

Status of KAGRA Detector Characterization

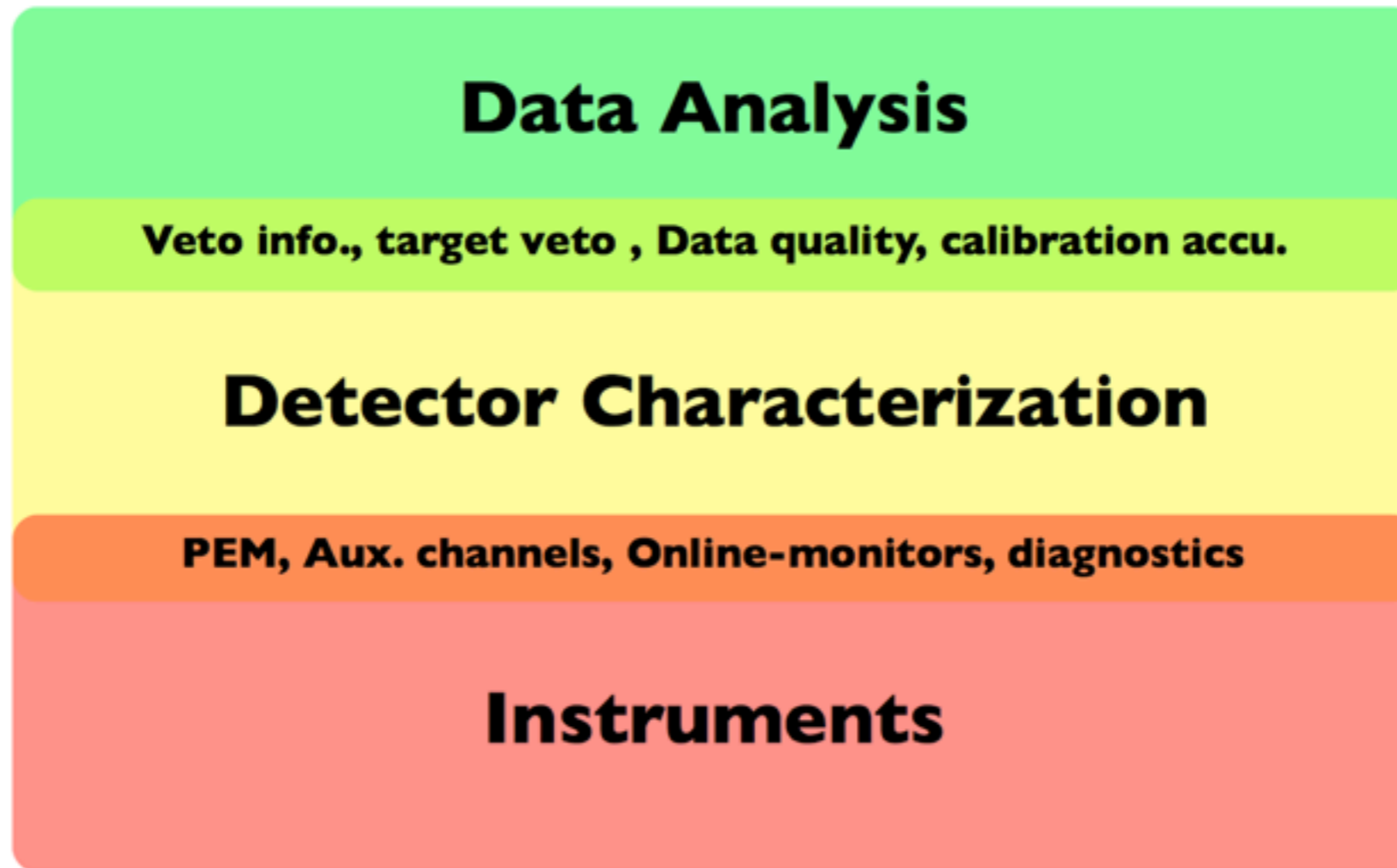
**Kazuhiro Hayama
on behalf of detector characterization group**

Human Resources



- **Kazuhiro Hayama**
- **Asano, Itoh, Mano, Ono, Yamamoto, Yokozawa, Yuzurihara, Narikawa, Ueno, Kanda, and so on**
- **John Oh, SangHong Oh, Young-Ming Kim, Edwin Son (KGWG)**
- **Keiko Kokeyama (LIGO)**
- **Didier Verkindt (Virgo)**

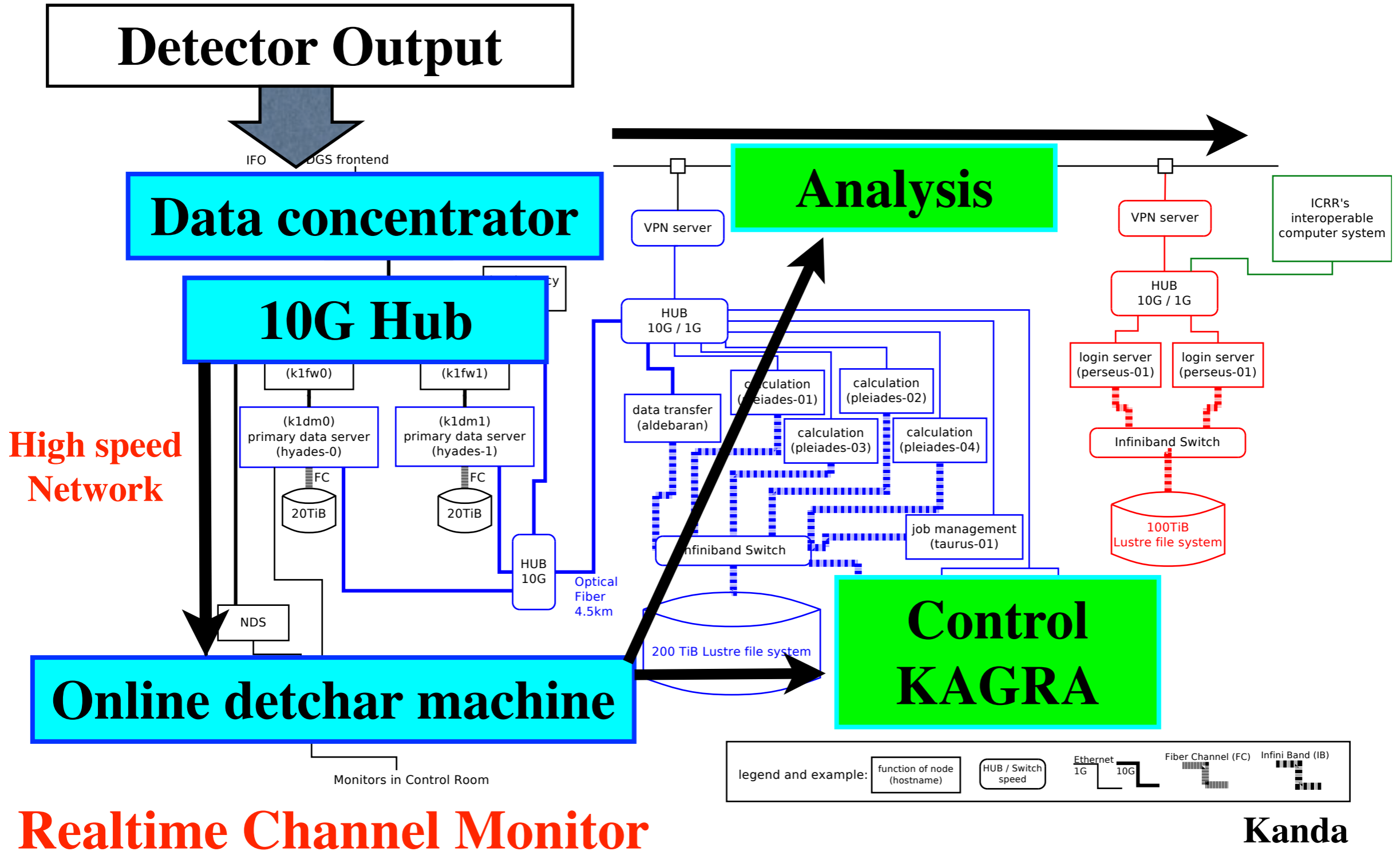
Interface of the detector characterization



