Experiments with quantum gases, quantum gates, and atom fibers

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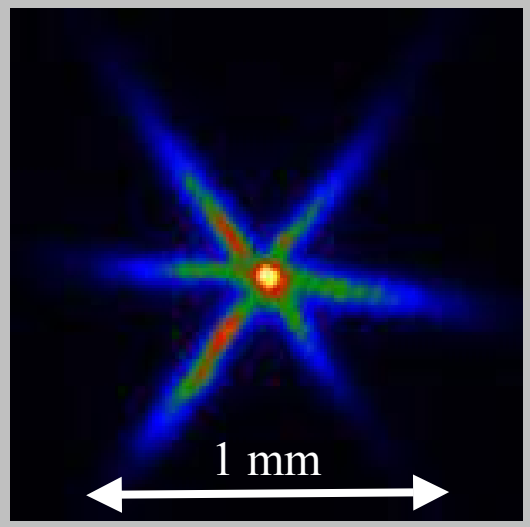


~10^6 atoms trapped by intersecting laser beams

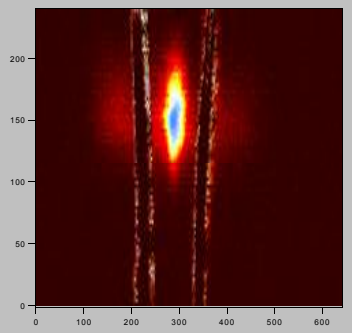
Ultracold atomic physics for quantum control and measurement

Controlling atomic motion
- Atom trapping
- atom optics

Precision measurements
- Clocks
- Standard model tests (Parity, EDM)

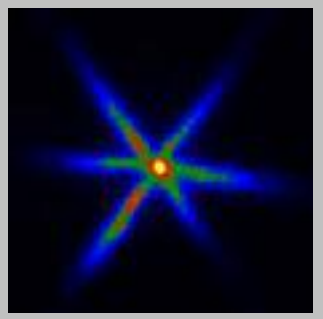
Quantum state engineering
- Schrodinger cats
- Quantum computers

