

SPECIFICATIONS FOR MR IMAGING & SPECTROSCOPY SYSTEM
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The objective of the system would be to perform intensive research on magnetic resonance imaging and spectroscopy pertinent to neuroscience. The equipment shall be installed on a turnkey basis and include erection of a suitable facility for the system. The system should consist of the following.

1. MAGNET

- Actively shielded super-conducting magnet with an operational field strength of 3 Tesla ($\pm 10\%$) suitable for high-resolution structural imaging, functional imaging, diffusion imaging and spectroscopy.
- Magnet bore to be sufficiently wide so that patient tube aperture, after positioning of gradient, shim and RF antennas is 60 cm for comfortable patient study.
- High performance and highly stable shim system with global and localized manual and auto-shimming for high homogeneity magnetic field for imaging (MRI/fMRI), magnetic resonance spectroscopy (MRS).
- Auto shim (global and voxel shim) should take minimum time to shim the magnet with patient in position. Total number of shim coils, details of higher order shimming provided should be specified.
- Devices for helium level monitoring in the magnet.
- Facility for quick shutdown of the magnet in case of emergency.
- Liquid helium should be supplied for 10 years.

2. GRADIENT SYSTEM

- High performance FDA-approved gradient system, with active shielding in X, Y, Z and other planes, that must be capable of simultaneously achieving a maximum gradient strength of 80 milliTesla/meter with a slew rate of 200 Tesla/meter/sec along each axis with a 100% duty cycle for full FOV.
- The system should be capable of performing single shot EPI including conventional and fluoroscopic imaging in all planes (X,Y,Z).
- Effective cooling system for gradient coil and power supply. The system should have efficient and adequate provision for eddy current compensation.

3. M.R SPECTROSCOPY

- System should have hardware and software capability to perform proton spectroscopy (^1H) and multinuclear spectroscopy (^{31}P , ^{13}C), along with optimized sequences and software for post processing and evaluation, including single-voxel/multi-voxel/global spectroscopic estimation quantitatively.
- Sequence and protocol for CSI phosphorous spectroscopy using proton decoupling and NOE. Water suppression ability.

4. RADIOFREQUENCY SYSTEM

- Broadband RF system. RF power to be adequate for high resolution imaging with acceptable power deposition (SAR check) in conventional and single shot EPI mode.
- High receiver bandwidth for EPI applications (specify).

- Support for adding quadrature phased array and flexi coils (specify).
- Capability for parallel imaging and multiband acquisition (specify technical details such as reduction of acquisition time and SNR degradation).
- Specify number of RF receiver channels, their technical specifications and the maximum number of elements/channels it can support in an RF coil.
- Interface for adding on 3rd party RF coils (specify).

5. RADIOFREQUENCY COILS

- One 64-channel head/neck coil for brain imaging, must be compatible with simultaneous EEG-fMRI, TMS-fMRI and TDCS-fMRI systems that are already available.
- Neck array coil
- Spine array coil
- Volume coil for imaging primate and small animal brains (specify best available)
- Body coil (specify best available)
- Surface coil for localized tissues such as visual cortex (specify best available)
- Coil storage cart for safe storage of coils

6. DATA ACQUISITION SYSTEM

The system should be capable of 2D and 3D acquisitions in conventional, fast & ultra-fast spin echo and gradient echo modes so that real-time online images can be observed if needed.

The system should include the following characteristics:

- Ability to replicate and automate scan parameters and sequences to minimize inter-scan variability for a single subject (specify details and sequences supported).
- Automatic Voxel/FOV placement for consistent placement of MRS voxels (specify).
- Data acquisition in all three standard planes (axial, sagittal, coronal) and oblique and double oblique planes.
- High matrix acquisition capability in single shot EPI. Acquisition time, TR, TE and slice thickness should be clearly mentioned and supported by data sheets.
- Dynamic acquisition (serial imaging) with capability to initiate scan sequences either from the magnet panel or from the console.
- Gating systems for wireless monitoring of physiological signals like ECG, pulse, pulse oximeter, respiratory, external signal triggering i.e. interface for triggering input pulse from external source (must include 2 systems for redundancy).
- 5 TTL-compatible programmable spare lines to be provided.
- Head motion sensor with 6-degrees of freedom measurement, with online correction of image acquisition based on subject movement. Specify for each imaging sequences and axes, the type of motion correction available.
- Online Artifact reduction/image enhancement/filtering (specify details)
- Fat saturation techniques: frequency selective RF pulses to suppress fat signals in the measured image FOV. ROI selective (regional) fat suppression should also be given.
- Magnetization transfer saturation: OFF resonance RF pulses to suppress signals from stationary tissue in FOV.
- Phase contrast capability in 2D and 3D mode. Image intensity correction.
- Breath hold acquisition.

