SPEC_SOFT Manual

Gratingworks LLC

Catalogue

1.	Spect	trometer Overview	3
2.	Softw	vare Usage Overview	4
	2.1	Home	5
		2.1.1 Data Sources	5
		2.1.2 Data Views	6
		2.1.3 Calibration	6
		2.1.4 Graph Window	8
		2.1.5 Status Bar	8
		2.1.6 Output	8
	2.2	Spec Pane	8
	2.3	Graph Controls	10
3.	Grap	h Control	11
	3.1	Peak	12
	3.2	GPIO & Lamp Control	12
4.	Firm	ware Settings	15
5.	Setup	o the CCD DC Bias.	16
6.	GPIC	O Controls	17
7.	PWM	I Control	18
8.	Meas	surements	19
	8.1	CCD Dark	19
	8.2	Scope measurement	19
	8.3	Absorbance	19
	8.4	Transmission	20
	8.5	Reflectance	20
9.	Calib	pration	20
10.	Linea	arity	21
11.	FIR f	filtering	22
12.	Firm	ware Upgrade	23

1. Spectrometer Overview

The spectrometer is powered through USB. Current consumption is under 150mA at 5Vdc. USB is either 2.0 Full Speed or 2.0 High Speed depending on the model.

Terminal block interface

- Pin 0 5Vdc from USB. Can be used as power supply for external units (<100mA) or as a input for 5Vdc power supply. (Closest to the USB connector.)
 Pin 1 External Acquisition Trigger, Falling Edge.
 Pin 2-7 GPIO 0-5. Output is 3.3Vdc, Input is 3.3-5Vdc compatible. Current is limited by the microcontroller.
 Pin 8 Lamp PWM Strobe, can be used to control Xenon/LED lamps.
 Pin 9 RS232 RX, Not implemented, OEM only.
 Pin 10 RS232 TX, Not implemented, OEM only.
- Pin 11 GND.

2. Software Usage Overview

Spec_soft GUI on windows provides a basic interface to the CONCAVUS and PSP family of spectrometers. It has the following functions.

- Graphical display of the spectrum in pixel or wavelength.
- Averaging, dark noise subtraction, CCD dark pixel subtraction.
- Wavelength Calibration.
- Find peaks and measure FWHM.
- Absorbance, Transmittance, Reflectance or oscilloscope measurement.
- 3D display of the spectrum.
- DFT of the spectrum.
- Pixel linearity correction.
- Filter out the Nyquist noise from CCD.
- Supports multiple CONCAVUS/PSP spectrometers.



Figure 2.1 Main Screens

2.1 Home

چ 🖬 🖆 🗋	Ŧ	
Home Spec	Graph Controls	
Cut	🗹 Data Sources 🗌 Data Views 🧼	
Сору	✓ Output	Windows
Select All	Vpgrade	windows
Clipboard	View	Window

Figure 2.2 Home Panel controls

2.1.1 Data Sources

List all the spectrometers connected.

Data Sources	џ	×
a		
🖃 🦞 XSPEC801		
🗄 🕂 Troperties		
🗄 🗝 🧲 Acquistion		
🖶 💮 CCD_DARK;R_Avg 1;I_Time 10000 u	s;	
🖻 🌞 CCD_DARK;R_Avg 1;I_Time 1000)O (ls;
🚊 📲 Data		
SCOPE spec6		

Figure 2.3 Data Sources

The name "XSPEC801" is user configurable. Right mouse click on "XSPEC801" to rename. The name is saved in the firmware.
List the properties of the spectrometer.
 Add Profile, F8. Add an acquisition profile with different parameters. Terminate Acquisition, F5, stop acquisition.
 Profile name contains the description of the acquisition. Subtracting CCD Dark, Running Average, Integration Time, FIR filtering. Use it as Dark Spectrum. Use it as Reference Spectrum. Delete this Profile. STOP E5

• Run Once F6.

• Run continuously F7.

Data Export the data to a text file for Excel import.

SCOPE spec6

- Overlay Saved File.
- Overlay Exported File.
- Remove Overlay File.

