BASELINE IN TDLS

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Baseline plays key role for trace molecules detection using Tunable Diode Laser Spectroscopy (TDLS). For the first time for author knowledge it was mentioned in [1]. In our experiments, when broad DL frequency tuning was used, baseline was observed without any problem and easily can be distinguished from interference fringes. Physical nature of baseline was explained in [2]. Recently baseline was investigated carefully using new technique developed. Some results of this investigation will be presented in the paper.

1. J.Reid, D.Labrie, Appl.Phys., B26, 203-210 (1981)
2. A.Nadezhdinskii, I.Zasavitskii, in “Monitoring of gaseous pollutants by tunable diode lasers”, R.Grisar, H.Preier, G.Schmidtke, G.Restelli (Ed.), Proc. Int. Symposium, Freiburg, FRG 1986, D.Reidel Publ.Com., Dordrecht, 1987, p.95-106.

STATISTICAL ANALYSIS OF DATA SERIES IN TDLS

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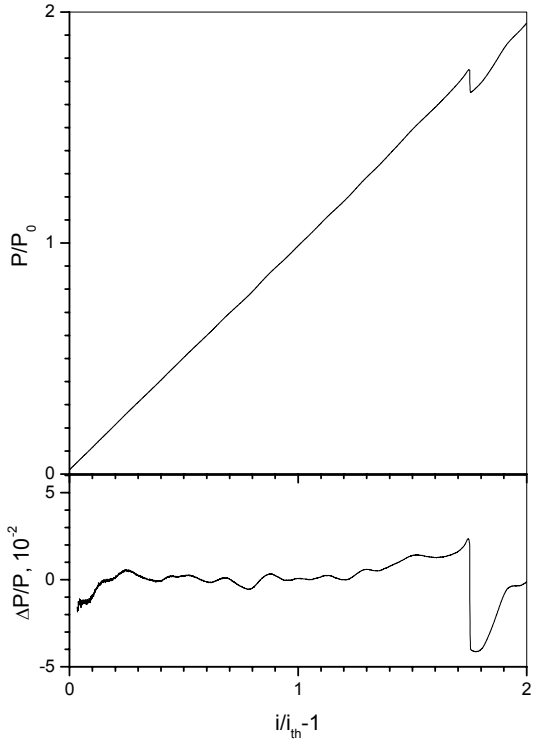
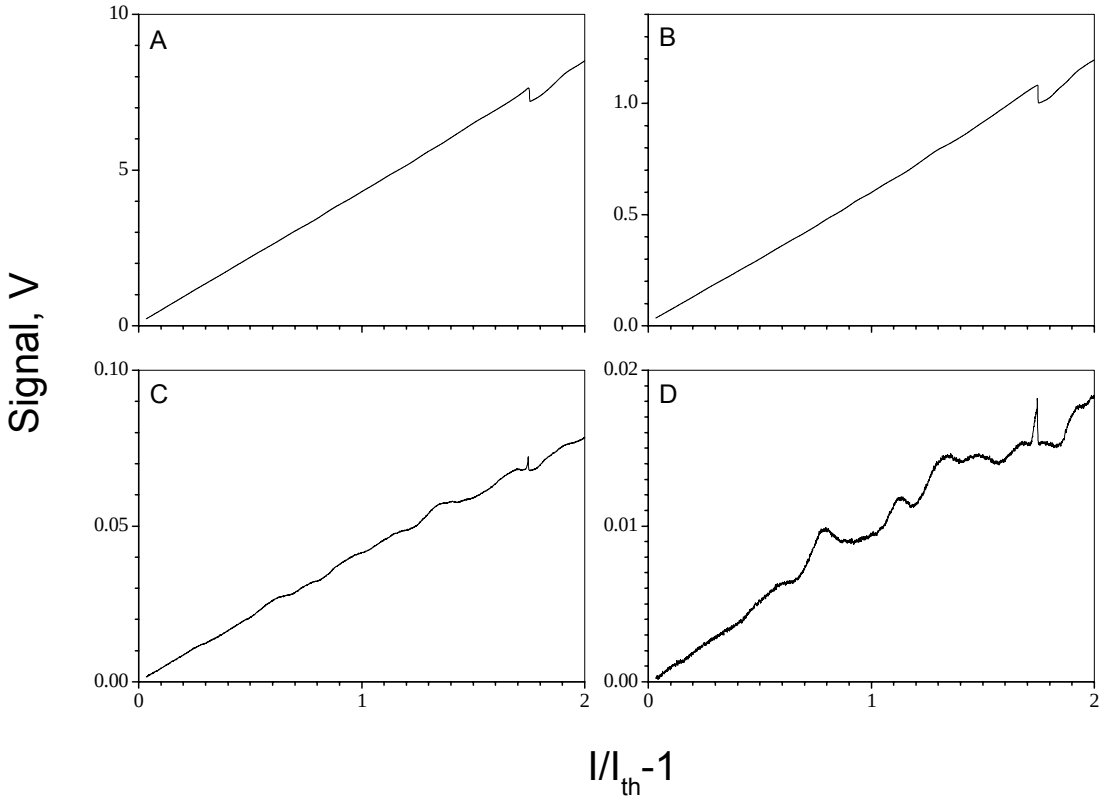
Baseline



