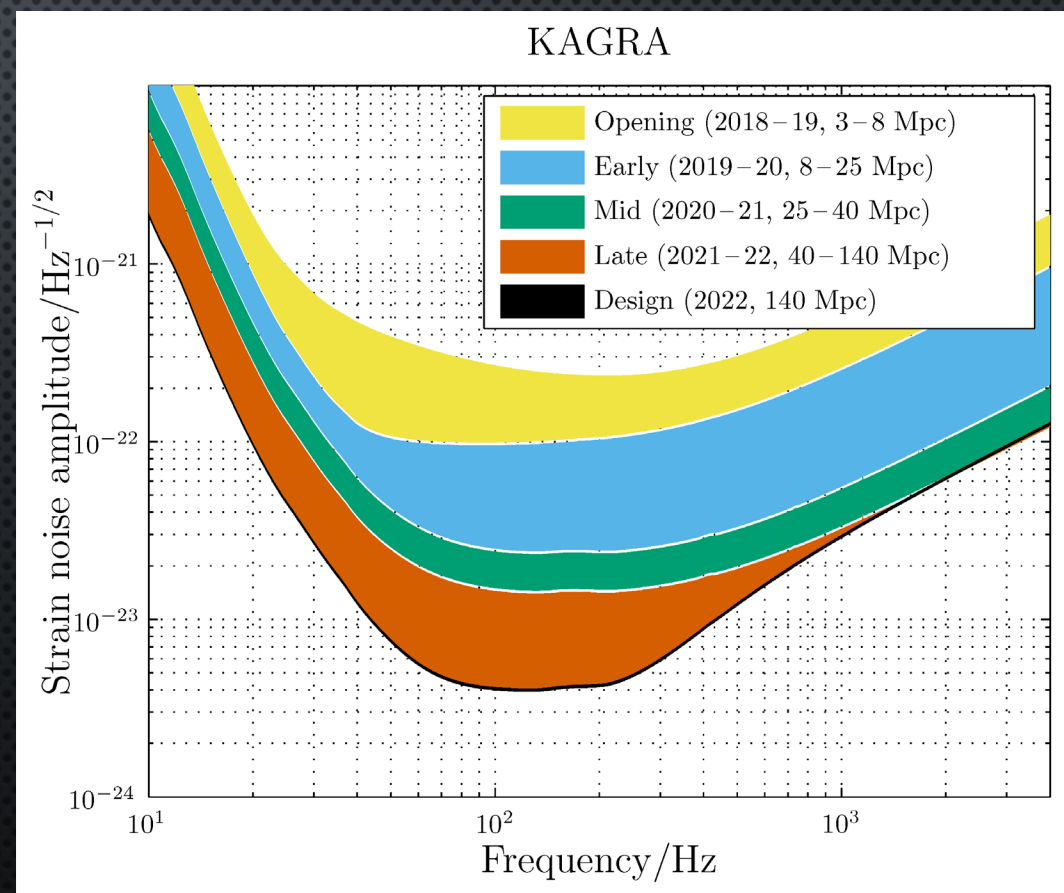
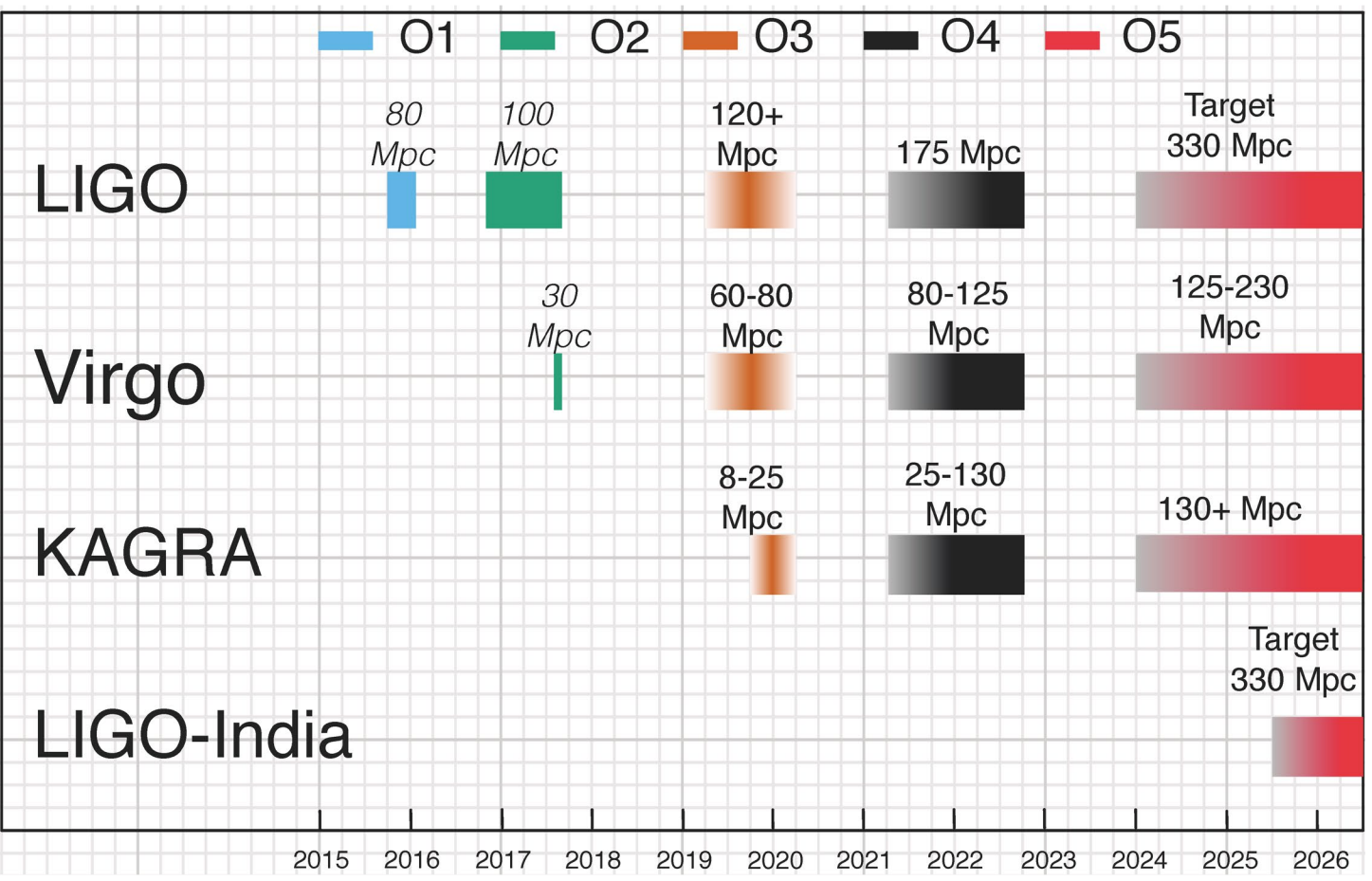
