Lucid Optical Services Ltd.

Certificate of Compliance

This is to certify that the optical output of the:

SENSORNET LR-DTS Temperature Sensing System:
(Variants Mark 1, Mark 2a and Mark 2b)

Meets the requirements stated in IEC 60825-1:2001
for laser product classification:

Class 1M

Analysis of the system against the IEC 60825-1:2001 laser safety standard is detailed in report No. Lucid 2004/02/Sensornet/01 by Lucid Optical Services Ltd.

Test performed: 29/7/2004

Certificate number: 2006/06/Sensornet/01

Dr Annette Colton,
Lucid Optical Services Ltd.

sensornet

THE SENSING ADVANTAGE

SENTINEL DTS QUICK START GUIDE

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1. SAFETY

GENERAL SAFETY

The following section provides Warnings, Cautions and Notes covering general safety aspects for the Sentinel DTS and Multiplexer. Please read all of the safety and operational warnings before connecting and operating this product.

WARNING! THIS IS A WARNING SYMBOL. THIS SYMBOL IS USED THROUGHOUT THE USER GUIDE WHENEVER THERE IS A RISK OF PERSONAL INJURY. ENSURE THAT THESE WARNINGS ARE READ AND UNDERSTOOD AT ALL TIMES.

CAUTION! This is a Caution symbol. This symbol is used throughout the user guide whenever there is a risk of damaging the Sentinel DTS system. Ensure that these warnings are read and understood at all times.

NOTES:
Used throughout the user guide to provide additional information, hints and tips.

WARNING! THE SENTINEL DTS IS HEAVY. ENSURE ADEQUATE CARE IS TAKEN WHEN LIFTING AND MOVING THE SENTINEL DTS. THE SENTINEL DTS SHOULD BE MOUNTED ON A SUITABLE SURFACE OR RACK MOUNT CAPABLE OF SUPPORTING THE SENTINEL DTS WEIGHT. THE SENTINEL DTS WEIGHS 23KG.

WARNING! THE SENTINEL DTS IS FITTED WITH COOLING VENTS AND FANS. UNDER NO CIRCUMSTANCES SHOULD THESE VENTS BE BLOCKED. FAILURE TO OBSERVE THIS WARNING MAY PRESENT A RISK OF FIRE.

CAUTION! Ensure the Sentinel DTS is connected to a suitable electrical supply. The Sentinel DTS should be connected to a 230 or 110VAC supply.

WARNING! ENSURE THE SENTINEL DTS IS ADEQUATELY EARTHED. FAILURE TO OBSERVE THIS WARNING MAY PRESENT A RISK OF ELECTRIC SHOCK.

WARNING! DO NOT EXPOSE THE SENTINEL DTS TO DAMP, HUMID OR WET CONDITIONS. FAILURE TO OBSERVE THIS WARNING MAY PRESENT A RISK OF ELECTRIC SHOCK.

WARNING! THERE ARE NO USER SERVICEABLE PARTS IN THE SENTINEL DTS. UNDER NO CIRCUMSTANCES SHOULD THE OUTER CASING OF THE SENTINEL DTS BE REMOVED. FAILURE TO OBSERVE THIS WARNING MAY PRESENT A RISK OF ELECTRIC SHOCK.

WARNING! DO NOT OPERATE THE SENTINEL DTS IN AN EXPLOSIVE OR FLAMMABLE ATMOSPHERE. FAILURE TO OBSERVE THIS WARNING MAY PRESENT A RISK OF EXPLOSION.

CAUTION! The Sentinel DTS should only be operated by suitably qualified personnel.

CAUTION! Never operate the Sentinel DTS if any damage is observed. Contact Sensornet Ltd for advice.

CAUTION! Do not expose the Sentinel DTS to adverse temperatures. This may seriously interfere with the correct operation of the Sentinel DTS.

LASER SAFETY

The Sentinel DTS is a Class 1M laser product.

The Sentinel DTS distributed sensing system incorporates a pulsed laser device whose invisible output radiation is potentially hazardous if viewed directly by eye. The laser radiation emission from the laser within the Sentinel DTS is permanently coupled into a 50/125 multimode optical fibre whose end is terminated with a E2000 angled optical fibre connector. An integral feature of the E2000 connector system is a shuttering mechanism that prevents laser radiation from being emitted when the connectors are disconnected or otherwise not in use.

