



Probe Software, Inc
885 Crest Dr
Eugene, OR, 97405
1-541-343-3400 (O)
1-541-485-7901 (F)

How to use fiducials for digitizing and managing standard positions

Karsten Goemann, 1 January 2015

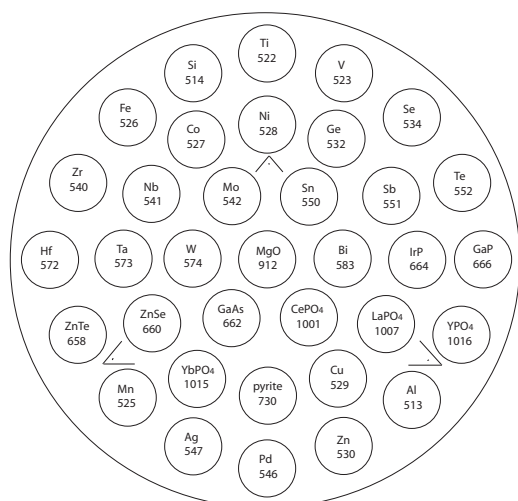
Table of Contents

Introduction	2
Creating Standard Position Files	3
Loading and Updating Standard Positions.....	17
Confirming Standard Positions.....	24
Translating Standard Positions	26
Assigning Fiducial Sets to Existing Standard Positions	33

Introduction

This tutorial was created using PROBE FOR EPMA in demo mode with a Cameca SX100 configuration. Depending on your instrument and configuration some details (e.g. stage positions) might be different. It is assumed that all standards to be digitized have already been entered into Standard.MDB using the STANDARD application.

The standard coordinates are digitized in three dimensions X, Y, Z (plus the W stage position for JEOL multi-position specimen stages only) and are typically referenced to three physical fiducial marks on the standard mount surface. These markers can be applied for example with a fine point diamond scribe using a triangular template for a 1 inch diameter mount, as shown schematically below for a metal standards block:

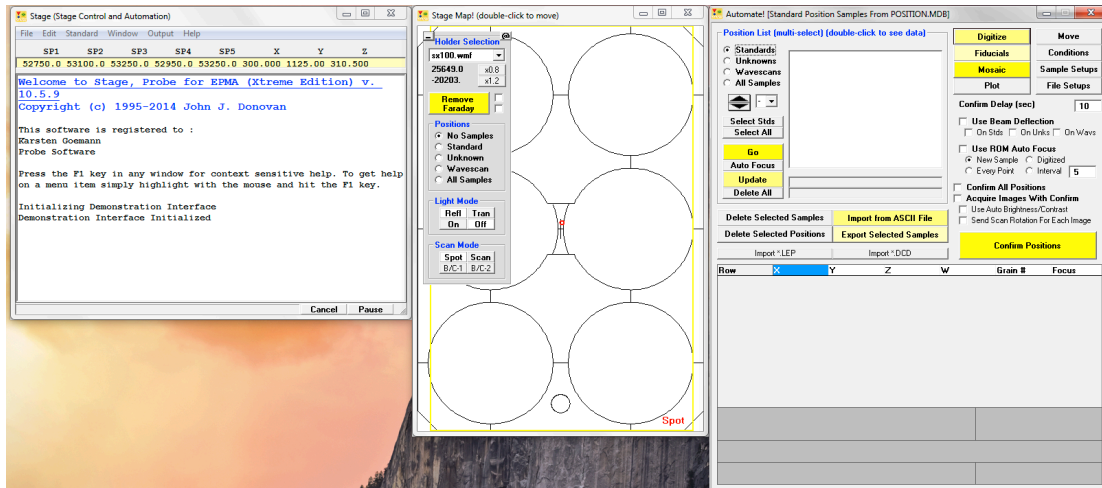


Other features like distinct grain edges in the corners of the mount can also be used as fiducial markers. All markers should provide distinct features on a micron scale to allow for high accuracy positioning and extend far enough in depth to be preserved after successive repolishing of the surface.

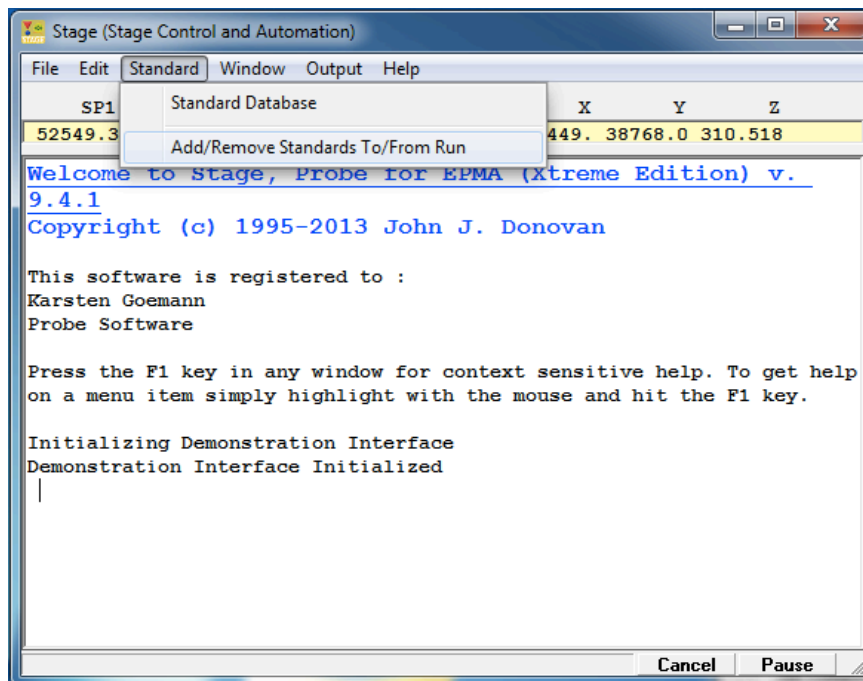
Creating Standard Position Files

The following procedure illustrates how to create a new standard position file with fiducial marker positions using the STAGE application. It can be performed in a similar way in the **Automate!** window of PROBE FOR EPMA.

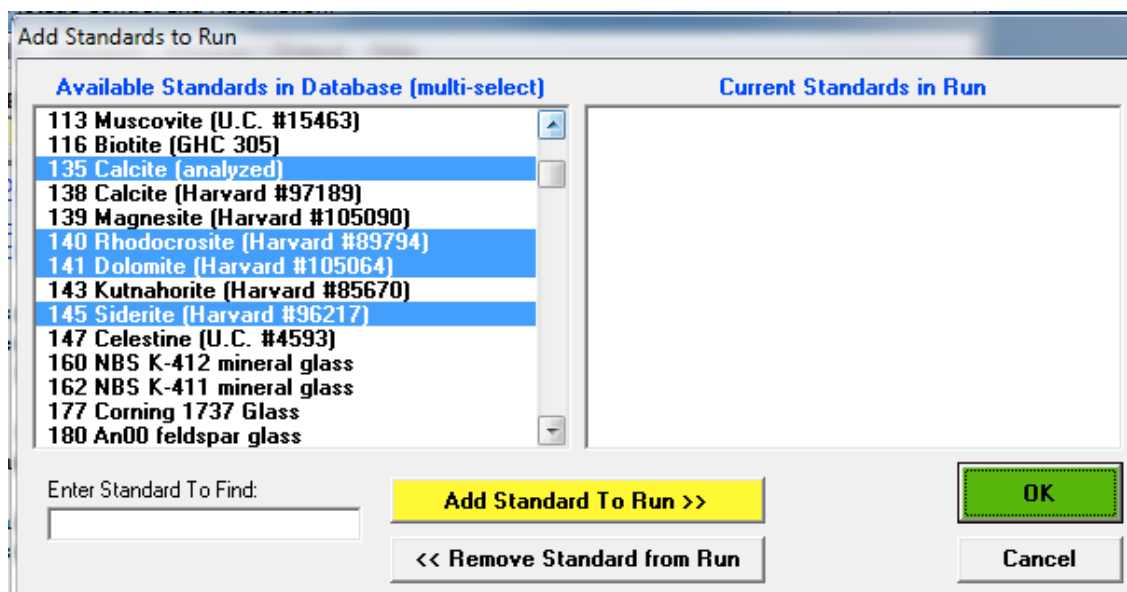
Open the STAGE application. The main **Stage** window, the **Stage Map!** window and the **Automate!** dialog open.



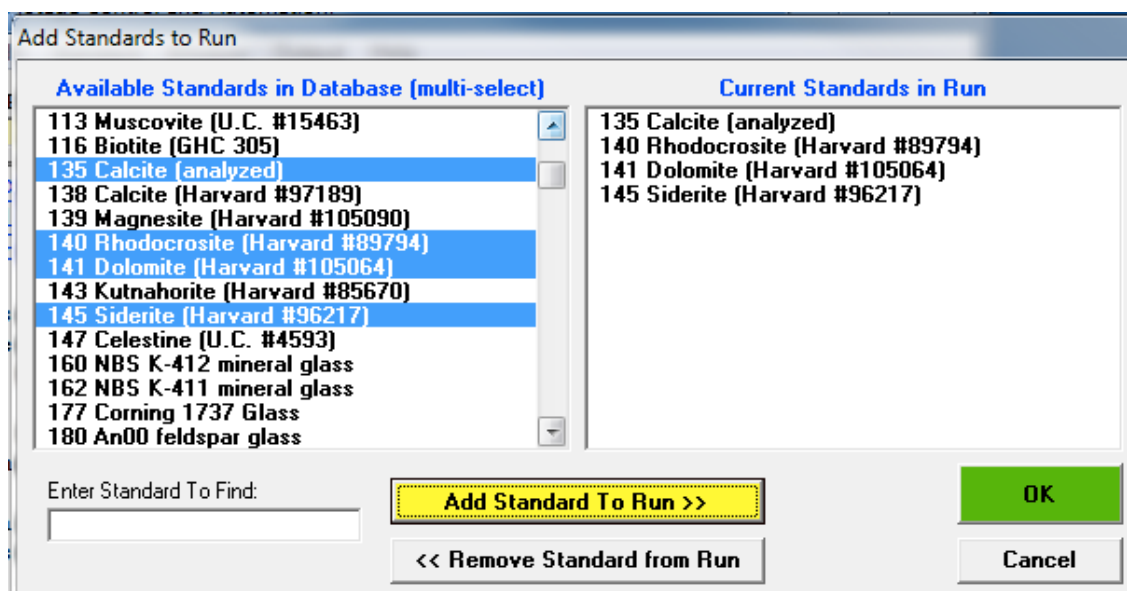
Select **Standard** from the menu bar and click on **Add/Remove Standards To/From Run** from the menu choices.



This opens the **Add Standards to Run** dialog box. Click on the name of each of the standards in the standard block to be digitized from the *Available Standards in Database* list box.

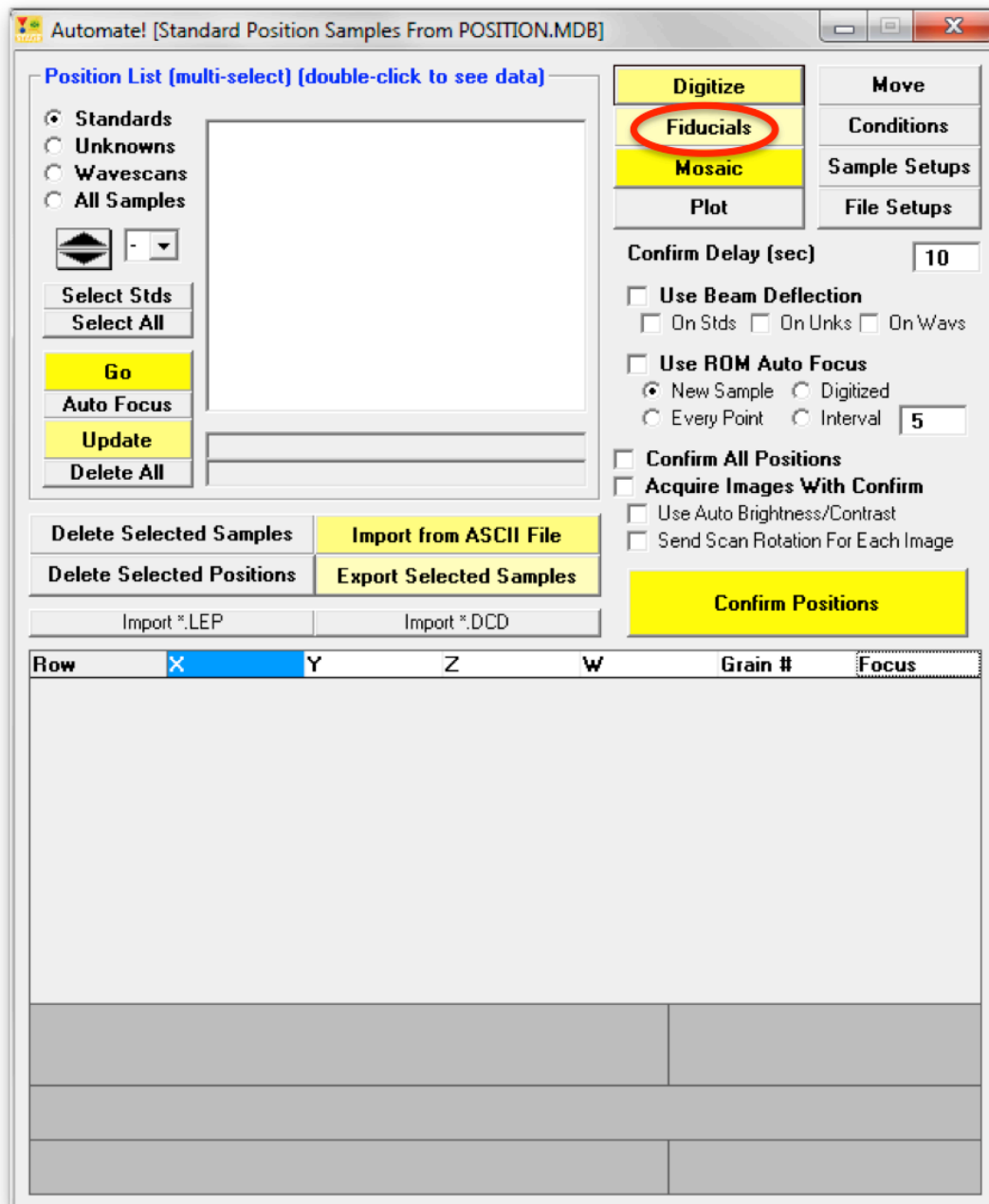


Click the **Add Standard to Run >>** button to move these standards into the current run. Standards may be added one at a time or the user may multi-select standards by holding down the <Ctrl> button on the keyboard as standards are selected. Double clicking each entry will also send the standard to the other column in the dialog window.

