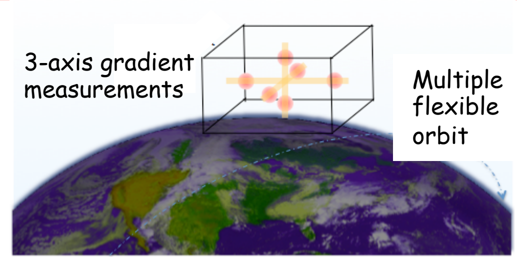
Advanced Gradiometer for Earth Gravity Measurements

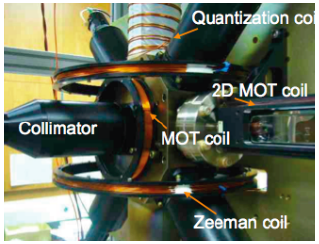
PI: Nan Yu, JPL

Objective

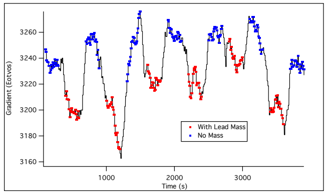
- Upgrade the terrestrial atomic gravity gradiometer prototype under previous development to advance the technology that enables high-spatial resolution measurements of time-varying gravity from a single satellite
- Verify the atomic gradiometer technology through
  - achieving beyond-the-state-of-the-art performance with the terrestrial instrument
  - testing space operation mode in laboratory simulated microgravity
  - conducting error budget analysis for an atomic gradiometer measurement system in space



Measurement concept



One of the two atom interferometer sensor heads



Test mass measurements


Terrestrial gravity gradiometer instrument

Accomplishments

- Designed and built a transportable gravity gradiometer instrument, and demonstrated its measurement sensitivity of 40 E/Hz$^{1/2}$. This performance is comparable to the best ground-based gradiometers' performance reported in literature.
- Validated the instrument gravity gradient measurement performance with modulation of a 33kg test mass.
- Verified the microgravity operation mode in atomic cloud releasing and detection with no expected degradation of instrument signal-to-noise ratio and performance.
- Completed the instrument error budget analysis and the gravity measurement recovery simulations. Results indicated that the instrument sensitivity in microgravity space environment would reach 1 E/Hz$^{1/2}$.
- Developed a compact, high-flux 2-dimensional magneto-optical trap subsystem with a high production efficiency of greater than 1×10^9 cold atoms when applying 20 mW laser power.
- Developed a closed loop measurement approach with 4-5 times better sensitivity than conventional ellipse fitting scheme.

Co-Is/Partners: Jim Kohel, Robert Thompson, Xiaoping Wu, JPL

TRL_{in} = 4 **TRL_{out} = 5**