



## 2-D Scene Calibration in ProAnalyst®

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### Abstract

This tutorial explains how to calibrate a 2-D scene in ProAnalyst. The two types of calibration (planar and perspective) are discussed, along with reasons and helpful hints for calibrating images and using multiple calibrations for a single video image. For planar (normal) calibration, examples are given for defining a scale and defining a coordinate frame. This tutorial also explains the procedures for setting the default calibration and saving and loading calibration files.

### Files Needed for this Tutorial

Click [here](#) to download these files.

*Rebecca03.avi*

*Rebecca04sub.avi*

*side\_impact\_side.avi*

### Introduction

Calibration is required to convert measurements from pixels in the image to real units, such as inches, feet, meters, etc. Calibration allows you to:

- Convert measurements in a video image into real-world dimensions such as inches, feet, meters, etc.
- Rotate the coordinate frame to remove any unwanted tilt by tilted cameras.
- Establish an origin (0,0) and X,Y coordinate plane for motion analysis.

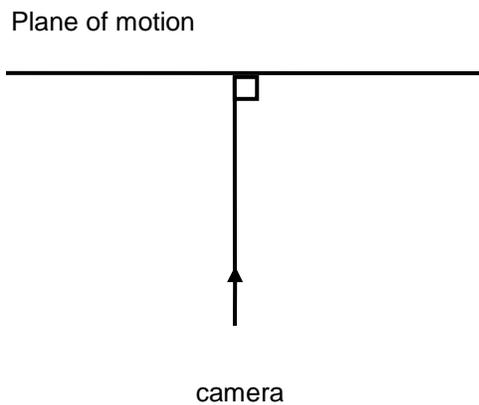
## Useful Tips

To simplify the calibration process, keep the following points in mind when you are capturing your videos:

- Know ahead of time what you will use as a length scale.
- Make sure that the action takes place in the same plane as your length scale.
- Use an object that takes up a large portion of the field of view.

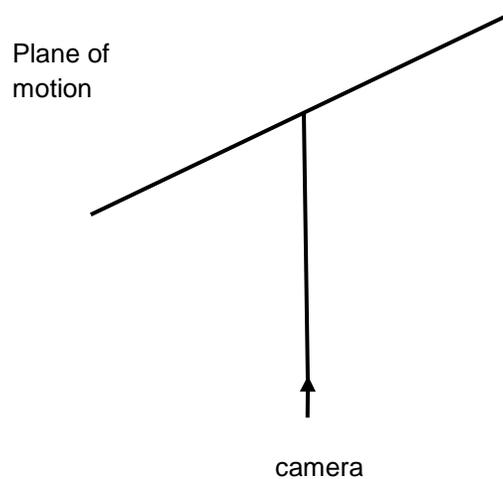
## 2-D Calibration

There are two types of 2-D calibration: planar (normal) calibration and perspective calibration. In planar calibration, motion occurs in a plane perpendicular to the camera direction, as shown in the top-down view in Figure 1.



**Figure 1. Planar (normal) calibration**

In perspective calibration, motion occurs in a plane that is angled relative to the camera direction, as shown in Figure 2.



**Figure 2. Perspective calibration**

### **Planar (Normal) Calibration**

Planar calibration assumes that the plane of the video image is perpendicular to the camera. For this type of calibration, a single object of known length can be used to calibrate the entire image.

### **Defining a Scale**

1. Create a new project by clicking **File** and then **New Project** from the toolbar at the top of the window. A window will open for Untitled Project 1.
2. Right-click in the project window and select **Project ► Add Video(s)**.
3. The Open window is displayed. Double-click on the thumbnail to add the *Rebecca04sub.avi* file to the project.
4. Click the **Save**  button at the top of the project window. Give your untitled project a location and a name and click **Save**. ProAnalyst assigns the file extension *.mpj* to project files.

5. The project window now contains the *Rebecca04sub.avi* file. Double-click on the thumbnail to open the Measurement window, shown in Figure 3.

