



Advanced Acoustic Emission Data Analysis, Pattern Recognition & Neural Networks Software



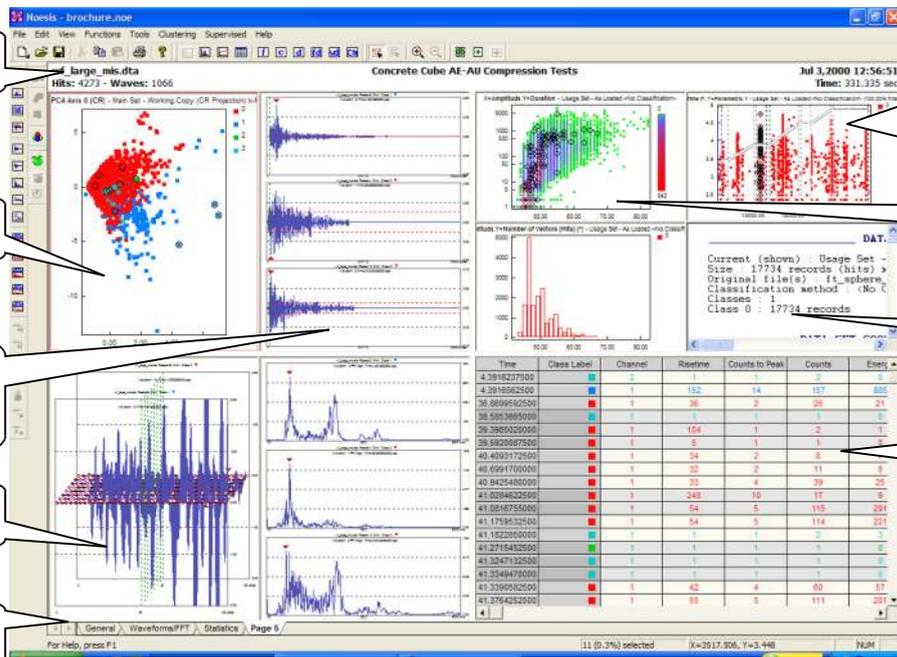
Envirocoustics SA presents *Noesis v5.0*. Noesis specializes in Acoustic Emission (AE) data analysis including real-time software feature extraction and data classification. The GUI is unique to Noesis with an intuitive way of setting up plots and arranging them in pages, giving high flexibility and a friendly working environment. Noesis, has been recognized by industry and research institutions, as the most advanced tool for AE data analysis and it is currently used in a large number of AE applications world-wide, from industrial inspections to aerospace research. It provides all the tools an analyst would like to use in industrial applications as well as for research

purposes with its very advanced data manipulation functions. The data handling capabilities and overall functions of the software have been further improved in this version. All Noesis functions are available to the user with a few mouse clicks, and special wizards are available, resulting in the most time effective means of treating AE data for any application. PR and Neural Network algorithms, in combination with the FX function and arbitrary data set and wave form support, allow deep investigation of any data set, making Noesis a powerful research tool. Moreover, all Noesis features are available for the real-time analysis of data.

General Specifications

- Windows 9x, NT4, 2000 and XP compatible.**
- Custom Page Interface.** A unique way of interfacing with the software and creating graphs and page layouts.
- Noesis supports all **PAC (DTA, TDA, WFS)** AE data files (SPARTAN, MISTRAS, DiSP, PCI-2 with DOS or AEwin™ software) and **ASCII (TXT, DAT)** files including **ASCII Waveform files** (subject to Edition). Fast load techniques make large AE files easy to use.
- The Noesis Document format for handling and storing files

- provides the user with a **compact and complete way** to store all information, from data to Supervised training strategies.
- Image and data copy/paste** functions for document creation integration with other Windows applications.
- Noesis utilizes **Windows features and conventions** including **Wizards** for navigating through menus, selecting properties etc.



Page header with file/test info.

Typical scatter plot. Colored by class.

Wave view with threshold and start lines. Corresponding FFTs below.

3D Multi-wave view. Zoomed.

Page tabs for navigation.

