

# KAGRA Detector Characterizationの 開発進捗状況 (III)

端山和大(大阪市大),阿久津智忠(NAOJ),熱田将(東工大),  
伊藤洋介(東大RESCEU),神田展行(大阪市大),苔山圭衣  
子(東大宇宙線研),宗宮健太郎(東工大),辰巳大輔(NAOJ),  
都丸隆行(KEK),成川達也(大阪市大),間野修平(統数研),  
宮川治(東大宇宙線研),宮本晃伸(大阪市大),山本尚弘(大  
阪市大),讓原浩貴(大阪市大),横澤孝章(大阪市大),上野  
昂(大阪市大)

# Detector Characterization

## Data Analysis

Veto info., target veto , Data quality, calibration accu.

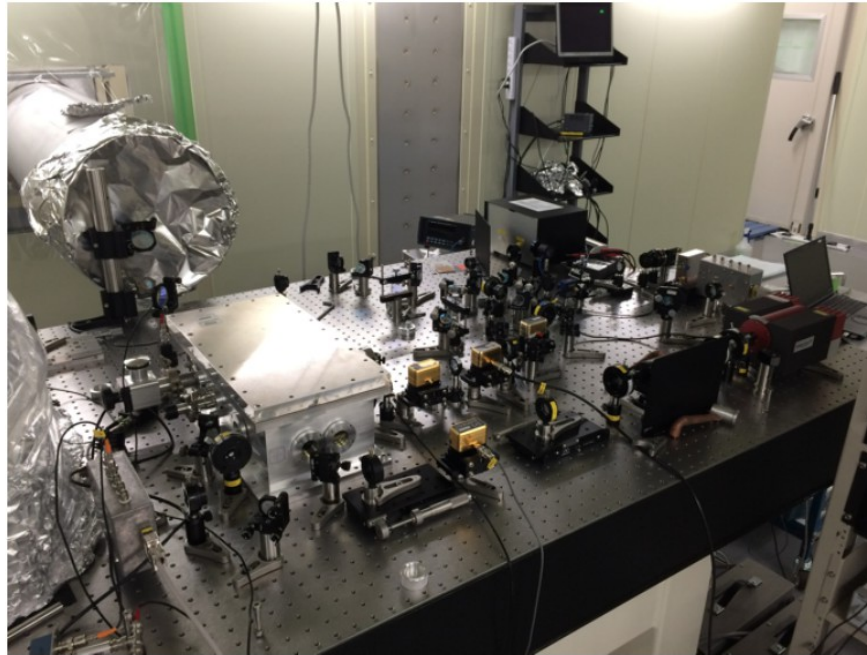
## Detector Characterization

PEM, Aux. channels, Online-monitors, diagnostics

## Instruments

# Detector Characterization

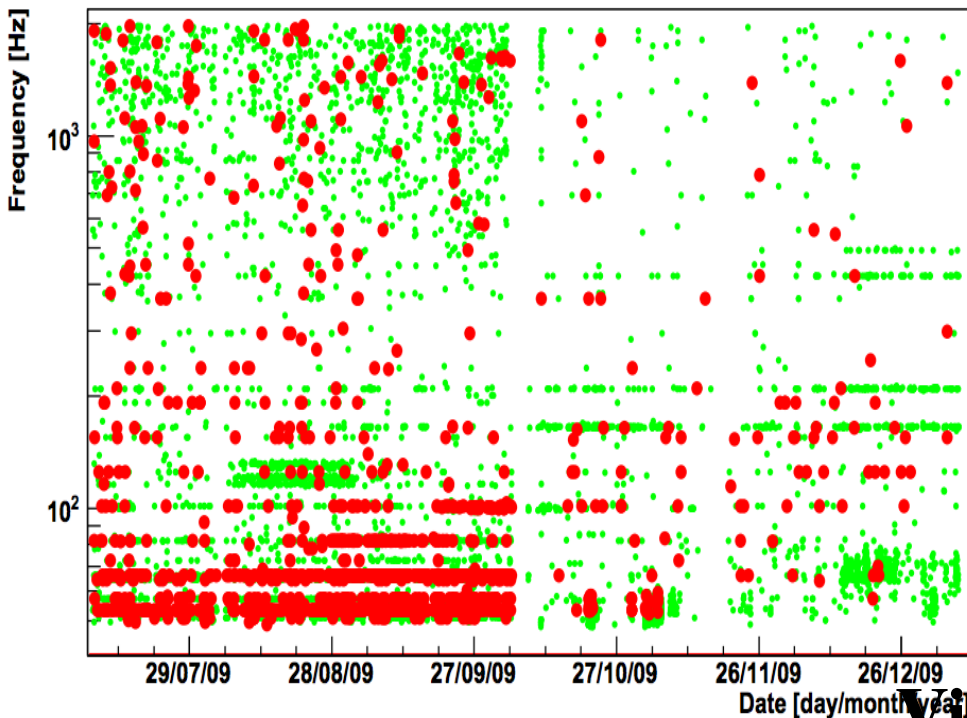
- 望遠鏡が正しく動作しているかどうかを診断
  - 奇妙な発振？ Saturation？ 雑音レベル？
  - カップルしているチャンネルは？ その起源は？
  - 定常性は？



