# 4 Determination of model parameters

## 4.1 MOT loading rate and lifetime

In order to determine the loading rate and the lifetime of the MOT, a few loading experiments are performed. The idea is to start out with no trapped atoms, and to then turn on the trapping lasers, until the number of atoms saturates. The easiest way to determine the number of atoms is to use the MOT cameras to observe the amount of fluorescence from the trapped atoms. These cameras have already been calibrated, see a detailed description in Hermans' Bachelor thesis [Her10, p. 13].

In order to be able to do this experiment in a repeatable way, the MOT cameras are triggered using the programmable pattern generator (PPG). The exposure time of the cameras is 5 ms and they are triggered at intervals of 40 ms. It is possible to obtain images with a time resolution of 5 ms, by doing eight experiments and shifting the timing of the PPG sequence by 5 ms each time. All 8 steps are repeated 25 times to average the results out.

A schematic representation of the sequence is given in Fig. 4.1. There are 30 camera trigger pulses, the first of which always occurs before the trapping lasers are turned on and the last one or two occur after the trapping laser is turned off. If the cameras missed a trigger pulse, black pictures will occur at different times, so that the measurement can be discarded. This generally does not occur since the cameras can be operated at least at 100 Hz, while they operate at only 25 Hz in this case.

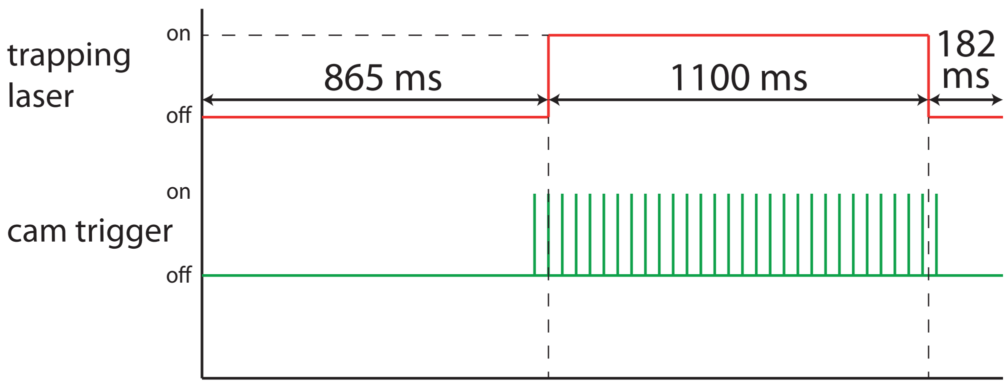


Figure 4.1: Schematic representation of the sequence used for the loading experiments. The time between two consecutive camera triggers is 40 ms. The entire trigger train is also shifted to later times in steps of 5 ms, so that the number of atoms can be determined with 5 ms time resolution.

In order to determine the number of atoms, the camera images can either be fitted with a 2D-Gaussian, or all pixel values can be summed. Both methods give very similar results. In the report the second approach is chosen. The results are plotted in Fig. 4.2. This number of atoms has been fitted with Eq. 2.5. In this figure, it can be seen that the cameras have a deviation of 15% in the number of atoms. This error originates in the calibration of the two cameras. Hence, the average is the best estimate that can be obtained $N_\infty = (2.2 \pm 0.2) \times 10^8$ atoms. The time-constant of the fit is the lifetime with