

## Notice Inviting e-Tender

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SUPPLY & INSTALLATION OF **3 TESLA** MRI MACHINE IN THE MEDICAL COLLEGE AND HOSPITAL OF GOVERNMENT OF WEST BENGAL.

(Submission of Bid through *online*)

Bid Reference No.: WBMSCL /NIT- 184 /2018

Dated –13.09.2018

### Amendment-III

## REVISED TECHNICAL SPECIFICATIONS

Equipment Name: **3 Tesla** MRI Scanner

WHOLE BODY 32 CHANNEL **3 TESLA** MAGNETIC RESONANCE IMAGING SYSTEM WITH STATE OF ART ADVANCED TECHNOLOGY

The essential features mentioned below should be verifiable from catalogue / technical brochures of equipment for the offered model of the equipment and vendor must specify page, paragraph and line number in technical literature that indicates compliance. The system should have True 32 channels RF system with 32 independent ADC. The system should be totally new and should not contain refurbished or having recycled items. Latest version of quoted equipment and accessories available in the market at time of issue of supply order is to be supplied by the firm.

#### I. MAGNET

**3 Tesla** (superconducting) Magnet with approximately 70 cm or more bore diameter.

- a) Field Strength: Helium only **3 Tesla** (superconducting) Magnet along with Magnet Power supply Facility for quick shutdown of the magnet in case of emergency.
- b) Field Stability over time: Should have active shielding, external interference shielding with good field stability

c) **Homogeneity:**

(i) Best homogeneity possible should be given.

Specify homogeneity in VRMS at 10 cm, 20 cm, 30 cm, 40 cm and 45 cm DSV and at maximum FOV achievable with the quoted scanner.

(ii) Should be very good for Single voxel and CSI spectroscopy. Specify values

(iii) Homogeneity at 40 cm FOV should be less than 1.5 PPM.

(iv) Automatic shimming in phantom.

(v) 2<sup>nd</sup> order shimming to maintain field homogeneity while the patient is inside the Gantry. 2<sup>nd</sup> order shimming may not be required in case Homogeneity at 40 cm FOV is less than 1 PPM

d) **Magnet Bore:** 70 cm or more magnet bore diameter, after positioning of gradient, shim and RF coils.

e) **Active Shielding/ Fringe field:** Quote values for 5 Gauss and 1 Gauss line.

f) **Ext. Shielding:** Ext. interference shield (sufficient to house the Magnet, Anaesthesia and physiologic monitors) should be provided.

g) **Magnet Cooling System:**

(i) Zero boil off rate of Helium.

(ii) Devices for helium level monitoring in the magnet should be supplied.

(iii) Liquid helium should be supplied during warranty period and Comprehensive AMC.

(iv) The vendor should include the Cold Head maintenance and replacement during warranty period and also during comprehensive AMC.

h) **Shim System:**

(i) High performance and highly stable shim system with global and localized manual and auto-shimming for high homogeneity magnetic field required for imaging (MRI / fMRI), single voxel spectroscopy (MRS), and spectroscopic imaging (MRSI).

3D shimming for volume imaging and CSI.

(ii) Auto shim (global and voxel shim) should take less than 3 seconds to shim the magnet with patient in position (specify the time).

(iii) Specify number of shim coils including higher order.

- iv) Please specify whether second order shimming is required for better results on spectroscopy studies for the quoted model. If yes the same should offered as standard
- v) Specify whether off centre FOV shimming is required, if yes, please specify the details.
- i) **Others:**
  - i) The scan range for imaging should be 200 cm or more
  - ii) The FOV (Field of view) in X, Y & Z directions should be 45 cm or more
  - iii) Please specify up to what FOV Gradient linearity is maintained
- J) Latest acoustic noise reduction technique should be available without significantly compromising image quality. Please mention the minimum decibel achieved.

## II. PATIENT TABLE MONITORING & COMMUNICATION

- a) The vendor should supply dockable Table with complete electronics assembly for the MRI. One MR compatible patient shifting trolley and one MR compatible wheel chair should be offered as standard.
- b) The table should be fully motorized, computer controlled table movements in vertical and horizontal directions.
- c) Table should be able to handle patient weight of 200 kg or a above.
- d) Cushions and other patient comfort accessories. All parts of the table should be protected from liquid spill
- e) The table should have facility for manual traction in case of emergency.
- f) Patient monitoring devices for ECG, respiratory, pulse rate, oxygen saturation, at the console etc. A comprehensive solution at patient side and at main console capable of gating the sequence protocols with respect to patient's heart (ECG) and respiratory rates. Remote display of gating signals on magnet and at console.
- g) The table should deliver the protocols for automatic bolus chasing in peripheral angio with automatic table movement.
- h) The table should have facility for manual traction in case of emergency.
- i) A CCTV system with LCD display to observe the patient should be provided.
- j) Two-way Patient communication with headphone, microphone and necessary

accessories

- k) There should be a hand held alarm for patients.

### III. GRADIENT SYSTEM

#### a) General:

- i) Actively shielded gradient system in X, Y, Z planes.
- ii) Minimum Gradient Strength should be 44 mT/m or more along each axis and a slew rate of 200 T/m/s in each axis.
- iii) In case of dual gradient systems, please mention the details in each axis separately.
- iv) Quote the minimum rise time at the maximum gradient strength offered. The rise time should not be more than 250 ms, to reach the maximum gradient strength
- v) Quote the Slew rate at the maximum gradient strength
- vi) Specify the linearity of the gradients at full FOV.
- vii) 100% duty cycle for full FOV.
- viii) Effective cooling system for gradient coil and power supply, for uninterrupted operation. The system should have efficient and adequate provision for eddy current compensation.

