Detector Characterization Status

K. Hayama (ICRR),
KAGRA detchar subsystem

Tasks

- **Support tools/Env sensors to understand what is happening in KAGRA**
  - DetChar tools, summary page
  - Environmental monitor sensors
  - Study of environmental issues
- **For Data quality Information for operation, data analysis**
  - To define DQ using DetChar tools
    - Practice : iKAGRA data characterization
  - Selection of channels to use for DQ
- **For Veto Information for data analysis**
  - Multi-channel analysis
  - Safe, unsafe channel analysis

tools for characterization

Non-Stationary

Line

Gaussianity

Time-Series Spectrum

GW range

Correlation

System Health

etc.

User Interface
- command line
- webbased

Monitoring Pages

Summary Pages

NDS tools

ChirpletMon

Environmental Monitors

Sensors Preparation

Arm mapping

Connection

PEM Injection

Site Study
-magnetic field
-water gravity

Data Categorization

DQ flag

iKAGRA Paper

DQ application

Logistics support
- DetChar Shifts

Current Organization

- DetChar tools, summary pages

  Hayama(ICRR), KGWG detchar members (John, (PilJong))
- Environmental Monitor

  GIF: Araya(ERI), Miyo, DET: Hayama
  - Main sensors **: Araya , Miyo, Hayama, Tanaka(ICRR,CRY)**
- Data quality, its application to data analysis

  Hayama, KGWG detchar members
- Basic study of environmental issues
  - Magnetic fields **: Hayama, Ogawa(ERI), Somiya(TITECH), LIGO, Virgo, Taruya (Kyoto), Himemoto(Nihon), Tanaka**
  - Water **: A. Nishizawa, Kasuya, Hayama Somiya, Y. Chen(Caltech)**

DetChar tools

o Interface:
command line, MATLAB, Python, GUI(in progress), web based(in progress)
>80 command line tools are developed and updating for using NDS tools

- Stationarity
  - Glitch Monitor
  - Line Monitor
  - BLRMS Monitor
- Gaussianity
  - Rayleigh Monitor
  - Student-t based non-Gaussian modeling
- Data behavior
  - Time-series
  - Spectrum
  - Spectrogram
- Sensitivity
  - Range to main GW sources
  - SensMon
- Correlation
  - Linear
  - Non-Linear (MIC, correlation distance)
- Coherence
  - coherence
  - Bruteforce coherence (BruCo)

DetChar tools

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Update :

MATLAB, Python, MEDM interface for the detchar tools

o MATLAB – in progress

Miyazaki (UT B4)

o Python

Calling shift

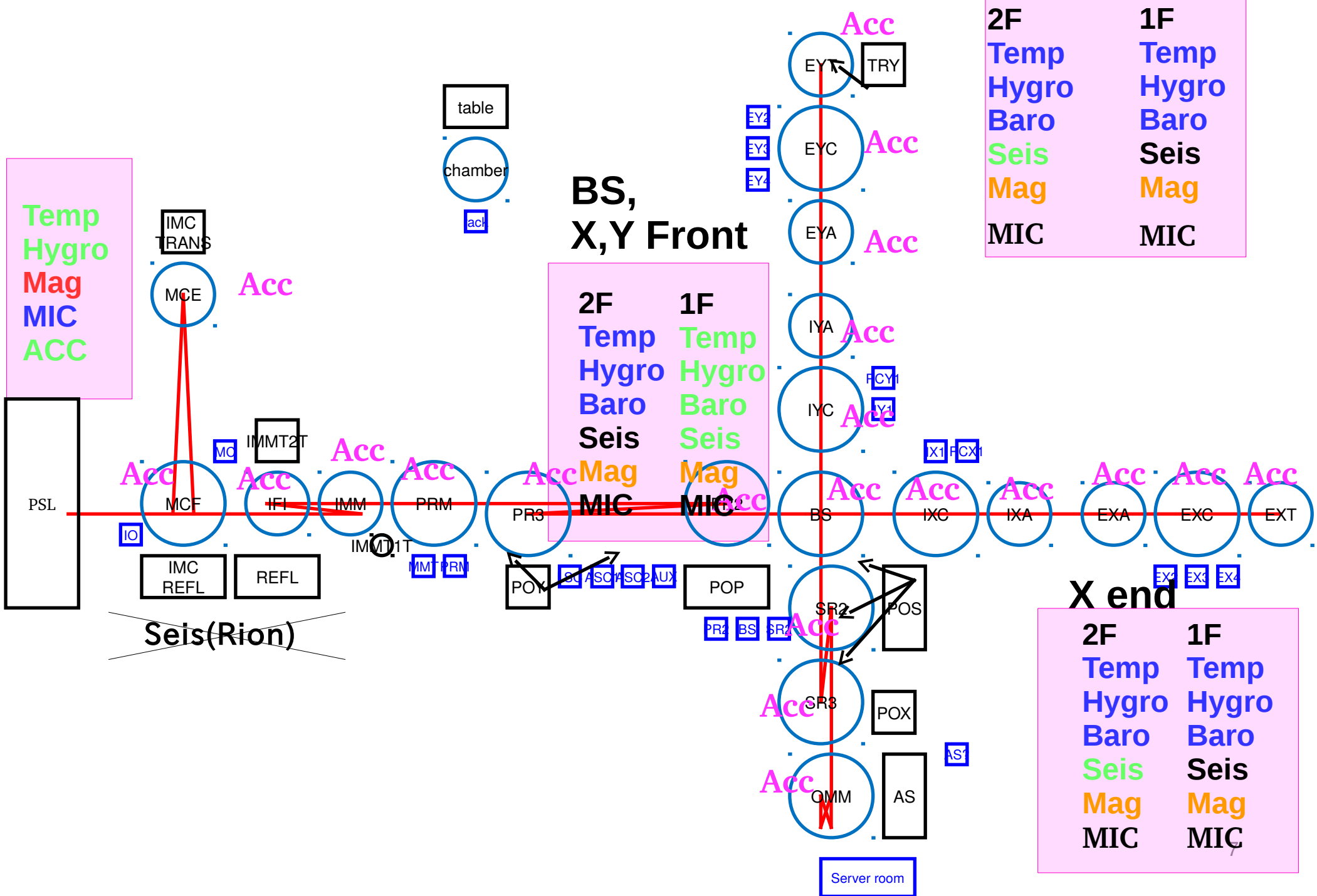
o MEDM

Pil-Jong will come to Kamioka for 1.5month and start from this Dec-Jan.

