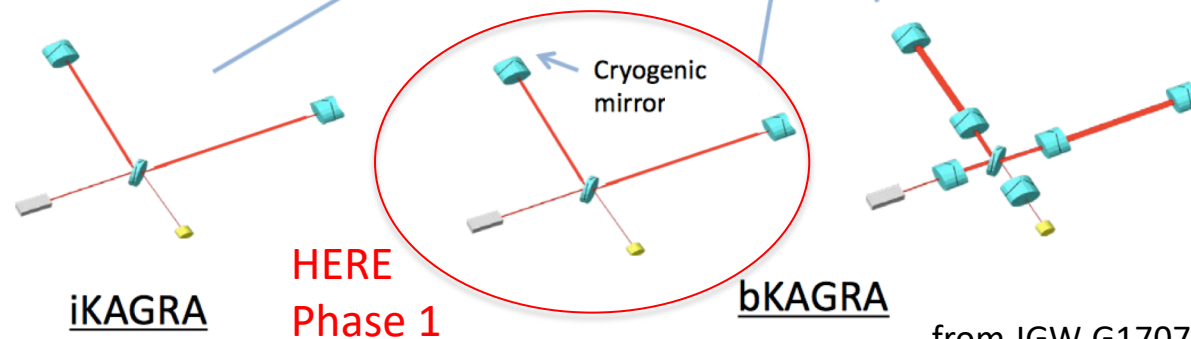
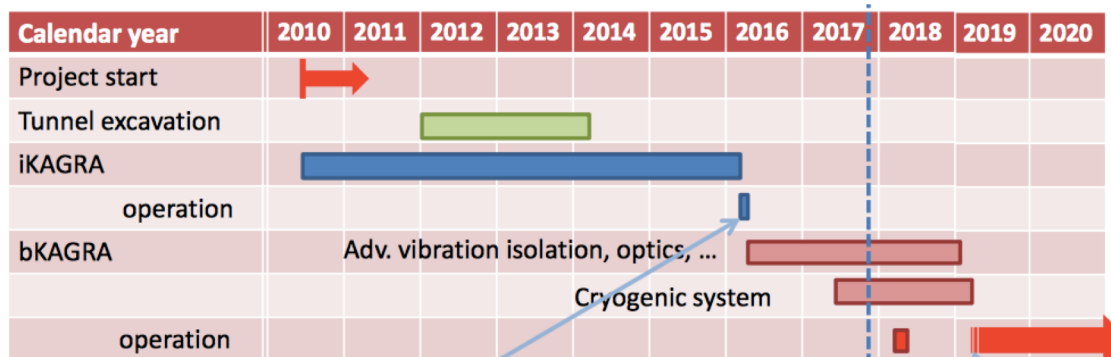


bKAGRA Phase 1 Overview

bKAGRA Phase 1 Overview

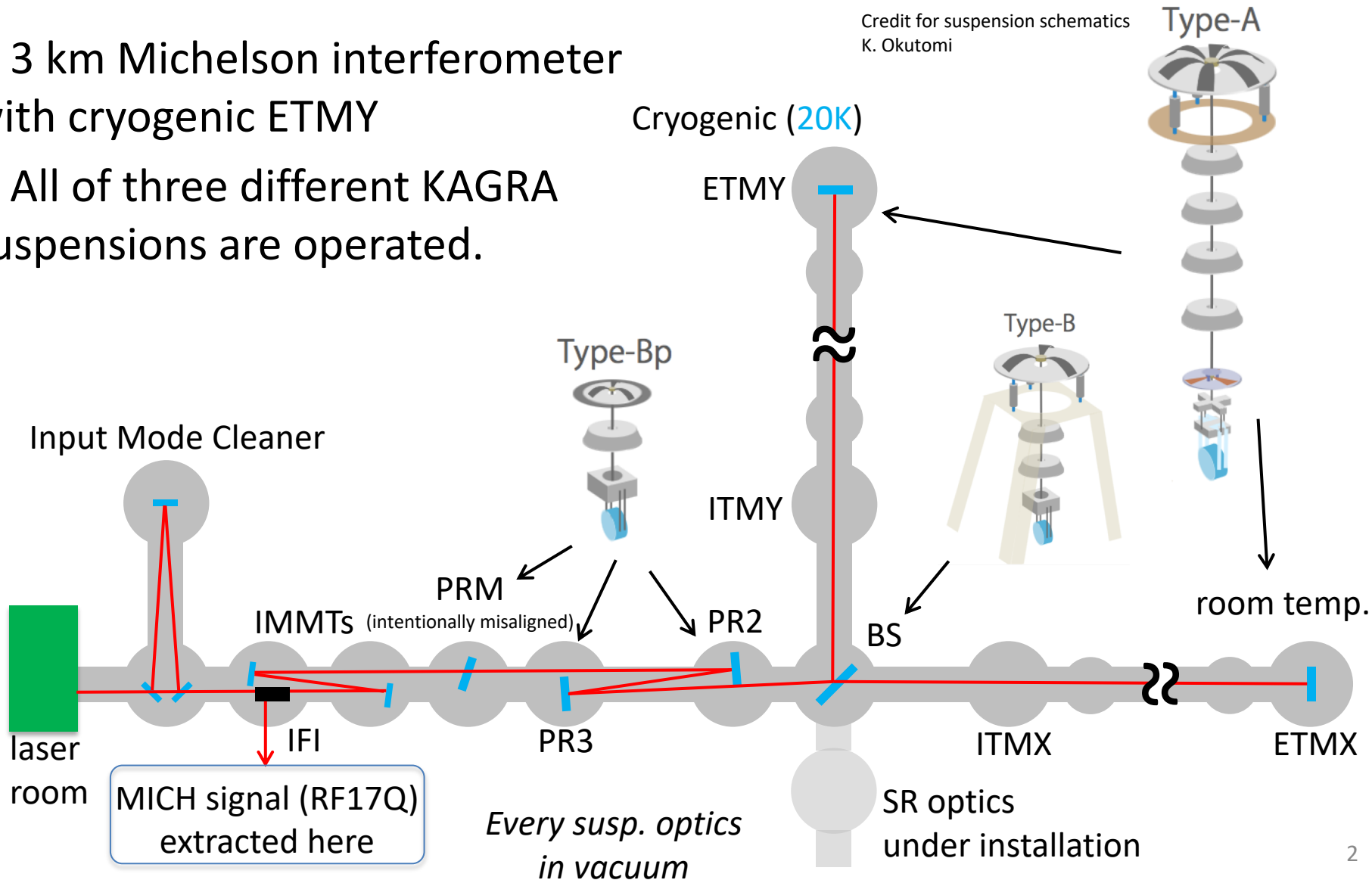
- bKAGRA Phase 1: Operation of large scale interferometer with a cryogenic mirror, held in Apr 28 – May 6, 2018
- Aim: Operation and characterization of full KAGRA suspensions including [cryogenic payload](#)



Phase 1 Overview

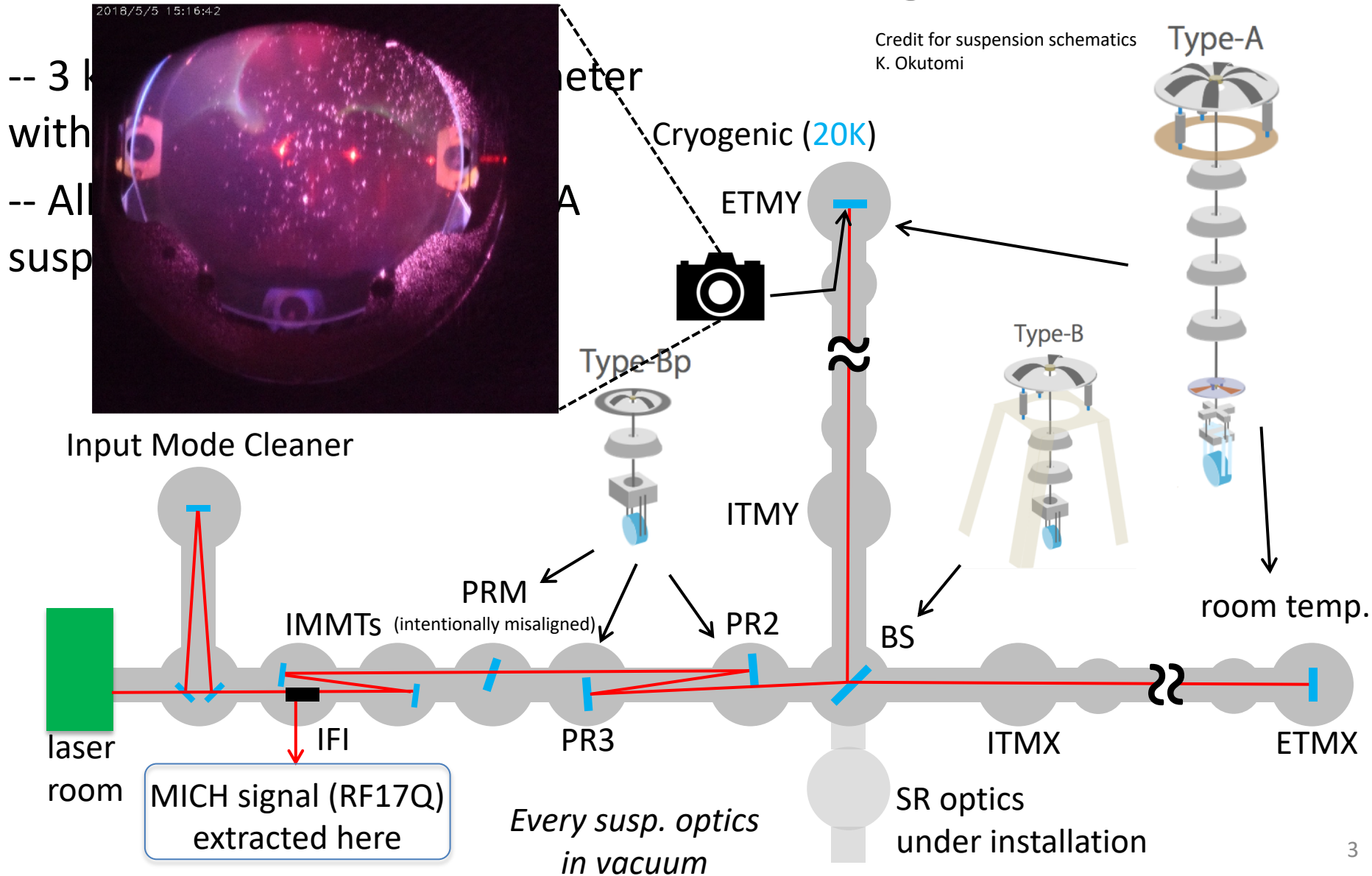
Interferometer configuration

- 3 km Michelson interferometer with cryogenic ETMY
- All of three different KAGRA suspensions are operated.



Phase 1 Overview

Interferometer configuration

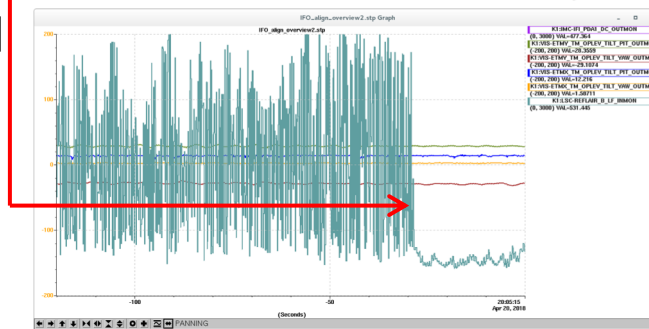
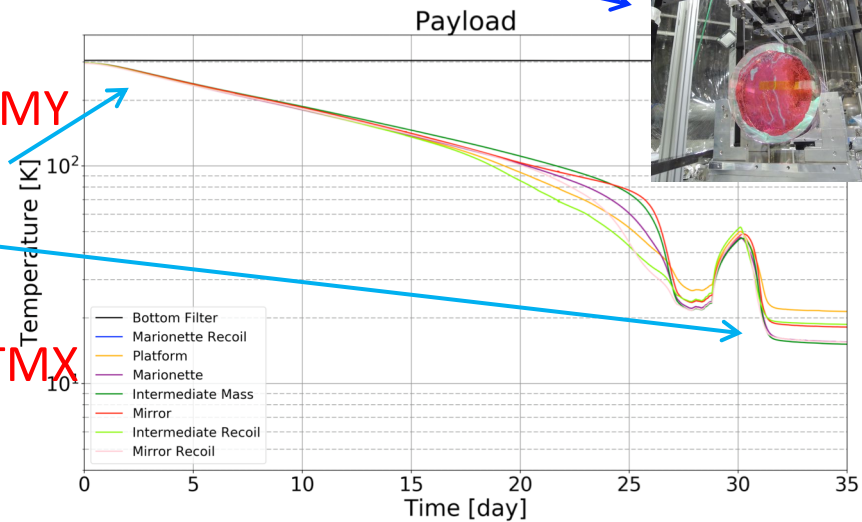
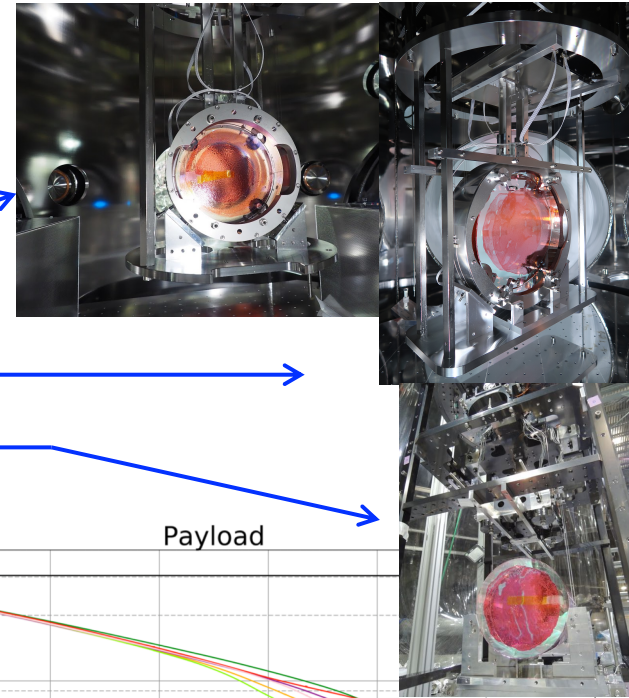


