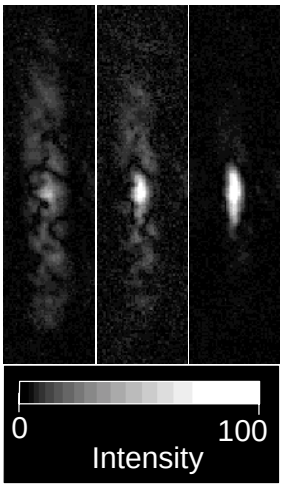
Non-destructive imaging of a Bose condensate

The first BEC experiments were done by switching off the trap and imaging an expanding condensate. This technique is necessarily destructive and probes the condensation phenomenon only in momentum space. However, in an inhomogeneous potential, e.g. in atom traps, the condensate and the normal fraction of a Bose gas are spatially separated [1]. Using dispersive imaging, we observed the spatially localized condensate [2].

Dispersive imaging collects the elastically scattered photons, in contrast to absorption imaging which maps out the spatial distribution of absorbed photons. The scattered photons can be separated from the incident light in the Fourier transform plane of the imaging system by spatial filtering.

The figure shows dark ground images taken around and below the BEC phase transition. It shows the growth of the condensate fraction inside the saturated Bose gas. Dispersive imaging is non-dissipative and does not heat up the condensate. More recently, we took over twenty images of the same condensate. This real-time observation of dynamical processes played an important role in many subsequent studies.



First direct observation of a Bose condensate of magnetically trapped atoms. The figures show clouds with a condensate fraction that is increasing from close to 0% (left) to almost 100 % (right).

1. K. Huang, *Statistical Mechanics*, second edition (Wiley, New York, 1987).
2. M.R. Andrews, M.-O. Mewes, N.J. van Druten, D.S. Durfee, D.M. Kurn, and W. Ketterle, Science **273**, 84 (1996).