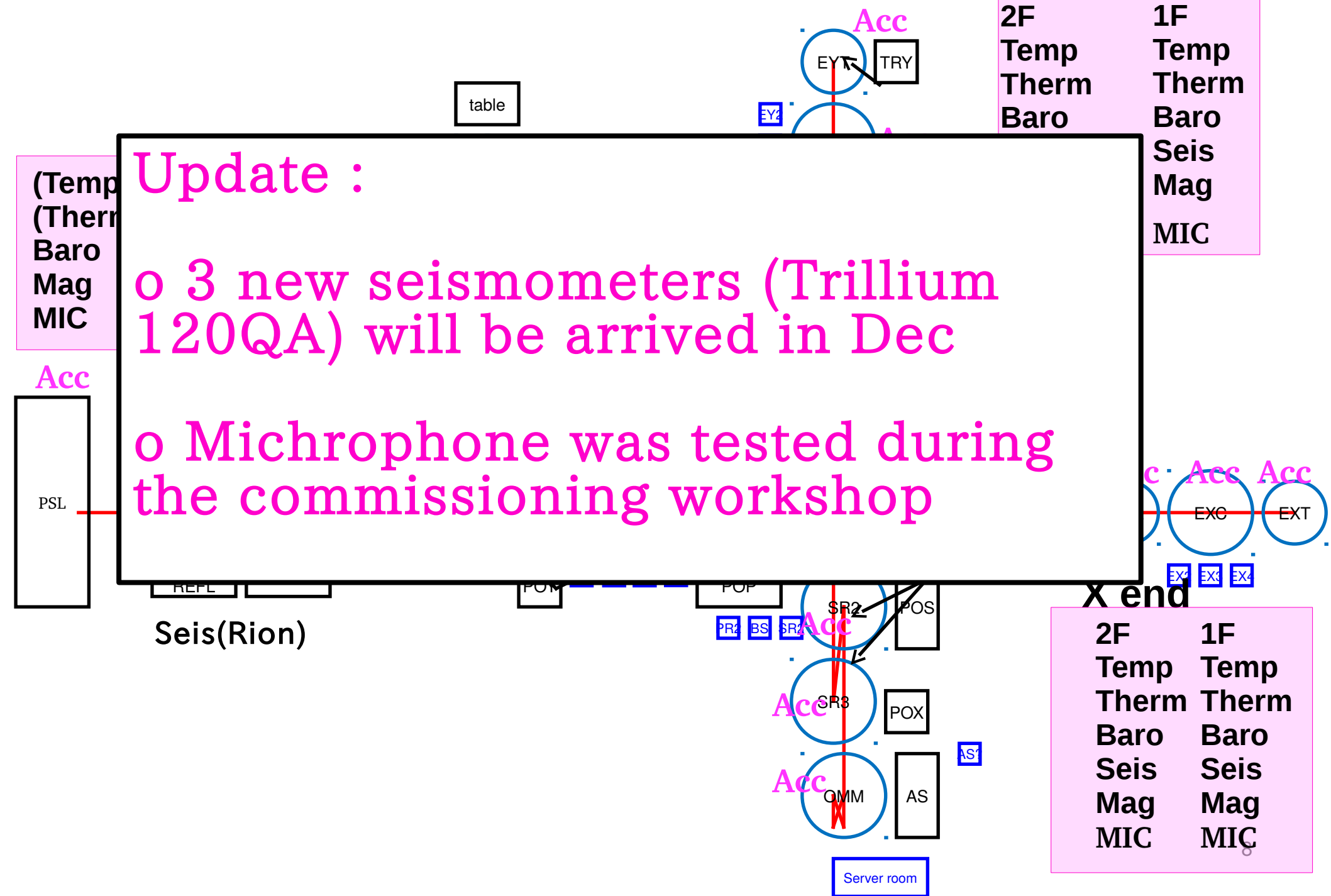
Daily summary page

NDS tools still not working well

Env. sensor locations



Env. sensor locations



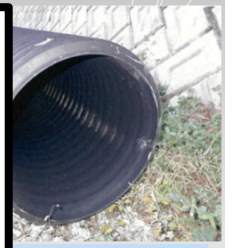
Study of Environmental Effect: Water gravity noise

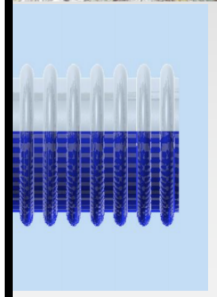
Nishizawa, Kasuya, Hayama, Somiya, Chen

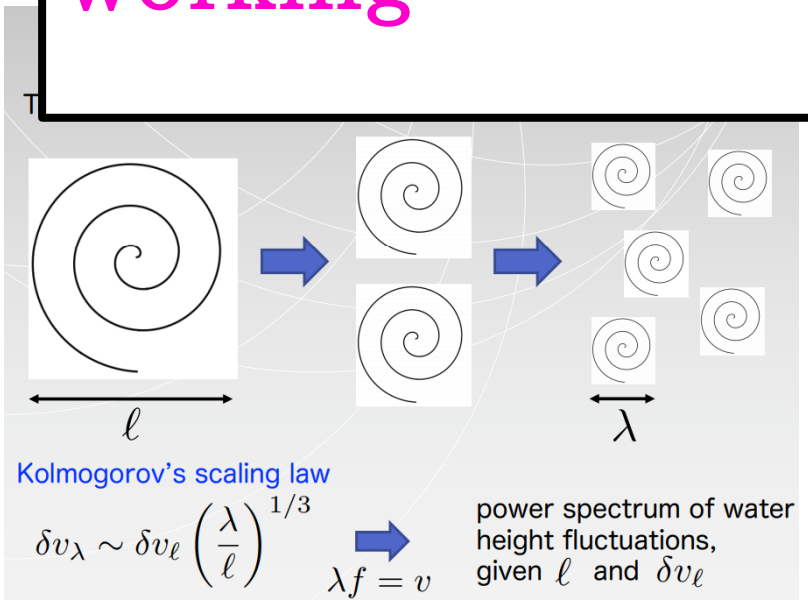
Update :

