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Installation of Input Mode Cleaner of iKAGRA

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1.Introduction

In initial KAGRA(iKAGRA), Input Mode Cleaner(IMC) reduces the beam jitter. The requested mode-matching ratio of IMC is ***93%(in bKAGRA)*** and the designed values of IMC are;

Round trip length ; ***L = 53.3 [m]***
MCi mirror: radius of curvature ∞[m]
MCo mirror: radius of curvature ∞[m]
MCe mirror : radius of curvature ***R = 37.3[m]***

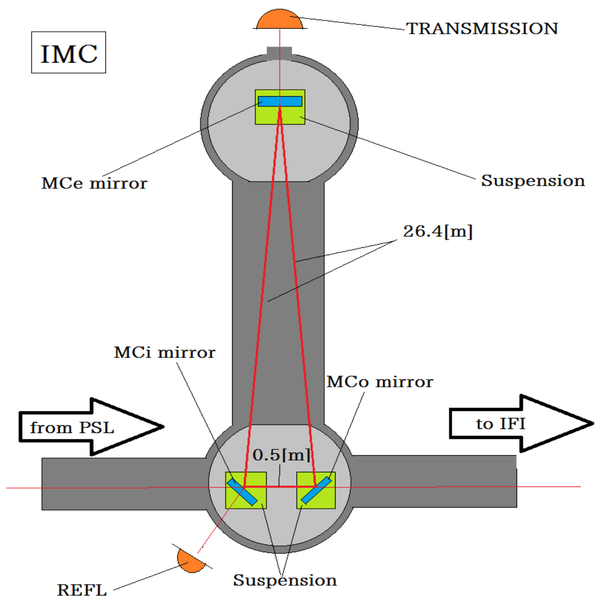

Fig.1.1: IMC

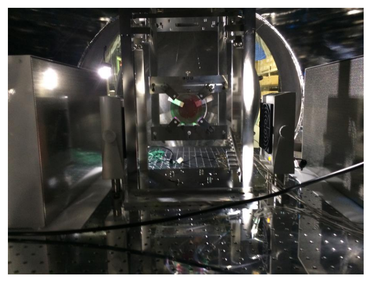

Fig.1.2: MCe

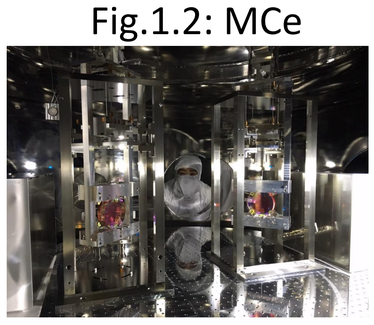

Fig.1.3: MCi and MCo

2.Installation of IMC

IMC was installed in four man group. First we read over the manual and cleaned up the vacuum chamber using the air-gun with HEPA filters all day long(Fig.2) and measured the number of particles(Fig.3). Second we practiced hanging dummy mirror with nano wires again and again and we rehearsed completely. Last, we installed the real mirror(Fig.4~Fig.6). We had three or four days to install only one mirror. After installation, we aligned IMC in order (MCi -> MCo -> MCe -> MCi -> …) by using the pico-motor.

