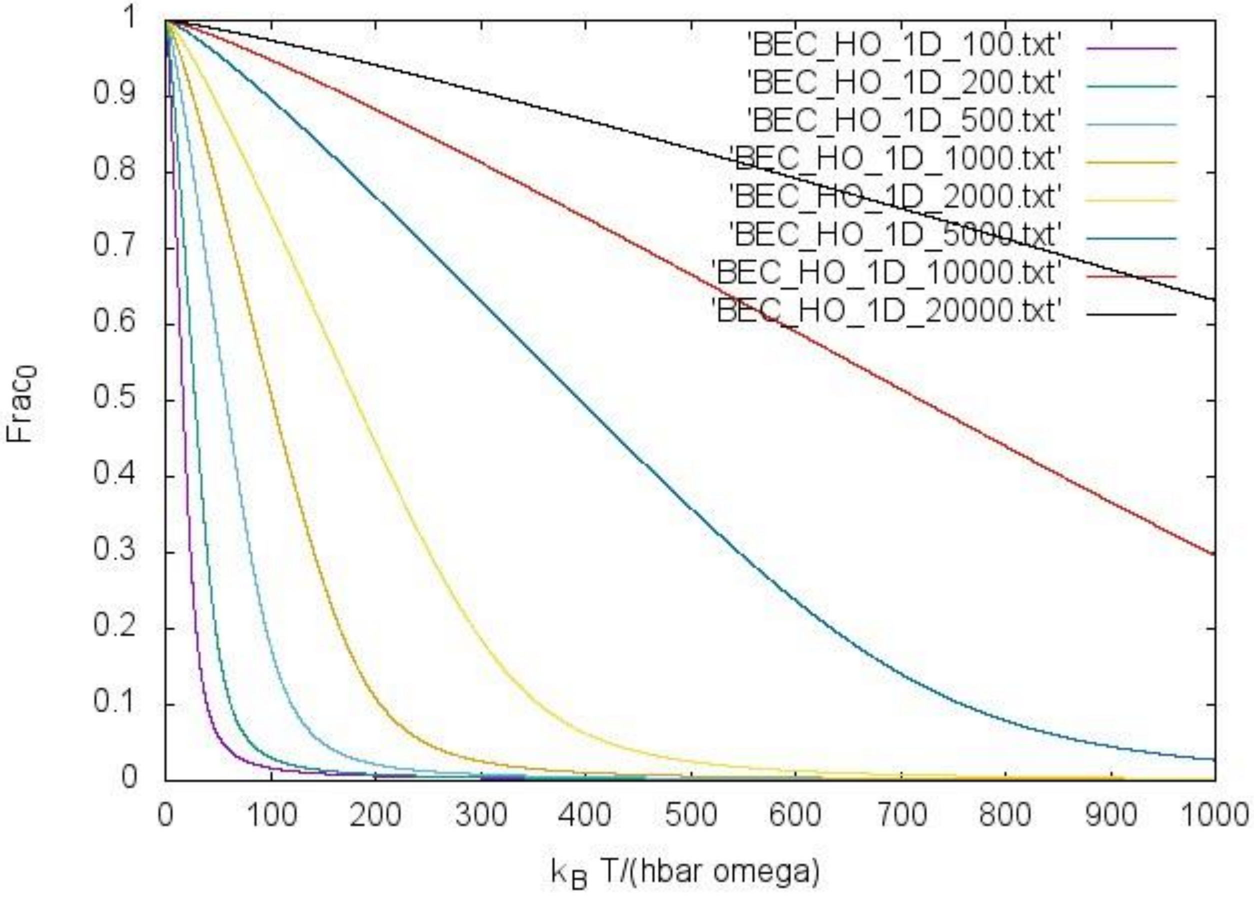
Numerical calculation of bosons in 1,2,3D HO