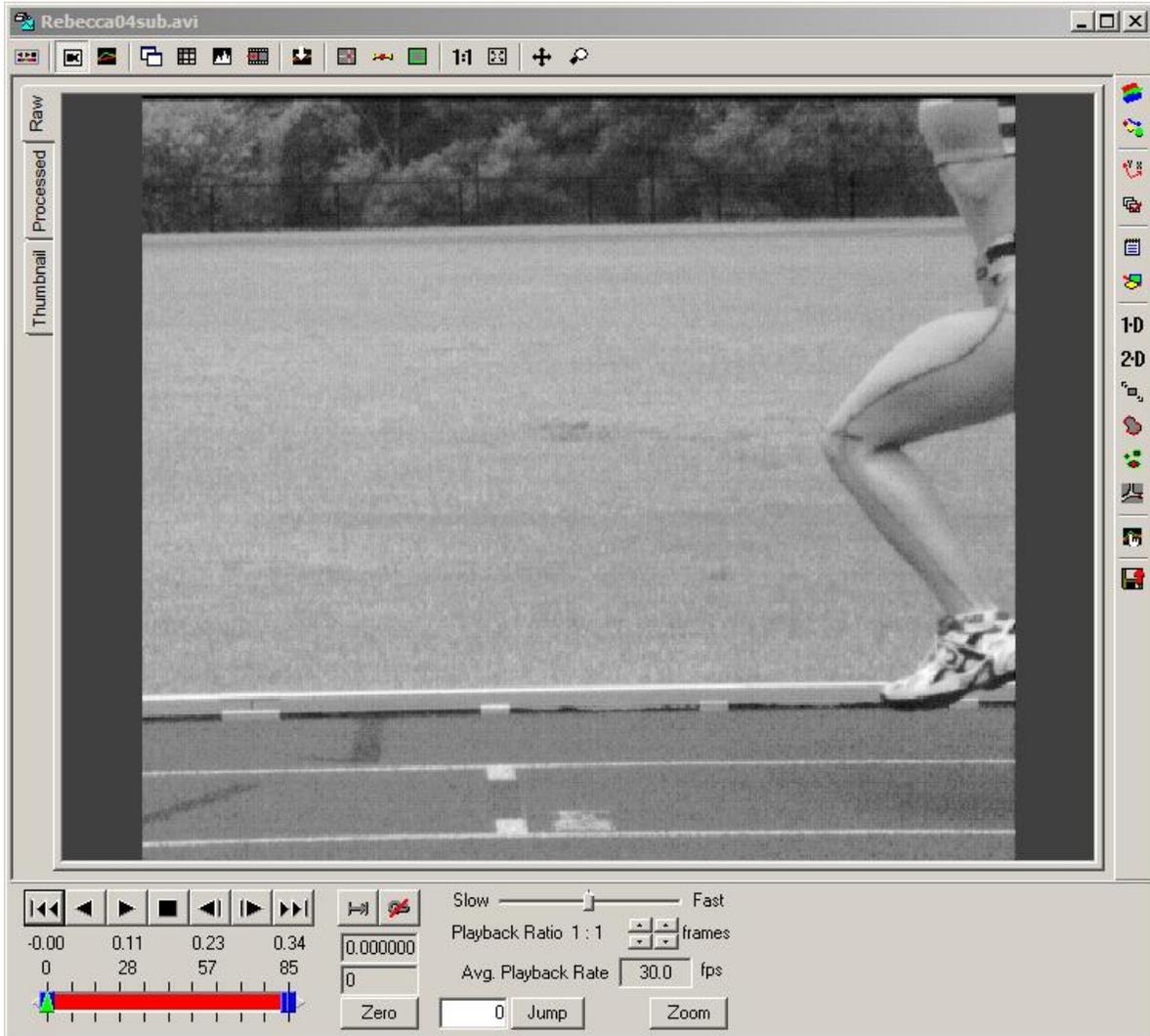
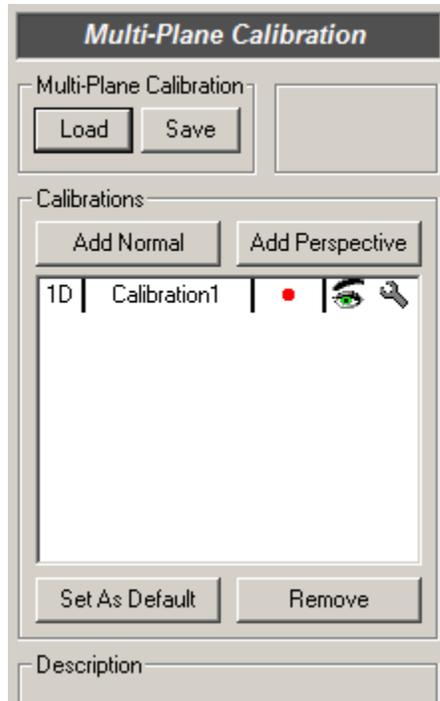