中野 F2F  
meeting (2015)

- データの状態や質を評価し、サイエンスを最大化させる。
  - 現在の観測データで見える重力波の距離
  - データに含まれている

# 重力波望遠鏡の観測データ（例）



	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

Virgo

Virgo

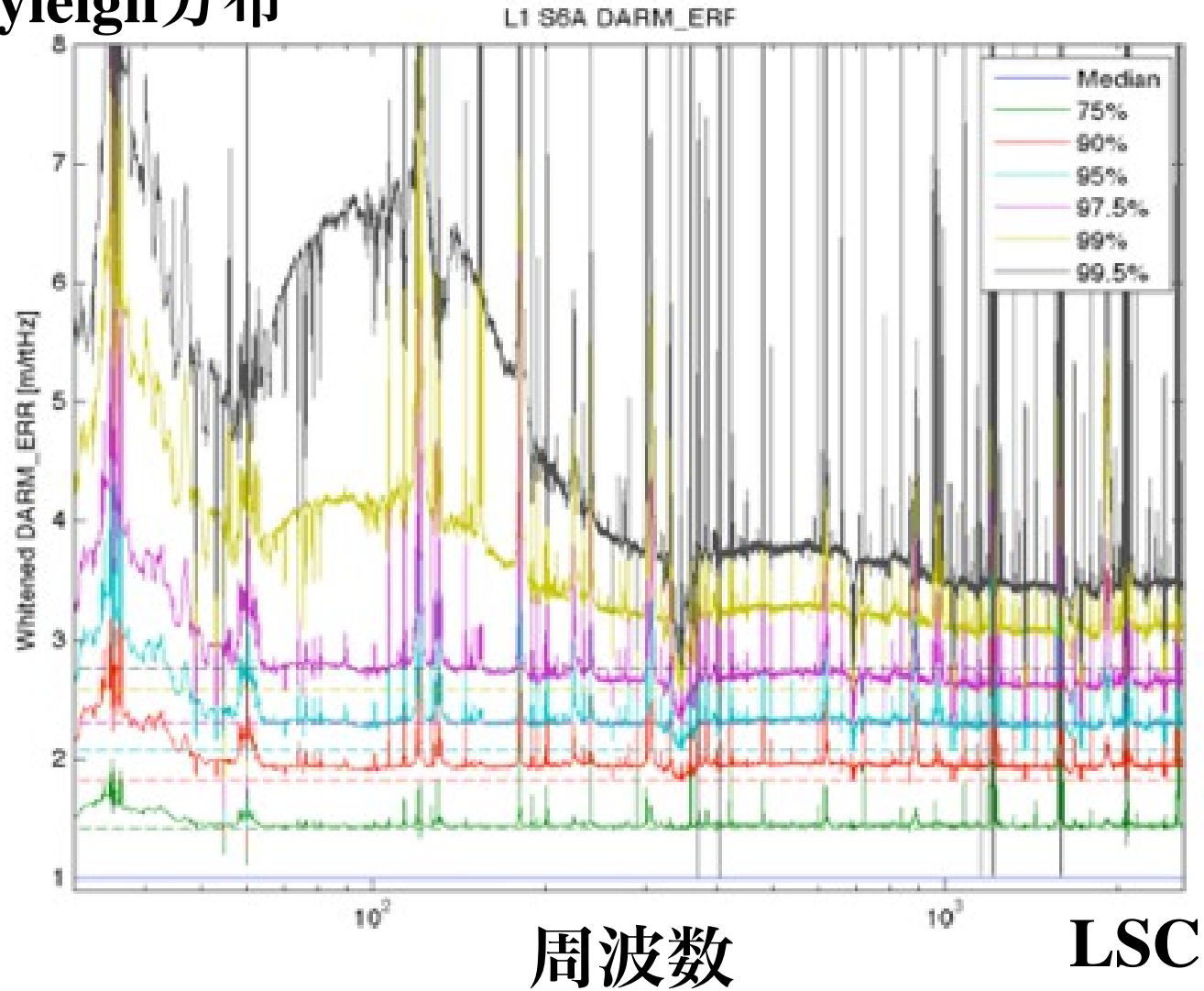
SNR>5のイベント  
が毎秒1.8個

1390のラインのうち、  
起源が特定できたのは960個

重力波発見を宣言には、こういった起源不明の雑音を特定、除去していかなければならない。

# データの（定常、非定常）非ガウス性

## Rayleigh分布







# 進捗状況：システム、ツール

- **Glitch Monitor**
- **Line Finder**
- **Line Tracking**
- **Line Removal**
- **Rayleigh Monitor**
- **Non-Gaussianity Monitor**
- **RMS Monitor**
- **Noise Floor Monitor**
- **Time-Series Monitor**
- **Spectrum Monitor**
- **Spectrogram Monitor**
- **Sensitivity Monitor**
- **Range Monitor**
  - **Inspiral**
  - **Inspiral-Merger-Ringdown**
  - **Ringdown**
  - **Stochastic**
- **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**

