



**SPEC**inc

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**CPIview<sup>©</sup>**  
**QUICKLOOK and EXTRACTOR**

**CPI DATA PROCESSING SOFTWARE**

by

**SPEC, Inc.**  
**3022 Sterling Circle, Suite 200**  
**Boulder, CO 80301**

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# CPI DATA PROCESSING SOFTWARE

## CPIview

### QuickLook and *Extractor*

CPIview requires:

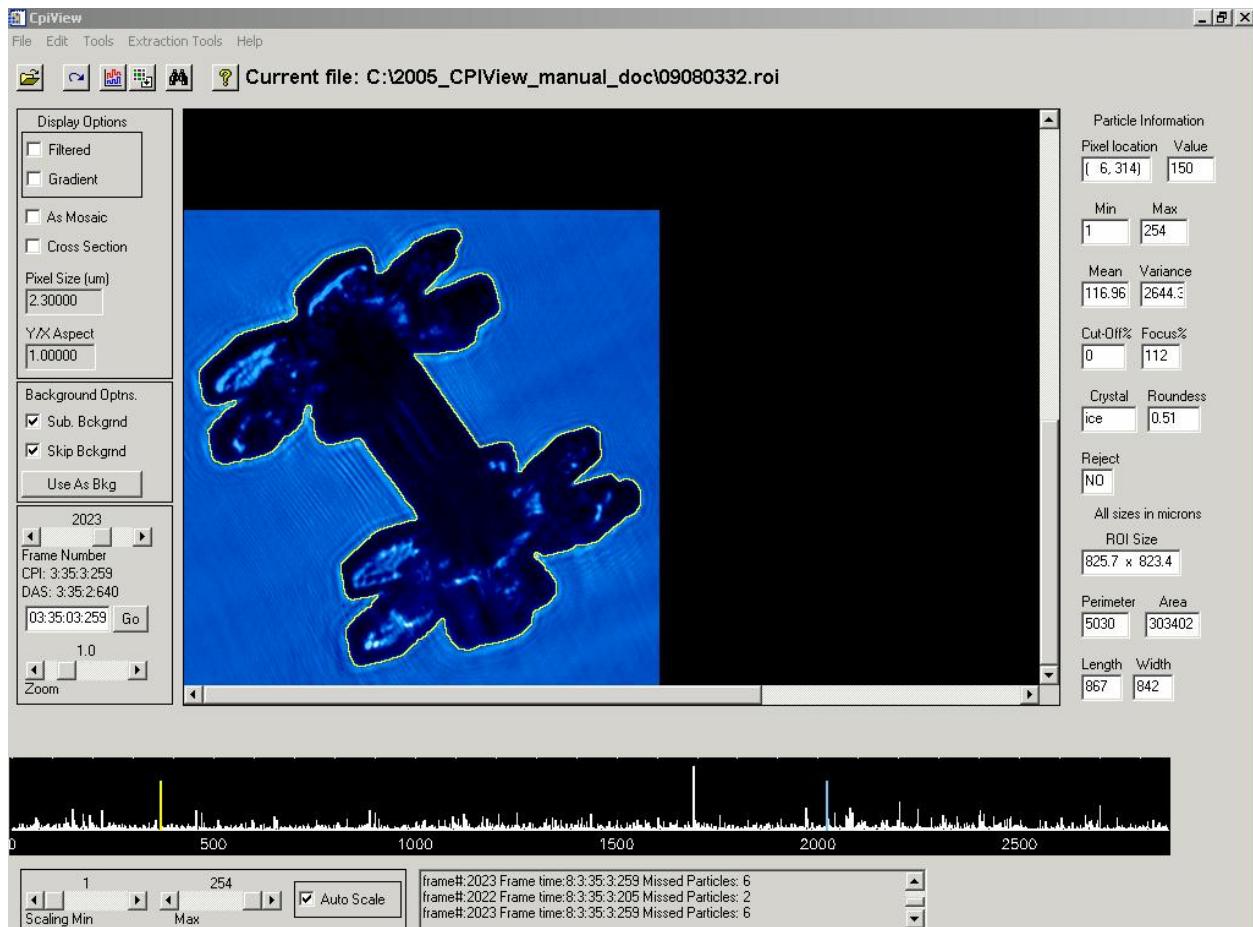
1. A PC running Windows NT, 98, XP, 2000 or Windows 7. Windows 98 cannot read the NTSF file format written by NT systems (NTSF is the file format used by the portable drives). Windows 2000 machines will read the NTSF formatted drives, but a drive that has been used on a 2000 machine will not be readable by Windows NT unless Windows NT has service pack 5 installed.
2. The PC must also have a licensed version of IDL version 6.3.
3. The PC must also have Adobe® Photoshop or comparable imaging software that reads Portable Network Graphic (PNG) images.
4. The PC screen resolution must be set to 1024 by 768 pixels or higher.

## 1 Installing Cpvivew

There are several components to the Cpvivew software package that need to be correctly installed on your computer. These files for cpiview have been pre-installed on your CPI computer, and can be transferred to a computer that meets the above requirements. These files need to be moved into the following folders if they are not currently in the directory:

Cpvivew.sav	to	RSI/idl63
Qllogo.jpg	to	RSI/idl63/lib/hook
EXLogo.jpg	to	RSI/idl63/lib/hook
CLLogo.jpg	to	RSI/idl63/lib/hook

Running cpiview: After installing cpiview, open IDL and type “cpiview” at the IDL command line. This will call up the cpiview program. The correct toolbox (quicklook, or extractor) will come up. If the toolbox not comes up, then click IDL file, click preference, Click path, and click insert, then click the CPIView software package directory for it to be added to the IDL path, then move that directory to the top ( above the IDL default). Click apply, click ok to close the path setup window. Then type @compilecpi at the IDL Command line, then type cpiview, this will call up the cpiview program. The correct toolbox (quicklook, or extractor) will come up. The cpiview interface is shown below.



1. A data file must be opened before processing can begin. Data files end in .roi (which stands for regions of interest). Select the File<sup>1</sup> menu item and select Open or click on the File Icon, , just below the File menu. Move to the appropriate directory and select a file as you would when opening a file using any other application. Note that only \*.roi files will be shown as choices.
2. Once the data file is loaded, the first particle will appear in the lower left-hand corner of the particle display window. The scrolling text box in the lower right portion of the screen shows: the number of images there are in the file, the number of background frames, the number of CCD camera pixels, and the location of the current background frame. Error messages will also be reported in the scrolling text box as the file is loaded. Step through the file by clicking on the Frame Number slider keys, [ $\blacktriangleright$ ] or [ $\blacktriangleleft$ ], at the lower left side of the particle display window to step forward or backward through the file. Information about each frame, including frame time and the number of particles detected by the PDS but not imaged (missed) are shown in the scrolling text box. The concentration plot displays the number of ROI's per frame for the file. The BLUE line marks the current frame, and the YELLOW line marks the current background. Information about each particle, including extracted

<sup>1</sup> Words in the Courier Font represent Interface names

information if an OBJ file has been made (see Extraction Tools section), is displayed on the right hand side in the Particle Information area when the cursor is placed over the particle.

3. A new file can be opened as described in 1 above, or the program can be exited by selecting Quit under the pull-down File menu.

## 2 BASIC FEATURES

### 2.1 Menu Items

Each menu item has a corresponding ToolBar button, the icons are:

- File: File allows you to load a new \*.roi file or to quit the program. You can also open a \*.roi file by pressing the  button.
- Edit: The Edit menu allows you to redraw the frame (you can also use ). At times it is necessary to redraw the frame if the color table (see Tools section below) has been changed. (The color table is changed when a time series is changed and may not change back automatically.)
- Tools: The Tools menu allows you to generate/view plots (you can also use ) which will be discussed in the Advanced Features section, as well as adjust the color table (you can also use  for dark or light data or if the color table has changed).
- Extraction tools: The Extraction Tools menu (you can also use ) available on eXtractor, allows you to create \*.obj files for better processing.
- Help: The Help menu (you can also use ) gives revision notes on this version of cpiview.

### 2.2 Particle Information

Particle information is shown to the right of the particle display window. By moving the mouse cursor over a Region Of Interest (ROI) image, information about the particle is displayed in the Particle Information area. The information is as follows:

1. Pixel Location: relative location of the cursor over the ROI in pixels.
2. Value: raw value of the cursor over the ROI in data units.
3. Min: minimum value of the ROI pixels.
4. Max: maximum value of the ROI pixels.
5. Mean: mean value of the ROI pixels.
6. Variance: variance of the pixels in the ROI.
7. Cut-off%: the amount of the particle that is cut-off by the boundary of the ROI box. It can be either user-set by right clicking on the ROI box or auto-extract set via Extraction Tools. EXtractor calculates cut-off when an \*.obj file is made. The value is a percentage from 0-100, but is stored as a 5-bit value with a range of 0-31.

8. Focus%: Either user-set or auto-extract set value displaying an estimate of the focus of the particle. This is user-set by right clicking on the ROI box. Values range from 0-100 with 100 being in focus, the default (rarely the value can be slightly greater than 100, these should be interpreted as 100). (eXtractor only or can be set with manual features)
9. Crystal: Either user-set or auto-extract set crystal type classification. This is user-set by right clicking on the ROI box and choosing a value from 0 – 31. Defaults are “spheroids” and “ice” based on roundness. (eXtractor only or can be set with manual features)
10. Roundness: Auto-extract computed roundness value of particle, 0-1.0 (eXtractor only)
11. Reject: Either user-set or auto-extract set parameter rejecting the particle. (eXtractor only)
12. ROI Size: Raw length and width from roi file, in microns.
13. Perimeter: Auto-extract computed perimeter in microns. (eXtractor only)
14. Area: Auto-extract computed area in microns. (eXtractor only)
15. Length: Auto-extract computed length in microns. (eXtractor only)
16. Width: Auto-extract computed width in microns. (eXtractor only)

Note: details on Manual Feature Processing (user-set options) are given below.

### **2.3 Display Options**

Display options are shown to the left of the particle display window.

**Filtered:** When checked, a 4<sup>th</sup> order median filter is applied to the ROI's.

**Gradient:** When checked, a 4<sup>th</sup> order median filter followed by a Sobel filter is applied to the ROI's.

**As Mosaic:** When checked, the frame is displayed with the ROI's arranged in the appropriate absolute locations relative to the CCD frame (represented by the box outline). When unchecked, the ROI's line up in the particle display window at a magnification of 1.0.

