

*Status report from subgroups:  
Data Analysis*

N.Kanda

## *The Aim of 'Data Analysis' subgroup*

- (1) to search for GW events in LCGT data**
- (2) to analyze GW events to extract physics, astrophysics and astronomical outcomes**
- (3) to cooperate with other GW experiments on event search**
  - Construct a data storage and computing system
  - Search and Analyze GW events
  - Analysis with other collaborations

# Possible GW sources for LCGT

## (1) Compact Binary Coalescence

- NS-NS, NS-BH, BH-BH
- for NS-NS

Range > 200 Mpc

( 281Mpc in VRSE-D ), S/N>8, optimal direction

Rate > Several Events / year

## (2) Burst GW

- from Supernovae  
Range ~ 1Mpc
- Ringdown GW from Blackhole QNM  
BH formed from NS-NS, NS-BH, or IMBH
- Pulsar Glitches

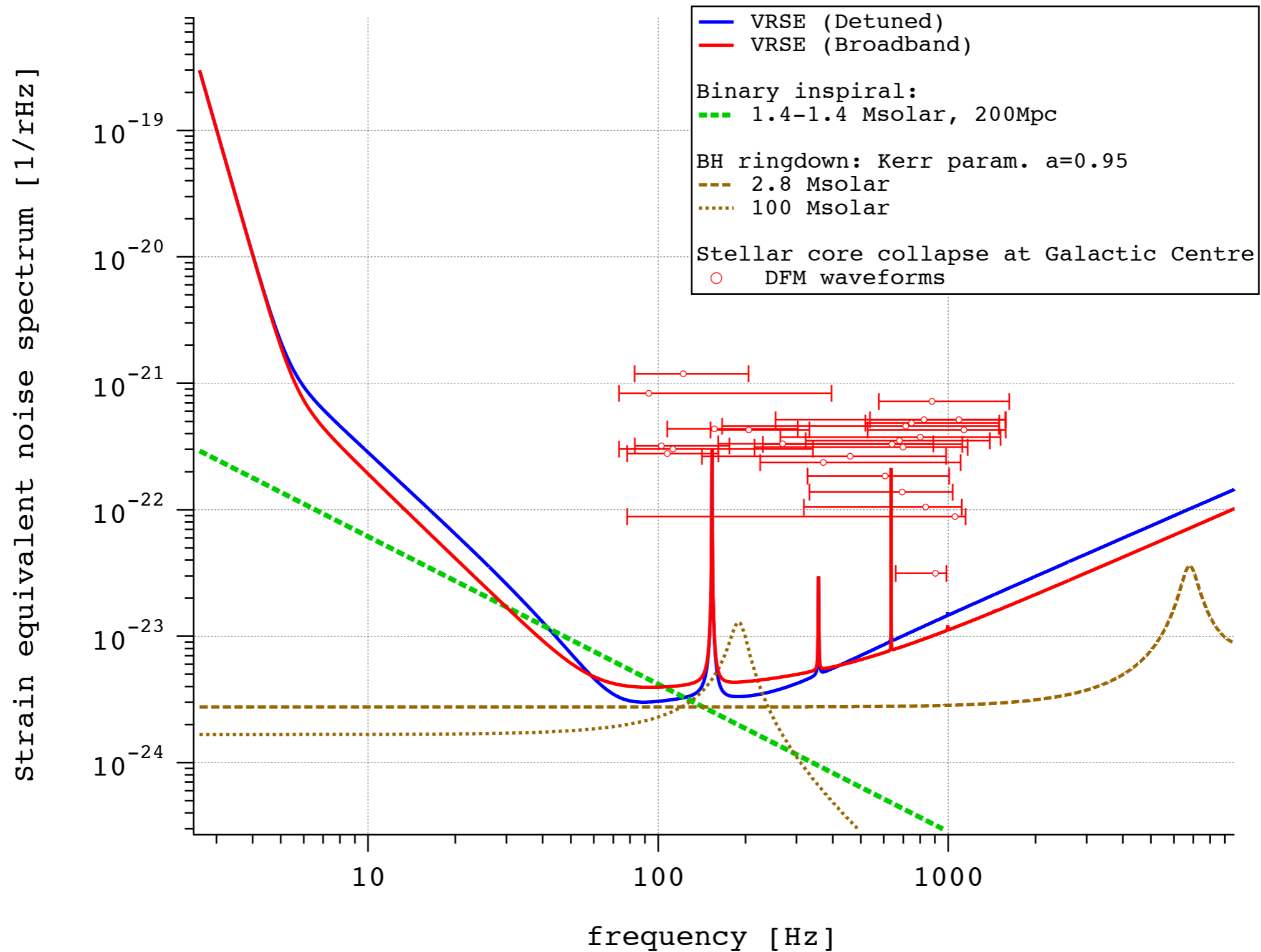
## (3) Continuous

- Pulsars

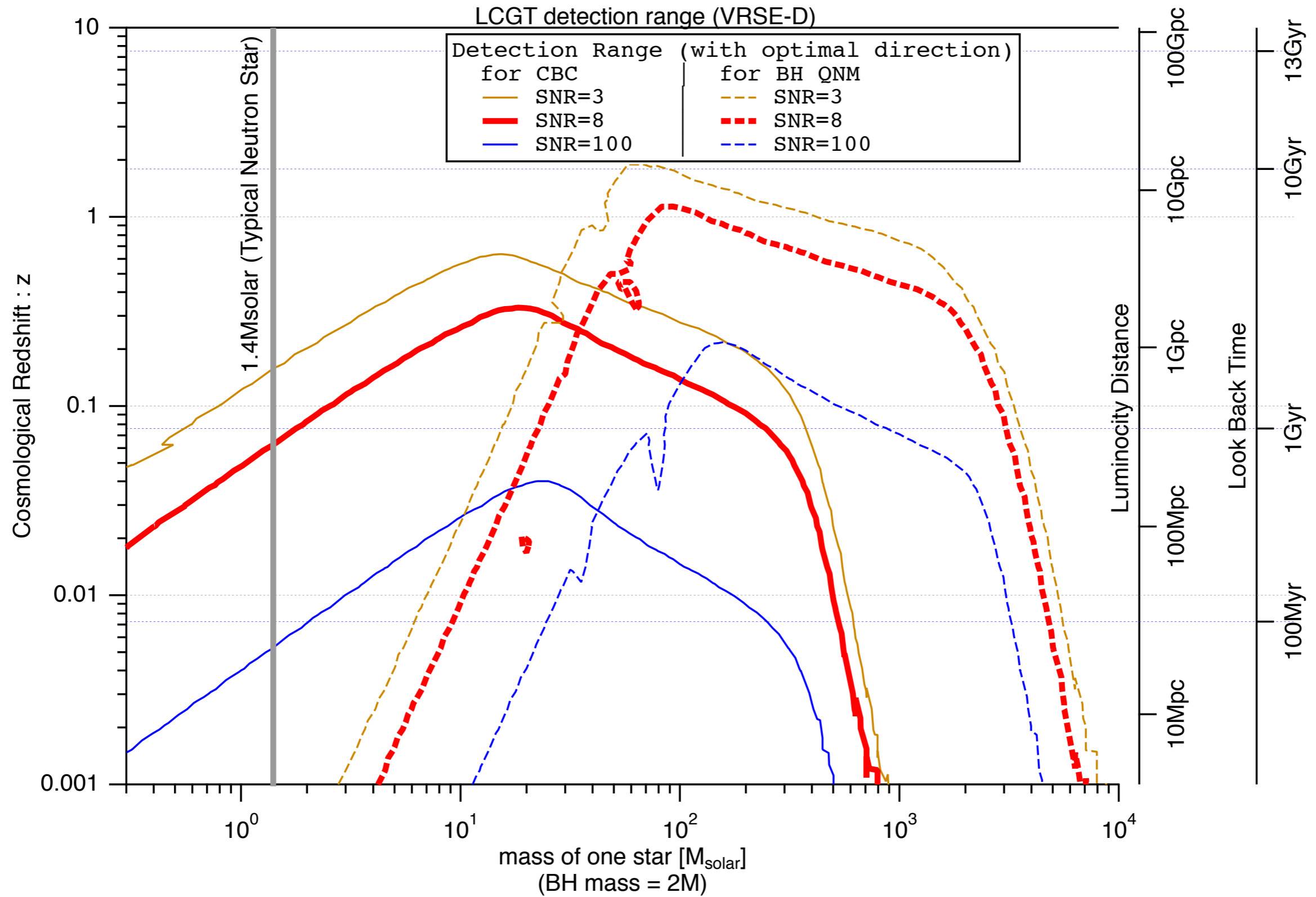
## (4) Stochastic GW

# Remark the Sensitivity of LCGT

BW working group

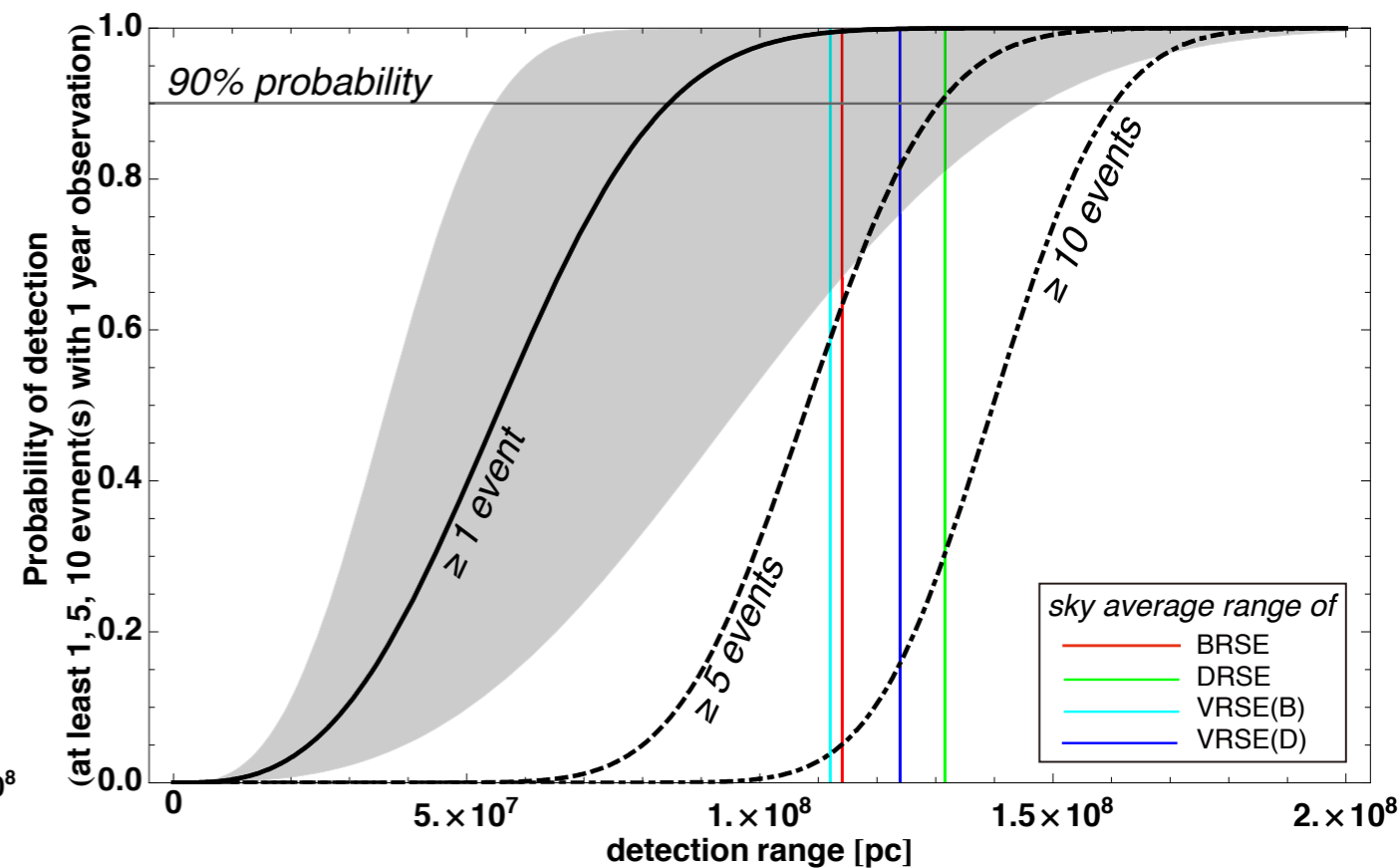
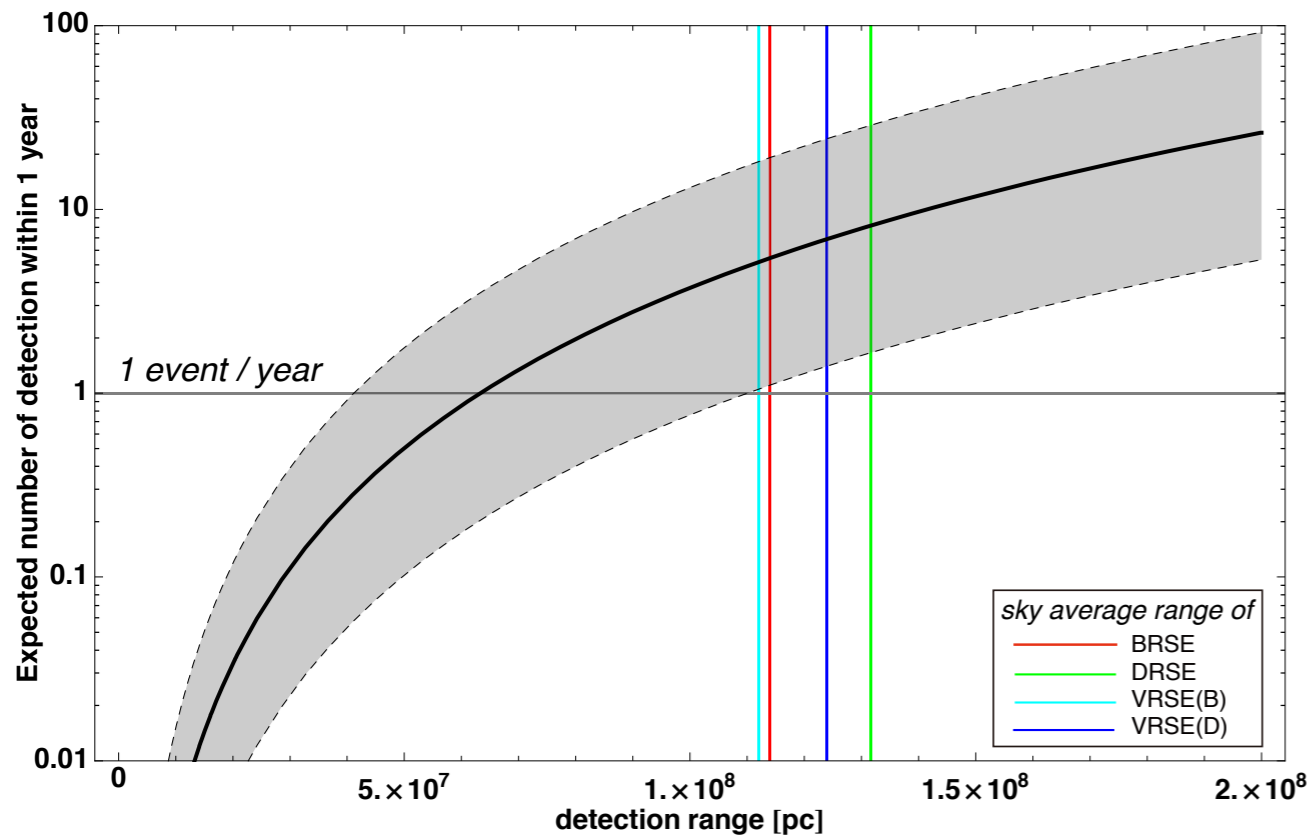