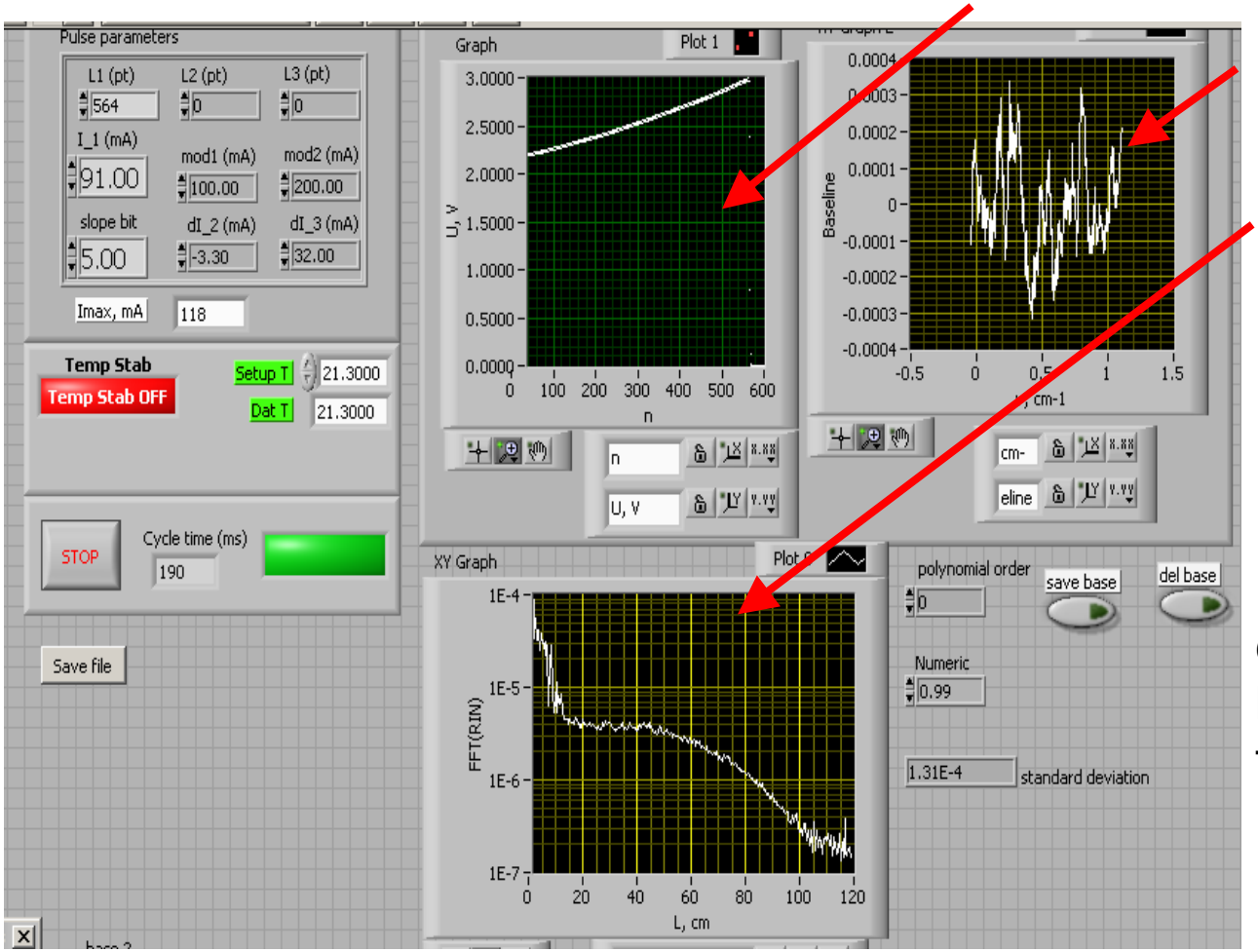
Recorded signal as function of excitation current and baseline