**Cross Section:** When checked, the user can select two points on a ROI using the left mouse button. The points under this line are plotted in the display window. Unchecking this box will clear the plot.

**Pixel Size:** The currently active pixel size of the CCD imager in microns. This can be edited but should be changed back before any processing begins.

**Y/X Aspect:** The Current aspect ratio applied to the display of ROI's. This can be edited for non-square pixels.

## **2.4 Background Options**

Sub. Bckgrnd: When selected and if a background frame exists in the file, the background is subtracted from each ROI displayed.

Skip Bckgrnd: When selected frames containing backgrounds are skipped. To see a background frame, unselect Skip Bckgrnd *and* Sub. Bckgrnd (choose As Mosaic to see the background fully).

Use as Bkg: Normally, the closest background in the file is the currently selected background. When viewing a background frame, this is over-ridden by pressing this button.

## **2.5 Frame Number: chooses the frame to be displayed**

Times:

CPI: CPI Internal clock time in Hr:Min:Sec:mSec

DAS: Data Acquisition system time in Hr:Min:Sec:msec

Go: Type in a time (Hr:Min:Sec:msec) to display the image that corresponds to that time in the particle display window and click Go. If no image exists at the provided time, the image closest to the time will be displayed.

Zoom: Chooses the magnification factor applied to the display.

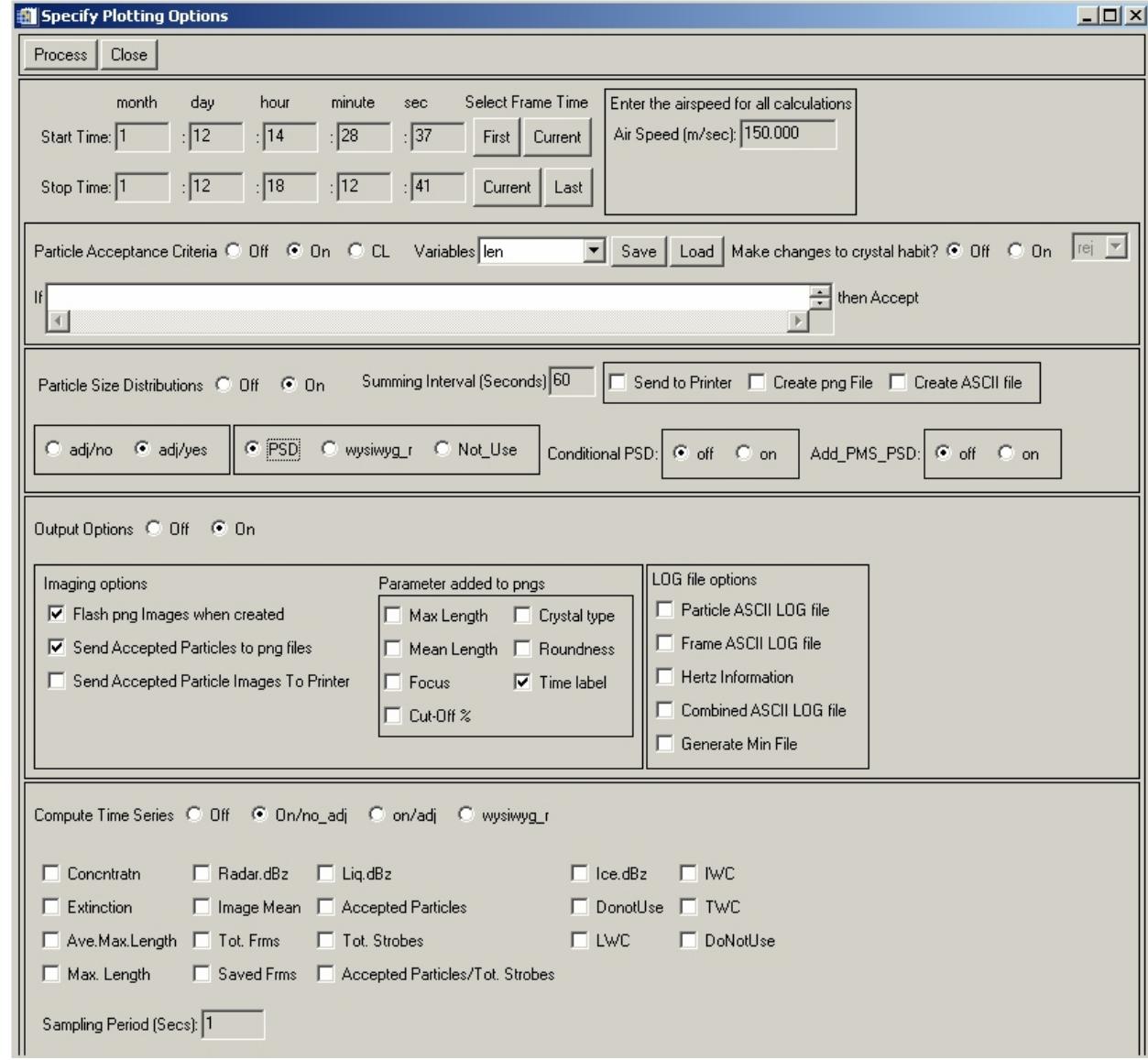
# **3 ADVANCED FEATURES**

## **3.1 Generate/View Plots**

The Generate/View Plots option brings up a window that is shown on the next page. A description of each function is described from the top down.

### 3.2 Process and Close

The process and close buttons are how to exit the window. Hit process to generate and receive the data products chosen below. Hit Close to exit the window without processing data.



### 3.3 Time Period and Air Speed selection

Enter time manually in the Month, Day, Hour, Minute, Sec entry boxes or Select via buttons. First is the time for the first frame in the file, Current is the time for the currently displayed frame, and Last is the time for the last frame in the file.

Airspeed (m/sec): Set the airspeed of the aircraft or the wind speed for surface data for particle concentration calculations in size distributions and in time series.

### 3.4 Particle Acceptance Criteria

This option allows manually entered particle acceptance criteria to be used to filter particles in all subsequent features. Clicking Particle Acceptance Criteria On enables this feature. Once enabled, criteria must be entered. The criteria are in the form of an IF (criteria) THEN accept. The criteria are entered in the text box below the Particle Acceptance Criteria On/Off buttons. Once entered, the criteria can be saved to a text file with the save button. Once a criterion is saved, it can be recalled at a later time. In this way, multiple criteria can be easily called up and reused. The variables available for filtering are presented in the variables droplist. The available variables depend on whether or not an \*.obj file is loaded: Without an \*.obj file (or in Quicklook), the variables are:

Len: represents the length of the raw roi  
Wid: represents the width of the raw roi  
Focus: represents the focus percentage (must be user set)  
Cut-off: represents the Cut-off percentage (must be user set)  
Crystal: represents the Crystal type number (must be user set)

Example acceptance criteria are:

Focus gt 75 and Cutoff lt 10  
Focus ge 50 and Crystal eq 2  
Crystal ge 5 and Crystal lt 8  
Focus gt 20 and len gt 100

With an OBJ file, the variables are:

Len: length of particle along major axis (microns)  
Wid: width of particle perpendicular to major axis (microns)  
Area: area of particle (square microns)  
Perim: perimeter of particle (microns)  
Roundness: roundness measure (0-1)  
Focus: focus parameter in percent  
FocusMin: Minimum focus value for the particle  
FocusMax: Maximum focus value for the particle  
FocusStdDev: Standard Deviation of the focus values.  
Cutoff: amount that particle is cut-off in percent  
Crystal: classification number 0-31  
P1: user set variable for custom identification purposes 0 or 1  
Holearea: the fraction of area above the shadow depth threshold

Acceptance criteria are entered as shown above. SPEC has created acceptance criteria for particle classification habits, an example of Cirrus cloud acceptance criteria

strings and notes are shown in Appendix A. Clicking `CL` will clear all criteria entered and will not be remembered within the program.

Particle Classification acceptance criteria can be loaded and a classification number or a 3-letter identifier can be assigned by loading a crystal acceptance criteria and turning on `Make changes to crystal habit?` and selecting a crystal type from the drop-down box. For example, loading a rosette criterion and then selecting the 3-letter identifier `ros` (followed by clicking `Process`) will assign “ros” to all particles that were accepted by the rosette criterion. Acceptance criteria can be loaded, and new identifiers can be selected one at a time until all particles have been classified. If you want to see and/or save the particles that are being accepted by a criterion while processing or output all images after all criteria have been loaded with an identifier labeled on each particle, you can click on the appropriate box in `Imaging options` (see Output Options section). After habit classification processing, moving the cursor over the ROI in the main screen and it will now show the manually assigned particle type in the `Crystal` box on the right side. If a particle is not accepted by the criteria it will still be called `ice`, the default setting. Once a change to the crystal habits was made, the OBJ will be forever modified and a new OBJ will need to be made if you want to start over.

### 3.5 Particle Size Distributions

Select this feature by clicking the `On` button. Once enabled, set the `Summing Interval (Seconds)`. This is the time over which the particle size distributions (PSDs) will be averaged. To do normal scaling, click on `PSD`. When the PSD option is checked, `adj/no` or `adj/yes` must be checked (no adjustment for particle detection system sensitivity or yes adjustment for particle detection system sensitivity). To do local scaling, click on `wysiwyg_r`. It does not matter if `adj/no` or `adj/yes` is checked when `wysiwyg_r` is checked, it will not have any effect. To make a Conditional PSD click `Conditional PSD` on. To add a PMS PSD click on `Add_PMS_PSD`. These options are all discussed in more detail in the following sections.

The `adj/no` option counts each image as one particle assuming the same sample volume for all particles. The `adj/yes` option accounts for particle detection system sensitivity varying with particle size.