Phase 1 Overview

Milestones

Suspension
Cryogenic
Interferometer

- * Sept 19 2017: All PR suspension installation completed
- * Sept 21 2017: BS suspension installed
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- * Oct 26 2017: Main beam reached Y end
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- * Apr 10 2018: Michelson fringe observed
- * Apr 20 2018: Michelson locked
- * Apr 28 2018: Phase 1 Operation started

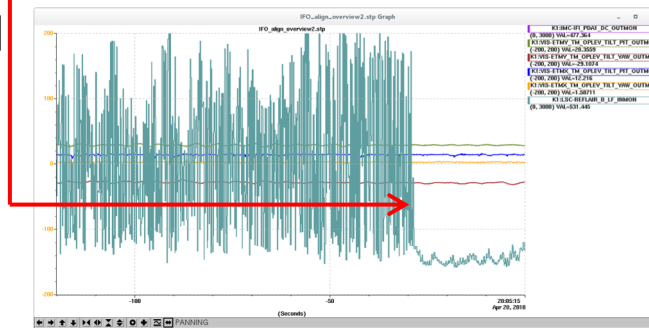
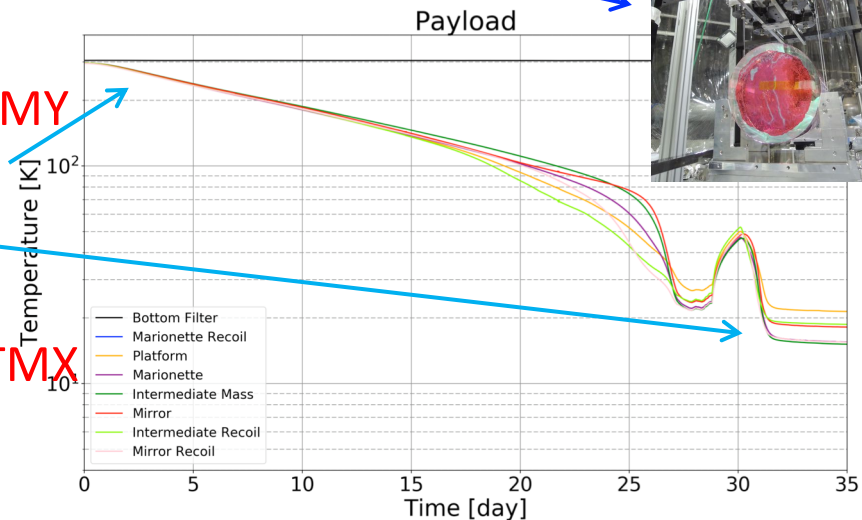
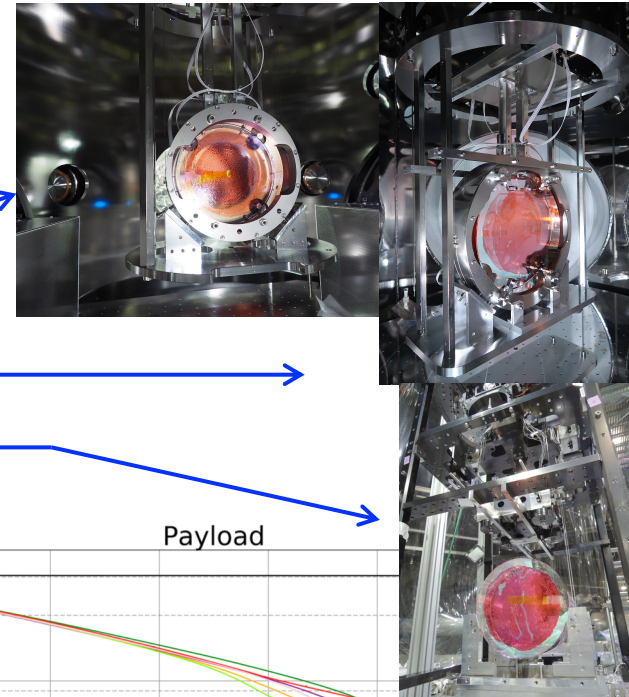


Phase 1 Overview

Milestones

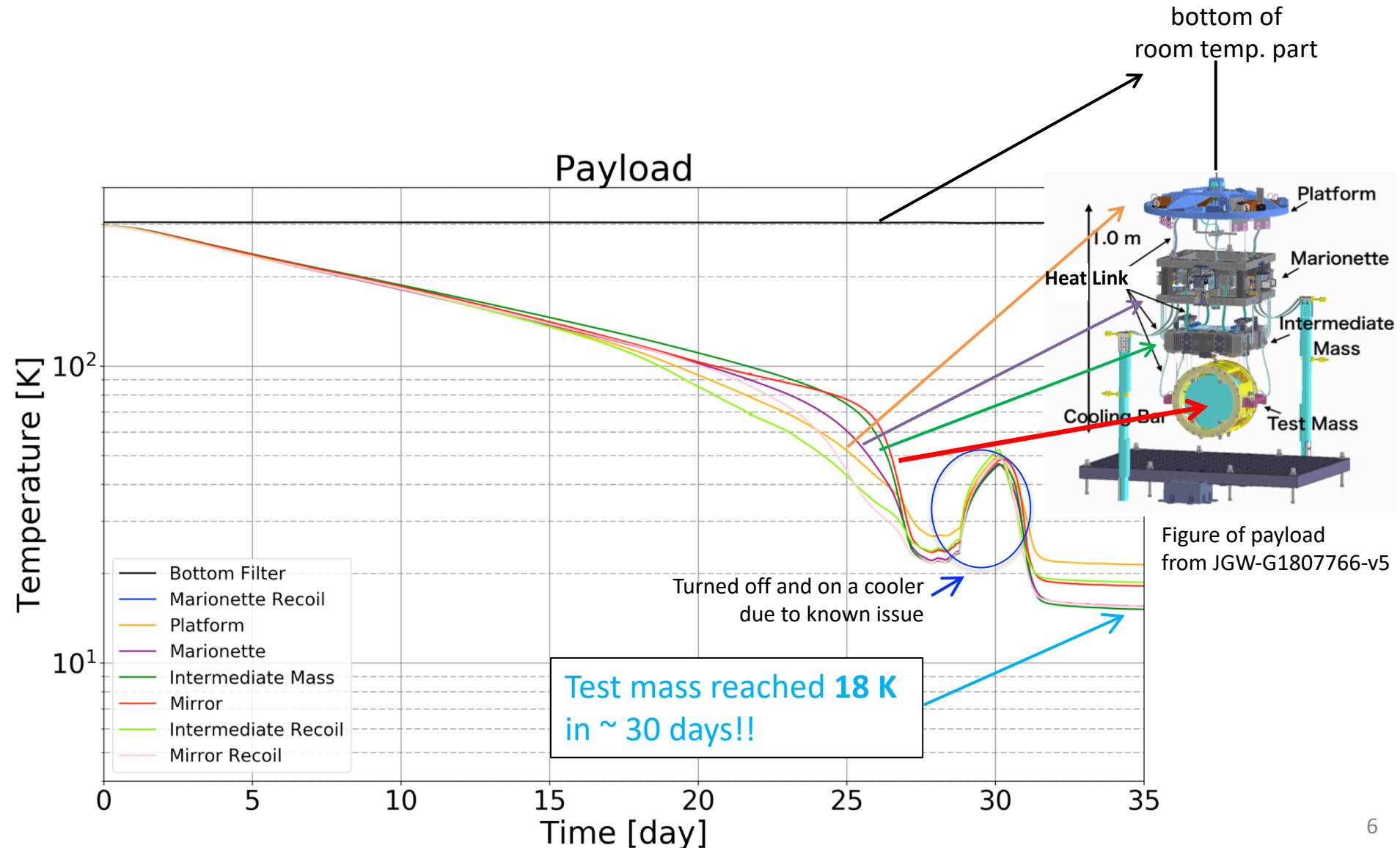
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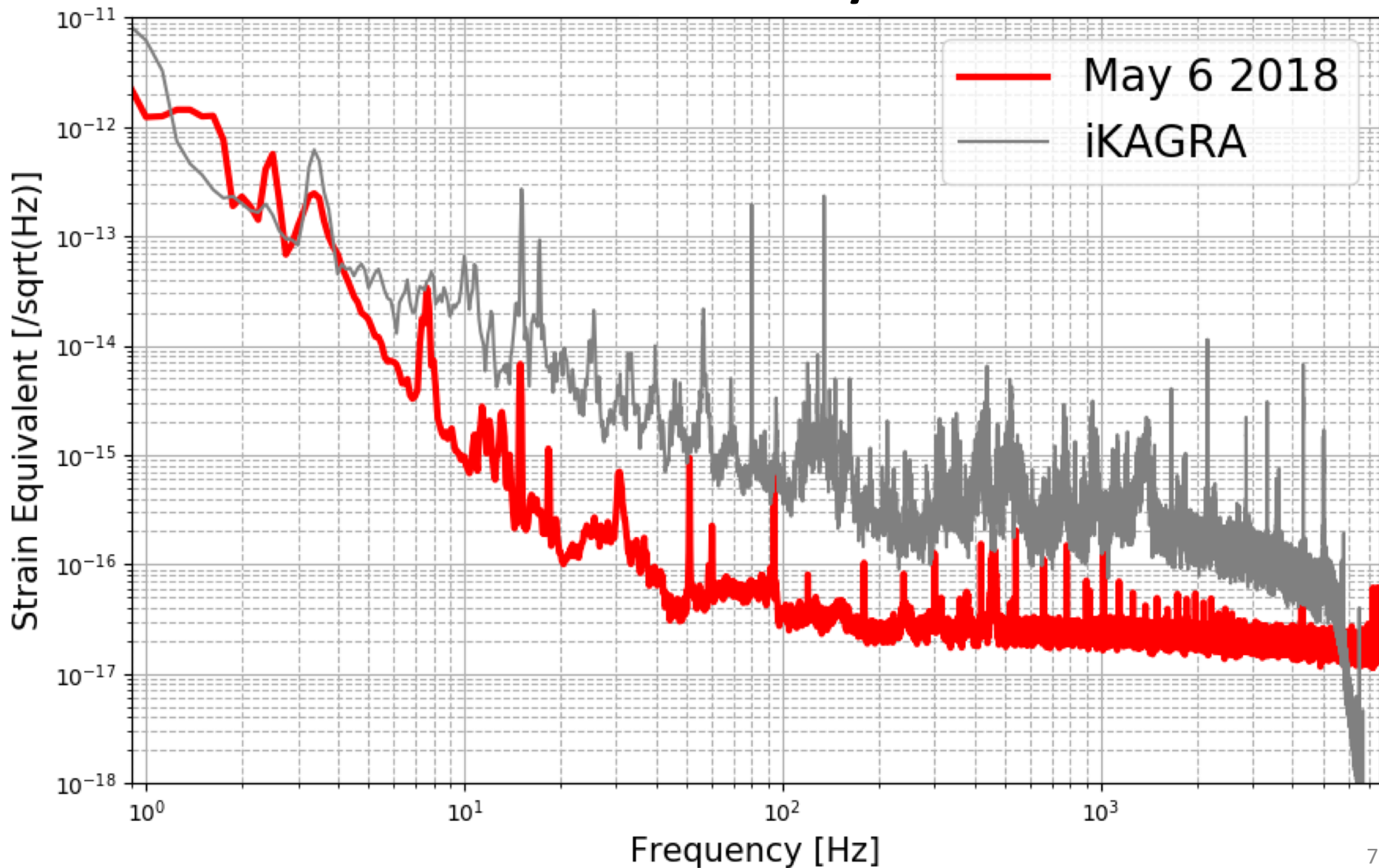


We rushed toward the Operation.

