

nanoREV Low Temperature STM

Specification Sheet

Version 7.x



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Cover Image: Royal Poinciana (Delonix Regia), popularly known here as the Gulmohar tree is a flamboyant flaming tree blooming in the summers, a sheer delight to the eyes in an otherwise scorching city heat. It is such a wonderful tree, but its numbers are dwindling in the Capital, we would love to see them flourishing always!

S1 Electronics

	Features	Description
1	Main Power Supply input ¹	220-240V AC/50 Hz, 15 W.
2	Power Supply outputs	+5V DC, ± 15 V DC, ± 110 V DC, 110V AC.
3	Computer Interface	USB 2.0 Port.
4	Measurement Channels	4-channels, 16-bit simultaneous sampling ADC.
5	Scan generator	4-channels, 16-bit D/A converter.
6	Scan speed	Upto 77ms/line (13Hz) for 256 pixel scan and re-trace image.
7	Scan drive signals	± 100 V DC.
8	Slope compensation	Digital horizontal and vertical slope compensation.
9	Tunnel Current Set Point Adj.	± 8 nA in steps of 5pA ± 80 nA in steps of 50pA (Optional).
10	Servo Control	Digital Feedback Parameter (Gain, Time Constant) Adjustments.
11	Walker Display	LCD Display of piezo-electric walker's direction and no. of steps.
12	Bias Settings	-10V to +10V in Steps of 0.3mV, -100V to +100V in Steps of 3mV.
13	Imaging modes	Topographic imaging with sub-atomic resolution in: - Constant Current (CC) Mode, - Constant Height (CH) Mode.
14	Imaging modes with LIA (Lock-in Amplifier)	Simultaneous imaging besides topography: - Local Density Of States (LDOS) imaging, - Local Barrier Height (LBH) imaging.
15	I-V Spectroscopy	0.3mV bias resolution for more than 65536 data points, with multi-point mode.
16	I-V Spectroscopy Modes	I/V , dI/dV (numerical) & Normalized dI/dV plots, Export to ASCII option available.
17	Spectroscopy with LIA	Simultaneous I/V and dI/dV acquisition from STM and LIA output channels, for multiple sample locations.
18	I-Z Spectroscopy	Tunneling Current vs tip-sample distance plots, Conductance vs Distance plots (Normal and Semilog) with data export options.
19	I-t Spectroscopy	Tunneling Current or feedback signal output vs time plots, for different feedback control settings. Data logging and export options available.
20	Auxiliary Channel Imaging	Signals from one other/auxiliary ADC channel can be acquired simultaneously while taking scans in the regular CC/CH modes.

¹Requires 5A Power Sockets (12 Points) that are properly grounded (voltage between neutral and Earth is $< 5V_{rms}$) both for various Electronics module(s) and its interfacing Computer.

S2 Scanner

At 300K (Room Temperature)				
	Sizes	Max. Area	Min. Area	X/Y Resolution
1	XL Area	$3.4\mu m \times 3.4\mu m$	$13.6nm \times 13.6nm$	$0.053nm$
2	Small Area	$348nm \times 348nm$	$0.13nm \times 0.13nm$	$5.3pm$
At 80K				
3	XL Area	$1.2\mu m \times 1.2\mu m$	$4.9nm \times 4.9nm$	$0.02nm$
4	Small Area	$43nm \times 43nm$	$0.018nm \times 0.018nm$	$1.9pm$
5	Z-resolution	Analog Mode : $\leq 10pm$ @ 300K		
		Digital : $17pm$ (Using 16-bit DAC) @ 300K		
6	Scan orientation	Horizontal and Vertical		
7	Max Z Range	± 400 to $\pm 550nm$ (Full-Stretch and Full-Retract)		
8	Sample approach	Piezo-tube Walker		
9	Sample size	Sample disc dia. 10mm.		

