

Summary of iKAGRA Test Run Mar 25-31, 2016

Yuta Michimura

Department of Physics, University of Tokyo

Quick Facts

- 3 km Michelson, mid-fringe lock
- input power to BS ~ 220 mW
- power at detection port (REFL) ~ 8 mW
- duration: Mar 25 9:00 JST - Mar 31 17:00 JST
(from 1142899217 to 1143446417 in GPS time)
- duty cycle (lock): 85.2 % (IMC was 94.4 %)
- total locked time: 129.5 hours
- longest lock: 3.6 hours (but typically ~ 30 minutes)
- strain sensitivity: $\sim 3e-15$ /rtHz @ 100 Hz
(~ 0.77 pc for 1.4Msun-1.4Msun NS-NS inspiral range)

Thanks to inputs from Y. Saito, T. Uchiyama, Y. Aso, O. Miyakawa, K. Kokeyama, K. Hayama, Y. Sasaki, M. Nakano, Y. Enomoto, T. Shimoda, etc

Interferometer Configuration

- 3 km Michelson, mid-fringe lock, UGF ~ 8 Hz
- suspended mirrors DC alignment controlled with oplevs

IMC

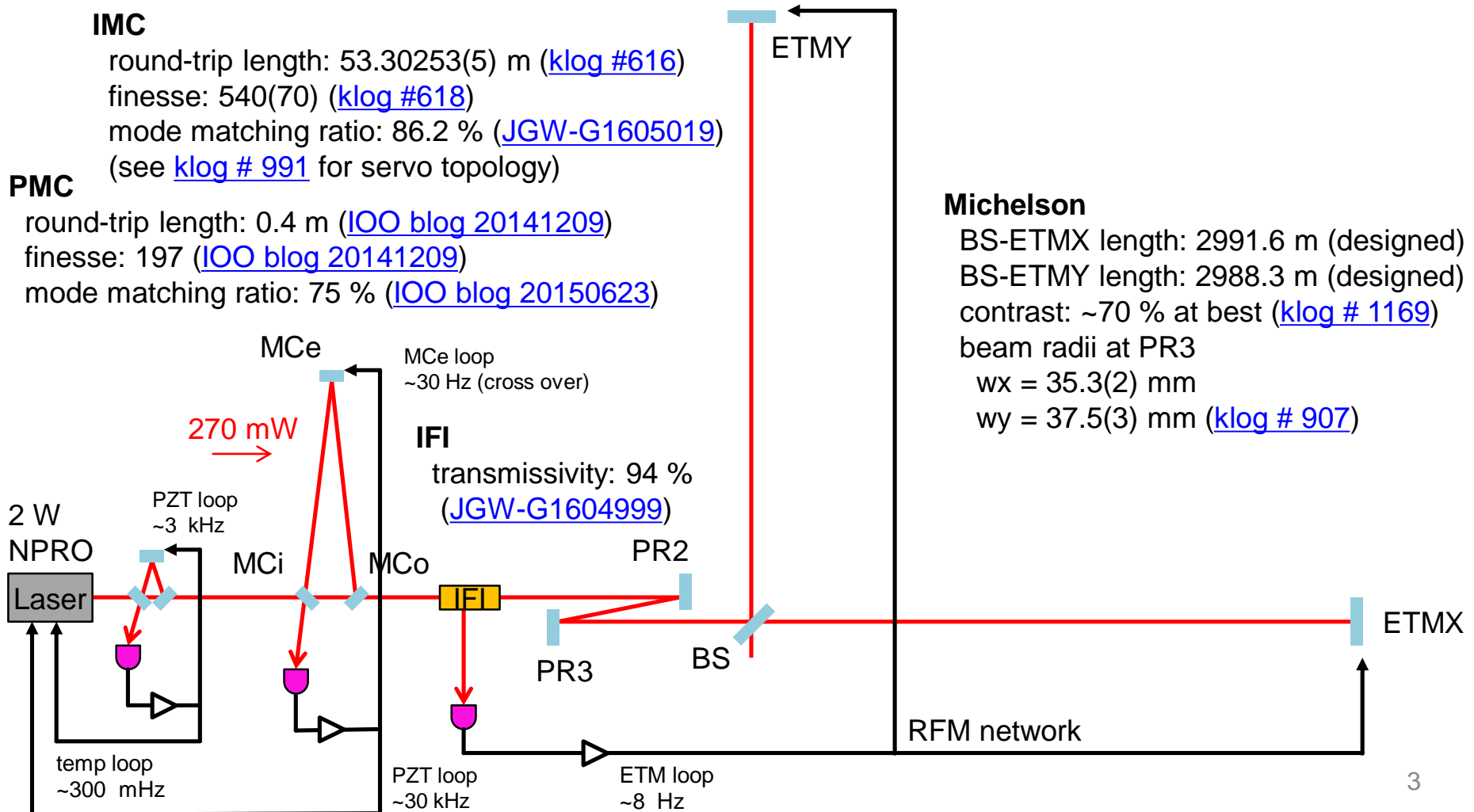
round-trip length: 53.30253(5) m ([klog #616](#))
 finesse: 540(70) ([klog #618](#))
 mode matching ratio: 86.2 % ([JGW-G1605019](#))
 (see [klog # 991](#) for servo topology)

PMC

round-trip length: 0.4 m ([IOO blog 20141209](#))
 finesse: 197 ([IOO blog 20141209](#))
 mode matching ratio: 75 % ([IOO blog 20150623](#))

Michelson

BS-ETMX length: 2991.6 m (designed)
 BS-ETMY length: 2988.3 m (designed)
 contrast: ~ 70 % at best ([klog # 1169](#))
 beam radii at PR3
 $w_x = 35.3(2)$ mm
 $w_y = 37.5(3)$ mm ([klog # 907](#))