# Detection Range for Compact Binary and BH QNM



# Probability of Detection

BW working group



NS-NS Detection Range (sky average)  
(optimal direction)

123 Mpc

281 Mpc

Expected # of events

$6.9^{+17.3}_{-5.5}$  events/year

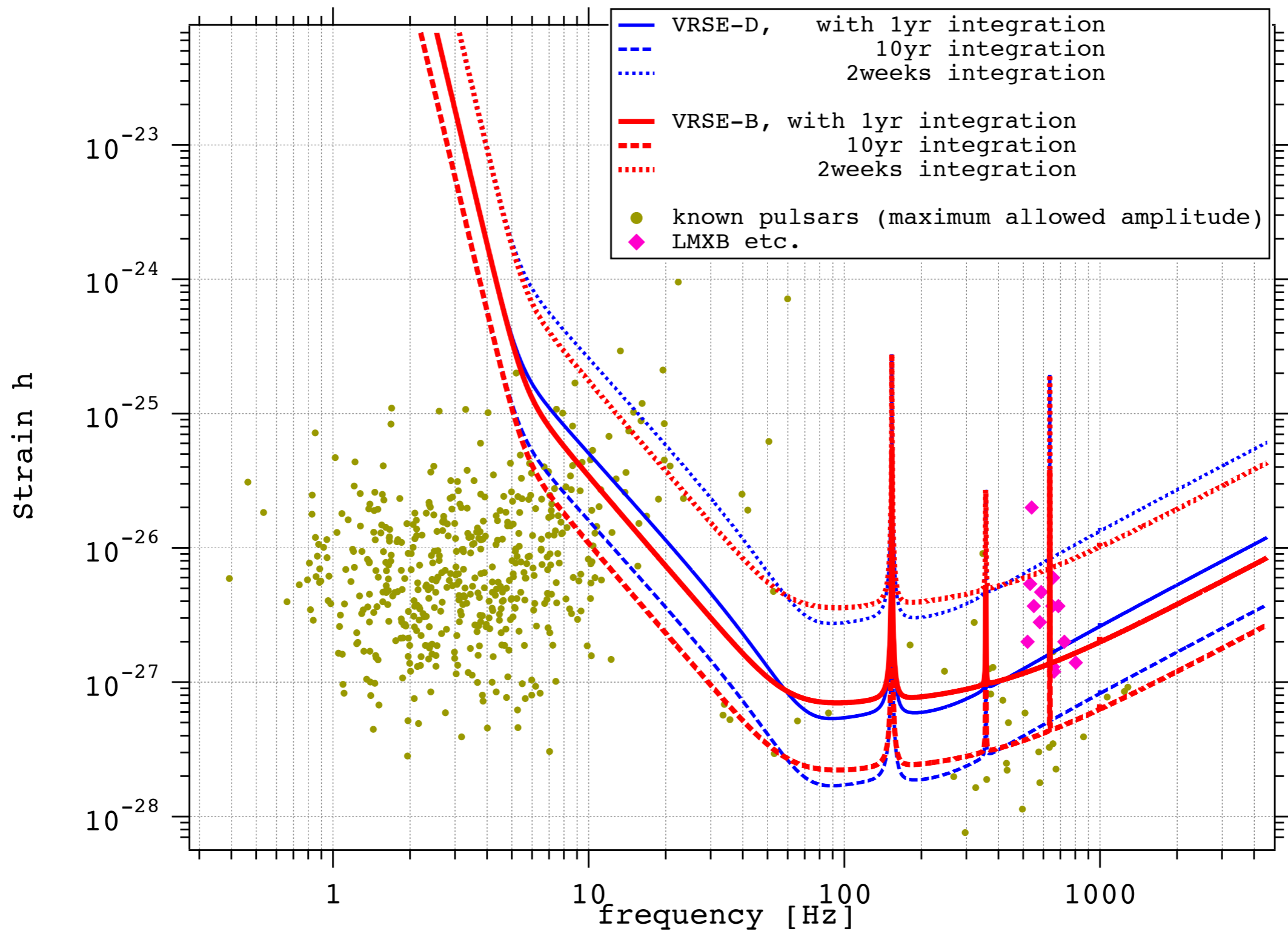
Probability of detection at least one event

