

CORNING

microHSI™ 410 SHARK (Selectable Hyperspectral Airborne Remote sensing Kit) User's Manual



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1 End User License Agreement

An end user license agreement (EULA) is an agreement between the software application developer and the user of that application. The terms of the HyperView EULA must be accepted to use this system's software. This EULA will be displayed when the web interface is first used. After carefully reading and agreeing to the conditions of the EULA the user must press the "I Accept" button at the bottom of the agreement to continue. If the user selects the "I Decline" button, the application's binary files will be removed from the system making it inoperable.



Caution: If the user selects the "I Decline" button, the application's binary files will be removed from the system making it inoperable.

2 Safety Considerations



Caution: The following paragraphs describe safety considerations for the system. Permanent damage can occur if they are not followed.

The system can be powered using a +8 VDC to +16 VDC power supply or battery capable of providing a minimum of 20 W of power. Do not exceed the voltage maximum or damage might occur. It is also critical that the power connections be made to the proper connector pins. Ensure the main power switch is off before connecting or disconnecting the power cable.

Do not run the SHARK without air flow over the unit otherwise it will overheat and possibly be damaged. The unit relies on air flow over the unit for cooling but may be run for a short time without air flow.

The GPS antenna connector supplies 3.0 VDC @ < 20 mA and only compatible GPS antennas should be used.

A good mechanical isolation will ensure getting the full INS (Inertial Navigation System) performance. High amplitude vibrations can cause a bias in accelerometer reading. The INS is calibrated at the factory and limits this effect. Nevertheless it cannot be fully avoided. This effect is called the VRE (Vibration Rectification Error) and comes from the internal accelerometer non-linearity. Ultimately, very high amplitude vibrations cause the sensor to saturate. The bias observed will be drastically increased, leading to a huge error on orientation.

To prevent fire, shock hazard or damage to the sensor system, do not expose to rain or excessive moisture.

When handling the sensor system take precautions to avoid electro-static discharge (ESD) to any exposed electrical connector pins and components.

3 Delivered Component List

3.1 microHSI™ 410 SHARK

The Selectable Hyperspectral Airborne Remote sensing Kit (SHARK) consists of the microHSI™ 410 sensor, INS and data acquisition system.



Figure 1: microHSI™ 410 SHARK Photo

3.2 Input Power Connector

An input power connector is supplied, Switchcraft Inc. #761K (Digi-Key part #SC1148-ND). Refer to section 5.1.5 for more information.



Figure 2: Input Power Connector

3.3 GNSS Antenna

The global navigation satellite system (GNSS) antenna provides accurate reception for all upper L- band GPS, GLONASS, Beidou, and Galileo signals (L1, G1, B1, B1 BOC, B1-2, E1) and associated augmentation signals (WAAS, EGNOS and MSAS SBAS).

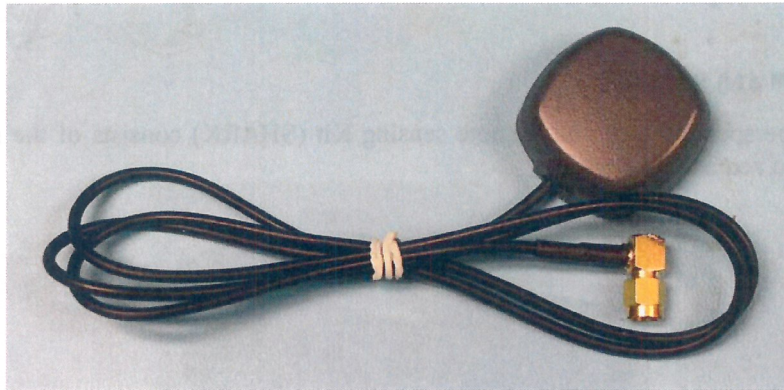


Figure 3: GNSS Antenna

4 Introduction

The Selectable Hyperspectral Airborne Remote sensing Kit (SHARK) is comprised of a hyperspectral microHSI™ 410 line scanning spectrometer, an inertial navigation system (INS), a system computer, and software to support the collection, annotation, and storage of imagery from airborne platforms. The user's control interface is browser based and no additional software is required on the client machine. Figure 4: SHARK Block Diagram outlines the key elements of the system.

4.1 System Block Diagram

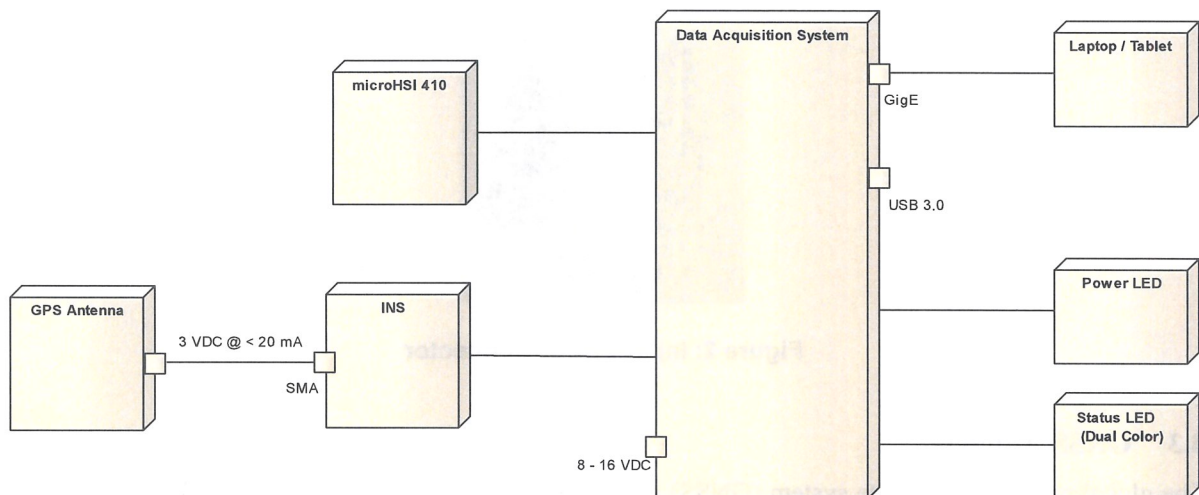


Figure 4: SHARK Block Diagram

4.2 Line Scanning Spectrometer

Corning's patented microHSI™ 410 Spectrometer is the key component of this system. The microHSI™ series of hyperspectral imaging spectrometers offers vastly reduced size, weight, and sensitivity over conventional hyperspectral imaging sensors. The microHSI™ 410 operating wavelengths are from 400 – 1000 nm covering the visible to NIR (visNIR) wavelengths.

The software is configured to read lines from the spectrometer at sizes of 1364 pixels by 308 spectral depending on the configuration. The binning significantly improves the signal to noise ratio and reduces the line size. The resultant lines are 1364 pixels wide with 77 (bin x4) or 154 (bin x2) spectral bands. Refer to section 10 for the complete specifications of the microHSI™ 410 SHARK.

4.3 Inertial Navigation System (INS)

Scanning spectrometers acquire single lines of imagery progressively as an aircraft flies over its target area. Irregularities in the aircraft's track and subtle changes in the aircraft's attitude as it flies over the target area are magnified by the aircraft's altitude. The result is wavy and irregular imagery of the scene being scanned. To adjust for these irregularities, frequent and precise position and attitude information is required. A miniature INS with an integrated Global Navigation Satellite System (GNSS) receiver and a MEMS-based Inertial Measurement Unit (IMU) is used to provide this information.

4.4 Data Acquisition System

A compact computer with a solid state drive (SSD) is used to acquire, process, and store the hyperspectral image and navigation data. In order to accurately geo-register the line scanned hyperspectral data, each frame is precisely time stamped as it's acquired.

The microHSI™ 410 SHARK processing architecture is based around using ENVI® or another image processing program capable of reading ENVI® file formats. *ENVI® (Environment for Visualizing Images – Harris Geo-Spatial) is a software application used to analyze hyperspectral data. Other image processing software can be used with the files generated by the microHSI™ 410-SHARK, but they must be capable of reading ENVI® file formats. A license to the ENVI® software application is not included with the purchase of the microHSI™ 410-SHARK. We make no representations and warranties about the ENVI® software application, and you agree that any use by you of it is at your own risk.*

Before the image data is written to disk the navigation information associated with the image acquisition time is stored in two different types of files. One is a text file where the navigation data, including position and attitude data, for each line of the image data is written. The second file created is the ENVI® compatible Input Geometry (IGM) file containing latitude and longitude for each pixel in the image.

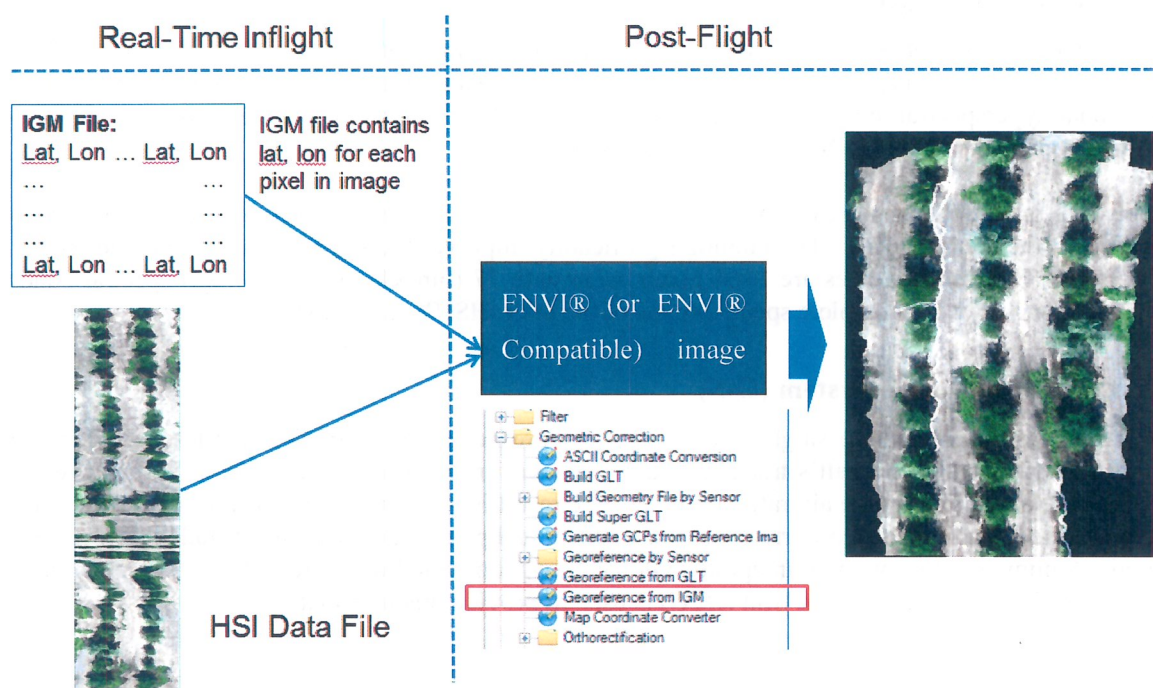


Figure 5: A typical Geo-reference workflow process

The image data is processed and stored as raw binned data (DN's) and calibrated data. The calibrated data applies a dark subtraction and non-uniformity correction (NUC) with the resulting units being $\text{W/m}^2/\text{sr}/\mu\text{m}$. It is possible to add additional real-time processing depending upon the CPU loading.

5 System Hardware Interfaces

Figure 6: SHARK Interfaces shows the locations for all of the interfaces for the 410 SHARK.

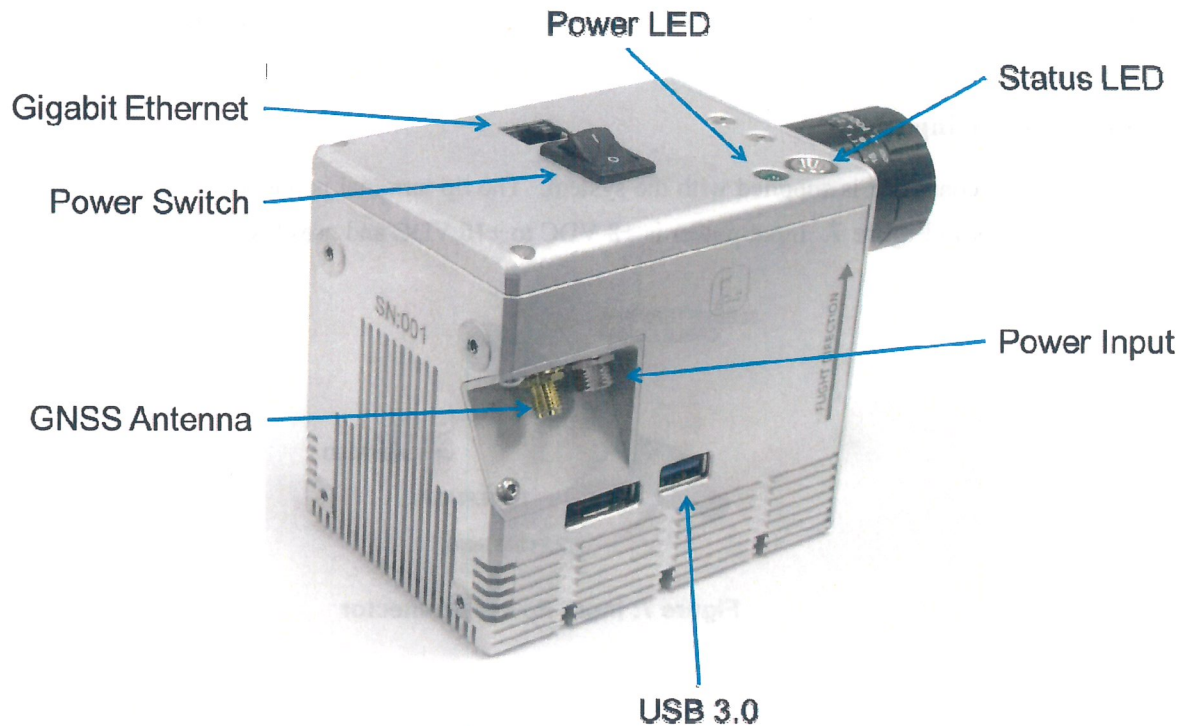


Figure 6: SHARK Interfaces

5.1.1 Gigabit Ethernet Port

A gigabit Ethernet port with a RJ45 jack is located on the top panel.

5.1.2 Power Switch

This switch turns the SHARK system on/off. Before connecting/disconnecting the power cable make sure the switch is in the OFF position.

5.1.3 GNSS Antenna

A SMA female jack connector is used for the GNSS antenna connection. The supplied antenna is an active antenna compatible with +3VDC @ < 20 mA supplied through the antenna cable. Do not use active antennas that exceed the specifications or an antenna that cannot accept the supplied voltage/current.

5.1.4 USB 3.0

A standard USB 3.0 Type A port is available to the user. This is the quickest method of transferring the data but not all devices are compatible with this port. Contact Corning for a list of tested devices.

5.1.5 Power Input

A compatible connector is supplied with the system. The tip terminal is positive and the sleeve terminal is ground, refer to Figure 7. Input power is +8 VDC to +16 VDC and uses less than 19W.

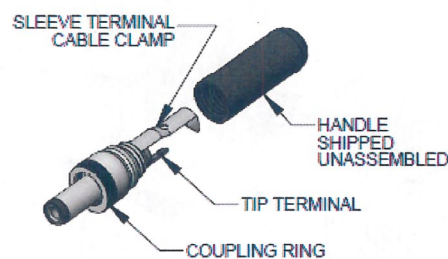


Figure 7: Input Power Connector

5.1.6 Status LED

This is a dual color red and green LED. When the SHARK is first powered on the status LED turns green and then quickly turns off. It turns red after the computer and the operating system are up. The red LED indicates the operating system is running but a profile has not been loaded.

The green LED indicates that a profile has been started and the system is ready for operation. For flight profiles, the status LED turns green only after the system can produce valid INS solutions. If the onboard magnetometer is not being used, the aircraft will require flying a dynamic flight path before valid INS solutions can be reached. Once a valid INS solution can be reached the status LED will turn green. The status LED is bright enough to be monitored by doing an aircraft fly over.

The LED is turns red when profiles are stopped or the system fails. Troubleshooting should include examining system logs.

5.1.7 Power LED

The green power LED serves two purposes. When the power switch is changed from off to on, the LED will light up and remain lit. When the system is already powered on and the user commands a shutdown,

the green LED will turn off indicating it's safe to move the power switch to the off position.

6 Quick Start Guide

6.1 Mounting Points

Eight hard mounting points are provided on the SHARK for 6-32 screws. Four are on the bottom of the finned heat sink area and four are on the back, opposite of the lens.

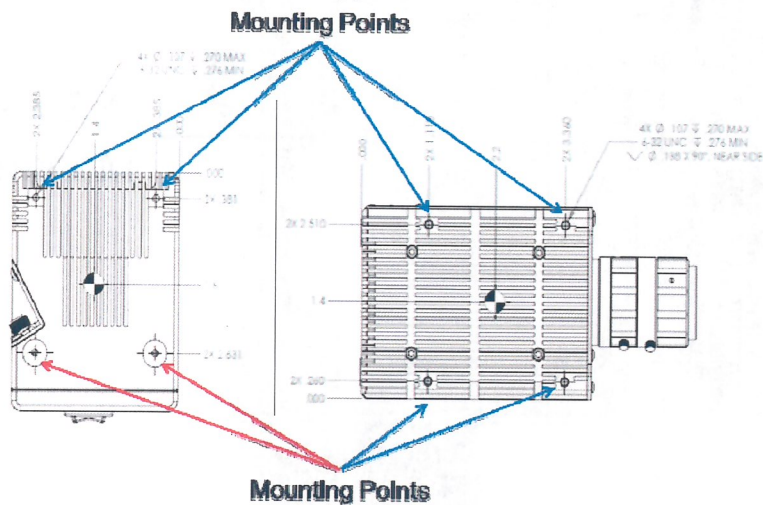


Figure 8: Mounting Points

Caution: Avoid using long screws in the two mounting points indicated by the red lines. These holes are through holes and using too long of a screw could damage internal components.

6.2 Mounting Orientation

Figure 9 shows the direction of flight marking on the SHARK. The 410 SHARK should be mounted and flown such that the actual flight direction corresponds to the marking.

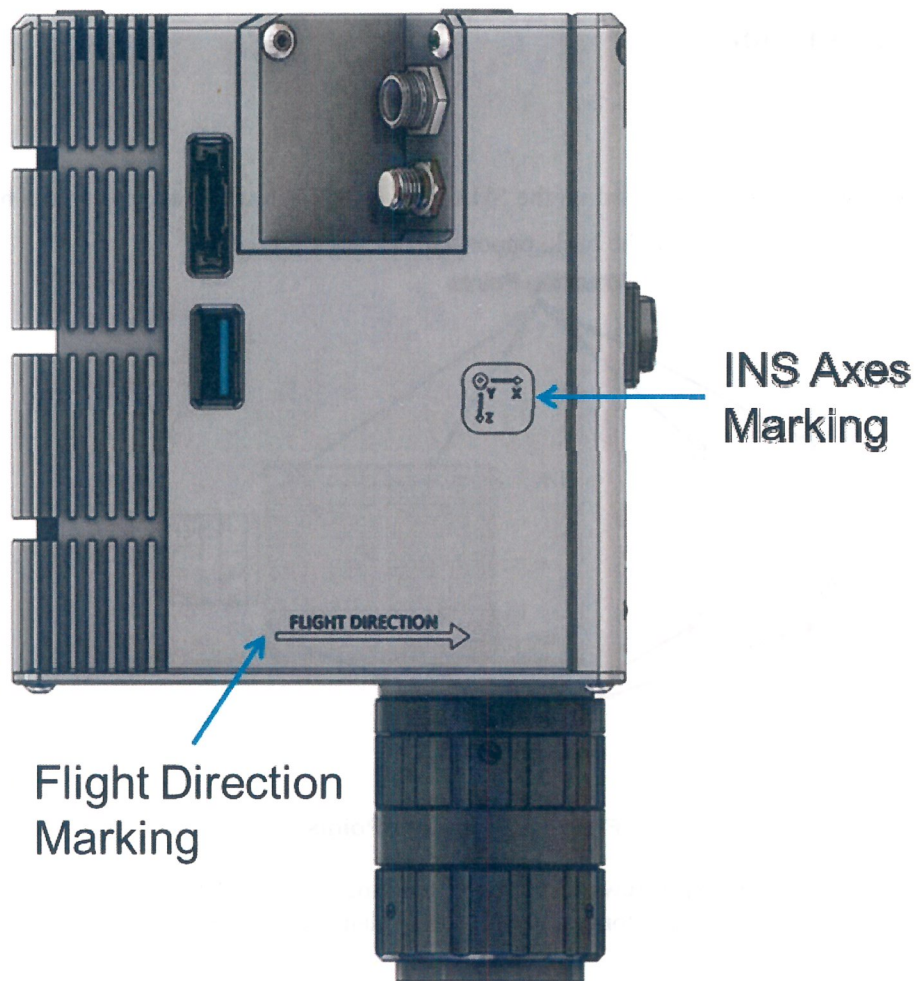


Figure 9: Flight Direction and INS Axes Indicators

6.3 Hardware Setup

1. Ensure the main power switch is in the off position. Connect the power cable to the system and to the DC power supply.
2. Connect the GPS antenna to the system.
3. Connect a computer to the SHARK using a Cat5e cable or better.
4. Turn on the system with the power switch.
5. The default setting for the magnetometer is off. Use of the magnetometer will improve the heading information but the magnetometer requires calibration before it can be used, refer to

section 7.4.5 for detailed calibration instructions. A 3D calibration is recommended for multi-rotor copters.



Warning: Enabling the magnetometer but not calibrating it will result in degraded navigation data.

6. Load the Digital Elevation Model (DEM) tiles onto the SHARK for the flight area. If the DEM tiles are not loaded the result will be degraded geo-referenced images. The NASA Shuttle Radar Topography Mission (SRTM) Version 3.0 DEM tiles are used and can be downloaded from the Internet. Refer to section 7.2.6 and Appendix B for more information.



