3D at Depth, Inc

WiSSL

Wide Swath Subsea LiDAR

Software User Manual

Version 1.2

December 2017

Change Record

Version	Date	Notes	Author
1.0	Aug 2017	Initial Release	B. Nickerson
1.1	Nov 2017	Pre ship updates	B. Nickerson
1.2	Dec 2017	Post FAT updates	B. Nickerson

Table of Contents

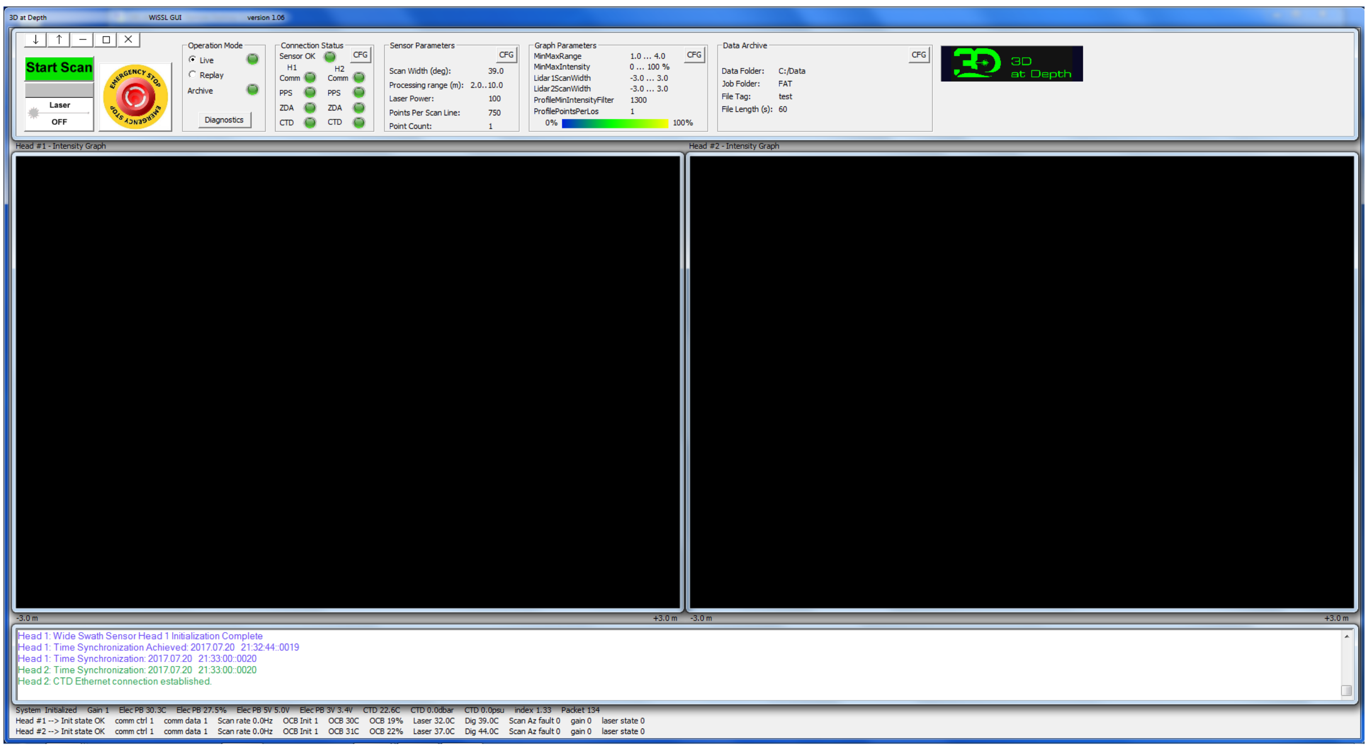
1 Sensor Startup

1.1 Laser Heads

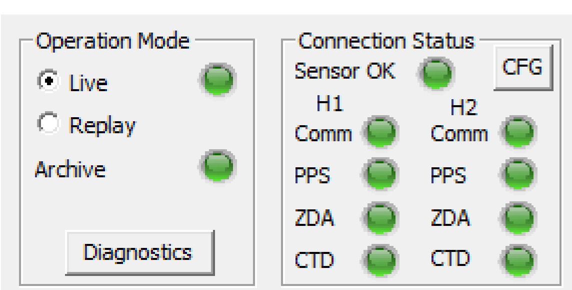
Upon power up, each laser head application will start automatically. Once the sensor has booted it will attempt connection to the WiSSL GUI. Once connected, the sensor heads will perform their boot level functions and startup testing, as depicted in the GUI text window.

1.2 Control Laptop Interface

Start the WiSSL GUI using the desktop icon on the Control Laptop. Once the GUI software connects with the laser heads, the laser head software will continue the boot process.

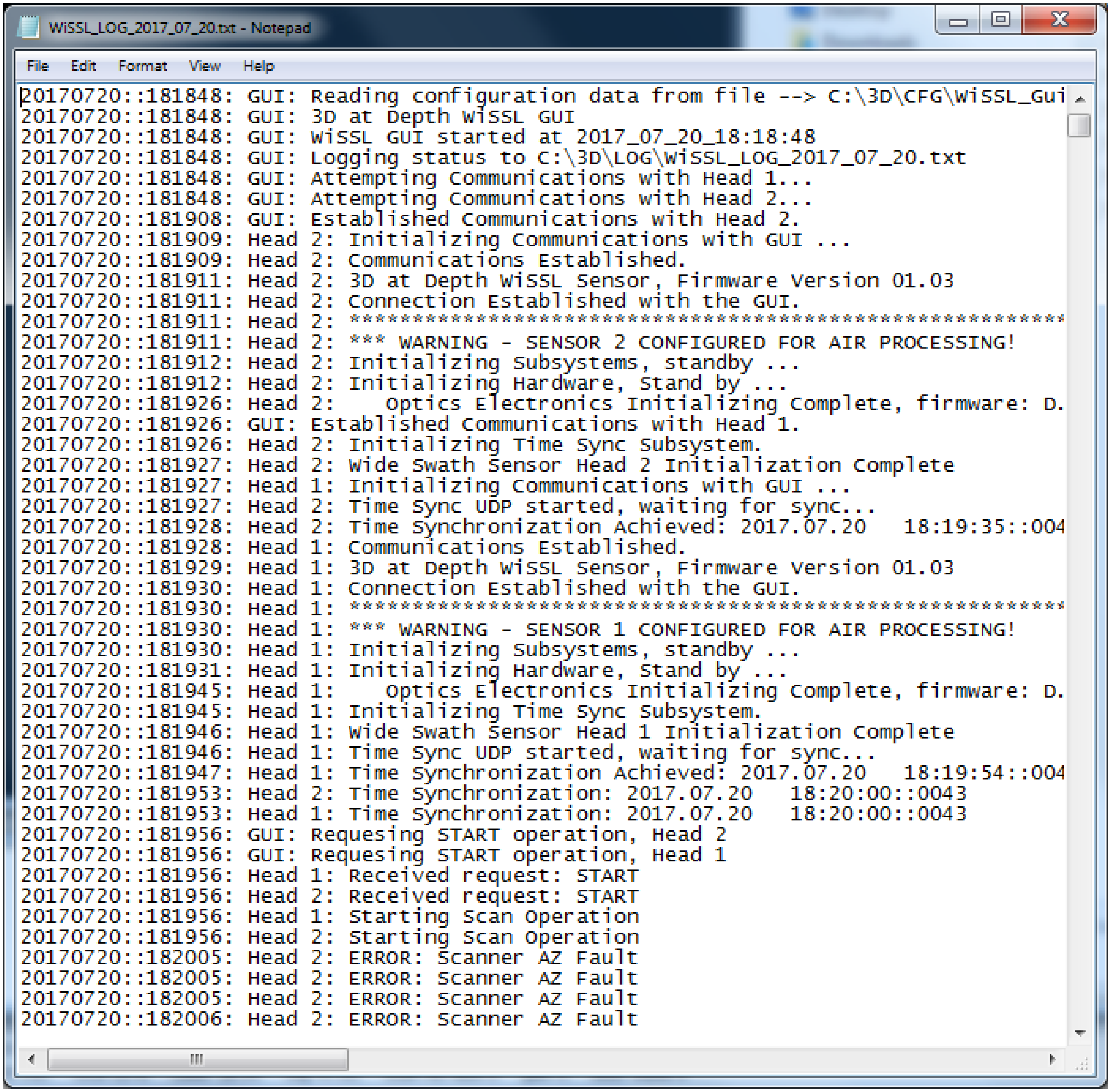


Once all LEDs become green, the sensor is ready for scanning operations.



