3D at Depth, Inc

WiSSL

Wide Swath Subsea LiDAR

Software User Manual

Version 1.4

May 2019

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
1.3	May 2019	Upgrade	D. Florin
1.4	May 2019	Cable update	C. Embry

Table of Contents

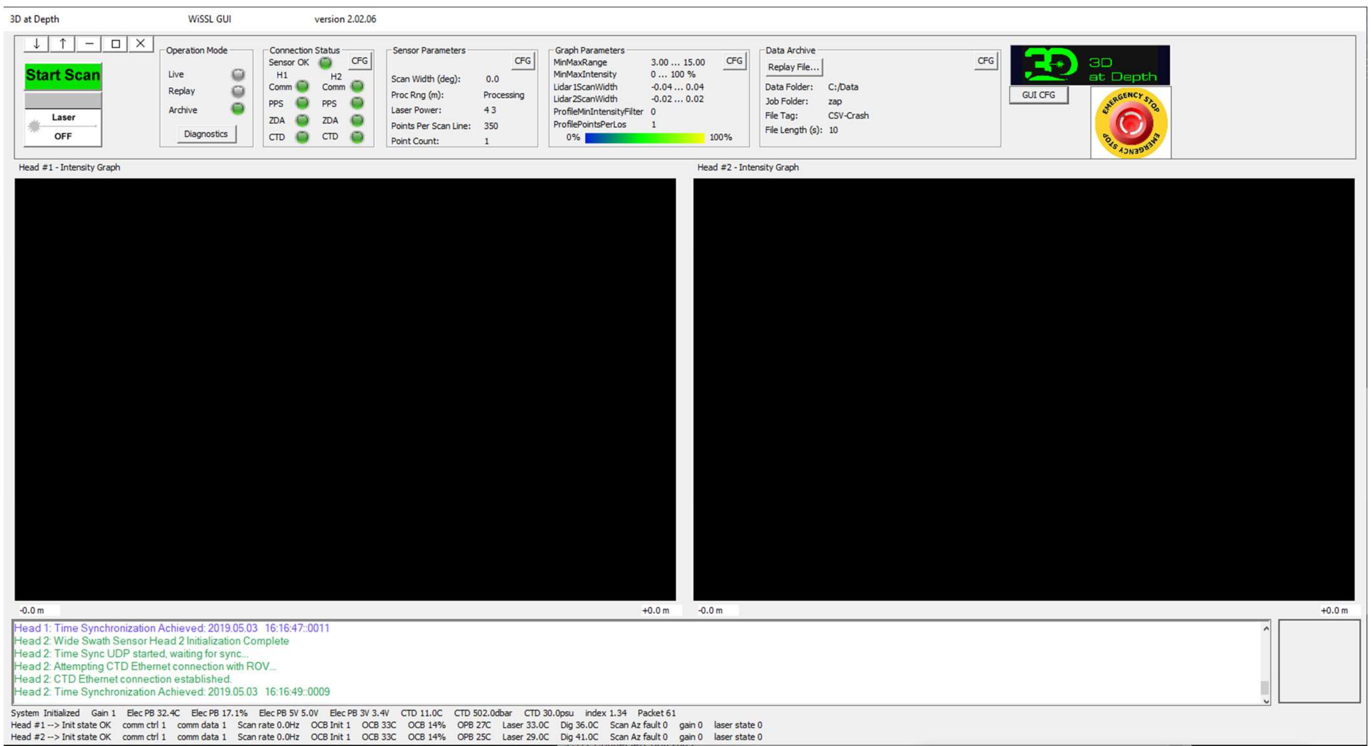
1 Sensor Startup

1.1 Laser Heads

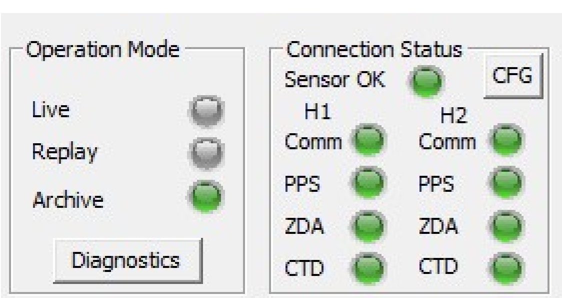
Upon power up, each laser head application will start automatically. Once the sensor has booted it will attempt connection to the WiSSL GUI. Once connected, the sensor heads will perform their boot level functions and startup testing, as depicted in the GUI text window.

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.

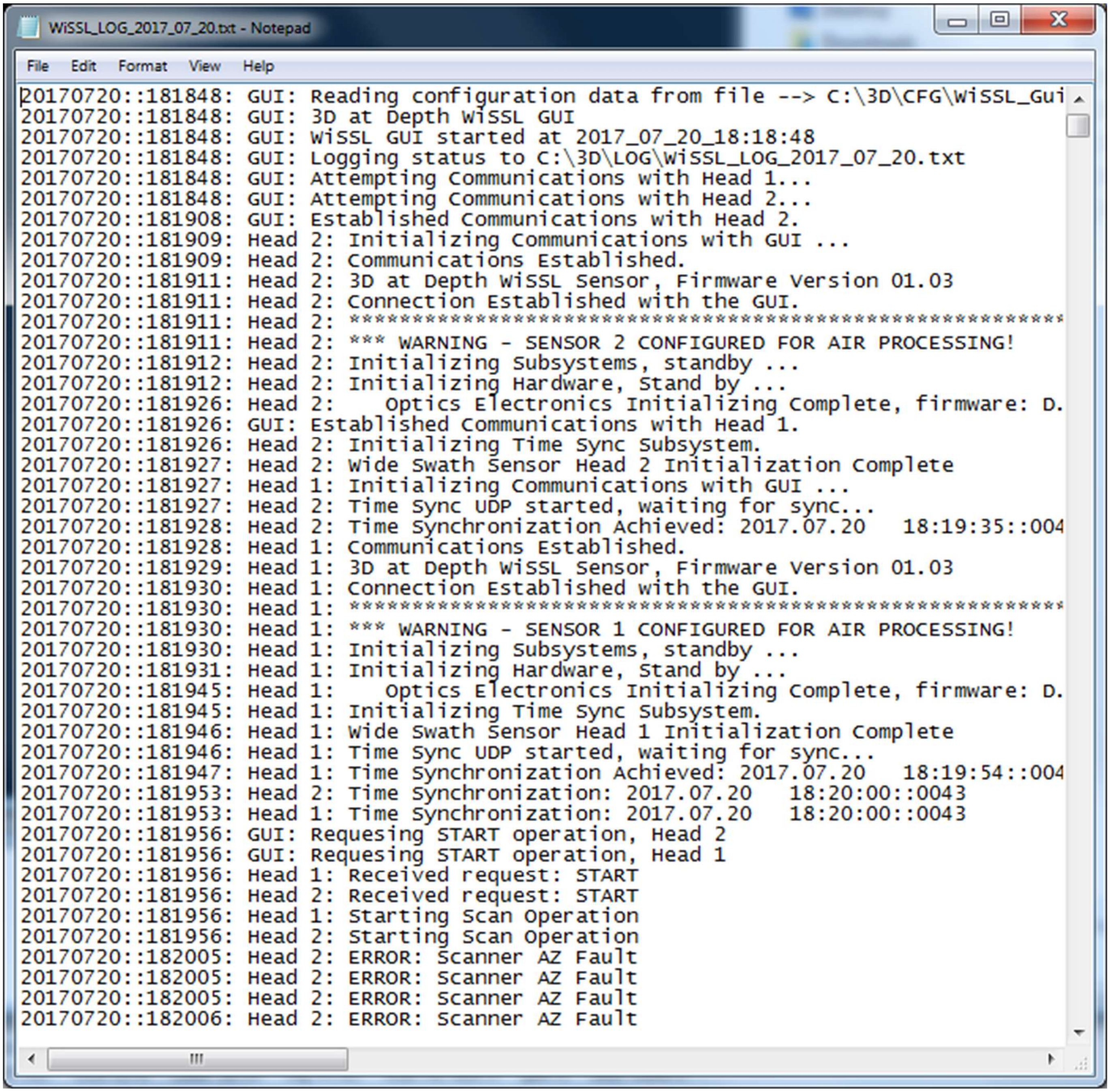


Once all LEDs become green, the sensor is ready for scanning operations.



