KAGRA Detector Characterization

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

Human Resources

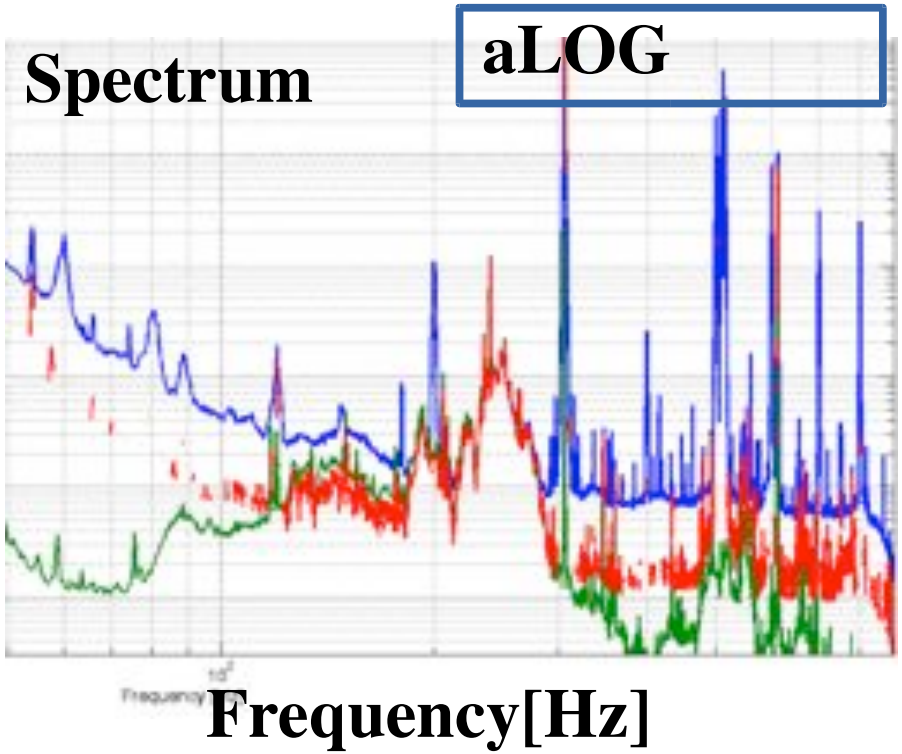
- **Hayama(OCU),**
  U. Tokyo:
  Araya, Itoh,Miyakawa,Ono,Uchiyama
  OCU :
  Asano, Kanda,Miyamoto,Yamamoto,
  Yokozawa, Yuzurihara
  ISM : Mano
  Osaka U: Narikawa, Ueno

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



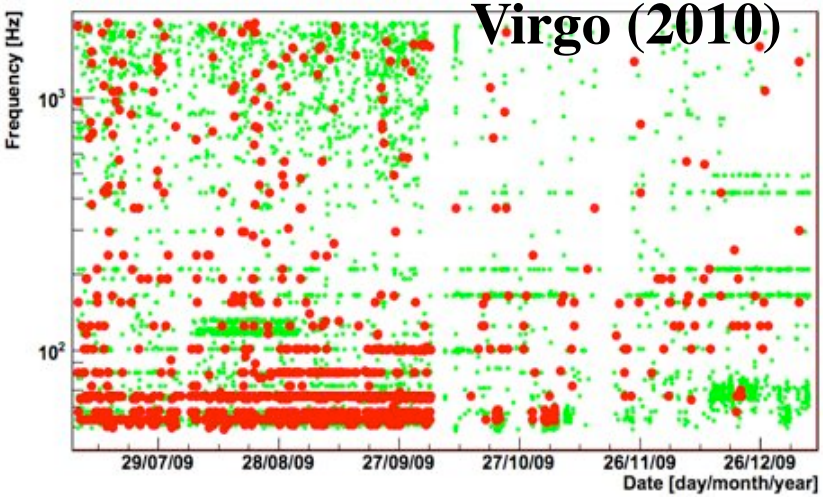
Experts finds noise sources from large degree of freedom
→ System localizes the sources and reduce the DoG

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?**

Virgo (2010)



