



Hepatica MD Patient Acquisition Manual for Philips Scanners

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1. Glossary

Term	Description
A-P	Anterior-Posterior
ARRT	The American Registry of Radiologic Technologists
B0	Main magnetic field
CE	Continuing Education
CLEAR	Constant LLevel AppeaRance
DICOM	Digital Imaging and Communications in Medicine
DOB	Date Of Birth
ECG	ElectroCardioGram
F-H	Feet-Head
FFE	Fast Field Echo
GRE	Gradient Recalled Echo
IDEAL	Iterative Decomposition of water and fat with Echo Asymmetry and Least-squares estimation
ID	Identifier
LMS	LiverMultiScan
MOLLI	Modified Look Locker Inversion Recovery
MOST	Magnitude Only thin-Slice T2*
MR	Magnetic Resonance
MRI	Magnetic Resonance Imaging
PACS	Picture Archiving and Communication System
PG	Peripheral Gating
PII	Personally identifiable Information
PPU	Peripheral Pulse Unit
R-L	Right-Left
RF	Radio Frequency
RIS	Radiology Information System
S-I	Superior-Inferior
SAR	Specific Absorption Rate
SNR	Signal-to-Noise Ratio
SSFP	Steady State Free Precession
ShMOLLI	Shortened-Modified Look Locker Inversion Recovery
THRIVE	T1-weighted HighResolution Isotropic Volume Examination

Term	Description
dB/dt	Time varying gradient

2. Introduction

2.1. Scope

This manual is intended to describe the correct procedure to perform the Perspectum set up protocol to an *MR* operator on Philips scanners. Please use this document as a reference guide when performing the protocol acquisitions. The manual is divided in three main sections: Preparation, Acquisition and Data Export.

2.2. Continuing Education

In some territories, such as the USA, this training is eligible for continuing education (*CE*) credit. The *CE* is sponsored by Perspectum and will be presented by a member of the Imaging Applications team. The presenter's name, date, and attendees will be written on the Imaging Staff Training Checklist at the time of training; this form will be kept in Perspectum's records of site training activities and an electronic copy will also be sent to the site. In order to qualify for *CE*, the document, Multiparametric Liver MRI Applications Training – MRA1157, should also be provided along with the training. This document includes post-activity evaluations that must be completed to award credit.

2.3. Compatibility and Requirements

All sequences described in this manual require scanner hardware and software to be compliant with all manufacturer's specifications, especially gradient performance, eddy current compensation, and magnetic field (*B0*) homogeneity and stability. The protocols cannot be utilized on scanners outside of the manufacturer's service specifications and calibration schedules. Do not use phased-array coils with failed elements or without *SNR* checks passed.

2.3.1. Volume requirement

The system should have 3D T1 THRIVE sequences available. This will allow a three-dimensional spoiled gradient echo pulse sequence. A multi-echo variant of this sequence with a water-fat separation 3D T1 mDIXON THRIVE is preferred. The latter allows acquiring in-phase and out-of-phase images in one single acquisition, to calculate water-only and fat-only images.

2.3.2. T1 Mapping Requirement

T1 mapping protocols require the manufacturer's clinically approved software product CardiacQuant.

2.3.3. T_2^* and Proton Density Fat Fraction Mapping Requirement

The system should also have the Multi-Echo Gradient-Echo package available. This package is offered as a product on most Philips scanners without the need of additional license.

2.4. References

Hepatica Supported MR Systems – PDM0384

Image Acquisition Protocols - MRA0671

3. Preparation

3.1. Patient Registration



CAUTION

Ensure the subject is registered to a new *MR* study.

The minimum required information for registering the patient is as follows:

- Registration *ID*: <Use agreed on Subject ID Naming Scheme>
- Patient Name: <Use Agreed Subject Naming Scheme>
- Date of birth (*DOB*): <Use agreed *DOB* Scheme>
- Study Comments: Operator <operator initials> (example: Operator AB)
- The patient's height (when available), weight and sex

Date of Birth (*DOB*) Scheme: If *PII* is allowed, the patient's date of birth *DOB* may be used. Otherwise, **please use 01-Jan, and the correct YEAR of birth.**

Please note that the MRI technician/radiographer who performs patient acquisition must have undergone training by either:

- (a) Authorised Perspectum Imaging Applications specialists
- (b) Previously trained site personnel authorised to perform internal training

A record of such internal training must be provided to Perspectum with the appropriate Imaging Staff Training Checklist.