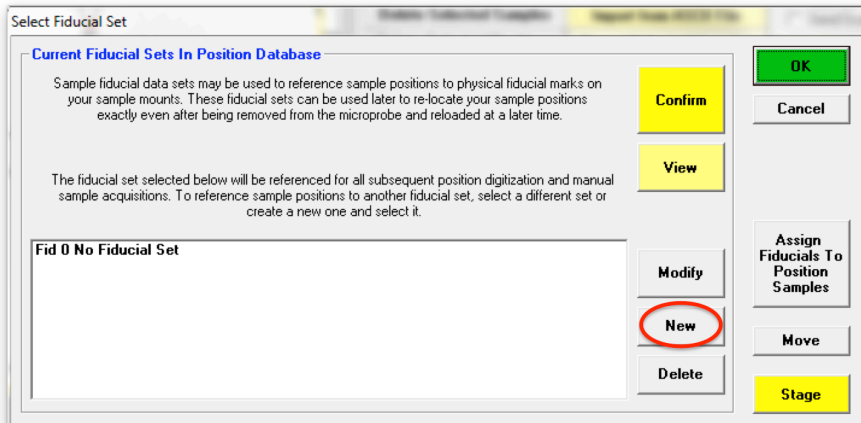


Click the **OK** button of the **Add Standards to Run** dialog box when finished.

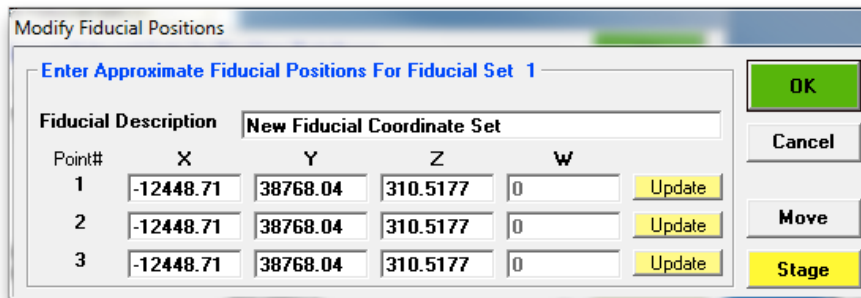
In the **Automate!** window, click the **Fiducials** button:



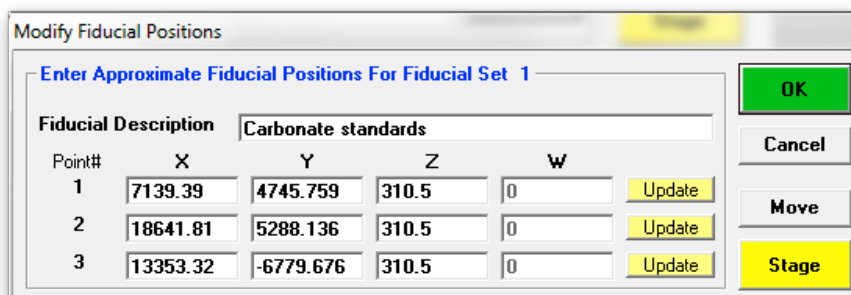
This opens the **Select Fiducial Set** window. Click the **New** button:



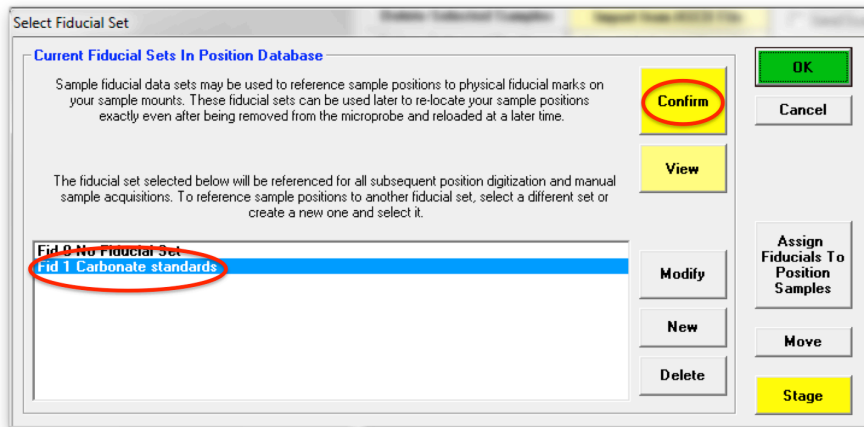
This opens the **Modify Fiducial Positions** window. The current stage coordinates are loaded by default.



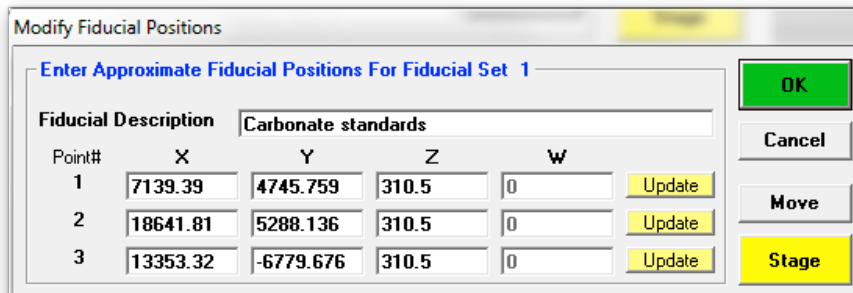
Type in a *Fiducial Description*. Enter the nominal coordinates or click on **Stage** to open the Stage Map! window to move to each of the three fiducial marks on the standard mount, determining their approximate coordinates and click the respective **Update** buttons. The following window will result.



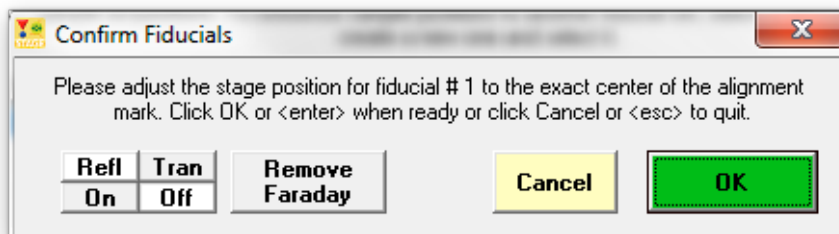
Click the **OK** button when done. This creates a new entry in the **Select Fiducial Set** list box as shown below. Select (highlight) the new fiducial set and click the **Confirm** button to initiate a precise centering of the three fiducial marks.



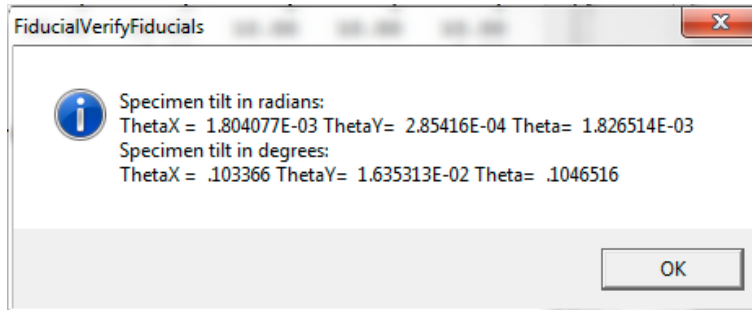
The **Modify Fiducial Positions** window opens displaying the originally entered fiducial coordinates. Click the **OK** button to initiate the centering process.



The computer then drives the stage to each fiducial mark and displays the **ConfirmFiducials** window. Adjust the stage position to center the fiducial mark and click the **OK** button.

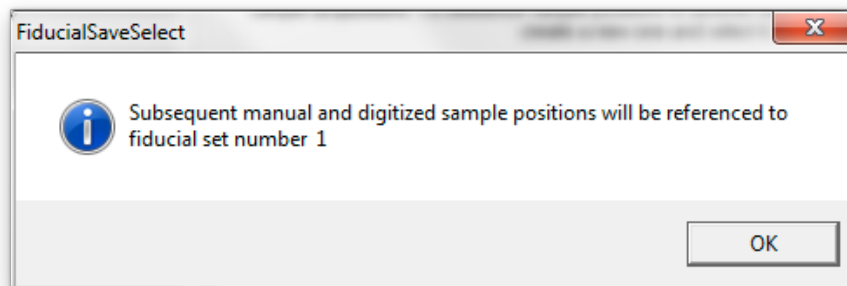


After centering the third fiducial mark and clicking the **OK** button, the **FiducialVerifyFiducials** window opens to display the specimen tilt in radians and degrees. A warning will be given if the sample is tilted at more than 0.5 degrees.



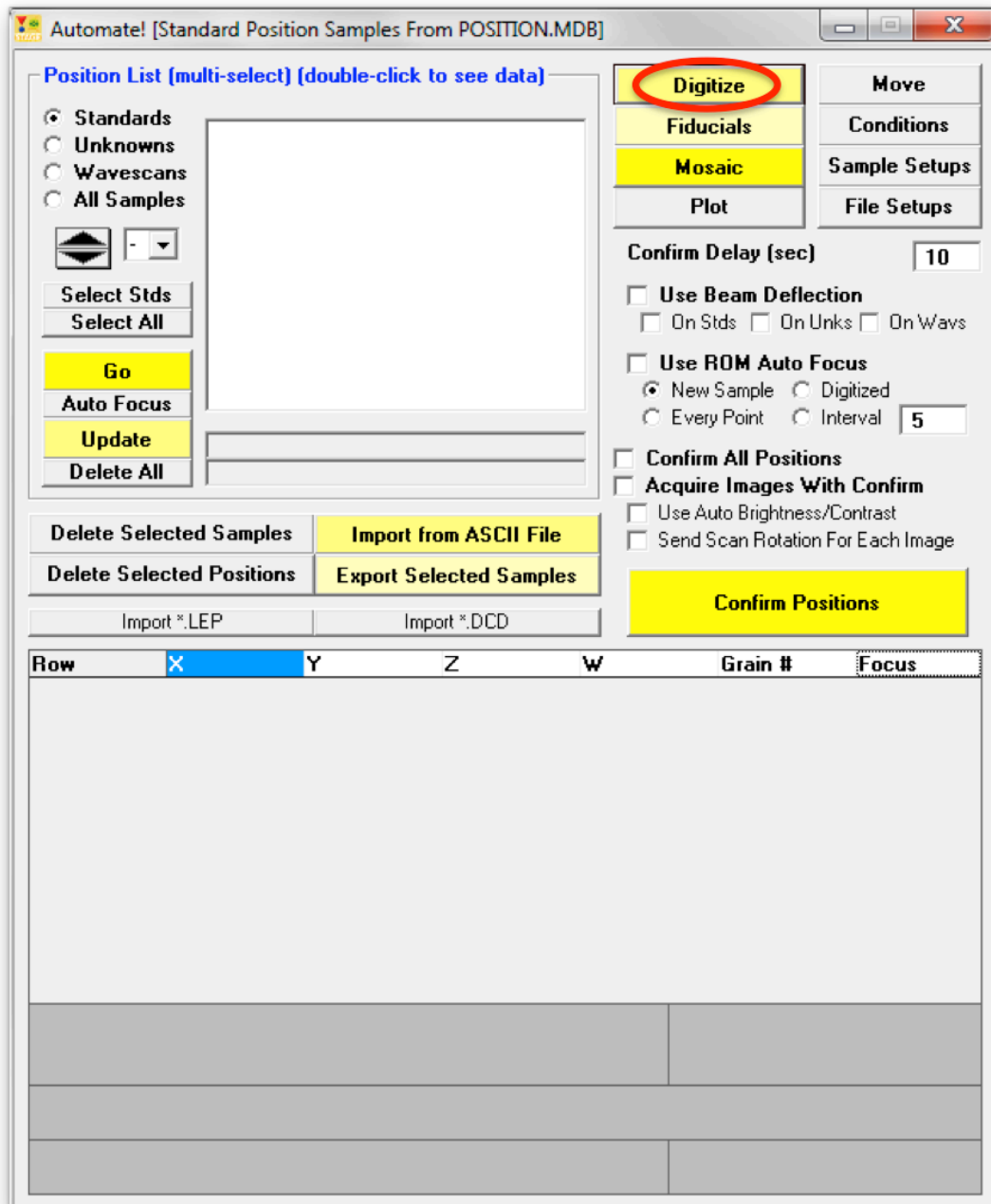
Click this **OK** button.

Closing the **FiducialVerifyFiducials** window returns to the **Select Fiducial Set** dialog box. Click the **OK** button. This opens the **FiducialSaveSelect** window to confirm the currently selected fiducial set:

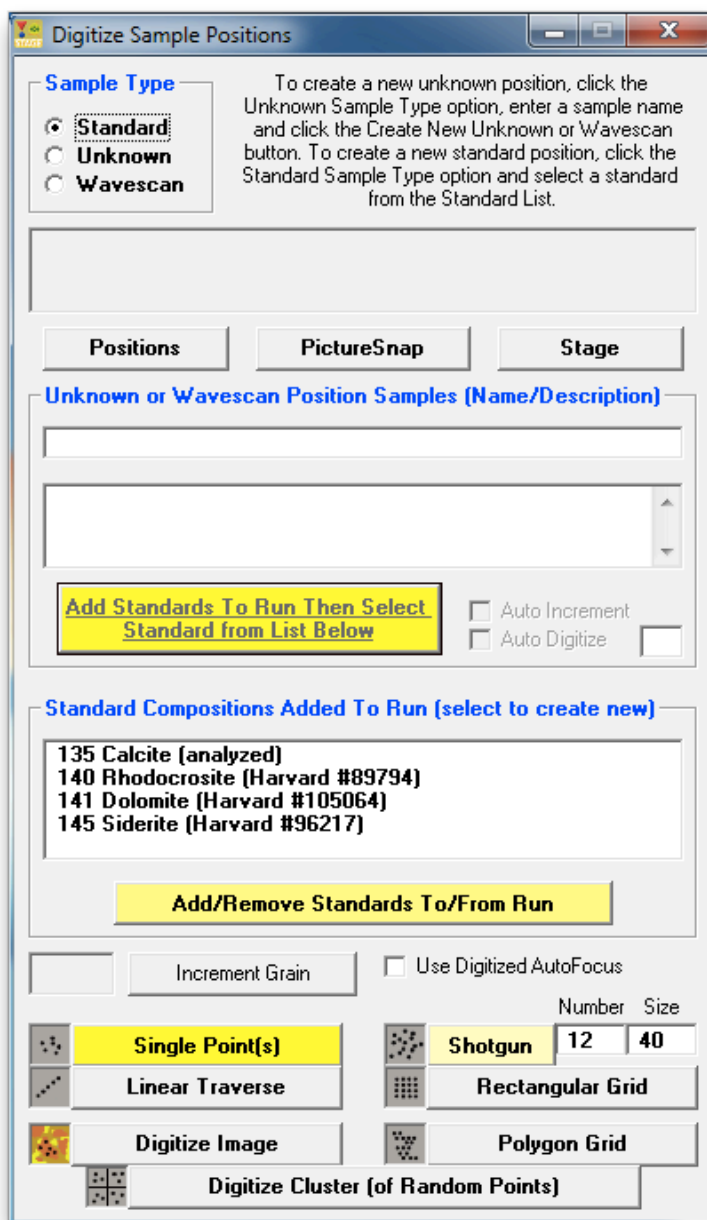


Click the **OK** button of the **FiducialSaveSelect** window.

