uScope Software PIV Probes

How to Use PIV Probes in uScope Software

uScope software makes it easy to create software probes to monitor flow characteristics. uScope can support as many PIV probes as your computer's processor can handle. Each probe can have its own properties; probes are almost always square, though it is possible to extend the probe in one direction to increase signal-to-noise ratio along that axis.

TIP: When learning how to use uScope's PIV probes it is useful to start with a stable particle flow, or a movie of a stable flow.

SETUP
1. Connect the SVM to the computer and turn on both.
2. Launch uScope software.
3. Prepare the microfluidic channel. Fill it out with the buffer and introduce a sample of polystyrene fluorescent particles.
4. Adjust focus, illumination and flow characteristics.

   Alternately, you can also open an existing flow movie by choosing **Video > Process Saved Video**. The video will loop until stopped.

CREATING PROBES

To create a probe:

1. Click the **PIV** toolbar button .
2. Double-click in the video image at the center point for the new probe. When you create a probe it will take on the properties of the last probe you altered. Once created you can change each probe's properties individually.
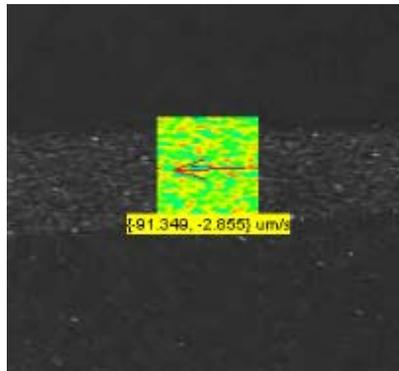
New probe showing correlation field, vector arrow and real time velocity as text.

   When you first create a probe uScope will experimentally determine the fastest FFT algorithm to use. This process may take up to 60 seconds to complete, at which point the software will begin calculating velocity at the location.

3. Click the **+** and **–** toolbar buttons to make the probes more or less transparent. The software will continue to calculate velocity at these locations even if you make the probes completely invisible.

4. To remove a probe, right click on it and choose **Delete**.

PROBE PROPERTIES

1. Double-click on a probe to open the **PIV Probe Properties** dialog box. You can also right-click on the probe and choose **Properties** to open the dialog box.
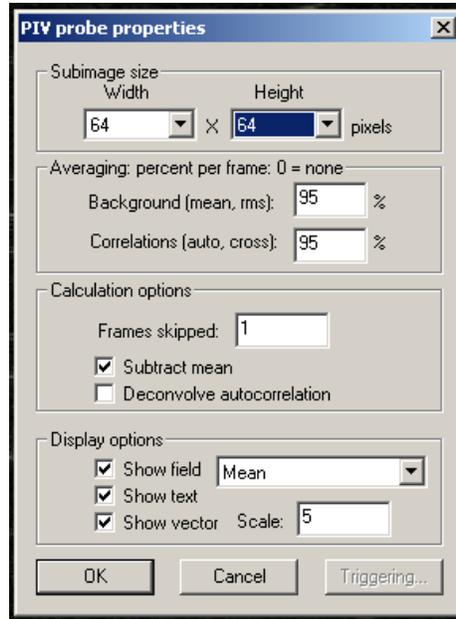
PIV Probe Properties dialog box.

2. Select the **Width** and **Height** of the probe window, the area over which statistics will be calculated. Some guidelines for setting the probe window size are:
    a. Probes should typically be the same size in both x and y directions.
    b. Smaller probes require less processing power, so use smaller window sizes to run more probes simultaneously.
    c. Increasing the probe size will improve the signal-to-noise ratio; decreasing the size will increase spatial resolution.
    d. If the probe is located in a region of fast flow, the probe size must be large enough that the correlation does not fall beyond the window. The **Cross Correlation** field (see below) can be an aid in setting the size.

NOTE: If you cannot achieve sufficient signal-to-noise ratio with a required probe size you may need to adjust the illumination, particle feed, etc. If the probe is in an area of steady flow then increasing time averaging may also help.

3. The **Averaging percent per frame** values help separate the useful flow information from the background data by weighing the previous frames of data versus the current frame. The default values of 95% are acceptable for most flows. Some guidelines for setting the percentages are:
    a. The **Background (mean)** percentage determines how much of the image field is considered "background" based on its steady presence over multiple frames. Increasing this value increases the amount of information that is ignored, such as stuck particles. Check the **Subtract Mean** box (see below) to apply this calculation and remove the data.
    b. Decreasing the **Correlation** value improves time resolution; increasing the value improves noise control.

