Basic Idea of iKAGRA Calibration

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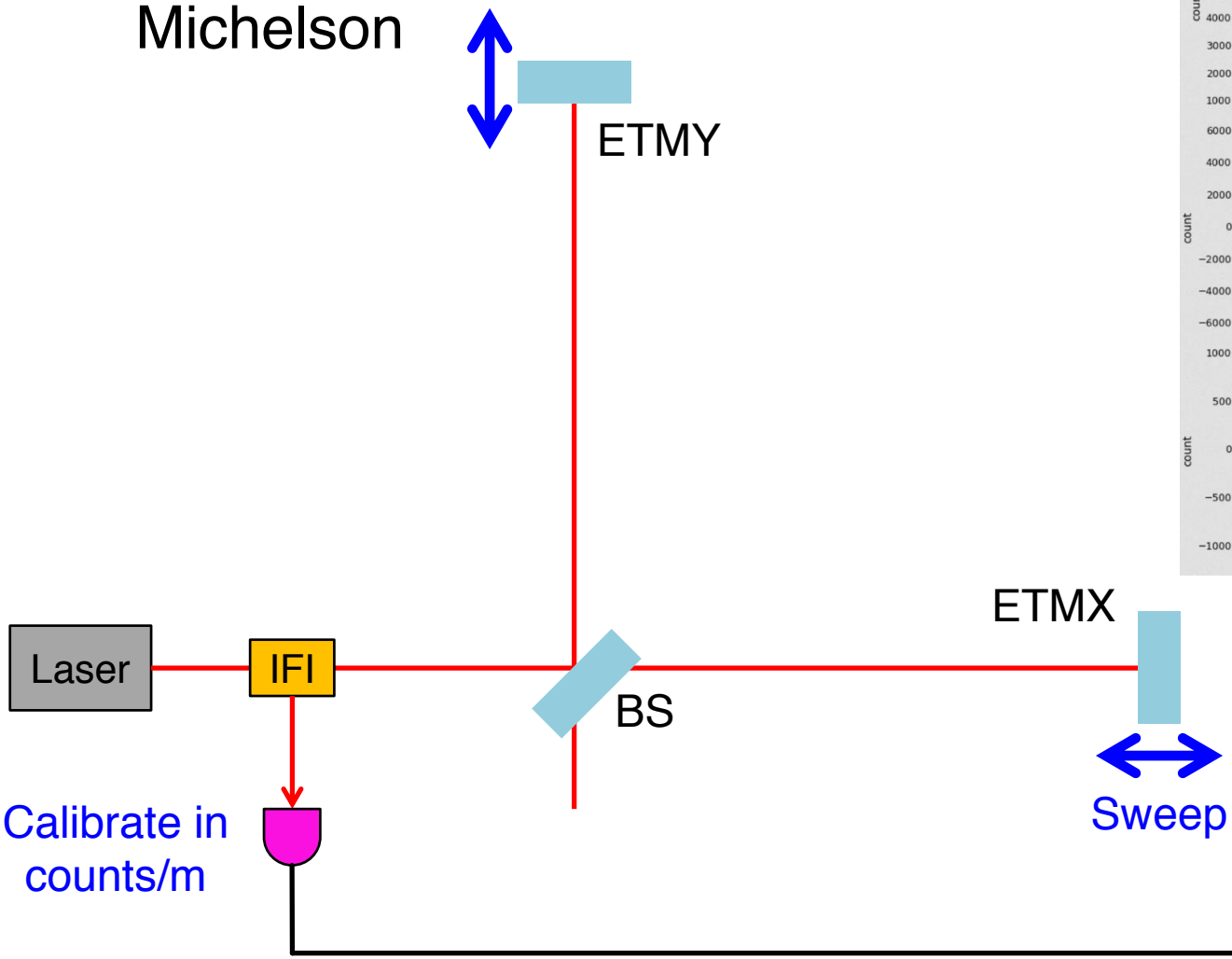
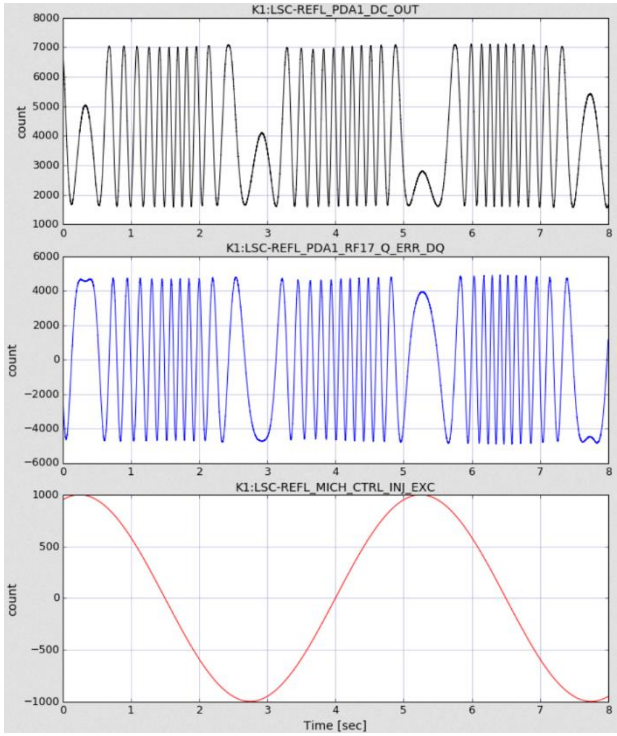
Optical Gain Calibration

