KAGRA Detector Characterization

Kazuhiro Hayama (Osaka City U)
On behalf of
The KAGRA Detector Characterization

Human Resources

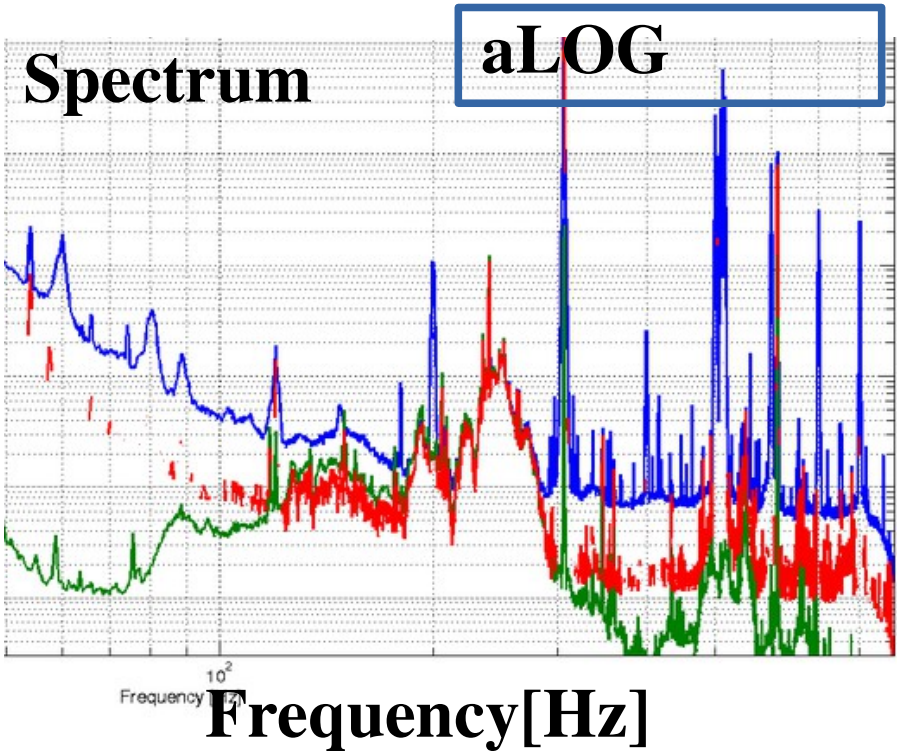
- **Hayama(OCU),**
  U. Tokyo:
  Araya, Itoh,Miyakawa,Ono,Uchiyama
  OCU :
  Asano, Kanda,Miyamoto,Yamamoto,
  Yokozawa, Yuzurihara
  ISM : Mano
  Osaka U: Narikawa, Ueno

Development of KAGRA

Design→Make→Installation→Design Sensitivity

- **Difficult to understand the km-scale instrument at a glance**

- **Important to have diagnostics system to know its behavior via ~1000 PEM and instrumental channels.**
  → DetChar group is developing the system and diagnostics tools

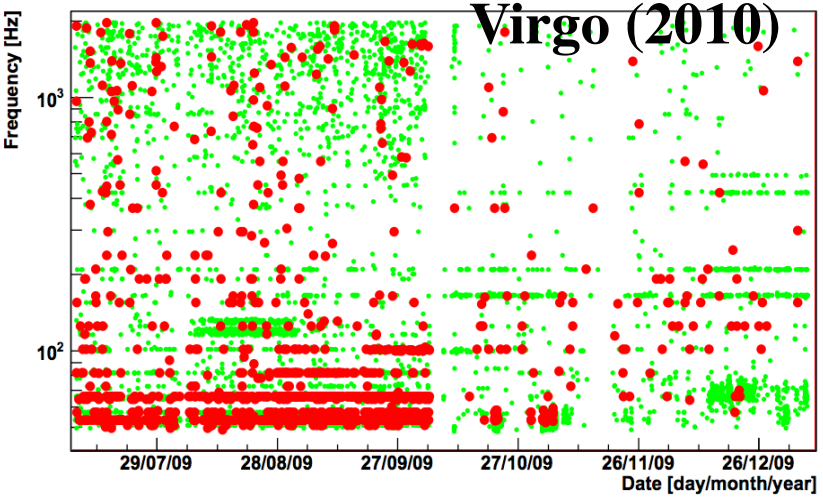


Experts finds noise sources from large degree of freedom
→ System localizes the sources and reduce the DoG

Observation of Gravitational Waves

Evaluation of data quality

- **Is KAGRA working properly? What about Environmental situation?**
- **Can we do science using the data taken today?**
- **The triggered signal, which is above the detection threshold statistically, is really gravitational wave? Or just artificial noise?**



1.8 [events/s] with SNR>5

	Line categories	Number of identified lines
Intrinsic lines	Violin modes	127
	Mechanical resonances	26
	Calibration and control	32
Noise lines	Power line and harmonics	40
	Vibration	24
	Magnetic	–
	Digital	73
	Sidebands	640

960/1390 identified

KAGRA detector characterization

- **To select tools for detector diagnostics, evaluation of data quality which has been useful for TAMA、LIGO、Virgo. We are developing the tools from scratch in order to do tuning for KAGRA deeply.**

- **So far we still have unidentified signals. We try to develop tools to understand such unidentified noise and make contribution to the GW committee.**

- **At the weekly meeting, we review aLOG and study what kind of tools are useful, what they need at the aLIGO commissioning.**

