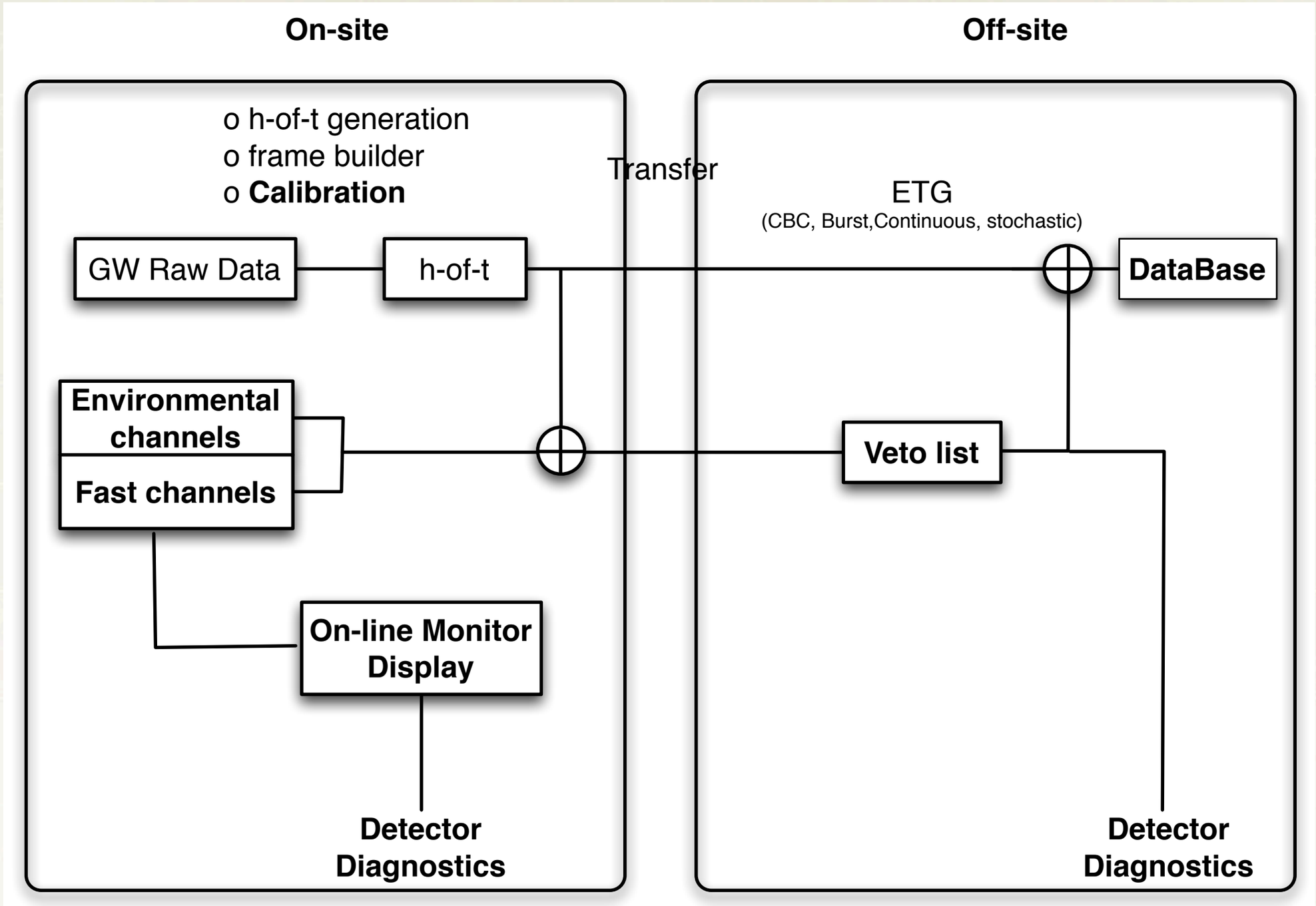
Current status of collaboration research on detector characterization

Japan & Korea
detector characterization team

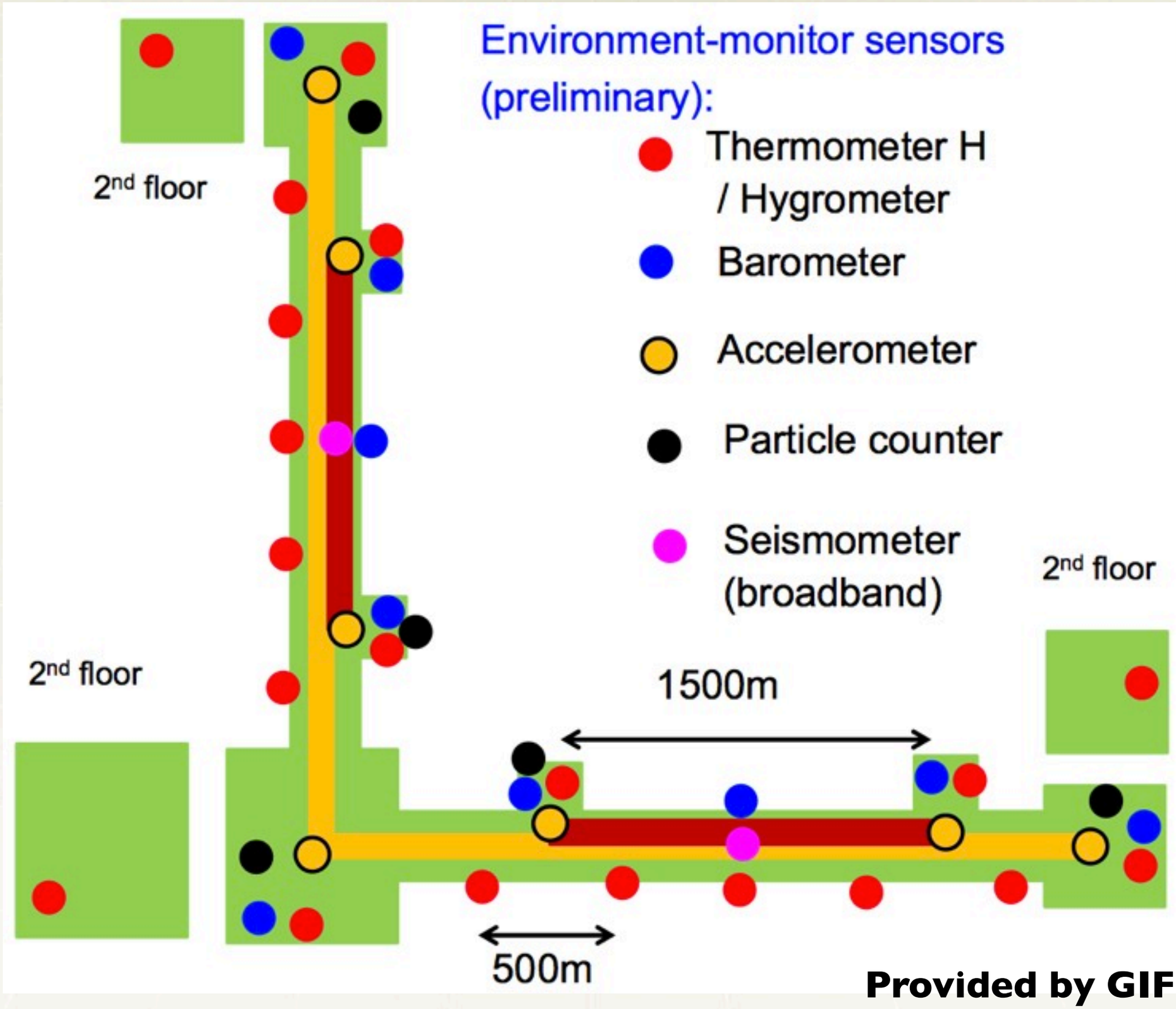
Scope of detector characterization

- **Commissioning stage**
  With each subsystem,
  - **Subsystem diagnostics**
  - **Kill sources of glitches**
  - **Speed-up commissioning**
  - **Calibration (with MIF, DGS, DMG etc)**
- **Observation stage**
  - **Veto analysis (rejection of glitches)**
  - **To improve false alarm rate**
  - **Multimessenger observation**

