# moorLDI2 USER MANUAL AND REFERENCE

moorLDI2-VR moorLDI2-HR
moorLDI2-IR moorLDI2-HIR

RESEARCH Software Versions 5.3 Issue 4: 06-07-12

**User Assistance Information**

In case of difficulties which cannot be solved easily by the material within this manual, please contact your distributor or Moor Instruments directly, quoting the instrument serial number


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**moorLDI** is patented: UK No. 2231742, USA No. 5588437, EPC No. 0465524, Israel No. 93909, Japan No. 3239952.

# EC DECLARATION OF CONFORMITY

Moor Instruments Ltd
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Declares that the medical device described hereafter:

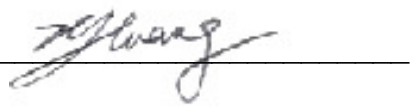
moorLDI2 Laser Doppler Imager

is in conformity with the essential requirements and provisions of Council Directive 93/42/EEC and revisions in accordance with Council Directive 2007/47/EC and is in conformity with the national standard transposing harmonised standards:

IEC 60601-1: 2005
IEC 60825-1: 2007

is subject to the procedure set out in Annex 2 of Directive 93/42/EEC and revisions in accordance with Council Directive 2007/47/EC under the supervision of Notified Body Number 0120, SGS United Kingdom Limited, Unit 202B, Worle Parkway, Weston-Super-Mare, Somerset BS22 6WA.

Axminster, England 06th July 2012



Xiabing Huang
Managing Director
on behalf of Moor Instruments Ltd

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# 1. SAFETY

## 1.1 INTRODUCTION AND INTENDED USE

The 'Moor Instruments moorLDI2 User Manual' reference for the following imager types:

| | |
|---|---|
| moorLDI2-VR | Visible red laser Class 3R |
| moorLDI2-IR | Near infra-red laser Class 3R |
| moorLDI2-HR | High Resolution version of moorLDI2-VR Class 3R |
| moorLDI2-HIR | High Resolution version of moorLDI2-IR Class 3R |

(NB: Separate User Manuals are available for the dual wavelength types moorLDI2-2λ and moorLDI2-HR2λ)

The moorLDI2 laser Doppler imager scans a low power laser beam in a raster pattern over skin or other exposed tissue surface. The beam is either a single visible beam, or a near infra-red beam in combination with a visible red aiming beam.

Moving blood in the microvasculature causes a Doppler frequency broadening of the scattered laser light. Some of this scattered light is photodetected in the imager, and then electronically and digitally processed to build up a colour coded image display of blood flow. The measurement is non-contact and can quantify differences in flow within a single image and/or image repetitively to assess evolving flow patterns over time. Up to 256 x 256 individual blood flow measurements are made for each image recorded. For the VR and IR versions of the imager the measurement resolution is 0.2mm to 2mm, with scanning distances between the instrument aperture and the tissue surface of 20cm to 100cm. For the high resolution imagers HR and HIR versions of the imager which employ a focussed beam, the maximum resolution is 0.1mm at a measurement distance of 25cm.

The moorLDI2 laser Doppler imagers are intended for measurement of blood flow in the microcirculation e.g. blood flow in the small blood vessels of the skin. It is suitable for a wide range of clinical research applications including plastic surgery, diabetes, dermatology, vascular surgery, wound healing, neurology, physiology, neurosurgery and rheumatology.

## 1.2 LASER SAFETY

This section can only act as a guide to the user, for full details of mandatory and recommended safety precautions consult IEC 60825-1:2007 Safety of Laser Products.

**This instrument must be installed and operated according to CAN/CSA-Z386-01: Laser Safety in Health Care Facilities.**

**CAUTION - Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.**

All versions of the moorLDI2 imager are classified as Type 3R.
The instruments are classified as per IEC 60825-1:2007 and as per US 21 CFD 104.10 and 1040.11 except for deviations pursuant to Laser Notice No. 50 dated June 24, 2007.

### 1.2.1 LASER SAFETY moorLDI2-VR AND moorLDI2-HR

The laser light source in these moorLDI2 scanners is a Helium-Neon visible red gas laser (633nm). The maximum accessible power is 2.5mW for instruments using the gas laser.

For the VR type the beam divergence is approximately 1.4 milliradians, with a beam diameter ($1/e^2$ points) at 50cm from the laser aperture of approximately 1.2mm.

The ocular hazard distance is 25m.

For the HR type the laser beam is focussed to a spot size of approximately 0.1mm at 25cm from the laser aperture.

The ocular hazard distance is 25m.

The level of laser radiation is below the maximum permissible exposure (MPE) for skin but it presents a significant hazard if the eye is exposed to the full power of the laser beam, either by direct viewing along the beam, or by specular reflection.

The blink reflex of the eye provides a measure of protection, however direct viewing of the beam should be avoided.

#### *1.2.1.1 Training*

Only persons who have received training to an appropriate level should be placed in control of the moorLDI2. The training, which may be given by the manufacturer or supplier of the system, the Laser Safety Officer, or by an approved external organization, should include, but is not limited to:

a. Familiarisation with system operating procedures.
b. The proper use of hazard control procedures and warning signs.
c. The need for personal protection.
d. Accident reporting procedures.
e. Bio-effects of the laser on the eye and the skin.

#### *1.2.1.2 Unauthorised Access*

When the moorLDI2 is not in use by authorised personnel, measures should be taken to prevent unauthorised use. This will normally be achieved by storage in a locked area.

*1.2.1.3 Warning Signs*

The entrance to areas where the moorLDI2 is to be used should be posted with appropriate warning signs:


No Unauthorised Entry

*1.2.1.4 Safety During Operation*

It is not generally necessary for the patient to wear protective eyewear; however the patient must always have eye protection if the patient's face is to be scanned. It is not necessary for trained operators to wear protective eyewear.

Operating the single wavelength visible beam moorLDI2:

The laser should only be operated in a controlled area and direct eye exposure (i.e. viewing along the beam) must be avoided.

To reduce the possibility of direct eye exposure to the patient, operators or other persons authorised to be present when the moorLDI2 is operated:

a. The laser beam should be directed below eye level wherever practicable, e.g. directing the beam downwards.

b. If the measurement requires the beam to be directed other than downwards, e.g. the beam closer to the horizontal than the vertical, a screen should be placed close behind the body being scanned such that if the laser light beam is missing the body it is stopped by the screen. A dark cloth screen is recommended. If a suitable screen is not available the body should be scanned with a wall as background. During a measurement no personnel other than the person being scanned should be present in the area between the scanner and the screen or wall.

c. Care should be taken to prevent unintentional specular reflections. Any metallic or other highly reflective surfaces must be removed from the area to be scanned or covered with material to produce diffuse reflection, e.g. removal or taping over of rings etc.

### 1.2.2 LASER SAFETY moorLDI2-IR AND moorLDI2-HIR

There are two laser light sources within the moorLDI2-IR scanner. These are a visible red laser diode, wavelength 660nm (the aiming or target beam) and the near infra-red laser diode, wavelength 785nm, used for the laser Doppler measurements. The lasers are housed in an optic combiner, each laser has a collimating lens.

The combiner produces a single laser light output beam with the red and infra-red beams coaxial. The visible aiming beam of 660nm has a power of less than 200µW and the infra-red working beam has its accessible power between 2.0mW - 2.5mW (between 1.3mW – 1.5mW for the moorLDI2-HIR).
The beam divergence is approximately 1.4milliradians.
The beam diameter ($1/e^2$ points) at 50cm from the Laser Aperture is approximately 1.2mm.
The nominal ocular hazard distance is 20 metres.

The scanner uses a 785nm infrared laser source with the accessible power set between 2.0mW - 2.5mW. This level of laser radiation is below the maximum permissible exposure (MPE) for skin (which is approximately 28mW for laser radiation wavelength 785nm) but presents a significant hazard if the eye is exposed to the full power of the laser beam, either by direct viewing along the beam or by specular reflection. The 785nm infra-red beam is not visible to the human eye; however this laser eye hazard is reduced because the visible aiming beam is always present. The aiming beam enables the operator to see the position of the beam at all times.

**The visible aiming beam is also sufficiently bright to provide blink reflex protection; however a number of additional safety measures must be taken by the operator to minimise the risks involved.** These measures are described in the following sections.

#### *1.2.2.1 Laser Protective Eyewear*

**WARNING -** Eye protection should be used by patient and operator at all times in the measurement area if the moorLDI2-IR imager is operated with the near infra-red laser ON. Eye protection for the patient may be completely opaque (e.g. pads fixed over the eyes) if normal visibility is not required.

Eye protection for the operator(s) and patients:

Protective goggles or protective glasses must have an OD (optical density) of at least 1.5 for the range 755nm to 855nm.

The protective eyewear for the operator must allow the LASER READY and IR EMISSION indicators to be clearly seen (these indicators have a wavelength centred at approximately 585nm), and the visible red (660nm) target beam to be clearly seen. All laser protective eyewear should be clearly identified as being suitable for use with the moorLDI2-IR. Moor Instruments will normally supply protective eye wear that can be worn over prescription glasses.

When, due to unusual operating requirements, the use of eye protection is not practicable, the operator may use the moorLDI2-IR without eye protection. However this should only be undertaken with the approval of the Laser Safety Officer.

If the patient’s or a volunteer’s face is to be scanned the patient or volunteer must use protective eye wear.

*1.2.2.2 Laser Safety Officer*

For installations where Class 3R laser products emitting energy outside of the 400nm to 700nm wavelength ranges are operated, a Laser Safety Officer should be appointed. It is the Laser Safety Officer's responsibility to review the following precautions and designate the appropriate controls to be implemented. The Laser Safety Officer should be familiar with the requirements of IEC 60825-1:2007 Safety of Laser Products and in particular Section 3 of this standard.

*1.2.2.3 Warning Signs*

The entrance to areas where the moorLDI2-IR is to be used should be posted with appropriate warning signs:


No Unauthorised Entry

*1.2.2.4 Training*

Only persons who have received training to an appropriate level should be placed in control of the moorLDI2-IR. The training, which may be given by the manufacturer or supplier of the system, the Laser Safety Officer, or by an approved external organisation, should include, but is not limited to:

a. Familiarisation with system operating procedures.
b. The proper use of hazard control procedures and warning signs.
c. The need for personal protection.
d. Accident reporting procedures.
e. Bio-effects of the laser upon the eye and the skin.

*1.2.2.5 Reducing Laser Radiation Hazards*

The laser should only be operated in a controlled area. Direct eye exposure (i.e. viewing along the beam or viewing strong, specular reflection must be avoided (see Beam Delivery System, Figure 1, Section 1.3).

To reduce the possibility of direct eye exposure to the patient, operators or other persons authorised to be present when the moorLDI2-IR is operated:

a. The laser beam should be directed below eye level wherever practicable, e.g. directing the beam downwards.

b. If the measurement requires the beam to be directed other than downwards, e.g. the beam closer to the horizontal than the vertical, a screen should be placed close behind the body

being scanned such that if the laser light beam is missing the body it is stopped by the screen. A dark cloth screen is recommended.

If a suitable screen is not available the body should be scanned with a wall as background. During a measurement no personnel other than the person being scanned should be present in the area between the scanner and the screen or wall.

c. Care should be taken to prevent unintentional specular reflections. Any metallic or other highly reflective surfaces must be removed from the area to be scanned or covered with material to produce diffuse reflection, e.g. removal or taping over of rings etc.

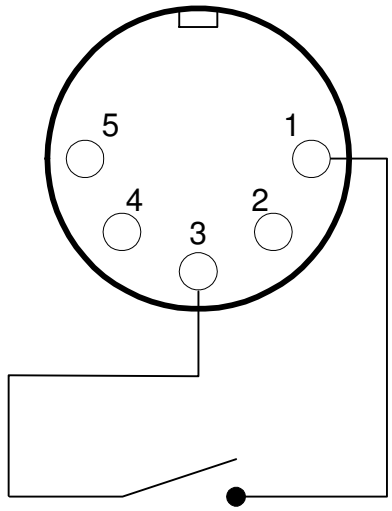
*1.2.2.6 Key Control*

The moorLDI2-IR has a key control that prevents access to the Near Infrared laser radiation (see Section 2 of this manual, Figure 2G). When the equipment is to be left unattended the key control should be set to the OFF position and the key removed to prevent unauthorised operation.

*1.2.2.7 Remote Interlock Connector*

The moorLDI2-IR scanner is provided with a remote interlock connector which can be connected to an emergency master disconnect interlock or to room, door or fixture interlocks if the Laser Safety Officer considers it necessary. The person in charge may temporarily override the remote interlock using the shorting plug supplied if it is clearly evident that there is no optical radiation hazard at the time and point of entry.

A non-wired plug is supplied with the system and may be wired to the interlock device(s) as shown below. When the interlock circuit is open, the infra-red laser is disabled.



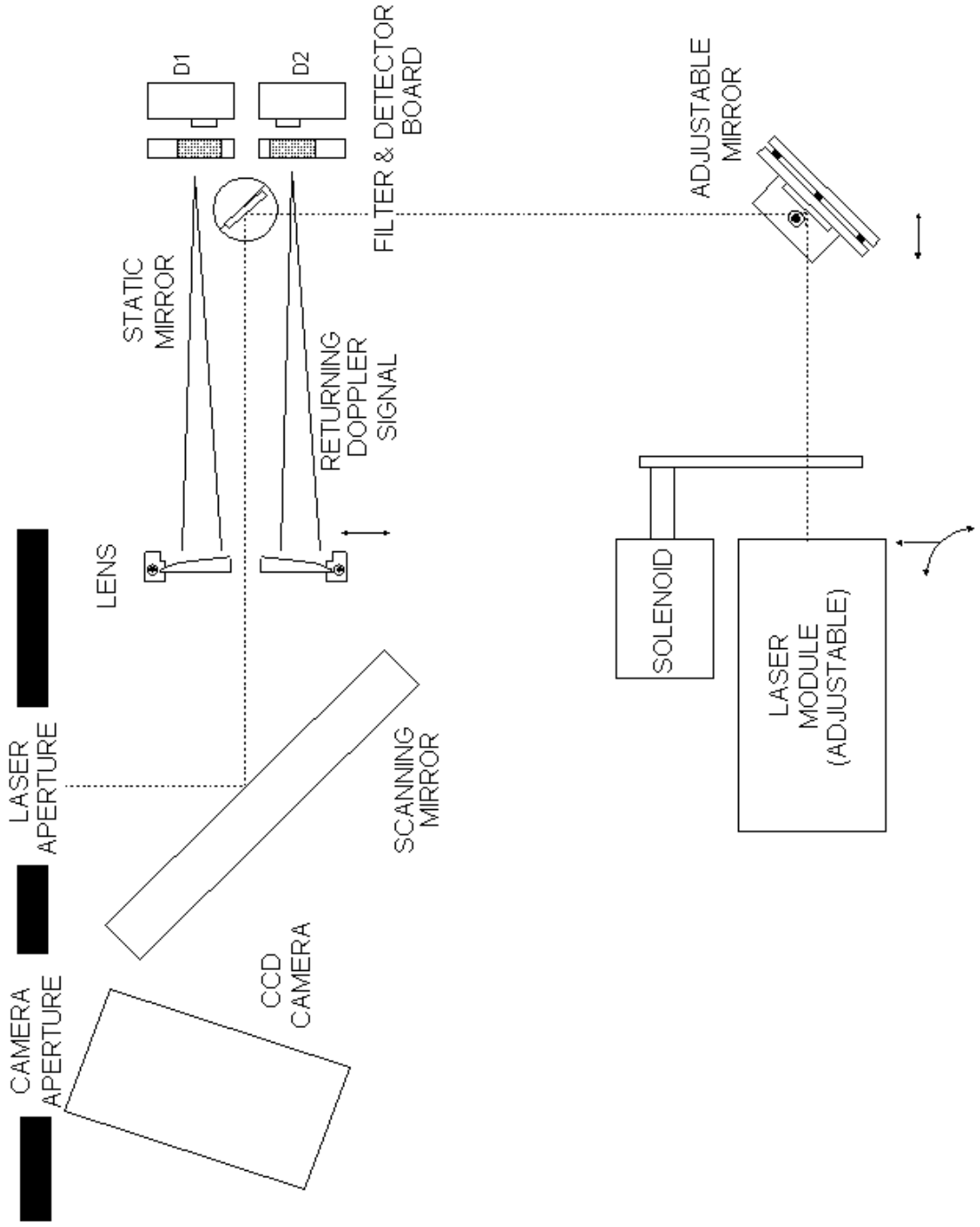

The interlock device should be wired to pins 1 and 3. The plug is shown as viewed from the inside (i.e. as seen when soldering connections). Follow the instructions supplied with the connector. Only insert contacts into the positions shown, any unused contacts may be discarded.

## 1.3 BEAM DELIVERY SYSTEM

The laser light source assembly consists of a visible red laser diode with a collimating lens to produce a beam of laser light (see Figure 1, below)

A solenoid operated attenuator mounted in front of the laser aperture of the assembly can be switched between a full power working beam (<2.5mW visible red) and an attenuated beam (<200µW). The beam is directed to the scanning mirror via two front silvered mirrors. The scanning mirror is computer controlled to direct the beam to the skin surface.

**FIGURE 1**



## 1.4 LASER WARNING LABELS

Location: Front panel adjacent to "LASER READY" indicator

**CAUTION -** CLASS 3R LASER RADIATION
WHEN OPEN AVOID DIRECT EYE EXPOSURE

Location: Scanner head rear panel
(for Visible Red System Class 3R)

**CAUTION** - CLASS 3B VISIBLE AND INVISIBLE LASER RADIATION WHEN OPEN AVOID EXPOSURE TO THE BEAM

Location: Scanner head rear panel
(for IR System Class 3R)

LASER APERTURE

Location: Scanner head front panel below the glass window aperture

**LASER RADIATION**
**AVOID DIRECT EYE EXPOSURE**
**CLASS 3R LASER PRODUCT**
**WAVELENGTH 633nm MAX. POWER 2.5mW**
**IEC 60825-1:2007**

Location: Scanner head top cover
(For Visible Red System Class 3R)

**VISIBLE AND INVISIBLE LASER RADIATION**
**AVOID DIRECT EYE EXPOSURE**
**CLASS 3R LASER PRODUCT**
**WAVELENGTH 785nm MAX. POWER 2.5mW**
**WAVELENGTH 660nm MAX. POWER 0.25mW**
**IEC 60825-1:2007**

Location: Scanner head top cover
(For Infrared System Class 3R)
For 785nm wavelength

**VISIBLE AND INVISIBLE LASER RADIATION**
**AVOID DIRECT EYE EXPOSURE**
**CLASS 3R LASER PRODUCT**
**WAVELENGTH 830nm MAX. POWER 2.5mW**
**WAVELENGTH 660nm MAX. POWER 0.25mW**
**IEC 60825-1:2007**

Location: Scanner head top cover
(For Infrared System Class 3R)
For 830nm wavelength

**This Equipment complies with 21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No. 50, dated June 24, 2007**

Location: Control box top cover
(for USA use only)

## 1.5 ELECTRICAL SAFETY LABELS

WARNING
ISOLATE MACHINE BEFORE REMOVING COVERS
ATTENTION
ISOLER MACHINE AVANT D'ENLEVER COUVERCLES
ACHTUNG
MASCINE ISOLIEREN BEVOR ENTFERNUNG DER DECKEL
AVISO
AISLE LA MAQUINA ANTES DE QUITAR
ATTENZIONE
ISOLARE MACCHINA PRIMA DI RIMOUVER COPERCHI

Location: Control box rear panel

Locations: Scan head rear panel adjacent to video connector.
Meaning: General Warning! The computer must be compliant with IEC 950 and be configured to comply with IEC 60601-1. Do not touch the patient and parts of either the connecting leads or mating sockets at the same time.

Locations: Control box rear panel adjacent to video connector.
Meaning: Caution! Non-isolated outputs (e.g. BNC output for devices such as MIC2, and RS-232 / Firewire connections). The computer must be compliant with IEC 950 and be configured to comply with IEC 60601-1. Do not touch the patient and parts of either the connecting leads or mating sockets at the same time.

Location: Rear panel of control box and scan head.
Meaning: This is to indicate that the equipment is of Type B as defined by IEC 60601-1, and has no applied parts which are intended to come into contact with the patient.

Locations: Control box rear panel and scan head real panel
Meaning: Refer to operating instruction before connecting the scan head to the control box.

CE 0120

Locations: Control box rear panel and scanner head real panel
Meaning: The marking of a product with the CE mark is intended to confirm that the product meets all of the essential Health & Safety Requirements contained in the relevant EU directive.

Locations: Control box rear panel
(See Section 26 Disposal)

## 1.6 ENVIRONMENTAL CONDITIONS

The scanner should not be used in conditions of high humidity (>80%) as this could cause misting (condensation) on the optical surfaces e.g. mirrors and aperture window. Also it is a potential electrical hazard.

The room temperature in which the scanner is operated must be in the range 15ºC to 30ºC. The instrument storage temperature range is 0-45ºC.

The operator should ensure the scanner is securely supported and free from vibrations due to external influences.

## 1.7 WARNINGS / CAUTION DO'S AND DON'TS

**Do** turn off mains power before disconnecting or connecting leads - possibility of damage to electrical components and corrupting the software.

**Do** turn on the computer before turning on the scanner control unit - possible loss of control of the scanner requiring power to be switched off and then re-powering in correct sequence.

**Do** follow the instructions for the safe operation of the laser - see Section 1.2 of this manual.

**Do not** touch the transparent area of the optical window.

**Do not** attempt to clean the optical window unless you have been instructed how to do so and have been authorised to do so - the surface is easily scratched. If scratched it will have to be replaced.

**Do** consult the responsible person for the moorLDI2 in your establishment or a Moor Instruments representative if you need advice.

**WARNING:** To avoid the risk of electric shock, this equipment must only be connected to a supply mains with protective earth.

**WARNING:** No modification of this equipment is allowed.

**WARNING:** The front panel of the scan head contains glass which is susceptible to shattering on impact.

## 2. SYSTEM DESCRIPTION

Figures 2A, 2B and 2C show the layout of the front and rear panels of the moorLDI2 control unit.

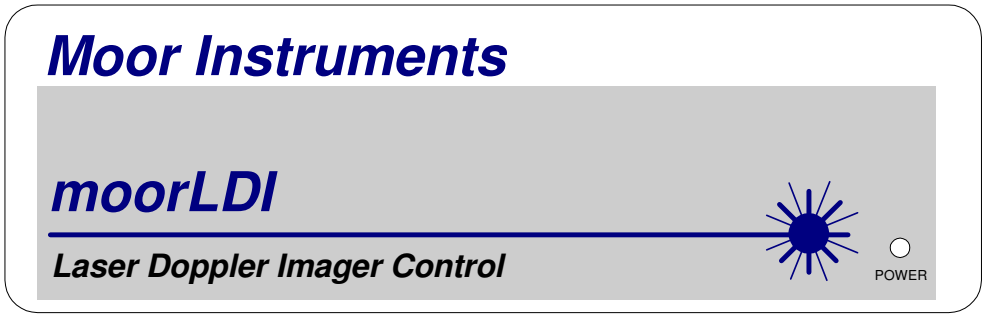
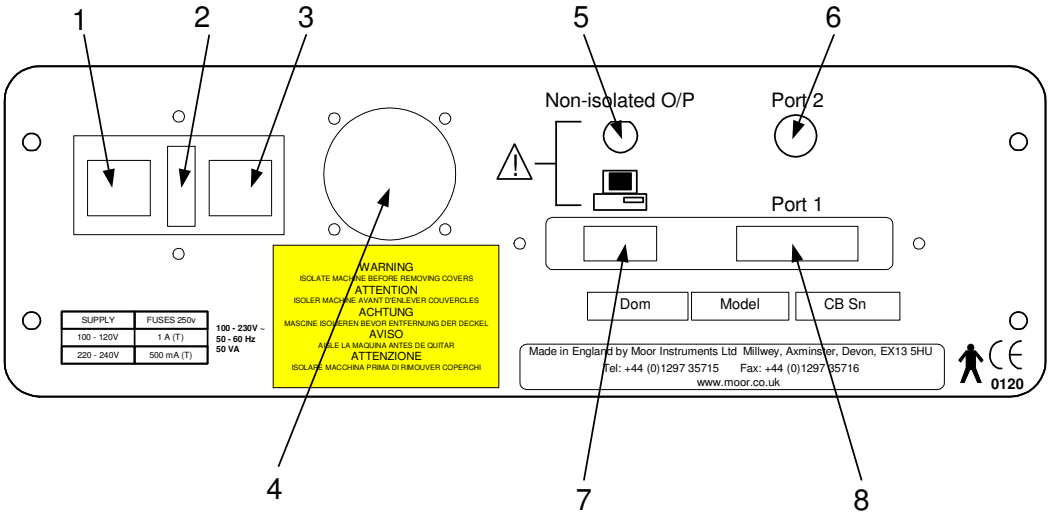
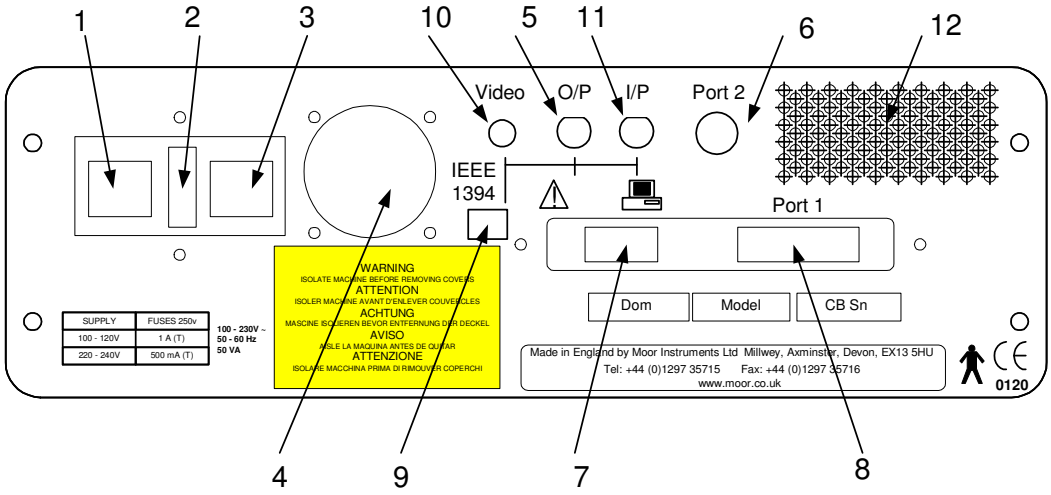



**FIGURE 2A - FRONT PANEL OF THE moorLDI2 CONTROL UNIT**




1. Socket for mains lead
2. Fuses.
3. ON/OFF switch.
4. Fan.
5. BNC output for devices (e.g MIC2).
6. Port 2: from scan head.
7. RS232 lead to PC.
8. Port 1: from scan head.

**FIGURE 2B - BACK PANEL OF THE CONTROL UNIT (ANALOGUE CAMERA MODEL)**

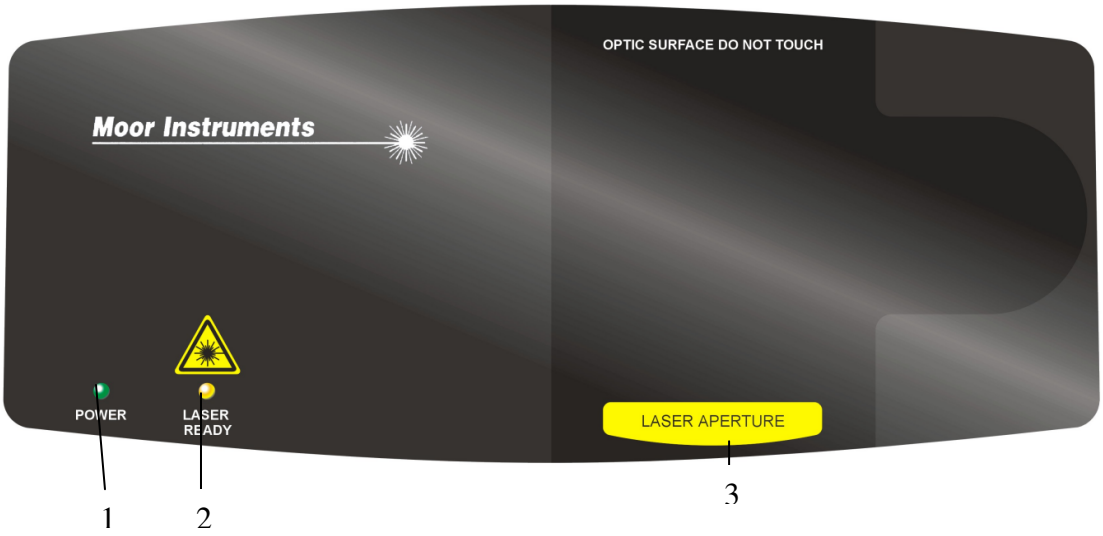



1. Socket for mains lead
2. Fuses
3. ON/OFF switch
4. Fan
5. BNC output for devices (e.g MIC2)
6. Port 2: from scan head
7. RS232 lead to PC
8. Port 1: from scan head
9. IEEE 1394 Firewire to PC
10. Video from scan head
11. BNC input for devices (e.g. MIC2)
12. Ventilation Holes

**FIGURE 2C - BACK PANEL OF THE CONTROL UNIT (FIREWIRE CAMERA MODEL)**

Figures 2D and 2E show the layout of the front panel and back panel labels of the moorLDI2 single visible wavelength scanner units

**moorLDI2-VR, moorLDI2-HR**




Warning LED's: 1, Power; 2, Laser ready, 3, The Laser Aperture , is indicated and shown here schematically by the rectangle above.

**FIGURE 2D - FRONT PANEL OF THE moorLDI2 VISIBLE SCANNER UNIT**


**FIGURE 2E - BACK PANEL LABELS OF THE moorLDI2 VISIBLE SCANNER UNIT**

Figures 2F and 2G show the layout of the front panel and back panel labels of the moorLDI2 single infrared wavelength scanner units.

**moorLDI2-IR and moorLDI2-HIR**

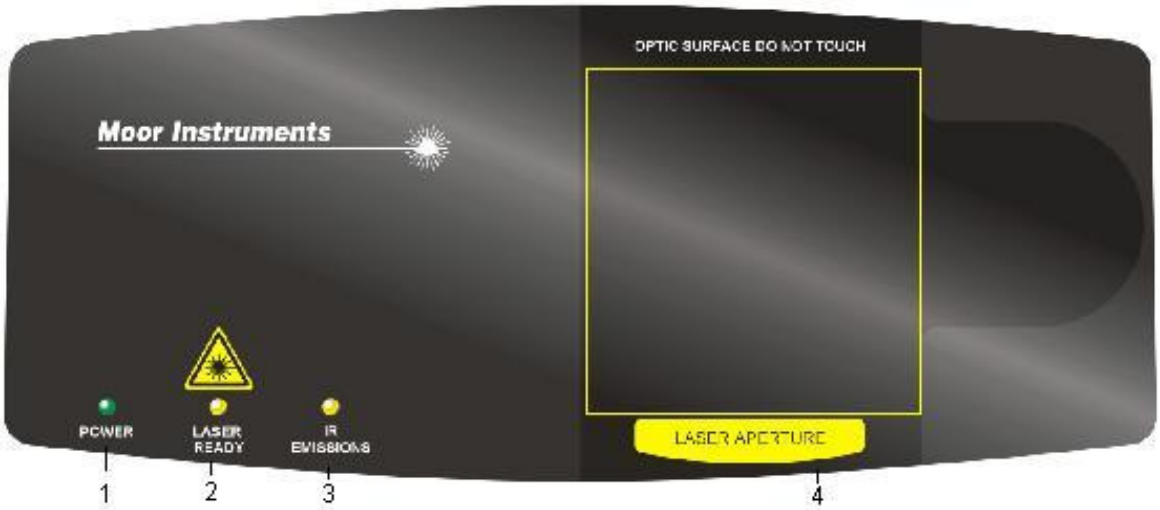
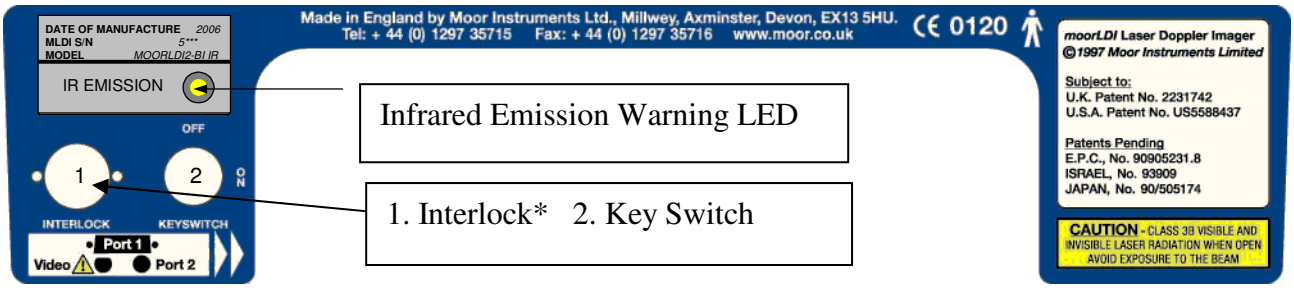



**FIGURE 2F - FRONT PANEL OF THE moorLDI2 INFRARED SCANNER UNIT**




(* Interlock – see section 1.2.2.7 . This connector socket and plug are not required for class 3R laser systems and are not present in the latest model of moorLDI2-IR imagers.)

**FIGURE 2G - BACK PANEL LABELS OF THE moorLDI2 INFRARED SCANNER UNIT**

# 3. moorLDI2 UNPACKING AND ASSEMBLY

The moorLDI2 will initially be installed by a Moor Instruments engineer or approved representative. The following instructions should be followed for subsequent installations.

The various stages of assembly prior to operating the moorLDI2 are:

a. **Stand assembly**, instructions for the moorLD-BS1 (basic stand) or moorLDI-DS2 (desktop stand with ratchet winder height adjustment) stand assembly are included with the stand, for the moorLDI-MS2 (clinical mobile stand), refer to Section 3.1.

b. **Unpacking the blue plastic transport case**. Connection of Scan Head to Control Box using either a wiring loom (clinical mobile stand) or separate leads (all other stands). Refer to Section 3.2.

c. **Installation of framegrabber card or Firewire card.** Note: if you have purchased a Panel PC Kit (moorLDI-PPC) from Moor Instruments then the framegrabber card will be pre-installed. Refer to Sections 3.3 and 3.4.

d. **Cable connections** (Refer to section 3.5).

## 3.1 STAND ASSEMBLY

### 3.1.1 SUMMARY CLINICAL MOBILE STAND – moorLDI-MS2

Note: a separate manual is supplied with the mobile stand. The following is an additional reference.

**WARNING**: the mobile clinical stand is heavy. Assembly by two persons is advised.

**The Base Frame**

This part consists of an 'H' frame and 4 swivel and lock wheels. The H frame also has a plate with 4 bolt holes and registration knob for attaching the vertical columns.

The standard H frame is supplied with the wheels attached (4 screws per wheel).

**The Vertical Column**

The vertical columns are supplied in two parts: lower and upper column assemblies. The winder box is usually attached to the upper column assembly.

Lock the wheels of the H frame.

Mount the lower column assembly onto the H frame, taking care to align correctly the hole for the registration knob. Secure all 4 bolts loosely then tighten all.

Attach upper column assembly (aligning the black ratchet track) and secure by tightening the two cross-head knobs at the top.

**The Transverse Arm**

This passes through the winder box. First remove the handle from the transverse arm and loosen the knobs on the side of the winder box. Pass the transverse arm, from the front, through the winder box (the longest forks of the H frame are at the front).

This part joins to the front of the vertical slide assembly on the vertical column.

**The Yoke and Scan Head**

The yoke is attached to the scan head at the side bearings: 4 bolts each. Recent models have a central screw to secure these components. Take care to include all parts of the bearing including O ring and pressure plate. Recent models incorporate a central holding screw.

Replace clamp handle and tighten with scan head mounting plate horizontal.

The yoke is then attached to the transverse arm via the top bearing.

**The moorLDI-THB**

The transformer housing box (THB) also contains the moorLDI2 control box and cable management.

The THB is attached to the back of the H frame: two lugs at the rear and one at the front.

**Assembly**

After checking all necessary parts are present and before cable connection, assemble the stand, using the supplementary guide provided.

### 3.1.2 BASIC STAND (moorLDI-BS1)

Components for the basic stand are packed separately. Unpack these components and assemble according to supplementary instructions provided.

### 3.1.3 DESKTOP STAND (moorLDI-DS2)

Components for the desktop stand are shipped separately in a cardboard carton. Remove these components from the carton and assemble according to supplementary instructions provided.

## 3.2 UNPACKING THE SCAN HEAD

The **moorLDI2** is shipped in the blue plastic transport case. This case contains two layers.

The top layer contains the following:

**Analogue Camera Model:**
1 off **moorLDI**2 controller
1 off **moorLDI**2 8-way scan head-to-controller cable (Basic stand and Desktop stand only)
1 off **moorLDI**2 25-way scan head-to-controller cable (Basic stand and Desktop stand only)
1 off **moorLDI**2 scan head-to-PPC framegrabber video cable
1 off framegrabber card (if a PPC Kit was supplied by Moor Instruments, the framegrabber card will already be installed and tested in the PC supplied)
1 off computer-to-controller serial cable
1 off mains electricity lead
1 off set of software installation discs/CD

**Firewire Camera Model:**
1 off **moorLDI**2 controller
1 off **moorLDI**2 8-way scan head-to-controller cable (Basic stand and Desktop stand only)
1 off **moorLDI**2 25-way scan head-to-controller cable (Basic stand and Desktop stand only)
1 off **moorLDI**2 scan head-to-controller video cable
1 off Firewire Interface Card (if a PPC Kit was supplied by Moor Instruments, the Firewire Interface card will already be installed and tested in the PC supplied)
1 off computer-to-controller serial cable
1 off IEEE 1394 Firewire cable
1 off mains electricity lead
1 off set of software installation discs/CD

The lower layer contains the scan head. Remove this carefully and attach it to the stand supplied (refer to supplementary instructions).

## 3.3 INSTALLATION OF F6C FRAMEGRABBER CARD (ANALOGUE CAMERA MODEL)

**Note: if you are using a laptop computer with a docking station, the framegrabber card is installed within the docking station. If a docking station is not used, the video signal will not be available.**

To install the card follow these steps:

1. Switch off your computer and all peripheral devices.

2. Remove the cover from your PC.

3. **Discharge yourself of electrostatic charge**: with the PC power cable plugged in the wall socket **but not switched on**, discharge yourself of electrostatic charge by touching the metal case of your computer.

4. Select a free PCI slot and remove the external cover.

5. Insert the framegrabber card carefully in the selected PCI slot.

6. Replace the cover of your PC.

7. Connect the video cable from the camera to the framegrabber card.

### 3.4 INSTALLATION OF FIREWIRE CARD (FIREWIRE CAMERA MODEL)

**Please note not all laptop computers with Firewire interface work with the Firewire camera, therefore only a laptop supplied by Moor Instruments can be guaranteed to work.**

To install the card in a desktop or panel PC follow these steps:

1. Switch off your computer and all peripheral devices.

2. Remove the cover from your PC.

3. **Discharge yourself of electrostatic charge**: with the PC power cable plugged in the wall socket **but not switched on**, discharge yourself of electrostatic charge by touching the metal case of your computer.

4. Select a free PCI slot and remove the external cover.

5. Insert the Firewire interface card carefully in the selected slot.

6. Replace the cover of your PC.

7. Connect the video cable from the scan head to control box, but do not connect the Firewire cable from the control box to the Firewire interface card at this stage.

## 3.5 CABLE CONNECTIONS

If a clinical mobile stand has been supplied, refer directly to Section 3.1.1

N.B. the mains supply to all equipment should be turned OFF until all connections have been made.

Connect cables as shown schematically below:

### 3.5.1 CABLING

**Analogue Camera Model:**

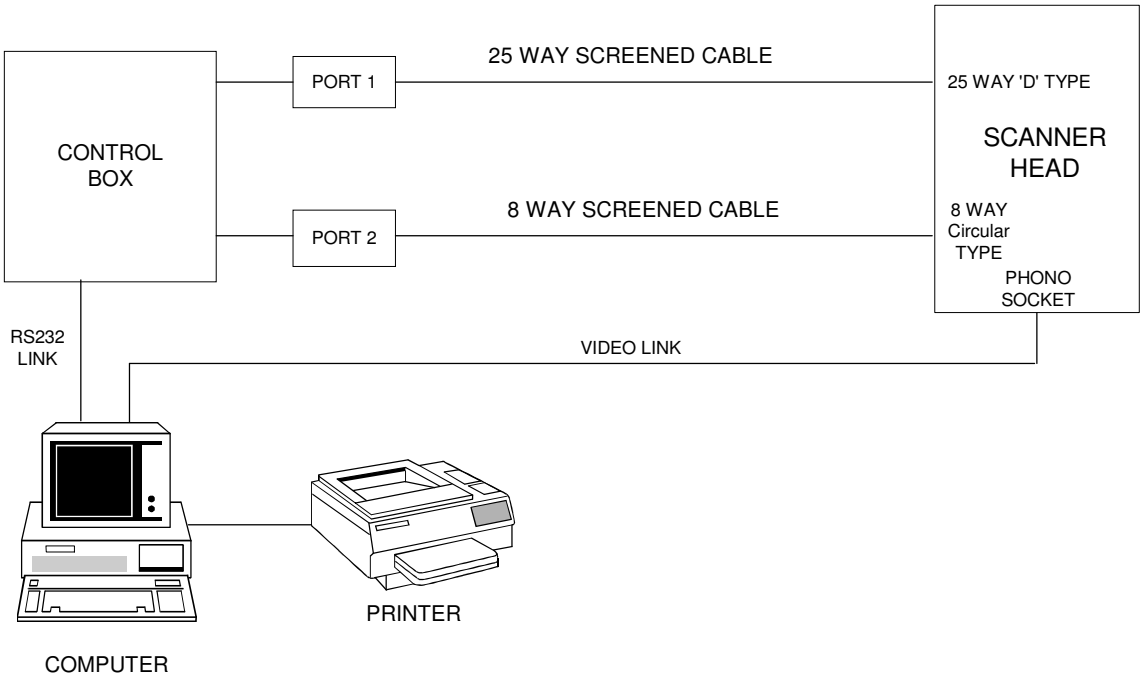
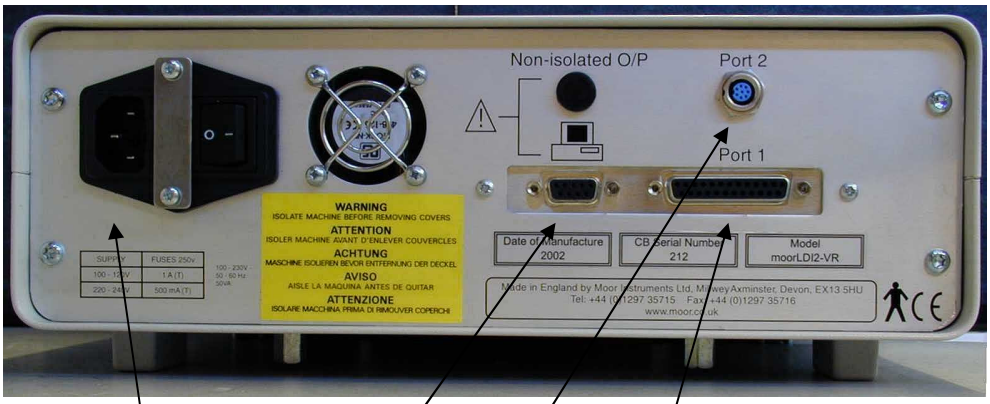
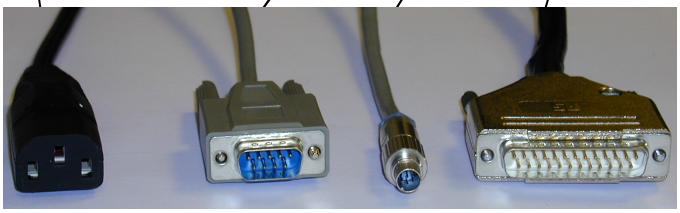



**FIGURE 3A – DIAGRAMMATIC REPRESENTATION OF THE CABLE CONNECTIONS (ANALOGUE CAMERA MODEL)**



Power cable | RS232 lead | 8 Way cable | 25 Way screened cable

**FIGURE 3B – BACK OF THE CONTROL BOX SHOWING CABLES AND THE CORRESPONDING CONNECTIONS (ANALOGUE CAMERA MODEL)**

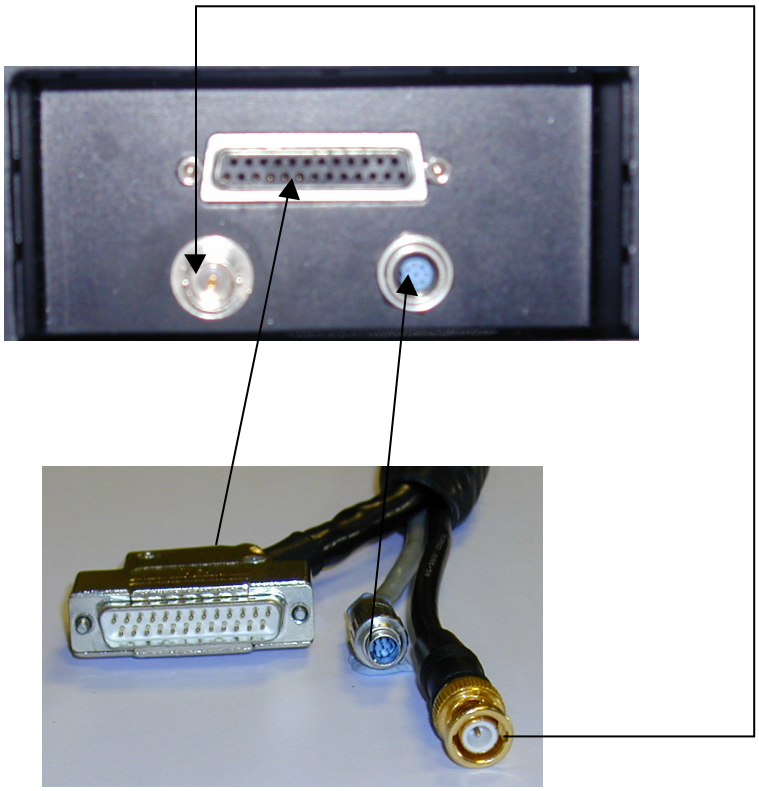



**FIGURE 3C – BACK OF THE SCAN HEAD AND CONNECTING CABLES (ANALOGUE CAMERA MODEL)**

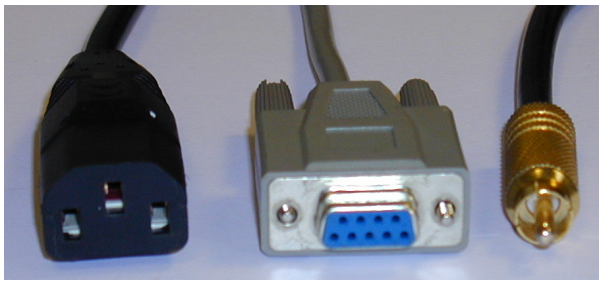



**FIGURE 3D – PC CONNECTION CABLES (ANALOGUE CAMERA MODEL)**

Referring to Figures 3B and 3C:

1. Connect one end of the 25-way cable to the control box connector marked "PORT1" and the other end to the scanning head 25-way connector. Secure the connectors with the screw fixings which should be finger tight. This cable is not directional.

2. Connect one end of the short 8-way cable to the control box connector marked "PORT2" and the other end to the scanning head 8-way connector. Secure the connectors with the screw fixings which should be finger tight. This cable is not directional.

   SAFETY NOTE: With the system powered **ON**, the user must not touch the patient and parts of either the connecting leads or mating sockets at the same time.

3. Connect male end (with exposed pins) of the long 9-way cable to the control box connector marked with the computer symbol:

   Connect the other end of the cable to one of the computer's serial ports. This will generally be at the rear of the computer and will be a 9-way male connector marked "COM1" or "COM2" or "SERIAL1" or "SERIAL2", any of these is ok (one of these may already be in use by a mouse or modem). If you are unable to identify the connector or if it has 25 pins rather than 9 please contact Moor Instruments for further advice. Secure the connectors with the screw fixings provided which should be finger tight.

   SAFETY NOTE: The computer must be compliant with IEC 950 and be configured to comply with IEC 60601-1. The connector port is marked with the  symbol to indicate this.