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

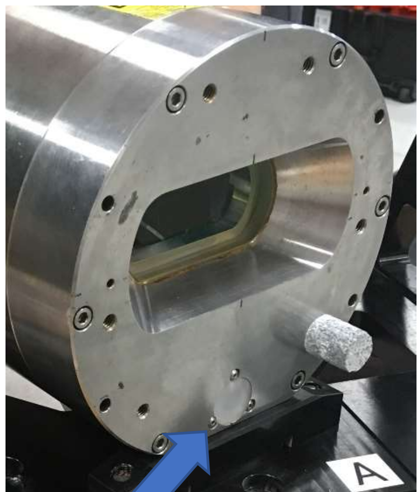
Note: All messages sent to the WiSSL GUI are logged to a file (WiSSL_LOG_yyyy_hh_ss.txt) located at “C:\3D\LOG”. An example log is shown below. Corresponding messages from the GUI and each laser head are delineated accordingly.




```
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.

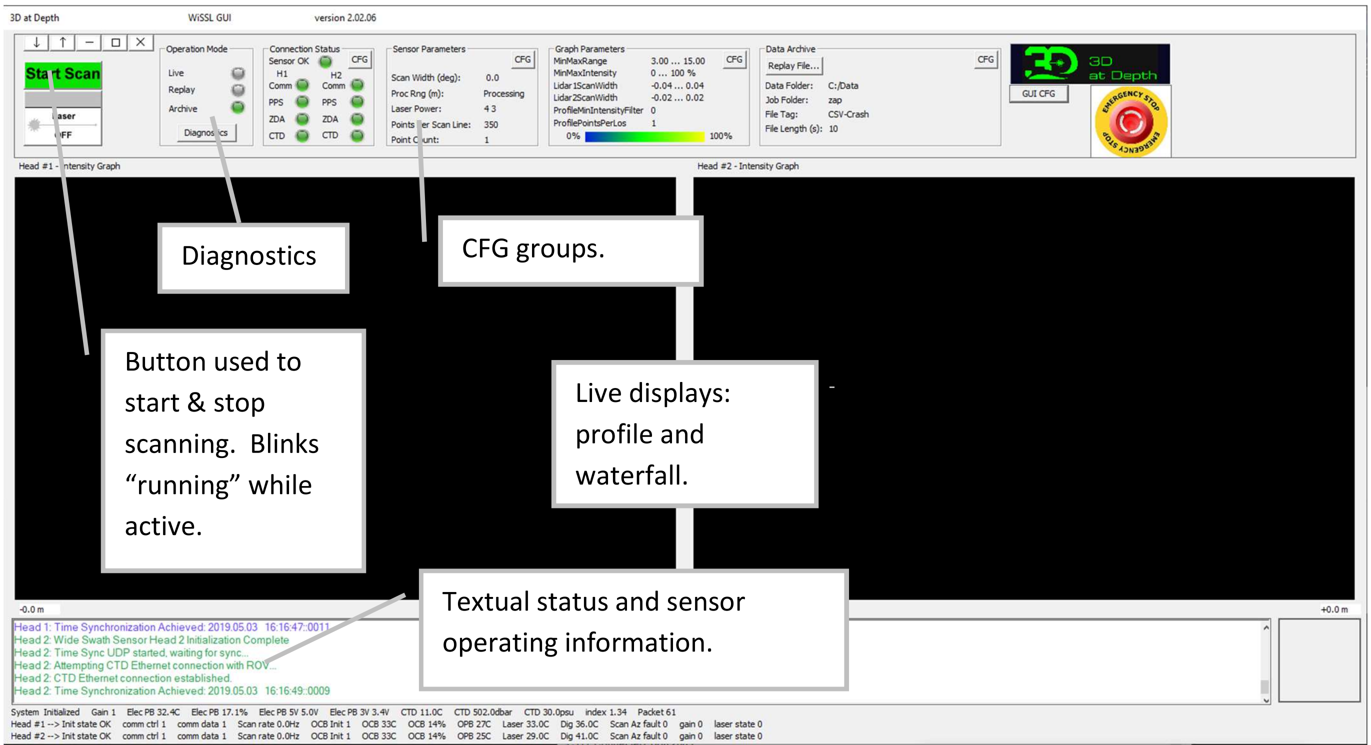


Safety Light (red) and Status light (yellow) both are seen here.

2 Graphical User Interface

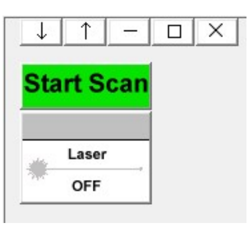
2.1 Main Screen

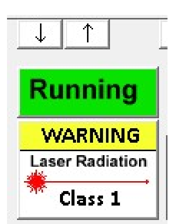
The 3D at Depth WiSSL Sensor is controlled via an Ethernet based Graphical User Interface (GUI). The GUI is used to configure, start/stop, and view resultant laser scans.



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. While running the laser Class will be identified, Class 1 is generally eye safe (yellow color), 3B is not (red color). The most conservative will be shown if the heads are running at different power levels.

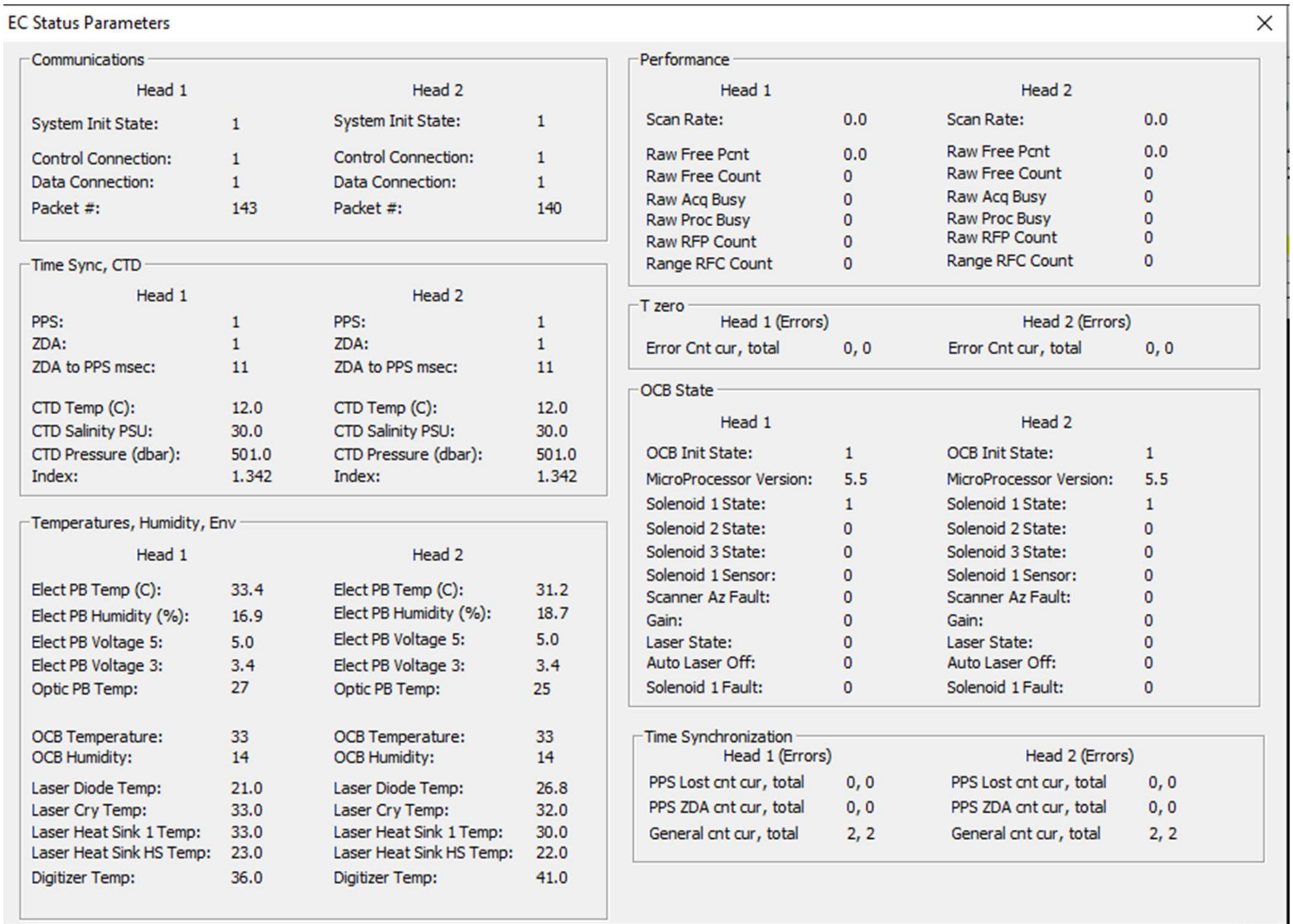




On right hand side

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.

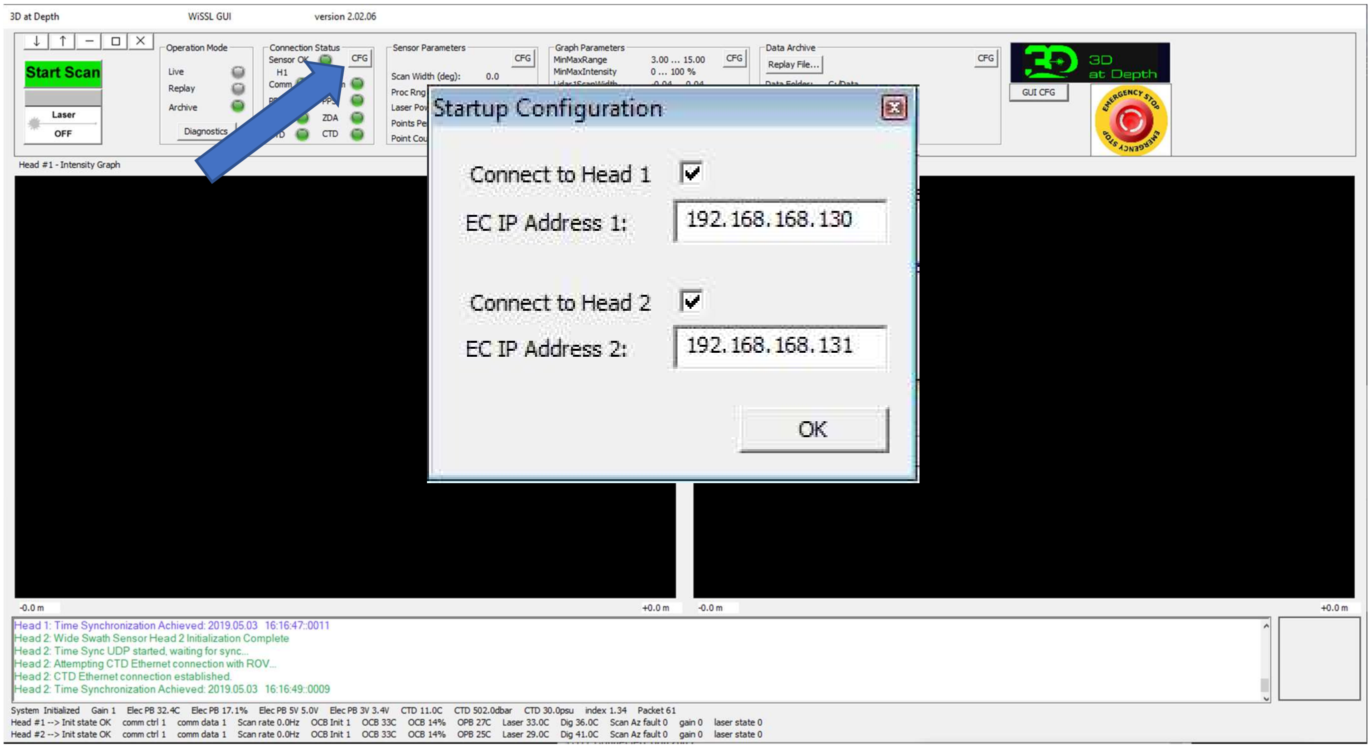


