3D at Depth

3D at Depth, Inc

SL Sensor Command & Control Interface Manual

Version C4

November, 2021

Change Record

Version	Date	Notes	Author
C.1	8 May-2019	Initial Release	J. Jeong
C.2	Sep-2019	Update to Ports and Ack/Status	D. Florin
C.3	Mar-2020	Updated RTV, playback, and XPF	D. Florin
C.4	22 Nov 2021	Clean up names	D. Florin

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0 Definition and Acronyms

ROV: Remote Operating Vehicle

CCI: Command and Control Interface

RTV: Real Time Viewer is a software program which shows Lidar scanning data in real time. This normally is located on the control laptop.

EC: Embedded Controller is the software which receives commands and controls the sensor. This is located on the SL sensor.

InstaCloud: InstaCloud is a software which processes the raw Lidar data and sends it to RTV and is located on the SL sensor.

3D Collect: 3D Collect is a user-friendly GUI (Graphic User Interface) to help command the sensor. This is normally located on the control laptop.

SL Sensor: Subsea Lidar Sensor

Riaat: Range, Intensity, Angle, Angle, and Time data in a 3D at Depth defined format

UDP: User Datagram Protocol

1 Introduction

There has been recent development of untethered ROV platforms to support various subsea activities. The Command and Control Interface was initially developed for the support of one such system, the SAAB Sabertooth. The CCI interface has also proved to be very low bandwidth and robust which caused it to be adopted as the low bandwidth communication preference for difficult remote field operations when communication bandwidth is a problem. The primary objective of this manual is to document the protocols for command and control using Ethernet communication as well as data transfer from the 3D SL sensor measurements. The CCI provides commands to SL sensor with short UDP packets. This also allows a series of commands to be saved on the sensor and the sequence to be kicked off with a single short command.

2 Overview

This manual describes how the 3D at Depth Lidar system works within the Sabertooth and software system. Refer to Figure 1 which provides a representation of the system.

The SL Sensor uses two programs, EC and InstaCloud. EC receives commands, controls the SL sensor, acquires data, transfers the data to InstaCloud, and report its status. InstaCloud converts the raw data to Riaat format, has the ability to store Raw and/or Riaat data in the sensor, and transfers the Riaat data to the Real Time Viewer on the Sabertooth computer.

Real Time Viewer opens a TCP port as a server for external communications. The interface serves up the point cloud information to third party navigation and mapping software. Its server port number is 2019.

Riaat-CCI type packets are transferred through the TCP connection. The Riaat-CCI packet structure is specified in a separate document (RTV CCI Communication Manual).

Figure 1 below provides a block diagram of the communication layout for the Sabertooth system. The green filled boxes identify 3D at Depth software.

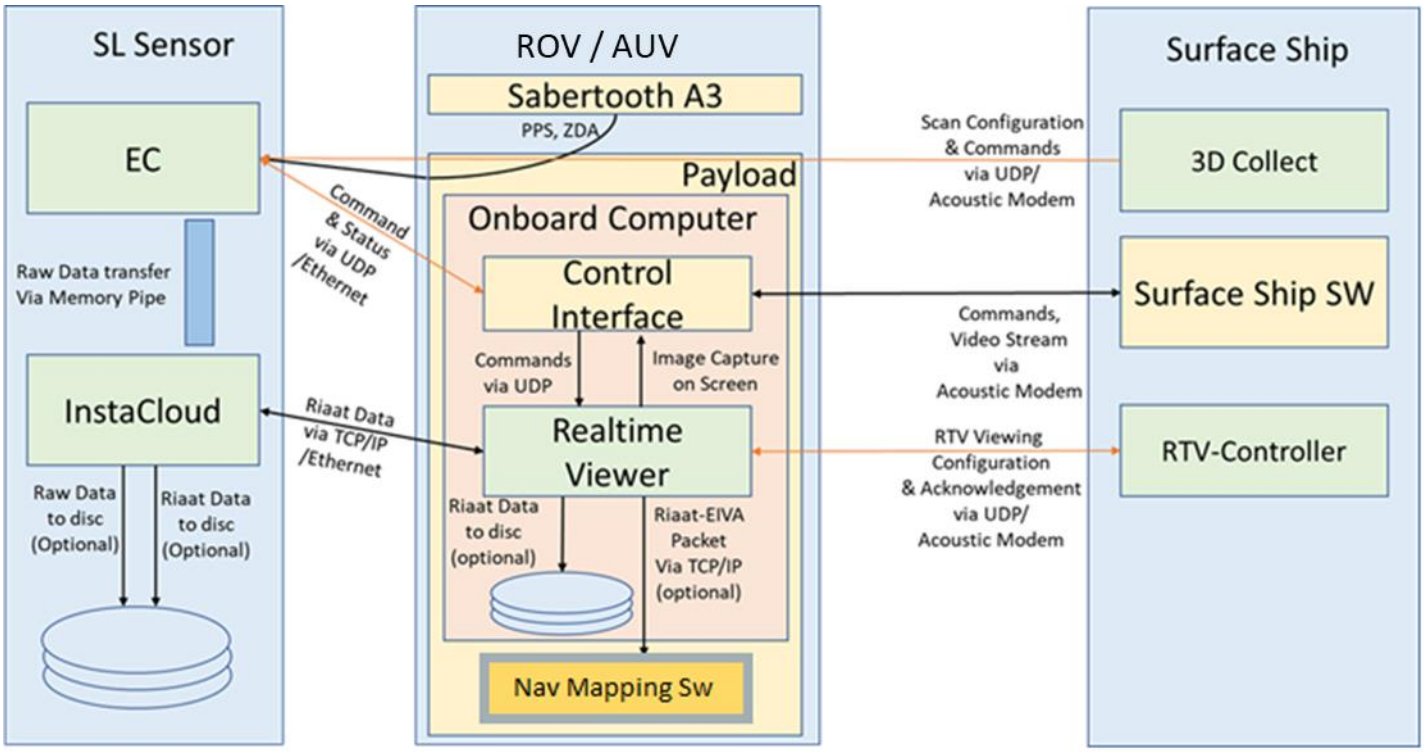

Figure 1. Overall Communication Schematic

3 System settings

For testing, a SL3 sensor was connected to the simulated ROV/AUV computer (top and middle in Figure 2) through a switching hub, and the simulated topside commanding center (top and left laptop in Figure 2) was also connected to the same switching hub. The CCI simulator was also connected to the same switching hub.