2.1.2 Data Views

List the data related to the spectrometer selected in the Data Sources.

Data Views							
{\$ • 🔊	1 🕹	۵ 🕞		٨	Х		

Figure 2.4 Data Views

First Button

- Peak Zoom. Default is on. Zoom in on each peak when click on 3rd & 4th buttons.
- Only show peak information in a single line.
- Continuously find peak. Used during assembly.
- Insert Hg/Ar lines. Insert the reference Hg/Ar line to check the calibration.
- Export Peak. Export the peak data in a text file.
- 2nd Button Refresh Peak.
- **3rd Button** Select the above peak.
- **4th Button** Select the next peak.
- **5th Button** Open the calibration dialog.
- **6th Button** Add the selected peak for calibration.
- 7th Button Add a marker for each peak.
- **8th Button** Remove all markers.
- **9th Button** Do a peak calculate and add the peak curve to the graph.
- **10th Button** Remove the peak curve.

In the peak below, you can right mouse click on a peak and select:

- Use the peak for calibration.
- Insert all the peaks for calibration.

2.1.3 Calibration

The calibration method use the data points given, let the user select a polynomial from 1^{st} order to 5^{th} order. It can graph the original data points with fitted data points so user can select the best fit.

First row has the pixel number. Second row has corresponding wavelength. To achieve a good calibration:

- More points the better.
- Have points cover the beginning and end of the wavelength range.
- Use graph to check the data points. If a point has a high deviation from the calibrated line, then the validity of the point is put into question and maybe it should be removed.
- From the graph, select an order that give a good STD DEV and also does not deviate at the wavelength range ends. You might not have data points at the two ends of the wavelength range and the polynomial fitting has no constraint at the ends.

							Add Row
	Pixel#	Wavelength	Element	Lines(nm)	Relative Intensity	_F	AUG KOW
Row 1	_		Hg	184.949200	1000		Del Row
Row 2			Hg	253.650600	15000		Graph Cal D
Row 3			Hg	265.204300	250		Calibrate
Row 4			Hg	265.368300	400		Store to Us
Row 5			Hg	265.513000	100		Save New Co
Row 6			Hg	296.728300	1200		File
Row 7			Hg	302.150000	300		Read From L
Row 8			Hg	312.567000	400		Revert to Backup Co
Row 9			Hg	313.155100	320		Store to BAC
Row 10			Hg	313.184200	320		
Row 11			Hg	365.015700	2800		Read From F
Row 12			Hg	365.483900	300		Save to File
Row 13			Hg	366.328100	240		Display Coe
Row 14			Hg	404.657200	1800		
Row 15			Hg	407.783800	150		
Row 16			Hg	433.922400	250		
Row 17			Hg	434.749600	400		
Row 18			Hg	435.833700	4000		
Row 19			Hg	491.607000	80	T	Clear Log

Figure 2.5 Calibration Dialog

After calibration is done, click on both "Store to User" and "Store to BACKUP" to save the data into the firmware. Or only "Store to User" if you don't want to erase the backup.

To enable the Output, select the Output Spectrum Info checkbox in the Graph Controls Panel.

2.1.4 Graph Window

Show the spectrum graph.

spec1	×											•
INTENS	Ì											01 S100us
+65000.00-												
+60000.00-												
+55000.00-												
+50000.00-												
+45000.00-												
+40000.00-												
+35000.00-												
+30000.00-												
+25000.00-												
+20000.00-	-											
+15000.00-												
+10000.00-												
+5000.00-												
+0.00- +21	3.38	+280.35	+347.32	+414.29	+481.26	+548.23	+615.20	+682.18	+749.15	+816.12	+883.09	Wave(nm)

Figure 2.6 Graph Window

2.1.5 Status Bar

Control the On/Off of the status bar on the bottom. There is a temperature sensor inside the Analog to Digital Converter. And it shows the temperature reading on the left side.

2.1.6 Output

Show some statistic information about the spectrum.





