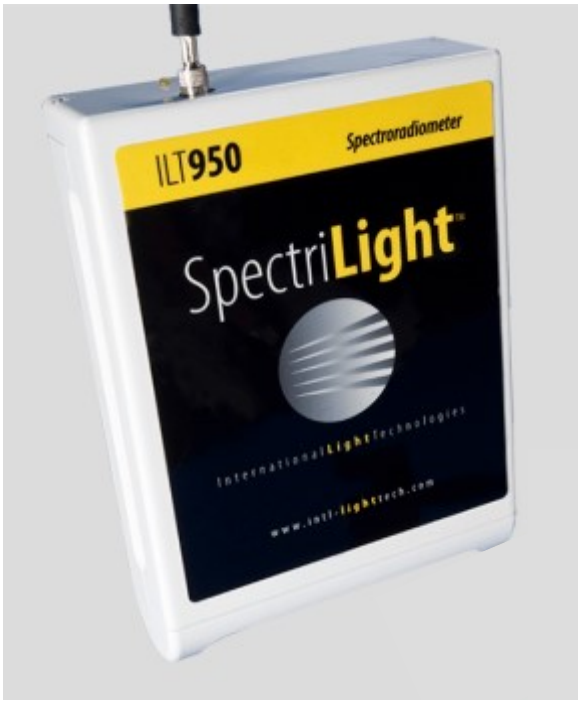
-



SpectrlLight III Version 3.5.4 Software Manual

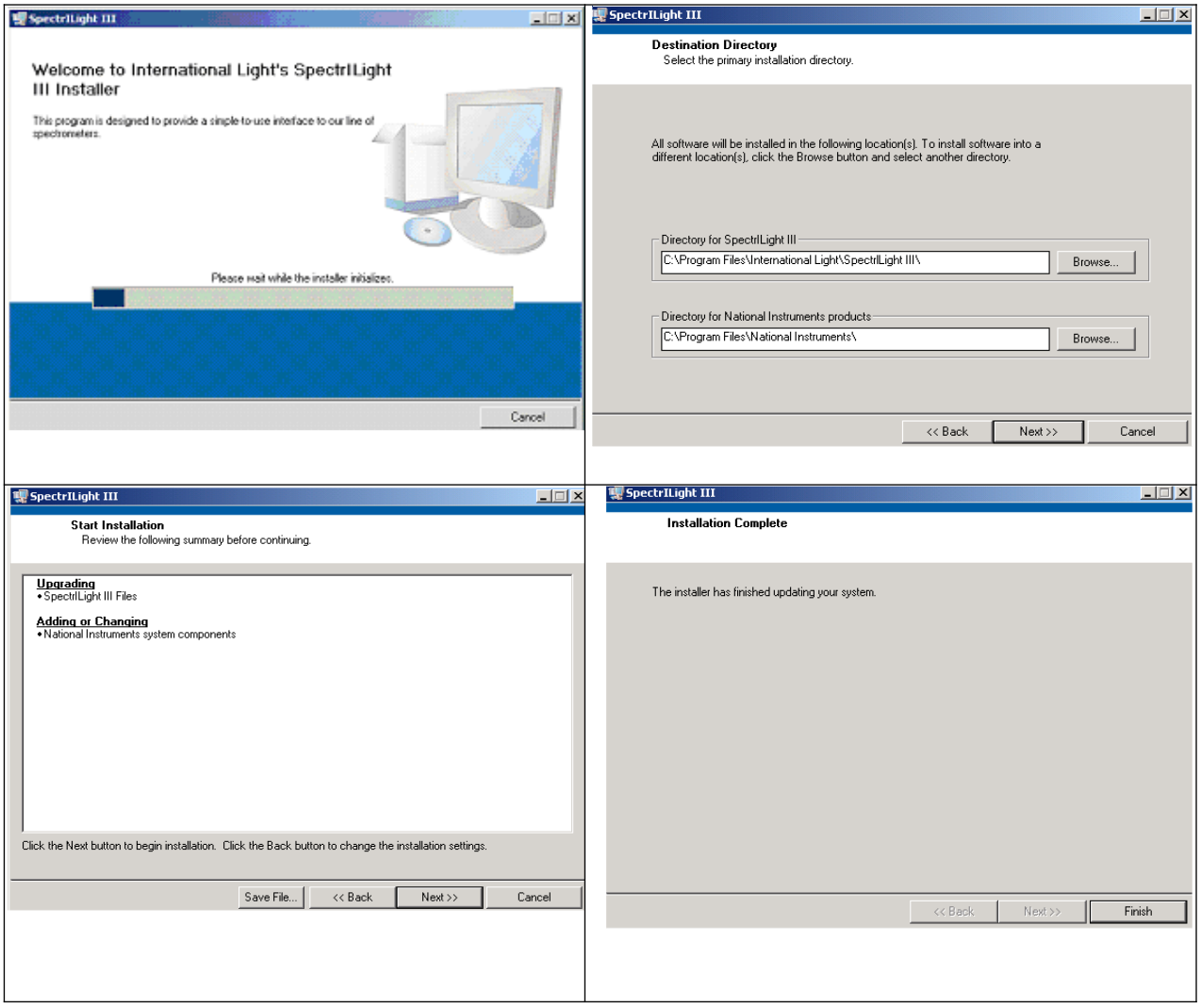
Table of Content

SpectrILight software is a user friendly software program written in Labview for operating all ILT spectrometers including ILT950, ILT960 and ILT560 series.

1. Installation of SpectrILight III software

Before installation, make sure that your system meets the following minimum system requirement:
Processor: 1Ghz; RAM: 1GB; Hard Disk: 100MB; Screen Resolution: 1024x768;
Operating system: Windows 7 SP1 or later
Microsoft .Net Framework 3.5 above need to be installed and enabled

With the spectrometer **disconnected**, insert the CD in the drive and run the installer file "Setup.exe" to install the software.

