



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



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What's NEW

NOESIS 5.0

Major Changes

- 1) New Pages function with auto/manual graph arrange functions.
- 2) Live-SPR with WFS files (real time extraction from Noesis) with all graphs, tools etc.
- 3) Arbitrary Waveform data import (ASCII file).
- 4) Extraction of multiple hits from saved waveforms (DTA, WFS, TDA). Post-processing acquisition.
- 5) Waveform Filters (Butterworth, Bessel etc) in plots, Feature Extraction, and export data.
- 6) Windowing (Triangle, Hamming etc)
- 7) Faster drawing for graphs and waveforms.
- 8) New data input format for many dialogs (grid).
- 9) Better memory usage to enhance manipulation of large files (Working Copy on demand).
- 10) Save DTA files from WFS, TDA, even from ASCII Waveforms.
- 11) Export graphs, single page or all pages to image files.
- 12) Page Headers for image export reporting and traceability.
- 13) Complete menu re-design to improve usability.
- 14) Event Select mouse mode. If selecting any hit all hits that belong to the same event are selected.

Minor Changes

- 1) Improved status bar info.
- 2) F7 and F8 for Previous-Next page viewing.
- 3) No data capability in plots.
- 4) Minor problem solving.
- 5) Remove not needed dialogs and functions to improve speed and usability.
- 6) Copy Bin Values from binned plots.
- 7) Log scale for binned plot axes.

OVERVIEW

- “Nous” (*Νους*), in the Hellenic language means brain
- “Noimosini” (*Νοημοσύνη*) means intelligence.
- “Noisi” (*Νόηση*) is the Hellenic origin of the word NOESIS, denoting intelligent thinking and, in general, the entire set of actions and procedures that a human brain performs resulting in intelligence.

The name, aims to emphasize the transfer of some of the “Nous” actions and intelligence to the computer for the analysis and evaluation of Acoustic Emission (AE) and NDT data in general.

**NOESIS is Specially Designed and Optimized
for Acoustic Emission Data Analysis &
Applications Development**

OVERVIEW

NOESIS has been used successfully for:

Noise Filtering, Failure Mechanisms Identification, Source Characterization, Severity and Criticality Evaluation, Automatic Classification Through Pattern Recognition and Neural Networks

USERS:

Laboratories and Research Organizations, Aerospace, Petrochemical Industries & Refineries, Power Production, NDT Testing Companies.

APPLICATIONS:

Static and Fatigue Testing (Composites, Metals and Concrete), Full Scale Testing, Pressure Vessels Testing, Tank Testing and Leak Detection.

NOESIS 5.0

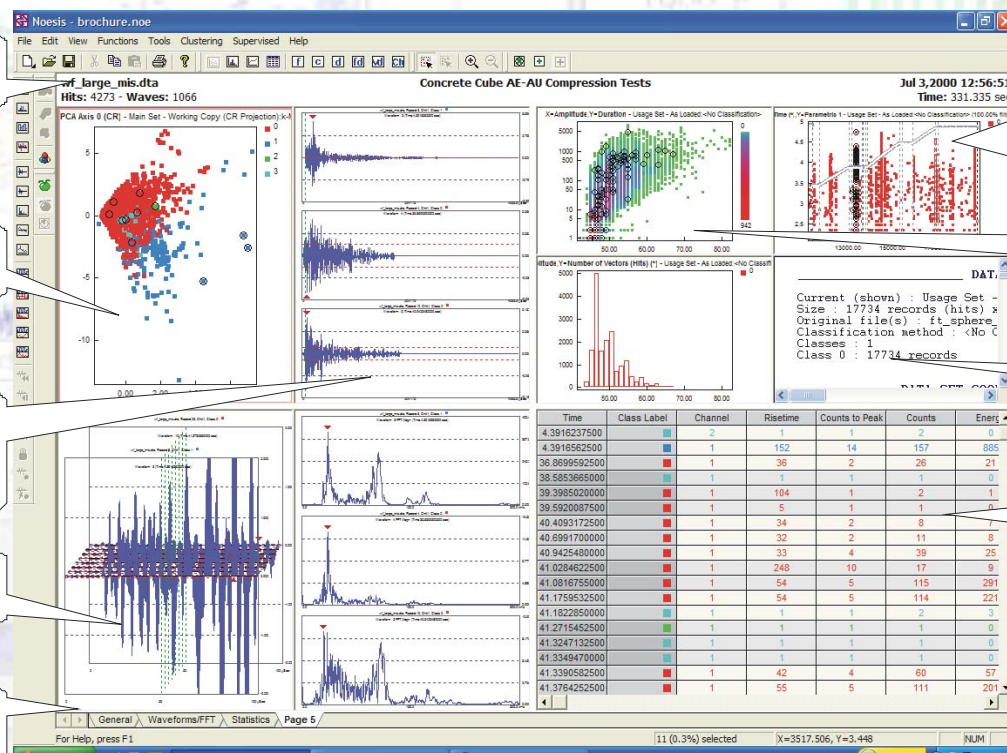


OVERVIEW

The software development is based on the **Visual Object Oriented** philosophy, resulting in a high degree of sophistication.

It has been designed to be **“User-Friendly”** and operates under Windows 9x, NT4, 2000 and XP.

NOESIS 5.0



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.

HIGHLIGHTS & UNIQUE FEATURES



Classical AE Analysis

- **PAC FILES I/O (Under License from PAC): READ AND WRITE PAC DTA, TDA, WFS** files from PCI-2, DISP, LOCAN, SPARTAN & MISTRAS.

MULTIPLE FILES SUPPORT (MERGE & SPLIT OPTIONS)

- **Other Files Supported:** ASCII Files, NOESIS & Class Files
- **DATA TYPES:** AE Hit data, time driven data, waveforms and system set-up information
- **GRAPH TYPES:** All classical AE graphs. Scatter/Correlation Plots, Distribution, Cumulative, History /Time, Activity, Waveforms and FFT. Hits table (listing mode).
- **MULTIPLE SPLIT WINDOWS & BACKGROUND PLOTS**
- **GRAPHICAL FILTERS**
- **HIT - POINT - WAVEFORM CORRESPONDENCE:** **Select one or more hits with mouse see it highlighted in ALL other graphs and listing mode**

Advanced Data Handling & Filtering

- **ADVANCED VIEWING:** Zoom & Panning, Dynamic Window Split, Multiple Symbols & Colors.
- **FILTERING:** Data points can be selected by mouse and selection reflect on ALL views.

ADVANCED DTA FILTER DIALOG SUPPORTS AND/OR, ACCEPT/REJECT MODES FOR COMPLEX FILTER SETUP

MOUSE SELECTION WITH LOGICAL AND/OR FROM DIFFERENT SCATTER & CUMULATIVE PLOTS

SELECTED DATA CAN BE DELETED, GROUPED OR TRANSFERRED TO OTHER APPLICATIONS BY SIMPLE COPY PASTE OPERATIONS

- **NORMALIZATION & DATA PROJECTION (Principal Comp.)**
- **STATISTICS:** Correlation, Descriptive (Min-Max, Mean Var.) & Discriminant Analysis.
- **CALCULATED FEATURES & WAVEFORM FEATURE EXTRACTION**

Pattern Recognition & Neural Networks

- **DATA PREPROCESSING:** Feature selection, normalization, principle axes analysis etc.
- **POWERFUL UNSUPERVISED ALGORITHMS:** Max-Min Distance, K-Means, Forgy, Cluster Seeking, ISODATA and LVQ NEURAL NET.
- **FLEXIBILITY:** Automatic or User Defined Initial Partition, Distance and Algorithm Parameters.

CLASSIFICATION RESULTS OUTPUT TO PAC dta FILES RESULTING IN ADVANCED FILTERING

DYNAMIC INTERFACE BETWEEN UNSUPERVISED & SUPERVISED ALGORITHMS

- **SUPERVISED ALGORITHMS:** k-Nearest Neighbor, Linear and Back Propagation Neural Net.

CLASSIFIER STORED FOR AUTOMATIC PREPROCESSING & CLASSIFICATION OF NEW DATA FROM SUBSEQUENT TESTS

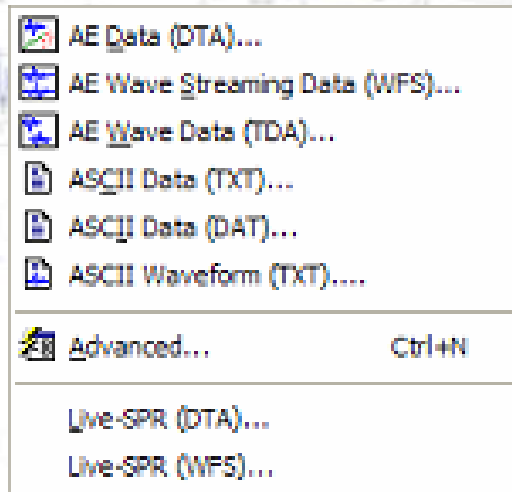
NOESIS 5.0

NOESIS DOCUMENT

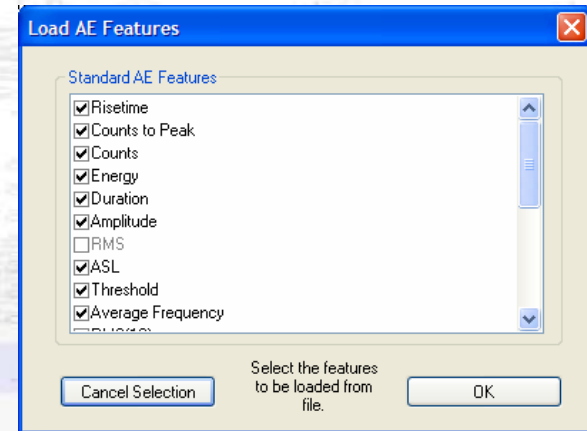
Files & Data I/O

- The NOESIS Document contains the DATA FILE(S) loaded, the PAGES and VIEWS the user has created, the CLUSTERING information, the PREPROCESSING (normalization etc.) performed, the TRAINING/TESTING strategies and the SUPERVISED algorithm along with any UNKNOWN data for supervised classification.
- The DATA FILE(S) (**any number of data files per document**) are PAC DTA, TDA or WFS files from LOCAN, SPARTAN, DiSP, LAM, MISTRAS, PCI-2 systems or ASCII data and waveform files.