# 進捗状況：システム、ツール

相関関係を調べる

## Glitch Monitor

非定常雑音モニタ

- Line Finder
- Line Tracking
- Line Removal

発振などの  
ラインモニタ

- Rayleigh Monitor
- Non-Gaussianity Monitor
- RMS Monitor
- Noise Floor Monitor

ガウス性、定常性、非ガウス性

- Time-Series Monitor
- Spectrum Monitor
- Spectrogram Monitor

データの様子、  
スペクトル

- Sensitivity Monitor
- Range Monitor

重力波への感度

- Inspiral
- Inspiral-Merger-Ringdown
- Ringdown
- Stochastic

## 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

インターフェース

## Health monitor

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



# aLIGOで有効なものを吸収

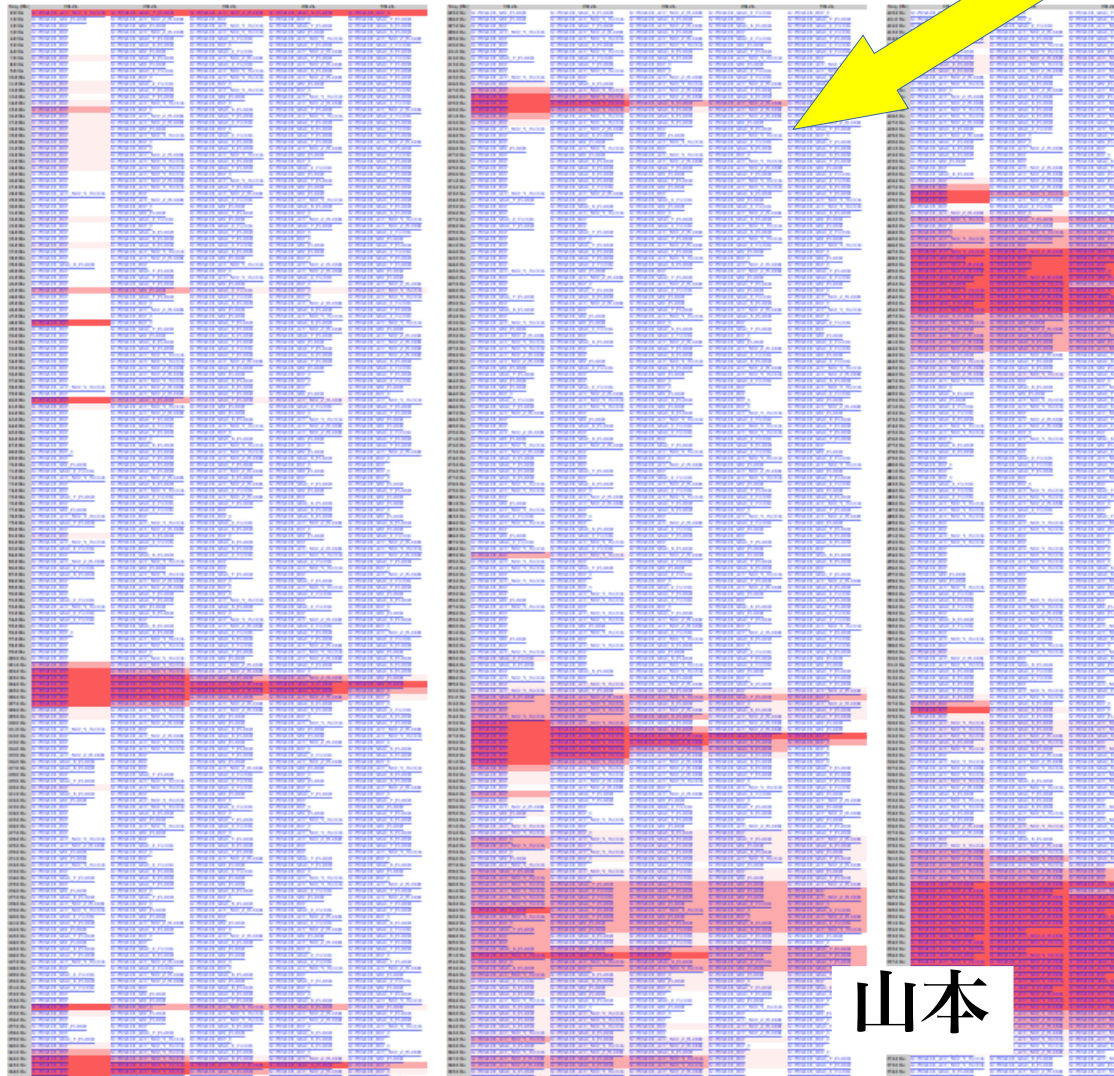
## HasKAL

GPS Time: 1120543424 (2015-07-10 06:03:27 UTC)

