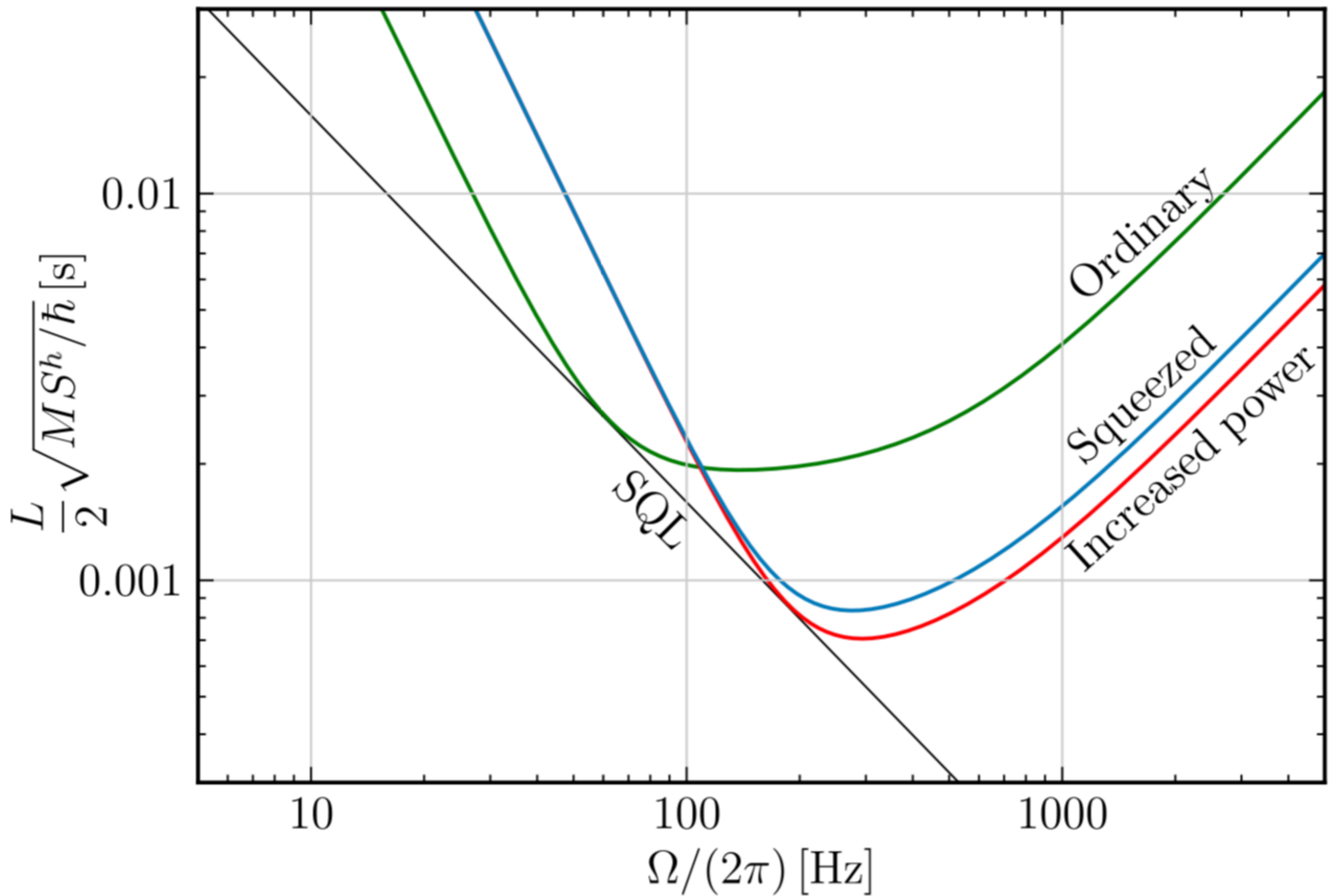


# Future Upgrade of KAGRA (proposal)

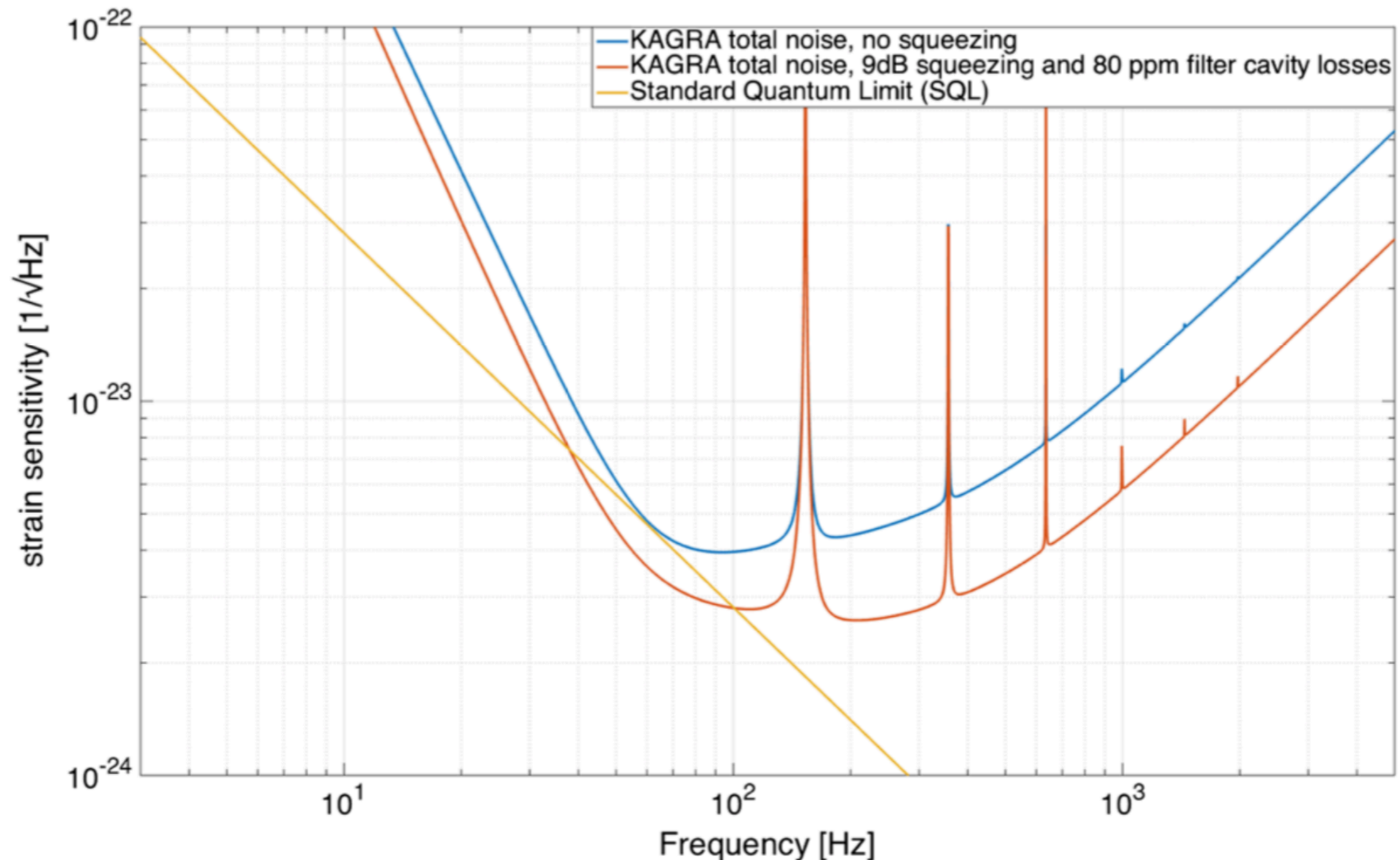
- **Task-Force on squeezer**
  - Frequency independent/dependent squeezer for KAGRA
- **with Ray-Kuang Lee (NTHU) and Matteo Leonardi (NAOJ)**
- **Taiwan side [Vanguard project (2019-2023), submitted]:**
  - Squeezer
  - Advanced Laser Technology
  - Calibration: Gravity field calibrator -> Energy problem
  - Burst or CW: Development of analysis method for Glitch -> Machine learning for Big data
- Tier 2 Data Storage at NCU (National Central Uni.)
- Computational facility at NCHC (Nat'l Center for High-Performance Computing)