The top side control center runs 3D collect and ICD-RTV controller. The ROV/AUV computer runs Real Time Viewer, and also opens a remote desktop to SL sensor. The CCI simulator program runs on a different computer to connect to RTV via TCP.

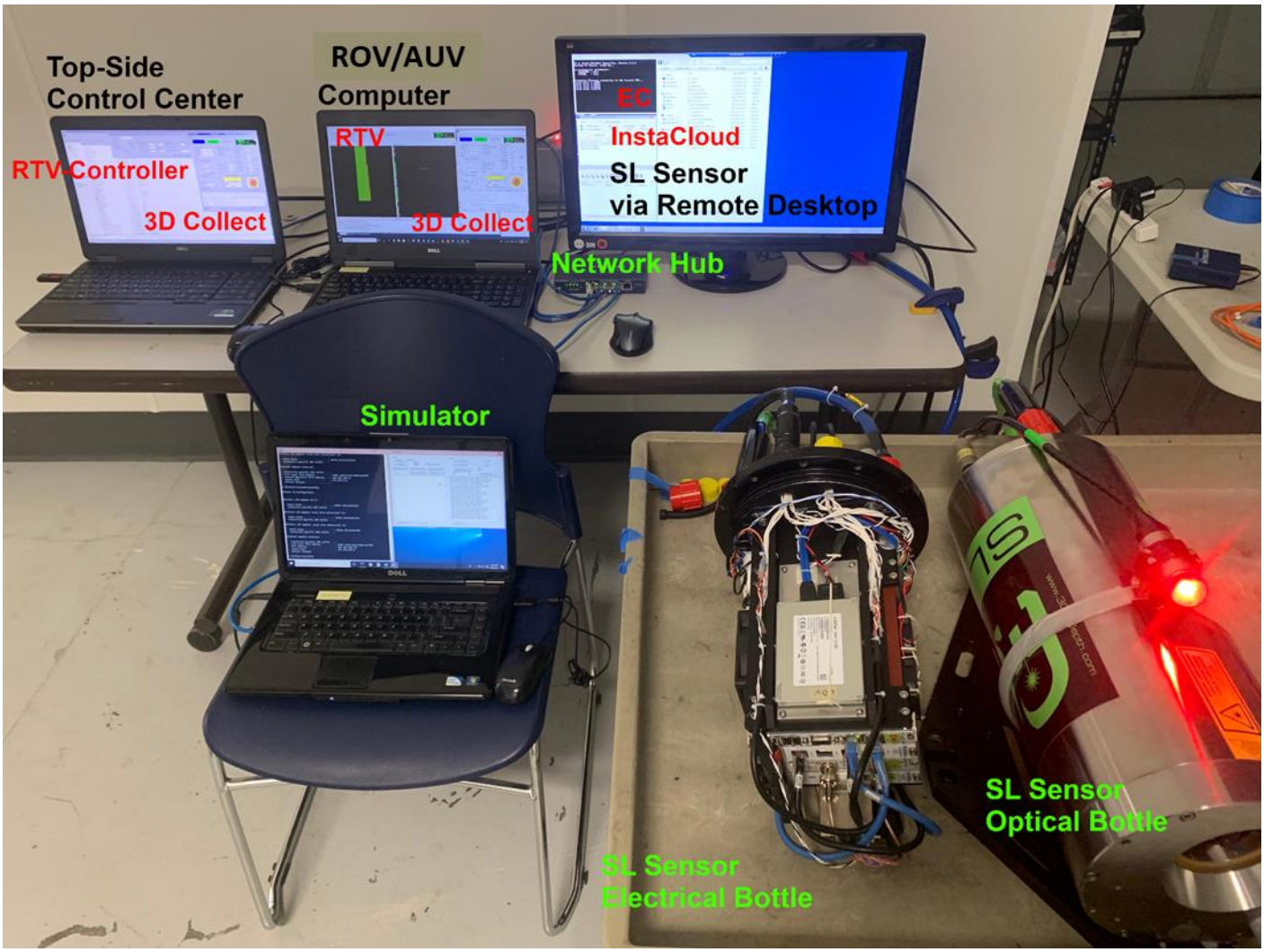

Figure 2 Test System Overview

3.1 Top Side 3D Collect

The top side control center runs 3D Collect and ICD-RTV Controller. 3D Collect generates a configuration file and sends the configuration file to the SL Sensor through UDP packets.

