

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 Monitor
- Spectrogram Monitor

Spectrum

- Sensitivity Monitor
- Range Monitor

GW Range

- 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

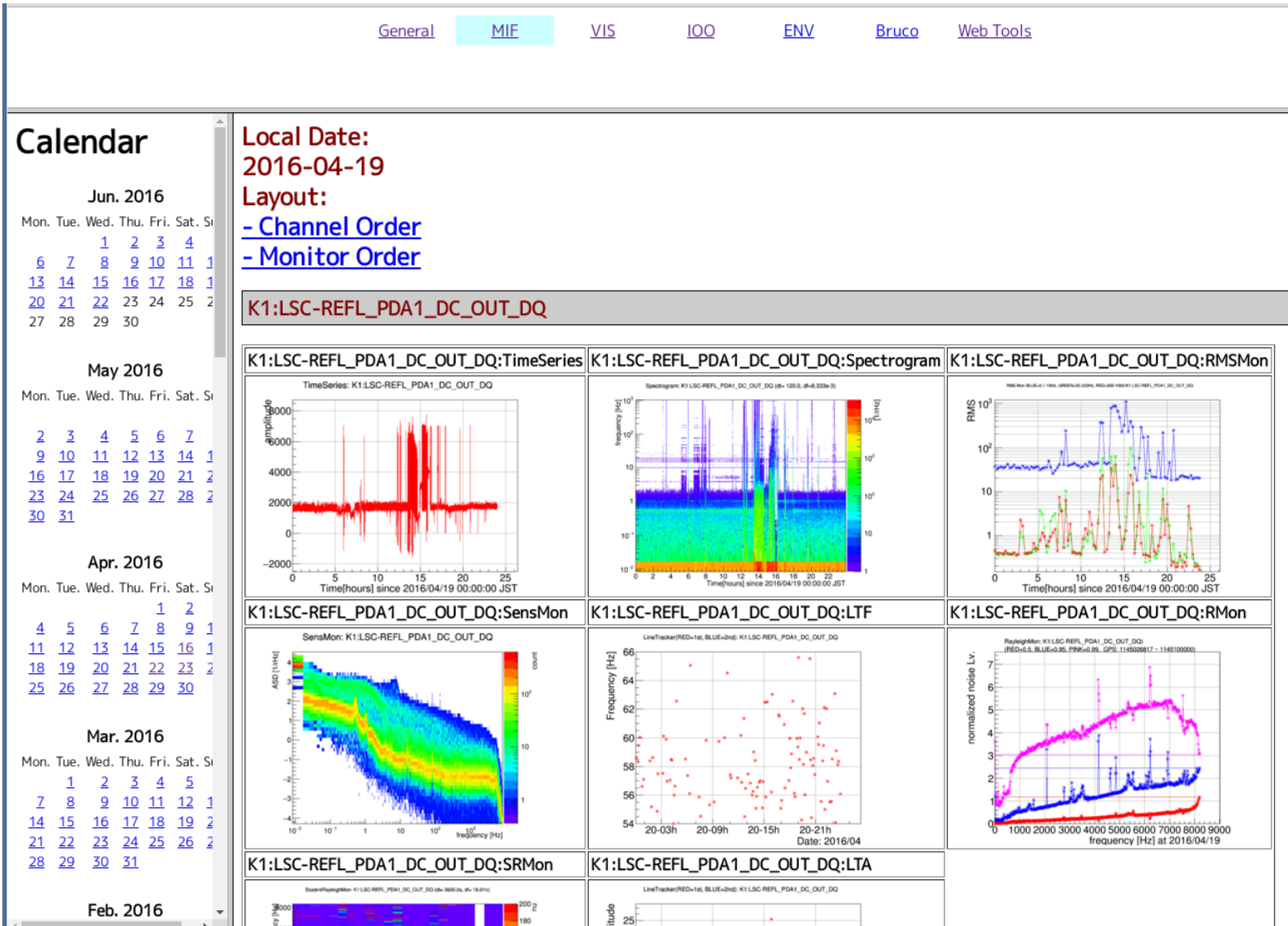
- Daily summary webpage
- GUI Interface
- Web-Base Interface
- Command-line Interface

User Interface

System Health

- Health monitor
- File Finder (New)
- Globally Correlated magnetic noise
- Violin mode
- Multi-channel analysis
- Newtonian noise
 - Effect of water inside the mountain

