Kaleidagraph Instructions

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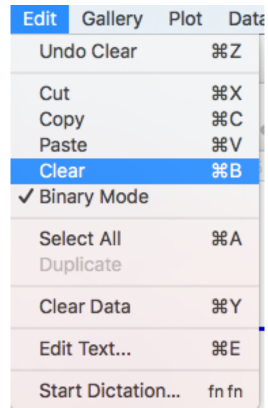
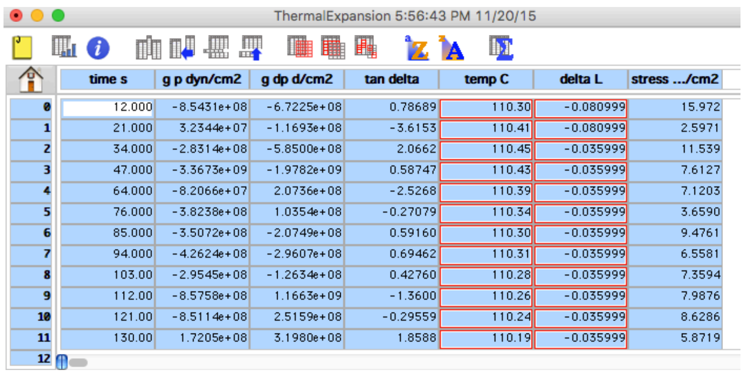
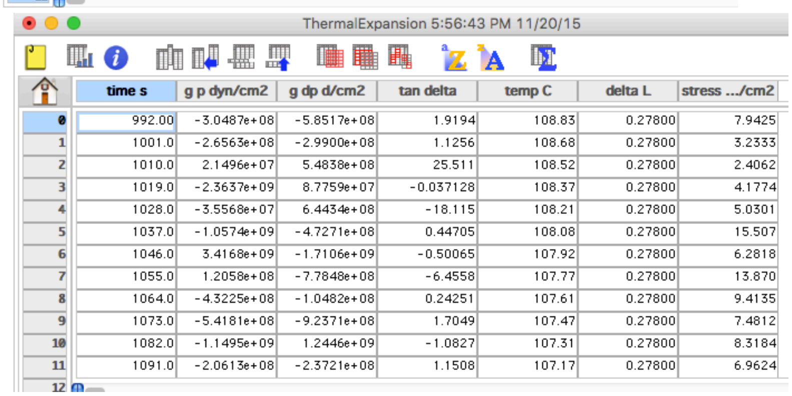
Lesson 5_Intermediate Curve fitting and taking a numerical derivative
Goal: to use the general curve fit feature and to be able to use the Macro menu to take a derivative.

1) Open the plot resulting from Lesson 4.
2) Erase the masked data. Do this by extracting the data from the plot by clicking on the gridiron in the upper right of the plot (as was done in a previous lesson). Click on the first row of the masked data and shift-click on the last row of the masked data and select clear from the edit pull down menu



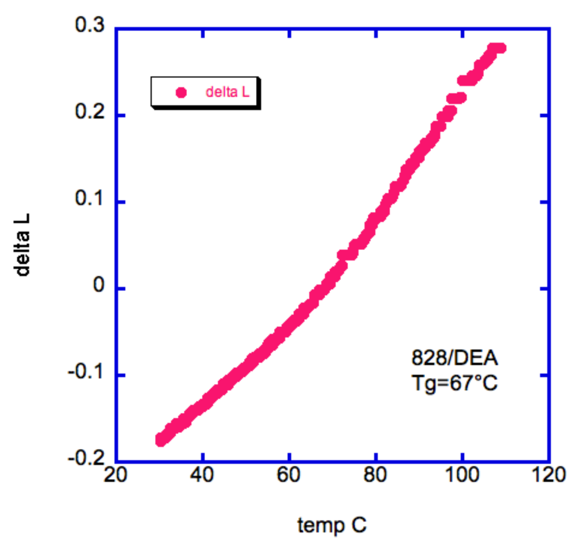

ThermalExpansion 5:56:43 PM 11/20/15

	time s	g p dyn/cm2	g dp d/cm2	tan delta	temp C	delta L	stress .../cm2
0	12.000	-8.5431e+08	-6.7225e+08	0.78689	110.30	-0.080999	15.972
1	21.000	3.2344e+07	-1.1693e+08	-3.6153	110.41	-0.080999	2.5971
2	34.000	-2.8314e+08	-5.8500e+08	2.0662	110.45	-0.035999	11.539
3	47.000	-3.3673e+09	-1.9782e+09	0.58747	110.43	-0.035999	7.6127
4	64.000	-8.2066e+07	2.0736e+08	-2.5268	110.39	-0.035999	7.1203
5	76.000	-3.8238e+08	1.0354e+08	-0.27079	110.34	-0.035999	3.6590
6	85.000	-3.5072e+08	-2.0749e+08	0.59160	110.30	-0.035999	9.4761
7	94.000	-4.2624e+08	-2.9607e+08	0.69462	110.31	-0.035999	6.5581
8	103.00	-2.9545e+08	-1.2634e+08	0.42760	110.28	-0.035999	7.3594
9	112.00	-8.5758e+08	1.1663e+09	-1.3600	110.26	-0.035999	7.9876
10	121.00	-8.5114e+08	2.5159e+08	-0.29559	110.24	-0.035999	8.6286
11	130.00	1.7205e+08	3.1980e+08	1.8588	110.19	-0.035999	5.8719
12							