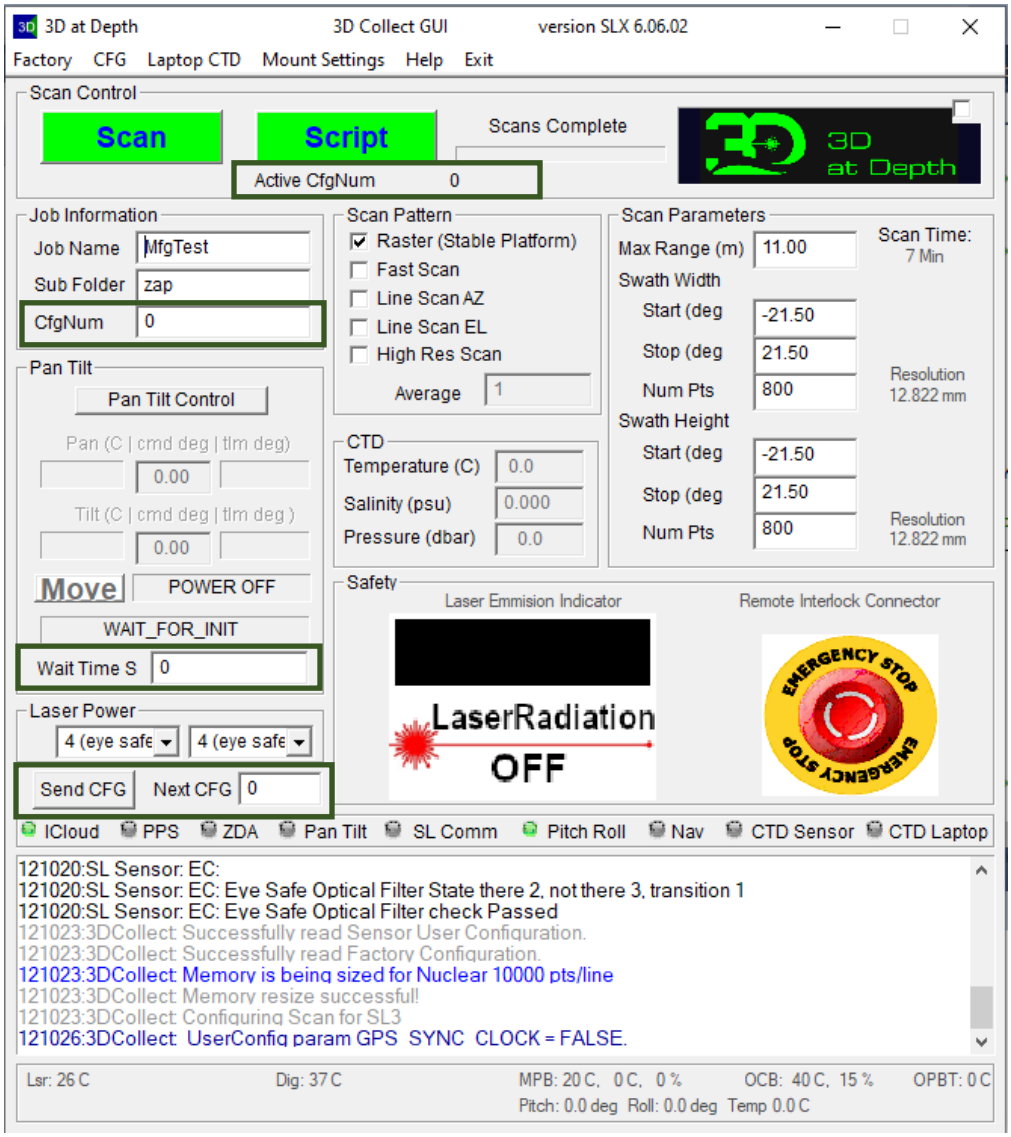

Figure 3 3D Collect

To enable command through the UDP packet option, open the 'Laptop Configuration' Window under 'CFG'-'Edit Laptop CFG', and check the 'Open UDP port' option as seen in Figure 4. When in the CCI command interface, there are several additional fields that are displayed in the GUI that are specific to CCI. The Active configuration at the top shows what configuration is active, if scanning or moving the pan tilt or in a time delay wait. In Job information CfgNum allows the user to set the configuration from the rest of the screen. Wait Time S is a command that sets a delay between pantilt motion and scanning. Next CFG sets what the next scan number to use when the current scan is done and this allows a user to build up a script.

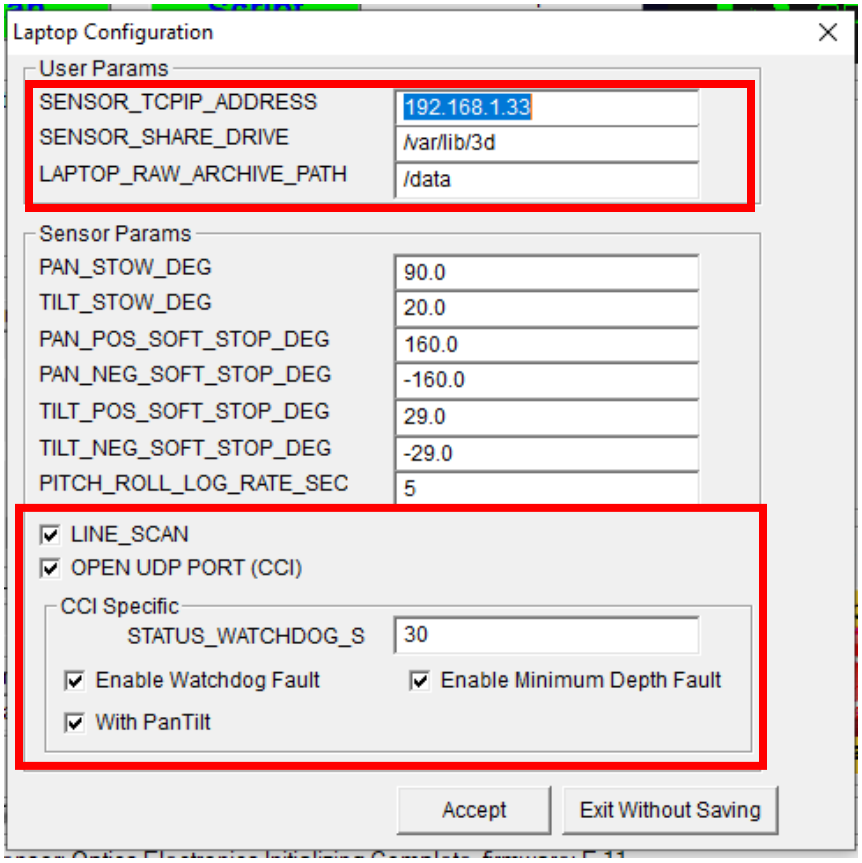

Figure 4 Laptop Configuration Window

Make sure the IP address of SL Sensor is correct and on the D drive for the parameter SENSOR_SHARE_DRIVE (SL3) or is set to /var/lib/3d for SL4 or SL5. If there is no pan tilt, the interface is the older version 0, and if the With PanTilt is selected, then the interface is the newer version 1 that add more functionality. Even if a PanTilt is not going to be used, it is recommended that all new configurations shift to this version 1 format.