Quantum degenerate gases
- Bose-Einstein condensates (BEC)
- Many-body physics



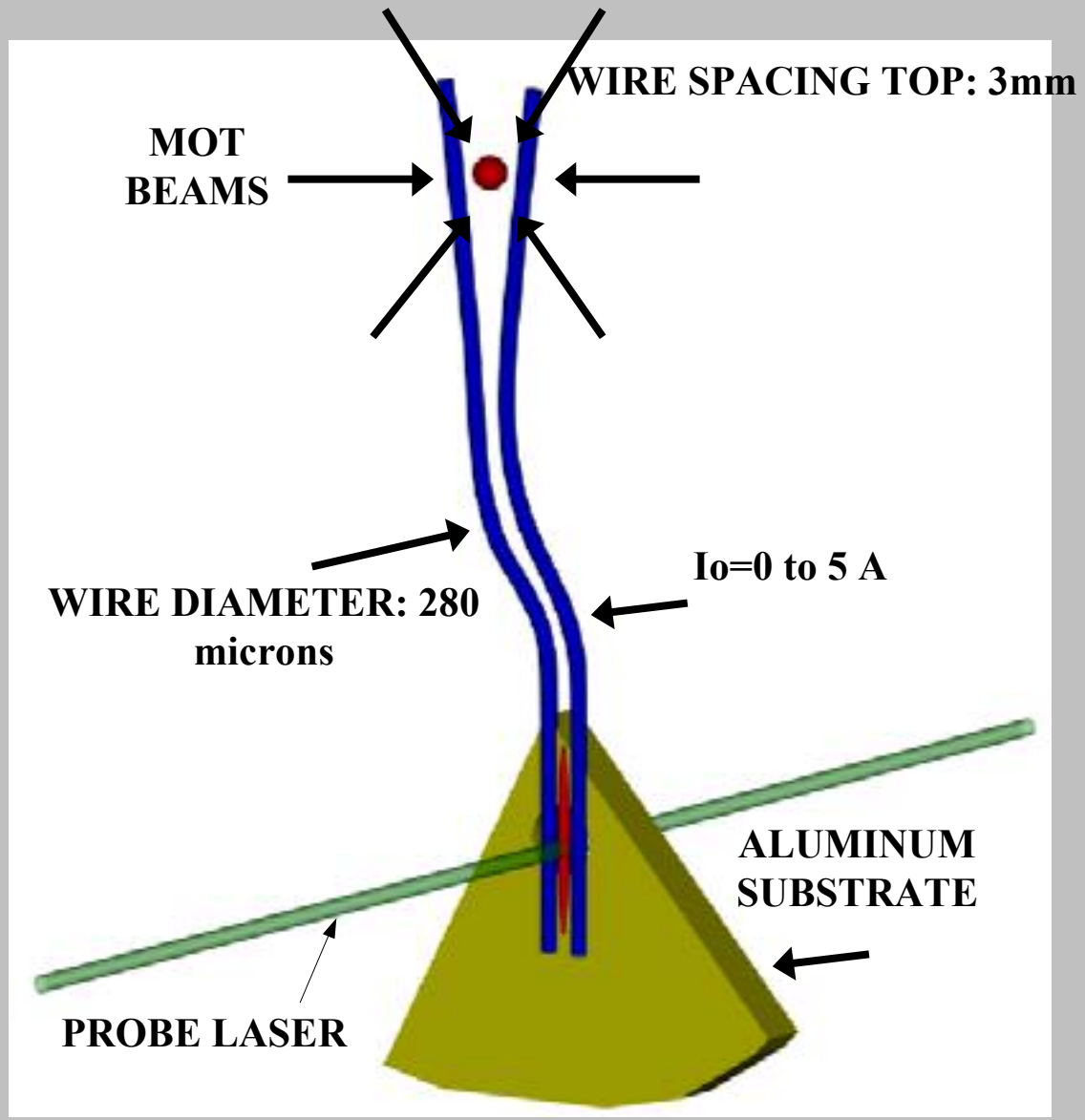
Magnetic guiding:
Atom fiber optics

Cavity QED:
Quantum Logic Gates

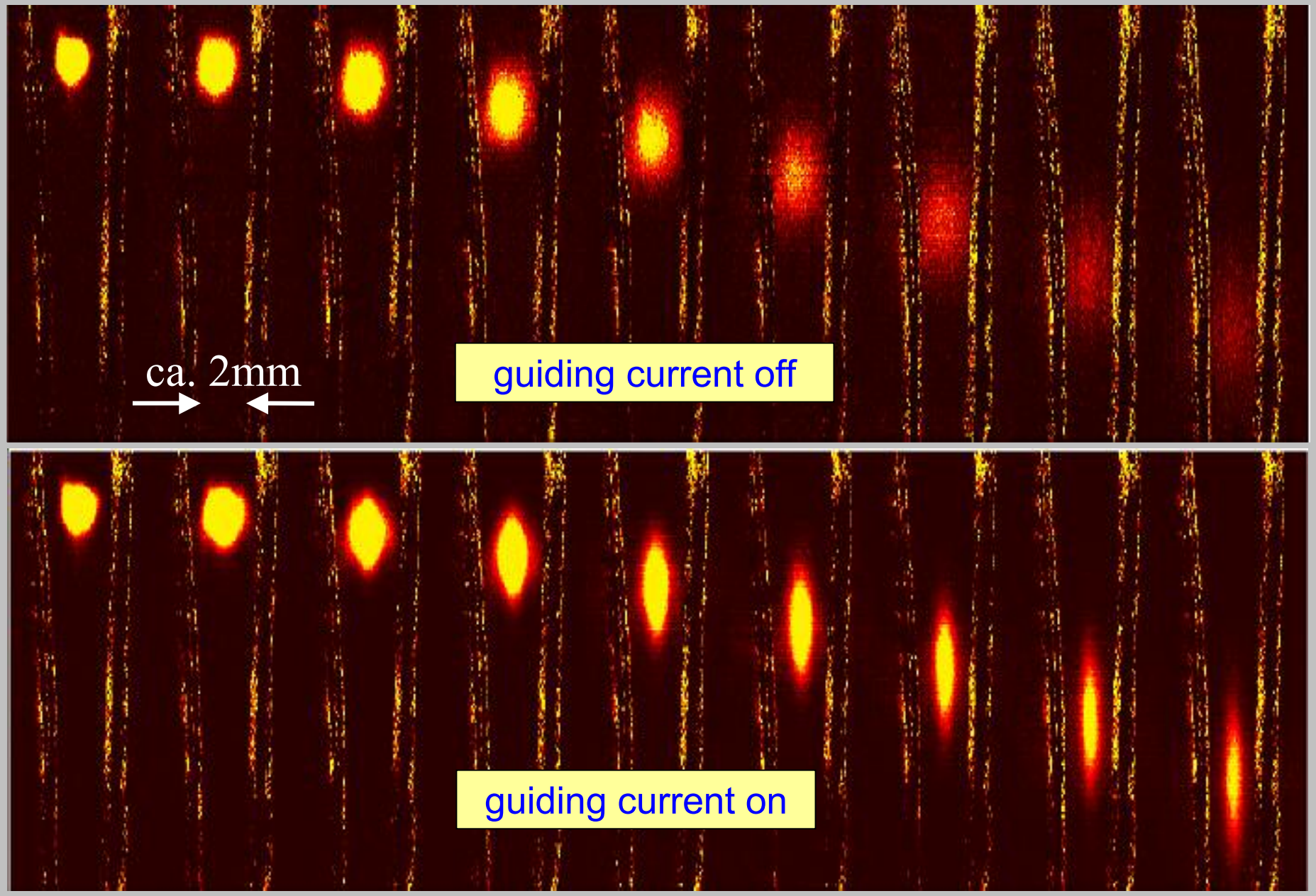


Optical trapping:
