

# KAGRA+ Upgrade Plans

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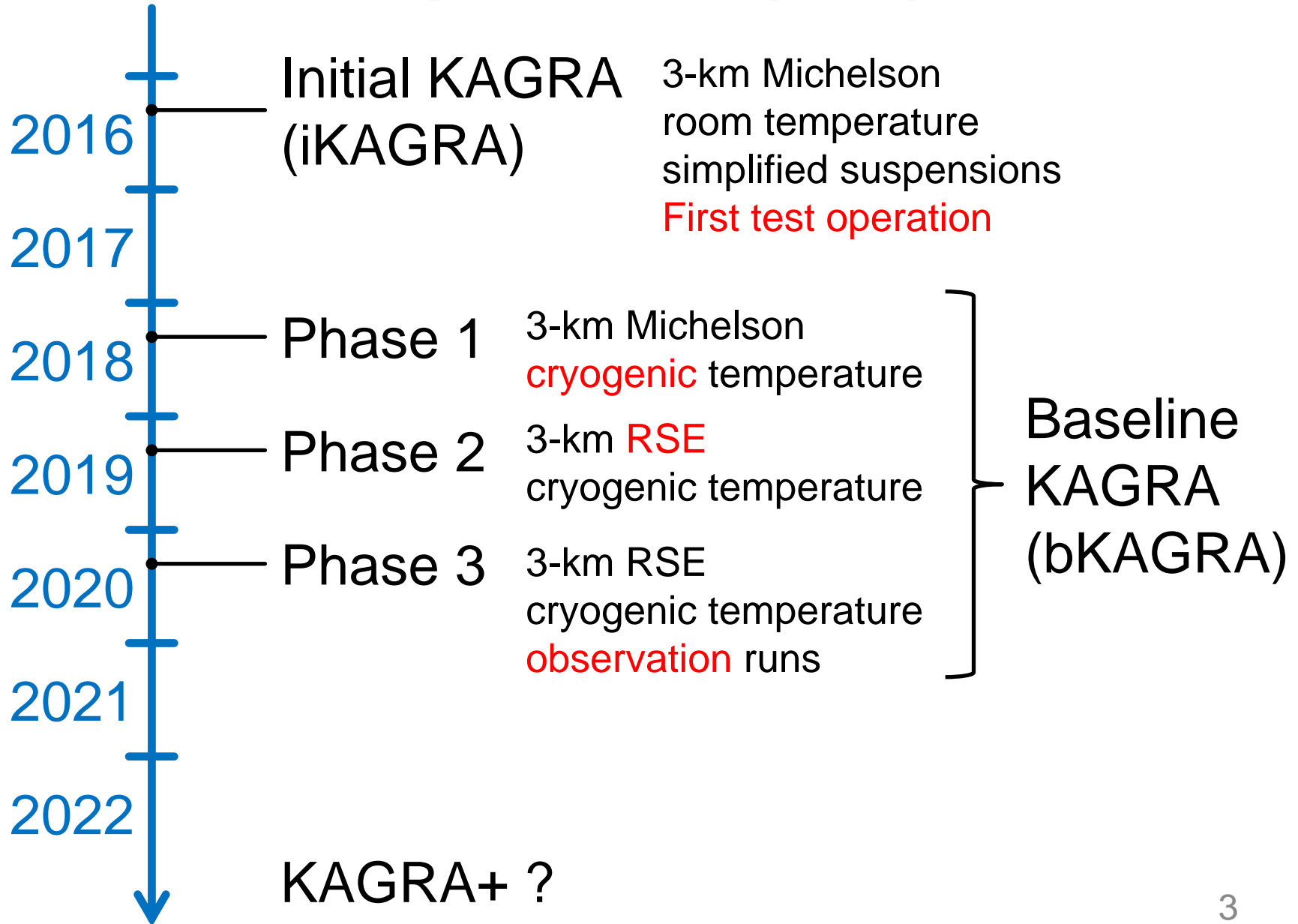
# Overview

- No concrete plan yet
- Some R&D on-going
- Integrated study initiated recently
- Aiming at the first observation in 2022~2024,  
within current facility