Figure 3. Project Measurement window

6. Click the **Image Calibration**  button on the right side of the Measurement window to open the Multi-Plane Calibration control panel, as shown in Figure 4.



**Figure 4. Multi-Plane Calibration window**

7. Click the **Wrench**  icon to the right of Calibration1 to open the Calibration 1 Settings window, shown in Figure 5.
8. Position the reticle on the knee and click **Set Point #1**.
9. Move the reticle to the ankle and click **Set Point #2**.
10. In the Distance Between Points field, enter **15** and select **Inches** from the dropdown menu.
11. Click the **Apply Scale >>** button. ProAnalyst will calculate the number of pixels per inch in the image.
12. Click **Apply** and **Close** at the bottom of the Calibration 1 Settings window to apply the settings to the calibration.

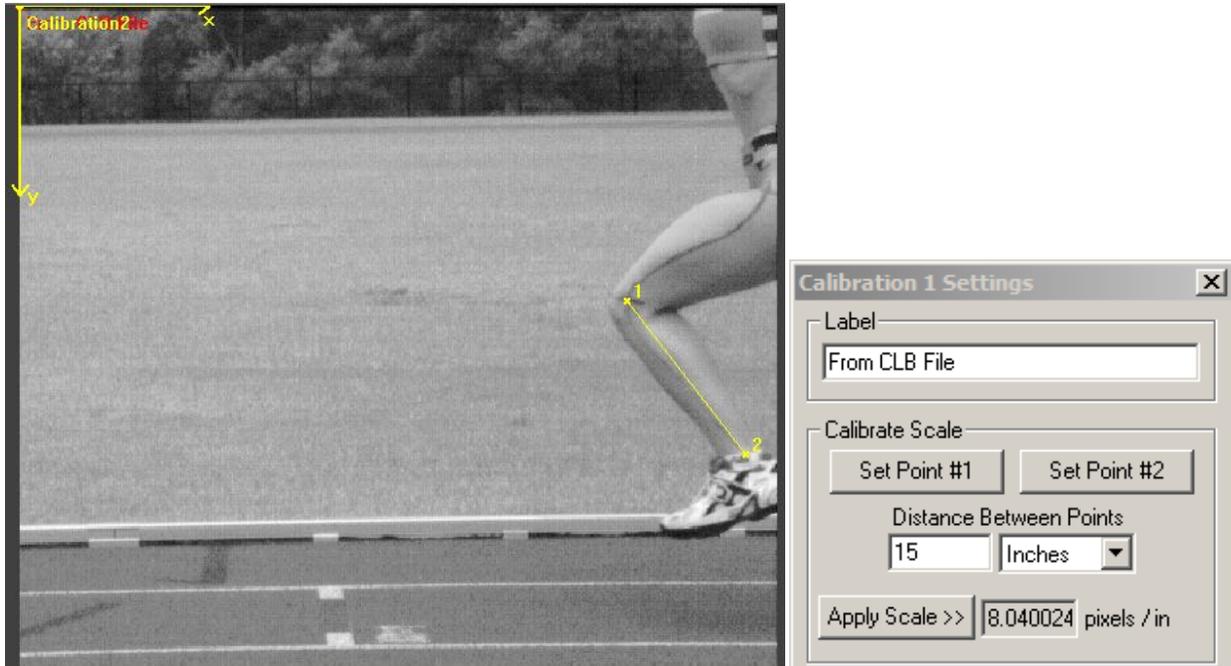


Figure 5. Defining a scale with calibration

## Defining a Coordinate Frame

The coordinate frame is defined by setting an origin (0,0 point) and the direction of the X and Y axes. To calibrate the origin and axes of the coordinate system, perform the following steps and refer to Figure 6.