#### b) Resolution Parameters:

- i) Field of View should be at least 45 cm in all three axes. Specify the minimum and maximum FOV achievable for the quoted MR system.
- ii) Minimum TE & TR in 2D/3D should be specified in relation to the sequences.
- iii) Specify min. slice thickness in 2D and 3D modes at 128x128, 256x256, 512x512 and 1024x1024 matrices (quote higher matrix resolution, if available)
- iv) The system should be capable of performing single shot EPI (in 64x64, 128x128, and 256x256 matrixes) including conventional and fluoroscopic imaging in the three orthogonal and also oblique planes.
- v) Echo Train length in both Spin echo and Gradient Echo should be at least 255 or more.
- vi) The measurement matrix should be from 128x128 to 1024x1024 in both 2D and 3D imaging as well.

#### IV. RF SYSTEM

##### a) RF Transmitter:

- (i) A fully digital RF System capable of transmitting power of at least 25 KW or more with a combination of RF power amplifiers (please quote the value). System should be capable of Multi Transmit / Multi Drive / True shape. (as per FDA guidelines),
- (ii) Specify max transmitter RF power available (at 50 impedance)

##### b) RF Receiver:

- (i) Optical / Digital RF receiver system with / high efficient RF receiver system / or its equivalent located on the magnet inside the shielded scan room.
- (ii) It should also have minimum of 32 independent ADC hardware RF channels without multiplexing, with each having bandwidth of 1MHz or more. Please provide the list of coils / coil-combinations that use this configuration
- (iii) Specify the RF receiver bandwidth for each channel.
- (iv) The system should have necessary hardware to support quadrature phased array and flex coils.
- (v) It should support Parallel acquisition techniques like ASSET / SENSE / iPAT / Sence /Grappa / dS-Sense with a factor of a least 4. Higher sectors if available should be offered optionally.
- (vi) Should allow remote selection of coils and/or coil elements.

##### c) RF Transmit technology:

- (i) Latest RF transmit system (like Multi-transmit/ Multi Drive transmit system or its equivalent/Trueshape multi-transmit, etc) with at least two independent output channels should be offered to improve RF uniformity and signal homogeneity and to reduce patient induced in-homogeneities.
- (ii) If the vendor has two RF amplifiers for producing better image quality/ features, the same should be quoted.

##### d) SAR limits:

SAR limits should be as per FDA guidelines for all protocols, including neuro / abdominal imaging.

e) Coils:

(i) The system body coil integrated to the magnet must be Quadrature / CP. In addition to this coil, following Coils (Preferably be with equal number of elements as the channels) be quoted. RF coils in addition to main body coil (Transmit / Receive or receive coils) auto tune, array or no tune coils. Coils for the following applications should be available with the system. Coil / RF design should support compatibility to coils manufactured by other manufacturers. If one coil can cover multi applications please mention it. Please confirm that the system can adapt to coils developed and manufactured by other manufactures. All coils offered should have SENSE / Ipat2 / GEM compatibility. All coils (other than coils for exclusive spectroscopy, like surface coils) should be compatible for parallel acquisition. Please specify the number of channels and elements available for each coil. Please mention the true acceleration factor for each of the array coil.

(ii) Head coil (32-channel or more) for EPI / DTI applications. Compatible with fMRI projection device quoted with the system.

(iii) Neurovascular coil (20-channel or more) for neurovascular applications. If separate neck coil can work in combination with head coil, then the neck coil is to be quoted, and the vendor should make sure NV application is satisfied.

(iv) Spine Array / Matrix Coils for thoracic and lumbar spine imaging - at least 32 elements or more.

(v) Body Array / Matrix coil with at least 45 cm coverage for imaging of whole abdomen (32 Channel or more).

If a single coil is not available with the vendor, then a combination of coils should be quoted (capable of single station Cardiac / abdominal imaging), so that the resolution over 40 FOV is not compromised.

(vi) Dedicated Bilateral Breast Coil with at least 16 channel or more (Coils should be capable of doing breast spectroscopy).

viii) Specify the coil to perform cardiac imaging (32 channel and above).

ix) Coils to do high resolution head, neck, spine in one go up to 75 cm coverage with parallel imaging techniques.

- x) Additional coil / coils for peripheral angiography application (32 Channel or more) with high SNR and high spatial resolution without venous contamination to be offered from pelvis to ankle. The coverage should be at least 60 cm and it should be possible to combine this coil with body coils to perform whole body angio exam.
  - xi) Shoulder array coil (16 Channel or more)
  - xii) Dedicated wrist coil (8 Channel or more)
  - xiii) Dedicated extremity coil (8 Channel or more) covering whole length of lower limb.
  - xiv) Knee imaging (Transmit/Receive 16 Channel or more)
  - xv) Set of large and medium/small general purpose wrap around flexible coils (minimum 2) for extremity Imaging (16 channel or more)
- f) **Coil technology:**  
Integrated coil technology, latest as available with the vendor to be quoted: Equivalent of TIM / GEM / D Stream to be offered.
- g) **Table technology:**  
Bolus chasing with automatic / continuous moving table should be offered and should be available with fluoro triggered MR angiography for manual and fast switchover in less than 1 sec for CE-MRA.