S3 Cryostat and Insert for LT-STM

1	Temperature Range	80K to 330K
2	Cryogen	Liquid Nitrogen
3	Exchange Gas	Helium
4	Construction	Double-walled (Heater Chamber and Sample/STM Chamber), each of them having independent vacuum and gas-exchange ports.
5	Cool-down time	300K to 80K in 2.5 hours (with exchange gas).
6	Hold-Time (@ 80K)	> 12 hours
7	Heaters	Dual Heaters, one each for sample and LT-STM Insert body
8	Spare Ports	For 2 electrical feed-throughs into LT-STM chamber
9	Insert Mounting Flange	ISO-KF50
10	Vibration Isolation ²	In-built on STM Insert inside cryostat
11	Vib. Iso. method	Cu-Be spring-based dampers
12	Vib. Iso. Cut-off	<10 Hz. Vibration suppression ensures atomic resolution imaging with the scanner
13	Vib. Iso. Stage Lock	Rotary feed-through to lock the Vib. Iso. stage inside the cryostat (during hoisting and descent into the cryostat)
14	Tip/Sample changing	By hoisting and rotating LT-STM stage, <i>ex-situ</i> only.
15	Tip-Sample approach ³	Piezo-based, 10 $\times$ magnified and illuminated tip-sample junction view camera attachment for coarse approach assistance, <i>ex-situ</i> only.
16	Tunneling Current Amplifier	Mounted on the LT-STM Insert (upper-end), inside the cryostat.
<i>Note: Liquid Nitrogen to be arranged by the user at the instrument-site.</i>		

²User to provide a quiet location for the STM setup which is preferably away from loud noise sources, mechanical pumps, vibrating machinery and from frequent human movements and activity.

³Recommended *ex-situ* or ambient conditions are with relative-humidity (RH) < 50%. Users to ensure requisite humidity-control arrangements at the installation-site where RH higher than specified here.

S4 Temperature Controller Specs (Basic)

Sample Heater (Linear Control, 35W DC)		
1	Sensors	Pt100
2	Temperature resolution	0.01 K
3	Temperature stability	Better than ± 0.1 K in isothermal mode
4	Control algorithm	PID
5	PID parameters	User configurable
6	Remote Control	Fully computer-controlled, all temperature-controller logs can be saved and plotted.
7	LT-STM Integration	Seamlessly-controlled from STM software, live plotting and temperature stamps with data acquired using LT-STM
Body (of the LTSTM-Insert) Heater (Switching Control, 35W DC)		
8	Sensors	Pt100
9	Temperature resolution	0.1 K
10	Temperature stability	Better than ± 1 K in isothermal mode
11	Control Mode	Manual front panel entry (not computer controlled)

S5 Vacuum Setup

1	Vacuum range	Ambient to 10^{-3} mbar
2	Vacuum Manifold	Fitted with vacuum-release valve (1), 1" BF Valves (1)
3	Vacuum Gauge	One Pirani gauge-head with analog meter (in mbar)
4	Rotary Pump	For vacuum range 10^{-2} to 10^{-3} mbar (3 rd party supply)
5	Exchange gas	Helium
6	Exchange gas Cylinder	10 liters. <i>(A full cylinder is supplied with the setup).</i>
7	Exchange gas Purity	99.99% <i>(All successive He gas refills to done by the user).</i>

S6 Frame and LT-STM Hoist/Lift

1	LT-STM Flange Hoist	Fully computer-controlled, motorized lifting/lowering arrangement for LT-STM Insert
2	Tip/Sample changing	- Lock Vib. Iso. stage using rotary feed-through. - Rotate by 90° the hoisted LT-STM Insert for easy access for tip and sample change. - In-built protection against accidental slips/free-fall during tip/sample replacement.
3	Camera Mount	HD 720p camera for visual assistance during tip approach ⁴ .
4	Instrument Frame	Rigid Frame mounted with vacuum-system also has: - STM hoisting arrangement - Cryogen-container placement - Refill arrangement for the cryogen
5	Vib. Iso. of Frame	Provided with vibration-damping base-feet.
6	Cryogen Container	Capacity 23 liters, loss-rate 0.35 liter/day. (3 rd party supply)

⁴The intensity of ambient light around the scan-head may affect the camera-view quality.