By clicking 'Accept', 3D Collect is changed to configuration generator and 'LaptopParas.bin' is saved. In 'Configuration Generator' mode, the 'Send Cfg' button and 'CfgNum' edit window are shown. Job Name and Sub Folder are not used in UDP mode and all the data will be saved in 'Udp Scan' folder as shown in Figure 5. The status watchdog timer is defined here as well as enable or disable of the status watchdog fault and the minimum depth fault.

3.2 Saved files in Sensor

Data files are stored on the SL sensor in the 'D:\data\UdpScan' folder. If the ARCHIVE_RIAAT_DATA value is selected to be 'True' and/or if the ARCHIVE_RAW_DATA value is selected to be 'True' in the User Configuration dialog (as shown in Figure 8) then the .riaat and .raw files are saved within this folder as shown in Figure 5 below.

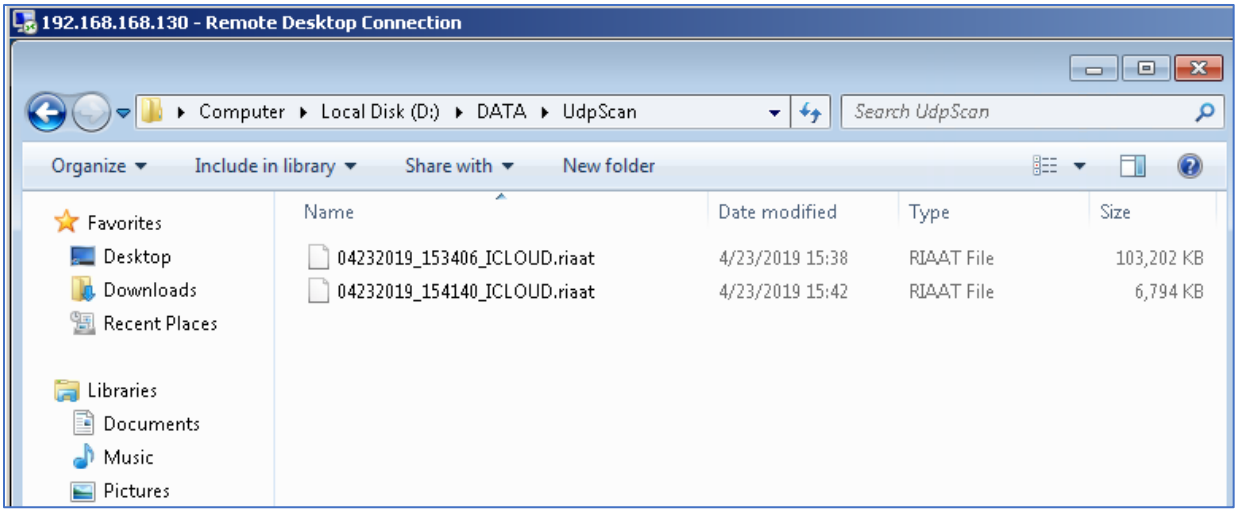

Figure 5 Scan data saved on SL Sensor

3D Collect in UDP mode reports opened UDP ports at a start with the status as shown in Figure 3. Note that port 2010 on the SL sensor is opened as the server. 3D Collect is the server for ports 2011 and 2012 as seen in Figure 6.

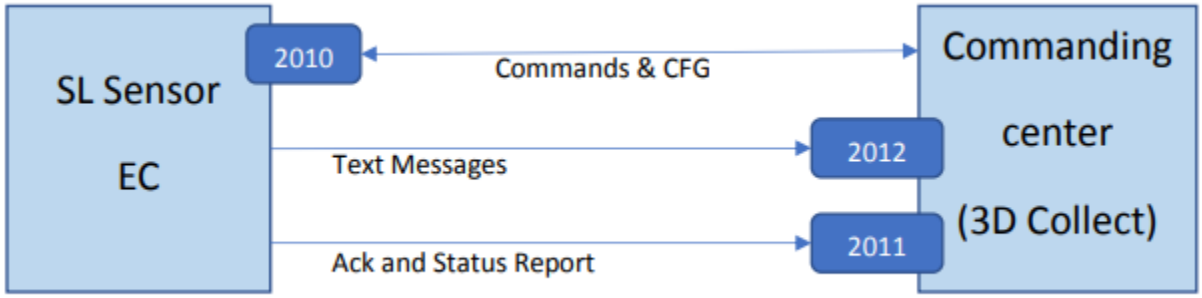

Figure 6 UDP Port openings and data flow

When connected to the sensor, the SL sensor reports its status and 3D Collect shows the status messages.

