Particle Analysis and Display System (PADS):

Cloud Imaging Probe (CIP) Module

Operator Manual

DOC-0180 Rev A-5

PADS 2.5.6

CIP Module 2.6.8

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C O N T E N T S

L i s t   o f   F i g u r e s

1.0 Introduction

The Particle Analysis and Display System (PADS) is a software package that interfaces with instruments produced by Droplet Measurement Technologies (DMT) and other leading instruments used in the atmospheric sciences. This manual describes the PADS module for the Cloud Imaging Probe (CIP).

For an explanation of the basic PADS setup and instructions on how to acquire data using PADS, consult the *PADS Operator Manual*. Definitions and calculations used in the CIP module are also described in the *PADS Operator Manual*.

2.0 Configuration

Using PADS, you can configure both the software for the instrument and the instrument's data display in PADS. The following two sections explain how to do this.

Configuring the CIP

Your CIP and data system should arrive preconfigured from DMT. In some cases, however, you may want to change the software configuration for the instrument. To do this, follow the steps below. *Note: Droplet Measurement Technologies STRONGLY recommends that customers contact our office prior to changing any of the parameters in the instrument configuration. Improper changes can result in communication failure and/or changes in PADS computation algorithms, which can compromise data validity.*

1. Click on the "CIP" tab.

2. From the **Configure** menu, select **Configure Instrument.** You will see the following window.
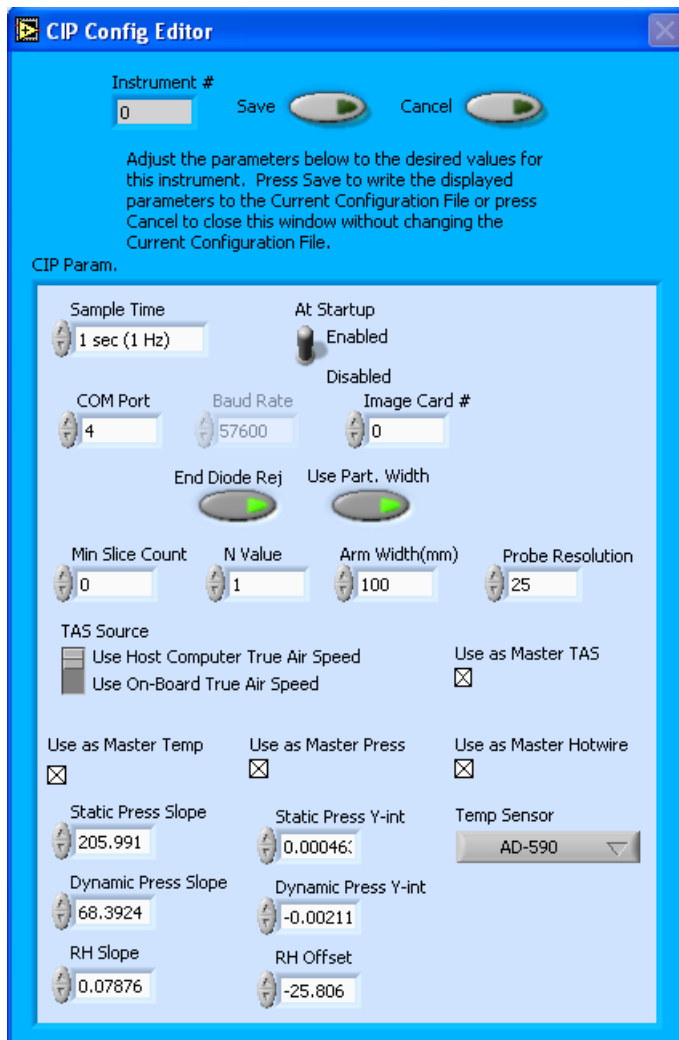
Figure 1: CIP Configuration Editor Window

3. Now you can configure the instrument parameters to your desired specifications. You will find a list of the parameters you may want to reconfigure in the two sections below, "Occasionally Reconfigured CIP Parameters" and "Rarely Reconfigured CIP Parameters." If at any time you would like to revert to the previously saved values for the CIP parameters, press **Cancel** to exit the window without saving changes.

4. When you are done configuring the CIP parameters, press **Save** at the top of the Config editor window. (If you would instead like to revert to the previously saved values, click **Cancel**.) Then press the green **Reset Program** button for the new configuration to take effect. Note that pressing the **Reset Program** button will clear any data currently being displayed.

Occasionally Reconfigured CIP Parameters

Sample Time: This parameter shows the time interval you'd like between samples. You can have the probe sample at intervals of .1, .2, .5, 1, 2, 5, or 10 seconds (10, 5, 2, 1, 0.5 or 0.1 Hz). A value of one is recommended, as described in the warning below. Note that if you increase the sample time, you will still collect data for the same number of particles. This is because the probe collects data continuously and relays cumulative data at each sampling interval. For example, say you have the sample time set to .5 seconds. You might see four particles of size 25 µm during the first sample, and five particles of this size during the second sample. If you had set your sample time to one second instead of .5 seconds, you would instead get one sample that showed nine particles of size 25 µm.

WARNING: One hertz sampling is currently recommended, as choosing other values will invalidate time-dependent PADS calculations like number concentration, volume concentration, and LWC on optical probes. (ED and MVD are not affected.) This is a known bug in PADS that will be fixed in an upcoming version of the program.