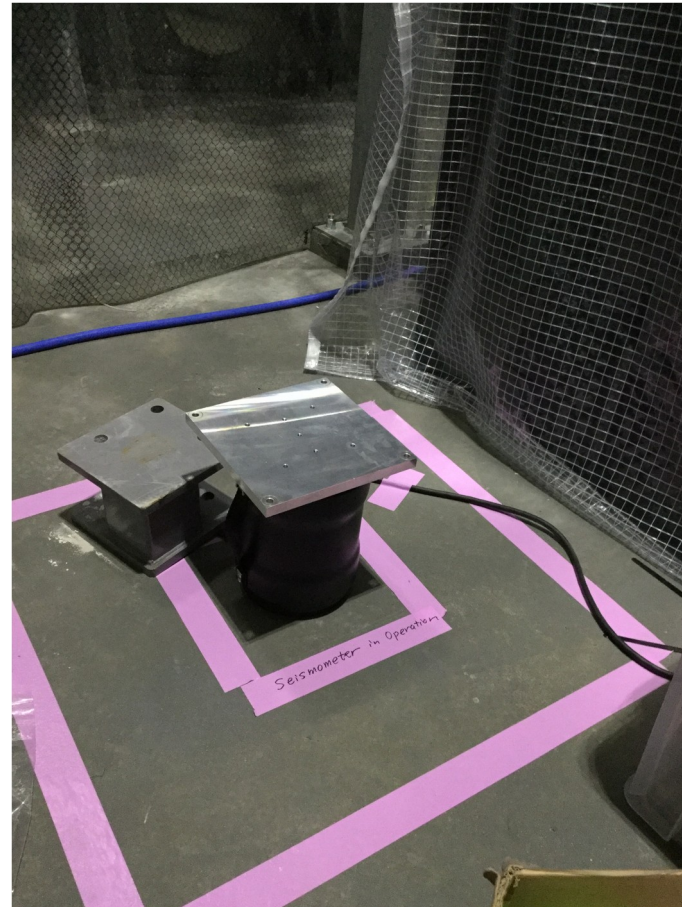
Daily Summary Monitors in iKAGRA

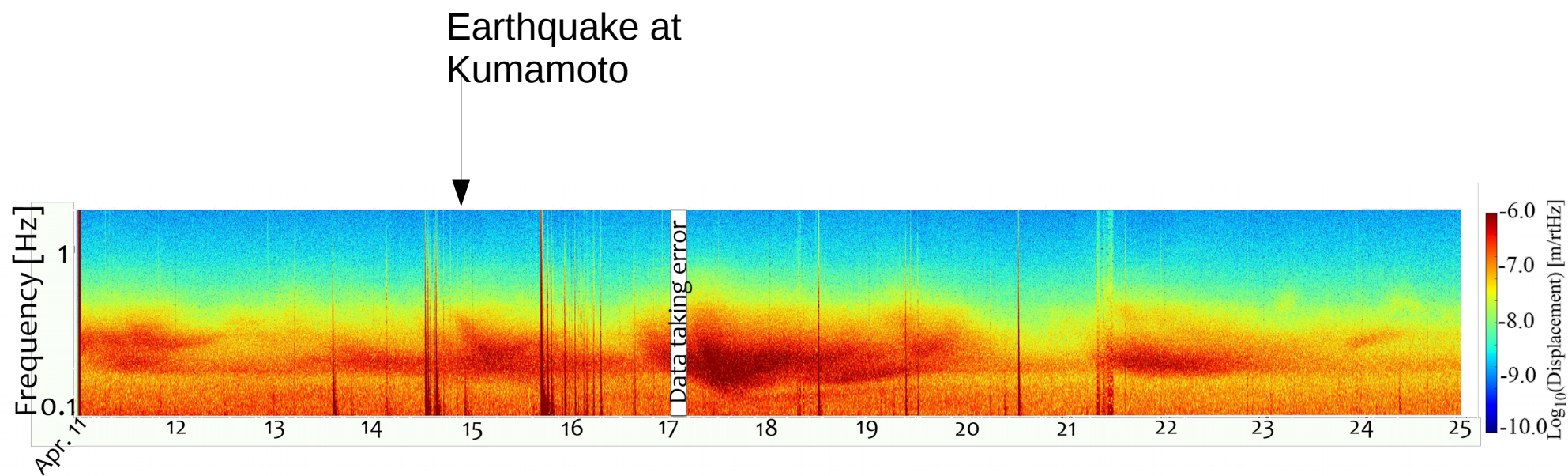


- Monitored 40's channels (almost 50 channels)
- Daily Summary Page was basically running correctly, but failed for several days.
 - In case some data is not normal (NAN), this can happen
- Computation time growin
- Poor documentation.
- Need some bootcamp