時期的に  
可能なのか？

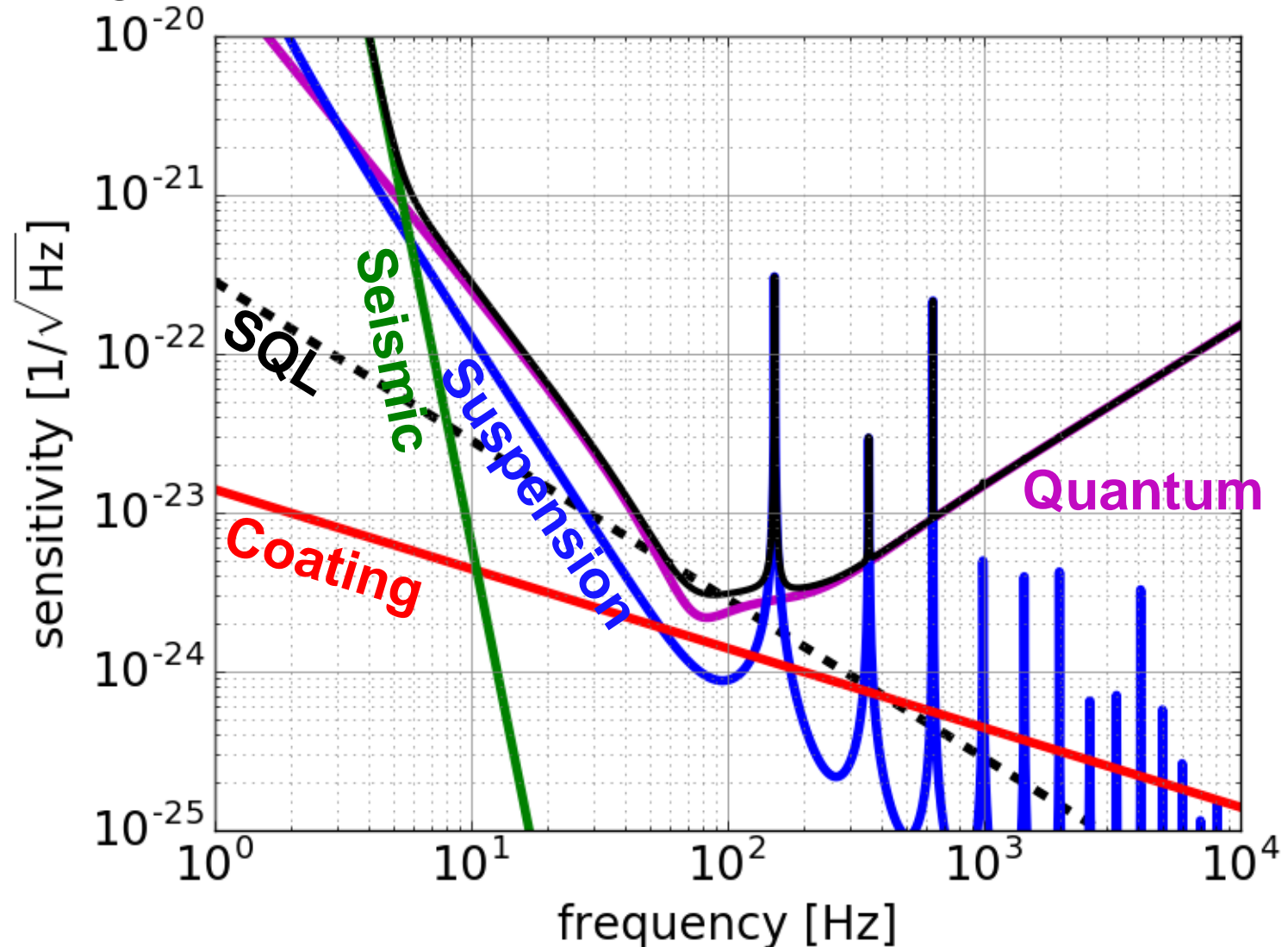


# KAGRA Timeline



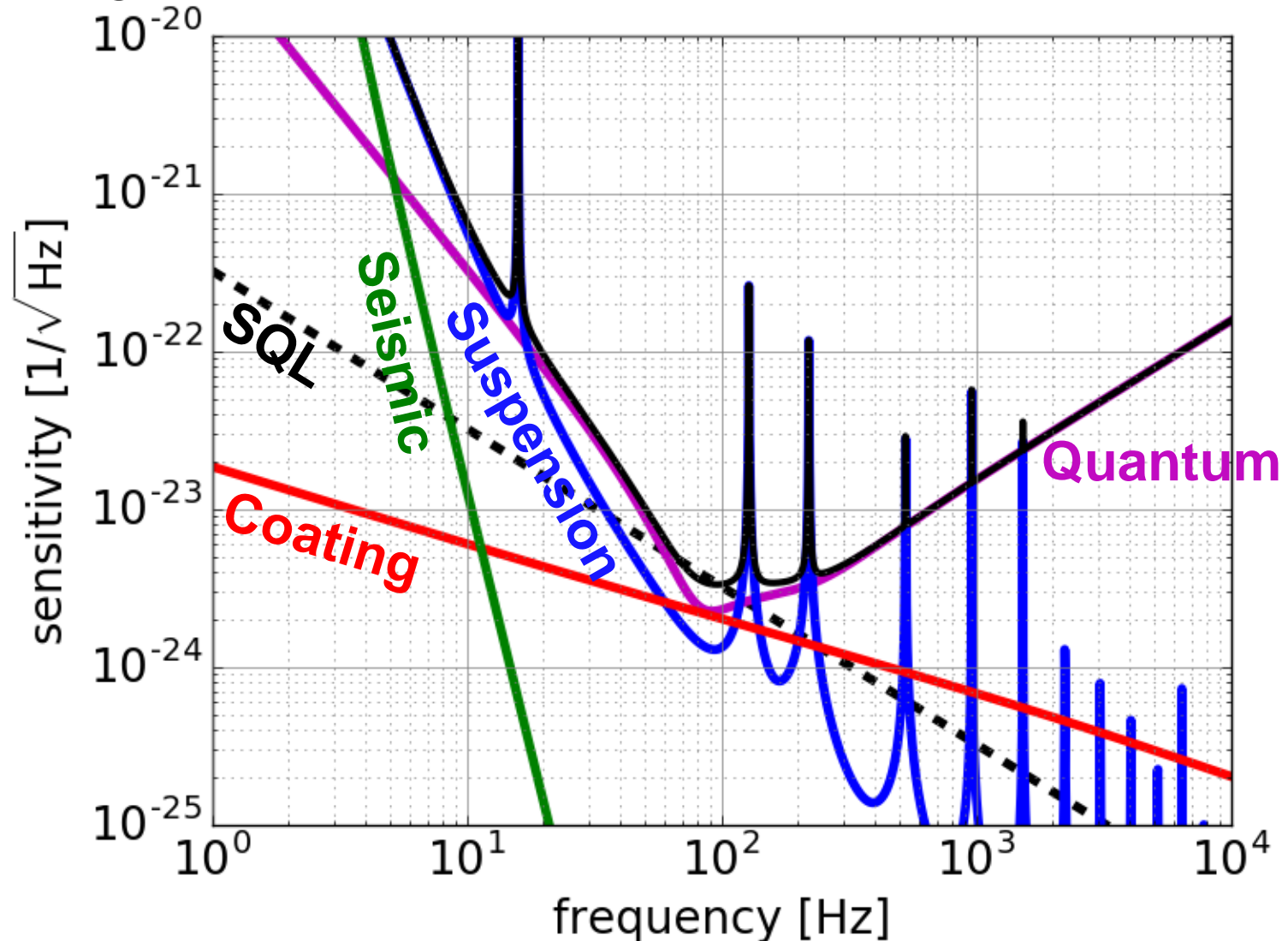
# KAGRA Official Sensitivity (v2009)

- 30 kg, 20 K, 825 W at BS  $\rightarrow$  BNS 171 Mpc



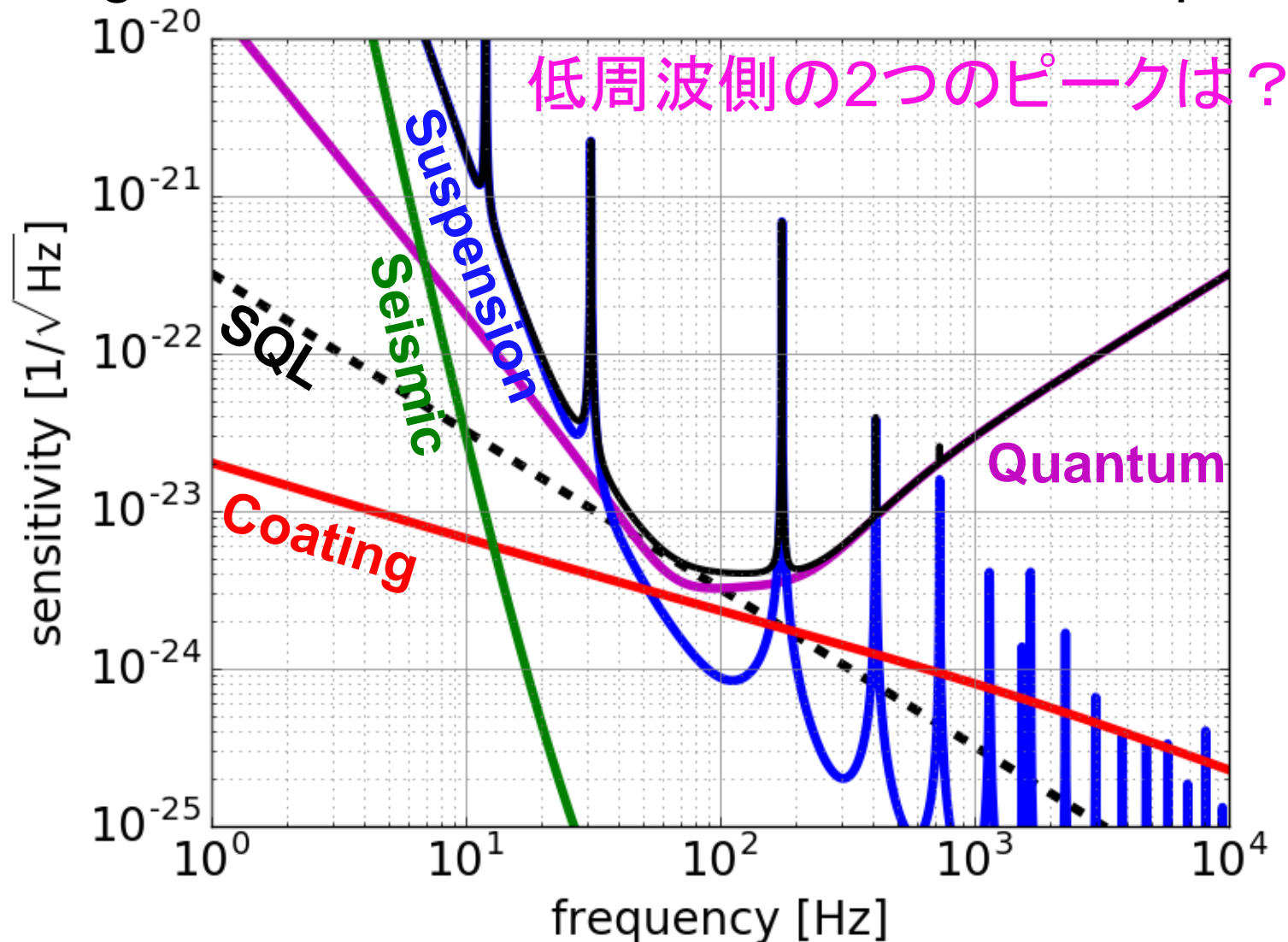
# KAGRA PRD Sensitivity (v2013)