All-optical BEC

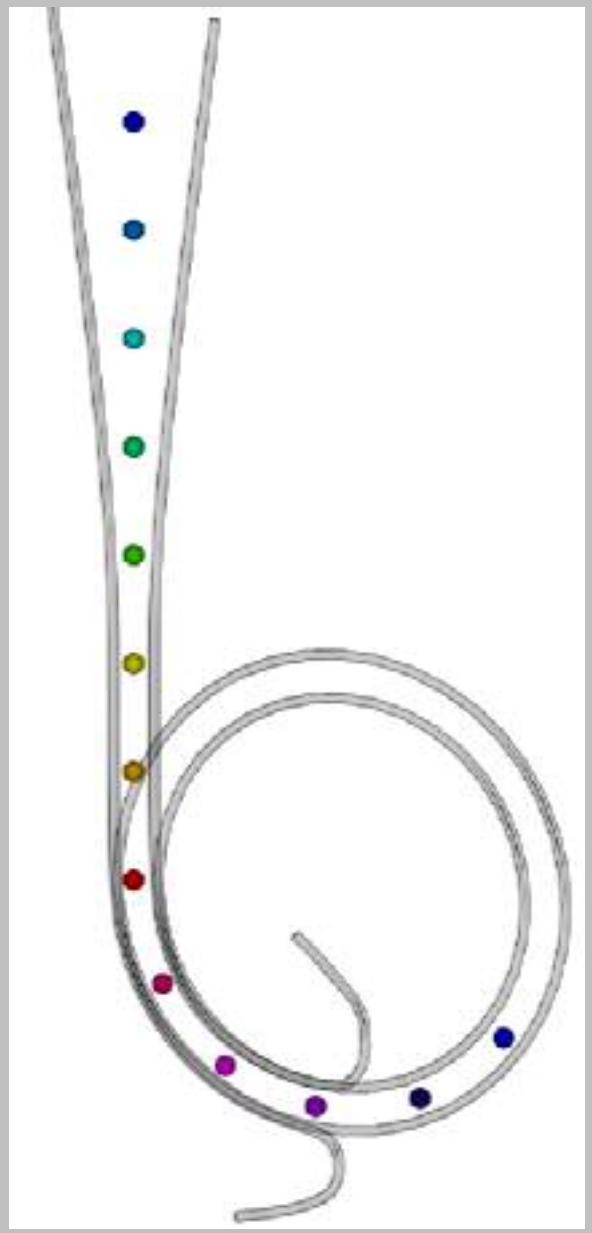
2-wire guide

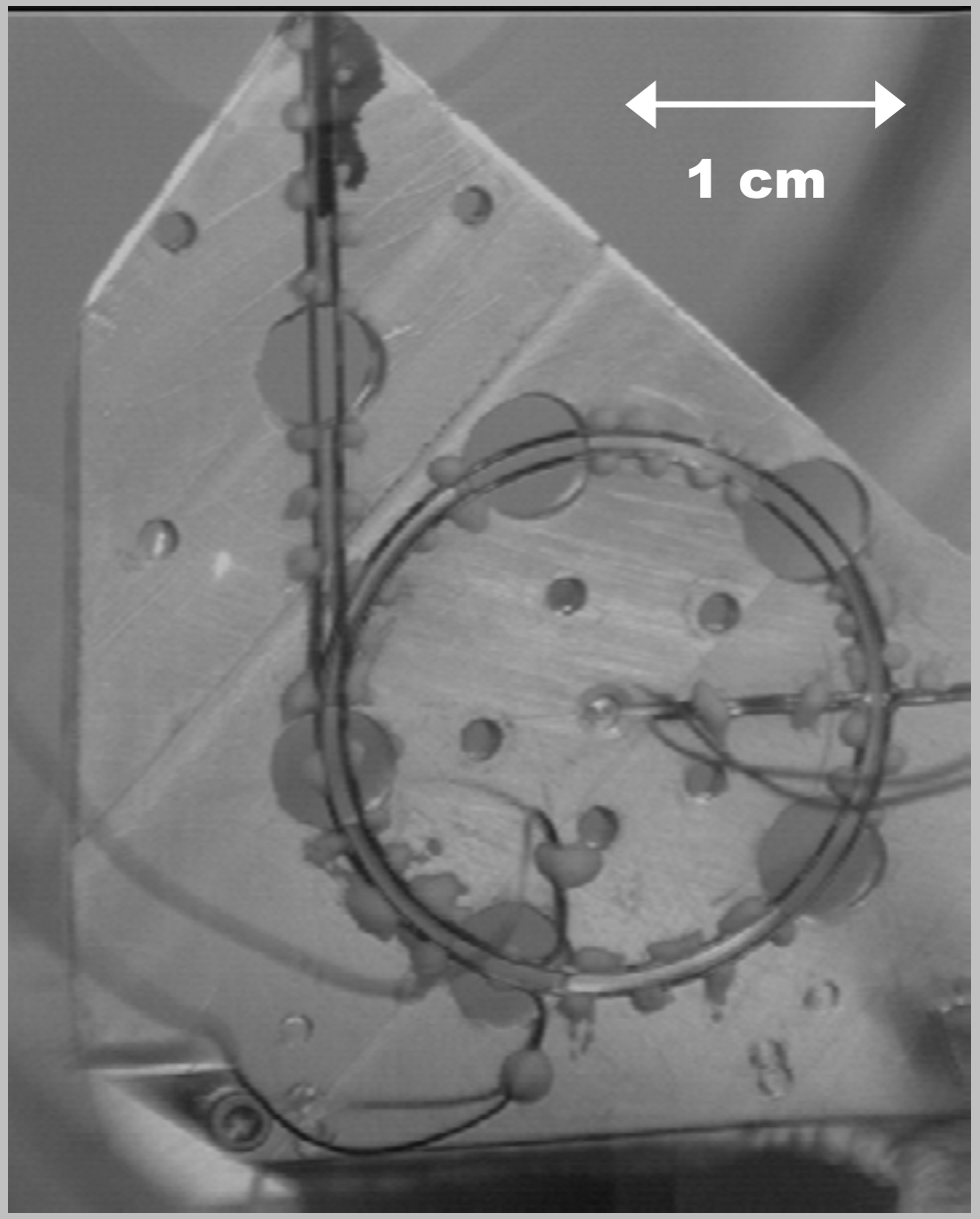

WIRE SPACING TOP: 3mm
MOT
BEAMS
WIRE DIAMETER: 280
microns
Io=0 to 5 A
ALUMINUM
SUBSTRATE
PROBE LASER
WIRE SPACING BOTTOM: 280 microns