Environmental Monitors in iKAGRA

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



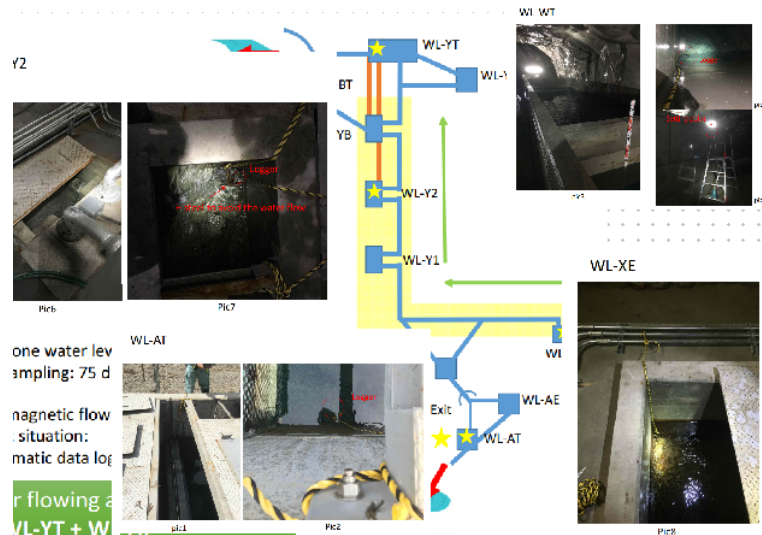


A. Shoda (NAOJ)

Start water monitoring

Shikano-san's talk

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

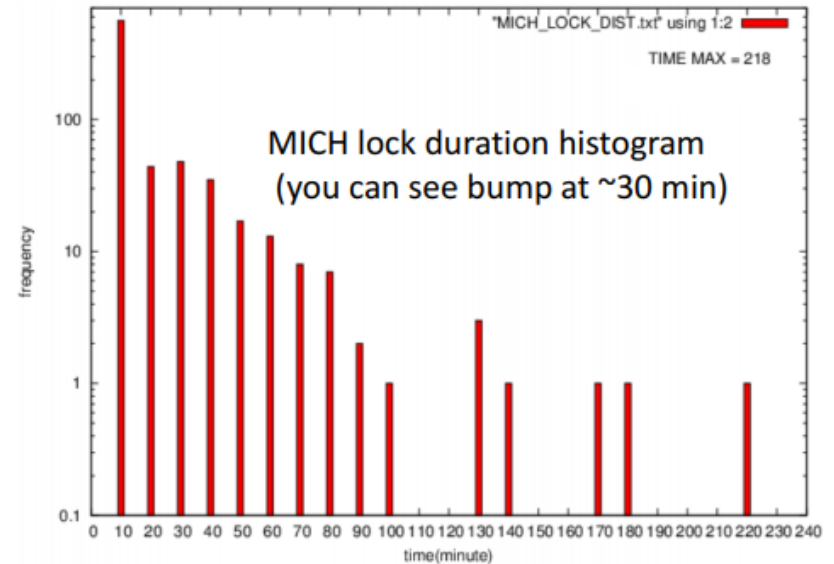
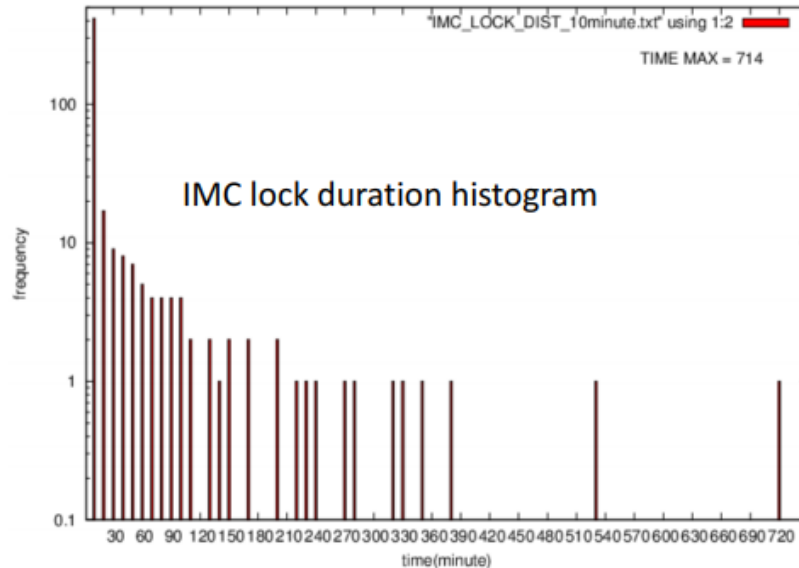
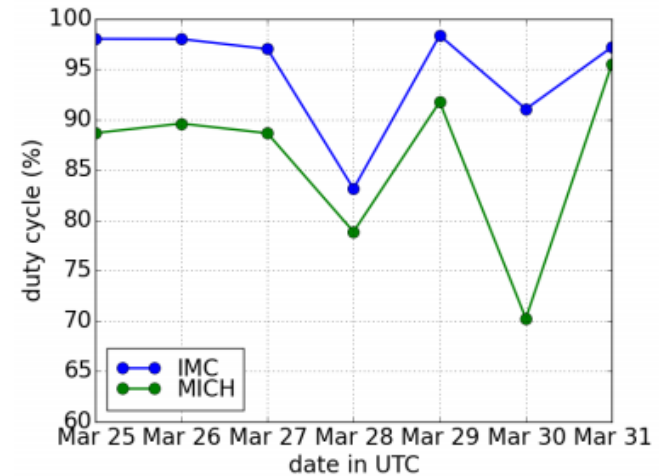


Duty Cycle(Mar.25-Mar.31,2016)

