

# Measurements with PCC

## INTRODUCTION

High-speed motion analysis has been a primary tool to measure moving objects by the defense, scientific, and industrial communities for years. Using the 2-D motion analysis tools incorporated in our PCC (Phantom Camera Control) software essentially turns your Phantom camera into an extremely effective test instrument.

Vision Research understands that any motion analysis tool must be easy to use, without sacrificing the ability to extract and quantify motion from a file. With our measurement features, the end-user can easily perform; coordinate, distance, velocity, angles and angular speed measurements, along with the ability to track multiple points or objects to compute their speed or acceleration. These measurement tools provide a motion analysis system that harmonizes measured data with images.

## MEASUREMENT APPLICATIONS

Applications that benefit most from the measurement tools include:

- Deployment velocity, acceleration, and position of airbags and crash test dummies
- Military test ranges
- Drop tests to find critical errors such as construction weaknesses
- Fluidic tests
- Biomechanics
- Any applications where measurements need to be performed.

## HOW TO PERFORM MEASUREMENTS

1. Set different units in **Manager > Preferences > Measurement**. Check that they will be the same in **Play > Measurements > Unit for Scale**, and later, when activating and selecting an Instant Measurement (distance, angle, speed, angular speed) and when using Process file – Compute speed/acceleration file (speed, acceleration).

## TEST WITH 'UNIQUE SCALE PER APPLICATION ENABLED (UNCHECKED)

2. Open a Cine that contains a fast-moving object (a launched object or a rotating object for which you know the rotating speed, for example). It will be easier for you to do the checking

calculations if the frame rate value means a round value for the time interval. For example, if the frame rate is 400 fps, the interval will be 2500 us.

3. Set the **calibration**:
  - a. Get to an image containing a known value of distance or size.
  - b. The status in Calibration area is '**No calibration done**' if no calibration was set before.
  - c. Press **Calibrate** button,
    - i. then click the first end of gauge on the image and then the second end of gauge. Enter the distance or size value for this gauge.
    - ii. or enter the scale value in the Scale field.

The message should say now '**Calibration done**'.

The scale value will be the one entered manually or calculated in distance units per pixel.

If you are working with several files, you can set the same calibration to all files by pressing '**Set to all**' button.

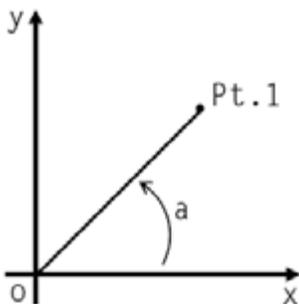
4. Set the **origin** of axes:
  - a. Check/uncheck '**Show**' option. This will display or not the axes.
  - b. Check/uncheck, '**Coordinates in mm** (or in whatever distance unit was selected in Preferences)' option. The coordinates values will be displayed in the application's status bar in pixels (unchecked) or in the define unit of measure.
  - c. The default origin is in the top left corner.
  - d. For a new origin: press the **Set Origin** button then click on the image to set the origin. You can set the origin in the center of the moving object.
  - e. The image on which the origin is set will be considered a reference image for some instant measurements.
5. Set the **instant measurements**:
  - a. Press the **browse** button next to the '**Report File path**' field in order to set the path where the report file will be saved. This file will contain the information about the

## Measurements with PCC

instant measurements you will select. It has extension .rep. A dialog box will open and you can enter some information about the measurement.

- Check/uncheck 'Query for comments' option. If checked, it will ask for comments before saving each instant measurement in the report file.
- Check 'Active' and select one of the four measurements in the list. While **Instant Measurements** are active you cannot change the Origin.

### DISTANCE AND ANGLE AND SPEED: ORIGIN + 1 POINT



It measures:

- distance from origin point to the selected point;
- angle made by the selected point with Origin and Ox axis;
- speed equals the measured distance / dt [time of the point frame] – [time of the origin frame] if point is on a frame different from the one where the origin was set;
- angular speed equals the measured angle / dt the [time of the point frame] – [time of the origin frame] if point is on a frame different from the one where the origin was set;

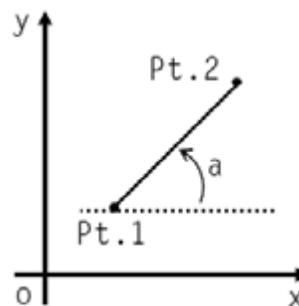
For this type of instant measurement you can use a Cine with a launching object. Set the origin in the initial position of the object. You can measure the distance between two different positions of the object (origin image and the next one or more images), the angle of the trajectory, the speed and the angular speed if the angle varies.

