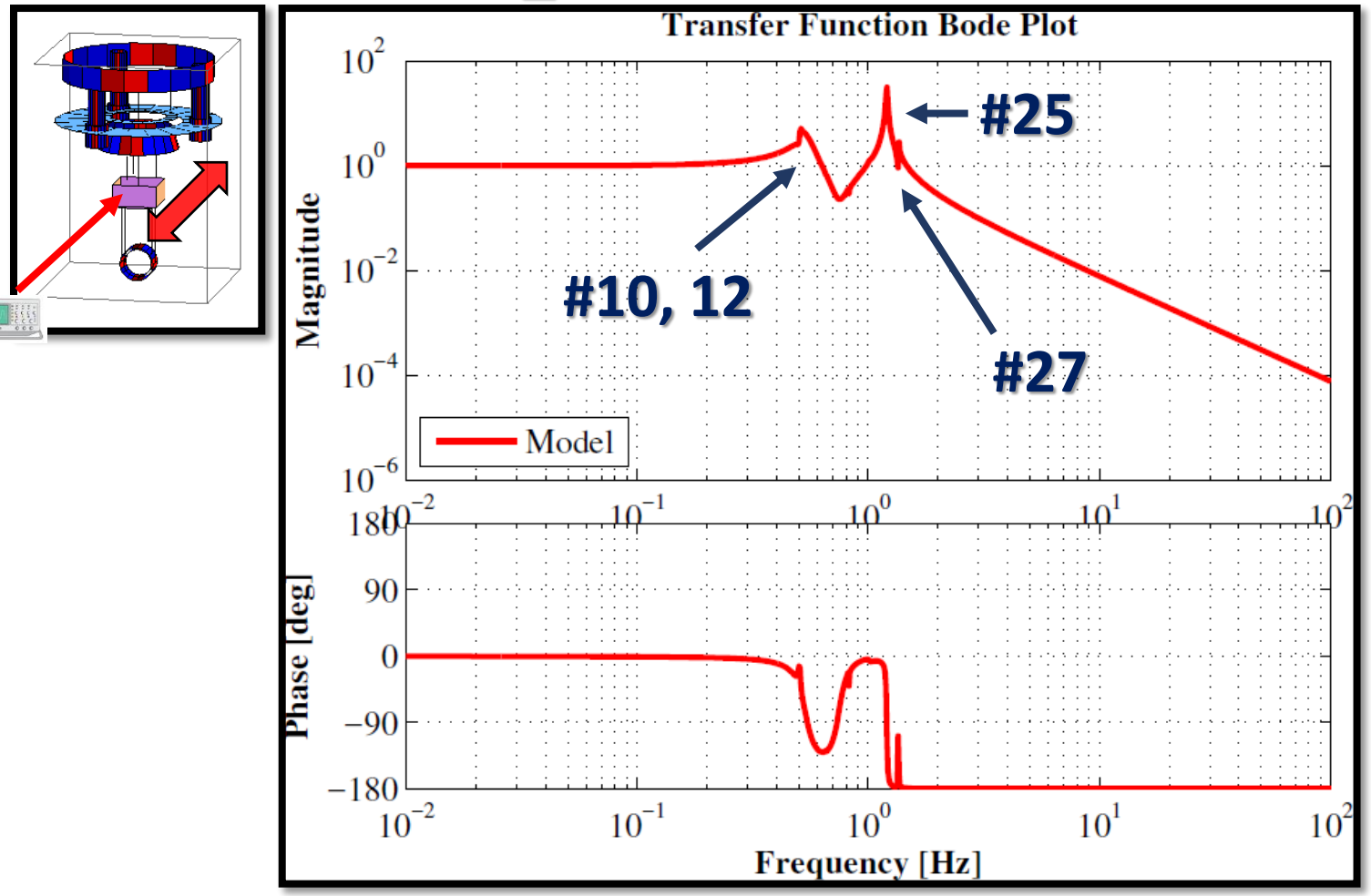
## LVDT_VF2 / actVF2





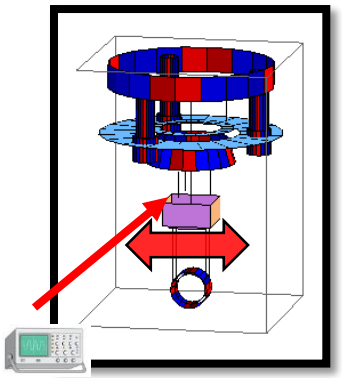
# Force Transfer Function

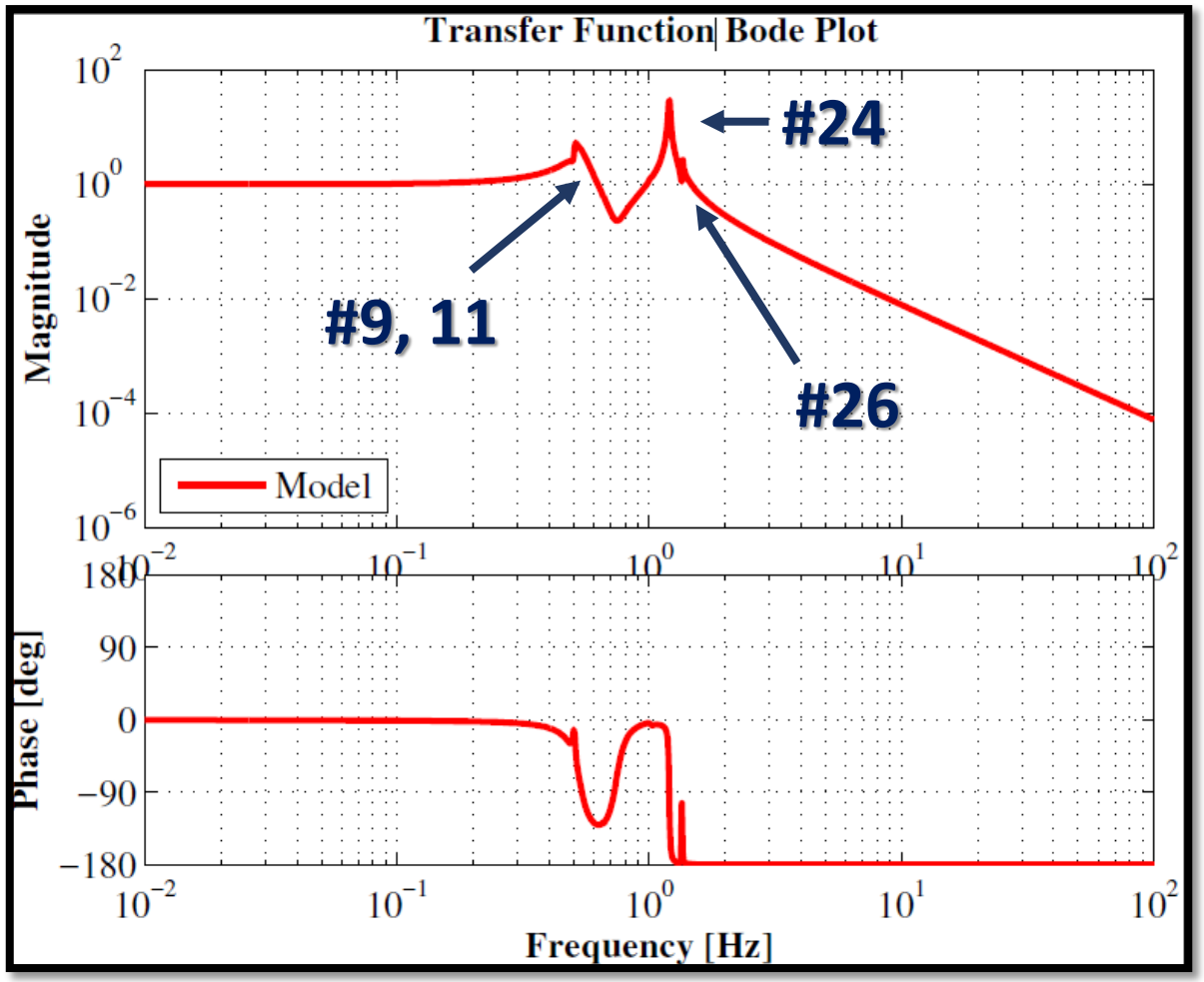
## OSEM_LIM / actLIM



# Force Transfer Function

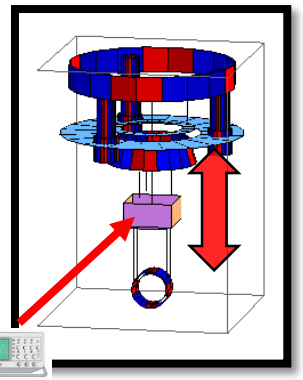
## OSEM_TIM / actTIM

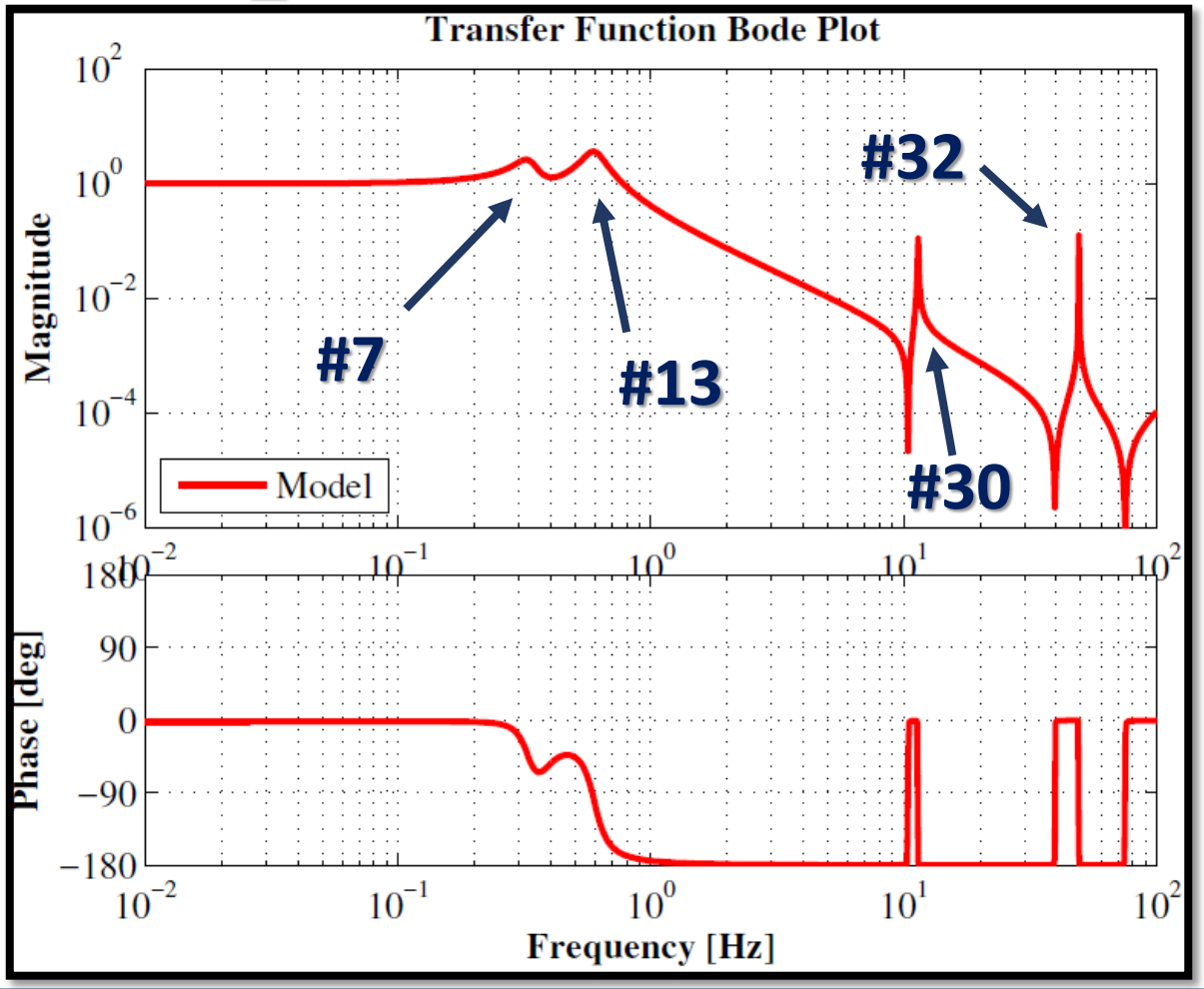




# Force Transfer Function

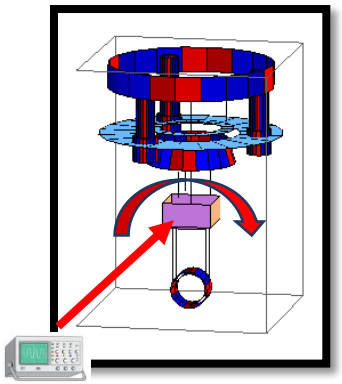
## OSEM_VIM / actVIM

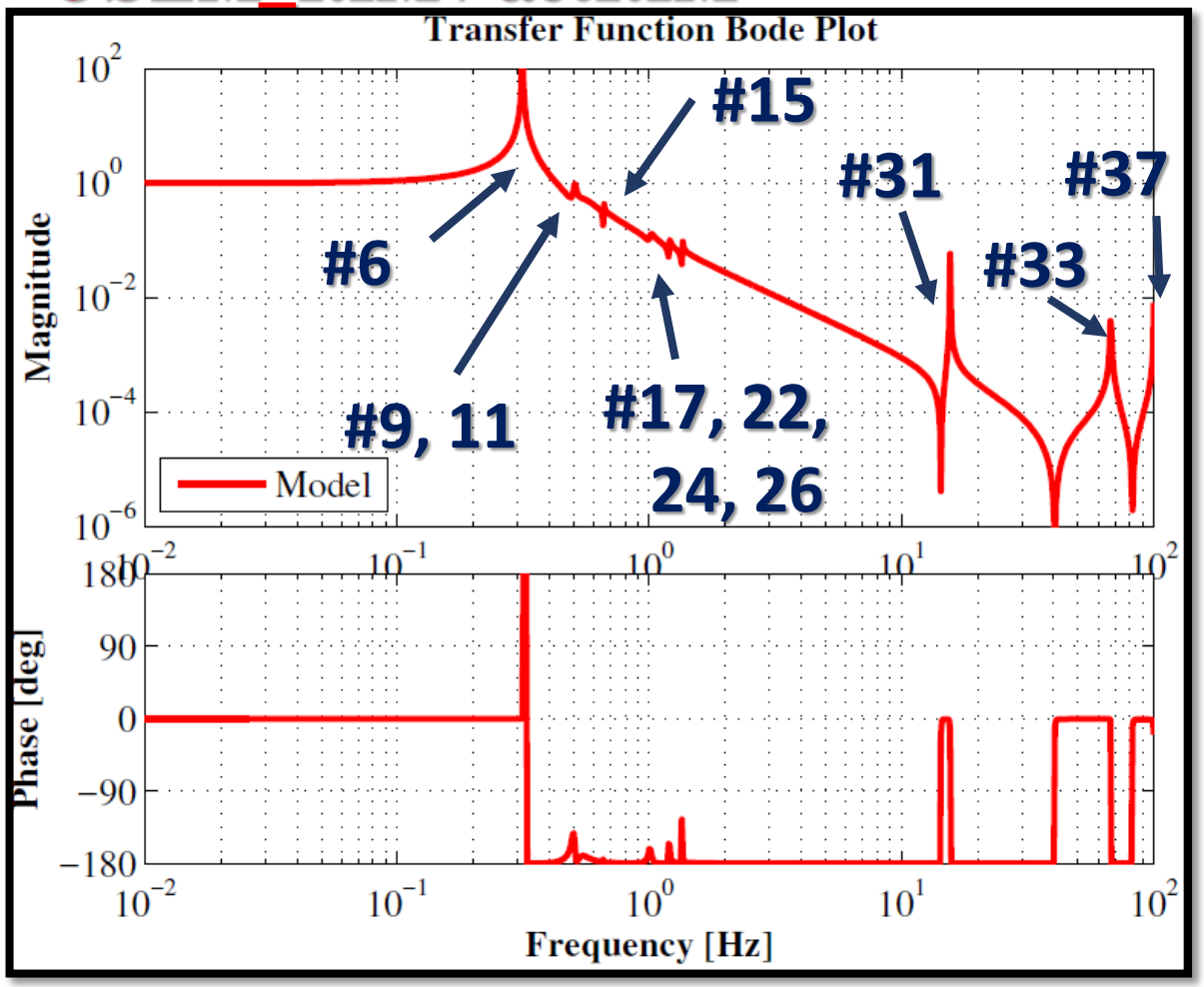