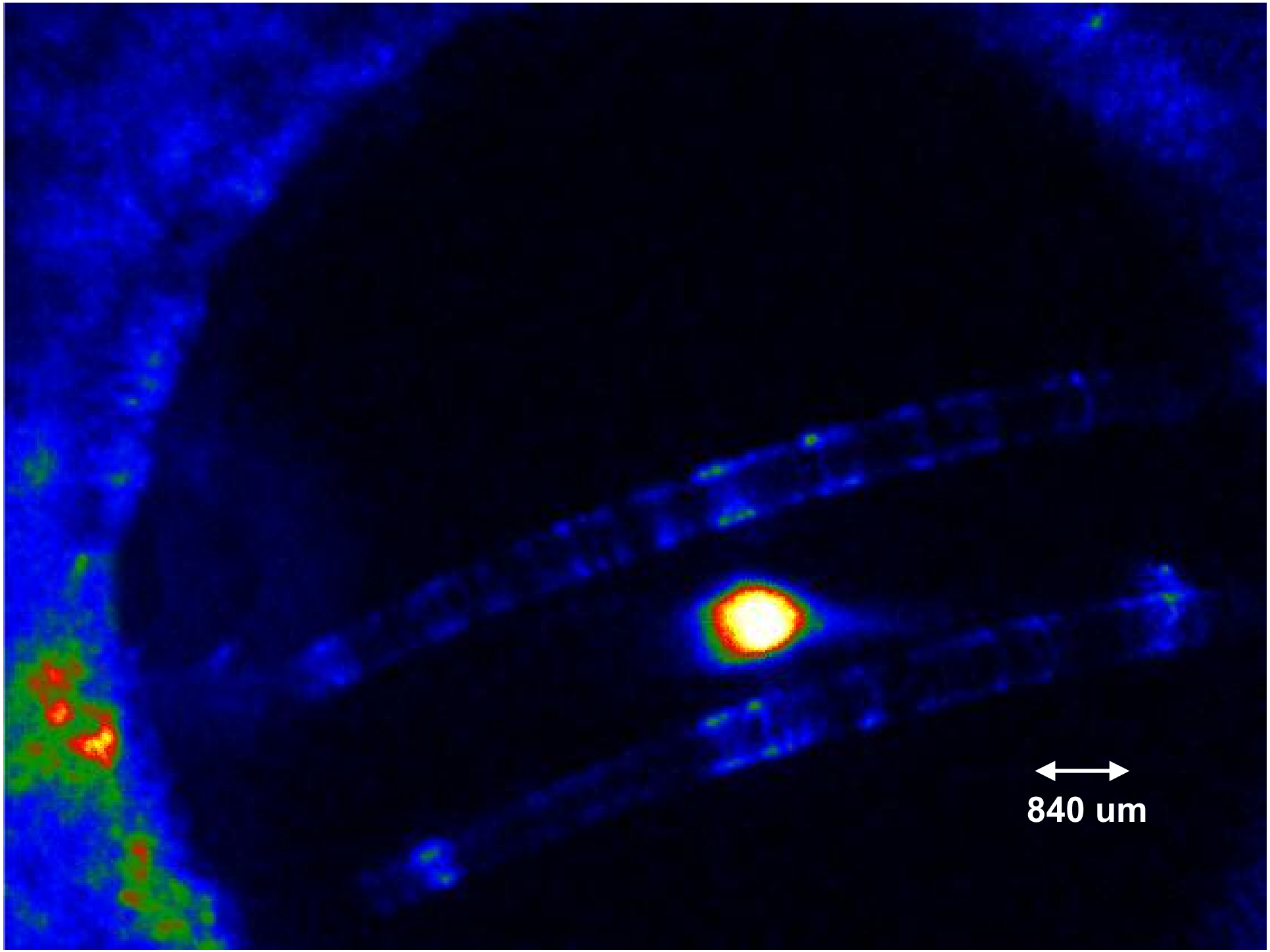
Experimental Results



Neutral Atom Storage Ring



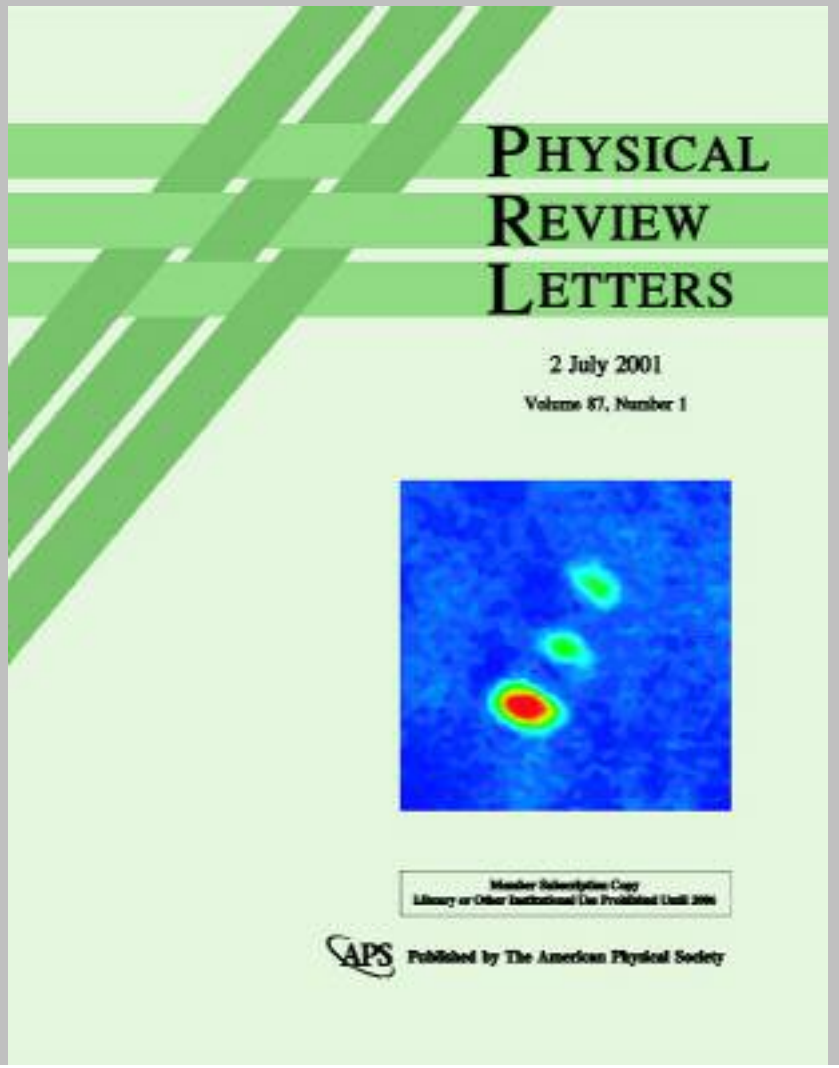



840 um

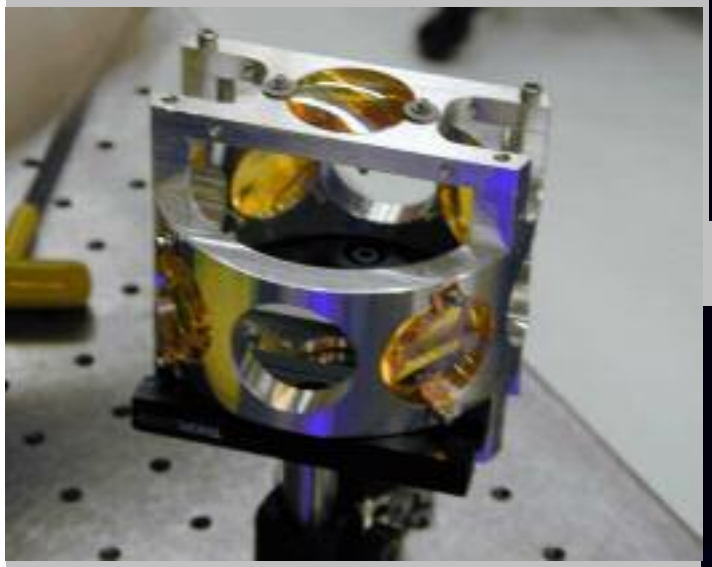
All Optical BEC—2001

