Status of
KAGRA detector characterization

Kazuhiro Hayama
on behalf of detector characterization group

Interface of Detector Characterization

Data Analysis

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

Detector Characterization

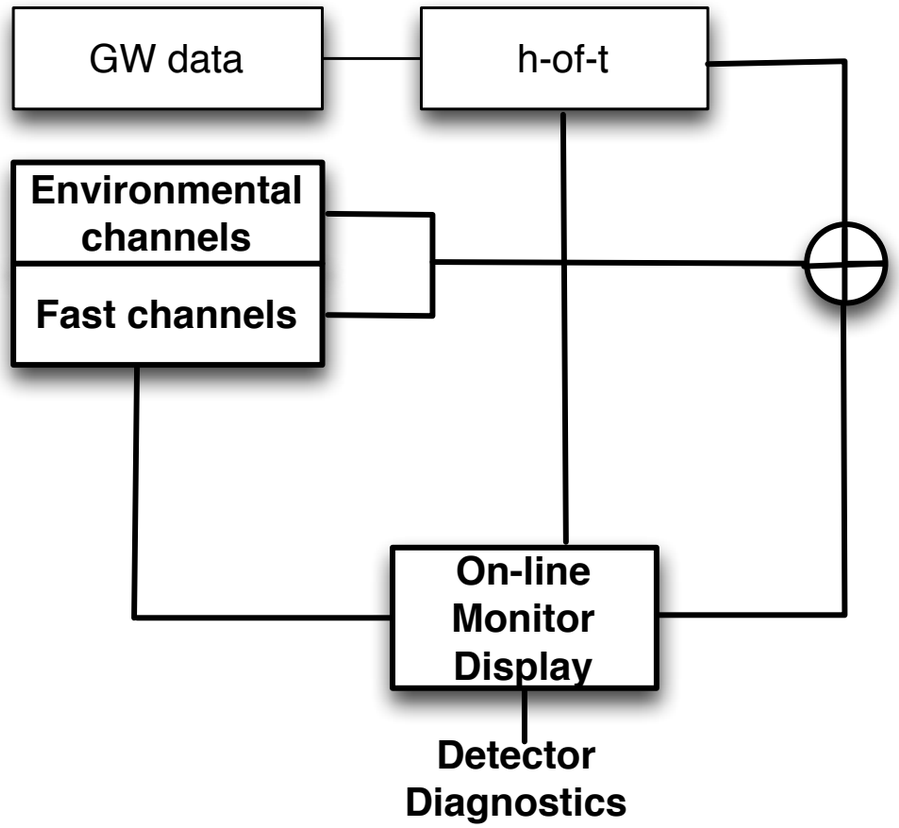
PEM, Aux. channels, Online-monitors, diagnostics

Instruments

Detector Characterization

- **Diagnostics system to know detector conditions, environmental noise, helping for improvement detector operation.**
- **Evaluation of data quality, distribution of the data quality information to collaborators.**
- **Veto analysis. Results are used for to obtain higher-quality scientific results.**

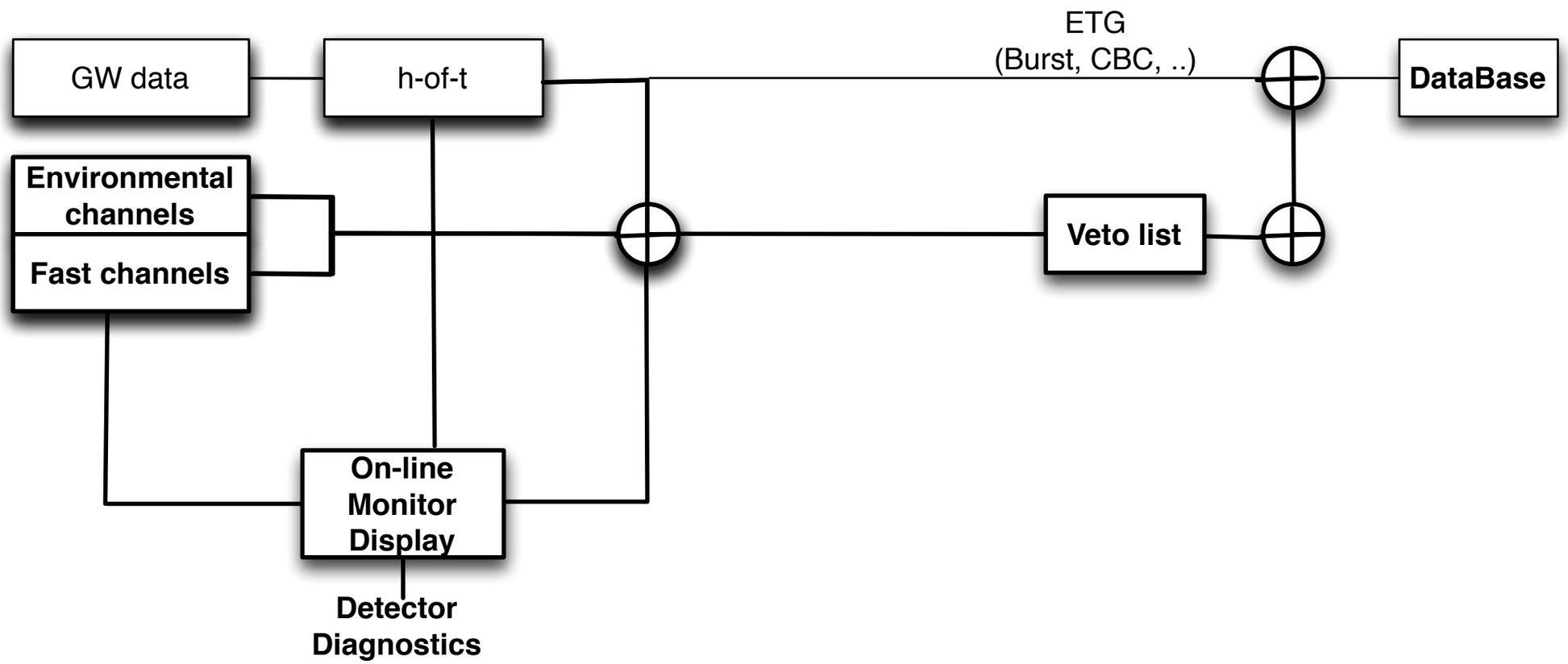
Detector Diagnostics



- **These channel data are analyzed and the results are displayed via the online monitor displays.**

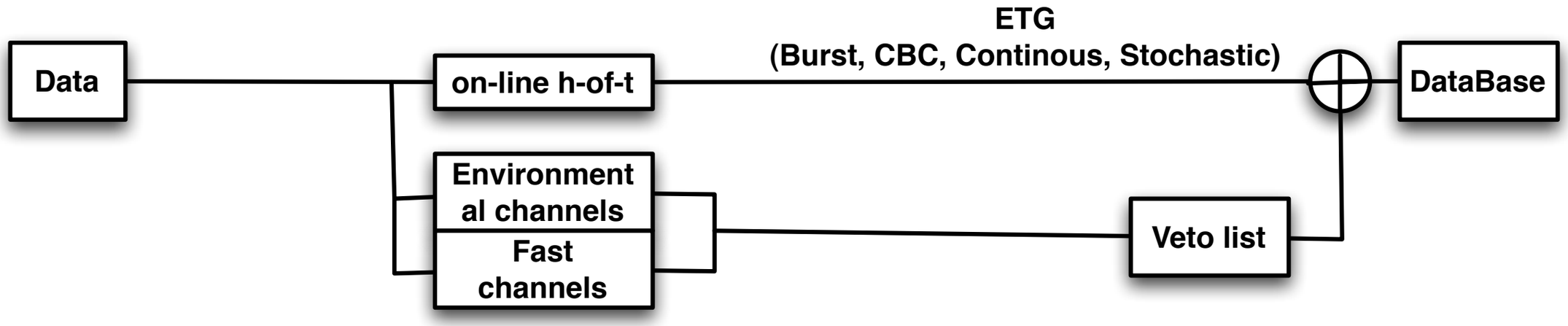
Realtime detector diagnostics for realtime adjustment of KAGRA operation