2.2 Spec Pane

	🗋 🚔 🕻	l 🖨 🗉				spec1 - spec					-	×
•	Home	Sper	Graph Controls									۲
(SFISo ST:Ski	ftware Triog	er 💆	INT Time (us) 100 # Number of Readings 0 # @ GPICALAMP	🕑 Load Int Time 🔜 Save Int Time	ACQUIRE STOP ACQUIRE Choe	Scope Absorbance Transmission Reflectance	KAVE 1 3 C Reset Avg	Use as Dark 🤗 Duse Dark -CCD Dark	□ 3D aD Controls	Sin Cal Use LC Use LC	Y FIR Filter	
Tr	iggering We	ode	Integration Time & Trig Ctrl	Load/Save Int Time	Spec Control	Neasurements	Post Processing	Dark & Ref	30	Linearity	Filter	

Figure 2.8 Spec Panel

Trigger

- Software Trigger: Acquisition initiated by software by sending over a command.
- External Hardware Trigger: Pin #2 (2nd PIN from left, closest to the USB connector) Negative edge trigger the

	start of Single/Continuous acquisition. Single/Continuous mode is still controlled by the software command.						
Skip	To slow down the reading rate, #numbers of readings are thrown away inside the firmware and are not sent to the USB.						
INT Time	In micro second 10 us to 65,000,000 us. Change the integration time here. To take effect, change the number and press enter. To save to the firmware, press "Save Int Time" button.						
Number of Readings	Take # of reading and then stop.						
GPIO & LAMP	Open the GPIO&LAMP control dialog.						
Load Int Time	Load the Integration Time stored in the firmware and display/use them on the GUI.						
Save Int Time	Save the current Integration Time to the firmware.						
ACQUIRE	Continuously acquire data.						
STOP	Stop the acquisition.						
ACQUIRE ONCE	Acquire once.						
Scope	Display in Scope mode. Default Mode.						
Absorbance	Absorbance mode. Make sure there is a Reference data set saved.						
Transmission	Transmission Mode. Make sure there is a Reference data set saved.						
Reflectance	Reflectance Mode. Make sure there is a Reference data set saved.						
Running Avg #	Display the graph in running average mode. The weight of the latest reading has 1/# weight in the averaging.						
DFT Use as Dark	Display the graph in Directe Fourier Transform. Save the current displayed spectrum as the dark spectrum.						

Use Dark	Check box to enable subtracting the dark spectrum.
Use as REF	Save the current displayed spectrum as the reference spectrum.
3D	Check box to enable the 3D display.
3D Controls	Open the 3D control dialog.
-CCD Dark	Subtract the dark pixel reading from each data pixel.

2.3 Graph Controls

C 🖉 🖬 🖶 =						spec1 - spec		- 8 ×
$\mathbf{}$	Home	Spec Crapt	Controls					v
🛷 Sel	ect Node	ofo Pan	Nessure	🚔 Print Graph	Remove Markers	🔍 Zoom 🚥 Reset X Zoom 📈 Reset Zoom 🦉 🚊 X Zoom In /2	Cutput Spectrum Info	
+ Curr	sor Mode	💢 Reset Pan	🔈 Add Label	A Properties		🙀 Fit All 🚦 Reset Y Zoom 🧱 Y Zoom In Fixed 🛛 I Zoom Cut II	✓ Tavelength or Pixel	
			🧨 Bdit	neset All		👖 Fit Y 🔍 Zoom Back 🙀 Y Zoom Cut Fixed	🖌 Update Graph	
Sel	lect	Pan	Annoation	Properties	Marker	Zoom	Options	

Figure 2.9 Graph Controls

Select Mode	Cursor in select mode.
Cursor Mode	XY cursor mode. Display cursor x,y, Integration time, Data point x,y.
Pan	Pan graph.
Reset Pan	Reset Pan.
Measure	Measure distance.
Edit	Edit the data point. Change the value of a data point.
Print Graph	Send the graph to a printer.
Properties	Open the properties dialog. Change properties for the chart, axis, curve, and peak.
Reset All	Reset all the default.
Remove Markers	Remove all makers. Markers can be added by click on the X or Y axis first
Zoom Controls	Various zoom controls.
Output Spectrum Info	Check box to enable/disable the output of the statistical data of the spectrum. Disable for performance.