Please refer to the Graphical User Interface section for complete details regarding the interface.

Note: All messages sent to the WiSSL GUI are logged to a file (WiSSL_LOG_yyyy_hh_ss.txt) located at "C:\3D\LOG". An example log is shown below. Corresponding messages from the GUI and each laser head are delineated accordingly.




```
20170720::181848: GUI: Reading configuration data from file --> C:\3D\CFG\WiSSL_Gui
20170720::181848: GUI: 3D at Depth WiSSL GUI
20170720::181848: GUI: WiSSL GUI started at 2017_07_20_18:18:48
20170720::181848: GUI: Logging status to C:\3D\LOG\WiSSL_LOG_2017_07_20.txt
20170720::181848: GUI: Attempting Communications with Head 1...
20170720::181848: GUI: Attempting Communications with Head 2...
20170720::181908: GUI: Established Communications with Head 2.
20170720::181909: Head 2: Initializing Communications with GUI ...
20170720::181909: Head 2: Communications Established.
20170720::181911: Head 2: 3D at Depth WiSSL Sensor, Firmware Version 01.03
20170720::181911: Head 2: Connection Established with the GUI.
20170720::181911: Head 2: **********************************************************
20170720::181911: Head 2: *** WARNING - SENSOR 2 CONFIGURED FOR AIR PROCESSING!
20170720::181912: Head 2: Initializing Subsystems, standby ...
20170720::181912: Head 2: Initializing Hardware, Stand by ...
20170720::181926: Head 2:    Optics Electronics Initializing Complete, firmware: D.
20170720::181926: GUI: Established Communications with Head 1.
20170720::181926: Head 2: Initializing Time Sync Subsystem.
20170720::181927: Head 2: Wide Swath Sensor Head 2 Initialization Complete
20170720::181927: Head 1: Initializing Communications with GUI ...
20170720::181927: Head 2: Time Sync UDP started, waiting for sync...
20170720::181928: Head 2: Time Synchronization Achieved: 2017.07.20   18:19:35::004
20170720::181928: Head 1: Communications Established.
20170720::181929: Head 1: 3D at Depth WiSSL Sensor, Firmware Version 01.03
20170720::181930: Head 1: Connection Established with the GUI.
20170720::181930: Head 1: **********************************************************
20170720::181930: Head 1: *** WARNING - SENSOR 1 CONFIGURED FOR AIR PROCESSING!
20170720::181930: Head 1: Initializing Subsystems, standby ...
20170720::181931: Head 1: Initializing Hardware, Stand by ...
20170720::181945: Head 1:    Optics Electronics Initializing Complete, firmware: D.
20170720::181945: Head 1: Initializing Time Sync Subsystem.
20170720::181946: Head 1: Wide Swath Sensor Head 1 Initialization Complete
20170720::181946: Head 1: Time Sync UDP started, waiting for sync...
20170720::181947: Head 1: Time Synchronization Achieved: 2017.07.20   18:19:54::004
20170720::181953: Head 2: Time Synchronization: 2017.07.20   18:20:00::0043
20170720::181953: Head 1: Time Synchronization: 2017.07.20   18:20:00::0043
20170720::181956: GUI: Requesing START operation, Head 2
20170720::181956: GUI: Requesing START operation, Head 1
20170720::181956: Head 1: Received request: START
20170720::181956: Head 2: Received request: START
20170720::181956: Head 1: Starting Scan Operation
20170720::181956: Head 2: Starting Scan Operation
20170720::182005: Head 2: ERROR: Scanner AZ Fault
20170720::182005: Head 2: ERROR: Scanner AZ Fault
20170720::182005: Head 2: ERROR: Scanner AZ Fault
20170720::182006: Head 2: ERROR: Scanner AZ Fault
```

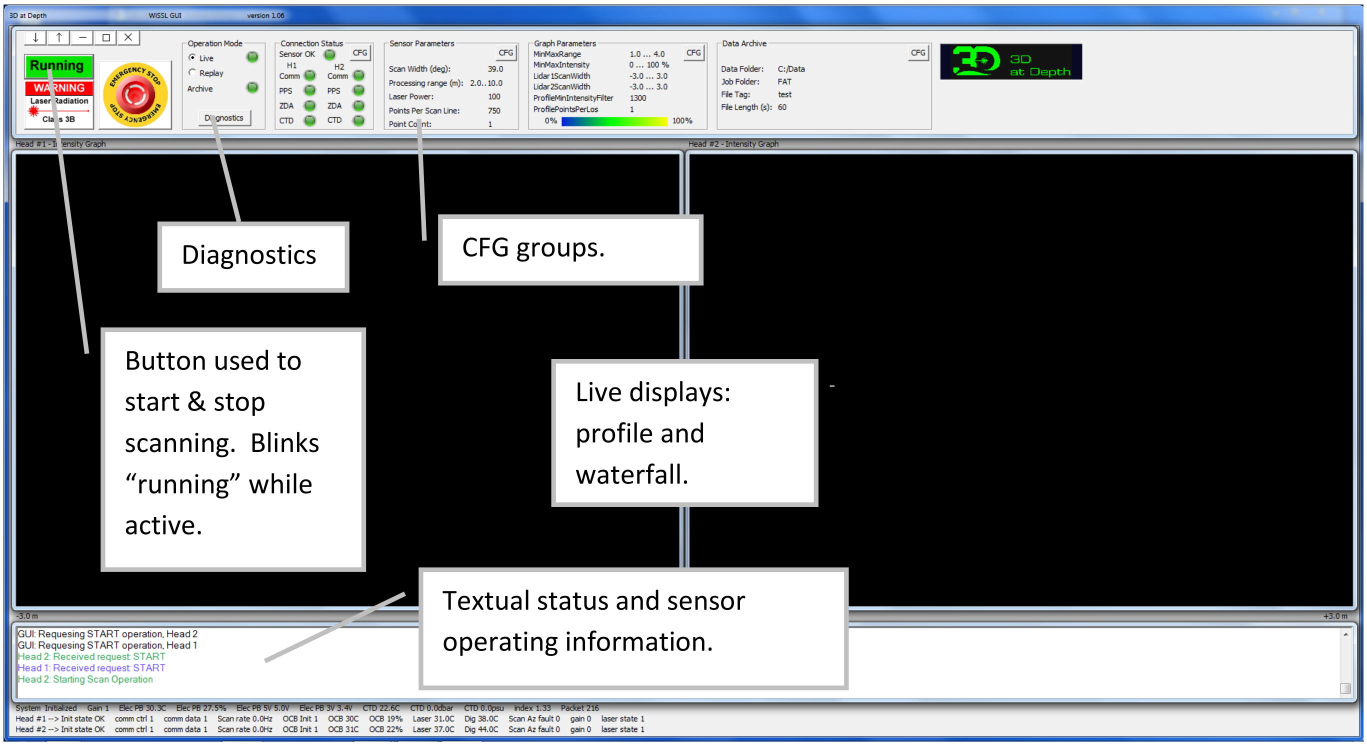
1.3 Sensor Head Safety and Status Light

Each optical head contains integrated safety and status lights built into the output cap housing. The safety light provides “laser on” indication using a red light, blinking at approximately 5 Hz. The status light, amber in color, is used for power and boot status. Upon power up, the status light blinks at approximately 4 Hz. Once the GUI has connected with the sensor via Ethernet, the status blink rate changes to 2 Hz. Once the sensor boot process has completed, the status blink rate again changes to approximately ¼ Hz. During scanning operation, with laser on, the status light is disabled.

