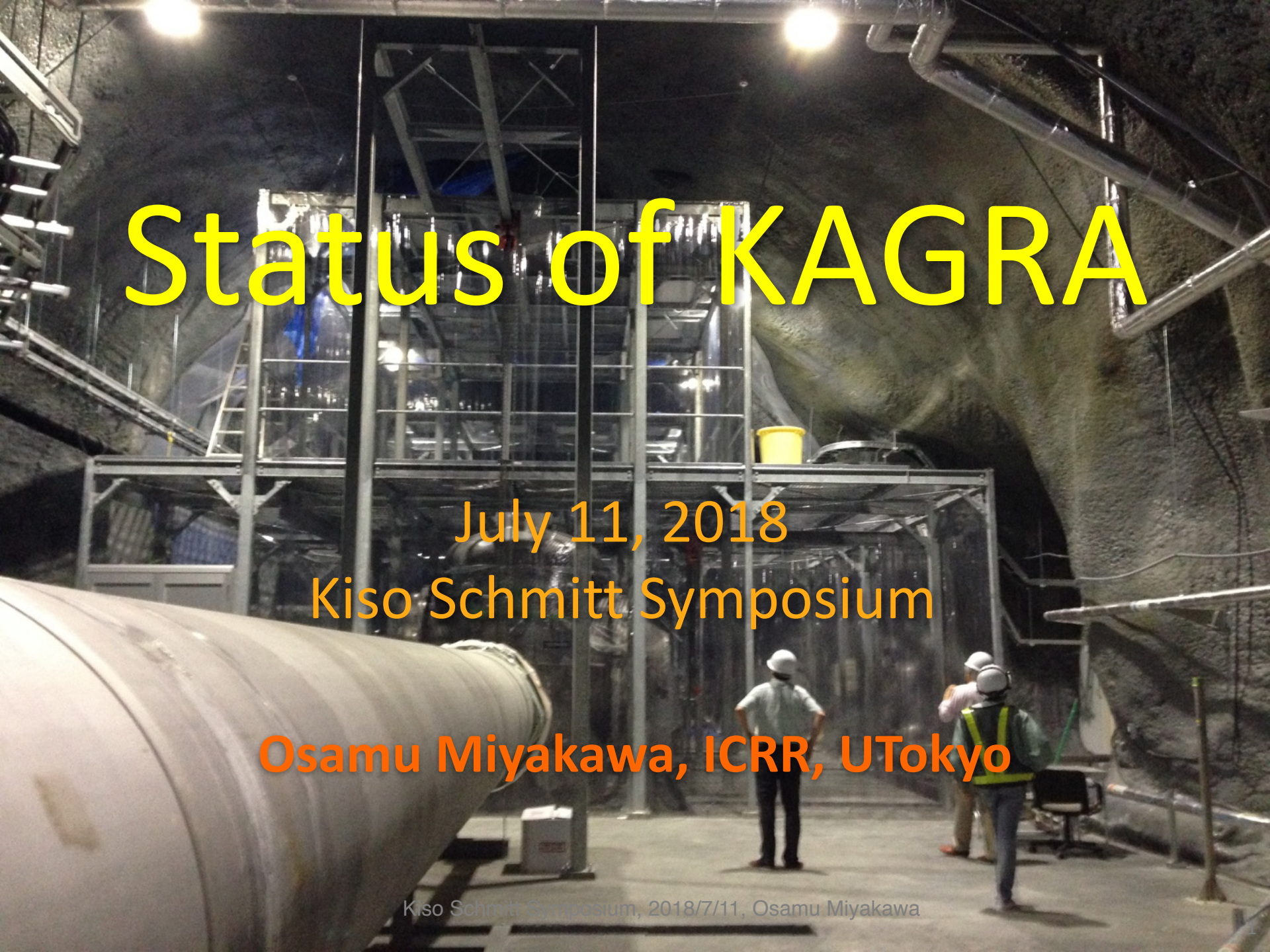
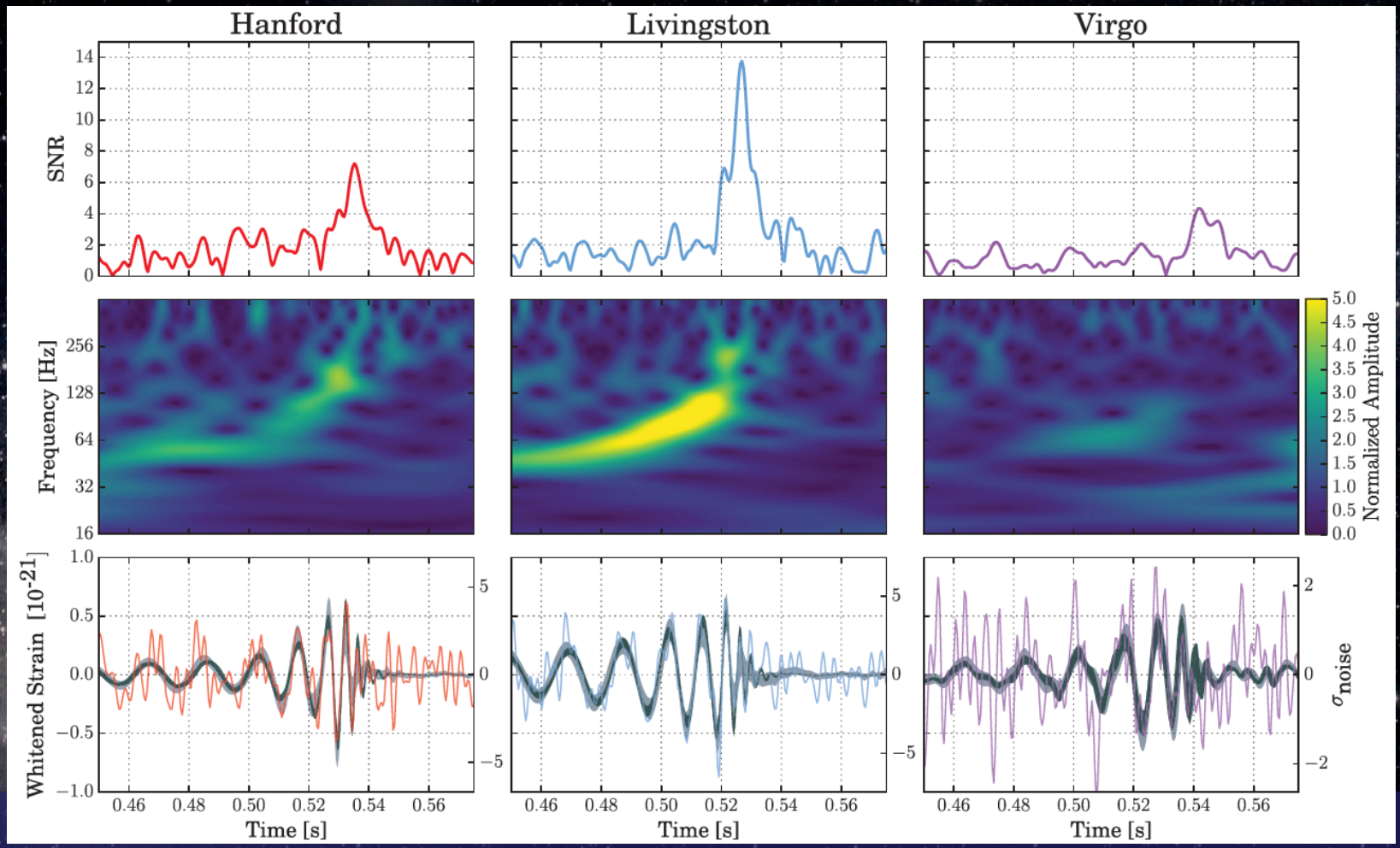