Warning: If the DEM tiles are not loaded for the flight area the geo-referencing will be degraded.

7. Measure and enter GPS antenna lever arm parameters, refer to section 7.2.2 for detailed instructions.
8. Configure automated start and stop of recording using the Commander Utility (optional), refer to section 8.
9. Proceed to the Software Setup.



Caution: Do not run the SHARK without air flow over the unit otherwise it will overheat and possibly be damaged. The unit relies on air flow over the unit for cooling but may be run for a short time without air flow.

6.4 Software Setup

6.4.1 System Initialization

1. Use a browser to enter the SHARK's IP address in the address bar: i.e. <http://192.168.1.80>. This directs your browser to the SHARK's web interface.

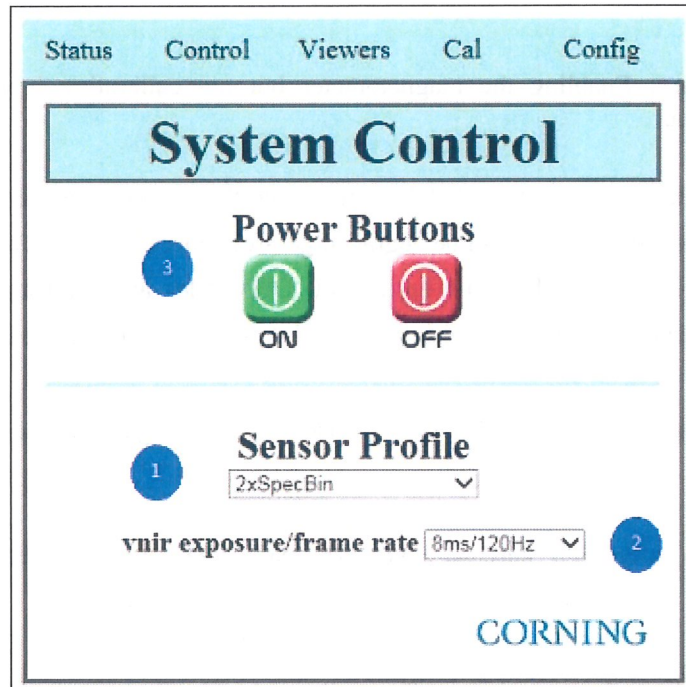


Figure 10: Sensor System Control

2. Select a sensor profile to run from the drop down list (1).
3. Select the desired exposure/frame rate from the drop down list (2).
4. Start the system software by pressing the “On” button (3). This will start the sensor profile software selected in step 2. After the system starts, the web interface will be directed to the “Status” page.
5. Wait for the system components to come up. System components are operational when they have a green check mark next to them. All components should be checked except for the navigation server. The yellow circle next to the navigation server indicates that it needs to be aligned. See Figure 11 below.

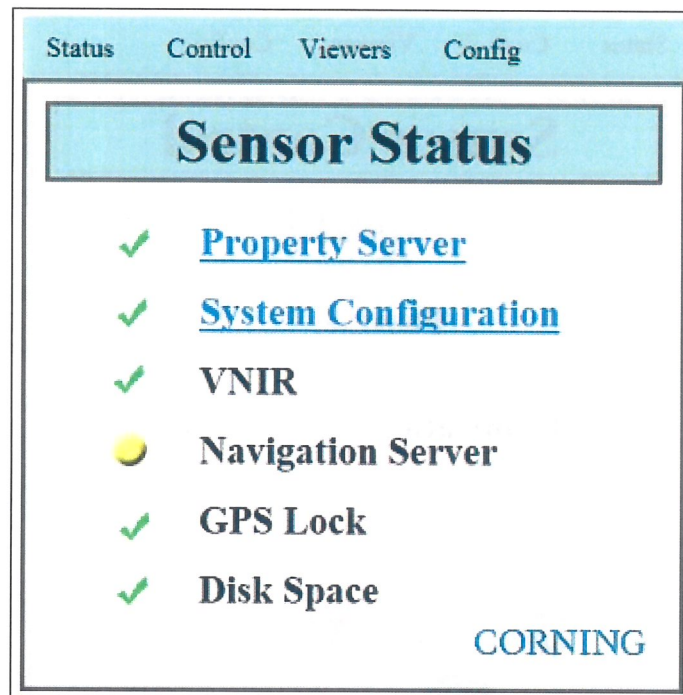


Figure 11: Sensor Status

6. If the onboard magnetometer is calibrated and used the navigation server will show a checkmark indicating it is ready. A figure 8 should be performed after takeoff to increase navigation data accuracy. If the onboard magnetometer is not used, perform navigation server alignment. The aircraft should take off and perform a figure 8 to obtain alignment. After a green check mark is displayed next to each item and the navigation server alignment is complete, the system is operational and ready for imaging. For UAV operation, this can be verified by a steady green status LED.
7. For manual operation start imaging per the 'Imaging Control' section that follows. An alternative is to use the commander utility to control imaging as described later in section 8.

6.4.2 Imaging Control

1. On the web browser, select the "Control" tab and then select the "Sensor" link.

Status Control Viewers Config

Sensor Control

TARGET
ID:
Pass:

Calibration:

Save Files: ☒

1 **Start** **Stop**

Response: **2**

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Figure 12: Sensor Control

2. Upon entering the target area, press the “Start” button (1) to issue the start command. See Figure 12. The response to the start command is displayed on the web interface (2). The system will start recording data.
3. View the image with the VNIR Waterfall Viewer by selecting the “Viewers” tab.
4. Upon exiting the target area, press the “Stop” button and data recording will stop.

6.4.3 System Shutdown

1. Select the “System” link from the “Control” tab on the web interface.
2. Press the “Off” button to close the profile. See Figure 10.

3. Select the “System” link from the “Control” tab. See Figure 10.
4. Select “SystemPower” from the “Sensor Profile” drop down list (1). Press the “Off” button. The computer will begin shutting down. When the green power LED turns off it is safe to switch the unit off.
5. When the green power LED turns off it is safe to switch the unit off. Press the power switch to turn off the power.

7 Operation

7.1 Profiles

A profile is a name assigned to the collection of configuration files used by the imaging system. Each profile is stored in a separate folder in the “C:\CorningHsi\profiles” directory. Profiles include:

- **2xSpecBin** - This is a flight profile that allows collecting imagery that is binned spectrally by 2. This profile allows the collection of un-calibrated image cubes, radiometrically calibrated image cubes, and selected radiometrically calibrated bands.
- **2xSpecBin_calOnly** – This is a flight profile that allows collecting imagery that is binned spectrally by 2. This profile allows the collection of radiometrically calibrated image cubes and selected radiometrically calibrated bands. It allows higher frame rates than the 2xSpecBin profile because it does not include un-calibrated imagery.
- **2xSpecBin_rawOnly** – This is a flight profile that allows collecting imagery that is binned spectrally by 2. This profile allows the collection of un-calibrated image cubes and selected un-calibrated bands. It allows for higher frame rates than the 2xSpecBin or 2xSpecBin_calOnly profiles because it does not include calibrated imagery.
- **4xSpecBin** - This is a flight profile that allows collecting imagery that is binned spectrally by 4. This profile allows the collection of un-calibrated image cubes, radiometrically calibrated image cubes, and selected radiometrically calibrated bands. It allows for higher frame rates than the 2xSpecBin as the cost of reducing the number of bands.
- **Lab_2xSpectralBin** – This profile allows collecting of un-calibrated imagery that is binned spectrally by 2. The lab profiles are intended for use in the lab and do not incorporate the systems INS. Darks taken with the lab profiles are saved to vnirCalibration folder and are used for radiometric calibration.
- **Lab_4xSpectralBin** – This profile allows collecting of un-calibrated imagery that is binned

spectrally by 4. The lab profiles are intended for use in the lab and do not incorporate the systems INS. Darks taken with the lab profiles are saved to vnirCalibration folder and are used for radiometric calibration.

- **SystemPower** – This profile is used to gracefully shut down the system.

7.1.1 **Changing Profiles**

Follow the steps below to select or change the profile.

1. Click on the “Control” tab on the user interface. This should take you to the “System Control” page.
2. Click on the “Off” button to close the currently selected profile if it is running.
3. Select the desired profile from the “Sensor Profile” drop down list.
4. Select the desired exposure time from the drop down box if it is displayed.
5. Click the “On” button and the request will be sent to the system to start the selected profile.

7.2 **Navigation**

7.2.1 **Inertial Navigation System (INS)**

The INS was selected to provide position and attitude updates of the aircraft with a quality sufficient for determining HSI image positioning. These messages provide updates at 200 Hz.

7.2.2 **INS Parameters**

Configuration of the INS is performed from the “parameters.xml” file located on the system at “C:\CorningHsi\config\parameters.xml”. Each installation requires the GPS antenna lever arm be measured and the values be entered into the “parameters.xml” file. The lever arm is the measurement from the SHARK’s axes marking (refer to Figure 9) to the GPS antenna, along each of the axis.

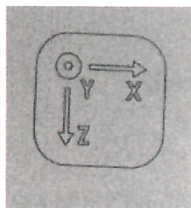


Figure 13: Axis Marking

A close up of the axis marking is shown in Figure 13. The x-axis is positive in the flight direction, the z-axis is positive down and the y-axis is positive coming out of the page.

The “navServer.lever_arm.x” property is measured parallel to the roll axis of the aircraft and toward the nose. For example, if the GPS antenna is forward of the “Axes Marking”, the measurement is positive and negative if behind. The “navServer.lever_arm.y” property is measured parallel to the pitch axis of the aircraft and toward the right wing. The “navServer.lever_arm.z” property is measured parallel to the yaw axis of the aircraft and points down. All measurements are in meters. An example of lever a level arm entry in the “parameters.xml” file is:

```
<property name=" navServer.lever_arm.x" value="0"/>
<property name=" navServer.lever_arm.y" value="0"/>
<property name=" navServer.lever_arm.z" value=-0.1524"/>
```

7.2.3 INS Data Logging

Raw INS messages are routinely logged. If it is desired not to save these messages, open the “C:\config\parameters.xml” file and modify the property “navServer.imu.datafile.use” by setting its value to “false”. Set this value to “true” to enable logging.

7.2.4 INS Alignment

Alignment of the INS is automatic once a GPS signal is obtained and the aircraft starts to move or if the on-board magnetometer is enabled. If the magnetometer is enabled then it must be calibrated, see section 7.4.5. To further improve the INS accuracy, a figure eight should be performed after takeoff and before the imaging run.

7.2.5 Navigation Server

The purpose of the navigation server is to receive the INS messages and record this information for use in determining ground point intercept information for the HSI imagery. A digital elevation map (DEM) is

used to provide ground intercept position elevation data which is referenced to mean sea level.

7.2.6 DEM Configuration

The navigation server uses a digital elevation model to improve the accuracy of its ground intercept positions and to provide for ground elevation data. We recommend that you use data obtained during NASA's Shuttle Radar Topography Mission of February 2011, which can be obtained and loaded into the system for the planned imaging areas. Data files are available for download in 1 arc second and 3 arc seconds resolutions. Data files can be obtained from NASA's Earth Data web site **Error! Hyperlink reference not valid.** Please note that in order to access such data files, you will need to agree to and comply with applicable NASA policies and terms and conditions. We make no representations and warranties about such data files, including as to their accuracy, completeness, or compatibility, and you agree that any use by you of such data files is at your own risk.

If the three arc second files are used for the area being imaged, ensure they are downloaded and placed in the "C:/CorningHsi/navDB/dem3ArcSecond" folder on the system. One arc second resolution files are the default file sizes used by the system. If the one arc second resolution files are to be used, place the files in the "C:/CorningHsi/navDB/dem1ArcSecond" folder on the system. To use three arc second files change the parameters.xml file to:

```
<property name="navServer.elevationDb.resolution.arcSeconds" value="3"/>
<property name="navServer.elevationDb.path" value="c:/CorningHsi/navDB/dem3ArcSecond"/>
```

7.2.7 Navigation Data Client Requests

Navigation requests and responses are provided via plain text messages (ASCII format). Navigation data to the "Viewers" is provided once per second. It is provided via Ethernet datagram packets to the host computer and via multicast to any other computers on the network that wish to monitor the INS data.

7.2.8 Sensor/INS Alignment

The line-of-sight of the spectrometer with regards to the INS system can be modified to account for errors in alignment between the axis of the sensor and the axis of the INS system. Modifications are made by editing the "C:/CorningHsi/config/parameters.xml" file. For a NADIR mounted system, if the two were perfectly aligned the values would be:

```
<property name="vnir.yaw" value="0"/>
```

Corning Restricted - Confidential under NDA

```
<property name="vnir.pitch" value="-90"/>
<property name="vnir.roll" value="0"/>
```

The values are in degrees. To determine the values, imagine the line-of-sight (LOS) of the sensor initially pointing at the front of the aircraft with the sensors scan line horizontal to the ground. This is the 0, 0, 0 position. From this position yaw, pitch, and roll are applied in that order. A positive yaw would move the LOS in the horizontal plane toward the right wing and a negative yaw would move it toward the left wing. From that position, pitch moves the LOS in a vertical plane. A positive pitch would move the LOS upward while a negative pitch would move it downward. A perfectly NADIR sensor would have a yaw of 0 degrees and pitch of -90 degrees. The roll is the rotation of the scan line about the resultant LOS. A positive roll rotates the scan line clockwise and a negative roll rotates it counter clockwise.

An example of an adjustment where all image pixels were routinely forward and to the left of their actual positions is:

```
<property name="vnir.yaw" value="-30.48"/>
<property name="vnir.pitch" value="-87.41"/>
<property name="vnir.roll" value="30.48"/>
```

7.3 Log Recorder

A log server and log recorder is typically run on the system computer to provide log information, warning, and error messages. The log recorder routinely saves these files to the "c:\output\logs" directory. See the "Logs" section below for information on viewing the system logs. To view log recorder entries when the system is running the "logRecorder.exe" file must be run on the client computer. Place the "Logrecorder.exe" file in a known location on the client computer. Open a "Command Prompt" and change to the directory containing the "LogRecorder.exe" file. Type the following command to start the logging:

```
"logRecorder.exe -i 192.168.1.80 -z"
```

7.4 Browser Based User Interface

7.4.1 Status Tab

In addition to the "Log Recorder", system status is available from the "Status" tab on the user interface. The "Status" tab is intended to provide a general overview of the major components of the system.

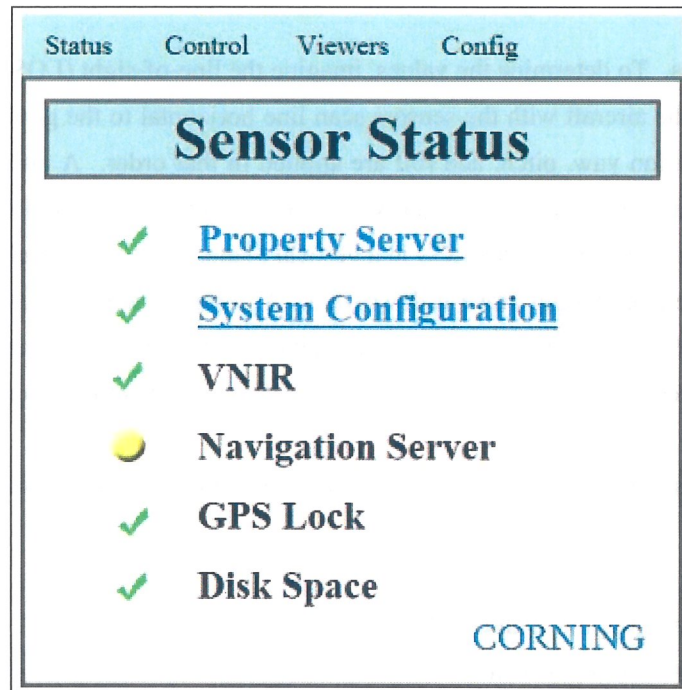


Figure 14: Sensor Status

For the system to function properly during a mission the user should check to ensure that all items on the "Status" page have a ✓ next to it. If any ✗ or ● appears, the system may not be able to obtain the imagery that is expected.

7.4.2 Control Tab

7.4.2.1 System Option

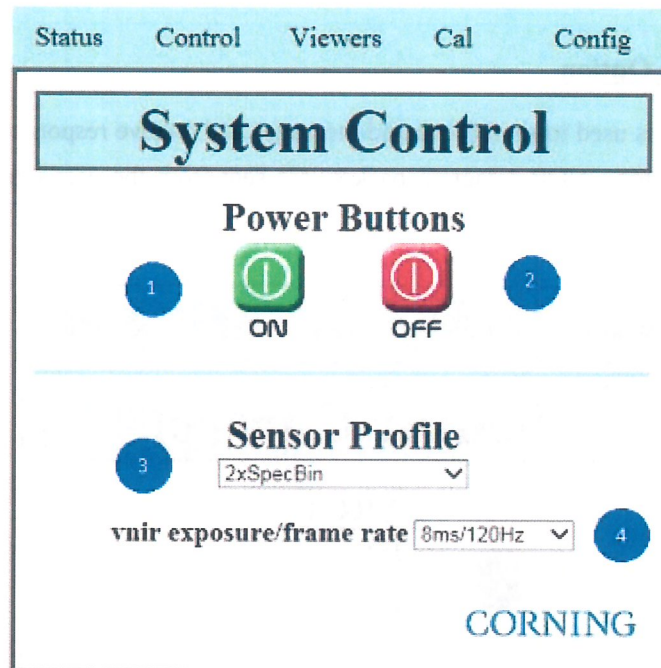


Figure 15: System Control

7.4.2.2 Power Buttons

Clicking the “On” button (1) will start the system software associated with the active profile. Specifically, when the “On” button is clicked, a script file called “startup.bat” is executed in the active profile’s folder. After this file executes, the web browser is redirected to the “Status” page.

Clicking the “Off” button (2) will stop the system software associated with the active profile. Specifically, when the “Off” button is clicked, a script file called “shutdown.bat” is executed in the active profile’s folder.

7.4.2.3 Sensor Profile

The active profile (3) indicates the profile that will be started or stopped by clicking on one of the power buttons. All available profiles are listed in this drop down list.

7.4.2.4 Vnir Exposure/Frame Rate

The “Vnir Exposure/Frame Rate” control (4) is displayed when the selected profile has predetermined exposure/frame rates available. The exposure/frame rate should be selected after the sensor profile is selected and before the on button is selected.

7.4.3 Sensor Option

The “Sensor Control” tab is used to send command messages and receive response messages necessary to start and stop data collection. UDP datagram packets are sent from the user interface to the system to initiate commands.

The screenshot shows a web-based interface for 'Sensor Control'. At the top, there are five tabs: 'Status', 'Control', 'Viewers', 'Cal', and 'Config'. The 'Control' tab is active. Below the tabs, the title 'Sensor Control' is displayed in a large, bold font. Underneath the title, there is a section labeled 'TARGET'. This section contains two input fields: 'ID: 001' and 'Pass: 001'. Below these fields, there is a 'Calibration:' dropdown menu set to 'None'. Further down, there are two buttons: a green 'Start' button and a red 'Stop' button. At the bottom left, there is a 'Response:' label next to a blue circular icon with the number '4'. The 'CORNING' logo is visible in the bottom right corner.

Figure 16: Sensor Control

7.4.3.1 Target Parameters

The target info (1) allows the user to provide information to the software at the start of each mission that is specific to the area currently being imaged. Information includes:

- ID – This is a 3 digit numerical value that the user can use to identify a specific target. The target ID is annotated to the filename of the imagery for easy identification.
- Pass – This is a 3 digit numerical value that the user can use to identify a specific pass over a specific target. The pass number is annotated to the filename of the imagery for easy identification.

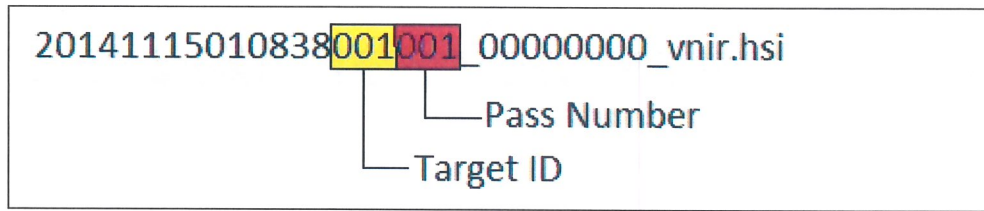


Figure 17: Target ID and Pass

7.4.3.2 Calibration

This is a drop down menu (2) that selects the calibration information to be sent with the command “Start” message. Choices include:

- “None” – When this is selected, the next “Start” message that is sent to the system commands it to start imaging without collecting darks. If the system is operational, it will immediately start imaging. This should be used when the sensor is not equipped with a shutter.
- “Darks w/o Start” – When this is selected, the next “Start” message that is sent to the system commands it to collect darks without starting to image. Cover the shutter before the “start” button is pressed. The system will take 100 dark frames. If this is used with a lab profile, the resultant darks are automatically copied to the C:\CorningHsi\vnirCalibration\darks folder for use during imaging.

7.4.3.3 Command Buttons

- When clicked, the command buttons (3) send commands from the web interface to the system. The buttons are: “Start” – this sends a start message to the system. This message is annotated with target and calibration information as described above.
- “Stop” – this sends a stop imaging message to the system.

7.4.3.4 Response

The response area (4) is used to display the systems initial response to the start or stop message.

7.4.4 Viewers Tab

The viewers are applets that are served by a web server located on the system computer. Three data streams feed the applets via UDP multicast or UDP datagram broadcast.

7.4.4.1 VNIR Waterfall Option

The waterfall image is displayed unregistered. Three selected bands are displayed as red, green, and blue. The bands can be selected via the active “Config” tab and selecting the “Active” link.