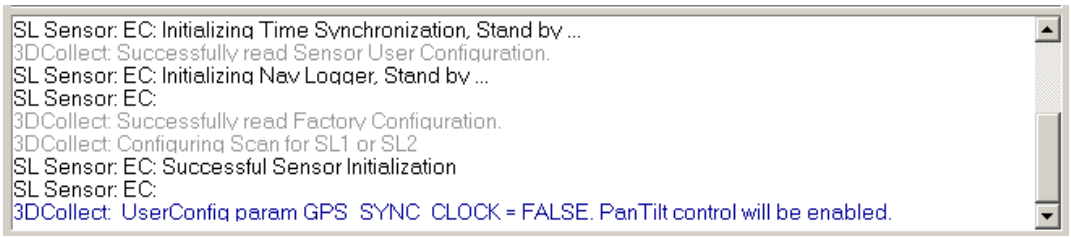

Figure 7 Status Window when the SL Sensor is connected

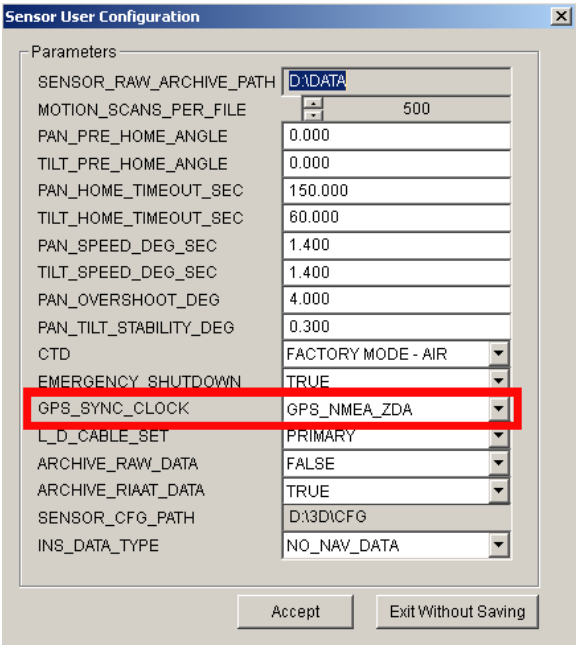

Figure 8 Sensor User Configuration

Since the SL2 shares a port for Pan/Tilt and Serial Time Synchronization, only one of these two options can be activated at once. To use the port as serial ZDA, choose the GPS_NMEA_ZDA option in 'Sensor User Configuration' window as seen in Figure 8. 'Sensor User Configuration' shows up by clicking 'Edit User CFG' under 'CFG' menu in 3D Collect. Pan/Tilt control functionality will be disabled when 'GPS_NMEA_ZDA' option is selected as seen in Figure 9.

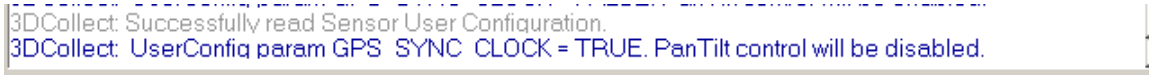

Figure 9 Status Message when 'GPS_NMEA_ZDA' option is selected.

Note that the setting in User Configuration is NOT saved on the sensor, but 'UserParams.bin' file where the 3D Collect is located so it may remember the settings of the Sensor User Configuration window. The same file will need to be **manually** copied into the sensor so that the software agrees with all the user settings, even the ones not specified in the command and control interface. Some of the options chosen in 'User Configuration' window, in 'Laptop Configuration' and at the 3D Collect main window are sent to sensor as a configuration when 'Send CFG' button is clicked (but not all). The configuration is saved in the SL sensor with a name of 'ConfigurationX.bin', where X is the configuration number input in at the 'Cfg Num' in Figure 3. When the configuration file is saved at the sensor, the sensor reports where the configuration file is saved as seen in Figure 10.

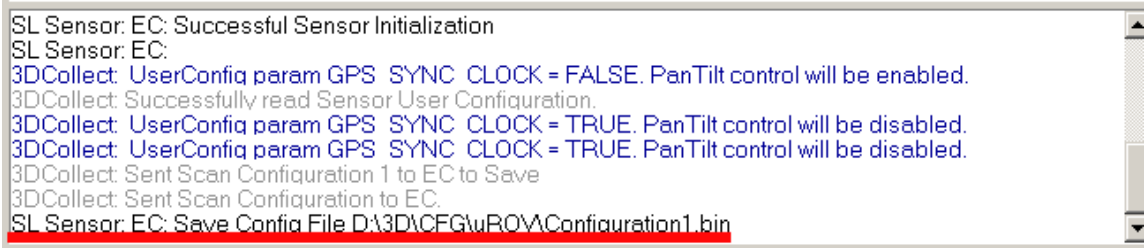

Figure 10 Status Message when Configuration is saved.

When '**Scan'** button is clicked in 3D Collect, an operation- Start packet with a configuration number in the file name is sent to the sensor, and the sensor opens the saved configuration file to start scanning. Note in the example below in Figure 11 the configuration file name and number are "Configuration1.bin."

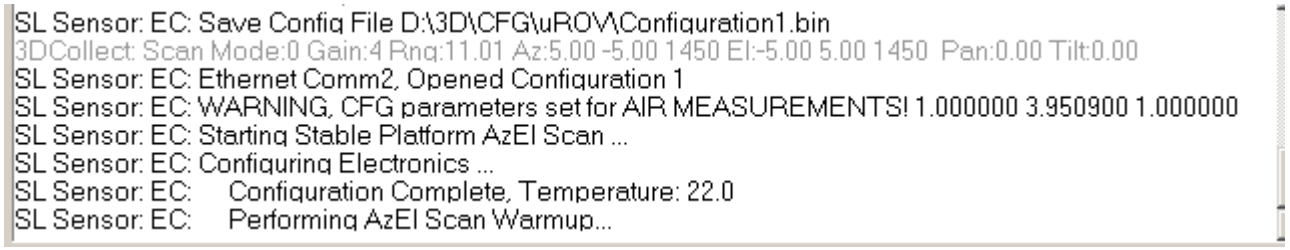

Figure 11 Status Messages when a scan starts.

3D Collect can add an additional configuration file with a different configuration number as shown in Figure 12 where the configuration number is 2.

Figure 12 Status Messages when another configuration saved

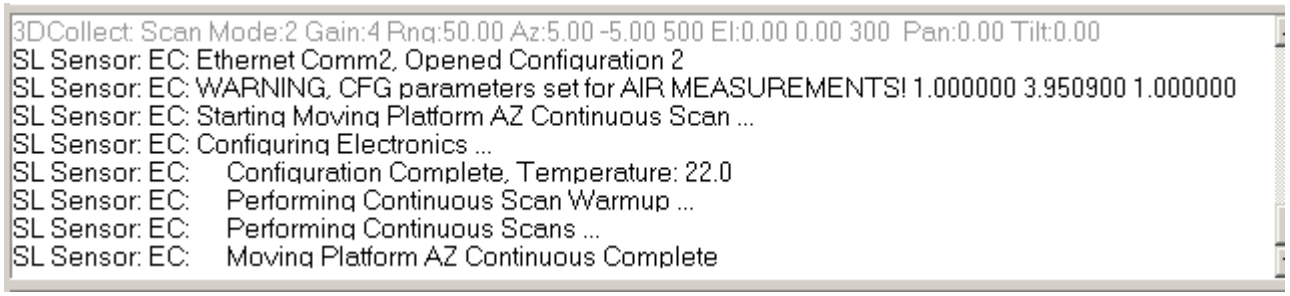

Figure 13 Messages when Scan starts with Configuration2

When the '**Scan**' button is pressed, 3D collect tells the SL Sensor ONLY a number to start scan, all other options and selections on the 3D Collect will be ignored.