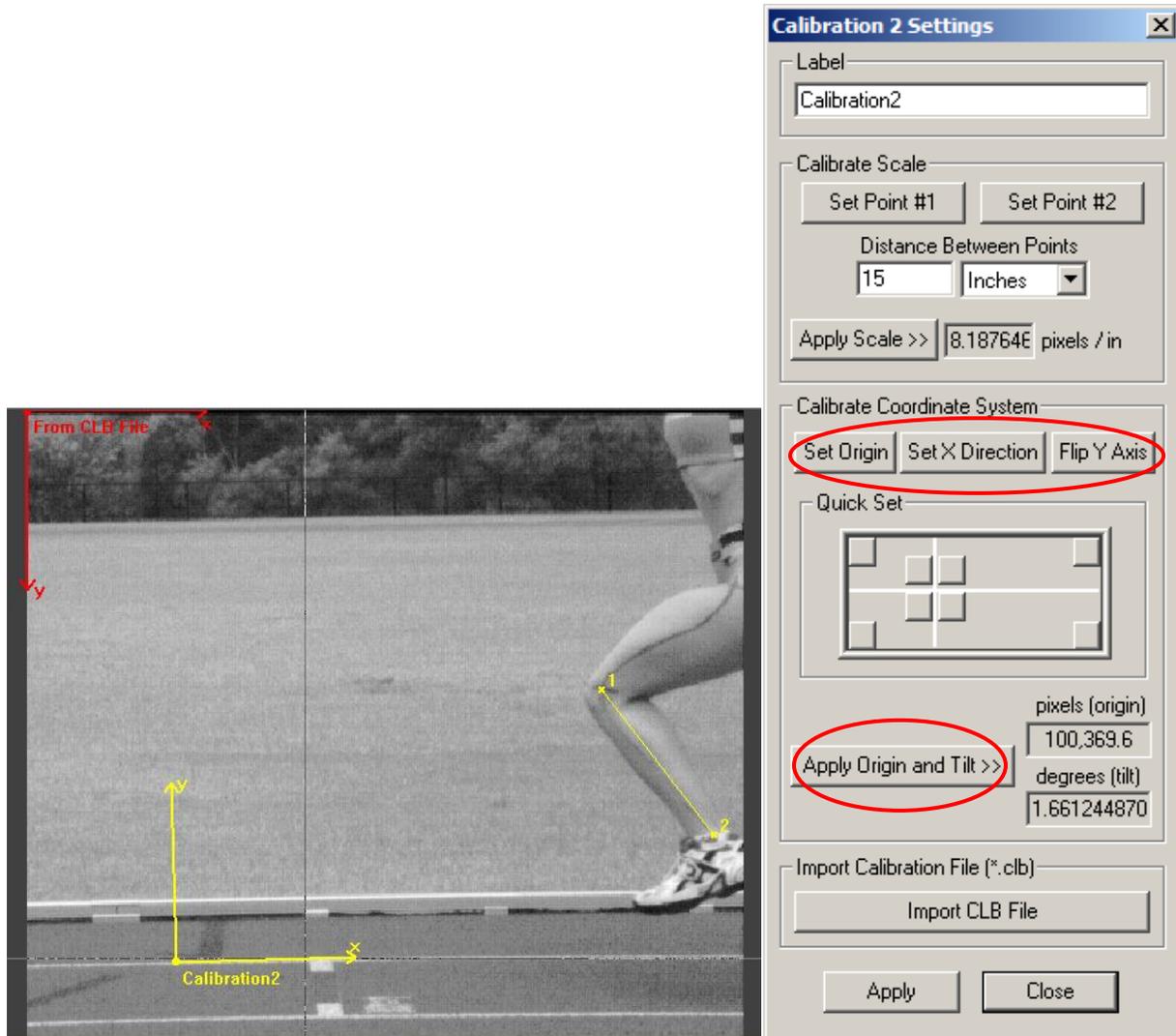


Figure 6. Defining the coordinate frame

1. With the Calibration 2 Settings window displayed, select a point in the image along the first lane marker in the track to serve as the origin of your coordinate frame (point 0,0). Click the point, using the reticle as a guide. In the settings dialog, click **Set Origin**. The coordinate system marker moves such that its 0,0 position is on the selected point.
2. Determine the appropriate positive X-axis direction, and click anywhere in the image in that direction. (In this example, you will click to the right of the origin.) The coordinate X,Y markers will rotate to align the X direction with the new reticle position. In the settings dialog, click **Set X Direction**. In the image, the coordinate markers will automatically rotate to align the X axis between the origin and the current point.