Wavelength or Pixel Set the X axis as Wavelength or Pixel.

Update GraphEnable/Disable update of the graph. Can be disable to
achieve the fastest data throughput.

3. Graph Control

3.1 Peak

In turn, click Graph Controls, Properties, and then Peak. 依次点击"Graph Controls", " Properties", 选择"Peak"标签页。

KGraph-Properties	×
Chart Axis Curve Peak	
Select curve 1 N9999us 💽 Data Avg 8286.54	
Data 1st Derivative Avg 65.44	
Label Style Linewidth	
Markersize Type Linecolor	
Visible Remove Curve	
Cutoff Threshold 150 👻 % of Data Avg	
Cutoff Threshold 150 🔶 % of 1st Derivative Avg	
Remove Old Peak Curves	
Find Peaks	
OK Cancel Apply	

Figure 3.1 Peak Controls

There are 2 threshold settings that control the peak selection. Peaks below the threshold are ignored. They are used to filter out the noise. First one is the data average, 2^{nd} one is the average of the 1^{st} derivative. Default settings are 150 for both.

3.2 GPIO & Lamp Control

In turn, click Spec, and than GPIO&LAMP.

pec2-IO Controls				
Pin 0:The Connector closest to the USB connector. 5V Pin 1: External Trigger, Falling Edge Pin 2-7: GPIO 0-5 Pin 8: LAMP PWM STROBE Pin 9: RS232 RX Pin 10: RS232 TX Pin 10: RS232 TX Pin 11: GND				
GPIO 0 GPIO 1 Bias Setting				
⊙ Input ○ 0 Period 11 →				
GPIO 2 GPIO 3 Duty Cycles 2				
Input C 0 Input C 0 START PWM				
GPIO 4 GPIO 5				
O Input ○ 0 Period 1024				
C Output © 1 C Output © 1 Duty Cycles 9				
START PWM				
LAMP PWM CONTROL				
Scaler1 8				
Scaler2 223 PWM Clock Source: Freq=26906Hz Period=37.17us				
53824				
Period 90021 PWM Period 2000458.67us;				
Duty Cycles 991 🕂 2nd Part HIGH1963626.50us				
DUTY LOW C DUTY HIGH				
SYNC with Acquisition START LAMP PWM END LAMP PWM				
READ from Unit WRITE to UNIT				

Figure 3.2 GPIO&LAMP Controls

GPIO control the input and output of the signal. When set to output, click on the "Write to Unit" to output the setting. When set to input, click "Write to Unit" to change to input and then "Read from Unit" to read the GPIO value.

Bias Setting Every TCD1304 CCD detector has small variation on the output bias voltage. The bias voltage also changes with temperature. Adjust the PWM setting so the output has the lowest dark reading (Closest to zero) at 10us integration. During the adjustment, make sure uncheck the –CCD Dark at the right corner of the Spec panel.

Negative Voltage Setting This is a factory setting. Adjust the negative voltage for the OPAMP so it can work in the 0vdc region.