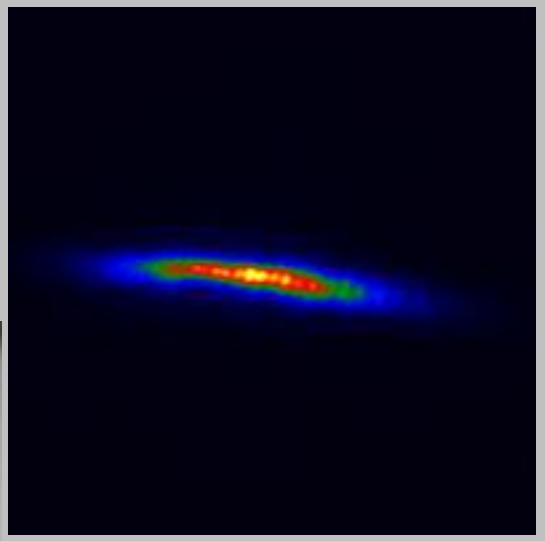
- All optical BEC is fast (and simple…)

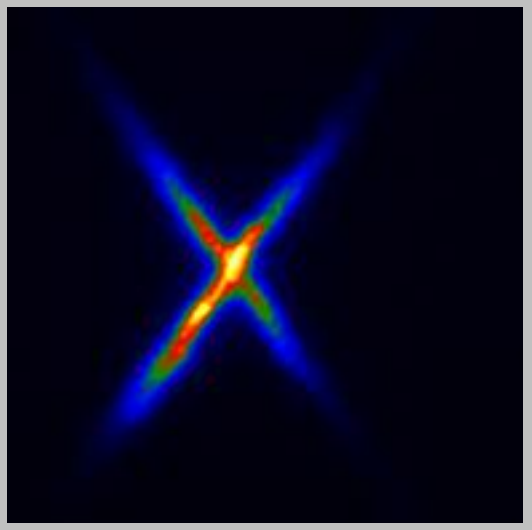
First cover illustration in 100 yr history of the Physical Review