S7 Software: SiM

	Features	Description
1	Image Display	Dual Imaging Window for Scan and Retrace Image Display (Image size: 256×256 to 750×750 pixels)
2	Oscilloscope	Multi-channel in-built software CRO for plotting signals from different ADC channels.
3	Movie Mode	Repetitive scan captured as frames of a movie, Movie processing, split into individual images and export to GIF format.
4	Sample Navigator	Graphical assistant for localized zooming w.r.t. a large area scan
5	3D	Colored 3D renderings, selection of color look-up tables
6	Data Export	Export to standard image file formats like jpg, ASCII, postscript format. Splits simultaneous channel data into individual image files.
7	Analysis Functions	Line (Single line profile) Extraction, localized Zooming, Roughness Display, Measure length and angles on the images, Spatial and Fourier Filtering, 2D-FFT with distance measurements.
8	Calibration	X/Y/Z-Calibration Utility.
9	Image Processing Tool	Slope and Z-drift Correction, Spatial and Fourier Low-Pass Filtering, Background Subtraction, Histogram Equalization, Zooming, Contrast, Contrast, Invert, Spike-noise Filter etc.
10	Batch Processing	Batch export to ACII, jpg. Export a batch or a sequence of scans into GIF animation.
11	Image Viewing	For quickly reviewing, basic processing, ranking and sorting <i>nanoREV</i> TM images (*.npic).
12	Tip Locator Window	Displays current position of the tip over the sample.
13	Nano-Lithography	In-situ tip cleaning & restructuring utility by applying voltage pulses to the sample
14	Color Mode Selection	Customizable gray-scale and color modes for the image (both in 2D and 3D)
15	Installer flash-drive	With drivers and software packages for the entire set-up.

S8 LIA Specifications (Basic)

1	Reference Generator	10Hz to 1MHz
2	Full Digital Control	Software control of all parameters of the reference generator, amplifier gains and low-pass filter (LPF) cut-off frequency.
3	Software Interface	Python and C++ SDK library for LIA control.
4	Main Power Supply input	220-240V AC/50 Hz
5	Computer Interface	USB 2.0 Port.

S9 LIA (Lock-in Amplifier) Integration

1	Multi-channel Imaging	Simultaneous acquisition and display of LIA outputs as images or plots.
2	User Interface	Seamless control of all LIA parameters from STM software: - Frequency, amplitude and phase of the reference signal. - Amplifiers gain-settings, ac/dc coupling, LPF cut-offs.
3	I/O Signals Interfacing	Front panel accessibility of modulation input and LIA output signals on STM .
4	Digital Phase Control	Auto phase-offset (due to external network) compensation.
5	Data Integration	For multi-channel modes, all the related LIA parameters stored along with STM images and plots data.

S10 Tool Kit

1	Pre-mounted Samples ⁵	HOPG(1) and Optical Drive(1).
2	Tools	Tweezers sets (2), Sample keys (2), Silver ink (1), Tip wire cutter (1).
3	Spares	Blank sample disc (8 no.s).

S11 Tip Kit

1	Platinum-Iridium tips	10 no.s with 0.25mm diameter, 8mm length.
2	Tungsten wire	0.25 mm diameter, 1m length.

S12 Manual

1	User Manual	Hard-copy (English) : 1 copy
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S13 Sample Kit (Optional)

1	Pre-mounted Samples	≤ 10 no.s of HOPG (Highly Oriented Pyrolytic Graphite), Indium Tin Oxide (ITO) and Optical Drives.
2	Sample Key	1

S14 Computer (Third Party Supply)

1	System Configuration ⁶	RAM ≥ 2 GB, Min. Resolution 1024×768 .
2	Computer Interface	With at least 3 spare USB 2.0 ports.
3	OS	Linux (runs on latest Ubuntu Long Term Support distribution).

⁵The demos with the pre-mounted samples would require a cleaning agent, preferably IPA (iso-propyl alcohol) 100ml, lint-free tissue paper (20 sheets), a 1/2 in. wide cello-tape roll and an aluminum-foil roll to be arranged by the user.

⁶Refer the quote for the detailed specs. of the computer being supplied. A regular computer table ($\sim 2ft \times \sim 4ft$) to be supplied by the user at the installation site.

