Redetermination of the spectral dependence of the Verdet coefficient of TGG and KTF

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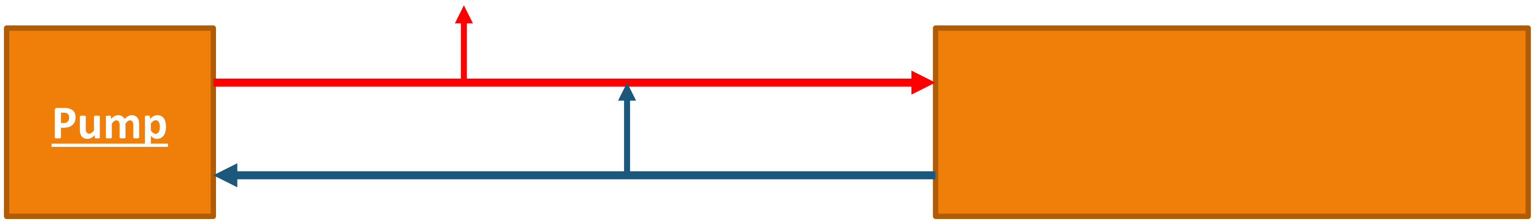
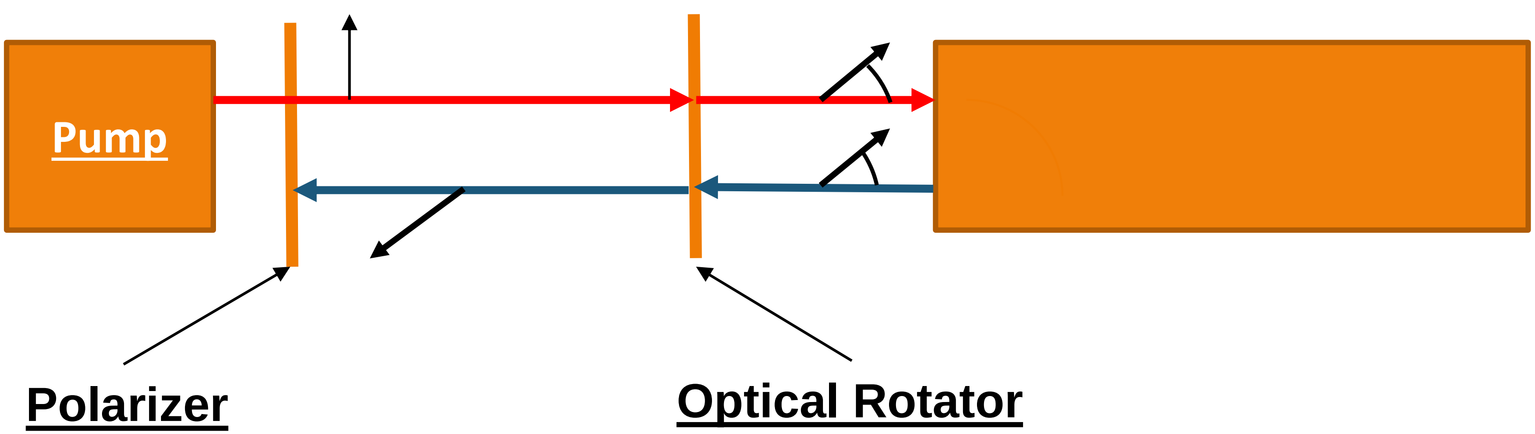
Optical Isolators