For Time Synchronization, if there is no ZDA message at all, then the General error count will increase but not ZDA or PPS. ZDA errors are limited to message format errors. PPS errors are only reported when ZDA messages are coming in and the header "GPZDA" is in the message; the message may not be fully correct but it needs to have at least that string in it. PPS error can be that no PPS pulse was detected or that the pulse came in and the time difference was more than the configuration parameter ZDA_TO_PPS_MAX_MSEC. Time is shifted 1 ms each second in the direction of the error while the time error is less than 5 seconds, effectively smoothing any time jumps. If the difference in time is over 5 seconds for 3 consecutive pulses, then the system will jump to the new time immediately. The time sync will only accept time differences over a day on startup. If time is different by more than a day this error message will be reported: `Time Sync failed, Time different by days requires sensor reboot to sync.` It is possible to receive this message when the day rolls over, and it can be ignored if it only occurs once.

2.3 Connection Status CFG

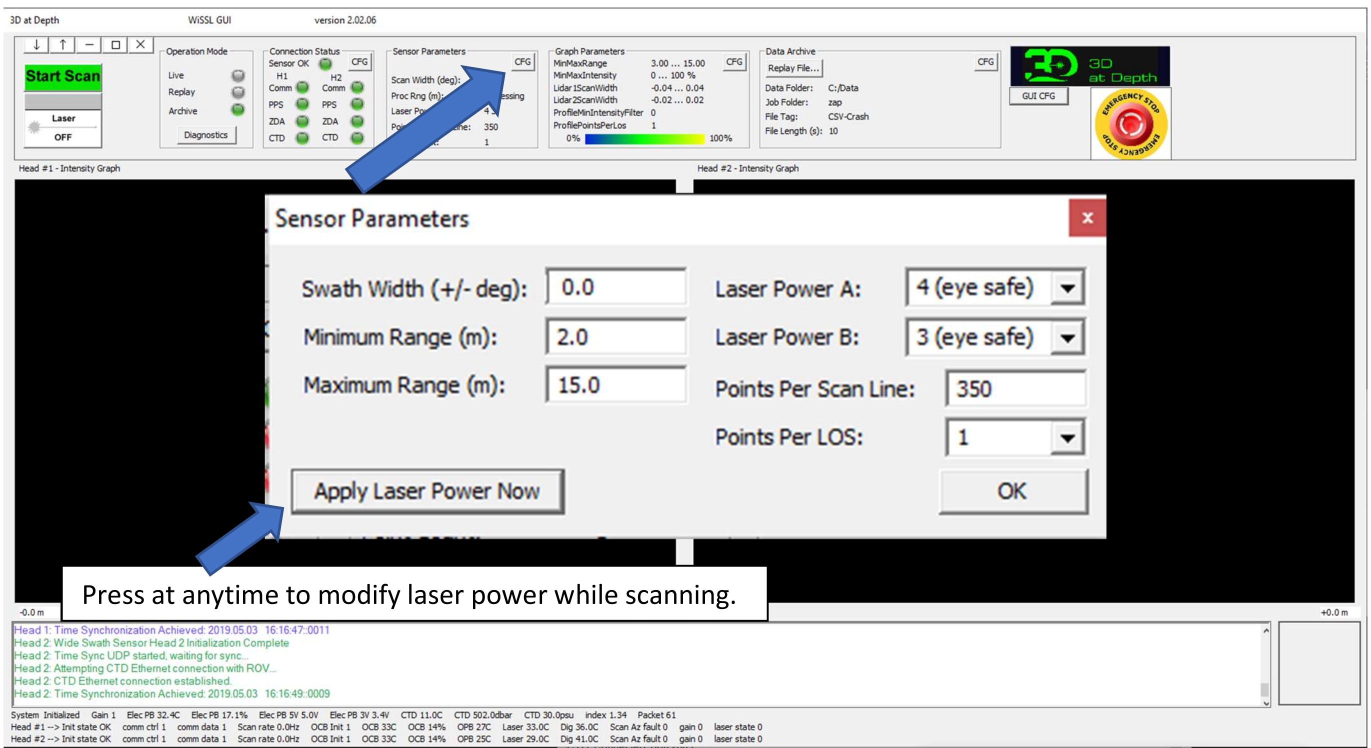
The Connection Status CFG sub window displays the current connection status and time synchronization information. A green LED indicates successful operation, and red indicates failure or non-operational. Under normal operation, all LEDs should indicate green.

