Wasatch Photonics

Ultimate Spectrometers

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About Wasatch Photonics

Wasatch Photonics specializes in high performance Volume Phase Holographic Gratings (VPHGs), Volume Phase Holographic Optical Elements (VHOEs), and systems based on these components. Systems include spectrometers for applications ranging from Raman spectroscopy to optical coherence tomography to hyper-spectral imaging for users including researchers, end users, and OEM's.

At Wasatch Photonics, we are committed to quality, innovation, and meeting the needs of our customers. With 130+ years of combined experience and 80+ patents in the design and manufacture of Volume Phase Holography and instruments, our skilled staff is unmatched in quality and know-how.

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Introduction

1.1 Description of product

The Stroker 785 is intended for use in OEM systems for Raman spectroscopy. Users are OEM's, researchers, and other spectroscopists who need a high-throughput, sensitive, compact and user-friendly 785nm Raman spectrometer. The optical design consists of a free-space f/1.3 spectrograph covering the wavelength range from 525 nm to 695 nm and utilizes a backthinned CCD.

1.2 Definitions, Acronyms, and Abbreviations

A	Amps
C	Celsius
°C	degrees Celsius
cm	centimeters
dB	decibels
I/O	input/output
mm	millimeter
nm	nanometer
□m	micron or micrometer
MSamp	Megasamples (10^6 samples)
RoHS	Restriction of Hazardous Substances
QE	Quantum Efficiency
sec	seconds
SM	single mode
V	Volts

1.3 Specifications

Optical

	Feature	*Detailed Spec*
	Design	Lens based spectrograph
	f/#	f/1.3
	Sample Input Format	SMA .35 NA fiber
	Power Convertor	30 μm x 600 μm @ slit to 150μm dia. SMA .35 NA
	Slit size	50μm x 1mm
	Wavenumber range	-150 – 4300 cm^{-1}
	Wavelengh range	528 – 690 nm
	Resolution	23 cm^{-1} with 50μm slit, 15 cm-1 with Power Convertor
	Excitation	785 nm
	Diffraction Grating	HD 1600 lpmm VPH
	Peak DE	83%
	CCD Image spot size	10 μm
	Transmission	80%
	Working Distance	Certain models are equipped with a interchangeable lenses that vary the working distance.

Electronics, camera, and control

	Feature	*Detailed Spec*
	Interface	USB 2.0, Type B female
	CCD	Hamamatsu S10420-1006 (low etaloning)
	Pixel format	1044 x 70
	Active pixels	1024 x 64
	Active area	14.336 x 0.896 mm
	CCD QE	78% Peak @ 600nm
	Integration time range	10 msec to 4 minutes (limited by dark current)
	Read Noise	6 e- rms
	Full Well Depth	300K e-
	Dark Current	50 e-/pixel/s

2 Setting up the Spectrometer

2.1 Input / Output Connectors

Front View (Stroker 785L shown)

Figure 1 Front View of Stroker 785L

Side View

Figure 2 Side view of Stroker 785L with USB port on left and 12V power input on right.

2.2 Sample Alignment

Spectrometers such as the Stroker 785L can come with a variety of interchangeable lenses for different working distances. Consult the diagram below for appropriately positioning your sample:

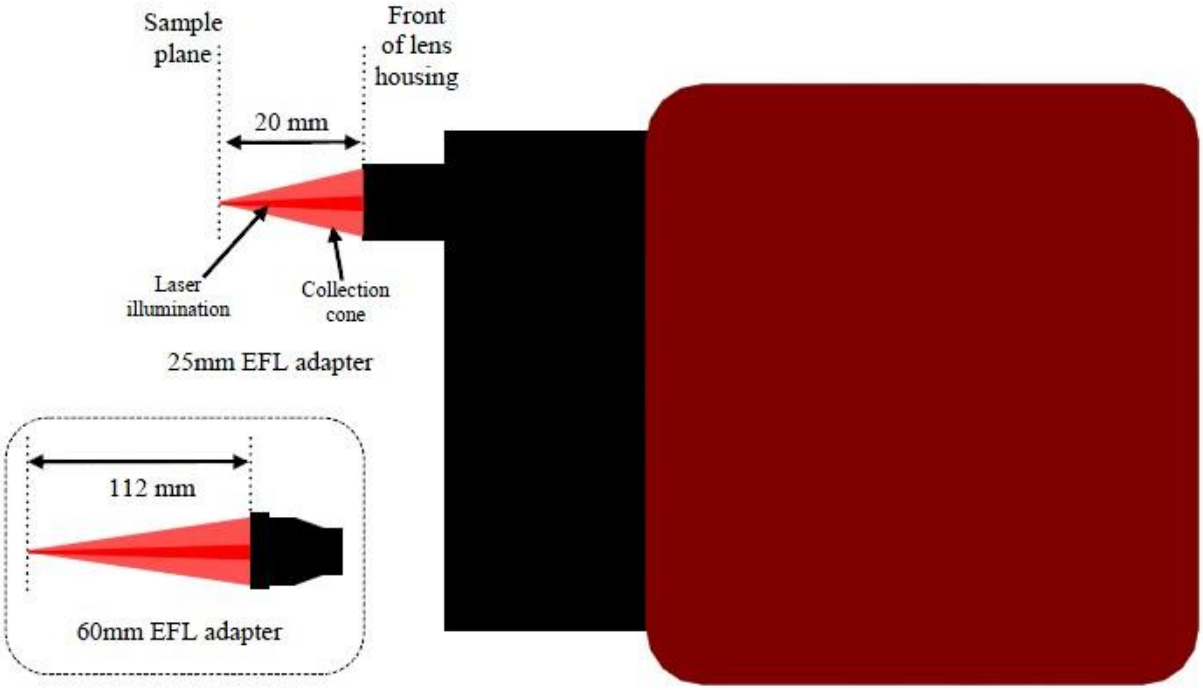

Figure 3 sample alignment with Stroker 785L

3. System Requirements

The Dash spectrometer control software has been tested with Windows 7, Vista, XP and to a limited extent, XP embedded. While Windows 7, Vista and XP Service Pack 2 provide all of the required libraries for Dash functionality, certain XP embedded installations will require the installation of MS Visual Studio 2008 runtimes and other libraries. Please consult your embedded system build documentation for details on how to install these libraries.

4. Software Installation

Dash installation (currently tested only on Win7 x32, Win7 x64, Vista x64, and XP x32 systems)

1) Ensure the spectrometer is **not** connected to the system.

2) Run the provided Dash-setup.exe file. Accept all of the defaults. During the installation process, click **Yes**, **Ok** or **Install** to any confirmation messages related to driver installation such as that shown in figure 4 below:

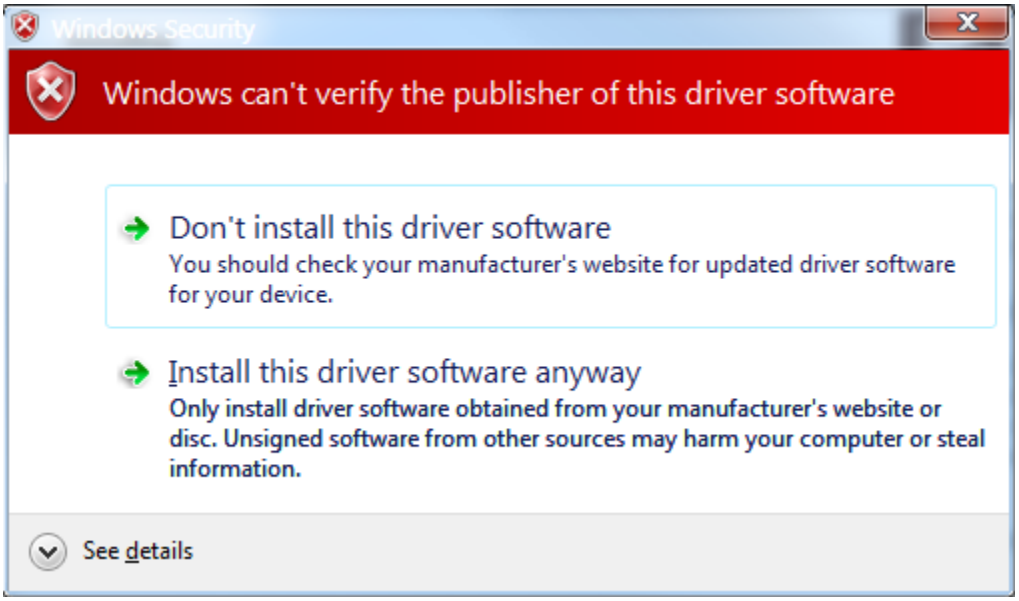

Figure 4 Example installation message

3) Click finish to launch the Dash application, and you should see a message like that shown below in figure 5:

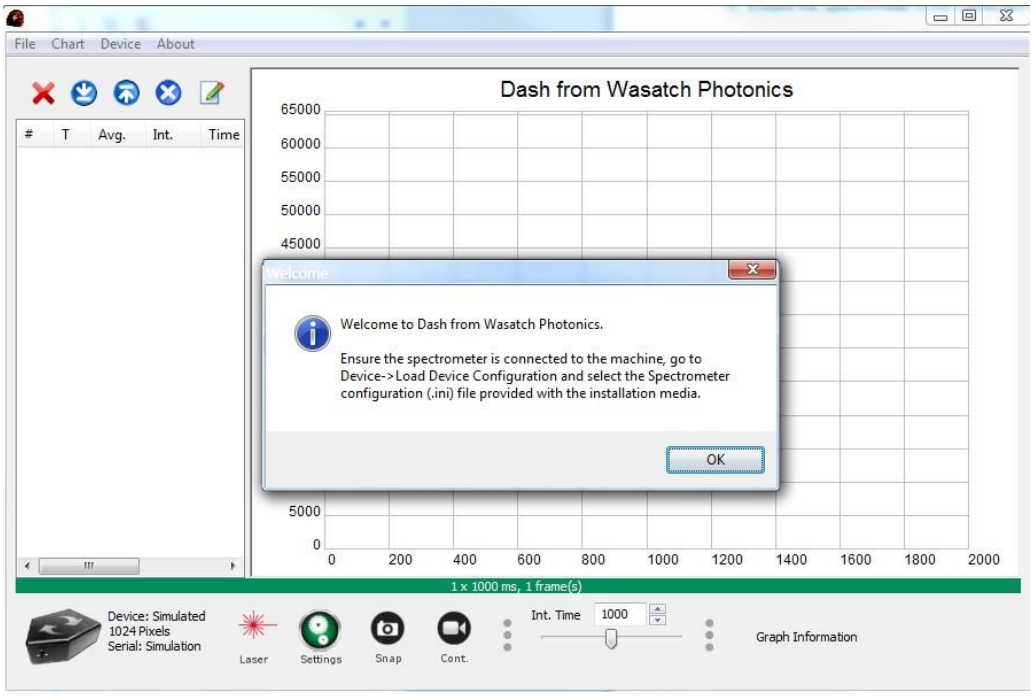

Figure 5 Dash startup message

4) Plug in the power to the spectrometer then plug in the USB cable to the spectrometer and the computer.
   Windows XP users: At this point you may see messages regarding further hardware configuration. Select **"No, not this time**" in response to the windows updated driver search function, click **Next**, then accept the default setting of "**Install software automatically (Recommended)"**. Then, click **Finish.**

5) Click the **OK** button in the Dash interface, then click **Device->Load Device Configuration.** Select the ini file for the specific spectrometer then click **Open**. The spectrometer is now ready for use.

2.4.1 Troubleshooting

1)When the system is first plugged into a computer with Windows 7, it may automatically load a driver for "ND-Tech USB Adapter". This is NOT the correct driver. To install the correct driver, follow these steps.
2) Go to control panel and double click on Device Manager.
3) Double click on Universal Serial Bus controller.
4) Right click on "ND-Tech USB Adapter".
5) Right-Click on "Update Driver Software".
6) Click on "Browse my computer for driver software"
7) Click on "Let me pick from list of device drivers on my computer".
8) Click on "Have disk".
9) Click on "Browse".
10) Navigate to the Stroker.inf file in the directory: ***<Program Files>:/Dash/driver/***
(Other environments may store the inf file in Program Files (x86))

The driver should now be installed. A single installation should work for all USB ports; installation for each USB port has not been needed.

Driver install can be verified by the presence of Stroker-<device ID> under the heading "libusb-win32 devices". If this is not seen, verify connection of the instrument.

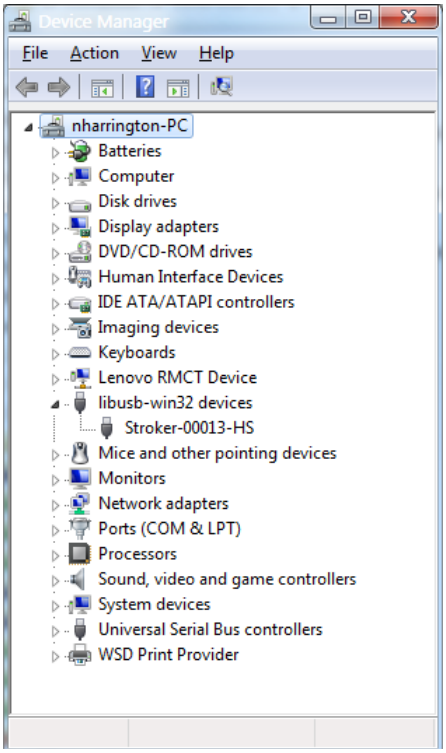

Figure 6 Device Manager screenshot

3 Software Interface

Dash is used to capture, view and save spectra from a Stroker 785 Raman spectrometer instrument. The software has the following basic features:

- USB communication with a Stroker 785 to acquire spectra
- Simulated spectra mode to familiarize the user with the spectral viewing and saving
- History window – all spectra captured in a session are held in memory unless cleared or the program is aborted
- Multiple x-axes available: pixel index, wavelength (nm) and wavenumber(cm^{-1})
- Saving of spectra image file
- Saving of all spectra data in current history window
- Loading spectra data into history (appending or overwriting current history)
- Capture of a user-defined number of spectra
- Capture of continuous spectra acquisitions
- Ability to average a user-defined number of spectra
- Ability to assign a baseline/blank spectra in history window such that all spectra *viewed* have that baseline/blank spectra subtracted
- Ability to clear individual or groups of spectra from the spectra frame history
- Ability for each capture frame to have its own unique calibration coefficients
- Excel report generation

3.1 Launching software

The Stroker 785 instrument should be powered and connected to the computer through the USB cable before launching the software. The software is launched using the Dash shortcut in the Programs menu. On initial startup the software needs to be pointed to the proper configuration file as instructed in the dialog below. As long as the instrument is plugged in on future Dash startups, the user should not need to "re-point" to the device configuration file. However, if communication is lost for any reason, the device can be found once again by pointing to the configuration file.

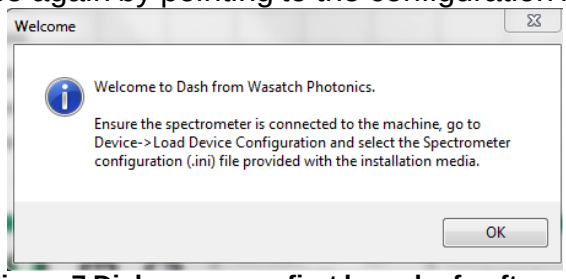

Figure 7 Dialog seen on first launch of software

Upon launching software, examine the button ribbon (see Figure 8). If the spectrometer is correctly found, then the Device should list, "Stroker 785". Otherwise, the Device will be listed as "Simulated." Please check the Device Manager (see Figure 65) for "libusb-win32 devices" and verify "Stroker <device-ID> " is in the subtree. Check connections to the instrument or power-cycle until libusb-win32 devices/Stroker <device-ID> shows up in the Device Manager. Then repoint Dash to the proper configuration file.