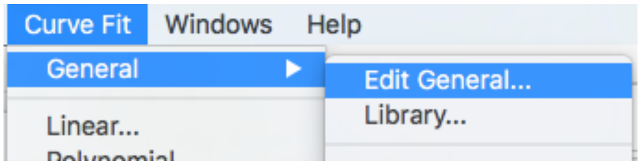

ThermalExpansion 5:56:43 PM 11/20/15

	time s	g p dyn/cm2	g dp d/cm2	tan delta	temp C	delta L	stress .../cm2
0	992.00	-3.0487e+08	-5.8517e+08	1.9194	108.83	0.27800	7.9425
1	1001.0	-2.6563e+08	-2.9900e+08	1.1256	108.68	0.27800	3.2333
2	1010.0	2.1496e+07	5.4838e+08	25.511	108.52	0.27800	2.4062
3	1019.0	-2.3637e+09	8.7759e+07	-0.037128	108.37	0.27800	4.1774
4	1028.0	-3.5568e+07	6.4434e+08	-18.115	108.21	0.27800	5.0301
5	1037.0	-1.0574e+09	-4.7271e+08	0.44705	108.08	0.27800	15.507
6	1046.0	3.4168e+09	-1.7106e+09	-0.50065	107.92	0.27800	6.2818
7	1055.0	1.2058e+08	-7.7848e+08	-6.4558	107.77	0.27800	13.870
8	1064.0	-4.3225e+08	-1.0482e+08	0.24251	107.61	0.27800	9.4135
9	1073.0	-5.4181e+08	-9.2371e+08	1.7049	107.47	0.27800	7.4812
10	1082.0	-1.1495e+09	1.2446e+09	-1.0827	107.31	0.27800	8.3184
11	1091.0	-2.0613e+08	-2.3721e+08	1.1508	107.17	0.27800	6.9624
12							

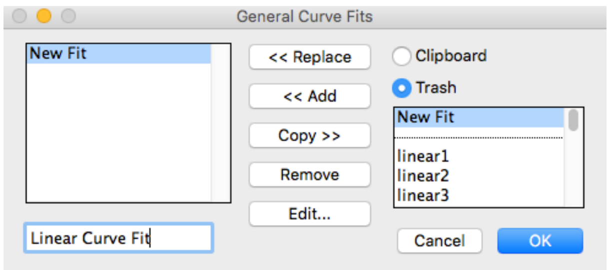
3) Delete the trend lines (click on a line and hit the delete key)



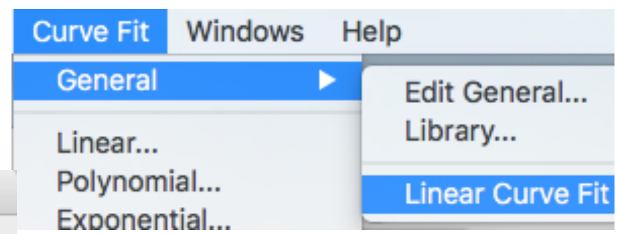
4) With the plot selected (and not the data window), select Curvefit->General->Edit General

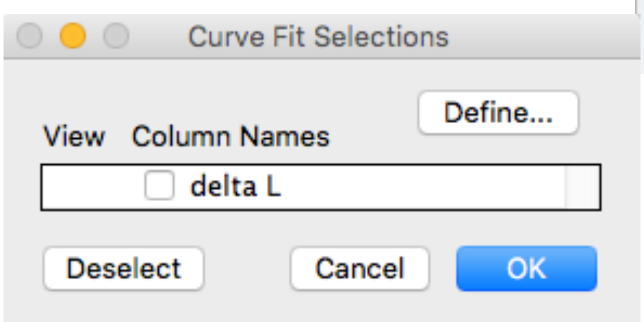


5) Select New Fit and click Add
Select New Fit and type in Linear curve fit and click OK