99.9 % for one year

90% for 1st event

4 months

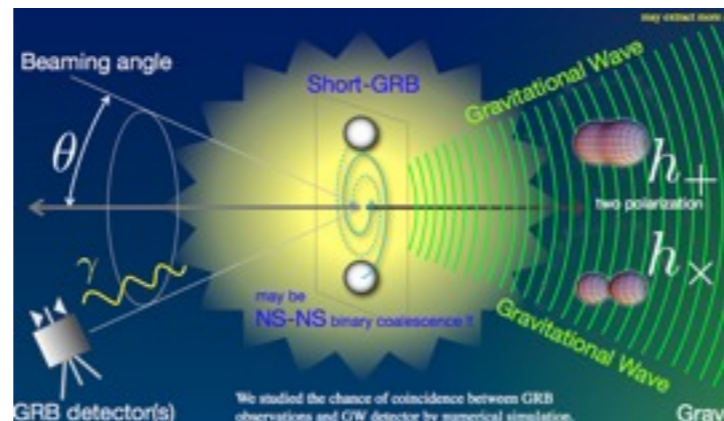
# Sensitivity for Continuous GW



# Recent topics : Mutually Followup Observations

Other astronomical observations (e.g. Optical, X-Ray, Gamma-Ray, Neutrino) are expected as counter part of GW observation.

**We are planning to apply “Grant-in-Aid for Scientific Research on Innovative Areas”**



If NS-NS = Short-GRB  
[Forecast]

merger before 30sec !  
direction (xx.xx, yy.yy)

Followup by  
**X, Gamma, Optical**

Confirmation of  
Afterglow

[Aux trigger]  
Date, direction, ...

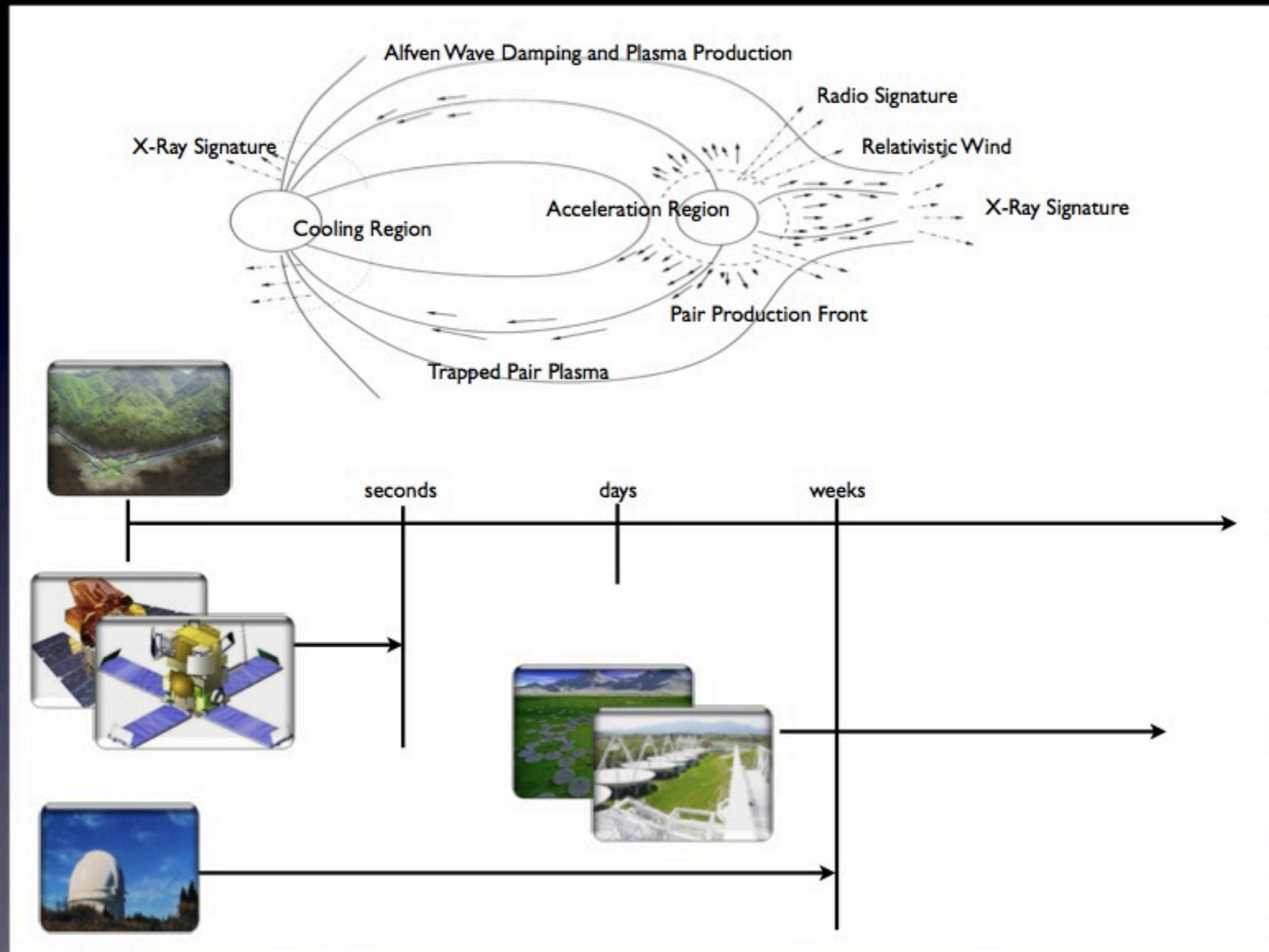
GW by LCGT etc.  
Real time analysis

Delayed precise  
analysis

[Alert]  
date, direction, distance,...