2 Graphical User Interface

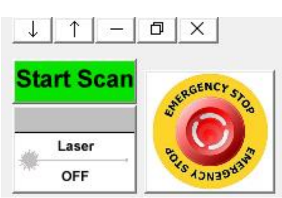
2.1 Main Screen

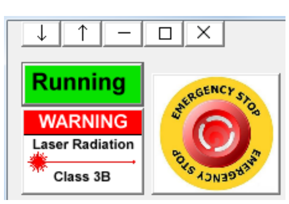
The 3D at Depth WiSSL Sensor is controlled via an Ethernet based Graphical User Interface (GUI). The GUI is used to configure, start/stop, and view resultant laser scans.



The GUI contains configuration (CFG), display, and status components. The top portion of the interface contains status indicators and configuration displays. The main portion of the interface contains two windows, one for each laser head for display of live profile and waterfall graphs. The bottom portion of the interface contains textual status and general operating information.

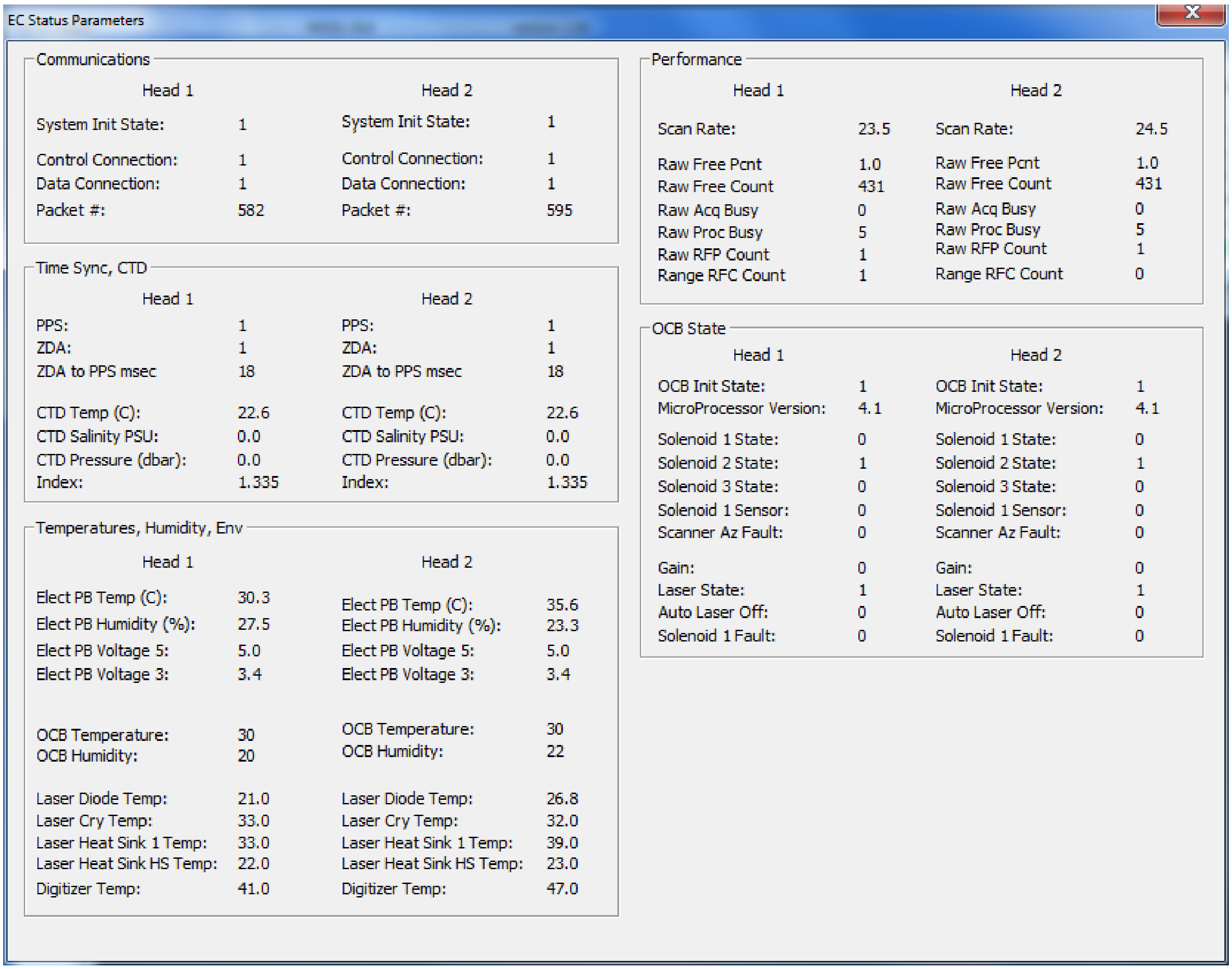
The "Start Scan" button starts scanning operations for both heads. Once operational, the button will blink "Running" to signify the status. Clicking the "Running" button will stop laser scanning. The Emergency stop button can also be used to stop scanning operation.





2.2 Diagnostics

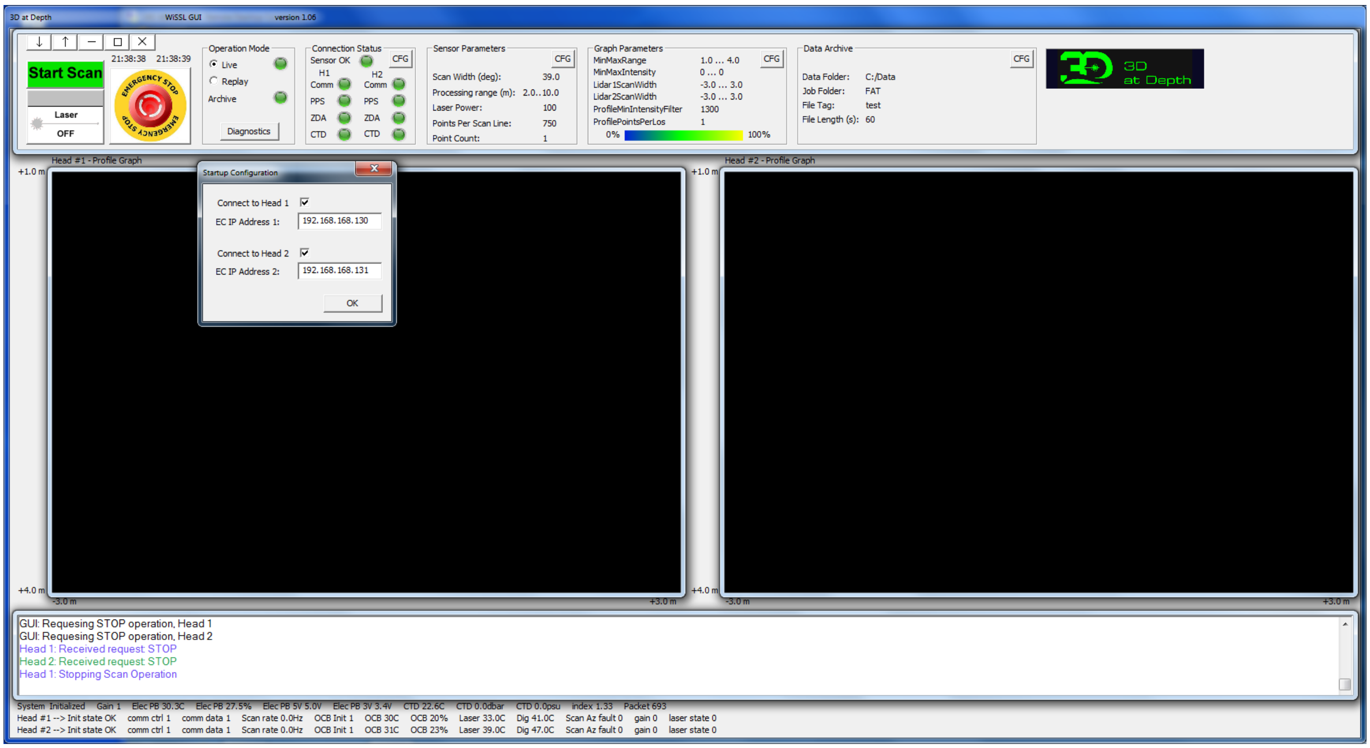
The Diagnostics button will bring up a diagnostics window providing current information as shown below. Of importance, this display contains operational temperatures, voltages, connection status, and performance information.