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.



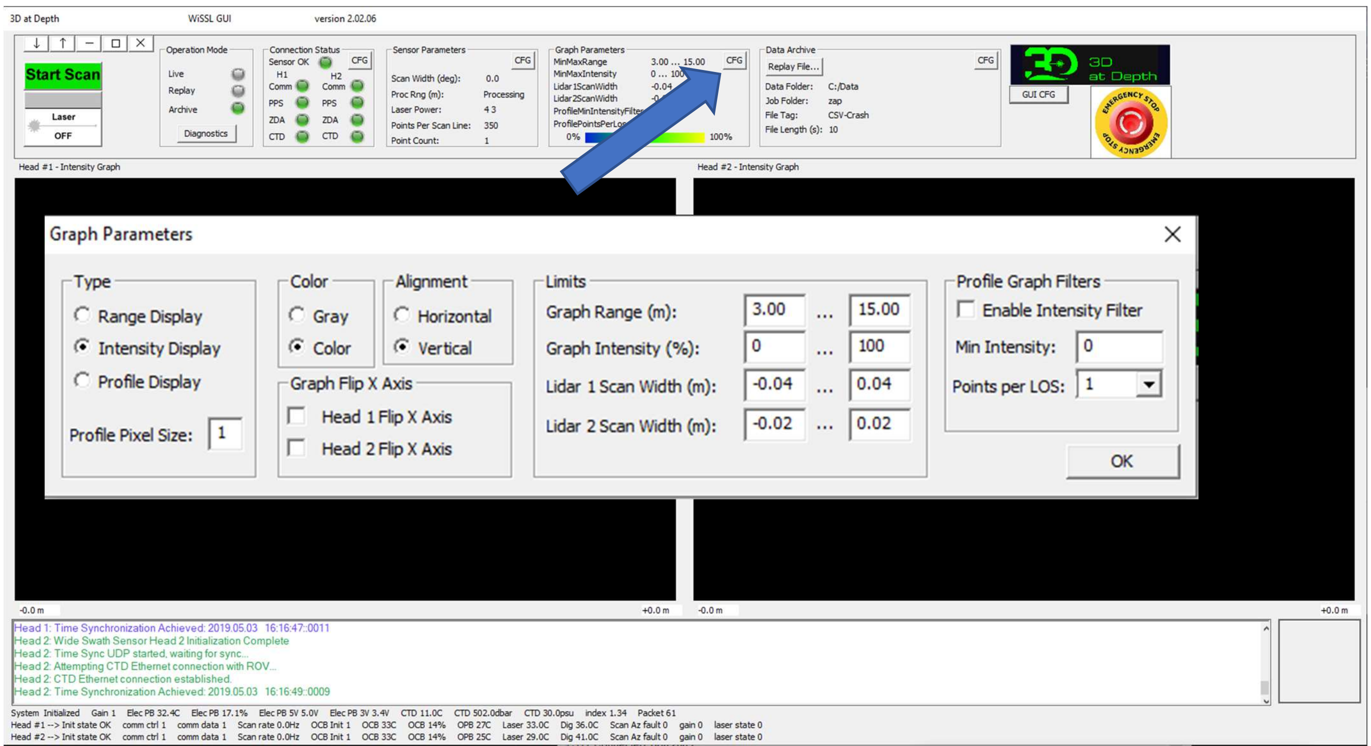
2.4 Sensor Parameters CFG

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 350 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, but it can be as large as 5. This window also now sets the Laser Power level per side and can be used to modify laser power while the sensor is scanning. Select the power level desired for both A and B sides then click Apply Laser Power Now. This window can be moved and placed anywhere on the desktop to make changes to the laser power level.



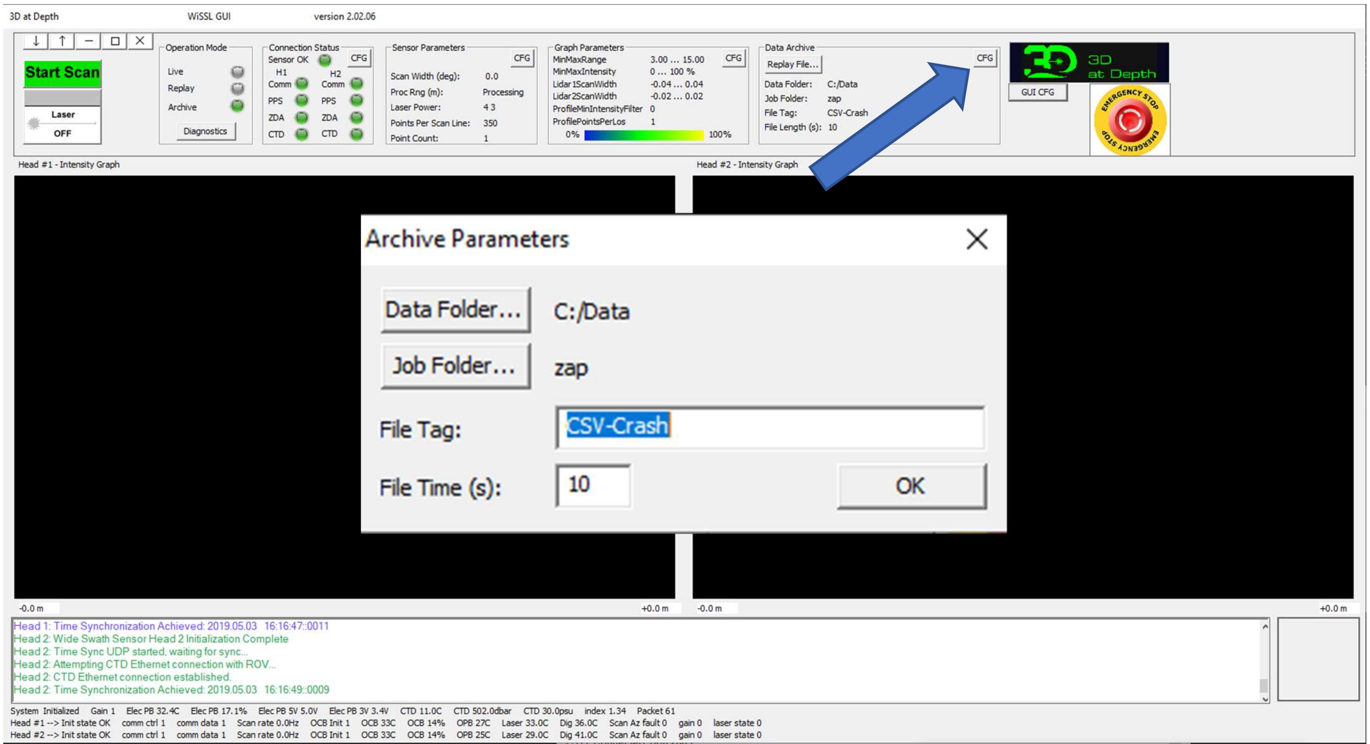
2.5 Graph Parameters CFG

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. In Profile display, the points per LOS is ignored and not useful. The intensity filter is also ignored for profile display. The point displayed is the largest intensity point for that location. In Range and Intensity Displays, the LOS, Intensity and Range filers are all used and applied.



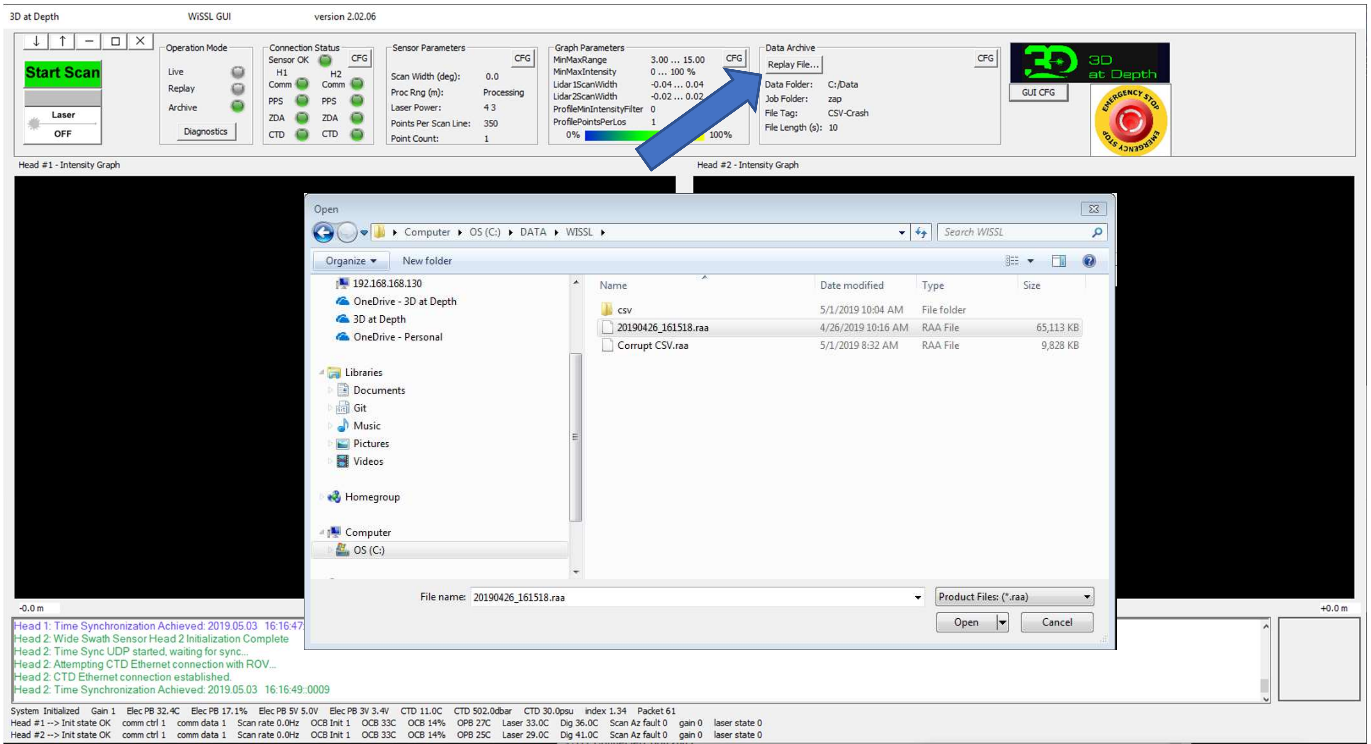
2.6 Data Archive CFG

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

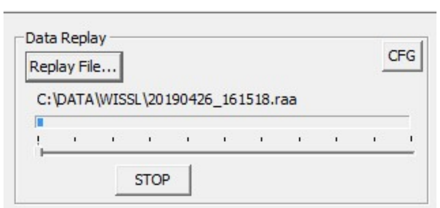


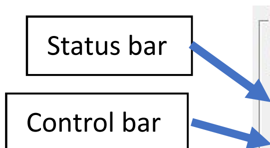
2.7 Replay File

