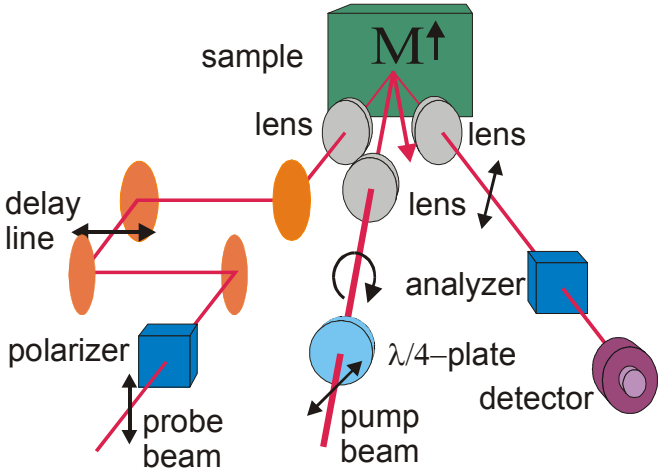
A Superconducting Cryostat for Research and Student Training in Magnetoelectronic Materials

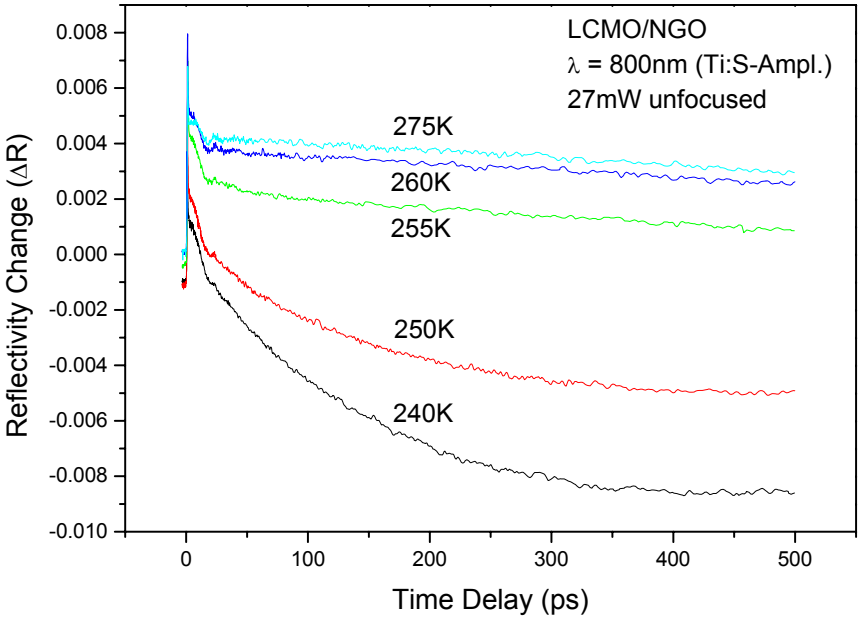
Anne Reilly and Gunter Luepke, College of William and Mary, DMR-0114124

Recent Activities

Magnetoelectronic thin films and their unique properties such as **giant and colossal magnetoresistance (GMR and CMR)** are revolutionizing electronics. Many questions remain on the dynamics of electron spins in these materials. The use of ultrafast nonlinear optical techniques are being applied with much success to answer some of these questions. A recently acquired cryostat allows a wide range of materials to be studied in temperatures of 1.5 – 300 K and fields up to 9 Tesla. The systems studied include semiconductors such as ZnMnSe/AlGaAs, magnetite materials displaying CMR and half-metallic materials such as CrO_2.



A nonlinear optical pump-probe setup for measuring spin and magnetization lifetimes.



Decay of the reflectivity change in a pump-probe laser experiment on a LCMO thin film, which displays colossal magnetoresistance. Different mechanisms of electron spin scattering give rise to fast (possibly Stoner excitations) and slow (phonon-magnon scattering) decay components when the material is in its ferromagnetic state.

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Education, Outreach and Mentoring

Research is done by **graduate** and **undergraduate** students in the areas of magnetooptical measurements and electronic and magnetic behavior of ferromagnetic thin film systems. About three physics majors per year do their senior thesis research in our group, and some of their work has led to publication in prestigious journals. We also participate in the NSF Research Experience for Undergraduates (REU) program. Several of our senior students have gone on to graduate school to study optics or materials.

We are collaborating closely with groups at national laboratories such as NIST, the Naval Research Lab and The Thomas Jefferson National Accelerator Facility. Our students benefit from these interactions.

We have developed new courses at William and Mary to teach students about ferromagnetism, lasers and optics and highly correlated electron systems. Lectures on topics such as “Lasers” and “Magnetism” , aimed at a middle school audience, have been developed based on concepts drawn from physics education research. These lectures have been delivered, with much success, to local middle schools.

The 9 Tesla superconducting magnetooptical cryostat recently installed at the College of William and Mary, for use by our graduate and undergraduate students in their research.