To save a hard copy of the PSDs, there are these choices:

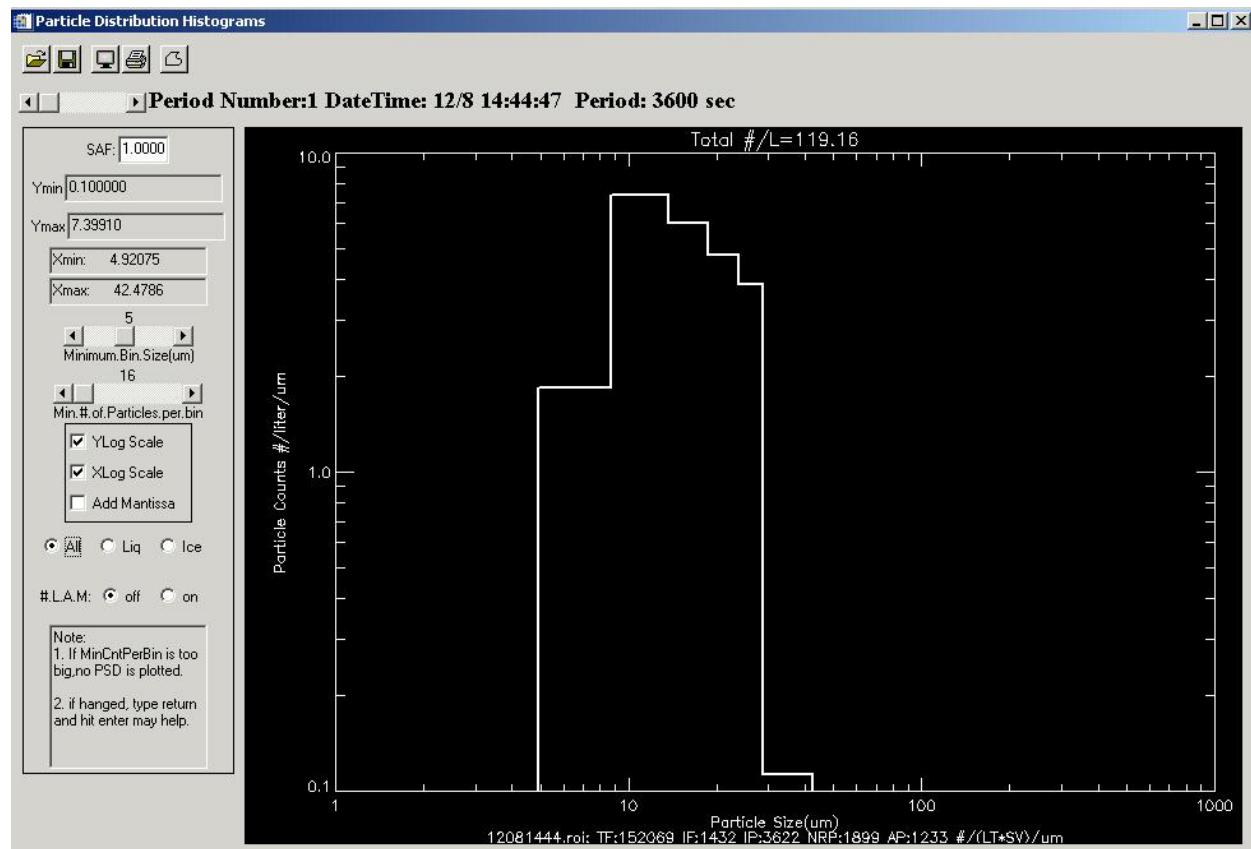
- `Send to Printer`: sends plots for each distribution in the summing interval selected (if data is present) to the default printer.
- `Create png File`: produces individual PNG files for each summing interval selected (if data is present).
- `Create ASCII file`: produces an ASCII file of the data values plus other info for each summing interval selected (if data is present).

Each of these options is also available in the Particle Distribution Histogram Viewer (described next).

### 3.6 Normal or wysiwyg\_r Particle Size Distributions

An example of the Particle Distribution Histogram Viewer (it displays after PSD or wysiwyg\_r is chosen and Process is pressed) is shown below. This window contains various options for displaying and printing Histograms.

1. The slider at the top is disabled. Only one period's PSD can be shown.
2. The SAF, Ymin, Ymax, Xmin, and Xmax boxes show the plot information.
3. The slider bars allow the user to modify the minimum bin size (um) and the minimum number of particles per bin.
4. Options are available to select an x or y Log Scale and Add Mantissa. Add Mantissa prints values above each bin. These values must be scaled by the decade value on the vertical axis when in Log Scale.
5. Checking All will show a PSD of all particles. Checking Liq will show a PSD of liquid particles only. Checking Ice will show a PSD of ice particles only.
6. Checking on #.L.A.M: shows four other PSD in units of: #/L/um, um/L/um, mm<sup>2</sup>/L/um, and mg/L/um.



7. The buttons at the top of the Particle Distribution Histogram are:

Import ASCII: Reads a previously saved histogram output file (See 10 Format for Particle Size Distribution ASCII Output for format details).

Export ASCII: Writes a \*.dat file for future analysis with the Particle Distribution Histogram Viewer or for use with other software.

Print: and both print the current histogram.

Save to PNG: creates a PNG file for the current Histogram

Exit: will close the window.

8. The total particle concentration is shown at the top of the PSD. The start time and the number of seconds in the summing period are next to the top disabled slider bar.

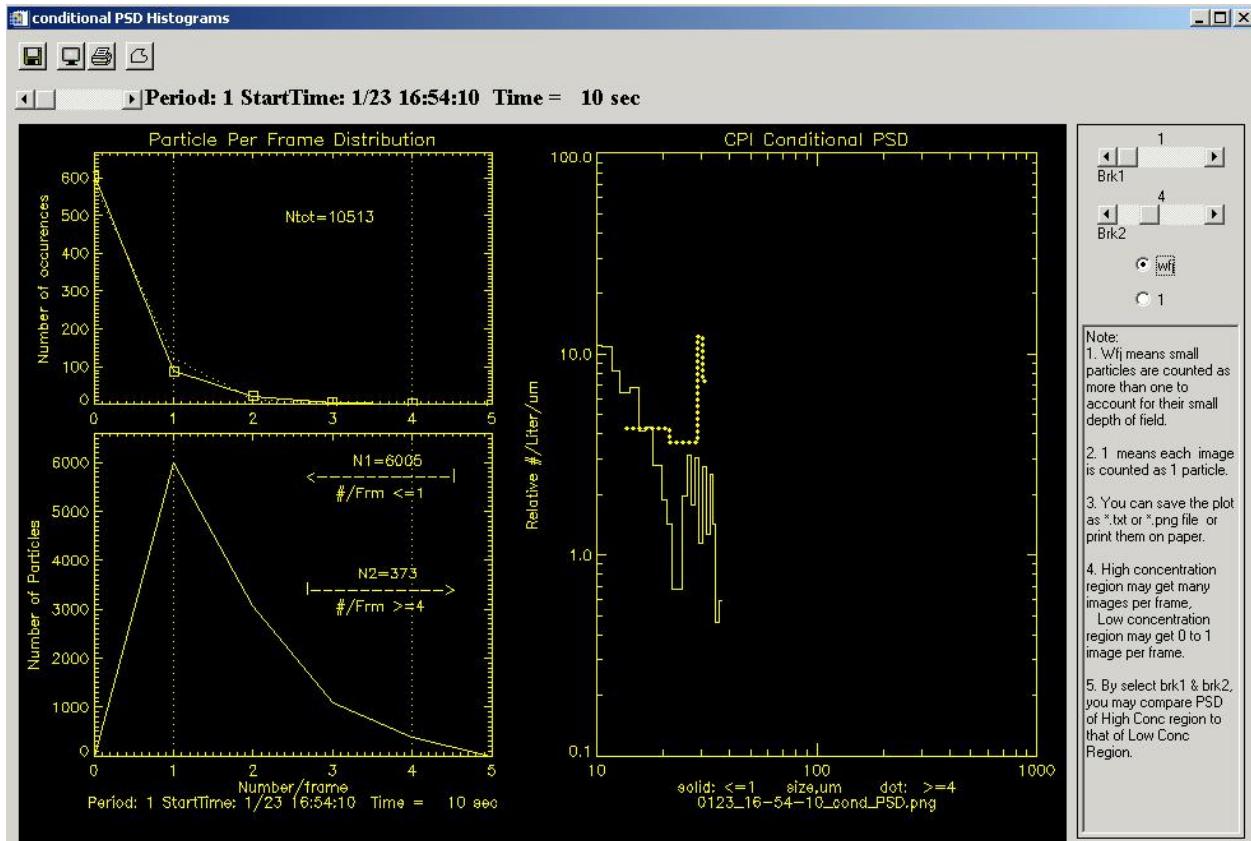
\*Note that if clear air is encountered, empty screens will be displayed with a note saying "no particles" or "too few particles".

Below the graph is a line of text showing:

1. The name of the roi file that was used in creating the histogram.
2. TF: Total frames captured by the probe during the time interval.
3. IF: The number of frames that had particles. (IF is a subset of TF)
4. IP: Total number of particles in the frames.
5. NRP: Total number of particles that were not rejected by the auto-extraction process (if you are using eXtractor and have created an obj file).
6. AP: Total number of accepted particles (the number of particles that passed the particle acceptance criteria). AP is the number of particles used to calculate the concentration for the histogram. (AP is a subset of NRP)
7. wysiwyg\_r: means PSD is scaled by random mode wysiwyg.
8. #/(LT\*SV)/um: means PSD is scaled in the normal way. Sample volume = CPI live time (LT) X sample area (S) X airspeed (V).

### 3.7 Conditional Particle Size Distributions

To look at the conditional PSD, first click Particle Size Distributions Off and then click Particle Size Distributions On (this will ensure that any earlier PSD sessions are erased from memory), then click Conditional PSD on. Type in the Start Time, Stop Time, and the Summing Interval (seconds). Press Process and this display window will be shown:



The notes to the right of the display window explain the scale options and the two slider bars at the top right of the window. The sliders Brk1 and Brk2 determine the N1 and N2 in the lower left plot. Checking the option w<sub>fj</sub> will use an adjustment factor that is greater than 1 to count images that are small. This accounts for small particles having smaller Depth of Field. Checking the option 1 will count all images as 1 particle regardless of size. The upper left plot shows the Particle Per Frame Distribution. The lower left plot shows the distribution of the Number of Particles in the number/frame bins. The right plot shows the Conditional PSD, which displays two PSDs segmented by the number of particles per frame (set by Brk1 and Brk2 sliders).

The plots of the conditional PSD can be saved as an ASCII text file, a PNG file, and be printed as was discussed in the 3.6 Normal or wywiwyg\_r Particle Size Distributions section.

### 3.8 Add\_PMS\_Particle Size Distributions

This option is for comparing FSSP, 2DC, 2DP, and CPI PSDs in the same time period.