Cooling down ETMY



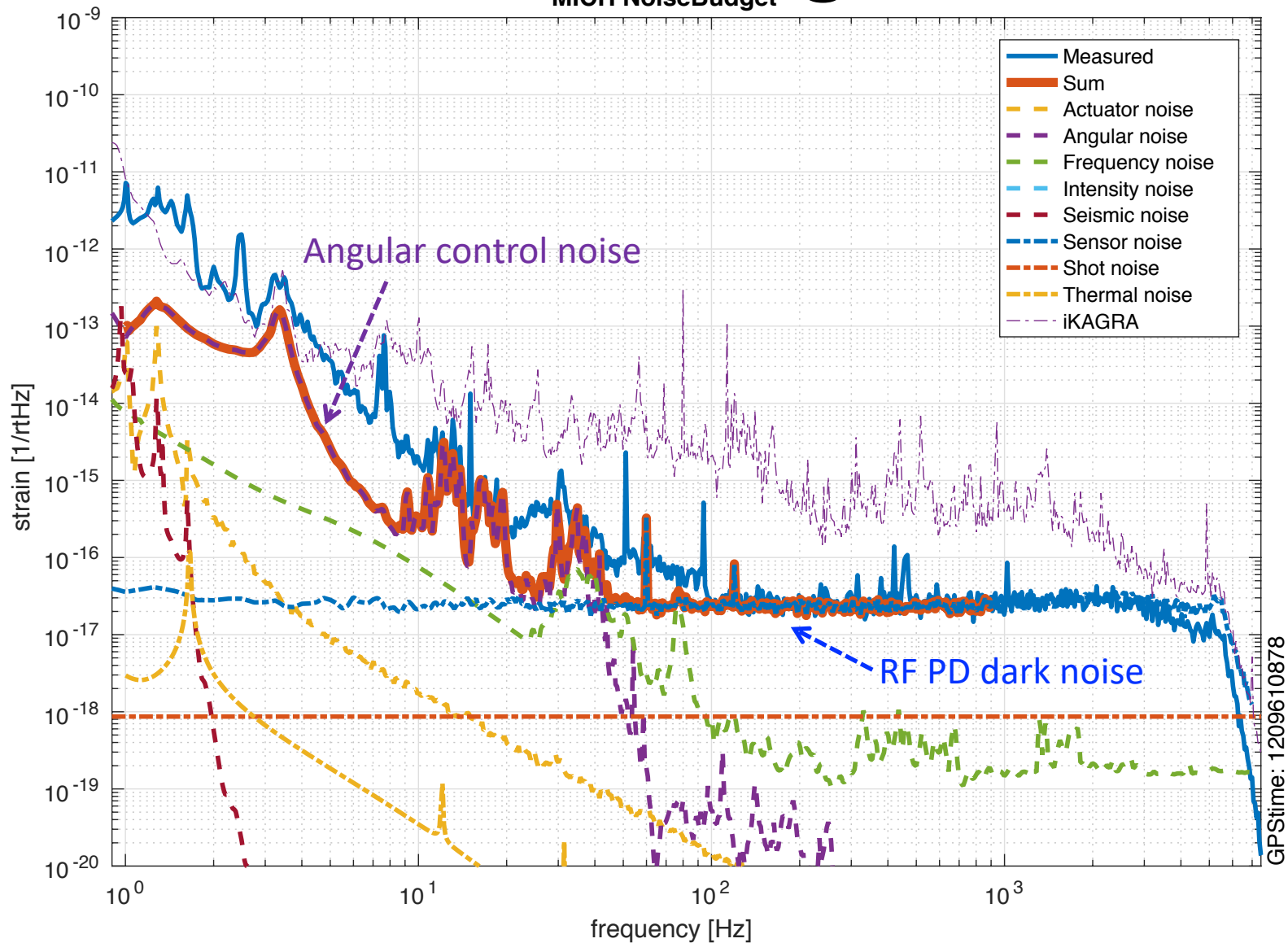
Sensitivity



Phase 1 Overview

Noise Budget

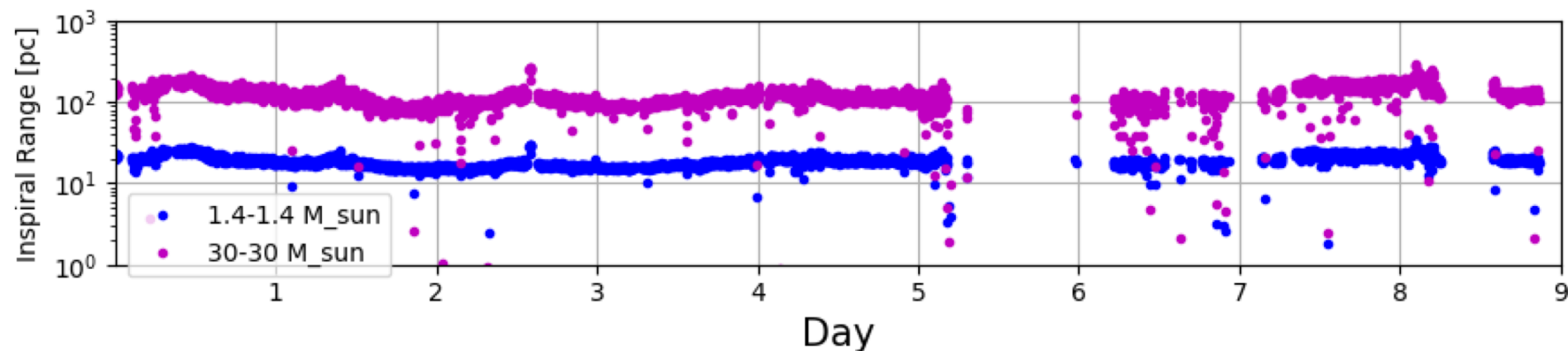
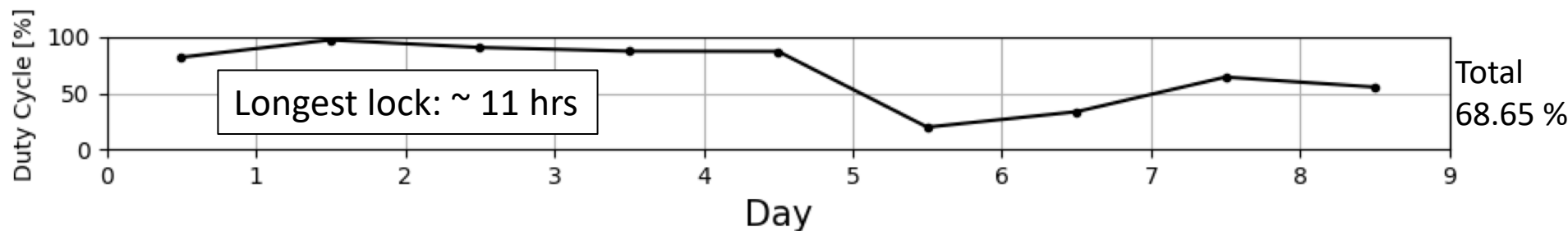
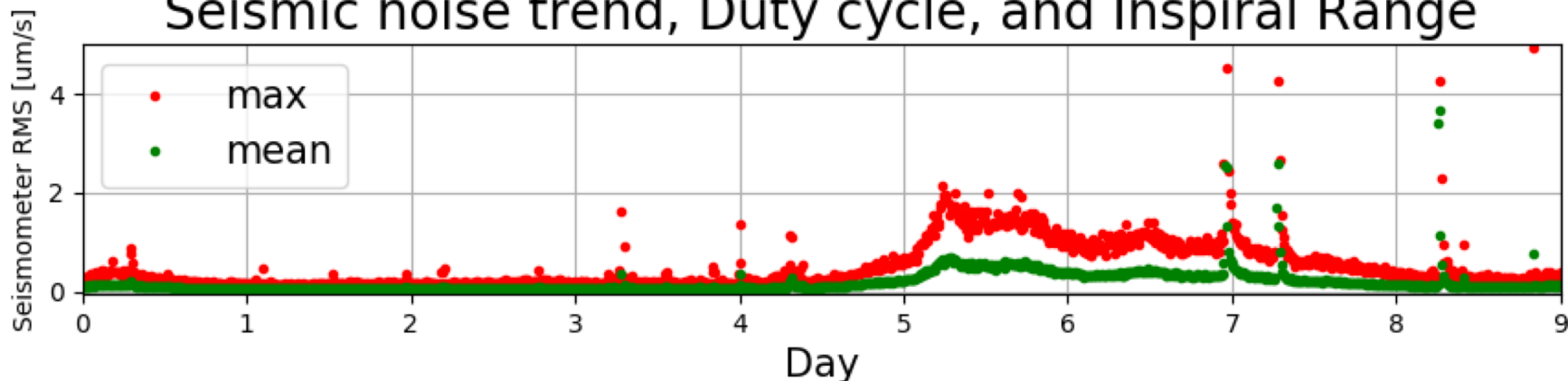
MICH NoiseBudget



