



Development of Auxiliary Locking System in Gravitational Wave Telescope KAGRA II

Ryosuke Sugimoto (U. Toyama) on behalf of KAGRA collaboration

email : m1841105@ems.u-toyama.ac.jp

Outline

- **Overview of Auxiliary Locking System**
- **Overview of fiber noise cancellation system**
- **Current status of fiber noise cancellation system**
- **Summary and future plan**

Outline

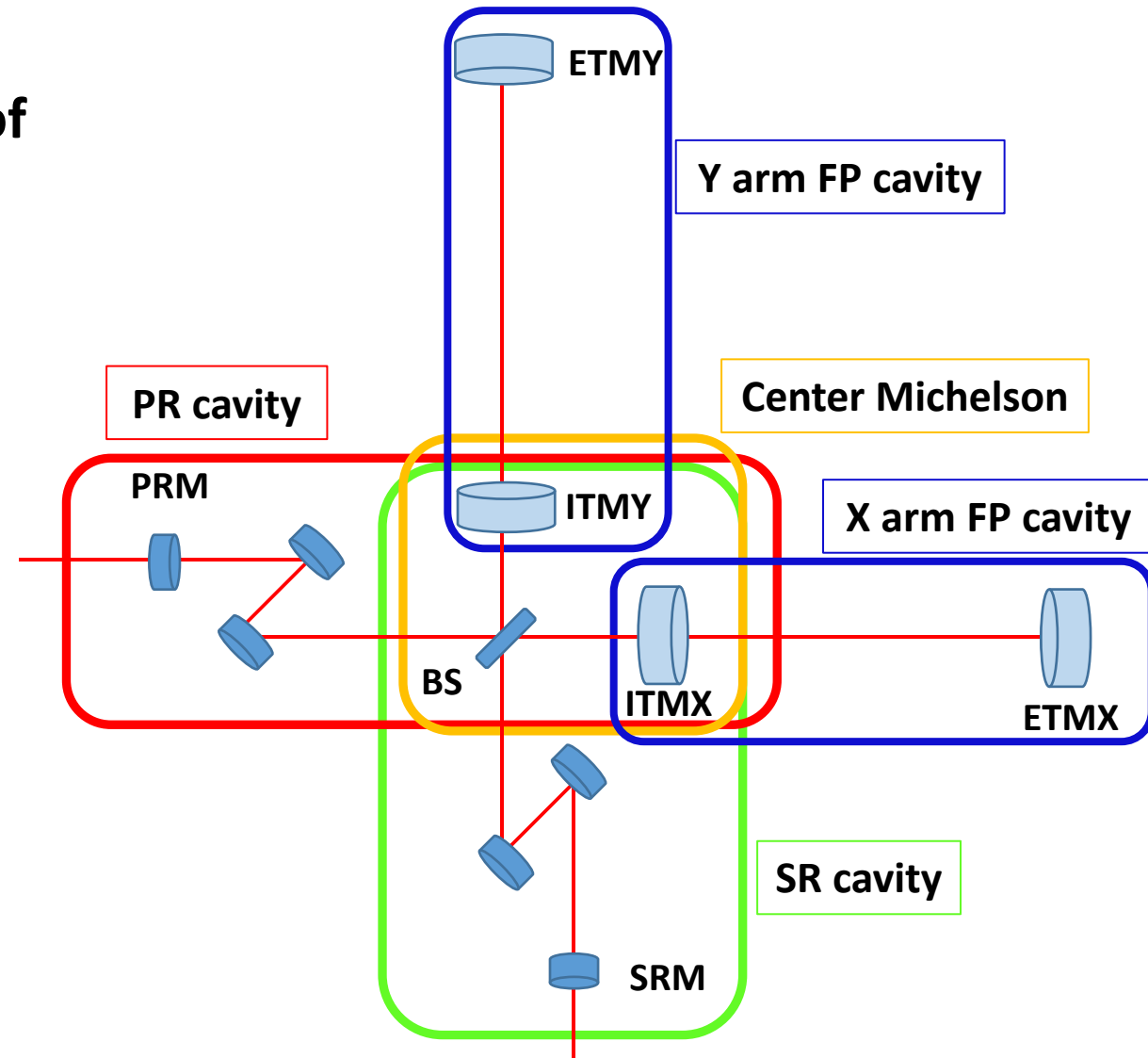
- **Overview of Auxiliary Locking System**
- Overview of fiber noise cancellation system
- Current status of fiber noise cancellation system
- Summary and future plan

Overview of length sensing and control

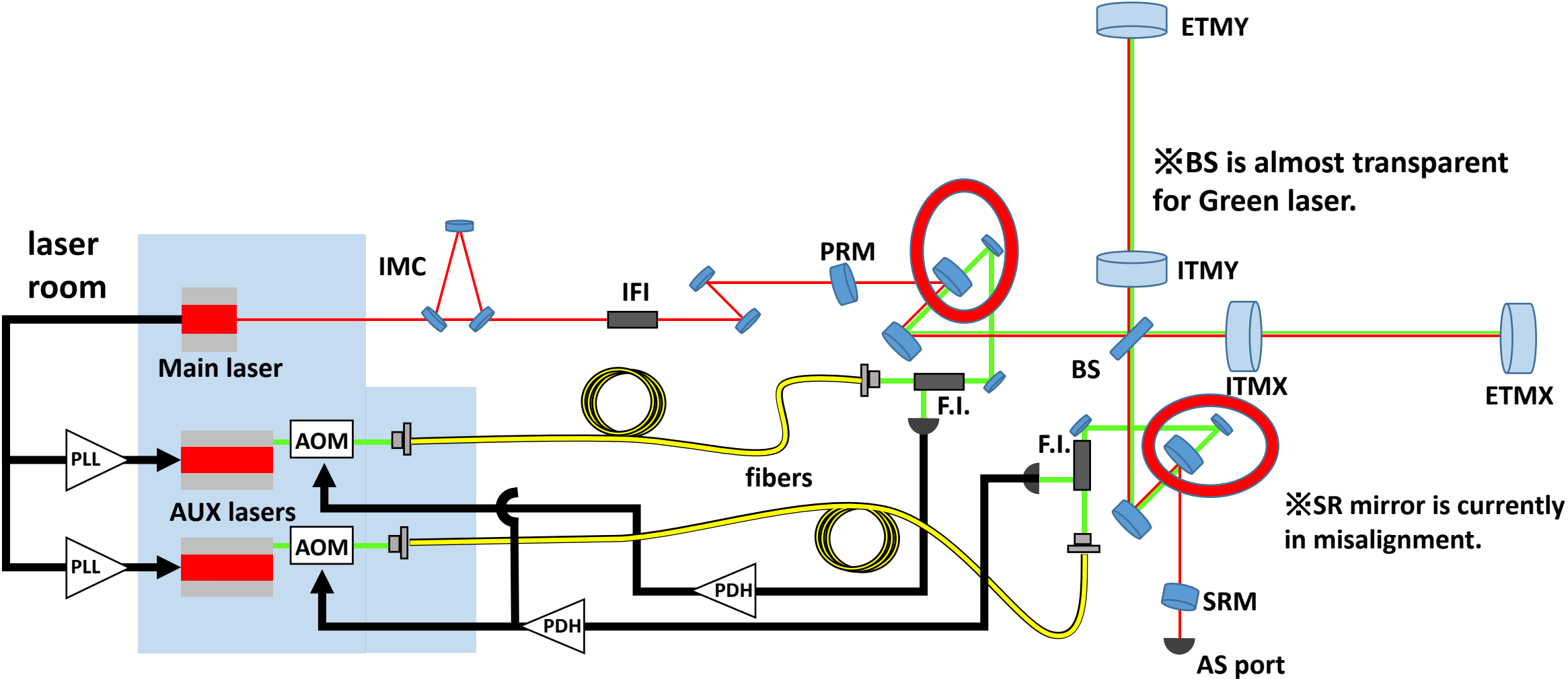
- KAGRA has complex configuration consisting of multiple interferometers and cavities.
- The distances between these mirrors must be controlled simultaneously.
- However, it is difficult to control these degrees of freedom at once.



