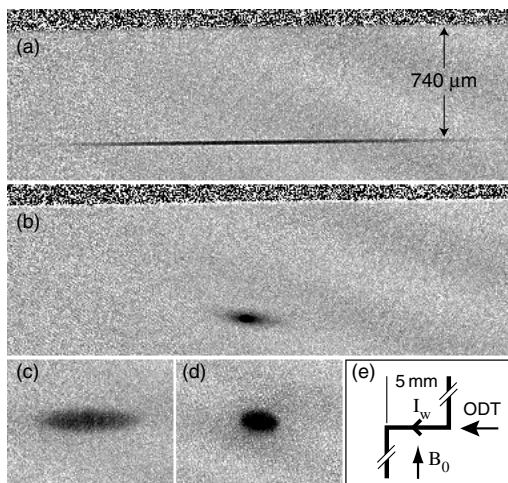


## Transport of Bose-Einstein Condensates with Optical Tweezers

Conventional condensate production techniques severely limit optical and mechanical access to experiments due to the many laser beams and magnetic coils needed to create BECs. This conflict between cooling infrastructure and accessibility to manipulate and study condensates has been a major restriction to previous experiments. So far, most experiments were carried out within a few millimeters of where the condensate was created. What is highly desirable is a condensate “beam line” that delivers condensates to a variety of experimental platforms.

We have transported gaseous Bose-Einstein condensates over distances up to 44 cm [1]. This was accomplished by trapping the condensate in the focus of an infrared laser and translating the location of the laser focus with controlled acceleration. Condensates of order  $10^6$  atoms were moved into an auxiliary “science” chamber which has excellent optical and mechanical access. This technique is ideally suited to deliver condensates close to surfaces, e.g., to microscopic waveguides and into electromagnetic cavities. As a proof-of-principle demonstration, we have used the tweezers technique to transfer condensates into a magnetic trap formed by a Z-shaped wire suspended in the science chamber. The same procedure can now be used to load condensates into atom chips. In such devices, patterns of wires are lithographically deposited on a surface and may allow the realization of single-mode waveguides and atom interferometers.



Absorption images of condensates in the science chamber, side view. All images have the same scale. Condensates of  $\approx 6 \cdot 10^5$  atoms are shown in (a) optical trap and (b) wire-trap. The center segment of the Z-shaped wire is visible as a dark speckled horizontal strip and is  $740 \mu\text{m}$  above the trapped atoms. The condensate was released from (c) an optical trap after 10 msec time of flight and (d) wiretrap after 23 ms time of flight. (e) Schematic of the wiretrap, top view.  $I_w = 2 \text{ A}$  is the current through the wire, and  $B_0 = 2.9 \text{ G}$  is the bias field. Atoms are trapped below the 5-mm-long central segment of the wire, which is aligned with the optical trap axis. The wiretrap was located 36 cm from where the condensates were produced.

1. T.L. Gustavson, A.P. Chikkatur, A.E. Leanhardt, A. Görlitz, S. Gupta, D.E. Pritchard, and W. Ketterle, *Transport of Bose-Einstein Condensates with Optical Tweezers*, Phys. Rev. Lett. **88**, 020401 (2002).