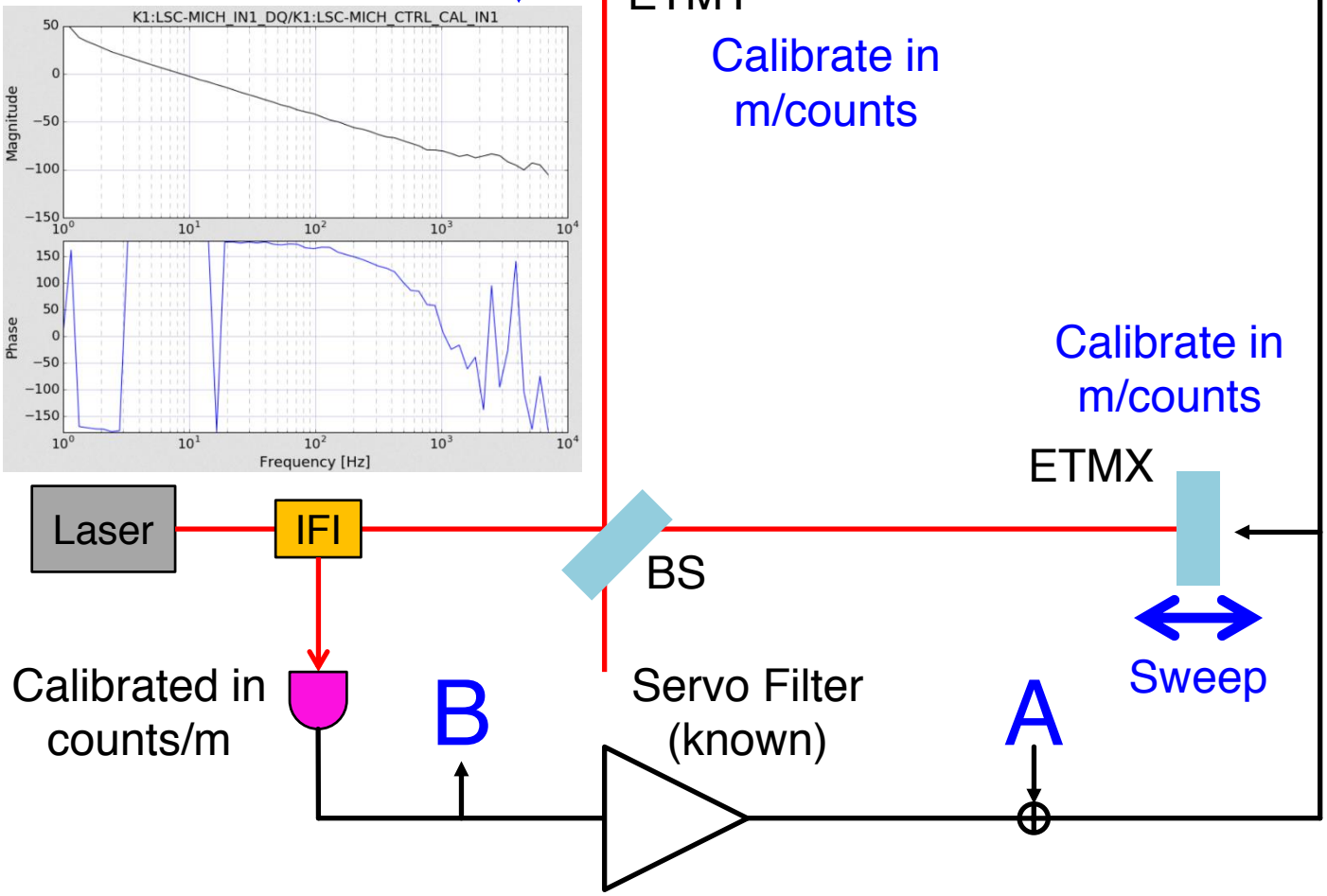
- Calibrate optical gain by sweeping Michelson