Data Quality Information



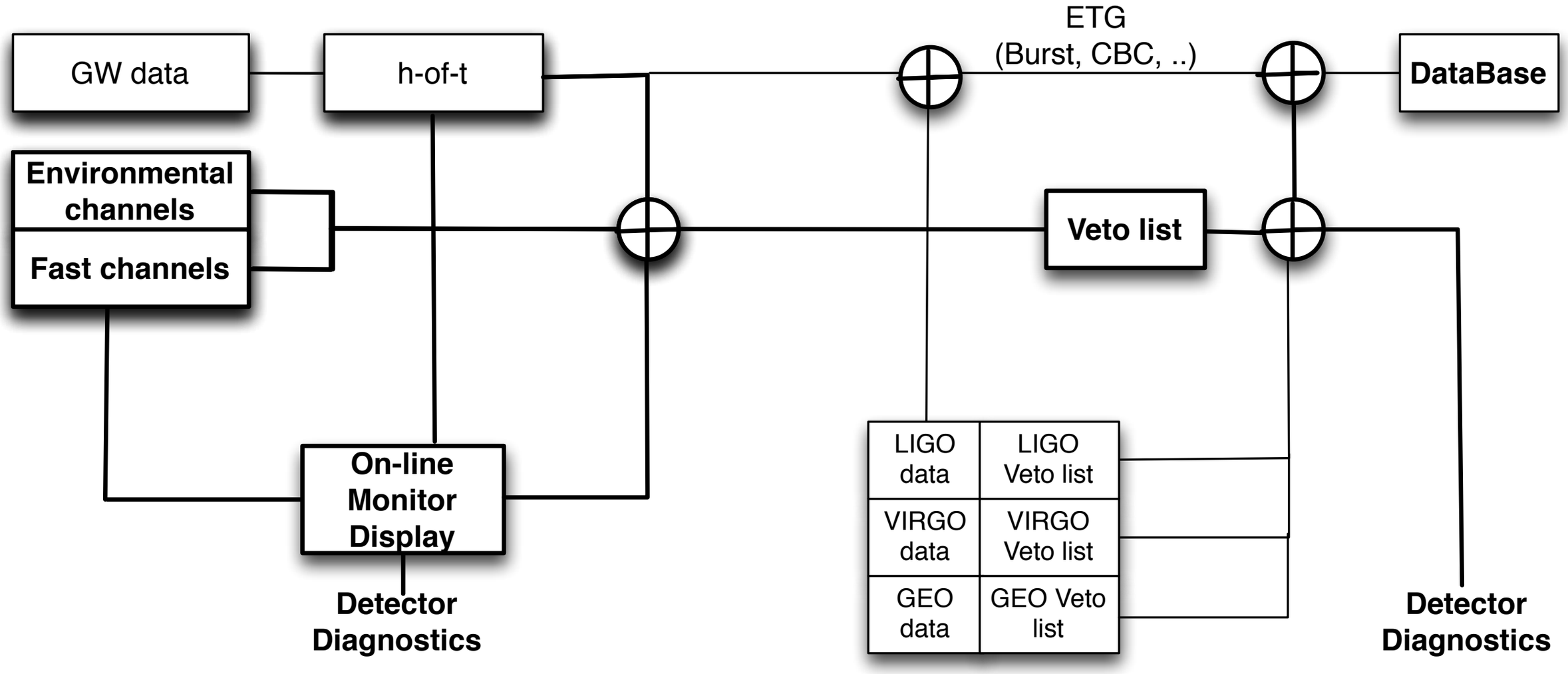
- **Both h-of, fast, slow channels are analyzed to find and reject noise artifacts.**
- **Coincidence, correlation analysis between detector, environmental channels and the h-of-t.**
- **Data quality and veto list are used for multimessenger observation and post-processing analysis of each GW search.**

Veto Analysis



Veto list generation		
Transient GW (CBC, Burst)	**Continuous GW (pulsar, LMXB, ...)**	**Stochastic GW (Early univ, ...)**
• Real-time glitch detection • Glitch classification • Coincidence analysis between the GW channel and auxiliary sensor channels. • ...	• Line tracking • Line detection • Removal of high frequency spikes • ...	• Noise floor monitor • Non-stationary • ...

Global Network Detchar



- **All veto lists combined and used for global detector network data analysis.**
- **Environmental channels may be correlated between LIGO, Virgo, GEO, KAGRA, ... Globally correlated magnetic noise**

On going DetChar projects

Primary Projects

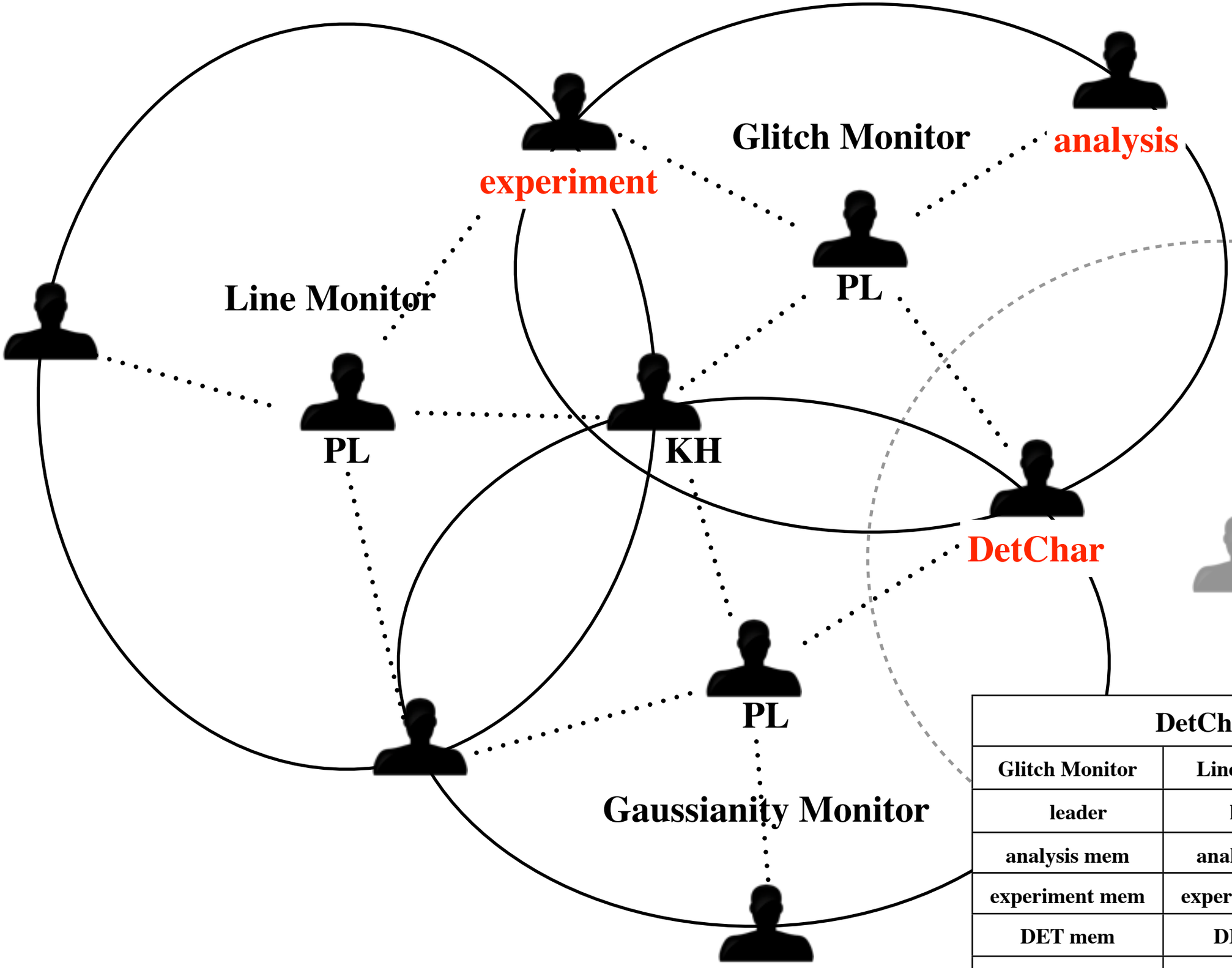
- To maintain Diagnostics Test Tool(Hayama, Miyakawa)
- Detchar GUI (Yamamoto,Hayama)
- Glitch Monitor (Hayama)
- Line Monitor (Itoh, Kokeyama)
- Gaussianity Monitor (Hayama)
- Noise Budget(Hayama, Miyakawa)
- Health Monitor
- Data base
- Quality flag(Hayama, Tatsumi)