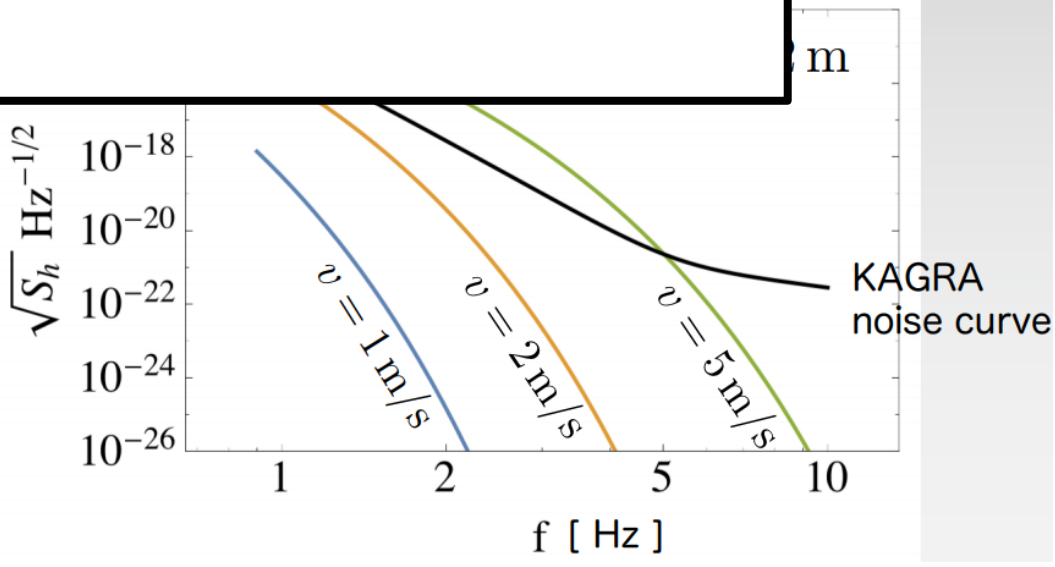
o Analitic studies have been finished.

o Simulation for validation is still working









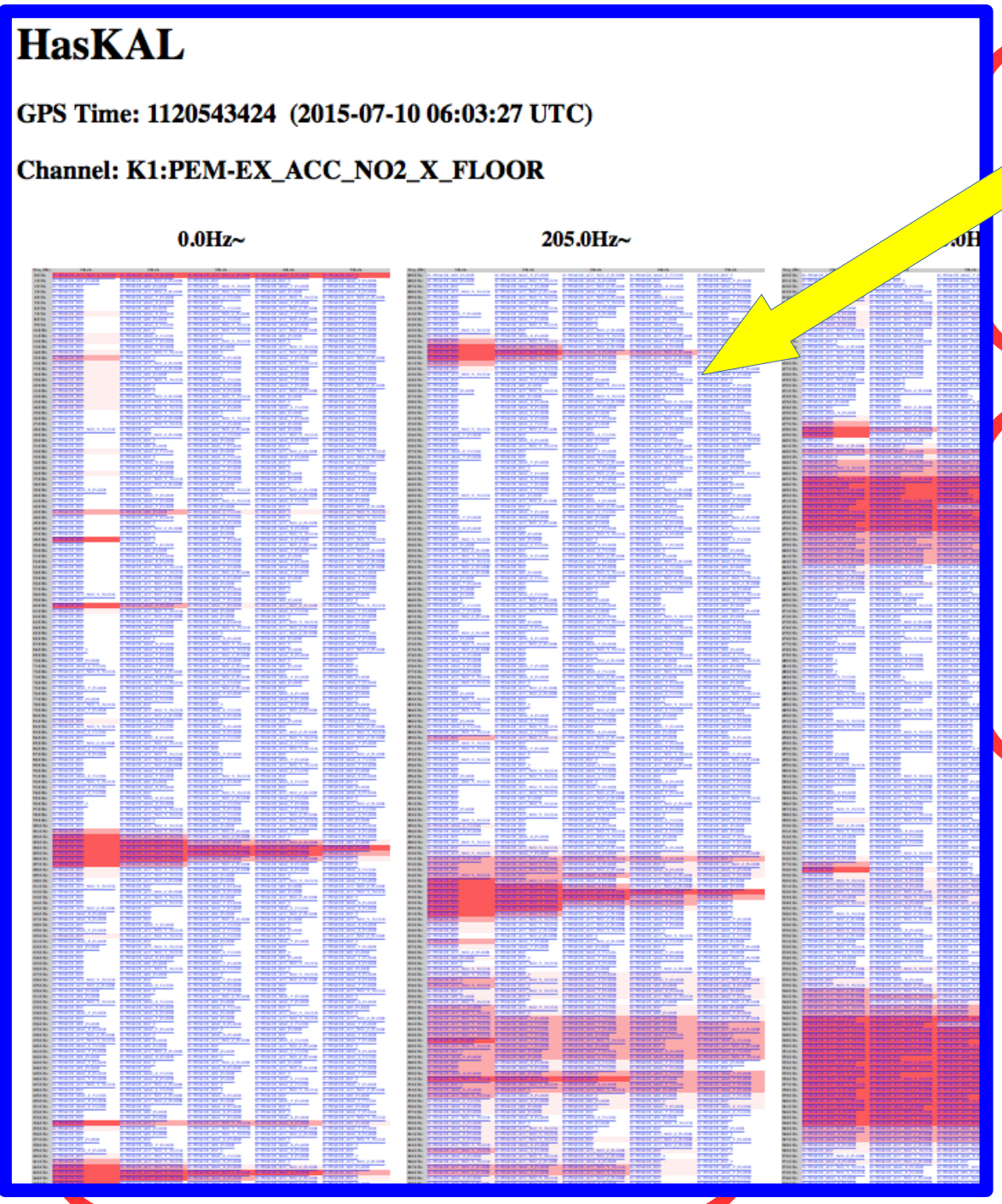
KGWG detchar group

- Safe Channel Study
  for Veto analysis
- CAGMon
  for Bruteforce correlation between channels

