Importing and processing of triggered and continuous Acoustic Emission data from Elsys systems
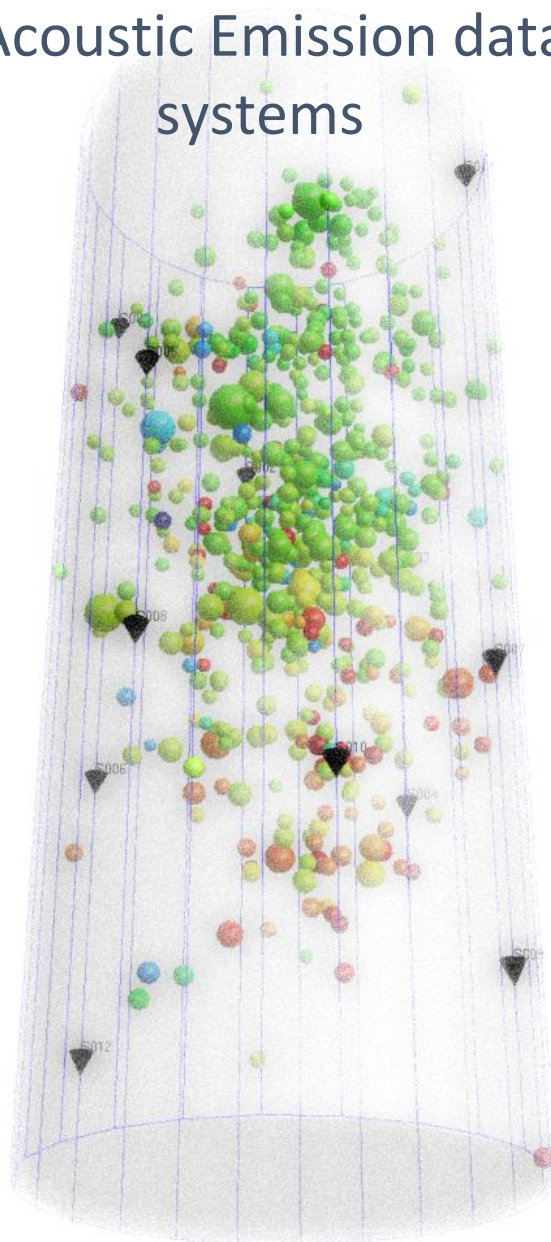
AE and ultrasonic survey data acquired using any of the systems supplied by Elsys instruments are saved as .BDF files. The storage location and configuration of the acquisition are set up using TranAX LE.

Each trigger produces a .BDF file and can consist of both the **triggered AE events** and **active surveys**. Similarly the continuous recording of an AE monitoring experiment produces a single BDF file created at the start of the monitoring and closed when acquisition is stopped.

Having acquired data on the data acquisition system, the next step is the processing of the data. This is done using the **Server Leach** and **InSite-Lab** software applications.

Before the import, leaching or processing, the user will also need to prepare the **Sensor Receiver Array** file, and configure InSite with the correct number of channels.

This guide explains the tools used in InSite-Lab to import the data. It does not discuss the details of the processing of the data such as picking and locating etc.

For this information, the user is required to refer to the InSite help documents, tutorials, and training.

1   Triggered (including survey) data

This section discusses the specific InSite-Lab tools for the processing of the triggered and survey data from the DAQ system using the Server Leach application (can be used for pseudo-real-time and offline importing of the triggered and survey data) and the **import data manager** (for importing data offline).
Server Leach imports the acquired **BDF** files and creates raw **BSF** data files that are imported by InSite-Lab's AutoLeach utility.

It does **not** discuss the basic setup and operation of InSite-Lab, or its data processing processes such as waveform picking and locating AE events etc. It is recommended that the user refer to the InSite help files and appendices for information on all these areas, which can be accessed via the InSite-Lab software under the <*help*> menu. For information regarding training courses and training material, which Applied Seismology Consulting Limited (ASC) can provide, please contact asc-support@appliedseismology.co.uk

1.1   Importing triggered data in real-time

Data acquired in triggered (ECR) mode (including survey data) with the TraNET EPC- AE-Amp system, can be processed in pseudo-real time (i.e. acquired data and surveys recorded as BDF files on the TraNET EPC system can be imported directly into InSite-Lab as they are performed and recorded) or offline (i.e. imported into InSite-Lab at a later stage for processing) in InSite-Lab using the **Server Leach and AutoLeach** software tools.