In addition to the CPI \*.roi file, a standard formatted data file must be made and put in the same directory as the \*.roi file. This file is generated from Spec Inc's program prep\_cpvview\_input.pro. To run prep\_cpvview\_input.pro, open it with IDL 6.0 and follow the prompts. It will input either Net CDF files from the RICO project or SMO files from

the SPEC Lear. The name of the file will be: mmdd\_hhmmss\_hhmmss\_fssp2dc1Hz.txt, where mmdd is month and day; hhmmss is hour, minute, second; the first hhmmss is the start time of the file and the second hhmmss is the end time of the file. The file has this format:

```
This file is generated from Spec Inc software prep_cpiview_input.pro
30      This-is-total_number-of-fssp--bins
103     This-is-total_number-of-twodc-bins
BinCenters      0.580    1.54     30      50      70
Bin_Widths       0.360    1.560    20.0    20.0    20.0
30290580        16.0     6.0      2.0      1.8      0.66
30290581        13.0     8.0      1.0      2.8      0.93
```

The first line is general information.

The second line gives the number of FSSP bins.

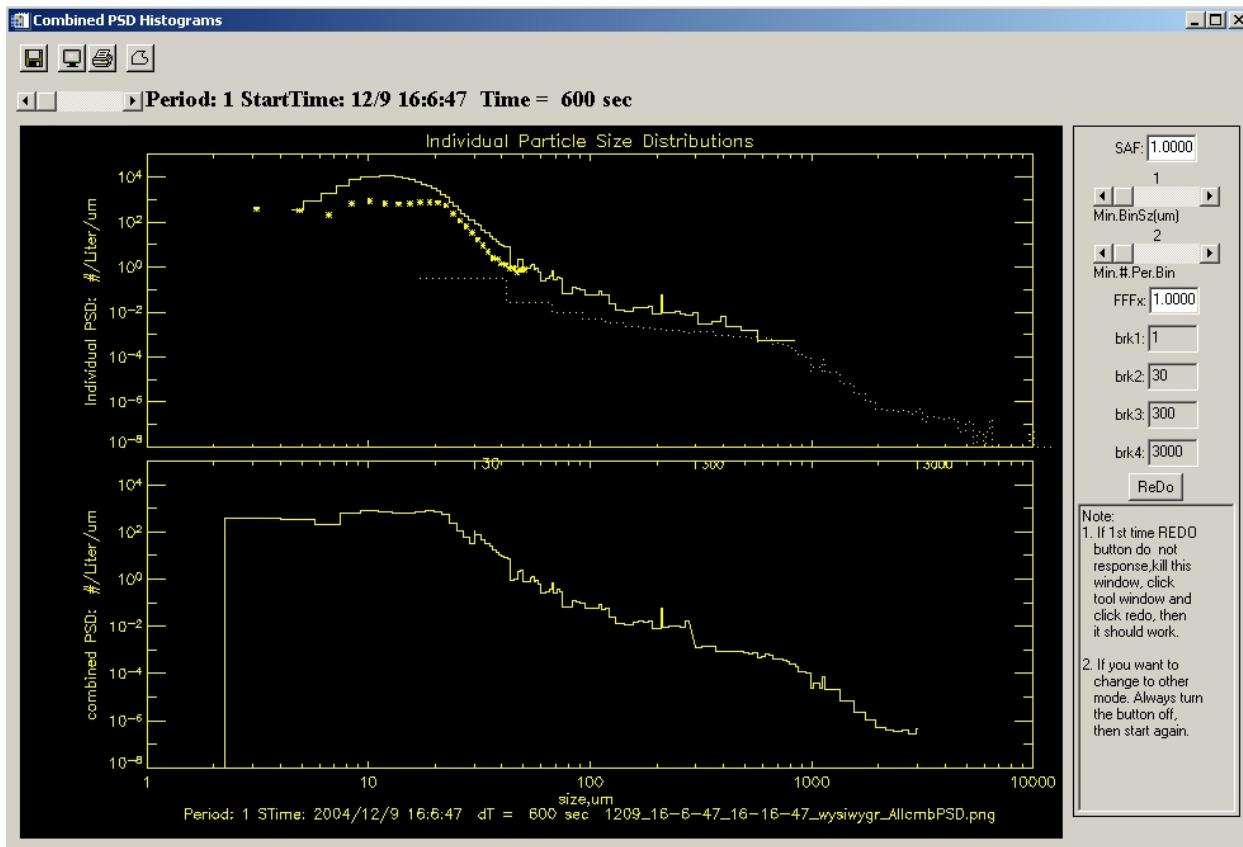
The third line gives the number of 2DC bins.

The next lines contain the values of all the bin centers and widths.

After the BinCenters and Bin\_Widths lines, the first column is the time (in seconds from midnight). The next column is the bin-height of the first bin of the FSSP (#/L/um). Additional columns will correspond to the total number of FSSP bins. The next column after the FSSP bin-height columns is the bin-height of the first bin of the 2DC (#/L/um). Additional columns will correspond to the total number of 2DC bins.

Either the PSD or wysiwyg\_r option must be checked on. When the Process button is pressed, a window will open asking you to load the standard formatted data file. Click on the first line of data when the ASCII Template window opens and then Next, Next, and Finish. Once a data file is selected and loaded, the Combined PSD Histogram Viewer will appear to show the PSD comparison.

The standard formatted data file only needs to be loaded once so multiple PSDs can be made (by going back to Specify Plotting Options screen) without having to load the file each time.



1. The CPI PSD shape can be changed by the `Min.BinSz(um)` and `Min.#.Per.Bin` sliders.
2. The CPI PSD curve can be moved up and down to align it with the FSSP and 2DC PSDs by changing the `FFFx` value.
3. The top plot is the `Individual PSD` plot. The bottom plot is the `combined PSD`. The plots can be saved as an ASCII text file, a PNG file, and be printed as was discussed in the 3.6 Normal or `wysiwyg_r` Particle Size Distributions section.
4. Use `brk1` and `brk2` to select the FSSP section when making a `combined PSD`.
5. Use `brk2` and `brk3` to select the CPI section when making a `combined PSD`.
6. Use `brk3` and `brk4` to select the 2DC section when making a `combined PSD`.
7. After you have modified the `brk1`, `brk2`, `brk3`, and `brk4` boxes, hit `ReDo` to redraw the plot with the new settings.

## 4 Output Options

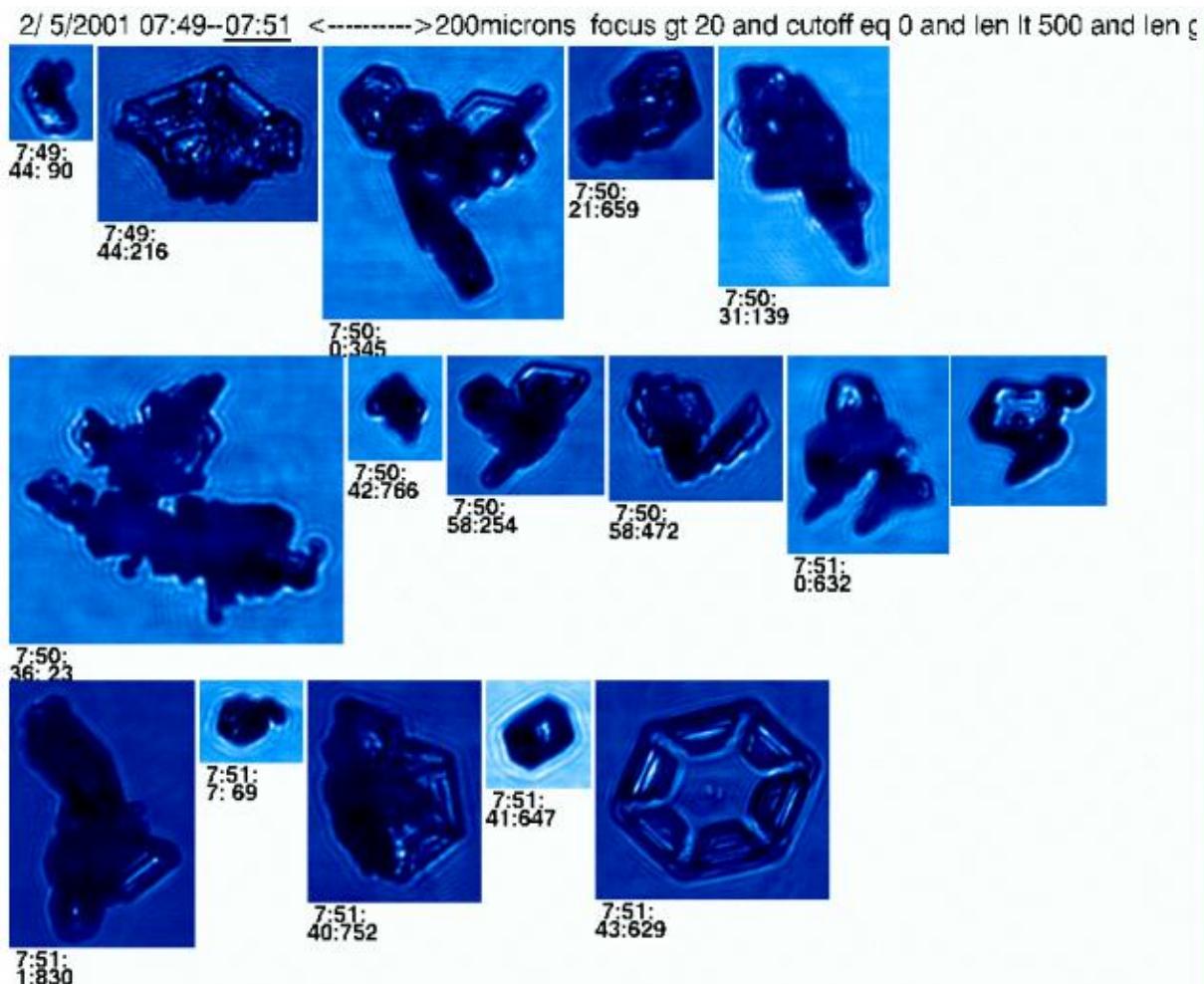
Select this feature by clicking the On button. This feature will create PNG files with ROI images on them and ASCII files with image information in them. Select the boxes to produce a particular output.

### 4.1 Imaging options:

Flash png Images when created: as a PNG frame is generated, it is displayed on the screen for a short time.

Send Accepted Particles to png files: this will send the PNG frame to a file. An example of a page of images printed from a \*.png file is shown below.

Send Accepted Particle Images To Printer: prints a page(s) of image(s) to the default printer.



The PNG images contain a header that includes: the date, the time period, a size scale, and the particle acceptance criteria used. (**Note** that the scale is only accurate when the zoom factor is set to 1.0 on the cpiview window (lower left) when the PNG files are made.)