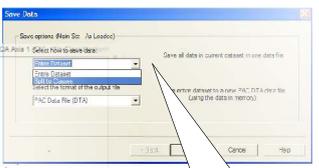
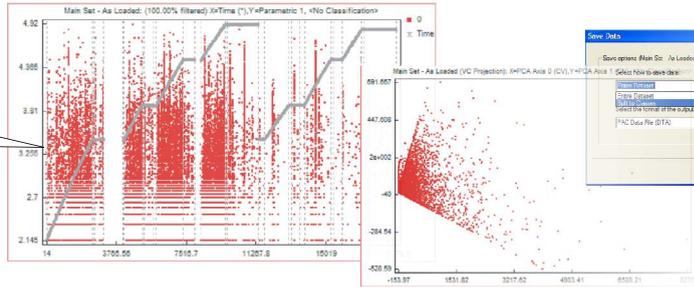
Background plot (grey points) in synch zoom with foreground scatter plot for detailed hit selection.

Density (color-by-value) scatter plot.

Statistics view.

Data table with class colors. Selected hits highlighted grey.

Typical AE data plots: Duration-Time (superimposed load), and Projection scatter plot (max separation space).



Save wizard. Treated data can be saved to any format.

Data Viewing

Noesis supports **scatter, density (color-by-value), line, bar, cumulative plots** as well as **tabular active views** of any data set.

All **plots can be fully customized** with minimum effort through advanced properties dialogs.

Zoom using On-Plot mouse selection or manual range setting.

Plot Panning so that data can be investigated in detail without unnecessary zoom-in, zoom-out functions.

Reverting to complex graph setups is made simple through the Noesis WorkspaceLayout file **save/load capability**.

Simple **copy/paste plot properties** function generates duplicate plots with great ease.

The **Custom Page Interface** function allows the user to **create pages and choose their layout effortlessly making working with Noesis easy and productive**. All page customization is done through a dedicated Properties dialog and the workspacesaved in aNWL file.

Special functions for Event graphs, including hit sequence and group selection (applied to any plot) and area plots (X-Y-Z) for location results presentation..

Data Handling

Any number of **data points can be selected with the mouse** or pre-set operations including logical selection modes. **Selections reflect on ALL views**, drastically enhancing the users insight, even in real-time.

Data can be **filtered**, either **graphically** in plots, or from the data set (data point removal) with simple **filtering, selection and delete operations**. **Complex Filtering** can be applied through the Data Filters dialog with set-up save/load capability. Entire time segments can be removed.

Data projections can be generated based on covariance and correlation matrices to project the data to a maximum separation space.

Copy/Paste operations are available for data transfer to other applications. This includes data, waveforms/DSP/FFT and bin values in cumulative or bar plots.

Data sorting to any feature (Time, FX Time, other features).

Import external (user generated) parametric files.

Work with TimeDriven Data only.

Waveform Feature Extraction (FX) for the whole data set. **Full hardware control**. Noesis can extract features even **break-down waveforms to multi-hits**. FX supports FX in time and frequency domains.

Calculated Features (CF) can be added to the data using mathematical operations between existing features (subject to Edition). A feature calculator is available with even trigonometric and log functions.

Zonal Source Location is implemented in an extended format so that the user gets information about all the hits involved in an event in the Event Sequence feature.

Linear 3D (xyz) Source Location with spatial sensor positioning and Global/Local location strategies including a neighbouring sensor techniques.

The screenshot displays the Noesis software interface with several key components highlighted by callouts:

- Data Table displaying selection:** A table at the top left showing columns for Time, Class Label, Channel, Realtime, and Counts to Peak.
- Complex Filter dialog:** A dialog box titled 'Filter Setup' with multiple filter sections (Filter 1-4) for selecting and rejecting data based on various characteristics.
- Filtered Scatter Plot (part of selection filtered):** A scatter plot in the top right showing data points with some points highlighted in red, indicating they are filtered.
- Scatter Plot displaying selection:** A scatter plot in the middle right showing data points with some points highlighted in red, indicating they are selected.
- Log scale Plot displaying selection:** A scatter plot in the bottom right showing data points on a logarithmic scale, with some points highlighted in red.
- Data Projection displaying selection:** A plot in the bottom middle showing data points in a 2D space, with some points highlighted in red.
- Multi-Wave Plot with class colors displaying selection:** A waveform plot at the bottom left showing multiple waveforms in different colors, with some segments highlighted in red.

