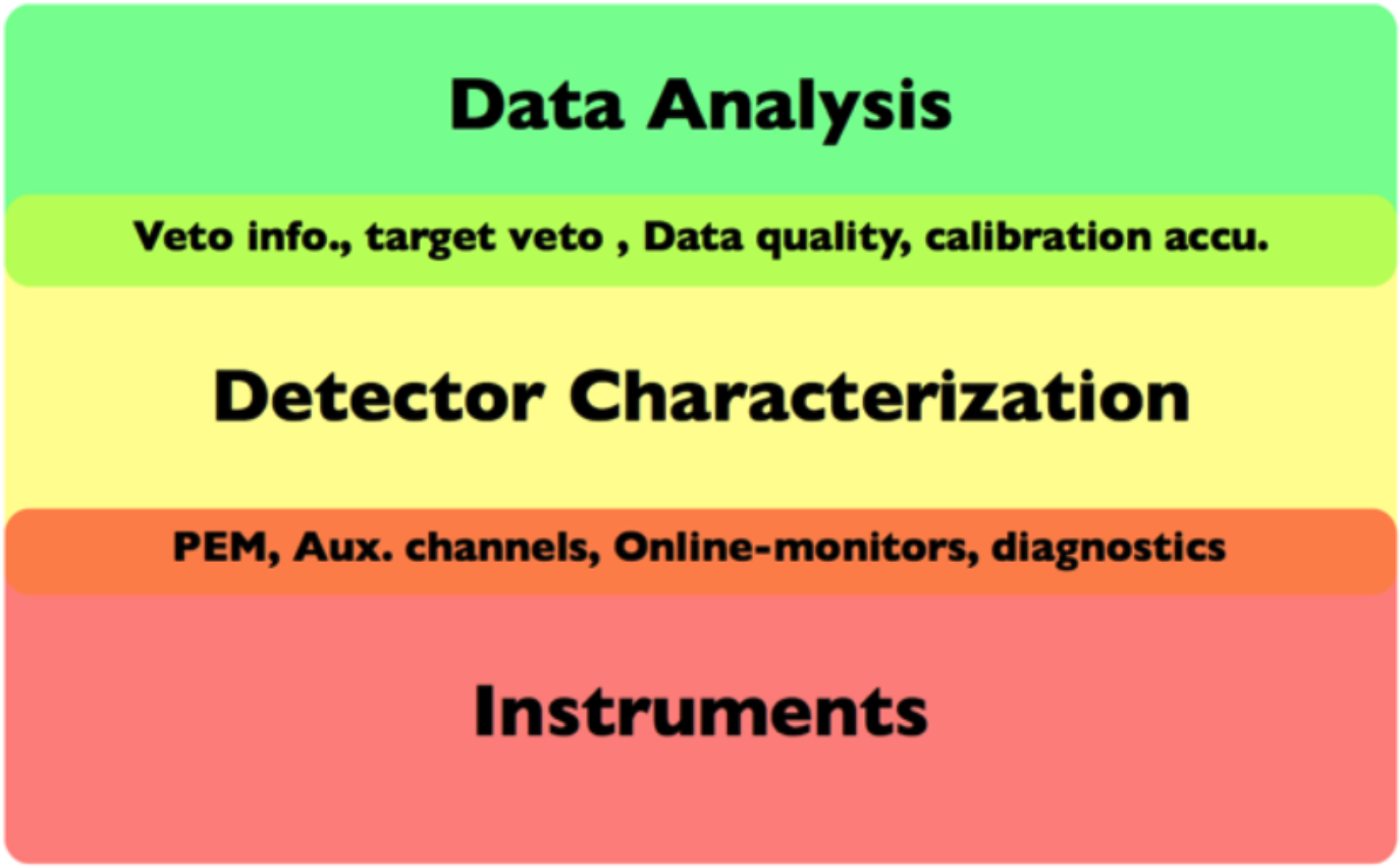
Status of KAGRA detector characterization

Kazuhiro Hayama (ICRR)

On behalf of KAGRA collaboration

Interface


Data Analysis
Veto info., target veto , Data quality, calibration accu.
Detector Characterization
PEM, Aux. channels, Online-monitors, diagnostics
Instruments

Scope

For Detector side

- Detector Diagnostics
  - Supports of subsystems
  - Help noise hunting
  - Development of characterization tools
  - Daily summary monitor
  - Monitoring Environment around KAGRA

For Data analysis side

- Data quality information
- Veto analysis with DAS

iKAGRA run

Tools running during iKAGRA

KAGRA Detector Characterization

Daily Summary Page

Web-Based Tools

Characterization of GW150914

Powered by HasKAL

DetChar Tools

Non-Stationarity

- Glitch Monitor

Line

- Line Finder
- Line Tracking
- Line Removal

Gaussianity

- Rayleigh Monitor
- Non-Gaussianity Monitor
- RMS Monitor
- Noise Floor Monitor

T.Yamamoto+ PRD (2016)

Time-Series

- Time-Series Monitor

Spectrum

- Spectrum Monitor
- Spectrogram Monitor

GW Range

- Sensitivity Monitor
- Range Monitor
  - Inspiral
  - Inspiral-Merger-Ringdown
  - Ringdown
  - Stochastic

Correlation

- Coherence Finder
- Multiple-channel coherence finder (BruCo)
- Pearson correlation Finder
- NonLinear correlation Finder

H.Yuzurihara+ PRD (2016)

- Realtime Quick look webpage

User Interface

- Daily summary webpage
- GUI Interface
- Web-Base Interface
- Command-line Interface

System Health

- Health monitor
- File Finder (New)
- Globally Correlated magnetic no
- Violin mode
- Multi-channel analysis
- Newtonian noise
  - Effect of water inside the mountain

Daily Summary Monitors in iKAGRA

General | MIF | VIS | IOO | ENV | Bruco | Web Tools

Calendar

Jun. 2016

Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Su
		1	2	3	4	
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

May 2016

Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Su
2	3	4	5	6	7	
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

Apr. 2016

Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Su
				1	2	
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

Mar. 2016

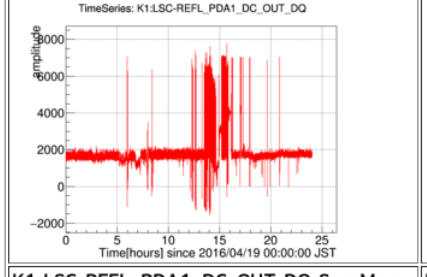
Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Su
	1	2	3	4	5	
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

Feb. 2016

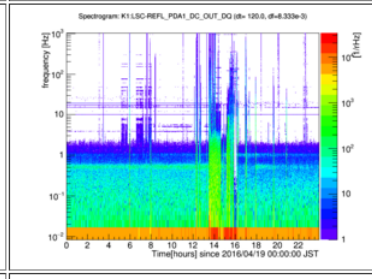
Local Date:
2016-04-19
Layout:
- Channel Order
- Monitor Order

