NDI 6D Architect User Guide

Revision 4.0
March 2004

IMPORTANT
Please read this entire document before attempting to operate the Measurement System

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1 Warnings and Updates

A complete list of the warnings, classifications, and approvals that apply to the Polaris, Polaris Accedo, and Optotrak Systems is included in the *"System Guide"* shipped with each system.

The following two warnings also apply:

Warning!

If a rigid body is dropped, the relative positions of markers may change. Changes in the positions of IRED markers will be detected if the change is greater than the Max3D error set when the rigid body definition was set in the rigid body file. If the rigid body includes imaginary markers, changes in these markers will not be detected and incorrect transformations may be reported that could cause personal injury and/or property damage. It is a good practice to pivot a probe before using it to confirm that no bending of the probe tip has occurred.

Warning!

Ensure that the correct rigid body file is used with the corresponding rigid body. If the rigid body definition does not match the rigid body, the rigid body may still be tracked but will report incorrect data. If a rigid body definition contains imaginary markers, but is used with the incorrect rigid body, the rigid body may still be tracked, but will report incorrect data for the imaginary points. Incorrect data could cause personal injury and/or property damage.

1.1 Updates

NDI is committed to continuous improvements in the quality and versatility of its software and hardware. To obtain the best results with your NDI system, please download the latest software from the Partner Site section of our website:

www.ndigital.com/login.php

Note **You will need to obtain a User ID and Password for the Partner Site if you do not already have one. Please allow two business days for activation of your login account.**

1.2 Questions?

Please contact NDI Technical Support at:

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2 Welcome to NDI 6D Architect

NDI 6D Architect software helps you characterize tools and rigid bodies for the following NDI measurement systems:

Polaris The Polaris family of optical tracking systems is a highly versatile, real-time tracking technology. By measuring the 3D positions of markers, the Polaris System determines the real-time positions and orientations of each tool.

Polaris Accedo The Polaris Accedo System differs from the Polaris System in that it only supports passive tools. In addition, it has a different measurement rate and can track a maximum of four tools at once.

Optotrak The Optotrak Systems are designed to track diodes that emit infrared light within a large characterized measurement volume. This functionality is valuable to both industrial and research markets.

6D Architect helps you perform the following tasks:

- characterize tools and rigid bodies using a wizard-based interface
- create and edit SROM Image Files (.ROM) and Rigid Body files (.RIG)
- create snapshots of single-faced wireless tools *without* using engineering data or a previously created SROM Image File
- save and reuse characterization settings
- view a graphical representation of the tool or rigid body
- test SROM Image Files before programming them onto SROM devices

This section explains the following topics:

- What is characterization?
- Explaining .RIG and .ROM
- Installing the Software

2.1 What is characterization?

The process of characterization creates a file that describes each feature of a tool or rigid body. These files are an important part of the measuring process, as they provide NDI measurement systems with the tool or rigid body's dimensions and marker placements. Without this information, a system cannot accurately interpret the data it has collected. It is one thing to find markers; it is another to know that they belong to a particular object, and where on that object they are located.

2.2 Explaining .RIG and .ROM

6D Architect offers you the option of working with either .RIG files or .ROM files. Make your selection based on which NDI measurement system and what type of tool or rigid body you are working with:

Measurement System	Tool Category	Tool Types	File Required
Polaris	Wired tools	Active tools	.ROM
	Wireless tools	Passive tools	.ROM
		Active wireless tools	.ROM
Polaris Accedo	Wireless tool	Passive tools	.ROM
Optotrak Systems	Rigid bodies		.RIG
	Tools		.ROM

Table 2-1 Selecting .ROM or .RIG

Essentially, when you characterize rigid bodies, you are creating a Rigid Body file (.RIG); when you characterize tools, you are creating an SROM Image File (.ROM).

Note **Although it is not explicit in the table above, active tools and active wireless tools that are normally associated with Polaris Systems can also be characterized with an Optotrak Certus System.**

This guide is written with the assumption that you have an understanding of these different tool categories and types. For more information about the different tools listed above, refer to the following tool design documentation:

Polaris System and Polaris Accedo System

- *Wiring Guide for Polaris Active Marker Tools*
- *NDI TB-0004 Polaris Tools Unique Geometry Specification*
- *NDI TB-0010 Technical Description of the Polaris Wireless Tool*
- *NDI TB-0011 Polaris Rigid Body Definition - Polaris Specific Parameters*
- *NDI TB-0021 Design and Manufacturing - Tools Incorporating IRED Markers*

Optotrak Systems

- *Optotrak Certus Rigid Body and Tool Design Guide*

Note **For the latest releases of NDI documents, software, and firmware, please visit the NDI Partner Site.**

2.3 Installing the Software

NDI 6D Architect uses an automatic installation wizard that, by default, stores all program files on **C:\Program Files\Northern Digital Inc\NDI 6D Architect**. This location can be changed during installation.

Follow the steps as directed by the installation wizard.

Note **Once the installation is complete, you will be prompted to restart your computer; as such, it is recommended that you close all other programs before installing NDI 6D Architect.**

About File Locations

NDI data files used and created by 6D Architect are stored in the ‘ndigital’ directory. The ‘ndigital’ directory is defined by the ND_DIR environment variable. This directory can typically be found in **c:\ndigital**.

NDI recommends that this directory not be changed during installation. All NDI programs use the ND_DIR environment variable. Changing the default settings may affect other NDI software.

3 Exploring 6D Architect Main Window

This section explains the following topics:

- Opening the Main Window
- The Main Toolbar
- The Marker Viewer Window
- The Orientation Toolbar
- SROM Image File Functionality
- Rigid Body File Functionality

3.1 Opening the Main Window

Before you start characterizing tools and rigid bodies, use this section to familiarize yourself with the 6D Architect interface.

All software functions are accessed through the 6D Architect main window.

1. Open 6D Architect. A pop-up dialog appears, asking you which characterizing task you wish to preform.
2. For now, close this dialog. The 6D Architect main window opens, displaying functions and fields specific to the last session (either .ROM or .RIG functionality).

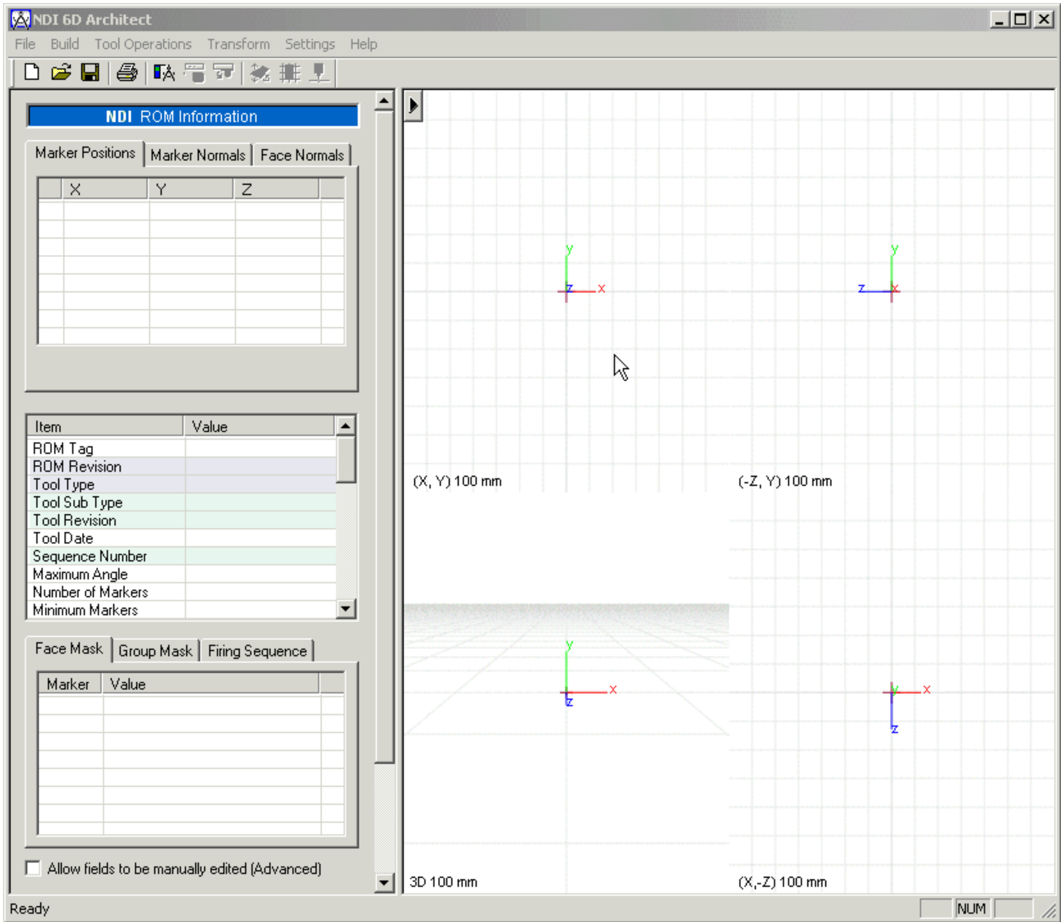


Figure 3-1 6D Architect Main Window (currently showing .ROM functionality)

3.2 The Main Toolbar

The following table describes the buttons on the main toolbar.

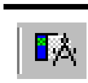
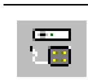
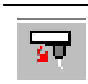
Command Icon	Description
	The **Characterization Wizard** button launches a characterization wizard. If tool information is already loaded, running the wizard will allow you to modify this information.
	The **Test Tool** button lets you test the tracking of the tool within the measurement volume.
	The **Program SROM** button lets you program the SROM Image File into the SROM device of a wired tool.

Table 3-1 Main Toolbar

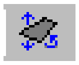
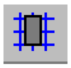
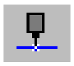
Command Icon	Description
	The **User-Specified Transformation** button lets you manually transform the orientation of the tool.
	The **Alignment Parameter Transform** button lets you align the Rigid Body onto a local coordinate system.
	The **Pivot Algorithm Transform** button launches the Pivot Alignment Wizard. This wizard is used to calculate the tool-tip offset of a tool.

Table 3-1 Main Toolbar

3.3 The Marker Viewer Window

The Marker Viewer Window, located on the left-hand side of the main window, illustrates tool marker geometry for the currently loaded SROM Image File or Rigid Body file.

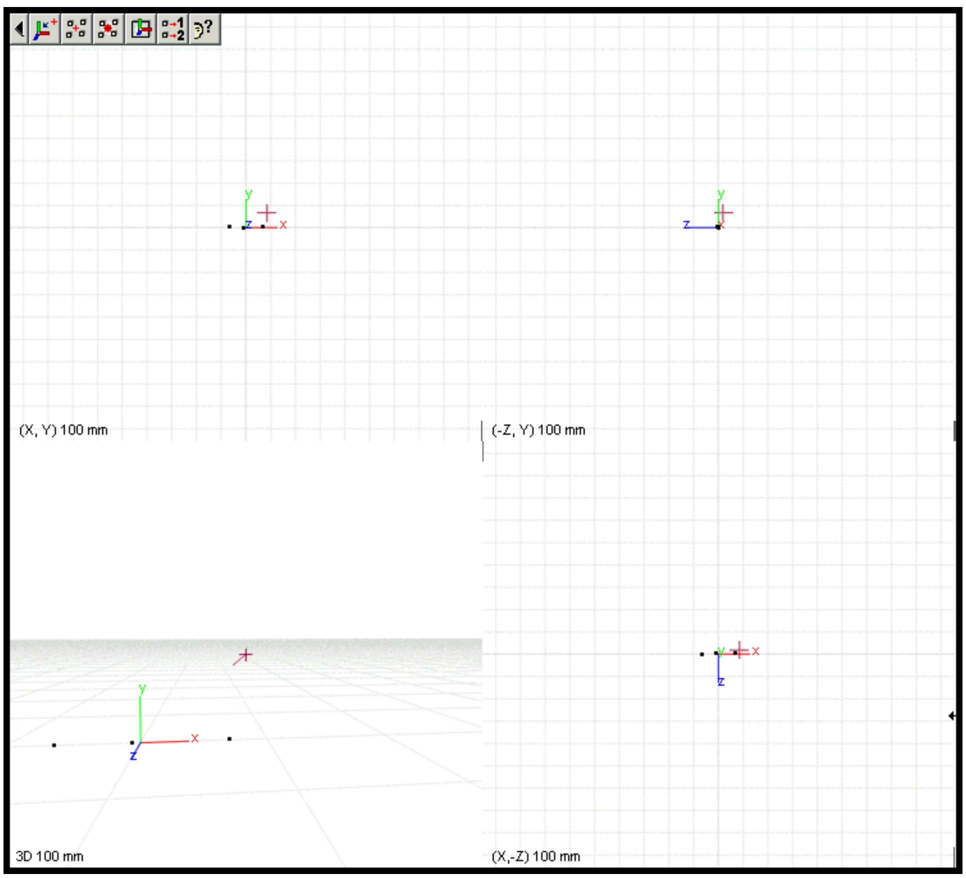


Figure 3-2 Marker Viewer Window

Four tool geometry viewer panes make up the Marker Viewer Window. Three of the four panes provide a two-dimensional representation of the tool's geometry (one for each axis plane). The remaining pane provides a three-dimensional representation of the same information.

Note **Information is displayed relative to the tool or rigid body's local coordinate system.**

To Manipulate the Two-dimensional Views

The xy, xz, and yz panes are views of each respective plane. You can manipulate a pane while keeping the others in view, or you can maximize a pane so that it covers the entire Marker Viewer Window.

Change to View	Action to perform
Maximize/minimize a pane	Double-click any pane.
Change the way the markers are displayed (squares, boxes or marker numbers)	Right double-click on any pane.
Reset the markers to their original positions	Press the 'O' key.
Translate the view	Hold the left mouse button and drag the cursor.
Zoom	Hold the right mouse button and move the cursor vertically.

Table 3-2 Manipulating Two-Dimensional View

To Manipulate the Three-dimensional View

The bottom left pane is a three-dimensional representation.You can manipulate this view in the following ways:

Change to View	Action to Perform
Zoom	Hold the 'Z' key and the left mouse button, and drag the cursor vertically.
Rotate the view	Hold the right mouse button and drag the cursor.
Rotate about the x-axis	Hold the 'Y' key and the left mouse button, and drag the cursor.
Rotate about the y-axis	Hold the 'R' key and the left mouse button, and drag the cursor.

Table 3-3 Manipulating Three-Dimensional View

Change to View	Action to Perform
Rotate about the z-axis	Hold the 'P' key and the left mouse button, and drag the cursor.
Rotate about all axes	Hold the 'Z' and the right mouse button, and drag the cursor.

Table 3-3 Manipulating Three-Dimensional View

3.4 The Orientation Toolbar

The following table describes the buttons used to manipulate the orientation of the tool. Display these buttons by clicking the arrow at the top of the Marker Viewer Window.

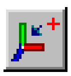
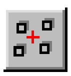
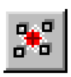
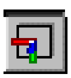
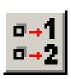
Command Icon	Description
	The **Reset** button resets the view of the markers to their original position.
	The **Centroid** button moves the view to the marker centroid.
	The **Lock Centroid** button locks/unlocks the view to the marker centroid.
	The **Frame of Reference** button toggles the system frame of reference.
	The **Display Type** button toggles the marker display type.
	The **Help** button opens accompanying navigation help.

Table 3-4 Orientation Toolbar

3.5 SROM Image File Functionality

If you are working with SROM Image Files, select **File** > **New** > **ROM File**. The main window updates its contents to reflect SROM Image File functions and fields.

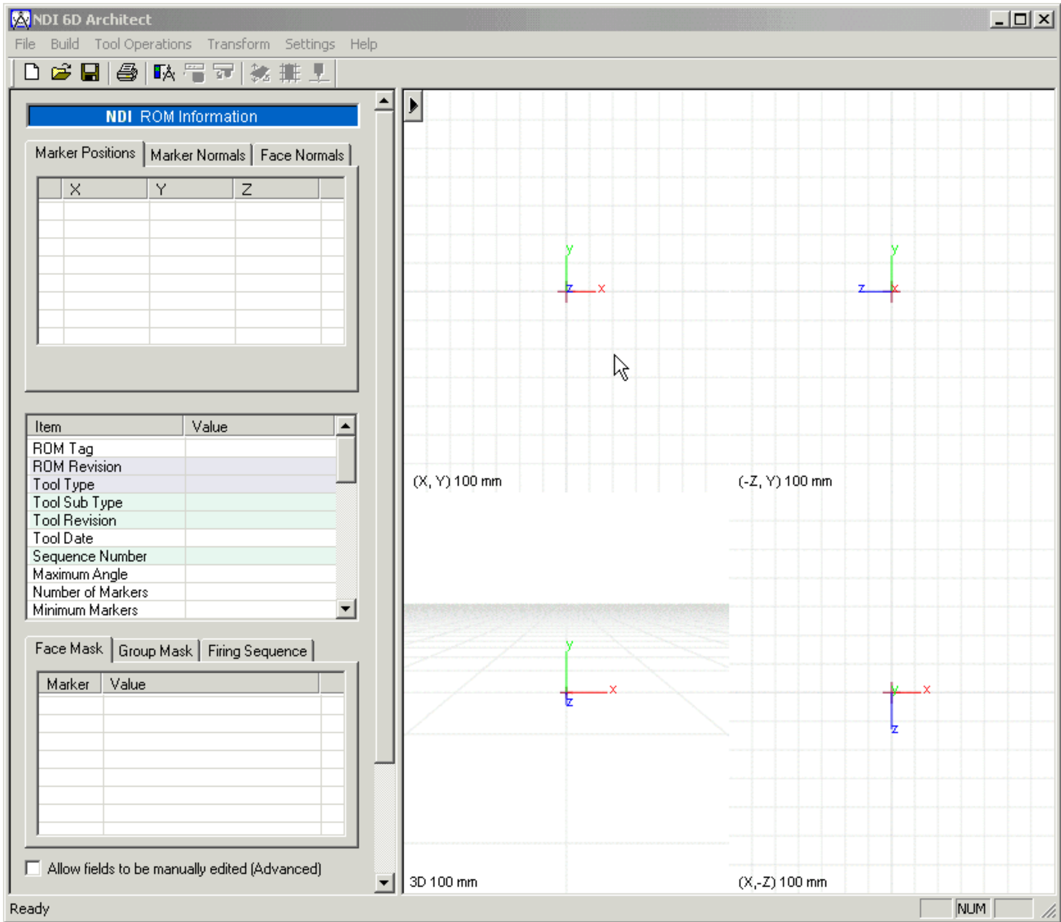


Figure 3-3 6D Architect Main Window (showing .ROM functionality)

Note See "Rigid Body File Functionality" on page 13 for information about changing the main window to reflect .RIG information.

NDI ROM Information Tables

Once the characterization of a tool is complete, you can view the configuration parameters and edit the values before applying the SROM Image File to the tool and its applications. This information is located to the left of the Marker Viewer Window:

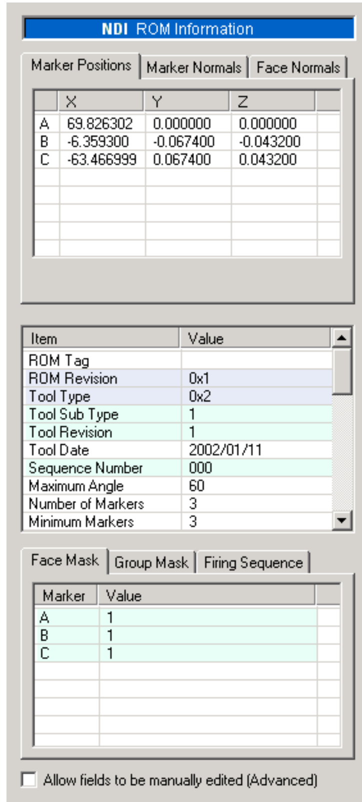


Figure 3-4 NDI ROM Information section

NDI ROM Information is divided into three separate tables:

Table	Description
Marker Positions, Marker Normals, and Face Normals	This table allows you to view and edit marker and face information.
Items and Values	This table lists all of the attributes of what will become the SROM Image File.
Marker Face Masks, Group Masks, and Firing Sequence:	This section allows you to view and edit each marker's Face Mask, Group Mask, and the Firing sequence.

Table 3-5 SROM Image File Information

Note **The value assigned to ROM Tag will always be “ NDI”.**

Some of the NDI ROM Information fields are coloured differently than others:

Colour	Meaning
Green	This field contains an integer value in decimal form.
Blue	This field contains an integer value in hexidecimal form.
White	This field contains a floating point value or a string.

Table 3-6 Field Colours

3.6 Rigid Body File Functionality

If you are working with Rigid Body files, select **File** > **New** > **Rigid Body File**. The main window updates its contents to reflect Rigid Body file functions and fields.

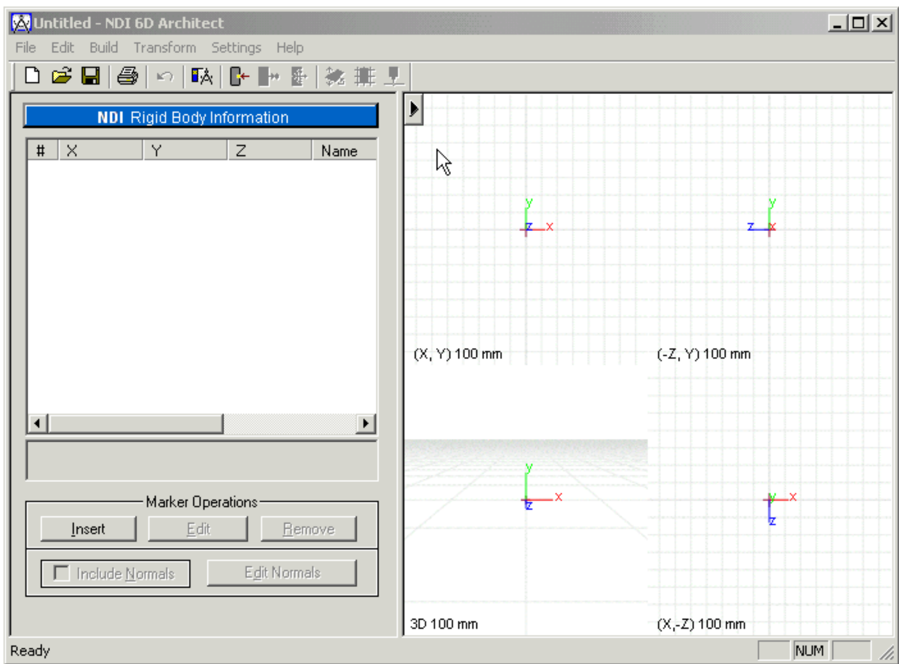


Figure 3-5 6D Architect Main Window (showing .RIG functionality)

NDI Rigid Body Information Tables

Once the characterization of a rigid body is complete, you can view the configuration parameters and edit the values in the main window. This information is located to the left of the Marker Viewer Window:

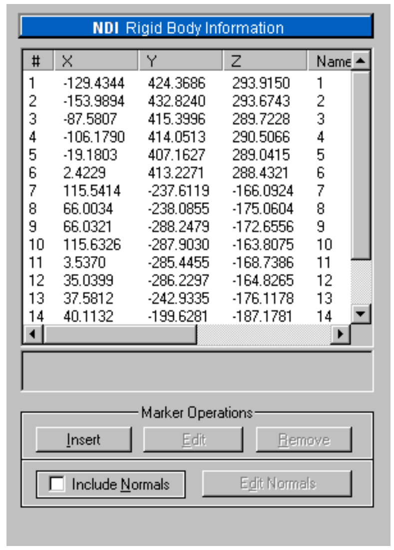


Figure 3-6 NDI Rigid Body Information

The NDI Rigid Body Information section has only one table, listing all the markers in the rigid body. This table includes the markers' assigned names and coordinates.

The NDI Rigid Body Information section also has several Marker Operations that you can perform: you can edit, remove and insert additional markers to table above. You can also change a marker's normals.

For more information about rigid body marker normals, see "Add Marker and Face Normals" on page 57.

4 Tool Characterization: The First Step

NDI 6D Architect provides you with a characterization wizard to guide you through the process of characterizing a tool and creating an SROM Image File.

Note **If you want to characterize a rigid body instead of a tool, see "Rigid Body Characterization: The First Step" on page 18.**

This section explains the following topics:

- Start the ROM Creation Wizard
- What Is Next?

4.1 Start the ROM Creation Wizard

The first screen of the ROM Creation Wizard allows you to choose the type of tool you are characterizing, and the method you plan to use.

1. Select **File** > **New** > **ROM File**.
2. Select **Build** > **ROM Creation Wizard**. The ROM Creation Wizard dialog opens, displaying a Welcome screen.

Note **6D Architect also gives you the opportunity to go directly to the ROM Creation Wizard's Welcome screen whenever you start the software. In the pop-up that appears upon opening 6D Architect, select "I want to create a new .ROM file."**

3. From the **Tool Classification** list, select the appropriate tool type. For example, if you want to create an SROM Image File for an active tool, select **Active**.
4. From the **Characterization Method** list, select the appropriate method. For example, if you plan to characterize your tool using data collected with an Optotrak Certus System, select **Optotrak**.

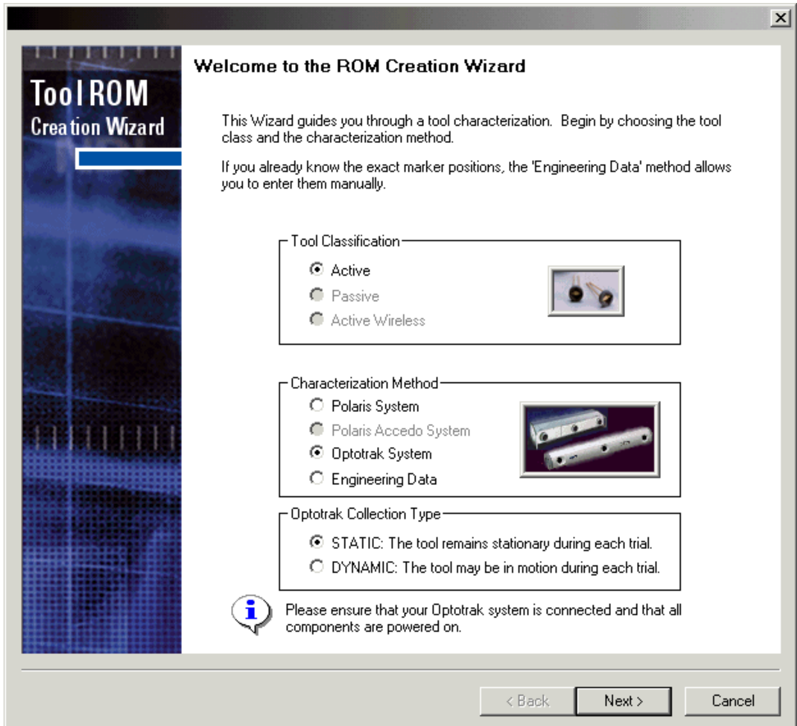


Figure 4-1 Starting the ROM Creation Wizard

Note **You can characterize a tool using the tool's design specifications. This method requires that you enter its marker information manually. To do this, select Engineering Data as your characterization method.**

5. Click **Next**.

4.2 What Is Next?

At this point, 6D Architect customizes ROM Creation Wizard procedures to match your tool type and system selections.

This guide is organized in a similar fashion, so that you can jump ahead to only the information relevant to your tasks:

If you have selected...	Go to:
Active Tool/Polaris System	"Active Tools: Characterizing with a Polaris System" on page 21
Active Tool/Optotrak System	"Active Tools: Characterizing with an Optotrak System" on page 42

Table 4-1 What Is Next?

If you have selected...	Go to:
Active Tool/Engineering Data	"Active Tool: Characterizing with Engineering Data" on page 63
Passive Tool/Polaris System	"Passive Tools: Characterizing With A Polaris System" on page 84
Passive Tool/Polaris Accedo System	"Passive Tools: Characterizing With A Polaris Accedo System" on page 104
Active Wireless Tool/Polaris System	"Passive Tools: Characterizing With A Polaris System" on page 84

Table 4-1 What Is Next?

4.3 About .CRM Files

Once you have completed characterizing a tool, 6D Architect allows you to save all the ROM Creation Wizard selections that you have made, in case you want to repeat the characterization process for additional tools using similar parameters. For more information about creating this file, see "Complete the Tool Characterization" on page 39.

You can open a .crm file at any time while working in the 6D Architect main window.

1. From the main window toolbar, click **Build** > **Load Characterization Template File**. The Auto-Characterization File dialog opens.
2. In the **File Name** field, enter the desired .crm file, or browse to it by clicking .
3. Click **Proceed**. The System Connection dialog opens.
4. Continue the characterization process with the ROM Creation Wizard.

5 Rigid Body Characterization: The First Step

NDI 6D Architect provides you with a characterization wizard to guide you through the process of characterizing a rigid body and creating a Rigid Body file (.RIG).

This section explains the following topics:

- Start the Rigid Body Creation Wizard
- What Is Next?

5.1 Start the Rigid Body Creation Wizard

1. Select **File** > **New** > **Rigid Body File**.
2. Select **Build** > **Build Rigid Body**. The Rigid Body Creation Wizard dialog opens.

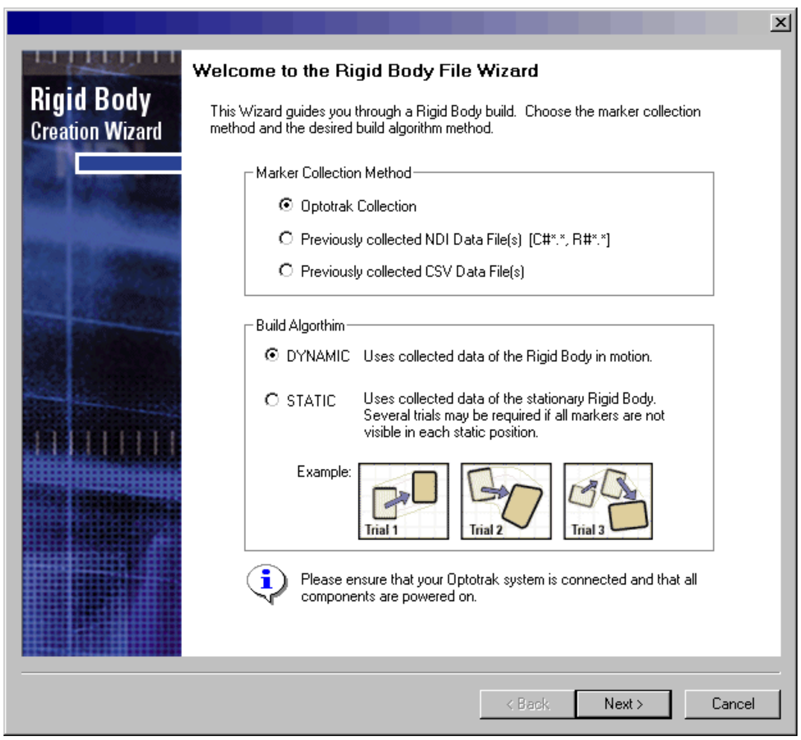


Figure 5-1 Rigid Body Creation Wizard Welcome Dialog

Note **6D Architect also gives you the opportunity to go directly to the Rigid Body Creation Wizard's Welcome screen whenever you start the software. In the pop-up that appears upon opening 6D Architect, select "I want to create a new .RIG file."**

3. From the **Marker Collection Method** section, select one of the following options:

Optotrak Collection Selecting Optotrak Collection allows you to perform data collections with an Optotrak System. This collected data will be used to characterize the rigid body.

Previously Collected NDI Data File Previously collected data files can also be used to characterize a rigid body. There are three types of data files that can be used:

NDI File Type	Description
Full Raw Data Files	An NDI data file containing the numeric values of the marker centroids, signal strength (high and low), and amplification measured over a specified period of time.
Raw Data Files	An NDI data file containing the numeric values of the marker centroids measured over a specified period of time.
3D Data Files	An NDI data file containing the x, y, z coordinates of markers measured over a specified period of time.

Table 5-1 NDI Data Files

Previously Collected CSV File CSV (Comma Separated Values) Files are text files containing a header and 3D marker data. This file must have been previously collected with an Optotrak System.

4. Select the Build Algorithm type:

Option	Definition
Static	The rigid body will not move during data collection. If it does, that data collection trial becomes invalid. Select this option if the Position Sensor can see all markers when the rigid body is stationary and in a single pose.
Dynamic	The rigid body can move during data collection.Select this option if the Position Sensor cannot see all markers when the rigid body is stationary and in a single pose.

Table 5-2 Build Algorithm Types

5. Click **Next**.

5.2 What Is Next?

6D Architect customizes the following Rigid Body Creation Wizard procedures to match the collection method chosen in the Rigid Body Creation Wizard Welcome dialog. This guide is organized in a similar fashion:

If you have selected...	Go to:
Optotrak Collection	"Rigid Bodies: Characterizing with an Optotrak System" on page 137
Previously Collected NDI Data Files	"Rigid Bodies: Characterizing with Previously Collected Data" on page 124
Previously Collected CSV Files	"Rigid Bodies: Characterizing with Previously Collected Data" on page 124

Table 5-3 What Is Next?

5.3 About .CRG Files

Once you have completed characterizing a rigid body, 6D Architect allows you to save all the Rigid Body Creation Wizard selections that you have made, in case you want to repeat the characterization process for additional rigid bodies using similar parameters.

Note **For more information about creating this file, see "Complete the Characterization" on page 151.**

You can open a .crg file at any time while working in the 6D Architect main window.

1. From the main window toolbar, click **Build** > **Load Characterization Template File**. The Auto-Characterization File dialog opens.
2. In the **File Name** field, enter the desired .crg file, or browse to it by clicking .
3. Click **Proceed**. The System Connection dialog opens.
4. Continue the characterization process with the Rigid Body Creation Wizard. For instructions, see "Rigid Bodies: Characterizing with an Optotrak System" on page 137.

6 Active Tools: Characterizing with a Polaris System

The following sections direct you through each window of the ROM Creation Wizard, to help you characterize an active tool with a Polaris System.

This section explains the following steps:

1. Start the Wizard
2. Enter Collection Settings
3. Describe Tool Properties
4. Define Marker Setup
5. Save Parameters
6. Collect Tool Marker Data
7. Define Groups and Faces
8. Align the Tool's Coordinate System
9. Add Marker and Face Normals
10. Complete the Tool Characterization
11. What Is Next?

6.1 Start the Wizard

Before continuing, you must open the wizard and indicate that you are characterizing an active tool with a Polaris System. For instructions, see "Tool Characterization: The First Step" on page 15.

Once this step is completed, you can continue the characterization process.

6.2 Enter Collection Settings

The ROM Creation Wizard's second screen is the Collection Settings dialog. Collection settings tell 6D Architect which port the tool is connected to, how many frames of data to collect, and what kind of Polaris System measurement volume you are using.

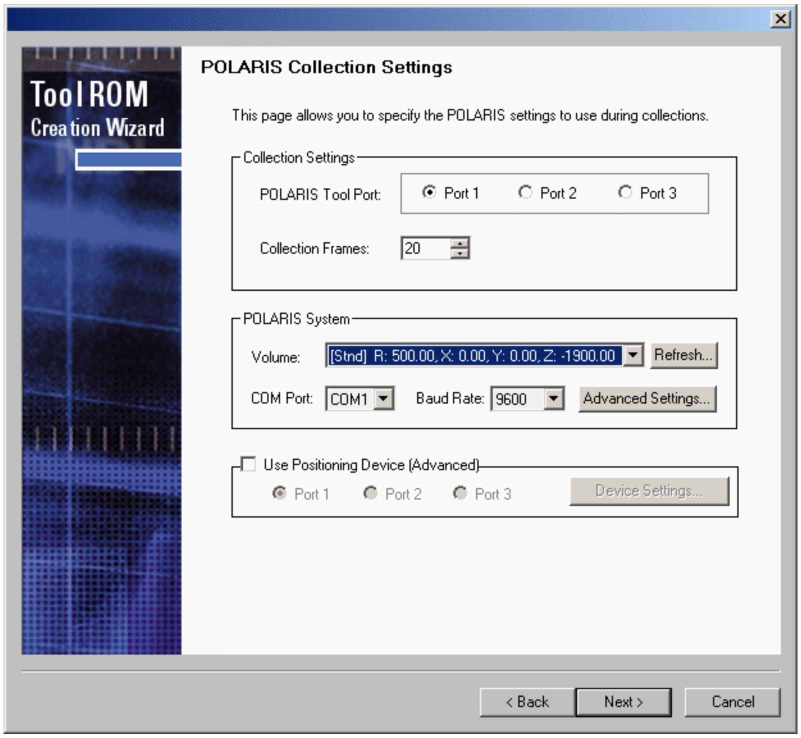


Figure 6-1 Collection Settings Dialog

1. Complete the Collection Settings section:

Field/Option	Definition
Polaris Tool Port	The tool port that the tool is plugged into.
Collection Frames	The number of frames 6D Architect will collect from the Polaris System as it tracks the tool. A frame is a single 3D measurement of the positions of all the markers in the measurement volume.

Table 6-1 Collection Settings Section

2. Complete the Polaris System section:

Field/Option	Definition
Volume	Your Polaris System's measurement volume type.
COM Port	The host computer's communications port to which the Polaris System is connected.

Table 6-2 Polaris System Section

Field/Option	Definition
Baud Rate	The host computer's baud rate. The default setting is 9600 to ensure communications can be established for all computer configurations.

Table 6-2 Polaris System Section

3. (Optional) If you are using a positioning device, refer to *TB-10029*.
4. (Optional) If you want to apply advanced system settings, see "Polaris/Polaris Accedo System Settings" on page 170.
5. Click **Next**. The Tool Description dialog appears.

6.3 Describe Tool Properties

In this screen, the ROM Creation Wizard will ask you to enter the parameters about the tool. This includes information such as the tool type, marker type, and the tracking algorithm.

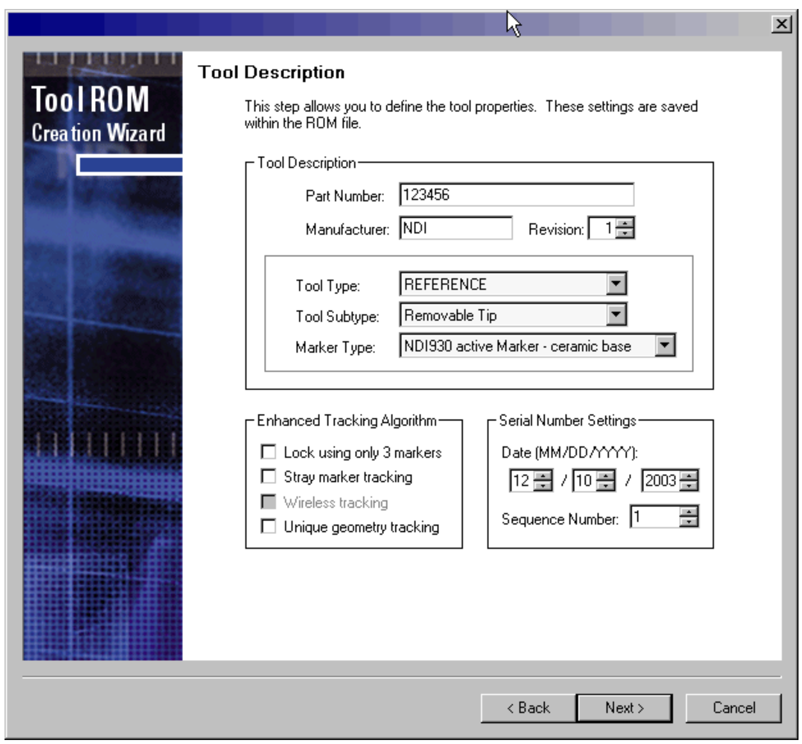


Figure 6-2 Tool Description Dialog

1. Complete the Tool Description section:

Field/Option	Action
Part Number	Assign a part number to your tool. You can use a maximum of 20 characters.
Manufacturer	Assign a manufacturer name to your tool. You can use a maximum of 12 characters.
Revision	Assign a revision number to your tool.
Tool Type	From the list, select the entry that reflects the tool type.
Tool Subtype	From the list, select the entry that reflects the tool subtype.
Marker Type	From the list, select the entry that reflects the tool marker type.

Table 6-3 Tool Description Fields

Note **The part number, manufacturer, and revision number are mandatory fields. This information uniquely identifies the tool's design, and associates it with a particular application.**

2. Complete the Enhanced Tracking Algorithm section:

Field/Option	Action
Lock using only 3 markers	If you want to reduce the acquisition time, choose this option.
Stray marker testing	If you want the Polaris System to track a single stray marker which may move with respect to the tool, select this option.
Wireless tracking	This is disabled for active tools.
Unique geometry tracking	If the tool meets unique geometry constraints, choose this option. This will result in a reduction of acquisition time for the tool.

Table 6-4 Algorithm Options

Note **A tool must meet the unique geometry constraints in order to use the Unique Geometry Tracking functionality. If you use Unique Geometry Tracking for a tool that does not meet the constraints, the tool cannot be tracked. For more information, see "Unique Geometry" on page 164.**

3. Complete the Serial Number Settings section:

Field/Option	Action
Date (MM/DD/YYYY)	Enter today's date using the format indicated.
Sequence Number	Enter 1 to indicate an increment of one for each serial number created.

Table 6-5 Serial Number Settings

The software will automatically calculate a unique serial number for your tool using these settings.

4. Click **Next**. The Marker Setup dialog opens.

6.4 Define Marker Setup

Once the tool description is defined, the ROM Creation Wizard will ask you to specify where the markers are within the wiring matrix, and if switches or LEDs are present on the tool. You can determine the firing sequence of the markers automatically, or by assigning a number manually.