Note that the configuration files are stored on the sensor as shown in Figure 14.

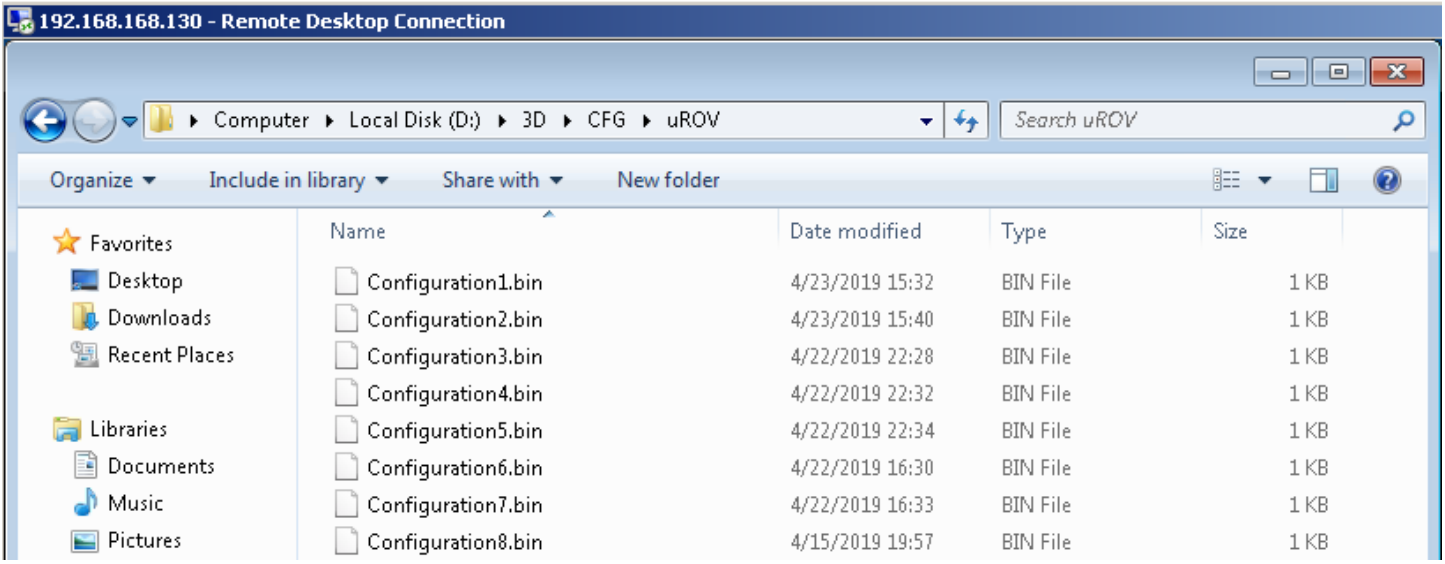

Figure 14 D:\3D\CFG Folder and configuration files in the sensor.

3.3 3D Collect Editor for CCI Configurations

There is an editor to assist in creating and viewing the configurations. This can be used to both create or to view ones already created. To open the editor, in 3D Collect GUI, select CFG, then near the bottom Edit CCI CFG, see Figure 15 Opening the CCI Configuration Editor below. The user can also just view them if they do not want to make any edits. The sensor has to be powered to view the files since the data is saved on the sensor.

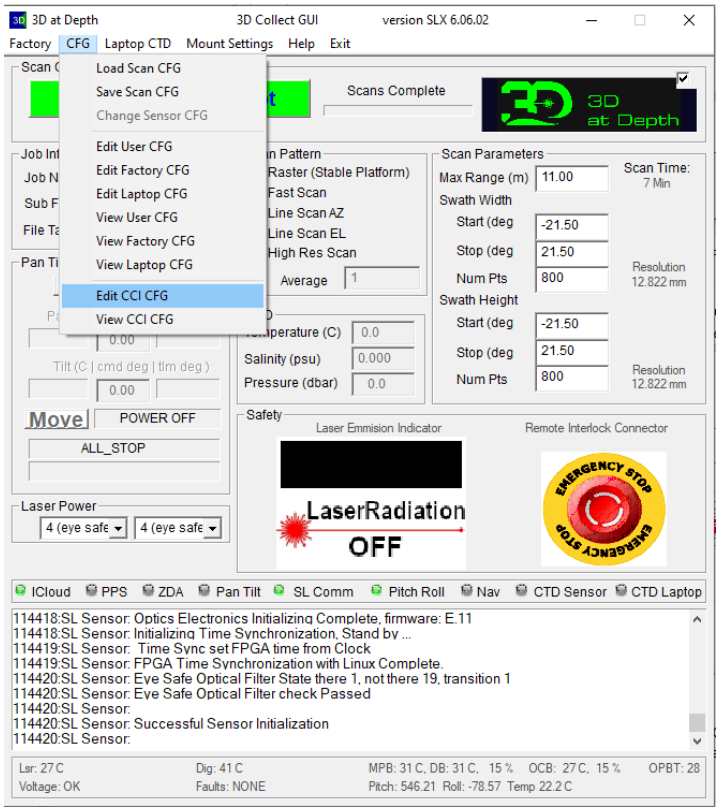

Figure 15 Opening the CCI Configuration Editor

The CCI configuration editor allows the user to enter in values in SI units or in Raw counts and to switch between them.

