

GWADW2025 Report



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Overview



GWADW 2025

May 18 - 23 ★ Cocoa Beach, Florida

- May 18-23, 2025
- Hilton Cocoa Beach Oceanview, Florida, USA
- No parallel sessions, one poster session
- Workshop lunch everyday, one dinner, one excursion (not attended)

- [Program and abstract available online](#)

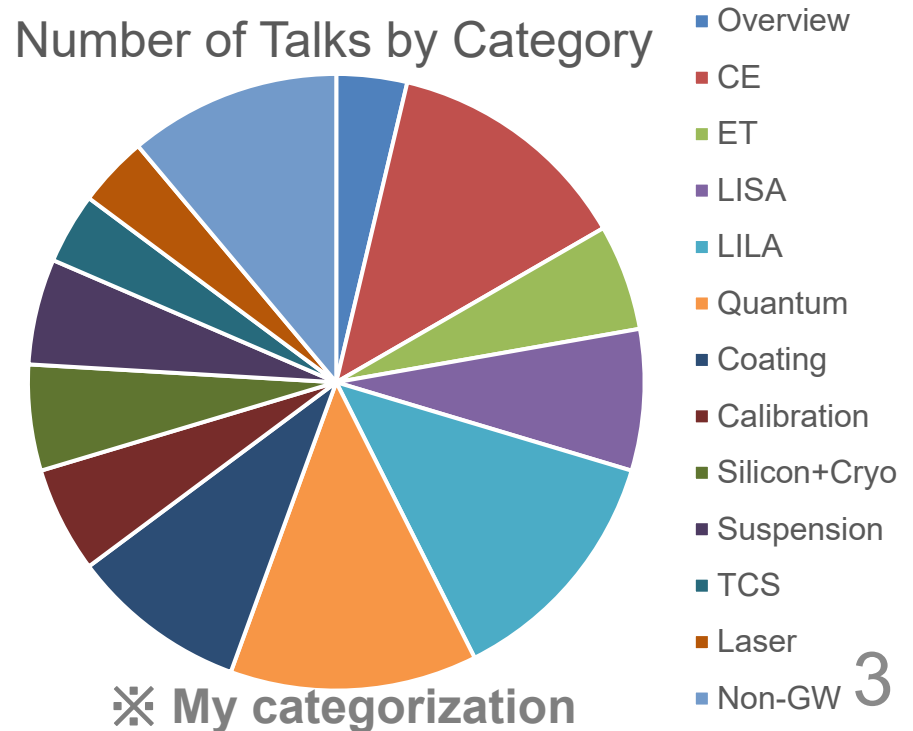
My personal GWADW history

2010	Kyoto ○	2020	-
2011	Elba	2021	Online
2012	Hawaii ○	2022	Online
2013	Elba	2023	Elba
2014	Takayama ○	2024	Hamilton Island
2015	Alaska ◎	2025	Florida ◎
2016	Elba ◎	2026	Elba
2017	Hamilton Island ◎		
2018	Alaska ◎		
2019	Elba		

○: attended
◎: presented

Overall Impression

- Great to talk with people during breakfast, lunch, dinner, and breaks
- More like how to realize CE kind of workshop, rather than Advanced Detector Workshop
 - which is also exciting that CE is getting more and more realistic
- No cryogenic session



KAGRA Participants

- Kazuhiro, Kentaro, Satoshi, Yuta and some students attended from KAGRA
- Only one poster on KAGRA
- Sorry for being in Florida

O4 Resumed on June 11 24:00 UTC !!!

gwistat

Gravitational Wave Detector Network

Operational Snapshot as of Jun. 11, 2025 20:50:53 UTC

Detector	Status	Duration [hh:mm]	Latency [s]
GEO600	Observing	04:13	34
LIGO Hanford	Observing	00:00	59
LIGO Livingston	Observing	03:07	45
Virgo	Observing	01:03	52
KAGRA	Observing	03:27	41

Out-of-the-Box



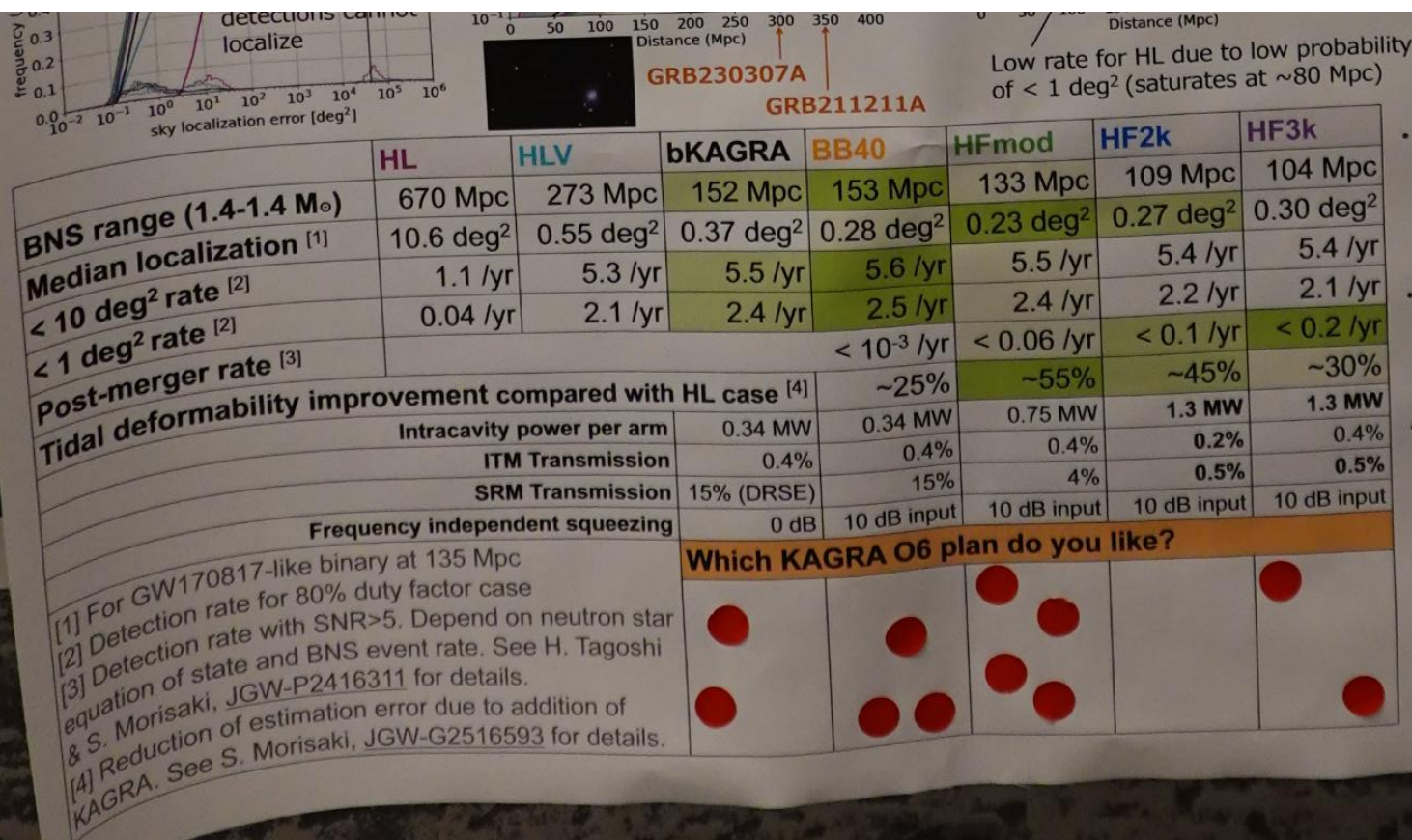
- Someone said...