- 23 kg, 20 K, 780 W at BS → BNS 148 Mpc



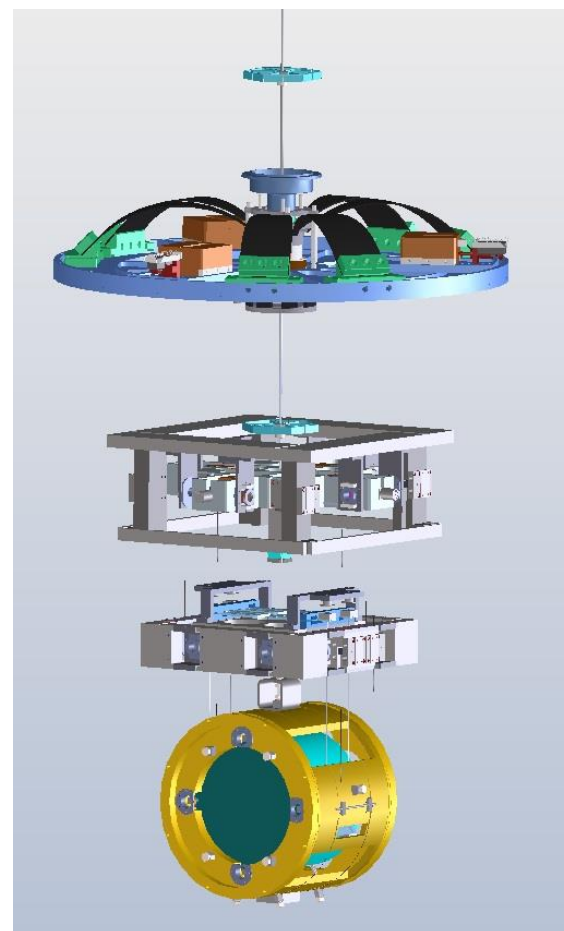
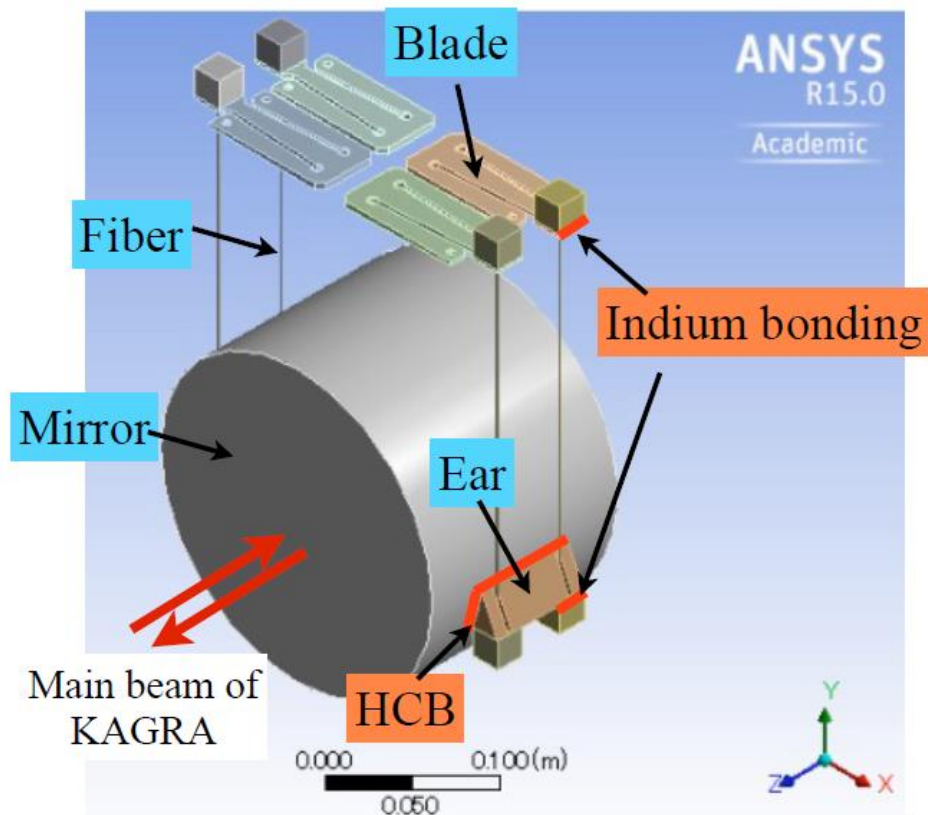
# Update on Official Sensitivity