**Firewire Camera Model:**

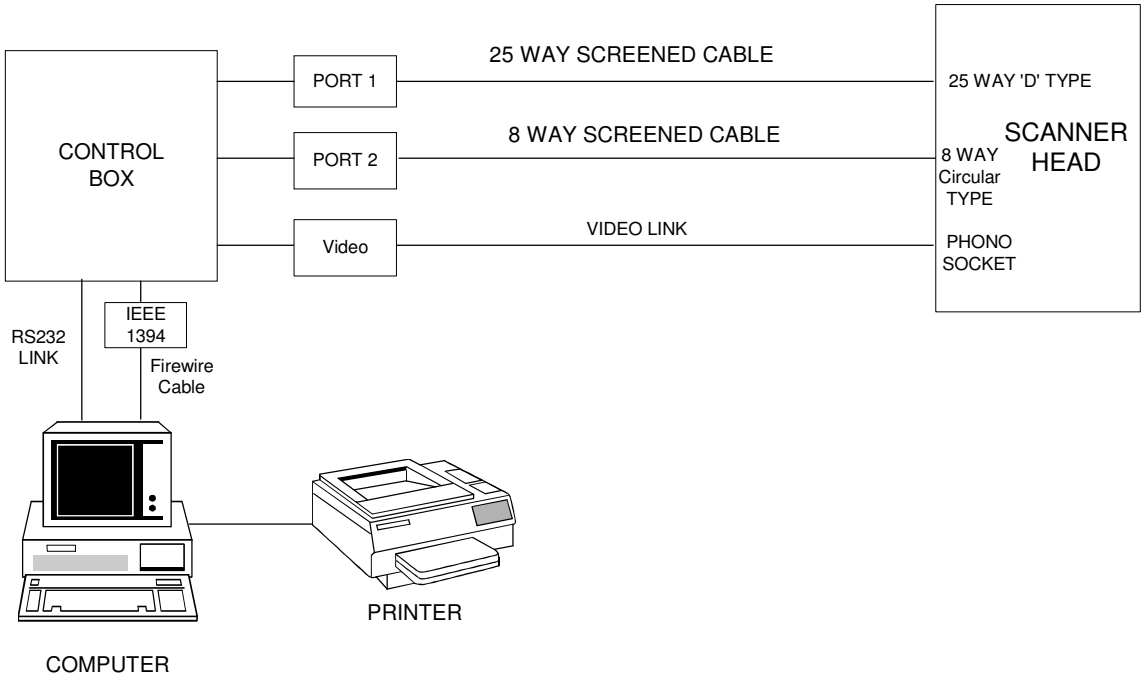
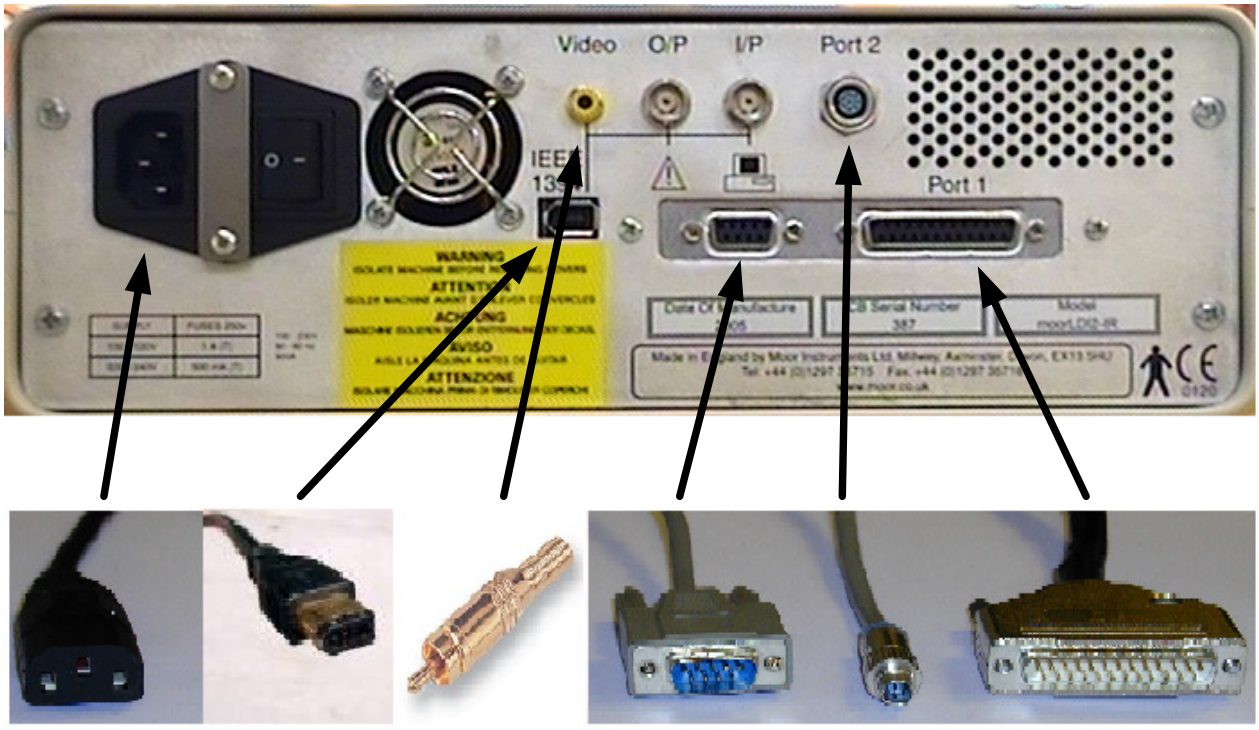
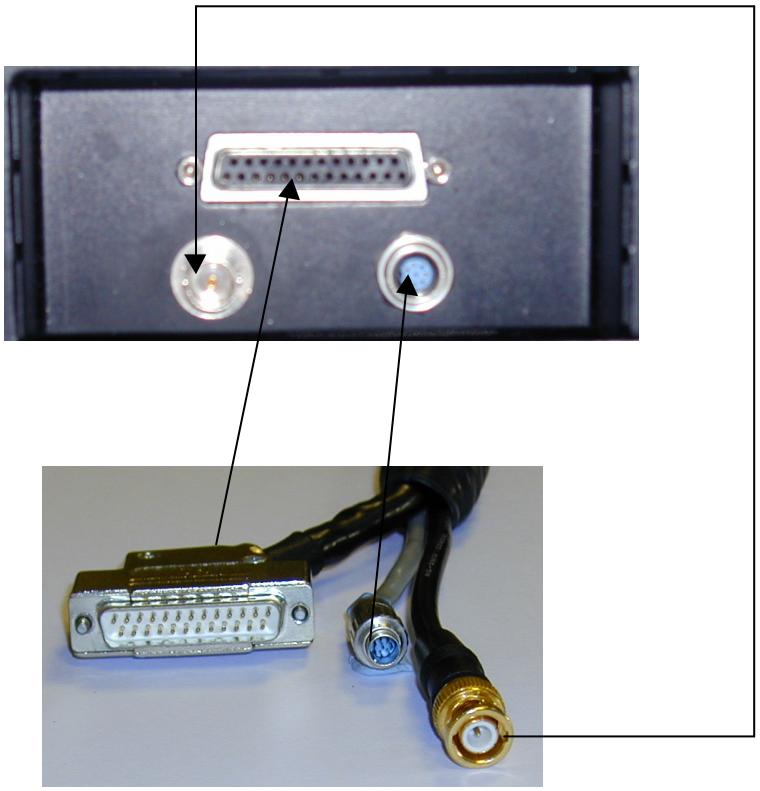



**FIGURE 3E – DIAGRAMMATIC REPRESENTATION OF THE CABLE CONNECTIONS (FIREWIRE CAMERA MODEL)**



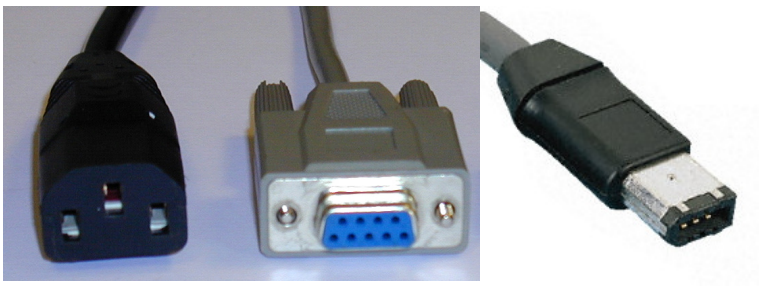

Power Cable Firewire Cable Video Cable RS232 Lead 8 Way Cable 25Way cable

**FIGURE 3F – BACK OF THE CONTROL BOX SHOWING CABLES AND THE CORRESPONDING CONNECTIONS (FIREWIRE CAMERA MODEL)**



25 way screened cable | 8 way connector | Video cable

**FIGURE 3G – BACK OF THE SCAN HEAD AND CONNECTING CABLES (FIREWIRE CAMERA MODEL)**



Power cable | RS232 lead | Firewire Cable

**FIGURE 3H – PC CONNECTION CABLES (FIREWIRE CAMERA MODEL)**

Referring to Figures 3F and 3G:

1. Connect one end of the 25-way cable to the control box connector marked "PORT1" and the other end to the scanning head 25-way connector. Secure the connectors with the screw fixings which should be finger tight. This cable is not directional.

2. Connect one end of the short 8-way cable to the control box connector marked "PORT2" and the other end to the scanning head 8-way connector. Secure the connectors with the screw fixings which should be finger tight. This cable is not directional.

3. Connect the phono end of the video cable to the control box connector marked "Video" and the BNC end to the scanning head video connector.

   SAFETY NOTE: With the system powered **ON**, the user must not touch the patient and parts of either the connecting leads or mating sockets at the same time.

4. Connect male end (with exposed pins) of the long 9-way cable to the control box connector marked with the computer symbol:

   Connect the other end of the cable to one of the computer's serial ports. This will generally be at the rear of the computer and will be a 9-way male connector marked "COM1" or "COM2" or "SERIAL1" or "SERIAL2", any of these is ok (one of these may already be in use by a mouse or modem). If you are unable to identify the connector or if it has 25 pins rather than 9 please contact Moor Instruments for further advice. Secure the connectors with the screw fixings provided which should be finger tight.

5. Connect one end of the Firewire cable to the control box connector marked with IEEE 1394. Do not connect the other end of the cable to the Firewire connector of the computer at this stage.

   SAFETY NOTE: The computer must be compliant with IEC 950 and be configured to comply with IEC 60601-1. The connector port is marked with the ⚠ symbol to indicate this.

### 3.5.2 MOBILE STAND AND CABLING

**Analogue Camera Model:**

Three of the cables (8-way, 25-way and video) for use with a moorLDI2-MS2 mobile stand are in a corrugated sleeve. This wiring loom is shipped in the THB transformer housing box. At one end the leads are short and of similar length (Figure 3C). This end is connected to the scan head. Connector sockets are protected by the hand-grip at the rear of the scan head and the cable positions are indicated on the back panel label: Port 1 (multi-way cable) is at the top, video is lower left and Port 2 is lower right (see Figure 3C). Connect these cables securely and replace the cover/handle (4 screws).

At the other end of the corrugated sleeve, connect the two shorter leads (Port 1 and Port 2) to the control box (Figure 3B) inside the transformer housing box and loop the video lead back out of the box with the PC mains lead and RS232 (COM1) lead.

The RS232 and mains leads are also connected to the rear of the moorLDI2-CB control box (Figure 3B).

Route the video, RS232 and mains cables through the PC supports as described in the moorLDI2-MS2 assembly instruction manual.

Connect the RS232 lead to COM1 port on the PC, the video cable to the video input socket and the mains cable to the mains electric socket (Figure 3D).

An extra mains electric cable will be required if a printer is attached to the moorLDI2 system. This is powered from the distribution board within the Transformer Housing Box (THB).
Secure all connections and replace the lid of the THB taking care not to pinch cables emerging from the semi-circular slot.

**Firewire Camera Model:**

Three of the cables (8-way, 25-way and video) for use with a moorLDI2-MS2 mobile stand are in a corrugated sleeve. This wiring loom is shipped in the THB transformer housing box. At one end the leads are short and of similar length (Figure 3G). This end is connected to the scan head. Connector sockets are protected by the hand-grip at the rear of the scan head and the cable positions are indicated on the back panel label: Port 1 (multi-way cable) is at the top, video is lower left and Port 2 is lower right (see Figure 3G).

Connect these cables securely and replace the cover/handle (4 screws).

At the other end of the corrugated sleeve, connect the three leads (Port 1, Port 2, and Video) to the control box (Figure 3F) inside the transformer housing box.

Connect the Firewire cable, RS232 lead, and mains lead to the control box (Figure 3F) and loop these leads out of the box.

Route the Firewire, RS232 and mains cables through the PC supports as described in the moorLDI2-MS2 assembly instruction manual.

Connect the RS232 lead to COM1 port on the PC, **not** the Firewire cable to the IEEE 1394 Firewire socket on the PC at this stage, and the mains cable to the mains electric socket (Figure 3H).

An extra mains electric cable will be required if a printer is attached to the moorLDI2 system. This is powered from the distribution board within the Transformer Housing Box (THB).
Secure all connections and replace the lid of the THB taking care not to pinch cables emerging from the semi-circular slot.

## 3.6 THE COMPUTER AND SOFTWARE INSTALLATION

### 3.6.1 COMPUTER SPECIFICATIONS

Only computers complying with IEC 950 may be used. (IEC 60950-1 Edition 1 Information technology equipment - Safety - Part 1: General requirements). Note that generally any commercially available PC will meet this standard. If the PC is supplied by Moor Instruments it will meet this standard and meet or exceed the minimum recommended specification detailed below.

The minimum recommended PC requirements for running the moorLDI2 V5.3 software are:

500 MHz processor; 512 MB RAM; 40GB HDD, CDRW Drive; mouse; keyboard; RS232 or USB* port; display 800 x 600. A half length PCI card slot is required for the analogue CCD video camera frame grabber board or an IEEE1394 interface card is required when using a moorLDI2 with a IEEE1394 camera (this card is not required if the PC supplied has an IEEE1394 port).
* If the PC does not have an RS232 port an RS232 to USB converter is needed as the serial output from the LDI control unit is via RS232. A suitable converter can be supplied by Moor Instruments.

Operating system – The moorLDI2 software can be used with Windows™ XP (Home or Professional), Windows™ 2000 and Windows™ Vista. Moor Instruments does not support its use with other Windows operating systems. When the software is used with Windows™ Vista, it is highly recommended that the Vista UAC (Use User Account Control) is disabled although not essential. If UAC has to be switched on, please keep it on whenever the moorLDI2 software is used; otherwise data loss may occur.

### 3.6.2 SOFTWARE INSTALLATION AND REGISTRATION

A working knowledge of Windows™ is assumed for installation and operation of moorLDI2 software. The software for moorLDI2 Version 5 is distributed on CD ROM.

**For customers who are upgrading from a version of moorLDI software earlier than V 3.08, it is necessary to prepare your moorLDI prior to installing Version 5.** Refer to “APPENDIX 1. PREPARING YOUR moorLDI2 IMAGER FOR THE NEW SOFTWARE”.

To use the moorLDI2 with the software, it must first be registered within the software. (The registration codes only need to be entered once). For users who purchased the software together with the moorLDI2 the registration number is saved on the software installation disc and is installed automatically when you install this software.
For some early moorLDI instruments you will also be asked to enter the serial number of the scanner. (found on the scanner head rear panel). Customers using **Version 3.08** or later versions, and customers purchasing a moorLDI2 supplied with version 5.3, do not have to do this preparation.

To install the drivers and the moorLDI2 V5.3 software follow these steps:

1. Make sure that the IEEE  Firewire cable is not connected to the PC before installing software and turn off the moorLDI2.

2. Insert the software installation CD-ROM disc into your CD-ROM drive.

3. If AutoPlay is enabled, the installation screen should appear. If AutoPlay is not enabled, or the installation does not start automatically, click on Windows® Explorer and select the setup file (mLDIV53Setup.EXE) from the CD-ROM drive.

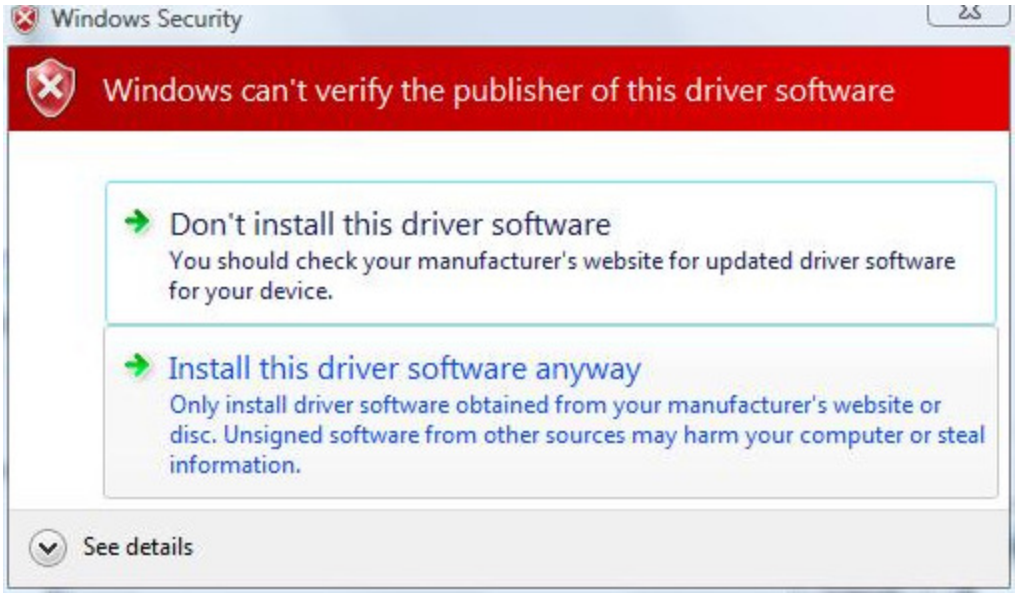
4. Follow the on-screen instructions. Once the “Driver Installation Wizard” window appears as shown below, connect the Firewire (IEEE1394) cable to the PC and turn the system on. After a short delay the IEEE 1394 converter will be detected as “Video to 1394 Converter Rev2”. Click **Next** to continue with installation. Note: if the F6 card is used (Analogue Camera model), click **Cancel** to skip this step.



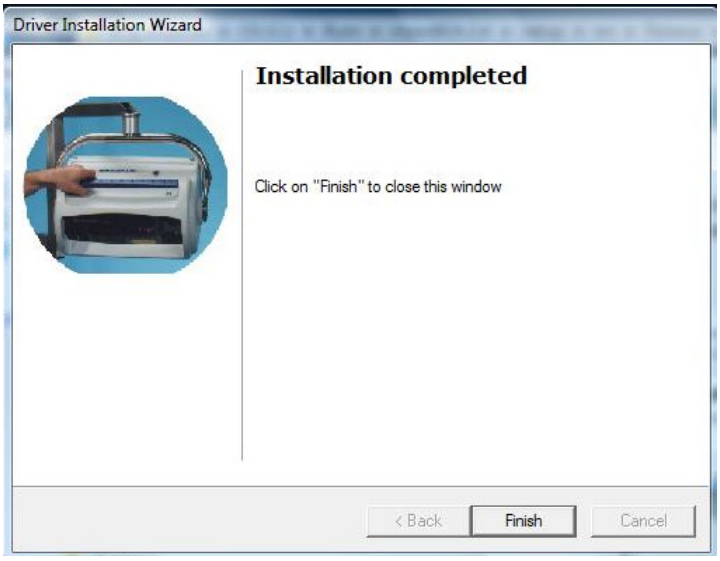
Note that the Windows **Found New HardwareWizard** may appear when the 1394 cable is connected and the moorLDI2 is turned on (see below), if this happens click **Cancel** to close it. Windows may display an error message in the task bar when the **Found New Hardware Wizard** is closed, this is normal and the error message can be safely ignored.


The driver will begin to install. A warning that the driver has not passed Windows Logo testing may be displayed. If this happens, click **Continue Anyway**.

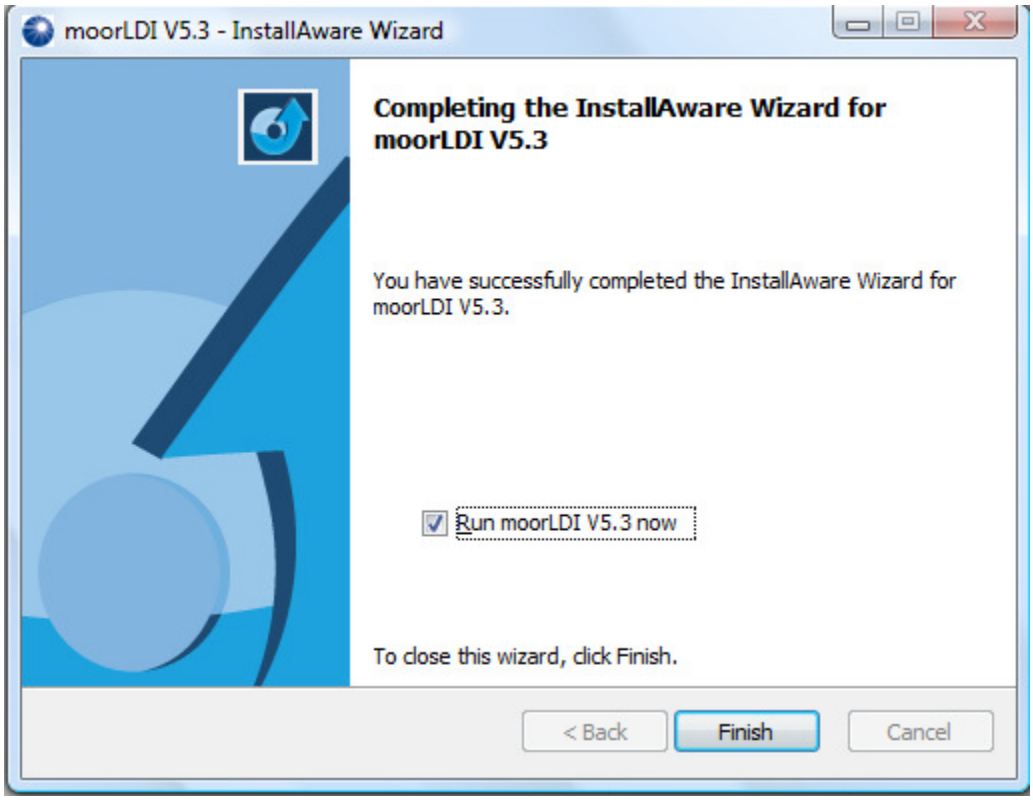

For Windows Vista click on the "**Install this driver software anyway".**




Driver installation is complete when the following window is displayed. Click **Finish** to complete driver installation.




5. To finish installing the software click on Finish when the following window is displayed:




6. Connect the RS232 or USB cable to the PC and the system is ready for use.

   The above installation is designed for use with the new Firewire camera model, if you are using the analogue camera with the F6 card and the F6 driver has not been installed on the PC before, you will need to install the driver separately after the above installation.

F6 card driver installation for Windows (not NT):

1. Switch on your PC, and Windows will automatically detect the card you have just installed.

2. The 'New Hardware Found' screen will be displayed.

3. Select '**Driver from the disk provided by hardware manufacturer**', click OK.

4. Click **Browse**, select the directory C:\Program Files\moorLDI V5.3\InstallFiles\F6\F6\Win2000 if you have not changed the location during installation. Click **OK** on the following screens.

For Windows NT:

The F6 driver for Windows NT is not a true multi-media driver, so does not install from the Control Panel.

To install the driver run INSTALL.EXE (located in C:\Program Files\moorLDI V5.3\InstallFiles\F6\F6nt\ if you have not changed the location during installation) and choose f6c_nt from the list box.

## 3.7 BEFORE FIRST USE

Once you have installed the software and set up the moorLDI2 system, you must carry out the following:

- Visual inspection of the whole system, looking for signs of damage or missing components.
- Turn the system on and carry out a system calibration check following the procedure detailed in section “19 Calibration and Stability”, of this user manual
- Check that the distance measurement is accurate to ± 5cm at 80cm scan distance

If you suspect your system may have been damaged, or if your system fails the calibration or distance checks, please contact your distributor or Moor Instruments directly, quoting the instrument serial number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## 3.8 TRANSPORTATION

When the mobile clinical stand is to be moved significant distances over unsmooth surfaces (e.g. between buildings) the scan head should be removed
Tighten the cross head bolts on the side of the winder assembly.
Push the stand with the long legs of the H frame facing forwards.

# 4. THE LASER DOPPLER TECHNIQUE

## 4.1 INTRODUCTION

The laser Doppler technique was first applied to monitoring tissue blood flow by Stern et al in 1975. Since then it has been applied to most branches of medicine and physiology.

There are two basic types of laser Doppler device: the laser Doppler perfusion monitor and the laser Doppler perfusion imager. The monitor usually employs optical fibre light guides to transmit light to the tissue and back to a detector for processing. Tissue contact is usually necessary with monitoring and a wide variety of probes enable access to most tissues for continuous monitoring. Laser Doppler imaging does not involve tissue contact.

The moorLDI2 has a fast scanning mode and the ability to function in ambient lighting. Further features are: non-contact measurement, high resolution imaging, a large scan range and user friendly Windows™ software for acquisition, display, image processing and analysis.

## 4.2 SPATIAL VARIATION OF PERFUSION

There can be considerable spatial heterogenity of blood flow across a tissue surface and this can change following stimulus or with pathology. The distribution of perfusion also evolves with time and it is for this reason that the moorLDI2 high speed, high resolution laser Doppler imager was developed.

## 4.3 PRINCIPLES OF THE LASER DOPPLER IMAGING TECHNIQUE

Low power laser light is directed via a moving mirror to execute a raster pattern across the tissue surface. The depth of tissue probed by the moorLD2 is tissue dependent and influenced by pigmentation. For skin it can be assumed that full dermal thickness is probed by both red and infra-red wavelengths. However, the infra-red wavelength will give a higher weighting to blood flow in the deeper dermis. An advantage of the infra-red wavelength is that it is not strongly attenuated by dark skin. This can lead to loss of image with the red wavelength.

The incident light is scattered by static tissue and by moving blood. The Doppler shifted light from moving blood and the non-shifted light from tissue is then directed by the same moving mirror (and other optics) onto two square-law detectors.

Light 'beats' at the detectors due to constructive and destructive mixing of the light. These intensity fluctuations are then processed to give parameters of flux (proportional to tissue blood flow) and conc (proportional to the concentration of moving blood cells).

Tissue blood flow varies with temperature and so it can be important to standardise conditions, including a period of acclimatisation, in any measurement protocol. Absence of blood flow during occlusion does not lead to zero laser Doppler flux values. This 'biological zero' effect is due to residual interstitial movement and in some cases of ischaemia it may be necessary to subtract this from values obtained. Under some low flow conditions it might be necessary to reduce scan speed to obtain the flux resolution required.

The laser Doppler technique is used to its best advantage when assessing microvascular function: before and after drug treatment, surgical procedure or a test stimulus. The moorLDI2 **Repeat Scan** mode and processing is well suited to this type of assessment.

## 4.4 ELEMENTS OF THE moorLDI2

### 4.4.1 THE LASER SOURCE

The laser wavelength, accessible power and laser classification depend on the moorLDI2 version.

1. moorLDI2-VR and moorLDI2-HR Class 3R visible laser.
   Either a Helium-Neon gas laser wavelength 633nm, maximum accessible power 2.5mW.
   Maximum scan area with large scan setting approximately 60 x 60 cm.

2. moorLDI2-IR and moorLDI2-HIR Class 3R near infra-red laser.
   A laser diode wavelength 785nm or 830nm, maximum accessible power 2.5mW.
   The near infra-red laser is combined with a visible red aiming beam.
   Maximum scan area with large scan setting approximately 60 x 60 cm.

During set up a solenoid actuated attenuator reduces the intensity of laser beam emitted to less than 200μW. The attenuated beam is a class 1 laser.

### 4.4.2 THE MIRROR

The incident laser light is deflected to the tissue surface by a front silvered mirror. Two DC motors manipulate the mirror so that a raster pattern is executed by the beam across the tissue surface. Geometrical correction algorithms are employed to ensure that a rectilinear pattern is followed. The light scattered by blood and tissue is directed back via the mirror and other optics onto two detectors.

### 4.4.3 OPTICS AND LIGHT DETECTION

A unique arrangement of optics in the moorLDI2 enables operation over a wide range of distances in ambient lighting. Extraneous light does not significantly influence the detector because only the laser spot and a small area around it is 'seen' by the detectors. Optical filters for the particular laser wavelength being used also help to eliminate extraneous light.

### 4.4.4 OPTIC WINDOW

The laser aperture region of the scanner front panel is sealed by a glass window. This is anti reflection coated and easily damaged by touching or by attempts to clean by wiping.
See Section 18.6 for advice on removing dust from the external surface of the window.

## 4.5 THE LASER DOPPLER PROCESSING ALGORITHM

After detection and amplification the signals are digitised and processed to yield flux (proportional to blood flow) and conc (proportional to the concentration of moving blood cells).

The algorithms used to compute these parameters are:

$$\text{flux} = k_1 \int_{\omega_1}^{\omega_2} \omega . \frac{P(\omega)\, d\omega}{dc} - \text{noise}$$

$$\text{conc} = k_2 \int_{\omega_1}^{\omega_2} \frac{P(\omega)\, d\omega}{dc} - \text{noise}$$

$\omega$ is the frequency of Doppler shift

$P(\omega)$ is the power of signal at frequency $\omega$

dc is the intensity of all detected light

$\omega_1$ is the high pass filter frequency

$\omega_2$ is the low pass filter frequency

$k_1$ and $k_2$ are scaling constants

noise is the shot and dark noise of the detector

Speed of blood can be deduced from flux/conc.

The bandwidth settings for the moorLDI2 are:-

| $\omega_1$ | $\omega_2$ | scan rate |
|---|---|---|
| 250Hz | 15KHz | 4ms/pixel* |
| 100Hz | 15KHz | 10ms/pixel |
| 20Hz | 15KHz | 50ms/pixel |

*This is the default setting.

Other bandwidth combinations are available but these should be used with care and are protected by password. They are $\omega_2$ = 3KHz and 22KHz and should be used in very low and high perfusion conditions, respectively. For low perfusion states a reduction in scan rate is also recommended to improve signal to noise.

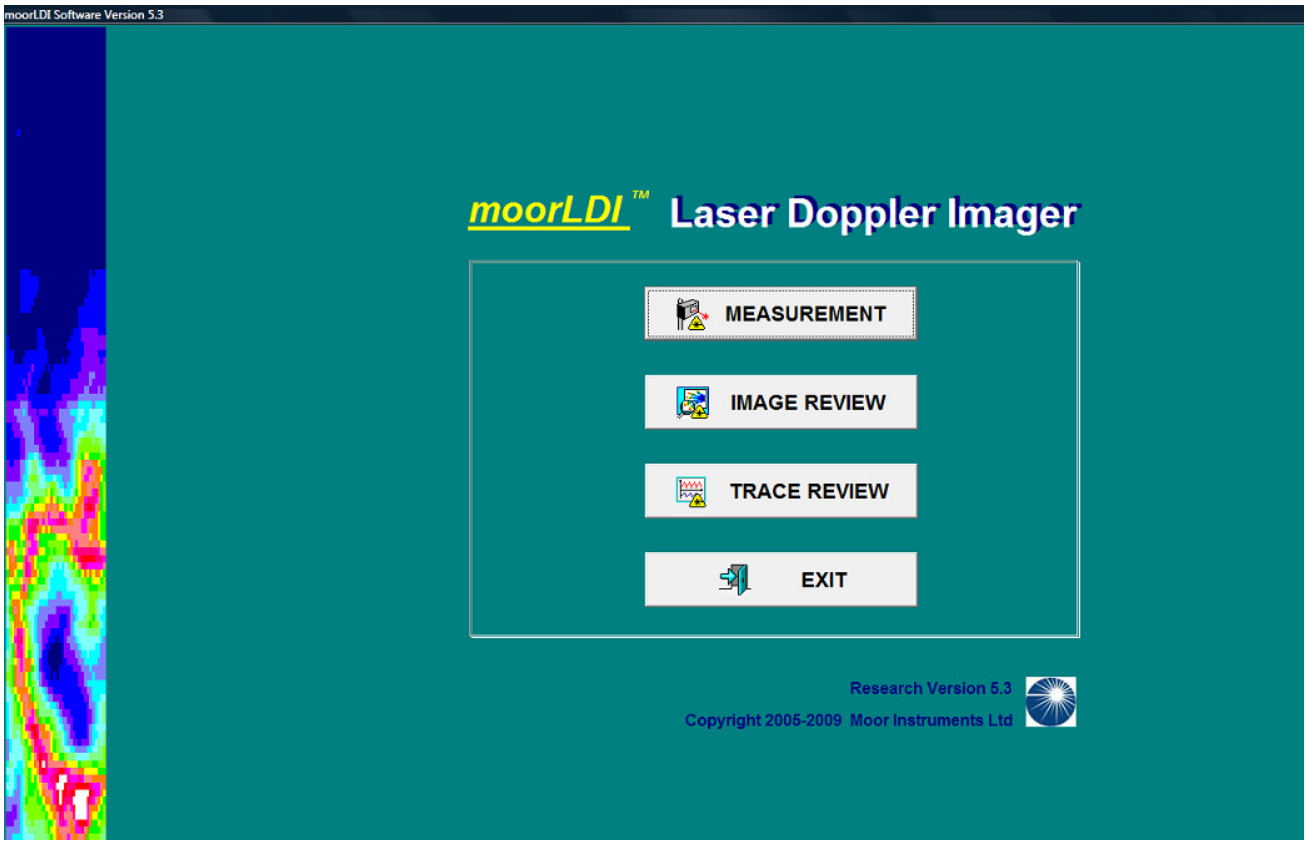
## Flow Units

It is generally agreed by researchers and manufacturers that because of the nature of the flow in capillaries and connecting small blood vessels and the effect of varying skin colour and structure, it is not generally appropriate to use absolute flow units such as ml/min/100gm. To justify the use of these units it is necessary to calibrate for the particular tissue type and site of the measurement. This is impractical except in very special circumstances and is not appropriate for normal day to day measurements.

Arbitrary units are used for Flux and DC in the moorLDI2 in common with most other manufacturers. To assign values to a measurement the imager is calibrated using flux standard: a standard flux signal which is generated by the laser light scattered from polystyrene microspheres undergoing thermal motion (i.e. Brownian motion). Ideally, calibration should always be at the same temperature though a change of $\pm$ 5$^{o}$C will result in changes of the average speed of only $\pm$ 5%. The increase in average speed results from the increase in kinetic energy with temperature increase, and from the decrease in the viscosity of water. Changes of a few $^{o}$C are acceptable; however, it is essential that temperature stability of the flux standard is achieved to avoid convection currents within the suspension of microspheres.

# 5. INTRODUCTION TO moorLDI2 SOFTWARE

Once loaded, the moorLDI2 V5.3 software presents the following options




1. MEASUREMENT To obtain Laser Doppler Measurements (scan, repeat scan, repeat line and single point measurement)

2. IMAGE REVIEW Image processing and analysis

3. TRACE REVIEW To review single point measurements.

## 5.1 OVERVIEW

1. The **MEASUREMENT module** has utilities required for:

   - obtaining LDI images and recording patient information
   - recording images- single and repeat scans
   - recording line images
   - recording colour video images
   - controlling the imager function
   - configuring image scans
   - display of acquired images
   - generation of printed reports
   - single point measurements
   - diagnostics.

2. The **IMAGE REVIEW module** has utilities required for:

   - reviewing images and saving processed images
   - printing images and patient information
   - analysis: statistics, histogram and profiles
   - area selection and line definition for above
   - image processing: eg smooth, cut and threshold etc
   - saving and printing out of results.

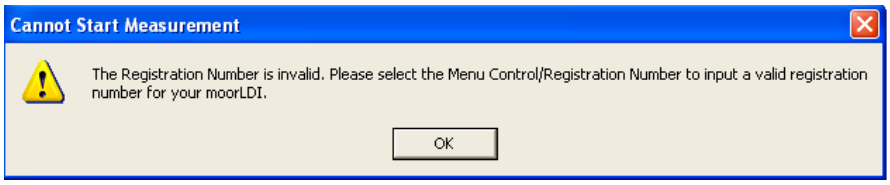
3. The **SINGLE POINT REVIEW** module has utilities for:

   - reviewing single point flux and conc measurements
   - printing out traces and patient information
   - segment selection and statistics
   - trace expansion, compression and smoothing
   - saving and printing out results.

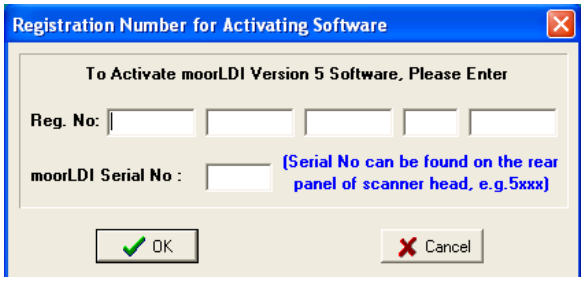
## 5.2 GETTING STARTED WITH the moorLDI2

For some early versions of the moorLDI instrument it is necessary to input a **registration number** and the serial number of the scanner.

For these instruments an error message will be displayed when the green start button is clicked  (see item 8 below).




The registration number can be entered by selecting the **Control** menu and then registration.




Note that in general you will need to set up the operating conditions for the moorLDI2 imager (see section **6 moorLDI2 SETUP** on the following page). Here you are just getting an idea of how images are taken and recorded. If the images you get at this first attempt are not as you wanted or expected do not be discouraged!

1. Turn on the computer so the WINDOWS program is operating.

2. Turn on the **moorLDI**2 controller by the mains switch at the rear of the control unit.

3. Load the moorLDI Main Menu program from the moorLDI2 application window. The software will automatically detect the com port and system type. An error message (Moor LDI is not ready, please make sure that the system is on, all cables are properly connected, then choose the correct comm port and the menu item control / system reset) will be displayed if the system is not ready or the software is not compatible with the system.

4. Choose the Measurement option.

5. Direct **moorLDI**2 scan head to a tissue surface at a distance of about 30cm from the optical window (distance mark on the scanner head). This will scan an area of 7.5 x 7.5cm$^2$ (approximately 3cm x 3cm for a High Resolution imager) at a resolution of 256 x 256 pixels. The duration of measurement will be just under 5 minutes if the imager has defaulted to the fast scan mode of 4ms/pixel.

6. Click on the image scan icon  **or** select: **Measurement -> Image Scan**

7. You will be prompted to either manually enter the scan head to tissue distance or confirm the automatic distance measurement itself.

8. Click on the green flag start icon (Note you can pause or stop the scan at any time).

8. At the end of a measurement save the image by clicking on the save icon or select:
**File**
**Save As**
Follow the normal Windows™ procedure for entering a filename.

Congratulations! You have captured your first laser Doppler image.

## 5.3 CHANGING SCAN PARAMETERS

Many configurations of the **moorLDI**2 are possible. The basic changes of **scan size** and **distance** require changes to the Image Scan configuration and System configuration.
The **duration** of a scan can be reduced by lowering the scan resolution.
Using the **Repeat Scan** function successive scans can be performed at preset or indefinite intervals, as the situation requires.
Please spend some time exploring the **moorLDI**2 software to get to know its functions and to make full use of its capabilities.

## 5.4 MOORLDI2-HR AND MOORLDI2-HIR SCAN DISTANCE AND SCAN SPEED

Scan areas at a given scan distance are approximately one half of those for the standard instruments.
Note:-

1. To get the high resolution scan distances between 20cm to 30cm must be used

2. That, because of the small (focussed) laser spot size, movement artefact noise generated as the beam moves over the scan area is greater than from a standard moorLDI instrument.
For some measurements eg low flow regions, it may therefore be necessary to scan at a slow speed 10m/s per pixel, or even slower at 50m/s per pixel, rather than the fast 4ms/pixel speed.

# 6. MOORLDI2 SET UP

This section describes how to set up the **moorLDI2** system for a specific measurement.

## 6.1 INTRODUCTION

The measurement module presents the following display header when a scan window has been opened, until then only icons 2 to 8 are shown and are active.


1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23

The operation of individual elements of the menu line and icon tool bar are described in the sections listed in brackets and the numbers refer to:

1. Save files with new names
2. Create an image scan window
3. Create a repeat image scan window
4. Create a line scan window
5. Create a single point measurement window
6. Open scanner set-up window
7. Open preference set-up window
8. Open subject details window
9. Open ionto protocol window
10. Start a measurement
11. Stop a measurement
12. Pause a measurement
13. Display an image in real aspect
14. Display LD photo or video image only
15. Display flux image only
16. Display both photo and flux images
17. Toggle between full size and actual size image display modes
18. Toggle between PU and RU display units
19. Open palette setup window
20. Toggle between all imges and sequential modes
21. Display previous image in repeat scan
22. Display next image in repeat scan

Note icons 21 and 22 are only displayed if the repeat scan function is selected.

The operations of each icon appear on the status bar at the bottom of the screen when an icon is touched by the cursor.

## 6.2 moorLDI2 IMAGE SCAN CONFIGURATION

### 6.2.1 INTRODUCTION

Single Image Acquisition should be used when only one image is required. If several images are to be recorded at fixed time intervals the repeat scan function (described later in this manual **Section 8**) can be chosen.

The following sections describe factors affecting image speed, size and shape.

### 6.2.2 SPEED OF IMAGING

**Total scan time** (for a single image) is determined by the following:

Scan speed (4, 10 or 50ms/pixel)
Width of window (scan region dx =1 to 256)
Scan resolution (predominantly the number of lines in the scan dy =1 to 256).
Large / normal scan size.

These settings are made within the **Scanner Setup , Image Scan** window. **(Section 6.3)**

### 6.2.3 SIZE OF IMAGE

**Size of image** is determined by the following:

**moorLDI**-to-tissue distance
Size of window
Selection of 'Normal' or 'Large' scan mode

The size can be set up and viewed prior to imaging using: **Scanner Setup, Image Scan.**

## 6.3 SCANNER SET-UP

The Scanner Set-up window enables the set up of:-
Image Scan
Video and Distance (measurement)
Repeat and Line Scan
Single Point (measurement)
General – Instrument Gain, Background etc. Settings.

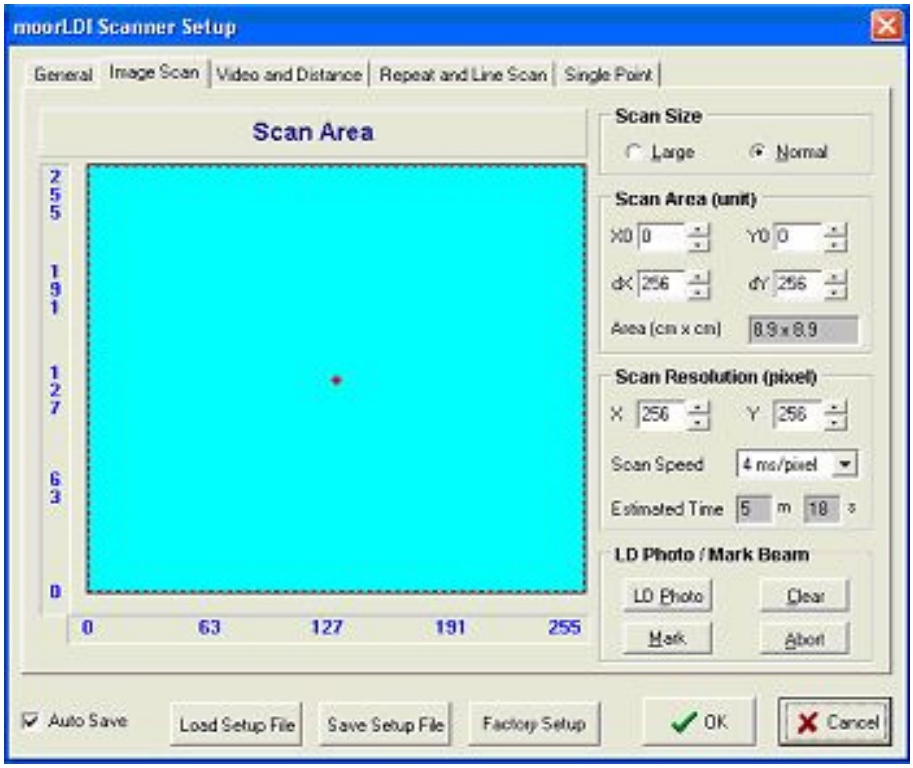
### 6.3.1 IMAGE SCAN

To open the Scanner Set-up window Click on the Scanner Setup icon 

or select: **Setup** (from menu line)

**Scanner Setup** (from drop-down menu)

The Image Scan window will normally be displayed. If one of the other Scanner Setup windows is displayed **Image Scan** can be selected pointing at 'Image Scan' and clicking the mouse left button .




The maximum scan area is also displayed in this window. If the size displayed is not large enough either:

- increase the **moorLDI**-to-tissue distance,

or - click on **Large** to double the area which can be scanned compared to the **Normal** setting.

*6.3.1.1 Scan Size, Area and Resolution*

Move the cursor into the blue scan area of the **Image Scan** configuration window, the region to be scanned is indicated by a rectangle the perimeter of which is marked with a red broken line. The current beam position is shown by a red spot.

To change the shape (dimensions) of the scan area :

- move cursor to one corner of the scan region box
- drag this (with the left mouse button depressed) to a new position
- repeat with other corners as required.
- Alternatively you can type in co-ordinates of your **scan area** in X0/Y0/dX/dY or use the increase/decrease arrows to the right of each box, pointing and holding down or clicking the mouse left button.

Moving the scan area:

- move the cursor to the centre of the scan region box
- drag the box to new position required

Alternatively you can type in co-ordinates of your scan area in X0/Y0/dX/dY.

To view a scan region on the tissue:

- click **Mark** in **LD Photo / Mark Beam** or press the M key, to start continuous marking.
- click **Abort** or press the A key to end the continuous marking..

Clicking on the LD Photo button will start a fast (32 lines) photo image.
Clicking on the Clear button will clear the photo image.

Scan area setup preferences can be saved using the **Save Setup File** button at the bottom of the screen. To load a previously saved setup file click on the **Load Setup File** button.

**Factory Setup** is the setup at manufacture (the user can set his/her own default settings).
Factory Setup is Scan Size Normal, XO=YO=0, dX=dY=256, Scan Resolution X=Y= 256, Scan Speed=4ms/pixel

HINTS

1. It is easier to target a scan region on the tissue (where the **moorLDI**2 scan head is capable of movement) if the scan region is symmetrical about the centre of the scan window. In this configuration the beam position defaults to the centre of the scan region.

2. A 'photo' image of the tissue can be scanned (**LD Photo** in the LD Photo/Mark Beam box). This can be used to check for saturation of the detected signals (DC too high indicated by white regions of the grey scale image and to aid positioning of the scan region box. The image is low resolution (32 lines) to reduce the scan time.

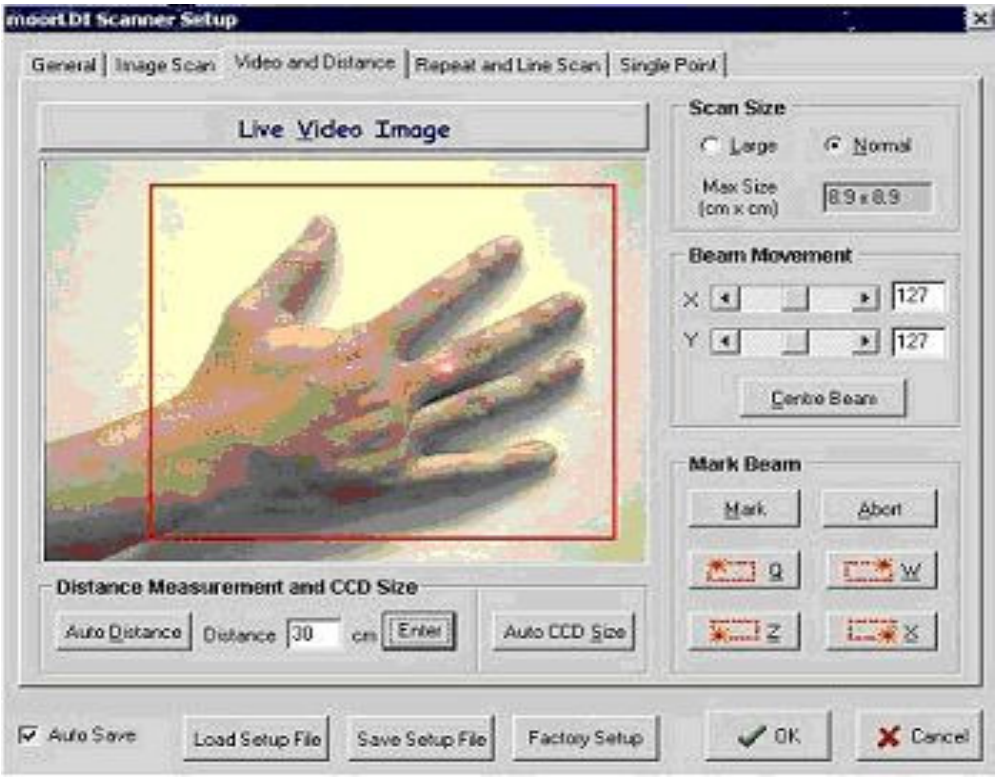
5. The **Scan Speed** can be increased by reducing the number of lines scanned, i.e. change Scan Resolution (dY) in the Y direction. For example if dY is decreased from 256 to 128 the scan time is halved.