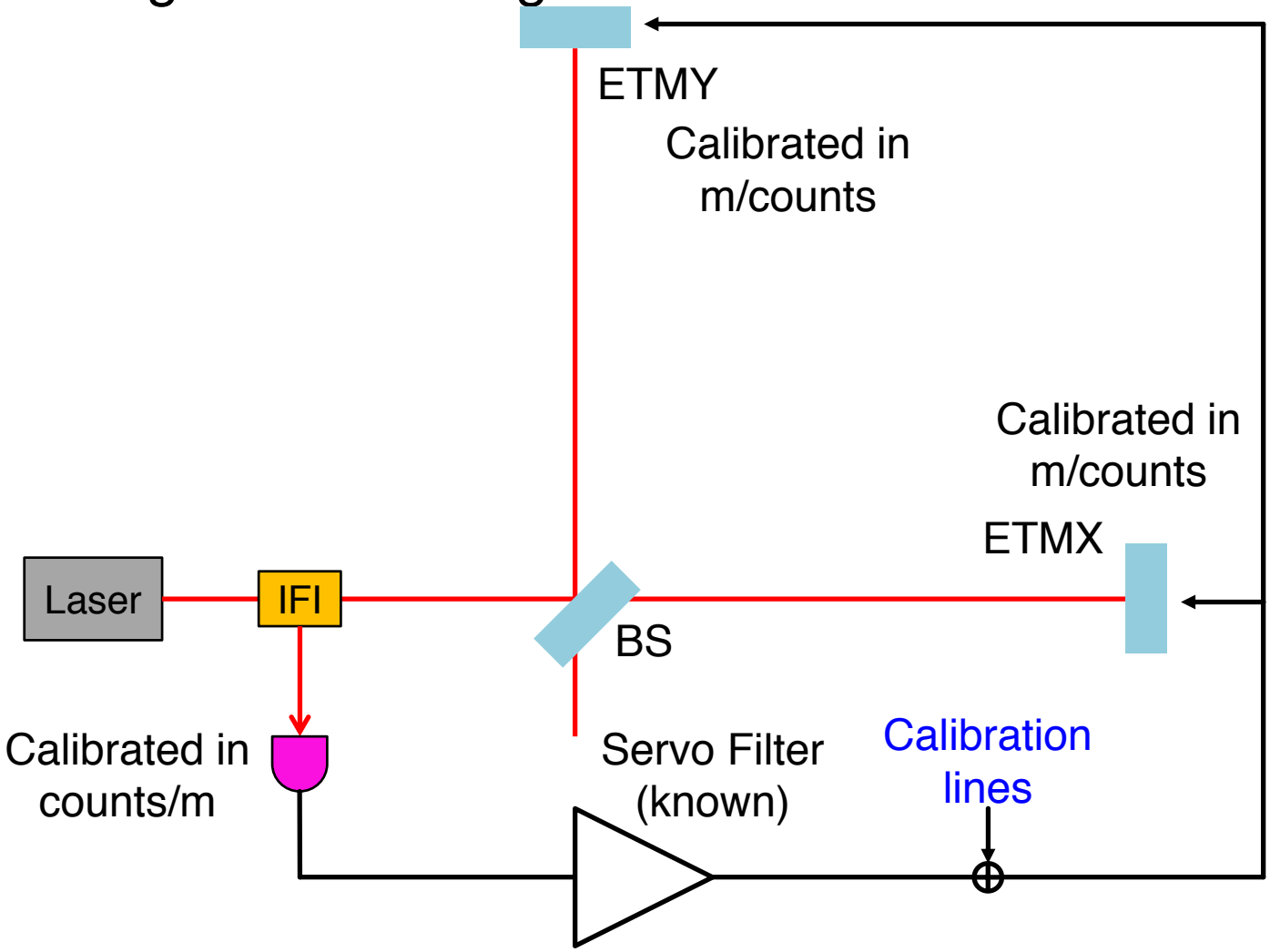
Actuator Efficiency Calibration

- Lock Michelson and measure TF from actuation (A) to error signal (B)