S. L. Danilishin and F. Ya. Khalili, Living Rev. Relativity, 15, 5 (2012).

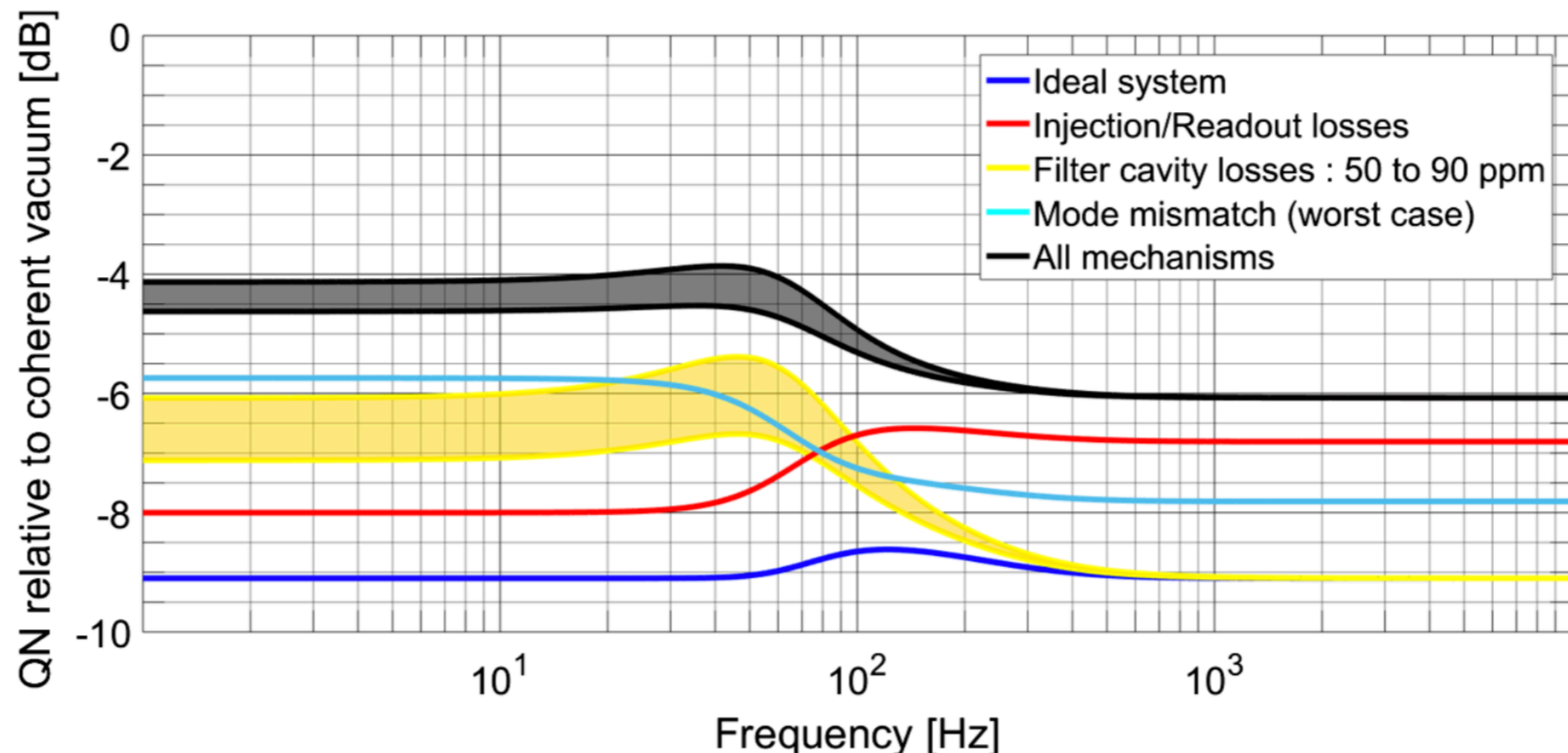
## Estimation of losses in a 300 m filter cavity and quantum noise reduction in the KAGRA gravitational-wave detector

Eleonora Capocasa,<sup>1,2,\*</sup> Matteo Barsuglia,<sup>1</sup> Jérôme Degallaix,<sup>3</sup> Laurent Pinard,<sup>3</sup> Nicolas Straniero,<sup>3</sup> Roman Schnabel,<sup>4</sup> Kentaro Somiya,<sup>5</sup> Yoichi Aso,<sup>2</sup> Daisuke Tatsumi,<sup>2</sup> and Raffaele Flaminio<sup>2</sup>