- 23 kg, 23.1 K, 550 W at BS → BNS 152 Mpc



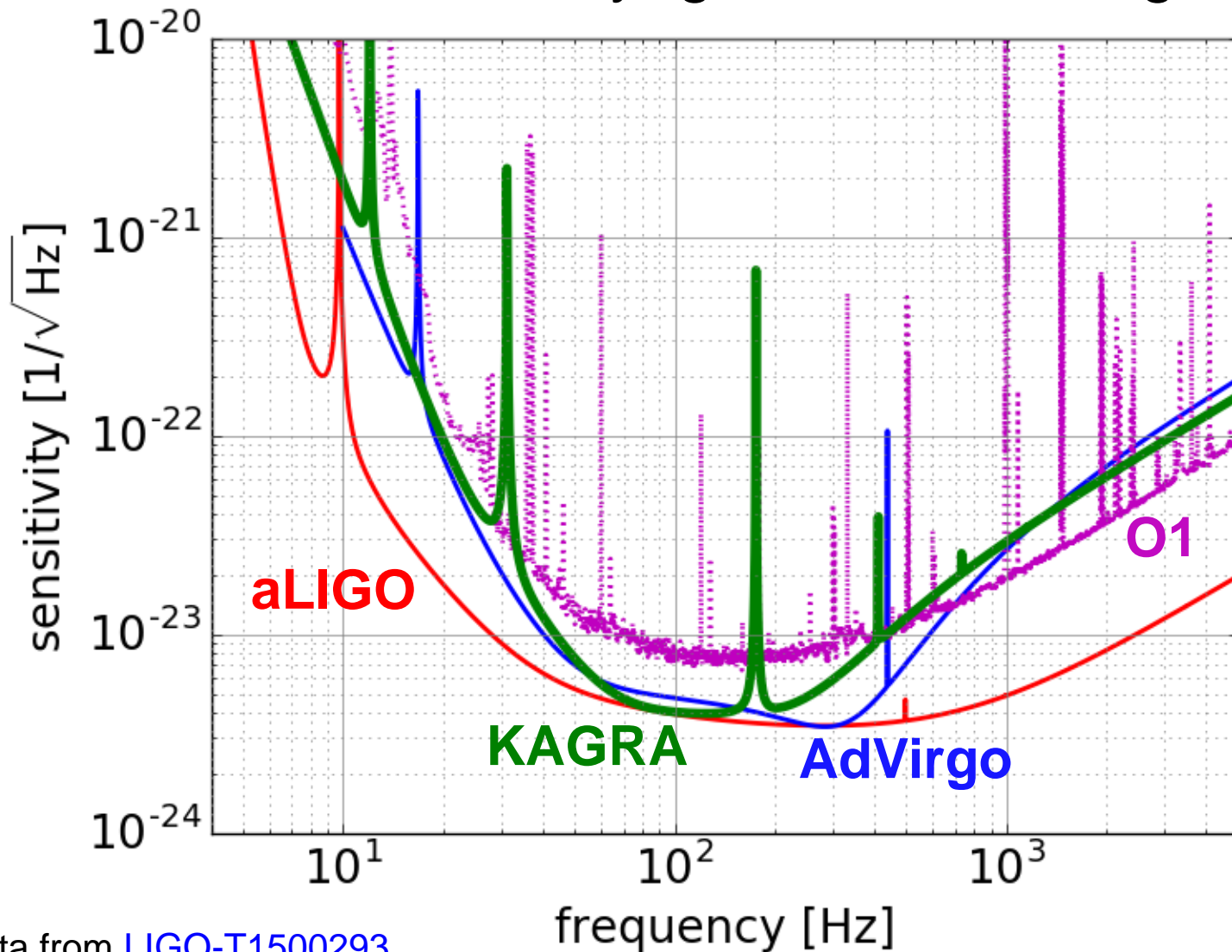
# Update details

- Update details (宗宮さんに聞く、オフィシャル感度更新は2009年以來?、2009年感度との比較にするか、麻生PRD2013との比較にするか)



# KAGRA vs Other 2G

- Not better even with cryogenic and underground





# KAGRA vs Other 2G

- Lower power and lighter mass increase quantum noise
- Thick sapphire increase suspension thermal noise (low frequency sensitivity is not limited by underground seismic noise)
- 他に言うことは？

# Ideas for Improving Sensitivity

- Increase the mass