3. A default Y-axis will also be drawn at a right angle to the X-axis. To flip the Y axis (reverse the positive Y direction), click the **Flip Y Axis** button. The Y-axis now points upward in the video image.
4. Click **Apply Origin and Tilt >>** to set the calibration. The origin location and the tilt degrees are displayed to the right of the button.
5. Click **Apply** and then **Close** to apply the settings to the calibration.

*Note: This new calibration is only valid for motion in the calibration plane. In this example, the calibration is valid for the body position and motion of a runner in that particular lane. This calibration cannot be used to measure other aspects of the image, such as the height of the fence in the background.*

## Perspective Calibration

Perspective calibration allows you to define planes of motion that are moving towards the camera, away from the camera, tilted upward or downward, or a combination of those. Perspective calibration requires four points with known locations. These four points do not have to be spaced equally apart, but they must all lie within the same plane. You need to know the X and Y coordinates of the four points. After you have entered the coordinates, ProAnalyst computes a perspective transformation that can calculate the real world coordinates of any point in the video image, so long as the point lies in the plane defined by the four known points.

A typical method for performing perspective calibration would be to place a rectangular object of known size along the path of motion. Let us say that the object is rectangular and has a width of 2 feet and a height of 1 foot. We can use the four corners of the object as the four known points.

1. Create a new project by clicking **File** and then **New Project** from the toolbar at the top of the window. A window will open for Untitled Project 1.
2. Right-click in the project window and select **Project ► Add Video(s)**.
3. The Open window is displayed. Double-click on the thumbnail to add the *side\_impact\_side.avi* file to the project.
4. Click the **Save**  button at the top of the project window. Give your untitled project a location and a name and click **Save**. ProAnalyst assigns the file extension *.mpj* to project files.
5. The project window now contains the *side\_impact\_side.avi* file. Double-click the thumbnail to open the Measurement window and click the **Fast Forward**  button to advance the video to the last frame.

6. Click the **Image Calibration**  button to open the Multi-Plane Calibration control panel, as shown in Figure 7.

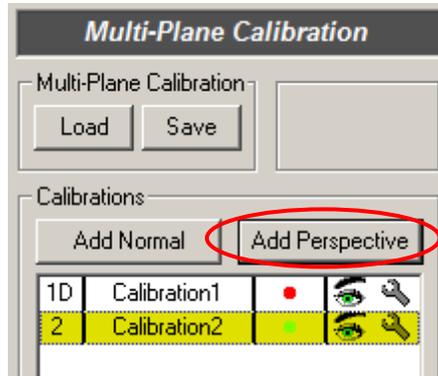


Figure 7. Multi-Plane Calibration control panel

7. Click **Add Perspective**. Notice that Calibration2 is added to the list of calibrations.
8. Click the Wrench  icon to open the Calibration 2 Settings window, as shown in Figure 8.