Special Projects

- Globally correlated magnetic noise (Nishizawa, Hayama, ...)
- Violin mode(Hayama,Sekiguchi,..)
- Multi-Channel Analysis (Korea detchar, Mano, Hayama)
- Detchar shift plan(Hayama)
- Newtonian Noise(Agatsuma)
- Magnetic field and Seismic noise at the KAHGRA site (Hayama, Ono, Yano, ...)

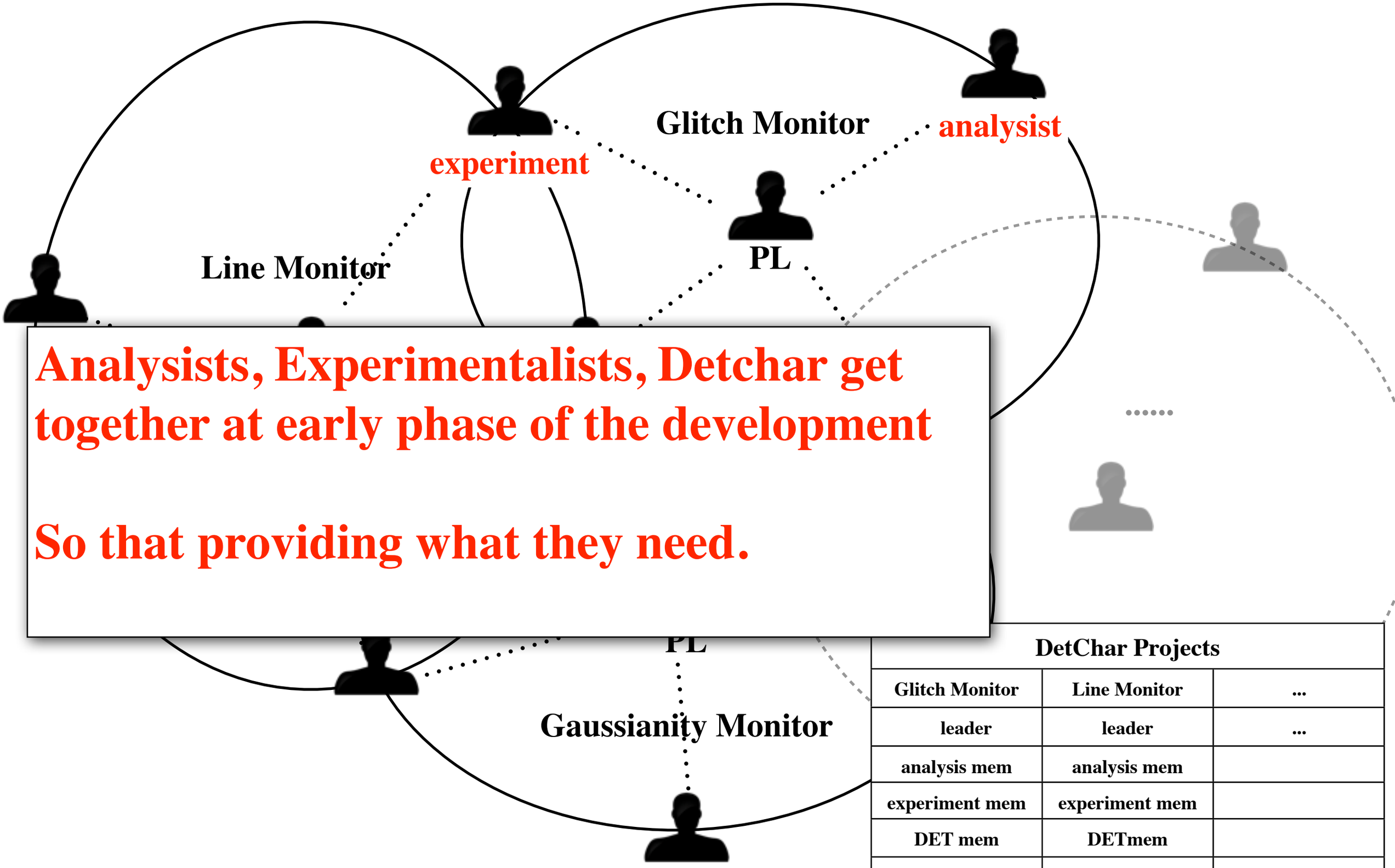
http://gwdoc.icrr.u-tokyo.ac.jp/cgi-bin/private/DocDB/ShowDocument?docid=1724

Structure of the projects



DetChar Projects		
Glitch Monitor	Line Monitor	...
leader	leader	...
analysis mem	analysis mem	
experiment mem	experiment mem	
DET mem	DETmem	

Structure of the projects



Analysists, Experimentalists, Detchar get together at early phase of the development

So that providing what they need.