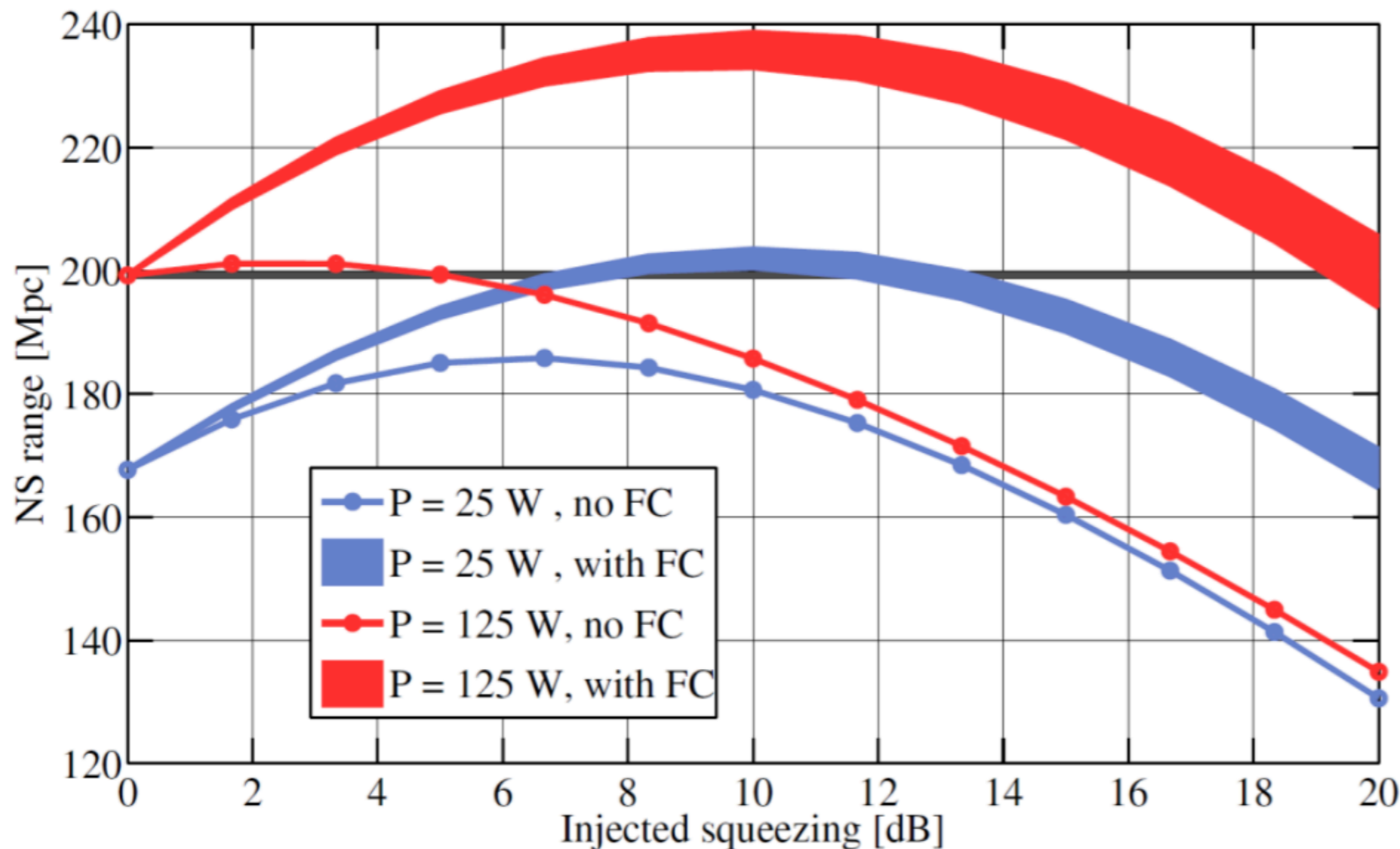
# Measurement of optical losses in a high-finesse 300 m filter cavity for broadband quantum noise reduction in gravitational-wave detectors

Eleonora Capocasa,<sup>1,2,\*</sup> Yuefan Guo,<sup>3</sup> Marc Eisenmann,<sup>4</sup> Yuhang Zhao,<sup>1,5</sup> Akihiro Tomura,<sup>6</sup> Koji Arai,<sup>7</sup> Yoichi Aso,<sup>1</sup> Manuel Marchiò,<sup>1</sup> Laurent Pinard,<sup>8</sup> Pierre Prat,<sup>2</sup> Kentaro Somiya,<sup>9</sup> Roman Schnabel,<sup>10</sup> Matteo Tacca,<sup>11</sup> Ryutaro Takahashi,<sup>1</sup> Daisuke Tatsumi,<sup>1</sup> Matteo Leonardi,<sup>1</sup> Matteo Barsuglia,<sup>2</sup> and Raffaele Flaminio<sup>4,1</sup>