3.2. Breath-hold Instructions

Breath-holding should be explained and practised when required because variations in the depth of a subject's breathing can markedly alter the image quality and the consistency of the abdomen position between acquisitions. End-expiration breath-hold is chosen because breathing out is a more repeatable process. This should be explained to the patient: 'The scans are better if you hold your breath after breathing out comfortably.' The following instructions should be given to the patient ahead of each scan:

- Breathe in.
- Breathe out.
- Stop and hold your breath there.
- Breathe away or Resume breathing (after data has been acquired).

3.3. Patient preparation

LMS requires cardiac gating, end-expiration breath-hold and phased-array receiver coils.

Please prepare the patient following these steps:

1. Explain and demonstrate the breath-hold instructions as above.
2. Position the patient in the supine position.
3. Set up cardiac trace input (gating or simulator) and check the signal has clear R-wave triggering.
4. Select the correct trigger source in the Gating Window.
5. Patient arms can be positioned at the sides, though above the head is acceptable if subject does not easily fit into bore.
6. Use the spine array and the torso/body phased-array coil.
7. Scanner laser should be landmarked on the xiphisternum of the patient.

3.4. Cardiac Trace Input

Some pulse sequences require cardiac triggering/gating. This input can be from either the patient or a cardiac trace simulator. Both methods are outlined below.

3.4.1. Cardiac Trace Simulator

This feature is only available when access to either gyrotest, MRService or MRResearch account is possible.

1. Right click the protocol window and select <control parameter editor>.
2. Under the <General Tab> select <Yes> for <Physiology Simulation>.
3. Set the number of RR intervals to 1.
4. Set the first RR interval to 1000.
5. Click <Apply>.
6. Under <patient information> tag please enter 60 for <entered heartrate>.