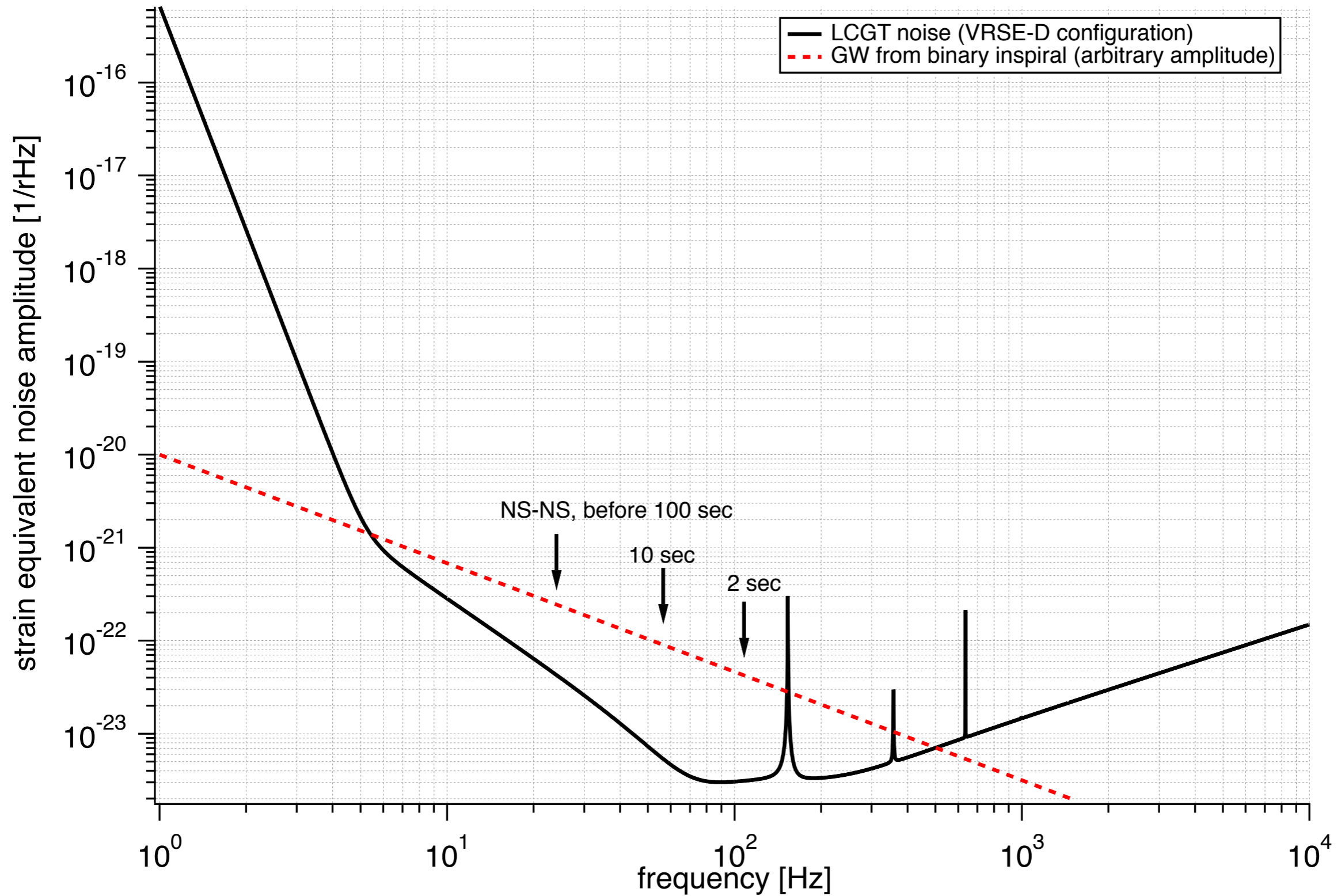
# CBC



2010年8月11日水曜日

by Hayama

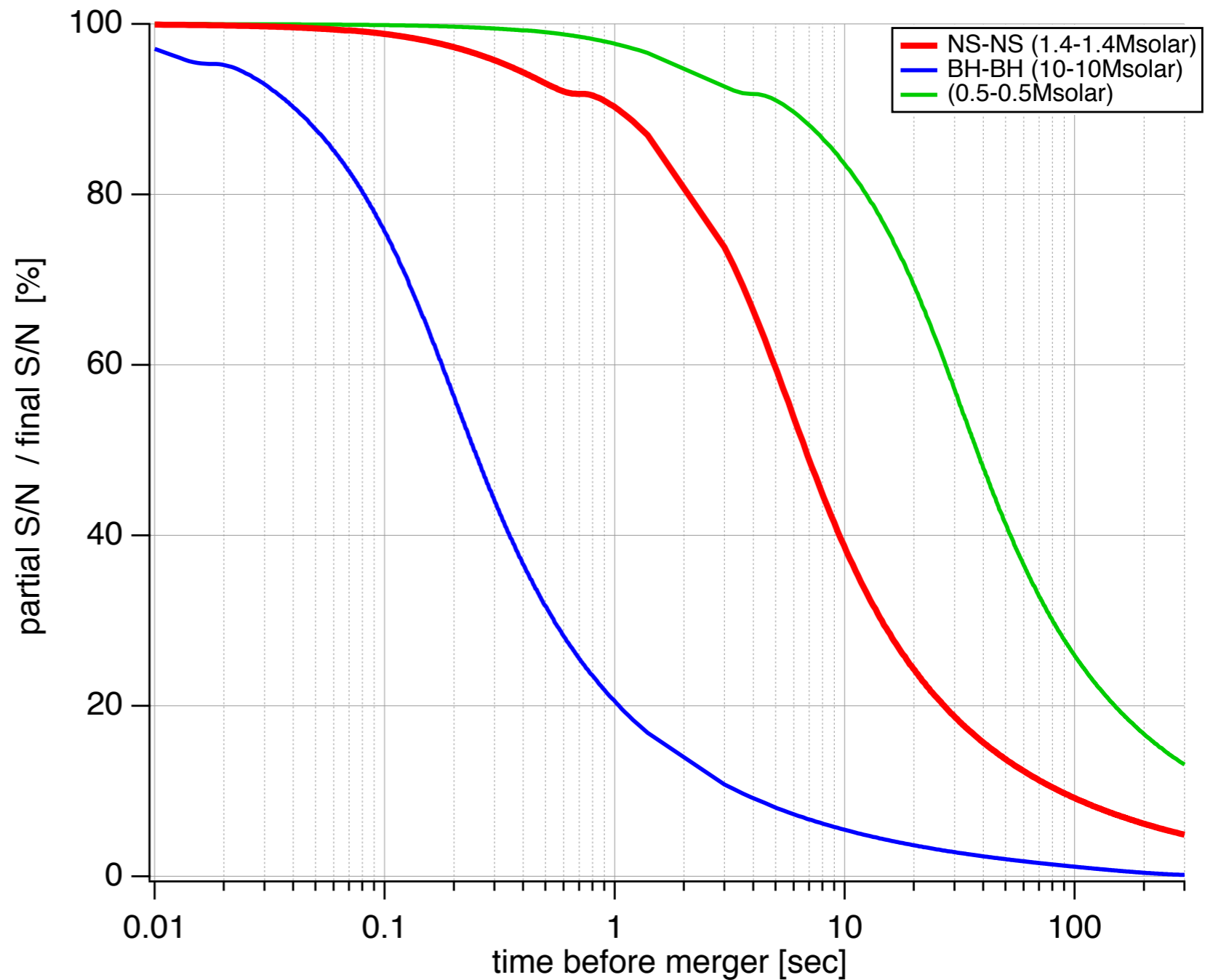
# Example of Practical Issue : NS-NS forecast



