

Summary of the iKAGRA Run

Yuta Michimura

Department of Physics, University of Tokyo

based on [JGW-T1605101](#), [JGW-T165177](#) by Y. Michimura

[JGW-G1605294](#) by S. Kawamura

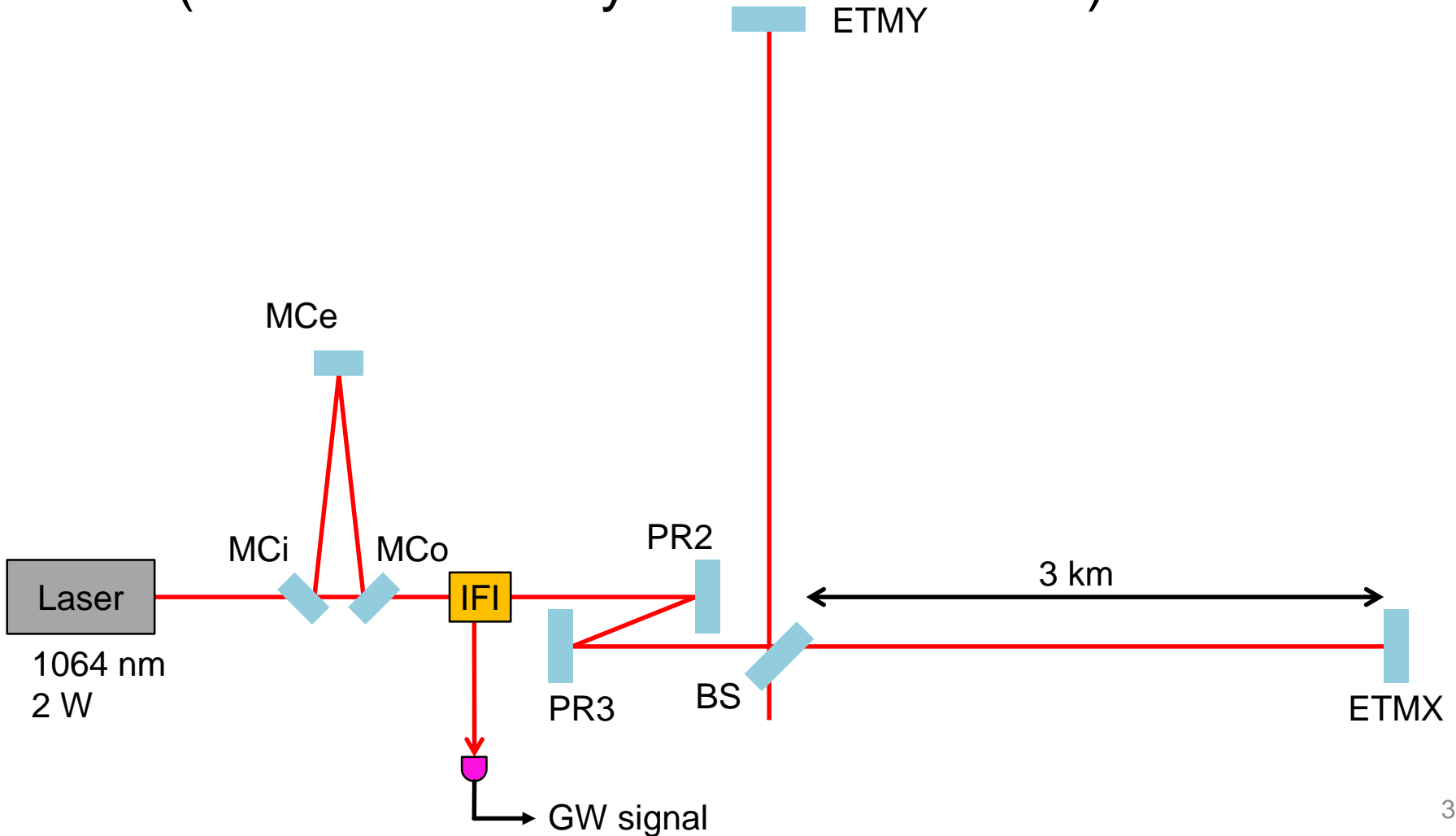
[JGW-G1605296](#) by K. Kokeyama

iKAGRA Test Run

- Period
 - 1st run: Mar 25 9:00 - Mar 31 17:00 (JST)
 - commissioning break
 - sensitivity and stability improvement
 - 2nd run: Apr 11 9:00 - Apr 25 17:00 (JST)
- Purpose
 - confirm the layout of the vacuum tanks
 - test control system, data acquisition/transfer/management, observation shift
 - get environmental data
 - obtain experiences of the management and operation of the km-class interferometer

