InSite Seismic Processor

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Why InSite?

- InSite is ASC's consulting tool for seismic data management, processing and visualisation.
- InSite has been developed over the past 7 years using ASC's experience in many different fields of seismology.
- InSite's toolbox of processing, visualisation and network functions are under continual development within a strict version control system.

InSite's Flexibility

- ASC specialises in providing seismic monitoring of rock masses and concrete structures, particularly for Radioactive Waste, Mining, Civil Engineering and Petroleum applications.
  - ASC (like many of its clients) needs versatile software tools.
  - These must be easily configurable and adaptable so as to process any seismic data from the laboratory up to petroleum seismics.
  - The data management system must be acquisition-system independent, so that the software can process many different formats of data using the SAME basic processing functions.
  - InSite (although complex) is designed to be user friendly, making it easy to navigate around the data and the different data processing and visualisation functions.

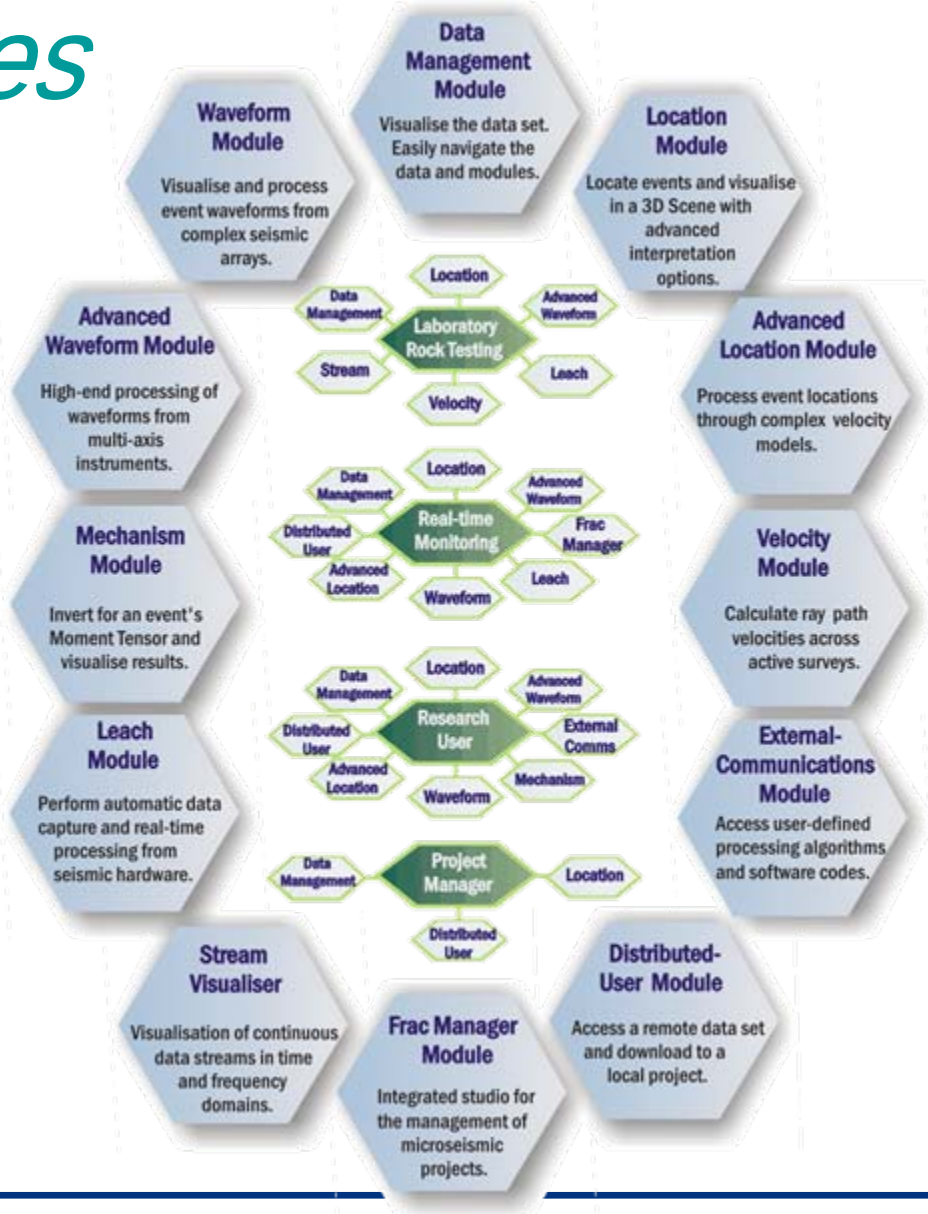
Software Consulting

- ASC provides customised software tools to its clients
  - InSite provides a robust platform for these tools to be developed onto.
  - Once the data is within InSite's data management system ANY processing or visualisation function can then be added on top.
  - InSite is therefore a *smart seismic data base* - it provides not only the data to the user, but also all of the processing and visualisation functions wanted for that data.

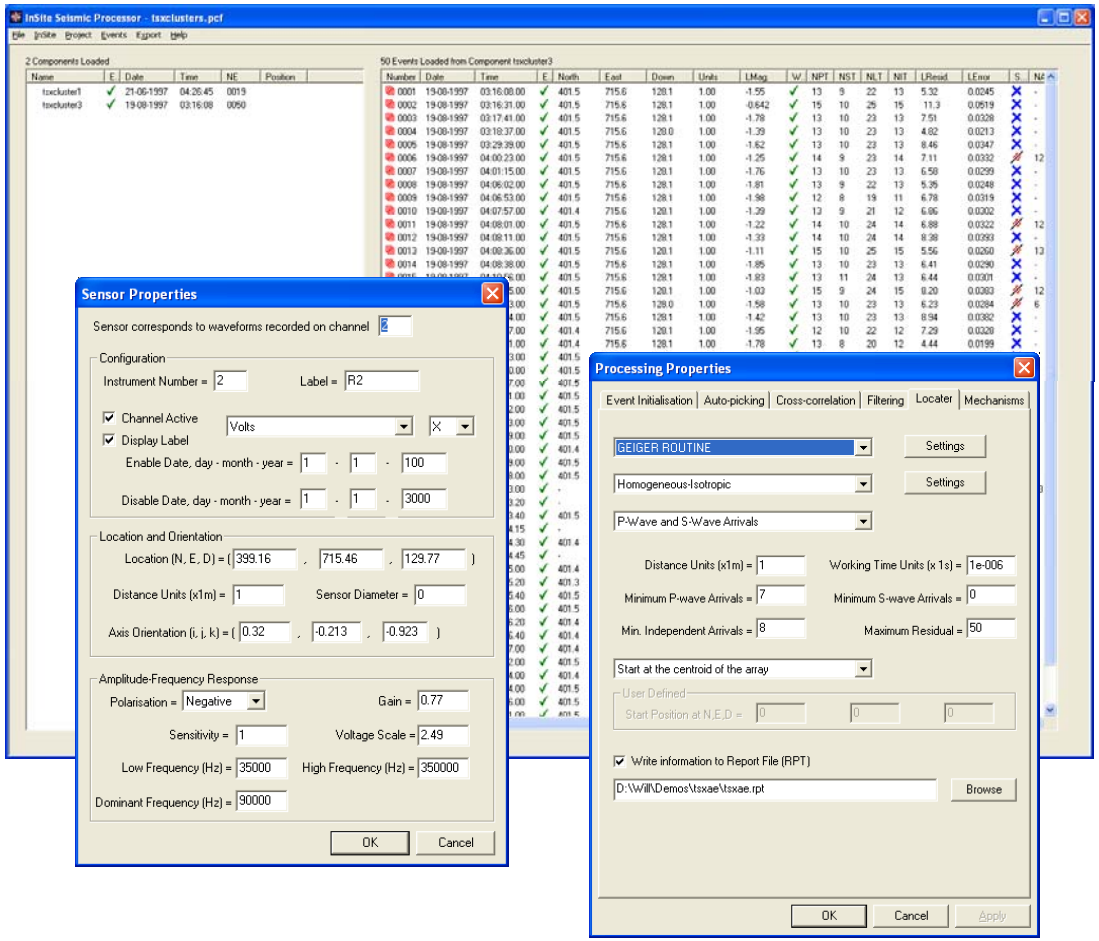
InSite's Structure

- InSite is a single program interface consisting of a series of modules.
  - Each module performs a different function.
  - The modules make InSite appear like a series of different programs.
  - Modules built onto a sophisticated data management platform seamlessly linking ALL of the seismic data.
  - New modules can be easily written and integrated into the data management platform.
  - The stucture means users can tailor licenses to their particular data type and processing requirements.