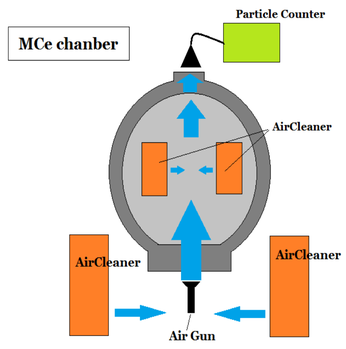

Fig.2; How to clean up

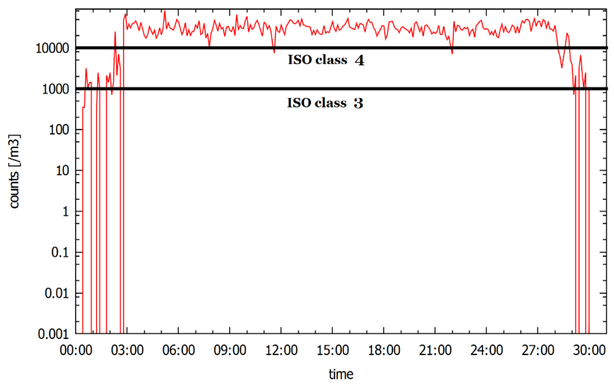

Fig.3; Cleaning result

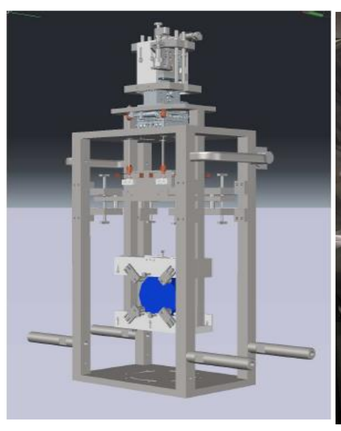

Fig.4; Suspension

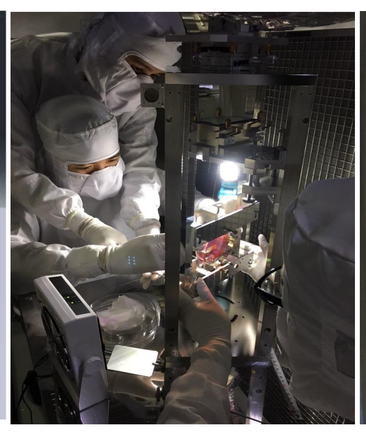

Fig.5; Installation

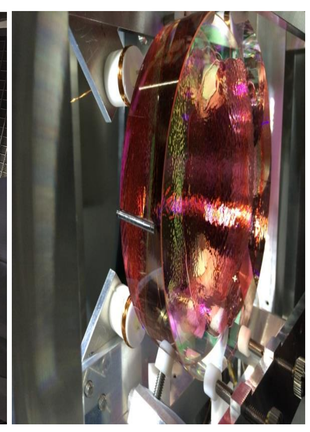

Fig.6; Mirror

3.Experiment

KAGRA

Mode-matching

Two mode-matching lens are chosen by JAMMT which is simulation soft. The two lenses are ***IMMT 1 (f=100[mm] z=0.816[m])*** and ***IMMT２ (f=200[mm] z=1.341[m])***.

Cavity scan

Cavity scan is to identify the phases of the higher-order mode peaks.

i. Sweeping the frequency of the input beam in 10[Hz] and observing the changes of the amount of transmissions
ii. Misaligning the MCi mirror in the direction of pitch and making the higher-order mode peaks higher
iii. Deciding the location of higher-order mode peaks by calculate the Gouy-phase of IMC
iv. Calculating the mode-matching ratio

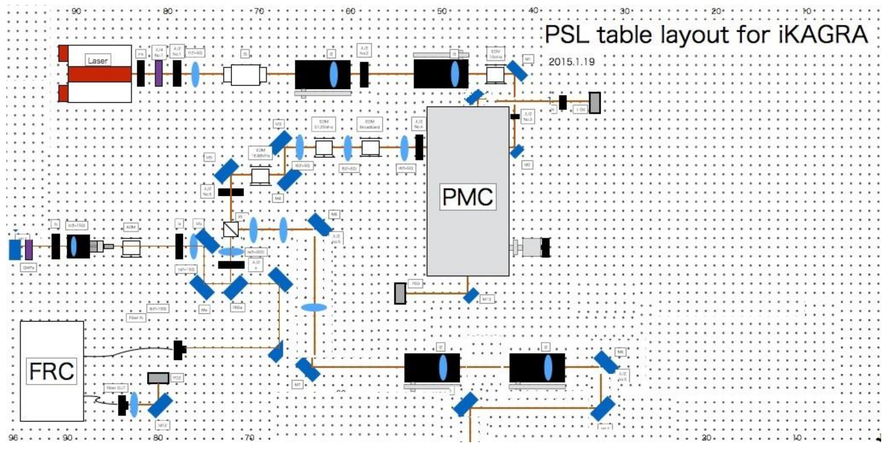

Fig.7: PSL table

4.Result

Waist size and location

$\omega_{ox} = 2157 +/-9.2(\mu m)$
$z_{0x} = 5.125 +/-0.264(m)$
$\omega_{oy} = 1995 +/-19(\mu m)$
$z_{0y} = 7.803 +/-0.273(m)$

