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 Coalesence

- 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

- from Supernovae

  Range ~ 1Mpc
- Ringdown GW from Blackhole QNM

  BH formed from NS-NS, NS-BH, or IMBH
- Pulsar Glitches

(3)Continuous

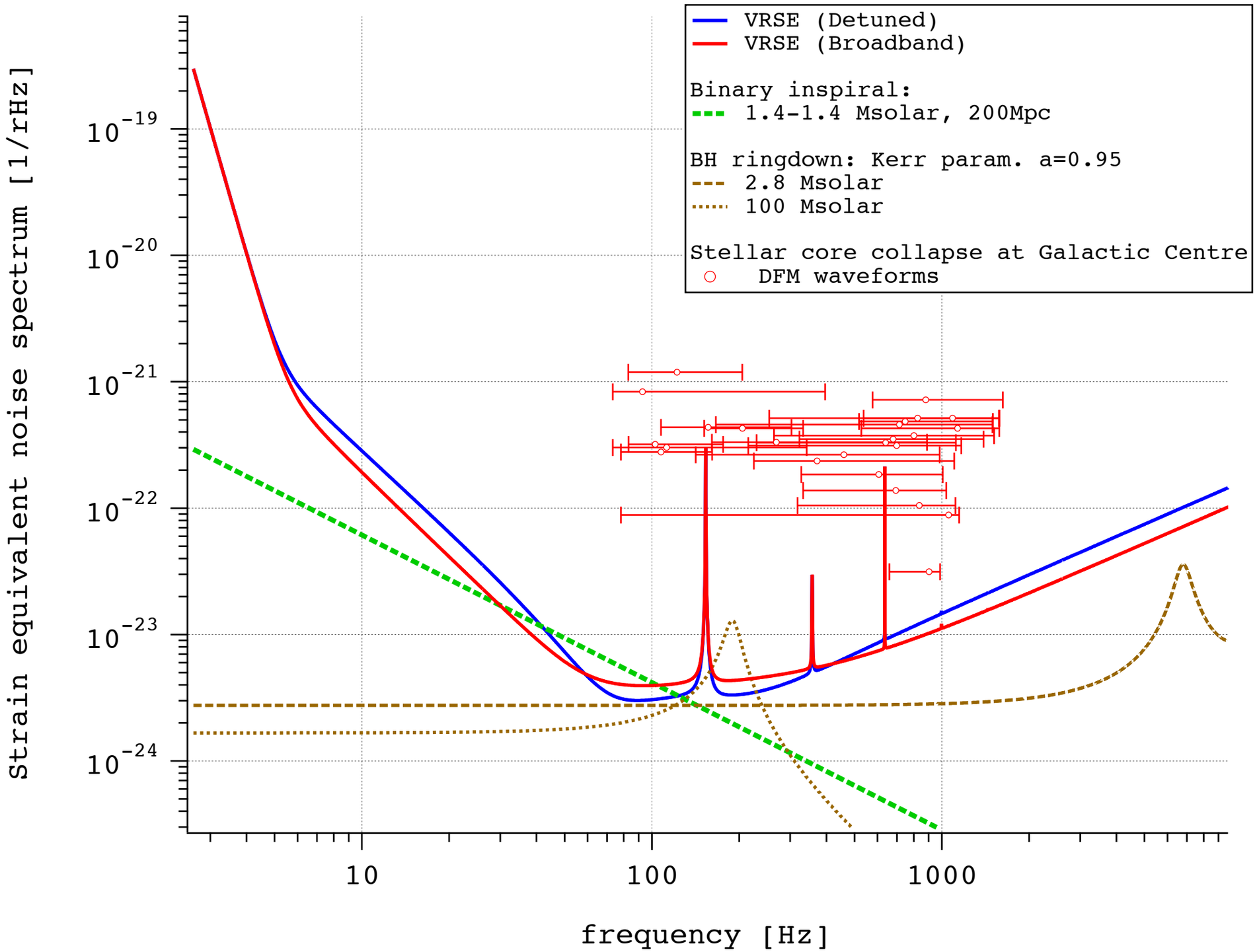