4. Firmware Settings

SETTING	3S			×
3720	Integration Time DACNov 17 2013:::12:31	:55;Flash Size 0X10000; Flash Pag	e Size 128; Flash Setting Start 0X	F000
0	(S)Int Mode O=regular 1=shutter	XSPEC80		User String
0	Trig mode 0=normal 1=external	XSPEC80	Description	Detector Linearity Coef
0	(N)External Trigger Delay	2.00	Firmware Version 0 0	4 0
0	Skip Count	20131108-165019	Serial 1 0	5 0
0	(N)Dark Offset	TCD1304	Detector 2 0	6 0
65000000	Lamp PWM Setting 0 Auto Adj CCD DC	5100	Grating 3 0	7 0
64946176	Lamp PWM Setting 1	360nm	Entrance Filter	· · ·
0	Multple Count	25um	Slit Size	
0	Lamp Mode	DOUBLE	Sorting Filter	
0	GPIO Port IO	rt 🛛 Wave End		
63	GPIO			
0	(S)Temp System Coef 0	0	0	0 0
58100	BIAS PWM User Coef 0	0	0	0
328704	NEG PWM MAC HEX 18 52	86 120 154 188	12.34.56.78.9a.bc	
3694	# of Pixels IP DEC 100	0	100	
19	Dark Start Pixel Gateway DEC 100	0 0 1		
31	Dark End Pixel Net Mask 255	255 255 0		
35	Data Start Pixel			
3682	Data End Pixel TCP PORT 00000 HTTP PORT 80	GATEWAY:100.0.0.1,	, then deraulist: (MAC:12.34.56. MASK:255.255.255.0, TCP:8888,	78.9a.bc, 19:100.0.0.100, HTTP:80)
READ	REFRESH USE_THIS (123)		Set Default	WRITE

In turn, click Home, Change Settings.

Figure 4.1 SETTINGS

Read/Refresh Read and refresh the values.

Set Default Change the values to system defaults values before initial calibration.

Write Write to firmware.

Note User can change all the values on this dialog, including the calibration values.

5. Setup the CCD DC Bias.

In turn, click Spec, GPIO&LAMP.

Bias Setting	
🗌 Auto Adj	DC at Startup
Period	36000 🔶
Duty Cycles	1
START PWM	Auto DAC ADJ

Figure 5.1 Bias Setting

To set the DC bias, Set INT time to 10us, and block all light input into the SMA fiber connector. You can either manually change the period value or click on "START PWM" button to change the DC bias. Then observe the spectrum taken with 10us INT time, the spectrum should be flat, and set the average DC value to 100-200 range.

Or you can click on "Auto DAC ADJ" and the firmware will adjust the DC bias automatically to 100-200 range.

If you enable the "Auto Adj DC at startup", every time the unit is powered up by plug in the USB cable; it will perform an auto DC bias adjustment.

6. GPIO Controls

In turn, click Spec, (GPIO&LAMP.
------------------------	------------

spec1-IO Controls	×				
Pin 0:The Connector closest to the USB connector. 5V Pin 1: External Trigger, Falling Edge Pin 2-7: GPIO 0-5 Pin 8: LAMP PWM STROBE Pin 9: RS232 RX Pin 10: RS232 TX Pin 11: GND Bias Setting					
GPIO 0 GPIO 1 Auto Adj DC at Startup					
Output ○ 1 ○ Input ○ 0 Period 36000 ♀					
CONTRACT CONTRACT Duty Cycles 1					
Input O O Input O START PWM Auto DAC ADJ					
CPTO 4 Neg Voltage Setting					
O Input ○ 0 ○ Input ○ 0 Period 1024					
Output O 1 Output O 1 Duty Cycles 7					
START PWM					
Scaler 1 8					
Scaler 2 223 PWM Clock Source: Ereg=26906Hz Period=37, 17us					
	4				
Period 53824 PWM Period 2000458.67us;					
Duty Cycles 991 2nd Part HIGH1963626.50us					
O DUTY LOW O DUTY HIGH					
SYNC with Acquisition START LAMP PWM END LAMP PWM					
READ from Unit WRITE to UNIT					

Figure 6.1 GPIO Controls

Change the input/output status for GPIO 0-5. If set to input, "Write to UNIT" first to change the state to INPUT, then do "READ from UNIT" to read the GPIO values. If set to output, set the value as well and then click "WRITE to UNIT".

Read from Unit Load the setting from the firmware.

Write to Unit Save the setting to the firmware.