Schedule

- Update of tools, web-based summary page
  - Continue to reflect the comments and get comments
  - Will start daily summary page in this Dec. First display will be oplev related plots (request from commissioning team)
- Environmental sensors
  - New seismometers will be tested in this Dec with GIF
- Unknown environmental noise
  - Finish water gravity noise study in this FY..
- DQ study
  - KGWG : hveto analysis, safe channel studies

BruCo



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

- Realtime Quick look webpage
- Daily summary webpage
- GUI Interface
- Web-Base Interface
- Command-line Interface

- Health monitor
- Globally Correlated magnetic noise
- Violin mode
- Multi-channel analysis
- Newtonian noise
  - Effect of water inside the mountain

Daily Summary Page

Calendar

Feb. 2016

Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.
1	2	3	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

Jan. 2016

Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.
				1	2	3
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	31

Dec. 2015

Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.
	1	2	3	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	31			

Nov. 2015

Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.
						1
2	3	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						

Oct. 2015

Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.
			1	2	3	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	31	

Sep. 2015

Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.
	1	2	3	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				

Aug. 2015

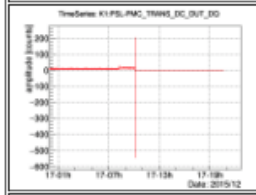
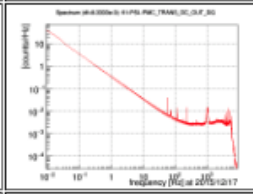
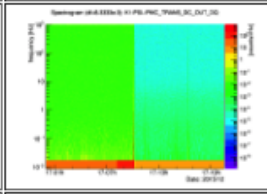
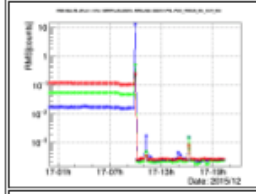
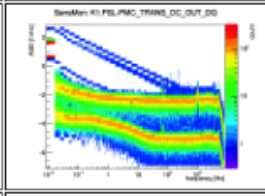
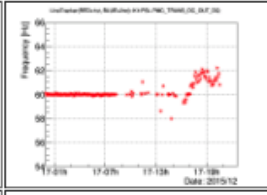
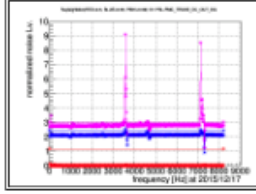
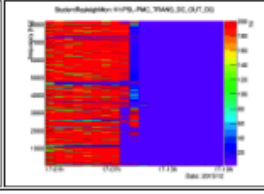
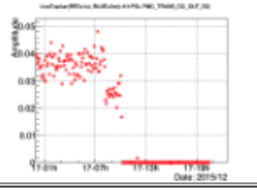
Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

Jul. 2015

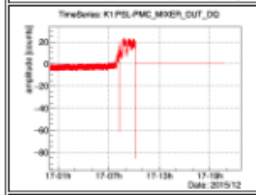
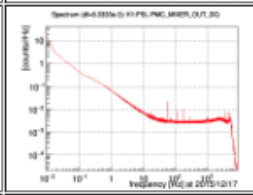
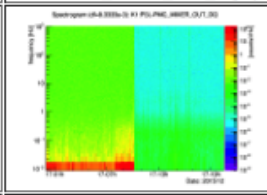
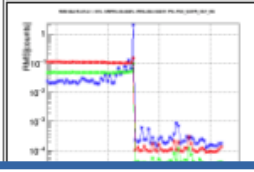
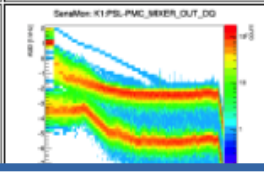
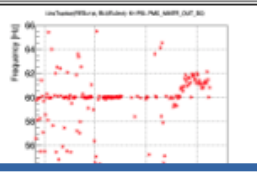
Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.
		1	2	3	4	5

IOO

K1:PSL-PMC_TRANS_DC_OUT_DQ

K1:PSL-PMC_TRANS_DC_OUT_DQ:TimeSeries	K1:PSL-PMC_TRANS_DC_OUT_DQ:Spectrum	K1:PSL-PMC_TRANS_DC_OUT_DQ:Spectrogram
		
K1:PSL-PMC_TRANS_DC_OUT_DQ:RMSMon	**K1:PSL-PMC_TRANS_DC_OUT_DQ:SensMon**	**K1:PSL-PMC_TRANS_DC_OUT_DQ:LTF**
		
K1:PSL-PMC_TRANS_DC_OUT_DQ:RMon	**K1:PSL-PMC_TRANS_DC_OUT_DQ:SRMon**	**K1:PSL-PMC_TRANS_DC_OUT_DQ:LTA**
		

K1:PSL-PMC_MIXER_OUT_DQ

K1:PSL-PMC_MIXER_OUT_DQ:TimeSeries	K1:PSL-PMC_MIXER_OUT_DQ:Spectrum	K1:PSL-PMC_MIXER_OUT_DQ:Spectrogram
		
K1:PSL-PMC_MIXER_OUT_DQ:RMSMon	**K1:PSL-PMC_MIXER_OUT_DQ:SensMon**	**K1:PSL-PMC_MIXER_OUT_DQ:LTF**
		

Web-Based Tools

Correlation between channels

Single Channel Analysis | Coherence Analysis | Correlation Map | Bruco | Detection Range | Daily Summary page

Date:
GPS Time: 1134572417
Local Time:
2015 Dec. 20
0 0 0 JST

Channel List:
make channel list
select channel list (Default)
Channel 1:
K1:PSL-FSS_FAST_MON_OUT_DQ
K1:PSL-FSS_MIXER_OUT_DQ
K1:PSL-FSS_PC_MON_OUT_DQ
K1:PSL-FSS_REFL_DC_OUT_DQ
K1:PSL-FSS_SLOW_MON_OUT_DQ

Parameters:
For General
Duration: sec. (default is 32s)
Freq. band: Hz ~ Hz
(default is from 0Hz to Nyquist freq.)