Flowchart of detector characterization



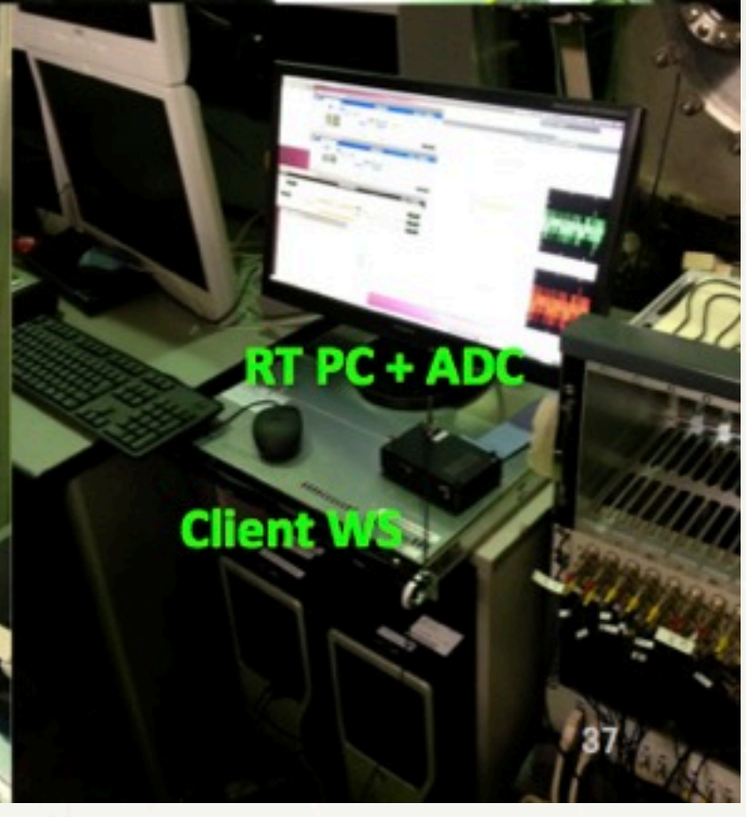
Environment monitor



Provided by GIF

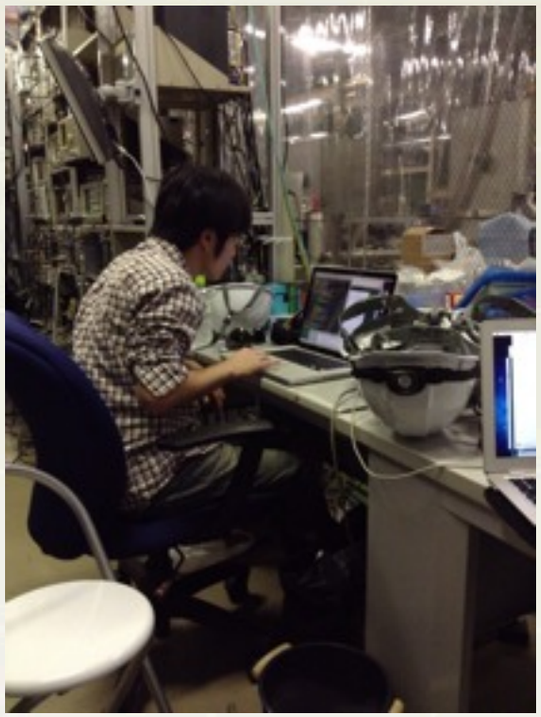
Developing detchar at NAOJ

- Simple standalone system (RT PC + ADC, Client WS, router) has been delivered to NAOJ on 12/6/2011.
- 3days work for installation, lecture and training
- Online analysis software will be developed by DAS group.



CLIO test operation in this Oct

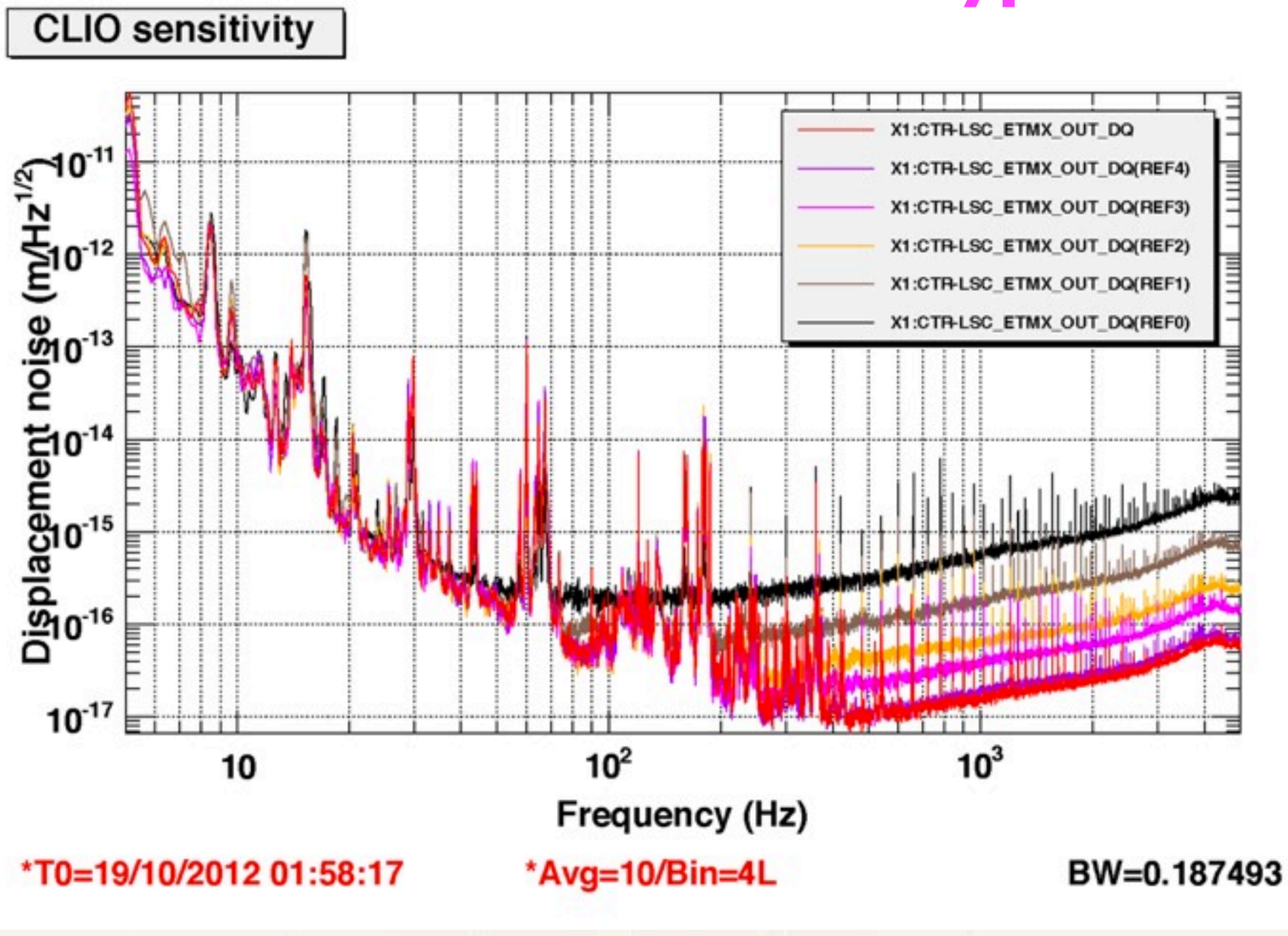
- **CLIO test operation in 15-19, Oct. 2012.**
  (Hayama, Miyakawa, Miyoki, Ohashi, Tanaka, Uchiyama, Yamamoto, Yuzurihara)
  - **End-to-end test of prototype detchar system during the operation.**
  - **Time domain calibration**
  - **Hardware injection of correlated glitches in GW and acceleration monitor.**