The angular speed can be better checked by using a Cine with a known angular speed rotating object – usually it is marked on the object (small motor or so) in revolutions per minute or per second. Choose a counter-clock rotating object. Set the origin in the center of the rotation. If the unit for the angular speed you set in Preferences is Revolution per second or Revolution per minute the value measured by the application should be the same with the one marked on the object.

### Testing:

- Open a Cine with a launching object.
- Select the image on which you set the origin (you have to remember its number). In order to get a valid value for speed measurements, the origin image should be the one when the motion starts.
- Activate **Instant Measurements**.
- Select the first instant measurement in the list.
- Validate "Coordinates in mm" option (or whatever the units are).
- Click a point in the origin image right on the Ox or Oy axis. Remember the X or Y value at this point. The Result field will display the calculated values for distance (d) and angle (a). You will find the same value for distance as for the X or Y value previously remembered. The angle will be 0 or 180 for a point on Ox axis or +/- 90 for a point on Oy axis. No speed (s) or angle speed (as) will be displayed if the selected point is on the origin image.
- In order to do new measurements select a point on a next image. Check that the values for speed are correct using the up mentioned formula. dt is a multiple of Interval value; one interval for each image played forward. Ignore the angular speed in this case. Don't forget that the angle is measured having Ox axis as a reference.
- In order to test the angular speed values use a file with a rotating object. Set the origin in the center of the motion on an image where the angle between the rotating object and Ox axis is null. Select a point on a different image. The angular speed should be the current angle divided by the time interval between the origin image and the current image. Check that it is the same value as the one you already know as being marked on the object.

### DISTANCE AND ANGLE AND SPEED: 2 POINTS



It measures:

- distance between the selected two points;
- angle made by a line formed by the two selected points with Ox axis;
- speed equals the measured distance / dt [time of the point frame] – [time of the origin frame] if the two points are on different frames;
- angular speed equals the measured angle / dt [time of the point frame] – [time of the origin frame] if the two points are on different frames;

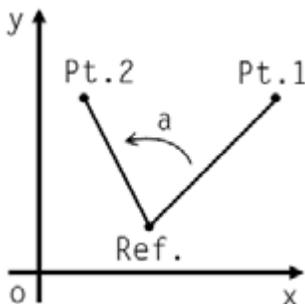
For this type of instant measurement you can use a file with a launching object. One point may be on an image and the other on a different image.

**Testing:**

1. Select the second instant measurement in the list.
2. The measurements are similar with the first type, but you can select pairs of points on any interval of the motion, not just related to the origin. Ignore the angular speed. It is not calculated based on the angle variation, it is calculated based on the angle measured related to Ox axis.

Select two points on Ox or Oy axis. Remember the coordinate values displayed on the bottom bar, calculate the differences between the values of the two points (X values for Ox axis and Y values for Oy axis) and check that the Result values are equal with the distances calculated by you. The angles are 0 or 180 for points selected on Ox axis and 90 or -90 for points selected on Oy axis.

**ANGLE AND ANGULAR SPEED: 3 POINTS**



It measures:

- angle made by three lines;
- angular speed equals the measured angle / dt [time

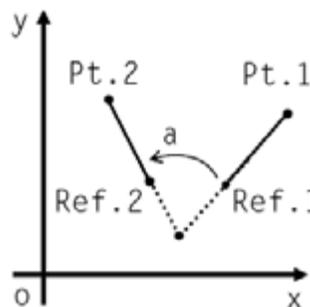
*of the last point frame] – [time of the first point frame] if the first and last points are on different frames;*

For this type of measurement use a file with a rotating object.