2.3 Connection Status CFG

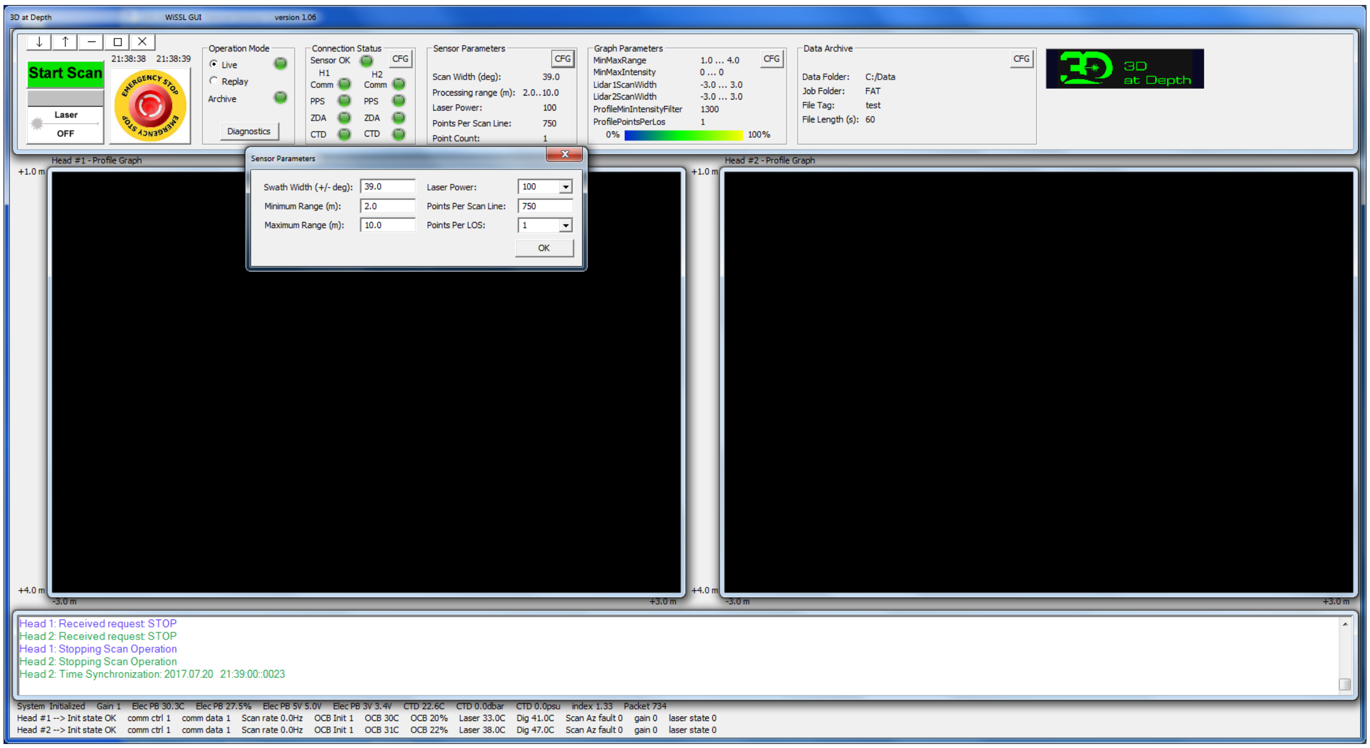
The Connection Status CFG sub window displays the current connection status and time synchronization information. A green LED indicates successful operation, and red indicates failure or non-operational. Under normal operation, all LEDs should indicate green.

The Connection Status CFG button is used to display the connection and Ethernet setup for each head. Note: If the configuration is changed, the WiSSL GUI must be restarted and the sensors must be re-connected before use.



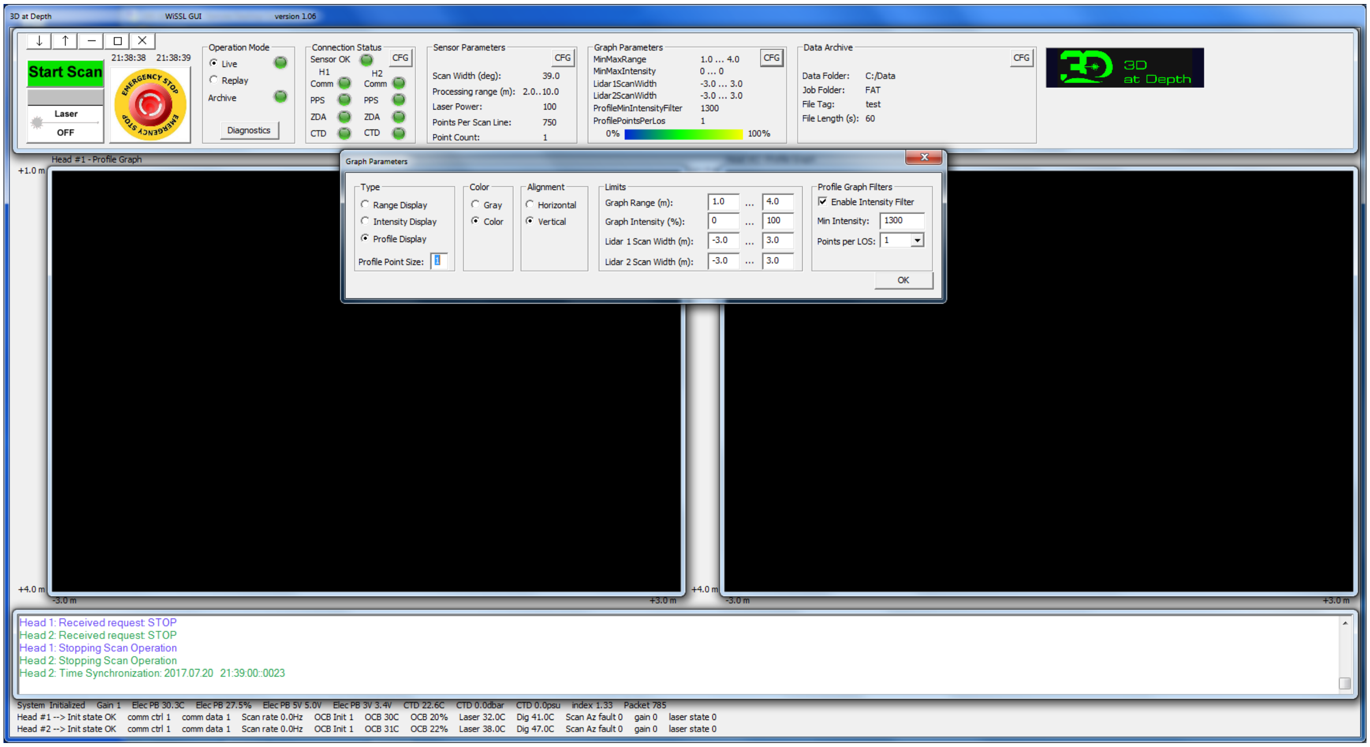
2.4 Sensor Parameters CFG

The Sensor Parameters CFG sub window displays information regarding the current sensor scanning setup. The CFG button displays the setup dialog for swath width (applies to both laser heads) and general scanning characteristics. Minimum and Maximum range values of 1 and 10 meters is recommended, and should be adequate for normal motion scanning scenarios. Suggested values for “Points per Scan Line” range from 500 to 2500 points. See the Scanning Performance section for more performance details. The WiSSL sensor supports multiple points per each laser pulse. This can be useful to take multiple line of sight (LOS) measurements with the laser spot is simultaneously on two targets. A value of 1 or 2 is recommended.



