

Research Result Report

ICRR Inter-University Research Program 2022

Research Subject: Measuring the birefringence of the sapphire mirrors installed in the KAGRA detector

Principal Investigator: Keiko Kokeyama

Participating Researchers:

Summary of Research Result : The research aims to measure the birefringence effect of the input test masses installed in the KAGRA detector. In the fiscal year of 2022, we considered how to apply the polarization phase camera (PPC) principle to the KAGRA interferometer during our KAGRA visit from September to October 2022. Although our visit was to contribute to the detector commissioning, not to conduct the inter-university research, we devised the application plan as follows.

Fig. 1 shows the PPC application for the KAGRA detector. The reference beam will be picked off from the pre-stabilized laser output and sent to the detection area by an optical fiber. The detection port is at the pick-off of the power recycling cavity (POP table), which is about 100 m from the pick-off point. Some fiber noise may be inserted during the path and needs to be characterized. The PPC detection will be configured on the POP table as depicted on the bottom in Fig. 1. The reference beam propagates the free-space on the POP table and is modulated by an AOM at 80 MHz. The POP beam is the beam picked off at the back side of the second power recycling mirror, that is, the sample beam in the PPC system, as it is reflected by the input test masses and affected by the sapphire birefringence. It will be sent to mix with the reference beam at the beam splitter (BS). The PZT scanner and polarized beam splitter (PBS) are also used to scan the beam over the beam spot and to analyze the S- and P-polarization components at the detection port, respectively. The S- and P-polarized light detected at the photodetectors are demodulated at 80MHz and at the combination between 80 MHz and the RF frequencies of the KAGRA length sensing scheme (i.e., at 80 ± 17 MHz and 80 ± 45 MHz) so to analyze the carrier and sideband

fields at ± 17 MHz or ± 45 MHz, independently.

In the fiscal year of 2022, a couple of items were purchased to prepare the detection area; the PBS and fiber laser checker.

In the next fiscal year, we must procure the optical fibers, fiber couplers, AOM, function generator, HWP, PZT scanner, and electronics for the demodulation and low pass filtering. The installation and commissioning schedule must be well adjusted not to disturb the KAGRA detector's commissioning activities pr observing run.

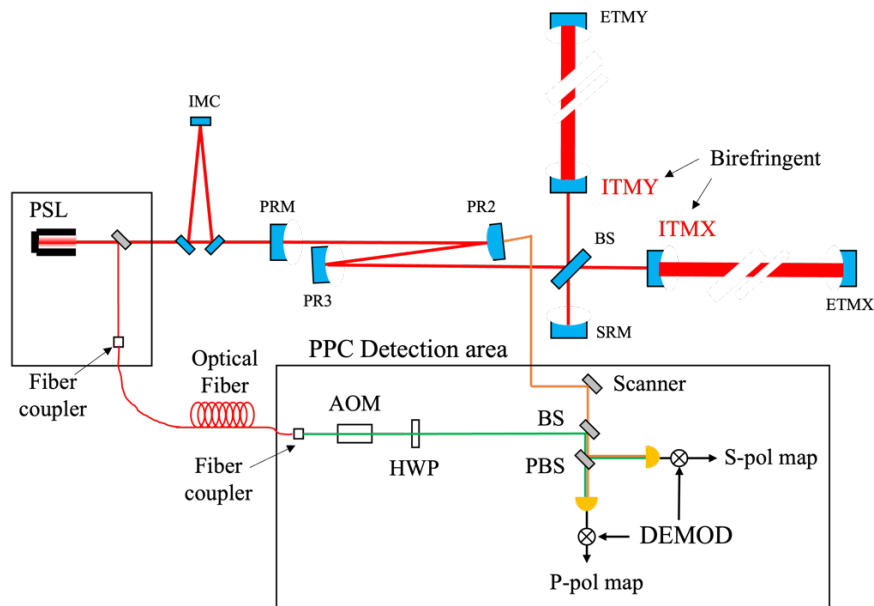


Figure 1: Application design for the polarized phase camera (PPC). The PPC detection area will be configured on the POP table. The pick off beam from the back side of the PR2 mirror (shown in orange) is the beam affected by the birefringence. The reference beam is picked off from the pre-stabilized laser (PSL) and sent to the POP table.