- Pulsars

(4)Stochastic

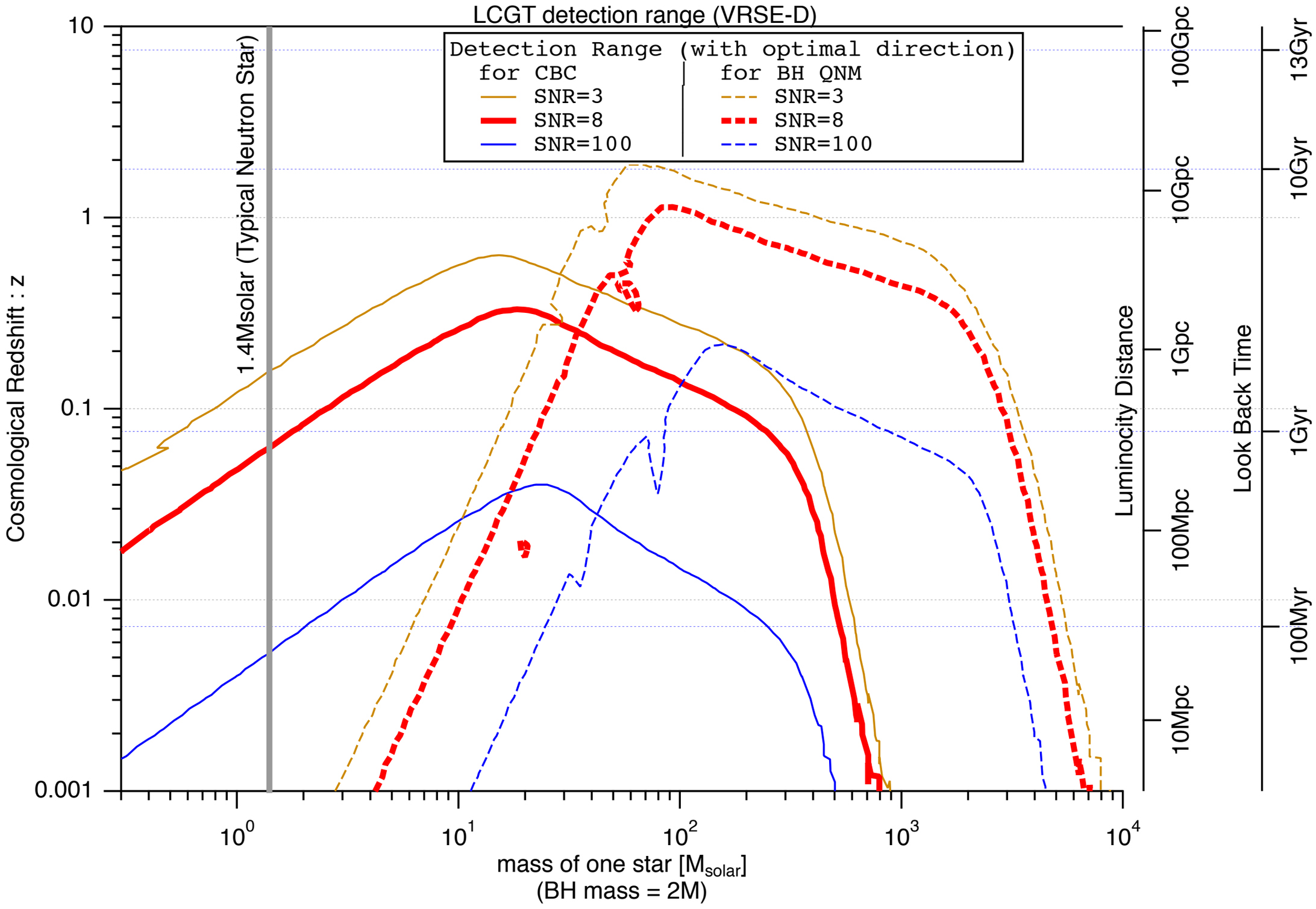
(5)Unexpected

Remark the Sensitivity of LCGT

BW working group

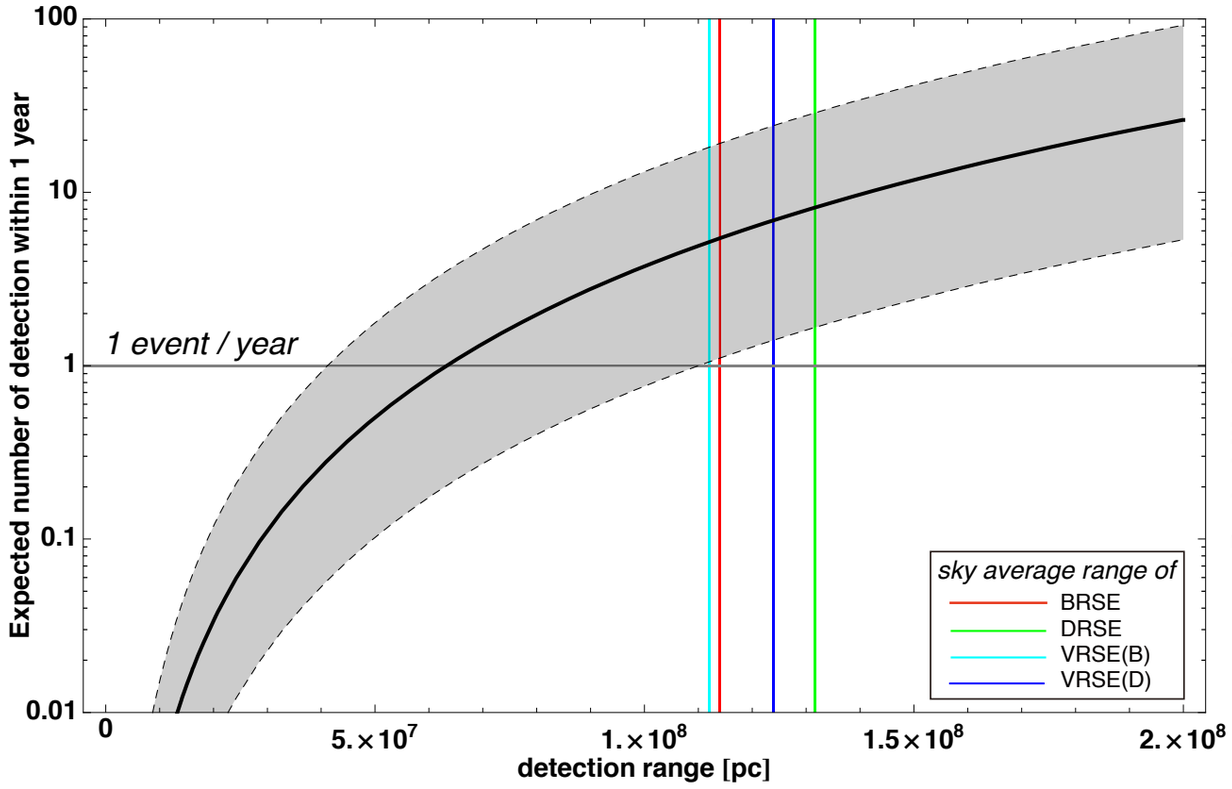


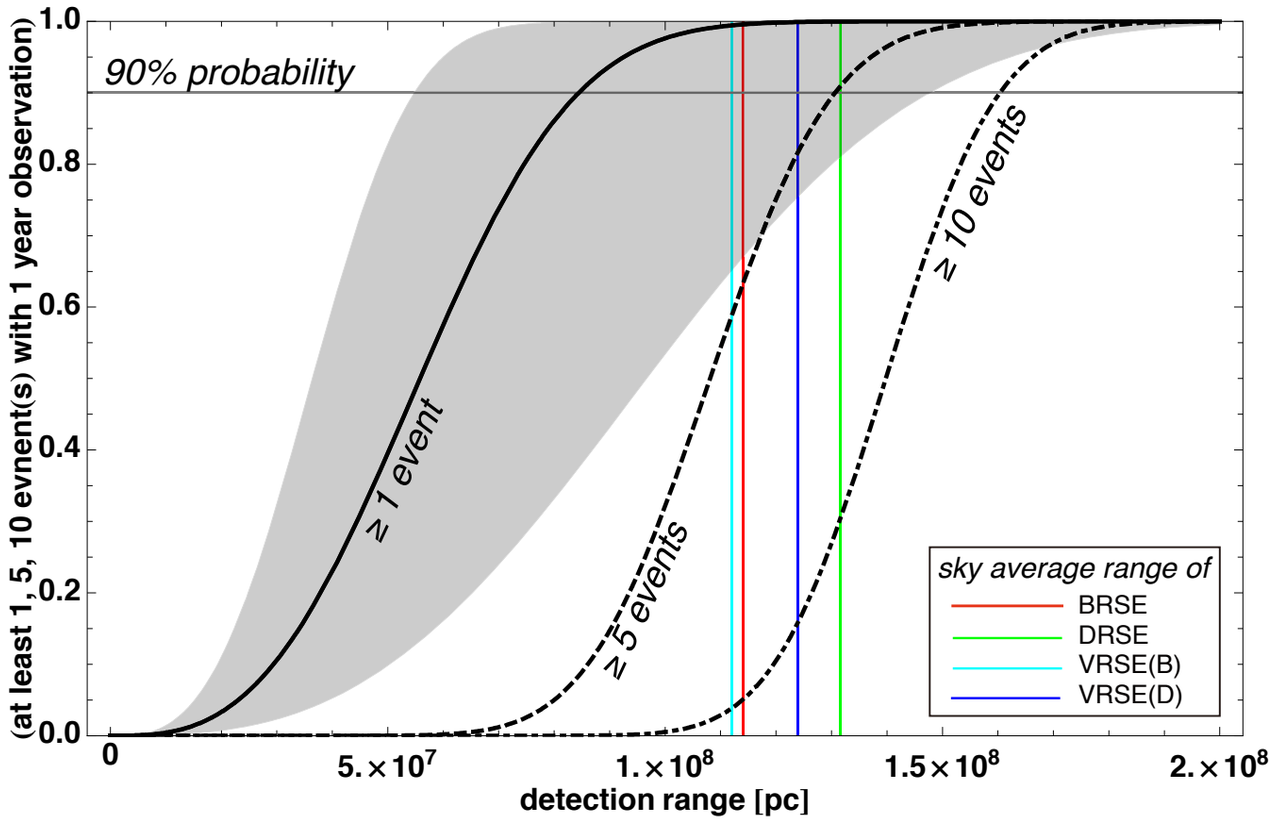
Detection Range for Compact Binary and BH QNM