Suspensions and Mirrors

- fused silica, room temperature

MCI, MCo, MCE

Type-C (double pendulum with stacks)
 x config magnets
 95.95 mm dia, 29.5 mm thick
 RoC = 37.33(9) m ([klog #711](#))

PR3

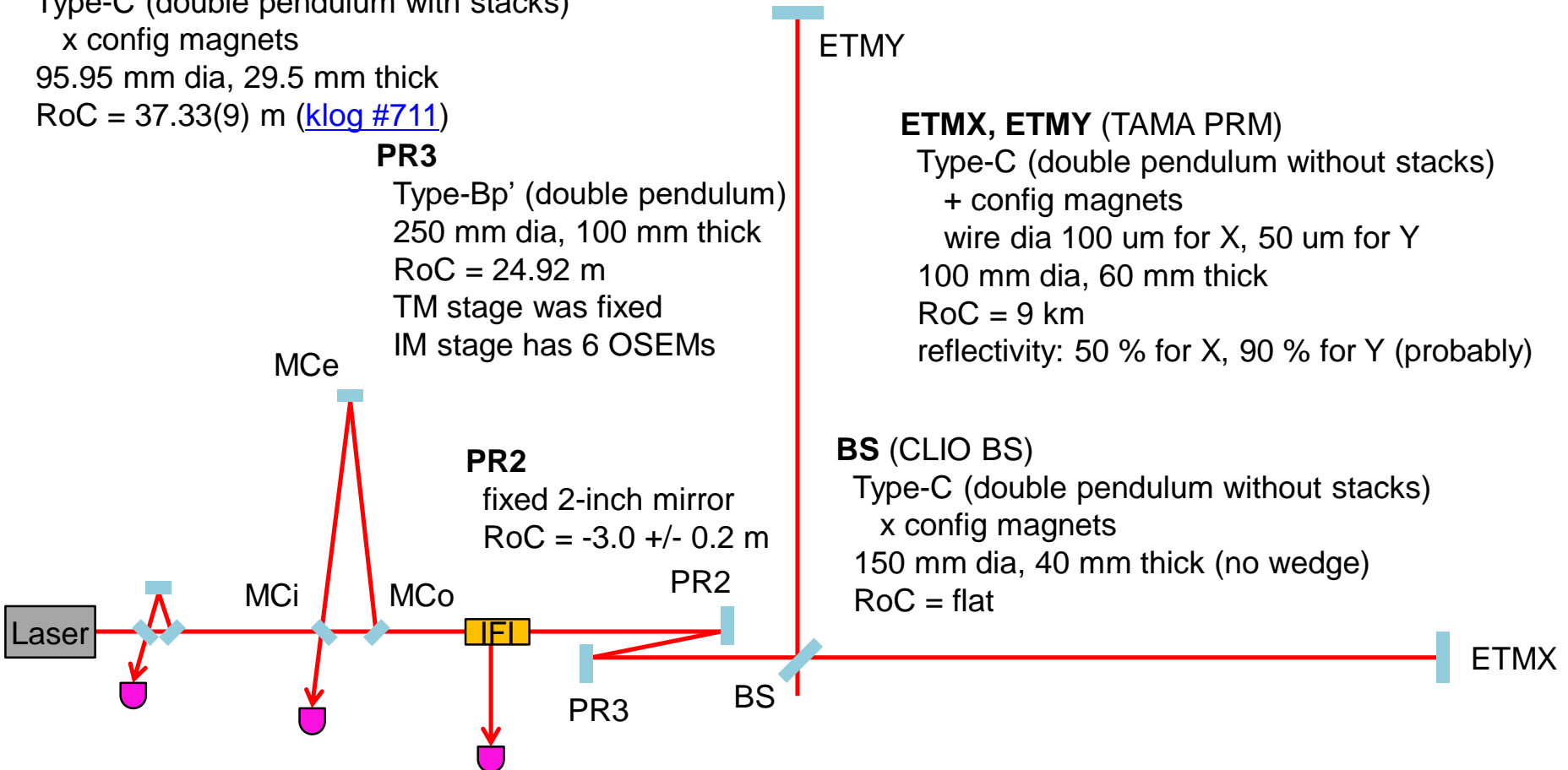
Type-Bp' (double pendulum)
 250 mm dia, 100 mm thick
 RoC = 24.92 m
 TM stage was fixed
 IM stage has 6 OSEMs

ETMX, ETMY (TAMA PRM)

Type-C (double pendulum without stacks)
 + config magnets
 wire dia 100 um for X, 50 um for Y
 100 mm dia, 60 mm thick
 RoC = 9 km
 reflectivity: 50 % for X, 90 % for Y (probably)

