L.8 Enhancement in atom transfer between two MOTs by using a pulsed push beam

In our setup for Bose-Einstein condensation (BEC) of 87Rb atoms, we have two magneto-optical traps (MOTs); first is prepared in a vapor chamber containing Rb-vapor ($\sim 10^{-8}$ Torr) in the background and second is prepared in a UHV chamber ($\sim 10^{-10}$ Torr) after ejecting the atoms from the first MOT using a push laser beam (Fig.L.8.1). Both these MOTs are respectively referred as vapor-cell-MOT and UHV-MOT. The requirement of UHV-MOT arises from the requirement of a longer lifetime of the atoms in the trap for evaporative cooling to achieve BEC. In transferring atoms from vapor-cell-MOT to load UHV-MOT, parameters of push beam play an important role and determine the number of atoms trapped in the UHV-MOT. We have investigated in detail the effect of push beam parameters on transfer and loading of atoms from vapor-cell-MOT to UHV-MOT. In this we have compared the effect of pulsed and continuous wave (CW) push beam on the number of atoms in UHV-MOT and observed many-fold enhancement in the number when pulsed push beam was used. We have also studied the effect of loading time of vapor-cell-MOT on the number of atoms loaded in the UHV-MOT, for the pulsed push beam case.

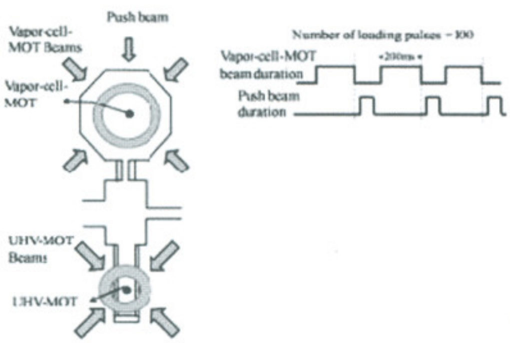

Fig. L.8.1 Schematic of the setup and sequence of pulses for pulse mode transfer.

The vapor-cell-MOT of 87Rb atoms is formed in a SS chamber (1×10^{-8} Torr) and has typically 7.63×10^{7} number of atoms after complete loading (duration ~1200 ms). The UHV-MOT is formed in a glass cell (1.6×10^{-10} Torr) connected to SS chamber through a narrow tube. The cooling laser beams for both the MOTs were generated from two separate grating controlled external cavity diode lasers, whereas the re-pumping laser beams for both the MOTs were obtained by dividing the output from a single laser of similar configuration. Cooling and re-pumping beams were first mixed, and the combined beam was passed through two acousto-optic modulators (AOMs) for operating MOT in a pulse mode. After AOMs the beam was expanded and split to generate the required laser beams for MOT operation. All lasers were frequency stabilized using saturation absorption technique. The push beam was a part of the cooling laser and was passed through separate two AOMs to generate the pulses. It can be operated either in pulse mode or in CW mode. The maximum power of the push beam was ~4mW (intensity ~58 mW/cm^2). The sequence of pulses for transfer is shown in Fig. L.8.1. This was generated from a computer-controlled controller developed by Laser Electronics Support Section. The number of atoms was estimated by fluorescence imaging technique using a digital CCD camera.

As shown in Fig. L.8.2, we observed that pulsed push beam results significant enhancement in atom number in UHV-MOT (shown by filled circles), as compared to number obtained with CW push beam (shown by continuous line). We also observed that in case of CW push beam, the number of atoms in UHV-MOT was larger if we used focused beam than that if we used unfocused beam. The horizontal line in Fig.2 shows the number for focused CW push beam for an optimum intensity $\sim 8.2\times10^{3}$ mW/cm^2. We have found that in case of pulsed push beam, the duration of push beam is important and has optimum value for number in UHV-MOT as is evident in Fig.L.8.2. We have also observed that loading time of vapor-cell-MOT is another important parameter governing the number in UHV-MOT and data shown in Fig. L.8.2 is for 200 ms loading of vapor-cell-MOT. For longer loading time of vapor-cell-MOT, the number in UHV-MOT deteriorates. The detailed analysis of results is in progress.

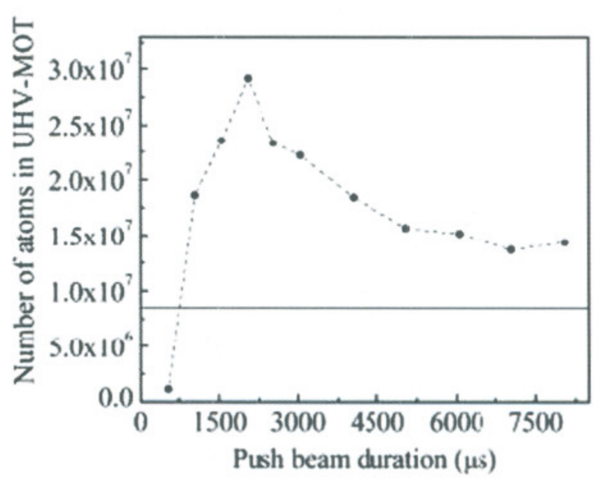

Fig.L.8.2. Filled circles show variation of number of atoms in UHV-MOT on push beam duration. Continuous horizontal line shows the number of atoms in UHV-MOT for a focused CW push beam.

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