Beam profiling

Designed values
$\omega_o = 2388.7(\mu m)$
$z_0 = 8.5\sim9.0(m)$

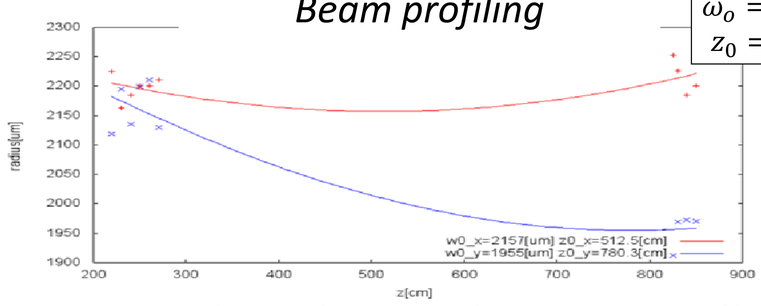

Fig.8: x-axis is a distance from PBS and y-axis is spot size of beam

Mode-matching ratio

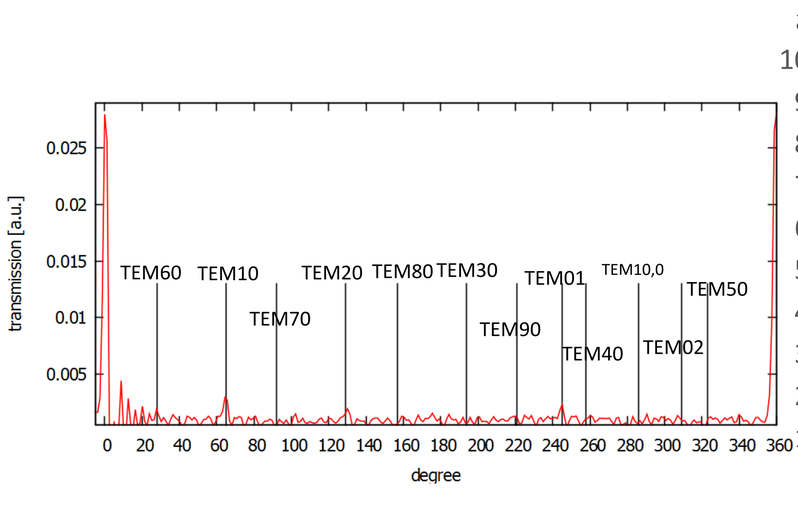

Fig.9: The transmission of MCe mirror and the vertical lines are phases of TEMnm

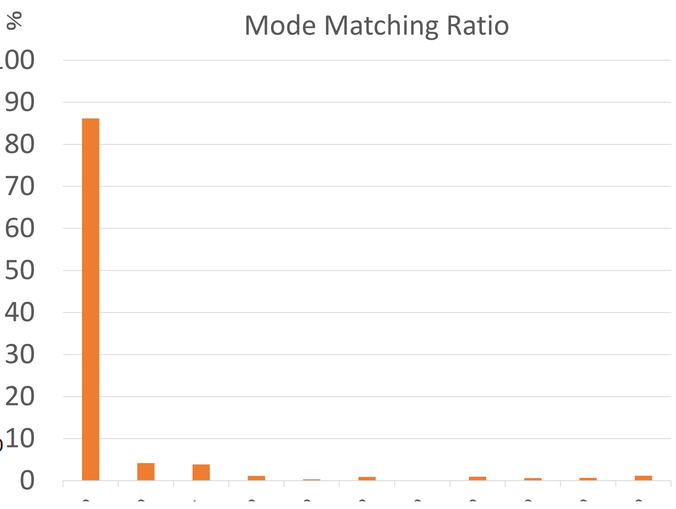

Fig.10: Mode-matching ratio

Mode-matching ratio is ***86.2%***

Conclusion

1 Installation
We have practiced hanging dummy mass and rehearsed completely. Then we have successfully installed PSL and IMC for iKAGRA, and also we have made the manuals about how to install IMC mirrors, which have been updated whenever incidents occurred.
2 Mode-matching
The mode-matching ratio is 86.2%. The measured waist size is different from the designed one by about 300 um. We assume that we should make much account of the waist size rather than the location of waist because the Rayleigh-length is very long(about 14[m]).
In bKAGRA, the mode-matching ratio should be 93%.