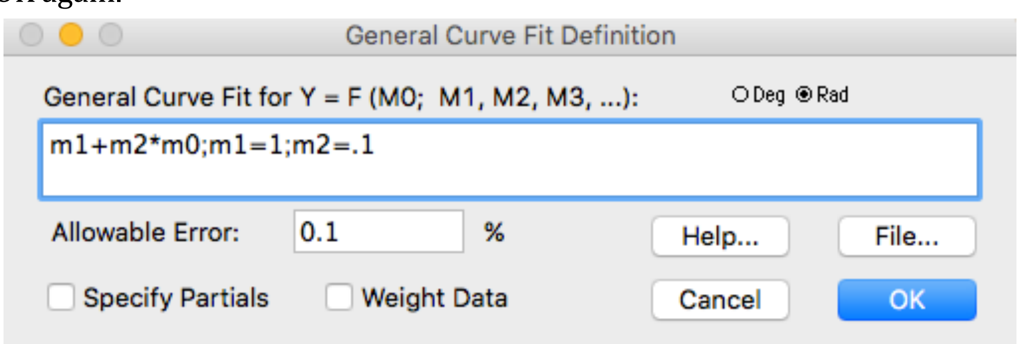


6) Select Curve fit-> General -> Linear Curve Fit

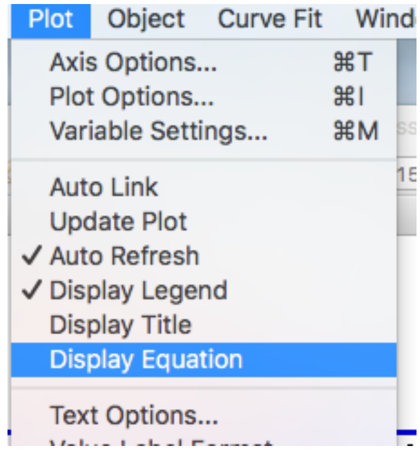


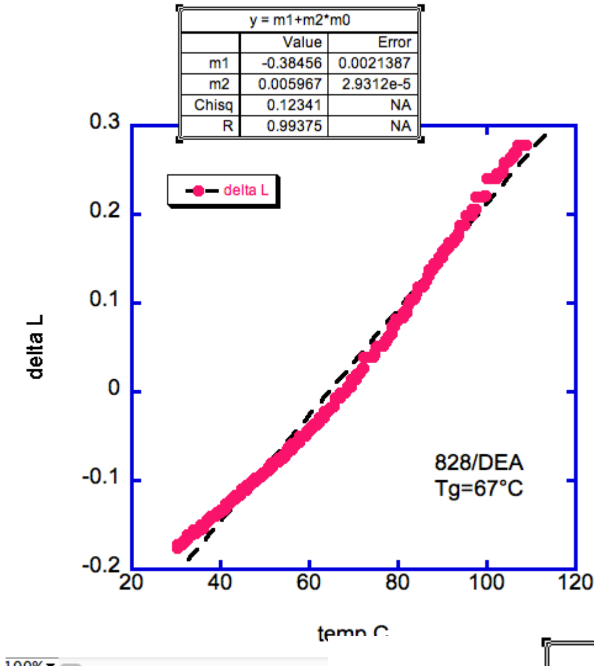


Select delta L and click "Define"
Type "m1+m2*m0;m1=1;m2=0.1"
m1 and m2 are curve fit parameters and m0 is the X in the plot (temperature in this case). The ;m1=1;m2=0.1 are initial guesses of the parameters. Select OK and then OK again.