- **User friendly GUI interface**
- **Web-based summary page**

DetChar Projects

Primary Projects

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

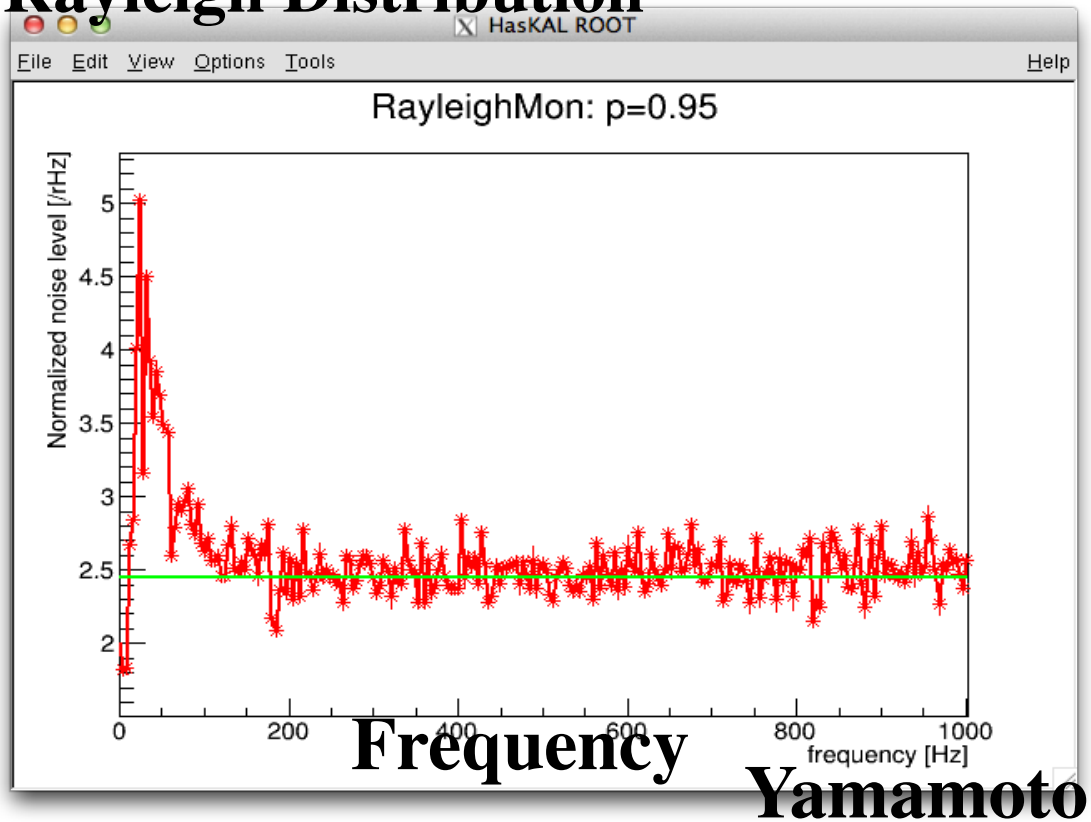
Special Projects

- 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

(Non-/) Stationary non-Gaussian Noise feature

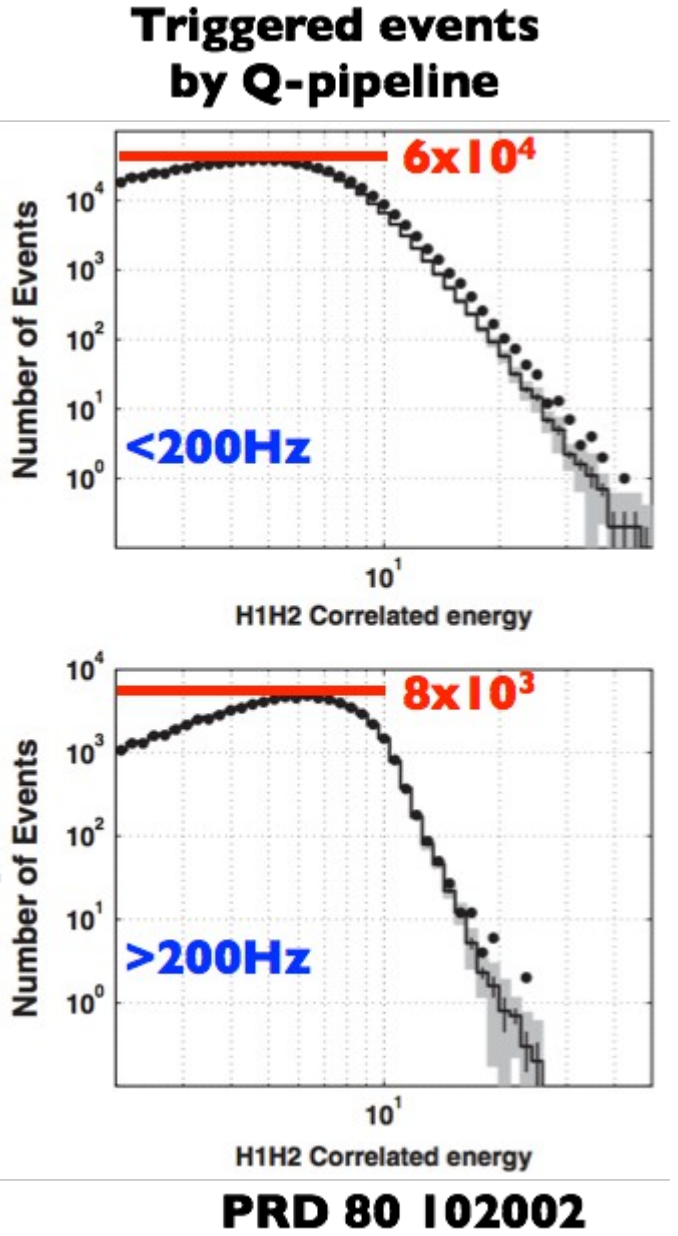
Rayleigh Distribution



Frequency

Yamamoto

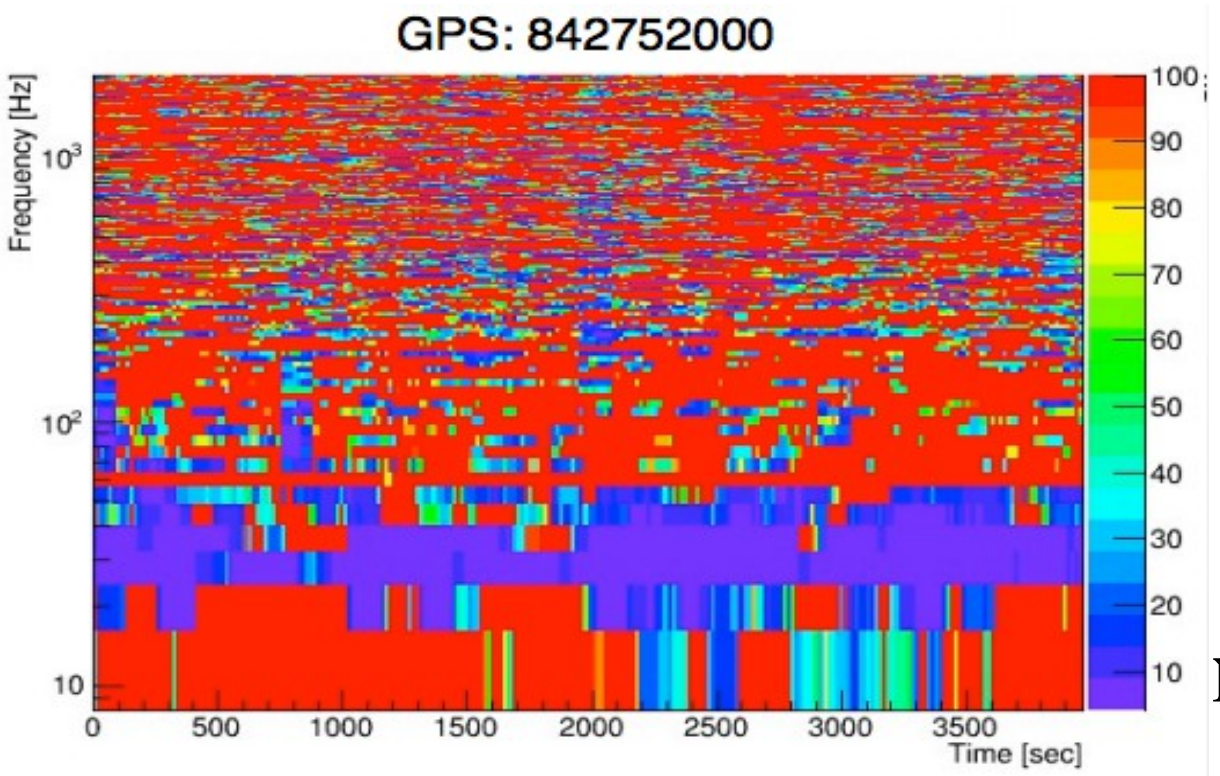
- Where the non-Gaussianity comes fr
- Is it intrinsic ?



Non-Gaussian Noise Modeling

Yamamoto

- **Noise Modeling using Student-t distribution.**
- **Characterizing non-Gaussianity using 1-parameter.**



