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JSATS Detector Software Manual

EY Choi
AE Flory
BL LaMarche
MA Weiland

June 2014

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Richland, Washington 99352

Preface

The Juvenile Salmon Acoustic Telemetry System (JSATS) software user's manual presented here describes the installation and use of the JSATS detector software. The software was developed for use with the JSATS cabled array system for detecting acoustic signals from acoustic micro-transmitters implanted in fish and digitizing the acoustic signal. A complementary manual describes the use of the decoder software used for decoding the digitized acoustic signals and recording the decoded information to file. This software was developed by the Pacific Northwest National Laboratory (PNNL) for the U.S. Army Corps of Engineers, Portland District (USACE) to assist with estimating dam passage survival and other performance measures stipulated by the 2008 Federal Columbia River Power System Biological Opinion (BiOp) and the 2008 Columbia Basin Fish Accords.

Many others made significant contributions to the development and testing of this software, including Tom Carlson, Daniel Deng, Tao Fu, Jayson Martinez, Tylor Abel, Yong Yuan, and Tom Seim.

Acronyms and Abbreviations

ADC	analog-to-digital converter
AGC	automated gain control
AMT	acoustic micro-transmitter
bwm	binary waveform
CSV or .csv	comma separated value
dB	decibel
DC	direct current
DIP switch	dual inline package switch
DSP	digital signal processor
FPGA	field programmable gate array
GB	gigabyte(s)
GHz	gigahertz
GMT	Greenwich Mean Time
GPS	global positioning system
GUI	graphical user interface
JSATS	Juvenile Salmon Acoustic Telemetry System
LED	light-emitting diode
mV	millivolt(s)
PC	personal computer
PCI	peripheral component interconnect
RMS	root mean square
SNR	signal-to-noise ratio
TOA	time of arrival
USACE	U.S. Army Corps of Engineers
UTC	Coordinated Universal Time
Vrms	volts root mean square

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1.0 Introduction

The Juvenile Salmon Acoustic Telemetry System (JSATS) detector is a software and hardware system that identifies and captures the encoded signals transmitted by JSATS acoustic micro-transmitters (AMTs), received on hydrophones, and output by the hydrophones to the processing hardware and software. The JSATS uses hydrophones arranged in arrays to transduce acoustic (pressure) signals propagating through water into electrical signals suitable for processing. The analog electrical signal out of a hydrophone is amplified and processed by an analog-to-digital converter (ADC) and digital signal processor (DSP) with a field programmable gate array (FPGA) board located in a computer. The ADC-DSP board digitizes the analog signal and processes the digital signal to determine if a possible AMT encoded signal is present. If a candidate JSATS AMT transmission is detected, the digitized waveform and a precise timestamp from the GPS board are saved to the computer for further analysis (Figure 1.1) where the signals can be processed to track fish in one, two, or three dimensions (McMichael et al. 2010; Deng et al. 2011; Weiland et al. 2011). This document describes the features and functions of the JSATS detector software.

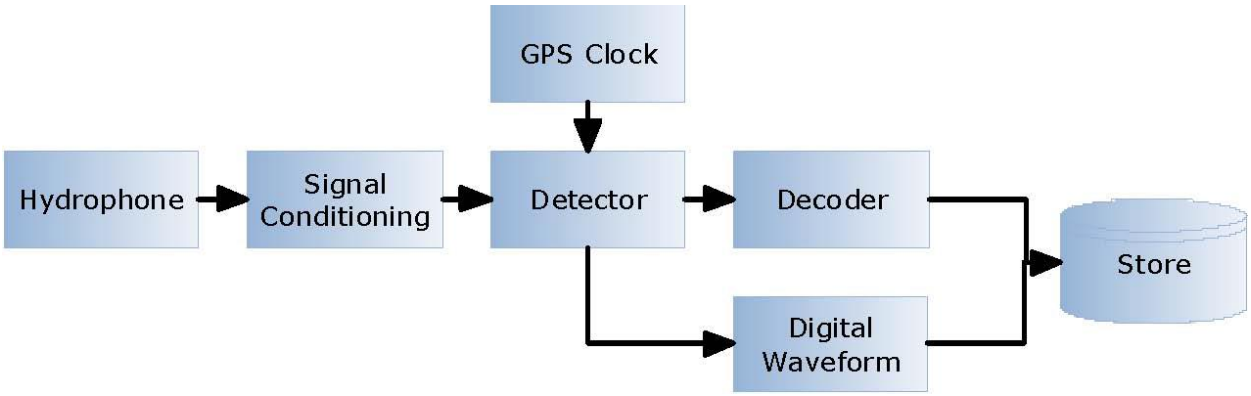

Figure 1.1. Flowchart Depicting the Flow of Data for the JSATS Cabled Receiver.

The JSATS cabled array is an integrated system of off-the-shelf and custom components (Figure 1.2) designed for detection and tracking of fish tagged with AMTs as they pass through the hydrophone array. This system was initially designed for use at hydroelectric facilities to track fish as they approach and pass the dam, but it can be adapted for many types of environments. The signal transmitted by the AMT implanted in a fish is detected by hydrophones deployed in known locations (surveyed position). This signal is amplified by the hydrophone(s), on which the signal is detected and passed through cables to a receiver where the signal is conditioned and further amplified. The signal is then passed to the DSP/FPGA board in the computer for signal verification and acceptance. The signal is paired with the time from the Global Positioning System (GPS) board to provide microsecond accuracy and then the data are written to disk as a binary waveform file (*.bwm*). If the JSATS decoder is running in the real-time mode and is able to keep up with the signals being written to disk, the file is opened, decoded, and the tag code decoded from the acoustic waveform is written to a *.csv* file for use in future analysis not described in this manual. If the real-time decoder is unable to keep up with the stream of incoming *.bwm* files or the data are not being decoded in real-time, the *.bwm* files can be decoded later during post-processing.

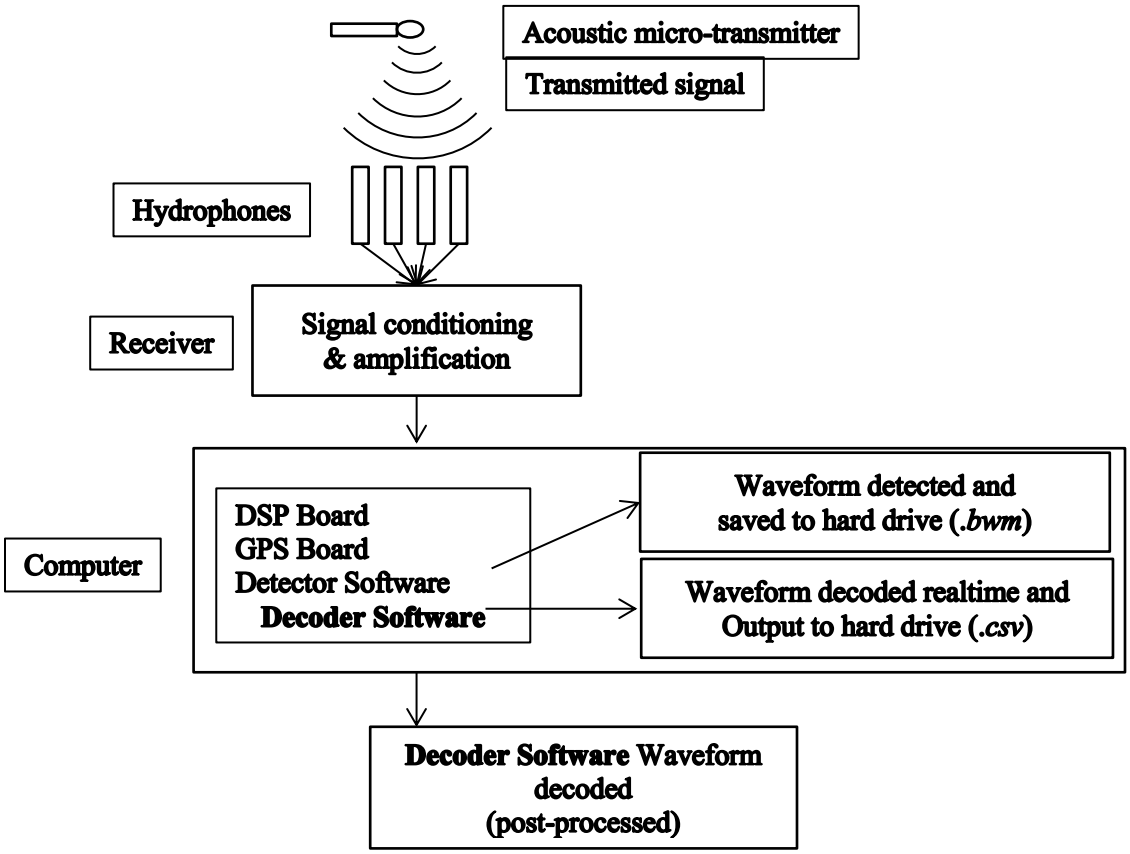

Figure 1.2. Structure of the JSATS Cabled Array System and JSATS Software.

Acoustic signals identified by the JSATS detector are digitized and saved to disk in a *.bwm* format. The signals are then decoded using the JSATS decoder software (explained in the JSATS Decoder Software Manual) into a list of potential JSATS AMT tag codes along with other descriptive data about the signal, including time of arrival (TOA) and signal-to-noise ratio (SNR). This field manual details the features and functionality of the JSATS detector software.

System requirements (Section 2.0) are presented first, followed by software installation instructions (Section 3.0), instructions for setting up and configuring the decoder (Section 4.0), and decoding process initiation (Section 5.0). Section 6.0 explains data and file formats for raw binary waveforms and comma separated value *(.csv*) files that contain root mean square (RMS) values are described.

2.0 System Requirements

The JSATS detector is designed to run with the minimum system requirements described below.

2.1 Hardware Requirements

The minimum computer requirements are listed in Table 2.1.