Channel: K1:PEM-EX\_ACC\_NO2\_X\_FLOOR

0.0Hz~

205.0Hz~



山本

- 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

# KAGRA発の評価法を開発

- **Glitch Monitor**

- **Line Finder**
- **Line Tracking**
- **Line Removal**

- **Rayleigh Monitor**

- **Non-Gaussianity Monitor**

- **RMS Monitor**
- **Noise Floor Monitor**

- **Time-Series Monitor**

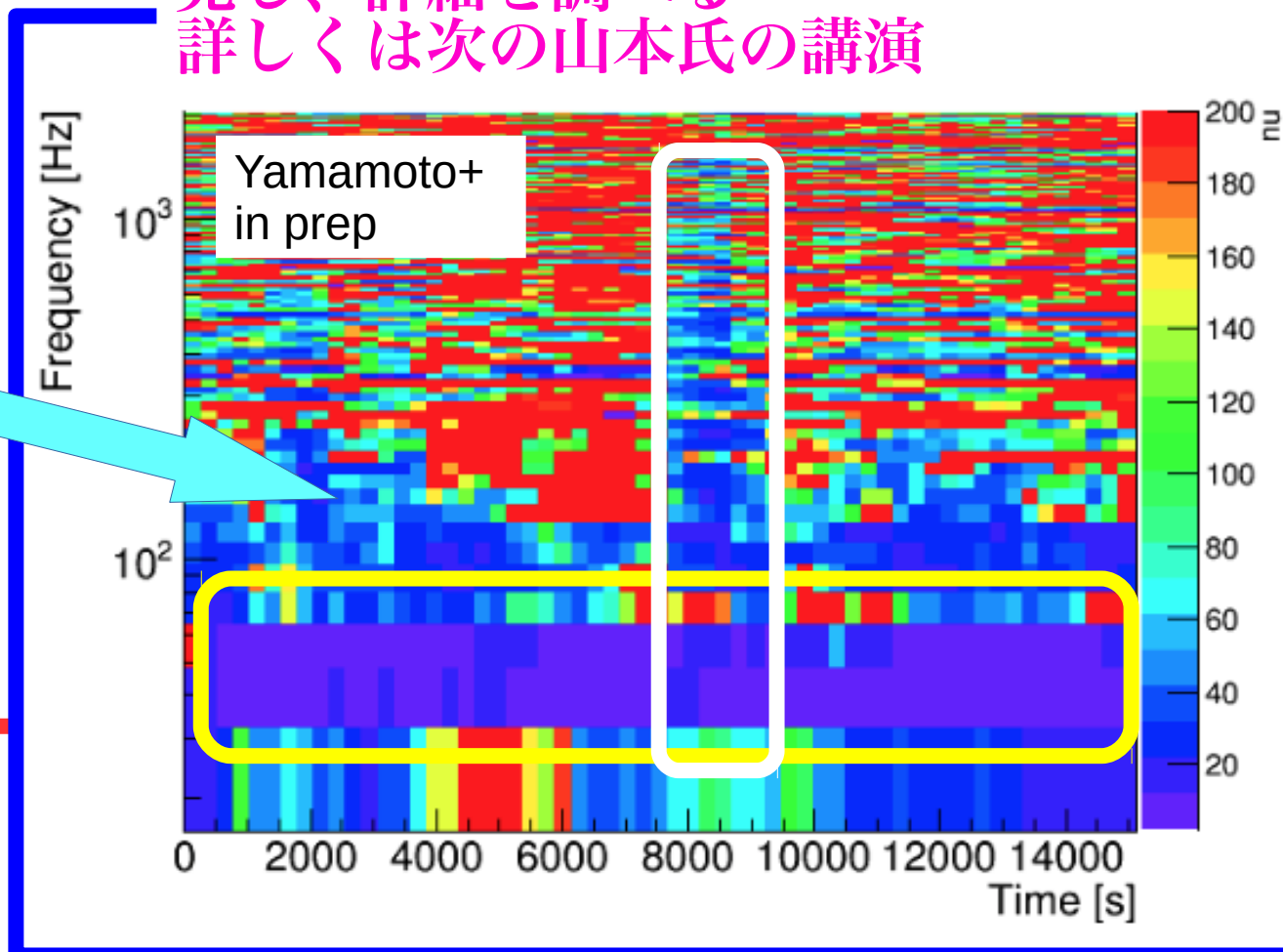
- **Spectrum Monitor**
- **Spectrogram Monitor**

- **Sensitivity Monitor**

- **Range Monitor**

- **Inspiral**
- **Inspiral-Merger-Ringdown**
- **Ringdown**
- **Stochastic**

定常非ガウス性、数100秒スケースの非ガウス性、それらの周波数依存性を発見し、詳細を調べる  
詳しくは次の山本氏の講演



This research has made use of data, software and/or web tools obtained from the LIGO Open Science Center (<https://losc.ligo.org>), a service of LIGO Laboratory and the LIGO Scientific Collaboration. LIGO is funded by the United States National Science Foundation.