3. The **Estimated Time** indicates approximately how long it will take to scan the selected area.

### 6.3.2 VIDEO AND DISTANCE

To open this window, click on  to open the scanner Setup window, then select the third tab button named **Video and Distance**.

On opening a live video image will be displayed in the **Live Video Image** window (see below). (Note that if the camera is not connected a message **No Camera** is displayed.)




When changing scan size between **Large** and **Normal**, a zoom change will be observed.

*6.3.2.1 Mark Beam*

The laser beam is visible in the **Live Video Image** screen. The beam position can be changed, in **Beam Movement**, by changing the values in the **X** and **Y** boxes, or clicking the left/right arrows.

In this window as with the **Image Scan** window, the mark function can be started by clicking the **Mark** function or by pressing the `m` key. The abort function can be started either by clicking the **Abort** button or by pressing the `a` key.

When the four corners of the scan area are on a two dimensional plane it is possible to mark the four corners of the scan area using the laser beam. By clicking on the W, Q, Z and X buttons in the mark beam box, or pressing the respective keys eg clicking on Q will move the beam to the left hand corner of the scan area.

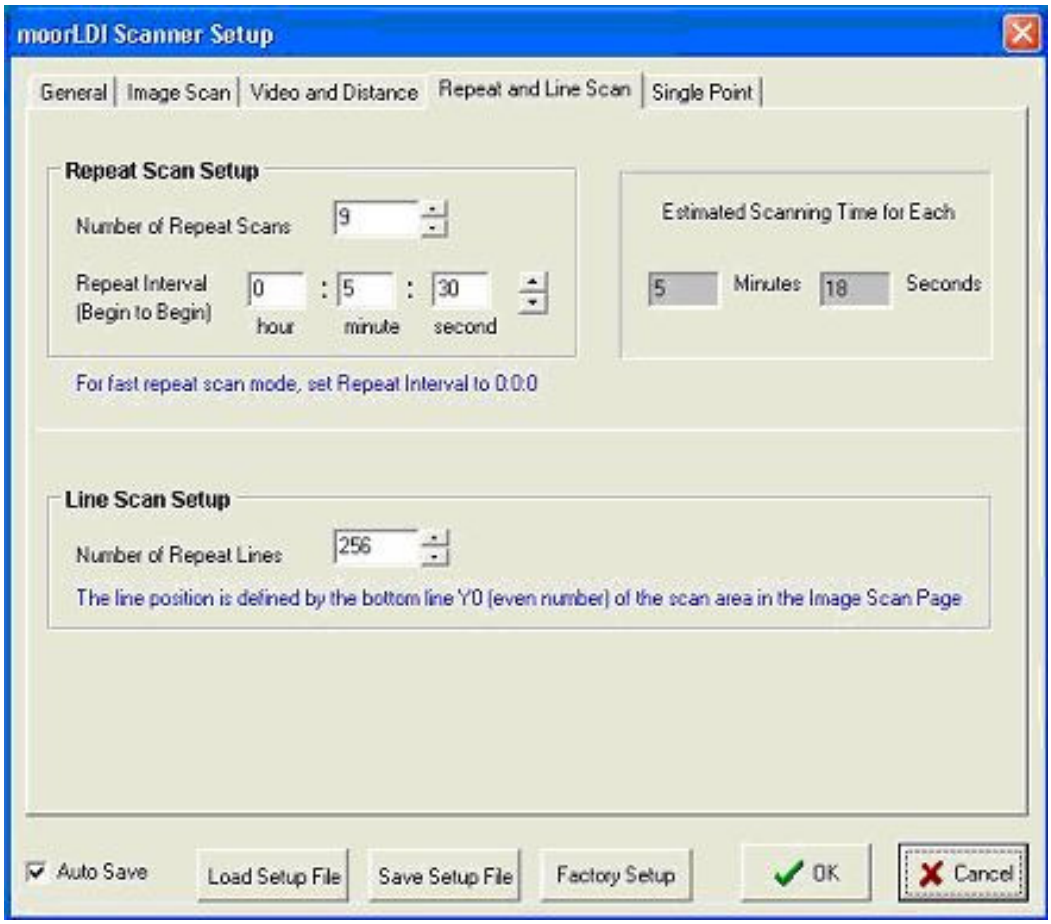
*6.3.2.2 Distance Measurement and CCD Size*

Clicking on the **Auto Distance** button will start the distance measurement using the integrated CCD camera. In order to make a good measurement it is important to avoid movement and objects which are highly reflective (such as shiny rings and watches). On completion of distance measurement, the measured distance will be displayed in the **Distance** box, and the CCD image size and camera zoom will be changed based on the measured distance.
Note: distance can also be entered manually by typing it in the **Distance** box. The **Enter** button to the right of the distance box must be clicked after typing the distance.
Blood flow measurements as recorded by the moorLDI2 are distance dependent so it is essential to use the correct scanner to tissue distance for the correct relative units-to-perfusion units conversion.

This is particularly important for applications where regular changes of distance are made (e.g. burn assessments). Note that should the wrong distance be used during measurement it is possible to change the distance at the data review stage.

### 6.3.3 REPEAT AND LINE SCAN SETUP

To open this window, click on  to open the scanner Setup window, then select the forth tab button named **Repeat and Line Scan** (see below).




#### *6.3.3.1 Repeat Scan Setup*

This windows allows you to setup the repeat scan mode.
The characteristics of the scan window and system set up are the same as for single Image Scan. It is also necessary for these features to be set up prior to Repeat Scan. The E**stimated Scanning Time** for a single scan is displayed. This time depends on the scan size and resolution, and on the scan speed eg 4ms/pixel etc.

Enter the number of scans you require in the **Number of Repeat Scans** box. This will determine the number of repeat scans in the series. Note the maximum possible is 105.

**Repeat Interval**: This sets the time between the starts of successive measurements.

If the Repeat Interval is set to 0:0:0, a fast repeat scan mode will be selected where the solenoid will not be turned off between each succesive scan. This ensures that the time between the finish of one scan and the start of the next is a minimum.

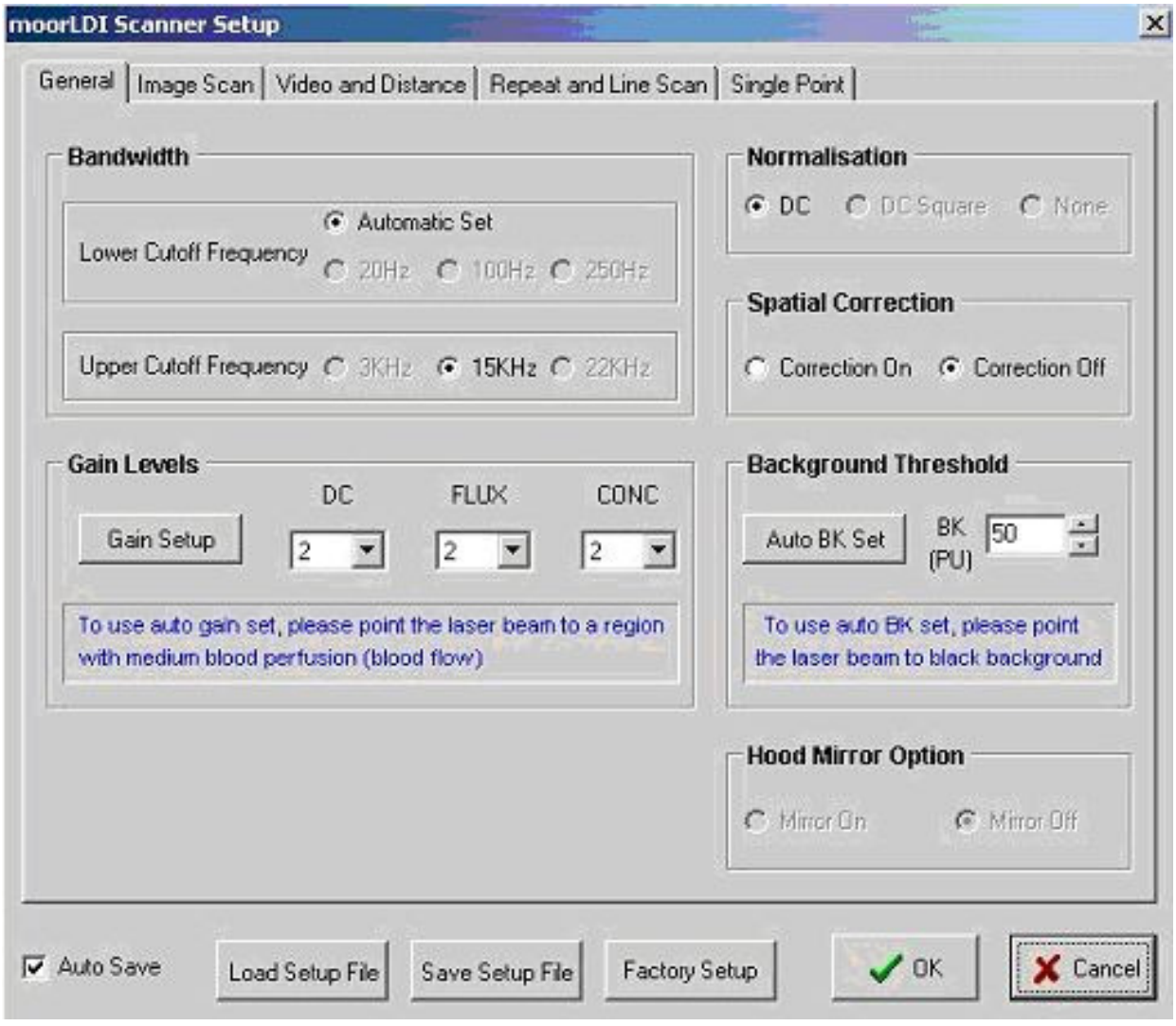
*6.3.3.2 Line Scan Setup*

This is a special type of repeat scan where Y is kept constant (there is no beam movement in Y direction during a line scan ie the beam is moved backwards and forwards along the same line ). The maximum line number in a Line Scan is 26250 (250x105).

If the **Number of Repeat Lines** is less than 250 the Line Scan will be treated as a Single Image and displayed as such. If the Number of Repeat Lines is more than 250 the Line Scan will be treated as a Repeat Image. For example if the Number of Repeat Lines is 1000 then 4 scan images of 250 lines will be displayed.

The line position is defined by the bottom line Y0 of the marked area of the scan area rectangle in the Image Scan page. (Y0 must be an even number).

6.3.4 GENERAL WINDOW OF SCANNER SETUP




*6.3.4.1 Bandwidth*

Automatic Set is selected by default. The upper cutoff frequency will be 15KHz and the lower cutoff will be automically selected to suit the scan speed. (20Hz for 50ms/pixel, 100Hz for 10 ms/pixel and 250Hz for 4ms/pixel.)
If the user wishes to change bandwidth, a password must be input in the Control menu.
Changing bandwidth will generally change the magnitude of the measured Flux so for consistency it is advisable to use the Automatic bandwidth setting. For very low flows, signal to noise can be improved by selecting the 3KHz upper Cutoff frequency and for very high flows the selection of the 22KHz upper cutoff frequency will result in more linear instrument response; however care must be taken when comparing measurements done at different bandwidths.

*6.3.4.2 Normalisation*

DC normalisation (ie division of the scaled flux by a factor proportional to the detected light intensity) is selected by default. If the user wishes to change normalisation to **$DC^2$ or no normalisation. A** password must be input in the Control menu to enable the change to be made.
Note that changing the normalisation will change the magnitudes of the flux values.
Changes can be made to normaliastion in the image processing program if the user chooses to do so.

*6.3.4.3 Background (BK) Threshold*

This is set (either manually from the key board or by Auto BK) to blank out all perfusion values where the detected light intensity is below the set threshold. If, for example a hand is placed on a dull (ie not shiny) black cloth background the DC background level for this may be close to zero for an imager using a visible red laser and 10 to 20 DC PU units for an infra-red laser imager.
As Flux measurements taken at very low DC levels are unreliable (eg close to the curved edge of a finger), the background threshold should be set low enough to remove edge effects from the recorded image but high enough to ensure the scanned tissue area is recorded. Note that the background threshold for recorded images can be changed in the image processing program so that the affect of different background threshold levels can be investigated to ensure that only those parts (those with low associated DC levels) which the user wishes to blank out are blanked out.

*6.3.4.4 Auto BK Set*

The beam can be moved to any cursor position within the image window by right clicking the mouse button. Moving the beam onto background cloth and clicking on Auto BK Set will set background to the level at that point.

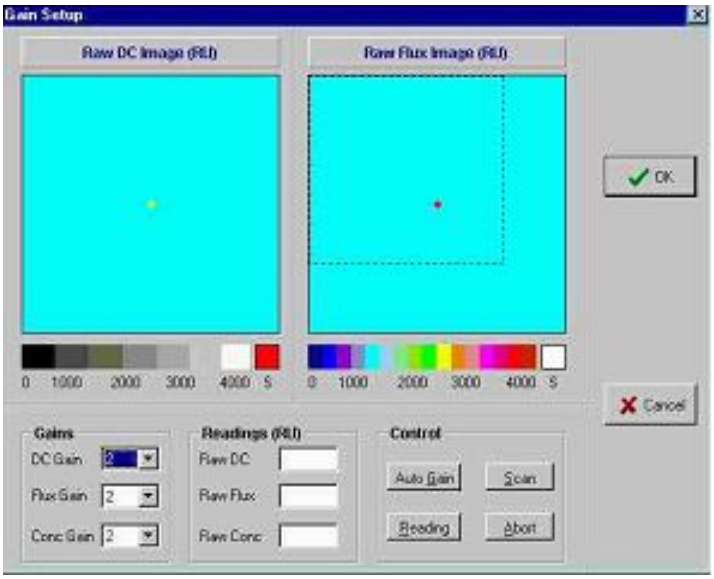
*6.3.4.5 Hood Mirror Option*

Select Mirror On only when the hood mirror is attached. (Only applicable to MK1 moorLDI imagers.)

*6.3.4.6 Gain Levels*

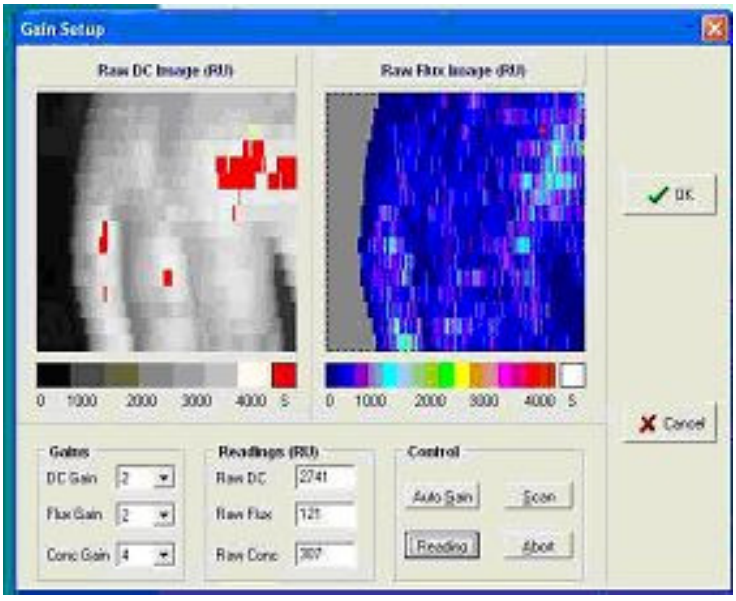
This enables gain settings to be selected for DC, Flux and Conc.
The gain settings from low to high are 0, 2, 4. In general the shorter the distance between the scanner and the skin surface being scanned, the lower the gain setting required. Too high a gain setting may result in signal saturation (on a relative scale the flux or DC will have a value close to 4000 which is

the limit of the 12 bit A/D convertor). For distances of about 40 to 60 cm the **Factory Setup** gains of 2, 2, 2 will probably be ok for most measurements. Gain settings can be entered in the DC, Flux and Conc boxes or the gains can be set automatically through **Gain Setup.**




*6.3.4.7 Auto Gain*

The beam can be moved to any position on the tissue surface by right clicking the mouse. The gain levels can be set automatically for that point (click **Auto Gain**).
There is large spatial heterogeneity of blood flow in many tissues so this technique may not be reliable for all parts of the tissue surface. The Auto Gain facility could be used as a guide only because the values are derived from one point only.
Gains need to be set according to the application: lower the gain when flux is high and the scan distance is close (to avoid signal saturation, shown as white on the flux image and red on the photo image); increase gains when flux is low and a longer scan distance is used (to make full use of moorLDI sensitivity.




The image above shows a region of DC saturation:

The DC gain should be reduced: in this example from 2 to the 0.

When moist tissue is being scanned, it is important to avoid scanning perpendicular to the tissue by angling the scan head (about 15degrees) to avoid direct laser reflection.

*6.3.4.8 Reading (RU)*

Clicking **Reading** displays the Raw values of DC, Flux and Conc measurements at the beam position. Note Raw values are the outputs of the 12 bit A/D range 0 to 4095 before scaling. The PU units are the Flux etc values after scaling and calibration. It can be useful to know the RU values in deciding on the gain settings.

*6.3.4.9 Scan*

This performs a low resolution image (16 lines) scan which will aid in deciding the gain settings. A dark blue image indicates a higher gain setting should be selected to make better use of the moorLDI dynamic range. Saturation (S) is shown as red in the DC image and white in Flux image.
A warning window appears if more than 5% of the image area is saturated.

*6.3.4.10 Abort*

Clicking the Abort 'key' or pressing A on the key board will stop the Scan at any time.

*6.3.4.11 Save Configuration*

Having spent time configuring the system and the scan window for a particular application it should be saved if it is likely to be needed again. To do this click the '**Save Setup File**' button.

Different configurations can be saved for different applications or user preferences.

Choose an appropriate filename and directory (folder) from the 'Save As' window which will be displayed, and the configuration will be saved in a *.mcf file.

The configuration can be modified and re-saved using the 'Save Setup File' command.

To install a saved configuration use the '**Load Setup File'** button.

To make sure that any changes made during a scan session are applied for the next time the moorLDI is used, tick the **Auto Save** box. This way, the configuration will be saved automatically when the program exits and will be automatically loaded for the next scan to be done.

## 6.3.5 SINGLE POINT MEASUREMENTS

The Single Point Measurement (SPM) function enables real time monitoring of laser Doppler flux and conc at a point on the tissue surface at relatively high data rates (upto 40Hz).


*6.3.5.1 Single Point Setup*

**- Sample Rate:** this can be selected between 1Hz to 40Hz (1Hz, 2Hz, 5Hz, 10Hz, 20Hz and 40Hz).

- **Automatic Gain Switch:** select this if Auto Gain is required, otherwise gains will depend on the settings selected in the General window. Automatic gain switching can only be had for single point measurements. Gains are not switched during an image scan.
The maximum monitoring duration is 12 hours at a sample rate of 40Hz, 24 hours at a sample rate of 20Hz, 48 hours at a sample rate of 10Hz and so on.

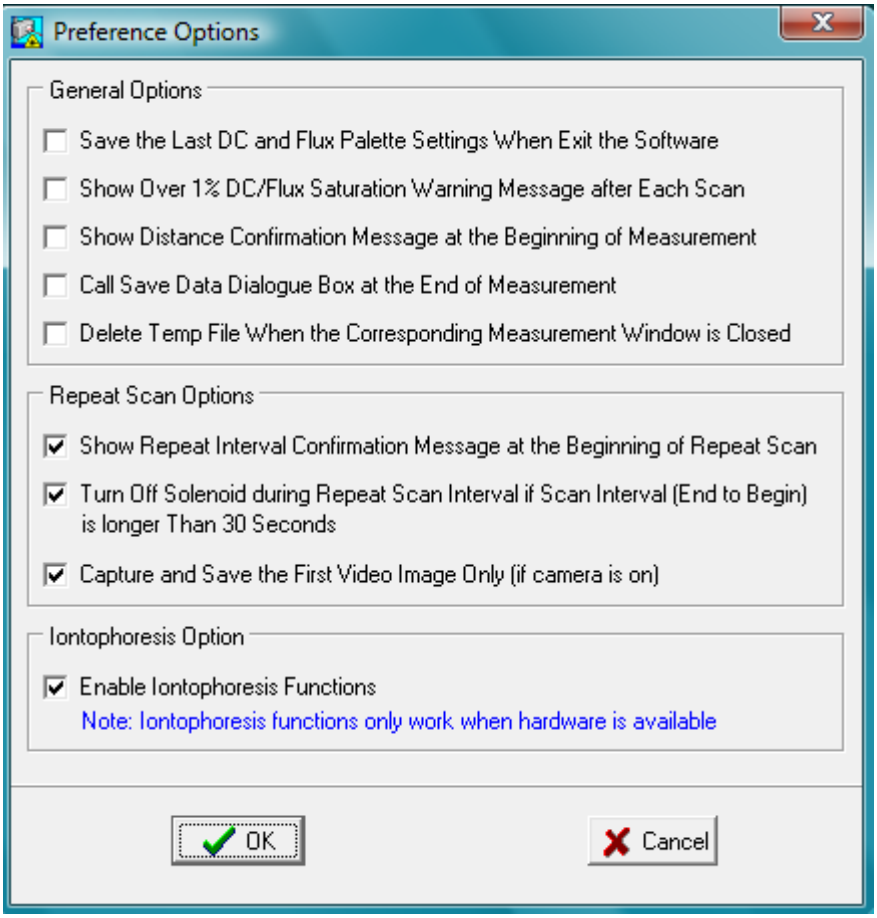
*6.3.5.2 Monitoring Duration*

- Free Run: monitoring ends at the maximum allowed duration depending on sample rate.

- Preset Time: monitoring ends at the Preset Time.

## 6.4 Setup: Preference Setup

Opens the Preference Setup dialogue box as shown below:




**Save the last DC and Flux Palette settings when Exit the Software:**

Select this option to remember the Palette settings when the software is closed.

**Show Over 1% DC/Flux Saturation warning Message after Each Scan:**

Select this option to enable the saturation warning message.

**Show Distance Confirmation Message at the Beginning of Measurement:**

Select this option to display the distance confirmation windows before every measurement.

**Call Save Data Dialogue Box at the End of Each Measurement:**

Select this option to open the File Save Window at the end of each scan.

**Delete Temp File When the Corresponding Measurement Window is Closed.**

Select this option to delete the temporary files (saved in the C: root directory) when the corresponding measurement window is closed.

**Show Repeat Interval Confirmation Message at the Beginning of Repeat Scan:**

Select this option to enable the warning message when the selected interval is shorter than the estimated scan (one image) time.

**Turn Off Solenoid during Repeat Scan Interval (End to Begin) is longer Than 30 Seconds:**

Select this option to attenuate the laser (turn the solenoid off) during repeat scan intervals (if the interval from the end of one scan to the start of the next one is longer than 30 seconds). Otherwise, the the laser will remain at full power (solenoid not turned off) during repeat intervals.

**Capture and Save the First Video Image Only (if camera is on) for Repeat Scan:**

Select this option to capture and save only one video/CCD image at the start of a repeat scan, otherwise a video image will be captured at the start of every repeat scan image (note: capturing a video image at the start of every repeat scan image will take significant harddisk/memory, therefore it is not recommended unless absolutely necessary).

**Enable Iontophoresis Functions:**

If iontophoresis hardware is available, select this option will enable all iontophoresis related functions. Measured voltage V1 (at the start of an image scan) and V2 (at the end of an image scan) will be displayed just below each Flux image.

# 7. SINGLE IMAGE SCAN

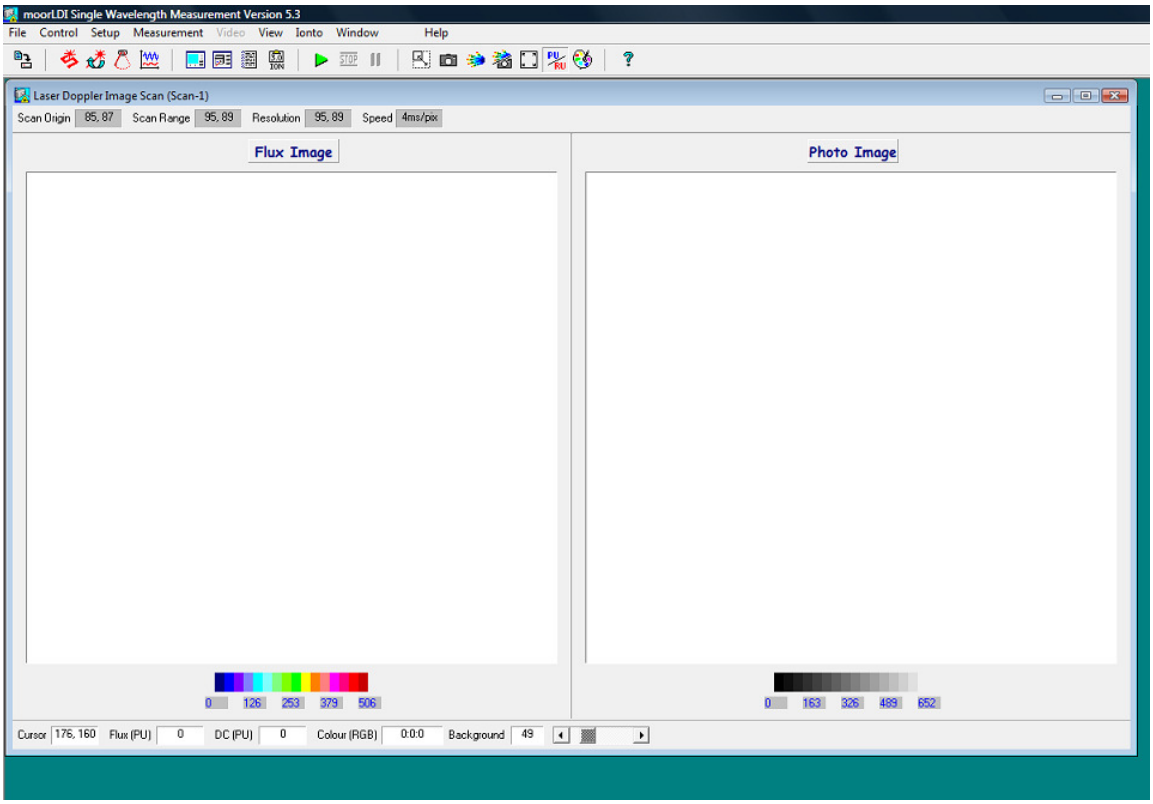
## 7.1 TO START

After setting up the scan window using **Setup** and configuring the system (or loading a previously defined configuration file) it is possible to proceed to imaging.
Click on the single scan icon 

(or type Alt M, I  ie hold dow the Alt key and type M followed by I)

**or** select **Measurement**
**Image scan**

The following measurement window is displayed when **Image scan** is selected:




This has additional icons for image acquisition, save and display on the icon tool bar.
To start collecting photo and flux images click on the green flag  .

The system will then prompt for the distance from scan head to tissue if the preference setup has been set to prompt. Note that the distance can be automatically measured and entered via the scanner setup window. If you wish to change the scan distance, without returning to scanner setup, then you need to enter the distance manually.

There is a raised plastic mark on each side of the scan head. The marks are approximately lined up with the bottom of the glass window where the ‘Laser Aperture’ is labelled. Measure from one mark, parallel with the laser line, to the plane of the tissue surface and enter the distance into the box.


Once the distance has been entered, click OK to start scanning.

## 7.2 SAVING AN IMAGE SCAN

On completion of an image scan it can be saved by clicking on the save icon
or by selecting **File** (from the menu bar)
**Save As**

Select the appropriate directory and enter a filename in the **Save As** window.

Three files are created:

*.dc contains the 'photo' image
*.flx contains the laser Doppler flux image
*.jpg contains the video image (note this is not created if the video camera is not used

## 7.3 IMAGE DISPLAY IN MEASUREMENT MODE

A limited number of display options are available from the measurement mode. These have the following icons:


1 2 3 4 5 6 7

1. Toggle Display image in real aspect.

2. Show photo image only.

3. Show flux image only.

4. Show both flux and photo images.

5. Toggle between full size and actual size image display.

6. Toggle between PU (perfusion units) and RU (relative units).

7. To open palette window for changing image display range.

These actions are self evident except for 6 and 7 which are described further in Sections 9.9 and 9.10, respectively. The status tag appears next to the icon when the mouse hovers over each icon.

# 8. REPEAT AND LINE SCAN MEASUREMENT

## 8.1 INTRODUCTION

There are many situations where it is an advantage to take successive measurements of the same tissue site to observe a response evolve in timed sequence.

The minimum time between successive measurements is determined by the size and resolution of the images to be taken.

In Version 5, the user can set a time interval between starting points of each image with safeguards to ensure that overlaps are not attempted.

A great advantage of the **Repeat Scan and Line Scan** function is the facility, within the processing module, for simultaneous processing and analysis of each image (described in Sections 11 and 14).

**Repeat Scan** repeatedly scans the same area. The time between scans can be set.

**Repeat Line** measures from the same line continuously, scanning backwards and forwards. The number of line scans can be set. Line scan enables measurements at upto 256 points on the line of scan in approximately one second with a fast scan speed (4ms/pixel).

## 8.2 REPEAT AND LINE SCAN SET UP

The characteristics of the scan window and system set up are the same as for single Image Scan. It is necessary for these features to be set up also prior to Repeat Scan. This is done in **Scanner Setup**

Repeat scan parameters are: the repeat interval
the number of scans (upto 105)

Repeat line parameters are: number of lines (up to 26,250 ie 105 x 250)

### 8.2.1 REPEAT INTERVAL

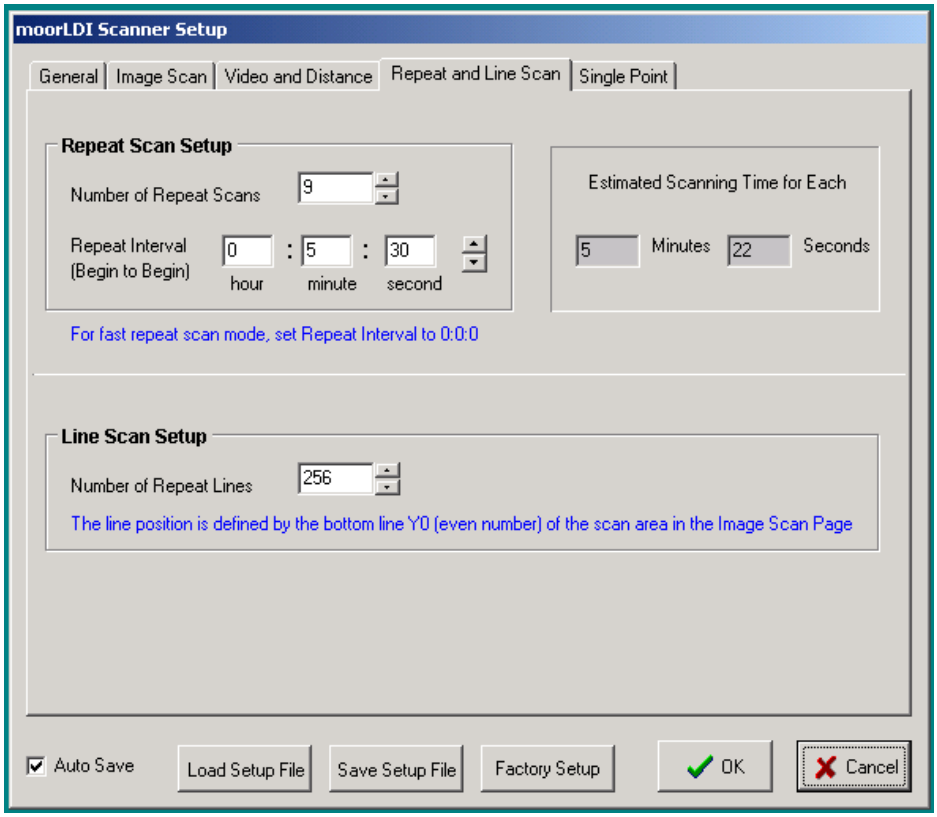
The interval which can be set by the user represents the time between the start of successive scans.

A Repeat Scan set can be interrupted with a **Pause** and will continue with the sequence when the Pause button is clicked. A **Line Scan** operates continuously i.e. there is no option to increase the time between successive lines.

The resolution of time interval is 1 second.

### 8.2.2 NUMBER OF SCANS

Set this to the total number of scans required upto a limit of 105 scans. Any number of scans can be performed (≤ 105).

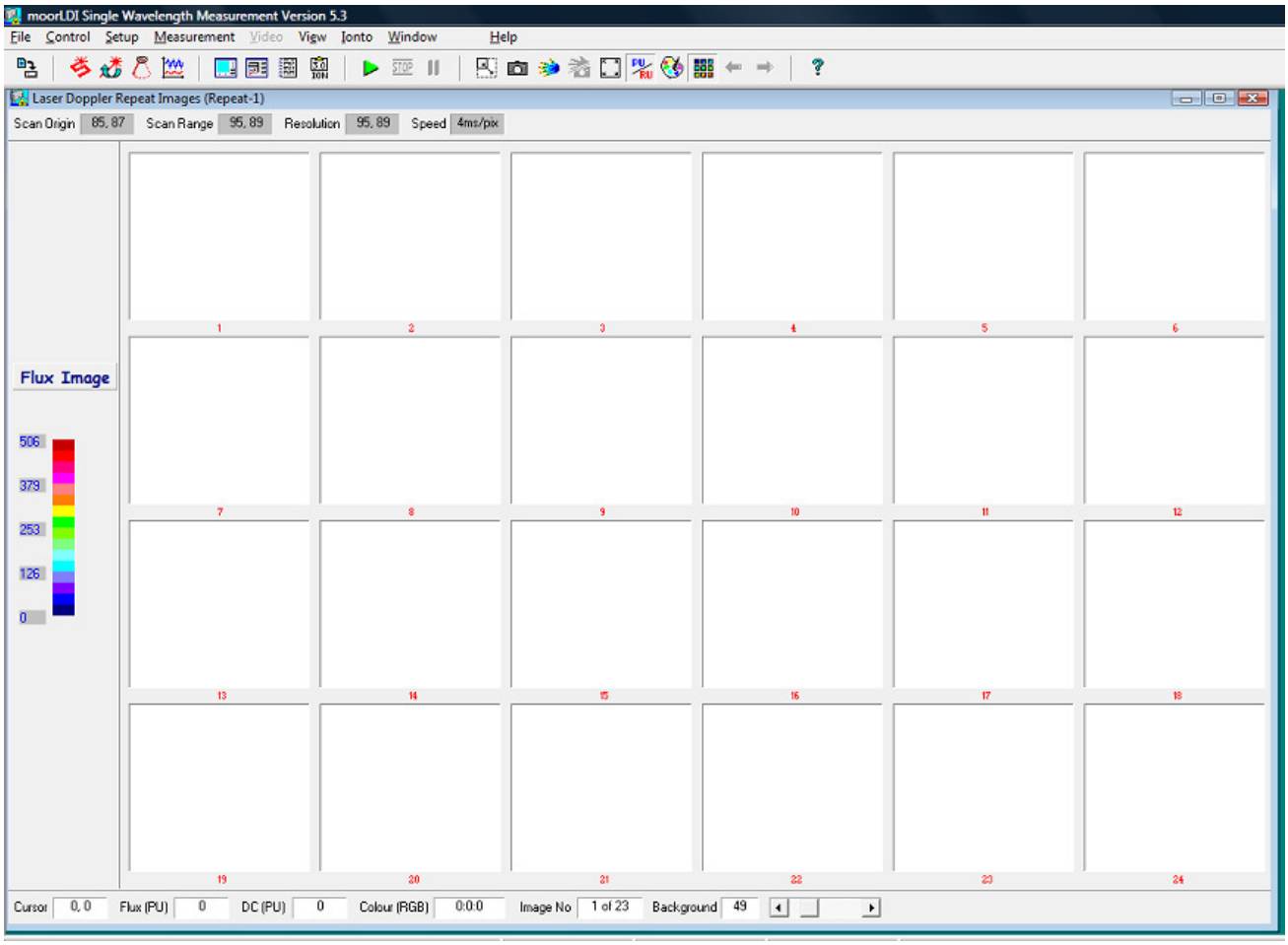



## 8.3 REPEAT SCAN START

After setting up the scan window, system configuration and repeat scan configuration (or loading a previously defined configuration file) you can proceed to Repeat Scan measurement.

Click on the Repeat Scan icon 

or select: **Measurement**
**Repeat Scan**




To start click on the green flag. 

## 8.4 REPEAT SCAN DISPLAY DURING MEASUREMENT

If a small area has been selected for a repeat scan it can be displayed either as the small portion it occupies in the image window or occupying the full scan window: click on the expand icon to toggle these options (see Section 6.3, icon 1). 

The expanded format is better for square images but will distort images with long or tall aspect ratios.

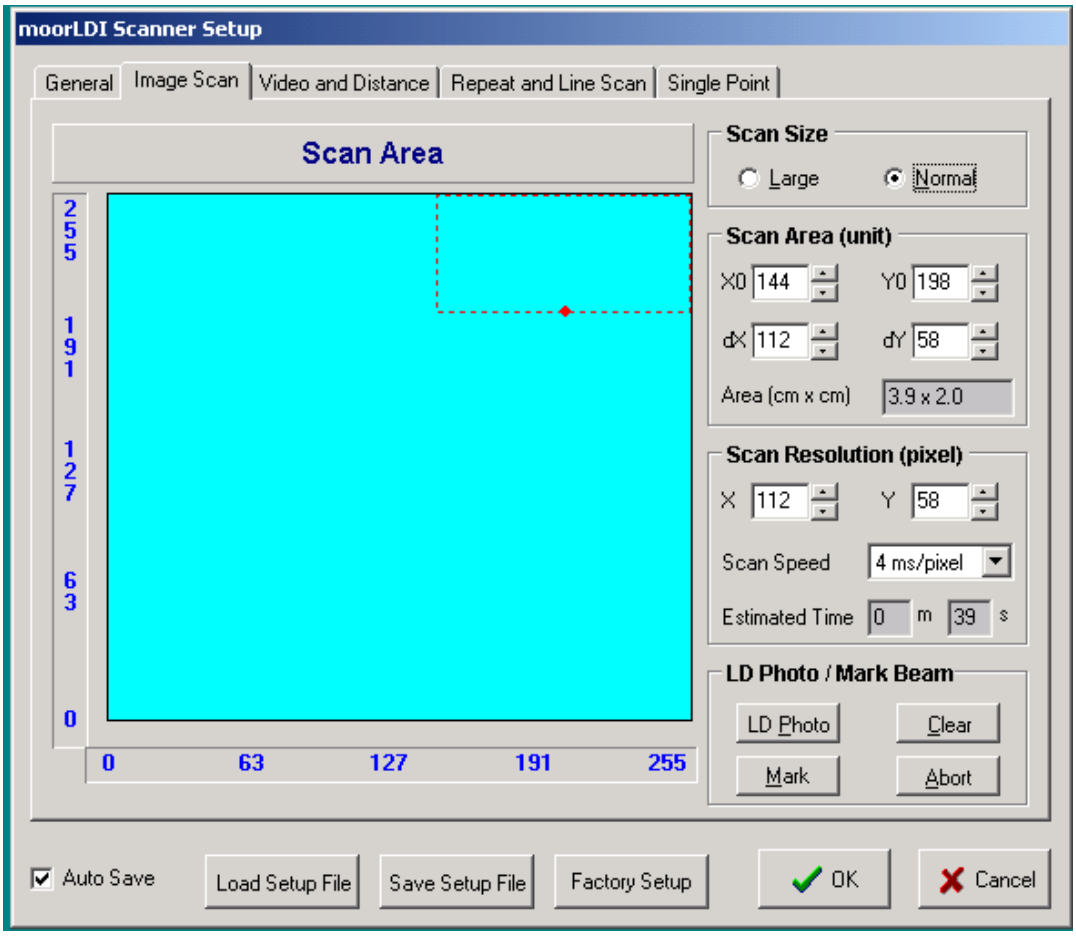
The screen display during repeat scan can be toggled between single image and multi image display by clicking on the 9-squares icon  .

These options can be selected prior to measurement, during a pause and post-measurement.

## 8.5 REPEAT LINE SCAN START

Once the repeat line has been defined, click on  to open a window for repeat line measurement.

Click the green arrow to start. Save the finished measurement in the same way as you would a single scan.




In the example above the line scanned has an origin (X0,Y0) 144,198 length dX 112 pixels. The origin and length of a line scan correspond to the bottom edge of the marked rectangle shown in the Image Scan window.

## 8.6 IONTOPHORESIS

This function (IONTO) is used to control the MIC1-e or MIC2 iontophoresis controller directly from the moorLDI imager (provided the moorLDI control box has been modified for this use).

Details for use of the MIC1e or MIC2 in conjunction with the moorLDI are given in the moorLDI IONTOPHORESIS USER MANUAL (see **Appendix 2**).

# 9. SINGLE POINT MEASUREMENT (SPM)

## 9.1 INTRODUCTION

The Single Point Measurement (SPM) function enables real time monitoring of laser Doppler flux and conc at a point on the tissue surface.

## 9.2 POSITIONING OF BEAM FOR SPM

To measure at the point of interest it is first necessary either to move the tissue to the beam position or to move the beam to the position required.

## 9.3 BEAM MOVEMENT

Enter the **Scanner Setup** by clicking on the icon  or **Setup** then **Scanner Setup** followed by **Image scan** selection.

Use of this window for imaging is explained in Section 5.4.

To move the beam, position the cursor at a point in the scan window and click the **right hand** mouse button. The beam will move to a position corresponding to the new screen position.

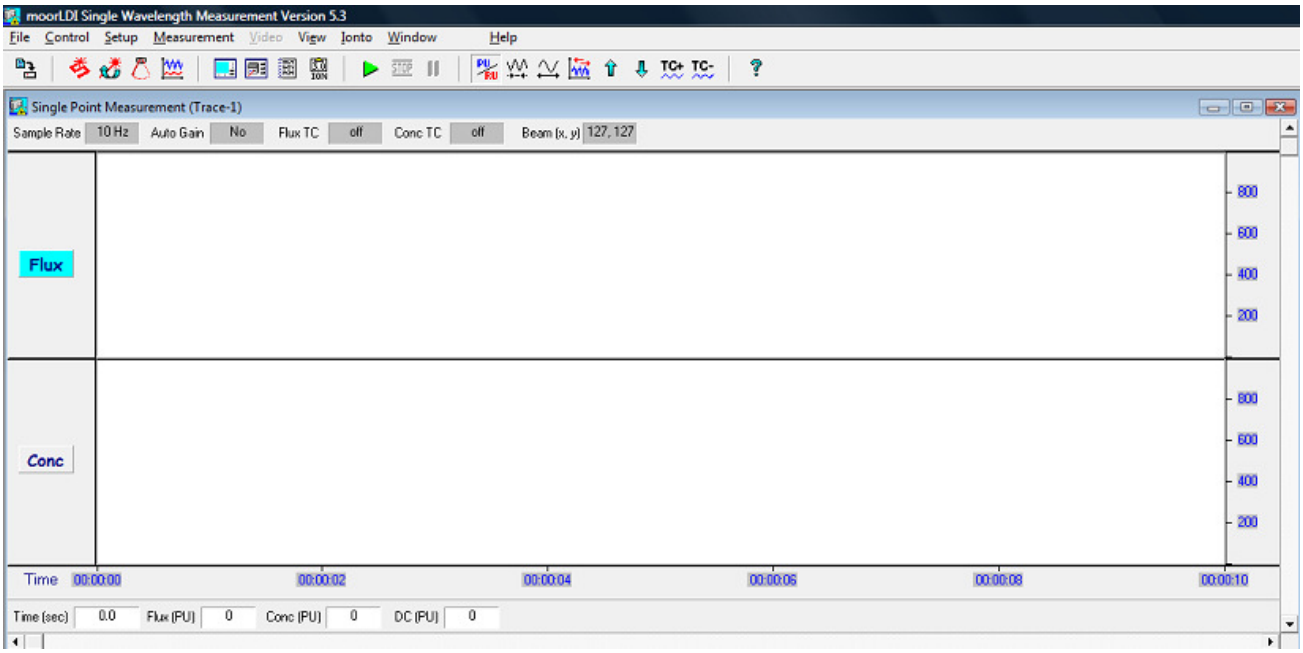
## 9.4 BEAM MOVEMENT RELATIVE TO PHOTO IMAGE

If it is more convenient to position the beam relative to a photo image of the tissue this can be done by selecting **LD Photo** in the **LD Photo/Mark Beam** box. This will scan the beam over the tissue area and display a low resolution Photo Image (16 lines).
To move the beam, position the cursor at a point in the Photo window and click the **right hand** mouse button. The beam will move to a position corresponding to the new screen position.

## 9.5 SINGLE POINT MEASUREMENT WINDOW

After positioning the beam at the required tissue site enter the Single Point Measurement window by:
clicking on the SPM icon 
or select **Measurement**
**Single Point**

The following window will be displayed:




On entering this window 14 new icons appear:

1. Start: to start a single point measurement.
2. Stop: to stop a single point measurement.
3. Pause/continue: to interrupt a single point measurement.
4. To expand the time scale.
5. To compress the time scale.
6. To increase the flux time constant, i.e. smooth the trace.
7. To decrease the flux time constant, i.e. show more flux structure.
8. To increase the conc time constant, i.e. smooth the trace.
9. To decrease the conc time constant, i.e. show more conc structure.
10. To view previous page.
11. To view next page.
12. To toggle between PU and RU: option available after measurement.
13. Store trace on file.
14. Help.
15. Toggle between scroll and slide display modes.

## 9.6 DISTANCE - moorLDI2-TO-TISSUE

This should be set within the **Scanner Setup** window as discribed for imaging. The correct distance ± 5cm needs to be entered for the correct conversion from RU to PU.

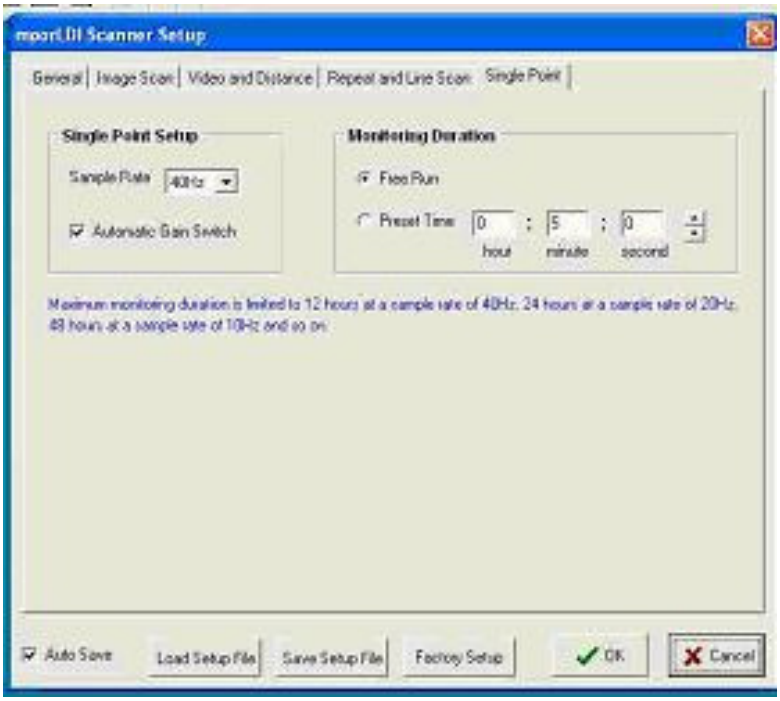
## 9.7 SINGLE POINT CONFIGURATION

The following parameters can be set in the SPM Configuration window.

Select using the **Scanner Setup** icon 

or **SetUp**
**Scanner Setup**

Click the right-most tab to configure the **single point** measurement.




Parameters that can be altered include;

Monitor Duration: free run/preset time (Preset time in Hours: Minutes: Seconds.
Sample Rate – selectable
Autmatic Gain Switch – on/ off

## 9.8 AUTOGAIN

Enables a wide range of flux values to be obtained without saturation occurring in the detection process. If this option is not selected the gain settings set for imaging are implemented.