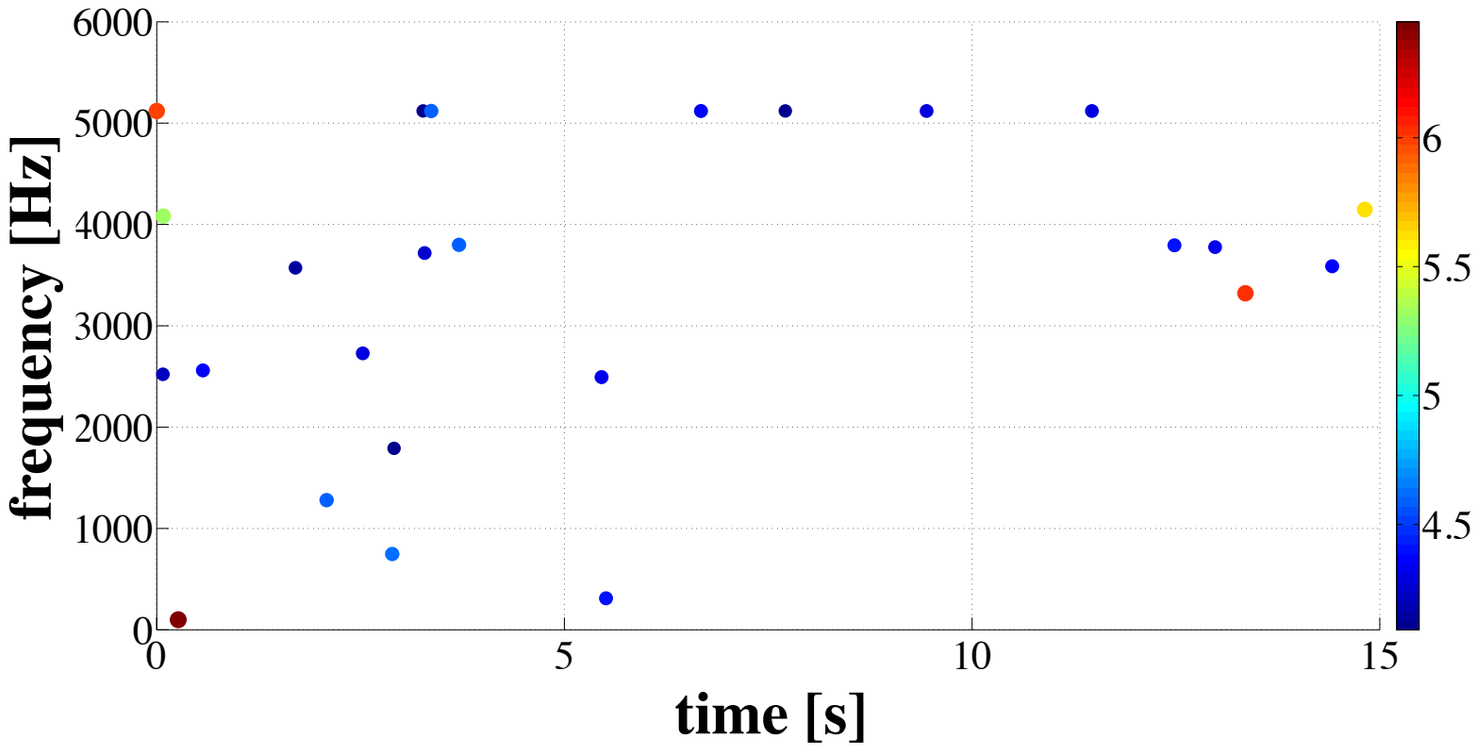
DetChar Projects		
Glitch Monitor	Line Monitor	...
leader	leader	...
analysis mem	analysis mem	
experiment mem	experiment mem	
DET mem	DETmem	

P : Glitch monitors

- Glitch detection
- Statistics (frequency,..)
- Characterization
- Coherency check between channels
- Event display

P : Glitch monitors

- **Some monitors are running:**
  KleineWelle, ...
- **KW is used in LIGO, Virgo: useful to compare detector conditions with the same algorithm.**



XML formatted data

```
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<!DOCTYPE LIGO_LW SYSTEM "http://gateway/doc/ligolwAPI/html/ligolw_dtd.txt">
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  <Table Name="sngl_burstgroup:sngl_burst:table">
    <Column Name="sngl_burstgroup:sngl_burst:ifo" Type="lstring"/>
    <Column Name="sngl_burstgroup:sngl_burst:peak_time" Type="int_4s"/>
    <Column Name="sngl_burstgroup:sngl_burst:peak_time_ns" Type="int_4s"/>
    <Column Name="sngl_burstgroup:sngl_burst:start_time" Type="int_4s"/>
    <Column Name="sngl_burstgroup:sngl_burst:start_time_ns" Type="int_4s"/>
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    <Column Name="sngl_burstgroup:sngl_burst:search" Type="lstring"/>
    <Column Name="sngl_burstgroup:sngl_burst:central_freq" Type="real_4"/>
    <Column Name="sngl_burstgroup:sngl_burst:channel" Type="lstring"/>
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    <Column Name="sngl_burstgroup:sngl_burst:bandwidth" Type="real_4"/>
    <Column Name="sngl_burstgroup:sngl_burst:event_id" Type="ilwd:char"/>
    <Column Name="sngl_burstgroup:sngl_burst:process_id" Type="ilwd:char_u"/>
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      "IBMRCBMwSAAAAQEAAA==",
      "",970014992,65307616,970014992,65185546,0.000244141,"kleineWelle",5120,
      "H1_LDAS-STRAIN_16_4096",1,3.14791,0,0,0,6144,"sngl_burst:event_id:3",
```

P : Line monitor

- Line detection
- Statistics (frequency,..)
- Characterization (duration, central frequency, power)
- Coherency check between channels
- Event display

o Useful to find weird oscillation of instruments in subsystems.
o Veto analysis

P : Gaussianity Monitor

- Noise floor tracking
- Power spectrum
- Rayleigh distribution tracking
- Realtime noise modeling
- Monitor display

o Useful to know detector conditions.
o Useful to improve performance of GW search pipelines.

P : Data quality study

Daisuke Tatsumi (NAOJ)

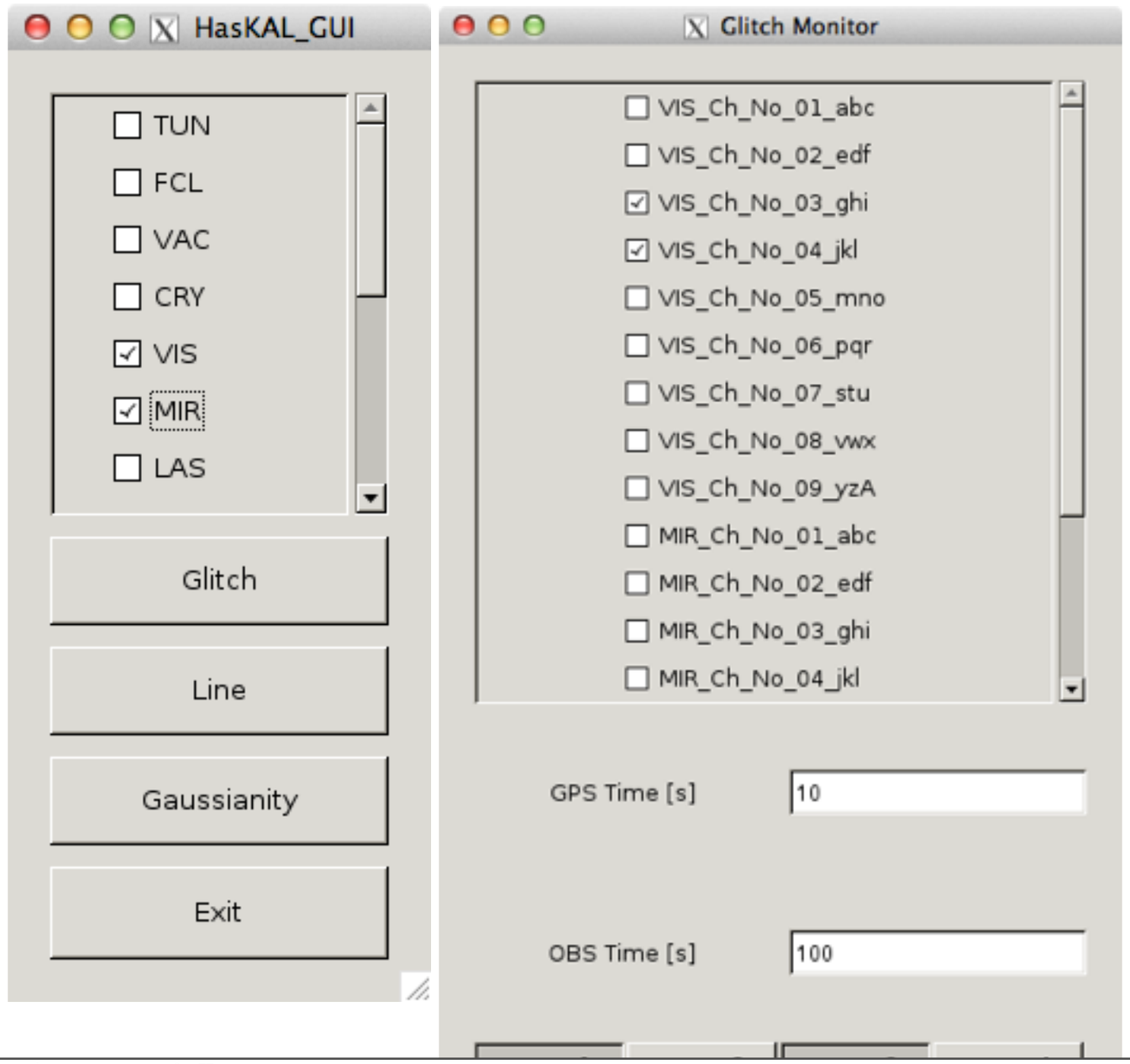
Reduction of cryogenic induced glitches
KAGRA is a unique cryogenic detector in the world.
We are developing a method to quality the data condition.