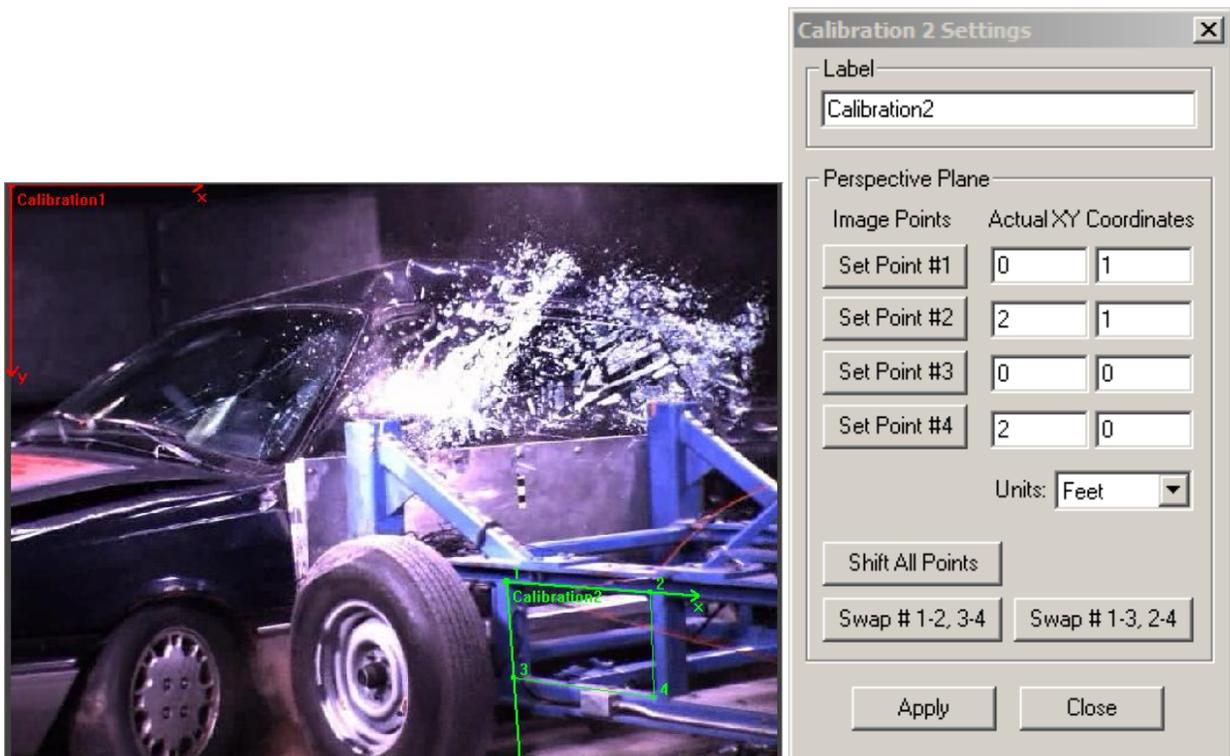


Figure 8. Four points defined for perspective calibration

9. We will use a portion of the frame of the ramming vehicle as the rectangular calibration object. Starting at the upper left side, click on a point inside the upper left corner of the frame of the ramming vehicle, then click **Set Point #1** in the Calibration 2 Settings window. Repeat this step for Points 2, 3, and 4, clicking on points at the upper right, lower left, and lower right of the frame as shown in Figure 8.
10. We now need to enter valid XY coordinates for each point into the Actual XY Coordinates fields. Since we know the width and height of the rectangle, we can enter the coordinates using these dimensions. Let us place the origin at point #3. The coordinates of point 3 will be **0, 0**. Let us define the x direction as the direction of motion for the ramming vehicle. Therefore, the coordinates of point 4 will be **2, 0**, since the rectangle is 2 feet wide. Let us define the positive Y direction as upward. So the coordinates of point 1 are **0, 1**. Finally, the coordinates of point 2 must be **2, 1**.
11. Click the arrow to the right of the Units field. Select **Feet** from the dropdown menu.
12. Click **Apply** and then click **Close**. This perspective calibration is suitable for determining the velocity of the ramming vehicle.

## Using Multiple Calibrations

Since each calibration is only valid for the plane in which it was defined, you can use multiple calibrations to handle multiple planes of motion. You may specify, label, and select a unique color for different calibrations, and you can assign a different calibration to each line and feature in 1-D and 2-D tracking.

Multiple calibrations are used when there are multiple planes of motion. Figure 9 shows an individual calibration defined for each runner's lane in the *Rebecca03.avi* video image.

