1. Scope: The purpose of this document is to detail the use of the Veeco D150 stylus profilometer. This document does not cover all aspects of the profilometer's operation. All users are required to read, understand, and comply with this document. It is not a substitute for in-person training and does not qualify an individual to use this system. Failure to follow this document may result in loss of tool access.

2. Reference Documents: Veeco Dektak User Manual

Figure 1: Measurement "tower" with closed cover

3. Tool Overview
    a. General Description: This system measures surface topology/step height features by passing a stylus across that feature. The sample and stylus are moved automatically during measurement.
    b. Technical Information: The stylus downforce can be varied from 1 to 15 mg. The installed stylus has a tip radius of 12.5 µm. When set to a measurement range of 6.55 µm, the measurements are vertically resolved to 1Å. Horizontal resolution is defined by the scan length; the profilometer provides up to 60,000 points per scan. The minimum measured step height is 10Å. The maximum sample thickness is 100 mm, and the maximum substrate size is 150 mm diameter. The (measurable) vertical range is 524 µm, and the maximum scan length is 55 mm.

4. Definitions
    a. Stylus: The diamond-tipped ‘needle’ that is passed across a surface. This stylus has a radius of 12.5 µm.
    b. Profilometer: the mechanical ‘tower’ (Fig. 1) that drives the stylus, supports the optics, and translates the stylus travel into numeric data for analysis.
    c. Downforce: the effective mass of the stylus. Low downforce will cause the stylus to slide across the surface without accurately sampling the topology.
    d. Automation program: A collection of parameters (stored as a file) required to make a measurement. Note that there is no ‘manual mode’ to make measurements.

5. Safety Precautions
    a. Hazards to you
        i. Electrical shock: There are three 120V plugs (tower, computer, and vacuum pump).
    b. Hazards to the tool
        i. Do not touch your sample, or the chuck, unless the stylus is fully retracted. Any mechanical disturbance while the stylus is in contact with a surface can damage it to the point of failure. If there is any question whether the stylus is fully retracted, ask the cleanroom staff for assistance.
        ii. Bumping the desk, opening/closing the tower cabinet, or turbulent air passing over the stylus can adversely affect your measurement.
        iii. NEVER touch the stylus. Should you notice any issues with it- fiber, contamination, damage- report to the cleanroom staff immediately.

6. Facilities
    a. Electrical- 120VAC
    b. Vacuum- Provided by small diaphragm pump underneath the desk.
    c. System Cover- Prevents turbulent air from affecting the measurement. Keep this door closed during measurements.

7. Tool Instructions
    a. Power Up
        i. Check the power switches to verify everything is powered up.
        ii. Turn on the vacuum pump (under the desk).
        iii. Press the white 'I' button on the EMO box. (Fig. 2). This will initialize the tower's stage limits (red LEDs).

Figure 2: EMO box with tower powered up

        iv. NOTE: The tower needs to be powered up at least 15 minutes for accurate and repeatable measurements.
        v. Press and release the button on the front of the computer.
        vi. Double-click the Dektak icon to start the software.
            1. The integration hardware initializes.
            2. When complete, READY appears in the lower left corner.

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b. Measurements
   i. The default program is set up to cover most profiling measurements for your work. Should there be a need to change the settings, please contact staff for support. Do not change the default program.

   ii. Default program:

Force	5 mg
Length	1000 µm
Duration	30 sec
Measurement Range	6.5 µm
Profile	Hills and Valleys
Display Range	Auto

   iii. Verify that the tower is raised; click the Raise Tower button if it is not, then wait until the movement is finished.
   iv. Open the door to the enclosure.
   v. The wafer remains on the chuck to protect your work and the stylus. Check the vacuum toggle (lower left of tower) and remove the wafer. Place your sample on the wafer and put the wafer back on the chuck. The leveling dial is pre-set for a level stage. Do not adjust this. (Fig 3)

