Spectral dependence of the Verdet coefficients of Terbium Gallium Garnet and Potassium Terbium Fluoride

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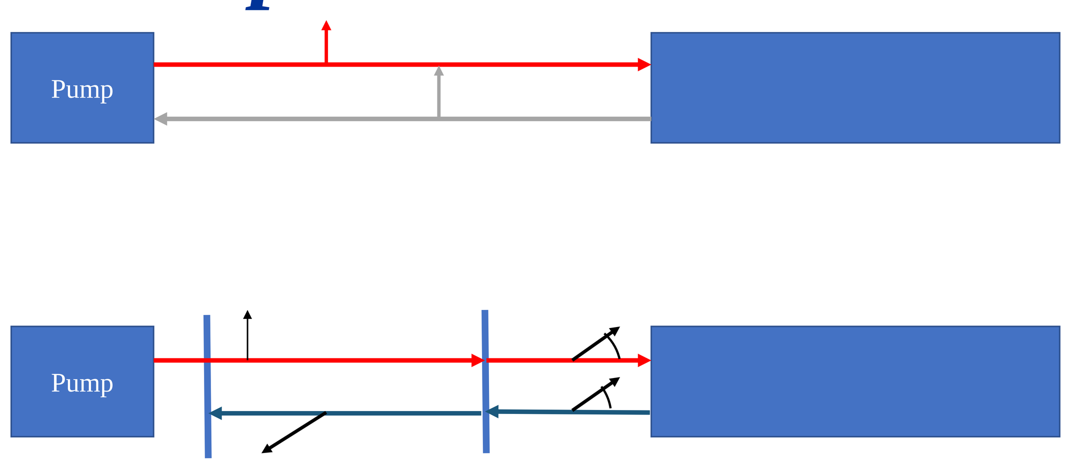
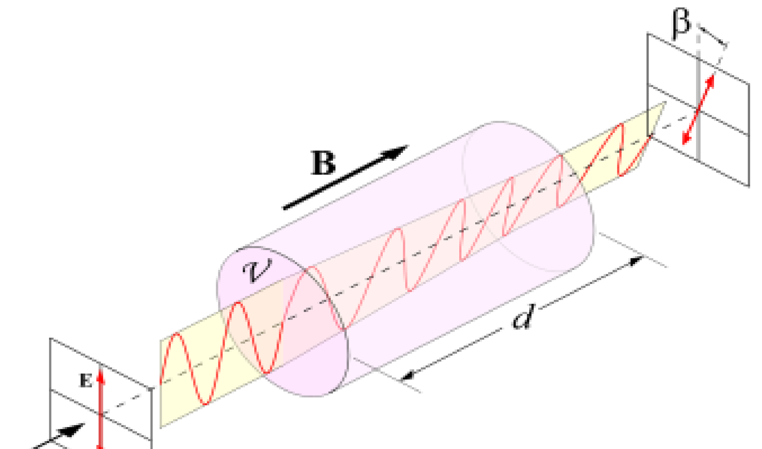
Abstract: High power laser systems require the use of optical isolators to prevent coupling of reflected light into the pump laser. Terbium Gallium Garnet (TGG) and Potassium Terbium Fluoride (KTF) are materials used as optical isolators and while they have been grown for many years, advances in crystal growth and processing make a new set of measurements of the Verdet coefficients of these materials desirable. We present new measurements of the Verdet coefficients of TGG and KTF from 0.405 µ to 1.55 µ and derive expressions for the spectral behavior of the Verdet coefficients.