# Force Transfer Function

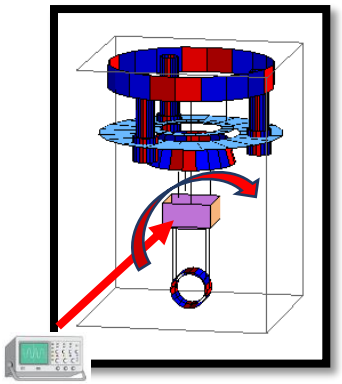
## OSEM_RIM / actRIM

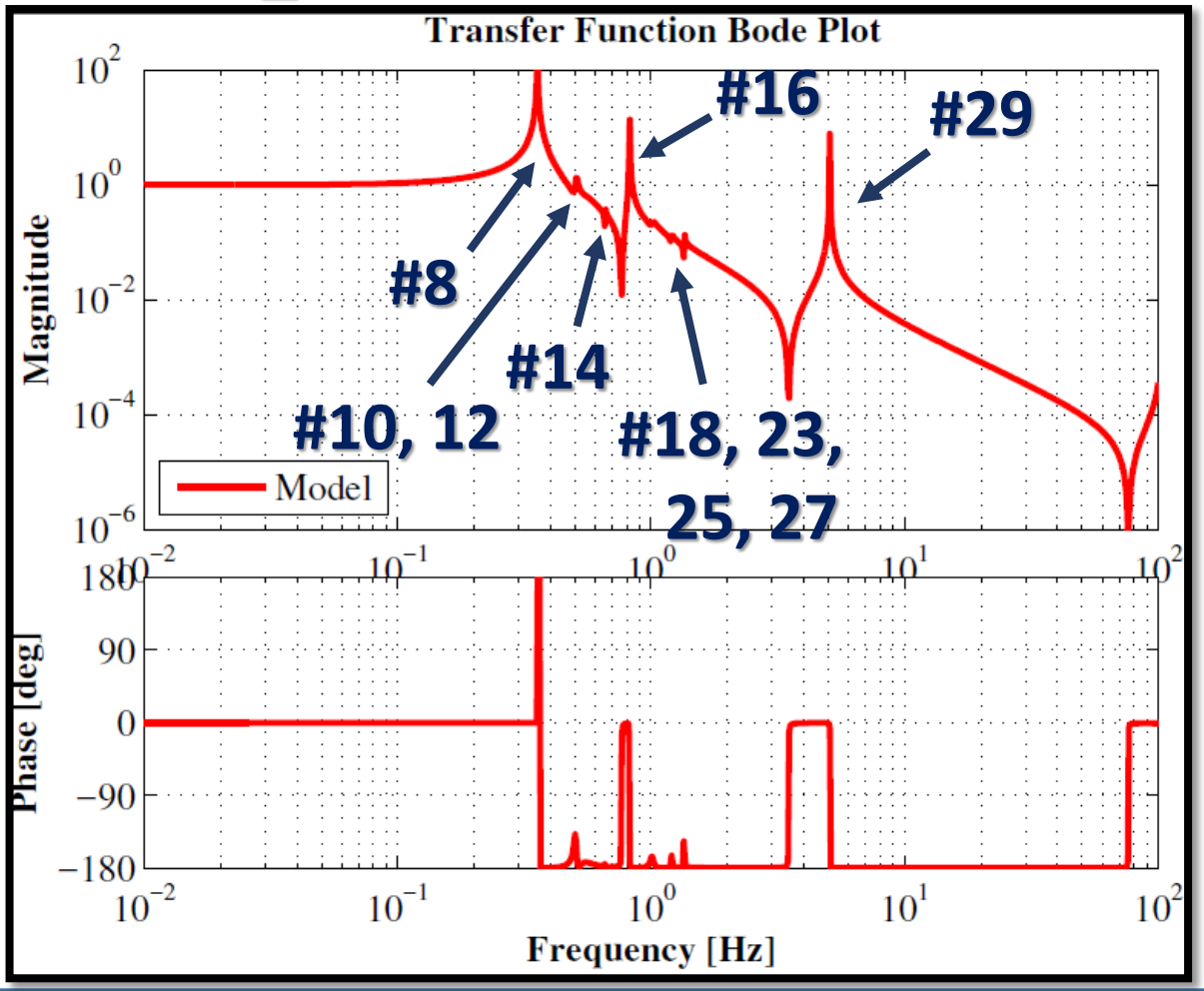




# Force Transfer Function

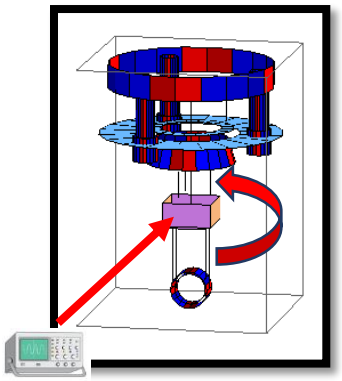
## OSEM_PIM / actPIM

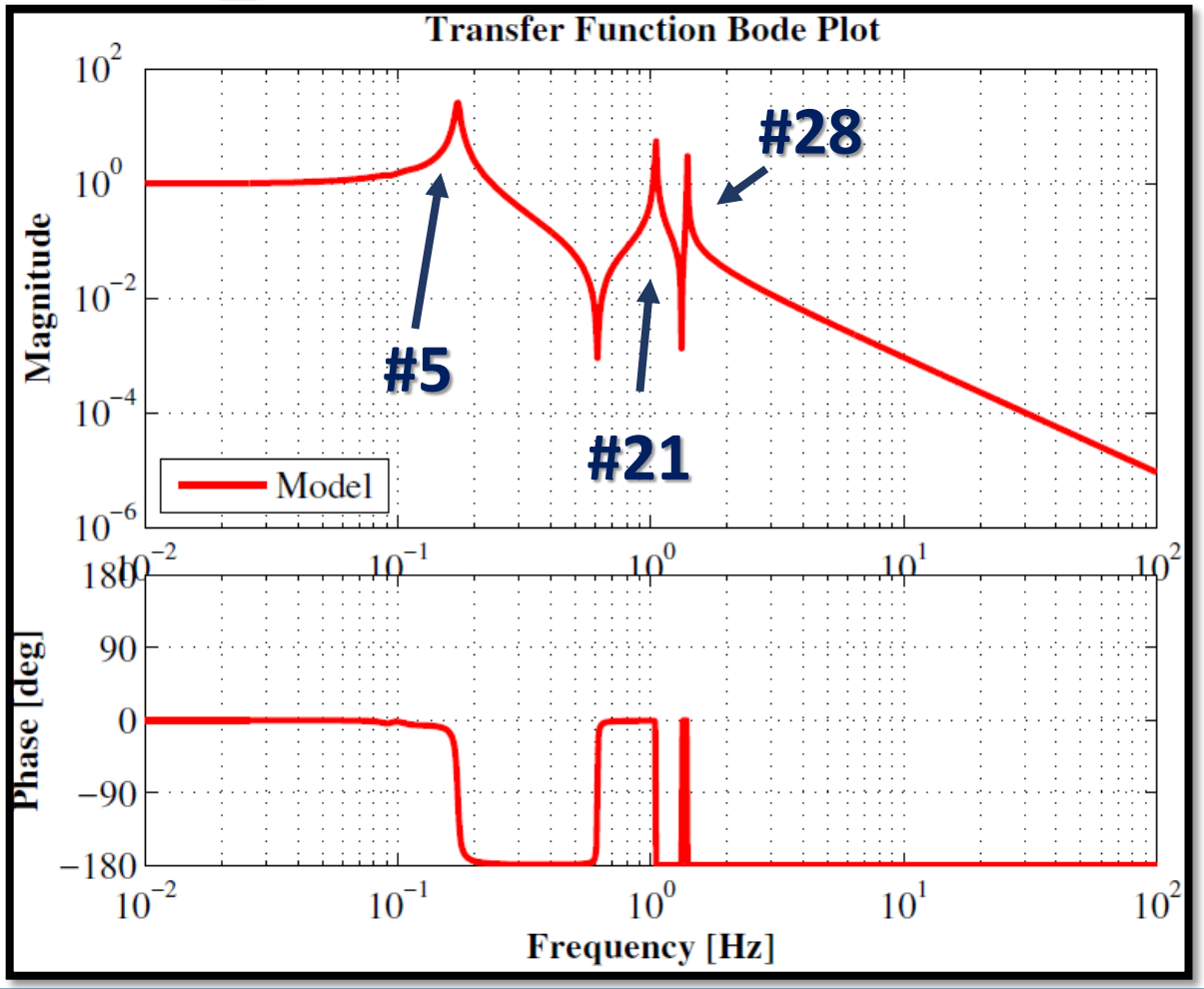




# Force Transfer Function

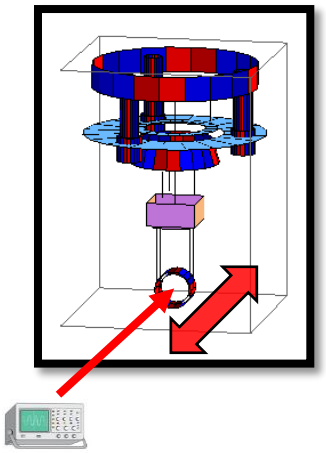
## OSEM_YIM / actYIM

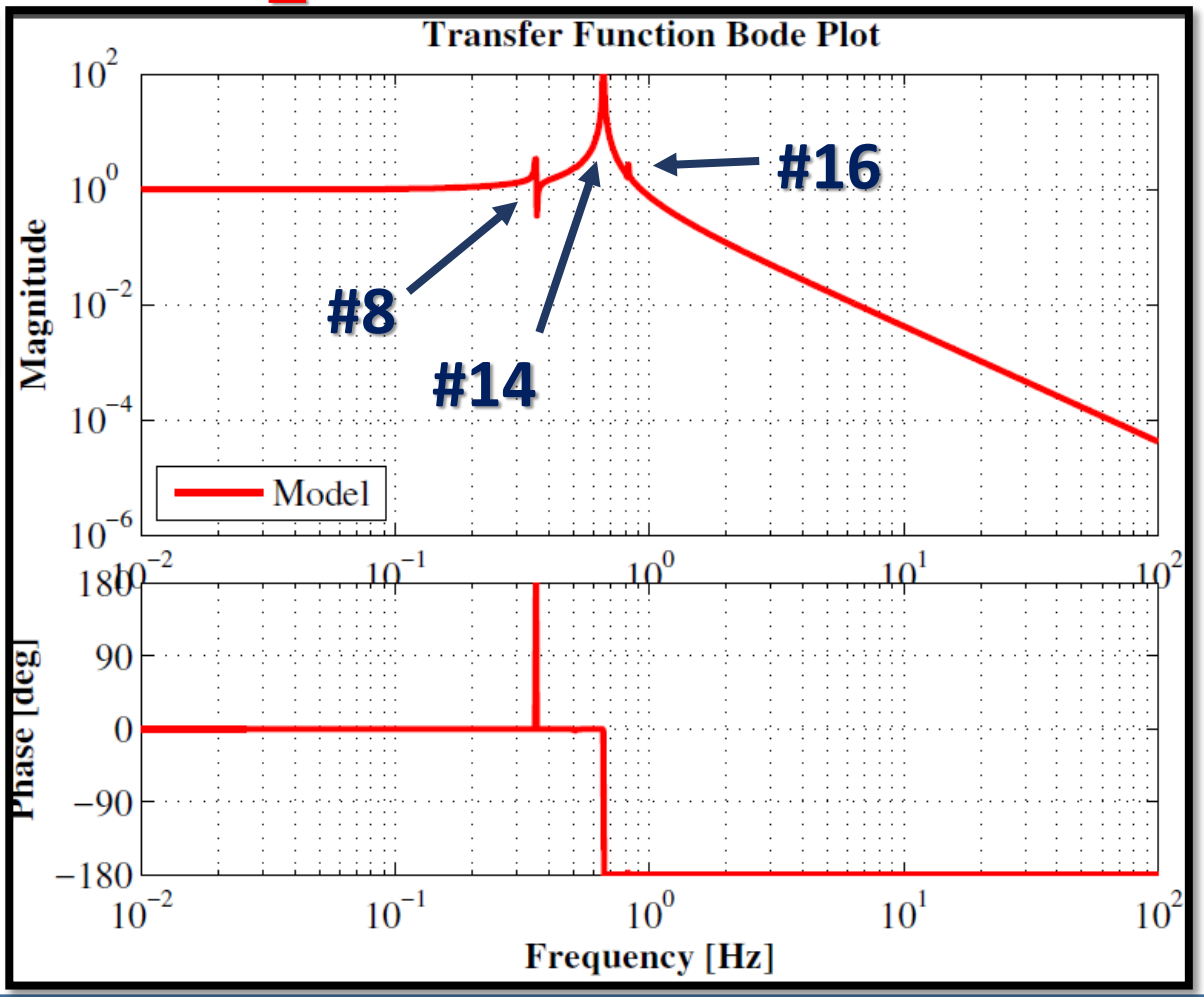