InSite's Modules



Data Visualiser I



The Data Visualiser allows the user to navigate around the entire data set. Events are split up into sets (called Components). Events can be sorted, organised, enabled, disabled and categorised into different types. The columns in the two panes show different parameters for the Components and Events, such as date, time, location and source information.

Data Visualiser II

- Import of waveform/event data into the data management structure.
- Construction of receiver and shot/transmitter lists.
- Visualisation of the complete event data set and processing results.
- Navigation of the complete event data set with links to waveform, location and source mechanism visualisers.
- Configuration of processing parameters.
- Auto-processing utilities allow the entire data set, or chosen parts of the data set, to be automatically processed using a menu of the different processes available.
- Export of processed results to ASCII file so that the data can be imported into other software.

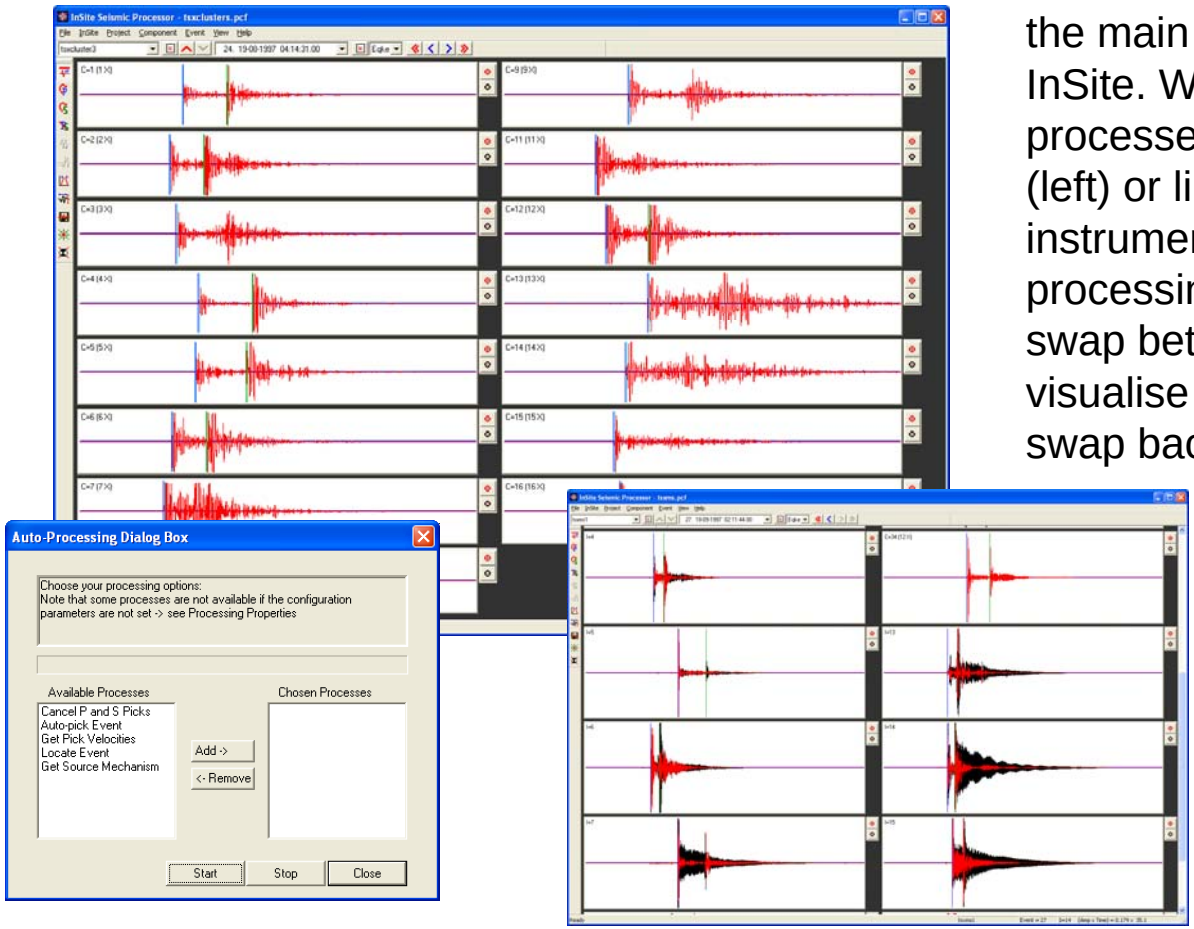
Components, Events and Channels

- InSite manages a data set by splitting it into these three data objects.
- Each object is a packet of information that can be shared between any of the processing or visualisation functions as required.
  - Channels – contain waveforms, sensor information, phase arrival picks, velocities, amplitudes etc
  - Events – contain a set of channels and event information such as type, time, location, mechanism source parameters etc.
  - Components – contain a set of events (e.g. on a particular day or in a particular sub-part of an experiment) and it's descriptive information.

Advantages of the Management Structure

- Event information can be managed easily.
  - Events can be organised into different sub-sets of a project.
  - Events can be safely deleted from a project, can be enabled, disabled or can be classified into different types.