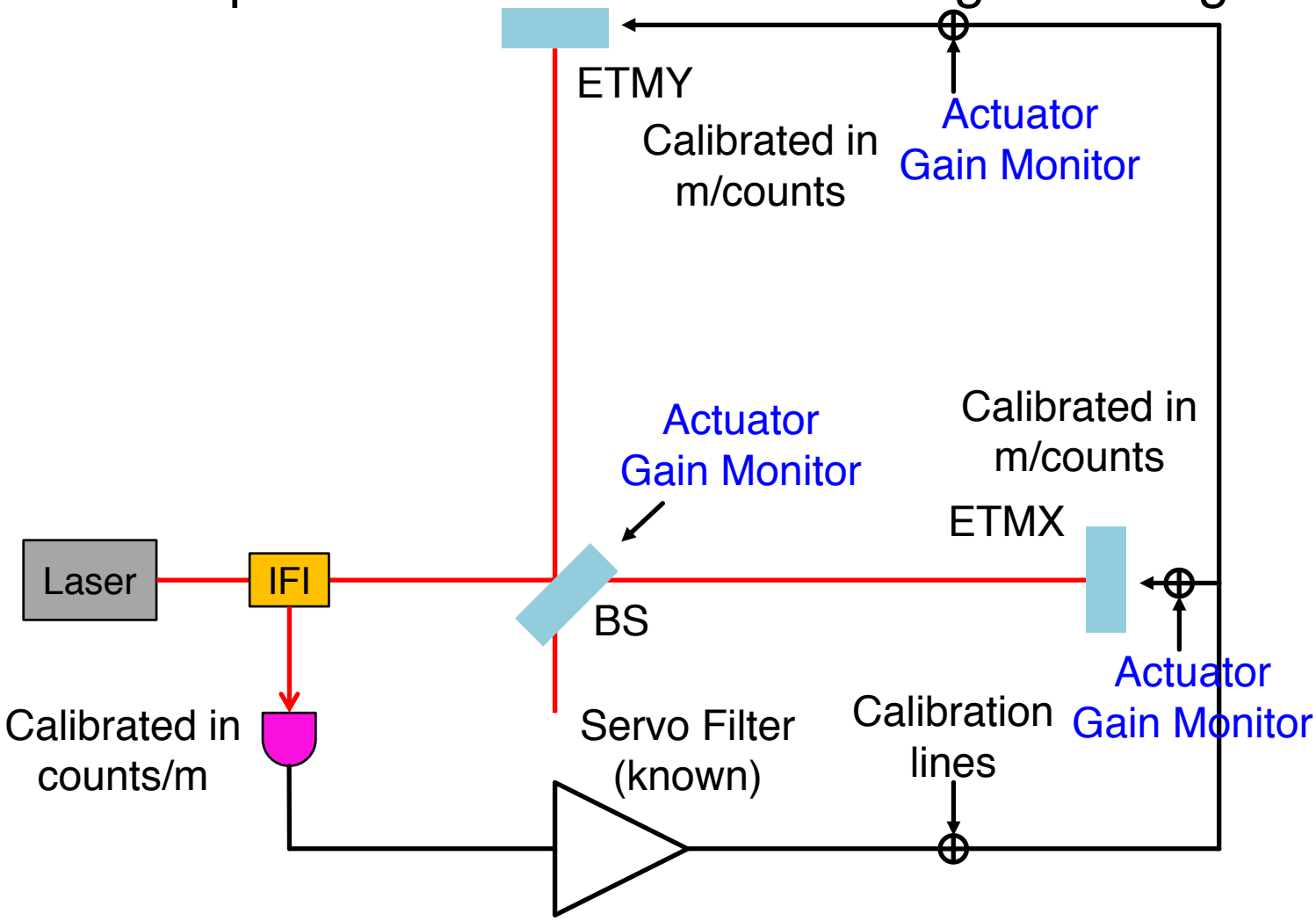
Calibration Lines

- Injected calibration lines (80Hz, 135Hz) to monitor openloop gain drift during test runs