Table 2.1. Minimum Computer Requirements for Operation of the JSATS Detector with GPS and P25M2 DSP Boards.

	Minimum	Recommended
Processor	Pentium IV	2 GHz multicore or greater
RAM	1 GB	4 GB or greater
Disk Space Installation	2.5 GB	2.5 GB
PCI-X slots	3	3

Additional disk space is required for acquisition of raw *.bwm* files and storing decoded waveform data. The amount of hard drive space needed depends on the number of *.bwm* files being acquired and decoded and the data stored in the individual *.csv* files.

2.2 Operating System Requirements

- Windows 7 (32- or 64-bit)
- Windows XP (Service Pack 2 or 3)

2.3 Required Utility Packages

- **.net Framework 4.0** – (http://www.microsoft.com/download/en/details.aspx?id=17718) – link accessed on December 12, 2012. This software installs the .net Framework files needed to run and support the detector. It includes runtime routines for software support.
- **Meinberg Radio Clock Monitor v3.06.99.10** (dkwin-3-06-99-10.exe or newer version), can be downloaded from the Meinberg Software Download website at: http://www.meinbergglobal.com/english/sw/ (link accessed on January 3, 2013). This software integrates with the Meinberg GPS 170PCI board to provide accurate time synchronization with the signal receivers and systems.
- **P25M Innovative Integration software Version 1.25** – This software can be downloaded from the Innovative Integrations website at: http://www.innovative-dsp.com/support/installfromwebWindows.htm (link accessed on January 3, 2013). Using the Web Product Installer utility, the latest versions of the software tool sets and their documentation are retrieved and saved to the hard drive.

3.0 Installation

To install and use the JSATS detector, the three software packages listed above in Section 2.3 need to be installed on the acquisition computer prior to installing the Innovative Integration P25M2 DSP boards into the computer.

3.1 Required Utility Software Installation

The required utility packages are installed as described below.

3.1.1 .net Framework 4.0

The .net Framework 4.0 software is installed on the JSATS acquisition computer without any configuration needed.

3.1.2 Meinberg Radio Clock Monitoring Software and Board Installation

The Meinberg Radio Clock Monitoring software will need to be configured to operate properly with the Meinberg GPS 170PCI board, to provide the correct time to the Innovative Integration P25M2 DSP boards, and to timestamp the acquired signal. Follow the steps below to properly install and configure the GPS board and software.

1. On the Meinberg 170PCI board set dual inline package (DIP) switch 9 to ON and all other DIP switches to OFF.
2. With the computer off, install the GPS board into PCI-X slot 1 and boot up the computer.
3. Install the self-extracting Meinberg software by double-clicking the executable file.
4. After installation is completed reboot the computer.
5. Double-click the Meinberg icon on the desktop to open the program for configuration.
6. Click *Setup* in the upper left corner of the graphical user interface (GUI) and Select *Reference Time* and click "GPS170PCI v1.10…" as the reference time.
7. Select the *Timezone* tab on the lower half of the GUI.
    a. The preference is to set the *Time Scale* to coordinated universal time (UTC)/local.
    b. Set the *Daylight savings not active* and *Daylight savings active* references.
    c. Set the time *Offset* relative to Greenwich Mean Time (GMT).
    d. In the *Daylight Savings* group box set the *Beginning* and *End* day, date, month, and time for daylight savings time.
    e. Leave *calculated* option box selected to keep this for every year.
    f. Select *Save.*
8. Select the Pulses tab on the lower half of the GUI.
    a. In the *Enable Output Signals* group box select *Fixed Freq* combo box and set it to *always*.

b. In the *Enable Output Signals* group box select *Pulses* combo box and set it to *after sync*.

c. On the *Out3* tab within the Pulses Tab set *Function* to *DCF77 Marks* and *timeout* to "0" [min].

3.1.3 P25M Innovative Integration Software Installation

The Innovative Integration software and drivers need to be installed on the data acquisition computer prior to installation of the DSP boards. Follow the steps below to properly install and configure the DSP boards.

1. Open the CD provided by Innovative Integration, Version 4.53 with the Innovative Integration P25M drivers.
2. In the () folder, right-click on *Setup.bat* and select *Run as Administrator*. Note: this installation can take a long time to complete.

   a. A command prompt will open and run the setup batch file (Figure 3.1).

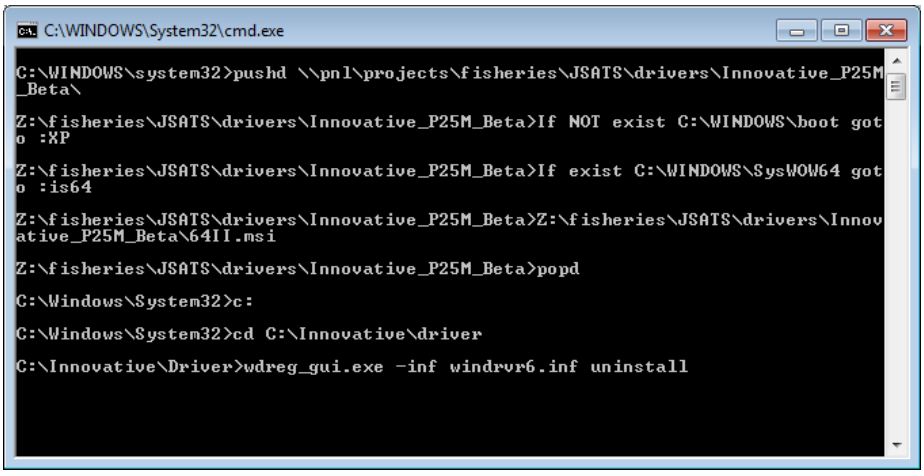

Figure 3.1. Command Prompt Running Setup Batch File.

   b. The first thing to install will be the Jungo Jungo drivers. Click *Install* (Figure 3.2).

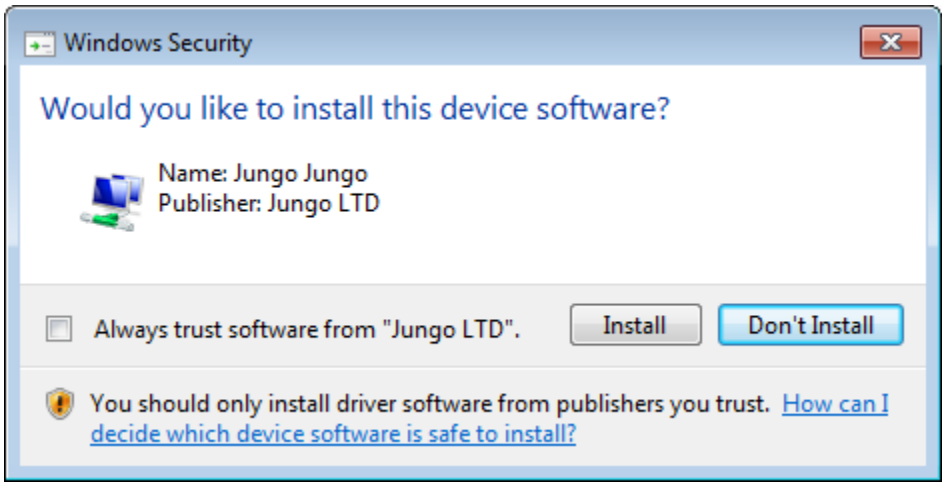

Figure 3.2. Installation of Drivers, Security Warning.

c. After installation of the drivers, continue with the MalibuRED Installation by clicking *Install MalibuRED* from the Innovative Integration Installer (Figure 3.3). Two other windows will appear and close during this installation (Figure 3.4 and Figure 3.5).

Figure 3.3. Main Installation Menu for Installation of the P25M2 DSP Boards.

Figure 3.4. Malibu RED Installation progress Bar During Installation of the Files for the P25M2 DSP Boards.

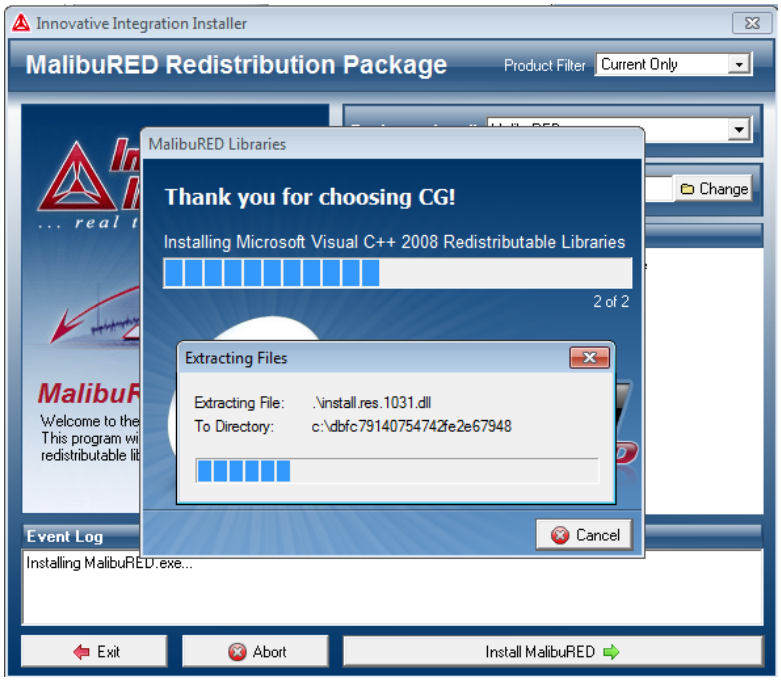

Figure 3.5. Second Popup Window During the MalibuRed Installation Process for Visual C++ Installation.

d. When the installation is complete, a dialog box will appear, verifying completion of the installation process and requesting a reboot of the computer (Figure 3.6). Select *Shutdown Now*.

Figure 3.6. Installation Complete Dialog Requesting Shutdown of the Computer.