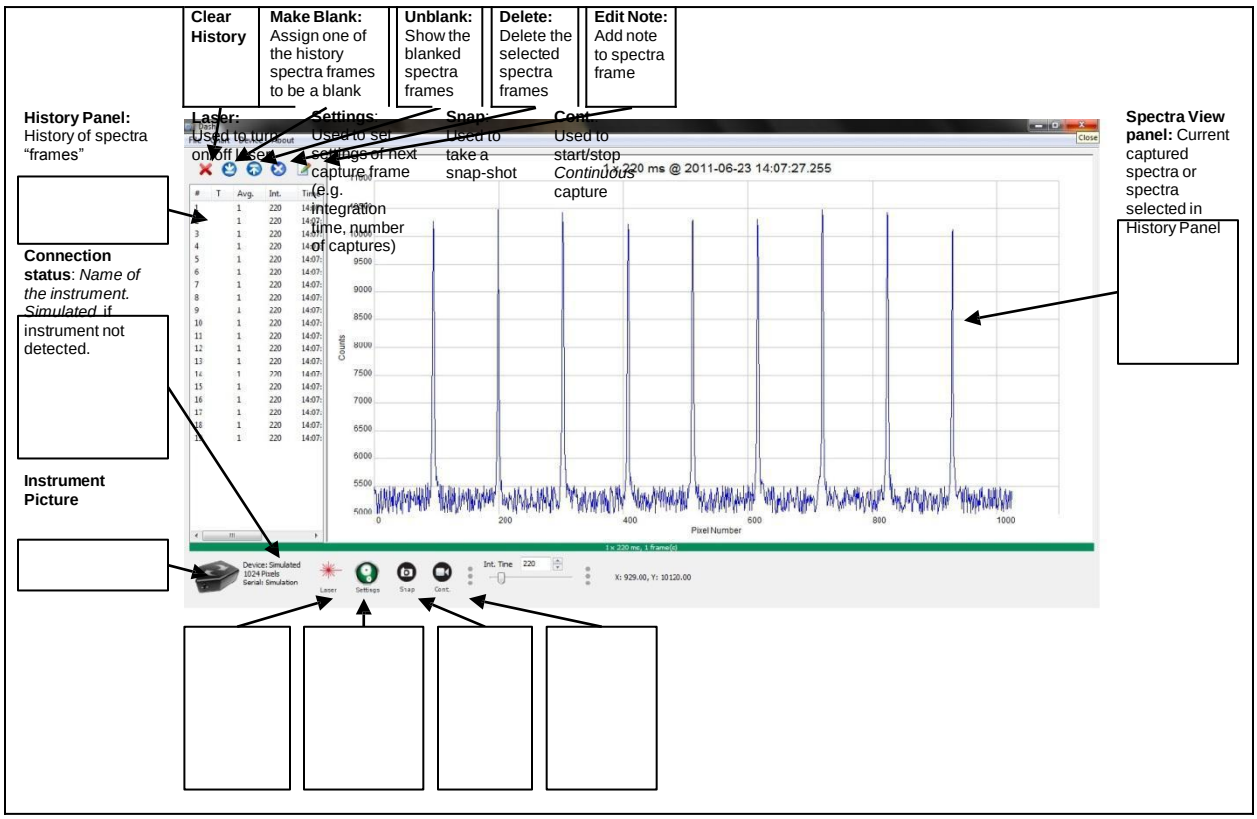

Figure 8 Dash Window

3.2 Running the software

The typical order of operations upon launch of the software is to select the button "Settings" and set the configuration for a capture.

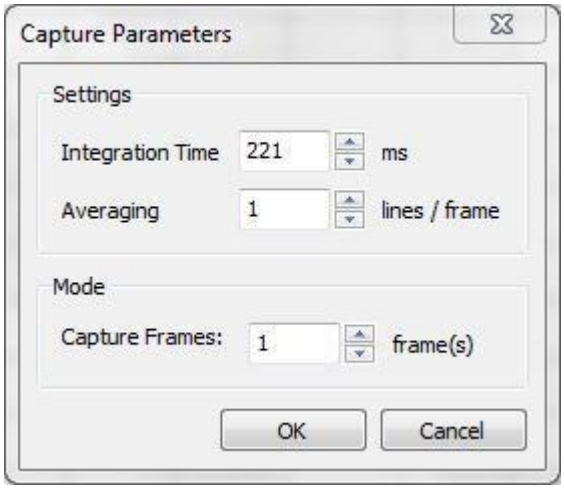

Figure 9 Settings Dialog

Capture Parameters:

- Settings
  - Integration Time: Time in milliseconds to integrate during capture.
  - Averaging (default = 1): Number of spectra captures to average to create a single spectral frame (a single spectra in the History panel).
- Mode
  - Capture Frames: Number of spectra frames to capture when the "Capture" button is clicked.

After the user has set up the Capture parameters, they are ready to start capturing spectra. Hit the Cont. or Snap button to start acquisition. Based on the settings in the Capture Parameters dialog box, one or more spectra will be averaged and/or acquired.

1. Clear ( )

This is used to clear the complete spectra history.

2. Subtracting Blanks(and)

The Make Blank button ( ) is used to assign a particular spectra from the history window as a "Blank spectra". This means that any spectra viewed after assigning a blank has the blank spectra subtracted from it. To "unassign" a blank, choose the balnk frame and hit the button. Note that if the spectra history is saved to file, only the raw data is saved, not the subtracted spectra. However, one can manually subtract

spectra since all of the history, including annotations of which frame is the blank spectra frame, is saved to file.

3.2.3 Delete Item

In Section 3.2.1 we saw that the Clear ( ) button clears the complete history. The Delete Item button ( ) allows individual or groups of selected spectra to be deleted from the history. Any selection of frames can be highlighted for deletion by using CTRL and SHIFT keys with mouse clicks (see Figure 7).