Status of KAGRA

July 11, 2018
Kiso Schmitt Symposium

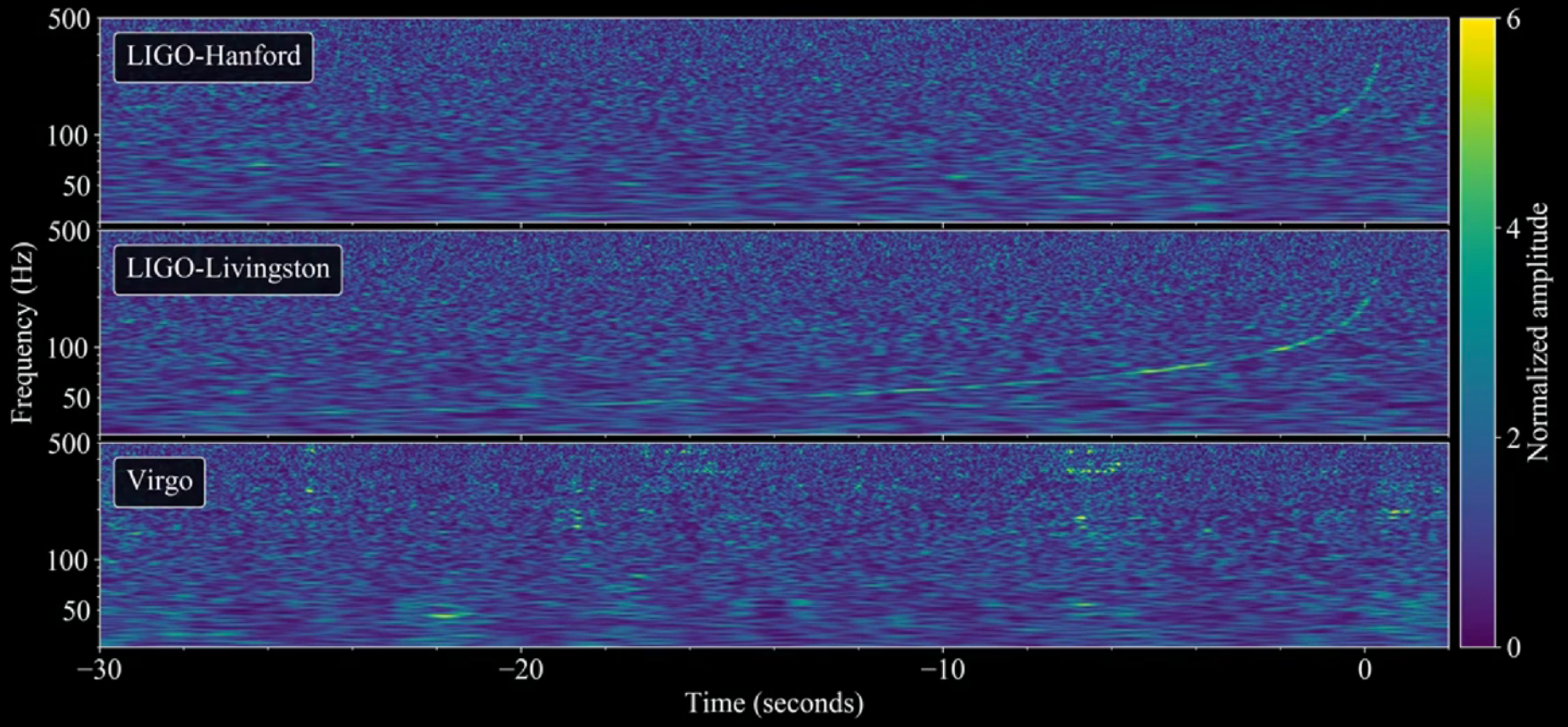
Osamu Miyakawa, ICRR, UTokyo

昨年8月、世界3台の検出器で重力波を検出



- 2台のLIGO+ヨーロッパにあるVIRGO
- VIRGOは低感度ながらも位置特定に貢献

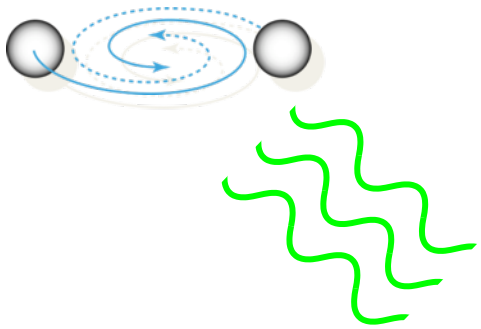
さらに中性子連星の合体での重力波検出



- Virgoはやはり感度が低いが、それでも貢献。
- 可視光でも観測された。

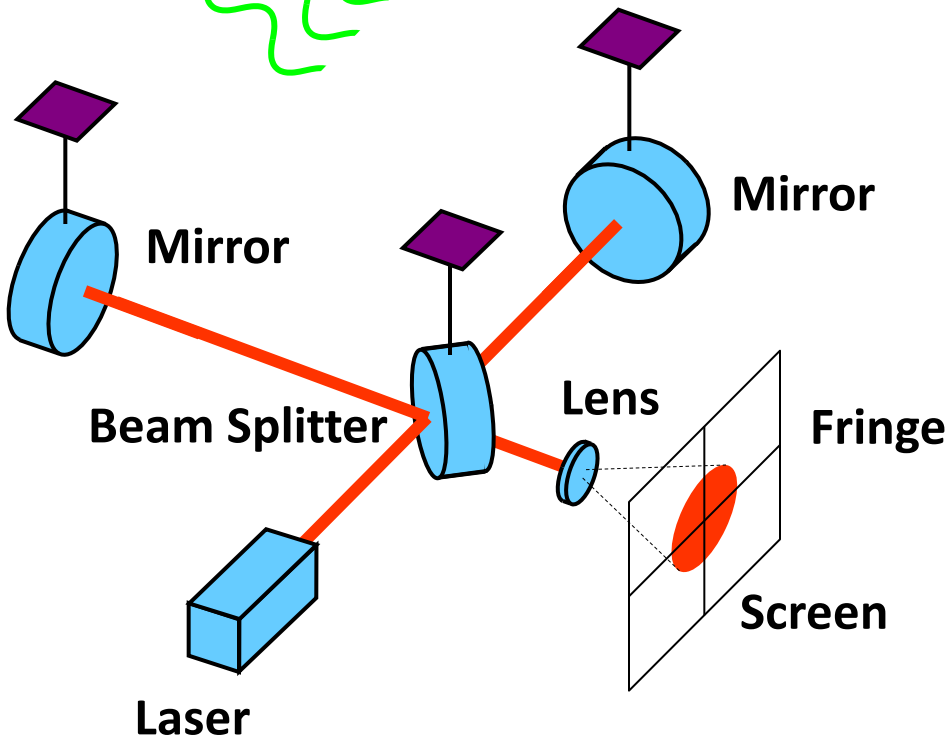
Detection of gravitational wave using laser interferometer

GWs move mirrors differentially.
We measure the distance between mirrors using fringe of light.

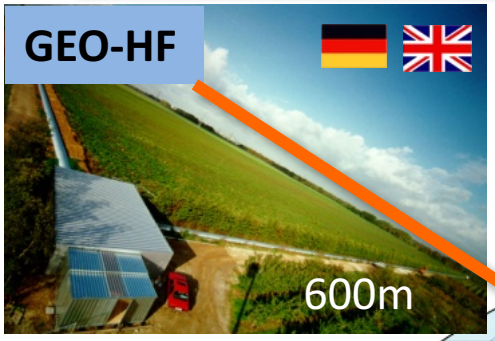


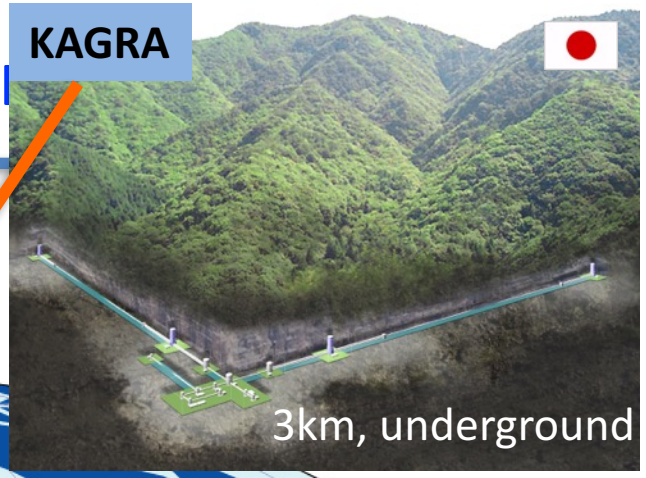
Expected length change by GW :