Phase 1 Overview

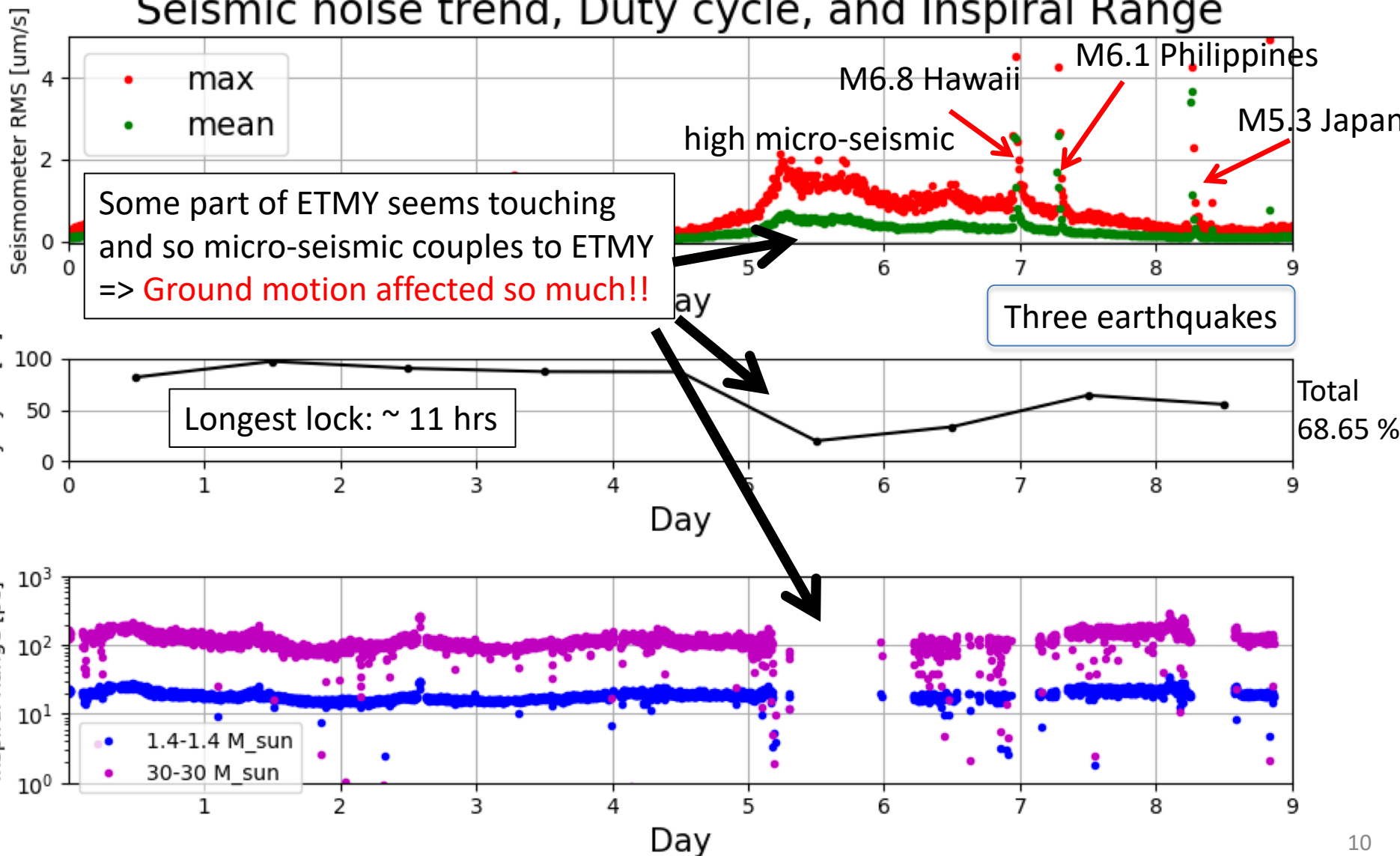
Operation Status

Seismic noise trend, Duty cycle, and Inspiral Range



Operation Status

Seismic noise trend, Duty cycle, and Inspiral Range



Characterization

Characterization

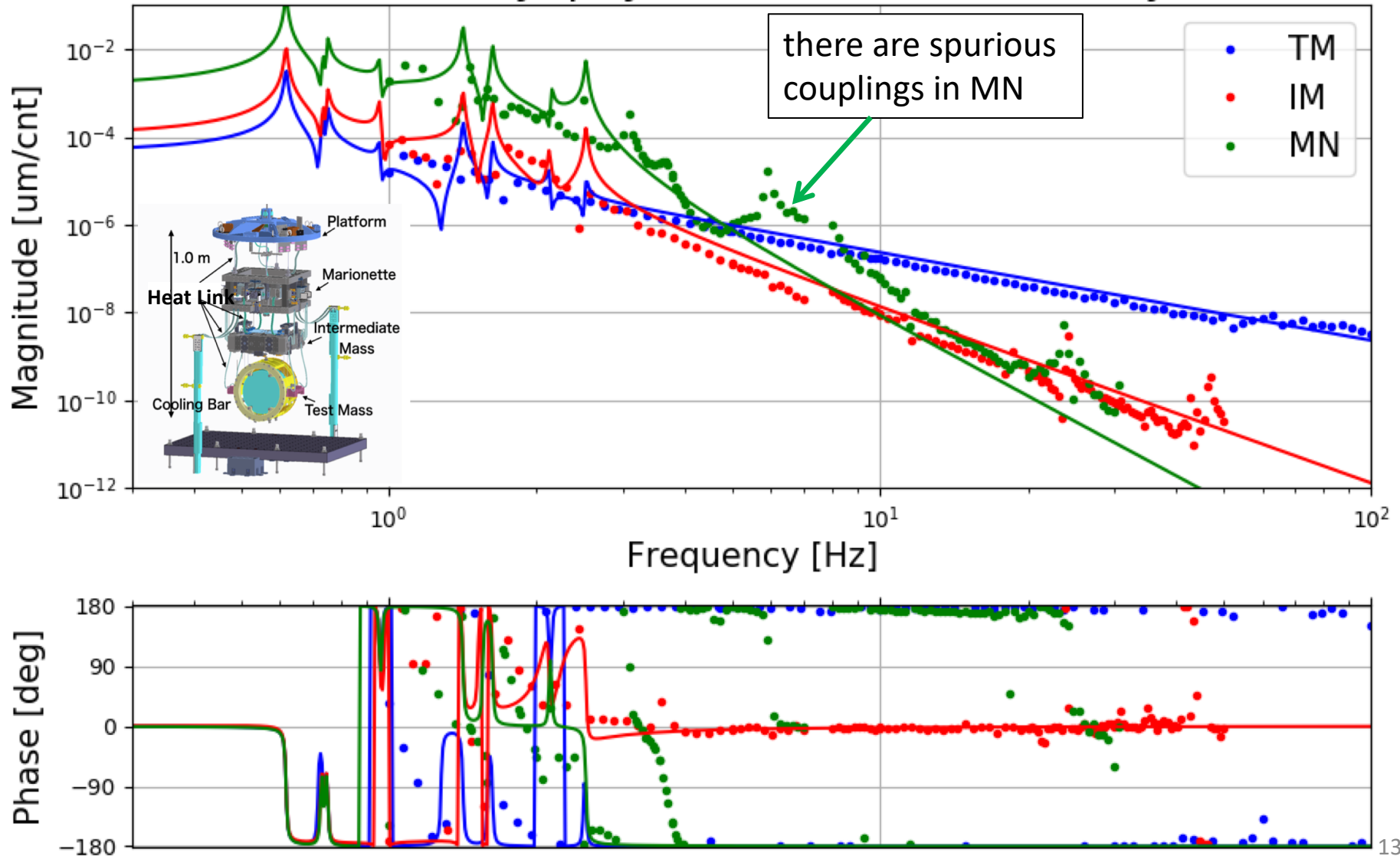
-- During 9 days of Operation, several experiments have been performed, using interferometer signal.

- * Actuator efficiency of ETMY (20 K), ETMX (300 K), and BS
- * Seismic attenuation factor measurement of ETMX
- * Detchar: PEM sensors and Injection test
- * Hardware injection test of Compact Binary Coalescence (CBC) and Continuous Wave (CW) signal

→ I am going to briefly explain them

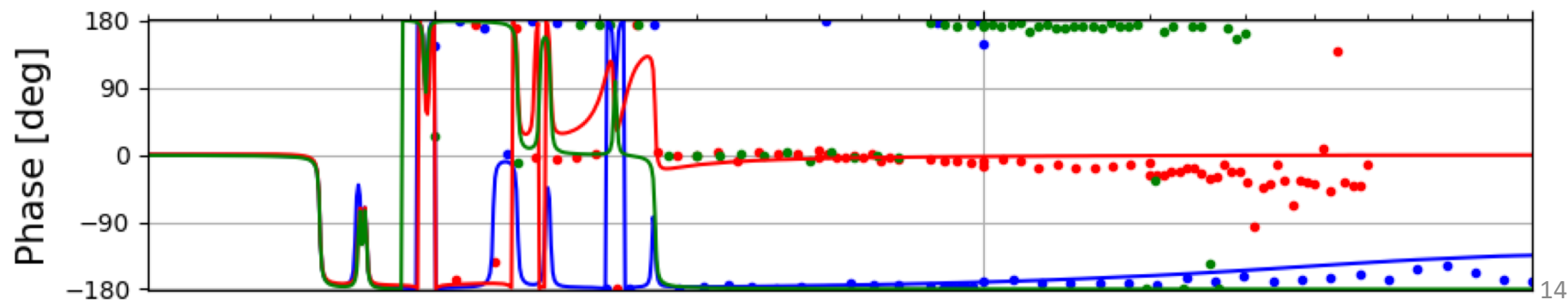
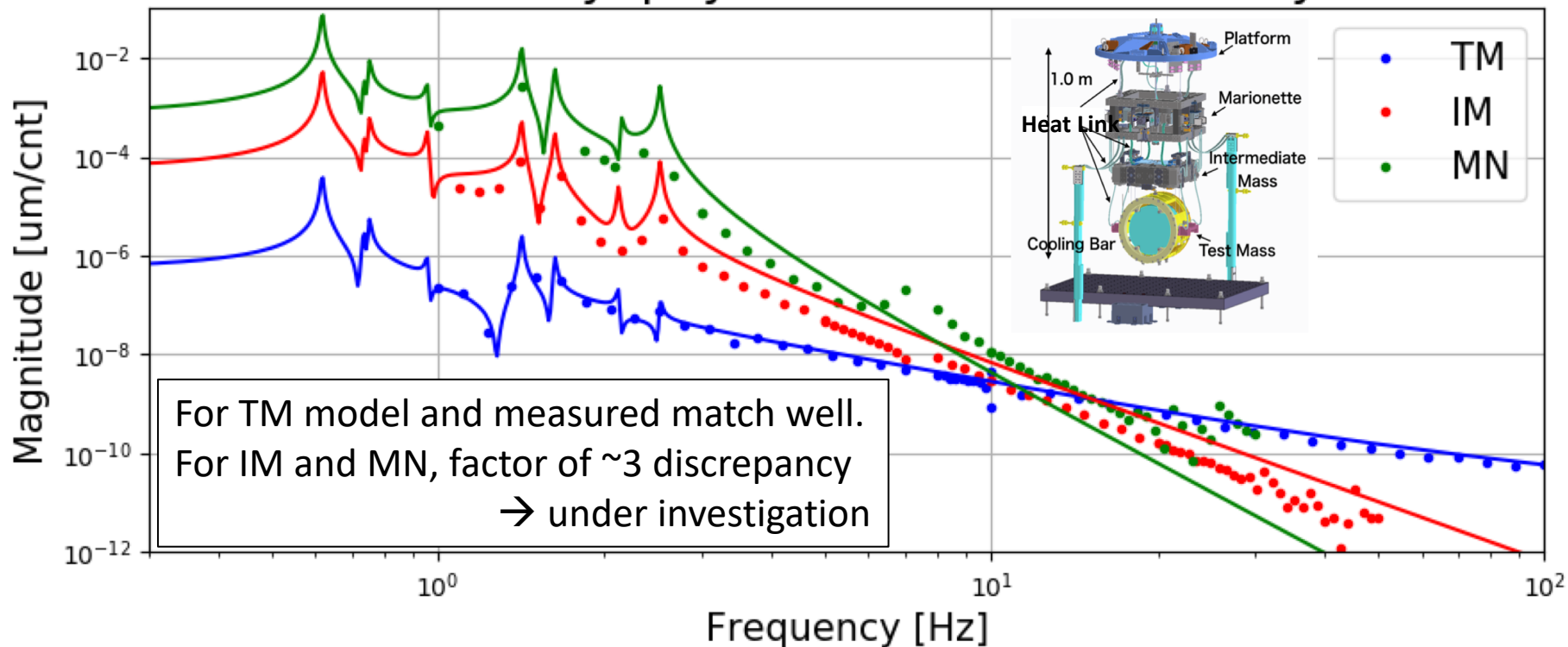
Act. Efficiency of EMTY (20 K)

ETMY Cryopayload Actuator Efficiency



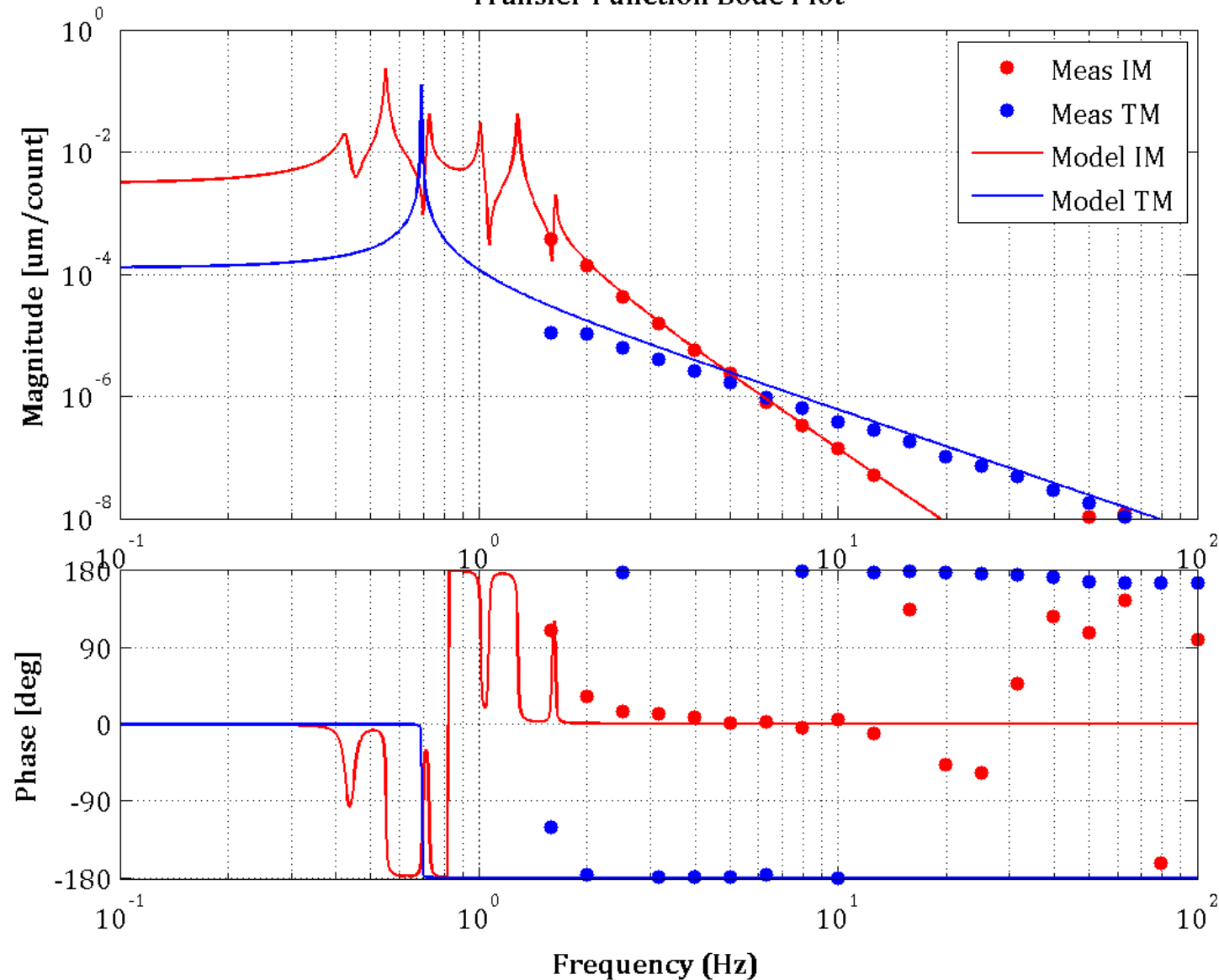
Act. Efficiency of EMTX (300 K)