  - Lengthy projects can be navigated very simply so that any event can be easily accessed, manually processed and visualised.
- Complex data configurations can be used easily.
  - Projects can contain events recorded on different acquisition systems.
  - Events can have different sensor array geometries, recorded with different acquisition parameters.
- The data set can be easily auto-processed.
  - Different functions, or different processing parameters, can be applied to different parts of the data set.
  - Different sets of events can then be sorted and discriminated easily, so that only select parts of a project can be visualised.

Waveform Visualiser I



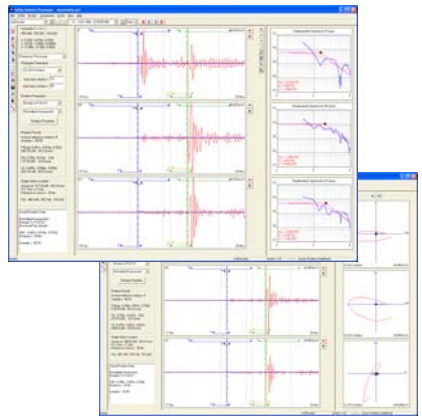
The Waveform Visualiser contains the main processing tools inside InSite. Waveforms can be processed as individual channels (left) or linked together as instruments (below). After processing, the user can easily swap between modules so as to visualise results and, if required, swap back to re-process.

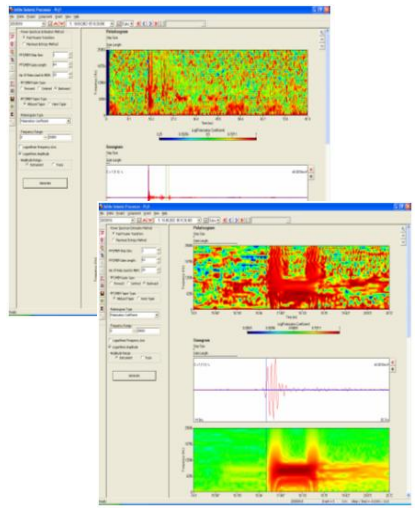
Waveform Visualiser II

- Visualisation of waveforms (when Events contain them) and event auto-processing for phase information.
- Manual waveform processing functions such as phase picking, source location and mechanism calculations, velocity and cross-correlation functions.
- Recording channels can be visualised individually or as Instruments. Instruments can contain between 1 and 4 channels allowing triaxials and quadraxials to be visualised and processed.
- Channels can be enabled and disabled so that noisy or malfunctioning sensors can be removed.
- Waveform frequency analyses and filtering can be performed.
- The user can navigate around the complete data set from within the waveform visualiser.
- Access to component, event and channel property sheets.
- Events can be reclassified as different types.
- Changes in location and source properties can be instantly visualised in the other software modules.