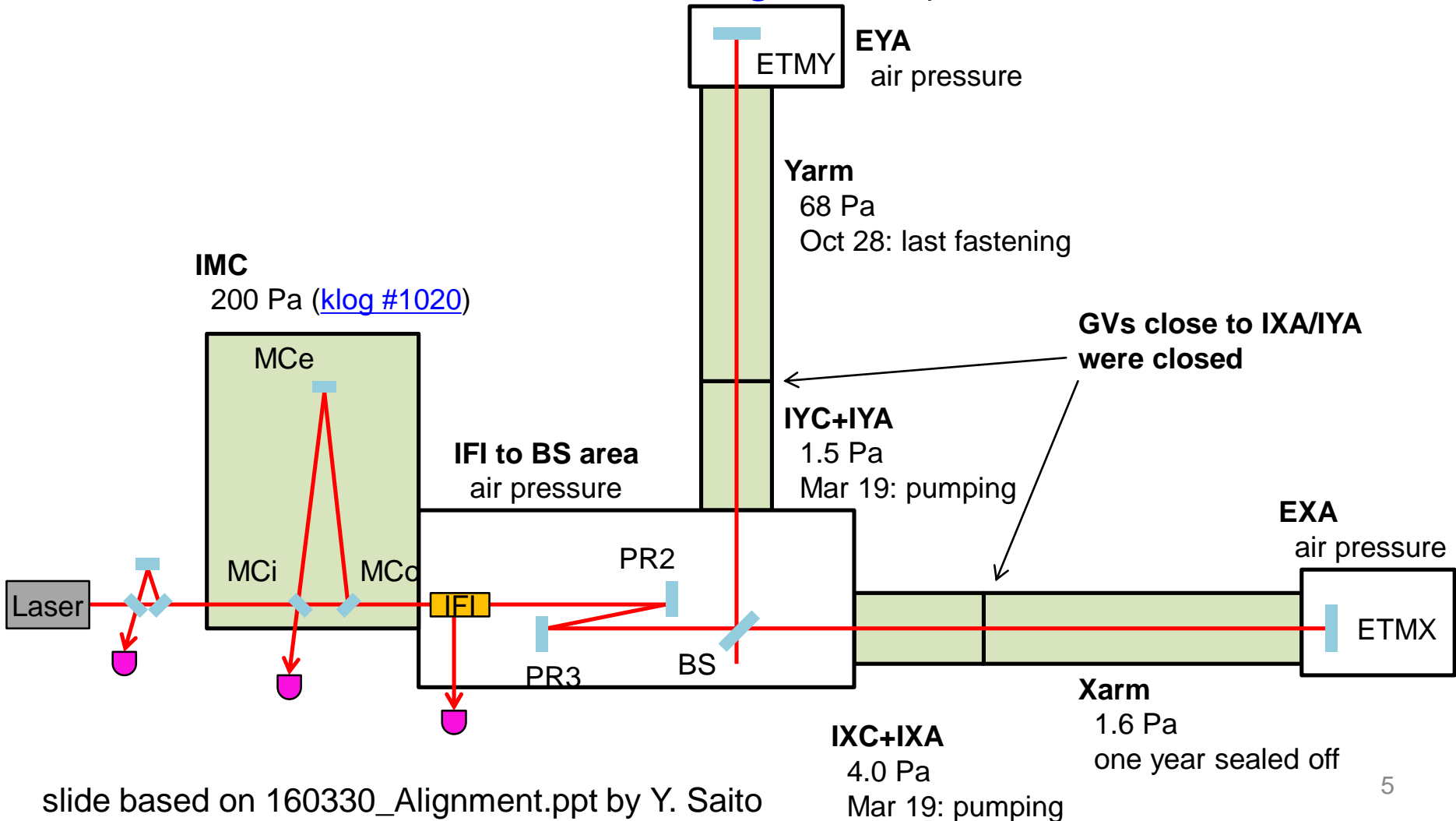
BS (CLIO BS)

Type-C (double pendulum without stacks)
 x config magnets
 150 mm dia, 40 mm thick (no wedge)
 RoC = flat



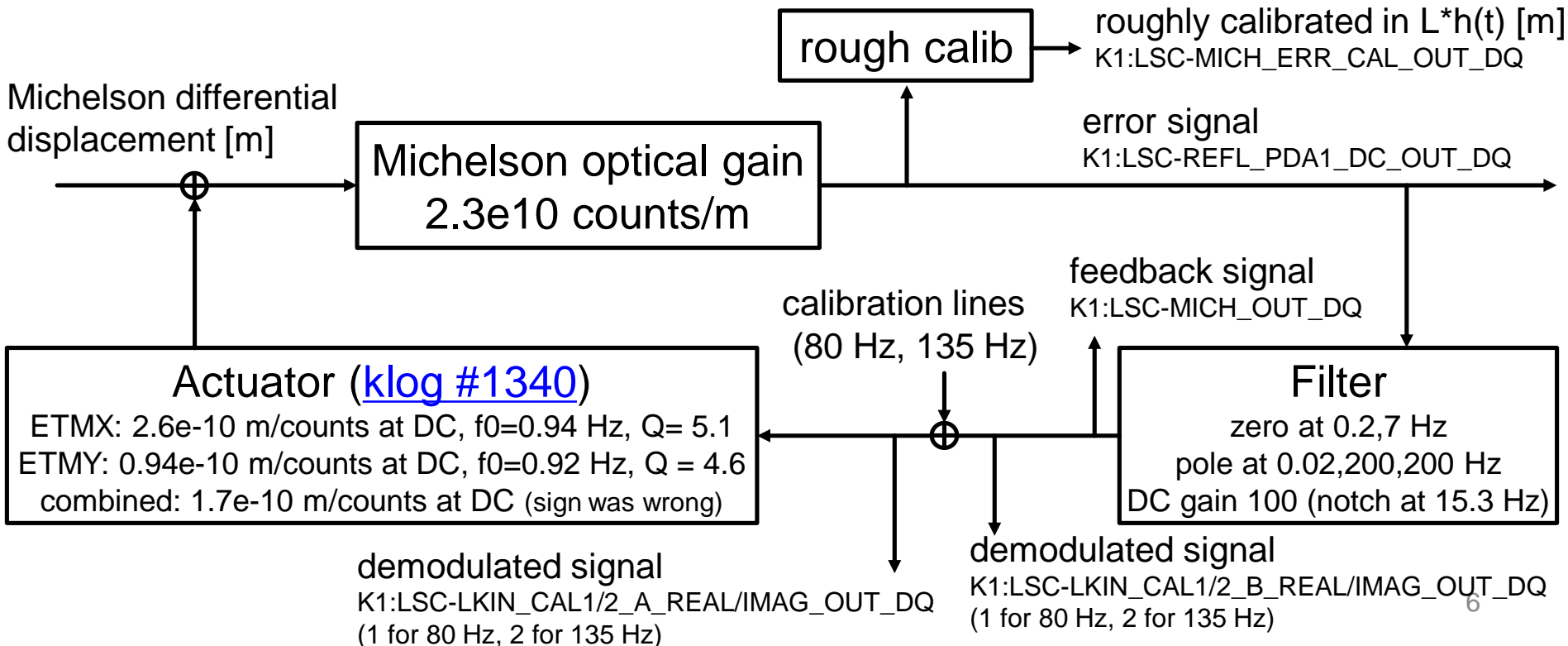
Vacuum

- central part and both ends were at air (PR2-BS was not connected, but covered; [klog #1078](#))