Gaussian

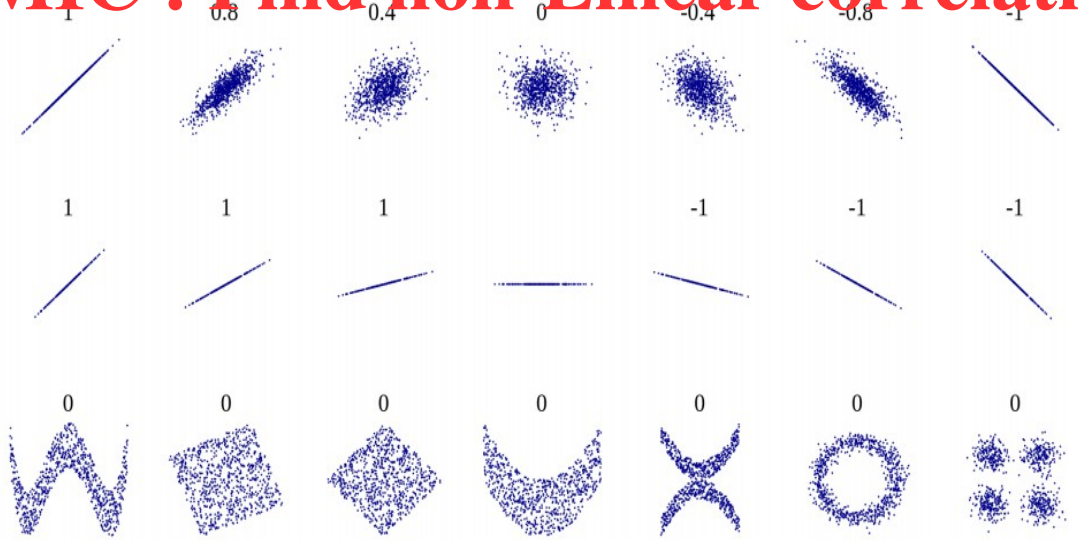
Non-Gaussian

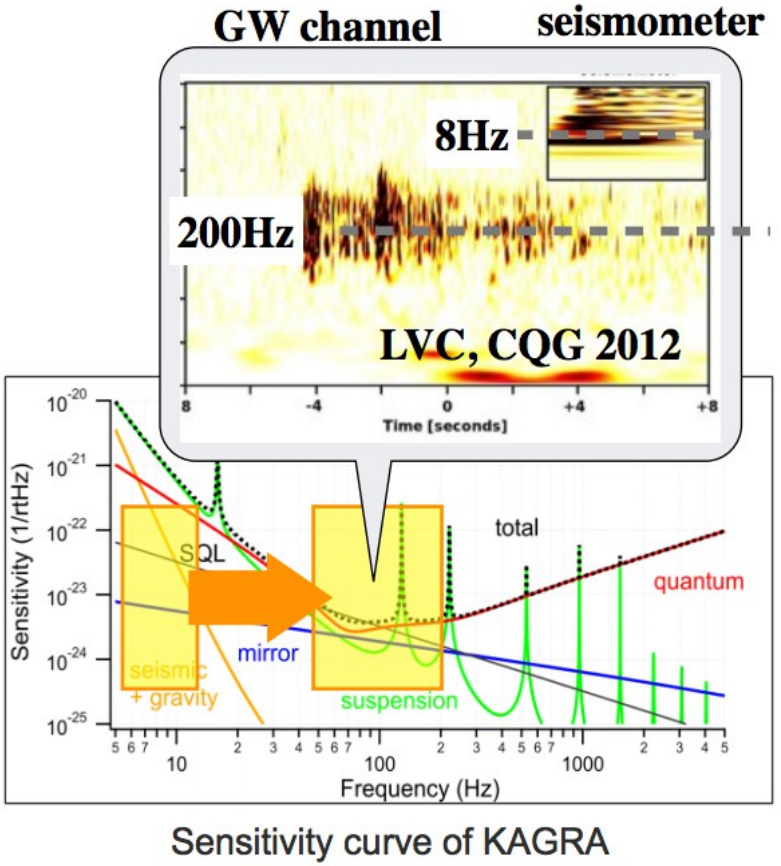
Correlation Finder

Yuzurihara, Hayama, Mano

Some noise sources make correlated noise in multiple channels

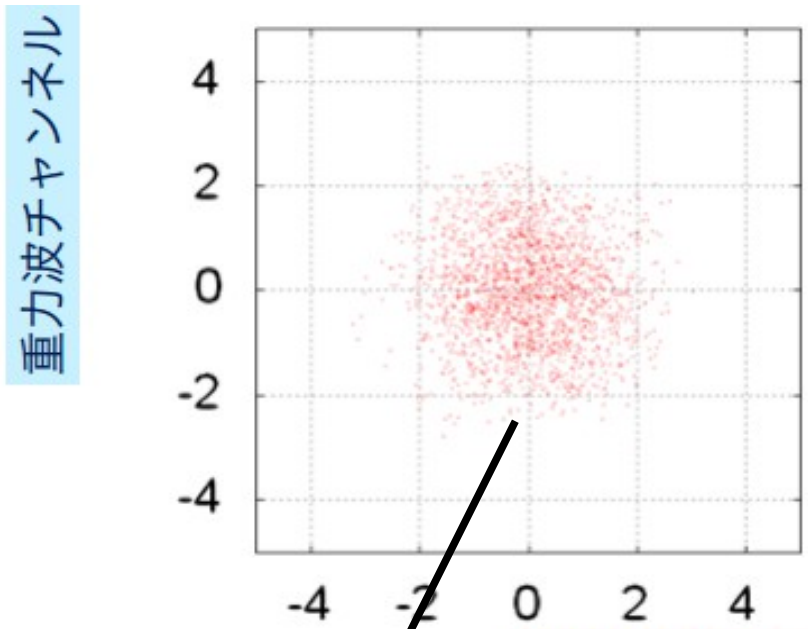
- **Finding Linear and non-Linear correlation from enormous channe**
- **Pearson : Find Linear correlation**
- **MIC : Find non-Linear correlation**