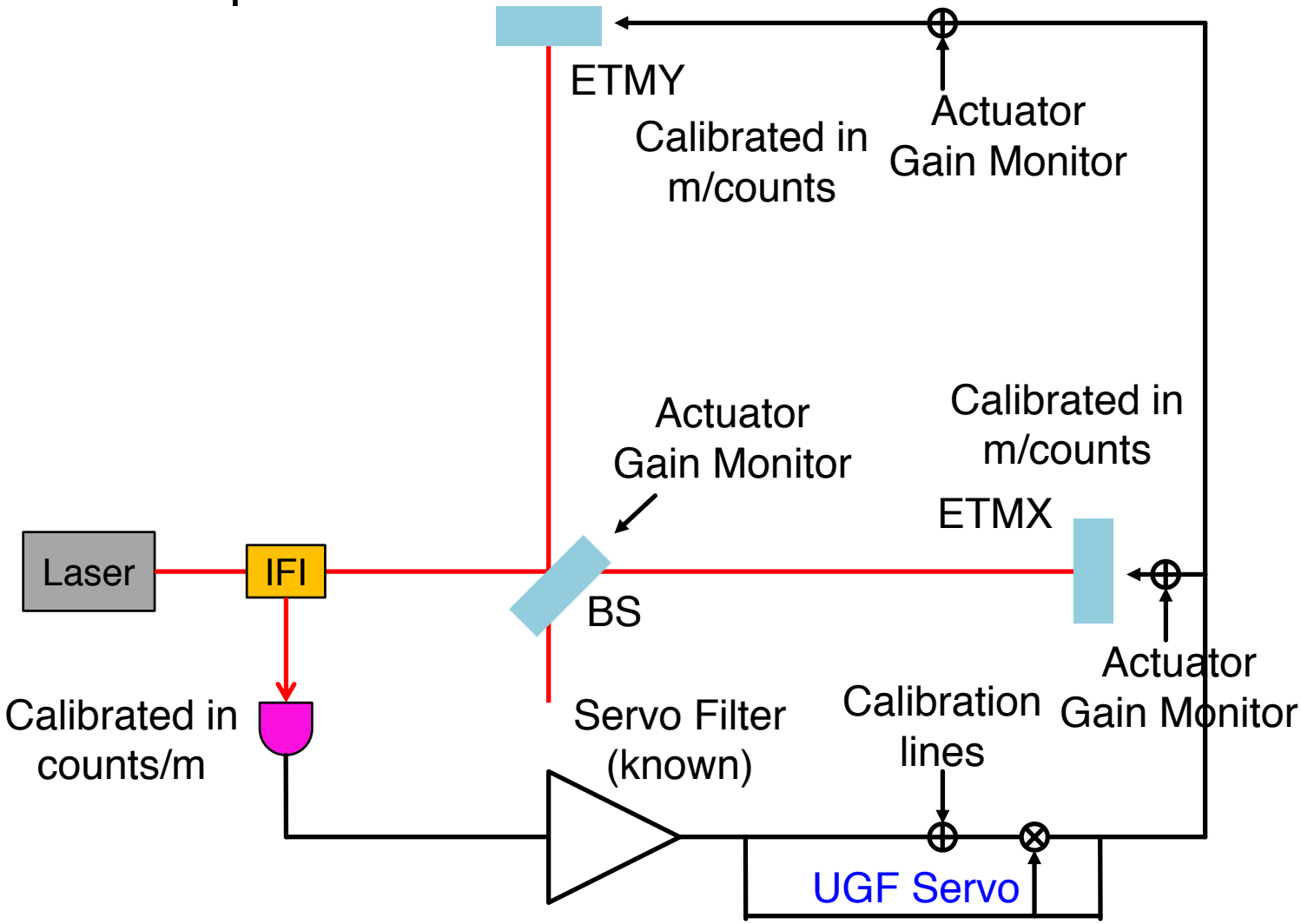
Actuator Gain Monitor (Apr only)

- Injected calibration lines with different frequency by suspensions to monitor actuator gain change



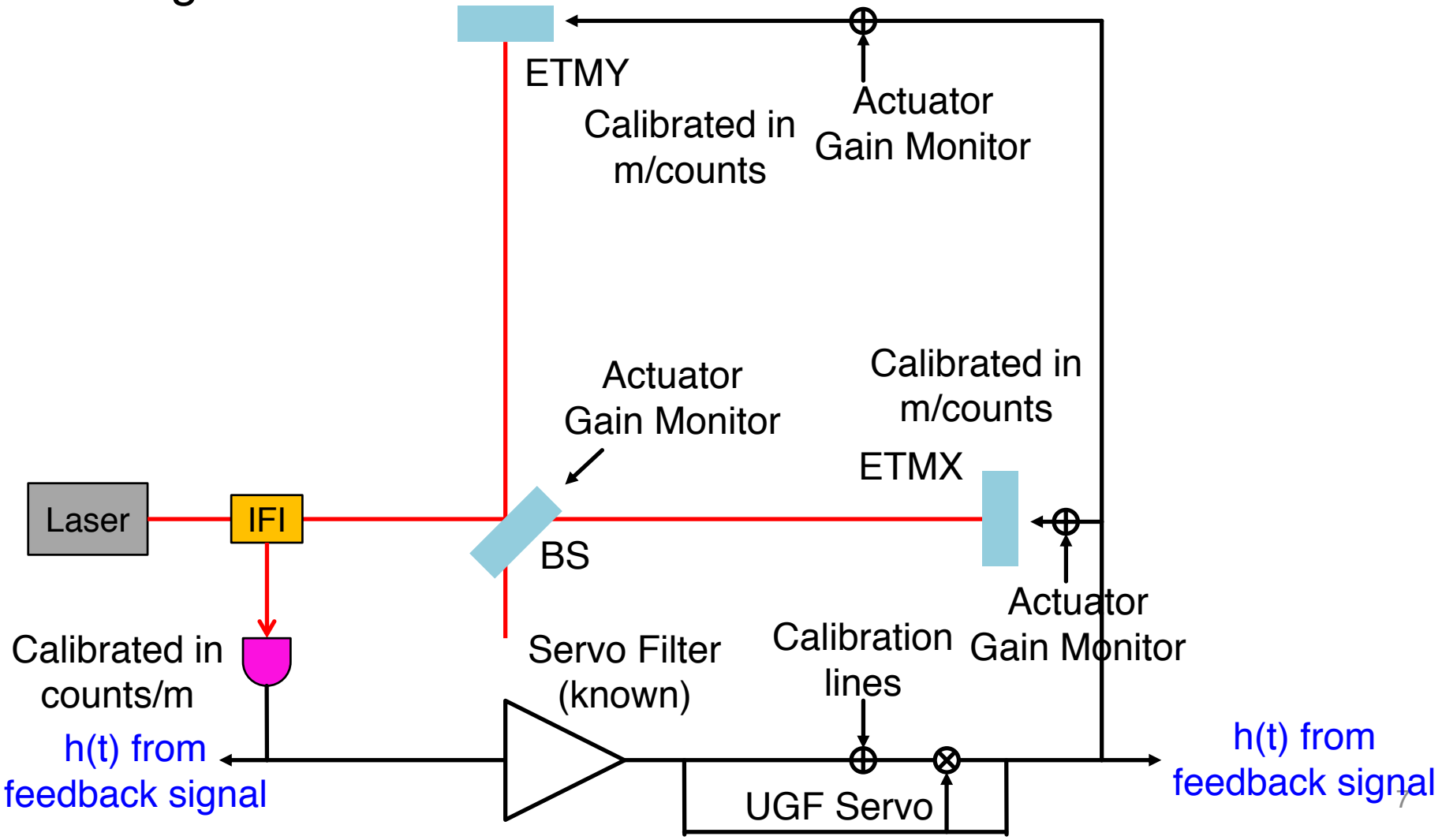
UGF Servo (Apr only)