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

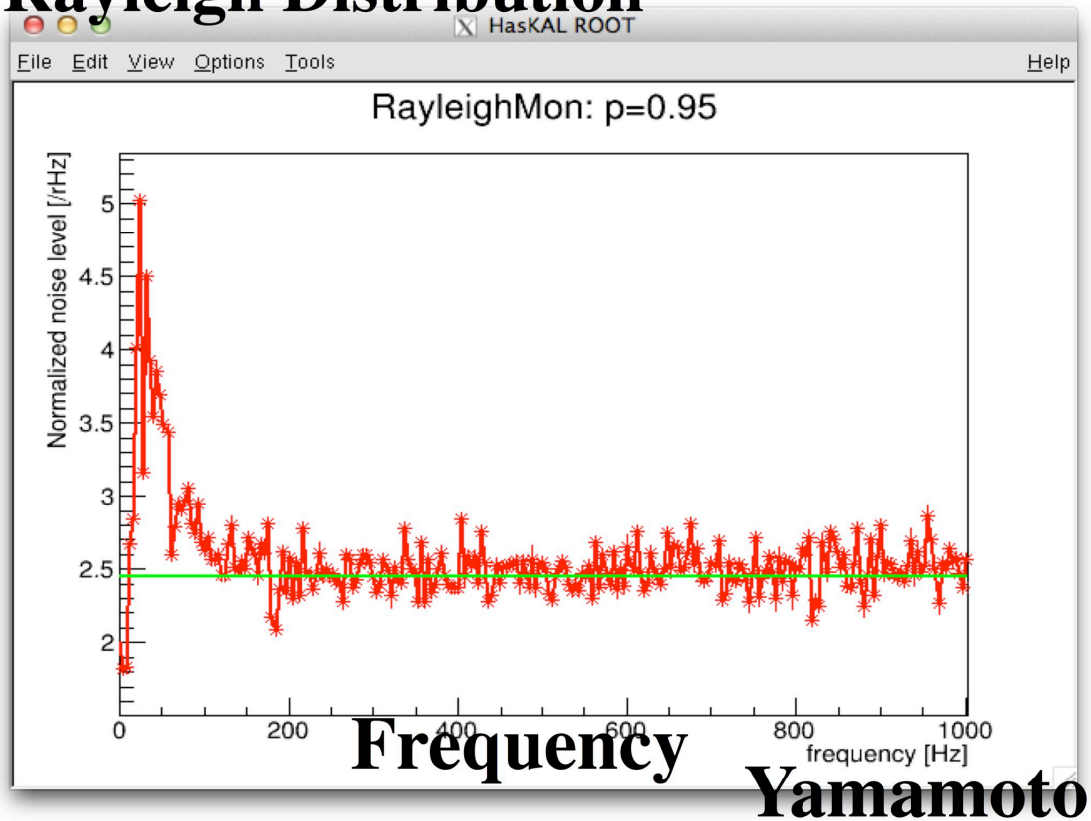
Special Projects

- 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

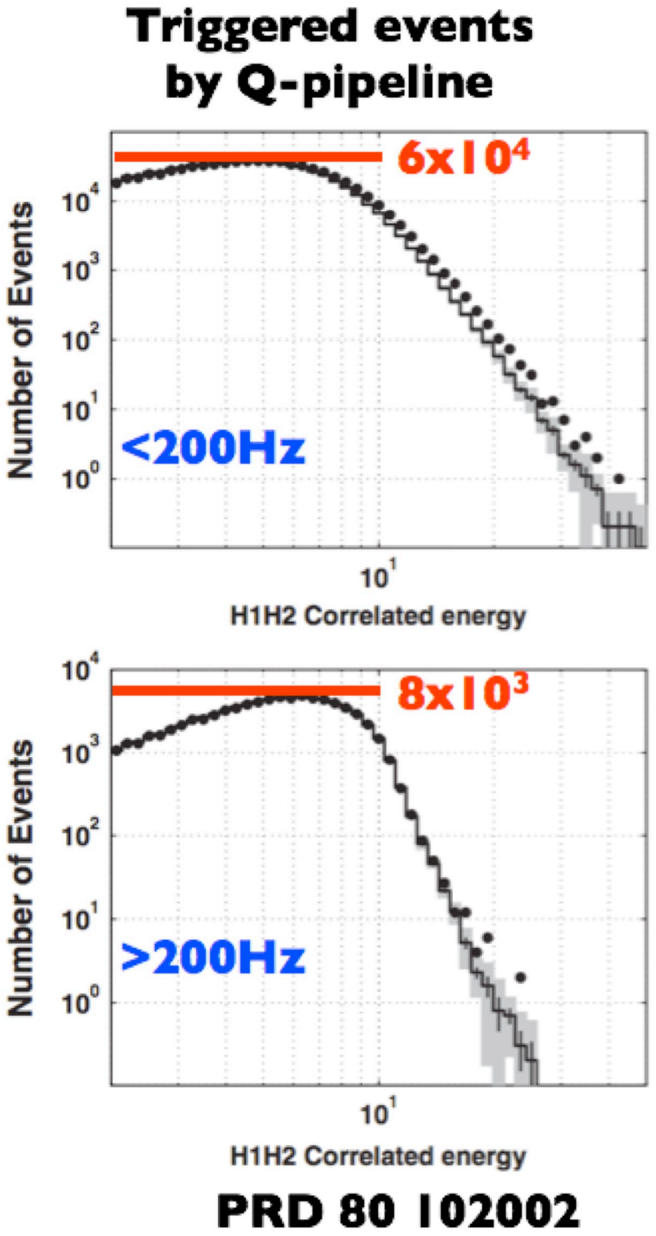
Rayleigh Distribution



Frequency

Yamamoto

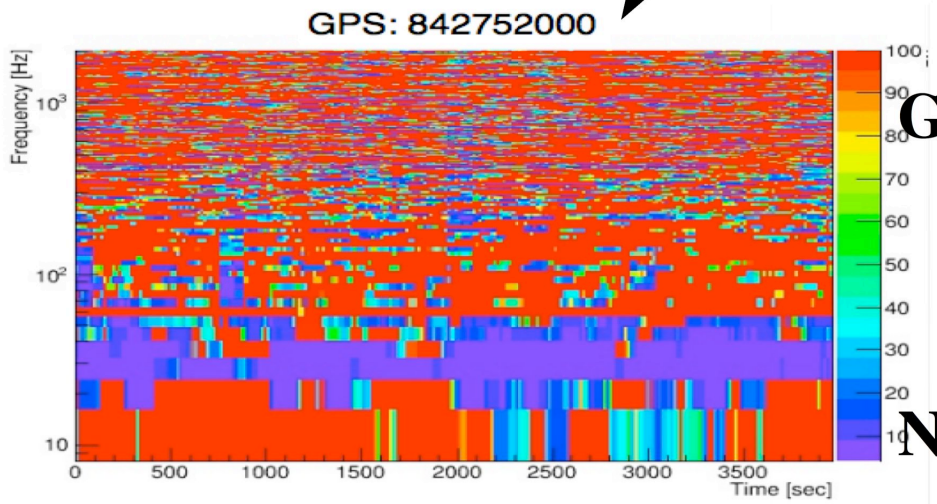
- Where the non-Gaussianity comes fr
- Is it intrinsic ?