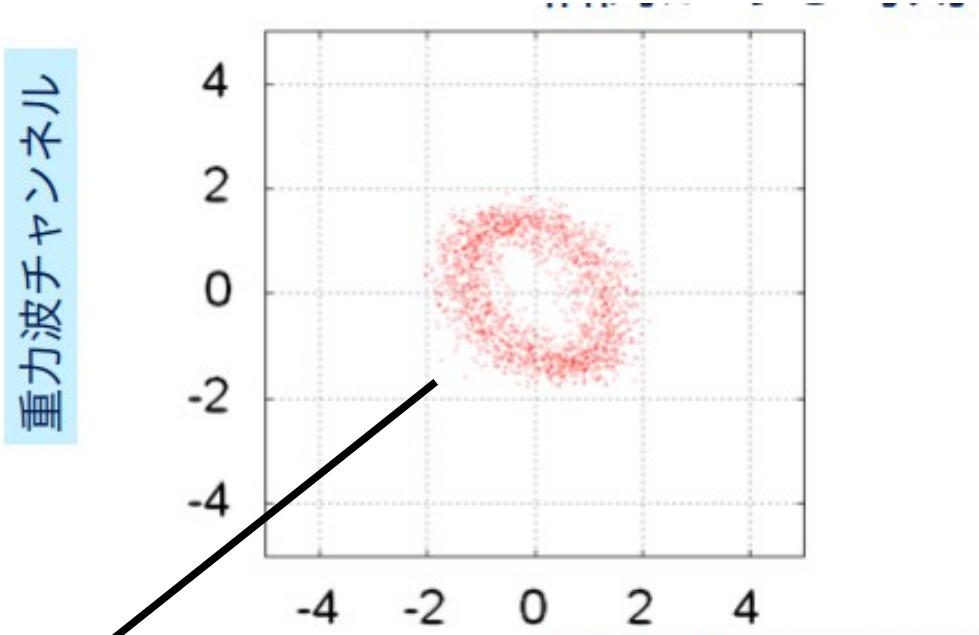


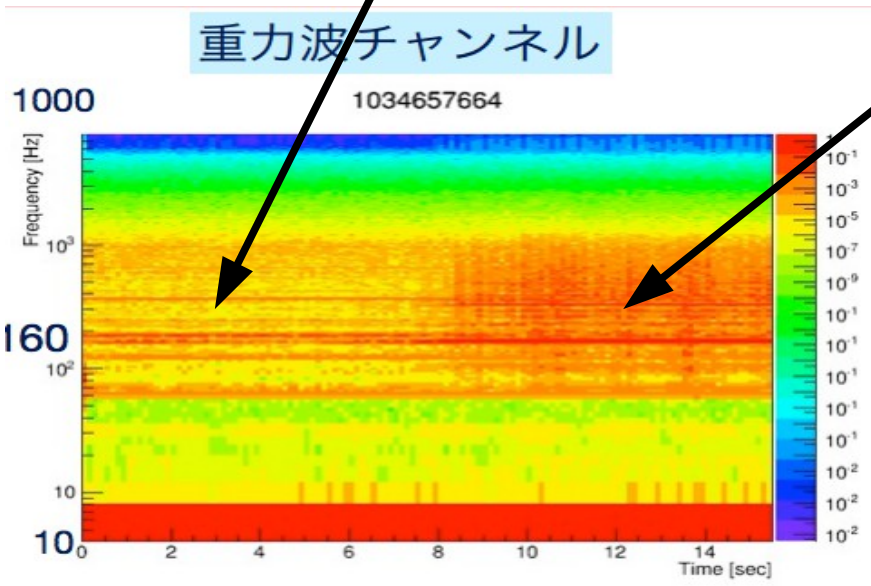


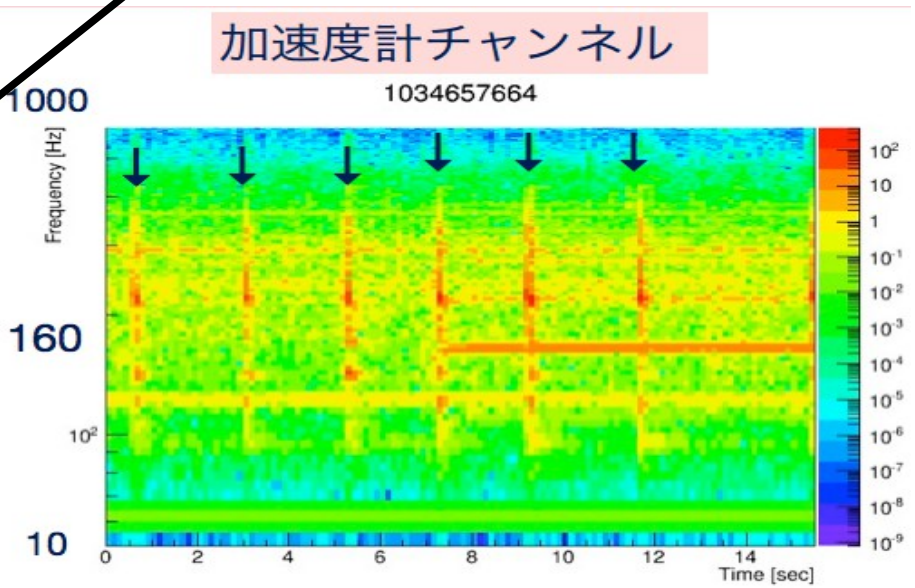
Sensitivity curve of KAGRA

CLIO Case (2012 Sep)