ETMX Cryopayload Actuator Efficiency

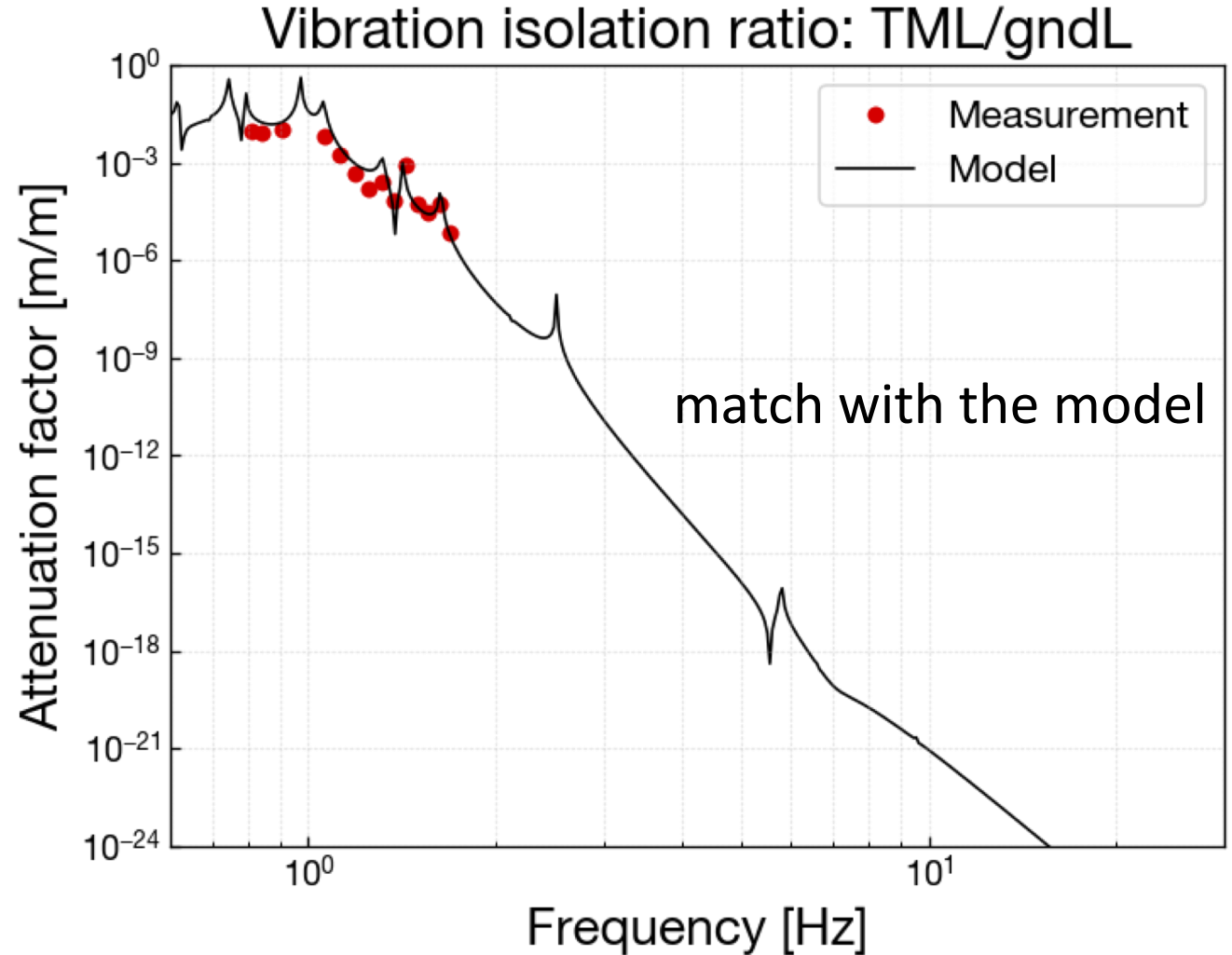
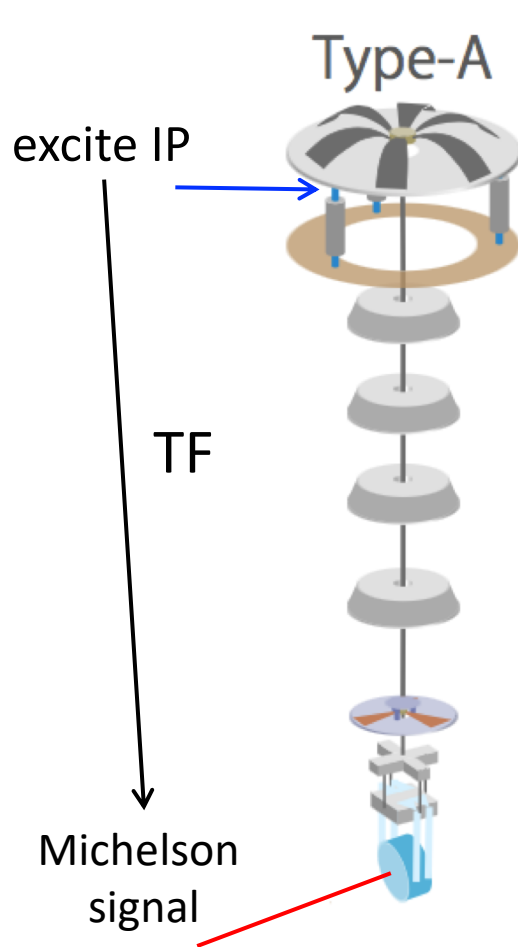


Act. Efficiency of BS

Transfer Function Bode Plot



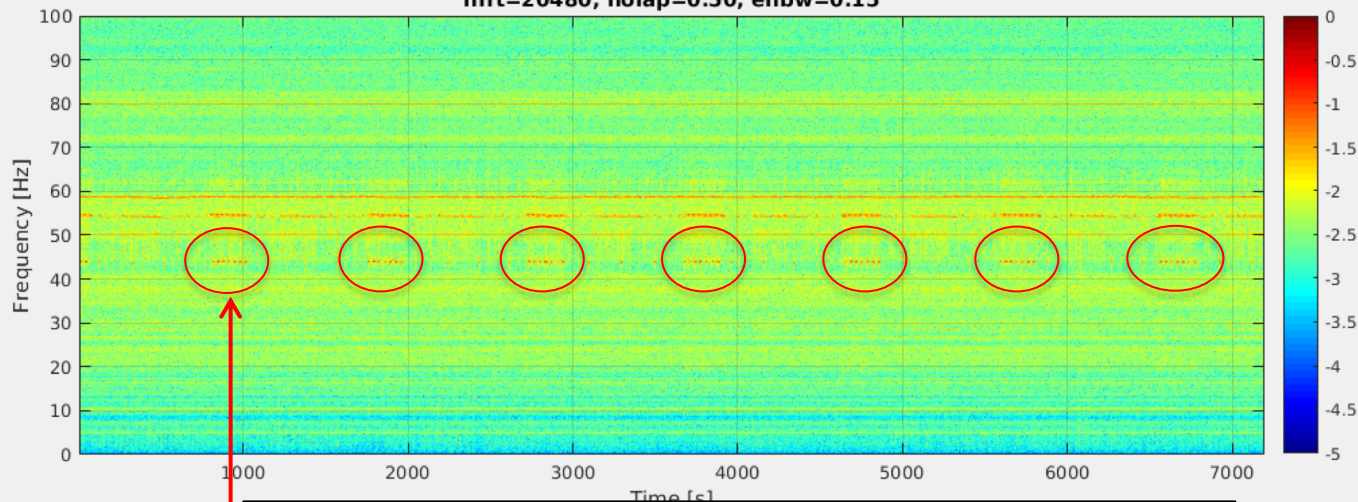
Seismic Attenuation of ETMX



Characterization

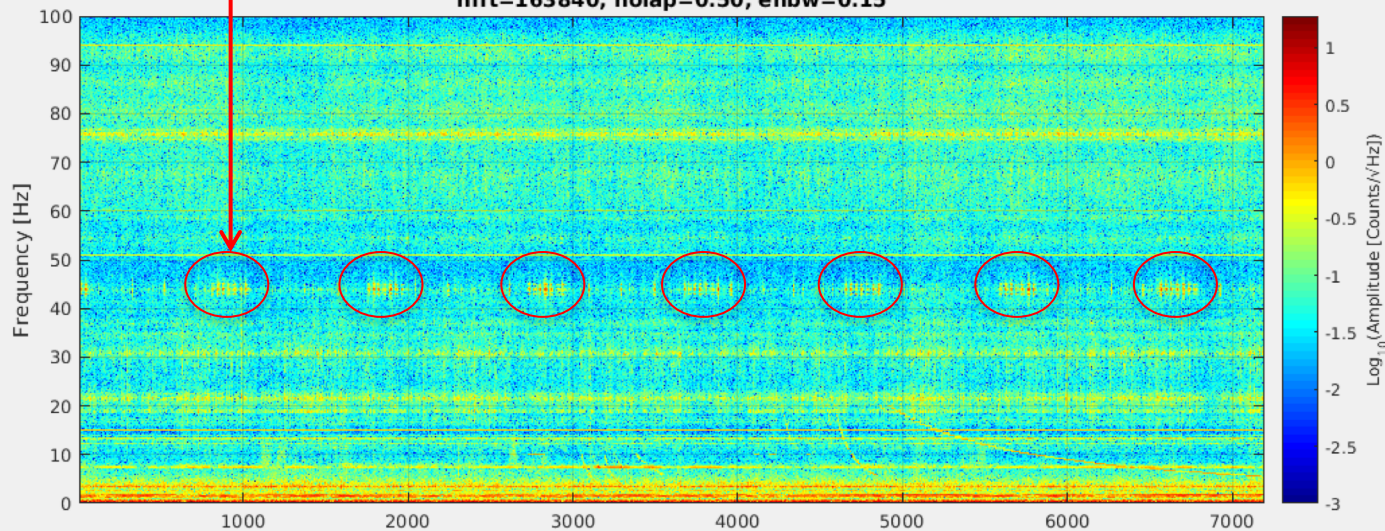
PEM related

Microphone close to BS

Spectrogram of 01:K1:PEM-IY0_SENSOR4_OUT_DQ
fs = 2048 : 7200s from 2018-04-28 22:24:27 -
nfft=20480, nolap=0.50, enbw=0.15

Periodically appearing (15 mins) noise at ~ 45 Hz

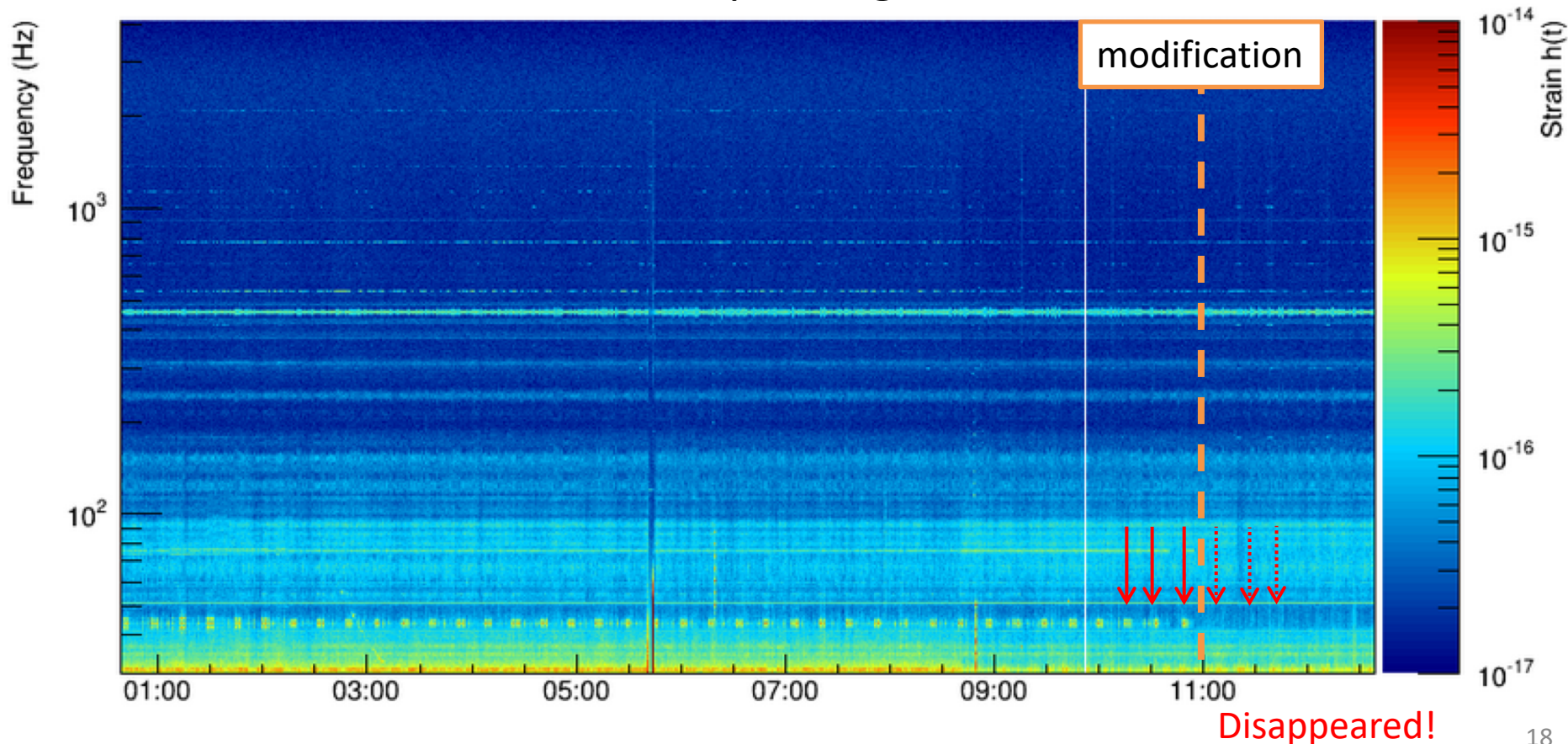
MICH signal

fs = 16384 : 7200s from 2018-04-28 22:24:27 -
nfft=163840, nolap=0.50, enbw=0.15

PEM related

- It turned out this noise has coherence with PR2 optical lever signal
- => we modified optical lever control loop of PR2