Non-Gaussian Noise Modeling

Yamamoto

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



Gaussian

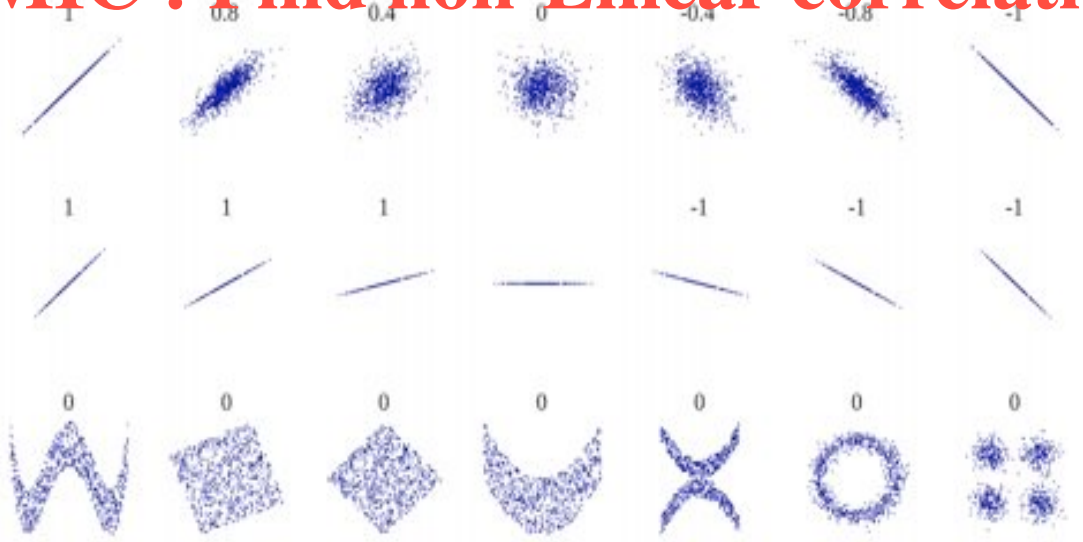
Non-Gaussian

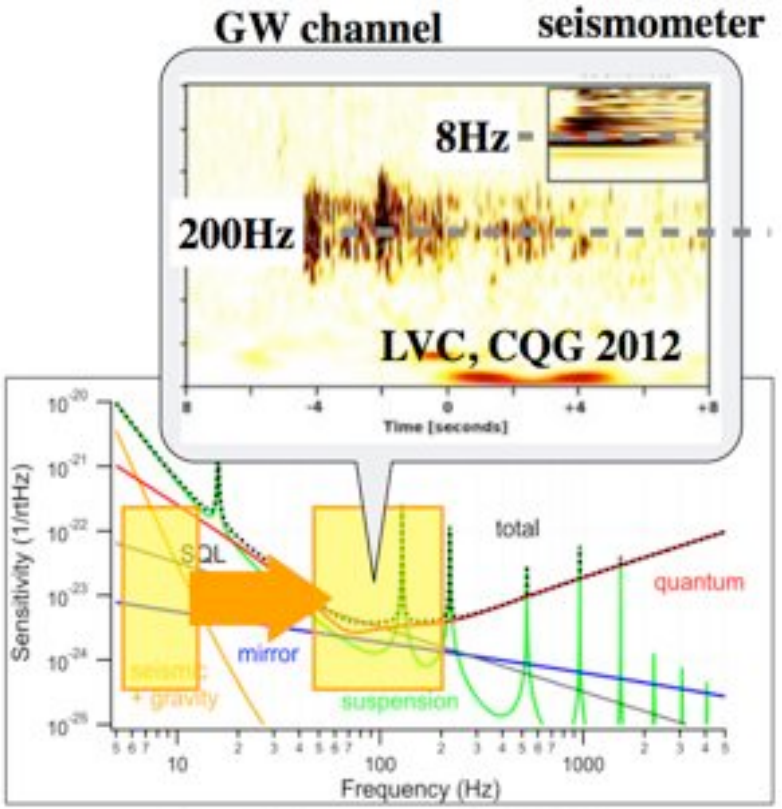
Correlation Finder

Yuzurihara, Hayama, Mano

Some noise sources make correlated noise in multiple channels

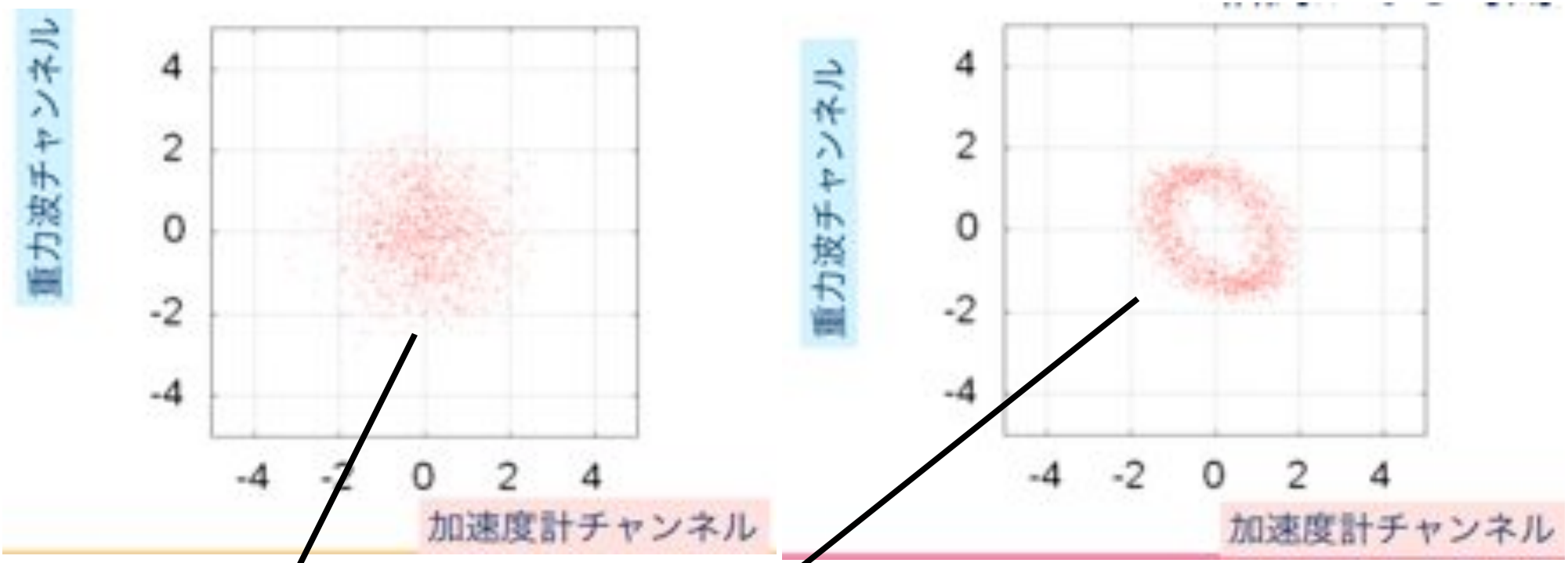
- **Finding Linear and non-Linear correlation from enormous channe**
- **Pearson : Find Linear correlation**
- **MIC : Find non-Linear correlation**