Next to the output buttons there is a box of options (Parameter added to pngs) that can be applied to each ROI in the PNG file. These are:

Max Length: add the maximum dimension of the particle ( $\mu\text{m}$ )  
Mean Length: add the mean dimension of the particle ( $\mu\text{m}$ )  
Focus: add focus value (auto-extract created value or manually set value)  
Cut-Off%: add cut-off value (auto-extract created value or manually set value)  
Crystal Type: add crystal type number or 3-letter identifier (auto-extract created value or manually set value)  
Roundness: add roundness value (auto-extract created)  
Time Label: add time label.

LOG file options are options to create ASCII output. These are:

Particle ASCII LOG file: outputs all available data in column format for each particle in two files: \*\_stats.csv and \*\_features.csv. Uses eXtracted values where appropriate.

Frame ASCII LOG file: Outputs ASCII log file of data for every frame in the selected time period.

Hertz Information: Creates a log file containing the probe's housekeeping data for the time period selected.

Combined ASCII LOG file: Outputs all available data pertinent to particle size and dimensions for each particle, like Particle ASCII LOG file but only creates one file.

Generate Min File: This is an outdated option, do not use it.

Log file contents are shown in 9 ASCII Format Definitions.

SPEC programs that use these log files are shown in 10 Format for Particle Size Distribution ASCII Output.

## 4.2 Compute Time Series

Select one of the three scaling options buttons to enable computation and display of time series. Once enabled, select the desired time series. Multiple data can be over-plotted onto the same graph. The available types are:

1. On/no\_adj: to calculate concentration (#/Liter in the sampling period) the number of imaged particles is counted and then divided by the estimated sample volume. This volume is given by the following equation:

$$(sum \sec s - \sum deadtimes) \times TAS \times \cos(\pi / 4) \times dx \times dy \times pixsize^2$$

Where TAS is the true airspeed;  $\cos(\pi / 4) \times dx \times dy \times pixsize^2$  is the cross sectional sample area.

2. On/adj: to calculate concentration (#/Liter in the sampling period) each imaged particle is counted and then the sum is divided by the estimated sample volume. This volume is given by the following equation:

$$1/adj \times (sum \sec s - \sum deadtimes) \times TAS \times \cos(\pi / 4) \times dx \times dy \times pixsize^2$$

Where TAS is the true airspeed,  $\cos(\pi / 4) \times dx \times dy \times pixsize^2$  is the cross sectional sample area. Adj is greater than or equal to 1. The smaller the particle the larger adj is. Adj accounts for the reduced probability of detection of smaller particles.

3. wysiwyg\_r\_scaled: Every imaged particle in the sampling period is counted and the sum is calculated. Then the sum is divided by the estimated sample volume. This volume is given by the following equation:

$$DOF \times totfrms \times area\_viewed\_by\_camera$$

The larger the particle is the larger the DOF (depth of field) is. DOF is capped at the window to window distance. Totfrms is the number of image frames taken during the time period.

#### A list of the time series variables:

1. Concentration: in units of #/Liter.
2. Extinction: in units of 1/km. It is derived from the particle's projected area divided by the sample volume.
3. Ave.Max.Length: average of the max lengths of all particles in sample period ( $\mu\text{m}$ ).
4. Max.Length: max length of largest particle in sample period ( $\mu\text{m}$ ).
5. Radar.dBz: radar reflectivity value from all particles.
6. Image Mean: average value of the CCD frame in data units.
7. Tot. Frms: number of frames in the sample period, includes empty frames.
8. Saved Frms: number of frames with ROIs in the sample period.
9. Liq.dBz: radar reflectivity of all liquid particles.
10. Accepted Particles: count of accepted particles in the sample period.
11. Tot. Strobes: number of PDS strobes in the sample period.
12. Accepted Particles/Tot.Strobes: ratio of 10 and 11 above.
13. Ice.dBz: calculated radar reflectivity from ice particles.
14. DonotUse: reserved for other time series

15. LWC: Liquid water content.
16. IWC: ICE water content.
17. TWC: Total water content ( which is the sum of liquid and ice water content).
18. DoNotUse: reserved for future usage.

There is also an entry box for Sampling Period (Secs), it sets the averaging interval for the time series plots.

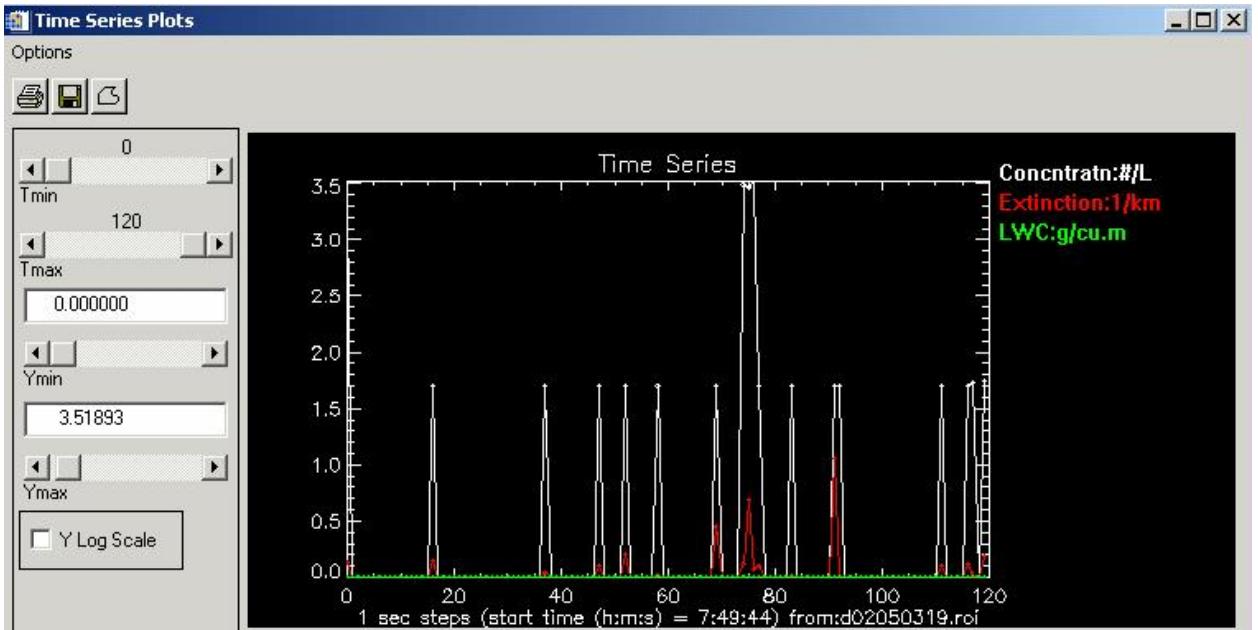
Note: For calculating IWC and LWC there are two choices, Auto select and Manual select. Auto select uses the extracted particle type for calculating either IWC or LWC. Manual select allows the user to determine particle type by particle acceptance criteria. When manual is selected, the particle type (as determined by the extraction process) is ignored. IWC and LWC will be calculated based on the particles that make it through the particle acceptance criteria. If your acceptance criteria selects only ice particles, and if you have selected a LWC choice, the result for LWC will be meaningless.

#### 4.3 Time Series Plots

The time series viewer allows changing of the axis scales and electing between log and linear Y-axis.

The Options menu contains:

- Print:  send plots to printer.
- Save Data to File:  write an ASCII file of the data.
- Save Plot to PNG:  create a PNG file of the data.
- Exit:  will close the window.



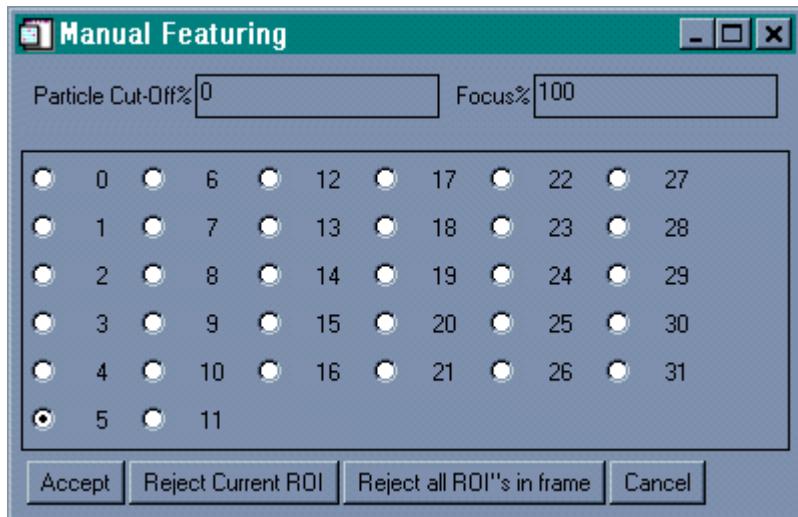
#### 4.3.1.1

#### 4.3.1.2

4.3.1.3\*This is the end of the Generate/View Plots section.

## 5 Manual Feature

In the main CPIView display window (when the mouse is over an ROI) right click to bring up the Manual Featurig window. An example is shown below:



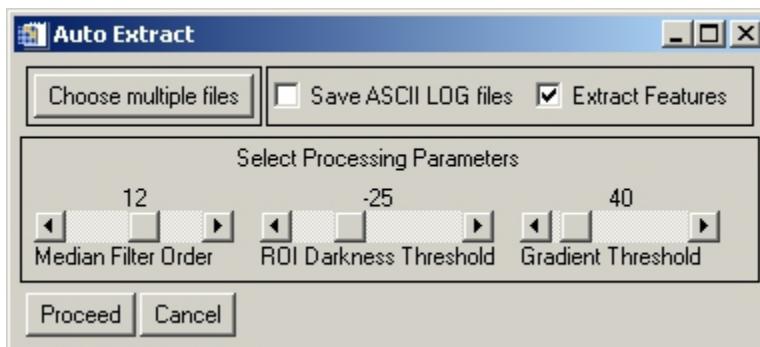
Set the desired values for Particle Cut-Off% and Focus% in the entry boxes and select the desired Crystal type (1-31). When done press Accept if satisfied or Cancel if not. The ROI selected can be rejected by clicking on the Reject Current ROI. Reject all ROI's in the frame by clicking on Reject all ROI's in frame. The

changes will be written to the file when the frame is changed with the Frame Number slider or the ReDo Frame button is pressed or the application is exited.