過去のGWADWのout-of-the-boxセッションを見返してみたが、現在生き残っているのはほとんどない。スクイージングくらいだ。最初から上手く行かないと提案者自身がわかっているような提案も多い。時間の無駄。先行研究の調査、将来の見通し、やり切ることの3つを条件としたい。[2つ目は記憶違いかも]

- I was actually excited for the out-of-the-box session when I was a student. I knew some of them will not succeed (at least with current technology). Even if 1 out of 100 is successful, 99 is not the waste of time. (Very similar to education...)

KAGRA O6 Voting Result

- People also voted for broadband options
- YC: DRSE, JH: BB40, CC: HFmod, JG: HF3k



Yanbei Chen: Science Review

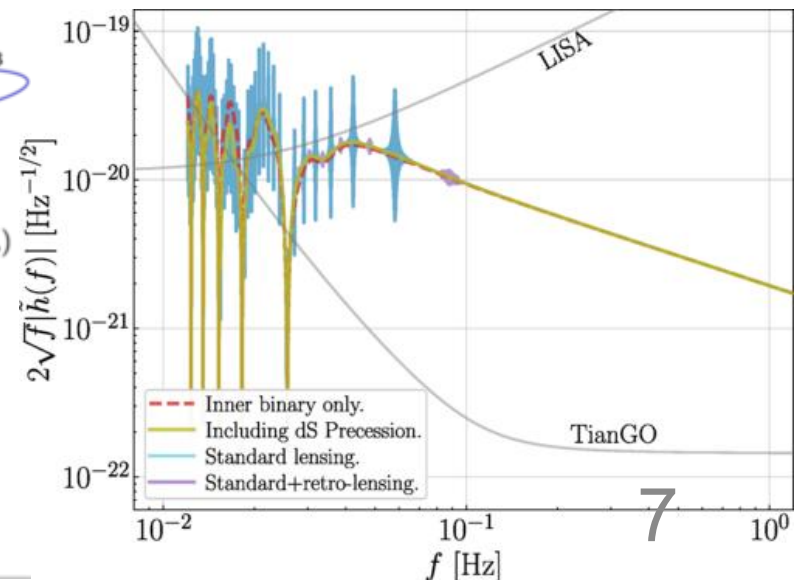
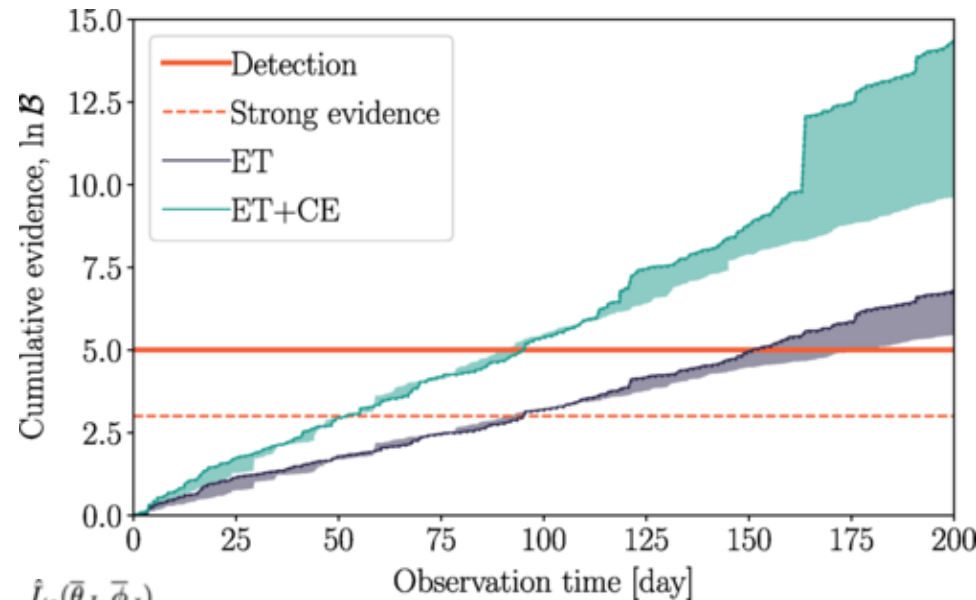
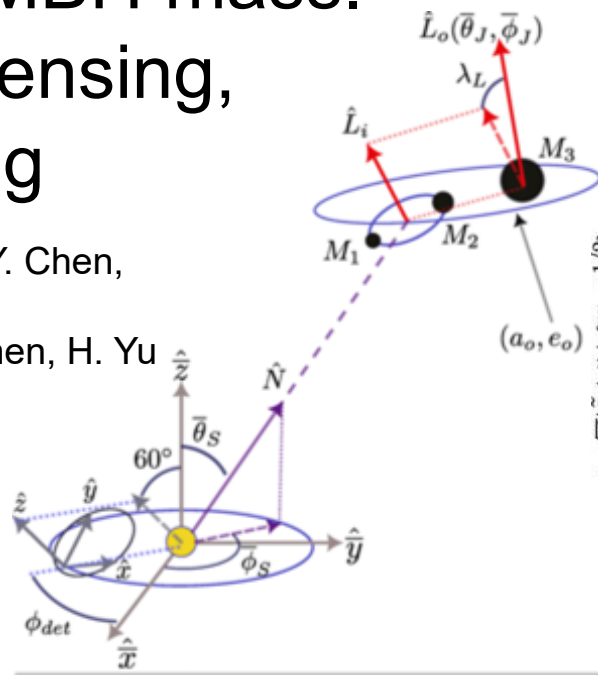
- ET and CE may detect both **displacement** and **spin** memory