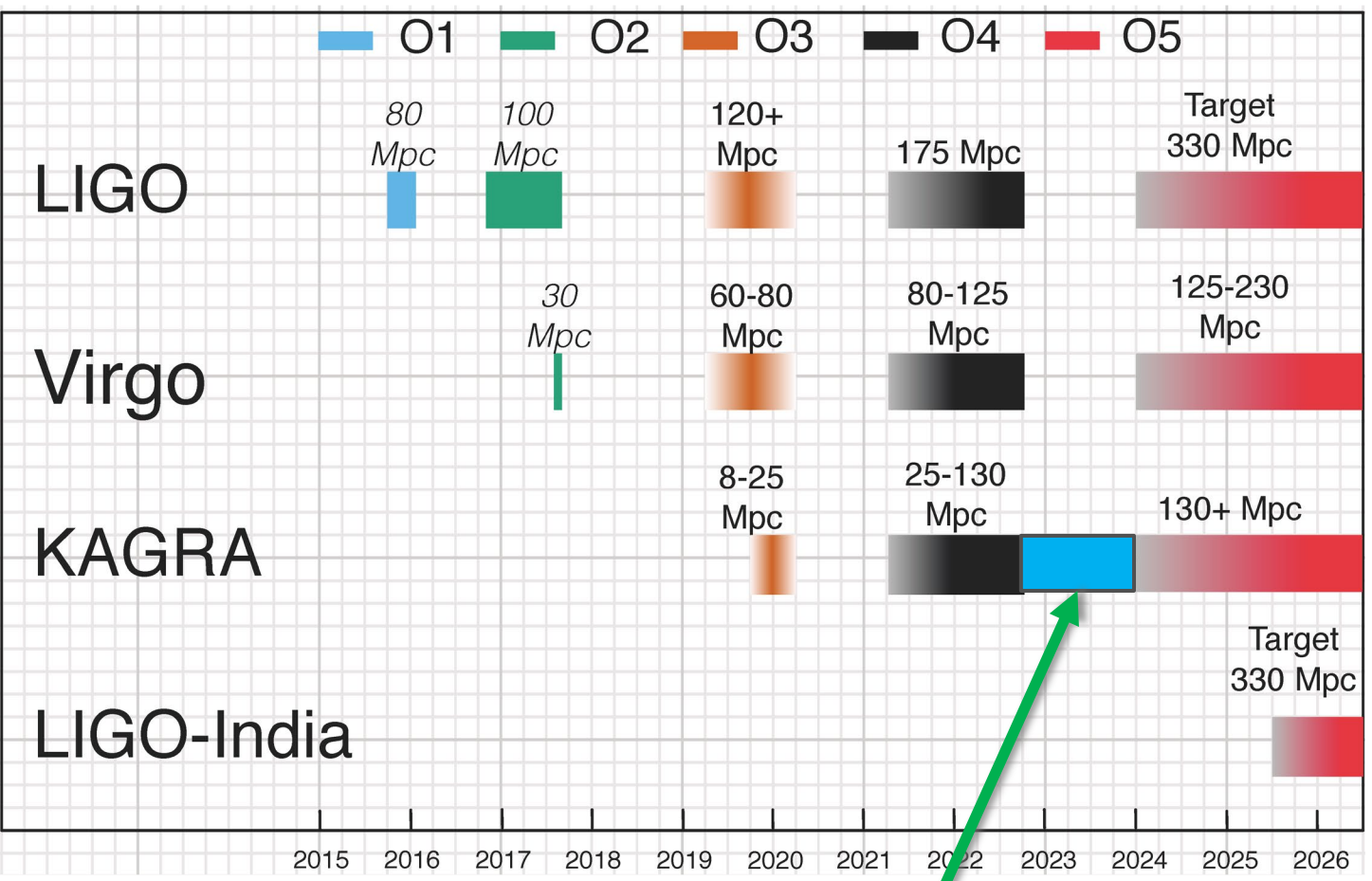