Taken by Yuzurihara

CLIO sensitivity

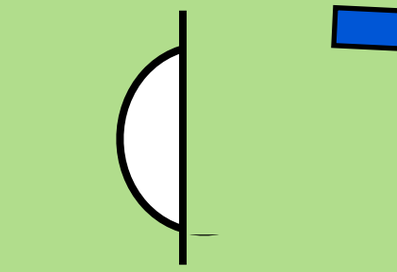
Test operation
~x10 worse than typical sensitivity



O. Miyakawa

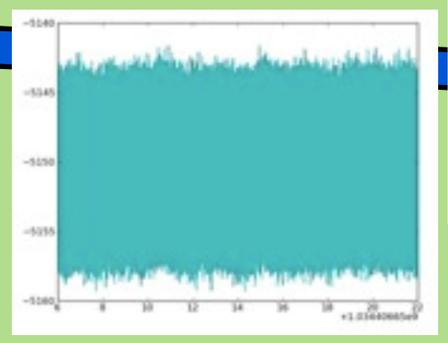
Detector Characterization

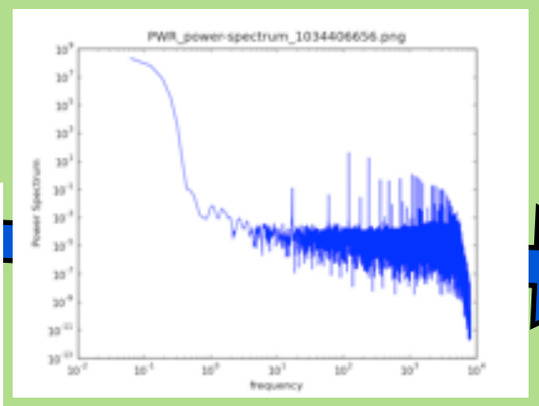
Inst. Mon



Laser Intensity

16s





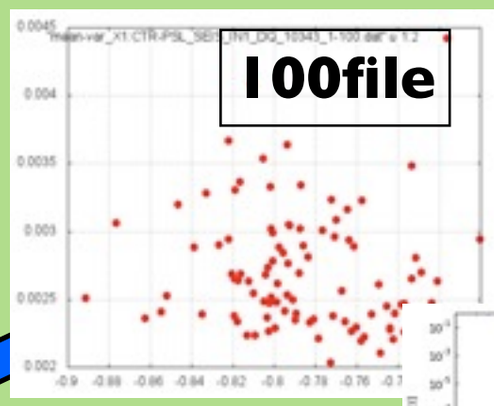
RT WS

RealTime update @16s

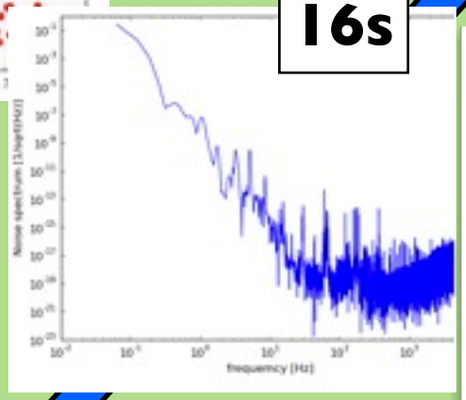
Env. Mon

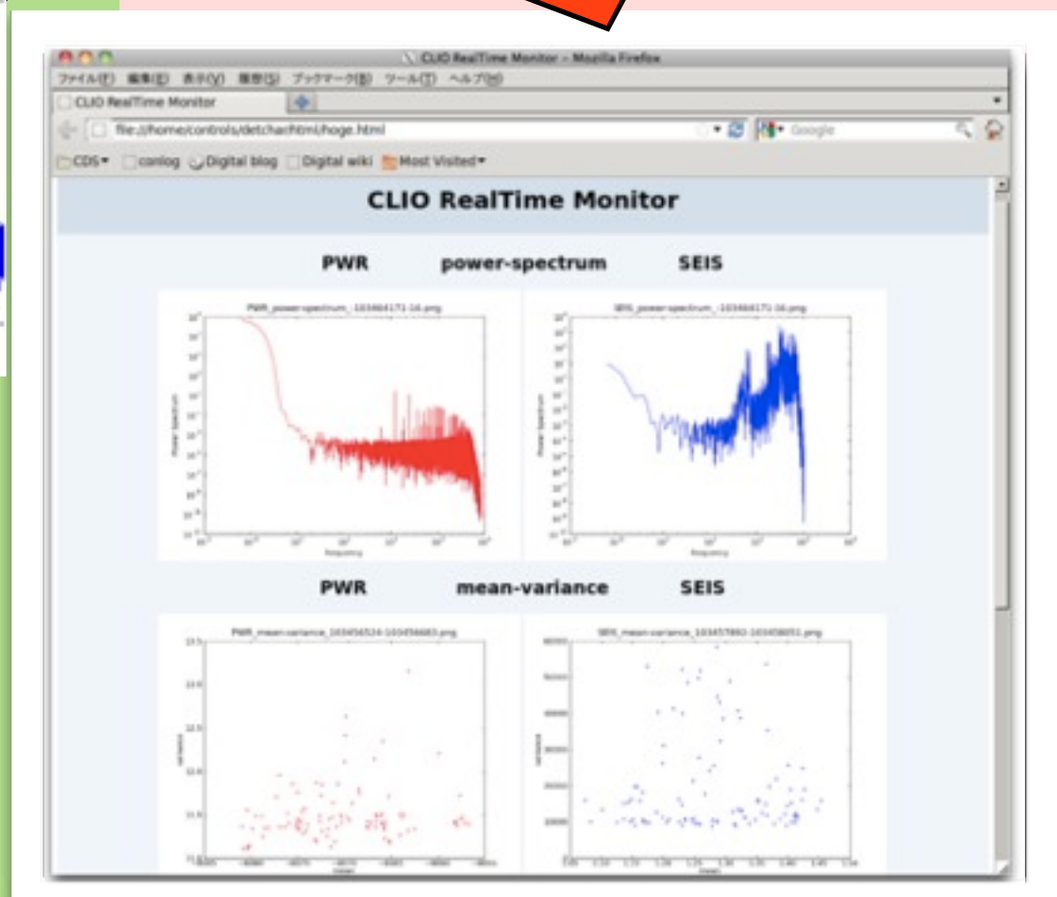
acce.