# Example of Practical Issue : NS-NS forecast

- Before merger,  
10% of final S/N before 1 min.  
40% before 10 sec.

for  $S/N > 8$ ,  
 1 min --> 25Mpc  
 10 sec --> 80Mpc  
 (\*optimal direction.)





Example of Practical Issue : NS-NS forecast

Angular resolution

角度分解能

(1.4,1.4)Msolar, @200Mpcの場合

LIGO-L1, VIRGO, LCGT 3台の場合

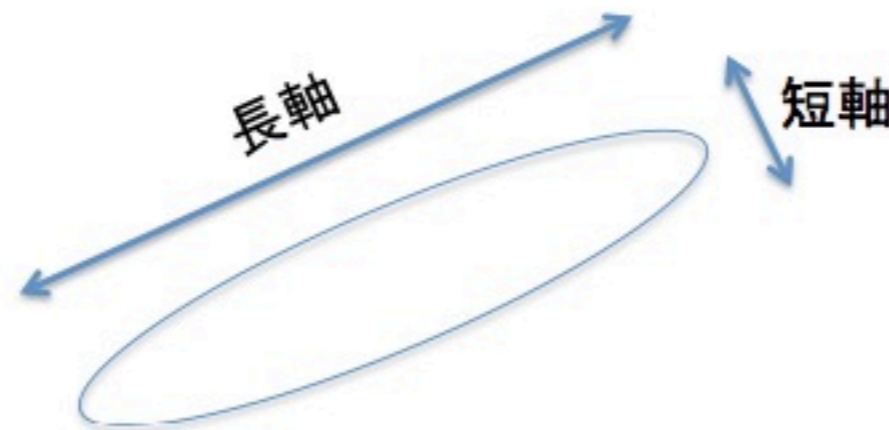
方向, inclination角, 偏極角に依存する.  
これらを乱数で与える.

ISCOまで積分:

平均S/N ( $\rho$ )            8.2から8.9 (各検出器で)  
平均角度分解能            長軸 7.6度, 短軸0.99度(3台のとき)

重力波周波数50Hzで打ち切り:

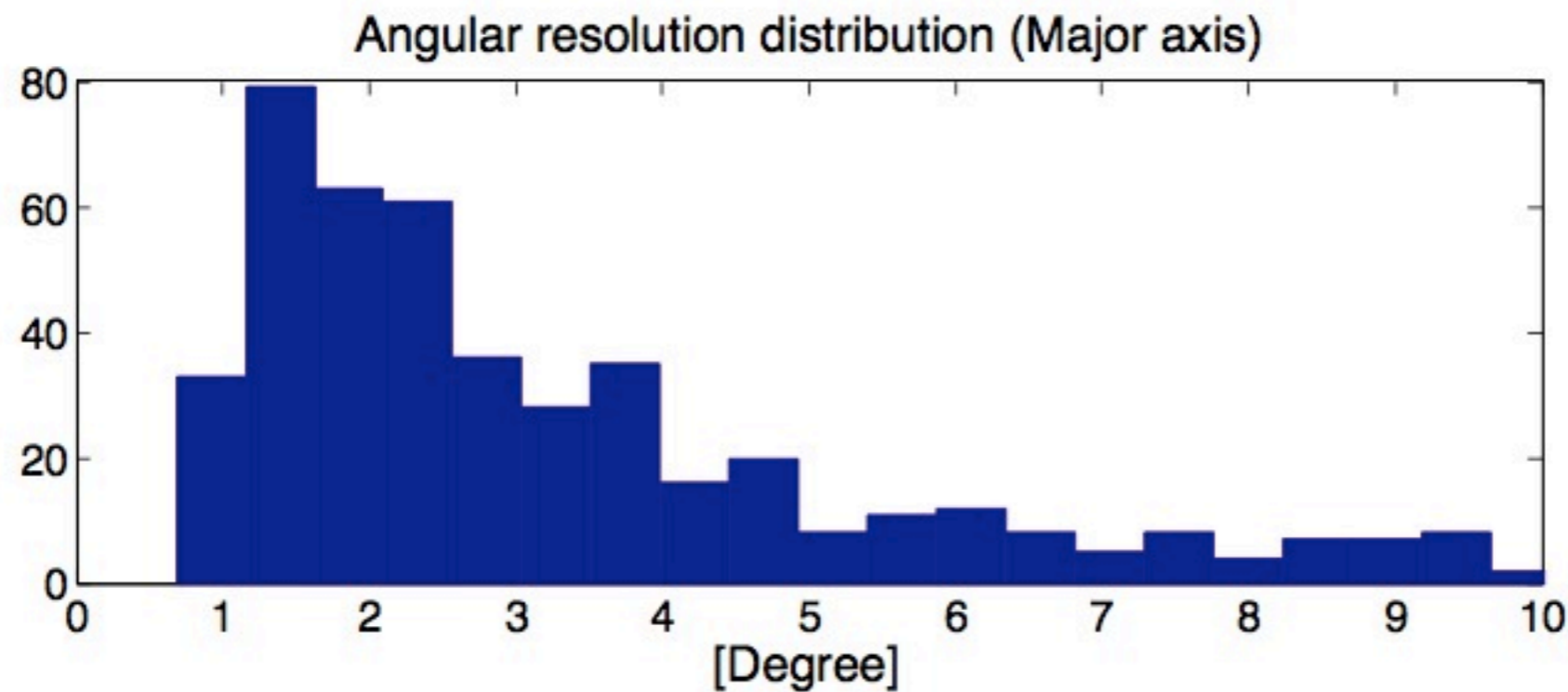
平均S/N( $\rho$ )            2.5から2.8 (各検出器で)  
平均角度分解能            長軸 123度, 短軸13度(3台のとき)



