

# Chip-Scale Atomic Beam System

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## **Simplified production and better stability in a smaller package for precision timekeeping and navigation**

This chip-scale technology produces an atomic beam with high collimation in a more easily manufactured and compact package. Developed by Georgia Tech, this atomic beam system offers greater long-term stability than vapor cell chip-scale systems and is produced in a smaller package than conventional Cesium (Cs) beam systems. It uses lithographically defined or machined planar wafers with internal cavities and channels to produce an evacuated vacuum package that houses a collimated atomic beam. Also incorporated are components to source atomic vapor as well as passive pumps to maintain vacuum conditions.

### **Summary Bullets**

- Precision timekeeping (e.g., chip-scale atomic clocks primarily used in cell phone base stations)
- Navigation (e.g., interferometers used in underwater oil and gas exploration)
- Robotics

### **Solution Advantages**

- **Improved stability:** Enables longer term stability than in traditional vapor cell chip-scale systems
- **Smaller package:** Utilizes a chip-scale system that is more compact than conventional Cs beam systems
- **Easily manufactured:** Uses lithographic fabrication to produce atomic beams with high collimation

### **Potential Commercial Applications**

- Precision timekeeping (e.g., chip-scale atomic clocks primarily used in cell phone base stations)
- Navigation (e.g., interferometers used in underwater oil and gas exploration)
- Robotics

### **Background and More Information**

Current atomic beam systems (such as Cs beam tubes for atomic clocks) exist either in lab-scale vacuum systems or in custom vacuum tubes. Georgia Tech's chip-scale system for producing atomic beams is composed of etched silicon and glass wafers that are anodically bonded under vacuum to form a hermetically sealed, evacuated device. The device consists of several chambers connected by high aspect-ratio channels to produce a collimated atomic beam. One chamber produces an atomic vapor, and another chamber provides a propagation volume for the atomic beam. Non-evaporable getter pumps and graphite are included to pump residual gases.

## Inventors

- Dr. Chandra Raman  
Professor - Georgia Tech School of Physics
- Chao Li  
Graduate Research Assistant - Georgia Tech School of Physics

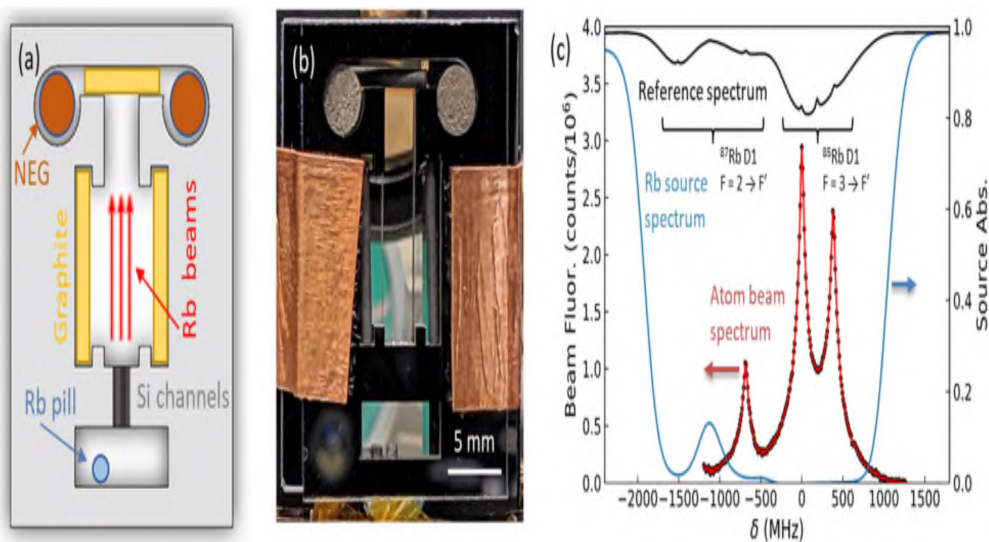
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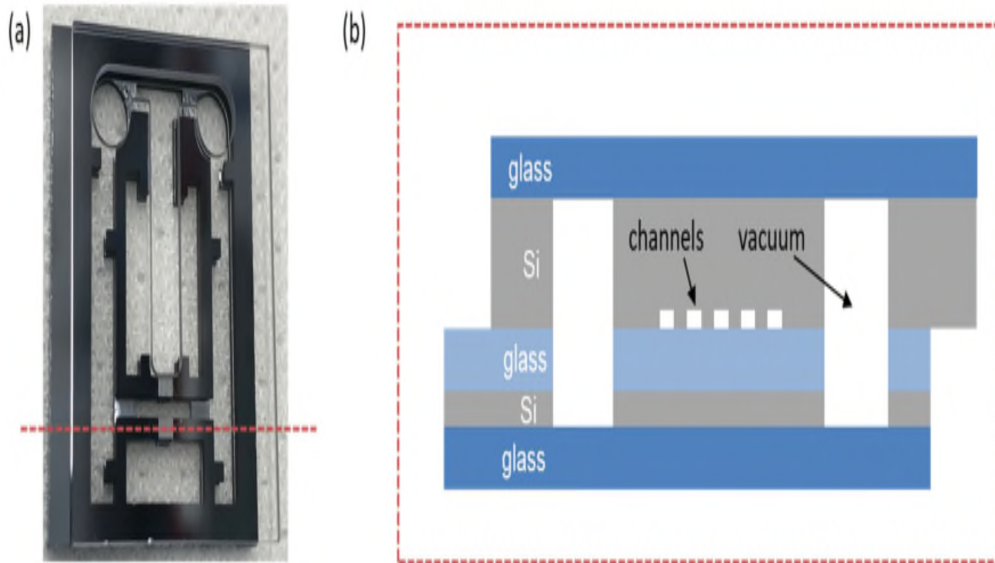
## Publications

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## Images



Miniaturized atomic beam source: (A) schematic of the rubidium (Rb) beam source; (B) image of assembled device; (C) Rb fluorescence spectrum measuring the transverse velocity distribution of the atomic beam and Rb absorption spectrum measuring the Rb vapor density feeding the channel array (a saturated absorption spectrum from a natural abundance Rb cell is included for reference)



(A) Atomic beam source during fabrication; (B) Cross-section of device along dashed line in “a” showing silicon and glass layers

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