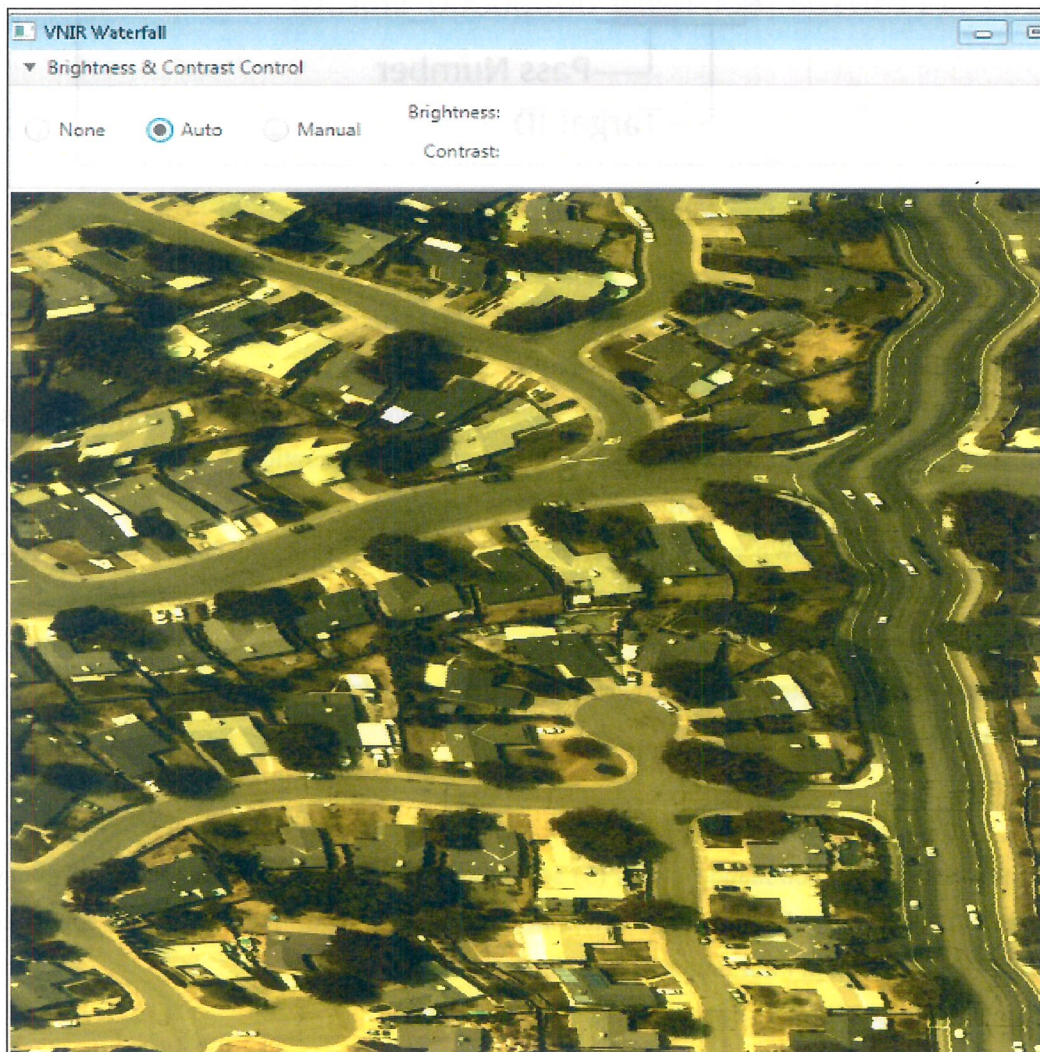


Figure 18: VNIR Waterfall

7.4.4.1.1 *Brightness & Contrast Control*

The “Brightness & Contrast Control” panel can be accessed by expanding the control in the VNIR waterfall display. The “Brightness & Contrast Control” allows for adjustment of the image being displayed on the waterfall. Using this control panel does not affect the imagery being saved by the system. Radio buttons allow selecting one of three control modes:

- None – in this mode the data is displayed as it is received from the waterfall data streams without modifying the imagery data.
- Auto – in this mode the data is stretched across the unused portion of the 256 bits used to display the data. This is done automatically by the applet as it reads data from the waterfall data stream. There is an initial adjustment each time that imaging starts.

- **Manual** – in this mode the user can use the slider bars to control brightness and contrast. Moving the brightness slider to the right adds a fixed value to each DN value making the image brighter. Moving the brightness slider bar to the left subtracts a fixed value to each DN making the image darker. Moving the contrast slider to the right increases the use of the unused DN range. Moving the contrast bar to the left returns the DN value toward its original value.

7.4.4.2 VNIR Histogram Option

The histogram maps the Digital Number (DN) to the number of sample elements that report that DN. By monitoring the histogram and comparing it with the scene, the user can monitor the exposure to determine if the imagery is being underexposed or overexposed.

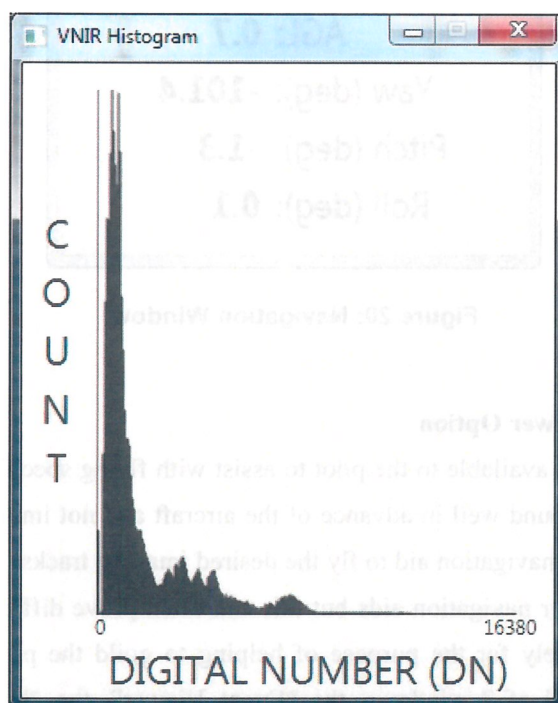


Figure 19: VNIR Histogram

7.4.4.3 Navigation Option

The Navigation display reads the INS data stream and displays it to the user. This data is updated every second. It includes UTC time, aircraft heading, aircraft speed, aircraft position, and aircraft attitude.

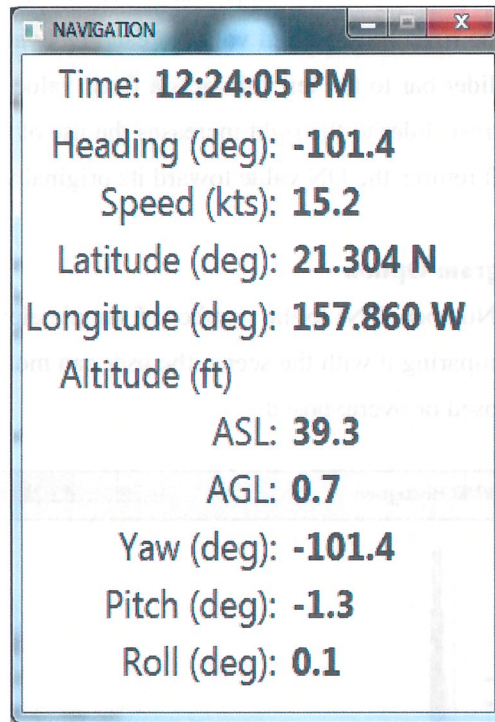


Figure 20: Navigation Window

7.4.4.4 Event Viewer Option

The "Event Viewer" is an aid available to the pilot to assist with flying specific tracks to obtain imagery. Because the pilot sees the ground well in advance of the aircraft and not immediately below the aircraft, the pilot will typically need a navigation aid to fly the desired imaging tracks. The pilot may desire to use their own GPS device or other navigation aids but this can often prove difficult. The "Event Viewer" is easily used and designed solely for the purpose of helping to guide the pilot to obtain imagery. The "Event Viewer" is comprised of 3 windows, the "Event Viewer", the "Navigation", and the "Event Selection" windows.

The "Event Selection" window is used to select one of the pre-entered events to be displayed in the "Event Viewer" and the "Navigation" windows. See Figure 21 below. This window also allows the user to reverse the track or to select "None" when no track is desired. Event tracks are specified in the "C:\eventConfig\EventTracks.xml" file located on the system computer. Reference paragraph 8 "Commander", when adding tracks to this file.

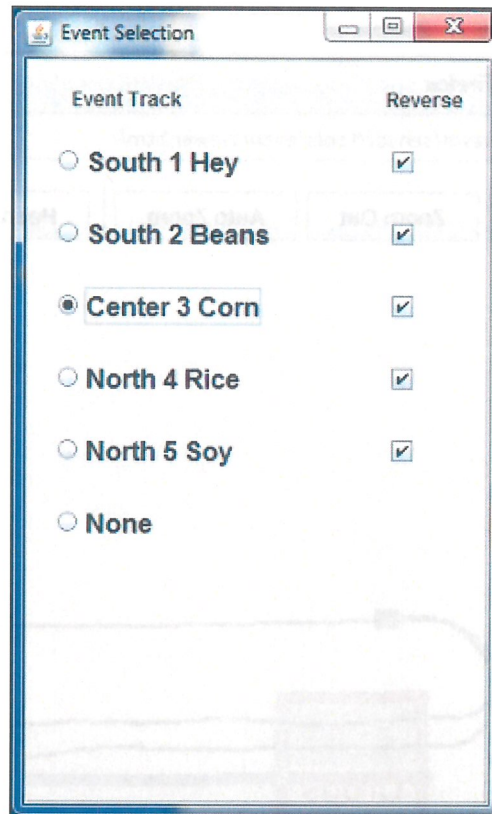


Figure 21: Event Selection Window

The “Event Viewer” window graphically displays the aircraft track, the event track, and specified areas. See Figure 22 below. An event track consists of a gate represented by 2 small circles, a lead-in track represented by a blue line, and the event track represented by a red line. The idea is that the plane is piloted to the gate as the entry point to the event track. Once the aircraft enters the gate, it aligns and steadies up with the lead-in track to put the aircraft in position to follow the event track. Once imaging starts, a gray area is added that indicates the view of the sensor on the ground. The gray area can be monitored to determine if the aircraft is on target and the track is being imaged. The user has buttons at the top of the screen to control the display. The user can select “Heading Up” or “North Up” as the display orientation. When “Auto Zoom” is enabled, the event viewer automatically zooms to an appropriate value to display the target and the next waypoint. If the display is in “Auto Zoom” and “North Up” the image is also centered. To bypass the “Auto Zoom” feature, the user simply presses the “Zoom In” or the “Zoom Out” button. When the “Auto Zoom” is disabled and in the “North Up” orientation, the user can use the mouse to pan and center the display.

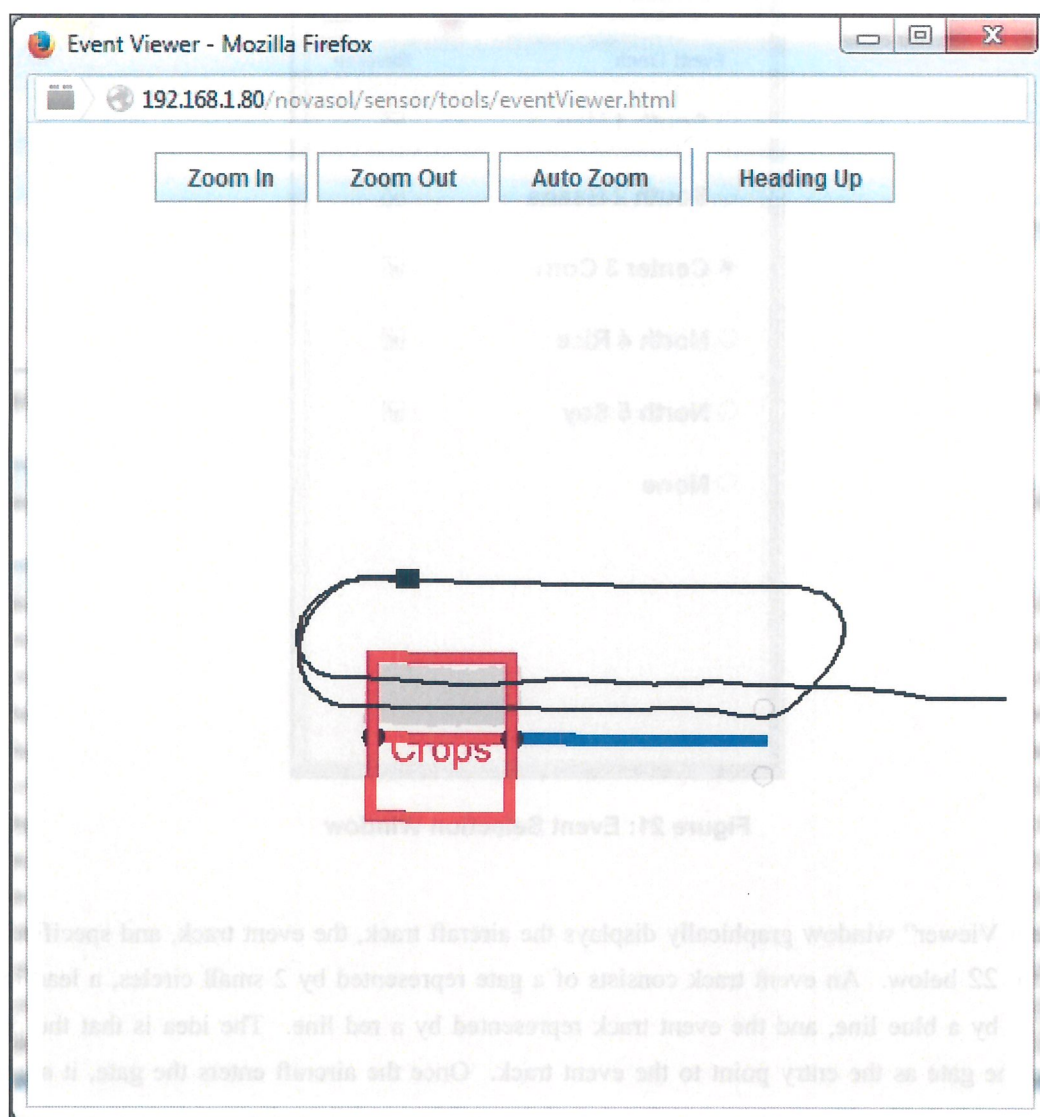


Figure 22: Event Viewer Window

The “Navigation” window provides a numerical display of the bearing and distance to the next point of the selected event track. See Figure 23 below. For example, this window shows “Center 3 Corn” as the selected track and the next point for that track is “Gate 2”. Gate 2 is 5.8 degrees relative (88.6 degrees magnetic) and 2.9 nautical miles away. The ground speed and the altitude above ground level are also displayed with the track data as these values are routinely monitored when actively imaging. The “Navigation” window also displays aircraft INS information that may be of interest. This display is updated once per second.

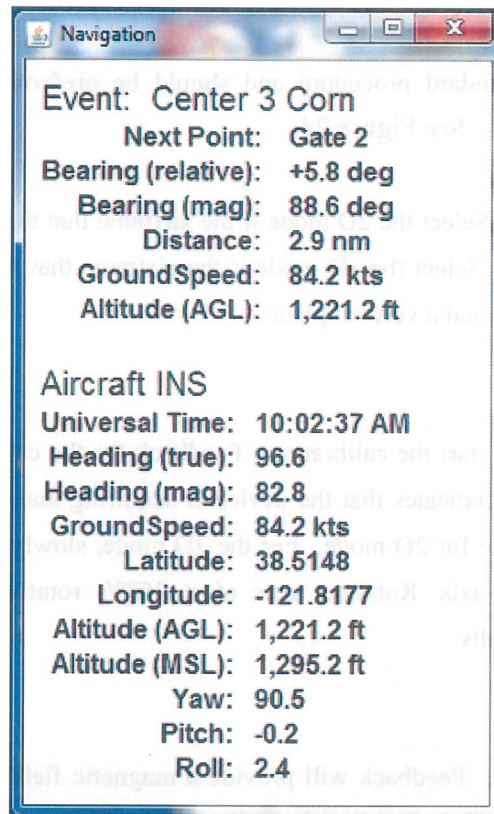


Figure 23: Navigation Window

7.4.5 Cal Tab (Magnetometer Calibration)

The “Cal” tab provides for magnetometer calibration. The magnetometer is used as an input to the INS and is intended to improve the heading accuracy and thus the image geo-location. In order to get good results, it is important to keep at least 3 meters away from all external sources of magnetic disturbances. Keep in mind that a building structure generally contains steel and other sources of interferences, as well as computers, chairs, desks, etc.

7.4.5.1 Magnetometer Use

There are three use options for the magnetometer: ‘always’, ‘never’, and ‘auto’ (1). If ‘always’ is selected, the magnetometer data will always be used, even if inaccurate. ‘Always’ is recommended for testing only. If ‘never’ is selected, the magnetometer will not be used. If ‘auto’ is selected, the magnetometer will be used based on the Kalman filter estimation of its confidence.

7.4.5.2 Calibration Mode

If a system profile has been started, use “System Control” under the “Control” tab to turn off the system profile. Two types of calibration are provided depending on the degree of freedom of the device. The 3D

calibration procedure is the standard procedure and should be preferred as it will provide the best performance in most applications. See Figure 24.

Select the calibration mode (2). Select the 2D mode if the airframe that the sensor is attached to can only be rotated in a horizontal plain. Select the 3D mode if the airframe that the sensor is attached to can be rotated in both a horizontal plane and a vertical plane.

7.4.5.3 Collect Data

Press the “collect” button (3) to start the calibration. Feedback for the calibration procedure is provided at (4). Wait until the feedback indicates that the device is acquiring magnetic field data. Slowly rotate the airframe in a horizontal plane for 2D mode. For the 3D mode, slowly rotate the airframe around the X-axis, the Y-axis, and the Z-axis. Rotation rates of $< 250^\circ/\text{s}$ rotations are acceptable. Too fast movements may weaken the results.

7.4.5.4 Calibrate

Press the “Calibrate” button (3). Feedback will provide a magnetic field deviation report. Review the deviation report and repeat “Collect Data” and “Calibrate” until you are satisfied with the deviation report. When satisfied, press the “Commit” button to save the values to the INS. Press the “Exit” button to exit without committing the calibration.

Figure 24. Magnetometer Calibration

7.4.6 Config Tab

The “Config” tab has two links. One is for active configuration and the other for sensor configuration.

7.4.6.1 Active Option

Most of the system’s configuration is performed when a profile is started. However, selected items are configurable after a profile has started. The “Active Configuration” web interface list some of these selected items and allows them to be changed. Steps include:

- Read the available configuration values (1). The link associated with each value provides additional information about that specific value.
- Make the desired changes and check the checkbox next to the items that should be changed.
- Press the “Change” button to submit the changes (2). When this happens, the new values are written to the property server and saved to the profile’s “activeConfig.xml” file as the new default value.

Status Control Viewers Config

Active Configuration

☐ [vnir.waterfall.redBand](#)
60

☐ [vnir.waterfall.greenBand](#)
26

☐ [vnir.waterfall.blueBand](#)
13

Change

CORNING

Figure 25: Active Configuration

7.4.6.2 Sensor Option

The “Sensor Configuration” page allows setting the exposure and frame rate of the lab profiles. The user enters the desired values which are then written to the configuration file and will be used the next time the profile is started. Steps include:

- Select the profile that you wish to change (1).
- A list of configuration variables for the selected profile will be listed at (2) with the current setting. Click on the link for desired settings to get the units and range allowed for that setting.
- Enter the new settings in the text box at (2).
- Press the “Change” button (3) to submit the changes. The software will check the data, write the new values to the appropriate files if correct, and display the new values.
- These values will be used the next time the selected profile is started.

Figure 26: Sensor Configuration

7.4.6.3 Data Selector

The “Data Selector” option allows the user to choose the type of data to be written to disk. The available data types are raw data, calibrated data (radiance) and band selected calibrated data. One or all three types of data types may be saved. As the number of data types saved increases, the recording time of the SSD decreases. This feature is only available for the following specific profiles.

- “2XSpecBin”
- “2XSpecBin_calOnly”
- “2XSpecBin_rawOnly”
- “4XSpecBin”

A description of these image types can be obtained by clicking on the blue links on the web page. Paragraph 7.4.6.4 describes the configuration of the “Select Bands Imagery”. Note that the “Navigation Data” is exactly the same for each image selection. Selecting all three will produce duplicate navigation files in each output image directory.

Simply check the desired checkboxes (1) and press the “Save” button” (2). The next time the profiles are loaded only the selected data types will be saved.

Figure 27: Data Selection

7.4.6.4 Band Selector

The “Band Selection” option allows the user to further reduce the data collected to the specific bands of interest. Minimizing the quantity of recorded data has many advantages including increased recording and flight time, reduced data offloading time, reduced post processing time, and reduced archival storage requirements. The user can individually select the bands for each set and store multiple sets. As with the “Data Selector” this feature is only available with the following profiles.

- “2XSpecBin”
- “2XSpecBin_calOnly”
- “2XSpecBin_rawOnly”
- “4XSpecBin”

7.4.6.4.1 Create a band set

These are the steps to create a new band set.

1. Use the radio buttons to select the binning profile, “Bin 2X” or “Bin 4X”.

2. Select “new” from the drop down box and type a unique name for the new set in the edit box (3).
3. Select the desired bands by checking the bands that should be included in the set (4). The “Select All” and “Clear All” buttons can aid in selection by selecting or clearing all bands (5).
4. After all of the desired bands are selected, press the “Save” button.

7.4.6.4.2 Deleted a band set

To delete a band set follow the steps below.

1. Use the radio buttons to select “Bin 2X” or “Bin 4X” profile.
2. Select the set for deletion from the drop down box (3).
3. Press the “Delete” button to effect the change.

7.4.6.4.3 Modify a band set

To modify a band set follow the steps below.

1. Use the radio buttons to select “Bin 2X” or “Bin 4X” profile.
2. Select the set to be modified from the drop down box (3).
3. Select the desired bands by checking the bands that should be included in the set (4). The “Select All” and “Clear All” buttons can aid in selection by selecting or clearing all bands (5).
4. After all of the desired bands are selected, press the “Save” button.