Auxiliary Locking System



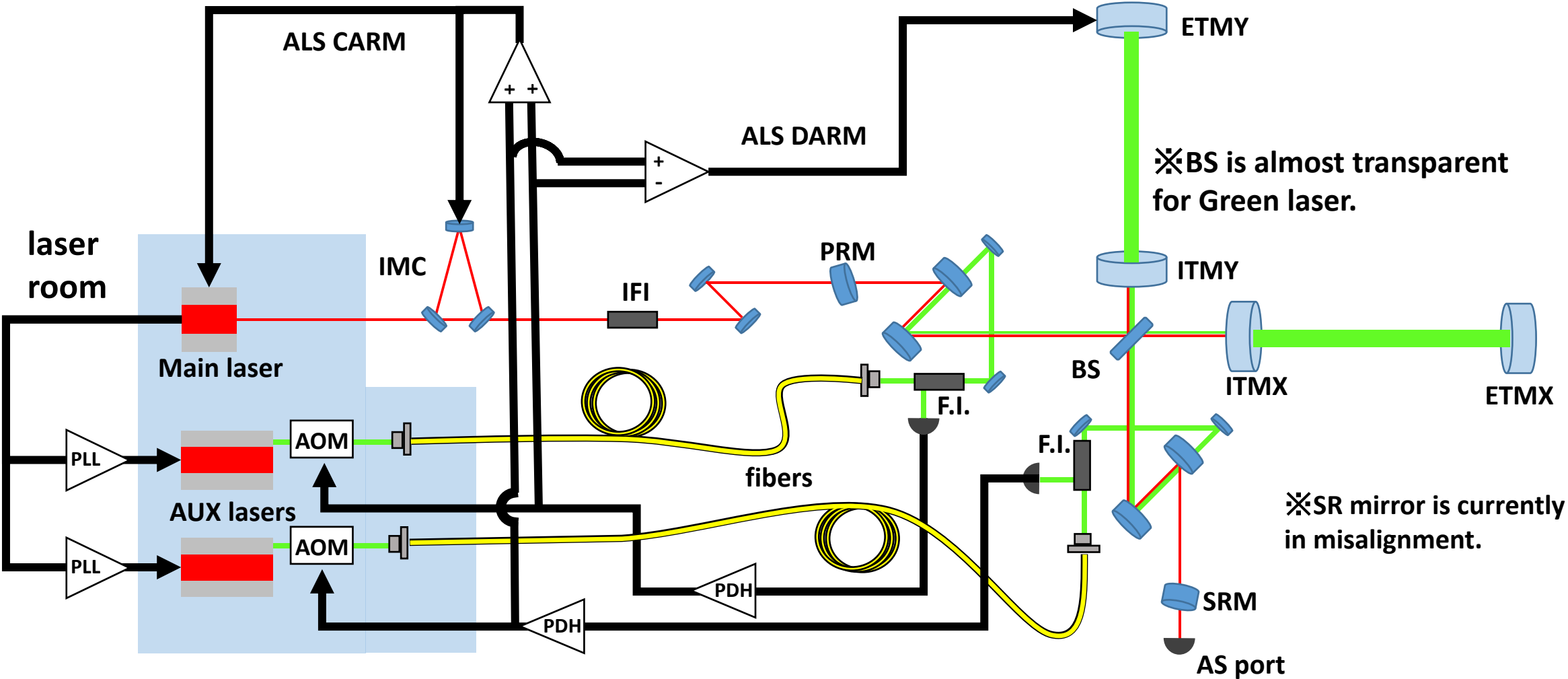
Overview of Auxiliary Locking System



※BS is almost transparent for Green laser.

※SR mirror is currently in misalignment.

Overview of Auxiliary Locking System

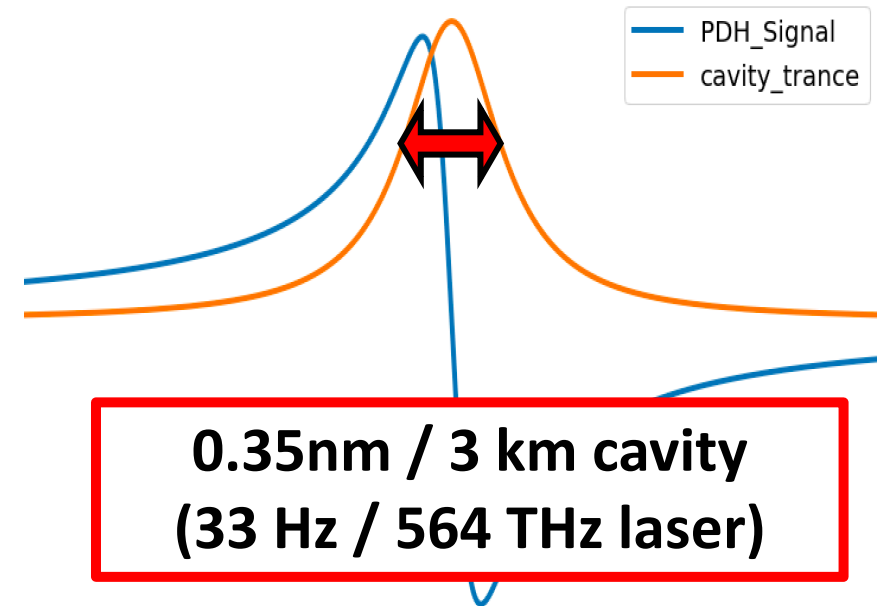


Overview of Auxiliary Locking System

Requirement of Auxiliary Locking System

- Fluctuation of arm length **<0.35 nm**
(Frequency fluctuation of green laser **<33 Hz**)
- Resonance duration with green laser
> 2 hours or more