## 6 Extraction Tools (eXtractor only)

The Extraction Tool  performs an analysis on each ROI and creates an object file (extension .obj). This file contains a rich set of parameters that can be used for crystal type identification and other classification techniques. If an \*.obj file was previously created and is in the same folder as the \*.roi file, then it will automatically be opened when the \*.roi file is opened.

The Auto-extract dialog is presented for fine-tuning of the algorithm.



To make an \*.obj file, click on Extract Features, choose thresholds, and Proceed. If desired, click on Choose multiple files to process more than the currently open \*.roi file. A large \*.roi file usually takes more than an hour (depending on computer speed) to make the \*.obj file. A common process is to Choose multiple files and let it run overnight with a group of \*.roi files in their own separate folder. Select Save ASCII LOG files to create an ASCII version of the binary \*.obj file. The Processing parameters can be adjusted if desired. The parameters are:

### Median Filter Order -

This is the number of consecutive applications of a 3x3 Median filter to the image. The median filter is used to remove "salt and pepper" noise.

### ROI Darkness Threshold -

Pixels with values above this threshold are not considered to be part of a particle. This is the primary criteria used in detecting and sizing particles.

### Gradient Threshold -

The magnitude of the 2-D gradient of the image is used to detect particle edges. Gradient values below this threshold are ignored, while values above it are used in conjunction with the ROI Darkness Threshold to determine the boundary of particles.

Press Proceed to process, or Cancel to abort. During processing, a progress bar is displayed on the CPIVIEW main display window below the Zoom option. NOTE: Processing can take a long time! A computer with a 1.0 Ghz processor or better is recommended. When complete, a dialog box informs the user. If a given \*.roi file does not have a background, the current directory will be searched for a nearby file that contains a background. This background will be used in the extraction process. The actual backgrounds used are listed in a log window at the completion of processing all the files.

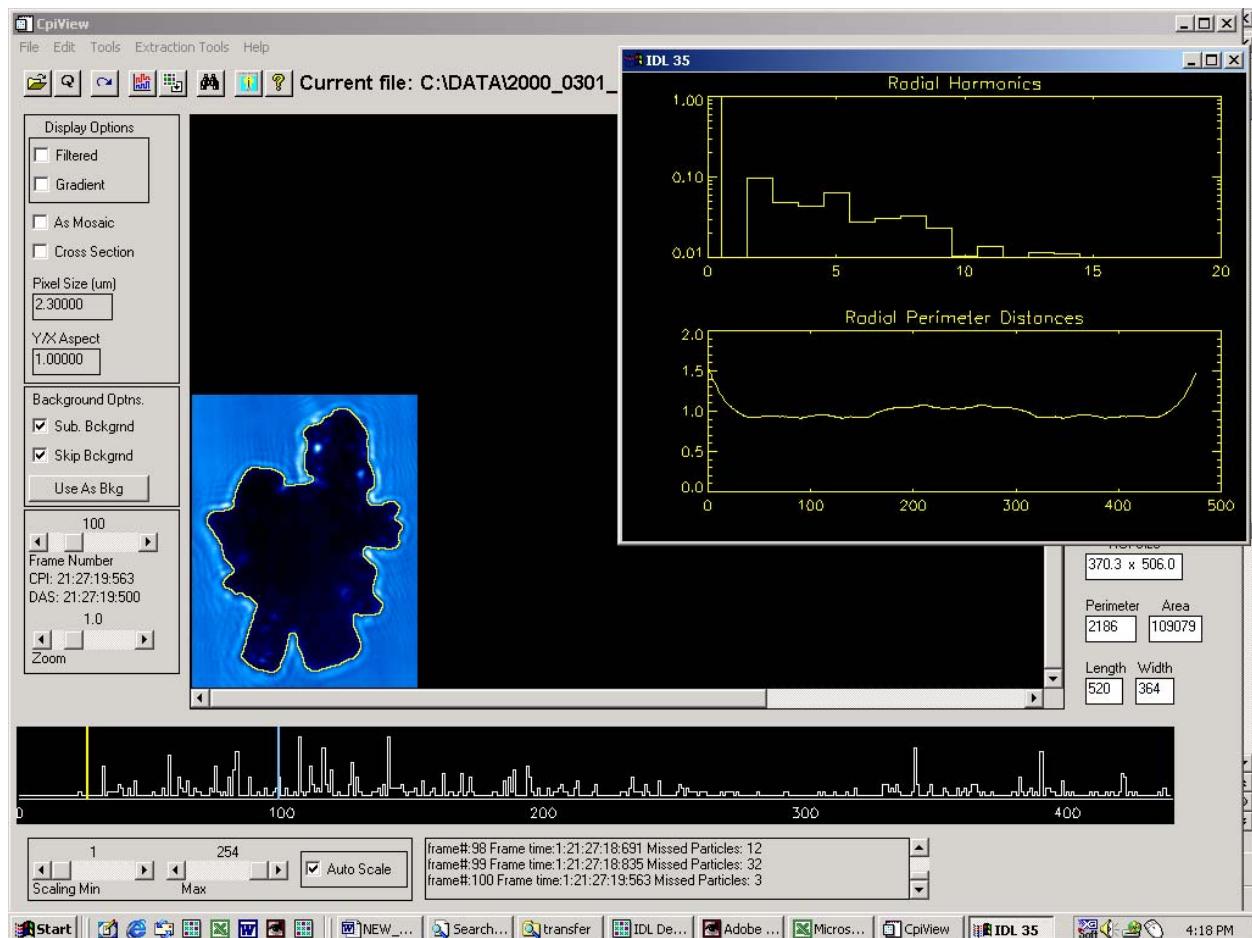
### **6.1 Viewing extracted features:**

By moving the mouse pointer over a ROI, information from the extraction appears on the right hand side of the interface. By left-clicking on any ROI, the perimeter of the particle is displayed. In some cases, the extraction procedure failed to complete and no perimeter is displayed. This is noted by the words "Particle Rejected" on the screen. When an \*.obj file is present upon opening an \*.roi file, the options available in the Generate/View plots particle acceptance criteria are increased to include the new features.

## **7 Additional features in CPIview**

### **Harmonics (eXtractor only):**

In order to view the harmonics for the particle, it is necessary to restart cpiview using the harmonics key word. I.e. on the IDL command line type "cpiview,/harmonics". Load a file that has an \*.obj file. Left click on a particle to open the harmonics window. A new window (as seen below) will appear that shows the radial harmonics as well as the radial perimeter distances of the particle.



## 8 Habit Classification Acceptance Criteria

During the extraction process CPIVIEW sets the variable called 'crystal' equal to 15 for ice, 1 for water, and 0 for rejected particles. You can further modify the values of 'crystal' either semi-automatically using the acceptance criteria option or manually by right clicking on any particle image.

An example of acceptance criteria strings that we use for cirrus clouds follows:

### Spheroid:

Focus gt 20 and cutoff lt 6 and crystal eq 1

Focus greater than 20 selects only particles of reasonably good image quality. Cutoff lt 6 selects particles that are completely or almost completely in the image frame. These two requirements are used for all habit types. Crystal eq 1 establishes spheroids as discussed above.

### Column:

Focus gt 20 and cutoff lt 6 and crystal ne 1 and (len gt 1.9\*wid and perim/area lt 1.3\*(2\*(len+wid)/(len\*wid)))

The column acceptance criterion eliminates the spheroids and insists that the length (len) be at least 1.9 times the width (wid). It also checks that the perimeter (perim) to area ratio is not too much higher than expected for simple columns.

### Plate:

Focus gt 20 and cutoff lt 6 and crystal ne 1 and not(len gt 1.9\*wid and perim/area lt 1.3\*(2\*(len+wid)/(len\*wid))) and (((h2 gt 0.01 and h3 lt 0.02 and h4 gt 0.01 and h5 lt 0.02 and h6 gt 0.01 and holearea gt 20) or (h2 gt 0.01 and h3 lt 0.02 and h5 lt 0.02 and h6 gt 0.01 and len lt 1.8\*wid and len gt 75 and h4 lt 0.02) or (len gt 75 and h2 gt 0.01 and len lt 1.8\*wid and ((h4 gt 0.01) or (h6 gt 0.01)) and h3 lt 0.02 and holearea gt 10)))

The plate acceptance criterion eliminates Columns and spheroids and then uses the low order harmonics (h2, h3...) and the amount of particle image area that is above a specified shadow depth in intensity (holearea).

### Rosette:

Focus gt 20 and cutoff lt 6 and crystal ne 1 and not(len gt 1.9\*wid and perim/area lt 1.3\*(2\*(len+wid)/(len\*wid))) and not(((h2 gt 0.01 and h3 lt 0.02 and h4 gt 0.01 and h5 lt 0.02 and h6 gt 0.01 and holearea gt 20) or (h2 gt 0.01 and h3 lt 0.02 and h5 lt 0.02 and h6 gt 0.01 and len lt 1.8\*wid and len gt 75 and h4 lt 0.02) or (len gt 75 and h2 gt 0.01

and len lt 1.8\*wid and ((h4 gt 0.01) or (h6 gt 0.01)) and h3 lt 0.02 and holearea gt 10))) and not((sqrt(area)/perim lt .175 and len gt 80))

The rosette criterion eliminates all of the above habits and then insists on the perimeter being at least as large as the square root of the area divided by 0.175. It also requires the length to be greater than 80 microns.

#### **Budding Rosette:**

Focus gt 20 and cutoff lt 6 and crystal ne 1 and not(len gt 1.9\*wid and perim/area lt 1.3\*(2\*(len+wid)/(len\*wid))) and not(((h2 gt 0.01 and h3 lt 0.02 and h4 gt 0.01 and h5 lt 0.02 and h6 gt 0.01 and holearea gt 20) or (h2 gt 0.01 and h3 lt 0.02 and h5 lt 0.02 and h6 gt 0.01 and len lt 1.8\*wid and len gt 75 and h4 lt 0.02) or (len gt 75 and h2 gt 0.01 and len lt 1.8\*wid and ((h4 gt 0.01) or (h6 gt 0.01)) and h3 lt 0.02 and holearea gt 10))) and not((sqrt(area)/perim lt .175 and len gt 80)) and (sqrt(area)/perim lt .2 and len gt 40)

The budding rosette criterion is similar to the rosette criterion but first also eliminates rosettes and then only requires the perimeter to be at least as large as the square root of the area divided by 0.2 and also only requires the length to be greater than 40 microns.