  - composite mass
  - A-axis sapphire mass
  - non-cylindrical mass
  - go silicon (upto 200 kg, 45 cm dia.)
- Focus on low frequency
  - low laser power, thin and long suspension
- Filter cavity
  - effectively increase mass and laser power
- ETM different from ITM, half-cryogenic, delay-line, folded arms, higher-order modes ..... ???

A-axisのサイズと重さ  
かまぼこのサイズと重さ  
サファイア結晶から鏡を  
くり抜く図

# Example KAGRA+ Sensitivity 1

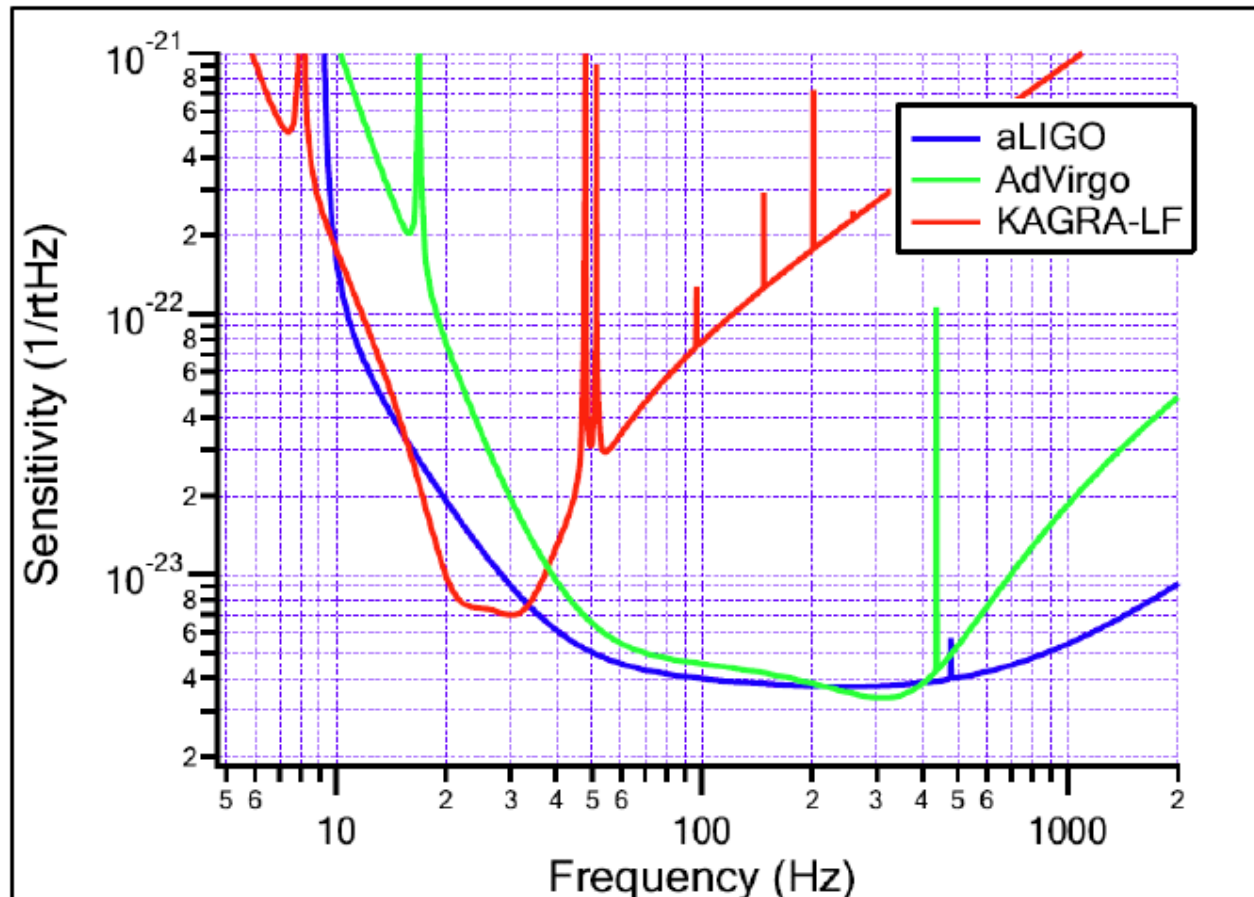
- Heavier mass (榎本くん?)