At Startup Enabled / Disabled: If you want the CIP to acquire data when PADS begins sampling, make sure this parameter is in the "Enabled" mode. In some cases, such as if the CIP is inoperative, you may want to use this control to disable the probe. Disabling the CIP allows data to transmit from other instruments without interference.

COM Port: This is the serial communications port that the CIP uses to connect with the computer. This number should match the computer hardware configuration for the particular computer you are using. If you are not using multiple computers, this number should not be changed.

Image Card #:   This is the communications port that the CIP uses to relay image data to the computer. The image card serial port differs from a standard serial port and can communicate data at higher speeds. If you have multiple instruments transmitting image data, the Image Card # tells you which port is being used by the current instrument, in this case the CIP. As with the Com Port parameter, you may need to change this if you are running PADS in data-acquisition mode on different computers.

End Diode Reject: Activating this button instructs the CIP to reject any particles for sizing that obscure an end diode. (Particles that obscure both end diodes are always rejected.) Particles that obscure one end diode usually extend outside the probe area, invalidating any size reading. Thus it often makes sense to exclude them from sizing.

If **End Diode Reject** is enabled, images of these particles are still recorded, and you can still do some sizing of these particles in post-processing. However, they won't be included in the on-board histogram analysis. If **End Diode Reject** is disabled, particles that obscure only one end diode will be sized, albeit incorrectly.

Note that if you want to measure very large particles, you may want to disable both **End Diode Reject** and **Use Part. Width.** See explanation below.

Use Part. Width: Activating this button instructs the CIP to use particle width to size particles for creating the 1D histogram. Particle width is the dimension parallel to the diode array. The other sizing option is to use particle length, which is the dimension perpendicular to the diode array. The default setting for this button is "On," since particle width is generally preferred to particle length as a sizing criterion. This is because length measurements depend on particle velocity and may be distorted if the air speed clock is set incorrectly. However, particles that are wider than the diode array may not be measurable unless the CIP measures their length rather than their width. These particles would block one end of the diode array, making it impossible to estimate their width. However, if you turn off **End Diode Reject** (which means the particle will get sized) and disable **Use Part. Width**, the CIP will record information about the particle's length and the width that was captured by the diode array. You can then use this information in post-processing to estimate the particle's size.

Min Slice Count: By setting the minimum slice count parameter, you can instruct PADS to store images only of larger particles. The probe will not retain any images of particles smaller than the minimum slice count. Each slice has a width of the probe resolution, so a minimum slice count of four on a CIP with 25 µm-resolution means that particles smaller than 100 µm will not be saved as images. Setting the value to zero means that all images will be recorded. Raising the minimum slice count helps conserve storage space on the computer disk and in very high concentrations will also prevent losing information due to limitations related to transmission bandwidth. Note that particles that are not saved as images will still be sized and used to create the 1D size distributions that are transmitted at a constant rate to the computer from the probe. It is recommended that this parameter be set to zero in most cases unless you are operating the system in an environment where concentrations are extremely high, such as in sprays, where the number concentration can exceed several thousand per liter.

N Value: This parameter determines what fraction of particle images get saved. Its default is one, meaning that all images are saved. Increasing the value decreases the number of images by a factor of N. So if N = 3, PADS will only save every third image. Raising the N value helps conserve disk storage space and limits transmission losses. Unless disk space is an issue, it is recommended that all images are saved.

TAS Source: This switch sets the source for true air speed that is used for controlling the rate at which images are sampled. The optimum rate will be one sample taken each time a particle moves across the array by one resolution step. For example, for a 25-μm resolution CIP, if the air is moving at a velocity of 100 m/sec, the image would be sampled once every 250 nanoseconds, or 25×10^{-8} seconds. This insures that the recorded images are not artificially elongated (over-sampled) or truncated (under-sampled).

Setting the value to "Use Host Control Air Speed" tells the probe to use the host computer's version of TAS. (The host computer's source for the TAS reading is in turn set in the Setup tab.) Setting the slide control to "Use On-Board True Air Speed" tells the probe to use its own internal measurement of TAS for clocking. Normally, the "Use Host Control Air Speed" is selected, since this is the airspeed computed from the pitot measurements of one of the probes and is most representative of the particle velocity at the point of measurement.

Note that the TAS source set in the CIP Config Editor window is only used to clock the probe. For calculations that use TAS, PADS uses the source set in the Setup window.

For on-the-ground data collection, TAS Source should be set to "Use Host Control Air Speed." On the Setup window, the TAS source should then be set to "Manual" and an appropriate value chosen, e.g. 25 m/sec if the instrument is using spinning glass disks.

You will notice that there are other parameters listed on the **CIP Config Editor** window. Most of these you should not need to change, and changing them inadvertently may compromise your data. If you are curious about these parameters or think you do need to modify them, see the section titled "Rarely Reconfigured CIP Parameters" below or consult with a DMT technical representative.

Rarely Reconfigured CIP Parameters

The CIP configuration editor displays several parameters that you will rarely need to modify. The following is a list of these parameters and an explanation of what they do.

Instrument #: This lists the number corresponding to the instrument you are viewing, in this case the CIP. If your CIP has been assigned instrument number one, you will see "1" in this field. You should not need to modify the instrument number, and in fact you are unable to do so from within PADS.