#### **Small Irregular:**

Focus gt 20 and cutoff lt 6 and crystal ne 1 and not(len gt 1.9\*wid and perim/area lt 1.3\*(2\*(len+wid)/(len\*wid))) and not(((h2 gt 0.01 and h3 lt 0.02 and h4 gt 0.01 and h5 lt 0.02 and h6 gt 0.01 and holearea gt 20) or (h2 gt 0.01 and h3 lt 0.02 and h5 lt 0.02 and h6 gt 0.01 and len lt 1.8\*wid and len gt 75 and h4 lt 0.02) or (len gt 75 and h2 gt 0.01 and len lt 1.8\*wid and ((h4 gt 0.01) or (h6 gt 0.01)) and h3 lt 0.02 and holearea gt 10))) and not((sqrt(area)/perim lt .175 and len gt 80)) and not(sqrt(area)/perim lt .2 and len gt 40) and (len lt 200)

The particles not identified by one of the above criteria are classified as small irregulars if their length is less than 200 microns.

#### **Big Irregular:**

Focus gt 20 and cutoff lt 6 and crystal ne 1 and not(len gt 1.9\*wid and perim/area lt 1.3\*(2\*(len+wid)/(len\*wid))) and not(((h2 gt 0.01 and h3 lt 0.02 and h4 gt 0.01 and h5 lt 0.02 and h6 gt 0.01 and holearea gt 20) or (h2 gt 0.01 and h3 lt 0.02 and h5 lt 0.02 and h6 gt 0.01 and len lt 1.8\*wid and len gt 75 and h4 lt 0.02) or (len gt 75 and h2 gt 0.01 and len lt 1.8\*wid and ((h4 gt 0.01) or (h6 gt 0.01)) and h3 lt 0.02 and holearea gt 10))) and not((sqrt(area)/perim lt .175 and len gt 80)) and not(sqrt(area)/perim lt .2 and len gt 40) and not(len lt 200) and (len ge 200)

The particles not identified by any of the above criteria are classified as big irregulars if their length is greater than 200 microns.

## 9 ASCII Format definitions

ASCII Particle stats File:

Col #	Heading	Format	Description
1	Year	Integer	Year of data acquisition
2	mm:dd:hh:mm:ss	Integer+float	Month-day-hour-minute-sec (sec is float to milliseconds)
3	ROI#	Integer	ROI Number in frame
4	ArrTime	Integer	Arrival time in $\mu$ sec
5	TS	Integer	Total strobe count
6	DeadTime	Float	Deadtime in milliseconds
7	Length	Float	Maximum length in $\mu$ m
8	Width	Float	Orthogonal width in $\mu$ m
9	Drk	Integer	Flag ( see note 1 below)
10	Area	Float	Area in sq. $\mu$ m
11	Perim	Float	Perimeter in $\mu$ m
12	Centroid	Integer array	Co-ordinates of particle centroid in relative pixels
13	Rndness	Float	Roundness measure
14	X_mnt	Float	X moment - 1/2 area on each side of vertical line
15	Y_mnt	Float	Y moment - 1/2 area on each side of horizontal line
16	Rub_band	Float	Rubber band - Measure of boundary roughness
17	Fract_dim	Float	Fractal dimension
18	SampPer	Float	Sample period of harmonic array in pixels???
19	Focus	Integer	% focus 0-100 Mean of 20 points on perimeter (255 indicates failure)
20	Fmin	Integer	Min of 20 points on perimeter
21	Fmax	Integer	Max of 20 points on perimeter
22	FStDv	Float	Standard Deviation of 20 points on perimeter
23	Fgd	Integer	Focus Good - ???
24	Cutoff	Integer	Cut-off – percentage that particle is cut-off optically
25	Crystal	Integer	Crystal type – number specifying crystal type
26	P1	Float	Used for internal purposes
27	P2	Float	Used for internal purposes
28	P3	Float	Used for internal purposes
29	P4	Float	Used for internal purposes
30	CurvWin		Curvature_Window- # of points in the local radius of curvature measurement
31	Focus_Sstats	Float array	Focus_Sstats – (see note 2 below)
32	Intensity_Sstats	Float array	Intensity_Sstats – same as above stats array
33	IntHLSsts	Float array	Intensity_HoleLess_Sstats – same as above stats array
34	GradSsts	Float array	Gradient_Sstats – same as above stats array
35	RadSsts	Float array	Radii_Sstats – same as above stats array
36	CrvSsts	Float array	Curvature_Sstats – same as above stats array
37	HCnt	Integer	Hole_Count – number of holes found
38	HAssts	Float array	Hole_Area_Sstats – same as above stats array
39	HintSsts	Float array	Hole_Intensity_Sstats – same as above stats array
40	HOSsts	Float array	Hole_Other_Sstats – same as above stats array
41	H1Ar	Float	Hole1 Area – area of hole
42	H1Ists	Float array	Hole1 Intensity_Sstats – same as above stats array
43	H1Prm	Float	Hole1 Perimeter – perimeter of hole found
44	H1Osts	Float array	Hole1 Other_Sstats – same as above stats array
45	H2Ar	Float	Hole2 Area – area of hole

46	H2Ists	Float array	Hole2 Intensity_Stats – same as above stats array
47	H2Perim	Float	Hole2 Perimeter – perimeter of hole found
48	H2Osts	Float array	Hole2 Other_Stats – same as above stats array
49	H3Ar	Float	Hole3 Area – area of hole
50	H3Ists	Float array	Hole3 Intensity_Stats – same as above stats array
51	H3Perim	Float	Hole3 Perimeter – perimeter of hole found
52	H3Osts	Float array	Hole3 Other_Stats – same as above stats array

ASCII Particle-features file:

1	HrmCnt	Integer	Harmonics Count - size of Harmonics array (variable)
2	Harmonics	Float	Harmonics - array of circular perimeter harmonics
3	BndCnt	Integer	Boundary Count - size of Boundary array (variable)
4	Boundary	Integer	Boundary - array of relative perimeter in 1D pixels
5	RadCnt	Integer	Radii Count - size of Radii array (variable)
6	Radii	Float	Radii – array of radial lengths from centroid to perimeter (units?)
7	CurvCnt	Integer	Curvature Count - size of Curvature array (variable)
8	Curvature	Float	Curvature - local radius of curvature measurement

ASCII Frame File :

Col #	Heading	Format	Description
1	SZE	Integer	
2	Version	Integer	Version number for data file. (determined by age of acquisition gui)
3	RoiCnt	Integer	Number of roi's in frame
4	roisze	Integer	Number of pixels saved from the frame
5	HouseTime	Integer	Probe time since beginning of year
6	Date	Integer	Date format: dd:hh:mm:ss
7	IMGtype	Float	
8	SX	Integer	
9	Sy	Integer	
10	Ex	Integer	
11	Ey	Integer	
12	Bgrate	Integer	Background rate
13	Bkgdst	Integer	
14	Frmsproc	Integer	
15	Ithr	Integer	
16	Roierr	Integer	
17	Roiminsz	Integer	
18	Roiaspect	Integer	
19	Roifill	Integer	
20	Roifcnt	Integer	
21	Imgmn	Integer	
22	Bkgmn	Float	
23	Spr1	Float	
24	ROIXPad	Integer	x-dim pad around particle in pixels
25	ROIYPad	Integer	x-dim pad around particle in pixels
26	Strbcnt		
27	Frmssvd	Integer	
28	Imgminval	Integer	
29	Imgmaxval	Integer	
30	Roissvd	Integer	

31	Chksum	Integer	
32	Pdshd1	Integer	
33	Pdshd2	Integer	
34	Pdshd3	Integer	
35	Time	Integer	
36	Arrvlt1		
37	Arrvlt2		
38	Transit_time		Transit time
39	Missed		Number of pds detections since camera was last available
40	Phght1		
41	Phght2		
43	Pdschks		
44	prbmode		

#### ASCII Combined Log File:

Col #	Heading	Format	Description
1	Year	Integer	Year of data acquisition
2	mm:dd:hh:mm:ss	Integer+float	Month-day-hour-minute-sec (sec is float to milliseconds)
3	ROI#	Integer	ROI Number in frame
4	ArrTime	Integer	Arrival time in $\mu$ sec
5	TS	Integer	Total strobe count
6	DeadTime	Float	Deadtime in milliseconds
7	Length	Float	Maximum length in $\mu$ m
8	Width	Float	Orthogonal width in $\mu$ m
9	Area	Float	Area in sq. $\mu$ m
10	Perim	Float	Perimeter in $\mu$ m
11	Focus	Integer	% focus 0-100 Mean of 20 points on perimeter (255 indicates failure)
12	Cutoff	Integer	Cut-off – percentage that particle is cut-off optically
13	Crystal	Integer	Crystal type – number specifying crystal type
14	P1	Float	Used for internal purposes
15	IntHLSsts	Float array	Intensity_HoleLess_Stats – same as above stats array
16	HrmCnt	Integer	Harmonics Count - size of Harmonics array (variable)
17	H1	Float	Hole1 Area – Area of Hole
18	H2	Float	Hole2 Area – Area of Hole
19	H3	Float	Hole3 Area – Area of Hole
20	H4	Float	Hole4 Area – Area of Hole
21	H5	Float	Hole5 Area – Area of Hole
22	H6	Float	Hole6 Area – Area of Hole
23	SX	Integer	
24	Sy	Integer	
25	Ex	Integer	
26	Ey	Integer	

#### Notes:

##### 1. Dark parameter codes (Dark: 2-byte word)

Byte	Meaning
1 <sup>st</sup> byte	darkness number
2 <sup>nd</sup> byte	LS 5-bits = Particle cutoff index: 0-31 (no cut-off to almost fully cut-off)

## 2: Meaning of Statistic arrays

<b>Array Element</b>	<b>Name</b>	<b>Meaning</b>
0	N	Size of sample set
1	Min	Minimum value
2	Max	Maximum value
3	Mean	Mean value
4	Median	Median Value
5	Mode	Mode
6	Std Dev	Standard Deviation
7	Skewness	Skewness
8	Kurtosis	Kurtosis

## 3. Codes for flag (Flags: 2-byte word)

<b>Bit Number</b>	<b>Meaning</b>
0-7	out of focus number
8-11	crystal type 0=circular 1=column 2=stellar 3=other
12	Not used.
13	ROI was drawn manually.
14	Crystal type was manually corrected.
15	Particle was manually rejected.