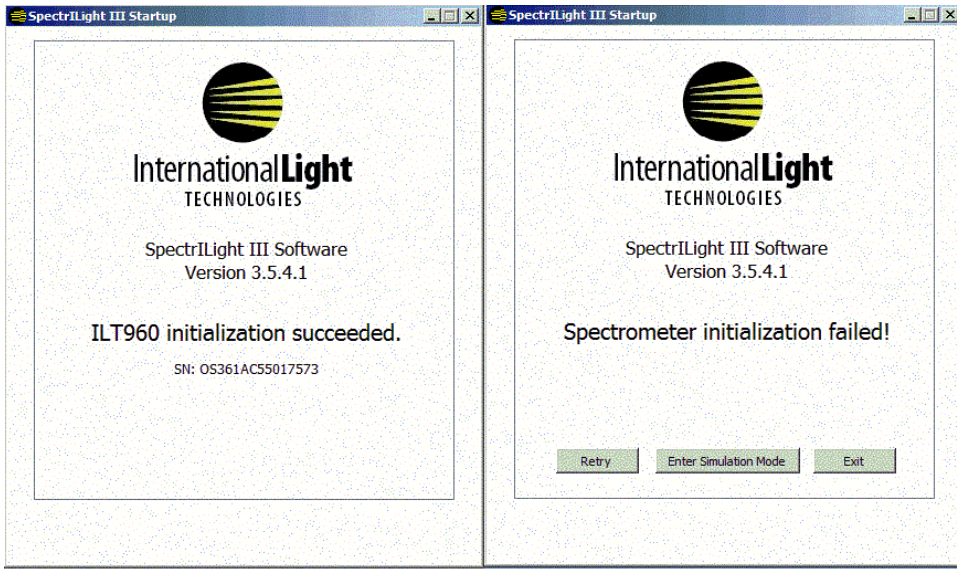


2. Launching the software

Launch the software by double clicking the shortcut icon on your computer.

2.1. Initialization

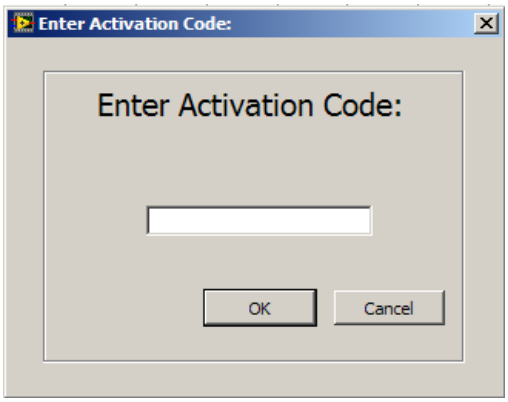
Before initialization, ensure that the driver for the specific spectrometer models has been installed successfully and the spectrometer is connected to the computer through USB cable. If the spectrometer is recognized by the software, you will see a pop-up window showing "the initialization was successful" right before entering the main GUI window. If the initialization fails because of the connection, make sure the spectrometer is connected to the computer and click "Retry" button. You can also enter the main GUI window by clicking "enter simulation mode" button without a spectrometer being connected. This mode allows you to import and view previously saved spectral data only.



Initialization pop up window: left: succeeded and right: failed

2.2. Software Activation

To activate the software, select from the menu the Help\Enter Activation Code and enter the 5 character code that is printed on the CD case. If you decide not to activate the received code, you have a 30 day trial period.



2.3. Load the Calibration file

For ILT950 and ILT960, if the calibration file is saved onto the spectrometer's EPROM, the calibration file is automatically loaded into the memory each time SpectrILight is launched and the connected spectrometer is recognized. If the EPROM is not saved to the spectrometer or you need a calibration file different from the one saved in the EPROM, you have to manually load the calibration file into the system. You can tell where the current calibration factors are loaded from the information bar at the bottom of the main GUI.

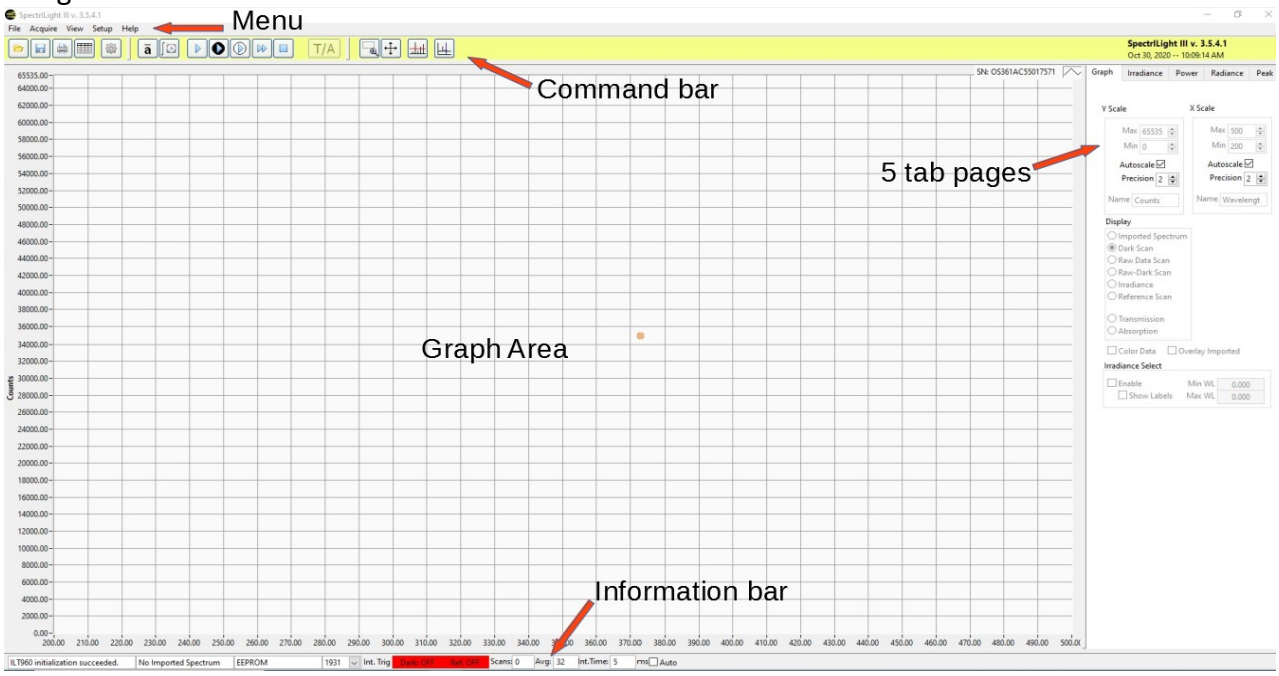
All the calibration files are located in the Cal_File folder on the calibration disk. Copy and paste this file onto your computer. The following is the default folder to place the calibration files. Replace "Username" with your user name.