## V. COMPUTER CONTROL SYSTEM

The vendor should supply the latest computer system along with the MR system, to handle all the latest applications available on the MR platform. During the warranty period, any hardware updates that are launched globally should be supplied and installed.

- a) **Host Computer and Array Processors:**
  - (i) Latest state-of-art computer system with sufficient RAM (8 GB or more) and computational speed to match the single shot Echo Planar Imaging (EPI), interactive angiogram, multi-planar three dimensional (3D) reconstruction, surface rendering and dynamic imaging, vascular imaging / angiography, and adequate storage for images and other applications.
  - (ii) Necessary image processor with large RAM for ultra-fast image reconstruction

capable of performing real-time image reconstruction should be provided. It should be at least 12 or higher GB RAM. Please specify RAM and reconstruction speed in images per second for full FOV 256 matrix.

- (iii) Total hard disk memory to be sufficient to store at least 250,000 images of 256x256 matrix data size.
- (iv) Monitor: 19" or more TFT monitor with enhanced graphics accelerator.
- (v) One measurement (Main) console capable of data acquisition and all online calculations (as required for all sequences in the tender), and Post processing (as required for all applications in the tender).
- (vi) Licenses for acquisition (as required for all sequences in the tender), post-processing and for special packages should be given explicitly (as required for all applications in the tender), listing all the capabilities of the vendor's quoted product (basic standard package, premium packages, etc).
- (vii) The main console/workstation should have pulse sequence software license that may be required to modify and run pulse sequences. If this is not possible, the vendor should provide the necessary hardware and software necessary for such application (like laptop with system interface solution). Appropriate procedures (like research agreement) should be finalized before the installation of the equipment, so that there is no delay in operation of any requirement.
- (viii) Dual DVD write/CD Read/Rewrite drive for writing of images, spectra and raw data along with the necessary software for reading the images and spectra on DVD/CD storing capabilities. Provision for archival of k-space data and raw (unprocessed) images.
- (ix) The main console should have facility and controls for music system for the patient in the magnet room.
- (x) There should be a provision of retrieval of the reconstruction data (raw files) in a user friendly manner.
- (xi) Dicom interface to hook DICOM dry/laser camera capable of storing printing 1024x1024 matrix size images at least in 16 format without loss of digital resolution.

(xii) The system should be capable to connect to PACS through RIS/HIS at no extra cost. Highest version of DICOM connectivity be provided.

**b) Additional workstations: Price to be quoted separately.**

(i) Two workstations with two concurrent licenses color TFT/LED display (19" or more) with evaluation capabilities as required for all applications in the tender. Server based workstations with 24,000 concurrent slice rendering capacity (like Advantage Windows server/ syngo.via MR/Intellispace portal) It should be with preferably the same user interface as of main console.

(ii) Hard disk of at least 1TB for at least 250,00 image storage in 256 matrix < and 32 GB RAM capacity or more, with self-playing DVD/CD achieving facility.

(iii) Separate licenses for all the post-processing (including special packages) should be provided for this workstation also as required for all applications in the tender.

(iv) Specify clearly the algorithms that require extra license and list them whether these have been included or not.

(v) Filming also should be possible from this workstation.

(vi) The vendor should mention which are the post-processing capabilities that have been quoted with additional workstation.

(vii) The workstation should display cardiac cine images in movie mode with rapid avi creation.

**c) Networking:**

(i) The vendor should provide Level 3 network Switch (with 32 nodes) or latest, to integrate the network.

(ii) Protocol - Ethernet TCP/IP standards - based image transfer with DICOM 3.0 over standard Ethernet IEEE 903 (DICOM send, receive and DICOM query modes).

(iii) The vendor should provide the connectivity with PACS available currently in the department.

(iv) The network speed and cables should match the latest industry standards (eg.10BaseT/100BaseT/1 GB)

(vi) System should be configured with different IP series, so as not to clash with different equipments already existing in the department.

**d) Printing solutions:**

- (i) DICOM interface to hook DICOM compatible, dockable, latest state-of-art Dry Laser Camera with integrated processor, of resolution more than 600 dpi, capable of storing/printing images of 1024 x 1024 (or higher, if available) matrix size in various matrix formats (including 16 format) without loss of digital resolution to be made available for filming from main console & workstation.
- (ii) It should be possible to connect other imaging modalities to the printer. 5000 compatible films to be provided.
- (iii) Colour Laser Network Printer (PCL6/PS) for printing of colour CSI/ Perfusion/BOLD maps and images on A4 size paper (minimum 24 ppm).

**e) Data archival for long time storage:**

Archival system (complete PACS server with hot swappable drives) for archival & storage of image and spectroscopy with a minimum capacity of **20 TB (Scalable & upgradable)**

**VI. IMAGING**

**a) Data Acquisition:**

- (i) The system should have basic sequences package with Spin Echo, Inversion Recovery, Turbo Spin Echo with high turbo factor of 256 slice or more. Gradient Echo with ETL of 255 or more.
- (ii) Single Slice, multiple single slice, multiple slice, multiple stacks, radial stack and 3D acquisitions for all applications.
- (iii) Single and multi shot EPI imaging techniques with ETL factor of 255 or more
- (iv) 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. All the sequences that are available with the vendor at the time of quote/ delivery should be provided as per their manual.
- (v) 2D multi-slice imaging should be possible in all planes (axial, sagittal, coronal, oblique and double oblique).
- (vi) Up to 1024 x 1024 matrix acquisitions preferred for all applications.