K1:LSC-REFL_PDA1_DC_OUT_DQ

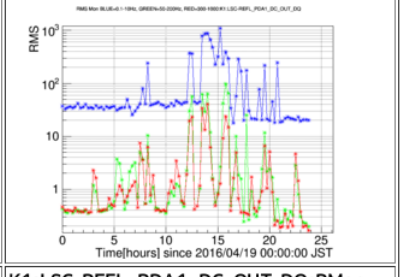
K1:LSC-REFL_PDA1_DC_OUT_DQ:TimeSeries



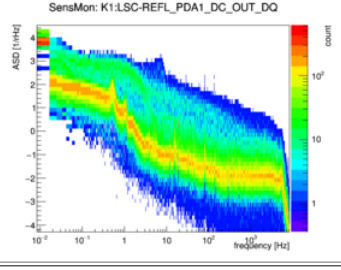
K1:LSC-REFL_PDA1_DC_OUT_DQ:Spectrogram



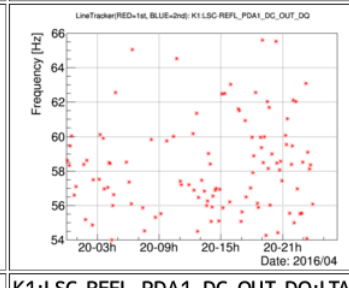
K1:LSC-REFL_PDA1_DC_OUT_DQ:RMSMon



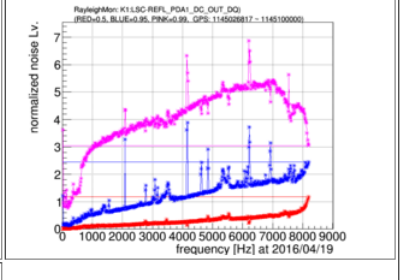
K1:LSC-REFL_PDA1_DC_OUT_DQ:SensMon



K1:LSC-REFL_PDA1_DC_OUT_DQ:LTF



K1:LSC-REFL_PDA1_DC_OUT_DQ:RMon



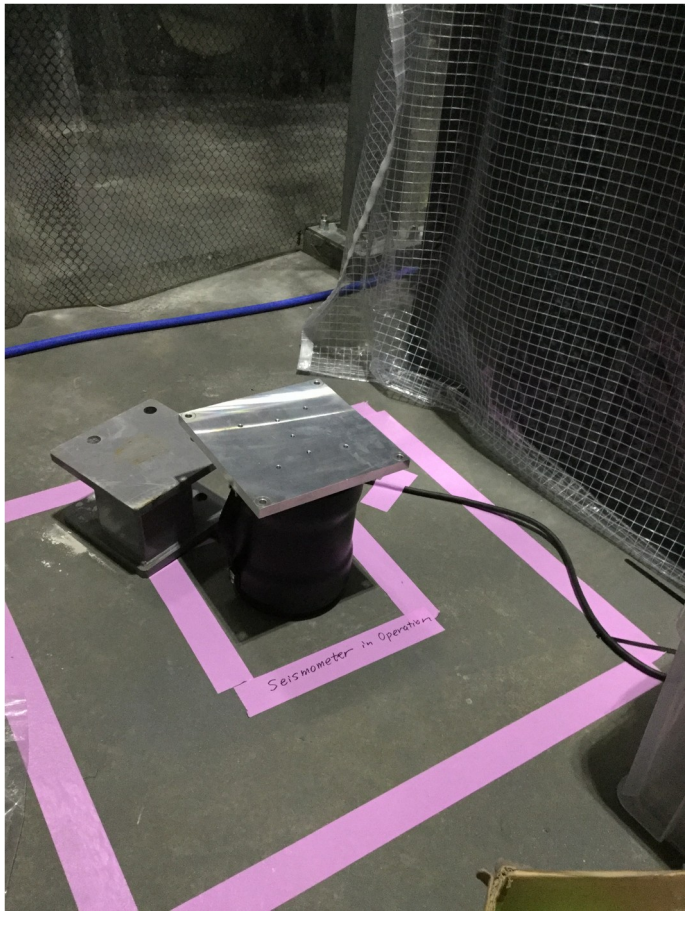
K1:LSC-REFL_PDA1_DC_OUT_DQ:SRMon

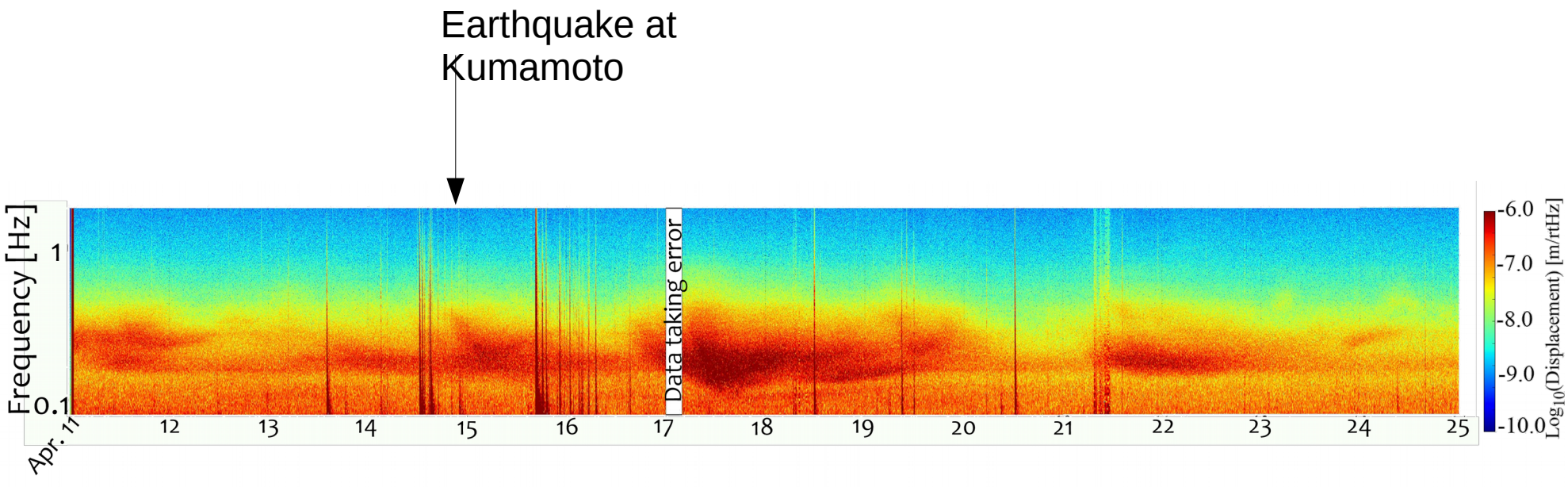
K1:LSC-REFL_PDA1_DC_OUT_DQ:LTA

- **Monitored 43 channels (almost 50 channels)**
- **Daily Summary Page was basically running correctly, but failed for several days.**
  - **In case some data is not normal (NAN), this can happen**
- **Computation time growin**
- **Poor documentation.**
- **Need some bootcamp**