C:\Users\Username\AppData\Local\Internationa Light\SpectrILight III\Calibration

To load the calibration file, click on the "Gear" button in  the command bar and select the correct file.

3. The Main GUI

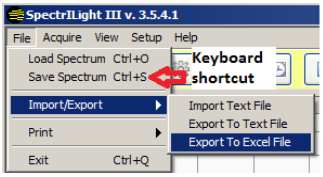
The main graphical user interface (GUI) consists of a menu bar, command bar, information bar, graph area and five tab pages. Most of the system operating functions can be easily realized by using the command buttons.

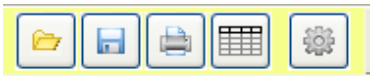


4. The Menu bar

The Menu contains five options: *File, Acquire, View, Setup and Help*. When you click on any of these options, you get a drop down menu showing a full list of the available menu selection. Some of the most used menu options have keyboard short-cuts listed besides them and are displayed as icon command buttons in the command bar as well.

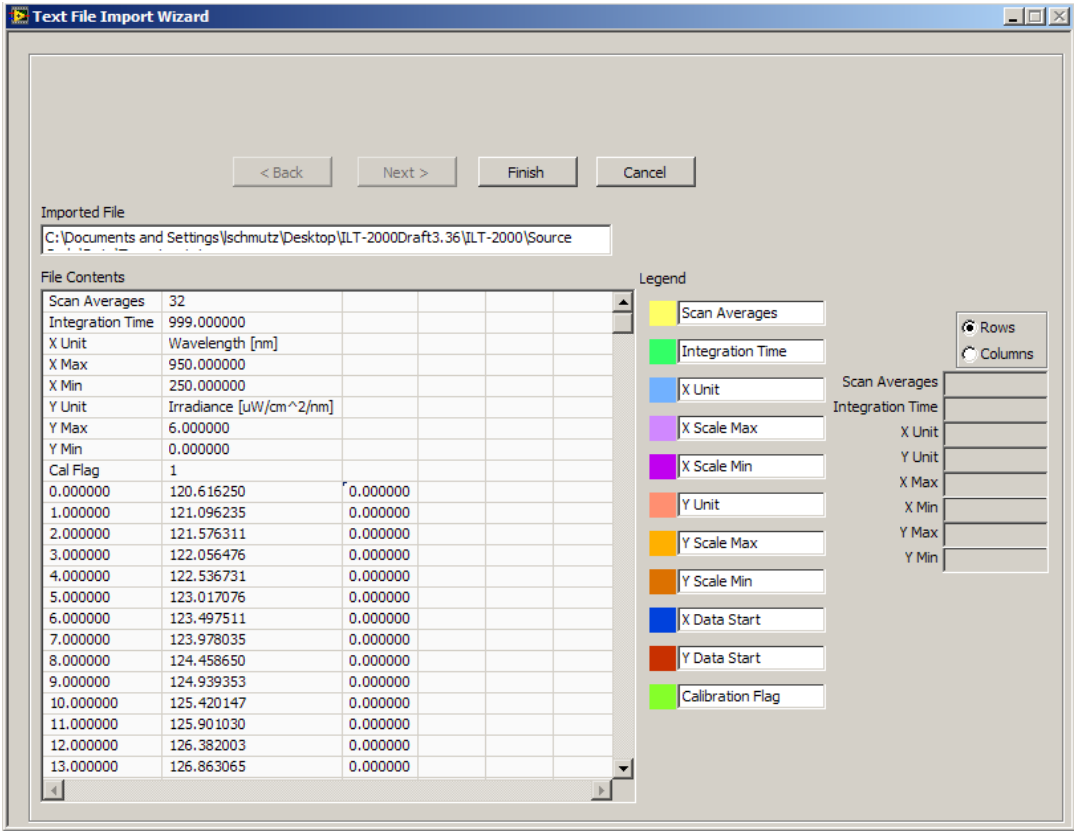
4.1. File Menu





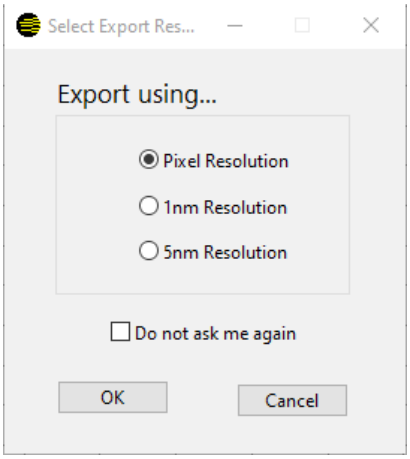
The spectrum data displayed in the main graph can be saved in binary format with file extension *.ilt using "*Save Spectrum*". You can load the saved binary file by clicking "*Load Spectrum*" and the loaded data will be displayed and replace the current spectrum.

The "*Import/export*" allows import and export data in the ASCII format of Tab Delimited text file. Its file format is seen in the screen shot below.



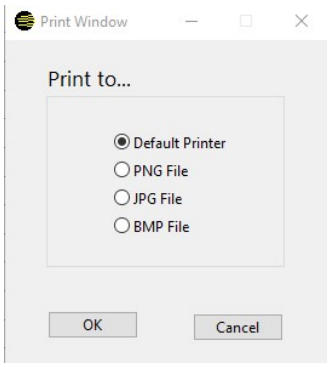
Scan Averages	32					
Integration Time	999.000000					
X Unit	Wavelength [nm]					
X Max	950.000000					
X Min	250.000000					
Y Unit	Irradiance [uW/cm^2/nm]					
Y Max	6.000000					
Y Min	0.000000					
Cal Flag	1					
0.000000	120.616250	0.000000				
1.000000	121.096235	0.000000				
2.000000	121.576311	0.000000				
3.000000	122.056476	0.000000				
4.000000	122.536731	0.000000				
5.000000	123.017076	0.000000				
6.000000	123.497511	0.000000				
7.000000	123.978035	0.000000				
8.000000	124.458650	0.000000				
9.000000	124.939353	0.000000				
10.000000	125.420147	0.000000				
11.000000	125.901030	0.000000				
12.000000	126.382003	0.000000				
13.000000	126.863065	0.000000				

The data can be exported as .txt (“Export to Text File”) or .xls (“Export to Excel File”) using wavelength data in pixel resolution, in 1 nm or 5nm increments.