Two Direction : To provide system, tools for

- **Detector diagnostics, helping speed-up commissioning**
- **Monitor data quality, Veto analysis**

Detector Characterization Cluster



Subsystem detector characterization

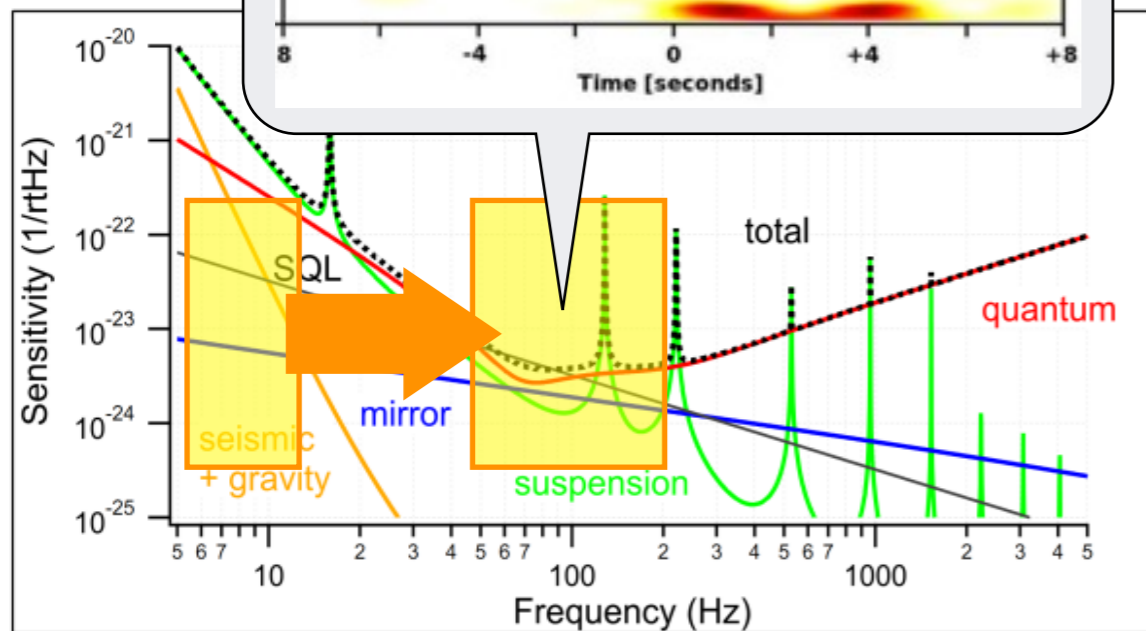
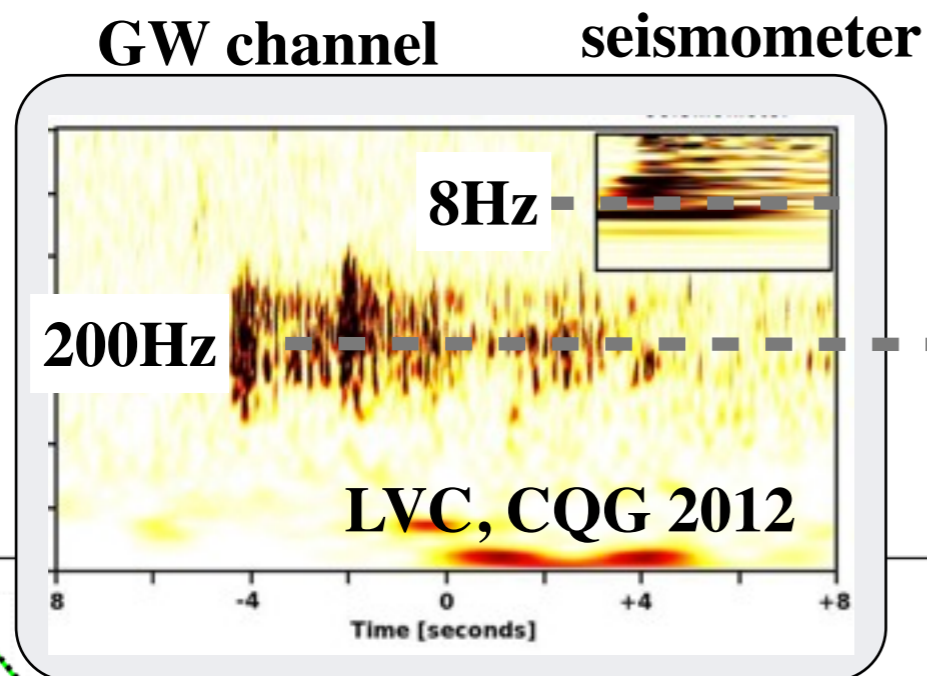
Speed-up commissioning

- **Single Subsystem Diagnostics**
 - **ADC noise is within range?**
 - **Whitening requirement?**
 - **Channel correlated noise?**
 - **Find good frequency region for calibration**
 - **Components consisting the subsystem is working correctly?**
 - **Noise budget**
- **Kill source of glitches, lines**
- **Will provide tools to do these effectively.**
- **Important to cooperate with subsystems at early phase of the development. (First, with VIS people)**

Multiple-subsystem characterization

Speed-up commissioning

Example of correlated noise between subsystems



Sensitivity curve of KAGRA

- Need to watch channels over subsystems
- **Up-conversion noise:** seismic glitches will excite optical bench motion which cause scattered light noise.
-> AOS-VIS channels
- **Non-linear correlation analysis** between multiple subsystems, **Multi variate analysis** using lots of channels will be important to find/understand/kill such noise source.

Data quality monitor, Veto Analysis

Data quality Evaluation

Category	Definition	Prescription for analyses
CAT1	Flags obvious and severe malfunctions of the detector.	Science data are re-defined when removing CAT1 segments.
CAT2	Flags noisy periods where the coupling between the noise source and the DF is well-established.	Triggers can be automatically removed if flagged by a CAT2 veto. Good performance.
CAT3	Flags noisy periods where the coupling between the noise source and the DF is not well-established.	CAT3 flags should not be applied automatically. Triggers flagged by a CAT3 veto should be followed up carefully.

LVC

Post processing : Veto Analysis for doing Science

Veto list generation		
Transient GW (CBC, Burst)	Continuous GW (pulsar, LMXB, ...)	Stochastic GW (Early Univ, ...)
<ul style="list-style-type: none"> • Real-time glitch detection • Glitch classification • Coincidence analysis between the GW channel and auxiliary sensor channels. • ... 	<ul style="list-style-type: none"> • Line tracking • Line detection • Removal of high frequency spikes • ... 	<ul style="list-style-type: none"> • Noise floor monitor • Non-stationary • ...