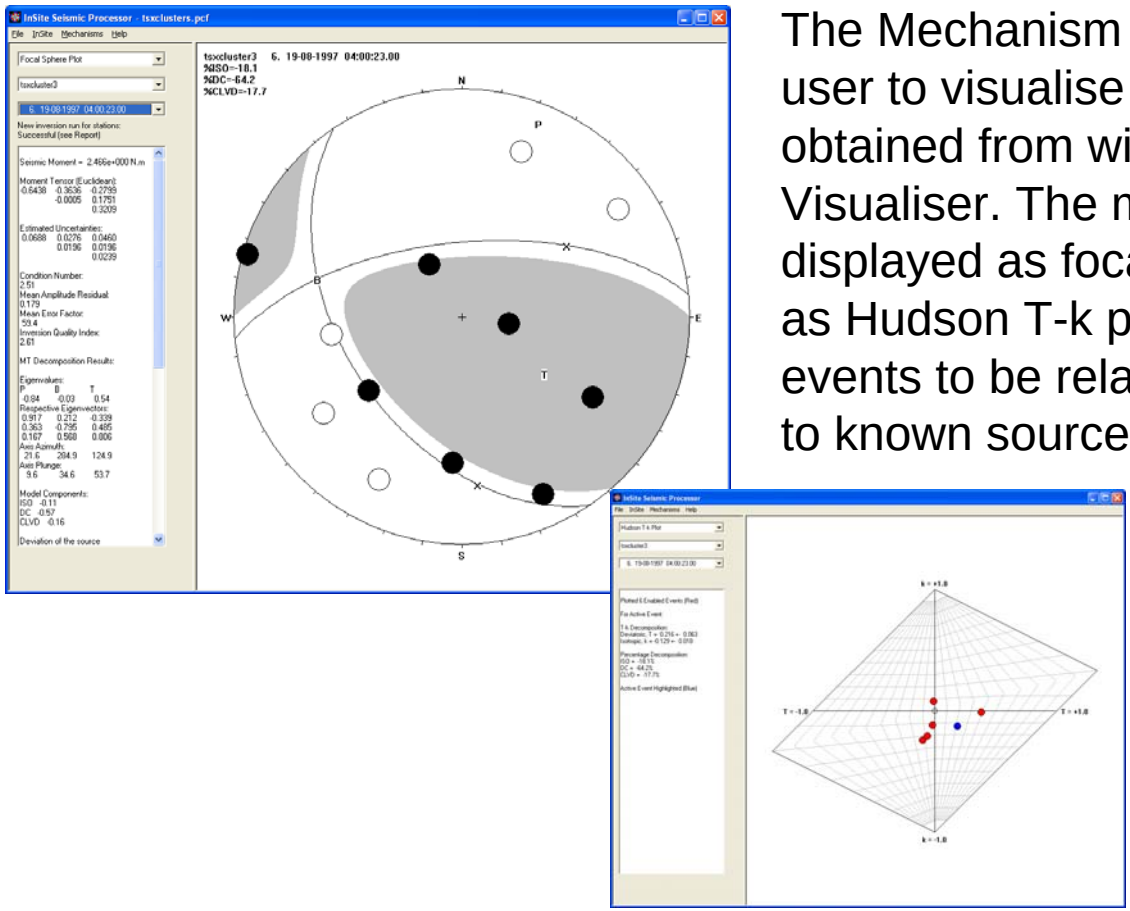
Advanced Waveform Visualiser

- Rotation of waveforms from triaxial or quadraxial instruments into ray coordinate systems, achieved through either an inverse or a forward approach, allowing ‘beam-steering’ applications.
- Display of rotated waveforms allowing picking of P and two S-wave arrivals and time domain amplitudes.
- Display of particle motions for the rotated P and S-waves on ‘Hodogram’ plots.
- Display of the displacement spectra (where applicable) allowing automatic and manual picking of frequency parameters.
- Calculation of ray vectors and single-station locations.
- Display of colour-density sonograms for each channel recorded on an instrument, allowing zooming in time and frequency and providing manual adjustment of picks.
- Display of polarisograms for triaxial or quadraxial instruments showing the spectral density of the waveform polarisation.