# Force Transfer Function

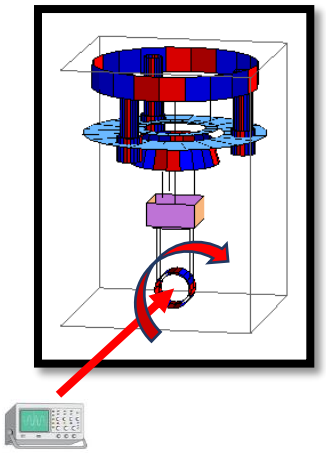
## OSEM_LTM / actLTM

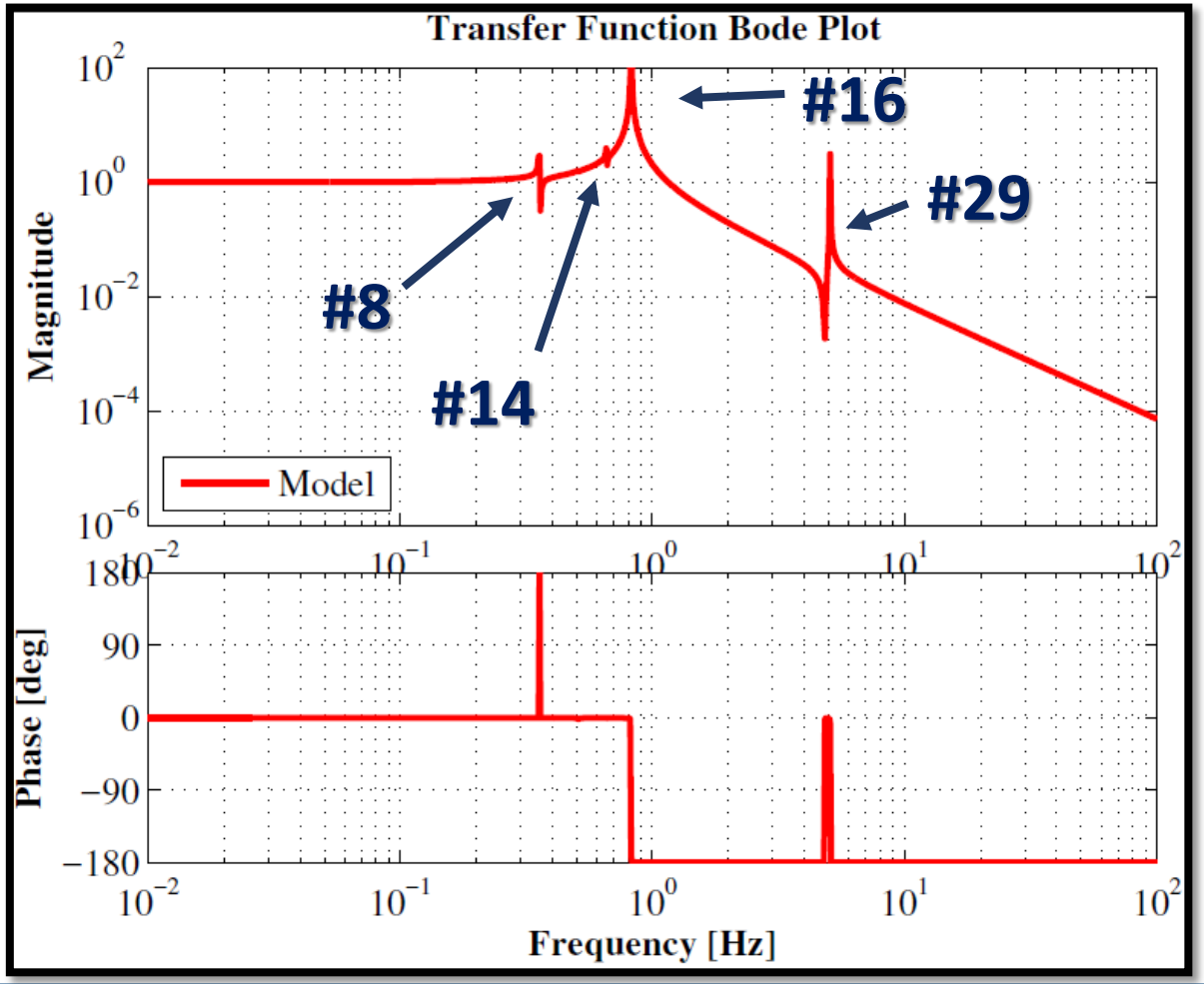




# Force Transfer Function

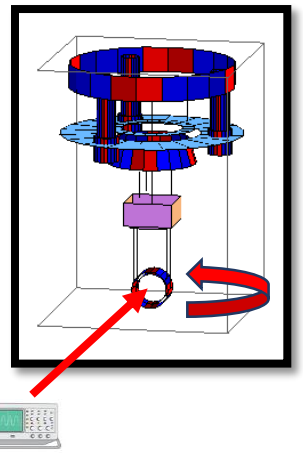
## OSEM_PTM / actPTM

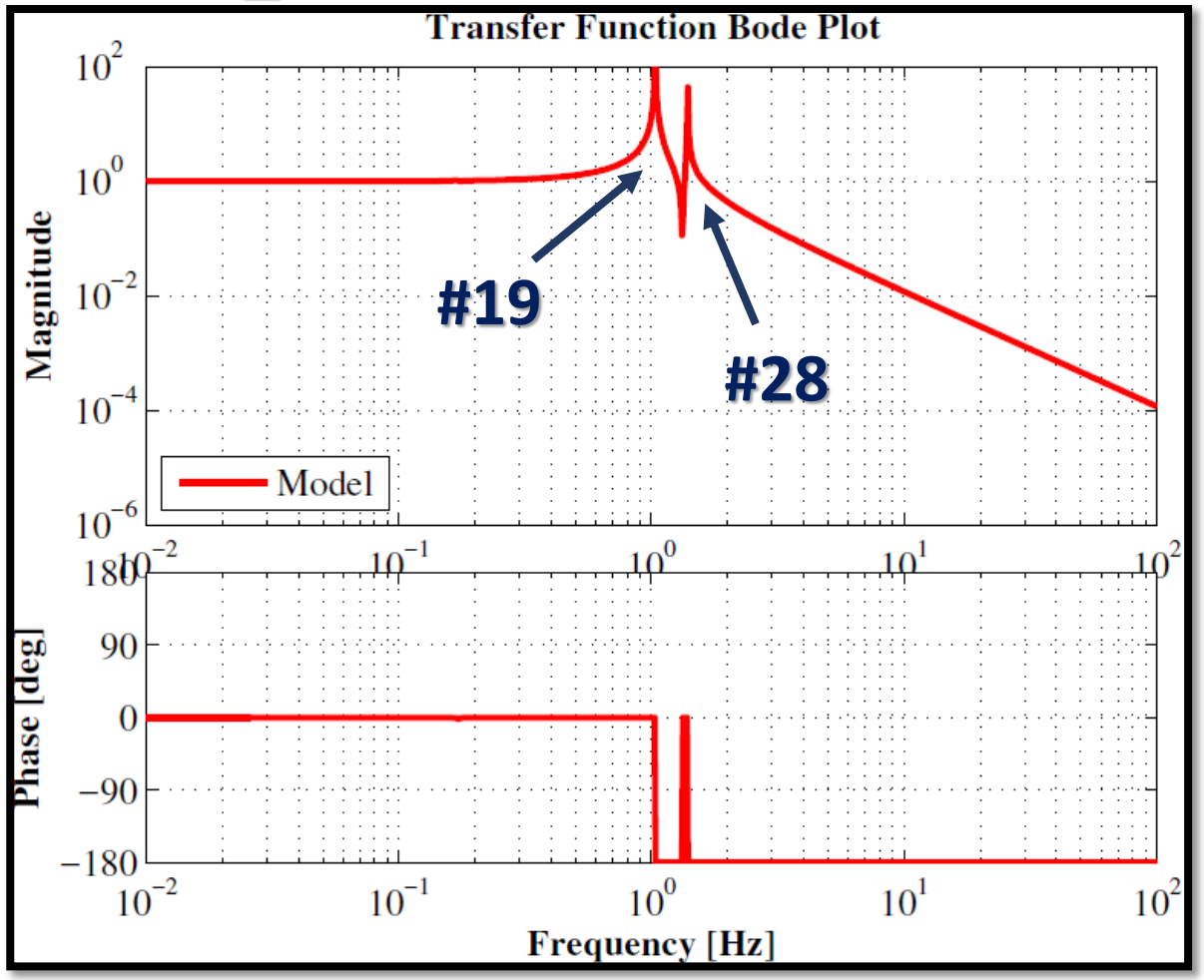




# Force Transfer Function

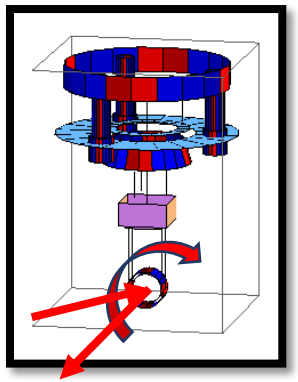
## OSEM_YTM / actYTM

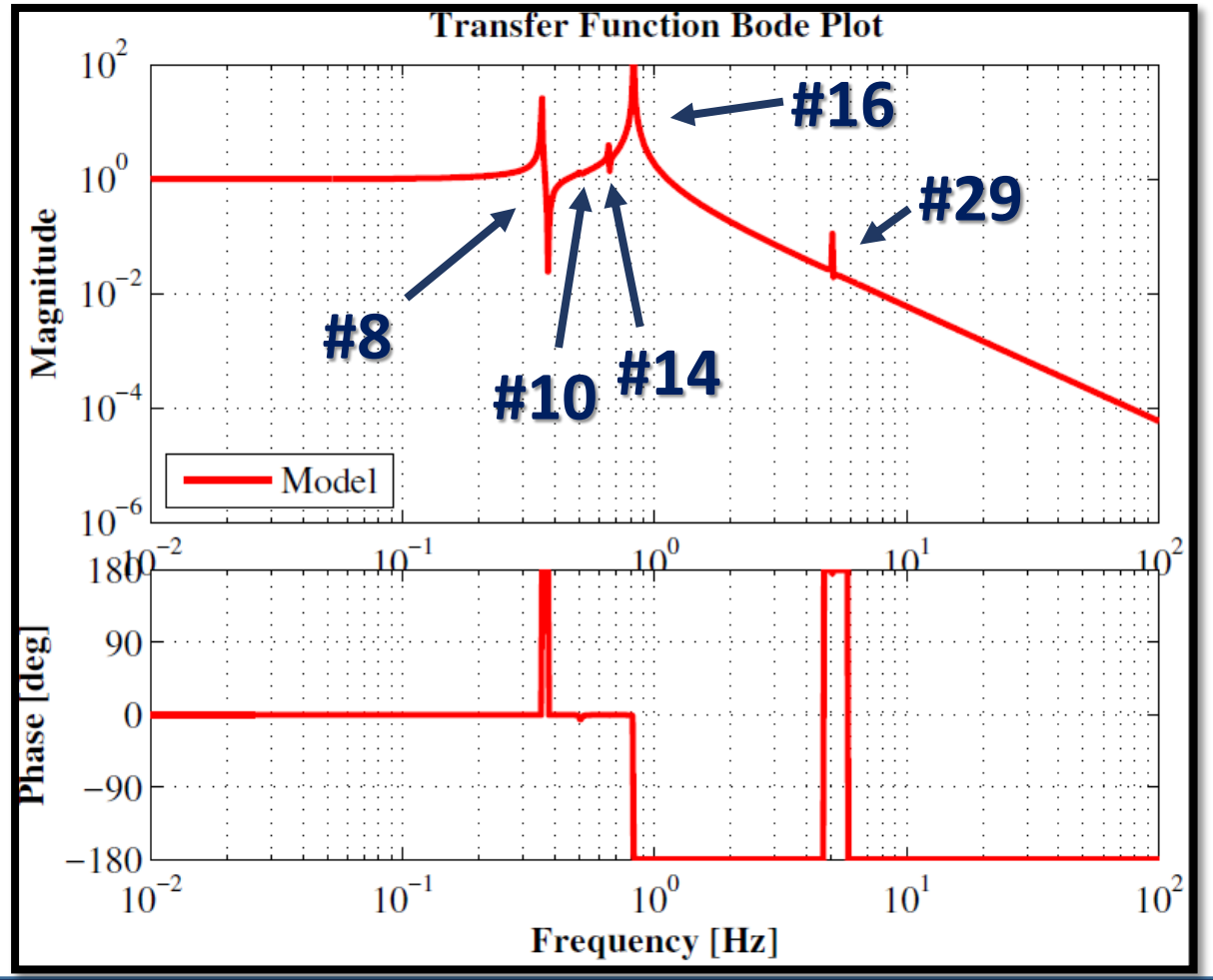




# Force Transfer Function

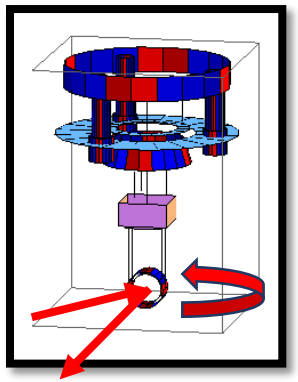