Environmental Monitors in iKAGRA

- **Seismoneters at Center, X-end,Y-end**



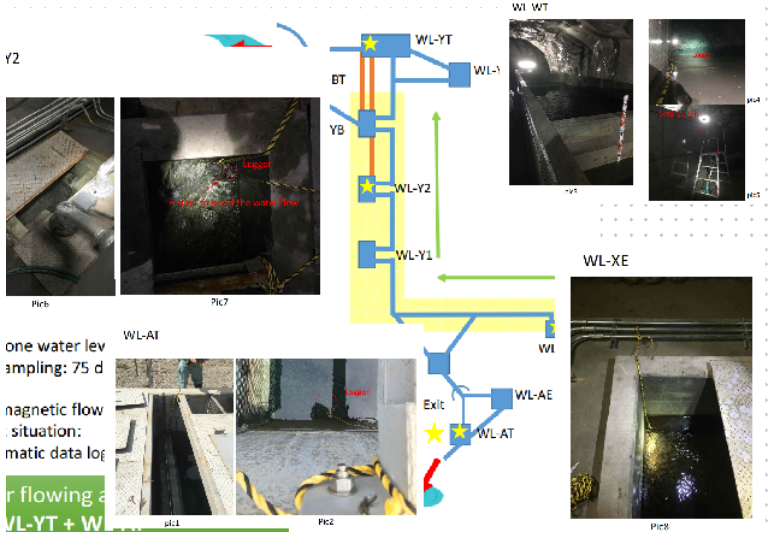

Earthquake at
Kumamoto
Frequency [Hz]
1
0.1
Data taking error
Apr. 11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
-6.0
-7.0
-8.0
-9.0
-10.0
Log10(Displacement) [m/rtHz]

A. Shoda (NAOJ)

Start water monitoring

Shikano-san's talk

- **Right before the 2nd iKAGRA test run, we started monitoring water level.**
- **The water monitoring is continuing.**

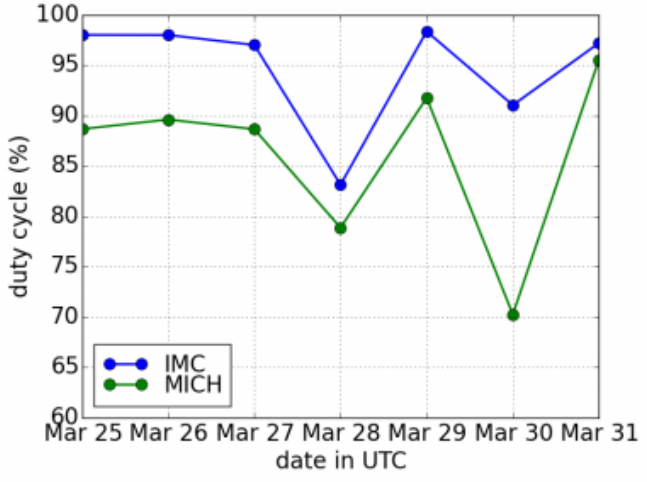


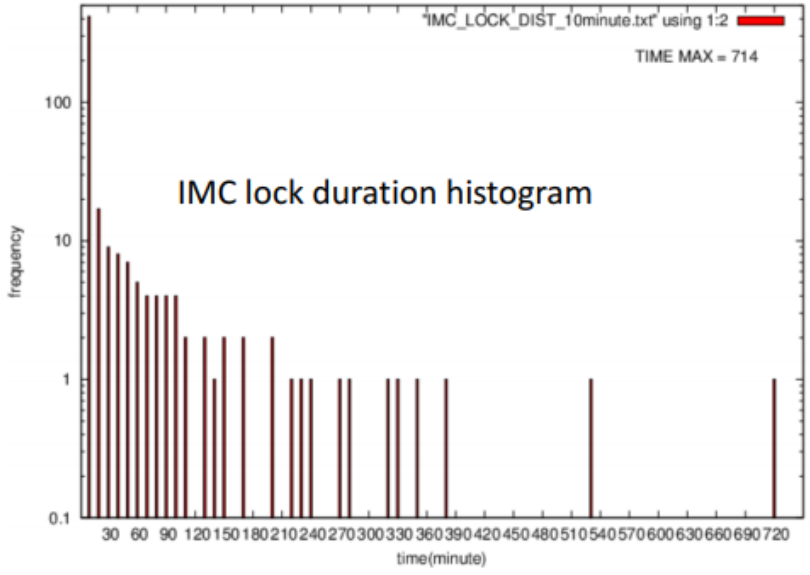
Duty Cycle(Mar.25-Mar.31,2016)

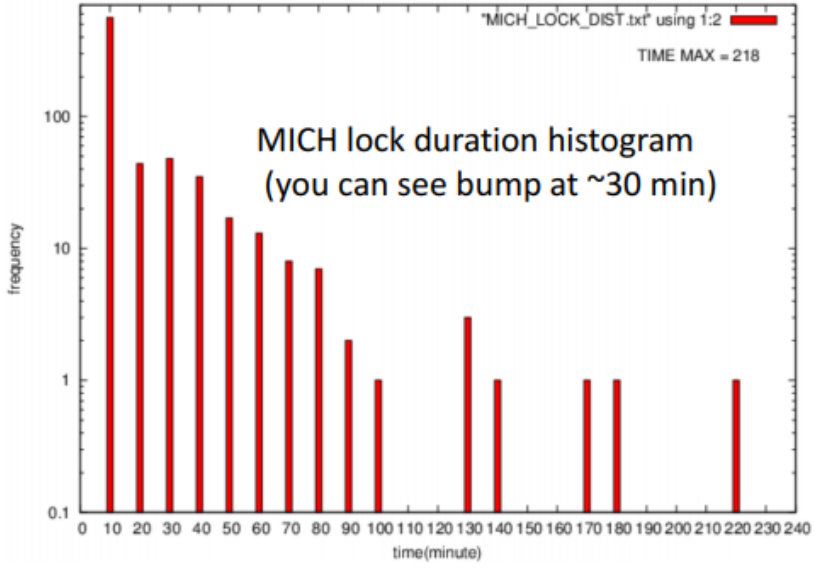
- **Duty factor: 85.2 %**
  (94.4 % for IMC)

data processing and plot by Y. Sasaki

- **Longest lock: 3.6 hours**
  (12 hours for IMC)