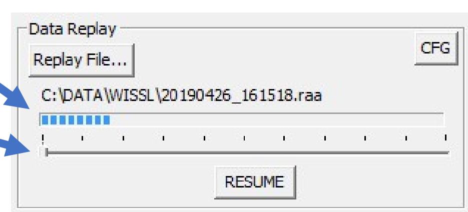
Allows the user to select a .raa file for replay. The data in the file is sent to the display and the user may select different Graph parameters. The range can be adjusted, the number of lines of sight (as long as the sensor data was saved with the asked for number of points, or more) and additional filters can be applied or removed. The data will come in on side A then side B, since that is how the data is saved in the file. The rate of replay is fixed and is faster than real time, but still allows the user to watch it come through.



After selection of the file to replay, the Data Archive box is updated. The file will start play automatically. There is a status bar that shows how far into the file the data is being replayed from and a control bar that allows the user to slide forward or backward to a new point in the file. A jump in the file location will clear the displays and playback will continue from that location on. A New file will stop the current file playback and start the new file.

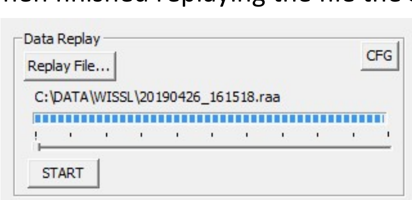




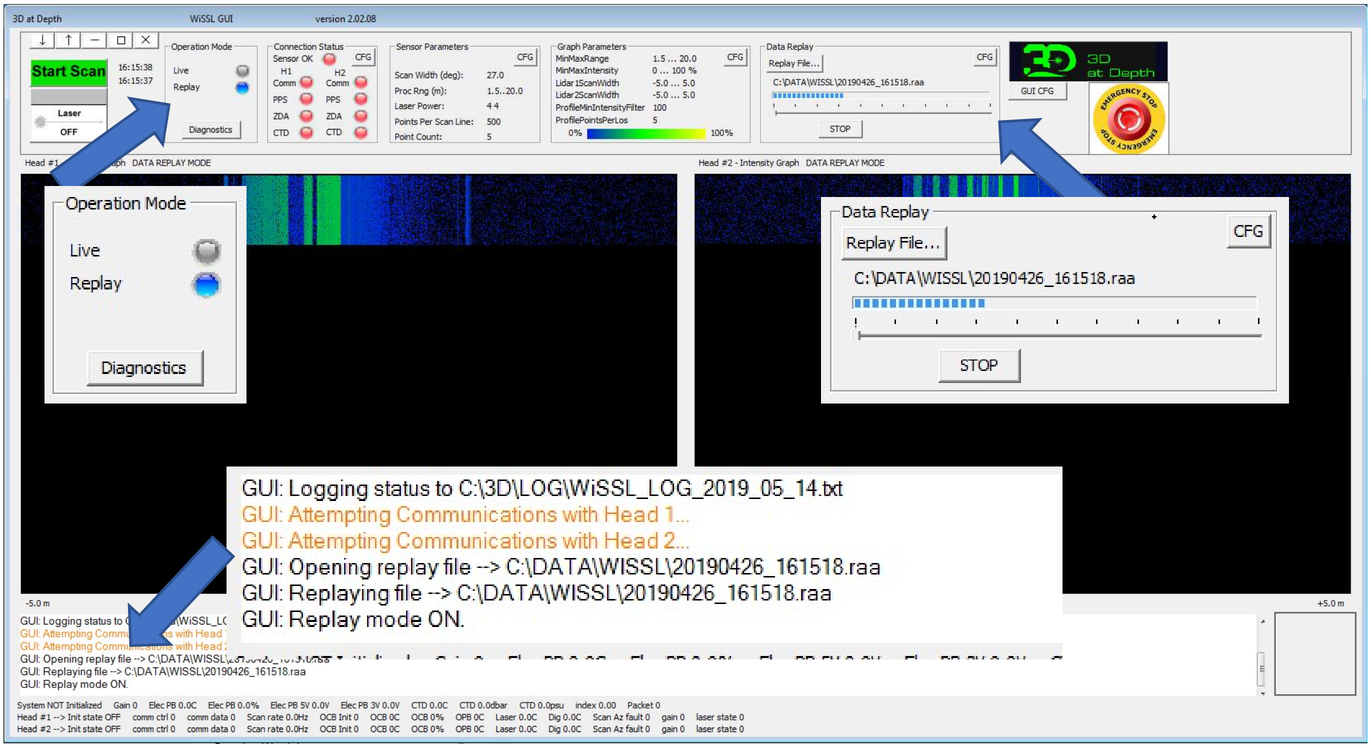


If Stop is pressed:

When finished replaying the file the Stop button will disappear and the Start button will appear. This allows the user to restart the file playing from the beginning if desired. The Resume button only is showing if the replay is stopped. Stop button is only showing if replaying is currently running. To exit replay, select Start Scan to go back into Live mode or the GUI could be closed as well if finished.

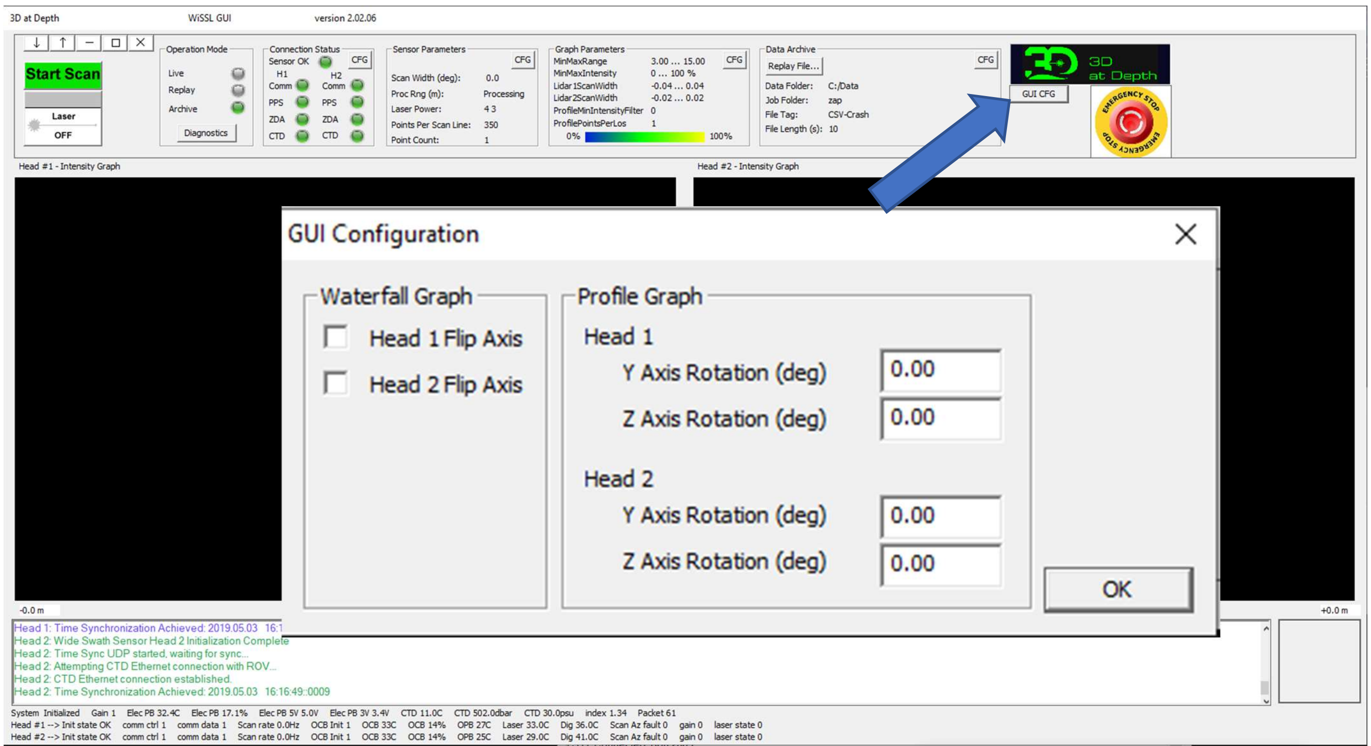


The status box will report what files are loaded and being replayed. This is the same file reported in the DATA replay window. The Operational Mode will indicate Replay (blue light). Below is an image of what file replay looks like.

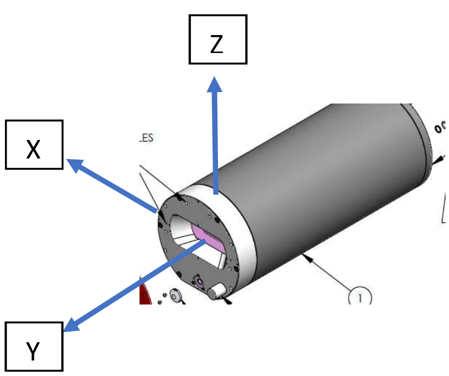


2.8 GUI CFG

Allows the user to rotate the graphs to any angle. Each head can be rotated independently. This allows the center of the screen to show data that will be picked up by both sensors. If the center is defined by the middle of the mounting plate, then both heads will need to be rotated. As measured this is 22.07 degrees (head A) and 22.02 degrees (head B) in Z. In addition one of them will also need to be flipped (since it is up-side down), this is usually defined as head B. The Y and Z axis is defined local to the head where Y is the distance from window and Z is positive up from the mounting feet, leaving X coming out the side so that X cross Y is Z (right handed system). This only affects the Graph view and does not