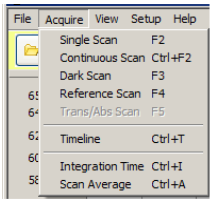
Checking “Do not ask me again”, the export routine will remember the resolution selection and the above pop-up window will not launch again. The default setting can be restored using Help\ Reset Factory Defaults.

Use “*Print\Print Window”* to print or save the main GUI window. The screen can be saved in PNG, JPG or BMP format.

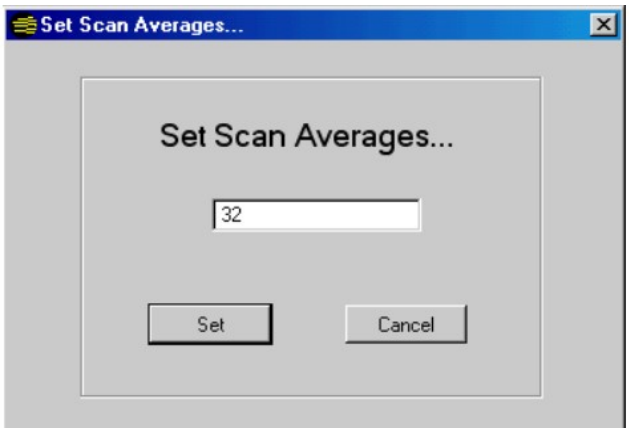


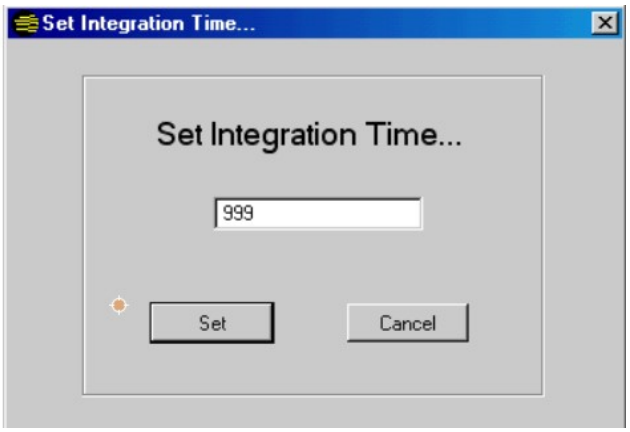
"*Exit*" is to exit program. The current configuration such as integration time, scan average, calibration file path will be saved to SpectrILight.ini configuration file right before exit. In case the software doesn't exit successfully, press CTRL+ALT+DEL and select Task Manager. Right-click on "SpectrlLight III v.3.5.4.1" and select End Task.

4.2. Acquire Menu



All the menu options in this section can been conveniently accessed through the command bar or the keyboard shortcut since they are directly related to data acquisition. The integration time controls the CCD exposure time in millisecond and the number of averages defines the number of acquisitions that are averaged for one scan output. In addition to command bar, these two configurations can be also entered just by clicking the information bar at the bottom of the GUI window.

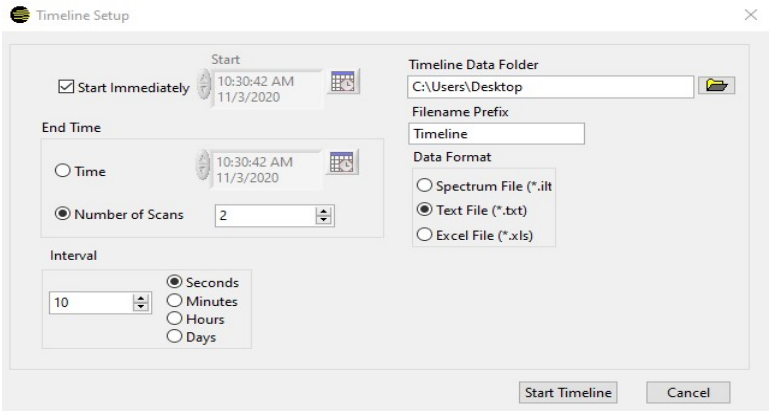




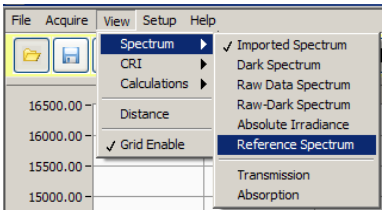
"Dark Scan","Reference Scan" and "Single Scan" all perform one scan, but display the data differently. "Dark Scan" saves the acquired raw counts (S) as dark scan (S_d=S). "Reference Scan" displays the current raw counts with dark scan subtracted (S_{ref}=S-S_d). which is saved as reference scan for ratio calculation later in T/A mode. "Single scan" applies the calibration factor C in the calibration file to the reference scan and shows the calibrated spectrum S_{cal}=C*(S-S_d). Depending on the type of calibration, the unit of the calibrated spectrum can be different. In T/A mode with "Trans/Abs" checked, the "Single scan" will show ratio of the acquired spectrum to the saved reference scan T=(S-S_d)/S_{ref}. This mode is usually used for transmission or absorption measurements. The "Continuous scan" continuously performs "Single scan" until the user hits the stop button on the command bar. 

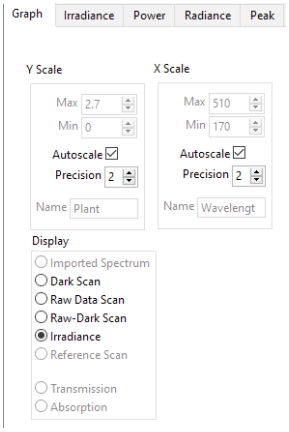
Taking advantage of the fact that "Dark Scan" displays the spectrum in raw counts, the user can keep adjusting the integration time and clicking the "Dark scan" until signal level is satisfactory before performing any formal measurements.

"Timeline" is a tool that allows you to schedule acquisition at specific times and intervals. You must complete a dark and reference scan prior to entering into the Timeline mode. Setup the information on the Timeline Popup window and press "Start Timeline". Wait until all the measurements are done. Data is automatically saved to the specified folder.