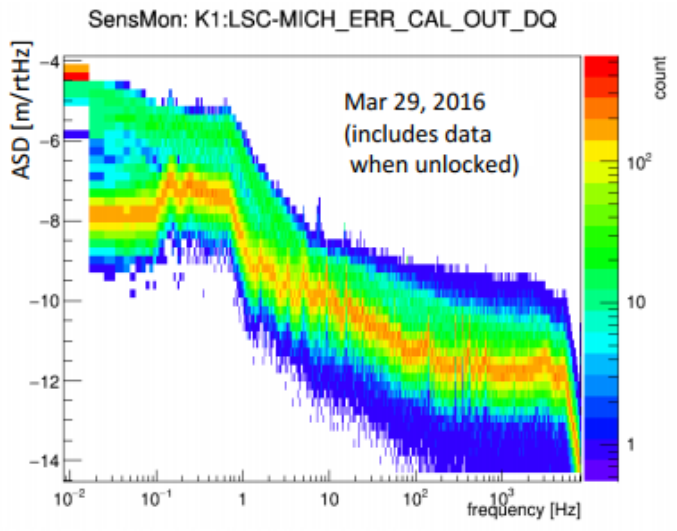


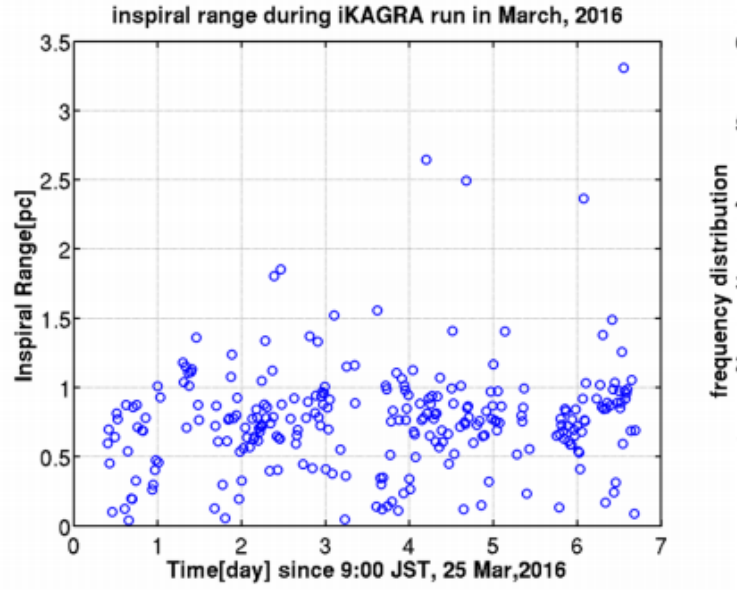


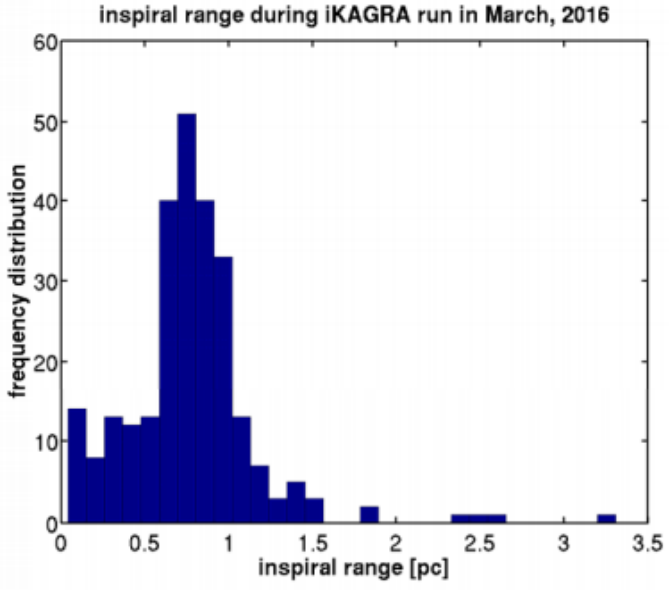


Inspiral Range

- **average: 0.77 pc**
  standard deviation: 0.39 pc
  for 1.4Msun-1.4Msun NS-NS
- **rough strain sensitivity fluctuated by roughly 1 order of magnitude**



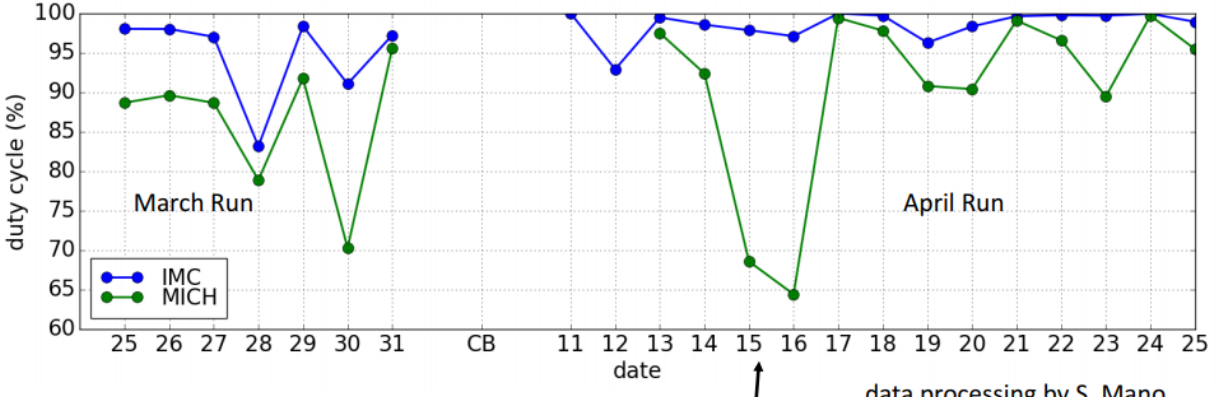




plot by K. Hayama

Duty cycle(April11-April25,2016)

- **duty factor: 90.4 % (98.5 % for IMC)**
  was 85.2 (94.4 % for IMC) during 1st Run



Plot generated using K1:GRD-IMC_LOCK_STATE_N and K1:GRD-MICH_LOCK_STATE_N.
Duty cycle for MICH on Apr 11 and 12 is not plotted because there was a bug in guardian state.

