Research Report
ICRR Inter-University Research Program 2020

Research Subject: Development of high power KAGRA LASER system

Principal Investigator: Sadakazu Haino

Participating Researchers: Sadakazu Haino, Darkan Tuyenbayev, Yu-Kuang Chu, Yun-Jing Huang, Ling-Wei Luo, Norikatsu Mio, Osamu Miyakawa, Yoshiki Moriwaki, Kenta Tanaka, Keiko Kokeyama, Masayuki Nakano, Yuki Kuromiya, Kanta Yamashita, Chiaki Hirose

Summary of Research Result :

KAGRA is a Gravitational Wave telescope located under Kamioka Mine consisting of a laser interferometer with two arms each with 3 km. Ultra-stable high-power laser system is an essential component of the long baseline interferometers for the GW detection. One way to further increase the sensitivity of current generation gravitational wave detectors is to increase the laser power injected into the interferometers. We are developing 60 W linearly polarized, single-frequency laser system at a wavelength of 1064 nm, based on single-pass Nd:YVO4 power amplifiers called neoVAN-4S-HP. The system has low power and frequency noise and very high spatial purity. Figure 1 shows the photo of the laser system consisting of 2W NPRO (Non-Planar Ring Oscillators) followed by 60 W neoVAN-4S-HP amplifier.

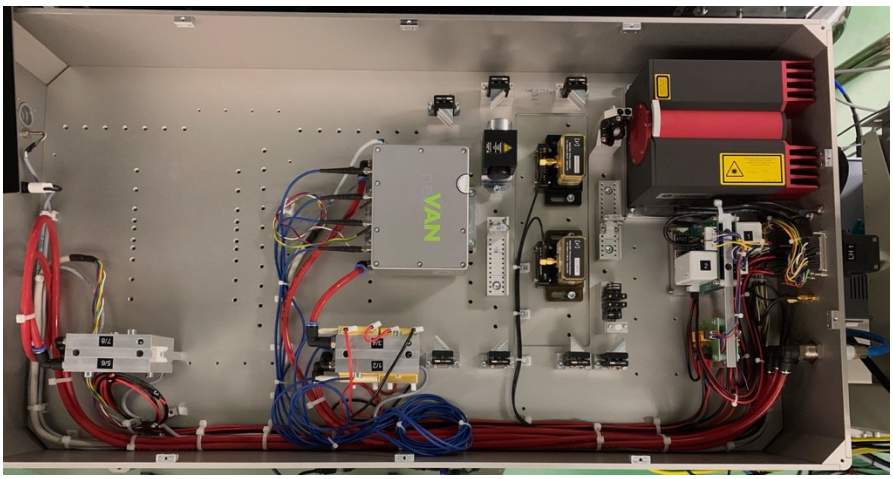

Figure 1. Schematic view of 60 W laser system for KAGRA with neoVAN-4S-HP solid state amplifier followed by NPRO seed laser.

The laser system was customly designed and produced at commercial company called neoLASE in Germany after several discussions and interactions between our group and them. The system completed in August 2019 and delivered at KAGRA site thanks to the strong supports by Prof. Saito (KAGRA project manager at that time) and technical staffs and secretaries at KAGRA site. In the following month in 2020 we have made further tests to check more detailed performance and long term stability with the strong collaboration of ICRR researchers led by Profs. Osamu Miyakawa and Norikatsu Mio as well as researchers at University of Toyama led by Prof. Yoshiki Moriwaki. The relative intensity noise, frequency noise and absolute laser frequency have been measured by the efforts led by Mr. Kenta Tanaka and other students. Figure 2 shows the comparison of relative intensity noise between the one we have developed and similar one which was developed by LIGO. It shows that our laser has similar or even better intensity noise than LIGO one. It is planned to install this laser at KAGRA site before the next observing run (O4) which will start in middle 2022.

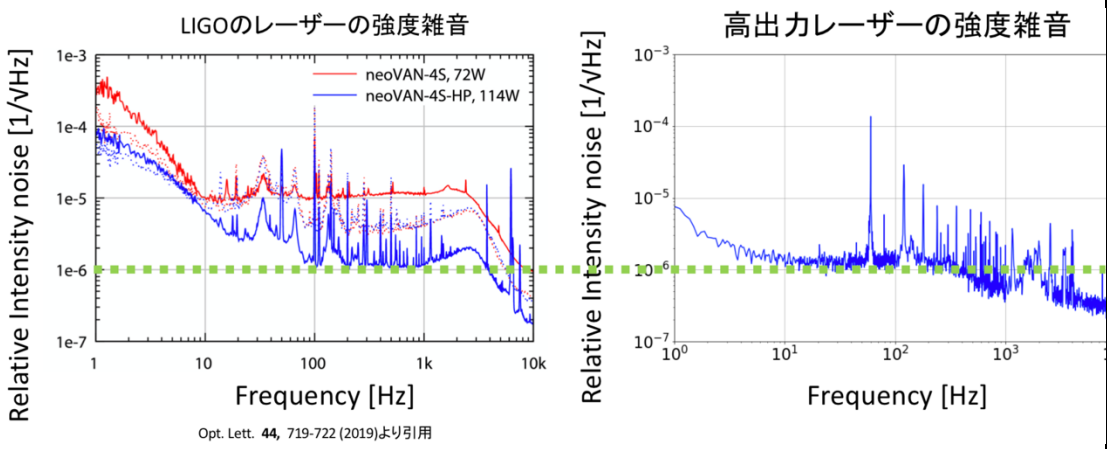

Figure 2. Relative intensity noise of high power laser developed with this ICRR collaborative research project (right) compared with similar laser developed in LIGO

No.