MICH spectrogram

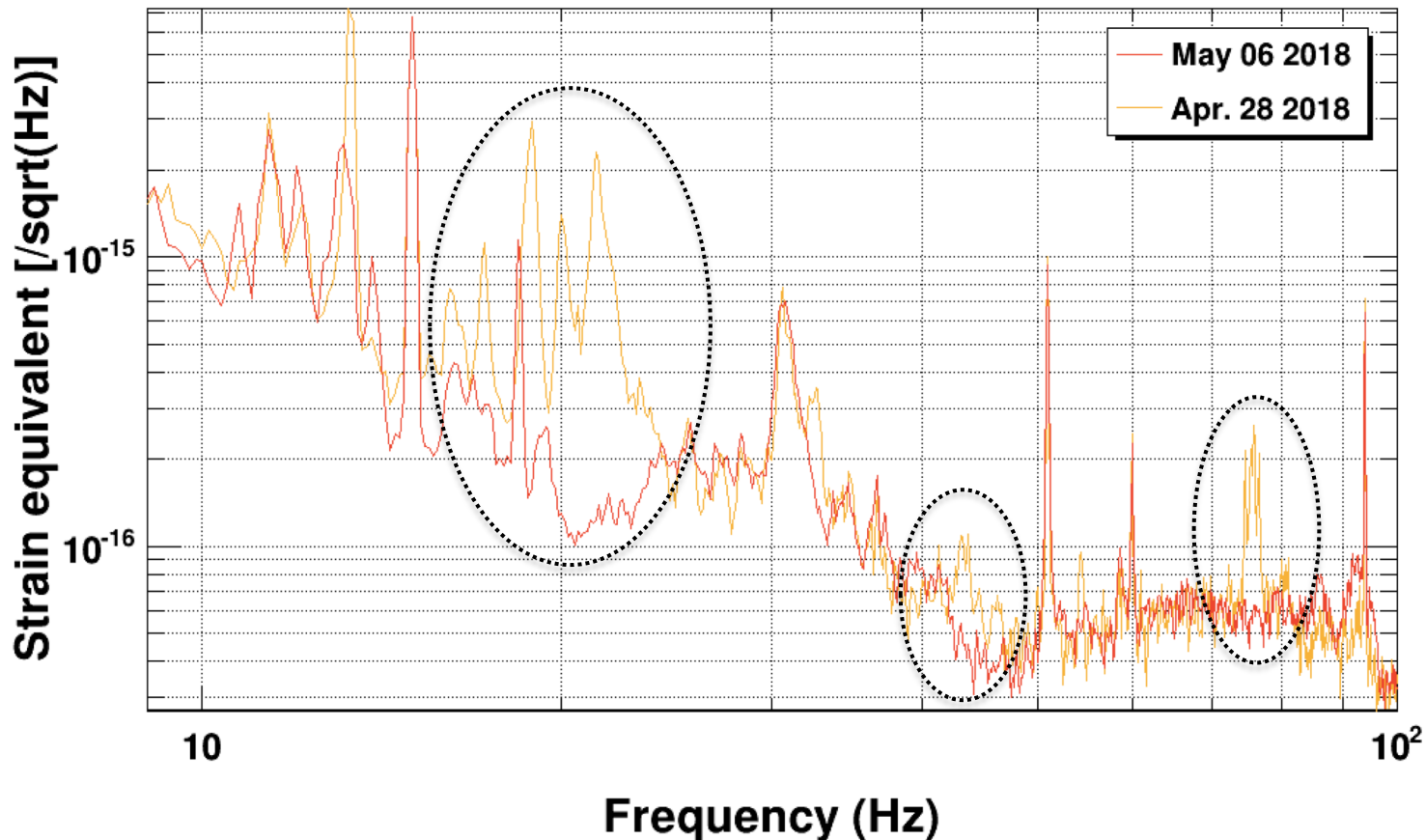


PEM related

- It turned out this noise has coherence with PR2 optical lever signal
- => we modified optical lever control loop of PR2

Strain $h(f)$

Some other structures also vanished thanks to this.



*T0=06/05/2018 03:01:00

*Avg=27

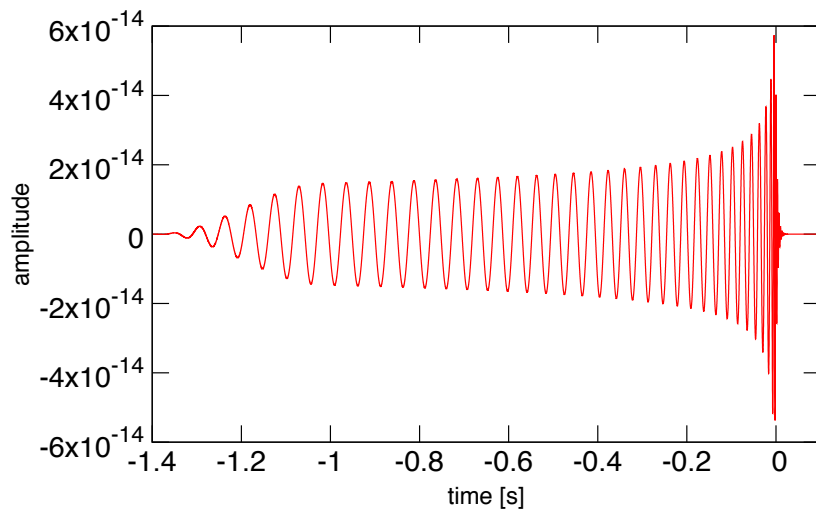
BW=0.187493

Hardware Injection Test

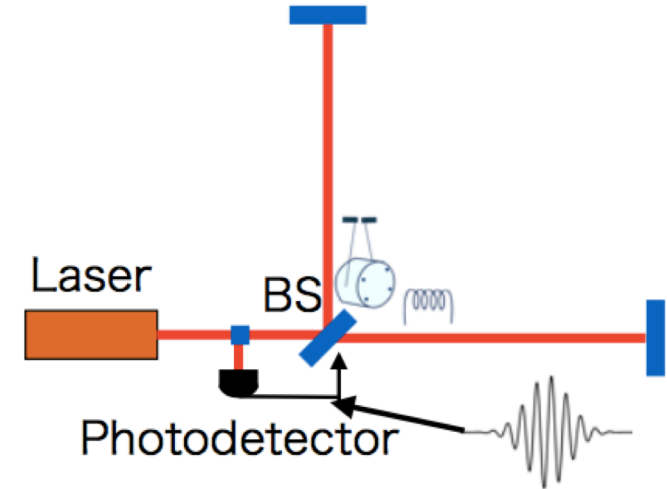
- Rehearsal for near future observation.
- Two types of waveforms were injected into feedback signal

* BBH CBC injection

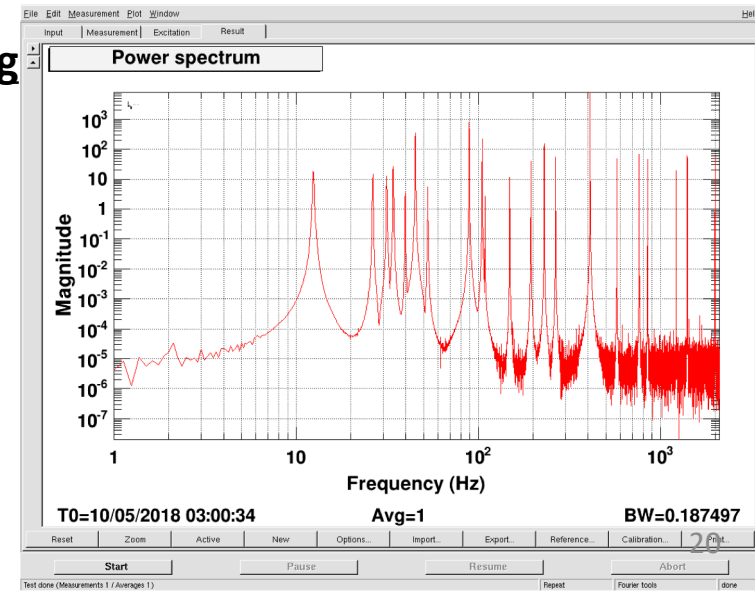
=> evaluate the effect of bias of detector response and calibration error on parameter estimation.



Analysis on going



* Continuous Wave injection



Summary

-- We recently had a so-called Phase 1 Operation.

→ Cryogenic Michelson was operated.

-- ETMY was successfully **cooled down to 20 K**

-- Cryogenic payload (test mass) was successfully actuated at cryogenic temperatures.

Issues around the payload was identified to some extent.

→ Identification and fixing are on-going toward the next step

-- Phase 1 has finished.

Installation and preparation for joining late O3 is NOW on-going.



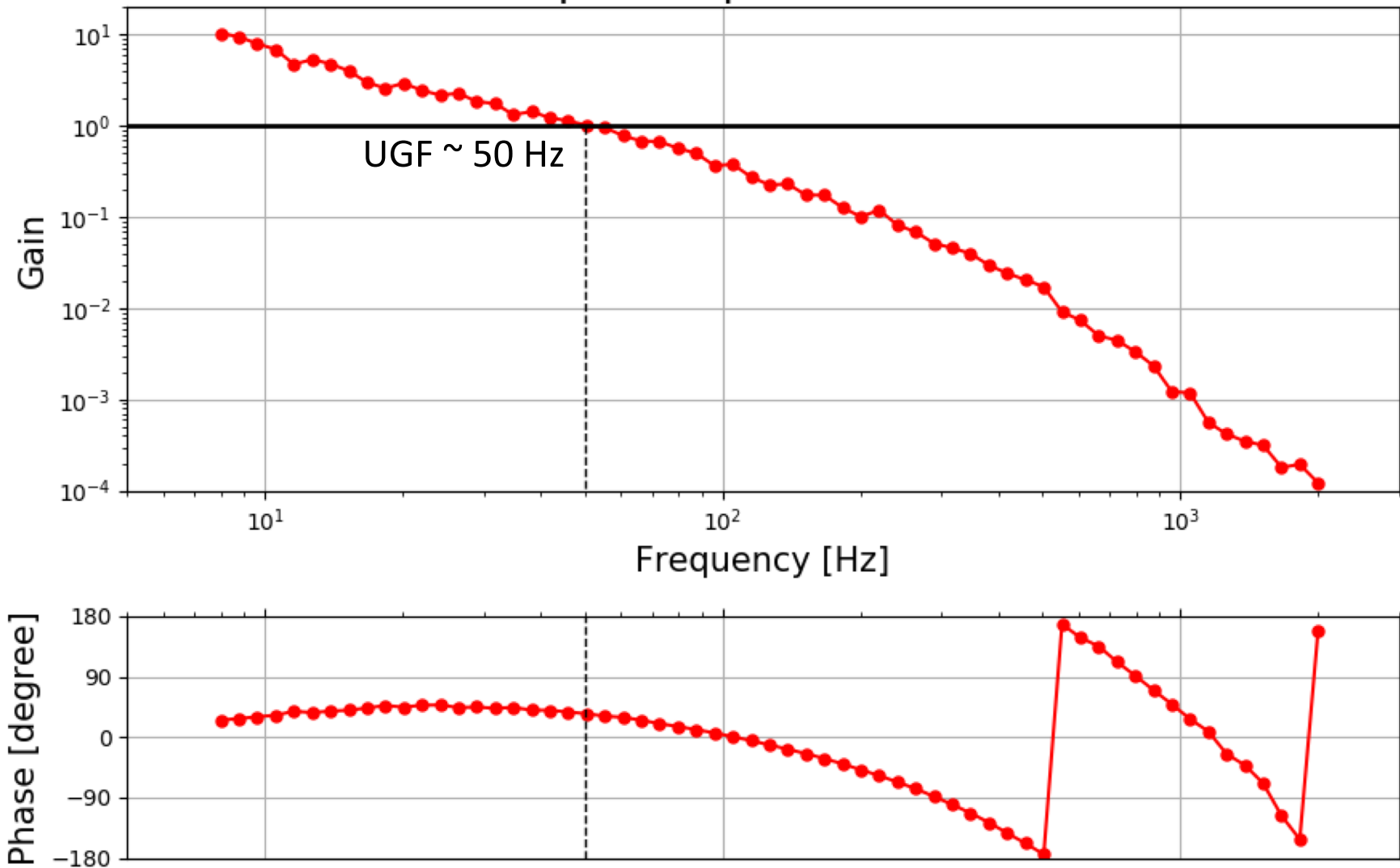
3-04-20
14:38:27 JST
8-04-20
05:38:27 UTC
Time
08237925

Thank you!

