Technical Specifications for the 'Cryo-Electron Microscopy Facility'

'Cryogenic Electron Microscopy (Cryo-EM) Facility' for single particle analysis and soft materials applications composed of two microscope combination, with rapid screening and continuous imaging capabilities to obtain structures of macromolecules and materials at angstrom resolution, composed of direct electron detectors, appropriate software for data collection, visualization and refinement, instrumentation capable of autoloading and storing of specimen under cryogenic conditions with appropriate facilities for sample preparation, along with accessories for uninterrupted functioning, inclusive of warranties and maintenance contract ensuring five years of continuous operation, to be installed and maintained at IIT Madras campus with the support of trained operator and service personnel.

The microscopy facility to be composed of:

1. Field Emission Cryo-Electron Microscope of 200/300 kV, at variable voltages down to 80 kV, for continuous data collection, built-in cold sample stage, energy filtered imaging, tomography and associated functions with best efficiency direct electron detector

Sl No.	Parameters	Technical specifications
1.	Energy filter (EF)	The instrument is expected to have an energy filter (EF) to be used for zero energy-loss imaging of biological samples as well as for energy resolved imaging/spectroscopy.
2.	Image distortion	The EF should have minimal image distortions preferably <0.3 rms in % with automatic alignment and tuning. It has to be well-screened from ambient noise for high resolution, stable imaging.
3.	Direct detection camera	Direct detection camera's expected features/specifications are appended below.*
4.	Resolution	Expected to have image resolution in the range of 0.12 nm, with highest stability and reduced drift.
5.	Automated sample vitrification	Fully automated sample vitrification for single particle analysis and Cryo-EM applications.

6.	Cryo-fixation	Cryo-fixation process to be conducted at controlled physical and mechanical conditions like blotting conditions, temperature, relative humidity and rate of freezing. All necessary tools, holders, tweezers and accessories for sample preparation, transfer, storage must be supplied and should be compatible with all the microscopes and sub-systems.
7.	Compatible storage dewars/containers	Compatible storage dewars/containers of prepared grids under liquid nitrogen conditions within and outside the microscope, including long term storage.
8.	Sputter coating device	Appropriate sputter coating device for making TEM support films for biological and material science samples.
9.	Glow discharge system	Compatible glow discharge system for preparation of high quality samples and observing them under microscopes.
10.	Autoloader/automated specimen exchange system	Autoloading, parking and analysis features. This automated system should store minimum 10 samples.
11.	Other accessories	All accessories for long term data collection and storage of samples and prepared grids.
12.	Tomography	Tomography capability.
13.	Electron micro diffraction (micro-ED)	Electron micro diffraction (micro-ED) capability.
14.	Software	Appropriate software for automated imaging, tomography, single particle analysis, micro-ED, etc., so that the instrumental capabilities are utilised fully under low dose conditions and near-perfect alignment for efficient imaging.
15.	Optional features	a) Cs Image Corrector.

		b) Compatible energy filter for imaging.

2. Field Emission microscope of 200/300 kV, at variable voltages down to 80 kV, for screening, imaging and tomography applications

Sl No.	Parameters	Technical specifications
1.	Cryo samples	Capabilities of high quality imaging and screening of cryo samples.
2.	Soft materials	Capabilities of high quality imaging of soft materials with atomic resolution.
3.	Apertures	Motorized apertures.
4.	Camera	4Kx4K CMOS or comparable camera.
5.	Sample holders	Single tilt, double tilt cryo and high field of view (for tomography) holders.
6.	Detectors	Dual detector (SDD) system for energy dispersive spectroscopy, imaging and tomography. HAADF-STEM capability.
7.	Software	Software for imaging, diffraction, micro-ED, tomography, etc., so that the instrumental capabilities are utilised fully.
8.	Optional features	a) EFTEM/EELS imaging. b) Gatan K3 or similar camera, please see the note below.*

3. For both the microscopes:

Sl No.	Parameters	Technical specifications
1	Contrast enhancement	Added state of the art features for contrast enhancement such as phase plate
2.	Consumables	Minimum consumables for standard operation of the instruments for 5 years including standard grids for cryo-EM, with a typical sample load, other consumables to maintain associated instrument, except liquid nitrogen to be supplied.
3.	Other accessories	Power cables, connections, UPS, batteries, etc., enabling continuous data collection and unattended operation.
4.	Manuals	Operation and service manuals to be supplied.
5.	Training	Training to be provided for initially two technicians/scientists at factory or at the site of a prominent user with comparable facilities as well as every year for the same or other technicians/scientists so that they are trained on most recent developments in hardware and software.
6.	Hands-on training	Hands-on training on operation and maintenance to be provided to a larger team of users at the time of installation and to be repeated every year for fresh batch of users.
7.	Availability of technical expertise in India	Technical expertise on operation and maintenance to be available in India and must be available at site within 24 hours, once the problem is reported. The facility has to be functional for all functions within two days, after the problem has been reported.
8.	Installation and maintenance	Installation and maintenance at site for 5 years with all components and spares included. All the facilities provided as part of the Cryo-EM facility must be covered for this period. There must be a single point of contact for