## 4. Codes for ROI ERROR

<b>Value</b>	<b>Meaning</b>
0	No error
1	ROI is smaller than Min Size limit
2	ROI Aspect Ratio is outside limits
3	ROI threshold density is too low - (not used in the newer Probes)
8	Image intensity was too low to process
9	Image intensity was too high to process
11	ROI record was generated while attempting to capture a background
15	ROI was generated as a test - Pre-Set ROIs option was selected

## 10 Format for Particle Size Distribution ASCII output

File header:

Plotcount, sumsecs, pixsize, typescaling, samplevolume, sizetype

- Plotcount: the number of histograms saved in the file.
- Sumsecs: the number of seconds averaged for each histogram.
- Pixsize: Pixel size. 2.3 microns.
- Typescaling: 1 = Total strobes scaling, 0 = Deadtime scaled
- Samplevolume: number of liters of air sampled during time period.
- Sizetype: 'mean' for meansize or 'max' for maxsize.

Individual data header:

Missed, deadtime, starttime, totfrmcnt, roifrmcnt, totimgpart

Nonrejpart, acceptpart, wysiwyg

Datasize

- Missed: Total Strobes count.
- Deadtime: Deadtime during the period.
- Starttime: Start time for time interval (number of seconds since Jan 1)
- Totfrmcnt: Total frame count, the total number of frames taken during the time period.
- Roifrmcnt: Roi frame count, the number of frames that contained roi's.
- Totimgpart: The total number of imaged particles
- Nonrejpart: Total number of particles that were not rejected
- Acceptepart: Total number of accepted particles.
- WYSIWYG: The WYSIWYG concentration for the time period.
- Datasize: Number of roi's in the time interval.

Data: There is one data point for each roi in the interval. The dimension of the particle is listed in the data section. If the particle was rejected for any reason (obj rejected, or particle acceptance criteria rejected) the particle dimension is replaced with a 0.0 value.

## Appendix 1: CPI raw data file format information

(This file is given by Jeffrey Schuenke to Brad, Paul, and Tara Jenson on 6/23/1999, user can use this information to write codes to read and process CPI raw data file if they want to )

A CPI raw .roi file is structured as follows:

{File header} {House Keeping block } {House Keeping block } ... {Frame Block}...  
{House Keeping block }...

where the HK blocks occur on 1 second intervals until a frame block is output. The frame block has priority, so multiple frame blocks may occur before the next HK block. If the frame blocks take more time to output than 1 seconds, the required HK blocks are buffered, and output when possible. Each HK block and each Frame block has a time stamp in seconds of year. Each Frame block has a matching HK block with the same time stamp. This HK block will always come after the Frame block and has the deadtime value associated with the frame.

### File header structure

Field name	Type	Description
Ver	Int	File version

Year	Int	Year
Month	Int	Month
DX	Int	Max Width of frame
DY	Int	Max Height of frame
Text	BYTARR(70)	Misc. text descriptor

## Frame header Structure

Field name	Type	Description
BlockNum	0	Header Block Marker
ItemSize	0L	Total bytes in this frameheader only
Ver	0	Version number of this frame
ROIsCount	0	number of ROI's in this frame
TotROIsSize	0L	total bytes of IMAGE data
day	0B	time of frame 1-31
hour	0B	time of frame 0-23
minute	0B	time of frame 0-59
sec	0B	time of frame 0-59
msec	0	time of frame 0-999
ImgType	0	bit array with data information
sx	0	upper left X corner of image
sy	0	upper left Y corner of image
ex	0	lower right X corner of image
ey	0	lower right Y corner of image
BGRate	0	time between backgrounds in tenths of a second, 0 means no bckgnds
BkgPDSThresh	0	number of machine strobes before a background can be collected
FrmsProc	0L	total number of frames processed so far
IThresh	0B	Image threshold 0-255, 0 means no thresholding done.
ROIErr	0B	ROI Rejection/Failure code
ROIMinSize	0	min particle rejection size
ROIAspect	0.0	particle aspect criteria
ROIFill	0.0	min value for (#pixels within ROI threshold)/# pixels in ROI)
ROIItemCount	0L	# pixels within ROI above threshold
ImgMean	0B	image mean value
BkgMean	0B	background mean value
Spare1	0	Unused
ROIXPad	0	width of border around sides of particle in pixels
ROIYPad	0	width of border around top/bottom of particle in pixels
StrobeCount	0L	Probe's strobe count per image
FrmsSaved	0L	number of frames saved to disk so far
ImgMinVal	0B	min image mean for an acceptable frame
ImgMaxVal	0B	max image mean for an acceptable frame
ROIsSaved	0L	total number of ROI's saved so far

ChkSum	0	Checksum
PDSHead	INTARR(3)	PDS data block
Time	0L	seconds of year
ArrivalT1	0	Arrival time ???
ArrivalT2	0	Arrival time ???
TransitT	0	Transit time ???
Missed	0	number of particles missed while processor is busy
PHeight1	0	??
PHeight2	0	?? Note: header file only has one of these listed!!
PDSChkSum	0	check sum
ProbeMode	0	probe mode

Image header - Data contained in the raw ROI file from the instrument

Field Name	Type	Description
BlockMark	0	Block mark
ROIInfoSize	0L	Total bytes in this block ( variable because of the last two fields)
ROIVer	0	Tracks this structures version
sx	0	Start X upper left corner of roi ( relative to CCD frame)
sy	0	Start Y upper left corner of roi ( relative to CCD frame)
ex	0	End X upper left corner of roi ( relative to CCD frame)
ey	0	End Y upper left corner of roi ( relative to CCD frame)
PixBytes	0	Bytes per pixel in image
Flags	0	Contains info about particle ( see definition below)
Len	0.0	Computed Length of particles major axis
SLen	0L	1D index coordinate of start of length vector
ELen	0L	1D index coordinate of end of length vector
Wid	0.0	Computed width of particle ( perpendicular to length vector)
SWid	0L	1D index coordinate of start of width vector
EWid	0L	1D index coordinate of end of width vector
Dark	0	Info on particle depth and cut-off (See definition below)
Area	Float	Area of roi in pixels
Perimeter	Float	Perimeter of roi in pixels

( ROI image data follows each image header. The .min file leaves this data out)

Object Structure Version 30

Field name	Organization	Type	Description
BlockMark	Scalar	Int	Block mark
ROIInfoSize	Scalar	Long	Total bytes in this block ( variable because of the last two fields)
ROIVer	Scalar	Int	Tracks this structures version
Sx	Scalar	Int	Start X upper left corner of roi ( relative to CCD frame)

Sy	Scalar	Int	Start Y upper left corner of roi ( relative to CCD frame)
Ex	Scalar	Int	End X upper left corner of roi ( relative to CCD frame)
Ey	Scalar	Int	End Y upper left corner of roi ( relative to CCD frame)
PixBytes	Scalar	Int	Bytes per pixel in image ( <b>if zero then image data excluded!</b> )
Flags	Scalar	Int	Contains info about particle ( see below)
Len	Scalar	Float	Computed Length of particles major axis
Slen	Scalar	Long	1D index coordinate of start of length vector
ELen	Scalar	Long	1D index coordinate of end of length vector
Wid	Scalar	Float	Computed width of particle ( perpendicular to length vector)
SWid	Scalar	Long	1D index coordinate of start of width vector
EWid	Scalar	Long	1D index coordinate of end of width vector
Dark	Scalar	Int	Info on particle depth and cut-off (See definition below)
Area	Scalar	Float	Area of object in square pixels
Perimeter	Scalar	Float	Perimeter of object in pixels
Centroid	1D Array	Int	Centroid of particle ( 2 elements )
Roundness	Scalar	Float	Measure of particle roundness
X_Moment	Scalar	Float	1/2 area on each side of vert line
Y_moment	Scalar	Float	1/2 area on each side of horiz line
Rubber_Band	Scalar	Float	Measure of boundary roughness
Fractal_dim	Scalar	Float	Fractal dimension
Harmonic_len	Scalar	Int	Number of elements in Harmonic array
Bound_len	Scalar	Int	Number of elements in Boundary array
Sample_period	Scalar	Float	Sample period of harmonic array in pixels
Focus	Scalar	Byte	% focus 0-100 Mean of 20 points on perimeter
FocusMin	Scalar	Byte	Min of 20 points on perimeter
FocusMax	Scalar	Byte	Max of 20 points on perimeter
FocusStdDev	Scalar	Float	Std Dev of 20 points on perimeter
FocusGoodSamples	Scalar	Byte	?
CutOff	Scalar	Byte	% particle is cut-off 0 – 100
Crystal	Scalar	Byte	Scalar type index meaning TBD
Confidence	Scalar	Byte	Factor assessing confidence in particle use 0-10
P1	Scalar	Float	1 if manual features set
P2	Scalar	Float	Place holder
P3	Scalar	Float	Place holder
P4	Scalar	Float	Place holder
Harmonics	1D Array	Float	Circular harmonics of boundary(var. len)
Boundary	1D Array	Int	Location of boundary pixels in ROI array ( 1D indicies) (var. len)

(note: roi image data may follow at this point if PixBytes not equal to zero. Option not currently implement)

An object file consists of a file header (see below), and a sequence of object frames. Object frames contain a frame header and a sequence of object headers, one for each ROI in the original frame.

#### **Dark: 2-byte word**

Byte	Meaning
1 <sup>st</sup> byte	darkness number
2 <sup>nd</sup> byte	LS 5-bits = Particle cutoff index: 0-31 (no cut-off to almost fully cut-off)

#### **Flags: 2-byte word**

Bit Number	Meaning
0-7	out of focus number
8-11	crystal type 0=circular 1=column 2=stellar 3=other
12	Not used.
13	ROI was drawn manually.
14	Crystal type was manually corrected.
15	Particle was manually rejected.

#### **Scan List structure; used to gather file info at load time**

Field Name	Type	Description
BlockMark	int	Marker
Fpos	long	File position
ImgType	int	Image type 1 = normal frame with roi's 2 = background 0 = error type -1 = house keeping block
HTime	long	House keeping time
day	byte	Day From header unless HK, then computed from Htime
hour	byte	Hour From header unless HK, then computed from Htime
minute	byte	Minute From header unless HK, then computed from Htime
sec	byte	Sec From header unless HK, then computed from Htime
msec	int	Msec From header unless HK, then 0
ROIsCount	int	Number of ROI's in block, 0 for HK blocks
HouseSize	int	Size of House Keeping block or 0 if Image block