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

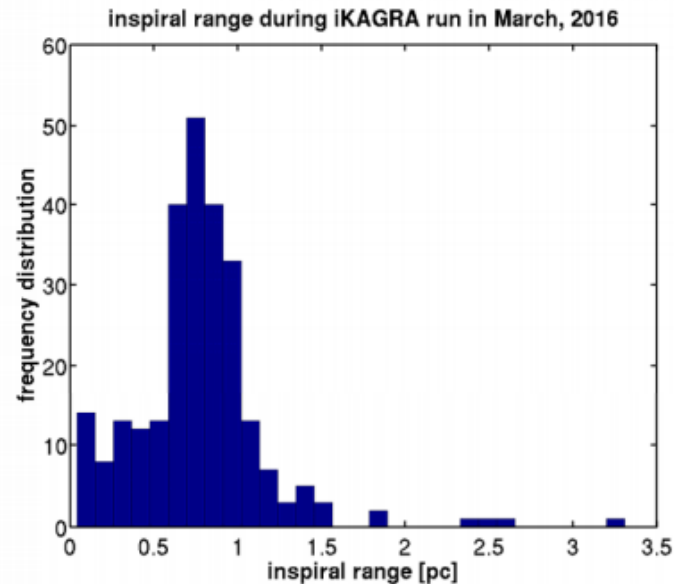
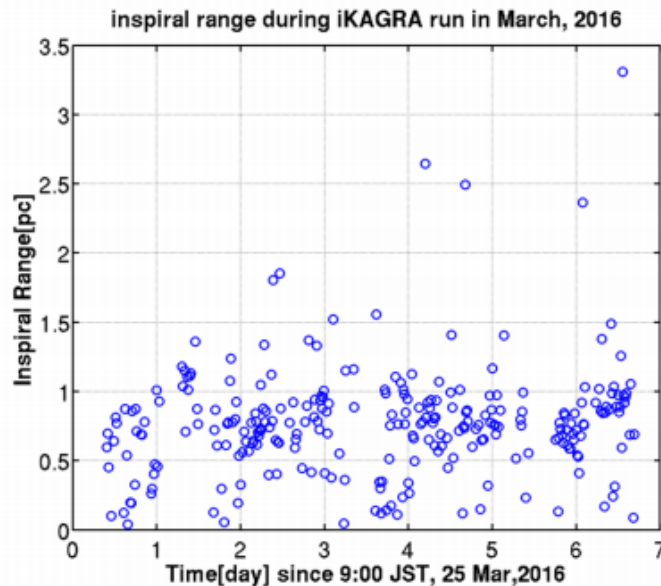
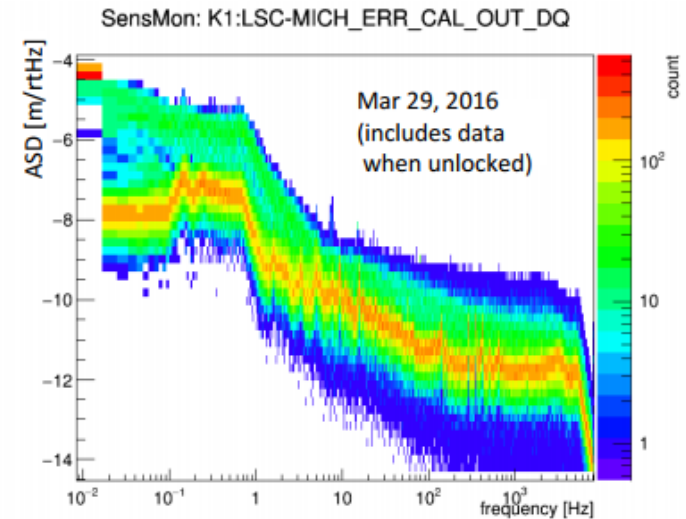
data processing and plot by Y. Sasaki

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



Inspiral Range

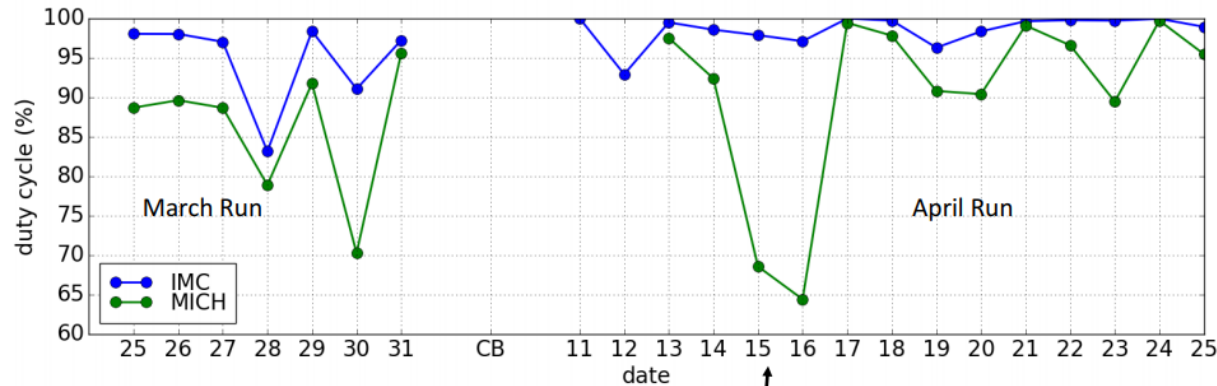
- average: 0.77 pc
standard deviation: 0.39 pc
for 1.4Msun-1.4Msun NS-NS
- rough strain sensitivity fluctuated
by roughly 1 order of magnitude



plot by K. Hayama

Duty cycle(April 11-April 25, 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.