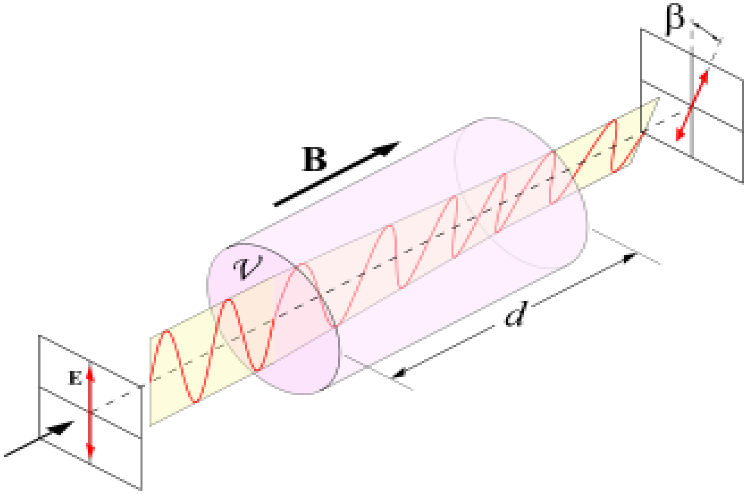


Faraday Effect

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



Motivation-Materials for Faraday Rotators

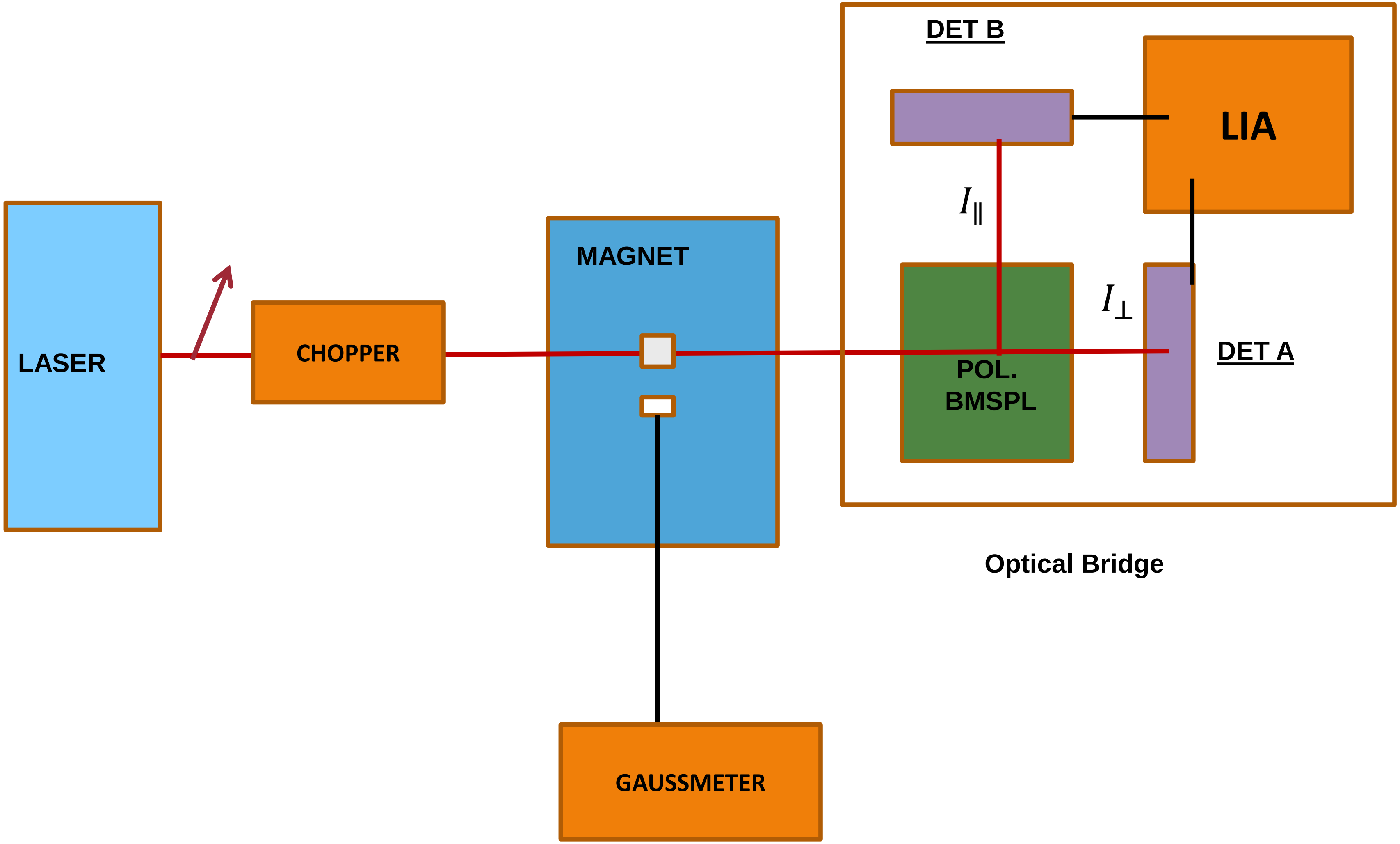
1. TGG

   a. Industry workhorse, not studied much during a time of advances in crystal growth
   b. Previous studies limited in spectral range
   c. Field on/Field off measurements

2. KTF has also benefited from advances in crystal growth and has advantages over TGG

   a. High Verdet Coefficient
   b. Low infrared absorption
   c. Optically isotropic
   d. Low refractive index, nonlinear index and dn/dT
   e. Less Complicated growth