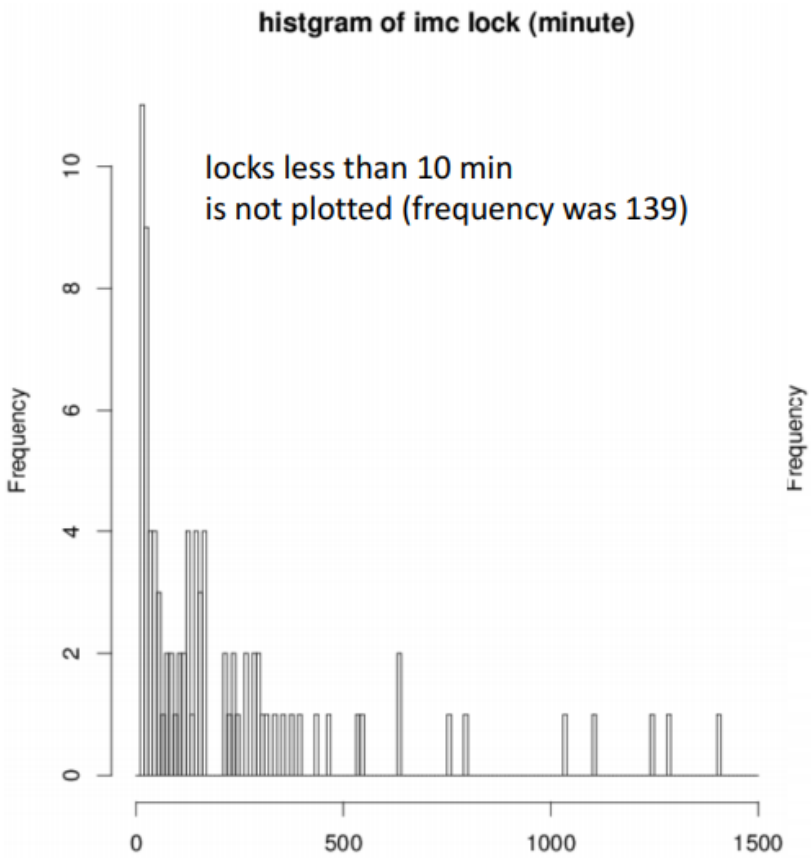
Kumamoto Earthquake, BS went wrong

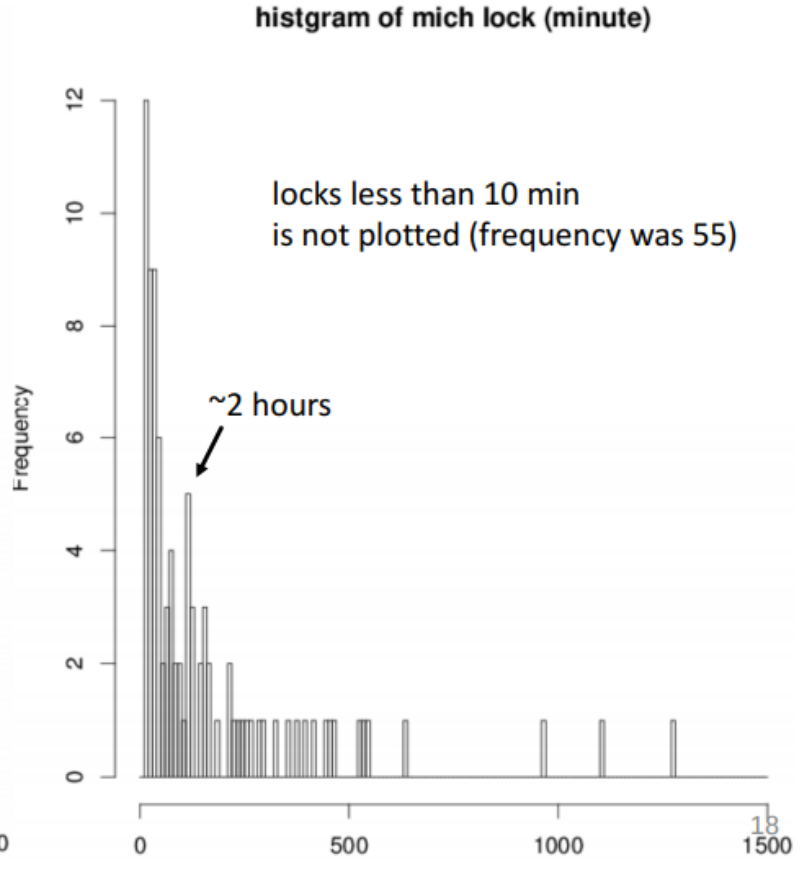
data processing by S. Mano
plot by Y. Michimura

Lock Duration(April11-April25)

- **longest lock: 21.3 hours (23.5 hours for IMC)**

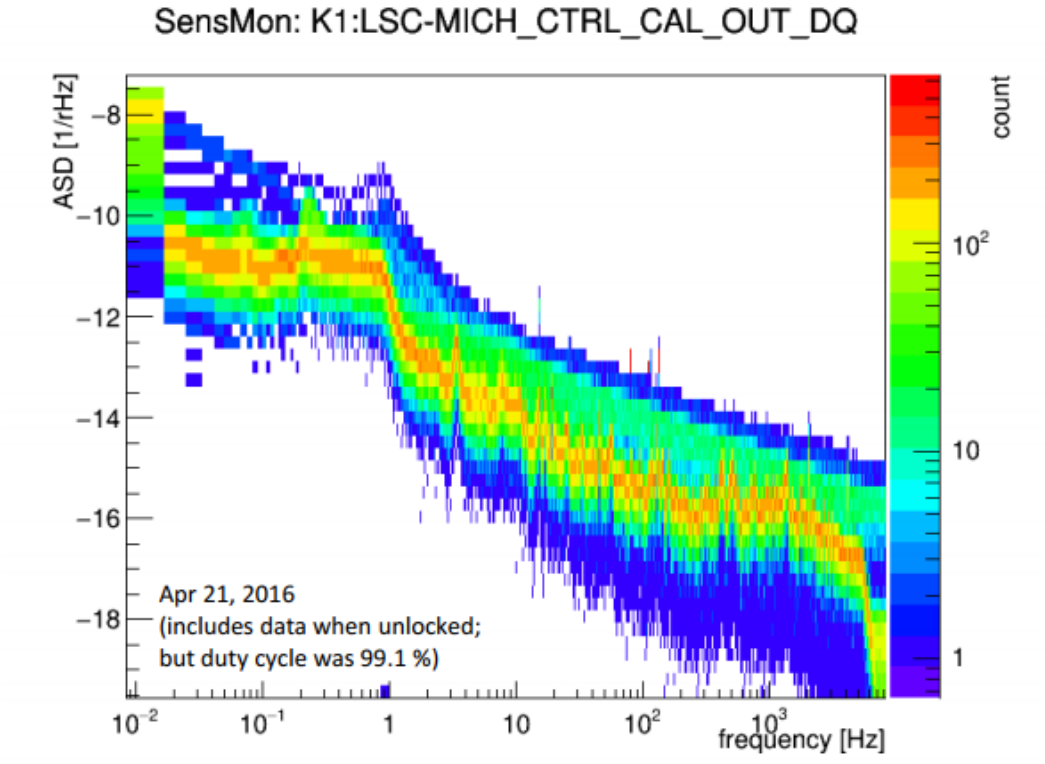
data processing and plot by S. Mano





Inspiral Range

- **~4.2 pc for 1.4Msun-1.4Msun NS-NS (average value on Apr 21) was 0.77 +/- 0.39 pc during March Run**
- **strain sensitivity fluctuated by roughly 1 order of magnitude**