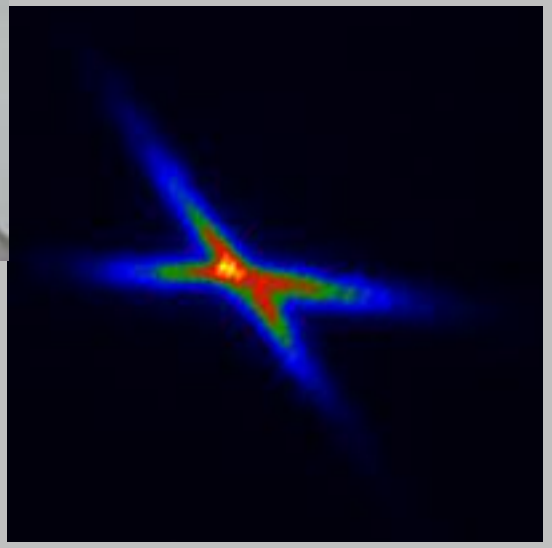


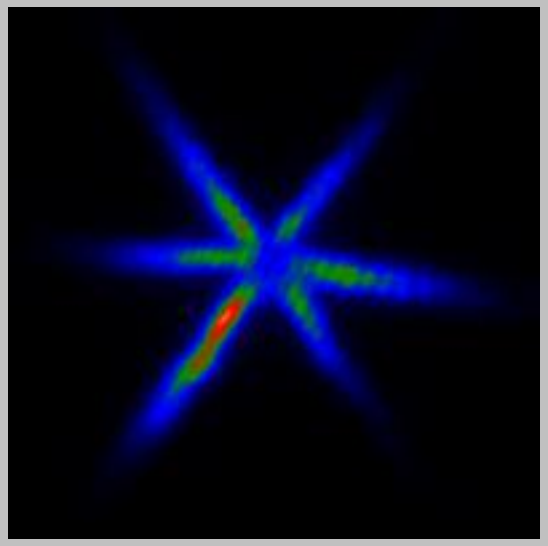
Gallery of optical traps



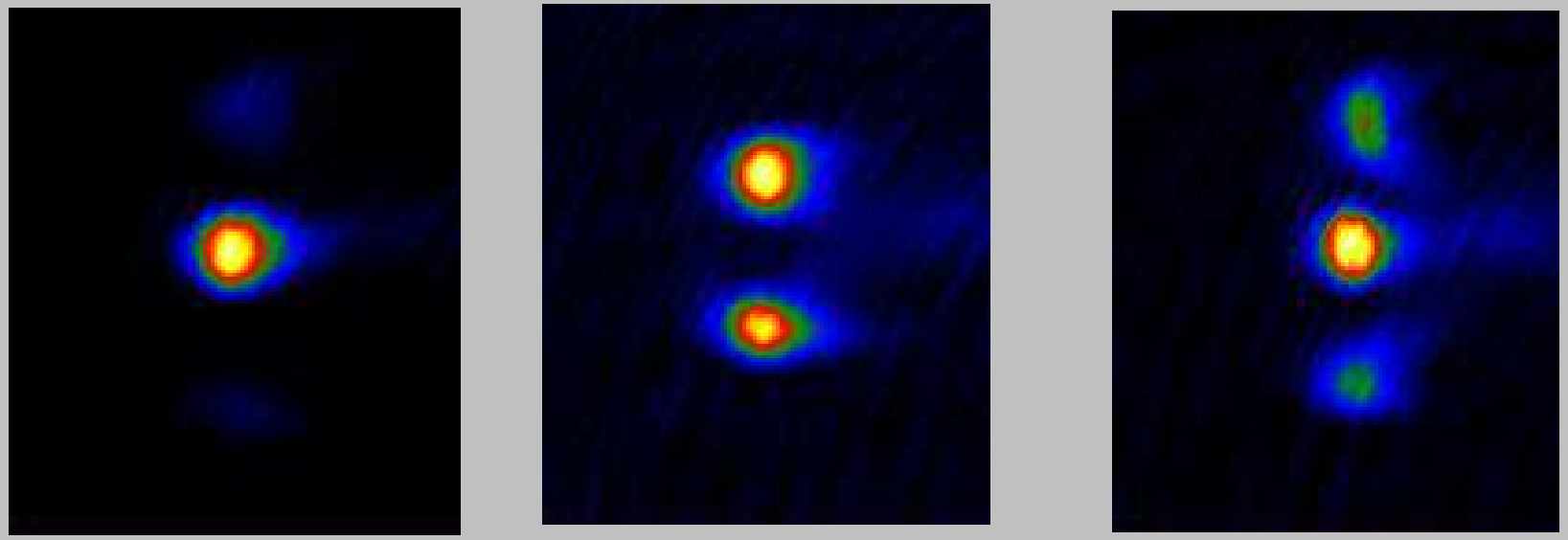


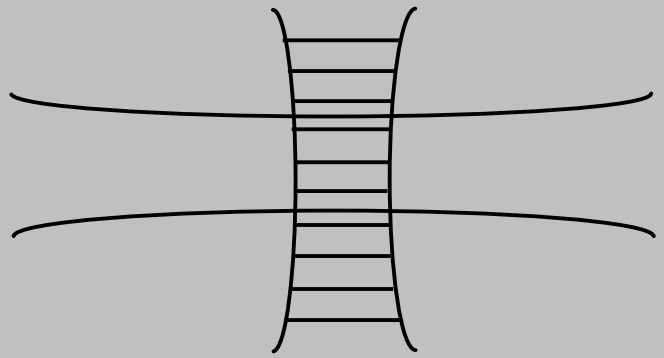






Controlling the site loading

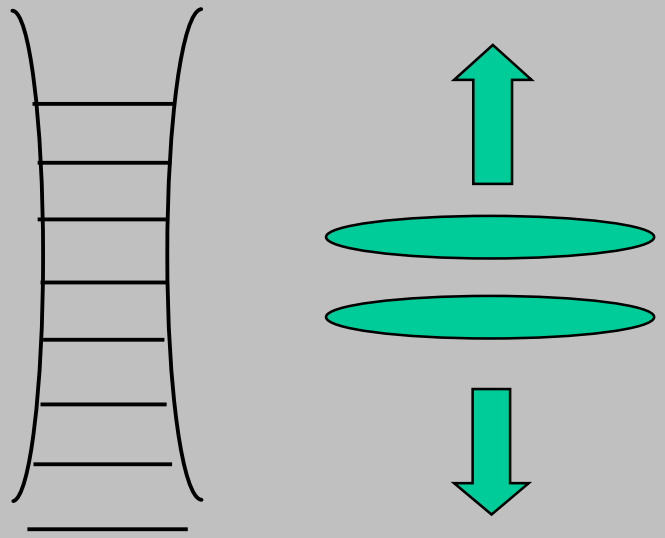




Vary ‘funnel’ powers and
lattice position during transfer