Monitors:
Pearson Correlation ~~MIC~~

plot view

HasKAL

GPS Time: 1134572417 (2015-12-19 15:00:00 UTC)

duration: 32s **Freq. band:** 0 - fNyquist Hz

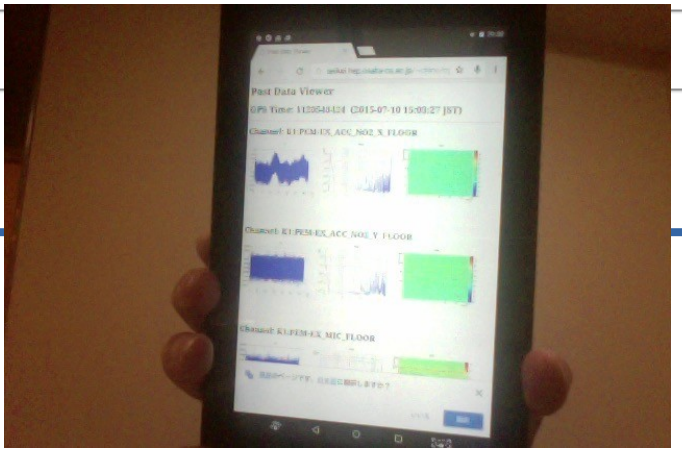
	K1:PSL-FSS_FAST_MON_OUT_DQ	K1:PSL-FSS_MIXER_OUT_DQ	K1:PSL-FSS_PC_MON_OUT_DQ	K1:PSL-FSS_REFL_DC_OUT_DQ	K1:PSL-FSS_SLOW_MON_OUT_DQ
K1:PSL-FSS_FAST_MON_OUT_DQ	1.00000	0.01447	0.02042	NaN	0.01939
K1:PSL-FSS_MIXER_OUT_DQ	0.01447	1.00000	0.01804	NaN	0.01404
K1:PSL-FSS_PC_MON_OUT_DQ	0.02042	0.01804	1.00000	NaN	0.02279
K1:PSL-FSS_REFL_DC_OUT_DQ	NaN	NaN	NaN	1.00000	NaN
K1:PSL-FSS_SLOW_MON_OUT_DQ	0.01939	0.01404	0.02279	NaN	1.00000

Get URL

[< Prev] [Back] [Next >]

Real time quick look page is here

Powerd by HasKAL



NDS tools

- ctl_getChannelInfo

  name, rate, signal_gain, signal_slope, signal_offset, signal_units

- ctl_getData
  you can get TP data in real-time

- ctl_showChannels

- ctl_runSensMon

KGWG detchar group

- Safe Channel Study
  for Veto analysis
- CAGMon
  for Bruteforce correlation between channels

On-Going

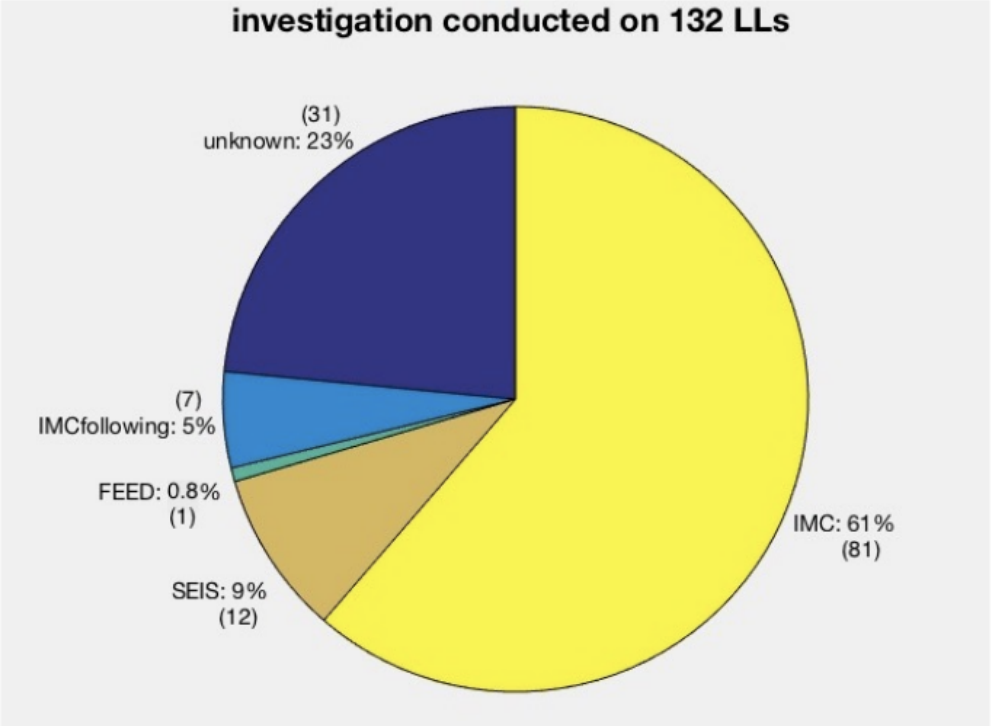
- Magnetometer
  - cabling, making amps, for the connection to rack
- Thermometer, Barometer, Hygrometer
  - 2 start test operation at the X arms (GIF DAQ)
  - cabling, amps finished. prepared for the connection to Kikiseigyo
- Seismometer
  - 2 is running at Xend, Yend
  - 1 is at BS, but realtime model should be checked