*Note: For additional practice, define multiple calibrations using the lanes of the track in Rebecca03.avi as the points of origin. Refer back to the instructions previously given for "Defining a Coordinate Frame" in the Planar Calibration section of this document. A different object of known length would be required for each lane to calibrate this image properly. For this example, you can ignore the scale calibration and practice defining multiple origins and coordinate frames. Click **Add Normal** to add each new calibration to the list.*

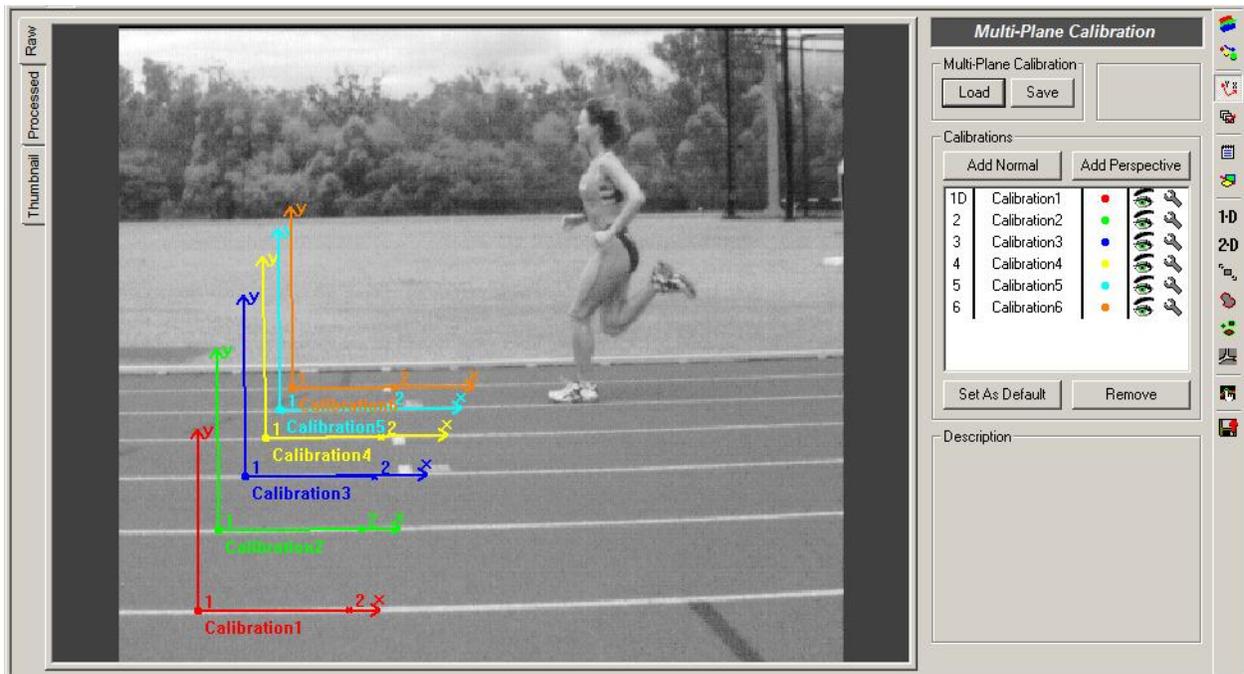


Figure 9. Multiple calibrations in a single image

### Setting the Default Calibration

One calibration performs a unique function from the rest. This calibration is known as the “Default” calibration. This calibration is used by default for any new feature or line tracking. It is also used as the calibration for any on-screen measurements using length or angle measurement annotations.

To change the default calibration, click on the desired calibration in the list displayed on the Multi-Plane Calibration control panel. Click the **Set As Default** button. The letter “D” appears next to the calibration number in the list, as shown in Figure 10.

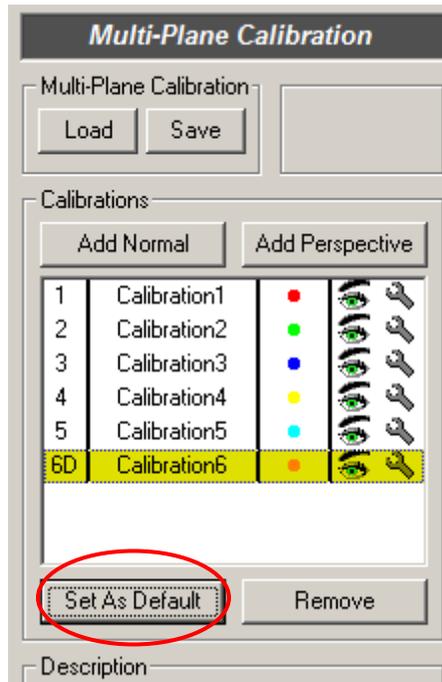


Figure 10. New default calibration setting

## Saving and Loading Calibration Settings

To save the current calibration values to disk at any time, click the **Save** button on the Multi-Plane Calibration control panel. The Select Destination for Calibration File dialog box appears, as shown in Figure 11. Enter a filename and click **Save**. ProAnalyst assigns the extension **.mcl** to calibration files.