		all of these.
9.	Operator and maintenance engineer	There must be one operator and one maintenance engineer available at site for 5 years from the date of commissioning to look after regular operations/maintenance, in addition to the staff available from IITM.
10.	Other accessories	LN2 dewars, storage and transfer tubes, gas cylinders if needed, installation/service tools and equipment, etc., to be provided.
11.	Suggested software	State of the art software for improved imaging, tomography, single particle analysis, micro-ED, etc., to be installed at free of cost. The suggested software options are: Relion, cryoSPARC, cryolo, Gctf, motionCor, etc.
12.	Computers and monitors	Computers and monitors for data collection and display for both the instruments separately, for EDS, and for associated facilities.
13.	High end computers	Two high end computers for image reconstruction and analysis with adequate computing power and storage.
14.	Licensed softwares for users	Licensed softwares for data visualisation and analysis to be made available to users.
15.	Collection, storage and transmission of data to institute supercomputer	Data from the microscopes to be collected, stored and transmitted to institute supercomputer and users across through the campus-wide network. Associated switches, servers, storage as outlined in Sarder, K. et al., Acta Crystallogr., Sect. D: Struct. Biol. 2020, 76, 313-325 for a multi-user facility.
16.	Light microscope and other accessories	A light microscope for assessing the quality and integrity of carbon-coated grids or holey carbon grids. Should be

		equipped for dark-field and phase contrast facility.
17.	Air conditioner	Facility to be supplied with appropriate very quiet and precision air conditioning systems, as per the requirements of the instruments.
18.	High quality UPS and other accessories	Facility to be supplied with high quality UPS to take care of power breakdowns of 2 hours duration with extra surge suppressors and any other protection to ensure the safety of the instruments.
19.	Vendor commitment	The vendor has to work with the Institute to ensure that the site for installation is as per the requirements of the instruments.
20.	Quotation for optional facilities	Vendor has to quote for optional facilities such as cryo-ultramicrotome, glass knife maker, high pressure freezer, etc., enabling better sample preparation/storage.
21.	Remote access	Remote access to the microscope for operation and maintenance is expected.

Note: Possibility of integrating all the features of the screening microscope in the existing and fully functional 300 kV microscope (installed in HSB-140) may be explored as an additional feature.

*Direct detection camera's expected/preferred features/specifications

The direct electron detection cameras to be considered for the microscopes will be Gatan K3 with/without BioQuantum energy filter, Falcon 4, 4Kx4K CMOS, etc.

Sl No.	**Parameters**	**Technical specifications**
1.	Sensor lifetime	Radiation hardened back-thinned sensor with sensor lifetime of at least 1 billion e/pix.
2.	Software	Complete software for all camera functions, low dose

		readout and low dose automated data acquisition. Automated magnification calibration and adequate safety measures for camera should be available.
3.	Modes of sensor	Real time fast Counting and Super resolution or integration read out modes should be available.
4.	Size of sensor	Sensor size should be at least 4K x 4K (four thousand by four thousand) pixels. Sensor read out should be >1000 full fps. Physical pixel size of the detector is expected to be in the range of 5 microns.
5.	Detector and software	The detector and software provided should be able to do sub-pixel averaging for more accurate determination of incident electrons. and also, preferably running in a Correlated Double Sampling (CDS) mode to minimize read noise.
6.	Pixels/resolution	It should be possible to observe Thon rings in a high-dose image from an amorphous carbon or Pt-Ir specimen out to the Nyquist resolution in the Fourier transform of an image that is at least 4K x 4K (four thousand by four thousand) pixels.
7.	Suitable PC hardware	Standard and suitable PC hardware and software for the operation of the direct detection camera should be provided. PC should be factory fitted and tested with pre-loaded, licensed software for trouble free operation of the system.
8.	Software with 'pre-configured' settings for operating voltages between 80 and 300 kV	The software provided as part of the proposed the system will include a range of 'pre-configured' settings for operating voltages between 80 and 300 kV (eighty and three hundred kilovolts) that can be easily selected for use with appropriate 'standard' samples.
9.	Data export	The images, data and metadata acquired, and subsequently analyzed and/or manipulated, to be saved in a default format that is widely compatible with other software packages. It is expected that the acquired data & metadata can be exported from the proposed detector in multiple formats (eg .mrc, .tiff, .jpeg, dm3, .txt,).
10.	High-speed fiber optic	A high-speed fiber optic data interface.

11.	Safety controls for software and hardware	The safety controls must be implemented in software as well as in hardware for protecting the operators, instrument and specimens.
12.	Software for single particle analysis and tomography	Automatic single particle analysis and tomography data acquisition software(s) is(are) expected be provided.
13.	Frame alignment software and motion correction software	A proper frame alignment software, to align the movie frames of collected movie images using the detector, should be supplied. In line /off-line motion correction software with suitable GPU hardware should be supplied.

Separate technical and financial quotations to be supplied.

Eligibility criteria:
(1) The vendor must have supplied similar instruments to institutions of repute.
(2) The vendor must demonstrate the availability of high quality data from instruments quoted against this tender.
(3) The vendor must have trained engineers available in India well-versed with the instrumentation.
(4) The vendor must be authorised to represent all the sub-systems quoted.