Start the process by launching the 'Server Leach' application. Server Leach connects to the TraNET EPC unit and searches for BDF files created when operating in ECR triggered mode. Server Leach imports all BDF files generated during a test and stored in the target folder. Server Leach searches for new files added at an interval set in the 'Trigger at (seconds)' variable, allowing the operation of the system in pseudo-real-time. Figure 1 shows the application and the steps to import triggered BDF files.
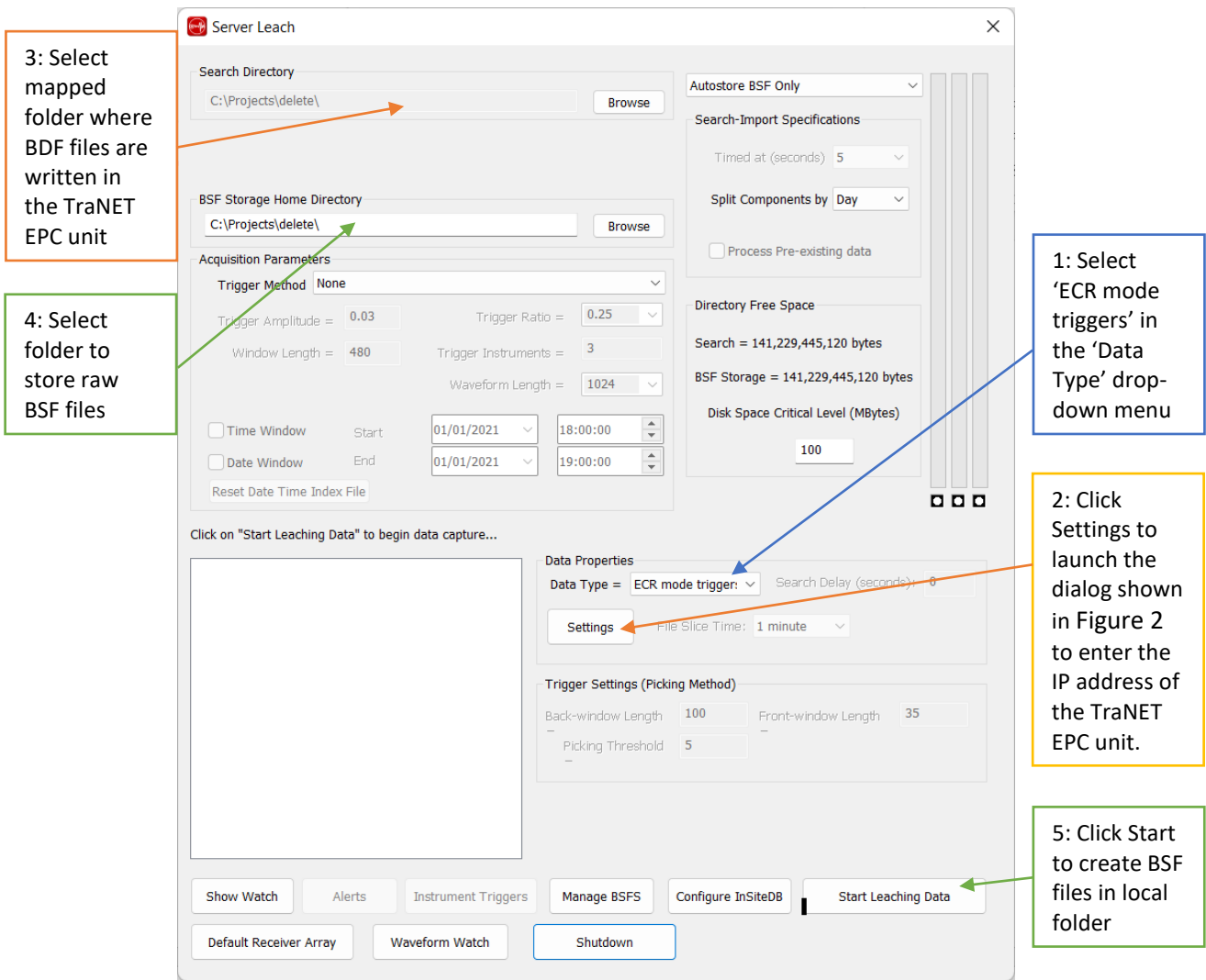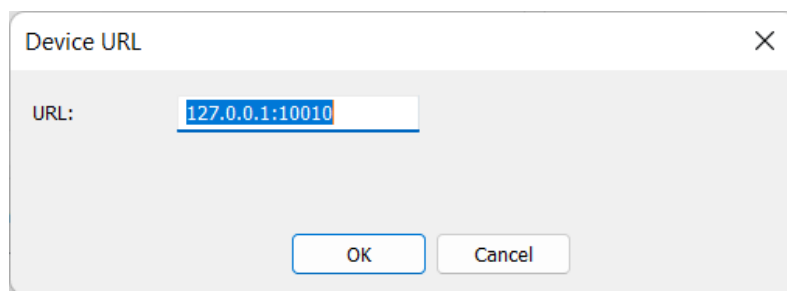
Figure 1: Interface of Server Leach

Figure 2:Dialog for input of TraNET EPC's address. The dialog is launched by clicking 'Settings' in the Server Leach interface.

Once the BSF files have been created in a local drive, the next step is opening InSite-Lab and setting up a project with the correct receivers and transmitters, and launch the AutoLeach tool, the user needs to select the data path/location of the BSF files acquired. In addition, the user also needs to set the location of where the ESF files (event storage data files containing waveform data created from the BSF files) will be stored.