Probability of Detection

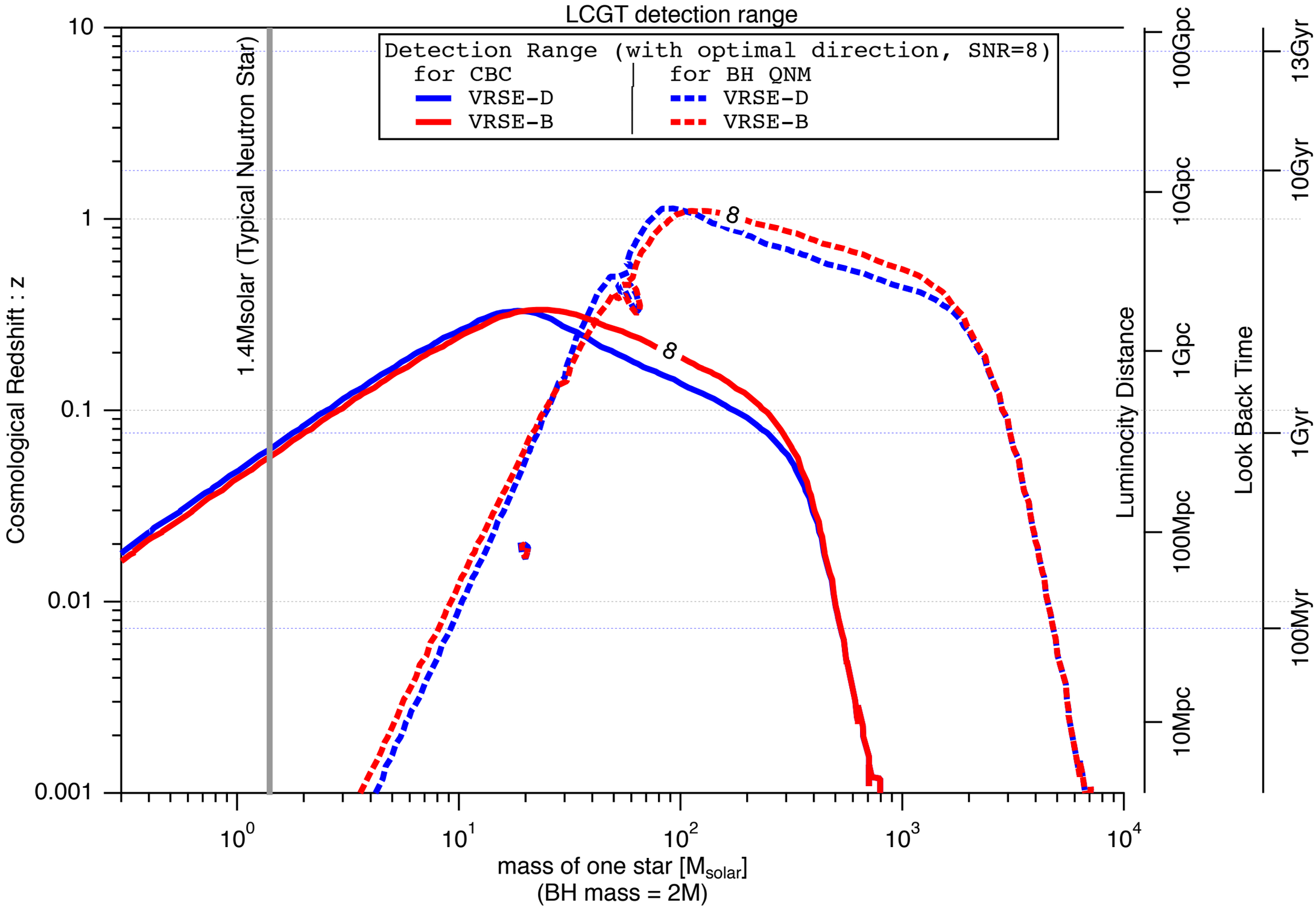
BW working group



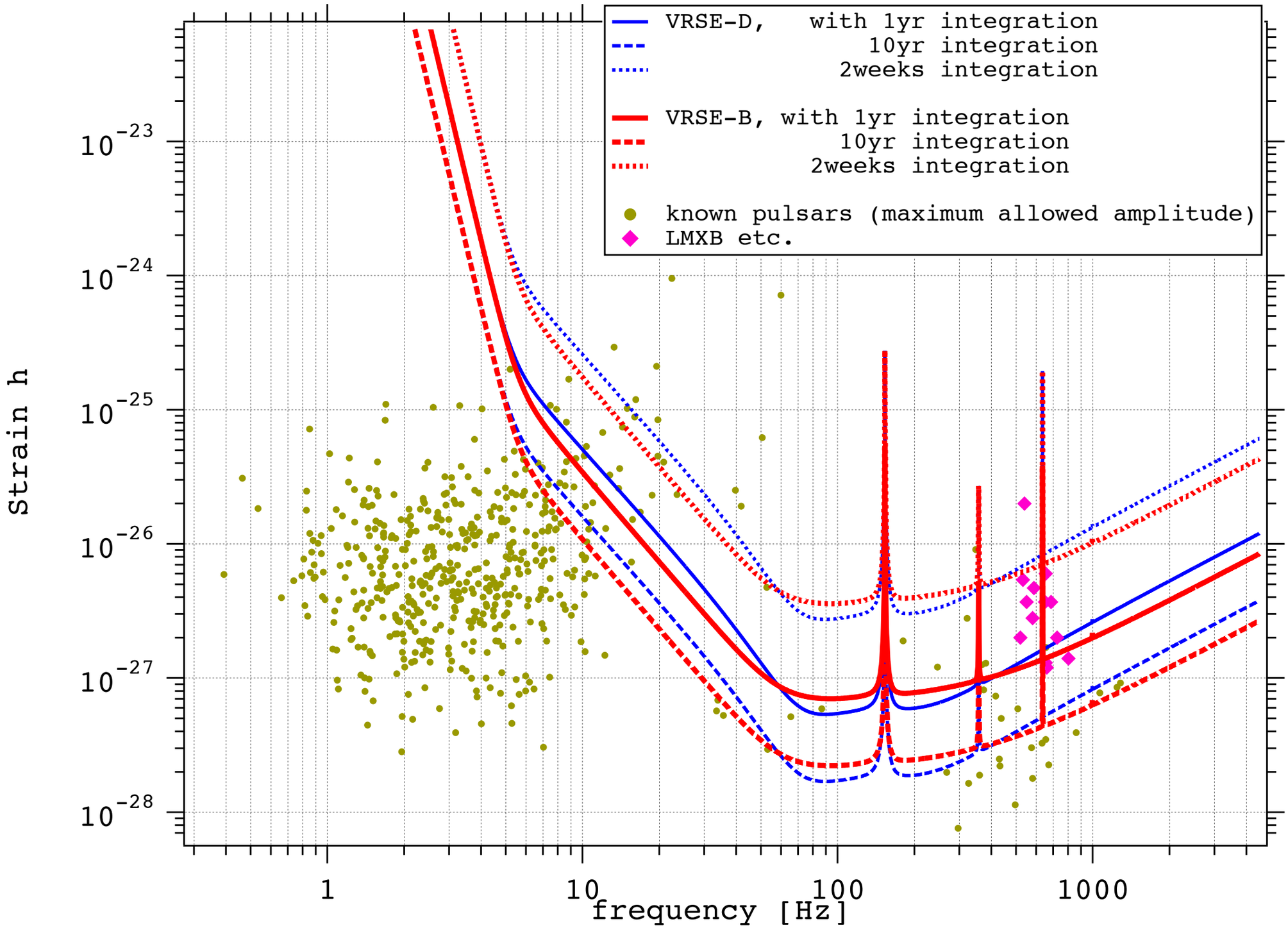


NS-NS Detection Range	(sky average)	123 Mpc
	(optimal direction)	281 Mpc
Expected # of events		$6.9\ ^{+17.3}_{-5.5}$ events/year
Probability of detection	at least one event	99.9 % for one year