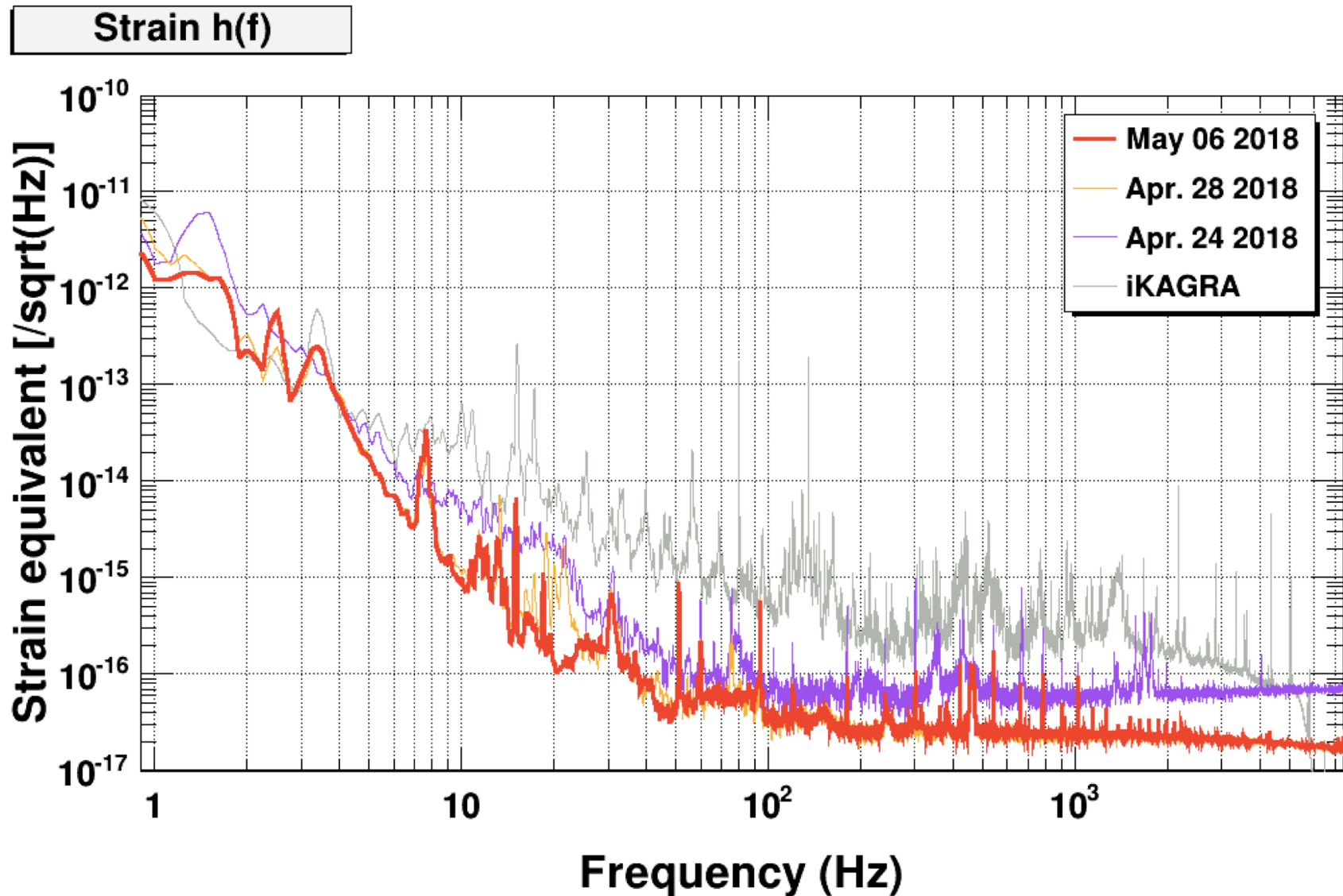
Phase 1 Overview

Open loop TF

Open loop TF of MICH



Noise curves



*T0=06/05/2018 03:01:00

*Avg=27/Bin=5L

BW=0.187493²⁴

Schnupp Asymmetry

→ intentional asymmetry in length of two arms of Michelson

-- I worked on this measurement as a main worker.

-- RF signal at REFL port of Michelson is:

$$P_{\omega_m} = \beta \sin [\omega_m (L_x - L_y)/c] \sin [2\omega_{\text{laser}} (L_x - L_y)/c] \times \cos \omega_m t$$

If you modulate the frequency,

$$\left. \frac{\partial P_{\omega_m}}{\partial \omega_{\text{laser}}} \right|_{\text{dark}} = \beta \sin [\omega_m (L_x - L_y)/c] \frac{2(L_x - L_y)}{c} \times \cos \omega_m t$$

-- We swung IMC length to modulate laser frequency, and looked at MICH signal.

-- We repeated the measurement three times

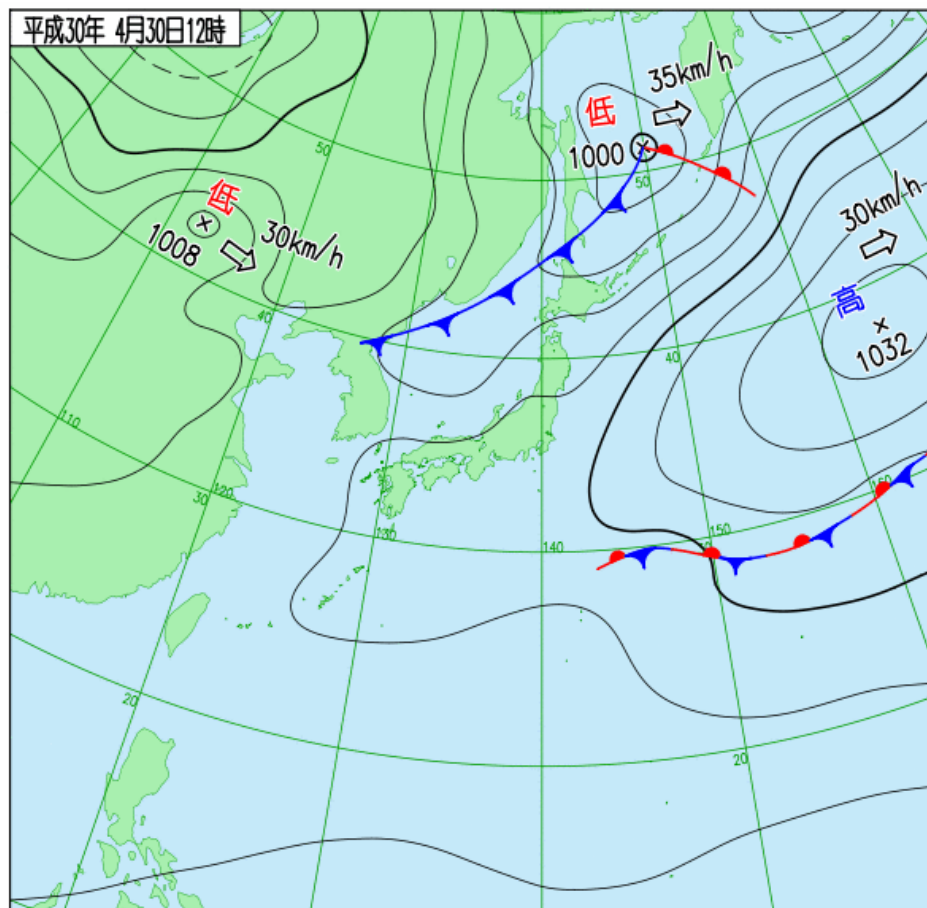
Results: 3.4(5) m, 4.5(7) m, 3.9(6) m (Design: 3.3298 m)

=> not very successful...