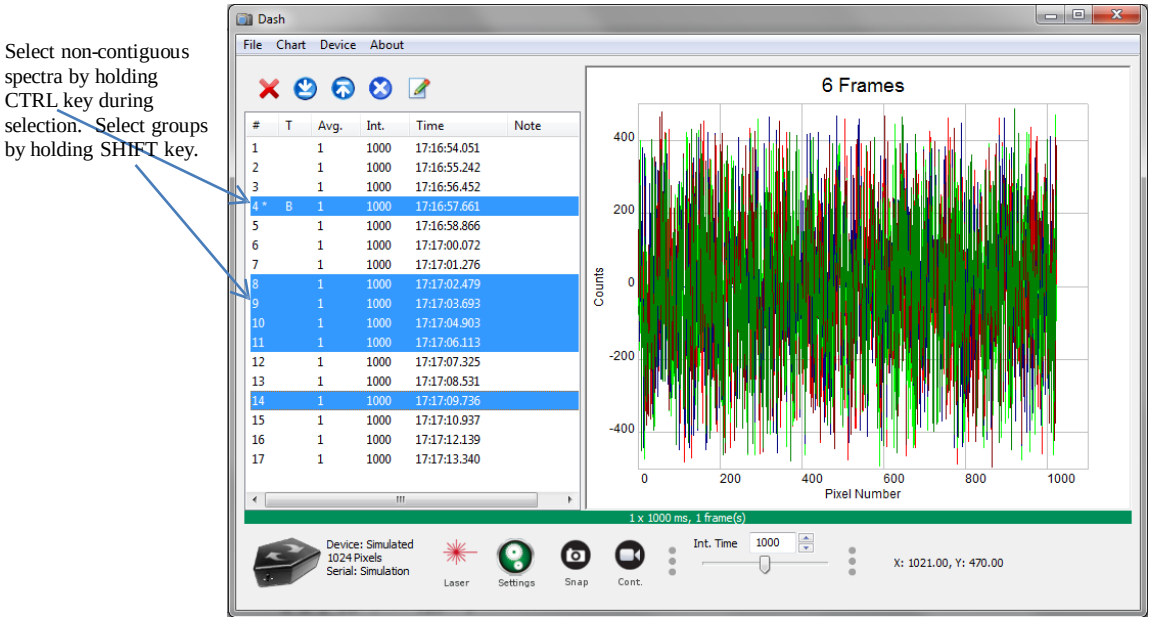

Figure 10 Selecting frames for overlap display or setting up for deletion using Delete Item key

Since “Saving spectra” (see Section 3.2.5) saves all spectra in the history, this operation is useful for clearing unwanted spectra before saving to file.

4. Overlaying Spectra

The user can overlay multiple spectra for visualization by using the CTRL/SHIFT selection detailed in Section 3.2.3 and Figure 7. Simply select multiple spectra and those selected will be overlaid in the spectra window using different colors.

5. History Window

The history window allows the user to view previously captured spectra frames. Simply select a recently acquired spectra and it will be displayed in the Spectra View panel. If the or button is pressed, the most recently captured spectra is automatically displayed in the Dash graph panel.

6. Saving Spectra

Under the File menu is the option to “Save File” and “Save Chart”.

- Save File…: This option saves all the spectra frames in the history to a CSV file. The format is described in the next section below.
- Save Chart… A single spectrum in the current display window is saved to the PNG file format.