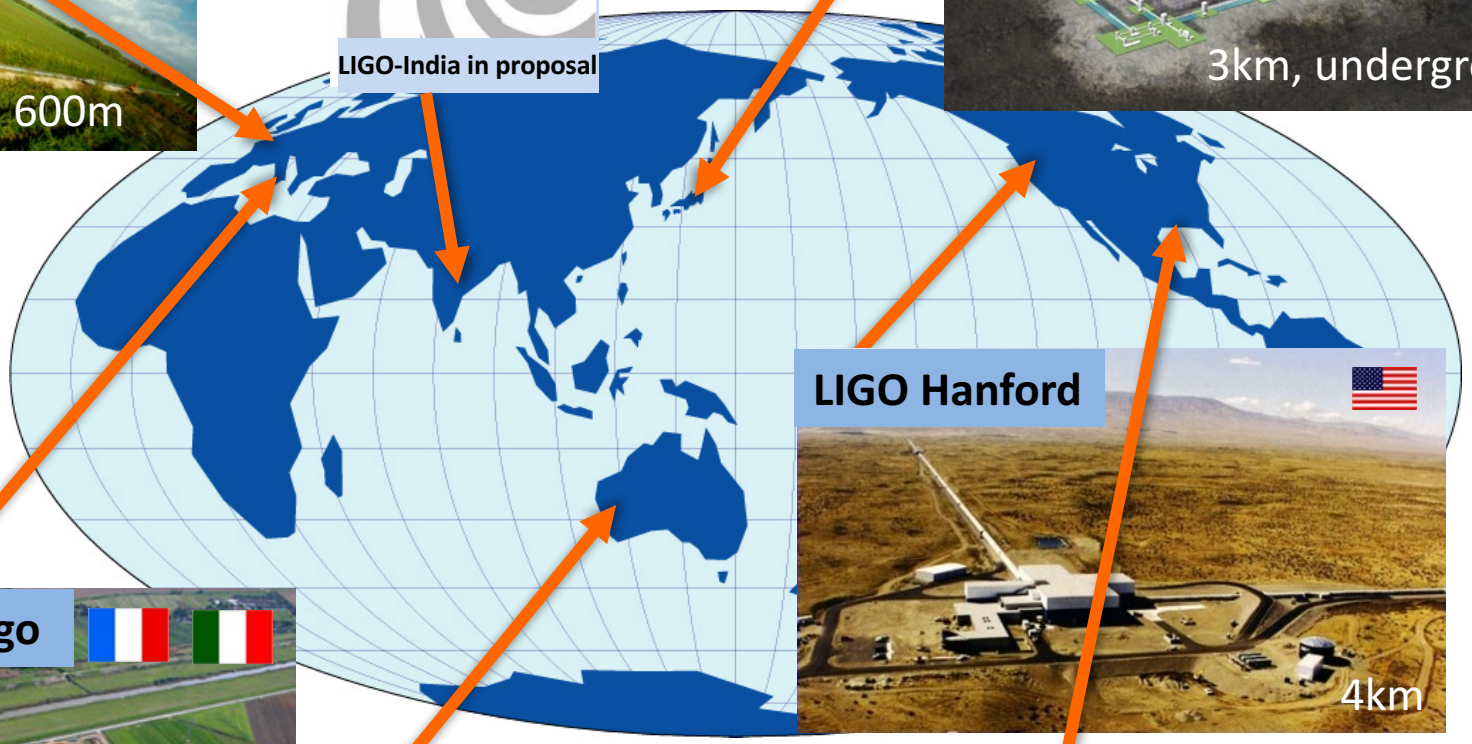
~1x10^{-19}m

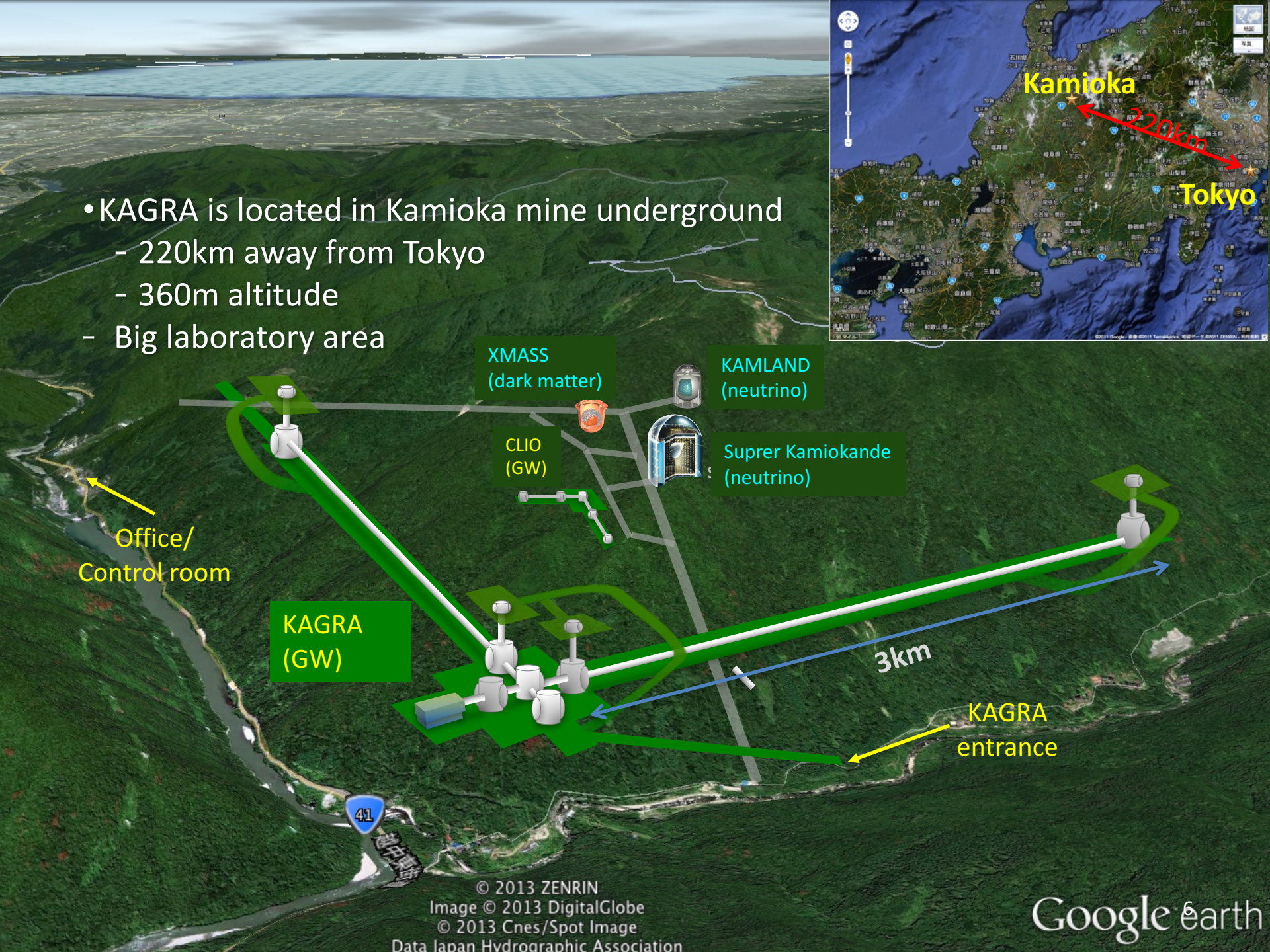


Network of GW detecto







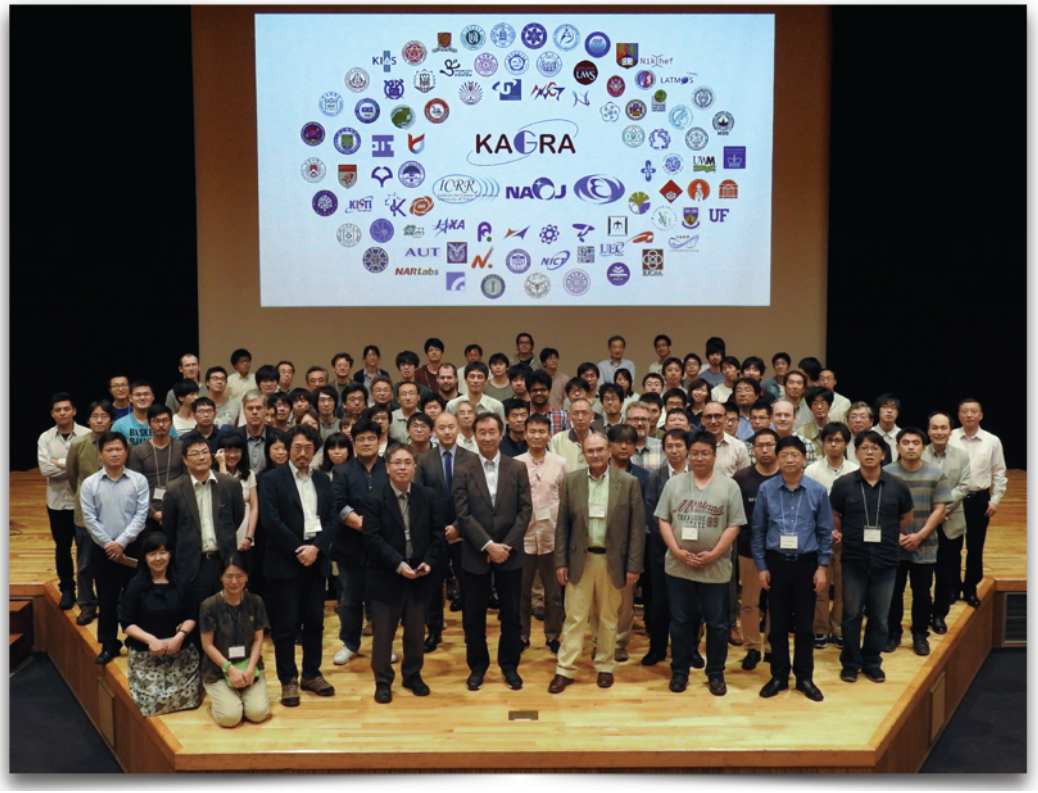

• KAGRA is located in Kamioka mine underground
- 220km away from Tokyo
- 360m altitude
- Big laboratory area
Kamioka
220km
Tokyo
XMASS
(dark matter)
KAMLAND
(neutrino)
CLIO
(GW)
Suprer Kamiokande
(neutrino)
Office/
Control room
KAGRA
(GW)
3km
KAGRA
entrance
41
© 2013 ZENRIN
Image © 2013 DigitalGlobe
© 2013 Cnes/Spot Image
Data Japan Hydrographic Association
Google earth