Baud Rate: The Baud rate for the probe is defined at manufacture, and you should not need to change it. PADS lists this parameter because some probes can run at different baud rates. So if you reconfigure your hardware, the baud rate may change. In general, a higher baud rate means that the probe can transmit data more quickly to the computer. However, higher baud rates may not work with some computers and can result in unreliable data transmission.

Arm Width (mm):   The distance between the probe's arms along which the laser travels. This value is used in calculating particle concentrations. (See the "Sample Volume" entry in the *PADS Operator Manual's Appendix A: Definitions* for details.) The arm width of your probe should not change. This parameter is only used in sample volume calculations.

Probe Resolution: This parameter indicates your probe's resolution in microns (µm). Because this was set at the time of manufacturing, you should not need to modify this parameter. In fact, doing so may compromise your data. This is because PADS uses the Probe Resolution number specified on the CIP Config Editor window to determine particle size and sample volume.

Use as Master TAS: When checked, this checkbox tells PADS to use the CIP as the default TAS Source on the Setup window.

Note that there are three different parameters related to TAS source:

1.) The "TAS Source" slide control on the Config Editor screen

2.) The "Use as Master TAS" checkbox on the Config Editor screen

3.) The "TAS Source" drop-down list on the Setup Screen

#2 and #3 determine the global TAS that PADS uses in calculations. If #2 is checked on the CIP Config Editor screen, then the CIP will be the default TAS Source listed in #3. You can override this choice by changing the value of #3.

#1, in contrast, is used not in calculations but in clocking the probe.

Several different instruments are capable of providing True Air Speed to PADS. If more than one such instrument is installed in your system, only one of them can be used as the global source for True Air Speed for calculations. When your system comes from DMT, one instrument will be selected as the Master TAS. This setting should not change unless you are using a spinning disk for testing or calibration, in which case the TAS Source parameter on the Setup screen should be set to "Manual."

Use as Master Temp: When checked, this box tells PADS to use the CIP's ambient temperature measurement as the default master temperature source on the Setup window. While multiple instruments can potentially provide this measurement, only one instrument should be selected as the source. (Note that what PADS displays as ambient temperature is really measured temperature that is several degrees warmer than the ambient; see entry under **Ambient Temperature** in the *PADS Operator Manual's Appendix A.*)

Use as Master Press: When checked, this box tells PADS to use the CIP's static pressure measurement as the default master source for static pressure. This source appears on the PADS Setup window upon startup. While multiple instruments can potentially provide this measurement, only one instrument should be selected as the source.

Use as Master Hotwire: When checked, this box tells PADS to use the CIP's hotwire measurement as the default master hotwire source on the Setup window. While multiple instruments can potentially provide this measurement, only one instrument should be selected as the source.

Note that in a CCP system, the Hotwire signal is measured by the CIP. In a CAPS system, the Hotwire signal is usually measured by the CAS, so the CAS and not the CIP should be set to Use as Master Hotwire for these systems.

Static Press Slope: This is the slope used in the linear function to derive static pressure from the voltage output of the static pressure transducer, as follows:

*Static Pressure = **(Static Press Slope)** * (Voltage) + Static Press Y-int*

Static Press Slope is a calibration coefficient measured by DMT and specific to your transducer. It assumes a 5-volt sensor range that is electronically multiplied by 2 before going to a 0-10 volt analog-to-digital converter. Do not change this parameter without consulting DMT first.

Static Press Y-int: This is the intercept term used in the linear function to derive static pressure from the voltage output of the static pressure transducer, as follows:

*Static Pressure = (Static Press Slope) * (Voltage) + **Static Press Y-int***

Static Press Y-int is a calibration coefficient measured by DMT and specific to your transducer. It assumes a 5-volt sensor range that is electronically multiplied by 2 before going to a 0-10 volt analog-to-digital converter. Do not change this parameter without consulting DMT first.

Dynamic Press Slope: This is the slope used in the linear function to derive dynamic pressure from the voltage output of the dynamic pressure transducer, as follows:

*Dynamic Pressure = **(Dynamic Press Slope)** * (Voltage) + Dynamic Press Y-int*

Dynamic Press Slope is a calibration coefficient measured by DMT and specific to your transducer. It assumes a 5-volt sensor range that is electronically multiplied by 2 before going to a 0-10 volt analog-to-digital converter. Do not change this parameter without consulting DMT first.

Dynamic Press Y-int: This is the intercept term used in the linear function to derive dynamic pressure from the voltage output of the dynamic pressure transducer, as follows:

*Dynamic Pressure = (Dynamic Press Slope) * (Voltage) + **Dynamic Press Y-int***

Dynamic Press Y-int is a calibration coefficient measured by DMT and specific to your transducer. It assumes a 5-volt sensor range that is electronically multiplied by 2 before going to a 0-10 volt analog-to-digital converter. Do not change this parameter without consulting DMT first.

RH Slope: This is the relative humidity (RH) slope used in the linear function to derive relative humidity from a relative humidity sensor, as follows:

*RH = **(RH Slope)** * (bits) + RH Offset*

RH Slope is a calibration coefficient measured by the sensor's manufacturer. Do not change this parameter without consulting DMT first.