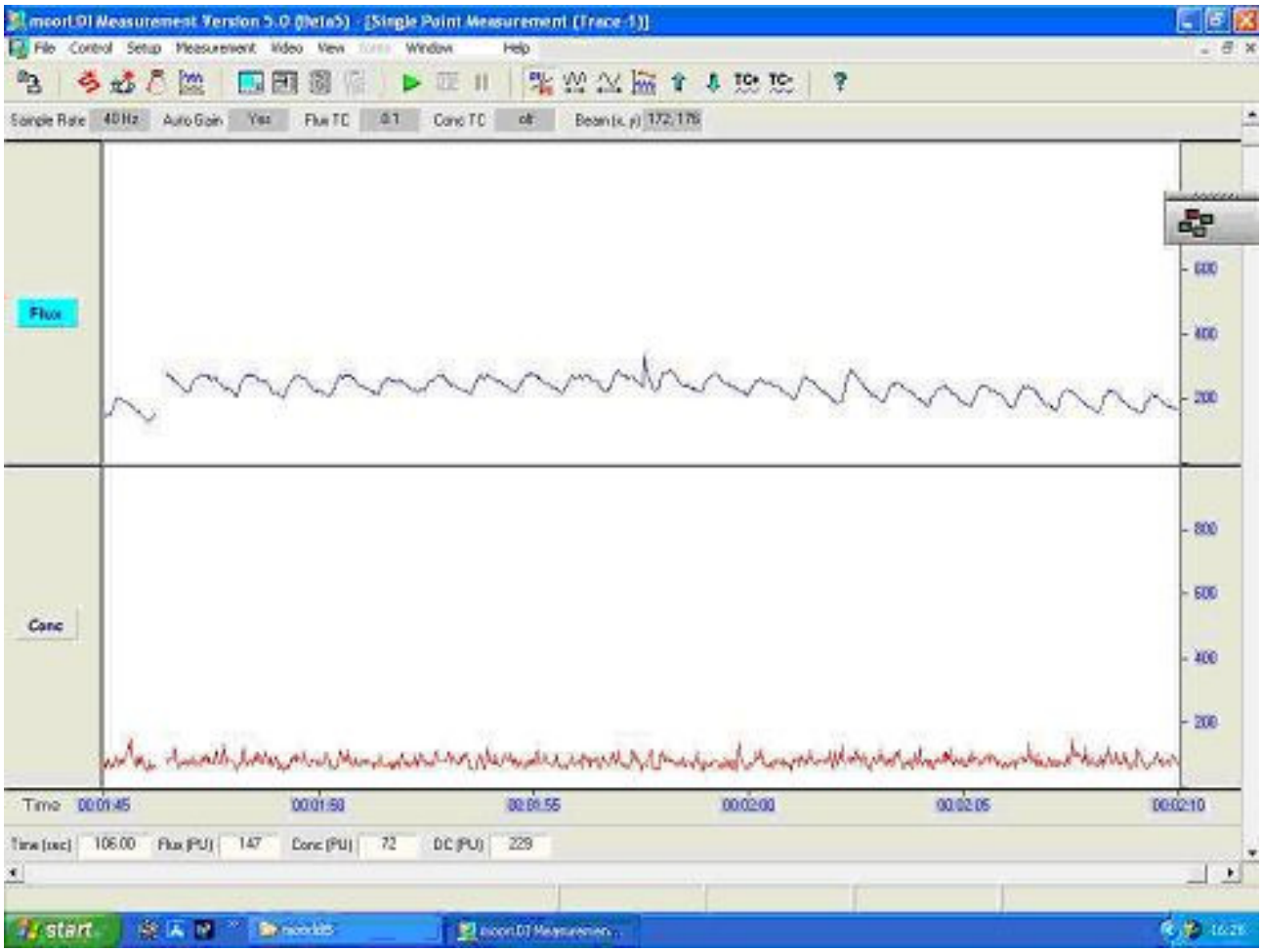
If selected, autogain is set up only at the start of a single point measurement. Changing position on the tissue for example, following a pause, can lead to errors in the autogain setting.

## 9.9 SINGLE POINT MEASUREMENT - START

After clicking the SPM icon  or selecting
**Measurement**
**Single Point**,
Position the beam at the tissue site eg on a finger.

click on the green flag start icon  .

You can expect to see pulsatile flow from a warm finger – see the example below.




To stop, click on the stop icon  .
To pause, click on the pause icon  .

## 9.10 SINGLE POINT MEASUREMENT - FILE STORE

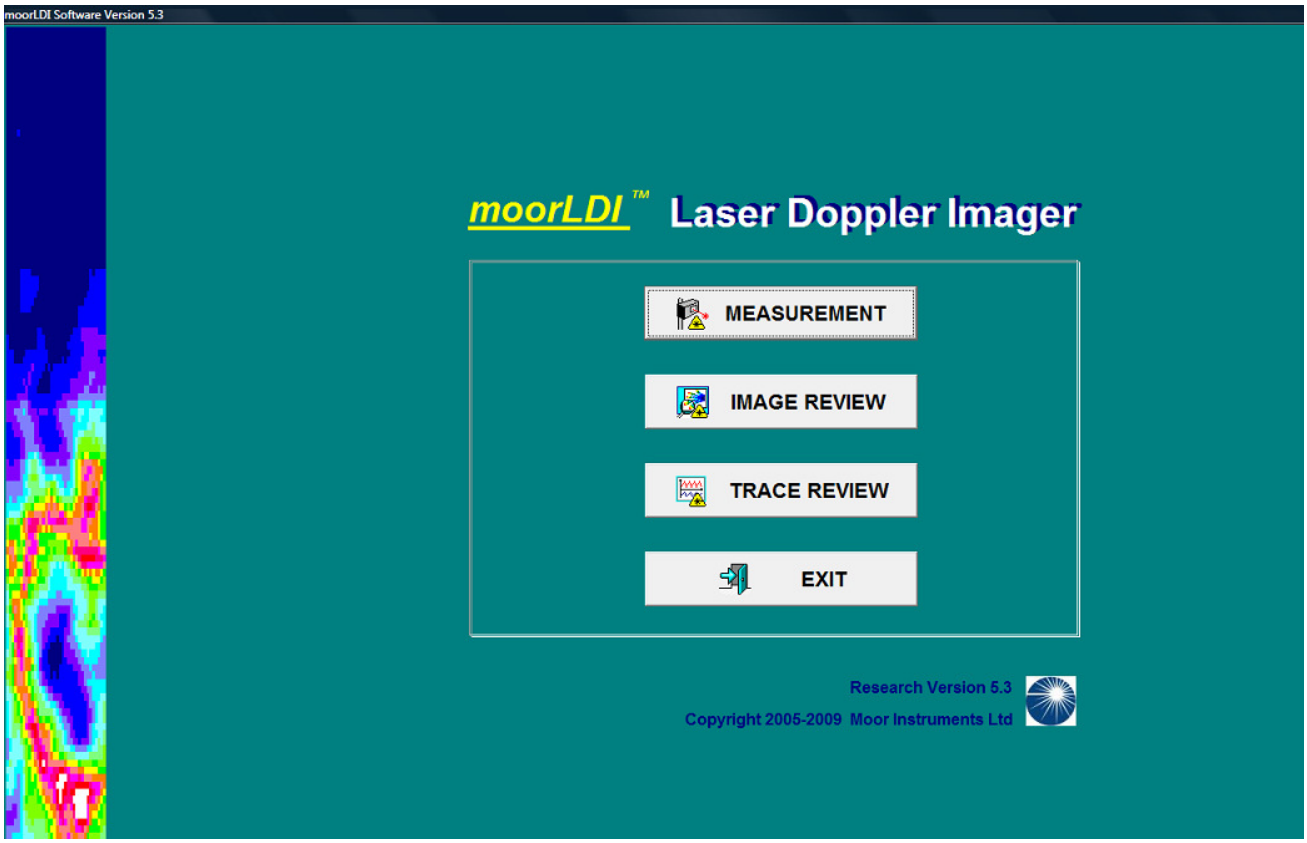
The single point measurement traces of flux and conc are stored using the file store icon or by selecting **File**, **Save As**. Storage is in *.SPM files.
For single point review see Section 14.

# 10. IMAGE REVIEW

## 10.1 INTRODUCTION

The image processing utilities enhance the displayed image for various applications. In this section are described image display utilities. Image processing is described in Section 10 and Analysis in Section 14.

Click on **IMAGE REVIEW** in the main moorLDI laser Doppler imager window to enter the image review progra. Note that if are running MEASUREMENT or TRACE REVIEW exiting these programs will return you to the main window .



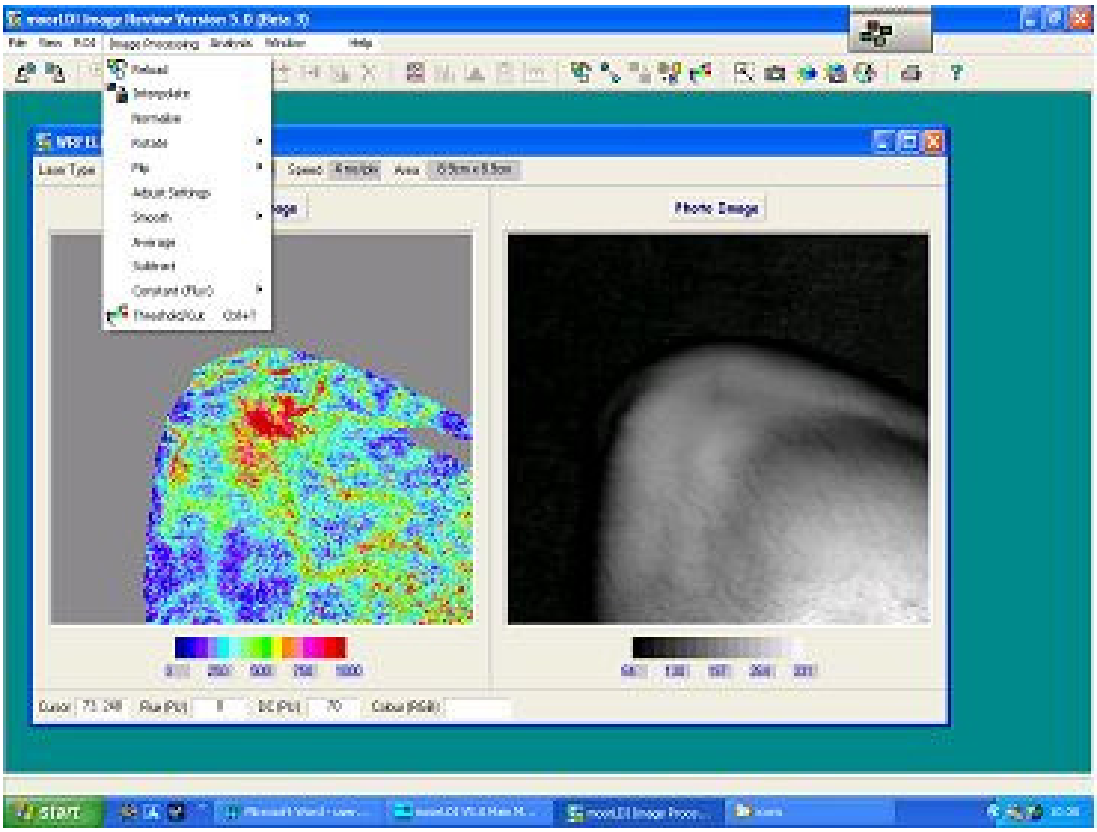

## 10.2 Summary of Image Processing Utilities

When you first enter **IMAGE REVIEW** only the open file  and the help icons  are active.

Other icons become active when an image file is opened. These are:-


1. Save Current File with different name
2. Select Cursor Mode
3. Select Rectangular ROI mode
4. Select Circle ROI mode
5. Select Polygon ROI mode
6. Select Line ROI mode
7. Show Image Information
8. Original image display - gets back to original after other processing operations.
9. Smooth - applies a low pass filter to flux image.
10. Interpolate - adds mean value pixel between existing pixels.
11. Subtract image - to present difference following a change.
12. Threshold Setup - to change min/ max threshold values.
13. Aspect toggle - toggles between full screen and correct aspect display.
14. Photo image - displays photo image only.
15. Flux image - displays flux image only.
16. Photo/Flux image - displays both photo/ flux images.
17. Palette - opens palette box to change image colour scale.
18. Print a Report

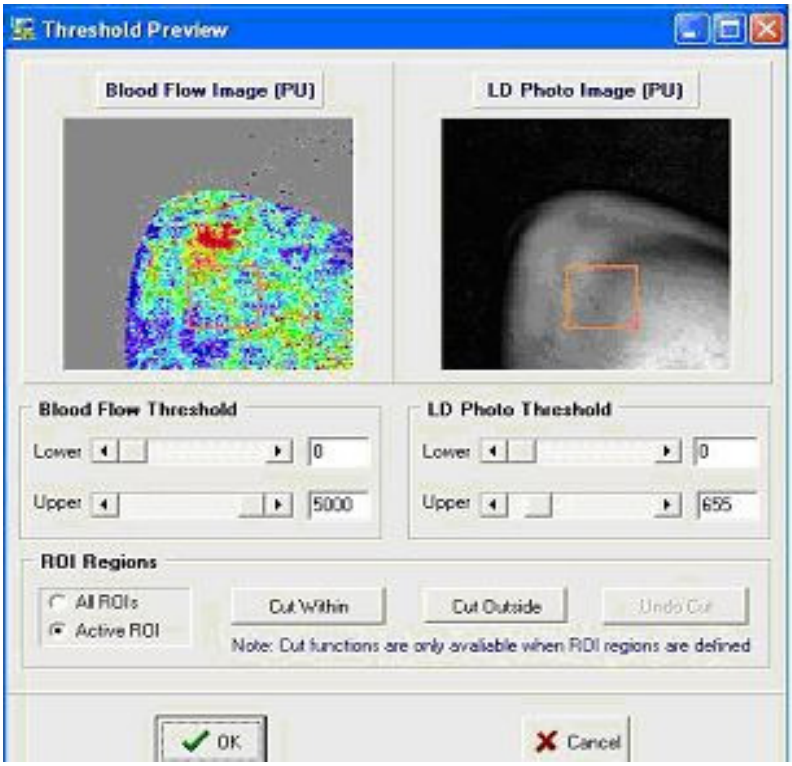
Further Image Processing utilities are available, other than those obtainable from shortcut icons, by clicking on the **Image Processing** toolbar:



| | |
|---|---|
| Reload | - reload original unprocessed image - as 8 above |
| Interpolate | - as 10 above |
| Normalise | - alter image normalisation – note default is division by DC |
| Rotate | - Rotate Left/Rotate Right |
| Flip | - FlipHorizontal/Flip Vertical |
| Flux:Adjust Settings | - change background level. |
| | - 'change' distance of object from moorLDI2. |
| Smooth | - flux or LD Photo (DC) image. |
| Average | - Averaging of selected repeat images (not applicable to single images) |
| Subtract | - subtract one flux image from another (must have same dY and dX) |

Constant (Flux):-

| | |
|---|---|
| Add Constant | - add a constant to the flux image |
| Subtract Constant | - subtract constant from flux image |
| Multiply Const | - multiply the flux image with a constant. |
| Divided Const | - divide the flux image by a constant |
| Threshold: | (Note can be opened from the key board with Ctrl+T) |
| | - Blood Flow Threshold |
| | - LD Photo Threshold |
| Upper -Cut Above | - remove flux /Dc values above set level. |
| Lower - Cut Below | - remove flux / DC values below set level. |

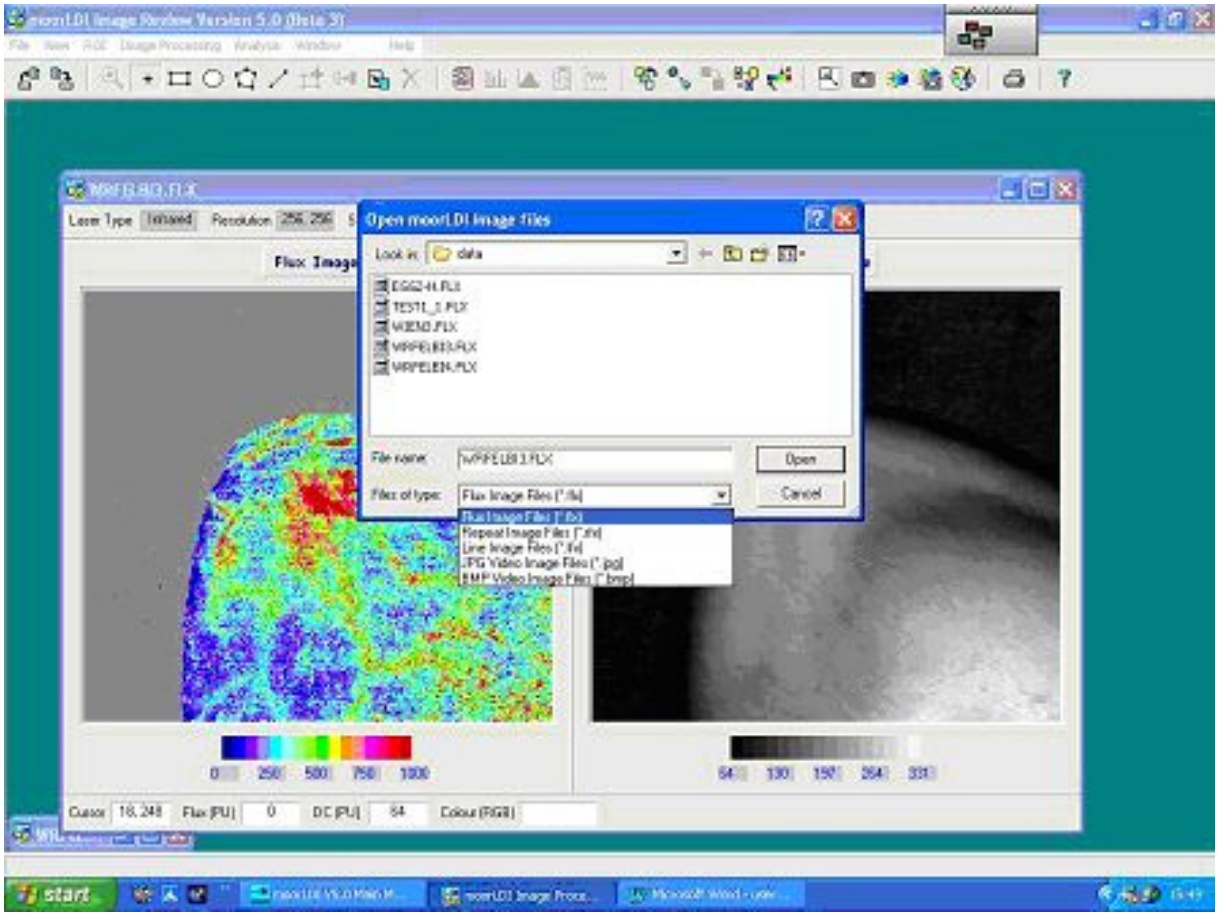



| | |
|---|---|
| ROI Regions | - applies to all ROI's or active ROI only |
| Cut Within | - remove flux values in ROI. |
| Cut Outside | - remove flux values outside ROI. |
| Undo Cut | - restore previously cut pixels. |

## 10.3 OPENING FILES and IMAGE DISPLAY

Open a file by clicking the  icon or select **File**, **Open**.

By default only *.flx file names for single images are displayed in the directory window. Other types (repeat scan/ repeat line/ JPG video and BMP video files) can be displayed by selection from the window below this.




After a file has been opened both flux and dc images are displayed if it is a single image and just the flux images of a repeat image set. These are the default display types. Other display options available are described below.

### 10.3.1 PHOTO IMAGE DISPLAY

To display the dc 'photo' image(s) only click on the camera icon  . The aspect ratio of the image will be stretched. This original aspect can be retrieved via the options menu. See Aspect below.

### 10.3.2 FLUX IMAGE DISPLAY

To display the flux image(s) only click on the hand icon  . To restore the image shape see **Aspect**, below.

### 10.3.3 FLUX AND PHOTO IMAGE DISPLAY

To display both flux and photo images click on the split camera/hand icon  . To obtain the correct aspect ratio of the images, see Aspect below.

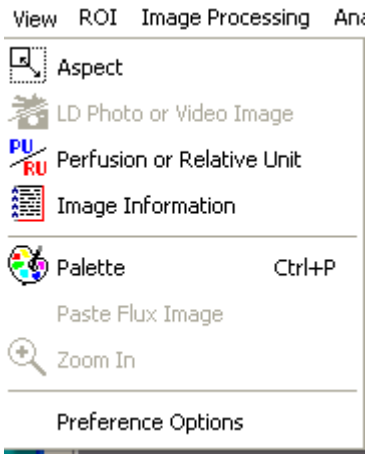
## 10.4 VIEW

### 10.4.1 ASPECT

There are many rectangular image shapes that can be imaged during measurement. The default display is to fill the whole display window. The effect of this is to distort the original image. Image shape can be restored but it is first necessary to reduce the size of the display window using the standard Windows™ utility (in the top right hand corner of the display window).

After window size reduction select: **View**
**Aspect**

Note that when loading images captured using other Moor LDI packages (e.g. BDA) it may not be possible to maintain the correct aspect ratio for the video image.




### 10.4.2 UNITS 

*10.4.2.1 Units – Relative Units (RU)*

To toggle between Relative Units (RU) and Perfusion Units (PU) click on **View**, then click the PU/RU icon.

The default display of flux image(s) is in Perfusion Units (PU). This unit system is used to compensate for raw unit differences due to gain setting selection and distance. This provides a means of comparison for images taken from different distances or with different gain settings.

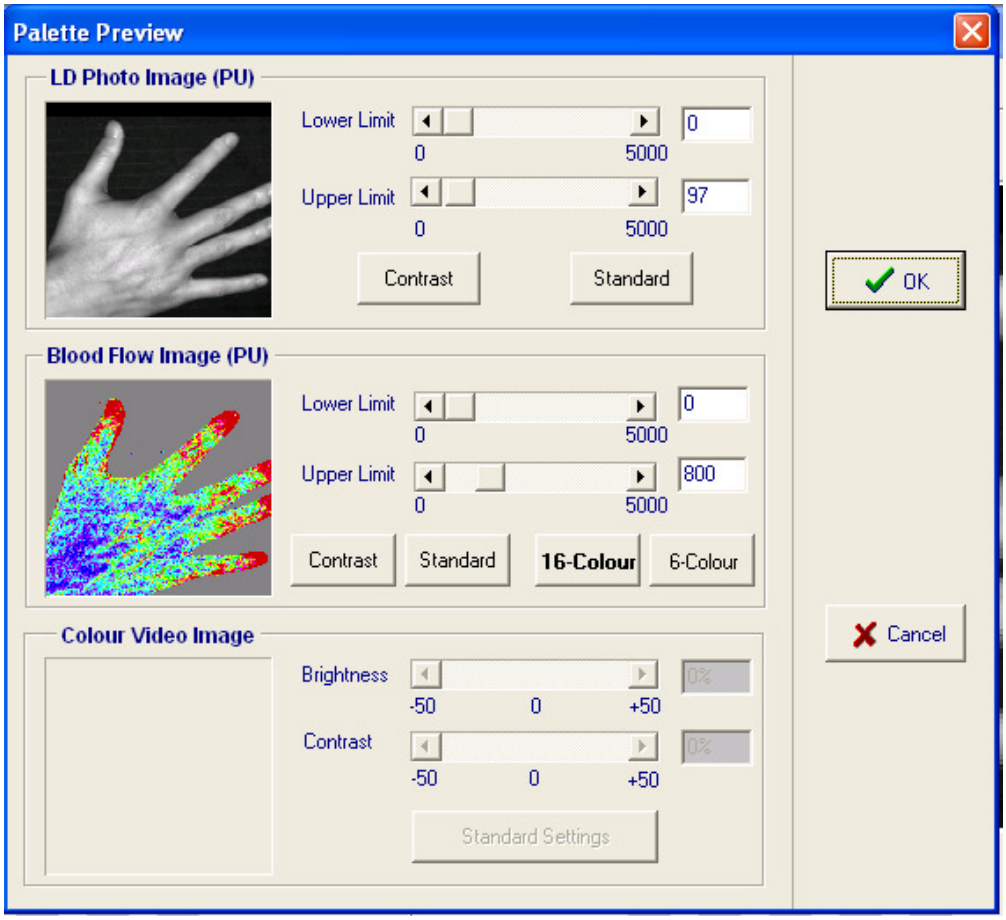
*10.4.2.2 Units – Perfusion Units (PU)*

The moorLDI2 imager is calibrated using a motility standard consisting of polystyrene microspheres in water. Calibration is done is done during the final testing before it leaves the factory. Calibration can be checked, and the imager recalibrated if necessary, by the user.
The use of these standardised Perfusion Units rather than the 'Relative Units' (which will vary with the gain settings and with scanner/tissue site distance), is recommended as it allows comparisons between measurements taken at different times with different instrument settings. It also allows comparisons between measurements taken with different moorLDI imagers to be more easily and reliablely achieved.

It is strongly recommended that when publishing results that Perfusion Units (PU) are quoted.

### 10.4.3 PALETTE

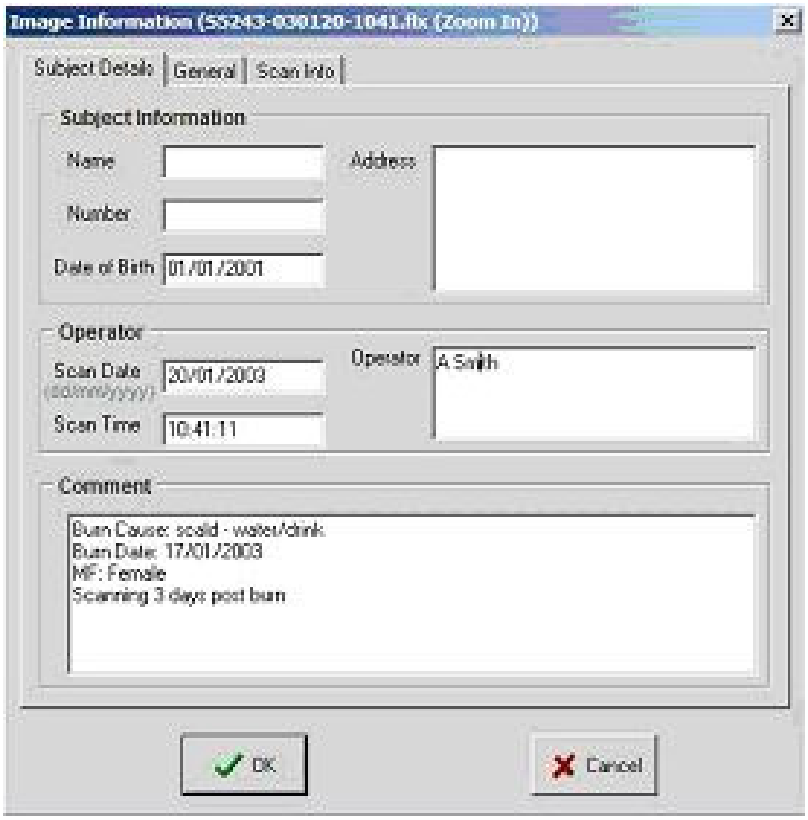
The type of palette and colour (or black and white) range of flux and photo images can be changed by selecting the **Palette** icon . This can be used to bring the displayed image(s) into the full colour range (increase the limits) or to highlight differences within a particular region of interest (e.g. reduce the limits to see flux differences within low flow areas of a free flap following plastic surgery).




Adjustments can be made to LD Flux, LD Photo and colour video images. Small preview windows are used to show the efect proposed palette changes will have on the images.

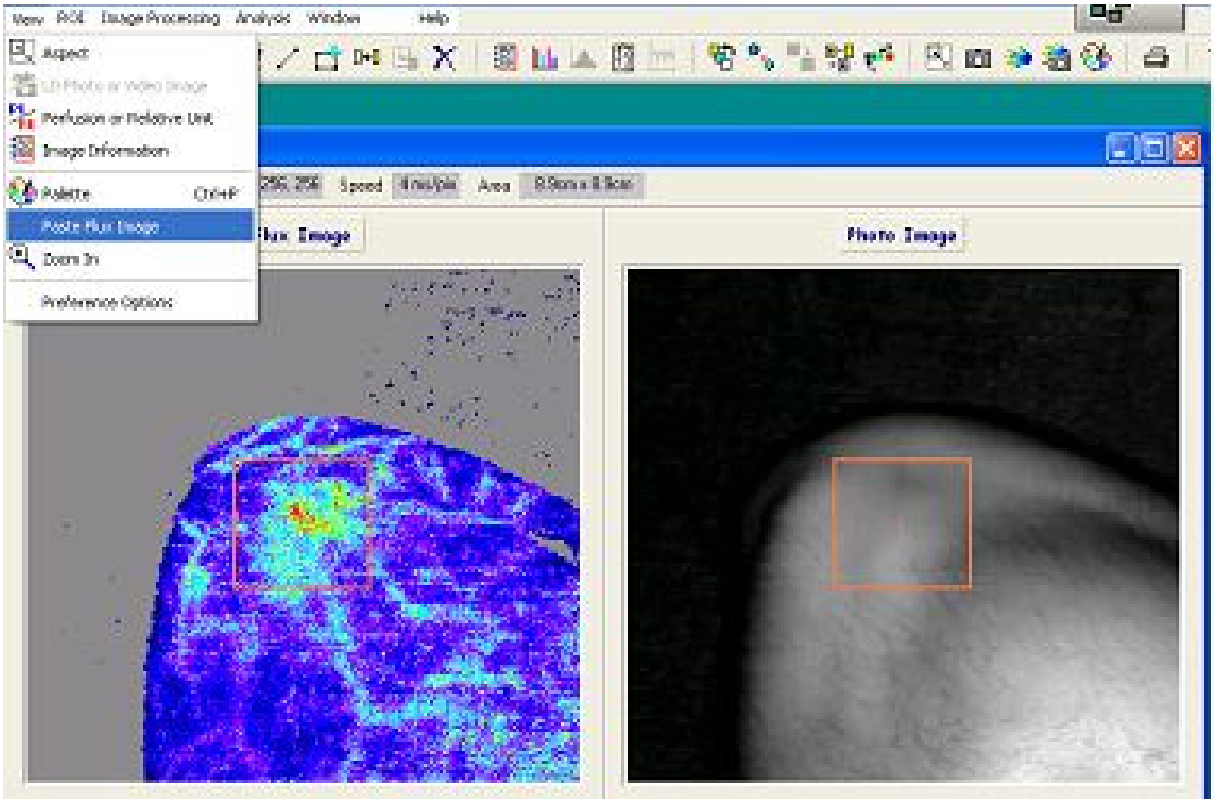
### 10.4.4 IMAGE INFORMATION

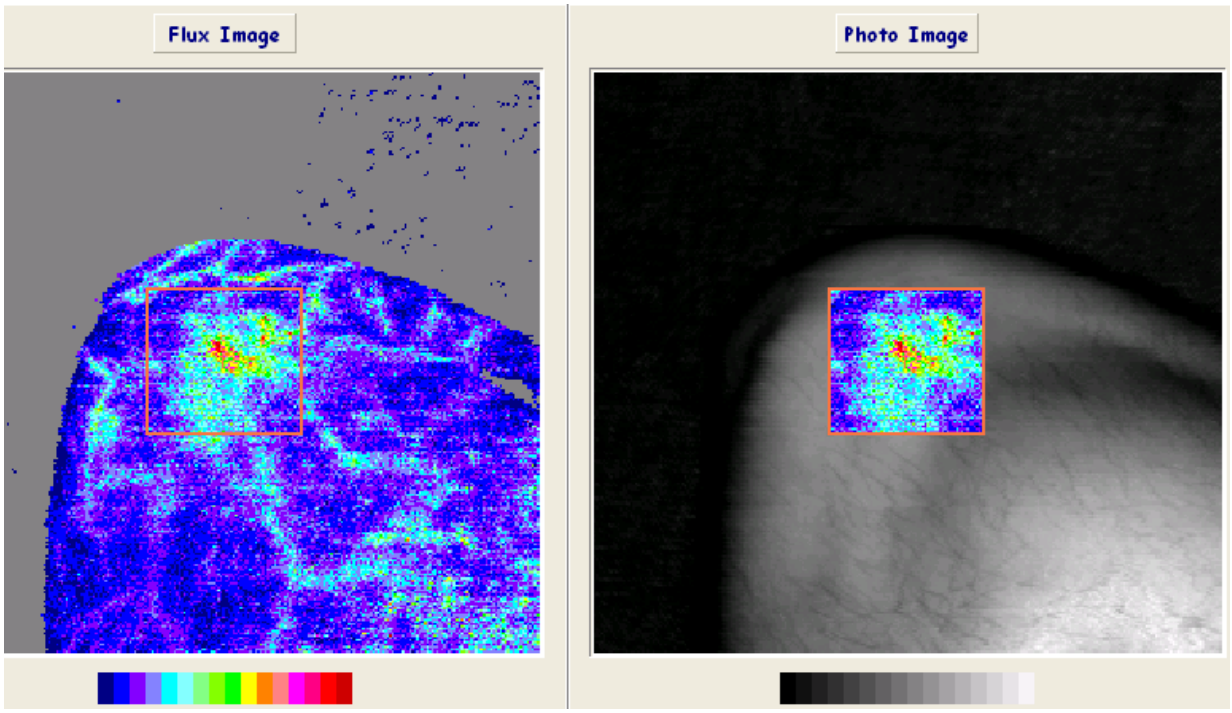
All the configuration parameters and operator entered data is stored with the image and can be recalled by clicking the information icon .



### 10.4.5 PASTE FLUX IMAGE

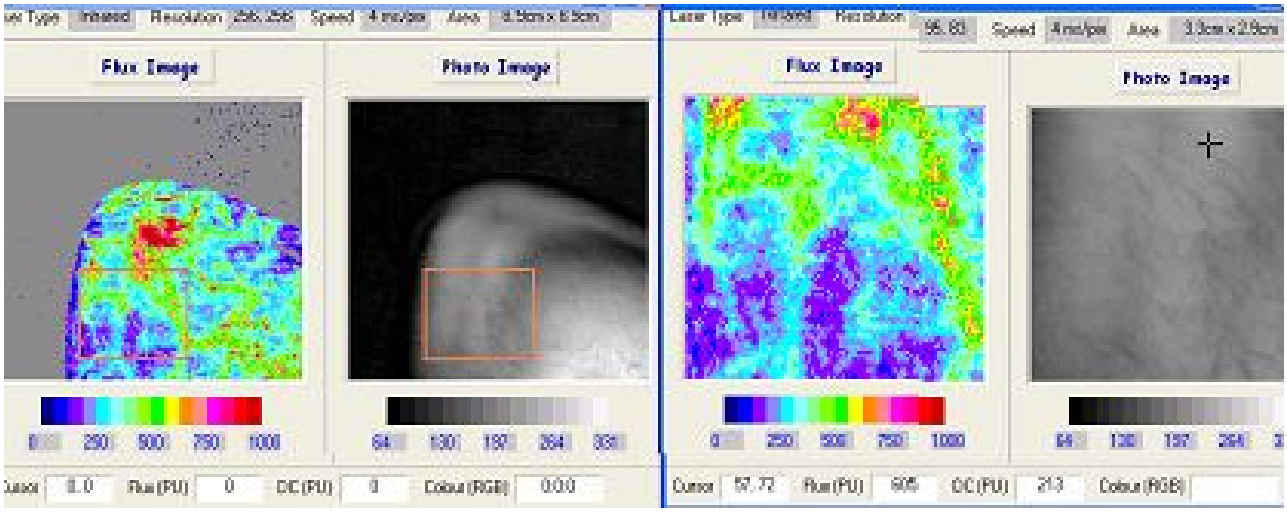
One or more (uptp 5) rectagular ROIs on the Flux image can be pasted on to the Photo Image.



### 10.4.6 ZOOM IN

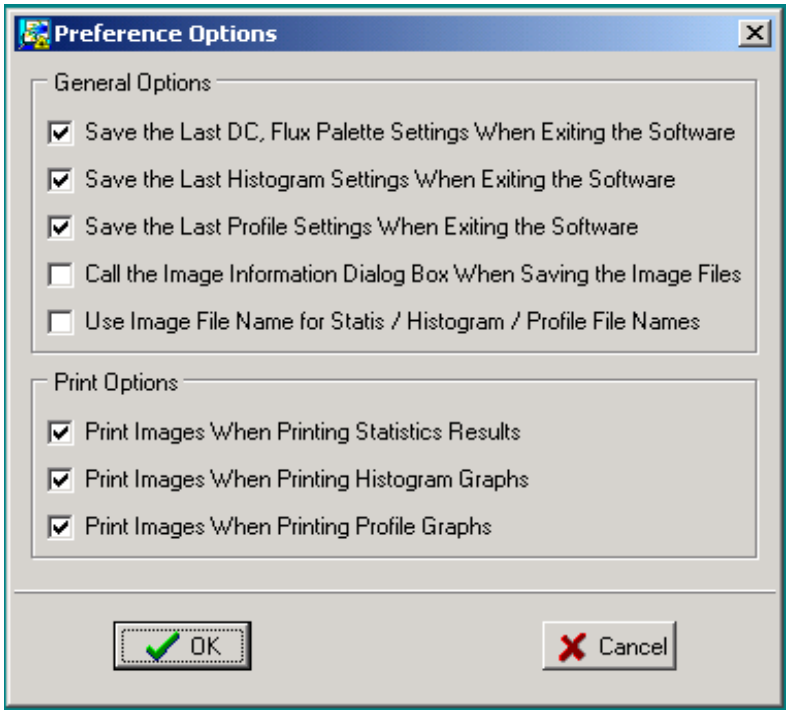
To enlarge a rectangular region of an image it is first necessary to define the rectangular region of interest. Zoom the ROI by clicking on the magnifying glass icon with the '+' sign. The zoomed image is opened in a fresh Window automatically.



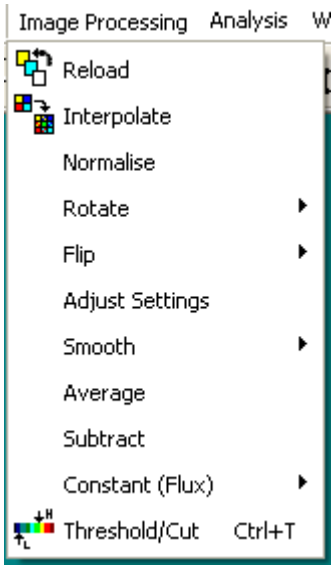

The zoomed part of an image can be saved as a separate image

## 10.5 PREFERENCE OPTIONS (For Image Review)

(Note that there is also a different Preference Option menu available in the moorLDI V5 measurement program.)
These image review options are for automatically saving (or not saving) pallette, histogram and profile settings, and saving,(or not saving), print selections. The print selections determine whether or not images are included in the printed reports.



# 11. IMAGE PROCESSING




## 11.1 RELOAD

This function is to re-load the original file ie the unprocessed image.

## 11.2 INTERPOLATE

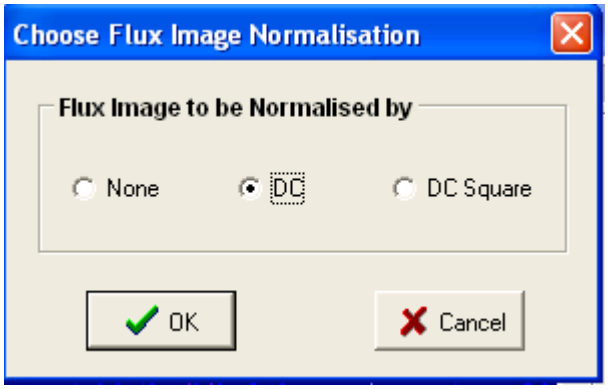
Low resolution or small images can be enhanced to increase the apparent resolution by interposing mean values between adjacent pixels. Interpolation can only be carried out when both X and Y resolutions are less than 128. The maximum number of pixels after interpolation is 256 x 256.

Interpolate by clicking on the  icon or select: **Image processing**
**Interpolate**

This applies to both photo and flux images.

## 11.3 NORMALISE

The standard moorLDI normalisation for the flux algorithm is division by DC ie by a quantity proportional to the detected laser light intensity. Users can change the normalisation to DC $^2$ or to no normalisation of the calculated Flux.



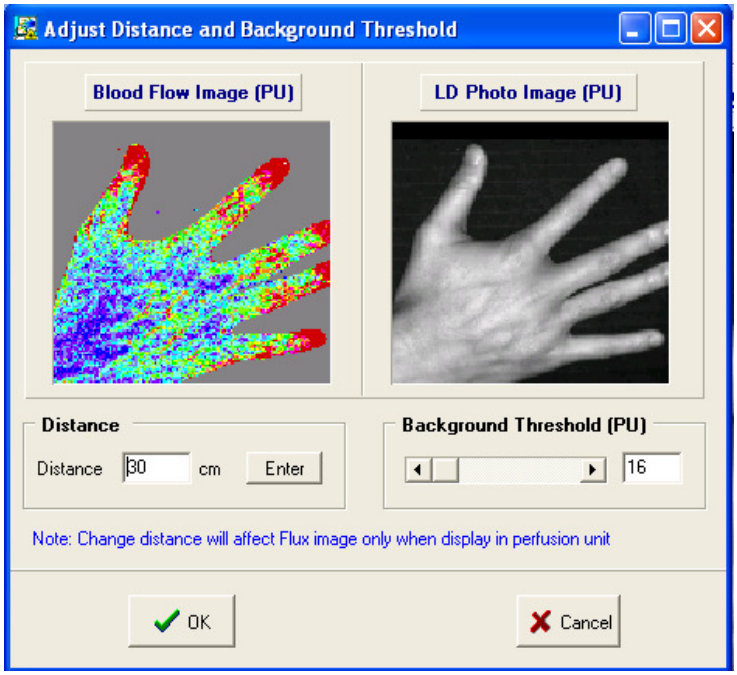
## 11.4 ROTATE or FLIP

The image can be rotated left (anti clockwise) or right (clockwise) by $90^{o}$ each time the operation is applied.

Images can also be flipped horizontally or vertically to give a mirror image of its former state.

Select Rotate or Flip using: **Image processing**
**Rotate/Flip** and choose operation required

## 11.5 ADJUST SETTINGS




### 11.5.1 DISTANCE

The measurement distance can be reset in the Adjust Settings window. This should be used only when the information was incorrectly set during measurement as flux results will be affected.

### 11.5.2 BACKGROUND THRESHOLD

When DC pixel values are below the threshold the respective flux at these pixels are set to zero and displayed in grey. The flux pixels displayed in grey are not used in flux image analyses even if they are part of the tissue (eg skin) area scanned. Resetting the background threshold to a higher value can be used to remove edge effects from an image eg the edge of a finger where the DC will be much lower than from the bulk of the finger.
Resetting the background to a lower value can display more of a flux image

## 11.6 SMOOTH

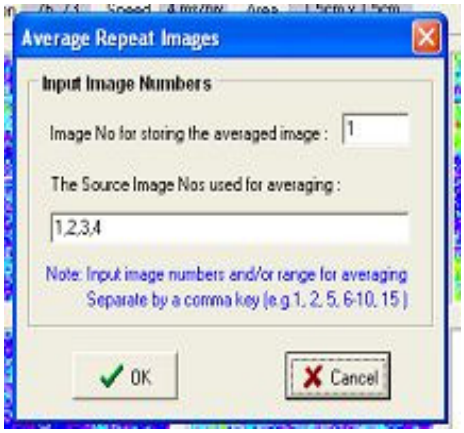
Some features of flux and photo images can be easier to see if the images are smoothed one or more times. Smoothing is an averaging operation using the pixel value and the values of the pixels nearest neighbours. Smoothing is performed by clicking on the  icon or by selecting:

**Image processing**
**Smooth**

If using the latter route, another option becomes available – smoothing the LD Photo image.

## 11.7 AVERAGE

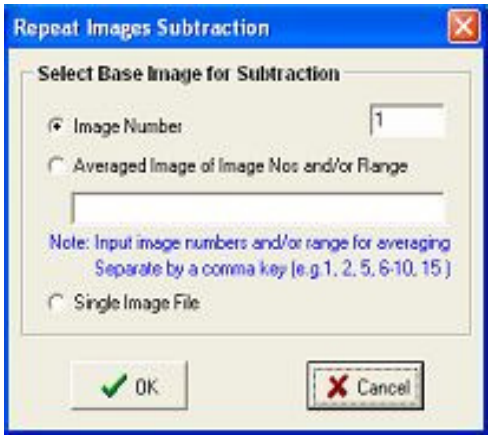
This function only applies to a repeat scan image. A number of images in the repeat sequence can be averaged and the resulting image can be stored in a user-chosen image position (i.e. an image number in the sequence).



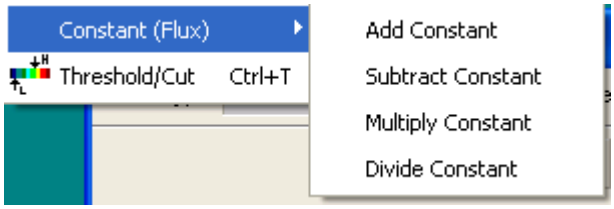

## 11.8 SUBTRACT

In the case of a single image, the image subtraction is between the current image and a user-selected image from a file.

In the case of a repeat image, the image subtraction is between the current image and a base image. The base image can be one of the three formats as shown in the following picture. ie either an image of the repeat scan images selected by number, or the averaged image of selected images or an image previously recorded as a single image. The subtraction applies to all images in the repeat sequence



## 11.9 CONSTANT (+,-,x,/)




### 11.9.1 ADD CONSTANT

Add a constant to the flux image.

### 11.9.2 SUBTRACT CONSTANT

Subtract a constant from the flux image.

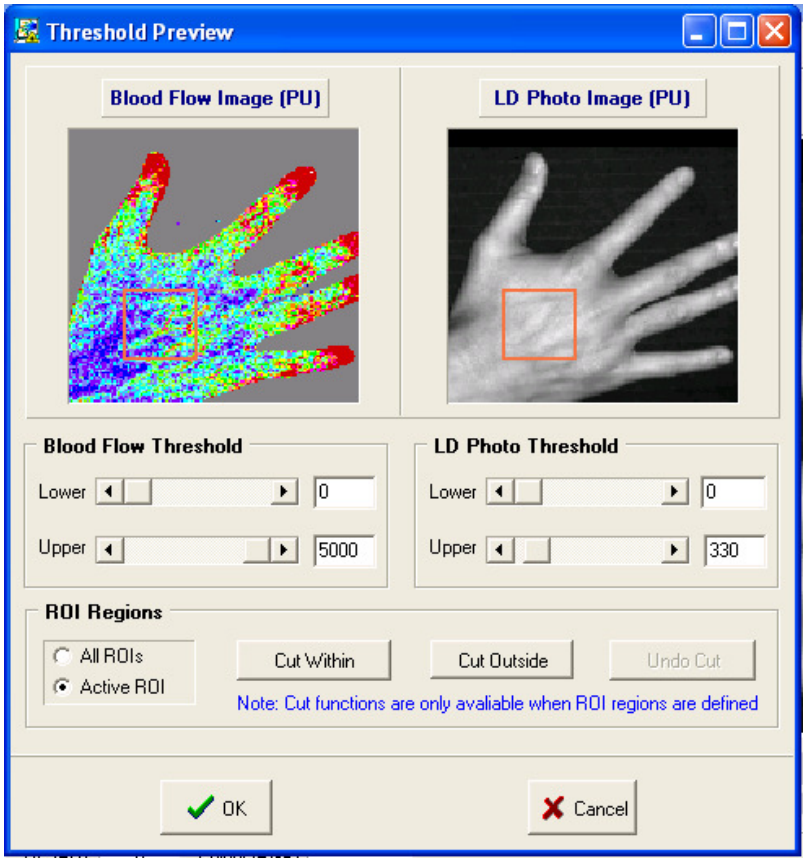
### 11.9.3 MULTIPLY CONSTANT

Enables rescaling of an image. An example of its use might be to set baseline images to similar values so that subsequent responses can be compared.
The validity of this manipulation should be carefully considered in each situation before it is applied.

### 11.9.4 DIVIDE CONSTANT

Divide the flux image by a constant.

## 11.10 THRESHOLD/ CUT

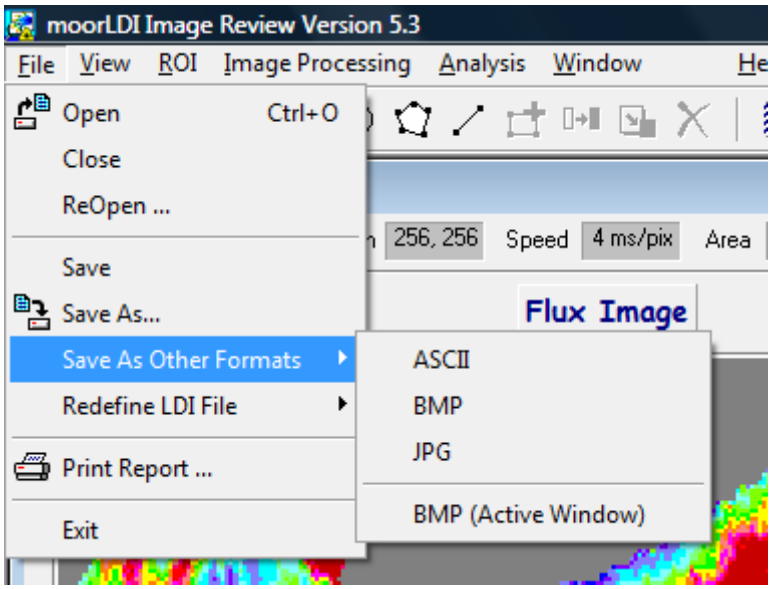



The **Threshold** function is used to discount pixels either above or below user set flux or DC values. Threshold can be applied to both Blood Flow images and LD Photo images. This can be used to assess the extent of flare removing pixels that are saturated on either flux or photo images and displaying them as background grey.

The **Cut** functions are used to remove pixels within or outside a region of interest. Cut can be performed on either the current active ROI only, or all ROI's.

# 12 FILE

## 12.1 SAVED IMAGE FILE FORMATS




After original files have been processed you might wish to save the file in its processed form (i.e. smoothed, interpolated, palette change etc).