Note **You can use the Auto-Detect feature to determine the location of the active markers and LEDs within the matrix. If you choose this option, the firing sequence is arbitrary.**

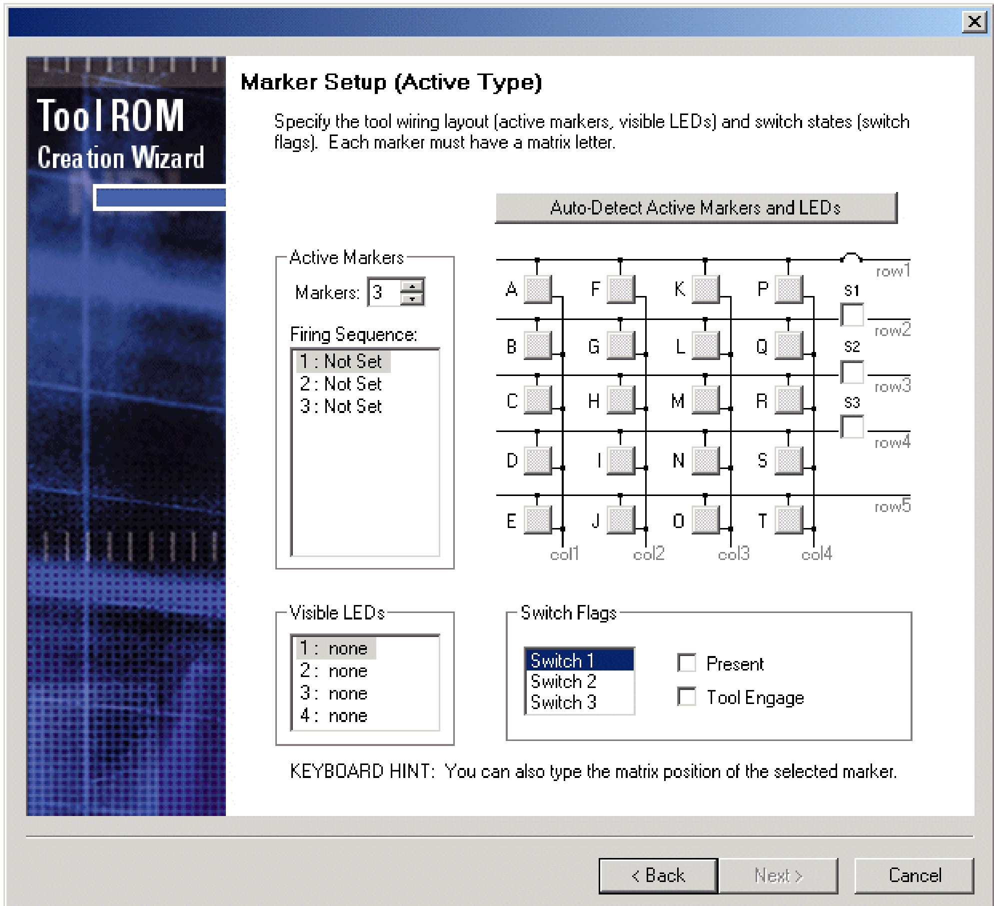


Figure 6-3 Marker Setup Dialog

To Automatically Detect the Active Markers

1. Click **Auto-Detect Active Markers and LEDs**. The system will automatically populate the matrix with the active markers (shown in white), and the visible LEDs (shown in green) associated with the tool.

Note **The software distinguishes between markers and LEDs using settings that you can change. See** **"Polaris/Polaris Accedo System Settings" on page 170** **for more information.**

2. If you are not setting switch flags, click **Next**. If you are setting switch flags, see below.

To Manually Set the Firing Sequence of the Markers

1. In the **Markers** field, select the number of markers on your tool.
2. From the **Firing Sequence** field, **click**, **drag**, and **drop** each marker from the list to the appropriate lettered square in the wiring matrix.

When adding a marker to the wiring matrix, you can also use any of the following shortcuts:

- double-click the marker to select the appropriate letter in the matrix
- right-click the marker to select the appropriate letter in the matrix
- click the marker and enter the letter on the keyboard

3. If you are not setting switch flags, click **Next**. If you are setting switch flags, see below.

To Set the Switch Flags

You can set up to three different switches for each tool.

1. In the Switch Flags section, select the switch for which you are defining parameters.
2. Choose **Present** to let the software know that a switch is present.
3. Choose **Tool Engage** if the tool has a removable tip. With this enabled, the system will disable the tool if its tip is removed and the switch is activated, during tracking. You will not be able to use the tool again until the tip is replaced or re-attached.
4. Click **Next**. The Save Parameters dialog opens.

6.5 Save Parameters

6D Architect saves the collected data in a .csv (Comma Separated Value) file, and stores it in the location indicated in this Save Parameters dialog. Once you have finished the entire characterization process, you can open and review the .csv file’s contents.

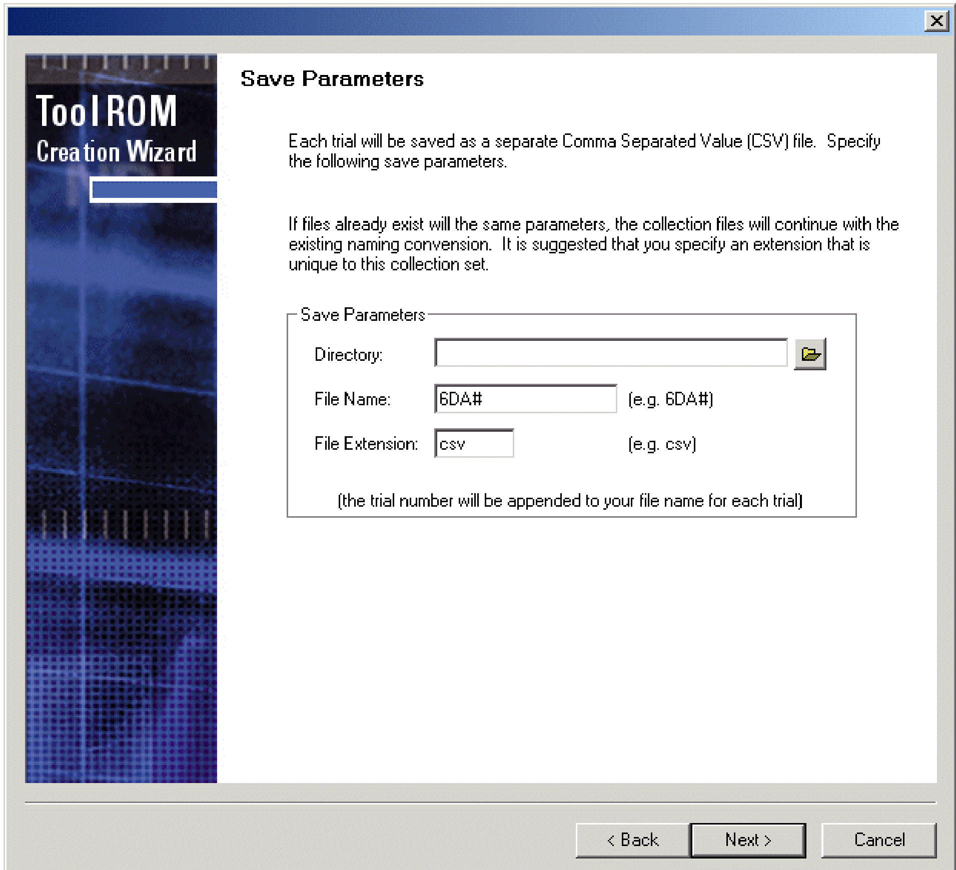


Figure 6-4 Save Parameters Dialog

1. Complete the Save Parameters section:

Field/Option	Action
Directory	Enter the directory location where you wish the files to be saved, or browse to a location by clicking .
File Name	Enter the name for the data collection.
File Extension	Enter **csv**.

Table 6-6: Save Parameters Section

2. Click **Next**. The Data Collection dialog opens.

Note **You will now be prompted to connect the Polaris System to the computer and ensure that the tool is connected to the correct port on the Tool Interface Unit.**

6.6 Collect Tool Marker Data

The Data Collection dialog allows you to view the tool within the measurement volume during each trial frame.

The tool must remain motionless during collection trials. If the tool is moved even slightly during a collection, the Polaris System cannot determine accurate positions of all markers with respect to each other. The tool characterization will likely fail.

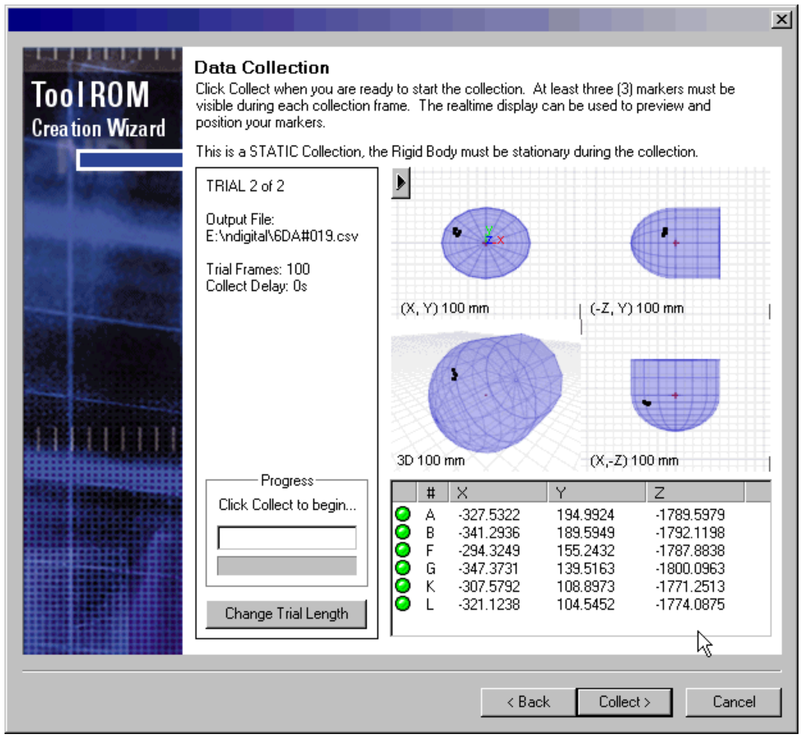


Figure 6-5 Data Collection Dialog

Note **Figure 6-5 shows a Polaris System using a standard measurement volume.**

---

1. (Optional) If you want to edit the collection trial length, click **Change Trial Length** and enter the new value. Increasing the trial length may increase the accuracy of the software's data interpretations.

2. Position the tool within the measurement volume. If you are unsure whether or not your markers are visible, observe the marker status in the bottom right of the window:

Marker Colour	Marker Status
Green	The marker is visible to the system and is inside the measurement volume.

Table 6-7 Marker Status Colours

Marker Colour	Marker Status
Yellow	The marker is visible, but not in the measurement volume.
Red	The marker is not visible to the system.

Table 6-7 Marker Status Colours

Each coloured circle corresponds to a marker. The number of circles should match the number of markers that are on the tool.

3. Click **Collect**. The system proceeds to collect information about each marker's position, for the number of frames specified. You can view this action in the marker status section of the dialog.

The Current Collection Status dialog opens, displaying this collected information. Use this dialog to view the collection results or record another trial:

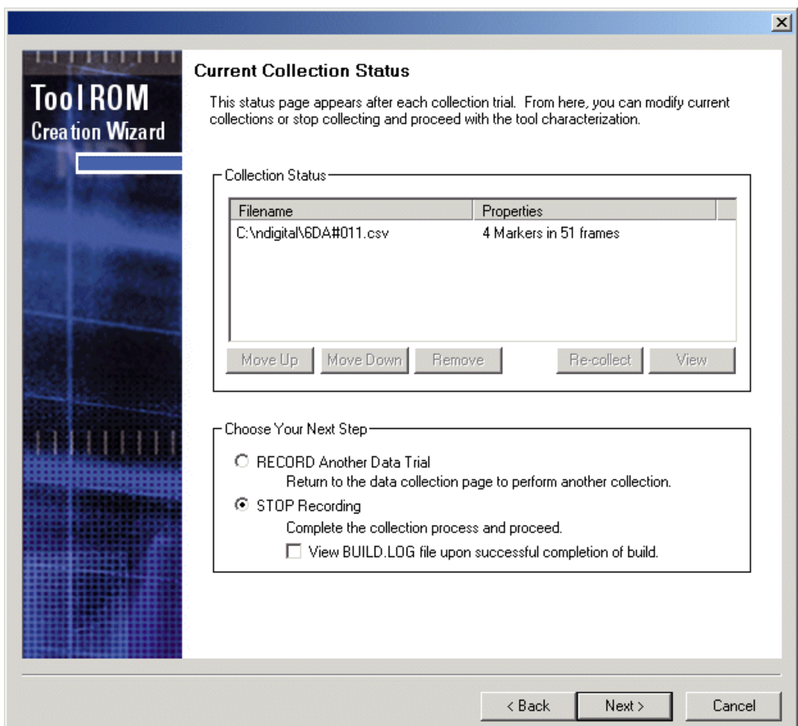


Figure 6-6 Current Collection Status Dialog

1. Select the newly-created .csv file from the **Collection Status** list.
2. (Optional) Click **View**. The .csv file results open for viewing. When you have finished reviewing the results, click **Close**.
3. (Optional) You can record additional data trials:

- If you want to collect another data trial, select **RECORD Another Data Trial**. You will be returned to the Data Collection dialog to begin the process again.
- If you want to overwrite an existing data trial, select the file that you wish to overwrite from the list, and click **Re-collect**. You will be returned to the Data Collection dialog to begin the process again.

4. When you are satisfied with the data collection, select **STOP Recording**.
5. (Optional) If you want to view the Build.log file at the end of the build (when you have completed the ROM Creation Wizard), choose **View BUILD.LOG upon successful completion of build**.
6. Click **Next**. The Groups and Faces dialog opens.

6.7 Define Groups and Faces

Once the firing sequence for the active markers has been defined, you can organize the markers into groups and faces.

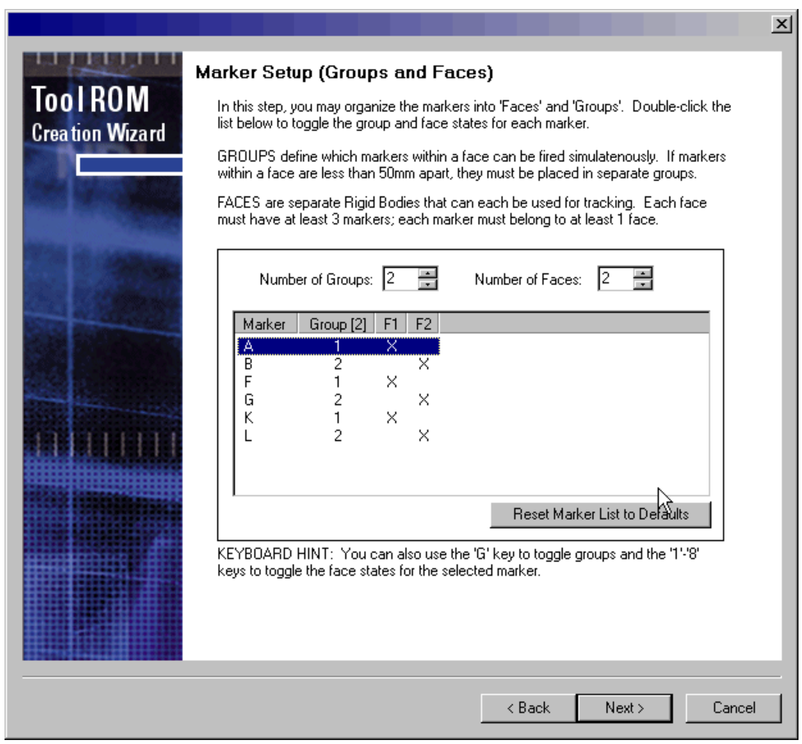


Figure 6-7 Marker Setup (Groups and Faces) Dialog

To Select the Number of Groups

1. In the **Number of Groups** field, select the number of groups you want to create.

2. Assign each marker in the table to group: in the table, double-click on a marker's **Group[N]** entry to toggle between group selections. By default, all markers are assigned to group 1.
3. (Optional) If you want to restore the groups to the original settings, click **Reset Marker List to Defaults.**

To Select the Number of Faces

1. In the **Number of Faces** field, select the number of faces.
2. Assign a marker to a face: in the table, double-click the marker's **F** column entry to change it to **X**. This means that this marker is included on the face.
3. (Optional) If you want to restore the faces to the original settings, click **Reset Marker List to Defaults.**
4. Click **Next**. The Tool Alignment dialog opens.

6.8 Align the Tool's Coordinate System

Before any measurement system can calculate the position and rotation of your tool, you will need to assign the tool a local coordinate system. Assigning a local coordinate system is an important step in producing accurate transformations.

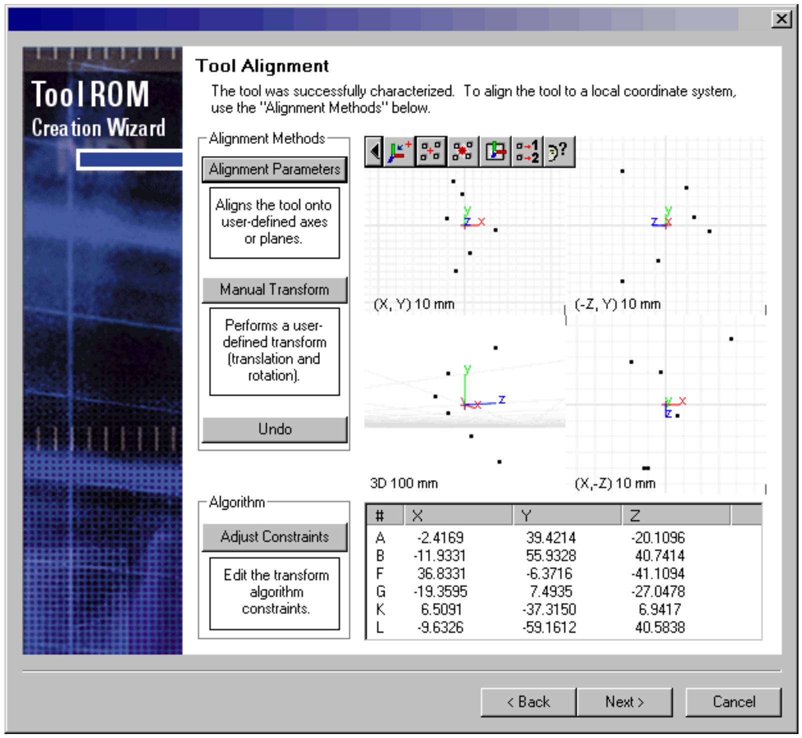


Figure 6-8 Tool Alignment Dialog

To Assign a Local Coordinate System Using Alignment Parameters

1. Click **Alignment Parameters**. The following dialog appears:

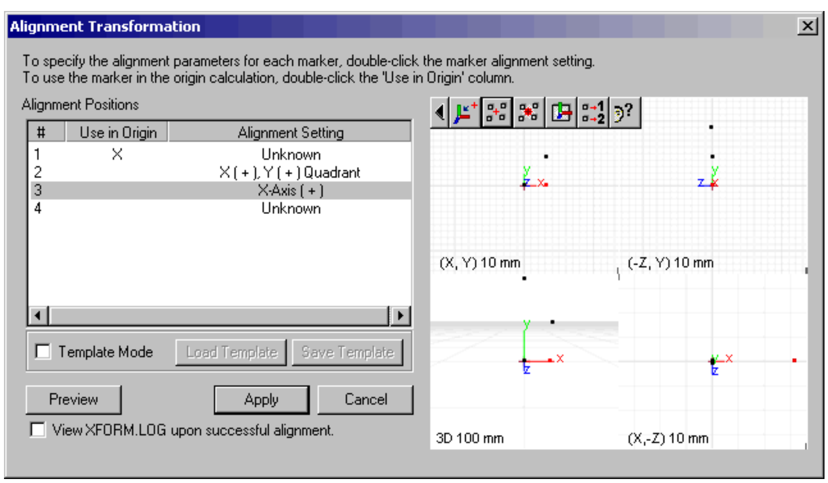


Figure 6-9 Alignment Transformation Dialog

2. To assign a marker as the origin of the local coordinate system, double-click that marker's entry under **Use in Origin**. If you select more than one marker as the origin of your tool , 6D Architect will place the origin at the geometric centre of these markers.

3. To place a marker onto an axis, right-click the marker's entry under **Alignment Setting**. Use the list that appears to constrain the marker to be on any positive or negative x, y, or z-axis.

4. To place a marker onto a plane of the local coordinate system, double-click that marker's entry under **Alignment Setting**. Use the list that appears to constrain the marker to any quadrant of any plane.

5. Click **Preview** to view the changes that you make in the marker window. This can help you visualize the chosen orientations and help trouble-shoot any conflicting alignments you may have accidentally made.

6. (Optional) If you want to either save these alignment settings to a template or open an existing alignment template and apply it to your tool, enable **Template Mode** to activate template functions.

7. When you are finished, return to the Tool Alignment dialog:

   - If you want to return to the original position and orientation, click **Cancel**.
   - If you are satisfied with the alignment parameters, click **Apply**.

8. (Optional) Define the algorithm constraints further by clicking **Adjust Constraints**. For more information about this function, see "Algorithm Constraints" on page 167.

Note **The algorithm constraints are advanced option parameters. If the intended result is not fully understood, do not perform this step and simply continue with the default settings.**

9. Click **Next**. The Marker and Face Normals dialog appears.

To Adjust the Local Coordinate System Manually

1. Click **Manual Transform**. The following dialog appears:

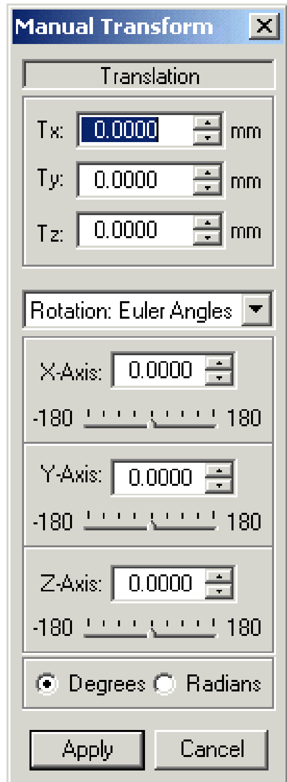


Figure 6-10 Manual Transform Dialog

2. Adjust each field incrementally to change the position and orientation of the local coordinate system. Each change is reflected in the graphic representations in the Tool Alignment dialog.
   - Use the **Tx**, **Ty**, and **Tz** fields to translate the origin of the local coordinate system.
   - If you are using the Euler Angles (as indicated in the drop-down list), use the **X-Axis**, **Y-Axis**, and **Z-Axis** fields to rotate the local coordinate system.

Note **The Rotation Matrix and Quaternion are advanced options. The easiest and most intuitive way to rotate coordinate systems is to use Euler Angles.**

3. Once you are satisfied, click **Apply** to save your changes.
4. (Optional) Define the algorithm constraints further by clicking **Adjust Constraints**. For more information about this function, see "Algorithm Constraints" on page 167.

Note **The algorithm constraints are advanced option parameters. If the intended result is not fully understood, do not perform this step and simply continue with the default settings.**

5. Click **Next**. The Marker and Face Normals dialog appears.

6.9 Add Marker and Face Normals

For each marker and face on your tool, you will need to assign a vector that defines which way they are facing. The system uses this vector, or *normal*, to help determine where the marker or face is pointing in the measurement volume. With this information, the system can determine if the marker or face is pointing at an angle that no longer provides accurate data.

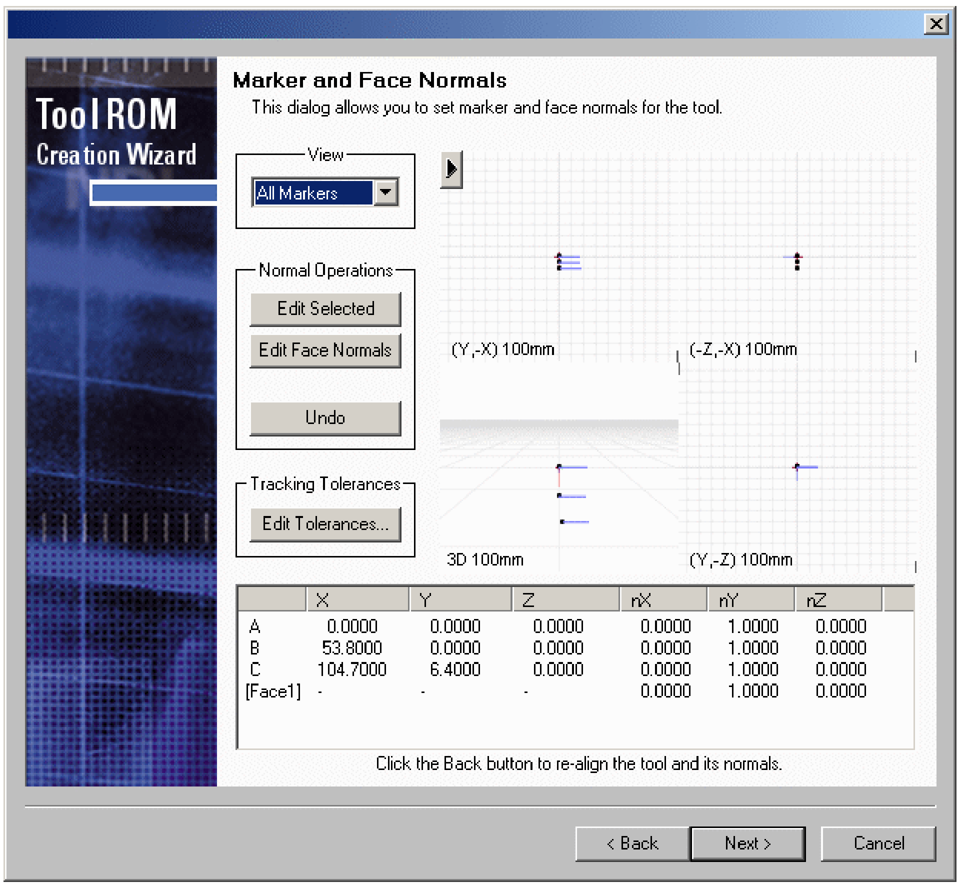


Figure 6-11 Marker and Face Normals Dialog

About Determining Normals

Note **You need to assign normals to all markers *and* all faces.**

6D Architect performs several calculations and displays the results at the bottom of the Marker and Face Normals dialog, to guide you in selecting the right normal values. These suggestions change depending on how many markers are selected, and where these markers are located on the tool:

Number of Markers Selected	Suggested Values Provided
1 marker	none
2 markers	coordinates of the centroid
3 markers	coordinates of the centroid, and coefficients of an imagined plane that the three markers would create.
4 or more markers	coordinates of the centroid

Table 6-8 Marker Information Provided By 6D Architect

Note **The centroid is the centre point of an imagined three dimensional volume created by the selected markers.**

You can use these suggested values when determining normals, but be sure to review and adjust the values as needed.

Note **A face normal must be perpendicular to its face. Individual marker normals, however, do not need to be perpendicular to the face that marker is assigned to.**

To Create a Normal for Individual Markers

1. In the **View** list, select **All Markers.**
2. In the table at the bottom of the dialog, press **Ctrl** and select three markers (the desired marker included).
3. Below the table, the software displays the centroid and a plane equation associated with the selected markers. Use this information to determine the coordinates of the ideal normal for the desired marker.

Note **The first three coefficients of the plane equation are coordinates for a normal vector perpendicular to the imagined plane.**

4. Select a single marker (or if you want to assign the same normal to multiple markers, select them while pressing the **Ctrl** key).

5. Click **Edit Selected**.
6. In the coordinate fields provided, enter the values that you determined in step 2 and adjust the values if necessary. Your changes are displayed graphically, to help you with these edits.
7. Click **OK**.

To Create Normals for Faces

1. In the **View** list, select the appropriate face**.**
2. In the table at the bottom of the dialog, press **Ctrl** and select three markers that are assigned to the face.
3. Below the table, the software displays the centroid and a plane equation associated with the selected markers. Use this information to determine the coordinates of the ideal normal for the desired marker.

Note **The first three coefficients of the plane equation are coordinates for a normal vector perpendicular to the imagined plane.**

4. Click **Face Normals**.
5. From the drop-down list, select the appropriate face.
6. In the coordinate fields provided, enter the values that you determined in step 2 and adjust the values if necessary. Your changes are displayed graphically, to help you with these edits.
7. Click **OK**.
8. (Optional) If you want to restore all of the normals and tolerances to the default settings, click **Undo**.
9. Click **Next**. The Characterization Completion dialog opens.

To Set Tracking Tolerances

1. In the **View** list, select **All Markers.**
2. In the table at the bottom of the dialog, select a marker.
3. Click **Edit Tolerances**. The following dialog opens.

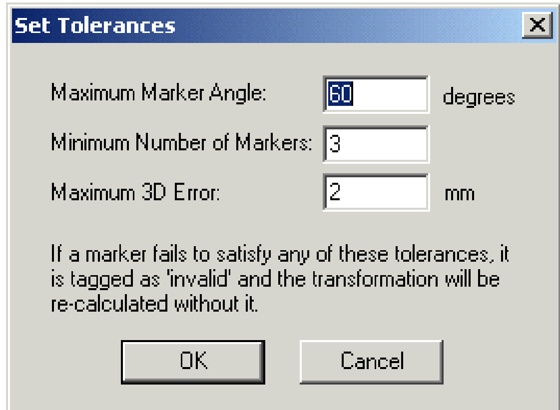


Figure 6-12 Set Tolerances Dialog

4. Complete the fields provided:

Field	Action
Maximum Marker Angle	Enter the maximum angle that a marker normal can be pointed *away* from the Position Sensor. Any marker turned away more than this value will not be used to compute a tool transformation.
Minimum Number of Markers	Enter the minimum number of markers that must be counted as present in the measurement volume, before the system produces a transformation for the tool.
Maximum 3D Error	Enter the maximum distance between where the marker is observed by the system and is expected to be in the tool's SROM Image File. If a marker exceeds this value, it is not used to compute a tool transformation.

Table 6-9 Tolerance Fields

5. Click **OK**.

6. Click **Next**. The Characterization Completion dialog opens.

6.10 Complete the Tool Characterization

6D Architect allows you to save all the ROM Creation Wizard selections that you've made, in case you want to repeat the characterization process for similar tools using similar parameters. Remember that although you can use the same wizard selections for similar tools, you will still need to perform separate and unique data collections for each

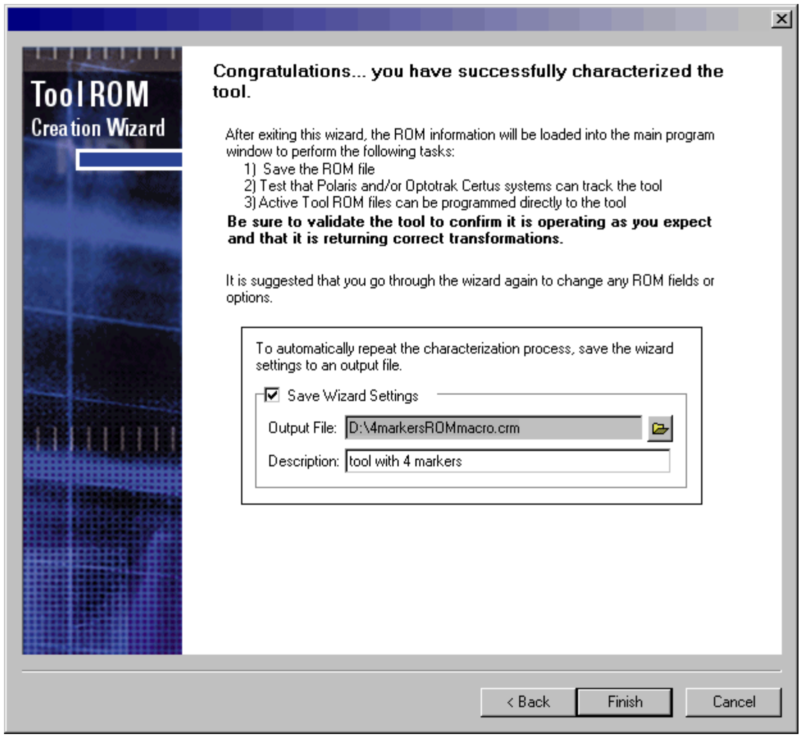


Figure 6-13 Characterization Completion Dialog

1. Enable **Save Wizard Settings**.
2. In the **Output File** field, browse to a location and enter a name by clicking .
3. In the **Description** field, enter an identifying description for this wizard session.
4. Click **Finish**. The software saves your settings in a ROM Characterization Macro (.crm) file.

Note **The saved parameter file contains the tool's characterization information. When applied to subsequent tools, the software will automatically increase the sequence number.**

Once the characterization is complete, the wizard closes and a graphical representation of the tool will be loaded into the main window. The tool parameters are loaded in the ROM section of the main window.

For more information about the main window, see "Exploring 6D Architect Main Window" on page 6.

6.11 What Is Next?

After you have created and saved the SROM Image File (.ROM) file, you must perform the following tasks:

1. Test the SROM Image File to ensure that the Polaris System can track the tool correctly. For more instructions, see “Testing Tools” on page 161.
2. Load the SROM Image File onto the tool’s SROM device. For instructions, see “Active Tools: Programming SROM Devices” on page 79.

7 Active Tools: Characterizing with an Optotrak System

The following sections direct you through each window of the ROM Creation Wizard, to help you characterize an active tool with an Optotrak System.

This section explains the following steps:

1. Start the Wizard
2. Enter the Collection Settings
3. Describe Tool Properties
4. Define Marker Setup
5. Save Parameters
6. Collect Tool Marker Data
7. Define Groups and Faces
8. Align the Tool's Coordinate System
9. Add Marker and Face Normals
10. Complete the Tool Characterization
11. What Is Next?

7.1 Start the Wizard

Before continuing, you must open the wizard and indicate that you are characterizing an active tool with an Optotrak System. For instructions, see "Tool Characterization: The First Step" on page 15.

When you select Optotrak System, the wizard automatically updates your options to include collection types:

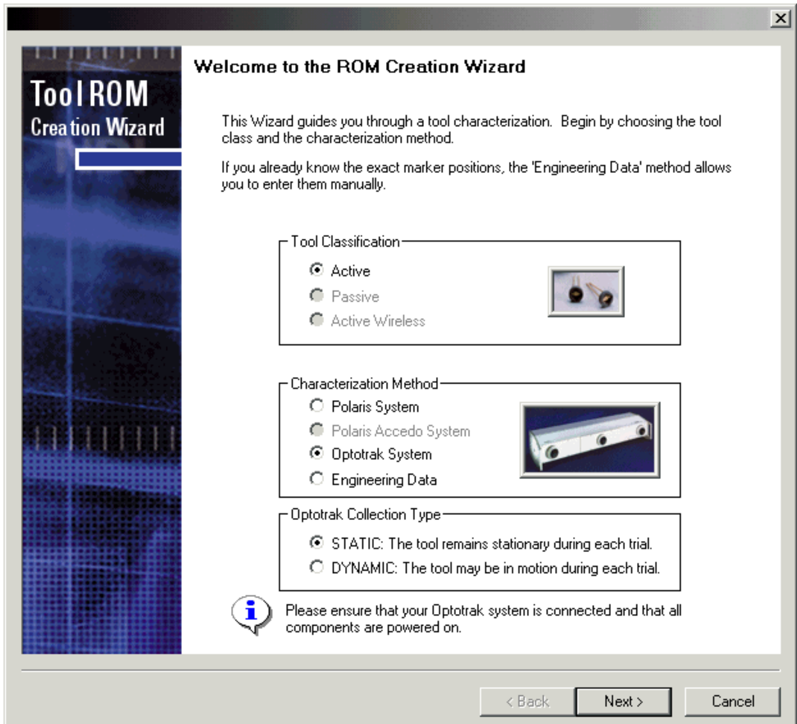


Figure 7-1 Updated ROM Creation Wizard Dialog

1. Select the Optotrak Collection Type:

Option	Definition
Static	The tool will not move during data collection. If it does, that data collection trial becomes invalid.
Dynamic	The tool can move during data collection.

Table 7-1 Collection Type Options

Note **Select Dynamic if not all tool's markers can be seen by the Position Sensor when the tool is in a single pose. You will need to be able to change the tool pose in order to collect information on all its markers.**

2. Make sure that the Optotrak System is connected and powered on.

3. Click **Next**.

At this point, 6D Architect connects to the Optotrak System to determine its type (Optotrak Certus or Optotrak 3020). Once this has been determined, the Collection Settings dialog appears, adjusted to reflect which Optotrak System was detected. From here, you can continue the characterization process.

7.2 Enter the Collection Settings

The ROM Creation Wizard's second screen is the Collection Settings dialog. Collection settings tell 6D Architect which what tool is being characterized, and how the Optotrak System reads the tool's markers.

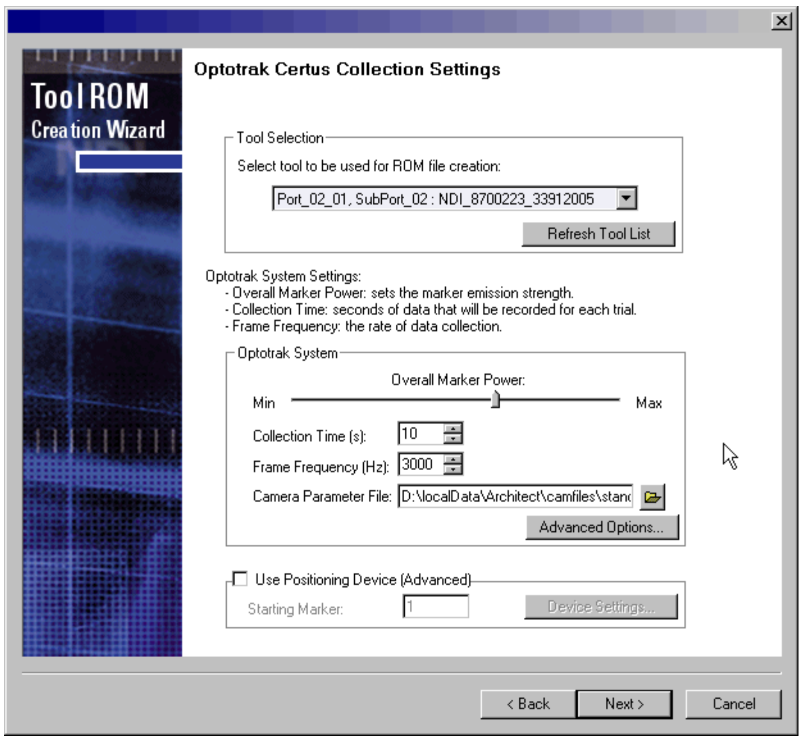


Figure 7-2 Collection Settings Dialog

Note **Figure 7-1 shows the Collection Settings dialog of an Optotrak Certus System. This contents of this dialog is slightly different for Optotrak 3020 Systems.**

---

1. From the **Tool Selection** drop-down list, select the tool you wish to characterize.

   Each selection is formatted in the following way:

   Port_A_B, Subport_C: Tool, where

   A is the port number on the SCU

B is the strober order number (assigned sequentially to each strober connected to the indicated port)

C is the strober's subport number

6D Architect automatically generates the **Tool Selection** list using information that it gathered when it first connected to your Optotrak System. If tools are switched or added to a port, click the **Refresh Tool List** button. 6D Architect will reconnect and update the selections available.

2. Complete the Optotrak System Settings section:

Field	Action
Overall Marker Power scale	Use this scale to indicate the intensity of light emitted from the markers.
Collection Time(s)	Enter the length of collection time required for each data collection trial (in seconds).
Frame Frequency	Enter the frame frequency (in Hz) used during data collection.
Camera Parameter File	Select the camera parameter file to be used to calculate 3D and 6D data.

Table 7-2 Optotrak System Settings

Note **The parameters for the Optotrak System must match the marker wavelength for the markers on the tool. These parameters are stored in the camera parameter file that you must select in the Collection Settings dialog.**

3. (Optional) If you are using a positioning device, refer to *TB-10029*.

4. (Optional) If you want to apply advanced system settings, see "Optotrak System Settings" on page 173.

5. Click **Next**. The Tool Description dialog appears.

7.3 Describe Tool Properties

In this screen, the ROM Creation Wizard will ask you to make selections about the tool. This includes information such as the tool type and marker type.

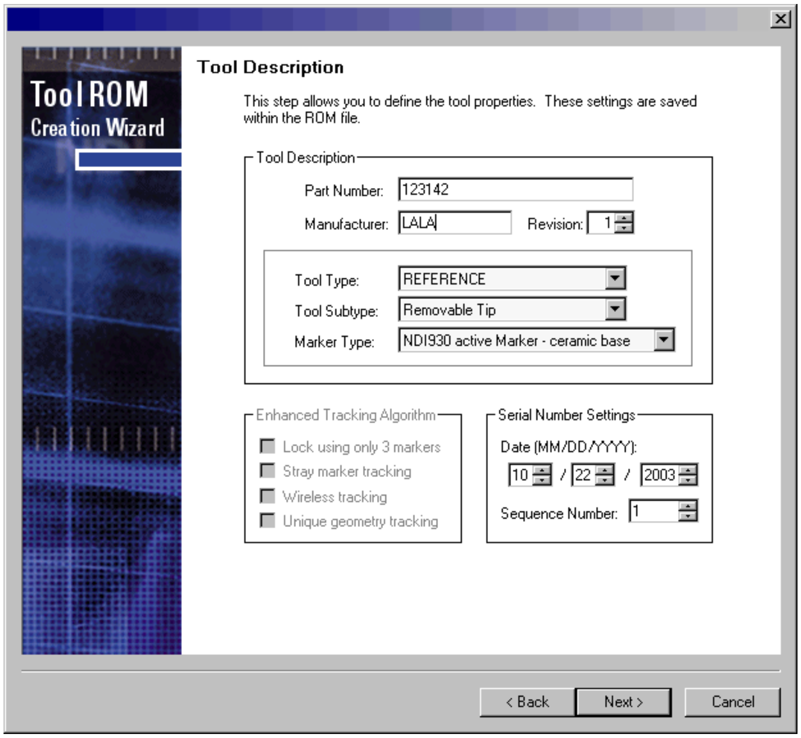


Figure 7-3 Optotrak Tool Description Dialog

1. Complete the Tool Description section:

Field/Option	Action
Part Number	Assign a part number to your tool. You can use a maximum of 20 characters.
Manufacturer	Assign a manufacturer name to your tool. You can use a maximum of 12 characters.
Revision	Assign a revision number to your tool.
Tool Type	From the list, select the entry that reflects the tool type.
Tool Subtype	From the list, select the entry that reflects the tool subtype.
Marker Type	From the list, select the entry that reflects the tool marker type.

Table 7-3: Tool Description Section

Note **The part number, manufacturer, and revision number are mandatory fields. This information uniquely identifies the tool's design, and associates it with a particular application.**

Note **Because you cannot use Enhanced Tracking Algorithms with an Optotrak System, that section is disabled.**

2. Complete the Serial Number Settings section:

Field/Option	Action
Date (MM/DD/YYYY)	Enter today's date using the format indicated.
Sequence Number	Enter 1 to indicate an increment of one for each serial number created.

Table 7-4: Serial Number Section

The software will automatically calculate a unique serial number for your tool, using these settings.

3. Click **Next**. The Marker Setup dialog opens.

7.4 Define Marker Setup

Once the tool description is defined, the ROM Creation Wizard will prompt you to specify where the markers are within the wiring matrix, and if switches or LEDs are present on the tool. You must also indicate the firing sequence of the markers.

