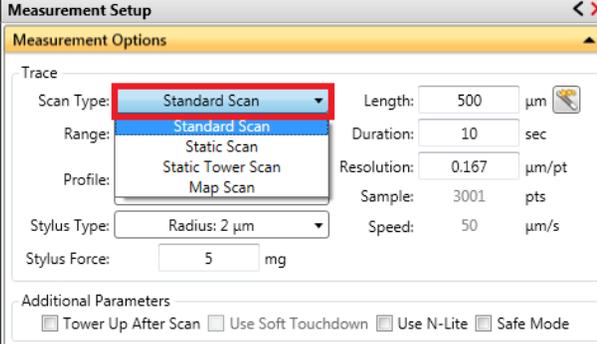
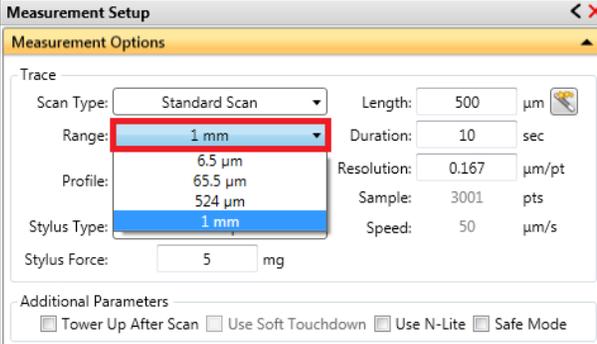
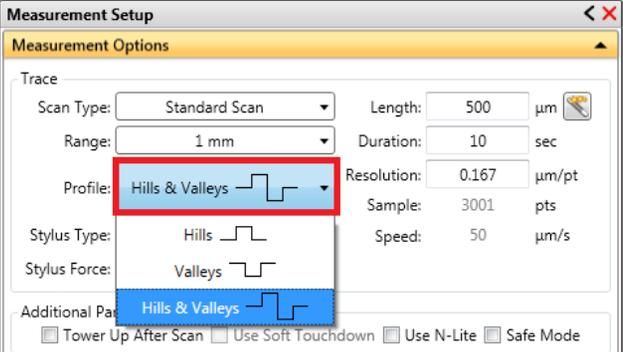
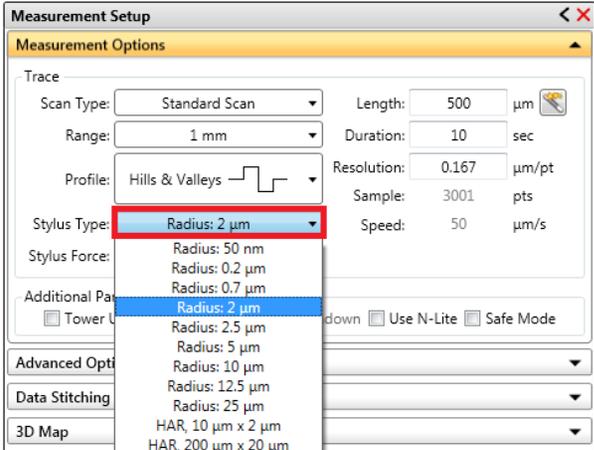


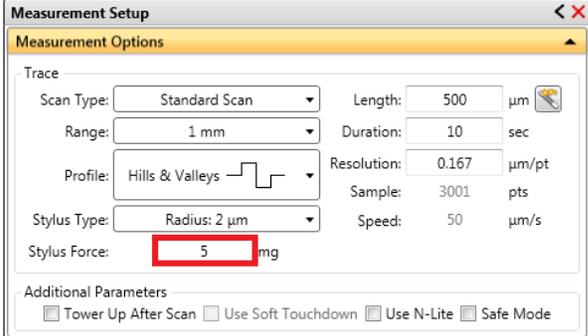
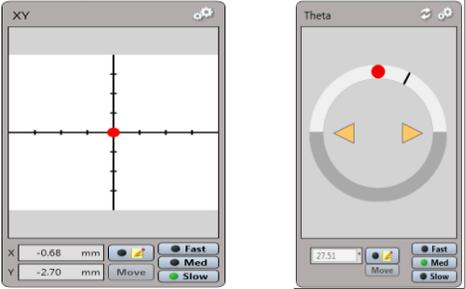
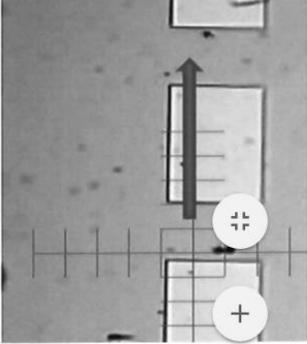
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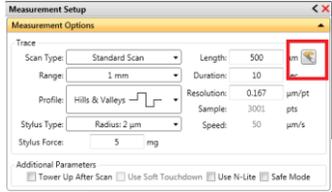
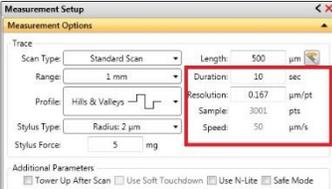
WORK INSTRUCTION BREAKDOWN SHEET