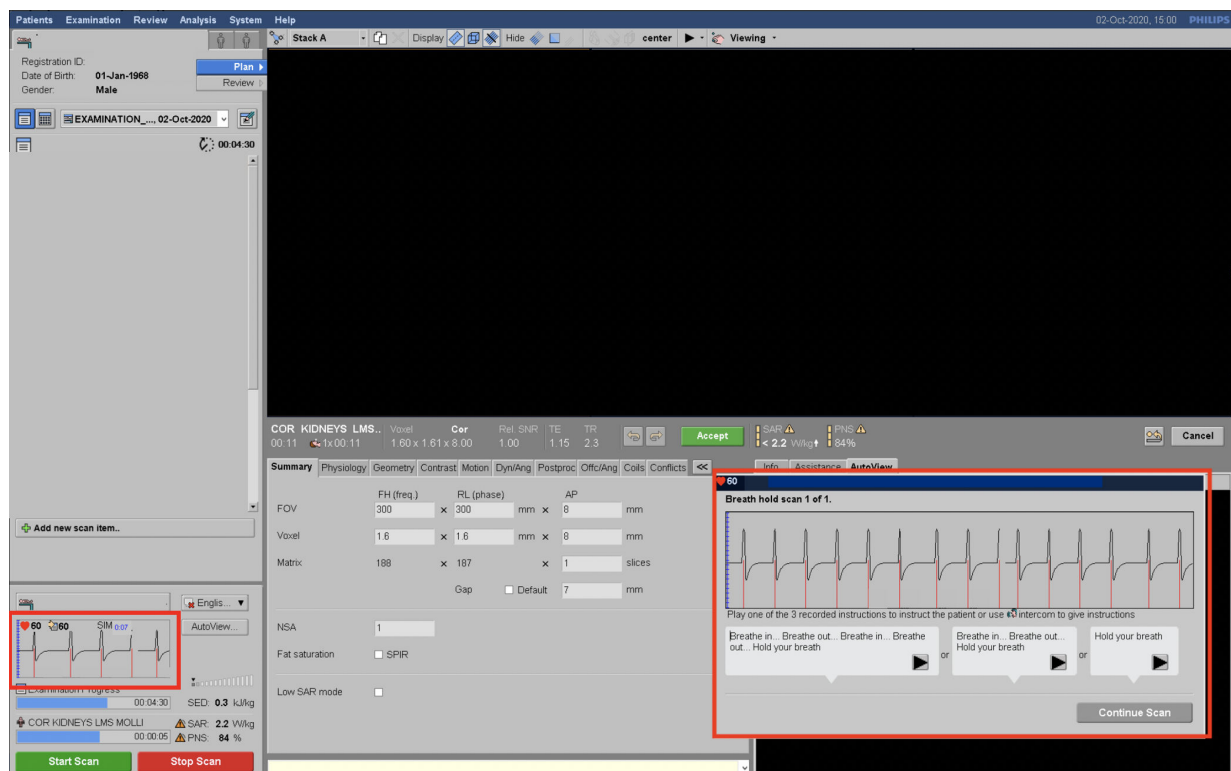


Figure 1. The simulated heartbeat is highlighted with a red box.

3.4.2. Cardiac Gating

1. Use *ECG* or pulse oximeter to set up the patient's cardiac gating.
2. select the correct trigger source in the gating window (physiology monitoring window) and confirm the signal has clear R-wave.

After a regular heartbeat is picked up by the *ECG* leads or pulse oximeter, double click on the second number on the right number and it will automatically update to the current heart rate. In the case of [Figure 2 \(page 6\)](#), the current heart rate is 60, and the expected heart rate is 65.

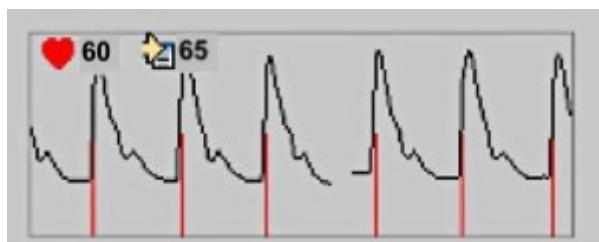


Figure 2. Update expected heart rate. 65 is the expected heart rate set by the radiographer and 60 is the actual heart rate of the patient detected by the scanner.



TIP

It is important to maintain the expected heart rate higher than the real heart rate to account for fluctuations.

4. Acquisition

Please note that:

1. All protocols must be acquired before any contrast agent injection. Note that contrast agents are not necessary for any of the acquisitions.
2. All scans are performed during end-expiration breath-hold, including the Survey scan.



CAUTION

Protocol parameters should not be changed. Any changes not specifically covered in these instructions risk corrupting the resultant parameters and cause data rejection by Perspectum Ltd.



CAUTION

Please do NOT inject any contrast agent prior to the acquisition of *LMS* protocol. This might result in erroneous parameter quantification.

4.1. Localization Protocols

4.1.1. Three-plane Survey

A three-plane Survey should be run at end-expiration breath-hold to produce at least one sagittal, one coronal and one transversal view of the abdomen.



CAUTION

Check that the phased-array coil is positioned to give good *SNR* over the entire liver. Reposition the coil on the patient if necessary. Low image *SNR* adversely impacts the quality of the resulting parameter estimates.

4.1.2. Additional Localizers (optional)

Additional localizers may be run to acquire axial/transversal slices to find the right view for subsequent *LMS* slice positioning.

4.2. Volume Acquisition

LMS Volume:

Alter the centre of the image volume so that the entire craniocaudal extent of the liver and spleen is captured. If the mDIXON option is available on the scanner, please make sure it is selected for this scan.



WARNING

Position the centre of the image volume so that the entire craniocaudal (H-F) extent of the liver and spleen is captured. The number of slices can be increased to cover the entire craniocaudal extent of the liver but the slice thickness should remain the same.