KAGRA Project

KAGRA collaboration: as of June 2018

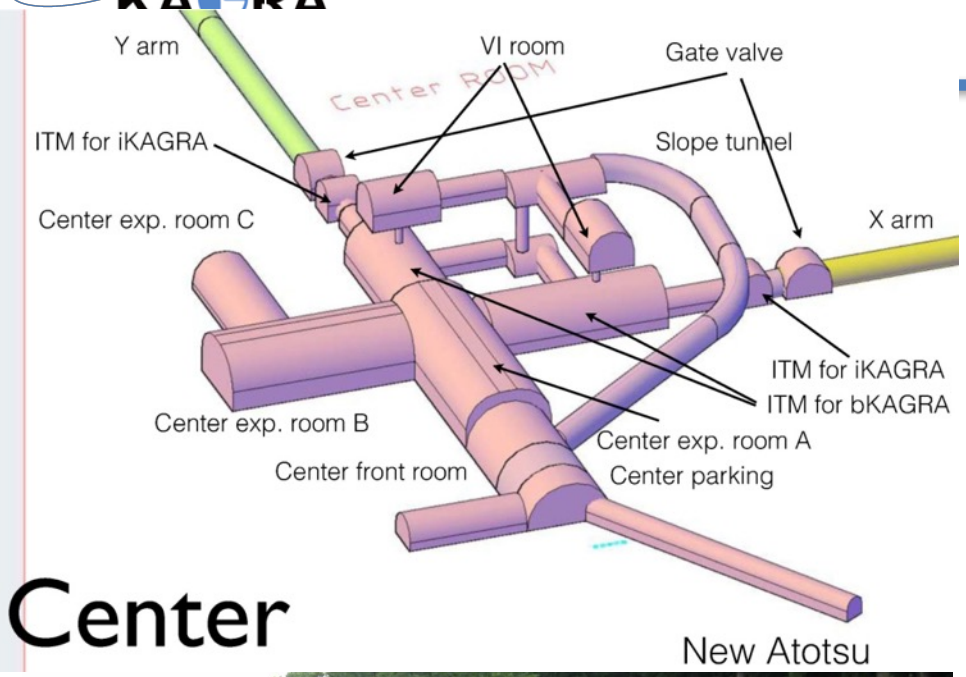
385 collaborators
(8 B students, 73 M students, 35 D students, 10 PDs)
90 institutes
15 countries
(Australia 5, China 35, France 1, German 1, India 3, Italy 17, Japan 253,
Korea 23, The Netherlands 1, Poland 2, Russia 1, Taiwan 34, UK 2, USA 10, Vietnam 2)

PI: Takaaki Kajita

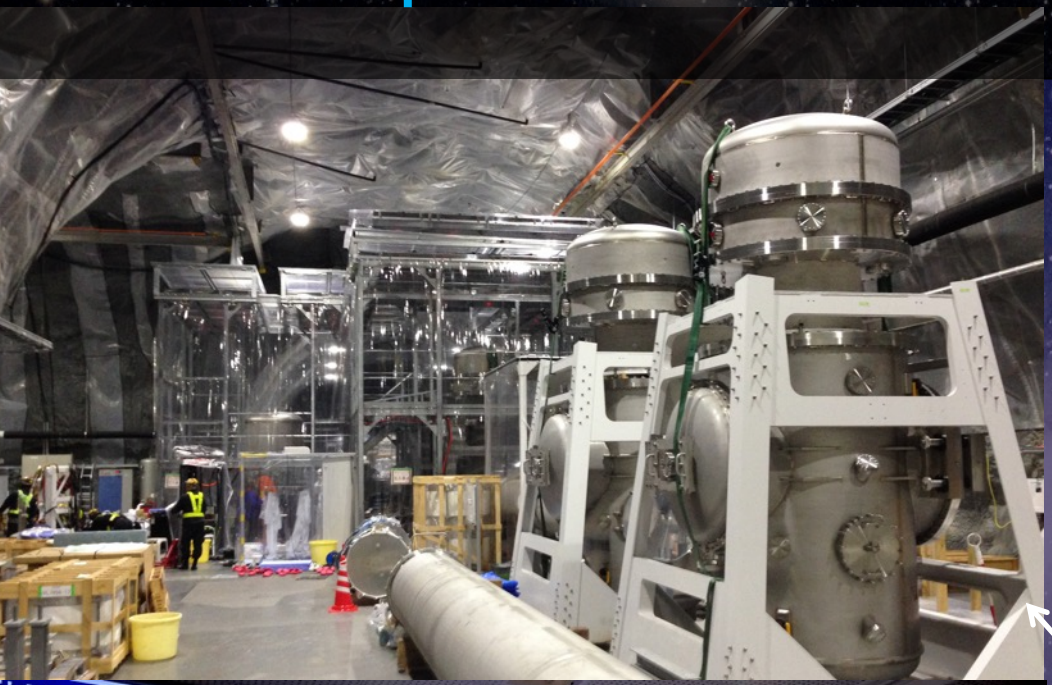


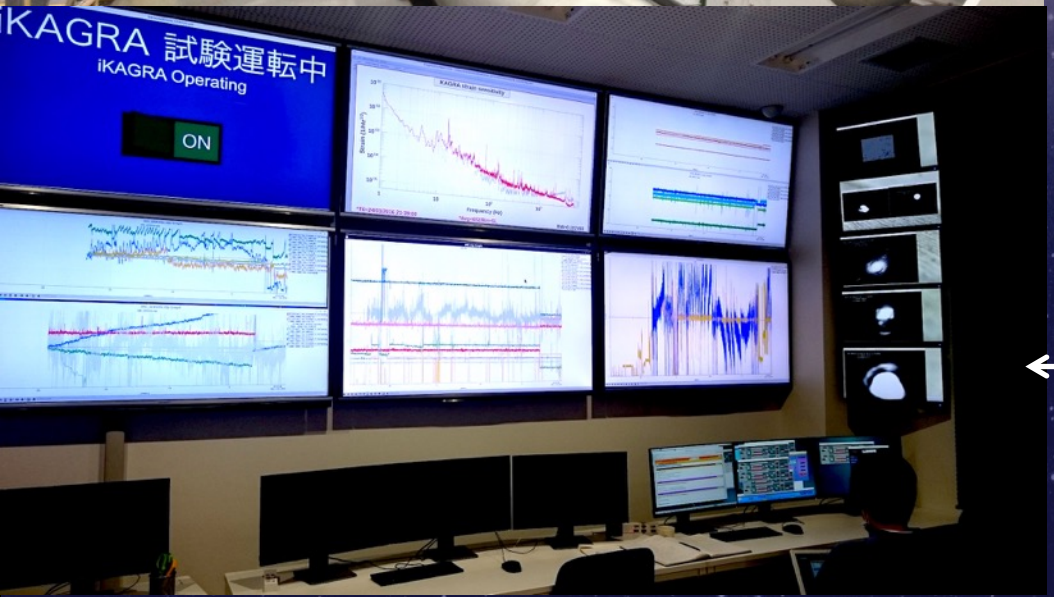
Face-to-Face meeting
at Osaka City Univ.
May 2018 ⇨