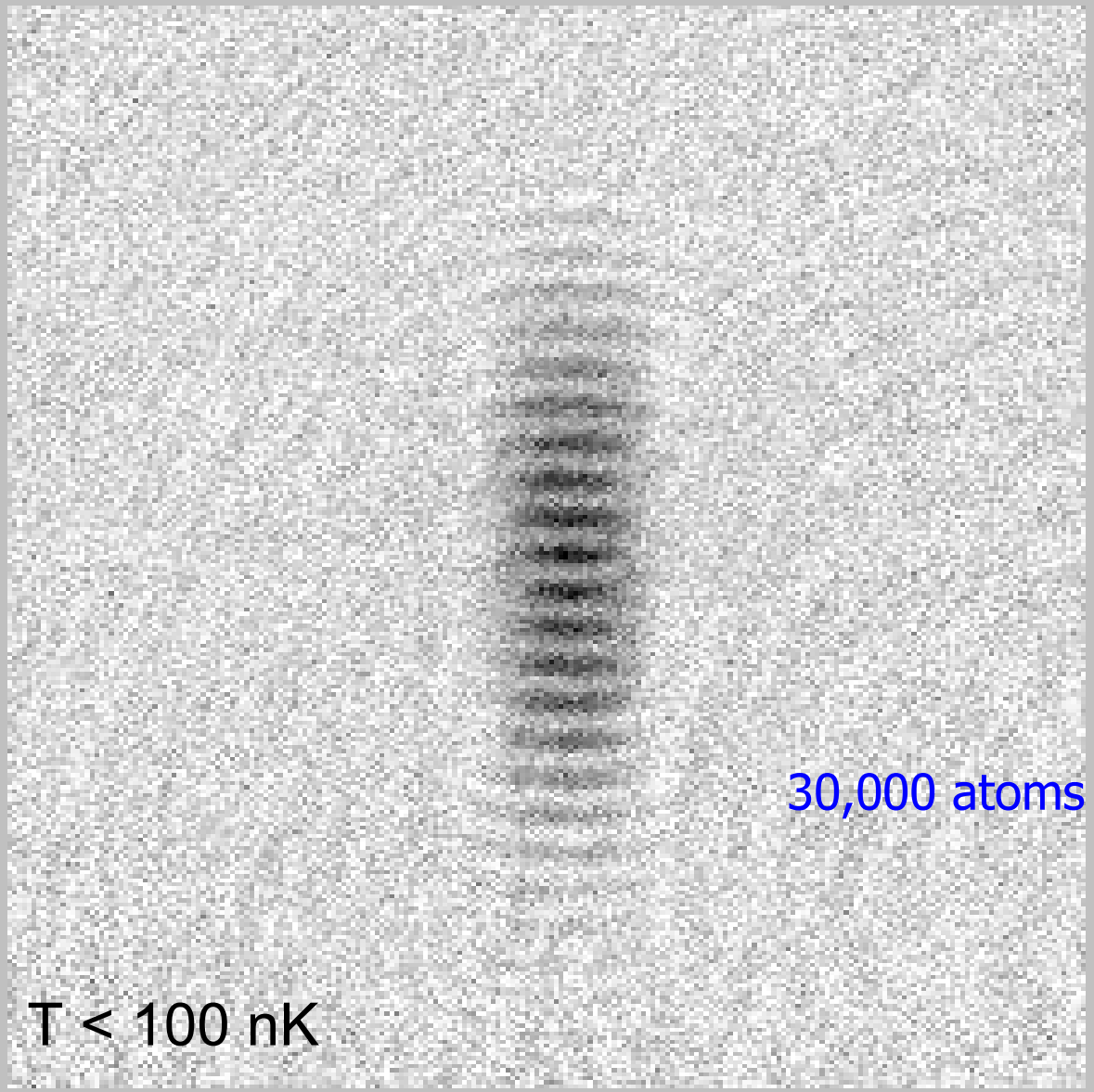
Interference of condensates

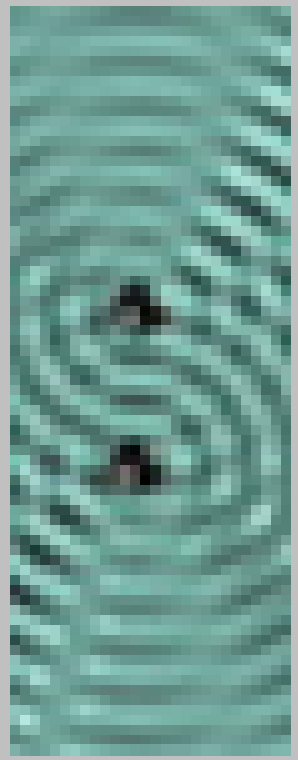
If two condensates overlap during
expansion, they should exhibit quantum interference



Analogous to interference of two
coherent independent lasers

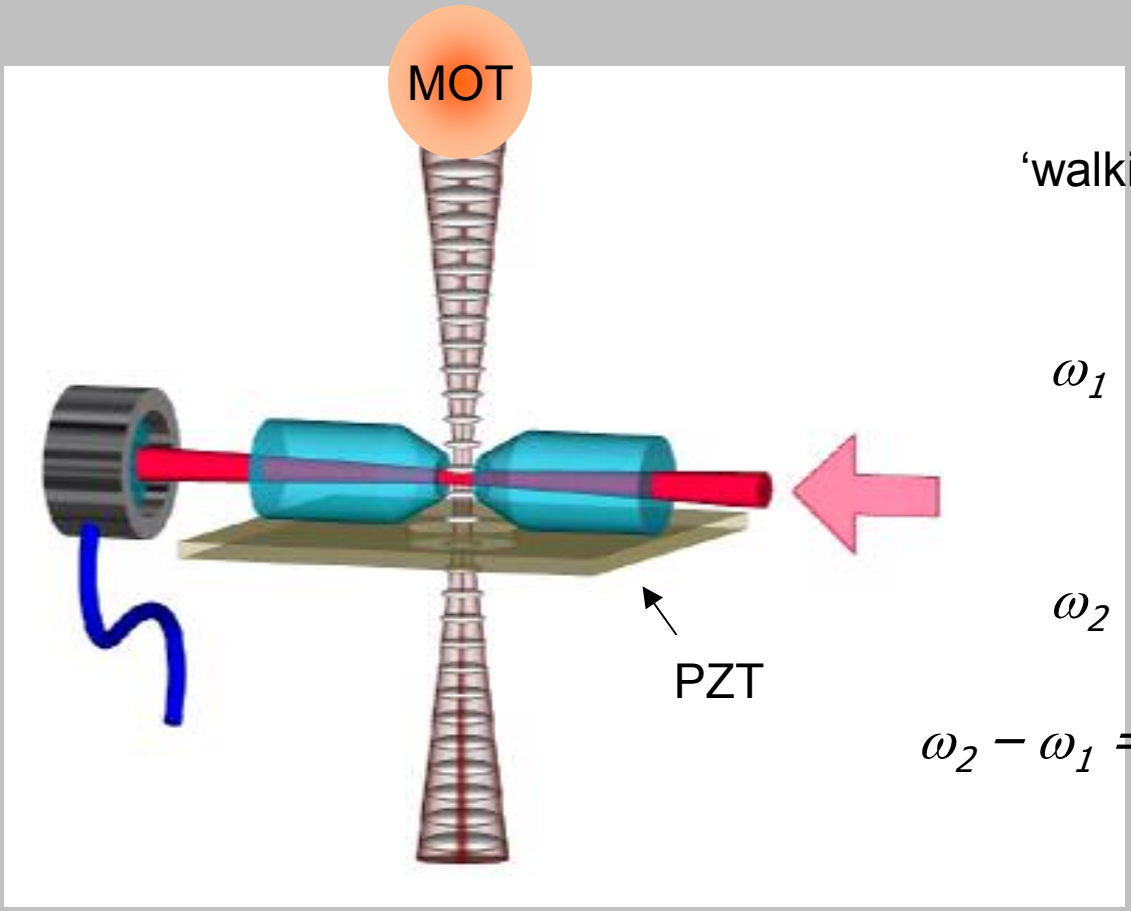
Atomic interference of Bose condensed atoms