Next, the positions of the standards have to be digitized. Click **Digitize** in the Automate! window:

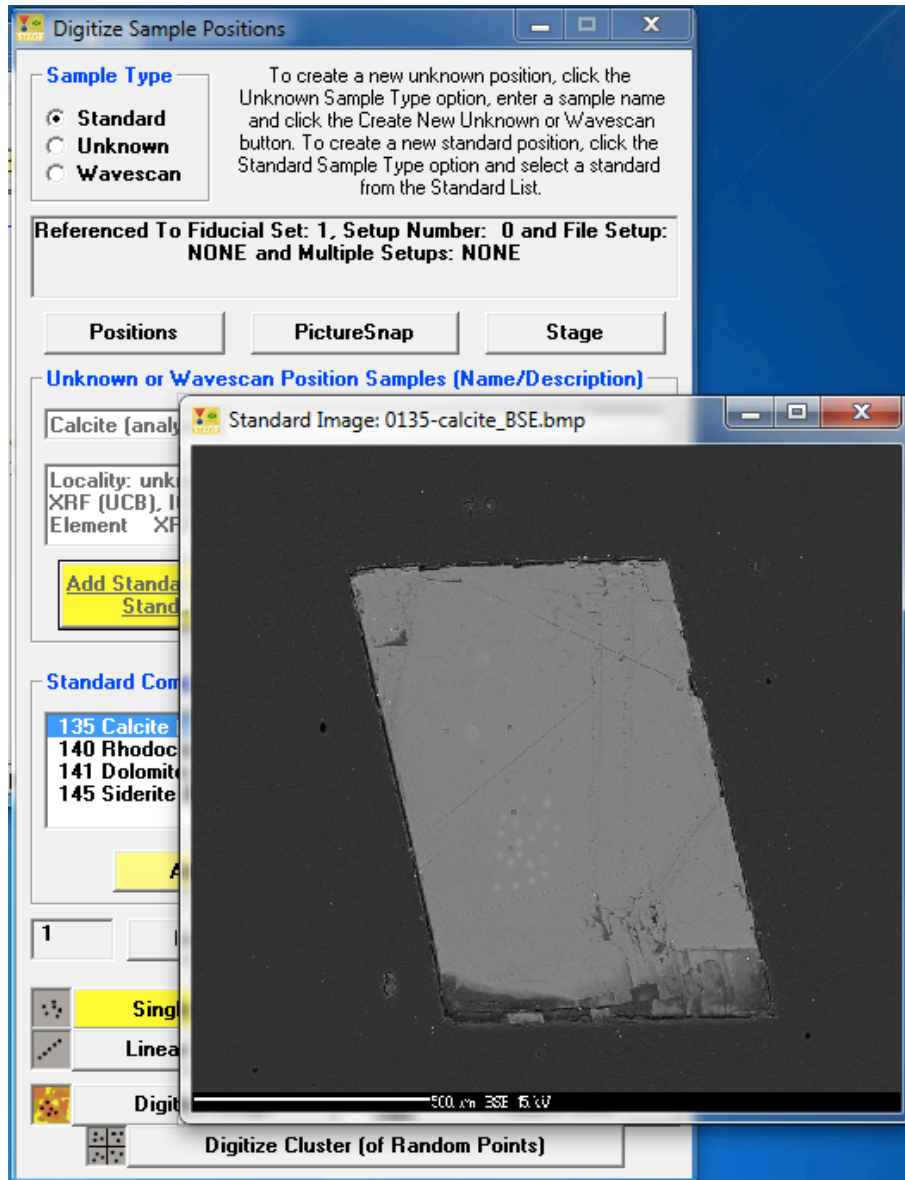


This opens the **Digitize Sample Positions** dialog box. The *Standard Compositions Added to Run* list box contains the standards already added to the run.

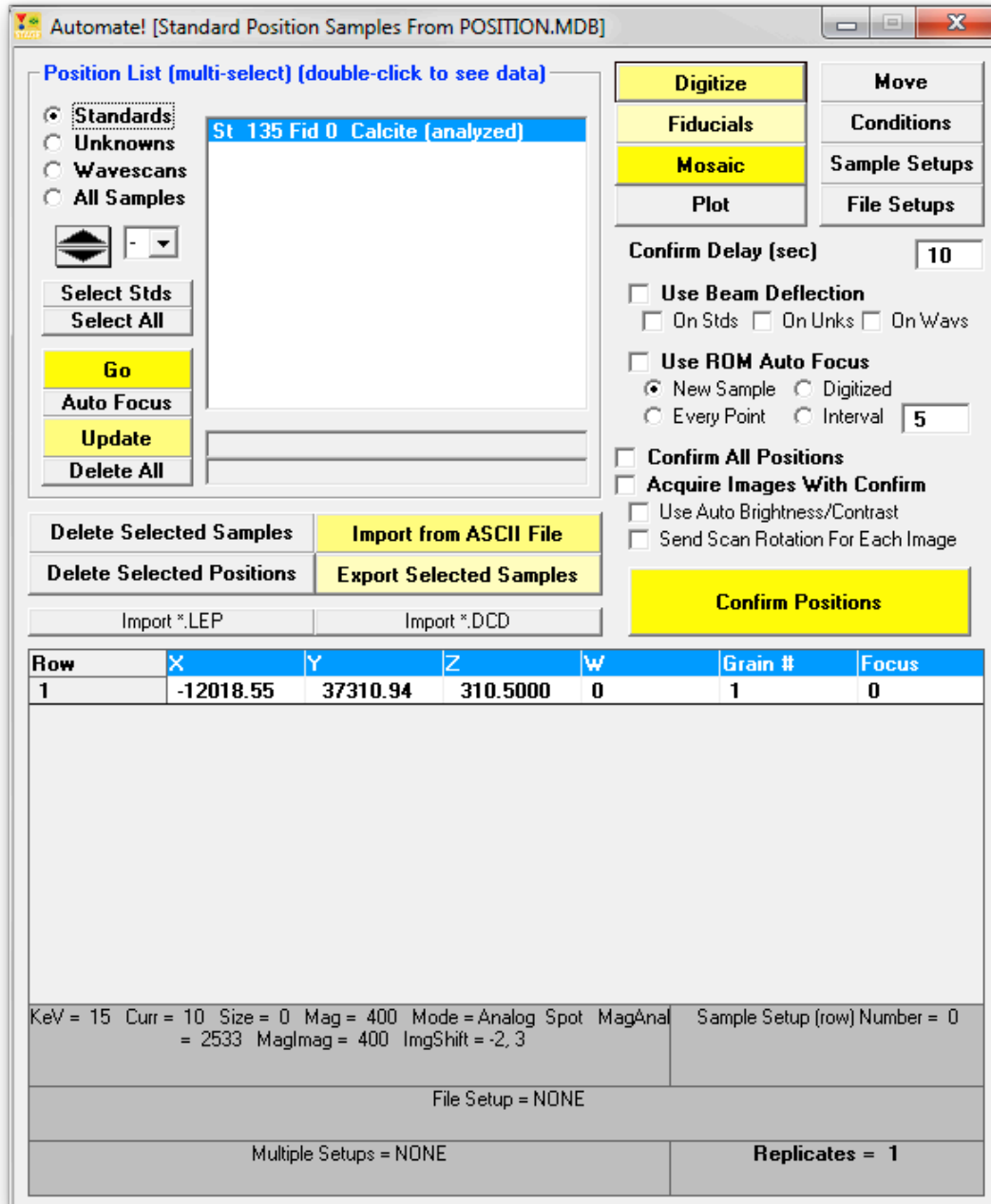


Drive the stage to the position for the first standard, for example by double clicking on the corresponding position in the Stage Map! window, by using the Stage Target Positions section in the Move window, or by using the instrument's joystick or trackball.

Select (highlight) the first standard to digitize from the *Standard Compositions Added to Run* list box. The standard will be added automatically to the **Automate!** *Position List*. If a BMP electron image file exists for the standard, then it too will be displayed. This can be used to check whether you are on the correct standard. Further, the image could be annotated to suggest places or grains to avoid during the standard digitization or acquisition process.

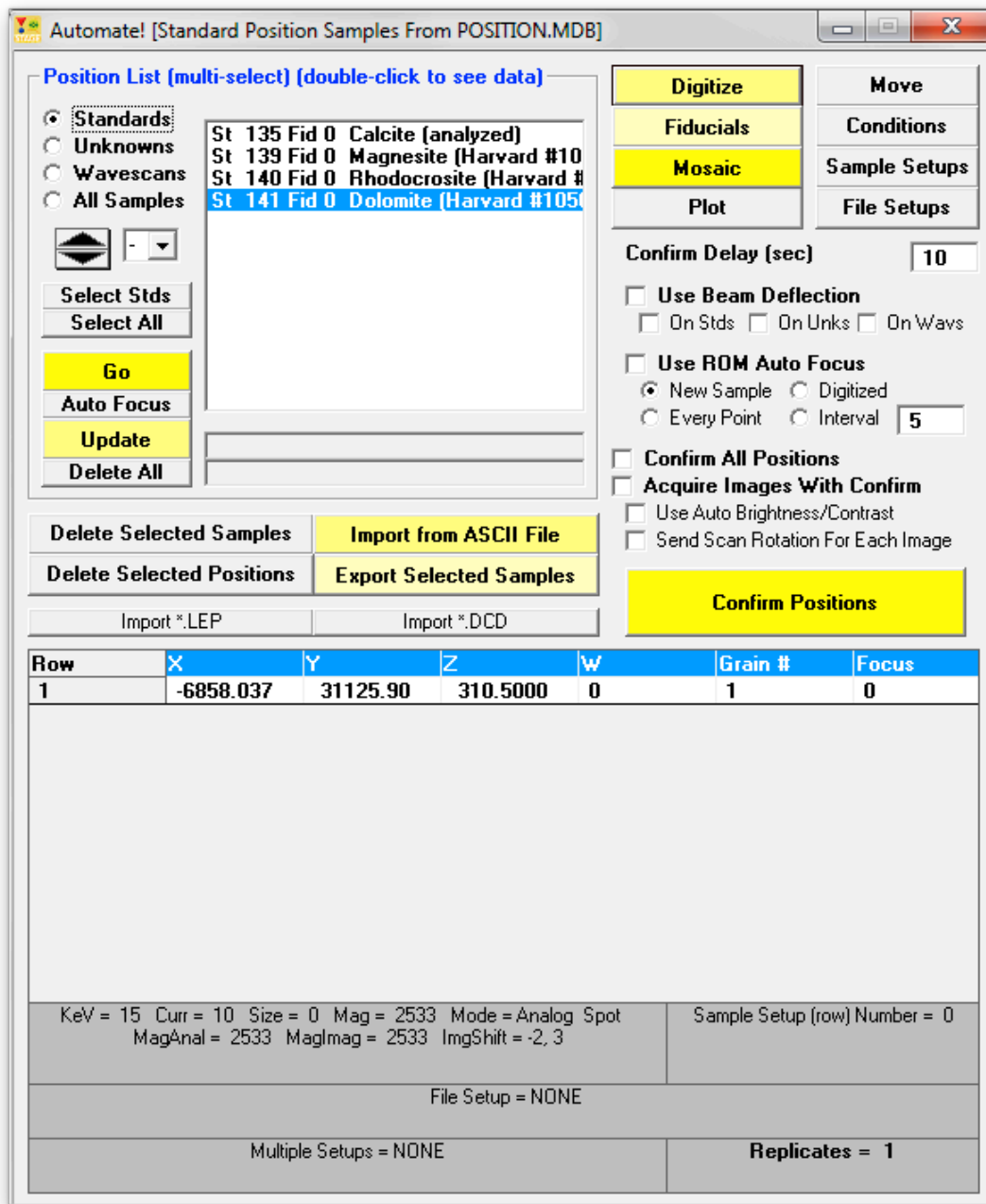


To digitize a random point on this standard, click the **Single Point(s)** button of the **Digitize Sample Positions** dialog box to record the current XYZ coordinates for this grain. The coordinates of this standard in the **Automate!** dialog box are seen below.



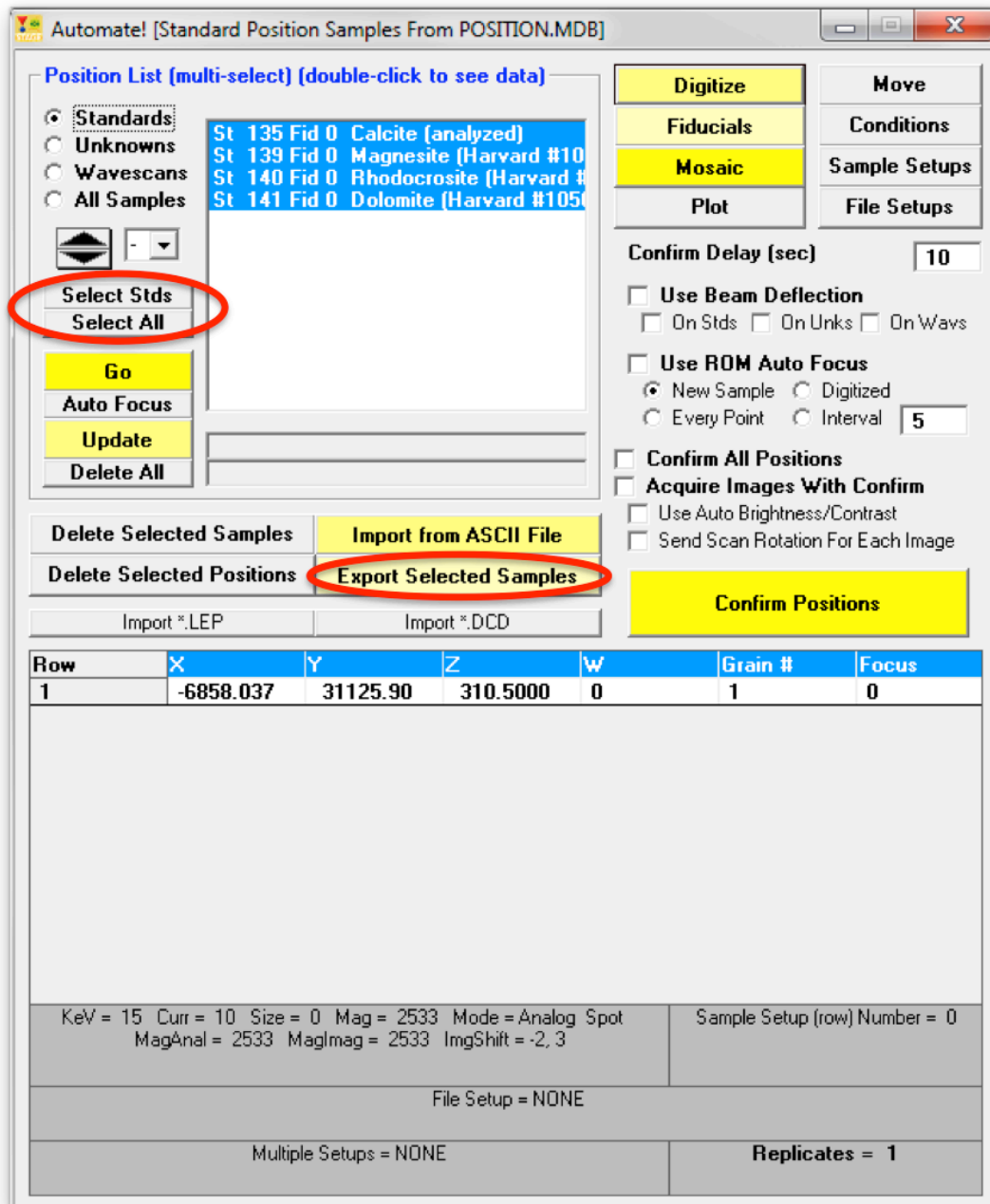
Note, that although only one position per standard needs to be digitized, if additional points are digitized, PROBE FOR EPMA will automatically utilize them. Otherwise, PROBE FOR EPMA will simply increment the stage X position for each additional acquisition required.