Calibration

- calibration of error signal (optical gain)
2.3e10 counts/m ([klog #1169](#))
- calibration of feedback signal (actuator efficiency)
1.8e-14 m/counts @ 80 Hz ([klog #1169](#))
- calibration lines at 80 Hz and 135 Hz to monitor loop gain

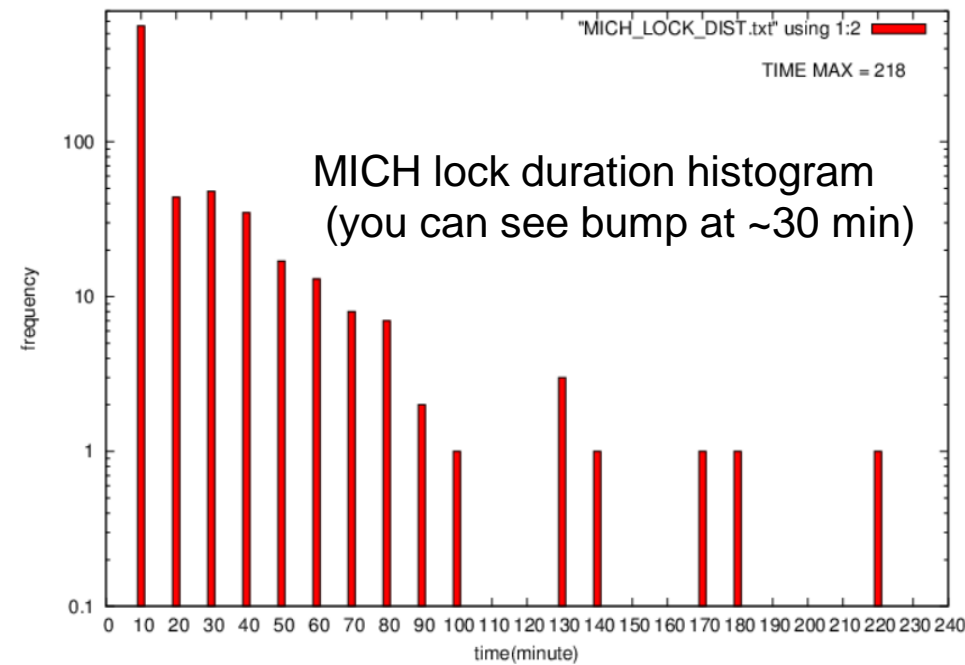
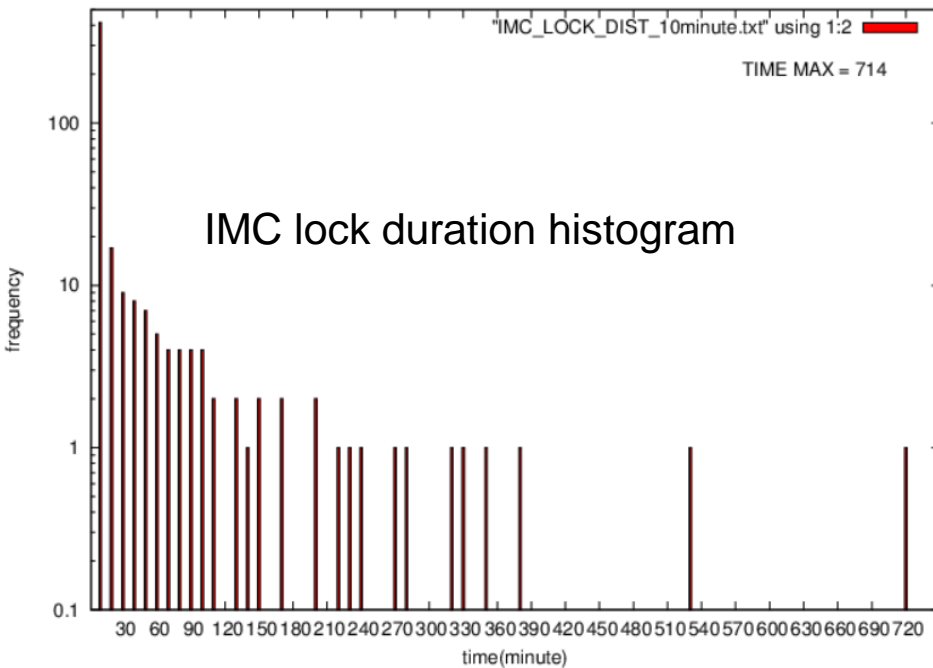
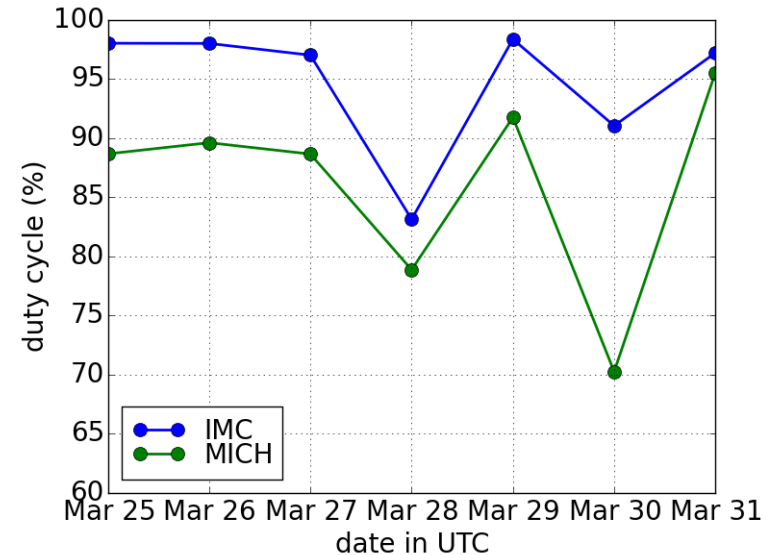