Note **You cannot use the Auto-Detect feature with an Optotrak System. This button is disabled.**

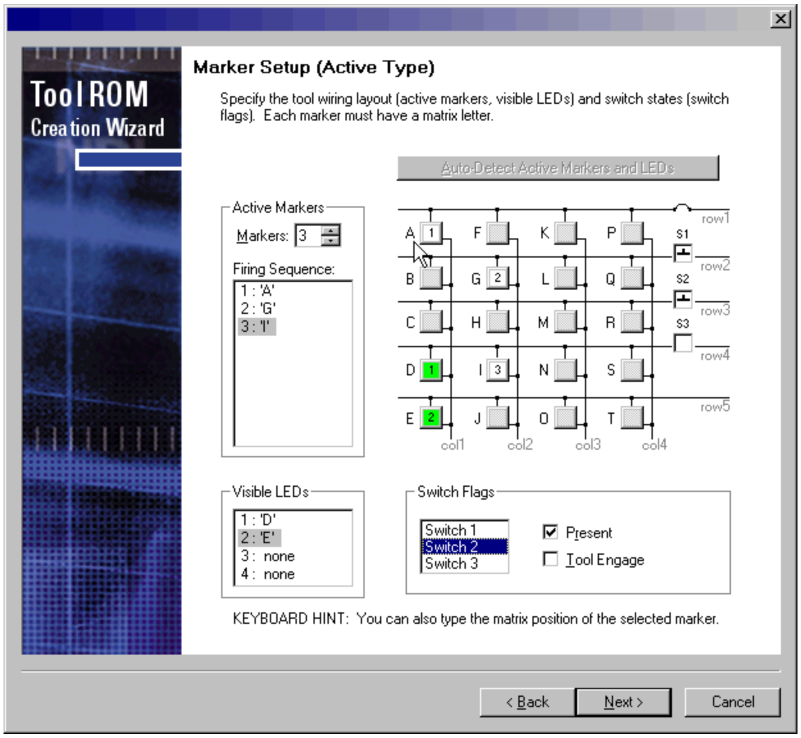


Figure 7-4 Marker Setup Dialog

To Set the Firing Sequence of the Markers

1. In the **Markers** field, select the number of markers on your tool.
2. From the **Firing Sequence** list, **click**, **drag**, and **drop** each marker from the list to the appropriate lettered square in the wiring matrix.

   When adding a marker to the wiring matrix, you can also use any of the following short-cuts:

   - double-click the marker to select the appropriate letter in the matrix
   - right-click the marker to select the appropriate letter in the matrix
   - click the marker and enter the letter on the keyboard
3. If you are not setting switch flags, click **Next**. The Save Parameters dialog opens.

   If you are setting switch flags, see below.

To Set the Switch Flags

You can set up to three different switches for each tool.

1. In the Switch Flags section, select a switch.

2. Choose **Present** to let the system know that this switch is present.
3. Choose **Tool Engage** if the tool has a removable tip. When enabled, the system will disable the tool if its tip is removed and this switch is activated, during tracking. You will not be able to use the tool again until the tip is replaced or re-attached.
4. Click **Next**. The Save Parameters dialog opens.

7.5 Save Parameters

6D Architect saves the collected data in a .csv (Comma Separated Value) file, and stores it in the location indicated by this Save Parameters dialog. When you have finished the entire characterization process, you can open and review the .csv file's contents.

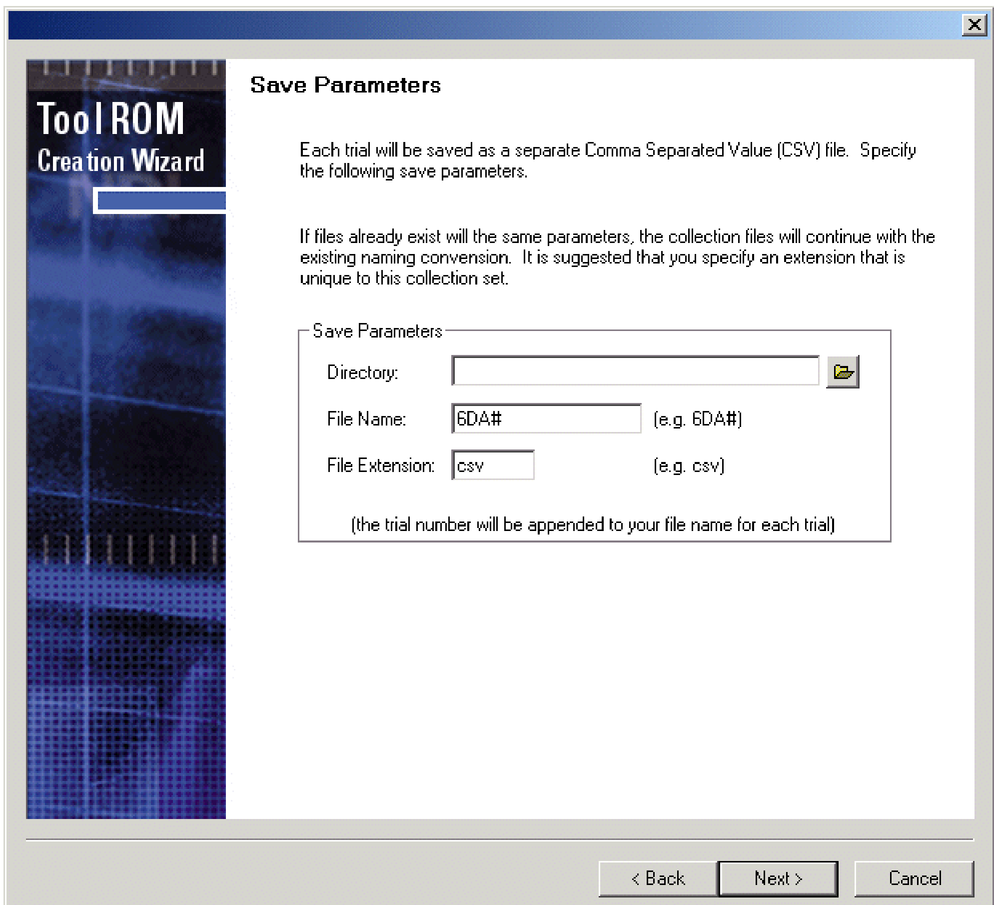


Figure 7-5 Save Parameters Dialog

1. Complete the Save Parameters section:

Field/Option	Action
Directory	Enter the directory location where you wish the files to be saved, or browse to a location by clicking .
File Name	Enter the name for the data collection.
File Extension	Enter **csv**.

Table 7-5 Save Parameter Fields

2. Click **Next**. The Data Collection dialog opens.

7.6 Collect Tool Marker Data

The Data Collection dialog allows you to check if all tool markers are visible to the Position Sensor both before and during data collection trials. The software requires accurate data collection in order to produce accurate information about each marker detected.

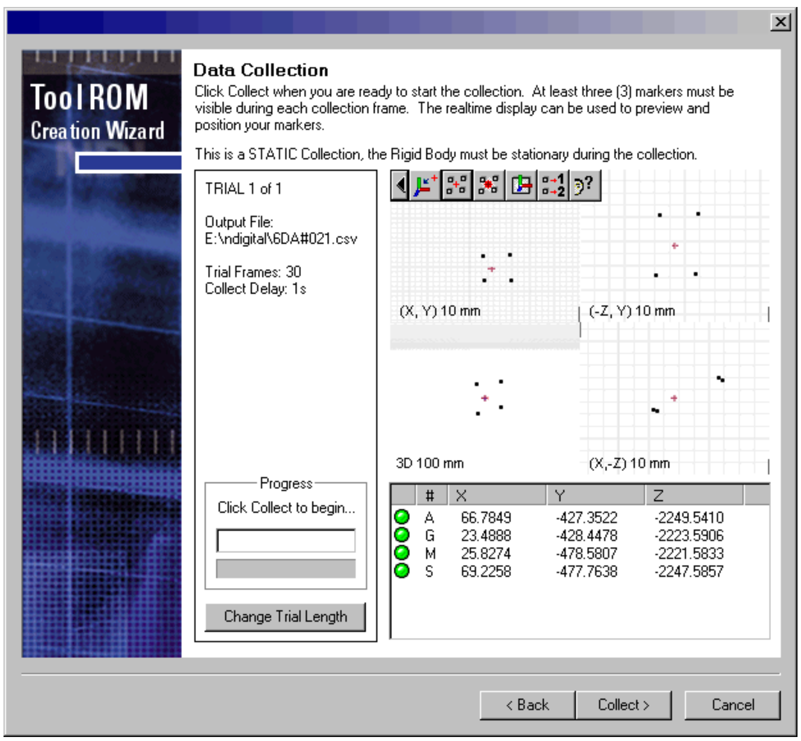


Figure 7-6 Data Collection Dialog

1. (Optional) If you want to edit the collection trial length, click **Change Trial Length** and enter the new length (in seconds). Increasing the trial length may increase the accuracy of the software's data interpretation.

2. Position the tool within the measurement volume. If you are unsure whether or not the markers are visible, observe the marker status in the bottom right of the window:

Marker Colour	Marker Status
Green	The marker is visible to the system and is inside the measurement volume.
Red	The marker is not visible to the system.

Table 7-6: Marker Status

Each coloured circle corresponds to a marker. The number of markers detected should match the number of markers that are on the tool.

Note **If you have set this to be a static collection, the tool must remain motionless during all collection trials. If the tool is moved during a static collection, the data collection trial becomes invalid. To set this as a dynamic collection rather than a static collection, see "Start the Wizard" on page 43.**

3. Click **Collect**. The system proceeds to collect data about each marker's position.The Current Collection Status Dialog opens, displaying this collected information.

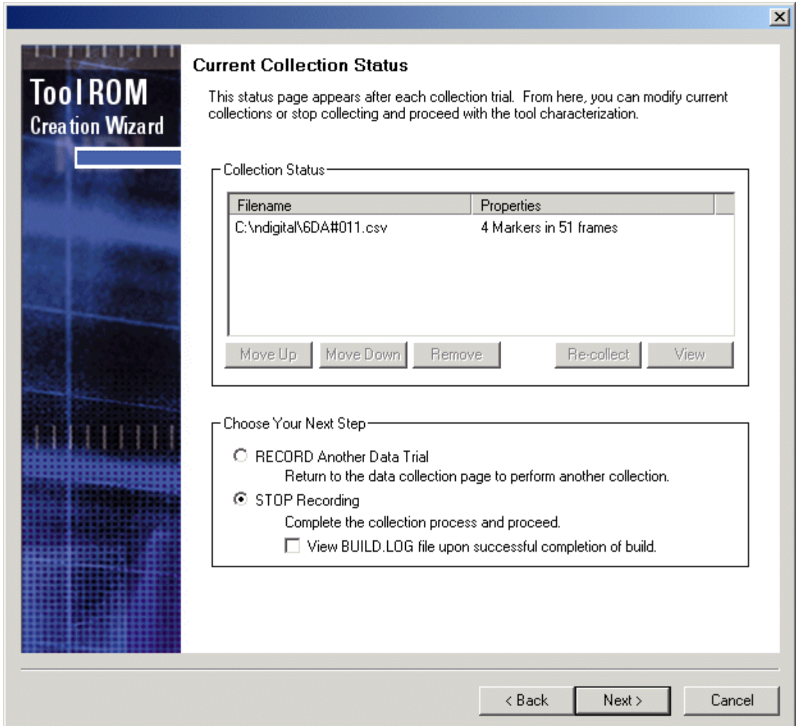


Figure 7-7 Current Collection Status Dialog

Use this dialog to view the collection results or record another trial:

1. Select the newly-created .csv file from the **Collection Status** list.
2. (Optional) Click **View**. The .csv file results open for viewing. When you have finished reviewing the results, click **Close**.
3. (Optional) You can record additional data trials:
   - If you want to collect another data trial, select **RECORD Another Data Trial**. You will be returned to the Data Collection dialog to begin the process again.
   - If you want to overwrite an existing data trial, select the file that you wish to overwrite from the list, and click **Re-collect**. You will be returned to the Data Collection dialog to begin the process again.
4. When you are satisfied with the data collection, select **STOP Recording**.
5. (Optional) If you want to view the Build.log file at the end of the build (when you have completed the ROM Creation Wizard), choose **View BUILD.LOG upon successful completion of build**.
6. Click **Next**. The Groups and Faces dialog opens.

7.7 Define Groups and Faces

Once the firing sequence for the active markers has been defined, you can organize the markers into groups and faces.

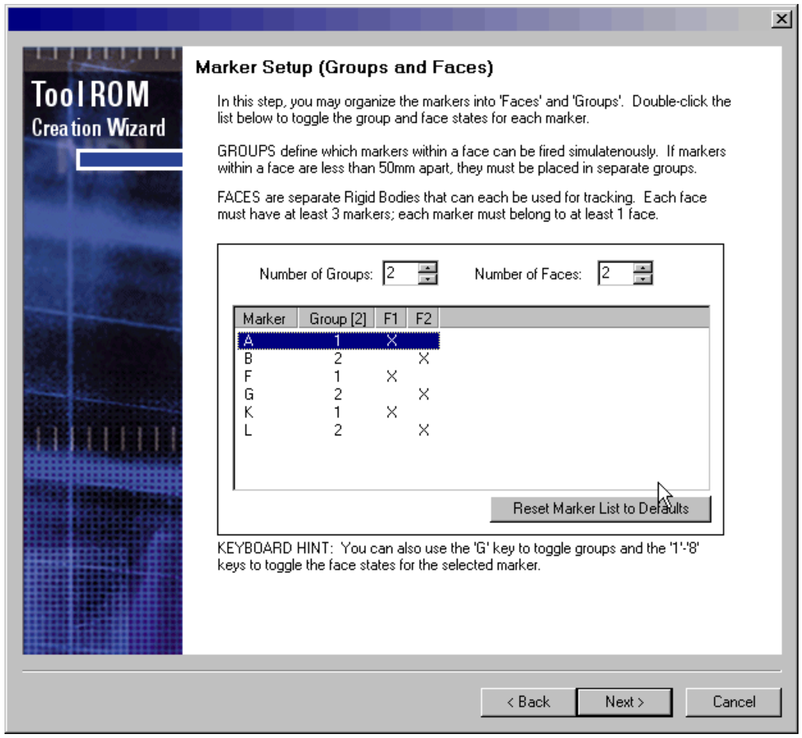


Figure 7-8 Marker Setup Dialog

To Select the Number of Groups

1. In the **Number of Groups** field, select the number of groups you want to create.
2. Assign each marker in the table to group: in the table, double-click on a marker's **Group[N]** entry to toggle between group selections. By default, all markers are assigned to group 1.
3. (Optional) If you want to restore the groups to the original settings, click **Reset Marker List to Defaults.**

To Select the Number of Faces

1. In the **Number of Faces** field, select the number of faces.
2. Assign a marker to a face: in the table, double-click the marker's **F** column entry to change it to **X**. This means that this marker is included on the face.

3. (Optional) If you want to restore the faces to the original settings, click **Reset Marker List to Defaults.**

4. Click **Next**. The Tool Alignment dialog opens.

7.8 Align the Tool's Coordinate System

Before any measurement system can calculate the position and rotation of your tool, you will need to assign the tool a local coordinate system. Assigning a local coordinate system is an important step in producing accurate transformations.

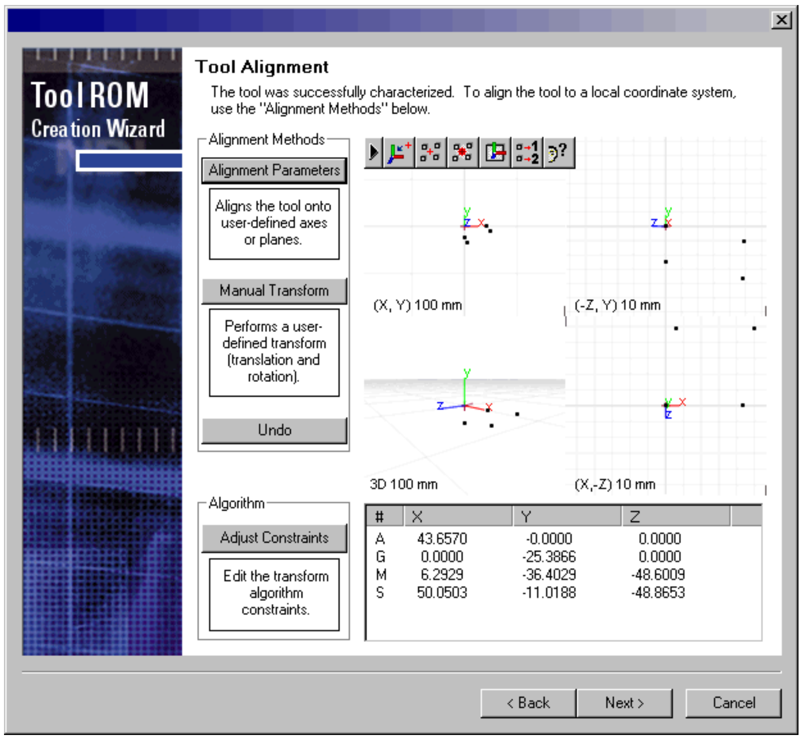


Figure 7-9 Tool Alignment Dialog

To Assign a Local Coordinate System Using Alignment Parameters

1. Click **Alignment Parameters**. The following dialog appears:

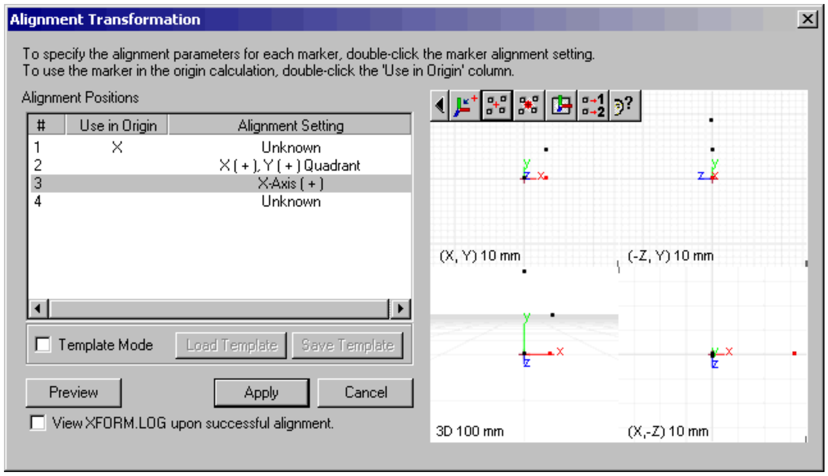


Figure 7-10 Alignment Transformation Dialog

2. To assign a marker as the origin of the local coordinate system, double-click that marker's entry under **Use in Origin**. If you select more than one marker as the origin of your tool , 6D Architect will place the origin at the geometric centre of these markers.

3. To place a marker onto an axis, right-click the marker's entry under **Alignment Setting**. Use the list that appears to constrain the marker to be on any positive or negative x, y, or z-axis.

4. To place a marker onto a plane of the local coordinate system, double-click that marker's entry under **Alignment Setting**. Use the list that appears to constrain the marker to any quadrant of any plane.

5. Click **Preview** to view the changes that you make in the marker window. This can help you visualize the chosen orientations and help trouble-shoot any conflicting alignments you may have accidentally made.

6. When you are finished, return to the Tool Alignment dialog:

   - If you want to return to the original position and orientation, click **Cancel**.

   - If you are satisfied with the alignment parameters, click **Apply**.

7. (Optional) Define the algorithm constraints further by clicking **Adjust Constraints**. For more information about this function, see "Algorithm Constraints" on page 167.

Note **The algorithm constraints are advanced option parameters. If the intended result is not fully understood, do not perform this step and simply continue with the default settings.**

To Adjust the Local Coordinate System Manually

8. Click **Manual Transform**. The following dialog appears:

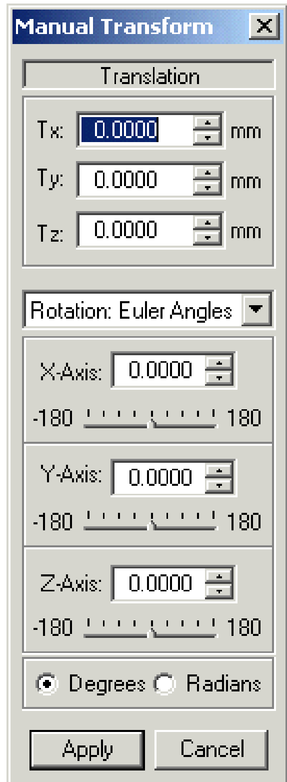


Figure 7-11 Manual Transform Dialog

9. Adjust each field incrementally to change the position and orientation of the local coordinate system. Each change is reflected in the graphic representations in the Tool Alignment dialog.
   - Use the **Tx**, **Ty**, and **Tz** fields to translate the origin of the local coordinate system.
   - If you are using the Euler Angles (as indicated in the drop-down list), use the **X-Axis**, **Y-Axis**, and **Z-Axis** fields to rotate the local coordinate system.

Note **Rotation Matrix and Quaternion are advanced options. The easiest and most intuitive way to rotate coordinate systems is to use Euler Angles.**

10. Once you are satisfied, click **Apply** to save your changes.
11. (Optional) Define the algorithm constraints further by clicking **Adjust Constraints**. For more information about this function, see "Algorithm Constraints" on page 167.

Note **The algorithm constraints are advanced option parameters. If the intended result is not fully understood, do not perform this step and simply continue with the default settings.**

12. Click **Next**. The Marker and Face Normals dialog appears.

7.9 Add Marker and Face Normals

For each marker and face on your tool, you will need to assign a vector that defines which way they are facing. The system uses this vector, or *normal*, to help determine where the marker or face is pointing in the measurement volume. With this information, the system can determine if the marker or face is pointing at an angle that no longer provides accurate data.

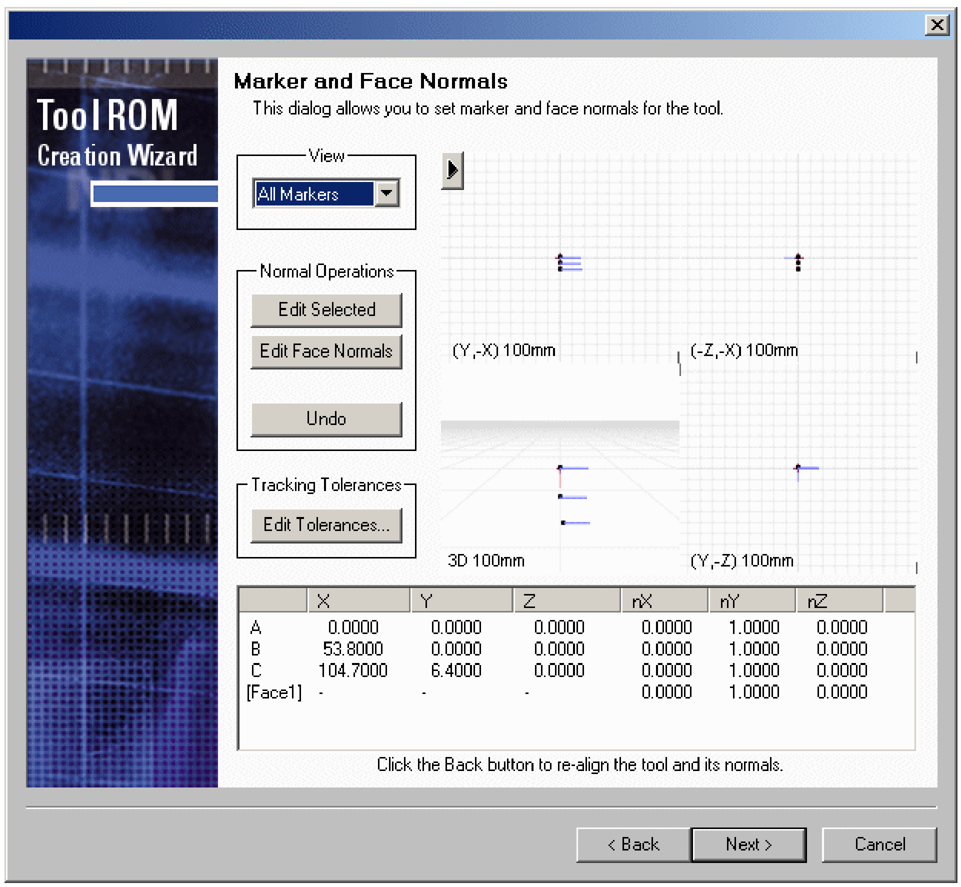


Figure 7-12 Marker and Face Normals Dialog

About Determining Normals

Note **You need to assign normals to all markers *and* all faces.**

6D Architect performs several calculations and displays the results at the bottom of the Marker and Face Normals dialog, to guide you in selecting the right normal values. These suggestions change depending on how many markers are selected, and where these markers are located on the tool:

Number of Markers Selected	Suggested Values Provided
1 marker	none
2 markers	coordinates of the centroid
3 markers	coordinates of the centroid, and coefficients of an imagined plane that the three markers would create.
4 or more markers	coordinates of the centroid

Table 7-7 Marker Information Provided By 6D Architect

Note **The centroid is the centre point of an imagined three dimensional volume created by the selected markers.**

You can use these suggested values when determining normals, but be sure to review and adjust the values as needed.

Note **A face normal must be perpendicular to its face. Individual marker normals, however, do not need to be perpendicular to the face that marker is assigned to.**

To Create a Normal for Individual Markers

1. In the **View** list, select **All Markers.**
2. In the table at the bottom of the dialog, press **Ctrl** and select three markers (the desired marker included).

   Below the table, the software displays the centroid and a plane equation associated with the selected markers. Use this information to determine the coordinates of the ideal normal for the desired marker.

Note **The first three coefficients of the plane equation are coordinates for a normal vector perpendicular to the imagined plane.**

3. Select a single marker (or if you want to assign the same normal to multiple markers, select them while pressing the **Ctrl** key).
4. Click **Edit Selected**.

5. In the coordinate fields provided, enter the values that you determined in step 2 and adjust the values if necessary. Your changes are displayed graphically, to help you with these edits.
6. Click **OK**.

To Create Normals for Faces

1. In the **View** list, select the appropriate face**.**
2. In the table at the bottom of the dialog, press **Ctrl** and select three markers that are assigned to the face.

   Below the table, the software displays the centroid and a plane equation associated with the selected markers. Use this information to determine the coordinates of the ideal normal for the desired marker.

Note **The first three coefficients listed for the imagined plane can be used as coordinates for a vector perpendicular to the imagined plane.**

3. Click **Face Normals**.
4. From the drop-down list, select the appropriate face.
5. In the coordinate fields provided, enter the values that you determined in step 2 and adjust the values if necessary. Your changes are displayed graphically, to help you with these edits.
6. Click **OK**.
7. (Optional) If you want to restore all of the normals and tolerances to the default settings, click **Undo**.
8. Click **Next**. The Characterization Completion dialog opens.

To Set Tracking Tolerances

1. In the **View** list, select **All Markers**.
2. In the table at the bottom of the dialog, select a marker.
3. Click **Edit Tolerances**. The following dialog opens:

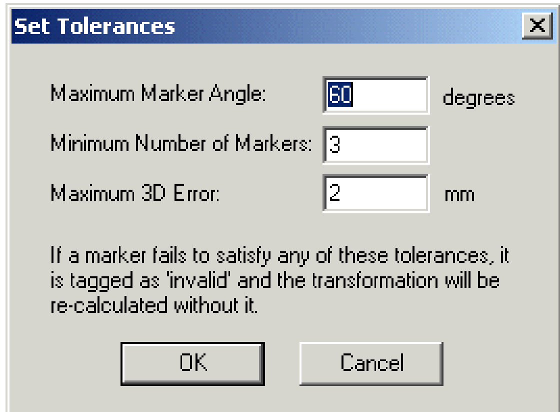


Figure 7-13   Set Tolerances Dialog

4. Complete the fields provided:

Field	Action
Maximum Marker Angle	Enter the maximum angle that a marker normal can be pointed *away* from the Position Sensor. Any marker turned away more than this value will not be used to compute a tool's transformation.
Minimum Number of Markers	Enter the minimum number of markers that must be counted as present in the measurement volume, before the system produces a transformation for the tool.
Maximum 3D Error	Enter the maximum distance between where the marker is observed by the system and is expected to be in the SROM Image File. If a marker exceeds this value, it is not used to compute a tool's transformation.

Table 7-8   Tolerance Fields

5. Click **OK**.

6. Click Next. The Characterization Completion dialog opens.

7.10 Complete the Tool Characterization

6D Architect allows you to create a macro file that contains all the ROM Creation Wizard selections that you've made, in case you want to repeat the characterization process for additional tools using similar parameters. Remember that although you can use the same wizard selections for similar tools, you will still need to perform separate and unique data collections for each.

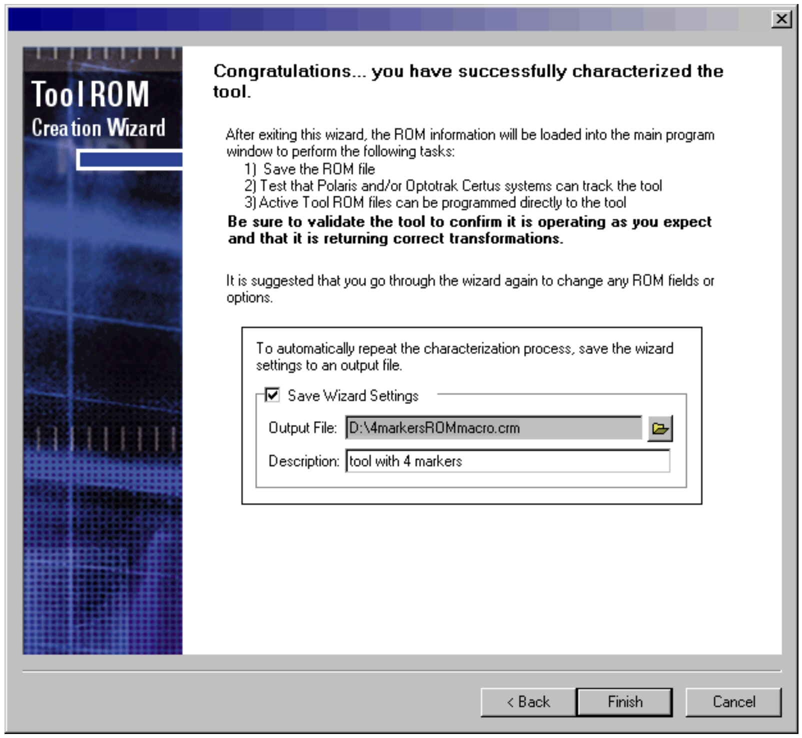


Figure 7-14 Characterization Completion Dialog

1. Choose **Save Wizard Settings**.
2. In the **Output File** field, browse to a location and enter a name by clicking .
3. In the **Description** field, enter an identifying description for this wizard session.
4. Click **Finish**. The software saves your settings in a ROM Characterization Macro (.crm) file.

Note **The saved parameter file contains the tool's characterization information. When applied to subsequent tools, the software will automatically increase the sequence number.**

Once the characterization is complete, the wizard closes and a graphical representation of the tool will be loaded into the main window. The tool parameters are loaded in the ROM section of the main window.

For more information about the main window, see "Exploring 6D Architect Main Window" on page 6.

7.11 What Is Next?

After you have created and saved the SROM Image File (.ROM) file, you must perform the following tasks:

1. Test the SROM Image File to ensure that the Optotrak System can track the tool correctly. For more instructions, see “Testing Tools” on page 161.
2. Load the SROM Image File onto the tool’s SROM device. For instructions, see “Active Tools: Programming SROM Devices” on page 79.

8 Active Tool: Characterizing with Engineering Data

The following sections direct you through each window of the ROM Creation Wizard, to help you characterize an active tool with engineering data.

This section explains the following steps:

1. Start the Wizard
2. Describe Tool Properties
3. Define Marker Setups
4. Enter Tool Marker Values
5. Define Groups and Faces
6. Align the Tool’s Coordinate System
7. Add Marker and Face Normals
8. Complete the Tool Characterization
9. What Is Next?

8.1 Start the Wizard

Before continuing, you must open the wizard and indicate that you are characterizing an active tool with engineering data. For instructions, see “Tool Characterization: The First Step” on page 15.

Once this step is completed, you can continue the characterization process.

8.2 Describe Tool Properties

The ROM Creation Wizard’s second screen is the Tool Description dialog. You will need to enter tool parameters, including information such as the tool type, marker type, and the tracking algorithm.

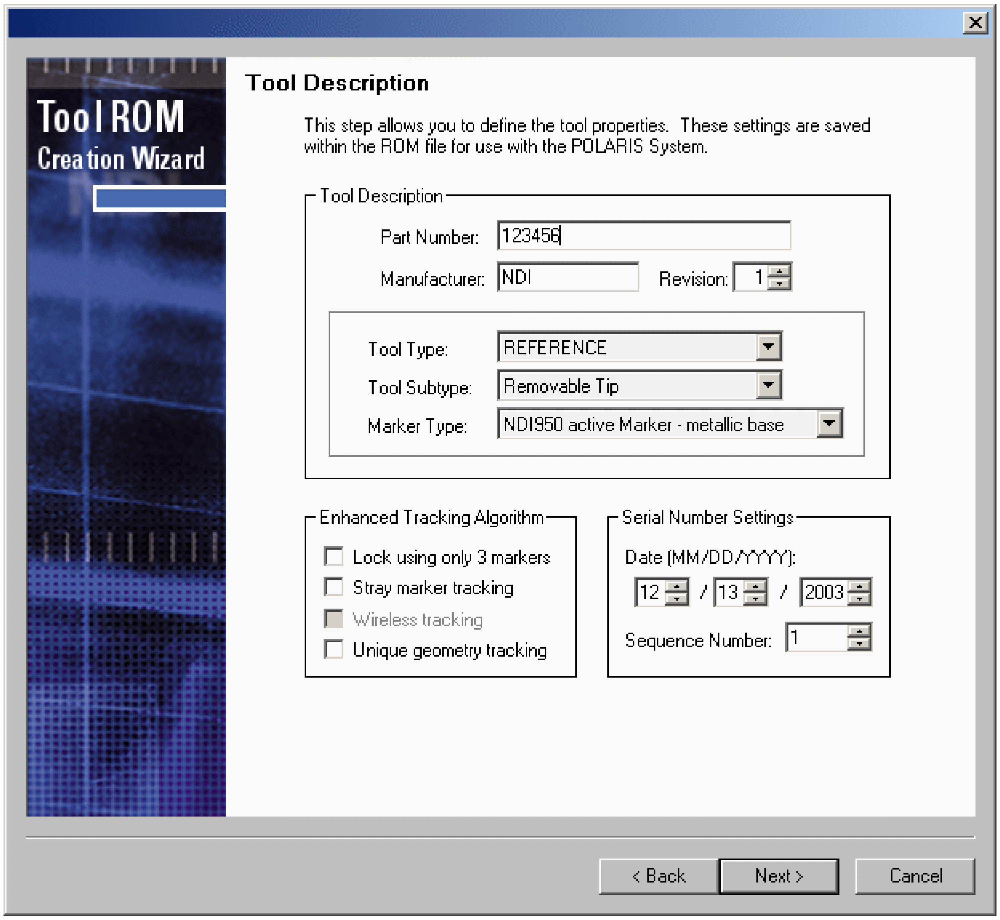


Figure 8-1 Tool Description Dialog

1. Complete the Tool Description section:

Field/Option	Action
Part Number	Assign a part number to your tool. You can use a maximum of 20 characters.
Manufacturer	Assign a manufacturer name to your tool. You can use a maximum of 12 characters.
Revision	Assign a revision number to your tool.
Tool Type	From the list, select the entry that reflects your tool's type.
Tool Subtype	From the list, select the entry that reflects your tool's subtype.
Marker Type	From the list, select the entry that reflects your tool's marker type.

Table 8-1: Tool Description Section

Note **The part number, manufacturer, and revision number are mandatory fields. This information uniquely identifies the tool's design, and associates it with a particular application.**

2. Complete the Enhanced Tracking Algorithm section:

Field/Option	Action
Lock using only 3 markers	If you want to reduce the acquisition time, choose this option.
Stray marker testing	If you want the Polaris System to track a single stray marker which may move with respect to the tool, select this option.
Wireless tracking	This is disabled for active tools.
Unique geometry tracking	If the tool meets unique geometry constraints, choose this option. This will result in a reduction of acquisition time for the tool.

Table 8-2: Enhanced Tracking Algorith Section

Note **A tool must meet the unique geometry constraints in order to use the Unique Geometry Tracking functionality. If you use Unique Geometry Tracking for a tool that does not meet the constraints, the tool cannot be tracked. For more information about unique geometry, see "Unique Geometry" on page 164.**

3. Complete the Serial Number Settings section:

Field/Option	Action
Date (MM/DD/YYYY)	Enter today's date using the format indicated.
Sequence Number	Enter 1 to indicate an increment of one for each serial number created.

Table 8-3: Serial Number Settings

The software will automatically calculate a unique serial number for your tool, using these settings.

4. Click **Next**. The Marker Setup dialog opens.

8.3 Define Marker Setups

Once the tool description is defined, the ROM Creation Wizard will ask you to specify where the markers are within the wiring matrix, and if switches or LEDs are present on the tool.

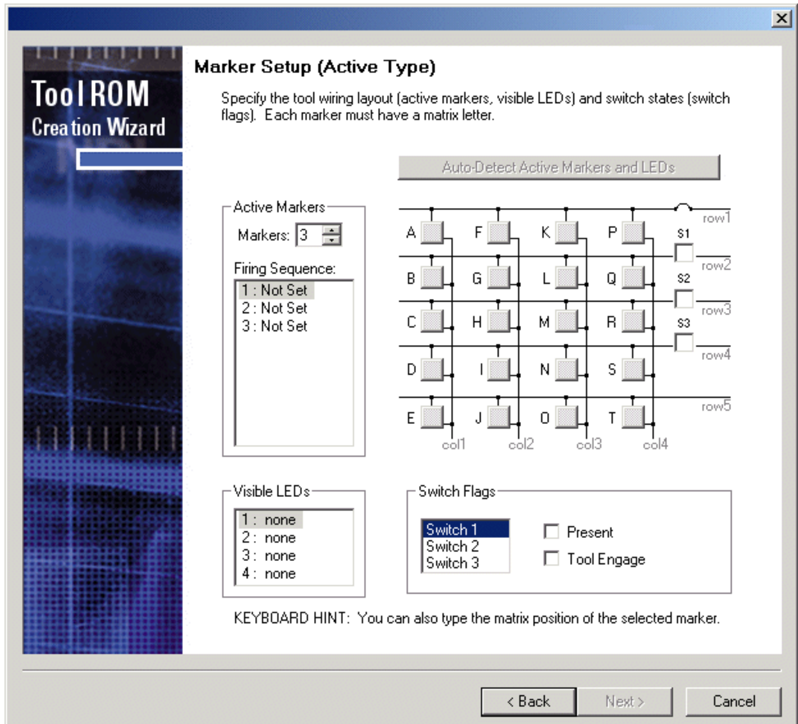


Figure 8-2 Marker Setup Dialog

Note **You cannot use the Auto-Detect feature to supply the active markers and LEDs with a matrix letter when characterizing with Engineering Data. This button is disabled.**

To Manually Set the Firing Sequence of the Markers

1. In the **Markers** field, select the number of markers on your tool.
2. From the **Firing Sequence** field, **click**, **drag**, and **drop** each marker from the list to the appropriate lettered square in the wiring matrix.

   When adding a marker to the wiring matrix, you can also use any of the following short-cuts:

   - double-click the marker to select the appropriate letter in the matrix
   - right-click the marker to select the appropriate letter in the matrix
   - click the marker and enter the letter on the keyboard

3. If you are not setting switch flags, click **Next**. If you are setting switch flags, see below.

To Set the Switch Flags

You can set up to three different switches for each tool.

1. In the Switch Flags section, select the switch for which you are defining parameters.
2. Choose **Present** to let the software know that a switch is present.
3. Choose **Tool Engage** if the tool has a removable tip. With this enabled, the system will disable the tool if its tip is removed and the switch is activated, during tracking. You will not be able to use the tool again until the tip is replaced or re-attached.
4. Click **Next**. The Enter Marker Values dialog opens.

8.4 Enter Tool Marker Values

6D Architect requires that you enter information about where each marker is placed on the tool. These coordinates can be entered using one of two different methods: load a Rigid Body file that has been previously created for the tool, or enter in each coordinate manually.

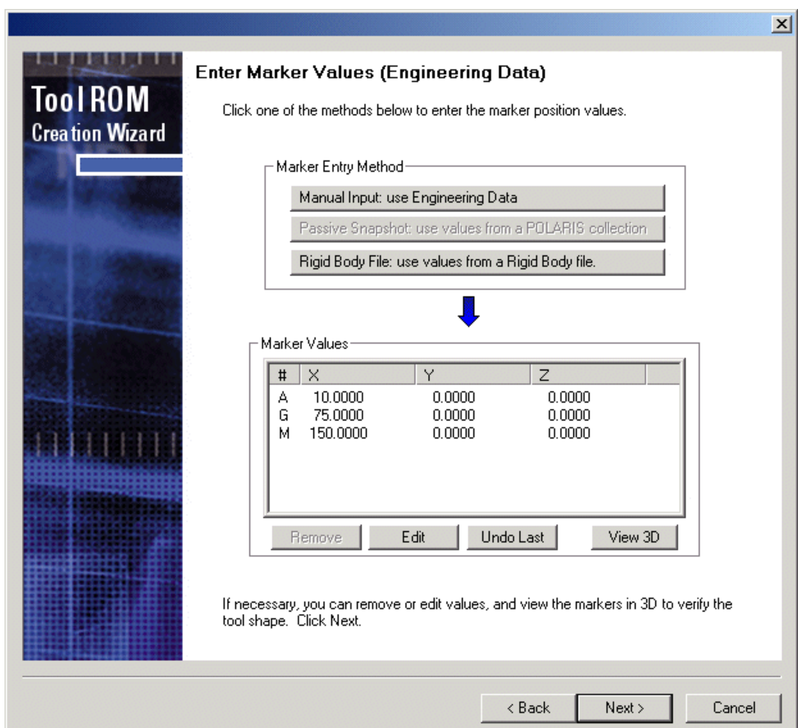


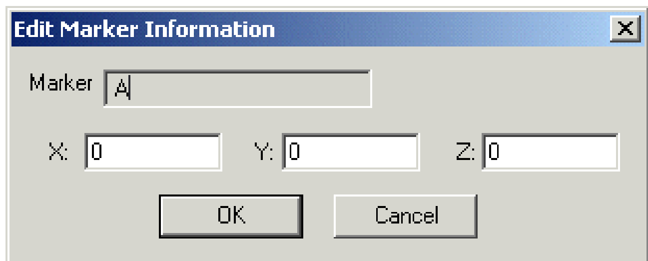
Figure 8-3 Enter Marker Values Dialog

To Enter Marker Values Using a Rigid Body File

1. Click **Rigid Body File: use values from a Rigid Body**.
2. Select the desired file.
3. Click **Open**. 6D Architect reads the Rigid Body file and plugs its marker values into the **Marker Values** list.
4. Click **Next**.

