GALIX
BIOMEDICAL INSTRUMENTATION, INC.

LATE POTENTIAL ANALYZER

LM®

Primer

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Late Potential Analysis with the GBI LM-LPA package

1. Windows™ Interface

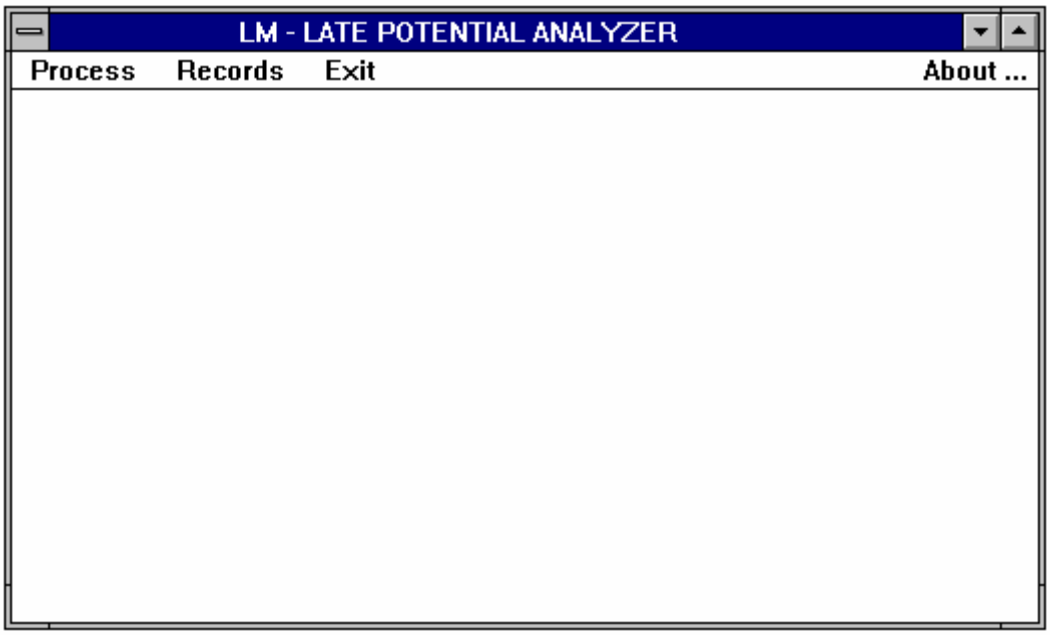
The LM-LPA runs on the Windows environment sharing the commands found in this type of applications. These commands include the following:

a) SYSTEM MENU: Pop-Down menu available after clicking the upper-left symbol of the window. Options are the following:

- RESTORE: the window resumes the original size from minimized form. This item is disabled when the window is not minimized.
- MOVE: the window can be moved to other position on the screen by means of the mouse.
- SIZE: allows window size modifications.
- MINIMIZE: turns the window into an icon which in turn can be restored to the original size. Minimization may also be performed with the "∇" button on the upper right side of the screen.
- MAXIMIZE: makes the window occupy the whole screen. Maximization may also be performed with the "Δ" button on the upper right side of the screen.
- CLOSE: closes the application ending the program.
- CHANGE TO: opens a dialog box with the program administrator.

b) SIZE MODIFICATION: may be performed either from the System Menu or from the window borders.

c) POSITION CHANGES: may be performed either from the system menu or by placing the mouse on the title bar and dragging it.



2. Main features

The GBI LM-LPA performs Late Potential Analysis of the XYZ Vector ECG recorded with the GBI Solid State Holter Recorder.

The software uses a propietary Adaptive-Filtering algorithm to process the raw ECG in order to get a "clean" ECG free from random and line noise. During ECG filtering the input noise is measured and the algorithm adapts itself in order to speed up processing. The outcome is a clean X-Y-Z Lead Beat which is stored in memory along with patient data for further analysis.

The Late Potential Analysis is performed in both Time and Frequency Domain. The Time Domain Analysis algorithm calculates the standard parameters: QRSd, RMS40 and LAS40 automatically. Pathologic results are identified in red colors on the screen.

Frequency Analysis results are highlighted by means of two plots: the Front View and the Bidimensional-Color View. In the Front View the Power Spectrum Density (PSD) is depicted as a function of time and frequency, using a well know representation schema. Isofrequency planes are identified with continuous colored lines.

The Bidimensional-Color view is presented as an upper-view geographic map on the time-frequency plane, with the different PSD ranges identified by means of color. Colored areas represents spectrum regions with PSD values within the same range.

Late Potential Signals are identified in the Frequency Domain representations as small "hills" in the QRS terminal part.

All high-resolution beats may be stored in memory for further analysis or comparison. Information is stored as individual files coded with patient name letters. Analysis is performed upon beat and patient data retrieval. A list of patient records is presented on a screen for selection. A date filter is provided to ease the search.