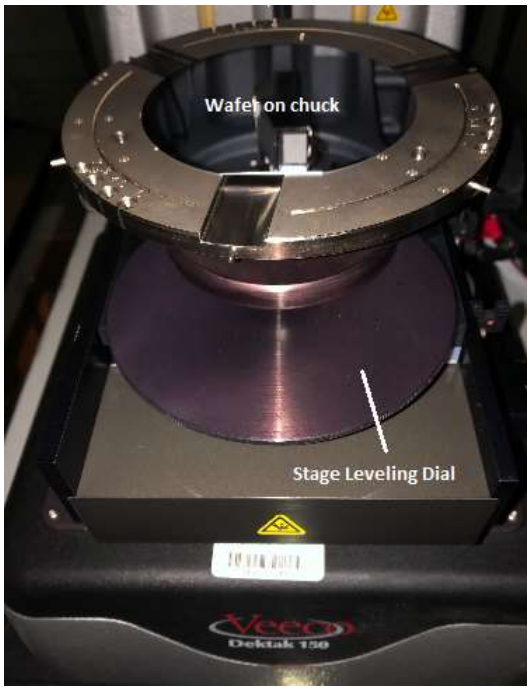

Figure 3: Sample chuck and the stage leveling dial you do not adjust

vi. Load your sample underneath the stylus (check by looking from the front and the side to verify the stylus will land on the sample).
vii. Select Window->Sample Positioning to display the sample positioning window.
viii. Lower the tower (Fig. 4) The stylus will lower to contact the sample, then initialize the Z-height. After that, the stylus backs away from the sample.

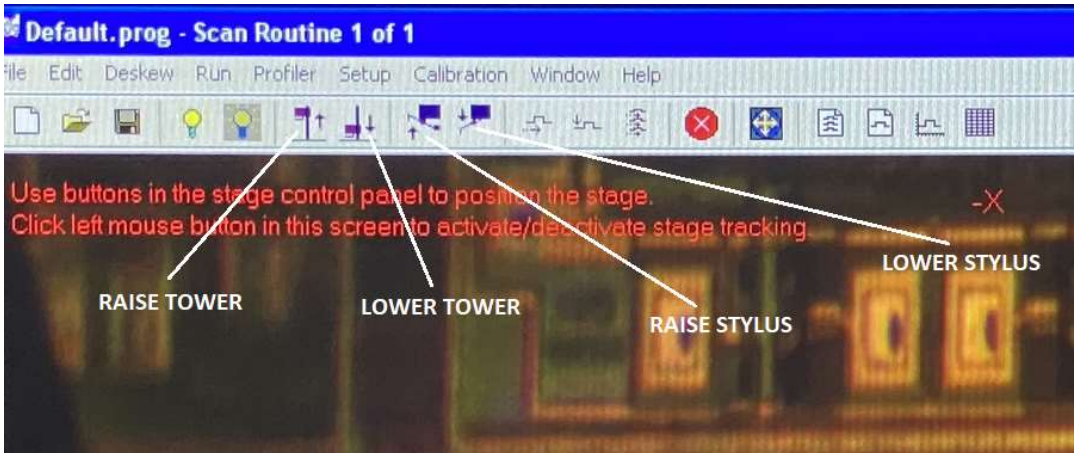

Figure 4: Tower and stylus pushbuttons

ix. The reticle on the display shows where the stylus will land for a measurement. Note that the stage will move down as the stylus measures, so position the reticle to the bottom of your measurement feature (Fig. 5).

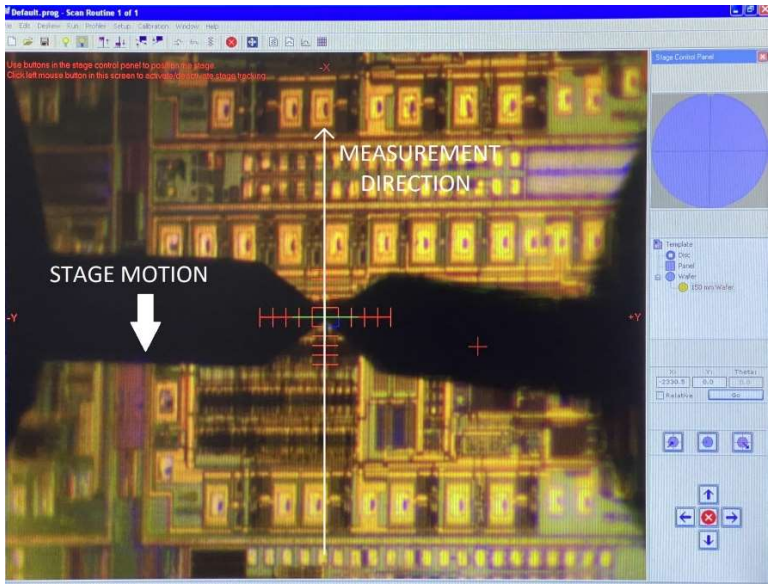

Figure 5: Stage motion and measurement direction

x. Sometimes it will be necessary to adjust the zoom. This is done by moving the zoom ring (Fig 6) as needed, then adjusting the focus.

Figure 6: Zoom and focus rings

xi. Adjust the illumination as needed (Fig. 7).