7. PWM Control

	In	turn,	click	Spec,	GPIO&L	AMP.
--	----	-------	-------	-------	--------	------

-LAMP PWM CON	ITROL	
Scaler 1	8 💙	
Scaler2	223 🛟	PWM Clock Source: Freq=26906Hz Period=37.17us
Period	53824 🤤	PWM Period 2000458.67us;
Duty Cycles	991 🛟	2nd Part HIGH 1963626.50us
OUTY LOW	O DUTY HIGH	L
SYNC with A	Acqusition	START LAMP PWM END LAMP PWM

Figure 7.1 PWM Controls

Scaler1, 2	Change the scaler divider for the input clock for the PWM. See the right text for the resulted frequency and period.
Period, Duty Cycle	Change the period and duty cycle for the PWM signal.
Duty Low/High	Set to low/high during the Duty cycle.
SYNC with Acquisition	When checked, a pulse rising edge occurs at the start of integration, and falling edge occurs at the end of the data acquisition, which is 3.7ms. In another word, the on time of the pulse for every integration is 3.7ms. If uncheck, PWM pulse turns on after user update the setting.
Start/End LAMP PWM	Send command to firmware to start/end the PWM.
Read/Write from/to Unit	Load/Save the setting from/to the firmware.

8. Measurements



Figure 8.1 Measurements

8.1 CCD Dark

CCD TCD1304DG has some pixels that are light blocked and are used as dark reference. Dark current is temperature sensitive and values changes with temperature. To keep reading constant over a temperature range, enable –CCD Dark during measurement.



- Dark Noise
 If you intend to use a spectrum as Dark noise, click on "Use as Dark", then enable "Use Dark".
- Reference
 If you intend to use a spectrum as reference, click on "Use as REF".

8.2 Scope measurement

Default setting is Scope mode. Click on ACQUIRE or ACQUIRE Once to acquire data and STOP to stop acquiring.

- A. Make sure you see a spectrum when there is no light signal into the SMA connector, when –CCD Dark, and Use Dark are not enabled. If all pixel readings are zero, adjust the DC Bias according to section 3.
- B. Eanble CCD Dark.
- C. Set the INT time, and click on ACQUIRE, make sure there is no light signal into the SMA connector. And click on "Use as Dark", and "Use Dark". The signal should fluctuate around zero.
- D. Turn on the light input and start Acquire.
- E. If you change the INT time, make sure you repeat III & IV again.

8.3 Absorbance

- A. Use Scope measurement to get a reference curve with maximum value around 60,000.
- B. Click on "Use as Ref".
- C. Click on Absorbance button. You should now a get a curve around zero. If the reference signal is very weak, you will get noisy readings.
- D. Insert a filter or a solution in the light path that needs to be measured.

E. Click on ACQUIRE.

8.4 Transmission

- A. Use Scope measurement to get a reference curve with maximum value around 60,000.
- B. Click on "Use as Ref".
- C. Click on Transmission button. You should now a get a curve around 100%. If the reference signal is very weak, you will get noisy readings.
- D. Insert a filter or a solution in the light path that needs to be measured.
- E. Click on ACQUIRE.

8.5 Reflectance

- A. Use Scope measurement to get a reference curve with maximum value around 60,000.
- B. Click on "Use as Ref".
- C. Click on Reflectance button. You should now a get a curve around 100%. If the reference signal is very weak, you will get noisy readings.
- D. Insert a filter or a solution in the light path that needs to be measured.
- E. Click on ACQUIRE.

9. Calibration

Calibration is done in the factory. The following description is a guide only. Make sure you save the coefficients before any modifications.

Calibr	ation						
	Pixel#	Wavelength	Element	Lines(nm)	Relative Intensity	^	Add Row
Row 1			Нg	184.949200	1000		Del Row
Row 2			Нg	253.650600	15000		Load DATA PTS
Row 3			Нg	265.204300	250		Save DATA PTS
Row 4			Нg	265.368300	400		
Row 5			Нg	265.513000	100		Graph Cal Data
Row 6			Нg	296.728300	1200		Calibrate
Row 7			Нg	302.150000	300		Store to User
Row 8			Нg	312.567000	400		Coef
Row 9			Нg	313. 155100	320		Store to BACKUP
Row 10			Нg	313. 184200	320		Read From Unit
Row 11			Нg	365.015700	2800		Read Coef <file< th=""></file<>
Row 12			Нg	365. 483900	300		Save coef to File
Row 13			Нg	366.328100	240		Display Coef
Row 14			Hg	404.657200	1800		
Row 15			Hg	407.783800	150	¥	Clear Log

In turn, click Date Views, and then the 5^{th} Button \bigcirc , open the Calibration dialog.