B. Goncharov, L. Donnay, J. Harms,
[PRL 132, 241401 \(2024\)](#)

- SMBH + BBH system to probe SMBH mass. Repeated lensing, retro lensing

H. Yu, Y. Wang, B. Seymour, Y. Chen,
[PRD 104, 103011 \(2021\)](#)

A. Laeuger, B. Seymour, Y. Chen, H. Yu
[PRD 109, 064086 \(2024\)](#)

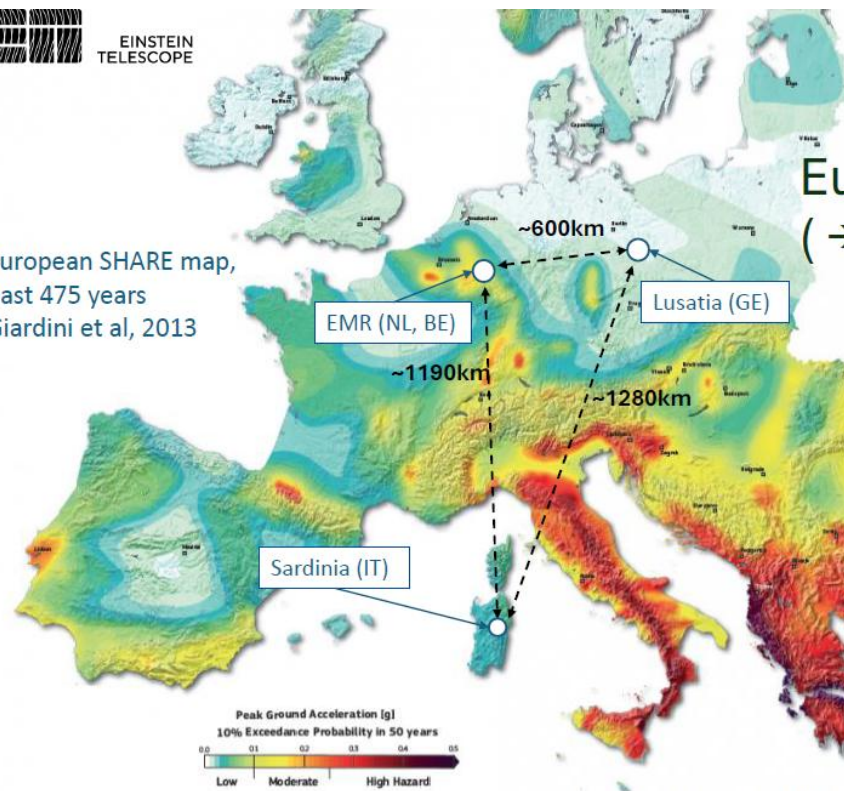


Luca Naticchioni: ET Updates

- Three promising sites: EMR(NL,BE,GE), Sardinia(Italy), **Lusatia**(GE)
- Two baselines: 10 km \triangle or 15 km 2L
- Blue Book released in March 2025



EINSTEIN
TELESCOPE

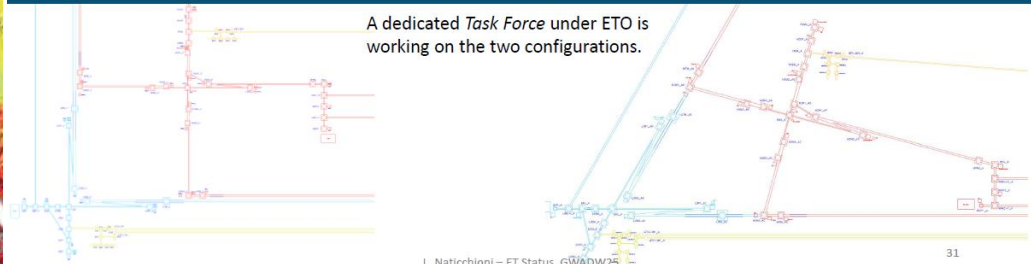


European SHARE map,
past 475 years
Giardini et al, 2013

The Science of the Einstein Telescope
[arXiv:2503.12263](https://arxiv.org/abs/2503.12263)



A dedicated *Task Force* under ETO is
working on the two configurations.



L. Naticchioni – ET Status, GWADW25

31

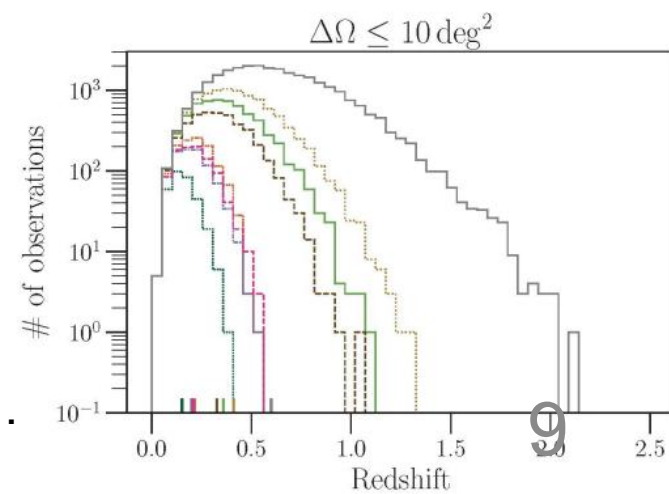
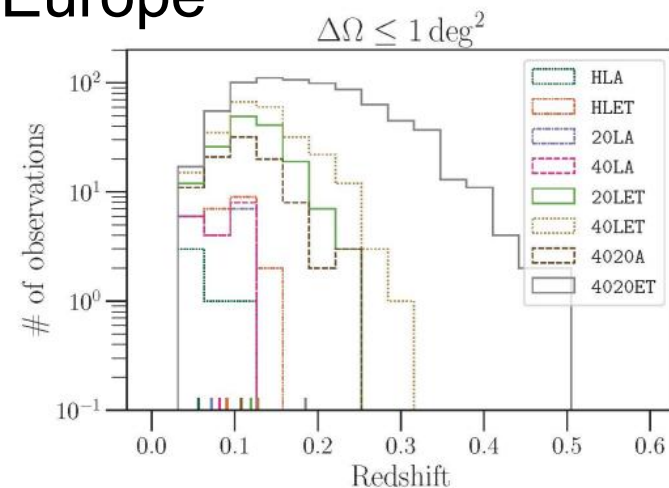
Matt Evans: CE Updates

- NSF MPSAC ngGW recommendations:
 - CE 40 km if ET in Europe
 - CE 40 km + CE 20 km if ET not in Europe
- Collaborations with ET, technology synergy with A#

Technical overlap between A# and Cosmic Explorer

	A ² R&D	CE R&D	Δ
Core Optics	Substrates (\$4.1.1)	production and polishing of fused silica optics 45 cm \varnothing , 100 kg	●
	Coatings (\$4.1.2)	amorphous coatings: materials better than A+ coatings and scaling	●
		crystalline coatings: birefringence tests and scaling	●
		crystalline coatings for future upgrades: further size scaling required	●
Vibration Control	Suspensions (\$4.2.1)	improved controllability, high stress fibers, test mass actuation, full scale prototype	●
	Active Vibration Isolation (\$4.2.2)	improved sensors and global control strategies	●
Lasers & Input	Lasers (\$4.3.1)	high power laser, beam quality	●
	Input Optics (\$4.3.2)	mitigation of laser noise couplings (intensity, frequency, beam jitter)	●
Readout & Quantum	Readout (\$4.4.1)	optimization of Balanced Homodyne	●
	Squeezing (\$4.4.2)	loss, mode mismatch and phase noise reduction, robustness	●

	A ¹ R&D	CE R&D	Δ
Sensing & Control	Length & Angle (\$4.5.1)	control noise reduction, optimal hierarchical control	●
	Mode (\$4.5.2)	improved sensors and actuators, evaluation of BS thermal lensing	●
	Parametric Instab. (\$4.5.3)	improved modeling and dampers	●
Facility & Interface	Vacuum system (\$5.2)	maintenance of existing infrastructure	●
	Newtonian Noise (\$5.1.2)	modeling and demonstration of subtraction techniques	●
	Stray Light (\$5.3)	incremental improvements, material research	●
	Environment (\$5.1.1)	incremental improvements	●
Computing & Data	Electronics (\$4.5.4)	advanced prototypes	●
	Digital I/O (\$4.6.1)	incremental improvements	●
	Calibration (\$4.6.2)	incremental improvements	●
	Data Analysis, Transfer and Storage (\$4.6.3)	integrated architecture for low-latency analysis of ~ 1000 daily events	●



Number of BNS events per year localized within...