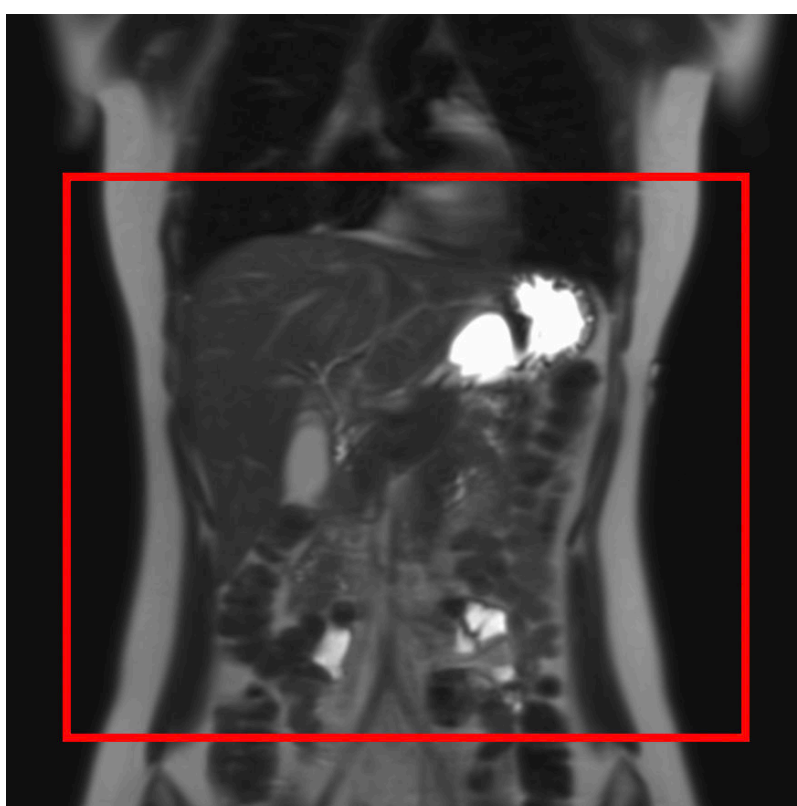


Figure 3. Example of the region which should be scanned with the LMS Volume acquisition

Motion and breathing : The LMS Volume image will need to be re-acquired if there is a motion artefact due to breathing as shown in [Figure 4 \(page 8\)](#).

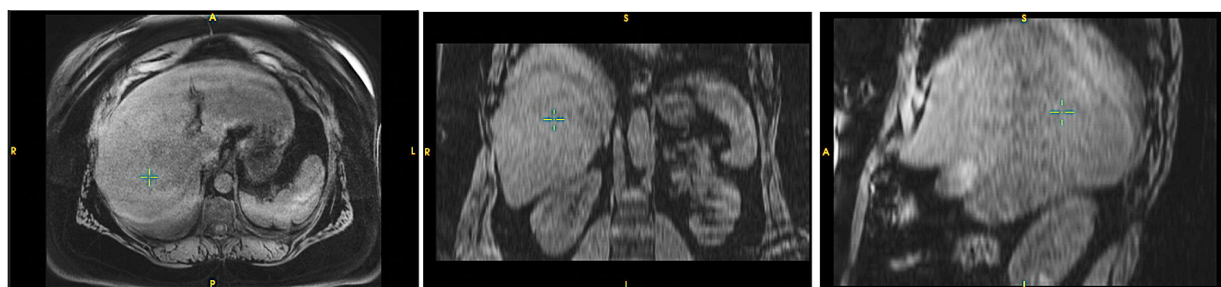


Figure 4. If the LMS Volume image shows motion artefacts due to breathing, re-acquire the image.

FOV coverage: If the acquired image doesn't cover the whole liver, as an example shown in [Figure 5](#) (page 9), increase the number of slices and ensure the entire craniocaudal extent of the liver is covered. The slice thickness should not be changed.



Figure 5. The Dome of the liver has been excluded in the acquisition, re-acquire the image with correct FOV positioning and increase the number of slices if necessary. Do not change the slice thickness.

4.3. Liver LMS Imaging Location

4.3.1. Base Slice Positioning

This slice location will be used as the centre for the majority of the sequences. Hence it is imperative to position correctly. The base slice should be positioned such that it intersects the porta hepatis, and it should display the liver, spleen, and may also contain the stomach.