KAGRA Upgrade Plan

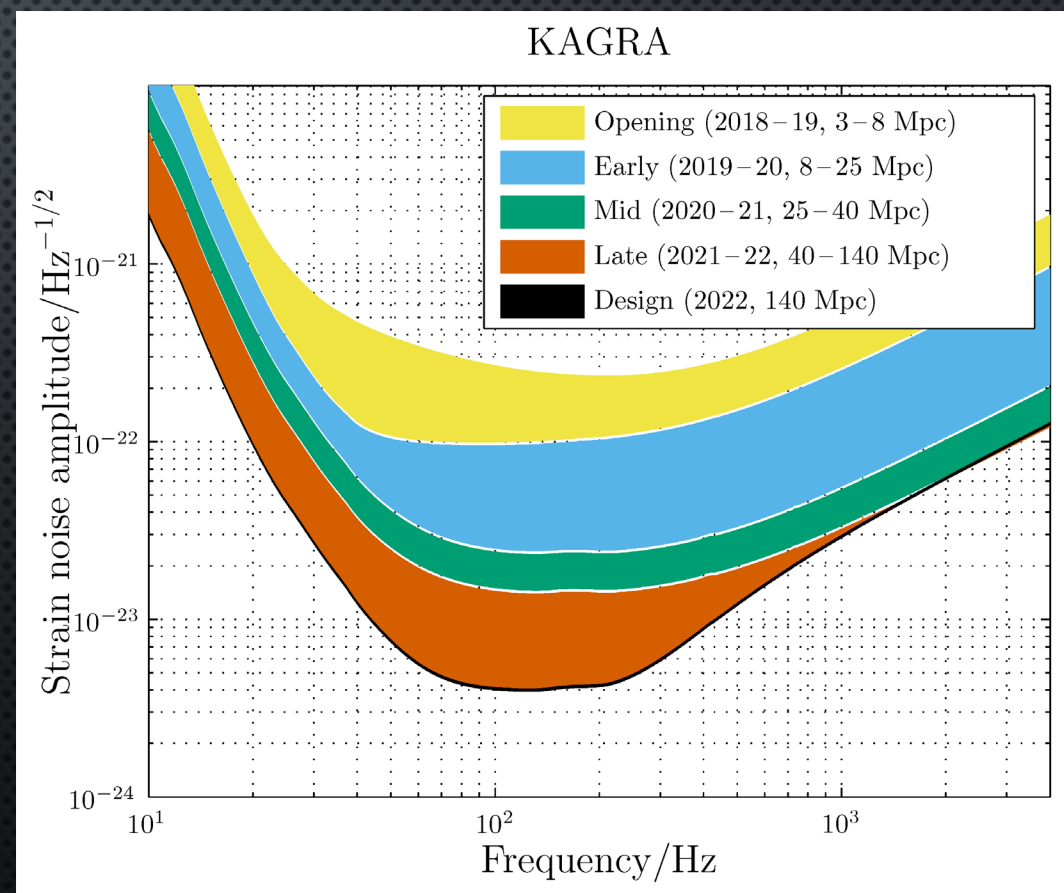
A 3D perspective rendering of the KAGRA detector upgrade plan. The image shows a complex network of large, cylindrical metallic components, likely mirrors or lenses, connected by a dense system of pipes and structural supports. The components are arranged in a long, linear fashion, extending into the distance. The background is a dark, textured surface with a repeating pattern of small, light-colored dots. The overall scene is illuminated from the side, creating strong highlights and shadows that emphasize the metallic surfaces and the intricate geometry of the detector.

2019/5/9@LIGO PAC
National Astronomical Observatory of
Japan
Yoichi Aso
On Behalf of The KAGRA Collaboration





Upgrade !?



Historical Background

- No official platform to discuss KAGRA upgrade until recently
 - PI wanted people to focus on the realization of the baseline KAGRA
 - Limited resource
 - Need to fulfill the commitments to the funding agency
- Unofficial activities for upgrade still existed