affect the saved data. The rotation is applied during replay of data files and different values can be tried on the same file until the data looks aligned. The Fixture rotation is ideally 22 degrees in AZ for each head. The Head flip axis will swap along the X axis so positive x values are now negitive and negitive are positive. This selection does the exact same thing as the Graph parameters “Head 1 Flip X Axis” and “Head 2 Flip X Axis”. Selecting both will only cause one flip (it will not flip it back). The Flip will cause an effective 180 degree rotation on Z so if an additional 180 on Z is selected, the result is no rotation at all.

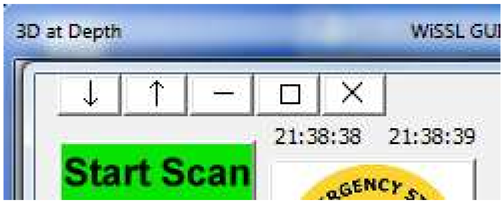


Axis Definition:

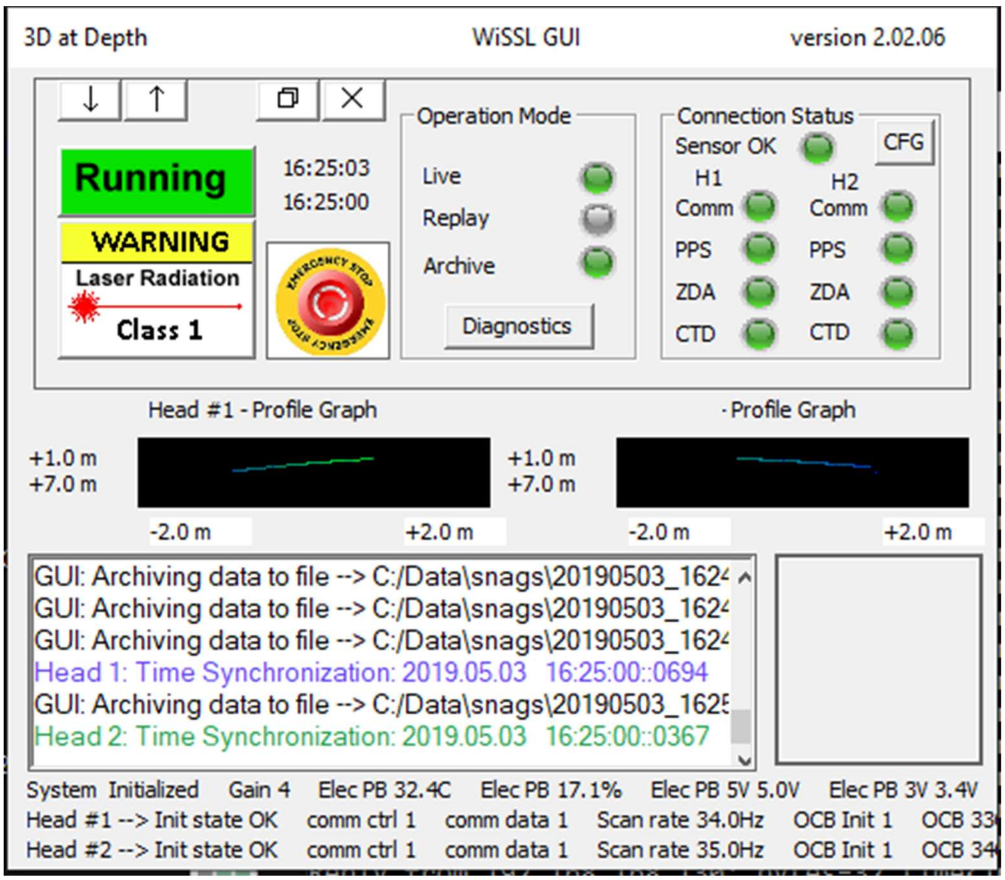


2.9 Resizing the GUI

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.



The GUI also has a few middle sizes that will increase the window size (up arrow) if something between the largest and smallest displays is desired.

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.**

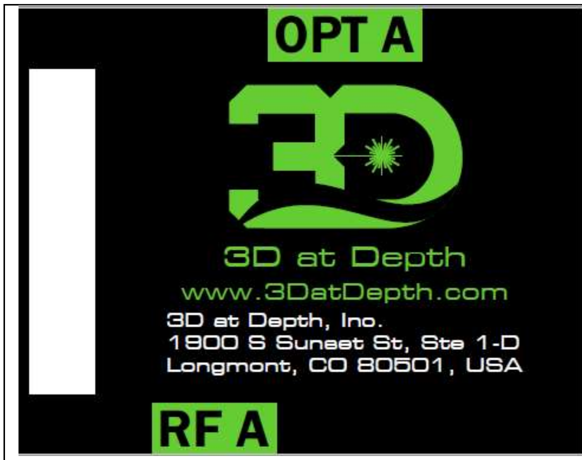
```
////////////////////////////////////////////////////////////////////////////
//
// 3D at Depth Wide Swath Sensor parameter configuration file
//
//////////////////////////////////////////////////////////////////////////