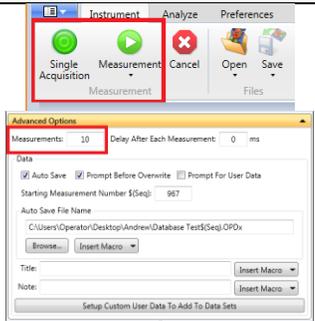
Operation: Profilometer **Operations**
 Instrument: Bruker Dektak XT Profilometer

IMPORTANT STEPS	KEY POINTS	REASONS WHY
<p>A logical segment of the operation when something happens to advance the work.</p>	<p>Anything in a step that might:</p> <ol style="list-style-type: none"> 1. Make or break the job 2. Injure the worker 3. Be a Cultural Consideration 4. Make the work easier to do (i.e., “knack”, “trick”, special timing, or bit of special information). 	<p>Reasons for each key point.</p>
2D Scans		
<p>Click on the Measurement Setup icon if it is not already selected.</p>		
<p>Select Standard Scan from the Scan Type drop-down list.</p>		
<p>Select appropriate Range height from the drop-down list.</p>	<p>Start with a large Range height and then go smaller so as to avoid lateral strain on the stylus from unexpectedly large features.</p>	

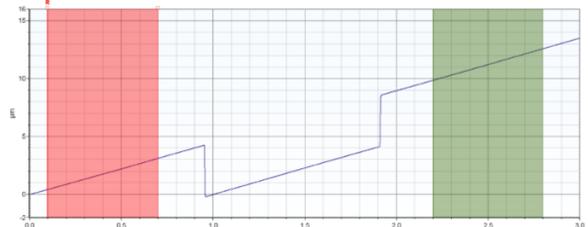
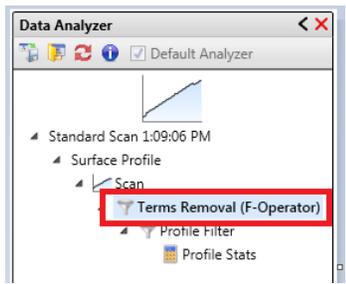
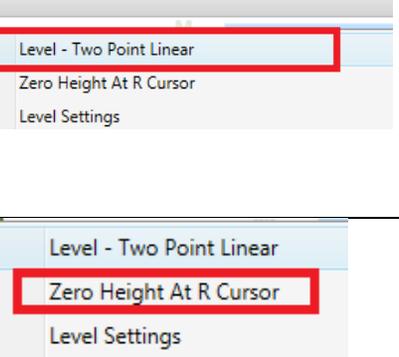
<p>Select appropriate Profile option from the drop-down list.</p>	<p>Hills and Valleys setting should almost always be selected first as it is often difficult and time consuming to ascertain the relative height of an initial starting point.</p>	<ul style="list-style-type: none"> • Hills assumes 90% of the scan data will be <i>higher</i> than the starting position of the stylus. • Valleys assumes 90% of the scan data will be <i>lower</i> than the starting position of the stylus. • Hills & Valleys assumes 50% of the scan data will be <i>higher</i> and 50% will be <i>lower</i> than the starting position of the stylus. 
<p>Select appropriate Stylus Type and radius from the drop-down list.</p>	<p>As of May 2017, Radius: 2µm should be selected.</p> 	<ul style="list-style-type: none"> • The Stylus Type should remain unchanged unless a different tip size is installed. • If a different tip size is installed, please either change back after completion of operation or place a prominent note on the profilometer indicating the tip size in place when Operator’s profilometer session is completed.

