ESRF	**Experiment title:** Mott transition in NiO under pressure	**Experiment number**: HC-830
Beamline: ID18	**Date of experiment**: from: 17.04.2013 to: 29.04.2013	**Date of report**: 20.08.2013
Shifts: 27	**Local contact(s)**: Dimitrios Bessas (email: bessas@esrf.fr)	*Received at ESRF:*

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Report:

Within the beam time allocated for proposal HC-830 a new monochromator for ^{61}Ni Mössbauer resonance was installed. That had greatly improved stability and flux for the experiments at ^{61}Ni Mössbauer resonance energy. Using it we performed a high-pressure study of magnetism in NiO was performed.

A new monochromator was made using a simple channel cut optical scheme. The monochromator combins the same flux as the previous model[1] with greatly improved angular stability. The old monochromator after adjusting the correct angular position for the resonance energy stayed in this position for no more than 0.5 hour, whereas the new is stable for more than 4 hours. Therefore, we could estimate that stability was improved by approximately an over a magnitude. This improved stability allows one to perform measurements even from samples with very low count rate, on the level of 0.01Hz. In this experiment, at very high pressure (above 100 GPa), due to a very small amount of sample the count rate was indeed at this level, but nevertheless successful NFS investigations were conducted due major improvement in stability.

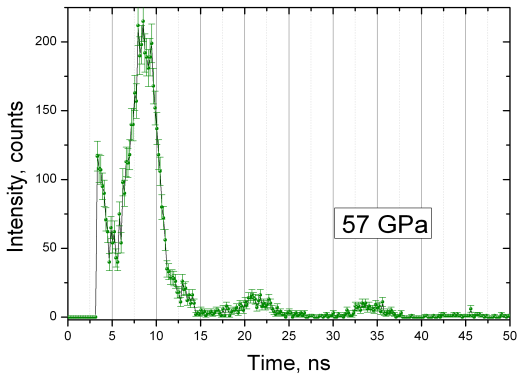

Fig. 1 Example of time evaluation spectrum of nuclear forward scattering spectra for NiO measured along the DAC axis at room temperature. Spectrum was acquired in 1.6 hours

The obtained results clearly show the feasibility of ^{61}Ni Mossbauer spectroscopy in Ni based compounds under high and ultra high-pressure. In less than two hours a spectrum with a good statistical quality can be acquired from a sample (in this case NiO) under high pressure (see Fig. 1). One should also keep in mind that conventional Ni Mossbauer spectroscopy at high pressure is not feasible.

In this experiment behavior of magnetism in NiO was investigated under pressure from ambient conditions to 280 GPa (Fig. 2). As was mention above, the measurements at pressures above 150 GPa were extremely difficult due to the low count rate, which made the sample search very time consuming as one can find the sample position by detecting a very weak delayed response. Our analysis of the data on the Fig.2 indicate that magnetic order in NiO exists all the way to ~280 GPa. Moreover, the hyperfine splitting on Ni atoms increase with pressure. Presence of magnetic ordering indicates absence of Mott type insulator-to-metal transition in NiO up to 280 GPa. This results contradict with recently presented reports [2] and corresponding manuscript is under preparation.

We should also mention that due to breakdown of main beamline computer a full shift (the last one) out of 15 shifts provided for us in 16 bunch mode was lost. This accident prevented us from measuring more point between 57 GPa and 150 GPa.

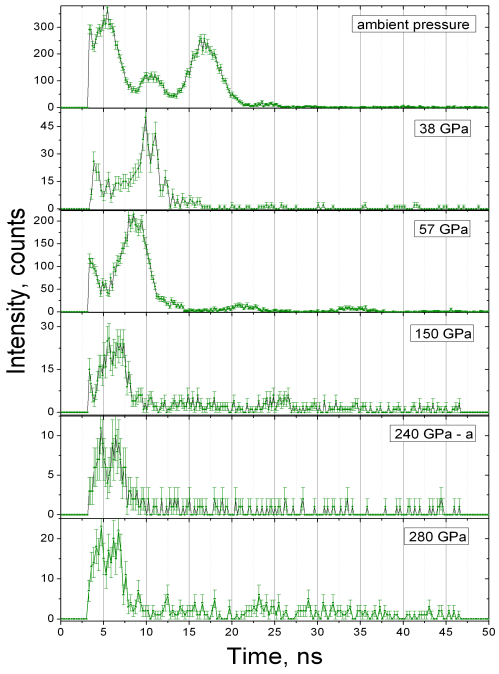

Fig. 2 Time evolution of the nuclear forward scattering spectra for NiO measured along the DAC axis at room temperature, from ambient conditions to ~280 GPa.

References:

[1] I. Sergueev, A. I. Chumakov, T. Beaume-Dang, R. Rüffer, C. Strohm, and U. van Bürck, Physical Review Letters **99**, 097601 (2007).

[2] A. Gavriliuk, I. A. Trojan, and V. V. Struzhkin, Physical Review Letters **109**, 086402 (2012).