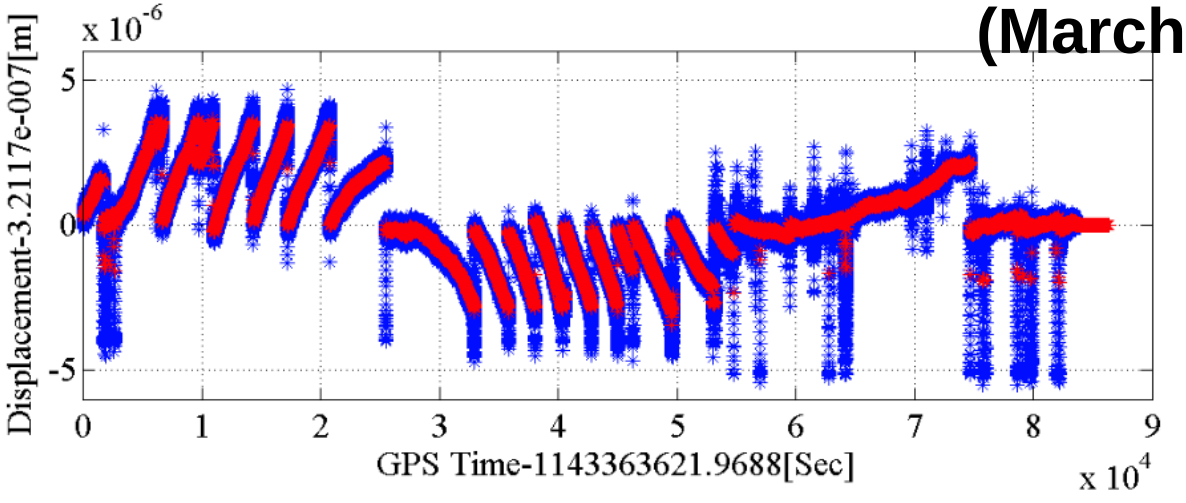


plot by K. Hayama

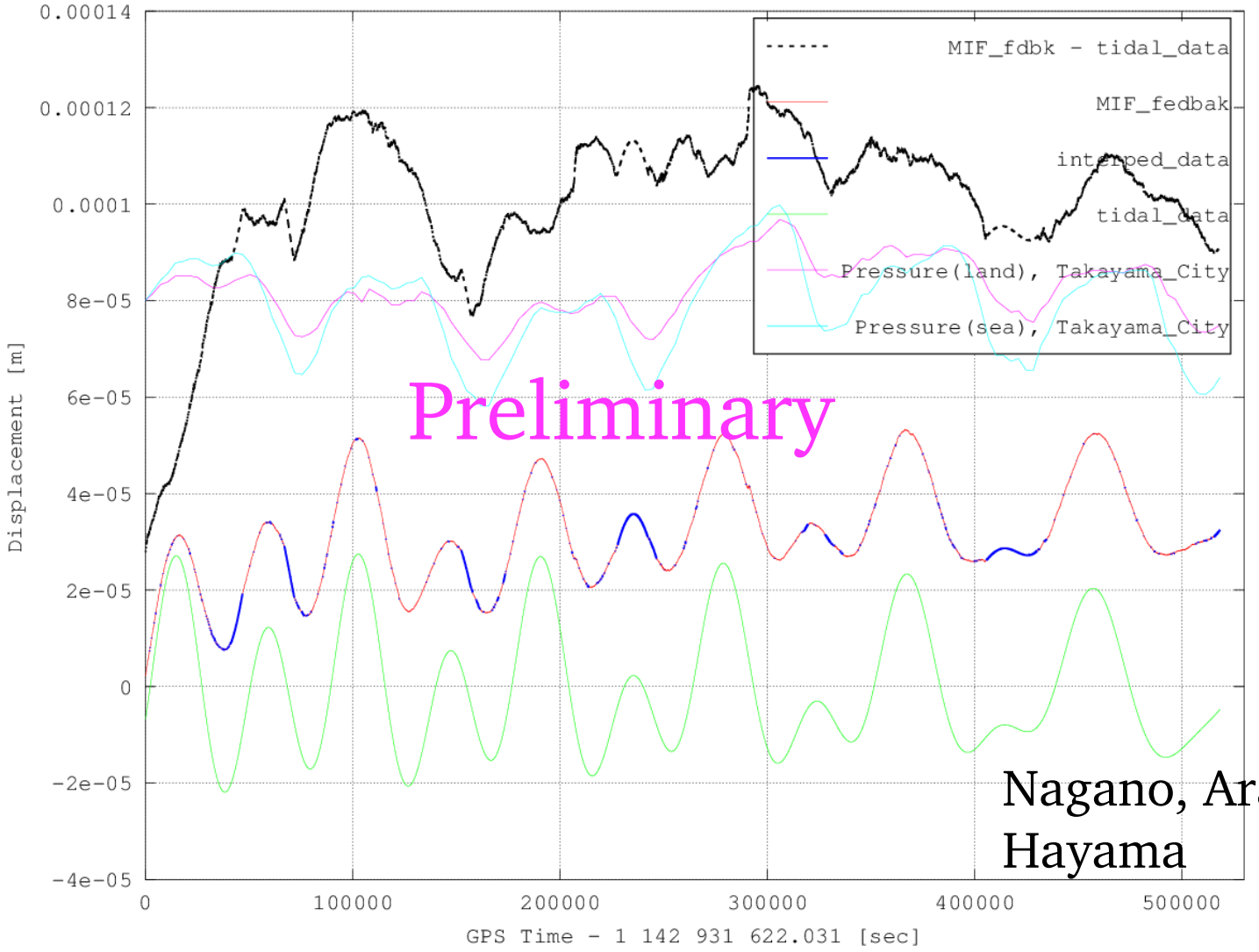
Differential of the X and Y arms

- During March test run, lock lost every 30min because feedback signals were saturated.
- We need more actuator range
- How large?

1day plot (March30-31)

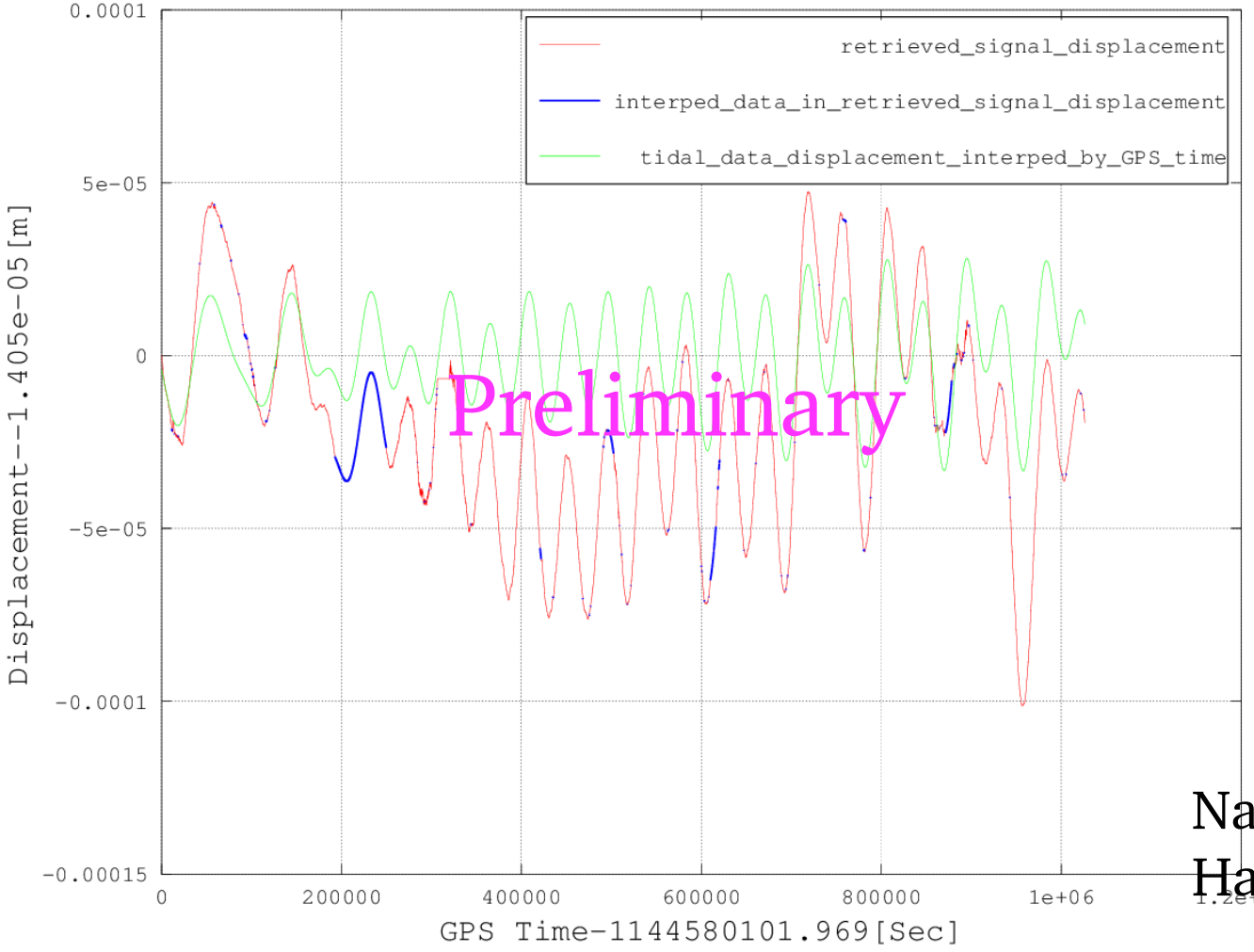


Tidal Distortion(Mar.25-Mar.31)