Optical Isolators

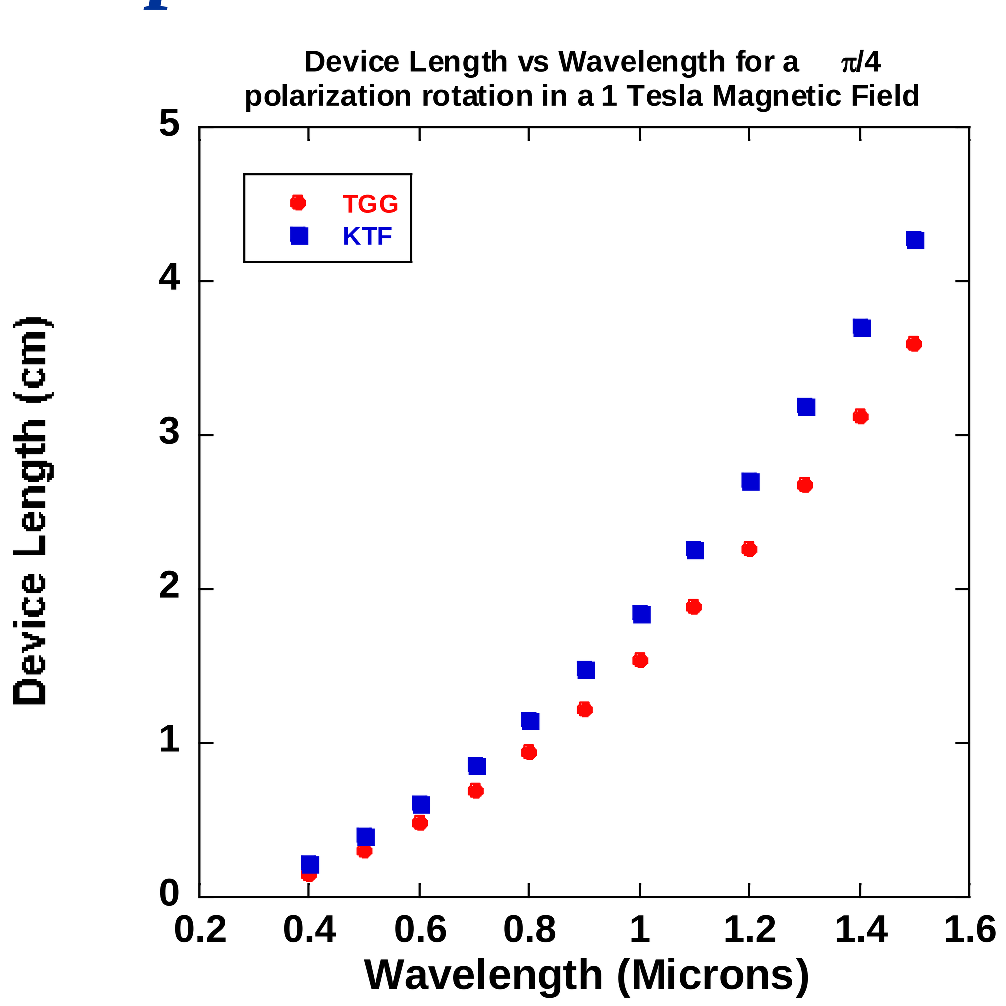


Faraday Effect

- **Optical rotators use the Faraday effect**
- The Faraday effect is magneto-optical phenomenon in which the plane of the polarization of light is rotated within a magnetic field
- The measure of the strength of the Faraday Effect of materials called the Verdet constant