7.4.6.4.4 Select the Active Set

The “Active Set” specifies the bands that will be collected when the “Selected Band Imagery” is checked on the “Data Selection” page. See the previous section for details. There are two active sets: one for “Bin 2x” and one for “Bin 4x” To select the active set:

1. Use the radio buttons to select “Bin 2X” or “Bin 4X” (1).
2. Select the desired set from the “Active Set” drop down box (2).
3. Press the “Save” button to enact the change (5).

Status Control Viewers Cal Config

Band Selection

☐ Bin 2X ☒ Bin 4X Active Set: testSet

Spectral **1** ation: 7.3 nm. **2**

Editor:

Set: new **3**

☐ 404	☐ 411	☐ 419	☐ 426	☐ 433	☐ 440	☐ 448
☐ 455	☐ 462	☐ 470	☐ 477	☐ 484	☐ 492	☐ 499
☐ 506	☐ 514	☐ 521	☐ 528	☐ 535	☐ 543	☐ 550
☐ 557	☐ 565	☐ 572	☐ 579	☐ 587	☐ 594	☐ 601
☐ 608	☐ 616	☐ 623	☐ 630	☐ 638	☐ 645	☐ 652
☐ 660	☒ 667 4	☐ 674	☐ 681	☐ 689	☐ 696	☐ 703
☐ 711	☐ 718	☐ 725	☐ 733	☐ 740	☐ 747	☐ 754
☐ 762	☐ 769	☐ 776	☐ 784	☐ 791	☐ 798	☐ 806
☐ 813	☐ 820	☐ 828	☐ 835	☐ 842	☐ 849	☐ 857
☐ 864	☐ 871	☐ 879	☐ 886	☐ 893	☐ 901	☐ 908
☐ 915	☐ 922	☐ 930	☐ 937	☐ 944	☐ 952	☐ 959
☐ 966	☐ 974	☐ 981	☐ 988	☐ 995		

Select All Clear All Save Delete **5**

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Figure 28: Band Selection

7.4.7 Network Cabling

Two options are available for physically configuring computers to access the system:

- The first option allows for a single computer to be connected to the system. Use a CAT5e or better Ethernet cable. The cable should be inserted into the Ethernet port on the top of the SHARK and into the Ethernet port on the client computer.
- The second option allows for multiple computers to be connected to the system. This requires the use of a gigabit Ethernet switch. The SHARK and other computers are then all connected to the switch.

7.4.8 Software Configuration

To be able to use the web interface, the client computer needs to be on the same network as the system computer. The default SHARK IP address is 192.168.1.80. Client computers would then have their IP address of the format 192.168.1.xxx. The “xxx” needs to be a unique number for the computers on the network between 1 and 254. Follow the steps below for a Windows 7 based system:

- From the desktop, click “start” then select “Control Panel”.
- Select “Network and Internet” from the “Control Panel”.
- Select “Networking and sharing Center” from the “Network and Internet” page.
- Select “Change Adapter Settings” from the left margin selections.
- Use the left mouse button to double click on the Ethernet card that is connected to the network.
- Select “properties”. A dialog box similar to this one will appear.

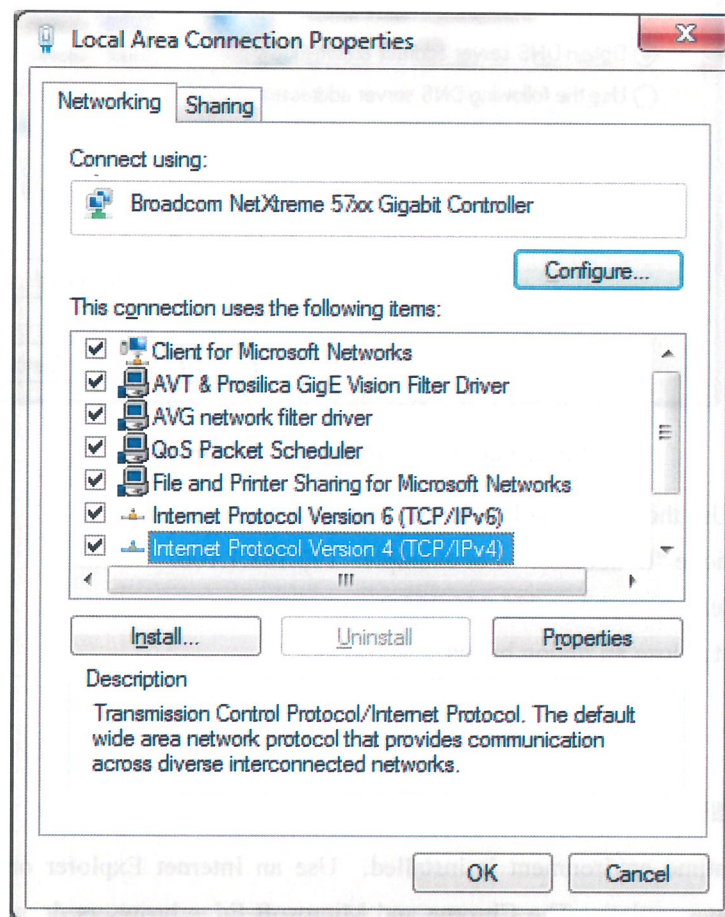


Figure 29: Local Area Connection Properties

- Select “Internet Protocol Version 4 (TCP/IPv4)” and click the “Properties” button. A new dialog

box similar to this one will appear.

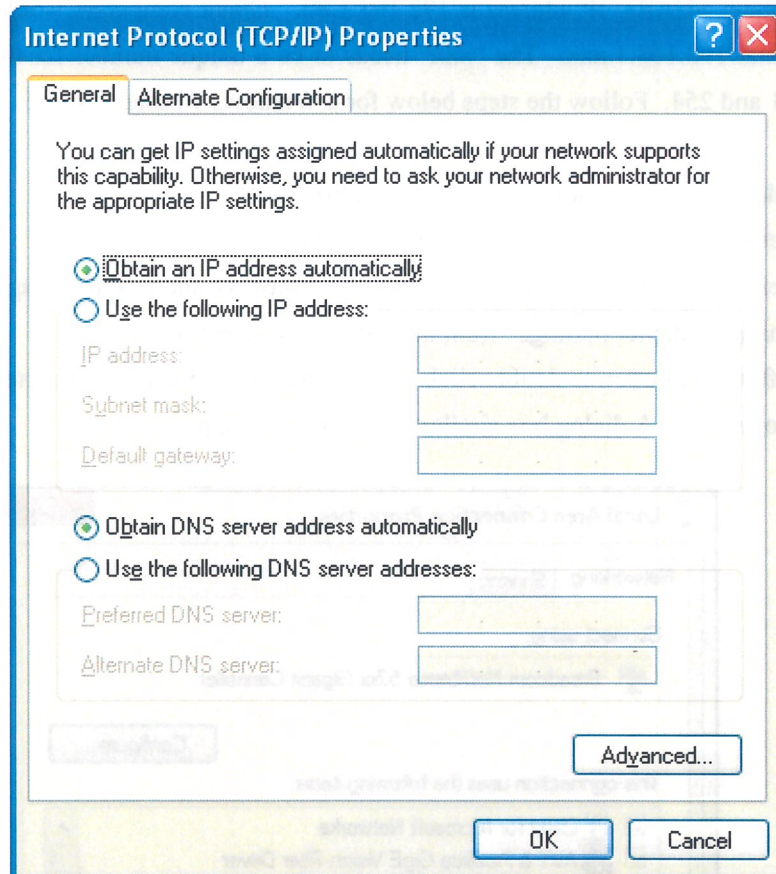


Figure 30: Internet Protocol Properties

- Select the “Use the following IP address” radio button.
- Enter the unique “IP address.” For example: 192.168.1.100.
- Enter the “Subnet mask” as 255.255.255.0.
- Press “OK” to close all dialog boxes.

7.4.9 Web Access

Ensure the Java runtime environment is installed. Use an Internet Explorer or Firefox web browser configured to use Java applets. The Chrome and Microsoft Edge browsers do not support Java. Once Java is downloaded and installed, Java needs to be configured to allow access to the Shark. On Windows systems:

- Navigate to Start->Control Panel->Programs->Java. The 'Java Control Panel' dialog is displayed.
- Select the 'Security' tab. See Figure 31
- Press the 'Edit Site List' button. The 'Exception Site List' dialog is displayed. See Figure 32
- Press the 'Add' button.
- Type the location 'http://192.168.1.80' and press 'OK'.
- Press 'Continue' at the security warning.
- Press 'OK' to close the Java Control Panel.

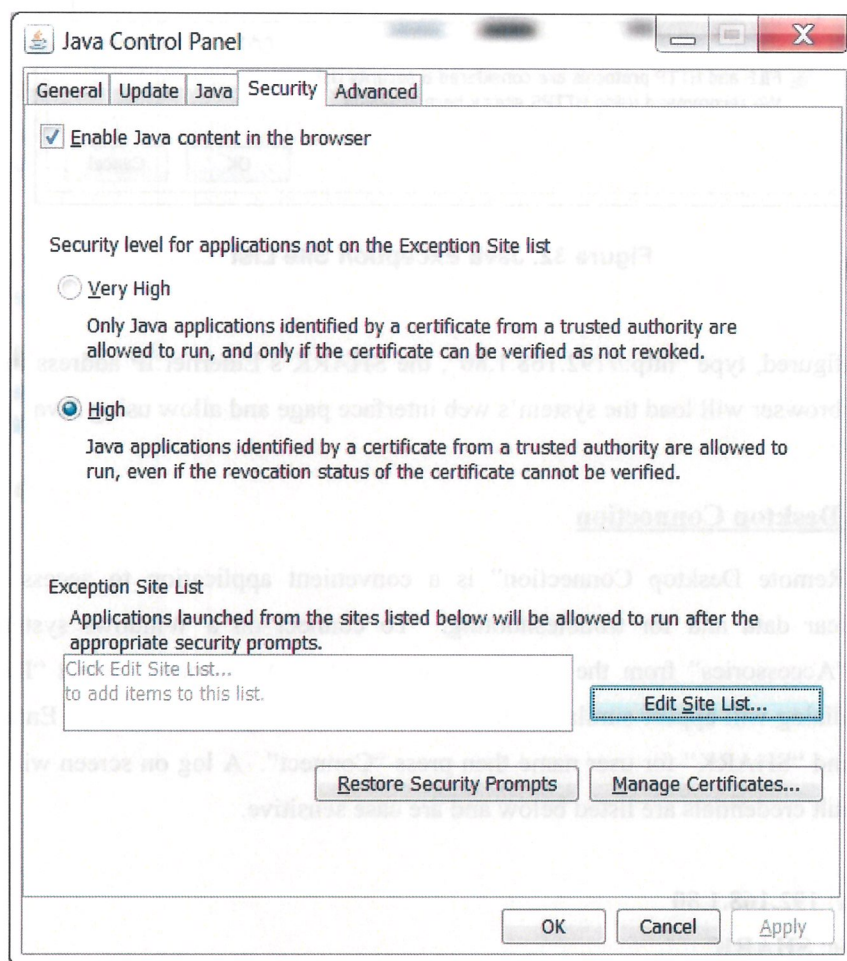


Figure 31. Java Control Panel

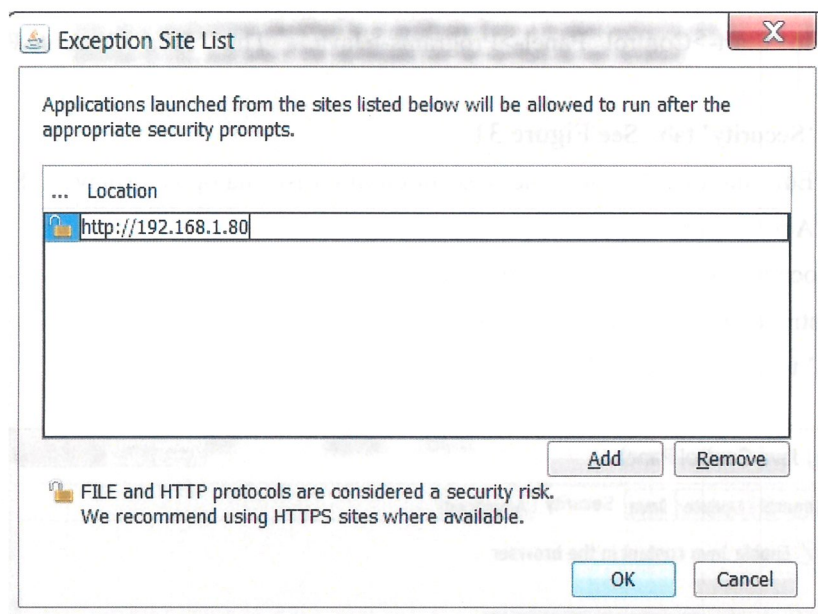


Figure 32. Java Exception Site List

After Java is configured, type “http://192.168.1.80”, the SHARK’s Ethernet IP address in the browser’s address bar. The browser will load the system’s web interface page and allow using Java applets.

7.4.10 Remote Desktop Connection

The Windows “Remote Desktop Connection” is a convenient application to access the system to download and clear data and for troubleshooting. To connect on a Windows system, go to “All Programs”, and “Accessories” from the “Start” menu. Under “Accessories” select “Remote Desktop Connection”. A dialog will appear similar to the one below. See Figure 33 below. Enter 192.168.1.80 for “Computer” and “SHARK” for user name then press “Connect”. A log on screen will appear for the system. The default credentials are listed below and are case sensitive.

- Computer: **192.168.1.80**
- User name: **SHARK**
- Password: **microHSI**

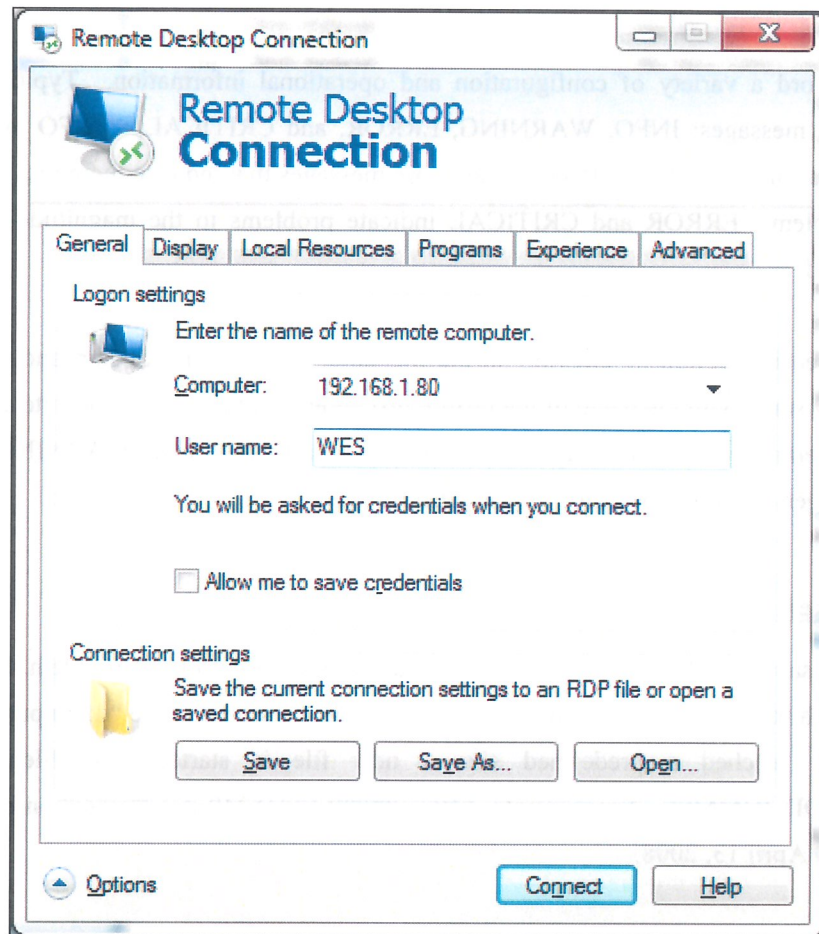


Figure 33: Remote Desktop Connection

7.5 Output Files

The output of the system is a set of data files that are copied to the data drive. The data drive is labeled the “D:” drive. The “output” folder contains subfolders for the system logs, Nav, vnir, and vnirNuc.

7.5.1 Log Folder

The log files are XML files containing status messages used for troubleshooting and monitoring the performance of the system. The log message files are contained in the “D:\output\logs\log-127.0.0.1” directory. A new log file is started each time the “On” button from the web interface is clicked to start a profile. When a log is started, it is assigned a unique date/time that is incorporated into its file name. For example, a log file may have the filename 20090306093630.xml. In the example, the file was started at 09:36:30 March 6, 2009.

Log messages record a variety of configuration and operational information. Typically there are 4 different levels of messages: INFO, WARNING, ERROR, and CRITICAL. INFO messages contain messages of general interest. WARNING messages are messages that indicate there may be a problem or a developing problem. ERROR and CRITICAL indicate problems to the magnitude that the system operation has failed.

Message logs are easily viewed by clicking on the filename. A browser will start and open the log for viewing. Each log starts with the name of the profile that generated the log and the date and time that the log started. Log entries contain message level, Time, subsysID, and text. WARNING, ERROR, and CRITICAL messages are color coded for easy identification.

7.5.2 Nav Folder

INS messages are saved by the system for Corning's use in troubleshooting a problem. Data is stored in folders labeled with the date they are acquired. These folders are stored in the "d:\output\Nav" directory. Once a file has reached a predefined size a new file is started. The filename format is SBG_YYYYMMDDHHMMSS. For example, SBG_20080513215340 is a Navigation message file that started at 12:53:40 April 13, 2008.

7.5.3 Vnir, VnirNuc, and VnirSelect Folders

The "vnir" folder contains the raw HSI data after binning and is stored in band interleaved by pixel (BIP) format. The data files themselves are in ENVI® compatible format, with a file for the data cube and a text header file.

The "vnirNuc" folder contains the HSI data after a radiometric calibration has been applied and is in $W/m^2/sr/um$. The calibrated data has been binned, dark subtracted, and a non-uniformity correction (NUC) has been applied. The calibrated data is in BIP format and the data files are in ENVI® compatible format, with a file for the data cube and a header file.

The "vnirSelect" file contains select bands. These files could contain raw data or calibrated data based on which profile was used for data collection. The data is stored in BIP format. The data cube is in ENVI® compatible format and has an associated header file.

The three folders are similarly organized and contain common supporting files such as the ENVI®

compatible IGM files and ASCII navigation data files.

7.5.3.1 Folder Organization

Within each date folder (2), subfolders are created when imaging is started. These subfolders contain the image files and are referred to as image folders (3).

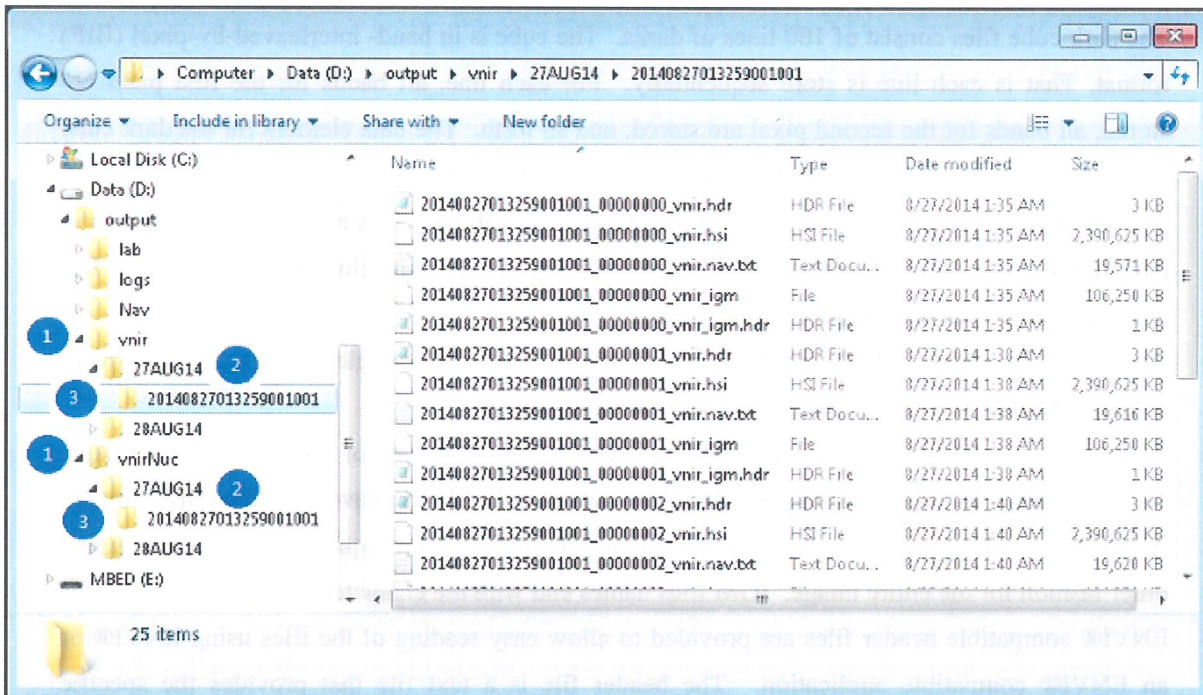


Figure 34: Imagery Folder Structure

The image folder names are unique within their respective directories and consist of date, time, and target information. The folder's name has the format YYYYMMDDHHMMSSTTTTPPP as outlined below:

- YYYY – year
- MM – month
- DD – day
- HH – hour
- MM – minute
- SS – second
- TTT – target id number.
- PPP – pass number

There are 9 different file types that can be stored in the image folders: dark cubes, dark cube header, average darks, average dark header, HSI, HSI header, IGM, IGM header, and navigation text. With the exception of the navigation text files all files have a format compatible with ENVI®, or an ENVI® compatible application..