RH Offset (called **RH Y-int** on some instrument screens)**:**   This is the intercept term used in the linear function to derive relative humidity from a relative humidity sensor, as follows:

*RH = (RH Slope) * (bits) + **RH Offset***

RH Offset is a calibration coefficient measured by the sensor's manufacturer. Do not change this parameter without consulting DMT first.

Temp Sensor: This control tells PADS what kind of temperature sensor is installed in the CIP. It is pre-configured to match the temperature sensor on your particular probe and should not be changed.

After making changes in the instrument configuration window, you will need to press the **Save** button and then click the green **Reset Program** to activate these changes. Clicking **Reset Program** will clear any data PADS is currently displaying.

Configuring the CIP Display

To configure the CIP display, go to the **Configure** menu from the CIP tab and select **Configure Display.** This will bring up the following window.
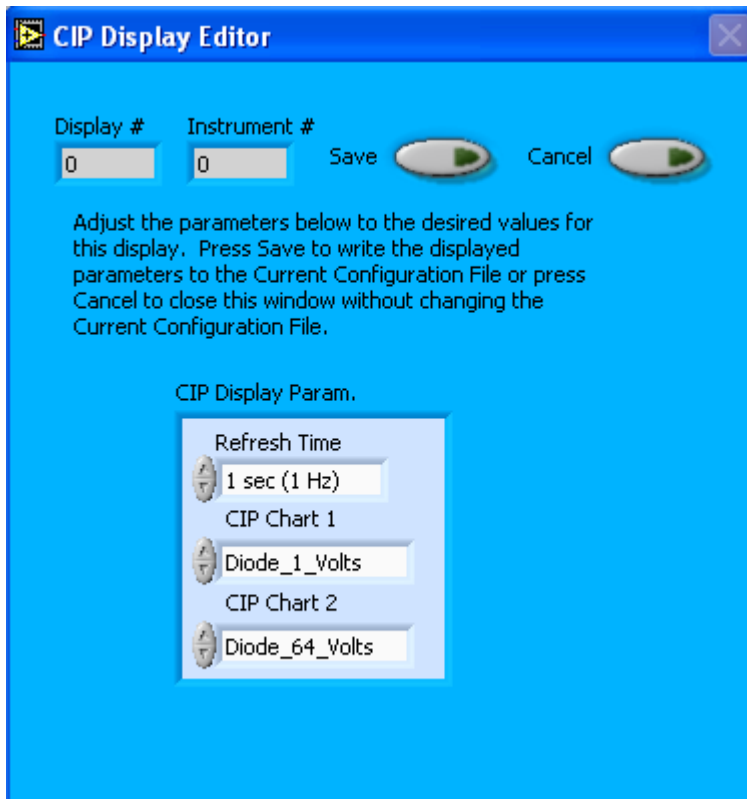

Figure 2: CIP Display Editor Window

You do not need to modify the **Display #** or **Instrument #**. Changing the **Refresh Time** allows you to set the time intervals for data display during acquisition mode; you can choose any time that is equal to or greater than the sample time. (Choosing a time less than the sample time is not useful, since the same data will be displayed multiple times.)

The CIP Display Parameter box at the bottom of the window also allows you to configure the channels on the CIP's selectable graphs. To change these channels, click on the arrow buttons to scroll between available options for the channels. You can also click on the white fields to bring up a list of all the available options, from which you can then choose the channel you want.

When you are done, click on **Save** to update the configurations or **Cancel** to revert to the previous configuration. After you reset PADS, you will be able to see any changes. Note that clicking **Reset Program** will clear out any data currently being displayed.

Configuring channels in the **Display Editor** will change the display upon start-up. Once PADS has started, you can select any channels to be displayed in the selectable charts. See the "Chart Displays" section for more information.

3.0 The CIP Window

The different parts of the CIP Window are discussed below. For explanations of the **Enable** button, **COM Port** indicator, and **Fault/No Fault** button, see the "Instrument Tabs" section of the *PADS Operator Manual*.

Channel Tabs

The CIP channel data section has three tabs at the top: CIP Data, CIP Housekeeping, and CIP Cal (Calibration). The CIP Data window is shown below.
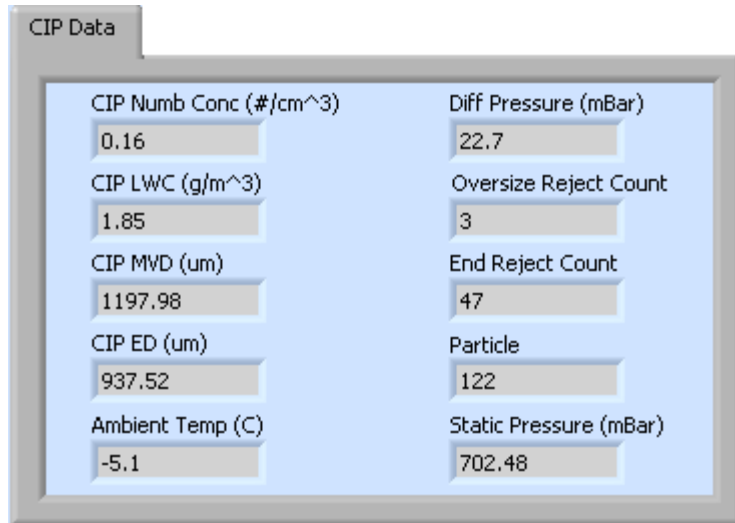
Figure 3: CIP Data Window

The CIP Data tab displays commonly used channels. The CIP Housekeeping tab shows channels that indicate whether the instrument is functioning properly. The CIP Cal tab shows channels that are used during instrument calibration. Note that some channels appear on several tabs—for instance, Laser Current (mA) appears on both the Housekeeping and Cal tabs.