The Sentinel DTS should be interfaced to a test fibre, using patch cord or pigtail assembly, fitted with a E2000 connector. The far end of the test fibre should be terminated to prevent free-space emission of laser radiation from the fibre end. It is recommended that where possible, E2000 connectors be utilized throughout the optical sensing network.

Because of the potential hazard posed by laser radiation being emitted from an exposed fibre end, the following safety warnings, cautions and notices should be observed.

WARNING! DO NOT LOOK AT OR EXAMINE EXPOSED FIBRE OR CONNECTOR ENDS WHENEVER THE DTS IS IN OPERATION.

WARNING! AVOID EYE EXPOSURE TO THE INVISIBLE LASER RADIATION EMITTED FROM FIBRE CONNECTORS OR EXPOSED FIBRE ENDS.

WARNING! DO NOT EXAMINE OR INSPECT EXPOSED FIBRE OR CONNECTOR ENDS USING A VIEWING AID SUCH AS AN EYE LOUPE OR MICROSCOPE.

WARNING! DO NOT UNDERTAKE FUSION SPLICING OR SIMILAR FIBRE JOINTING WHEN THE DTS IS IN OPERATION.

WARNING! THE DTS SYSTEM CONTAINS NO USER SERVICEABLE PARTS AND THE PROTECTIVE HOUSING FULLY ENCLOSES A CLASS 3B (EMBEDDED) LASER DEVICE. UNDER NO CIRCUMSTANCES SHOULD THE PROTECTIVE HOUSING BE REMOVED.

2. CONNECTING THE SENTINEL DTS & MULTIPLEXER

The following connections should be made between the Sentinel DTS and if required the Multiplexer and the installation.

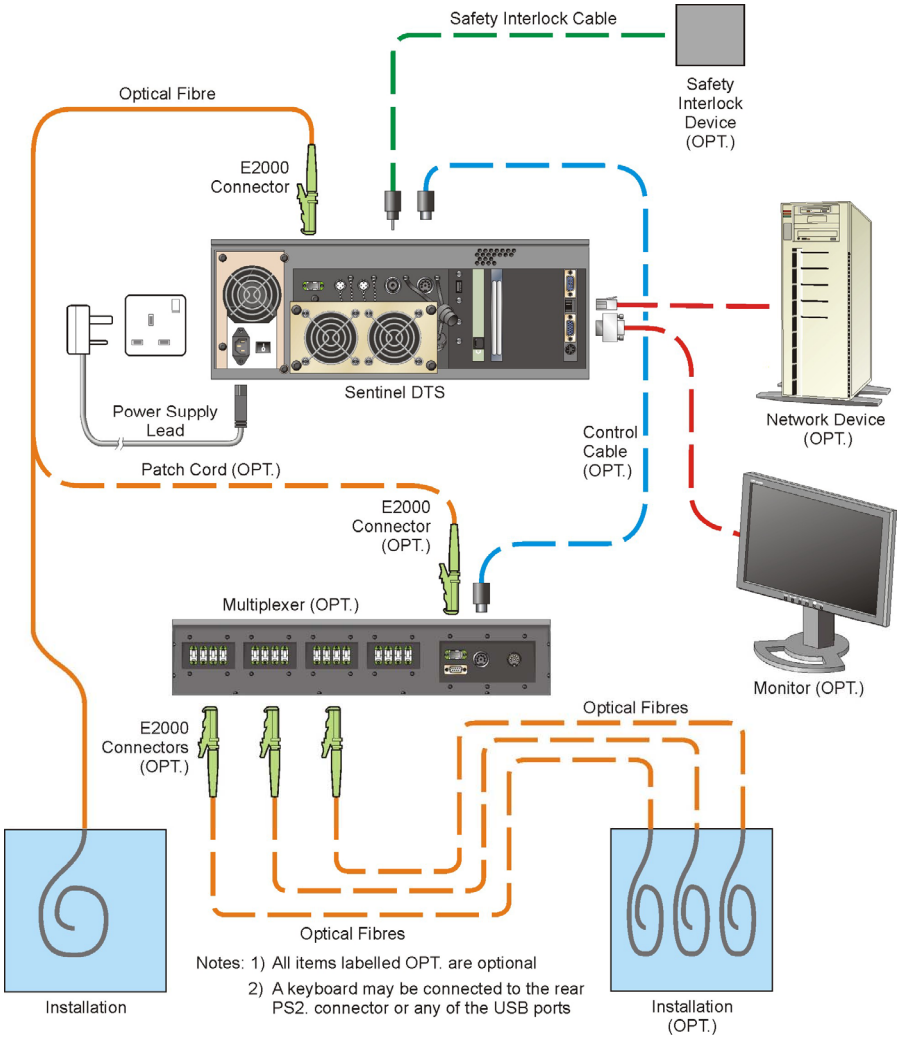

Figure 1 – The Sentinel DTS and Multiplexer Connection Diagram.