## OpLev_PTM / actPTM

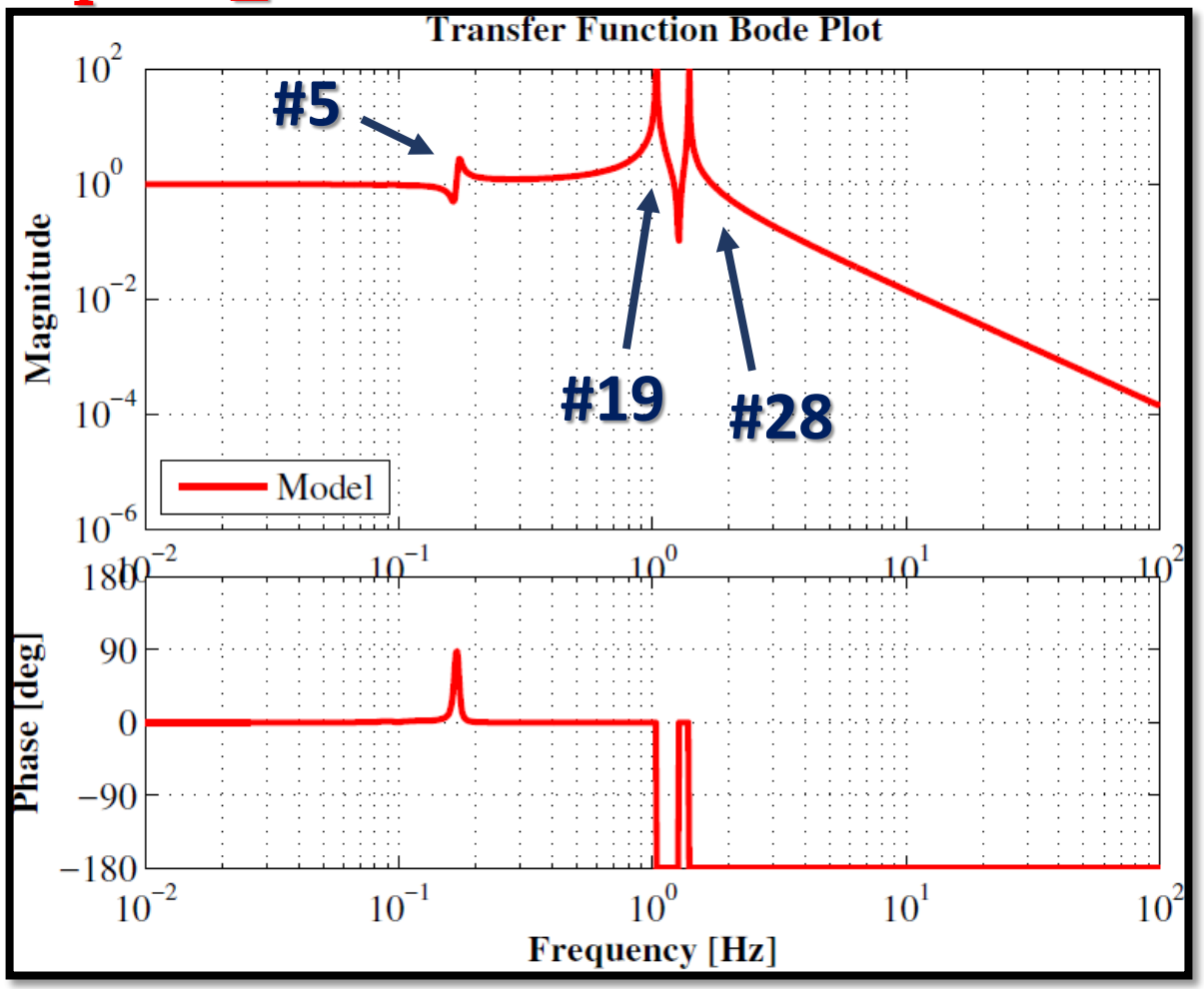




# Force Transfer Function

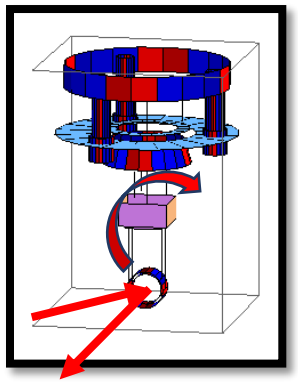
## OpLev_YTM / actYTM

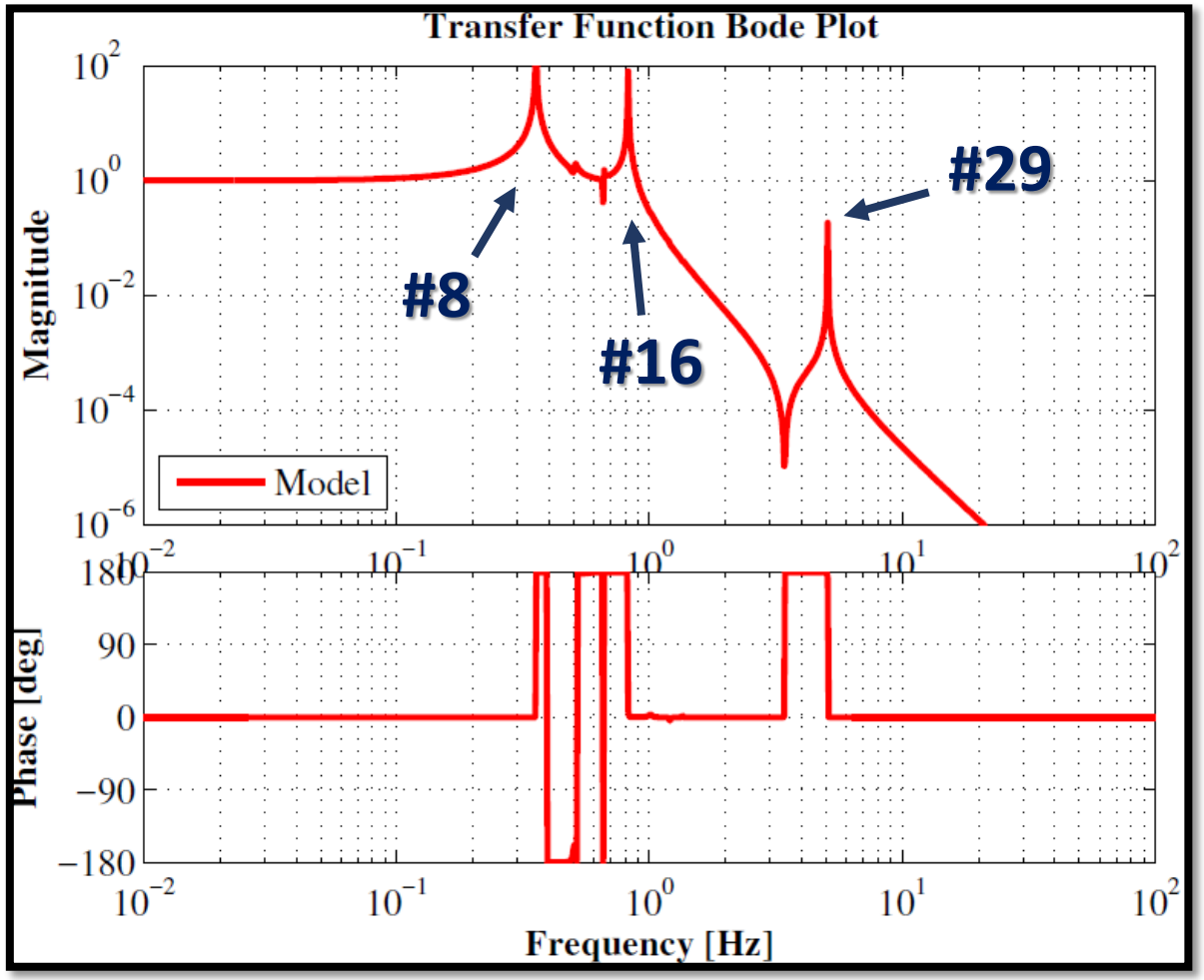




# Force Transfer Function

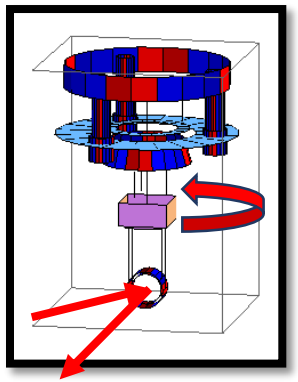
## OpLev_PTM / actPIM

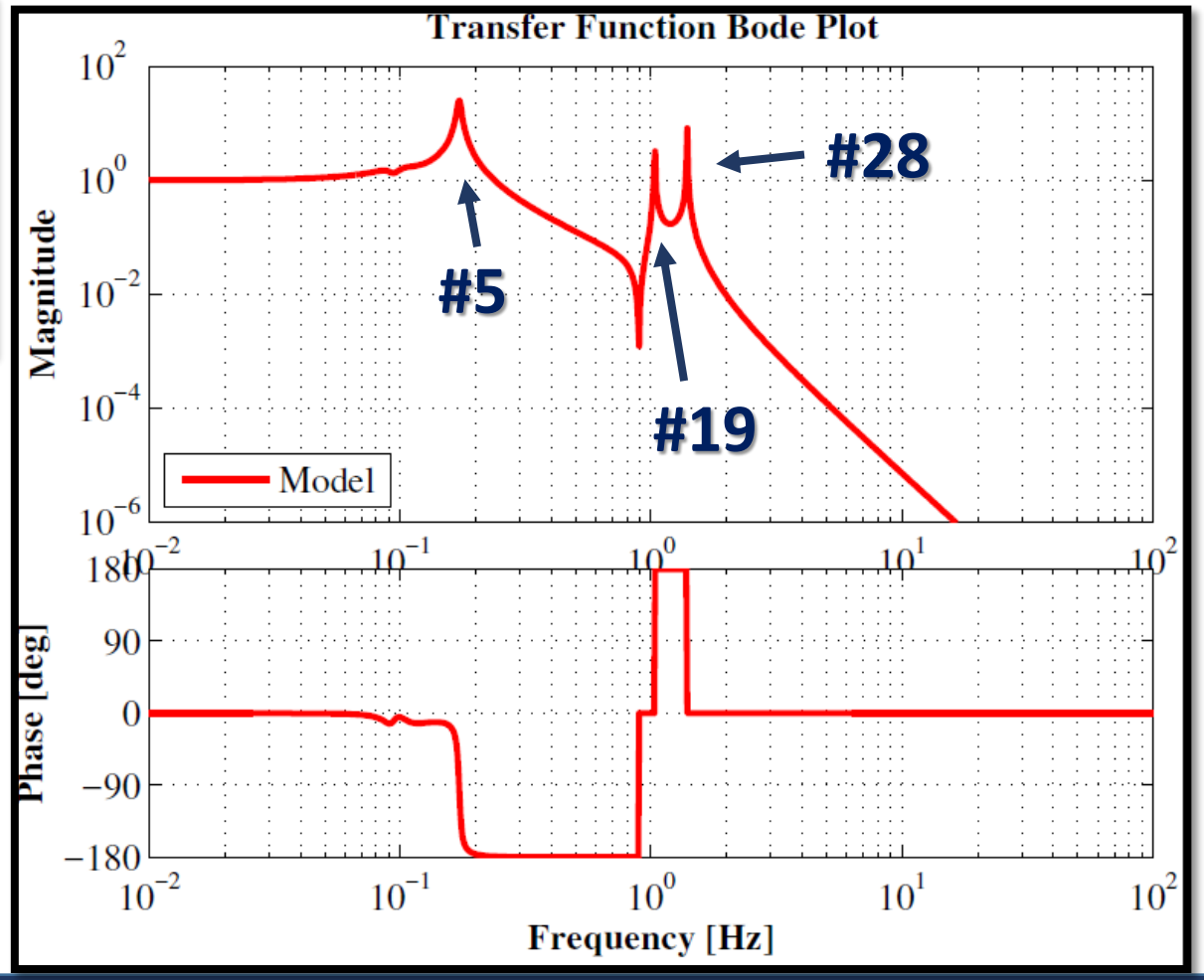




# Force Transfer Function

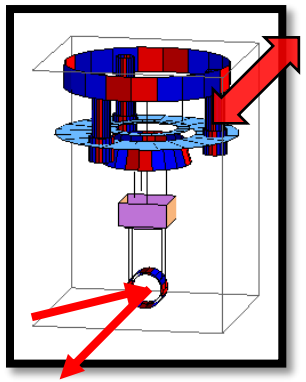