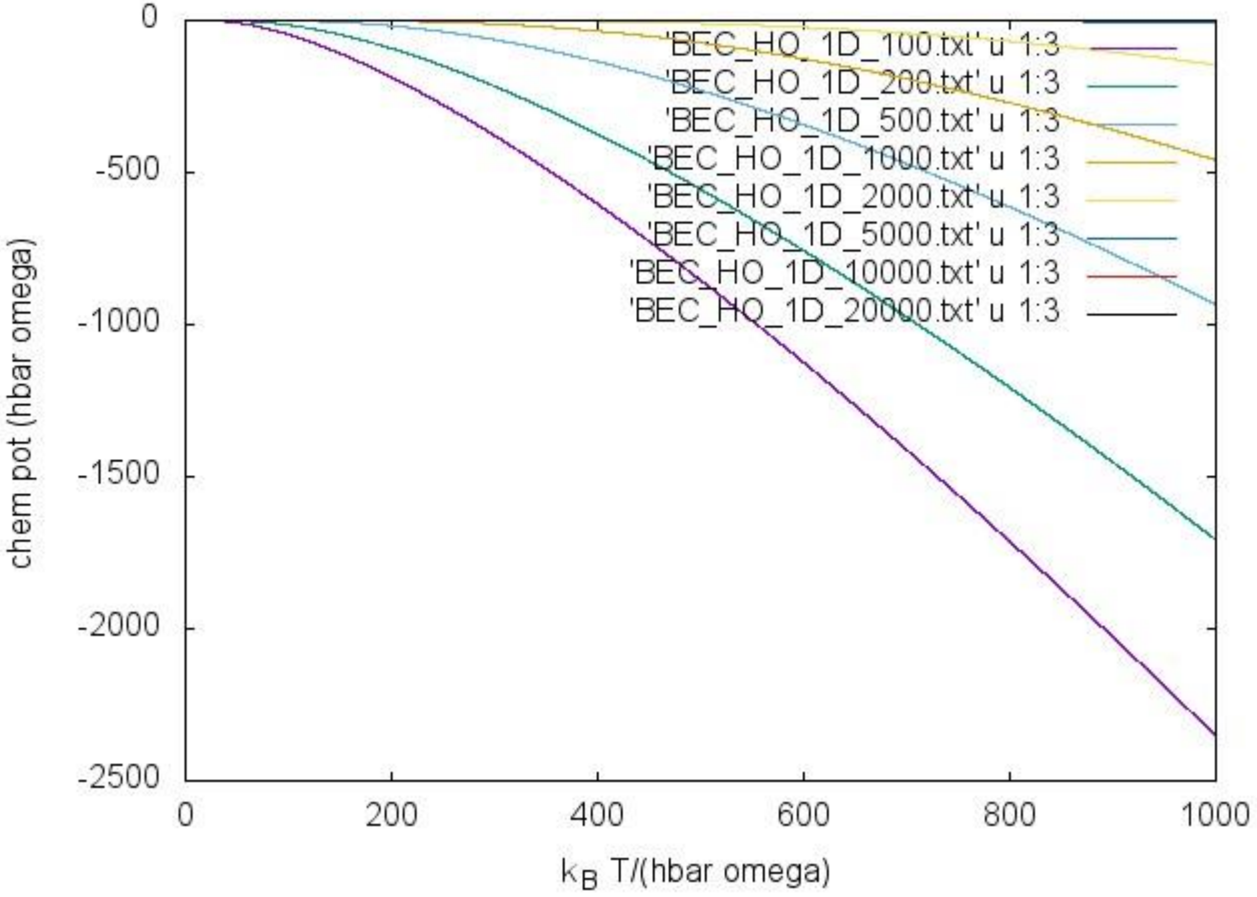
Performed numerical sums of the Bose-Einstein distribution to obtain the fraction of atoms in the ground state and the chemical potential vs the temperature for different numbers of particles 100 to 20,000

Calculations were done for 1D, 2D, and 3D harmonic oscillators

1D does not show a BEC transition
2D and 3D show a transition that gets sharper as the number of particles increases