Data Statistics

Min, Max, Mean, Skewness, Curtosis etc. for all datasets.

Feature **correlation** matrices and **dendrograms**

Various **criteria** for vector/feature statistics (Wilk's, Rij etc.)

Class Statistics (cluster centers,

cluster distances etc.)

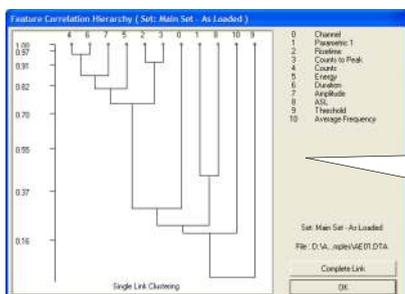
Channel Statistics (min, max, total etc)

Amplitude Distribution tables.

Periodic statistics provide a means to monitor class evolution and other periodic features.

The screenshot shows the 'Location Setup' dialog box, which includes fields for Group, Channel, Type, Wave Velocity, Units, Location, Date, Class (C), and Actual Date. It also has buttons for 'OK', 'Cancel', and 'Apply'.

Location setup dialog.



Dendrogram showing feature correlation.

DATA SET COORDINATES (FEATURES)			
Feature 0	:	RISE Risetime.
Feature 1	:	PCNT Counts to Peak.
Feature 2	:	CNTS Counts.
Feature 3	:	ENER Energy.
Feature 4	:	DURA Duration.
Feature 5	:	AMPL Amplitude.
Feature 6	:	AFRO Average Frequency.

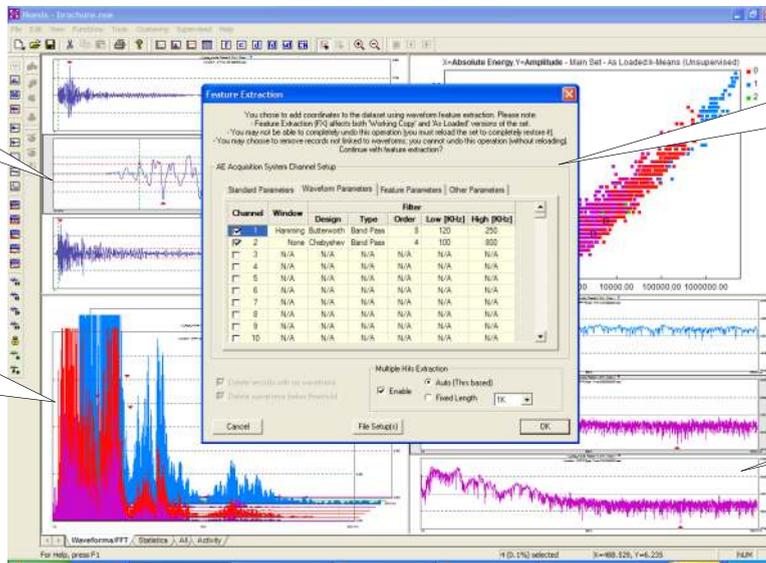
FEATURE DISCRIMINANT STATISTICS			
Ord	Name	Wilk's	Rij
0	Feature: 4 (DURA)	0.1082	0.7677
1	Feature: 2 (CNTS)	0.1544	0.1398
2	Feature: 3 (ENER)	0.2130	0.0162
3	Feature: 5 (AMPL)	0.2351	1.9756
4	Feature: 0 (RISE)	0.4220	6.9760
5	Feature: 1 (PCNT)	0.4535	4.8252
6	Feature: 6 (AFRO)	0.9303	27.3253

Noesis Feature Statistics.

Waveforms / DSP

Waveforms can be displayed in any split window view. **Multiple waveforms** can be displayed in any view. Waveform views can be **fully customized**.
 Waveform Streaming support (WFS files), Long waveform support (TDA files) from PAC TRA wave data and ASCII Wave file support.
 Advanced waveform viewing including **DSP Filters (fully customizable)** and graphical filtering.
3D presentation of multiple waveforms or waveform FFTs.