## OpLev_YTM / actYIM

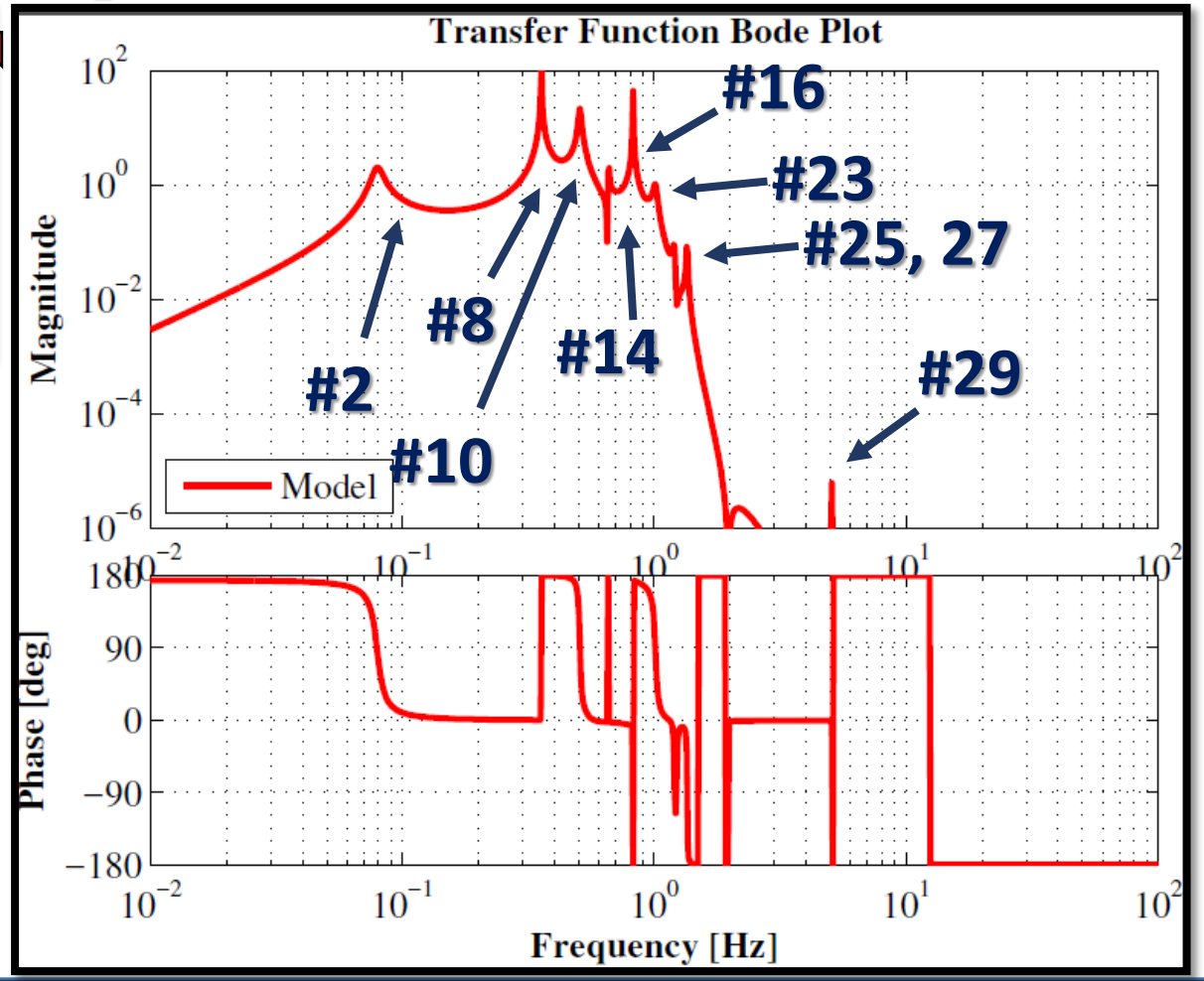




# Force Transfer Function

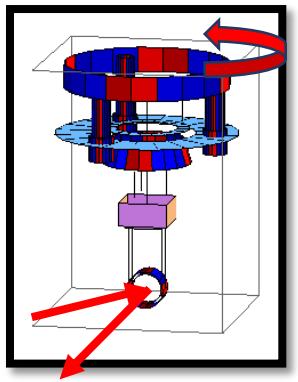
## OpLev_PTM / actLF1

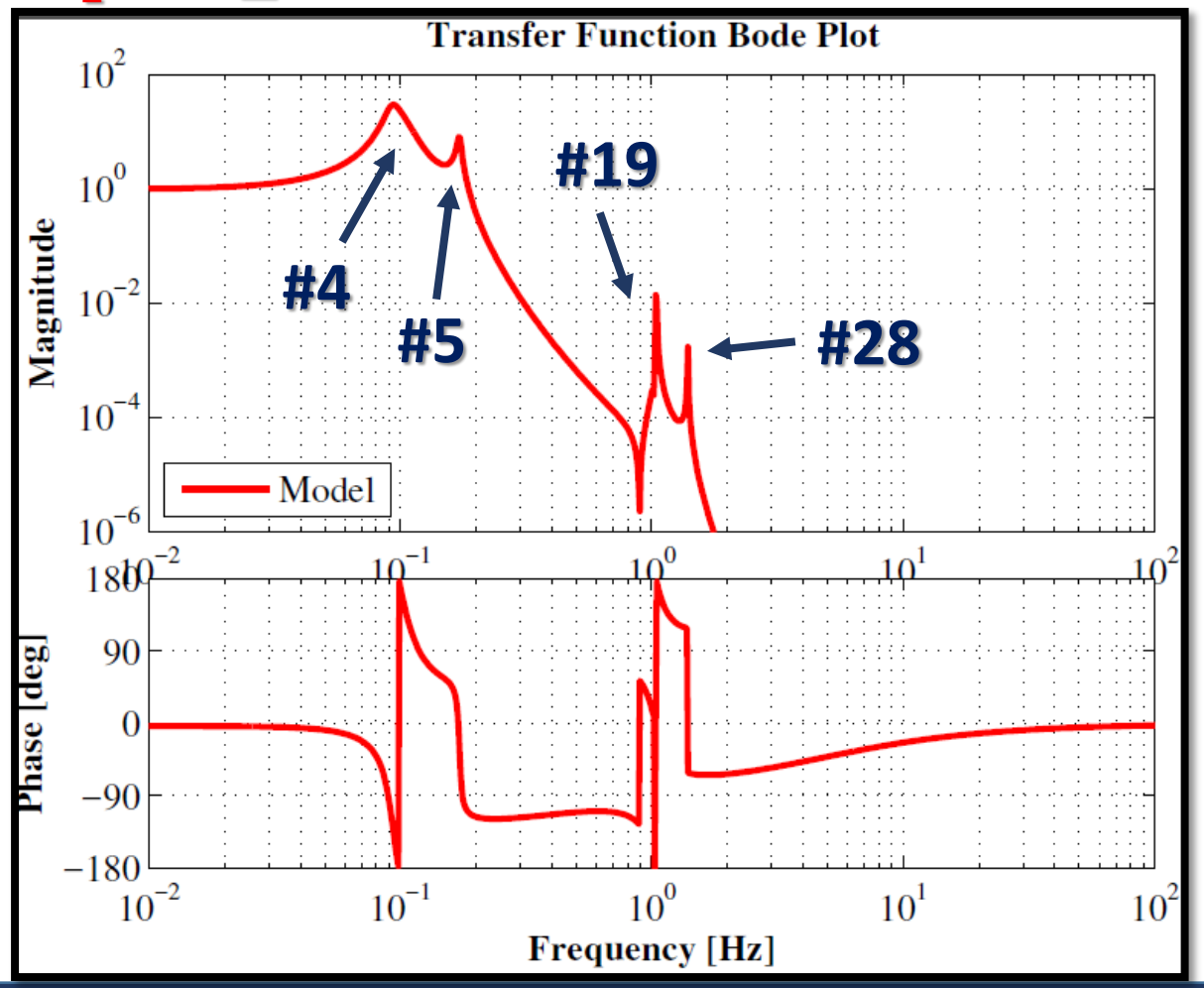




# Force Transfer Function

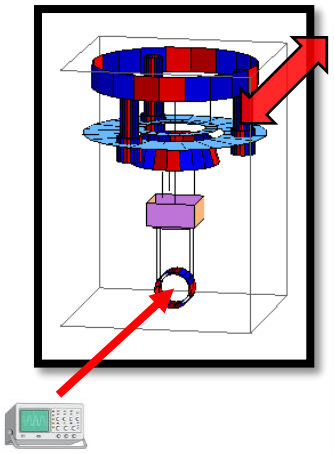
## OpLev_YTM / actYF1

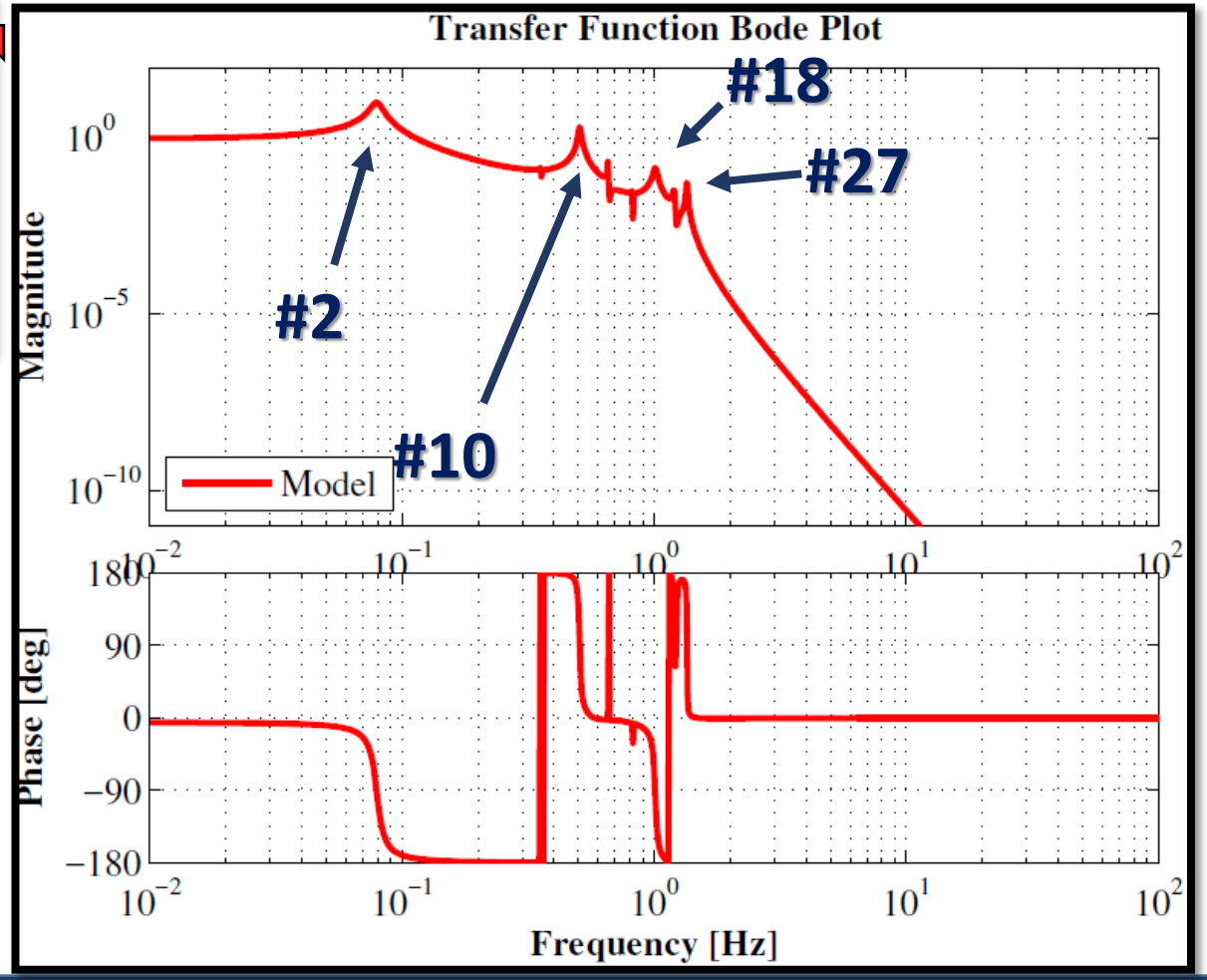




# Force Transfer Function

## GlobalSensor_LTM / actLF1





# Spectra

## without control

## using 90 percentile