4. The **Calculations Options** control how the flow parameters are calculated:
   a. Enter **1** in the **Frames Skipped** box to calculate cross correlation for every sequential pair of frames. Enter **2** to use every other frame, **3** for every third frame, etc. This option is useful for examining very slow flows.
   b. **Subtract Mean** subtracts the background (non moving) data from the flow calculations. The amount of data that will be subtracted is based on the **Background %** value (see above).

   NOTE: If the probe is located in an area of very slow flow then subtracting the background could delete active particles.

   c. **Deconvolve Autocorrelation** is an advanced option for high precision measurements. This option deconvolves the cross correlation by the autocorrelation, which can remove the effects of blur and particle size such that each particle is treated as a single point. It is most useful when the signal-to-noise ratio is extremely high.

5. The **Show Field** options control which data are displayed for each probe window:
   a. **Cross correlation** determines how far the particles move between frames (or between every few frames, based on the **Frames Skipped** option). This field is a good diagnostic tool to help you optimize experiment parameters. The red dot will move further from the center as the flow velocity increases. The dot should be small and well defined to achieve the most reliable measurements. If the flow is too fast the red dot will move outside of the window, and uScope will not be able to measure the velocity. In this case, increase the window size, which will improve the signal-to-noise ratio.
   b. **Autocorrelation** is an indicator of resolution. The mass at the center of the window will become sharper with smaller particles and better focus.
   c. **Mean** shows the data that is being subtracted as part of the Background (based upon the **Background %** described above). Showing the Mean can be helpful for highlighting stuck particles and other anomalies in the flow.
   d. **RMS** is an indicator of the amount of useful signal available for the calculations.
   e. **Show Text** turns on and off the text-based velocity display.
   f. **Show Vector** displays an arrow in the direction of the flow. The size of the arrow will change with velocity. You can also set the **Scale** to increase or decrease the size of the arrow.

RECORDING DATA

Data can be recorded simultaneously from all probes. To record data:

1. Choose **File >Measurement File Naming** to select how the recorded data will be save:
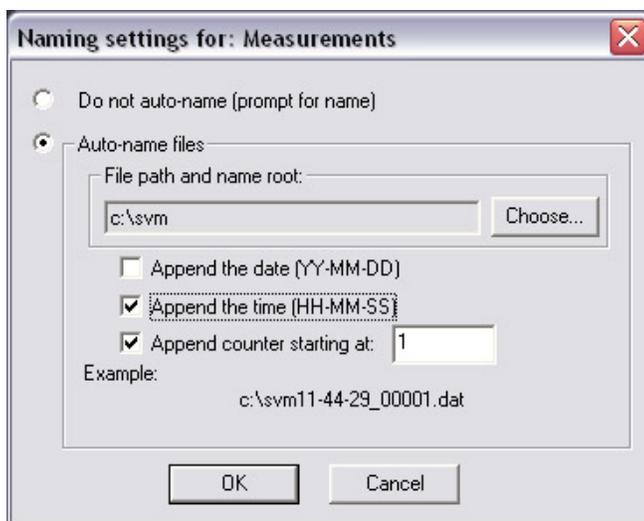
Naming settings for new measurements dialog box.

    a. If you choose **Do not auto-name**, uScope will prompt you for a file name and location for each new recording.

    b. Choose **Auto-name files** to automatically name each recording. Check **Append the date**, **Append the time**, and/or **Append counter** to add these values to the new file names. An example of how the name will appear is shown at the bottom of the dialog box.

2. To begin recording choose **File >Record**, or click the **Start/Stop** toolbar button. If Autonaming is selected, recording will begin immediately. Otherwise, recording will begin after you name the file and click **OK**.

3. To end recording, choose **File > Record** or click the **Start/Stop** button again.

The PIV output file will include four columns for each probe: the X and Y locations of its centroid, measured from the upper left of the window, and the X and Y velocity at each point in time. The X/Y location columns will only have entries in the first row.

SAVING PROBES

A set of probes can be saved to disk and recalled later:

1. Arrange the probes and set their Properties.
2. Choose **File >Save Probes As** to create a new probe file.
3. Select the name and location for the file and click **Save**.

To recall a stored set of probes choose **File > Open**.