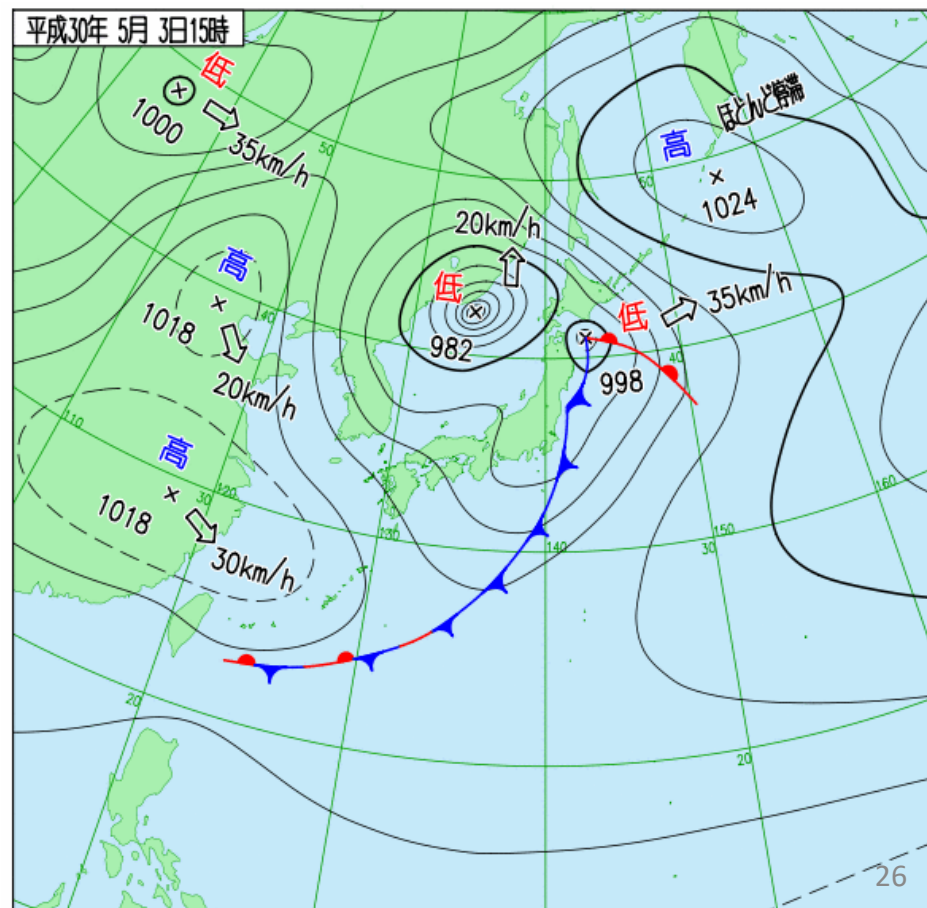
What I Learned

Micro-Seismic Noise

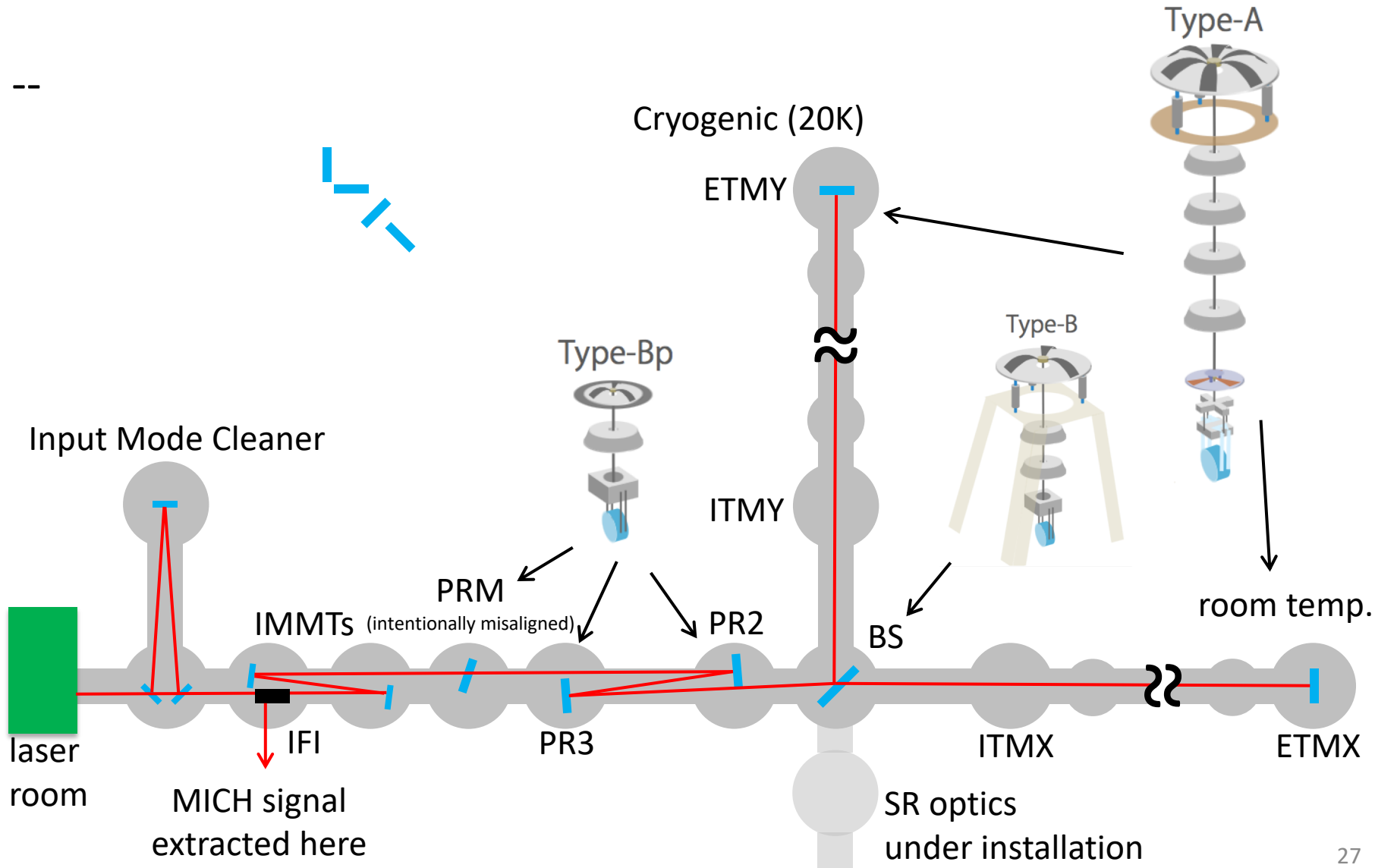
Quiet case



Noisy case



Interferometer configuration



Cooling down ETMY

Cooling Curve of ETMY

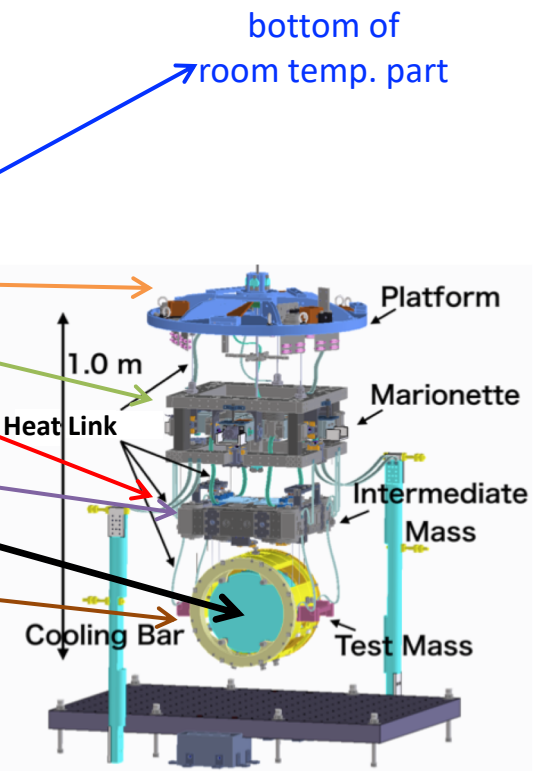
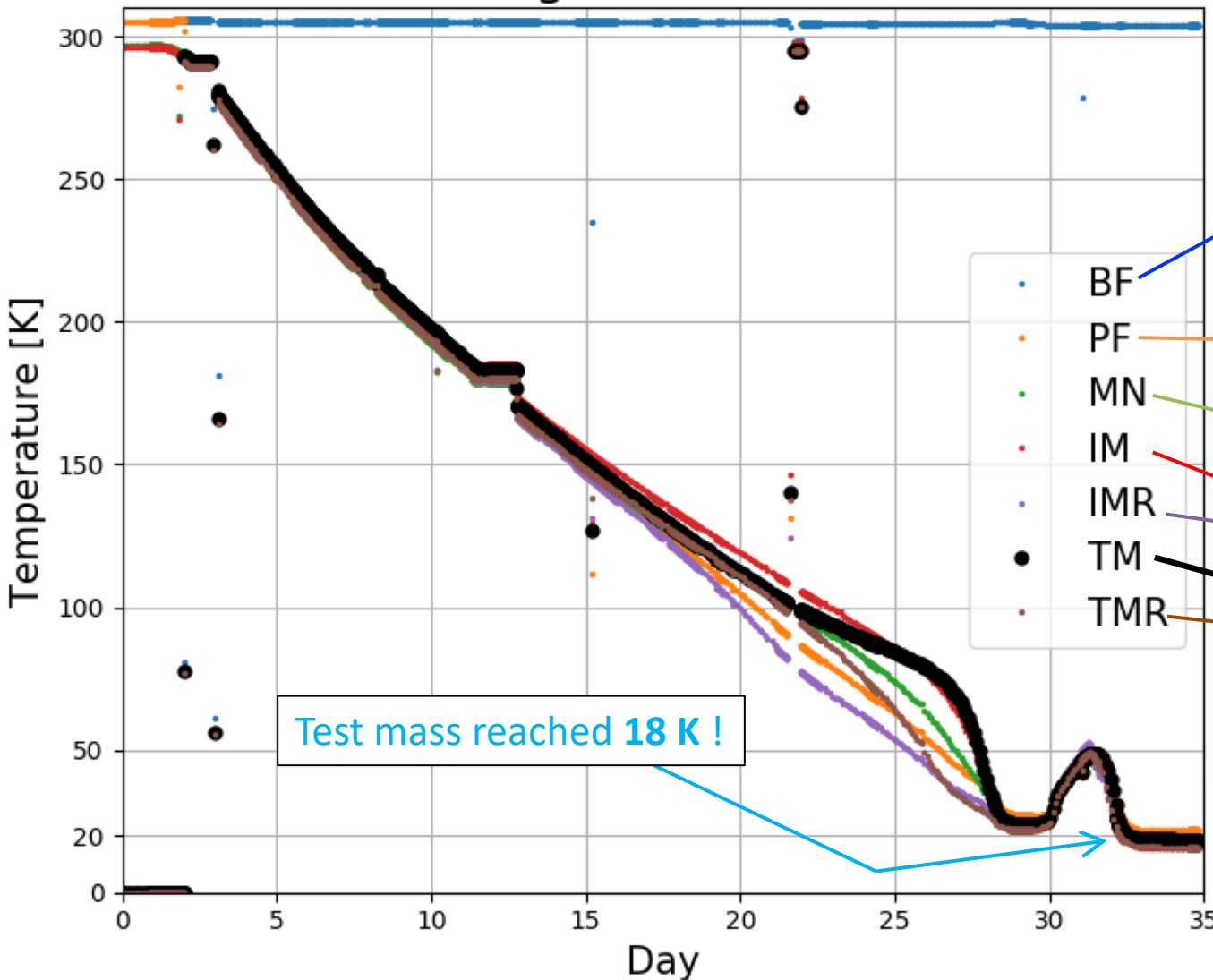
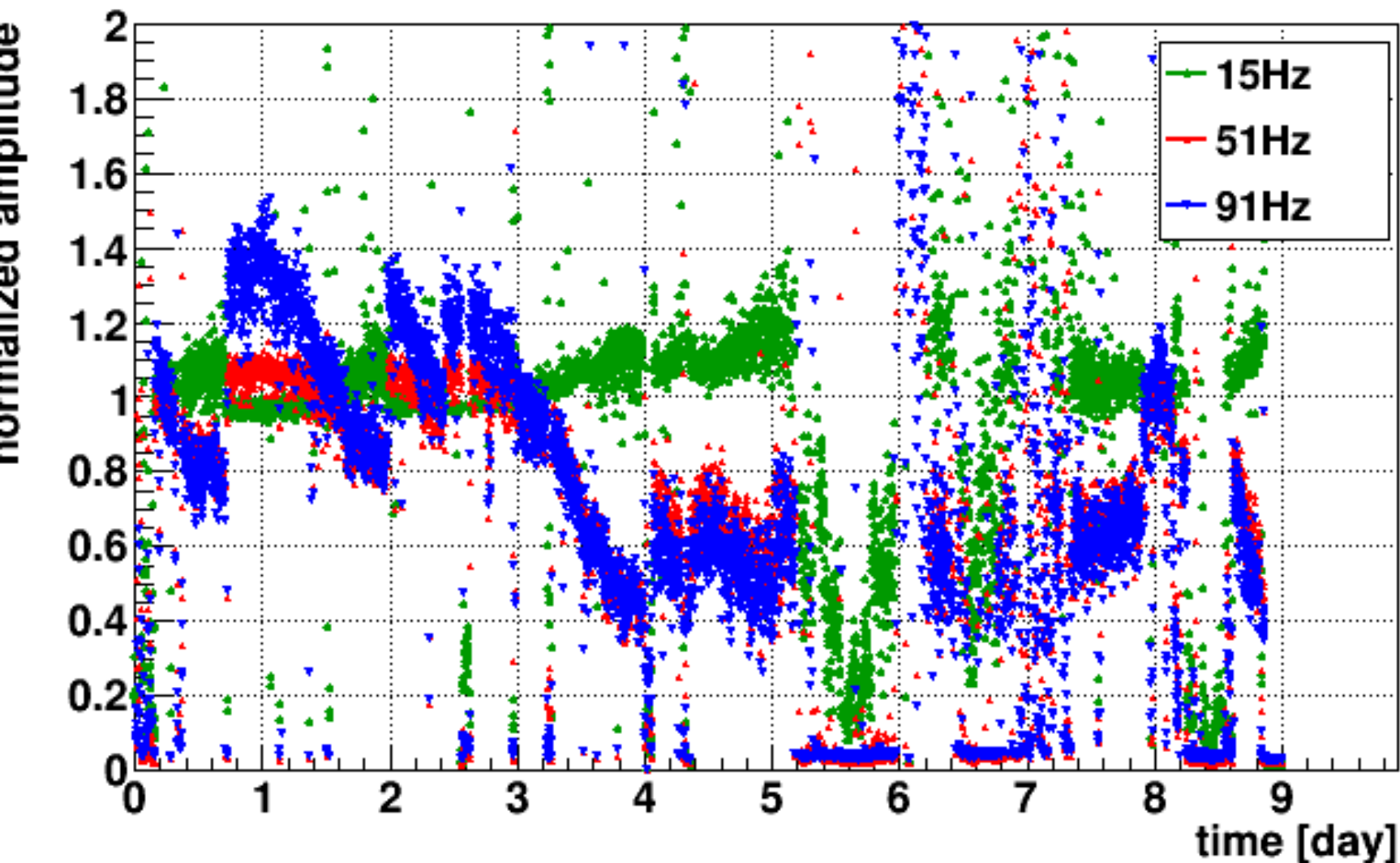


Figure of payload from JGW-G1807766-v5

Operation Status

CAL line

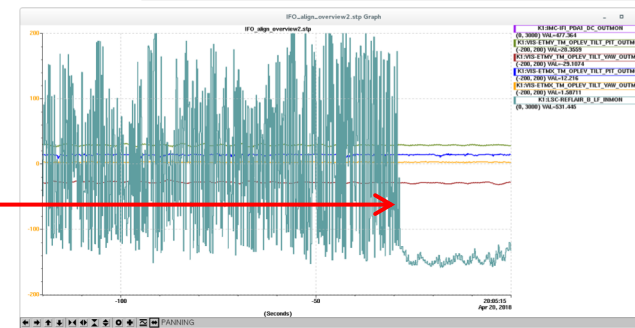
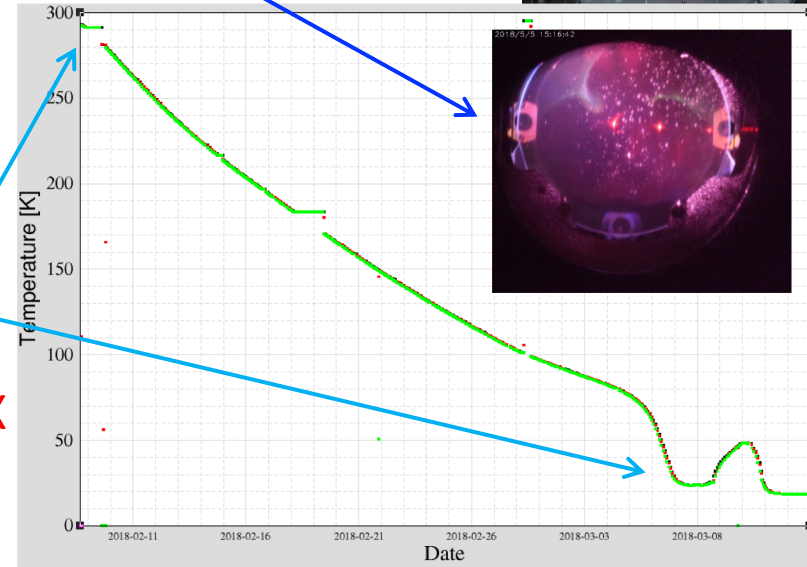
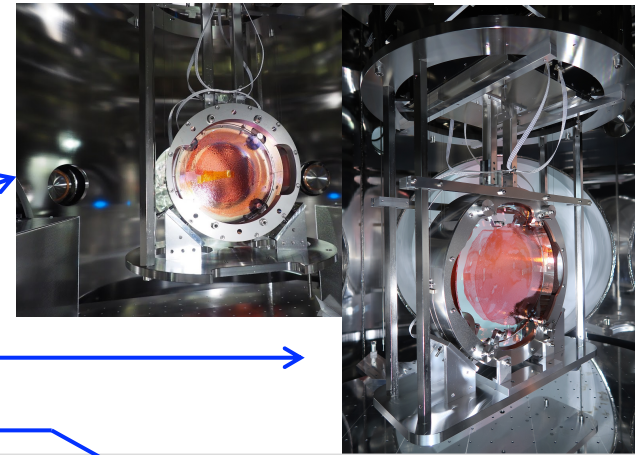


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