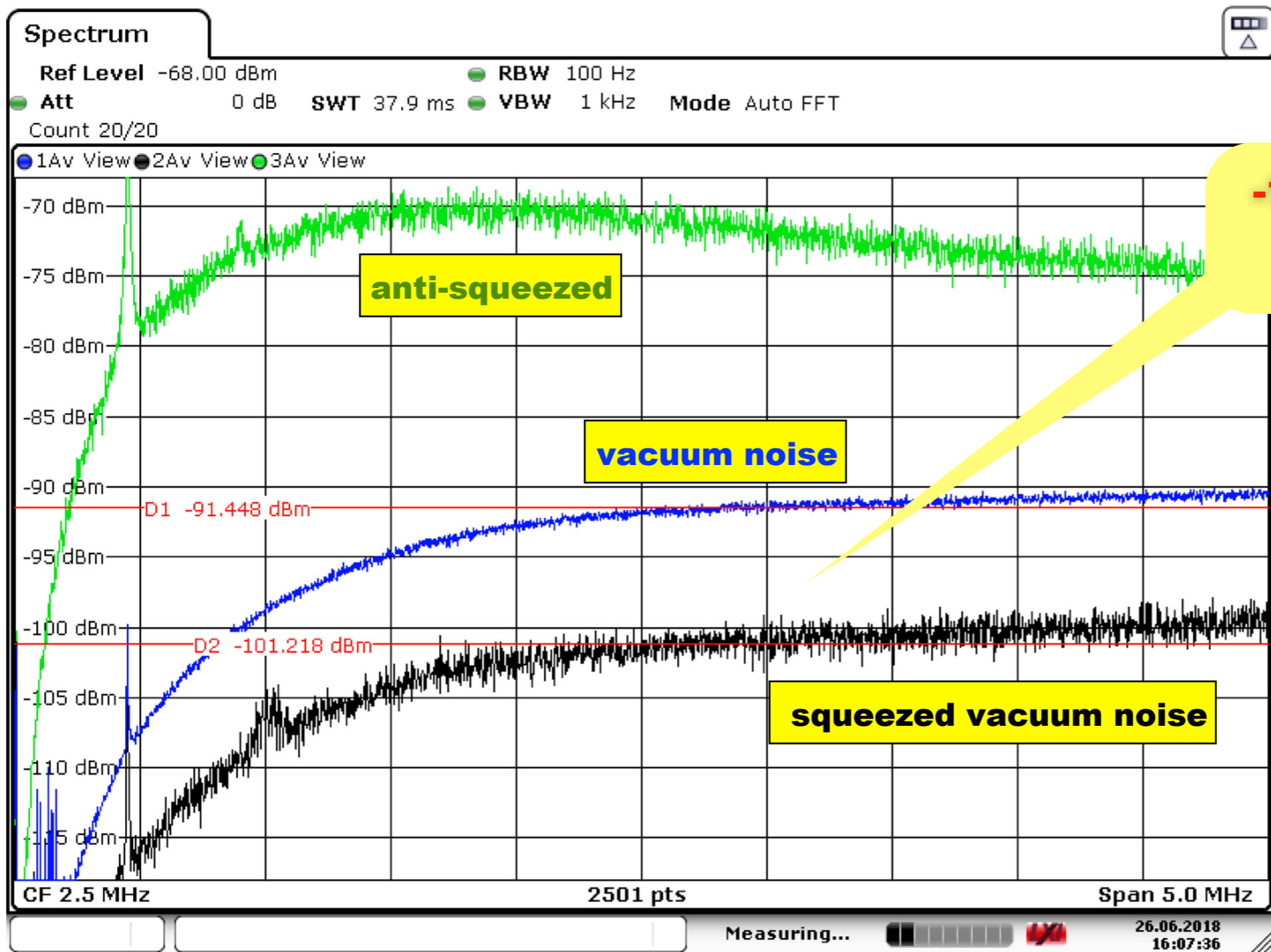
# For aLIGO parameters, about 10dB injection is optimal.

Range v squeezing



- Injecting more squeezing is not always a good thing
- Coupling from anti-squeezing can increase the noise

Figure Credit: John Miller



**-10dB Squeezed vacuum  
between 1-5 MHz**

Scan 10Hz ~ 5MHz  
 RBW=100 Hz

Squeezed at 3MHz  
 -9.76dB

Blue Line: 14.5mW Vacuum noise  
 Black Line: Squeezed signal  
 Green Line: Anti-squeezed signal