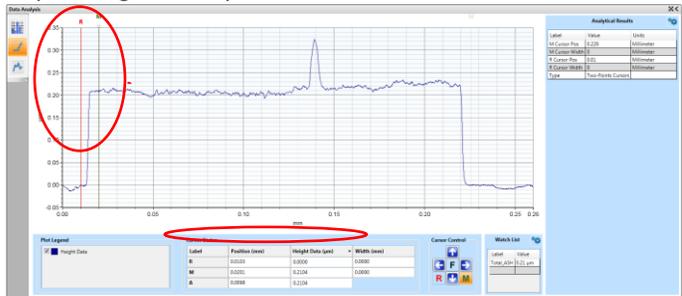
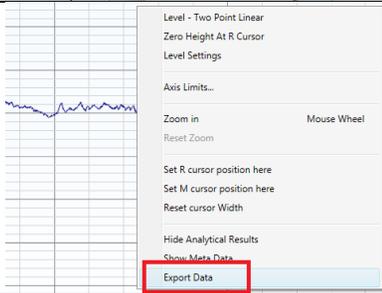
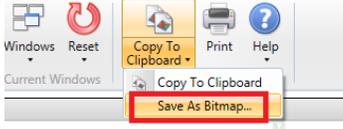
<p>Set the Stylus Force.</p>	<ul style="list-style-type: none"> • Stylus Force is typically set at 5 mg. • Stylus Force range is 0.3mg to 15mg.  <p>The screenshot shows the 'Measurement Setup' dialog box with the 'Measurement Options' tab selected. The 'Stylus Force' field is highlighted with a red box and contains the value '5 mg'. Other settings include Scan Type: Standard Scan, Length: 500 μm, Range: 1 mm, Duration: 10 sec, Profile: Hills & Valleys, Resolution: 0.167 μm/pt, Sample: 3001 pts, Stylus Type: Radius: 2 μm, and Speed: 50 μm/s.</p>	<p>Forces of 10mg should not harm most samples, but sample hardness should be taken into consideration when setting Stylus Force to avoid damage to the sample and stylus.</p>  <p>Image: Stylus tip, arm and covering</p>
<p>Adjust stage to appropriately align sample to the effective stylus scan path:</p> <ul style="list-style-type: none"> • Use “XY” control window for linear adjustments; • Use “Theta” control window for rotational adjustments. 	<p>When aligning sample on stage, NOTE:</p> <ul style="list-style-type: none"> • Effective stylus path travels in a straight line from front of profilometer (closest to Operator) to rear (furthest from Operator). • Depending on goal of analysis, sample’s features of interest should be aligned either parallel or perpendicular to the stylus arm. • When moving stage to align sample, Operator should frequently check position of stylus tip relative to sample surface to minimize risk of damaging stylus tip as per warnings listed in Profilometer Startup/Shutdown. • For efficiency, the speed setting in both the “XY” and “Theta” control windows can initially be set to “medium” for gross positioning, and later changed to “slow” for fine positioning.  <p>The screenshots show two control windows: 'XY' and 'Theta'. The 'XY' window displays a coordinate system with X and Y axes and a red dot indicating the current position. The 'Theta' window displays a circular dial with a red dot indicating the current angle. Both windows have 'Fast', 'Med', and 'Slow' speed settings.</p>	 <p>Arrow in B&W image above shows direction of effective stylus path.</p> <ul style="list-style-type: none"> • “Effective stylus path” is the apparent path along which data are collected from the sample; technically, the stylus remains stationary while the stage moves the sample. • If the sample is not appropriately aligned with the effective stylus path, the collected data may yield misleading information (e.g., slope rather than step, etc.).