7. SUBJECT HANDLING SYSTEM

- Computer controlled subject table with movement in vertical and horizontal direction.
- Subject table should be able to take at least 150 kg load. Emergency manual traction of the subject from the magnet. Audio alarm operated by the subject should be provided.
- Necessary accessories for subject comfort, which should include: Subject communication, MR compatible padding, syringe/infusion pump, lighting, non-magnetic IV stand, etc.
- Remote display of gating (physiological) signals.
- MR-compatible subject trolley.
- Close circuit color TV and color CCD video camera for patient monitoring.

8. IMAGING SEQUENCES

- Sequences for structural imaging, BOLD imaging (including EPI sequences), Arterial spin labelling, Perfusion imaging, T1 and T2 maps, non-contrast and contrast-enhanced MR angiography
- High resolution whole brain diffusion tensor imaging along with tractography software (specify maximum available number of directions and other technical details).
- Specify all standard & advanced sequences available, as well as in-progress sequences that can be made available through the research agreement.
- Fast sequences with SE and GE sequences in 2D and 3D mode. Fat suppression sequences, water excitation sequences, Dixon-type sequences (specify all details)
- Capability for calculating ADC map (isotropic and anisotropy) from the regular diffusion and tensor data.
- Provision for B0 phase + magnitude map.
- Provision of obtaining k-space data, and raw and unprocessed images.

9. POST PROCESSING AND EVALUATION SOFTWARE

- 3D Multiplanar reconstruction (MPR) in any arbitrary plane including curved planes with freely selectable slice thickness and slice increments.
- 3D Surface Reconstruction and evaluation.
- Maximum Intensity Projection (MIP) in 2D and 3D mode, targeted/segmented MIP in any orthogonal axis with cine mode.
- Voxel-based morphometry.
- Software for evaluation of functional images of brain with appropriate statistical algorithms, color display and overlay on base anatomical images.
- Image filtering, coregistration and Image fusion software. Specify what modalities that can be co-registered.
- Software for evaluation of functional mapping [BOLD evaluation] and neurometabolite mapping, with provision to superimpose neurotractography geometry and tensor diffusion field on both functional mapping and neurometabolite mapping.
- Software to conduct behavioural experiments in the scanner

10. HOST COMPUTER AND ARRAY PROCESSORS

- High-performance computer system suitable for the technical requirements of the scanner, data acquisition, imaging sequences, online display and post-processing with capability to access scanner logs. Specify all details.
- One extra satellite console with capabilities identical to the main console.
- Support for exporting data in multiple formats (DICOM, NII, ANALYZE)
- Dual DVD write drive for writing of images, spectra and raw data along with the necessary software for reading the images and spectra on DVD/CD ROM.
- High speed USB/Firewire ports for writing of images, spectra and raw data.
- Reconstruction and visualization console especially for diffusion imaging (DTI) e.g. for online tracking for voxel placement
- Online display of acquired raw images during scan
- Compatible with data archiving systems (specify how this can be implemented)

11. ACCESSORIES

- MR-compatible high resolution (24-inch or higher) display system with RF shielding
- MR-compatible noise-reducing stereo headphones
- MR-compatible 4-key response system (2 nos, one for each hand)
- Hardware for synchronizing scanner acquisition with stimulus display and responses.
- All the necessary interconnecting interfaces, cables, modules and other hardware and software to fully integrate the system to operational status.
- All necessary interconnecting cables, interfaces, RF filters and waveguides for integrating MR-compatible EEG-fMRI, TMS-fMRI and TDCS-fMRI systems.
- Integrated thin client system for access to all of the vendor supplied software for 10 virtual workstations. Specify the technical specs of each thin client, number of simultaneous users or licenses and the capability of each license, and the cost per license.
- Integrated PACS system for archival and storage.
- Temperature and humidity control systems for optimal scanner performance.
- MR. compatible pressure injector for double barrel perfusion imaging, infusion pumps, contrast enhanced MR angiogram & bolus tracking. Give the name and model of injector offered.
- All consumables should be provided for the guarantee period (excluding contrast agents).
- Imaging Phantoms (including structured phantoms and brain striatal [polyurethanetissue equivalent] anthropomorphic phantoms with separate tissual compartments, for quantitative imaging, fillable with MRI signal producing solutions. Also MRI lesion detection phantom (e.g. Harpell phantom).
- Phantoms for diffusion imaging
- AAPM recommended distortion measurement phantoms.
- Service phantoms and quality assurance phantoms.
- Quality assurance as per AAPM standard for SNR for different coils and nuclei, spatial resolution, magnetic field in-homogeneity, eddy current compensation, RF power and in-homogeneity measurement.
- Hand held metal detectors & other MR safety equipment (2 Nos.).
- MRI-compatible fire extinguisher

- MRI monitoring systems: Network analyzer, CRO, SAR monitoring, gradient and RF coil temperature monitoring.