Wherever 2048 matrix available, please mention.

- (vii) Half Fourier or other techniques to reduce scan acquisition time while maintaining adequate SNR
- (viii) 3D volume, multiple contiguous slabs, multiple interleaved and multiple overlapping slabs
- (ix) Fat suppression for high quality images both STIR and SPIR
- (x) Slice thickness in 2D and partition in 3D to be freely selectable.
- (xi) Dynamic acquisition (pre and post contrast scans and time intensity studies) with capability to initiate scan sequences either from the magnet panel or from the console. The number of repeat scans and the delay time (identical or variable) should be selectable
- (xii) The system should acquire motion artifact free images in T2 studies of brain and whole body in restless patients also less sensitive to motions such as CSF and blood flow or flow artifacts, breathing, patient tremor or voluntary movements. Motion artifact free imaging with Diffusion weighted studies and musculoskeletal studies will be added advantage. This application to be compatible with PAT - like Propeller 3.0 Multivane XD, Presto, Snapshot, Blade etc. Body navigators may be offered as well.
- (xiii) Auto-slice positioning from the localizer images.
- (xiv) Maximum-off center positioning both anterior-posterior and lateral direction and should be selectable
- (xv) Gating: physiological signals like ECG, pulse, respiratory, External signal triggering (interface for triggering input pulse from external source). The provision should be available at the console also (for fMRI, EEG, etc).
- (xvi) Simultaneous acquisition, processing and display of image data in 2D multi-slice mode.
- (xvii) Selection of voxels from oblique slices should be possible while doing spectroscopy
- (xviii) Artefact reduction/imaging enhancement / image filtering /image subtraction / addition / multiplication/division techniques

- (xix) Flow: 1st and 2nd order flow artefact compensation
- (xx) Presentation slabs: a number of relocatable saturation bands to be placed either inside or outside the region of interest
- (xxi) Fat saturation techniques: frequency selective RF pulses to suppress fat signals in the measured image FOV. ROIselective (regional) fat suppression should also be given
- (xxii) Magnetization transfer saturation: Off resonance RFpulses to suppress signals from stationary tissue in FOV
- (xxiii) Phase contrast capability in 2D and 3D mode.
- (xxiv) Image intensity correction Breath hold acquisition
- (xxvi) EPI mode
- (xxvii) DTI with MDDW or equivalent with a minimum of 12 and selectable up to 128 direction encoding
- (xxviii) Data acquisition in all three standard planes (axial, sagittal, coronal) and oblique and double oblique planes or more oblique planes.
- (xxix) Higher matrix acquisition capability in single shot EPI. Acquisition time, TR, TE and slice thickness should be clearly mentioned and supported by data sheet reference.
- (xxx) Multi coil acquisition in order to optimize throughput increase and increased effective FOV. Individual acquisition elements of every coil should be mentioned.

**b) Imaging Pulse sequences:**

- (i) All standard and special pulse sequences available at the time of quote/delivery should be offered and quoted in the bid. If the vendor does not have any particular sequence/s but offers a work in progress (WIP) sequence/s, then it should be provided without any pre-condition. This also applies to any post-processing software that is offered which is WIP.
- (ii) The system should be capable of selecting TR and TEs as per requirement in majority of the pulse sequences.
- (iii) Spin echo (SE): multi-slice single echo, multi-slice multiecho (8 echo or

more), SE with symmetrical and asymmetrical echo intervals and fast spin echo. MT-SE imaging sequence.

- (iv) Inversion recovery (IR): including short TI modified IRSE, FLAIR, DIR (Double Inversion Recovery).
- (v) Gradient echo (GE): with transverse gradient/RF spoiling, and transverse gradient re-phasing, e.g., GRASE or equivalent etc. 3D gradient echo with shortest TR and TE, free choice of flip angle selection, while maintaining SNR.

c) **Fast sequences:**

- (i) Fast spin echo and GE sequences in 2D and 3D mode with T1, T2 and PD contrast capable of acquiring maximum number of slices with a given TR a minimum TE, echo train should be at least 128 or more in fast spin echo mode
- (ii) Half Fourier acquisition capabilities should be available with/without diffusion gradients and in combination with fast spin echo
- (iii) Fast inversion recovery with spin echo
- (iv) Fast gradient spin echo IR multi-slice multi-echo mode with maximum ETL. Sequences should incorporate RF focusing to acquire ultra-fast gradient spin echo.  
Fast gradient echo sequence should incorporate RF spoiling and other technique to acquire images in ultra-fast 2D and 3D modes
- (vi) Fat and water suppressed imaging sequences.
- (vii) EPI optimized sequences (with and without fat suppression)
- (viii) For T1, T2, PD imaging, perfusion, regular diffusion values (at least 5b values, 3 directions) EPI-FLAIR, EPI-IR, EPI-FLAIR diffusion tensor, EPI-MT-FLAIR, tensor diffusion (at least 10 "b" values, and 128 directions) and diffusion studies. Suitable artifact/ fat suppression techniques to be incorporated in the sequence to have optimum image quality.
- (ix) There should be capability of calculating ADC map (isotropic and anisotropy from the regular diffusion and tensor data).