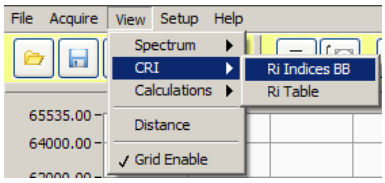


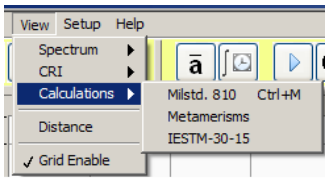
4.3. View Menu



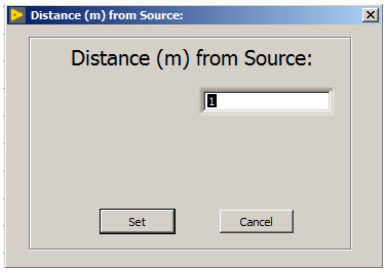


The user can choose to view different spectrum on the main graph area either from "*View/Spectrum*" menu or radio buttons in the "*Display*" section on the "*Graph*" tab page at the right side of the main GUI. For example the calibrated measurement results are displayed when checking the "*Absolute Irradiance*" menu or selecting "Irradiance" radio button. In T/A mode, the ratio spectrum can be displayed in percentage or logarithm scale when "*transmission*" or "*absorption*" checked.



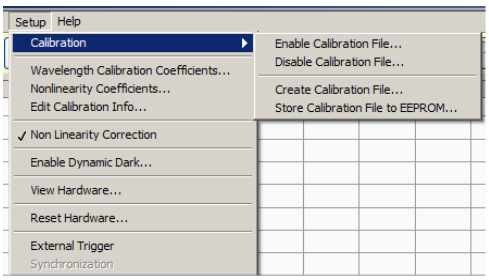


The calculated color rendering index can be seen from the pop up window through the "*CRI*" menu. The rendering index values are tabulated for 15 different color test samples with reference to black body illuminant with the same measured CCT "Ri Indices BB", an Illuminant A at 2856K and a D65 lamp at 6500K "Ri Table".
Additional calculations based on the current spectral acquisition are also provided for various applications and standards including MIL-STD-810 standards, Metamerisms and IESTM-30-15 for solid state illumination.
"Distance" is the place to enter the distance of the input optics to the light source under measurement, which is used for luminous intensity calculation that is shown in the "Irradiance" tab page.



The menu item "*Grid Enable*" removes or displays the grid lines in the graph.

4.4. Setup Menu

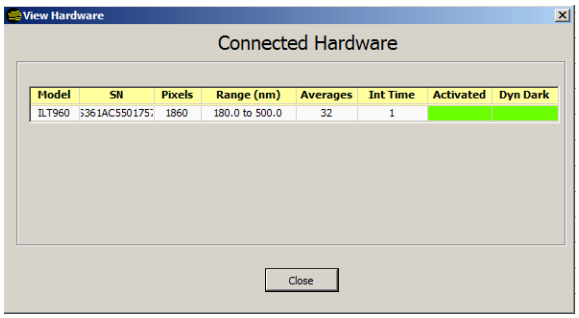


Under "*Calibration*" menu, the user can load and remove the calibration file with "*Enable Calibration File...*" or "*Disable Calibration File...*". The "*Create Calibration File...*" and "*Store Calibration File to EEPROM...*" are normally reserved for use by International Light Technologies and can not be accessed without a password.

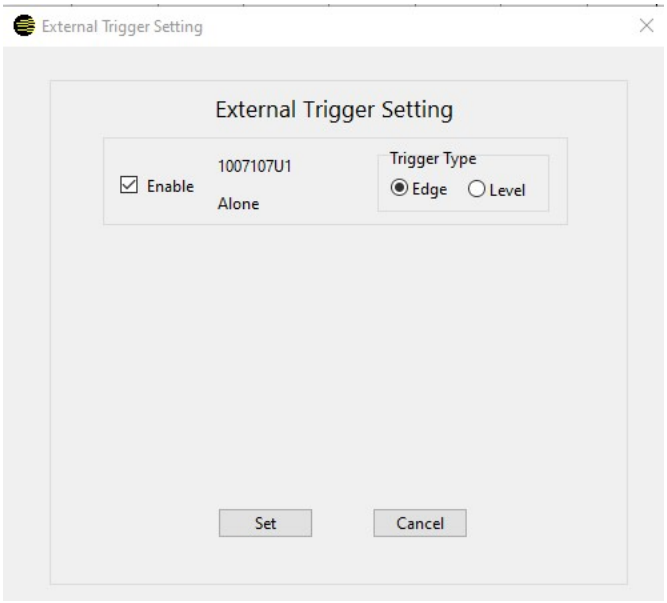
The Wavelength Calibration Coefficients A0-3 are displayed by "Wavelength Calibration Coefficients...". The information about current calibration file can be assessed by "Edit Calibration Info...". All these information should not be edited by the customer.

By default, the "*Non Linear Correction*" and "*Enable Dynamic Dark*" should be turned on to take full advantage of the system's dynamic range for more accurate measurements.

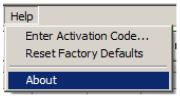
"*View Hardware...*" lists the setup information about the spectrometers connected to the computer and recognized by the software.



"Reset Hardware..." closes the connection and reinitialize the communication to the device. This is usually used to regain the spectrometers' connection without exit the program.
The trigger function is currently only supported by the ILT950 series. When "*External Trigger*" is enabled, the spectrometer acquires the spectrum after the specified type of external trigger is received.



4.5. Help Menu



Please refer to section 2.2 for "*Enter Activation Code...*" item. "*Reset Factory Defaults*" allows user to go back to the default setting of export and import files. "*About*" accesses the current software version information.

5. The Command Bar

Most of menu items under file and acquisition sections can also be realized by directly clicking buttons on the command bar for quicker and easier access.

(1). **LOAD:** same as "File/Load Spectrum", refer to section 4.1

(2). **SAVE:** same as "File/Save Spectrum", refer to section 4.1

(3). **PRINT:** same as "File/Print/Print Window"

(4). **EXCEL:** export a file which can be opened by Excel

(5). **CALIBRATION**: load the calibration file into the software

(6). **AVERAGE:** the number of scans to be averaged for one output spectral data.

(7). **INTEGRATION TIME:** The integration time in milisecond for one scan.

(8). **SINGLE SCAN:** Single scan button.

(9). **DARK SCAN:** Dark scan button.

