# Experimental report

12/11/2018

**Proposal:** 5-32-858 **Council:** 4/2018

**Title:** Temperature evolution of short range spin correlations in ordered anddisordered Co5TeO8 spinels

**Research area:** Physics

**This proposal is a new proposal**


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**Local contacts:** Lucile MANGIN-THRO


**Samples:** Co5TeO8 (ordered)
Co5TeO8 (disordered)

| Instrument | Requested days | Allocated days | From | To |
|---|---|---|---|---|
| D7 | 7 | 4 | 17/09/2018 | 21/09/2018 |


## Abstract:

We would like to investigate features of short range magnetic correlations of recently discovered Co5TeO8. This compound itself has two polymorphs, one is a classical Fd-3m and another one - P4332 ordered spinel. While disordered polymorph has a single magnetic phase transition at 40 K with an emergence of a collinear ferrimagnetic ordering, ordered one demonstrates two magnetic phase transitions: firstly, a transition to an incommensurate-spiral phase below 50 K which allows an electric polarization and therefore a ferroelectric transition followed by emergence of collinear ferrimagnetic component and suppression of spiral component at 30 K. Nevertheless neutron powder diffraction reveal strong magnetic diffuse scattering in wide temperature ranges: 60 – 1.7 K for disordered and 75 - 30 K for ordered Co5TeO8 indicating a presence of short range magnetic ordering within both systems. With present proposal we would like to carry out a polarized neutron experiment at D7 to evaluate a temperature evolution of spin correlations and thus to characterize short range magnetic ordering and mechanisms of phase transitions in ordered and disordered Co5TeO8.

**Experiment 5-32-858**

**Temperature evolution of short range spin correlations in ordered and disordered $Co_5TeO_8$ spinels**

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## Introduction

$Co_5TeO_8$ compound has a spinel structure and could be synthesized in two polymorphs: a classical *Fd-3m* and an ordered $P4_332$. While disordered polymorph has a single magnetic phase transition at 40 K with an emergence of a typical for magnetic spinels collinear ferrimagnetic ordering, an ordered one demonstrates two magnetic phase transitions: firstly, a transition to an incommensurate-spiral phase below 50 K, followed by emergence of collinear ferrimagnetic component and suppression of spiral component at 30 K. Nevertheless neutron powder diffraction reveal strong magnetic diffuse scattering in wide temperature range for ordered $Co_5TeO_8$, indicating a presence of short range magnetic ordering. The main aim of this experiment was to investigate a nature of short-range spin correlations and mechanisms of a long range ordering in $Co_5TeO_8$ compound.

## Experimental

For XYZ neutron polarization analysis around 10g of ordered $Co_5TeO_8$ was packed into double wall cylindrical aluminum container in order to reduce absorption and multiple scattering effects. To probe magnetic scattering of a studied sample at various temperatures D7 diffuse scattering spectrometer was used with λ = 3.1 Å and scattering patterns were collected in Q region between 0 $Å^{-1}$ to 3.8 $Å^{-1}$, in order to get a good statistics non-spin flip to spin flip ratio was 1:4. Calibration and attenuation measurements were performed before the data collecton. Studied sample was measured at T = 30, at T = 30 K, 35 K, 40 K, 50 K, 60 K, 80 K and 90 K. Data treatment is done by reverse Monte Carlo method by the SPINVERT package.

## Preliminary results

During the experiment an ordered polymorph of $Co_5TeO_8$ has been investigated. The polarization analysis allowed to separate magnetic component from the total scattering signal. Pure magnetic scattering shows development of a long range ordering below 45 K while at the temperature region between 50 K and 90 K there is only magnetic diffuse scattering (Fig. 1).

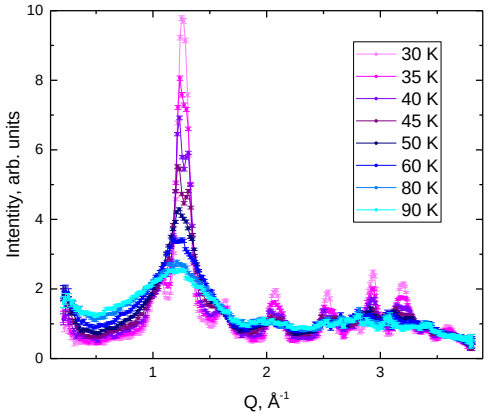


Figure 1. Temperature evolution of $Co_5TeO_8$ magnetic scattering.

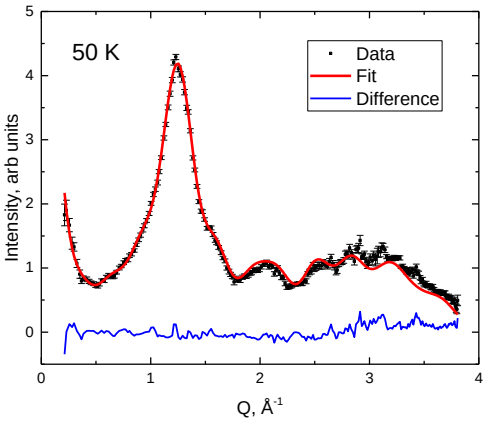


Figure 2. RMC fit of diffuse neutron scattering pattern collected at 50 K.

Temperature evolution of a spin-spin correlation function obtained on results of RMC (fig. 3) fit didn't reveal any dramatic qualitative changes upon temperature decrease and mutual orientation for magnetic moments for $Co^{2+}$ ions at the same crystallographic sites ($Co_{octahedral}$- $Co_{octahedral}$ or $Co_{tetrahedral}$- $Co_{tetrahedral}$ bonds) is predominantly parallel whereas for $Co^{2+}$ ions at different sites ($Co_{octahedral}$ - $Co_{tetrahedral}$ bonds) spin orientation found to be antiparallel. This result is consistent with results obtained by neutron powder diffraction for an ordered state.

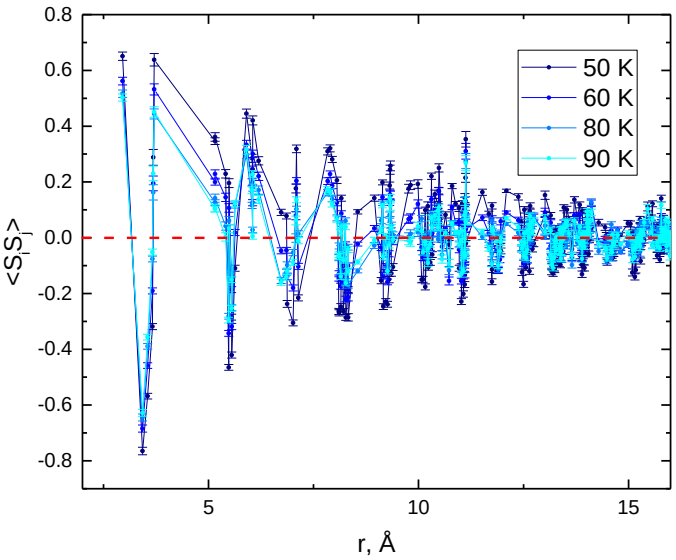


Figure 3. Radial spin-spin correlation functions for 90, 80, 60 and 50 K obtained with RMC fit.