Unofficial technical studies of KAGRA upgrade

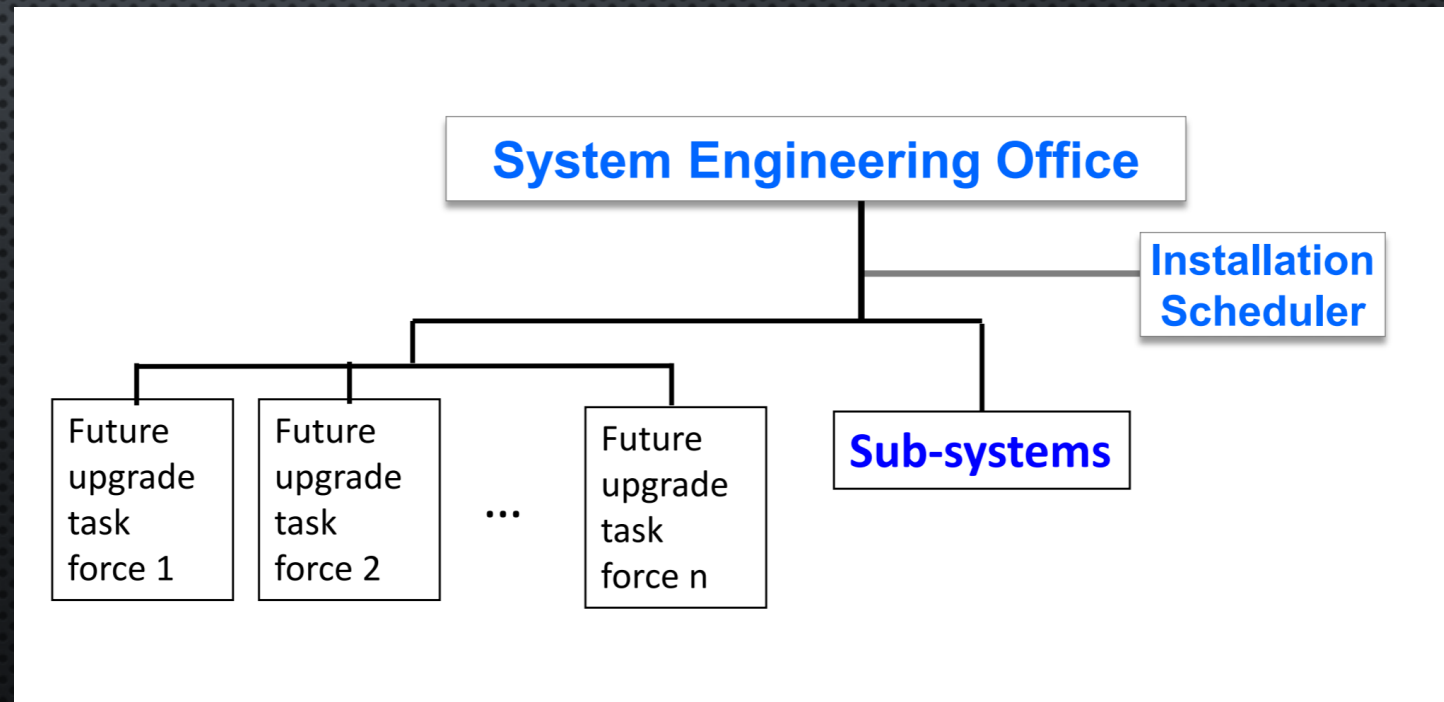
- Proposal for the discussion: 2017 March F2F meeting
 - [JGW-G1706398](#)
- Discussions at KAGRA International Workshops
- Presentations at Japan Physics Society meetings
- Satellite meeting: 2017 Dec. 4th @TITECH
<http://gwwiki.icrr.u-tokyo.ac.jp/JGWwiki/LCGT/Meeting/f2f/2017Dec/Sateite>
- KAGRA upgrade document tree
 - [JGW-E1809314](#)

Kajita-san's presentation@F2F in August 2018

- [JGW-G1808915](#)
- Officially presented PI's vision on the future upgrade scheme of KAGRA
- Recognized the need for starting the discussion of upgrade

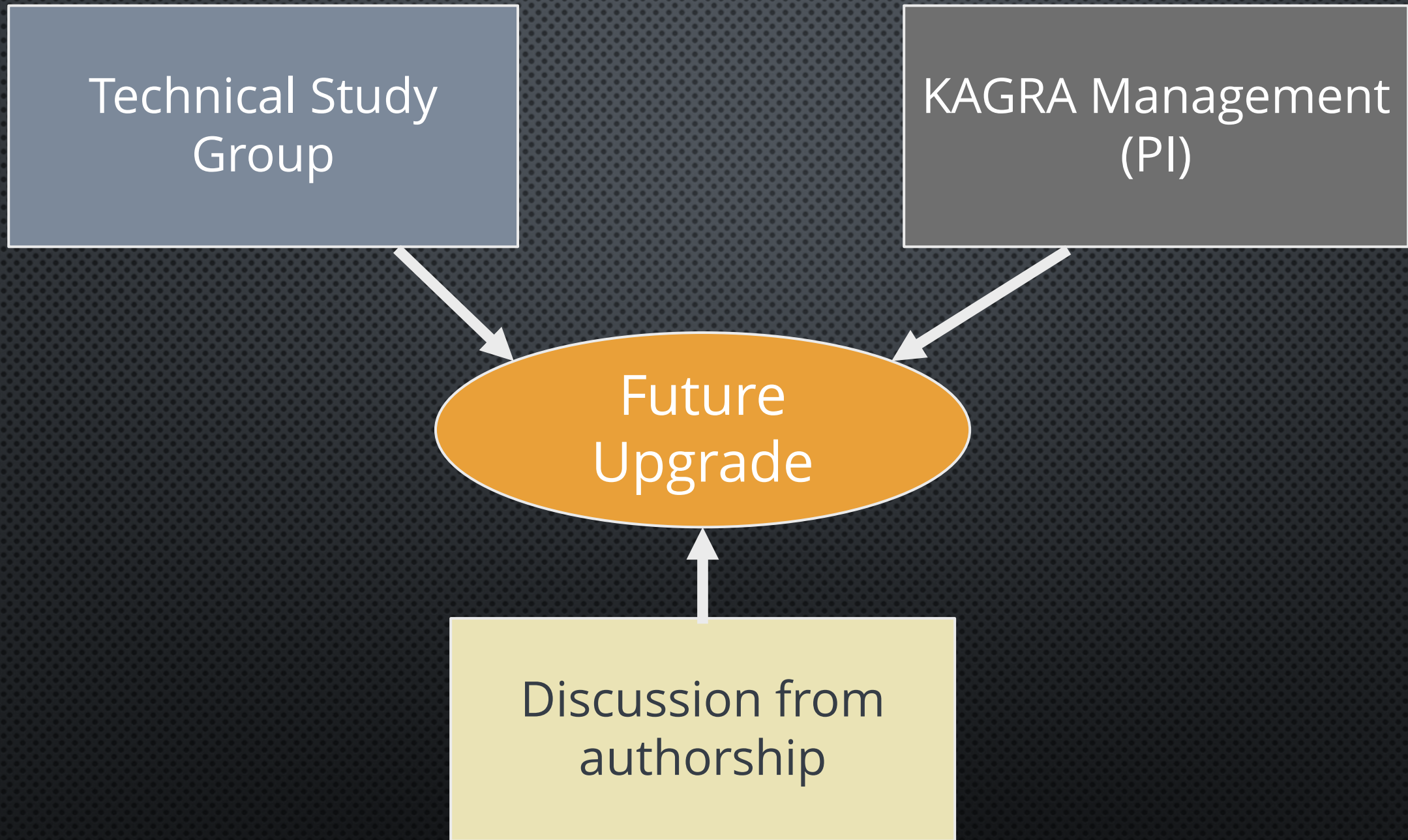
Funding scheme:

Each group proposing an upgrade item should obtain grant by themselves



Discussion from another viewpoint: Authorship

- KAGRA wants to join O3: Authorship becomes a serious matter
- What are counted as contributions to warrant authorship ?
 - KAGRA authorship policy [JGW-M1503490](#)
 - “Contributions for research and development activities **authorized by** the project are also included”
- **Problem:** No procedure to **authorize** an R&D by the project existed
- We need to establish a process to recognize important R&Ds for KAGRA upgrade
- To assess the importance of an R&D, we need a reference frame
 - A white paper on KAGRA upgrade plan
- This issue was raised at the F2F in May 2018



Technical Study
Group

KAGRA Management
(PI)

Needed to develop a unified framework

Discussion from
authorship

Future
Upgrade

Proposal to set up two committees under KSC

- Future Planning Committee (FPC)
 - Manage the discussion of KAGRA future upgrade plan
 - Produce a white paper for future upgrade
- Project R&D Committee (PRDC)
 - KAGRA Project R&D is an official R&D of KAGRA to be counted towards authorship
 - PRDC manages the selection of the Project R&Ds
 - Judgement is made based on the white paper by the FPC
- Approved at the F2F meeting in Dec. 2019

FPC released the first draft of the white paper recently: [JGW-M1909590](#)

Funding Scheme

Basic direction given by the PI

- Each group responsible for an upgrade item should obtain funding for the upgrade work
- Especially, contributions from outside Japan is important
- One example
 - Backup laser (60W) for O3 and 140W laser for O4
 - Academia Sinica (Taiwan) will procure commercial amplifiers (neoVAN-4S-HP) [JGW-G1910052](#)
 - The funding comes from Taiwan

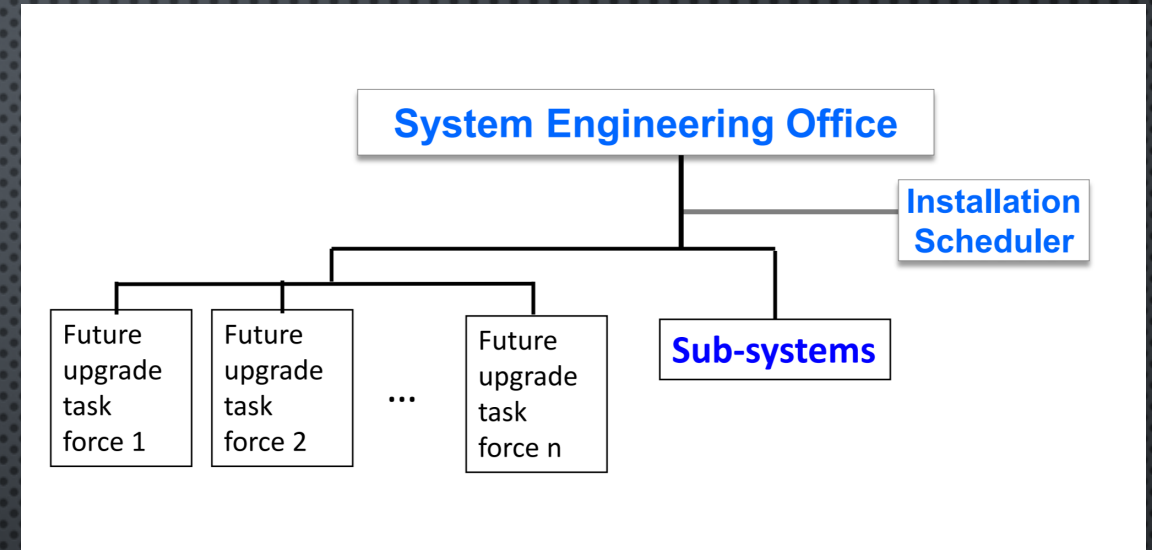
Aso's personal opinion

- KAGRA project as a whole should still seek for a large funding from MEXT
- In fact, we are applying for another Tokusui (~5MUSD)

Organization, Management

Basic idea given by Kajita-san

- A task force for each upgrade item
- SEO manages the overall upgrade



Aso's personal opinion

- A vast improvement in the project management is necessary for the upgrade
- Implementing standard engineering management practices is important
 - Need to hire dedicated engineers for this
- Need to find a practical compromise
 - Available resources
 - KAGRA people's mindset for the project

Overview of the upgrade white paper

[JGW-M1909590](#)

- List up scientific targets
- List up potential technologies to be adopted for upgrade
 - Score the significance and feasibility of each technology
- List up 4 candidates for upgrade
 - Low frequency optimization (LF)
 - Heavier mirror (40kg)
 - Frequency dependent squeezing (FDsq)
 - High frequency optimization (HF)