- The dark cube files consist of 100 lines of darks. The cube is in band- interleaved-by-pixel (BIP) format. That is each line is store sequentially. For each line, all bands for the first pixel are stored, all bands for the second pixel are stored, and so forth. The data element for the dark cube is a 16-bit unsigned integer. The dark cube has a “.cdk” file extension.
- The average darks file is the average of the darks cube file above. This represents a single line in BIP format. The data element for the average darks file is a 32 point floating point integer. The average dark file has an “.adk” file extension.
- Image files are stored in BIP format as 16 bit integers or as 32 bit single precision floating point values. They are indicated by the “.hsi” the file extension.
- Input Geometry (IGM) files contain the latitude and longitude points for each pixel of the image. They are stored as binary double floating point values in band-interleaved-by-line (BIL) format. All of line 1 latitudes are stored followed by line 1 longitudes. Subsequent values follow in line order fashion for the entire image. IGM files names end with the characters “igm”.
- ENVI® compatible header files are provided to allow easy reading of the files using ENVI® or an ENVI® compatible application. The header file is a text file that provides the specific information necessary to read the files. The header files are indicated with the “.hdr” file extension and correspond to the file name described above.
- The navigation text files provide the navigation data that corresponds to the image files. The navigation files are indicated by the “.nav.txt” extension. One navigation entry is recorded per image line.

Image files are named for easy identification. The date and time used to create this name is with reference to GMT. The file name format is YYYYMMDDHHMMSSTTTPPP_#####.xxx as outlined below:

- YYYY – year
- MM - month
- DD - day
- HH - hour
- MM - minute
- SS - second

- TTT - target id number.
- PPP - pass number
- nnnnnnnn - consecutive sequence for this event
- ##### -sensor and file type identification: vnir, vnir_igm, vnir.nav.
- xxx - file extension: hsi, nav, hdr, or txt.

7.5.4 Navigation Text File

The navigation files contain inertial navigation system and geo-location information for each line of the image. This file is in text format to allow it to be easily interpreted and used for further analysis. An example of an entry is provided below in Figure 35 below.

The files are easily read and interpreted with the following additional explanation:

- FRAME_ID: This corresponds to the line number of the image.
- PACKET_SIZE: This was the message size at some point in time used for internal processing. This value may no longer be valid.
- START_TIME: This is the GPS time for which the navigation data is valid.
- REQUEST_TIME: This is the GPS time for which the navigation data was requested.
- CAM_LOC_LAT, CAM_LOC_LON, and CAM_LOC_ALT refers to the location of the aircraft. The latitude and longitude are with regard to the WGS84 ellipsoid. The altitude is in meters and with respect to the EGM96 geoid.
- The velocity vectors VELOCITY_EAST, VELOCITY_NORTH, and VELOCITY_UP are indicated in meters-per-second.
- The sensor attitude values, SENSOR_ATT_YAW, SENSOR_ATT_PITCH, and SENSOR_ATT_ROLL represent the attitude of the line-of-sight of the sensor with respect to the INS and typically the frame of the aircraft.
- The line-of-sight (LOS) values LOS_ATT_YAW, LOS_ATT_PITCH, and LOS_ATT_ROLL are derived sensor LOS values referenced from north in a horizontal plane at the camera location. Values are in degrees.
- The center position, CENTER_LAT, CENTER_LON, and CENTER_ALT represents the derived center position of the image line on the earth. The altitude is in meters and uses a digital elevation map if available.
- The upper left position, UPPER_LEFT_LAT, UPPER_LEFT_LON, and UPPER_LEFT_ALT represents the derived position of left end of the image line on the earth.

- The upper right position, UPPER_RIGHT_LAT, UPPER_RIGHT_LON, and UPPER_RIGHT_ALT represents the derived position of the right end of the image line on the earth.
- The registration points, REGPOINTS, provide the positions for selected pixels across the image line. The 23 following "REGPOINTS" indicates 23 registration positions follow. The 23 positions follow. Each position is made of 4 numbers: pixel number, latitude, longitude, and elevation.

```

FRAME_ID 1
PACKET_SIZE 012973
START_TIME 1093285591.120965
REQUEST_TIME 1093285591.120965
ANGULAR_UNITS degrees
GROUND_SPEED_UNITS meters/sec
GROUND_SPEED 5.764
CAM_LOC_LAT 36.179159
CAM_LOC_LON -121.130674
CAM_LOC_ALT 183.609
CAM_LOC_ALT_ELLIPSOID 149.611
VELOCITY_EAST 1.590038
VELOCITY_NORTH -5.540196
VELOCITY_UP -0.138648
PLATFORM_ATT_YAW 162.4570
PLATFORM_ATT_PITCH 40.0453
PLATFORM_ATT_ROLL -1.9010
SENSOR_ATT_YAW 0.0000
SENSOR_ATT_PITCH -90.0000
SENSOR_ATT_ROLL 0.0000
LOS_ATT_YAW 165.4101
LOS_ATT_PITCH -49.9172
LOS_ATT_ROLL 0.0000
CENTER_LAT 36.17856545
CENTER_LON -121.13048359
CENTER_ALT 102.836
UPPER_LEFT_LAT 36.17864706
UPPER_LEFT_LON -121.13018259
UPPER_LEFT_ALT 103.343
UPPER_RIGHT_LAT 36.17848718
UPPER_RIGHT_LON -121.13079341
UPPER_RIGHT_ALT 102.936
REGPOINTS 23,
1,0036.1786470410,-121.1301825810,000000103.34271, 32,0036.1786393502,-121.1302094070,000000103.24613,
63,0036.1786316660,-121.1302363789,000000103.14904,94,0036.1786239506,-121.1302634608,000000103.05154,
125,0036.1786164880,-121.1302908545,000000102.99909,156,0036.1786093513,-121.1303185571,000000102.99366,
187,0036.1786020523,-121.1303462207,000000102.96739,218,0036.1785947364,-121.1303739483,000000102.94105,
249,0036.1785874036,-121.1304017402,000000102.91465,280,0036.1785800537,-121.1304295965,000000102.88819,
311,0036.1785726868,-121.1304575176,000000102.86167,342,0036.1785653027,-121.1304855035,000000102.83509,
373,0036.1785579014,-121.1305135546,000000102.80845,404,0036.1785504828,-121.1305416711,000000102.78174,
435,0036.1785431389,-121.1305698687,000000102.76791,466,0036.1785359142,-121.1305981401,000000102.77079,
497,0036.1785287202,-121.1306264601,000000102.77910,528,0036.1785215581,-121.1306548231,000000102.79282,
559,0036.1785144291,-121.1306832235,000000102.81191,590,0036.1785073344,-121.1307116558,000000102.83635,
621,0036.1785002752,-121.1307401143,000000102.86610,652,0036.1784932524,-121.1307685936,000000102.90111,
680,0036.1784871777,-121.1307934089,000000102.93587

```

Figure 35: Nav Text Entry Sample

8 Commander Utility

The SHARK system can be used on both manned platforms and unmanned aerial vehicles (UAV's). To avoid having the sensor collect data continuously and provide copious amounts of data which a user must sift through to find the desired target imagery, a method is needed to automatically command the starting and stopping of imaging when entering and leaving the target area. The "Commander" is an application designed to do this. It reads an event tracks file which can contain areas, start and stop points, or tracks. Based on the INS broadcast, which provides the UAV position every second and the event track file entries, it automatically commands the start/stop of imaging.

The event tracks file is an XML file that is used by the commander and the event viewer. Because it is an XML messages, those entries that are unique for one application will be ignored by the other application. The event tracks file is located here:

“C:\CorningHsi\eventConfig\EventTracks.xml”.

The event tracks file is an XML file that is used by the commander and the event viewer. Because it is an XML messages, those entries that are unique for one application will be ignored by the other. The different automatic imaging modes are shown in Figure 36: Automatic Imaging Modes below.

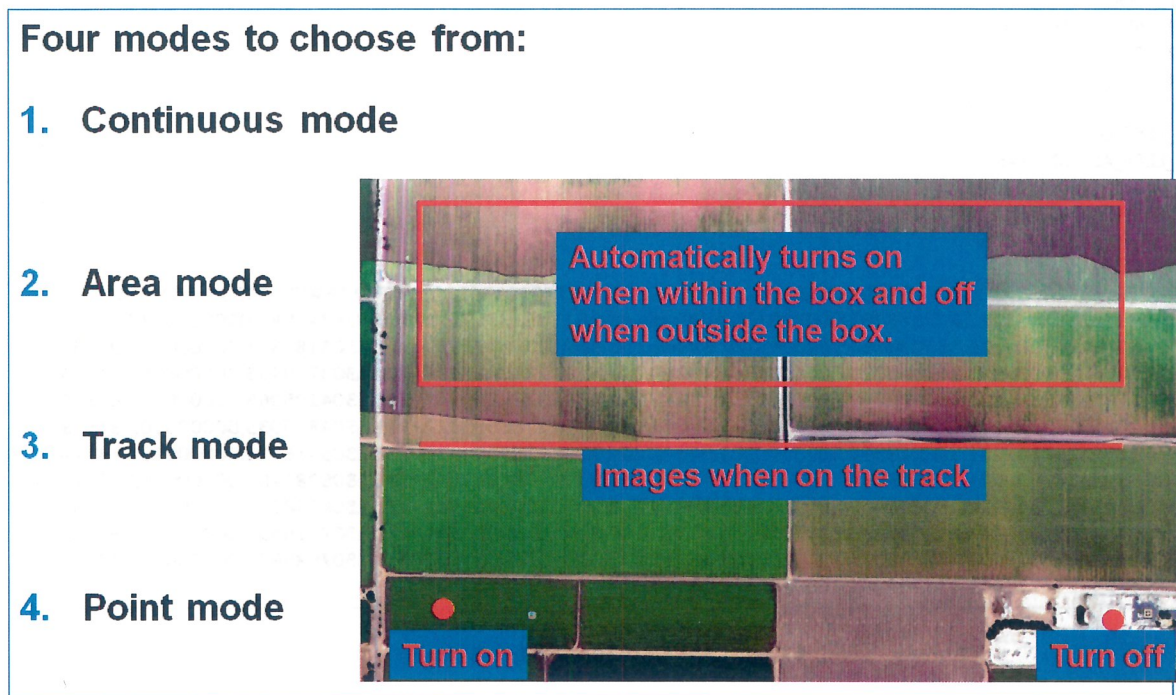


Figure 36: Automatic Imaging Modes

8.1 Event Tracks XML File Format

XML is typically the first line of an XML file or message. Although this file is in XML format, it is best to confine the format as listed in this document as the Commander and Event Viewer applications do not support all XML features. All XML tags must be specified in lower case. The entry associated with the

tag can be upper and lower case.

8.1.1 Set Entry

The set entry marks the beginning and the ending of the entries for this file. It is required by both the Commander and Event Viewer applications.

8.1.2 Field of View Entry

The field of View (FOV) entry is a required entry used by the Event Viewer application. It is not used by the Commander application. It is used by the Event Viewer to determine the area being imaged and graphically display this area when on track.

8.1.3 Mode Entry

The mode entry is a required entry used by the Commander application. It is ignored by the Event Viewer application. The mode indicates what entries the Commander should monitor when controlling the sensor. Valid values are:

None	No commands will be issued
Continuous	Imaging will be commanded when a specified velocity is optioned and stopped when the velocity falls below this value. Typically, this will be on takeoff and landing.
Area	Imaging will be commanded when entering any areas and stopped when exiting any areas.
Track	Imaging will be commanded when the aircraft flies one of the specified tracks and stopped when the aircraft departs from the track.
Point	The point mode allows the aircraft operator to start and stop imaging by flying over any of the specified points.

Figure 37: Commander Modes

8.1.4 Track Entry

The track entry is used by both the Commander and the Event Viewer. It is a required entry for the Event Viewer. It is a required entry for the Commander when the “Track” mode is indicated. More than one track entry can be made. See Figure 38 as an example of the track entry.

```
<?xml version="1.0" encoding="utf-8"?>
<set>
```

```

<fov>29.5</fov>
<mode>track</mode>
<track>
  <name>PowerPlantRoad</name>
  <units>meters</ units >
  <leadin>500</leadin>
  <floor>300</floor>
  <ceiling>700</ceiling>
  <latlon>21.347,-157.725</latlon>
  <latlon>21.365,-157.709</latlon>
  <latlon>21.379,-157.697</latlon>
</track>
</set>

```

Figure 38: Track Entry

8.1.4.1 Name Entry

This is a name that can be used to uniquely identify the track. This name is used by both the Commander and the Event Viewer but is not required by either. The Commander will use it to annotate to log entries when making commands. The Event Viewer will use the name to label tracks for user selection.

8.1.4.2 Units Entry

This indicates the units used for the lead in, the floor, and the ceiling. Valid values for this entry are “feet” or “meters”. This entry is used by both the Commander and the Event Viewer but is not required by either. If it is missing the default value will be set to “meters”.

8.1.4.3 Lead In Entry

The lead in entry is used by both the Commander and the Event Viewer.

The field has a default value of 200, so it is not a required field. The Commander uses it as the distance from the first latitude/longitude pair to initialize imaging. The Event Viewer uses it to provide a pre-waypoint to help ensure the aircraft is aligned when it reaches the first latitude/longitude pair of the track.

8.1.4.4 Floor Entry

The floor indicates the minimum altitude that aircraft must have before the Commander will start imaging for this track. A value of 0 indicates that that no minimum altitude will be used. This is not a required

field for the Commander. If it is missing the default value is 0 is used. This field is not used by the Event Viewer.

8.1.4.5 Ceiling Entry

The ceiling indicates the maximum altitude that aircraft can have for the Commander to start imaging for this track. A value of 0 indicates that no maximum altitude will be used. This is not a required field for the Commander. If it is missing the default value is 0 is used. This field is not used by the Event Viewer.

8.1.4.6 Lat/Lon Entries

Latitude and longitude entries are required to describe the track. These values are required by both the Commander and the Event Viewer applications. A minimum of two latitude/longitude pairs is required.

8.1.5 Area Entry

The area entry is used by both the Commander and the Event Viewer. It is a required entry for the Commander when the “Area” mode is indicated. It is not required by the Event Viewer. It is used by the Event Viewer to display any areas that may be significant to the pilot or the system operator. More than one area entry can be made. See Figure 39 as an example of the area entry.

```
<area>
  <name>Restricted</name>
  <color>red</color>
  <units>meters</ units >
  <floor>300</floor>
  <ceiling>700</ceiling>
  <latlon>21.347,-157.7</latlon>
  <latlon>21.347,-157.69</latlon>
  <latlon>21.357,-157.69</latlon>
  <latlon>21.357,-157.7</latlon>
</area>
```

Figure 39: Area Entry

8.1.5.1 Name Entry

This is a name that can be used to uniquely identify the area. This name is used by both the Commander and the Event Viewer but is not required by either. The Commander will use it to annotate to log entries

when making commands. The Event Viewer will use to label areas on the screen.

8.1.5.2 Color Entry

The color entry is used by the Event Viewer when drawing areas. It is not a required entry. It is not used by the Commander. Available colors entries are “blue”, “cyan”, “darkGray”, “gray”, “green”, “lightGray”, “magenta”, “orange”, “pink”, “red”, “white”, and “yellow”.

8.1.5.3 Floor Entry

The floor indicates the minimum altitude that aircraft must have before the Commander will start imaging for this area. A value of 0 indicates that that no minimum altitude will be used. This is not a required field for the Commander. If it is missing the default value is 0 is used. This field is not used by the Event Viewer.

8.1.5.4 Ceiling Entry

The ceiling indicates the maximum altitude that aircraft can have for the Commander to start imaging for this area. A value of 0 indicates that no maximum altitude will be used. This is not a required field for the Commander. If it is missing the default value is 0 is used. This field is not used by the Event Viewer.

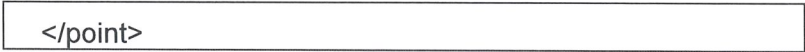
8.1.5.5 Lat/Lon Entries

Latitude and longitude entries are necessary to describe the track. These values are required by both the Commander and the Event Viewer applications. A minimum of three latitude/longitude pairs is required. The latitude/longitude pairs should be entered in the ordered necessary to produce the desired areas.

8.1.6 Point Entry

The Point Entry is used by the Commander. It is not used by the Event Viewer. The idea is that the pilot can use a waypoint to start and stop imaging by flying over designated points. To start imaging, the pilot would fly the aircraft over one of the specified waypoints. Imaging would continue until the pilot flies over one of the specified waypoints to stop imaging. See Figure 40 as an example of the Point Entry.

```
<point>
  <name>goldEntry</name>
  <units>meters</units>
  <standoff>200</standoff>
  <latlon>21.2852,-157.6923</latlon>
```



```
</point>
```

Figure 40: Point Entry

8.1.6.1 Name Entry

This is a name that can be used to uniquely identify the point. The Commander uses it to annotate to log entries when making commands.

8.1.6.2 Units Entry

This indicates the units used for the standoff, the floor, and the ceiling. Valid values for this entry are “feet” or “meters”. If it is missing the default value will be set to “meters”.

8.1.6.3 Standoff Entry

The Commander uses the standoff as the distance from the indicated latitude/longitude pair to start or stop imaging. The field has a default value of 200, so it is not a required field.

8.1.6.4 Floor Entry

The floor indicates the minimum altitude that aircraft must have before the Commander will start or stop imaging for this point. A value of 0 indicates that that no minimum altitude will be used. This is not a required field. If it is missing the default value is 0 is used.

8.1.6.5 Ceiling Entry

The ceiling indicates the maximum altitude that aircraft can have for the Commander to start or stop imaging for this point. A value of 0 indicates that no maximum altitude will be used. This is not a required field. If it is missing the default value is 0 is used.

8.1.6.6 Lat/Lon Entries

One latitude/longitude entry if required for each point entry. Since there is only one entry, it is not annotate with a number as latitude/longitude pairs are for the track and area entries.

8.1.7 Continuous Entry

The continuous entry is used by the Commander. It is not used by the Event Viewer. The continuous entry is used to image continuously from take-off until landing. To determine that the aircraft has taken off, the velocity is monitored and compared to the entry. When the velocity is exceeded, imaging is started. When the velocity falls below this threshold, imaging is stopped. See Figure 41 as an example

of the continuous entry.

```
<continuous>
  <units>knots</units>
  <velocity>40</velocity>
</continuous>
```

Figure 41: Continuous Entry

8.1.7.1 Units Entry

This indicates the units used for the velocity. The values for this entry are “knots” or “metersPerSecond”. If it is missing the default value will be set to “knots”.

8.1.7.2 Velocity Entry

This is the threshold for the velocity. It is a required field.

8.2 Example XML File

The following is an example of a complete file. Unused entries can be kept in the file and activated simply by changing the mode entry.

```
<?xml version="1.0" encoding="utf-8"?>
<set>
  <fov>29.5</fov>
  <mode>track</mode>
  <continuous>
    <velocity>40</velocity>
  </continuous>
  <point>
    <name>goldEntry</name>
    <units>meters</units>
    <standoff>200</standoff>
    <latlon>21.2705,-157.7313</latlon>
  </point>
  <point>
```

```

<name>goldExit</name>
<units>meters</units>
<floor>2000</floor>
<ceiling>4000</ceiling>
<standoff>200</standoff>
<latlon>21.2852,-157.6923</latlon>
</point>
<track>
  <name>Baker1</name>
  <units>meters</units>
  <floor>4000</floor>
  <ceiling>8000</ceiling>
  <leadin>500</leadin>
  <latlon>21.347,-157.725</latlon>
  <latlon>21.365,-157.709</latlon>
  <latlon>21.379,-157.697</latlon>
</track>
<track>
  <name>Plumber2</name>
  <leadin>500</leadin>
  <latlon>21.265,-157.745</latlon>
  <latlon>21.27,-157.73</latlon>
</track>
<area>
  <name>Restricted</name>
  <color>red</color>
  <latlon>21.347,-157.7</latlon>
  <latlon>21.347,-157.69</latlon>
  <latlon>21.357,-157.69</latlon>
  <latlon>21.357,-157.7</latlon>
</area>
<area>
  <name>GrayArea</name>
  <color>gray</color>
  <floor>0</floor>

```



```

<ceiling>0</ceiling>
<latlon>21.347,-157.735</latlon>
<latlon>21.347,-157.745</latlon>
<latlon>21.379,-157.75</latlon>
<latlon>21.379,-157.703</latlon>
</area2>
</set>

```

Figure 42: Example Commander XML File

9 Trouble Shooting

Trouble shooting should begin by examining the logs as described in the “Output” section. The logs are color coded to easily identify warnings and errors. Examining the logs should provide some insight into the problem. Next you may wish to check system connections. Frequently a loose connection is responsible for the problems seen. If you continue to have problems, Corning may be able to assist. We will need a copy of the log record and a copy of the profile that produces the problem.