NOESIS 5.0



Data file types that can be loaded



Selecting the features to be loaded from these files

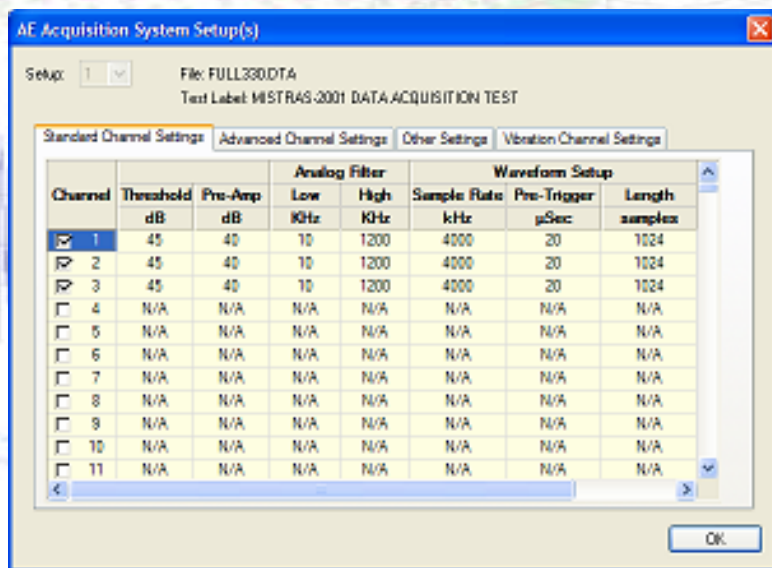
NOESIS DOCUMENT

Files & Data I/O

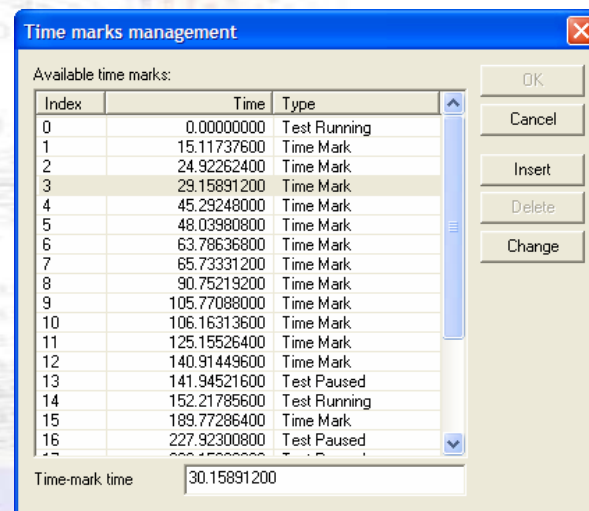
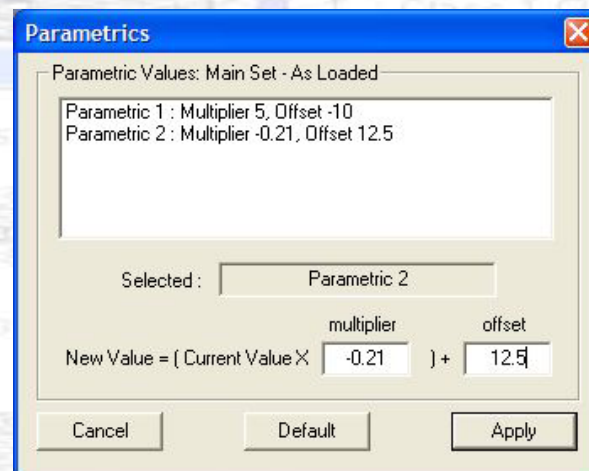
The information retrieved includes:

AE hits (hit features), Time Driven Data,
Hardware Settings, Waveforms,

Time Messages (Time Marks, Pause, Run, Stop).



Hardware setup for every file and channel loaded



User defined Parametrics setup (Load, Displacement, etc..) in HDD and TDD data and Time Mark management

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NOESIS DOCUMENT

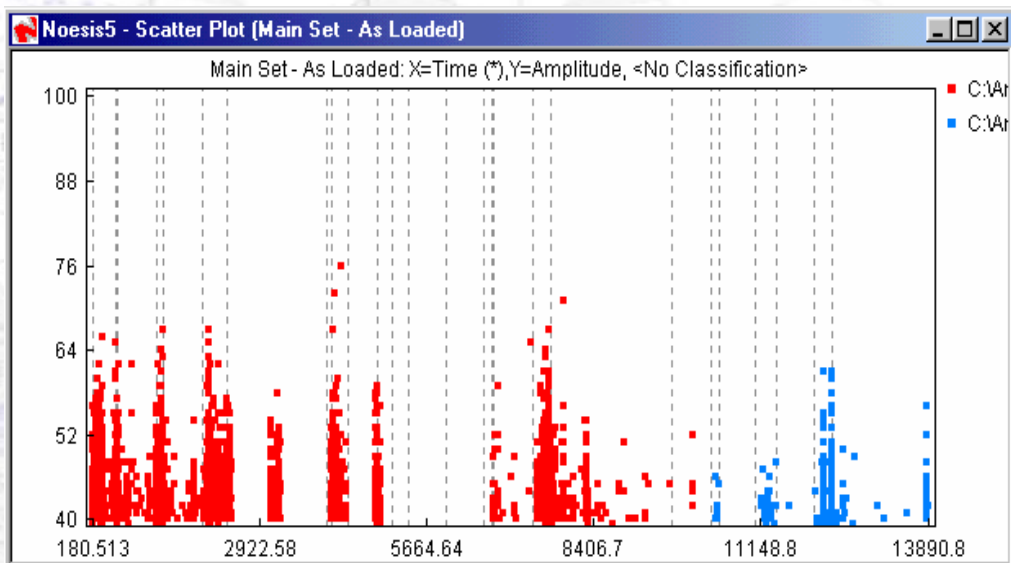
Files & Data I/O



The capability of NOESIS to load multiple data files in each NOESIS Document is complemented with **TIME MERGING** to arrange the multiple files in time (FILE MERGING).

Data can be EXPORTED to PAC DTA or TDA file format. Clusters (groups of data) can be created and exported to DTA files effectively providing a very advanced tool for **FILE SPLITTING** and for creating filtered files through the advanced filtering and selection capabilities of NOESIS.

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Two files loaded and merged sequentially in time

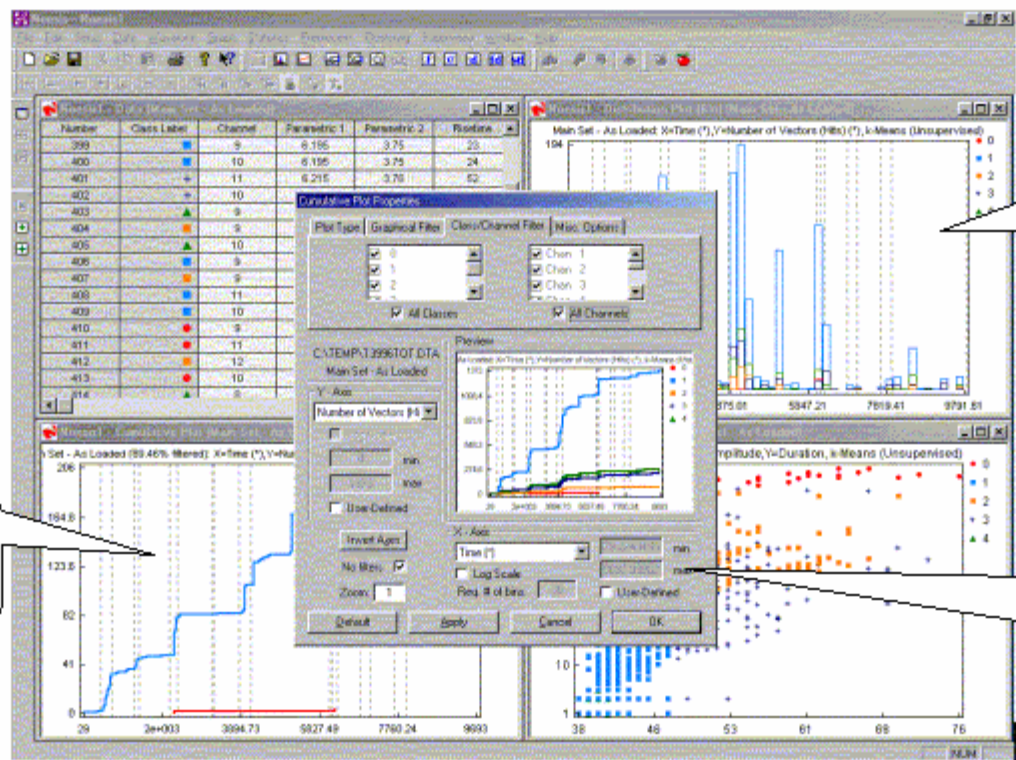


DATA VIEWING

Basic Graphs & Views

- All plots can be fully customized (from plot type to axes scaling and feature to font type and size) using the plot properties dialog, with just a simple mouse right-click.
- A large variety of plots are available including all classical AE analysis plots.
- Pages set-up resulting in multiple SCREENS with any combination of graphs.

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Cumulative Plot with active class/channel filtering

Number of Hits Bar Plot with Time Marks

Plot Properties Dialog with Preview and Class/Channel Filter tab activated

DATA VIEWING

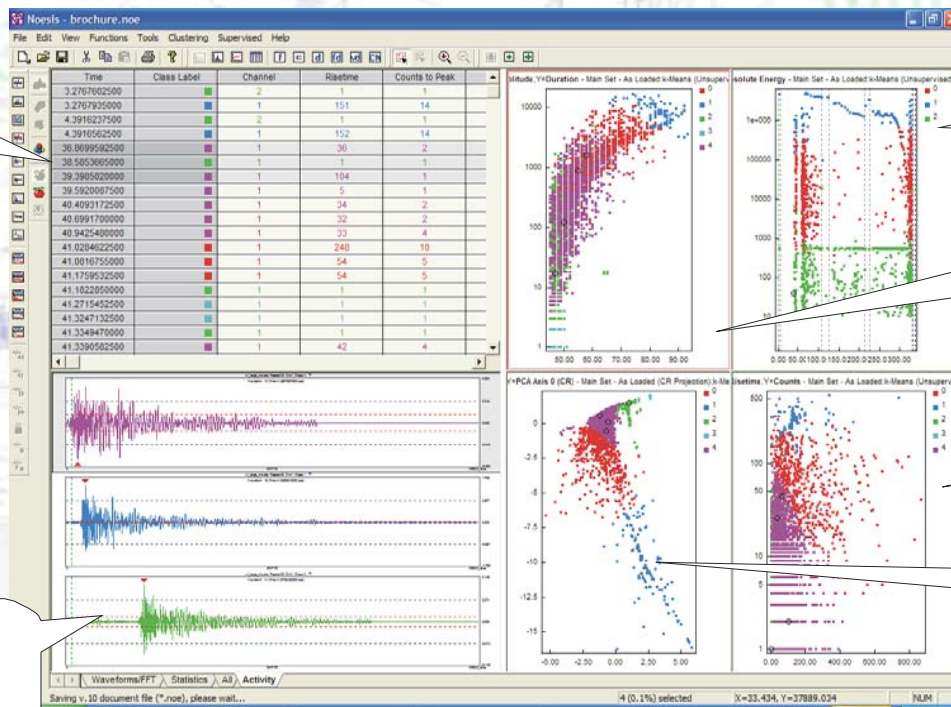
Basic Graphs & Views



- Selections can be made on ANY plot type or view, using the mouse.
- Selections are reflected on ALL plots and views resulting in powerful HIT-POINT-WAVEFORM CORRESPONDENCE .