Experimental Setup



Optical Bridge Calculations

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

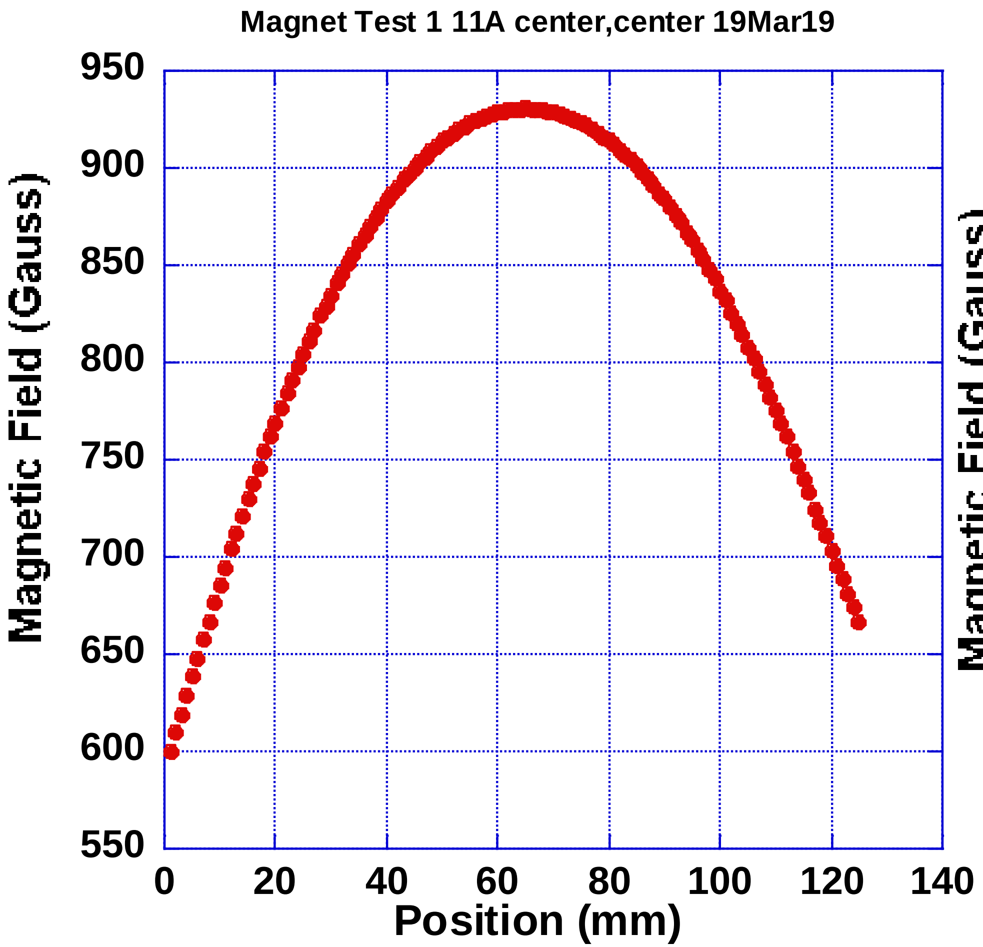
$$I_{\perp} = I_0(\cos^2(\theta + \Delta\theta))$$

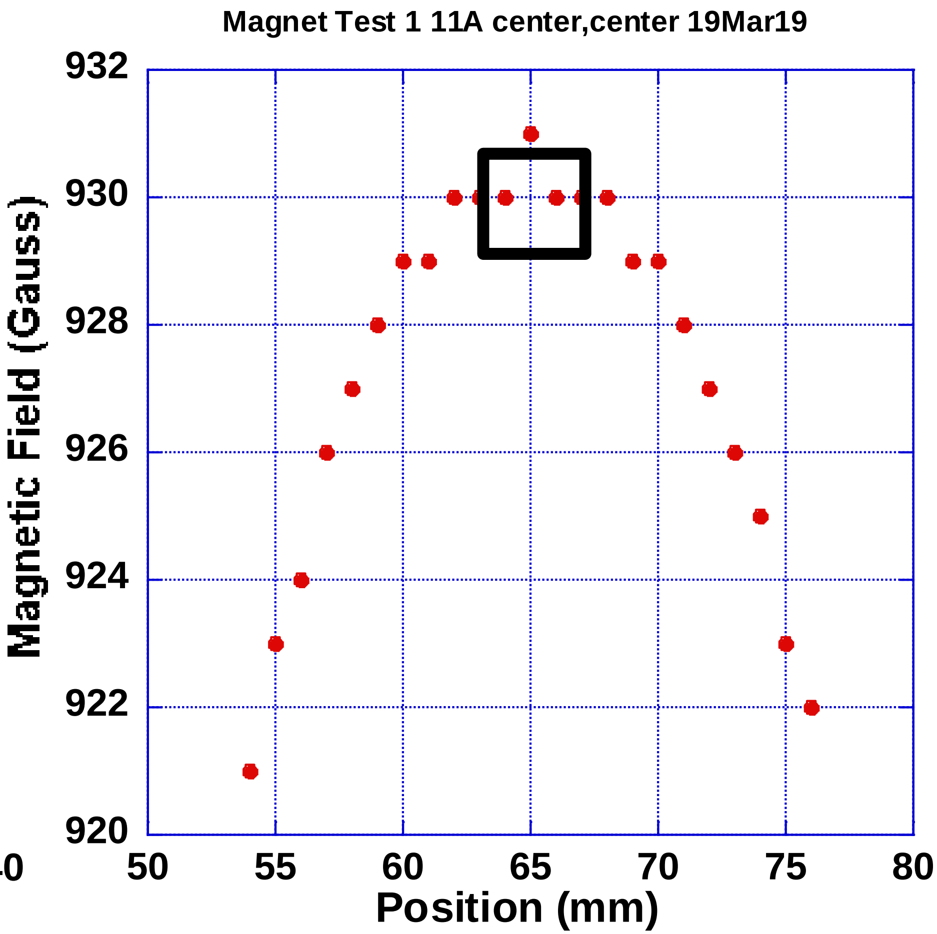
$$I_{\parallel} = I_0(\sin^2(\theta + \Delta\theta))$$