- **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.**

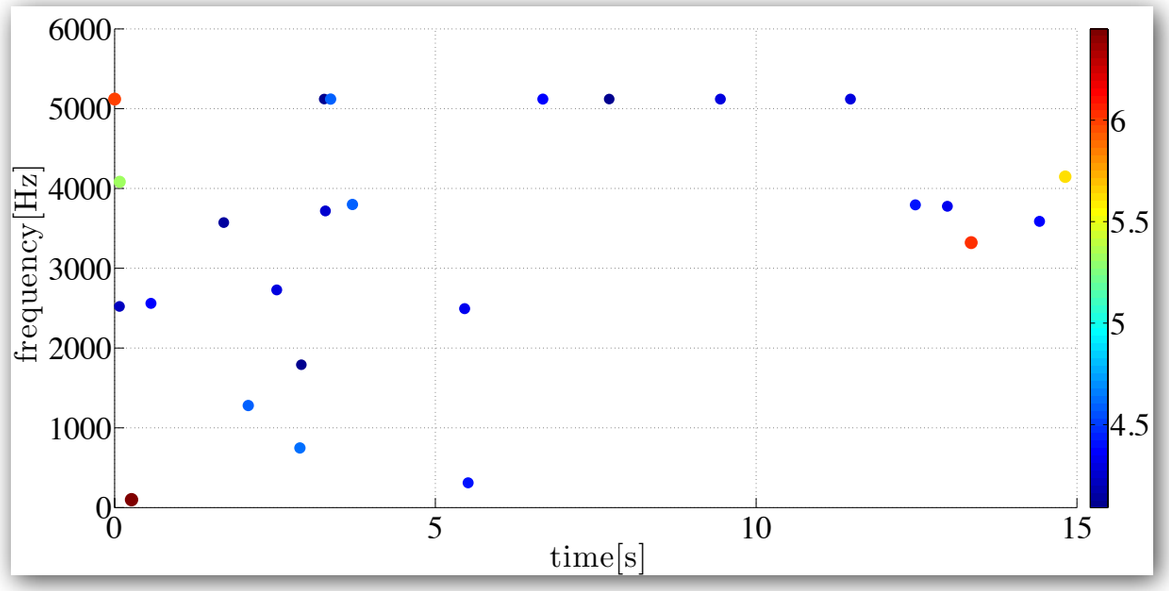
P : Detector characterization system : GUI

Takahiro Yamamoto
(Osaka City Univ.)

- **An experimentalist can monitor various channels with the user-friendly GUI system to see what happen in multiple subsystems when he find weird condition of KAGRA.**



Glitch display



S : Un-supervised glitch clustering

Shuhei Mano
The Institute of Statistical Mathematics, Japan

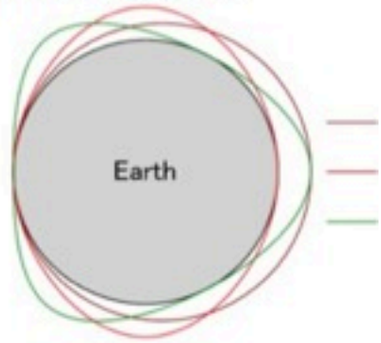
- **From the experience of TAMA300, LIGO, Virgo, there are glitch families, but the number is unknown.**
- **Identification of glitch families is important to exclude their origins.**
- **We propose a Bayesian clustering method**
  - **Dirichlet process Mixture can find how many clusters exist, how they are distributed.**
  - **Test pipeline are ready to go, now discussing how we construct the input vector.**

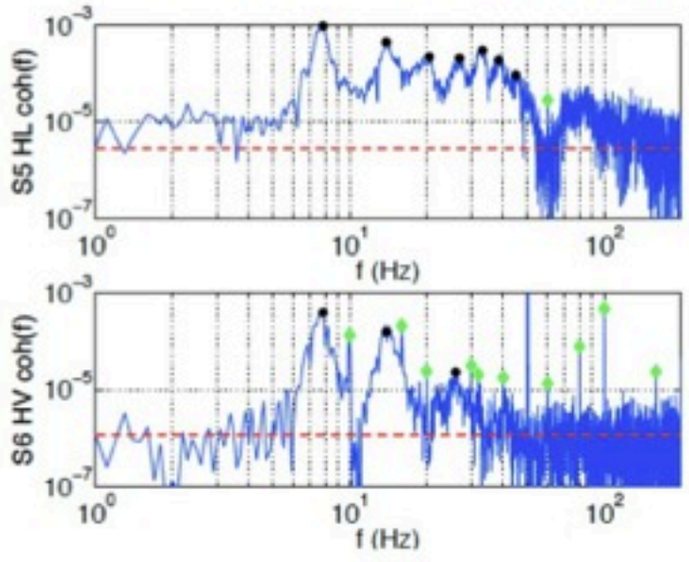
http://gwwiki.icrr.u-tokyo.ac.jp/JGWwiki/KAGRA/Subgroups/DET/Meet/Agenda20131126?action=AttachFile&do=view&target=gw1311.pdf

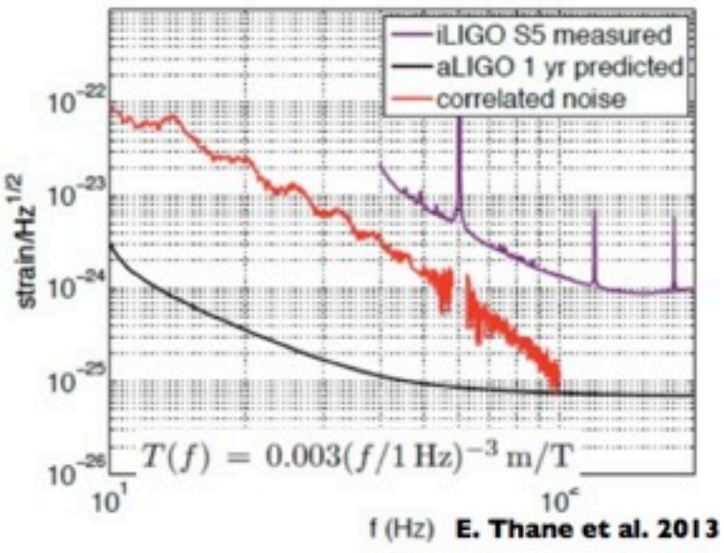
S : Globally Correlated Magnetic Noise

Atsushi Nishizawa
Kyoto Univ.