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Data Table displaying selection



Filtered Scatter Plot (part of selection filtered)

Scatter Plot displaying selection

Log scale Plot displaying selection

Data Projection displaying selection

Multi-Wave Plot with class colors displaying selection



DATA VIEWING

Advanced Waveforms and Feature Extraction

- Waveforms plots can be used as ordinary plots including simple formatting and SELECTION ability.
- FFT (imaginary, real etc.) and Power Spectrum for any waveform.
- Advanced Individual, Syncro, User Defined etc. Zoom and scroll (panning) options.
- Feature extraction for each waveform with user defined settings to view changes.
- Complete file Waveform Feature extraction including additional features

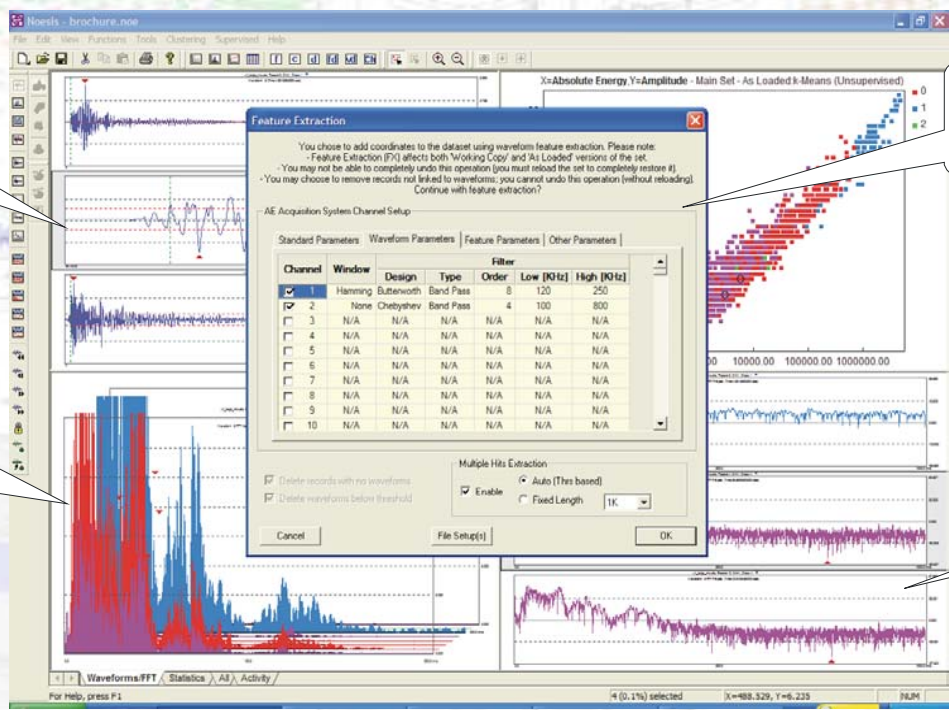
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Multi-wave window with single waveform zoom

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

Feature Extraction Set-up

Multi Power Spectrum view





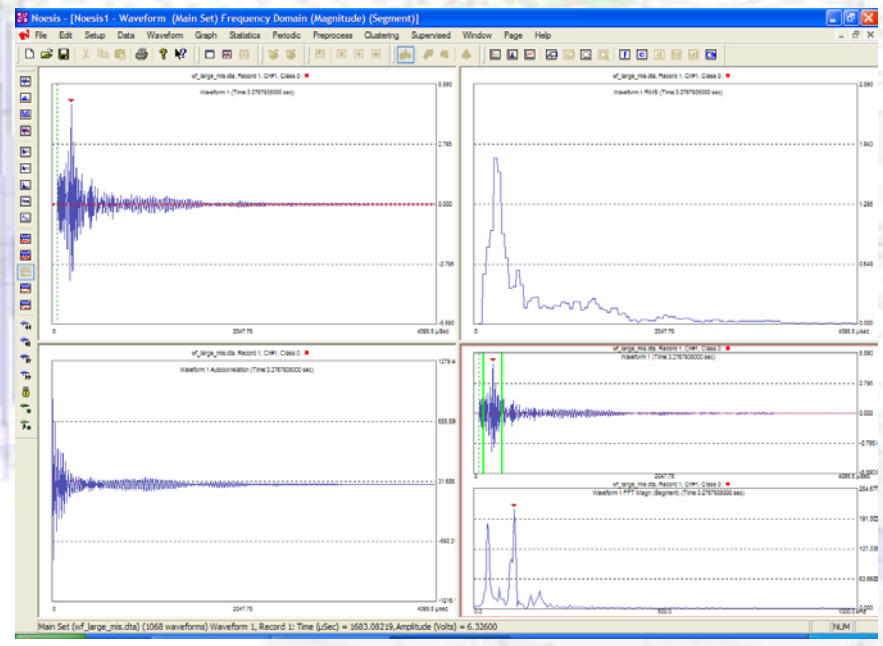
DATA VIEWING

Advanced Waveforms and Feature Extraction

Waveforms plots can also show:

- Waveform RMS (user defined sampling)
- Autocorrelation.
- Apply Filters and Windowing for viewing.
- Segment Waveform FFT views. The user can define a segment of the waveform and get FFT functions for this segment.

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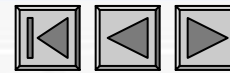


The 'Waveform Plot Properties' dialog box is shown with the 'Signal Filter' tab selected. It contains the following settings:

- Window: Type: 0. None
- Filter: Design: 1. Butterworth, Type: 2. Band Pass, Order: 8, Ripple: 10, Low Freq [KHz]: 100, High Freq [KHz]: 20
- Preview: A small plot showing the filtered waveform.
- Y-Axis: min: 0, max: 0, Use Range: , Auto Range: , Syncro Selection:
- No filters: Events:
- X-Axis: min: 0, max: 255, Use Range: , Auto Range: , Syncro Selection:

Buttons at the bottom: Default, Apply, Cancel, OK.

ADVANCED DATA HANDLING & FILTERING



Hits can be selected from scatter plots, cumulative (no bins), listing mode, waveform/FFT plots, and the selection is reflected on ALL other windows including projections. Selected points remain enabled, while the user moves from one window or view to another, allowing a selection that is based on several criteria:

LOGICAL AND

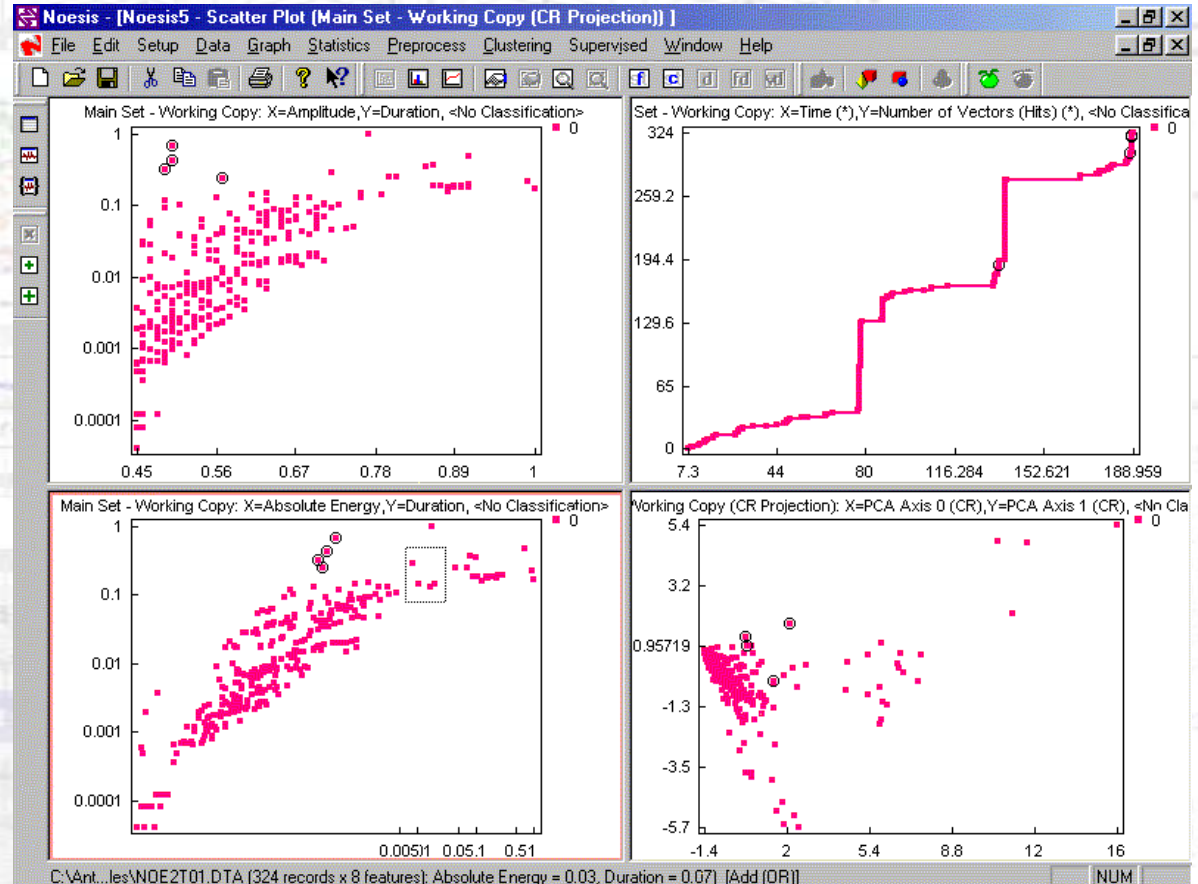
Adds points to the pre-selected points. The additional points can be selected from another scatter/cumulative plot.

LOGICAL OR

Accepts previously selected points, only in the case of common hits in the existing and the new selection, i.e. sub-select points.

LOGICAL AND NOT

Accepts previously selected hits, only if these are outside the new selection.