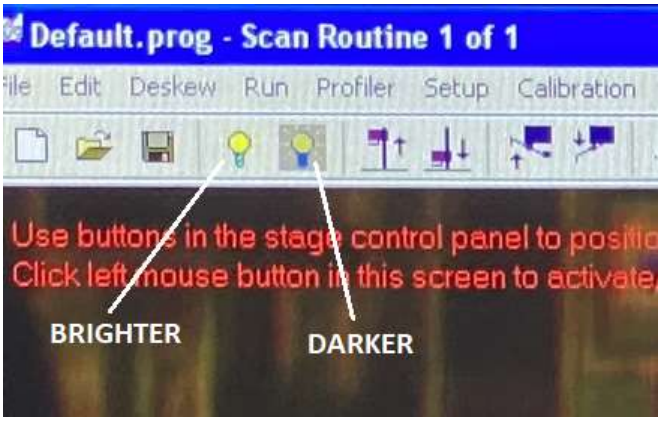

Figure 7: Illumination controls

xii. The sample stage is driven by software; use the arrow buttons (Fig. 8) to move the stage around. Note that the buttons note show the stage direction; the image will “move” in the opposite direction. Hold down the CTRL key to move at a faster speed.

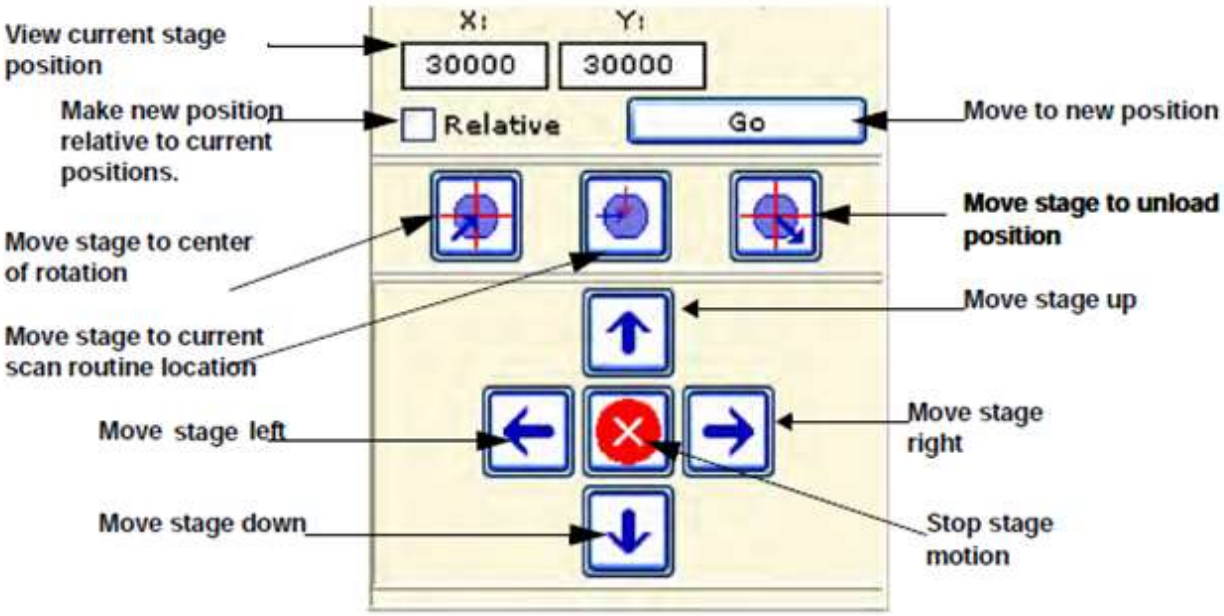

Figure 8: Stage Control Buttons

xiii. Once the position is correct, click Run -> Scan here.

xiv. The display will show the stage movement and overlay the stylus trace onto the image. Once the scan is completed, the 'Data XY Chart' is shown (Fig. 9).