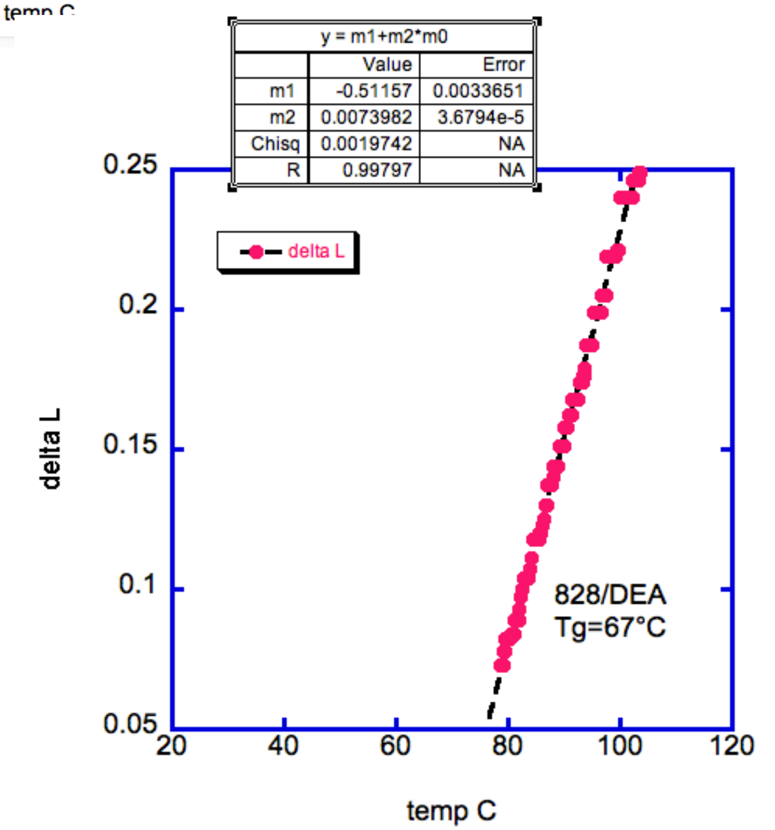


7) Select Plot->display equation and drag the equation off to the side

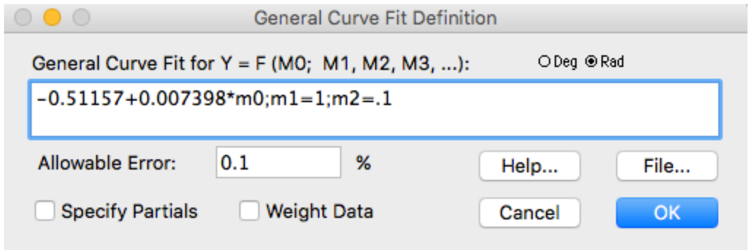


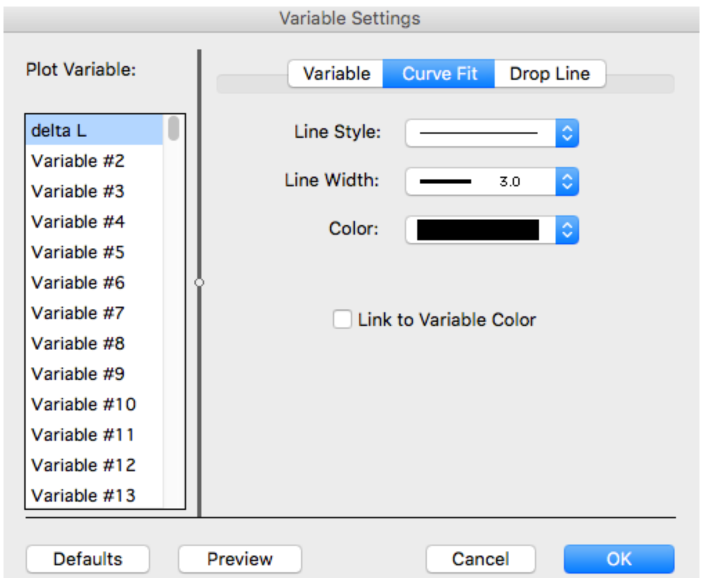


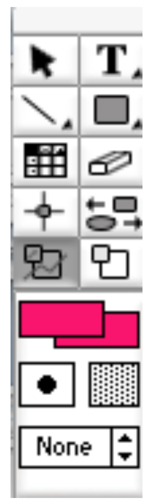
8) Mask all but the upper part of the curve.

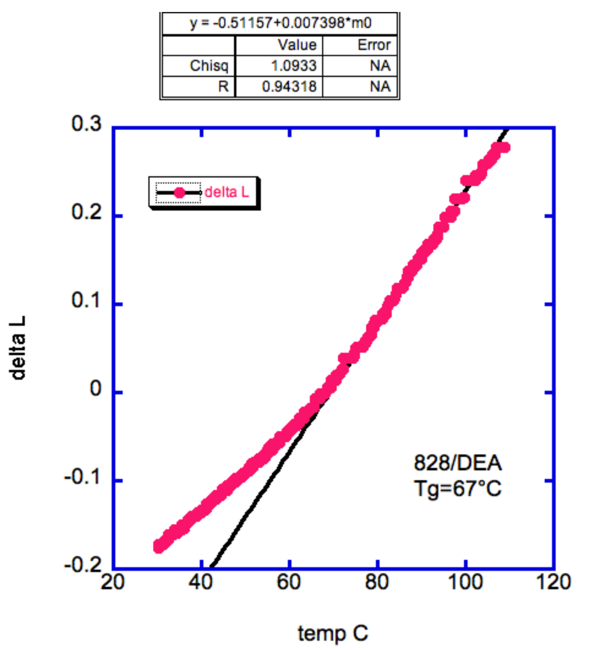


9) Select Curvefit->General->General Curve Fit and enter the m1 and m2 from the curve fit (to "hardwire" the fit) and hit ok. Also change the curve fit line into a solid line. Then double click on the mask tool to unmask the data