Duty Cycle and Lock Duration

- duty cycle: 85.2 %
(94.4 % for IMC)

data processing and plot by Y. Sasaki

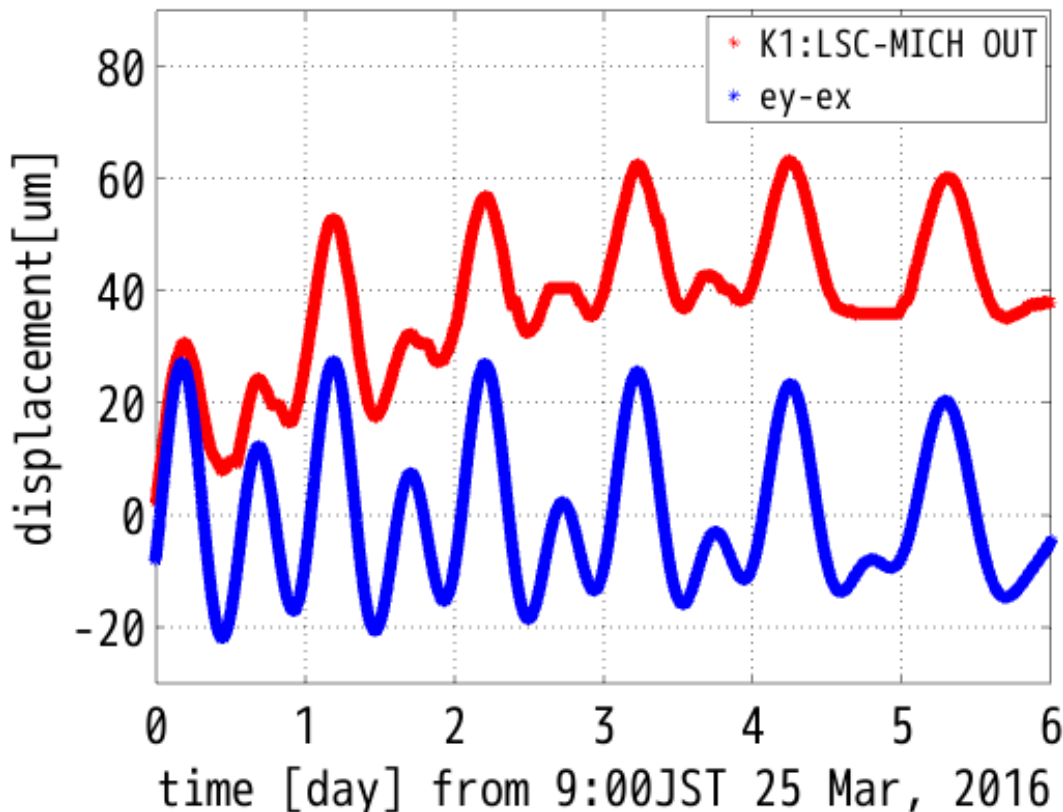
- longest lock: 3.6 hours
(12 hours for IMC)



Tidal Drift

- X arm length and Y arm length drifts by ~ 60 μm
- this caused lock loss every ~ 30 min because of the saturation of the feedback signal

→ needs more actuation range

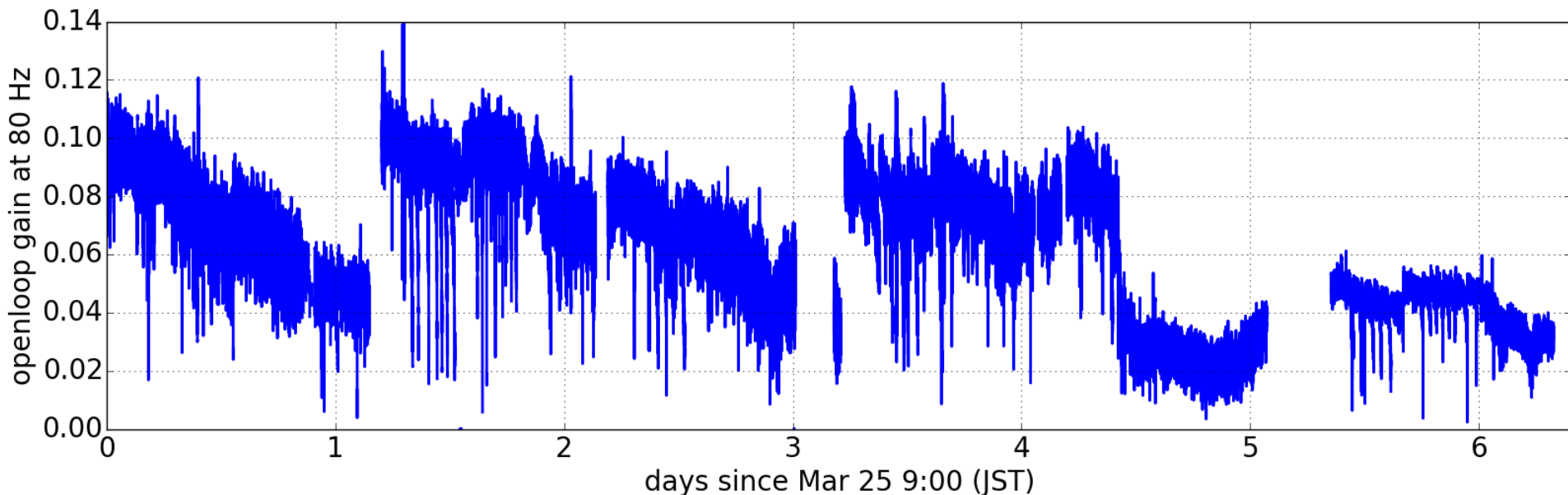


measured with 3-km Michelson

prediction calculated by A. Araya
[JGW-E1605098](#)
used GOTIC2 (tidal effect from
the Moon and the Sun)