The line width of the main cavity
for the main laser

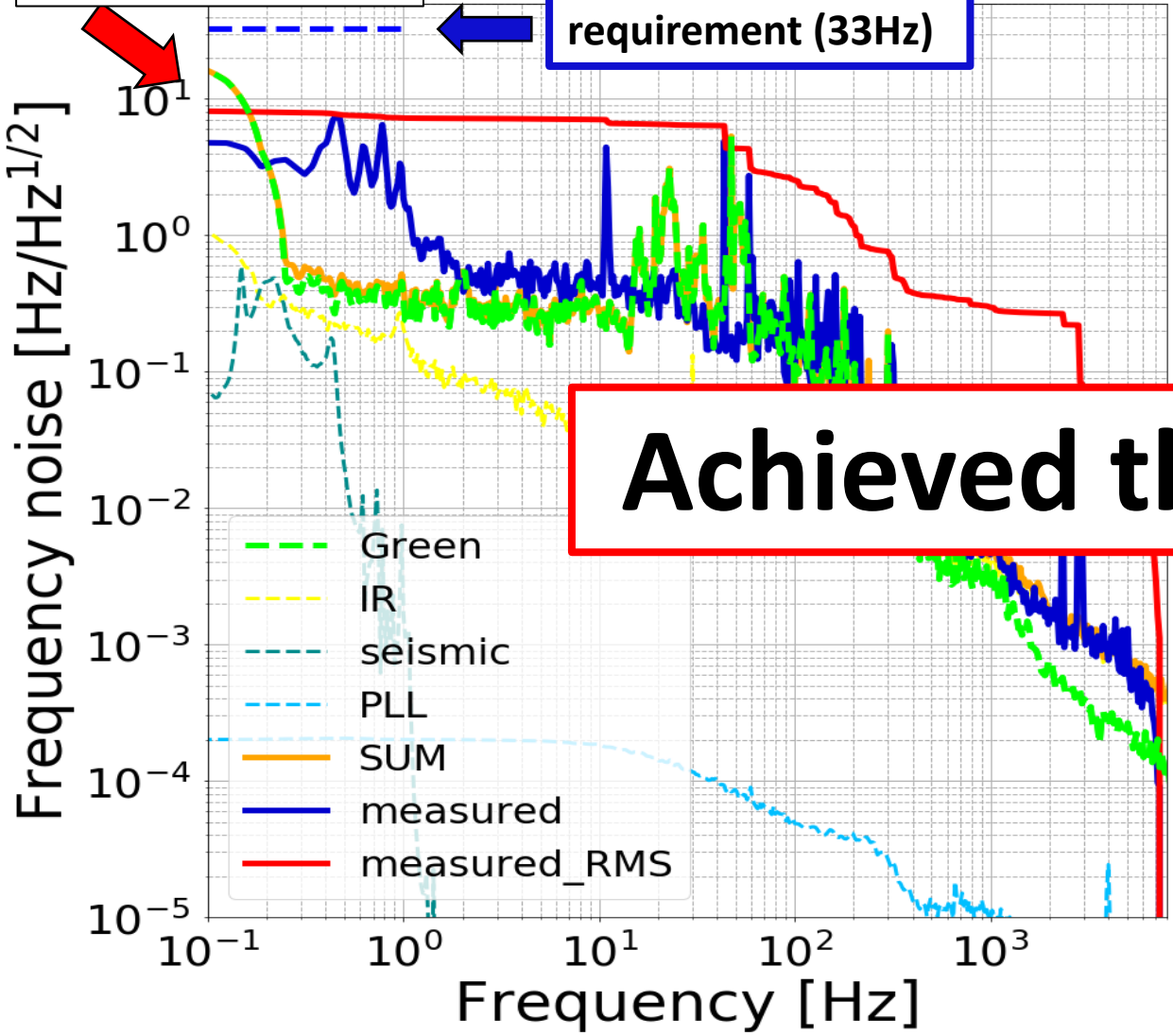


The noise budget of Auxiliary Locking System

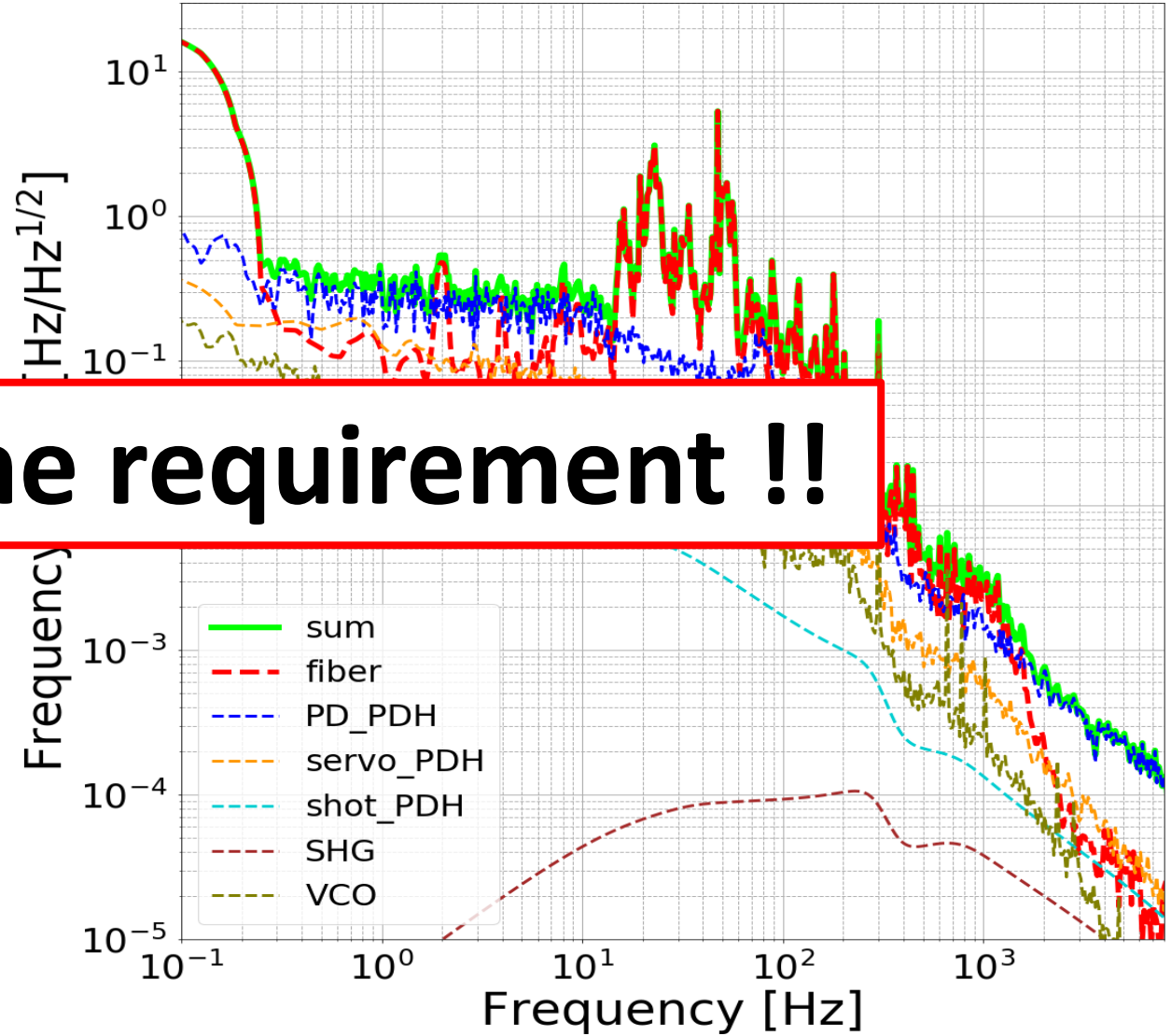
Measured noise RMS
= **8.2Hz** @ 0.1Hz

requirement (33Hz)