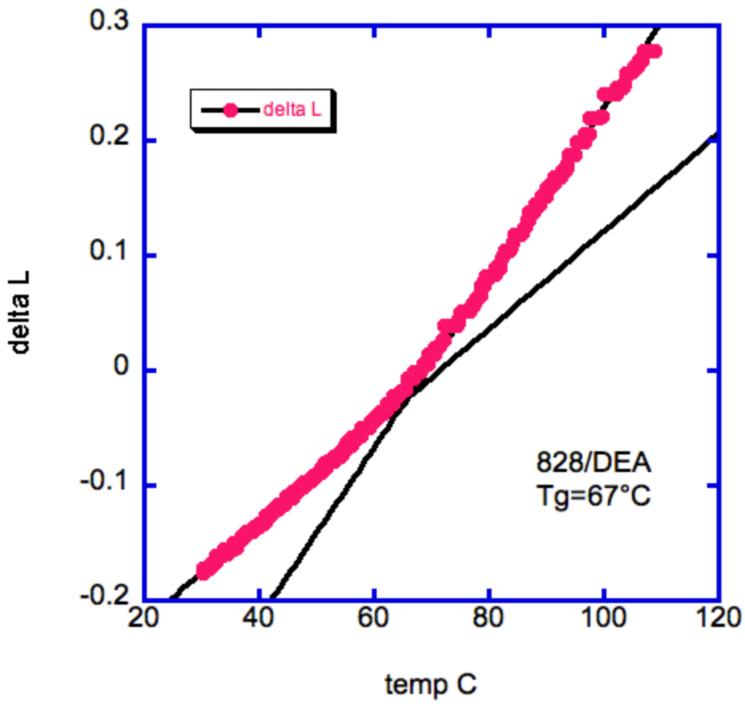


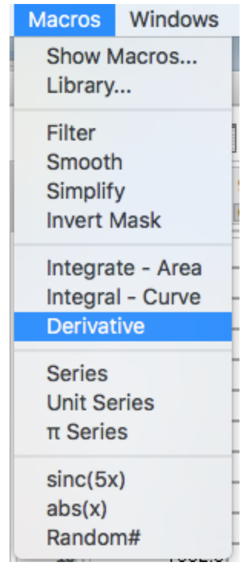




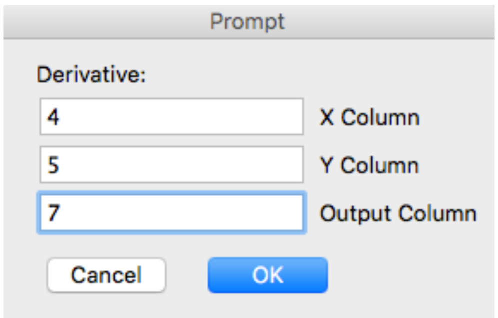


10) Create a second Curve Fit (Linear Curvefit 2) and repeat the above pocedure for the low T points. Erase the displayed equations (click on them and hit delete key)





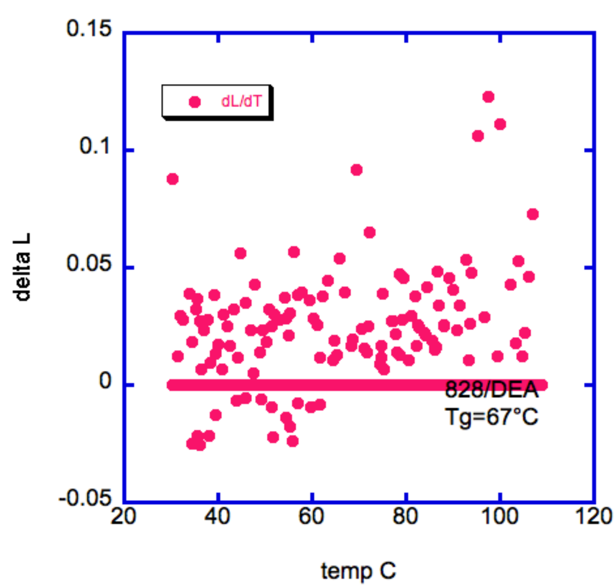
11) take the derivative to get function proportional to linear expansion coefficient. Turn off curve fits and extract data (with gridiron) and turn on column numbers. With the data window selected, choose Macros-> derivative. Put the column numbers for x and y in the prompt window and select a new ouput column (7)



