

Current Situation

Introduction

AMICE (Advanced Multimodal Imaging Centers) is a national collaborative network of experimental and preclinical imaging facilities across all Dutch academic medical centers and universities, established in 2021. Through a prestigious NWO Roadmap grant, the consortium has secured funding to upgrade and modernize preclinical MRI infrastructure at several participating institutions. These MRI systems are primarily used for advanced imaging of laboratory animals and ex vivo tissues in support of biomedical and translational research. In addition, many of the facilities provide imaging services for industry-sponsored and contract research projects, thereby facilitating collaboration between academia and commercial partners and supporting the translation of novel imaging methodologies into practical applications.

Of note, the NWO Roadmap Grant includes the plan to integrate ultrasound (US) and PhotoAcoustic-imaging capabilities into the MRI systems at Radboud UMC and UMC Utrecht. At three institutions the preferred solution is to reuse the existing magnet and replace all other system components. For this market survey co-development proposals are also acceptable, as long as they are **clearly labeled** as such.

AMICE MRI Scanners

The table below provides a general overview of the scanners that will be refurbished.

Institute	
Erasmus MC	Refurbishment of current 7T GE/Varian MRI system Magnet type: DiscoveryTM MR 901 (7T)
UMC Utrecht	Refurbishment of current 9.4T Varian MRI system Magnet type: Magnex 9.4-T, 210-mm horizontal bore actively shielded magnet system
Radboud UMC	Refurbishment of current 7T Clinscan MRI system Magnet type: Bruker 70/30 USR
Leiden University Medical Center	Software upgrade of current 7T Bruker MRI system Magnet type: 7T / 16 cm bore / Ultra Shielded (US) superconducting magnet

Questions to the Market

Functionality

General

1. Can you provide a concise overview of your MRI portfolio and indicate which systems you would recommend as refurbishment solution for the MRI systems listed above (see table)?
2. Can you provide an overview of the technical specifications of the different (sub-)systems in your portfolio, including, for example, B0 field homogeneity, helium consumption, maximum gradient amplitude and rise time per axis, gradient linearity, first- and higher-order B0 shimming capabilities, maximum field of view (FOV) in all directions, and the number of RF transmit and receive channels?
3. Which tools and accessories are available for positioning laboratory animals within your MRI systems?
4. What are the key unique selling points that distinguish your MRI systems or refurbishment solution from competing solutions?

RF Receive Coils

5. Which RF receive coils are available for each of the MRI systems?
6. Can you provide a concise overview of the key specifications of these coils, including parameters such as geometry, number of receive channels, sensitivity, signal-to-noise ratio (SNR) performance, and anatomical coverage?

MRI Acquisition & Reconstruction Methods

7. Which MRI methods are available as standard and optional packages on your MRI systems?
8. What capabilities do your systems offer for MR spectroscopy (proton and X-nuclei), and which X-nuclei are supported by your platform?
9. Which acceleration techniques are available, and to which anatomical regions can these be applied?
10. What are the reconstruction times for the different acquisition methods?
11. What capabilities do your systems provide for prospective and retrospective gating and triggering of MRI acquisitions? Which physiological signals can be used as input for these functions?
12. Which hardware and software are available for the physiological monitoring and regulation of laboratory animals? To what extent is this monitoring integrated into the MRI system?
13. What options are available for integrating third-party monitoring and physiological support hardware into the acquisition protocol? Examples include mechanical ventilation, EEG readout, delivery of external stimuli, and administration of pharmaceuticals.
14. To what extent can scan parameters be adjusted while the animal remains in the scanner, and while remaining within the acquisition protocols?

MRI Post-processing

15. Can you describe the post-processing methods available on the acquisition workstation, including multiplanar reconstruction (MPR), maximum intensity projections (MIP), subtractions, multi-station scans, diffusion imaging, and fMRI? How long do these methods take, or to what extent do they interrupt image acquisition? Which methods are automated? Would you recommend any additional hardware for these purposes (e.g., multiple displays, a dedicated workstation, or other hardware)?
16. To what extent are (AI-based) tools available for:
 - a. Immediate quality control of a scan to enable direct rescanning while the laboratory animal remains in the scanner?
 - b. Whole-body reconstructions?
 - c. Fat–water separation (Dixon) techniques, and how many points/echoes are supported?
 - d. Automatic positioning of imaging volumes based on localizer scans?
 - e. Organ segmentation on the scanner?
 - f. Accelerating post-processing of, for example, dynamic contrast-enhanced protocols, functional MRI, bolus passage estimation, cardiac analysis, flow visualization, respiratory compensation, or triggering?

ICT

17. What operating system is used by your MRI scanners?
18. What data format(s) are used for image and spectroscopy data generated by your systems?
19. What is the storage capacity for raw data and DICOM images on the different systems, expressed in terabytes, and what is the typical retention period during which data can remain stored on the system?
20. If DICOM is supported, can the MRI scanner export MRI data in both Enhanced DICOM and standard DICOM formats? Can this be configured on a per-destination basis?
21. If DICOM is supported, is it possible to export DICOM data from a study directly to a network drive (i.e., not via the DICOM protocol)?

Quality Assurance

22. Please describe your system for periodic quality assurance and the associated analysis software. Include the phantoms required for image quality assessment, as well as analysis of geometric accuracy, B0 mapping, and B1 mapping.