	90% for 1st event	4 months

VRSE-D vs VRSE-B

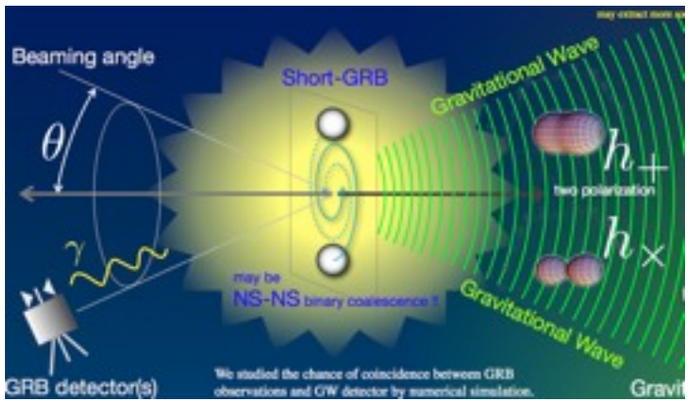


Sensitivity for Continuous GW



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)

GW by LCGT etc.
Real time analysis

Delayed precise analysis

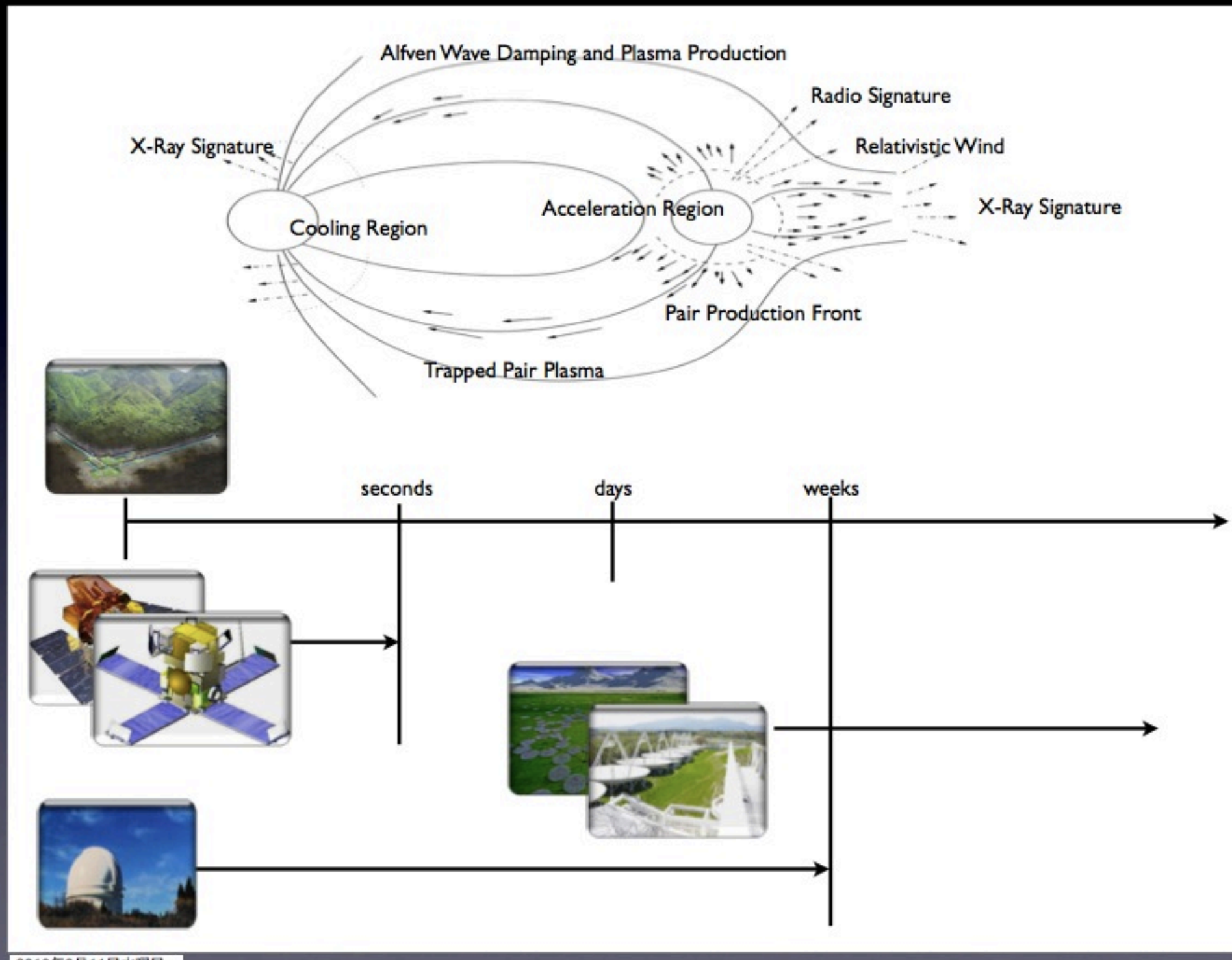
[Aux trigger]
Date, direction, ...