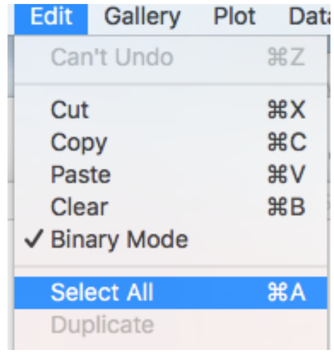
ThermalExpansion 8:04:32 PM 11/20/15

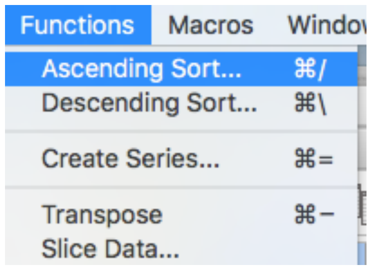
	g p dyn/cm2 C1	g dp d/cm2 C2	tan delta C3	temp C C4	delta L C5	stress .../cm2 C6	dL/dT C7
0	-3.0487e+08	-5.8517e+08	1.9194	108.83	0.27800	7.9425	0.0000
1	-2.6563e+08	-2.9900e+08	1.1256	108.68	0.27800	3.2333	0.0000
2	2.1496e+07	5.4838e+08	25.511	108.52	0.27800	2.4062	0.0000
3	-2.3637e+09	8.7759e+07	-0.037128	108.37	0.27800	4.1774	0.0000
4	-3.5568e+07	6.4434e+08	-18.115	108.21	0.27800	5.0301	0.0000
5	-1.0574e+09	-4.7271e+08	0.44705	108.08	0.27800	15.507	0.0000
6	3.4168e+09	-1.7106e+09	-0.50065	107.92	0.27800	6.2818	0.0000
7	1.2058e+08	-7.7848e+08	-6.4558	107.77	0.27800	13.870	0.0000
8	-4.3225e+08	-1.0482e+08	0.24251	107.61	0.27800	9.4135	0.0000
9	-5.4181e+08	-9.2371e+08	1.7049	107.47	0.27800	7.4812	0.0000

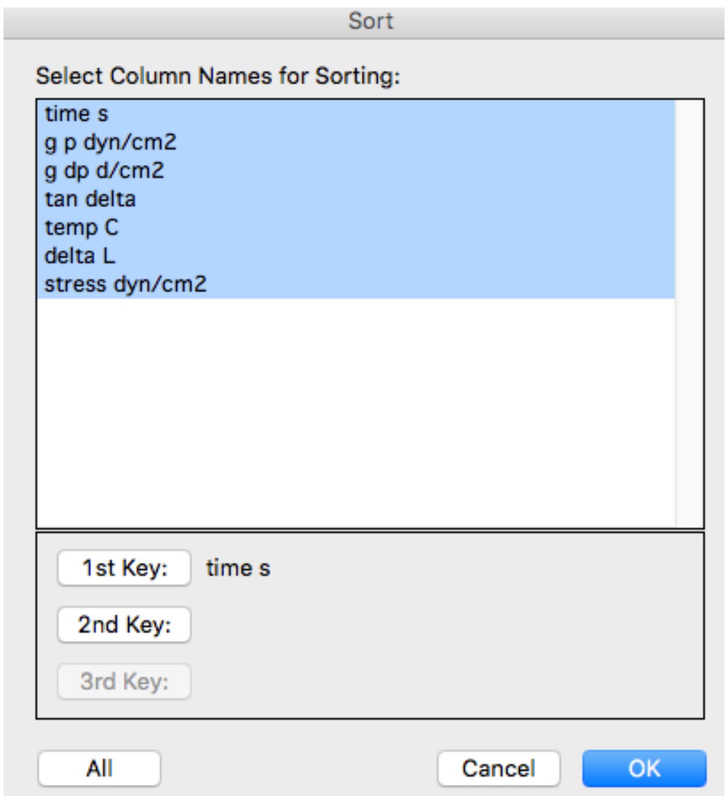
Create a New Plot of dL/dT vs. T. The result is just noise! This is an illustration of how numerical derivatives amplify noise. In order to get a meaningful derivative, the data must be smoothed before the derivative is taken.



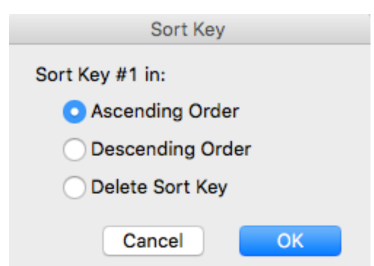
12) For this data, the "smooth" curvefit works ok, however, the data needs to be sorted first. Go back to the previous L vs. T plot and extract the data. In the data window select all the data. Select Functions-> Ascending Sort