Openloop Gain Drift

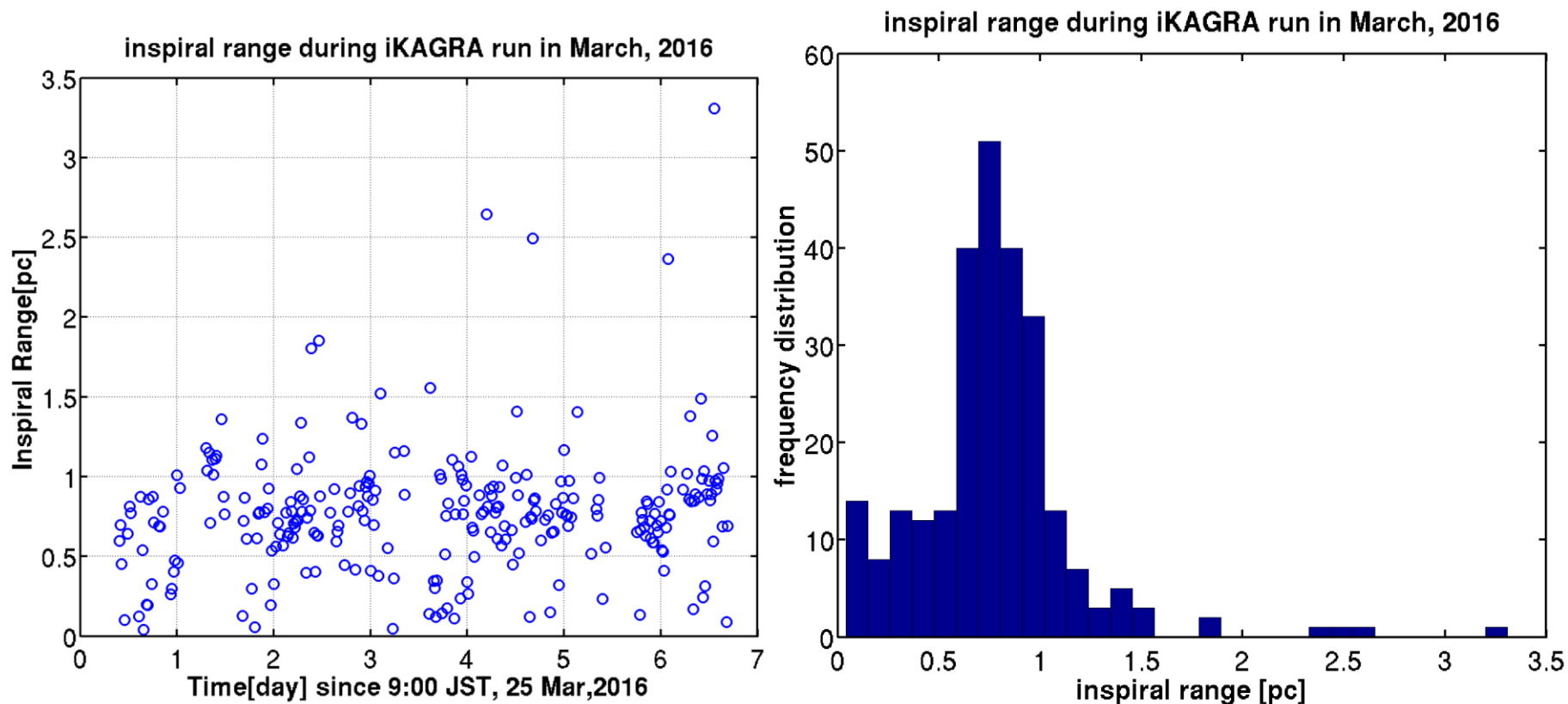
- MICH openloop gain degraded by almost 80 % (likely by alignment drift)
→ needs UGF servo (and online calibration)



calculation done using K1:LSC-LKIN_CAL1_A/B_REAL/IMAG_OUT_DQ
by Y. Sasaki & Y. Michimura