Once the file paths have been configured, the next step is to start the autoleaching process to begin the process of importing the BSF data files into InSite-Lab in pseudo real-time or offline. A dialog window may be displayed with the message that x number of BSF files have been written/found, and would you like to import these files, which should be done.
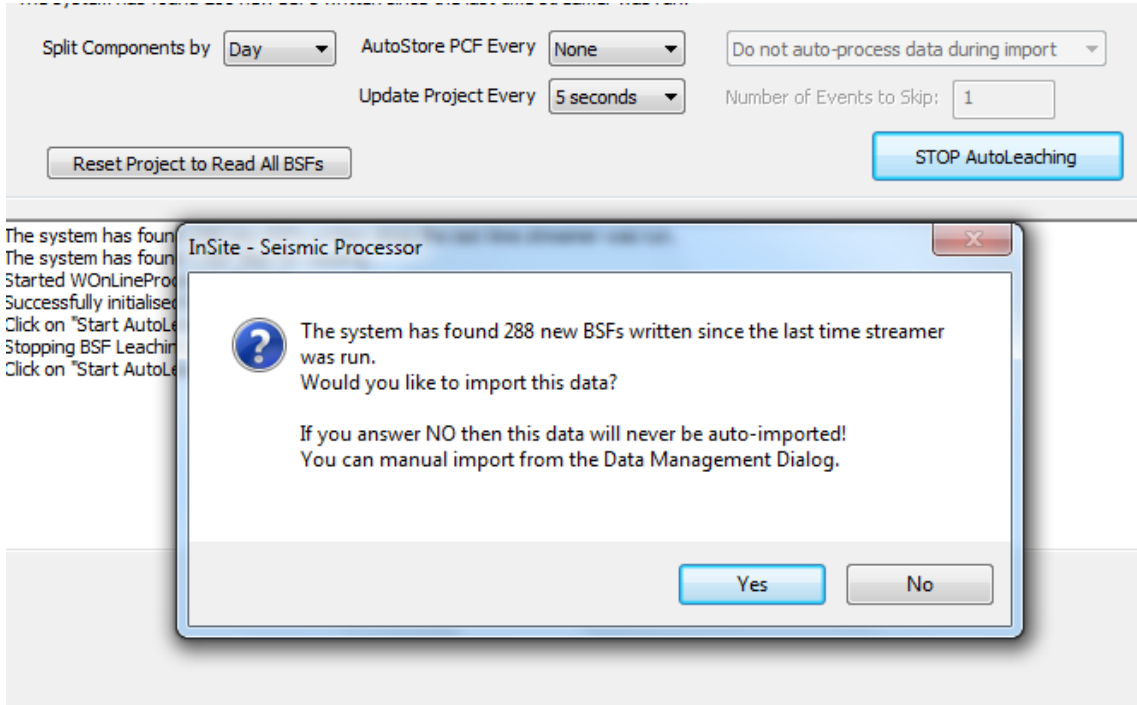

Figure 3: InSite-Lab's AutoLeach module and starting Autoleach process.

To summarise:

(1) Setup up the pcf project with the receiver and transmitter arrays;

(2) Select the location where the new ESF files to be created will be located;

(3) Select the path to the BSF storage file location as set in the Server Leach.

(4) All other settings can be left as. To start the autoleaching of triggered (and survey) data in pseudo-real time or offline press the ***Start Autoleaching*** button. Press the YES button when asked to confirm importing of data.

(5) The triggered events (including surveys) are stored in the defined ESF component folder and can be viewed in the project component visualiser-management window in InSite-Lab.
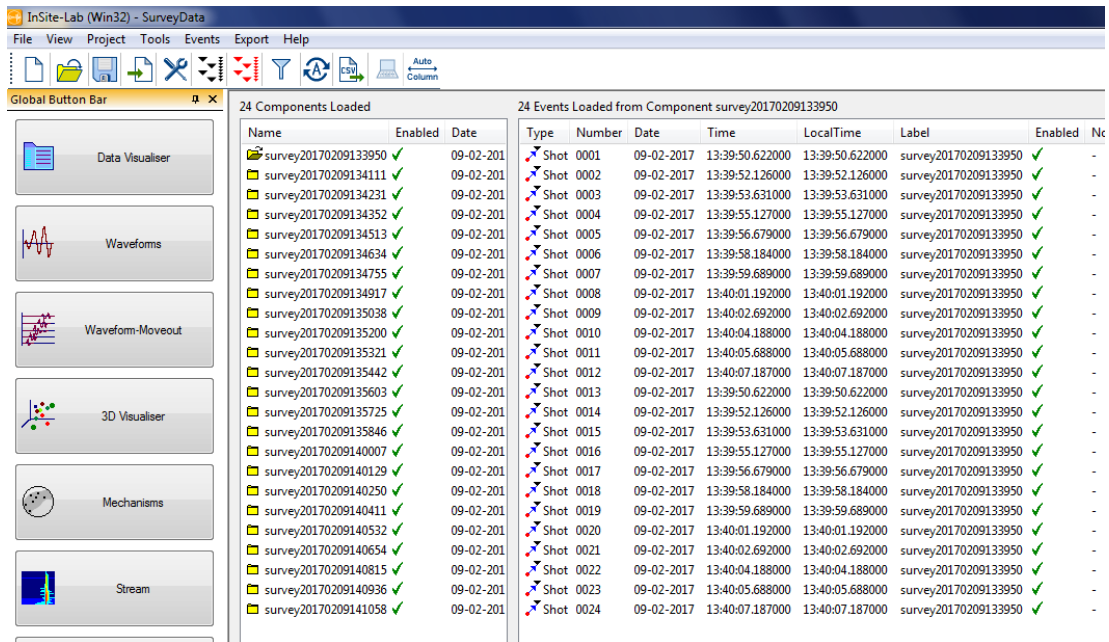
Figure 4: InSite-Lab's component visualiser – Example