(10). **REFERENCE SCAN:** Reference scan button.

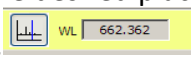
(11). **CONTINUOUS SCANNING:** Starts Continuous Scanning.

(12). **STOP CONTINUOUS SCANNING:** Button to stop Continuous Scanning.

(13). **TRANSMISSION / ABSORPTION:** Enter the transmission/absorption mode

(14). **ZOOM:** A rectangular area defined by mouse will be zoomed to the whole graph area when this button is pressed down

(15). **RESET ZOOM**: Resets the graph to the original scale.

(16). **PEAK DETECT:** Enable to find local peaks of the plotted spectrum. The peak position and its wavelengths are labeled on the graph window and listed in the "Peak" tab page at the right side of the main window as well.
(17). **CURSOR:** When pressed a blue vertical cursor line will appear. Move the line using your mouse to the desired place and its wavelength position will be shown in the WL indicator besides this button. 

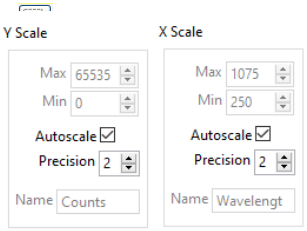
6. Tab pages

Various controls, indicators and selections are grouped into 5 tab pages on the right side of the main GUI for convenient access. "Graph" and "Peak" pages are always enabled while for the other three pages, which one is enabled depends on the type of calibration in the system.

6.1. Graph tab page

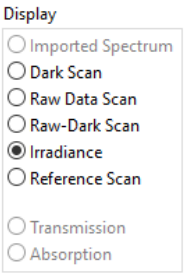
The "Graph" tab page always appears on top by default. It has the operations directly related to the main graph area.

You can either automatically scale or manually enter the scale range for both X and Y axis.

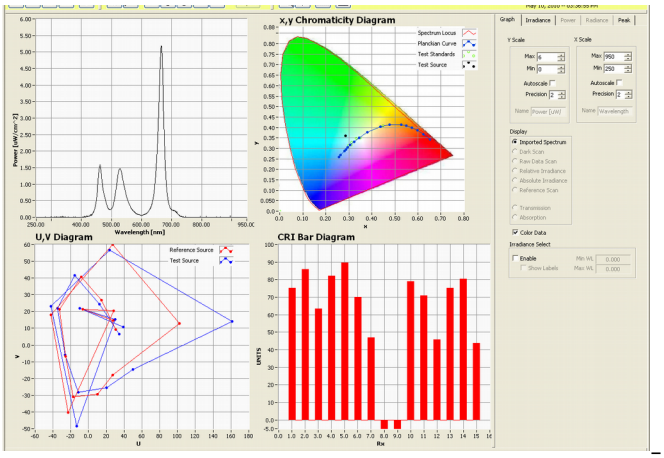


Note here that the zoom function doesn't work when "Auto-scale" is enabled.

As mentioned in section 4.3, user can switch between each display mode by clicking radio button inside the display section to choose different spectrum to display.



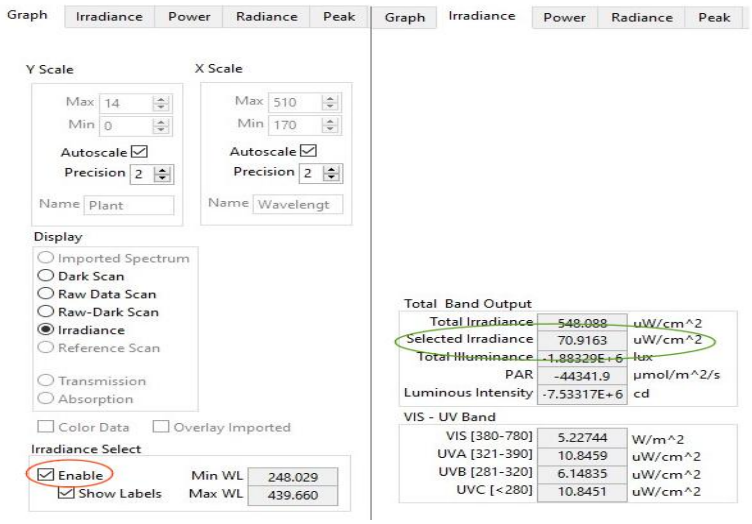
When the "Color Data" box is enabled, the graph area changes to 4 subplots to display multiple colorimetric plots: the current spectrum, the CIE chromaticity diagram, the U*, V* diagram and the CRI bar chart for 15 test color samples specified by CIE standard.



Color data display

When the “overlay imported spectrum” box is checked, the measured spectrum will be plotted together with the spectrum imported from the file for easy comparison.

Checking the box “Enabled” (marked by red circle below) turns on the “Irradiance Select” section in “irradiance” display mode and two vertical cursors appear in the graph area. Move these two vertical lines by left-clicking the mouse to define the minimum and maximum wavelengths of interest. The total integrated area for the plotted spectrum over this selected wavelength range gets updated in the “Selected Irradiance” indicator (see green circle in below) on the “Irradiance” tab page. The min and max wavelength of the integration range can be also entered under the “Irradiance Select” section through “Min WL” and “Max WL”.



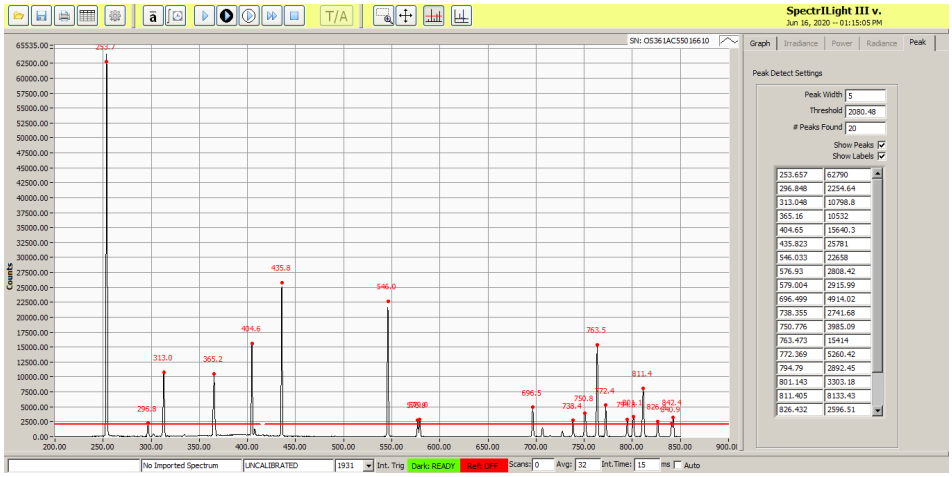
6.2. Tab pages related to calculation of calibrated measurement