For information on specific channels, their definitions, and their acceptable ranges, consult *Appendix A: CIP Channels* and the PADS Operator Manual's *Appendix A: Definitions*.

Histogram Data Window

Below the channel tabs is the histogram display of CIP-acquired particle data, as shown below. Like the channel data display, the histogram shows time-specific data.
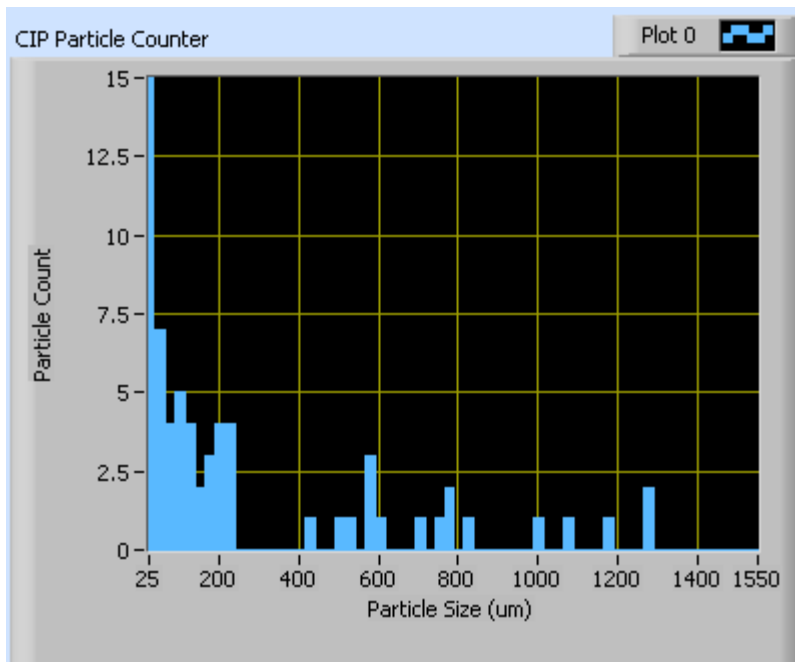
Figure 4: CIP Histogram Window

The histogram shows the number of particles counted in a given size range. In the example above, CIP has measured the most particles (15) in the 25-µm size bin during the sample time period.

Note that each size shown in the histogram's x-axis actually refers to a size range. For instance, the particles listed of size 200 µm refer to those sized 188.5 – 212.5 µm. This is because the data were generated with a 25 µm-resolution CIP, as can be inferred from the fact that the first label on the x-axis is at 25 µm. Particles trigger the diodes when they cover more than 50% of the diode—in this case, if particles are wider than 12.5 µm. So particle size is measured ±12.5 µm. For more information on particle sizing with the CIP, refer to the *DMT Data Analysis User's Guide*.

To display histogram data in other formats, click on the **Plot** tab in the upper right corner of the histogram window. This will bring up a list of formatting and style options. To view a larger histogram, click on the **Full Hist** tab in the Chart Displays section described below.

Chart Displays

The CIP chart displays consist of two time-series windows with two charts each, a real-time image display, and a real-time particle-size histogram. You can access any of these