**d) Optimized sequence Packages:**

(To be provided as part of standard equipment with no additional cost)

**1) Neuro:**

- (i) All T1 (2D, 3D), T2 (2D, 3D), IR (2D, 3D), Dual IR (2D, 3D) sequences
- (ii) Sequence for internal ear imaging for visualization of fine structures like cranial nerves (appropriate sequences like CISS, etc or equivalent). Mention the sequences provided.
- (iii) 3D sequences for internal auditory canal imaging
- (iv) Dynamic imaging of pituitary using appropriate sequence
- (v) Whole spine T1, T2, IR sequences
- (vi) Whole neuro examination with automatic planning, scanning and post-processing, with single localiser positioning, without changing the coils/ repositioning

**2) Angiography:**

- (i) MR angiography: 2D/3D TOF, 2D/3D Phase contrast (with and without gating) and magnetization transfer saturation, black blood angiography for cerebral, pulmonary, abdominal and peripheral vessels.
- (ii) For peripheral moving table angiography should be offered covering hip to limbs to be examined in one go with high resolution and high SNR.
- (iii) Bolus tracking software package.
- (iv) Sequences for breath hold angiography with contrast enhancement.
- (v) Sequences for time resolved angiography with contrast kinetics.
- (vi) ECG triggered non-contrast angiography
- (vii) Contrast bolus tracking (including single shot whole body MRA, interactive and automatic tracking, etc.).
- (viii) Perfusion study in organ systems like kidney, brain, heart etc. with T1 perfusion with permeability maps, and quantitation of rCBF/ rCBV, MTT, etc, with color maps.

**3) Cardiac package:**

- (i) Full comprehensive cardiac sequences which includes, MR cardiology package for evaluation of heart in long and short axis with black blood cardiac imaging.

- (ii) Package for coronary artery imaging including sequences for motion compensation - prospective and retrospective gating, etc.
- (iii) EPI based sequence for stress perfusion MRI including ability to adjust the cardiac phases required with increasing HR
- (iv) Myocardial tagging sequence
- (v) 2D and 3D Sequences enabled with delayed enhancement
- (vi) 3D sequence of cine (bright blood & dark blood options)
- (vii) Rapid acquisition of heart using acceleration techniques
- (viii) STIR sequence for cardiac use
- (ix) 3D whole heart sequence (with & without contrast for coronary imaging)
- (x) Ability to acquire multiple arterial and venous phases on CE MRA.
- (xi) Quantitative flow analysis software
- (xii) 3D acquisition of whole heart in one breath-hold
- (xiii) 4D TRAK/ TRICKS-XV/ TWIST/ equivalent (with maximum FOV)
- (xiv) Provision for timing /Stop watch (MR compatible) for timing drug infusion

#### 4) Diffusion / DTI:

- (i) Sequence package for diffusion including DTI (tractography) study in organs like brain, kidney, muscle, heart, spine, breast, prostate, etc.
- (ii) There should be capability of calculating ADC map (isotropic and anisotropic from the regular diffusion and tensor data).
- (iii) MR diffusion tensor imaging package with tractography
- (iv) MR neuro functional imaging sequence package (incl. Mosaic, etc)

#### 5) Body imaging:

- (i) Flow quantification in vessels and CSF, hepatobiliary system.
- (ii) Fly-through facility with Flow analysis including display of various velocity values. Optimized breath hold sequences for abdominal studies including angiogram.
- (iv) MR Cholangiography and Pancreatography: Specialized sequences and processing to perform MRCP.
- (v) Pulmonary 2D/3D MRA sequence, including single breath hold sequence.
- (vi) MR ventriculography, cisternography, myelography.

- (vii) Single sequence to acquire four different contrast (inphase, out-of-phase water only, fat only). The same technique should be used in other sequences, for dynamic angiography/T1 quantitative analyses.
- (viii) Parallel acquisition techniques including new sequences.  
Specify the technique used and the factor by which the acquisition time is reduced for similar acquisition with and without parallel imaging technique. Mention the sequences.
- (ix) Flow quantification packages for CSF with dynamic CSF flow imaging, aqueduct and spinal canal.
- (x) Radial/Spiral pulse sequences for ultrafast imaging.
- (xi) Suitable artefact/fat suppression techniques to be incorporated in all the sequences to have optimum image quality.
- (xii) A sequence for differentiation of fluid and cartilage in ortho applications (sequence like DESS or equivalent)
- (xiii) Susceptibility artefact correction techniques to be incorporated in all the sequences to have optimum image quality.

6) **SWI**: Sequences for susceptibility imaging

7) **Prostate imaging**: Sequences for imaging of prostate

8) **Breast imaging**: Sequences for imaging of breast (including sagittal bilateral breast imaging in a single acquisition)

9) **Motion correction**:

- (i) Sequence for in-line motion correction for uncooperative patients/ children (with software and acquisition - sequences like BLADE, PROPELLAR, Multivane or equivalent)
- (ii) Sequence with ultra-short TE
- (iii) Sequence for nullifying CSF pulsation artifacts
- (iv) Sequence enabling prospective motion correction in quick time and in real time during f MRI.