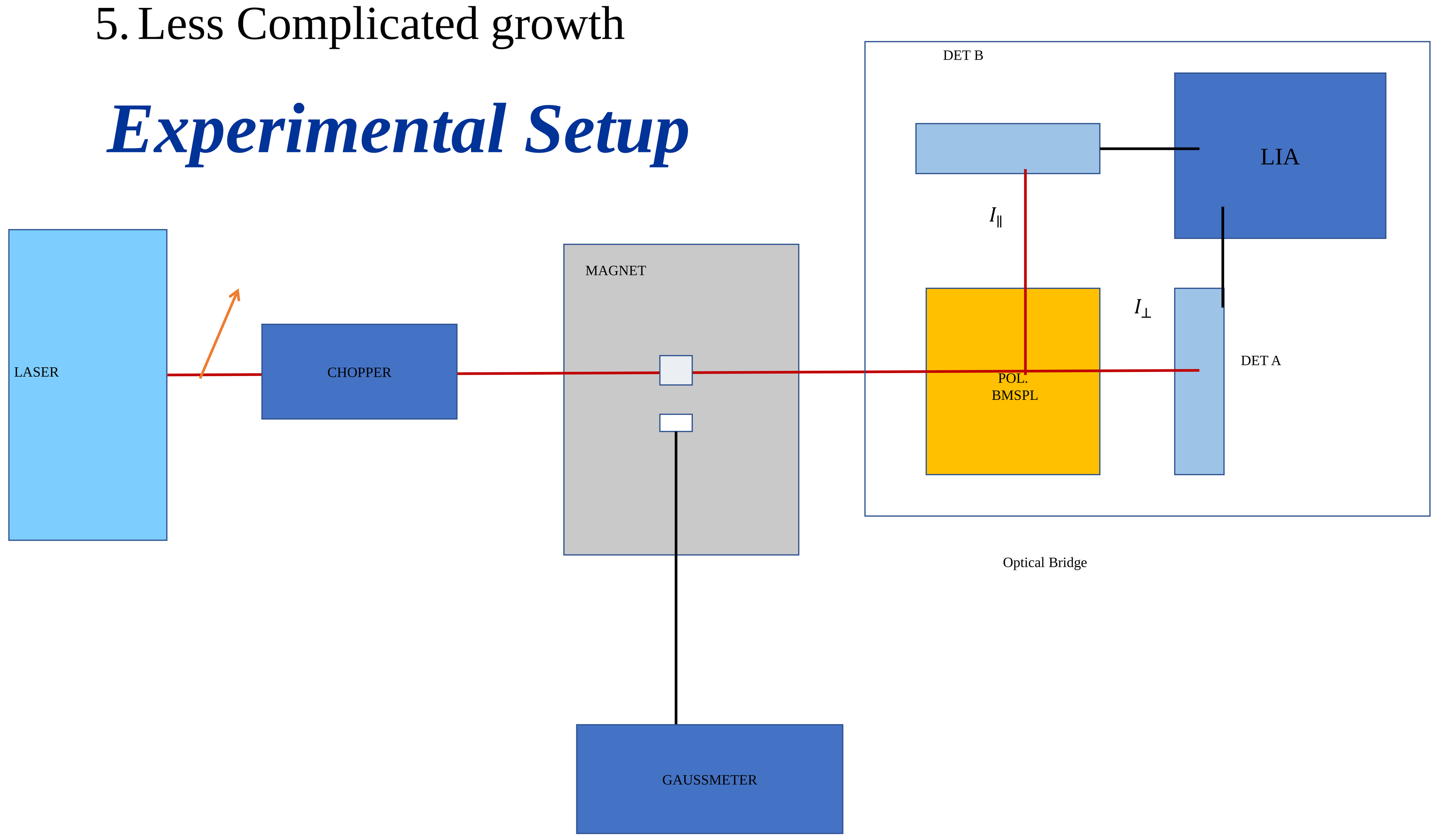
Simple Device Calculations



Materials for Faraday Rotators

1. **TGG**
   1. Industry workhorse, not studied much during a time of advances in crystal growth
   2. Previous studies limited in spectral range
   3. Field on/Field off measurements
2. **KTF has also benefited from advances in crystal growth and has advantages over TGG**
   1. High Verdet Coefficient
   2. Low infrared absorption
   3. Optically isotropic
   4. Low refractive index, nonlinear index and $\frac{dn}{dT}$
   5. Less Complicated growth