3. After the computer is shut down, unplug the power to the computer for installation of the boards.

3.2 GPS and DSP Board Installation

The first step in installing the peripheral component interface (PCI) boards in the personal computer (PC) is to insert both the Innovative P25M2 DSP and Meinberg GPS boards into the appropriate sockets in the PC chassis. Follow the instructions below to install the PCI boards.

1. Find three empty PCI slots closest to the power supply.
2. Plug the GPS board into the PCI slot closet to the power supply.
3. Plug each board of the DSP boards into the next two PCI slots.
4. Close the computer case and screw in any remaining screws.
5. Plug the computer in and turn it on.

3.3 Detector Software Installation

This section explains the installation of the detector software without and with Auto Restart for 32- and 64-bit computer operating systems. The available detector formats are as follows:

- Without Auto Restart:
  - 32-bit System: JSATSSetup_3_1_2_0_x86.msi
  - 64-bit System: JSATSSetup_3_1_2_0_x64.msi
- With Auto Restart:
  - 32-bit System: JSATSAutorestart_1_1_0_0_x86.msi
  - 64-bit System: JSATSAutorestart_1_1_0_0_x64.msi.

Start installation of the JSATS detector by choosing the version of the software that is compatible with the computer system and whether the Auto Restart feature is preferred or not. Locate the preferred

software installer package and double-click on the file name to initiate the JSATS detector installation process (Figure 3.7).

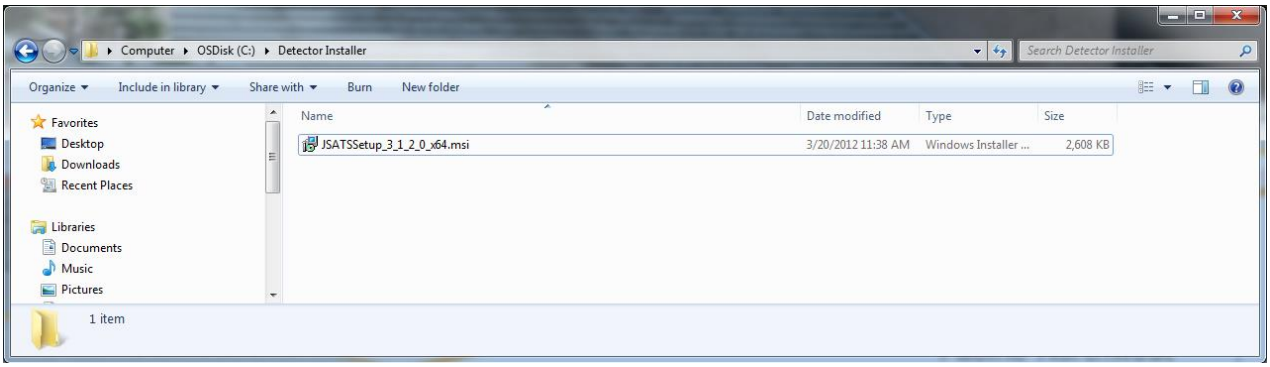

Figure 3.7. To Begin Installation Double-Click on the JSATS Installer Package.

The JSATS Detector Setup Wizard will guide the user through the series of steps required to install the detector on the computer (Figure 3.8. To Begin Installation Double-Click on the JSATS **Installer** Package.

Figure 3.8. To Begin Installation Double-Click on the JSATS Installer Package.

The first step of installation is for the user to identify the folder in which to install the detector. The default location for the installation folder is shown in the Select Installation Folder dialog box (Figure 3.9). Enter the installation location in the folder text box, or browse and select the designated folder location. Select the appropriate user option button to choose whether or not the JSATS detector will be available for others that may use the computer. Continue the installation process by clicking *Next*.

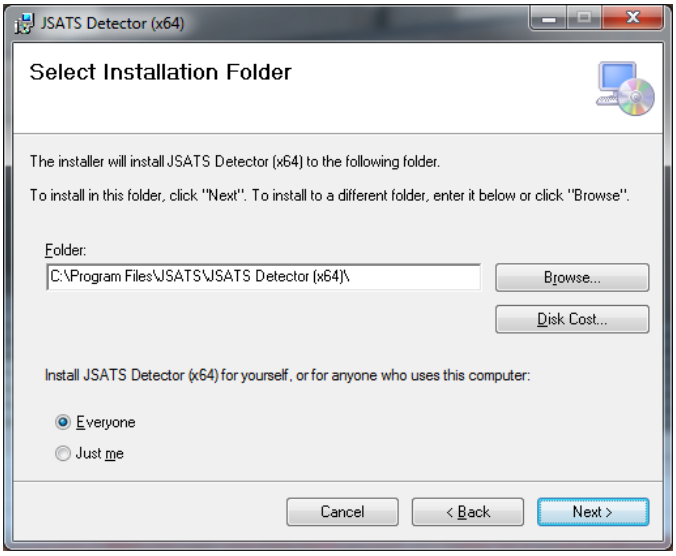

Figure 3.9. Select the Folder Installation Location for the JSATS Detector (first install screen).

The Select Installation Folder dialog box will close and the Confirm Installation dialog box will open (Figure 3.10). Click *Next* to confirm the JSATS detector installation.

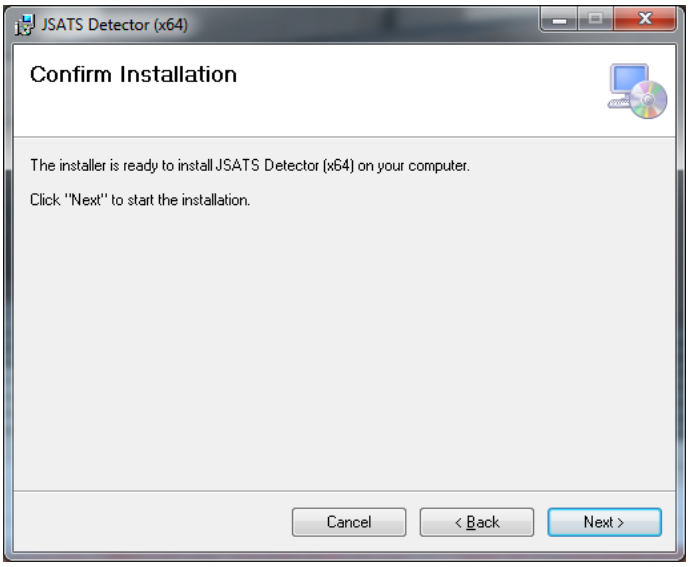

Figure 3.10. Select the Next Button in the Confirm Installation Dialog Box to Initiate the Install Process (second install screen).

The status of the detector installation progress will be indicated by the progress bar shown in the Installing JSATS Detector Dialog Box (Figure 3.11).

When installation is complete, select *Next*.

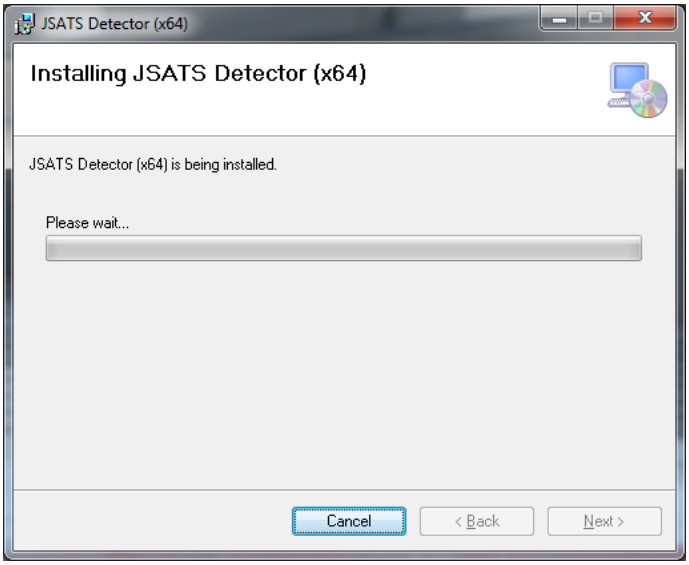

Figure 3.11. Installation Progress is Indicated in the Installing JSATS Detector Dialog Box by the Progress Bar (third install screen).

A new dialog box will open indicating the successful installation of the JSATS detector (Figure 3.12). Select *Close* to complete the installation process.

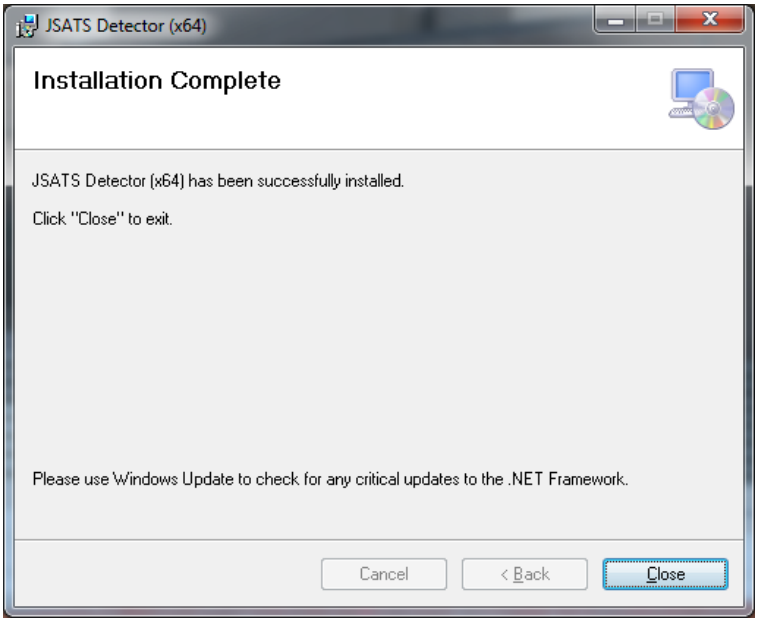

Figure 3.12. The Successful Installation of the JSATS Detector Will Be Indicated in the Installation Complete Dialog Box (final install screen).

