Recent developments of laser control and manipulation of atoms have led to new types of precision inertial force
and gravity sensors based on atom interferometry. Atom interferometers exploit the quantum mechanical wave
nature of atomic particles and quantum gases for sensitive interferometric measurements. Ground-based
laboratory experiments and instruments have already demonstrated beyond the state of the art performances of
accelerometer, gyroscope, and gravity measurements. The microgravity environment in space provides
opportunities for further drastic improvements in sensitivity and precision. Such inertial sensors will have great
potential to provide new capabilities for NASA Earth and planetary gravity measurements, for spacecraft inertial
navigation and guidance, and for gravitational wave detection and test of properties of gravity in space.

Currently the most mature development of atom interferometers as measurement instruments are those based on
light pulsed atom interferometers with freefall cold atoms. There remain a number of technical challenges to infuse
this technology in space applications. Some of the identified key challenges are (but not limited to):

- Compact high flux ultra-cold atom sources for free space atom interferometers (Example: >1x10^6 total
  useful free-space atoms, <1 nK, Rb, K, Cs, Yb, Sr, and Hg. Performance and species can be defined by
  offerors). Other related innovative methods and components for cold atom sources are of great interest,
  such as a highly compact and regulatable atomic vapor cell.
- Ultra-high vacuum technologies that allow completely sealed, non-magnetic enclosures with high quality
  optical access and the base pressure maintained <1x10^-9 torr. Consideration should be given to the
  inclusion of cold atom sources of interest.
- Beyond the state-of-the-art photonic components at wavelengths for atomic species of interest, particularly
  at NIR and visible: efficient acousto-optic modulators (low RF power ~ 200 mW, low thermal distortion,
  ~80% or greater diffraction efficiency); efficient electro-optic modulators (low bias drift, residual AM, and
  return loss, fiber-coupled preferred), miniature optical isolators (~30 dB isolation or greater, ~ 2 dB loss or
  less), robust high-speed high-extinction shutters (switching time < 1 ms, extinction > 60 dB are highly
  desired).
- Flight qualifiable lasers or laser systems of narrow linewidth, high tunability, and/or higher power for clock
  and cooling transitions of atomic species of interest. Cooling and trapping lasers: 10 kHz linewidth and ~ 1
  W or greater total optical power. Compact clock lasers: 5x10^-15 Hz/√s near 1 s (wavelengths for Yb+, Yb,
  Sr clock transitions are of special interest).
- Analysis and simulation tool of a cold atom system in trapped and freefall states relevant to atom
  interferometer and clock measurements in space.

All proposed system performances can be defined by offerers with sufficient justification. Subsystem technology
development proposals should clearly state the relevance, define requirements, relevant atomic species and working laser wavelengths, and indicate its path to a space-borne instrument.