Updates and Upgrades

23. What is the expected lifetime of your MRI scanner refurbishment solution?
24. Which software and hardware updates and upgrades do you offer to keep systems up to date? What options are available for upgrading (parts of) the gradient and RF chains?
25. How much time is required to perform software or hardware upgrades?
26. The use of an operating system (OS) for which vendor support has been discontinued is increasingly considered undesirable (NEN7510). Please describe the options available to ensure that the MRI scanner can operate throughout its lifetime using an OS that remains supported by the OS vendor.
27. Which subscription models do you offer for MRI acquisition and reconstruction methods?

Innovation and Translation

28. What options do you offer for extending software capabilities to test new functionality?
29. What options do you offer for developing custom pulse sequences?
30. What options do your systems provide for exporting k-space data?
31. What options do your systems provide for modifying image reconstruction, either prospectively or retrospectively?
32. What support do you provide for the use of custom-built RF and/or gradient coils?
33. What capabilities and level of autonomy do you provide for using such coils on your MRI systems?
34. What options do you offer to synchronize and interface additional imaging systems with your MR system? Describe what information can be transferred between such system and your MR system, and in which direction the transfer can take place.

Operator Workload

35. What features do your systems provide to improve operational efficiency, for example:
 - a. Automating laboratory animal positioning?
 - b. Remote operation of the scanner?
 - c. Remote viewing and monitoring?
 - d. Simplifying the operator workflow as much as possible?

Protocol management and portability

36. What features does your system provide for managing protocols?
37. Which solutions do you provide for sharing protocols between:
 - a. MR systems of different software level?
 - b. MR systems of different models within your product portfolio?
 - c. MR systems of different vendors?
 - d. MR systems for clinical human use and pre-clinical use?

Application Training

38. How do you provide application training to MRI operators?
39. How do you provide additional application training following software updates and hardware upgrades?
40. How do your application specialists support MRI operators in protocol optimization?

Construction and Installation

Installation Requirements

41. Can you provide a concise overview of your MRI portfolio, including for each system the key characteristics relevant to installation, such as:
 - a. Electrical power requirements: consumption at idle, during typical scanning, and at peak load.
 - b. Cooling water requirements (m^3/h) and inlet temperature specifications.
 - c. Cooling water: indication of the amount of dissipated energy at idle and during scanning.
 - d. Room ventilation: the amount of heat dissipated to the air at idle and during scanning, for the control room, technical room, and MRI room.
 - e. Room ventilation requirements, including temperature and humidity specifications.
 - f. Technical room: minimum required and recommended floor space (m^2).
 - g. All of our MRI scanners are installed indoors. What are the minimum requirements for transport openings for vertical and horizontal transport?
 - h. Are there any other installation-related considerations that you consider important?

Lead Time

42. What is the time required to upgrade an existing system to a new system and complete acceptance testing?

RF Cages

43. Is an RF cage always required (particularly in locations where one is not currently available)?
44. Can your systems be installed in existing RF cages, and if so, what special considerations, modifications, or installation work are required?
45. What are the minimum requirements you impose on RF cages to ensure proper operation of your MRI systems, for example with respect to RF shielding and acoustic attenuation?

Roadmap

46. We would appreciate insight into the software and hardware developments you foresee within your portfolio over the next three years. Could you elaborate on developments in the following areas:
 - a. New systems expected to be introduced to the market in the near future? When are these expected to become available?
 - b. Technical developments, for example in magnet technology, RF receive coils, animal comfort, workflow optimization, and MRI imaging methods.

Service

47. From which location does your service organization operate for the Dutch market?
48. Can you provide an overview of the service and maintenance models available for your MRI scanners, including options for helium coverage, spare parts coverage, preventive and corrective maintenance, and response times (both remote and on-site)?
49. Is it possible, within your service model, to order magnet maintenance on demand?
50. Which tools and documentation are made available to our technical staff to diagnose and resolve system failures independently? How can you provide remote support in this process?
51. How can our technical staff gain access to the scanner service menu, and are any restrictions associated with this access? Can the service menu also be accessed remotely by our technicians?
52. What support do you provide during and outside office hours to prevent further damage to the MRI scanner in the event of an actual or impending quench, or any other malfunction requiring urgent intervention?
53. Are MRI scanners monitored remotely, and do you proactively respond to an actual or impending quench, or other malfunctions requiring immediate follow-up?

Total cost of ownership (TCO)

54. What are the costs associated with the purchase and installation of the various types of 7T and 9.4T preclinical system upgrades? Please specify these costs and provide a high-level overview of the proposed configuration. We are not looking for list prices, but rather for a realistic estimate that will allow AMICE to make an informed assessment for budgeting purposes.
55. What are the costs associated with the various service and maintenance models you offer? Please specify preventive maintenance, collaborative service models, and full-service contracts.
56. Do you offer a model in which all software upgrades are available for a fixed annual fee? If so, what does this model include? Does it also cover hardware upgrades and new acquisition methods? What are the associated costs?
57. What are the costs of application training?
58. Which components and consumables require replacement or replenishment during the lifetime of the MRI scanner, such as helium, RF coils, and support materials? What are the associated costs?
59. What opportunities do you see for reducing the TCO of the new MRI systems, and what consequences would these measures have for system use?
60. What benefits would AMICE receive if an existing system is removed and traded in?

Sustainability

61. What are the key principles and objectives of your circularity policy, both within your company and in the production and maintenance of MRI scanners?
62. How is this policy reflected in practice throughout the life cycle of the MRI equipment you produce and sell? Please consider aspects such as environmental impact throughout the supply chain, material usage, energy efficiency, lifetime extension, and refurbishment or recycling opportunities.
63. What is the typical annual electrical energy consumption (kWh/year) of your systems, and what options (e.g., energy-saving modes) are available to influence or reduce this consumption?