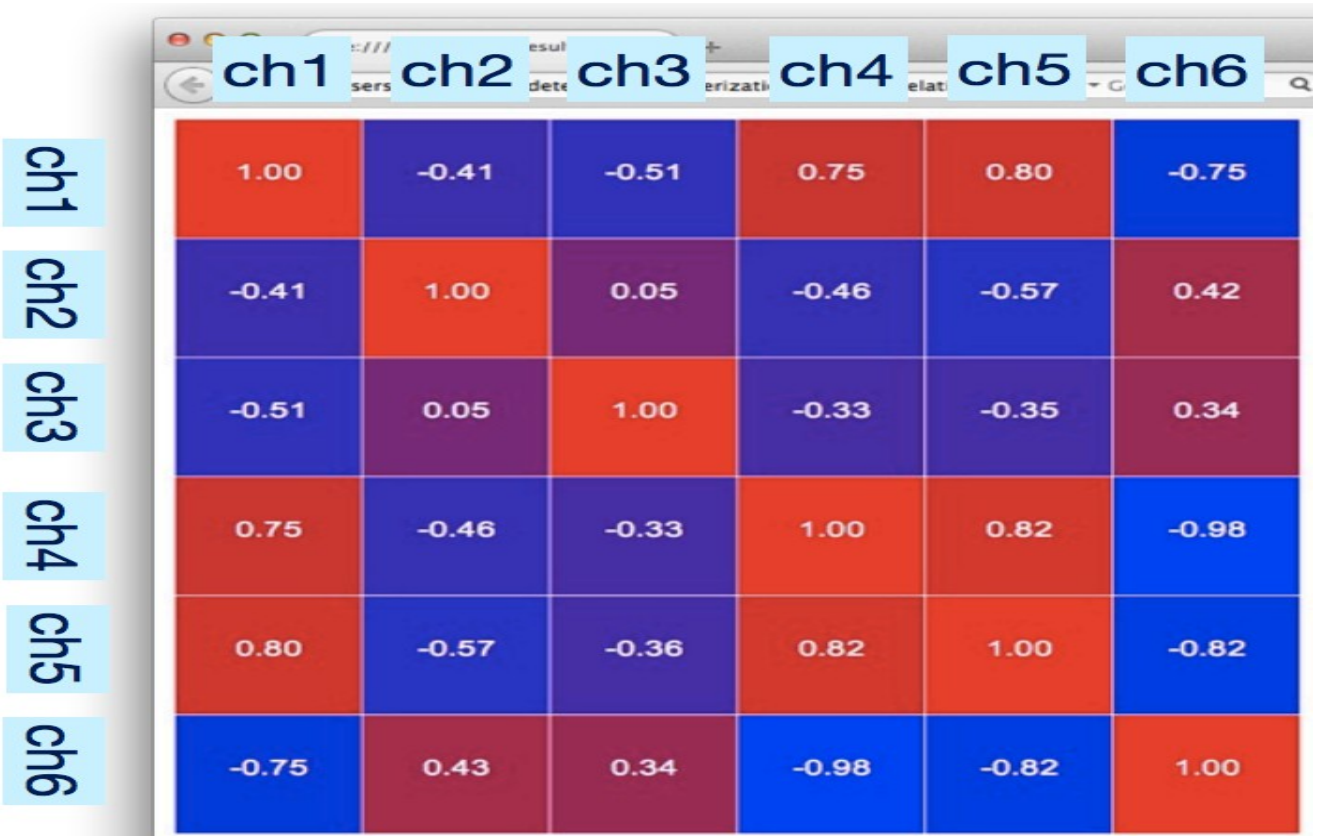








Correlation Heat Map

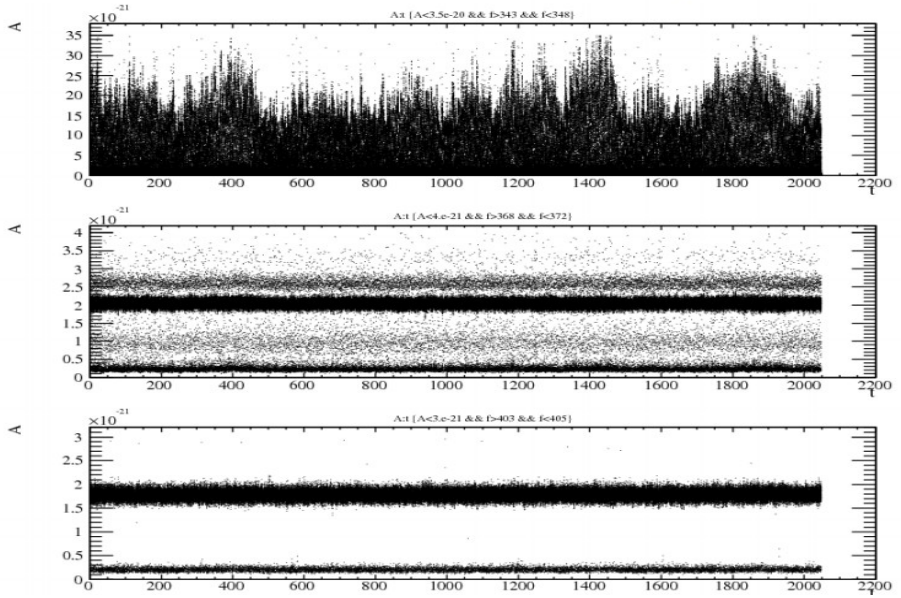


Yuzurihara

Line Characterization