Digital Signal Processing on waveforms (Autocorrelation, RMS, FFT Real, Imaginary, Magnitude, Phase, Power Spectrum).
Waveform Segment FFT viewing and feature extraction. Graphical and Box (Range) **Zoom functions** for all waveform and FFT views including selection range synchro, auto-scale, and user-range.
Data selection from waveform views including logical modes.



Multi-wave window with single waveform zoom

3D multi-FFT view by class color, zoomed for signal FFT comparison

Feature Extraction Set-up

Multi Power Spectrum view

Unsupervised Pattern Recognition (UPR)

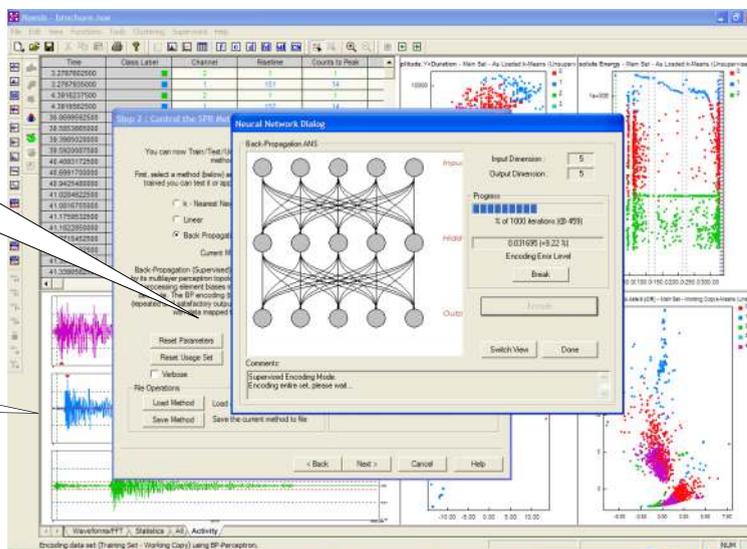
UPR Wizard. Guided wizard for a complete UPR on any data. It provides full information, suggestions and tools for even novice users to perform PR.
Data pre-processing, normalizing, projection generation etc. to assist in more efficient and arithmetically solid clustering via UPR.
Multiple UPR algorithms, including Neural Networks, for clustering data (Max-Min Distance, k-Means, LVQ Net etc).

All actions are applied to a **Working Copy** of the data leaving the **Main Data Set** unaffected for better result viewing and reporting.
Manual clustering is available for evaluation and classification using common AE practices.
Classification result output to PAC compatible files.

Supervised Pattern Recognition (SPR)

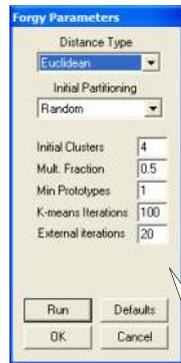
SPR Wizard. A complete, guided "toolbox" for training SPR methods, with information, suggestions and tools to complete an SPR training with ease.
 Automatic **Usage Set (unknown data)** pre-processing based on **Noesis Script Log**.

Multiple SPR algorithms including Neural Networks (k-NNC, BP Net etc.).
Interactive SPR algorithm **training and testing** modes.
Classification results output to PAC (*.DTA) files.



The SPR Wizard has launched the Neural Net Interactive dialog and the method is being trained.

UPR results reflect on all views.