Some of the photometric and radiometric values calculated from the measured spectrum are displayed in the tabs: “Irradiance”, “Power” and “Radiance”. The page that is enabled depends on the loaded calibration file since the display units are different for these physical quantities. These pages display more calculated results in photometry and radiometry using the measured spectrum. Photometric data include color coordinates for various color space, CCT, CRI (color rendering index) for the first 8 samples and dominant-complementary wavelength. The “Total Band Output ” section displays the integrated quantities over the entire spectral range as well as the selected range by the user. The “UV-VIS Band” section shows the total radiometric data integrated over various popular preset spectral range .

Note here that the distance of the input optics to the light source required for the “Luminous Intensity” calculation is entered through menu “*View/Distance*”.

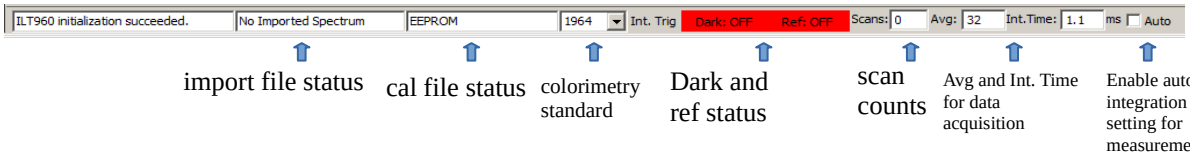
6.3. Peak tab page

The “Peak” page gets automatically selected when “Peak Detect” button in the command bar is pressed and vice versa. The red horizontal line on the graph represents the baseline threshold and can be moved up and down by clicking and dragging the mouse on the line. The number of peaks, peak locations and intensities gets listed on the peak tab page.



7. Information bar

The information bar provides quick information about the spectrometer configuration and measurement status.



“Import file status” indicates whether a file has been imported and if yes, displays the imported file name.

"Cal file status" indicates whether and where the calibration factors are loaded. "UNCALIBRATED" shows no calibration factors are loaded. "EEPROM" means the calibration is loaded from the internal EPROM of the device. When the calibration factors are loaded from a calibration file, the file name is displayed.
When these boxes are double clicked, a file selection dialog window will appear and the user can select the imported file or the calibration file to load.
"colorimetry standard" shows which tristimulus functions are used in the colorimetric calculation: 10º observer for "1964" and 2º observer for "1931" standard.

"Dark and ref status" shows the current status of dark and reference spectrum. Green means that a spectrum has already been saved in the software as dark or reference spectrum.

"Scans" keeps track of number of measurements performed by "single scan".

"Avg and Int. Time" displays the number of average and integration time used for the data acquisition. You can also change these settings by double clicking the text boxes.

"Auto" enables the software to automatically set the integration time. The algorithm takes the current integration time and doubles or halves it within the range of 2ms-2s until the maximum of the spectrum in raw counts reaches between 40% to 80% of the full scale. However if the signal is too low or too high to meet this target within the range of integration time, it flashes a "signal is low" or "signal is saturating" warning window. Since multiple scans are performed automatically to determine the proper integration time, it might take a while for the software to respond depending on measured light intensity.
One trick to expedite this process is to set the average to 1 and start with short integration time like 10-20ms.

8. Measurement setup and data acquisition consideration

8.1. Integration time and number of averages

Setting an appropriate integration time and number of averages is very critical to obtain data with a good Signal to Noise ratio (S/N), and this may require a trial and error process.

Longer integration time and larger number of averages can usually lead to a better S/N for the same light intensity. However the integration time cannot be set too high as this may saturate the detector. For ILT950/960, the full scale of counts based on 16 bits A/D is 2^{16} (65536). A good practice to find a proper integration time is to adjust the integration time until the peak signal reaches about 75% of the maximum scale. This is what the program does automatically when the auto integration time setting on the information bar at the bottom of the GUI window is enabled. Similarly, the S/N of the collected spectra improves by the square root of the number of scans averaged. For example, 16 averages is 4 times that of 1 average in S/N, keeping everything else the same. For a weak signal, the total time required to obtain one scan can be too long to wait with large number of averages and long integration time. In this case, a compromise has to be

made to have a reasonable S/N and realistic acquisition time. Typically, an average number between 4 and 32 is a good starting point.

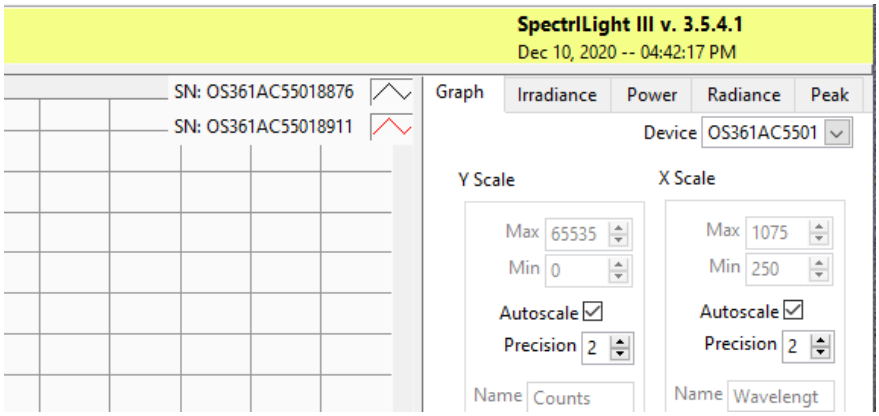
8.2. Measurement setup

Before making any serious measurement, a dark scan needs to be taken. This dark scan accounts for all the background light as well as the inherent electric dark noise. When taking dark scan, the light source to be measured needs to be blocked (e.g. by a shutter or a blackout fabric or board). Once the dark scan is acquired, the reference scan or single scan should be taken under the same measurement setup and integration time to cancel out the impacts of all the background signal impacts by dark scan subtraction. One simple way to check the effectiveness of the dark scan subtraction is to take a reference scan right after the dark scan without unblocking the source. The reference spectrum should appear to be a noisy signal with an average at around zero.