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

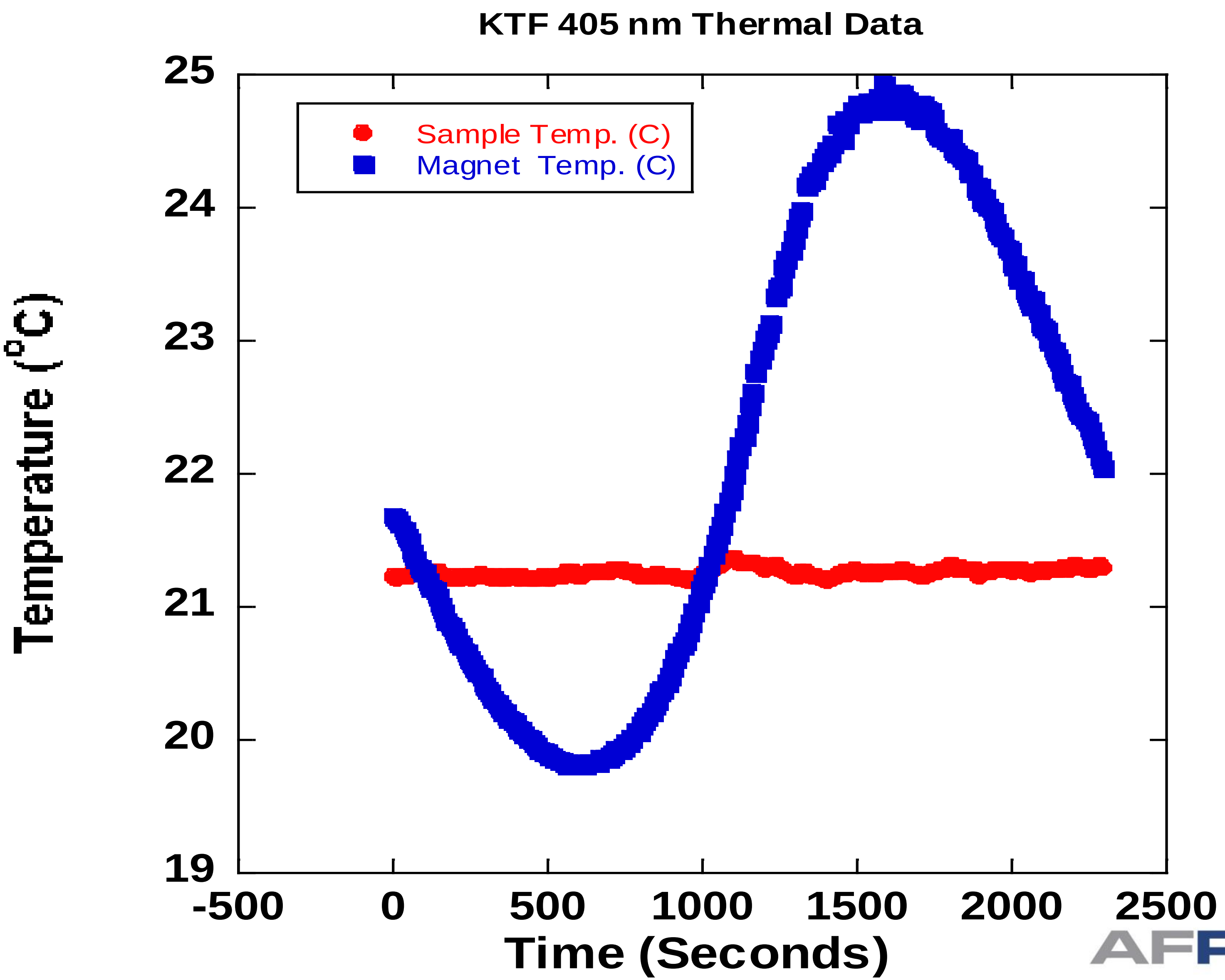
$$I_{\perp} - I_{\parallel} = I_0 \cos(2(\theta + \Delta\theta)) = I_0 \cos(2(\theta + \mathrm{VLB}))$$