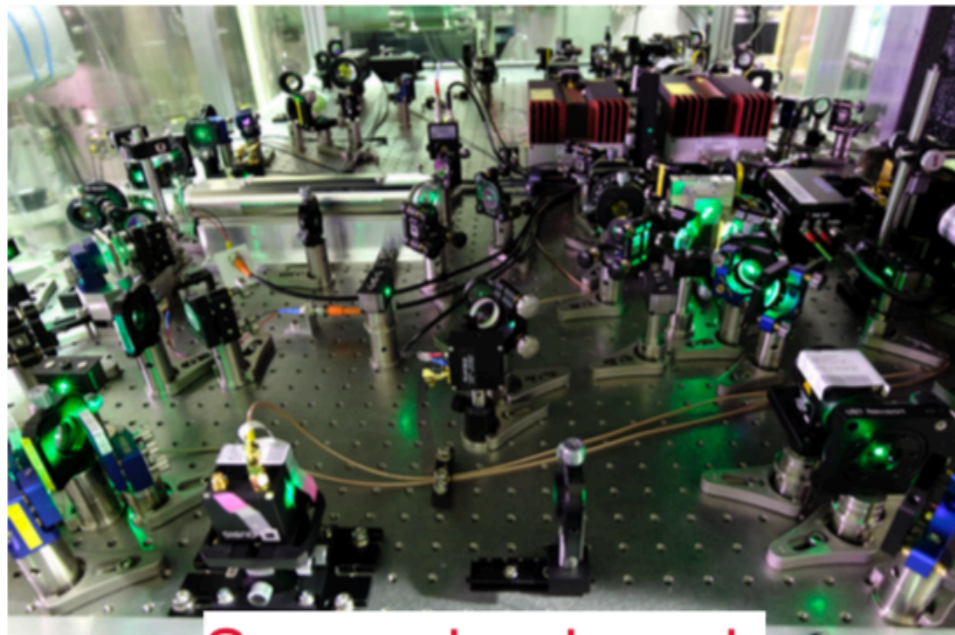
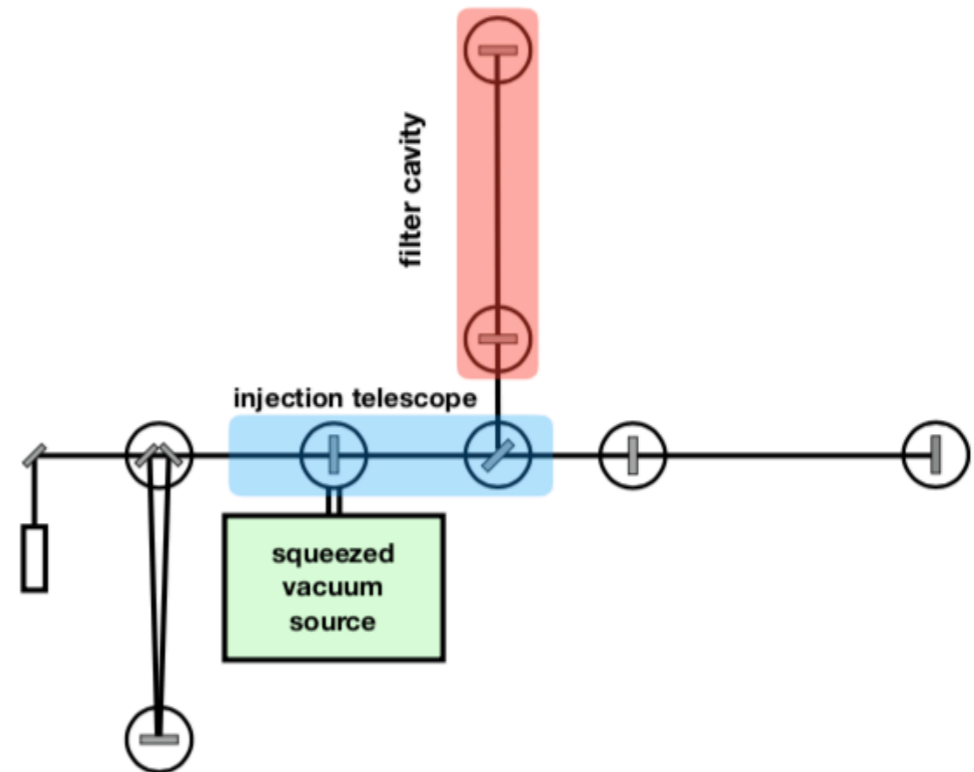
by Chien-Ming Wu (吳建明博士)