Figure 9.1 Calibration Dialog

- A. Click on "Read From Unit";
- B. Click on "Display Coef";
- C. Click on "Save Coef to File"; then input pixel/wavelength pairs into the Excel-like spreadsheet in the Calibration dialog.
- D. Click on "Calibrate";
- E. Click on "Store to user";
- F. Click on "Store to BACKUP" if you wish to replace the BACKUP.

10.Linearity

Detector Linearity			×
		✓ 1Best Fit/0-regression	Run
10 🔷 Start Integration Time	1400	Pixel Number	STOP
200 🗘 End Integration Time	1500	Pixel Number 8	Fit
10 🗘 Integration Step	1600	Pixel Number	
	1700	Pixel Number File->Coef	Coef->File
10 Average	1800	Pixel Number	Coef->Flash
Remove Lines	1900	🗘 Pixel Number 📃 Apply Lin Coe	f Crash
0 Cutoff Level	2000	Pixel Number Normalize	Graph
65535 🗘 End point for Linear	2100	Pixel Number	Next
65530 🗘 Saturation Level	2200	Pixel Number	Prev
Load Points Save Points	Std Dev or SNR		
Load Founds Save Founds Me	asure SNR at 9 p	points in 1000 measurements.	
			Clear Log
			>

In turn, click Spec, and then Lin Cal, open the Detector Linearity dialog.

Figure 10.1 Detector Linearity

For fixed pixels, diagnose the linearity of readings of each pixel with respect to integration time. We found the linearity of TCD1304 is excellent that requires no linearity correction.

11.FIR filtering

In turn, click Spec, and then FIR Filter, open the Filter Setting dialog.

Filter Setting	\mathbf{X}
Select FIR File	C:\Program Files\XSpec\filter.fir
<	
	OK Cancel

Figure 11.1 Filter Setting

Select a file with FIR coefficients, Format of the file:

```
#comments 450000 is the cutoff frequency, ADC is 1MHz. 32 is number of taps.
"Description" 450000 32
Coef 0
Coef 1
...
Coef 32
------
Enable "Use FIR" to apply the FIR. The defaults FIR file is used to remove the CCD Nyquist noise at 500 KHz.
```

12.Firmware Upgrade

A. Connect device, make sure you see the device.



B. On Home TAB, click on Upgrade



C. Load File, Download Firmware file from http://www.gratingworks.com/products/tech.htm, Unrar and load the bin file.

UPGRADE CONT	ROL	×
Load File Copy to a temporary place in flash COPY TO FIRMWARE	Read 10113 bytes from pwm1-22-2013.bin, MAX FLASH size 0x7800,30720.	-
Verified copied content VERIFY		
Replace the program and restart		-
REPLACE RESTART	Cancel	

D. Click on copy to firmware, it will copy the new file to a temporary place in flash. It does not replace the running program yet. If you see X or error, pull out the USB cable and restart the operation.

UPGRADE CONT	ROL	×
Load File Copy to a temporary place in flash COPY TO FIRMWARE Verified copied content	0X0 0X40 0X80	<u> </u>
VERIFY Replace the program and restart	0XC0 FILE Verification Succussful.	<u>_</u>
REPLACE RESTART		Cancel

E. Verify, make sure download is correct.

UPGRADE CONTROL		×
Load File		
place in flash	0X0	
COPY TO FIRMWARE	0X40	
Verified copied content	0X80	
VERIFY	0XC0	
Replace the program and restart	FILE Verification Succussful.	•
REPLACE RESTART		Cancel

- F. Click on REPLACE&RESTART to replace the running program and restart the unit. You will hear the USB power off/on sound.
- G. UPGRADE DONE.