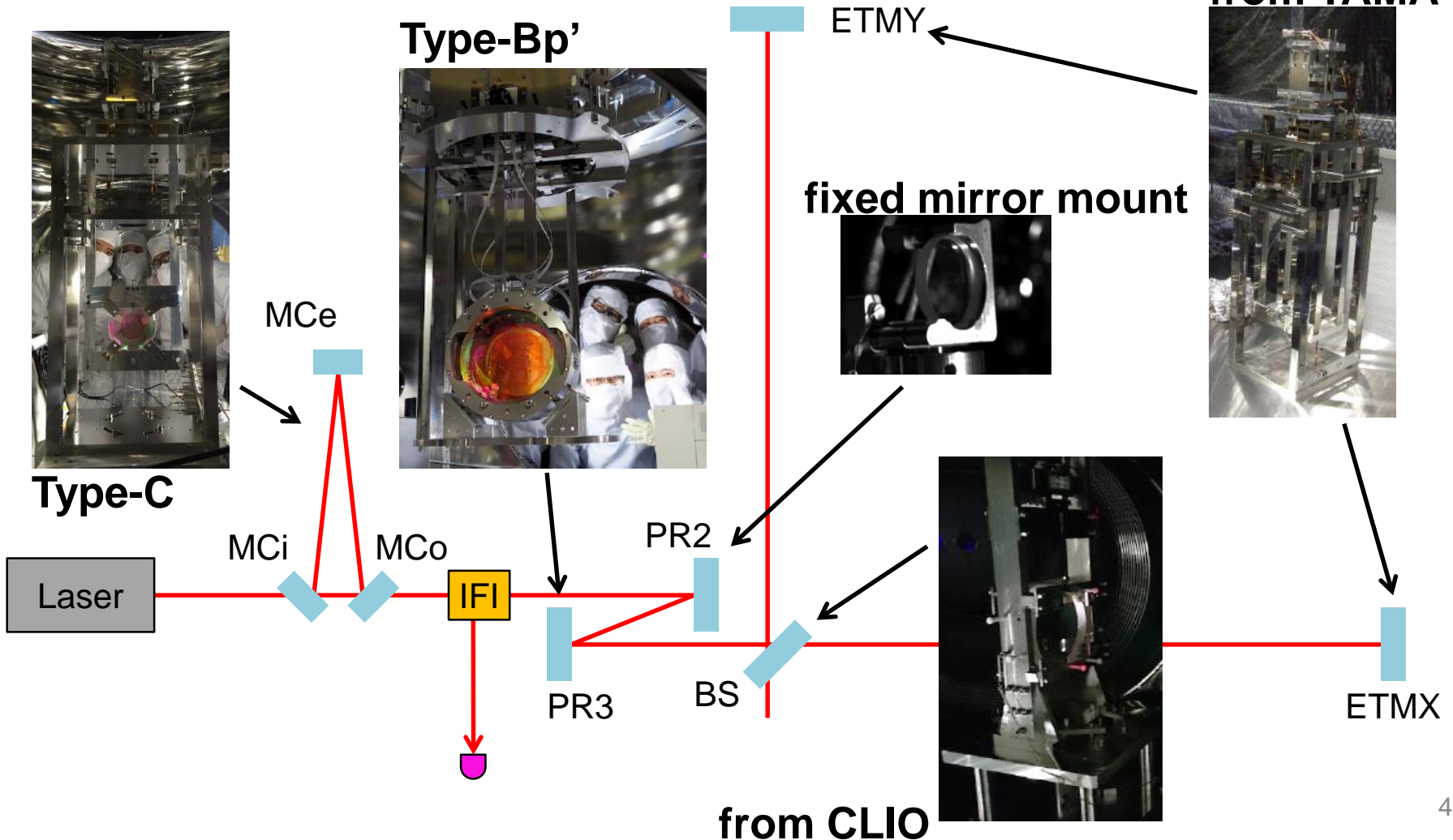
Configuration

- 3-km Michelson interferometer
(instead of Fabry-Perot Michelson)