For more information on making connections using optical fibres, please refer to the Sentinel DTS User Guide.

3. THE SENTINEL DTS CONTROLS AND INDICATORS

THE SENTINEL DTS

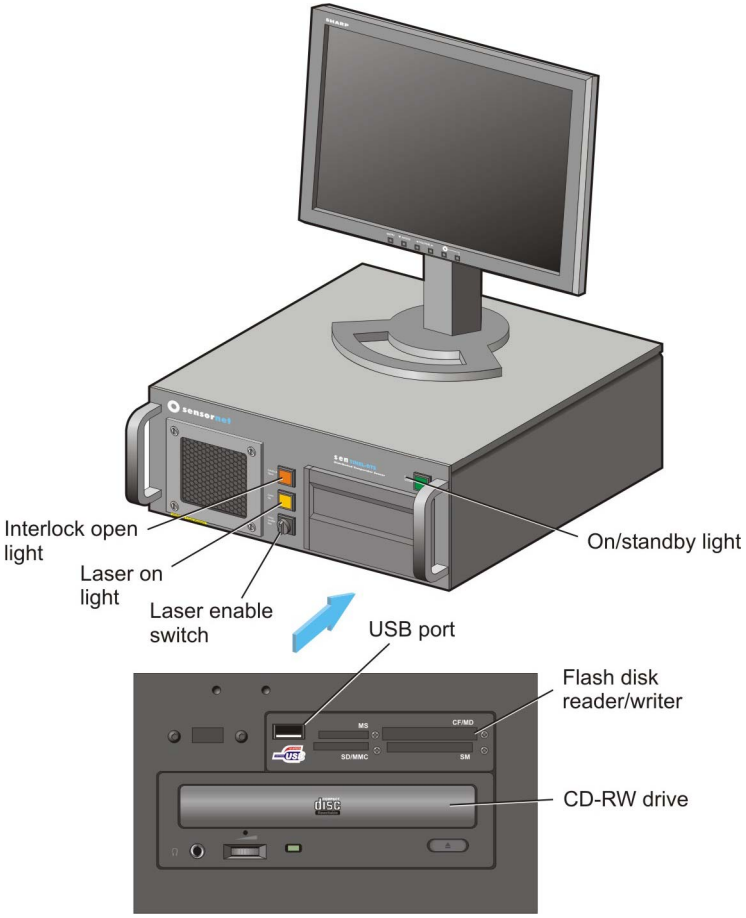

Figure 2 – The Front of the Sentinel DTS.

ON STANDBY LIGHT

When illuminated, this indicates that the Sentinel DTS is in operation.

INTERLOCK OPEN LIGHT

When illuminated, this indicates that the safety interlock has been activated and the laser is disabled.

LASER ON LIGHT

When illuminated, this indicates that the laser is operational and is emitting.

LASER ENABLE SWITCH

The Laser Enable Switch is a safety device and is used to manually prevent laser operation. To enable laser operation, turn to the horizontal position. To disable laser operation, turn the switch to the vertical position.

CD-RW DRIVE

The CD-RW drive can be used to load and save configuration and measurement data.

FLASH DISK READER / WRITER

The Flash Disk Reader / Writer can be used to load and save configuration and measurement data.

USB PORT

The USB Port can be used to insert a keyboard or USB Flash Memory Stick.

4. START MEASURING USING THE SENTINEL DTS

Once the connections shown in section 2 have been made, the Sentinel DTS is ready to use. Before operating the Sentinel DTS, ensure all users have read and fully understood the safety section of this quick start guide.