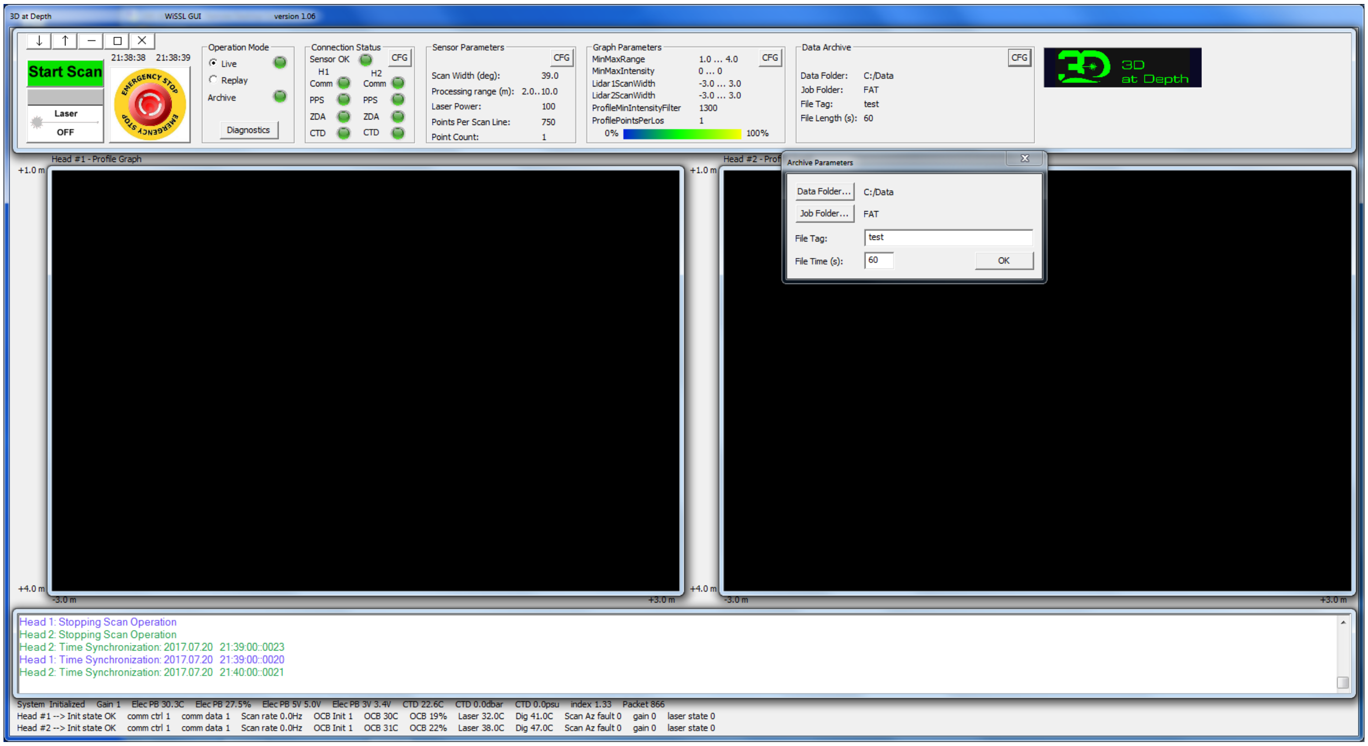
2.5 Graph Parameters CFG

The Graph Parameters CFG sub window displays information regarding the current display setup. The CFG button displays the setup dialog for display of live data on the screen for each head. Three graphs can be selected – a waterfall range display, a waterfall intensity display, and a live profile, or “wedge” display. The other fields provide display parameters and scaling options. These displays do not affect data archival – just display characteristics. A display intensity filter can also be used to filter out low intensity points. Intensity ranges from approximately 100 to 27000. All laser returns greater than an intensity value of 27000 are considered saturated and will always be depicted in red.



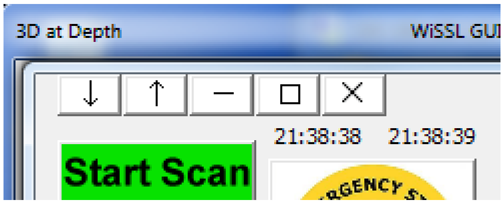
2.6 Data Archive CFG

The Data Archive CFG sub window provides display and setup for data archival.

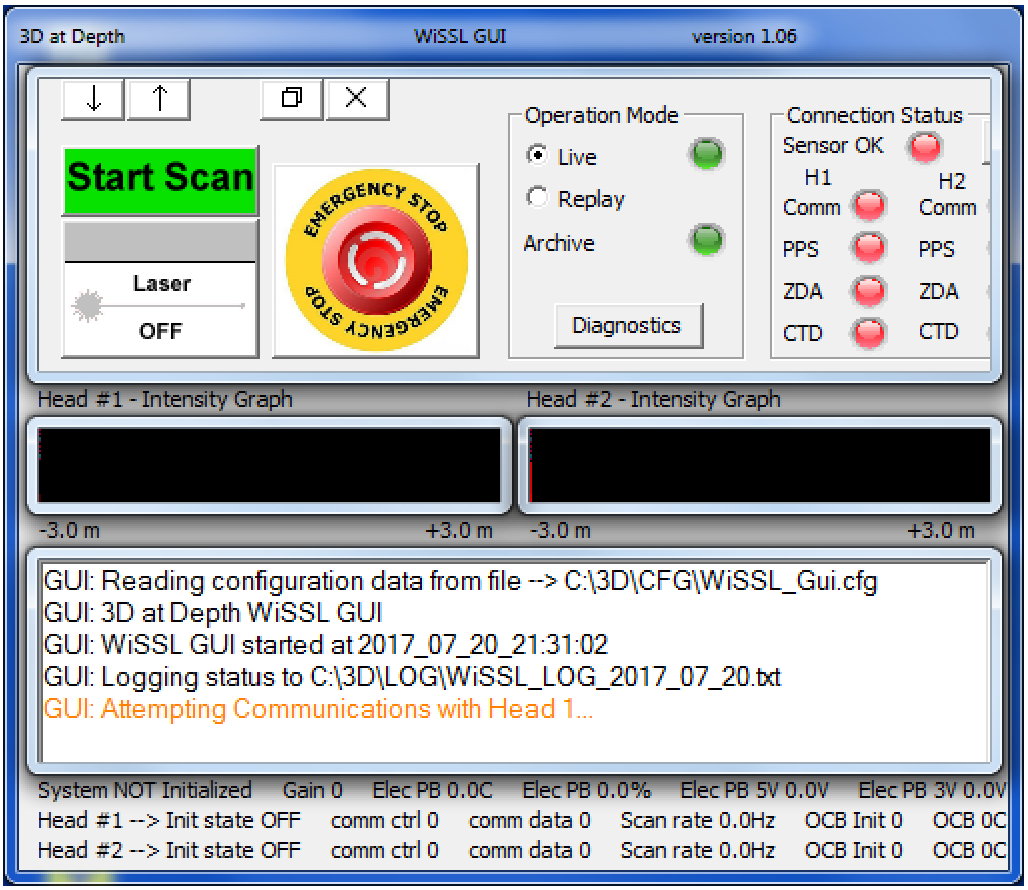


2.7 Resizing the GUI

The GUI application can be resized and *partially* minimized utilizing the buttons shown below.



The minimize button will shrink the GUI, but not fully remove it. This is necessary for laser safety reasons.



3 Configuration Files

3.1 GUI Configuration file

Configuration files are used by the WiSSL sensor to provide startup information and consistency between operations. On the control laptop, the GUI utilizes the configuration file named "C:\3D\CFG\WiSSL_Gui.cfg". This is a binary file, and cannot be edited. Should the GUI not launch correctly, the operator can delete this file and restart the application. However, all existing configuration data will be defaulted.

3.2 Laser Head Configuration file

Each laser head utilizes a configuration file located on the corresponding laser head processor. To access the configuration file, the user must remote desktop to the specific laser head and modify the file "D:\3D\CFG\WSparams_ec.cfg". This CFG file is text based and can be modified by the user. The user must restart the EC application for changes to take effect. A sample CFG file is provided below – Note, the CFG values are samples only, not intended for actual operation. Please see the actual sensor CFG values located on the sensor.