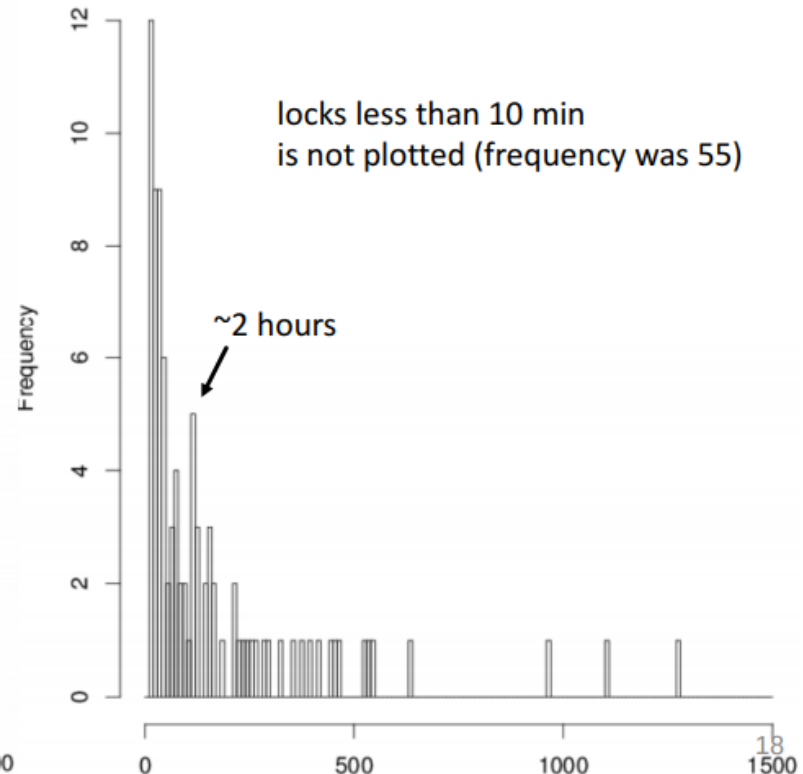
Kumamoto Earthquake,
BS went wrong

data processing by S. Mano
plot by Y. Michimura

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

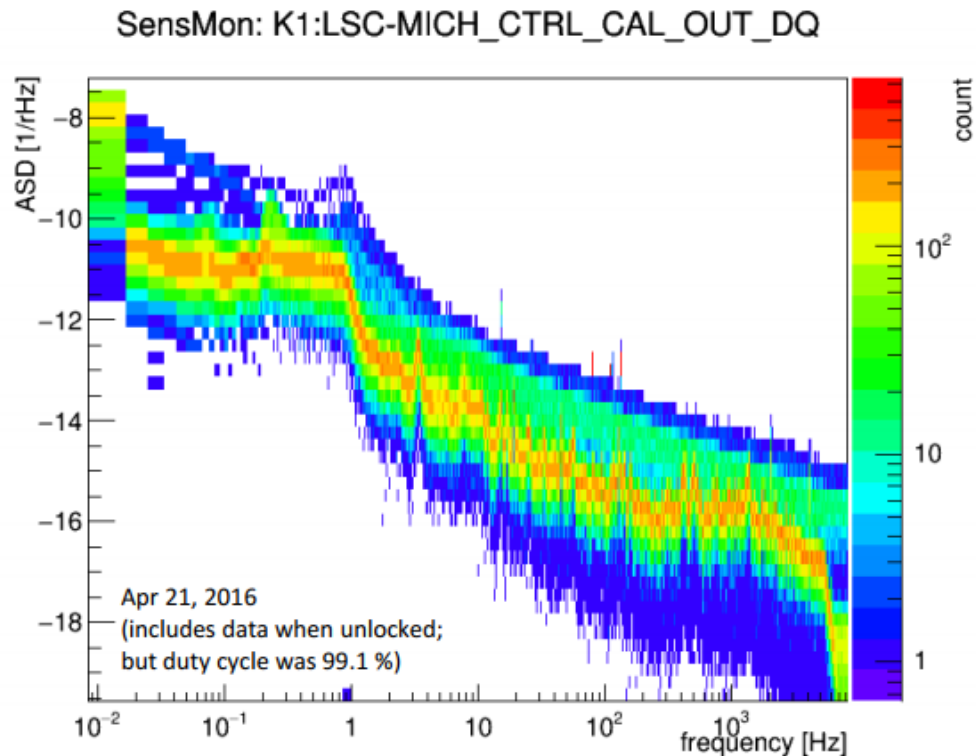
histogram of mich lock (minute)

histogram of mich lock (minute)



Inspiral Range

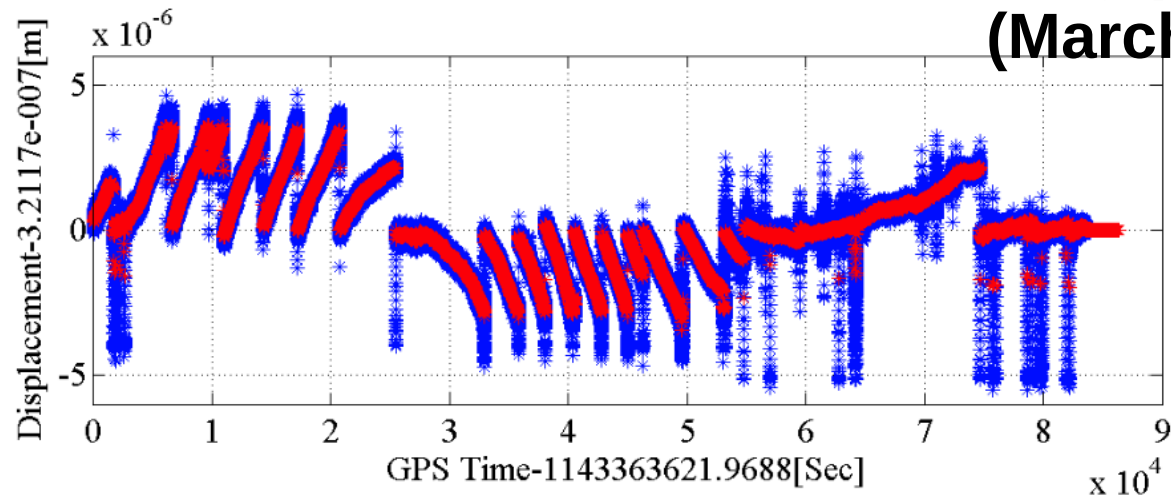
- ~ 4.2 pc for 1.4Msun-1.4Msun NS-NS
(average value on Apr 21)
was 0.77 ± 0.39 pc during March Run
- strain sensitivity fluctuated by roughly 1 order of magnitude