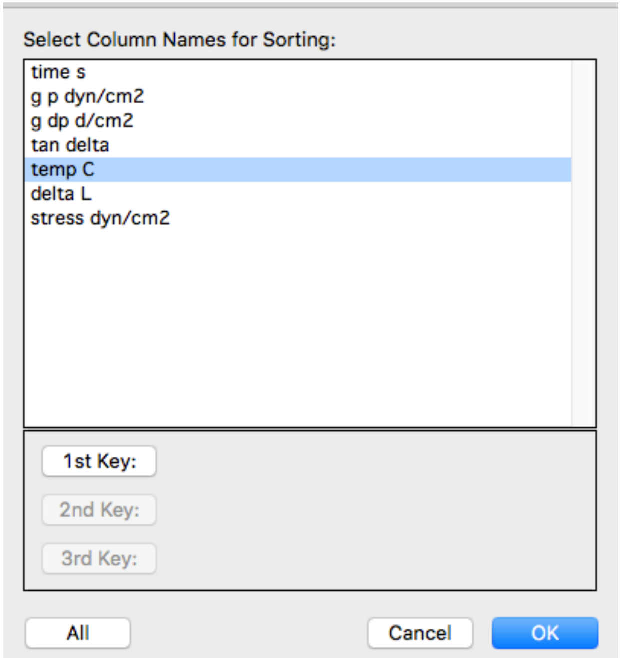




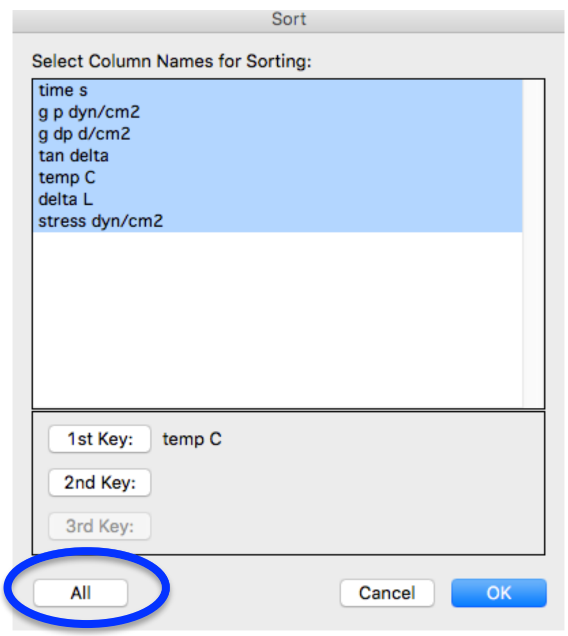
Click "1st Key". Select Delete Sort Key and click OK



13) select temp C and click 1st Key. Select Ascending Sort and click OK



14) Select all and click OK

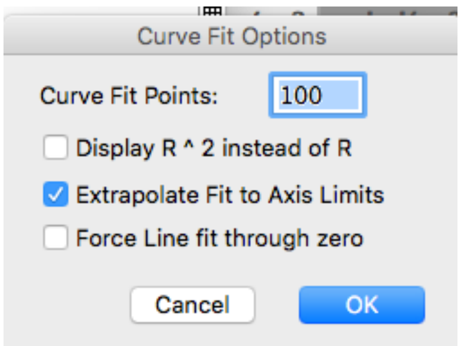


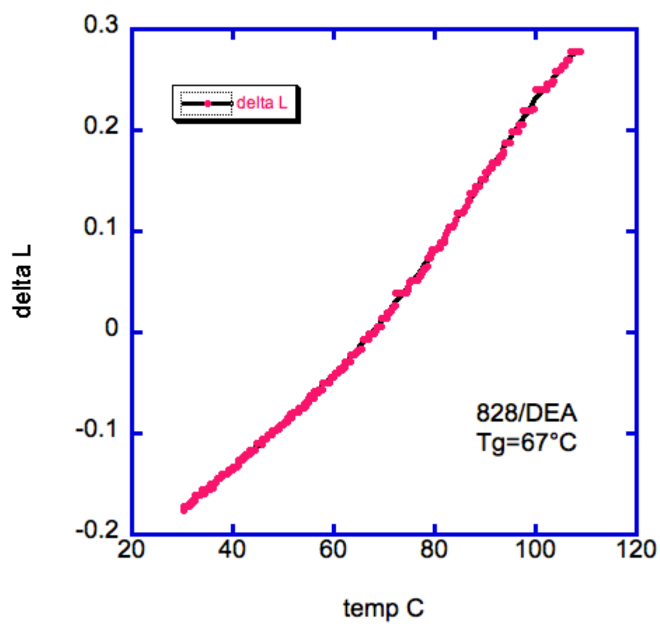
15) clcik on the data window so the data becomes unselected. You should now see:

ThermalExpansion 8:04:32 PM 11/20/15

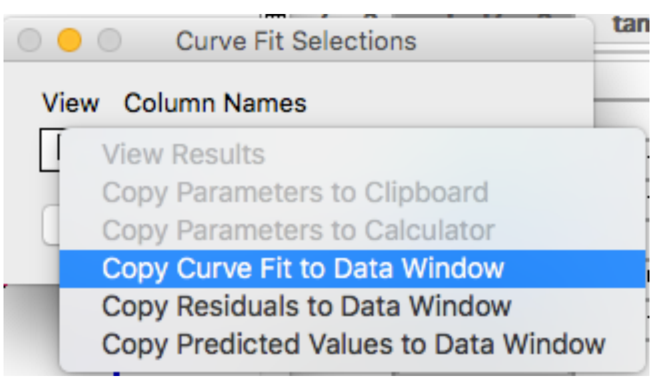
	time s	g p dyn/cm2	g dp d/cm2	tan delta	temp C	delta L	stress .../cm2
0	5736.0	-2.6189e+08	8.0607e+08	-3.0779	30.183	-0.17700	16.973
1	5727.0	1.9357e+08	-1.2217e+09	-6.3113	30.240	-0.17200	8.6209
2	5718.0	-1.5685e+09	4.8950e+08	-0.31208	30.301	-0.17200	11.041
3	5709.0	-7.1448e+08	2.5245e+08	-0.35332	30.387	-0.17200	15.123
4	5700.0	-1.3806e+08	6.3613e+08	-4.6075	30.467	-0.17200	13.374
5	5691.0	-3.4596e+08	3.4576e+07	-0.099942	30.553	-0.17200	3.1170
6	5682.0	-1.8423e+09	1.3350e+09	-0.72466	30.660	-0.17200	29.127
7	5673.0	-3.3932e+07	1.9456e+08	-5.7338	30.783	-0.17200	2.8029
8	5664.0	-7.2027e+08	6.7588e+07	-0.093837	30.915	-0.17200	9.5933
9	5655.0	-1.4108e+09	-2.8059e+08	0.19889	31.072	-0.17200	19.425