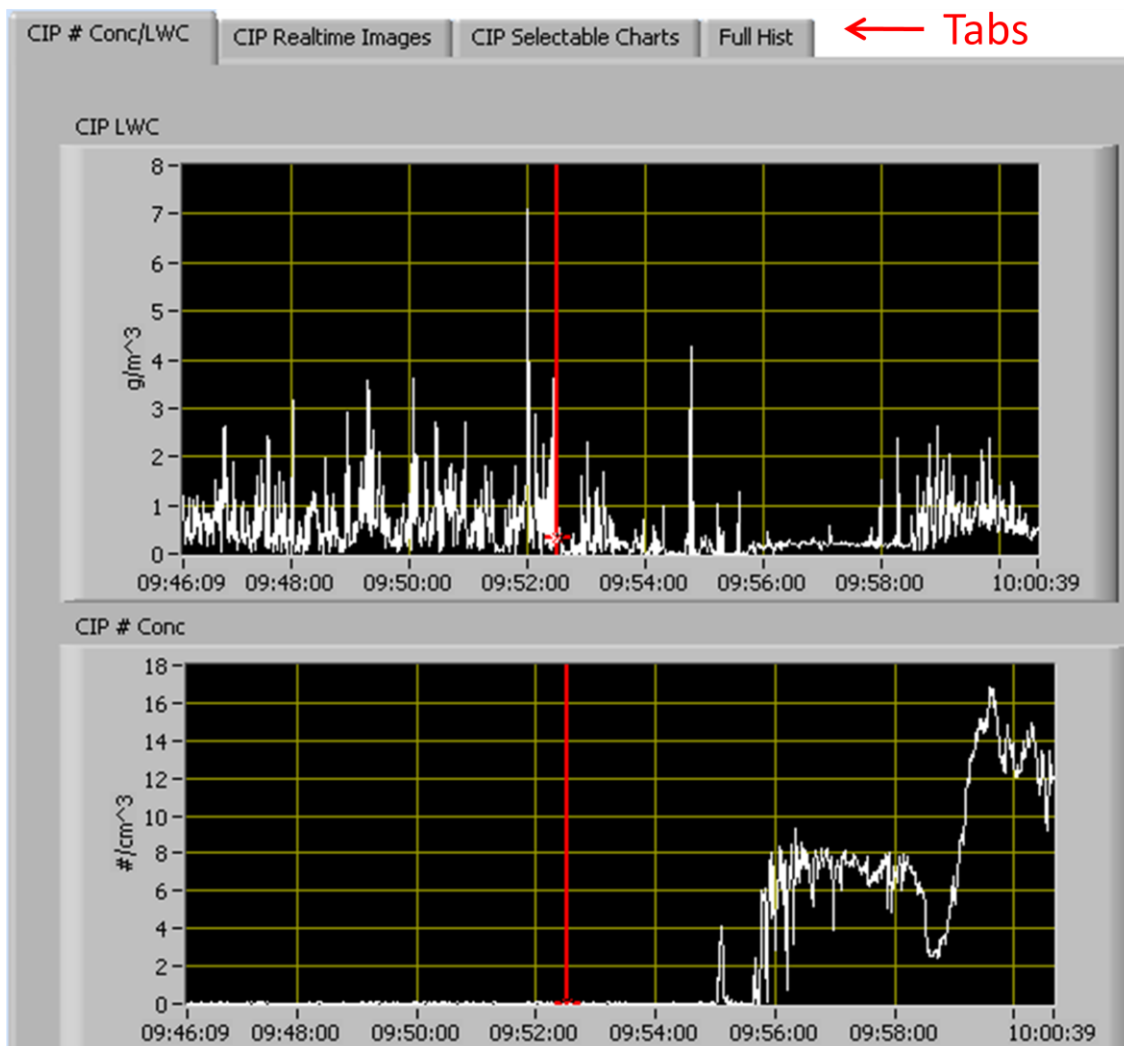charts by selecting the tabs in the upper part of the chart display window, as shown in the following figure.

Figure 5: CIP Time-Series Charts

When you access time-series charts in playback mode, the currently selected moment in time is indicated by a red cursor, as shown above. The y-axis value for this time is indicated by cross (+) on this cursor. Note that when you display a large range of time-series data, the chart display does not have sufficient resolution to display each individual time point. To increase resolution, zoom in on the data by changing the time interval to a smaller range.

On all the charts with x and y axes, you can change the scale by typing a different number into the starting and ending values on each axis. For instance, if you want to change the time period in one of the graphs above to end at 09:50:00, you simply select

the field that currently says 10:00:39, type in 09:50:00, and hit the <Enter> key. In acquisition mode, you must disable autoscaling (see below) before you modify fields in this way.

Many charts also show you options for scaling and copying the data when you right-click on them. These options are as follows:

Autoscale This autoscales the relevant axis. In autoscaling mode, the minimum and maximum values of the axis are set automatically so that all data points can be seen in the display. Note that on charts that have autoscale buttons, like the large histogram chart on some instrument tabs, the buttons override the Autoscale options in the drop-down menu. To see autoscaling options in the drop-down menu, position the cursor over the relevant axis before right-clicking. Note that you may not always be able to autoscale the x-axis.

Copy Data This copies the chart to the clipboard using a screen capture. This chart can then be pasted into other documents like Word or PowerPoint presentations.

Export Simplified Image This copies a simplified image of the data to the clipboard or an output file. You can choose the format you desire—bitmap (.bmp), encapsulated postscript (.eps), or enhanced metafile (.emf). Note that when you select the .eps option, you must copy the data to a file. Unless you specify otherwise, output files will be saved in the time-and-date-specific output file directory for the current session.

Clear Graph This erases the currently displayed data points from the graph.

More information about each of the tabs on the chart displays section is given below.

1. CIP # Conc/LWC Tab

The two graphs on the first tab, **CIP # Conc/LWC**, plot particle concentration (#/cm^3) and LWC (g/m^3) as a function of time. In playback mode, you can zoom in or out by using the time controls.