100file

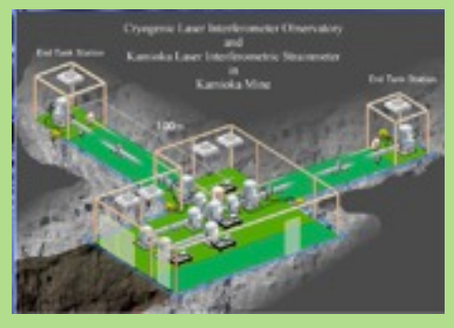


16s





Sens. Mon



CLIO

K.Tanaka

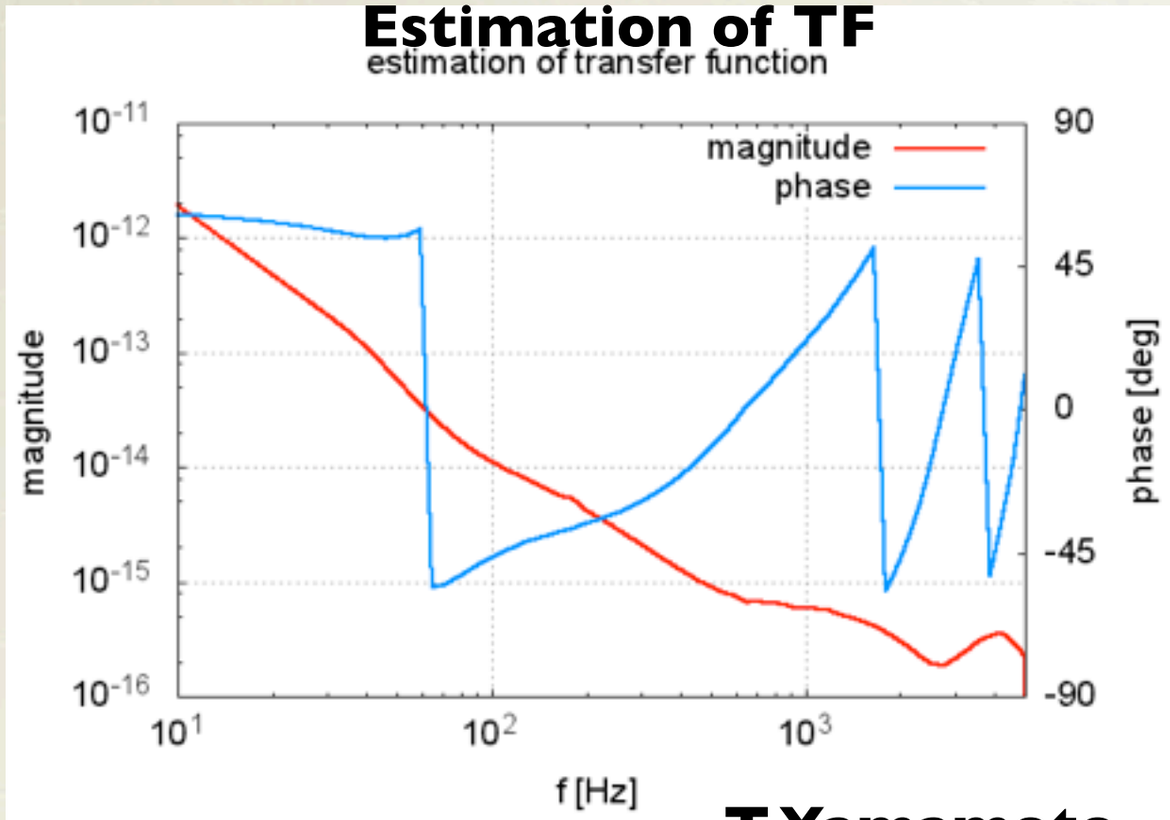
Calibration

Convert to physical unit

Processing on time-series data

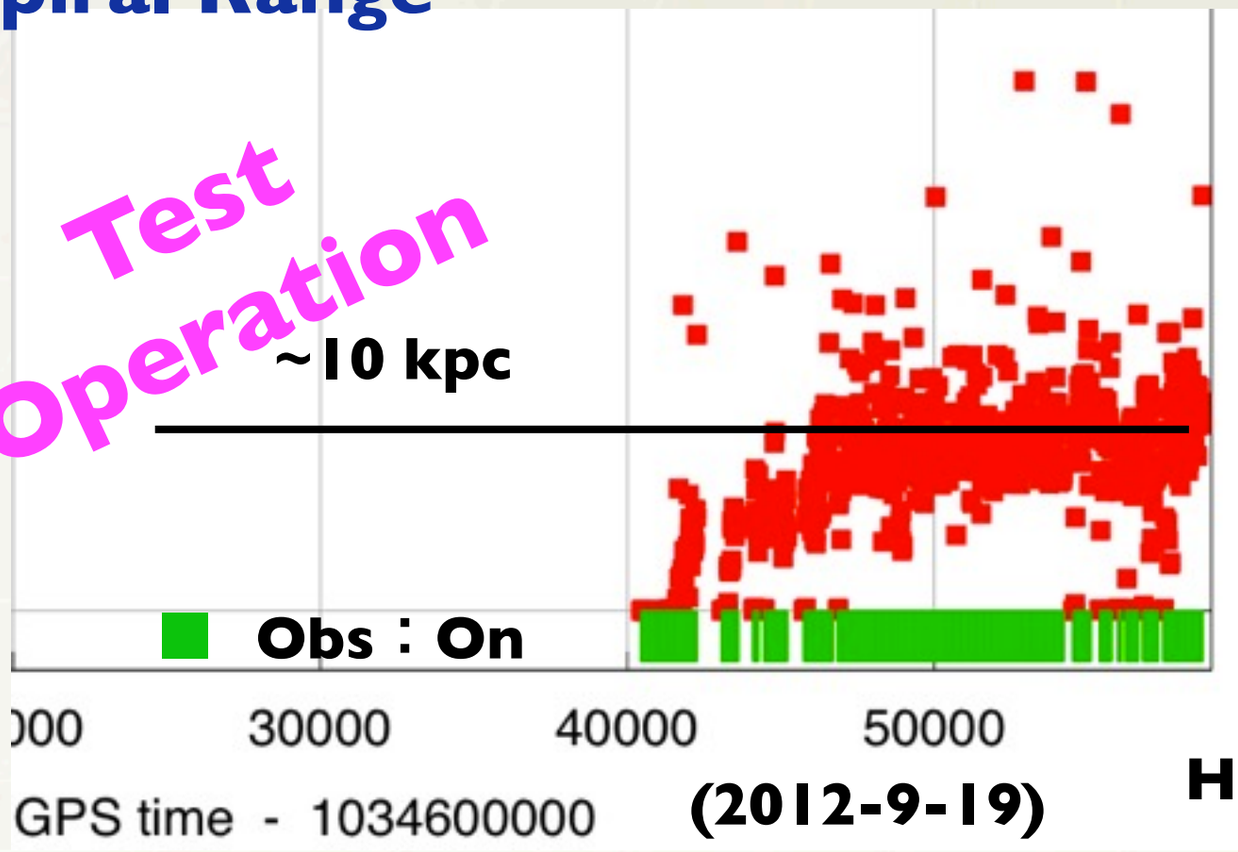
Generation of filters of TF

→various kinds of analysis



T.Yamamoto

Inspiral Range



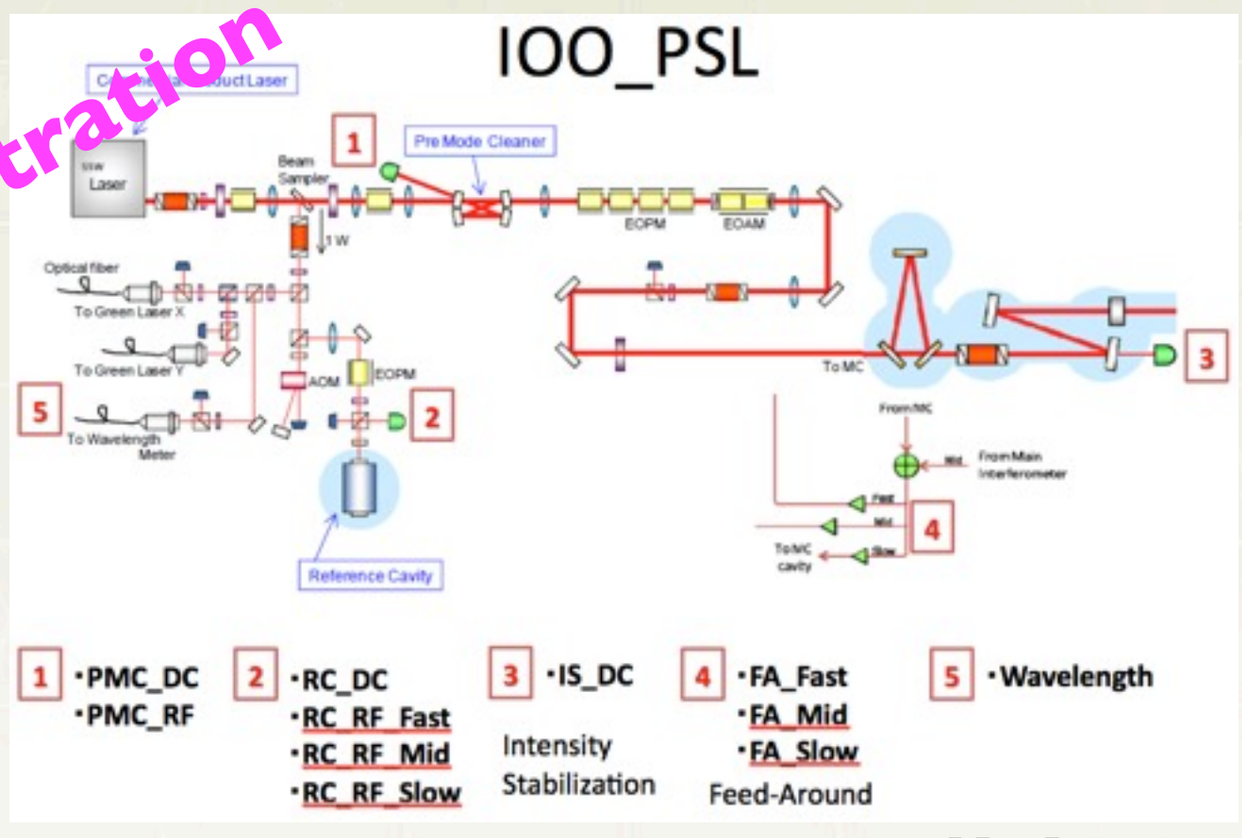
(2012-9-19)

- **Real time display of the inspiral range**
- **Total locked time ~13hrs**

H.Yuzurihara

Commissioning Stage

- Subsystem diagnostics
  - ADC noise is within range ?, Whitening requirement
  - Channel-correlated noise ?
  - Find frequency of calibration line
