The CeIn$_3$ compound is an intermetallic heavy fermion with a ground state resulting from the competition of a long ranged magnetically ordered state produced by RKKY interactions and the Kondo effect. The former dominates at low temperatures leading to an antiferromagnetic phase (AFM) for temperatures $T < 10$ K. However, under relative small pressure ($\sim 25$ kbar) the screening of the 4f moments by the conduction electrons compensates the RKKY interaction and a particular situation where neither one of the ground state dominates leads to the formation of a quantum critical point (QCP). In a similar fashion the magnetic ordering temperature $T_N$ may also be suppressed by applying high magnetic fields $H \sim 60$ T with a possible emerging quantum critical point.

In this work we have determined the $H$-$T$ phase boundary of the AFM phase using specific heat (see Fig.1(a)) and magnetocaloric effect (see inset of Fig.1(b)) measurements. The main panel of Figure 1(b) summarizes the obtained diagram with star symbols indicating the specific heat measurements and circles symbols corresponding to magnetocaloric effect (MCE) measurements. In the MCE experiments the temperature of the sample is recorded during a rapid sweep of the magnetic field as shown in the inset of Figure 1(a). Here the phase transition manifest itself as a kink in the quasi-adiabatic $T(H)$ evolution without any evidence of field irreversibility in agreement with a second order transition.

The phase diagram depicted in Figure 1(b) exhibits a quadratic field dependence at low fields that turns into a linear dependence at high fields and extrapolates to $T_N = 0$ at $H \sim 80$ T. This value is significantly higher than the previous estimations using a quadratic fitting. In any case, these data confirm that as $T_N \rightarrow 0$, the slope of the phase diagram remains finite implying that the transition at $T_N = 0$ is still second order making it a good candidate for quantum criticality[1].

References