If the lungs are visible in the transverse slice, please shift the image lower on the patient's abdomen as the lungs will cause susceptibility artefacts. Please refer to the localizer images in [Figure 6](#) (page 9) for positioning of the transverse slice.

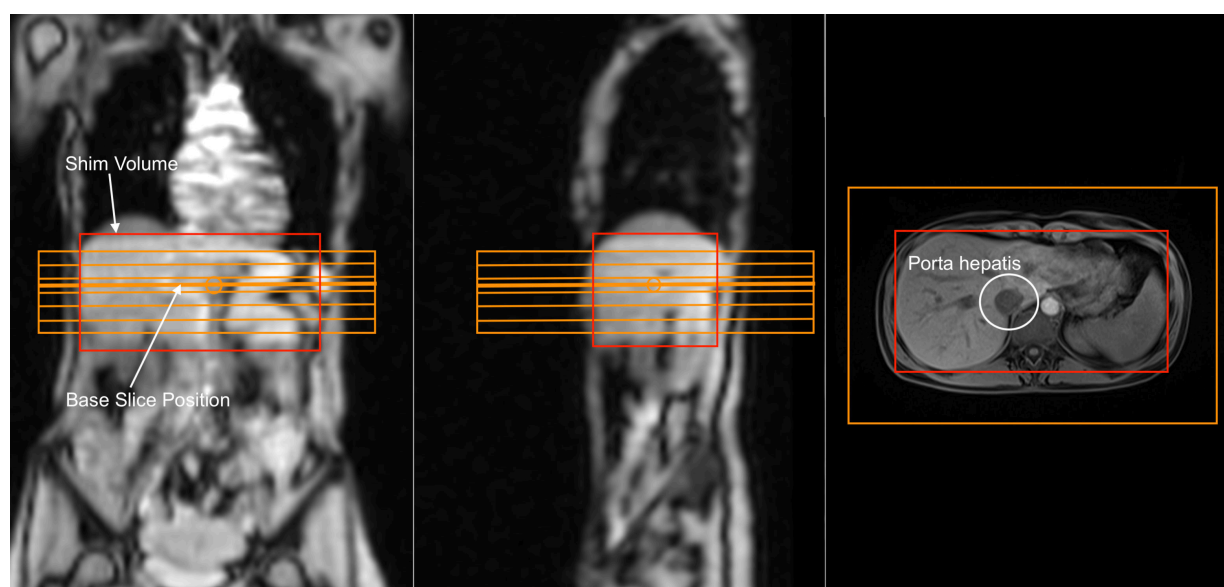


Figure 6. Three-plane Survey view of the abdomen in coronal, sagittal, and transversal (axial) plane. The base slice location for LMS protocol is indicated in orange and the shim volume in red.

4.3.2. Shimming

The shim volume should be centred as shown in [Figure 6 \(page 9\)](#) . The *F-H* direction should cover the entire stack of slices and should be remained as in the protocol. In the *R-L* and *A-P* directions, the shim volume can be adapted until the liver is fully covered, excluding as much air as possible. Please also exclude the subcutaneous fat in obese patients.



CAUTION

Shim adjustments other than those described in this manual may corrupt the parameter mapping.



CAUTION

Susceptibility Artefacts

Magnetic susceptibility artefacts appear due to: poor shim, proximity to the lungs, bowel gas or metallic implants. Susceptibility artefacts in the liver will preclude accurate parameter estimation in the areas affected as shown in [Figure 7 \(page 10\)](#).

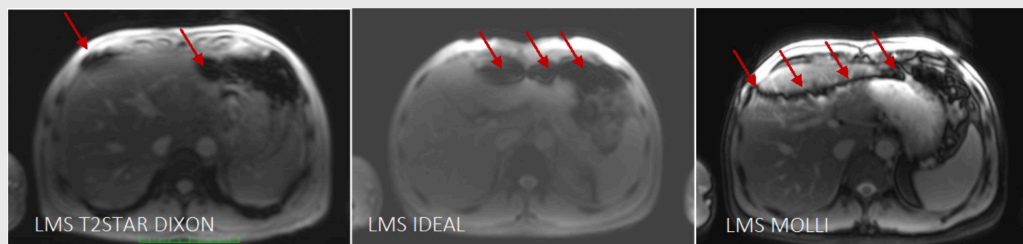


Figure 7. Susceptibility artefacts will appear as dark, distorted areas, in LMS MOLLI it also can appear as a banding artefact.