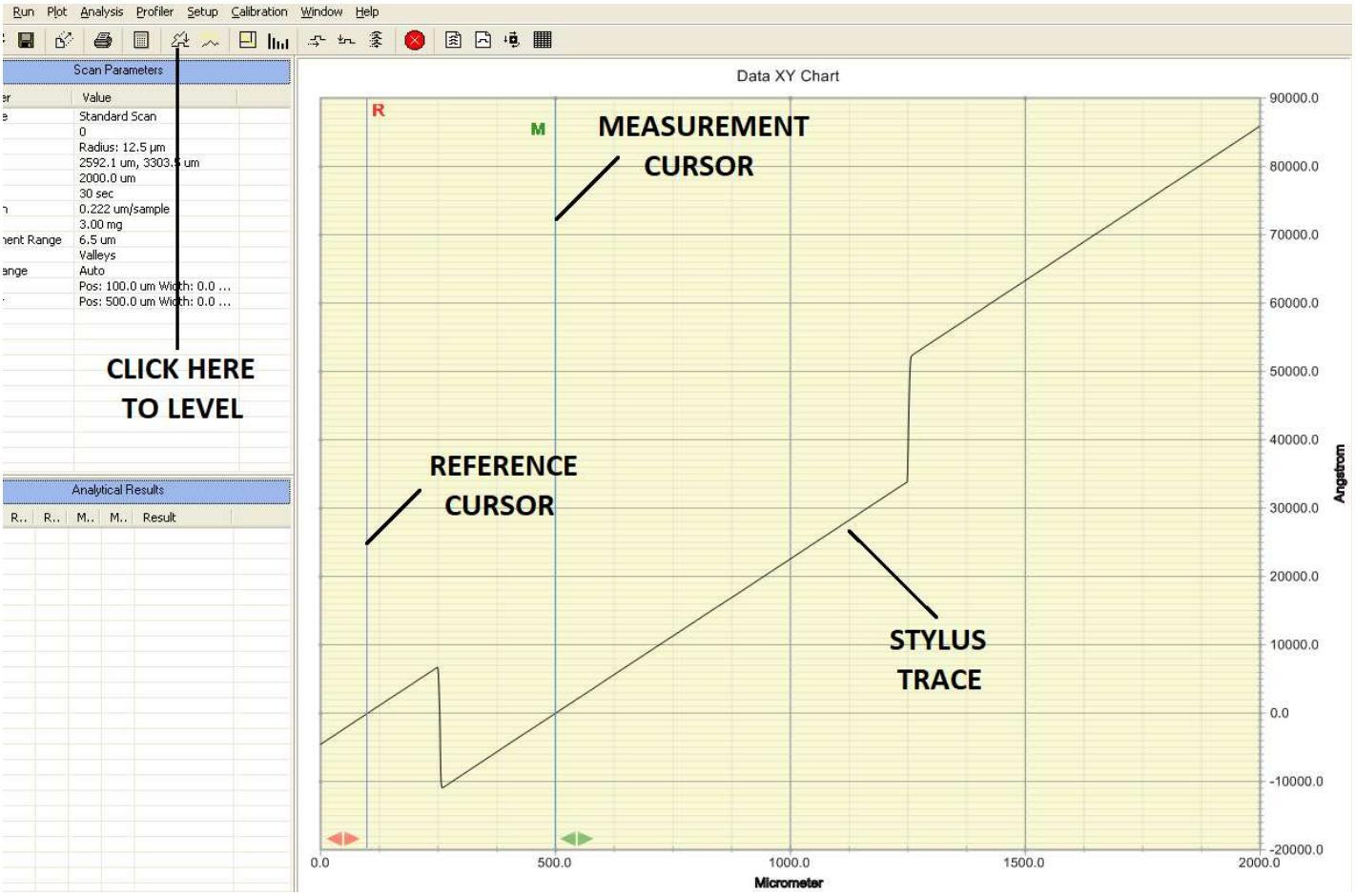

Figure 9: Data XY chart

xv. Drag the one of the cursors (left click and hold) to the baseline of the trace. Drag the other cursor to another flat part of the baseline (both need to run at the same level). Click the level icon, or press F7, or select Plot -> Level. This will flatten out the trace.

xvi. Move either of the cursors so that one intersects the measured feature line. The measurement data are listed at the lower left (Fig. 10).

