The phenomenon of frustration appears in a compound whose geometry is such that the spins can not access an order at low temperature. Several configurations that tend to minimize the energy of interaction between the spins coexist, making the minimum energy state not unique (degenerate ground state).
The magnetic compound geometrically frustrated I study is $Tb_2Ti_2O_7$. This compound is really particular: it does not display any magnetic phase transition and it does not show a spin ice ground state either. Instead it seems to remain in a paramagnetic state down to the lowest temperatures where it has been studied ($\sim$30 mK). $Tb_2Ti_2O_7$ is therefore believed to be a spin-liquid system.
By specific heat measurements on samples from differents bars of $Tb_2Ti_2O_7$, with diffrent procedures to be synthesized, large differences in the evolution of specific heat with temperature appeared. We are especially interested in two bars synthesized at different growth rates: we call C the bar with a growth rate of 7mm/h and D the one which is synthesized at 3mm/h.

A couple of years ago at ISIS, with MuSR spectrometer, Y. Chapuis (PhD thesis, Université Joseph Fourier, September 2009, Grenoble) observed of a non-exponential relaxation at low-temperature for $Tb_2Ti_2O_7$. The polarisation is fit with the following model function: a sum of a stretched exponential function plus a time independent background, $a_0 P_Z(t) = a_s \exp[-(\lambda_Z t)^\beta] + a_{BG}$. Few month ago, the group Magnetism and Frustration of SPSMS/CEA Grenoble visualized a rise of magnetic specific heat below 140 mK on the same compound. This result could lead to reconsider the nature of the compound, previously described as "spin liquid". The aim of the experiments on the samples was to determine whether the non-exponential behaviour found previously is still present and if a magnetic transition can be observed at low temperature.

The asymmetry allows to determine the validity of the adjustment function: when a_s does not change with temperature, we consider the proper adjustment. It depends only on the geometry of the installation. The figure 1, at 13 mT for the single crystal C, shows a change of the mean value: from 0.9 above 3 K to 1.2 below this temperature. The figure 2 presents the zero field measurement on the sample D: then, is a transition appears, it could come from both nuclei and electrons. The measure have been done until 1 K so a change on the exponent β is not observed. The figure 3, at 13 mT for the single crystal D, shows a change of the mean value β: from 1.0 above 3 K to 1.3 below this temperature. The change in the value of β seems to reflect a slowdown in the fluctuations in our compounds. The evolution of the relaxation rate λ_Z is the same fot the sample we have, so it doesn't depend of the sample and the way it is prepare. The decay of the relaxation rate is characteristic of the magnetic acceleration, consistent with the evolution of the exponent β. The increase of relaxation rate at low temperature implies a decrease in the characteristic time of fluctuations in the magnetic material. These magnetic fluctuations are typical of a frustrated system, whose geometry varies for lack of a single state that minimizes the energy.

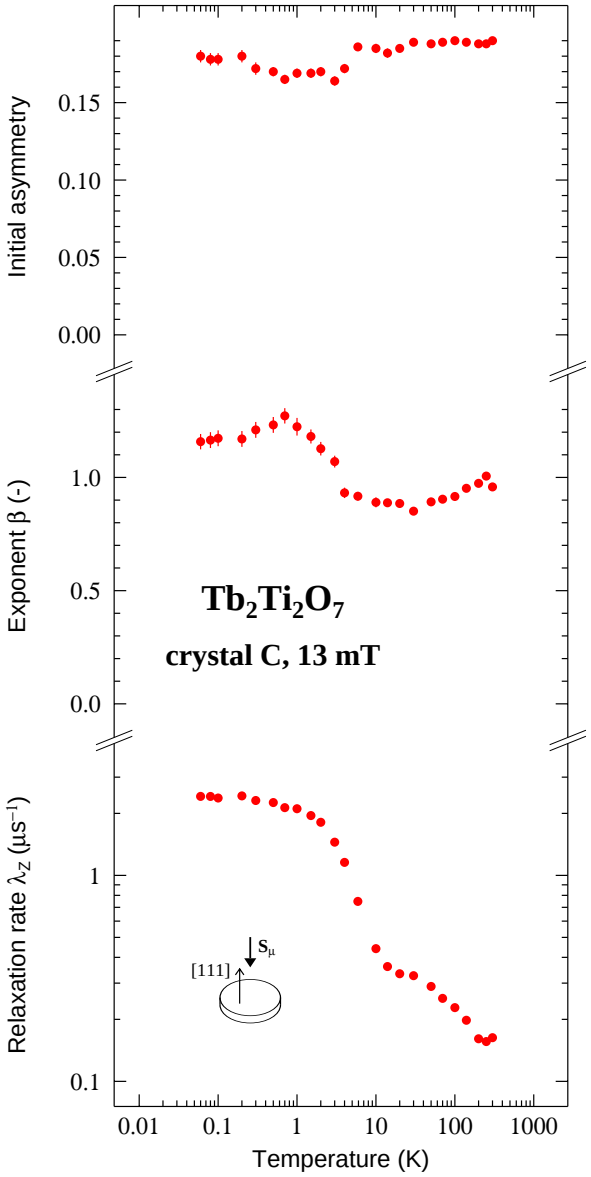

Fig. 1: Temperature dependence from 0.05 K to 300 K with 13 mT for the single crystal C of $Tb_2Ti_2O_7$ of the value of the relaxation rate λ_Z, the asymmetry a_s, and of the stretched exponent β.

