IIP PROJECT HIGHLIGHT

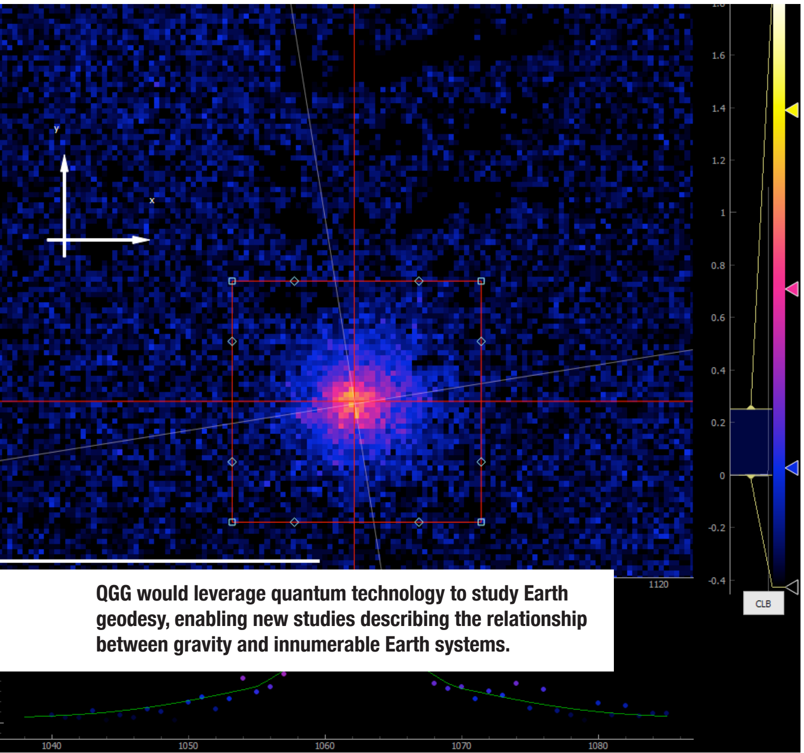
QUANTUM GRAVITY GRADIOMETER

OVERVIEW

The Quantum Gravity Gradiometer Pathfinder (QGGPf) Project will use atom interferometry to measure nuances in Earth's gravitational field with unprecedented accuracy. The objectives include long-interrogation time atom interferometry and validating a novel laser optical system, as well as testing control algorithms and electronics. QGG will rely on a single sensor using laser-cooled atoms as proof-masses. QGGPf is a critical first step for developing a science-grade quantum sensor for recovering geophysical features of a planet's surface in high resolution, globally.

SCIENCE AREA

Earth geodesy is a dynamic system shaped by phenomena like surface topography, hydrology, and oceanography. QGG will allow researchers to probe these targets with unprecedented accuracy and with far greater efficiency than is currently available with traditional methods. In particular, QGG will allow scientists to identify untapped aquifers and other subterranean resources, paving the way streamlined resource extraction and water management.



QGG would leverage quantum technology to study Earth geodesy, enabling new studies describing the relationship between gravity and innumerable Earth systems.

TECHNOLOGY

QGGPf relies on rubidium atoms collected and cooled by lasers into a small cloud within a magneto-optical trap (MOT). The cold atoms are shuffled from the source preparation region to a dedicated atom interferometer region by introducing a slight frequency shift between pairs of lasers. Two clouds are prepared and positioned about half meters apart. Three controlled laser pulses are applied to the two clouds in a time span of few seconds to facilitate simultaneous atom interferometers. After the three interferometer pulses, an interferogram i on each cloud registers local acceleration during the interferometer time. The gravity gradient is derived from the difference of the accelerations.

ADVANCEMENTS

- **Global first for space-based remote sensing** establishes national leadership in quantum sensing, paving the way for future science missions and information supremacy.
- **End-to-End system engineering** demonstrates the ability to implement and to autonomously operate such a complex instrument on a free flyer in low Earth orbit.
- **Baseline attitude control** demonstrates the feasibility of keeping two atomic clouds separate in space, a critical milestone for gathering gradient measurements of Earth's gravity field using QGG in low Earth orbit.
- **Key technology demonstration for SGI** will energize the capability of US government agencies and industry for quantum sensor development, implementation, and operation.

CONTACT INFO

PI : Sheng-wey Chiow / JPL
Email : sheng-wey.chiow@jpl.nasa.gov

This project is managed under the Instrument Incubator Program (IIP). For more information, please visit esto.nasa.gov.

ESTO EARTH SCIENCE TECHNOLOGY OFFICE