10 Post-Processing, Display and Exploitation

The microHSI™ 410 SHARK processing architecture is based around using ENVI® or another image processing program capable of reading ENVI® file formats. *ENVI® (Environment for Visualizing Images – Harris Geo-Spatial) is a software application used to analyze hyperspectral data. Other image processing software can be used with the files generated by the microHSI™ 410-SHARK, but they must be capable of reading ENVI® file formats. A license to the ENVI® software application is not included with the purchase of the microHSI™ 410-SHARK. We make no representations and warranties about the ENVI® software application, and you agree that any use by you of it is at your own risk.*

11 Specifications

11.1 microHSI™ 410 SHARK Specifications

Sensor Type	Push-broom Line Imaging Spectrometer
--------------------	--------------------------------------

Spectrograph	Solid Block Offner
Grating	Diamond-Ruled High Efficiency Reflective Blazed
FPA Detector	CCD/CMOS hybrid
Effective Pixel Size	11.7 μm
Effective Array Size	682 max x 160 max (2x2 binning min)
Focal Lengths, f/#	16 mm, f/1.4 standard
Full FOV	29.5 degrees (499 mrad) full angle standard
IFOV	732 μrad standard
Spectral Range	400 nm – 1000 nm +/- 1%
Spectral Bin Size (per effective pixel)	4 nm
Maximum Frame Rate	> 300 Hz (profile dependent)
Data Readout	12-bit (camera)
INS	GPS + Mems IMU + Kalman Filtered solution
Size (standard lens, processor, data storage, INS)	5.37" x 3.44" x 2.77" with lens 3.77" x 3.44" x 2.77" without lens
Weight (standard lens, data storage, INS)	1.6 lb. (0.73 kg)
Power Consumption (complete system)	< 19 W @ 12 VDC
Input Voltage	+8 VDC to +16 VDC
Etendue	50 steradian μm^2

Table 1: microHSI™ 410 SHARK Performance Characteristics

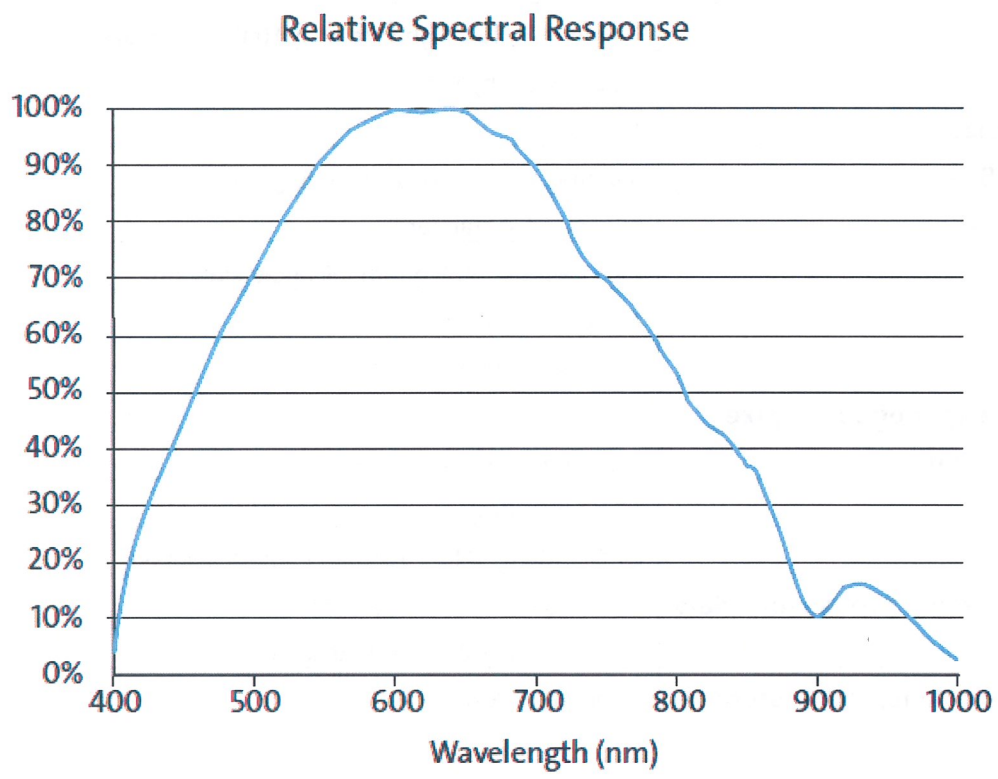


Figure 43: Relative Spectral Performance

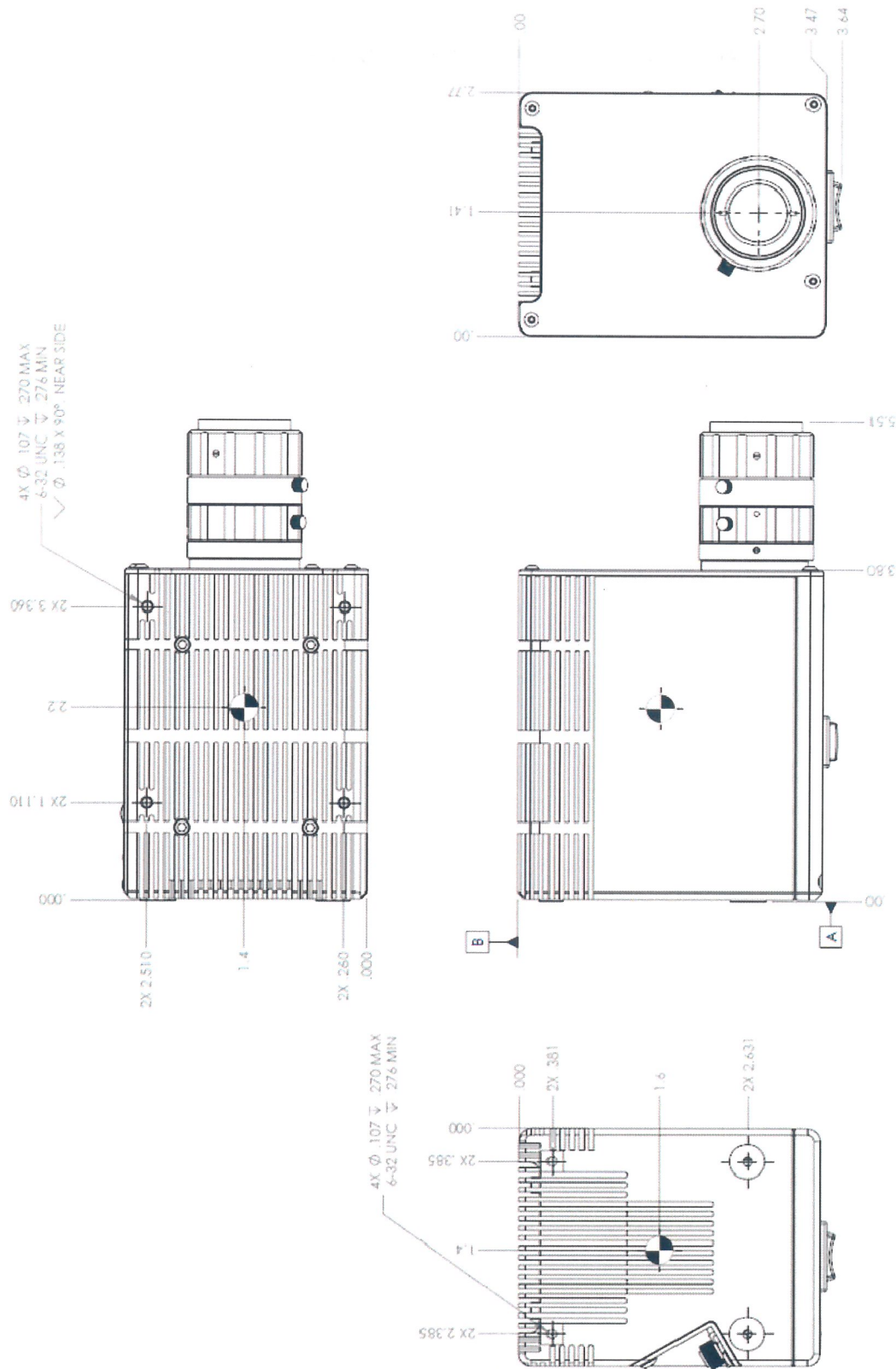
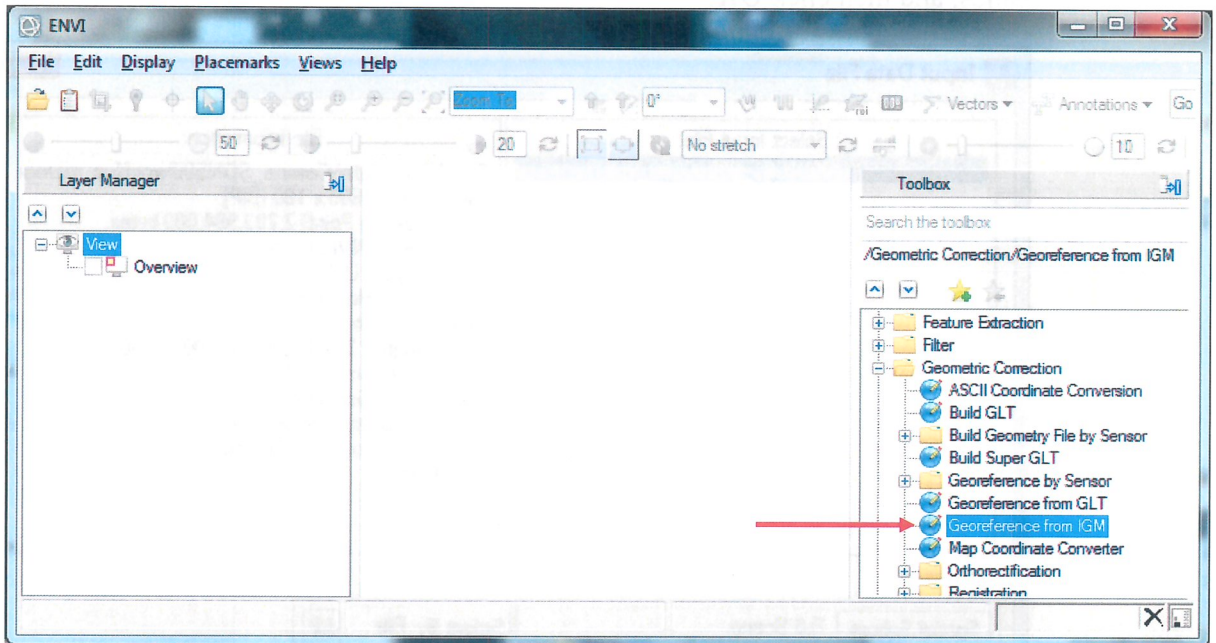


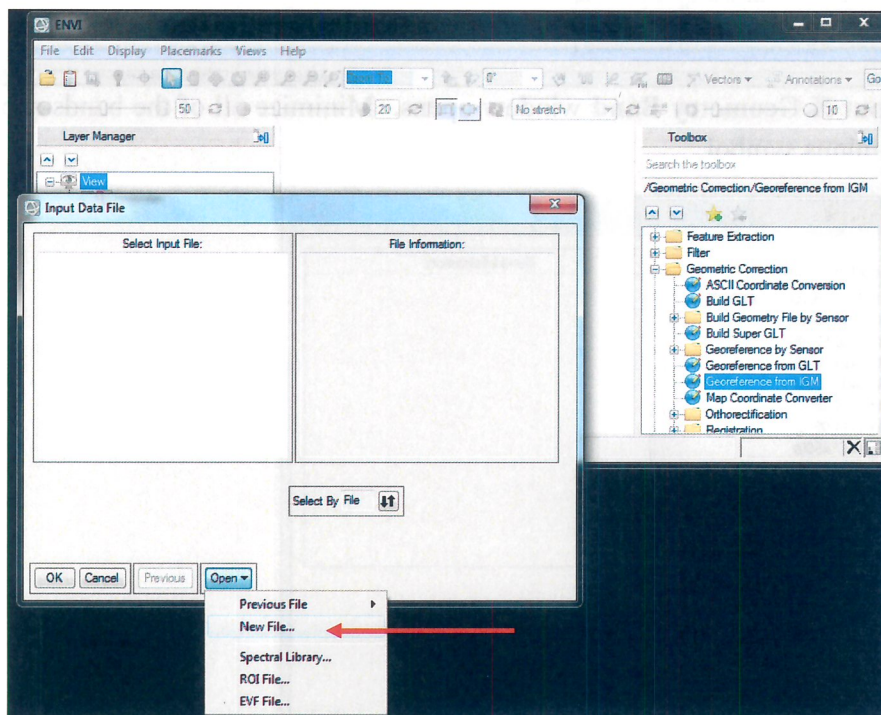
Figure 44: microHSI™ 410 SHARK Drawing

Appendix A Geo-Registering Corning's HSI Data Using ENVI® 5.3

1. Start **Georeference from IGM** tool from the **Toolbox**.



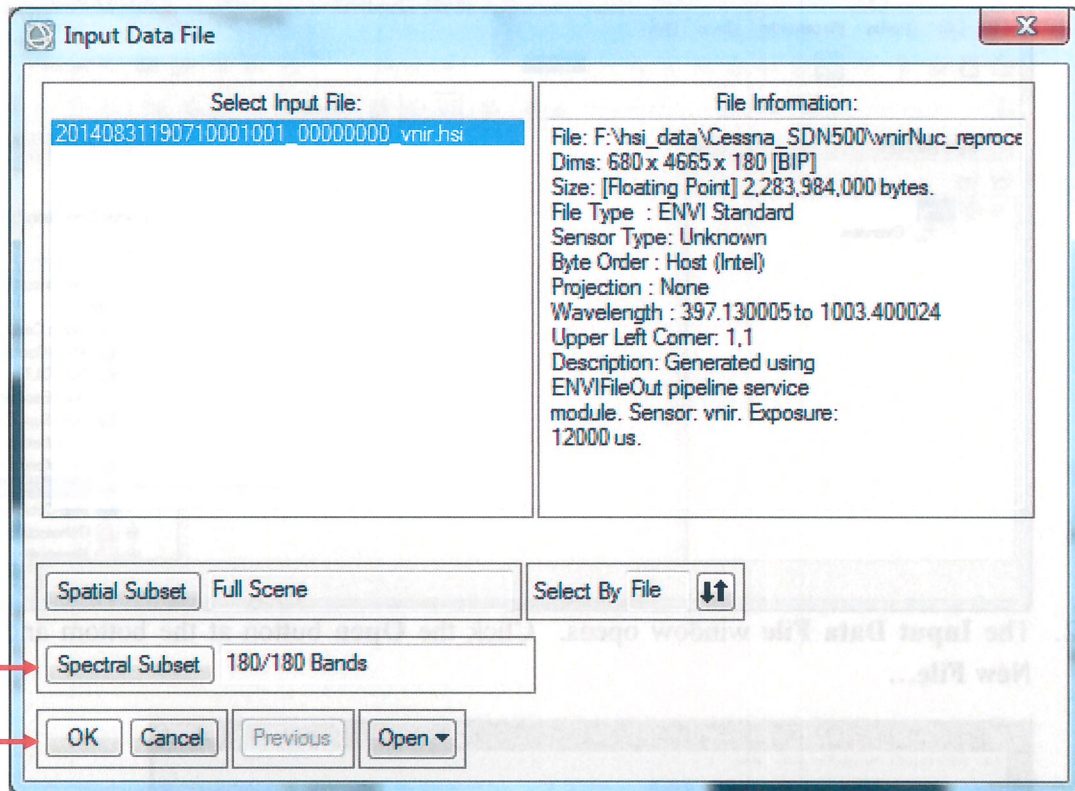
2. The **Input Data File** window opens. Click the **Open** button at the bottom and select **New File...**



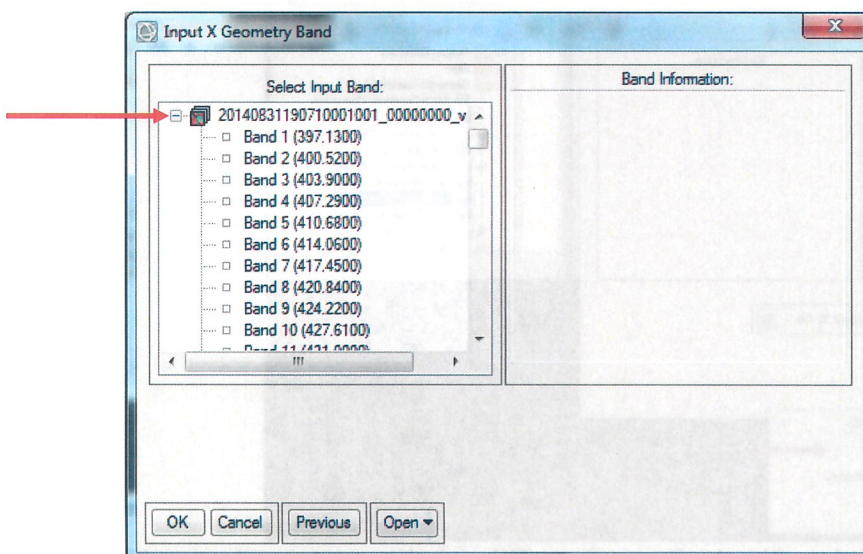
3. After selecting the HSI data file, the **Input Data File** window opens and you will see its

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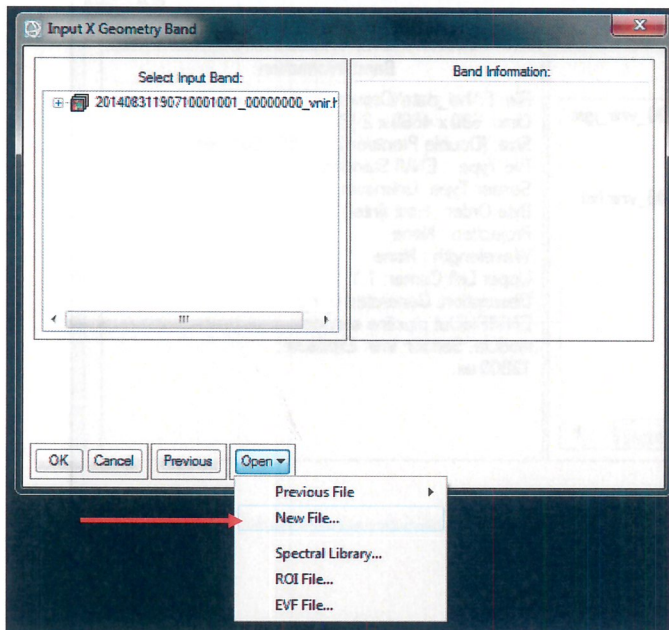
information. If you want to geo-register all of the bands then click **OK**. If you only want a RGB image (quicker) then click the **Spectral Subset** button, choose the three RGB bands, and then click **OK**.



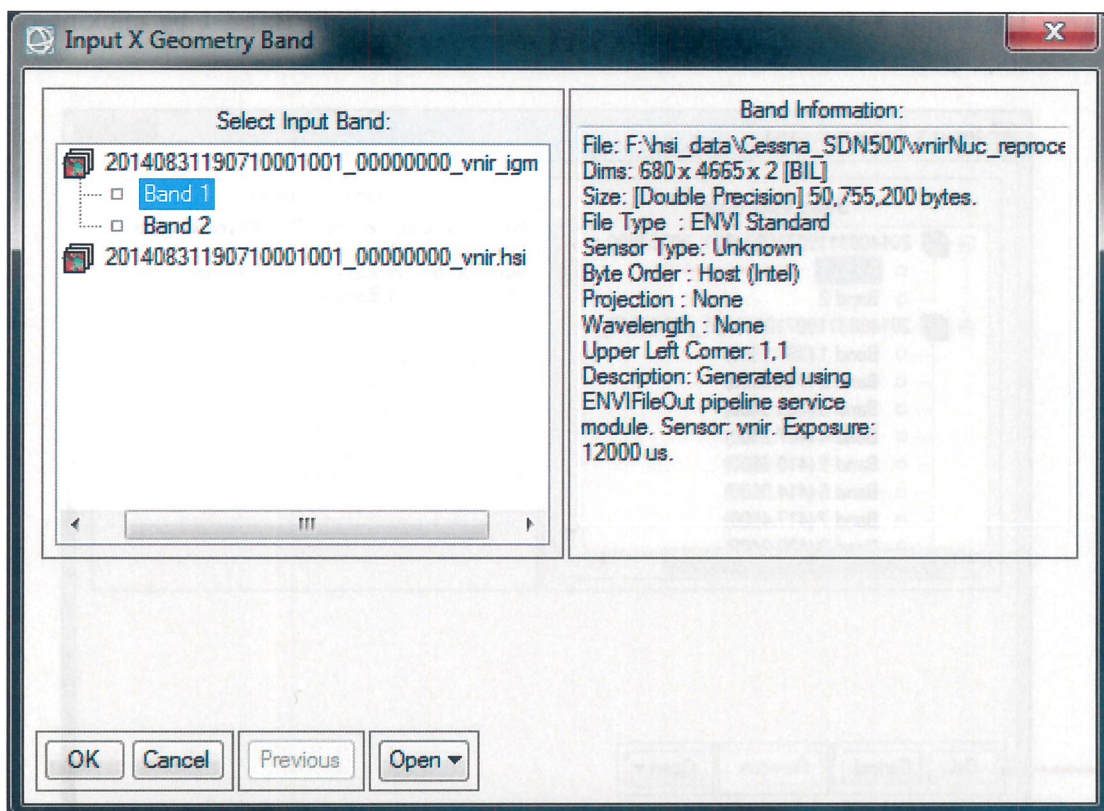
4. Now the **Input X Geometry Band** window opens. Minimize all of the bands shown by clicking the minus symbol.



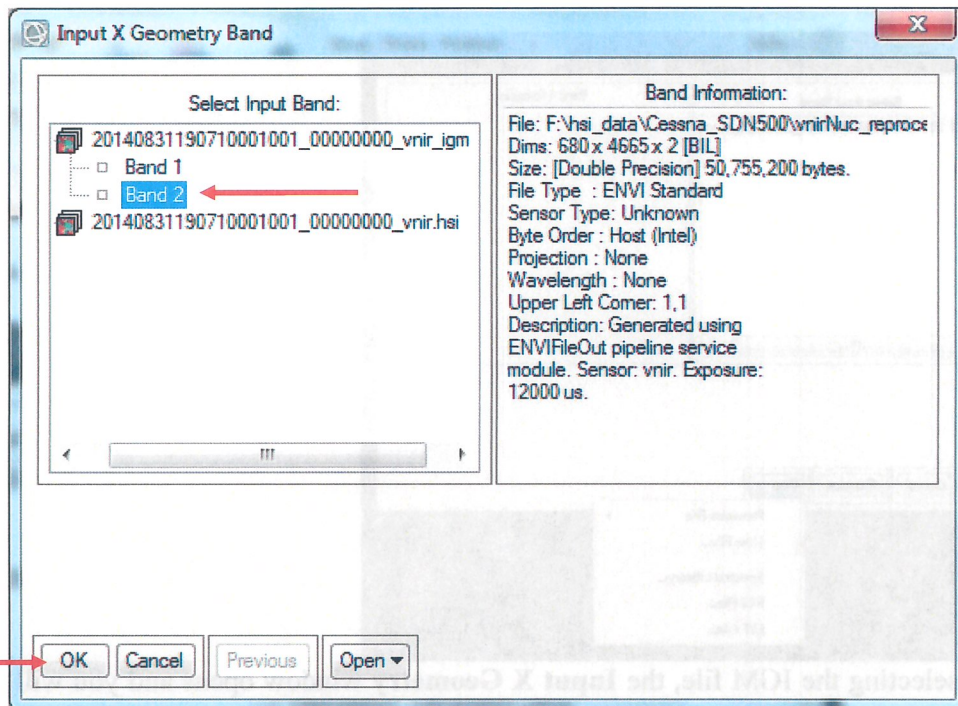
5. Click **Open->New File...** and pick the corresponding IGM file.