10) **MR Spectroscopy**:

- (i) Proton MRS Sequence for single-voxel acquisition, with selectable fat/lipid saturation bands, options of water saturation (eg. VAPOR, CHESS, etc) with all post-processing software
- (ii) Proton Multi-voxel CSI [2-D and 3-D] acquisition and metabolite mapping with all necessary RF sequences (and post processing algorithms) with all post-processing software
- (iii) If separate coils are needed for carrying out MRS, it should be provided.
- (iv) Sequences for phosphorous single voxel and multi-voxel spectroscopy should be provided, with all post-processing software
- (v) RF sequences for cardiac, prostate, breast, liver, musculoskeletal and brain (if there are any specialised/optimised sequence available, the same should be offered)- with all postprocessing software
- (vi) Water and lipid suppression in automated sequences.
- (vii) The pulse sequences for 1H MRS for liver spectroscopy should have external gating provision with triggering bases on ECG/ Respiratory, with all post processing software.
- (viii) Please give details of spectroscopic packages offered and not offered (but available with the vendor).

**11) Others:**

- (i) Sequence employing arterial spin labelling (ASL) technique
- (ii) Whole body imaging (using body coil and surface coils)
- (iii) Whole body diffusion weighted imaging (using body coil and surface coils)
- (iv) Automated fusion and composing for the above two (without any artefacts)
- (v) Volume acquisitions for neuro applications.
- (vi) Head first or feet first for all imaging
- (vii) Single sequence for Triglyceride Fat and iron quantification software for Liver should be offered - Like IDEAL IQ, Liver LAB, mDixon Quant
- (viii) Software for fusion imaging CT/PET/SPECT/USG
- (x) T2 cartilage coloured mapping sequences for early detection of osteoarthritis like Map IT, Cartigram, T2 Mapping

**12. Post Processing and evaluation:**

- (i) Licences of all the post processing and evaluation packages should be provided for the main and additional console/ workstation
- (ii) Specify clearly number wise the algorithms that need licenses and a statement whether these have been provided in both the main console and the additional workstation (satellite console/ extended workspace)

**13. Special Application Packages:**

The vendor must provide their specialized and optimized imaging sequences with post-processing packages of those listed below along with the standard or basic package at no additional cost.

Please quote prices separately if the packages are not part of standard equipment.

Please list other applications available with the Vendor, which are part of standard or basic package.

**1) MPR:**

- (i) Multi-planar reconstruction (MPR) in any arbitrary plane including curved planes with freely selectable slice thickness and slice increments.
- (ii) Surface Reconstruction and evaluation on reconstructed images with minimum time.
- (iii) MIP in displaying in cine mode 2D and 3D mode, targeted/ segmented MIP in any orthogonal axis with minimum processing time and capable of displaying in cine mode.

**2) Cardiac evaluation package:**

- (i) Full cardiac evaluation: Operator selective or automatic contour mapping and calculation of cardiac parameters like wall thickness, stroke volume, Ejection Fraction, filling rate, myocardial wall motion including display of data in table, graph and in cine mode, blood flow quantitation, velocity mapping, pressure gradient quantitation, shunt quantitation, regurgitation calculation, stenosis, blood flow, etc. These should be usable on main as well as on additional workstation/ satellite console.

- (ii) Semi- and fully quantitative analysis of myocardial perfusion
- (iii) Quantification of myocardial scar vs total myocardium volume / mass on DE imaging
- (iv) Analysis of both RC and LV volumes mass and ejection fraction to be available separately; should be possible to do manually and in fully automated manner
- (v) Non contrast coronary angiography with single vessel approach/whole heart approach
- (vi) Sequences and post-processing for T1, T2 mapping
- (vii) T2\* imaging with quantification

### 3) ADC, perfusion:

- (i) Evaluation and display of diffusion images, ADC map, fMRI in reference of EPI optimized sequence.
- (ii) Perfusion image evaluation with time intensity graph and other statistical parameters
- (iii) Evaluation package for calculating rCBV, rCBF, MTT, perfusion map, Corrected CBV calculation; Fusion of perfusion map with Contrast enhanced 3D T1 images etc. Mention the package/software offered with brochure.
- (iv) Flow quantification and evaluation for vascular (high & low) CSF, bladder outlet and cine display.

4) BOLD analysis: Evaluation of functional images of brain with appropriate statistical algorithms, colour display and overlay on base anatomical images.

5) Tractography: Post-processing package for DTI and Tractography, estimation of ADC, FA (Lamda- parallel, perpendicular separately and combined), Fiber tracking, fiber statistics, and display of fiber tracks on anatomical image(s).

### 7) Image statistics:

- (i) Measurement of distance, area, volume, angle, mean, SD, image addition, subtraction, multiplication, division, interpolation, segmentation, threshold, histogram.
- (ii) Image filtering and Image fusion software.
- (iii) Software for co-registering MRI/fMRI/MRS/Metabolitemapping images with images

from CT, PET, and SPECT.

- (iv) Evaluation features like zoom, rotation, scroll, roaming, image synthesis, multi point T1 and T2 calculation (more than 8) window stretching, text dialogues graphics, sorting, searching, archiving, recalling etc.