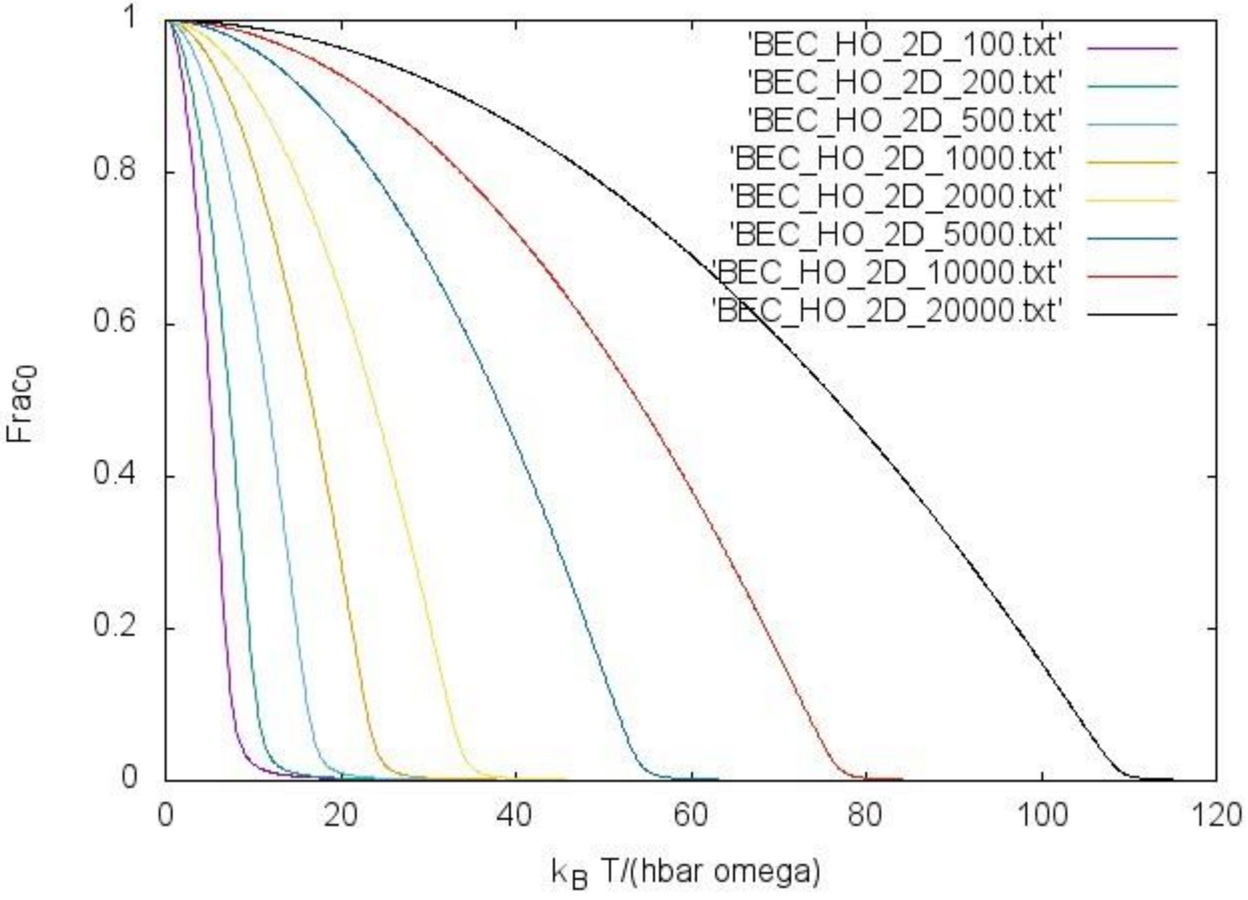
1D Harmonic oscillator, N = 100 to 20,000