Green noise budget

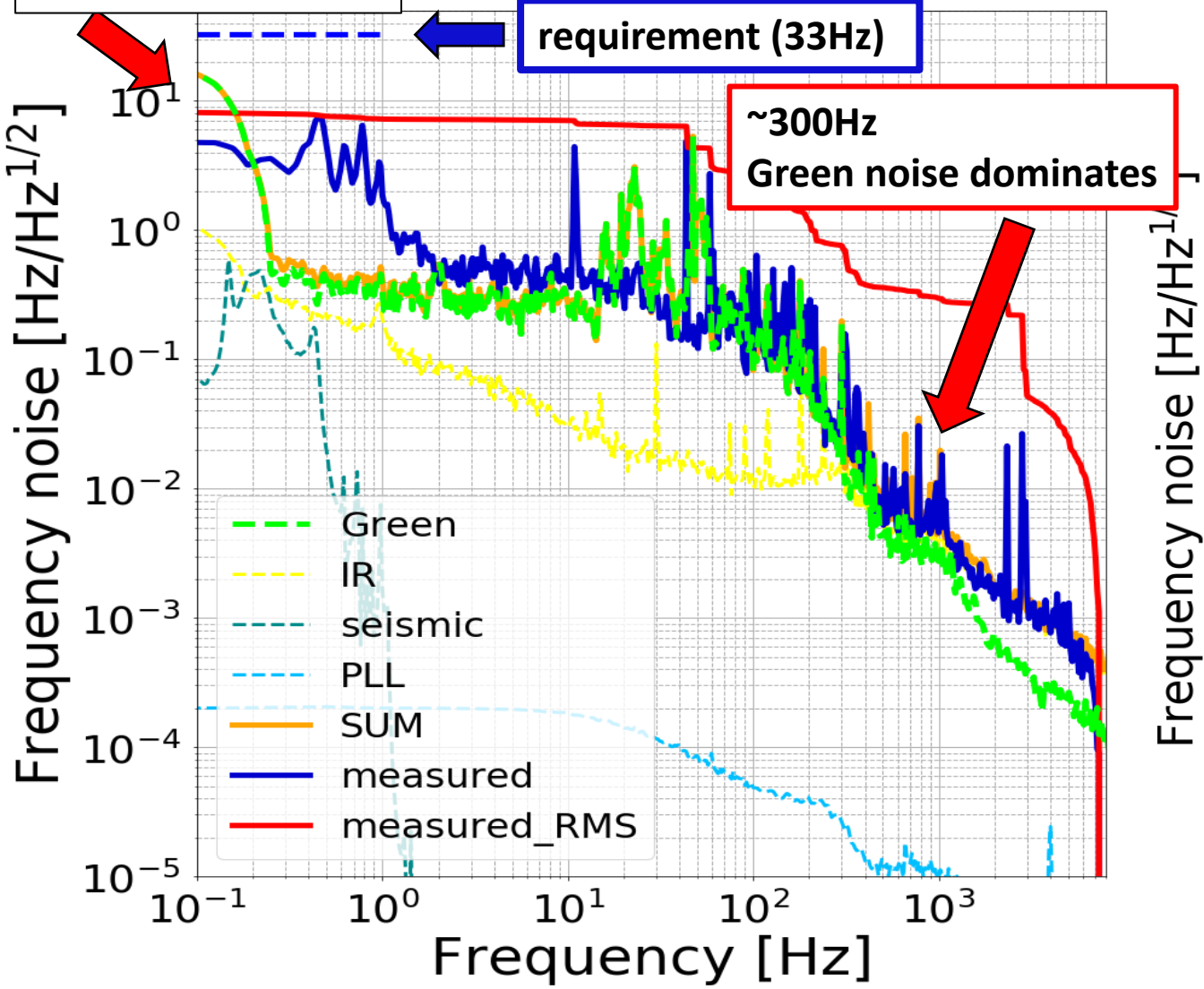


Achieved the requirement !!

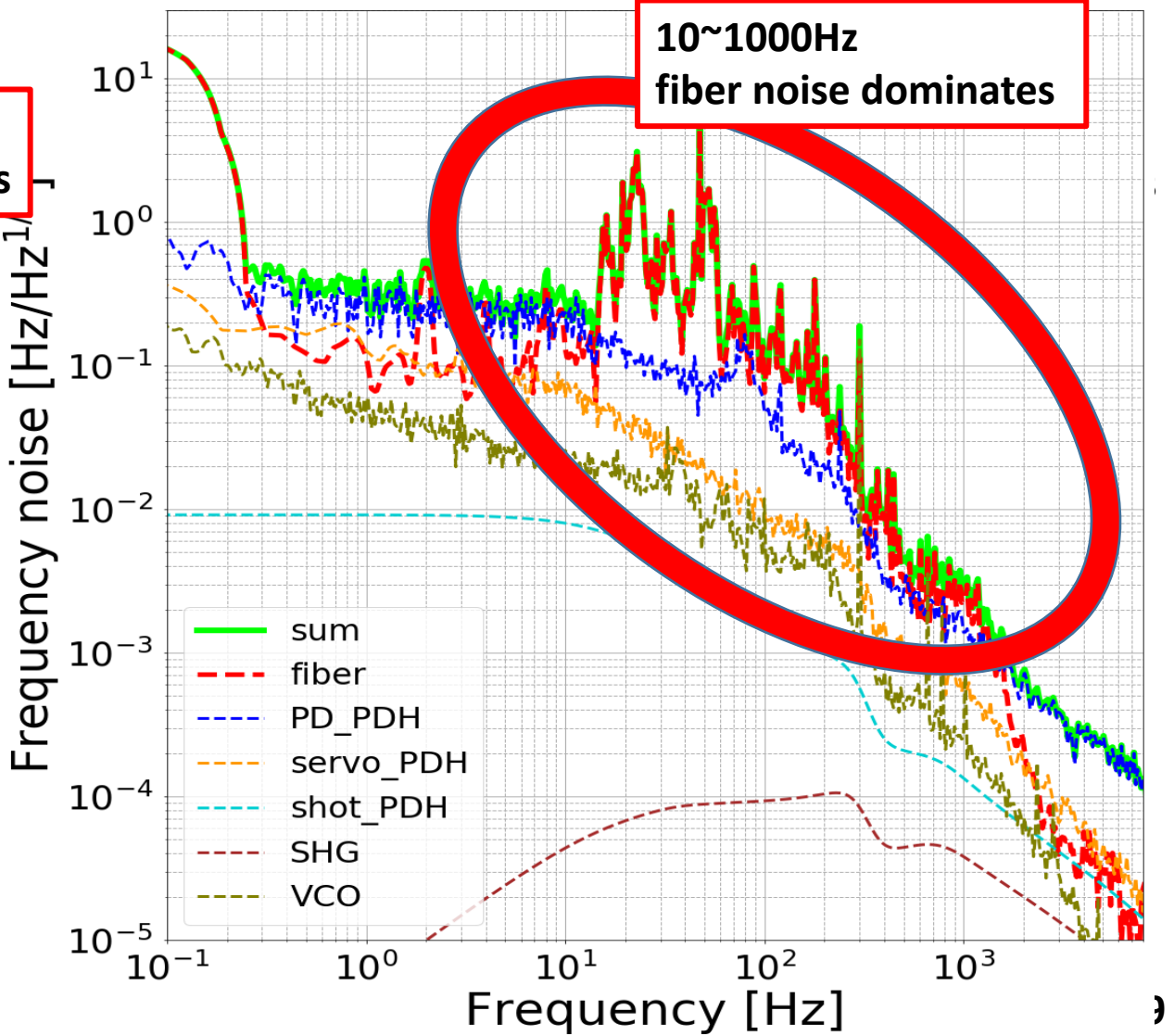


The noise budget of Auxiliary Locking System

Measured noise RMS
= **8.2Hz** @ 0.1Hz



Green noise budget

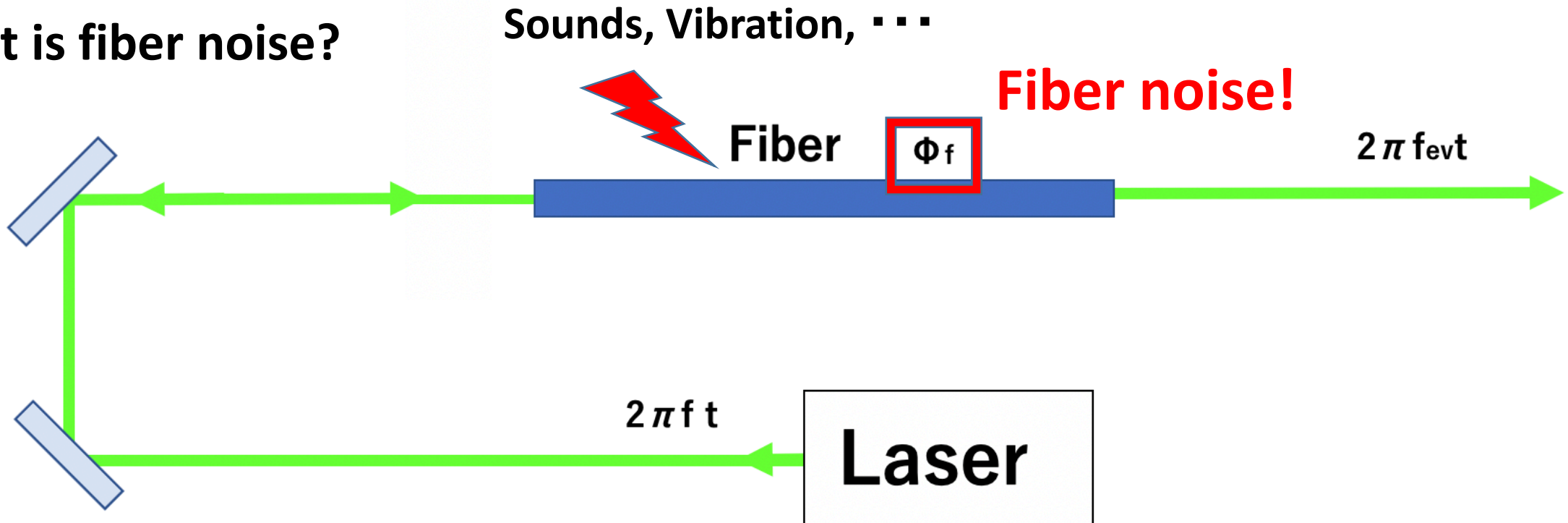


Outline

- Overview of Auxiliary Locking System
- **Overview of fiber noise cancellation system**
- Current status of fiber noise cancellation system
- Summary and future plan