  - Components consisting the subsystems is healthy?
- Kill sources of glitches, lines
- Speed-up commissioning
- Calibration Accuracy

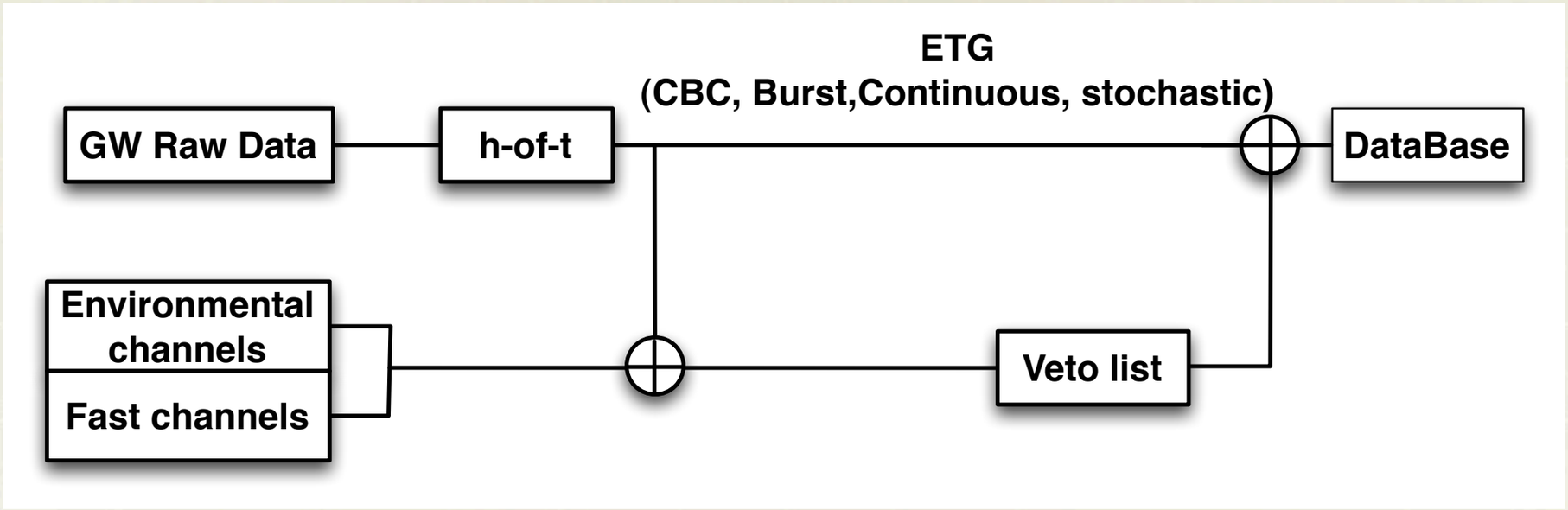


K. Agatsuma

Observation Stage

- **Veto analysis (rejection of glitches)**
- **Improve false alarm rate**
- **Multimessenger observation**

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 • ...

Improvement of False Alarm Rate

- **An interferometric GW telescope is changing its statistical behavior with short-time scale (~minute-hours).**

- **An interferometric GW telescope is very sensitive to instruments, environmental phenomena around.**