Followup by
X, Gamma, Optical

Confirmation of Afterglow

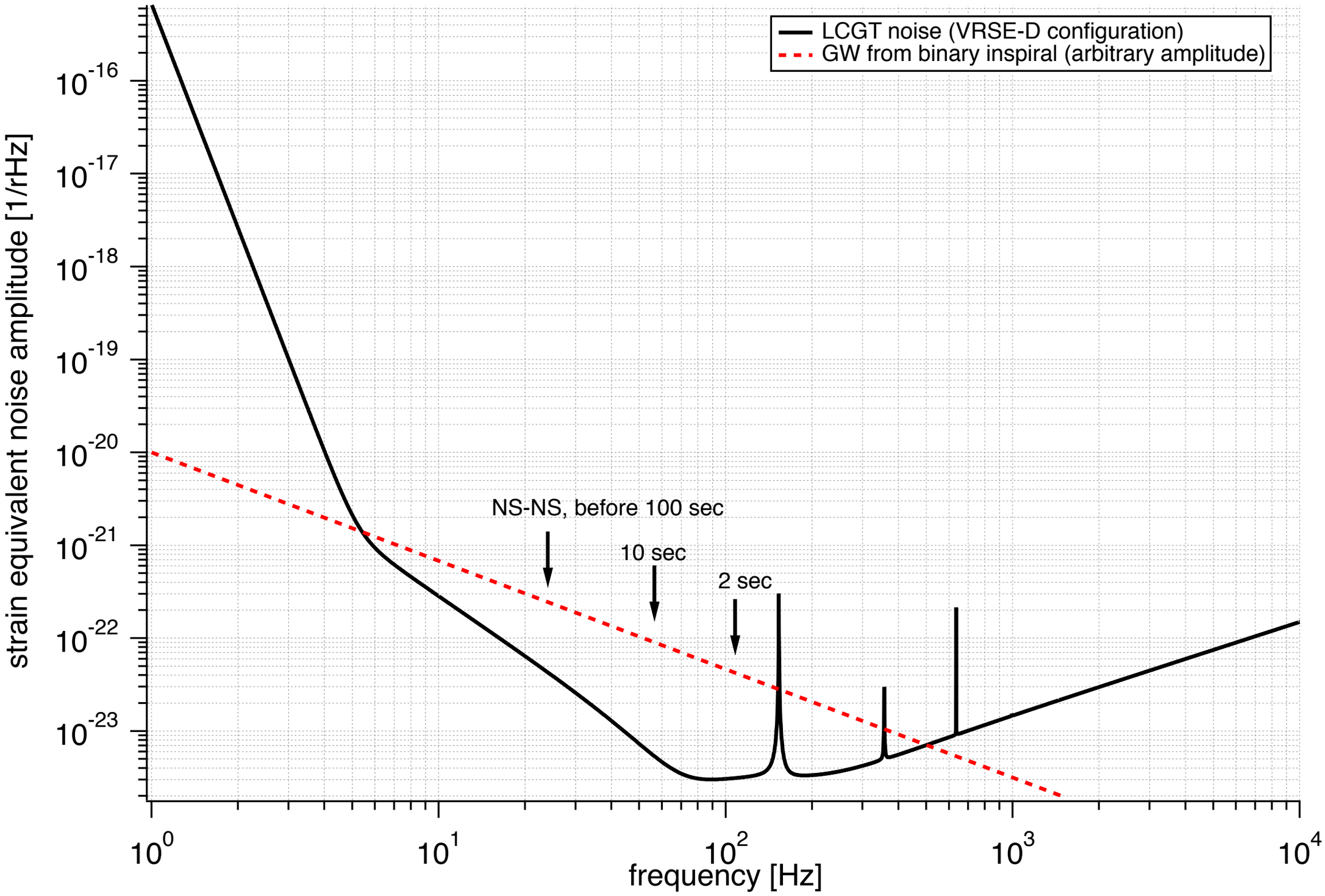
[Alert]
date, direction, distance,...

CBC



by Hayama

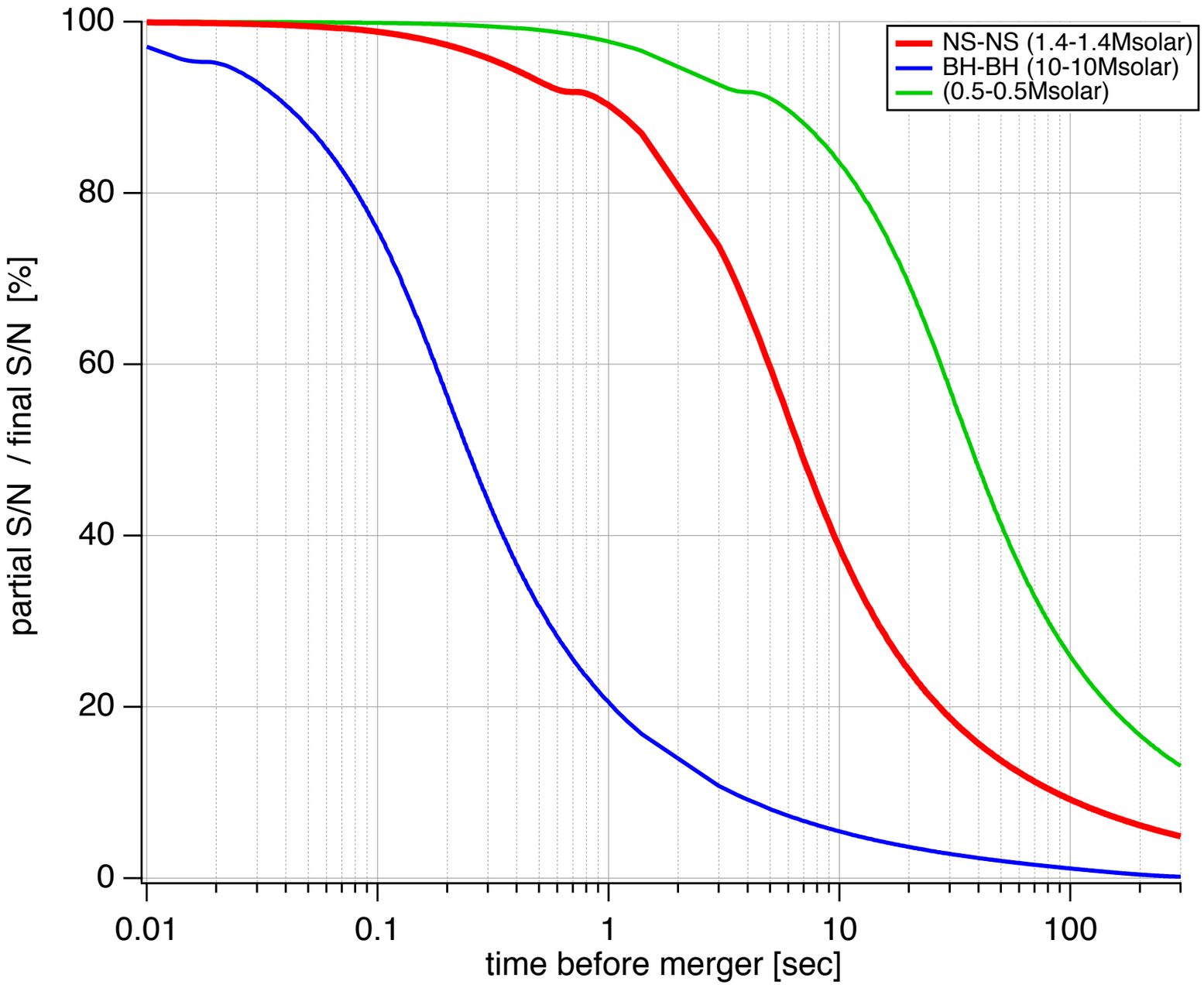
Example of Practical Issue : NS-NS forecast