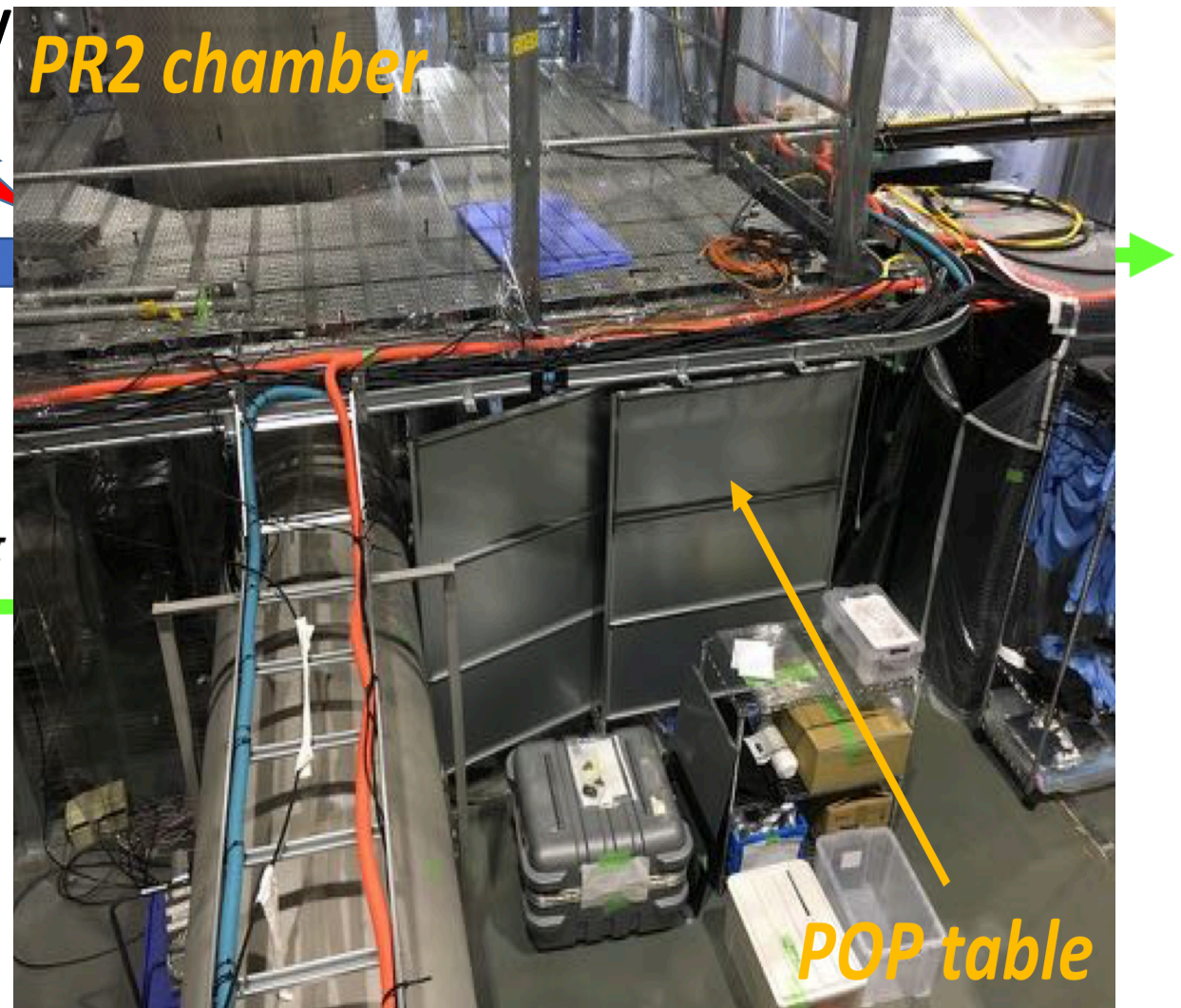
Overview of fiber noise cancellation system

What is fiber noise?