The next stage is to process the harvested event data (in InSite-Lab) using the ***picking*** and ***location*** algorithms and other processing tools available in InSite-Lab. Please refer to the InSite-Lab help menu for further details on these and other processing modules. For further information and details regarding training, which ASC provide in InSite software, please contact us at asc-support@appliedseismology.co.uk or visit the webpage at www.appliedseismology.co.uk

1.2   Importing data offline (post experiment)

To import triggered data (including surveys) into InSite-Lab **offline**, the user can perform the following steps:

1.   Having opened up an existing project (*.pcf) template or started a new project and imported the sensor receiver array file, in the InSite project (pcf) file, under the <project> menu, select the option to *Import and Manage Data* which will open the *Data Management Dialog* window.
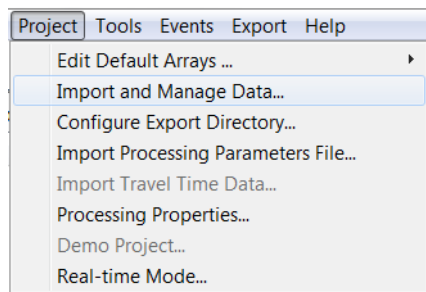

Figure 5: InSite-Lab. Example of InSite-Lab's Project menu and data import tool
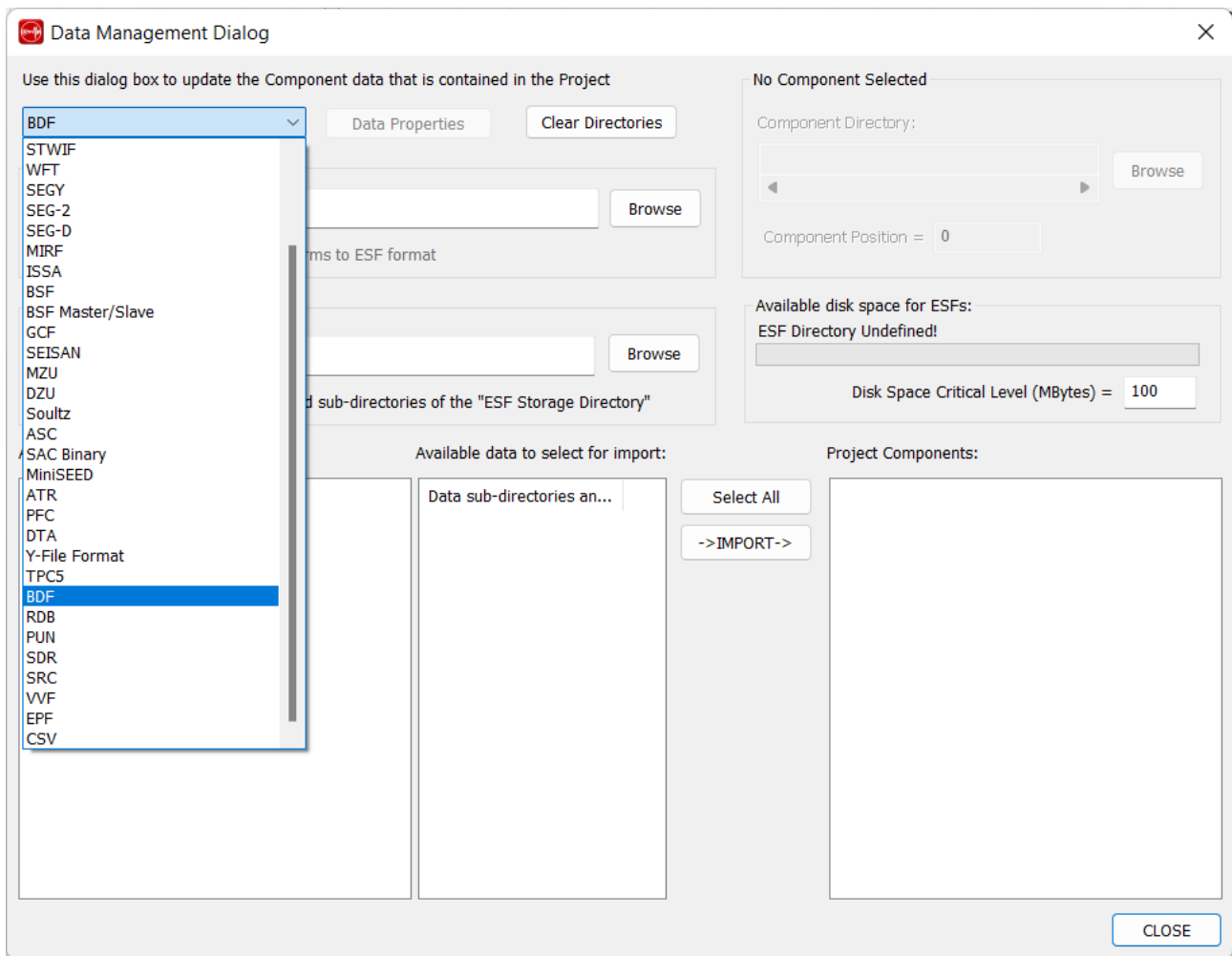
Figure 6: InSite-Lab. Example of InSite-Lab's Data Management Dialog window

2. In the *Data Management Dialog* window, from the dropdown list of the data options for import, select the "BDF" file type for import.