- Change filter gain according to measured gain change to keep UGF constant



h(t) Generation

- h(t) can be generated using error signal and/or feedback signal



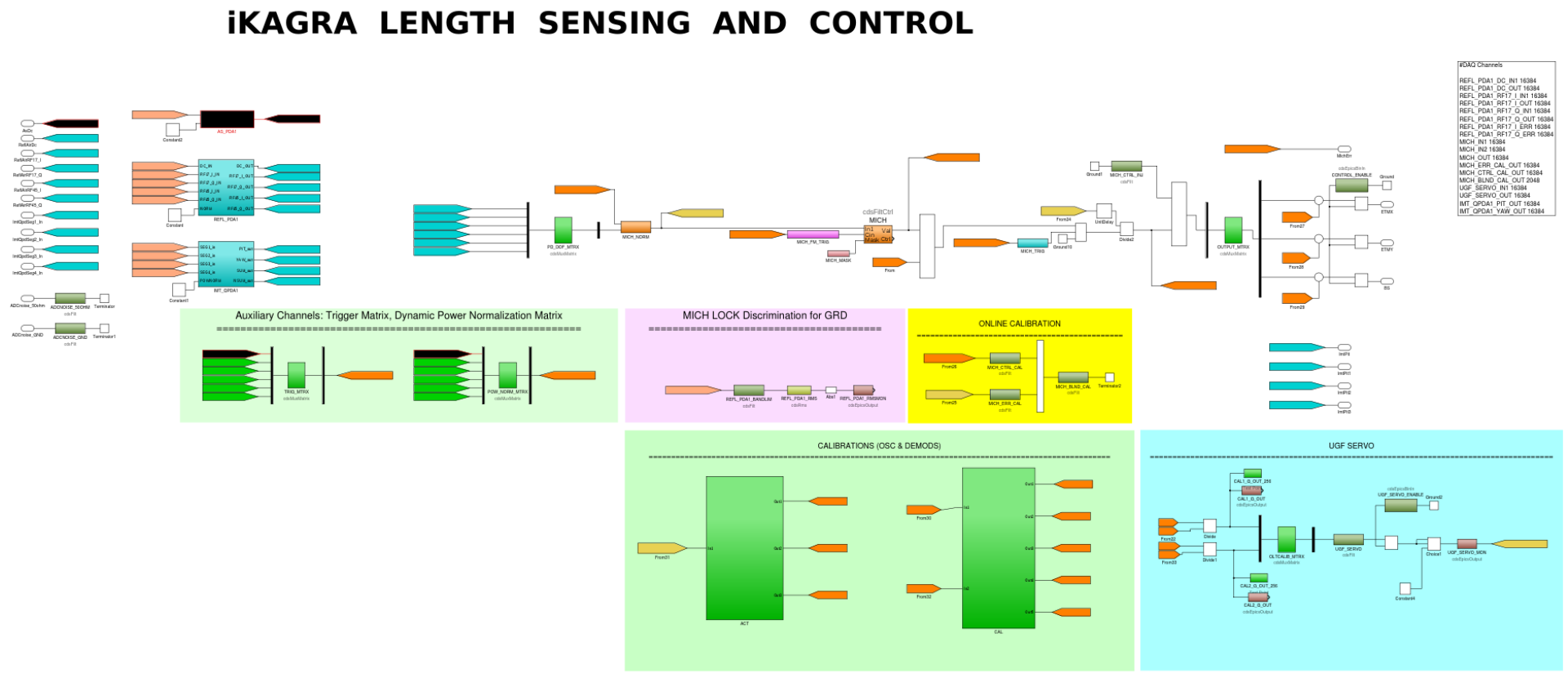
What can we do to improve?