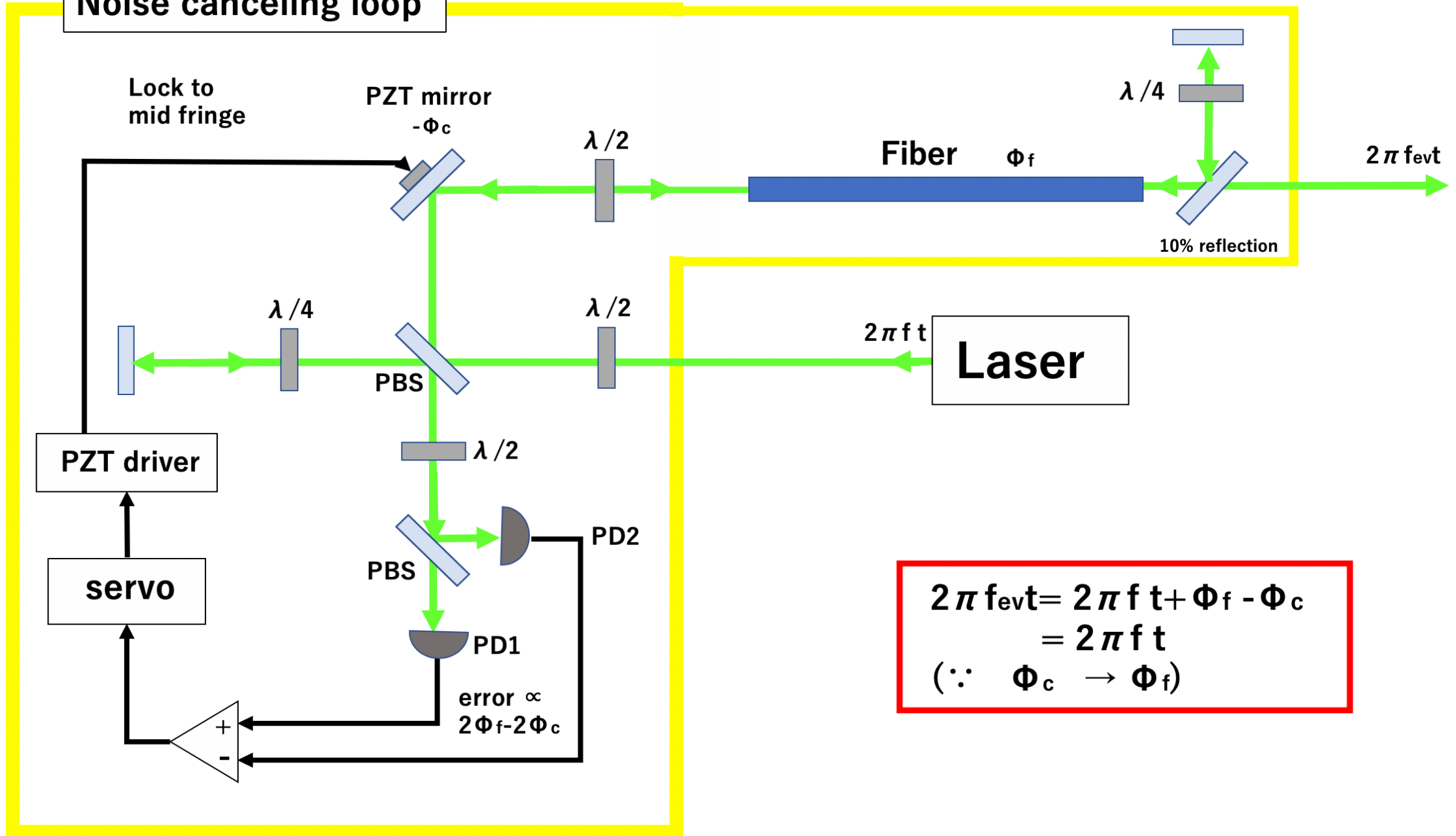
$$2\pi f_{ev} t = 2\pi f t + \Phi_f$$

Overview of fiber noise cancellation system



K. Yokogawa JGW-G1808954-v1

Noise canceling loop

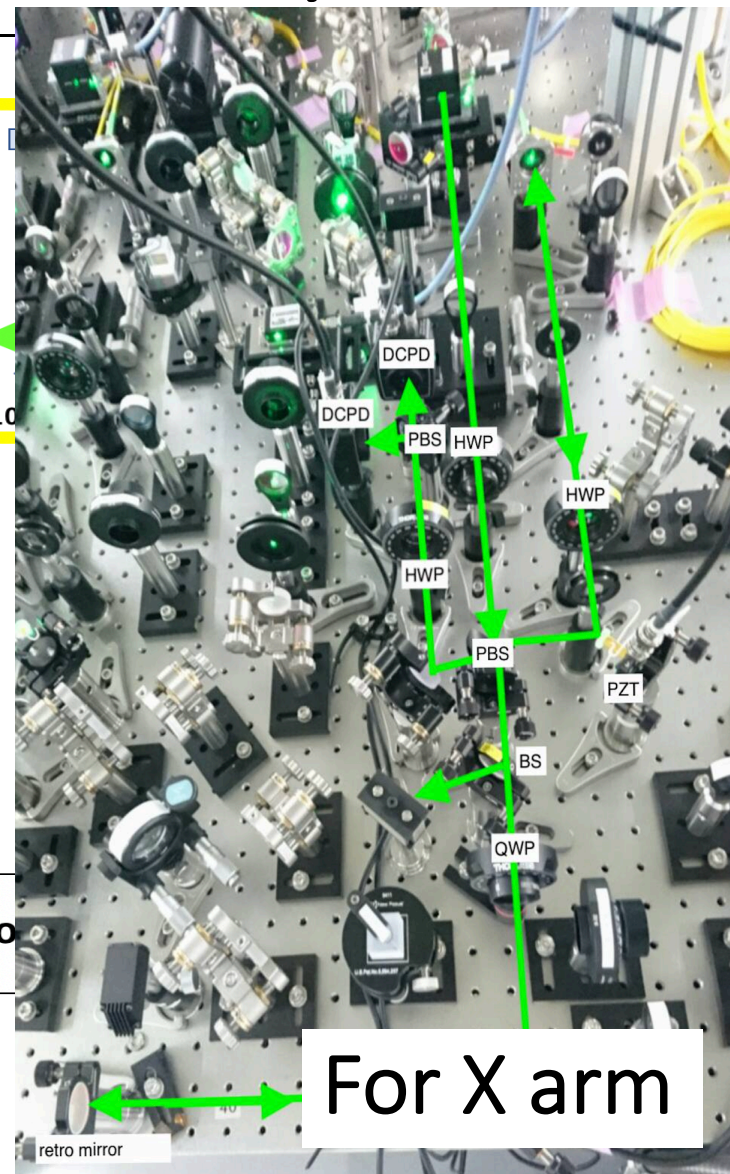
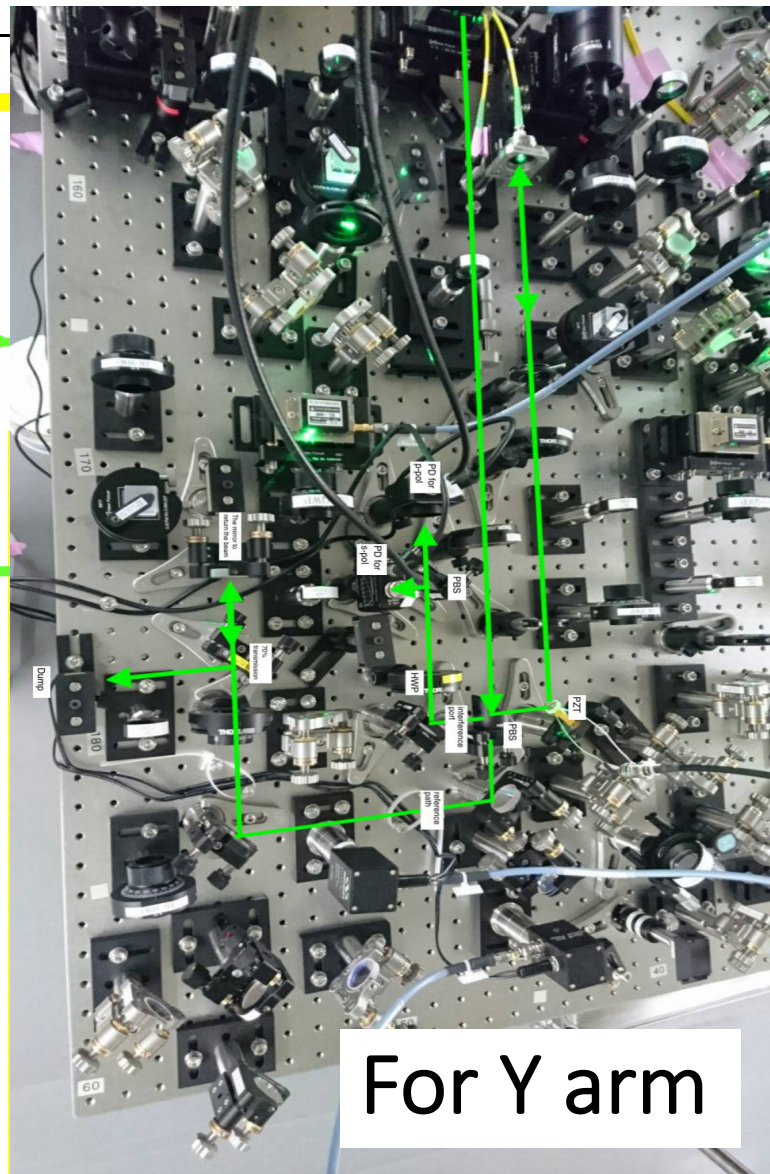
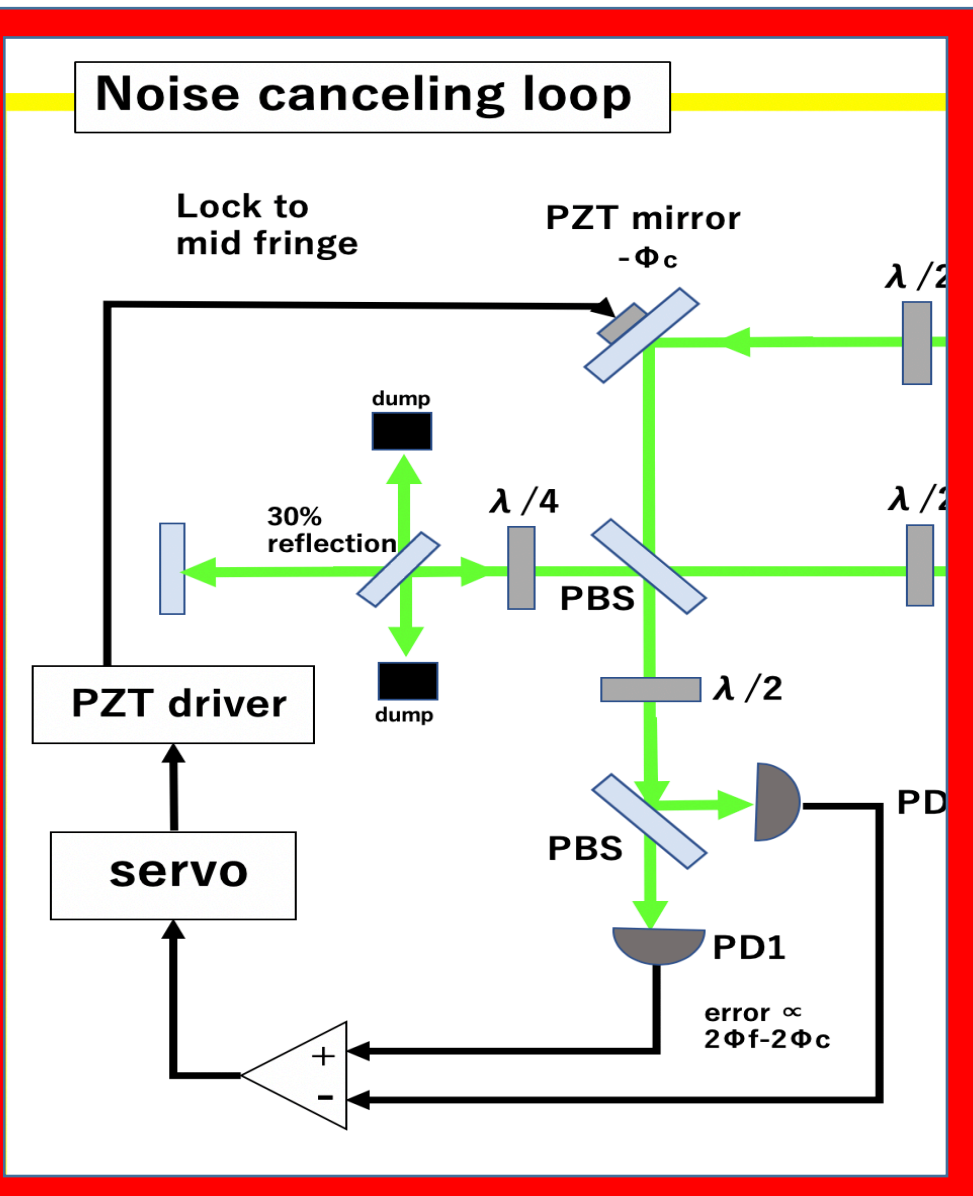