To mitigate susceptibility artefacts:

1. Ensure the centre of the multi-slice is at isocentre and make sure the shim volume is positioned as shown in [Figure 6 \(page 9\)](#).

2. Force a re-shim by :

Postproc tab > Set the Preparation Phases method to “Full” > Run the sequence again.

3. Re-acquire the data.

4.4. Liver LMS IDEAL

This is a 5-slice multi-echo sequence performed at end-expiration breath-hold. The breath-hold lasts approximately 9 seconds. This sequence will be used to generate a PDFF map of the liver.

1. Prescribe the slice stack so that the 3rd slice (middle slice) intersects the porta hepatis.
2. The shim volume should be centered as the slice stack and the R-L and A-P directions can be adapted to ensure the entire abdomen is included in the transverse view and the liver and the spleen are completely covered as shown in [Figure 6 \(page 9\)](#).
3. The (F>>H) shim volume thickness should be manually adjusted to '90mm'.

4.5. Liver LMS MOST

This is a single-slice multi-echo gradient-echo sequence performed at end-expiration breath-hold. The breath-hold lasts approximately 11 seconds. This sequence will be used to generate a T2* map of the liver.

1. Set the centre of the slice and shim volume identical to LMS *IDEAL* (same GEO name).
2. Make sure the shim volume thickness is 20mm. Repositioning of the adjust volume may be required.
3. Give the breathing instruction, "**Breath in**", "**Breath out**", "**Hold your breath**" and then run the sequence.
4. Once the acquisition is complete, tell the patient to "**Resume breathing**"

4.6. Liver LMS T2STAR DIXON

This is a single-slice multi-echo gradient-echo sequence performed at end-expiration breath-hold. The breath-hold lasts approximately 10 seconds. This sequence will be used to generate a T2* map of the liver.

1. Set the centre of the slice and the shim volume identical to LMS *MOST* (same GEO name).

4.7. Liver LMS MOLLI

This is a multi-slice, multi-breath-hold, cardiac-gated acquisition performed at end-expiration breath-hold. This scan acquires 5 transverse slices, one slice per breath-hold. Each breath-hold lasts approximately 9-12 seconds. This sequence will be used to generate a T1 map of the liver.

After each slice has been acquired the operator will be prompted to give breathing instruction for the next slice. During the scan, it is imperative to monitor the physiological recording trace to check **no heartbeats are missed** by the system's triggering algorithm.

1. Set the LMS *MOLLI* slice centre as same as LMS *IDEAL* by ensuring they have the same GEO name.
2. The slice stack and shim volume should be positioned as shown in [Figure 6 \(page 9\)](#).

5. Data Export



UPLOAD SINGLE COMPRESSED FILE

Please compress all sets of data for the **same** patient into **one** file and proceed with the upload.



IMPORTANT

Please follow the arrangement for personally identifiable information (*PII*) as agreed for your site, as the removal of *PII* may not be necessary for your site.

Private *DICOM* tags are special tags added by the manufacturer to describe the MRI sequence. They do NOT refer to private information, nor *PII*. Many *DICOM* anonymization tools have an option to remove all Private Tags. Do not remove Private Tags when exporting data.



CAUTION

Private *DICOM* tags must be preserved in any data export. Private *DICOM* tags are not *PII* tags.

These instructions cover exporting data from the Philips scanner for transfer. If your site is unable to export from the scanner directly and transfers data via a *PACS* system please use the *PACS* export to save the *DICOM* images.

5.1. Saving *DICOM* Images for Transfer

To export data from the Philips MRI Scanner directly, from the <Patient> menu pick <Administration> to open the Patient Administrator.