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:

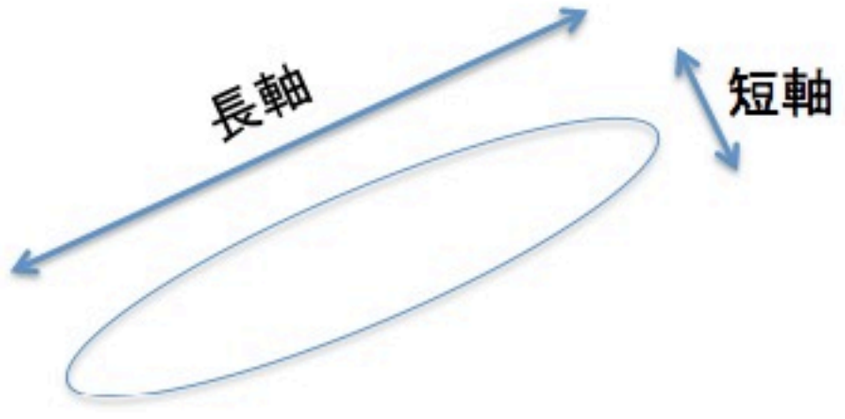
平均S/N (ρ)　　8.2から8.9 （各検出器で）

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(ρ)　　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)

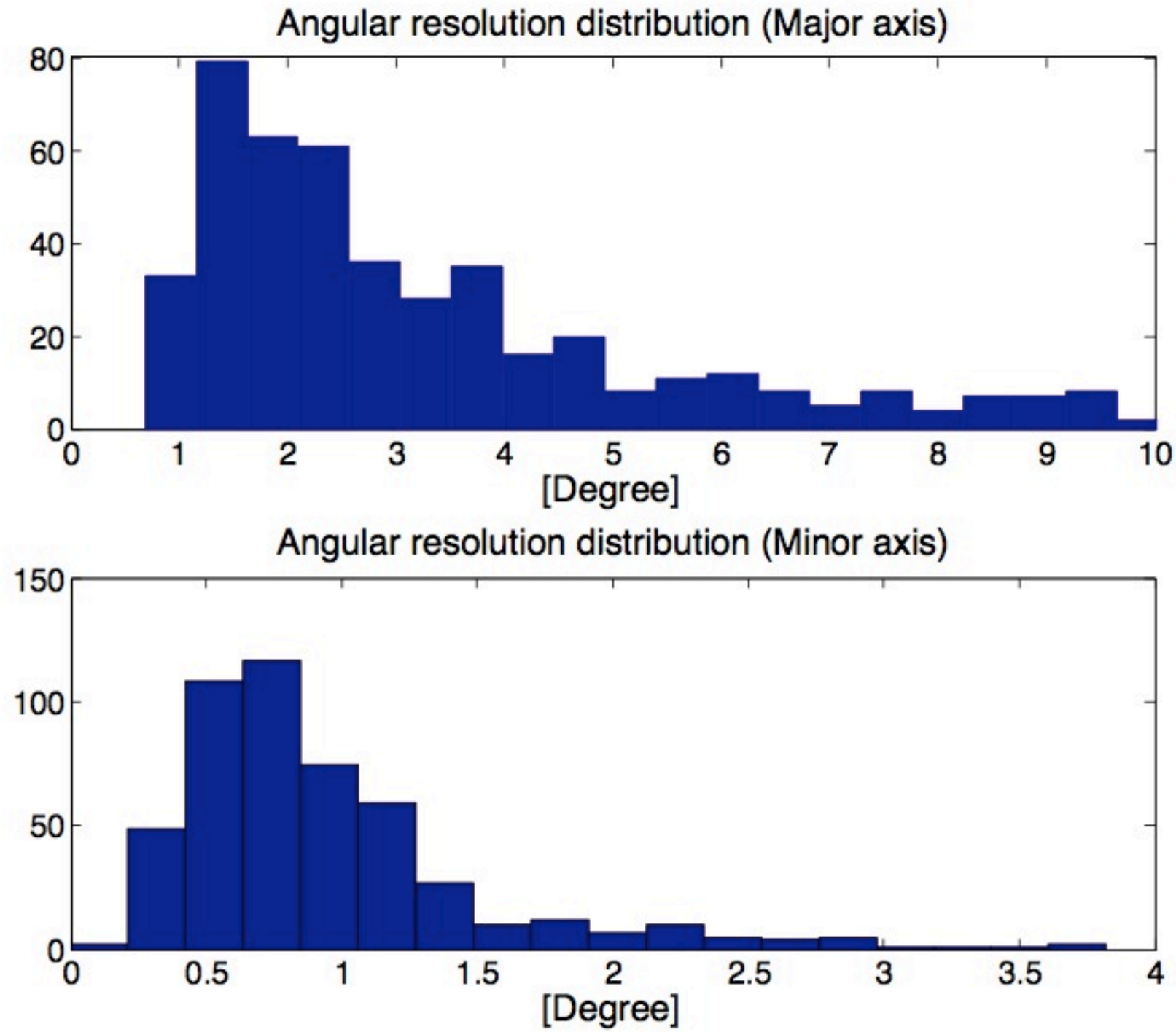


by Tagoshi

5

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

6

Counterpart of NS-NS <---> GRB?