4.0 JSATS Detector Software Interface

This section covers the setup and use of the JSATS detector without Auto Restart (with Auto Restart is explained in Section 4.4). The user interface consists of a File menu, four control buttons, and three main tabs: *Configure*, *Capture*, and *Voltage Control* (Figure 4.1). Each component of the interface is described in this section.

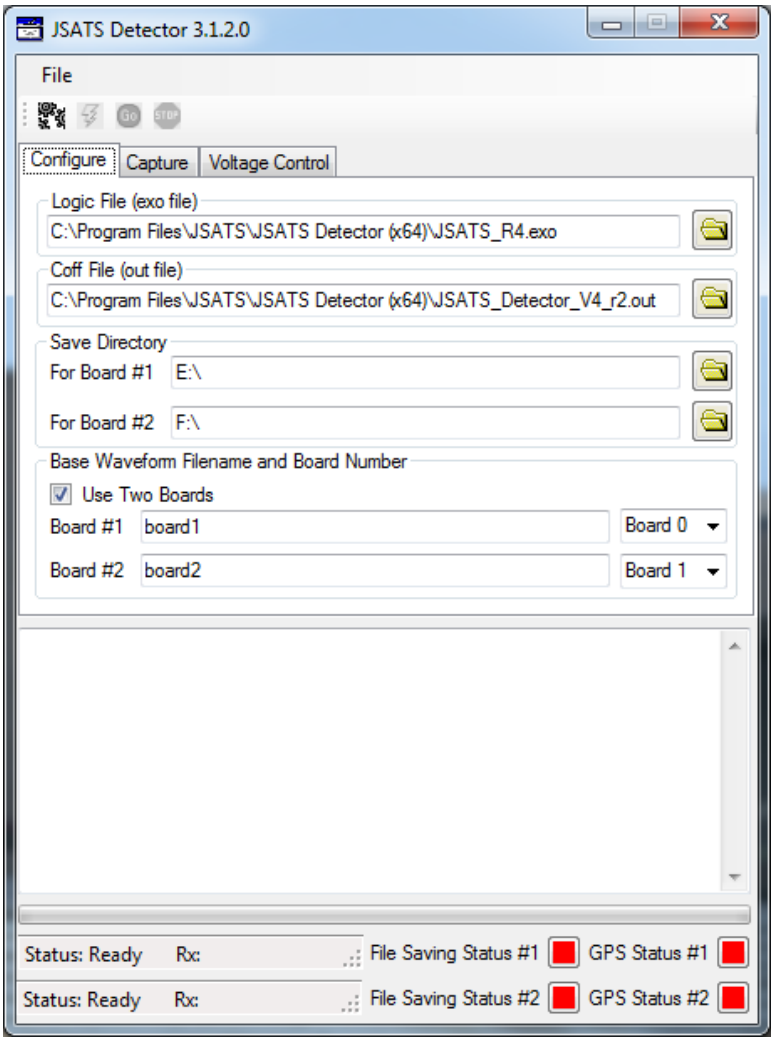

Figure 4.1. JSATS Detector Window and Three Main Tabs; Configure, Capture and Voltage Control.

4.1 File Menu

The File menu allows the user to save or load a settings file from the dropdown menu (*.ini* file) (Figure 4.2). The settings file contains the configuration settings and naming the user sets up in the software. The last file settings used are saved as the default so it is not necessary to configure the detector each time the program is loaded unless changes are needed.

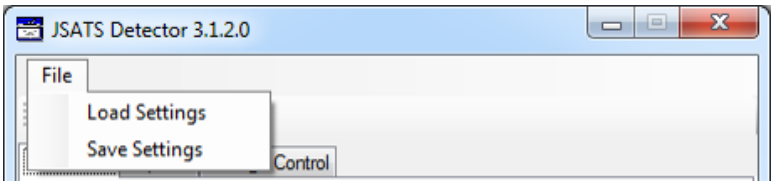

Figure 4.2. The Dropdown File Menu in the JSATS Detector Startup Window Allows Settings to Be Loaded or Saved.

4.2 Configure Settings

The Configure tab allows for the selection of the detector configuration parameters and the naming of the files and directories and locations where the *.bwm* data files will be saved (Figure 4.1).

4.2.1 Logic File (exo file)

The logic file is used to load code to the FPGA on the DSP board. The default logic file for the JSATS decoder is *JSATS_R4.exo*.

4.2.2 Coff File (out file)

The coff file is used to load code to the DSP on the DSP board. The default coff file for the JSATS decoder is *JSATS_Detector_V4_r2.out*.

4.2.3 Save Directory

The Save Directory section allows users to select the location (hard drive and directory) where data received by the signal processing boards will be saved. If two signal processing boards are installed in the computer running the JSATS detector, the data from the two boards should be saved in separate directories; an example is provided in Figure 4.3, where the directory name includes the drive letter, location of data acquisition (i.e., dam), computer system name, and the detection board (i.e., CH12 = channels 1 and 2; CH34 = channels 3 and 4).

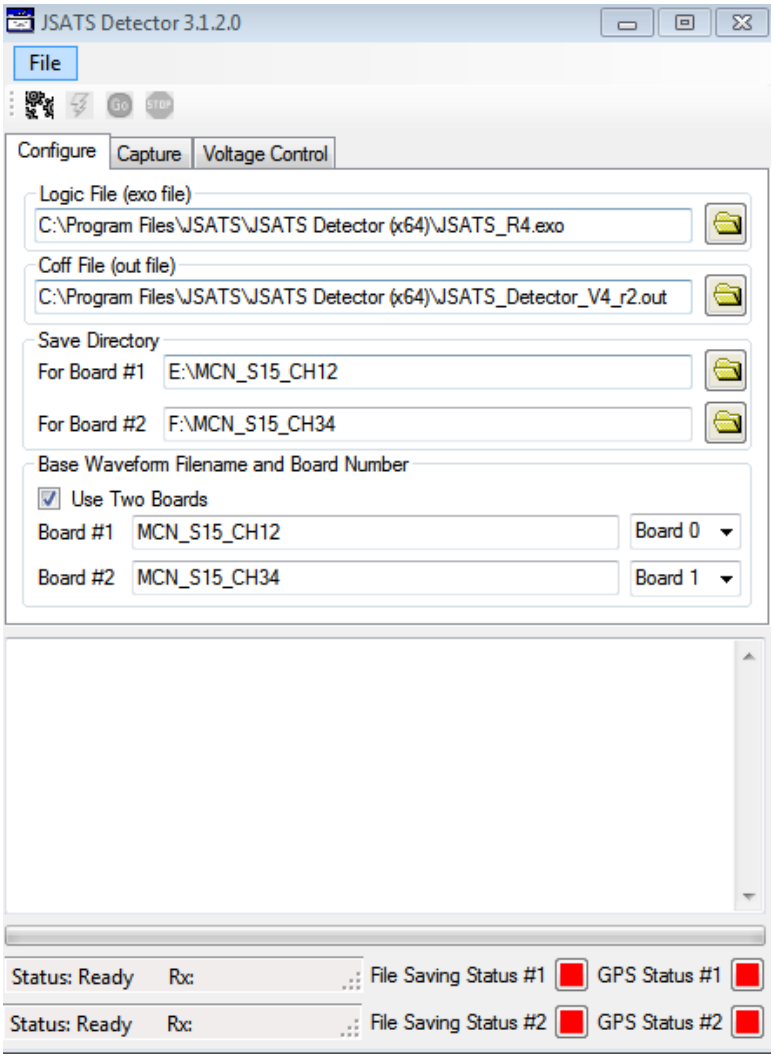

Figure 4.3. Example of the Save Directory and Base Waveform Filename Sections of the Configure Tab Populated with Variable Names.

4.2.4 Base Waveform Filename and Board Number

The Base Waveform Filename and Board Number section allows users to specify whether one or two boards will be used by the detector for data acquisition. If the check box is selected the detector will use two boards, otherwise one board will be used. Users may also specify which DSP/FPGA board will be Board 0 and which will be Board 1, and select the desired base waveform filename. This name typically identifies the location (i.e., dam) on which the JSATS receiving array is deployed and the location of the hydrophones connected to the DSP/FPGA boards within the receiving array (see example in Figure 4.3).

4.3 Capture Settings

The items in the Capture tab of the JSATS detector permit the user to name receiving channels for each hydrophone, adjust threshold settings, and to observe RMS noise and direct current (DC) voltage

levels for each hydrophone (Figure 4.4). Settings for each designation are discussed in the following subsections.