Mechanism Visualiser I

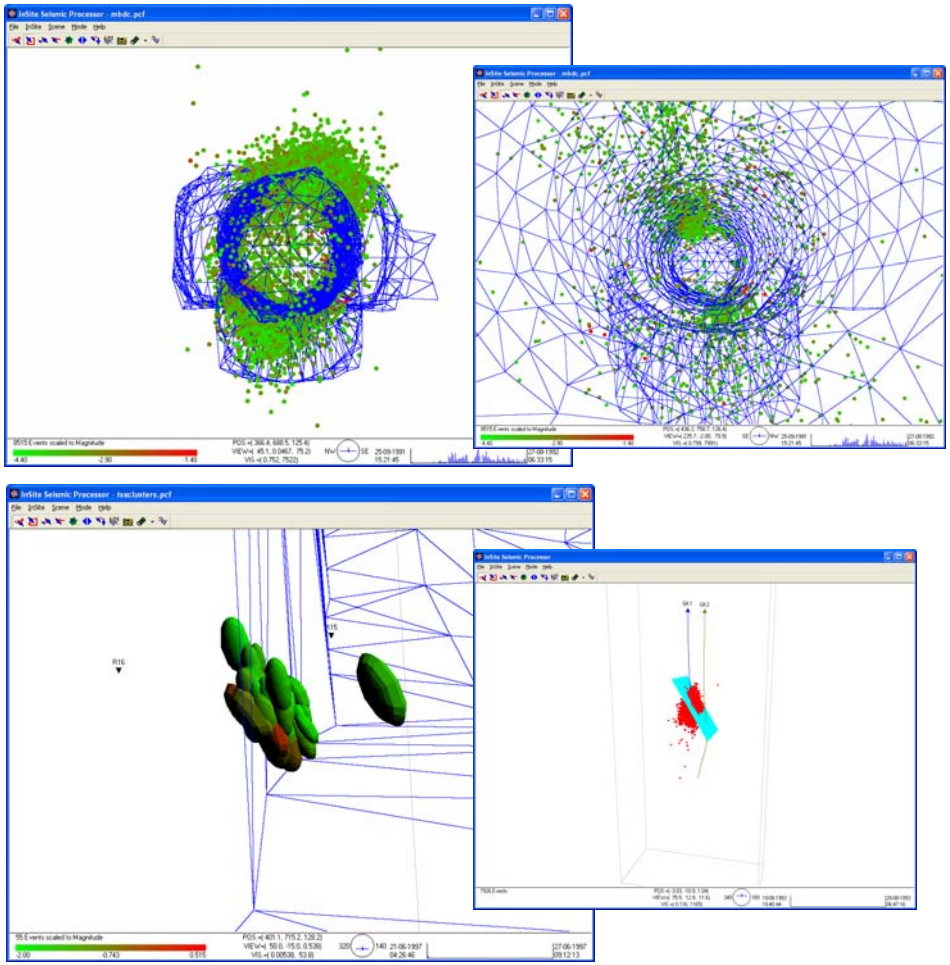


The Mechanism Visualiser allows the user to visualise moment tensor results obtained from within the Waveform Visualiser. The mechanisms can be displayed as focal sphere plots (left) or as Hudson T-k plots (below) allowing events to be related to one another and to known source types.

Mechanism Visualiser II

- Visualisation of source mechanisms from moment tensor inversion.
- Event mechanisms can be visualised using the classic focal sphere plot or using the Hudson T-k plot.
- The Hudson T-k plot allows multiple events to be compared with each other and with known source types (such as double-couple or tensile fracture).
- Mechanism error ellipsoids can be visualised on the Hudson T-k plot.
- Station (sensor) positions on the focal sphere can be toggled on/off and displayed using polarity symbols or station numbers.
- Linking between visualisers allows the user to easily correct mis-picked amplitudes.
- A data pane shows the full inversion decomposition.