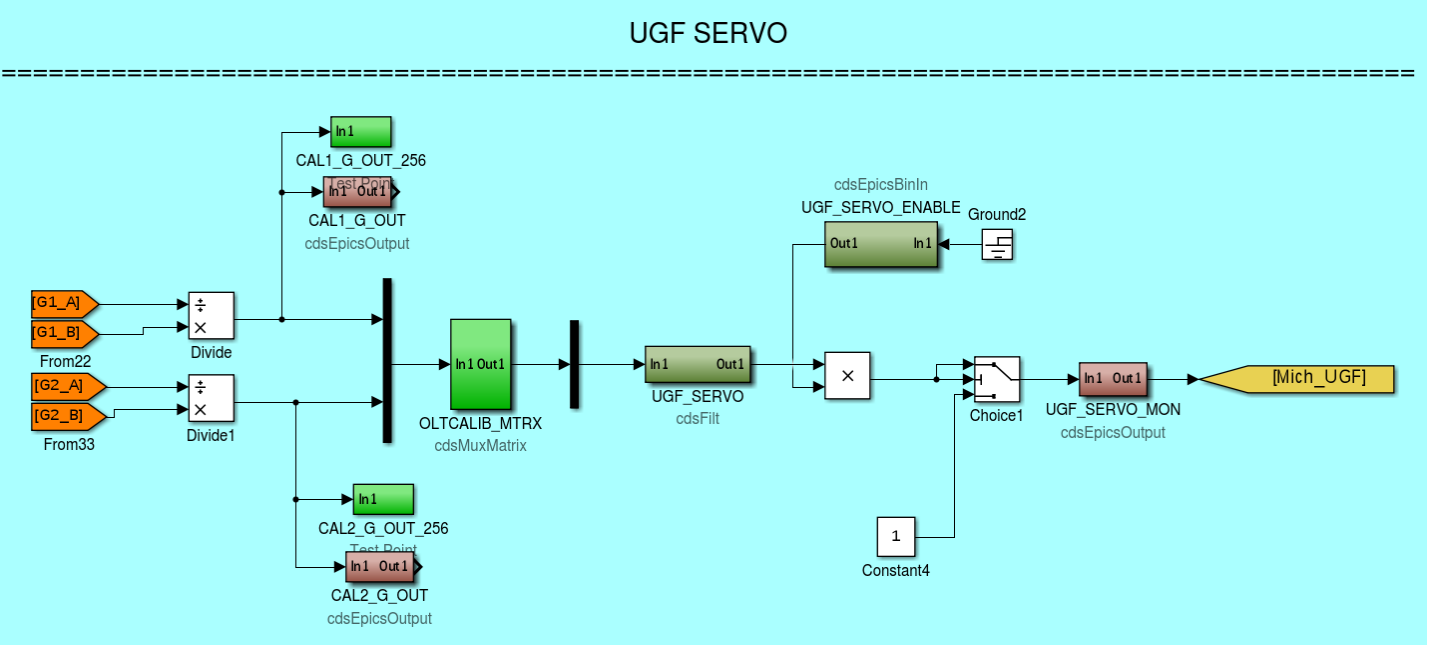
- Prepare the calibration real-time model beforehand
  - consistent channel name
- Calibration line frequency investigation
  - frequencies were determined at random in iKAGRA
- Precise modeling of actuators
  - multiple pendulum
  - time variation model
- Characterize ADC/DAC and AA/AI beforehand
  - timing, delay, transfer function
  - CLIO data was used in iKAGRA calibration