**Save As**
This operation willsave the active image in a moorLDI format. These images can only be displayed using the moorLDI software.

**Save As Other Format**
There are 3 storage formats that can be chosen, singly or simultaneously, following a **Save As Other Formats** instruction:

| | |
|---|---|
| ASCII | - numerical output, readable by spreadsheet packages |
| BMP | - individual images in Windows™ bit-mapped format for some word processor and graphics software packages |
| JPEG | - format used by some external image processing packages |

For compiling reports, the JPEG file format is likely to be most useful. However, use of PrtSc (print screen key) and Edit, Paste within a graphics package (e.g. Windows Paint™) will provide a complete view of the moorLDI screen display, suitable for further editing.

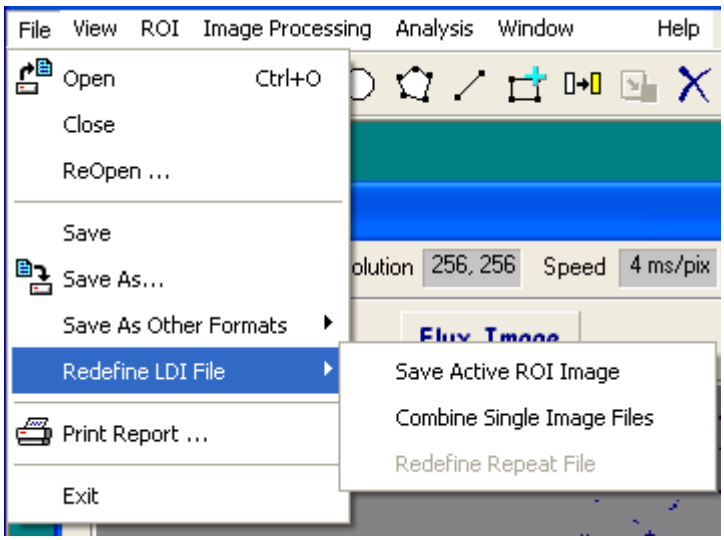
BMP (Active Window) saves the flux and photo/video display window.

## 12.2 REDEFINE LDI FILE

Save Active ROI image: if there are rectangle ROIs defined, images within the active rectangle ROI will be saved into a new file.

Combine Single Image Files: combine single image files into one repeat image file. The single images must have the same LDI type, Scan Size, Scan Range and Resolutions. Follow the steps below to choose files to be combined:

1) Locate the image data directory in the left column.
2) Select files to be combined in the middle coloum, then click on the Add to button to add the files to the list (third column).
3) Click on the Save Repeat File button to combine and save the repeat file.




Note, it will be assumed that all single images have the same scalers, gains, distance, background, normalisation, wavelength etc.

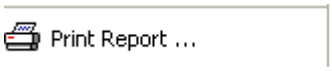
All parameters extracted from the first file in the selected list will be used for the new repeat file. A table will be given to display single image file names that have different parameters (e.g. distance, wavelength, DC/Flux scalers and distance scalers).

Redefine Repeat File: this function can be used to redefine (e.g. delete one or some of the images, redefine the sequence.) repeat image. You can input image number or range using the following two formats:

Separate by commas e.g. 1, 4, 7, or select a range e.g. 3-7. You can use a combination of the two formats.

If only one image number is selected, the image will be saved as a single image file.

## 12.3 PRINT REPORT




A report printing function is avaliable:

If you select: **File** **Print Report** or click the icon 

Images will be printed together with information relating to the patient , operator , file name, scan setup conditions and comments.
A sample printout is in **Appendix 3**

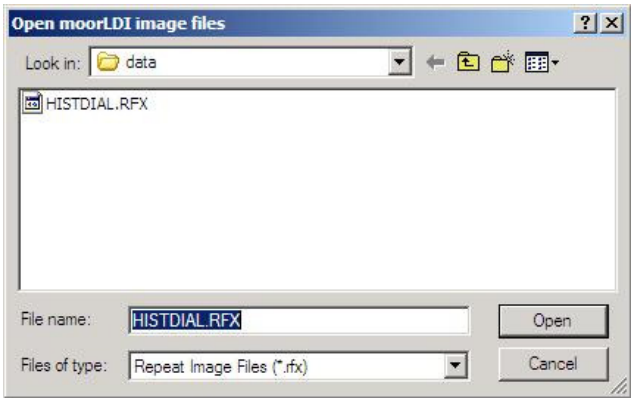
# 13 REPEAT SCAN PROCESSING

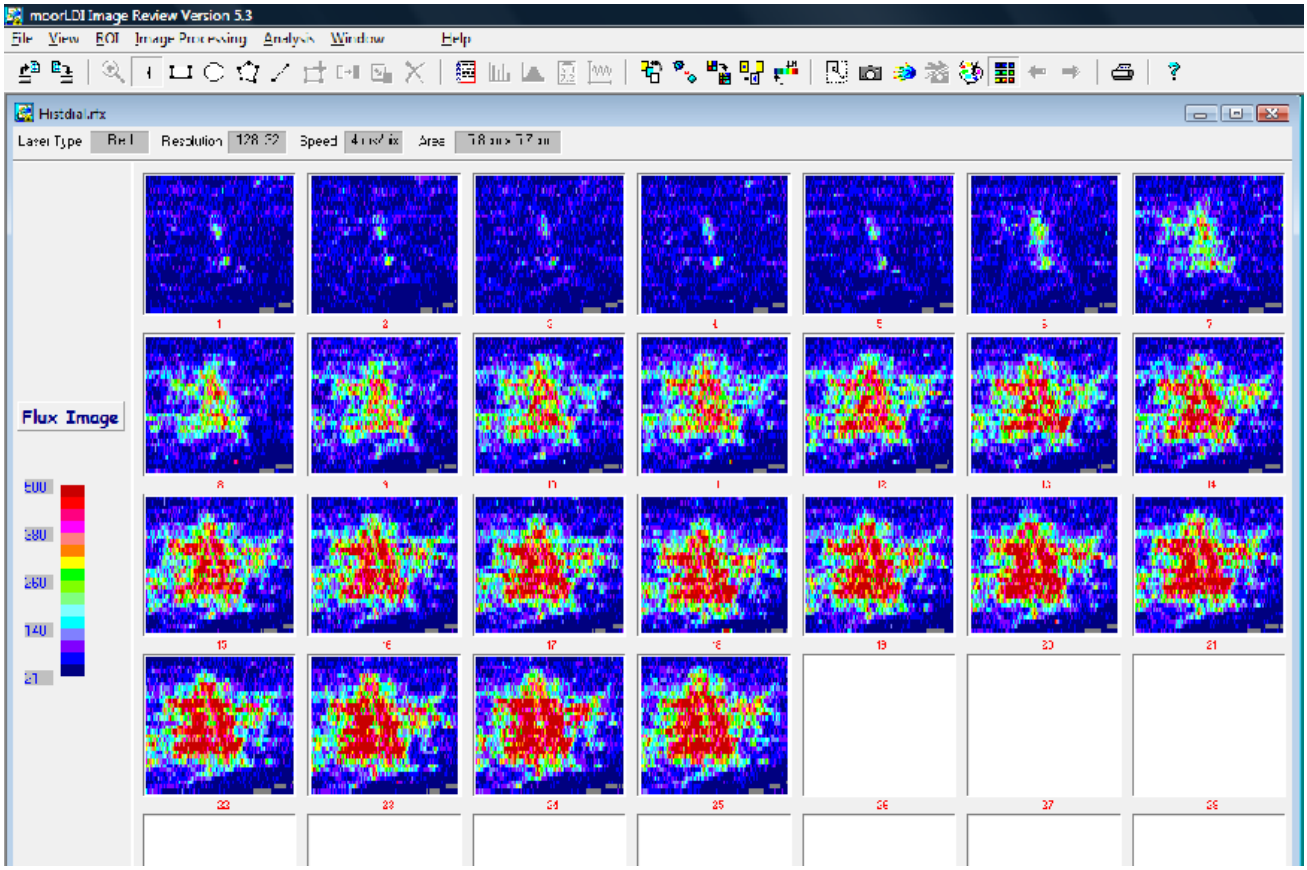
## 13.1 INTRODUCTION

All the utilities for processing and analysing single images can also be used on repeat scan images. A powerful function of the repeat scan utility is the simultaneous processing of all images.

## 13.2 REPEAT SCAN DISPLAY

To open a repeat scan set click on the **File types** box and select Repeat Image Files *.rfx. When the required file has been selected, click **open** for display.



## 13.3 SEPARATE IMAGE DISPLAY

In addition to all the display and image processing options for single images (described in Section 10) the repeat images can also be displayed individually: by clicking on the 9-square icon (or by double clicking on the image to be displayed) . Return to multi-image display by toggling this icon again.

Each repeat image can be viewed by clicking on the right arrow icon to move forward or the left arrow icon to move back through the repeat image set.

Click the 9-square icon to toggle between multi-image and single image display.

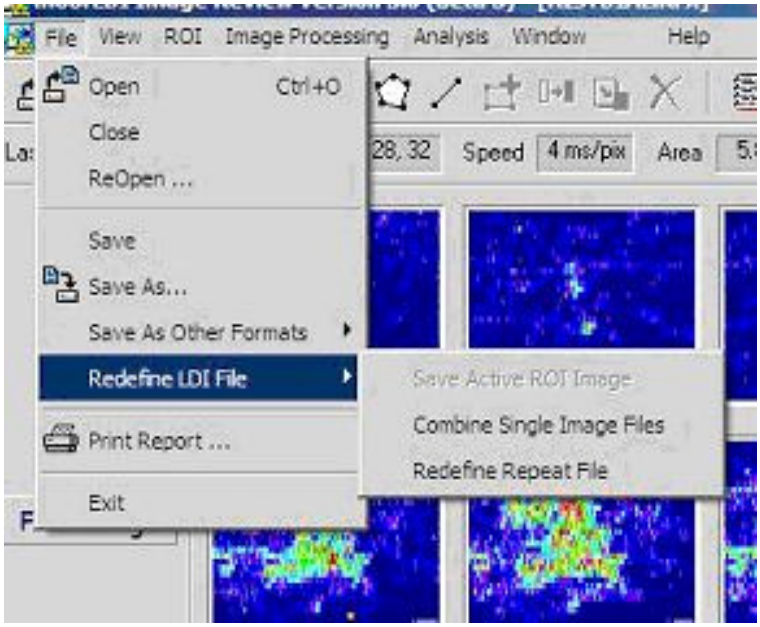
Click the right arrow icon to move forwards through single images.

Click the left arrow icon to move backwards through single images.

N.B. with faster computers clicking through the individual images in rapid succession can give a good 'slow motion' visual impression of responses evolving.

## 13.4 RE-DEFINE REPEAT FILE

To use this function choose **File** menu then **Redefine LDI File.**




Two options are available – either combining a string of single images of the same resolution into one single repeat file or the redefinition of the repeat file to only include a selection of the repeat images.

# 14. REGION OF INTEREST

## 14.1 INTRODUCTION

The simplest form of image analysis is to obtain the flux and dc values at an image position. These are shown at the bottom of the screen when the cursor is placed at any position on either the flux or the photo image.

Other forms of analysis require a region of interest or a profile line to be defined first. The following analyses can then be performed: histogram
profile
statistics

## 14.2 REGION OF INTEREST (ROI): ROI TOOLBAR

A region of interest (ROI) is defined by either a rectangle, circle or user defined polygon on the flux and photo images.

1 2 3 4 5 6 7 8 9

1. Cursor Analysis: Use to obtain spot values – displayed in the boxes below image
2. Rectangular ROI: Use to specify a Rectangular ROI
3. Circular ROI: Use to specify a Circular or elliptical ROI
4. Polygon ROI: Use to define a polygon around the ROI (tip: right click mouse to close ROI)
5. Profile tool: Use to define a line for profiling
6 Add ROI: Use to add either rectangular, circular, polygon or line ROI';s. Up to 5 ROI's of any one type can be defined per image
7 Copy ROI: Copies the active ROI
8. Paste ROI: Pastes a copy of the active ROI
9: Delete ROI: Deletes the active ROI

Note that to activate a ROI, it is necessary to press the *Insert* key after clicking on the chosen ROI Icon.

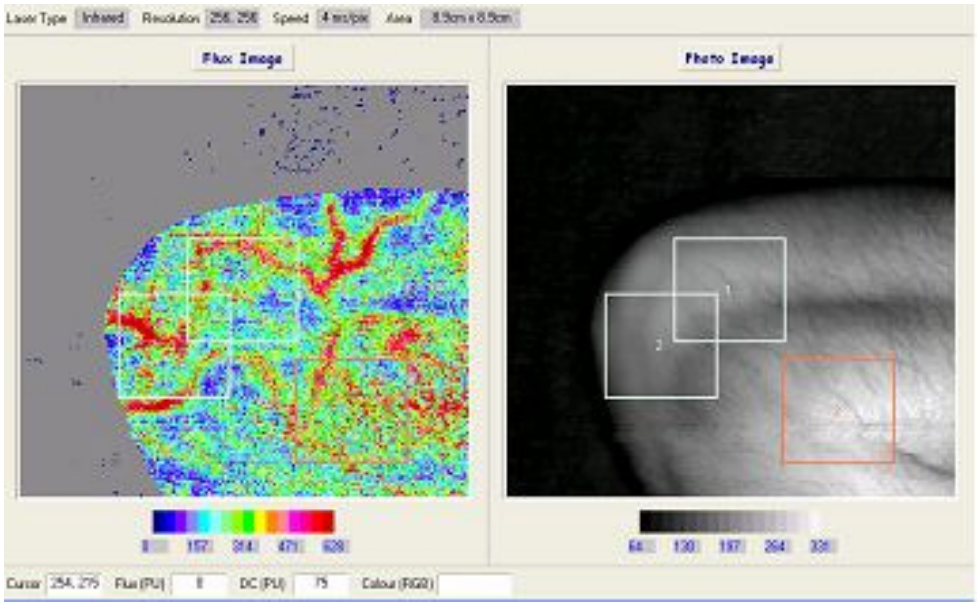
ROI size can be changed by dragging a corner of a rectangle ROI (or cicle ROI limit line) or by dragging the points or lines of a polygon ROI.

Move an ROI by dragging its centre.

When the *Insert* key is pressed for subsequent rectangular or circular ROIs, the next ROI is created over the current ROI with the same size and position; drag to the required position and re-size.

## 14.3 DEFINING ROI's - GENERAL

Click on either a rectangular, circular, polygon or line followed by the Add ROI button 
or the **Insert key**, and the choosen ROI will appear on the Flux and Photo images, if in single image mode, or on all the Flux images if repeat scans are being displayed.
Note that the ROI can be defined with reference to photo images of a repeat scan set if the camera icon is clicked.
ROI's can be dragged around the image by clicking on the centre of the box.
The size of ROI is adjusted by dragging the box corners.




The image above shows 3 ROIs (Regions Of Interest). Each region requires the Add ROI button to be clicked or the Insert key to be pressed. Note too that when ROI 2 is inserted it is superimposed (overlaps) the ROI 1. ROI 2 will be the active ROI and it can be dragged and resized. To make ROI 1 the active ROI left click with the screen pointer within the ROI.

## 14.4 ZOOM IN

This applies only to rectangular ROIs. To look at the ROI region in detail first define a rectangular ROI and zoom with the + magnifying glass icon  . The zoomed ROI will now fill the new image window. This can be treated as a 'new' image allowing all the image processing operations to be done. It is now possible to mark a ROI in the zoomed image and perform the statistics on this ROI.

## 14.5 POLYGON ROI

Click on the polygon icon  . The polygon now has to be defined by the 'elastic band' technique: move the cursor to the first position on the edge of the ROI then click. As the cursor is moved a line radiates from the first point to the cursor position. When the cursor is placed at the next position on the ROI boundary click again. Follow this procedure until the ROI is outlined, positioning the cursor on or near the first point to complete the polygon or right click to complete the polygon. The maximum number of points on the polygon is 40.

The polygon can be dragged around the image by clicking on the centre of the polygon.

When the ROI is complete the statistics or a Histogram can be constructed for the flux values within.

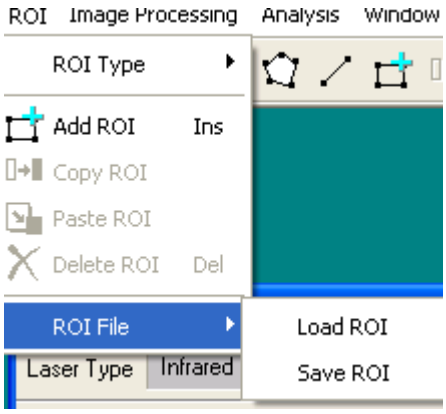
## 14.6 CIRCULAR ROI

Click on the Circle ROI icon and press insert key to create a circular ROI.

Change the circle size by pressing the Shift key and simultaneously drag the corner or the rectangular guidelines. An ellipse is created if the corner is dragged without pressing the Shift key.

## 14.7 SAVING ROI

The ROI co-ordinates can be saved for later use on the same or another image. To do this select ROI, ROI file, **S**ave ROI; Select a directory (folder) and enter a filename in the **S**ave As window.
The ROI co-ordinates are saved in a *.ROI file. To use this ROI again select ROI, ROI file, **L**oad ROI.



# 15. IMAGE ANALYSIS

## 15.1 INTRODUCTION

To analyse a either a whole image or sections of an image or equivalent parts of each image within a repeat scan set, it is first necessary to load the image(s) onto screen:

Click the open file icon 
Select file and open

### 15.1.1 TYPES OF IMAGE ANALYSIS

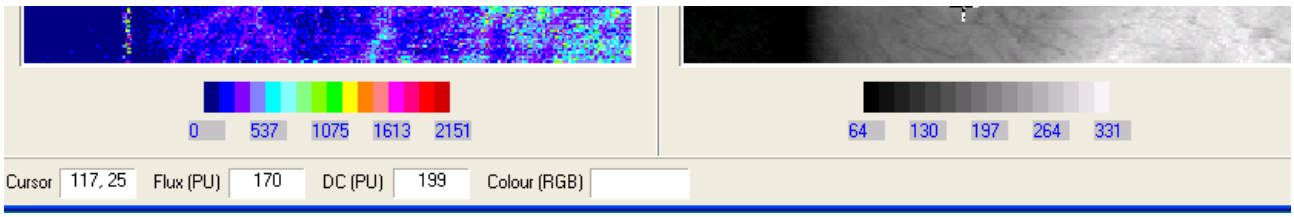
There are three types of analysis that can be performed:

Statistics 
Histogram 
Profile 

Before these can be applied it is first necessary to define a region of interest (ROI).
(For ROI refer to Section 13).
N.B. a small ROI can be defined after zooming a box ROI.

### 15.1.2 PIXEL VALUES

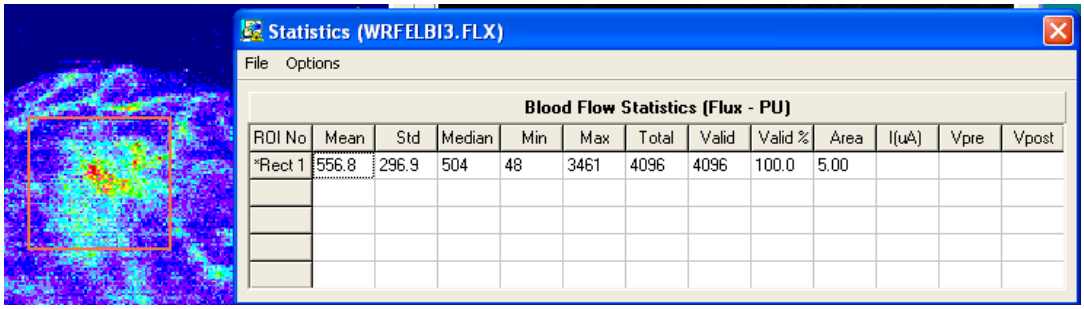
By moving the cursor over the image, the flux and dc values at the cursor position are displayed in boxes below the image window.

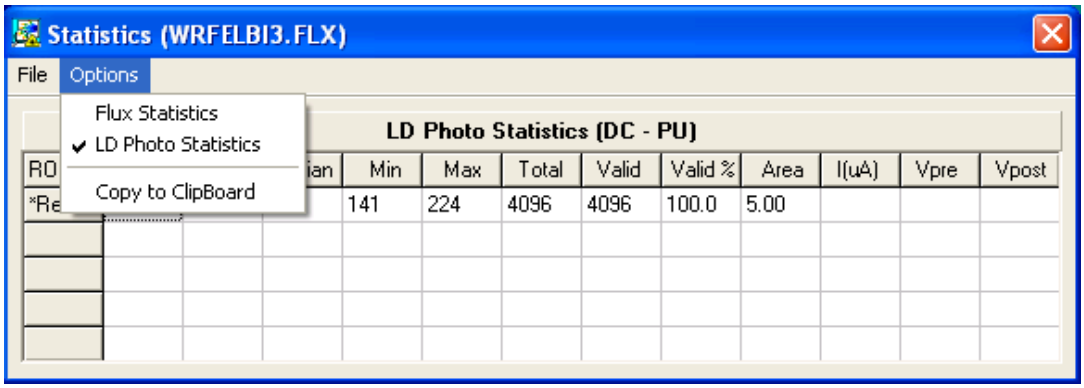


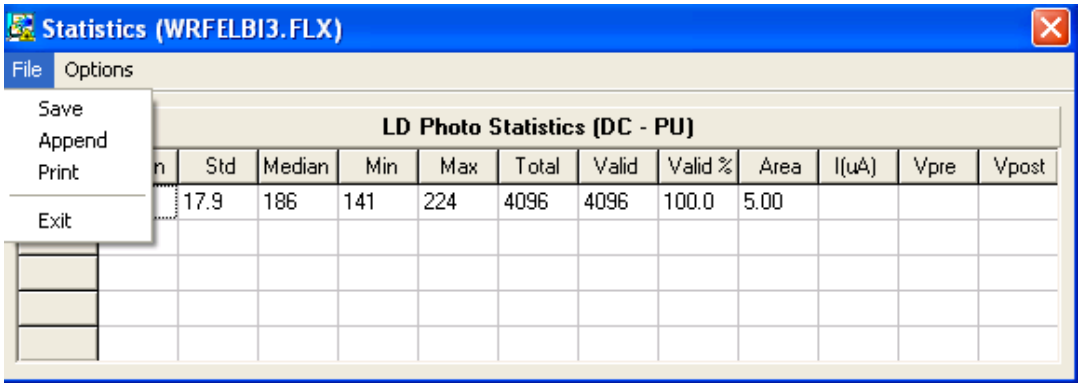

N.B. images can be displayed in RU (relative units) or PU (perfusion units). See Section 10.4 for RU, PU definitions. RU and PU display can be toggled with the RU/PU icon. In the above example values are displayed in PU units.

## 15.2 STATISTICS - SINGLE IMAGE SCAN

After defining a region of interest click on the statistic icon  .
An information window will be displayed similar to that shown below.




### 15.2.1 FILE - SAVE

The statistical information can be saved to an ASCII file (*.sta) by selecting **F**ile, **S**ave. A file directory should be selected and filename given in the **Save As** window which appears.

### 15.2.2 FILE - APPEND

Statistical information from another ROI can be appended to a previously used statistics file by selecting **F**ile, **A**ppend and confirming the file in the Save As window.

15.2.3 FILE - PRINT

Select **F**ile, **P**rint to print out the statistics window.

15.2.4 FILE – EXIT

Select **E**xit to remove the statistics window.

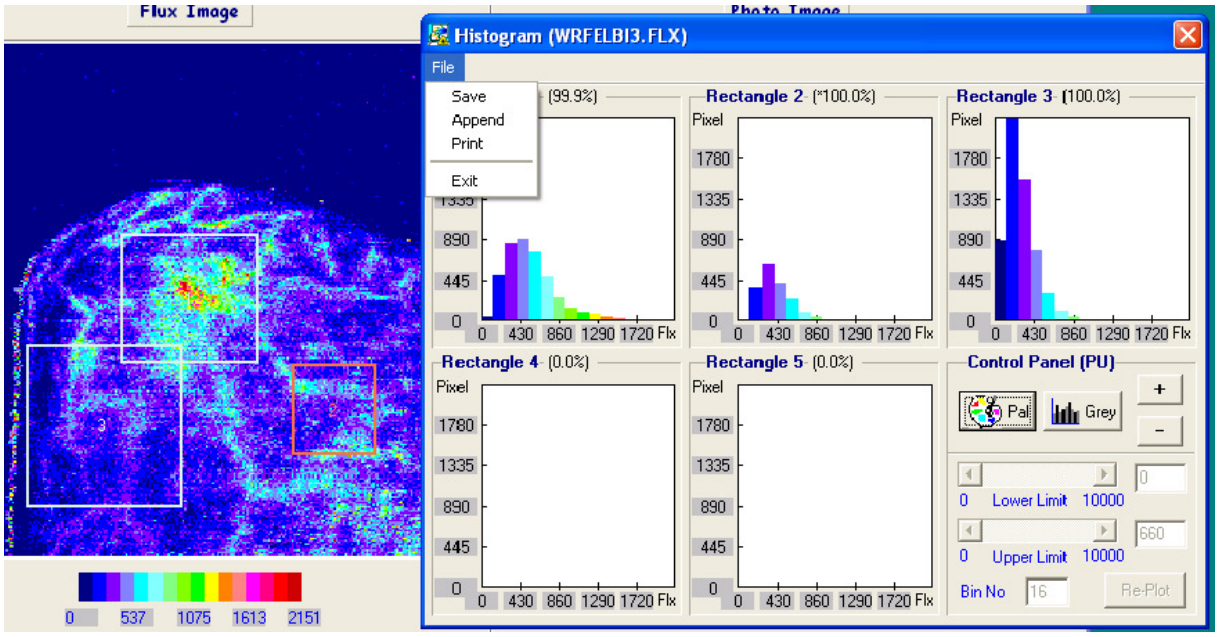
Users of Windows™ 95 can click on the X at the top right hand corner of the window to close.

15.2.5 OPTIONS

| | |
|---|---|
| Option: Flux Statistics | Display Flux statistics results. |
| Option: LD Photo Statistics | Display LD Photo statistics results. |
| Option: Copy to Clipboard | Copy the current statistics table to clipboard, so that it can be pasted to other program (e.g. MS Excel) |

## 15.3 HISTOGRAM

The **Histogram** analysis can only be selected after an ROI (Section 13) has been defined.
Select the histogram icon  and a window similar to that shown in section 13.5.4 is displayed.

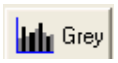



Two histogram display modes are available:

Palette mode 

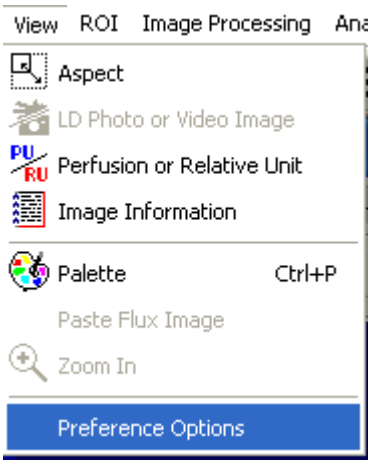
:

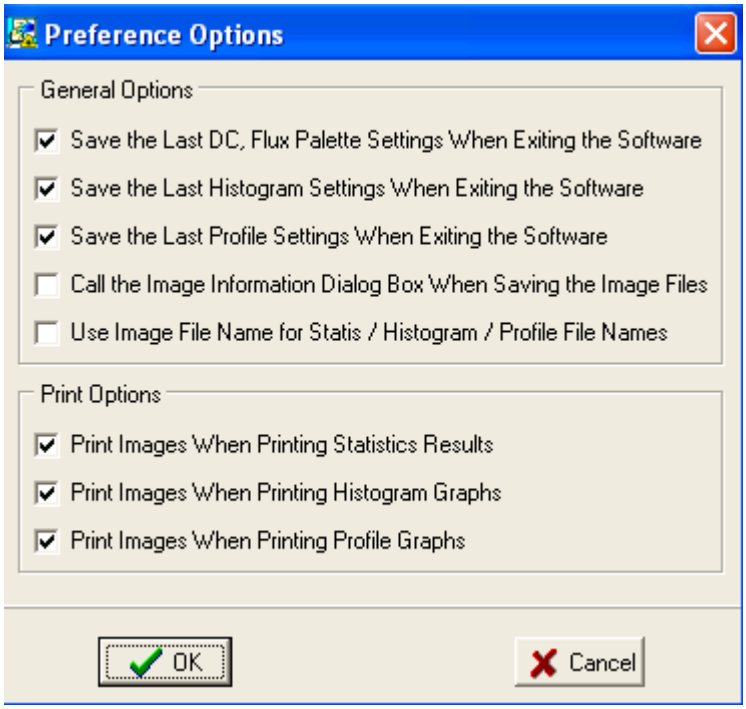
when this option is selected, a fixed Bin Number of 16 will be used, also the palette limits of the current image window will be used as the lower limit and upper limit in the histogram calculation. These three parameters are not editable in the Histogram window. The histogram bar colour will correspond to image colour (ie either the 6 or 16 colour pallette).

Black and Grey mode 

:
when this option is selected, bin number and lower/upper limits are editable by changing the upper and lower limits of thje histogram.
Alternative black and grey colours are used to plot the histogram bars.

A **File** menu is accessible at the top of the Histogram window. The histogram results can be saved/appended into a text file. The results can be printed with or without small LDI images (this option is set in the Preference setup – click **View** then select **Preference Options**)




### 15.3.1 HISTOGRAM LIMITS

The limits can be changed by dragging the slides at the bottom of the window or by changing the numbers in the adjacent boxes. If the latter option is used then it is important to **change the upper limit first**.

Changing the lower limit will make the first bin start at the new lower limit. The graph will remain with the origin at (0, 0).

The amplitude of the histogram (y-axis scale) can be increased using the + box or decreased using the – box to the left of the histogram.

### 15.3.2 BIN NUMBER

The number of bins, ie the number of histogram sections, is either 16 or 6 if a colour palette is used. If the grey scale is selected the bin numbers can be set by entering a number in the Bin No. Box. After Limits or Bin number have been changed click on Plot to replot the histogram.

N.B. the flux axis (x-axis) always has 5 equal graduations marked on it and alternate graduations annotated. For these to be easy to read and use requires a sensible choice of Upper Limit and Box No. eg multiples of 10.

### 15.3.3 OTHER FEATURES

**File**
**Save**
**Append**
**Print**
**Exit**

The operation of the above features is described in the **statistics** section (Section 14.2).

### 15.3.4 SAVE HISTOGRAM RESULTS

The information **S**aved from a Histogram analysis is stored on a *.HIS ASCII file and contains information as shown below. This file can be reviewed using a Windows™ utility (e.g. Notepad) but not using MLDI software. Note that the example is for an image recorded with a 16 colour pallette giving a 16 Bin histogram.

**moorLDI Image Histogram (WRFELBI3.FLX)**
**==========**
**ROI Type: Rectangle**

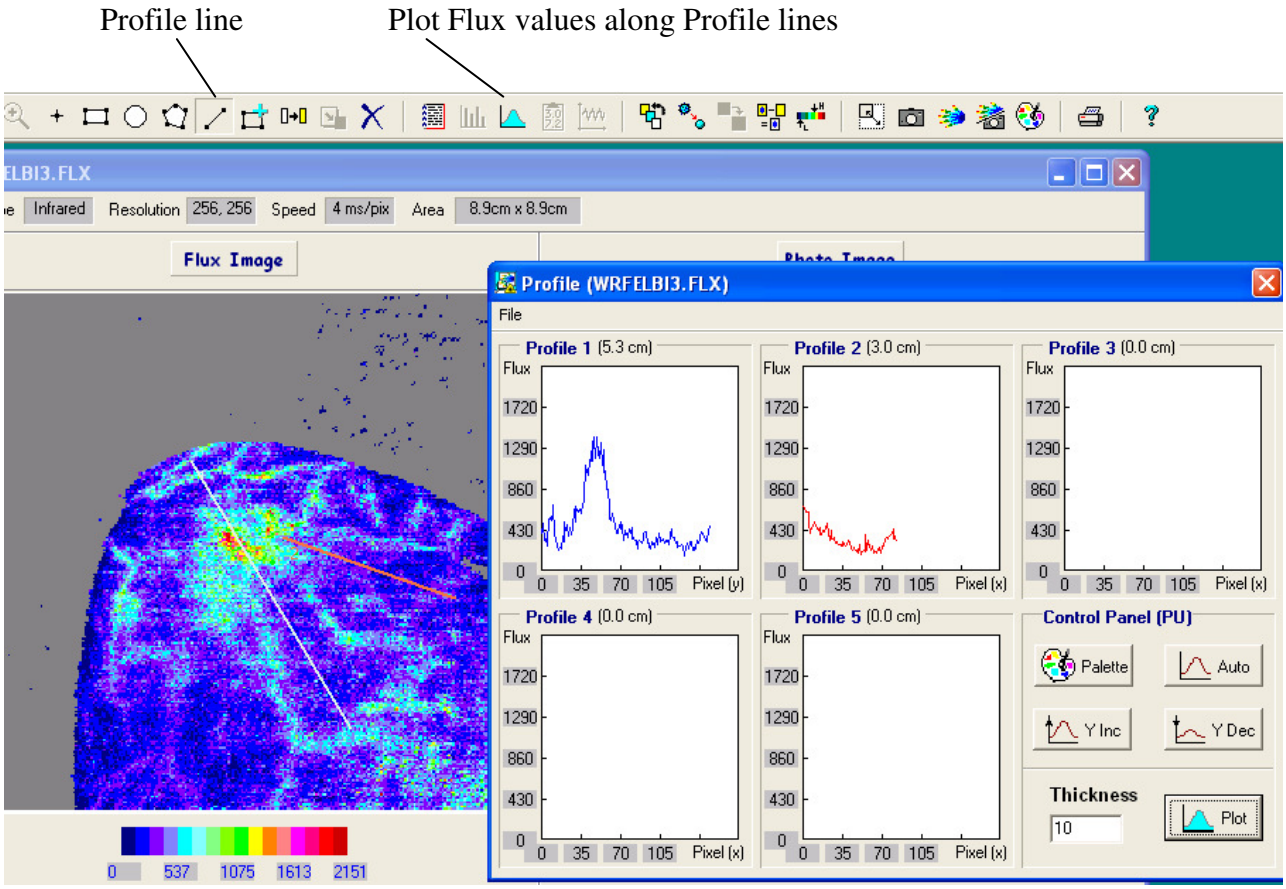
**Lower limit = 0 Upper Limit = 2151 Total Bin No = 16**
**ROI No Valid Rate (%)**
**1 99.9**

**Flux Histogram (Perfusion Unit):**
**ROI1 35 496 836 876 745 478 248 137 84 72 32 24 12**
**8 9 0**

## 15.4 PROFILE

### 15.4.1 INSERTING PROFILE LINES

The Profile analysis can only be selected after a line has been defined across an image. To achieve an averaging affect a wide line (in the example below it is 10 pixels wide) can be defined from the profile window.




To define a line on the image click on the line icon followed by the insert icon (or the Insert key on the keyboard) and then move the cursor and click at the start position. Move to the end position and click again. This can be repeated upto 4 more times to give 5 different lines An example of a profile analysis for 2 lines is shown above.

### 15.4.2 PROFILE DISPLAY

Click on the profile icon to create a profile window of flux against pixel number as shown above. The direction of the profile is the direction in which the profile line was defined and the line co-ordinates are displayed in the lower left corner of the Profile window.

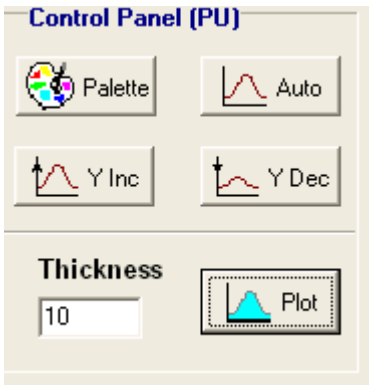
### 15.4.3 THICKNESS OF PROFILE LINE

Enter the thickness (usually between 2 to 10 ) and click the Plot box to see the new profile graphs.

The default thickness of the profile line is one pixel. This often results in a noisy-looking profile and the appearance can be improved by increasing the thickness of the line to include pixels adjacent to the line. This operation is exact when the profile line is vertical or horizontal. The value assigned to the profile plot is the mean of the pixels perpendicular to the profile line. If the line is at an angle then the thickness extends either horizontally or vertically depending on whether the line is greater or less than an angle of $45^{o}$ (pixelunit displacement).
Another way of smoothing the profile plot is to smooth the original image before plotting the profile.

### 15.4.4 PROFILE AMPLITUDE

The profile amplitude on the y-axis can be increased or decreased clicking the Y Inc or Y Dec boxes in the Control Panel. Auto will automaticall scale the plots and the Palette option will produce plot scale directly related to the palette scales.




### 15.4.5 PROFILE FILE SAVE, APPEND AND PRINT

**F**ile
**S**ave
**A**ppend
**P**rint
**E**xit

Information **S**aved from Profile analysis is stored in a *.PRO ASCII file and contain information as shown below. Note that if the line makes an angle equal to or less than $45^{0}$ to the X axis of the image the X values are displayed in the Profile Plots. If the angle is greater than $45^{0}$ then thr Y values of the pixel positions on the Profile line are plotted.

moorLDI Image Profile (WRFELBI3.FLX)

==========

| Line No | Thickness | Average-Dir | Length(cm) |
|---|---|---|---|
| 1 | 10 | Y | 5.3 |
| 2 | 10 | X | 3.0 |
| 3 | 10 | Y | 4.2 |

Flux Profile (Perfusion Unit):

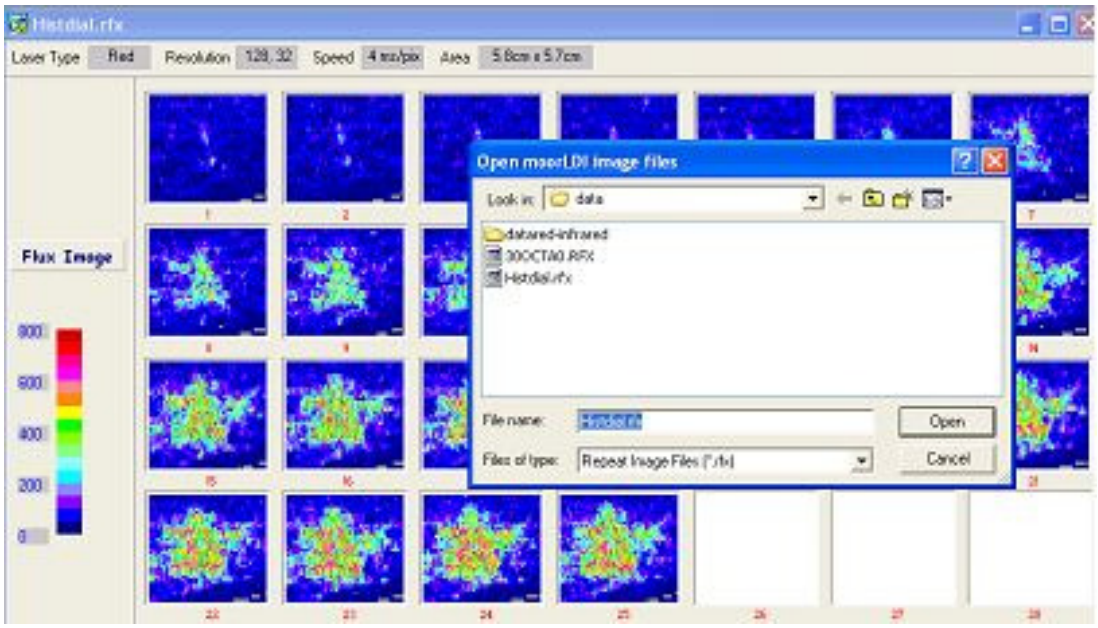
| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Line1 | 391 | 391 | 494 | 312 | 335 | 256 | 286 | 526 | 556 | 526 | 635 | 693 | 389 |
| | 339 | 271 | 220 | 228 | 241 | 223 | 367 | 307 | 513 | 421 | 483 | 370 | 459 |
| | 459 | 376 | 445 | 646 | 515 | 668 | 631 | 623 | 644 | 602 | 631 | 667 | 762 |
| | 1107 | 1035 | 1057 | 1006 | 1165 | 1156 | 1354 | 1144 | 1396 | 1186 | 1401 | 1221 | |
| | 1221 | 1181 | 1338 | 1112 | 1267 | 1032 | 1041 | 853 | 853 | 682 | 557 | 527 | 599 |
| | 536 | 470 | 469 | 400 | 400 | 480 | 440 | 510 | 460 | 315 | 416 | 391 | 391 |
| | 349 | 435 | 398 | 450 | 338 | 356 | 312 | 312 | 234 | 311 | 312 | 299 | 296 |
| | 325 | 377 | 401 | 401 | 288 | 287 | 255 | 228 | 298 | 293 | 251 | 251 | 351 |
| | 271 | 392 | 308 | 347 | 326 | 333 | 293 | 300 | 312 | 324 | 280 | 385 | 437 |
| | 357 | 352 | 353 | 292 | 305 | 247 | 262 | 262 | 268 | 254 | 254 | 156 | 250 |
| | 282 | 265 | 227 | 298 | 298 | 211 | 217 | 243 | 235 | 326 | 292 | 340 | 361 |
| | 403 | 395 | 363 | 337 | 313 | 308 | 429 | 470 | 487 | | | | |
| Line2 | 672 | 672 | 656 | 611 | 612 | 619 | 492 | 396 | 455 | 461 | 510 | 492 | 479 |
| | 443 | 428 | 458 | 379 | 383 | 421 | 415 | 433 | 436 | 503 | 400 | 315 | 421 |
| | 335 | 329 | 348 | 287 | 307 | 305 | 273 | 271 | 255 | 305 | 259 | 294 | 253 |
| | 274 | 300 | 314 | 304 | 236 | 222 | 236 | 245 | 222 | 222 | 180 | 276 | 264 |
| | 173 | 196 | 213 | 205 | 381 | 222 | 322 | 254 | 219 | 216 | 264 | 190 | 205 |
| | 187 | 189 | 216 | 249 | 183 | 251 | 257 | 259 | 313 | 348 | 355 | 333 | 362 |
| | 380 | 400 | 434 | 340 | 368 | 304 | | | | | | | |
| Line3 | 325 | 325 | 363 | 430 | 440 | 348 | 624 | 554 | 514 | 559 | 414 | 414 | 422 |
| | 406 | 352 | 295 | 319 | 491 | 373 | 408 | 395 | 410 | 331 | 370 | 329 | 307 |
| | 367 | 325 | 389 | 464 | 391 | 391 | 496 | 403 | 323 | 311 | 368 | 325 | 346 |
| | 455 | 420 | 420 | 509 | 475 | 482 | 653 | 561 | 456 | 507 | 509 | 387 | 399 |
| | 399 | 366 | 383 | 314 | 328 | 403 | 304 | 337 | 256 | 256 | 282 | 317 | 341 |
| | 345 | 238 | 308 | 337 | 336 | 319 | 311 | 307 | 251 | 255 | 303 | 236 | 357 |
| | 398 | 386 | 404 | 404 | 368 | 347 | 304 | 278 | 264 | 223 | 258 | 274 | 254 |
| | 254 | 209 | 206 | 206 | 230 | 209 | 269 | 217 | 219 | 209 | 216 | 269 | 252 |
| | 287 | 239 | 225 | 263 | 274 | 229 | 269 | 269 | 285 | 280 | 195 | 240 | 171 |
| | 171 | 135 | 186 | 167 | | | | | | | | | |

# 16 REPEAT IMAGE ANALYSIS

## 16.1 INTRODUCTION

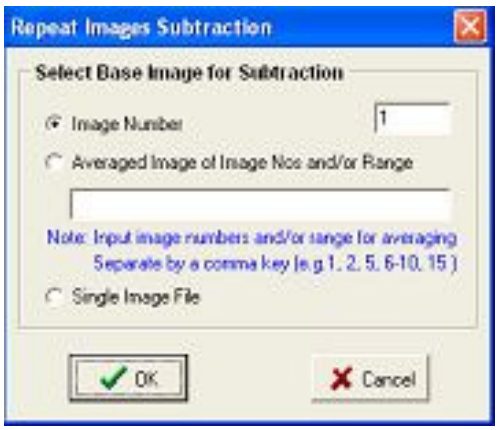
The analyses available for single image processing are also available for repeat scan images. All repeat images are processed and analysed simultaneously.

To open a repeat image file click on icon  and select from 'files of type' Repeat Image Files (*.rfx)




### 16.1.1 IMAGE SUBTRACTION

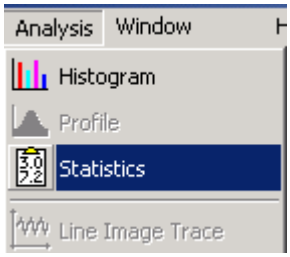
To subtract any one image from all other images select image subtraction: click on the  icon or select: **Image Processing** , **Subtract.** The following image subtraction box will appear:-

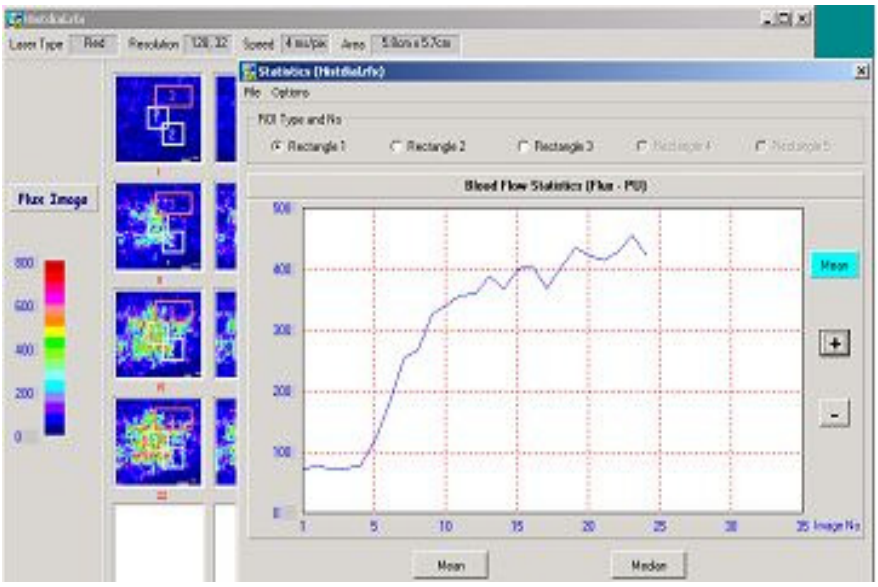


This feature can be useful for observing more clearly responses to a stimulus by subtracting a baseline image from all other images.
Enter the number of the image to be subtracted. You can also choose to average the first several repeat images then use this averaged image as the base image for subtraction or select a single image file. Note that this single image must have the same number of pixels and the same aspect as that of the repeat image.

### 16.1.2 STATISTICS – REPEAT SCAN 

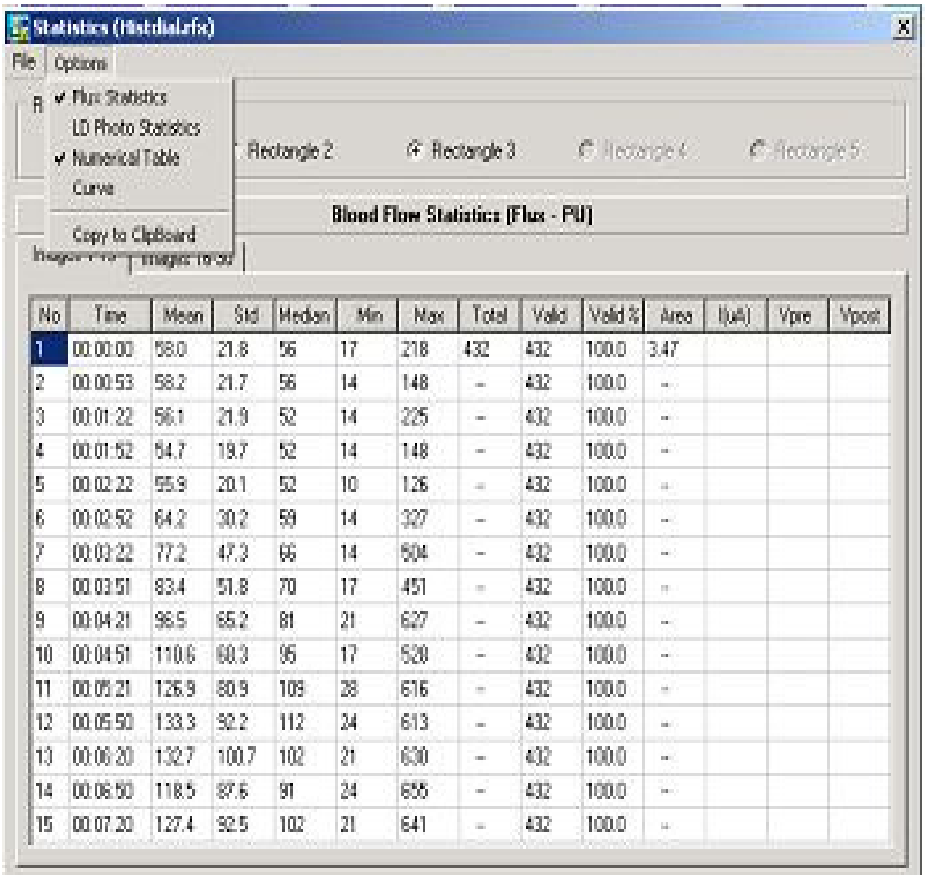
The basic statistics of flux and dc values within a region of interest (ROI) can be obtained in the same way as for single images. (Section 14)
The example below shows a repeat image with 3 ROIs defined. The Statistics window is opened by Selecting **Analysis** followed by **Statistics**




To display the statistics graphically (Curve) select: **Options Curve**
In the above example ROI 1 is selected for the graphical display of the 25 image repeat scan.