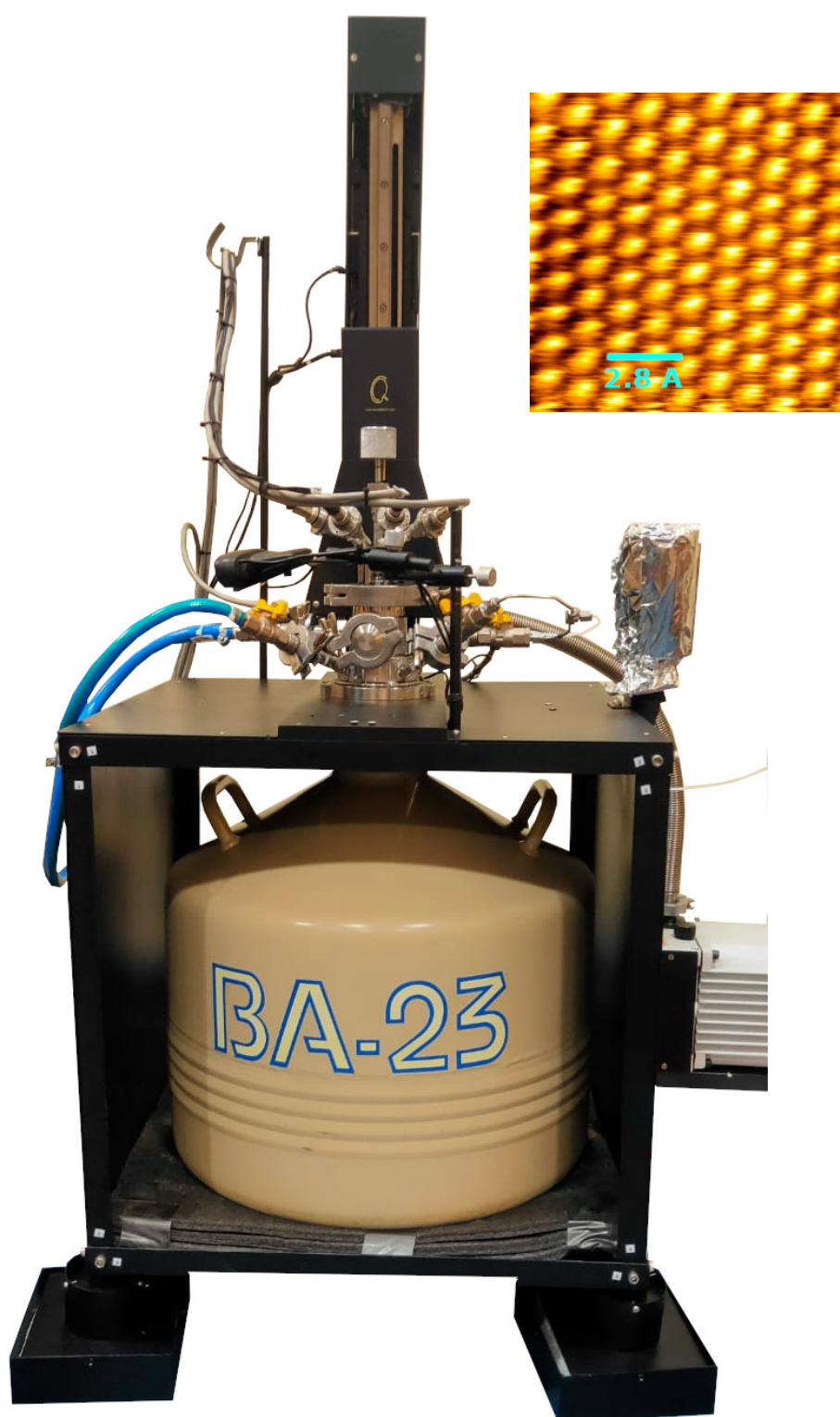


Figure 1: A *nanoREV*[™] LT-STM in action with the atomic resolution scan of HOPG @ 77K obtained using it, shown in the inset.