Location Visualiser I

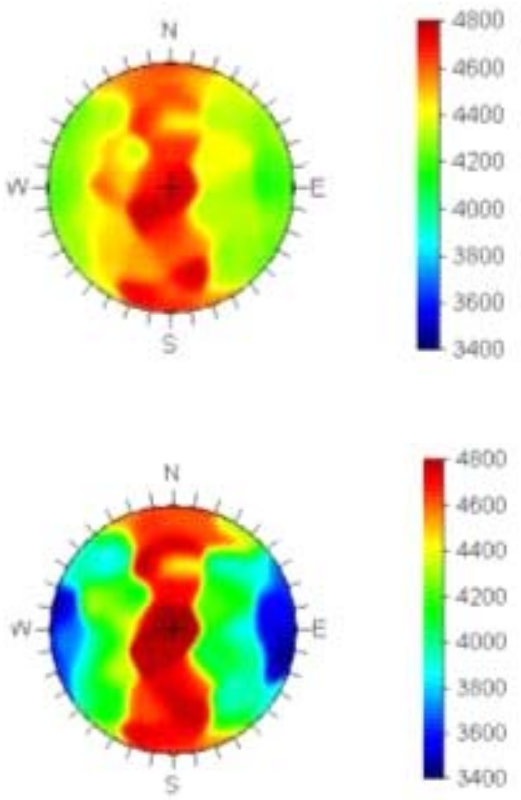


The Location Visualiser allows the user to visualise event locations inside a fully 3D scene. The user can move around the scene, flying through objects such as tunnels and galleries or around boreholes. The scene can be manipulated through rotation, panning and zooming. Error ellipsoids can be visualised (lower left). Fracture planes can be introduced (as many as the user wishes) and manipulated to analyse lineations (lower right). The events and objects can be played through time allowing galleries or boreholes to appear only once excavated. Event properties and waveforms can be accessed by clicking on individual events.

Location Visualiser II

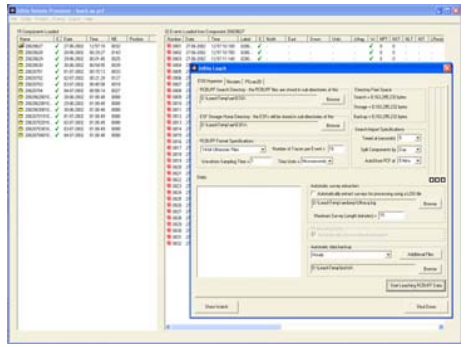
- Three-dimensional (3D) visualisation of the event locations.
- A full 3D scene allows the user to rotate, pan, magnify and fly around and through the events.
- Insertion of 3D scene objects, such as sensors, boreholes and tunnels.
- Complex 3D objects can be inserted using AutoCad DXF format. Simple 3D objects can be imported using InSites own Drawing Object Files.
- Interactive time histogram for analysis of temporal response.
- Playback features allow events to be stepped through in time.
- 3D scene objects have time dependency allowing them to be switched on/off as the project progresses.
- Insertion of 3D fracture plane sets so as to analyse linearities in the location data.
- Visualisation of 3D event error ellipsoids and collapsing of event locations.
- Links between visualisers and property sheets are activated by mouse clicking in the scene.

Velocity Module



- Analyses ‘active’ data for velocity and amplitude information. Active data is produced from a man-made source such as a shot or a transmitter.
- P and S-wave transmission velocities are calculated from time of flight between source and receiver using the picked arrivals.
- A waveform cross-correlation algorithm allows P and S-wave velocity changes to be calculated precisely between repeated surveys. The cross-correlation algorithm can be configured to the data quality with various waveform processing functions being applied.
- The cross-correlation algorithm allows efficient automatic processing of surveys for velocity data resulting in 1000s of surveys being processed automatically. Signal amplitude information from the arrivals is also obtained for use in attenuation studies.

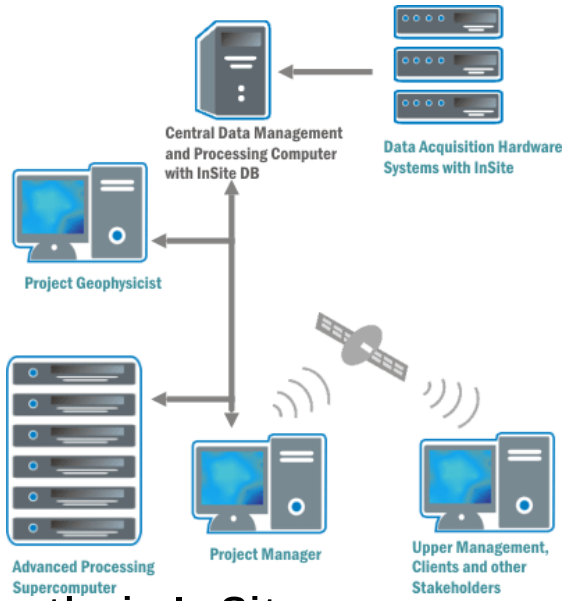
Leach Module



- The InSite Leach provides on-line data-capture facilities and direct acquisition-system control. The modular interface integrates with different hardware products, importing data directly into InSite's data management system and applying 'on-line' processing functions.
- A flexible code framework has been developed so that the software can be easily updated to be compatible with any seismic acquisition hardware.
- The Leach's operational efficiency is increased when run on a multi-processor machine, advantageous for using the software in a high-data-transfer environment such as for acoustic emission processing in the laboratory.
- The data can be automatically processed for seismic parameters such as locations and source magnitudes during the import process providing 'real-time' feedback to the user.