LAUNCHING THE SENSORNET SENTINEL DTS SOFTWARE

Turn on the Sentinel DTS system by switching the power isolation switch on the rear panel to the ON position. The Sentinel DTS is configured to automatically load and run the DTS measurement software. However if the software is not running once the operating system has loaded, double click on the Sentinel DTS Icon as shown in Figure 3 or alternatively click on Start / Programs / Sentinel DTS.

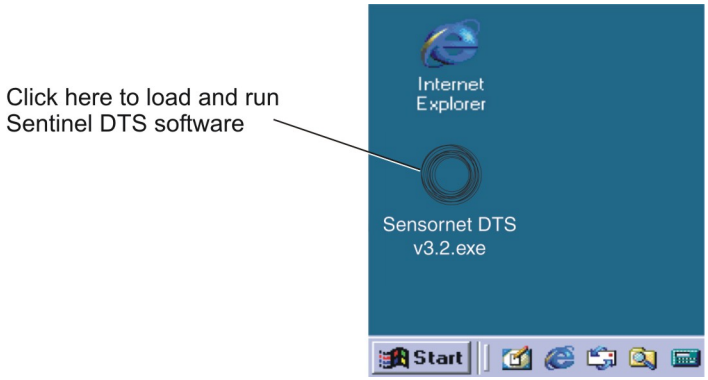

Figure 3 - The Sensornet DTS Software Icon.

NOTE:
Hardware Initialisation may take up to 60 seconds to perform.

Once the hardware has initialised, the Sensornet DTS Sentinel Main Menu will appear as shown in figure 4.

Figure 4 – The Sensornet DTS Sentinel Main Menu.

To begin measurements immediately using the factory set calibration values, click Start Measurement. Alternatively, the configuration file can be modified using either the Configuration Wizard or the Configuration Editor.

5. THE SENSORNET DTS SENTINEL DATA DISPLAY SCREEN

The Sensornet DTS Sentinel Data Display screen is the main control screen for the Sentinel DTS. The screen is divided into 5 different sections which allow the user to view and manipulate individual functions. The Sensornet DTS Sentinel Data Display screen is shown in figure 5.

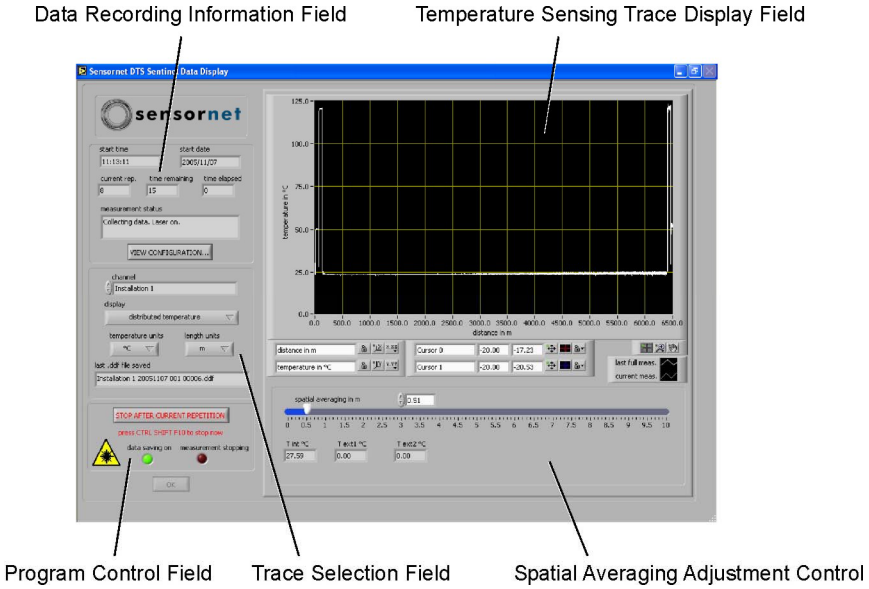

Figure 5 – The Sensornet DTS Sentinel Data Display Screen.

THE TEMPERATURE SENSING TRACE DISPLAY FIELD

The Temperature Sensing Trace Display Field shows the distributed temperature trace of the optical fibre being measured in a graphical format. The default display type is Distributed Temperature, which displays the trace data as temperature vs distance in the selected units. The grey trace represents the current measurement and is updated every 10 seconds. The white trace is the result of the last full measurement.

THE TRACE SELECTION FIELD

The Trace Selection Field allows the user to select the channel, the way in which the distributed trace data is displayed and the units of measure for the axes. The user can select to display, distributed temperature, raw data or points data.