$$\begin{aligned}
 2\pi f e v t &= 2\pi f t + \Phi_f - \Phi_c \\
 &= 2\pi f t \\
 (\because \Phi_c &\rightarrow \Phi_f)
 \end{aligned}$$

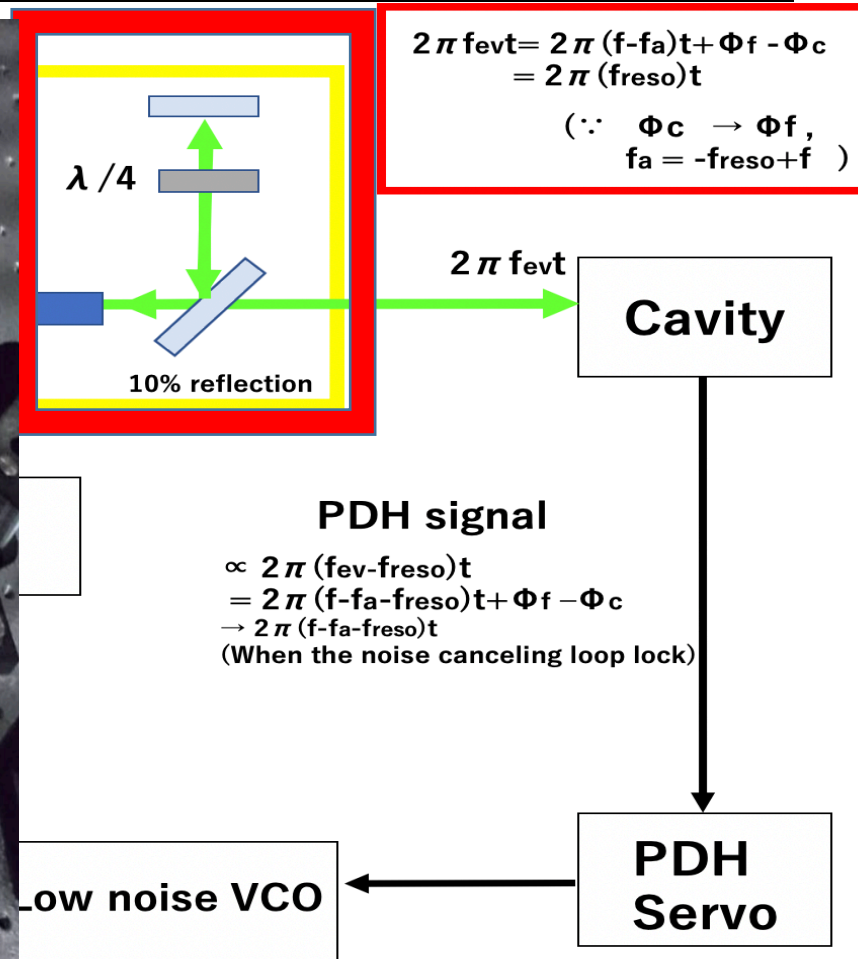
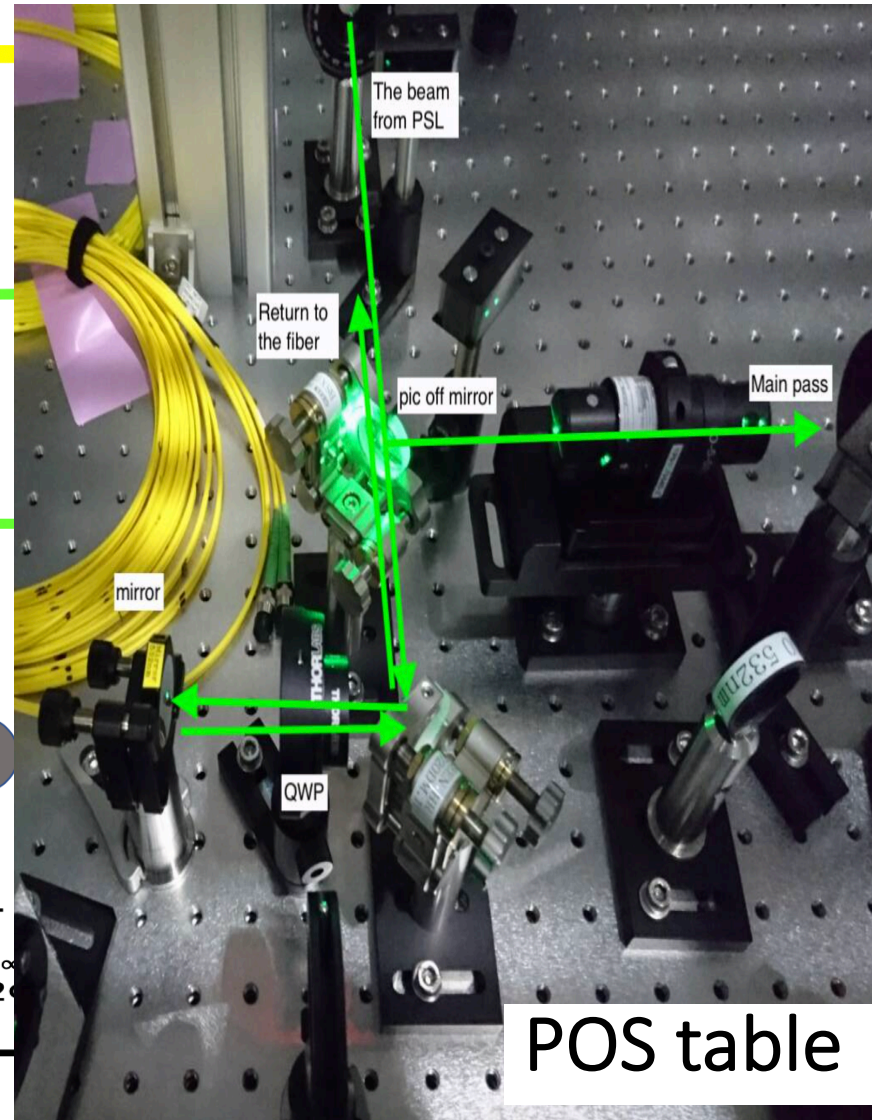
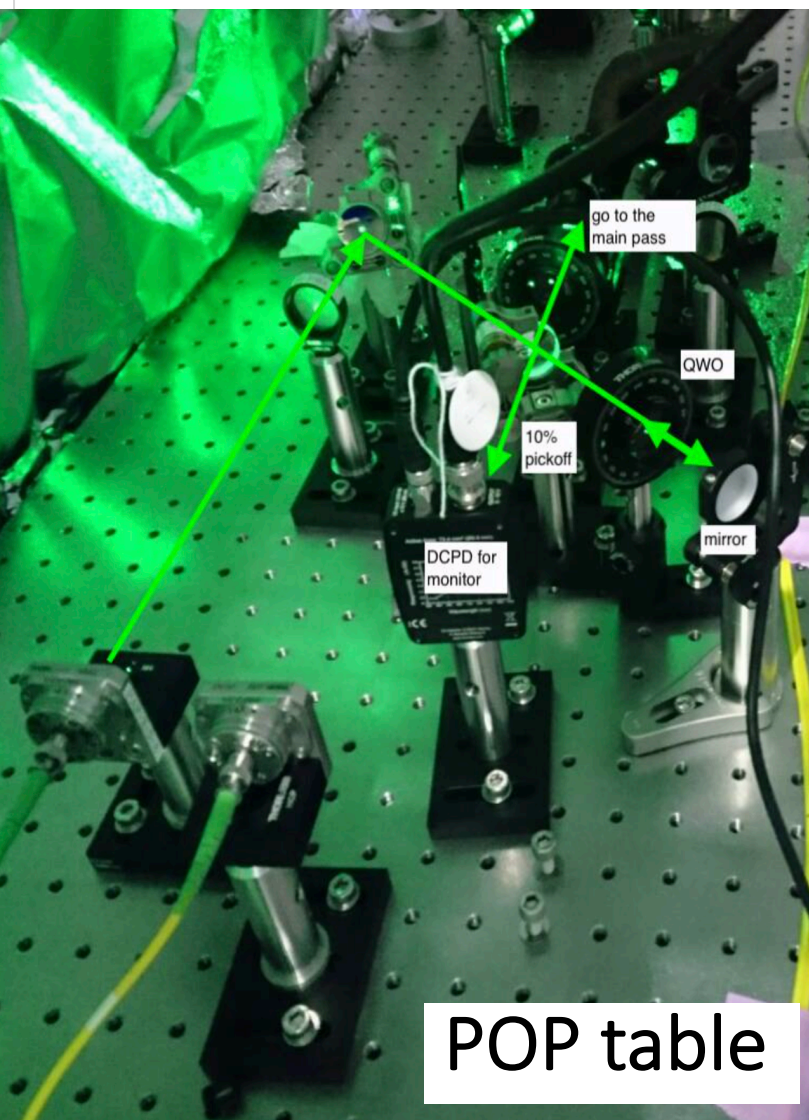
Outline