Move the stage to the next standard, select the standard from the list box in the **Digitize Sample Positions** window and click the **Single Point(s)** button again. Continue until all of the remaining standards in the standard block are digitized:

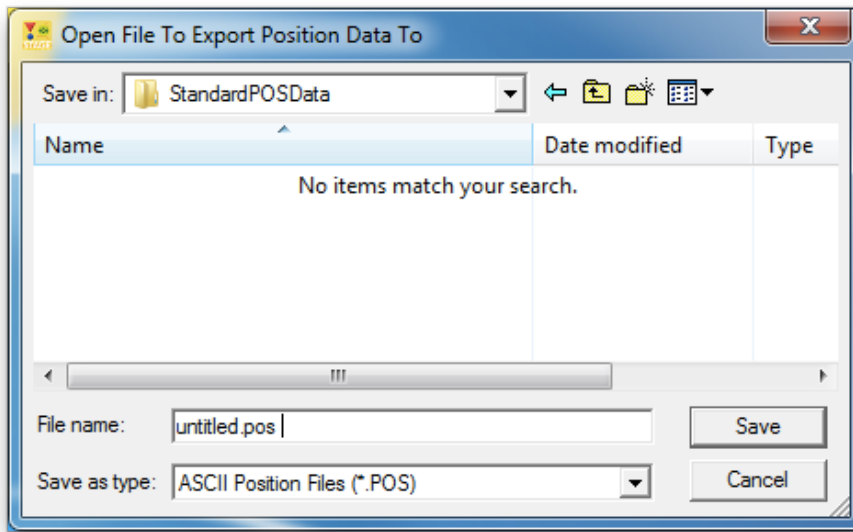


Close the **Digitize Sample Positions** dialog box by clicking the **Close** button in the upper right corner.

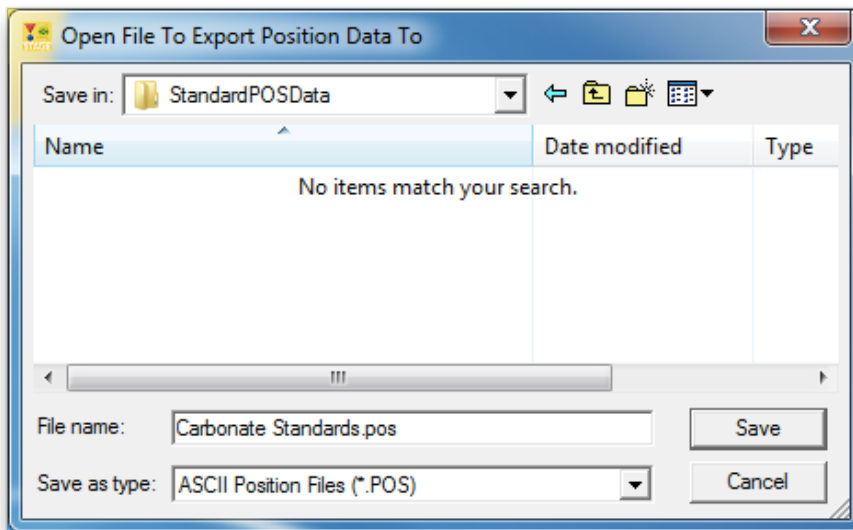
Finally, store the new pre-digitized standard coordinates to disk as an ASCII position file (.POS). Select all of the standards using the **Select Stds** or **Select All** button and click the **Export Selected Samples** button:



The **Open File To Export Position Data To** window opens. The default *Save in:* location is specified by the StandardPOSFileDirectory keyword in the PROBEWIN.INI file.

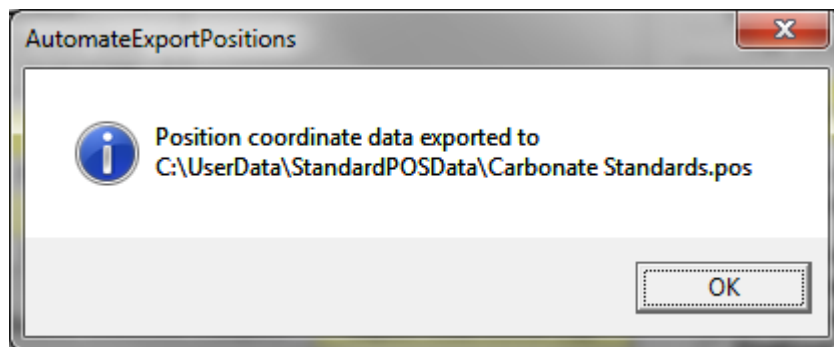


Type in an appropriate *File name:*



Click the Save button of the **Open File To Export Position Data To** window.

After the positions are written to disk, the **AutomateExportPositions** window appears.



Click the **OK** button.

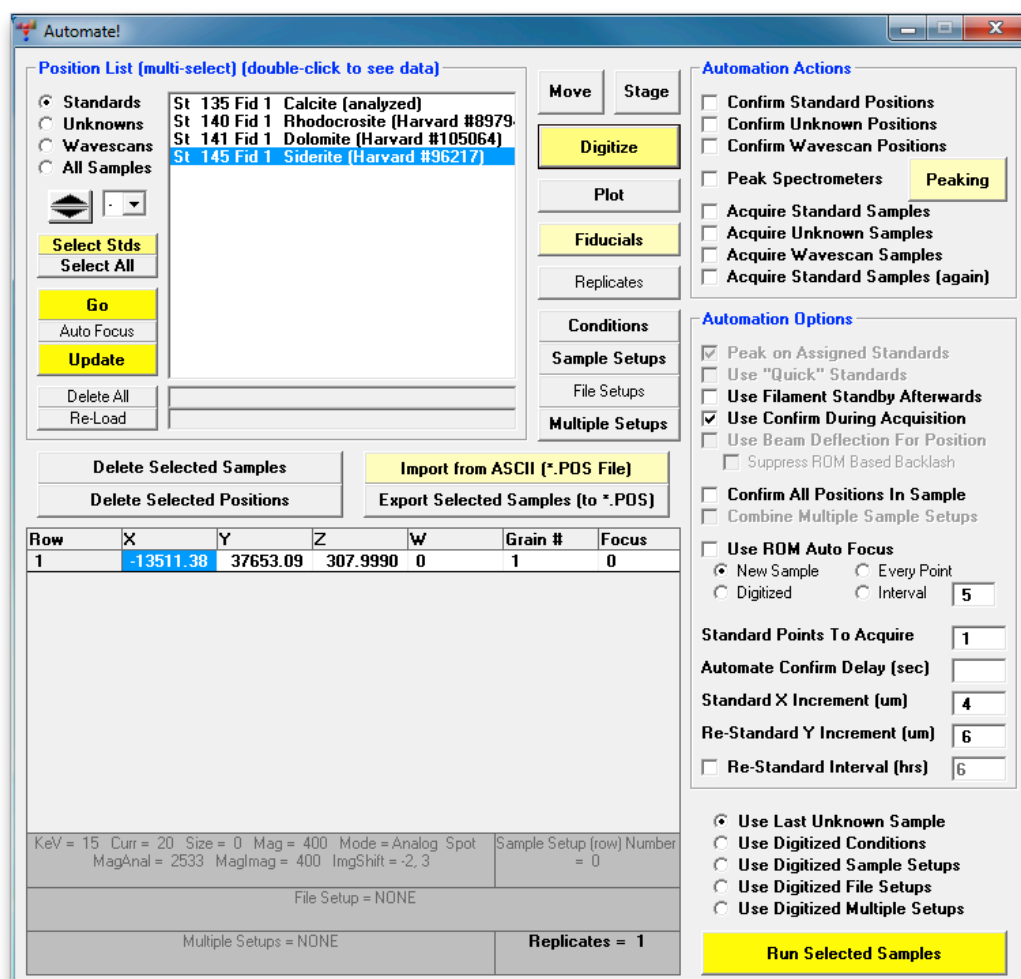
These .POS files are now available for future use in PROBE FOR EPMA. They can be loaded back in and positions updated using the fiducial markers. Further standards can be added to the same files at a later stage. Only 4 standards were digitized in the above example, but for the typical scenario that the standards for a particular instrument are grouped together in a range of 1 inch diameter mounts, it is recommended to keep the positions for all standards in one mount together in the same .POS file.

It is recommended to keep backup copies of standard .POS files in a separate location.

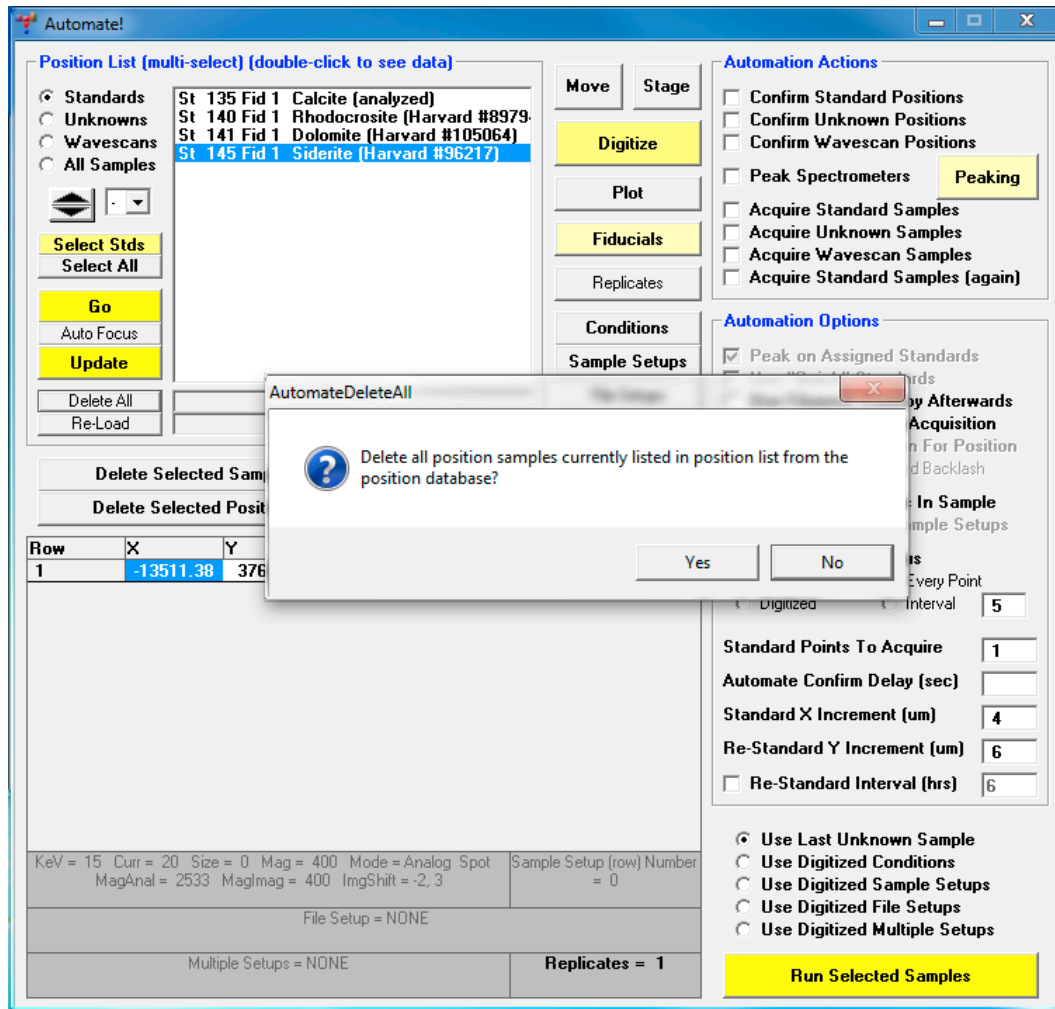
Loading and Updating Standard Positions

To load .POS files back in and update their positions, we'll use the **Automate!** window in PROBE FOR EPMA this time, but it can be done in a similar way in the STAGE application.

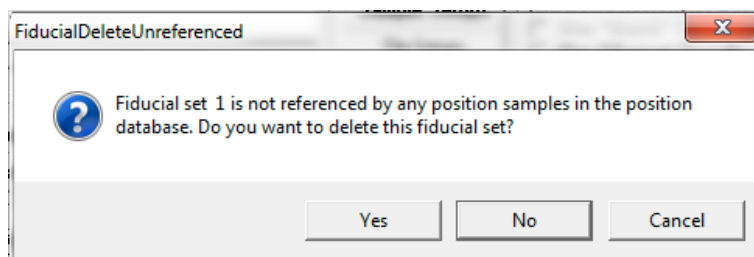
When opening Automate!, the last set of digitized positions used is always still visible in the *Position List* box. Currently, the carbonate standards digitized previously are listed. These will be deleted and replaced by other standards as an example.



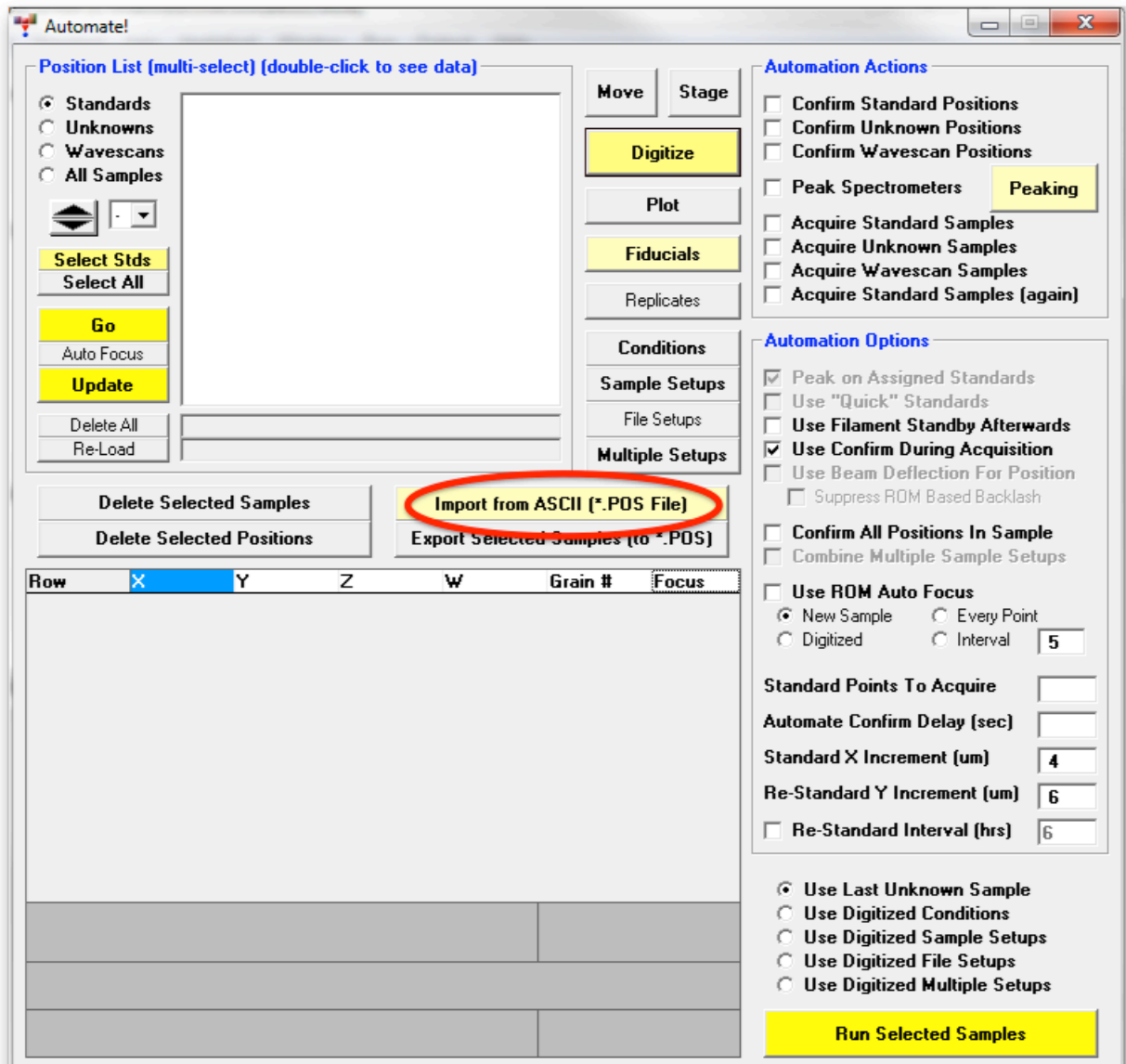
Click the **Delete All** button. This opens the **AutomateDeleteAll** window. Click the **Yes** button of the **AutomateDeleteAll** window to clear the *Position List* box of all displayed position samples.