Experimental Setup



Optical Bridge Calculations

$$I_{\perp} + I_{\parallel} = I_0$$

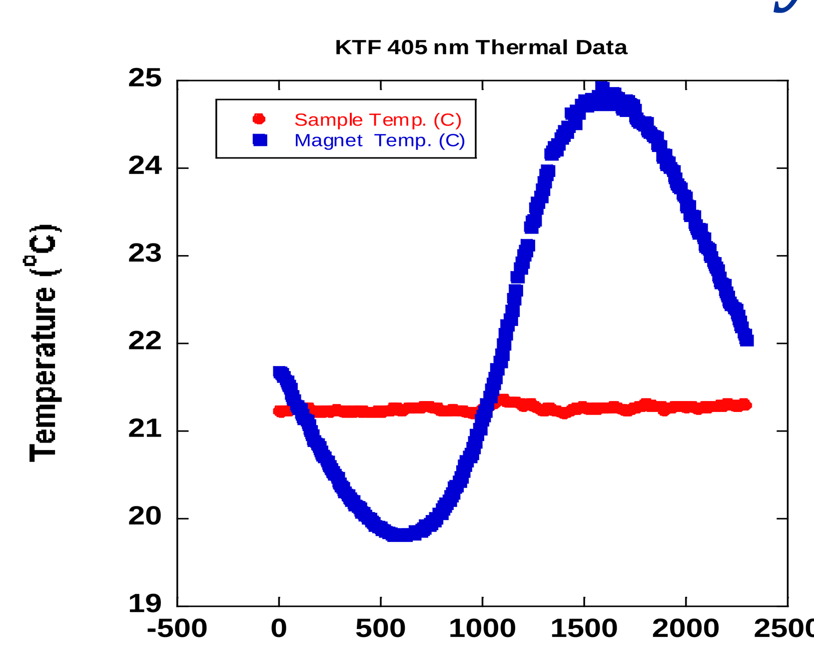
$$I_{\perp} = I_0(\cos^2(\theta + \Delta\theta))$$