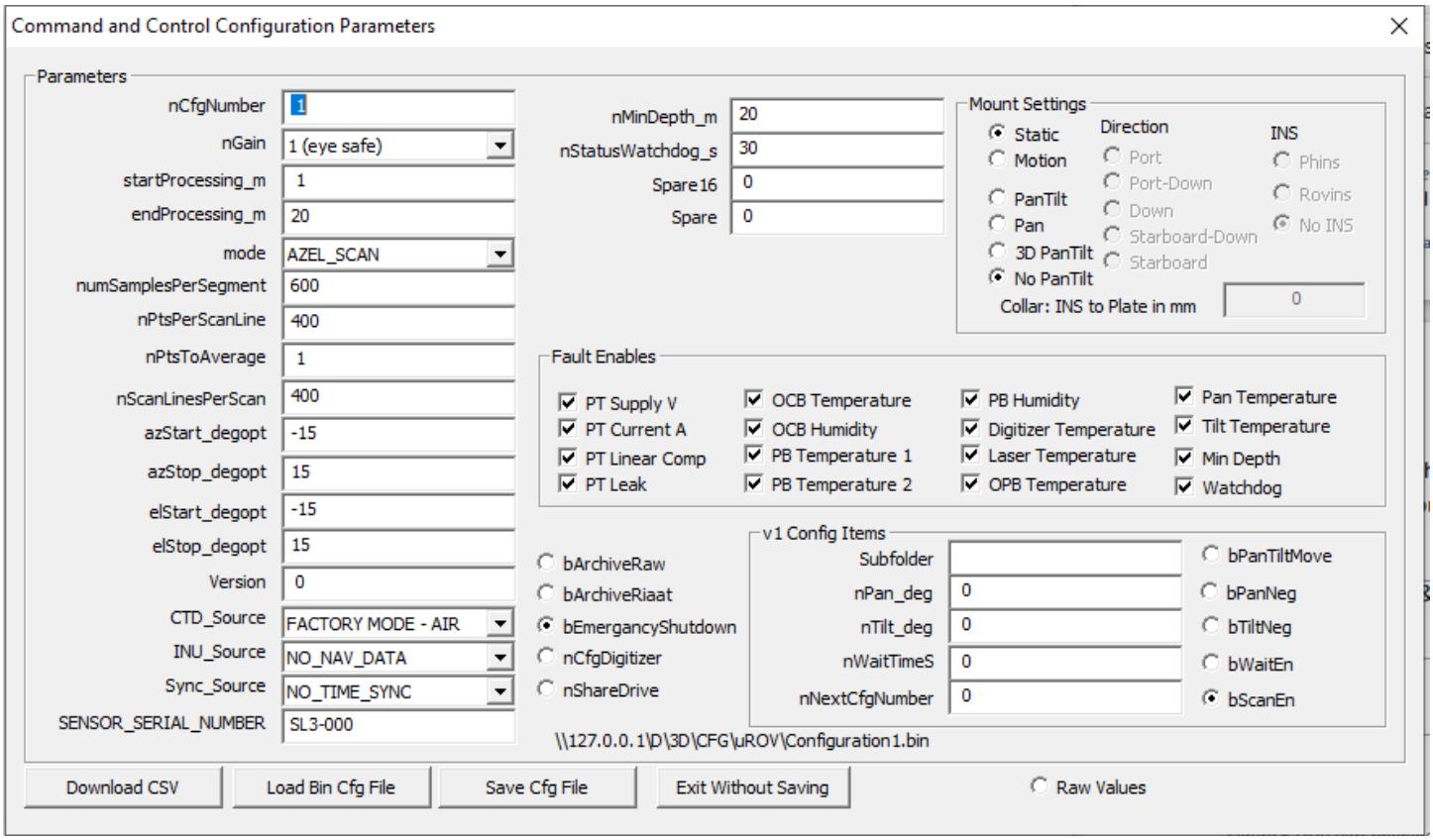

Figure 16 CCI Configuation Editing

This is the full definition that can be modified in the CCI mode. Each configuration can define a move, a delay and a scan. They do not need to contain all items but they could define all three actions. See the documentation on 3D Collect for details on each field.

3.4 Real Time Viewer

While scanning is in progress, RTV shows the 3D data in real time. When the RTV program starts, RTV reads the local 'LaptopParams.bin' file and checks to determine the UDP option is selected. Thus, the Sabertooth computer must have the 'LaptopParams.bin' file in the 'C:\3D\CFG\' folder of the computer running RTV.

If the 'Open Server for CCI checkbox is selected, RTV opens a TCP port as a server and sends the scan data to the CCI attached system one scanline at a time. This is also an option that can be selected in the RTV configuration and when a new RTV configuration is sent to RTV it will be acted on.