2. CIP Realtime Images

The **CIP Realtime Images** tab shows two-dimensional images of particles, as shown in Figure 6. Images are only available during acquisition mode. For viewing particles in playback mode, use the PADS Integrated Image Playback System.
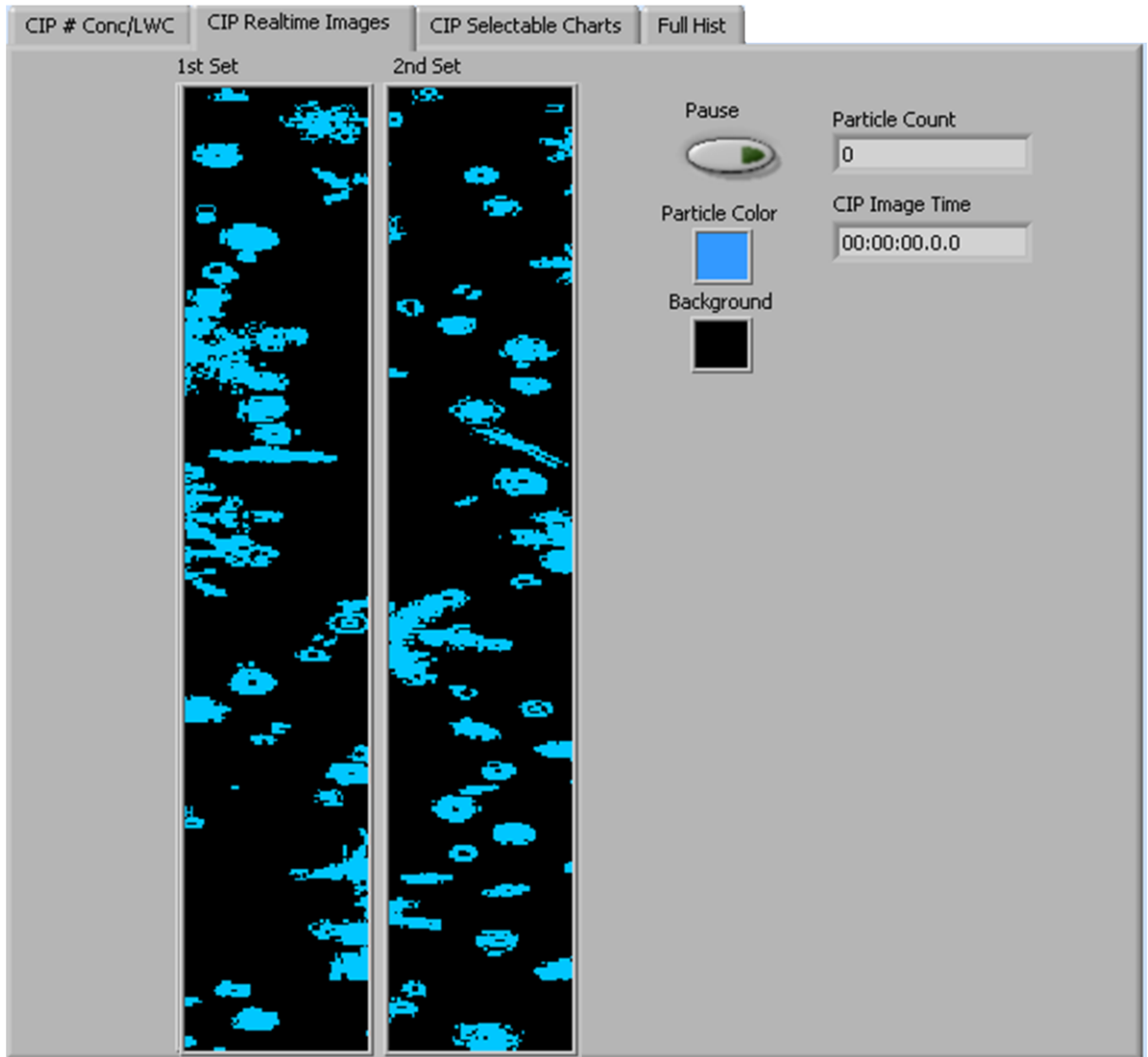
Figure 6: CIP Realtime Images Window

Images are shown for the current point in time unless you press pause, at which point the images freeze. The **Particle Count** reflects the cumulative number of particles PADS has counted in the current session. This number may be larger than the number of particles that have been imaged, depending on your *N* parameter. Particle count rolls over to zero when it hits 65,000. **CIP Image Time** indicates the time at which the particles were imaged.

3. CIP Selectable Charts

The **CIP Selectable Charts** tab displays two charts with user-specified channels plotted as a function of time. To change the channels plotted in the selectable charts, you have two options:

1.) To change the charts for the current session only, click on the **CIP Selectable Charts** tab and use the control in the upper left of the chart to select the channel you desire. You can either click on the text control to the right, which brings up a selectable list of channels, or you can use the button on the left to scroll between channels.
2.) To change the channels shown in the chart's display when PADS starts, go to the **Configure** menu, select **Configure Display**, and choose the desired channel. Then press the **Reset Changes** button to apply this configuration.

4. Full Histogram

The **Full Hist** tab shows a larger version of the particle-size histogram in the bottom left of the CIP screen. This histogram also allows you to manipulate the display using the controls and features described below.

Autoscale Buttons

The Autoscale controls, Autoscale X and Autoscale Y, let you control how the x and y scales are set. If you enable autoscaling, PADS will automatically select an appropriate scale with which to display the current data. For instance, if the probe is not currently detecting many particles, the y-axis range will decrease. On the other hand, if you disable autoscaling, the scale of the axes will remain constant. In this case, the range will always be the same as it was when autoscaling was disabled. The minimum and maximum Y values can then be changed manually by typing new numbers into these fields. *In playback mode, autoscaling will not take effect until you change the time using the time controls.*

Note that the Autoscale Y button overrides the Autoscale Y option in the drop-down menu that appears when you right-click on the chart.