by Tagoshi

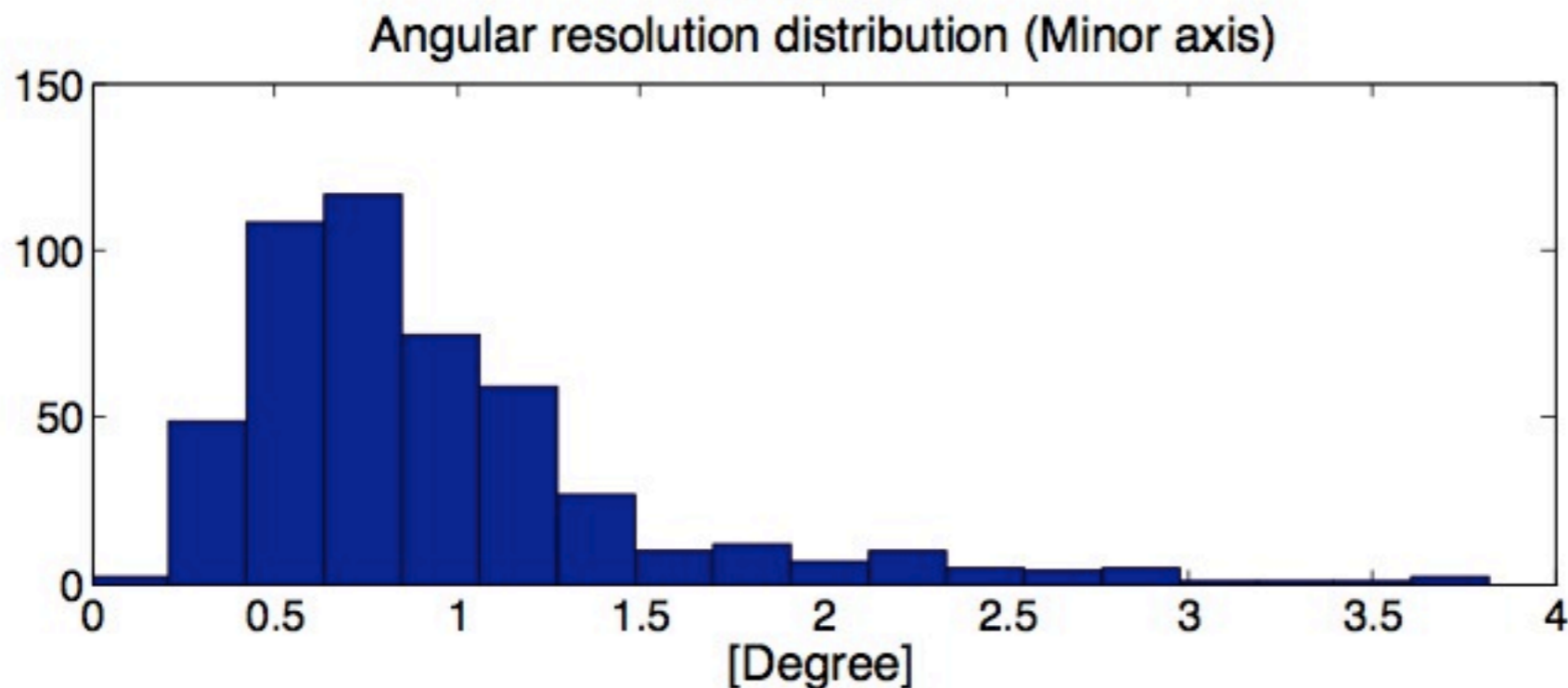
Example of Practical Issue : NS-NS forecast

# 角度分解能の分布



ISCOまで積分

500回  
シミュレーション



by Tagoshi



# Example of Practical Issue : Supernovae

## (1) GW

- Typical Range < 1Mpc
- Typical Angular Resolution ~ 3 degree

## (2) Neutrino (Super-Kamiokande)

- Typical Range ~ 1Mpc
- Typical Angular Resolution  
at 10kpc  
C.L.68% (=1 sigma) --> 4.7 degree  
C.L.95% (=2 sigma) --> 7.8 degree