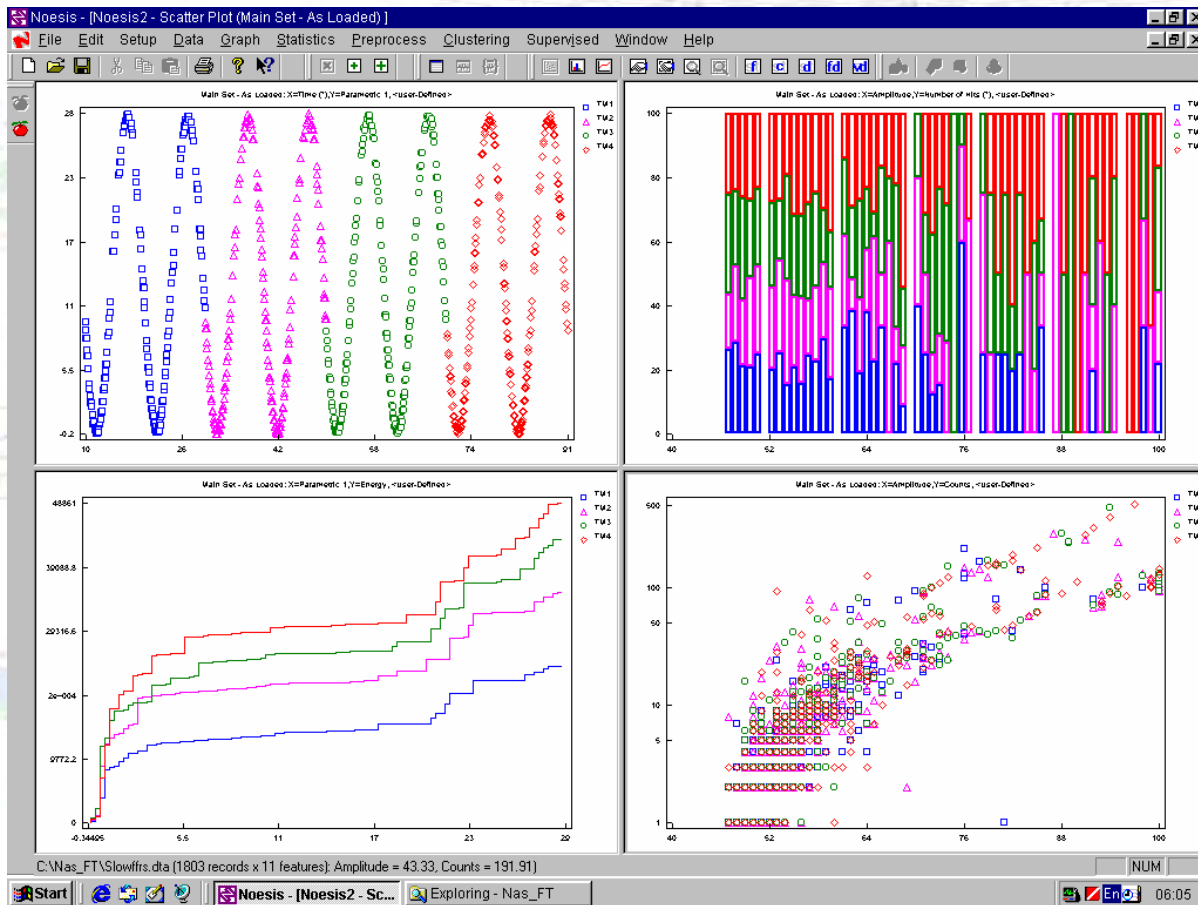
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DATA HANDLING & FILTERING EXAMPLE



EXAMPLE OF MANUAL CLUSTERING/ADVANCED VIEWING FOR FATIGUE EVALUATION

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- Manual Selection of loading cycles (each selection is two cycles)
- Amplitude distributions (%) colored by time - period (last periods show higher percentages of large Amplitudes)
- Energy cumulation vs. Load for each period (Energy per time - period increases, possible damage accumulation)
- Typical Counts vs. Amp. Scatter plot (signatures overlap in all periods)



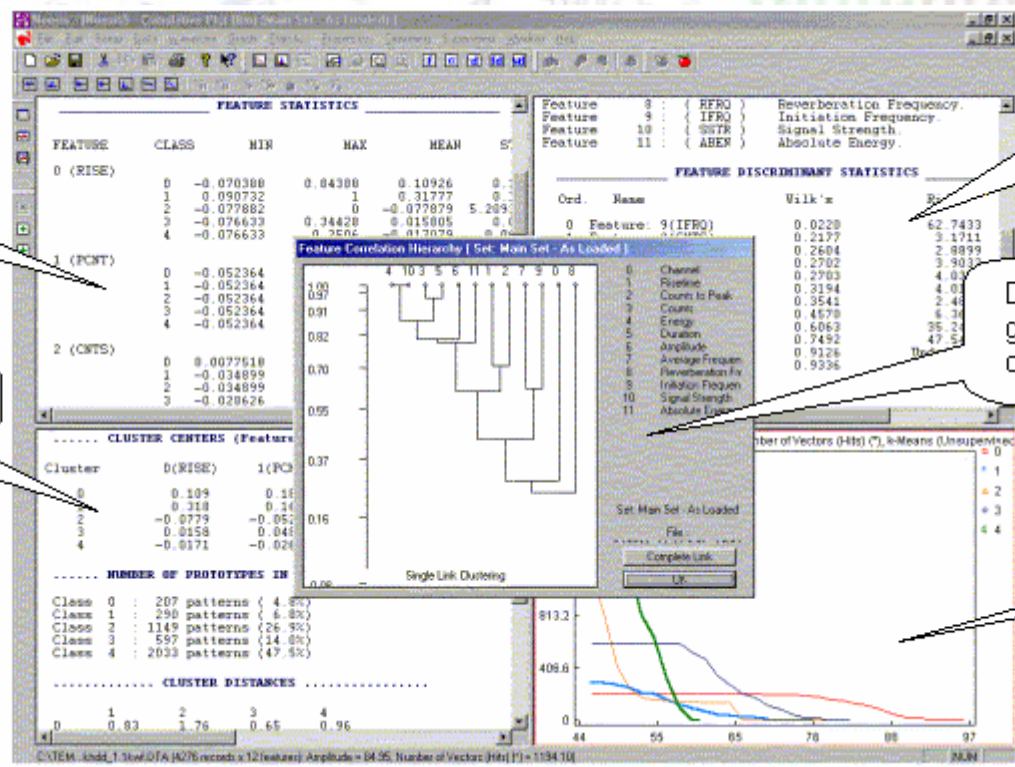
STATISTICS

- Min, Max, Mean, Skewness, Curtosis etc. for all data sets.
- Feature correlation matrices and dendrograms
- Various Discriminant criteria for vector or feature statistics.
- Class Statistics (cluster centers, cluster distances etc.)

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Feature Statistics view

Class Statistics view

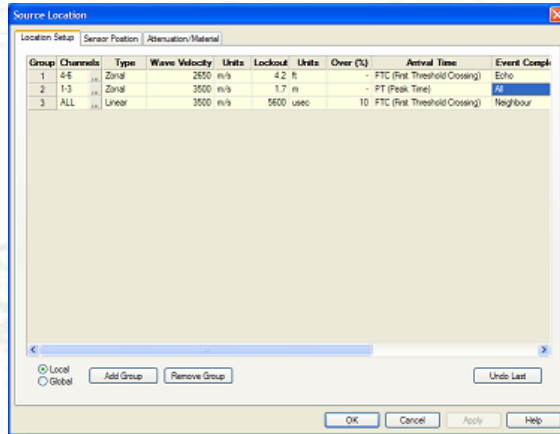
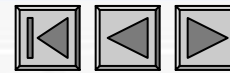


Feature Discriminant Statistics

Dendrogram displaying graphically feature correlation

Max-Min Cumulative Plot

EVENT SEQUENCE & ZONAL SOURCE LOCATION MODULE



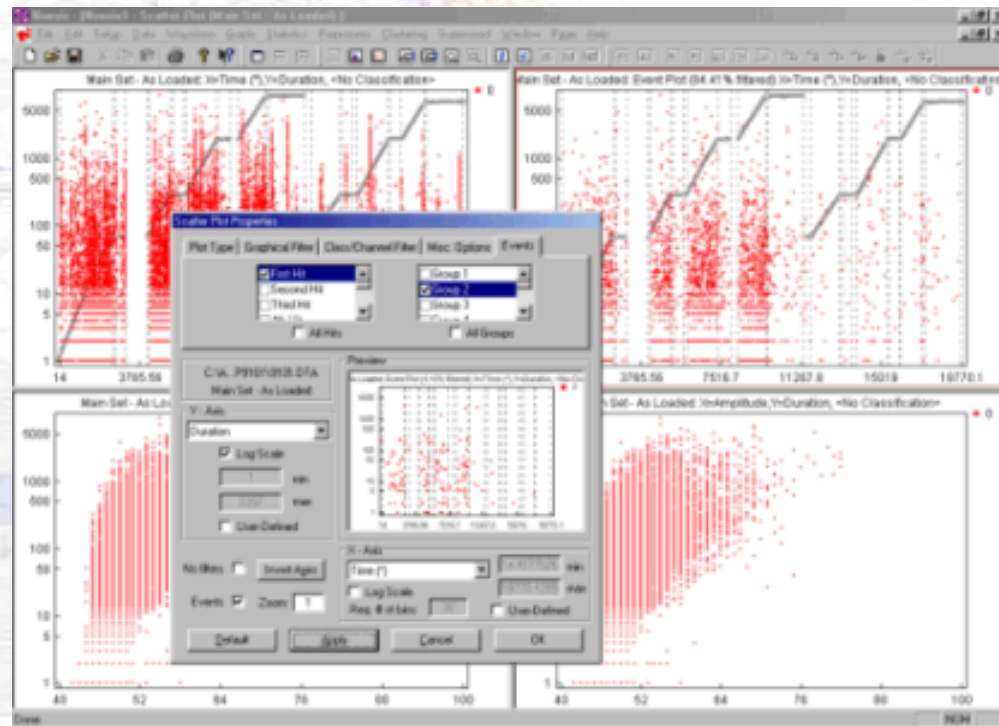
The acoustic emission zonal location set-up dialog:

Simple selections allow the user to add, delete and modify each location group in seconds.

Various units (both SI and Imperial) are supported for international users.

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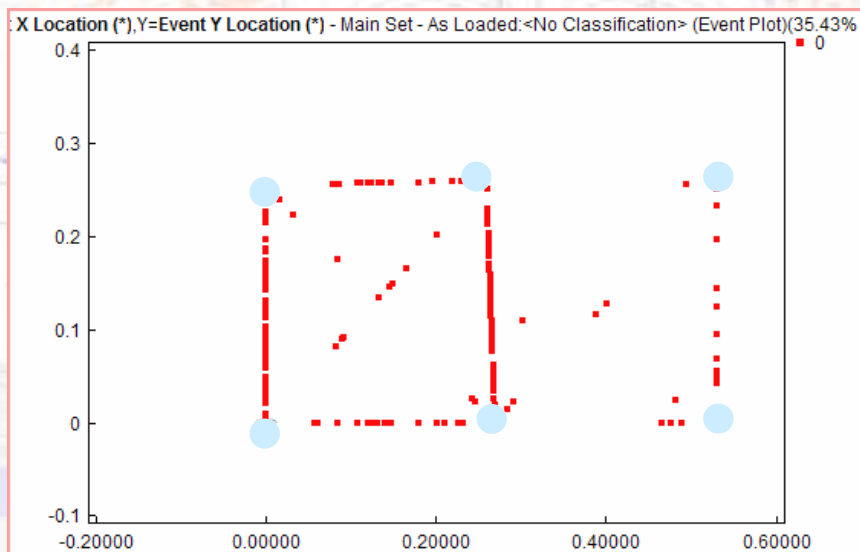
NOESIS typical screen with zonal location information applied to an actual acoustic emission data file (PAC DTA, TDA, WFS format). The plot-properties dialog refers to the upper-right graph and the user has chosen to view the first hits of zonal group 2 only. The difference with the upper left graph where all hits are shown is evident.