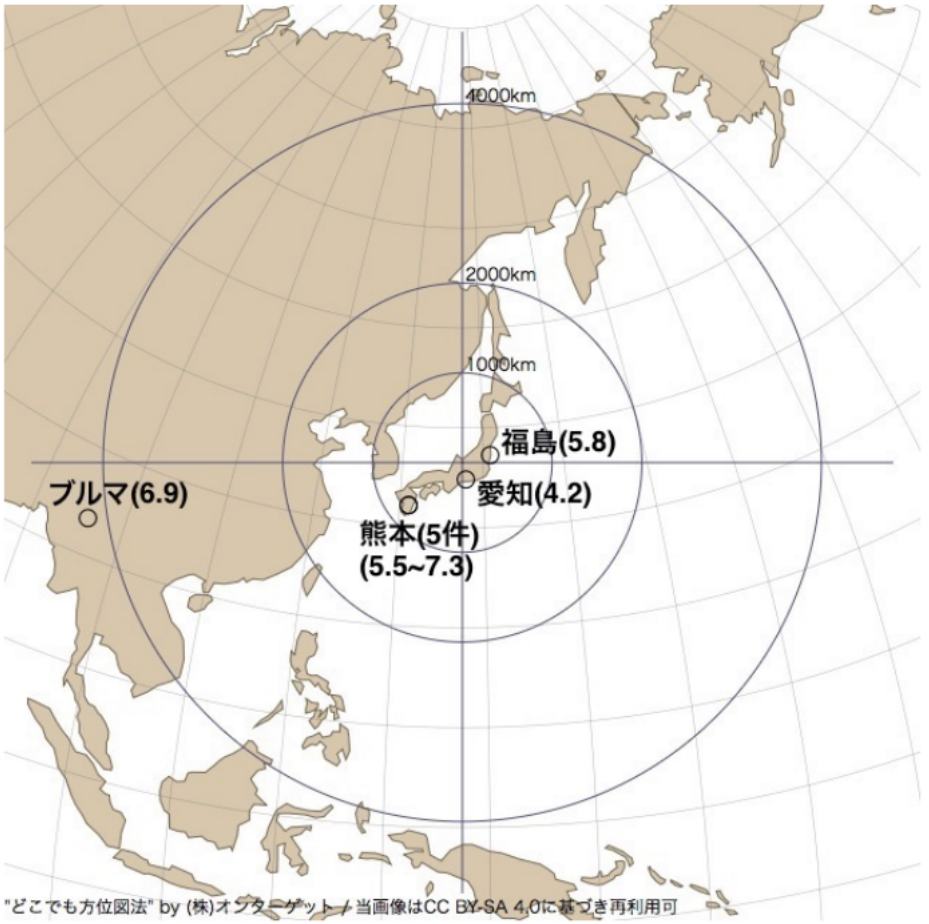
Number of Sensors at present

- **Thermometer : 13**
- **Hygrometer : 13**
- **Barometer : 9**
- **Accelerometer : 10 + 12**
- **Seismometer : 3 + 3**
- **Magnetometer : 4 + 3**
- **microphone +7**

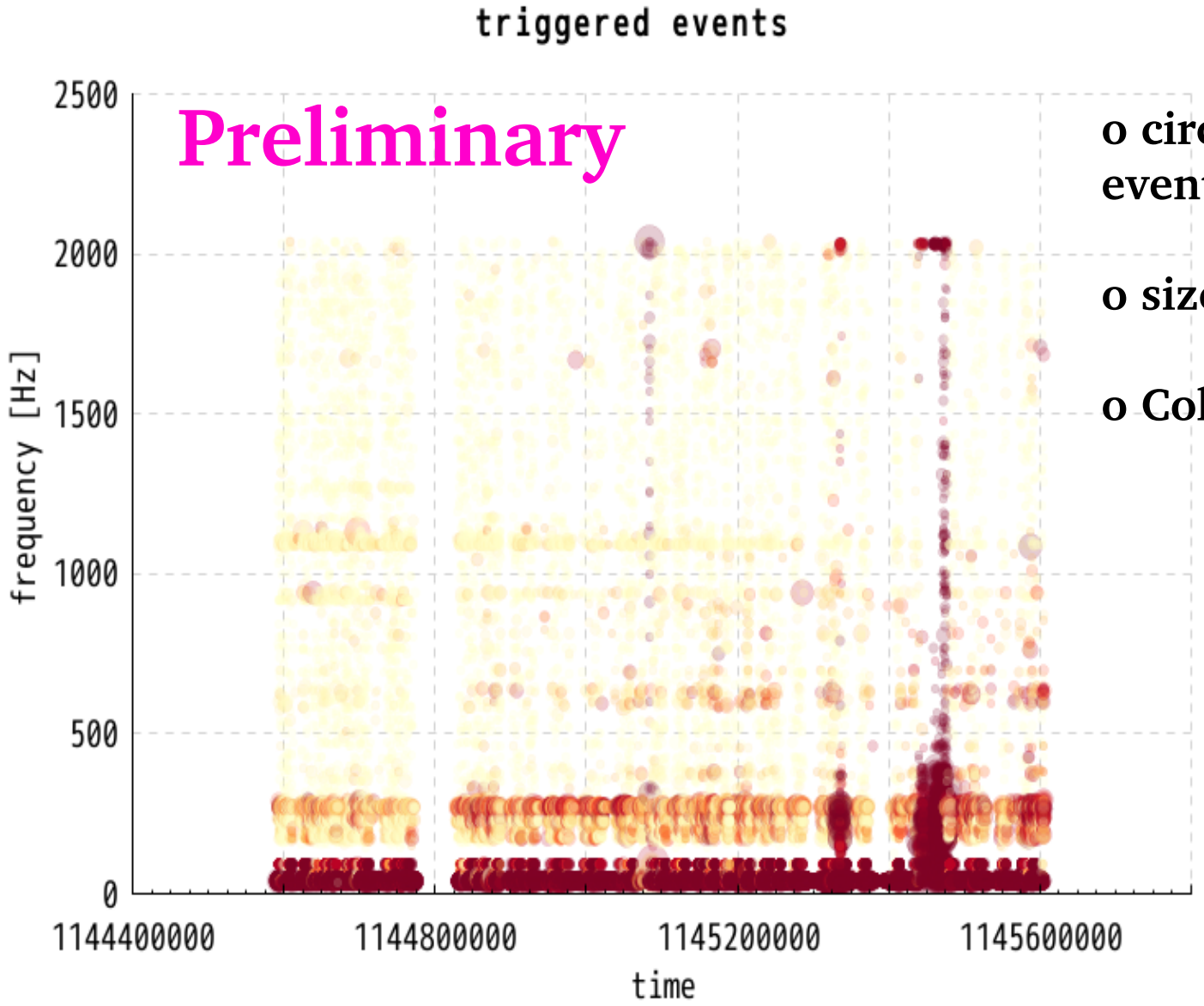
iKAGRA Data Characterization
Lock Loss Study