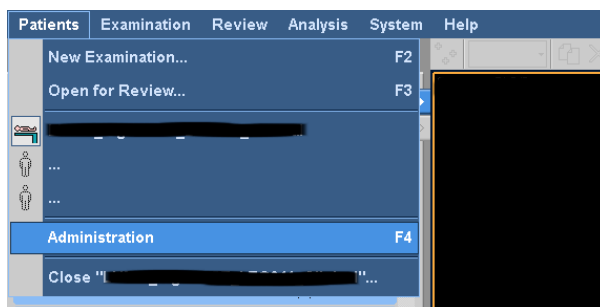


Figure 8. Click on Administration from the Patients tab to export data.

The source database or device can be chosen from the top-left corner. The default is the <Local Patient Database>. Select the data you want to export.

Exporting data to a CD or DVD:

Please select DVD as a destination on the Patient Administration window.

Exporting data to a specific location to the file system with a USB stick or external hard drive:

Please export the data in the following steps:

1. In <Patient Administration> select the appropriate subject folder.
2. click on <Disk Files> icon to open the <Export to Files> pop-up window.
3. Browse to your destination. This can be an external USB stick or hard drive.
4. Select format as <Classic DICOM>.
5. Confirm with Proceed.



CAUTION

DO NOT select <suppress patient data> or <Anonymize>.

To check the status of data transfer, select <Queue Manager> from the <System> main menu or from the <Patient Administration> window.

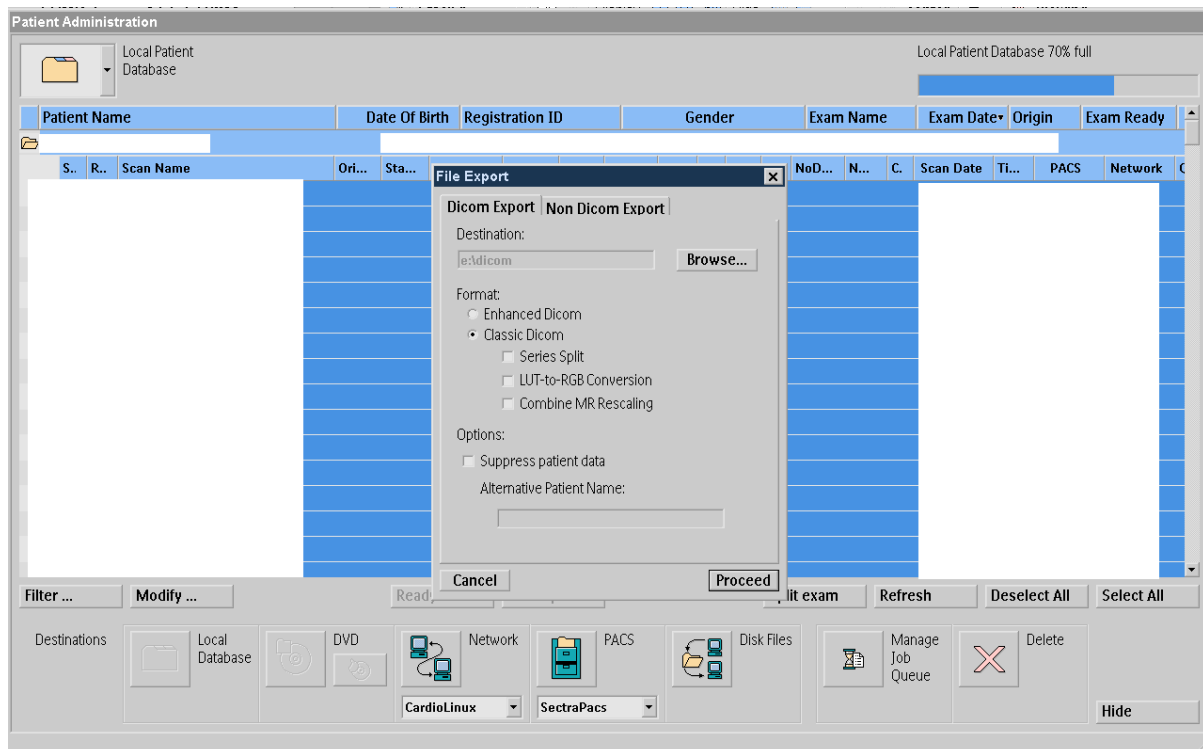


Figure 9. Data Export options.