**Testing:**

1. It is not absolutely necessary to set the origin in the rotating center because you can select the second point in the rotating center. So, set the origin similar to the upper picture.
2. Activate **Instant Measurements**.
3. Select the third instant measurement in the list.
4. Select the first point on the rotating object on an image, the second point in the rotation center and the third point on the rotating object on the next one or more images. Check that as value is equal to the known rotation speed.

**ANGLE AND ANGULAR SPEED: 4 POINTS**



It measures:

- angle made by two lines (Pt.1 – Ref.1 and Pt.2 – Ref.2);
- angular speed equals the measured angle / dt [time of the last point frame] – [time of the first point frame] if the first and last points are on different frames;

**Testing:**

1. Use a Cine with a rotating object.
2. Set the origin in the rotation center
3. Activate **Instant Measurement**
4. Select the fourth instant measurement
5. Select an image in which the rotating object is on the Ox axis
6. Select two points on the object like in the upper image
7. Get to the image in which the rotating object is on the Oy axis and select two points
8. The result should say that the angle is approximately 90 deg. and the angular speed has the same value as the one you already know.

## Measurements with PCC

### COLLECT POINTS

Use a Cine with a linear motion or with a rotation.

1. Click on the **Browse** button to open an existing .pps (point position) file or create a new one
2. Set the PPF value, the number of points per frame that are going to be collected
3. Activate **collecting points**
4. Check the option '**Coordinates in mm**'
5. Step to an image and select the number of points you set for PPF. Remember the image number and X and Y values for each point. Then step to the next image and do the same. The last selected points will be correctly saved if you step to the next image after the last point was selected.
6. Open the .pps file (use Notepad ++ for a better display of the information) and check the image number and X and Y values. X and Y values are in the unit selected in Preferences. Check also the Time for each image. The title line of the file contains the value for all the parameters you selected (PPF, file name and path, measurement unit, the origin position in pixels and the calibration scale). Close the file.
7. Select one or two images that precede the ones selected before and collect points from these images too. If you open the .pps file now you will see these last points in the list following the ones collected before. Close the file.
8. Click on '**Process file**' button and select '**Sort and Optimize**'. This will eliminate the multiple appearances of some points in the .pps file and will sort the information based on the increasing image number. Open the file with the collected points, check that the optimization and sorting is done. Close the file.
9. Select an image with collected points and open the '**Current point**' list. Select one of these points and click on the button on the right side (X) to delete that point. Use the '**Current point**' list also for adding missing points on an image. Every time a change is made – adding or deleting a point – the Point Position file is updated.
10. Click on '**Process file**' and select '**Compute speed file ...**' or '**Compute Acceleration file ...**'. A 'Save as' dialog window will open. Give a name to the speed file (.psp) or acceleration file (.pac). These files will contain the speed or acceleration values for each X or Y coordinate on each image except the starting one. Check that the speed and acceleration values were correctly calculated:

$$\text{speed} = \text{distance} / \text{time interval}$$

$$\text{acceleration} = \text{distance} / (\text{time interval} * \text{time interval})$$

### TEST WITH 'UNIQUE SCALE PER APPLICATION' DISABLED (CHECKED)

Doing measurements on several files with **unique scale**.

While doing measurements on a Cine, there is an option that sets the same Scale on all opened Cines – '**Set to all**'.

But if the user wants to keep the same scale from one application session to another, the '**Unique scale per application**' can be used. The scale value is always remembered in the settings .xml file and it is applied to each Cine opened in PCC when this option is validated in **Manager > Preferences > Measurement**.

#### Testing:

1. Open a Cine in PCC that has images of a known value of distance or size.
2. Do the calibration as described above.
3. Remember the value displayed in Scale field.
4. Close PCC.
5. Open PCC again. You should find the same value for Scale as before closing PCC.
6. Open several other Cines. The Scale value should be the same on all opened Cines.
7. Uncheck the **Unique scale** option in Preferences.
8. Close PCC.
9. Open PCC again. The files should have now the default Scale which is 1mm/pix or whatever the distance unit is set in Preferences.

VISION  
RESEARCH

AMETEK®  
MATERIALS ANALYSIS DIVISION

100 Dey Road  
Wayne, NJ 07470 USA  
+1.973.696.4500

[www.phantomhighspeed.com](http://www.phantomhighspeed.com)