# KAGRA発の線形でない相関を発見する手法の開発

## • Glitch Monitor

- Line Finder
- Line Tracking
- Line Removal

## • Rayleigh Monitor

- Non-Gaussianity Monitor

## • Coherence Finder

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

## • Time 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

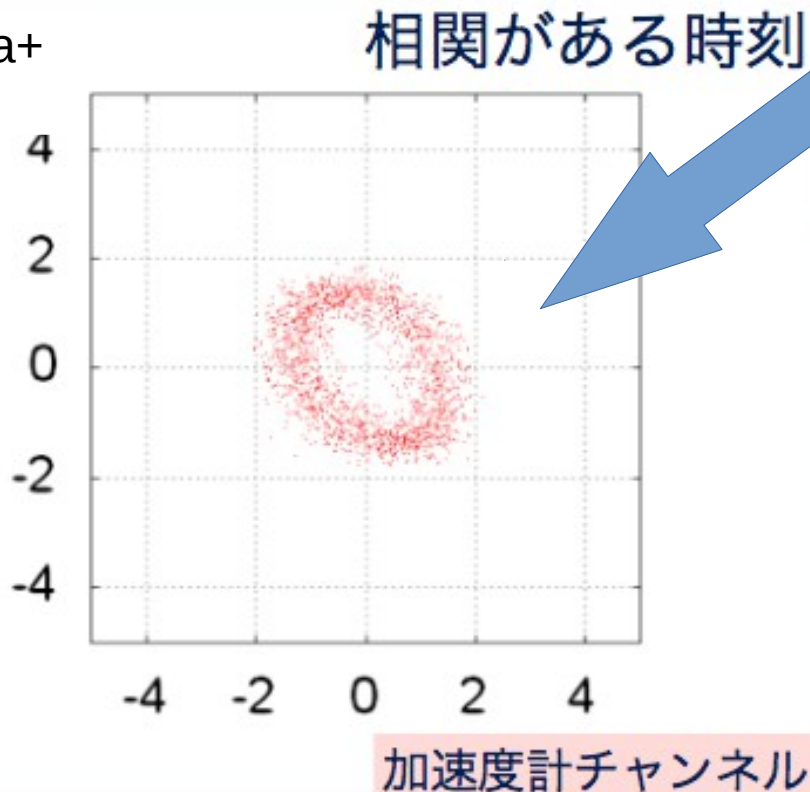
## • Newtonian noise

- Effect of water inside the mountain

Yuzurihara+  
in prep

重力波チャンネル

譲原



- Stochastic

enoshima authored 18 hours ago latest commit df515b023e

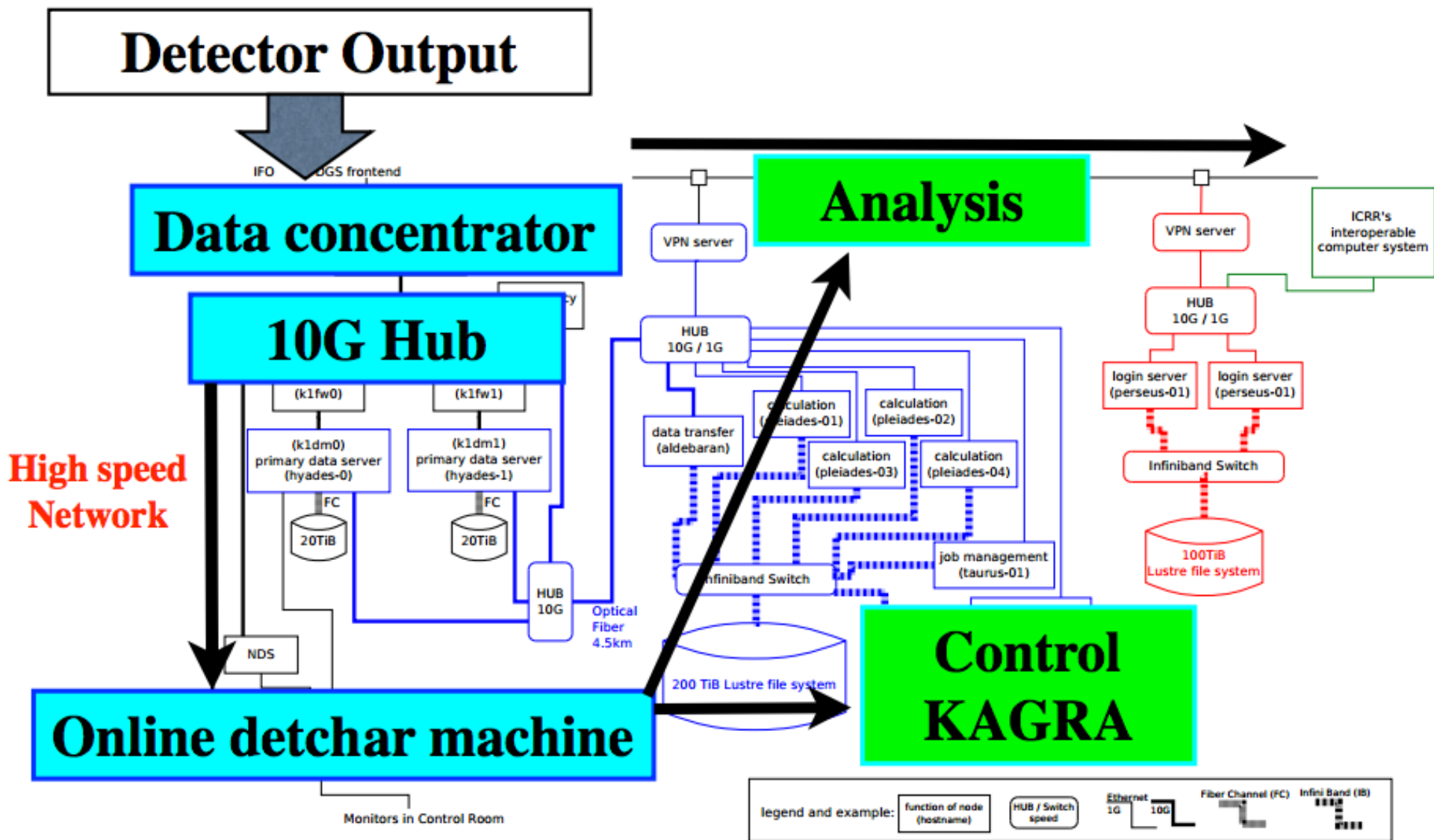
HasKAL

..		
Constant	remove haddock header	2 months ago
DataBaseUtils	added function	2 months ago
DetectorUtils	small change	22 days ago
ExternalUtils	bug fixed in DKGLUtils.c	10 days ago