Recommendations

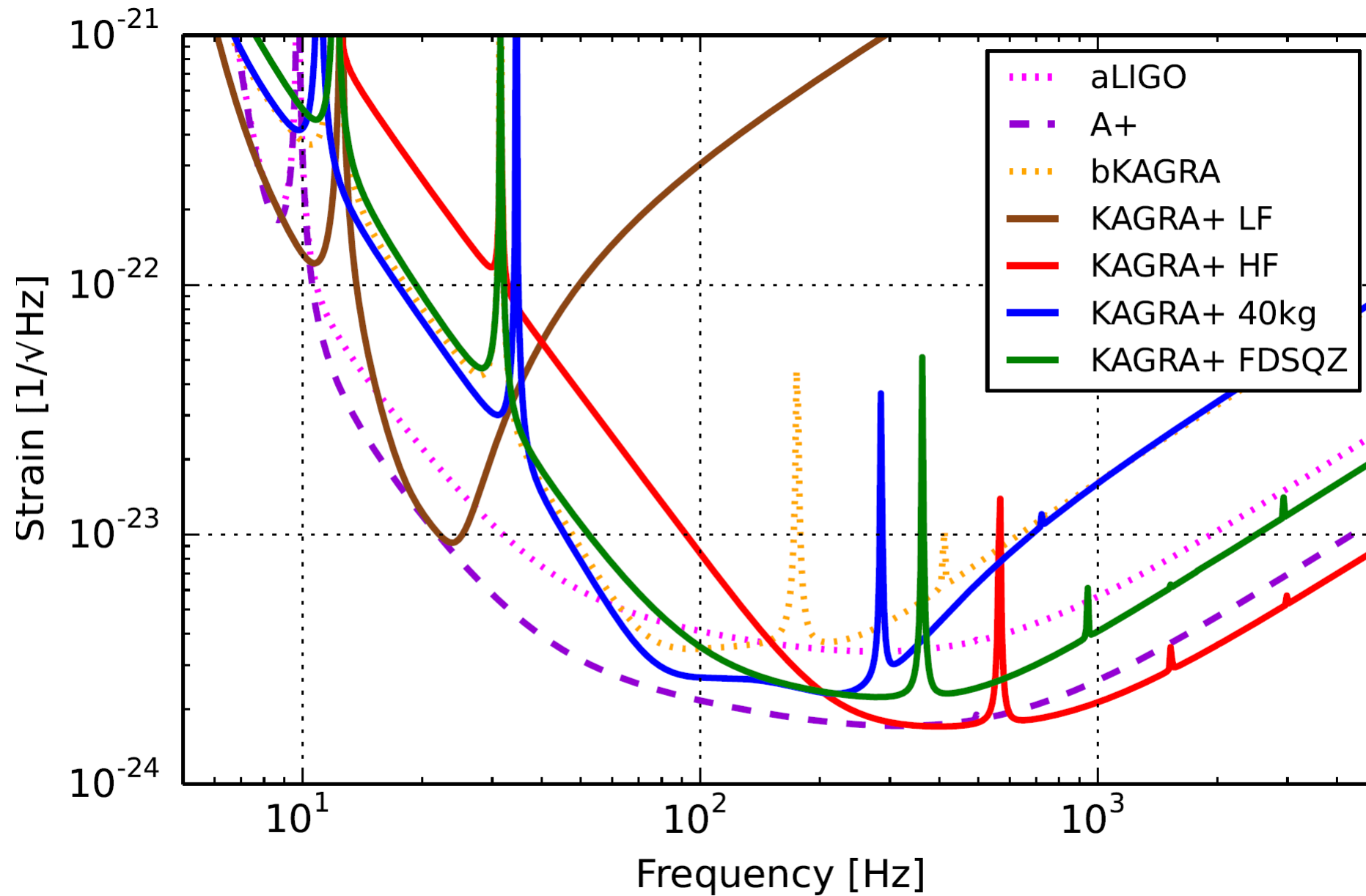
- HF & FDsq for 5 year upgrade (after O4)
- Continue R&D on LF and 40kg for longer term upgrade