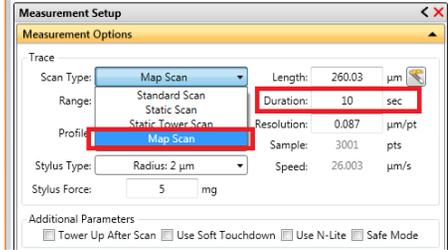
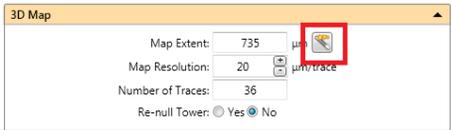
<p>Click the wand button under the measurement options.</p>		<p>Begins 2-step process of defining desired scan distance.</p> 
<p>Set the Starting Point (“bottom” extent) of desired scan length.</p>	<p>When setting scan Starting Point, NOTE:</p> <ul style="list-style-type: none"> • Ensure stylus tip does not run off sample during this step. • First, use the XY instrument control to move the origin of the red crosshairs to the Starting Point (“bottom” extent) of the desired scan length (i.e., “beginning of the scan”). • Select the “Next” button. • NOTE: the start location is the origin of the red crosshairs; not the shadow of the stylus tip. 	 <p>Keeping stylus tip on the sample minimizes risk of damaging stylus tip as per warnings listed in Profilometer Startup/Shutdown.</p>
<p>Set the Ending (“top” extent) of desired scan length.</p>	<p>When setting scan Ending, NOTE:</p> <ul style="list-style-type: none"> • Ensure stylus tip does not run off sample during this step. • Second, use the XY instrument control to move the origin of the red crosshairs to the Ending (“top” extent) of the desired scan length (i.e., “end of the scan”). • NOTE: it is not necessary to set the Ending (“top” extent) in a perfectly straight line relative to the Starting Point. • Select the “Done” button. 	 <p>Keeping stylus tip on the sample minimizes risk of damaging stylus tip as per warnings listed in Profilometer Startup/Shutdown.</p>
<p>If desired or necessary, adjust the Duration of the scan.</p>	<p>OPTIONAL: Increasing scan Duration (sec) yields finer Resolution ($\mu\text{m}/\text{pt}$).</p> 	<p>Allows Operator to prioritize Resolution or time/Duration.</p>

<p>Determine appropriate scan option and then start scan.</p>	<p>To scan only once over the features of interest:</p> <ul style="list-style-type: none"> • Select the “Single Acquisition” button on top. <p>To automatically scan several times over same scan line:</p> <ul style="list-style-type: none"> • Expand the “Advanced Options” window; • Enter the number of desired passes in the “Measurements:” field; • Click the “Measurement” button. • NOTE: the resulting profile is the average of all the passes. 	
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2D Data Review and Analysis

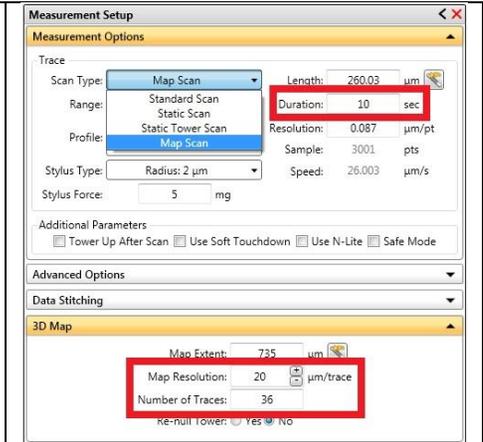
<p>After the scan is completed, if not already selected, click the “Data Analysis” tab to review the results of the scan.</p>		
<p>Level the scanned sample profile.</p>	<p>When leveling the scanned sample profile, NOTE:</p> <ul style="list-style-type: none"> • In the Data Analyzer window, click “Terms Removal (F-Operator)”. • CLICK+DRAG the Reference (R) and Measurement (M) cursors to two locations on the profile with same known flat elevation. • Expand the cursors to cover a larger area. • Right click on the graph and select “Level – Two Point Linear”. 	
<p>If desired, assign the “R” cursor area as the datum, or “zero” elevation.</p>	<p>To assign a zero datum at a specific elevation, move the “R” cursor to that location, right click on the graph, and select “Zero Height at R Cursor”.</p>	