Recorded signals as function of excitation current when photodiode was installed in different parts of laser diagram

Resume: In present case baseline is determined by small scale inhomoginiety of near field of DL radiation.

BaseLine Software



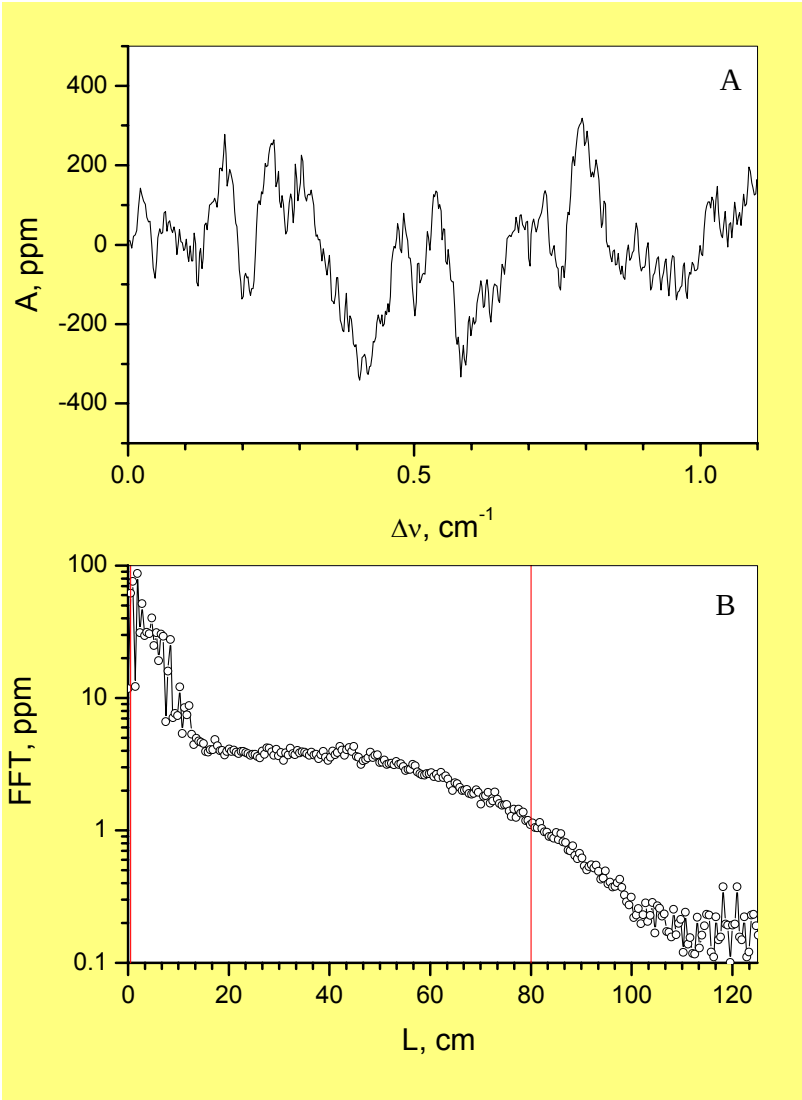
Baseline,

Baseline FFT, averaged over realizations.