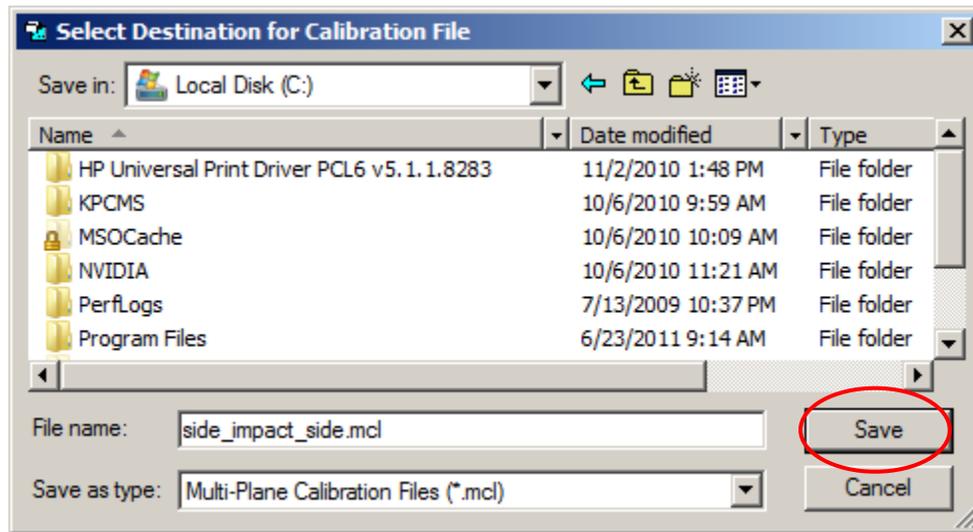


Figure 11. Select Destination for Calibration File dialog box.

To load a previously stored calibration, click the **Load** button on the Multi-Plane Calibration control panel. The Select Calibration File dialog box appears, as shown in Figure 12. Select the calibration file you wish to apply to the image and click **Open**.

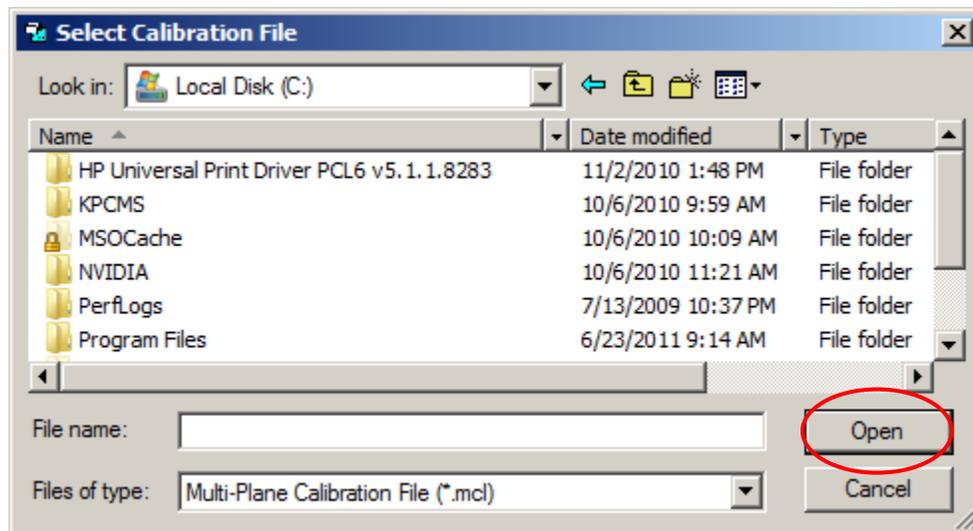


Figure 12. Select Calibration File dialog box

## **Congratulations!**

You have completed the tutorial and learned how to create different types of calibrations. For more information on calibration, please refer to the *ProAnalyst User Guide*.

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Xcitex Inc.  
25 First Street, Suite 105  
Cambridge, MA 02141 USA