(1) Gamma Ray Burst Observations

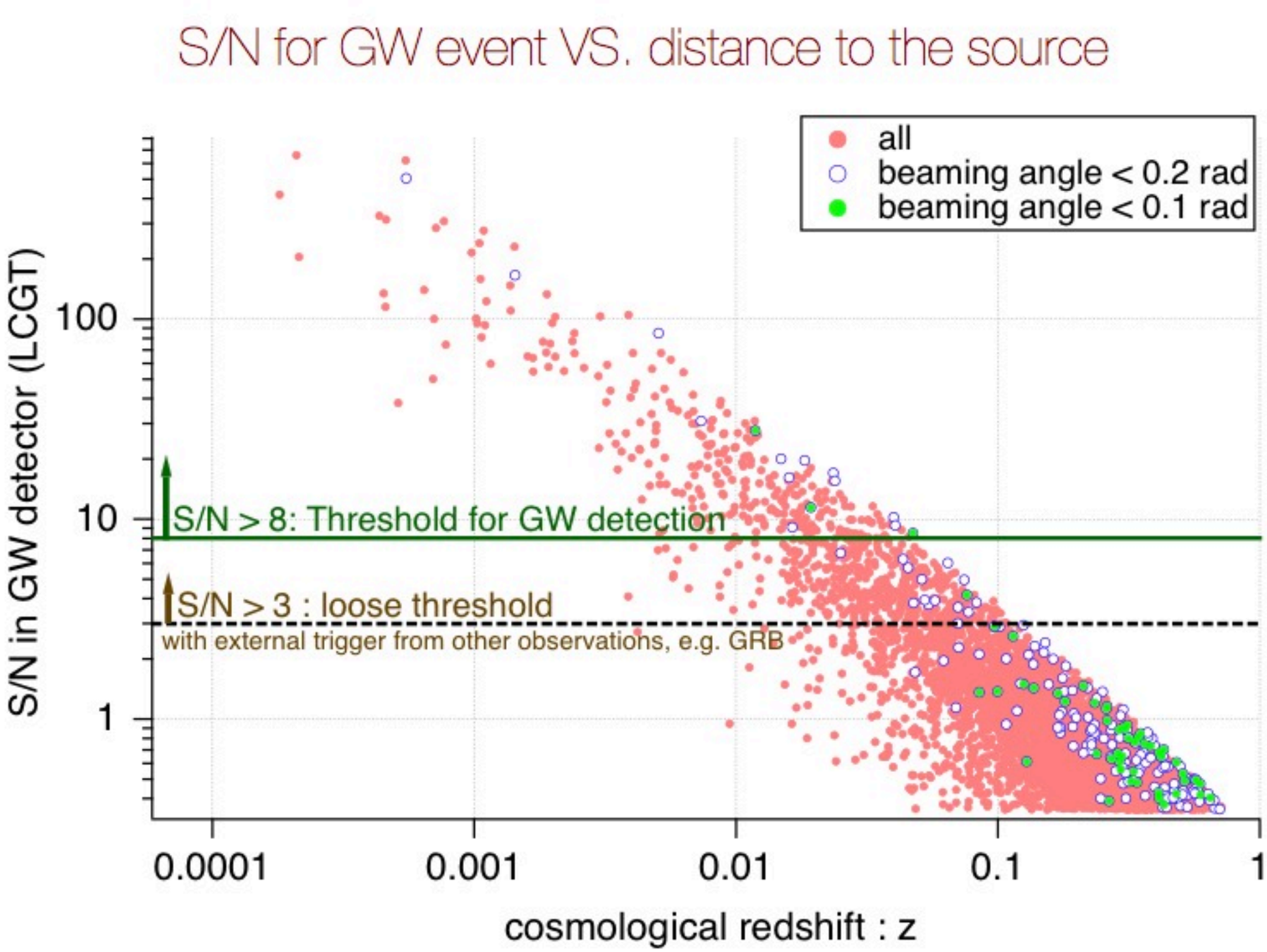
- for ‘Burst’ events

(2) X-Ray, Opical band

- After glow <-- Follow up

Since the error box of GW observation is large,
Follow up observations need to develop **large field of view** telescope.

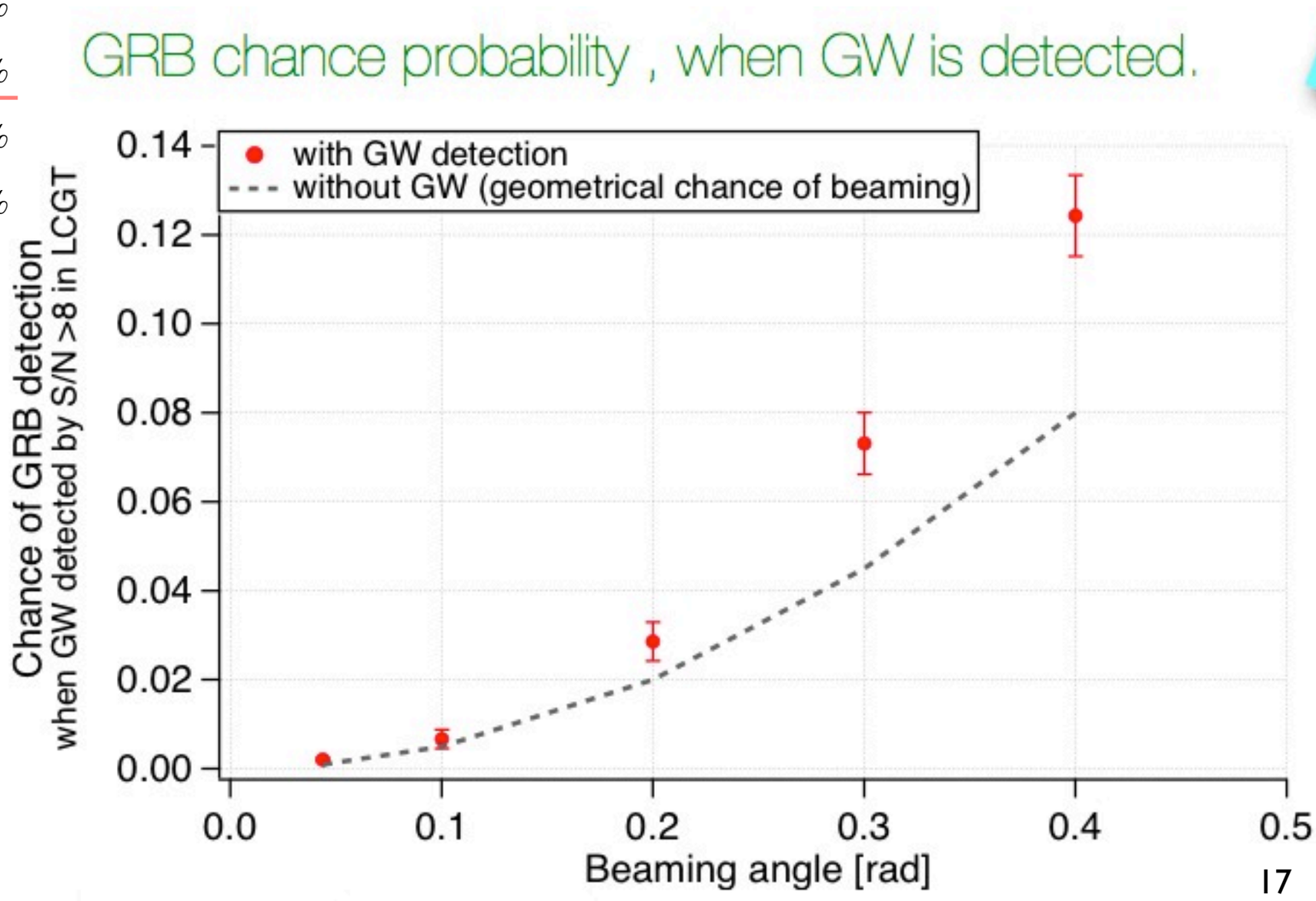
Is it possible to find coincidences between GW and GRB?



Probability for when GW is detect ...

z distribution	Beaming of GRB	Chance of GRB found
pre-Swift	0.2 rad	2.9%
Swift	2.5 deg	0.2%
	0.1 rad	0.7%
	0.2 rad	2.9%
	0.3 rad	7.3%
	0.4 rad	12.4%

If beaming of GRB is about 0.2 rad, a chance is once for 30 times.