Parameters for candidate upgrade options

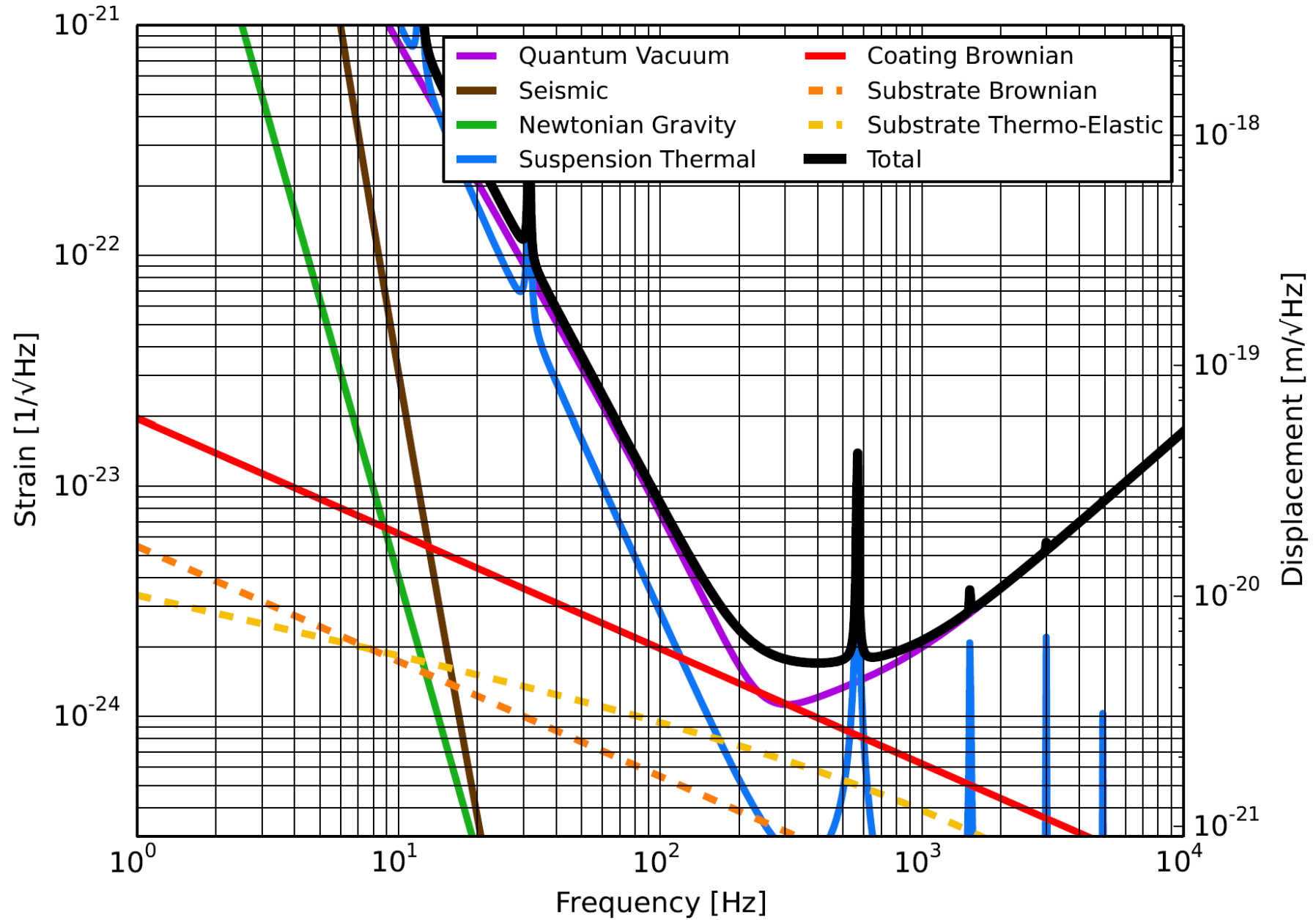
	bKAGRA	LF	HF	40kg	FDsq
detuning angle (deg)	3.5	28.5	0.1	3.5	0.2
homodyne angle (deg)	135.1	133.6	97.1	123.2	93.1
mirror temperature (K)	22	23.6	20.8	21.0	21.3
SRM reflectivity (%)	84.6	95.5	90.7	92.2	83.2
fiber length (cm)	35.0	99.8	20.1	28.6	23.0
fiber diameter (mm)	1.6	0.45	2.5	2.2	1.9
mirror mass (kg)	22.8	22.8	22.8	40	22.8
input power at BS (W)	673	4.5	3440	1500	1500
maximum detected squeezing (dB)	0	0	6.1	0	5.2 (FC)

Table 25: Detector parameters for the upgrade options.