- Schumann resonance
  Resonance of the ionosphere due to discharge of thunders, solar wind,...
  - very weak (0.5-1E-12T/rHz) (Earth's:1E-5T)
  - Long coherent length ~1000km
  - Correlation shows up by 1year integration







Influence on SGWB search

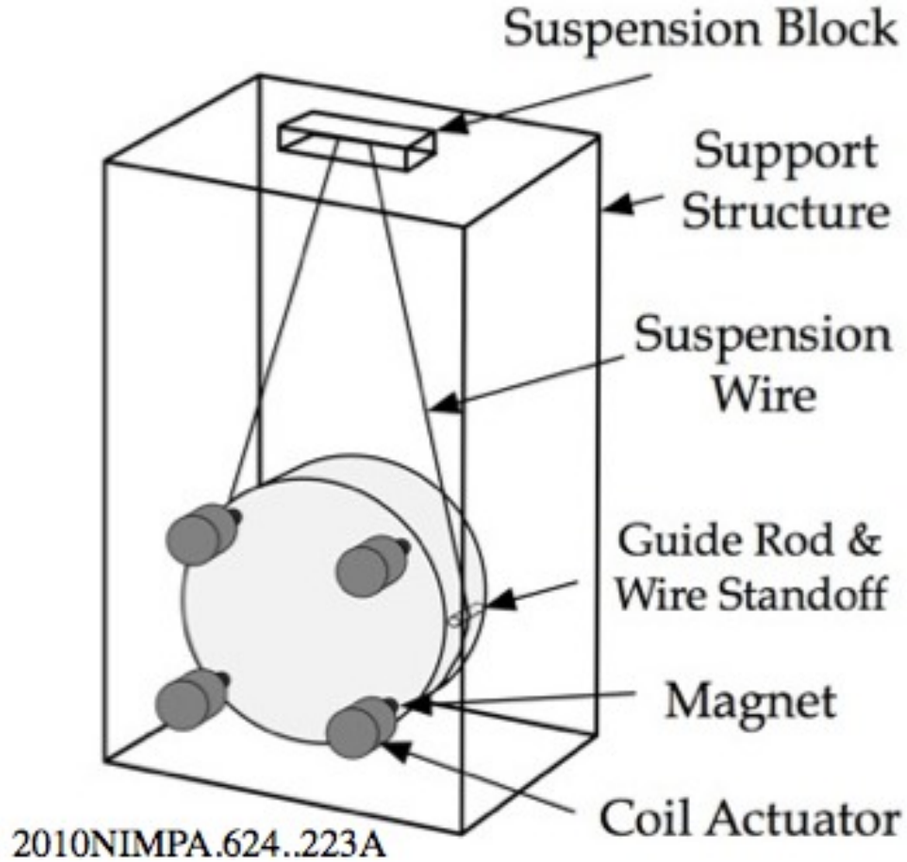
detector pair	$h_0^2\Omega_{\rm gw}$ w/o magnetic noise	$h_0^2\Omega_{\rm gw}$ w/ magnetic noise	degradation factor
HL	5.5×10^{-9}	2.5×10^{-8}	4.55
HV	2.4×10^{-8}	4.1×10^{-8}	1.71
LV	2.0×10^{-8}	3.5×10^{-8}	1.75
KH	3.8×10^{-8}	5.0×10^{-8}	1.31
KL	6.4×10^{-8}	7.7×10^{-8}	1.20
KV	2.2×10^{-8}	3.4×10^{-8}	1.54

表 1: Detectable $h_0^2\Omega_{\rm gw}$ with SNR $= 5$ for 1 yr observation time. Note that when correlation noise limits the sensitivity to $\Omega_{\rm gw}$, longer observation time does not help improve the sensitivity.

S : The magnetic field affects the KAGRA's mirror actuation?

- **How much does the Mag. field affect Magnet-Coil actuators?**
- **What about non-stationary noise ?**

We measured the magnetic field at the KAGRA site.



S : Seismic Activities at the KAGRA site

- **The KAGRA Vibration Isolation System will attenuate seismic noise.**
- **Up-conversion noise induced by non-linear coupling of scattered light with the seismic noise shows up in the observation band(~ a few 100Hz).**
  How about KAGRA?

We measured the seismic noise at the KAGRA site.

Measurement of the magnetic field and seismic activities at the KAGRA site

- We measured the magnetic field and seismic activities at the KAGRA site in 21-25 Oct., 2013.
- Kenji Ono will give a talk about the measurement of the magnetic field
- Kazuhiro Yano will give a talk about the measurement of the seismic motion

Collaboration with the KGWG detchar group

- **Multivariate analysis based on ANN for the Veto study (See Young-Min's talk)**
- **We have bi-weekly telecons since last KJ workshop.**

So far, the development done using mostly LIGO data

- **Analysis method should be along with a detector.**
- **Development of Hilbert-Huang Translation pipeline using CLIO data.**
- **The obtained data has been provided to the KGWG detchar group and hope to help the development of the multivariate analysis for KAGRA**

Collaboration with Virgo

- **With help of Raffaele Flaminio, we contacted the Virgo director Federico Ferrini, the spokesman Vinet Jean-Yves, the Virgo DQ leader Didier Verkindt.**
- **We now have a Virgo cluster account, can access to Virgo GW, PEM channel data.**
- **We are planning to start joint meetings every month from this Dec.**

