

Characterization and commissioning of the SR suspensions of KAGRA

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Requirements





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3.1 m

Type B model in SUMCON



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Type B eigenmodes





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Cross-coupling on the IP stage



IP frequency tuning

But first...

Add mass on the IP table to get a lower resonant frequency.





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IP sensor/actuator diagonalization



Sensors and actuators of the IP at different positions

Safety band for diagonalization

Eigenmode list of SRM.

#29	1.1705	PF2, LIR, PIR, LIM, PIM, LRM, PRM, LTM.	IM pendulum	
#30	1.2328	PF2, RF2, TIR, LIR, PIR, RIR.	F2 pitch roll	
#31	1.2341	PF2, RF2, TIR, LIR, PIR, RIR.	F2 pitch roll	
#32	1.3749	YIM, YRM, YTM.	TM yaw	
#33	1.5218	TF1, LF1, PF1, RF1, TF2, LF2, PF2, RF2, TIR, LIR, PIR, RIR, TIM, LIM.	pendulum	
#34	1.5251	TE1 LE1 PE1 RE1 TE2 LE2 PE2 RE TIR LIR PIR RIR TIM LIM	pendulum	
#35	5.0066	PIM, PRM.	RM pitch	
#36	11.6134	VIM, VRM, VTM.	TM vertical	
#37	15.9279	RRM, RTM.	TM roll	
#38	49.4722	VIM, VRM.	IM vertical	
#39	52.0648	VMD.	MD vertical	
#40	52.4298	PMD.	MD pitch	
#41	52.4634	RMD.	MD roll	
#42	65.9552	RIM, RRM.	IM roll	

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Useful gap for diagonalization.

IP sensor/actuator diagonalization



Measure the motion of the IP stage when injecting a signal at a single frequency within the 'safety band' at each coil, using the sensing matrix.

Get the TF coefficients for each DoF and compute the TF coefficients matrix. Use the inverse of this matrix as the new coil matrix.



IP stage ZPK fitting to help with the design of active filters.



GAS Filter Chain ZPK fitting to help with the design of active filters.₁₄

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IM stage ZPK fitting to help with the design of active filters.



Mirror stage ZPK fitting to help with the design of active filters.



Sensors used at each stage and its active filter control.



Control filters for Calm-down phase.



Control filters for Lock-acquisition phase.





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10²

K1VISSRMT.txt

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10²

K1VISSRMT.txt





Damping of the torsion mode (#1)



Damping of the torsion mode (#1)



Damping of the Torsion mode (SR3)



Meeting the requirements



Angular fluctation of SRM. Pitch: 10.3µrad --> 1.17µrad. Yaw: 24.4µrad --> 1.18µrad.

Angular fluctation of SRM. Pitch: 10.3µrad --> 3.3µrad. Yaw: 24.4µrad --> 0.4µrad.

We need to work in the tuning of the controls.

But we have also other urgent problems...

Problems: Glitches

Glitches found at ETMY, BS and, later on, SR3.



DAC Glitches

Glitches found at ETMY. klog4072



Glitches are a common issue in high speed D/A converters.

Some causes:

- Time skew between bits of incoming data.
- Major- carry transition of bits.

• Timing difference in the operation of the switches of the internal architecture.

Splitting real-time model of BS and SRM





Future Work



Hardware

- Debug remote switch for stepper motor drivers.
- Revisit length sensing oplev.

Characterization

- IM stage diagonalization.
- Include signal from Geophones.

Controls

- Implement IP stage inertial damping (geophone).
- Revisit optical lever and GAS filter controls.
- Coupling cancellation filters for payload.
- Sort out Guardian for Type B suspensions.

Real time model

 Split the models of SR2 and SR3 suspensions.





Thank you!

Extras

Analog-Digital diagram



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.

IM OSEMs and TM coil actuators



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

4 Coil actuators at the Optics stage.

IM stage and OSEMs