The **FiducialDeleteUnreferenced** window opens. Click the **Yes** button to clear the fiducial coordinate set from the position database.



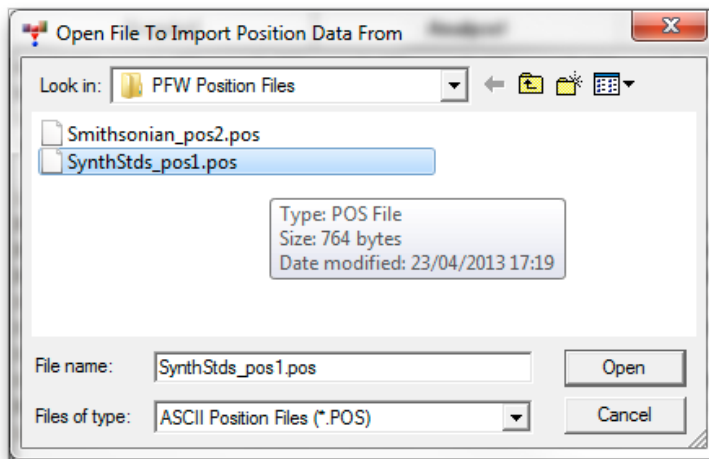
Click the **Import from ASCII File (*.POS File)** button to import position samples from a previously saved ASCII file.



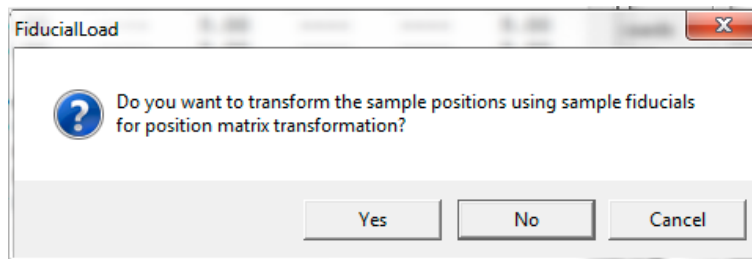
This action opens the **Open File To Import Position Data From** window.

The default location for *.POS files is specified in the PROBEWIN.INI file.

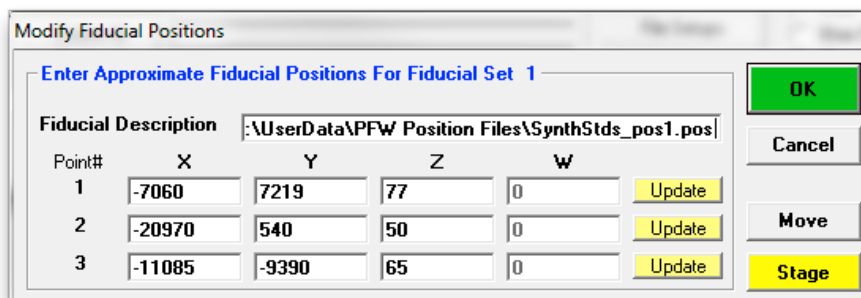
Select the desired position file in the list and click the **Open** button.



This action opens the **FiducialLoad** window. Click the **Yes** button to do a fiducial transformation on this pre-digitized standard block to obtain an accurate set of standard positions.

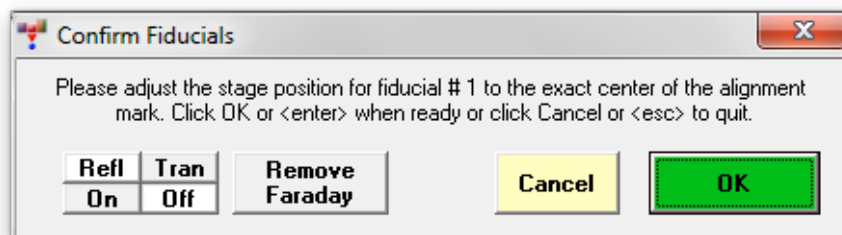


The **Modify Fiducial Positions** window opens. Normally the user would simply accept the defaults or edit the position text boxes for each point. When done, click the **OK** button.

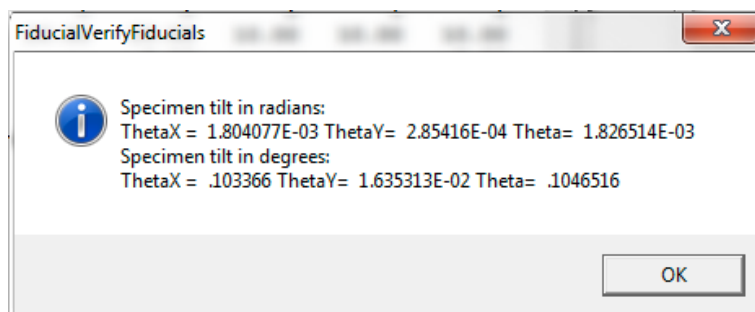


This action causes the stage motors to drive to the first fiducial coordinate .

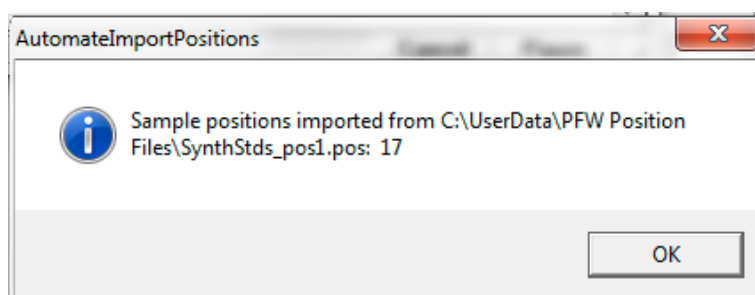
The **FiducialVerifyFiducial** window appears. Adjust the stage motors to center the first fiducial mark, click the **OK** button.



The computer will drive to each of the three fiducial marks for centering. Clicking the **OK** button after the third fiducial mark opens the **FiducialsVerifyFiducials** window. Click this **OK** button.

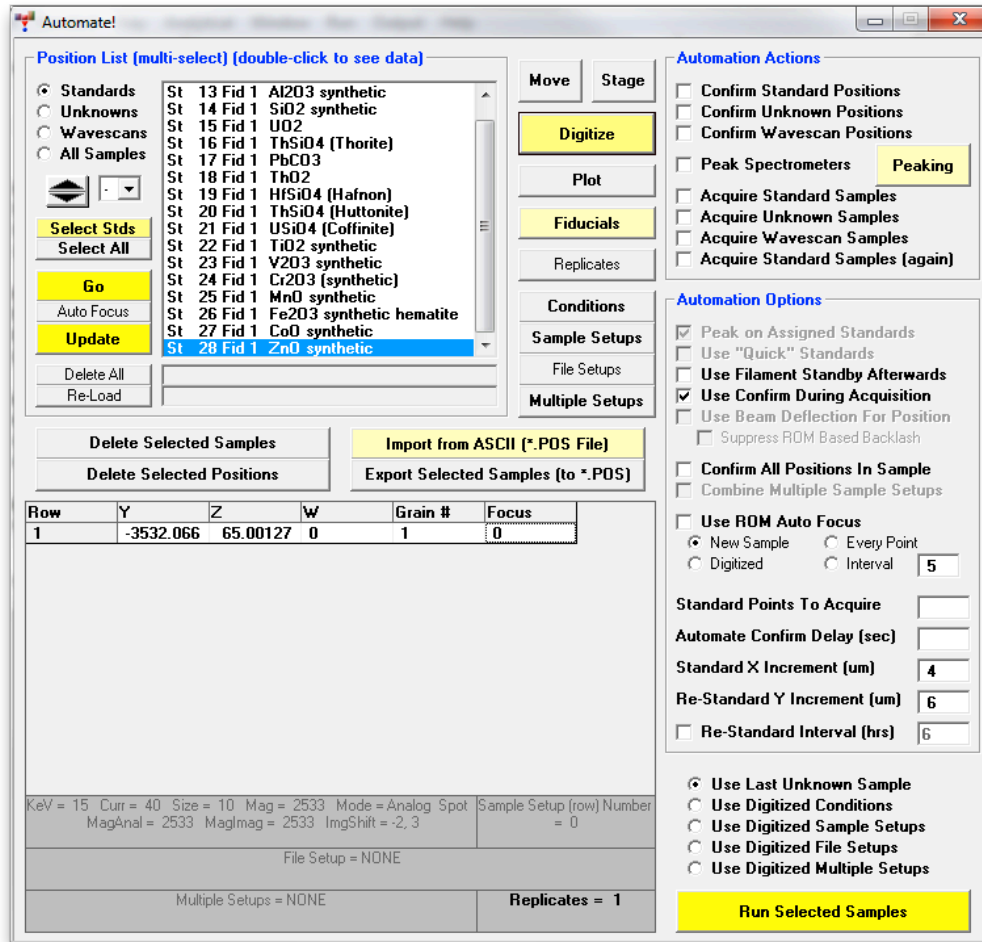


The program then imports and updates the position coordinates of all of the standards in the pre-digitized standard position file. The **AutomateImportPositions** window opens.

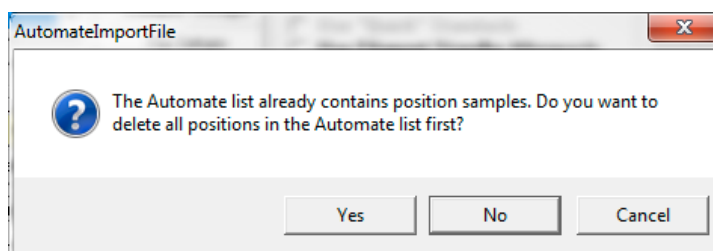


Click the **OK** button returning to the **Automate!** window.

The **Automate!** window would appear as below. The currently transformed standard position file is listed in the *Position List* box.



Repeat the same loading procedure for the other standard position files required for use in the automation. After clicking the **Import from ASCII File** button, the **AutomateImportFile** window opens.



Typically, when using more than one standard mount, the user would not delete all positions in the *Position List*, instead appending the additional position files to the first file. Select **No** and import additional standards.

All of the standards loaded are listed in the *Position List* box of the **Automate!** window. These may now be accessed by the program during any automation action. For instance, it is now possible to drive to any standard located on the imported blocks by double clicking on the standard in the list first and then double clicking on the coordinate row. A distinct set of 3 fiducials is assigned to each set of standard imported from a separate .POS file.

The screenshot shows the Automate! software interface. The main window is titled "Automate!".

Position List [multi-select] [double-click to see data]

- Standards (selected)
- Unknowns
- Wavescans
- All Samples

Buttons: Select Stds, Select All, Go, Auto Focus, Update, Delete All, Re-Load.

Position List Table:

St 462	Fid 2	Obsidian USNM 111240752
St 463	Fid 2	Glass, basaltic USNM 1134
St 464	Fid 2	Obsidian USNM 113716
St 465	Fid 2	Obsidian USNM 72854
St 466	Fid 2	Glass, synthetic tektite US
St 467	Fid 2	Hornblende (Arenal) USNM
St 468	Fid 2	Hornblende (Kakanui) USN
St 469	Fid 2	Hypersthene, johnstown U
St 470	Fid 2	Ilmenite USNM 96189
St 471	Fid 2	Magnetite (minas gerais) U
St 473	Fid 2	Olivine (Fo90) USNM 1113
St 474	Fid 2	Olivine USNM 2566 (Fo 83
St 475	Fid 2	Omphacite USNM 110607
St 477	Fid 2	Plagioclase (Lake County)
St 478	Fid 2	Garnet USNM 143968
St 480	Fid 2	Scapolite USNM R6600-1

Buttons: Move, Stage, Digitize, Plot, Fiducials, Replicates, Conditions, Sample Setups, File Setups, Multiple Setups.

Automation Actions

- Confirm Standard Positions
- Confirm Unknown Positions
- Confirm Wavescan Positions
- Peak Spectrometers (Peaking)
- Acquire Standard Samples
- Acquire Unknown Samples
- Acquire Wavescan Samples
- Acquire Standard Samples (again)

Automation Options

- Peak on Assigned Standards
- Use "Quick" Standards
- Use Filament Standby Afterwards
- Use Confirm During Acquisition
- Use Beam Deflection For Position
- Suppress RDM Based Backlash
- Confirm All Positions In Sample
- Combine Multiple Sample Setups
- Use RDM Auto Focus
 - New Sample (selected)
 - Every Point
 - Digitized
 - Interval: 5
- Standard Points To Acquire: |
- Automate Confirm Delay (sec):
- Standard X Increment (um): 4
- Re-Standard Y Increment (um): 6
- Re-Standard Interval (hrs): 6
- Use Last Unknown Sample
- Use Digitized Conditions
- Use Digitized Sample Setups
- Use Digitized File Setups
- Use Digitized Multiple Setups

Buttons: Delete Selected Samples, Delete Selected Positions, Import from ASCII (*.POS File), Export Selected Samples (to *.POS), Run Selected Samples.

Table:

Row	X	Y	Z	W	Grain #	Focus
1	-17049.70	-7077.103	65.00159	0	1	0

KeV = 15 Curr = 40 Size = 10 Mag = 2533 Mode = Analog Spot Sample Setup (row) Number = 0
MagAnal = 2533 MagImag = 2533 ImgShift = -2, 3
File Setup = NONE
Multiple Setups = NONE Replicates = 1

Confirming Standard Positions

If the exact positions of standards on a block have changed, for example after repolishing the block, updating the positions can be automated.