LINEAR 3D SOURCE LOCATION MODULE

NOESIS implements a Linear 3D (xyz) location to pinpoint source in 1D, 2D or 3D between sensors. PAC DTA, TDA and WFS files can be used. The data can be shown in any Noesis graph. The example below shows a 2D linear location graph with 6 sensors..

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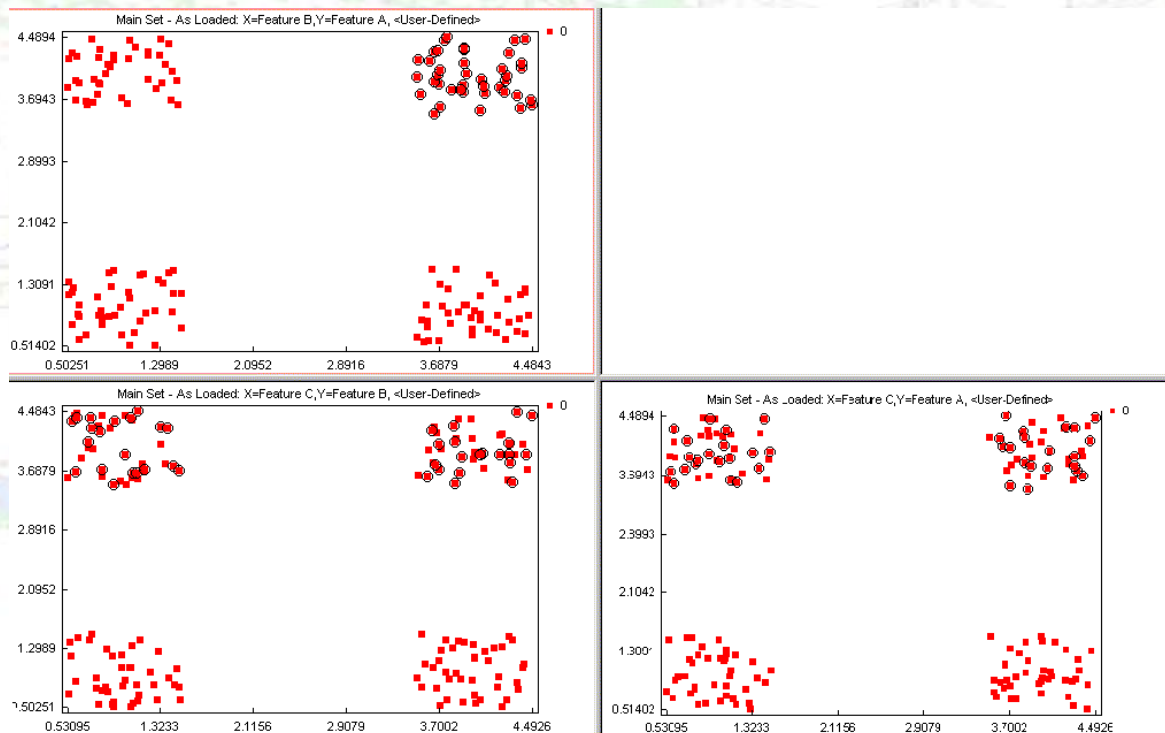


PATTERN RECOGNITION & NEURAL NETWORKS. WHY ?



- Without Pattern Recognition, the user, typically, examines 2-D scatter plots (e.g. Counts vs. Amplitude) to identify AE sources (corrosion, crack growth, leak etc.) and discriminate noise (bangs, EMI etc.). This is not always possible – Data overlaps in 2-D
- To realize that, consider the following example of artificial data, with three features; Feature A, Feature B, Feature C. What is the structure of the data?

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- Observing one 2-D plot (A vs. B), four distinct clusters appear. Is this the solution? Let's select one of them.

- Observing the remaining two possible scatter plots (B vs. C and A vs. C) the cluster “breaks”!
- Solution is difficult to visualize with 2-D plots.

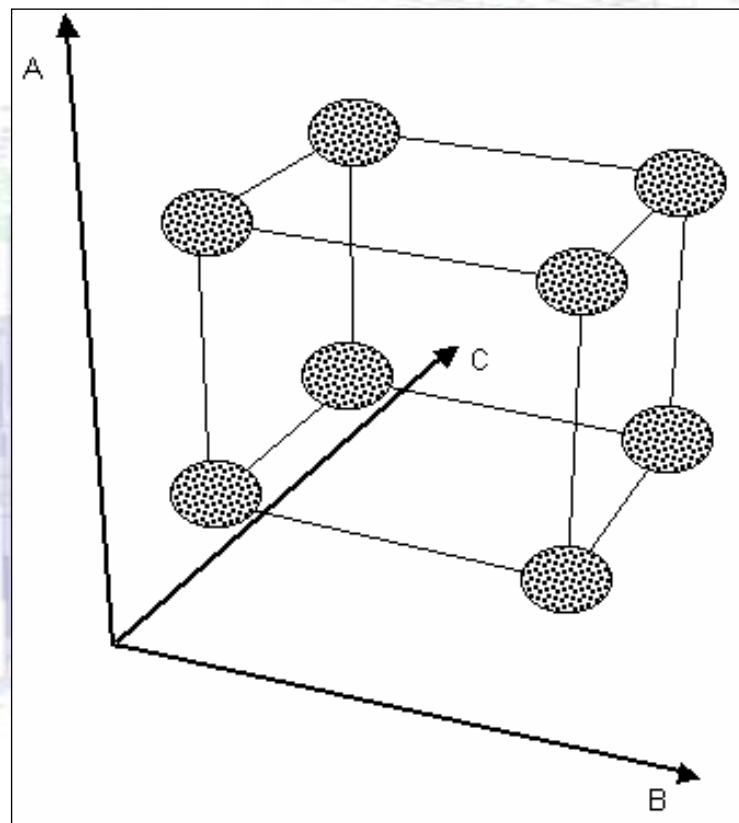
PATTERN RECOGNITION & NEURAL NETWORKS. WHY ?



THE REAL DATA STRUCTURE OF THE PREVIOUS DATA SET !

Cluster	Percentage
Receiver	2.1 %
Class 1	2.5 %
Class 2	66.3 %
Class 3	10.2 %
Class 4	21.5 %
Pulsar	2.5 %
Class 5	4.8 %

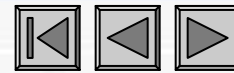
NOESIS 5.0



- The data set actually contains 8 distinct clusters.
- Even for this simple case with three features, 2-D plots proved inadequate for the user to distinguish the data structure.
- Only the 3-D plot identified the structure (visually).
- In the case of AE data, there are many AE features (usually more than 5 to 20, even more).
- The problem of identifying the data structure becomes tremendously complex, as humans can't visualize more than 3 features at the same time.

Solution: Clustering algorithms can work in multi-dimensional space (they use all desired features) to identify data structure and divide the data into clusters.

HOW DOES PATTERN RECOGNITION & NEURAL NETWORKS WORK ?



- Each Acoustic Emission hit is considered to be a VECTOR in a multidimensional space.
- The coordinates of this vector (hit) are its AE features.
- For instance one hit can be described as:

$$\rightarrow \text{HIT} \equiv (\text{AMP}, \text{CNTS}, \text{DUR}, \text{ENER}, \text{RISETIME}, \text{CNTSTP}, \text{AVGFREQ}, \dots)$$

- Clustering Algorithms segregate the data based on how close the corresponding vectors fall with respect to one another.
- To do so, they calculate the “distances” between these vectors.
- NOESIS 3 offers plenty of clustering algorithms, each one follows a particular “logic” to decide about which vectors will form each cluster.
- There are plenty of user defined parameters and criteria for each algorithm.
- CLUSTERING IS PURELY MATHEMATICAL. THE USER MUST ENSURE THAT THERE IS CORRESPONDANCE BETWEEN THE CLASSES AND THE ACTUAL PHYSICAL PHENOMENA

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PATTERN RECOGNITION & NEURAL NETWORKS

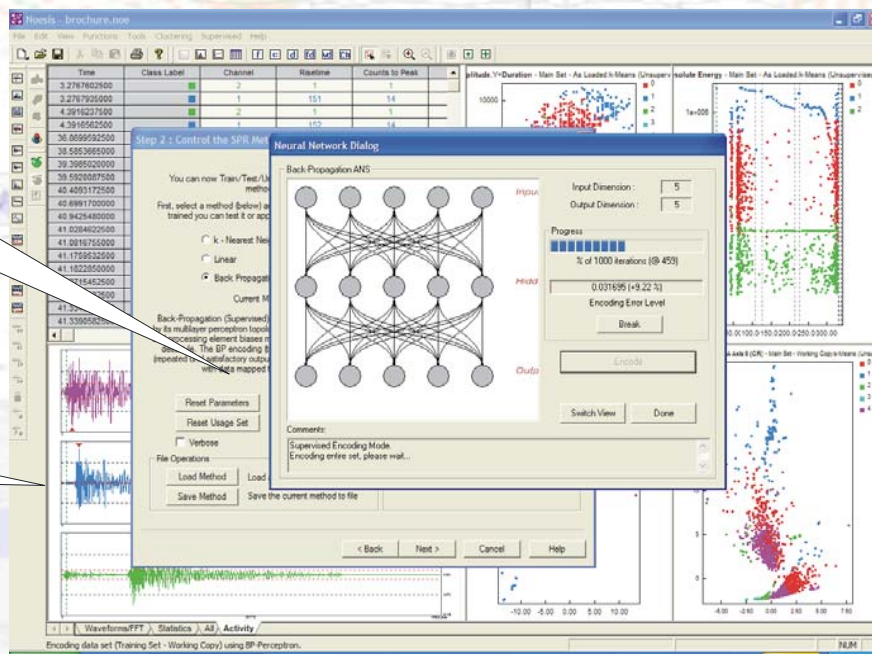


- Multiple UPR algorithms, including Neural Networks, for clustering data (Max-Min Distance, k-Means, LVQ Net etc.) with simple parameters dialogs.
- Manual clustering is available for evaluation and classification using common AE practices.
- Multiple SPR algorithms including Neural Networks (k-NNC, BP Net etc.).
- Interactive SPR algorithm training and testing modes.