seismic noise

# ❖ From http://gwdoc.icrr.u-tokyo.ac.jp/DocDB/0039/T1503908/002/TypeBpDesign.pdf

## 2 Seismic noise level at the Kamioka site

The seismic displacement and velocity we used is shown in Fig.2 and ??[2]. This is the one called high-noise model. The seismic displacement in Kamioka is below this level for 90 % of time.

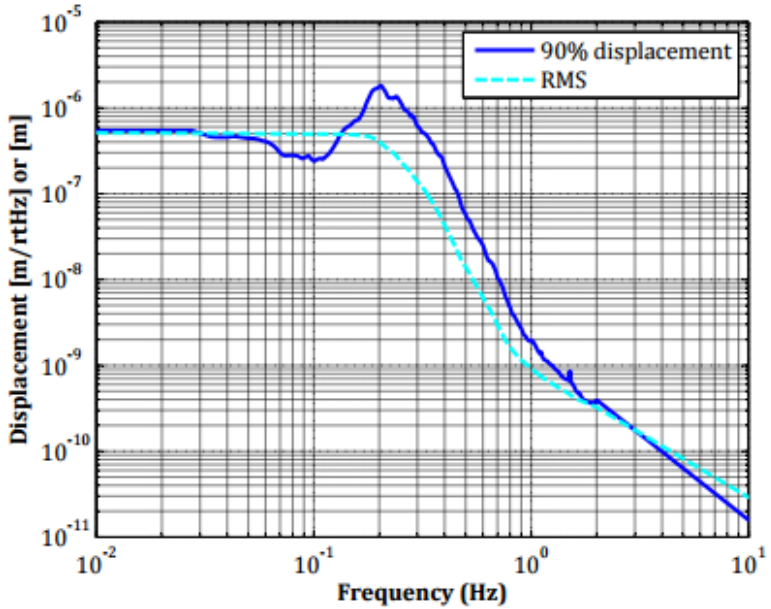



Figure 1: The high-level seismic displacement in Kamioka.