- Overview of Auxiliary Locking System
- Overview of fiber noise cancellation system
- **Current status of fiber noise cancellation system**
- Summary and future plan

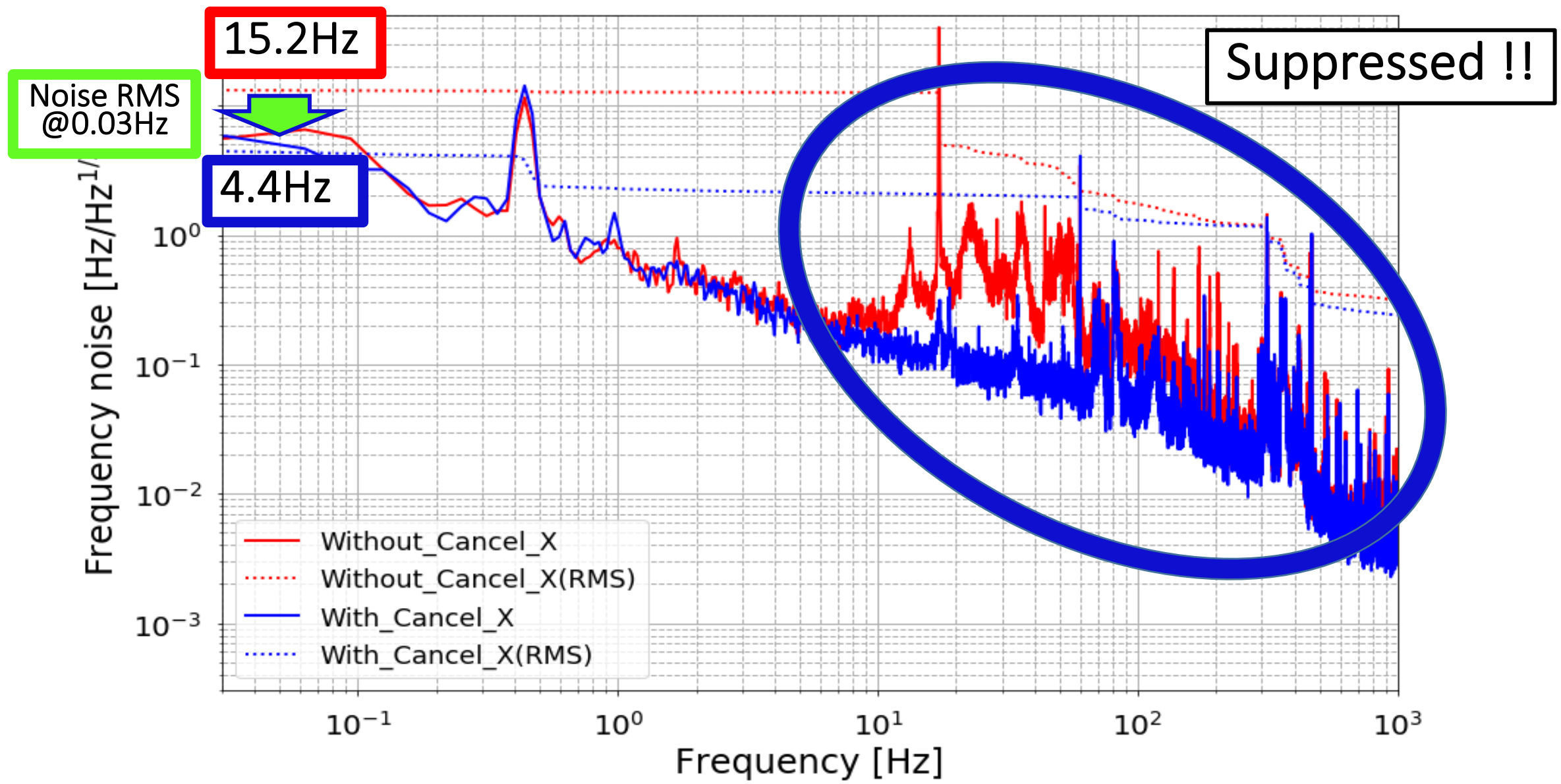
Current status of fiber noise cancellation system



Current status of fiber noise cancellation system



Sensing noise of Auxiliary Locking System



Outline

- Overview of Auxiliary Locking System
- Overview of fiber noise cancellation system
- Current status of fiber noise cancellation system
- **Summary and future plan**

Summary

- **Auxiliary Locking System is indispensable for KAGRA into observation run.**
- **We installed the Auxiliary Locking System with the fiber noise cancellation system in the both arms of X and Y.**
- **The sensing noise of Auxiliary Locking system successfully reduced by the cancellation loop.**
RMS (@0.03Hz) of the sensing noise reduced from about 15Hz to about 4Hz.
- **We can control the interferometer stably.**