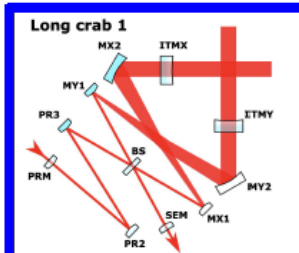
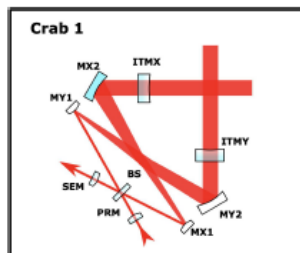
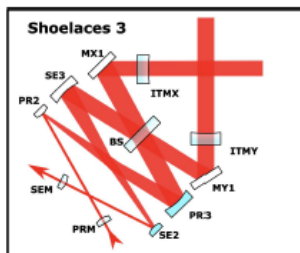
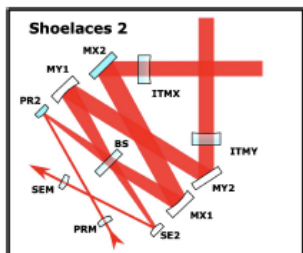
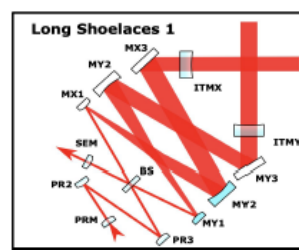
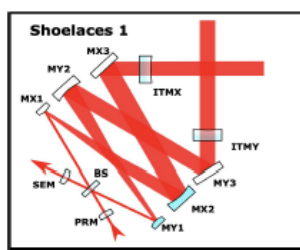
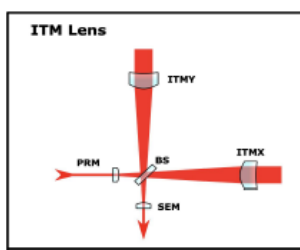
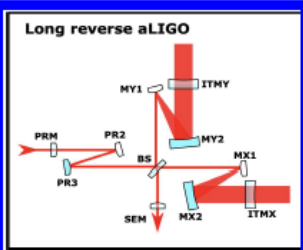
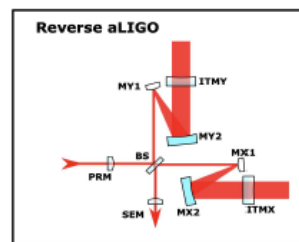
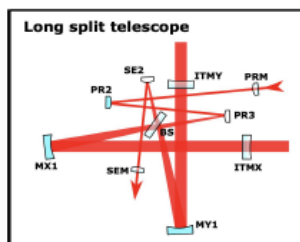
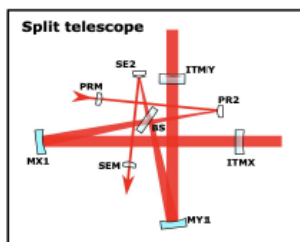
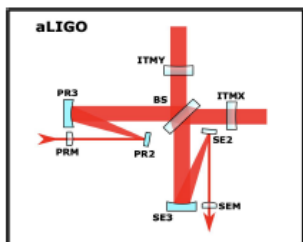
A. Corsi+, [arXiv:2402.13445](https://arxiv.org/abs/2402.13445)

CE Corner Design

- I liked “Shoelaces 1” (flat 45 deg mirror) but down selected (to reduce suspensions)

Slide from Sagar Kumar Gupta

Design Down-selection



More details on optical design process and down selection in Dr. Paul Fulda's and Matthew Todd's posters. Please have a look!