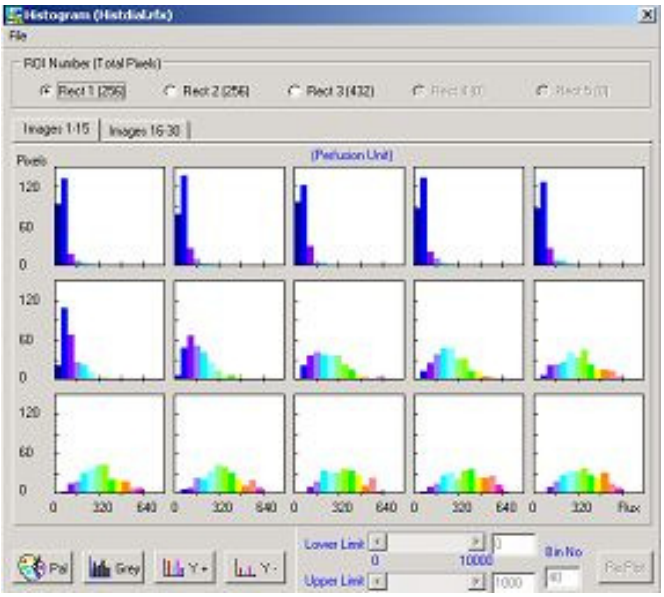
To display the statistics numerically select Numerical Table from the menu.




| No | Time | Mean | Std | Median | Min | Max | Total | Valid | Valid % | Area | I(uA) | Vpre | Vpost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 00:00:00 | 58.0 | 21.8 | 56 | 17 | 218 | 432 | 432 | 100.0 | 3.47 | | | |
| 2 | 00:00:53 | 58.2 | 21.7 | 56 | 14 | 148 | -- | 432 | 100.0 | -- | | | |
| 3 | 00:01:22 | 56.1 | 21.9 | 52 | 14 | 225 | -- | 432 | 100.0 | -- | | | |
| 4 | 00:01:52 | 54.7 | 19.7 | 52 | 14 | 148 | -- | 432 | 100.0 | -- | | | |
| 5 | 00:02:22 | 55.9 | 20.1 | 52 | 10 | 126 | -- | 432 | 100.0 | -- | | | |
| 6 | 00:02:52 | 64.2 | 30.2 | 59 | 14 | 327 | -- | 432 | 100.0 | -- | | | |
| 7 | 00:03:22 | 77.2 | 47.3 | 66 | 14 | 504 | -- | 432 | 100.0 | -- | | | |
| 8 | 00:03:51 | 83.4 | 51.8 | 70 | 17 | 451 | -- | 432 | 100.0 | -- | | | |
| 9 | 00:04:21 | 96.5 | 65.2 | 81 | 21 | 627 | -- | 432 | 100.0 | -- | | | |
| 10 | 00:04:51 | 110.6 | 80.3 | 95 | 17 | 520 | -- | 432 | 100.0 | -- | | | |
| 11 | 00:05:21 | 126.9 | 80.9 | 109 | 28 | 616 | -- | 432 | 100.0 | -- | | | |
| 12 | 00:05:50 | 133.3 | 92.2 | 112 | 24 | 613 | -- | 432 | 100.0 | -- | | | |
| 13 | 00:06:20 | 132.7 | 100.7 | 102 | 21 | 630 | -- | 432 | 100.0 | -- | | | |
| 14 | 00:06:50 | 118.5 | 87.6 | 91 | 24 | 655 | -- | 432 | 100.0 | -- | | | |
| 15 | 00:07:20 | 127.4 | 92.5 | 102 | 21 | 641 | -- | 432 | 100.0 | -- | | | |

## 16.1.3 HISTOGRAM: REPEAT SCAN

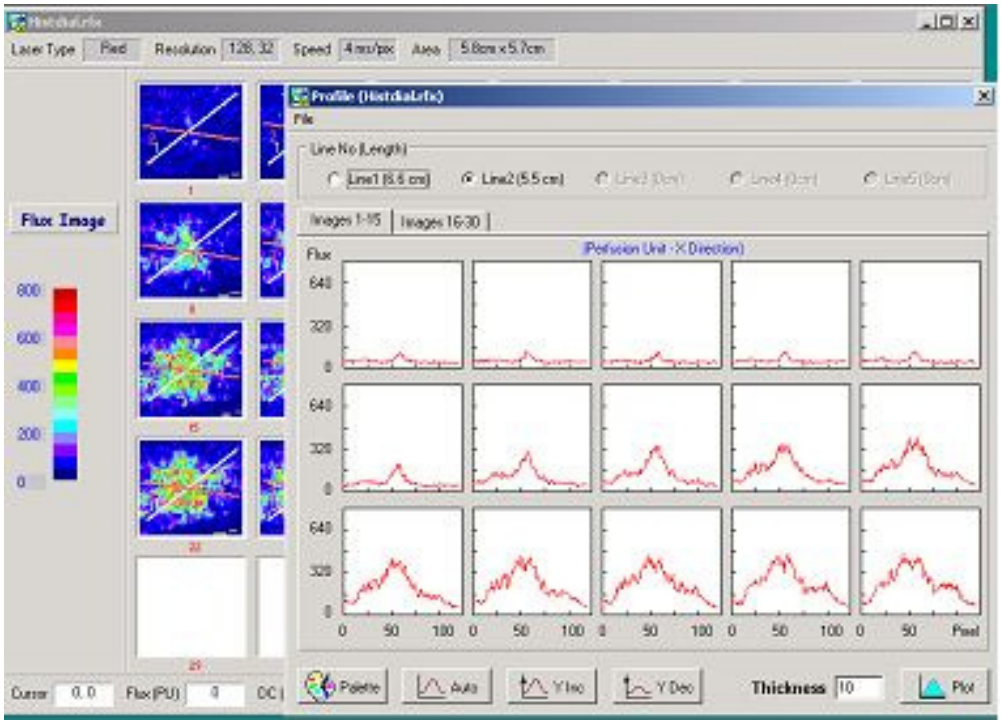
After defining Regions of Interest (ROI, see Section14) for the repeat images histograms (section 15.3) of the flux levels can be constructed.



### 16.1.4 PROFILE: REPEAT SCAN

Profile lines can be placed on the repeat images by clicking the profile icon  and the insert icon  .

Profiles are displayed by clicking the ‘open profile window’ icon  .




In the example the profiles for line 2 are plotted. The controls **Palette, Auto, Y Inc, Y Dec and Thickness** have been explained in **section 15.4.**

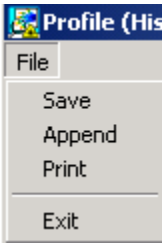
## 16.2 SAVING RESULTS OF REPEAT IMAGES

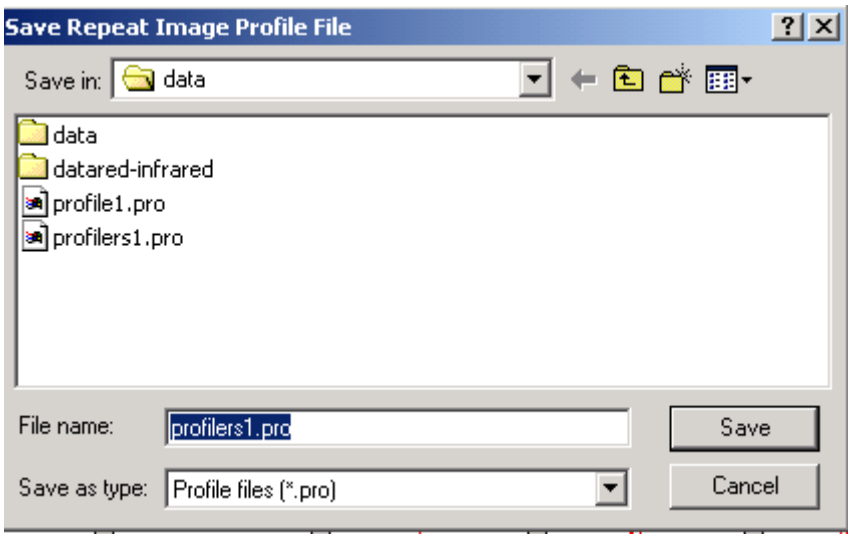
All results from repeat image analysis can be stored into ASCII format files. These can be imported into spreadsheet packages for further processing or inspected visually using Windows™ Notepad.

The following file extensions are used:

*.PRO for profile results
*.HIS for histogram results
*.STA for basic statistics

The example below is the naming and saving of profile data.




## 16.3 REPEAT LINE ANALYSIS

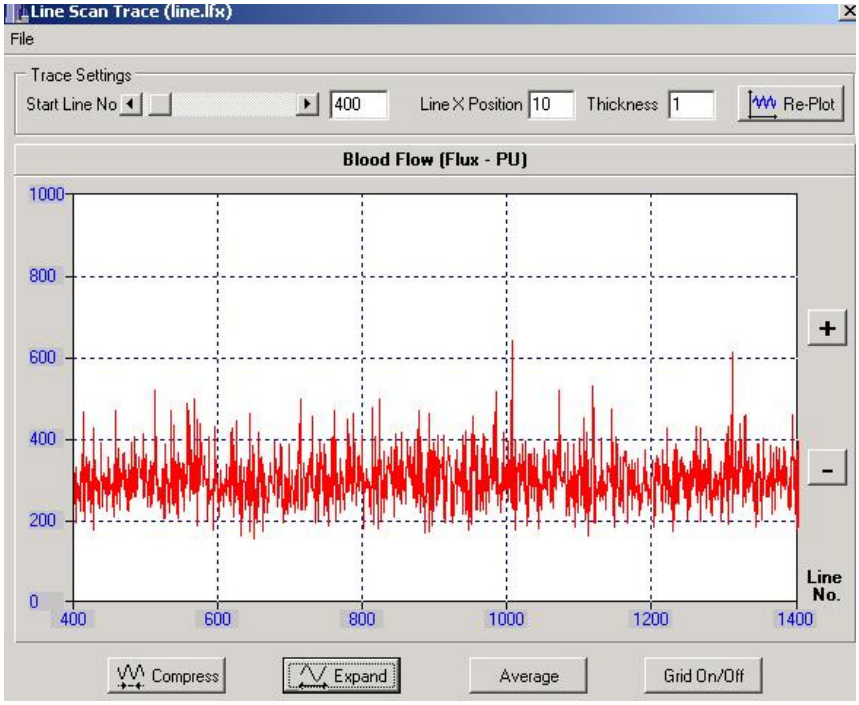
Analysis: Line Image Trace 
Open Line Image Trace window as shown below:
It displays a curve of Flux values against Line No.

Start Line No: define the starting point of the curve.
Line X Position: position (along the line) taken for calculation.

Thickness: average pixel number (P). The mean Flux value for that line (average from pixel X-P/2 to pixel X+P/2) will be calculated and plotted on the curve.
Compress: compress the trace.
Expand: expand the trace.
Average: average the trace (average with the point before).
Grid On/Off: toggle the grid on or off.
+ and – buttons: change the display scales.

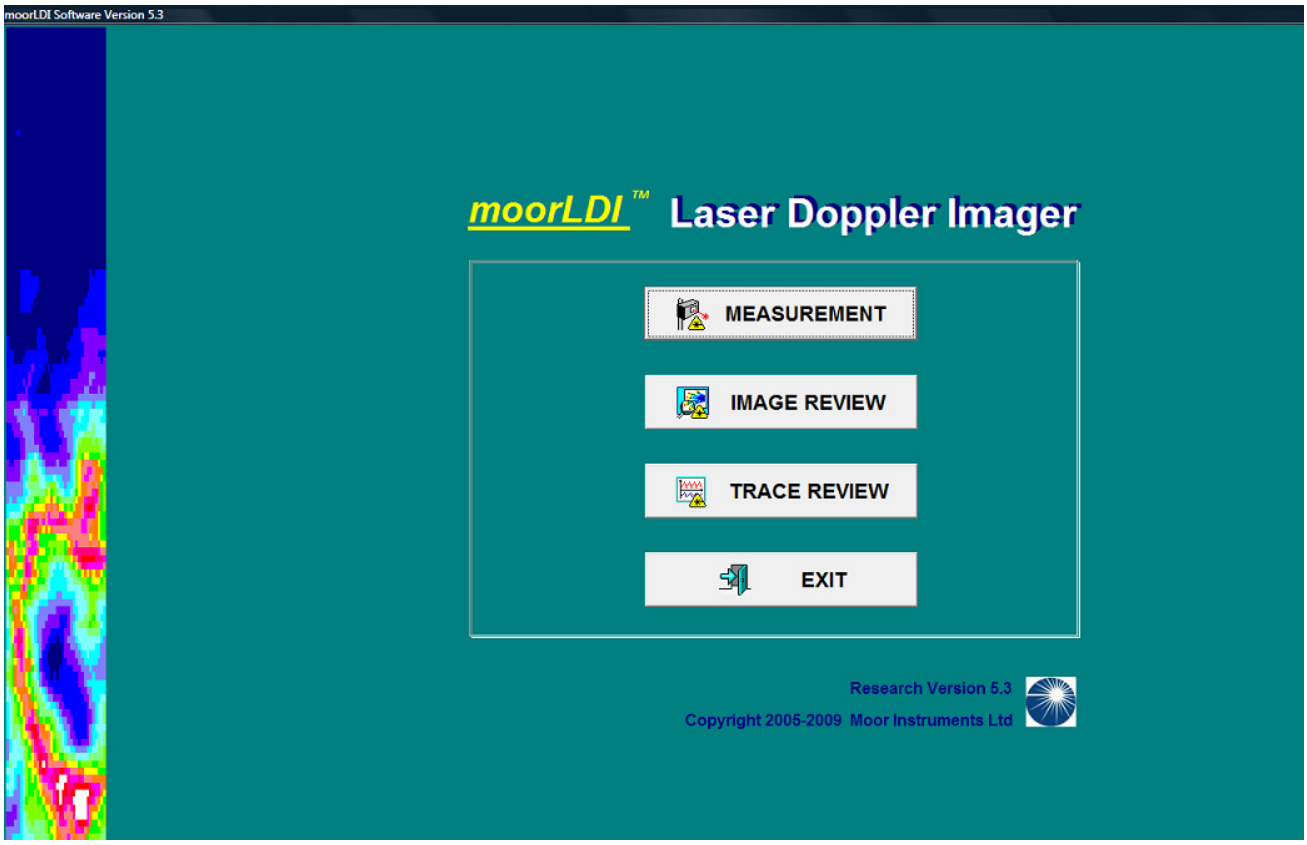
A File menu is accessible at the top of the Line Image Trace window. The trace can be saved/appended into a text file.

The trace displayed can be printed with or without the grid.



# 17. TRACE REVIEW (SINGLE POINT MEASUREMENTS)

## 17.1 INTRODUCTION

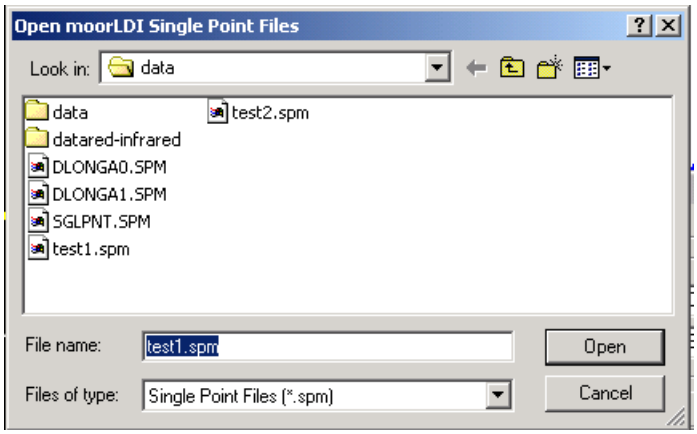


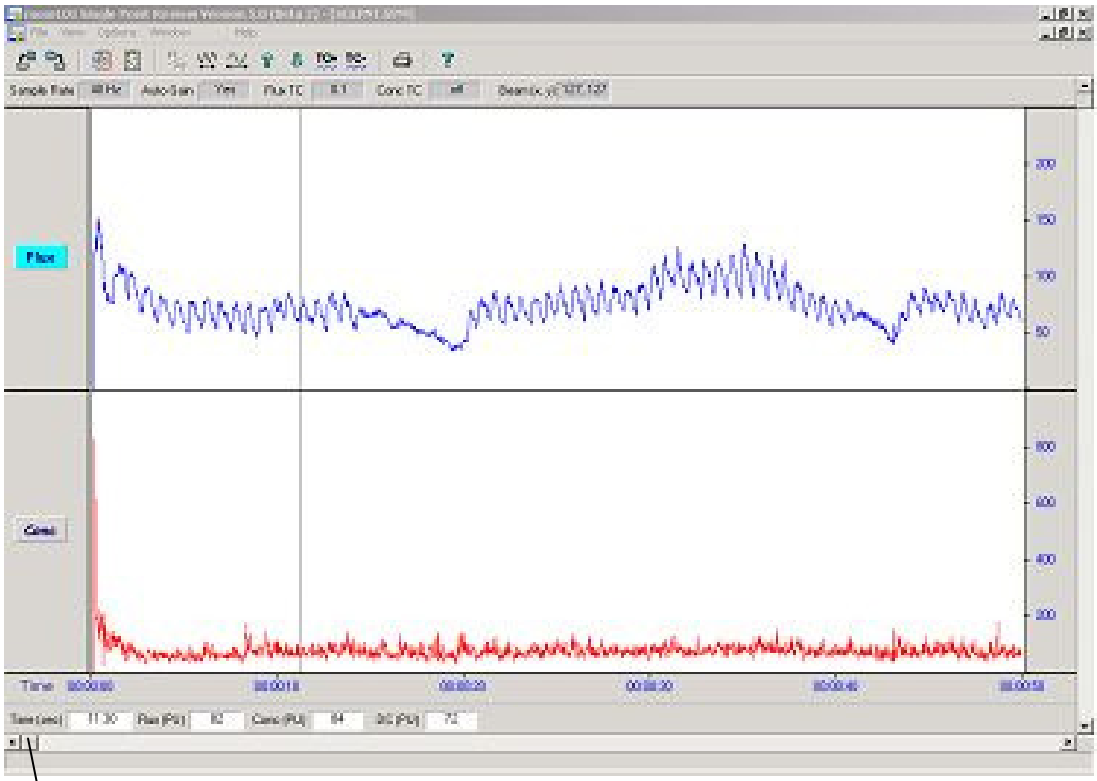

Traces of the blood flow flux and conc values obtained by **single point** measurement are reviewed by a program separate from the Image Review program.

To run this program click on the Trace Review (single point measurement) icon  .

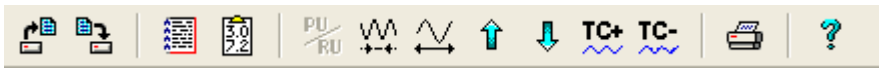
## 17.2 SINGLE POINT MEASUREMENT DISPLAY

To review a single point measurement click on the open file icon  or select: **File Open**






Trace Slide




1 2 3 4 13 5 6 7 8 9 10 11 12

These icons have the following functions:-

1. Open file.
2. Save file - to be used on an edited file: it overwrites previous.
3. Show SPM information.
4. Statistics of selected data block (see data block section).
5. Expand time scale.
6. Compress time scale.
7 Increase ‘gain’ for Y scale (Flux or Conc depending on which labelto left of graph is highlighted )
8. Decrease ‘gain’ for Y scale.
9. Increase flux or conc time constant, i.e. smooth trace.
10. Decrease flux or conc time constant.
11. Print report with Flux/Conc graphs. (see Appendix 3 for sample print out)
12. Help - contains brief information on program functions.
13. PU/RU If active this enables switching between Perfusion Units and Relative Units (ie gain dependent units). If single point measurements are done with the auto gain setting on then only PU units will be displayed. The PU/RU icon will be greyed out ie inactive.

## 17.3 TRACE SCROLLING

Use the scroll bar at the bottom of the window to move back or forward through the trace record as follows:
- to scroll, use the arrows at each end of the scroll bar;
- to move by time interval steps, click on the scroll bar slide; to the right of the bar slider to advance, to the left to return
- to move continuously and quickly, drag the bar slider.

## 17.4 SPM ANALYSIS

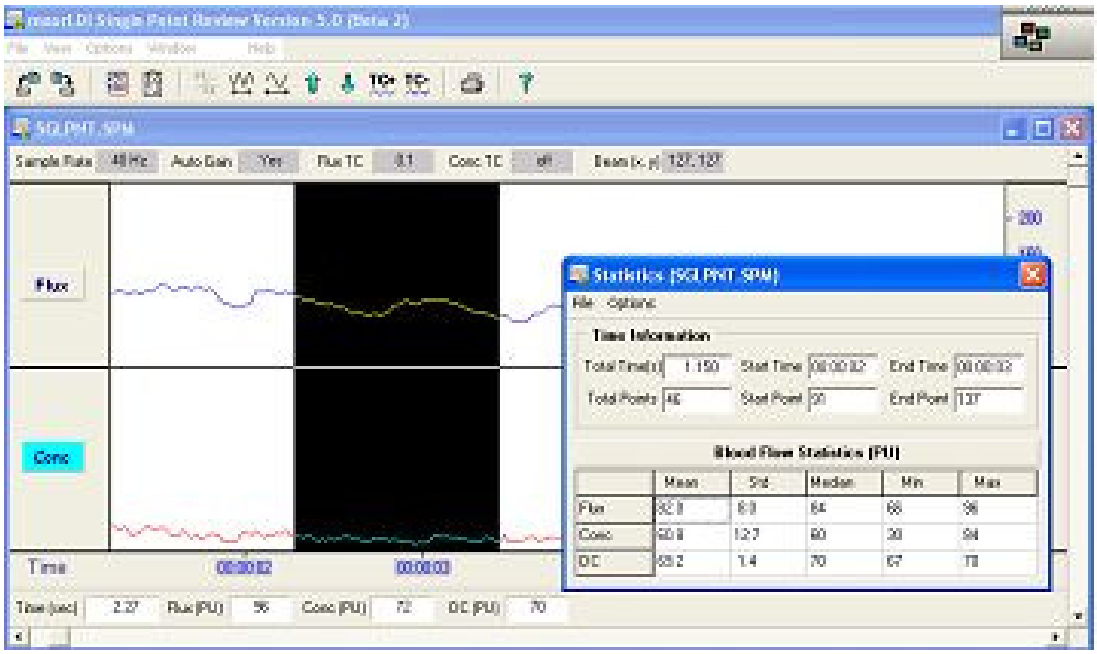
The single point traces can be analysed in compressed or expanded form. To display values of individual points the time expanded view is necessary. The statistical calculations include all recorde values in the block of selected data wheteher displayed in compressed or expanded form.

### 17.4.1 SPM TRACE VALUES

To display flux and conc values (also dc and time), click with the cursor at the required point on the trace. A cursor line will be drawn at the point of interest.

### 17.4.2 SPM DATA - BLOCK MARKING

Before a segment of the trace can be analysed it is necessary to block mark the data:-
Click at the start of the segment.
Drag the cursor to the end of the segment. The segment is shown by change of colour.

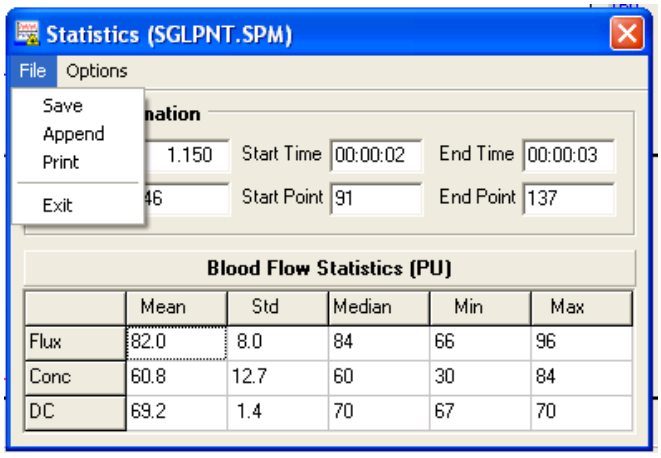


### 17.4.3 SPM STATISTICS

After block marking the data statistics can be generated by:

clicking on the statistics icon 

or selecting **Options**, **Statistics**




## 17.5 SPM TRACE PRINTOUT

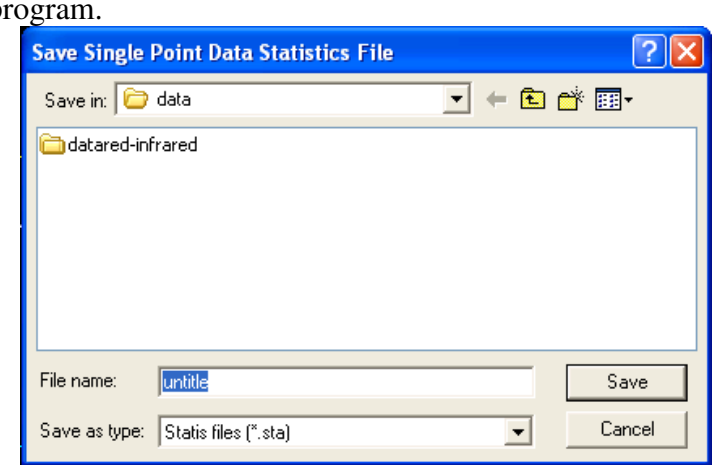
The traces can be printed, as displayed on screen, by clicking on the printer icon (see 17.2 above).

## 17.6 SPM STATISTICS PRINTOUT

To print out the table of statistics values in the statistics window, select: File, Print.

## 17.7 SPM STATISTICS - SAVING RESULTS

The statistics information can be stored in a *.sta file by selecting File, Save from the statistics window. A suitable name should be chosen in the Save As window.
The *.sta file can be reviewed using, for example, Windows™ Notepad or imported into a spreadsheet program.



# 18. TROUBLESHOOTING

Common problems are listed below. If you are unable to find a solution to your problem here contact your moorLDI2 agent or Moor Instruments Ltd. There are no user serviceable parts in the moorLDI2.

Circuit diagrams and parts lists will be made available to approved service personnel upon request.

## 18.1 NO FLUX IMAGE DURING ACQUISITION

**LD Photo Image black and/or Flux Image is all grey or blue:**

1. Change the palette range to a lower value (or use Contrast).
2. Increase the gain levels using Scanner Setup
3. Check that the background threshold has not been set excessively high (e.g. reduce to 100 or lower).
4. Check the power of the laser beam during a measurement .( Most easily done during a single point measurement as the beam is stationary.)
5. For the IR (Infra Red laser ) imagers check the key switch is ON and Interlock in place. The IR emission LED should be on during a measurement.

**Image is all white:**

1. Check the palette range: increase range or use Contrast.
2. Reduce the gain settings.

**Poor photo image:**

1. Check the palette range: increase range or use Contrast.
2. Increase the dc gain if photo appears dark and grainy (usingscanner setup).
3. Decrease the dc gain if photo appears white and bleached (usingscanner setup).
4. If the image is 'pixelated' this can be improved at measurement time by increasing the image resolution using Scanner Setup, Image.

   At image review the image can be presented more clearly using **Interpolate** and **Smooth** functions.

## 18.2 SLOW COMPUTER RESPONSE

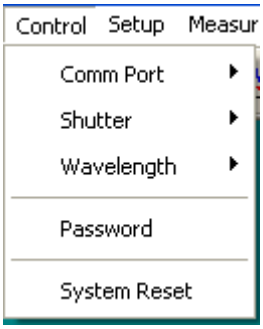
1. Insufficient memory.
   This can occur when there are many other applications being run or there are too many files open. Solve it by closing unnecessary applications and files or increase the available memory. A fast and easy solution is to close down the computer and start again. However, a longer term solution to memory availability should be found.

2. Slow processor.
   Analysis of Repeat Scan images may be slow on older PC's. If this becomes a problem then a computer with a faster processor is recommended.

## 18.3 LOSS OF COMMUNICATION WITH COMPUTER

1. If an USB-RS232 converter is used make sure that the USB Serial port is set between COM1 to COM9. If the USB Serial port is set above COM9 the software will not work. The port setting needs to be changed (in Device Manager under Control Panel) before using with the software.

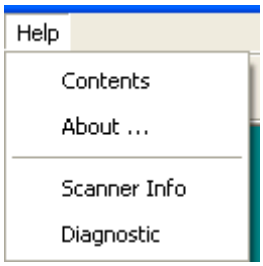
2. If the imager fails to respond to software commands this can be either real or apparent. An apparent loss of communications occurs when many images have been acquired or reviewed and left open when there is too little computer memory available. This can slow down program operation severely. To restore normal operation close down all moorLDI2 programs and then restart them.
   If a real loss of communication occurs it is re-established by issuing a **System Reset** command. This item is found in the **Control** menu from the menu bar at the top of the display window. You will be asked to confirm the operation before a reset is executed.

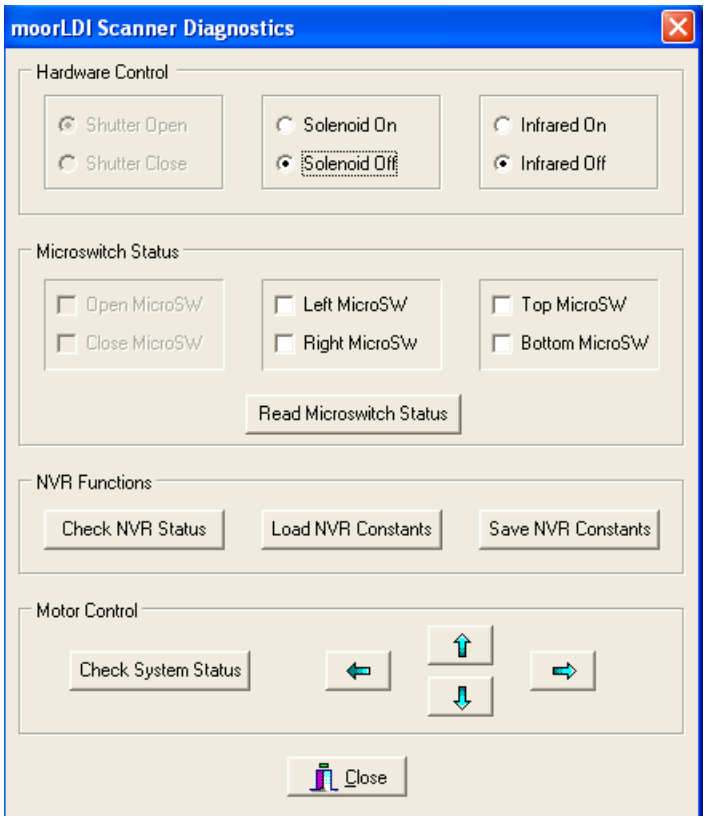



3. If there is still loss of communication then:

   a. Close down the moorLDI2 application program.
   b. Switch off the moorLDI2 controller unit.
   c. Switch off the PC.
   d. Check all connections.
      Now turn on the PC and then turn on the controller unit. If the communiction is ok you will hear a 'De-la De-la' sound generated in the control unit. The laser beam moves to its central position. If these events do not occur the problem could be either:-
      1. the NVR is corrupted (NVR  Non Volatile Ram which stores data for motor control etc).
      2. Poor connection (one or other of the connecting leads may be faulty)
      3. A control motor or encoder has failed.

1 and 3 can be checked using the diagnostics window in the moorLDI Measurement program. This is found in the Help menu.
Poor connections and/or faulty leads can be checked both by eye for damage and using a multimeter for continuity checks and shorts to the common earth terminal or screen.

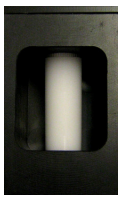


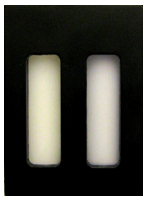

moorLDI Diagnostics window

# 19 CALIBRATION AND STABILITY

There are two versions of calibration software, depending on when the LDI system was purchased



**Version 1.x calibration block**



**Version 2.0 calibration block**

- V1.x calibration uses a single tubed calibration block and requires the calibration block to be setup at the right position and distance manually (See 19.1 for calibration information).

- V2.0 calibration uses the calibration kit with a dual tubed calibration block, this allows easier calibration when required (see 19.2 for calibration information)

## 19.1 moorLDI V1.0 CALIBRATION GUIDE

The calibration software needed for this procedure is **calibration.exe**. It is loaded by clicking on the desktop icon if displayed or loading from the installation CD ROM for the moorLDI software. Calibration checks should be performed weekly.

### 19.1.1 Set-up

1. Avoid bright lighting.
2. Avoid vibration.
3. Flux standard is equilibrated to room temperature for 60 minutes.
4. Warm up LDI for 30 minutes.
5. Gently shake calibration block for 10 seconds - allow to settle for 2 minutes before calibrating.
6. Set up calibration block 30cm from the front panel of LDI-1(*Figure 19.1.1(a)*), 30cm from the indicated mark* on LDI-2(*Figure 19.1.1(b)*). Adjust the position of the block so the centre of the bottle is illuminated.
   *For early MoorLDI2 without a distance mark, the mark position is 10cm in front of the axis of the support bearings.

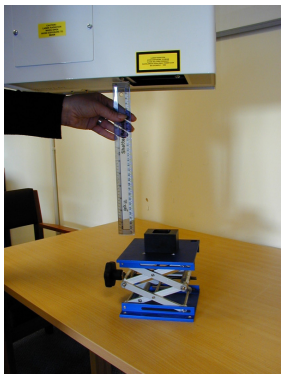


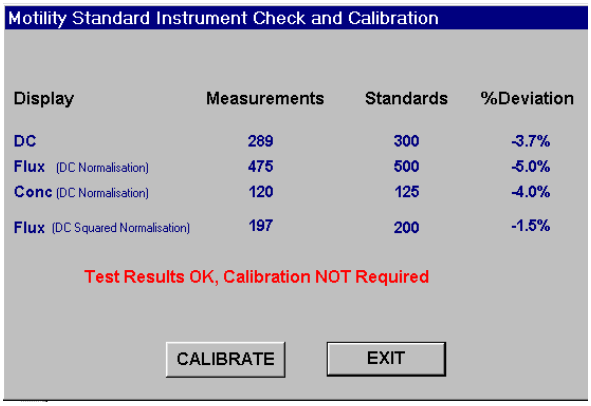
**Figure 19.1.1(a).**

**Figure 19.1.1(b).**

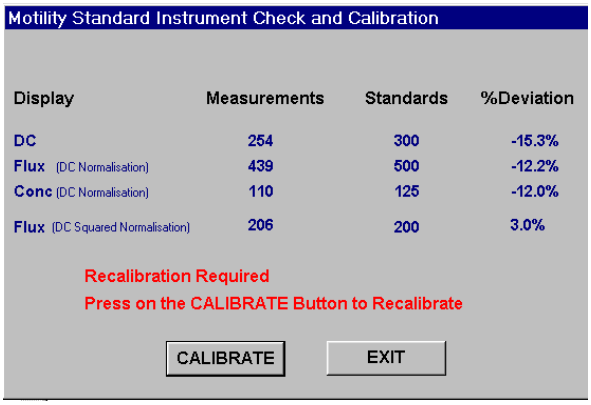
### 19.1.2 Calibration

1. Load Moor Calibration utility **(exit any other MoorLDI measurement software beforehand)**.
2. Check set up conditions on start-up screen and click the NEXT button. Note you will not be able to progress to check and calibrate unless these conditions have been satisfied.
3. The Measurement screen appears next. This allows the user to check actual measurements from the motility standard with normal values. Click Measurement to proceed.

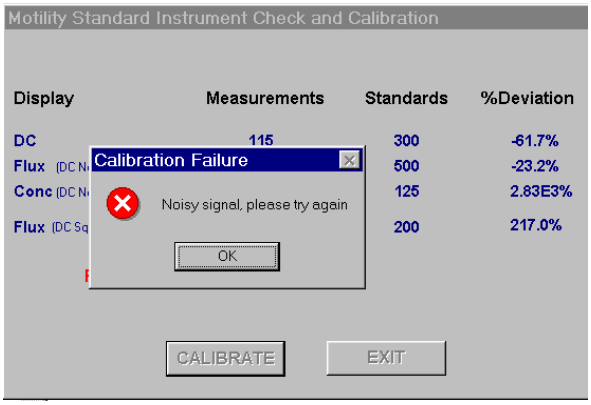
4. Test results appear with %Deviation from standard calculated. In the example (right) Deviation is within the acceptable range and calibration is not recommended - in which case quit the utility with the EXIT key.



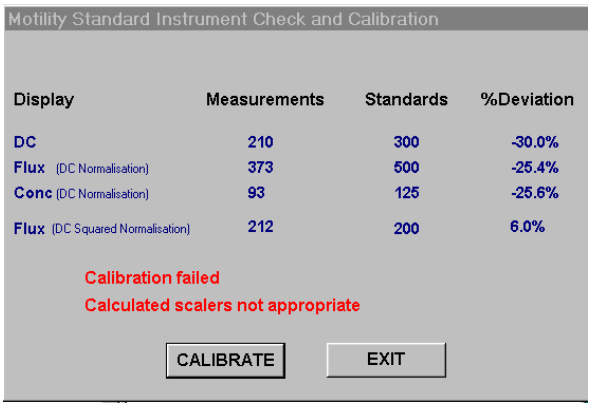

5. If measured values are outside acceptable limits, then proceed to calibration with the CALIBRATE key. Do not calibrate if there is any doubt about the set up and accurate positioning of the calibration block. Exit and repeat from 1.




6. If there is excessive vibration during calibration then the Noisy Signal Message appears. Attempt calibration a second time by clicking OK then CALIBRATE.
If the MoorLDI persistently fails to calibrate, consult Moor Instruments or your authorized distributor for further guidance.



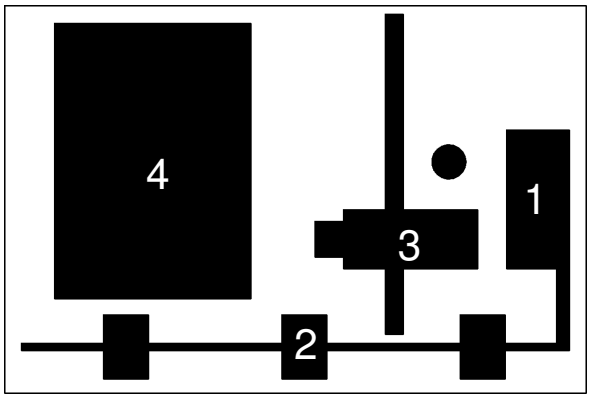

7. If the ‘Calibration failed’ message appears, press EXIT and re-load the calibration utility. Pay particular attention to measurement conditions, following instructions from 2. (over).
If the MoorLDI persistently fails to calibrate, consult Moor Instruments or your authorized distributor for further guidance.



## 19.2 moorLDI V2.0 CALIBRATION GUIDE

The calibration software needed for this procedure is **Calibration V2.0**. It is loaded by clicking on the **Start** menu, under **moorLDI V5.3**. Calibration checks should be performed weekly.

### 19.2.1 Calibration kit contents




1. Calibration Block
2. Calibration Arm
3. Calibration Mount
4. Calibration Instructions

### 19.2.2 Installing mount

- Open the calibration kit box and remove the calibration mount.
- Separate the top part of the mount by removing the top screw and splitting the mount in two (see **figure 1.**).

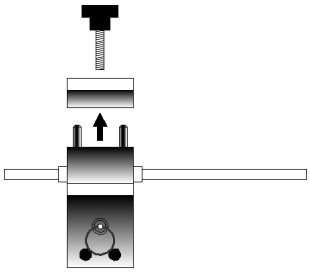


**Figure 1.**

- Push the bottom part of the mount behind the moorLDI handle, ensuring that the ruler rod end tip is positioned closest to the right side of the handle (see **figure 2**). This will ensure that once the calibration arm is fixed to the mount, the calibration block will be centralised underneath the moorLDI scan area.

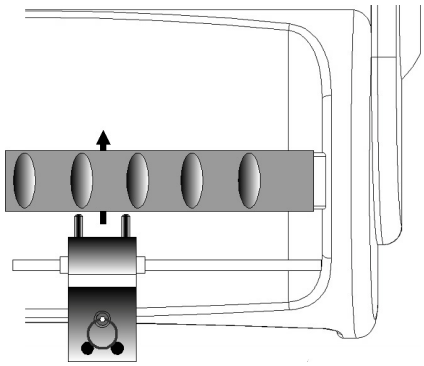


**Figure 2.**

- Attach the top part of the calibration mount to the bottom of the calibration mount. Use the screw provided tighten and lock the top part with the bottom part, ensuring that the complete mount is tightly fitted and secure (see **figure 3**).

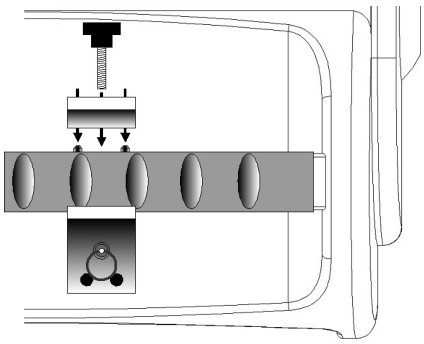


**Figure 3.**

### 19.2.3 Installing arm

- Remove the calibration arm from the kit and position the top of the arm underneath the secured calibration mount so that the calibration block is directly underneath the moorLDI scan head.

- Fix the arm to the mount by pulling and holding the ring on the mount and insert the arm underneath the mount in the slot (see **figure 4**).

- Push the arm completely in and release the ring. Gently pull the arm down to make sure that it is locked into place within the mount.

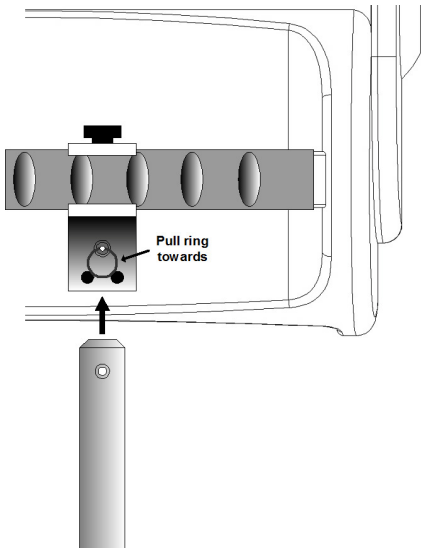



**Figure 4.**

### 19.2.4 Performing calibration

***Note:*** *Ensure that the moorLDI has been powered on for at least 30 minutes and the calibration block has been gently shaken before using the calibration software.*

- Open the moorLDI calibration software located on your desktop or from the start menu.

- Once open, read through the questions and tick the "**Yes**" check boxes if the operation has been performed (see **figure 5**).

***Note:*** *Please ensure that the laser is centred on the calibration block prior to clicking "**Check Calibration**". If the laser is not centred, check that the calibration mount/arm is in the correct position or use the Arrows on the "**Laser Beam Position**" section to manually move the laser to the centre.*

***Note:*** *When calibrating dual wavelength moorLDI systems, you must calibrate each wavelength individual to perform a complete calibration.*

Once all questions have been answered "**Yes**", the "**Check Calibration**" button will be enabled

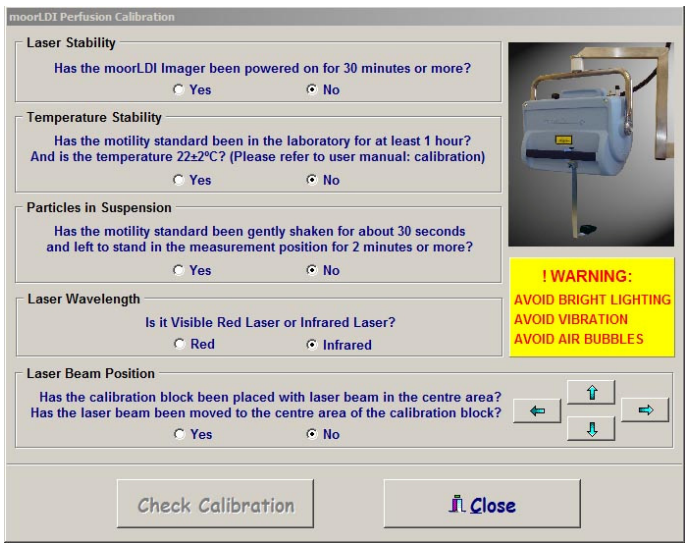



**Figure 5.**

- The moorLDI will now perform a quick scan to locate the centre of the calibration block.

  If the calibration block centre is found, the software will begin the calibration check. If not, a message will appear requiring the user to check the position of the calibration block, repeat the calibration centre check by pressing the "**Quick Scan**" button (button 2 of **figure 6**).

  If the calibration check failed then a message will be displayed informing the user to check or shake the calibration block and perform another calibration check by pressing "**Calibration Check**" button (button 3 of **figure 6**).

  If the calibration check is within specification, then no further calibration is required. If the calibration check is not within specification, then the user can perform a calibration; press the "**Calibration**" button (button 6 of **figure 6**).

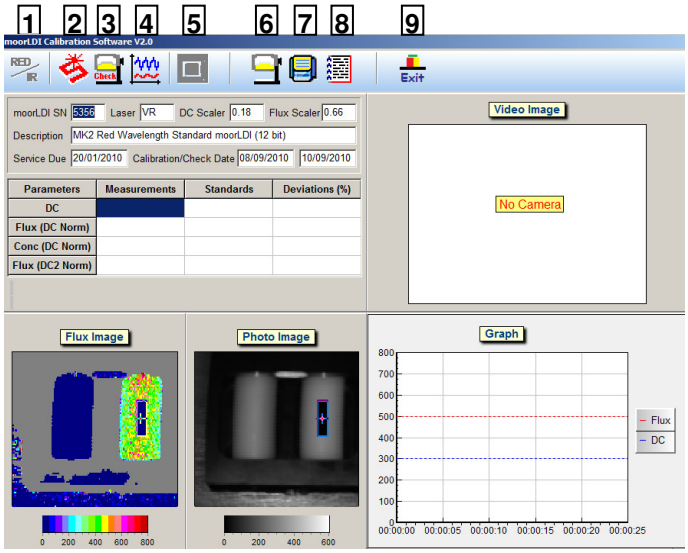



**Figure 6.**

- Once the calibration is complete, click the "Exit" button to close the calibration software (button 9 on **figure 6**).

- Features of calibration software (see **figure 6**):

| | |
|---|---|
| **Button 1** | Toggle between wavelengths when performing a calibration check (**Dual wavelength moorLDI only**). |
| **Button 2** | Perform a quick scan to determine calibration block position. |
| **Button 3** | Perform calibration check. |
| **Button 4** | Perform single point measurement. |
| **Button 5** | Stop the current operation (e.g. single point measurement). |
| **Button 6** | Perform calibration. |
| **Button 7** | Save screenshot, flux image, photo image and graph trace. |
| **Button 8** | View the calibration log (previous records of calibrations). |
| **Button 9** | Exit calibration software. |

### 19.2.5 Remove calibration kit

The calibration mount can be permanently attached to the moorLDI handle once fitted. This helps when a calibration is due as the mount is already fitted and all that needs to be attached is the moorLDI calibration arm.

- Remove the arm by using one hand to hold the arm while using the other hand to pull the ring on the front of the mount. This releases the arm and can be removed (see **figure 7**).

- (**Optional**) While holding the bottom of the mount using one hand, unscrew and remove the screw at the top of the mount. Once complete and while still holding the bottom of the mount, remove the top of the mount from the handle and remove the bottom part as well.

- Put the calibration kit back inside the case in the correct way and store in a suitable place which is in constant room temperature.

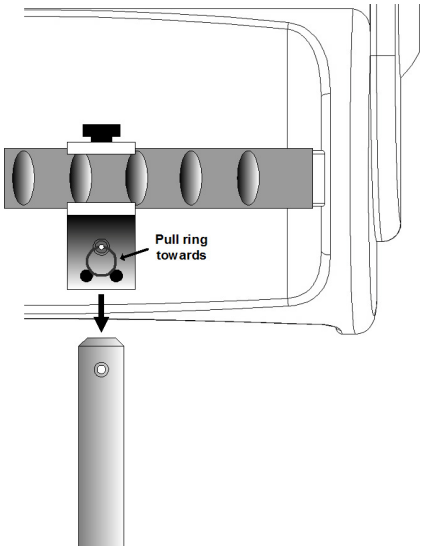



**Figure 7.**

### 19.2.6 Calibration kit care

- The calibration block that comes with the calibration kit has an expiration date. Using the calibration block after expiration will increase the chance of faulty/incorrect calibration. It is therefore recommended to replace the calibration block before the expiration date is due. The calibration block that comes with the calibration kit has a shelf-life of 12 months and should be replaced annually. Contact Moor Instruments for a replacement calibration block.