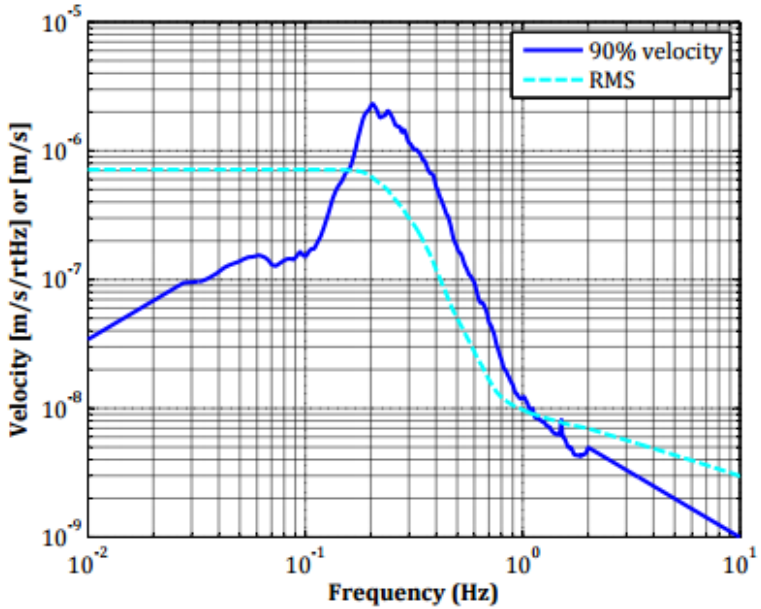
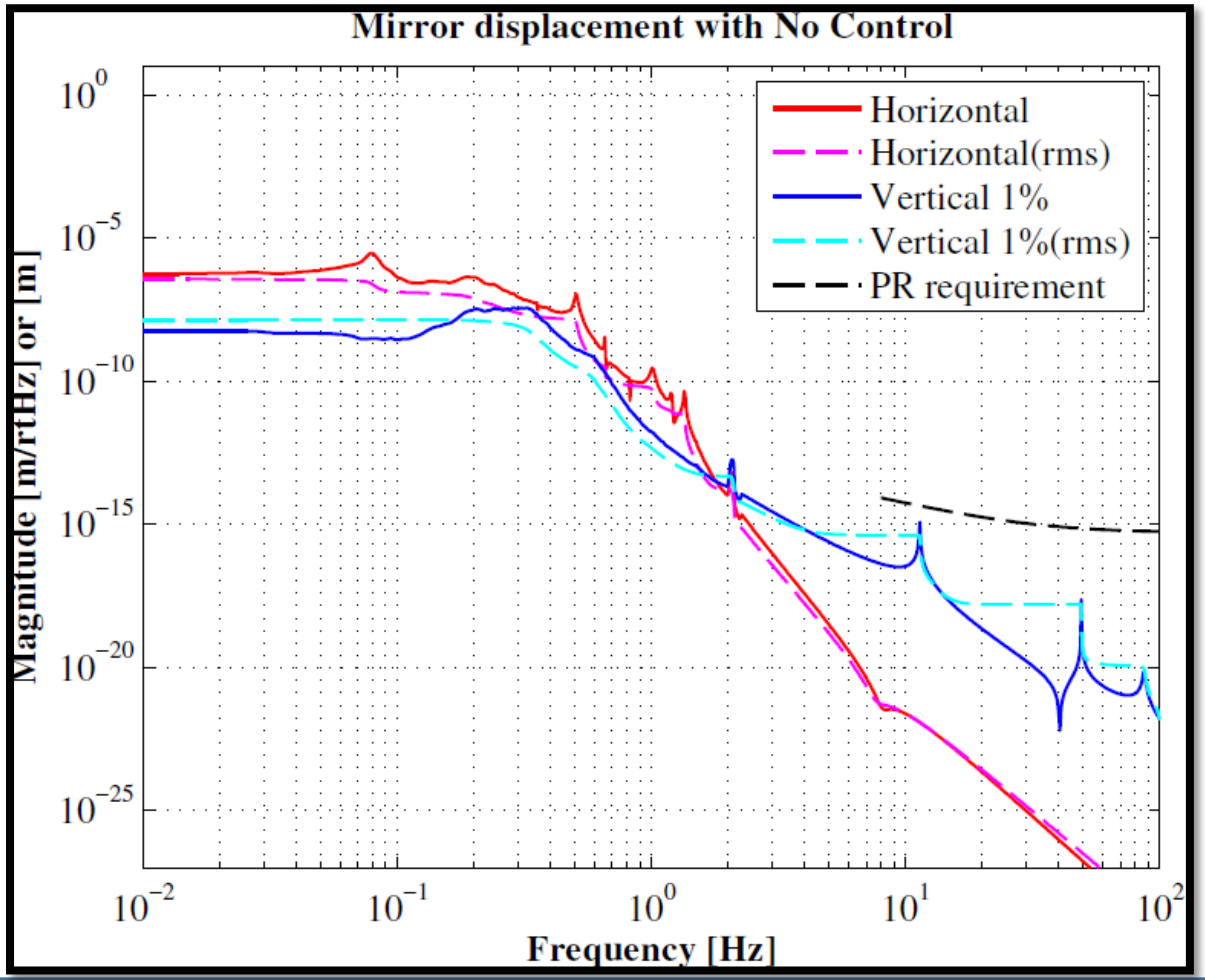


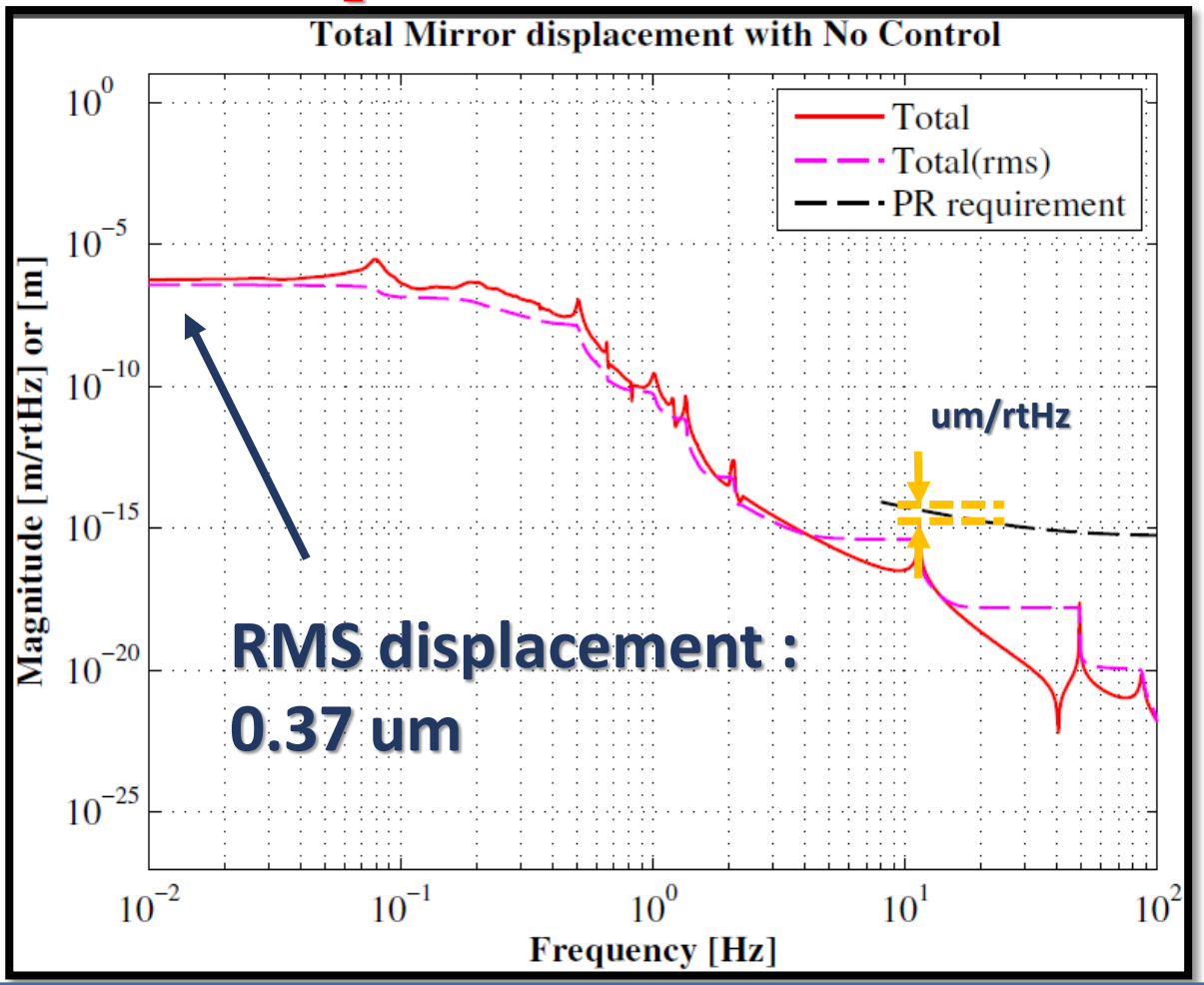

Figure 2: The high-level seismic velocity in Kamioka.