Design and on site pictures



KAGRA pictures



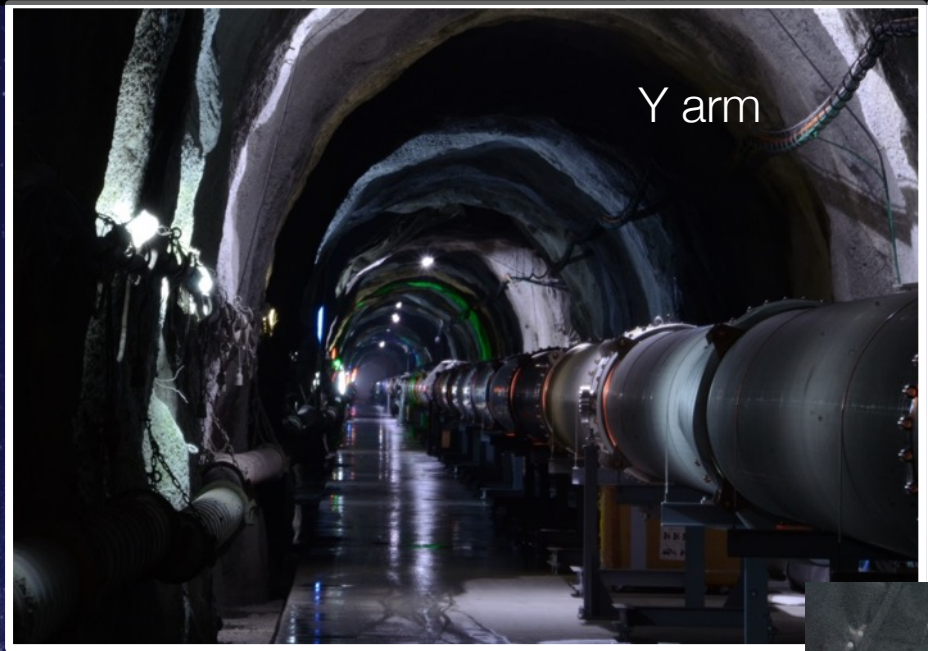


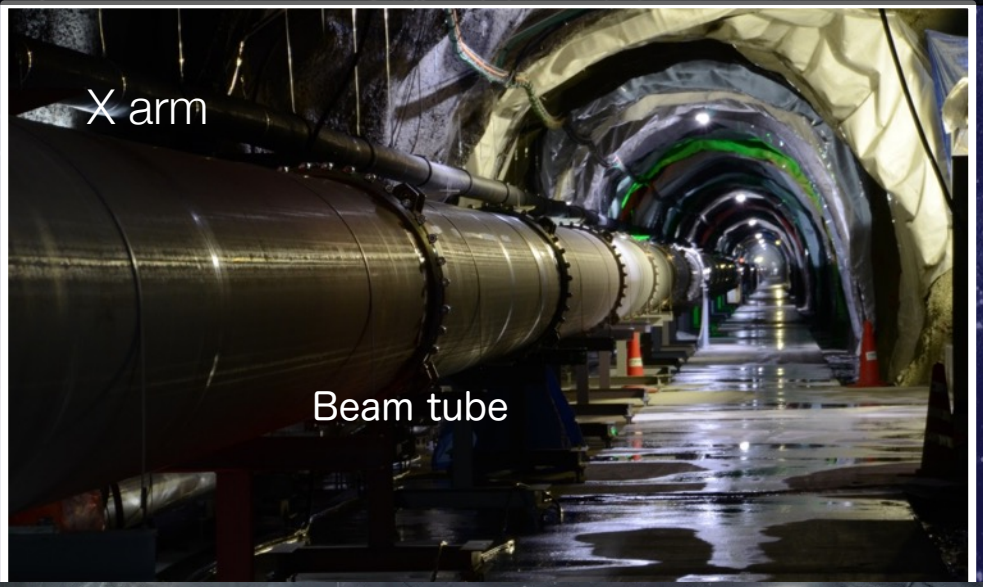
Vacuum chambers

Entrance of KAGRA

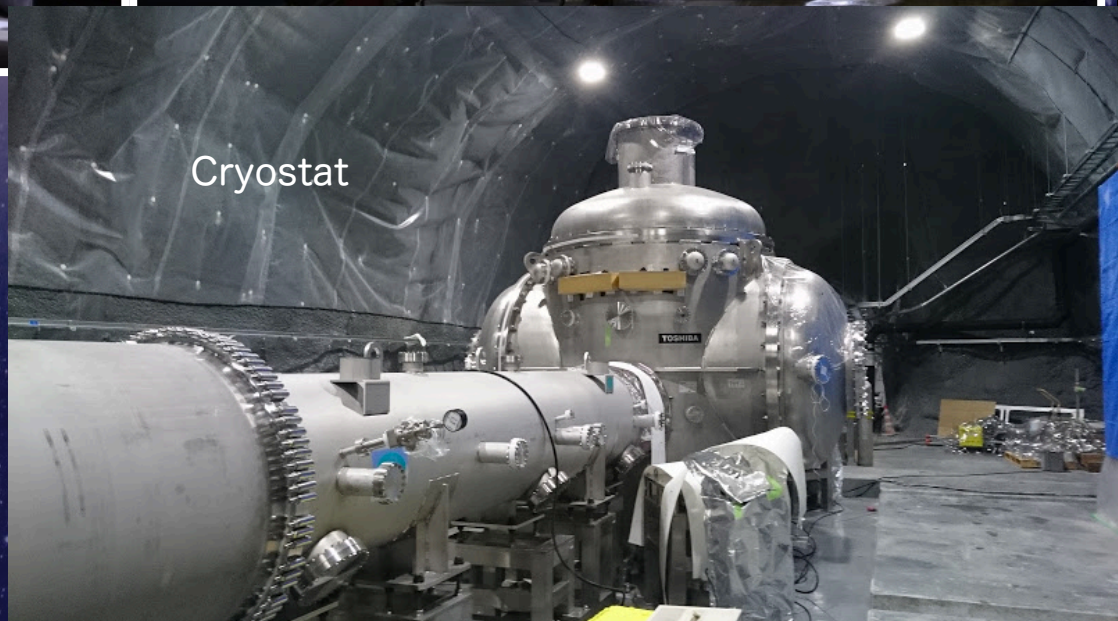
Remote control room

KAGRA pictures



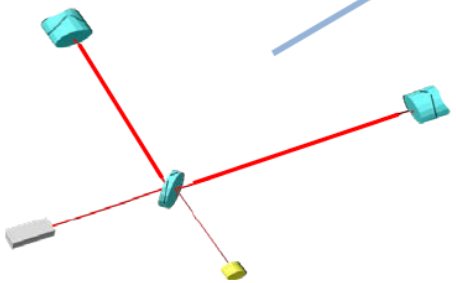


Sapphire mirror



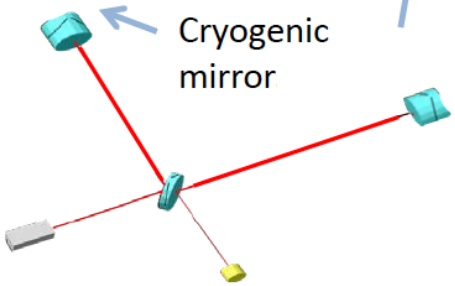
Overall plan

Calendar year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Project start											
Tunnel excavation											
iKAGRA											
operation											
bKAGRA			Adv. vibration isolation, optics, ...								
								Cryogenic system			
operation											

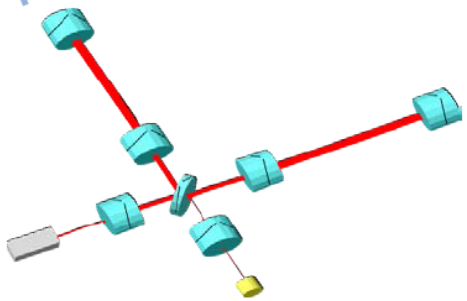


iKAGRA

Michelson at
room temperature.



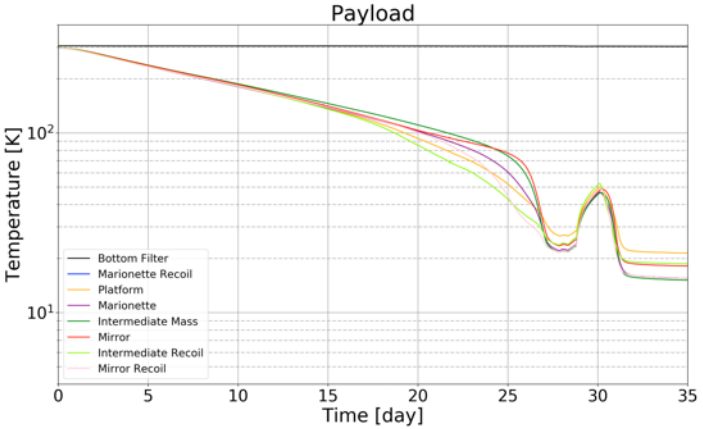
bKAGRA

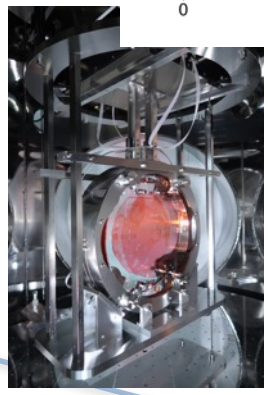


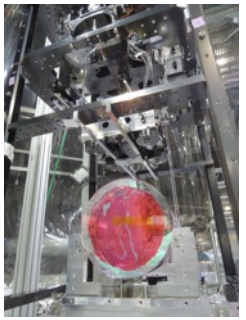
(*) The configuration in 2019 is still to be decided referring the milestones.