# Example KAGRA+ Sensitivity 2

- Silicon (小森ちゃんと長野くん?)

# Example KAGRA+ Sensitivity 3

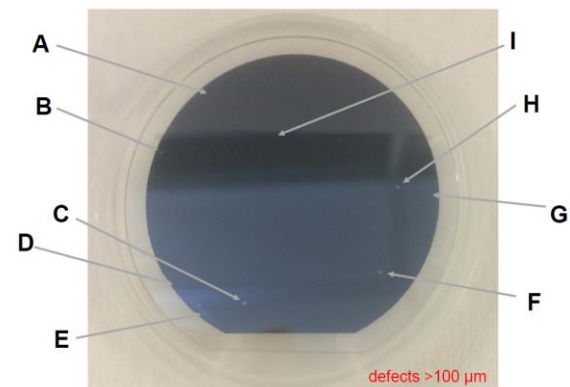
- Low frequency (宗宮さんにスペクトルをもらう)



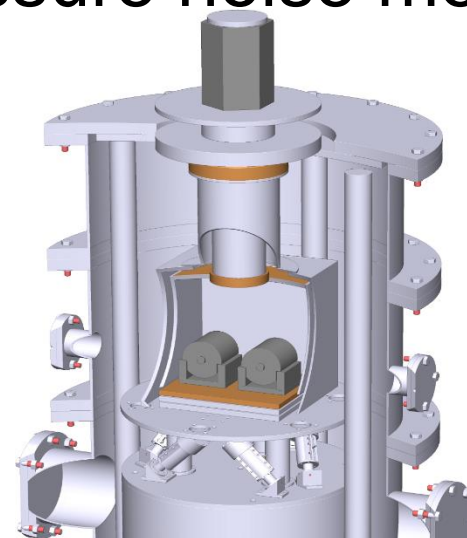
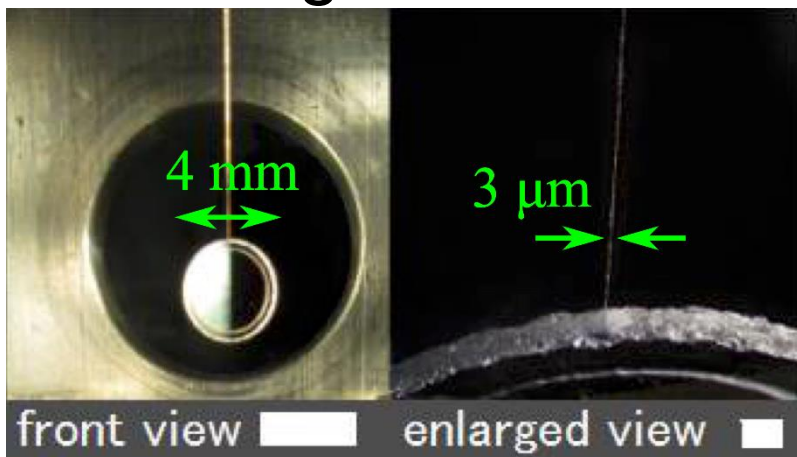
# R&D Activities

NAOJ figures from [JGW-G1605361](https://www.nao.ac.jp/figure/JGW-G1605361) by Y. Aso

- Crystalline coating on sapphire
- Cryogenic silicon cavity for thermal noise measurements
- Mirror absorption characterization
- 300m filter cavity at TAMA300
- Quantum radiation pressure noise measurement with mg-scale mirror



2-inch GaAs/AlGaAs on sapphire  
6ppm scattering  
9 large defects



Cryostat for cryogenic silicon cavities



# KAGRA+ Planning Schedule

- February 2017:  
Informal brainstorming
- March 2017:  
Call for volunteers
- June 2017:  
Organize 2-3 teams
- August 2017:  
Report proposal from 2-3 teams  
→ select one proposal