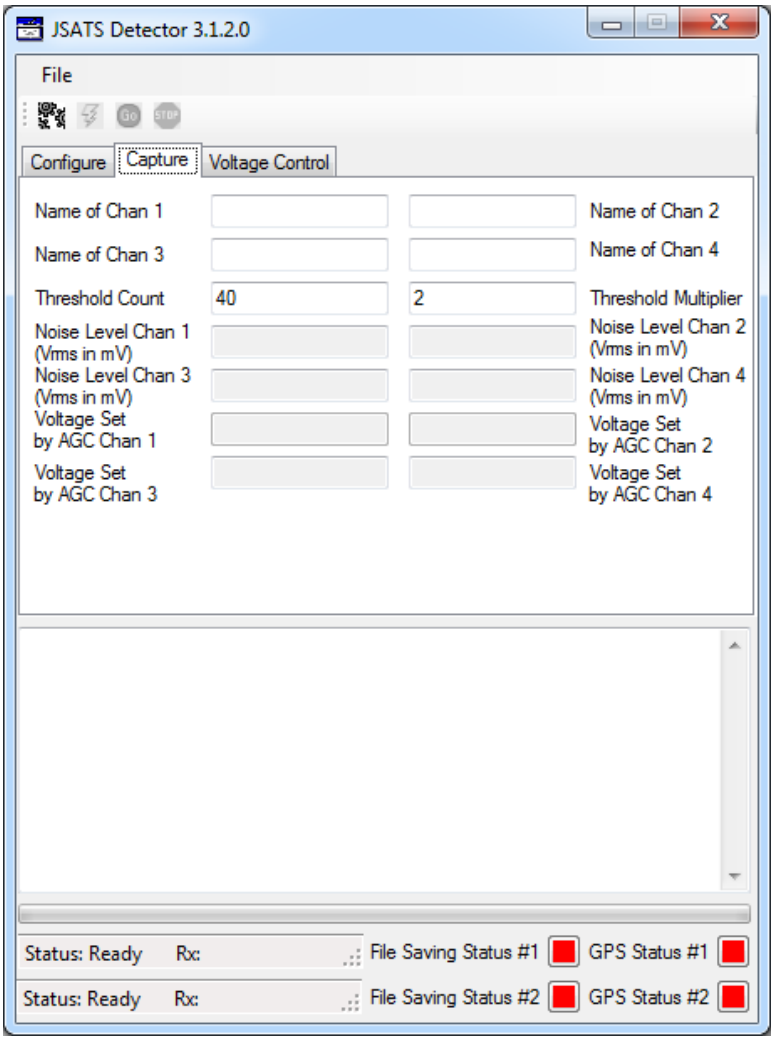

Figure 4.4. The Capture Tab in the JSATS Detector Startup Window Allows the User to Select Settings and Track Capture Status.

4.3.1 Channel Naming

Depending upon the number of boards installed in the PC and in operation, up to four channels (hydrophones) can be processed by a single computer. Each channel can be assigned a unique name in the Name of Chan # text box. The name assigned to each of the channels is included in the output file of the JSATS decoder for unique identification of the hydrophone on which the signal was detected. Examples are provided in Figure 4.5, where for Channel 1, the first 'S'=spillway, 15_16=on pier between spill bays 15 and 16, and second S=hydrophone is shallow.

- **Name of Chan 1**: Identifies signals detected on Channel 1 in the saved files.
- **Name of Chan 2**: Identifies signals detected on Channel 2 in the saved files.
- **Name of Chan 3**: Identifies signals detected on Channel 3 in the saved files.

- **Name of Chan 4**: Identifies signals detected on Channel 4 in the saved files.

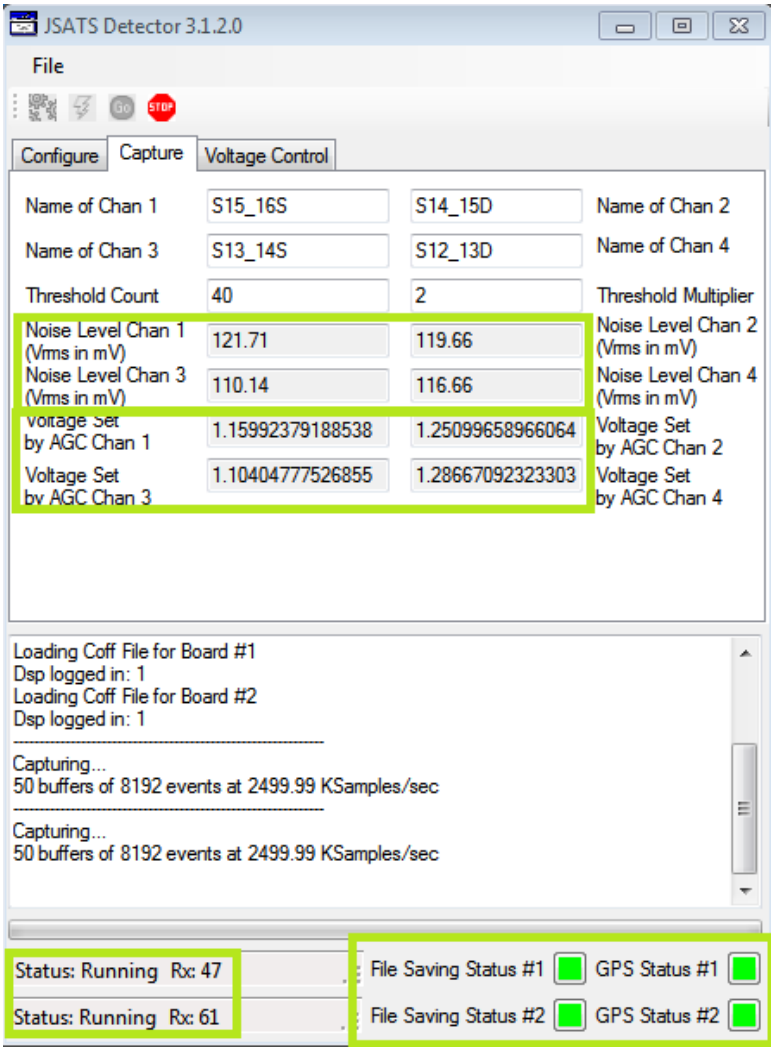

Figure 4.5. Examples of Channel Naming in the Capture Tab. Display of status values for individual hydrophones and the system are outlined with green boxes.

4.3.2 Threshold Settings

- **Threshold Count**: The Threshold Count setting is one of the variables in the cross-correlation filter used in evaluating whether an incoming signal meets the criteria of a JSATS acoustic tag and the signal should be saved to the hard drive. The default value for the threshold count setting is 40. The settings have been extensively tested. If changes are made to the threshold values, the changes should be evaluated.

- **Threshold Multiplier**: The Threshold Multiplier setting is one of the variables in the cross-correlation filter used to evaluate whether the incoming acoustic signal is a specific multiplier above the acoustic noise floor. The default value of the multiplier is 2. This setting has been extensively tested. If changes are made to the threshold values, the changes should be evaluated.

4.3.3 Noise Level

The Noise Level (i.e., volts root mean square [Vrms]) is a calculation of the background noise floor in millivolts (mV) for each channel. The background noise level range the system maintains is configured in the Voltage Control tab as described in Section 4.4.

- **Noise Level Chan 1 (Vrms in mV)**: The value that appears in this menu item when the detector is operating indicates the background noise level of incoming signals on Channel 1.
- **Noise Level Chan 2 (Vrms in mV)**: The value that appears in this menu item when the detector is operating indicates the background noise level of incoming signals on Channel 2.
- **Noise Level Chan 3 (Vrms in mV)**: The value that appears in this menu item when the detector is operating indicates the background noise level of incoming signals on Channel 3.
- **Noise Level Chan 4 (Vrms in mV)**: The value that appears in this menu item when the detector is operating indicates the background noise level of incoming signals on Channel 4.

4.3.4 Voltage Set

The Voltage Set is the monitored amount of gain provided to the incoming signal through the automated gain control (AGC) feedback loop. The range is 0 to 2 volts gain with every 0.5 volt equivalent to 20 dB gain.

- **Voltage Set by AGC Chan 1**: The value that appears in this menu item when the detector is operating indicates the current DC level output controlled by the automated gain control for Channel 1.
- **Voltage Set by AGC Chan 2**: The value that appears in this menu item when the detector is operating indicates the current DC level output controlled by the automated gain control for Channel 2.
- **Voltage Set by AGC Chan 3**: The value that appears in this menu item when the detector is operating indicates the current DC level output controlled by the automated gain control for Channel 3.
- **Voltage Set by AGC Chan 4:** The value that appears in this menu item when the detector is operating indicates the current DC level output controlled by the automated gain control for Channel 4.

4.4 Voltage Control Settings

This Voltage Control tab allows the user to set the output values for the AGC. The user also may manually set gain voltage values and determine whether to record RMS background noise level values.

4.4.1 Voltage Control 1

The settings within the Voltage Control 1 menu (Figure 4.6) control the automated gain settings for the two receiving channels of DSP Board 1.

- **DC Voltage Chan 1**: The value assigned in this box sets the initial DC voltage for Channel 1 when operating in AGC mode. When operating manually, it is the assigned setting for manual control of the DC voltage .
- **DC Voltage Chan 2**: The value assigned in this box sets the initial DC voltage for Channel 2 when operating in AGC mode. When operating manually, it is the assigned setting for manual control of the DC voltage.
- **Min Vrms in mV Chan 1**: This box is used to set the lower-bound noise level for Channel 1 when operating in AGC mode.
- **Max Vrms in mV Chan 1**: This box is used to set the upper-bound noise level for Channel 1 when operating in AGC mode..
- **Min Vrms in mV Chan 2**: This box is used to set the lower-bound noise level for Channel 2 when operating in AGC mode..
- **Max Vrms in mV Chan 2**: This box is used to set the upper-bound noise level for Channel 2 when operating in AGC mode.

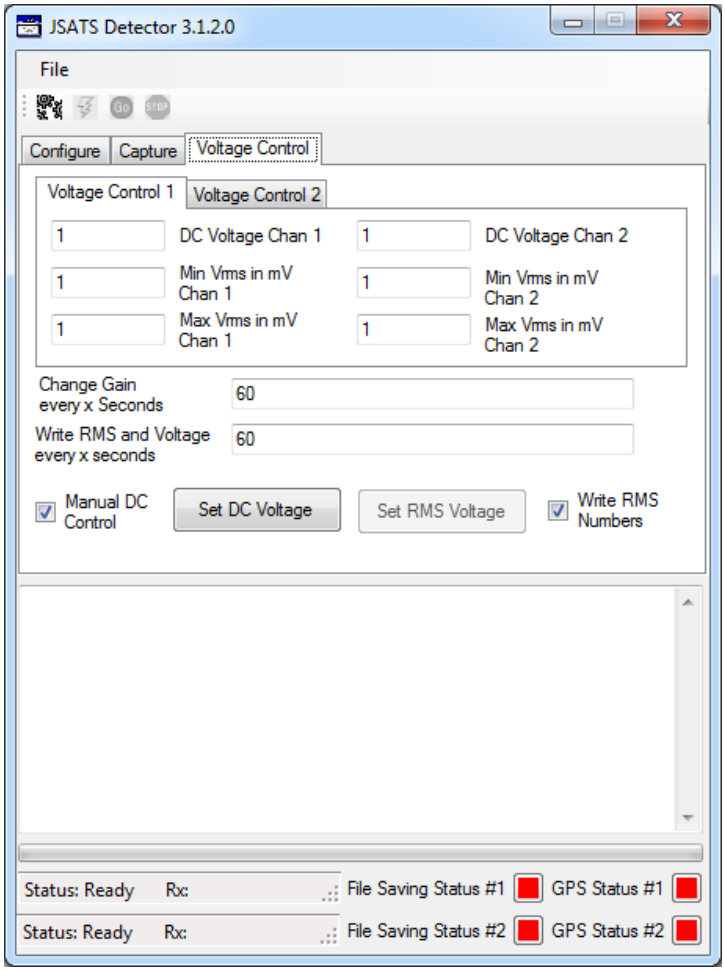

Figure 4.6. The Voltage Control 1 Tab in the Voltage Control Section of the JSATS Detector Window Allows Parameter Modifications for the Receiving Channels of DSP Board 1.