DetChar Tools



- Software developed on GitHub, free, no maintenance is needed. We can concentrate into development.
- Progress is reported in detchar blog

<http://gwclio.icrr.u-tokyo.ac.jp/lcgsubgroup/detectorcharacterization/>

15 commits per a week

The screenshot shows the GitHub repository page for 'detector-characterization'. At the top, statistics are displayed: 365 commits (circled in red), 3 branches, 0 releases, and 8 contributors. Below this is a progress bar and a dropdown menu for the 'master' branch. The commit history is shown as a list of changes:

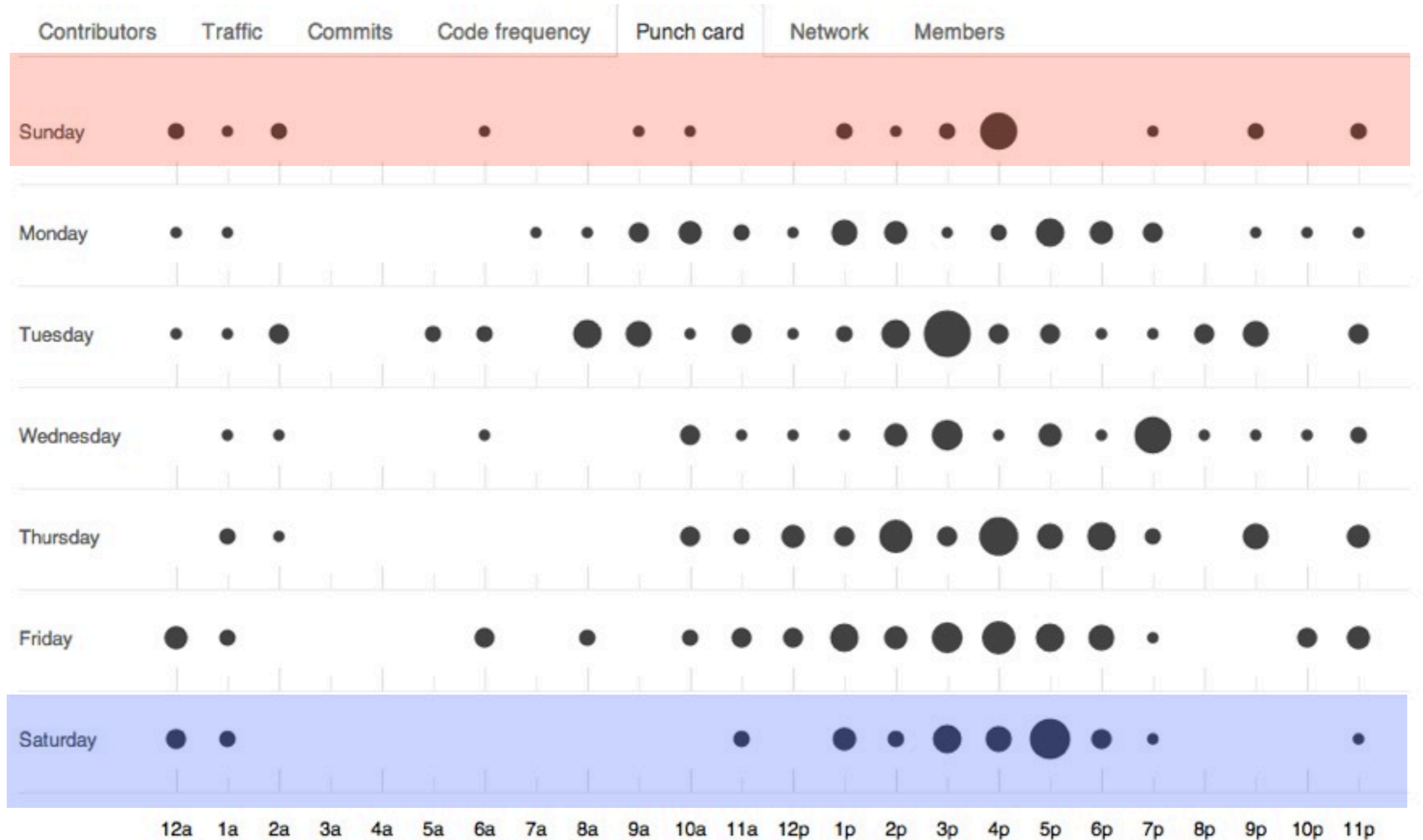
Commit Message	Author	Time
added test code to perform permutation test in haskell	enoshima	22 hours ago
HasKAL rename files		22 hours ago
attic added test code to perform permutation test in haskell		22 hours ago
optFiles add test code for student rayleighMon		17 days ago
test test (Asano)		9 days ago
.gitignore Initial commit		6 months ago
HasKALopt window function is selectable in gwpsdCore		a month ago

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

Weekly Activities



○ Circle shows volume of commits



12a 1a 2a 3a 4a 5a 6a 7a 8a 9a 10a 11a 12p 1p 2p 3p 4p 5p 6p 7p 8p 9p 10p 11p

1am

10am

5pm

11pm

Structure of HasKAL



DetectorUtils	fix bug in Detector module
ExternalUtils	change module name
FrameUtils	change Type of the sampling frequency, Double. change the local funct...
GUI_Utils	add FitMethod type for SRMon
Misc	add module of flip for 3 parameters
MonitorUtils	modify bug of StochMon
PlotUtils	add plotSaveAsPicture function in module
SignalProcessingUtils	reduced input number of filter functions
SimulationUtils	move DetectorNoiseGenerator.hs
SpectrumUtils	move DetectorNoiseGenerator.hs
StatisticsUtils	rename files
TimeUtils	make gps2timetuple by yokozawa

<https://github.com/gw-analysis/detector-characterization/tree/master/HasKAL/src/HasKAL>

DetChar projects

Primary Projects

- To maintain Diagnostics Test Tool
- Detchar GUI
- Glitch Monitor
- Detchar web page
- Line Monitor
- Noise Modeling
- Rayleigh Monitor
- Noise Floor Monitoring
- Range Monitor
(Inspiral,
Ringdown,
Insp-Merger-Ringdown,
Stochastic)
- Noise Budget
- Health Monitor
- Data base
- Quality flag

Special Projects

- Globally correlated mag noise
 - Violin mode
 - Multi-Channel Analysis
(with Korea detchar, Mano)
 - Detchar shift plan
 - Newtonian Noise
- in progress
 in slowly progress

Noise Characterization at the KAGRA site



DetChar GUI

Running Glitch Monitor (kleineWelle)

The screenshot displays the DetChar GUI interface. The 'KleineWelle' window is active, showing a list of parameters for monitoring. The 'Cache file' is set to 'gwffiles_sort...'. The date and time are set to 2014, 3, 17, 16:15:12 JST. The plot titled 'TITLE 3' shows a scatter plot of data points with a y-axis from 0 to 700 and an x-axis from 1079075742.5 to 1079075757.5. The plot contains several colored circles (blue, green, orange, red, yellow) representing data points. A legend at the bottom left of the plot shows a blue circle labeled 'HOGHEHOGE'.

Cache file: gwffiles_sort...