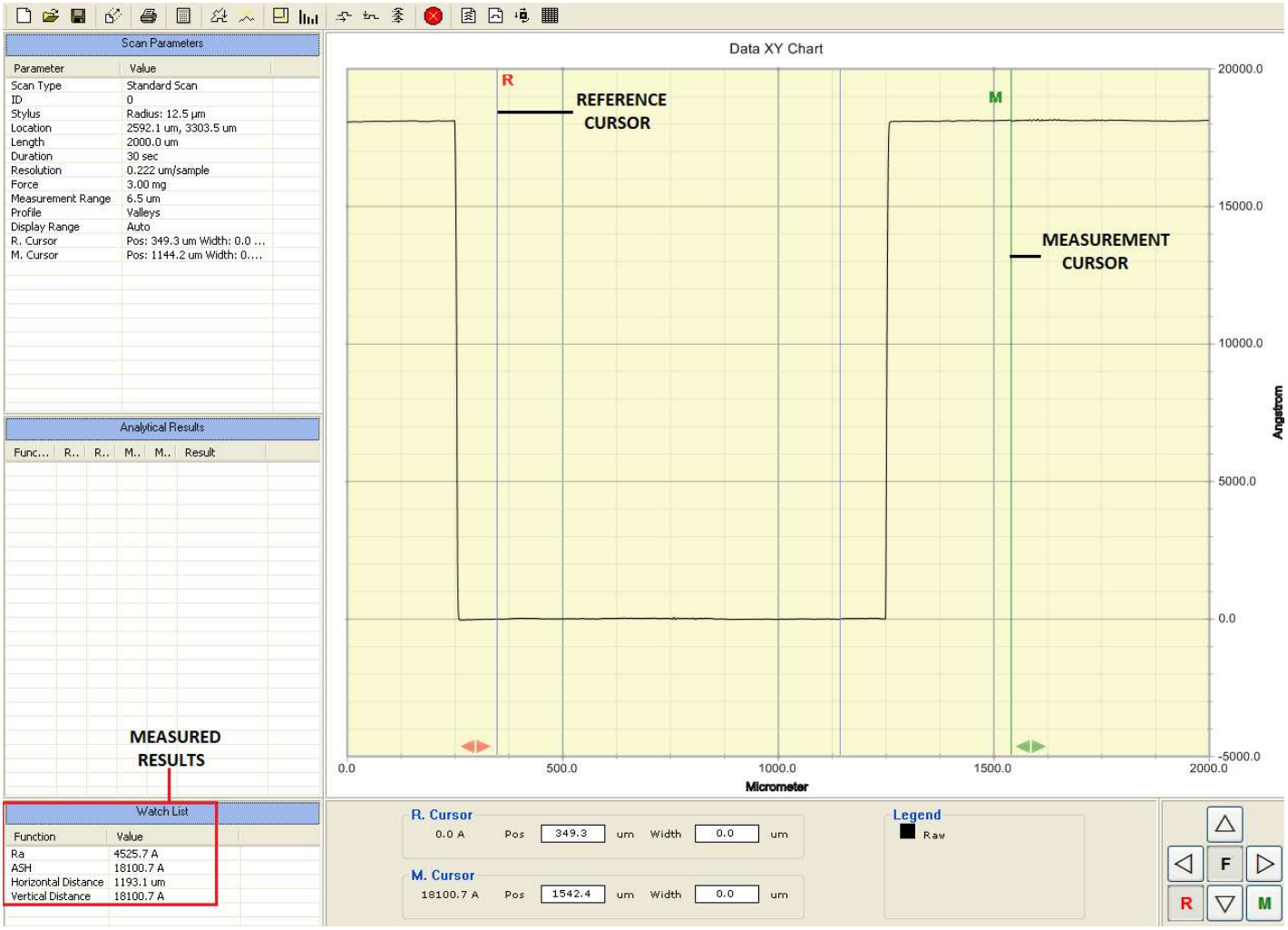

Figure 10: Leveled Data XY chart

xvii. Remember to raise the tower should you need to measure a different sample.

xviii. To capture the data, it is recommended to take a photo of the data chart and the sample positioning window. Should you need to use these as figures in a publication, use the ‘print screen’ and back the PNGs up onto a thumb drive.

c. Shut Down
   i. Switch to the sample positioning window, then raise the tower (Fig 4). Once the tower is raised, the word 'Ready' appears in the lower left.
   ii. Close the Dektak software.
   iii. Shut down the computer.
   iv. Switch off the vacuum pump.
   v. Press the black '0' switch on the EMO box (Fig. 2) to turn power off.

8. Appendix
   a. Soft or otherwise deformable materials may be damaged by the stylus and may permanently damage the stylus. Should you need to measure the thickness of photoresist or E-beam resists, use the ellipsometer.

   b. Table 1, below, shows the pressure the diamond-tipped stylus will place upon the sample.

Table 1: (12.5 µm radius) stylus force and pressure on sample

Stylus Force (mg)	Pressure (kg/cm²)	Pressure (lbs/in²)
1	0.14	2.01
2	0.28	4.02
3	0.42	6.04
4	0.57	8.05
5	0.71	10.06
6	0.85	12.07
7	0.99	14.09
8	1.13	16.10
9	1.27	18.11
10	1.41	20.12
11	1.56	22.13
12	1.70	24.15
13	1.84	26.16
14	1.98	28.17
15	2.12	30.18