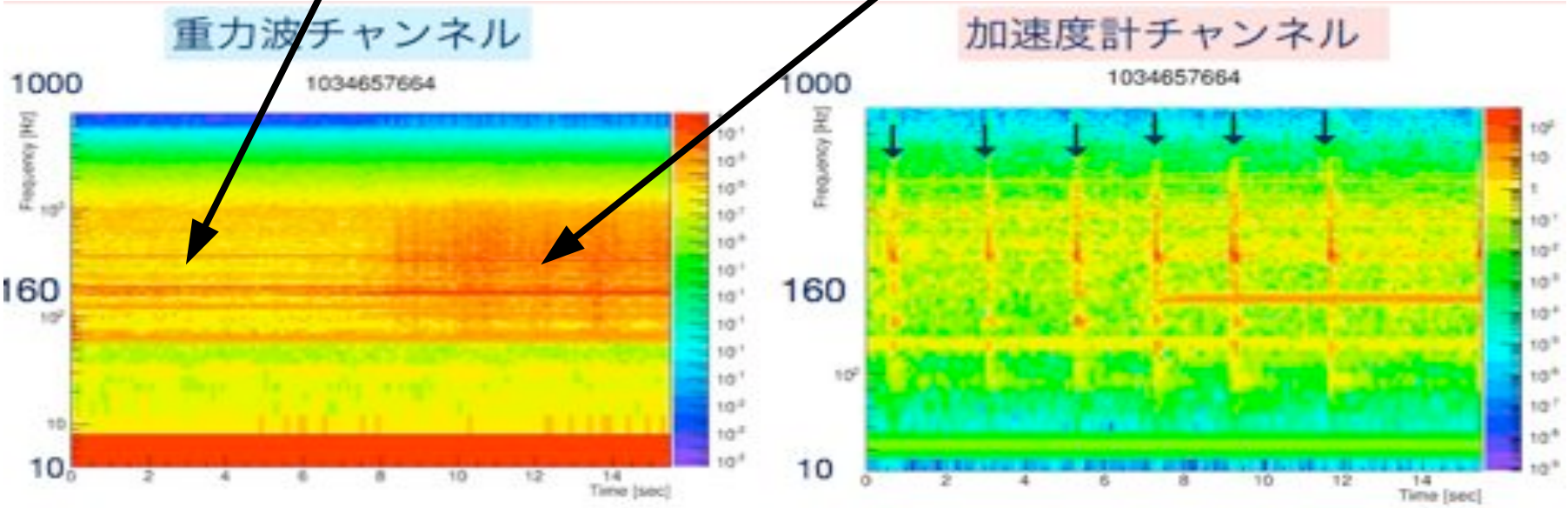




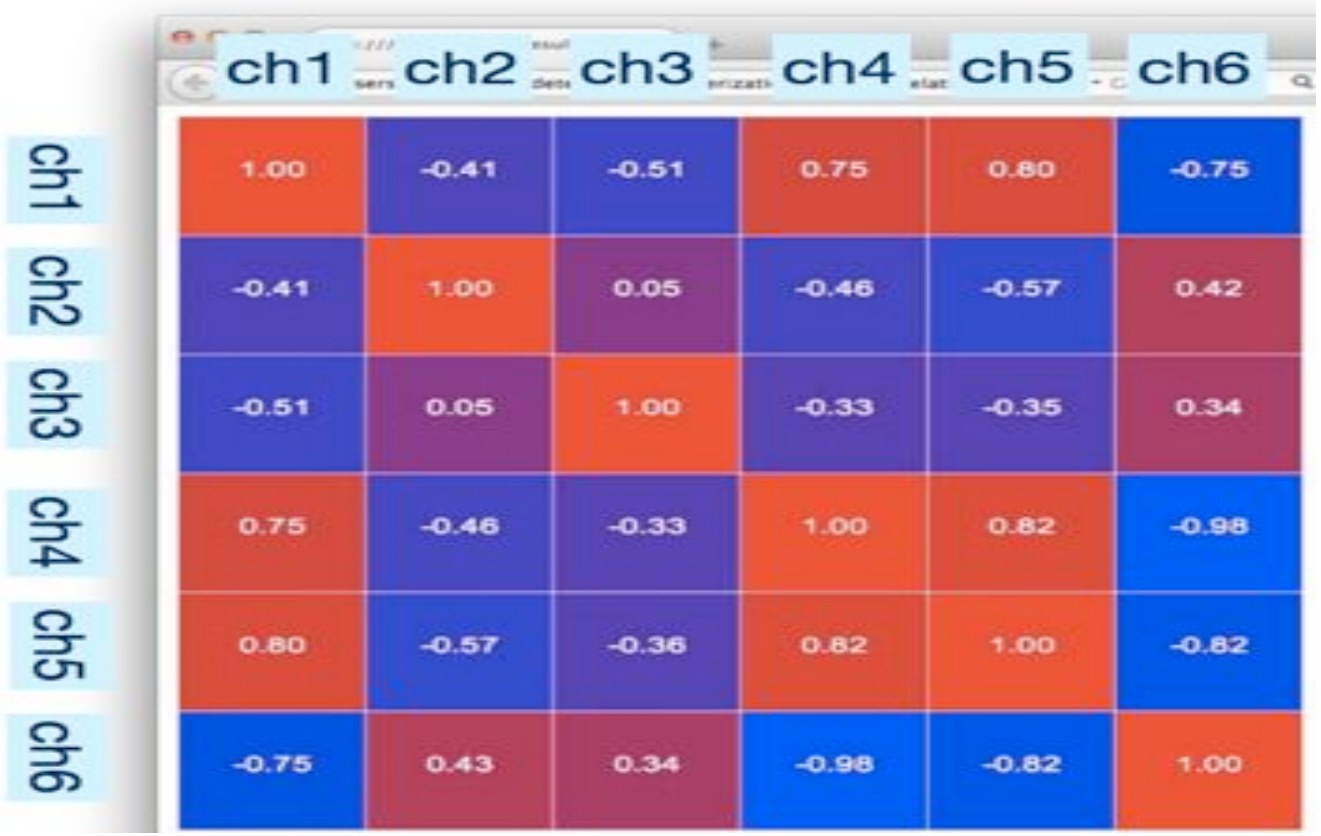
Sensitivity curve of KAGRA

CLIO Case (2012 Sep)