$$I_{\parallel} = I_0(\sin^2(\theta + \Delta\theta))$$

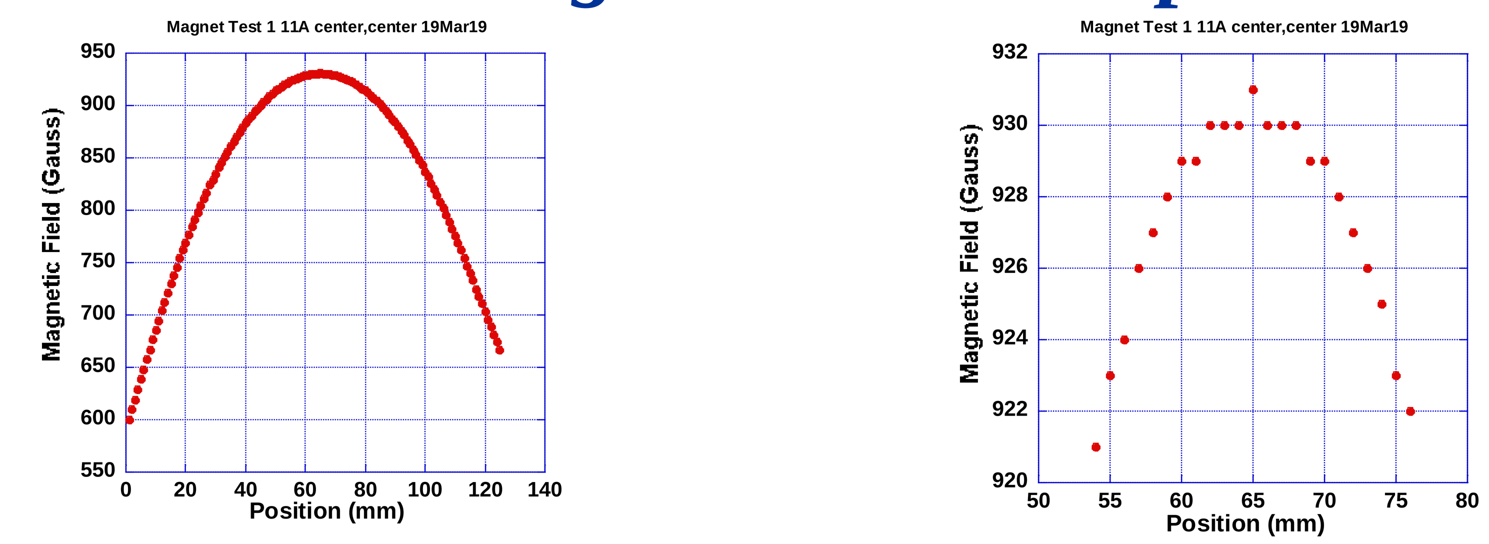
VLB= $\boldsymbol{\Delta\theta}$

$$I_{\perp} - I_{\parallel} = I_0\cos(2(\theta + \Delta\theta))$$
$$= I_0\cos(2(\theta + \mathrm{VLB}))$$