3. Specify the directory path where the raw BDF files were recorded. The BSF files will be imported into InSite-Lab from this specified directory/location.

4. The raw BDF files when imported into InSite-Lab will be visualised and will be converted/stored to a new waveform event data storage format with the file extension "*.ESF." Specify a suitably defined (named) directory where the new processed waveform data will be stored.

5. The BSF data files available for import will be listed under the "Available data in Import directory" dialog box. Click on the folder listed and click the import button and the BSFs will be imported into InSite-Lab.

The next stage is to process the imported BSF data (in InSite-Lab) using the *picking* and *location* algorithms and other processing tools available in InSite-Lab. Please refer to the InSite-Lab help menu for further details on these and other processing modules. For further information and details regarding training, which ASC

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2   Importing and processing of Continuous data in InSite-Lab

Continuous data must be imported and processed offline (i.e. post experiment / completion of lab tests) in InSite-Lab.

The continuous data will have been acquired and recorded as a single .BDF file in the user specified directory on the TraNET EPC system.

This section discusses the specific InSite-Lab tools for the harvesting and processing of the continuous data using the *Streamer Leach* modules.

It does **not** discuss the basic setup and operation of InSite-Lab, or its data processing processes such as waveform picking and locating AE events etc. It is recommended that the user refer to the InSite help files and appendices for information on all of these areas, which can be accessed via the InSite-Lab software under the *<help>* menu. For information regarding training courses and training material, which ASC can provide, please contact asc-info@appliedseismology.co.uk

To harvest the continuous data and to extract discrete AE events from the data, the ***Streamer Leach*** software module in InSite-Lab is used. This is the primary step in the processing of the continuous data.

The Leach process involves harvesting the continuous data i.e. searching through the continuous data to extract discrete AE events. These will be stored as BSF and ESF files in the storage location provided by the user. The harvesting is based on using the user selected triggering parameters in the Streamer Leach window. *For more details, please refer to the InSite-Lab help menu.*

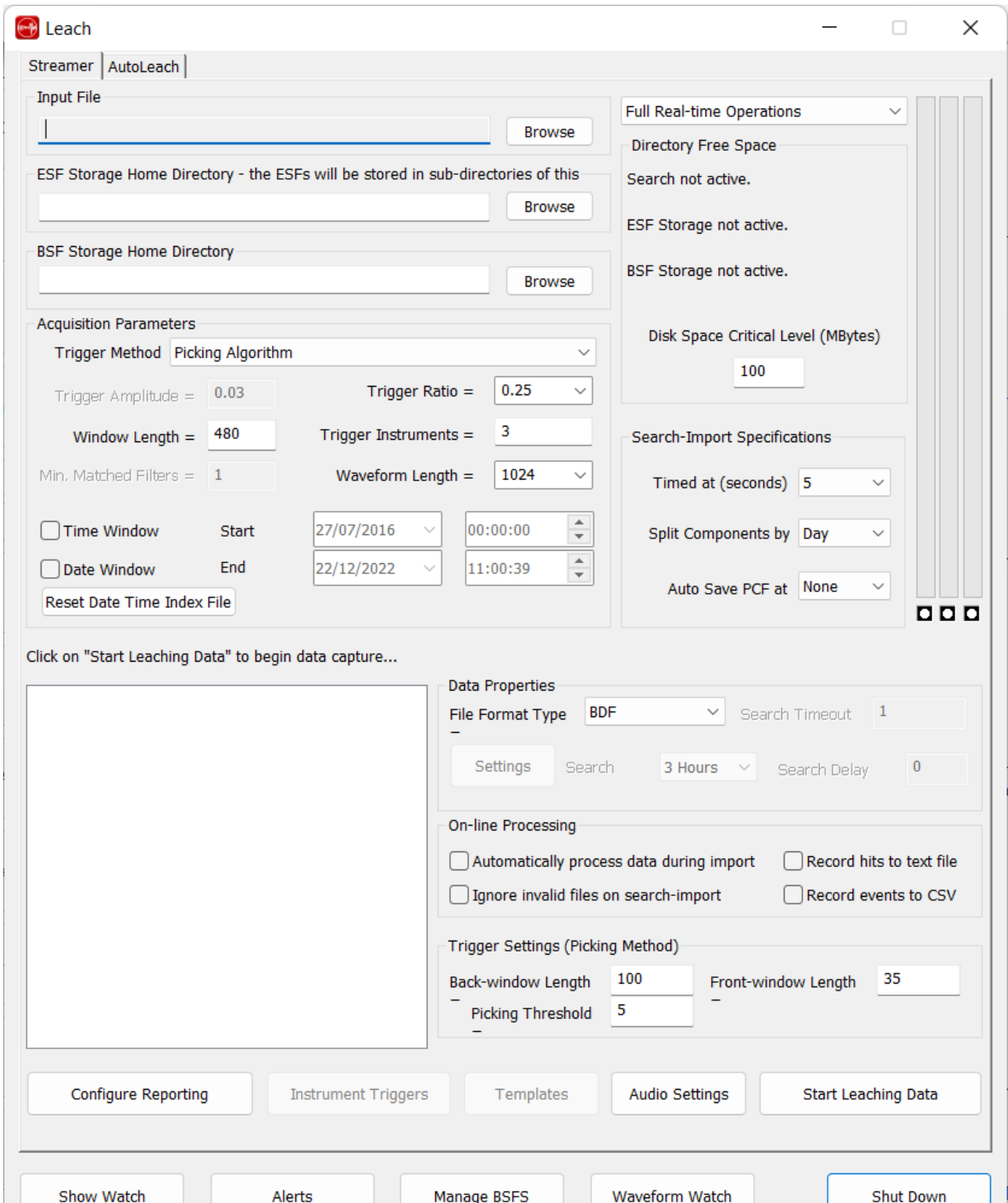1) To launch the ***Streamer Leach*** from the main menu, under the Tools menu, select Launch InSite Leach.