Date: June 26th, 2018

# Experiment overview

from: Eleonora Capocasa's slides

- Cavity length: 300 m
- Finesse: 4400
- 9 dB freq. independent squeezing



Squeezing bench



TAMA central building

**Dr. Chia-Ming Wu  
(NTHU)**

**Dr. Eleonora Capocasa  
(NAOJ)**

**Mr. Yuhang Zhao  
(NAOJ)**

**Miss Shu-Rong Wu  
(NTHU)**

**Mr. Naoki Aritomi  
(NAOJ)**

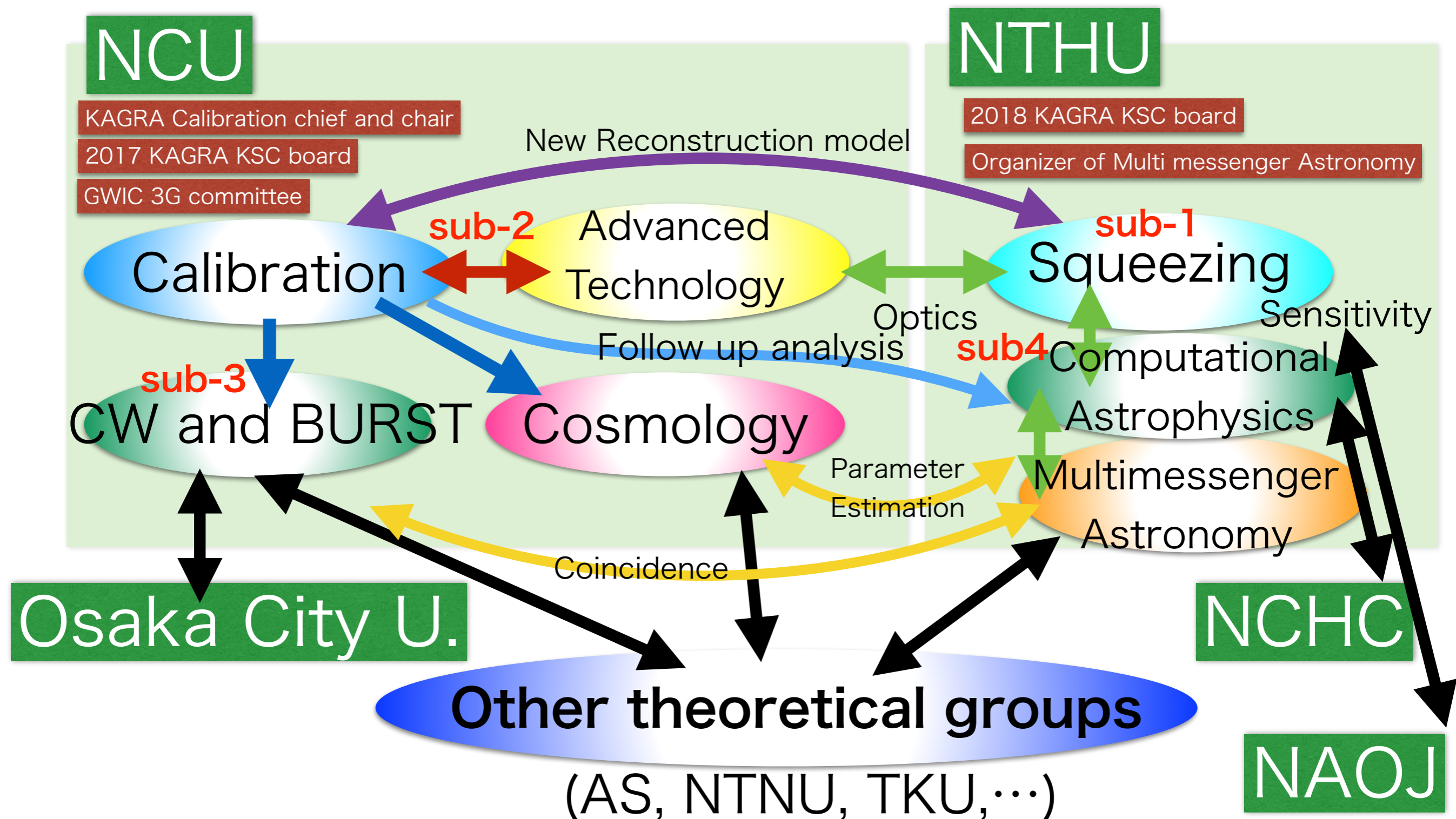


NAOJ, Nov. 25, 2018.