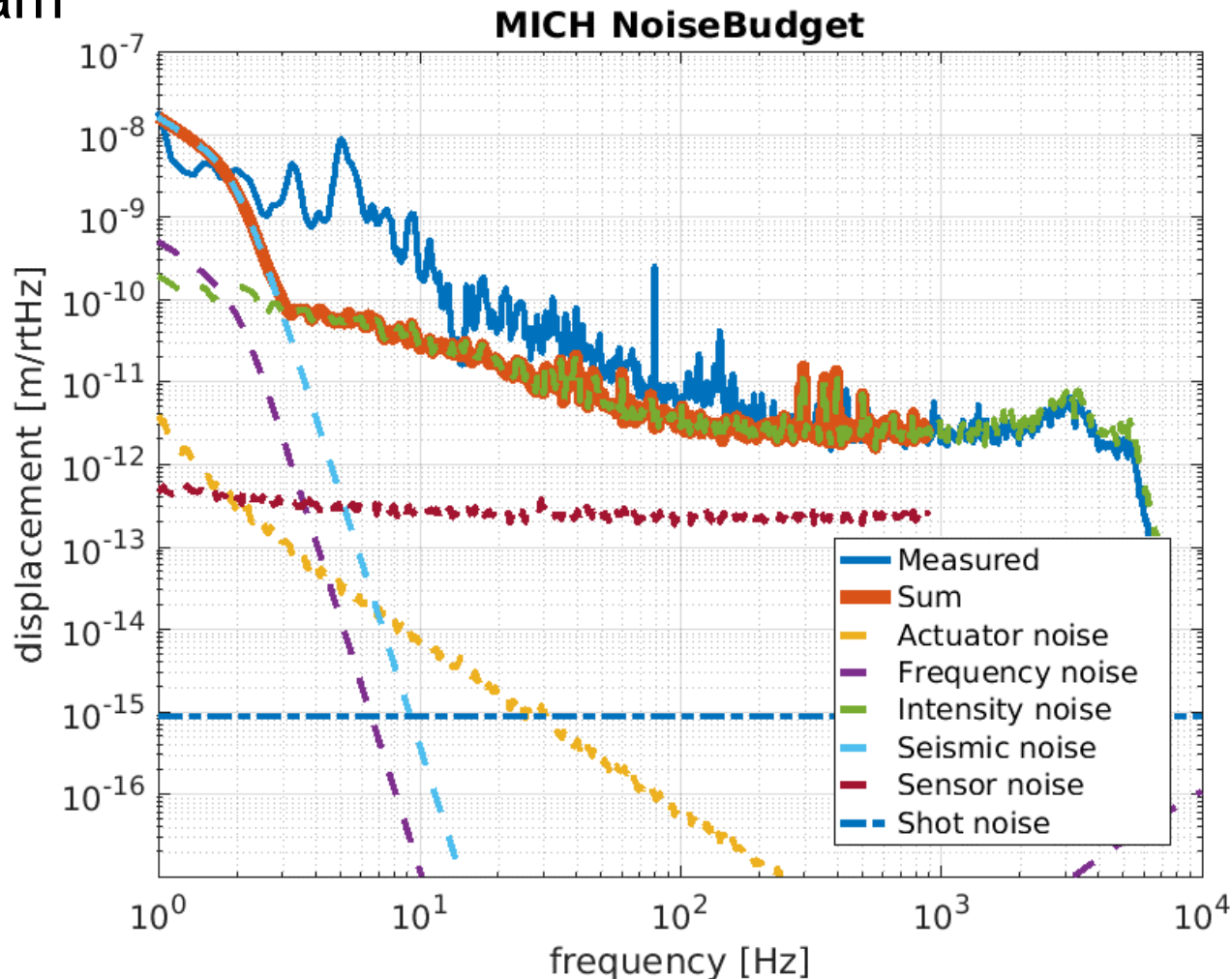
Inspiral Range

- average: 0.77 pc, standard deviation: 0.39 pc for 1.4Msun-1.4Msun NS-NS



Noise Budget

- likely to be limited by intensity noise of the IMC transmitted beam



Issues in March Test Run

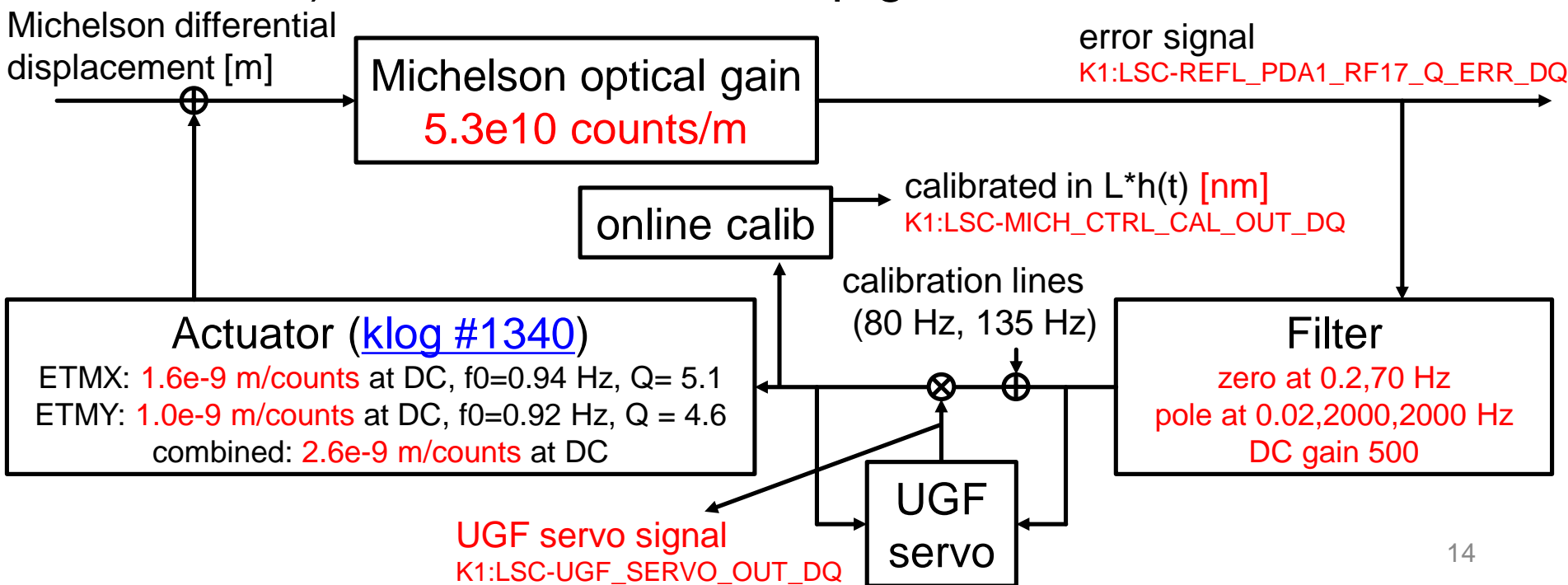
- Michelson lock was lost every ~30 minutes
- Alignment was adjusted manually ~ once per day
- Calibration was done offline
- PMC was re-locked manually
- GVs close to IXA/IYA was closed
- PR2-BS duct was not connected
- Some unsafe issues left unaddressed