4.4.2 Voltage Control 2

The settings within the Voltage Control 2 menu (Figure 4.7) control the automated gain settings for the two receiving channels of DSP Board 2.

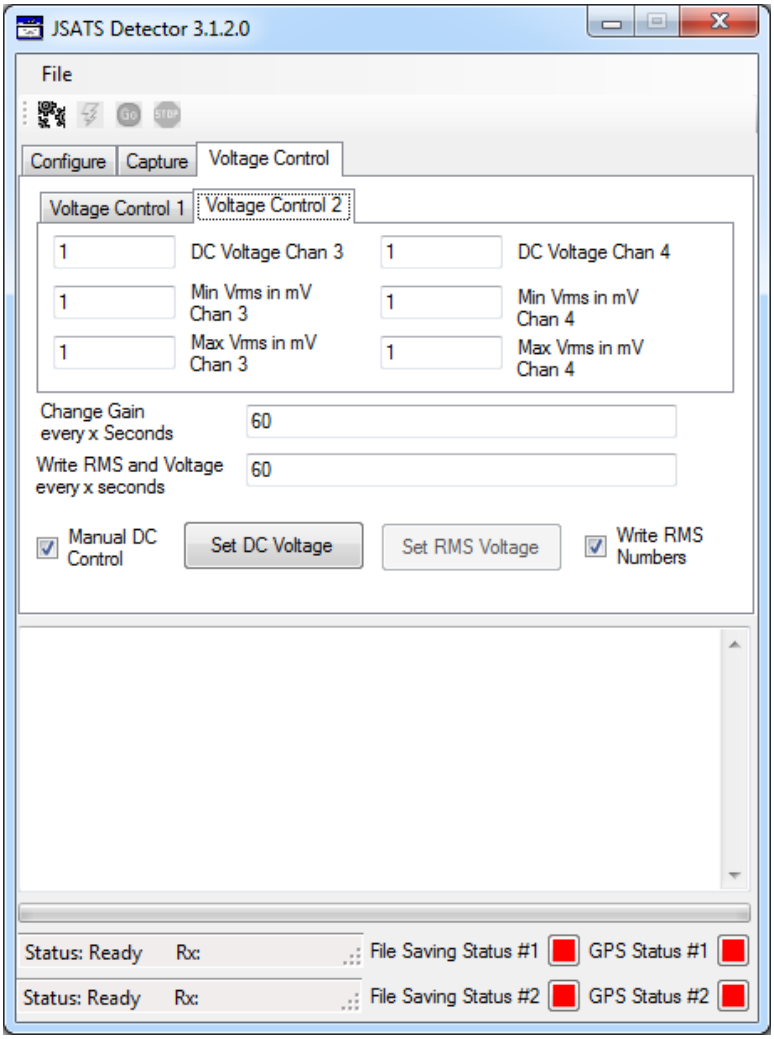

Figure 4.7. The Voltage Control 2 Tab in the Voltage Control Section of the JSATS Detector Window Allows Parameter Modifications for the Receiving Channels of DSP Board 2.

- **DC Voltage Chan 3**: The value assigned in this box sets the initial DC voltage for Channel 3 when operating in AGC mode. When operating manually, it is the assigned setting for manual control of the DC voltage.
- **DC Voltage Chan 4**: The value assigned in this box sets the initial DC voltage for Channel 4 when operating in AGC mode. When operating manually, it is the assigned setting for manual control of the DC voltage.
- **Min Vrms in mV Chan 3**: This item is used to set the lower-bound noise level for Channel 3 when operating in AGC mode.

- **Max Vrms in mV Chan 3**: This item is used to set the upper-bound noise level for Channel 3 when operating in AGC mode.
- **Min Vrms in mV Chan 4**: This item is used to set the lower-bound noise level for Channel 4 when operating in AGC mode.
- **Max Vrms in mV Chan 4**: This item is used to set the upper-bound noise level for Channel 4 when operating in AGC mode.

4.4.3 Automated Gain Control

Automated gain control selections are found in both the Voltage Control 1 and Voltage Control 2 tabs.

- **Manual DC Control Check box**: By checking the "Manual DC Control" box the user selects manual DC control. If unchecked, the automated DC control is activated.
- **Change Gain every x seconds**: The value entered into this box determines how often the AGC will change the DC control level.
- **Set DC Voltage button**: The "Set DC Voltage" button allows the user to set the DC level when the detector is being operated in manual mode.
- **Set RMS Voltage button**: The "Set RMS Voltage" button allows the user to set and update the upper and lower bound of the RMS voltage for the AGC.

4.4.4 RMS and Voltage Recording

RMS and Voltage Recording selections are located in both the Voltage Control 1 and Voltage Control 2 tabs.

- **Write RMS and Voltage every x seconds**: The value entered here determines how often the RMS and DC voltages are recorded to a *.csv* file, if the "Write RMS Numbers" box is checked.
- **Write RMS Numbers Check box**: If the Write RMS Numbers box is checked, RMS and DC voltage values will be recorded and saved. If left unchecked, the values will not be saved.

4.5 Auto Restart Controls

The information provided in this section is available only in the versions of the JSATS detector that have the automatic restart feature. This feature was added to allow for automatic restart of acquisition computers at locations where there are sporadic power outages and where the location means the systems cannot be monitored frequently.

4.5.1 File Menu

The JSATS Auto Restart file dropdown menu (Figure 4.8) allows settings to be loaded and saved as well as enables automatic restart of the detector and the capacity to edit the restart time.

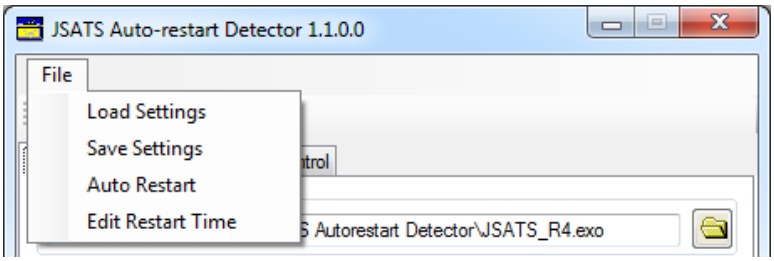

Figure 4.8. The File Menu for the JSATS Auto Restart Detector Function.

4.5.2 Enabling Auto Restart

The Auto Restart function for the detector is enabled by checking the *Auto Restart* option in the file dropdown menu, as shown in Figure 4.9.

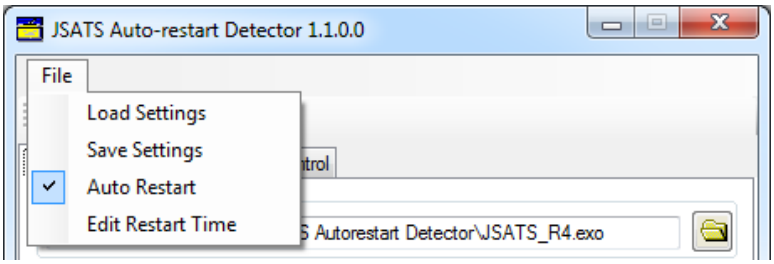

Figure 4.9. The Detector Auto Restart File Menu Showing the Auto Restart Function Enabled.

4.5.3 Edit Restart Time Option

Selecting *Edit Restart Time* allows the user to set the delay interval in minutes before the JSATS detector will automatically restart in the event of a hardware failure (Figure 4.10).

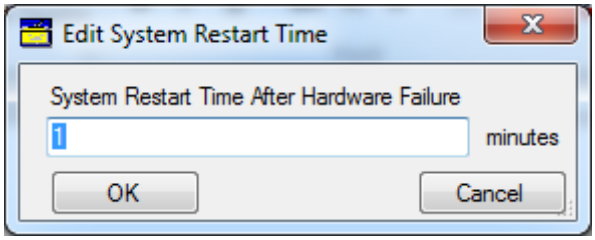

Figure 4.10. The Edit System Restart Time Dialog Box.

5.0 Detection of Candidate JSATS Tag Signals

During normal operation, the JSATS detector takes packets of data that may contain candidate JSATS tag signals from the outputs of the DSP boards and stores them in *.bwm* files on the computer's hard drive. This operation, which can occur up to approximately 20 times per second per board, should not be interrupted without good cause. Because there are few differences between versions, operation for both versions of the JSATS detector are explained in this section.

5.1 Starting JSATS Tag Detection

To initiate detection, load the coefficient file by clicking the button on the far left hand side of the toolbar located near the top of the JSATS detector window (Figure 5.1).

Figure 5.1. Select the Coefficient File by Choosing the Gear Icon Button Found in the Detector Toolbar Located near the Top of the JSATS Detector Window.

