Balancing detectors for noise cancelling in ultrafast laser spectroscopy experiments

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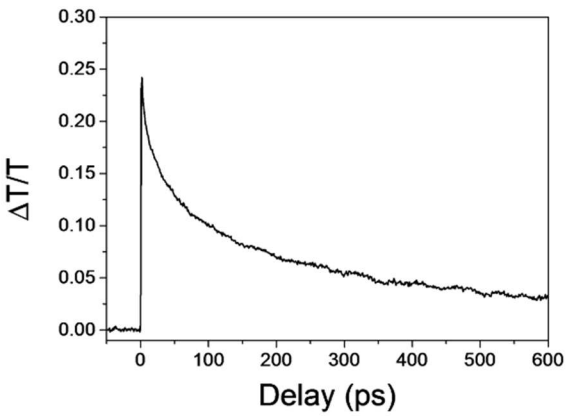
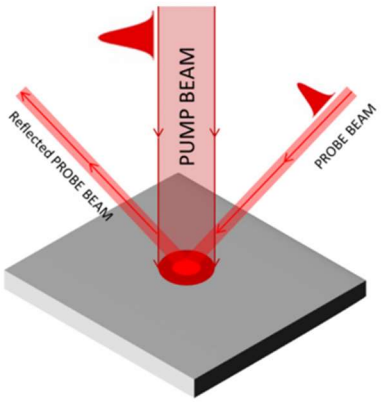
In our Laboratory of Opto-Spintronic (LOS), light is used to study ultrafast spin dynamics in magnetic materials. In the so-called “pump&probe” methods, we are exciting magnetic sample with a strong laser pulse (pump) of a duration of only 100fs, triggering non-equilibrium spin dynamics. The dynamics is then studied using weaker “probe” pulses, time-delayed with respect to the “pump”beam. Both pump and probe beams are spatially and temporally overlapped on the sample.

In our particular experimental settings, the pump-induced spin dynamics is studied by means of time-resolved magneto-optics, which requires extremely sensitive detection of changes of polarization state of the probe beam. For this purpose, a special detection scheme – an optical bridge – is implemented which contains two crucial components. Firstly, the *photodetector*s are to detect the light from the sample and to transfer it to an electronic signal readable by a computer. Secondly, a differential preamplifier serves to subtract signals from two detectors to record small changes in the optical bridge while cancelling optical and electronic noise. Up to now, we have been using home-made preamplifiers and detectors. Recently we have purchased a highly sensitive balanced detector from Thorlabs that promises a better sensitivity and higher signal-to-noise ratio. These new systems now need to be tested in a real experiment and find its ultimate working conditions, which is an objective of this student project.





[1] M. Surýnek, L. Nádvorník, E. Schmoranzerová, and P. Němec, *Quasi-nondegenerate pump-probe magnetooptical experiment in GaAs/AlGaAs heterostructure based on spectral filtration*, New J. Phys. 22, 093065 (2020).