Note: **All parameters that are highlighted in Yellow can be edited by the user. All other parameters should not be modified unless specified by 3D a Depth personnel.**

```
///////////////////////////////////////////////////////////////////////////
//
// 3D at Depth Wide Swath Sensor parameter configuration file
//
//////////////////////////////////////////////////////////////////////////

///////////////////////////////////////////////////////////////////////////
//
// The following parameters can be modified by the end user

// These values specify the amount of angular movement, per button hit, in the
// factory mode GUI
FACTORY_SCANNER_LRG_DEG = 0.4
FACTORY_SCANNER_MED_DEG = 0.04
FACTORY_SCANNER_SML_DEG = 0.004

// laser start time before acquisition can begin
LASER_START_TIME_SEC     = 4.0

// the maximum time from receipt of PPS to receipt of ZDA string before an error will be issued
ZDA_TO_PPS_MAX_MSEC      = 250

// the UDP port for the sensor to listen for ZDA packets
ZDA_UDP_PORT                   = 2007

// the TCP/IP port for the sensor to listen for CTD packets
CTD_TCP_PORT                   = 2009

// EMERGENCY_SHUTDOWN controls whether to issue a warning
// when temperature, humidity, and/or leak checks go above their
// maximum values as defined below
//
EMERGENCY_SHUTDOWN       = "TRUE"

///////////////////////////////////////////////////////////////////////////
//
// The following parameters SHOULD NOT be modified unless under specific instruction
// from 3D at Depth personnel

// must be 1 or 2
LASER_HEAD_NO = 1

// Set to 1 ONLY for factory use
PROCESS_FOR_AIR = 0

// should always be true for standard operation
PERFORM_TEMPERATURE_COMPENSATION          = "TRUE"


OCB_TEMPERATURE_LIMIT_C   = 58.0
OCB_HUMIDITY_LIMIT        = 50.0
PB_TEMPERATURE_LIMIT_1_C = 58.0
PB_TEMPERATURE_LIMIT_2_C = 58.0
PB_HUMIDITY_LIMIT         = 50.0
```

```
DIG_TEMPERATURE_LIMIT_C  = 57.0

//
OCB_COMM_PORT           = "COM1:"

///////////////////////////////////////////////////////////
// Quad Angle Calibration
//
AZ_AO_DEG_TO_VOLT       =  4

// Calibration in Factory mode
//AZ_AI_NEG_V_TO_DEG      =  3.9697
//AZ_AI_POS_V_TO_DEG      =  3.9895

AZ_AI_NEG_V_TO_DEG      =  1
AZ_AI_POS_V_TO_DEG      =  1

SCANNER_NEG_POLYNOM_0 = 4.016189337
SCANNER_NEG_POLYNOM_1 = 0.003091633
SCANNER_NEG_POLYNOM_2 = 0.00302357
SCANNER_NEG_POLYNOM_3 = 0.000658871
SCANNER_NEG_POLYNOM_4 = 0.000039209

SCANNER_POS_POLYNOM_0 = 4.022244578
SCANNER_POS_POLYNOM_1 = 0.002392077
SCANNER_POS_POLYNOM_2 = -0.001057046
SCANNER_POS_POLYNOM_3 = 0.000080588
SCANNER_POS_POLYNOM_4 = -0.000002046

EL_ANGLE_FIXED_DEG  = 4.6015

///////////////////////////////////////////////////////////
// range calibration - air
T1_AIR                  =  2.2003
FF_AIR                  =  1

///////////////////////////////////////////////////////////
// range calibration - water
//RF-M-001 Optical A
T1_WATER_G4000          =  1.4674
FF_WATER_G4000          =  0.98373
T1_WATER_G3000          =  1.4446
FF_WATER_G3000          =  0.98327
T1_WATER_G2000          =  1.4637
FF_WATER_G2000          =  0.98330
T1_WATER_G1000          =  1.5298
FF_WATER_G1000          =  0.98349
T1_WATER_G400           =  1.4790
FF_WATER_G400           =  0.98370
T1_WATER_G300           =  1.4859
FF_WATER_G300           =  0.98396

//RF-M-003 Optical A
//T1_WATER_G4000          =  1.7837
//FF_WATER_G4000          =  0.98308
//T1_WATER_G3000          =  1.7992
//FF_WATER_G3000          =  0.98327
//T1_WATER_G2000          =  1.8183
//FF_WATER_G2000          =  0.98330
//T1_WATER_G1000          =  1.9301
//FF_WATER_G1000          =  0.98367
//T1_WATER_G400           =  1.8550
//FF_WATER_G400           =  0.98397
//T1_WATER_G300           =  1.8351
//FF_WATER_G300           =  0.98371

//RF-M-004 Optical A
//T1_WATER_G4000          =  1.7471
//FF_WATER_G4000          =  0.98308
//T1_WATER_G3000          =  1.7626
//FF_WATER_G3000          =  0.98327
//T1_WATER_G2000          =  1.7817
//FF_WATER_G2000          =  0.98330
//T1_WATER_G1000          =  1.8935
//FF_WATER_G1000          =  0.98367
//T1_WATER_G400           =  1.8184
//FF_WATER_G400           =  0.98408
//T1_WATER_G300           =  1.8059
//FF_WATER_G300           =  0.98394

//RF-M-005 Optical A
//T1_WATER_G4000          =  1.64460
//FF_WATER_G4000          =  0.98308
//T1_WATER_G3000          =  1.66010
//FF_WATER_G3000          =  0.98327
//T1_WATER_G2000          =  1.67920
//FF_WATER_G2000          =  0.98330
//T1_WATER_G1000          =  1.7453
//FF_WATER_G1000          =  0.98349
//T1_WATER_G400           =  1.6925
//FF_WATER_G400           =  0.98394
//T1_WATER_G300           =  1.7034
//FF_WATER_G300           =  0.98450

//RF-M-006 Optical A
```

```
//T1_WATER_G4000          =  1.7899
//FF_WATER_G4000          =  0.98308
//T1_WATER_G3000          =  1.8054
//FF_WATER_G3000          =  0.98327
//T1_WATER_G2000          =  1.8245
//FF_WATER_G2000          =  0.98330
//T1_WATER_G1000          =  1.8906
//FF_WATER_G1000          =  0.98349
//T1_WATER_G400           =  1.8483
//FF_WATER_G400           =  0.98366
//T1_WATER_G300           =  1.8382
//FF_WATER_G300           =  0.98360

///////////////////////////////////////////////////////////
// temperature compensation
TEMP_COMP_POLY          = -0.29421793
TEMP_COMP_POLY1         = -0.00090929
TEMP_COMP_POLY2         = 0.00017962

// laser start time
LASER_START_TIME_SEC    = 4.0

SCANNER_SHIFT_CTS       = 0.9

TRIGGER_LEVEL_VOLT  = 1.3

// end of configuration file
```

3.3 RF Cable Configuration

3D at Depth is supplying 6 pairs of RF cables. Each optical head has a primary cable that is either calibrated for head A or head B. The remaining 4 pairs of cables can be used on either head if a primary cable is damaged. Each cable pair has associated calibration coefficients that must be used when the cable is in use. The coefficients are unique to each cable set and to each head. For example, if the operator is using cable RF-M-04 on Head B, then the RF-M-04-B coefficients must be entered into the config file.

In a cable set, one cable is connected to the L port and one is connected to the D port on both the electronics bottle and the optical bottle. The cables are color coded to assist the operator. On the optical and electronics bottles, head A's L and D ports are colored Blue and Yellow. Head A's L and D ports are colored Green and White. A cable that has been calibrated for both heads, such as RF-M-05 shown below, uses both color codes to indicate that the cable can be used on either head.

The primary cables, which are only calibrated for one head only contain that head's color codes, as shown with cable RF-M-01 shown below, which can only be used for head A.