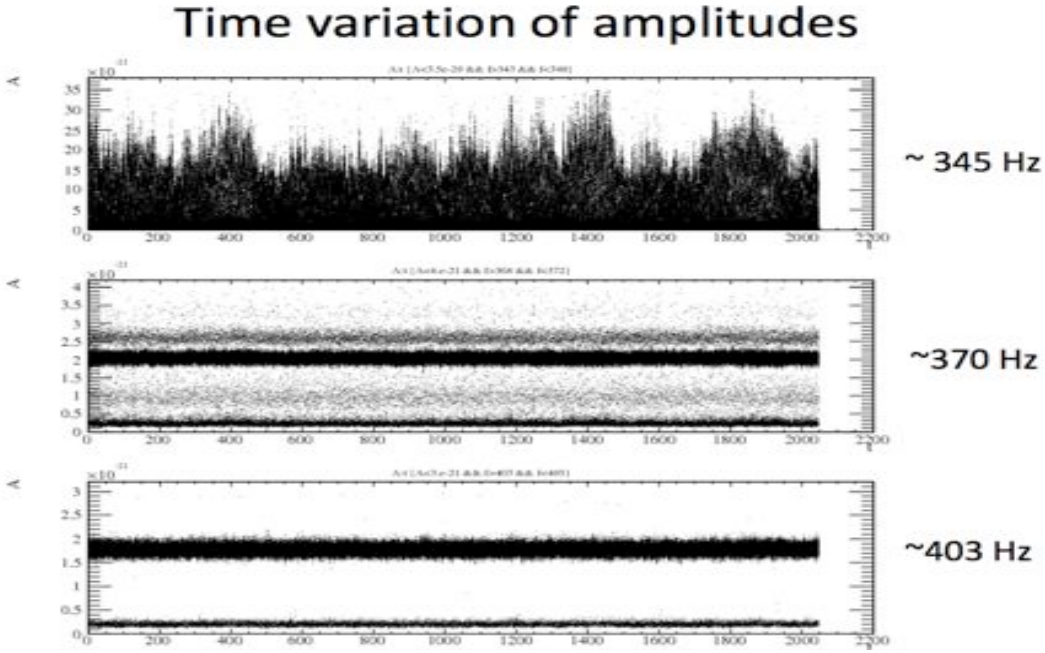
Correlation Heat Map



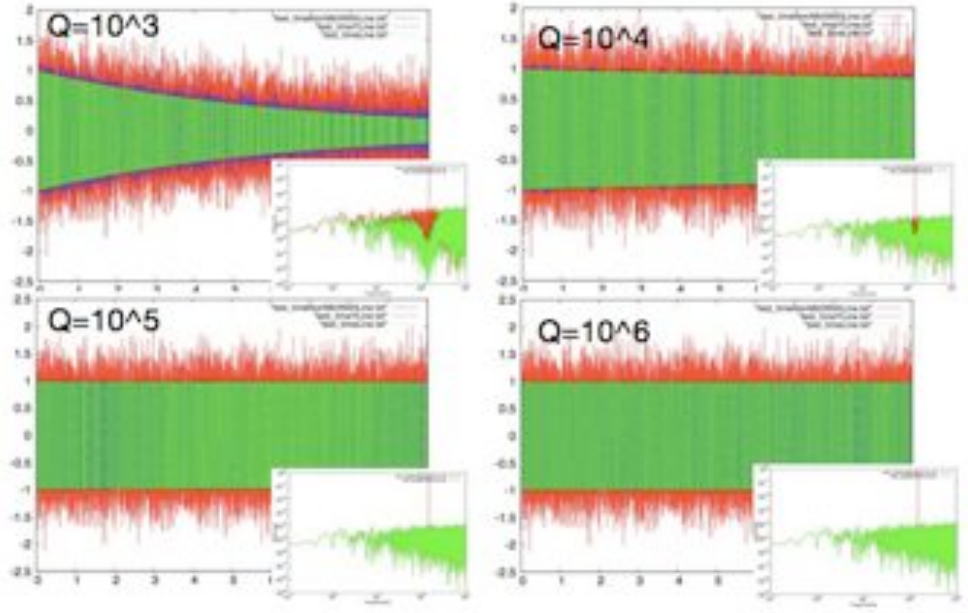
Yuzurihara

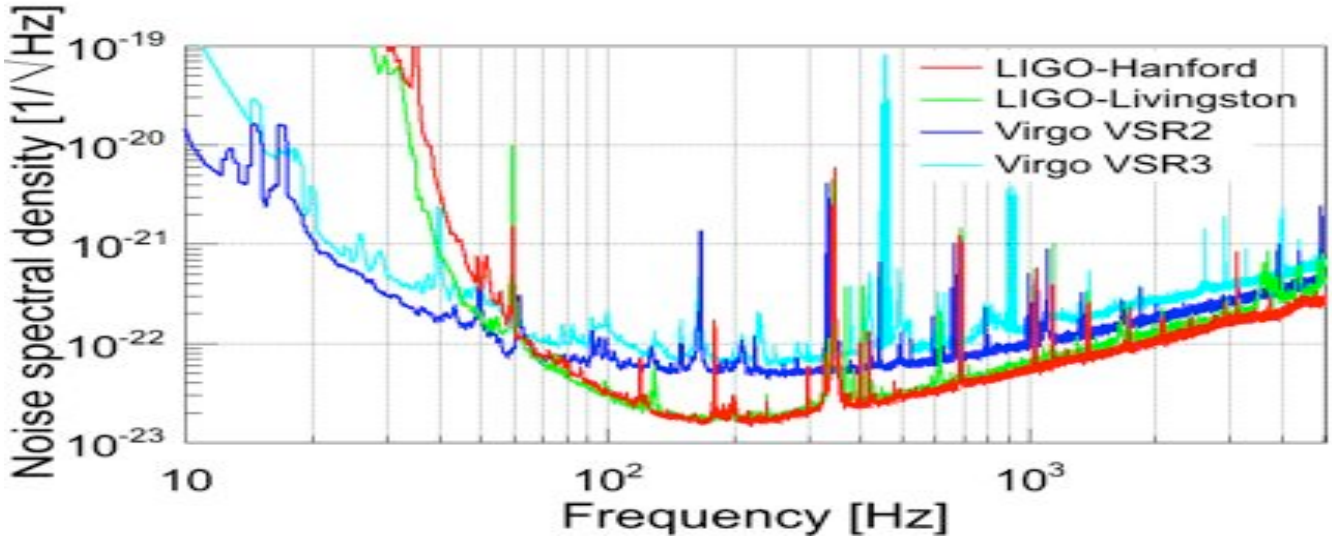
Line Characterization

Line Tracking(Ueno)