FrameUtils	remove haddock header	2 months ago
GUI_Utils	modified GUI for StochMon update	11 days ago
LineUtils/LineRemoval	modify a sample kagali code	26 days ago
MathUtils/LinearAlgebra	changed directory structure	3 days ago
Misc	remove haddock header	2 months ago
MonitorUtils	RMSMon : modify daily RMSMon and measure running time	9 days ago
PlotUtils	added new function for spectrogram plot	19 hours ago
SearchUtils	added SearchUtils	a year ago
SignalProcessingUtils	added function	18 hours ago
SimulationUtils	remove unnecessary comment	2 months ago
SpectrumUtils	remove function runmed and unnecessary comment	2 months ago
StatisticsUtils	change module name	a year ago
TimeUtils	added function for converting time	a month ago
WaveUtils	add dropWaveData, takeWaveData	a year ago
WebUtils	minor update	10 days ago
Constant.hs	remove haddock header	2 months ago
DataBaseUtils.hs	added DataBaseUtils related	3 months ago
DetectorUtils.hs	added module of modules	a year ago
TimeUtils.hs	added module-setting module	a year ago
WaveUtils.hs	added module-setting file	a year ago
WebUtils.hs	added blank	2 months ago

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



# 進捗状況：ネットワーク



Realtime Channel Monitor

Kanda

# コミッションングに役立てるために

- Webから各種ツールがすぐ使える
- Webからデータをモニタできる
- スマホからも使える

### Past Data Viewer

Date:

GPS Time: 1115097401

Local Time: 2015 Jan. 01 00:00:00 JST

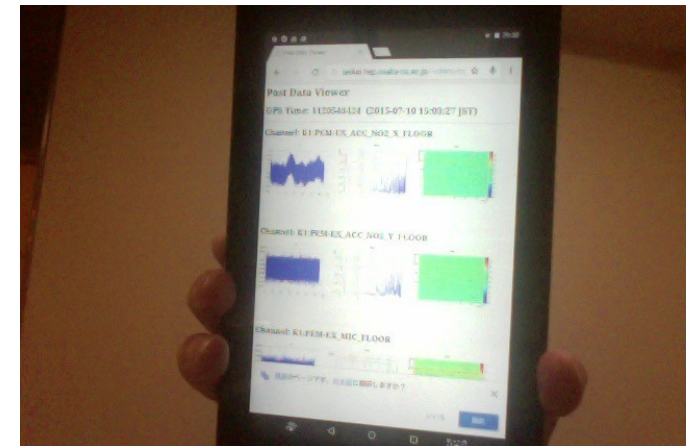
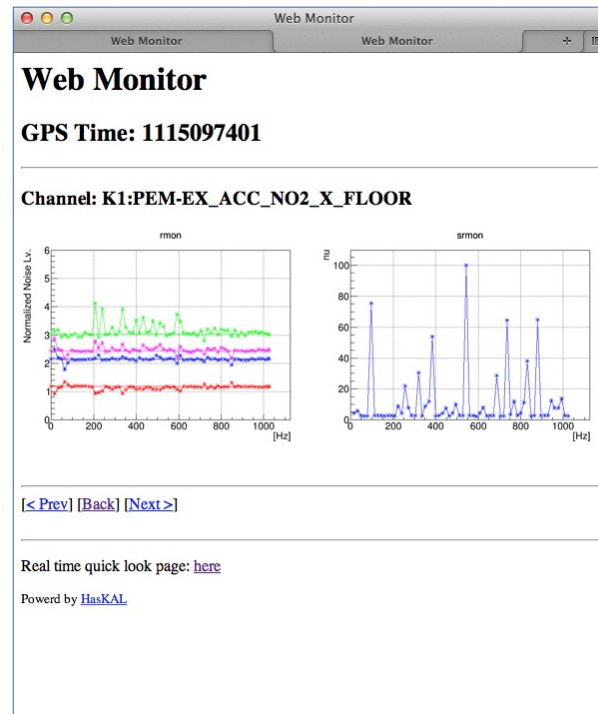
Duration: 32 sec.