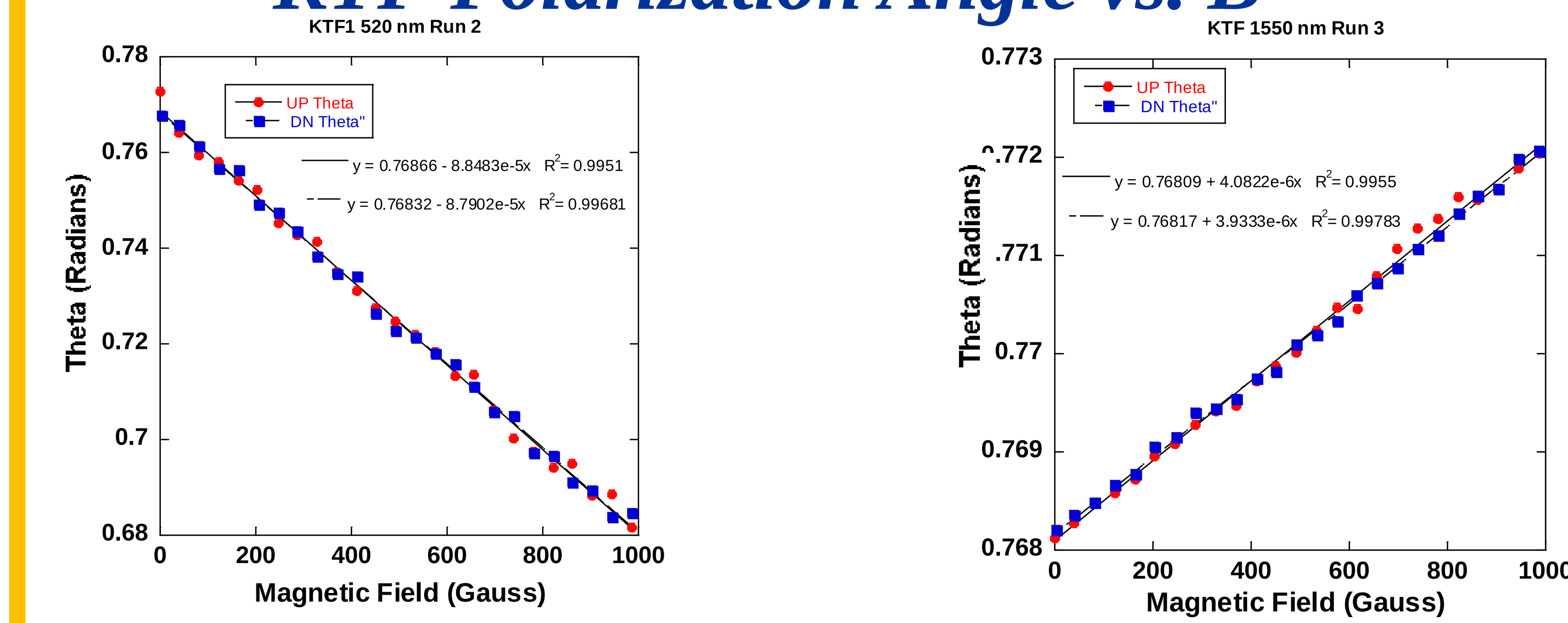
Thermal Stability



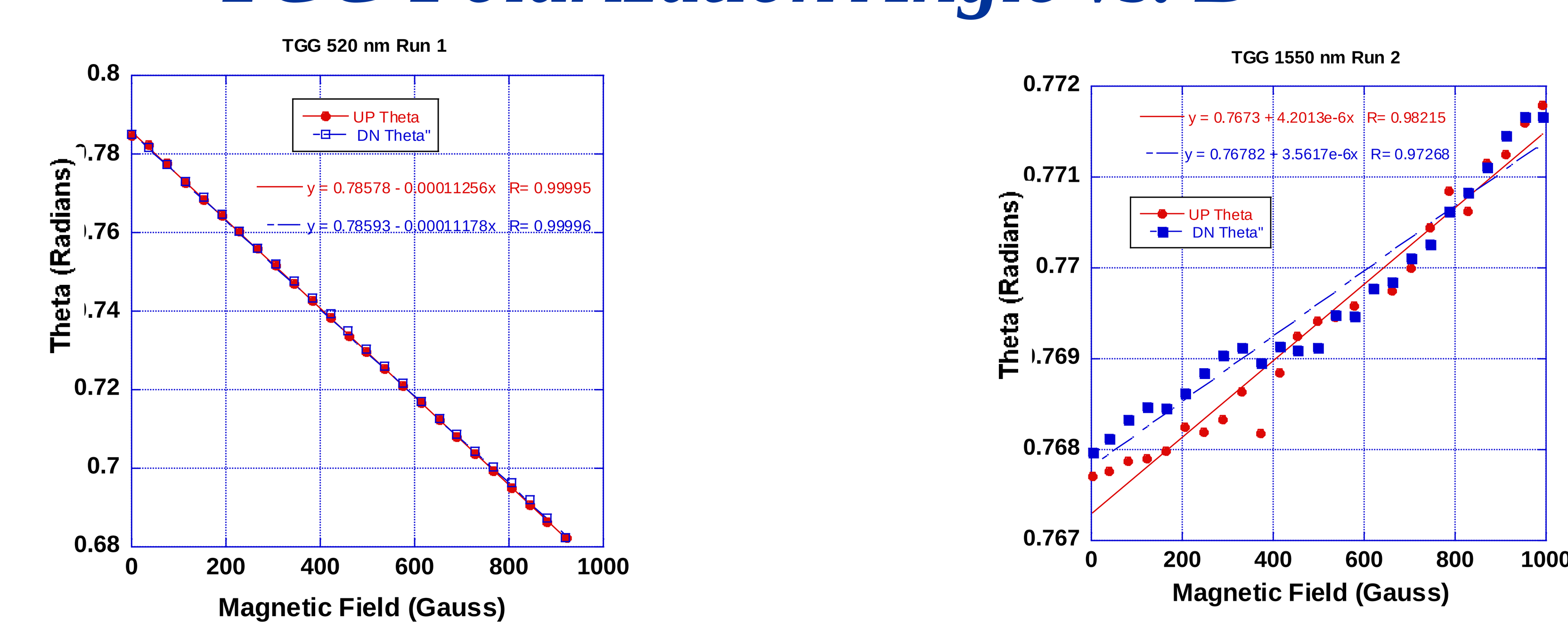
Magnetic Field Map



KTF Polarization Angle vs. B



TGG Polarization Angle vs. B



Verdet Coefficient vs. Wavelength

Wavelength (Microns)	Verdet Coefficient KTF (Rad./(m-T))	Verdet Coefficient TGG (Rad./(m-T))
.405	333.42±2.57	481.92±2.97
.520	186.01±2.08	246.97±1.53
.633	114.12±4.67	147.89±2.53
.726	84.14±5.32	93.13±12.88
.830	66.31±5.10	63.65±3.85
.940	38.36±2.88	
1.064	30.68±2.38	36.11±2.14
1.310	18.77±.52	25.83±2.75
1.550	8.19±0.31	8.16±0.75