<p>Analyze step height.</p>	<p>To analyze step height, NOTE:</p> <ul style="list-style-type: none"> • CLICK+DRAG the R and M cursors to the bottom and top of a step; if appropriate, expand the cursors to include a range of “noise” to average it. • Step height (Δ) is displayed in Angstroms (Å) or μm depending on sample features and scan resolution. 	<p>It is best to include a range of values within the expanded R and M cursors as there is often significant variation (i.e., “noise”) along known “flat” surfaces.</p> <table border="1" data-bbox="1486 321 1938 428"> <thead> <tr> <th colspan="4">Cursor Status</th> </tr> <tr> <th>Label</th> <th>Position (mm)</th> <th>Height Data (μm)</th> <th>Width (mm)</th> </tr> </thead> <tbody> <tr> <td>R</td> <td>0.0103</td> <td>0.0000</td> <td>0.0000</td> </tr> <tr> <td>M</td> <td>0.0201</td> <td>0.2104</td> <td>0.0000</td> </tr> <tr> <td>Δ</td> <td>0.0098</td> <td>0.2104</td> <td></td> </tr> </tbody> </table>	Cursor Status				Label	Position (mm)	Height Data (μm)	Width (mm)	R	0.0103	0.0000	0.0000	M	0.0201	0.2104	0.0000	Δ	0.0098	0.2104	
Cursor Status																						
Label	Position (mm)	Height Data (μm)	Width (mm)																			
R	0.0103	0.0000	0.0000																			
M	0.0201	0.2104	0.0000																			
Δ	0.0098	0.2104																				
<p>If desired, save the data in Vision 64 software format.</p>	<p>OPTIONAL: Click the “Save” dropdown and select “Dataset”.</p>																					
<p>If desired, export data in CSV format for analysis in Excel.</p>	<p>OPTIONAL: Right click on the graph and select “Export Data”.</p>																					
<p>If desired, save the graph of your data.</p>	<p>OPTIONAL: Click on the “Copy to Clipboard” dropdown arrow and select “Save As Bitmap...”.</p>																					
<p>If Operator is finished with profilometer session, remove the sample.</p>	<p>When completely finished analyzing sample, NOTE:</p> <ul style="list-style-type: none"> • Click on the “Measurement Setup” tab, and select “Unload Sample”. • “Tower Home”, or “Tower Up” can also be used to raise the stylus tip safely away to load and unload samples. 																					

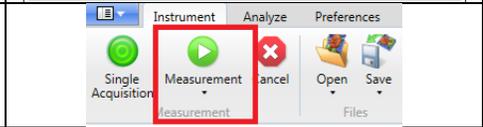
3D Scans		
<p>If necessary, repeat the loading sample procedure, then Click on “Measurement Setup” tab and select the “Map Scan” option from the Scan Type dropdown list.</p>		
<p>Ensure 3D Map Scan does not repeat.</p>	<p>To save time:</p> <ul style="list-style-type: none"> • Expand the “Advanced Options” window; • Enter “1” in the “Measurements:” field; 	<p>3D Map Scans take significantly longer than 2D Standard Scans.</p>
<p>Set the left and right bounds of the scan.</p>	<p>To start setting the scan limits, in the 3D Map window, click on the wand icon.</p> 	<p>Begins 2-step process of defining desired scan width.</p>
<p>Set the Starting Point (“bottom/right”) extent of desired scan area.</p>	<p>When setting scan Starting Point, NOTE:</p> <ul style="list-style-type: none"> • Ensure stylus tip does not run off sample during this step. • Default Starting Point is the same Starting Point set in 2D Standard Scan setup. • If Operator wants to change the default Starting Point: first, use the XY instrument control to move the red crosshairs origin to the “bottom/right” extent of the desired scan area (i.e., “beginning [right edge] of the map extent”); • Select the “Next” button. • NOTE: the start location is the origin of the red crosshairs; not the shadow of the stylus tip. 	<p></p> <p>Keeping stylus tip on the sample minimizes risk of damaging stylus tip as per warnings listed in Profilometer Startup/Shutdown.</p>
<p>Set the left extent of desired scan area.</p>	<p>When setting the left extent of the scan, NOTE:</p> <ul style="list-style-type: none"> • Ensure stylus tip does not run off sample during this step. • Second, use the XY instrument control to move the red crosshairs origin to the left extent of the desired scan area (i.e., “end [left edge] of the map extent”); • Select the “Done” button. • NOTE: Scan length (i.e. “top” extent) is/was determined during 2D Standard Scan setup. 	<p></p> <p>Keeping stylus tip on the sample minimizes risk of damaging stylus tip as per warnings listed in Profilometer Startup/Shutdown.</p>

If desired, adjust Map Resolution to adjust the Number of Traces and total scan/mapping time.

- OPTIONAL:**
- Enter desired values in the “Map Resolution” and “Number of Traces” fields in the 3D Map window.
 - Duration in Measurement Options window can also be changed to affect the Resolution.
 - Total scan time can be estimated by multiplying the Number of Traces by scan Duration.

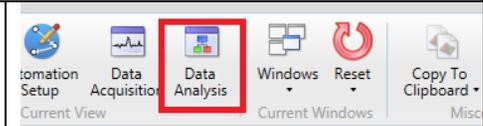


Click Measurement button to start the scan.



3D Map Review

- If not already selected, click the Data Analysis tab to view 3D images and data.
- Data can be saved and exported using the same steps as for 2D Standard Scan.



Proceed to “Profilometer Shutdown” Work Instructions