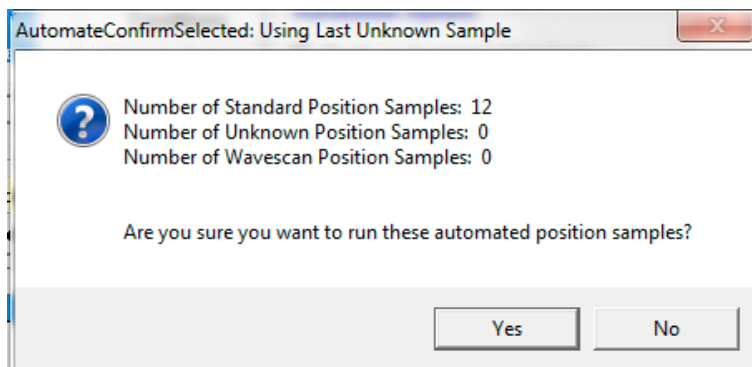
Import the .POS file into **Automate!** as described before, and click the **Select All** button, or shift-click into the *Position List* to select only a range of the imported standards. Click the box for *Confirm Standard Positions* under *Automation Actions*, and click the **Run Selected Samples** button in the bottom right corner of the window.:

The screenshot shows the Automate! software interface with the following components:

- Position List (multi-select) (double-click to see position data)**: Last POS File: Smithsonian_pos2.pos. A list of standards is shown, with the first row selected.
- Automation Actions**: Confirm Standard Positions (circled in red), Confirm Unknown Positions, Confirm Wavescan Positions, Peak Spectrometers (with a yellow Peaking button), Acquire Standard Samples, Acquire Unknown Samples, Acquire Wavescan Samples, Acquire Standard Samples (again).
- Automation Options**: Peak on Assigned Standards, Use "Quick" Standards, Use Filament Standby Afterwards, Use Confirm During Acquisition, Use Beam Deflection For Position (with sub-options: On Stds, On Unks, On Ways, Suppress RDM Based Backlash), Confirm All Positions In Sample, Combine Multiple Sample Setups, Use ROM Auto Focus (with sub-options: New Sample, Every Point, Digitized, Interval, 5), Standard Points To Acquire: 1, Automate Confirm Delay (sec): 10, Standard X Increment (um): 10, Re-Standard Y Increment (um): 10, Re-Standard Interval (hrs): 6, Automate Probe Image (with a Browse button).
- Buttons**: Select All (circled in red), Go, Auto Focus, Update, Delete Selected Samples, Delete Selected Positions, Import from ASCII (*.POS File) (with a Help button), Export Selected Samples (to *.POS), Import *.LEP, Import *.DCD, Run Selected Samples (circled in yellow), Help.
- Table**:

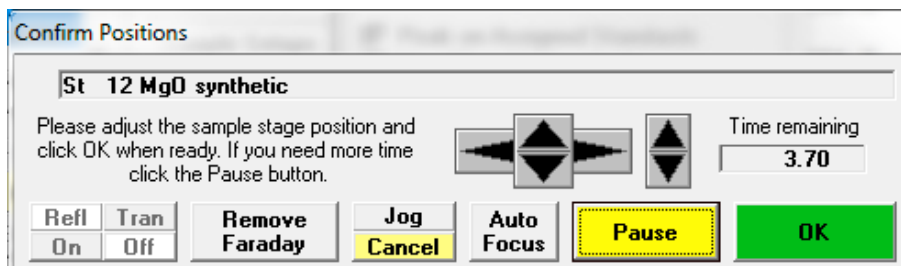
Row	X	Y	Z	W	Grain #	Focus
1	-7042.018	6146.982	78.99976	0	1	0
- Metadata**: KeV = 15, Curr = 10, Size = 0, Mag = 2533, Mode = Analog, Spot, MagAnal = 2533, Magmag = 2533, ImgShift = -2, 3, Sample Setup (row) Number = 0, File Setup = NONE, Multiple Setups = NONE, Replicates = 1.

The **AutomateConfirmSelected** window opens informing the user how many standards were chosen and asks if the user wants to run these automated samples. Click **Yes**.

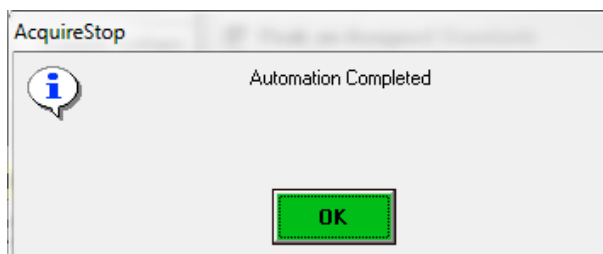


The program then sends the stage motors to the fiducial transformed coordinates for the first selected standard and opens the **Confirm Positions** window. Clicking the two-way **Pause/Continue** button suspends the 10 second countdown (user defined in the PROBEWIN.INI file). Adjust the stage motors (X, Y, and Z) to the new position. Click the **OK** button of the **Confirm Positions** window when done, sending the stage to the next standard to confirm its position. Again, the **Confirm Positions** window opens, allowing the user to pause the countdown and adjust the sample position.

If more than one position is digitized, the software moves to the first position and updates all positions for that sample by the same X, Y, and Z offset.



After the final standard is confirmed, the **AcquireStop** window appears. Click this **OK** button to return to the **Automate!** dialog box.

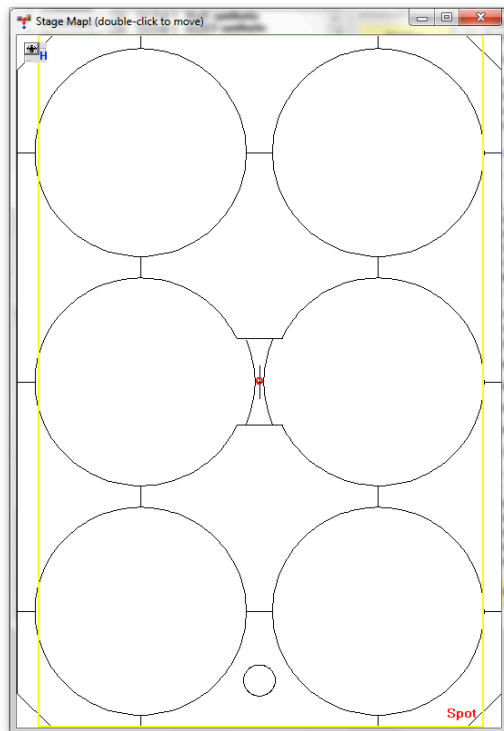


The updated positions can now be exported to a .POS file as described before at the end of the **Creating Standard Position Files** section.

Translating Standard Positions

The easiest and fastest way to use PROBE FOR EPMA's system of managing standard positions (absolute XYZ coordinates with 3 fiducial markers) is to always mount standard blocks in the same position in a holder. However, this might not always be possible, and PROBE FOR EPMA provides a simple method to translate (i.e. shift) standard coordinates for different holder positions.

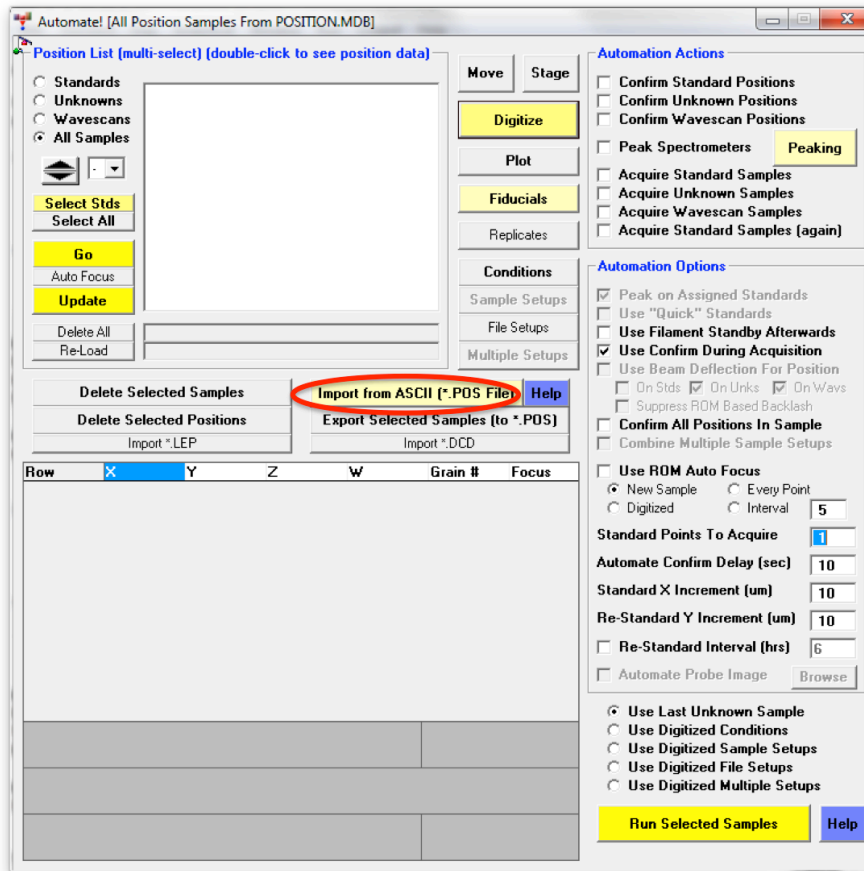
For example, the Cameca HO6 holder has six positions for 1 inch diameter mounts:



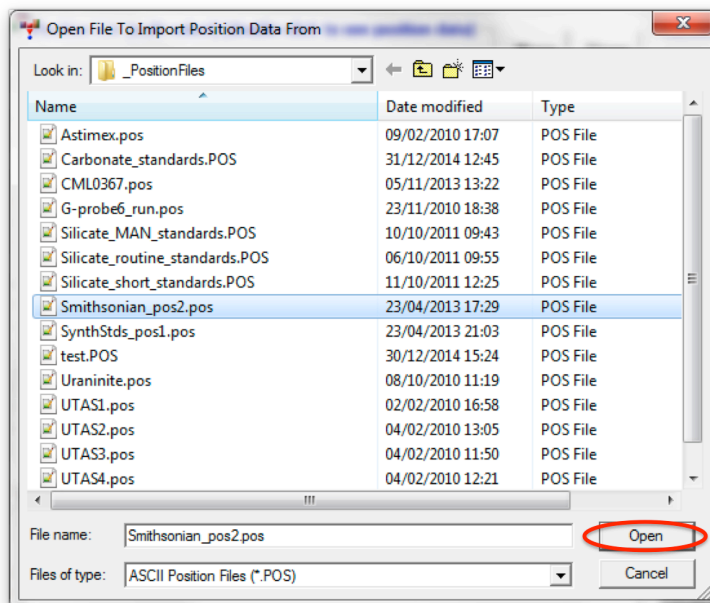
The distance between these positions is around 27 mm both in X and Y direction. The exact amount of shift depends on several parameters like exact diameter of the standard mount, order in which the two Allen screws holding the mount are fixed, etc.

In this example, we'll again start with an empty position list and will import and translate positions for range of Smithsonian microbeam standards, which have been mounted together in a standard block and already been digitized in the middle-left position of the Cameca HO6 holder.

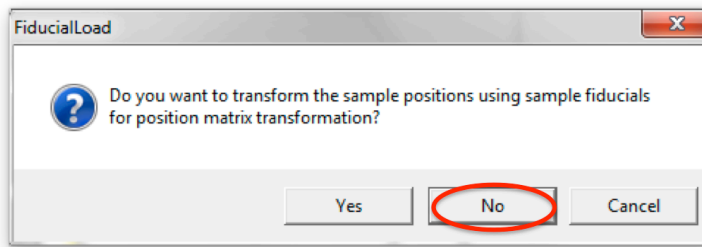
As before, click **Import from ASCII** in the **Automate!** window:



Select (highlight) the standard .POS file in the list and click **Open**:



But in the next step, different to before, click **No** in the message box on fiducial transformation:



The **Increment Position Translation/Import** window opens. Assuming that the standard block has been mounted in the middle-right position instead of the "normal" middle left, we have to translate the coordinates by +27000 microns in X, and zero microns in Y, so we have to set the corresponding *Base* and *Factor* values as shown below. The original and shifted positions are displayed in the corresponding tables:

Increment Position Translation/Import

Enter Micron Increment and Increment Factor

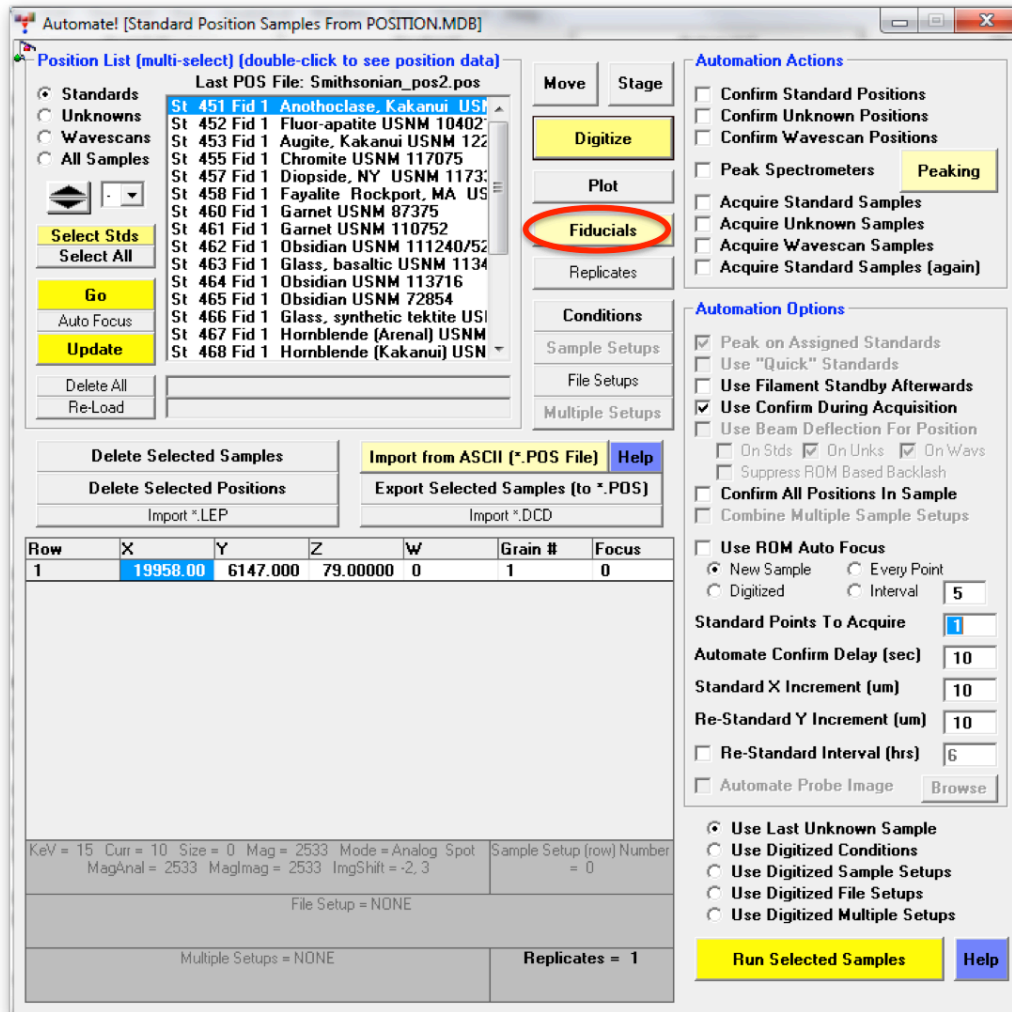
	Base	Factor	Total
X Increment (um)	27000	1	27000
Y Increment (um)	0	0	0

Enter the base increment and the multiplication factor for the total position import increment or click cancel for no import increment.