What's New in April Test Run

- Michelson lock was lost every ~30 minutes
 - improved to ~~????~~ (tidal won't be a problem this time [klog #1446](#))
 - new actuation efficiency (ETM differential): $2.6e-9$ m/C at DC ([klog #1340](#)), higher UGF ([klog #1344](#)), RF lock instead of DC lock ([klog #1389](#)), x10 sensitivity ([klog #1389](#)), folded oplev for ETMs to reduce L2A ([klog #1355](#))
 - more stable IMC (less feedback to mirrors [klog #1388](#), oplev damping turned off [klog #1449](#))
- Alignment was adjusted manually ~ once per day
 - dither alignment installed for IMC ([klog #1474](#))
- Calibration was done offline
 - UGF servo ([klog #1425](#)) and online calibration ([klog #1456](#))
- PMC ~~was re-locked manually~~ remote control restored ([klog #1351](#))
- GVs close to IXA/IYA was ~~closed~~ opened ([klog #1338](#))
- PR2-BS duct was ~~not connected~~ connected
- Some unsafe issues ~~left unaddressed~~ partially addressed

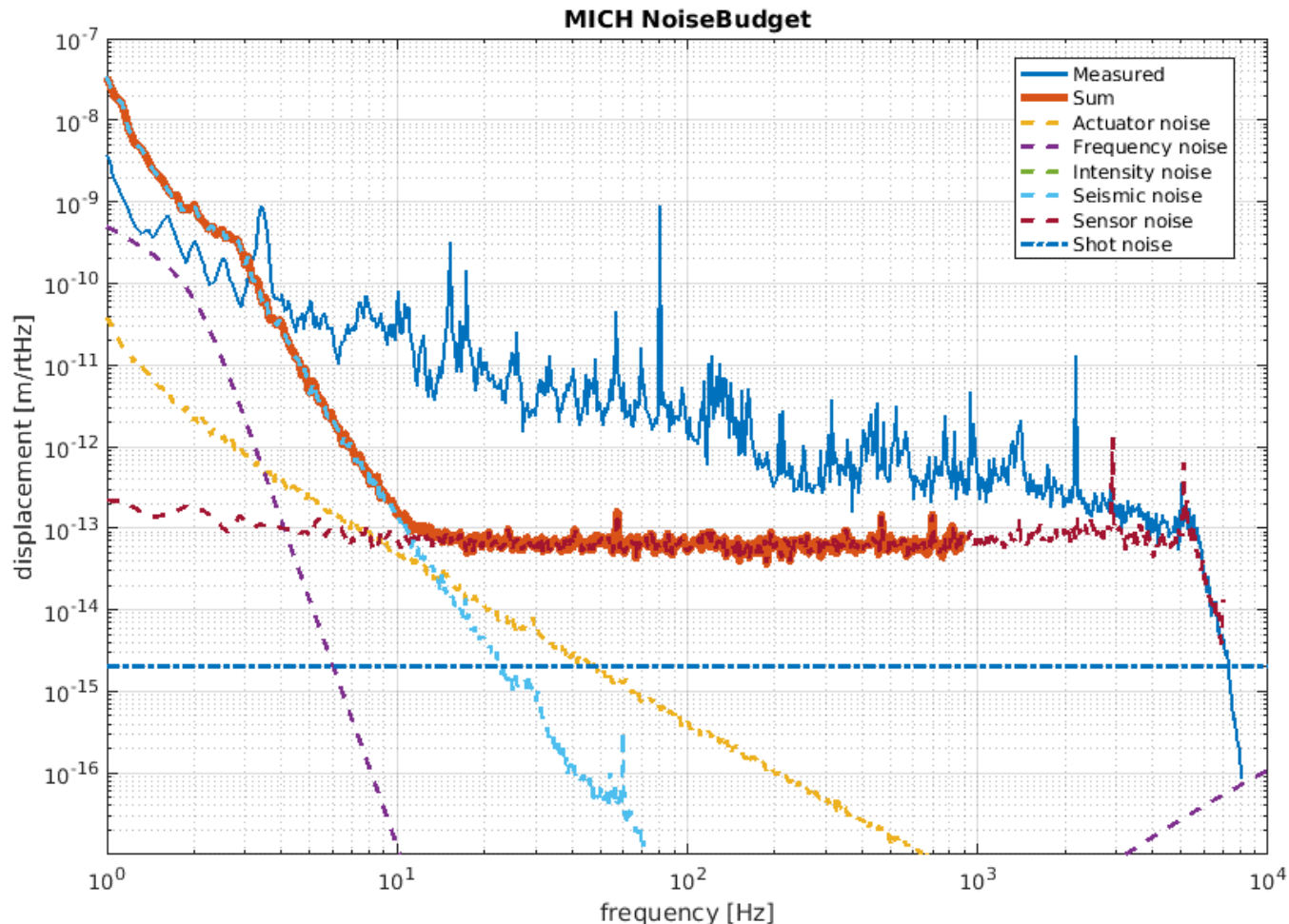
Calibration for April Test Run

- calibration of error signal (optical gain)
 $5.3e10$ counts/m ([klog #1455](#))
- calibration of feedback signal (actuator efficiency)
 $2.6(1)e-9$ m/counts @ DC ([klog #1340](#))
- calibration lines at 80 Hz for UGF servo (UGF controlled at 100 Hz) and at 135 Hz for loop gain monitor



Updated Noise Budget

- not limited by intensity noise of the IMC transmitted beam
- could be BS angular noise coupling?



What To Do After April Test Run

- evacuate central part and both ends
 - to open all GVs and see optical axis change
 - to investigate alignment change during evacuation
- PR3 height check
- oplev stability, noise measurements with fixed mirror
- investigate scattering noise from vibration of ducts
- what else?