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

UPR results reflect on all views.



Forgy Parameters

Distance Type: Euclidean

Initial Partitioning: Random

Initial Clusters: 4

Mult. Fraction: 0.5

Min Prototypes: 1

K-means Iterations: 100

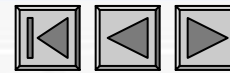
External iterations: 20

Run Defaults

OK Cancel

Typical UPR algorithm settings dialog

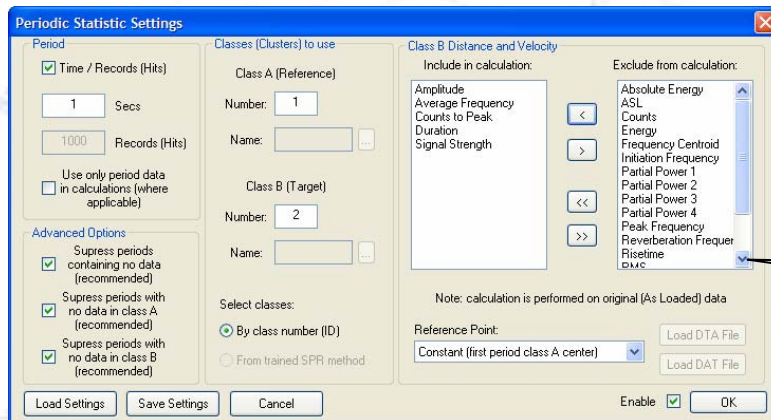
Live-SPR. Real-time data classification and processing.



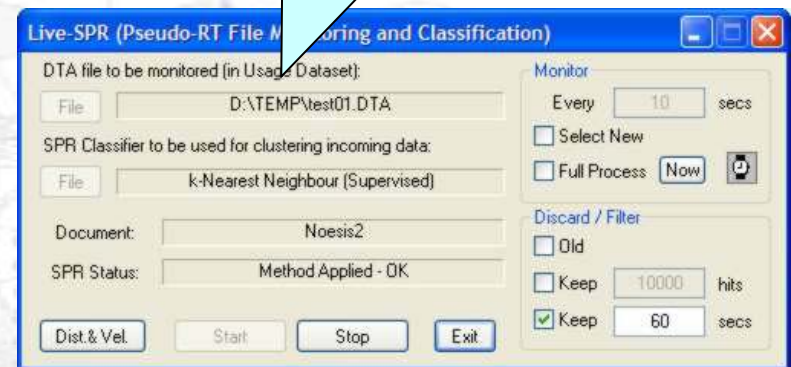
DTA files: As the data are acquired by e.g. AEwin, Noesis can read, classify and otherwise process AE hits, time data, waveforms, time messages and other informatio.

WFS files: Noesis can load WFS files as they are acquired. Depending on classifier Noesis will extract features and break-down a single WFS wave to multi-hits and classify the data.

In parallel with live classification Noesis can compute a variety of Periodic Statistics that follow cluster evolution based on calculated parameters real-time. This feature is also available during post-processing.



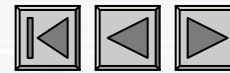
Live-SPR dialog with all relevant settings.



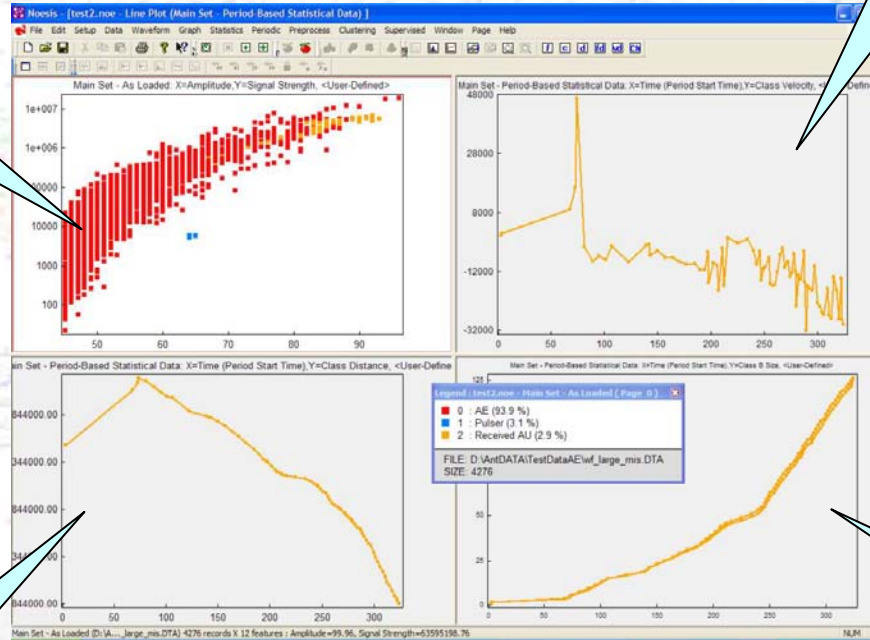
Periodic Statistics dialog with relevant settings for real-time cluster evolution monitoring.

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Live-SPR. Real-time data classification and processing.



Data scatter plot with the data classified immediately with acquisition.



Class velocity graphs, showing how fast the center of one class approaches or moves away from the center of the reference class or point.

Cluster distance, showing the evolution of cluster center distances in time.

Cluster size, showing the evolution of the cluster data in time.

NOESIS 5.0

NOESIS EDITIONS & OPTIONAL MODULES



NOESIS 5.0

Edition Name	Features
Light	<p>*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.</p>
Professional	<p>*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.</p>
Enterprise	<p>*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.</p>

Module Name	Description
TXT (ASCII File Import)	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 (X-Y-Z) Location for PAC (DTA, TDA, WFS) files including First Hit determination, Event Sequence of arrival, Location XYZ plots, plot selection and correspondence etc.

STEP-by-STEP EXAMPLE



Example Objectives:

- Understanding of basic functions & data handling in NOESIS
- Introduction to multidimensional sorting and data clustering
- Supervised method training and **AUTOMATIC CLASSIFICATION OF unknown data**

Data Used :

- Artificial data containing Simulated AE signals, Mechanical Friction, EMI, Mechanical Impact data.
- One file containing all data types is used for initial classification and Supervised method training.

DATA01.DTA	Data Type	Time (sec)	Hits	DATA02.DTA	Data Type	Time (sec)	Hits
With Waveforms	Acoustic Emission	0-116	0-24	With Waveforms	Acoustic Emission	0-119	0-14
	Mechanical Friction	155-185	25-49		Mechanical Friction	Mechanical Friction	143-149
	EMI	214-322	50-69				
	Mechanical Impact	350-409	70-89				

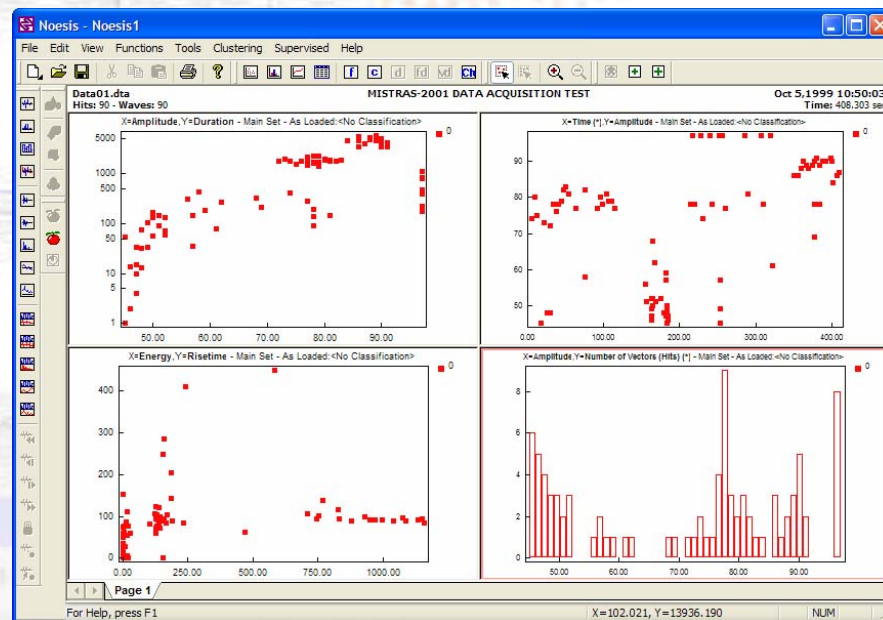
Data file content examples.

STEP-by-STEP EXAMPLE



Loading and Viewing the Data :

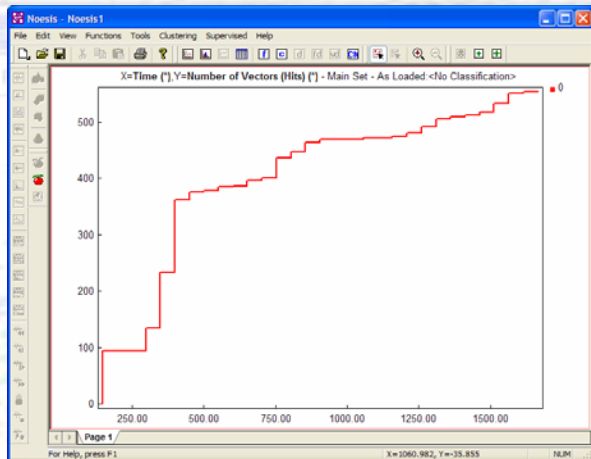
- A New NOESIS Document is created and the first data file (containing all data types) is loaded as the MAIN DATA SET.
- A single page containing one graph appears. This page can be modified to show several views in any arrangement. A choice of standard layouts or custom can be used.
 - The data due to the experimental procedure are separated in time.
 - Overlapping is evident in Amplitude and other features.
 - Already, from the graphs presented, some conclusions can be made about the nature of the data, from an experienced AE operator (e.g EMI presence).