- Store the calibration kit in a suitable place when not in use. Avoid storage in places where temperatures could fall below 0°C (32°F) as freezing of the calibration block within the calibration kit can cause irreversible damage and faulty calibrations. Ideally the calibration kit should be stored at room temperature.

- The calibration kit parts can be cleaned using an approved cleaning method, usually using medical wipes or an alcohol based cleaning product. Keeping the calibration kit parts within the case when not in use will keep the parts from getting dirty and soiled. **Do not sterilise the calibration kit or use acids to clean!**

- The calibration block has been optimised for accurate calibration. Do not disassemble or open the calibration block, doing so will cause incorrect and faulty calibration checks. Never open the vials containing the calibration fluid as evaporation and fluid spillage will cause inaccurate calibrations.

- Do not drop the calibration kit or parts as this can cause deviations from correct calibration checks. If you suspect the kit or parts have been dropped. Check the calibration of the moorLDI again to confirm if any damage has occurred that will affect calibration.

- For all other questions and support, please contact Moor Instruments for further information.

## 19.3 THE DISTANCE FACTOR

A full detailed description of the distance factor procedure performed during manufacture and checked at installation is in **Appendix 1**.

To obtain laser Doppler blood flow values that are independent of skin-to-scan head distance a correction table is used to scale raw values. This table is defined by the distance factor.

The specified range of measurement distances for flux measurements is 30cm to 100cm; however measurements can be made from 30cm to 20cm and from 100cm to 120cm.

For the distances above 100cm,where the detected light will be of relatively low intensity, it is important to take measurements in low ambient lighting conditions to avoid the possibility of signal contamination from background lighting.

The moorLDI is calibrated with the motility standard (see the Calibration section of this user manual) at 30cm from the 'laser aperture'. This is from the front panel of MK1 imagers and is measured from the vertical raised mark on the side of the scanner case for the MK2 imager.

The distance factor scales all values to those obtained at 30cm. At distances other than 30cms the flux value is automatically multiplied by a distance factor. Note that this automatic multiplication can only occur if the distance between skin and aperture is accurately measured (to +/- 2cm).

The **distance factors** are stored as tables in software for each instrument and for each of the three normalisation conditions, i.e.

**unnormalised**
**dc normalised**
**and dc squared normalised.**

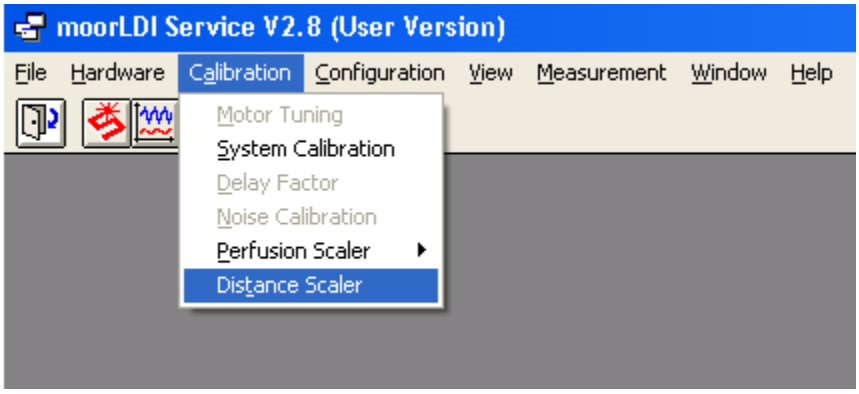
**dc normalised** is the **default normalisation** for the moorLDI. This is the division of the flux signal by a quantity proportional to the dc signal (the measure of the detected laser light intensity). It has been shown to be a more accurate way of measuring flux differences, over a curved area of skin, than using dc squared normalisation (as used in optic fibre systems).

Using dc normalisation the typical difference between flux measured at 30cm and that at 100cm is approximately 20%.

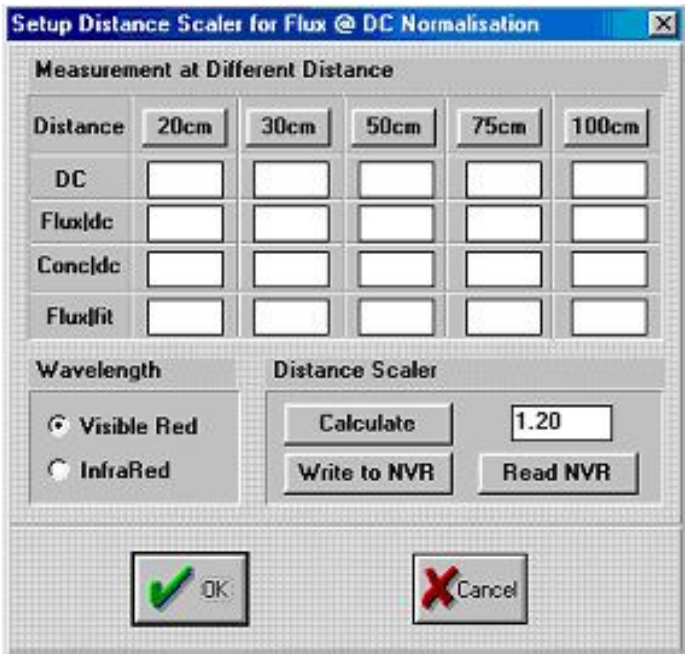
The default distance factor (the multiplier) at 100cm is x 1.2 and the distance factors for distances between 30cm and 100cm can be determined to a good approximation (typically better than +/- 5%) assuming a linear increase in multiplier from 30cm to 100cm. So at 65cm (halfway between 30 and 100cm) the multiplier is x 1.1.

To set the distance factor for a moorLDI, it is necessary to run the mldise29u service software or above (available from Moor or your local distributor). Close all other moorLDI measurement software before use.

Select Calibration, Distance Scaler as shown:




The following window opens and enables the distance factor to be calculated:




Using calibration block procedures previously described (Section 9.1, Set-up) and with the scan head directing the beam at a constant height above a table, place the calibration block at the distances indicated in turn (20, 30, 50, 75, 100cm).

At each distance, click on the appropriate distance button for measurements to be taken. When complete, click on **Calculate** and then **Write to NVR**. Click **OK** to finish the procedure and close the program.

The table below shows scaling constants for the default distance factor, 1.2 (DF|dc):

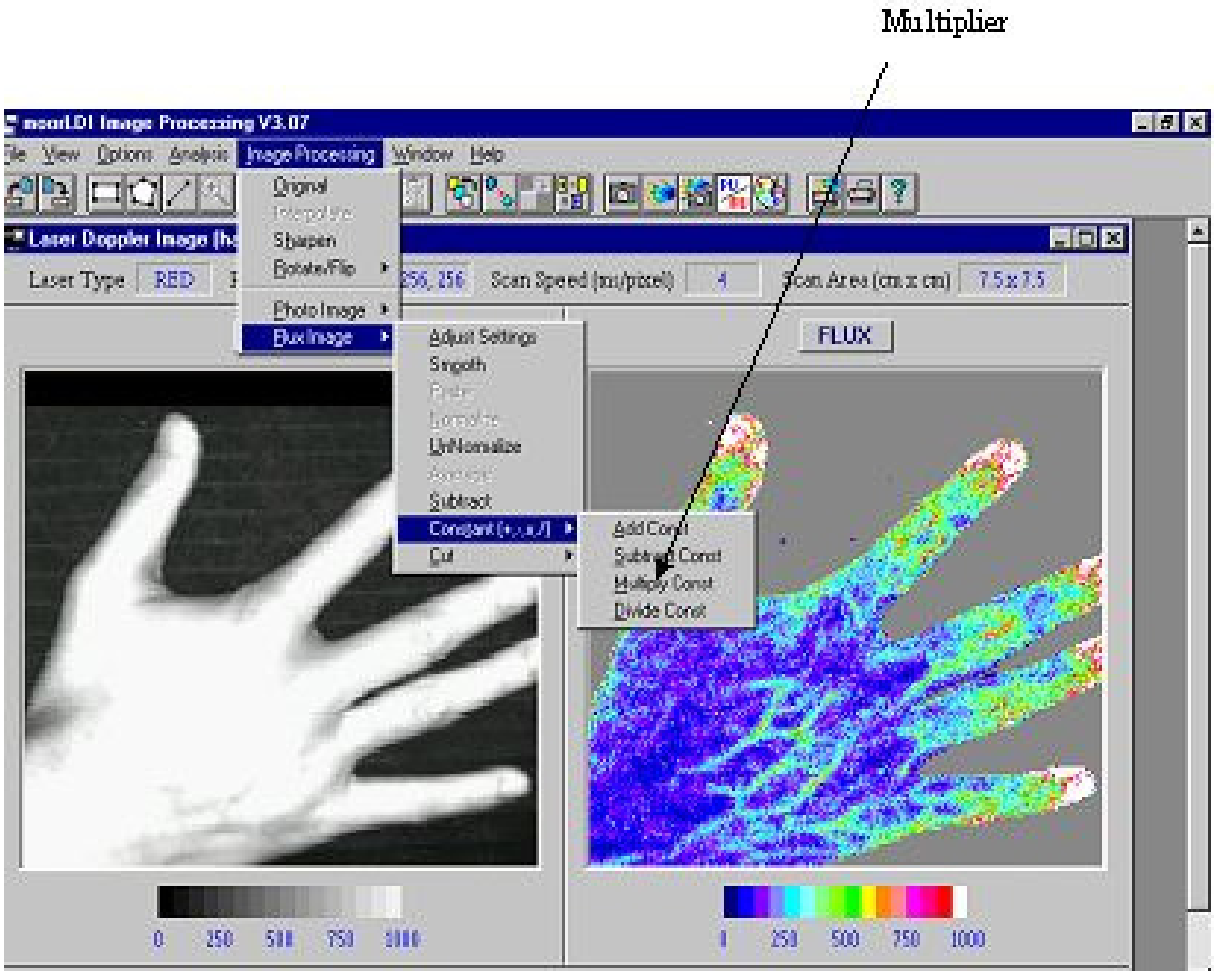
| **New MK1 & MK2 Scanner Distance Tables - Multipliers** | | | |
|---|---|---|---|
| **Distance** | **DF\|none** | **DF\|dc** | **DF\|dc2** |
| 10 | 4.56 | **1.35** | 0.37 |
| 15 | 3.12 | **1.20** | 0.50 |
| 20 | 1.90 | **1.10** | 0.68 |
| 25 | 1.19 | **1.05** | 0.87 |
| 30 | 1.00 | **1.00** | 1.00 |
| 35 | 1.00 | **1.01** | 1.00 |
| 40 | 1.04 | **1.03** | 0.97 |
| 45 | 1.08 | **1.04** | 0.86 |
| 50 | 1.25 | **1.06** | 0.79 |
| 55 | 1.46 | **1.07** | 0.70 |
| 60 | 1.76 | **1.09** | 0.63 |
| 65 | 2.03 | **1.10** | 0.55 |
| 70 | 2.35 | **1.11** | 0.49 |
| 75 | 2.70 | **1.13** | 0.43 |
| 80 | 3.10 | **1.14** | 0.37 |
| 85 | 3.48 | **1.16** | 0.34 |
| 90 | 3.90 | **1.17** | 0.31 |
| 95 | 4.39 | **1.19** | 0.27 |
| 100 | 4.88 | **1.20** | 0.25 |
| 105 | 5.40 | **1.21** | 0.22 |
| 110 | 5.95 | **1.23** | 0.20 |
| 115 | 6.50 | **1.24** | 0.19 |
| 120 | 7.30 | **1.26** | 0.16 |

Note for dc normalisation the flux decreases as the measurement distance increases from 30cm to 120cm but for dc squared normalisation it increases - an increase of approximately 4 at 100cm (this requires a distance factor multiplier of X0.25).

**Note**: all moorLDI's have the same distance factor multiplier look up tables for dc squared and unnormalised flux. These are only an approximation. If you are using either of these conditions and you wish to compare measurements taken at different distances you must take measurements at the two distances using the motility standard. Comparisons can then be made and the appropriate multiplier used in post detection processing (see Figure below).

For dc normalisation the default distance factor table is a good approximation; however to achieve more accurate results each instrument can have the 100cm multiplier entered via the service software (done at manufacture post March 2002). For instruments manufactured before March 2002 this could not be done; however software is now (March 2002) available.

If the distance factor software is not available the user can apply his/her measured multipliers (found by taking flux measurements from the motility standard at 30cm and at at the chosen measurement distance) using the moorLDI image processing software. This has a multiplier operator as illustrated in Figure 3. Multiplier = (Flux at 30cm)/(Flux at measurement distance). For consistency with Table 1 it is advised that the distance entered is kept at 30cm ie 30cm for the chosen measurement distance and the 30cm distance.




**Note the conditions for measuring from the motility standard are those advised for calibration**:

- moorLDI to be switched on 30 minutes prior to measurements.
- Low level background lighting (no bright sunlight!).
- Minimum vibration of scanner and motility standard (solid floor or stable bench).
- Motility standard to be at room temperature - leave in place for 1 to 2 hours.
- Motility standard gently shaken for a few seconds and allowed to stand for 1 to 2 minutes before the measurement.

## 19.4 STABILITY TESTING

Stability of the laser is checked during manufacture by making flux recordings from a calibration block over a period of 12 hours.

Variations of flux of ± 5% during this time period are acceptable. (Note that variations due to movement artefact noise and/or temperature variation of several degrees Celsius can be greater than ± 5%).

Short term variation over a 60 second period (using a time constant of 3 seconds) is typically less than ± 2%.

# 20. MAINTENANCE

**The following schedule of maintenance should be carried out on an annual basis by a suitably qualified person. Note that only a Moor Instrument trained engineer should undertake servicing of the imager.**

**Circuit diagrams and parts lists will be made available to approved service personnel upon request.**

## 20.1 LASER OUTPUT POWER

The laser output power of the moorLDI2-VR, HR, IR and HIR should be checked using an optical power monitor capable of measuring 0-5mW at the specified wavelength of the imager. Both the measurement beam (unattenuated) and the target aiming beam in an imager (the attenuated measurement beam) if applicable, should be checked against the acceptable values stated within the specifications section for the type of model being measured.

(Care must be taken to take account of the effect of ambient light on the power measurements). If the power of either beam falls outside its acceptable values the equipment should not be used and should be returned to Moor Instruments for service.

## 20.2 LASER BEAM PROPERTIES

Examination of the beam profile.

The laser beam follows the path through the scanner head as indicated in Figure 1 Section 1.3. It reflects off a small mirror positioned in front of the photodetectors, and between the two convex light collecting lenses, before being reflected from the centre of the scanning mirror, through the aperture optical window, to the tissue surface being measured.

The beam profile can most easily be assessed if the attenuated (~200µW) beam is examined when it is incident on a white card at about 30-50cm from the aperture. The beam should have a circular cross section and to the eye appear to have an approximate uniform intensity distribution across most of the beam front.

The beam should maintain this appearance wherever it is positioned in the scan area. If it does not (or there is evidence of scattering of the laser light within the scanner head) it is probable that one or more optical components has become misaligned. This should be reported to your distributor or directly to Moor Instruments who will arrange servicing.

## 20.3 MECHANICAL CHECKS

a. Check all external screws and bolts if the scan head is attached to a yoke. Tighten if necessary. Also check the screws and bolts of the stand being used.

b. During operation of the scanner check for any unusual sounds or vibrations or jitter (sudden acceleration or deceleration) of the laser beam which could indicate that a component is loose or is exhibiting undue wear.

   Report any perceived problems to your distributor or Moor Instruments who will arrange servicing.

## 20.4 OPERATION OF THE SOLENOID ACTUATED OPTICAL ATTENUATOR

This is mounted within the scanning head metal enclosure and is located at the laser output aperture. The solenoid is a rotating type with a 45º angular position change of the solenoid shaft produced by powering the solenoid.

In the moorLDI2 measurement mode and Mark (during scan set-up) the solenoid is powered to enable the solenoid shaft to rotate to swing an optical attenuator out of the laser beam path.

At other times the solenoid is unpowered and the visible red laser beam is attenuated. The attenuated beam is used for indicating the centre of the measurement area.

The attenuator acts as a fail safe component. A return spring causes it to rotate to the laser beam attenuated position.

Failure of the solenoid, e.g. it remains stuck in its ON or OFF position, should be reported to your distributor or Moor Instruments.

## 20.5 LEADS

All leads should be checked for wear to the insulation and to the wires and connections. If a lead has indications of wear it should be replaced.

## 20.6 CLEANING

**Warning!** The system must be turned off and disconnected from the mains cable before cleaning.

**Warning!** Do not clean the optical window on the front of the scan head, doing so will damage the optical coating and will degrade system performance.

**Warning!** Do not sterilise the system or any part of the system, or use any alternative cleaning process (likely to be in use in the healthcare Environment). Doing so may damage parts and cause a safety risk.

**Warning!** Do not use any other types of solvent or cleaning agents. This may prove detrimental to the general working function of the device and may invalidate your warranty and/or service contract.

The *moorLDI2* should be operated in a relatively dust free environment as dust settling on any of the mirror, filter, detector or lens surfaces can have adverse effects on the performance of the imager. To reduce contamination by dust we recommend that the complete imaging system is covered with a dust sheet when disconnected from mains electricity and not in use.

In normal use the scanner may be subjected to biological contaminates and general dirt; the instructions below are approved for cleaning the complete *moorLDI2* system.

**External Surfaces and Cables**

The mobile stand, scan-head enclosure (but **NOT** the Optic window) and cabling can be disinfected using an approved medical wipe (e.g. Medi-Wipe®) containing:

- Isopropanol (rubbing alcohol) or Ethanol alcohol >=70% w/w.
- And an optional antiseptic agent such as Chlorhexidine Digluconate.

Guide for using medical wipes:

- Turn the system off and disconnect the mains cable before cleaning.
- Ensure that the medical wipes are not overly wet when cleaning the enclosure.
- Allow the system to dry fully before connecting the mains cable and switching on.

**Optic Window**

- If dust settles on the optic window this can be removed using low pressure compressed air, e.g. using a commercially available compressed air canister. **Do not attempt** to wipe the surface of the optic window because it is easily scratched.
- Cleaning an optical surface, and in particular a glass surface or front silvered mirror, other than with compressed air should only be done by someone with appropriate experience and skills.

## 20.7 CALIBRATION AND STABILITY

Calibration and stability testing is described in Section 19 and should be done at least on an annual basis and following impacts which might occur during transport.
We recommend that the calibration software is used weekly to assess if calibration is required.

# 21. ELECTROMAGNETIC COMPATABILITY

The moorLDI2 laser Doppler imager (SN5500 or above) complies with the requirements of IEC 60601-1-2:2007 Electromagnetic Compatibility of Medical Electrical Equipment. Medical electrical equipment needs special precautions regarding electromagnetic compatibility and needs to be installed and put into service in accordance with the following information.

- Mobile radio frequency communications equipment can affect medical electrical equipment.
- The moorLDI2 should not be used adjacent to or stacked with other equipment. If adjacent or stacked use is necessary, the moorLDI2 should be observed to verify normal operation in the configuration in which it will be used.

## 21.1 CABLING

The moorLDI2 is compliant with IEC 60601-1-2:2007 only when used with the following range of connecting leads. Modification of cables or use of cables other than those supplied may result in increased emissions or decreased immunity of the equipment.

**PORT 1 LEAD** 25 way lead connecting the control box to scanner head (2 or 4 meters).
**PORT 2 LEAD** 8 way lead connecting the control box to scanner head (2 or 4 meters).
**VIDEO LEAD** coaxial video lead connecting the control box to scanner head (2 or 4 meters).
**RS232 LEAD** RS232 lead connecting the control box to PC (less than 3 meters).
**FIREWIRE LEAD** Firewire 6-4 or 6-6 way lead connecting the control box to PC (less than 3 meters).

## 21.2 GUIDANCE AND MANUFACTURER'S DECLARATION – ELECTROMAGNETIC EMISSIONS

| **Guidance and manufacturer's declaration – electromagnetic emissions** | | |
|---|---|---|
| The moorLDI2 is intended for use in the electromagnetic environment specified below. The user of the moorLDI2 laser Doppler imager should assure that it is used in such an environment. | | |
| **Emissions Test** | **Compliance** | **Electromagnetic environment – guidance** |
| RF emissions CISPR 11 | Group 1 | The moorLDI2 uses RF energy only for its internal function. Therefore, its RF emissions are very low and are not likely to cause any interference in nearby electronic equipment. |
| RF emissions CISPR 11 | Class B | The moorLDI2 is suitable for use in all establishments, including domestic establishments and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes. |
| Harmonic emissions IEC 61000-3-2 | Not applicable (Power input < 75W) | |
| Voltage fluctuations/ flicker emissions IEC 61000-3-3 | Not applicable (Power input < 75W) | |

## 21.3 GUIDANCE AND MANUFACTURERS DECLARATION – ELECTROMAGNETIC IMMUNITY

| **Guidance and manufacturer's declaration – electromagnetic immunity** | | | |
|---|---|---|---|
| The moorLDI2 is intended for use in the electromagnetic environment specified below. The user of the moorLDI2 laser Doppler imager should assure that it is used in such an environment. | | | |
| **Immunity test** | **IEC 60601 test level** | **Compliance level** | **Electromagnetic environment – guidance** |
| Electrostatic discharge (ESD) IEC 61000-4-2 | ±6 kV contact<br>±8 kV air | ±6 kV contact<br>±8kV air | Floors should be wood, concrete or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30% |
| Electrical fast transient/burst IEC 61000-4-4 | ±2 kV for power supply lines<br><br>±1 kV for input/output lines | +2 kV for power supply lines<br><br>Not applicable | Mains power quality should be that of a typical commercial or hospital environment. |
| Surge IEC 61000-4-5 | ±1 kV differential mode<br><br>±2 kV common mode | ±1 kV differential mode<br><br>±2 kV common mode | Mains power quality should be that of a typical commercial or hospital environment. |
| Voltage dips, short interruptions and voltage variations on power supply input lines IEC 61000-4-11 | <5% $U_T$ (>95% dip in $U_T$) for 0.5 cycle<br><br>40% $U_T$ (60% dip in $U_T$) for 5 cycle<br><br>70% $U_T$ (30% dip in $U_T$) for 25 cycle<br><br><5% $U_T$ (>95% dip in $U_T$) for 5 sec | <5% $U_T$ (>95% dip in $U_T$) for 0.5 cycle<br><br>40% $U_T$ (60% dip in $U_T$) for 5 cycle<br><br>70% $U_T$ (30% dip in $U_T$) for 25 cycle<br><br><5% $U_T$ (>95% dip in $U_T$) for 5 sec | Mains power quality should be that of a typical commercial or hospital environment. If the user of the moorLDI2 laser Doppler imager requires continued operation during power mains interruptions, it is recommended that the moorLDI2 be powered from an uninterruptible power supply or a battery. |
| Power frequency (50/60Hz) magnetic field IEC 61000-4-8 | 3 A/m | 3 A/m | Power frequency magnetic fields should be at levels characteristic of a typical location in a typical commercial or hospital environment |
| | | | Portable and mobile RF communications equipment should be used no closer to any part of the moorLDI2, including cables, than the recommended separation distance |

| | | | |
|---|---|---|---|
| | | | calculated from the equation applicable to the frequency of the transmitter.<br><br>**Recommended separation distance** |
| Conducted RF<br>IEC 61000-4-6 | 3 Vrms<br>150 kHz to 80 MHz | 3 Vrms | $d = 1.2\sqrt{P}$ |
| Radiated RF<br>IEC 6100-4-3 | 3 V/m<br>80 MHz to 2.5 GHz | 3 V/m | $d = 1.2\sqrt{P}$ 80 MHz to 800 MHz<br><br>$d = 2.3\sqrt{P}$ 800 MHz to 2.5 GHz<br><br>where $P$ is the maximum power rating of the transmitter in watts (W) according to the transmitter manufacturer and $d$ is the recommended separation distance in metres (m).<br><br>Field strengths form fixed RF transmitters, as determined by an electromagnetic site survey, [a] should be less than the compliance level in each frequency range.[b]<br><br>Interference may occur in the vicinity of equipment marked with the following symbol:<br>  |

NOTE1 At 80 MHz and 800 MHz, the higher frequency range applies.
NOTE2 these guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.

[a] Field strengths from fixed transmitters, such as base stations for radio (cellular/cordless) telephones and land mobile radios, amateur radio, AM and FM radio broadcast and TV broadcast cannot be predicted theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site survey should be considered. If the measured field strength in the location in which the moorLDI2 is used exceeds the applicable RF compliance level above, the moorLDI2 should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as reorienting or relocating the moorLDI2.

[b] Over the frequency range 150 kHz to 80 MHz, field strengths should be less than 3 V/m

| **Rated maximum output power of transmitter** W | **Separation distance according to frequency of transmitter** m | | |
|---|---|---|---|
| | **150 kHz to 80 MHz** $d = 1.2\sqrt{P}$ | **80 MHz to 800 MHz** $d = 1.2\sqrt{P}$ | **800 MHz to 2.5 GHz** $d = 2.3\sqrt{P}$ |
| 0.01 | 0.12 | 0.12 | 0.23 |
| 0.1 | 0.38 | 0.38 | 0.73 |
| 1 | 1.2 | 1.2 | 2.3 |
| 10 | 3.8 | 3.8 | 7.3 |
| 100 | 12 | 12 | 23 |

For transmitters rated at a maximum output power not listed above, the recommended separation distance *d* in meters (m) can be estimated using the equation applicable to the frequency of the transmitter, where *P* is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer.
NOTE 1 At 80 MHz and 800 MHz, the separation distance for the higher frequency range applies.
NOTE 2 These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.

# 22. SPECIFICATIONS

The moorLDI2 is a class IIa device under EC directive 93\42EEC 14 June 1993 Medical Device Directive.

**LASER SOURCE**

**moorLDI2-VR** **moorLDI2-HR**
Helium Neon Red Gas Laser: 633nm
(moorLDI2-VR) Accessible power 2.0mW - 2.5mW
(moorLDI2-HR) Accessible power 1.6mW – 1.8mW
Beam diameter ($1/e^2$ points) at 50cm from scanner window 1.2mm $\pm$ 0.2mm (moorLDI2-VR)
Beam diameter ($1/e^2$ points) at 25cm from scanner window 0.1mm $\pm$ 0.1mm (moorLDI2-HR)
Beam divergence 1.4 $\pm$ 0.2milliradians
Ocular Hazard Distance 25m.
All measurements include cumulative measurement uncertainties and expected increases after manufacture.
Class 3R per IEC 60825-1:2007 and complies with 21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No. 50, dated June 24, 2007.

**moorLDI2-IR** **moorLDI2-HIR**
Infra-Red Laser Diode: 785 $\pm$ 10nm
(moorLDI2-IR) Accessible power 2.0mW - 2.5mW
(moorLDI2-HIR) Accessible power 1.3 - 1.5mW
Beam diameter ($1/e^2$ points) at 50cm from scanner window 1.2mm $\pm$ 0.2mm (moorLDI2-IR)
Beam diameter ($1/e^2$ points) at 25cm from scanner window 0.1mm $\pm$ 0.1mm (moorLDI2-HIR)
Beam divergence is 1.4 $\pm$ 0.2milliradians
Ocular Hazard Distance 20m.
All measurements include cumulative measurement uncertainties and expected increases after manufacture.
Class 3R per IEC 60825-1:2007 and complies with 21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No. 50, dated June 24, 2007.

Visible Laser Diode (target beam for infrared systems): 660nm ± 10nm
(moorLDI2-IR) Accessible power 30µW to 200 µW.
(moorLDI2-HIR) Accessible power 30µW to 200 µW.
Beam diameter ($1/e^2$ points) at 50cm from scanner window 1.2mm $\pm$ 0.2mm
Beam divergence is 1.4 ± 0.2milliradians
All measurements include cumulative measurement uncertainties and expected increases after manufacture.
Class 1 per IEC 60825-1:2007 and complies with 21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No. 50, dated June 24, 2007.

## PROTECTIVE EYEWEAR REQUIREMENTS

**moorLDI2-VR** **moorLDI2-HR**
The nominal ocular hazard distance is 25 metres.
Operation at single wavelength visible red: wavelength range 630nm to 700nm, OD = 1.0.

**moorLDI2-IR** **moorLDI2-HIR**
The nominal ocular hazard distance is 20 metres.
Operation at single wavelength infrared 785nm: wavelength range 755nm to 850nm, OD = 1.5.

## ENVIRONMENT CONDITIONS

Temperature: 15°C to 30°C
Humidity: 45% to 75 %
Atmospheric pressure: within the range 86,0 kPa to 106,0 kPa (645mmHg to 795mmHg).

Flammable Anaesthetics: the system must not be operated in the presence of flammable anaesthetics.

## BANDWIDTH

Scan rate dependent: low frequency cut-off (3db) 20Hz, 100Hz or **250Hz .**
Selectable upper cut-off frequency (0.1db) 3KHz, **15KHz** or 22.5KHz. Default Bandwidth in Bold.

## RANGE AND SCAN AREA

**Standard Instruments**
At 20cm distance, Normal area = 6.6cm x 5.5cm; Large Area =13cm x 13cm.
At 100cm distance, Normal Area = 25cm x 25cm; Large Area = 50cm x 50cm.

**High Resolution Instruments**
At 20cm distance, Normal Area = 2.5cm x 2.5cm; Large Area = 5cm x 5cm
At 30cm distance , Normal Area = 3.4cm x 3.4cm; Large Area = 6.8cm x 6.8cm

## SCAN SPEED

Scan speed is approximately **4ms/pixel**, 10ms/pixel or 50ms/pixel (at maximum resolution).
Scan duration is typically 40 seconds for a 12.5cm x 12.5cm image at 64 x 64 pixel resolution, about 6 minutes for a 50cm x 50cm image at 256 x 256 pixel resolution at 4ms/pixel and 100cm distance.

## SPATIAL RESOLUTION

**Standard Instrument**
Up to 256 x 256 pixels (actual measurements not by interpolation): 0.2mm/pixel at 20cm, 'normal scan'; 2.0mm/pixel at 100cm, 'large scan'.

**High Resolution Instrument**

Upto 256 x 256 pixels (actual measurements not by interpolation): 0.1mm/pixel at 20cm for the'normal' size scan.

**LIGHTING CONDITION**

Normal, ambient room lighting.

**MEASUREMENTS**

FLUX

Accuracy: ± 10% relative to Moor Instruments 'moorLDI2 standard'
Precision: ± 3% of measurement value
Range: 0-5000PU

CONC

Accuracy: ± 10%
Precision: ± 5% of measurement value
Range: 0-5000AU

DC

Accuracy: ± 10%
Precision: ± 3%
Range: 0-5000AU

**CCD CAMERA**

Auto Focus, Motorised 10× zoom. 752 × 582 Pixel Resolution.

**SOFTWARE**

Windows™ based control, processing and analysis.

**COMPUTER REQUIREMENTS**

Only computers complying with IEC 950 may be used. (IEC 60950-1 Edition 1 Information technology equipment - Safety - Part 1: General requirements). Note that generally any commercially available PC will meet this standard. If the PC is supplied by Moor Instruments it will meet this standard and meet or exceed the minimum recommended specification detailed below.

The minimum recommended PC requirements for running the moorLDI software are:

500 MHz processor; 512 MB RAM; 40GB HDD, CDRW Drive; mouse; keyboard; RS232 or USB* port; display 800 x 600. A half length PCI card slot is required for the analogue CCD video camera

frame grabber board or an IEEE1394 interface card is required when using a moorLDI2-BI with a IEEE1394 camera (this card is not required if the PC supplied has an IEEE1394 port).
* If the PC does not have an RS232 port an RS232 to USB converter is needed as the serial output from the LDI control unit is via RS232. A suitable converter can be supplied by Moor Instruments.

Operating system – The moorLDI2-BI software can be used with Windows™ XP (Home or Professional), Windows™ 2000 and Windows™ Vista. Moor Instruments does not support its use with other Windows operating systems. When the software is used with Windows™ Vista, it is highly recommended that the Vista UAC (Use User Account Control) is disabled although not essential. If UAC has to be switched on, please keep it on whenever the moorBDA software is used; otherwise data loss may occur.
Analogue Camera Model: A half length PCI card slot is required for the CCD video camera framegrabber board.
Firewire Camera Model: A half length PCI card slot or a PCMCIA slot is required for the CCD video camera Firewire interface card.
* If the PC does not have an RS232 port an RS232 to USB converter is needed, as the serial output from the LDI control unit is via RS232. A suitable converter can be supplied by Moor Instruments.

Operating system - Windows™ 2000 and XP or higher.

**ELECTRICAL SAFETY CLASSIFICATION**

Type of protection against electric shock - Class I.
Degree of protection against electric shock - Type B.
Degree of protection against ingress of liquid - IPXO (not protected).
Degree of protection against flammable anaesthetics - equipment not suitable for use in the presence of a flammable anaesthetic mixture with air or with oxygen or nitrous oxide.
Mode of operation - continuous.

**GENERAL**

Universal voltage switch mode power supply.
Range 100 to 230V AC 50VA, 50 to 60Hz.
Control Unit: Dimensions W H D mm 305 x 115 x 260: Weight 4.5kgs.
Scan Head: Dimensions W H D mm 426 x 244 x 300: Weight 8kgs.
Operating environment: Indoor hospital or laboratory use.
Operating temperature: 15-30$^{O}$C.

**STORAGE AND TRANSPORTATION CONDITIONS**

Temperature: 0-45$^{O}$C.
Humidity: 0-80% RH.
Atmospheric Pressure: 50,0 kPa – 106,0 kPa.

# 23. RETURNS PROCEDURE

1. Contact Moor Instruments in advance to inform us of the defective equipment to be returned and Fax the completed contamination form (A28) to Moor Instruments for inspection. A Moor Instruments returns number can be issued (if required) at this stage for tracking progress.
2. Pack the instrument very carefully, preferably in its original case, to avoid damage in transit. When returning Moor Instruments Equipment always return ALL associated leads, flux standard and optic probes being used with the equipment at the same time for checking.
3. It is important that parts are cleaned and, if necessary, decontaminated before return to Moor Instruments. Repairs cannot be started until decontamination has been certified.
4. Include a delivery note to include all parts returned, recording serial numbers of parts (if available).
5. Include a fault report note explaining exactly what difficulties or fault you have encountered or other reason for return and action required.
6. Ship to Moor Instruments Limited, carriage paid, marked FRAGILE.
7. If exporting to the UK please return using the appropriate IPR number and clearly mark on all paperwork "RETURN FOR REPAIR"

## 23.1 DECONTAMINATION

To protect Moor Instruments staff from pathogens all equipment returned for inspection, service or repair must be decontaminated, if appropriate, before it is sent.

The decontamination should be certified by enclosing a Decontamination Certificate with packaging documents. **No equipment will be handled unless it is accompanied by a Decontamination Certificate**.

**Procedures:**

A. Decontamination is not necessary if equipment has been in contact with skin only and in an environment which presents no biological or chemical hazards. In this case Box A of the DECONTAMINATION form should be ticked.

B. Where equipment has been contaminated with body fluids or other pathogens it should be decontaminated and Box B of the DECONTAMINATION form should be ticked and the method of decontamination described.

C. Where equipment has been in contact with body fluids or pathogens and has not been decontaminated, Box C should be ticked and the certificate only should be sent to Moor Instruments. DO NOT SEND THE EQUIPMENT UNTIL IT HAS BEEN DECONTAMINATED. IT IS AN OFFENCE TO SEND CONTAMINATED GOODS BY MAIL OR BY COURIER (WITHOUT PRIOR AGREEMENT OF ALL PARTIES).

# 24. WARRANTY AND SERVICE POLICY

We warrant all products manufactured by Moor Instruments Limited to be free from defects in material and workmanship for the following:

moorLDI2 and stand (all models supplied new): 2 years from date of delivery.

Should a defect occur within the above period of time we will either replace or repair any defective parts of the instrument free of charge, provided that:
(1) The instrument is returned to Moor Instruments Limited, carriage paid, by customer.
(2) Our examination discloses to our satisfaction that the part(s) are defective.

This warranty is not applicable to any instrument which has been repaired or altered in any way so as to affect, in our judgement, its operation, stability, and/or reliability, or has been subject to neglect, misuse, abuse, negligence or accident. Neither shall this warranty apply to any instrument that has not been connected and/or operated according to the instructions provided by Moor Instruments Limited. Software programs are supplied without warranty that the functions performed are free from errors, defects or bugs. Software upgrades that fix known bugs will be supplied free of charge, on request, within the warranty period.

Moor Instruments Limited will be pleased to assist you in, and answer all questions pertinent to, the installation and operation of your instrument. Please feel free to write to us or telephone/fax/email us at any time. We shall endeavour to provide prompt and useful advice. We will try to diagnose the problem and will give verbal instructions on how to proceed. If your problem cannot be resolved through our combined efforts we may prefer to authorise the return of your unit to Moor Instruments Limited. In this case read and follow the instructions on Returns (Section 23).

## 24.1 Service Due Warning

A warning is given to remind users when an annual service is required:


When this message is displayed, arrangements should be made for equipment to be serviced.

# 25. ACCESSORIES

The following accessories are available for use with the moorLDI2:

### 1. Mobile Stand

Part No. moorLDI2-MS2. Enables flexible positioning of LDI scan head. Vertical adjustment provided by ratchet winding handle. Positioning provided towards and away from the vertical twin support pillars to enable 'reaching' over a bed. Yoke style holder for scan head to allow positioning and rotation to any angle. Stand fully mobilised on anti-static castors. Laptop computer/keyboard platform provided. Rear container with built-in system, controller, power supply and isolation transformer.

The mobile stand accepts the scanning head and control box and provides a wide variety of operating positions. The mobile stand allows the height of the moorLDI2 to be adjusted between 30-180cm from the ground and the angle to be adjusted in both X and Y axis. The mobile stand is fitted with casters allowing it to be moved from room to room.

### 2. DeskTop Stand

Part No. moorLDI2-DS2.

The desktop stand provides a means of height and angular adjustment for the scanning head when the system is used on the bench.

### 3. moorLDI2-PPC kit

Panel PC kit designed for use in conjunction with the MS2 system. Standard specification touch screen panel PC with mounting arm to fit directly to the MS2. Supplied with miniature keyboard and trackball, framegrabber card and 2 year 'return to base' warranty. Also included - mini colour Bubblejet printer for printout of results.

# 26. DISPOSAL

**WEEE Statement**

In an effort to improve waste management in the European Union, the European Union has enacted a Directive 2002/96/EC on Waste Electrical and Electronic Equipment (WEEE Directive). Annex 1A and 1B, Item 8 Medical devices (with the exception of all implanted and infected products) and Item 9 Monitoring and Control Instruments applies to products manufactured by Moor Instruments Ltd.

According to the WEEE Directive, Moor Instruments Ltd must take back waste electrical or electronic equipment covered under the WEEE Directive, for all products it puts on the market after 13 August 2005. Products entitled to free take-back are:

1. Purchased after 13 August 2005, or
2. Labeled with the WEEE label (shown on the right), on the product or packaging, or
3. Unlabeled, historical waste if customers are replacing product with new product of a like kind.

**The Return Process:**

1. Customer contacts Moor Instruments Ltd for details of return procedure (see section 23).
2. Upon completion of returns procedure, Customer sends product using the address provided by Moor Instruments Ltd.
3. All returned goods must be marked according to Moor Instruments Ltd returns procedure.

# APPENDIX 1. PREPARING YOUR moorLDI2 IMAGER FOR THE NEW SOFTWARE

The following procedures have been performed at manufacture and installation for all **moorLDI2** imagers from August 2002. The proceedures should be applied to earlier **moorLDI2** imagers.

## Overview

Before you can run the latest release software, it is necessary to:

Use the Service Software (mldise29u) to record the serial number of your system in LDI memory.

Use the Calibration Software V1.1 to perform a calibration check and recalibrate if required.

Use the Service Software (mldise29u) to calculate the individual distance scaler for your system.

**Note: only one software program should be running at any one time:**

**Close the Service software prior to opening the Calibration software.**

**Close the Calibration software prior to opening the Service software.**

When these tasks have been completed, you should use the installation disc supplied with this package to load the new software onto your PC.

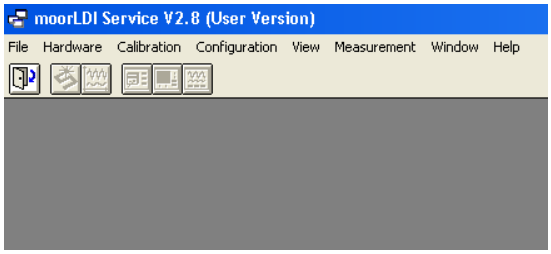
Full information is to be found on the following pages.

## Record the serial number of your LDI

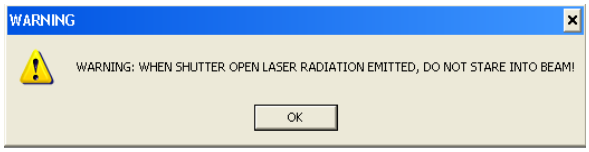
Examine the labels on the back panel of either the scan head or the control box for the MLDI number. This is a four figure number beginning **MLDI 5 _ _ _.** Make a note of this number.

Ensure the LDI is connected to the PC via the Moor RS232 lead and that both the PC and the LDI are switched on.

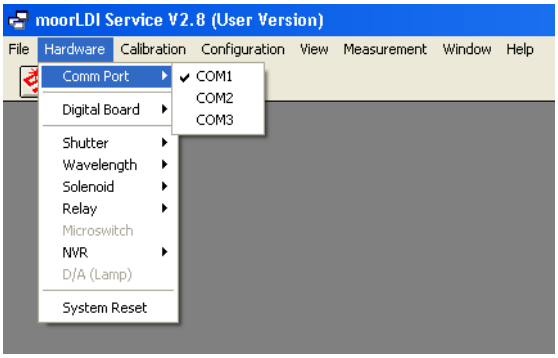
1.1 Load the moorLDI service package 2.8 (Mldise29u.exe). The following screen will appear:



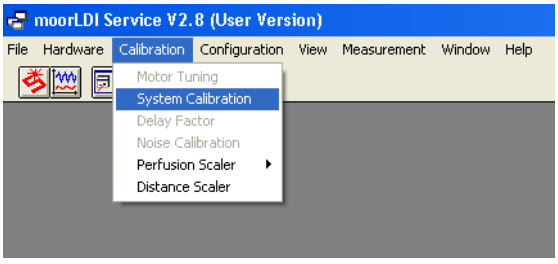

1.2 Click the Shutter Open icon and observe the laser hazard warning.



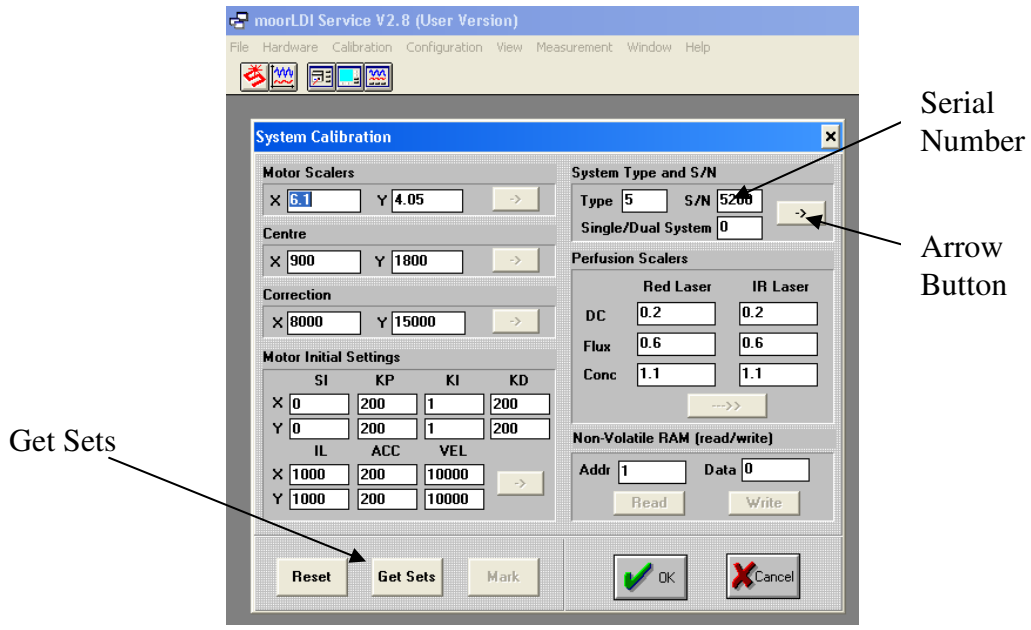

1.3 Check the COM port setting is correct. This is set by default to COM1 but if your LDI is connected to COM2 or COM3 etc then you will need to select accordingly.




1.4 Check if the serial number is already in the LDI memory by clicking on ‘Calibration’ then ‘System Calibration’….




….then ‘Get sets’. If the serial number is already loaded, it will appear in the appropriate box. See below:




1.5 If the serial number box is blank or the serial number displayed is incorrect, re-enter the correct serial number in the appropriate box and click the small right arrow button to the right of the Serial Number box. Confirm that the correct settings are entered by clicking on ‘Get sets’ again.

## Perform a calibration check and recalibrate if required

**Note:** This calibration check is only for calibration software V1.0 users. Systems with LDI calibration V2.0 should consult section 19.2 for calibration checks.

**Set Up:**

2.1 Avoid bright lighting; draw blinds/curtains and switch off desk lamps.

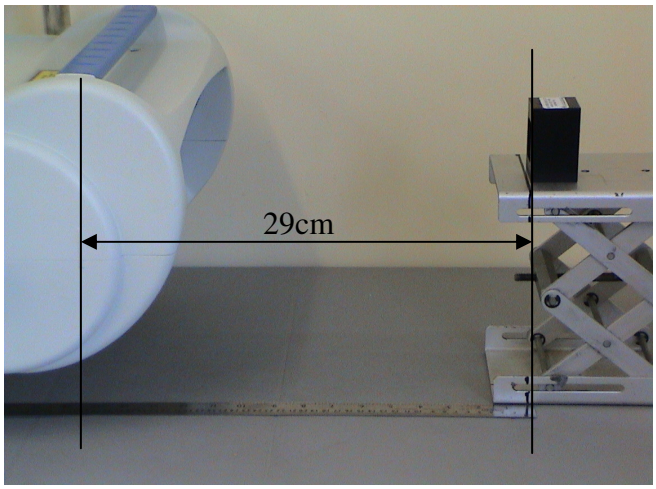
2.2 Avoid vibration.

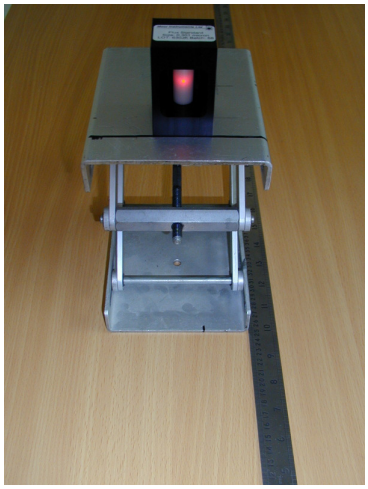
2.3 Ensure the flux standard is equilibrated to room temperature for at least 60 minutes.

2.4 Ensure the LDI has been powered on for at least 30 minutes.

2.5 Gently shake calibration block for about 10 seconds - allow to settle for about 2 minutes before calibrating.

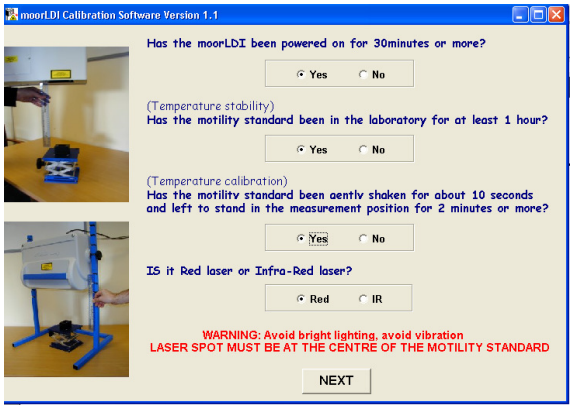
2.6 Set up the open face of the calibration block 29cm from the front panel of the moorLDI (below left). The bottle surface will then be 30cm from the front panel of the LDI as it is recessed within the block. Adjust the position of the block up and down so that the **centre** of the bottle is illuminated - a lab jack stand is an ideal tool for this (below right).