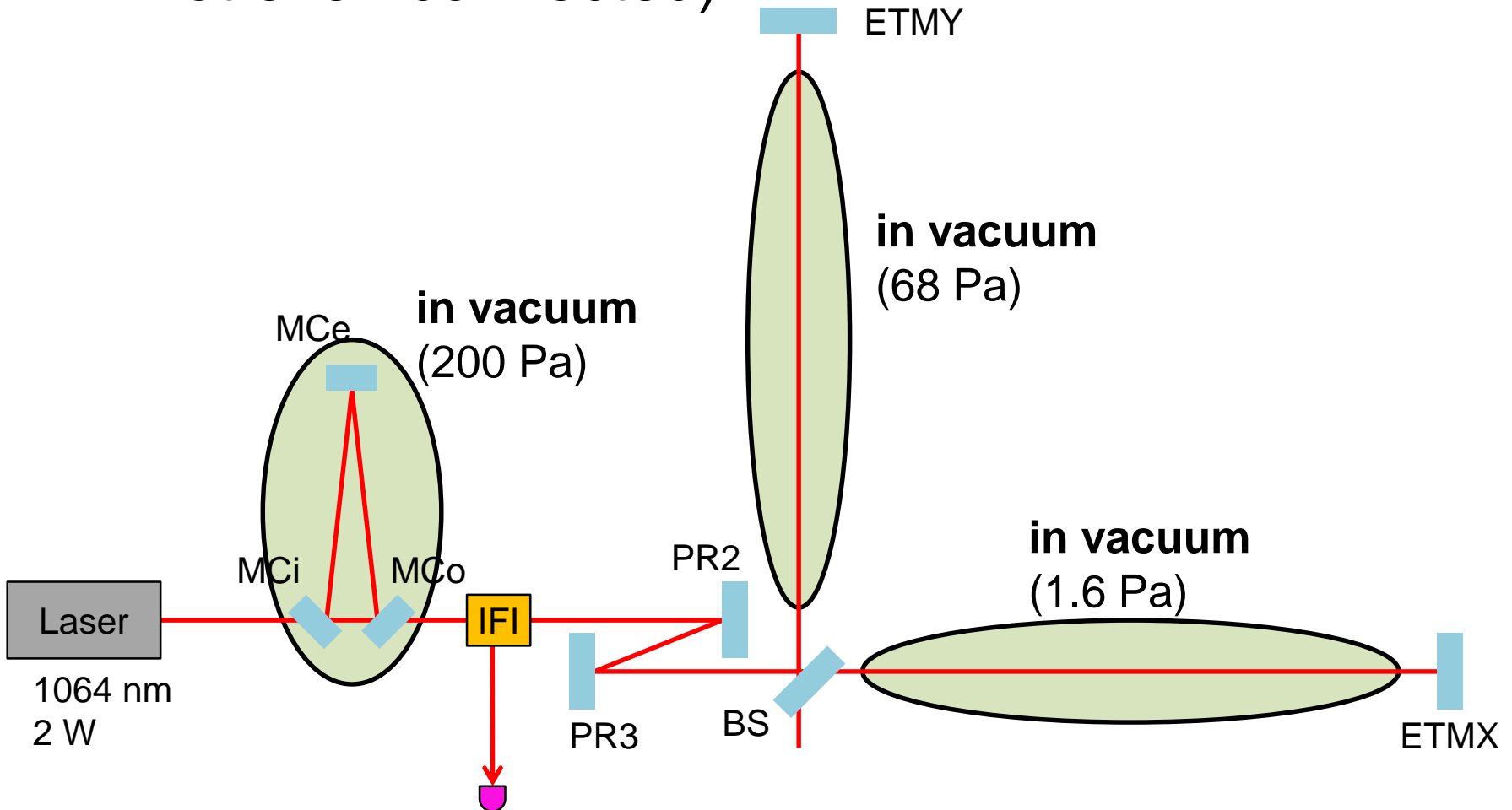
Simplified Suspensions

- most of the suspensions were simplified/replaced to meet the deadline



Vacuum

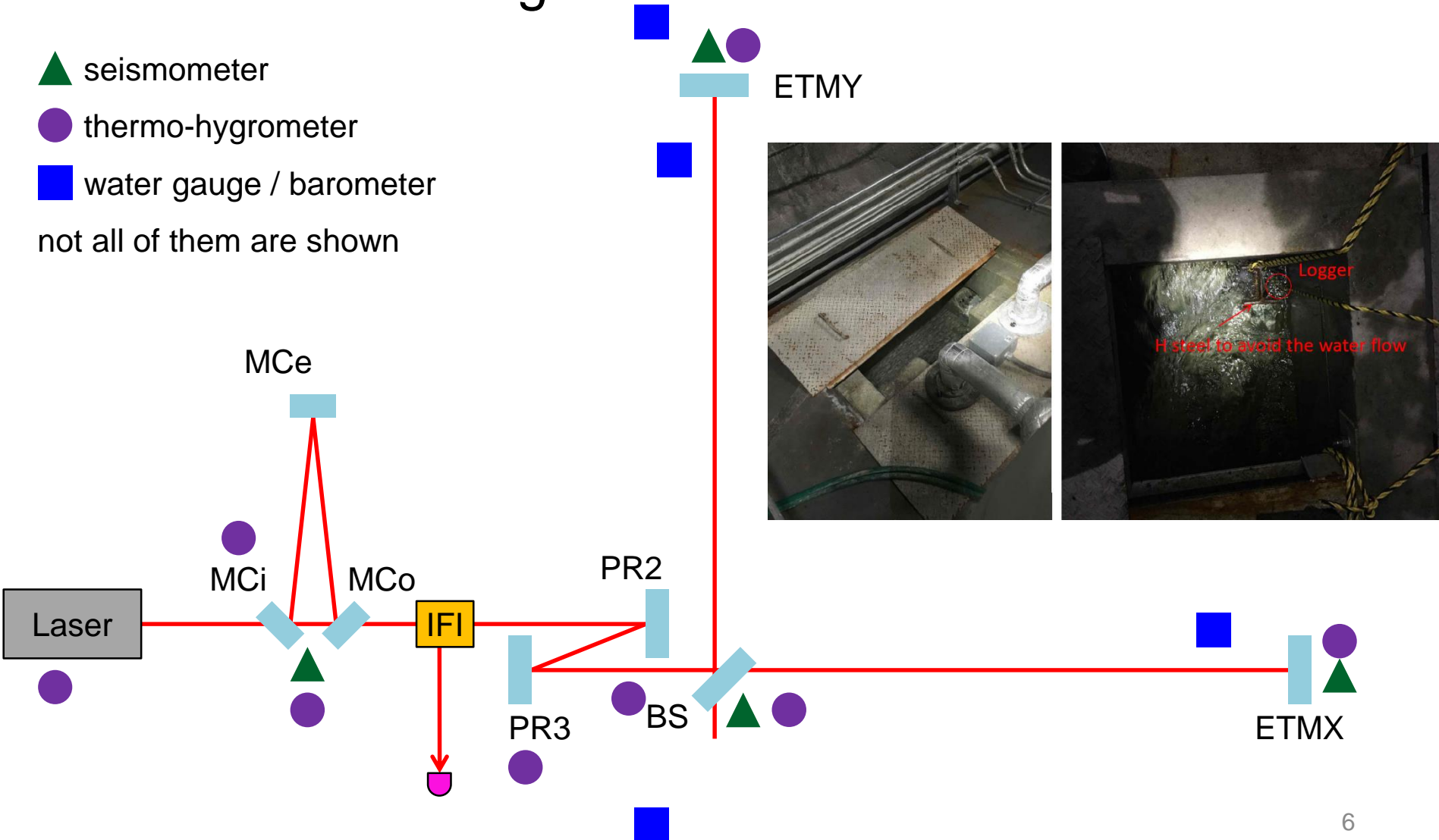
- central part and both ends were at air (PR2-BS was not even connected)