Miyazaki, Michimura, Hayama, Ando





iKAGRA DQ study

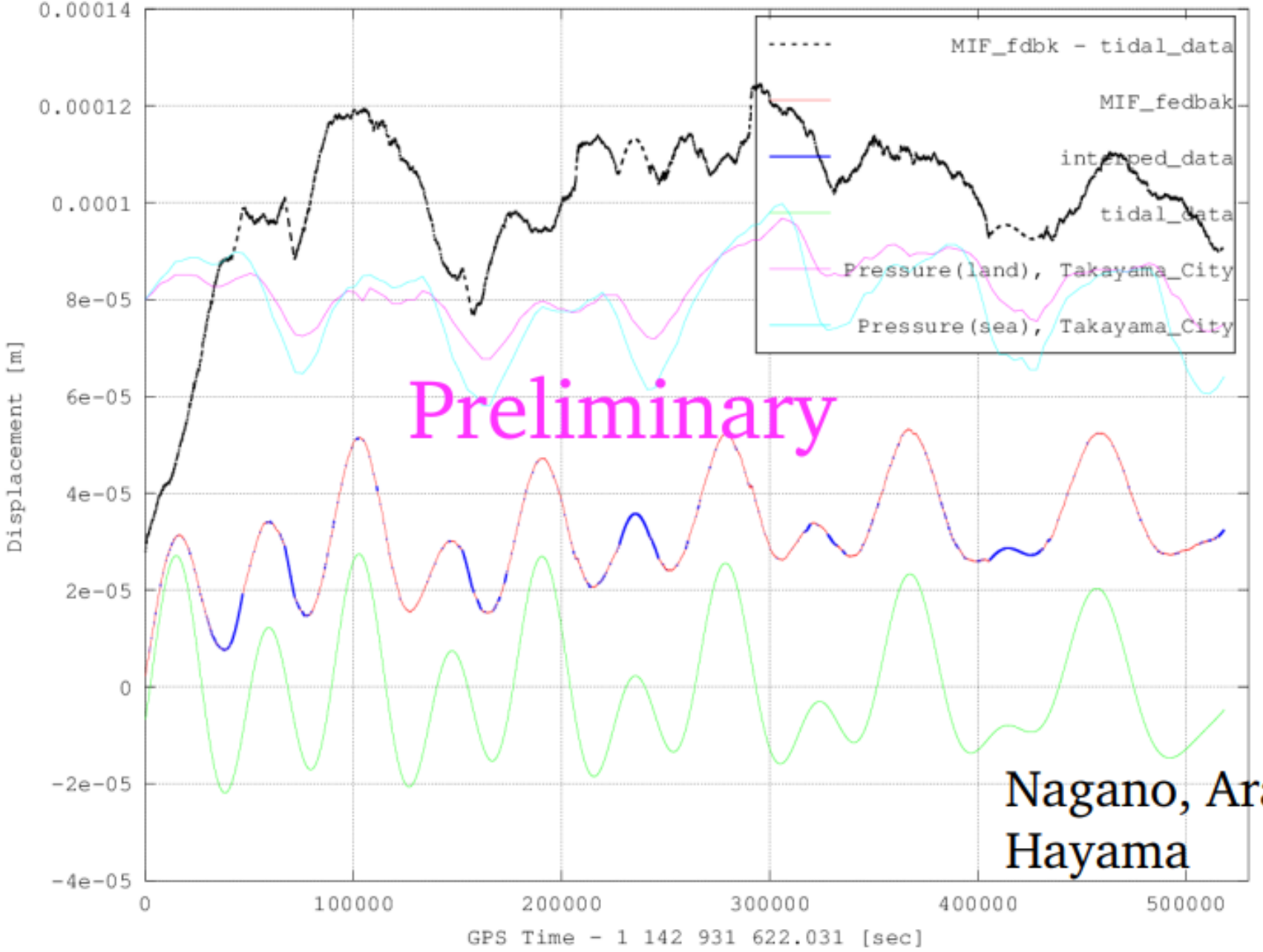


o circle: triggered events

o size: # of pixcels

o Color: SNR

Tidal Distortion(Mar.25-Mar.31)



iKAGRA data chracterization

- Safe Channel Study is on going
- …
- All studies will be compiled˜ November 2017, and be reported.

HasKAL

- Tools for detector diagnostics, data quality study, noise hunting
- Interface
  - CUI (Commandline User Interface)
  - GUI (Graphical User Interface)
  - Web-based
  - Haskell
  - Near future,
    interface of Python、Octave(MATLAB)

Structure of HasKAL modules

- Constant
- DataBaseUtils
- DetectorUtils
- ExternalUtils
- FrameUtils
- GIFUtils
- GUI_Utils
- IOUtils
- LineUtils
- MathUtils
- Misc
- MonitorUtils
- OptimizationUtils
- PlotUtils
- SearchUtils
- SignalProcessingutils
- SimulationUtils
- SpectrumUtils
- StatisticsUtils
- Timeutils
- WaveUtils
- WebUtils

https://github.com/gw-analysis/detector-characterization

Command Line Tools

Tools for cheking channels defined in KAGRA

- existChannel : check whether channel exists at gps
  Usage: existChannel channel gps
- existChannelNow:check whether channel exists now
  Usage: existChannelNow channel
- showChannels : list channels saved in
  Usage: showChannels -f file or showChannels gps
- showChannelandSamplingRate : list of channel and rate
  Usage : showChannelandSamplingRate [-f] gps[file]
- showCurrentChannels : : list of channels at present
  Usage : showCurrentChannels

Tools for time conversion

- localtime2gps : conversion of local time to gps
  Usage: localtime2gps DATE [ST]

  DATE:: yyyy-mm-dd HH:MM:SS

  yyyy mm dd HH MM SS

  ST:: JST, UTC ..
- gps2localtime : conversion of gps to local time
  Usage: gps2localtime GPS [ST]

  ST:: JST, UTC ...
- getCurrentGPS : show current gps time
  Usage : getCurrentGPS
- showGPSInfo : show info of gps related
  Usage: showGPSInfo frameFileName

Tools for data retrieval

- frame2stdout : extract data from gwf file
  Usage: frame2stdout [-t(--withTime), -c(--chachefile)] ch framefile(list)
- removeSpace
- kagraDailyDataFind : daily list of gwf files
  Usage: kagraDailyDataFind day(yyyy-mm-dd) localtime(JST,UTC,etc)
- showKagraData : data retrieval of kagra data
  Usage: showKagraData [-r(--resample) P/Q, -l(localtime)] chname gps duration
- gif_bin2stdout : data retrieval of main GIF