Last software version developed calculates also baseline correlation function.

Calibration:
Horizontal scale is calibrated to give distance between surfaces of reflection - L
Vertical scale gives amplitude of harmonic component

Baseline



Experiment explanation:
Photo-diode was installed at distance of 80 cm from diode laser and detected small part of laser radiation (no optical elements between DL and PD). DL module had window at 2 mm from laser. Possible distances of reflection are shown by red vertical lines. All interference effects were reduced below 10^{-6} level.

Baseline (A) and its FFT (B)

Resume: Baseline is determined by DL properties.

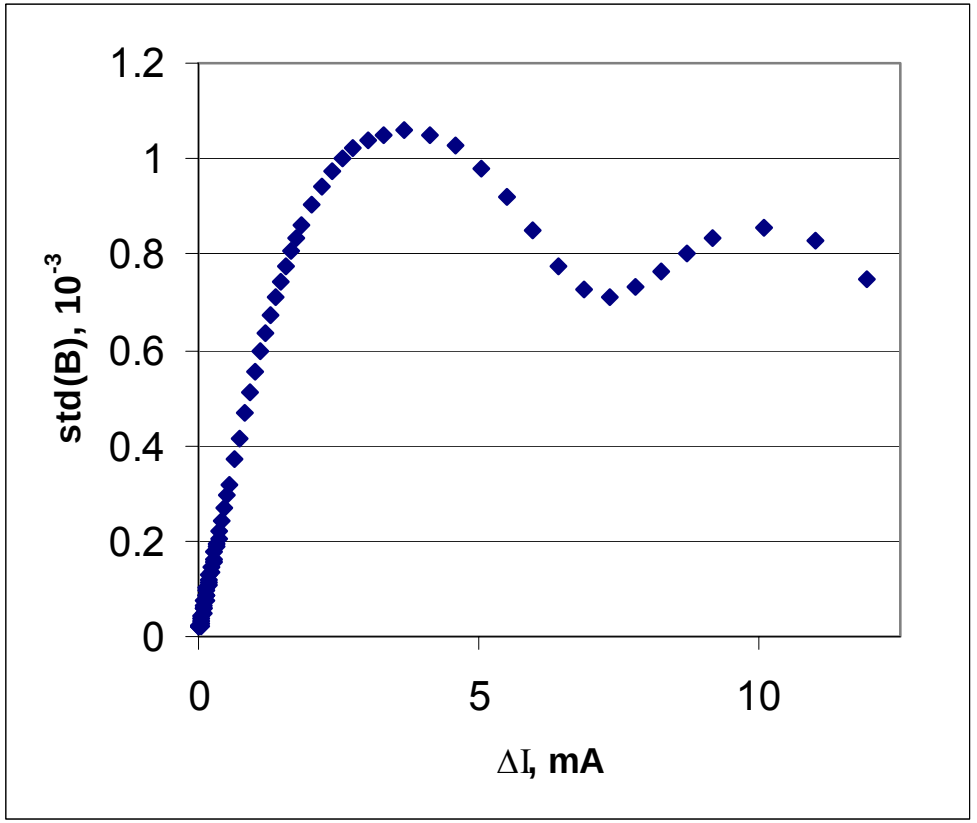
Baseline Current Dependence

Experiment parameters:
For given excitation current modulation amplitude - ΔI baseline B(I) was recorded for $I_1 < I < I_2$ (<B>=0):

$$B(I) = A(I + \Delta I) - A(I - \Delta I)$$

A(I+ΔI) и A(I-ΔI) correspond to upper and lower modulation, respectively (see separate poster).
Baseline standard deviation std(B) was determined for realization under consideration