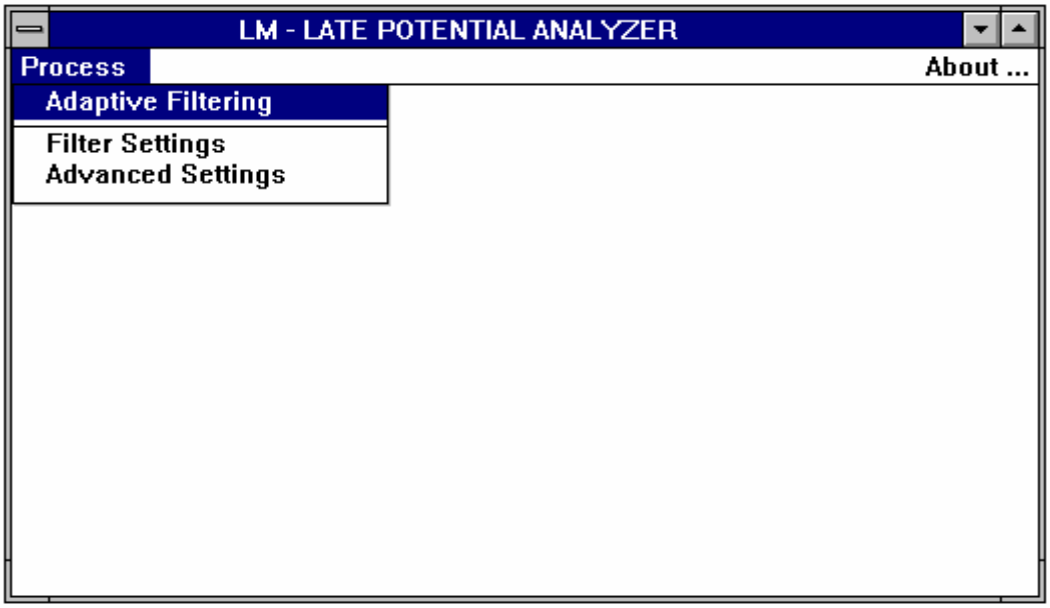
3. Operating procedure

The Late Potential Analysis with the LM-LPA has two steps:

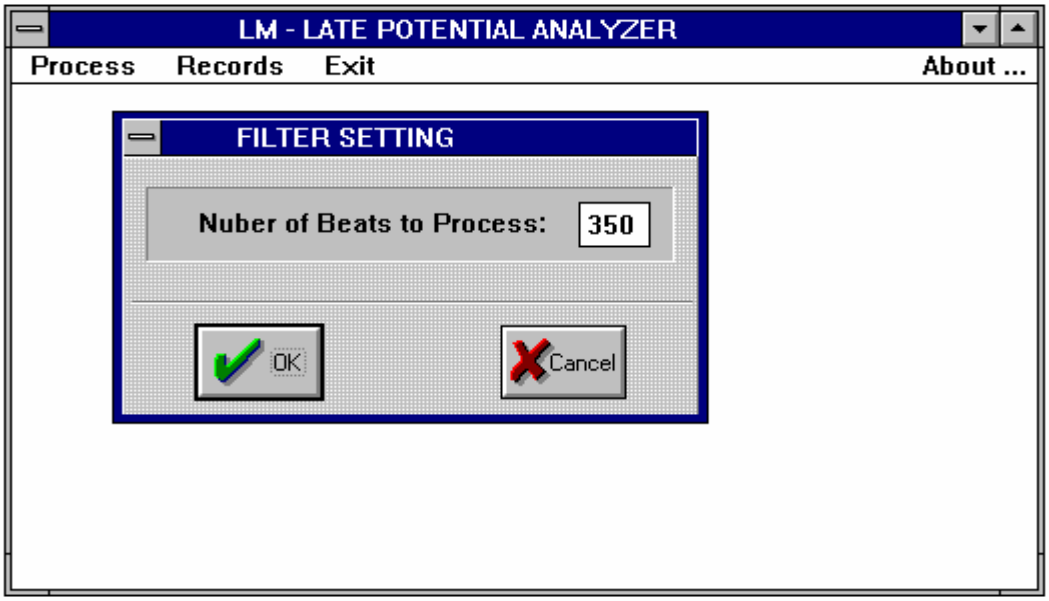
a) ECG PROCESSING: reduces the noise levels, generates a "clean" beat which is stored in memory for further analysis.
b) RECORD REVIEW: allows ECG and Patitent Data retrieval and Time and Frequency Domain Analysis.

