# Research Report
## ICRR Inter-University Research Program 2021

Research Subject:

Filter cavity experiments for the frequency dependent squeezed light for KAGRA

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Summary of Research Result :


With ICRR and NAOJ, in this ICRR Inter-University Research Program 2021, entitled "Filter cavity experiments for the frequency dependent squeezed light for KAGRA," we worked with the KAGRA Filter Cavity (KFC) working group. The target is to implement this FDSQZ to upgrade the sensitivity of KAGRA.


However, due to the Covid-19 pandemic, we could not conduct our research as initially planned. The travel to Japan is almost forbidden in the FY 2021.


Nevertheless, regularly we have bi-weekly telecoms with the working group on the KAGRA Filter Cavity. We are in charge of the Interface Optics in the KFC working group. In addition, we also received the Vanguard Project (for 4 years), entitled "Development on the Instrumentations and Data Analyses for Advanced Gravitational Wave Detectors," from the Ministry of Science and Technology (MOST), Taiwan. With this support from MOST, we should contribute more to the KAGRA project in the coming years.


At the same time, we developed about machine-learning (ML) enhanced quantum state tomography (QST) for squeezed states, as a crucial diagnostic toolbox for the advanced gravitational wave detectors. Two papers are conducted along this research

direction,

- Hsien-Yi Hsieh, Yi-Ru Chen, Hsun-Chung Wu, Hua Li Chen, Jingyu Ning, Yao-Chin Huang, Chien-Ming Wu, and RKL, "Extract the Degradation Information in Squeezed States with Machine Learning," Phys. Rev. Lett. 128, 073604 (2022).
- Hsien-Yi Hsieh, Jingyu Ning, Yi-Ru Chen, Hsun-Chung Wu, Hua Li Chen, Chien-Ming Wu, and RKL, "Direct parameter estimations from machine-learning enhanced quantum state tomography," Special Issue "Quantum Optimization & Machine Learning"; Symmetry 14, 874(2022).

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