Year: 2014

Month: 3

Day: 17

Hour: 16

Minute: 15

Second: 12

timeZone: JST

Parameters:

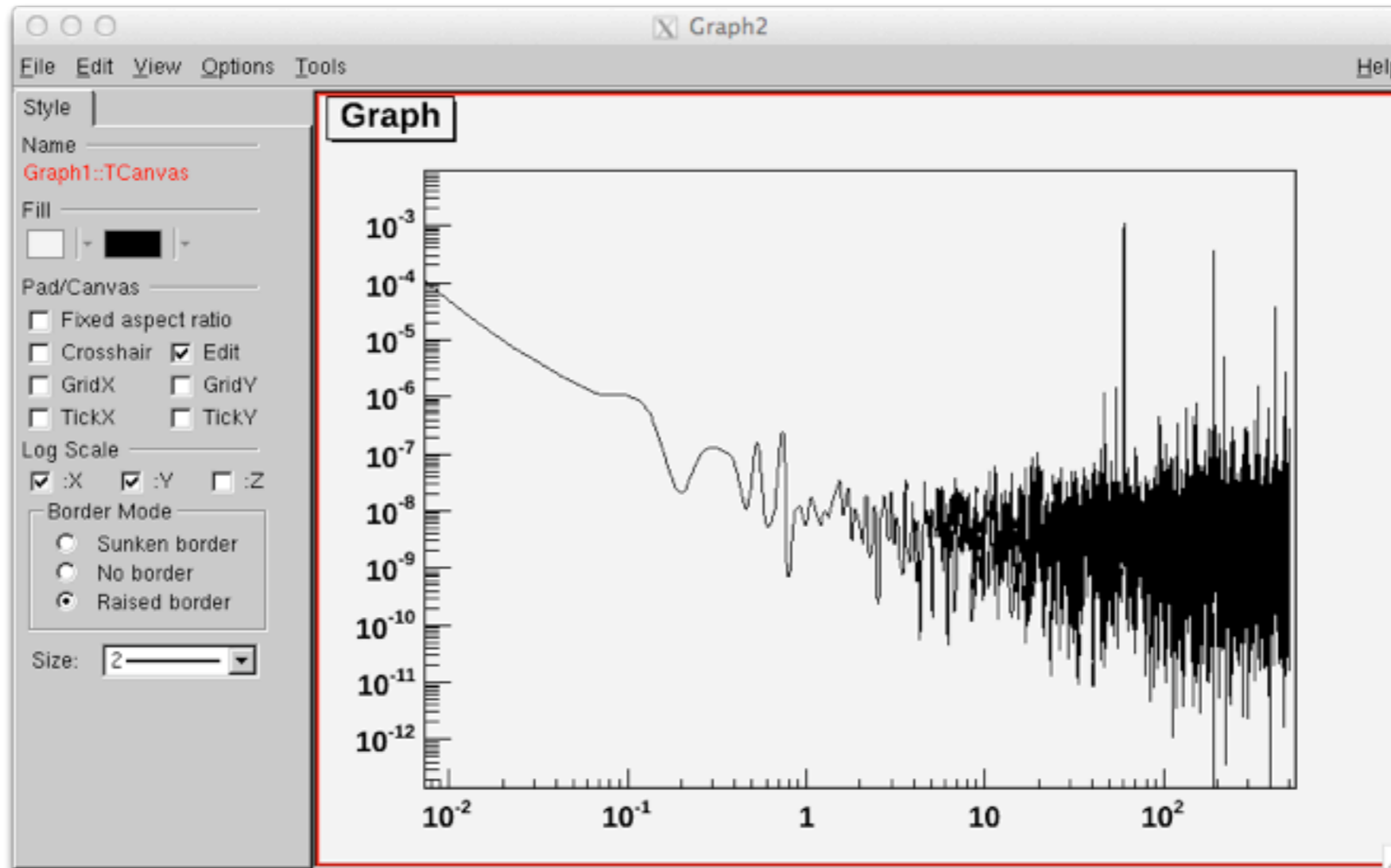
- ifo
- peak_time
- peak_time_ns
- start_time
- start_time_ns
- duration
- search
- central_freq
- channel
- amplitude

Buttons: Glitch, Line, Gaussianity, RangeMon, Exit, KleineWelle, Close

```
Write data. Start: 1079075824:000000000 end: 1079075840:
1:X15-ADC_FILTER_00_IN1_DQ-1079075824-16.xml
Write data. Start: 1079075840:000000000 end: 1079075856:
Q-1079075824-16.xml
# finished processing stride - Thu Jun 19 16:51:57 2014
# processing at 1079075840:000000000 offset 1.07908e+09
Write data. Start: 1079075840:000000000 end: 1079075856:
1:X15-ADC_FILTER_00_IN1_DQ-1079075840-16.xml
Write data. Start: 1079075840:000000000 end: 1079075856:
Q-1079075840-16.xml
# finished processing stride - Thu Jun 19 16:51:57 2014
# processing at 1079075856:000000000 offset 1.07908e+09 16 0 - T
Write data. Start: 1079075856:000000000 end: 1079075872:000000000
1:X15-ADC_FILTER_00_IN1_DQ-1079075856-16.xml
Write data. Start: 1079075856:000000000 end: 1079075872:000000000
Q-1079075856-16.xml
# finished processing stride - Thu Jun 19 16:51:57 2014
No more requested files
synch: Unable to fetch next frame
Synch failed
# finished.
Data environment has terminated with Term/Attn/finish/EOF =0/0/0/
Run Plot tool
```