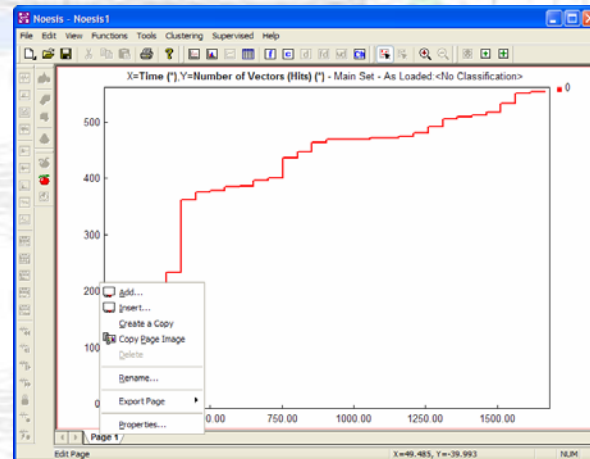
NOESIS 5.0

STEP-by-STEP EXAMPLE

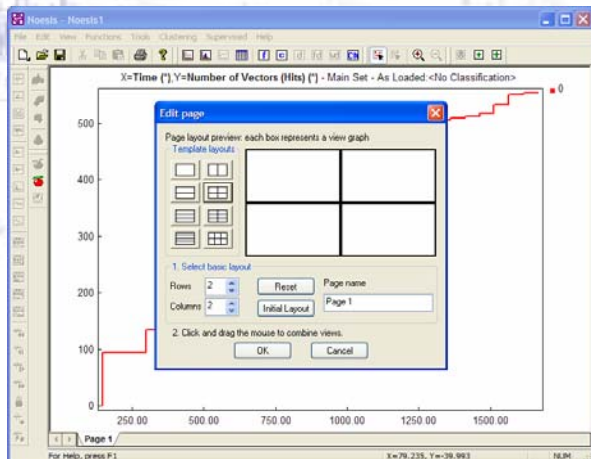
NOESIS 5.0



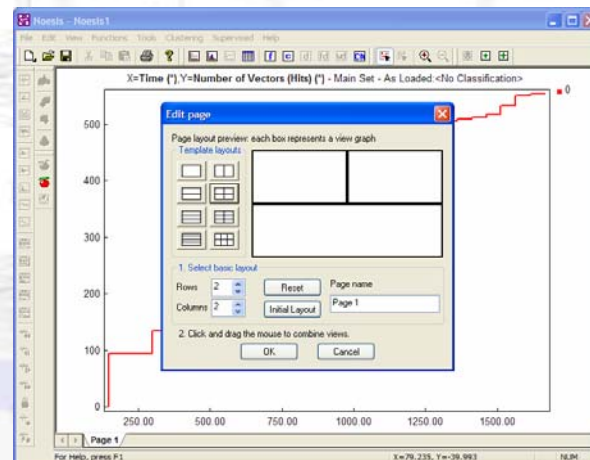
The standard first page and single graph when loading data.



Right-click on the tab to get to the context menu.



The Page properties dialog. Use the standard layout buttons or the row-column controls to create (split) the page to the desired number of views and see the result in the preview area.



Left-click and drag the mouse over the preview area to merge views and achieve complex layouts. In this case merge the two bottom views to one by left-click on the lower left view and drag the mouse to the lower-right view.

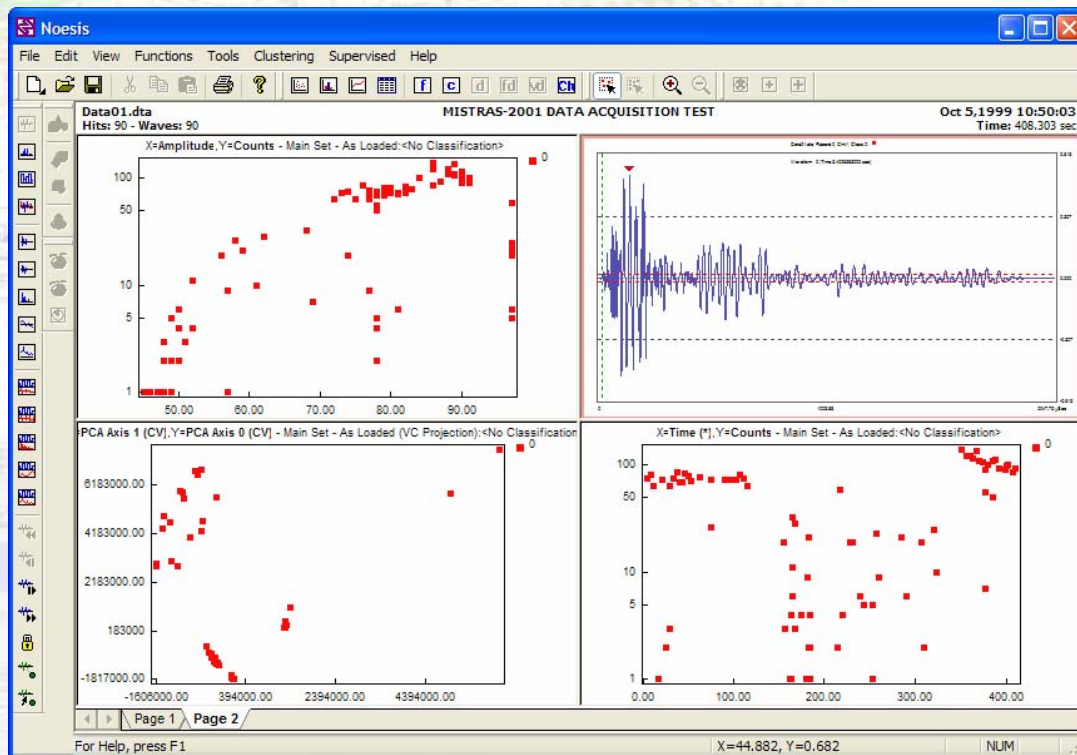
STEP-by-STEP EXAMPLE



Advanced Viewing :

- The data can be viewed in a variety of ways. Waveforms and corresponding FFTs can be displayed in any view.
- Hits can be selected using the mouse or other pre-set operations to view their correspondence on other plots or waveforms etc.

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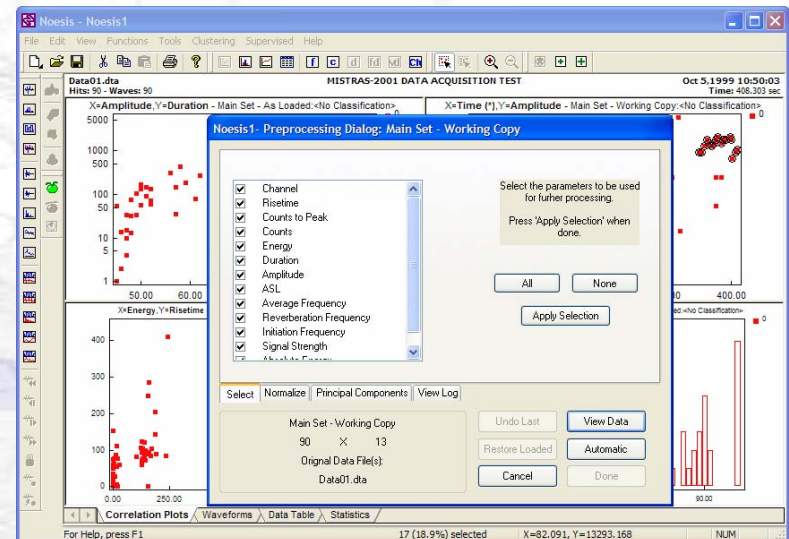
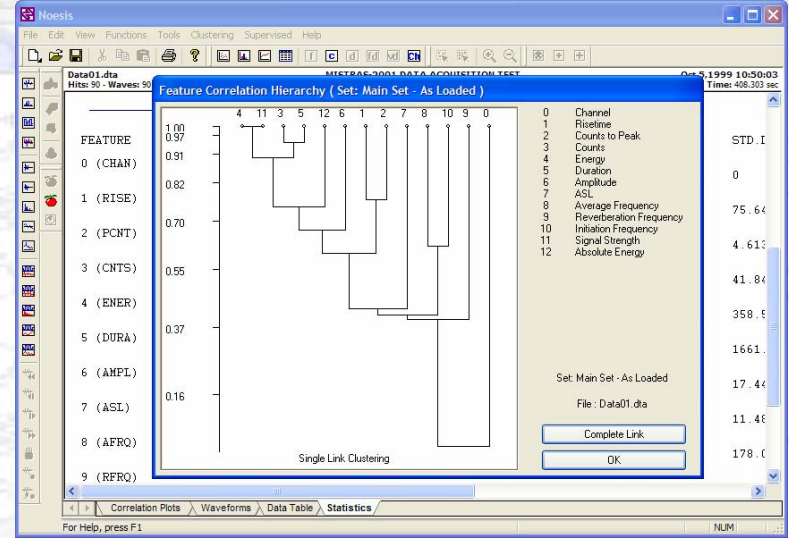


STEP-by-STEP EXAMPLE

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•Advanced Viewing :

- The data overlapping observed earlier can be viewed via statistics and correlation plots such as the Correlation Hierarchy (dendrogram) plot. E.g. Energy and Sig. Strength (4 and 11) are two highly correlated features and do not provide separate information about data structure and separation. Information from one of the two is enough.
- Knowing the data in this small data file the user can select manually and create clusters according to the known types and their separation in time. Selecting the hits generated by mechanical impact (see screen shot), it is evident from the other plots that if we didn't know a priori the type of data, even an experienced user would be uncertain in distinguishing Simulated AE from Mech. Impact.



STEP-by-STEP EXAMPLE



•Preprocessing and Clustering :

- Some features are not useful in distinguishing different types of signals. Correlated features produce classification biasing and should be removed accordingly from the clustering process.
- Normalizing the data provides arithmetic correctness in automatic clustering.
- Creating projections utilizes maximum separation space.

•ALL PREPROCESSING IS APPLIED TO THE “WORKING COPY” OF THE DATA.

•SMART, EDUCATED PREPROCESSING PROVIDES IMPORTANT INFORMATION TO THE CLUSTERING ALGORITHMS

•Applying Preprocessing :

- Remove correlated features.
- Normalize data.

STEP-by-STEP EXAMPLE



Applying UNSUPERVISED PATTERN RECGNITION (UPR) (CLUSTERING):

- Using k-MEANS with TIME DISTRIBUTION as initial partitioning provides clustering results indicative of the physical phenomena artificially generated.