When the gear icon button is clicked, the coff file described earlier (Section 4.1.3) will load the DSP code. When the coff file is loaded, the second button showing the lightening icon will be enabled. Selecting the lightening icon will initiate the loading of the exo file (Section 4.1.2), the logic file containing the FPGA code. The progress bar will show the installation progress for the loading of the FPGA code onto the DSP boards (Figure 5.2).

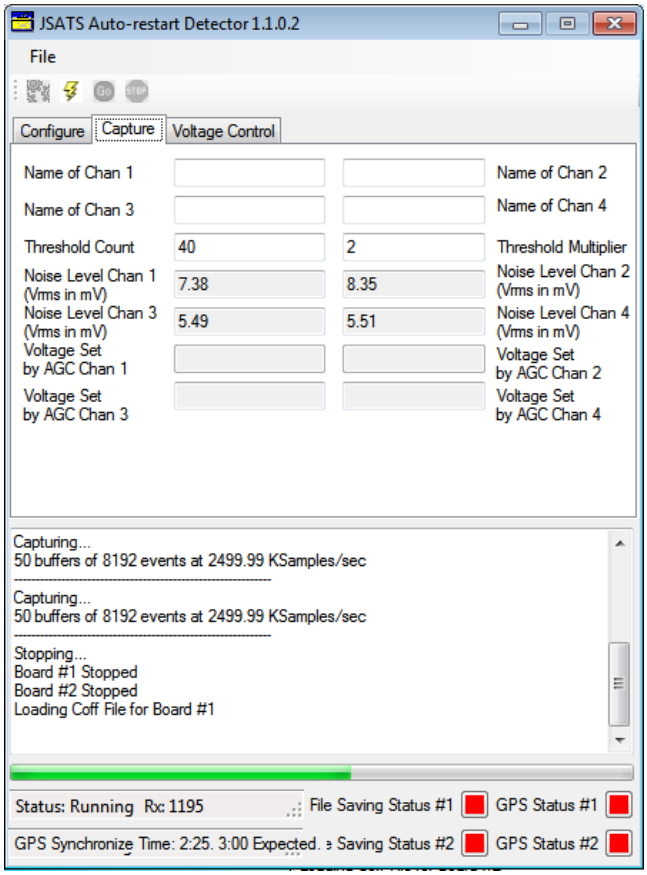

Figure 5.2. The JSATS Detector Dialog Box Showing the exo File-Loading Progress Bar.

When the exo files have loaded the Go icon button in the Detector Window Toolbar will be enabled. To begin operation of the detector, click the Go icon button (Figure 5.3).

Figure 5.3. The JSATS Detector Window Toolbar Showing the Location of the Go Icon Button.

Detector data processing and acquisition starts approximately 2 minutes after clicking the Go button. This allows time for the GPS and DSP boards to syncronize. A counter communicates the time elapsed from when the Go icon button was clicked. When Auto Restart is enabled in the File menu of the JSATS Auto Restart Detector dialog box, the detector will execute all three actions (Gear, Lightning, and Go) without user intervention. Also, the detector will restart if it does not receive a valid detection within the set time interval described in Section 4.5.3. The lower panel of the JSATS Auto Restart Detector dialog box displays detector progress (Figure 5.4).

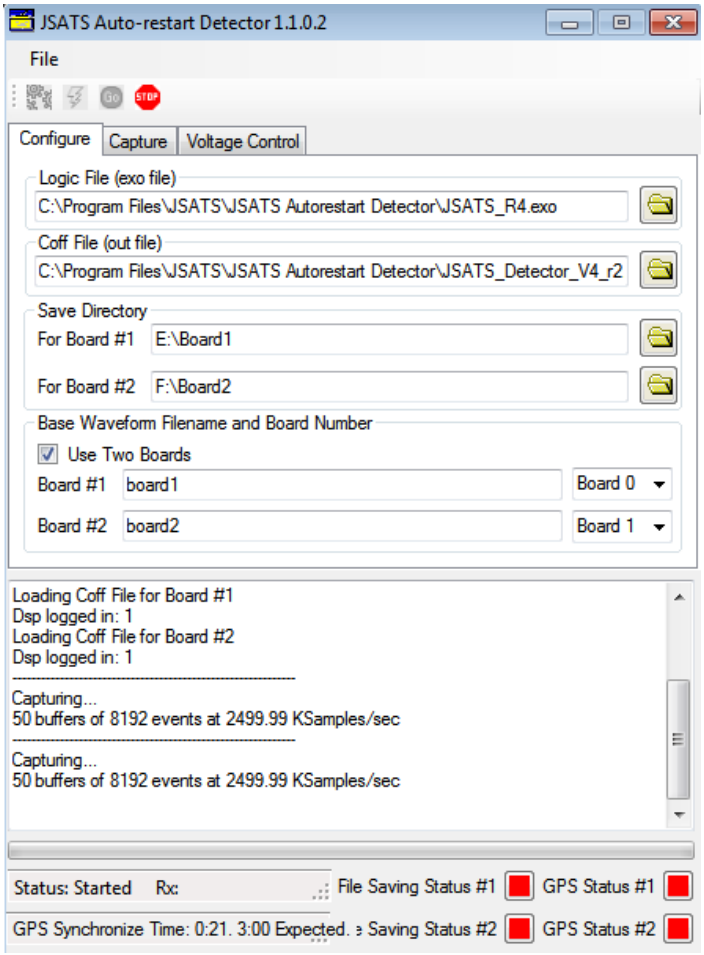

Figure 5.4. The JSATS Auto Restart Dialog Box Showing the Typical Detector Screen Immediately Following Auto Start with the "GPS Synchronize Time" Displayed at the Bottom.

When the JSATS detector receives the first data packets, two light-emitting diodes (LEDs) at the bottom of the JSATS Detector dialog box will turn green indicating which board(s) are receiving files (Figure 5.5). When Auto Restart is enabled in the File menu of the JSATS Auto Restart Detector dialog box, the GPS Synchronize Timer shown in Figure 5.4 will disappear.

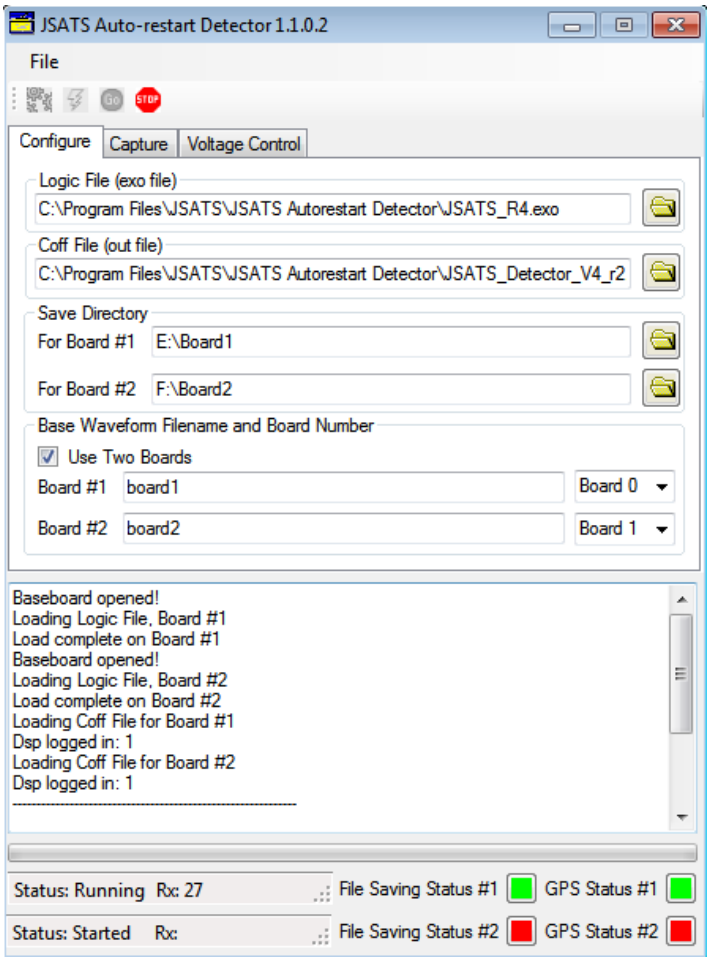

Figure 5.5. The JSATS Detector Dialog Box Showing Green LEDs Indicating DSP Board 1 is Receiving Data Packets Containing Candidate JSATS Tag Signals.

A common problem is seen if the detector is started before Board 2 is synchronized. The detector status shown in **Error! Reference source not found.** will indicate data packets are arriving from only one board, If enabled, Board 2 will synchronize a few seconds after Board 1 and synchronization must be complete before the detector will start collecting data. Figure 5.6 shows the detector operational status when both boards are enabled and the DSP boards are receiving candidate JSATS tag signal data packets.

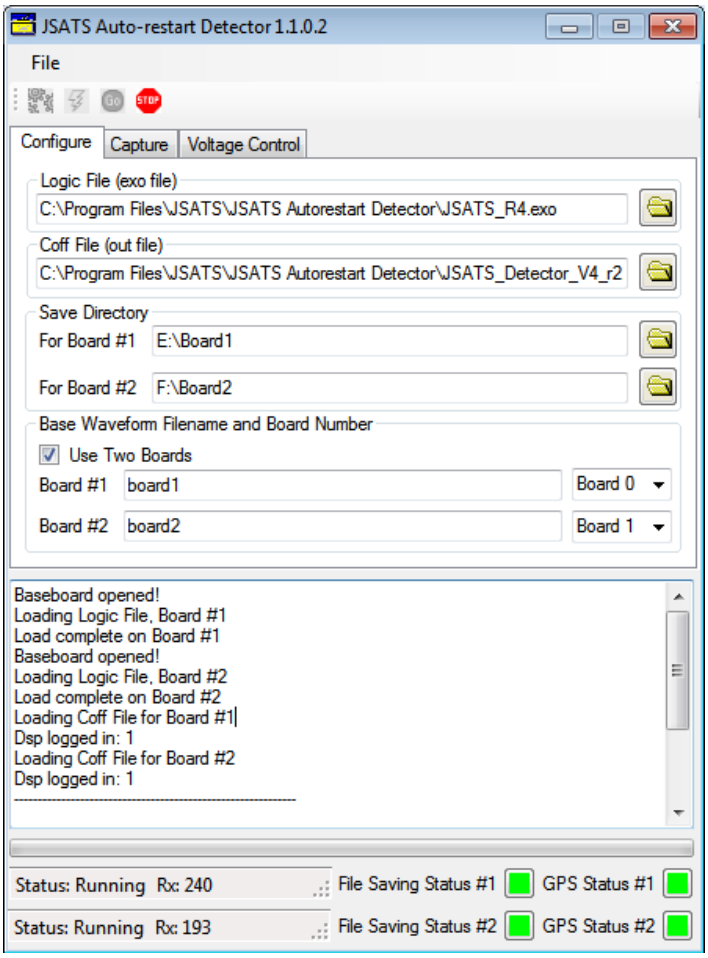

Figure 5.6. The JSATS Detector Dialog Box Showing the Green LEDs that Indicate that Both DSP Boards are Enabled and are Receiving Data Packets Containing Candidate JSATS Tag Signals.

