National Aeronautics and Space Administration

FY23 Topic Areas Research and Technology Development (TRTD)

Theoretical modeling and design of field-deployable continuous-wave atom laser

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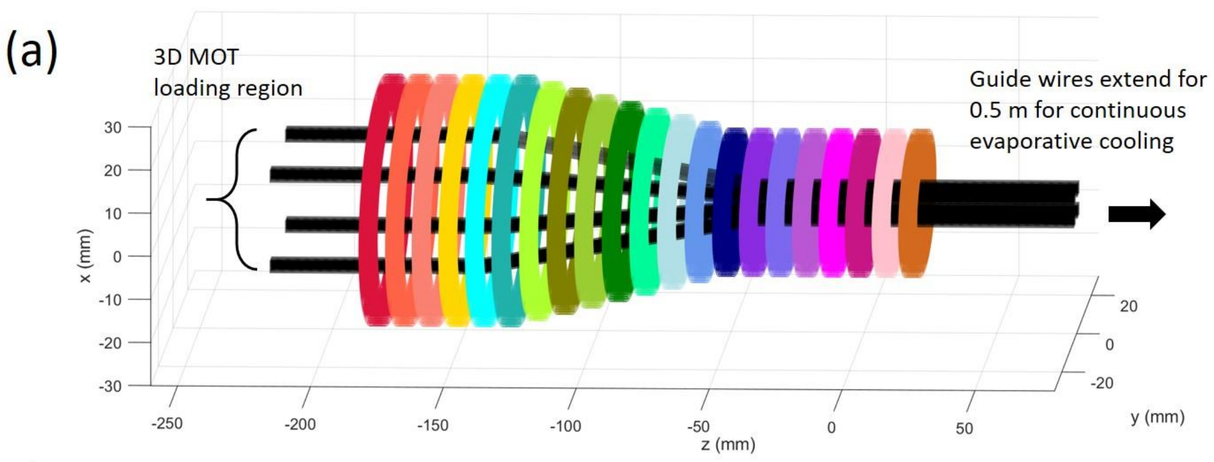
Strategic Focus Area: Gravitational astrophysics and fundamental physics

Objectives: Continuous generation of a coherent matter wave source for quantum sensing.

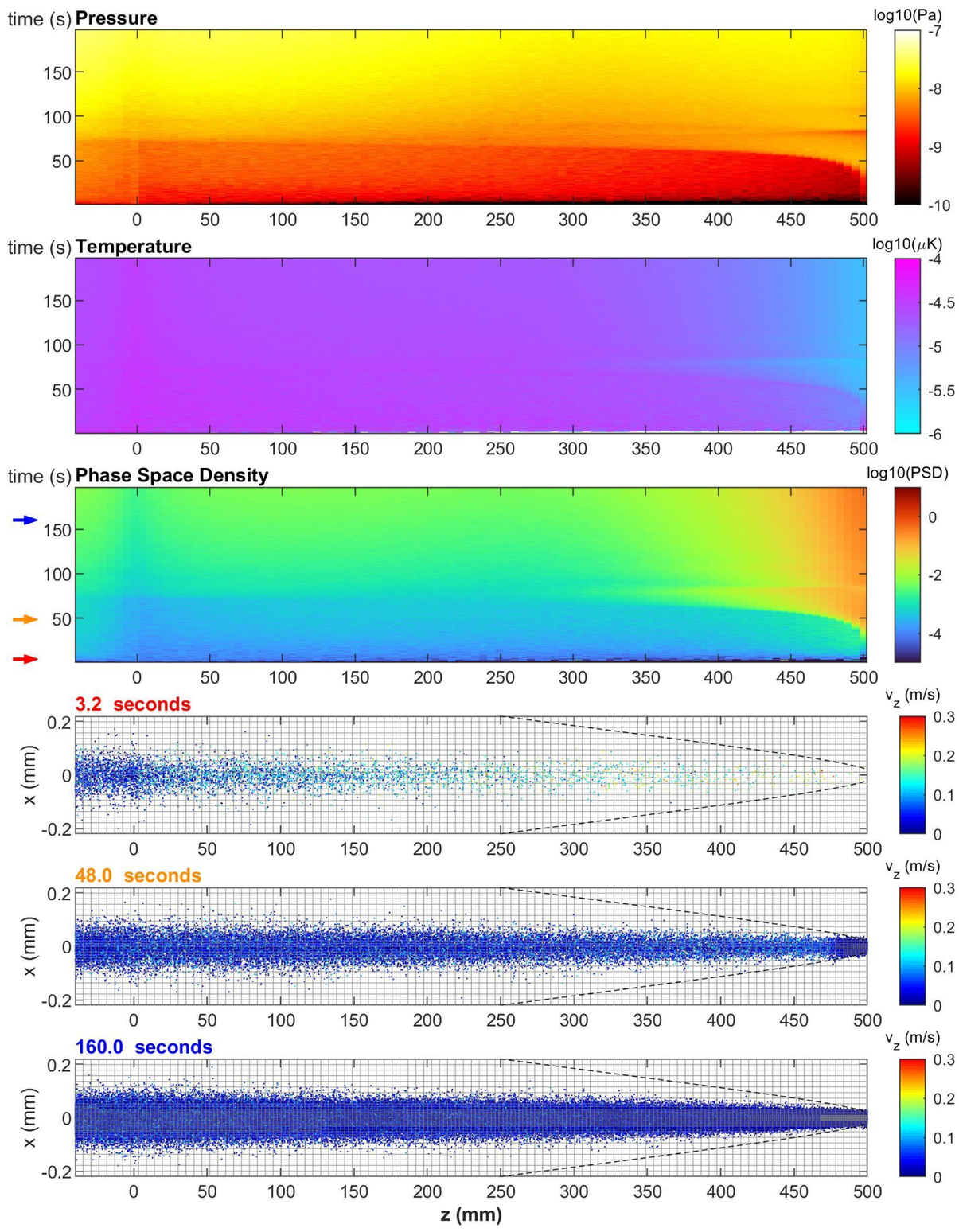
Background: Conventional Bose-Einstein Condensates (BECs) are generated in a pulsed manner, where atoms are first laser-cooled and then evaporatively cooled to quantum degeneracy.

Approach and Results:

We theoretically investigate non-destructive approaches to continuously load laser-cooled atoms into a reservoir while simultaneously extracting atoms from this region and evaporatively cooling the extracted beam to degeneracy within a spatially separated magnetic guide region.



Input coupler to maximize starting phase space density and to optimize mode matching.



Continuous evaporative cooling in an atom guide (Direct Simulation Monte-Carlo).

Significance/Benefits to JPL and NASA:

- Improving BEC atom flux for science-grade instruments.
- Facilitating the transition of quantum sensors from pulsed to continuous operation for inertial sensing, gravitational wave detection, and searches for non-Newtonian forces.

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