Distributed Software Module

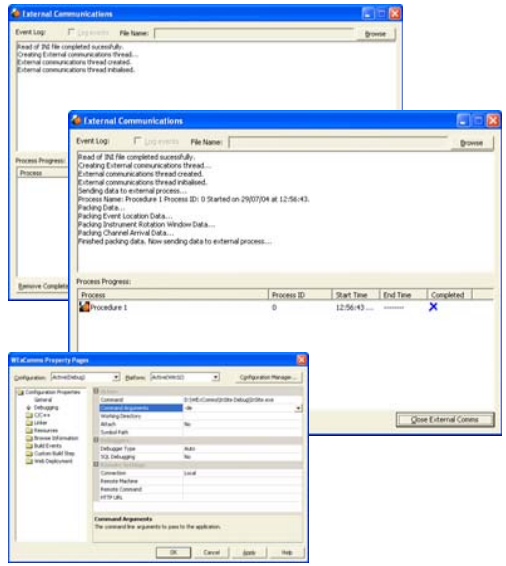
- The Distributed-User Module allows users of InSite, working on networked PCs, to download data to their PC from a remote data base managed by InSite on a server computer.
- Data bases can be stored on a single centralised computer so that a team of users can easily access them or an individual users can share data on their computers.



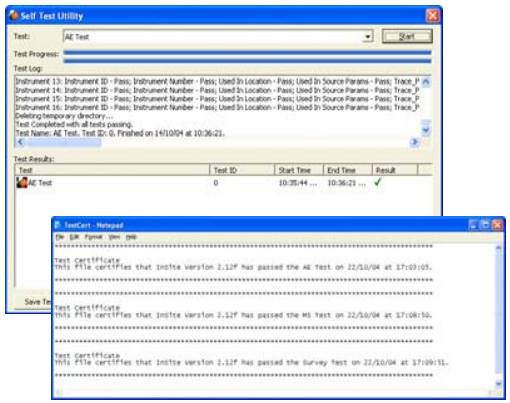
- Any licensed user of the module can transform their InSite project into any number of servers (for sending data) and/or clients (for receiving data).
- The communications across the network uses DCOM (Microsoft Distributed Component Object Model), allowing event parameter information and event waveform data to be transferred between the InSite projects.

External Communications Module

- This module has been developed so that InSite can be interfaced with external procedures created by a user, thus allowing the user to implement their own algorithms into InSite.
- Includes an efficient configuration scheme, allowing the user to implement multiple procedures, and includes a visualiser that provides feedback on the processes currently running in the multi-threaded environment.
- The user's external procedures can process the waveforms directly or use parameters resulting from InSite's internal processing algorithms allowing data to be stored, processed and visualised back in the software.
- Open-source codes contained in a Dynamic Link Library (dll) receive data from InSite through a message passing interface. The user's own codes can be stored in the dll directly, or as an interface within the dll that communicates to their own software, for example, across a network, ideal for performing tailored high-end data processing on super-computer clusters.



Self Test Module



- The Self-Test Module allows users of InSite to validate that the processing-algorithms, in their current version of InSite, function correctly.
- Validates InSite using AE, MS or survey data sets.
- Tests are tailored to the type of data being processed and processing functions employed.
- A full set of results for each test is displayed, which can be saved.
- A certificate file and/or test log can be produced providing documented proof if all the parts of a test pass for inclusion in an international safety certification.

InSite Demonstration

- InSite Demo has been designed to give you the opportunity to try InSite.
- It does not have the full features but hopefully it will give you the flavour.
- If you have any comments on the software, or maybe see an opportunity for how it can help you, then please get in touch.