iKAGRAからの進展

- 2つのエンドの鏡が低温で制御される。
- 防振装置の大幅なアップグレード
  ー5つのKAGRA仕様の防振装置を導入

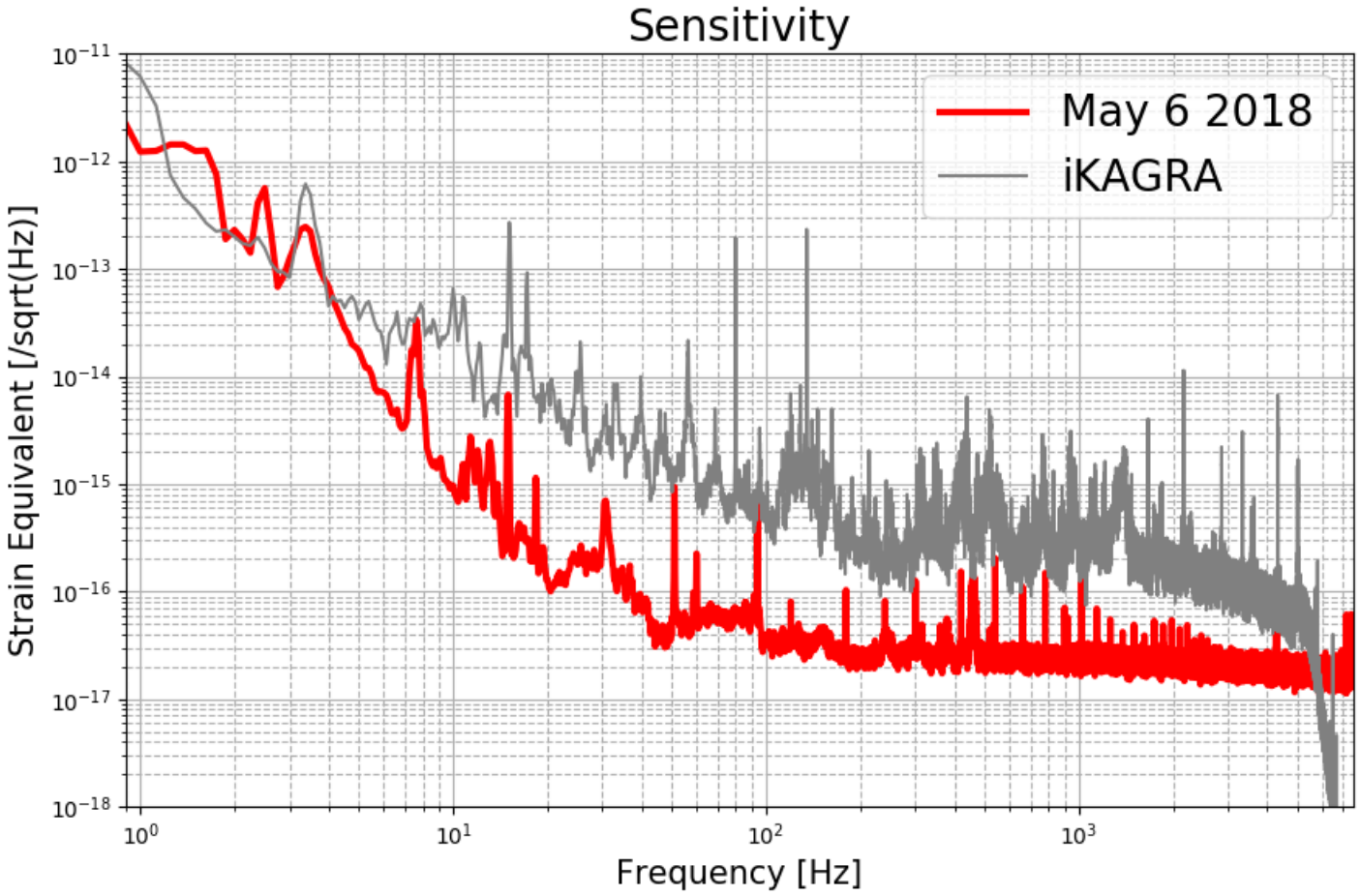






- iKAGRA時代
  ーたった1つだけのKAGRA仕様の防振装置
  ー他の鏡は固定してあるか
  ーTAMA/CLIO時代の防振装置を再利用

Noise spectrum



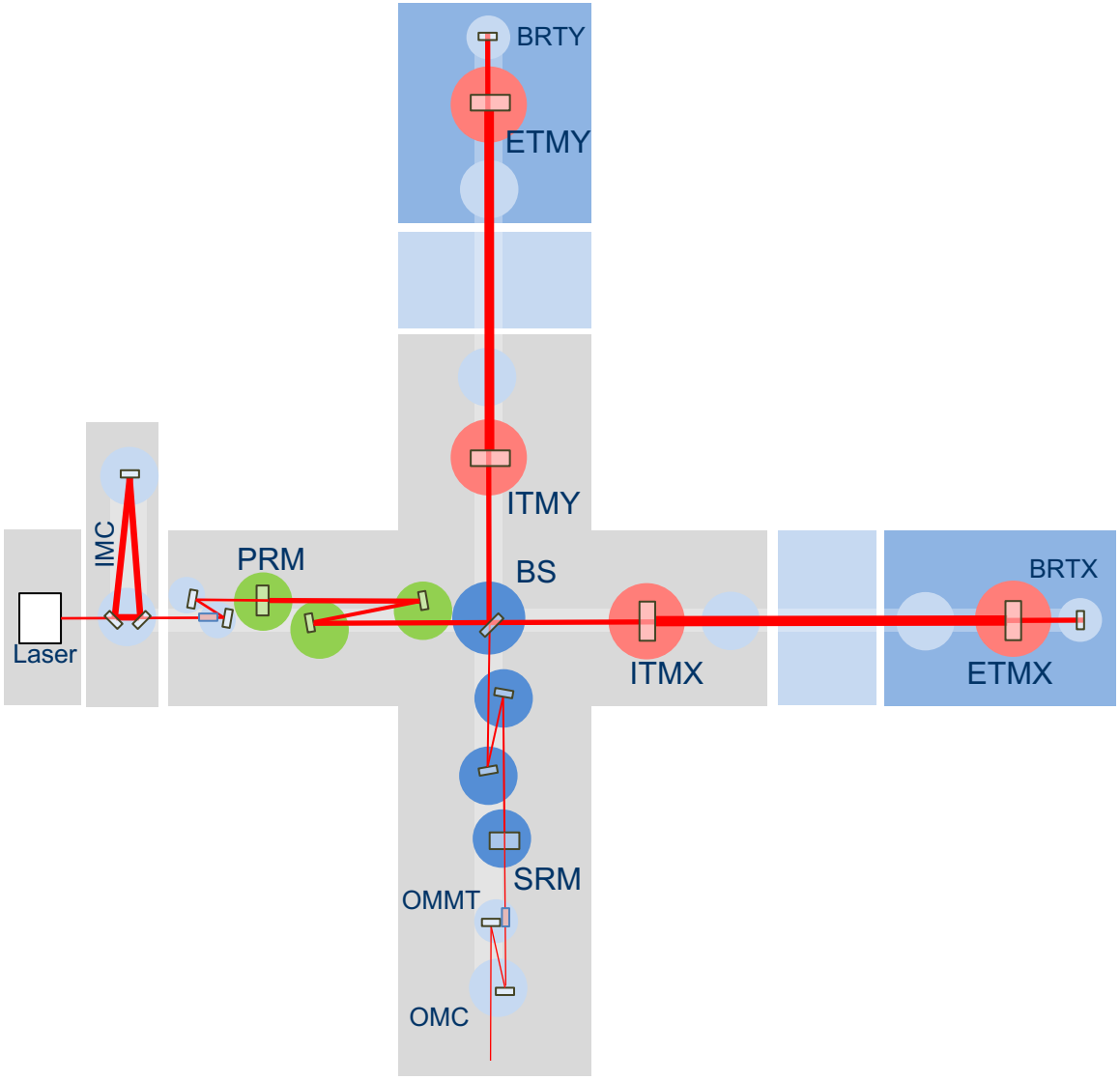
- iKAGRAでの感度に比べて、今回ほぼ全周波数に渡って、1~1.5桁感度が向上した。
- 理由は主に、鏡を含むすべての機器が真空中に設置されたことにより、音響雑音が減ったからである。

bKAGRA phase1 operation schedule

	4/28	4/29	4/30	5/1	5/2	5/3	5/4	5/5	5/6	5/7
Day (9:00-17:00)	OLG measurements	Type-A Yend TRF	BS TRF	Type-A Xend TRF	Noise injection Center	Noise injection YEND	Schnupp Assymmetry & IFO noise budget	Noise injection XEND	CRY Extra EXP. 1 & 2	Phase 2
Night (17:00-9:00)	OLG measurements	Type-A Yend TRF	CW injection	Type-A Xend TRF	CBC injection	CBC injection	Schnupp Assymmetry & IFO noise budget	OLG measurements	CRY Extra EXP. 1 & 2	
Parallel	Data transfer, Pipeline tests, GIF									

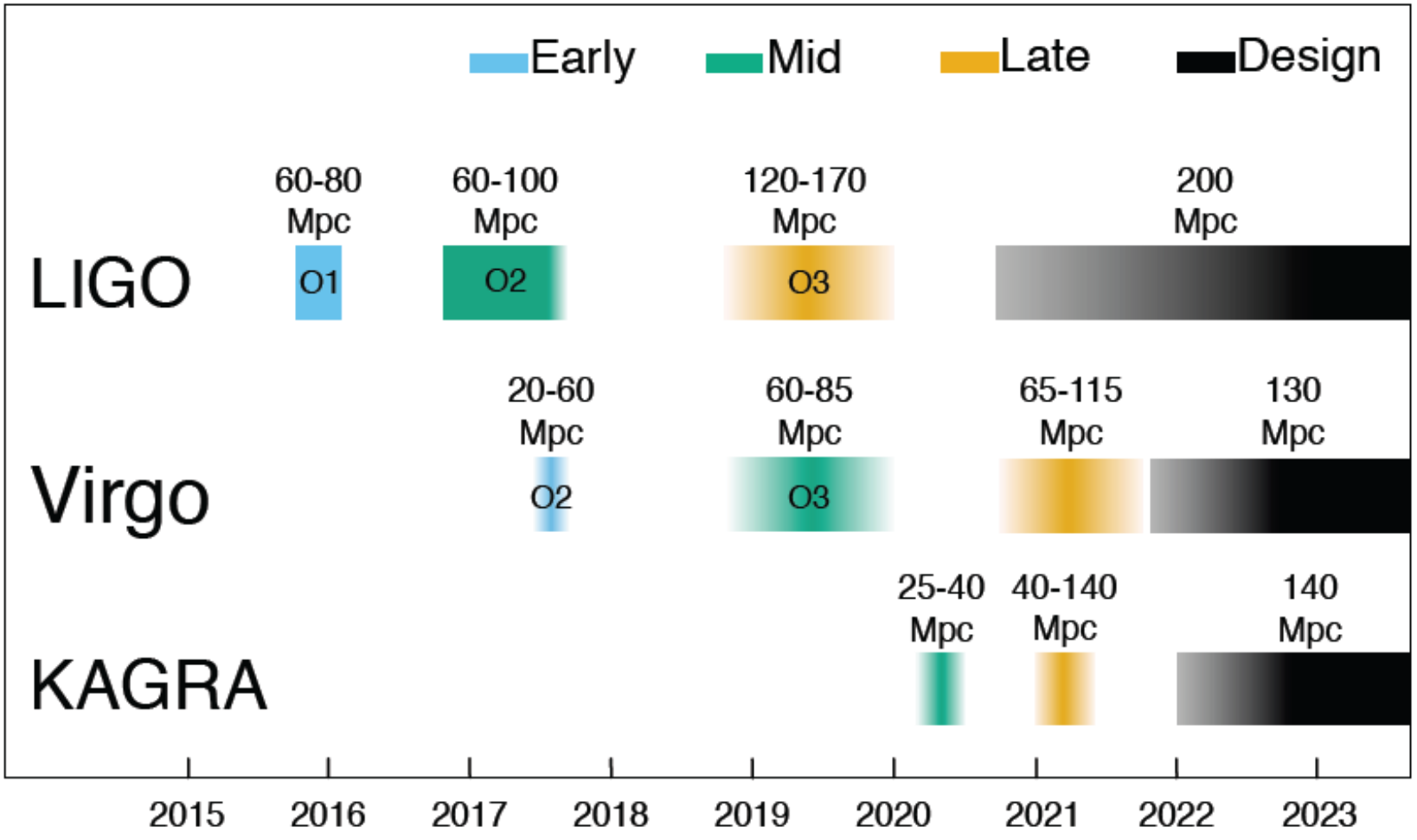
- もともと4/23(月)開始予定だった。
- 実際には真空リークにより5日遅れの4/28(土)となった。
- 干渉計としてはこの遅れに助けられた。今回最初のロック(動作開始)が4/20で、数十秒続いたのみ。
- その後、調整の時間を稼ぐことができ、連続10時間程度のロックまで持ち込むことができた、