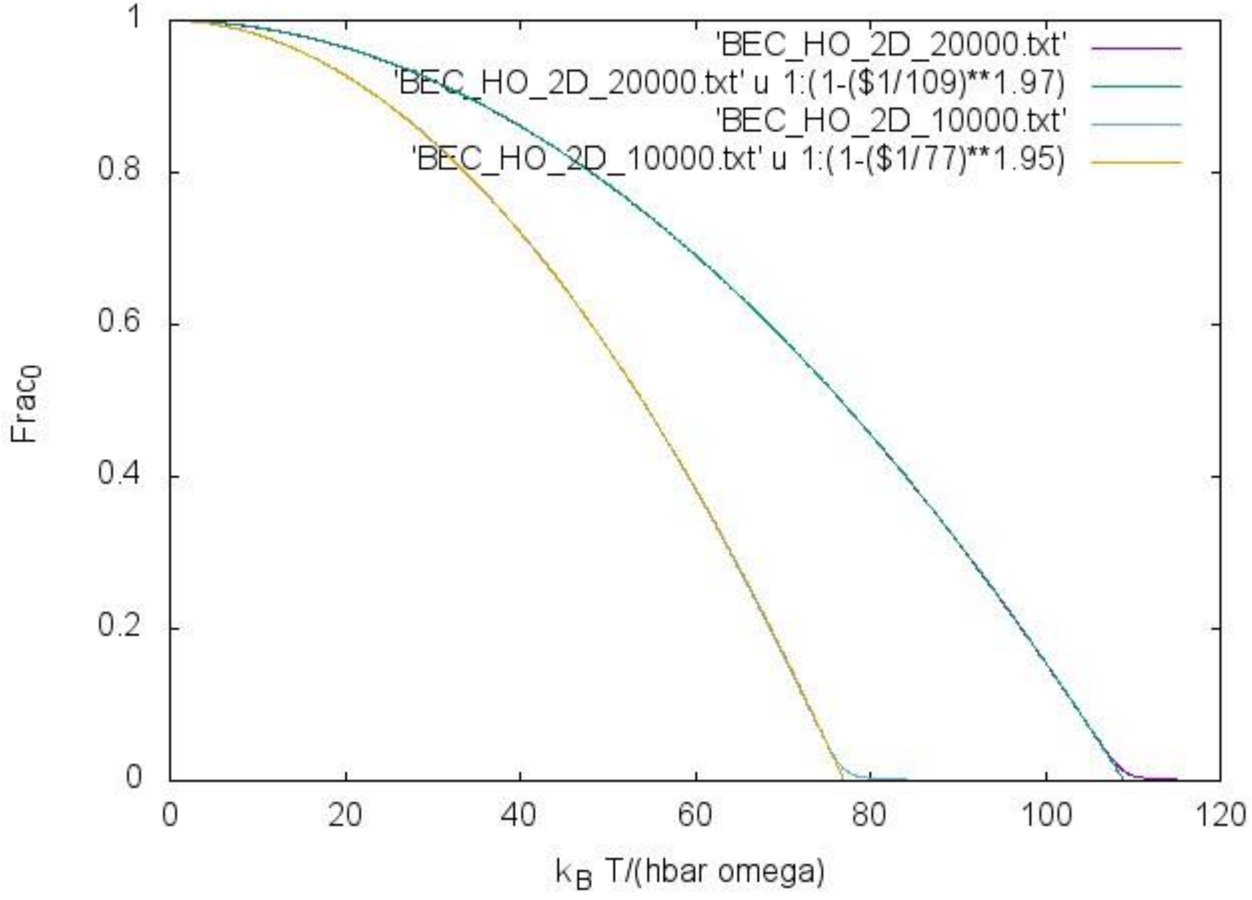




The left plot is fraction of atoms in ground state, right plot is chemical potential
There isn't a clear transition

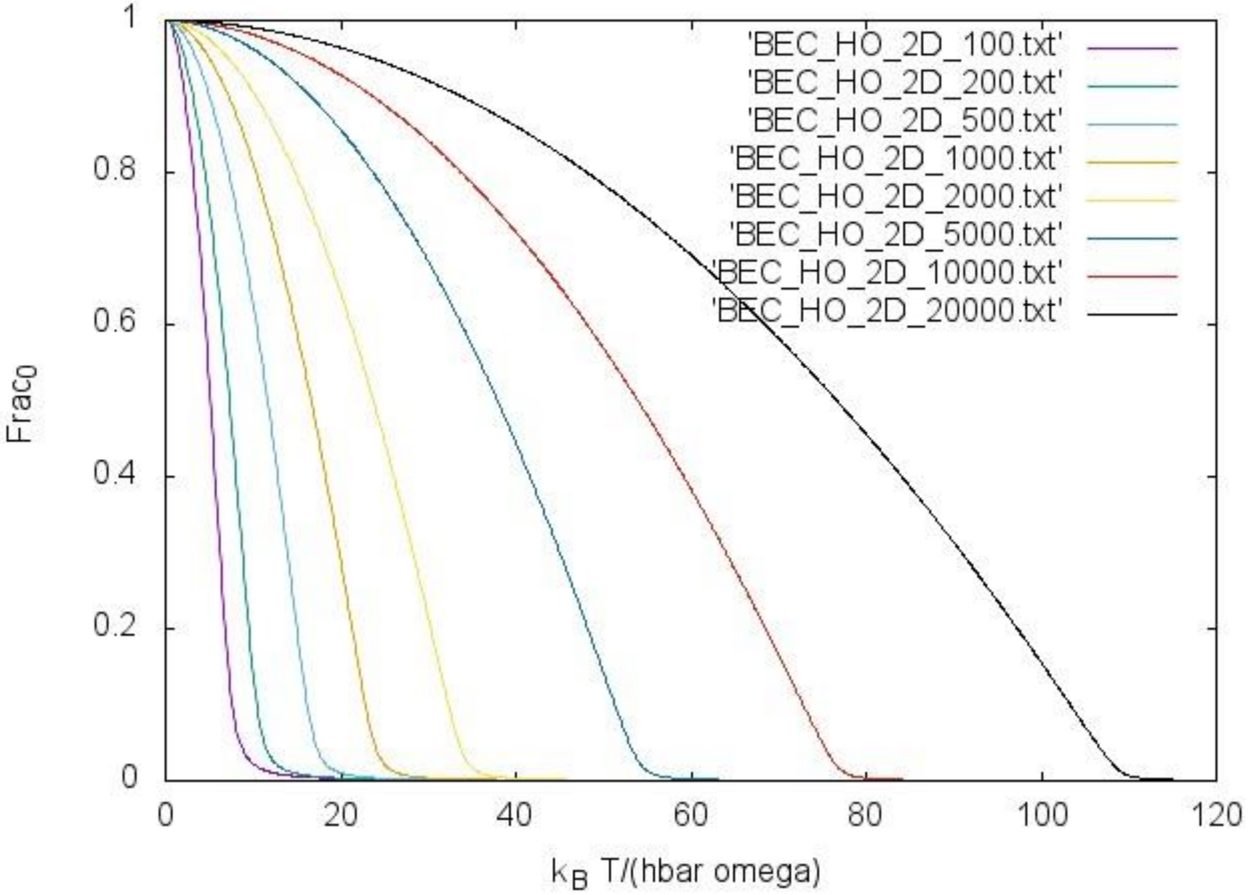
2D Harmonic oscillator, N = 100 to 20,000