plot by K. Hayama

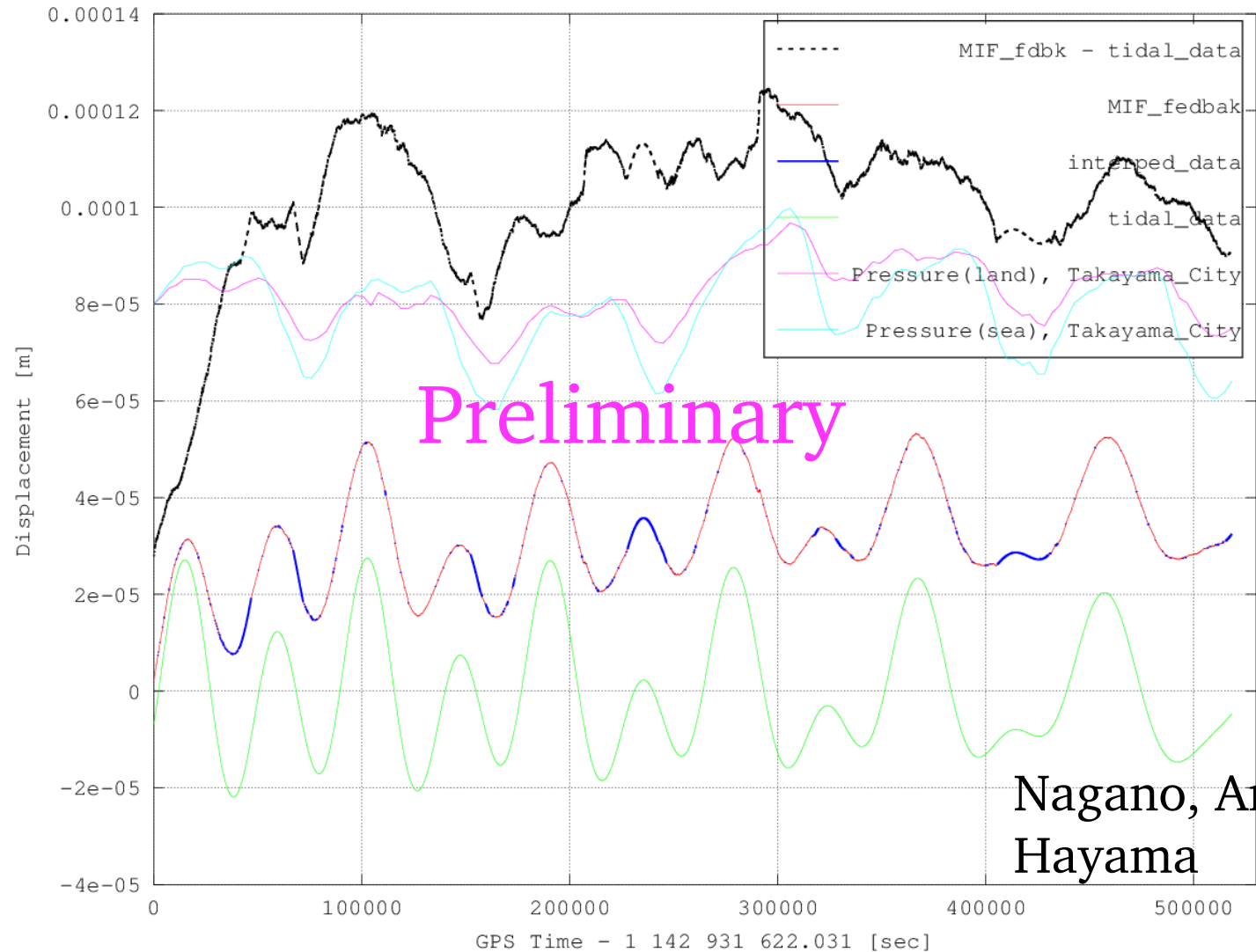
Differential of the X and Y arms

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



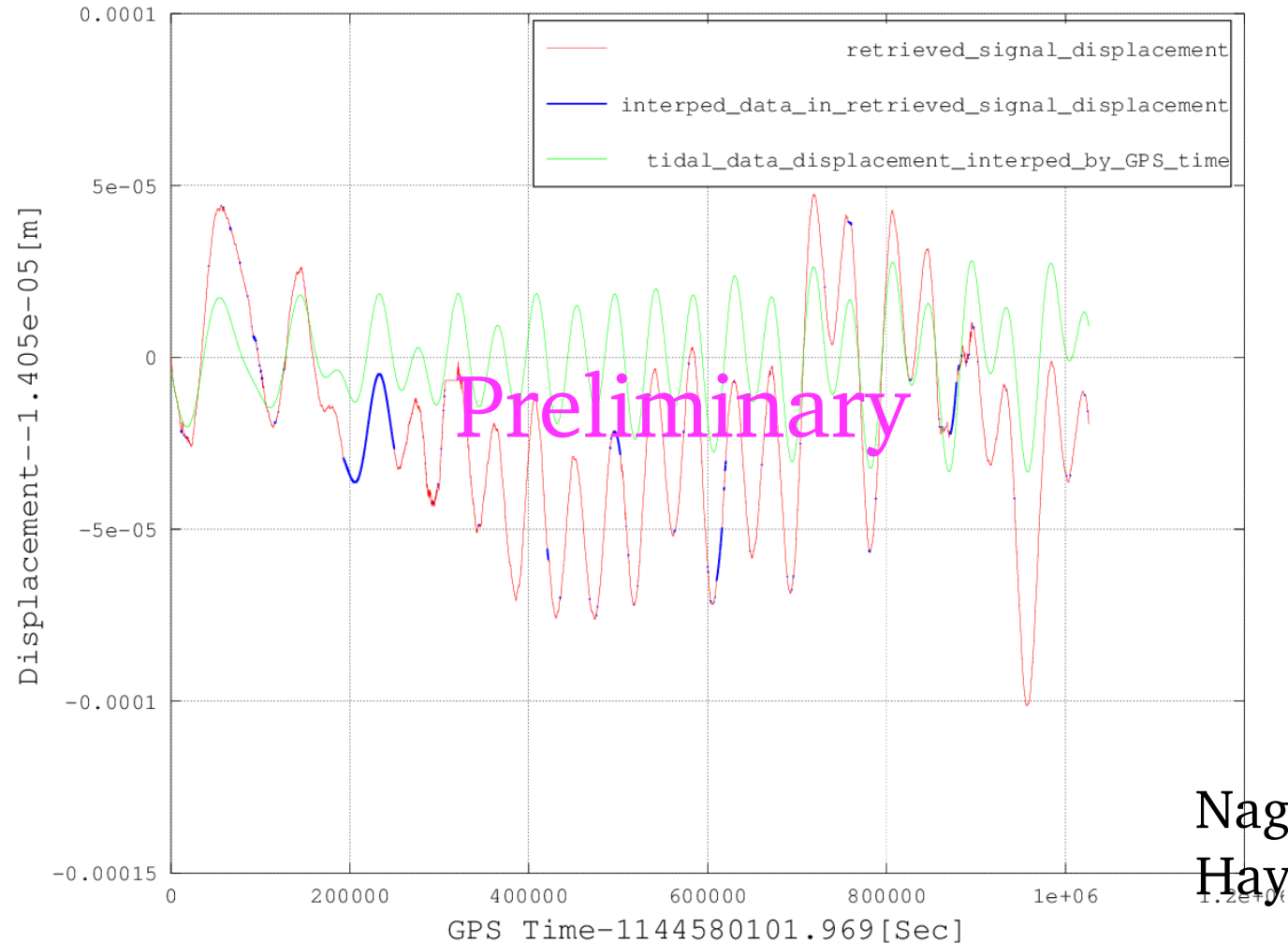
1day plot
(March30-31)