bKAGRA: Full configuration



Observation Scenario at 2017

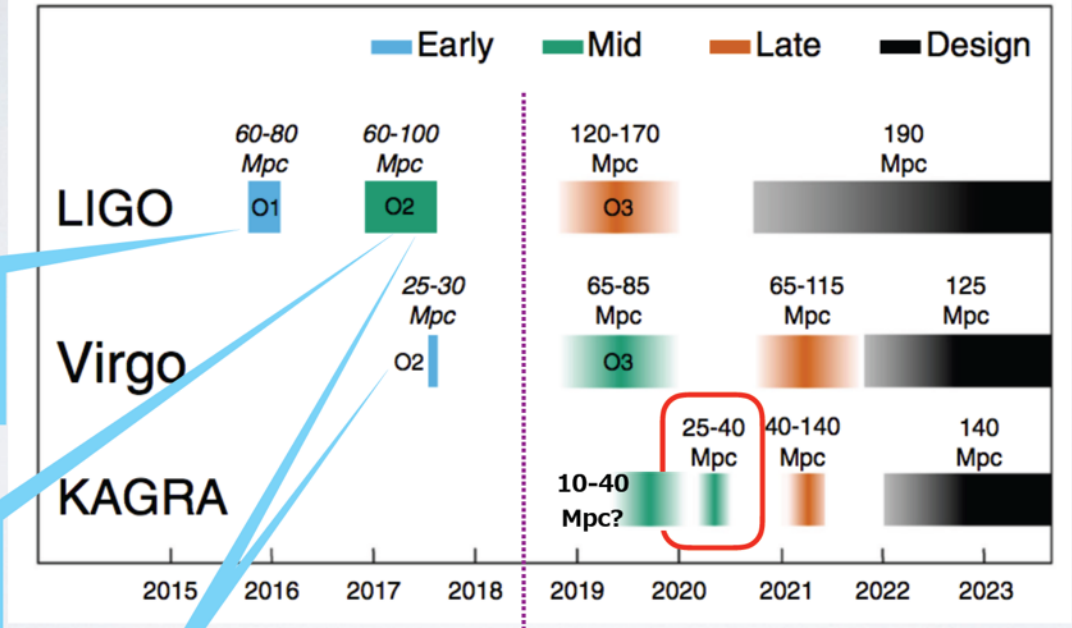
I showed this slide the last year.



Observation Scenario in 2018

"Scenario Paper"

Living Rev Relativ (2018) 21:3
https://doi.org/10.1007/s41114-018-0012-9

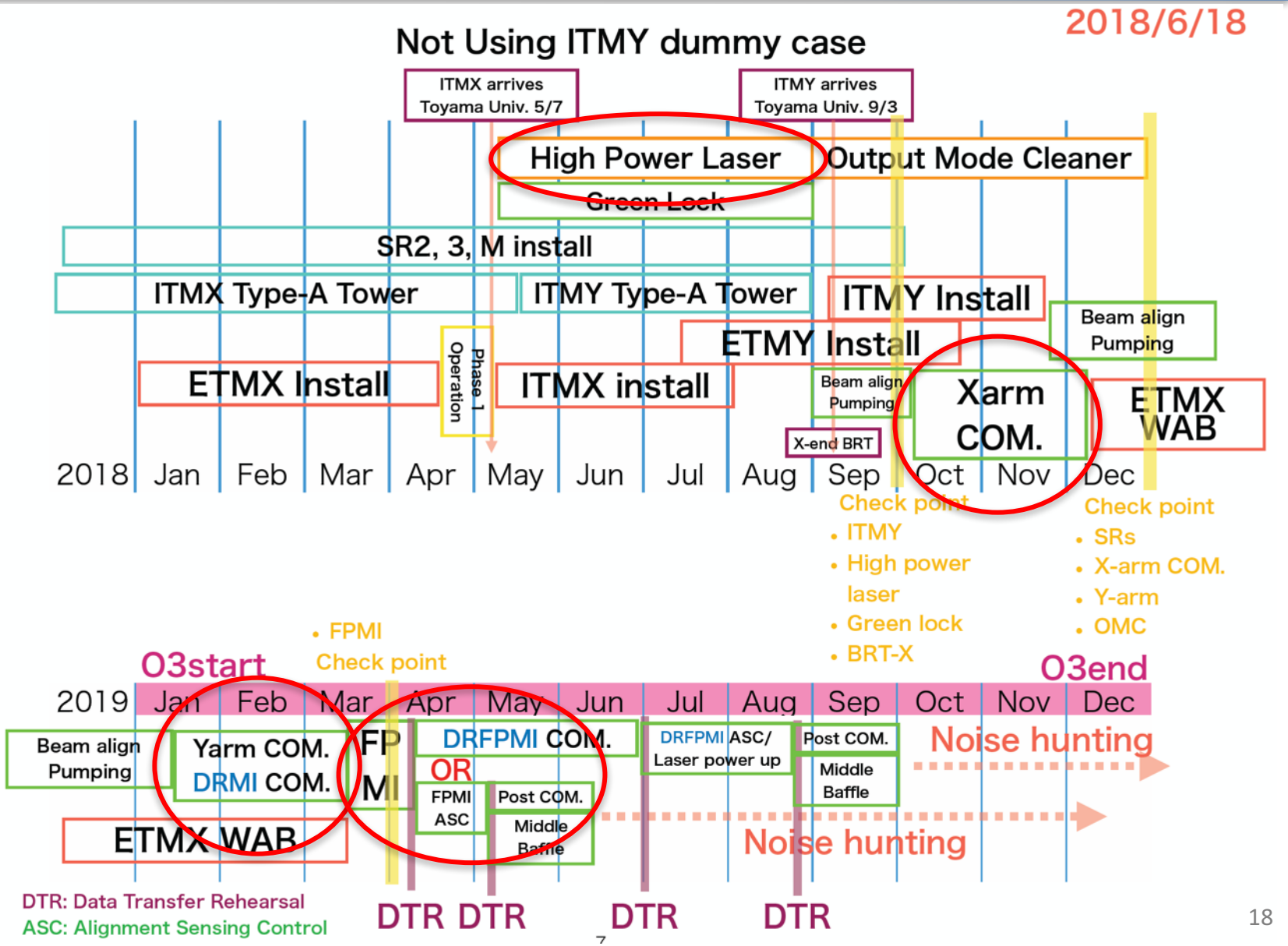


GW150914 BHBH@440Mpc
GW151226 BHBH@440Mpc
GW170104 BHBH@880Mpc
GW170608 BHBH@340Mpc
GW170814 BHBH@540Mpc
GW170817 NSNS@40Mpc