Environmental Sensors

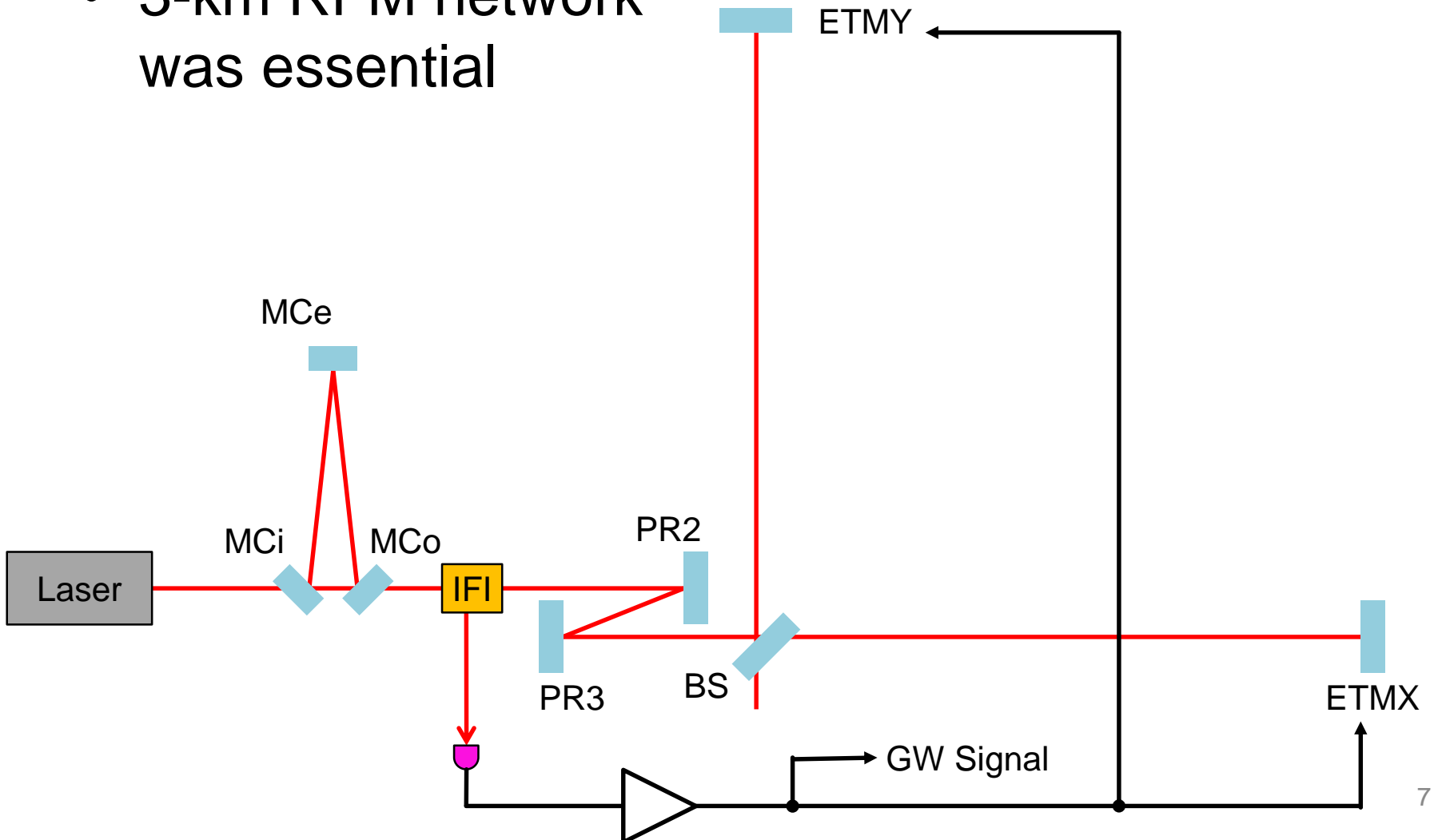
- for noise hunting and Newtonian noise estimation

▲ seismometer
● thermo-hygrometer
■ water gauge / barometer
not all of them are shown



