Vibration analysis of Cryostat on KAGRA site

Toshiro Ochi[1], Kazuhiro Yamamoto[2], Nobuhiro Kimura[3], Toshikazu Suzuki[3],
Shigeaki Koike[3], Takayuki Tomaru[3] , Shinji Miyoki[2]
[1]*ICRR*, [2]*The Univ. of Toyama*, [3]*KEK*,

1. Introduction

The mirrors in Fabry-Perot cavity of KAGRA, which is a laser interferometric type gravitational wave detector, are cooler down(20K) by cryocoolers to reduce thermal noise. Also, a heat link to cool the mirror is connected to Cryogenic payload to reduce vibration propagating.

As a result, the vibration of cryocoolers and ground by way of heat links can shake mirror, which is a noise source for the gravitational wave signal(Fig.1). Radiation shield has a double structure, outer 80K shield, inside 8K shield(Fig.2).

In this poster, we report the vibration measurement result of the cryostat and the hammering test result.

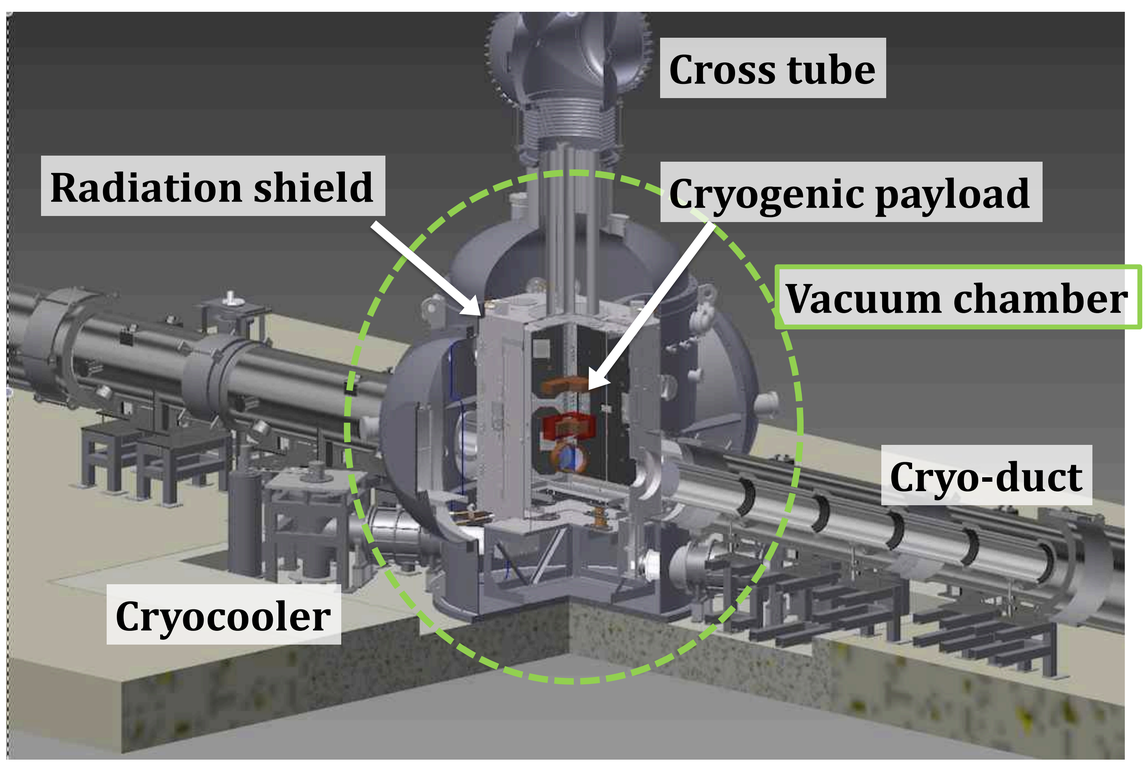

Fig.1 Cryostat and Cryocooler

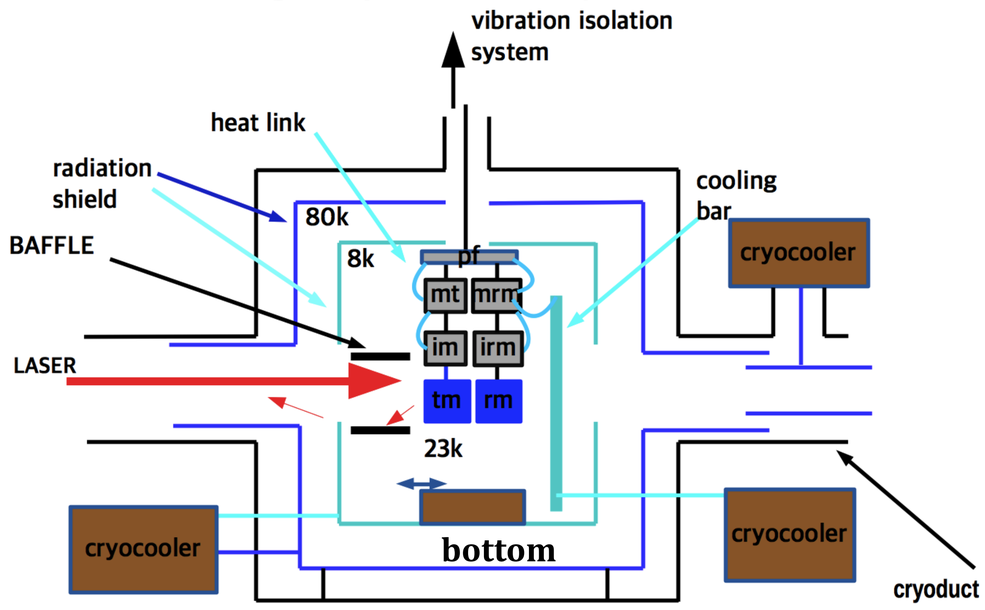

Fig.2 Radiation shield and Cryogenic Payload

2. Purpose and Method

Purpose

We measured the radiation shield vibration with the cryocooler running. So we are going to estimate noise due to cryocooler running.

And we carried out hammering test to investigate the resonance frequency of each part of the cryostat.

Using Accelerometer

- Cryo-accelerometer we developed
  → installed on the 8K radiation shield bottom
- commercially available accelerometer
  → to measure the vibration of other places in cryostat

3. Measurement Results

Cryocooler vibration and Identification of peaks in shield vibration spectrum

2 types of cryocoolers with different operating frequencies :1.6 Hz and2 Hz
1.6Hz:for cryo-duct
2Hz:for radiation shield and cryogenic payload

➡ Observed!