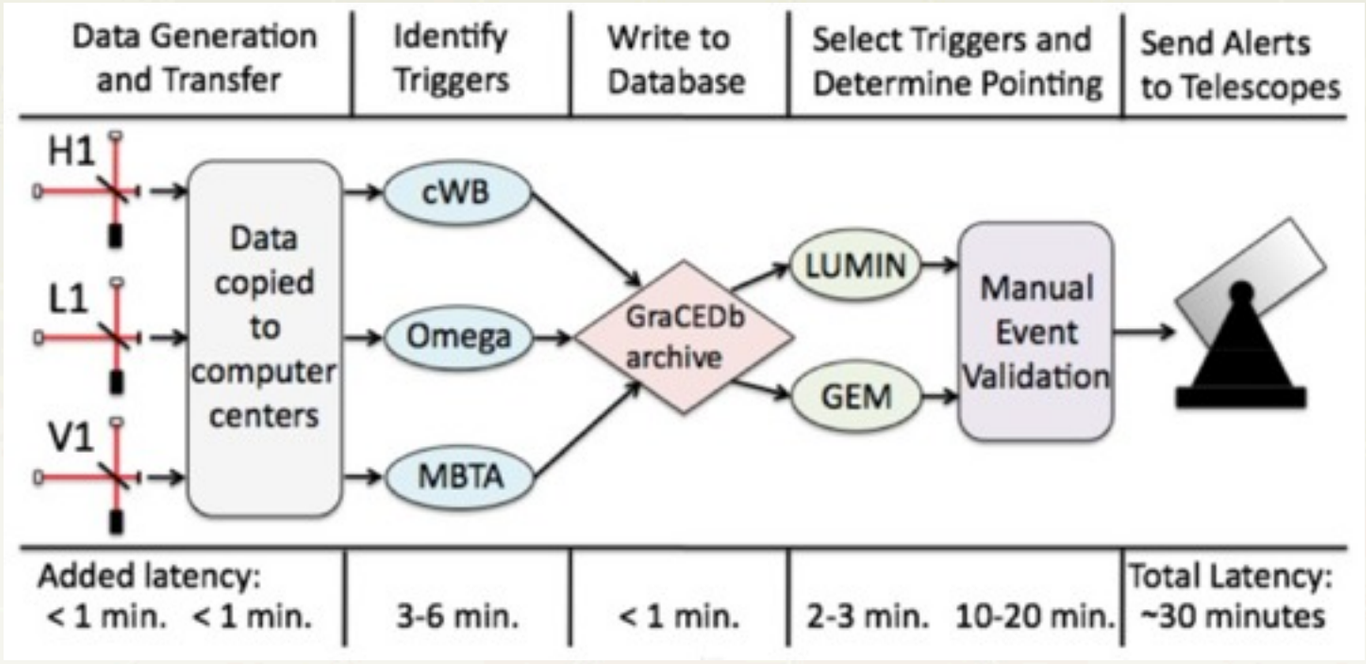
- **Artificial noise is mixed into gravitational wave channel of the telescopes as well, which is sometimes very difficult to distinguish between glitches and GW signals.**

False alarm rate becomes high.

Multi-Messenger Observations

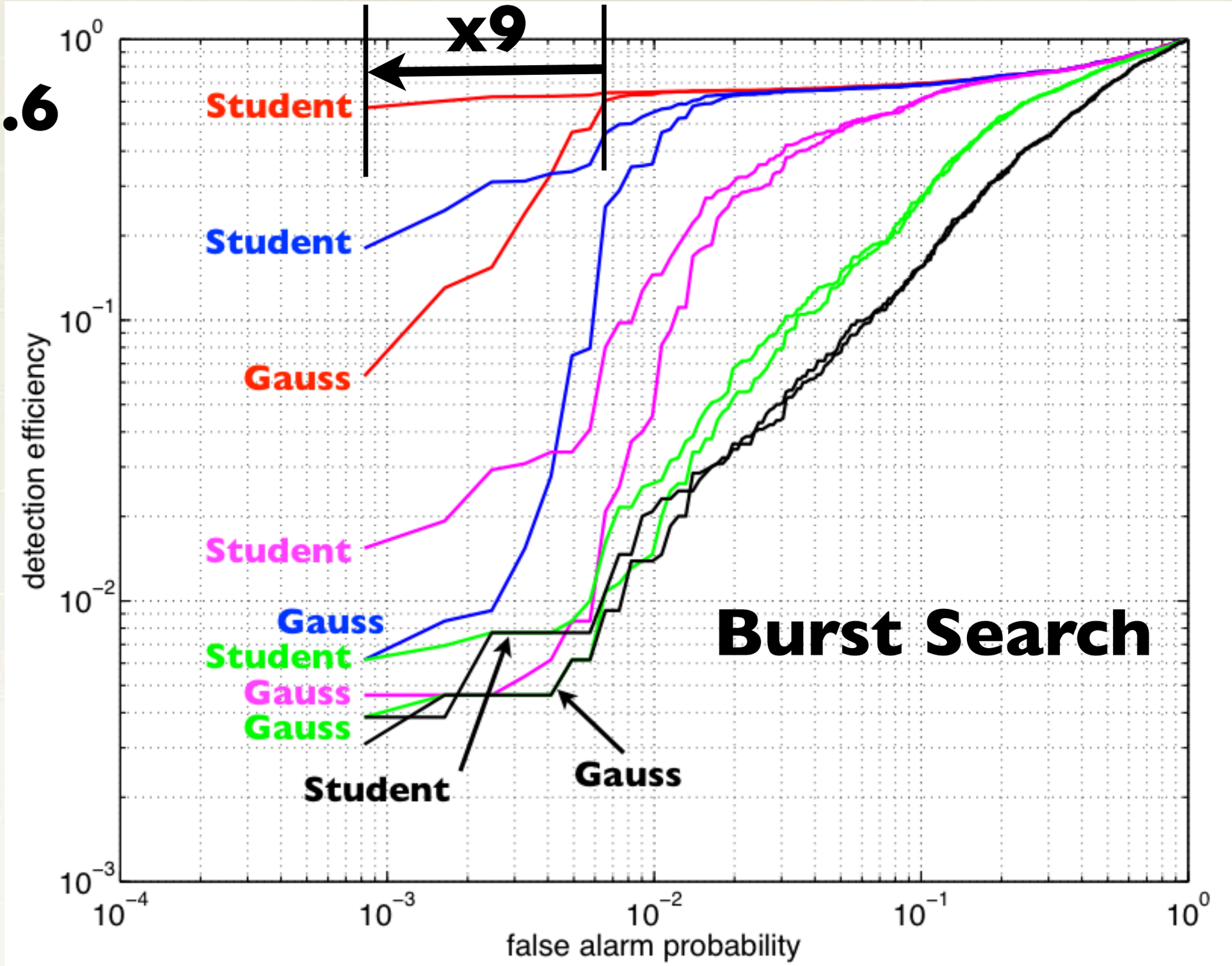
Very important 2 issues to make MMO success from GW side.

- **Real-time distribution of data-quality information to collaboration.**
  →Low latency data analysis
- **Rate of GW event alert should be low (not 1 event/one day)**
  →Low false alarm rate



