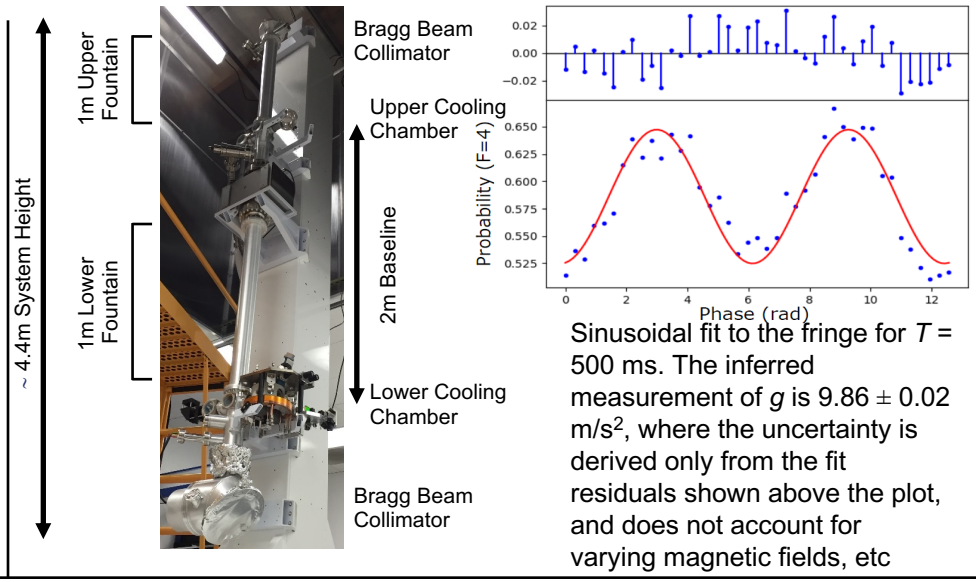
Cold Atom Gradiometer for Geodesy

PI: Babak Saif, NASA GSFC

Objective

- Design, construct and test a sensitive, low-drift gravity gradiometer instrument aimed at improving satellite geodesy measurements
- Develop instrument based on light-pulse atom interferometry using ultracold atomic samples as ideal proof masses
  - Resolution goal when extrapolated to microgravity environment is 10^{-5} Eotvos per measurement at 0.03 Hz repetition rate
  - Sensitivity better than previous development with acceleration sensitivity at 1.5 x 10^{-9} m/s^2/Hz$^{1/2}$



Sinusoidal fit to the fringe for T = 500 ms. The inferred measurement of g is 9.86 ± 0.02 m/s^2, where the uncertainty is derived only from the fit residuals shown above the plot, and does not account for varying magnetic fields, etc

Accomplishments

- Completed the build of the sensor head, laser system, and control electronics for the lower arm of the interferometer
- Demonstrated magnetic lensing, reaching an inferred temperature of ~50nK with an atom flux of 10^8 atoms/s
- Shuttled the atoms with a 2D/3D lattice from the cooling chamber to the launch tube and dropped them
- Demonstrated atom interference fringes with dropped atoms with interrogation time of 100 ms and 500 ms
- Demonstrated inferred measurement of gravity, g = 9.86 ± 0.02 m/s^2
- Completed an analysis to determine the optimal gradiometer configuration and parameter for space use

Co-Is/Partners: Scott Luthcke, David Rowland, GSFC; Adam Black, AOSense, Inc,

TRL_{in}= 3 **TRL_{out}= 4**

ESTO Earth Science Technology Office