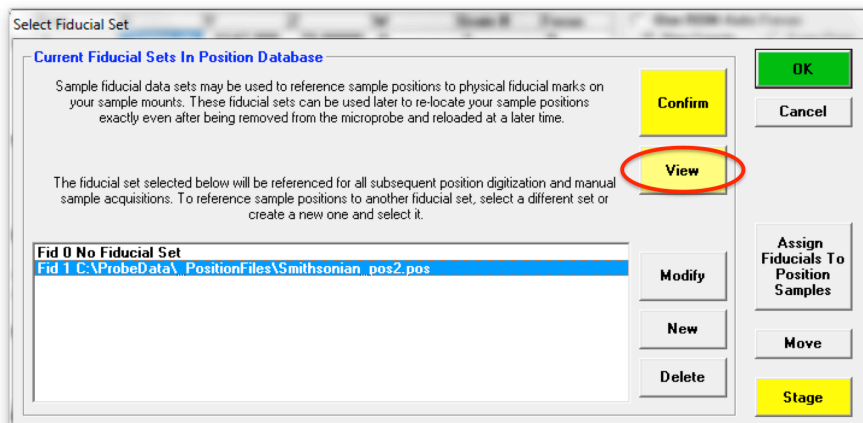
Original Positions				Incremented Positions			
Row	X	Y	Z	Row	X	Y	Z
1	-7042.0	6147.00	79.0000	1	19958.0	6147.00	79.0000
2	-5698.0	2689.00	89.0000	2	21302.0	2689.00	89.0000
3	-20599.	508.000	50.0000	3	6401.00	508.000	50.0000
4	-8894.0	7547.00	77.0000	4	18106.0	7547.00	77.0000
5	-19394.	3665.00	54.0000	5	7606.00	3665.00	54.0000
6	-13499.	-7989.0	63.0000	6	13501.0	-7989.0	63.0000
7	-11858.	7807.00	69.0000	7	15142.0	7807.00	69.0000
8	-6029.0	-926.00	82.0000	8	20971.0	-926.00	82.0000
9	-7698.0	-5257.0	77.0000	9	19302.0	-5257.0	77.0000
10	-19892.	-2537.0	57.0000	10	7108.00	-2537.0	57.0000
11	-18994.	-5711.0	56.0000	11	8006.00	-5711.0	56.0000
12	-16321.	-6782.0	60.0000	12	10679.0	-6782.0	60.0000
13	-16199.	6422.00	68.0000	13	10801.0	6422.00	68.0000
14	-10532.	-7772.0	65.0000	14	16468.0	-7772.0	65.0000
15	-11032.	-7692.0	65.0000	15	15968.0	-7692.0	65.0000
16	-13477.	-8132.0	66.0000	16	13523.0	-8132.0	66.0000
17	-15738.	-7483.0	65.0000	17	11262.0	-7483.0	65.0000
18	-10983.	-9309.0	65.0000	18	16017.0	-9309.0	65.0000
19	-13643.	-1092.0	65.0000	19	13357.0	-1092.0	65.0000
20	-12922.	-3902.0	65.0000	20	14078.0	-3902.0	65.0000
21	-11009.	-3829.0	65.0000	21	15991.0	-3829.0	65.0000
22	-13902.	-3029.0	65.0000	22	13098.0	-3029.0	65.0000
23	-19993.	-5098.0	65.0000	23	7007.00	-5098.0	65.0000
24	-17049.	-7077.0	65.0000	24	9951.00	-7077.0	65.0000

The coordinates for the fiducial markers are not shown in this list but are translated in the same way. Click OK, to import the translated coordinates.

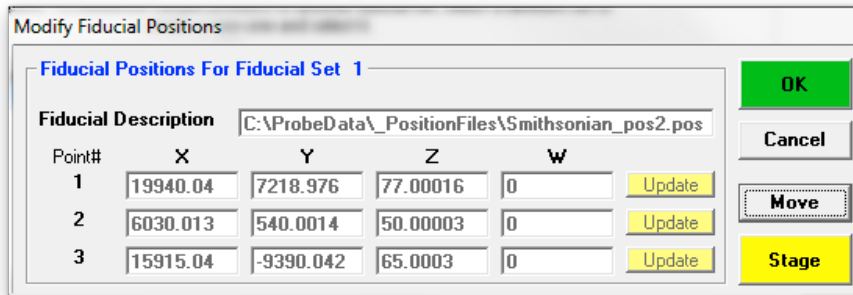
To view the translated fiducial coordinates and update the exact standard positions using the fiducial markers, click **Fiducials** in the **Automate!** window:



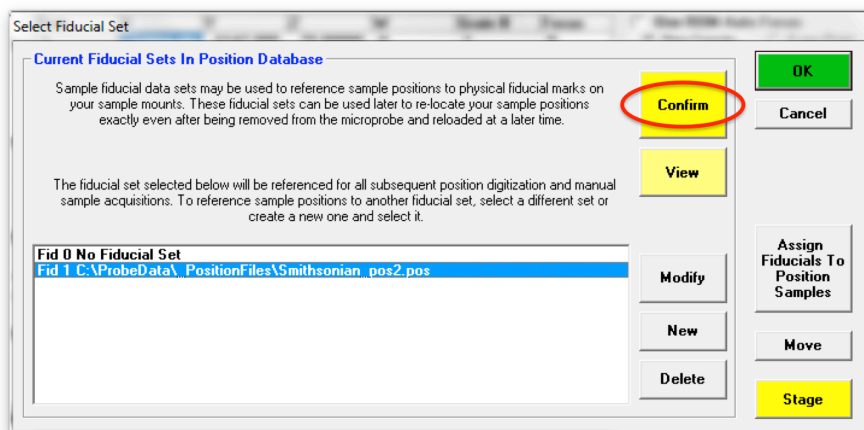
Highlight the fiducial set associated with the translated standard positions and click **View** to view the actual coordinates of the fiducial markers:



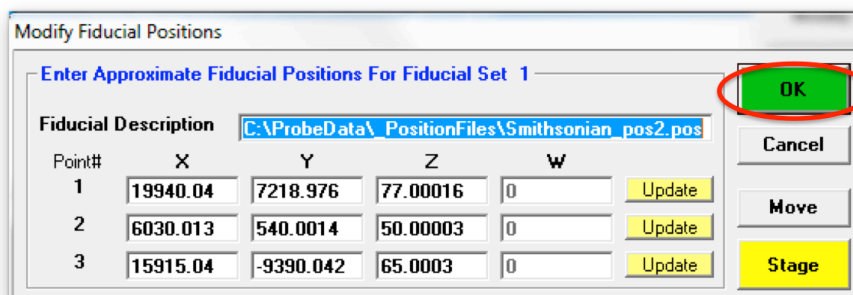
The translated fiducial positions are displayed, but greyed out, indicating that this mode is for viewing only:



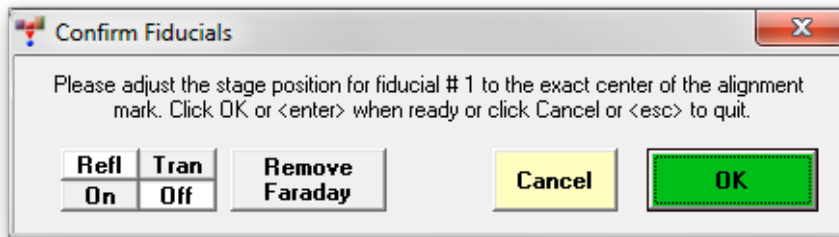
Click **OK** to return to the **Select Fiducial Set** window. To now actually update the standard positions using the fiducial markers click **Confirm**:



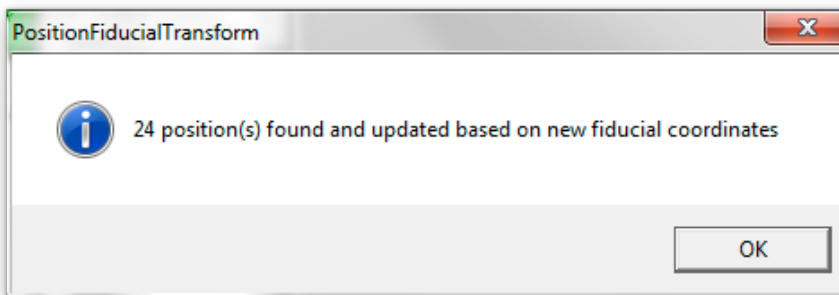
The **Modify Fiducial Positions** window opens. Click the **OK** button to start updating the fiducial positions as described before (see e.g. the **Loading and Updating Standard Positions** section):



As before, adjust and confirm the stage positions for each of the 3 fiducials:

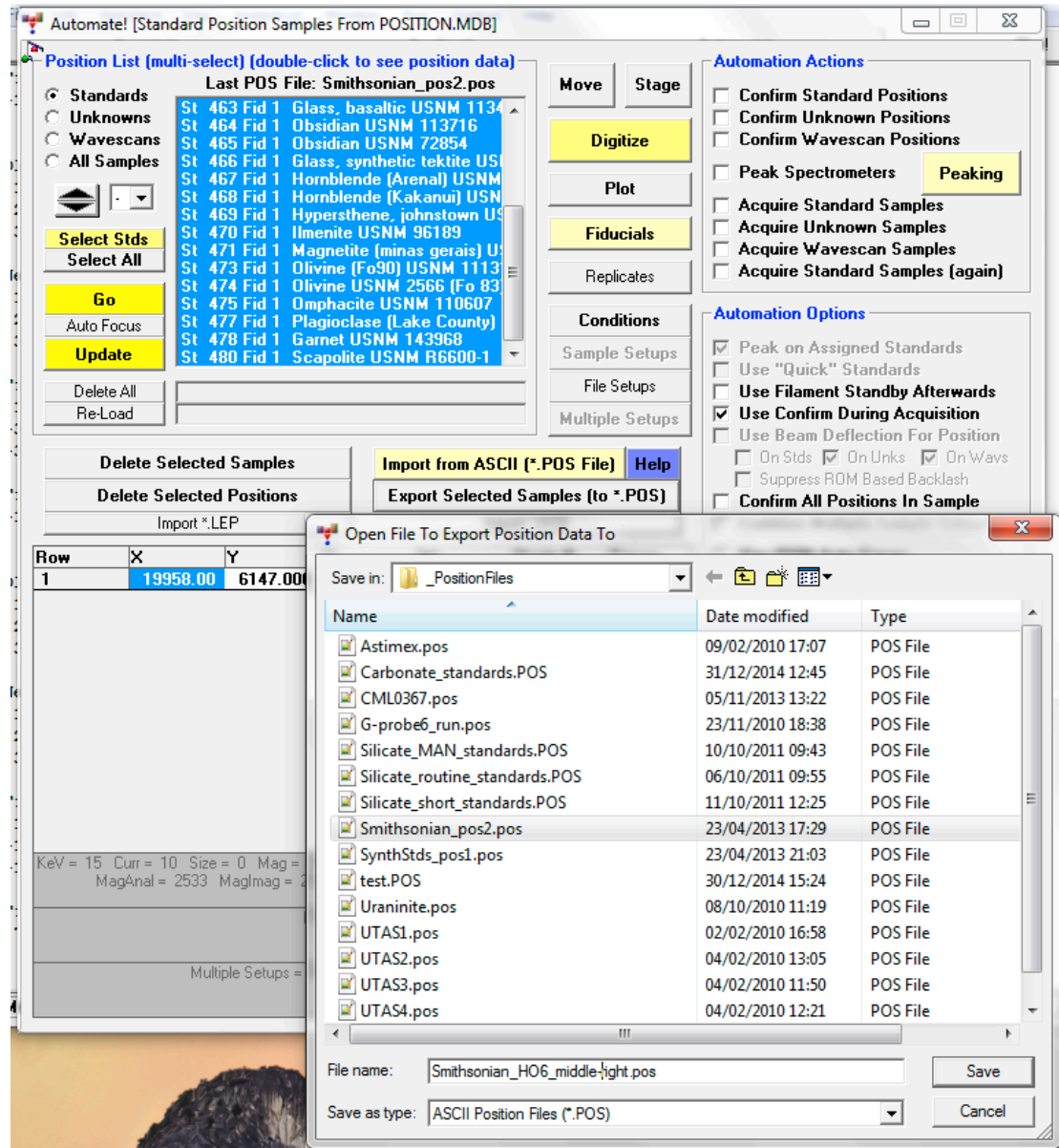


After completion, the software will again display the message box with information about the sample tilt and then a box confirming the update of the positions based on the new fiducial coordinates:



Click **OK**, and click **OK** in the **Select Fiducial Set** window to return to the **Automate!** window.