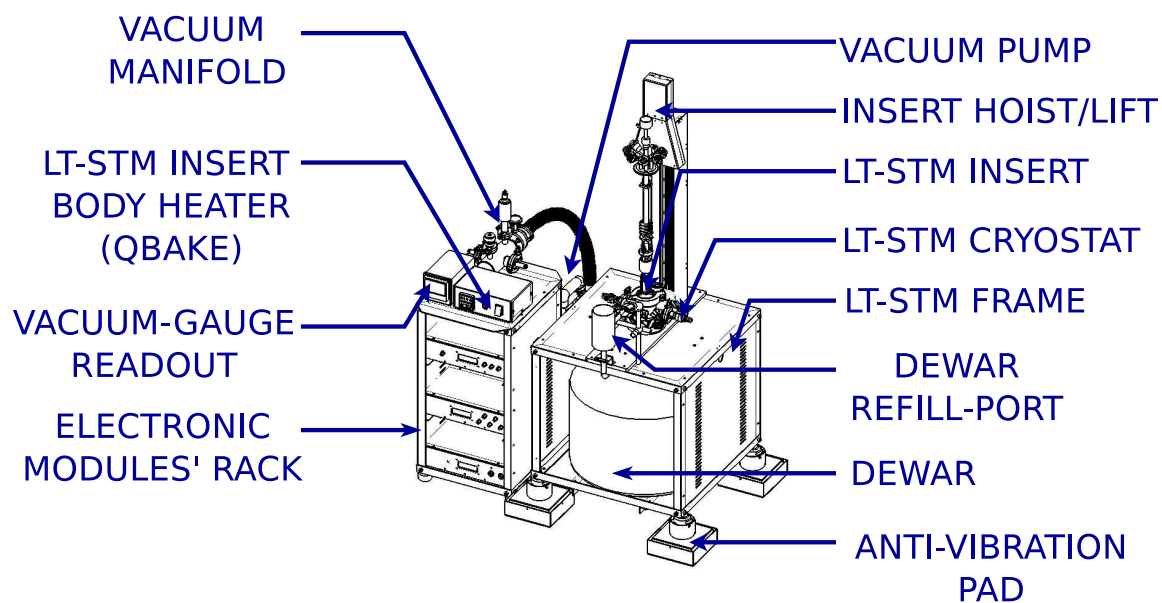


Figure 2: Main modules of the *nanoREV™* LT-STM setup (exchange-gas and all-vacuum lines not shown).

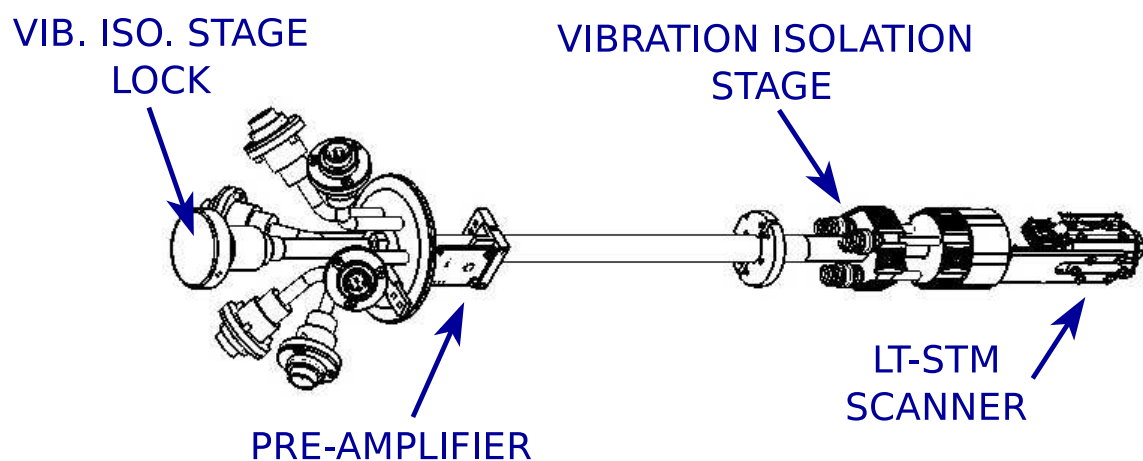


Figure 3: *nanoREV™* LT-STM Scanner which is lowered into the Cryostat.