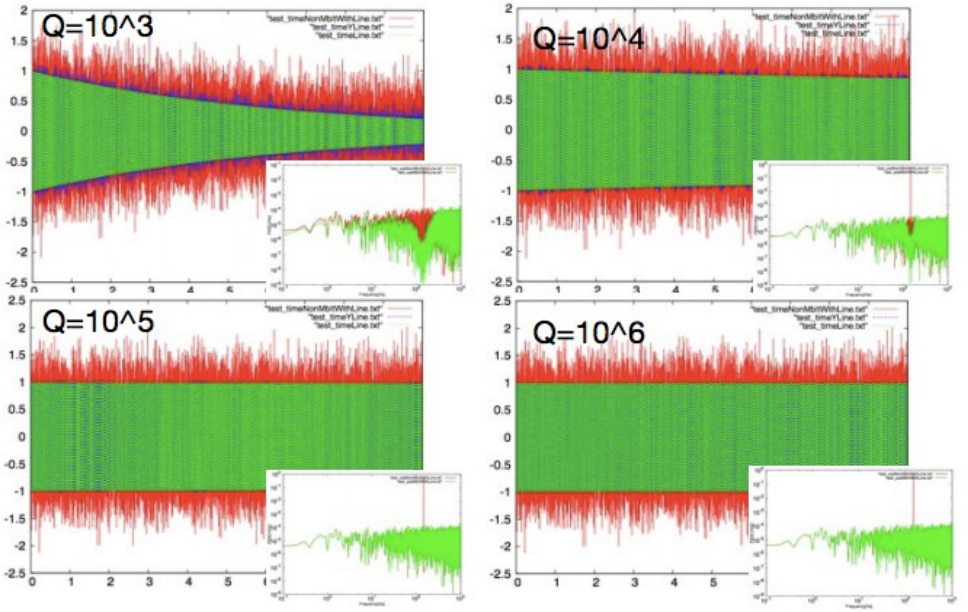
Line Tracking(Ueno)

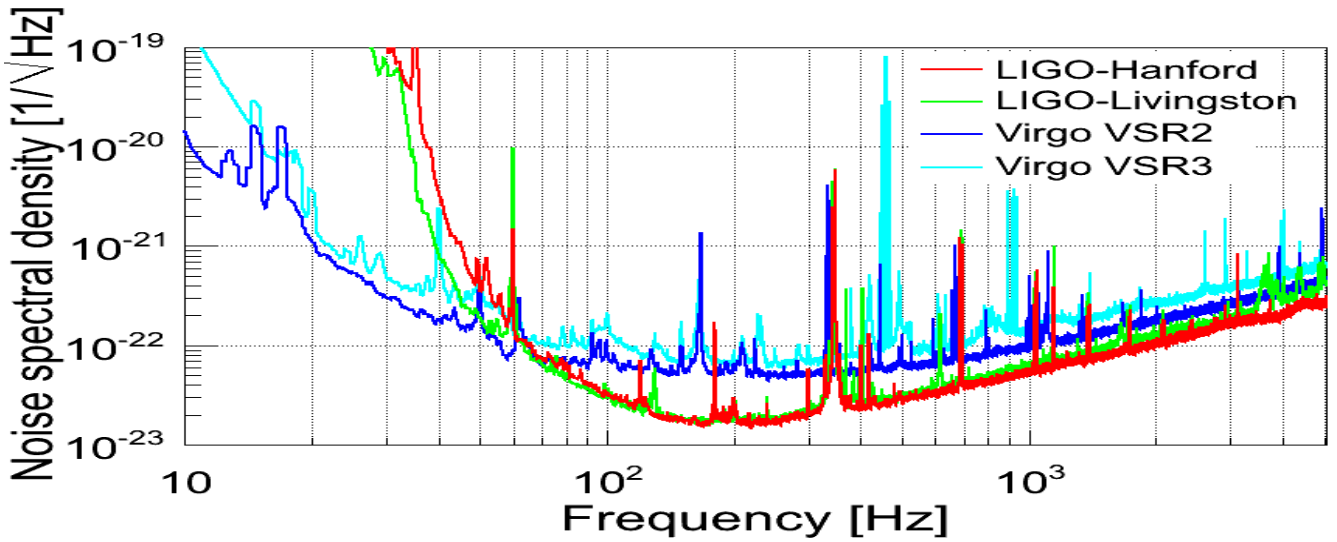
Time variation of amplitudes



Asano, Ueno

Line Removal (Asano)