# Spectra without ctrl

## TM displacement : H and V 1%

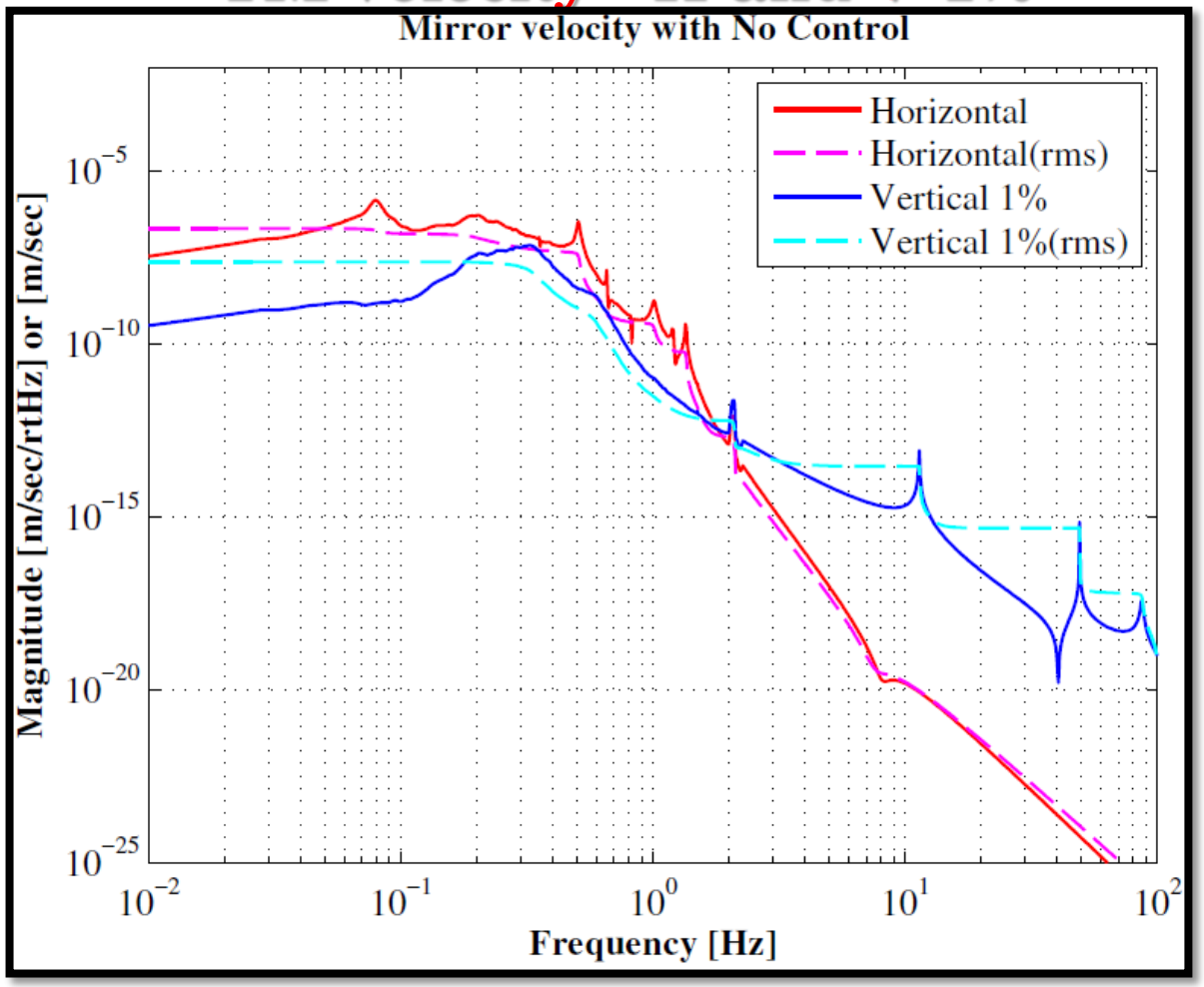



## TM displacement : H + V 1%

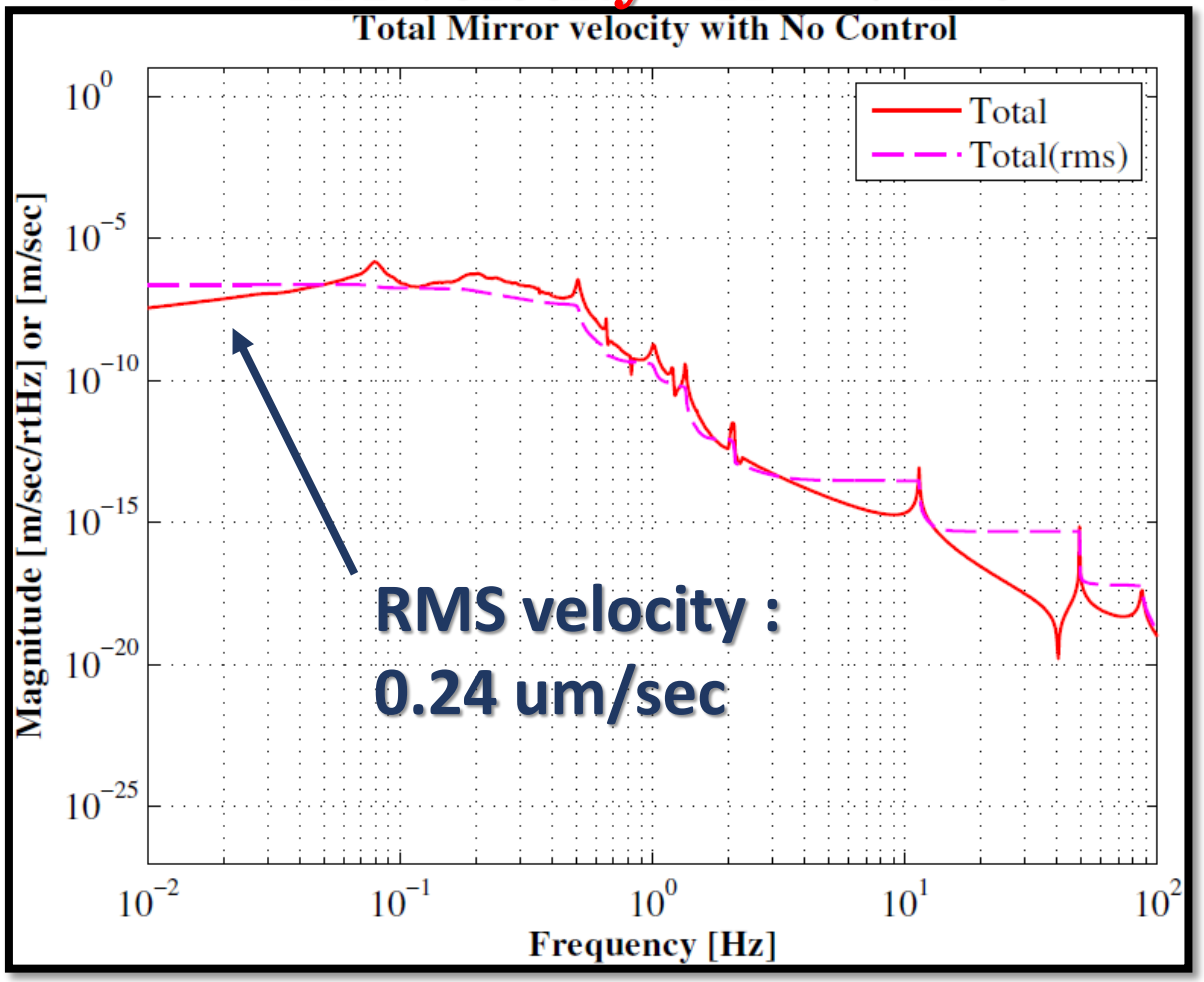


# Spectra without ctrl

## TM velocity : H and V 1%

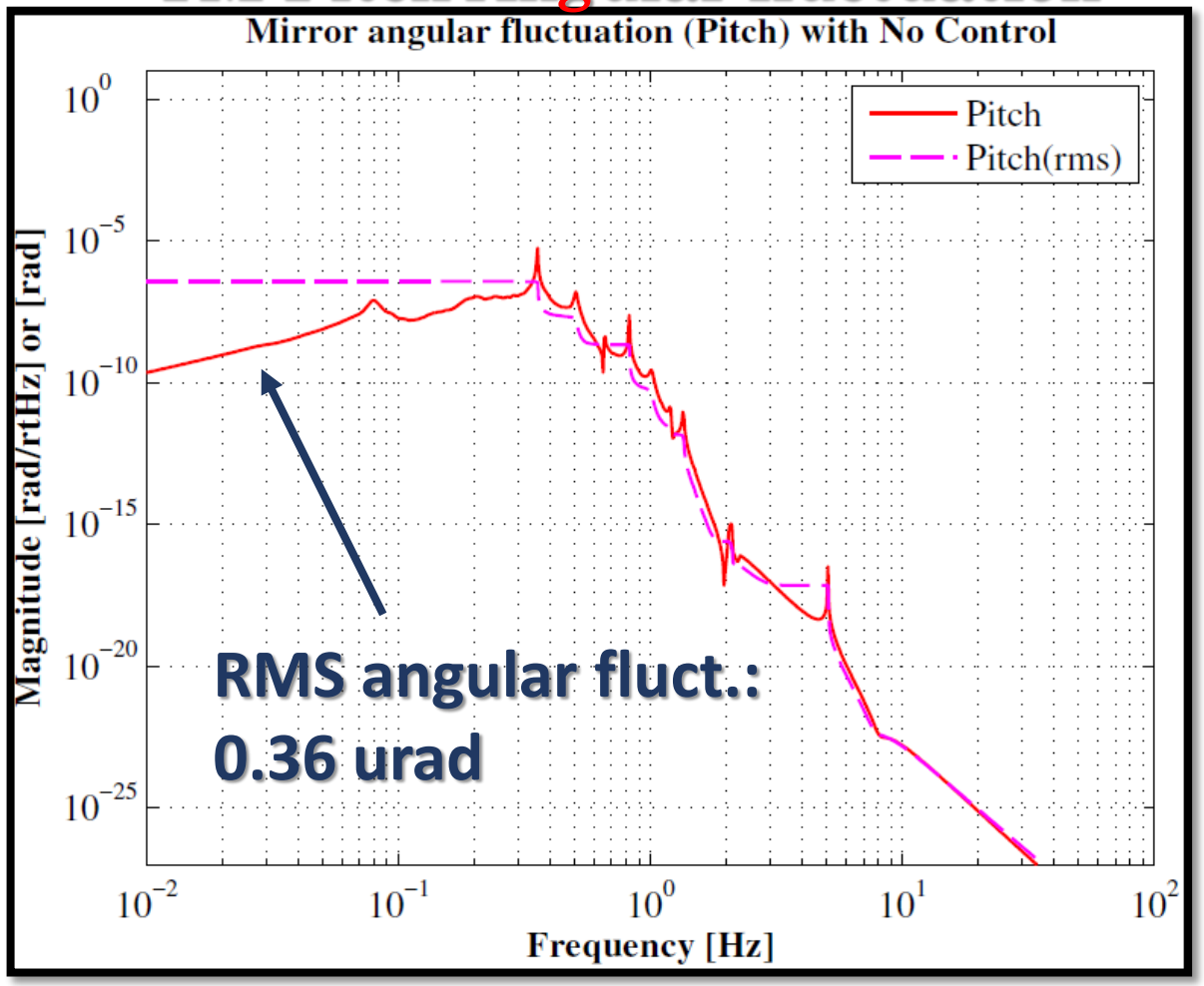



## TM velocity : H + V 1%



# Spectra without ctrl

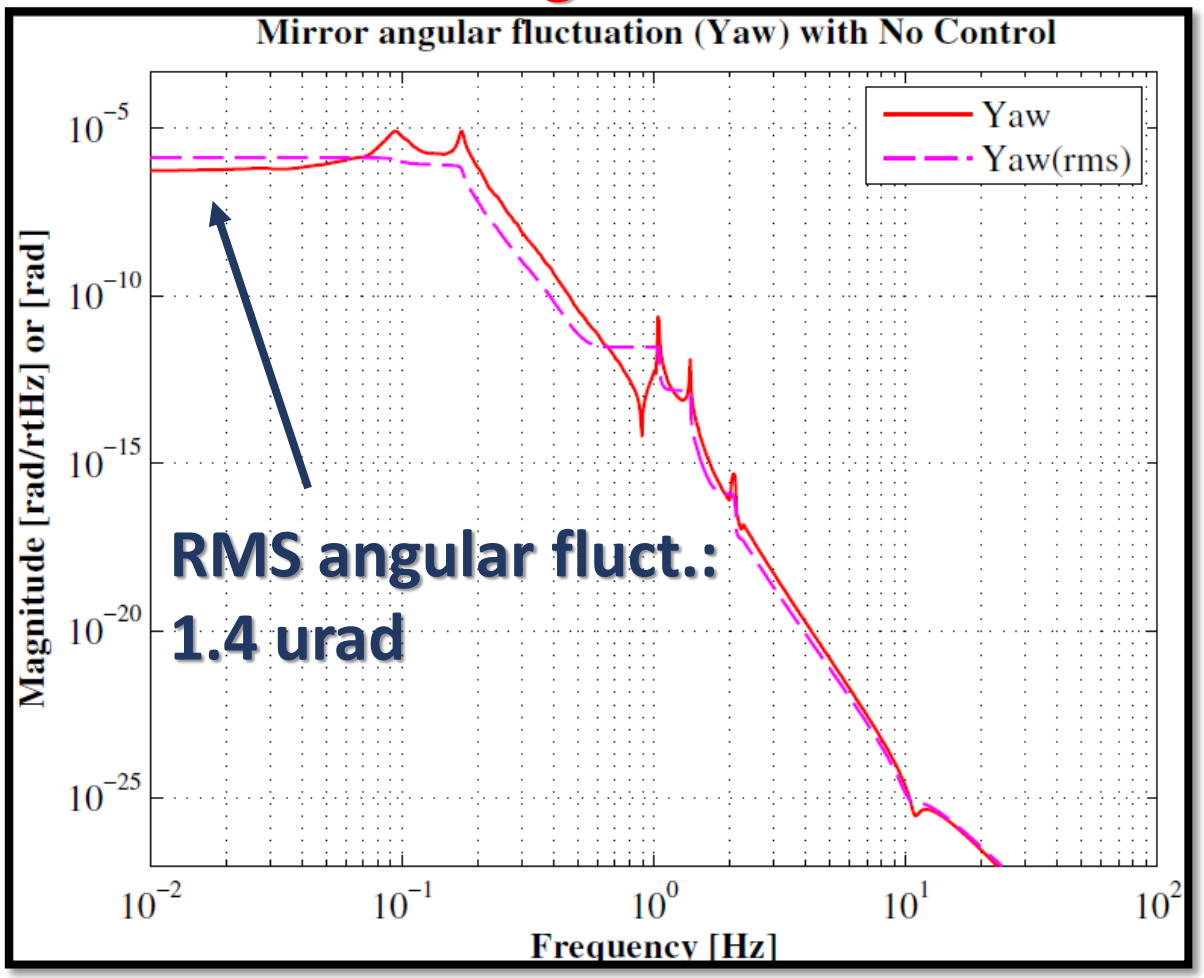
## TM Pitch Angular fluctuation




**TM Pitch fluctuation**
**excited by Longitudinal GND motion**

# Spectra without ctrl

## TM Yaw Angular fluctuation




**TM Yaw fluctuation excited by Yaw GND motion**

# Control Simulation Results

# Filter shape

# OLTF

# CLTF

# Q factor in damping control

# Impulse response