Experimental report

30/08/2017

Proposal:	**CRG-2374**	**Council:**	4/2016
Title:	Spin fluctuations of Mn5Si3		
Research area:			

This proposal is a new proposal

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Samples: Mn5Si3

Instrument	Requested days	Allocated days	From	To
IN12	8	8	14/09/2016	22/09/2016

Abstract:

Background:

The search for more efficient use of energy has been leading to a growing interest for the research field of magnetocaloric materials. The magnetocaloric cooling process is based on the magnetocaloric effect (MCE). MCE is the reversible temperature change of a magnetic material upon the application or removal of a magnetic field. The MCE can be characterized as direct or inverse if a magnetocaloric compound heats up or cools down by applying an external magnetic field adiabatically. An entropy transfer between crystal lattice and the magnetic spin system has to take place. Among different compounds under investigation, the system $Mn_{5-x}Fe_xSi_3$ shows a modestly large MCE close to room temperature at low magnetic fields, which is promising for magnetic refrigeration applications. The parent compound Mn_5Si_3 on cooling undergoes a first phase transition at $T_{N2} \approx 100$ K toward a collinear antiferromagnetic ground state (AF2) and a second transition to a non-collinear antiferromagnetic phase (AF1) that occurs at $T_{N1} \approx 66$ K. Its specificity is to exhibit positive and negative magnetic entropy change in relation with two distinct magnetic phase transitions at $T_{N1}{\approx}66$ K and $T_{N2}{\approx}100$ K, respectively.

Aim of the experiment:

The aim of this experiment was to investigate the in plane spin dynamics under field applied parallel to c axis at 50K and 65K (AF1 phase), 80K (AF2 phase) and at 120K (PM state) (the orthorhombic cell is derived from the ortho-hexagonal cell of the PM space group $P6_3/mcm$, therefore the a, b plane will be referred to as the ‘‘plane’’).

Experimental setup:

The IN12 spectrometer was set up in W configuration and collimators 80’-open-open were used. We used a PG monochromator (double focusing mode), a monitor, slits before and after the sample and a PG analyser. All data have been collected with a fixed k_f=1.8$Å^{-1}$. The single crystal (with a mass of about 6g) was mounted with the [100] – [010] directions in the scattering plane inside a vertical 10T magnet.

Results:

Experiments were performed on a single crystal of about 1.5 cm^3 on the IN12 spectrometer. In order to investigate the spin dynamics under magnetic field along the [010] and [100] direction spectra were collected in three temperature regions: in the PM state (T=120K), in the collinear antiferromagnetic AF2 phase (T=80K) and in the non collinear antiferromagnetic AF1 phase (T=65K and T=50K). Most scans were performed for an energy transfer of 3 and 5meV around (1 2 0) and (0 3 0) Bragg positions. In Figure 1 one can see characteristic const. E spectra collected at different temperatures and magnetic fields around (1 2 0) Bragg position. The intensity in the PM state (T=120K), in the collinear AF phase (T=80K) and at T=65K (around the transition from non-collinear AF2 to collinear AF1) decreases as the magnetic field increases for $H \geq 7.5$T. In the AF1 phase (T=50K) the sharp spin waves observed at zero field are substituted with a diffused signal for magnetic fields $H \geq 8.5$T, indicating a transition for AF1 to AF2. This is consistent with the recent established (T-H) magnetic phase diagram and early neutron diffraction measurements where it is shown that a magnetic transition from AF1 to AF2 occurs when field is applied along the c-axis [1,2].

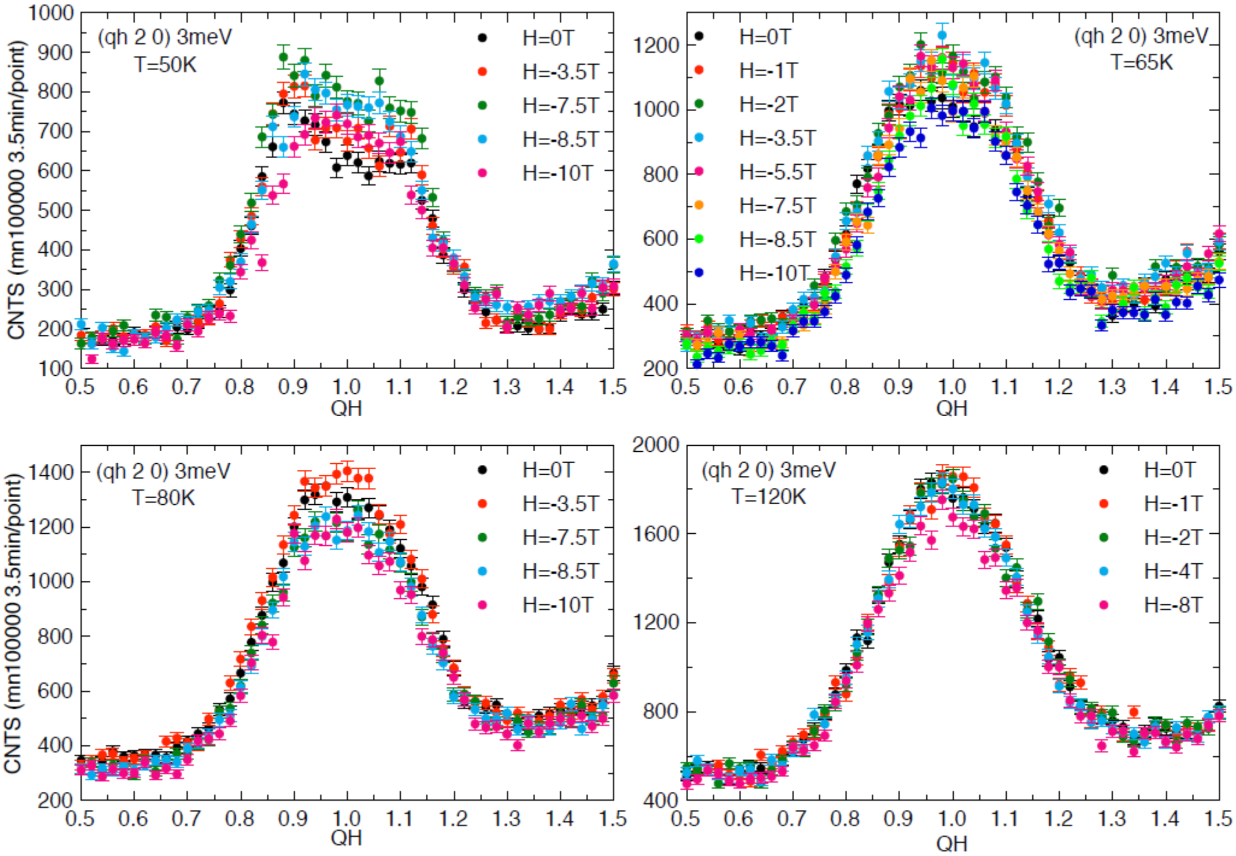

Figure 1: Q-scan (Qh, 2, 0) at 3meV on IN12 spectrometer obtained at different temperatures and magnetic fields.

[1] C. Suergers, et al., arXiv:1609.05047, (Submitted: 16.11.2016).
[2] M. R. Silva et al., J. Phys. Condens. Matter. 14, 8707–8713 (2002).