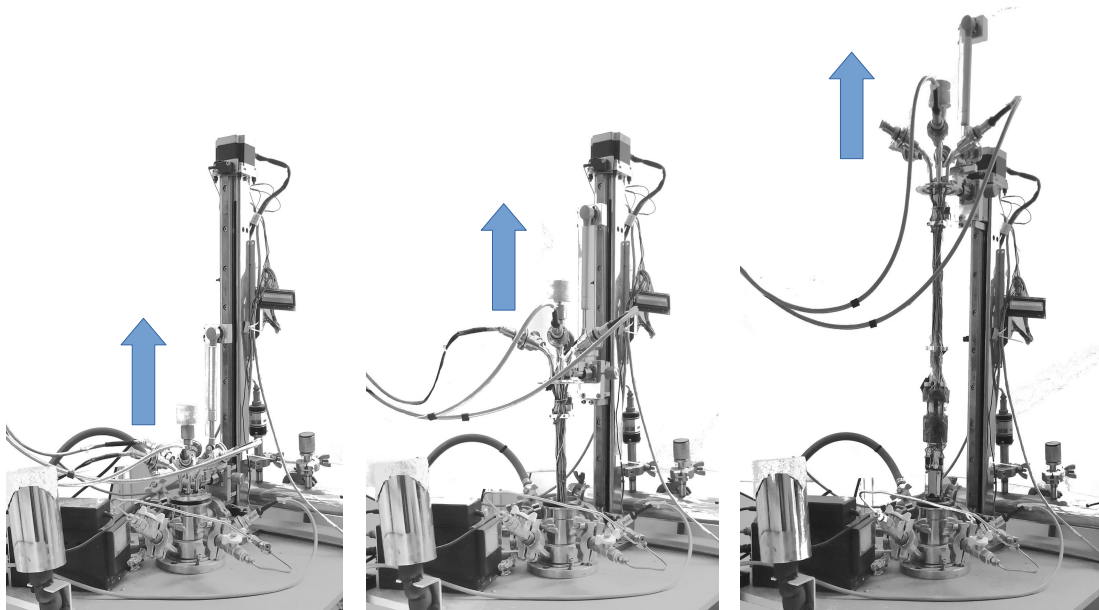


Figure 4: Computer-controlled lift mechanism for easy movement, in and out of the cryostat, of the *nanoREV*TM LT-STM Insert.