To Enter Marker Values Using Engineering Data

1. Click **Manual Input: use Engineering Data**. The following dialog opens:



2. Edit Marker Information Dialog
3. Enter the **x**, **y**, and **z** positions for the marker indicated in the **Marker** field.
4. Click **OK**. The Edit Marker dialog closes.
5. Repeat this process for all markers on the tool.

To Edit Marker Values

Once you have entered marker values, you can edit them in the following ways:

Edit or Change	Action
Edit a marker's values	Select the marker and click **Edit**.
Remove a marker from the list	Select the marker and click **Remove**.
Undo the last edit action	Click **Undo Last**.
View the marker(s) in 3D	Select the marker and click **View 3D**.

Table 8-4 Editing Marker Values

6. Click **Next**.

8.5 Define Groups and Faces

Once the firing sequence for the active markers has been defined, you can organize the markers into groups and faces.

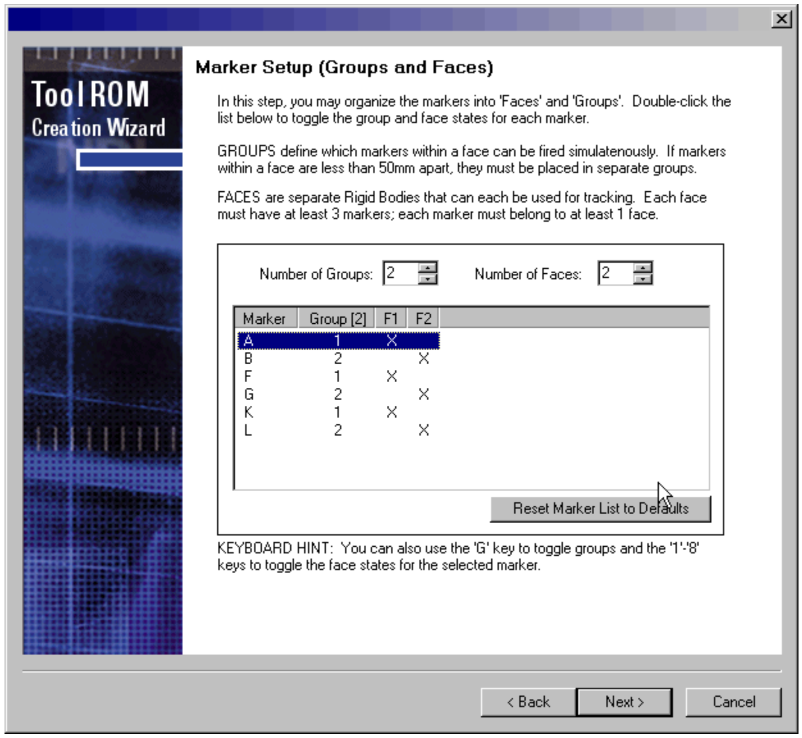


Figure 8-4 Marker Setup (Groups and Faces) Dialog

To Select the Number of Groups

1. In the **Number of Groups** field, select the number of groups you want to create.
2. Assign each marker in the table to group: in the table, double-click on a marker's **Group[N]** entry to toggle between group selections. By default, all markers are assigned to group 1.
3. (Optional) If you want to restore the groups to the original settings, click **Reset Marker List to Defaults.**

To Select the Number of Faces

1. In the **Number of Faces** field, select the number of faces.
2. Assign a marker to a face: in the table, double-click the marker's **F** column entry to change it to **X**. This means that this marker is included on the face.

3. (Optional) If you want to restore the faces to the original settings, click **Reset Marker List to Defaults.**
4. Click **Next**. The Tool Alignment dialog opens.

8.6 Align the Tool's Coordinate System

Before any measurement system can calculate the position and rotation of your tool, you will need to assign the tool a local coordinate system. Assigning a local coordinate system is an important step in producing accurate transformations.

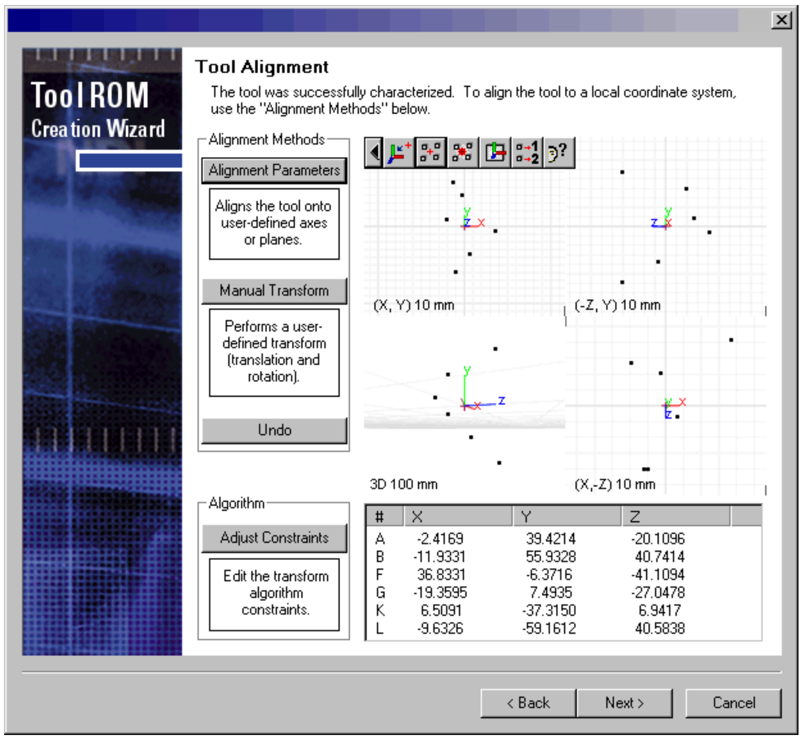


Figure 8-5 Tool Alignment Dialog

To Assign a Local Coordinate System Using Alignment Parameters

1. Click **Alignment Parameters**. The following dialog appears:

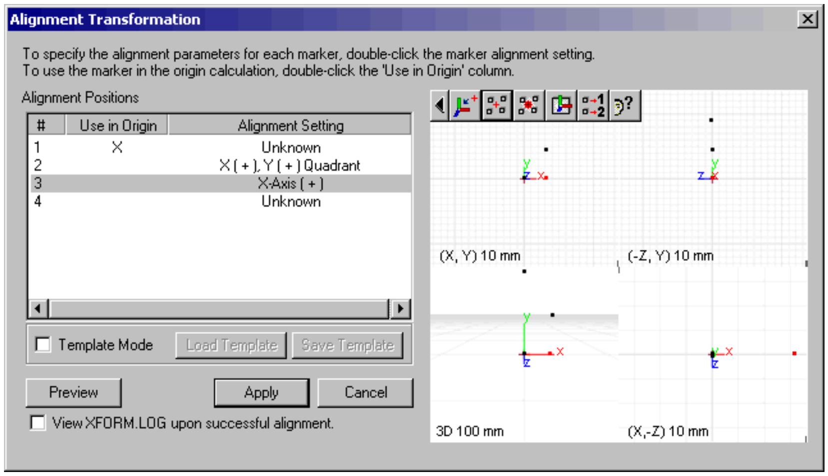


Figure 8-6 Alignment Transformation Dialog

2. To assign a marker as the origin of the local coordinate system, double-click that marker's entry under **Use in Origin**. If you select more than one marker as the origin of your tool , 6D Architect will place the origin at the geometric centre of these markers.
3. To place a marker onto an axis, right-click the marker's entry under **Alignment Setting**. Use the list that appears to constrain the marker to be on any positive or negative x, y, or z-axis.
4. To place a marker onto a plane of the local coordinate system, double-click that marker's entry under **Alignment Setting**. Use the list that appears to constrain the marker to any quadrant of any plane.
5. Click **Preview** to view the changes that you make in the marker window. This can help you visualize the chosen orientations and help trouble-shoot any conflicting alignments you may have accidentally made.
6. (Optional) If you want to either save these alignment settings to a template or open an existing alignment template and apply it to your tool, enable **Template Mode** to activate template functions.
7. When you are finished, return to the Tool Alignment dialog:
   - If you want to return to the original position and orientation, click **Cancel**.
   - If you are satisfied with the alignment parameters, click **Apply**.
8. (Optional) Define the algorithm constraints further by clicking **Adjust Constraints**. For more information about this function, see "Algorithm Constraints" on page 167.

Note **The algorithm constraints are advanced option parameters. If the intended result is not fully understood, do not perform this step and simply continue with the default settings.**

9. Click **Next**. The Marker and Face Normals dialog appears.

To Adjust the Local Coordinate System Manually

1. Click **Manual Transform**. The following dialog appears:

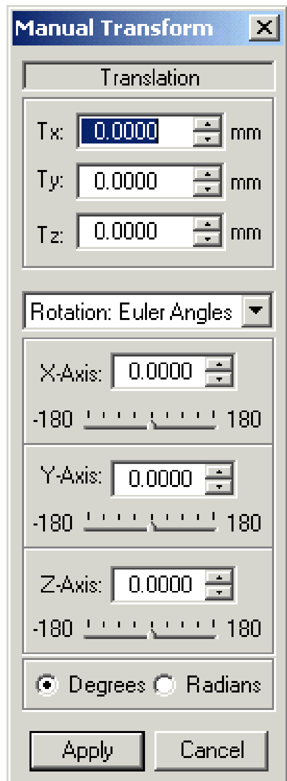


Figure 8-7 Manual Transform Dialog

2. Adjust each field incrementally to change the position and orientation of the local coordinate system. Each change is reflected in the graphic representations in the Tool Alignment dialog.
   - Use the **Tx**, **Ty**, and **Tz** fields to translate the origin of the local coordinate system.
   - If you are using the Euler Angles (as indicated in the drop-down list), use the **X-Axis**, **Y-Axis**, and **Z-Axis** fields to rotate the local coordinate system.

Note **The Rotation Matrix and Quaternion are advanced options. The easiest and most intuitive way to rotate coordinate systems is to use Euler Angles.**

3. Once you are satisfied, click **Apply** to save your changes.
4. (Optional) Define the algorithm constraints further by clicking **Adjust Constraints**. For more information about this function, see "Algorithm Constraints" on page 167

Note **The algorithm constraints are advanced option parameters. If the intended result is not fully understood, do not perform this step and simply continue with the default settings.**

5. Click **Next**. The Marker and Face Normals dialog appears.

8.7 Add Marker and Face Normals

For each marker and face on your tool, you will need to assign a vector that defines which way they are facing. The system uses this vector, or *normal*, to help determine where the marker or face is pointing in the measurement volume. With this information, the system can determine if the marker or face is pointing at an angle that no longer provides accurate data.

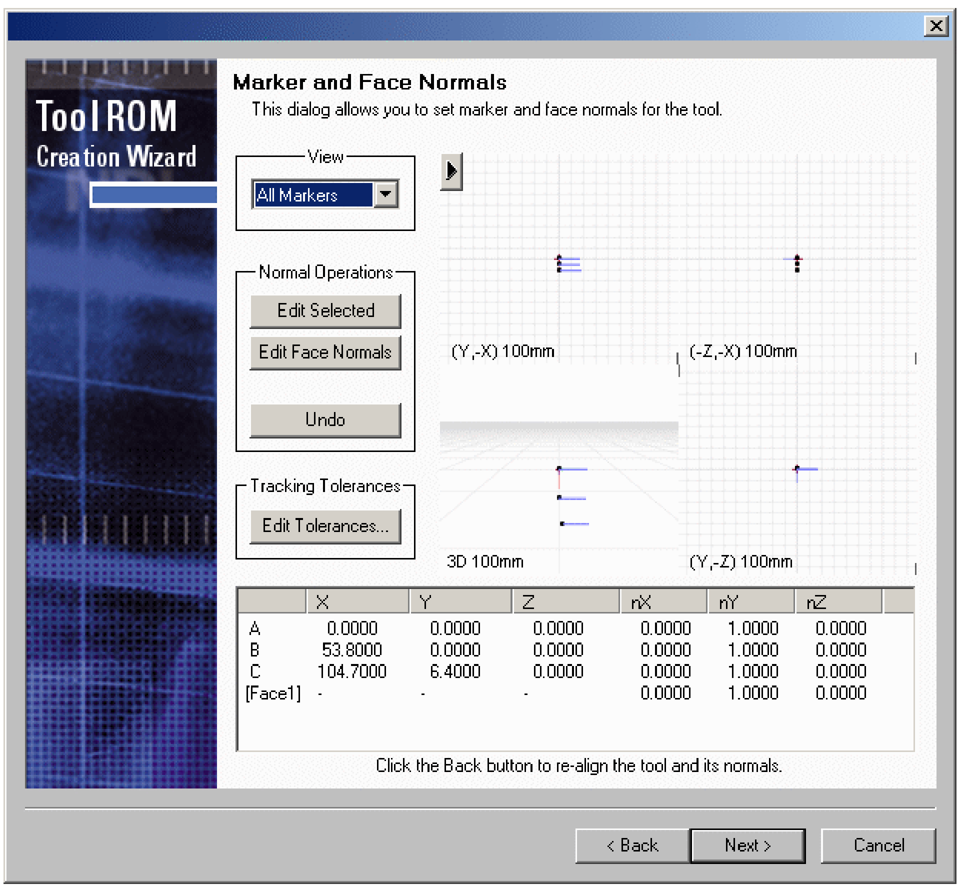


Figure 8-8 Marker and Face Normals Dialog

About Determining Normals

Note **You need to assign normals to all markers *and* all faces.**

6D Architect performs several calculations and displays the results at the bottom of the Marker and Face Normals dialog, to guide you in selecting the right normal values. These suggestions change depending on how many markers are selected, and where these markers are located on the tool:

Number of Markers Selected	Suggested Values Provided
1 marker	none
2 markers	coordinates of the centroid
3 markers	coordinates of the centroid, and coefficients of an imagined plane that the three markers would create.
4 or more markers	coordinates of the centroid

Table 8-5 Marker Information Provided By 6D Architect

Note **The centroid is the centre point of an imagined three dimensional volume created by the selected markers.**

You can use these suggested values when determining normals, but be sure to review and adjust the values as needed.

Note **A face normal must be perpendicular to its face. Individual marker normals, however, do not need to be perpendicular to the face that marker is assigned to.**

To Create a Normal for Individual Markers

1. In the **View** list, select **All Markers.**
2. In the table at the bottom of the dialog, press **Ctrl** and select three markers (the desired marker included).

   Below the table, the software displays the centroid and a plane equation associated with the selected markers. Use this information to determine the coordinates of the ideal normal for the desired marker.

Note **The first three coefficients of the plane equation are coordinates for a normal vector perpendicular to the imagined plane.**

3. Select a single marker (or if you want to assign the same normal to multiple markers, select them while pressing the **Ctrl** key).
4. Click **Edit Selected**.
5. In the coordinate fields provided, enter the values that you determined in step 2 and adjust the values if necessary. Your changes are displayed graphically, to help you with these edits.
6. Click **OK**.

To Create Normals for Faces

1. In the **View** list, select the appropriate face**.**
2. In the table at the bottom of the dialog, press **Ctrl** and select three markers that are assigned to the face.

   Below the table, the software displays the centroid and a plane equation associated with the selected markers. Use this information to determine the coordinates of the ideal normal for the desired marker.

Note **The first three coefficients listed for the imagined plane can be used as coordinates for a vector perpendicular to the imagined plane.**

3. Click **Face Normals**.
4. From the drop-down list, select the appropriate face.
5. In the coordinate fields provided, enter the values that you determined in step 2 and adjust the values if necessary. Your changes are displayed graphically, to help you with these edits.
6. Click **OK**.
7. (Optional) If you want to restore all of the normals and tolerances to the default settings, click **Undo**.
8. Click **Next**. The Characterization Completion dialog opens.

To Set Tracking Tolerances

1. In the **View** list, select **All Markers.**
2. In the table at the bottom of the dialog, select a marker.
3. Click **Edit Tolerances**. The following dialog opens.

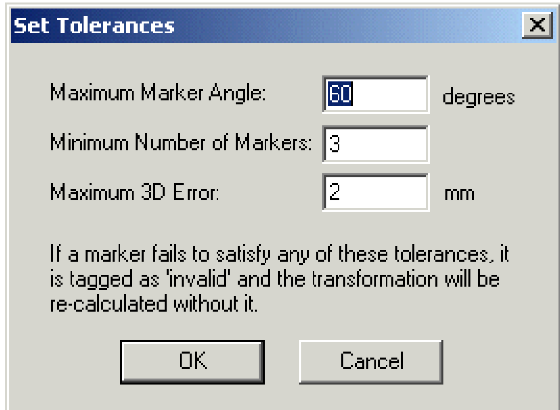


Figure 8-9 Set Tolerances Dialog

4. Complete the fields provided:

Field	Action
Maximum Marker Angle	Enter the maximum angle that a marker normal can be pointed *away* from the Position Sensor. Any marker turned away more than this value will not be used to compute a tool transformation.
Minimum Number of Markers	Enter the minimum number of markers that must be counted as present in the measurement volume, before the system produces a transformation for the tool.
Maximum 3D Error	Enter the maximum distance between where the marker is observed by the system and is expected to be in the tool's SROM Image File. If a marker exceeds this value, it is not used to compute a tool transformation.

Table 8-6 Tolerance Fields

5. Click **OK**.

6. Click **Next**. The Characterization Completion dialog opens.

8.8 Complete the Tool Characterization

6D Architect allows you to save all the ROM Creation Wizard selections that you've made, in case you want to repeat the characterization process for similar tools using similar parameters. Remember that although you can use the same wizard selections for similar tools, you will still need to perform separate and unique data collections for each.

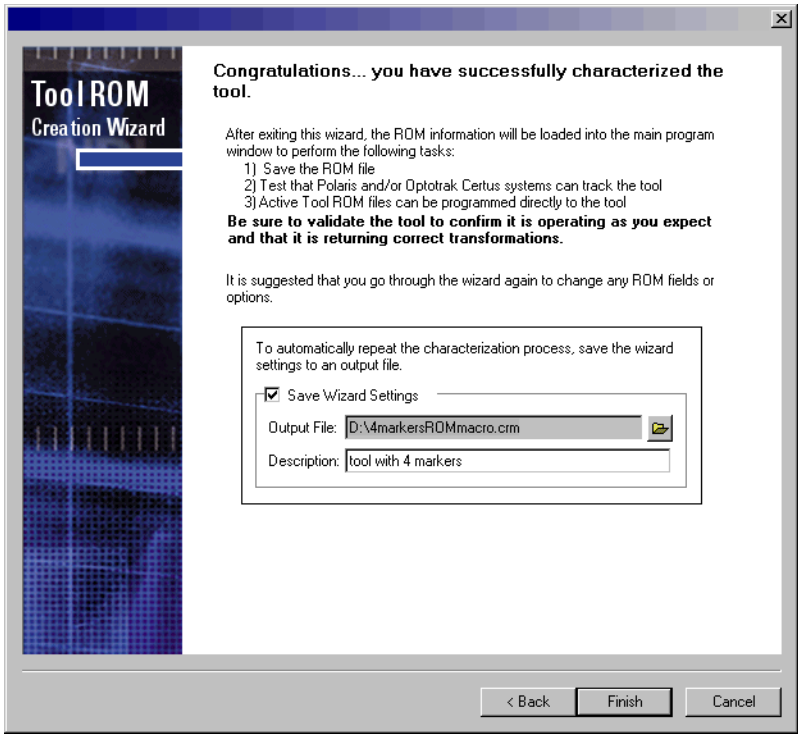


Figure 8-10 Characterization Completion Dialog

1. Choose **Save Wizard Settings**.

2. In the **Output File** field, browse to a location and enter a name by clicking .

3. In the **Description** field, enter an identifying description for this wizard session.

4. Click **Finish**. The software saves your settings in a ROM Characterization Macro (.crm) file.

Note **The saved parameter file contains the tool's characterization information. When applied to subsequent tools, the software will automatically increase the sequence number.**

Once the characterization is complete, the wizard closes and a graphical representation of the tool will be loaded into the main window. The tool parameters are loaded in the ROM section of the main window.

For more information about the main window, see "Exploring 6D Architect Main Window" on page 6.

8.9 What Is Next?

After you have created and saved the SROM Image File (.ROM) file, you must perform the following tasks:

1. Test the SROM Image File to ensure that the Polaris System can track the tool correctly. For more instructions, see “Testing Tools” on page 161.
2. Load the SROM Image File onto the tool’s SROM device. For instructions, see “Active Tools: Programming SROM Devices” on page 79.

9 Active Tools: Programming SROM Devices

The SROM device is located inside an active tool's connector. Use 6D Architect to load the SROM Image File (.ROM) onto the SROM device, so that the tool can carry its own information. Whenever the tool connects to an NDI measurement system, the SROM Image File is automatically retrieved from the SROM device for interpretation.

Note **Because the SROM device can only be programmed once, it is essential to view the tool parameters and test the tracking ability before programming. For instructions, see** **"Testing Tools" on page 161****.**

This section explains the following steps:

1. Open the SROM Image File
2. Edit the SROM Image File
3. Test Tool Tracking
4. Program User-Specified SROM Tags
5. Program the SROM Device

9.1 Open the SROM Image File

1. Plug the tool into a port of either your Optotrak System or Polaris System.
2. If you do not already have the tool's SROM Image File open in the main window, open it using one of the following methods:
    - If you are reading the SROM Image File directly from the connected tool, select **File** > **Load ROM From Tool**. In the dialog that appears, select the system you are using, and the desired tool from the drop-down list.
    - If you are opening an SROM Image File saved on the host computer from previous a previous characterization session, select **File** > **Open** and select the appropriate .ROM file.

9.2 Edit the SROM Image File

You have the option of manually editing SROM Image File information directly in the 6D Architect main window, but only after enabling the **Allow fields to be manually edited (Advanced)** option, located at the bottom of the ROM Information table.

After choosing this option, double-click a value in any of the NDI ROM Information tables to edit that value.

Note **For more information, see** **“SROM Image File Functionality” on page 10.**

9.3 Test Tool Tracking

Before the SROM Image File information is programmed into the SROM device, you should test its tracking ability. For instructions, see “Testing Tools” on page 161.

9.4 Program User-Specified SROM Tags

You can add four additional tags to a tool’s SROM Device, to further identify the parameters of your tool:

Tag Type	Description
Tip Location	This tag sets the location of the tool’s end tip, and consists of x, y, and z coordinates.
Trajectory	This tag sets the tool’s trajectory, and consists of quaternion coordinates.
Type	This tag assigns a tool type number to the tool, with a maximum value of 65,535.
Manufacturing	This tag assigns a manufacturing name to the tool, with a maximum of 12 characters.

Table 9-1 Tag Types

1. Click **Tool Operations** > **SROM Tags**. The Port Selection dialog opens.
2. From the **Select System** list, choose the system you are testing the tool with.
3. Indicate where the tool is located:
   - If you are testing with a Polaris System, select the appropriate tool port from the drop down menu.
   - If you are testing with an Optotrak Certus System, click the **Find Tools** button. The system will collect data information from the measurement volume, and report back which tools were found. Select the appropriate tool from the drop-down list.

Note **If you change the tools connected to the Optotrak System during this procedure, you must click the Find Tools button to refresh the list.**

4. Click **OK**. The User-Specified ROM dialog opens.

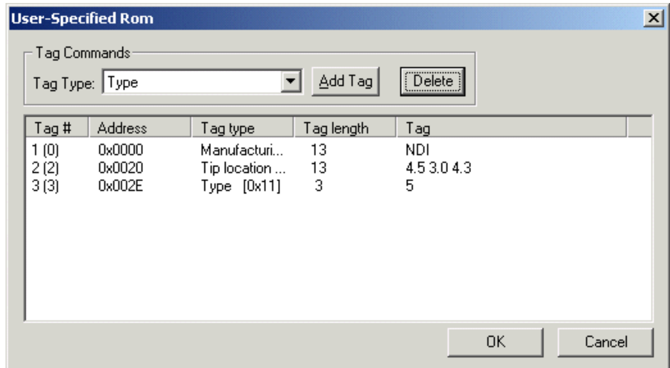


Figure 9-1 User-Specified ROM Dialog

Note **If pre-existing information resides on your SROM Image File, that information will appear inside the Tag Viewer section of the User-Specified ROM dialog.**

The following describes this dialog's table in more detail:

Column	Description
Tag#	The first number lists the currently existing tags. The bracketed number is a zero-based index of all tags on the ROM (including any previously deleted tags).
Address	The address in memory.
Tag Type	The tag description with corresponding tag identification.
Tag length	The tag length in bytes.
Tag	The tag contents.

Table 9-2 SROM Tag Table

5. From the **Tag Type** field, select the type of tag you wish to add.
6. Click **Add Tag**. A brief dialog will appear with the appropriate data fields for the tag type you selected.
7. Complete these fields and click **OK**.
8. (Optional) To remove a tag, select the tag from the SROM Tag table and click **Delete**.
9. When you have finished adding and editing the SROM tags, click **OK**. The Changes to SROM File dialog appears.

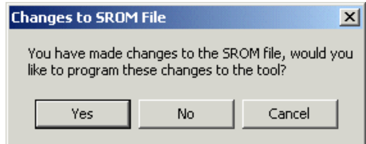


Figure 9-2 Changes to SROM File dialog

10. Click **Yes** to program the changes to the tool.

Note **No changes will be made to the SROM Image File until you click Yes. Any changes made without clicking Yes will be lost.**

9.5 Program the SROM Device

Once you are satisfied with the SROM Image File, you can use 6D Architect to write it onto the tool's SROM device.

1. In the 6D Architect main window, select **Tool Operations** > **Program SROM**.
2. From the **Select System** list, choose the system you are testing the tool with.
3. Indicate where the tool is located:
   - If you are testing with a Polaris System, select the appropriate tool port from the drop down menu.
   - If you are testing with an Optotrak Certus System, click the **Find Tools** button. The system will collect data information from the measurement volume, and report back which tools were found. Select the appropriate tool from the drop-down list.

Note **If you change the tools connected to the Optotrak System during this procedure, you must click the Find Tools button to refresh the list.**

4. Click **OK**. The Programming Tool dialog opens asking if you are sure you want to program the tool in the selected port.

Warning! **Do not interrupt the communication between the host computer and the measurement system once you beginning transferring the SROM Image File to the SROM Device. If there is an interruption, the SROM Device may be permanently damaged.**

5. Click **OK**.

6. If your tool already contains a SROM Image File, a Warning dialog appears stating that your tool is already programmed and that continuing the action may corrupt the tool. If you wish to continue programming the SROM, click **Yes**. If not, click **No**.

   If your tool does not contain a SROM Image File, a dialog appears stating that programming the SROM device was successful.

10 Passive Tools: Characterizing With A Polaris System

The following sections walk you through each window of the ROM Creation Wizard, to help you characterize an passive tool with a Polaris System.

Note **This section also applies to characterizing active wireless tools with a Polaris System; all screens and procedures are the same.**

This section explains the following steps:

1. Start the Wizard
2. Enter Collection Settings
3. Describe Tool Properties
4. Enter Tool Marker Values
5. Saving Parameters
6. Define Faces
7. Align the Tool's Coordinate System
8. Add Marker and Face Normals
9. Complete the Tool Characterization
10. What Is Next?

10.1 Start the Wizard

Before continuing, you must open the wizard and indicate that you are characterizing a passive tool or an active wireless tool with a Polaris System. For instructions, see "Tool Characterization: The First Step" on page 15.

Once this step is completed, you can continue the characterization process.

10.2 Enter Collection Settings

The ROM Creation Wizard's second screen is the Collection Settings dialog. Collection settings tell 6D Architect how many frames of data to collect, and what kind of measurement volume is supplying this data.

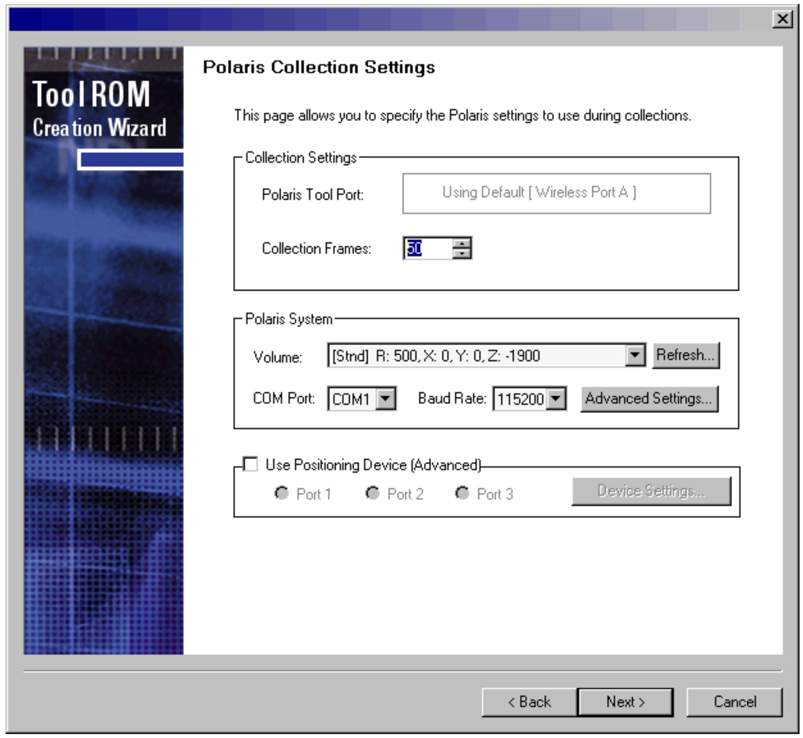


Figure 10-1 Collection Settings Dialog

1. Complete the Collection Settings section:

Field/Option	Definition
Polaris Tool Port	This field is disabled, with its default value set to "Wireless Port A".
Collection Frames	The number of frames 6D Architect will collect from the Polaris System as it tracks the tool. A frame is a single 3D measurement of the positions of all the markers in the measurement volume.

Table 10-1 Collection Settings Section

2. Complete the Polaris System section:

Field/Option	Definition
Volume	Your Polaris System's measurement volume type.
COM Port	The host computer's communications port to which the Polaris is connected.

Table 10-2 Polaris System Section

Field/Option	Definition
Baud Rate	The host computer's baud rate. The default setting is 9600 to ensure communications can be established for all computer configurations.

Table 10-2 Polaris System Section

3. (Optional) If you are using a positioning device, refer to *TB-10029*.
4. (Optional) If you want to apply advanced system settings, see "Polaris/Polaris Accedo System Settings" on page 170.
5. Click **Next**. The Tool Description dialog appears.

10.3 Describe Tool Properties

In the following screen, the ROM Creation Wizard will ask you to enter the parameters about the tool. This includes information such as the tool type, marker type, and the tracking algorithm.

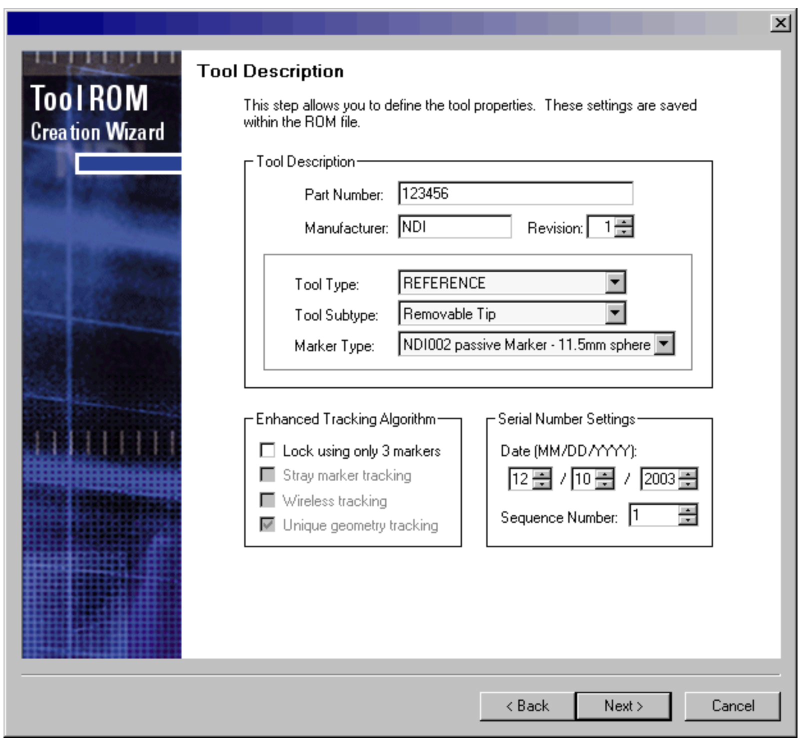


Figure 10-2 Tool Description Dialog

1. Complete the Tool Description section:

Field/Option	Definition
Part Number	Assign a part number to your tool. You can use a maximum of 20 characters.
Manufacturer	Assign a manufacturer name to your tool. You can use a maximum of 12 characters.
Revision	Assign a revision number to your tool.
Tool Type	From the list, select the entry that reflects the tool type.
Tool Subtype	From the list, select the entry that reflects the tool subtype.
Marker Type	From the list, select the entry that reflects your tool's marker type.

Table 10-3: Tool Description Section

Note **The part number, manufacturer, and revision number are mandatory fields. This information uniquely identifies the tool's design, and associates it with a particular application.**

2. Complete the Enhanced Tracking Algorithm section:

Field/Option	Definition
Lock using only 3 markers	If you want to reduce the acquisition time, choose this option.
Stray marker testing	This is disabled for passive tools.
Wireless tracking	This is automatically disabled.
Unique geometry tracking	This is automatically enabled.

Table 10-4: Enhanced Tracking Algorithm Section

Note **For more information about unique geometry, see "Unique Geometry" on page 164.**

3. Complete the Serial Number Settings section:

Field/Option	Action
Date (MM/DD/YYYY)	Enter today's date using the format indicated.
Sequence Number	Enter 1 to indicate an increment of one for each serial number created.

Table 10-5: Serial Number Settings

The software will automatically calculate a unique serial number for your tool, using these settings.

4. Click **Next**. The Marker Setup dialog opens.

10.4 Enter Tool Marker Values

6D Architect requires that you enter information about where each marker is placed on the tool. These coordinates can be entered using one of three different methods:

- load a Rigid Body file (.RIG) that has already been created for the tool
- use data collection through the Polaris System
- enter in each coordinate manually

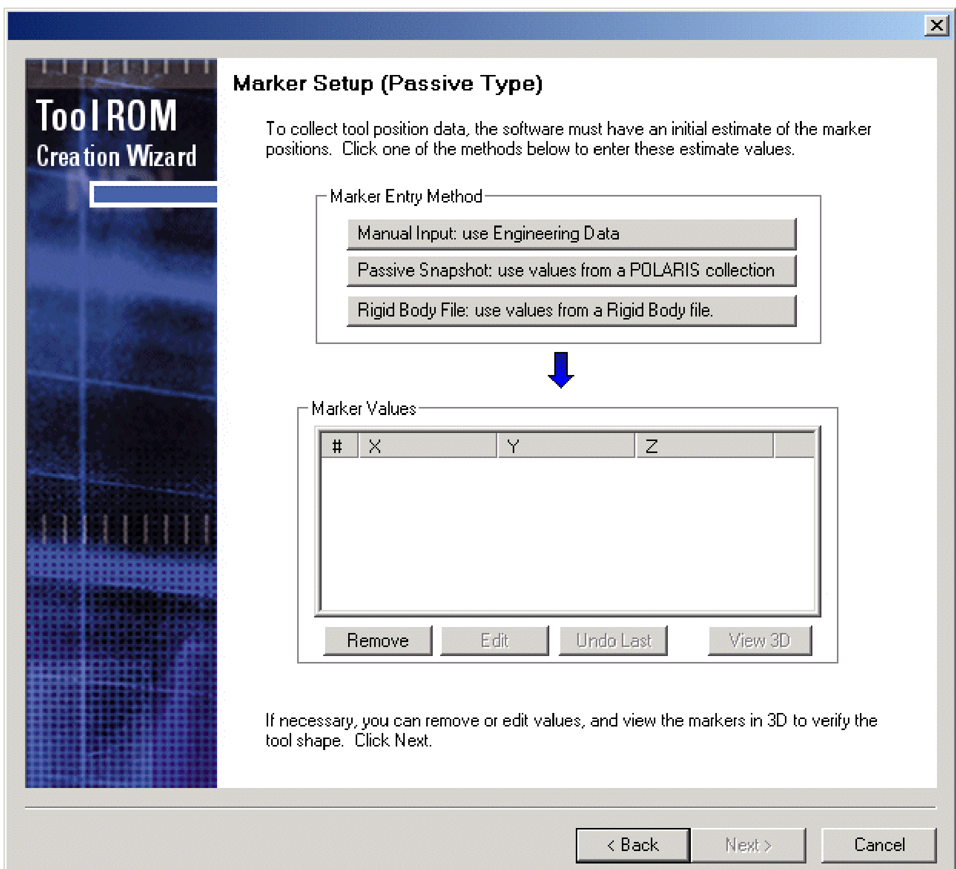


Figure 10-3 Marker Setup Dialog

To Enter Marker Values Using a Rigid Body File

1. Click **Rigid Body File: use values from a Rigid Body**.

2. Select the desired file from the directory.
3. Click **Open**. 6D Architect reads the Rigid Body file and plugs its marker values into the **Marker Values** list.
4. Click **Next**.

To Enter Marker Values Using Engineering Data

1. Click **Manual Input: use Engineering Data**. The Edit Marker Information dialog opens.

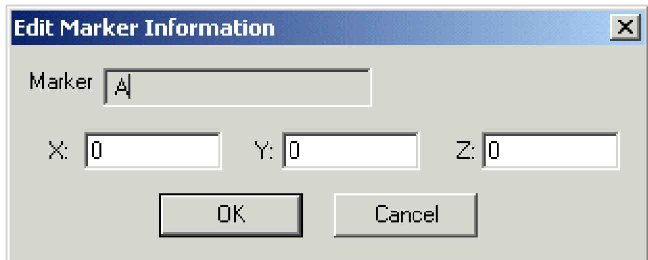


Figure 10-4 Edit Marker Information Dialog

2. Enter the x, y, and z positions for all markers on the tool.
3. Click OK. The Edit Marker dialog closes.
4. Once you have entered marker values, you can edit them in the following ways:

Edit or Change	Action
Edit a marker's values	Select the marker and click **Edit**.
Remove a marker from the list	Select the marker and click **Remove**.
Undo the last edit action	Click **Undo Last**.
View the marker(s) in 3D	Select the marker and click **View 3D**.

Table 10-6 Changing Marker Values

5. Click **Next**. The Marker Setup (Groups and Faces) dialog appears.
6. Proceed directly to section "Define Faces" on page 94.

To Enter Marker Values Using the Tool Snapshot Method

1. Click **Passive Snapshot**. The following dialog opens:

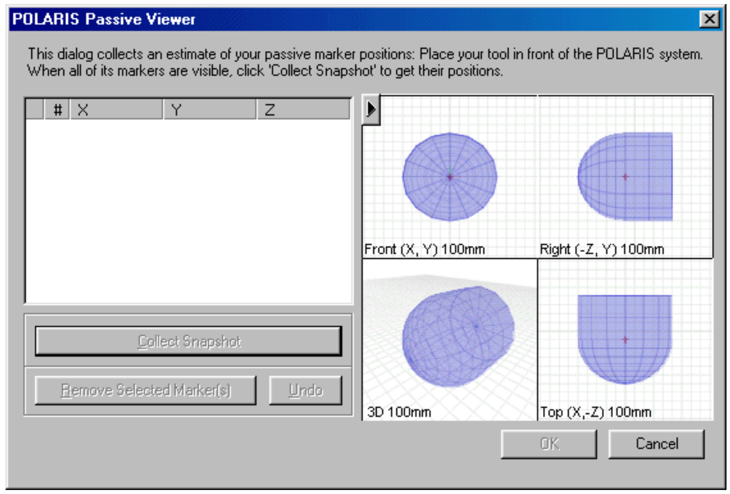


Figure 10-5 Passive Viewer Dialog

2. Position the tool in front of the Position Sensor until ALL markers are within the measurement volume. Ensure that the tool is perfectly stationary.

Note **If the number of markers that appear are greater than the number of markers on your tool, the system may be detecting phantom markers. You can eliminate phantom markers by slightly repositioning the tool.**

3. Click **Collect Snapshot**.
4. If there are phantom markers that need to be removed, select the marker from the list and click **Remove Selected Marker(s)**.
5. Once you are satisfied with the collection, click **OK**. The Polaris Passive Viewer dialog closes and you are returned to the Marker Setup dialog.
6. Click **Next**. The Save Parameters dialog opens.

10.5 Saving Parameters

6D Architect saves the collected data in a .csv (Comma Separated Value) file, and stored it in the location indicated by this Save Parameters dialog. Once you have finished the entire characterization process, you can open and review the .csv file's contents.