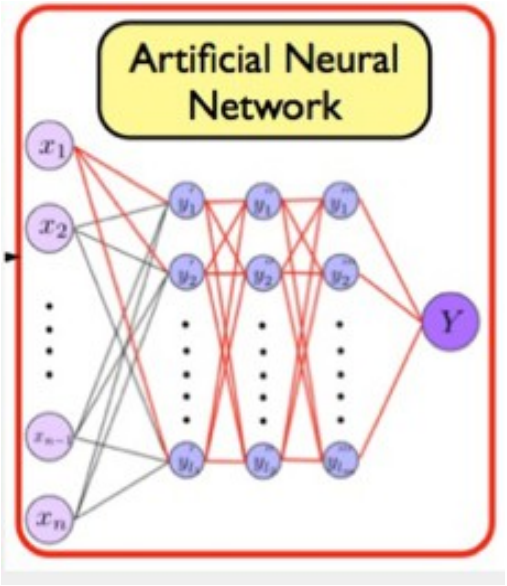


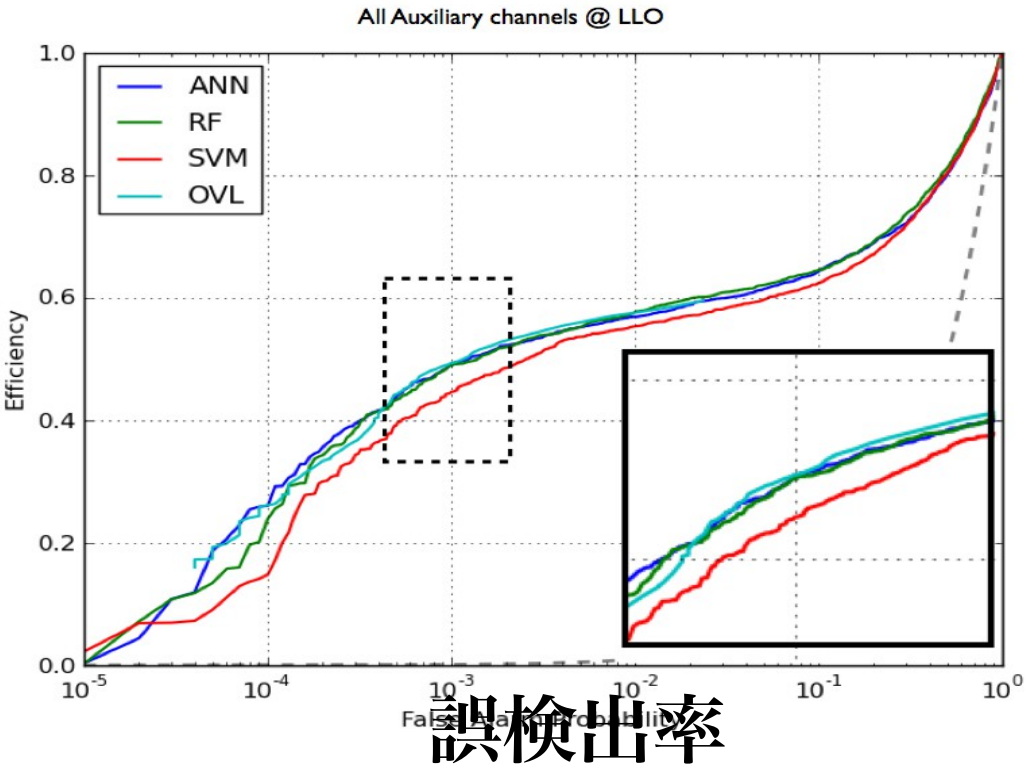
LIGO,Virgo

Localizing Noise sources using Multichannel Analysis

KGWG(Korea)

- **Neural Network based method （KGWG）**





効率

誤検出率

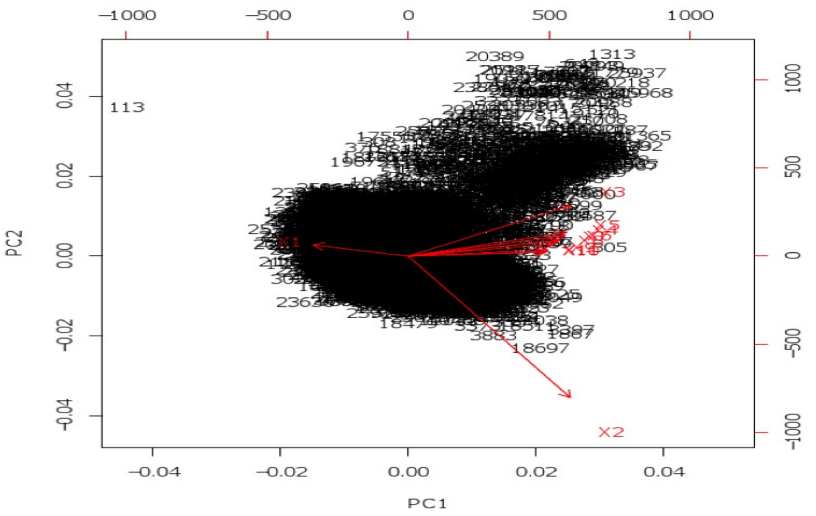
Localizing Noise sources using Multichannel Analysis

Mano(ISM)