Magnetic Field Map

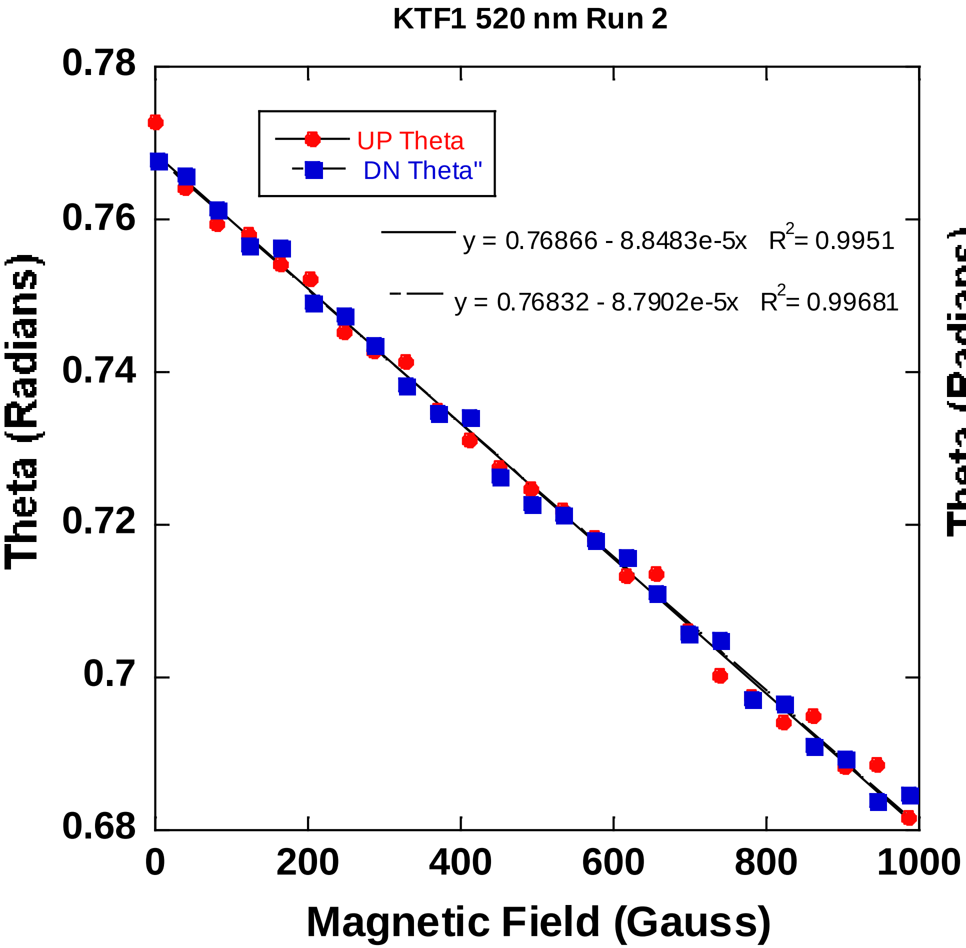


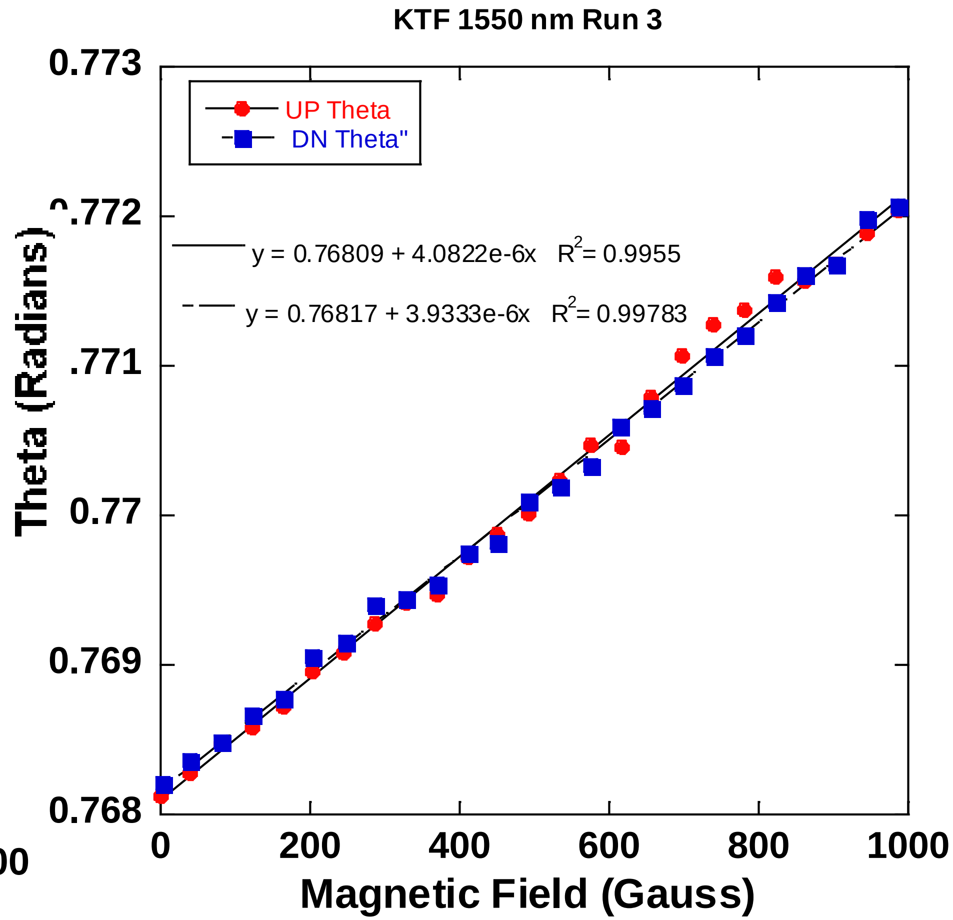


Thermal Stability

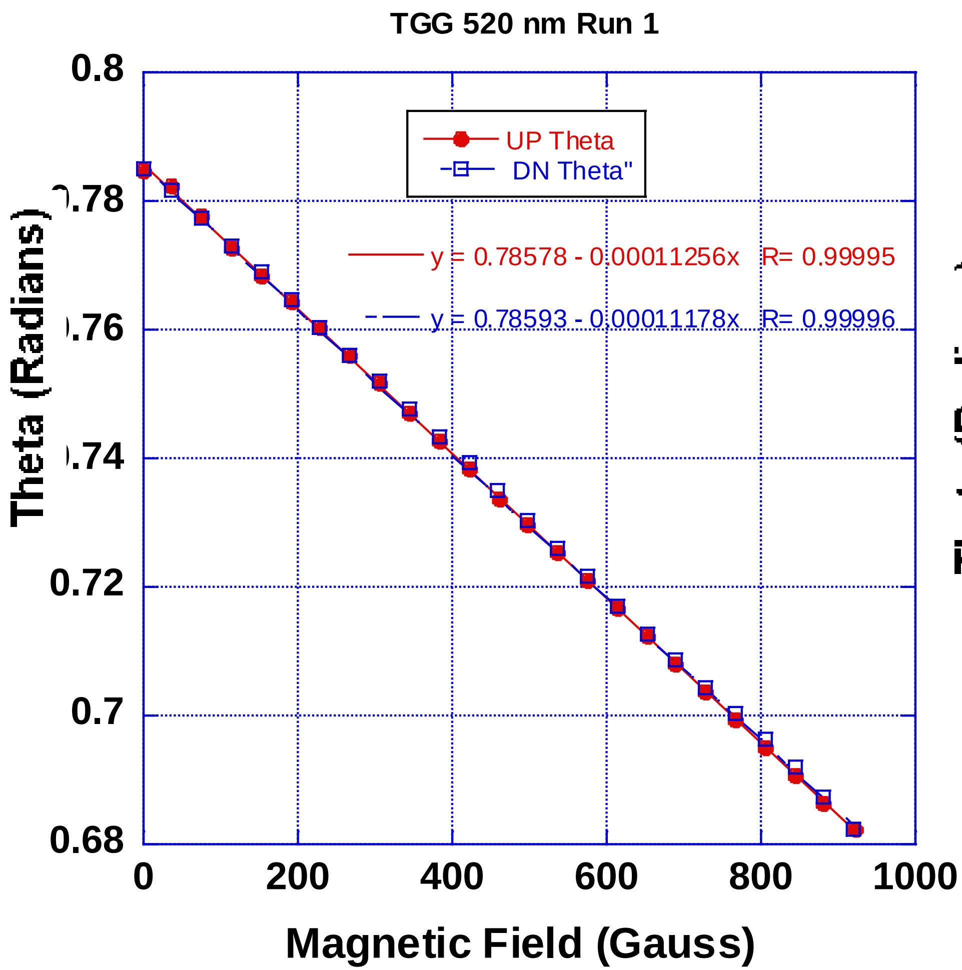


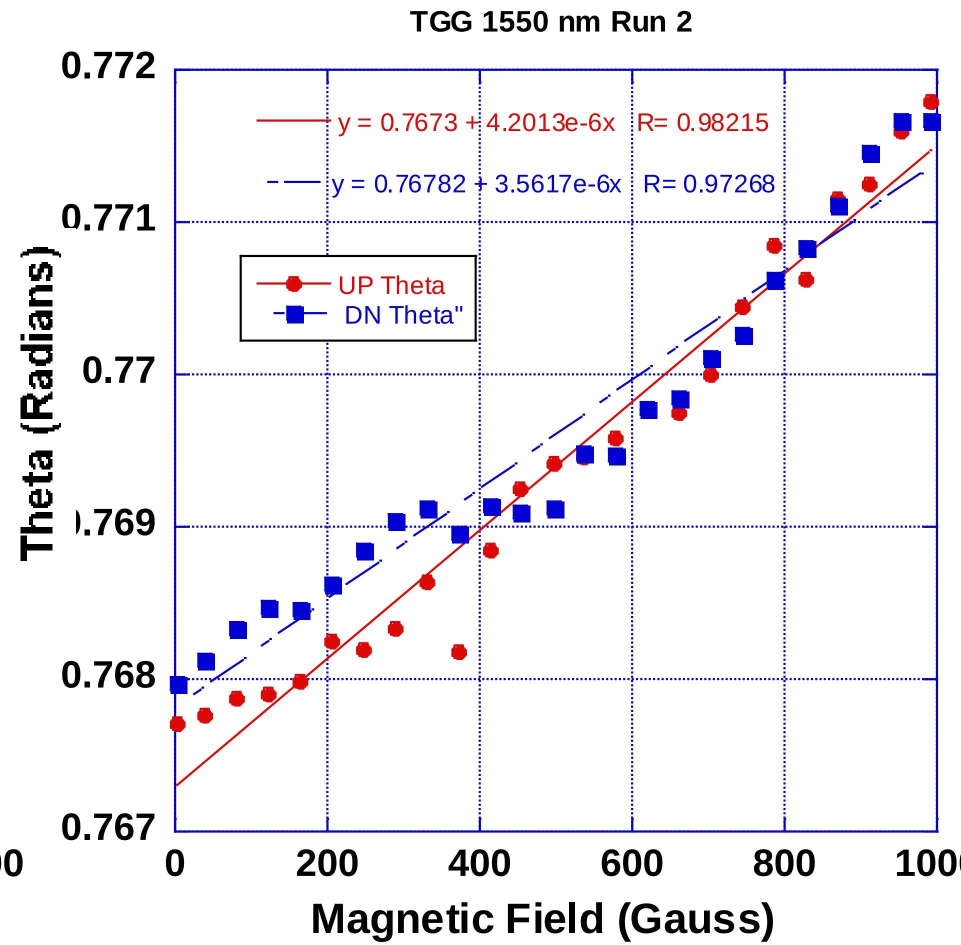
KTF Polarization angle vs. B





TGG Polarization angle vs. B

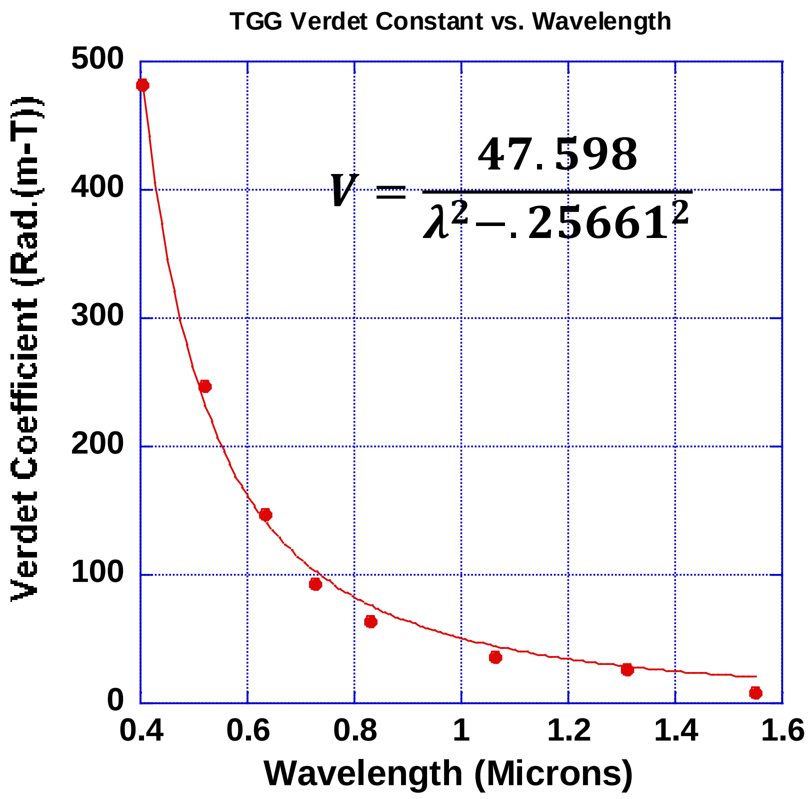