$$std(B) = \sqrt{\frac{1}{I_2 - I_1}\int_{I_1}^{I_2} B(I)^2\, dI}$$



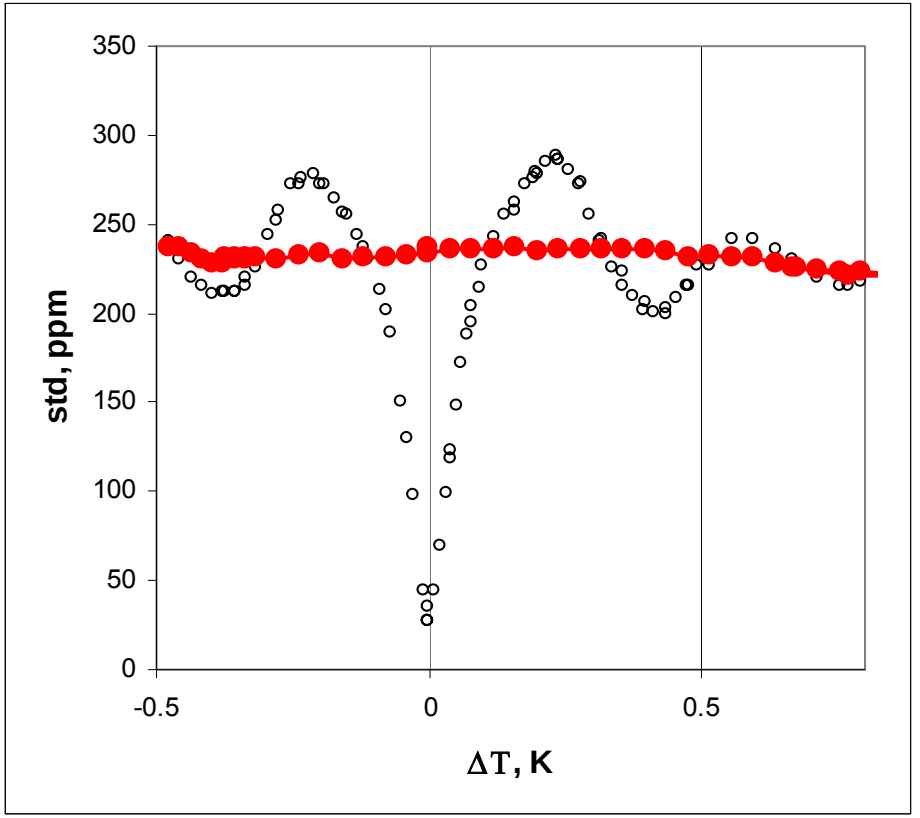
Baseline std as function of modulation amplitude ΔI shows resonance behavior.

Baseline Temperature Dependence

Experiment parameters:
Following previous experiment baseline $B_0(I)$ was recorded for DL temperature T_0. Then baseline B(I) was measured for DL temperature T. Using these data std(B-B_0), and std_0 were calculated for given realization:

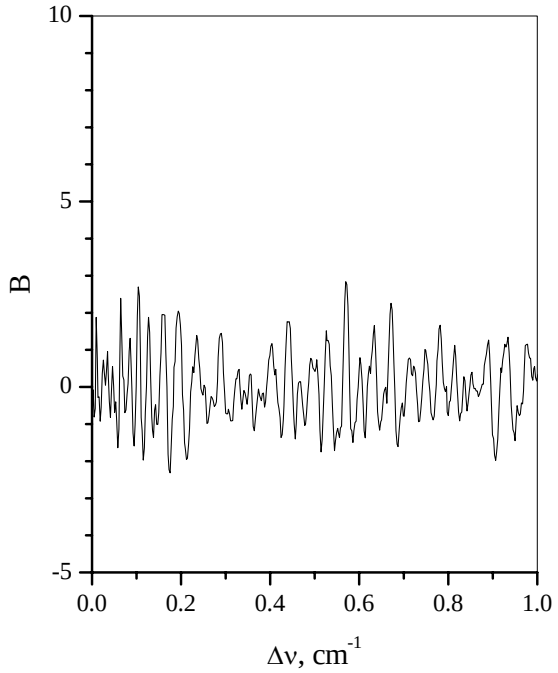
$$std(B-B_0)=\sqrt{\frac{1}{I_2-I_1}\int_{I_1}^{I_2}\left[B(I)-B_0(I)\right]^2 dI}$$