Craig Cahillane: CE Input Optics

- I thought double-pass configuration can be used to simplify the layout

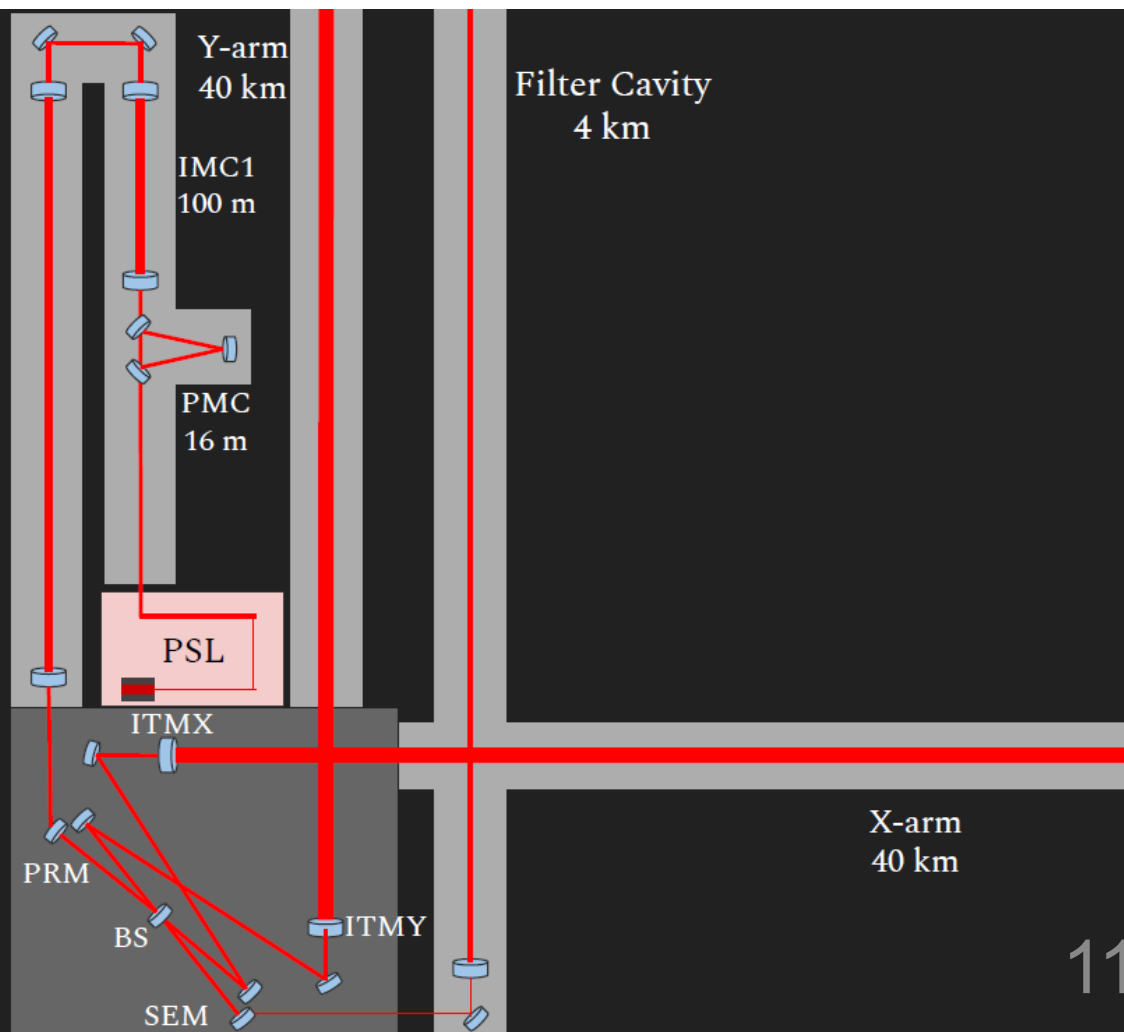
IO Layout

Solution:

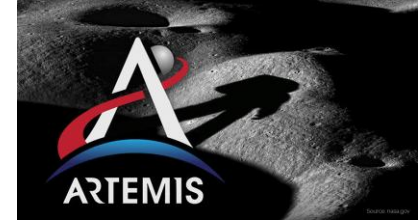
Three mode cleaners

- 1) Pre-mode cleaner
16 m
- 2) Input mode cleaner 1
100 m
- 3) Input mode cleaner 2
330 m

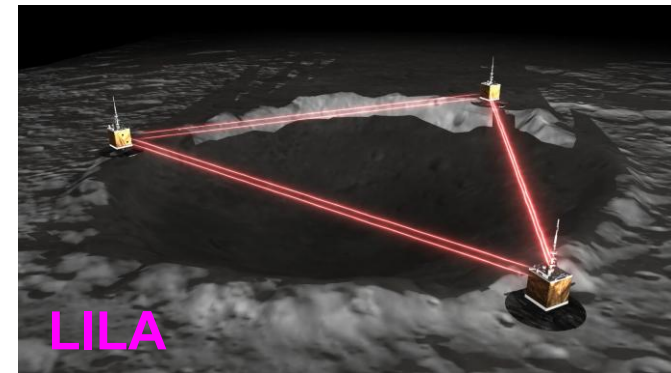
LVEA



Lunar Detectors



- Whole Friday morning dedicated to Lunar detectors (7 talks), but, actually, all talks are from **LILA** (Laser Interferometer Lunar Antenna) team

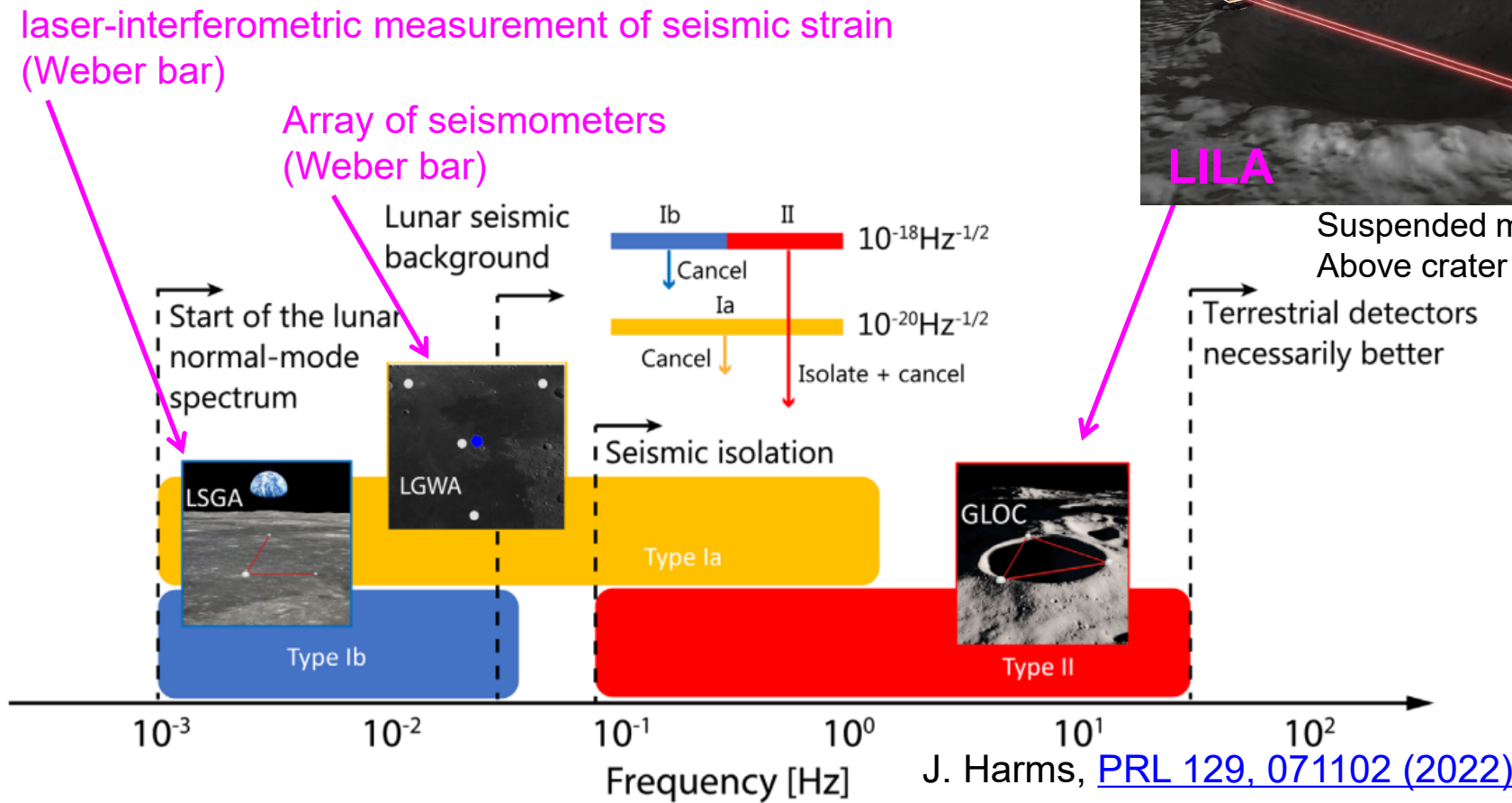


LILA

Suspended mirrors
Above crater to avoid dust

Terrestrial detectors
necessarily better

But large
temperature
change



Bram Slagmolen & Jiri Smettana

- Combined talk on TorPeDO and Birmingham torsion balance (6D seismometer)
- Tsunami, Dark matter, Semiclassical gravity ...
- Test of pre-selection SN?