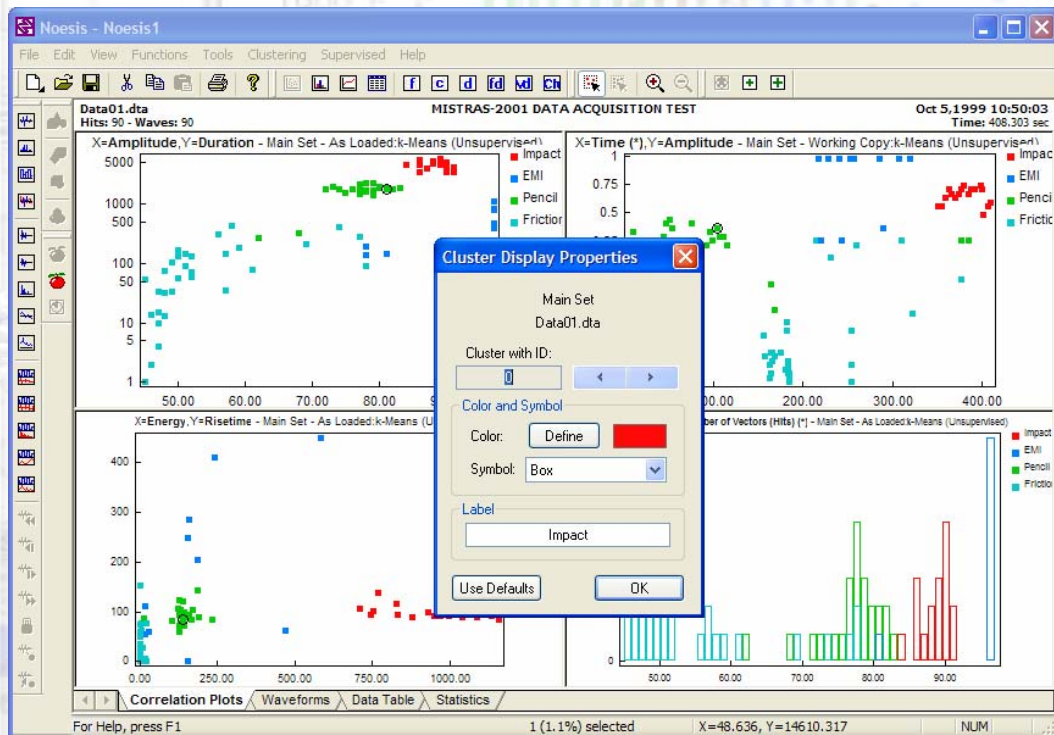
K-Means Parameters

Distance Type
Euclidean

Initial Partitioning
Random

Initial Clusters: 4
Iterations: 100

Run Defaults
OK Cancel



- Several mathematical criteria and indexes are calculated which may be a measure of the clustering efficiency (Wilk's, Rij etc.).

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STEP-by-STEP EXAMPLE

Customizing Data Viewing:

- Cluster colors and labels (names) can be changed at any time.
- New plots can be created as necessary.

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NOESIS - Noesis1

File Edit View Functions Tools Clustering Supervised Help

Data01.dta
Hits: 90 - Waves: 90

HISTRAS-2001 DATA ACQUISITION TEST Oct 5, 1999 10:50:03
Time: 408.303 sec

Number	Time	Class Label	Channel	Risetime	Counts to Peak	Counts	Energy
62	256.4294525000	EMI	1	206	18	23	187
63	259.3422772500	Friction	1	3	1	9	21
64	284.7955910000	EMI	1	268	16	21	159
65	289.6499137500	EMI	1	60	4	6	30
66	306.4674122500	EMI	1	63	2	19	468
67	309.5583600000	Friction	1	8	1	2	18
68	319.5731892500	EMI	1	448	13	25	584
69	322.1589007500	Friction	1	58	8	10	3
70	350.0539907500	Impact	1	103	7	138	751
71	354.0763045000	Impact	1	94	7	120	745
72	359.1582402500	Impact	1	93	8	119	949
73	362.5789850000	Impact	1	91	6	115	1038
74	365.9272065000	Impact	1	101	7	134	930
75	369.0506567500	Impact	1	98	9	107	1073
76	373.9202147500	Impact	1	117	9	104	828
77	376.3730915000	Impact	1	90	7	90	879
78	376.3981792500	Pencil	1	85	5	56	168
79	376.4243610000	Friction	1	78	3	7	20
80	379.5072465000	Impact	1	85	5	99	1155
81	383.8311307500	Impact	1	96	8	108	832
82	383.8749422500	Pencil	1	96	8	50	159
83	387.2286525000	Impact	1	90	6	111	1087
84	390.8695700000	Impact	1	92	6	92	1132
85	398.5027362500	Impact	1	93	8	90	970
86	399.1071342500	Impact	1	95	7	98	1150

Correlation Plots | Waveforms | Data Table | Statistics

For Help, press F1 11 (12.2%) selected NUM

NOESIS

File Edit View Functions Tools Clustering Supervised Help

Data01.dta
Hits: 90 - Waves: 90

HISTRAS-2001 DATA ACQUISITION TEST Oct 5, 1999 10:50:03
Time: 408.303 sec

DATA STATISTICS

..... CLUSTER CENTERS (Features Vs Class)

Cluster	0(CHAN)	1(RISE)	2(PCNT)	3(CNTS)
0 Impact	1	98.6	6.88	106
1 EMI	1	172	8.45	17.5
2 Pencil	1	92	10	68.2
3 Friction	1	26.8	2.14	5.11

..... NUMBER OF PROTOTYPES IN EACH CLASS

Class 0 Impact : 17 patterns (18.9%)
Class 1 EMI : 11 patterns (12.2%)
Class 2 Pencil : 25 patterns (27.8%)
Class 3 Friction : 37 patterns (41.1%)

..... CLUSTER DISTANCES

	1	2	3
0			
1	4.6e+006	5.9e+006	6.7e+006
2		2.9e+006	3.3e+006
			8.4e+005

Average distance : 4e+006
Minimum distance : 8.4e+005
Maximum distance : 6.7e+006

..... MEDIAN BETWEEN CLUSTER DISTANCES

Correlation Plots | Waveforms | Data Table | Statistics

For Help, press F1 NUM

STEP-by-STEP EXAMPLE

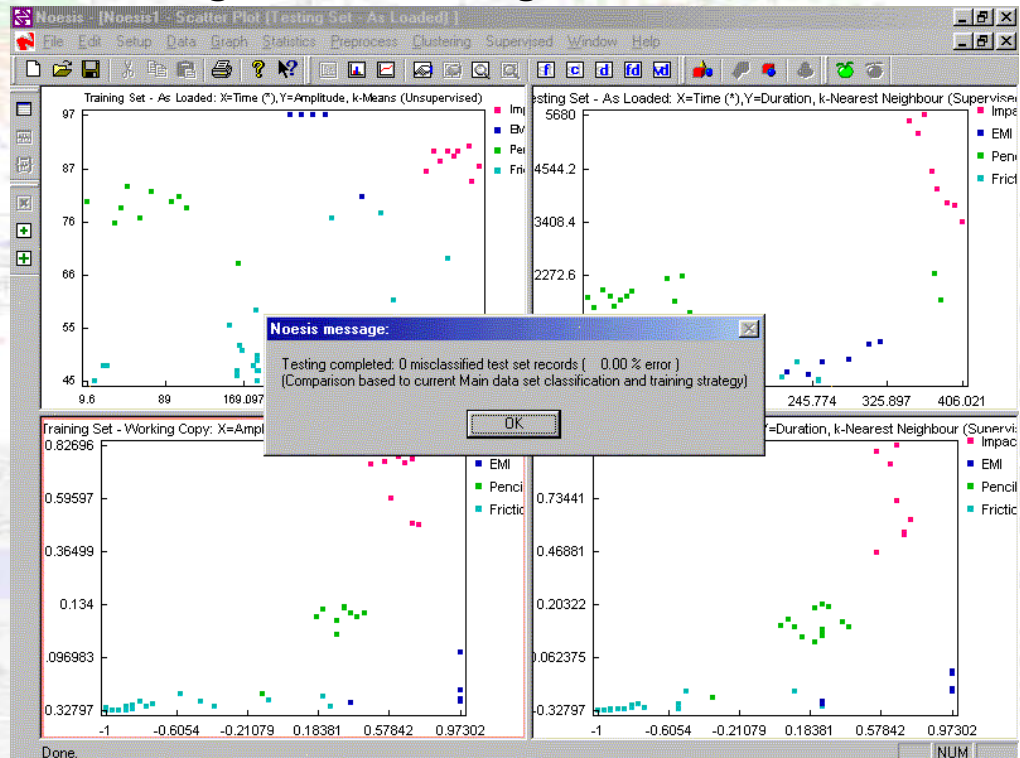


SUPERVISED PATTERN RECOGNITION (SPR) = AUTOMATIC CLASSIFICATION OF UNKNOWN DATA :

- Having achieved an acceptable classification SUPERVISED METHODS CAN BE TRAINED to recognize the existing types of signals in unknown data.
- A training and testing set are created (type is chosen by user) and the desired SPR algorithm is chosen and trained. **Training a Nearest Neighbor Classifier:**

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- Training error is indicated along with various statistics regarding the success of the training.



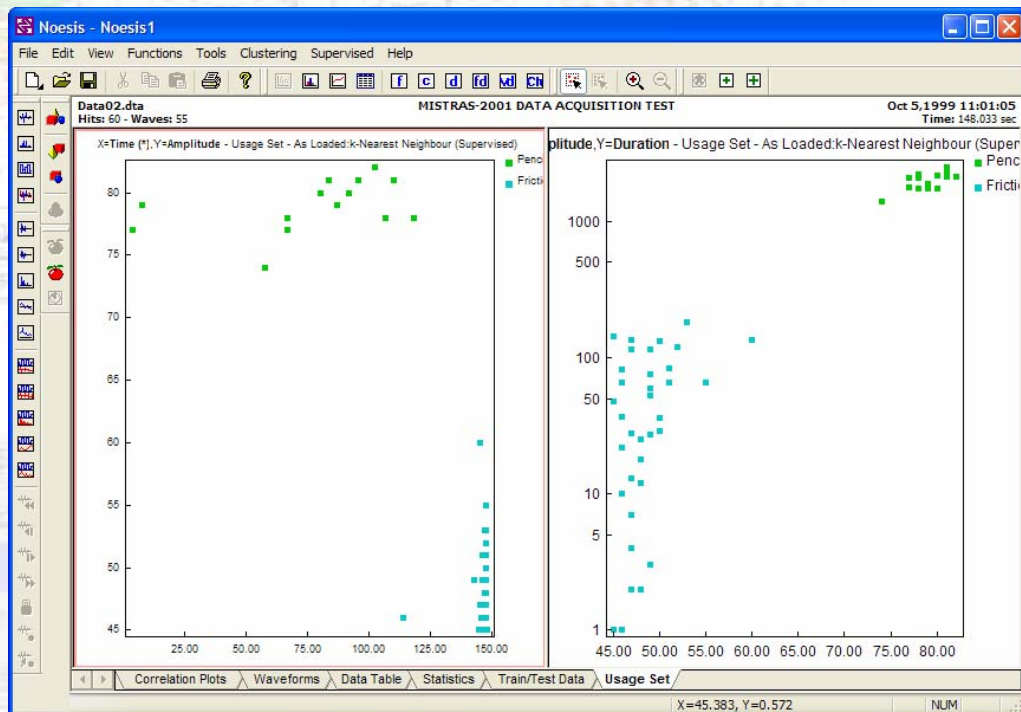
STEP-by-STEP EXAMPLE



Applying Trained CLASSIFIER to Unknown Data:

- When applying a trained classifier to new, unknown data, these must be of similar nature to the ones used to train the method.
- Load other example files containing some but not all the signal categories existing in the original data file and see the performance of the classifier.

- Only two classes of signals are found in this data file presented to the trained SPR. Simul. AE and Friction.



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