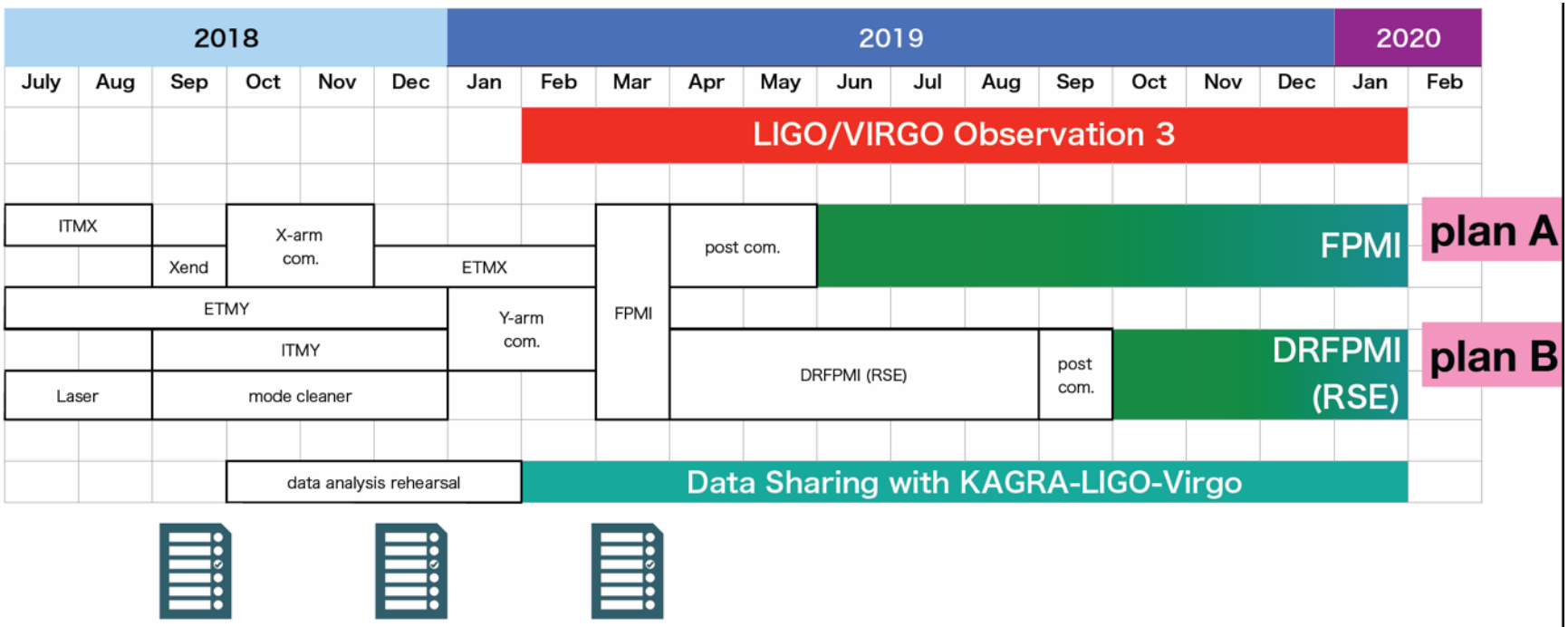
today

"We try to catch up with O3"

Schedule

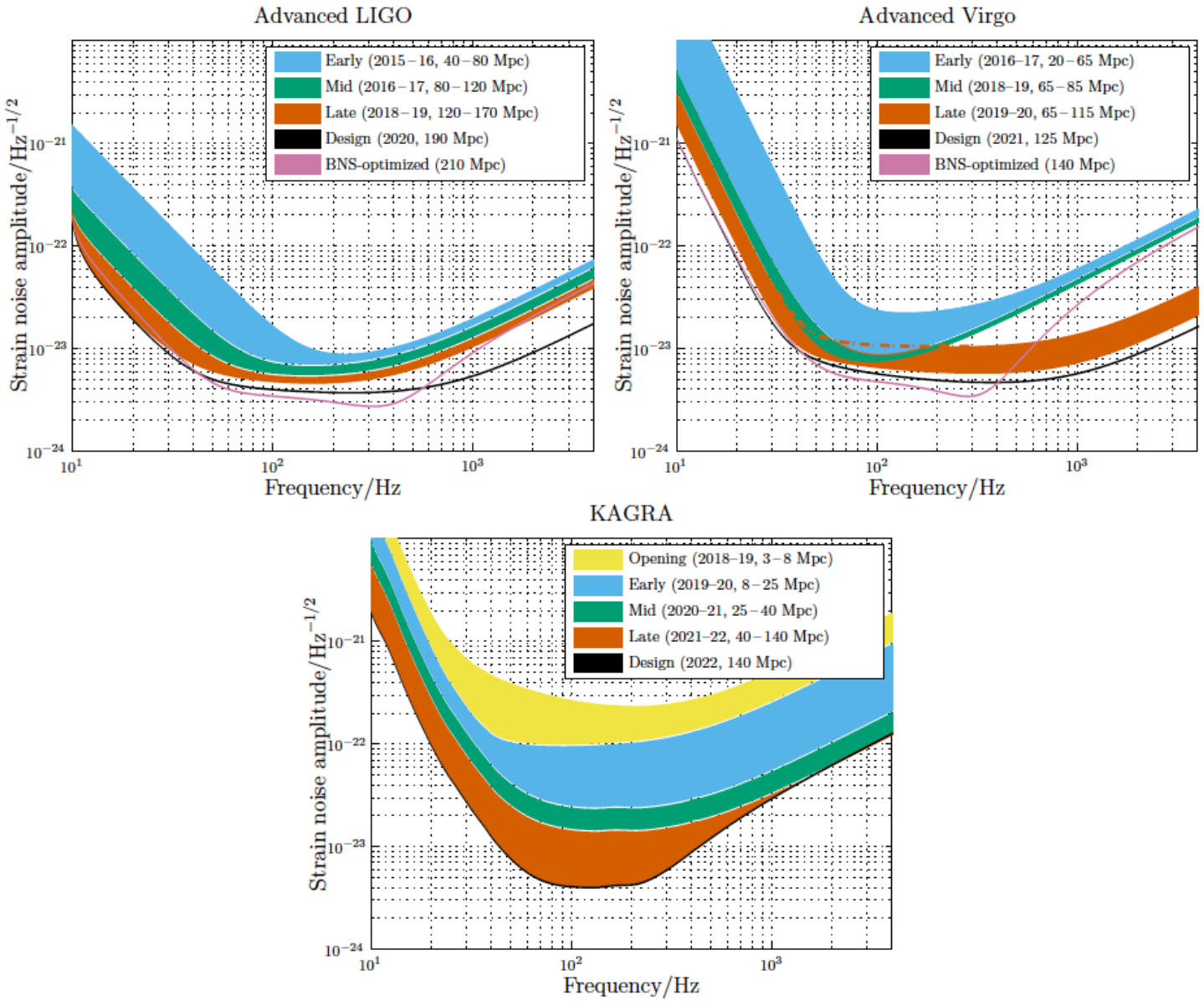

2018/6/18
Not Using ITMY dummy case
ITMX arrives Toyama Univ. 5/7
ITMY arrives Toyama Univ. 9/3
High Power Laser
Output Mode Cleaner
Green Lock
SR2, 3, M install
ITMX Type-A Tower
ITMY Type-A Tower
ITMY Install
ETMY Install
Beam align Pumping
ETMX Install
Phase 1 Operation
ITMX install
Beam align Pumping
Xarm COM.
ETMX WAB
X-end BRT
2018 Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Check point
• ITMY
• High power laser
• Green lock
• BRT-X
Check point
• SRs
• X-arm COM.
• Y-arm
• OMC
• FPMI Check point
O3start
O3end
2019 Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Beam align Pumping
Yarm COM.
DRMI COM.
FPMI
DRFPMI COM.
OR
FPMI ASC
Post COM.
Middle Baffle
DRFPMI ASC/ Laser power up
Post COM.
Middle Baffle
Noise hunting
ETMX WAB
Noise hunting
DTR: Data Transfer Rehearsal
ASC: Alignment Sensing Control
DTR DTR
DTR
DTR

Joining LIGO/VIRGO O3 run



— either DRFPMI(RSE) (30-40Mpc, Oct?) or FPMI (10-20Mpc, June?)
checking points: Sep/2018, Dec/2018 and Mar/2019

Expected sensitivities



Expected area improvements at very first stage of full KAGRA

LALInference Nested Sampling

By Narikawa, Morisaki

Source:
BNS (1.5, 1.25) Msolar at 40Mpc
Inclination = 30 deg

BNS range of detectors:
LIGO: 120Mpc
Virgo: 60Mpc
KAGRA: 10Mpc

Injected SNR 20.5 (H), 13.1 (L), 10.7 (V), 3.6 (K)

Detectors	HL	HLV	HLVK
90% $\Delta\Omega$ [deg^2]	120	21.9	12.4

Injected SNR 18.5 (H), 17.1 (L), 8.7 (V), 3.7 (K)

Detectors	HL	HLV	HLVK
90% $\Delta\Omega$ [deg^2]	115	20.6	11.7

Injected SNR 19.8 (H), 26.8 (L), 2.6 (V), 3.4 (K)

Detectors	HL	HLV	HLVK
90% $\Delta\Omega$ [deg^2]	91.7	25.5	22.2

Summary

- 低温鏡の稼働を含む、bKAGRA phase 1と呼ばれる段階が完了した。
- 次期phase2段階を今後1年程度で終え、その後LIGO/VIROGのO3 runにKAGRAも参加することを決定した。
- 干渉計設定は進捗具合により決定される;
  - シンプルなFPMI: 低感度~10Mpc, 早い観測開始
  - 複雑なRSE, 高感度~20Mpc, 遅れての観測開始
- 初期段階の感度で、O3中の重力波検出に貢献したい。