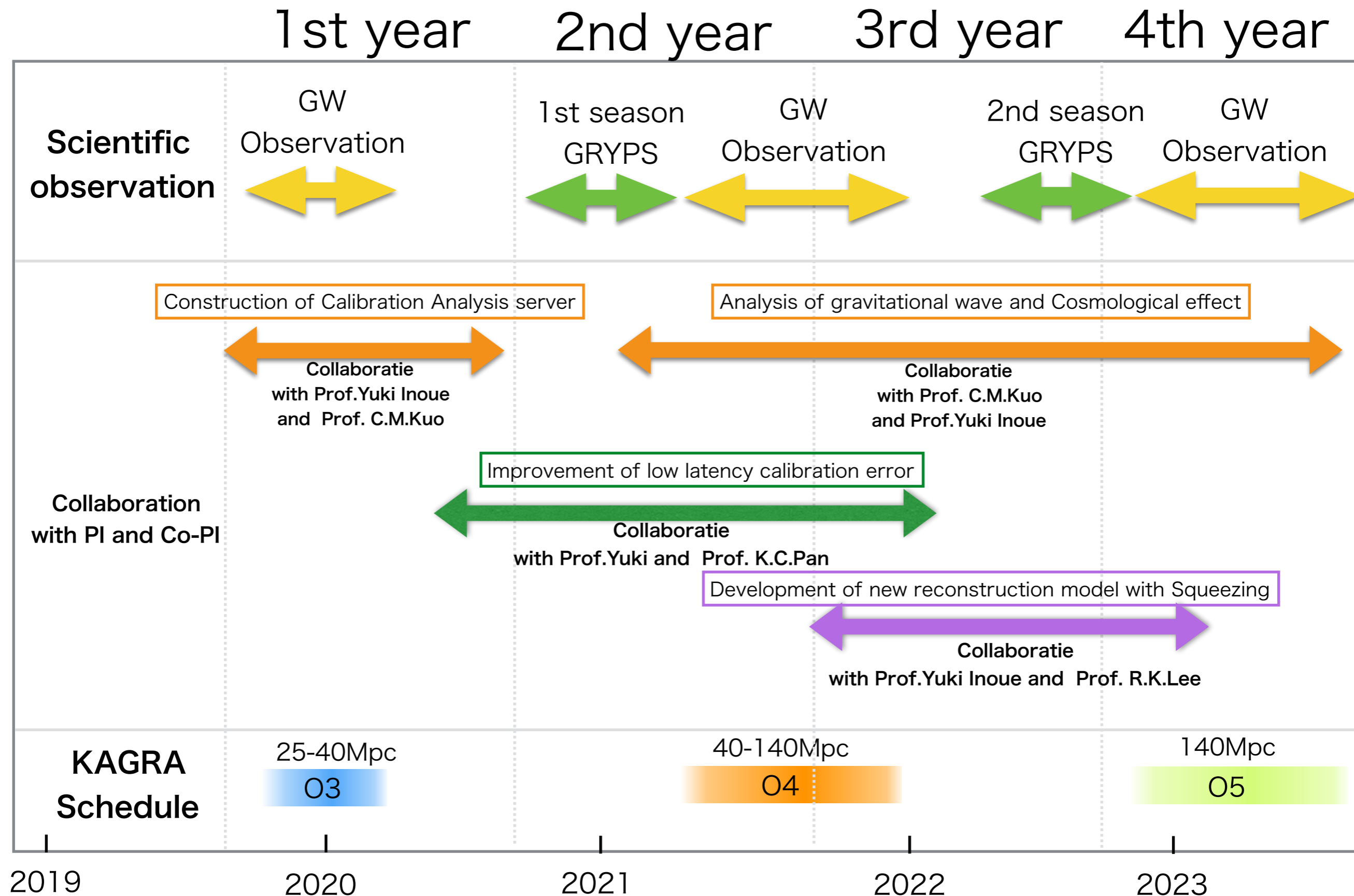
- **Taiwan side (with the Vanguard project):**
- **NT\$ 40 M (USD\$ 1.3 M) in total**
- **Starts from Aug. 2019 to July 2023 (KAGRA O3 - O5)**
- **Sub-Project 1: Frequency dependent squeezing light source for the gravitational wave detectors, PI: Prof. Ray-Kuang Lee (IPT/NTHU)**
- **Sub-Project 2: Cosmological and beyond the Newtonian survey by improving the calibration for gravitational wave observation, co-PI: Assistant Prof. Yuki Inoue (Phys/NCU)**
- **Sub-Project 3: Physics analysis of continuous wave and burst with KAGRA, co-PI: Associate Prof. Chia-Ming Kuo (Phys/NCU)**
- **Sub-Project 4: Gravitational waveforms from core-collapse supernova simulations, co-PI: Assistant Prof. Kuo-Chuan Pan (IoA/NTHU)**

# Experimental approach based on the collaboration of NTHU and NCU

from: Yuki Inoue's slides



The experimental approach is essential for Taiwan GW  
community



# Outlook:

- **Task-Force on squeezer**
  - Frequency independent/dependent squeezer for KAGRA
- **with Ray-Kuang Lee (NTHU) and Matteo Leonardi (NAOJ)**
- ✓ toward -10dB squeezing
- toward audio-frequency via filter cavity, with NAOJ (2019)
- frequency dependent squeezing (2020)
- (**target: 140 Mpc for O5**)
- **Challenges:**
  1. Budget
  2. On-site Foot Space and Commissioning (O4 - O5)

# Thanks for your attentions ^.^