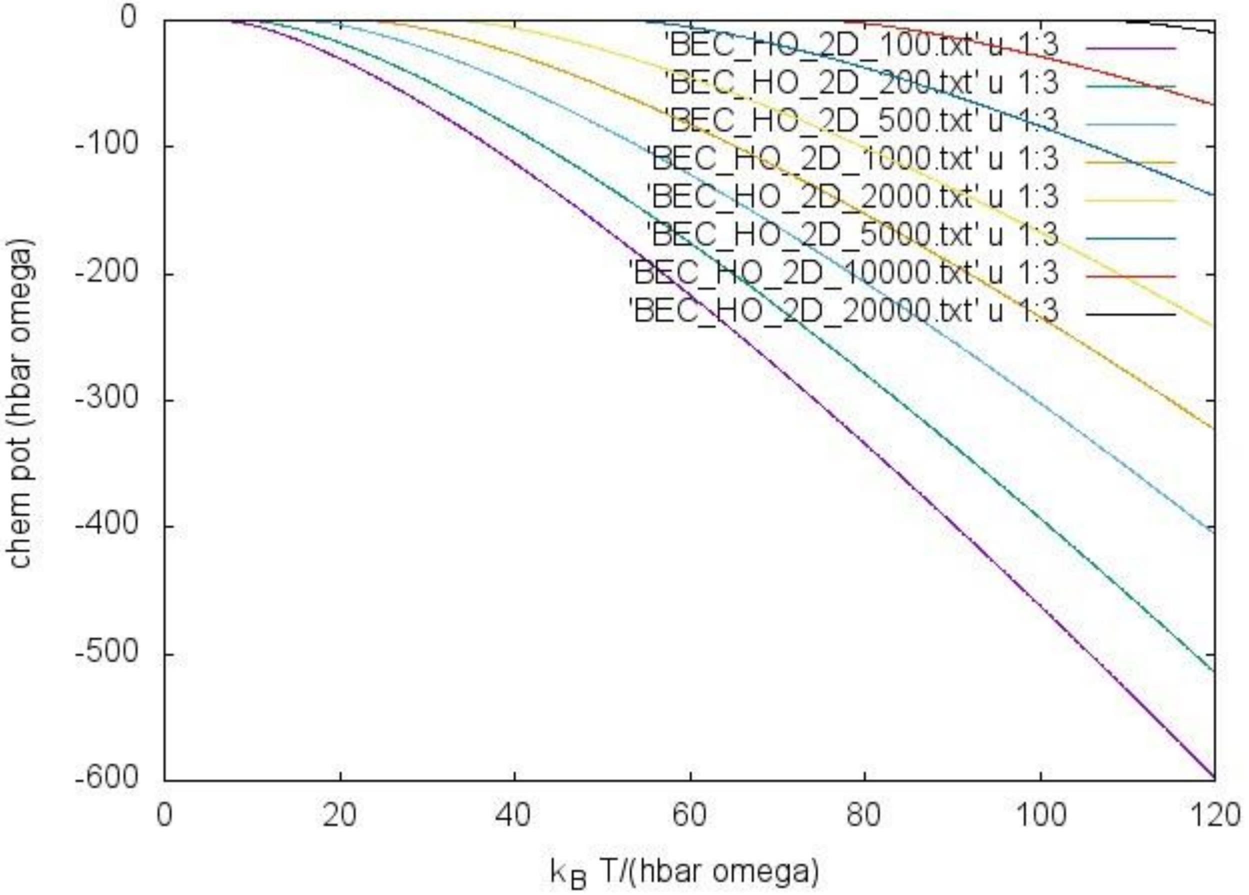




The left plot is fraction of atoms in ground state, right plot is a “by eye” fit to the fraction
There is a clear transition that becomes sharper with increasing N
Fraction is proportional to $1 - (T/T_C)^2$ with T_C proportional to the square root of N