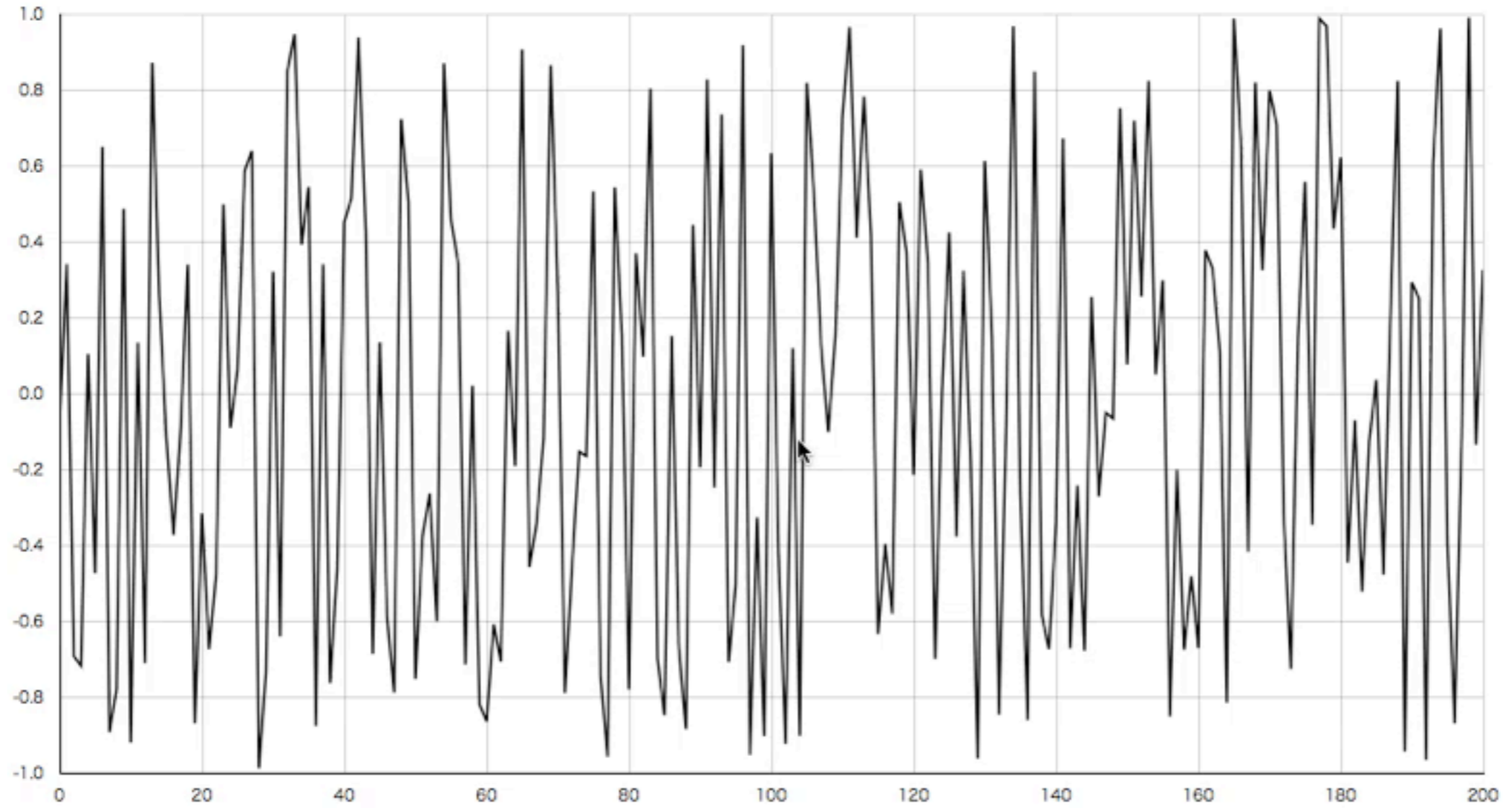
Yamamoto+

ROOT based plotting



Yuzurihara

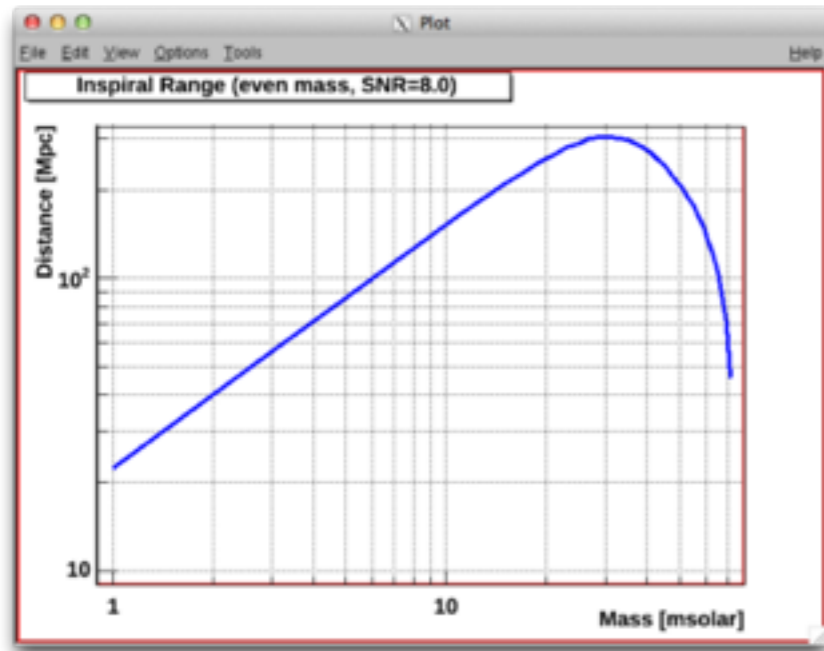
Dynamical Plotting Tools



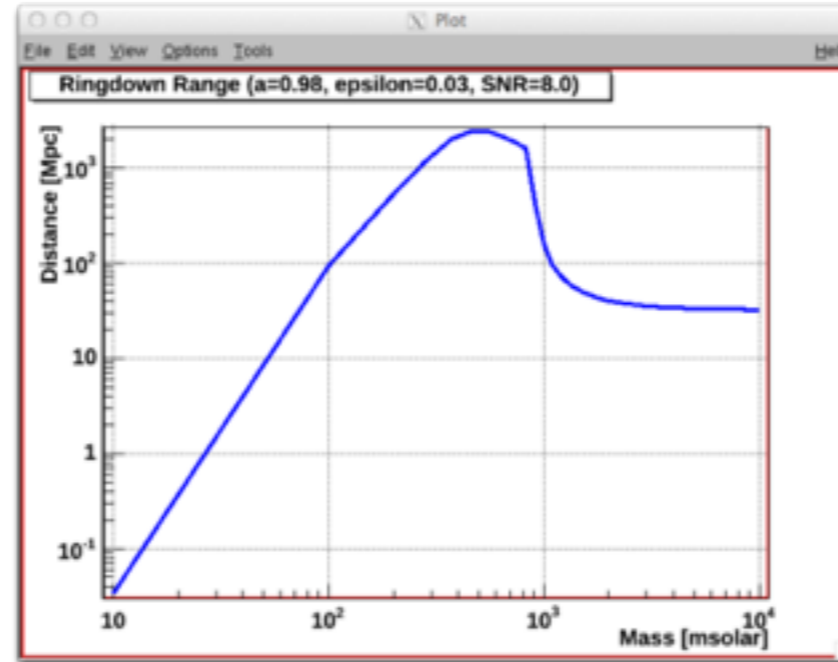
Range Monitor

Characterizing telescope sensitivities

Inspiral



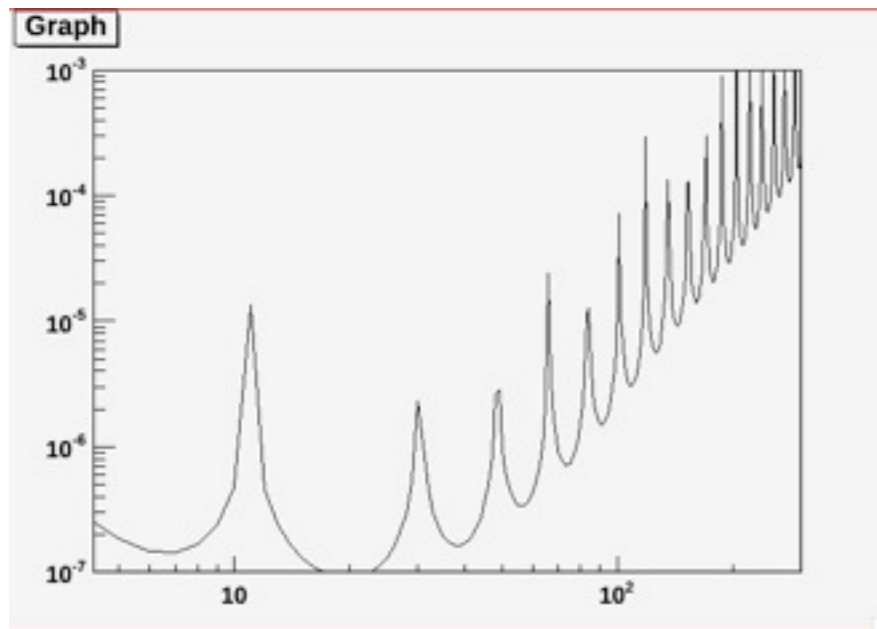
Ringdown



IMBH (Inspiral+Merger+Ringdown)