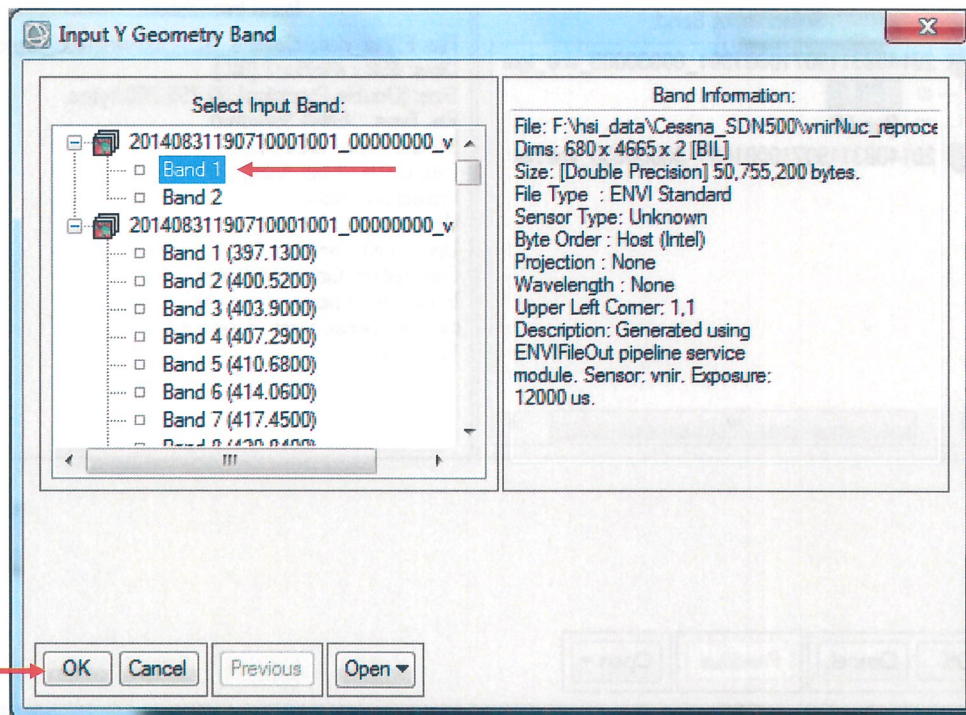
6. After selecting the IGM file, the **Input X Geometry** window opens and you will see the IGM file information displayed.



7. Now click on **Band 2** to highlight it and then click **OK**.

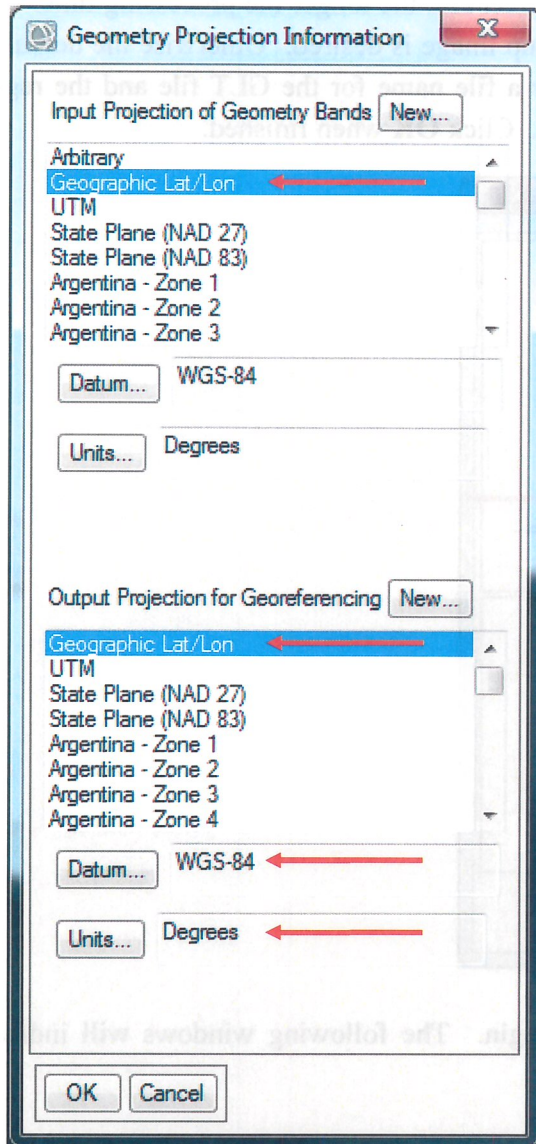


8. The **Input Y Geometry Band** window opens. Highlight **Band 1** by clicking on it and click **OK**.

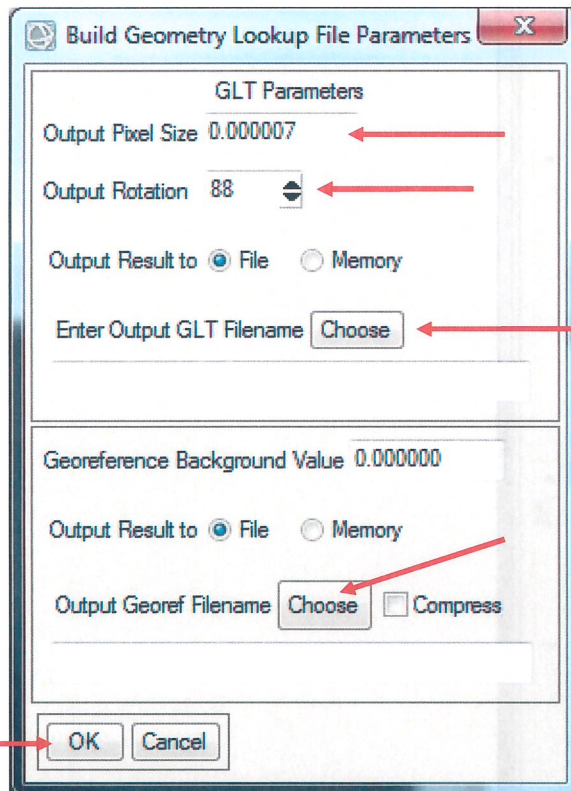


9. The **Geometry Projection Information** window opens. Highlight **Geographic Lat/Lon**

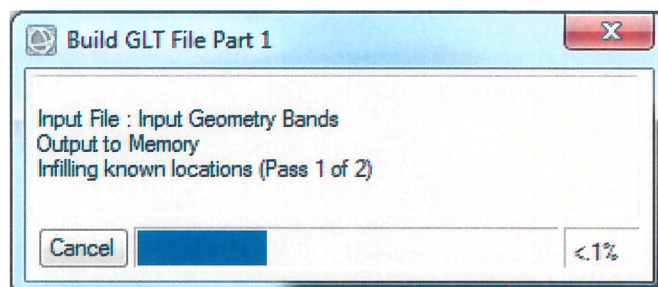
for both the **Input and Output Projections**, confirm that the **Datum** is set to **WGS-84**, and the **Units** are **Degrees**. Click **OK**.

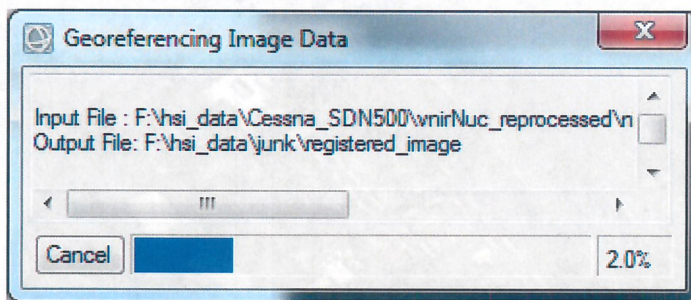
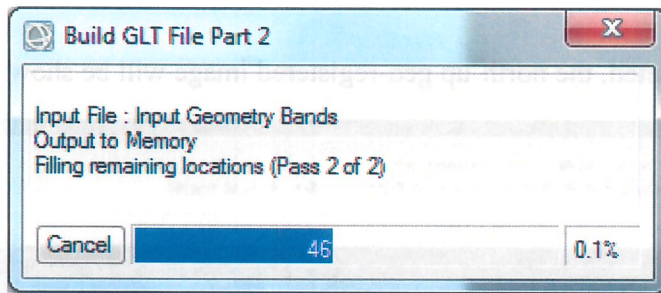


10. The **Build Geometry Lookup File Parameters** window will open. Enter the **Output Pixel Size** in degrees. The smaller the pixel size the longer the processing time. Change the **Output Rotation** to zero if a north up image is desired. Otherwise the default value will create the smallest file size. Enter a file name for the GLT file and the registered image by clicking on the **Choose** button. Click **OK** when finished.

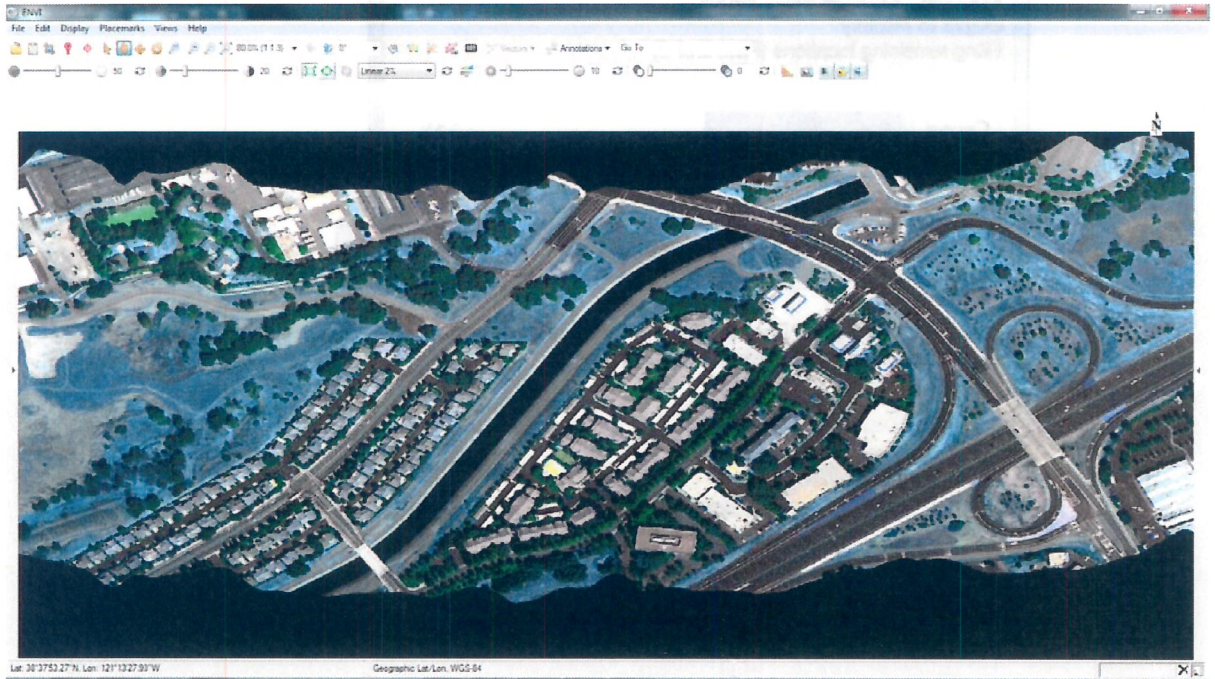


11. The geo-registration processing will begin. The following windows will indicate the status of the processing.



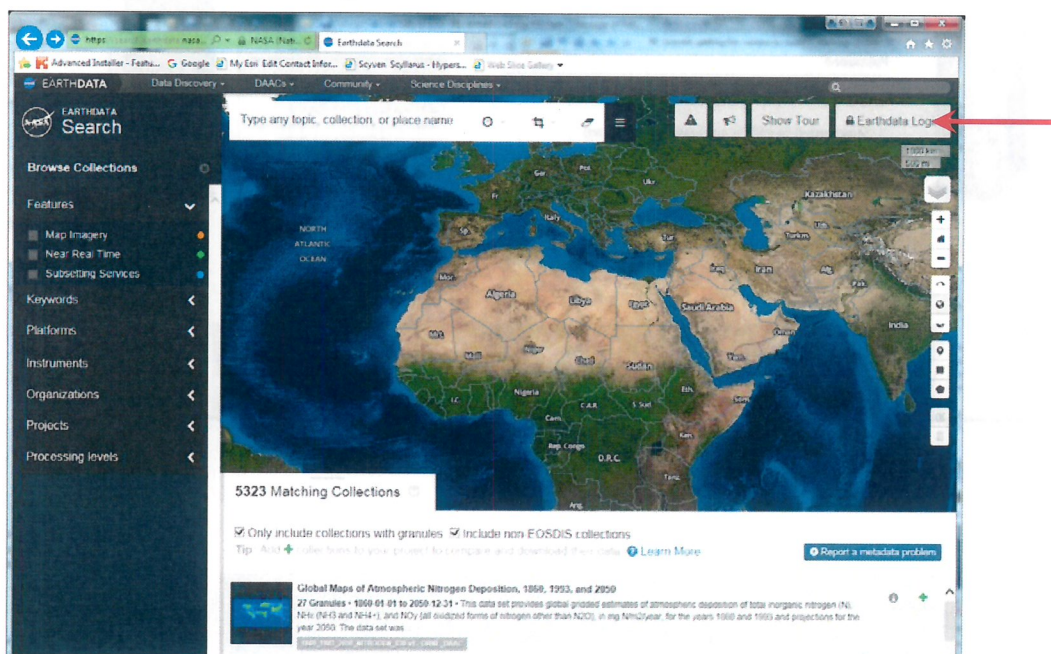


12. When the processing is completed, the north-up geo-registered image will be shown.



Appendix B How to Download DEM Data from the Internet

1. Go to NASA's Earth Data web site <https://search.earthdata.nasa.gov/>.
2. In the upper right hand corner click on **Earthdata Login**.



3. Register for an account or log in.

Earthdata Login

Username

Password

☐ Stay signed in (this is a private workstation)

LOG IN REGISTER

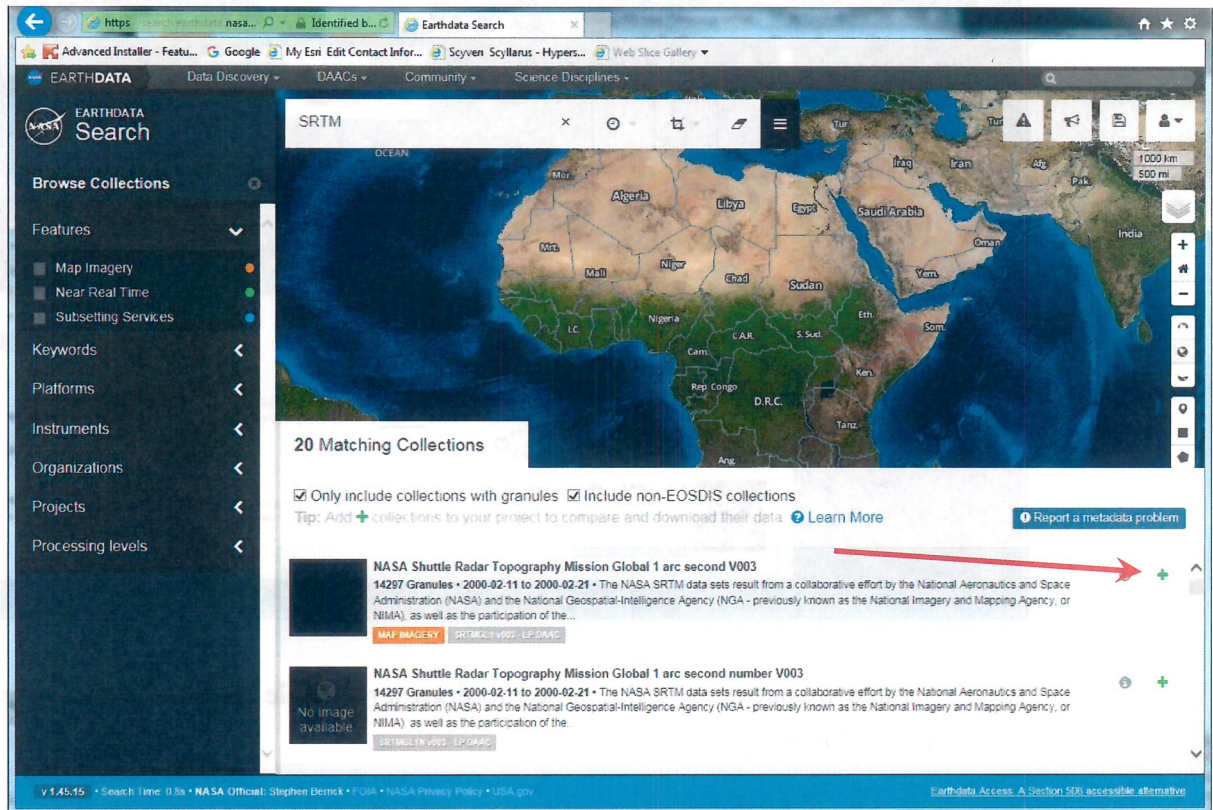
[I don't remember my username](#)
[I don't remember my password](#)
[Help](#)

The Earthdata Login provides a single mechanism for user registration and profile management for all EODIS system components (DAACs, Tools, Services). Your Earthdata login also helps the EODIS program better understand the usage of EODIS services to improve user experience through customization of tools and improvement of services. EODIS data are openly available to all and free of charge except where governed by international agreements.

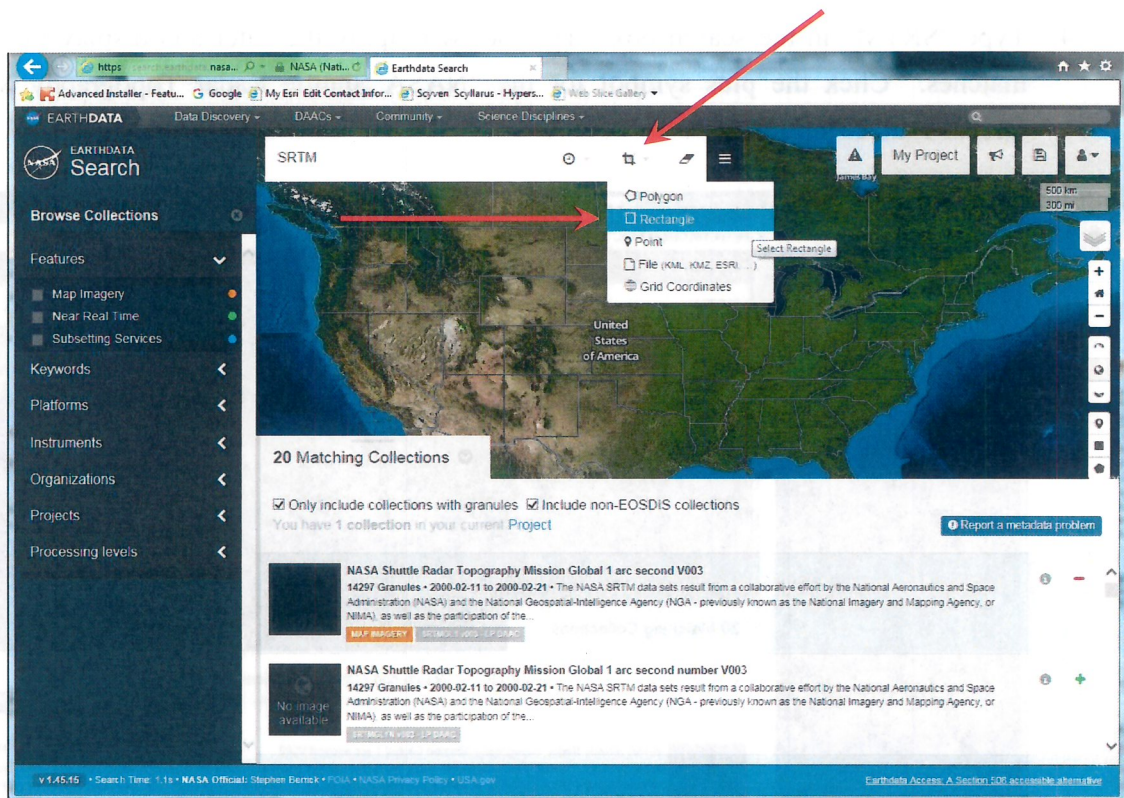
Get single sign-on access to all your favorite EODIS sites

REGISTER FOR A PROFILE

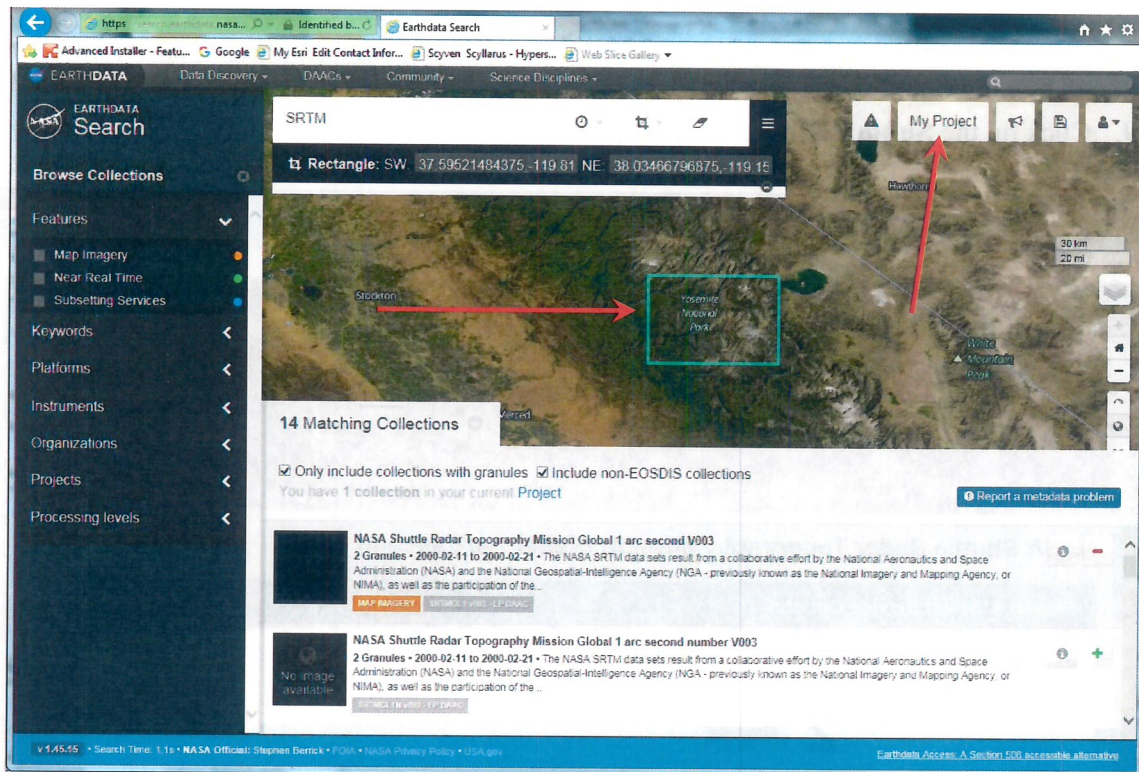
4. Type “SRTM” in the search box. The tool will apply the filter and display the SRTM matches. Click the plus symbol for the “NASA Shuttle Radar Topography Mission Global 1 arc second V003”.