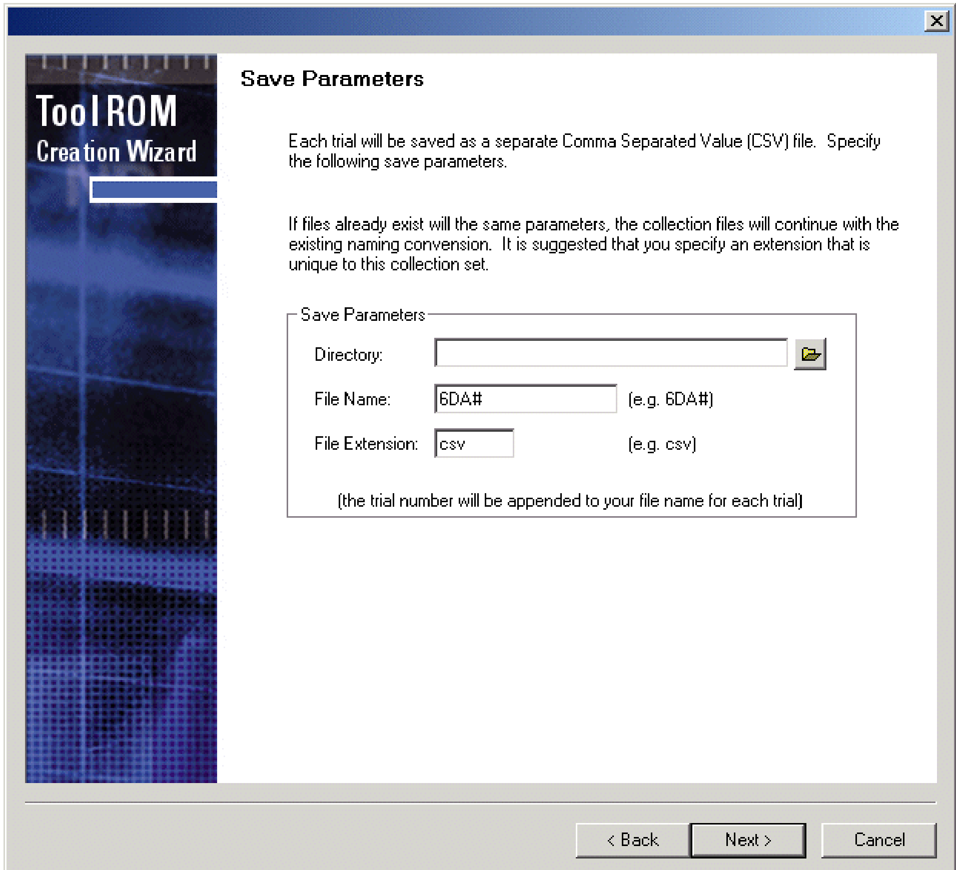


Figure 10-6 Save Parameters Dialog

1. Complete the Save Parameters section:

Field/Option	Action
Directory	Enter the directory location where you wish the files to be saved, or browse to a location by clicking .
File Name	Enter the name for the data collection.
File Extension	Enter **csv**.

Table 10-7: Save Parameters Section

2. Click **Next**. The Data Collection dialog opens.

The Data Collection dialog allows you to view the tool within the measurement volume during each trial frame.

The tool must remain motionless during collection trials. If the tool is moved during a collection, one or more of the markers may not be seen by the Polaris System and will be reported as missing.

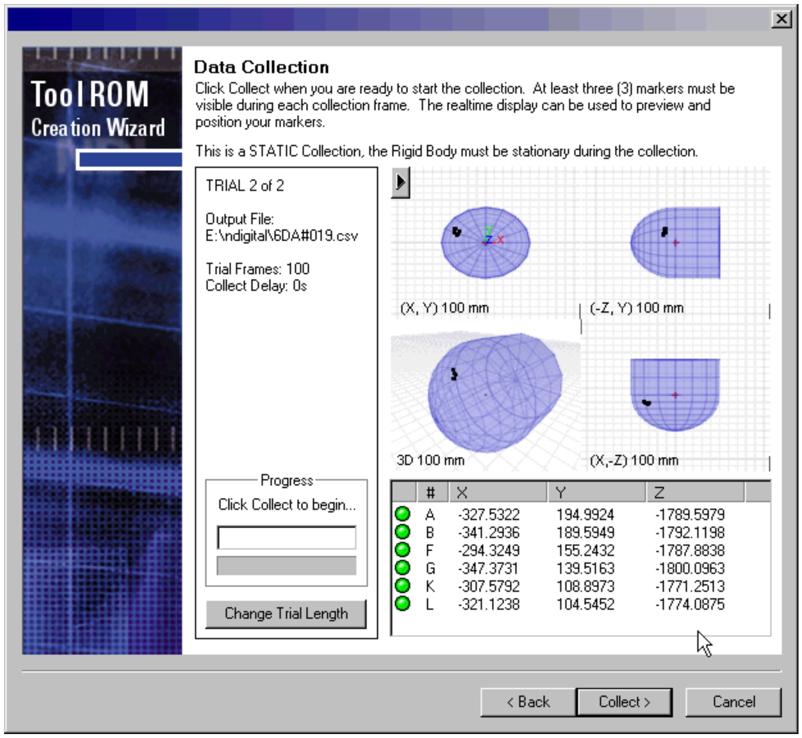


Figure 10-7 Data Collection Dialog

Note **Figure 6-5 shows a Polaris System that uses a standard measurement volume.**

1. (Optional) If you want to edit the collection trial length, click **Change Trial Length** and enter the new value. Increasing the trial length may increase the accuracy of the software's data interpretations.

2. Position the tool within the measurement volume. If you are unsure whether or not your markers are visible, observe the marker status in the bottom right of the window:

Marker Colour	Marker Status
Green	The marker is visible to the system and is inside the measurement volume.
Yellow	The marker is visible, but not in the measurement volume.
Red	The marker is not visible to the system.

Table 10-8: Marker Status

Each coloured circle corresponds to a marker. The number of circles should match the number of markers that are on the tool.

3. Click **Collect**. The system proceeds to collect information about each marker's position, for the number of frames specified. You can view this action in the marker status section of the dialog.

   The Current Collection Status Dialog opens, displaying this collected information.

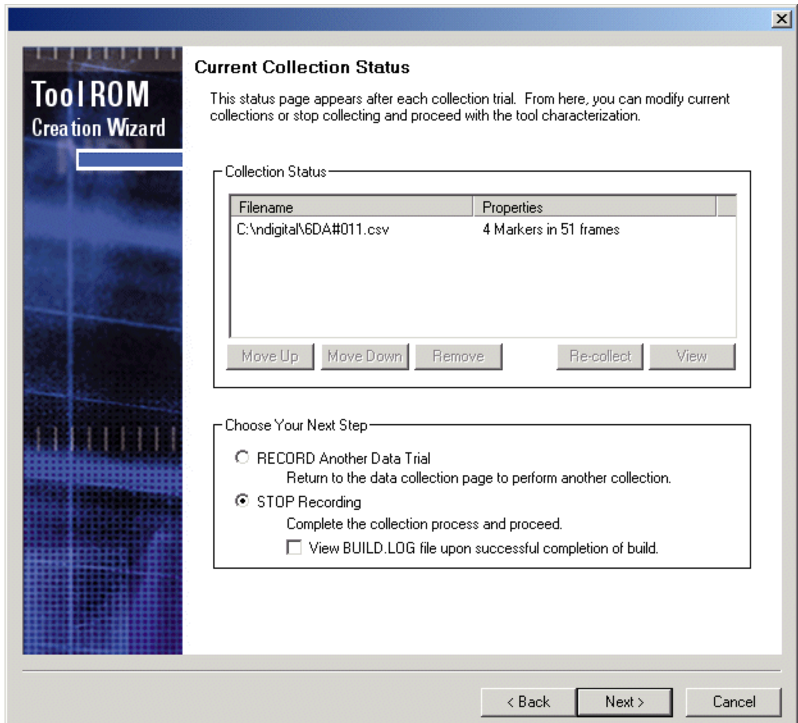


Figure 10-8 Current Collection Status Dialog

Use this dialog to view the collection results or record another trial:

1. Select the newly-created .csv file from the **Collection Status** list.
2. (Optional) Click **View**. The .csv file results open for viewing. When you have finished reviewing the results, click **Close**.
3. (Optional) You can record additional data trials:
   - If you want to collect another data trial, select **RECORD Another Data Trial**. You will be returned to the Data Collection dialog to begin the process again.
   - If you want to overwrite an existing data trial, select the file that you wish to overwrite from the list, and click **Re-collect**. You will be returned to the Data Collection dialog to begin the process again.

4. When you are satisfied with the data collection, select **STOP Recording**.
5. (Optional) If you want to view the Build.log file at the end of the build (when you have completed the ROM Creation Wizard), choose **View BUILD.LOG upon successful completion of build**.
6. Click **Next**. The Groups and Faces dialog opens.

10.6 Define Faces

Once the firing sequence for the active markers has been defined, you can organize the markers into faces.

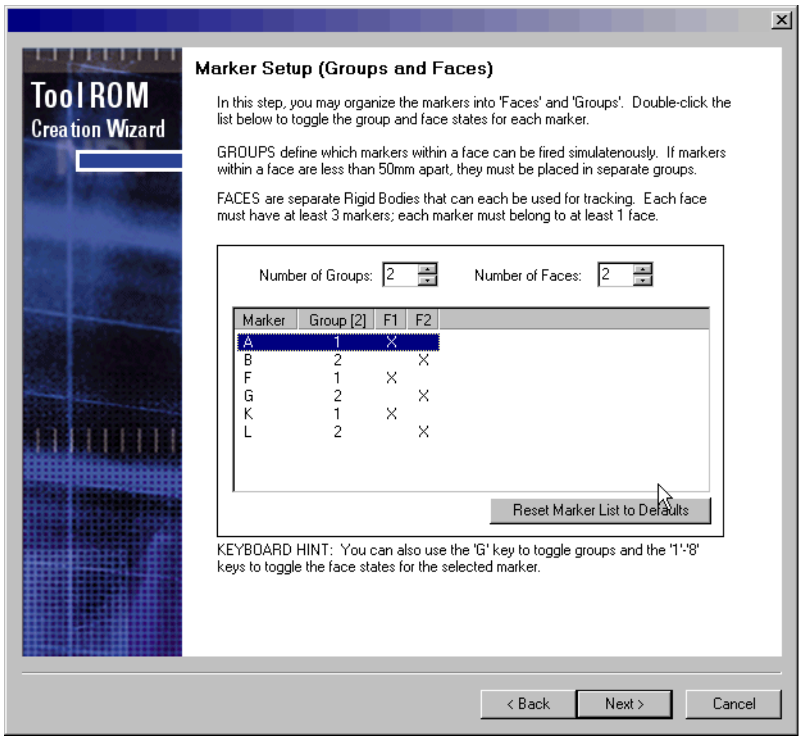


Figure 10-9 Marker Setup (Groups and Faces) Dialog

1. In the **Number of Faces** field, select the number of faces.
2. Assign a marker to a face: in the table, double-click the marker's **F** column entry to change it to **X**. This means that this marker is included on the face.
3. (Optional) If you want to restore the faces to the original settings, click **Reset Marker List to Defaults.**
4. Click **Next**. The Tool Alignment dialog opens.

10.7 Align the Tool's Coordinate System

Before any measurement system can calculate the position and rotation of your tool, you will need to assign the tool a local coordinate system. Assigning a local coordinate system is an important step in producing accurate transformations.

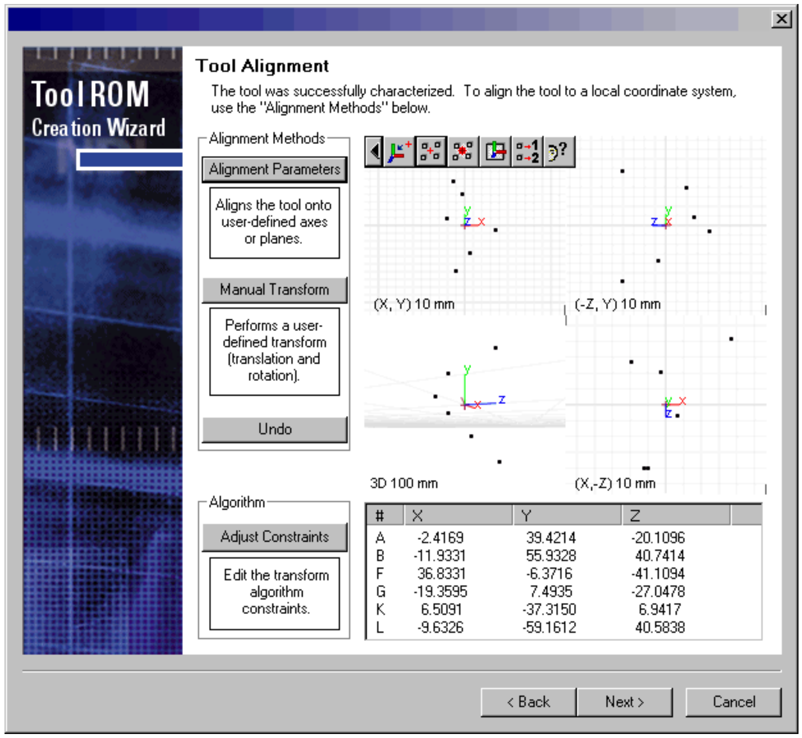


Figure 10-10 Tool Alignment Dialog

To Assign a Local Coordinate System Using Alignment Parameters

1. Click **Alignment Parameters**. The following dialog appears:

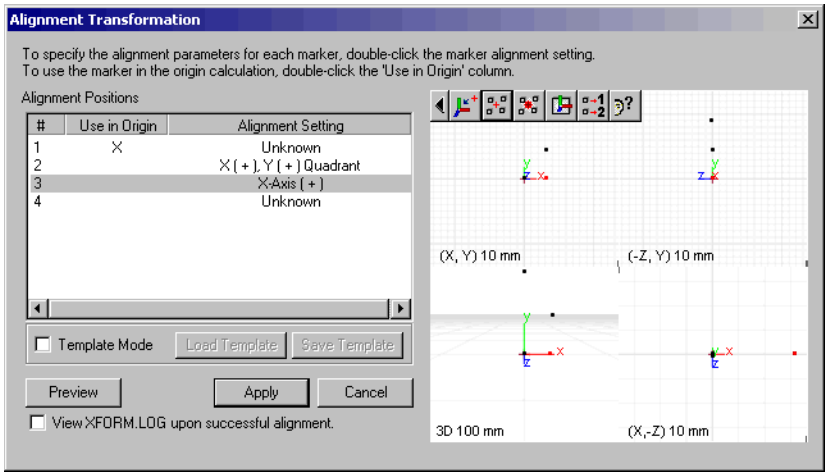


Figure 10-11 Alignment Transformation Dialog

2. To assign a marker as the origin of the local coordinate system, double-click that marker's entry under **Use in Origin**. If you select more than one marker as the origin of your tool , 6D Architect will place the origin at the geometric centre of these markers.
3. To place a marker onto an axis, right-click the marker's entry under **Alignment Setting**. Use the list that appears to constrain the marker to be on any positive or negative x, y, or z-axis.
4. To place a marker onto a plane of the local coordinate system, double-click that marker's entry under **Alignment Setting**. Use the list that appears to constrain the marker to any quadrant of any plane.
5. Click **Preview** to view the changes that you make in the marker window. This can help you visualize the chosen orientations and help trouble-shoot any conflicting alignments you may have accidentally made.
6. (Optional) If you want to either save these alignment settings to a template or open an existing alignment template and apply it to your tool, enable **Template Mode** to activate template functions.
7. When you are finished, return to the Tool Alignment dialog:
   - If you want to return to the original position and orientation, click **Cancel**.
   - If you are satisfied with the alignment parameters, click **Apply**.
8. (Optional) Define the algorithm constraints further by clicking **Adjust Constraints**. For more information about this function, see "Algorithm Constraints" on page 167.

Note **The algorithm constraints are advanced option parameters. If the intended result is not fully understood, do not perform this step and simply continue with the default settings.**

9. Click **Next**. The Marker and Face Normals dialog appears.

To Adjust the Local Coordinate System Manually

1. Click **Manual Transform**. The following dialog appears:

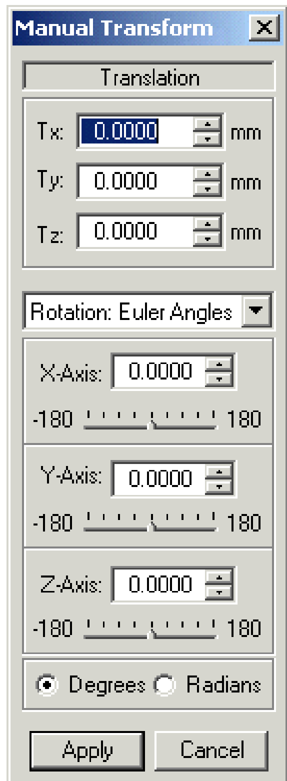


Figure 10-12 Manual Transform Dialog

2. Adjust each field incrementally to change the position and orientation of the local coordinate system. Each change is reflected in the graphic representations in the Tool Alignment dialog.
   - Use the **Tx**, **Ty**, and **Tz** fields to translate the origin of the local coordinate system.
   - If you are using the Euler Angles (as indicated in the drop-down list), use the **X-Axis**, **Y-Axis**, and **Z-Axis** fields to rotate the local coordinate system.

Note **The Rotation Matrix and Quaternion are advanced options. The easiest and most intuitive way to rotate coordinate systems is to use Euler Angles.**

3. Once you are satisfied, click **Apply** to save your changes.
4. (Optional) Define the algorithm constraints further by clicking **Adjust Constraints**. For more information about this function, see "Algorithm Constraints" on page 167

Note **The algorithm constraints are advanced option parameters. If the intended result is not fully understood, do not perform this step and simply continue with the default settings.**

5. Click **Next**. The Marker and Face Normals dialog appears.

10.8 Add Marker and Face Normals

For each marker and face on your tool, you will need to assign a vector that defines which way they are facing. The system uses this vector, or *normal*, to help determine where the marker or face is pointing in the measurement volume. With this information, the system can determine if the marker or face is pointing at an angle that no longer provides accurate data.

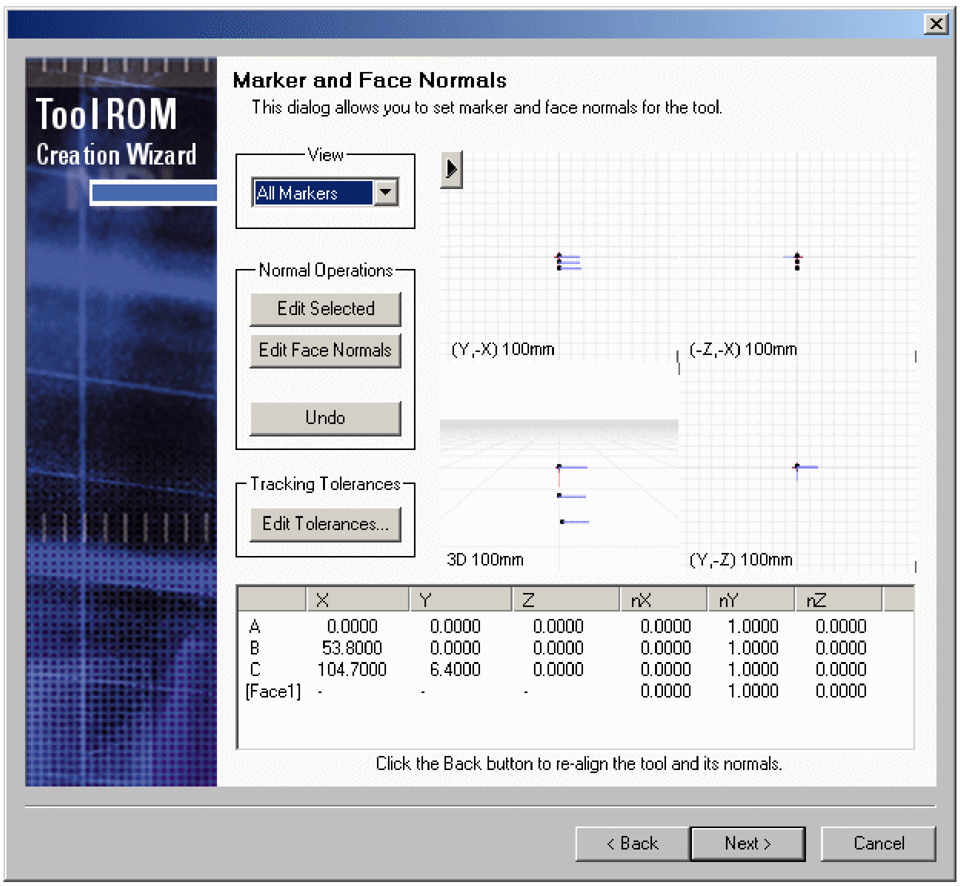


Figure 10-13 Marker and Face Normals Dialog

About Determining Normals

Note **You need to assign normals to all markers *and* all faces.**

6D Architect performs several calculations and displays the results at the bottom of the Marker and Face Normals dialog, to guide you in selecting the right normal values. These suggestions change depending on how many markers are selected, and where these markers are located on the tool:

Number of Markers Selected	Suggested Values Provided
1 marker	none
2 markers	coordinates of the centroid
3 markers	coordinates of the centroid, and coefficients of an imagined plane that the three markers would create.
4 or more markers	coordinates of the centroid

Table 10-9 Marker Information Provided By 6D Architect

Note **The centroid is the centre point of an imagined three dimensional volume created by the selected markers.**

You can use these suggested values when determining normals, but be sure to review and adjust the values as needed.

Note **A face normal must be perpendicular to its face. Individual marker normals, however, do not need to be perpendicular to the face that marker is assigned to.**

To Create a Normal for Individual Markers

1. In the **View** list, select **All Markers.**
2. In the table at the bottom of the dialog, press **Ctrl** and select three markers (the desired marker included).

   Below the table, the software displays the centroid and a plane equation associated with the selected markers. Use this information to determine the coordinates of the ideal normal for the desired marker.

Note **The first three coefficients of the plane equation are coordinates for a normal vector perpendicular to the imagined plane.**

3. Select a single marker (or if you want to assign the same normal to multiple markers, select them while pressing the **Ctrl** key).
4. Click **Edit Selected**.
5. In the coordinate fields provided, enter the values that you determined in step 2 and adjust the values if necessary. Your changes are displayed graphically, to help you with these edits.
6. Click **OK**.

To Create Normals for Faces

1. In the **View** list, select the appropriate face**.**
2. In the table at the bottom of the dialog, press **Ctrl** and select three markers that are assigned to the face.

   Below the table, the software displays the centroid and a plane equation associated with the selected markers. Use this information to determine the coordinates of the ideal normal for the desired marker.

Note **The first three coefficients listed for the imagined plane can be used as coordinates for a vector perpendicular to the imagined plane.**

3. Click **Face Normals**.
4. From the drop-down list, select the appropriate face.
5. In the coordinate fields provided, enter the values that you determined in step 2 and adjust the values if necessary. Your changes are displayed graphically, to help you with these edits.
6. Click **OK**.
7. (Optional) If you want to restore all of the normals and tolerances to the default settings, click **Undo**.
8. Click **Next**. The Characterization Completion dialog opens.

To Set Tracking Tolerances

1. In the **View** list, select **All Markers.**
2. In the table at the bottom of the dialog, select a marker.
3. Click **Edit Tolerances**. The following dialog opens.

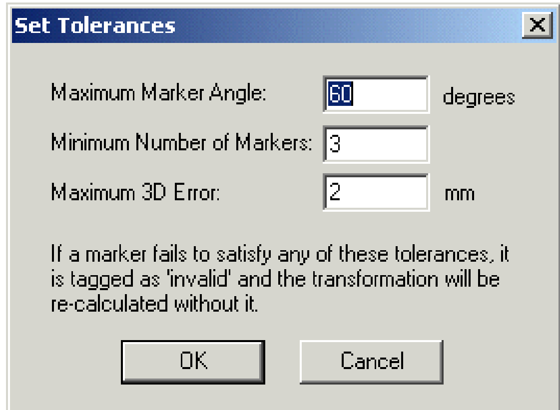


Figure 10-14 Set Tolerances Dialog

4. Complete the fields provided:

Field	Action
Maximum Marker Angle	Enter the maximum angle that a marker normal can be pointed *away* from the Position Sensor. Any marker turned away more than this value will not be used to compute a tool transformation.
Minimum Number of Markers	Enter the minimum number of markers that must be counted as present in the measurement volume, before the system produces a transformation for the tool.
Maximum 3D Error	Enter the maximum distance between where the marker is observed by the system and is expected to be in the tool's SROM Image File. If a marker exceeds this value, it is not used to compute a tool transformation.

Table 10-10 Tolerance Fields

5. Click **OK**.

6. Click **Next**. The Characterization Completion dialog opens.

10.9 Complete the Tool Characterization

6D Architect allows you to save all the ROM Creation Wizard selections that you've made, in case you want to repeat the characterization process for similar tools using similar parameters. Remember that although you can use the same wizard selections for similar tools, you will still need to perform separate and unique data collections for each.

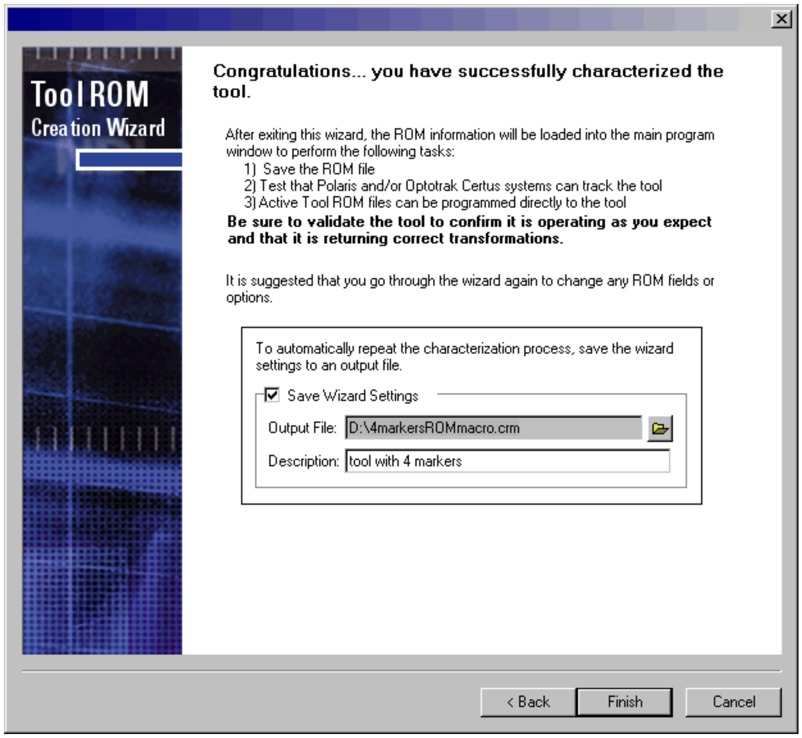


Figure 10-15 Characterization Completion Dialog

1. Choose **Save Wizard Settings**.
2. In the **Output File** field, browse to a location and enter a name by clicking .
3. In the **Description** field, enter an identifying description for this wizard session.
4. Click **Finish**. The software saves your settings in a ROM Characterization Macro (.crm) file.

Note **The saved parameter file contains the tool's characterization information. When applied to subsequent tools, the software will automatically increase the sequence number.**

Once the characterization is complete, the wizard closes and a graphical representation of the tool will be loaded into the main window. The tool parameters are loaded in the ROM section of the main window.

For more information about the main window, see "Exploring 6D Architect Main Window" on page 6.

10.10 What Is Next?

After you have created and saved the SROM Image File (.ROM) file, you must test the SROM Image File to ensure that the Polaris System can track the tool correctly. For more instructions, see “Testing Tools” on page 161.

11 Passive Tools: Characterizing With A Polaris Accedo System

The following sections walk you through each window of the ROM Creation Wizard, to help you characterize an passive tool with a Polaris Accedo System.

This section explains the following steps:

1. Start the Wizard
2. Enter the Collection Settings
3. Describe Tool Properties
4. Enter Tool Marker Values
5. Save Parameters
6. Collect Tool Marker Data
7. Define Faces
8. Align the Tool’s Coordinate System
9. Add Marker and Face Normals
10. Complete the Tool Characterization
11. What Is Next?

11.1 Start the Wizard

Before continuing, you must open the wizard and indicate that you are characterizing a passive tool with a Polaris Accedo System. For instructions, see “Tool Characterization: The First Step” on page 15.

Once this step is completed, you can continue the characterization process.

11.2 Enter the Collection Settings

The ROM Creation Wizard’s second screen is the Collection Settings dialog. Collection settings tell 6D Architect how many frames of data to collect, and what kind of measurement volume is supplying this data.

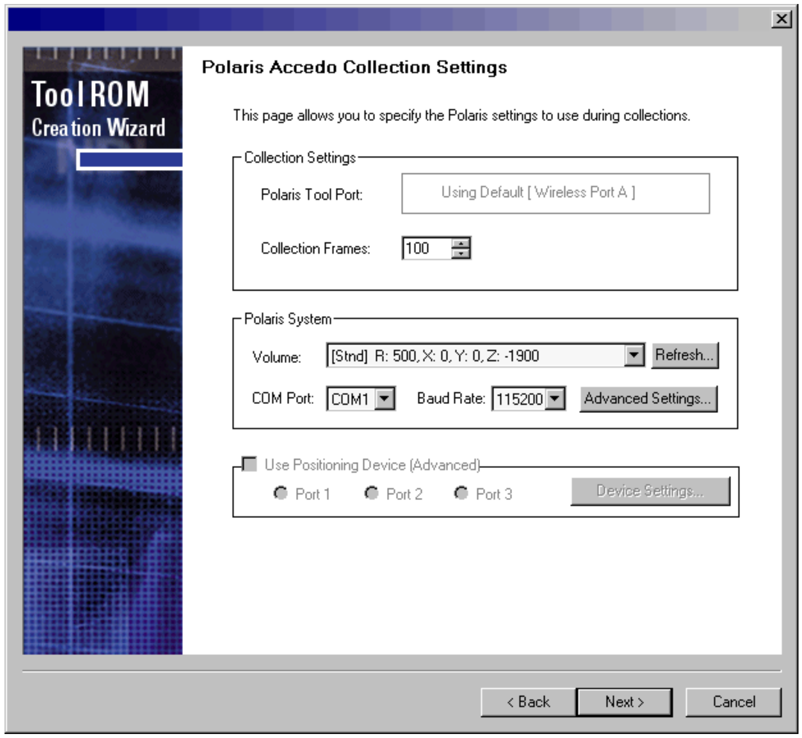


Figure 11-1 Collection Settings Dialog

1. Complete the Collection Settings section:

Field/Option	Definition
Polaris Tool Port	This field is disabled, with its default value set to “Wireless Port A”.
Collection Frames	The number of frames 6D Architect will collect from the Polaris Accedo System. A frame is a single 3D measurement of the positions of all the markers in the measurement volume.

Table 11-1 Collection Settings Section

2. Complete the Polaris Accedo System section:

Field/Option	Definition
Volume	Your Polaris Accedo System’s measurement volume.
COM Port	The host computer’s communications port to which the Polaris Accedo is connected.

Table 11-2 Polaris Accedo System Section

Field/Option	Definition
Baud Rate	The host computer's baud rate. The default setting is 9600 to ensure communications can be established for all computer configurations.

Table 11-2 Polaris Accedo System Section

3. (Optional) If you want to apply advanced system settings, see "Polaris/Polaris Accedo System Settings" on page 170.
4. Click **Next**. The Tool Description dialog appears.

11.3 Describe Tool Properties

In the following screen, the ROM Creation Wizard will ask you to enter the parameters about the tool. This includes information such as the tool type, marker type, and the tracking algorithm.

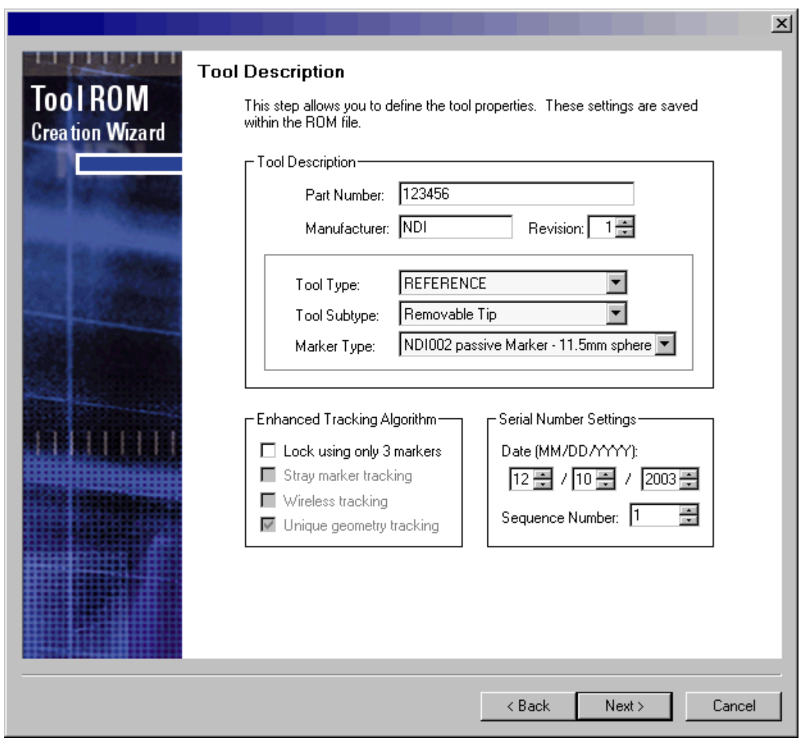


Figure 11-2 Polaris Accedo Tool Description Dialog

1. Complete the Tool Description section:

Field/Option	Definition
Part Number	Assign a part number to your tool. You can use a maximum of 20 characters.
Manufacturer	Assign a manufacturer name to your tool. You can use a maximum of 12 characters.
Revision	Assign a revision number to your tool.
Tool Type	From the list, select the entry that reflects the tool type.
Tool Subtype	From the list, select the entry that reflects the tool subtype.
Marker Type	From the list, select the entry that reflects your tool's marker type.

Table 11-3 Tool Description Section

Note **The part number, manufacturer, and revision number are mandatory fields. This information uniquely identifies the tool's design, and associates it with a particular application.**

2. Complete the Enhanced Tracking Algorithm section:

Field/Option	Definition
Lock using only 3 markers	If you want to reduce the acquisition time, choose this option.
Stray marker testing	This is disabled for passive tools.
Wireless tracking	This is automatically disabled.
Unique geometry tracking	This is automatically enabled.

Table 11-4 Enhanced Tracking Algorithm Section

Note **For more information about unique geometry, see "Unique Geometry" on page 164.**

3. Complete the Serial Number Settings section:

Field/Option	Action
Date (MM/DD/YYYY)	Enter today's date using the format indicated.
Sequence Number	Enter 1 to indicate an increment of one for each serial number created.

Table 11-5 Serial Number Settings

The software will automatically calculate a unique serial number for your tool, using these settings.

4. Click **Next**. The Marker Setup dialog opens.

11.4 Enter Tool Marker Values

6D Architect requires that you enter information about where each marker is placed on the tool. These coordinates can be entered using one of three different methods:

- load a Rigid Body file (.RIG) that has already been created for the tool
- use data collection through the Polaris Accedo System
- enter in each coordinate manually.

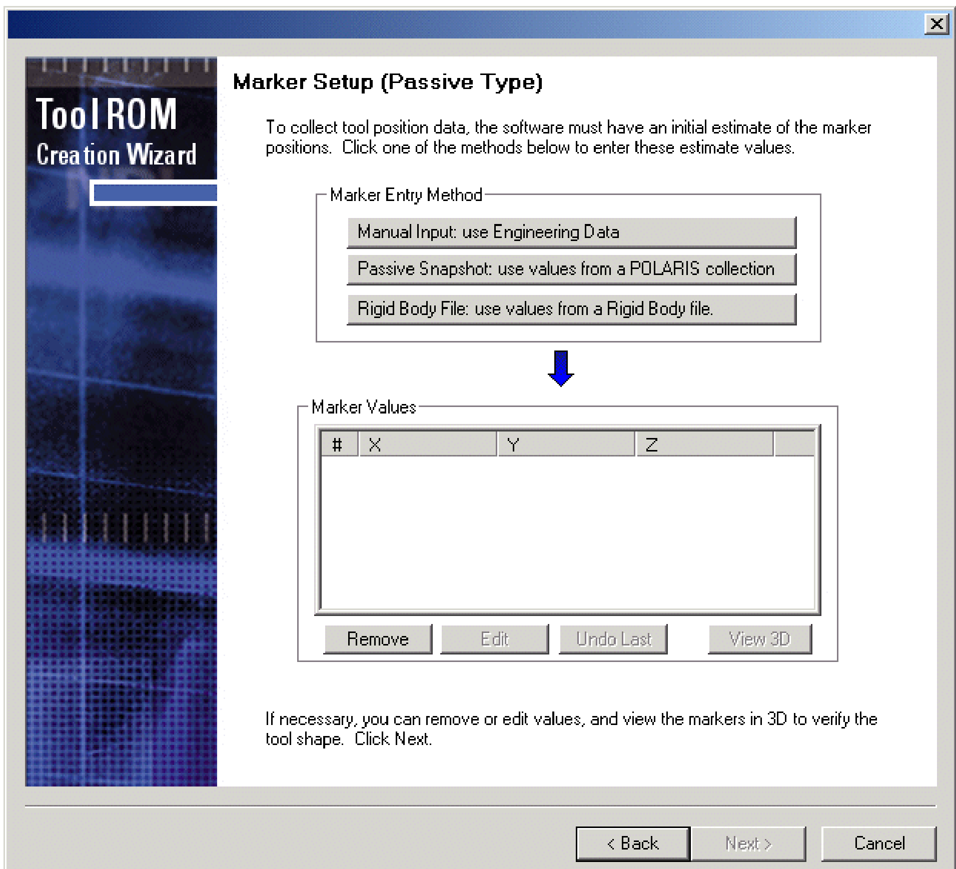


Figure 11-3 Marker Setup Dialog

To Enter Marker Values Using a Rigid Body File

1. Click **Rigid Body File: use values from a Rigid Body**.

2. Select the desired file from the directory.
3. Click **Open**. 6D Architect reads the Rigid Body file and plugs its marker values into the **Marker Values** list.
4. Click **Next**.

To Enter Marker Values Using Engineering Data

1. Click **Manual Input: use Engineering Data**. The Edit Marker Information dialog opens.

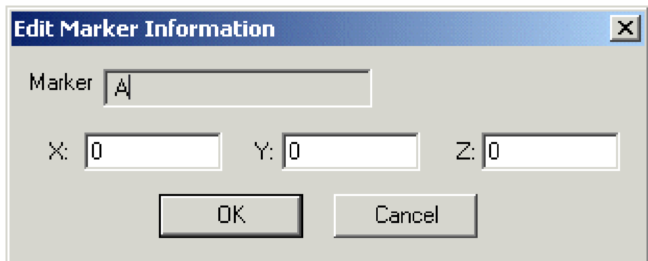


Figure 11-4 Edit Marker Information Dialog

2. Enter the x, y, z positions for all markers on the tool.
3. Click OK. The Edit Marker dialog closes.
4. Once you have entered marker values, you can edit them in the following ways:

Edit or Change	Action
Edit a marker's values	Select the marker and click **Edit**.
Remove a marker from the list	Select the marker and click **Remove**.
Undo the last edit action	Click **Undo Last**.
View the marker(s) in 3D	Select the marker and click **View 3D**.

Table 11-6 Changing Marker Values

5. Click **Next**. The Marker Setup (Groups and Faces) dialog appears.
6. Proceed directly to section "Define Faces" on page 114.

To Enter Marker Values Using the Tool Snapshot Method

1. Click **Passive Snapshot**. The following dialog opens:

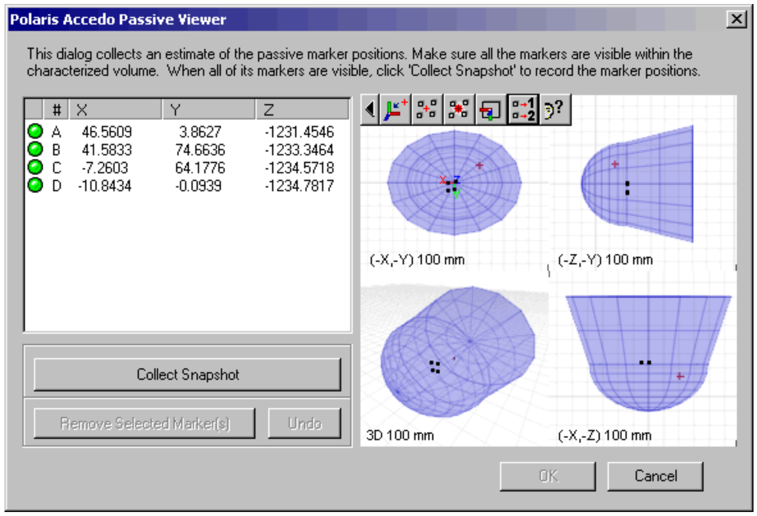


Figure 11-5 Passive Viewer Dialog

2. Position the tool in front of the Position Sensor until ALL markers are within the measurement volume. Ensure that the tool is perfectly stationary.

Note **If the number of markers that appear are greater than the number of markers on your tool, the system may be detecting phantom markers. You can eliminate phantom markers by slightly repositioning the tool.**

3. Click **Collect Snapshot**.
4. If there are phantom markers that need to be removed, select the marker from the list and click **Remove Selected Marker(s)**.
5. Once you are satisfied with the collection, click **OK**. The Polaris Passive Viewer dialog closes and you are returned to the Marker Setup dialog.
6. Click **Next**. The Save Parameters dialog opens.

11.5 Save Parameters

6D Architect saves the collected data in a .csv (Comma Separated Value) file, and stored it in the location indicated by this Save Parameters dialog. Once you have finished the entire characterization process, you can open and review the .csv file's contents.

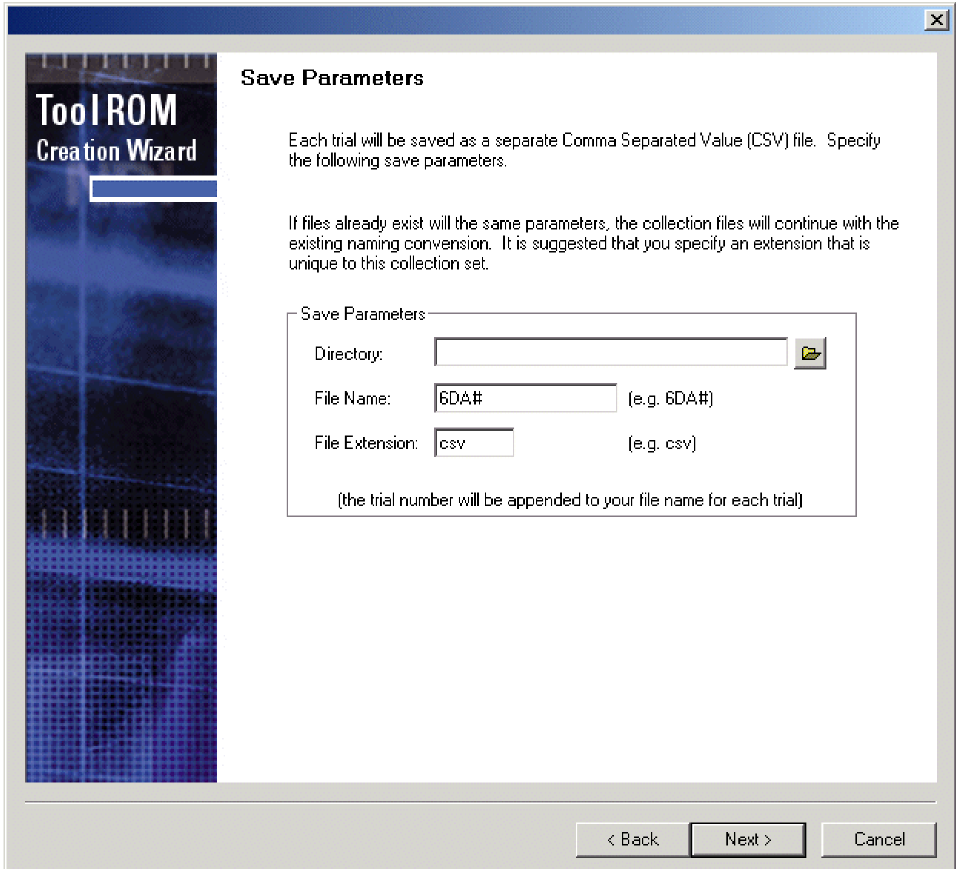


Figure 11-6 Save Parameters Dialog

7. Complete the Save Parameters section:

Field/Option	Action
Directory	Enter the directory location where you wish the files to be saved, or browse to a location by clicking .
File Name	Enter the name for the data collection.
File Extension	Enter **csv**.