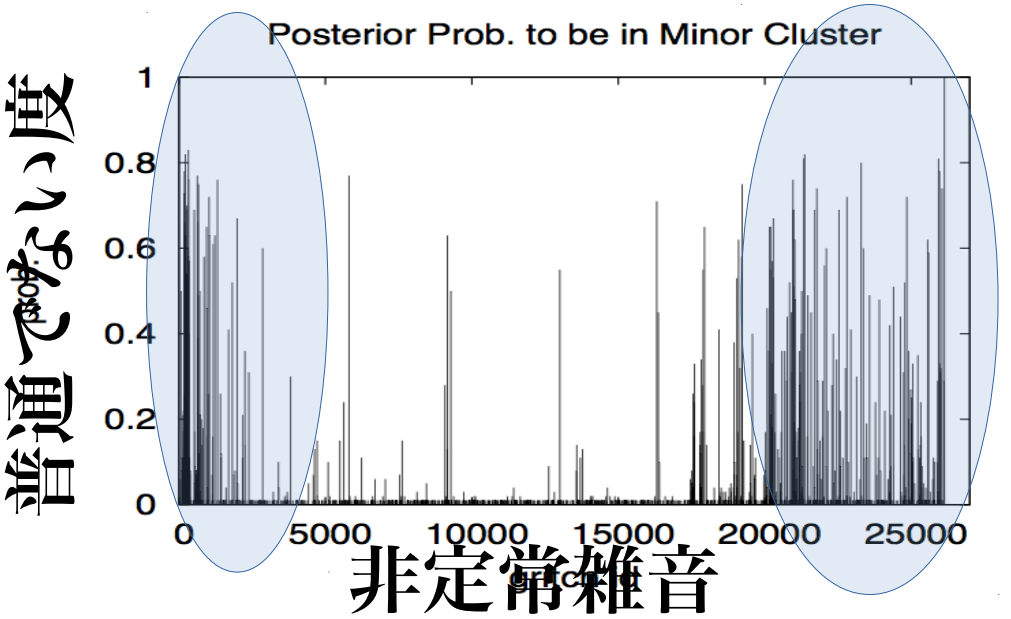
Bayesian Non-parametric Clustering

- Non-Supervised Machine Learning
- To show “uncommon” noise events

TAMA300のデータから採集した2万6000の非定常雑音カタログをクラスタリング



干渉計の状態の悪化で普通でない雑音群が生じる



HasKAL
Detector Characterization Analysis Tools

upload MBLT items

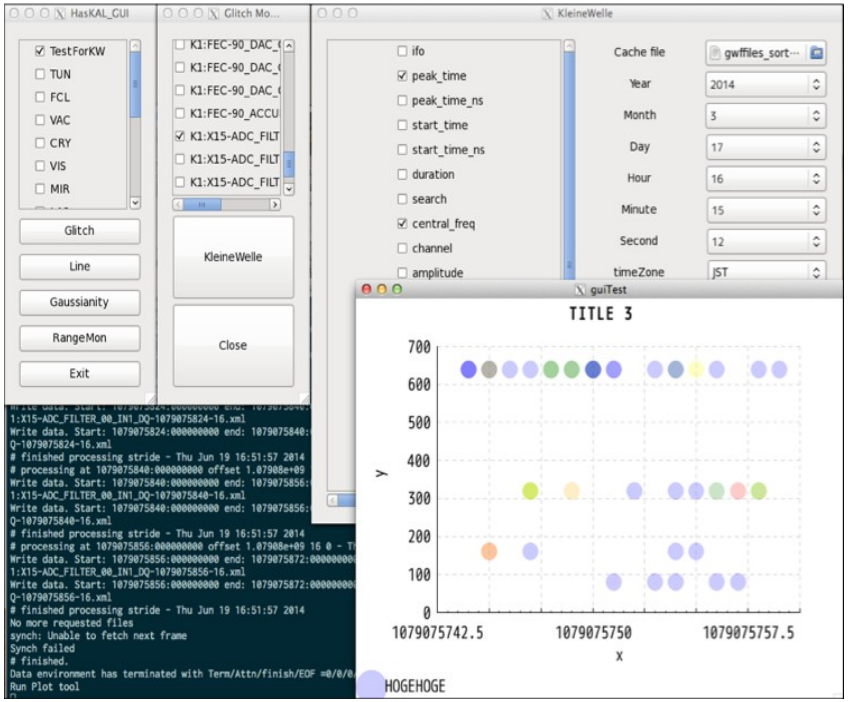
asano0622 authored 9 days ago — latest commit 9fa358144c

..

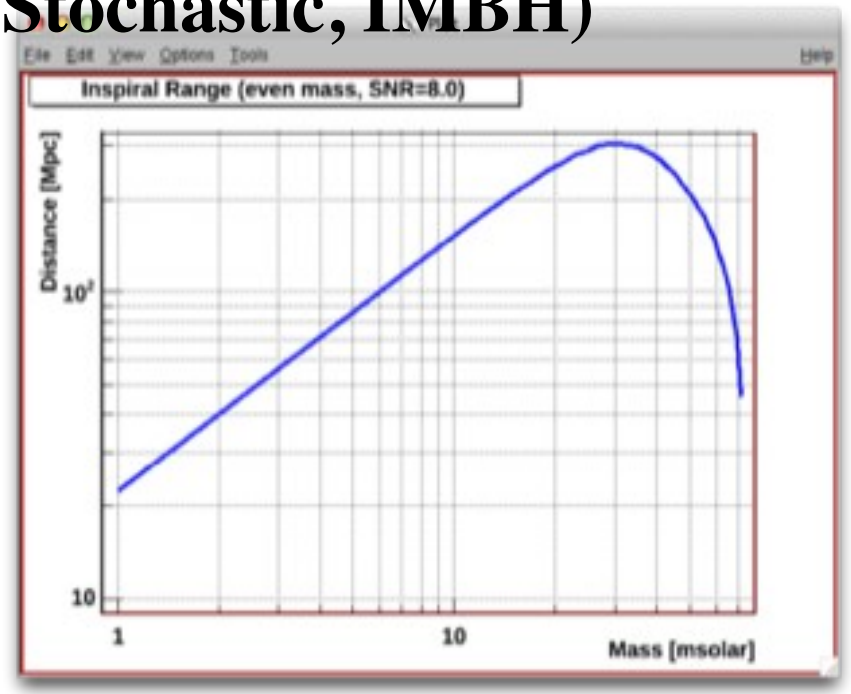
DetectorUtils	working around injection	19 days ago
ExternalUtils	Mine.hs updated	14 days ago
FrameUtils	small change	11 days ago
GUI_Utils	changed GUI_Utils for plot tool update	11 days ago
LineUtils/LineRemoval	upload MBLT items	9 days ago
Misc	move haskalOpt to Environment module	2 months ago
MonitorUtils	change plot tool of RayleighMon from Chart to HROOT	14 days ago
PlotUtils	modified plot tool	11 days ago
SearchUtils	added SearchUtils	22 days ago
SignalProcessingUtils	minor update	13 days ago
SimulationUtils	add injection function which uses bang method for memory saving	18 days ago
SpectrumUtils	minor change of DetectorSensitivity	11 days ago
StatisticsUtils	change module name	13 days ago
TimeUtils	change function fromGPS to deformatGPS	19 days ago
WaveUtils	add dropWaveData, takeWaveData	13 days ago
DetectorUtils.hs	added module of modules	2 months ago
TimeUtils.hs	added module-setting module	19 days ago
WaveUtils.hs	added a module-setting file	19 days ago

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

GUI Interface



Range Monitor (CBC, Ringdown, Stochastic, IMBH)



Developers:
Asano, Hayama, Itoh, Mano, Ono, Ueno, Yamamoto, Yokozawa, Yuzurihara,

And so on …

Plan

- **In 2014、GUI tools、Web-based summary tools will be version1**
- **Mar. in 2015 Participation of PEM monitor operations by GIF**
- **～2015 Dec, improvement, modification**
- **IKAGRA operation**
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終わり