Figure 7: InSite-Lab. Example of InSite-Lab's Streamer Leach Dialog window.

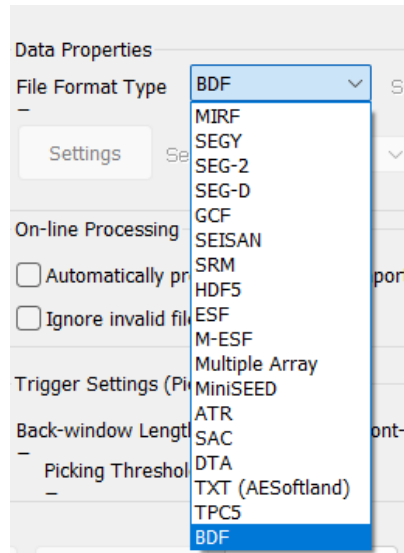2) Left-click on the down arrow of the *'File Format Type'* and select *BDF*

Figure 8: InSite-Lab. Example of InSite-Lab's Streamer Leach Dialog window. Selection of data type.

3) Select storage directories for the BSF and ESF files. These should be stored in a suitable folder (directory) on the data drive of the Processing PC.
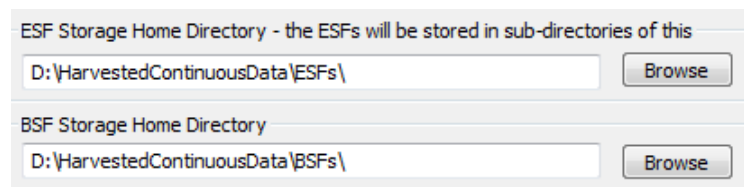

Figure 9: InSite-Lab. Example of InSite-Lab's Streamer Leach Dialog window. Selection of storage folders.

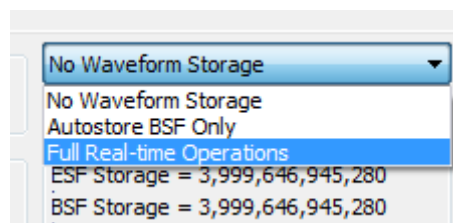4) Select full Real-Time Operations for full storage of waveforms.

Figure 10: InSite-Lab. Example of InSite-Lab's Streamer Leach Dialog window. Selection of operation mode.

5) Click on the *'Browse'* button by the 'Input file' dialog to select the raw BDF file.