Asano, Ueno
Line Removal (Asano)



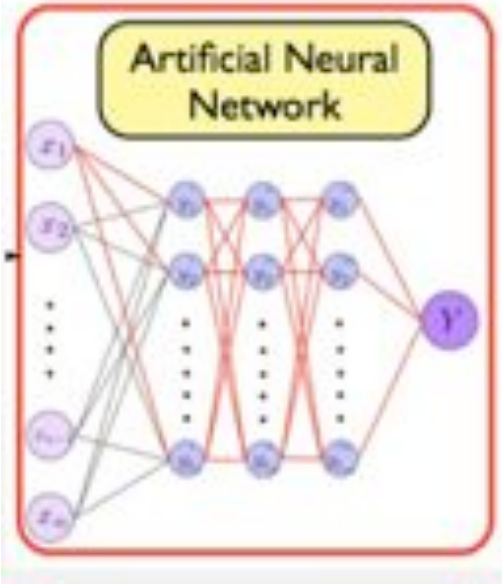


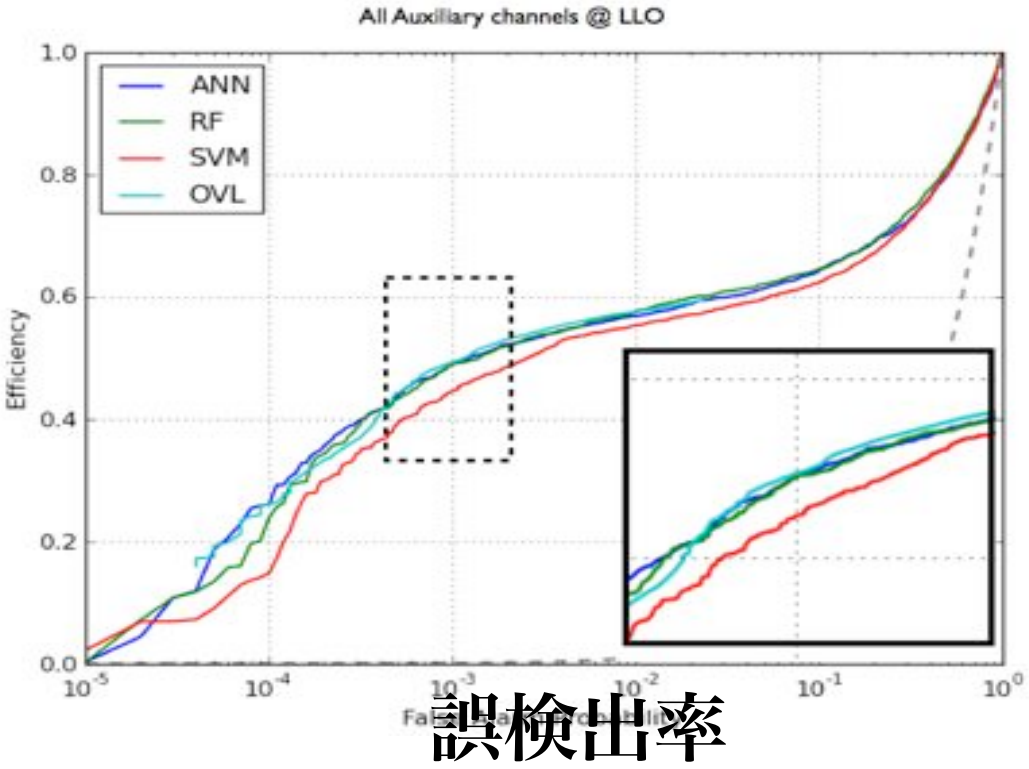
LIGO,Virgo

Localizing Noise sources using Multichannel Analysis

KGWG(Korea)