Tidal Distortion(Mar.25-Mar.31)



Nagano, Araya,
Hayama

Tidal Distortion(April11-April25)



Nagano, Araya,
Hayama

Veto Analysis

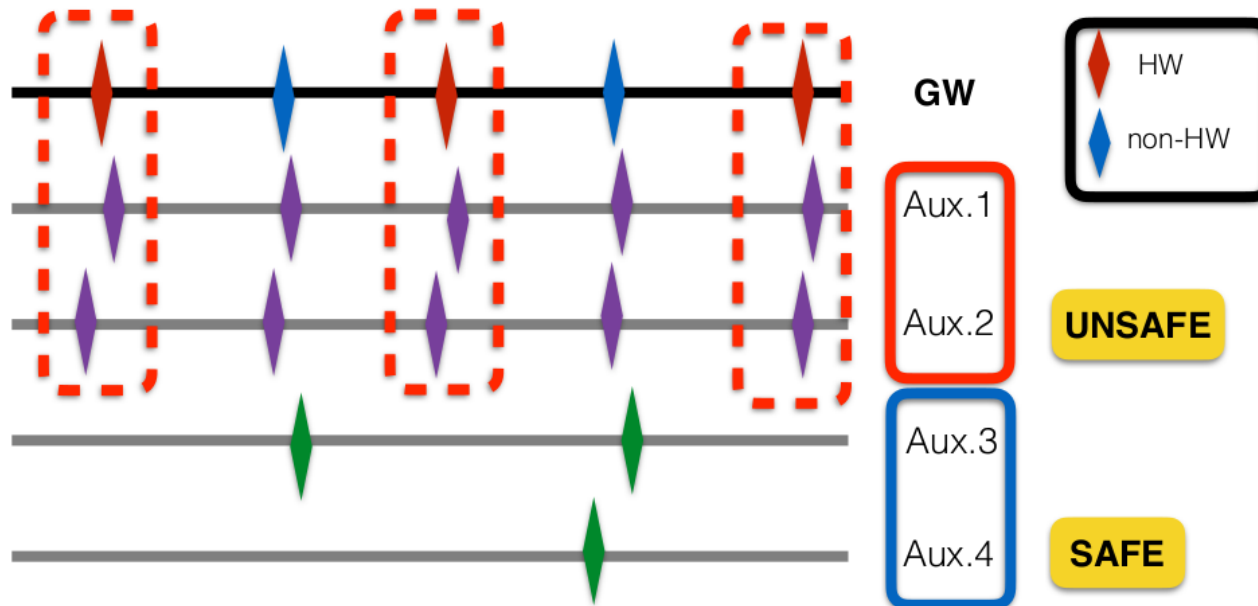
KGWG detchar

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

Safe Channel Study

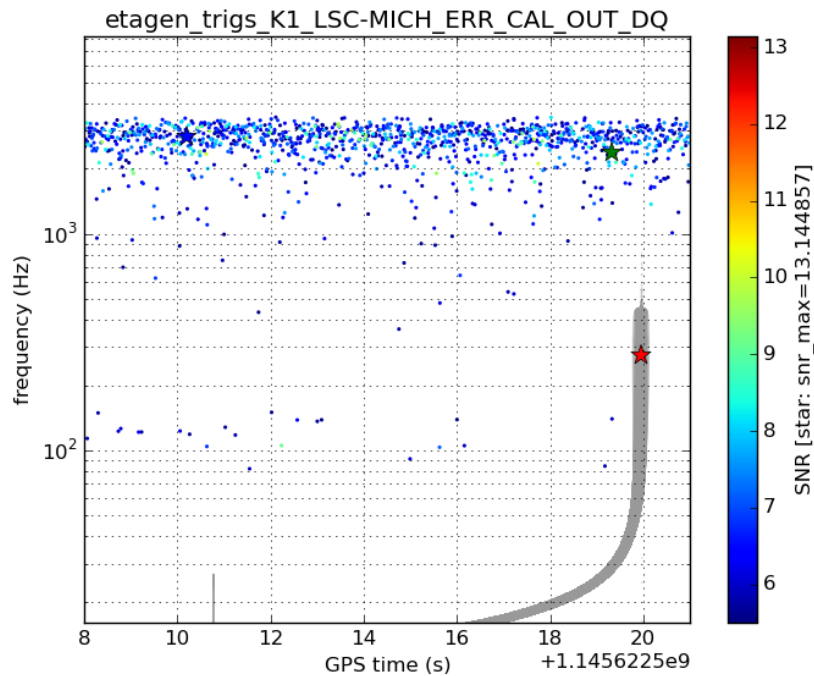
Young-Min Kim

- The safety of a veto is important for veto criteria not to remove (SNU) 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 $h(t)$.