T. Yan+, [arXiv:2411.17817](https://arxiv.org/abs/2411.17817)

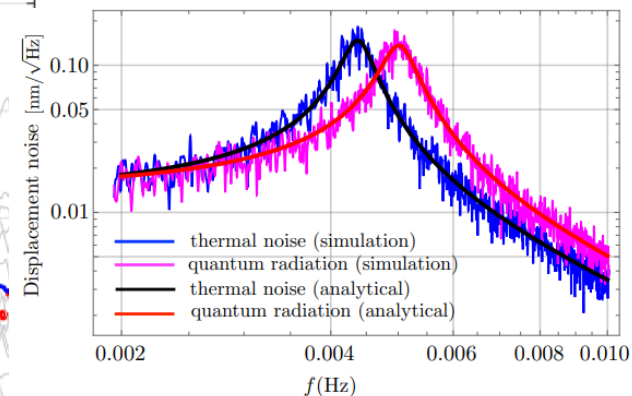
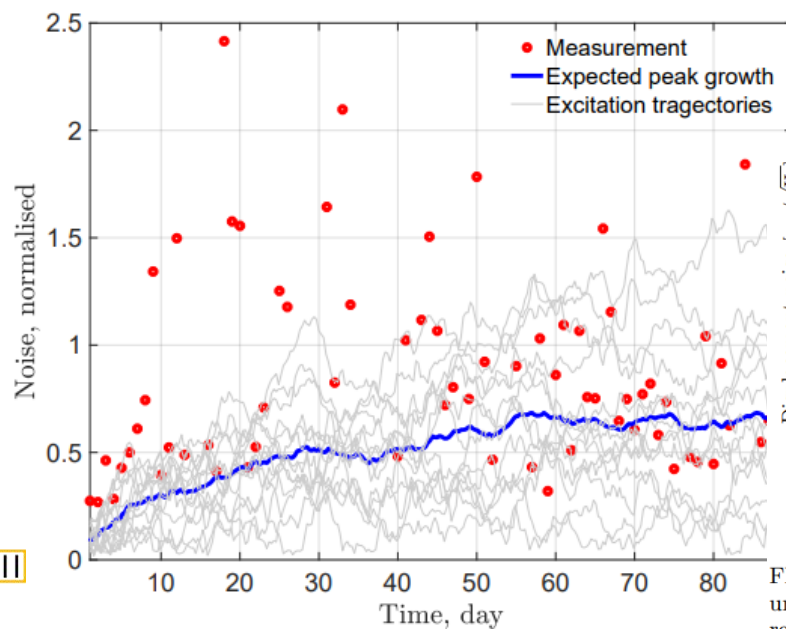
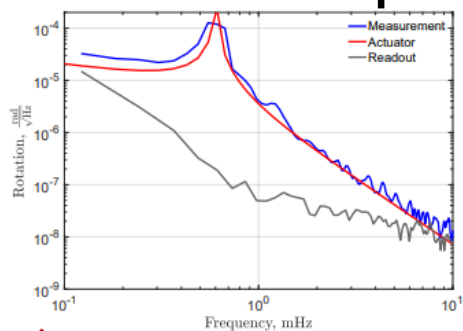
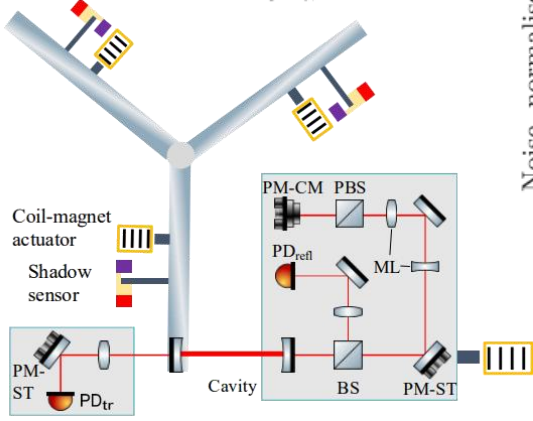


FIG. 4. Simulated noise spectrum in the quadratic regime under the pre-selection prescription. The black and blue lines represent the thermal noise spectrum obtained from analyt



Classical Gravity Models

Slide from
Midterm seminar 2025

- D. Miki, Y. Kaku, Y. Liu, Y. Ma, Y. Chen, [arXiv:2503.11882](https://arxiv.org/abs/2503.11882)

Class	Model	Auxiliary Observers Introduced?	Auxiliary Outcomes used to Generate ϕ ?	Experimental Measurement Outcomes used to Generate ϕ ?	Features
Collapse Models	Diosi-Penrose [19, 20]	Measure g everywhere	No	No	Gravity not implemented
	CSL [21, 22]	Measure Smeared Matter Distribution	No	No	
Schrödinger-Newton	Pre-Selection [3, 6] S-N	No	No	No	Violates Page-Geilker
	Post-Selection S-N [6]	No	No	Yes	Future measurement choices influence past.
	Causal-Conditional S-N [7, 8, 10, 11]	No	No	Obtain conditional expectation of positions then generate gravity via classical feedback	Preserves causality
Classical Gravity with Auxiliary Observers	N-H extension of S-N [23]	Measure g everywhere	Yes	No	Classical gravity via Diosi-Penrose
	KTM Model [13, 14]	Measure position of each mass	Uses instant	No	More general and includes NH and KTM
	Oppenheimer Model [24]	Measure position of each mass	No	No	More general and includes NH and KTM
	Unified model	Measure position of each mass	Yes	Yes	Can incorporate all above models

For some reason collapses

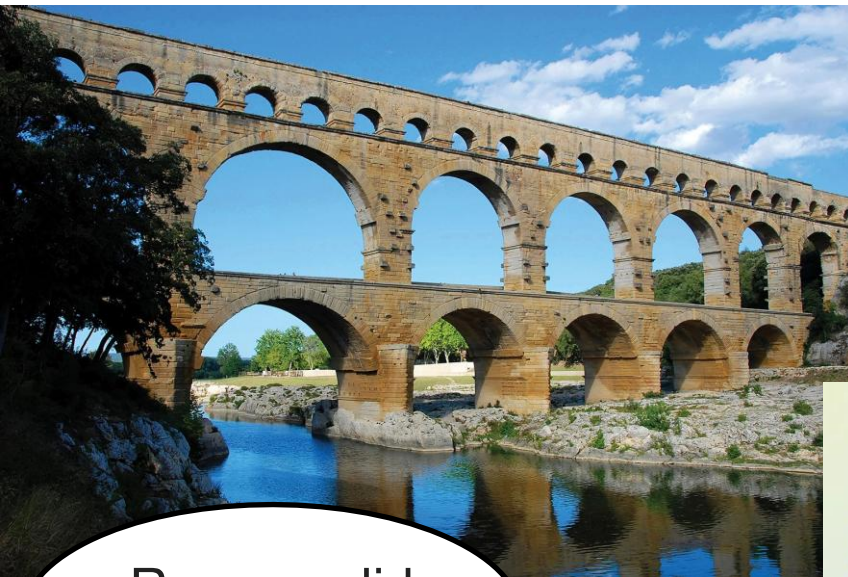
Gravity generated at expectation value

Some argue that, to apply position dependent gravity, strong measurement is necessary, and this backaction prevents creating gravity induced entanglement. [YC]