これでいい？  
予算やどういう組織で  
議論しているかの話は？

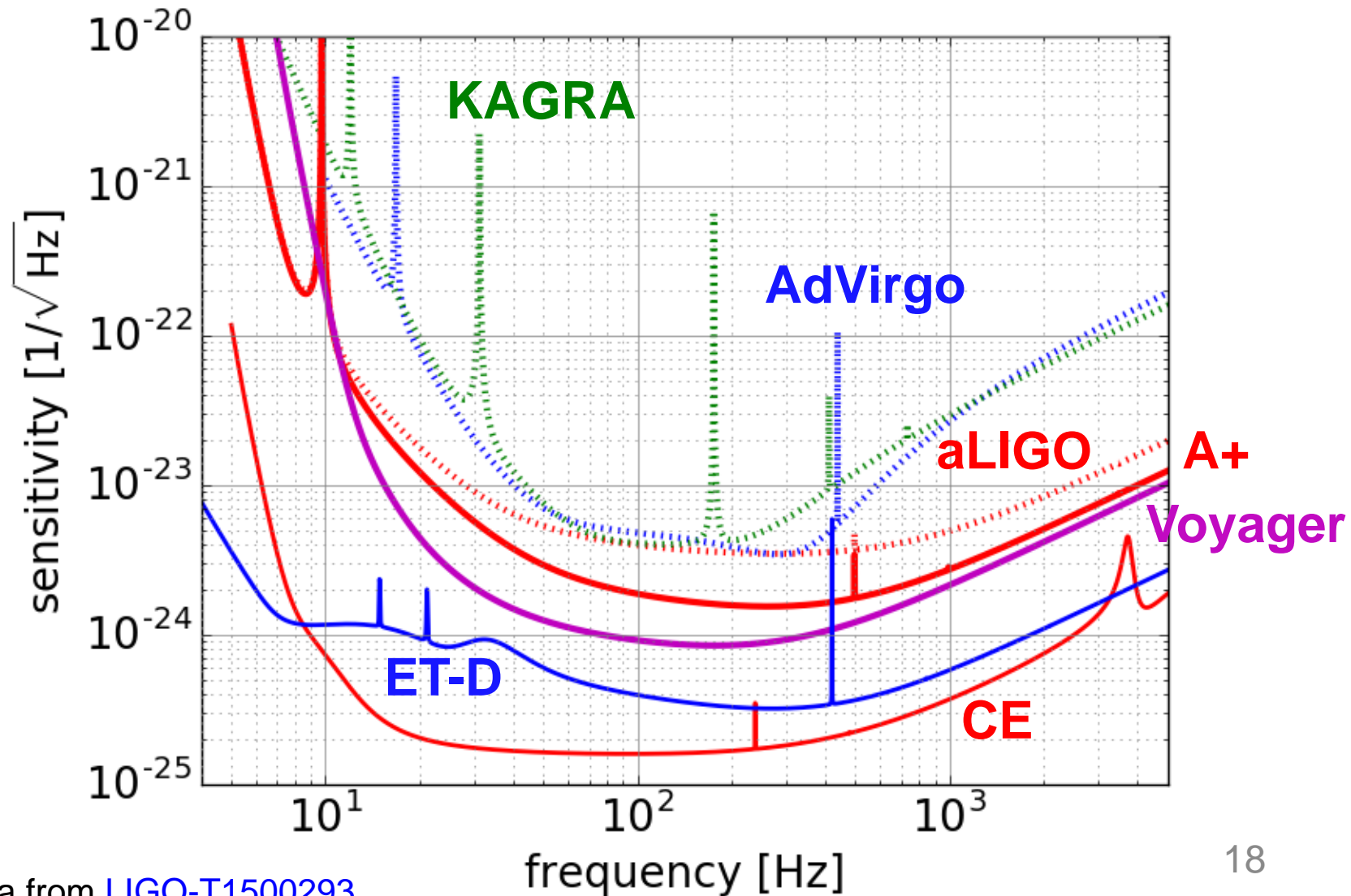
# Summary

- R&D on-going for future KAGRA upgrade
- Integrated sensitivity design study on KAGRA+ initiated recently



# Supplementary Slides

# 2-3G Sensitivity Comparison



# Other References

- K. Somiya, 感度について [JGW-G1605698](#)  
On recent official sensitivity update
- K. Somiya, KAGRA2020 [JGW-G1503551](#)  
Slides for GWADW2015 on KAGRA upgrade
- K. Somiya *et al.*: LCGT-LF report [JGW-T1100446](#)  
Study report on a reconsideration of the LCGT  
bandwidth for low-frequency measurements
- M. Ando *et al.*: Study report on LCGT  
interferometer observation band [JGW-T1000065](#)