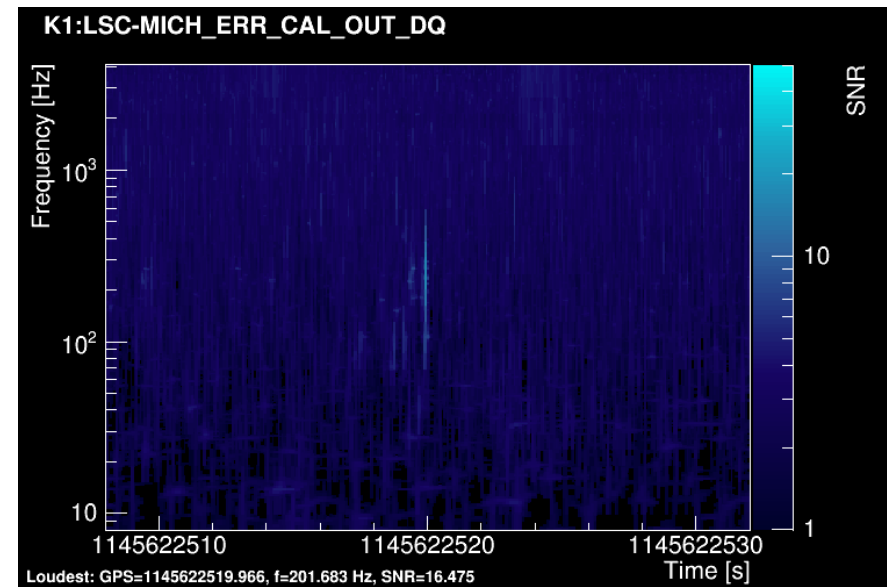


Multiple Glitch Detection

EtaGen, Son E. ++



Omicron imported from LVC,
Kim, Young-Min

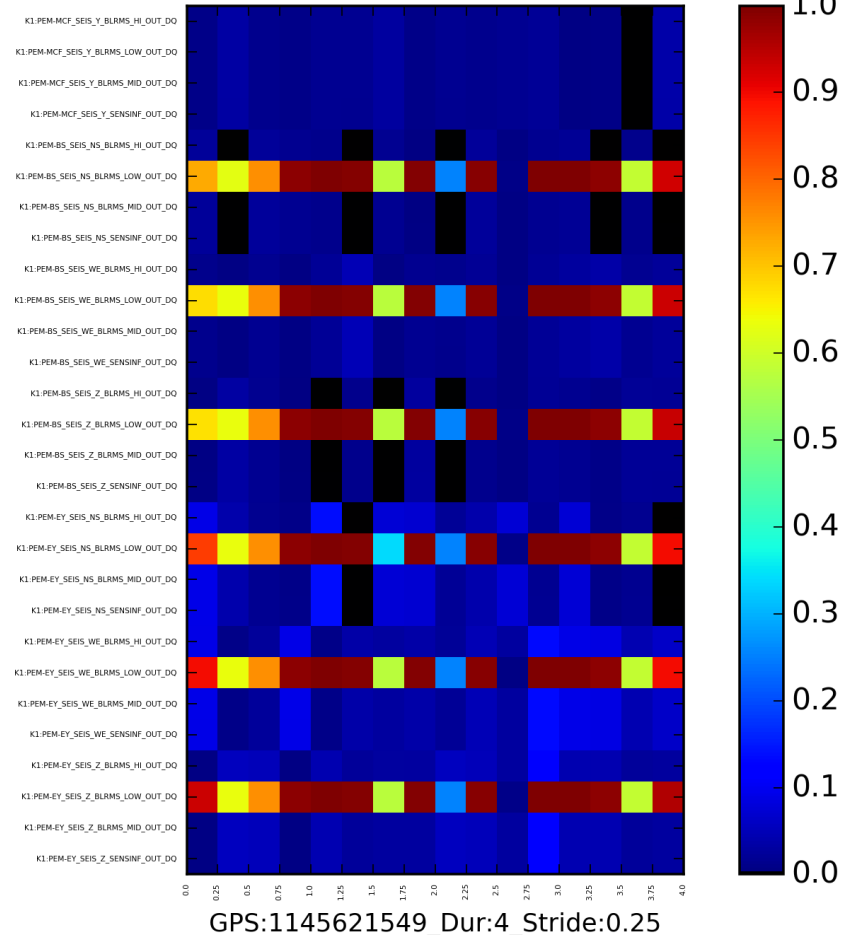


<http://seikai.icrr.u-tokyo.ac.jp/~eddy/etagen-1145622508-13.html>

Correlation analysis between GW and PEM

J. Oh ++

Correlation Matrix via Ktau between Auxiliary and GW Channels



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 $< 100\text{Hz}$ because of long-distance coherence($\sim 10000\text{km}$)

- 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



END

Channel ↔ Audio Transform