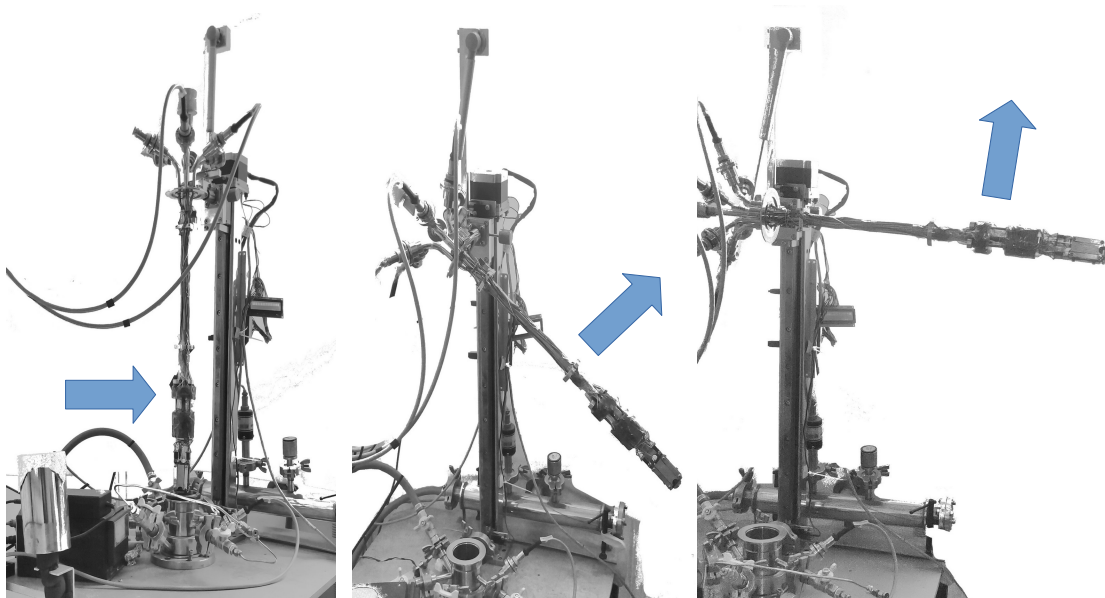


Figure 5: Rotate the LT-STM scanner insert for easy tip/sample access during their replacements. It has an in-built protection mechanism against accidental slips/free-fall during this process.