$$std_0=\sqrt{\frac{1}{I_2-I_1}\int_{I_1}^{I_2}\left[B(I)^2+B_0(I)^2\right]dI}$$

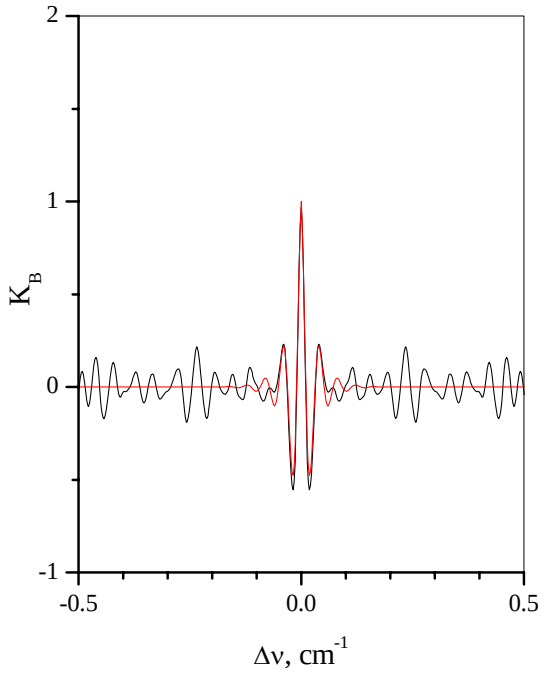


std(B-B_0) (open black cycles) and std_0 (solid red cycles) as function of temperature difference $\Delta T=T-T_0$ shows resonance behavior.