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





効率

誤検出率

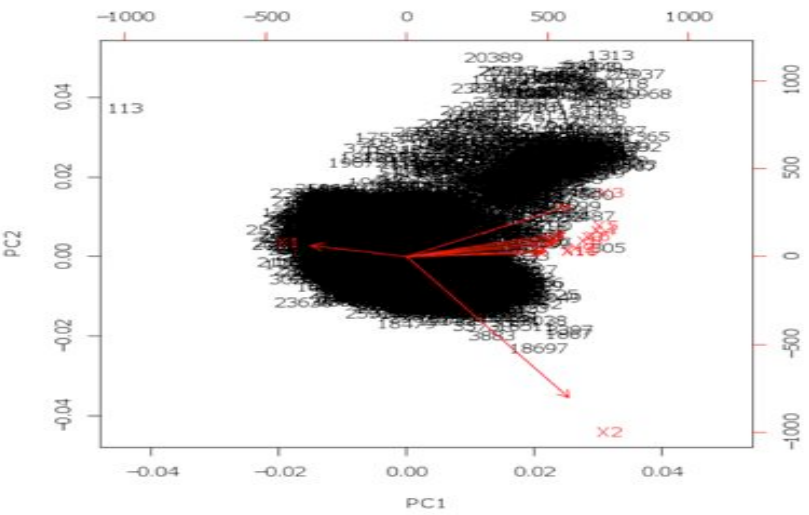
Localizing Noise sources using Multichannel Analysis

Mano(ISM)

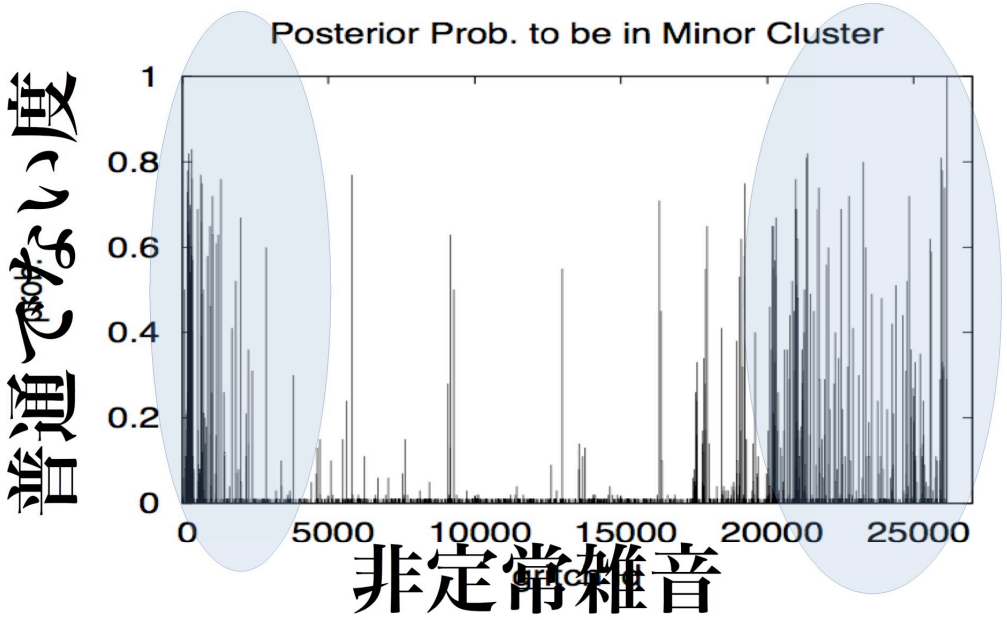
Bayesian Non-parametric Clustering

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

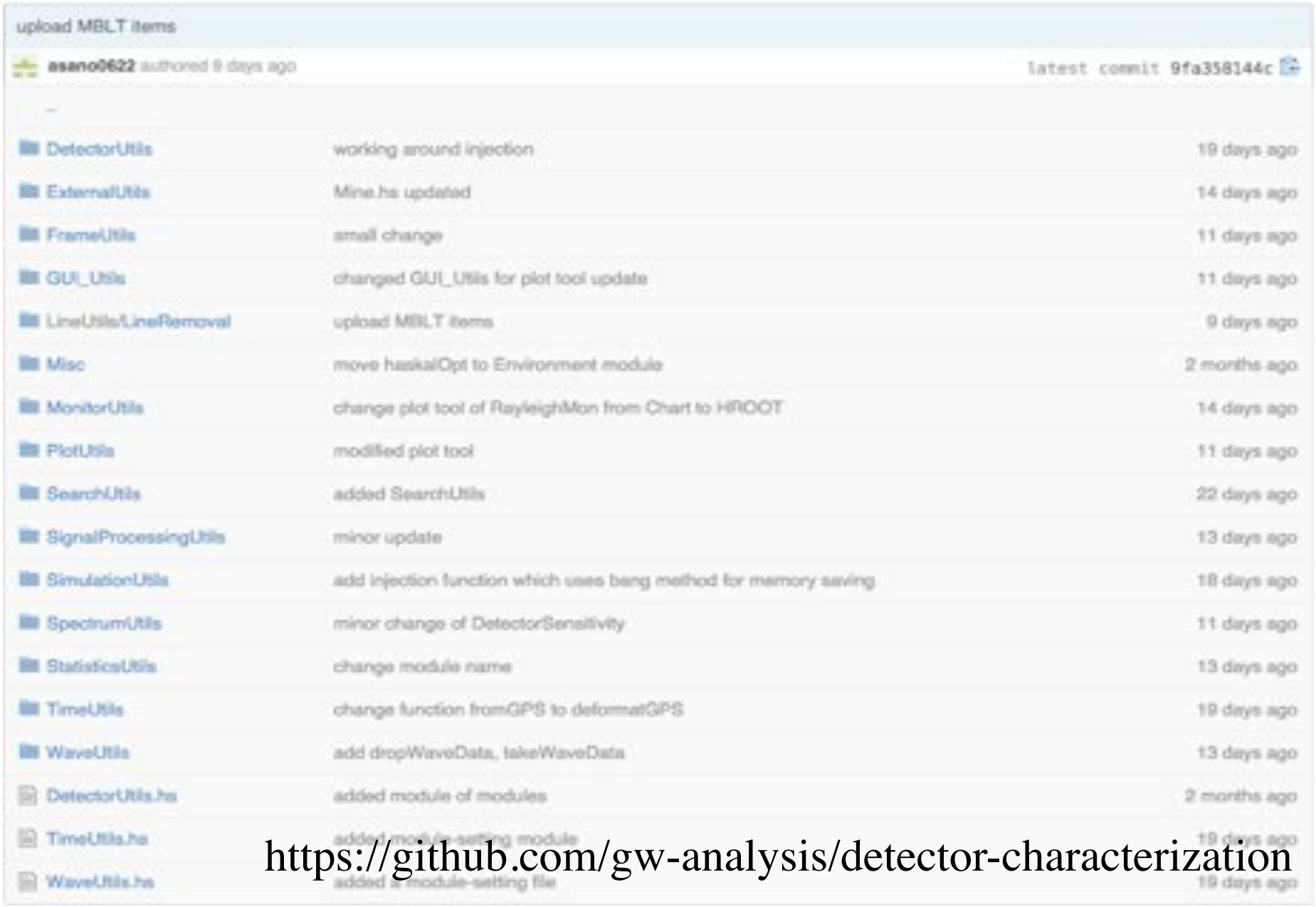
TAMA300のデータから採集した2万6000の非定常雑音カタログをクラスタリング