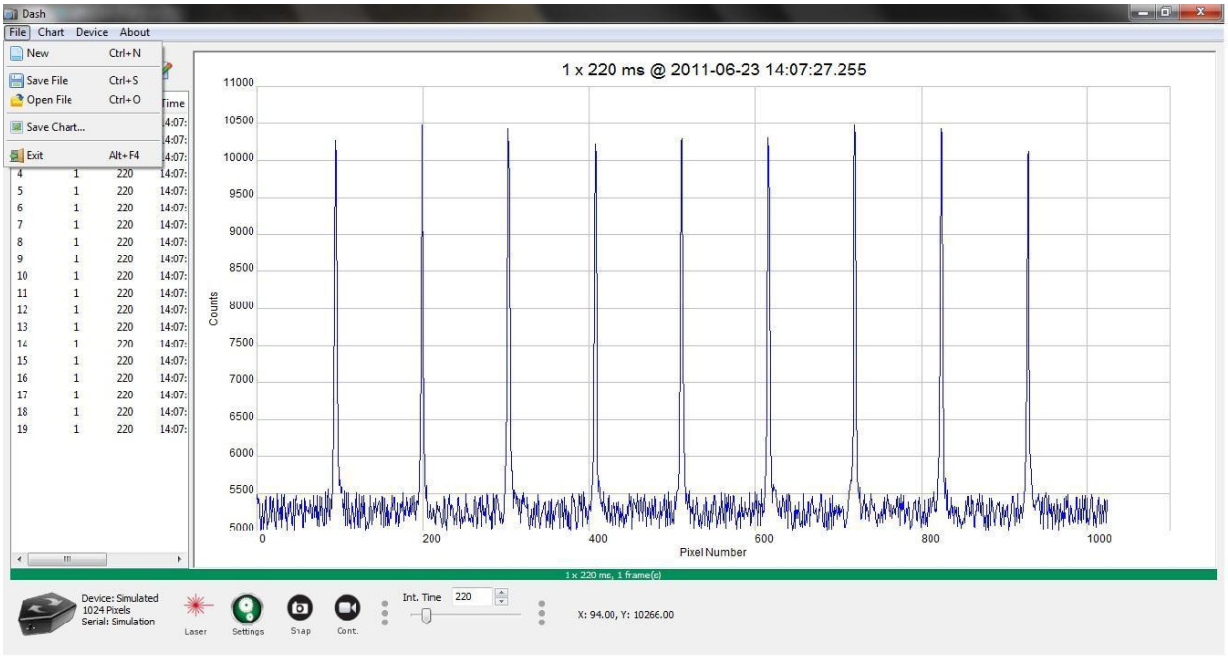

Figure 11 File Menu

3.2.6.1 Save File format

As mentioned, "Save File…" saves all the data in the history window to a CSV file. Layout can be chosen as row or column-based, which allows data to be displayed horizontally or vertically. A portion of an example CSV file (by row) is shown below. Note that the CCD actually captures 1044 horizontal pixels but only 1024 are active and displayed/saved unless *Chart→Setup→Show Diagnostic Data* is checked (by **default** this is left unchecked). These extra pixels are appended in the display to the end of the spectra.

Each capture frame has multiple data annotated to it. These fields include:

Frame number: incremental index
Type: P=primary, B=blank
Lines: number of spectra integrated to produce frame
Integration Time: time in milliseconds for each capture
Timestamp: date and time of acquisition of the frame
Offset: digital offset (default = 0)
Gain: digital gain (default = 1.9)
Laser Wavelength: laser excitation in nanometers
Coefficients: wavelength calibration coefficients (C0…C4, see below)

Laser power mW: (only if measurement supported by hardware; otherwise, 0)
Note: text input by user annotation individual frame
Pixel intensities: In the header these are pixel numbers, 0 to 1023. In each frame, these are the associated 16-bit (0 to 65535) pixel intensities

Below is an annotated example of a data spectra file saved in "row format".

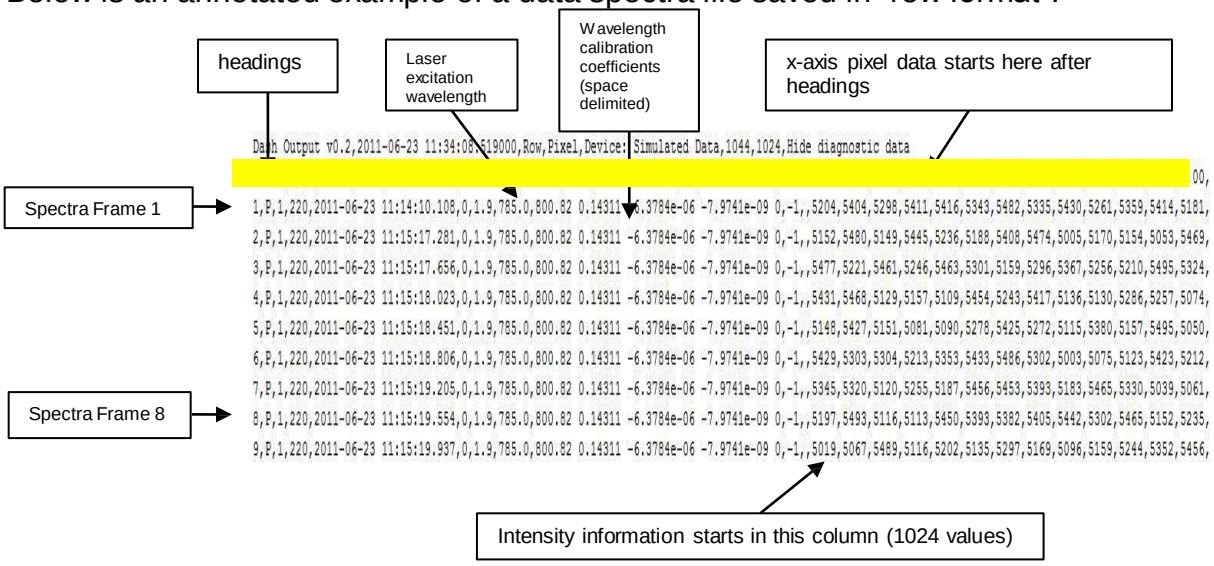

Figure 12 Row-based CSV data file (user can also choose column-based CSV file)