The specific heat measurements below 400 mK for sample D, which will be made in

July, will assist in the interpretation of data obtained at the MuSR spectrometer of ISIS.

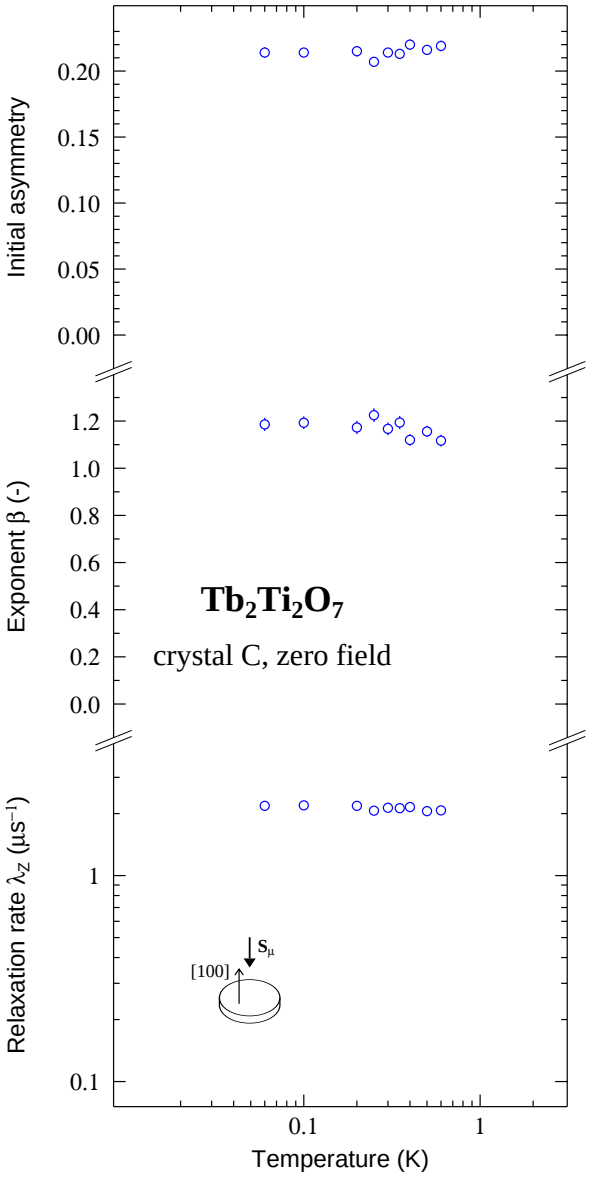

Fig. 2: Temperature dependence from 0.06 K to 1 K with zero field for the single crystal D of $Tb_2Ti_2O_7$ of the value of the relaxation rate λ_Z, the asymmetry a_s, and of the stretched exponent β.

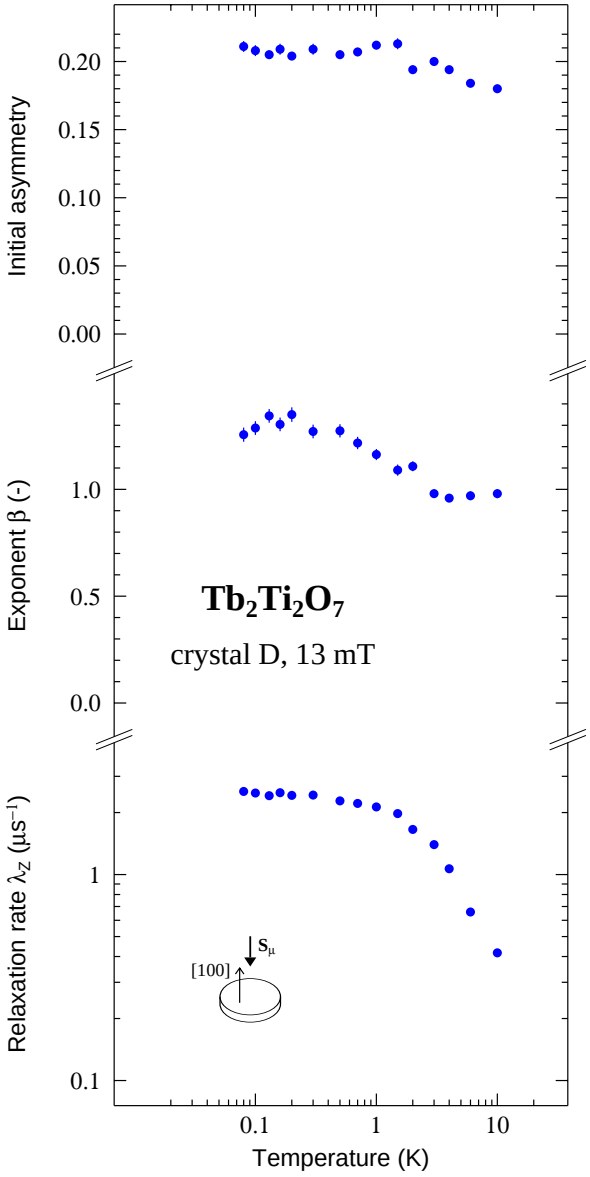

Fig. 3: Temperature dependence from 0.06 K to 10 K with 13 mT for the single crystal D of $Tb_2Ti_2O_7$ of the value of the relaxation rate λ_Z, the asymmetry a_s, and of the stretched exponent β.