Table 11-7 Save Parameters Section

8. Click **Next**. The Data Collection dialog opens.

11.6 Collect Tool Marker Data

The Data Collection dialog allows you to view the tool within the measurement volume during each trial frame.

The tool must remain motionless during collection trials. If the tool is moved even slightly during a collection, the Polaris Accedo System cannot determine accurate positions of all markers with respect to each other. The tool characterization will likely fail.

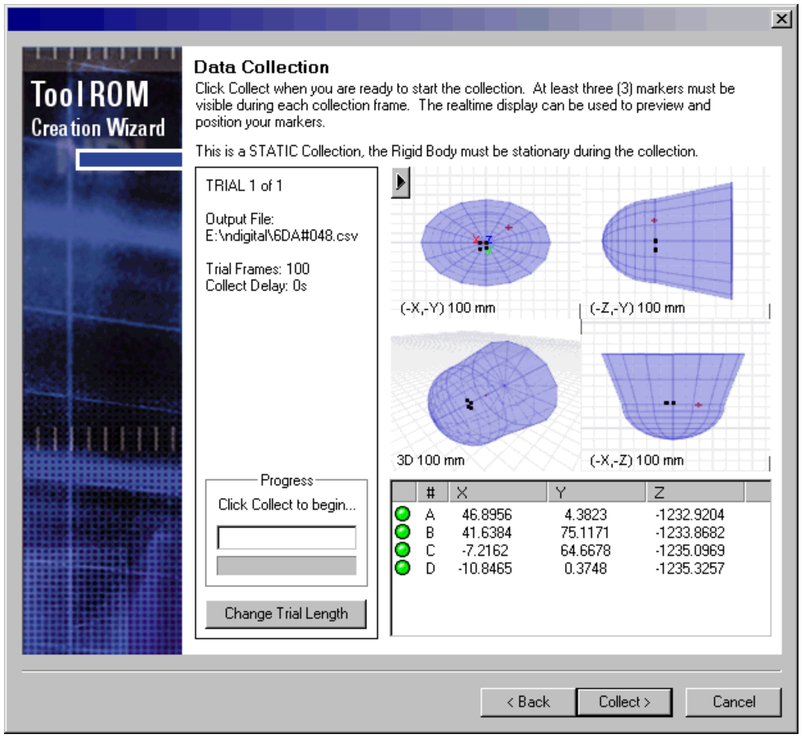


Figure 11-7 Data Collection Dialog

Note **Figure 6-5 shows a Polaris Accedo System using a Comet measurement volume.**

1. (Optional) If you want to edit the collection trial length, click **Change Trial Length** and enter the new value. Increasing the trial length may increase the accuracy of the software's data interpretations.

2. Position the tool within the measurement volume. If you are unsure whether or not your markers are visible, observe the marker status in the bottom right of the window:

Marker Colour	Marker Status
Green	The marker is visible to the system and is inside the measurement volume.
Yellow	The marker is visible, but not in the measurement volume.
Red	The marker is not visible to the system.

Table 11-8: Marker Status

Each coloured circle corresponds to a marker. The number of circles should match the number of markers that are on the tool.

3. Click **Collect**. The system proceeds to collect information about each marker's position, for the number of frames specified. You can view this action in the marker status section of the dialog.

   The Current Collection Status Dialog opens, displaying this collected information.

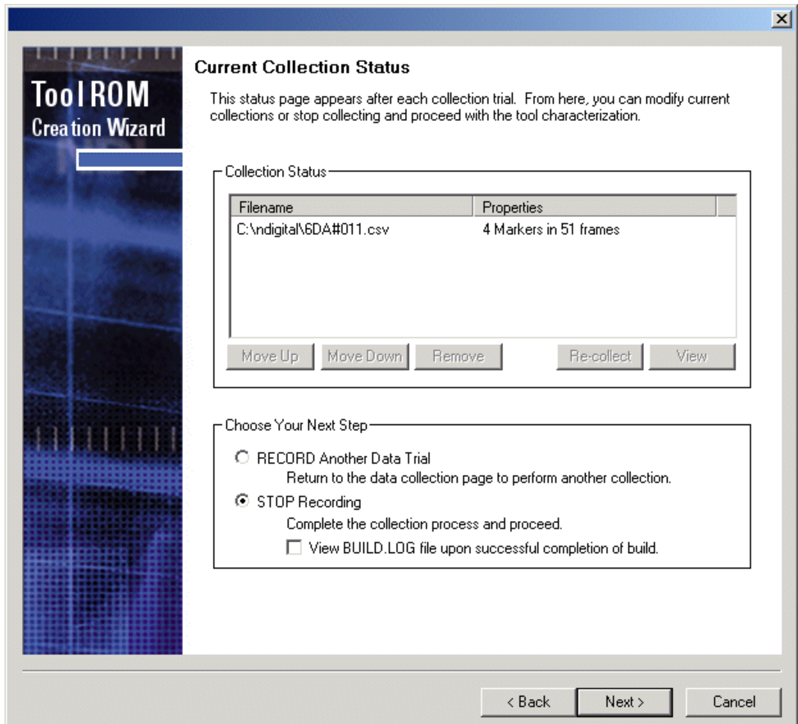


Figure 11-8 Current Collection Status Dialog

Use this dialog to view the collection results or record another trial:

1. Select the newly-created .csv file from the **Collection Status** list.
2. (Optional) Click **View**. The .csv file results open for viewing. When you have finished reviewing the results, click **Close**.
3. (Optional) You can record additional data trials:
   - If you want to collect another data trial, select **RECORD Another Data Trial**. You will be returned to the Data Collection dialog to begin the process again.
   - If you want to overwrite an existing data trial, select the file that you wish to overwrite from the list, and click **Re-collect**. You will be returned to the Data Collection dialog to begin the process again.

4. When you are satisfied with the data collection, select **STOP Recording**.
5. (Optional) If you want to view the Build.log file at the end of the build (when you have completed the ROM Creation Wizard), choose **View BUILD.LOG upon successful completion of build**.
6. Click **Next**. The Groups and Faces dialog opens.

11.7 Define Faces

Once the firing sequence for the active markers has been defined, you can organize the markers into faces.

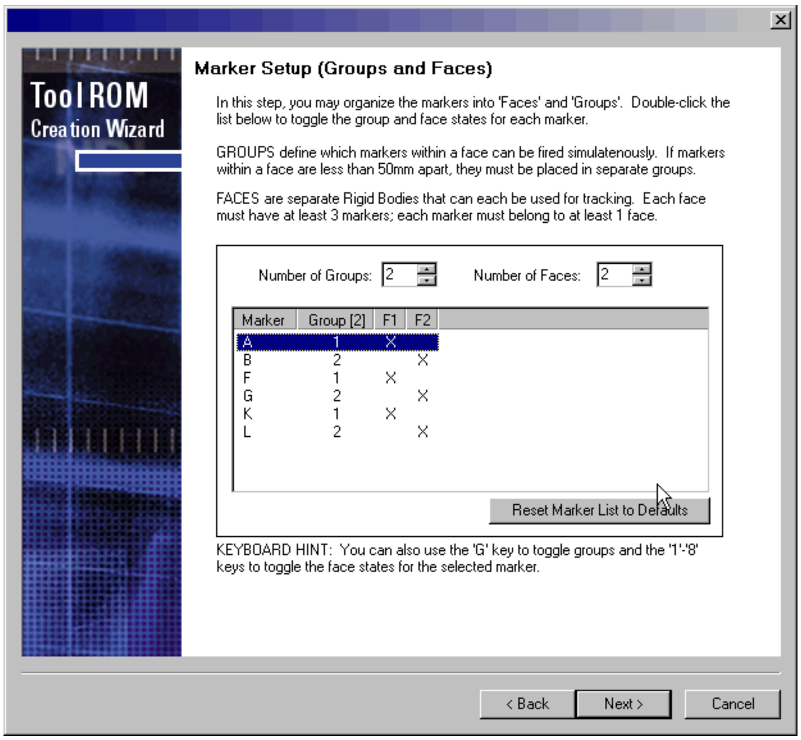


Figure 11-9 Marker Setup (Groups and Faces) Dialog

1. In the **Number of Faces** field, select the number of faces.
2. Assign a marker to a face: in the table, double-click the marker's **F** column entry to change it to **X**. This means that this marker is included on the face.
3. (Optional) If you want to restore the faces to the original settings, click **Reset Marker List to Defaults.**
4. Click **Next**. The Tool Alignment dialog opens.

11.8 Align the Tool's Coordinate System

Before any measurement system can calculate the position and rotation of your tool, you will need to assign the tool a local coordinate system. Assigning a local coordinate system is an important step in producing accurate transformations.

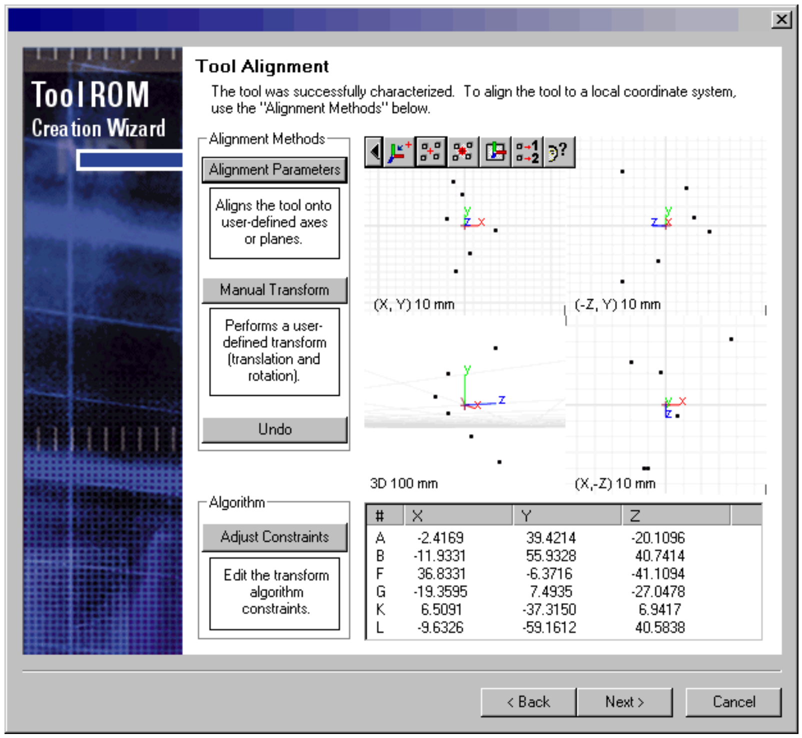


Figure 11-10 Tool Alignment Dialog

To Assign a Local Coordinate System Using Alignment Parameters

1. Click **Alignment Parameters**. The following dialog appears:

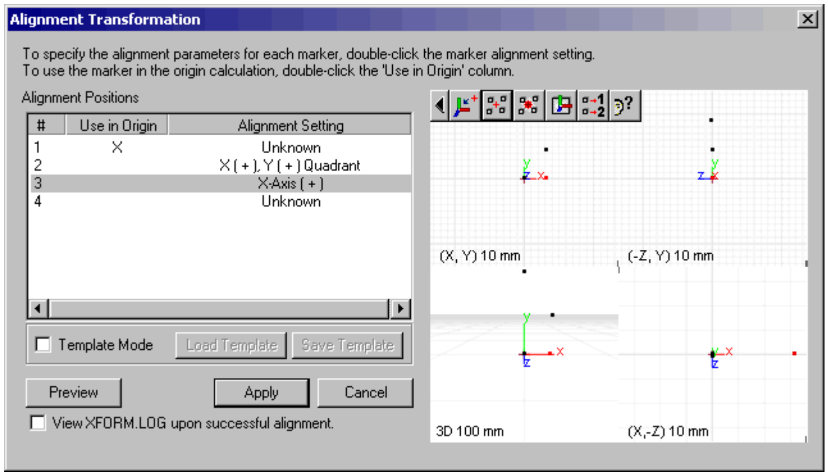


Figure 11-11 Alignment Transformation Dialog

2. To assign a marker as the origin of the local coordinate system, double-click that marker's entry under **Use in Origin**. If you select more than one marker as the origin of your tool, 6D Architect will place the origin at the geometric centre of these markers.

3. To place a marker onto an axis, right-click the marker's entry under **Alignment Setting**. Use the list that appears to constrain the marker to be on any positive or negative x, y, or z-axis.

4. To place a marker onto a plane of the local coordinate system, double-click that marker's entry under **Alignment Setting**. Use the list that appears to constrain the marker to any quadrant of any plane.

5. Click **Preview** to view the changes that you make in the marker window. This can help you visualize the chosen orientations and help trouble-shoot any conflicting alignments you may have accidentally made.

6. (Optional) If you want to either save these alignment settings to a template or open an existing alignment template and apply it to your tool, enable **Template Mode** to activate template functions.

7. When you are finished, return to the Tool Alignment dialog:

   - If you want to return to the original position and orientation, click **Cancel**.
   - If you are satisfied with the alignment parameters, click **Apply**.

8. (Optional) Define the algorithm constraints further by clicking **Adjust Constraints**. For more information about this function, see "Algorithm Constraints" on page 167.

Note **The algorithm constraints are advanced option parameters. If the intended result is not fully understood, do not perform this step and simply continue with the default settings.**

9. Click **Next**. The Marker and Face Normals dialog appears.

To Adjust the Local Coordinate System Manually

1. Click **Manual Transform**. The following dialog appears:

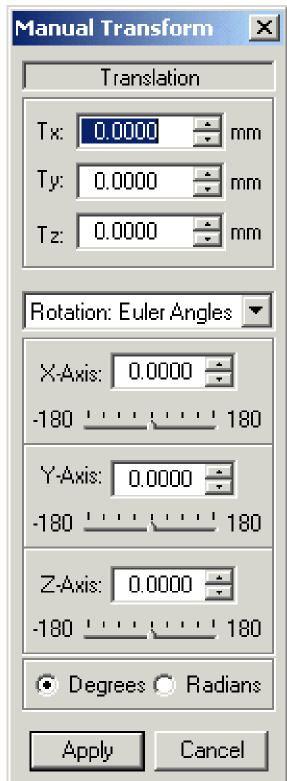


Figure 11-12 Manual Transform Dialog

2. Adjust each field incrementally to change the position and orientation of the local coordinate system. Each change is reflected in the graphic representations in the Tool Alignment dialog.
   - Use the **Tx**, **Ty**, and **Tz** fields to translate the origin of the local coordinate system.
   - If you are using the Euler Angles (as indicated in the drop-down list), use the **X-Axis**, **Y-Axis**, and **Z-Axis** fields to rotate the local coordinate system.

Note **The Rotation Matrix and Quaternion are advanced options. The easiest and most intuitive way to rotate coordinate systems is to use Euler Angles.**

3. Once you are satisfied, click **Apply** to save your changes.
4. (Optional) Define the algorithm constraints further by clicking **Adjust Constraints**. For more information about this function, see “Algorithm Constraints” on page 167.

Note **The algorithm constraints are advanced option parameters. If the intended result is not fully understood, do not perform this step and simply continue with the default settings.**

5. Click **Next**. The Marker and Face Normals dialog appears.

11.9 Add Marker and Face Normals

For each marker and face on your tool, you will need to assign a vector that defines which way they are facing. The system uses this vector, or *normal*, to help determine where the marker or face is pointing in the measurement volume. With this information, the system can determine if the marker or face is pointing at an angle that no longer provides accurate data.

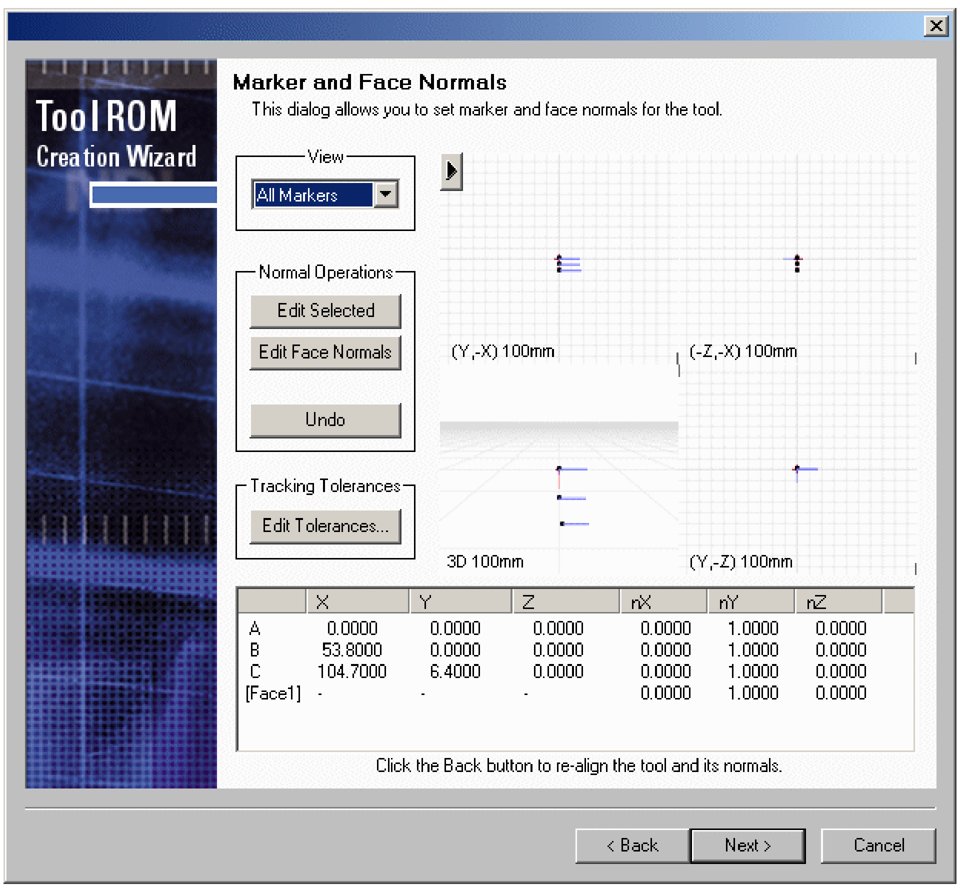


Figure 11-13 Marker and Face Normals Dialog

About Determining Normals

Note **You need to assign normals to all markers *and* all faces.**

6D Architect performs several calculations and displays the results at the bottom of the Marker and Face Normals dialog, to guide you in selecting the right normal values. These suggestions change depending on how many markers are selected, and where these markers are located on the tool:

Number of Markers Selected	Suggested Values Provided
1 marker	none
2 markers	coordinates of the centroid
3 markers	coordinates of the centroid, and coefficients of an imagined plane that the three markers would create.
4 or more markers	coordinates of the centroid

Table 11-9 Marker Information Provided By 6D Architect

Note **The centroid is the centre point of an imagined three dimensional volume created by the selected markers.**

You can use these suggested values when determining normals, but be sure to review and adjust the values as needed.

Note **A face normal must be perpendicular to its face. Individual marker normals, however, do not need to be perpendicular to the face that marker is assigned to.**

To Create a Normal for Individual Markers

1. In the **View** list, select **All Markers.**
2. In the table at the bottom of the dialog, press **Ctrl** and select three markers (the desired marker included).

   Below the table, the software displays the centroid and a plane equation associated with the selected markers. Use this information to determine the coordinates of the ideal normal for the desired marker.

Note **The first three coefficients of the plane equation are coordinates for a normal vector perpendicular to the imagined plane.**

3. Select a single marker (or if you want to assign the same normal to multiple markers, select them while pressing the **Ctrl** key).
4. Click **Edit Selected**.
5. In the coordinate fields provided, enter the values that you determined in step 2 and adjust the values if necessary. Your changes are displayed graphically, to help you with these edits.
6. Click **OK**.

To Create Normals for Faces

1. In the **View** list, select the appropriate face**.**
2. In the table at the bottom of the dialog, press **Ctrl** and select three markers that are assigned to the face.

   Below the table, the software displays the centroid and a plane equation associated with the selected markers. Use this information to determine the coordinates of the ideal normal for the desired marker.

Note **The first three coefficients listed for the imagined plane can be used as coordinates for a vector perpendicular to the imagined plane.**

3. Click **Face Normals**.
4. From the drop-down list, select the appropriate face.
5. In the coordinate fields provided, enter the values that you determined in step 2 and adjust the values if necessary. Your changes are displayed graphically, to help you with these edits.
6. Click **OK**.
7. (Optional) If you want to restore all of the normals and tolerances to the default settings, click **Undo**.
8. Click **Next**. The Characterization Completion dialog opens.

To Set Tracking Tolerances

1. In the **View** list, select **All Markers.**
2. In the table at the bottom of the dialog, select a marker.
3. Click **Edit Tolerances**. The following dialog opens.

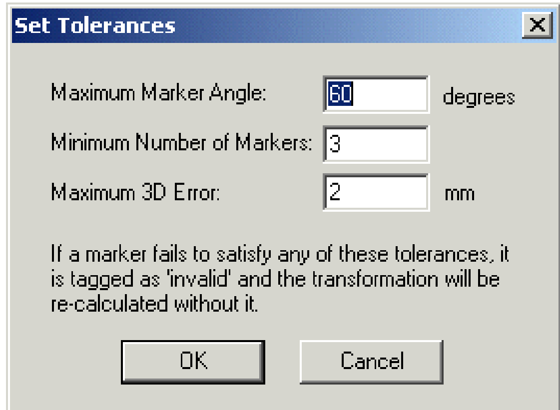


Figure 11-14 Set Tolerances Dialog

4. Complete the fields provided:

Field	Action
Maximum Marker Angle	Enter the maximum angle that a marker normal can be pointed *away* from the Position Sensor. Any marker turned away more than this value will not be used to compute a tool transformation.
Minimum Number of Markers	Enter the minimum number of markers that must be counted as present in the measurement volume, before the system produces a transformation for the tool.
Maximum 3D Error	Enter the maximum distance between where the marker is observed by the system and is expected to be in the tool's SROM Image File. If a marker exceeds this value, it is not used to compute a tool transformation.

Table 11-10 Tolerance Fields

5. Click **OK**.

6. Click **Next**. The Characterization Completion dialog opens.

11.10 Complete the Tool Characterization

6D Architect allows you to save all the ROM Creation Wizard selections that you've made, in case you want to repeat the characterization process for similar tools using similar parameters. Remember that although you can use the same wizard selections for similar tools, you will still need to perform separate and unique data collections for each.

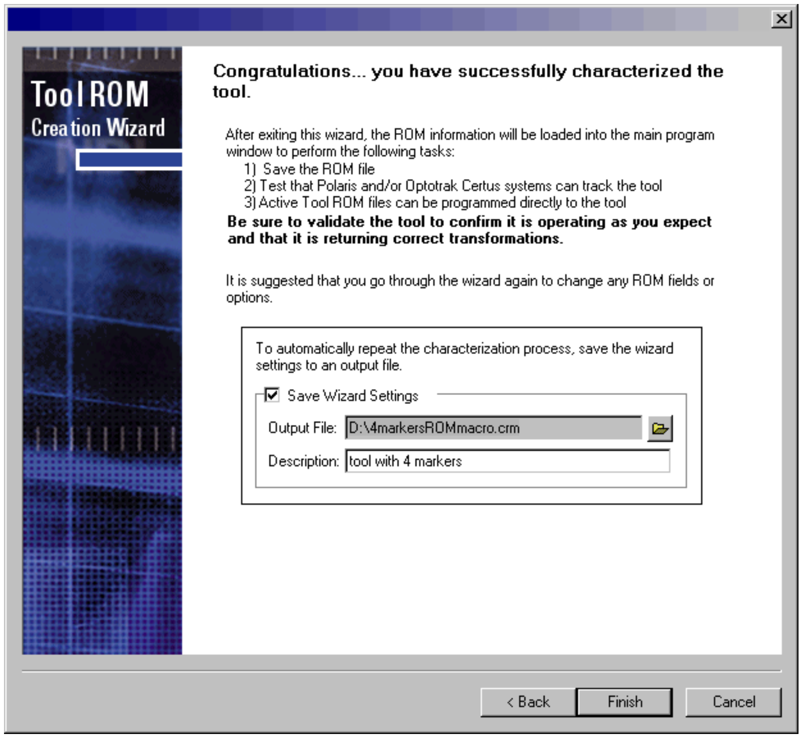


Figure 11-15 Characterization Completion Dialog

1. Choose **Save Wizard Settings**.
2. In the **Output File** field, browse to a location and enter a name by clicking .
3. In the **Description** field, enter an identifying description for this wizard session.
4. Click **Finish**. The software saves your settings in a ROM Characterization Macro (.crm) file.

Note **The saved parameter file contains the tool's characterization information. When applied to subsequent tools, software will automatically increase the sequence number.**

Once the characterization is complete, the wizard closes and a graphical representation of the tool will be loaded into the main window. The tool parameters are loaded in the ROM section of the main window.

For more information about the main window, see "Exploring 6D Architect Main Window" on page 6.

11.11 What Is Next?

After you have created and saved the SROM Image File (.ROM) file, you test the SROM Image File to ensure that the Polaris System can track the tool correctly. For more instructions, see "Testing Tools" on page 161.

12 Rigid Bodies: Characterizing with Previously Collected Data

Characterizing a rigid body through previously collected data files allows you to perform the characterization using full raw data files, raw data files, or 3D data files.

Note **These sections also apply to characterizing a rigid body with previously collected CSV files; all screens and procedures are the same.**

This section explains the following steps:

1. Start the Wizard
2. Select the Data File
3. Specify the Build Parameters
4. Align the Rigid Body's Local Coordinate System
5. Add Marker Normals
6. Complete the Characterization
7. What Is Next?

12.1 Start the Wizard

Before continuing, you must open the wizard and indicate that you are characterizing an rigid body with previously collected data. For instructions, see "Rigid Body Characterization: The First Step" on page 18.

Once this step is completed, you can continue the characterization process.

12.2 Select the Data File

The Rigid Body Creation Wizard's second screen allows you to select the data file that you want to use to characterize the rigid body.

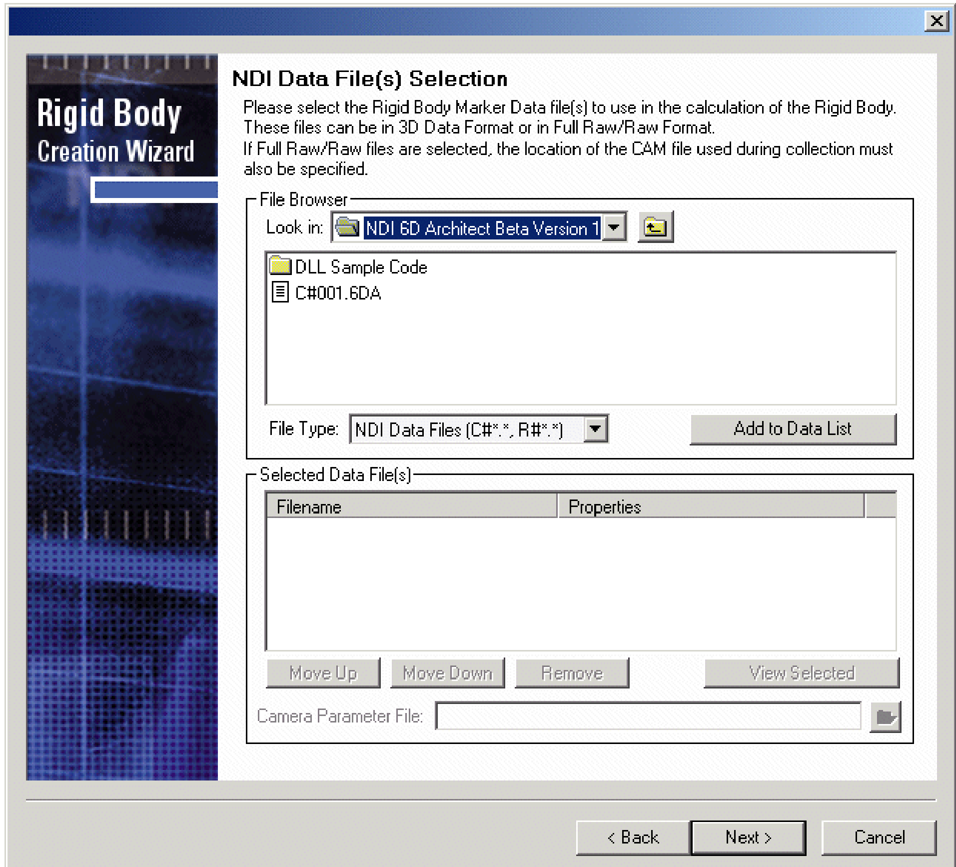


Figure 12-1 NDI Data File(s) Selection

Note **The process for creating a rigid body using a CSV file is the same as the creating a rigid body with an NDI data file. The only difference is in the type of file used.**

1. In the File Browser section, enter the name of the file, or click  to browse to its location and select it manually.
2. Click **Add to Data List**.
3. (Optional) If you want to view the data file before moving on to the next step, click **View**.
4. When you have finished reviewing the data, click **Exit** to return to the Data File(s) Selection dialog.
5. Click **Next**. The Build Parameters dialog opens.

12.3 Specify the Build Parameters

Once you have collected data about each marker, you must specify which markers are part of the Rigid Body, and whether or not these markers are sequential.

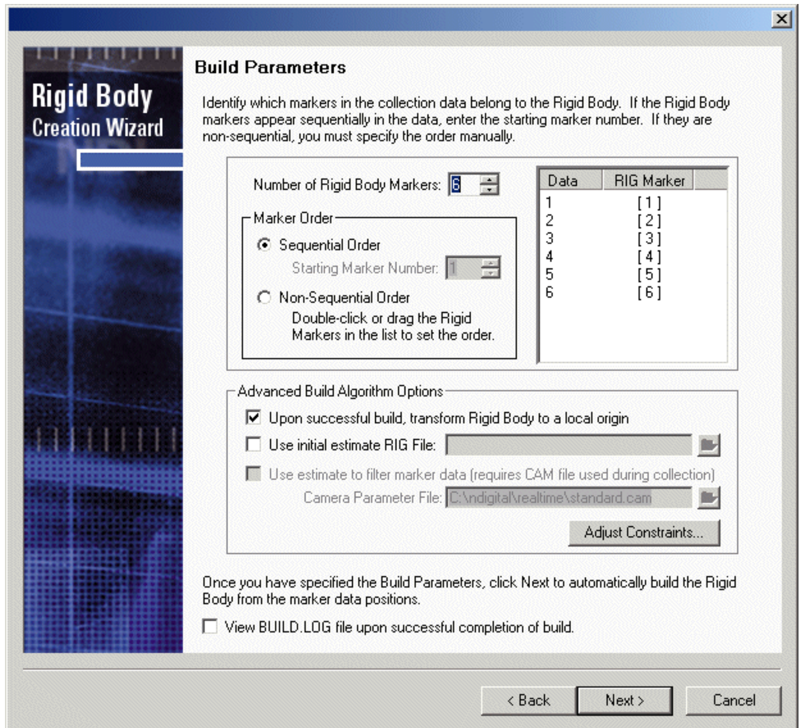


Figure 12-2 Build Parameters Dialog

1. In the **Number of Rigid Body Markers** field, select the number of markers on your Rigid Body.

   Keep in mind that the system has collected data about all markers found, as shown in the Data column on the right-hand side of the dialog. The **Number of Rigid Body Markers** field allows you to indicate whether all markers found are in fact part of the rigid body.

2. You must indicate which marker is associated with what collected marker data. Complete the Marker Order section by choosing either **Sequential Order**, or **Non-Sequential Order**.

   - If you choose sequential order, you must specify the **Starting Marker Number**.
   - If you choose non-sequential order, you must drag and drop the entries in the list on the right, to assign each marker to its correct data.

3. Complete the Advance Build Algorithm Options section:

Option	Action
Upon successful build, transform Rigid Body to a local origin	It is recommended to choose this option.
Use initial estimate RIG File	If you want to use an existing Rigid Body file as an estimate, select the file from the directory.

Table 12-1 Advanced Build Options

4. (Optional) Define the algorithm constraints further by clicking Adjust Constraints. For more information about this function, see “Algorithm Constraints” on page 167.

Note **The algorithm constraints are advanced option parameters. If the intended result is not fully understood, do not perform this step and simply continue with the default settings.**

5. Click **Next**. The Rigid Body Alignment dialog opens.

12.4 Align the Rigid Body’s Local Coordinate System

Before any measurement system can calculate the position and rotation of your rigid body, you will need to assign it a local coordinate system. Assigning a rigid body a local coordinate system is an important step in producing accurate transformations.

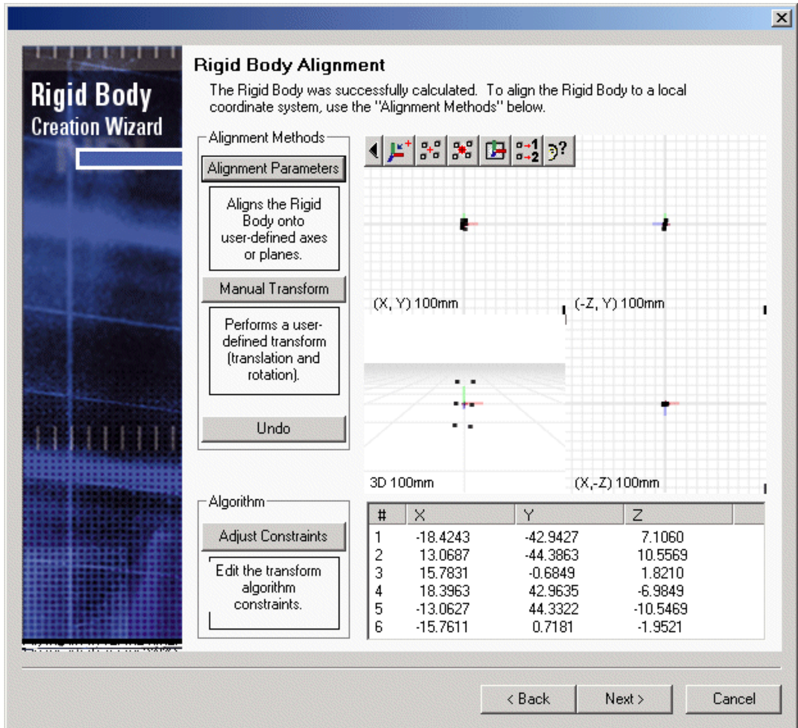


Figure 12-3 Rigid Body Alignment Dialog

To Assign a Local Coordinate System Using Alignment Parameters

1. Click **Alignment Parameters**. The following dialog appears:

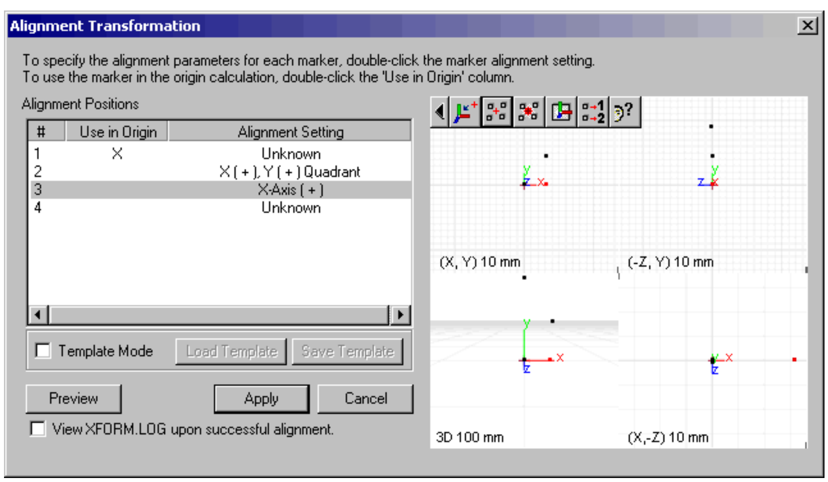


Figure 12-4 Alignment Transformation Dialog

2. To assign a marker as the origin of the local coordinate system, double-click that marker’s entry under **Use in Origin**. If you select more than one marker as the origin of

your rigid body , 6D Architect will place the origin at the geometric centre of these markers.

3. To place a marker onto an axis, right-click the marker's entry under **Alignment Setting**. Use the list that appears to constrain the marker to be on any positive or negative x, y, or z-axis.
4. To place a marker onto a plane of the local coordinate system, double-click that marker's entry under **Alignment Setting**. Use the list that appears to constrain the marker to any quadrant of any plane.
5. Click **Preview** to view the changes that you make in the marker window. This can help you visualize the chosen orientations and help trouble-shoot any conflicting alignments you may have accidentally made.
6. When you are finished, return to the Rigid Body Alignment dialog:
   - If you want to return to the original position and orientation, click **Cancel**.
   - If you are satisfied with the alignment parameters, click **Apply**.
7. (Optional) Define the algorithm constraints further by clicking Adjust Constraints. For more information about this function, see "Algorithm Constraints" on page 167.

Note **The algorithm constraints are advanced option parameters. If the intended result is not fully understood, do not perform this step and simply continue with the default settings.**

8. Click **Next**. The Rigid Body Normals dialog opens.

To Assign a Local Coordinate System Manually

1. Click **Manual Transform**. The following dialog appears:

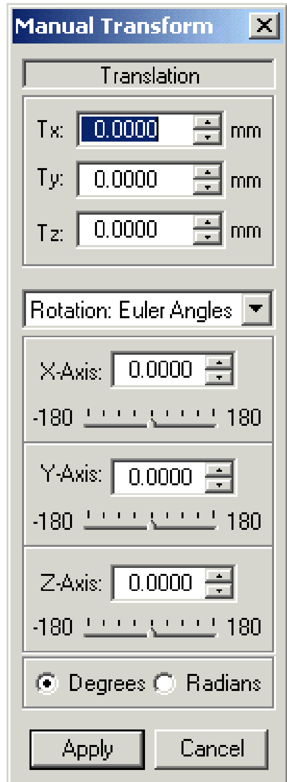


Figure 12-5 Manual Transform Dialog

2. Adjust each field incrementally to change the position and orientation of the local coordinate system. Each change is reflected in the graphic representations in the Rigid Body Alignment dialog.
   - Use the **Tx**, **Ty**, and **Tz** fields to translate the origin of the local coordinate system.
   - If you are using the Euler Angles (as indicated in the drop-down list), use the **X-Axis**, **Y-Axis**, and **Z-Axis** fields to rotate the local coordinate system.

Note **Rotation Matrix and Quaternion are advanced options. The easiest and most intuitive way to rotate coordinate systems is to use Euler Angles.**

3. Once you are satisfied, click **Apply** to save your changes.
4. (Optional) Define the algorithm constraints further by clicking Adjust Constraints. For more information about this function, see "Algorithm Constraints" on page 167.

Note **The algorithm constraints are advanced option parameters. If the intended result is not fully understood, do not perform this step and simply continue with the default settings.**

5. Click **Next**. The Rigid Body Normals dialog opens.

12.5 Add Marker Normals

For each marker on the rigid body, you will need to assign a vector that defines which way they are facing. The system uses this vector, or *normal*, to help determine where the marker is pointing in the measurement volume. With this information, the system can determine if the marker is pointing at an angle that no longer provides accurate data.

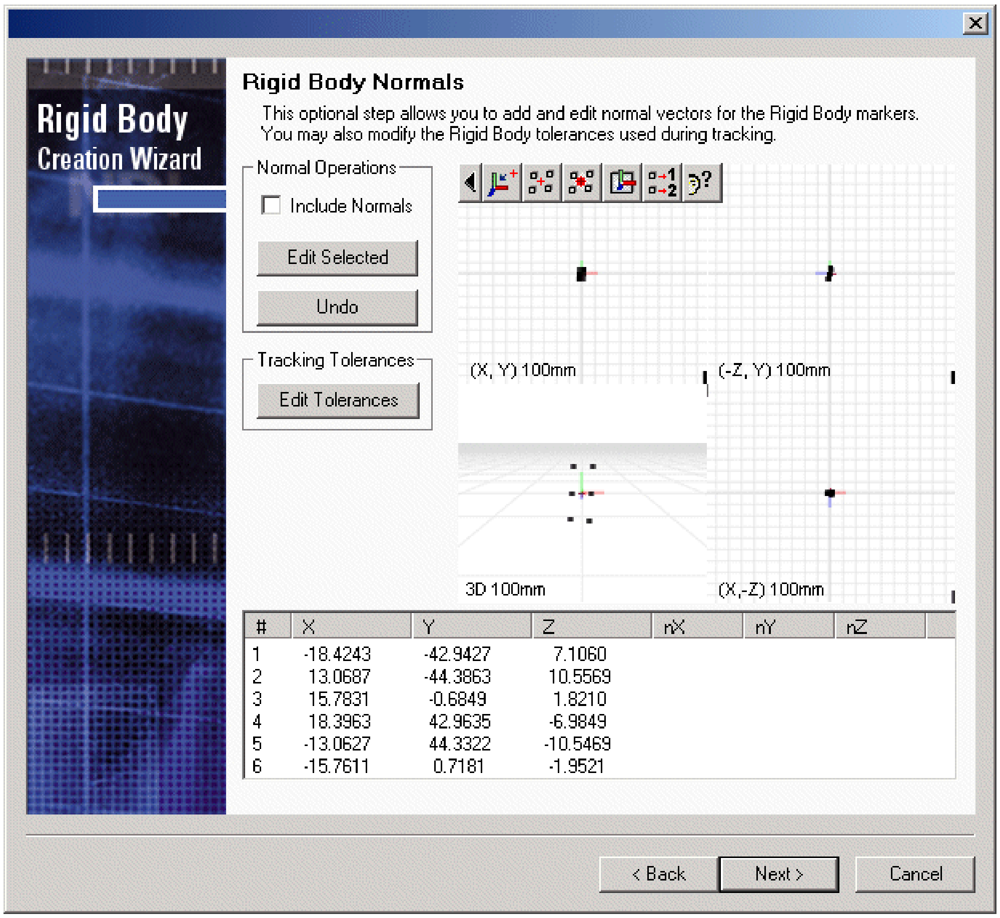


Figure 12-6 Rigid Body Normals Dialog

About Determining Normals

Note **You need to assign normals to all markers.**

6D Architect performs several calculations and displays the results at the bottom of the Rigid Body Normals dialog, to guide you in selecting the right normal values. These suggestions change depending on how many markers are selected, and where these markers are located on the tool:

Number of Markers Selected	Suggested Values Provided
1 marker	none
2 markers	coordinates of the centroid
3 markers	coordinates of the centroid, and coefficients of an imagined plane that the three markers would create.
4 or more markers	coordinates of the centroid

Table 12-2 Marker Information Provided By 6D Architect

Note **The centroid is the centre point of an imagined three dimensional volume created by the selected markers.**

You can use these suggested values when determining normals, but be sure to review and adjust the values as needed.