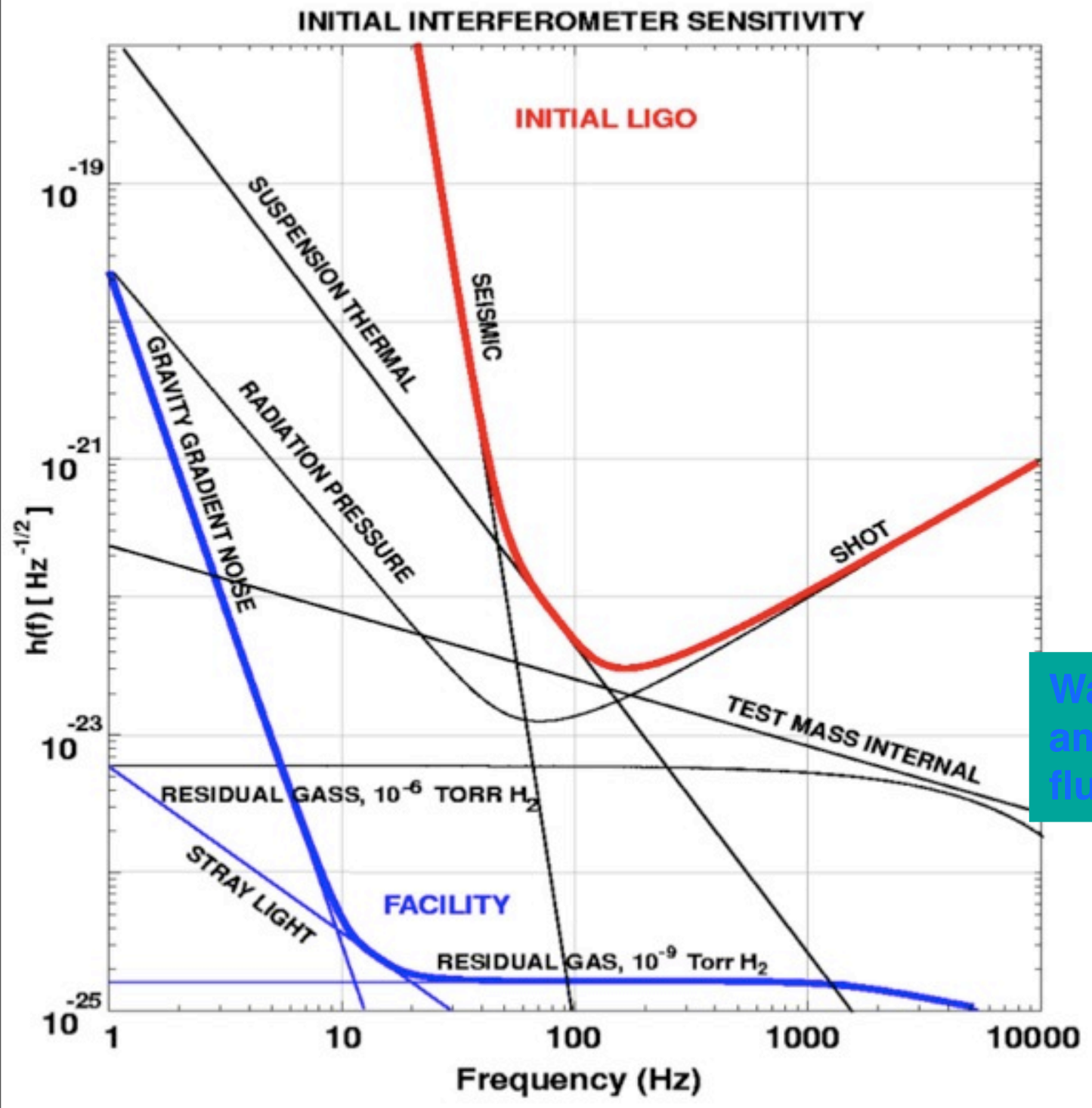
Summary

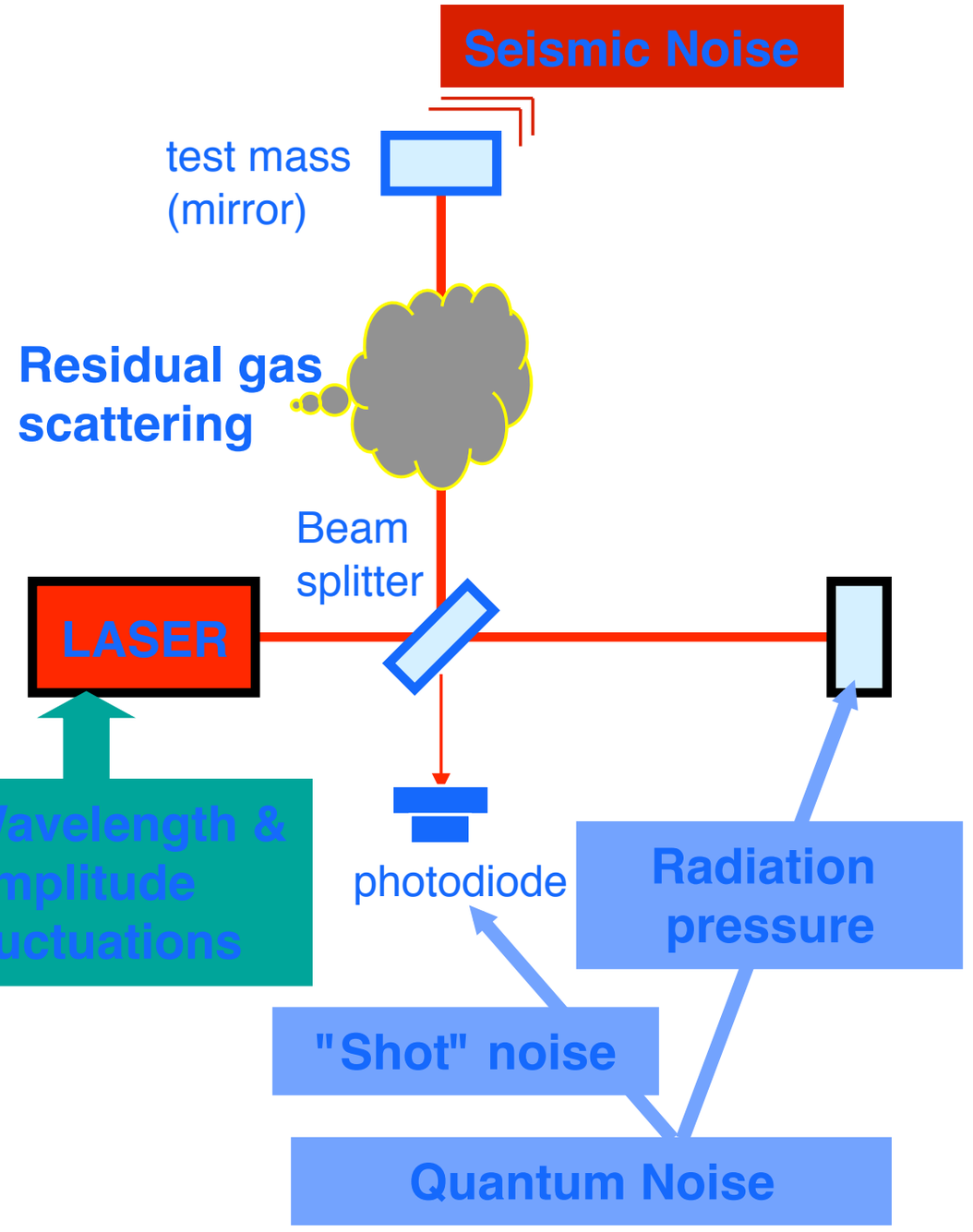
Toward coming commissioning stage,

- **Developing a system to monitor ~10,000 channels of KAGRA**
- **Knowing noise characteristics at the KAGRA site**

We are discussing other measurements at the KAGRA site. Good opportunity to join such activities?