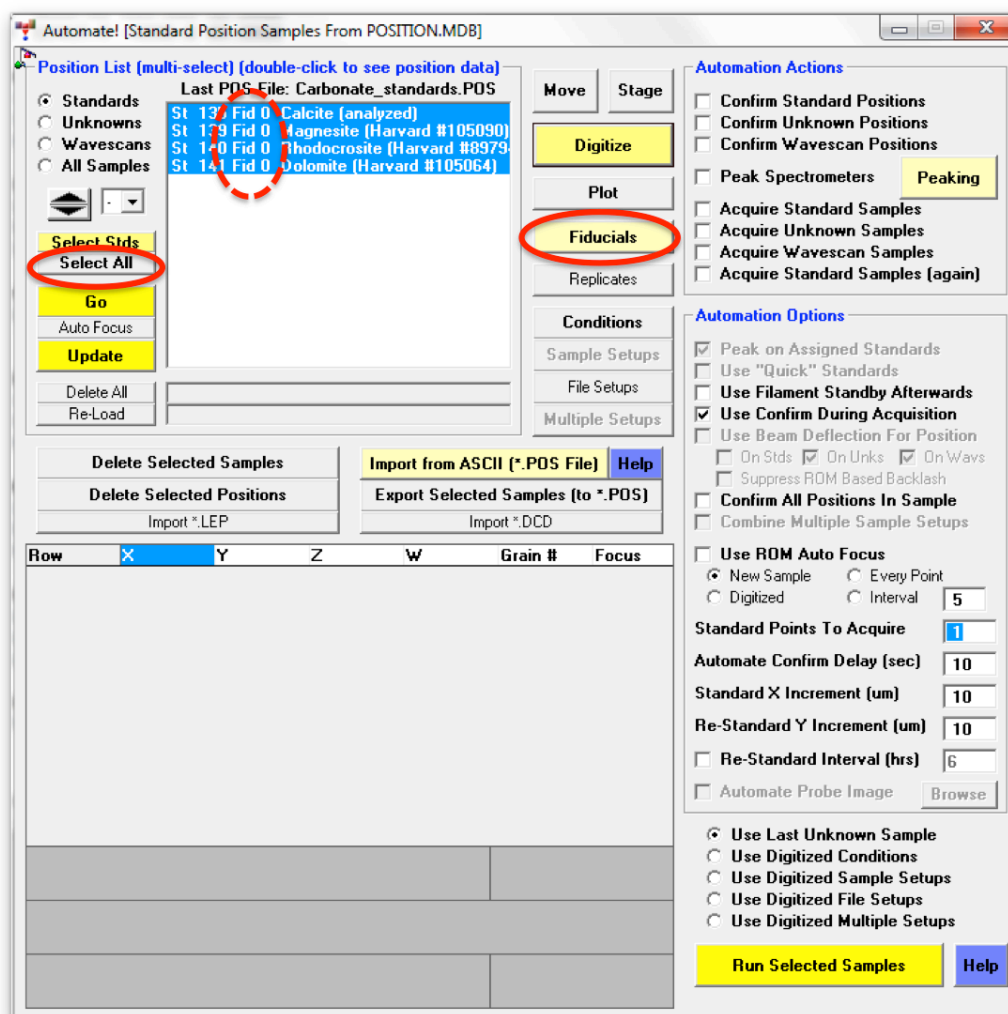
To provide a separate .POS file for the different holder position for this standard block, the updated positions could now be exported to a separate .POS file (see the end of the **Creating Standard Position Files** section) indicating the holder and holder position in the file name:



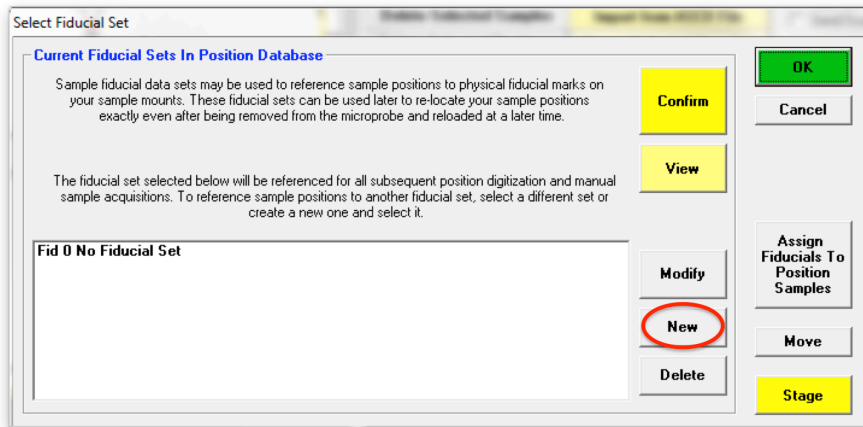
Assigning Fiducial Sets to Existing Standard Positions

In some cases users may have digitized standard positions without creating a corresponding fiducial set first. It is still possible to create a fiducial set later and assign it to existing standard positions.

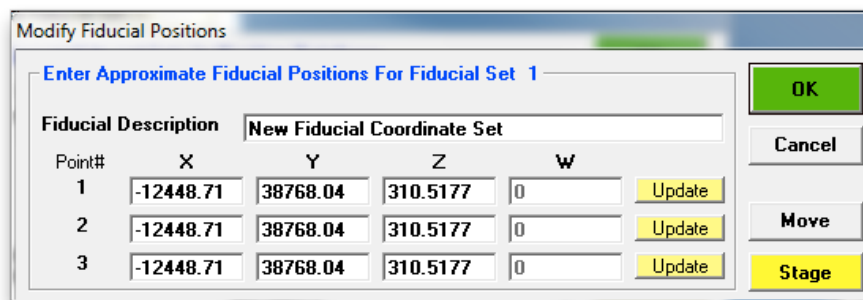
In the following example, 4 carbonate standards have been digitized without specifying a fiducial set first, as indicated by the "Fid 0" label in the Position List. Click **Select All** to select all 4 standards and then click the **Fiducials** button to create and assign a fiducial set:



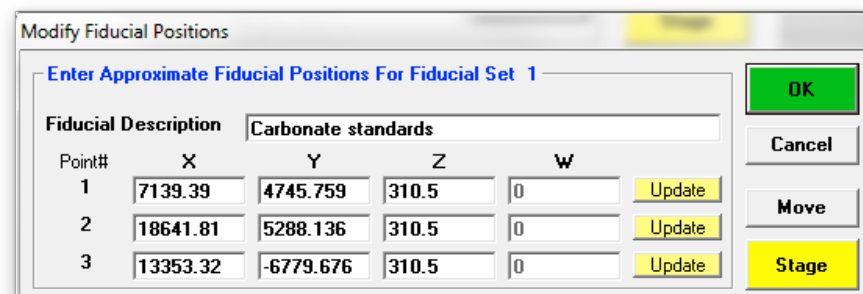
This opens the **Select Fiducial Set** window, which currently doesn't contain any fiducial sets. To create a fiducial set (similar to already described in the **Creating Standard Position Files** section), click the **New** button:



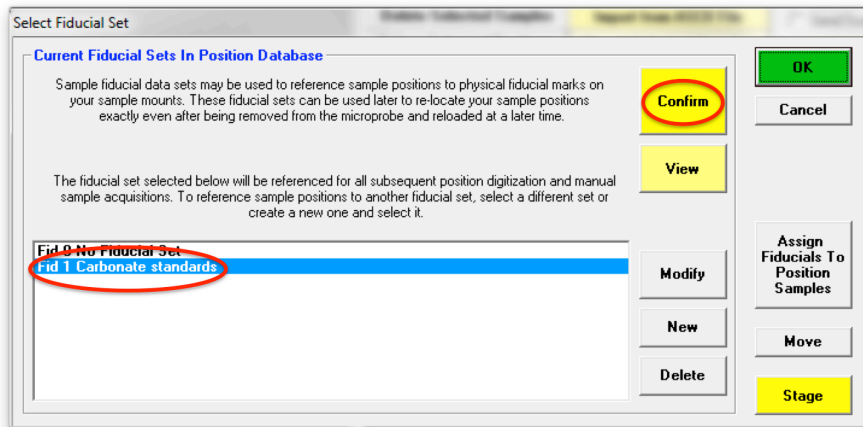
This opens the **Modify Fiducial Positions** window. The current stage coordinates are loaded by default.



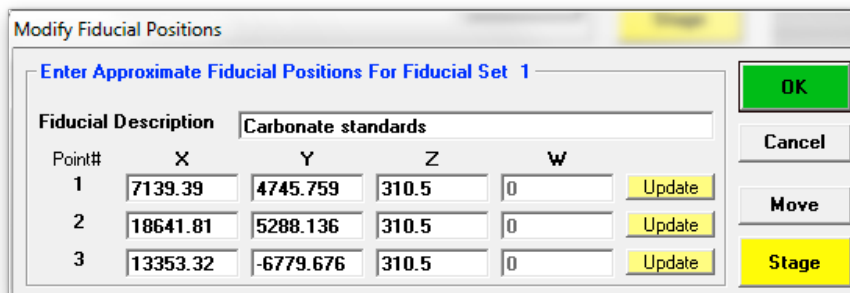
Type in a *Fiducial Description*. Enter the nominal coordinates or click on **Stage** to open the Stage Map! window to move to each of the three fiducial marks on the standard mount, determining their approximate coordinates and click the respective **Update** buttons. The following window will result.



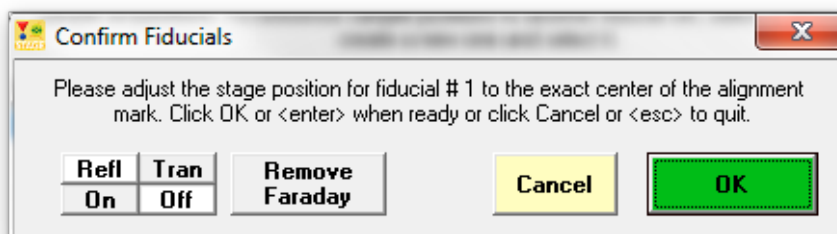
Click the **OK** button when done. This creates a new entry in the **Select Fiducial Set** list box as shown below. Select (highlight) the new fiducial set and click the **Confirm** button to initiate a precise centering of the three fiducial marks.



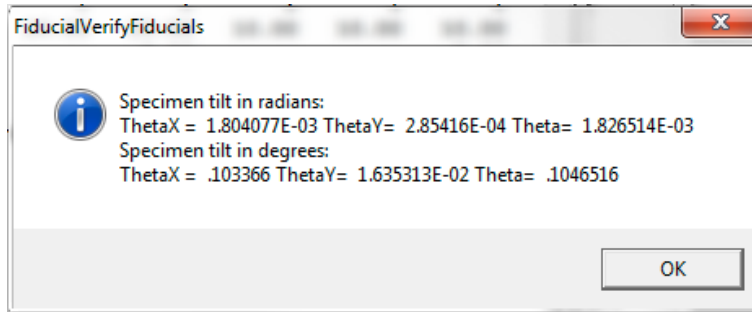
The **Modify Fiducial Positions** window opens displaying the originally entered fiducial coordinates. Click the **OK** button to initiate the centering process.



The computer then drives the stage to each fiducial mark and displays the **ConfirmFiducials** window. Adjust the stage position to center the fiducial mark and click the **OK** button.

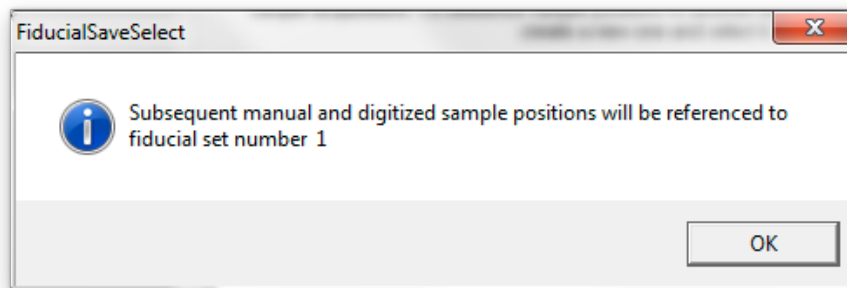


After centering the third fiducial mark and clicking the **OK** button, the **FiducialVerifyFiducials** window opens to display the specimen tilt in radians and degrees. A warning will be given if the sample is tilted at more than 0.5 degrees.

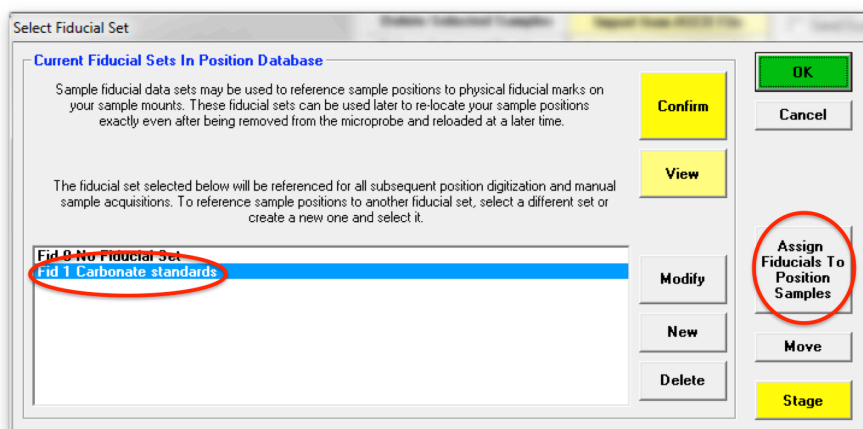


Click this **OK** button.

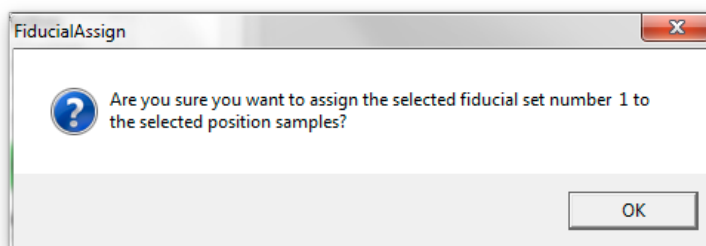
Closing the **FiducialVerifyFiducials** window returns to the **Select Fiducial Set** dialog box. Click the **OK** button. This opens the **FiducialSaveSelect** window to confirm the currently selected fiducial set:



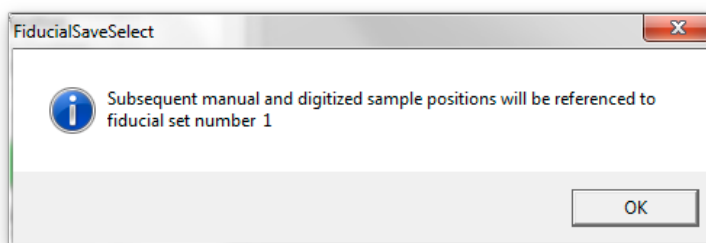
Click the **OK** button of the **FiducialSaveSelect** window. The new fiducial set is now available as **Fid 1** and is automatically selected. Click **Assign Fiducials To Position Samples**:



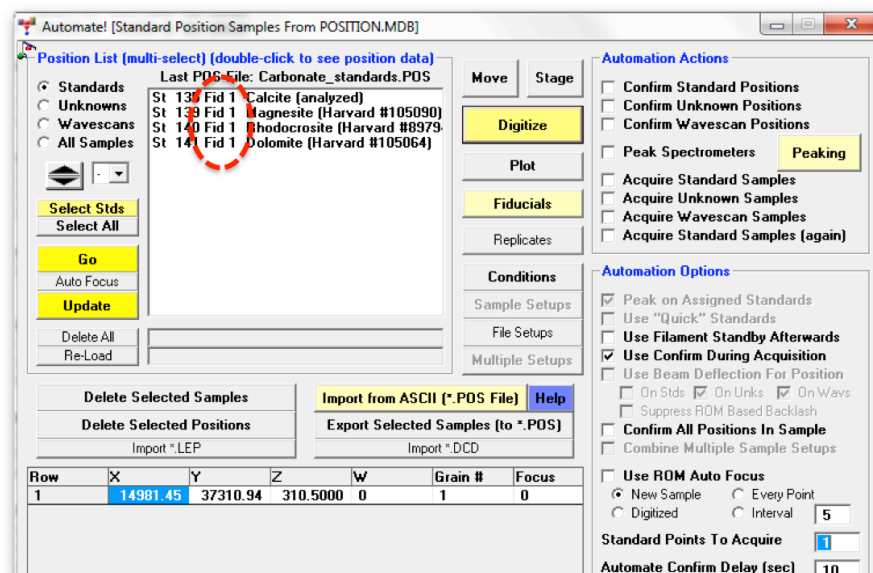
And click OK in the following message box to confirm assignment of the new fiducial set to the currently selected standard positions:



Again a message box is displayed indicating that subsequently digitized positions will have the new fiducial set assigned, for example in case further standard positions need to be added. This assignment can be changed at any stage later using the same procedure:



Click **OK** to confirm, and click **OK** once more in the **Select Fiducial Set** window to return to the **Automate!** window. The four carbonate standards now have fiducial set 1 assigned:



The new standard positions with their matching fiducial set can now be exported for future use using the Export Selected Samples button as described earlier at the end of the of **Creating Standard Position Files** section.