16) We are now ready to do a curve fit. Click on the plot to bring it to the forground and select Curvefit-> smooth and then select curvefit-> curvefit options. Change the Curve fit points to 1000 and click OK. Reduce the point size for the red data to 9 pt

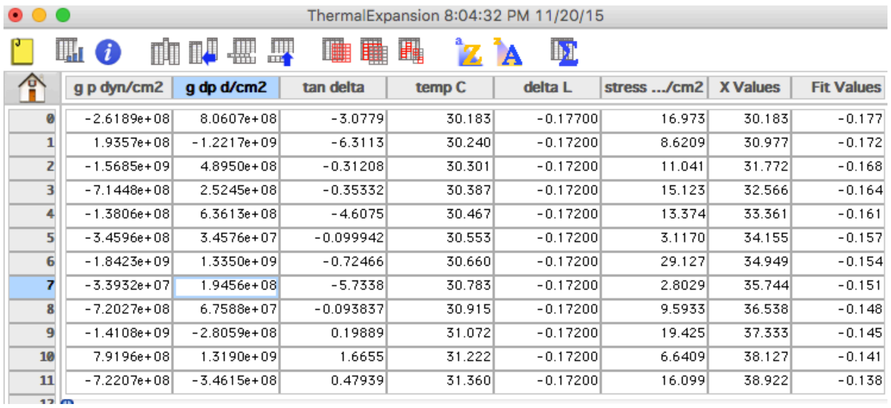




17) Select Curve fit-> Smooth and copy curve fit to data window

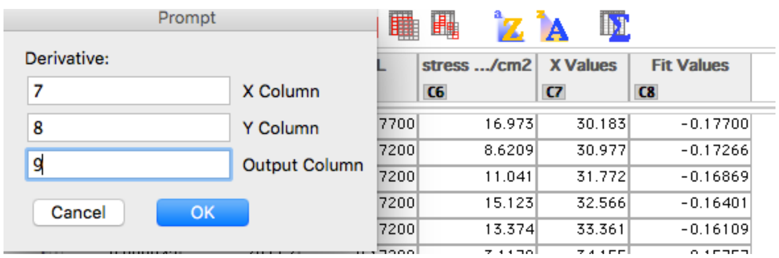


18) There should now be two new columns in the data window with the T (X Values) vs. L (Fit Values) from the curve fit



	g p dyn/cm2	g dp d/cm2	tan delta	temp C	delta L	stress .../cm2	X Values	Fit Values
0	-2.6189e+08	8.0607e+08	-3.0779	30.183	-0.17700	16.973	30.183	-0.177
1	1.9357e+08	-1.2217e+09	-6.3113	30.240	-0.17200	8.6209	30.977	-0.172
2	-1.5685e+09	4.8950e+08	-0.31208	30.301	-0.17200	11.041	31.772	-0.168
3	-7.1448e+08	2.5245e+08	-0.35332	30.387	-0.17200	15.123	32.566	-0.164
4	-1.3806e+08	6.3613e+08	-4.6075	30.467	-0.17200	13.374	33.361	-0.161
5	-3.4596e+08	3.4576e+07	-0.099942	30.553	-0.17200	3.1170	34.155	-0.157
6	-1.8423e+09	1.3350e+09	-0.72466	30.660	-0.17200	29.127	34.949	-0.154
7	-3.3932e+07	1.9456e+08	-5.7338	30.783	-0.17200	2.8029	35.744	-0.151
8	-7.2027e+08	6.7588e+07	-0.093837	30.915	-0.17200	9.5933	36.538	-0.148
9	-1.4108e+09	-2.8059e+08	0.19889	31.072	-0.17200	19.425	37.333	-0.145
10	7.9196e+08	1.3190e+09	1.6655	31.222	-0.17200	6.6409	38.127	-0.141
11	-7.2207e+08	-3.4615e+08	0.47939	31.360	-0.17200	16.099	38.922	-0.138

19) take the derivative (as above) of the two fit columns



20) Plot dL/dT vs. "X-values" Although still noisy, a clear trend can be seen (note that the experiment was from high T to low and the high T data still has some "start-up" issues (blue circle). If this were a plot for publiction, considerably more time would be spend in choosing the "right" curve fit so that the derivative is as smooth as possible.