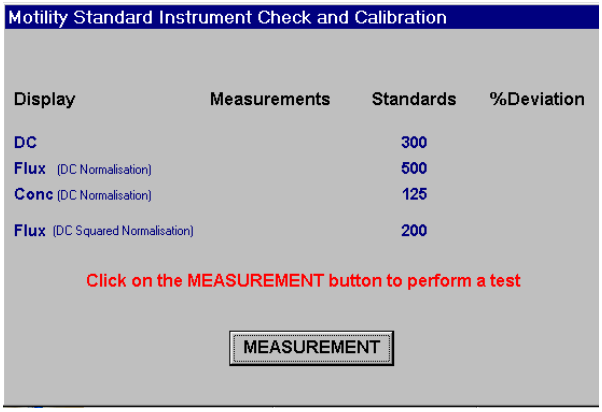



2.7 Load Moor Calibration utility **(exit any other moorLDI measurement software beforehand)**.

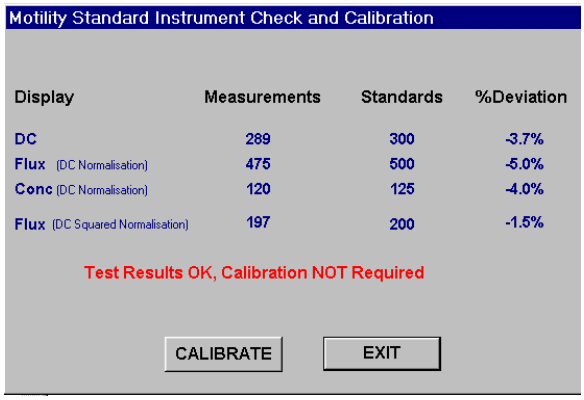
2.8 Check set up conditions on start-up screen and click on the NEXT button. Note you will not be able to progress to check and calibrate unless these conditions have been satisfied.

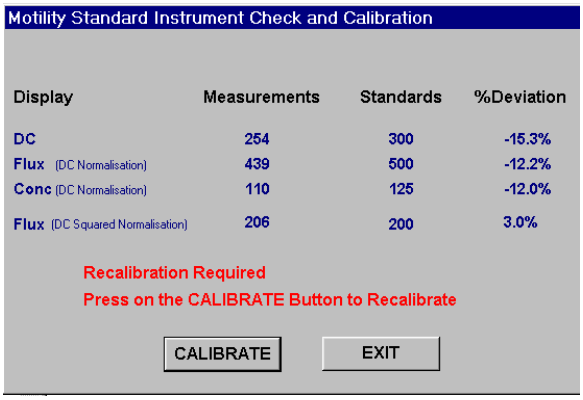



2.9 The Measurement screen appears next. This allows the user to check actual measurements from the motility standard with standard values.
Click Measurement to proceed.




2.10 Test results appear with % Deviation from standard calculated. In the example, below left, the deviation is within the acceptable range and calibration is not recommended - in which case quit the utility with the EXIT key.



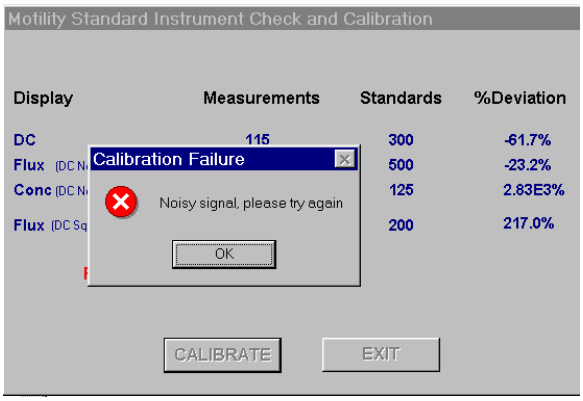



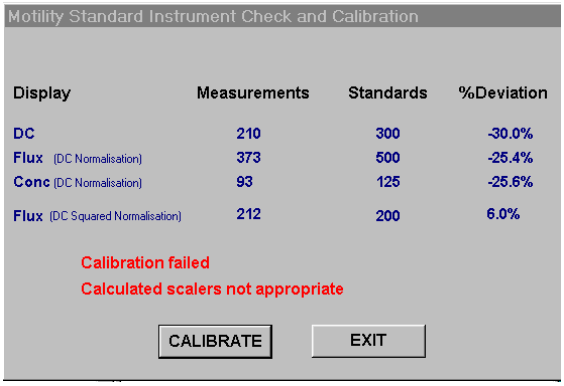
2.11 If measured values are outside acceptable limits (above right), then proceed to calibration with the CALIBRATE key.

Do not calibrate if there is any doubt about the set up and accurate positioning of the calibration block. Exit and repeat, from 2.1.

2.12 If there is excessive vibration during calibration then the Noisy Signal Message appears (below left). Attempt calibration a second time by clicking OK, then CALIBRATE.

If the moorLDI persistently fails to calibrate, consult Moor Instruments or your authorised distributor for further guidance.



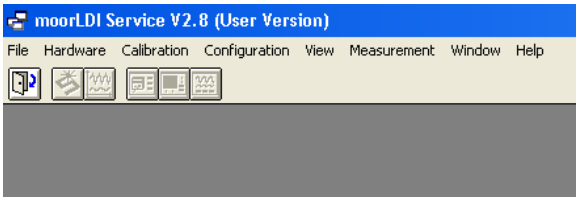



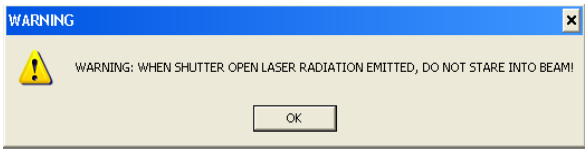

2.13 If the 'Calibration failed' message appears (above right), press EXIT and re-load the calibration utility. Pay particular attention to measurement conditions, following instructions from 2.1. If the moorLDI persistently fails to calibrate, consult Moor Instruments or your authorised distributor for further guidance.

## Setting Distance Scaler

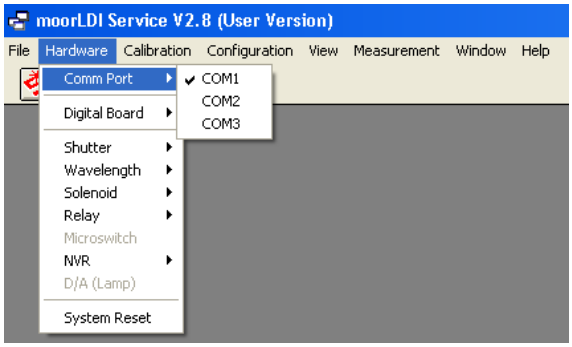
3.1 Exit Calibration package and re-load moorLDI Service V2.8 (Mldise29u.exe).

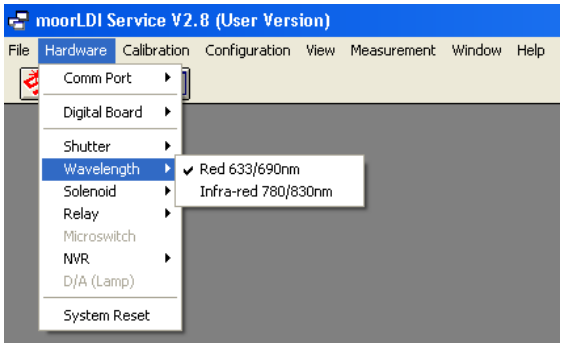
3.2 Open shutter and observe laser safety warning.



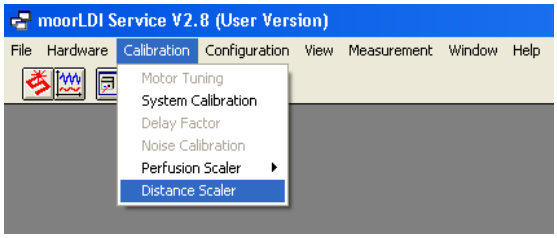




3.3 Check the COM port corresponds to your system (i.e. COM1) and that the laser wavelength is set to red.

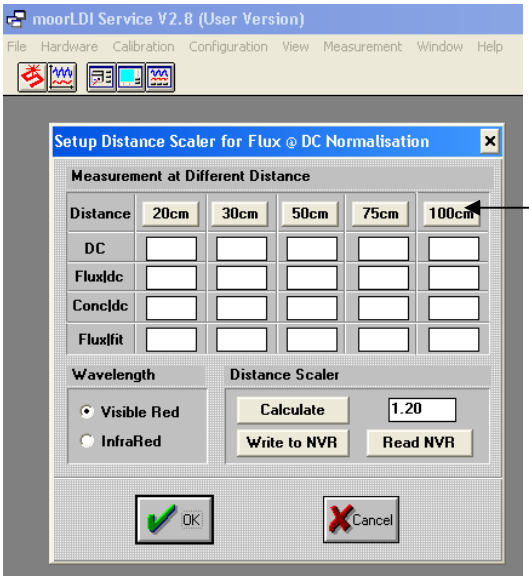



3.4 Select ‘Calibration’ and Distance Scaler’.



The following screen will appear:




3.5 **Check the background lighting: this is an important step. The background lighting must be sufficiently low prior to calculation of the distance scaler.**

a) Set up the LDI in exactly the same way as for calibration, observing the same precautions.
b) Remove the calibration block. Place a piece of black cloth 100cm from the front of the LDI.
c) Ensure the laser beam is aimed at the black cloth.
d) Ensure there is no reflection into the scan head i.e. from a white/light coloured wall or surface.
e) Click on the 100cm measurement button.
f) If the DC reading is HIGHER than five; reduce the lighting and repeat steps a-e.
g) If the DC reading is below five; continue with the distance scaler measurements (see 3.6).

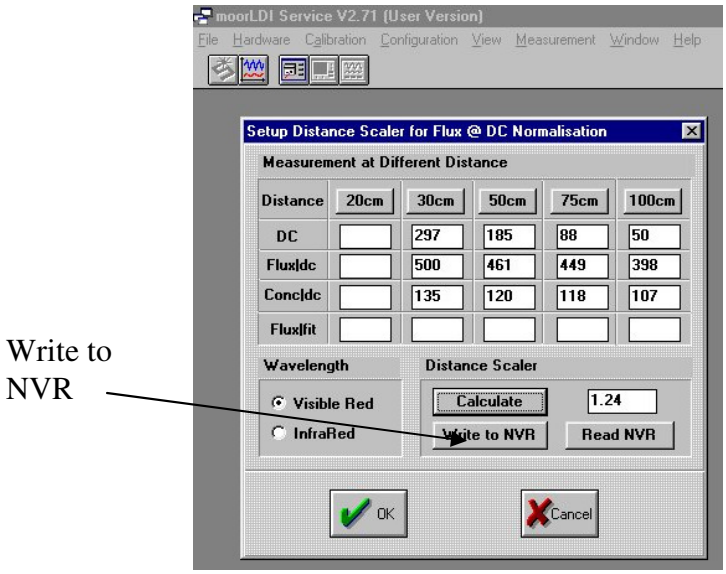
3.6 Click 30cm button to perform the flux measurement at 30cm.

3.7 Move the front face of the calibration block to 48cm from the LDI front panel. Check the laser is still aimed at the centre of the calibration bottle. Click the 50cm button to perform a flux measurement.

3.8 Move the front face of the calibration block to 73cm from the LDI front panel. Check the laser is still aimed at the centre of the calibration bottle. Click the 75cm button to perform a flux measurement.

3.9 Move the front face of the calibration block to 98cm from the LDI front panel. Check the laser is still aimed at the centre of the calibration bottle. Click the 100cm button to perform a flux measurement.

3.10 After all four measurements have been performed, click ‘Calculate’. This function calculates the ‘best fit’ Distance scaling factor for your system.




3.11 Press the 'Write to NVR' button to record the distance scaler in the LDI memory.

3.12 Click OK and exit the service program.

3.13 Your LDI is now ready to use with the new software.

# APPENDIX 2. moorLDI/IONTOPHORESIS USER MANUAL V5

## 2.1 INTRODUCTION

This Appendix covers information specific to use of **moorLDI** laser Doppler imagers suitably modified for running iontophoresis protocols.

For a general introduction to iontophoresis and the MIC1-e and MIC2 iontophoresis controllers, this manual should be read in conjunction with the MIC1-e or MIC2 Iontophoresis Controller User Guides.

**The MIC1-e or MIC2 User Guide should be consulted regarding electrical safety: the Warnings and Precautions should be read prior to use.**

**moorLDI** functions for the MIC1-e and MIC2 devices are similar: **moorLDI** protocol software controls either device to output the required current during each scan period of a repeat scan set. The MIC2 has the additional function to output iontophoresis voltage. This signal is acquired by **moorLDI** and can be used to calculate skin resistance.

## 2.2 INSTRUCTIONS FOR USE OF moorLDI / IONTOPHORESIS

### 2.2.1 Protocol Duration

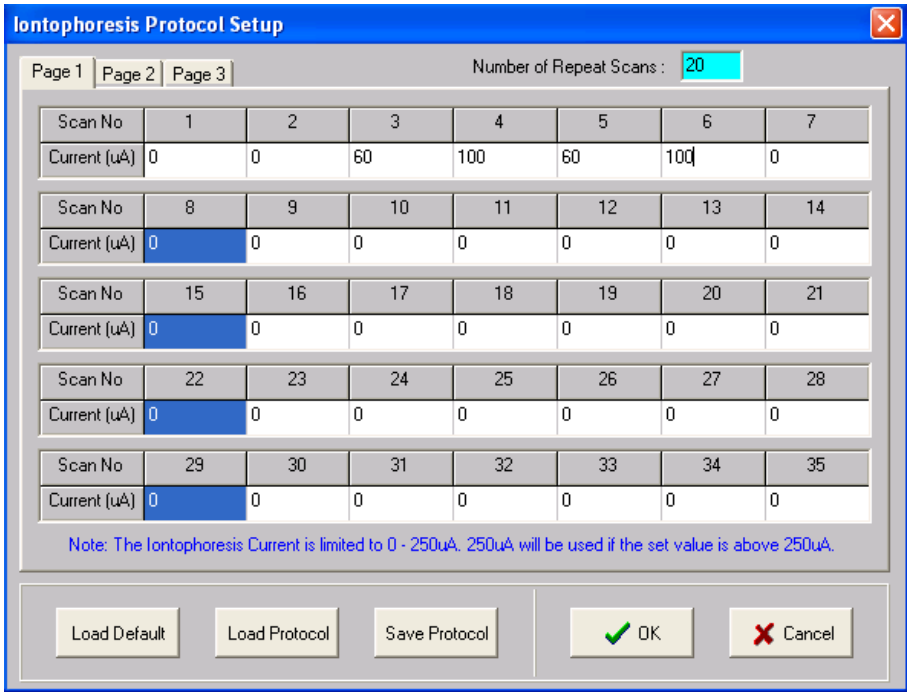
The overall duration of **moorLDI**/ionto measurement protocol is determined by the Repeat Scan number (max 105) and Interval. The required interval must exceed the scan duration (determined by scan area and resolution; as set in the Scanner Setup window.

### 2.2.2 Period of Iontophoresis

Iontophoresis is timed to start and stop with increments equal to one or more scan intervals i.e. iontophoresis starts at the start of one scan and stops just before the start of the next.

### 2.2.3 Iontophoresis Protocol Configuration

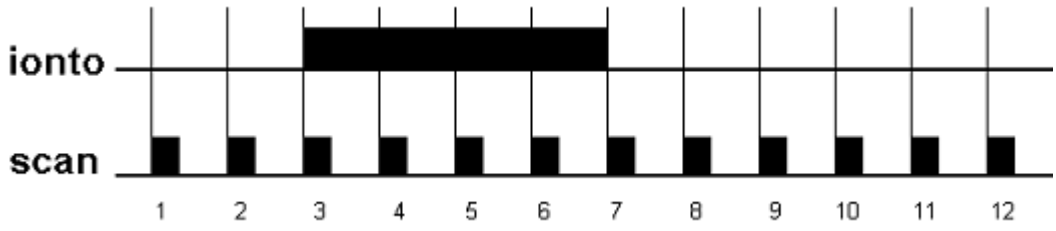

To set up an automatic iontophoresis protocol select Ionto or click the ION icon
Iontophoresis Protocol Menu




**The minimum current that will activate the MIC1-e controller is 10µA.**
**The minimum current that will activate the MIC2 controller is 4µA*.**
**The maximum current that can be selected is 250µA for MIC1-e or MIC2**

* A minimum current of 1µA can be obtained when the MIC2 is used in manual mode.

Other variables within the Iontophoresis Protocol Settings window are:
**Number of Repeat Scans -** the total number of scans.
The total duration of iontophoresis is determined by the **Repeat Interval** and the number of scans during which a current is selected. The repeat interval is set in Scanner Setup, Repeat and Line Scan. (see Section 8)




Schematic to show the Iontophoresis Current/ Scan interval protocol

## 2.3 PAUSE FUNCTION

The normal pause function operates as follows:

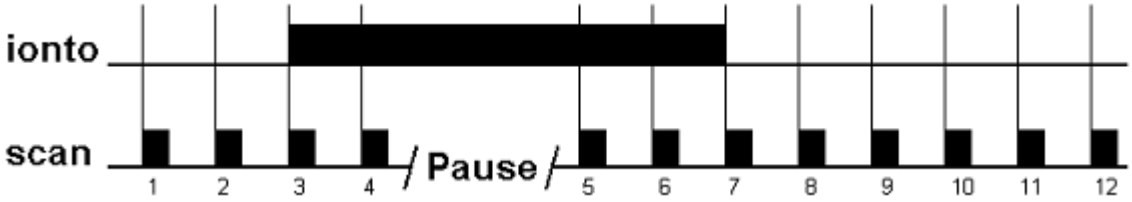
During a scan the scan stops but the iontophoresis continues at its set current.

During the interval between scans the iontophoresis continues at its set current.

Pause can be used to manually alter the iontophoresis duration and scan interval.

There is a timer at the bottom left of the screen. This continues to count down the time remaining of the total scan interval and then counts up the **extra** time caused by the Pause function.

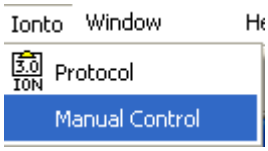
Pause can be useful to allow extra temperature equilibration time after filling an ion chamber when dry and wet skin baseline measurements are required. **The effect of a pause is shown below.**

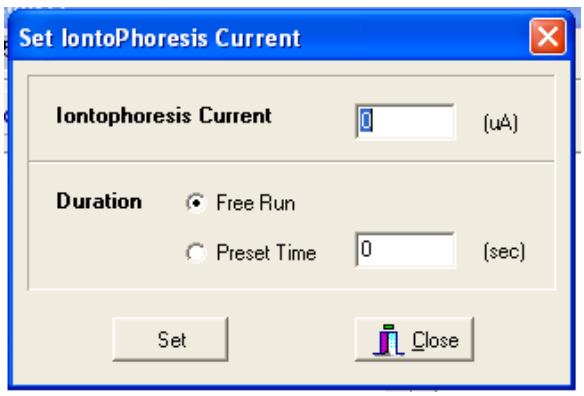



## 2.4 MANUAL IONTOPHORESIS

This is intended for use only when periods are required unrelated to scan interval. The baseline recording and response recordings can only be made in separate single scan and or repeat scan window. It cannot be used during an interval within a repeat scan.

To iontophorese using this mode select **Ionto, Manual Control**
The **Iontophoresis Cuurent** window will then allow **Current** and its **Duration** to be set.

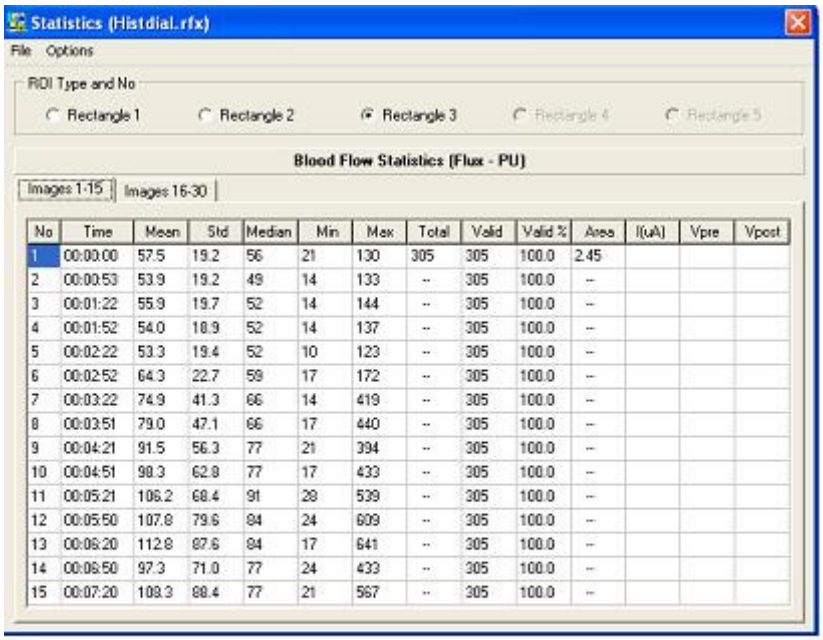



To start the iontophoresis current click on **Set** and at the end of iontophoresis click on **Close**. A scan cannot be started until this window is closed.

## 2.5 PROTOCOL ANALYSIS

Iontophoresis responses are assessed after selecting a region of interest (ROI) on the flux or DC image corresponding to the area iontophoresed. Statistical analysis of the ROI tabulates results for flux and dc levels, as per the standard **moorLDI** analysis, and also tabulates set current (I[uA]) and voltages (V1 and V2[V]) measured at the start and end of a scan interval.




| No | Time | Mean | Std | Median | Min | Max | Total | Valid | Valid % | Area | I(uA) | Vpre | Vpost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 00:00:00 | 57.5 | 19.2 | 56 | 21 | 130 | 305 | 305 | 100.0 | 2.45 | | | |
| 2 | 00:00:53 | 53.9 | 19.2 | 49 | 14 | 133 | -- | 305 | 100.0 | -- | | | |
| 3 | 00:01:22 | 55.9 | 19.7 | 52 | 14 | 144 | -- | 305 | 100.0 | -- | | | |
| 4 | 00:01:52 | 54.0 | 18.9 | 52 | 14 | 137 | -- | 305 | 100.0 | -- | | | |
| 5 | 00:02:22 | 53.3 | 19.4 | 52 | 10 | 123 | -- | 305 | 100.0 | -- | | | |
| 6 | 00:02:52 | 64.3 | 22.7 | 59 | 17 | 172 | -- | 305 | 100.0 | -- | | | |
| 7 | 00:03:22 | 74.9 | 41.3 | 66 | 14 | 419 | -- | 305 | 100.0 | -- | | | |
| 8 | 00:03:51 | 79.0 | 47.1 | 66 | 17 | 440 | -- | 305 | 100.0 | -- | | | |
| 9 | 00:04:21 | 91.5 | 56.3 | 77 | 21 | 394 | -- | 305 | 100.0 | -- | | | |
| 10 | 00:04:51 | 98.3 | 62.8 | 77 | 17 | 433 | -- | 305 | 100.0 | -- | | | |
| 11 | 00:05:21 | 106.2 | 68.4 | 91 | 28 | 539 | -- | 305 | 100.0 | -- | | | |
| 12 | 00:05:50 | 107.8 | 79.6 | 84 | 24 | 609 | -- | 305 | 100.0 | -- | | | |
| 13 | 00:06:20 | 112.8 | 87.6 | 84 | 17 | 641 | -- | 305 | 100.0 | -- | | | |
| 14 | 00:06:50 | 97.3 | 71.0 | 77 | 24 | 433 | -- | 305 | 100.0 | -- | | | |
| 15 | 00:07:20 | 108.3 | 88.4 | 77 | 21 | 567 | -- | 305 | 100.0 | -- | | | |

Note that the initial iontophoresis voltage is measured 0.5 seconds after the start of each scan and the second measurement is made immediately before the end of each scan interval. The initial delay is necessary to enable voltage to reach a meaningful value close to the initial peak and the second measurement records the final, plateau level. (It is not possible to monitor voltage continuously by **moorLDI**, due to image data requirements. This feature is available on the DRT4 laser Doppler/Temperature Monitor.)

Both voltages are displayed during measurement and review below the corresponding repeat scan image. The set current (I) can be used to calculate skin resistance: the current will be accurate to within +/-1uA unless resistance is too high and voltage approaches the 27 V maximum.

## 2.6 RECOMMENDATIONS AND PROTOCOLS

Suggestions for protocols are based on analyses that can be obtained with the standard repeat scan analysis and any subsequent processing by hand or within a spreadsheet etc.

### 2.6.1 Recommendations

1. Perform at least 2 baseline images to test for baseline stability.

2. Apply low currents (i.e. less than 100µA per $cm^2$) to avoid the non-specific 'galvanic effect'.

3. Using the complete protocol test for galvanic effect using blank controls i.e. vehicle (e.g. sterilised water) alone without any dissolved drug.

4. Assess, by pilot study, the time to reach a response plateau for each drug used and in each patient group.

5. Each scan takes a finite time so the responses at the beginning and end of a scan may be different. To avoid problems over this reduce the scan duration (lower the image resolution) and only take note of plateau levels whenever practical.

### 2.6.2 Protocol 1

Select a scan interval of 60 seconds. The total protocol duration will be 15minutes.

| Scan | Current |
|---|---|
| 1 | 0 |
| 2 | 0 |
| 3 | 0 |
| 4 | 25 |
| 5 | 25 |
| 6 | 25 |
| 7 | 25 |
| 8 | 25 |
| 9 | 25 |
| 10 | 25 |
| 11 | 25 |
| 12 | 25 |
| 13 | 25 |
| 14 | 0 |
| 15 | 0 |
| etc | |

### 2.6.3 Protocol 1 Analysis

The baseline flux values can be averaged (B) and the plateau level assessed from the values of scans 11, 12 and 13 (P). The coefficient of variance (COV) is likely to be improved by expressing the response as a percentage change: i.e. P/B x 100%

The persistence of response (R) cannot easily be assessed by imaging because of the discrete measurement intervals. In place of this one may assess the fall off at a particular time (5 mins, say) after stopping iontophoresis e.g. $R(5) = \frac{\text{level at 5 minutes post}}{P} \times 100\%$

(The above protocol could be simplified by using a **6 minute Pause** instead of scans 5 to 10, because iontophoresis is maintained at the set current during Pause. However this requires manual intervention. The plateau can be assessed from scans 11 – 13).

### 2.6.4 Protocol 2

This protocol may be used to obtain a cumulative dose response curve: the suggested scan interval is 5 minutes, the total protocol duration is 45 minutes.

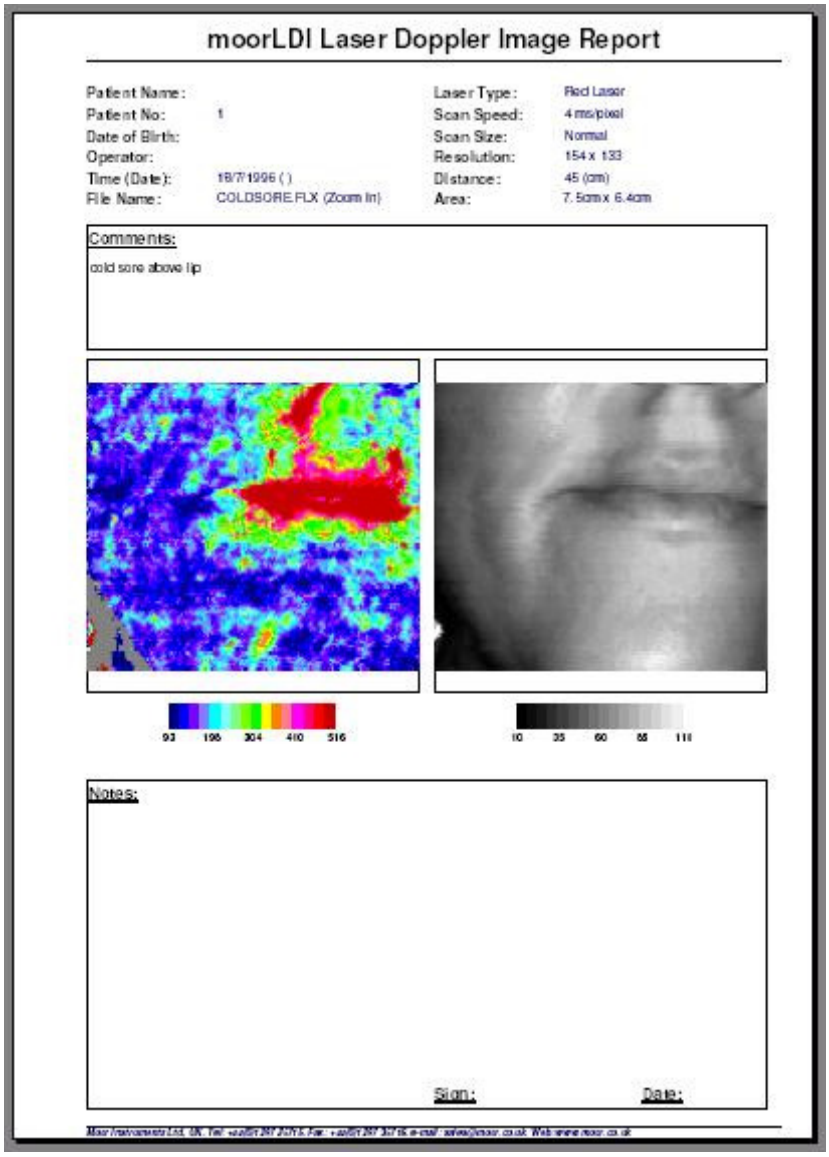
| Scan | Current |
|---|---|
| 1 | 0 |
| 2 | 20 |
| 3 | 20 |
| 4 | 40 |
| 5 | 40 |
| 6 | 80 |
| 7 | 80 |
| 8 | 0 |
| 9 | 0 |

### 2.6.5 Protocol 2 Analysis

Analyses are similar to that of protocol 1:B, P(20), P(40), P(80) and R(5).

Assuming scan duration is small compared to response times, the P(20) value can be obtained from scan 4, P(40) from scan 6, P(80) from scan 8 and R(5) from scan 9. B can be obtained from scans 1 and 2. This can only be done if a pilot study with more frequent scans shows that initial responses are negligible within a single scan duration.

# APPENDIX 3. PRINTOUTS FROM PROCESSING


moorLDI Laser Doppler Image Report

Patient Name:
Patient No: 1
Date of Birth:
Operator:
Time (Date): 18/7/1996 ( )
File Name: COLDSORE.FLX (Zoom In)

Laser Type: Red Laser
Scan Speed: 4 ms/pixel
Scan Size: Normal
Resolution: 154 x 133
Distance: 45 (cm)
Area: 7.5cm x 6.4cm

Comments:
cold sore above lip

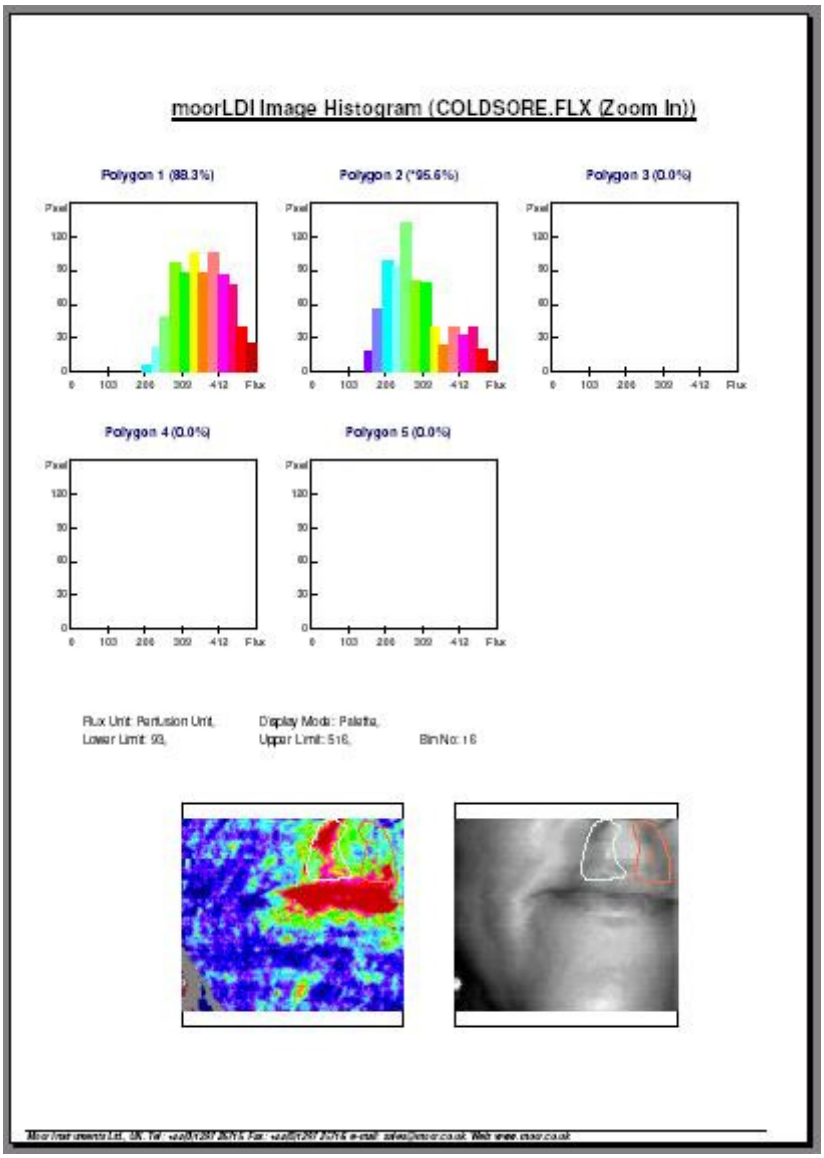
93 196 304 410 516

10 35 60 85 110

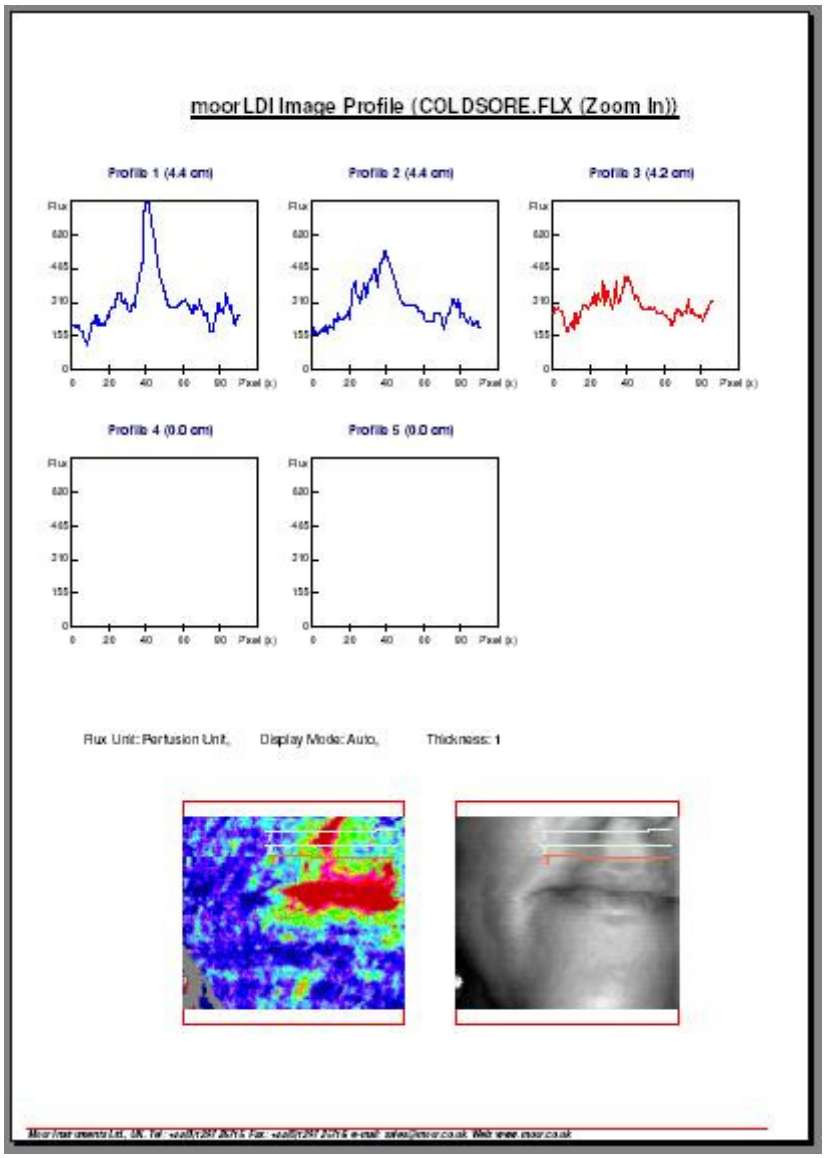
Notes:

Sign: Date:

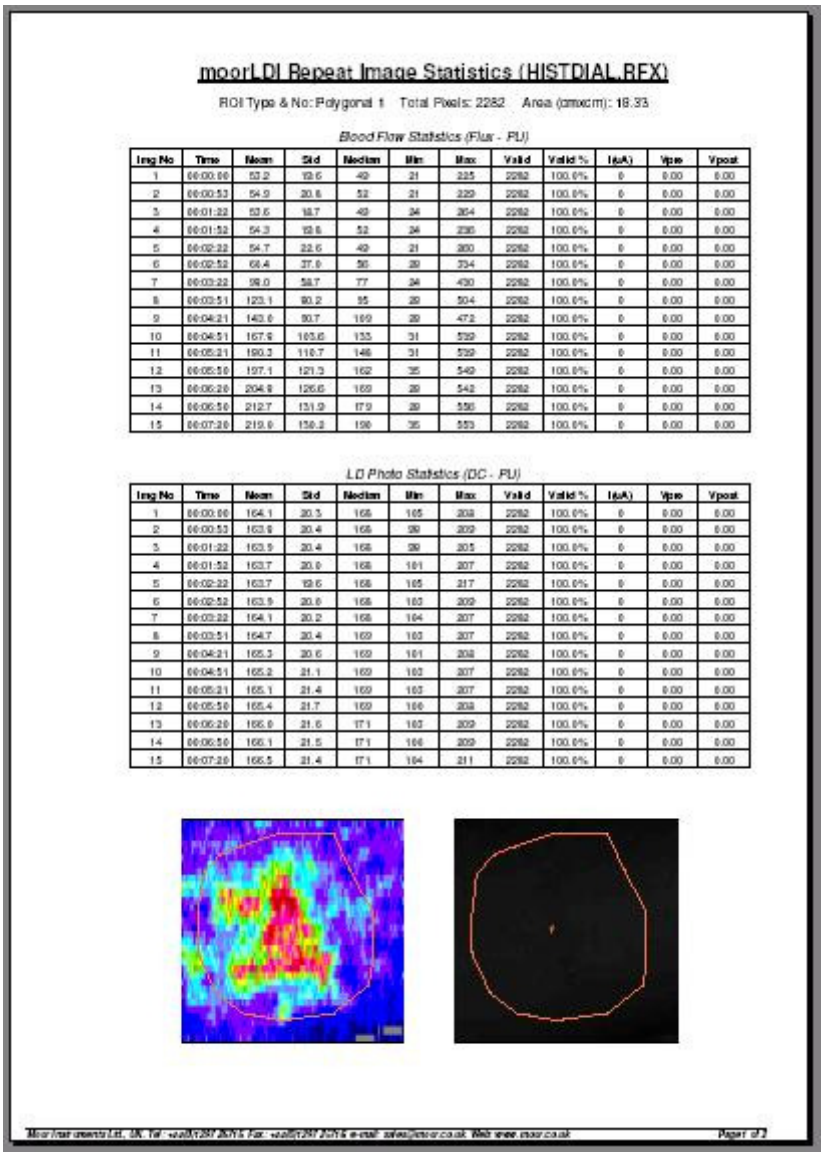
Report generated by the PRINT REPORT function (see section 12.3)




Report generated when a Histogram window printout is selected (see section 15.3).




Report generated when a Profile window printout is selected (see section 15.4).



moorLDI Repeat Image Statistics (HISTDIAL.REX)

ROI Type & No: Polygonal 1  Total Pixels: 2282  Area (cm²cm): 18.33

*Blood Flow Statistics (Flux - PU)*

| Img No | Time | Mean | Std | Median | Min | Max | Valid | Valid % | I(uA) | Vpre | Vpost |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 00:00:00 | 53.2 | 19.6 | 49 | 21 | 225 | 2282 | 100.0% | 0 | 0.00 | 0.00 |
| 2 | 00:00:53 | 54.9 | 20.6 | 52 | 21 | 229 | 2282 | 100.0% | 0 | 0.00 | 0.00 |
| 3 | 00:01:22 | 52.6 | 18.7 | 49 | 24 | 264 | 2282 | 100.0% | 0 | 0.00 | 0.00 |
| 4 | 00:01:52 | 54.3 | 19.6 | 52 | 24 | 236 | 2282 | 100.0% | 0 | 0.00 | 0.00 |
| 5 | 00:02:22 | 54.7 | 22.6 | 49 | 21 | 280 | 2282 | 100.0% | 0 | 0.00 | 0.00 |
| 6 | 00:02:52 | 58.4 | 37.9 | 50 | 20 | 334 | 2282 | 100.0% | 0 | 0.00 | 0.00 |
| 7 | 00:03:22 | 98.0 | 58.7 | 77 | 24 | 430 | 2282 | 100.0% | 0 | 0.00 | 0.00 |
| 8 | 00:03:51 | 123.1 | 80.2 | 95 | 20 | 504 | 2282 | 100.0% | 0 | 0.00 | 0.00 |
| 9 | 00:04:21 | 143.6 | 90.7 | 109 | 20 | 472 | 2282 | 100.0% | 0 | 0.00 | 0.00 |
| 10 | 00:04:51 | 167.9 | 103.6 | 133 | 31 | 539 | 2282 | 100.0% | 0 | 0.00 | 0.00 |
| 11 | 00:05:21 | 190.3 | 110.7 | 146 | 31 | 539 | 2282 | 100.0% | 0 | 0.00 | 0.00 |
| 12 | 00:05:50 | 197.1 | 121.3 | 162 | 35 | 549 | 2282 | 100.0% | 0 | 0.00 | 0.00 |
| 13 | 00:06:20 | 204.8 | 126.6 | 169 | 20 | 542 | 2282 | 100.0% | 0 | 0.00 | 0.00 |
| 14 | 00:06:50 | 212.7 | 131.9 | 179 | 20 | 550 | 2282 | 100.0% | 0 | 0.00 | 0.00 |
| 15 | 00:07:20 | 219.9 | 136.2 | 186 | 35 | 553 | 2282 | 100.0% | 0 | 0.00 | 0.00 |

*LD Photo Statistics (DC - PU)*

| Img No | Time | Mean | Std | Median | Min | Max | Valid | Valid % | I(uA) | Vpre | Vpost |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 00:00:00 | 164.1 | 20.3 | 168 | 105 | 209 | 2282 | 100.0% | 0 | 0.00 | 0.00 |
| 2 | 00:00:53 | 163.8 | 20.4 | 168 | 99 | 209 | 2282 | 100.0% | 0 | 0.00 | 0.00 |
| 3 | 00:01:22 | 163.9 | 20.4 | 168 | 99 | 205 | 2282 | 100.0% | 0 | 0.00 | 0.00 |
| 4 | 00:01:52 | 163.7 | 20.9 | 168 | 101 | 207 | 2282 | 100.0% | 0 | 0.00 | 0.00 |
| 5 | 00:02:22 | 163.7 | 19.6 | 168 | 105 | 217 | 2282 | 100.0% | 0 | 0.00 | 0.00 |
| 6 | 00:02:52 | 163.9 | 20.6 | 168 | 103 | 209 | 2282 | 100.0% | 0 | 0.00 | 0.00 |
| 7 | 00:03:22 | 164.1 | 20.2 | 168 | 104 | 207 | 2282 | 100.0% | 0 | 0.00 | 0.00 |
| 8 | 00:03:51 | 164.7 | 20.4 | 169 | 103 | 207 | 2282 | 100.0% | 0 | 0.00 | 0.00 |
| 9 | 00:04:21 | 165.3 | 20.6 | 169 | 101 | 208 | 2282 | 100.0% | 0 | 0.00 | 0.00 |
| 10 | 00:04:51 | 165.2 | 21.1 | 169 | 103 | 207 | 2282 | 100.0% | 0 | 0.00 | 0.00 |
| 11 | 00:05:21 | 165.1 | 21.4 | 169 | 103 | 207 | 2282 | 100.0% | 0 | 0.00 | 0.00 |
| 12 | 00:05:50 | 165.4 | 21.7 | 169 | 106 | 208 | 2282 | 100.0% | 0 | 0.00 | 0.00 |
| 13 | 00:06:20 | 165.6 | 21.6 | 171 | 103 | 209 | 2282 | 100.0% | 0 | 0.00 | 0.00 |
| 14 | 00:06:50 | 165.1 | 21.5 | 171 | 106 | 209 | 2282 | 100.0% | 0 | 0.00 | 0.00 |
| 15 | 00:07:20 | 165.5 | 21.4 | 171 | 104 | 211 | 2282 | 100.0% | 0 | 0.00 | 0.00 |





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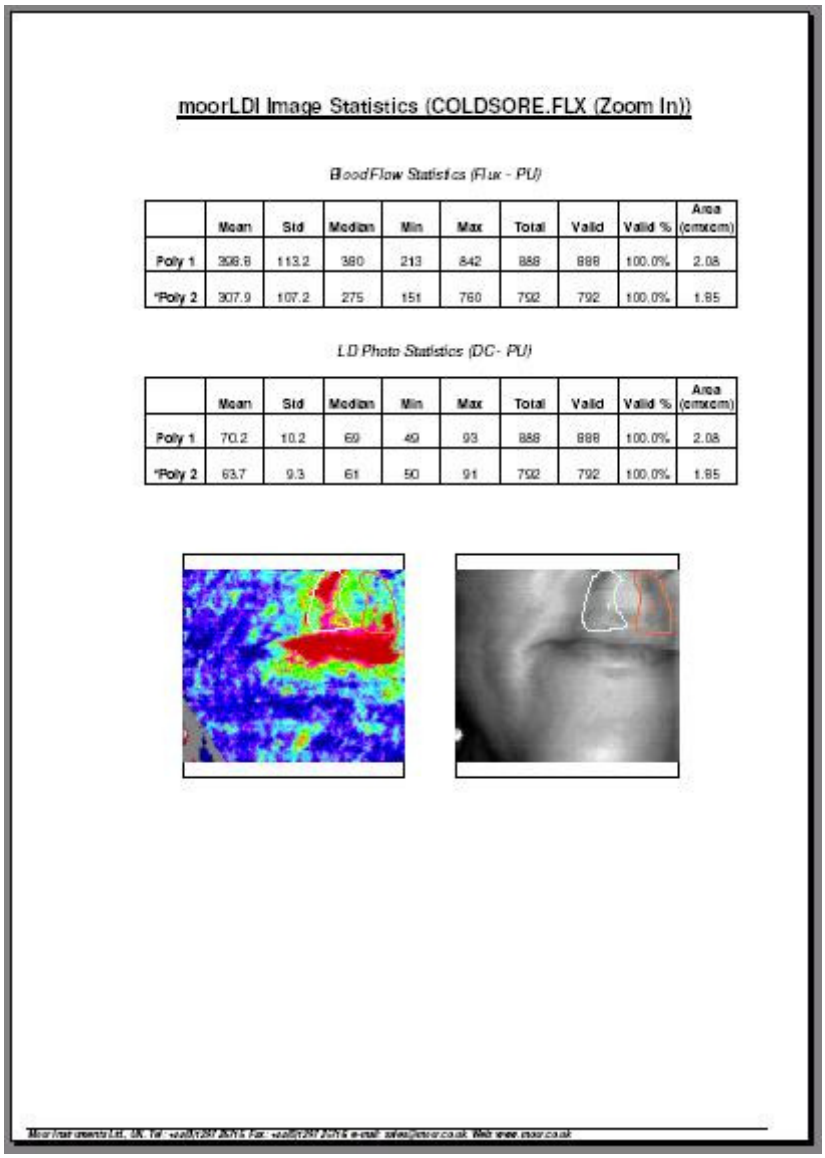
Report generated when Repeat Scan Statistics (Numerical Table) are printed (see section 16.1.2).



moorLDI Image Statistics (COLDSORE.FLX (Zoom In))

*BloodFlow Statistics (Flux - PU)*

| | Mean | Std | Median | Min | Max | Total | Valid | Valid % | Area (cmxcm) |
|---|---|---|---|---|---|---|---|---|---|
| Poly 1 | 398.8 | 113.2 | 380 | 213 | 842 | 888 | 888 | 100.0% | 2.08 |
| *Poly 2 | 307.9 | 107.2 | 275 | 151 | 760 | 792 | 792 | 100.0% | 1.85 |

*LD Photo Statistics (DC - PU)*

| | Mean | Std | Median | Min | Max | Total | Valid | Valid % | Area (cmxcm) |
|---|---|---|---|---|---|---|---|---|---|
| Poly 1 | 70.2 | 10.2 | 69 | 49 | 93 | 888 | 888 | 100.0% | 2.08 |
| *Poly 2 | 63.7 | 9.3 | 61 | 50 | 91 | 792 | 792 | 100.0% | 1.85 |

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Report generated when a Single Image Statistics window printout is selected (see section 15.2).

# INDEX

## *R*



## *S*



## *T*



## *U*



## *V*



## *W*