6) Set the configuration of the ultrasonic surveys by clicking the 'Settings' button within the 'Data properties' box. Ensure these values are the same input in 'AE-amp' during the configuration of the acquisition and ultrasonic surveys.
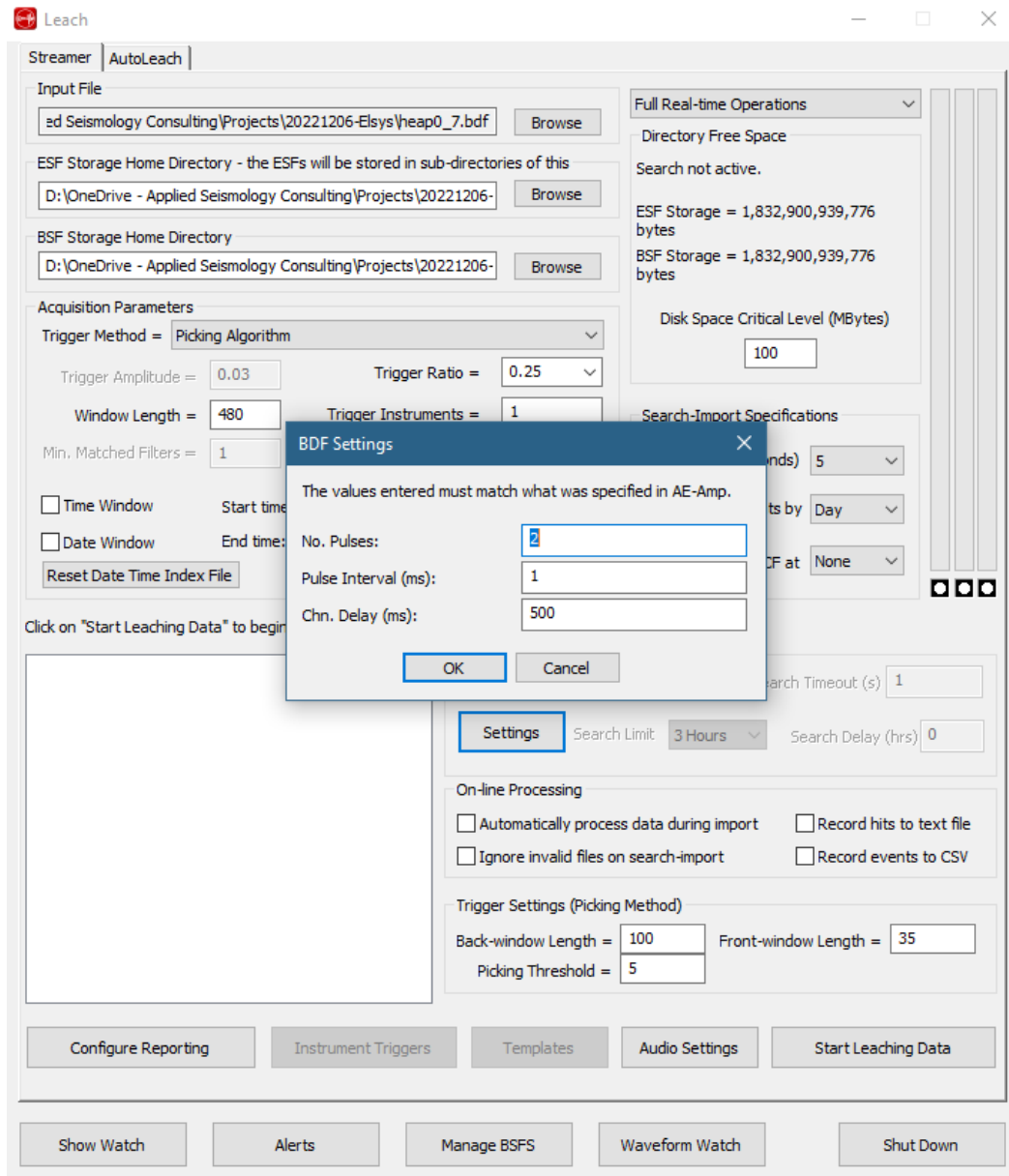

Figure 11: BDF settings dialog to configure the extraction of ultrasonic survey data from the continuous stream.

7) The next step is to set up the Acquisition parameters to define how the continuous data will be harvested and how triggers will be identified. The acquisition parameters are defined as follows:

Trigger Method -> Amplitude threshold (the default and preferred setting to use), picking algorithm and external file;

Trigger Ratio -> Ratio of pre- to post-trigger data points in captured waveform (e.g. 0.25 means 25% of the captured trace points are pre-trigger and 75% post-trigger);

Trigger Amplitude -> Amplitude (volts) threshold for trigger detection (e.g. 0.04)

Trigger Instruments -> total number of Richter system channels exceeding the trigger threshold within the given time window (window length) to be considered a valid triggered event

Window Length -> Data window, in sample points, within which triggers must occur (e.g. 500 which equates to 50 microseconds when sampling at 10 MS/s);

Waveform Length -> Length (in sample points) of the extracted triggered event (i.e. captured) waveform (e.g. 4096)

Time and Date Window -> In InSite-Lab version 3.10, there is now the option to harvest continuous data based on a range of times and/or dates if the corresponding tick boxes are checked.
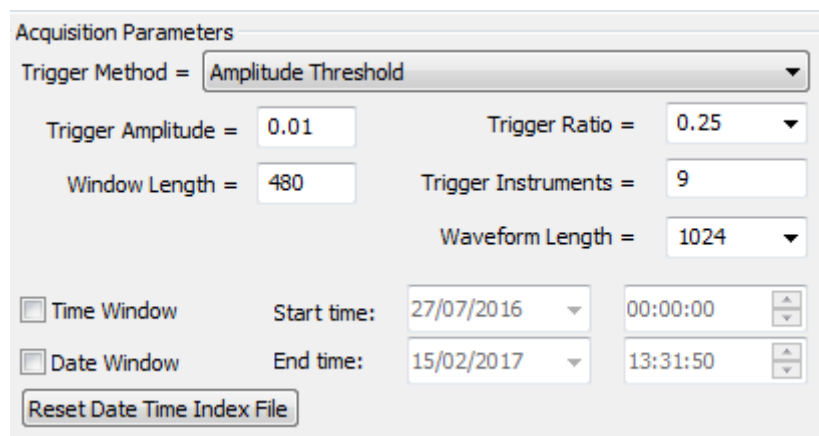

Figure 12: InSite-Lab. Example of InSite-Lab's Streamer Leach Dialog window. Triggering parameters

8) Having setup, the Acquisition Parameters, the next step is to start the leaching process. The on-line processing boxes can be left unticked as the processing can be performed after leaching. Open the *show-watch* window, which will display information regarding the progress of the harvesting of the continuous data. When ready press the ***Start Leaching*** Data button. A dialog box will pop up with message to say, "*The system has found 1 new file written since … Would you like to stream this data?*". This always appears when starting the leaching process. Simply click the YES button and proceed.