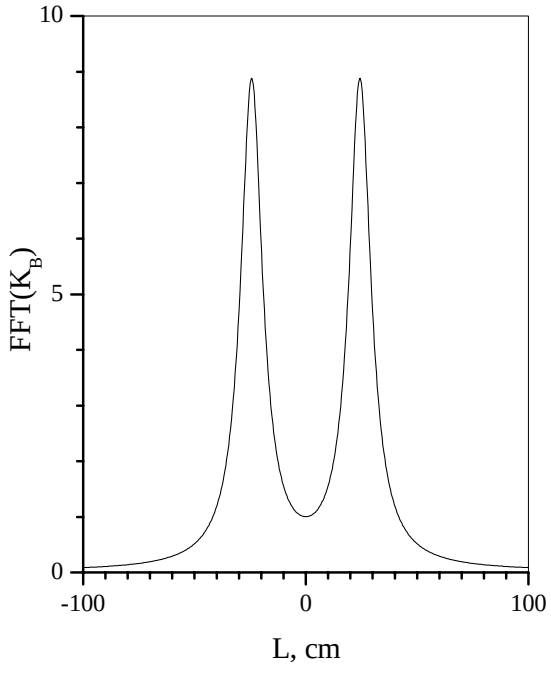
Baseline Statistical Investigation



Baseline

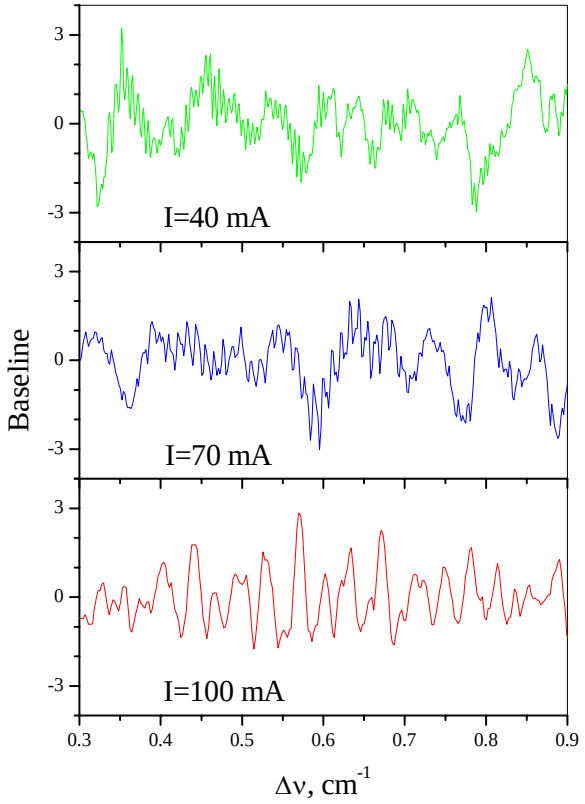


Baseline autocorrelation function

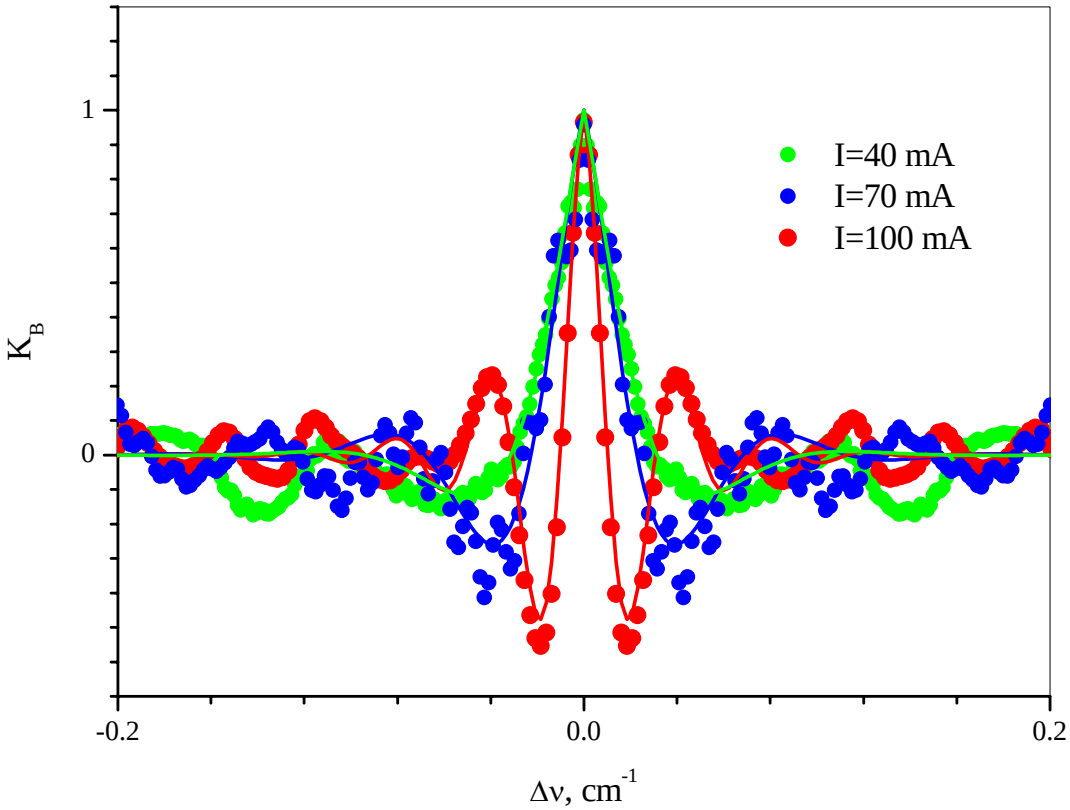


Baseline FFT

Baseline and its Correlation Function

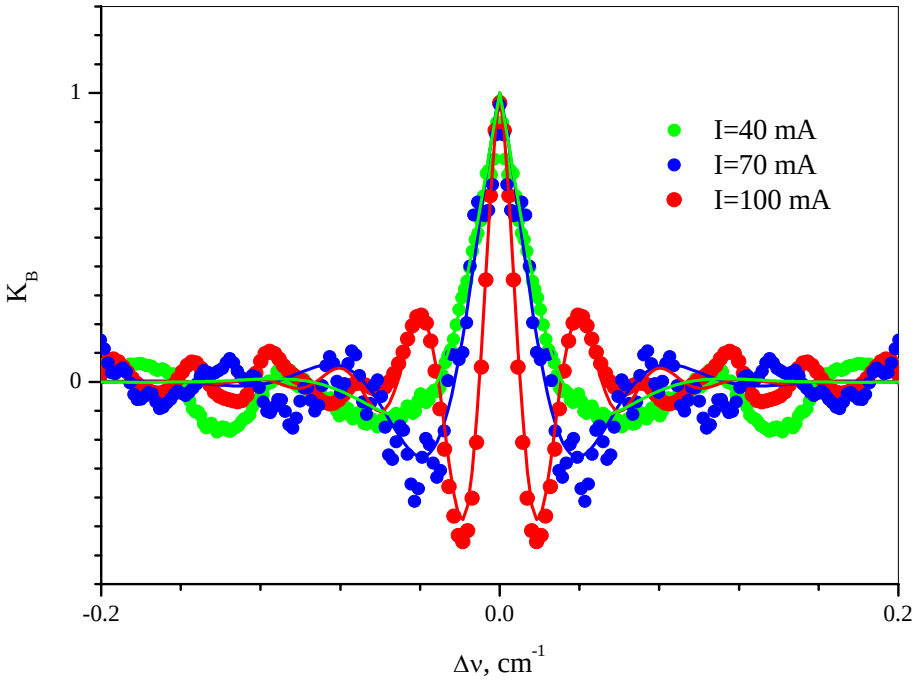


Baseline structure changing for different excitation current values. Baseline is normalized to its std.

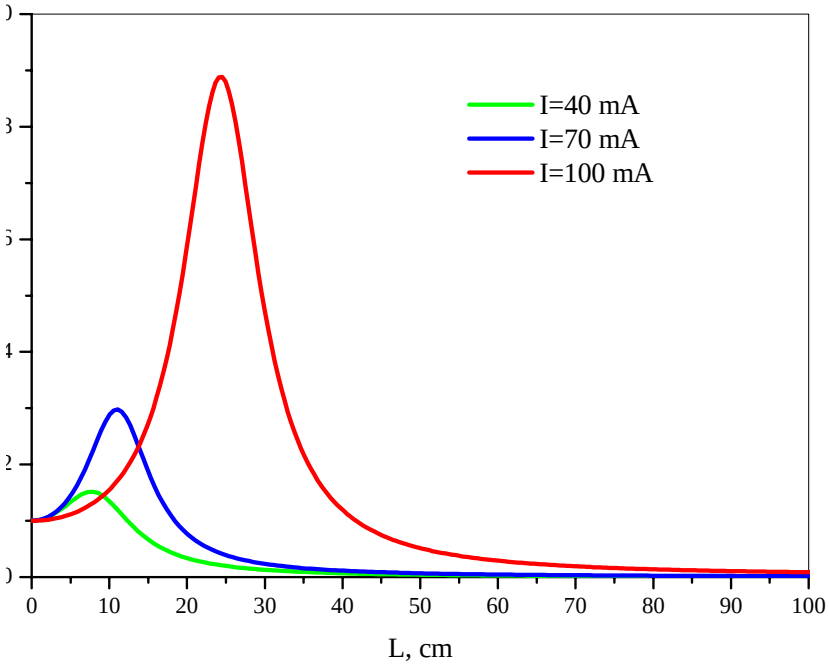


Baseline autocorrelation functions for different excitation current values and their fitting.

Baseline FFT



Baseline autocorrelation functions for different excitation current values and their fitting.



FFT of baseline autocorrelation functions for different excitation current values.

Resume: FFT of baseline autocorrelation function demonstrates behavior similar to that of "relaxation oscillations".

Physical Nature of Baseline in TDLS

- ***Inhomoginiety of different processes in DL active area is physical origin of baseline.***
- ***Baseline is determined by interaction of inhomoginiety under consideration with DL electromagnetic standing wave.***
- ***When above mentioned interaction is taking into account: baseline is measure of parameter of interest as function of some effective coordinate in DL active area.***
- ***Baseline autocorrelation function is determined by inhomoginiety under consideration smoothed by diffusion in DL active area***
- ***Above mentioned diffusion is determined by relaxation in electrons-photons system known as “relaxation oscillations”***