Log-Scale Button

When you turn on the Log-Scale button, PADS scales the y-axis logarithmically rather than linearly. Autoscaling can be enabled or disabled with this option.
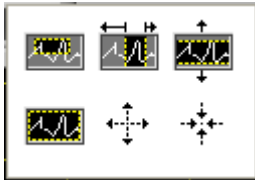
The Graph Tools Buttons

The graph tools buttons look like this:

The left button currently does not have functionality.

The right button allows you to move the histogram display around in the window.

Clicking on the middle button brings up the zoom window, which looks like this:

Before using the zoom controls, turn off autoscaling so your scaling changes stay in effect when new data are displayed.

Selecting the icon on the upper left allows you to select data on the histogram screen and magnify it. This changes both the x and y axes.

Selecting the button on the upper middle allows you to select a horizontal range of data you'd like magnified. This will change the x axis but not the y axis.

Selecting the button on the upper right allows you to select a vertical range of data you'd like to see magnified. This will change the y axis but not the x axis.

Selecting the button on the bottom left sets the axis to the same limit autoscaling would use. Autoscaling is not enabled, however, so when the data change, the axis limit stays constant.

Selecting the button on the bottom middle allows you to zoom in on a target.

Selecting the button on the bottom right allows you to zoom out on a target.

Appendix A: CIP Channels

A complete list of CIP data channels appears below. The CIP output file will contain data values for each channel for each sampling instance. You can also plot each of these channels as a function of time using the CIP Selectable Charts tab.

For definitions of the channels, see *Appendix A* in the *PADS Operator Manual*. Channels that start with "CIP" are the CIP's results for channels that are often calculated by several instruments. For these definitions, look under the more general term in the *PADS Operator Manual*. For instance, for the definition of CIP_ED, see "ED" in the main manual. CIP_Numb refers to the CIP Number Concentration.

Time	Bin_31	DOF_rej_counts
Over_rej_count	Bin_32	End_rej_counts
Bin_1	Bin_33	Diode_1_Volts
Bin_2	Bin_34	Diode_64_volts
Bin_3	Bin_35	Diode_32_volts
Bin_4	Bin_36	Diff_Press
Bin_5	Bin_37	Static_Press
Bin_6	Bin_38	LWC_Hotwire
Bin_7	Bin_39	LWC_Slave
Bin_8	Bin_40	DSP_board_temp
Bin_9	Bin_41	RH%
Bin_10	Bin_42	Spare_analog_2
Bin_11	Bin_43	Optional_temp_1
Bin_12	Bin_44	Optional_temp_2
Bin_13	Bin_45	Optional_temp_3
Bin_14	Bin_46	Ambient_temp
Bin_15	Bin_47	Laser_curr
Bin_16	Bin_48	Spare_analog_3
Bin_17	Bin_49	Particle_counter
Bin_18	Bin_50	Seconds
Bin_19	Bin_51	Milliseconds
Bin_20	Bin_52	Hours
Bin_21	Bin_53	Minutes
Bin_22	Bin_54	Host_Sync_Counter
Bin_23	Bin_55	Reset_Flag
Bin_24	Bin_56	True Air Speed
Bin_25	Bin_57	CIP_Numb
Bin_26	Bin_58	CIP_LWC
Bin_27	Bin_59	CIP_MVD
Bin_28	Bin_60	CIP_ED
Bin_29	Bin_61	Status
Bin_30	Bin_62	GPS Time

CIP channels fall into several broad categories:

Time Channels: Time, Hours, Minutes, Seconds, Milliseconds, and GPS Time store time data. Time is generated by the PADS computer clock and is the time when the program receives the CIP data. It is given in seconds after midnight on the day the program was started. Hours, Minutes, Seconds, and Milliseconds are times that the CIP clock generates when the probe collects data. (PADS sets the CIP clock, so although times are not perfectly synchronized, they are very close.) GPS Time is included in every instrument's list of channels whenever a GPS is included as one of the PADS instruments. GPS Time may be collected from an instrument other than the CIP, even though it appears as a channel in the CIP output file.

Bin Channels: Channels labeled Bin_[*i*] store data on the number of particles of different sizes that the CIP has detected. These data are used in the histogram display.

Channels for Other Statistical Data: Over_rej_count, DOF_rej_counts, End_rej_counts, and Particle_counter store particle statistics collected by the CIP. Status stores statistical data the CIP has gathered on the communication between PADS and the probe.

Housekeeping Channels: The CIP has 16 A/D housekeeping channels that have a 0-10 V range measured by a 12-bit A/D converter that gives integer values from 0 to 4095. Several of the housekeeping channels store data that indicate whether the probe is functioning properly. A complete list of housekeeping channels is given below.

Diode_1_Volts	*Static_Press*	*RH%*	*Optional_temp_3*
Diode_64_volts	*LWC_Hotwire*	*Spare_analog_2*	*Ambient_temp*
Diode_32_volts	*LWC_Slave*	*Optional_temp_1*	*Laser_curr*
Diff_Press	*DSP_board_temp*	*Optional_temp_2*	*Spare_analog_3*

CIP Calculated Channels: CIP_Numb, CIP_LWC, CIP_MVD, and CIP_ED store the results of calculations PADS has performed on CIP particle data. True Air Speed stores the true air speed collected by the master TAS source designated on the PADS Setup screen.

Channels Reserved for Internal Use: These channels are reserved by the system; they include Host_Sync_Counter and Reset_Flag.