9) The harvested events are stored in the defined BSF and ESF folders previously selected and the ESF component folders and can be viewed in the project component visualiser-management window.
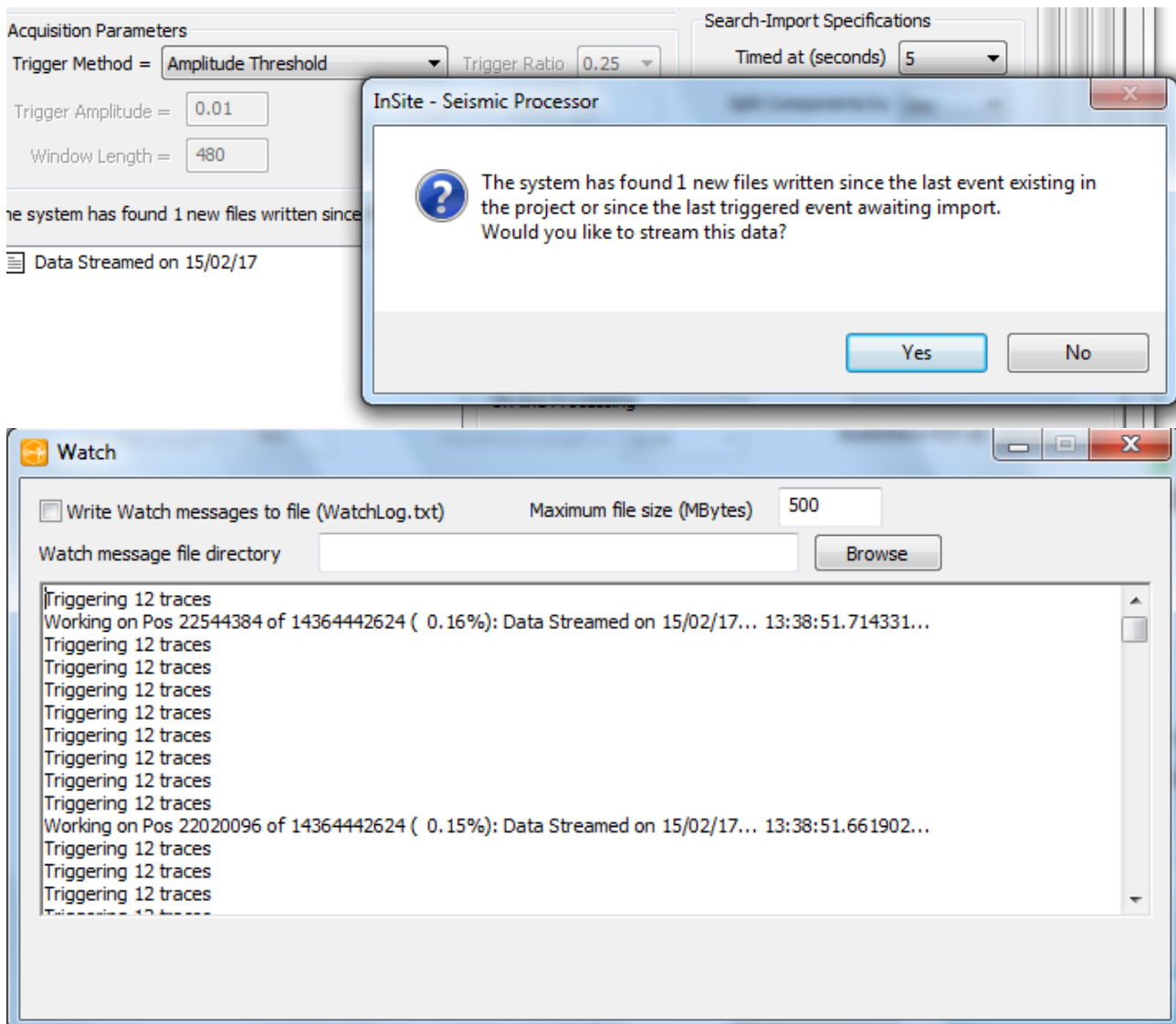
Figure 13: InSite-Lab. Example of InSite-Lab's Streamer Leach Dialog window. Process log shown in Watch window.

The next stage is to process the harvested event data (in InSite-Lab) using the *picking* and *location* algorithms and other processing tools available in InSite-Lab. Please refer to the InSite-Lab help menu for further details on these and other processing modules. For further information and details regarding training, which ASC provides on InSite software, please contact us at asc-info@appliedseismology.co.uk or visit ASC's webpage www.appliedseismology.co.uk