THE SPATIAL AVERAGING ADJUSTMENT CONTROL

The Spatial Averaging Adjustment Control allows the user to set the amount of spatial averaging applied to the distributed temperature trace data. Apply spatial averaging to remove unwanted noise but at the expense of degrading spatial resolution.

THE DATA RECORDING INFORMATION FIELD

The Data Recording Information Field displays information regarding the distributed temperature sensing data determined by the configuration file including start and stop times, the current repetition and the measurement status.

THE PROGRAM CONTROL FIELD

The Program Control Field allows the user to view and control the execution status of the program.

NOTE:
For more information on using the Sensornet software, please refer to the User Guide.

6. CREATING CONFIGURATION FILES

To enable the Sentinel DTS system to accurately sense distributed temperature, it is important that the correct configuration file is chosen. First time users should use the factory set configuration values pre-loaded. This allows the user to gain experience and become familiar with making temperature measurements using the Sentinel DTS. To load the last configuration file and begin measurements, click the Start Measurement button.

As you gain experience you should either load and edit a configuration file or create a new one using the configuration wizard. To do this, click on the Edit Configuration button in the Sensornet DTS Sentinel Main Menu and select Go Straight to Editor or Run Configuration Wizard.

The following parameters can be set when creating configuration files.

LENGTH CORRECTION

When creating or editing a configuration file, length correction can be applied. This is used to correct for dispersion within the fibre cable and ensure both the stokes and anti-stokes data are range calibrated. This is normally performed by referencing to the end of the optical fibre and adjusting the displayed trace to match stokes and anti-stokes data. The default values should be correct in most cases.

MEASUREMENT RANGE

The measurement range allows the user to limit the amount of distributed temperature sensing data to a useful minimum. Meaningless data is generated beyond the end of the installed fibre length and appears as very large noise spikes on the distributed temperature trace. Reducing the measurement range to the last point of interest along the optical fibre can remove this ‘noise’ from the trace and help to reduce data file sizes.

TEMPERATURE SLOPE CORRECTION

When creating or editing a configuration file, temperature slope correction can be applied. Temperature slope correction is used to remove any length dependency of the temperature values for optical fibre. Length dependency manifests itself as a gradual slope in the distributed temperature sensing trace over the length of a uniform area along the optical fibre. Temperature slope correction is normally performed by entering a predetermined fixed value or by referencing two regions of the optical fibre that have a uniform temperature. The exact temperature of the region is not required. The Sensornet DTS software automatically calibrates the trace as required.

TEMPERATURE OFFSET

Temperature offset allows the user to calibrate the absolute temperature values for the Sentinel DTS. This is normally performed by entering a predetermined fixed value or by referencing a section of the optical fibre in a specific region with the temperature values of a reference probe or region of known temperature.

CHART RECORDER POINTS

Chart recorder points are used to monitor specific points of interest along the optical fibre. Once chart recorder points are created they can be viewed in real time while measurements are being taken. The values are displayed as temperature vs time.

TRACE AVERAGING

Trace averaging allows the user to specify the measurement time and amount of spatial averaging applied. The measurement time is the amount of time the Sentinel DTS averages distributed temperature sensing data before displaying it on the graphical display. By increasing the measurement time, better temperature resolution can be achieved. Spatial averaging is used to remove any unwanted random variability or noise from the trace. Increasing the value of spatial averaging can remove noise and smooth out the trace but this may also remove useful information. Unless the desired temperature resolution cannot be obtained by increasing the measurement time, Sensornet generally recommends leaving the spatial averaging on the default measurement setting. Both measurement time and spatial averaging are applied by entering a predetermined value or adjust the trace using the sliders.

MEASUREMENT AND REPETITION TIME

When creating or editing a configuration file, both measurement time and repetition time can be set. The measurement time is the time over which the Sentinel DTS will perform averaging of the signal to reduce noise and improve the temperature resolution. The repetition time is the total time between consecutive temperature sensing measurements and may include some idle time if the repetition time is greater than the measurement time. The Sentinel DTS may be set to operate continuously, by checking the appropriate tick box, or for a limited number of repetitions, un-checking the tick box and entering the desired number of repetitions.

For more information on setting the above parameters within the configuration editor or the Configuration Wizard, please refer to the User Guide.