To Create a Normal for Individual Markers

1. Enable **Include Normals**. The software attempt to calculate normals for each marker on the rigid body.
2. In the table at the bottom of the dialog, press **Ctrl** and select three markers (the desired marker included).

   Below the table, the software displays the centroid and a plane equation associated with the selected markers. Use this information to determine the coordinates of the ideal normal for the desired marker.

Note **The first three coefficients of the plane equation are coordinates for a normal vector perpendicular to the imagined plane.**

3. Select a single marker (or if you want to assign the same normal to multiple markers, select them while pressing the **Ctrl** key).
4. Click **Edit Selected**.
5. In the coordinate fields provided, enter the values that you determined in step 2 and adjust the values if necessary. Your changes are displayed graphically, to help you with these edits.

6. Click **OK**.
7. Click **Next**. The Characterization Completion dialog opens.

To Edit Tolerances

1. Enable **Include Normals**.
2. In the table at the bottom of the dialog, select a marker.
3. Click **Edit Tolerances**. The following dialog appears:

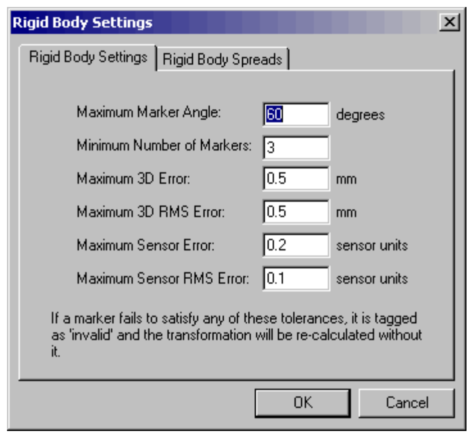


Figure 12-7 Set Tolerances Dialog

4. In the **Rigid Body Settings** tab, complete the fields provided:

Field	Action
Maximum Marker Angle	Enter the maximum angle that a marker normal can be pointed *away* from the Position Sensor. Any marker turned away more than this value will not be used to compute a rigid body's transformation.
Minimum Number of Markers	Enter the minimum number of markers that must be counted as present in the measurement volume, before the system produces a transformation for the rigid body.
Maximum 3D Error	Enter the maximum distance between where the marker is observed by the system and is expected to be in the Rigid Body file. If a marker exceeds this value, it is not used to compute a rigid body's transformation.

Table 12-3 Rigid Body Settings

Field	Action
Maximum 3D RMS Error	Enter the maximum 3D RMS error that a measurement system will accept. If the calculated 3D RMS error of a transformation is greater than the value specified in this field, the transformation will be tagged as missing.
Maximum Sensor Error	Enter the maximum calculated sensor position for each Optotrak sensor to the nominal sensor positions which are based on the rigid body file. If the difference for a particular marker/sensor pair is greater than the specified Maximum Sensor Error, then that pair's data will be tagged as bad and the transformation will be re-determined.
Maximum Sensor RMS Error	Enter the maximum sensor RMS error that the measurement system will accept. This parameter is considered a final check to determine if you will capture data for this frame or not. If the calculated sensor RMS error is greater than the value specified in this field the transformation will be tagged as missing.

Table 12-3 Rigid Body Settings

5. Click the Rigid Body Spread tab:

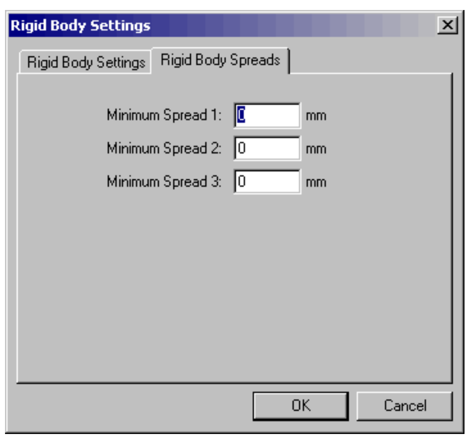


Figure 12-8 Rigid Body Spread Tab

6. Enter the three minimum spreads.

7. Click **OK**.

8. Click **Next**. The Characterization Completion dialog opens.

12.6 Complete the Characterization

6D Architect allows you to save all the Rigid Body Creation Wizard selections that you have made, in case you want to repeat the characterization process for additional rigid bodies using similar parameters. Remember that although you can use the same wizard selections for similar rigid bodies, you will still need to perform separate and unique data collections for each.

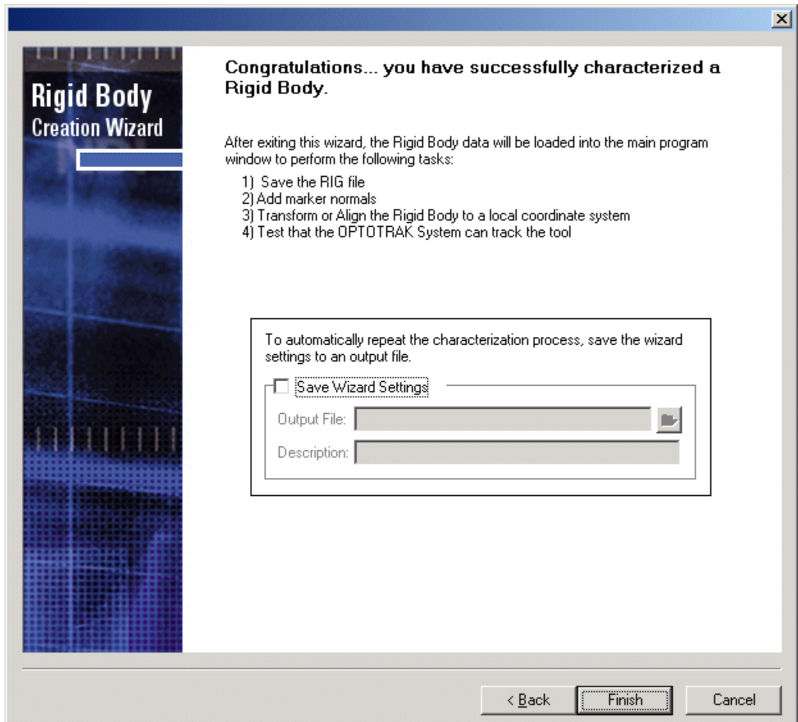


Figure 12-9 Characterization Completion Dialog

1. Choose **Save Wizard Settings**.
2. In the **Output File** field, browse to a location and enter a name by clicking .
3. In the **Description** field, enter an identifying description for this wizard session.
4. Click **Finish**. The software saves your settings in a .RIG Characterization (.crg) file.

Note **Your saved parameter file contains your rigid body's characterization information. When applied to subsequent rigid bodies, the software will automatically increase the sequence number.**

Once the characterization is complete, the wizard closes and a graphical representation of the rigid body will be loaded into the main window.

For more information about the 6D Architect main window, see "Exploring 6D Architect Main Window" on page 6.

12.7 What Is Next?

After you have created and saved the Rigid Body (.RIG) file, you must test it to ensure that the Optotrak System can track the rigid body correctly. For more instructions, see "Testing Rigid Bodies" on page 163.

13 Rigid Bodies: Characterizing with an Optotrak System

The following sections walk you through each window of the Rigid Body Creation Wizard, to help you characterize a rigid body with an Optotrak System.

This section explains the following steps:

1. Start the Wizard
2. Enter the Collection Settings
3. Save Parameters
4. Collect Marker Data
5. Specify the Build Parameters
6. Align the Rigid Body's Local Coordinate System
7. Add Marker Normals
8. Complete the Characterization
9. What Is Next?

13.1 Start the Wizard

Before continuing, you must open the wizard and indicate that you are characterizing a rigid body with an Optotrak System. For instructions, see "Rigid Body Characterization: The First Step" on page 18.

Once this step is completed, 6D Architect connects to the Optotrak System. Once this is complete, you can continue the characterization process.

13.2 Enter the Collection Settings

The Rigid Body Creation Wizard's second screen is the Collection Settings dialog. Collection settings tell 6D Architect the collection time, the marker power, and the tracking frame frequency of your Optotrak System.

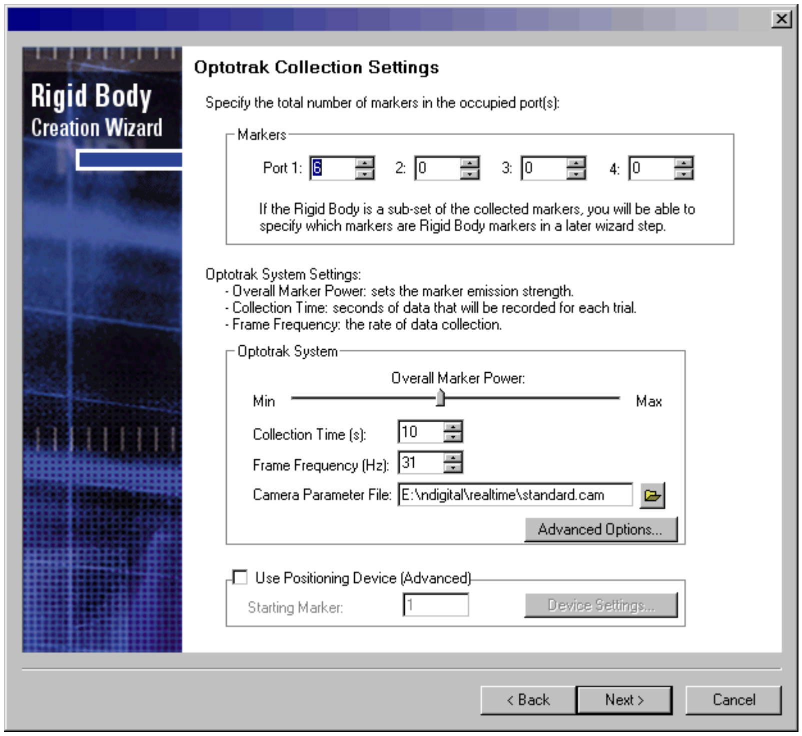


Figure 13-1 Collection Settings Dialog

Note **Figure 12-1 shows the Collections Settings dialog that applies to an Optotrak 3020 System. Optotrak Certus Systems have three ports, not four.**

To Enter the Collection Settings

1. In the Markers section, enter the total number of markers that are connected to each port. These totals may include markers that are not part of the rigid body.

2. Complete the Optotrak System section:

Field/Option	Action
Overall Marker Power	Adjust the slide to indicate the intensity of light emitted from the markers.
Collection Time	Enter the length of the intended collection time in seconds.
Frame Frequency	Enter the frame frequency (in Hz) used during data collection.
Camera Parameter File	Select the camera parameter file to be used to calculate 3D and 6D data.

Table 13-1 Collection Settings

3. (Optional) If you are using a positioning device, refer to *TB-10029*.

4. (Optional) If you want to apply advanced system settings, see "Optotrak System Settings" on page 173.

5. Click **Next**. The Save Parameters dialog opens

13.3 Save Parameters

6D Architect saves the collected data in a .dat file, and stores it in the location indicated by this Save Parameters dialog. When you have finished the entire characterization process, you can open and review the .dat file's contents.

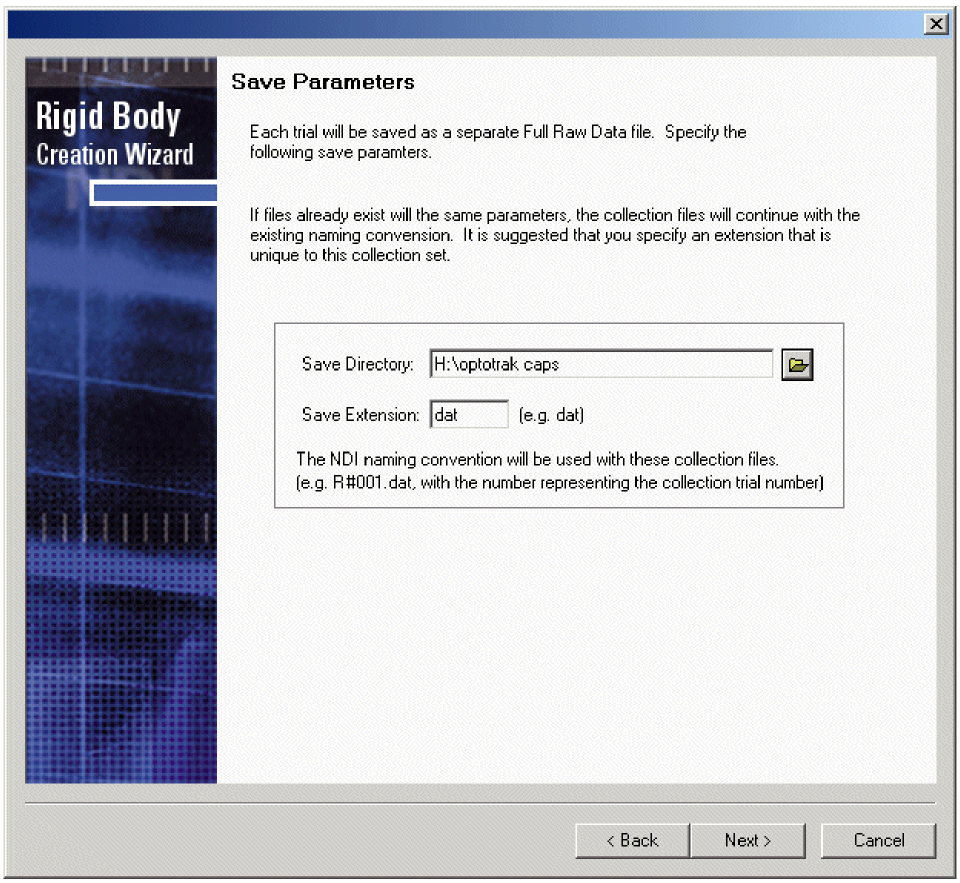


Figure 13-2 Save Parameters Dialog

1. In the **Save Directory** field, enter the desired directory location, or browse to a location by clicking .

2. In the **Save File Name** field, enter the name for the data collection.

3. In the **Save Extension field**, enter **dat**.

4. Click **Next**. The Data Collection dialog opens.

13.4 Collect Marker Data

The Data Collection dialog allows you to view the rigid body within the measurement volume during each data collection trial frame.

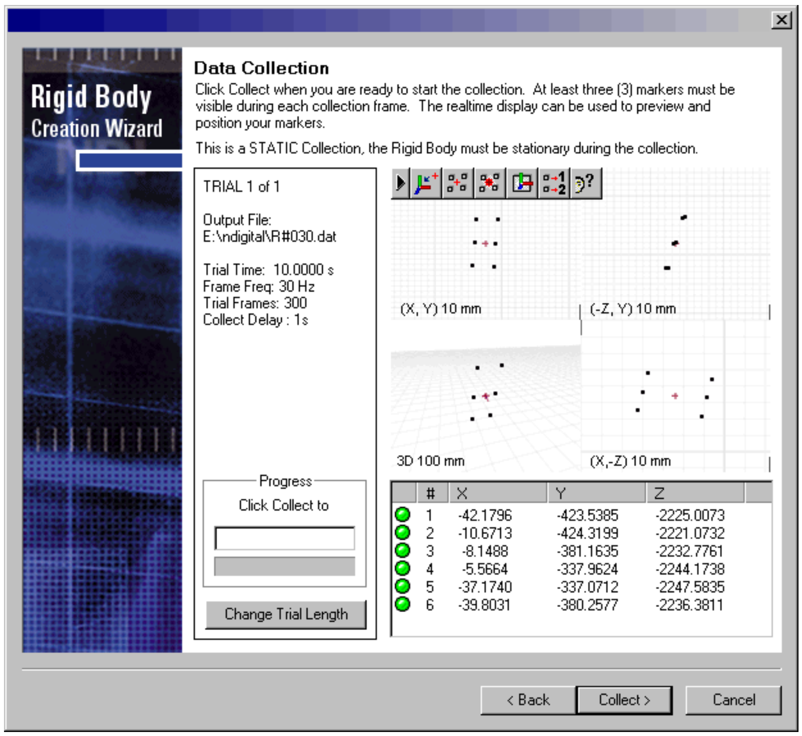


Figure 13-3 Data Collection Dialog

1. (Optional) If you want to edit the collection trial length, click **Change Trial Length** and enter the new value. Increasing the trial length may increase the accuracy of the software's data interpretation.
2. Position the rigid body within the measurement volume. If you are unsure whether or not your markers are visible, observe the marker status in the bottom right of the window:

Marker Colour	Marker Status
Green	The marker is visible to the system and is inside the measurement volume.
Red	The marker is not visible to the system.

Table 13-2: Marker Status

Each coloured circle corresponds to a marker detected in the measurement volume. Keep in mind that these represent all markers in the measurement volume; your rigid body's markers may be only a small subset of these. You will make these distinctions later.

3. Click **Collect**. The system proceeds to collect data about each marker's position. The Current Collection Status Dialog opens, displaying this collected information:

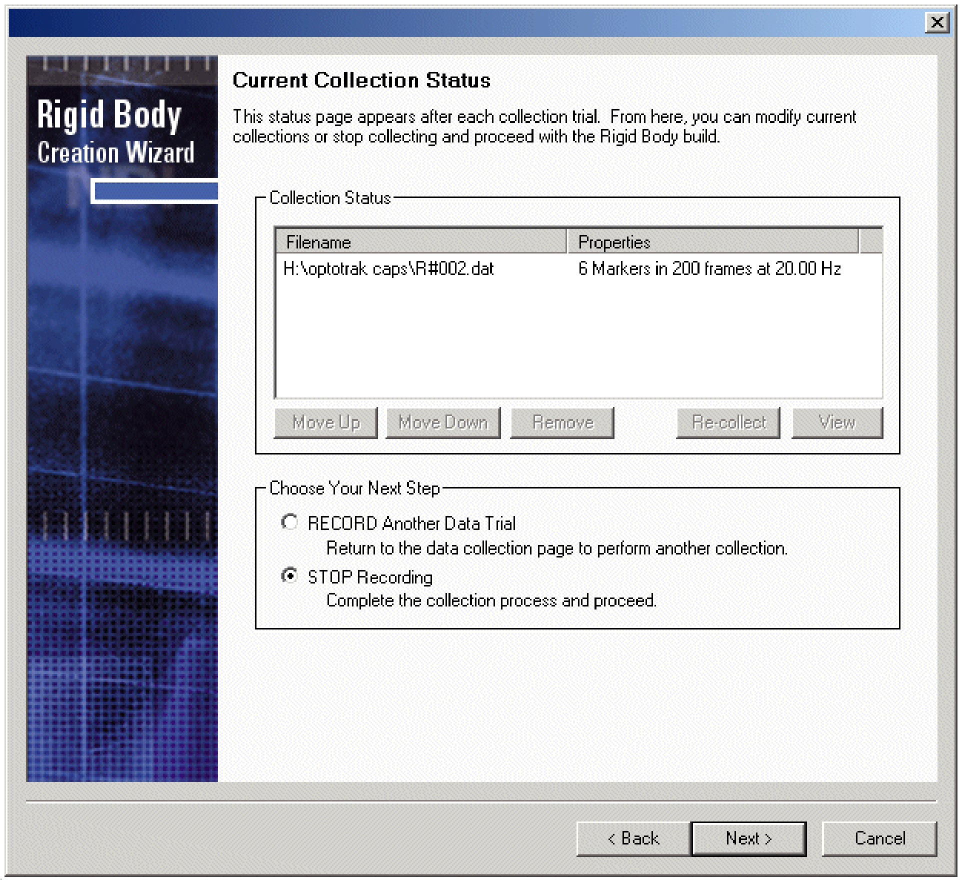


Figure 13-4 Collection Status Dialog

4. Select the newly-created .dat file from the C**ollection Status** list.

5. Click **View**. The .dat file results open for viewing.

6. When you have finished reviewing the results, click **Close**.

7. (Optional) If you want to collect another data trial, select **RECORD Another Data Trial**. Select the file that you wish to overwrite, then click **Re-collect**. You will be returned to the Data Collection dialog to begin the process again.

8. When you are satisfied with the data collection, select **STOP Recording**.

9. (Optional) If you want to view the log file for the collection, choose **View BUILD.LOG upon successful completion of build**.

10. Click **Next**. The Build Parameters dialog opens.

13.5 Specify the Build Parameters

Once you have collected data about each marker, you must specify which markers are part of the Rigid Body, and whether or not these markers are sequential.

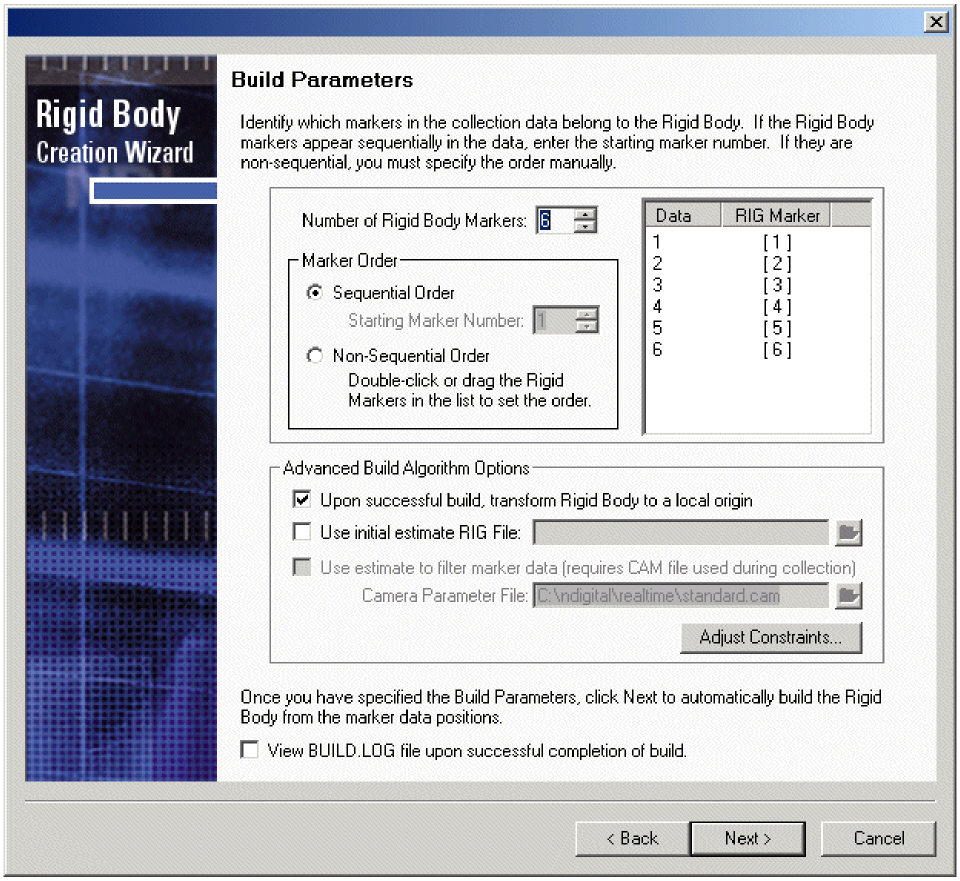


Figure 13-5 Build Parameters Dialog

1. In the **Number of Rigid Body Markers** field, select the number of markers on your Rigid Body.

   The system has collected data about all markers found, as shown in the Data column on the right-hand side of the dialog. The **Number of Rigid Body Markers** field allows you to indicate whether all markers found are in fact part of the rigid body.

2. You must indicate which marker is associated with what collected marker data. Complete the Marker Order section by choosing either **Sequential Order**, or **Non-Sequential Order**.
   - If you choose sequential order, you must specify the **Starting Marker Number**.
   - If you choose non-sequential order, you must drag and drop the entries in the list on the right, to assign each marker to its correct data.
3. Complete the Advance Build Algorithm Options section:

Option	Action
Upon successful build, transform Rigid Body to a local origin	It is recommended to choose this option if you are unsure how to align the rigid body. Otherwise, disable this option.
Use initial estimate RIG File	If you want to use an existing Rigid Body file as an estimate, select the file from the directory.

Table 13-3 Advanced Build Options

4. (Optional) Define the algorithm constraints further by clicking Adjust Constraints. For more information about this function, see "Algorithm Constraints" on page 167.

Note **The algorithm constraints are advanced option parameters. If the intended result is not fully understood, do not perform this step and simply continue with the default settings.**

5. Click **Next**. The Rigid Body Alignment dialog opens.

13.6 Align the Rigid Body's Local Coordinate System

Before any measurement system can calculate the position and rotation of your rigid body, you will need to assign the rigid body a local coordinate system. Assigning the rigid body a local coordinate system is an important step in producing accurate transformations.

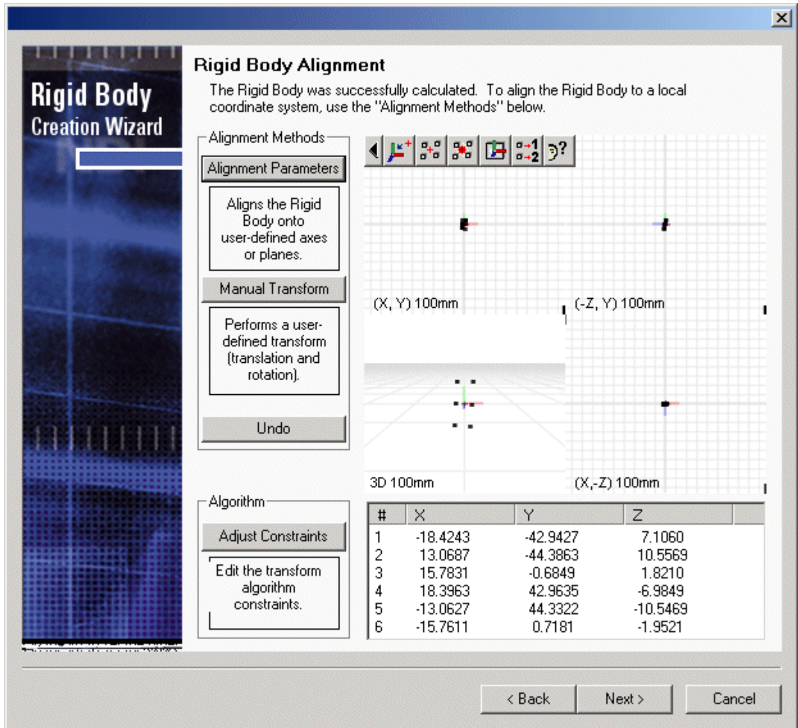


Figure 13-6 Rigid Body Alignment Dialog

To Assign a Local Coordinate System Using Alignment Parameters

1. Click **Alignment Parameters**. The following dialog appears:

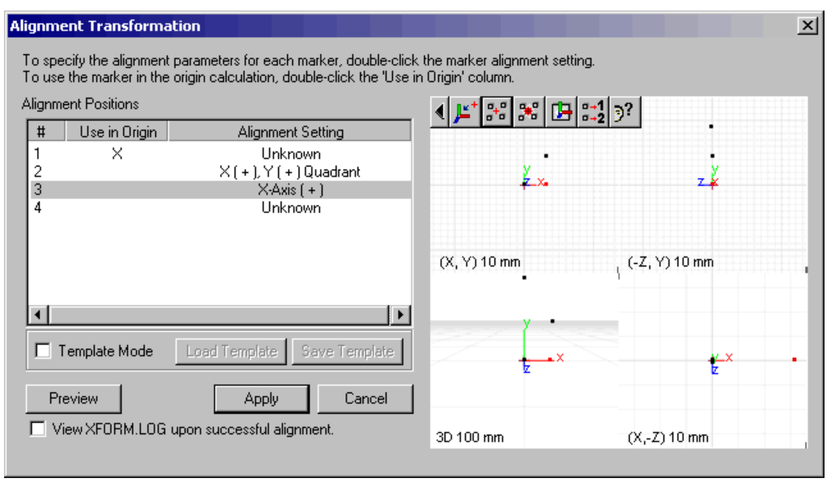


Figure 13-7 Alignment Transformation Dialog

2. To assign a marker as the origin of the local coordinate system, double-click that marker's entry under **Use in Origin**. If you select more than one marker as the origin of

your rigid body , 6D Architect will place the origin at the geometric centre of these markers.

3. To place a marker onto an axis, right-click the marker's entry under **Alignment Setting**. Use the list that appears to constrain the marker to be on any positive or negative x, y, or x axis.
4. To place a marker onto a plane of the local coordinate system, double-click that marker's entry under **Alignment Setting**. Use the list that appears to constrain the marker to any quadrant of any plane.
5. Click **Preview** to view the changes that you make in the marker window. This can help you visualize the chosen orientations and help trouble-shoot any conflicting alignments you may have accidentally made.
6. When you are finished, return to the Rigid Body Alignment dialog:
   - If you want to return to the original position and orientation, click **Cancel**.
   - If you are satisfied with the alignment parameters, click **Apply**.
7. (Optional) Define the algorithm constraints further by clicking Adjust Constraints. For more information about this function, see "Algorithm Constraints" on page 167.

Note **The algorithm constraints are advanced option parameters. If the intended result is not fully understood, do not perform this step and continue with the default settings.**

8. Click **Next**. The Rigid Body Normals dialog opens.

To Assign a Local Coordinate System Manually

1. Click **Manual Transform**. The following dialog appears:

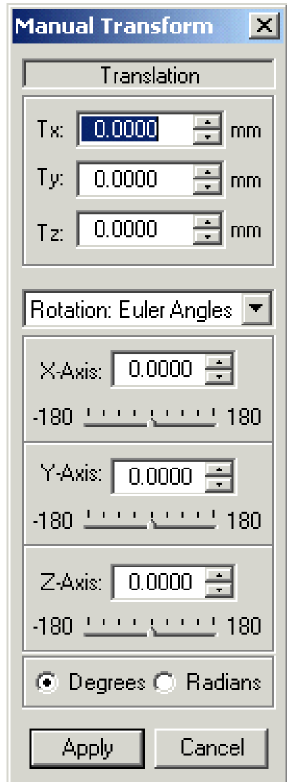


Figure 13-8 Manual Transform Dialog

2. Adjust each field incrementally to change the position and orientation of the local coordinate system. Each change is reflected in the graphic representations in the Rigid Body Alignment dialog.
   - Use the **Tx**, **Ty**, and **Tz** fields to translate the origin of the local coordinate system.
   - If you are using the Euler Angles (as indicated in the drop-down list), use the **X-Axis**, **Y-Axis**, and **Z-Axis** fields to rotate the local coordinate system.

Note **Rotation Matrix and Quaternion are advanced options. The easiest and most intuitive way to rotate coordinate systems is to use Euler Angles.**

3. Once you are satisfied, click **Apply** to save your changes.
4. (Optional) Define the algorithm constraints further by clicking Adjust Constraints. For more information about this function, see "Algorithm Constraints" on page 167.

Note **The algorithm constraints are advanced option parameters. If the intended result is not fully understood, do not perform this step and simply continue with the default settings.**

5. Click **Next**. The Rigid Body Normals dialog opens.

13.7 Add Marker Normals

For each marker on the rigid body, you will need to assign a vector that defines which way they are facing. The system uses this vector, or *normal*, to help determine where the marker is pointing in the measurement volume. With this information, the system can determine if the marker is pointing at an angle that no longer provides accurate data.

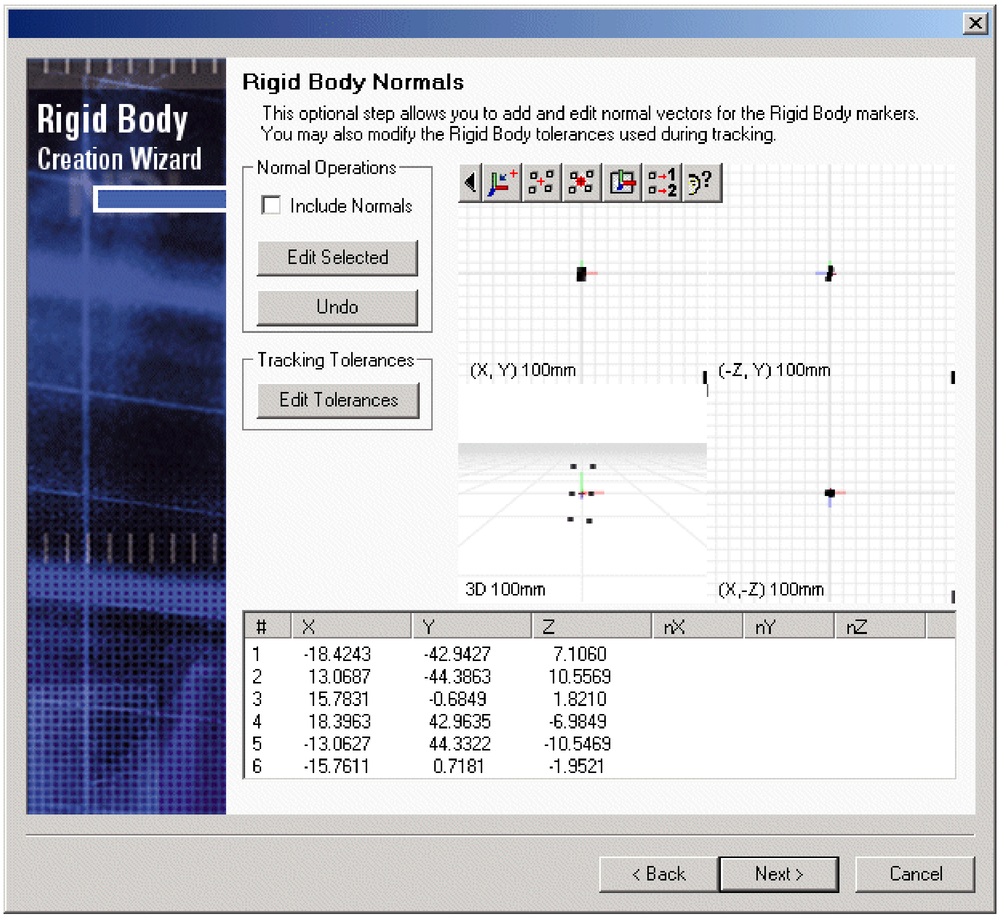


Figure 13-9 Rigid Body Normals Dialog

About Determining Normals

Note **You need to assign normals to all markers.**

6D Architect performs several calculations and displays the results at the bottom of the Rigid Body Normals dialog, to guide you in selecting the right normal values. These suggestions change depending on how many markers are selected, and where these markers are located on the tool:

Number of Markers Selected	Suggested Values Provided
1 marker	none
2 markers	coordinates of the centroid
3 markers	coordinates of the centroid, and coefficients of an imagined plane that the three markers would create.
4 or more markers	coordinates of the centroid

Table 13-4 Marker Information Provided By 6D Architect

Note **The centroid is the centre point of an imagined three dimensional volume created by the selected markers.**

You can use these suggested values when determining normals, but be sure to review and adjust the values as needed.

To Create a Normal for Individual Markers

1. Enable **Include Normals**. The software attempt to calculate normals for each marker on the rigid body.
2. In the table at the bottom of the dialog, press **Ctrl** and select three markers (the desired marker included).

   Below the table, the software displays the centroid and a plane equation associated with the selected markers. Use this information to determine the coordinates of the ideal normal for the desired marker.

Note **The first three coefficients of the plane equation are coordinates for a normal vector perpendicular to the imagined plane.**

3. Select a single marker (or if you want to assign the same normal to multiple markers, select them while pressing the **Ctrl** key).
4. Click **Edit Selected**.
5. In the coordinate fields provided, enter the values that you determined in step 2 and adjust the values if necessary. Your changes are displayed graphically, to help you with these edits.

6. Click **OK**.
7. Click **Next**. The Characterization Completion dialog opens.

To Set Tracking Tolerances

1. Enable **Include Normals**.
2. In the table at the bottom of the dialog, select a marker.
3. Click **Edit Tolerances**. The following dialog appears:

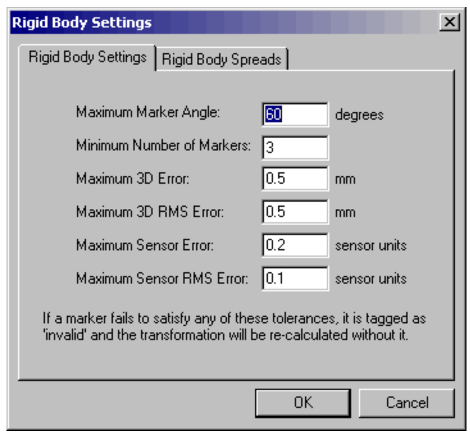


Figure 13-10 Set Tolerances Dialog

4. In the **Rigid Body Settings** tab, complete the fields provided:

Field	Action
Maximum Marker Angle	Enter the maximum angle that a marker normal can be pointed *away* from the Position Sensor. Any marker turned away more than this value will not be used to compute a rigid body transformation.
Minimum Number of Markers	Enter the minimum number of markers that must be counted as present in the measurement volume, before the system produces a transformation for the rigid body.
Maximum 3D Error	Enter the maximum distance between where the marker is observed by the system and is expected to be in the Rigid Body file. If a marker exceeds this value, it is not used to compute a rigid body's transformation.

Table 13-5 Rigid Body Settings

Field	Action
Maximum 3D RMS Error	Enter the maximum 3D RMS error that a measurement system will accept. If the calculated 3D RMS error of a transformation is greater than the value specified in this field, the transformation will be tagged as missing.
Maximum Sensor Error	Enter the maximum calculated sensor position for each Optotrak sensor to the nominal sensor positions which are based on the rigid body file. If the difference for a particular marker/sensor pair is greater than the specified Maximum Sensor Error, then that pair's data will be tagged as bad and the transformation will be re-determined.
Maximum Sensor RMS Error	Enter the maximum sensor RMS error that the measurement system will accept. This parameter is considered a final check to determine if you will capture data for this frame or not. If the calculated sensor RMS error is greater than the value specified in this field the transformation will be tagged as missing.

Table 13-5 Rigid Body Settings

5. Click the Rigid Body Spread tab:

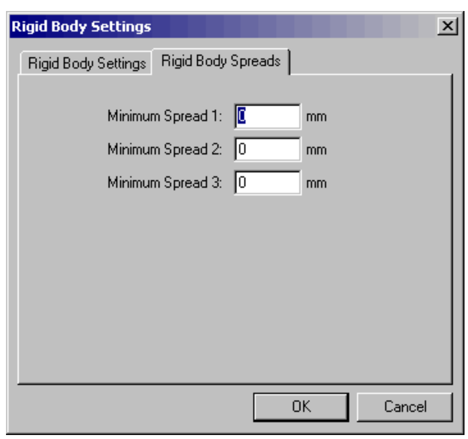


Figure 13-11 Rigid Body Spread Tab

6. Enter the three minimum spread values.
7. Click **OK**.
8. Click **Next**. The Characterization Completion dialog opens.

13.8 Complete the Characterization

6D Architect allows you to save all the Rigid Body Creation Wizard selections that you have made, in case you want to repeat the characterization process for additional rigid bodies using similar parameters. However, remember that although you can use the same wizard selections for similar rigid bodies, you will still need to perform separate and unique data collections for each.

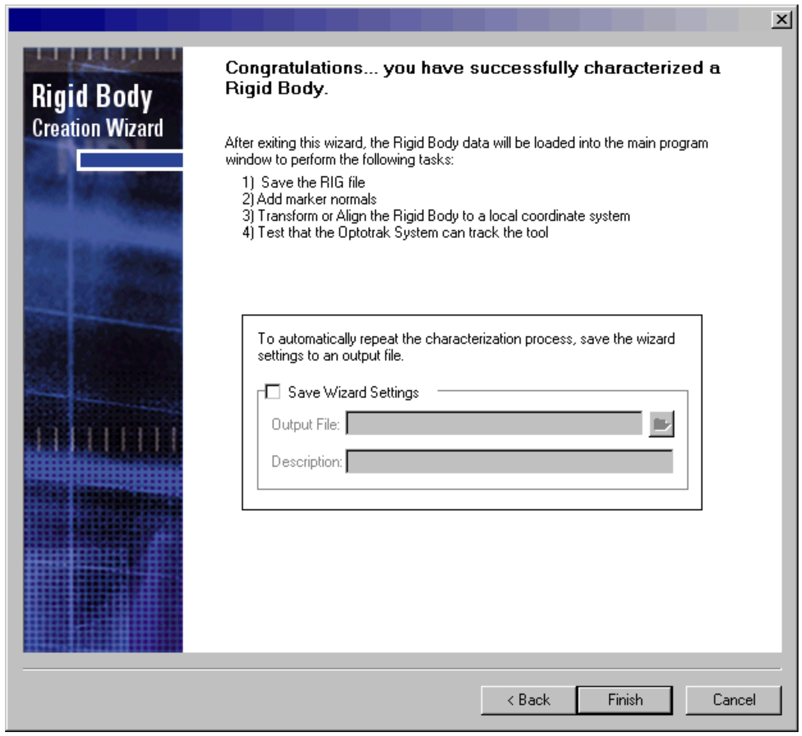


Figure 13-12 Characterization Completion Dialog

1. Choose **Save Wizard Settings**.
2. In the **Output File** field, browse to a location and enter a name by clicking .
3. In the **Description** field, enter an identifying description for this wizard session.
4. Click **Finish**. The software saves your settings in a .RIG Characterization (.crg) file.

Note **Your saved parameter file contains your rigid body's characterization information. When applied to subsequent rigid bodies, the software will automatically increase the sequence number.**

Once the characterization is complete, the wizard closes and a graphical representation of the rigid body will be loaded into the main window.