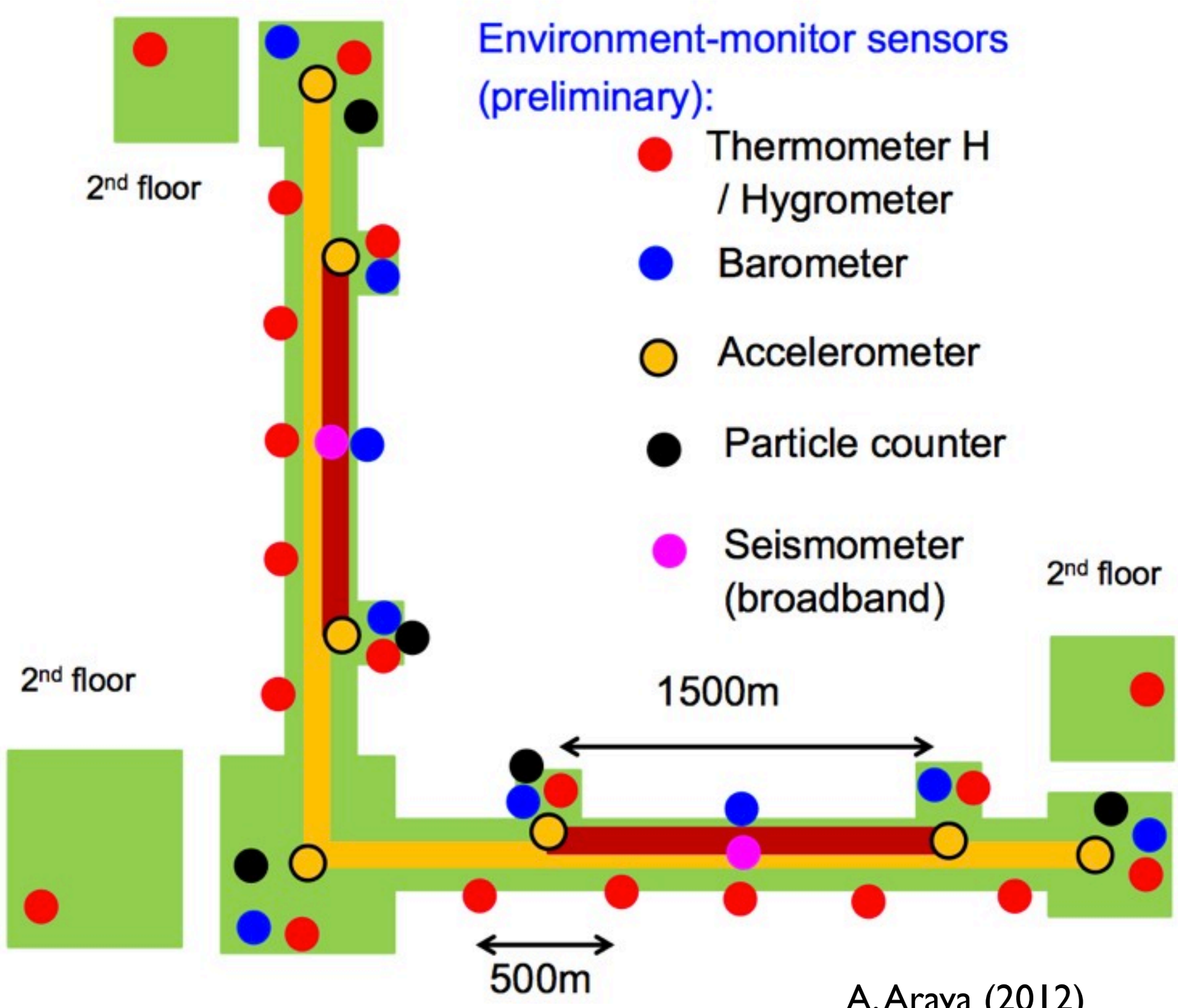
Noise sources in a GW telescope





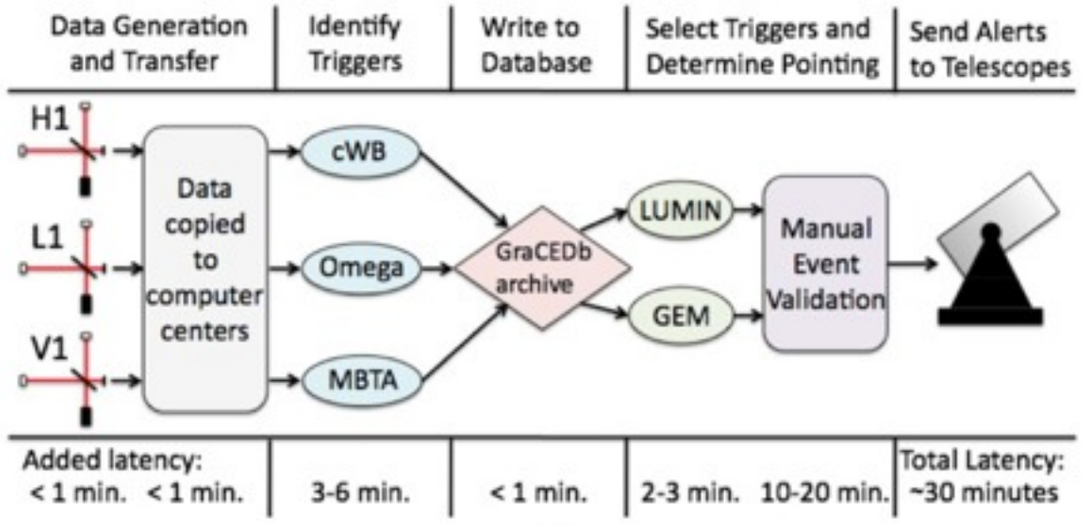
Rana

Environmental Monitors

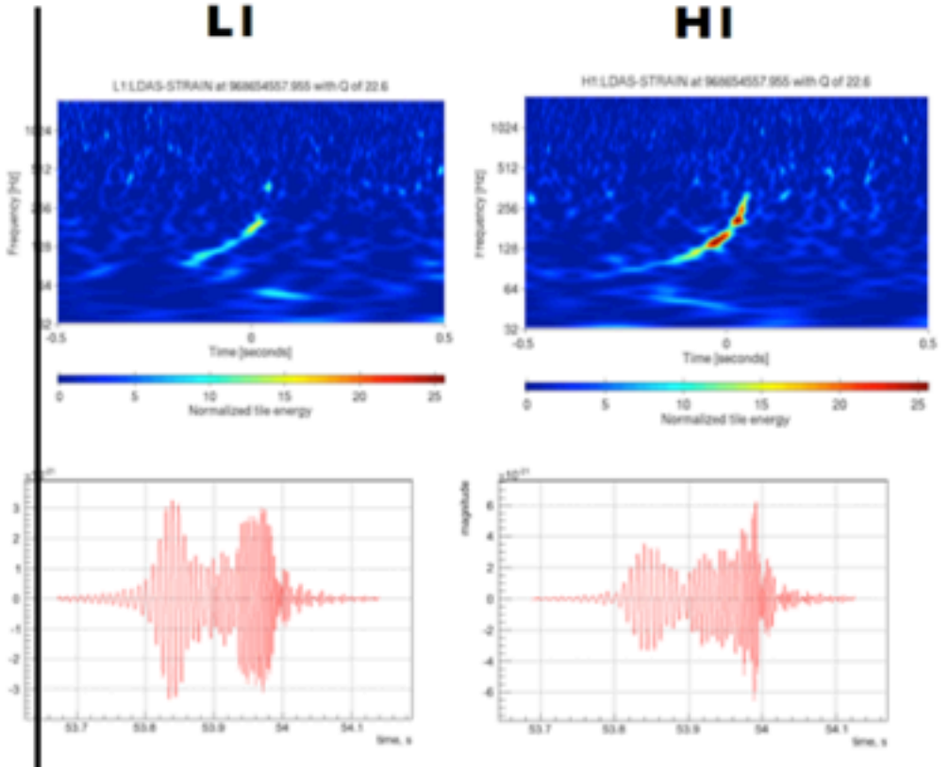


A. Araya (2012)

Realtime detector characterization



Burst pipeline (cWB)



‘gold plated inspiral at first glance’ (Igor)

t_{dog}+8[m]

Human Check

Undefined flags

- Are there any undefined CAT 1 or CAT 2 flags? : No
- If Yes, please include the names of the flags here:

- GO/NOGO: GO
- Checked by: Christian Ott
- Comments:

Sanity Checks Script

See sanity check script output - '+' means GO / 'f' or '-' means NOGO

- Within detector locks: GO
- DQ Flags: GO
- KleineWelle trigger rate: GO

- GO/NOGO: GO
- Checked by: Christian Ott, Peter Shawhan, LLO SciMon
- Comments: Confusion about error messages concerning Virgo (script says 'ignore')

Control Room Sign-off - Include any notes on Omega grams or FOM

- H1:
  - Scimon Name: Kiwamu Izumi
  - GO
- L1:
  - Scimon Name: Rahul Kumar
  - GO
- V1:
  - Scimon Name:K.Borkowski
  - GO

- GO/NOGO: GO
- Comments:

t_{dog}+42[m]

Data quality check and Decision