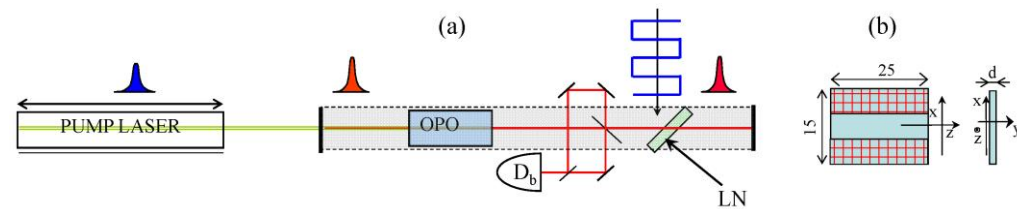
Auxiliary observers measure wave function and generate gravity

Stephen Eikenberry: GravComb

- GravComb: Tabletop deci-Hz Frequency Comb Gravitational Wave Detector
- Measure position of levitated mirrors (~ 2 m apart) from a rigid frame with frequency combs
- Newtonian noise is small due to ~ 2 m (!) *Sensors* **2023**, 23(1), 301



Romans did know siphons



When are you going to do displacement noise calculations?



Other Talks

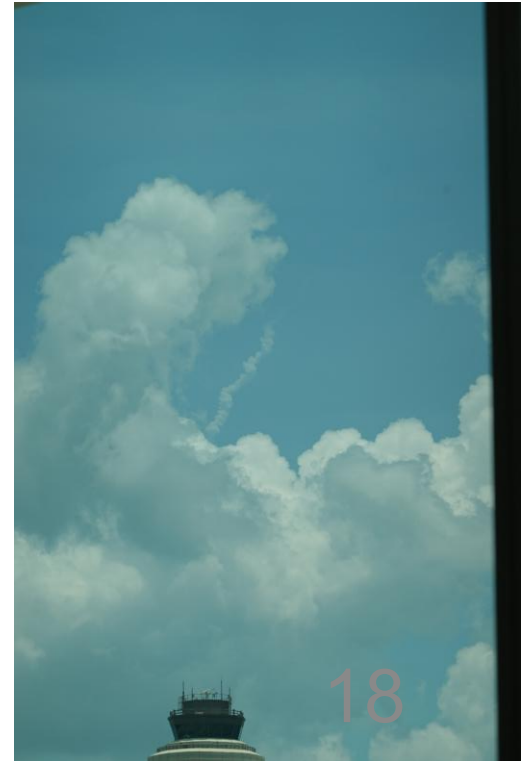
- **Stefan Ballmer:** Status of Coatings Development for GW Detectors
 - 20 cm dia. AlGaAs now possible
 - AlGaAs^N for zero birefringence
- **Zeb Van Ranst:** All-polarisation beamsplitters for speedmeter applications
 - Also relevant to DANCE
- **James Gardner:** Bayesian waveform estimation at the fundamental quantum limit
 - Limit of Bayesian vs Fisher quantum frequency estimation
- **Jacques Ding:** Two filter cavities vs coupled filter cavity for Frequency Dependent Squeezing
 - Sounds challenging to reduce losses from coupling mirror (<~ppm)

Other Talks

- **Andrea Moscatello:** Stray light noise from dust in ground-based GW Interferometers
 - 10 particles/sec detaching enough to limit ET sensitivity?
- **Flavio Travasso:** Current leading technologies in crystalline test mass suspensions
 - a lot of progress also on Sapphire suspensions (diffusion welding, laser welding)
- **Juliane von Wrangel:** Micrometer Precision for Hydroxide Catalysis Bonding and Laser Welding the 100g Mirrors for the AEI 10m Prototype Suspensions
 - composite fibers to mitigate cracks
- **Harold Hollis:** The Heterodyne Detection System for the ALPS II Experiment
 - x30 better than ALPS limit from ALPS II initial run

Panel Discussions

- Quantum sensing and squeezing
 - Call for questions from participants, and questions were chosen by roulette
 - Can we do better than going larger and heavier?
I felt like this kind of question is suppressed.
 - Discouraging comments on AMO applications to GW detectors
(GW detector is big and continuous, but AMO is small and almost pulsed)



Panel Discussions Led by Reitze

- Science flowdown driven detector design - are we there yet?
L. Barsotti, Yanbei Chen, Kate Dooley, and Rob Ward
- The long and winding road to improving test mass mirror coatings for ground-based detectors
Stefan Ballmer, Volker Quetschke, and Manel Molina-Ruiz
- What technologies are we not using that we could be using for ground-based* and space-based detectors?
John Conklin, Vicky Xu, and Steve Eikenberry
- Outstanding challenges in developing cryogenic detectors and how to overcome them
Luca Naticchioni, David Tanner, Michele Valentini, and slides from Kazuhiro Yamamoto

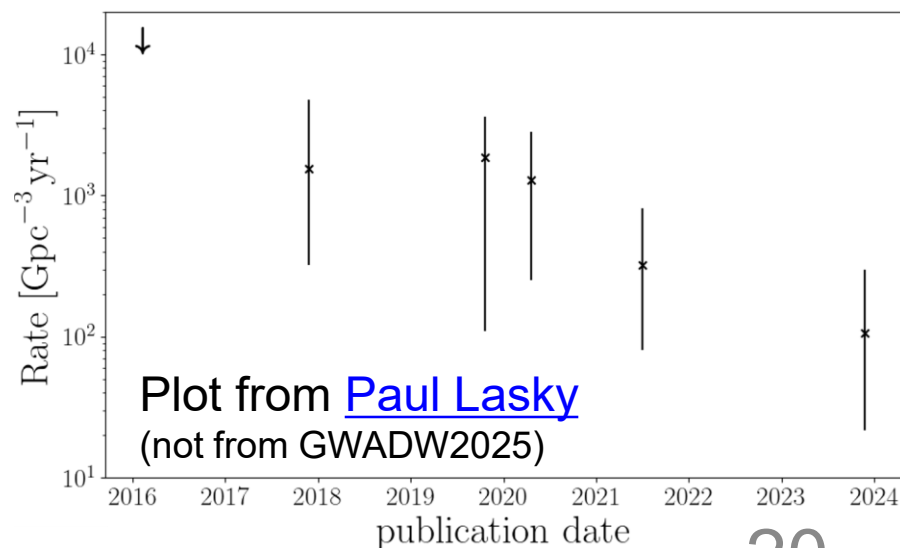
Science Panel Discussions

- Science Traceability Matrix like NASA
- NEMO experience
- Dark matter etc. discussions
- I (tried to) comment that designing GW detectors to have more sensitivity to dark matter has little point (GW is more important than DM for GW detectors)