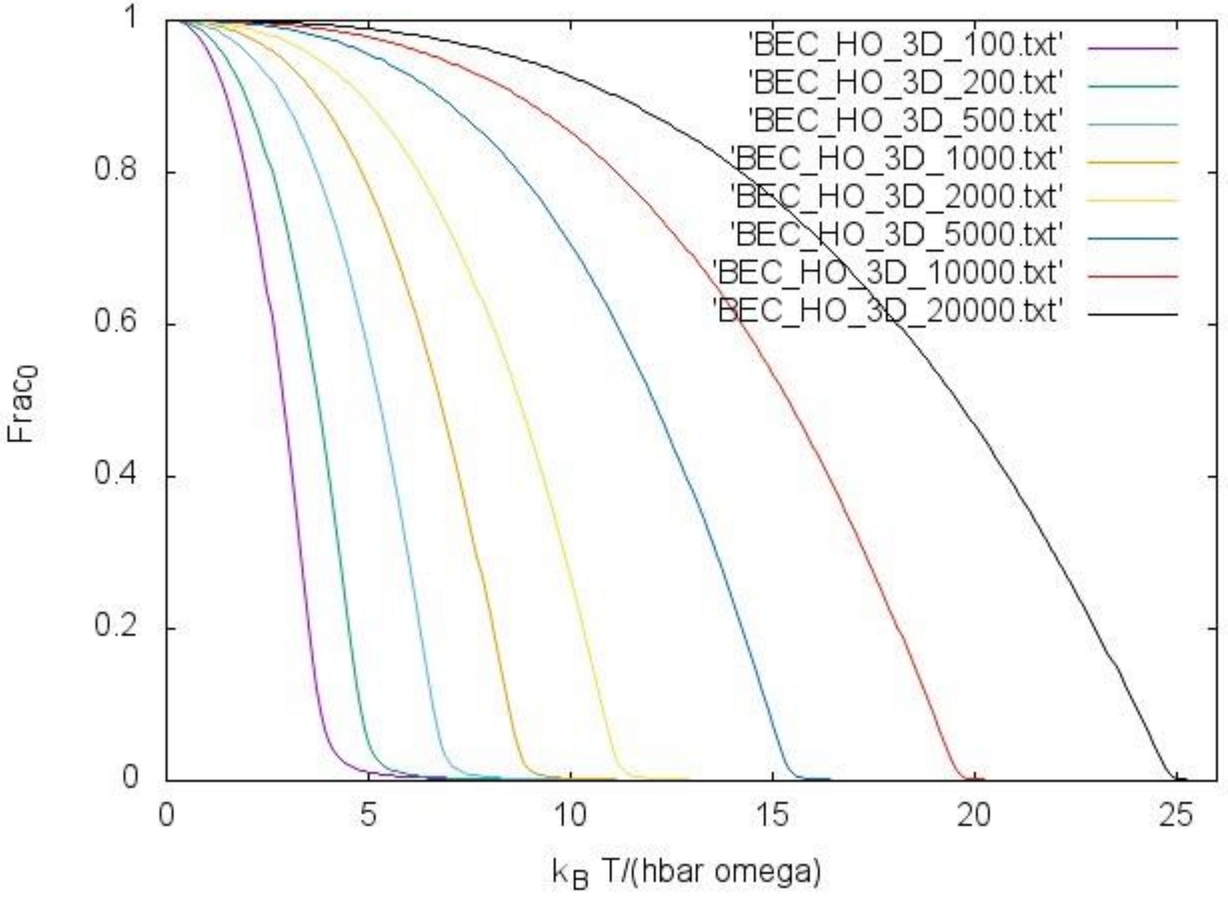
2D Harmonic oscillator, N = 100 to 20,000