**9) Spectroscopy:**

- (i) Full post-processing for single-voxel MRS, CSI (multivoxel MRS), metabolite mapping with colour coding (metabolic images), 31P MRS post-processing, etc., for brain, breast, prostate and for other applications.
- (ii) Post processing should include FFT, base line correction, curve optimization, automatic phase correction, metabolite imaging, spectral mapping, magnetic resonance spectroscopic imaging (molecular imaging) with naming and peak integral values for all in-vivo metabolites

**10) Functional MRI accessories and post-processing:**

- (i) Functional Imaging with package for BOLD imaging and processing package (capable of real-time processing and display of colour overlay (in real time) using 32-channel Head coil being supplied with the system.
- (ii) Complete fMRI solution including audio-visual projection system, with headphones with very good noise suppression (> 30dB) (Preferable to have LCD/LED monitor for projection).
- (iii) Binocular eye tracker cameras, integrated with the visual system (preferable to have separate wearable eye-tracker cameras)
- (iv) The audio-video projection system should have the capability to project images / movies to the subject, and should be compatible with the 32-channel head coil, and should all attachments that may be required for complete integration.
- (v) The system should be integrated with stimulus presentation/ paradigm generator software, along with permanent license (like Superlab, eprime, Presentation, etc), which is capable of presenting audio-visual picture, audio, video (multiple formats), etc.
- (vi) The paradigm presentation should be synchronised with the scanner (for starting along with measurements)

- (vii) Integration (and Provision near the console) for external trigger (of the sequence) for synchronising fMRI acquisition with paradigm
- (viii) Provision for serial ports and DB15 ports in the penetration panel for routing SVGA/EEG connections (one each for customer use).
- (ix) FMRI console should have all relevant functions to develop and integrate the paradigm, to deliver the paradigm and also, to monitor the task being presented. The volume control option should be available with the operator (at a convenient place at the console)
- (x) Post-processing workstation / server with post-processing software and hardware associated, with licenses for processing the BOLD data (with required licensed operating platform required like MATLAB, IDL, etc)
- (xi) The system should have integrated MR compatible binocular eye-tracker (binocular), along with eye-tracking software at the console (on a separate PC/laptop).

(xii) The entire fMRI hardware package should be available for complete integrated solution

## **VII. QUALITY ASSURANCE AND PHANTOMS**

- (i) Calibration Phantoms for routine quality assurance for all coils (including body coil)
- (ii) Chemicals for spectroscopy phantoms for important short echo time neuro metabolites (NAA, Cho, Cr), breast (Cho, Cr) and prostate (Cho, Cr, Citrate, polyamines) with appropriate MR compatible phantom containers.
- (iii) Quality assurance as per AAMP standard for SNR for different coils and nuclei, spatial resolution, magnetic field inhomogeneity, eddy current compensation, RF power and inhomogeneity measurement. Specify the details of the QA package.

## **VIII. SAFETY FEATURES:**

- (i) The magnet system should include an Emergency Ramp Down unit ERDU for fast reduction of the magnetic field with Ramp Down time below 3 minutes.
- (ii) The magnet should have quench bands that contain the fringe fields to a;
- (iii) specified value in the event of a magnet quench

- (iv) Real time SAR calculation should be performed by software to ensure that RF power levels comply with regulatory guidelines and are displayed on each image
- (iv) The system shall have manual override of the motor drive for quick removal of the patients from the magnet bore.
- (v) Temperature sensor (built in) for magnet refrigeration efficiency must be provided

**IX. STANDARD MRI ACCESSORIES:**

- (i) Hand held metal detectors (2 Nos.)
- (ii) MR compatible (minimum 2000 Gauss line) cardiac and physiological monitor (ECG, NIBP, SPO2,) for neonates/ infants and adults (with all accessories for five years) (MedRad/In-vivo/better models)
- (iii) MR compatible (minimum 1000 Gauss line) syringe/infusion pump. (MedRad/MRIdium/better models)
- (iv) MR Compatible Dual Pressure injector (minimum 2000 Gauss line) (MedRad / better models)
- (v) MR compatible Anaesthesia Workstation with ventilator (US FDA approved) machine (for Paediatric and adults use) with dual vaporisers (for isoflurane, halothane), and other accessories (minimum 1000 Gauss line).
- (vi) Non-ferromagnetic patient transfer trolley of international make should be provided (2 No's) & non-magnetic wheel chair - 1 no's
- (vii) Provision for external trigger (of the sequence) near the console
- (viii) Provision for serial ports and DB15 ports in the penetration panel for routing SVGA/EEG connections (one each for customer use).
- (ix) Patient addressing system between console to Gantry room.
- (x) Two quantity: Non-magnetic IV stand
- (xi) Two quantity: Digital Patient Weighing Scale (in the range between 0 to 200 kg)
- (xii) MR compatible storage carts and wall mounted cabinets.
- (xiii) Water chillers for Cold Head/Gradients
- (xiv) Coil cabinets to be provided.
- (xv) Network cable and other required materials for the complete installation to be provided by the supplier

## **X. OTHER ACCESSORIES:**

- (i) Six Revolving chairs with ergonomic support
- (ii) Table for the MRI console, MRI additional console/ workstation, fMRI workstation  
**Necessary Desk, chair and Rack** for the PACS Server & Workstation to be provided by the supplier
- (iii) All the necessary interconnecting interfaces, cables, modules and other hardware and software to fully integrate the system for full operational status.
- (iv) **Online Uninterrupted power supply (UPS) with sufficient capacity and 30 minutes back up for the full load MR system and its accessories during patient MR imaging.**
- (v) PACS system should be connected to the UPS (If a separate UPS is required for this purpose, this should be provided)
- (vi) Two (quantity) MR compatible oxygen cylinders (for the anaesthesia system)
- (vii) Good quality air curtain at MRI entrance (for patient entry), to filter the dust and prevent the leakage of a/c.