Selecting the Capture tab will open the dialog box showing noise and AGC output values (Figure 5.7). The noise levels on each input channel (hydrophone) will be written to the top-most board output directory for later use.

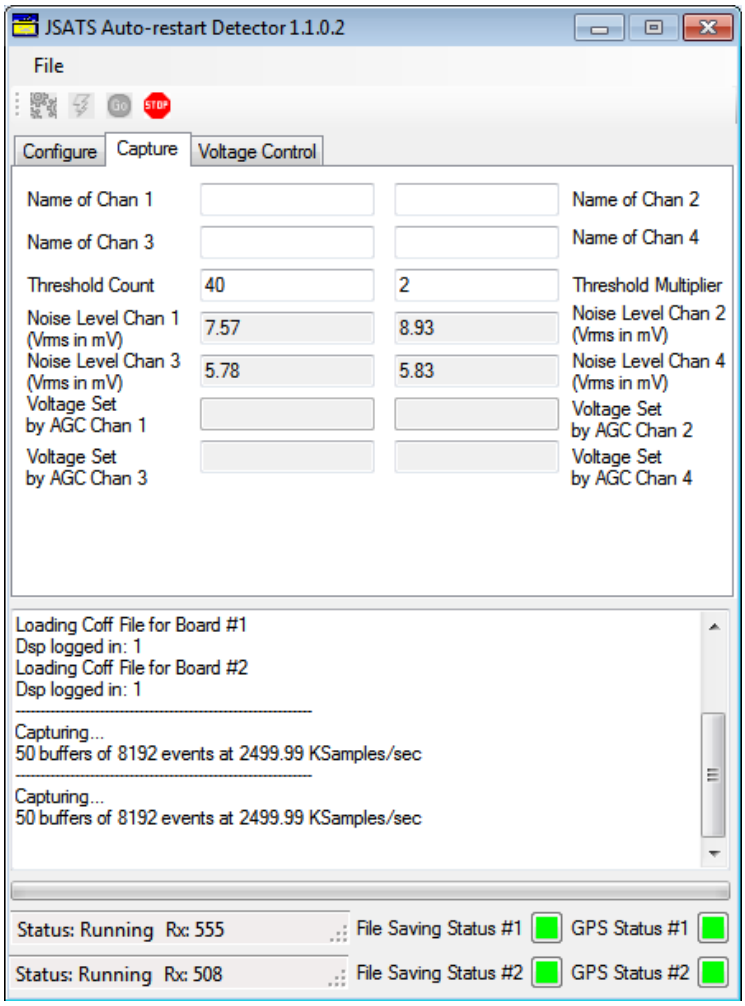

Figure 5.7. The Capture Tab JSATS Detector Dialog Box Indicates Detector Noise and Threshold Status.

To stop detecting, click the Stop icon button in the Detector Toolbar, located near the top of the JSATS detector Window (Figure 5.8).

Figure 5.8. The JSATS Detector Window Toolbar Showing the Location of the Stop Button.

When the detector has stopped, the JSATS Detector window will look similar to the screen shown in Figure 5.9. When the detector stops, the load coff file button in the toolbar is disabled, which is contrary to the state observed when the application first starts. The coff file does not need to be reloaded unless the computer has been restarted.

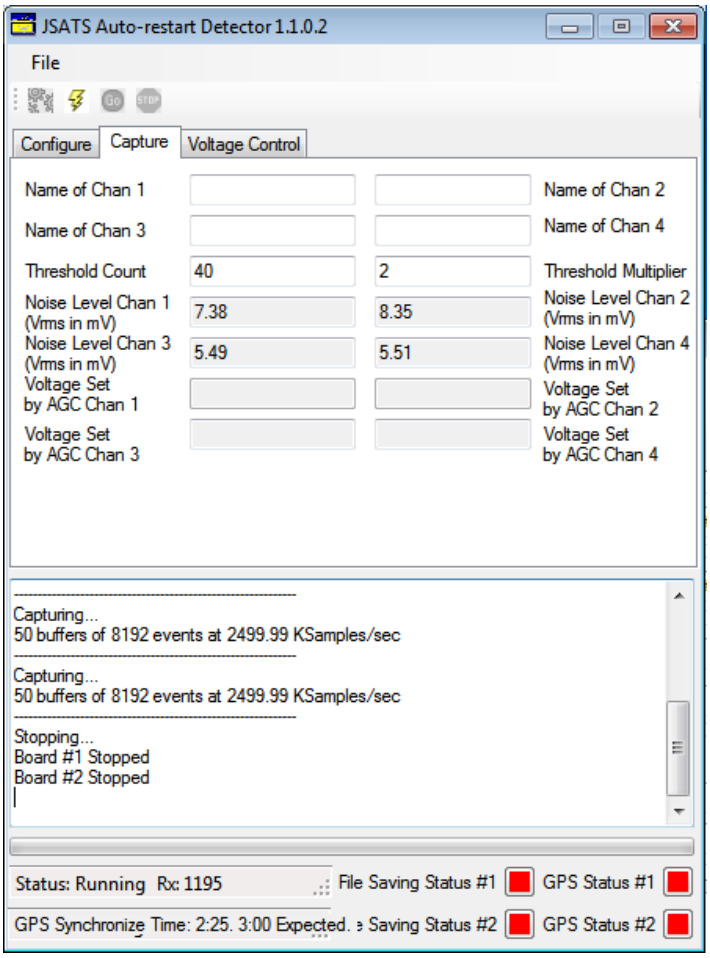

Figure 5.9. The JSATS Auto Restart Detector Menu Screen after the Detector Has Been Stopped.

6.0 File Formats

The JSATS detector saves two different types of files, binary waveform files with a *.bwm* extension and comma separated value (CSV) files with a *.csv* extension, for the RMS noise data. These signal files contain noise and AGC values.

6.1 BWM Files

Files with a *.bwm* extension contain the digitized acoustic signals acquired by the hydrophones and accumulated by the detector. The *.bwm* files for Board 1 and 2 are stored in the "Save Directory For Board #1" and the "Save Directory For Board #2", respectively. The files are stored in hierarcial directories with a layered data structure. The top level folder is the Base Waveform Filename, as shown in Figure 4.3, followed by the date recorded and the time. An example of a full file path is: *E:\MCN_S15_CH12\MCN_S15_16_07.26.2012.10.05.31.1234567.bwm.* Directories are created automatically with 7,000 *.bwm* files stored in each directory.

6.2 RMS CSV Files

Files with a *.csv* extension contain noise data in Vrms, and the DC inputs from the receiving array hydrophones. The noise *.csv* files (RMS data files) are stored in their respective Board 1 or Board 2 save directories. Each file is prefixed with RMS followed by an underscore, the date the data were acquired, followed by a number indicating the chronological order of RMS values recorded that day. An example file name is *RMS_03.02.2012_00.csv*. This file contains RMS noise data acquired on March 3, 2012 and the first in the sequence of files for that day.

The noise *.cvs* files also contain a list of five values: a timestamp, the first DC input, the Channel 1 noise level, the second DC input, and the Channel 2 noise level. Values are listed in chronological order and, if not interrupted, will start at midnight (00:00 am) and end at 11:59 pm that day. An example of data contained in one of these files is shown in Table 6.1.

Table 6.1. Noise File Data Showing DC Input and RMS Noise Levels for Two Channels of a Single DSP Board.

	Channel 1		Channel 2	
Time	DC input V	Vrms	DC input V	Vrms
0:00:48	1	2.1884	1	1.4786
0:01:48	1	2.1548	1	1.4184
0:02:48	1	2.0364	1	1.5149
0:03:48	1	2.0768	1	1.6316
0:04:48	1	2.0298	1	1.667
0:05:48	1	1.9957	1	1.6559

7.0 References

Deng Z, MA Weiland, T Fu, TA Seim, BL Lamarche, EY Choi, TJ Carlson, and MB Eppard. 2011. "A Cabled Acoustic Telemetry System for Detecting and Tracking Juvenile Salmon: Part 2. Three-Dimensional Tracking and Passage Outcomes." *Sensors* 11(6):5661-5676.

McMichael GA, MB Eppard, TJ Carlson, JA Carter, BD Ebberts, RS Brown, MA Weiland, GR Ploskey, RA Harnish, and Z Deng. 2010. "The Juvenile Salmon Acoustic Telemetry System; A New Tool." *Fisheries* 35(1):9-22.

Weiland MA, Z Deng, TA Seim, BL Lamarche, EY Choi, T Fu, TJ Carlson, AI Thronas, and MB Eppard. 2011. "A Cabled Acoustic Telemetry System for Detecting and Tracking Juvenile Salmon: Part 1. Engineering Design and Instrumentation." *Sensors* 11(6):5645-5660.

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