In order to use a certain cable on a certain head, the operator must ensure that the sensor is using the correct calibration coefficients. To select the correct coefficients, comment out all of the coefficients that should not be used with // place before each line. Make sure that the coefficients to be used are not commented-out. An example shown below shows how to use the coefficients for RF-M-001 on Optical Head A. Note that the coefficients for cable RF-M-01 are not commented out, but the coefficients for RF-M-03 are commented out.

```
//RF-M-001 Optical A
T1_WATER_G4000          =  1.4674
FF_WATER_G4000          =  0.98373
T1_WATER_G3000          =  1.4446
FF_WATER_G3000          =  0.98327
T1_WATER_G2000          =  1.4637
FF_WATER_G2000          =  0.98330
T1_WATER_G1000          =  1.5298
FF_WATER_G1000          =  0.98349
T1_WATER_G400           =  1.4790
FF_WATER_G400           =  0.98370
T1_WATER_G300           =  1.4859
FF_WATER_G300           =  0.98396

//RF-M-003 Optical A
//T1_WATER_G4000          =  1.7837
//FF_WATER_G4000          =  0.98308
//T1_WATER_G3000          =  1.7992
//FF_WATER_G3000          =  0.98327
//T1_WATER_G2000          =  1.8183
//FF_WATER_G2000          =  0.98330
//T1_WATER_G1000          =  1.9301
//FF_WATER_G1000          =  0.98367
//T1_WATER_G400           =  1.8550
//FF_WATER_G400           =  0.98397
//T1_WATER_G300           =  1.8351
//FF_WATER_G300           =  0.98371
```

Once the operator has the config file setup with the right constants, save the config file, then reboot the sensor to pick up the change.

The calibration coefficients are saved in the config files on each sensor head and they are also saved in the delivered file RF_Cable_Coefficients.xlsx

4 Sensor Performance

4.1 Scan Rate Performance

The WiSSL sensor was tested for differing scan resolutions at maximum scan angle width. The tests were performed for water, full Cross track scan width.

Index = 1.33				
Scan Frequency (Hz) down and back	**Pts per Scan Line cross track**	**Max Angle Step @ Center (deg)**	**Range Depth (meter) configuration**	**Center of Scan Cross Track Resolution at 2.5 meter LOS**
35	500	0.2	10	0.0087
29	600	0.16	10	0.0070
25	700	0.13	10	0.0057
22.5	800	0.11	10	0.0048
19.5	900	0.1	10	0.0044
18	1000	0.09	10	0.0039
16.5	1100	0.08	10	0.0035
15	1200	0.07	10	0.0031
14	1300	0.065	10	0.0028
13	1400	0.06	10	0.0026
12	1500	0.055	10	0.0024
11.5	1600	0.053	10	0.0023
10.5	1700	0.05	10	0.0022
10	1800	0.045	10	0.0020
9.5	1900	0.043	10	0.0019
9	2000	0.041	10	0.0018
8.5	2100	0.039	10	0.0017
8.3	2200	0.037	10	0.0016
8	2300	0.036	10	0.0016
7.7	2400	0.034	10	0.0015
7.4	2500	0.032	10	0.0014

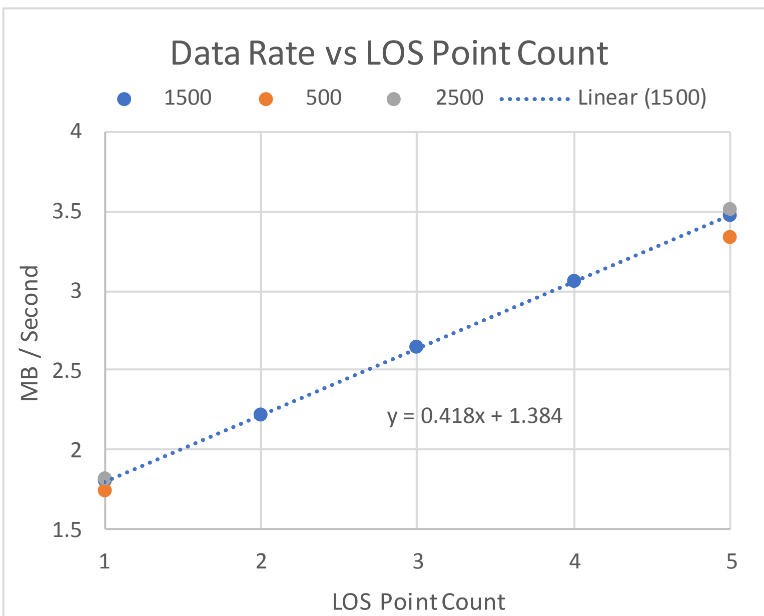
Additional performance testing was performed for other LOS range values. The follow configurations per range depth and intended resolution are recommended.

	Swath Width deg (air / water) per head	**Points Per Scan Line**	**Max Range**	**Scan Rate (Hz)**
Maximize Resolution	+/- 36/27	2500	15	4
Maximize Range	+/- 36/27	600	25	8.5
Maximize Speed	+/- 36/27	300	10	54
Other	+/- 36/27	600	10	30
	+/- 36/27	750	10	24
	+/- 36/27	800	10	23

4.2 Data Rate

Data Rate generation was measured for the WiSSL sensor per the configurations listed below. In general, data rate generation is quite linear as shown in the graph. As an approximation, if the sensor was configured for 5 LOS points per laser pulse, the laptop would be able to store approximately 75 hours of data in continuous operation (assumes 950 GByte available).

Cross Track Points per Line	LOS Points per Pulse	Processing Rate Hz	MB/Sec	MB/Min
1500	1	12.25	1.8	108
1500	2	12.25	2.22	133.2
1500	3	12.25	2.64	158.4
1500	4	12.25	3.06	183.6
1500	5	12.25	3.47	208.2
500	1	35	1.74	104.4
500	5	35	3.34	200.4
2500	1	7.25	1.82	109.2
2500	5	7.25	3.51	210.6



5 CTD Ethernet Interface

The WiSSL sensor listens for TCP/IP CTD data packets provided on the CTD port defined in the sensor configuration file. The "sending" application must first perform a TCP/IP connection to the sensor head utilizing the sensor static IP address and CTD port number. The WiSSL sensor starts a "server" type connection and listens for the corresponding client connection. The sensor utilizes the CTD information in processing the laser return data. The packet format is as follows.

CTD Packet		
Item	**Value**	**Bytes**
File Header		
Project code	0x3D03	2 (1 UINT16)
version	0x01	1 (1 UINT8)
CTD Information		
Water Temperature C		8 (1 double)
Water Salinity psu		8 (1 double)
Water Pressure dbar		8 (1 double)

6 ZDA Ethernet Interface

The WiSSL sensor listens for UDP data packets broadcasted on the ZDA UDP port defined in the sensor configuration file. The WiSSL sensor attempts to bind to a UDP socket to receive packets containing ZDA time synchronization messages.

The sensor looks for a standard NMEA ZDA string as the entire UDP packet message, defined as:

```
$GPZDA,hhmmss.ss,dd,mm,yyyy,xx,yy*CC

where:
  hhmmss          HrMinSec(UTC)
  dd,mm,yyy       Day,Month,Year
  xx              local zone hours -13..13
  yy              local zone minutes 0..59
  *CC             checksum
```

7 Range Angle Angle Data Format

The WiSSL Sensor collects binary sensor data and processes it to provide corresponding range angle data, and saves this data to a binary file. This file, named yyyymmdd_hhmmss.raa is located per configuration in the GUI. A timestamp is provided for each line scan recorded in the file. This timestamp is the time of the first laser pulse for that scan. The µsec time value listed for each laser pulse is the relative time between each successive pulse, offset from the timestamp. The value for the first pulse should be subtracted from all pulses in that scan (including itself), such that the first pulse would be 0 µsec accordingly.

All range, angle, and offsets measurements are provided relative to the front, center of glass. A right-handed coordinate system is utilized with the laser beam emitting from the sensor along the Y axis, parallel to the axis of the sensor bottle. The X axis is orthogonal to the sensor, pointing to the right. The Z axis is orthogonal to the sensor, pointing up. In this fashion, azimuth scanner motion, or cross track motion, moves the beam left and right in the XY plane. Elevation direction is in the YZ plane.