Georgia Tech, 2002

Atoms optically transported to cavity



‘walking wave’

ω_1

ω_2

$\omega_2 - \omega_1 = 2\pi\ 200\ kHz$

Trap parameters

λ_{trap} = 850 nm

w_0 = 22 μm

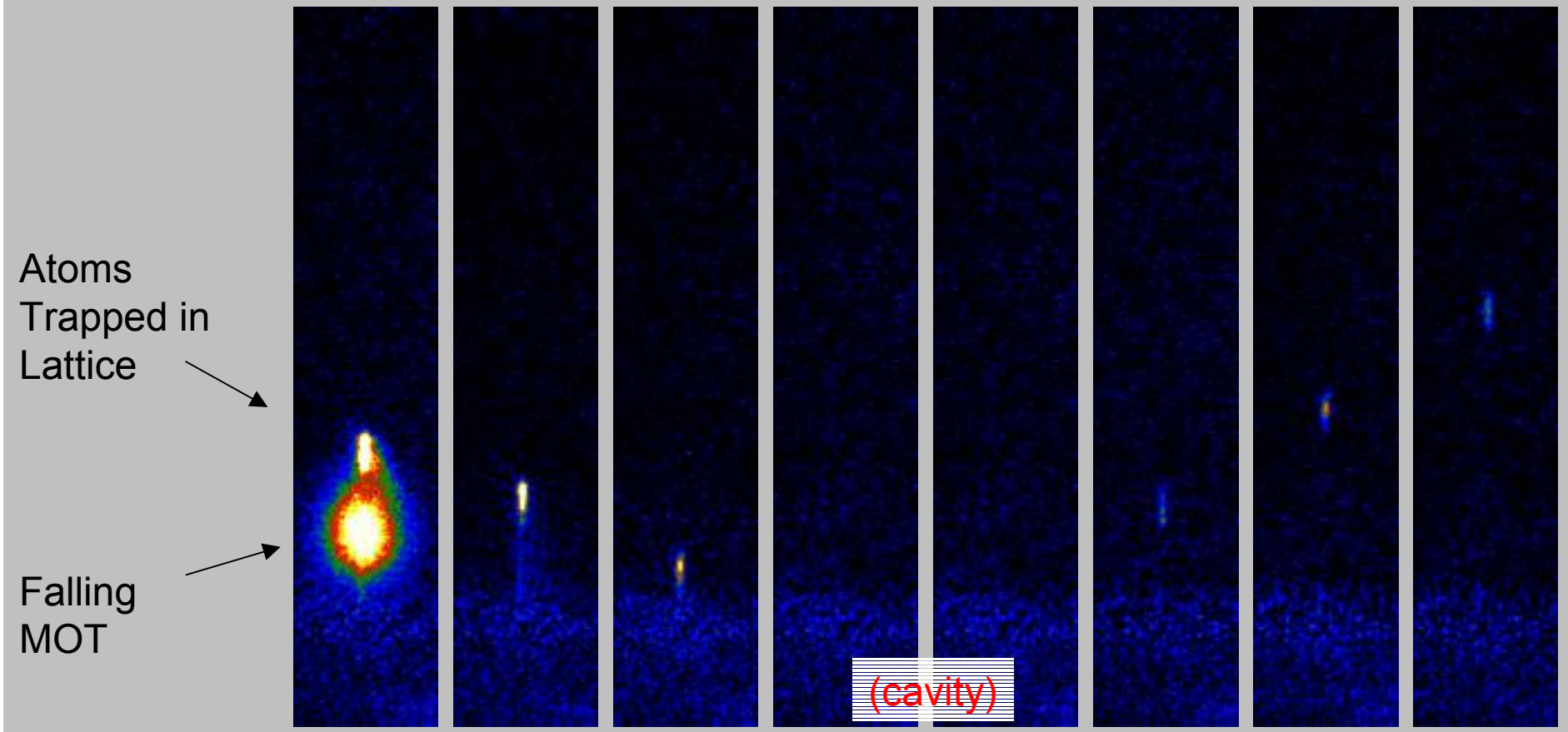
P = 140 mW/beam

U_0 = 350 μK

Optical dipole trap

Atoms are transported from the magneto-optic trap (MOT) to the cavity below using a translating 1-D optical lattice

DELIVERY OF ATOMS



Time-lapse images showing the atoms transported first down into the cavity, and then back up out of the cavity