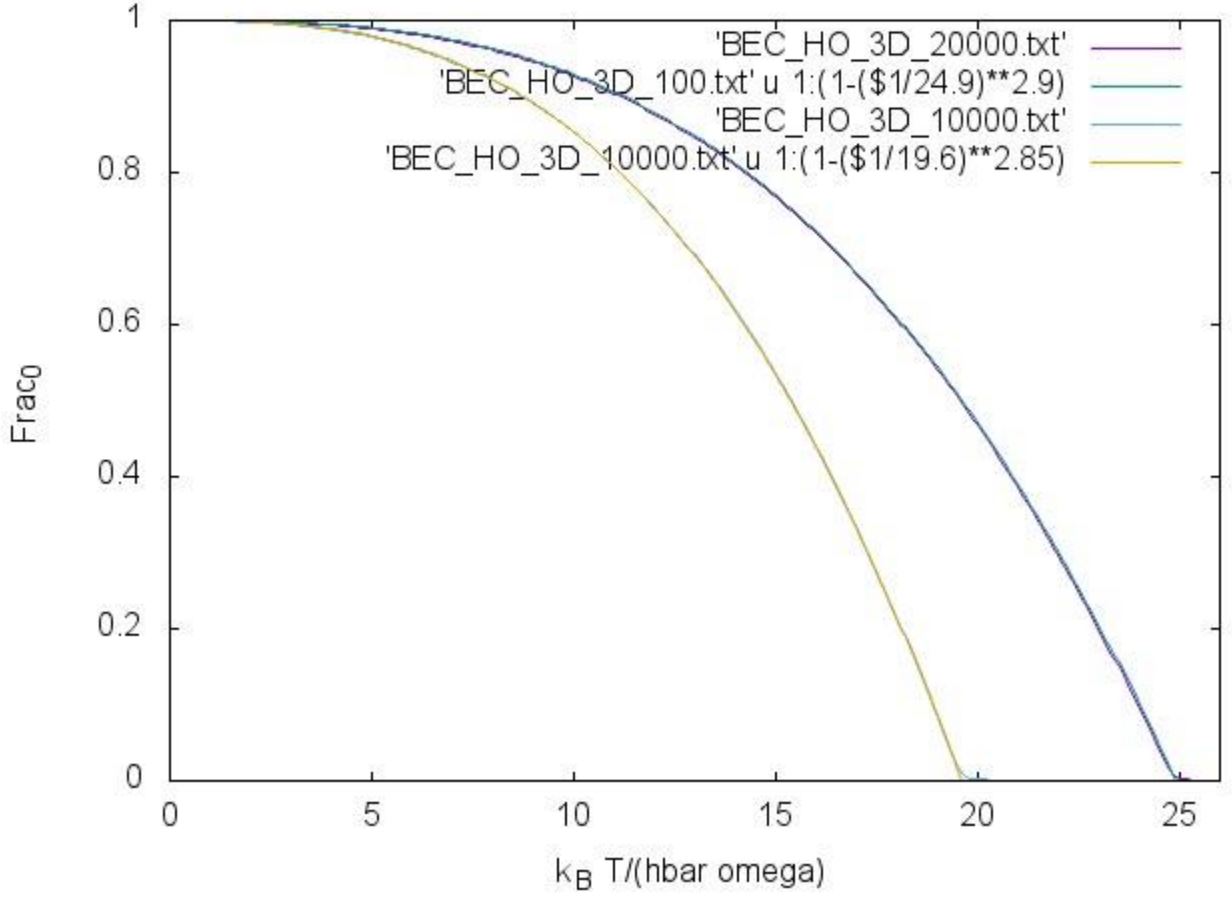




The left plot is fraction of atoms in ground state, right plot is chemical potential
There is a clear transition that becomes sharper with increasing N
The chemical potential is ~0 where the ground state fraction is non-negligible, then decreases rapidly

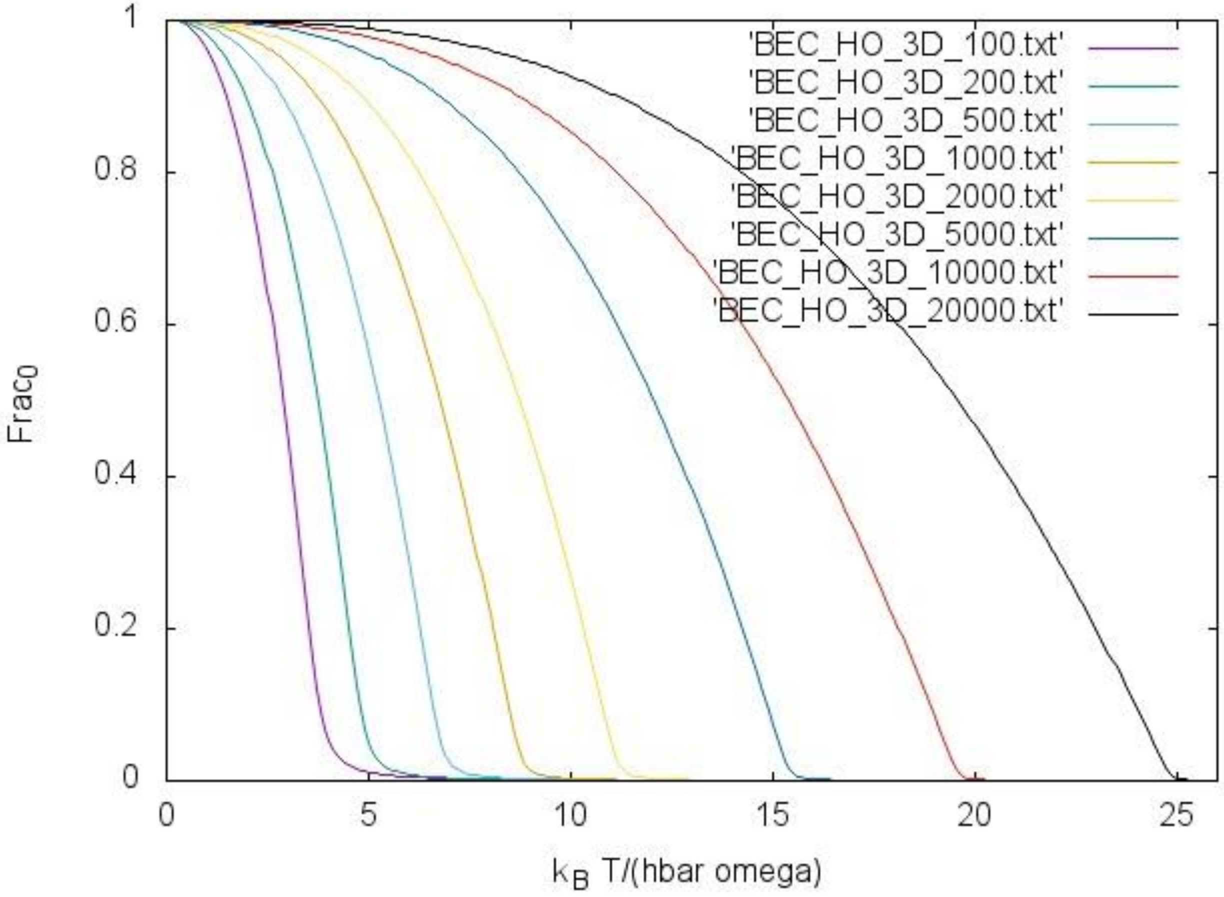
3D Harmonic oscillator, N = 100 to 20,000