Stochastic

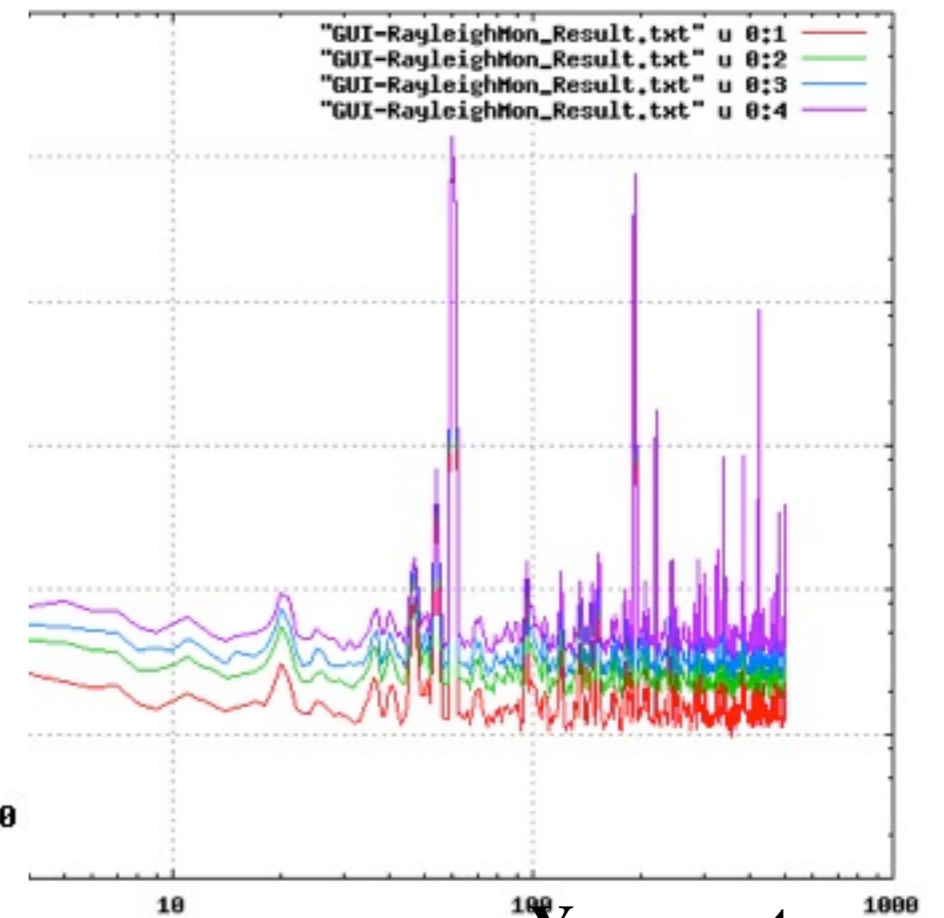
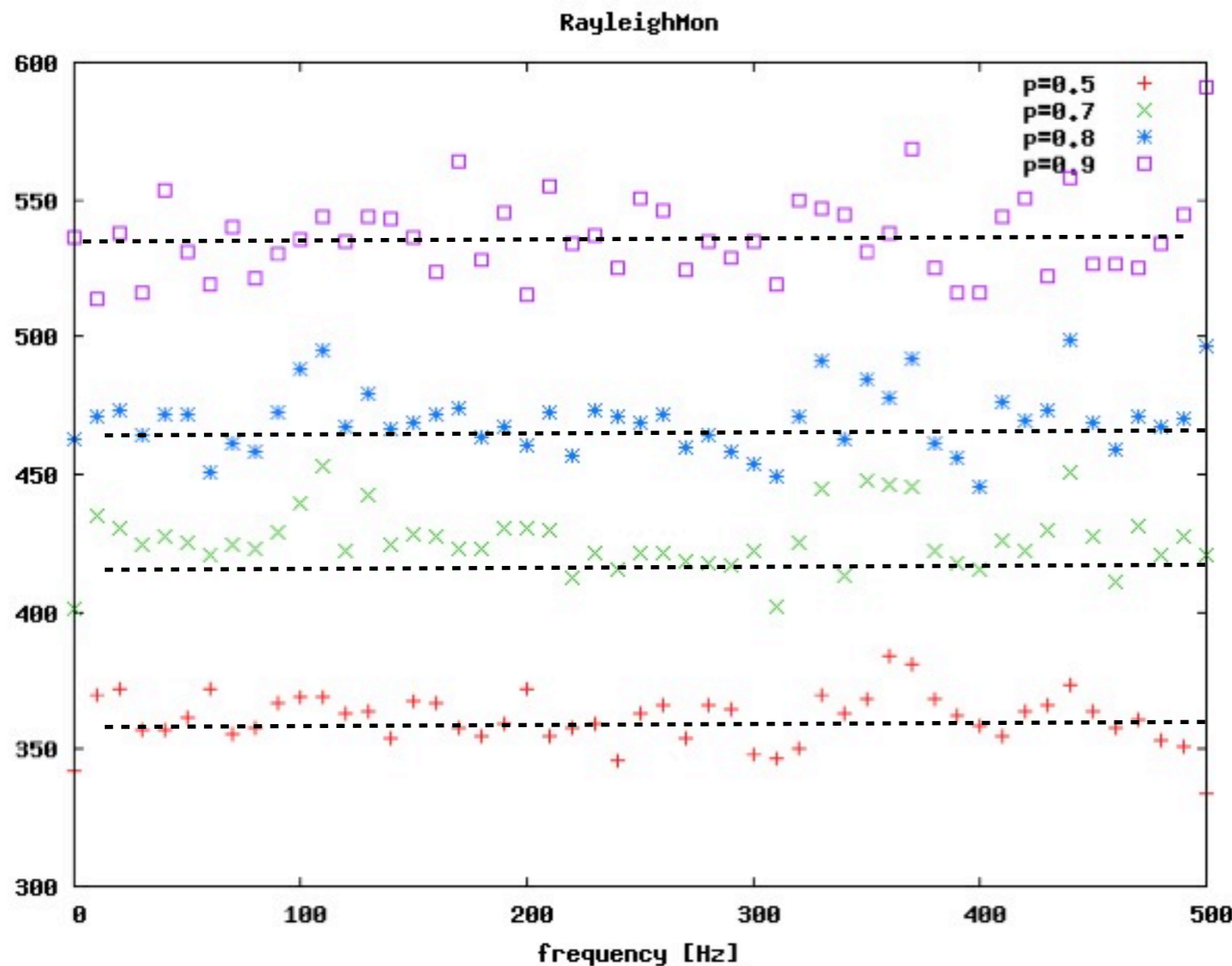


Ono, Hayama, Yokozawa

Rayleigh Monitor



Investigating noise behavior at various frequency regions



Yamamoto

Correlation Analysis



- Finding both linear and **nonlinear** correlations between channels and infer such as up-conversion noise which are not found/understood.

○

	ch1	ch2	ch3	ch4	ch5	ch6
ch1	1.00	-0.41	-0.51	0.75	0.80	-0.75
ch2	-0.41	1.00	0.05	-0.46	-0.57	0.42
ch3	-0.51	0.05	1.00	-0.33	-0.35	0.34
ch4	0.75	-0.46	-0.33	1.00	0.82	-0.98
ch5	0.80	-0.57	-0.36	0.82	1.00	-0.82
ch6	-0.75	0.43	0.34	-0.98	-0.82	1.00

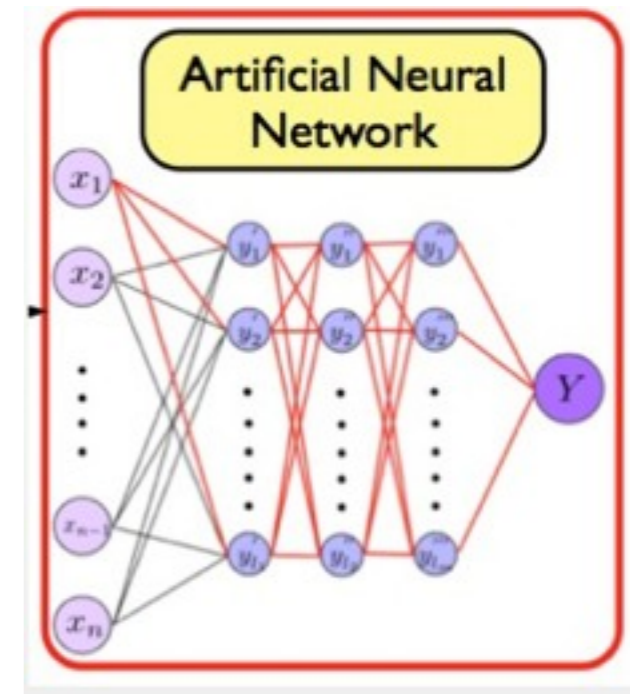
Yuzurihara

Development of New Noise Characterization Tools



- **Realtime non-Gaussian noise modeling**
 - **In reality, even stationary noise is different from Gaussian noise.**
- **Globally detector network monitor**