  Usage: gif_bin2stdout fD(fF) filepath

Quick analysis

- filter : High(Low) pass filter
  Usage: filter ch fs f_cutt type[High, Low] stdin
- window : taking window function
  Usage: window [-t(--withTime), -w(--windowtype) WinType] stdin
  available window function is Hann, Blackman, Hamming, Tukey, Kaiser
- resampler : P/Q resampling
  Usage: resampler ch P/Q fs stdin
- BLRMS : Band limited root mean square
  Usage: BLRMS [-t(--withTime)] t0 fs fftsec channel f1low f1high STDIN
- runDataConditioningSTDIN : whitening filter
  Usage runDataConditioningSTDIN conffile fs startGPStime STDIN
- runEventTriggerGenerationSTDIN : event trigger generation
  Usage runEventTriggerGenerationSTDIN conffile fs startGPStime STDIN
- plotter : plot data
  Usage: plotter -X ch fs t0 stdin
- plotTimeseries : plot time series data with some options
  Usage: plotTimeseries [-r P/Q] [-o outputFile] [-i inputData] [-X] [-p figfile] stdin
- plotHistgram : plot histogram
  Usage: plotHistgram title min max #bin stdin
- plotSpectrum : plot spectrogram
  Usage: plotspectrum [-X] [-p figFile] ch fs t0 dt stdin
- plotSpectrogram : plot spectrogram
  Usage: plotSpectrogram [-X] [-p figFile] ch fs t0 dt ot stdin

dropData : drop n samples from the beginning
Usage: dropData n stdin

takeData : take n samples from the beginning
Usage: takeData n stdin

maximum : index and value of the maximum value
Usage: maximum stdin

minimum : index and value of the minimum value
Usage: minimum stdin

mean : mean value of the list from stdin
Usage: mean stdin

std : standard deviation of the list from stdin
Usage: std stdin

var : variance of the list from stdin
Usage: var stdin

sqrt : take square of the list from stdin
Usage: sqrt stdin

bekijo : beki-jo of the list from stdin
Usage: bekijo stdin

Tools for simulation

- amplifier : multiply constant value to the list from stdin
  Usage: amplifier [-t(--withTime)] amp stdin
- signalInjection : signal injection tools
  Usage: signalInjection [-t(--withTime)] sigfile n t0 fs stdin
- GWDetectorResponseInjection : GW(plus,cross) injection
  Usage: GWDetectorResponseInjection [-t(--withTime)] sigfile det phi theta psi n t0 fs stdin
- getAntennaPattern : return value of antenna pattern function
  Usage: getAntennaPattern det longitude(deg) latitude(deg) psi(deg)
  Output : F+, Fx, delay from when GW reached at the reference (the center of the earch)

Tools in the KAGRA control room

- ctl_getChannelInfo : channel information from nds
  Usage: ctl_getChannelInfo [OPTION...] gps[localtime] channel1 channel2 …
  -l --localtime getChannelInfo -l "2017-01-01-00:00:00 JST" channel
- ctl_getData : data retrieval from nds
  Usage: ctl_getData [OPTION...] channel gps[localtime] duration

  -l --localtime ctl_getData -l channel "2017-01-01-00:00:00 JST" duration
- ctl_showChannels : channel list from nds
  Usage: showChannels -f file or showChannels gps...

  -f FILE --file=FILE frame file
- ctl_runSensMon : show result of sensmon from nds data
  Usage: runSensMon [OPTION...] "yyyy-mm-dd hh:mm:ss Locale" duration fftsec ch

  -r P/Q --resample=P/Q resampling factor P/Q

  -o --output output FILE

  -l --Localtime Localtime

  -p FILE --plot=FILE plot file

  -X --Xplot X plot

Monitor tools

- runCoherenceMon : taking coherence between two channels
  Usage: CoherenceMon yyyy mm dd hh mm ss duration fftsec ch1 ch2
- runRMSMon : show BLRMS of 3 selected frequency bands
  Usage: RMSMon yyyy mm dd hh mm ss duration fftsec channel f1low f1high f2low f2high f3low f3high
- runRMSMonSTDIN : same but data is given from STDIN
  Usage: RMSMon t0 fs fftsec channel f1low f1high f2low f2high f3low f3high STDIN
- runRangeMonNSNS : NS-NS inspiral range at SNR of 8
  Usage: runRangeMonNSNS yyyy mm dd hh mm ss chunk[s] duration [s] channel
- runRangeMonBHBH : BH-BH inspiral range at SNR of 8
  Usage: runRangeMonNSNS yyyy mm dd hh mm ss chunk[s] duration [s] channel
- runRayleighMon : Rayleigh distribution to know Gaussianity

  Usage: runRayleighMon fs dtfft df ID framefile
- runRayleighMonDat : same but data in a given file

  Usage: runRayleighMon fs dtfft df ID datfile(one-column)
- runRayleighMonSTDIN : same but data from STDIN
  Usage: runRayleighMon fs dtfft df stdin
- runBruco : take Bruto force coherence
  Usage: Bruco yyyy mm dd hh min ss duration[s] fftsec[s] mainch ch.lst

- runSensMon : spectrum histogram
  Usage: SensMon yyyy mm dd hr min sec dur fftsec ch
- runSensMonDat : same but data in a given file
  Usage: SensMon fs dur fftsec ID ColumnAsciiFile
- runSensMonSTDIN : same but data from STDIN
  Usage: SensMon fs dur fftsec ID stdin
- runStudentRayleighMon : non-Gaussianity using Student-t
  Usage: SRMon yyyy mm dd hh mm ss duration[s] chunklen[s] fftsec[s] dt[s] df[Hz] channel
- runLineTrackMon : tracking frequency and amplitude of lines
  Usage: LT yyyy mm dd hh mm ss duration nframe fcenter channel
- runLineTrackMonSTDIN : same but data from STDIN
  Usage: runLineTrackMonSTDIN t0 fs nframe fcenter STDIN
- runGlitchMonCachefile : glitch monitor for a given gwf filelist
  Usage: runGlitchMonTime chname fname
- runGlitchMonGWFfile : same for a gwf file
  Usage runGlitchMonFile chname fname
- runGlitchMonDATfile : same for a dat file
  Usage runGlitchMonFile conffile fs startGPStime datfile
- runGlitchMonSTDIN : same for data from STDIN
  Usage runGlitchMonSTDIN conffile fs startGPStime STDIN