Nagano, Araya, Hayama

Tidal Distortion(April11-April25)



Nagano, Araya, Hayama

Veto Analysis

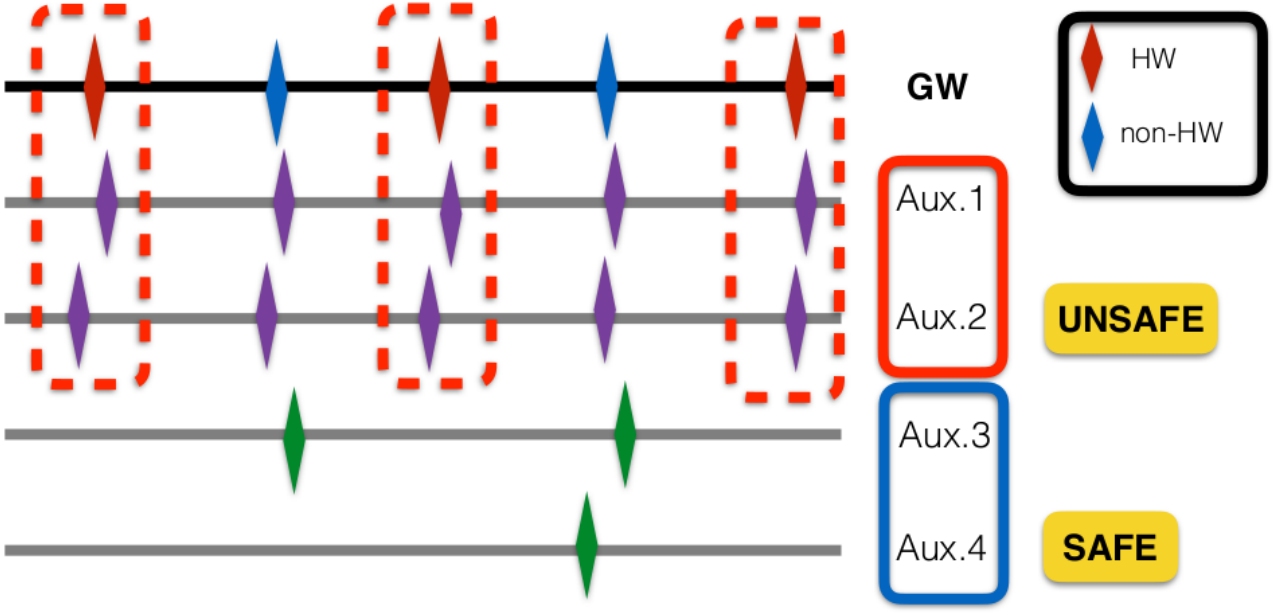
KGWG detchar

- Using multi-channel information
  - Safe channel study
  - Correlation analysis between GW channel and Aux channels

Safe Channel Study

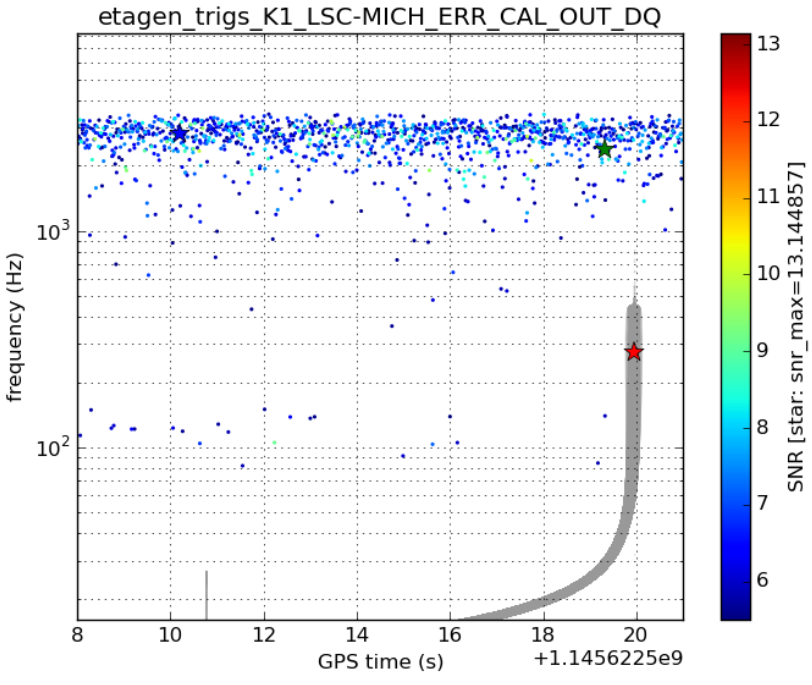
Young-Min Kim (SNU)

- The safety of a veto is important for veto criteria not to remove accidentally a true gravitational wave signal.
  - ***unsafe*** channels : Auxiliary channels with non-negligible couplings from GW channel. A corresponding response to HW injections is greater than expected by chance.
  - ***safe*** channels : it can be used as a veto or to study glitches in h(t).