SCIENCE TRACEABILITY MATRIX

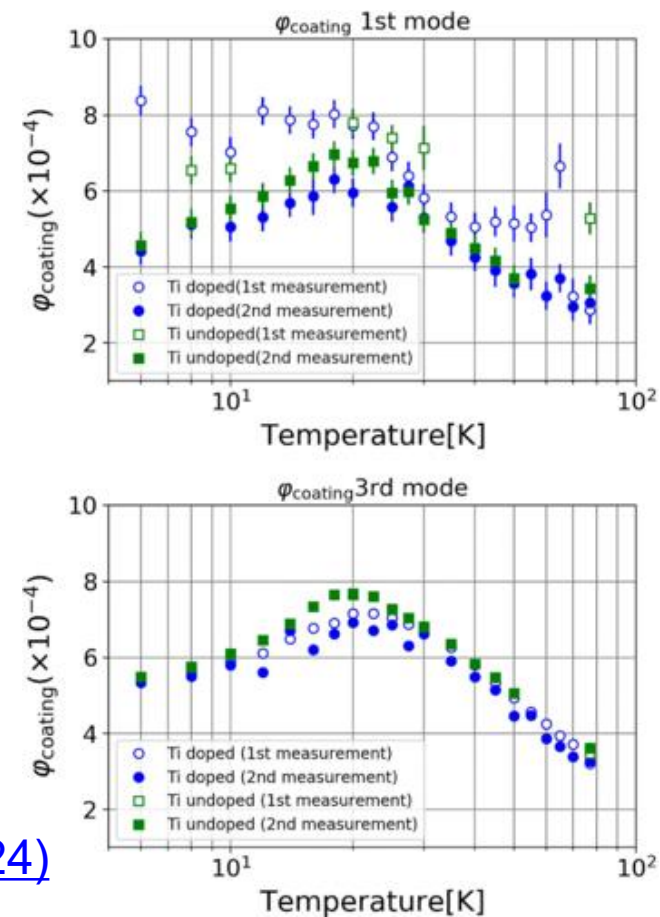
Science Goal	Science Objective	Key Observations	Measurement Requirements	Mirror and Instrument Requirements		
				Instrument	Property	Value
See the Dawn of Black Holes	Observe progenitors of supermassive black holes at their seed stage at $z=10$	Detection of black holes in $z=10$ galaxies down to a mass limit of $M_{\text{BH}}=10,000 M_{\odot}$ over a volume with 10^4 - 10^5 potential host galaxies. §13.1, Appendix A.3	Surveys with flux limits (0.5–2 keV): • 1.6×10^{-18} erg/s/cm ² over 1 deg ² • 7×10^{-19} erg/s/cm ² over 400 arcminutes ²	Mirror+ HDIO	Angular Resolution (NFW)	<1 arcseconds across the field
Reveal Invisible Drivers of Galaxy and Structure Formation	Determine the state of diffuse baryons in galactic halos to guide the galaxy formation models	Direct imaging observations of 15 low- z galaxies with $M_{\text{BH}}=3 \times 10^7 M_{\odot}$. §2.1.4, Appendix A.5	Reach 10% accuracy for derived thermodynamic parameters of hot gas at 0.5 r_{vir}	Mirror+ HDIO	Effective Area @1 keV	2 m ²
		Characterization of hot halos beyond the virial radius in ~ 30 galaxies with mass 10^{11} – $10^{12} M_{\odot}$ at $z=0$ –1. §2.1.5, Appendix A.5	Observe 80 bright AGN sight lines to reach the sensitivity of 1 mÅ for OIV and OIII absorption lines	XGS	Field of View	30 arcminute radius
	Establish the energetics, physics, and the impact of energy feedback on galactic scales	Spatially and spectrally resolve the structure of starburst-driven winds in low-redshift galaxies. §2.2	Measure the outflow velocity profile in 20 galaxies with 100 km/s accuracy, and derive the momentum and energy flux	LXM / Ultra High Resolution Array	Spectral Resolution @1 keV	40 eV (FWHM)
		Determine the effects of AGN energy feedback on ISM, and determine the physical state of gas near the SMBH sphere of influence in nearby galaxies. §2	In 30 nearby galaxies, resolve extended emission line regions, AGN inflated bubbles, and characterize the thermodynamic state of gas with 10% precision at or close to the Bondi radius from the central black hole	Mirror + LXM / Enhanced Main Array	Particle Background @0.5–2 keV	< 0.0005 cts/keV/cm ² /s
Unveil the Energetic Side of Stellar Evolution and Stellar Ecosystems	Constrain SN explosion physics, the origin of elements, and a relation between SN activity and local environment	Survey of young SNI in Local Group galaxies. §3.3	Measure spatial structure of SNI in spectral lines of individual elements (e.g. Fe-K α) and in non-thermal emission	LXM / Main Array	Spectral Resolving Power	5,000
Mission Functional Requirements					Effective Area at 0.5–2 keV	4,000 cm ²
Operate and survive in the science orbit, with a minimum observing efficiency of 85% for the duration of the 5-yr mission					On-axis Angular Resolution	0.5 arcseconds (NFW)
Accommodate payload in the Launch Vehicle					Spectrometer Pixel Size	0.5 arcseconds
Provide data collection that is sufficient for uninterrupted observations by all science instruments					Energy Resolution @0.6–7 keV	3 eV (FWHM)
Provide pointing attitude control and knowledge consistent with sub-arcsecond imaging, as well as stability consistent with a 1 arcminute FoV					Spectrometer Subarray Size	1 arcminute \times 1 arcminute
					Spectrometer Field of View	5 arcminutes \times 5 arcminutes
					Energy Resolution @0.6–7 keV	3 eV (FWHM)
					Effective Area @6 keV	1,000 cm ²

Table 5.2



Coatings Panel Discussions

- There was a comment that KAGRA is using room temperature coating ($\text{Ta}_2\text{O}_5/\text{SiO}_2$) [MMR]
 - I commented that it is OK
 - Peak depend on vendors
 - Low temperature peak is not significant (and can be removed by annealing [SB])
- なぜ何も知らずに
批判(言及)するのか...



New Tech / Cryo Panel Discussions

- There was comments that DECIGO is not feasible due to doppler shifts (PD range?), point ahead, phasemeter noise etc.
 - I think they are confused with LISA...
 - なぜ何も知らずに批判するのか...
- Frosting
- There was a question that what is needed for green light to cryogenic interferometers [LB]
 - I said testing everything is necessary but testing everything at cryogenic temperatures is hard (e.g. TWE measurements at cryogenic temp.)



Questions to KAGRA from DR

- How can we effectively make cryogenics work in a vacuum that is really good but not perfect?
 - Frosting, heaters
- Whether the KAGRA cryogenic system introduces excess displacement noise?
 - Not yet
 - Heat link vibration and Newtonian noise OK
- How long can a detector reasonably stay cold?
 - 2 years (2022 – 2024; Stopped intentionally after Noto EQ)
- Is there a way to clean surfaces in situ/in vacuo?
 - Heaters

KY prepared slides, but not explicitly discussed in the panel

Summary

- 全体的に夢がない？ 雰囲気の研究会
- ロケットの打ち上げを2回見れたのは夢があった
- 日本からの参加者が少なく、KAGRA/DECIGOについてなにか言わないといけない気持ちになる
- ご飯がおいしかった