AIST PROJECT HIGHLIGHT

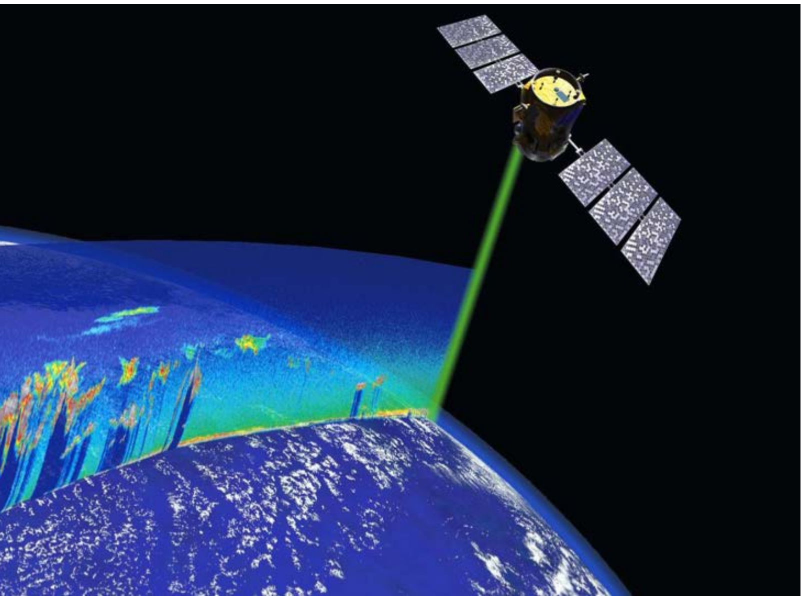
AN INNOVATIVE SUNLIGHT DENOISING TECHNIQUE TO IMPROVE FUTURE SPACEBORNE LIDAR

OVERVIEW

This project aims to develop an innovative quantum computing technique to mitigate the effects of sunlight noise in spaceborne lidar data analysis. While lidar systems excel at capturing high-quality measurements at night, their effectiveness during the day is hindered by solar interference. This research will investigate three distinct quantum approaches to subtract sunlight noise from lidar images by solving constrained minimization problems using the state-of-the-art Dirac-3 quantum computer. The performance of these quantum methods will be evaluated against classical computing techniques in terms of both noise reduction efficacy and computational efficiency.

SCIENCE AREA

Spaceborne lidar is a vital tool for Earth science remote sensing, offering vertical profiles of key atmospheric and oceanic parameters such as temperature, water vapor, wind speed, aerosols, clouds, and phytoplankton. However, sunlight noise during daytime measurements necessitates complex lidar systems. Achieving the required signal-to-noise ratios (SNRs) for scientific objectives demands high laser power, significantly increasing mission costs.



TECHNOLOGY

This project will reformulate the sunlight denoising challenge as a constrained minimization problem optimized for quantum computing hardware. This approach leverages two key insights: (1) sunlight noise is spatially incoherent, whereas backscattered signals from the atmosphere and ocean exhibit spatial coherence, and (2) sunlight noise follows a Poisson distribution, where the mean equals the variance and can be measured between laser shots.

ADVANCEMENTS:

- **Three different quantum annealing approaches** will be tested and optimized: the Variance Method, the Covariance Method, and the Quantum Auto-Regressive–Moving-Average (ARMA) method.
- **The effectiveness of these techniques** will be evaluated using lidar data from IceSat-2, CATS, and CALIPSO missions.
- **Cost savings for future lidar missions** will be quantified given the implementation of these methods.

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TRL : **4, expected by 2026**

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