It is preferable to compress the folder of exported DICOMs and submit the single compressed file to the Portal.

- **On a Windows:** right click on the folder in Windows Explorer and select <Send To> and <Compress (zipped) folder>. If the folder resides on a CD or DVD, you will need to copy the folder to a location that can be saved to.
- **On a Mac:** hold Ctrl and click on the folder, then select <Compress>.

Upload the compressed file to the Perspectum Portal.

For additional instruction on using the Portal, please see the Portal Customer User Guide - PDM0077 on the Portal website.

6. Acquisition Checklist

Step	Task
Patient information	<input type="checkbox"/> Patient name: Use agreed patient naming scheme <input type="checkbox"/> Registration ID: Use agreed patient ID naming scheme <input type="checkbox"/> Date of birth: Use agreed scheme <input type="checkbox"/> Correct sex, height, weight and exam date <input type="checkbox"/> Study Comments: Input the initial of the operator. <input type="checkbox"/> Patient Position: Select the appropriate position. <input type="checkbox"/> Leave the rest of the fields empty.
Localiser (one breath-hold)	<input type="checkbox"/> Run localiser on expiration
LMS Volume (one breath-hold)	<input type="checkbox"/> Place the FOV to cover the entire craniocaudal extent of the liver <input type="checkbox"/> Scan the sequence at end of expiration <input type="checkbox"/> Check image quality, if there is motion artefacts or the liver isn't fully covered, re-acquire the sequence.
LMS IDEAL (one breath-hold)	<input type="checkbox"/> Place the slice stack (5 slices) so that the middle slice (third slice) will intersect the porta hepatis. <input type="checkbox"/> Position the shim volume centred on the slice stack. <input type="checkbox"/> Adjust the shim volume only in R-L and A-P directions to the patient's dimensions so all of the abdomen is included in the transverse view. <input type="checkbox"/> Scan the sequence at end of expiration. <input type="checkbox"/> Check image quality, if there is motion artefacts please re-acquire the sequence.
LMS MOST (one breath-hold)	<input type="checkbox"/> Position the single with the same centre of LMS IDEAL, intersecting the porta hepatis. <input type="checkbox"/> Position the shim volume centred on the slice; shim volume is thicker than the slice. <input type="checkbox"/> Adjust the shim volume only in R-L and A-P direction to the patient's dimensions so all of the abdomen is included in the transverse view. <input type="checkbox"/> Scan the sequence at end of expiration. <input type="checkbox"/> Check image quality, if there is motion artefacts please re-acquire the sequence.

Step	Task
LMS T2STAR DIXON (one breath-hold)	<ul style="list-style-type: none"> <input type="checkbox"/> Position the slice with with the same centre of LMS MOST, intersecting the porta hepatis. <input type="checkbox"/> Position the shim volume centred on the slice. shim volume is thicker than the slice thickness. <input type="checkbox"/> Adjust the shim volume only in R-L and A-P direction on the patient's dimensions so all of the abdomen is included in the transverse view. <input type="checkbox"/> Scan the sequence at end of expiration. <input type="checkbox"/> Check image quality, if there is motion artefacts please re-acquire the sequence.
LMS MOLLI (5 breath-holds)	<ul style="list-style-type: none"> <input type="checkbox"/> Position the slice stack with the same centre of LMS IDEAL. <input type="checkbox"/> Make sure the shim volume is centred on the slice stack and adjust the shim volume only in R-L and A-P direction so all of the abdomen is included in the transverse view. Exclude subcutaneous fat as much as possible. <input type="checkbox"/> Check image quality for each slice; are there artefacts? If so, please re-acquire the sequence.

7. Issue control

Issue	Details	Date	Initial
1.0	New document	Oct 26, 2020	FSN
2.0	Correct MOLLI slice number	Aug 20, 2021	FSN

8. Approvals

Job title	Name	Signature
Chief Operating Officer	Dr. Rexford Newbould	
Chief Technical Officer	Prof. Matthew Robson	
Chief Quality and Regulatory Compliance Officer	Dr. Jaco Jacobs	
Product Manager	Dr. Sean Pollock	