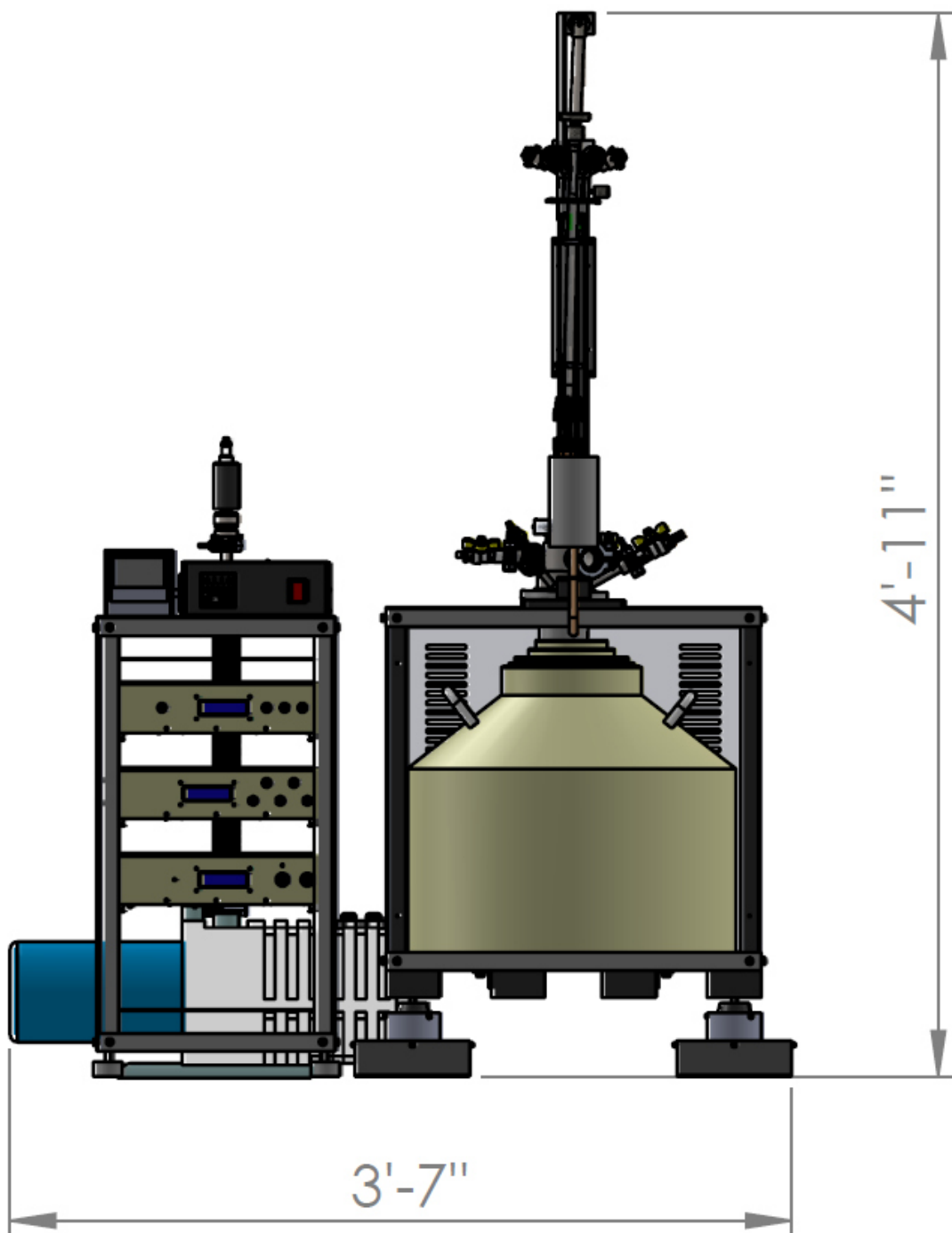


Figure 6: An estimate of width and height of *nanoREV™* LT-STC setup (with STM-Insert Hoist fully up).

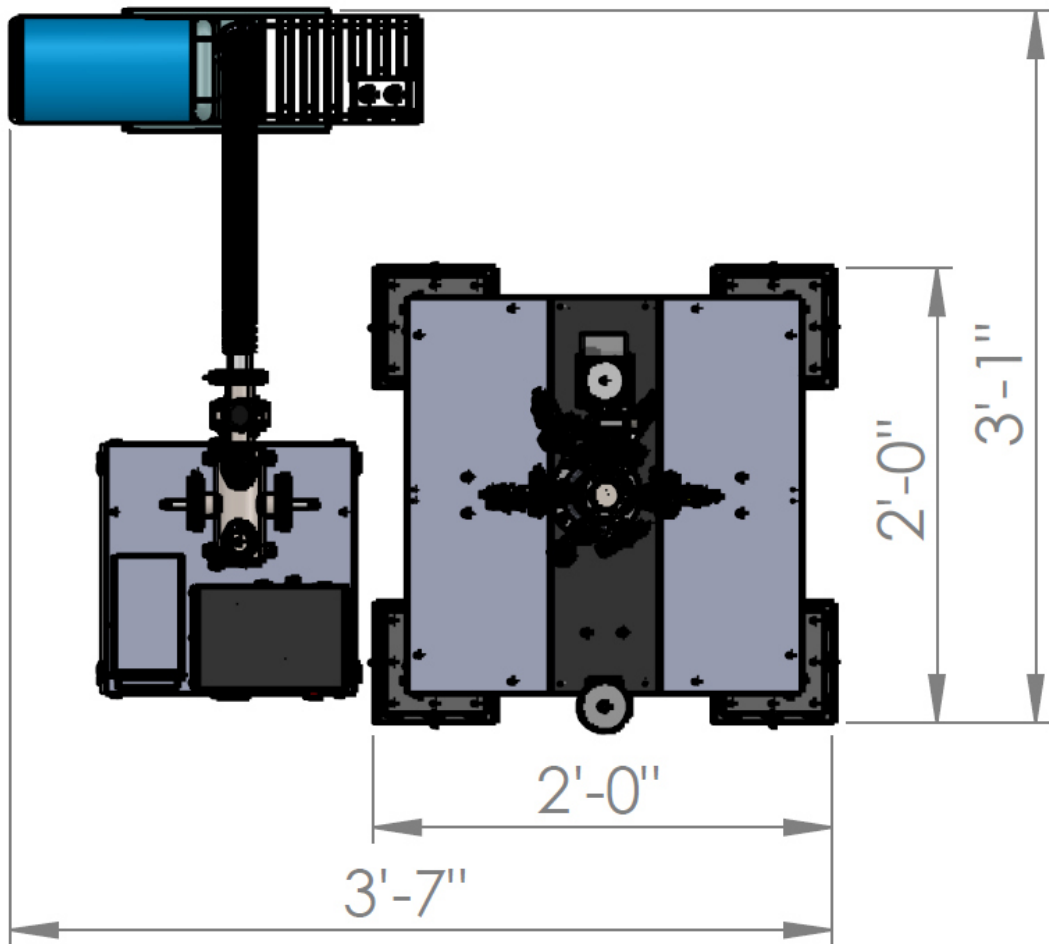


Figure 7: An estimate of the floor-area of *nanoREV™* LT-STM. The space for interfacing desktop-computer is additionally required.