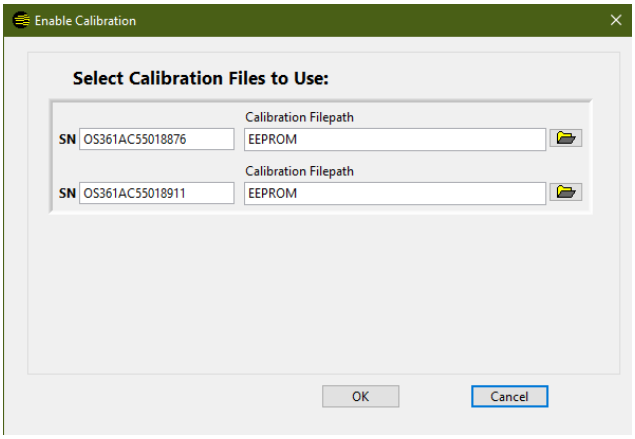
8.3. Multiple Device Support

The software supports multiple devices within the same model series. It supports multiple ILT950s or ILT960s, but will not recognize ILT950 and ILT960 at the same time.

Serial number of all the spectrometers that were successfully initialized are listed on the top right of the graph. Display of the average, integration time and the information on the tab pages can be toggled between different spectrometers using the drop-down list on the top right of the tab pages.



The process of selecting the calibration file for the spectrometer is the same as while using a single spectrometer, except the file has to be chosen using a pop-up window as shown below for each spectrometer. The process of acquisition is the same as for a single spectrometer. Scans for all the spectrometers are also displayed and saved together.



9. Configuration file

The configuration file SpectrILight.ini for SpectrILight software is located in the User Application Data directory: (replace the "Username" with your username)
C:\Users\Username\AppData\Local\Internationa Light\SpectrILight III\
The current settings are saved before exiting the program and the software loads it when the application is launched again with the same device. A configuration file will be created with default values when running the software even if there is no such ini file found in the above directory.

9.1. File format

The configuration file consists of 2 sections; standard sections and expanded sections. The standard section starts with the **[SN]** section and ends with the **[CALIBRATION]** section. It contains the configurations for spectrometers with no specific serial number. The expanded sections that follow the standard section contains individual configuration for each spectrometer which has been successfully initialized by SpectrIlight, each labeled with its serial number**.** For example: subsection **[SN]** becomes **[SN serial number]**.

9.2. Editing the File

Most of the configurations can be accessed through the GUI. However, cutoff wavelength range can only be changed through this file. Outside this range, the calibrated spectrum value will be cut off and is forced to zero even if the device is receiving light containing those wavelengths. To make the changes, go to the section with title that matches with your spectrometer model. For example, to change the configuration for ILT960, go to the section with **[ILT960]** inside the standard section. Under that section, change the CutOffWLH and CutOffWLL for high and low limits, respectively. If the spectrometer is a UV model, go to CutOffWLH_uv and CutOffWLL_uv. Save the file after modification and the new configurations will be loaded the next time the application is launched. **Note that you need to close the program before making any changes to the ini file.**

Standard section

```
[SN]
SerNum=""
[COMMON]
coefs_a0=348.600000000000020E+0
coefs_a1=436.000000000000000E-3
coefs_a2=45.000000000000003E-6
coefs_a3=0.000000000000000E+0
coefs_b0=0.000000000000000E+0
coefs_b1=0.000000000000000E+0
coefs_b2=0.000000000000000E+0
coefs_b3=0.000000000000000E+0
inttime=5.000000
averages=32
trigger_mode=10
xaxis_data_reverse=0
sync_enable=FALSE
sync_SN=""
ext_trigger_enable=FALSE
ext_trigger_type=0
ext_trigger_scans=1
distance=1.000000
[SPECTROMETER]
spectrometer_type=3
[ILT950]
pixelnumber=2048
array_size=2048
input_mode=1
xaxis_min=250
xaxis_max=1075
xaxis_min_uv=200
xaxis_max_uv=450
yaxis_min=0
yaxis_max=65535
CutOffWLH=1050
CutOffWLL=250
CutOffWLH_uv=450
CutOffWLL_uv=200
PollScanDelay=5
NLCor=0
DynDark=TRUE
[ILT960]
pixelnumber=2048
array_size=2048
input_mode=1
xaxis_min=250
xaxis_max=1075
xaxis_min_uv=200
xaxis_max_uv=450
yaxis_min=0
yaxis_max=65535
CutOffWLH=1050
CutOffWLL=250
CutOffWLH_uv=450
CutOffWLL_uv=200
PollScanDelay=5
NLCor=1
DynDark=TRUE
[CALIBRATION]
cal_enable_flag=1
cal_filepath=""
aFitCoeff=40.576000
bFitCoeff=-4803.020000
cFitCoeff=1.145200
dFitCoeff=398.217000
eFitCoeff=65656.300000
fFitCoeff=-23088380.000000
gFitCoeff=3328896000.000000
```

Expanded Section labeled with serial number

```
[SN OS361AC55017573]
SerNum="OS361AC55017573"

[COMMON OS361AC55017573]
coefs_a0=163.850934570655230E+0
coefs_a1=187.869431916624310E-3
coefs_a2=-4.303716877475381E-6
coefs_a3=-1.760828234255314E-9
coefs_b0=0.000000000000000E+0
coefs_b1=0.000000000000000E+0
coefs_b2=0.000000000000000E+0
coefs_b3=0.000000000000000E+0
inttime=5.000000
averages=32
trigger_mode=10
sync_enable=FALSE
sync_SN=""
ext_trigger_enable=FALSE
ext_trigger_type=0
ext_trigger_scans=1
distance=1.000000
xaxis_data_reverse=0

[SPECTROMETER OS361AC55017573]
spectrometer_type=3

[ILT960 OS361AC55017573]
DynDark=TRUE

[CALIBRATION OS361AC55017573]
cal_enable_flag=1
cal_filepath="EEPROM"
aFitCoeff=40.576000
bFitCoeff=-4803.020000
cFitCoeff=1.145200
dFitCoeff=398.217000
eFitCoeff=65656.300000
fFitCoeff=-23088380.000000
gFitCoeff=3328896000.000000
```