Multi-Channel Analysis



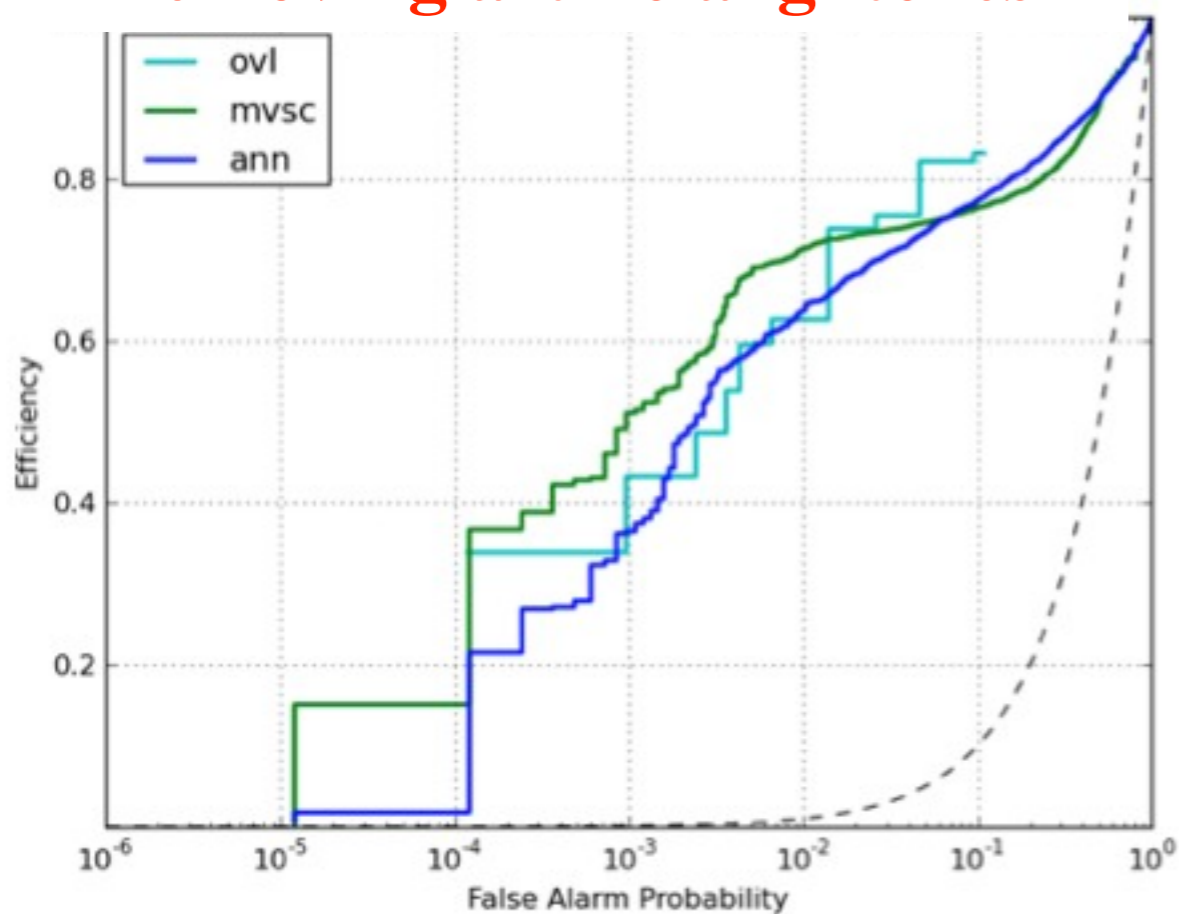
- Lead by Korean GW group
- Initial Goal:
 - Development of a method **for localize noise sources using auxiliary channels and PEMs** to support find/kill noise sources.
 - **KGWG has been developing ANN** based one for post-processing analysis in LVC.
 - We **focuses on a tool useful for commissioning.**
- **Account to access KISTI cluster**

Integrating iDQ into HasKAL

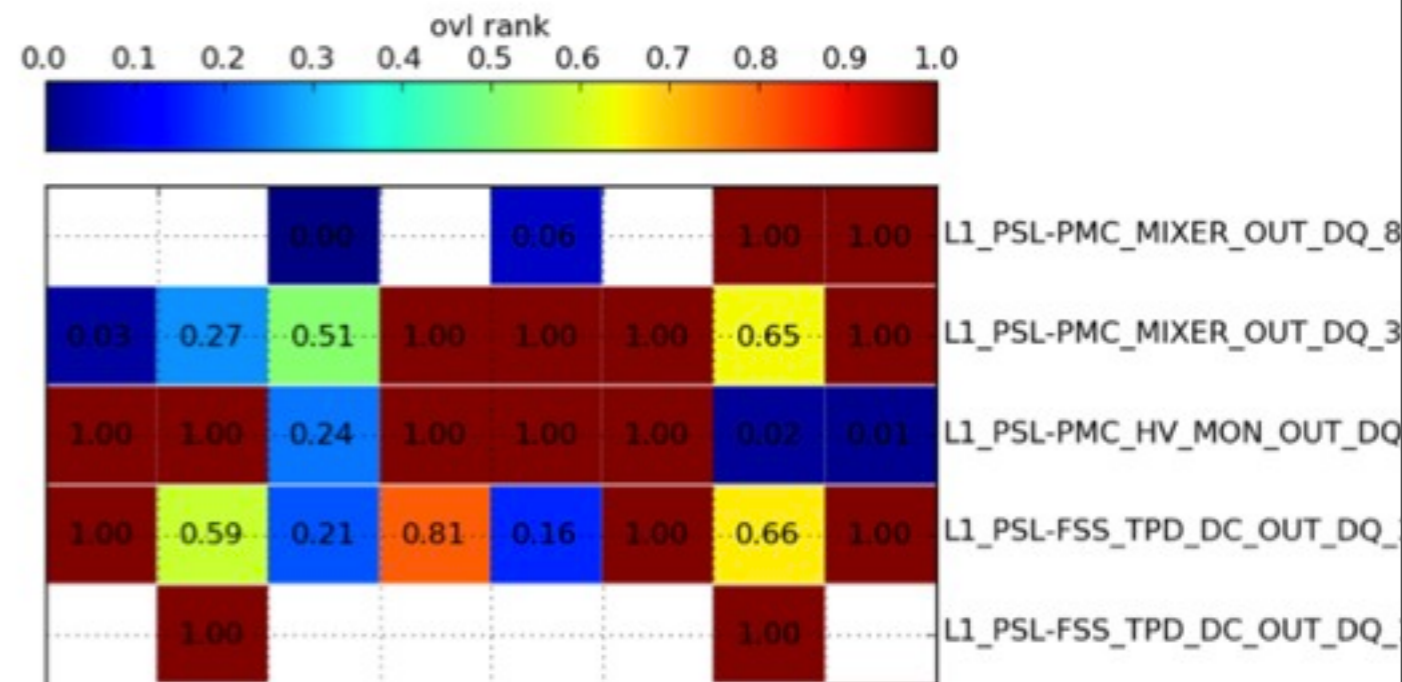
- a low-latency pipeline which makes event-by-event predictions about the glitchiness of GW data based on auxiliary channel informations and provides data quality information.
- Finding responsible channels of glitches

Will integrate iDQ into HasKAL.

Improvement of efficiency by removing artificial glitches



Finding glitch-introduced channels



Young-Min Kim (Pusan Nat'l Univ.)

Japan-Korea KAGRA DetChar Call @ April 22, 2014

Data quality study (cryogenic glitches)



Daisuke Tatsumi (NAOJ)

Reduction of **cryogenic induced glitches**

KAGRA is a unique cryogenic detector in the world.