12. PERSONNEL

- An on-site MRI engineer should be posted exclusively at the facility for the duration of the guarantee period to assist in system maintenance, troubleshooting and research.

13. FACILITY & TURN-KEY ARRANGEMENT

- The vendor shall provide a separate facility for housing the MRI system (2,500 sq feet x 2 floors) that is constructed for optimal performance of the scanner with suitable provisions for patient/subject preparation and data archiving and installing thin client systems (including power, LAN and Wifi).
- The facility must be equipped with suitable air-conditioning and humidity control devices to ensure optimum scanner performance.
- The facility must be equipped with a suitable true-online UPS unit with a minimum backup of 30 minutes as well as an alternate power supply to run the scanner for longer durations in the absence of power.
- The vendor shall identify a suitable location for the facility that is optimal for stable operation of the scanner, including liquid Helium circulation and quench duct routing.
- The detailed plan for the facility shall be finalized in consultation/coordination with a committee constituted for this purpose.
- The facility including the fully-operational MRI system shall be handed over to us on a turnkey basis.
- **The total cost of the facility should be quoted separately.**

14. OTHER ITEMS

- The cost of the MRI system, facility and that of each accessory to be quoted separately.
- **The vendor must submit a signed compliance document mentioning whether their scanner meets each and every specification detailed above.**
- The award of the tender will be decided by the institute as per price of the complete system. All insurance charges shall be borne by the vendor.
- Technical and financial bids should be submitted separately.
- All prices of the MRI system, accessories, building and turnkey installation, should be quoted in Indian Rupees. The specifications mentioned shall be understood to be the minimum required. Additional technical and research features suitable to our requirements shall be given due reference.
- Vendors that submit qualifying technical and financial bids are required to send competent representatives from the sales and technical divisions for further negotiations.

SPECIFIC TERMS AND CONDITIONS

The following requirements should be specifically adhered to by the vendor, and express indication should be given regarding adherence.

1. GUARANTEE PERIOD

- The equipment should be guaranteed for a period of 60 months from the date of handing over the fully functional unit of all coils and the accessories supplied (such as UPS, AC, Generator, etc.) to the Institute, against manufacturing defects of material and workmanship. The Helium Supply and cold head repairs (including replacement, if needed) should be included in the guarantee period.
- The vendor should take care of all external and internal services and the day-to-day running of UPS, AC and alternate power supply on 24 hour basis with manpower.
- During the guarantee period, a cumulative uptime of 95% of 365 days (24/7 basis) will be ensured by the vendor. The vendor must specify the Service Level Agreement (SLA) that will be adhered to throughout this period, which includes the uptime guarantee, periodicity of measurement, and mean time to restore operations in the event of failure.
- One lot of spares, decided mutually by the vendor and the institute shall be made available at the site.
- In case the down time exceeds the 5% limit, a penalty will be imposed consisting of extension of the warranty period by **three days for every day of downtime** during the first 7 days, which will be doubled to **one week for every subsequent day of downtime** after the first week of downtime.

2. POST GUARANTEE ANNUAL COMPREHENSIVE MAINTENANCE CONTRACT (CMC)

- The post-guarantee (after 5 years) CMC should be comprehensive and should include helium and cold head (repair and/or replacement) + labor + spares for the complete system which includes all the accessories supplied such as UPS, Generator, AC, etc.
- The desired cumulative up-time guarantee is 95% of 365 days (24 hrs basis) along with the penalty clause of the above-mentioned amount per day in case the machine is found not to be working for reasons other than force majeure conditions. The rate of post warranty comprehensive CMC should be available from the bidder for at least five years and be offered in Indian rupees.
- The amount due every year on account of the CMC will be paid at the beginning of the year to the vendor.

3. WARRANTY

- The complete system is to be under warranty period of 5 years including free supply of spare parts, liquid helium and labour from the date of functional installation, commissioning and acceptance. Note that any Liquid Helium loss due to quenching or due to any other causes during the guarantee period shall be borne by the firm.
- During the period of warranty the supplier is required to take full responsibility to re-commission the system in the event of magnet quench for whatsoever reasons.
- During the warranty period the supplier will also undertake the responsibility to maintain UPS system including batteries.

4. REPLACEMENT OF DEFECTIVES

Items found not acceptable or missing by the committee should be replaced by the supplier free of cost including the forwarding and Insurance expenses. Replacement of parts that become defective during installation and warranty should be arranged free of cost through the Indian associate of the supplier including all incidental charges.