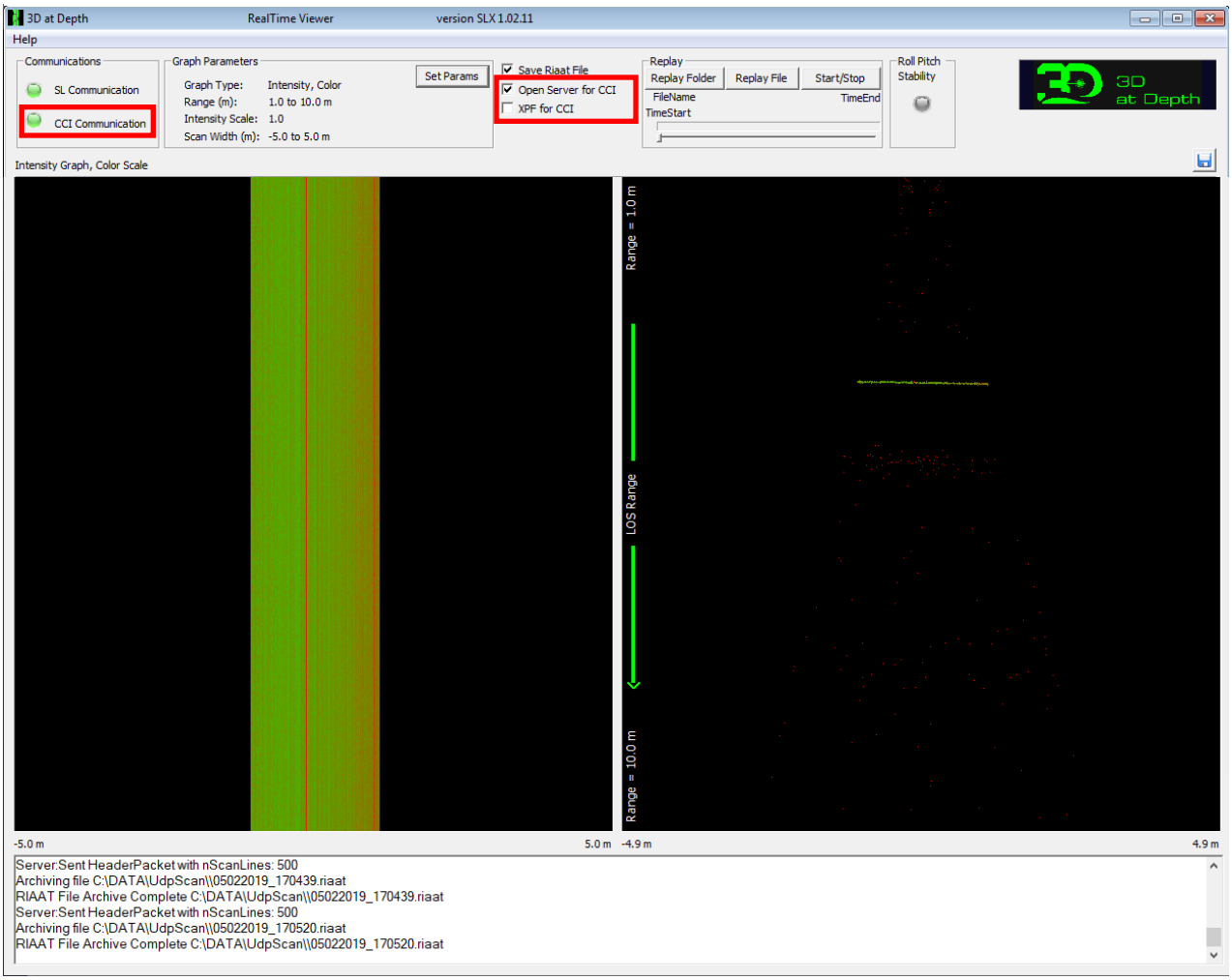

Figure 17 Real Time Viewer with a scan in progress

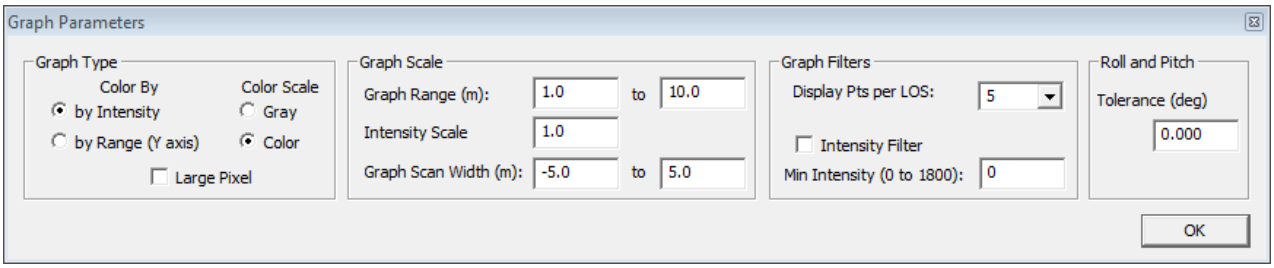

Figure 18 RTV Graph Parameters Window

3.5 ICD-RTV Controller on Topside Computer

Figure 17 shows the ICD-RTV Controller window. To control the RTV, RTV-controller needs to know the IP address where RTV is running.

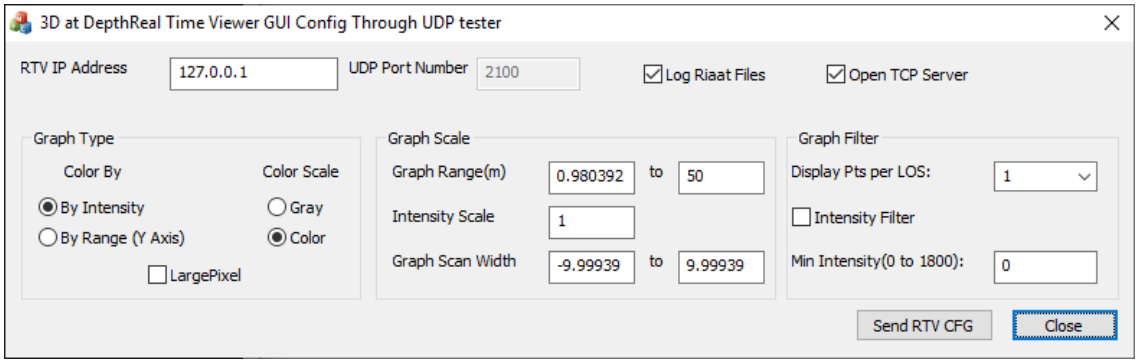

Figure 19 RTV Controller through UDP Program

The ICD RTV Controller program has a similar sub window GUI to that of the RTV 'Graph Parameter' window. This program sends UDP packets to RTV to change the RTV viewing options. Note that there is a minor difference between the values for each for the parameters 'Graph Range' between RTV Controller and RTV shown on the GUIs. This is due to a resolution issue related to compression and recovery of the UDP packets. As an example, when RTV Controller sends '1m' as 'Graph Range', 1m is encoded to 1byte number (represented within 256 quantization levels between 0 to 50m and the nearest value of 1 is 0.980392) and decoded at RTV. RTV rounds the number on its window for convenience, but RTV also replies with the original value it received from RTV Controller. RTV controller shows the actual received value. So even though you may see slightly different values between Control RTV and RTV, it is not an error.

3.6 Multiple 3D Collects on the network

Two or more 3D Collect GUIs may at some time be connected simultaneously to the Sensor since they communicate through UDP. However, this is not recommended because the Text packets which the SL sensor sends back are delivered to only one of them - normally the one that sent the last command. Since RTV uses TCP connection to the SL sensor, only one RTV is connected to the SL sensor at a time. In this case the most recently connected one gets the priority.

Figure 20 Multiple 3D Collects on the network

3.7 Local Config files review

SL sensor requires UserParams.bin and FactoryParams.bin on the sensor, located in the folder 'D:\3D\CFG\'.

RTV needs LaptopParams.bin at the Sabertooth Computer in the folder "C:\3D\CFG'.

3D Collect needs UserParams.bin, FactoryParams.bin and LaptopParams.bin for its initial values on its windows.