The laser return signal from a laser pulse may contain more than one usable range measurements. Often, this occurs when the pulse is partially clipped between two or more objects in the laser line of sight (LOS). New for WiSSL, these multiple laser measurements are collected per LOS. This setting is configurable from 1 to 5 in the control GUI interface. In practice, 2 or 3 is suitable. Accordingly, the data below provides for multiple LOS measurements.

The binary file contains data for both laser heads, as designated in the scan line header.

Range Angle Angle data format (binary)		
Item	**Value**	**Bytes**
File Header		
Record ID – WiSSL	0x3D47	2 (1 UINT16)
File Magic Number	0x3D08	2 (1 UINT16)
File version	1	2 (1 UINT16)
File sub version	1	2 (1 UINT16)
Scan Information		
AZ, Cross track angle start, typical (deg)		4 (1 float32)
AZ, Cross track angle end, typical (deg)		4 (1 float32)
Pulses per cross track, scan line		2 (1 UINT16)
Number pulses per LOS		1 (1 UINT8)
Scan lines per this File, Head A		2 (1 UINT16)
Scan lines per this File, Head B		2 (1 UINT16)
Calibration Information		
Calibration Structure, Head A		Size of calibration structure
Calibration Structure, Head B		Size of calibration structure

Pulse ID and Timestamp (1 to n Scans)		
Record ID – Head A or B	0x3D53, 0x3D54	2 (1 UINT16)
Timestamp year (true year)		2 (1 UINT16)
Timestamp month (1-12)		1 (1 UINT8)
Timestamp day		1 (1 UINT8)
Timestamp days since Jan 1		2 (1 UINT16)
Timestamp hour		2 (1 UINT16)
Timestamp minutes		1 (1 UINT8)
Timestamp seconds		1 (1 UINT8)
Timestamp nano seconds		4 (1 UINT32)
Gain (laser power)		1 (UINT8)
Digitizer temperature C		4 (float)
CTD temperature C		4 (float)
CTD salinity psu		4 (float)
CTD pressure dbar		4 (float)
Index		4 (float)
Start processing m		4 (float)
End processing m		4 (float)
Pulse Count this scan line		4 (1 UINT32)
Laser Pulse Data (1 to m pulses per scan)		
AZ, Cross track angle (deg)		4 (1 float32)
EL, Forward track angle (deg)		4 (1 float32)
AZ, Cross track offset (m)		4 (1 float32)
EL, Forward track offset (m)		4 (1 float32)
Pulse time offset (sec)		4 (1 float32)
LOS Range 1 (from glass front) meters		4 (1 float32)
…		
LOS Range n (from glass front) meters		4 (1 float32)
Amplitude LOS 1 / peak of signal		2 (1 UINT16)
…		
Amplitude LOS n / peak of signal		2 (1 UINT16)

Each RAA file begins with a File Header, followed by a “Scan Information” block and a “Calibration Information” block of data. Then, the file contains scan line data. The data for each scan line contains: a Record ID (head designator), a full timestamp, and a” Laser Pulse Data” collection of data. Note, Head A and B scanlines are interleaved in the RAA file per their specific time stamps.

For example, if the sensor was configured for 250 pulses per scan line and 3 LOS range measurements per pulse, the following data would be present in the RAA file:

File Header
Scan Information
Calibration Information Head A
Calibration Information Head B

(1) Record ID (A or B)
    Pulse Timestamp
    Pulse count this scan line

    (1) Laser Pulse Data:
        AZ angle
        EL angle
        AZ offset
        EL offset
        Pulse time offset
        Range Data:
            LOS Range 1
            LOS Range 2
            LOS Range 3
        Intensity Data:
            Intensity 1
            Intensity 2
            Intensity 3

        …

    (250) Laser Pulse Data:
        AZ angle
        EL angle
        AZ offset
        EL offset
        Pulse time offset
        Range Data:
            LOS Range 1
            LOS Range 2
            LOS Range 3
        Intensity Data:
            Intensity 1
            Intensity 2
            Intensity 3

…

Note: based on laser head performance, differing counts of data sets may exist for Head A and B. The ".raa" file extension is used for the binary file. The Calibration data structure is provided below. Sensor calibration values are stored on each sensor in the parameters file as described previously.

```
typedef struct
{
        char                          CFG_PATH[ 64 ];
        int                           LASER_HEAD_NO;                       // either 1 or 2
        int                           PROCESS_FOR_AIR;                     // 1 = air, else water
        bool                          PERFORM_TEMPERATURE_COMPENSATION;
        bool                          EMERGENCY_SHUTDOWN;

        float                         OCB_TEMPERATURE_LIMIT_C;
        float                         OCB_HUMIDITY_LIMIT;
        float                         PB_TEMPERATURE_LIMIT_1_C;
        float                         PB_TEMPERATURE_LIMIT_2_C;
        float                         PB_HUMIDITY_LIMIT;
        float                         DIG_TEMPERATURE_LIMIT_C;

        char                          L_D_CABLE_SET[ 24 ];

        char                          OCB_COMM_PORT[ 24 ];
        char                          OCB_COMM_CFG [ 24 ];

        float                         AZ_AO_DEG_TO_VOLT;
        float                         AZ_AI_NEG_V_TO_DEG;
        float                         AZ_AI_POS_V_TO_DEG;

        float                         T1_AIR;
        float                         FF_AIR;
        float                         T1_WATER_G4000;
        float                         FF_WATER_G4000;
        float                         T1_WATER_G3000;
        float                         FF_WATER_G3000;
        float                         T1_WATER_G2000;
        float                         FF_WATER_G2000;
        float                         T1_WATER_G1000;
        float                         FF_WATER_G1000;
        float                         T1_WATER_G400;
        float                         FF_WATER_G400;
        float                         T1_WATER_G300;
        float                         FF_WATER_G300;
        float                         T1_WATER_SECONDARY_G4000;
        float                         FF_WATER_SECONDARY_G4000;
        float                         T1_WATER_SECONDARY_G3000;
        float                         FF_WATER_SECONDARY_G3000;
        float                         T1_WATER_SECONDARY_G2000;
        float                         FF_WATER_SECONDARY_G2000;
        float                         T1_WATER_SECONDARY_G1000;
        float                         FF_WATER_SECONDARY_G1000;
        float                         T1_WATER_SECONDARY_G400;
        float                         FF_WATER_SECONDARY_G400;
        float                         T1_WATER_SECONDARY_G300;
        float                         FF_WATER_SECONDARY_G300;

        double                        TEMP_COMP_POLY2;
        double                        TEMP_COMP_POLY1;
        double                        TEMP_COMP_POLY;

        float                         LASER_START_TIME_SEC;
        float                         SCANNER_SHIFT_CTS;

        float                         FACTORY_SCANNER_LRG_DEG;
        float                         FACTORY_SCANNER_MED_DEG;
        float                         FACTORY_SCANNER_SML_DEG;

        float                         EL_ANGLE_FIXED_DEG;

} StructWSCalibration;
```

8 GUI Software Installation

An external drive has been provided to allow installation of the WiSSL GUI onto a non-3D at Depth computer. To install the GUI, perform the following:

- From the memory stick, double click on “3DTools_v045.msi”
    - This will install the 3D at Depth tool suite – creates a c:\3D at Depth and c:\3D folders
- From the memory stick, copy (and overwrite) the 3D folder to C:\3D
- From the memory stick, copy (and overwrite) the “3D at Depth” folder to C:\ 3D at Depth

The operator should now be able to run the C:\3D at Depth\X64\WiSSL_GUI_v1.0x application from their laptop.

9 Remote Desktop to Laser Heads

Each laser head processor can be reached via Windows remote desktop. Utilizing this interface, log in to each laser head (IP address, User name “EC” and password “3d”). The IP addresses are 192.168.168.130 for head A, and 192.168.168.131 for head B. Each head runs the Windows Embedded OS, and can be accessed via normal Windows operations.