5. MAINTENANCE

Comprehensive maintenance contract (CMC) for the complete system will be start after expiry of the warranty period as per agreed terms and conditions. This will include replacement of spares including all consumables and sealed units, liquid Helium and labour. The contract will also include the recommissioning of the system in the event of magnet quench for whatsoever reasons. The maintenance contract will also cover comprehensive maintenance (Labour + spares) for UPS including batteries. Note that any Liquid Helium lost due to quenching or due to any other causes during the guarantee period shall be borne by the firm. System spare parts availability should be guaranteed for at least 10 years from the delivery of the system.

6. DOCUMENTATION

- Two sets of operational/service/application manuals are to be provided along with the equipment.
- Detailed documentation on various sequences, spectroscopy, application software and evaluation software etc. are to be provided and the same must be updated regularly for next 10 years as and when these are released.
- Supplier is required to ensure mailing of product/research newsletters (on MRI and MRS) released from their R&D sites to the our site on a regular basis. This is to keep this centre abreast of the latest developments taking place in system technology and research techniques.
- The vendor is to provide a tender compliance sheet by giving all the necessary specifications, which should be supported by printed documentation sheets and certification of each item. In the absence of such documentation, a letter from the principals of the company should be provided.

7. SOFTWARE UPGRADATION

Software upgrades for the core system and all related applications for next 10 years to be provided free by the firm as a matter of routine as and when these are released, inclusive of minor hardware changes.

8. RESEARCH COOPERATION

The firm is required to provide work in progress packages to us for research trial as for their other research sites. The firm should provide an exhaustive list of the areas in imaging and spectroscopy in which research input and cooperation will be available to us. The firm should extend demonstrated cooperation regarding design and implementation of novel hardware and software inputs as required by the user, such as newer tailor made coils and pulse sequences, pre- and post-processing, phantom development (digital and physical phantoms), synthesis of spectroscopy and imaging (magnetic resonance spectroscopic imaging), multimodal consolidation with other modalities such as computed tomography, emission tomography,

molecular imaging etc. Specific proposal regarding research collaboration will be submitted subsequently for consent and counter signatures of the principals on the research proposal.

9. DELIVERY, INSTALLATION & COMMISSIONING OF THE SYSTEM

The facility should be built and the MRI system should be delivered, installed and functionally commissioned within 9 months from the date of receipt of confirmed supply order. The supply of the items will be considered as effected only on satisfactory commissioning and inspection of the system and inspection of all the items and features/capabilities tested by a board of officers constituted by the institute. After successful installation and inspection by the committee, the date of taking over of the entire complete running MRI system by the institute shall be taken as the start of the warranty period.

10. CUSTOM CLEARANCE

The Institute will furnish the necessary papers for the import of items into India, necessary custom duty exemption certificate and other supporting documents to facilitate the import of the items.

11. TRAINING

The supplier, at their expense, will arrange for an application specialist, immediately after the installation and commissioning of MRI system, to demonstrate the capabilities/features of the system and also to impart training to staff members of MRI Centre.

The supplier, at their expense, shall provide initial specialized training at our site by a research scientist and a research engineer from the supplier's international R&D Centre or from a internationally renowned centre; the training shall cover the state of art research application, functional and diffusion imaging and spectroscopy, together with system operation and first line maintenance of the system, system and application software, along with developmental aspects such as pulse sequence programming [including pulse program language] for modifications and development of user defined sequences, coil designing and fabrication for various application purposes, etc.

The travel, boarding and lodging expenses of the above scientist and engineer shall be borne by the vendor and this training should be completed before handing over the MRI system to us.

12. MODE OF SHIPMENT

The consignment must be air-lifted, insured and transported to the installation site by the supplier.

13. PAYMENT TERMS

A confirmed irrevocable and divisible letter of credit will be opened with the bank designated by the vendor with 90% of the total cost payable against confirmed proof of dispatch and the remaining 10% balance on successful installation against a bank guarantee of 10% of the total cost for the 5 years warranty period.

ADDITIONAL ACCESSORIES (TO BE QUOTED SEPARATELY)

MR SPECTROSCOPY

- Specify other molecules available for spectroscopy. Specify whether the magnet needs to be upgraded to add spectroscopy for a new molecule.
- Head coil for high resolution MRS for ^1H , ^{31}P , ^{13}C (specify best available)
- Hardware for double resonance technique [^1H , ^{31}P]
- Hardware/software for multinuclear diffusion spectroscopy (specify best available)
- Multicolour plotter for spectroscopy.
- Spectroscopy phantoms to model brain tissue and vessels to simulate aqueous flow and diffusion process.

RADIOFREQUENCY COILS

- Spare 32-channel head/neck coil for brain imaging.
- Spare 64-channel head/neck coil for brain imaging, compatible with simultaneous EEG-fMRI, TMS-fMRI and TDCS-fMRI systems.
- Wrist coil (specify best available)
- Finger coil (specify best available)
- Flexible coil for imaging limbs (specify best available)

EYE TRACKER

- MR-compatible monocular eye tracker (60 Hz).