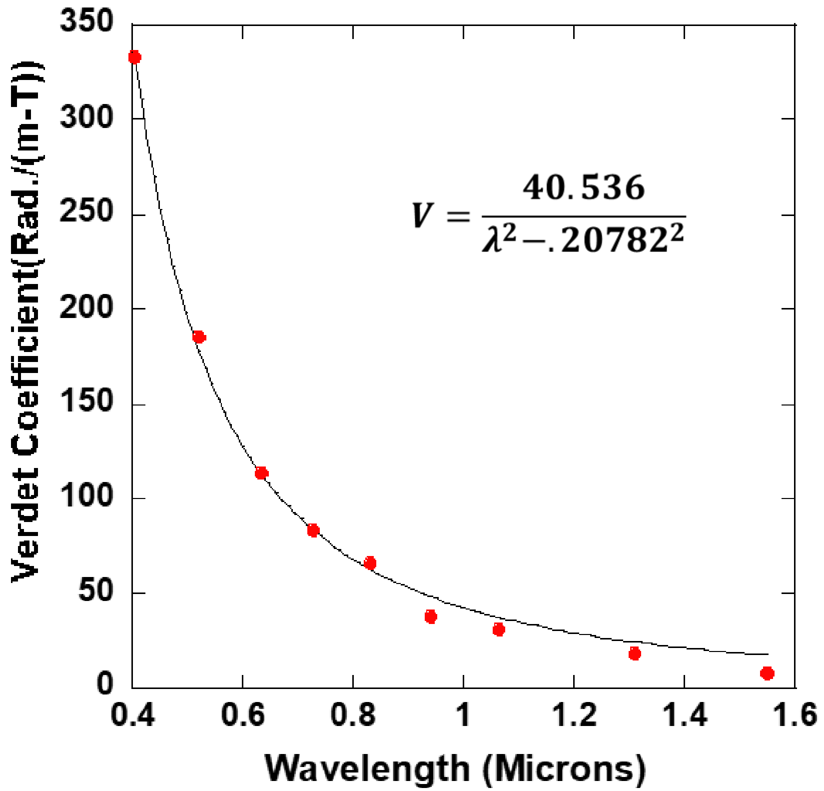


Verdet Coefficient vs. Wavelength

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

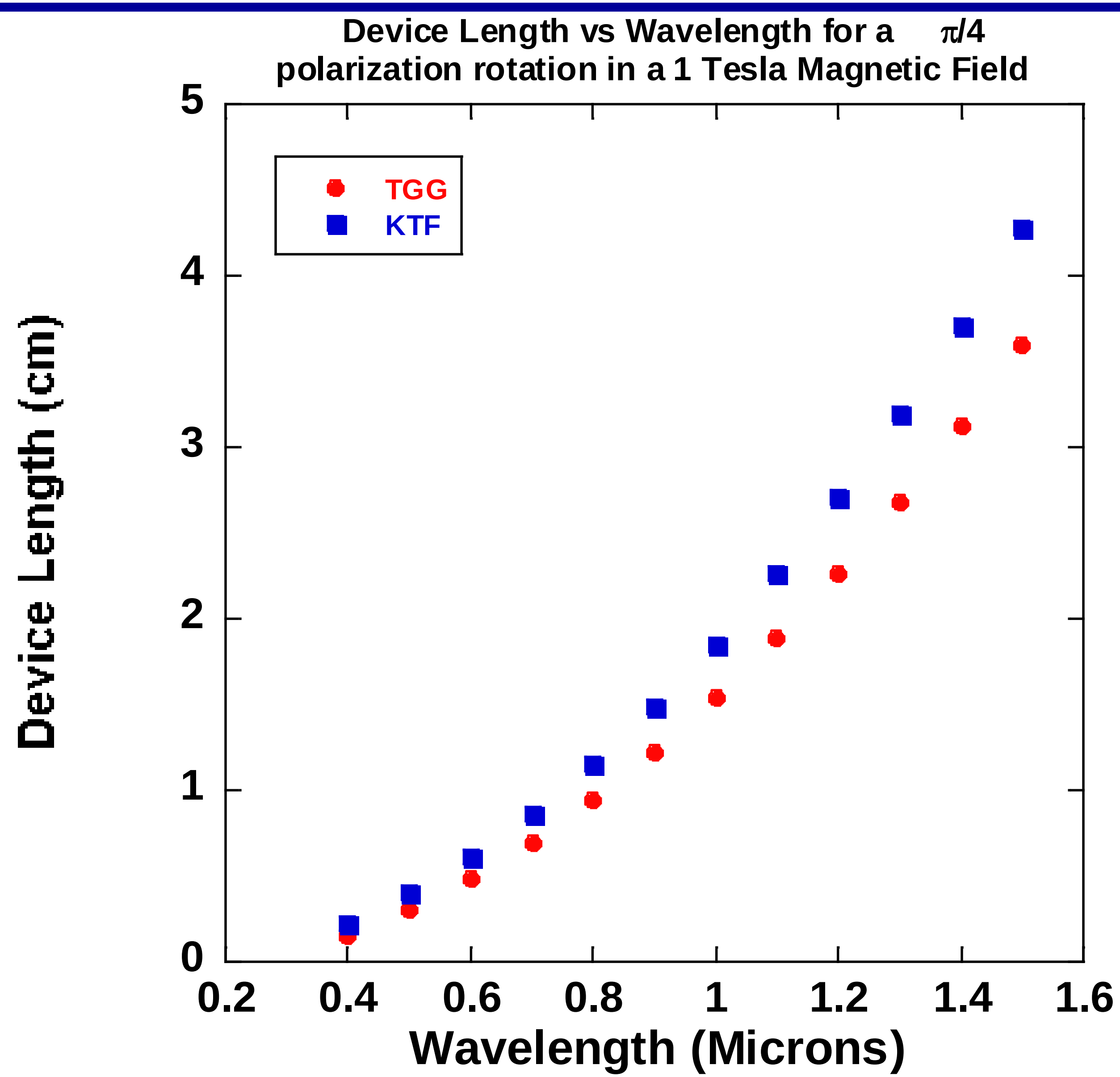
Spectral dependence of Verdet Coefficient –TGG and KTF





J. H. Van Vleck, *Electric and Magnetic Susceptibilities* (Oxford University Press, London, 1932), p. 243.

Simple device calculations



$VLB = \Delta\theta$

Summary

1. Verdet coefficients of TGG and KTF have been measured from .405 to 1.55 micron.

2. Devices approximately 1.5 cm long are required for sufficient polarization rotation at 1.06 microns

3. Rotation angle increases linearly with B field at all wavelengths and the Verdet coefficient varied with wavelength in accordance with the theory of VanVleck

4. Verdet constant of potassium terbium fluoride was found to be similar to that of TGG. Because of its other superior properties, it has the potential for replacing TGG in high power systems