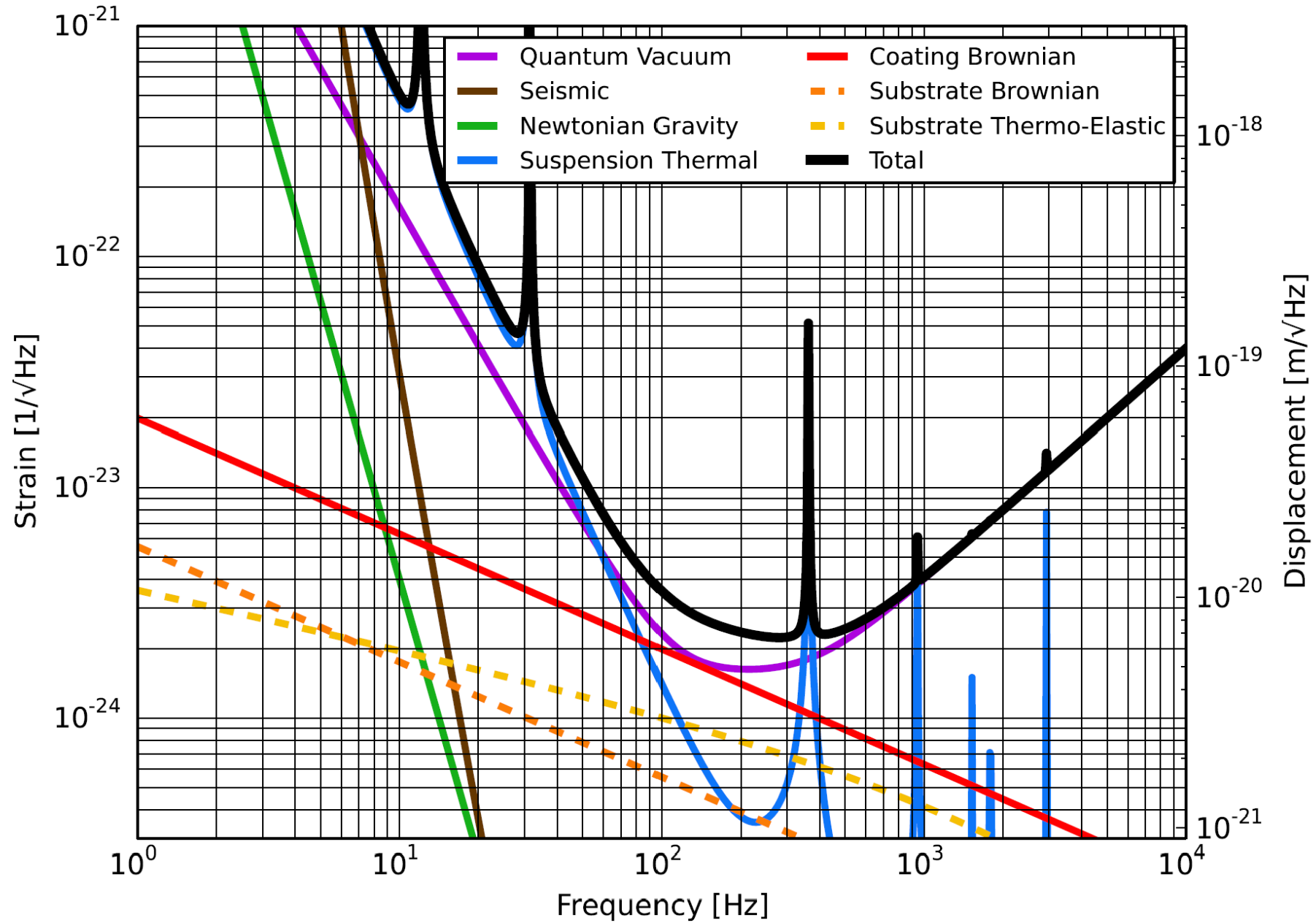
Comparison of noise curves



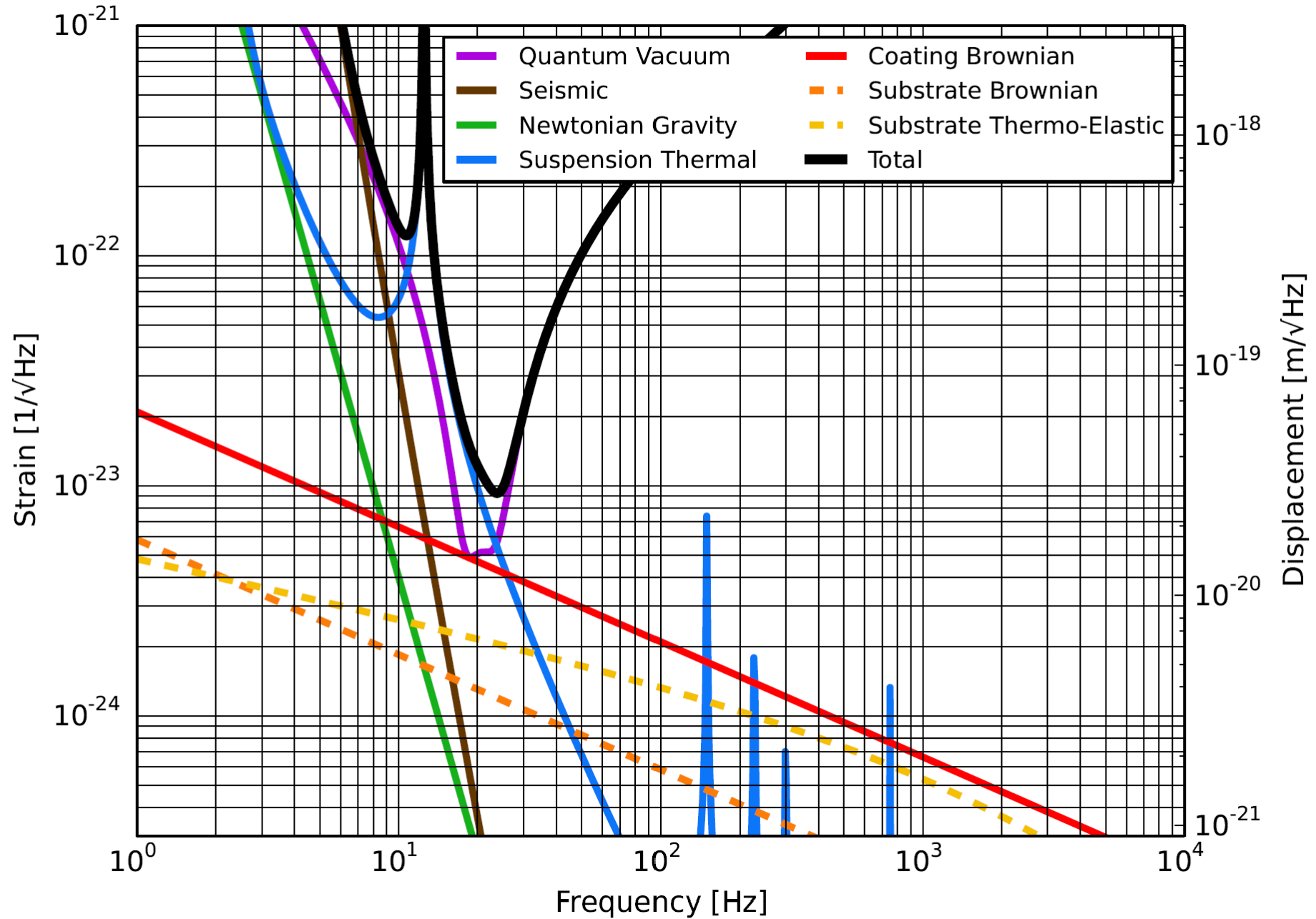
KAGRA+ (HF)



KAGRA+ (FDSQZ)



KAGRA+ (LF)



KAGRA+ (40kg)