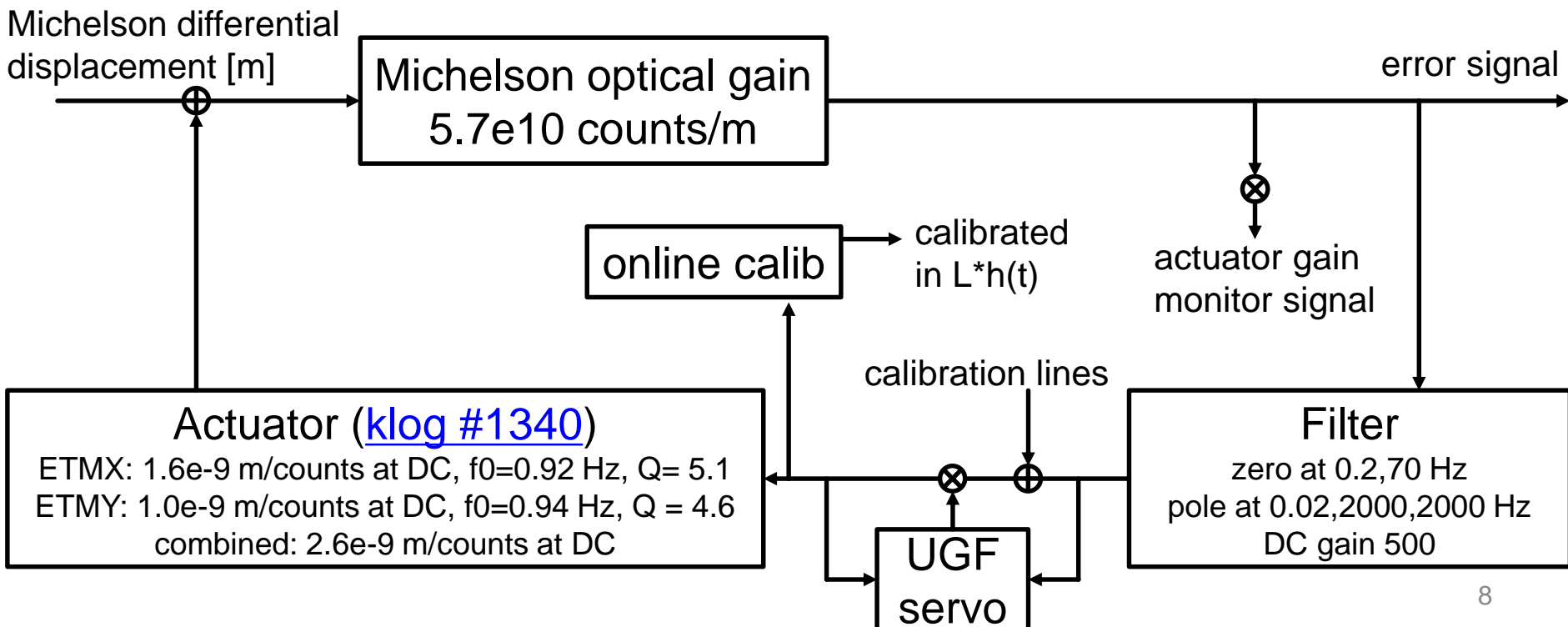
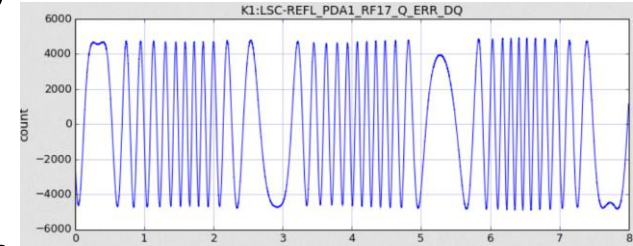
Controls and Readout

- reflection port for sensing, ETMs for actuation
- 3-km RFM network was essential