## **XI. SUITABLE RF ENCLOSURE**

**RF cabin:** the system should be supplied with imported RF cabin with RF room shielding. RF Door Screen, and interiors for the same should be carried out suitably

## **XII. INSTALLATION**

A list of installations of the quoted model in Government / Private institutions in India to be provided. Satisfactory service back up facility should be available. Please mention the service centre available nearest to the site of installation and total No. of MRI service engineers employed in India.

## **XIII. APPLICATION SUPPORT**

Applications specialist should be available on site for a total duration of 6 weeks to train the technical staff. Advanced training to be provided by the vendor at the site for Faculty, Residents, students and Radiographers, so as to benefit the latest applications available on the system. Please provide certificate from existing installed base for proof of providing application support time to time

**XIV. STANDARD AND CERTIFICATION :** Should be FDA **and** CE approved product.

**XV. GUARANTEE:** The vendor should guarantee the service and spare support for 10 years of

the system including Helium and cold head and all accessories

**XVI. DOCUMENTS:** The offer should be accompanied by Original data sheet of the product.. Refurbished Units will not be accepted. Verification Certificate for authorized reputed third party agencies to be attached. Incomplete data sheets and offers which are speculative are not to be submitted.

**XVII. TURNKEY OFFER:**

- (v) Turnkey offer for Civil, Electrical and A.C works etc. are to be given after visiting the place of installation for which the bidder has to make a request. Please give drawings for civil, electric, and any other required for installation and reporting. Prior approval to be taken from the department

## Specifications for Turnkey Work

Carpet Area in the Scope of work: 1000 Sq. feet

The room should be renovated according to the need of the specific machine. The indicative renovation work to be undertaken is noted below:

- i) **Painting of the rooms** – 2 coats synthetic enamel paints over 2 coats primer over wall putty (if required) wherever required
- ii) **Viewing Window: Viewing Window:** RF shielded Viewing window.
- iii) **Floor:** Floor (except of MRI room) should be of premier quality double charged joint less vitrified mirror polished tiles.
- iv) **Wall (except MRI room):** Walls should be of premier quality double charged joint less vitrified mirror polished tiles up to false ceiling other than the marble finished wall. Necessary replacement / repair of damaged marble before polish.
- v) **Ceiling:** Ceiling should be of Mineral fiber board with aluminum grid. 2/3 coats of distemper on true ceiling. / High quality Ceiling paneling as suitable with existing infrastructure.
- vi) **RF Cabin:** The RF cabin should be imported type. Required RF shielding should be as per the guidelines of the competent authority
- vii) All existing doors in the designated area are to be replaced with a new one.
- viii) **Height of the room (up to false ceiling):** 3.0 m and above
- ix) **Specification of Doors:**
  - Main Doors: Steel Door
  - Other Doors:

- x) Necessary electrical fittings are to be installed.
- xi) High quality room lighting (LED up to 400 LUX of illuminance)
- xii) Earthing: Two nos. Copper plate earthing as per PWD schedule

**Wiring System:**

- a) Light, Fan, 5 Amp Plug: 3 X 1.5 sq. mm copper conductor FRLS wire should be provided.
  - b) Power Plug (15 Amp): 2 X 2.5 + 1 X 1.5 sq. mm copper conductor FRLS wire should be provided.
  - c) Split AC wiring: 2 X 4 + 1 X 2.5 sq. mm copper conductor FRLS wire should be provided Necessary electrical earthing facility is to be prepared.
- xiii) False ceiling / High quality Ceiling paneling should be provided in all rooms.
  - xiv) Medical Gas Pipeline system [O<sub>2</sub>, N<sub>2</sub>O, Air (4 Bar) and Suction] with imported MRI compatible outlet points along with matching adapter etc. should be provided in MRI room and in patient waiting area. Inside pipeline in the Gantry room to be completed in all respect and the entry points of the pipelines should be terminated at a suitable place outside the Gantry room with medical grade isolation valves.

**Air Conditioning**

The entire carpet area of 1000 sq. feet should be air conditioned. The bidder should consider the tonnage calculation with 100% backup. The Air conditioning machines should be run on timer. High quality Mitsubishi / Hitachi / O-General make (Green Gas) Air Conditioning machine with 5 star rating should be installed.

**Furniture item to be supplied:**

- a) Executive revolving chair with arm rest: 6 Nos. (Godrej / Featherlite or equivalent)
- b) Storage Cupboard: 3 Nos. high quality customized Wall mounted with locking facility
- c) Shoe Rack: 2 No
- d) Corner Table: 2 Nos. (Godrej / Featherlite or equivalent)
- e) Change room with Mirror
- f) Kg Fire extinguisher cylinder: 4 Nos.
- g) Console Table from OEM
- h) Metal Detector-Hand Held: 01
- i) Music System (Sony/Philips/Bosch): 01
- j) LED view box for four films: 01
- k) MRI compatible Patient trolley with mattress, side rails, oxygen cylinder and fluid stand attachment: 2 Nos.

- l) MRI compatible Wheel Chair with mattress, side rails, oxygen cylinder and fluid stand attachment: 2 Nos.
- m) Dehumidifier (22 Ltrs): 4 Nos.
- n) Patient waiting chair for at least 30 nos.