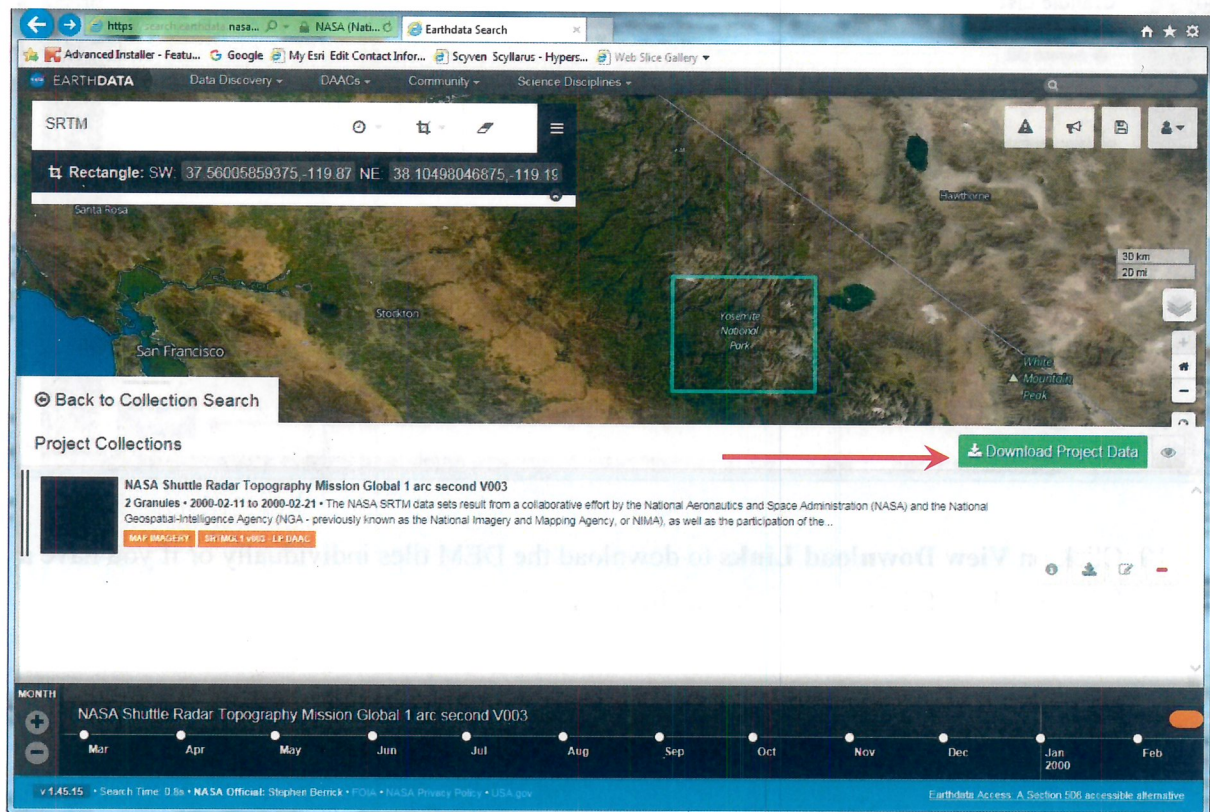
5. Click on the map area. Pan and zoom to the area of interest. The mouse wheel will zoom in and out. Holding the left mouse button down while moving the mouse will allow panning of the map.
6. Click on the **Spatial** drop down menu and select **Rectangle**.



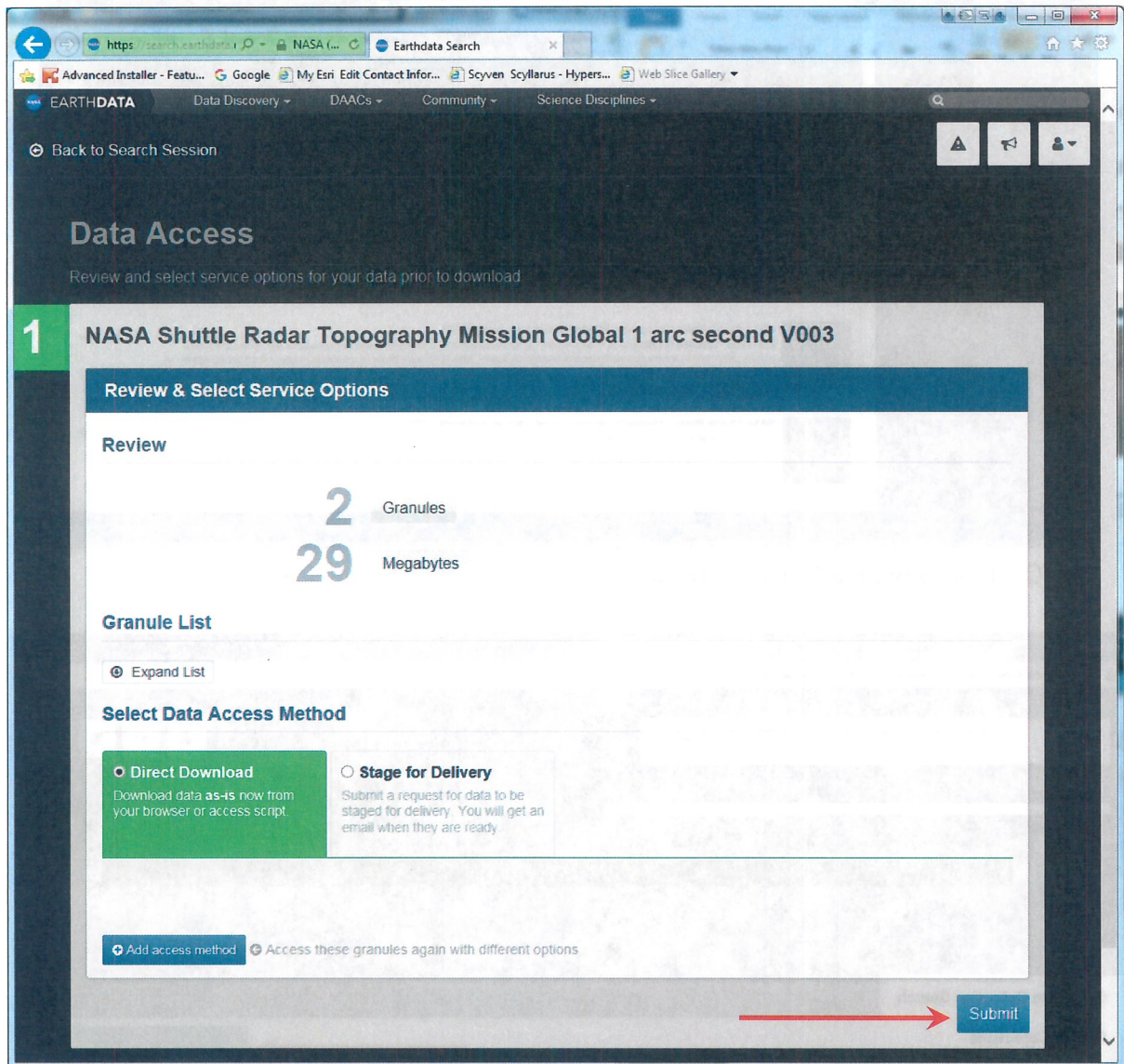
7. A cross hair will appear. Use the mouse to draw a rectangle around the area of interest. Then click on **My Project**.



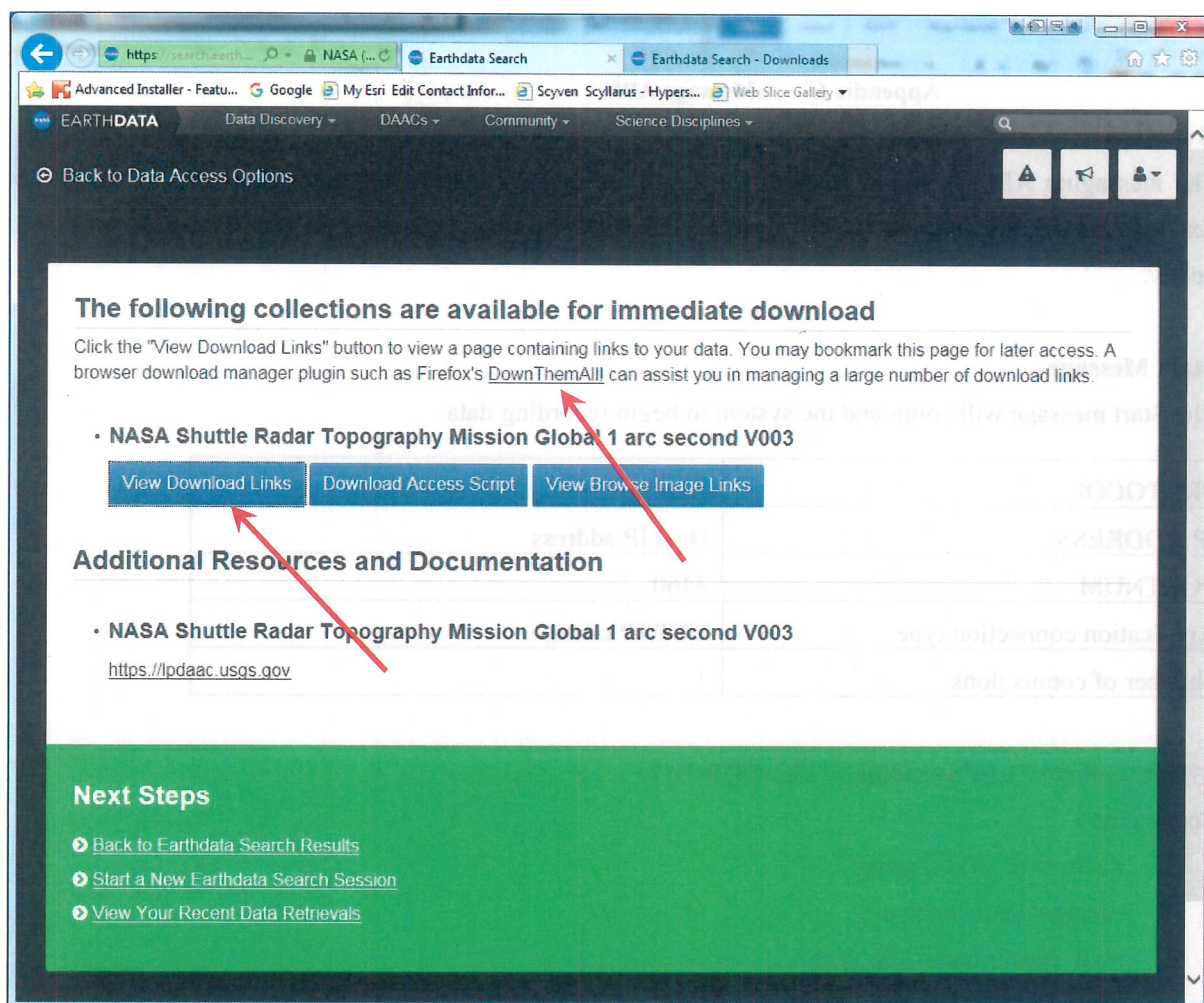
8. Click on Download Project Data.



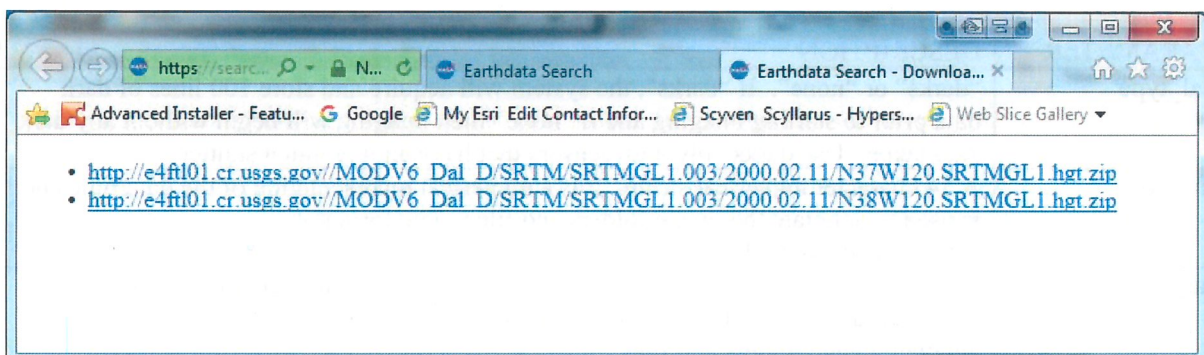
9. Click on the **Submit** button.



10. Click on **View Download Links** to download the DEM tiles individually or if you have a large number of tiles use the **DownThemAll!** utility.



11. Download the tiles individually by clicking on each tile. Unzip and load the tiles onto the SHARK. The SHARK's C drive has space to store the DEM tiles for the entire continental US.



Appendix C Message API

Overview

The messaging API sends and receives messages via sockets and the commands are defined using the Extensible Markup Language (XML) format. The XML message format for each command is described below.

Start Message

The Start message will command the system to begin recording data.

PROTOCOL	UDP
IP ADDRESS	Host IP address
PORTNUM	4460
Application connection type	UDP/IP client
Number of connections	1

```
<?xml version="1.0" encoding="ISO-8859-1"?>
```

```
<command>
```

```
  <sensor>2_HSI</sensor>
```

```
  <image>start</image>
```

```
  <cal_type>nones</cal_type>
```

```
  <mission>mission </mission>
```

```
  <target>target</target>
```

```
  <pass>pass</pass>
```

```
  <frames>100</frames>
```

```
</command>
```

PARAMETER	DESCRIPTION
cal_type	“darks” or “none”. If “darks”, the system will acquire and store 100 lines of dark data prior to starting imaging and if “none” then imaging will begin without any dark data taken. Use darks only with sensors that have an integrated shutter.
mission	A 14 character numerical string. It is a numerical representation of the data/time and is used to annotate the image folders and files. The format is YYYYMMDDHHMMSS.
target	A 3 character numerical string. The user can select and number between 000 and 999 to uniquely identify a target. If this is not used we enter 001. It is used to annotate image folders and files.
pass	A 3 character numerical string. The user can select and number between 000 and 999 to uniquely identify a target. It was intended to indicate a specific pass over the

	specified target. If this is not used we enter 001. It is used to annotate image folders and files.
frames	The number of frames to capture. This can be set to 0 to capture continuously until a stop message is sent.

Stop Message

The Stop message will command the system to stop recording data.

PROTOCOL	UDP
IP ADDRESS	Host IP address
PORTNUM	4460
Application connection type	UDP/IP client
Number of connections	1

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<command>
  <sensor>2_HSI</sensor>
  <image>stop</image>
</command>
```

Calibrate Message

The Calibrate message will command the system to take 100 lines of darks.

PROTOCOL	UDP
IP ADDRESS	Host IP address
PORTNUM	4460
Application connection type	UDP/IP client
Number of connections	1

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<command>
  <sensor>2_HSI</sensor>
  <image>calibrate</image>
  <cal_type>darks</cal_type>
</command>
```

Status Message

Clients shall be able to connect to the specified socket to receive the status messages.

PROTOCOL	UDP
IP ADDRESS	Host IP address
PORTNUM	4460
Application connection type	UDP/IP client
Number of connections	1

Request:

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<command>
  <sensor>2_HSI</sensor>
  <type>status</type>
</command>
```

Response:

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<status>
  <sensor>2_HSI</sensor>
  <time>20150925122552</time>
  <result>error</result>
  <code>900</code>
  <text>Controller is not responding</text>
</status>
```

PARAMETER	DESCRIPTION
time	Time is formatted as YYYYMMDDHHMMSS
result	Ready, busy, done, error.
code	102 Busy, Calibrating 104 Busy, Imaging 202 Done, Calibration Complete 204 Done, Imaging Complete 205 Done, Calibration Terminated 500 Ready 900 Error
text	Text message

Get Sensor Info Message

Clients shall be able to connect to the specified socket to receive the status messages.

PROTOCOL	UDP
IP ADDRESS	Host IP address
PORTNUM	4460
Application connection type	UDP/IP client
Number of connections	1

Request:

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<command>
  <sensor>2_HSI</sensor>
  <type>info</type>
</command>
```

Response:

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<info>
  <sensor>2_HSI</sensor>
  <serialNum>SN0024</serialNum>
  <modelNum>MN00342</modelNum>
  <pixels>680</pixels>
  <bands>60</bands>
  <wavelengths>400-1000</wavelengths>
  <exposure>10</exposure>
  <gain>0</gain>
  <frameRate>66</frameRate>
  <binningSpatial>2</binningSpatial>
  <binningSpectral>4</binningSpectral>
</info>
```

PARAMETER	DESCRIPTION
serialNum	Serial number
modelNum	Model number
pixels	Number of spatial pixels after binning

bands	Number of bands after binning
wavelengths	Wavelength range in nanometers
exposure	Integration time in micro seconds
gain	Gain value
frameRate	Frame rate
binningSpatial	Spatial binning
binningSpectral	Spectral binning

HSI Data Message

This message sends either raw binned data or calibrated data via a TCP/IP socket. The client connects to the TCP/IP server socket to receive the HSI image. If the system is configured to transmit radiometric data, then the data format is 32-bit floating point. If the system is configured for raw data then the format is unsigned 16-bit integer data. Imagery data is sent one frame at a time as band interleaved by pixel (BIP). As there is no header associated with this file, the user must know the spatial and spectral dimensions of the frame.

PROTOCOL	TCP
IP ADDRESS	Host IP address
PORTNUM	28888
Application connection type	TCP/IP client
Number of TCP/IP connections	1

Waterfall Data Message

The client opens a UDP socket to receive the RGB waterfall data. The waterfall data is 8-bit RGB data. One datagram packet is sent for each line of the image. Each packet includes a 12 byte header as follows:
RGB XXXXNNNN

- RGB - Indicates the start of the RGB packet
- XXXX – Total message size in bytes including 12 byte header.
- NNNN – Index to indicate the line sequence.

Following the header, the remainder of the message is the 8-bit RGB data.

PROTOCOL	UDP
----------	-----

IP ADDRESS	Group=230.0.0.3
PORTNUM	22060
Application connection type	UDP Multicast
Number of TCP/IP connections	Multiple

Histogram Data Message

The client opens a UDP socket to receive the histogram data. The histogram data represents the occurrence of the different DN values for one line. The data contains 256 increments evenly divided between 0 and the maximum DN value. Each packet has a 12 byte header as follows:
HISTXXXXMMMM

- HIST - Indicates the start of the histogram packet.
- XXXX - Total message size in bytes including 12 byte header.
- MMMM - Maximum DN value that can be represented in this data.

Following the header, the remainder of the data is unsigned shorts that represent the count of DN values from 0 to the maximum DN value.

PROTOCOL	UDP
IP ADDRESS	Group=230.0.0.3
PORTNUM	22066
Application connection type	UDP Multicast
Number of TCP/IP connections	Multiple

Parameters Message

Clients shall be able to get and set values for current parameters. This is accomplished by a client connecting to the TCP/IP socket server at the defined IP address and port number. The messages use the XML format as the message format. The parameters or properties consist of a name and value pair. Users are able to send multiple parameters in each message. Examples are shown below.
Name value pair:

```
<property name="vnir.rgb.red" value="40"/>
```

Get parameter value:

```
<?xml version="1.0"?>
<get>
  <property name="vnir.rgb.red"/>
</get>
```

Set multiple parameters:

```

<?xml version="1.0"?>
<set>
  <property name="vnir.rgb.red" value="40"/>
  <property name="vnir.rgb.green" value="30"/>
  <property name="vnir.rgb.blue" value="20"/>
</set>

```

PROTOCOL	TCP/IP
IP ADDRESS	Host IP address
PORTNUM	33026
Application connection type	TCP/IP client
Number of TCP/IP connections	Multiple

PROPERTY NAME	DESCRIPTION
vnir.rawData.save	true/false. Enable writing raw HSI data to disk.
vnir.calData.save	true/false. Enable writing calibrated HSI data to disk.
vnir.selectData.save	true/false. Enable writing selected HSI data to disk.
vnir.histogram.enable	true/false. Enable streaming histogram data to a socket.

vnir.imgFile.cor	The name of the current visNIR radiometric corrected image file.
vnir.imgFile.raw	The name of the current visNIR non-calibrated image file.
vnir.rgb.blue	Band number for the blue component of the visNIR waterfall.
vnir.rgb.green	Band number for the green component of the visNIR waterfall.
vnir.rgb.red	Band number for the red component of the visNIR waterfall.
vnir.waterfall.enable	true/false. Enable streaming RGB waterfall data to a socket.