Channel:

K1:PEM-EX\_ACC\_NO2\_X\_FLOOR  
K1:PEM-EX\_ACC\_NO2\_Y\_FLOOR  
K1:PEM-EX\_ACC\_NO2\_Z\_FLOOR  
K1:PEM-EX\_MAG\_X\_FLOOR  
K1:PEM-EX\_MAG\_Y\_FLOOR

Type:

Time Series  
 Spectrum  
 Spectrogram

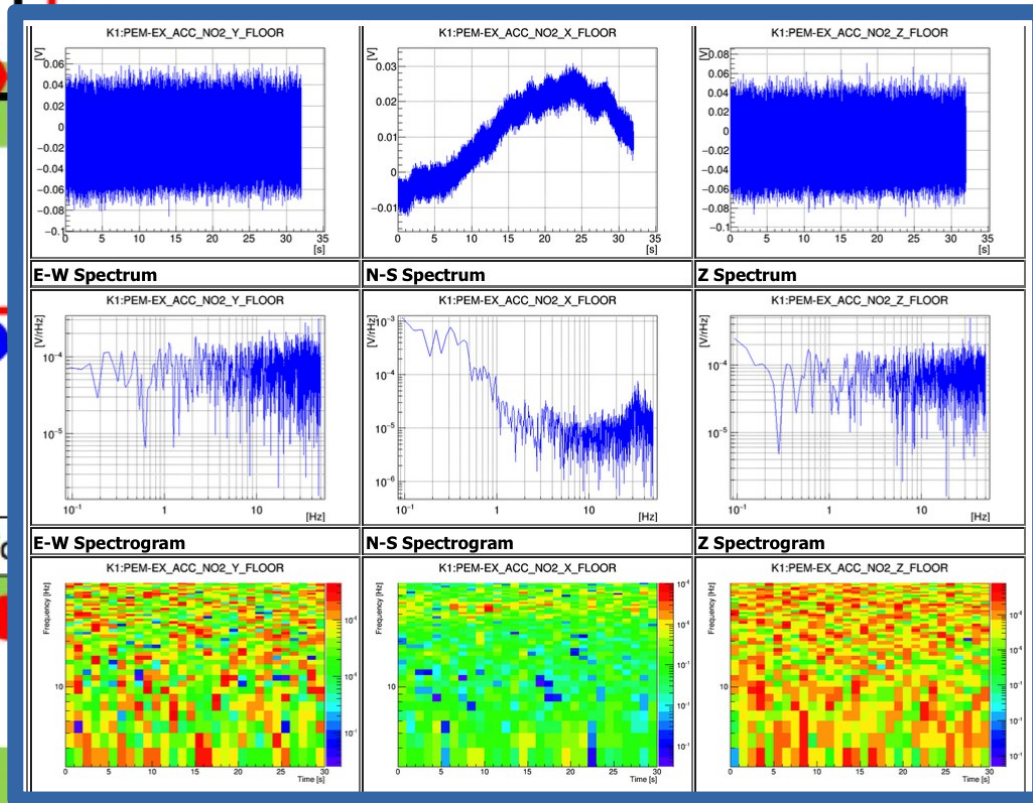




# 環境モニタ

## X-Endで環境モニタ

2nd floor



1st floor

500m



## Next

- **detcharシステムをonline-detchar計算機に組み込む。（現在その途中）**
- **サブシステムのdetector characterization**
  - **Pre-Stabilized Laserから始まることにな（りそう？）**
  - **そのほか続々と**
- **サブシステムDetchar結果をベースとしたシステムティックなデータ評価基準の定義**
- **環境雑音の測定**