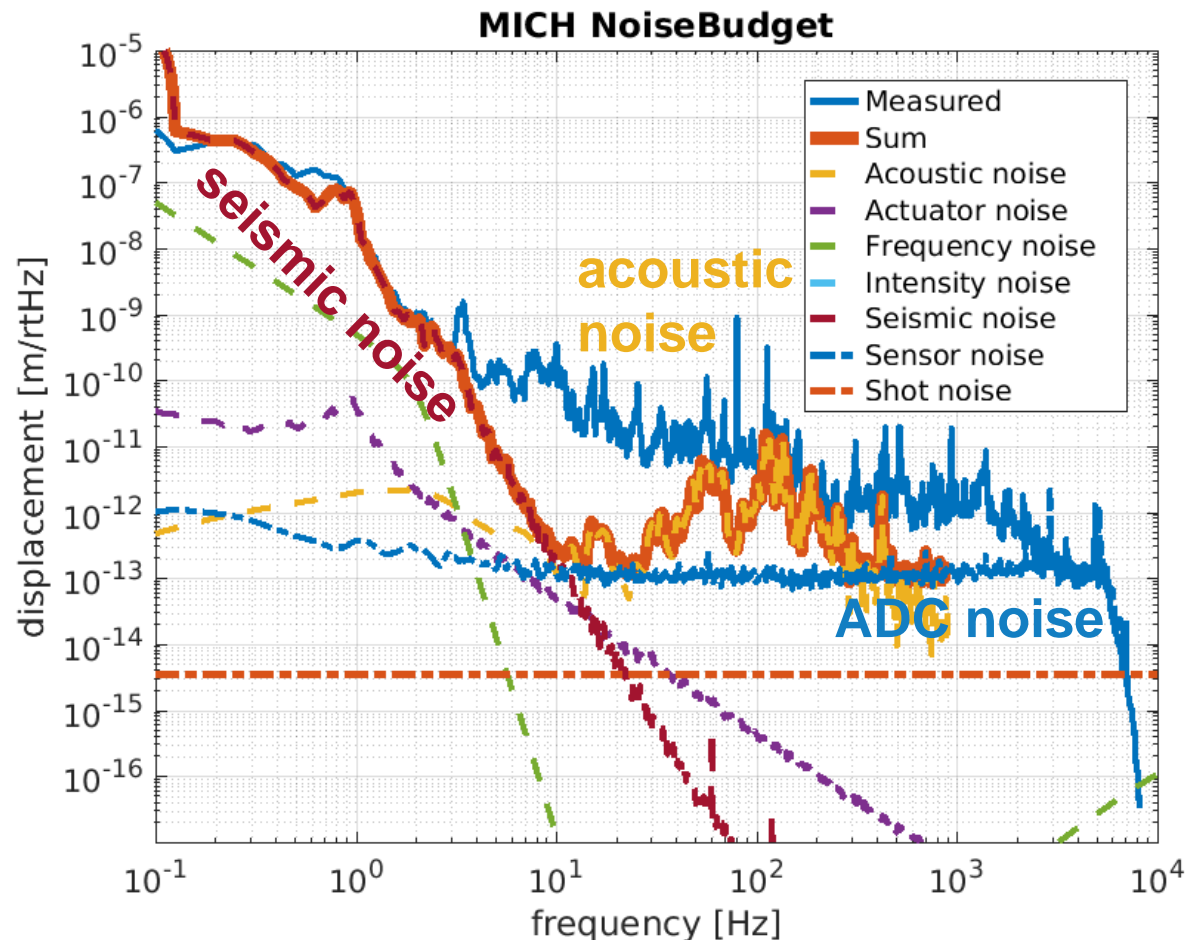
Calibration

- optical gain calibration using fringes
- actuator calibration by transfer function measurements
- calibration lines to monitor TF drift



Sensitivity

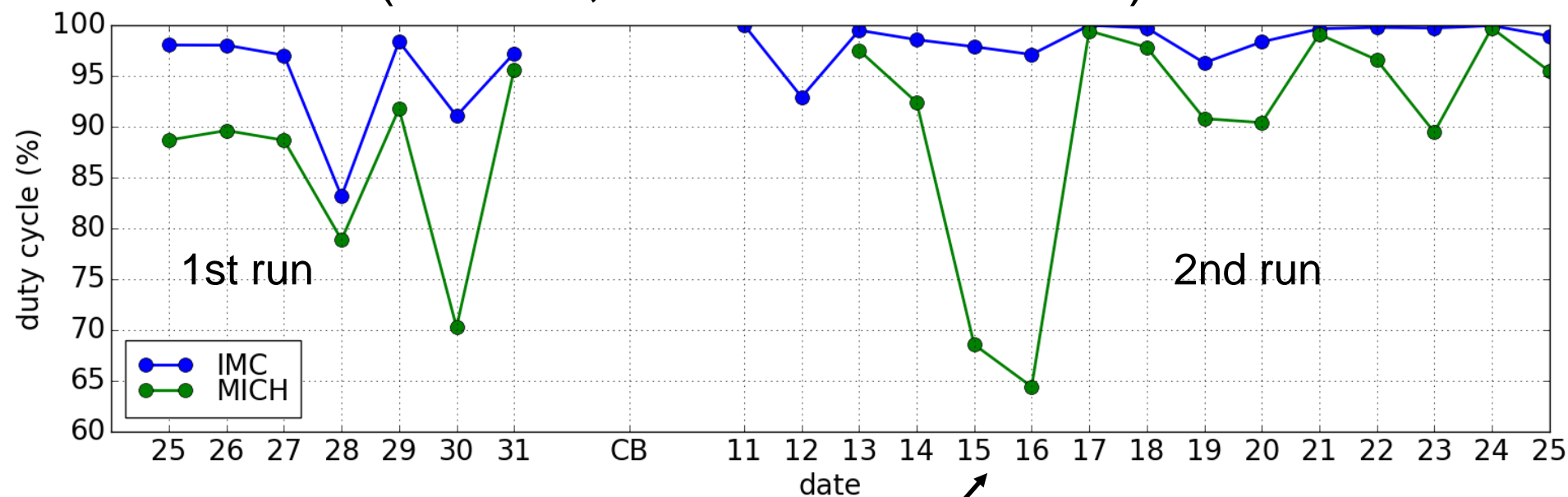
- limited by **seismic noise** below ~4 Hz, **acoustic/fan noise** at around 100 Hz, **ADC noise** above ~3 kHz
- $\sim 3\text{e-}15$ /rtHz @ 100 Hz
- ~ 4.2 pc for 1.4M-1.4M NS-NS (0.77 pc for 1st run)



plot by T. Shimoda, M. Nakano, Y. Michimura

Duty Factor and Longest Lock

- 1st run: 85.2 %, 3.6 hours
(94.4 %, 12 hours for IMC)
- 2nd run: 90.4 %, 21.3 hours
(98.5 %, 23.5 hours for IMC)



Kumamoto Earthquake,
BS went wrong

data processing by S. Mano
plot by Y. Michimura

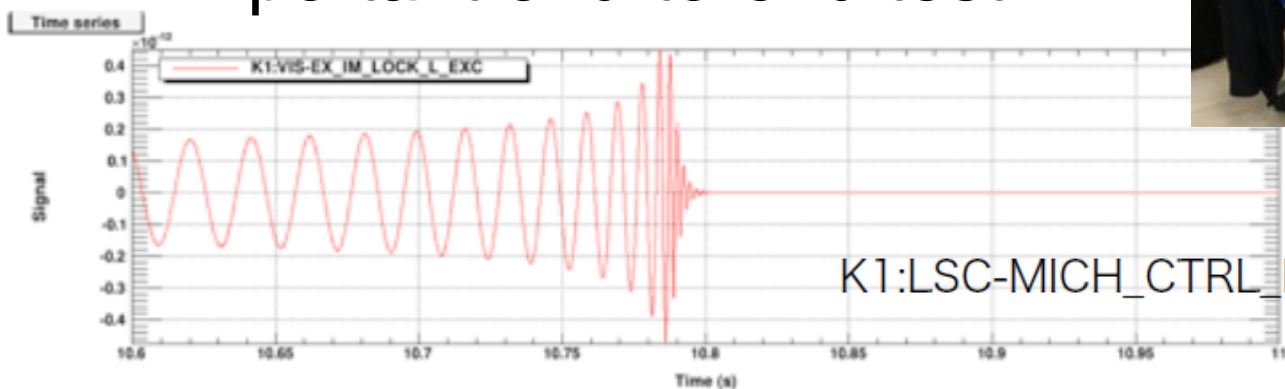
Data Management

- real time transfer to **ICRR Kashiwa** and **Osaka City Univ.**
(~3 sec latency, ~ 200 MB/sec)
- delayed mirroring at **Academia Sinica, Taiwan** and **KISTI, Daejeon**
- 7.5 TB in total