干渉計の状態の悪化で普通でない雑音群が生じる

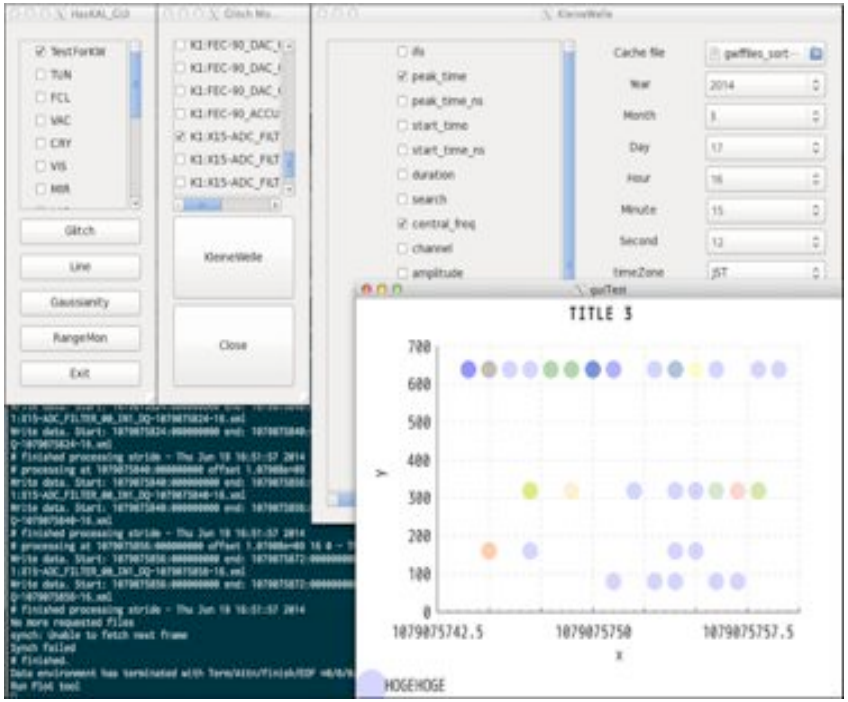


HasKAL
Detector Characterization Analysis Tools

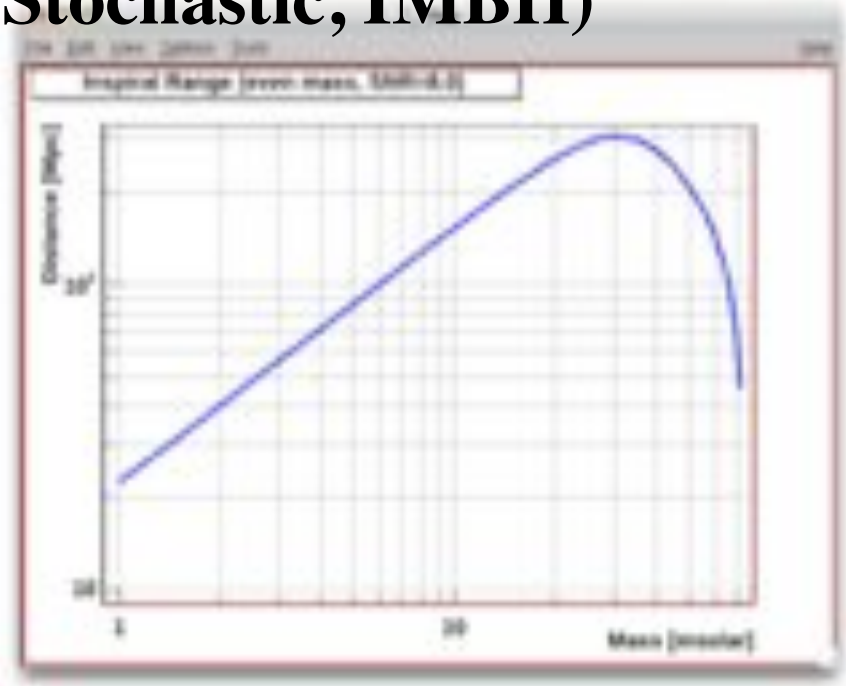


https://github.com/gw-analysis/detector-characterization

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