7. THE DATA FILES

During operation, the Sentinel DTS system stores the various data files within the Sensornet DTS folder. The directory route is C:\Sensornet DTS. An example of the expanded directory route is shown in figure 6.

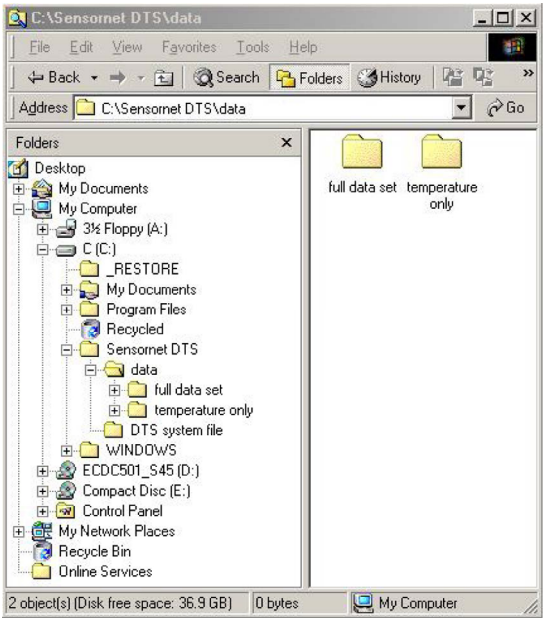

Figure 6 – The Expanded Directory Route.

The Sentinel DTS generates two types of distributed data files. These are Full Data and Temperature Only data files.

FULL DATA SET FILES

Full Data Set files contain the complete data set generated by the Sentinel DTS system after every repetition of the measurement cycle. These contain the distributed temperature data, raw signal data and various installation details – name, time, date etc. A data status field is also included. The data files have a .ddf file extension.

TEMPERATURE ONLY DATA SET FILES

The Temperature Only Data Set files contain only the temperature data generated by the Sentinel DTS system after every repetition of the measurement cycle. The Temperature Only Data Set files have a .dtd file extension.

8. TROUBLESHOOTING

Problem	Common Causes	Suggested Fix	Comments
•Temperature trace has excessive noise •Temperature trace does not read correctly to the end of the fibre	•Dirty connectors •Connectors not fully inserted and latched •Large splice losses •Sharp bends in fibre cable •Differing fibre types joined together •Fibre break	•Clean connectors •Re-splice fibre joints •Check cable run for sharp bends / breaks •Check fibre types use in cable run	Point losses and a fibre break can easily be identified from the raw signal display. Typical connector loss = 0.3dB Typical fusion splice loss = 0.1dB
•Temperature trace exhibits step changes at fibre joints	•Dirty connectors •Large splice losses •Different fibre types joined	•Clean connectors •Re-splice fibre joints	
•Unstable calibration – temperature trace jumps excessively after each measurement •Incorrect slope or offset on temperature trace	•Calibration options defined inappropriately •Fibre loss variations e.g. bad connector or fibre join	•Check reference sections have been chosen appropriately •Try using fixed calibration constants	Avoid having reference sections across a temperature step
•Error saving data / writing to file or disk	•Incorrect Installation name •Bad CD-ROM •File permissions set to read only	•Ensure there are no spaces at the end of Installation name or Channel name •Try a new CD	Note: When writing to CD-ROM, a delay of several minutes may occur if the DTS is logging data

		•De-select read only permissions for all files and folders in C:\Sensornet DTS	
•Slow or sluggish response from DTS	•Large amount of network activity •Other processes occurring on the DTS • Hard disk full	•Ensure no other programs are running • Delete unwanted data files and folders	
•Remote access problem	•Incorrect Router / gateway settings •System was not powered down correctly	•Check router or gateway settings with network administrator •Reset VNC passwords	
•Multiplexer channel data appears incorrect •Multiplexer Expansion Unit error	•Fibre cables connected to wrong multiplexer channels •Expansion unit cable fault	•Check fibre cable connections and active channels •Ensure Expansion unit cable is connected correctly	If problem persists, contact Sensornet Ltd
•DAQ timeout error	•Interlock(s) open •Laser outside operating temperature range	•Check interlock status •Reboot system	If problem persists, contact Sensornet Ltd
•Fatal error & DTS s/w exits		•Power down and reboot system	If problem persists, contact Sensornet

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