Typical UPR algorithm settings dialog

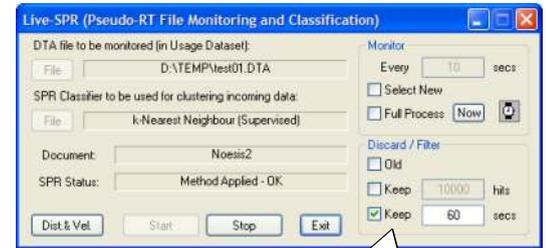
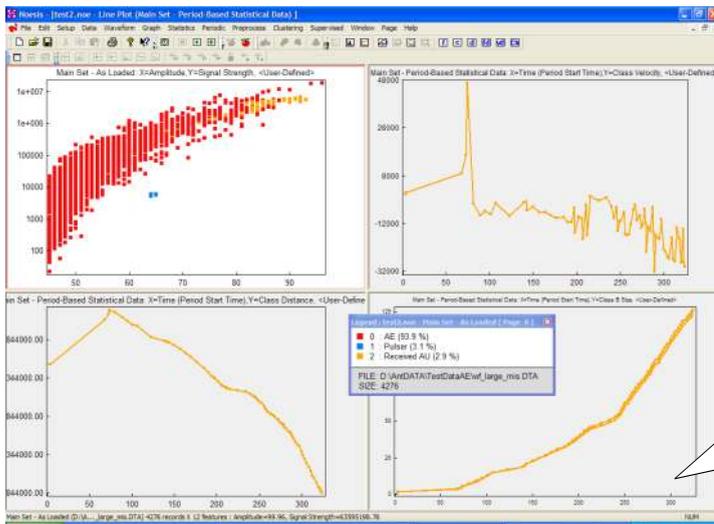
Data Classification during Acquisition (Live-SPR)

Live-SPR is a complete set of Noesis functions to read and classify data during acquisition.

During Live-SPR the **data can be manipulated as in post-processing**. Change graphs, add graphs, select data, get statistics, change scales etc.

Periodic Statistics is a set of Noesis functions for monitoring cluster evolution and other features at certain intervals.

Periodic Statistics can be applied either during acquisition or in post-processing.



Noesis is displaying, classifying and processing data as it is acquired. Shaded plots are live periodic statistics.

Live-SPR dialog for real time data classification.

Noesis Editions and Modules

NOESIS Editions refer to the various installation options for the basic software configuration. NOESIS Modules refer to the extra options available for installation in any Edition.

Editions Description

Light

***Noesis Light Edition** comes with full support for PAC DTA, TDA and WFS acoustic emission data files with save and export capabilities. It includes all basic software functions such as: ***Pages**, all plot types (scatter, bar etc) with plot management, **graphical filtering**, background plots and tabular data views ***export or copy** plot and page images ***multiple data file** loading and time management *hit sorting/time ordering *hit selection and hit correspondence in all views *data/time deletion *import external parametric file *complex **data filters** ***statistics** *copy/paste operations *advanced waveform viewing/handling ***FFT**, Power Spectrum, Autocorrelation, RMS and other DSP features ***Windowing and Filters** ***Waveform Feature Extraction** supporting new features and user defined settings.

Professional

*The **Professional Edition** includes: ***ALL** the functions of the Light Edition ***Multiple Hits extraction** from waveforms ***segment Wave/FFT** views *Calculated and **User Defined Features** including a **Feature Calculator** with functions such as trigonometric and logarithmic *Unsupervised Pattern Recognition (**UPR**) and the Supervised Pattern Recognition (**SPR**) algorithms and functions relating to PR (e.g. pre-processing, axes projections etc) * extended data sets (testing, training, usage) ***advanced statistics** and correlation plots ***data projections** for all data are also available.

Modules Description

TXT (ASCII File Support)

Allows the use and manipulation of text (ASCII) **data** and **waveforms** in tab delimited files, using all Noesis filtering, viewing, clustering, SPR, UPR functions.

LOC (Location Module)

Provides **Multi Sensor Group Zonal and Linear 3D Location** for PAC (DTA, TDA, WFS) files including First Hit determination, Event Sequence of arrival and spatial source location between sensors. Noesis Location can use extracted arrival times (from Feature Extraction) to further investigate acquisition settings in location.

Enterprise

*Noesis Enterprise Edition contains **ALL** features described above for the Light and Professional Editions along with Live-SPR. This is a Noesis function that allows **real-time feature extraction and classification of data from DTA or WFS** files with graphs and all other Noesis functions.

***All modules** described below are also included.

For more information about Noesis please contact Envirocoustics SA at:

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Noesis is also available through Physical Acoustics Corp sales network. Contact PAC through www.pacndt.com.