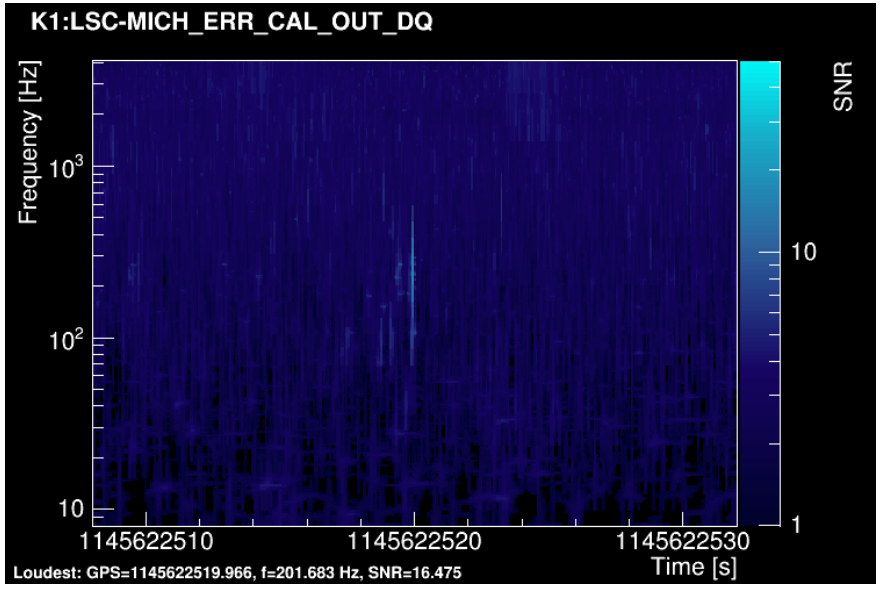


Multiple Glitch Detection

EtaGen, Son E. ++



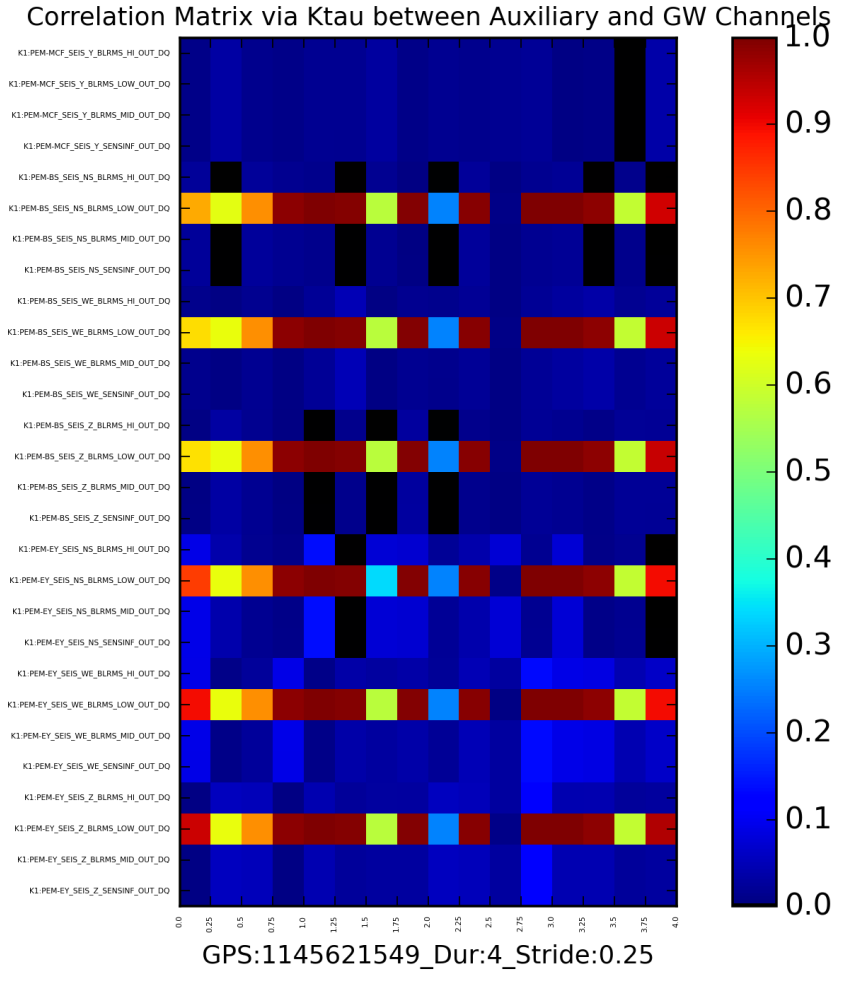
Omicron imported from LVC,
Kim, Young-Min



http://seikai.icrr.u-tokyo.ac.jp/~eddy/etagen-1145622508-13.html

Correlation analysis between GW and PEM

J. Oh ++



Measurement of the Schumann resonance

Proposal: http://gwdoc.icrr.u-tokyo.ac.jp/cgi-bin/private/DocDB/ShowDocument?docid=5421

A. Araya, S. Atsuta, N. Kanda, Y. Kataoka, O. Miyakawa, S. Miyoki,

T. Ogawa, Y. Saito, Y. Shikano, K. Somiya, T. Uchiyama, M. Uyeshima,

For the detection of GW from the early universe,

Schuman resonance may affect it in < 100Hz because of long-distance coherence(~10000km)

- Development of subtraction method in collaboration with LIGO, Virgo
- July 20-22, 2016, coincidence observation of the SR has been made and currently analysis is on going

Atsuta, Kataoka's talk

Schedule (Data Characterization)

- IKAGRA (in 2016)
  - Stationarity evaluation
  - Trend of x-y
  - Gaussianity
  - Lock loss study
    - IMC and
  - Multichannel correlation (with KGWG)
  - Safe Channel study (with KGWG)
- Schumann filter(with LIGO and Virgo) (in October 2016)
- Rough estimation of water GGN (in middle of 2017)

Schedule (Env Monitor)

タスク名	期間	開始日	終了日
Environment	**443日**	**16/07/20 (水)**	**18/03/30 (金)**
Schumann resonance	3日	16/07/20 (水)	16/07/22 (金)
Seismometer	**23日**	**16/08/01 (月)**	**16/08/31 (水)**
[Center] Relocation of the seismometer	23日	16/08/01 (月)	16/08/31 (水)
[Xend] Relocation of the seismometer	23日	16/08/01 (月)	16/08/31 (水)
[Yend] Relocation of the seismometer	23日	16/08/01 (月)	16/08/31 (水)
Thermometer	**88日**	**16/08/01 (月)**	**16/11/30 (水)**
[Center]Thermometer and Hygrometer	23日	16/08/01 (月)	16/08/31 (水)
Pre-Amps for Therm. & Hygro.	22日	16/09/01 (木)	16/09/30 (金)
[Xend] Thermometer & Hygrometer	20日	16/10/03 (月)	16/10/28 (金)
[Yend] Thermometer & Hygrometer	20日	16/10/03 (月)	16/10/28 (金)
DAQ	23日	16/08/01 (月)	16/08/31 (水)
Magnetometer	**110日**	**16/08/01 (月)**	**16/12/30 (金)**
[Mag] Cabling	23日	16/08/01 (月)	16/08/31 (水)
[Mag] Setting up	22日	16/09/01 (木)	16/09/30 (金)
[Mag] Reservation	21日	16/10/03 (月)	16/10/31 (月)
[Mag] Relocation	9日	16/11/01 (火)	16/11/11 (金)

タスク名	期間	開始日	終了日	先
[Mag] Realtime Modeling	22日	16/11/01 (火)	16/11/30 (水)	
[Mag] Add one	22日	16/12/01 (木)	16/12/30 (金)	
Water	**443日**	**16/07/20 (水)**	**18/03/30 (金)**	
Retrieving data at X-arm	3日	16/07/20 (水)	16/07/22 (金)	
interpretation of data during iKAGRA	32日	16/07/19 (火)	16/08/31 (水)	
Modeling water GGN	87日	16/09/01 (木)	16/12/30 (金)	
Software	**444日**	**16/07/19 (火)**	**18/03/30 (金)**	
QuickLook for CRY	45日	16/08/01 (月)	16/09/30 (金)	
Web Based Tools	435日	16/08/01 (月)	18/03/30 (金)	
Updating Daily Summary Page	435日	16/08/01 (月)	18/03/30 (金)	

Schedule

- Seismometer
  - First: Center at 1st floor, X, Y end at 1st floor (in Sep,2016)
  - After setting up of Digital system on 2nd floor:

    Center at 2nd Floor, X,Y end at 2nd floor
- Thermometer, Hygrometer, Barometer
  - First: Center for one (in Sep, 2016)
  - After setting up of low sampling DAQ
- Magnetometer
  - Cabling in Aug, 2016.
  - Setting up (pre amp,..), and in Sep, 2016
  - Center, after getting 2 more magnetometer, Y,X end

Schedule(Arm Env. Monitor)

As the minimum setup

- Temperature (arm distribution)
- Humidity (arm distribution)
- Air pressure (arm distribution / daily fluctuation)
- Magnetic Field (arm distribution (mainly DC component)

Schedule

- - Nov. 2016
  - Set up at IMS, NINS
  - Test operation at IMS, NINS
- Dec. 2016
  - Test installation at KAGRA
- Jan. – Mar. 2017
  - Adjustment and full installation at KAGRA

大学共同利用機関法人 自然科学研究機構
分子科学研究所

END

Channel ↔ Audio Transform