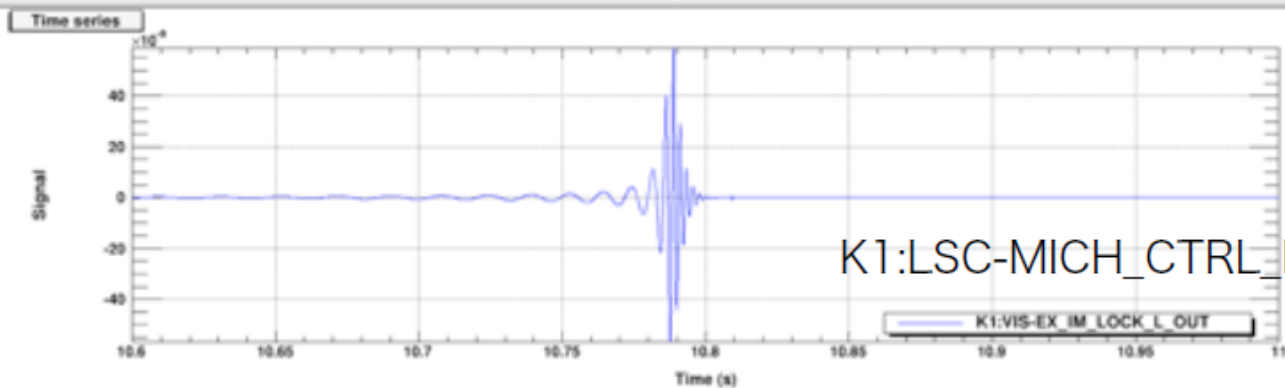
Hardware Injection

- right after 2nd iKAGRA run
- gravitational waveforms of CBC, Supernovae, etc.
- important end-to-end test



TD=21.04.2016 06:32:45

Avg=1

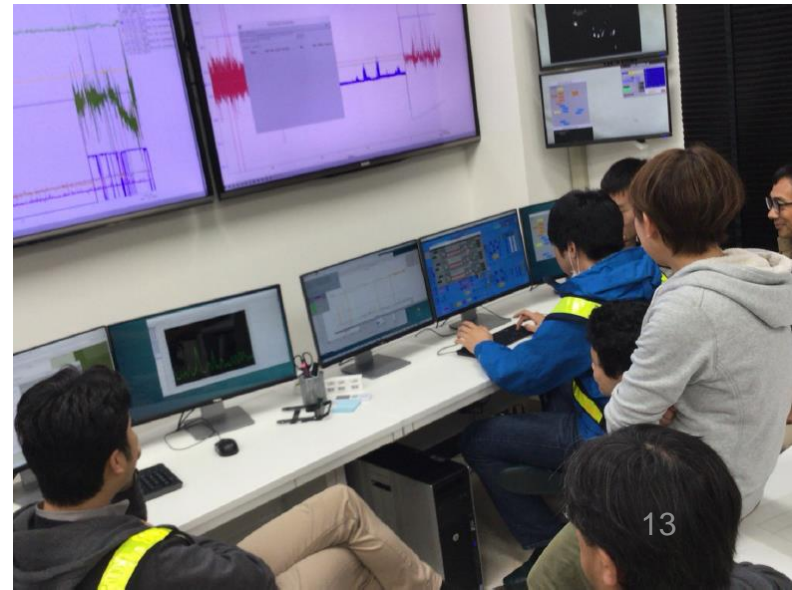


TD=21.04.2016 06:32:45

Avg=1

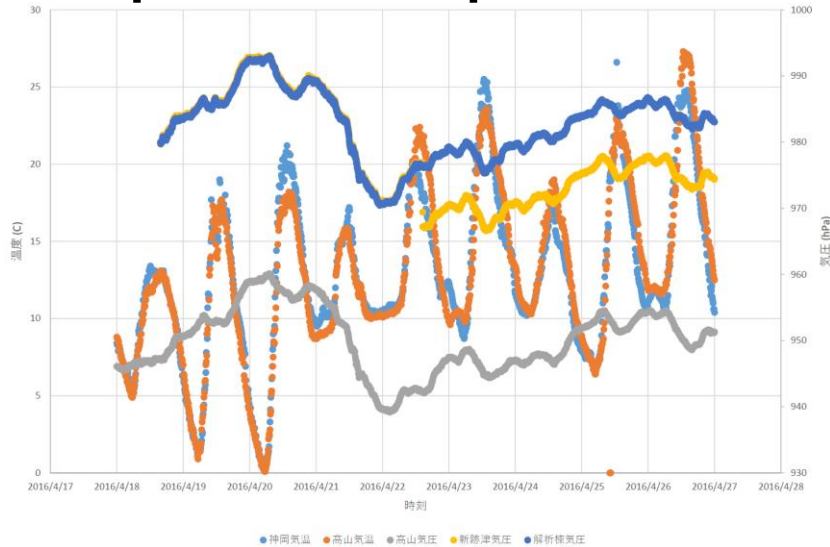
Good Findings

- The beam went back and forth the 3-km X/Y arms
 - Acquired tidal and environmental sensors data
 - Type-Bp' was stable enough for 3-km Michelson
 - Controlled the ETMs via 3-km RFM network
 - Observation shift worked well without big trouble
 - Data management also worked very well
-
- Many people enjoyed the integration, commissioning, and operation of the large scale interferometer (with some struggle)