Erik in LV meeting at Orsay

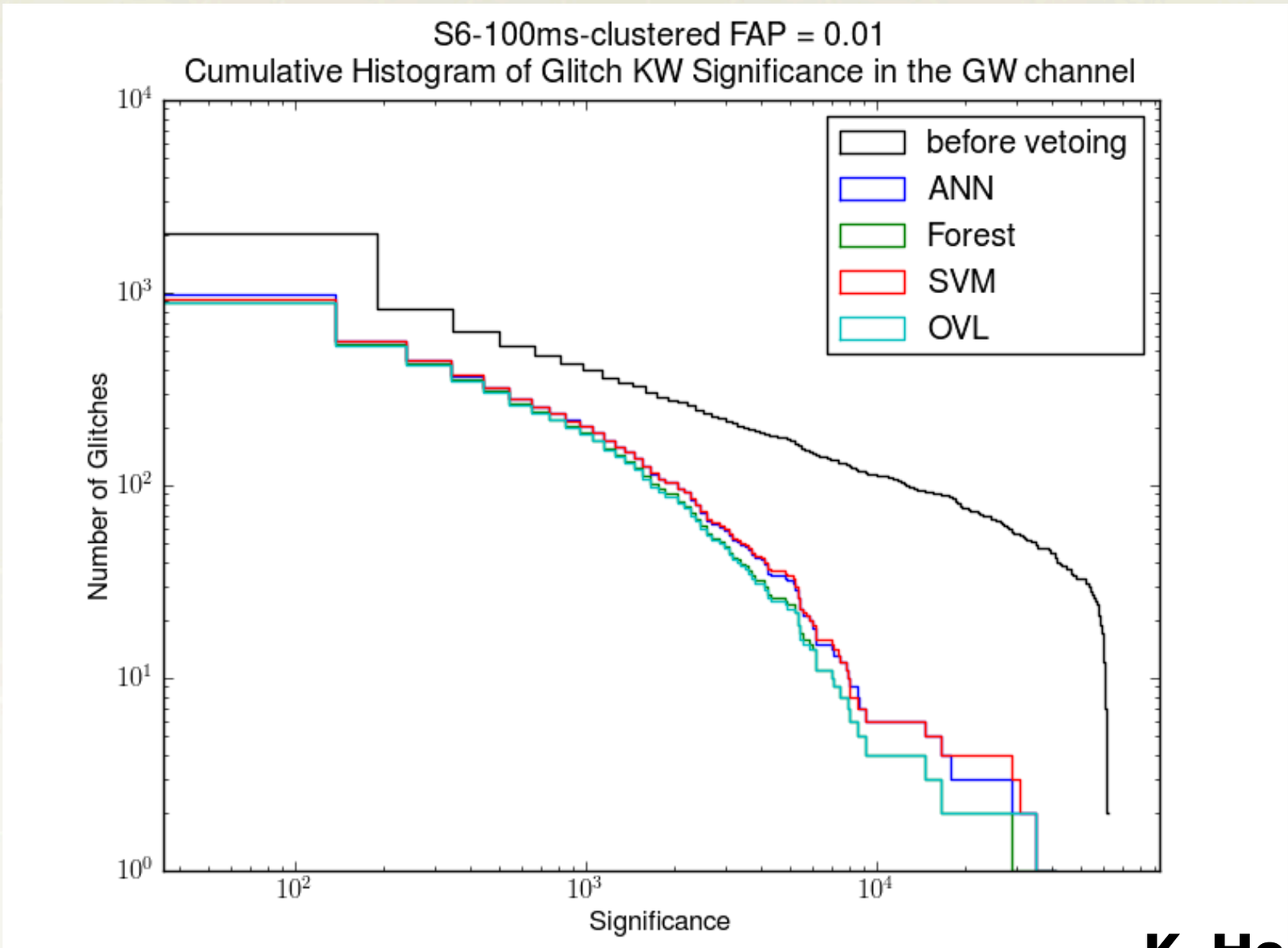
Reducing FAR : New technique



Hayama, Roever

Reducing FAR : Multi-channels analysis

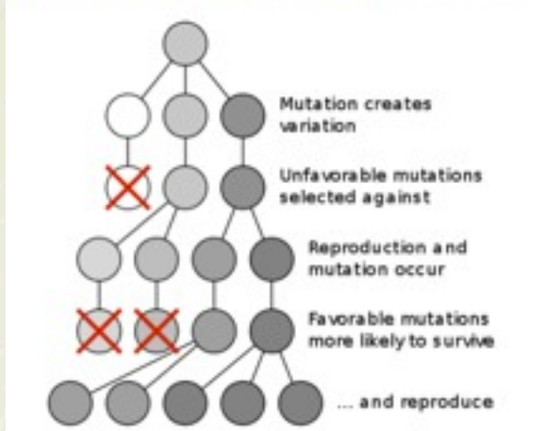
- Several methods are being developed.
  - Analysis of auxiliary channels using multi-variate analysis
    - Supervised classifier : ANN, RF, SVN,...