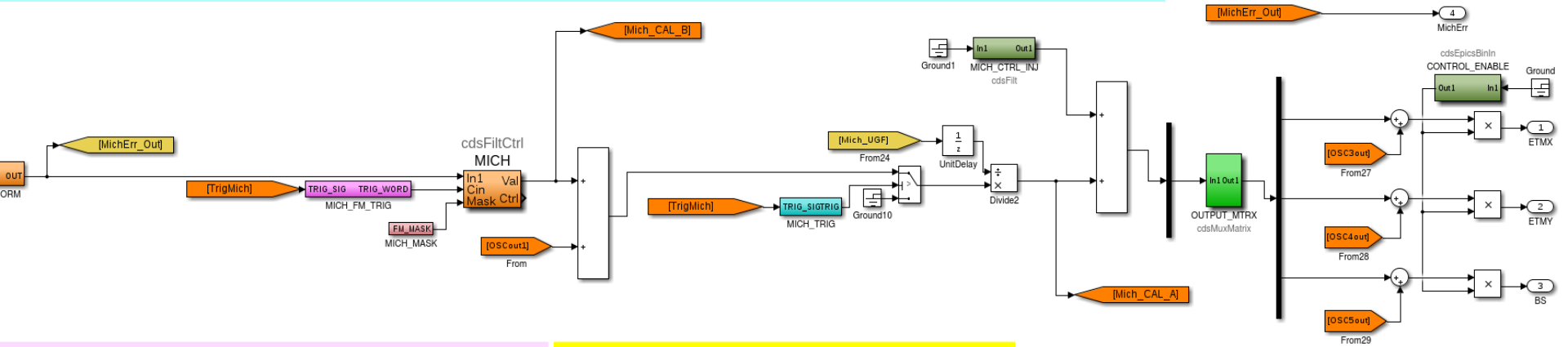
Further Reading

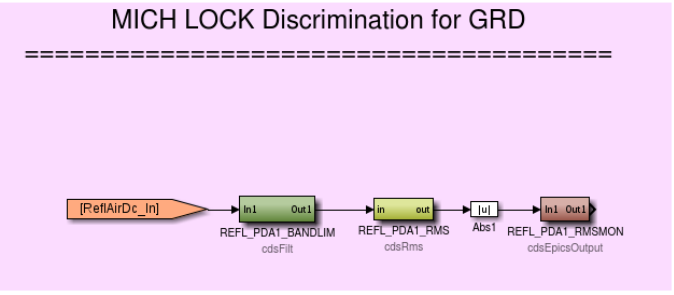
- JGW-T1605101
  Summary of iKAGRA Test Run March 2016
- JGW-T1605177
  Summary of iKAGRA Test Run April 2016
- MICH Calibration (by Yoichi Aso)
- Post Run MICH Calibration (by Yoichi Aso)

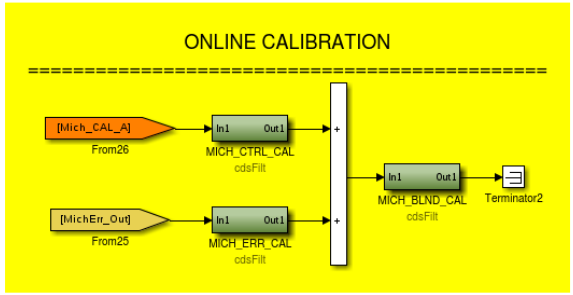
Calibration Model

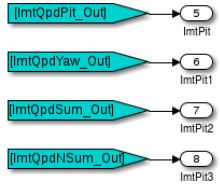



UGF SERVO
In1
CAL1_G_OUT_256
In1 Out1
CAL1_G_OUT
cdsEpicsOutput
[G1_A]
[G1_B]
From22
Divide
[G2_A]
[G2_B]
From33
Divide1
In1 Out1
OLTCALIB_MTRX
cdsMuxMatrix
In1 Out1
UGF_SERVO
cdsFilt
cdsEpicsBinIn
UGF_SERVO_ENABLE
Ground2
Out1 In1
Choice1
In1 Out1
UGF_SERVO_MON
cdsEpicsOutput
[Mich_UGF]
In1
CAL2_G_OUT_256
In1 Out1
CAL2_G_OUT
cdsEpicsOutput
1
Constant4


[MichErr_Out]
4
MichErr
Ground1
In1 Out1
MICH_CTRL_INJ
cdsFilt
cdsEpicsBinIn
CONTROL_ENABLE
Out1 In1
Ground
[Mich_CAL_B]
[MichErr_Out]
cdsFiltCtrl
MICH
In1 Val
Cin Ctrl
Mask
[TrigMich]
TRIG_SIG TRIG_WORD
MICH_FM_TRIG
FM_MASK
MICH_MASK
[OSCout1]
From
[Mich_UGF]
From24
1/z
UnitDelay
[TrigMich]
TRIG_SIGTRIG
MICH_TRIG
Ground10
Divide2
[Mich_CAL_A]
In1 Out1
OUTPUT_MTRX
cdsMuxMatrix
[OSC3out]
From27
[OSC4out]
From28
[OSC5out]
From29
1
ETMX
2
ETMY
3
BS


MICH LOCK Discrimination for GRD
[ReflAirDc_In]
In1 Out1
REFL_PDA1_BANDLIM
cdsFilt
in out
REFL_PDA1_RMS
cdsRms
|u|
Abs1
In1 Out1
REFL_PDA1_RMSMON
cdsEpicsOutput


ONLINE CALIBRATION
[Mich_CAL_A]
From26
In1 Out1
MICH_CTRL_CAL
cdsFilt
[MichErr_Out]
From25
In1 Out1
MICH_ERR_CAL
cdsFilt
In1 Out1
MICH_BLND_CAL
cdsFilt
Terminator2


[ImtQpdPit_Out]
5
ImtPit
[ImtQpdYaw_Out]
6
ImtPit1
[ImtQpdSum_Out]
7
ImtPit2
[ImtQpdNSum_Out]
8
ImtPit3