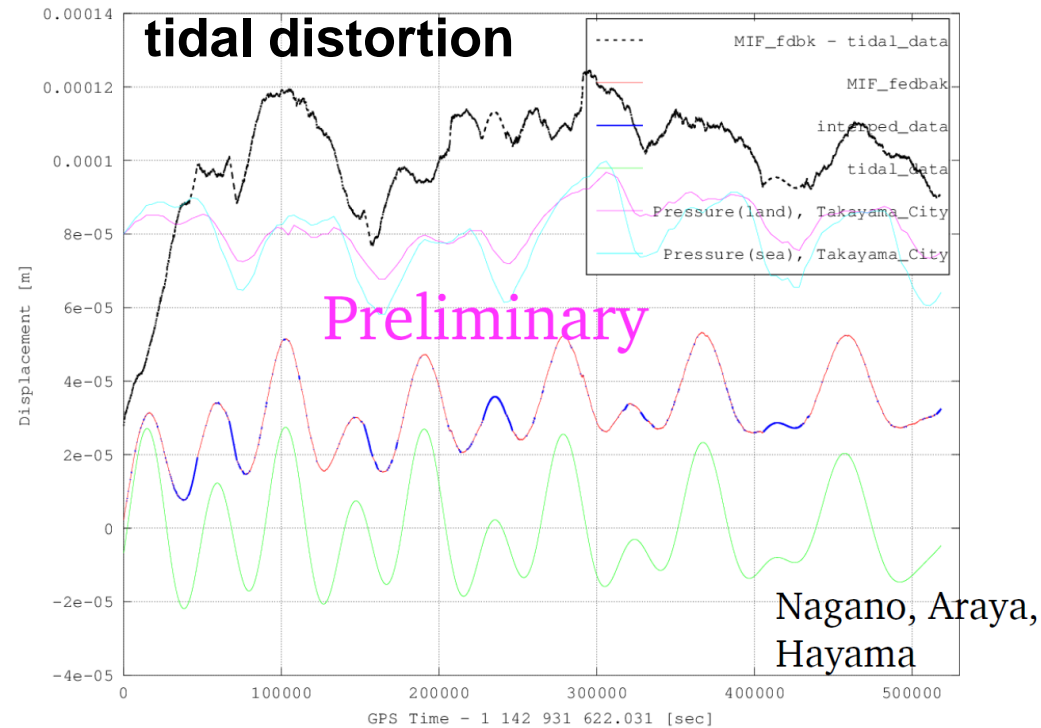


Environmental Data

temperature / air pressure



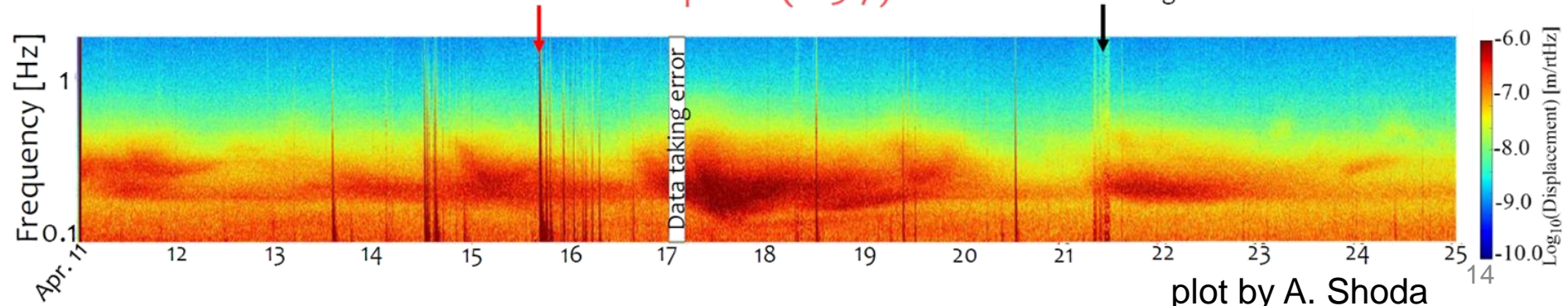
plot by Y. Shikano



seismic stability

Kumamoto earthquake (M5.7)

Data taking error



Lessons Learned

- Simple mistakes could happen
 - Careful preparation and planning is important
 - Careful instrumentation is also important (no more loose cables and screws/bolts)
 - Lack of documents / drawings and communication caused troubles
 - More effort on safety needed
- extended chief meetings
schedule tracking scheme
better infrastructure to share drawings
safety review



After the Run

- post-run calibration, transfer function, ADC/DAC and RFM time delay measurements
- saved and summarized the IFO parameters
- data processing for analysis and detchar
 - data correction
 - offline calibration
 - search for GW signals
 - Newtonian noise estimation etc...
 - still work in progress
- publication plan?

Summary

- iKAGRA Run was successful
- We had a lot of downgrades to meet the deadline
- Acquired useful data for bKAGRA
- Obtained precious lessons for bKAGRA
- Data processing and characterization still on going