Users can derive wavelength (nm) and wavenumber (cm^{-1}) information from pixel number and the calibration coefficients. The formula is

If p=0…1023,

( )

where *p* is pixel index.
The wavenumber can be derived by the following equation

7. Chart menu option

The chart menu option allows the user to alter the x-axis displayed. The choices are:

- **Pixel index**
- **Wavelength (nm)**
- **Wavenumber (cm^{-1})**

Calibration coefficients are included in the data file to derive wavelength and wave number. (See the following section)

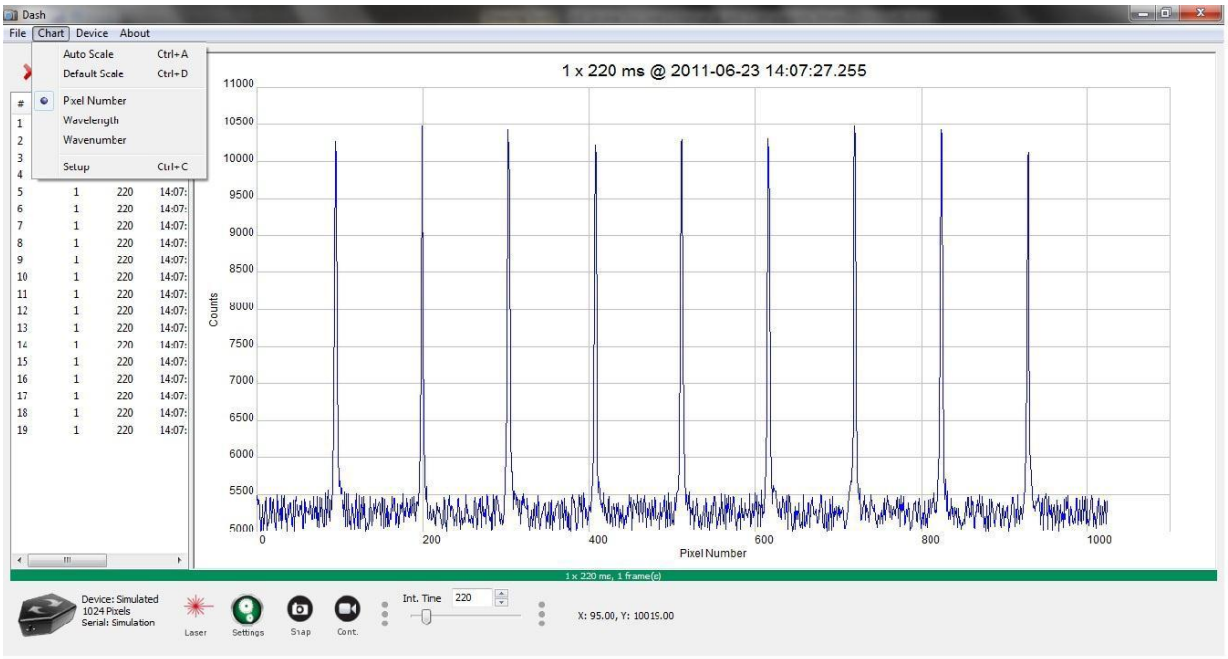

Figure 13 Chart Menu

Scaling options include:

- Autoscale: automatically fit the x-axis and y-axis value range to the current display window. A useful keyboard shortcut to set autoscale is CTRL-A.
- Default scale: The default scale is set up for each axis type. The intensity range (y-axis) defaults to 0…65535. The x-axis in pixel mode defaults to 0…1023 while in wavelength and wavenumber mode it defaults to the max range given by use of the calibration coefficients. A useful keyboard shortcut to set default scale is CTRL-D.

The Setup option enables chart configuration, where users can show markers on the chart, show diagnostic data (inactive data), and show grid.

4 Mechanical and Environmental Specifications

Physical Specifications

	Feature	*Detailed Spec*
	Size	4.25” x 6.5” x 1.9” housing
	Weight	0.9 kg
	Power supply weight	0.5 kg

Electrical Power

	Feature	*Detailed Spec*
	Requirement	2A at + 12VDC
	Supply voltage	12 – 14 VDC
	Power up time	30 seconds
	Power consumption	12W

Environment

	Feature	*Detailed Spec*
	Operating Range	10 – 50C; no condensation
	CCD Operating Temp	Maintain a ΔT of up to 20 ^{o}C with ambient (fanless)
	Storage Temp Range	0 to 70 ^{o}C
	Relative Humidity	0 – 90% noncondensing

5 Troubleshooting

Please contact Wasatch Photonics in Durham, North Carolina with any troubleshooting questions.

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