// must be 1 or 2
LASER_HEAD_NO = 1

PROCESS_FOR_AIR = 0

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

// EMERGENCY_SHUTDOWN controls whether to shut down the sensor
// when temperature, humidity, and/or leak checks go above their
// maximum values as defined below
//
// If value is "TRUE", or if the parameter line is commented-out,
// sensor shutdown behavior will be enabled
// If value is "FALSE", shutdown behavior is disabled,
// and the GUI will only display warning messages.
//
// This should always be set to TRUE, unless a faulty temperature
// or humdity sensor is causing unwanted shutdown scenarios.
//
EMERGENCY_SHUTDOWN      = "TRUE"

//    all temperatures at 58 C or below
//    all humidities   at 50 %
//
OCB_TEMPERATURE_LIMIT_C   = 58.0
OCB_HUMIDITY_LIMIT        = 58.0
PB_TEMPERATURE_LIMIT_1_C = 58.0
PB_TEMPERATURE_LIMIT_2_C = 58.0
PB_HUMIDITY_LIMIT         = 50.0
DIG_TEMPERATURE_LIMIT_C   = 58.0

OCB_COMM_PORT           = "COM7:"

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

AZ_AI_NEG_V_TO_DEG      =  1.0
AZ_AI_POS_V_TO_DEG      =  1.0

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
```

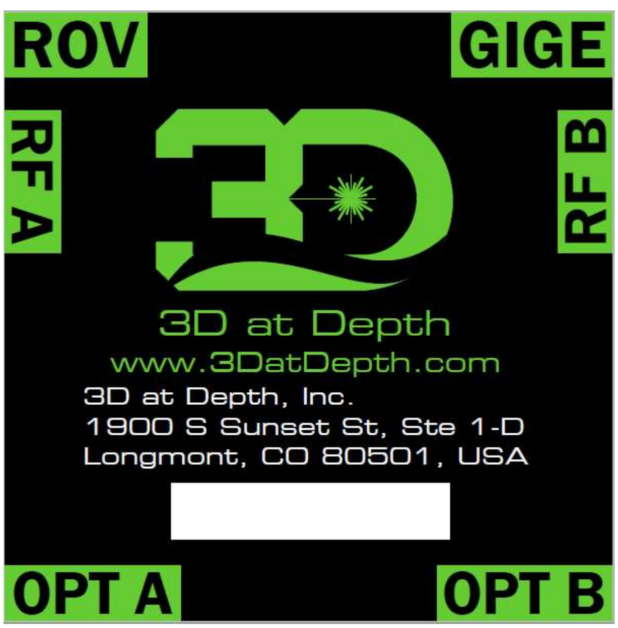
```
SCANNER_POS_POLYNOM_0 = 4.016189337
SCANNER_POS_POLYNOM_1 = 0.003091633
SCANNER_POS_POLYNOM_2 = 0.00302357
SCANNER_POS_POLYNOM_3 = 0.000658871
SCANNER_POS_POLYNOM_4 = 0.000039209

///////////////////////////////////////////////////////////
// range calibration - air
//
T1_AIR                  =  3.0
FF_AIR                  =  1


///////////////////////////////////////////////////////////
// range calibration - water
//
T1_WATER_G4000          =  2.8
FF_WATER_G4000          =  0.98

T1_WATER_G3000          =  2.8
FF_WATER_G3000          =  0.98

T1_WATER_G2000          =  2.8
FF_WATER_G2000          =  0.98

T1_WATER_G1000          =  2.8
FF_WATER_G1000          =  0.98

T1_WATER_G400           =  2.8
FF_WATER_G400           =  0.98

T1_WATER_G300           =  2.8
FF_WATER_G300           =  0.98


///////////////////////////////////////////////////////////
// temperature compensation
//
TEMP_COMP_POLY          = -2.0
TEMP_COMP_POLY1         =  0.02
TEMP_COMP_POLY2         = -0.01

FACTORY_SCANNER_LRG_DEG   = 0.4
FACTORY_SCANNER_MED_DEG   = 0.04
FACTORY_SCANNER_SML_DEG   = 0.004
FACTORY_DIG_CNT_TO_VOLTS  = 0.00003829

// laser start time
LASER_START_TIME_SEC    = 4.0


SCANNER_SHIFT_CTS       = 1.0

EL_ANGLE_FIXED_DEG      = 5.0

ZDA_TO_PPS_MAX_MSEC           = 250
ZDA_UDP_PORT                  = 2007
MIN_TIME_DIFF_UPDATE_MSEC     = 2
SHOW_TIME_SYNC_ERRORS         = "FALSE"

CTD_TCP_PORT                  = 2009

///////////
TRIGGER_LEVEL_VOLT            = 0.6
MF_T0_POSITION                = 63
MF_START_PROC                 = 200
DIG_REF_POS_T0_CNTS           = 64
T0_MIN_HEIGHT_RAWCTS          = 150

// end of configuration file
```

3.3 RF Cable Configuration

3D at Depth is supplying 10 RF cables. The cable can be used on either head and there is no longer any need to specify any calibration data due to the cable. This is part of the upgrade in Feb 2019.

In a cable set, the cable is connected to the RF port on both the electronics bottle and the optical bottle. The cables are color coded to assist the operator. A cable can be used to connect to either head. The colors may assist users in making sure head A is connected appropriately. Do not connect head A to Electronics B as the calibration parameters for Head A are stored in Electronics A side (and vice a versa).

 The RF Port is used and connected.	 The other port is no longer used and will always be capped.



Example RF Cable. Color code is now just to keep track of what is connected to each head. Only one RF cable is needed per Head.

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

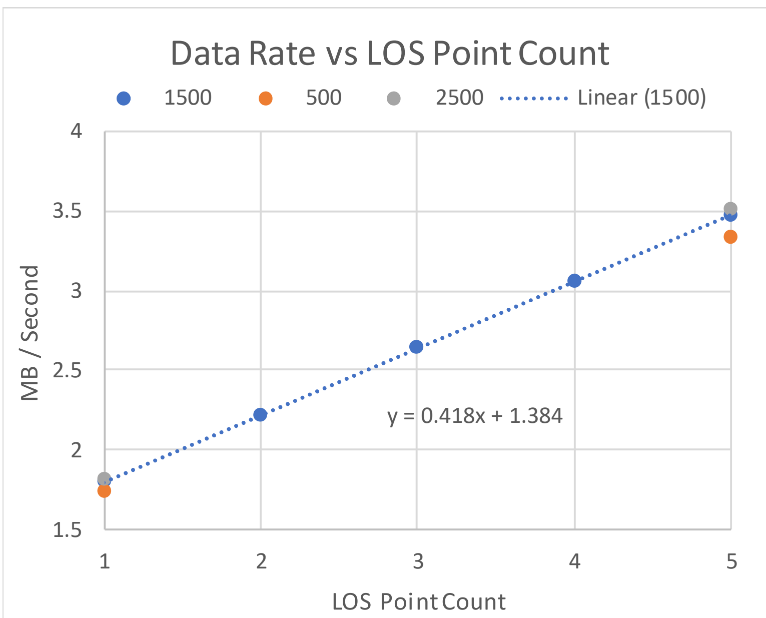
Additional performance testing was performed for other LOS range values. The follow configurations per range depth and intended resolution are recommended.

	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 at start).

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	2	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 of Refraction		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)
Diagnostic 1		1 (1 UINT8)
…		
Diagnostic n		1 (1 UINT8)

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
            - Diagnostic Data:
                - Diagnostic 1
                - Diagnostic 2
                - Diagnostic 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
            - Diagnostic Data:
                - Diagnostic 1
                - Diagnostic 2
                - Diagnostic 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. The Configuration structure was updated for May 2019.

```
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            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;

        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           FACTORY_DIG_CNT_TO_VOLTS;

        float           EL_ANGLE_FIXED_DEG;
        int             ZDA_TO_PPS_MAX_MSEC;
        int             ZDA_UDP_PORT;
        bool            SHOW_TIME_SYNC_ERRORS;
        int             MIN_TIME_DIFF_UPDATE_MSEC;

        int             CTD_TCP_PORT;

        double          TRIGGER_LEVEL_VOLT;
        int             MF_T0_POSITION;
        int             MF_START_PROC;
        int             DIG_REF_POS_T0_CNTS;
        int             dummy;
```

```
        int                         T0_MIN_HEIGHT_RAW_CTS;

        double                      SCANNER_NEG_POLYNOM_0;
        double                      SCANNER_NEG_POLYNOM_1;
        double                      SCANNER_NEG_POLYNOM_2;
        double                      SCANNER_NEG_POLYNOM_3;
        double                      SCANNER_NEG_POLYNOM_4;
        double                      SCANNER_NEG_POLYNOM_5;

        double                      SCANNER_POS_POLYNOM_0;
        double                      SCANNER_POS_POLYNOM_1;
        double                      SCANNER_POS_POLYNOM_2;
        double                      SCANNER_POS_POLYNOM_3;
        double                      SCANNER_POS_POLYNOM_4;
        double                      SCANNER_POS_POLYNOM_5;

} 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. To update to the latest GUI, just copy the executable, WiSSL_GUI_v2.02.08.exe to the C:\3D at Depth\X64\ folder. Usually a shortcut is created on the desktop that points to the executable, but it is up to the user how they wish to configure their system.

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. DO NOT connect based on the computer name, only the IP address. The computer name is the same for both heads and thus it is not unique. Network traffic should also use IP address and not rely on network name lookup services (if any even exist).