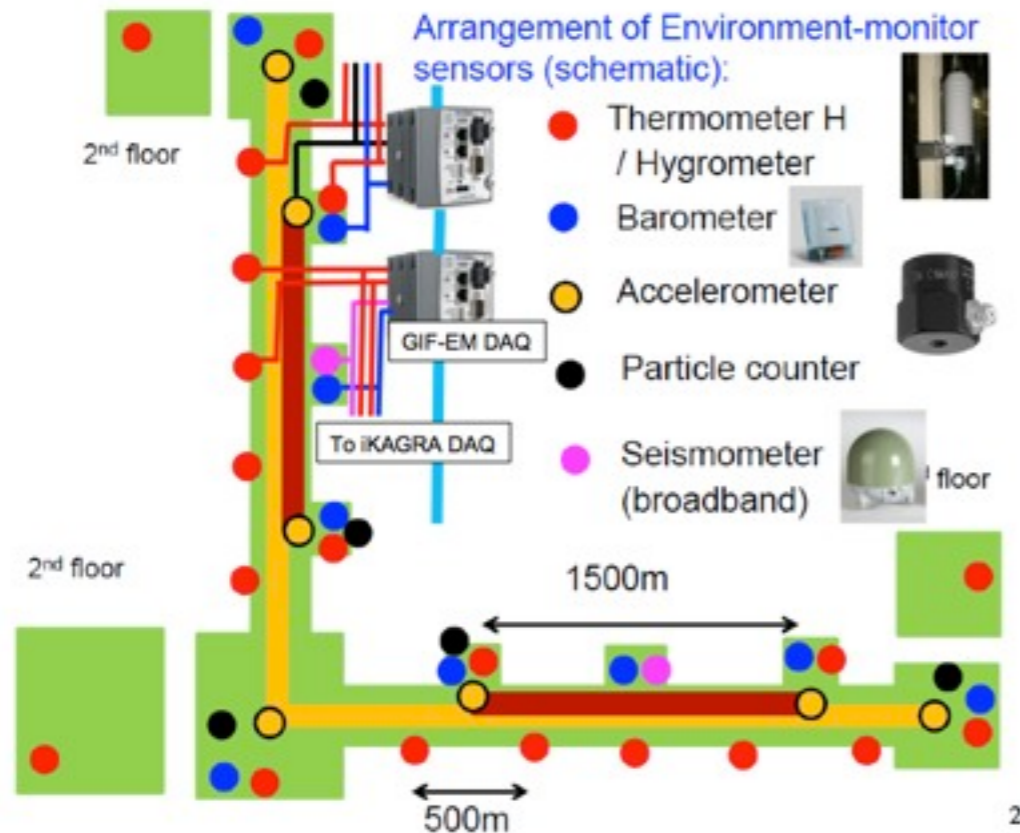
We have to a method to quality the data condition.

- **A noise monitoring system for the cryogenic system is developed at TAMA 300.**
- **Our goal is to develop a system to reduce the false alarm rate to 1/month.**

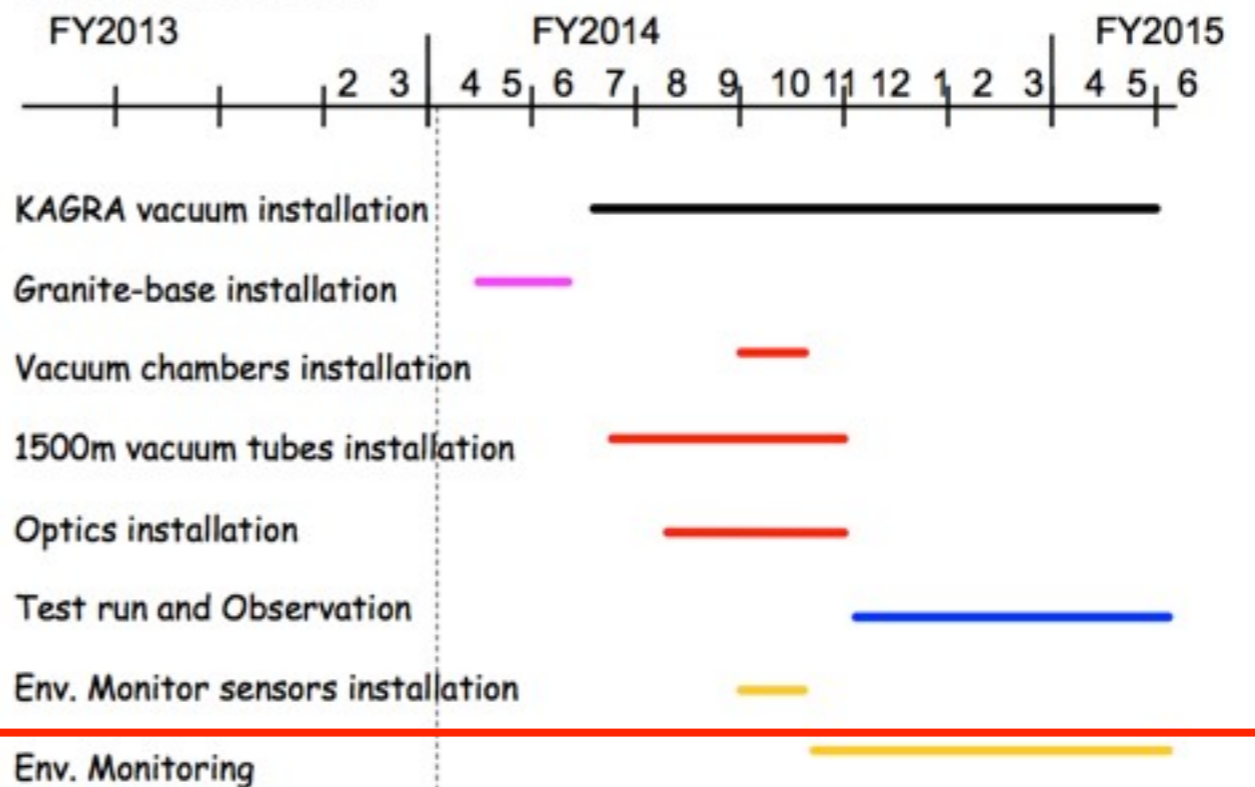


Schedule

- ☑ 2014 June : Installation of detchar GUI on VIS digital system at NAOJ so that we get advice, feedback from VIS people
- ☐ 2014 Oct ~ : GIF will start operate some of environmental monitors. These monitor data will be retrieve by same digital system as KAGRA. We will do test-operation of the detchar system/ tools using the monitor data.
- ☐ 2014Oct-2015Dec Updating/Developing system and tools.



Installation Schedule



DetChar:

Comment at External Review



1) A way to maximize the utility of DetChar in speeding the commissioning progress in the early days is for the commissioning team to construct well-defined start-up projects for the DetChar team. An example of one created for LIGO is here:

https://nodus.ligo.caltech.edu:30889/wiki/doku.php?id=detector_commissioning_characterization_projects

2) It would be helpful to have remote interferometer experts able to do remote monitoring and data analysis during the commissioning phase. Will there be remote data mirrors, data access, workstations?

Rana

- **We developed/developing the detchar tools. Some of them are equivalent to LIGO tools and some of them are brand new.**
- **That does not satisfy us.**
- **To make them useful for speed-up commissioning, we need feedback / advice from subsystems. Now Akutsu-kun helps/gives us information about VIS->AOS up-conversion noise and we discuss how to find/characterize that noise and give him information to kill them. We would like to contact others and request helps.**

TODO



- **Web-based detchar**
- **Data-base**