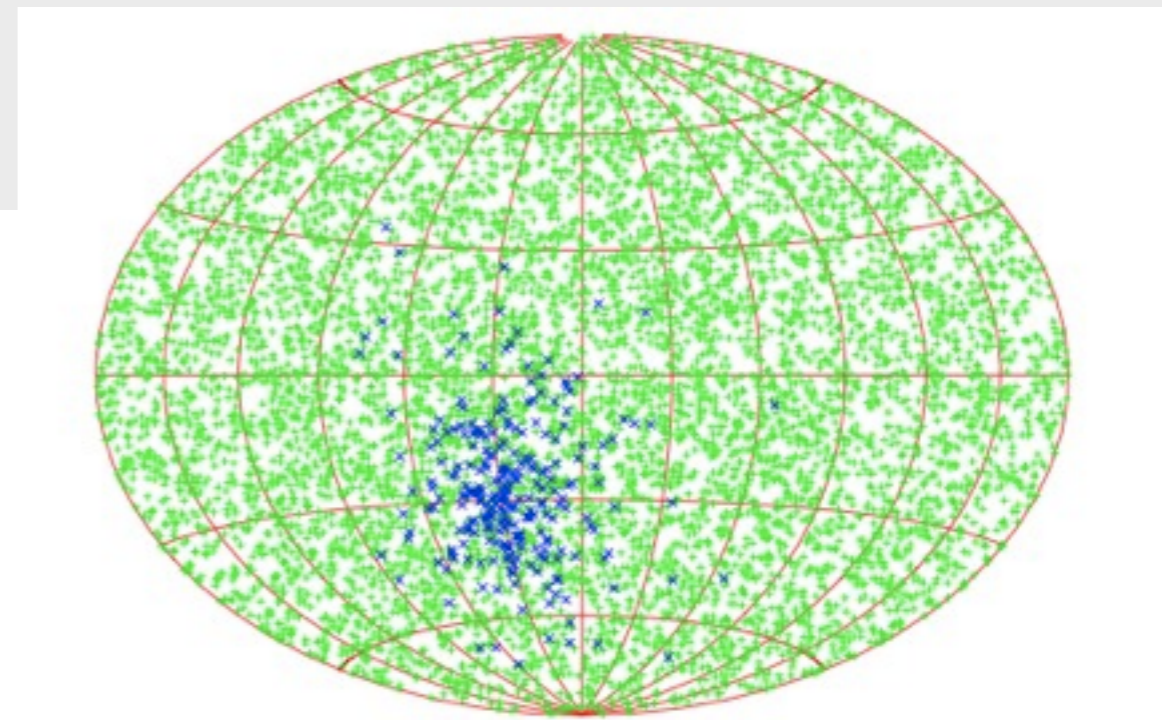
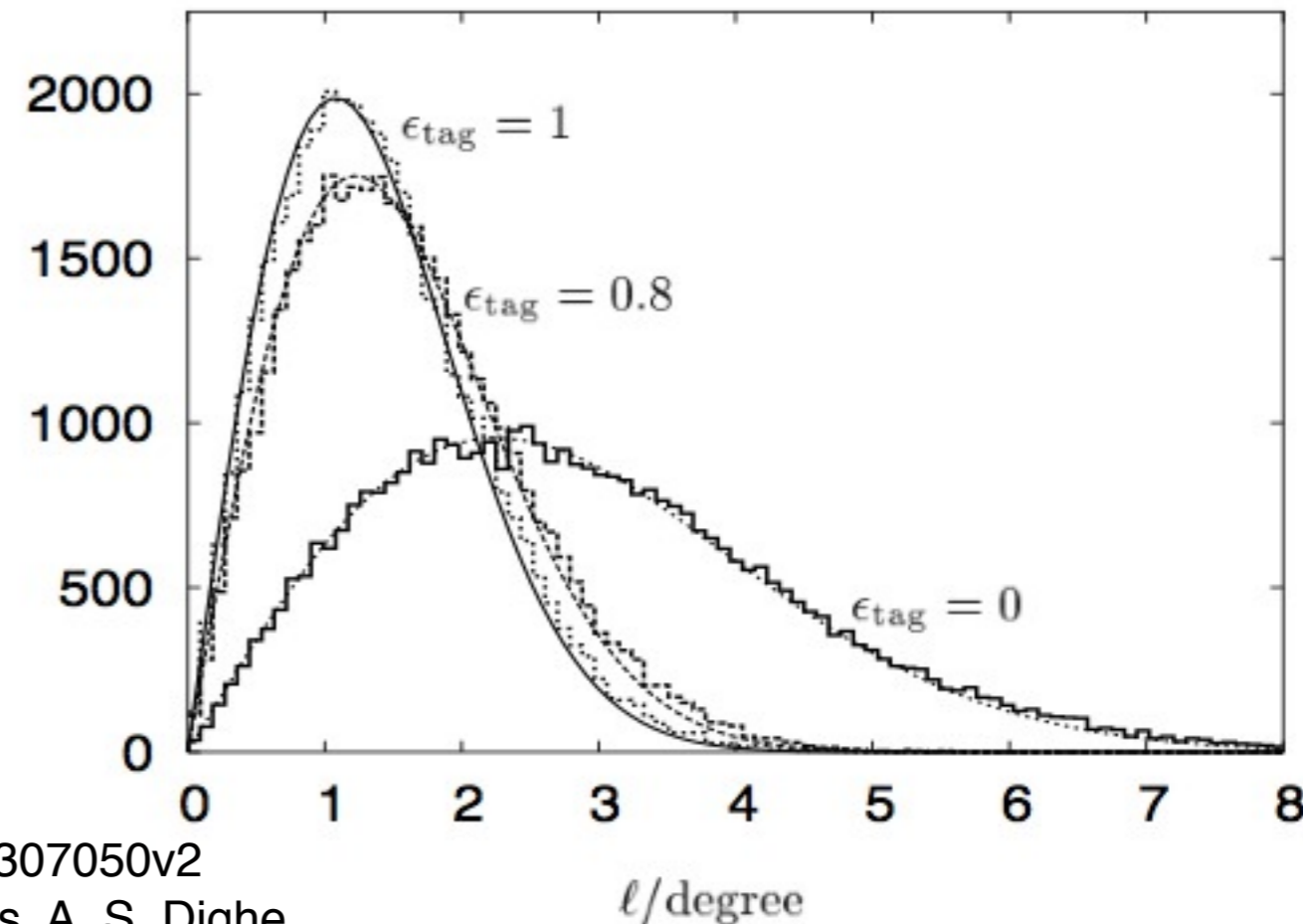


FIG. 4: Angular distribution of  $\bar{\nu}_e p \rightarrow n e^+$  events (green) and elastic scattering events  $\nu e^- \rightarrow \nu e^-$  (blue) of one simulated SN



Phys.Rev. D68 (2003) 093013 / arXiv:hep-ph/0307050v2

R. Tomas, D. Semikoz, G. G. Raffelt, M. Kachelriess, A. S. Dighe

# road map of 'Data Analysis' subgroup

	LCGT 1st year	2nd year	3rd year	4th year	5th year	6th year	7th year
Target	<b><u>Prepare Data Analysis for 4th year</u></b>			<b><u>System Test of Pipeline of Data Analysis</u></b>	<b><u>Build up full data system</u></b>	<b><u>Analyze Observation Data Continuously</u></b>	
Main tasks on LCGT itself	Development of software, Computing Environment etc.  Implement GW search methods  Prepare Cooperative Analysis with other GW obs.			Construct a data storage and computing system  Calibration & Injection test  <u>Search for GW</u>		<b><u>Search for GW !</u></b>  International Cooperative Analysis	
Tasks on Counter-part Obs.	Prepare Mutually Followup with Other Obs. (EM, Neutrino etc.)			Test of information/data exchange protocol  Coincidence Serch		<b><u>Mutually Followup with Other Obs.</u></b>	

# road map of 'Data Analysis' subgroup

	LCGT 1st year	2nd year	3rd year	4th year	5th year	6th year	7th year
Target	Prepare Data Analysis <u>for 4th year</u>			<u>System Test</u>	Build up <u>full data system</u>	<u>Analyze Continuously</u> Followup with Other Obs.	
Hardware	small cluster mini-system		<u>partial system</u>		<b><u>full system</u></b>	+ cpu, storage, peripherals	
Software	Construct common environment Implement GW search			<b><u>whole data pipeline test</u></b>			
Budget (Computing)	0.5 billion yen (0.1 + 0.2 + 0.2)			1 billion yen (0.3 + 0.7)			
Budget (Human Resources)	1.5 billion yen (Post-Doc &/or outsourcing : 6 persons x 4.5 years)						