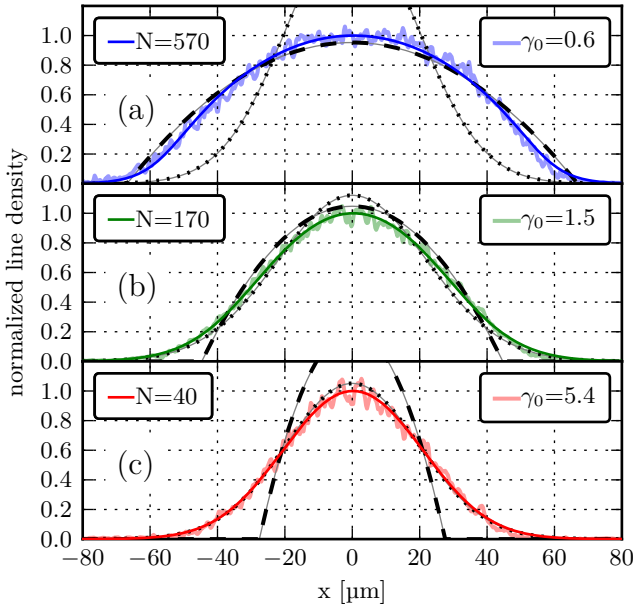

FIG. 1. (color online). (a)-(c) *In situ* density profiles from data set C (light solid) for increasing distance from the trap center, corresponding to different interaction strengths and same temperature. The exact YY fits are shown as dark solid lines. N denotes the number of atoms. The peak densities are $n_{1D}(x=0)$: (a,b,c)=$(6.2,2.7,0.7)\times10^6\,\mathrm{m}^{-1}$. The asymptotic solutions with the same number of atoms as for the exact YY-fit are also shown: TF-profile ($T=0\,\mathrm{nK}$) (dashed) and ideal Bose gas (dotted).

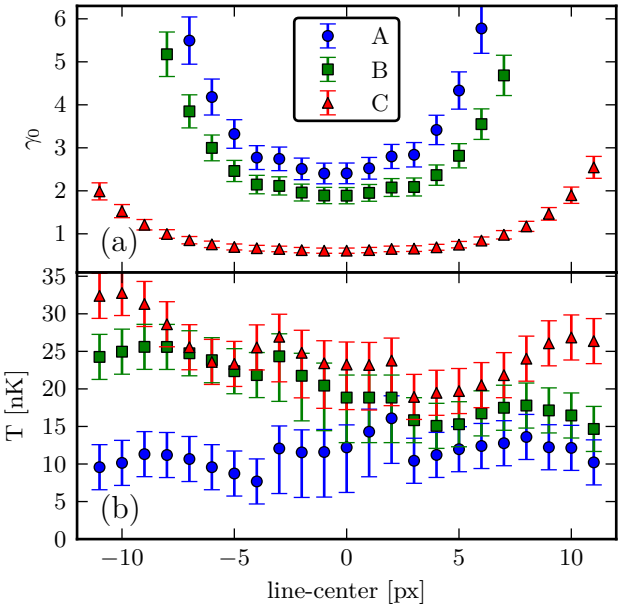

FIG. 2. (color online). (a) Central interaction strength γ_0. (b) Temperature T from a fit with the exact YY theory. Every point represents one line in R for the corresponding data set. Negative (positive) values of the x-axis represent the upper (lower) half in R.

$\omega_{ax}=2\pi\times12.7\pm1.7\,\mathrm{Hz}$ (C). The angle between the lattice axes and the EB is 45 °. Therefore, the pixel size is chosen to be 273 nm and the total imaging duration is 30 ms. The fast scanning direction is oriented along the 1D gases, such that the scan speed is much faster than the speed of sound. All single-shot pictures are corrected for angle and position drifts and summed up. This yields an image sum P for each of the three samples (A,B,C) containing 3200, 3900 and 1900 pictures respectively.

We decompose the integrated density profiles using an inverse Abel transformation $\mathcal{A}^{-1}$. Altough the 2D lattice in our setup has a four-fold symmetry it is smeared out due to the SEM imaging settings and the post-processing. Therefore, the prerequisite of cylindrical symmetry is approximately fulfilled. To perform the Abel inversion, we make use of the BASEX-method [33] in a modified way [34]. The noisy central region [35] (±3 pixel) is interpolated with a Abel inverted gaussian fit on P. Every horizontal line in the resulting image $R=\mathcal{A}^{-1}(P)$ corresponds to an average of all 1D gases which are at the same distance from the symmetry axis and thus have the same central interaction parameter $\gamma_0=\gamma(x=0)$. For every line in R we perform a fit with the exact Yang-Yang theory (YY) [2], making a local density approximation [22]: $\mu(x)=\mu_0-V_{ax}(x)$, where $\mu(x=0)=\mu_0$ is the central chemical potential and $V_{ax}(x)=m\omega_{ax}^2x^2/2$. The line-density is fixed by a normalization with the atom number and the pixel size, leaving the temperature as the only free parameter. As can be seen in Fig.1, the fits reproduce the density profiles very well. The temperatures show only moderate variations which are compatible with the estimated error (Fig.2b). We find (A,B,C): ($\bar{T}=11(2)\,\mathrm{nK}$, $\bar{T}=20(4)\,\mathrm{nK}$, $\bar{T}=25(4)\,\mathrm{nK}$). This indicates an adiabatic loading of the lattice without significant perturbations. The residual variations of T originate from the inversion method as well as the interpolation in the center. The temperatures were further cross-checked via a fugacity analysis by fitting a thermal distribution to the wings of each profile. As shown in Fig.1, the density profiles change drastically with the interaction parameter γ_0. This is due to the reduction of interaction energy $E_{int}\simeq n_{1D}g_{1D}$. Note, that even though γ_0 is increasing towards the outer tubes, the absolute value of the interaction energy drops as n_{1D}. The critical density at which the thermal energy dominates is defined via the dimensionless degeneracy temperature $\tau(x)=T/T_d(x)$ with $T_d(x)=\hbar^2n(x)^2/2m$ [22]. For Fig.1a the value in the center is $\tau(0)=0.2$ and the density profile is close to a Thomas-Fermi distribution. For the high-temperature region ($\tau(0)=15$, Fig.1c) the effect of interaction is masked, because the mean inter-particle distance is larger than the thermal de-Broglie wavelength and the system is dominated by the thermal energy, resulting in a thermal distribution.