Example of Practical Issue : Supernovae

(1)GW

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

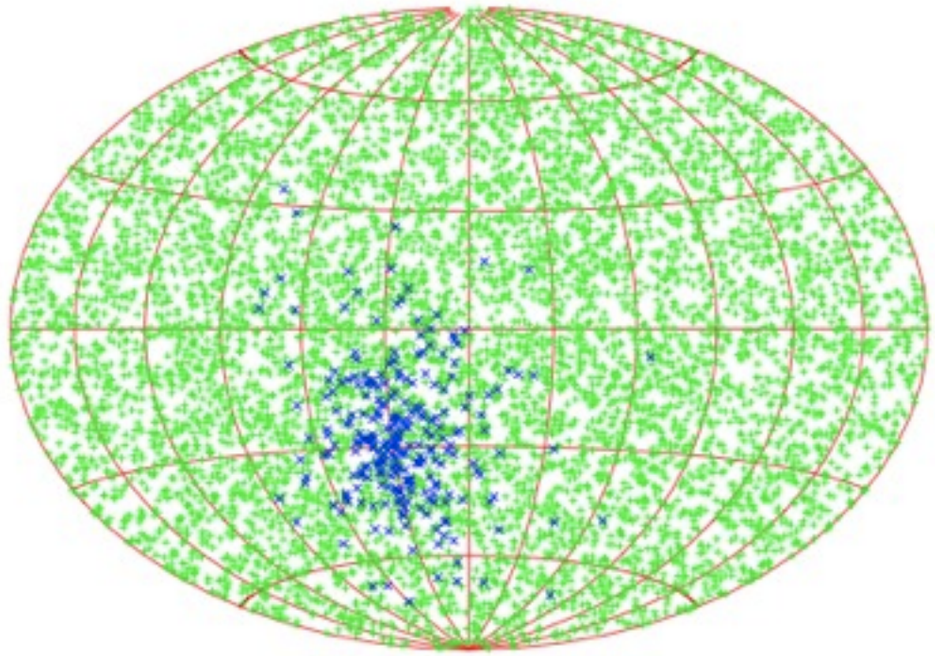


FIG. 4: Angular distribution of $\bar{\nu}_e p \to n e^+$ events (green) and elastic scattering events $\nu e^- \to \nu e^-$ (blue) of one simulated SN.

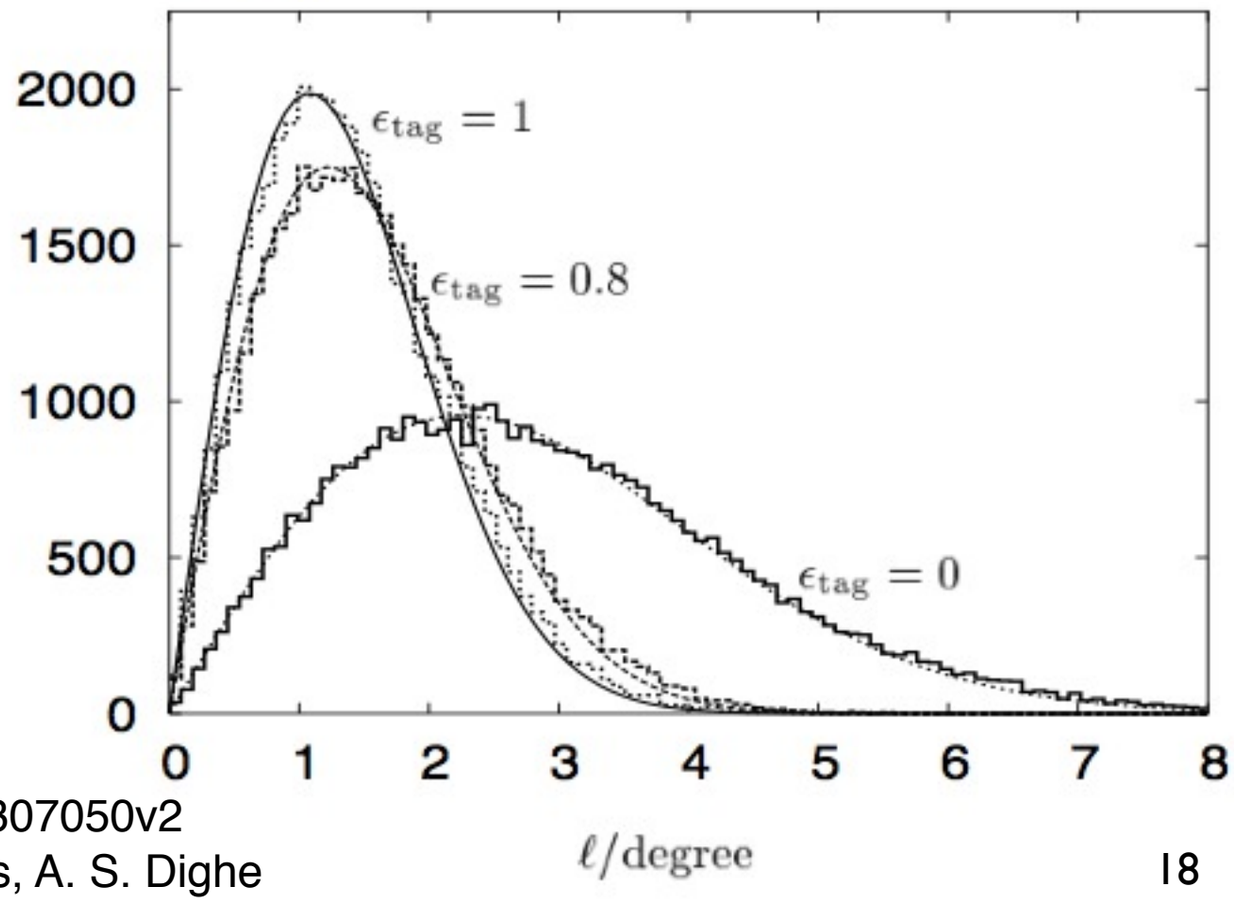
(2)Neutrino (Super-Kamiokande)

- Typical Range ~ 1Mpc
- Typical Angular Resolution

  at 10kpc

  C.L.68% (=1 sigma) --> 4.7 degree

  C.L.95% (=2 sigma) --> 7.8 degree



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	**Prepare Data Analysis for 4th year**			**System Test of Pipeline of Data Analysis**	**Build up full data system**	**Analyze Observation Data Continuously**	
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 Search for GW		**Search for GW !** 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		**Mutually Followup with Other Obs.**	

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 for 4th year			System Test	Build up full data system	Analyze Continuously Followup with Other Obs.	
Hardware	small cluster mini-system		partial system		**full system**	+ cpu, storage, peripherals	
Software	Construct common environment Implement GW search			**whole data pipeline test**			
Budget (Comput--ing)	50 million yen (10 + 20 + 20)			100 million yen (30 + 70)			
Budget (Human Resouces)	150 million yen (Post-Doc &/or outsourcing : 6 persons x 4.5 years)						