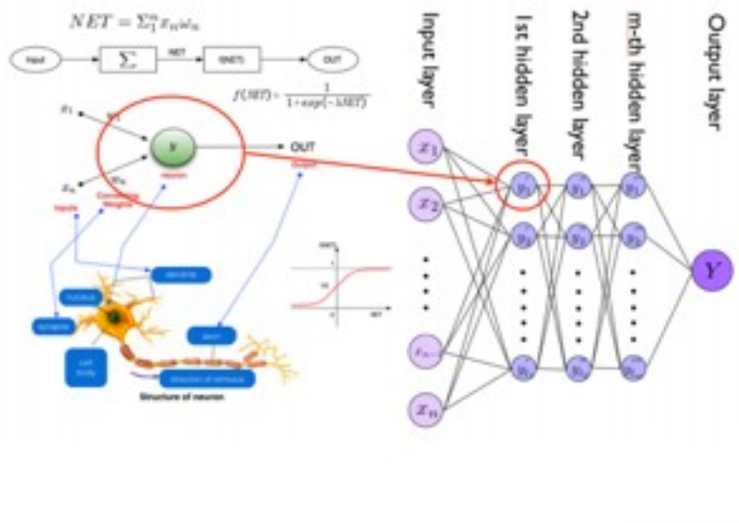


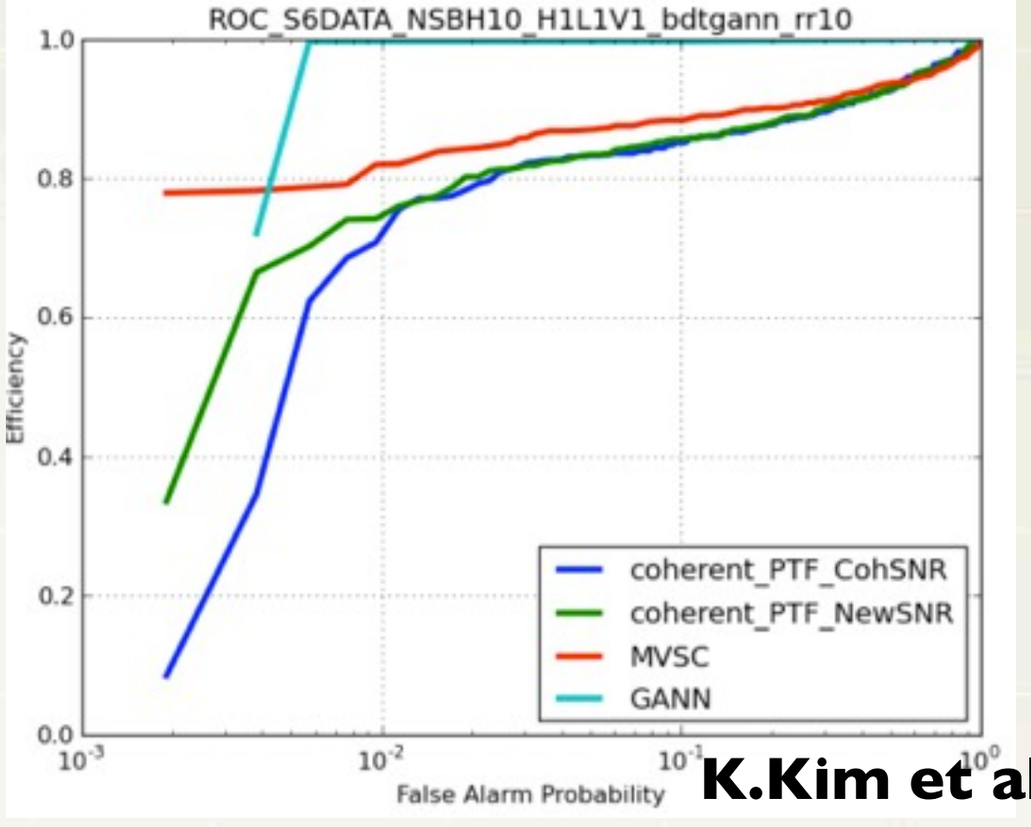
K. Hodge et al

ANN KGWG detchar team

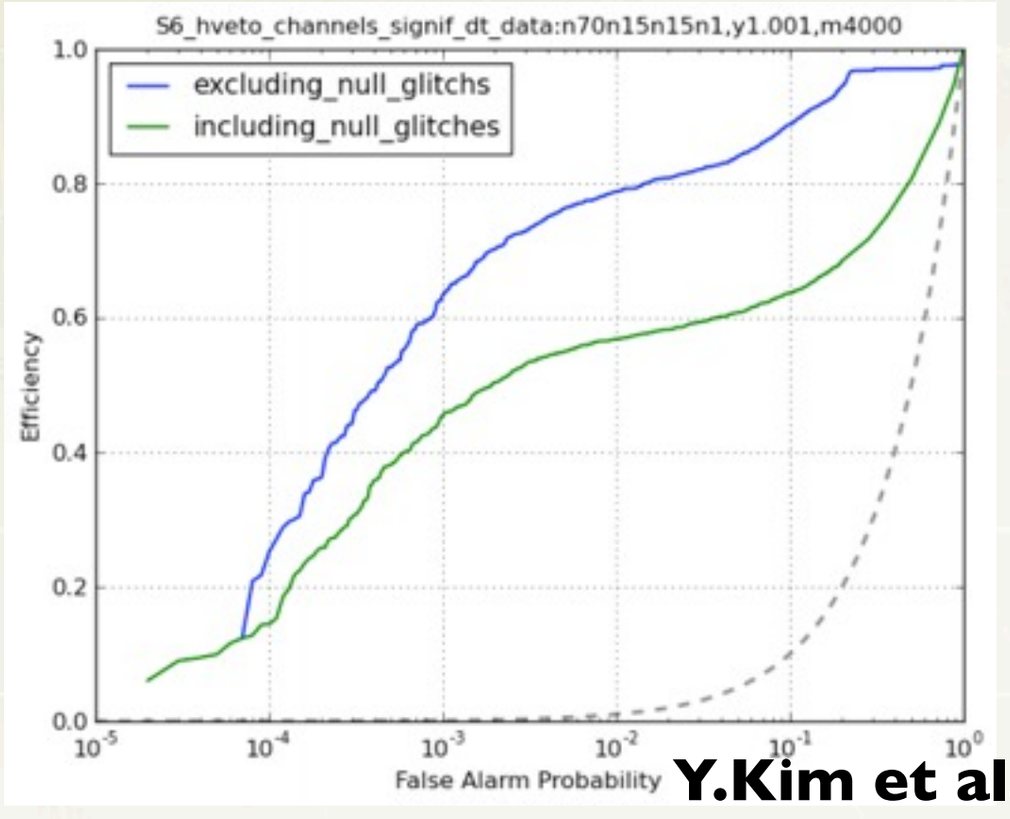
Artificial Neural Network based.
Genetic Algorithm included. (E. Son's talk tomorrow)







K.Kim et al.



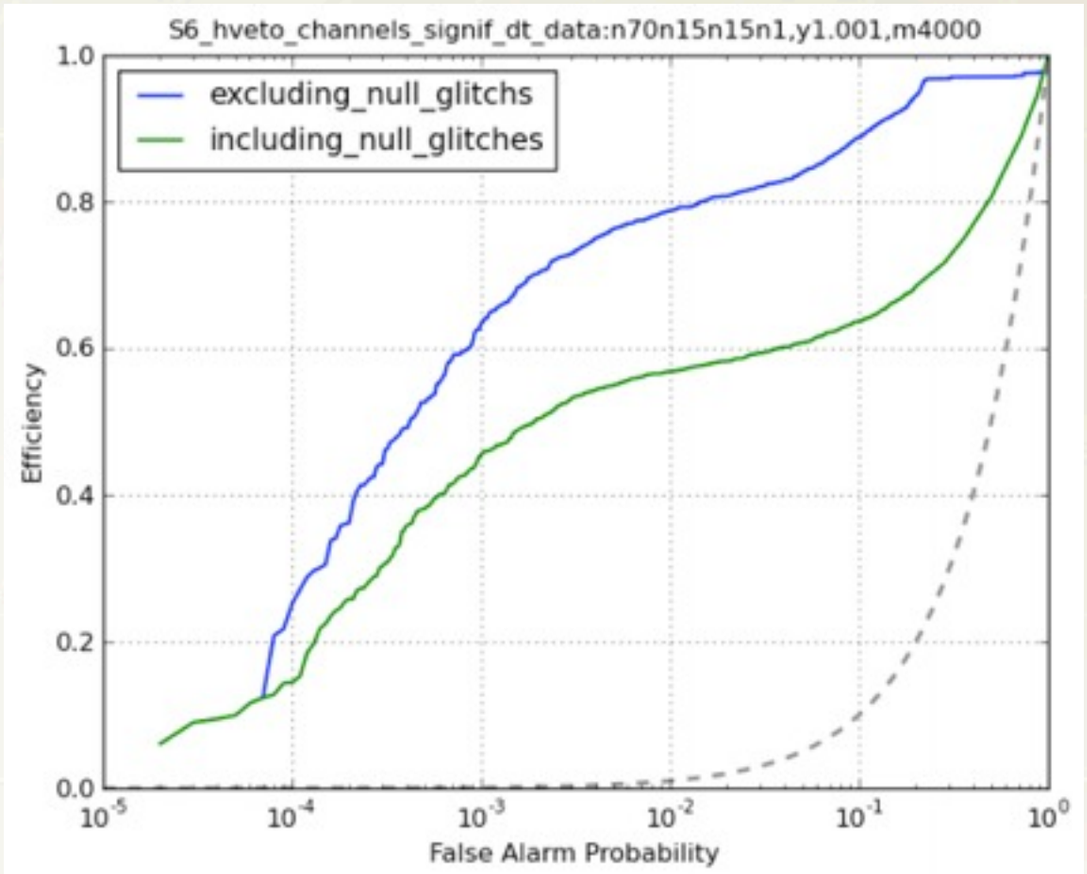
Y.Kim et al.

SangHoon will introduce them.
See K. Kim and Y.Kim's talks tomorrow also

Collaboration at NIMS

- **Discussion on multi-channel analysis using ANN**

See SangHoon's slides



KGWG F2F meeting at SNU in summer

- **7 Aug., 2012, KGWG F2F meeting on mainly data analysis at SNU.**

Program (tentative)

Time	Title	Speaker
13:30-14:00	Paper Review 1 *The NINJA-2 catalog of hybrid post-Newtonian/numerical-relativity waveforms for non-precessing black-hole binaries*[+]	Gungwon Kang
14:00-14:30	Invited talk **Current Status of KAGRA Data Analysis**	Kazuhiro Hayama
14:30-15:00	Coffee Break	
15:00-15:30	Report I: Santa Barbara meeting "Shine & Rattle" report	Hyung Mok Lee
15:30-16:00	Report II: GA-ANN development progress report Report Old Report	John J. Oh
16:00-17:00	Discussion	

- [+] Published in Class.Quant.Grav. 29 (2012) 124001, DOI: 10.1088/0264-9381/29/12/124001, Conference: C11-07-10.1, e-Print: arXiv:1201.5319, https://dcc.ligo.org/cgi-bin/private/DocDB/ShowDocument?docid=85265

Participants

Hyung Mok Lee, Gungwon Kang, Hyunkyu Lee, John J. Oh, Sang Hoon Oh, Edwin J. Son, Sooil Lim, Young-Min Kim, Kyungmin Kim, Yong Bum Kim, Kazuhiro Hayama

Developing multi-variate analysis

- **Supervised (Korea, currently on-going in LVC)**
- **Unsupervised (New project)**

These methods may help to find noise sources.

Unsupervised

- Affinity propagation based
  - Extend to the paper (Hayama,2009)
  - Too many classes for now