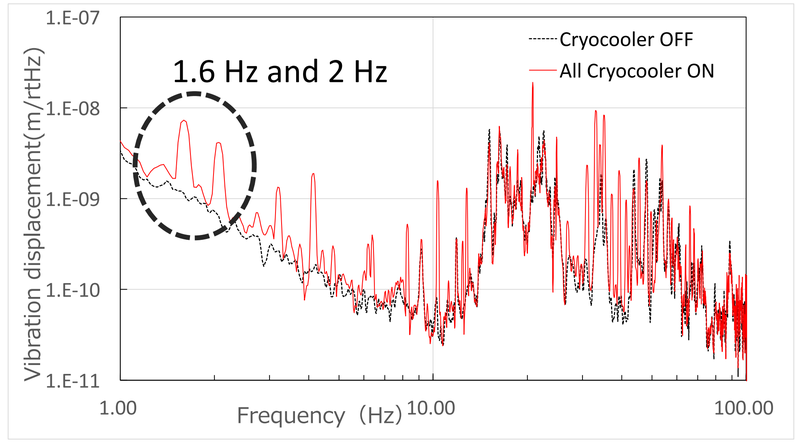

Fig.3 cryocooler vibration

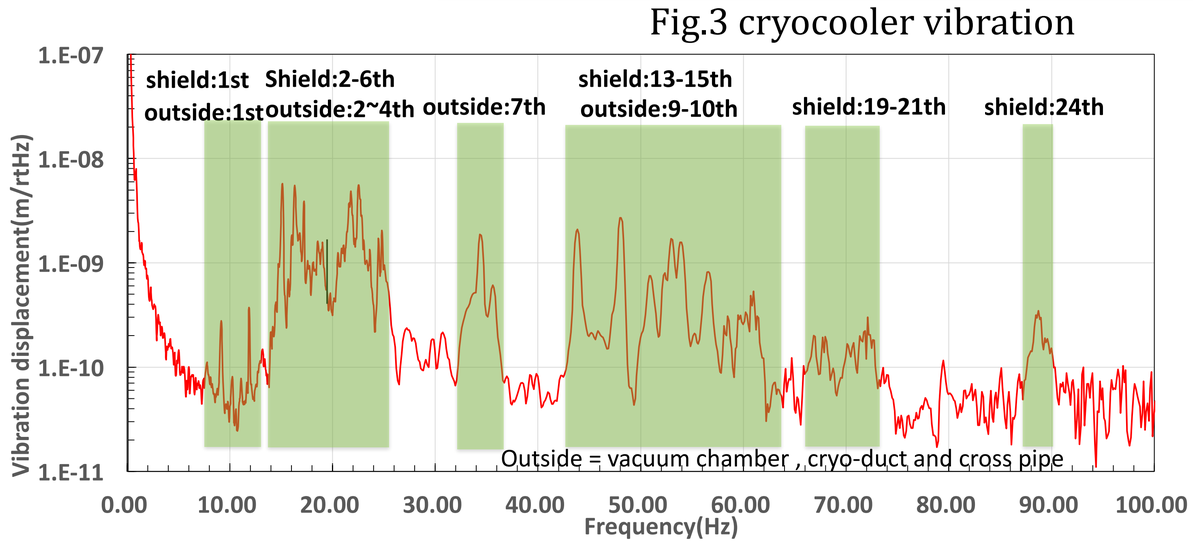

Fig.4 vibration of radiation shield and resonance frequency

We measure the vibration of the bottom of the radiation shield under room temperature and vacuum(Fig.3). And we compared with the resonance frequency obtained in the hammering test. Many peak frequencies in spectrum of shield vibration are consistent with resonant frequencies in hammering test result(Fig.4).

Correlation of vibration between radiation shield bottom and the top of the cooling bar(cryocooler operating)

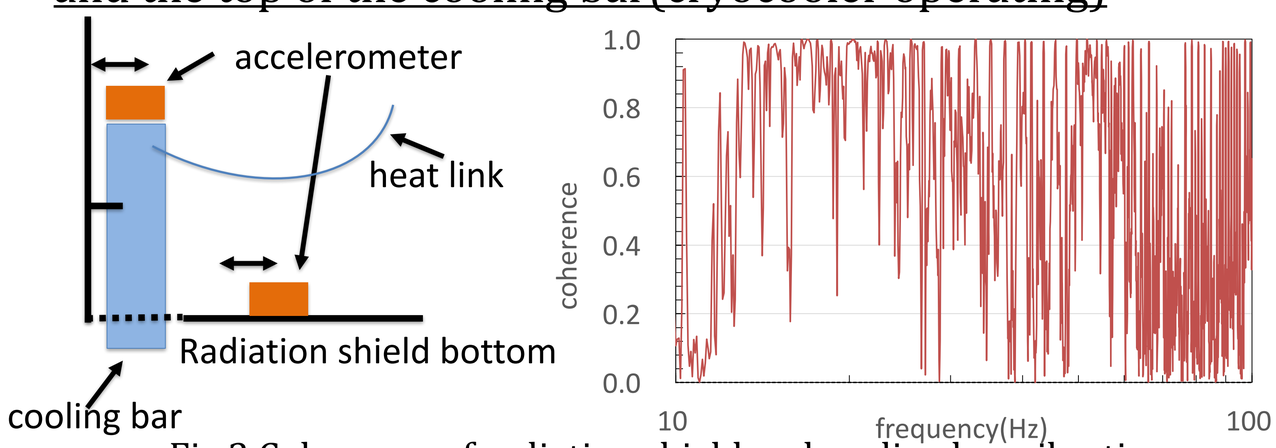

Fig.3 Coherence of radiation shield and cooling bar vibration

Simultaneous measurement of the vibration of the bottom of the radiation shield and the top of the cooling bar was performed in the EYC cryostat, while operating the cryocooler. As a result of calculating its coherence, it was found that there is a correlation particularly in the vicinity of the peak in the region of 10 to 100 Hz.

4. Summary

We conducted the vibration measurement and hammering test of the radiation shield of the cryostat. As a result, the peaks appearing in the vibration spectrum were due to the resonance of the vacuum chamber and the radiation shield. In addition, it was found that there is a correlation between the vibration of the radiation shield bottom and the tip of the cooling rod.