Introduction
Spin dimer compounds possess ground states that are the direct product of spin singlets, and so these ground states are non-magnetic. The recent interest in these systems is due to quantum phenomena associated with their magnetic excitations, called triplons. Upon application of a magnetic field larger than the critical field $H_{c1}$ necessary to close the spin gap, one can drive a spin dimer system to a long-range magnetically-ordered state [1]. For dimer systems characterized by spin-rotational symmetry in the $H < H_{c1}$ regime and delocalized triplet excitations, the ordered state can be described as a Bose-Einstein condensate (BEC) of triplons.

Experimental
We recently performed both heat capacity and magnetocaloric effect (MCE) measurements of the new spin ½ dimer compound $\text{Ba}_3\text{Cr}_2\text{O}_8$, specifically using a 35 T resistive magnet at NHMFL. The purpose of this experiment was to investigate the field-induced order in this system.

Results and Discussion
Some representative MCE traces are depicted in Fig. 1a and b. The dotted (solid) lines represent traces where the field was swept up (down). We find evidence for two transitions at $H_{c1}(T => 0) \sim 12.5$ T and $H_{c2}(T => 0) \sim 23.6$ T respectively. The MCE effect is essentially reversible at the $H_{c1}$ transition, but clearly irreversible at the $H_{c2}$ transition. This suggests that the lower transition is second order, while the upper transition is first order. Further evidence for this is found in our earlier torque measurements (Fig. 1c) as we observed magnetic hysteresis around the upper transition only. From a combination of torque, MCE, and heat capacity measurements (Fig. 1d), we have constructed a complete phase diagram for the $H || c$ orientation of this system (Fig. 2). Our phase diagram looks qualitatively consistent with the dome-like shape expected for a BEC of triplons system, and the lack of magnetization plateaus in our torque data is consistent with such an interpretation. Furthermore, recent neutron scattering measurements [2] suggest that spin-rotational symmetry is present in the $H < H_{c1}$ regime for $\text{Ba}_3\text{Cr}_2\text{O}_8$, and so the system can truly be described as a realization of a BEC of triplons material.

Conclusions
We have investigated field-induced order in the spin dimer system $\text{Ba}_3\text{Cr}_2\text{O}_8$. We found that the ordered state in this system can be described as a BEC of triplons, but in the present study we could not determine the spin structure in the ordered state. For this purpose, neutron scattering and nuclear magnetic resonance experiments in high magnetic fields are necessary.

References