For more information about the 6D Architect main window, see "Exploring 6D Architect Main Window" on page 6.

13.9 What Is Next?

After you have created and saved the Rigid Body (.RIG) file, you must test it to ensure that the Optotrak System can track the rigid body correctly. For more instructions, see "Testing Rigid Bodies" on page 163.

Appendix A Pivot Alignment

Using the Pivot Alignment Wizard, you can calculate the location of a tool or rigid body's tool-tip. You can add this information to an existing SROM Image File or Rigid Body file. You can also use this information to transform a local coordinate system so that its origin is located at the tool-tip.

This section explains the following topics:

- Transforming Local Coordinate Systems: SROM Image Files
- Transforming Local Coordinate Systems: Rigid Body Files

A.1 Transforming Local Coordinate Systems: SROM Image Files

1. Open the SROM Image File that you wish to adjust.
2. From the main window menu, select **Transform** > **Using Pivot Algorithm**. The Pivot Alignment Wizard dialog opens:

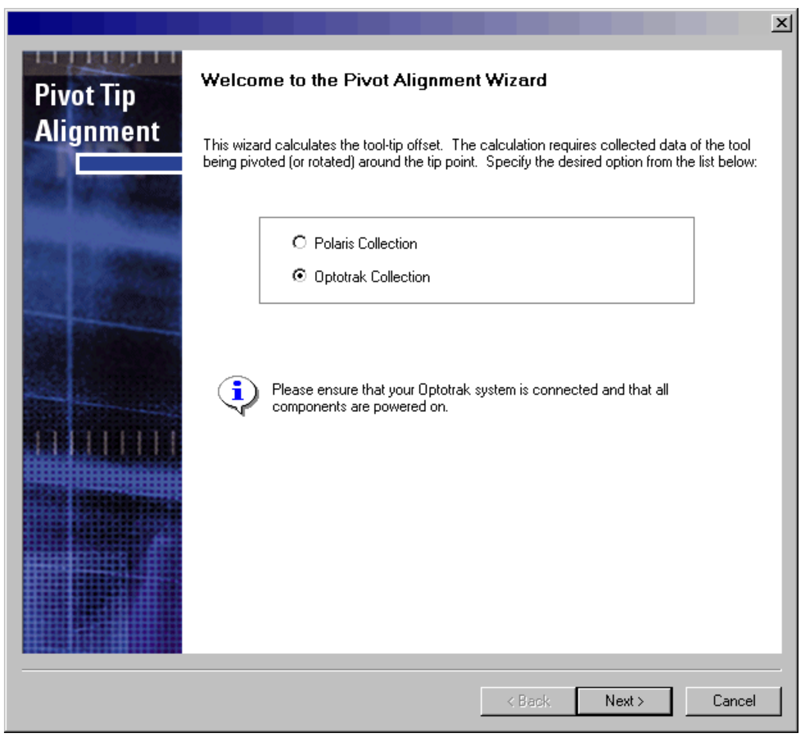


Figure A-1 Pivot Alignment Wizard Dialog

3. Select the NDI measurement you are using to characterize the tool. In Figure B-1, Optotrak Collection is selected.
4. Click **Next**. The Collection Settings dialog opens.

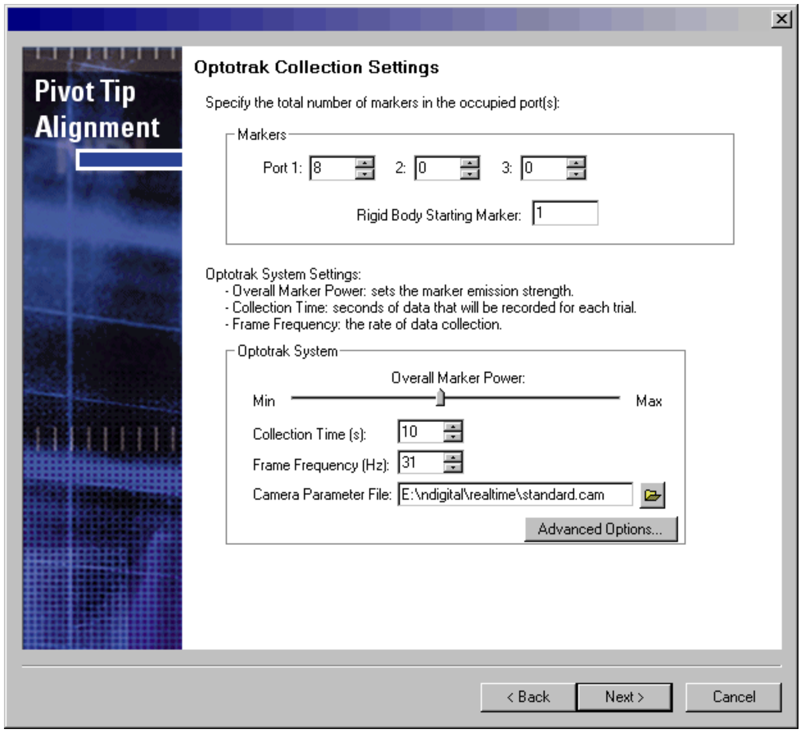


Figure A-2 Collection Settings Dialog

5. Complete the collection settings. For more instructions on how to complete this dialog, refer to one of the following sections:

   - If you are characterizing with an Optotrak System, see "Enter the Collection Settings" on page 44.
   - If you are characterizing with a Polaris System, see "Enter Collection Settings" on page 21.

Note **Figure B-2 describes the collection settings for an Optotrak Certus System. This screen differs for Polaris Systems.**

Note **If an SROM Image File is saved with an incorrect marker type, you may not be able to access the desired port while pivoting the tool. If this occurs, edit the marker type using the characterization wizard and save the new SROM Image File information.**

6. Click **Next**. The Pivot Rotation Data dialog appears.

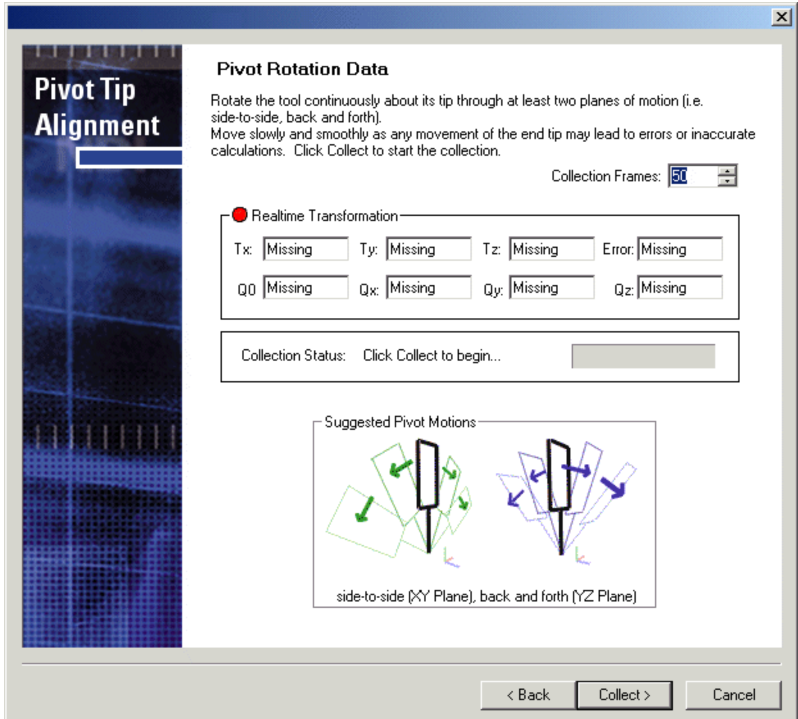


Figure A-3 Pivot Rotation Data Dialog

7. Position your tool in the measurement volume with its tool-tip placed on a fixed point. Ensure that all markers are visible and that the **Realtime Transformation** light is green.

Note **It is very important that the tool-tip remain stationary while the tool is being rotated.**

8. Click **Collect** to begin the data collection trial.

9. As the measurement system collects the data, continuously rotate the tool back and forth and side to side, with its tool-tip remaining stationary at the fixed point. The Pivot Results dialog opens, displaying the calculated results of the tool-tip data:

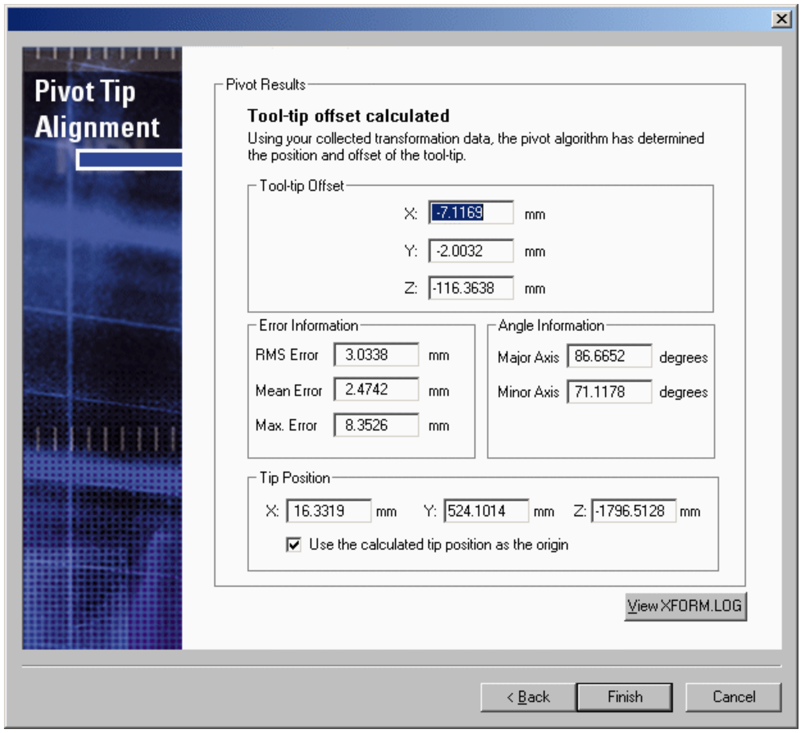


Figure A-4 Pivot Results Dialog

The Pivot Results dialog provides the following information, based on the data collection trial results:

Results	Description
Tool-tip Offset	The x, y, z position of the tool-tip in relation to the origin of the tool's local coordinate system.
Error Information	The RMS, Mean, and Max. Errors in millimeters.
Angle Information	Maximum and minimum angles in degrees of the pivot you measured.
Tip Position	The x, y, z position of the tip in the relation to the global coordinate system.

Table A-1 Pivot Results

10. (Optional) If you want to transform the origin of the tool's local coordinate system so that it is located at the tool-tip, enable **Use the calculated tip as the origin**.

11. (Optional) If you want to view the report generated from the calculation, click **View XFORM.LOG**.

12. Click **Finish**. The Pivot Alignment Wizard closes and you are returned to the 6D Architect main window.

A.2 Transforming Local Coordinate Systems: Rigid Body Files

1. Open the Rigid Body file that you wish to adjust.
2. From the main window menu, select **Transform** > **Using Pivot Algorithm**. The Pivot Alignment Wizard dialog opens:

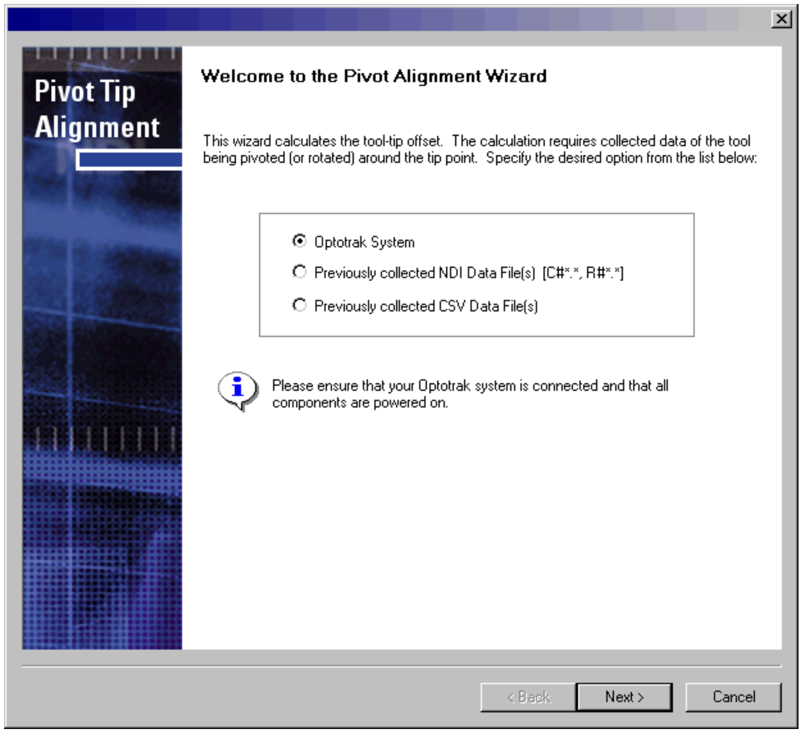


Figure A-5 Pivot Alignment Wizard Dialog

3. Select one of the following collection methods:

Collection Method	Description
Optotrak Collection	Selecting Optotrak Collection allows you to perform data collections with an Optotrak System. This collected data will be used to characterize the rigid body.
Previously Collected NDI Data File	Previously collected data files can also be used to characterize a rigid body.
Previously Collected CSV File	CSV (Comma Separated Values) Files are text files containing a header and 3D marker data. This file must have been previously collected with an Optotrak System.

Table A-1 Data Collection Methods

Note NDI recommends that you collect current tool-tip data using the Optotrak Collection option, as previously collected information may be out of date. The nature of the tool-tip may change should any physical change or damage occur to the rigid body. It is best practice to re-collect data and apply the most recent calculations to the Rigid Body file.

4. Click **Next**.
   - If you have selected Optotrak Collection, the Collection Settings dialog appears. Go to step 5.
   - If you have selected either Previously Collected NDI Data File or Previously Collected CSV File, the Pivot Results dialog appears. Go directly to step 10.
5. In the Collection Settings dialog, complete the fields and options provided:

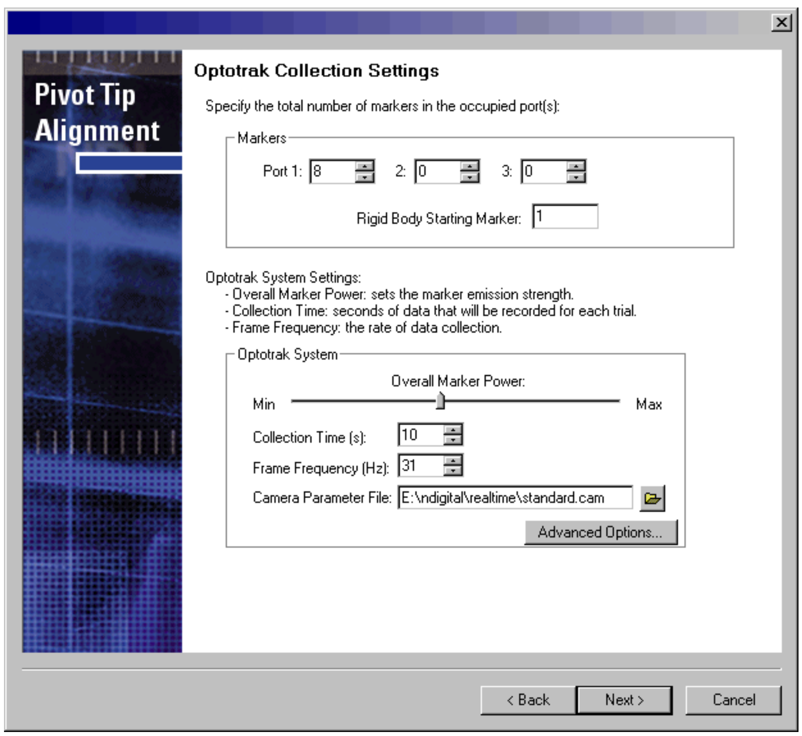


Figure A-6 Collection Settings Dialog

For instructions on how to complete these fields, see "Enter the Collection Settings" on page 137.

6. Click **Next**. The Pivot Rotation Data dialog appears:

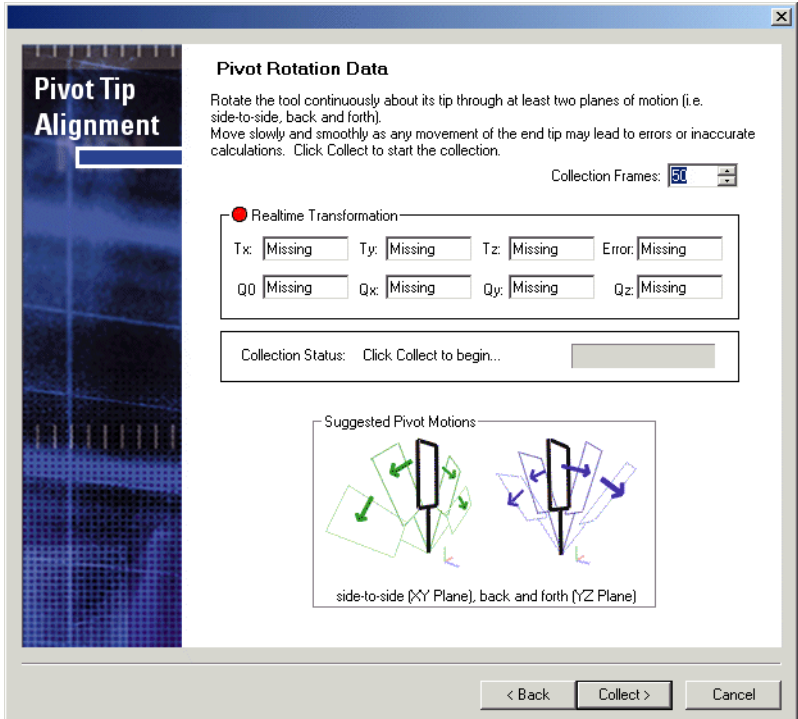


Figure A-7 Pivot Rotation Data Dialog

7. Position your tool in the measurement volume with its tool-tip placed on a fixed point. Ensure that all markers are visible and that the **Realtime Transformation** light is green.

Note **It is very important that the tool-tip remain stationary while the tool is being rotated.**

8. Click **Collect** to begin the data collection trial.
9. As the measurement system collects the data, continuously rotate the tool back and forth and side to side, with its tool-tip remaining stationary at the fixed point.
10. The Pivot Results dialog opens, displaying the calculated results of the tool-tip data:

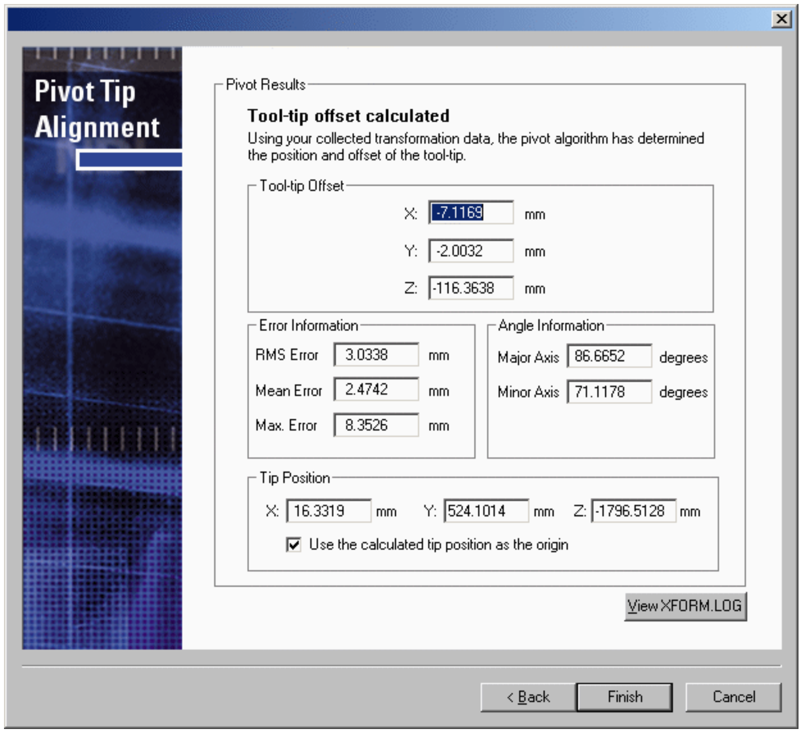


Figure A-8 Pivot Results Dialog

The Pivot Results dialog provides the following information, based on the data collection trial results:

Results	Description
Tool-tip Offset	The x, y, z position of the tool-tip in relation to the origin of the rigid body's local coordinate system.
Error Information	The RMS, Mean, and Max. Errors in millimeters.
Angle Information	Maximum and minimum angles in degrees of the pivot you measured.
Tip Position	The x, y, z position of the tip in the relation to the global coordinate system.

Table A-2 Pivot Results

11. (Optional) If you want to transform the origin of the rigid body's local coordinate system so that it is located at the tool-tip, enable **Use the calculated tip as the origin**.

12. (Optional) If you want to view the report generated from the calculation, click **View XFORM.LOG**.

13. Click **Finish**. The Pivot Alignment Wizard closes and you are returned to the 6D Architect main window.

Appendix B Testing Tools

Tools should be tested to make sure that they have been characterized correctly.

1. If you do not have a .ROM file already open, from the main window menu, select **File** > **Open**.

2. Make sure that your measurement system is properly connected to your computer, and that the tool you plan to test is ready for use and placed in the measurement volume.

3. Select **Tool Operations** > **Test Tool**. The Test Tool dialog appears:

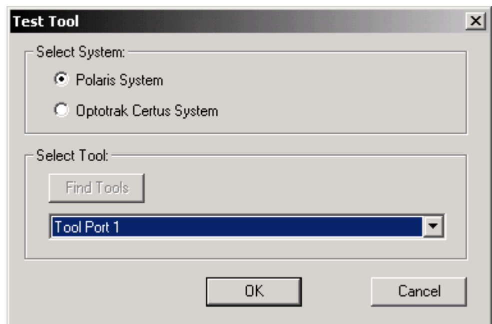


Figure B-1 Test Tool Dialog

Note **Figure A-1 shows testing a tool with a Polaris System. For more information about selecting tools with an Optotrak Certus System, see** **"Enter the Collection Settings" on page 44****.**

4. From the **Select System** list, choose the system you are testing the tool with.

5. Indicate where the tool is located:

   - If you are testing with a Polaris System, select the appropriate tool port from the drop down menu.
   - If you are testing with an Optotrak Certus System, click the **Find Tools** button. The system will check and report back which tools were found. Select the appropriate tool from the drop-down list.

Note **If you change the tools connected to the Optotrak System during this procedure, you must click the Find Tools button to refresh the list.**

6. Click **OK**. The Realtime Tracking Information dialog opens:

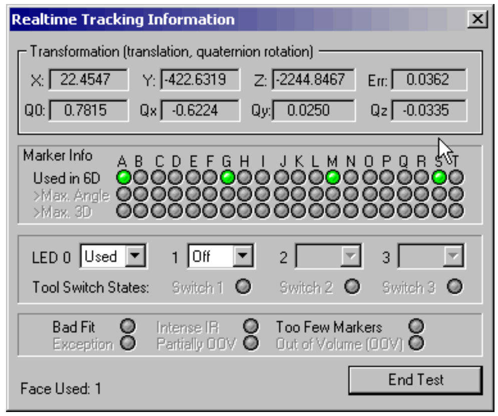


Figure B-2 Realtime Tracking Information Dialog

The software tests the SROM Image File by applying its parameters to the tool as the system tracks it in the measurement volume. You can view the results in realtime using this dialog, to help you evaluate the accuracy of the SROM Image File.

Note **Figure A-1 displays a Realtime Tracking Information dialog for an Optotrak Certus System. When using a Polaris System, this dialog has more options and fields enabled.**

7. Click **End Test** once you are finished testing.

Appendix C Testing Rigid Bodies

Rigid Bodies should be tested to make sure that they have been characterized correctly.

1. If you do not have a .RIG file already open, from the main window menu, select **File** > **Open**.
2. Make sure that your measurement system is properly connected to your computer, and that the rigid body you plan to test is ready for use and placed in the measurement volume.
3. Select **File** > **Test Rigid Body**. The Test Rigid Body Options dialog appears:

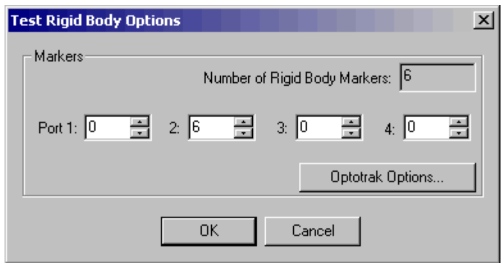


Figure C-1 Test Rigid Body Options Dialog

4. Enter the total number of rigid body markers that are connected to each port.
5. Click **OK**. The Test Rigid Body File dialog appears, displaying realtime tracking results.

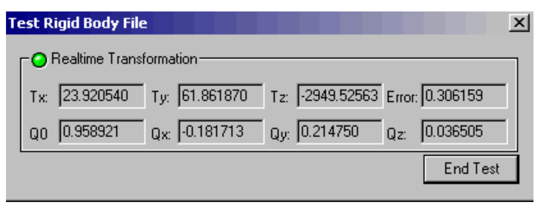


Figure C-2 Test Rigid Body File Dialog

The software tests the Rigid Body File by applying its parameters to the rigid body as the system tracks it in the measurement volume. You can view the results in realtime using this dialog, to help you evaluate the accuracy of the Rigid Body File.

6. Click **End Test** when you are finished testing.

Appendix D Unique Geometry

Wireless tools are not physically connected a measurement system; therefore, that system cannot directly read the tool's design information and recognize which marker is which on the tool's face. As such, wireless tools require unique geometry -- markers positioned in such a way that they cannot be misidentified when discovered in the measurement volume.

Note **See "*TB-0004, Revision 007: Unique Geometry Specifications for Polaris System Tools*" for information concerning geometry constraints.**

Use 6D Architect to test your tool design's unique geometry before you actually build the tool:

1. Create a tool design.
2. Produce engineering files.
3. Using these engineering files and 6D Architect, characterize each face of the tool. This will produce a .ROM file representing each face.
4. Using 6D Architect, convert each .ROM file into a .RIG file. This step is required, as 6D Architect can only test the geometry of .RIG files. Instructions are included in this appendix.
5. Using the 6D Architect Unique Geometry functionality, test each .RIG file to ensure that your tool has identifiable marker positions.
6. Manufacture the tool.

D.1 Characterizing Faces

For more information about how to characterize each face of your tool using engineering files, see "Active Tool: Characterizing with Engineering Data" on page 63.

D.2 Converting .ROM to .RIG

1. Once a .ROM file is loaded into the Marker Viewer window, click **File** > **Save As**.
   The Save As dialog opens.
2. From the **Save in** list, select the directory location for your .RIG file.
3. From the **Save as type** list, select **Rigid Body Files (*.rig)**.
4. Click **Save**.
   The NDI Rigid Body Information for the tool geometry file is now displayed.

D.3 Testing the Unique Geometry

Use 6D Architect to test your tool's unique geometry.

1. From the main window, click **Tool Operations** > **UG Test**.

   The Unique Geometry Test dialog appears.

2. In the **File Name** field, select the Rigid Body file that you wish to test from its stored directory location.
3. Click **Add to List** to add the .RIG file to the test list.
4. (Optional) If you wish to test all the faces of your tool together, repeat Steps 2 and 3 to add all the related .RIG files. The program will consider them together when calculating marker and segment distances.
5. Complete the following fields in the Options section:

Field	Definition
Segment Difference Tolerance	This field dictates how similar to each other segments can be. The default value is 2 mm; you can increase this value if you want to allow for manufacturing tolerances, but **do not decrease it**.
Minimum Segment Length	This field dictates how far each marker must be from all other markers. The default value is 5 mm; you can increase this value if you want to allow for manufacturing tolerances, but **do not decrease it**.
Angle Separation Tolerance	This field is only available if you are testing multiple .RIG files at once. It dictates how different the angle between two segments on one tool or face must be to two segments of a similar length on another tool or face.

Table D-1 UG Test Options

6. Click **Run**. Results of the test are displayed in the window on the right. If the test fails, an error message opens.

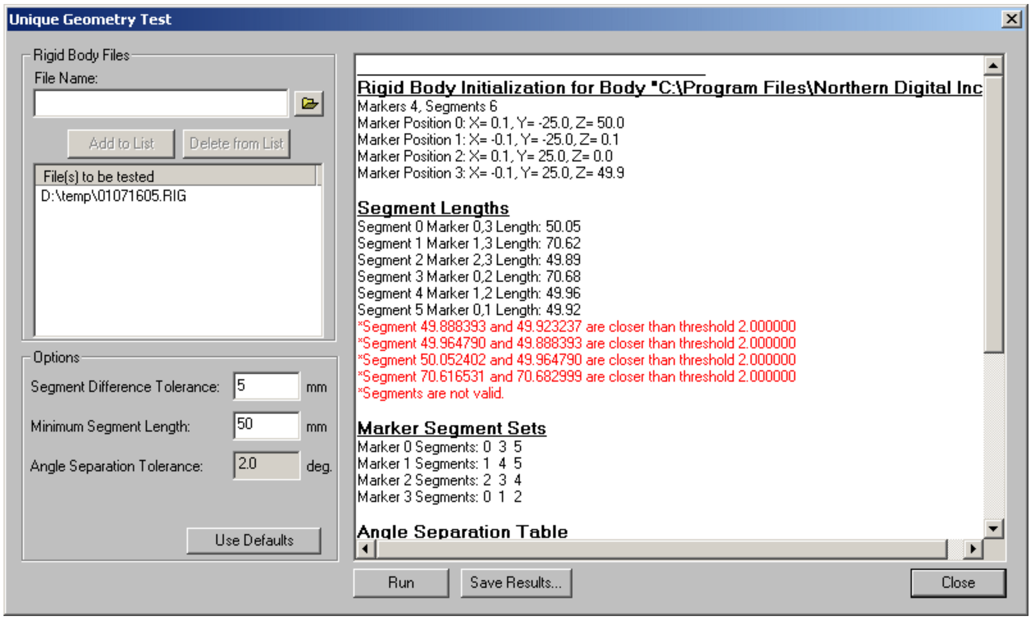


Figure D-1 Unique Geometry Test Dialog

7. (Optional) If you want to save the test into a .log file, click **Save Results**.
8. To exit the UG Test window, click **Close**.

Appendix E Algorithm Constraints

Defining the algorithm constraints includes setting build parameters, transformation parameters, and pivot parameters. The system uses these constraints when transforming a rigid body to a local coordinate system.

Note **The algorithm constraints are advanced option parameters. If the intended result is not fully understood, continue with the default settings.**

This section explains the following topics:

- About Build Parameters
- About Transformation Parameters
- About Pivot Parameters
- Defining Algorithm Constraints

E.1 About Build Parameters

Defining the build parameters sets the algorithm variables used when building a rigid body. These variables can be used for either a single dynamic view or a series of static view files.

Parameter	Description
Max. Marker Error	Specifies the maximum allowable error, in millimetres. If a marker in any view has a 3D error greater than the Max. Marker Error, that marker's data in that view is marked as 'bad' and a new estimate of the rigid body definition is computed.
Max. Overlay Error	Specifies the maximum allowable RMS error for overlay transformations, in millimeters. The Max Overlay Error is used to exclude an entire view's data from determination of an estimate for a rigid body.
Min. Marker Views	Specifies the minimum number of collection trials in which a marker is visible. If this number is met or exceeded, the tool characterization will fail.
Max. Overlay Iterations	Specifies the maximum number of overlay attempts the build algorithm should use to determine a new rigid body estimate.

Table E-1 Build Parameters

E.2 About Transformation Parameters

The transformation determination algorithm is an iterative algorithm, which requires some measure to decide when the algorithm is complete. Each time the algorithm generates a new estimate of the transformation, the ‘stopping’ criteria is checked to determine whether the algorithm is complete.

Parameter	Description
Yaw Accuracy	Specifies the threshold difference between successive iterations for the rotation about the x-axis. This threshold determines when sufficient convergence has been achieved.
Roll Accuracy	Specifies the threshold difference between successive iterations for the rotation about the z-axis. This threshold determines when sufficient convergence has been achieved.
Pitch Accuracy	Specifies the threshold difference between successive iterations for the rotation about the y-axis. This threshold determines when sufficient convergence has been achieved.
xt Accuracy	Specifies the threshold difference between successive iterations for the x component of the transformation. This threshold determines when sufficient convergence has been achieved.
yt Accuracy	Specifies the threshold difference between successive iterations for the y component of the transformation. This threshold determines when sufficient convergence has been achieved.
zt Accuracy	Specifies the threshold difference between successive iterations for the z component of the transformation. This threshold determines when sufficient convergence has been achieved.
Max. Coordinate Error	Specifies the maximum error, in millimeters, for between the defined x, y, or z coordinates and those discovered after a transformation has been applied.
Max. Chi Square Error	Specifies the maximum chi square error for the final estimate of the transformation.
Max. Average RMS Error	Specifies the maximum average RMS error for the final estimate of the transformation.

Table E-1 Transformation Parameters

Parameter	Description
Max. Iterations	Specifies the maximum number of iterations the transformation determination algorithm should perform.

Table E-1 Transformation Parameters

E.3 About Pivot Parameters

A Rigid Body transformation is determined for each pivot algorithm frame of data. The Max. QRMS Error parameter is used to exclude an entire frame's data from the pivot algorithm. If the RMS Error for the transformation is greater than the specified QRMS Error, that frame of data is ignored in the rest of the pivot calculations.

E.4 Defining Algorithm Constraints

1. From the main window menu, select **Settings** > **Algorithm Constraints**.
   The Algorithm Constraints dialog opens.

Note **If you are adjusting the algorithm constraints through the ROM Creation or the Rigid Body Creation Wizard, you do not need to perform step 1.**

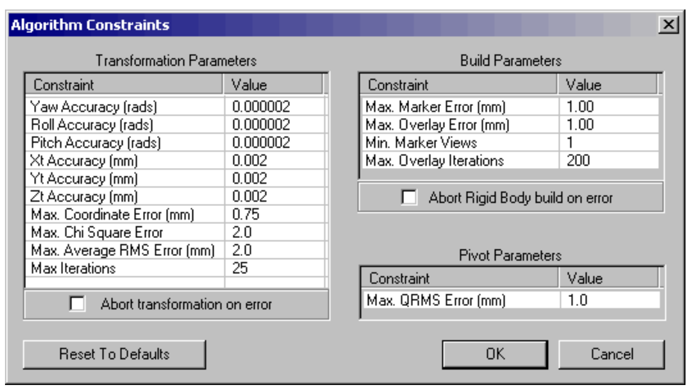


Figure E-1 Algorithm Constraints Dialog

Note **The Abort on Error option allows you to check against algorithm constraints. If any values do not meet their algorithm constraints, the rigid body calculation returns as failed. If you do not choose Abort on Error, the rigid body calculation will proceed regardless of the returned values.**

2. Double-click on any of the values to change their parameters.

3. Click **OK**.

Appendix F Polaris/Polaris Accedo System Settings

This section describes the various advanced system settings available for Polaris Systems and Polaris Accedo Systems.

Note **These settings are advanced features. If you are unsure of the intended result, continue with 6D Architect's default settings.**

1. From the main window, select **Settings** > **Polaris**.

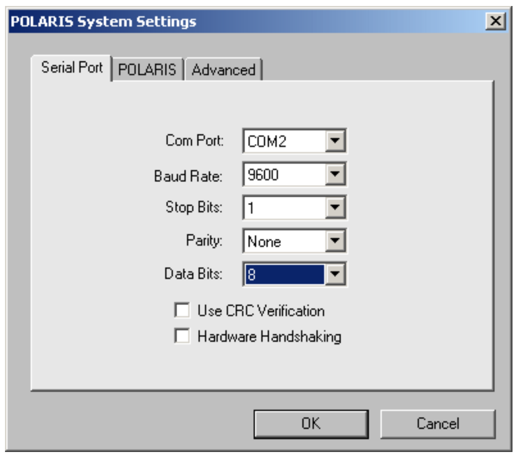


Figure F-1 System Settings Dialog

2. Click the **Serial Port** tab.

3. Define the following parameters:

Field/Option	Action
Com Port	Select the host computer port that the Polaris System uses to communicate with the host computer.
Baud Rate	Enter the baud rate for the communication between the Polaris and your host computer.
Stop Bits	Enter the number of stop bits you require between units of transmission. NDI recommends that you do not change the default value of 1.
Parity	Enter the number of parity bits that mark a unit of transmission.

Table F-1 Serial Port Settings

Field/Option	Action
Data Bits	Enter the number of data bits that make up a unit of transmission. NDI recommends that you do not change the default value of 8.
CRC Verification	Enable this option if you want all commands and responses to go through Cyclic Redundancy Checks.
Hardware Handshaking	Enable this option if you want hardware handshaking.

Table F-1 Serial Port Settings

4. Click the **Polaris** tab.

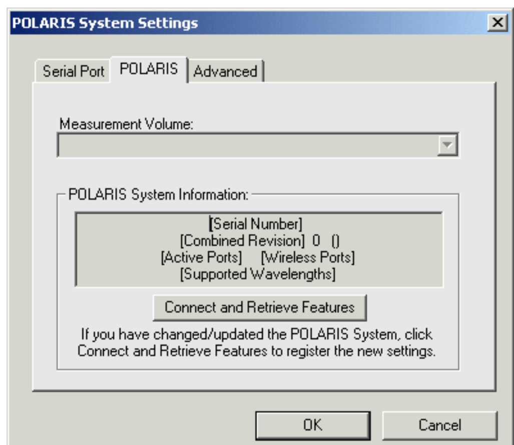


Figure F-2 Polaris Tab

5. Click **Connect and Retrieve Features**. 6D Architect connects to the Polaris System and retrieves the system specifications. The following dialog opens:

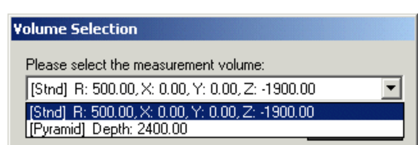


Figure F-3 Volume Selection Dialog

6. From the drop-down list, select the appropriate measurement volume type.
7. Click **OK.** The Volume Selection dialog closes and the measurement volume is added to the System Settings dialog. This list can be edited once the system settings are changed and the dialog is closed.
8. Click the **Advanced** tab.

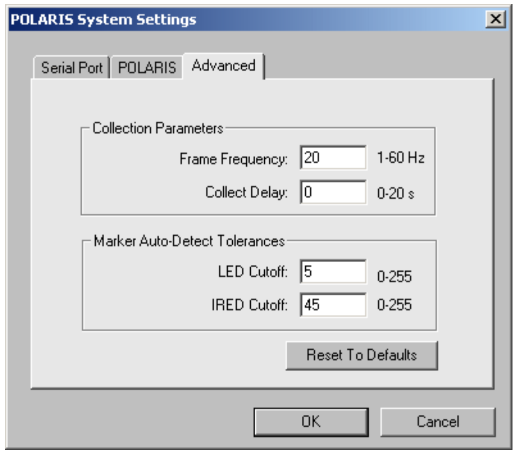


Figure F-4 Advanced Tab

9. Complete the following parameters:

Field/Option	Action
Frame Frequency	Enter the maximum update rate to be used while collecting data for your tool's characterization, in Hz.
Collect Delay	Enter the delay before the collection starts. The system will wait for the specified duration, after you request a collection to begin.
LED Cutoff	Enter the cutoff value in milliamps that determines it is an LED.
IRED Cutoff	Enter the cutoff value in milliamps that determines it is an IRED.

Table F-2 Advanced Fields

10. Click **OK**.

Note **NDI does not recommend changing the default values for LED Cutoff and IRED Cutoff. Contact NDI technical support for details.**

Appendix G Optotrak System Settings

This section describe the various advanced system settings available for Optotrak 3020 and Optotrak Certus Systems.

Note **These settings are advanced features. if you are unsure of the intended result, simply continue with 6D Architect's default settings.**

1. From the main window, select **Settings** > **Optotrak**. The Optotrak Settings dialog appears:

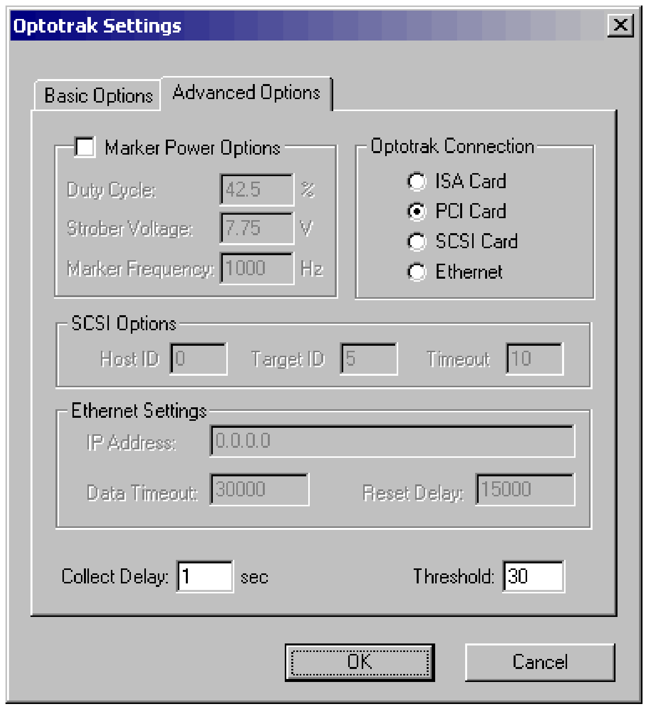


Figure G-1 Optotrak Settings Dialog

2. Click the **Basic Options** tab and complete the fields provided:

Field/Option	Action
Overall Marker Power	Adjust the slide to indicate the intensity of light emitted from the markers.
Frame Frequency	Enter the frame frequency (in Hz) used during data collection.
Camera Parameter File	Select the camera parameter file to be used to calculate 3D and 6D data.

Table G-1 Basic System Settings

3. Click the **Advanced Options** tab.
4. (Optional) Enable **Marker Power Options** to edit the **Duty Cycle**, **Strober Voltage** and **Marker Frequency** fields.
5. From the **Optotrak Connections** list, select the appropriate connection type. Depending on which one you select, other related fields are made available for editing.
6. Complete the fields at the bottom of the screen:

Field	Action
Collect Delay	Enter the number of seconds you wish 6D Architect to delay, before beginning a data trial collection.
Threshold	Enter the static noise threshold, using a value between 0 and 255 only. NDI recommends that you leave this at the default value of 30.

Table G-2 Advanced Options

7. Click **OK** when you have finished your changes.

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