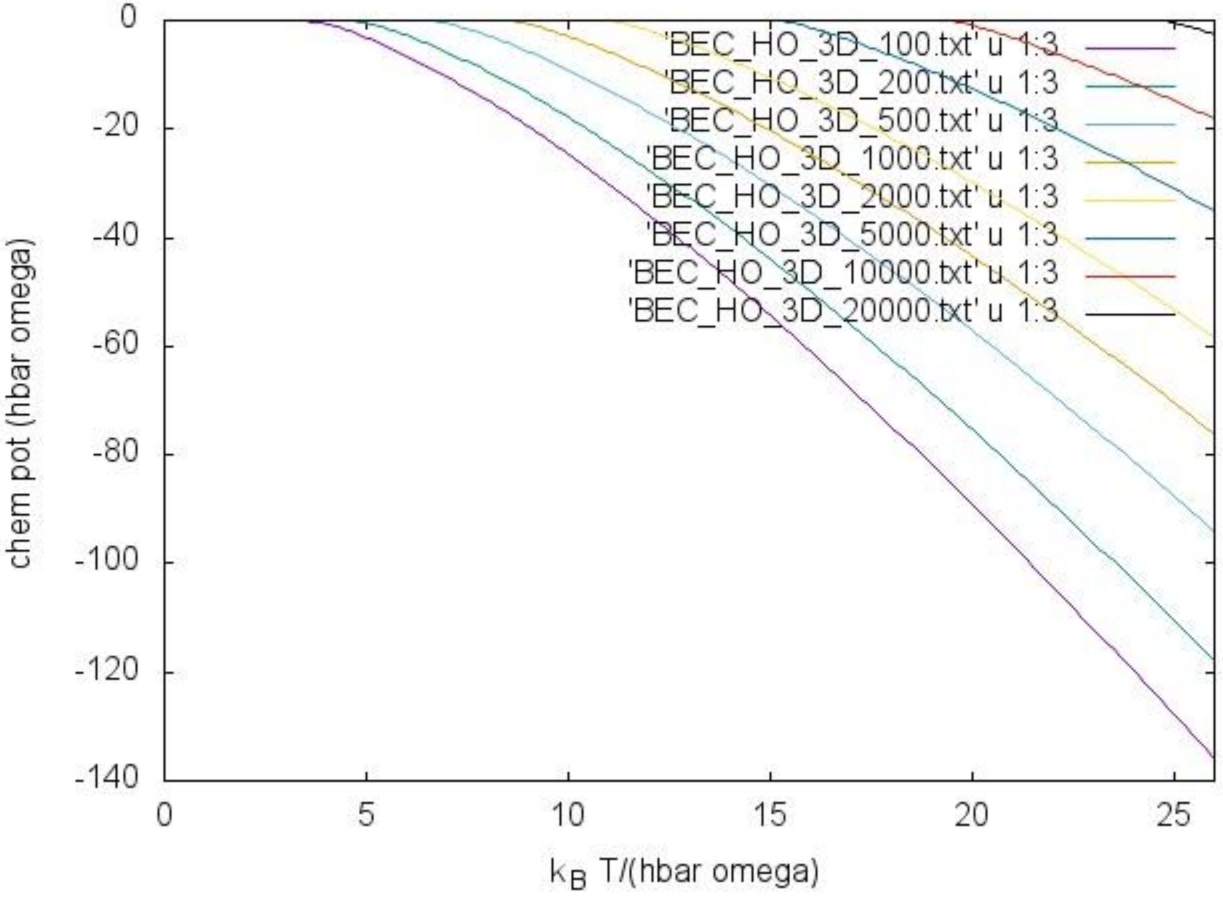




The left plot is fraction of atoms in ground state, right plot is a "by eye" fit to the fraction
There is a clear transition that becomes sharper with increasing N
Fraction is proportional to $1 - (T/T_C)^3$ with T_C proportional to the cube root of N

3D Harmonic oscillator, N = 100 to 20,000





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