3.1. Configuring the ECG Processing

Upon invoking the LM-LPA program, the **Main Menu** screen appears. The user has to insert the PCMCIA Holter Memory Card in the corresponding card reader and click on the **Process** option of the Main Menu. Three new options appear: **Adaptive Filtering, Filter Settings and Advanced Settings.**



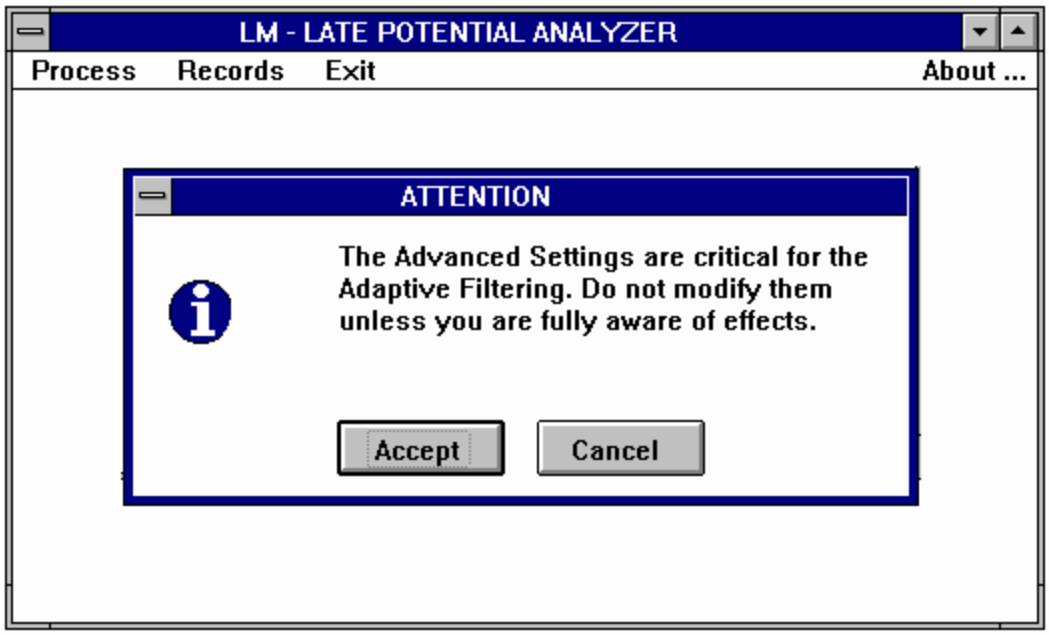
Prior to start he Adaptive Filtering, the user has to check the **Filter Settings** by clicking this option. The following screen appears:



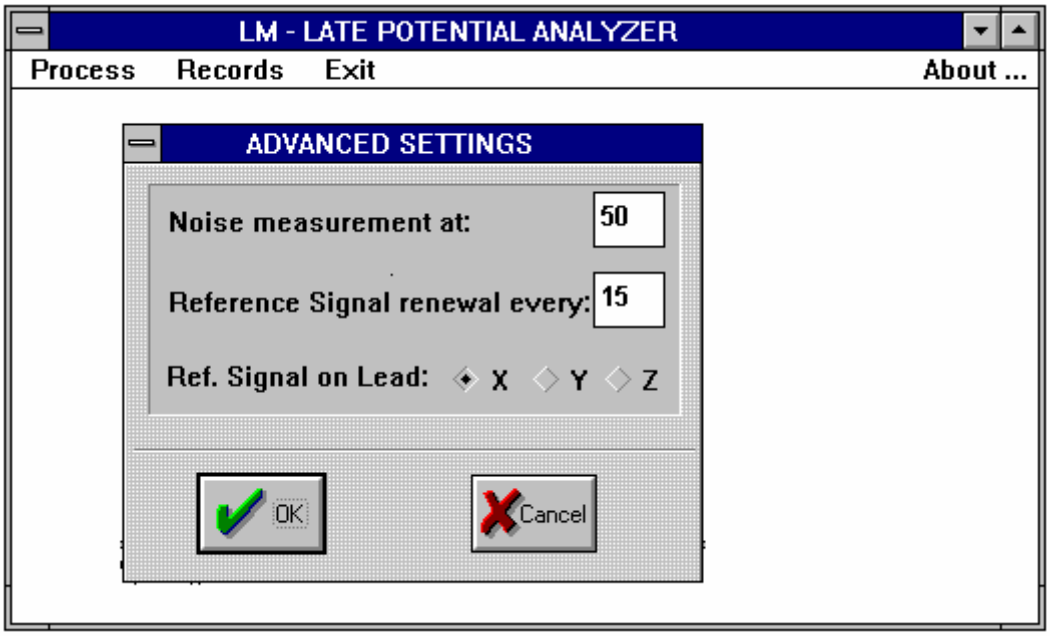
The user has to enter the **Number of Beats** to process (default value: 350). This is the maximum number of beats to process which is related to the number of beats stored during the acquisition

process. The number of beats to process will depend on the noise level at the input. Nevertheless the latter number may not exceed the value entered through the presented dialog box. Generally, the larger the Number of Beats, the smaller the final noise and the larger the processing time. Upon typing the value, the user must click on OK as it is established in the Windows environment. The screen will show the Main Menu Screen.

Alternatively, the experienced user may choose the **Advanced Settings** option of the Process screen. After clicking this option, the following screen appears:



This is an ATTENTION screen since critical parameters will be available for modification. After clicking on the Accept button, the following screen appears:



The user is prompted to enter two values corresponding to the parameters:

- **Noise measurement at**:,

- **Reference Signal renewal every:**

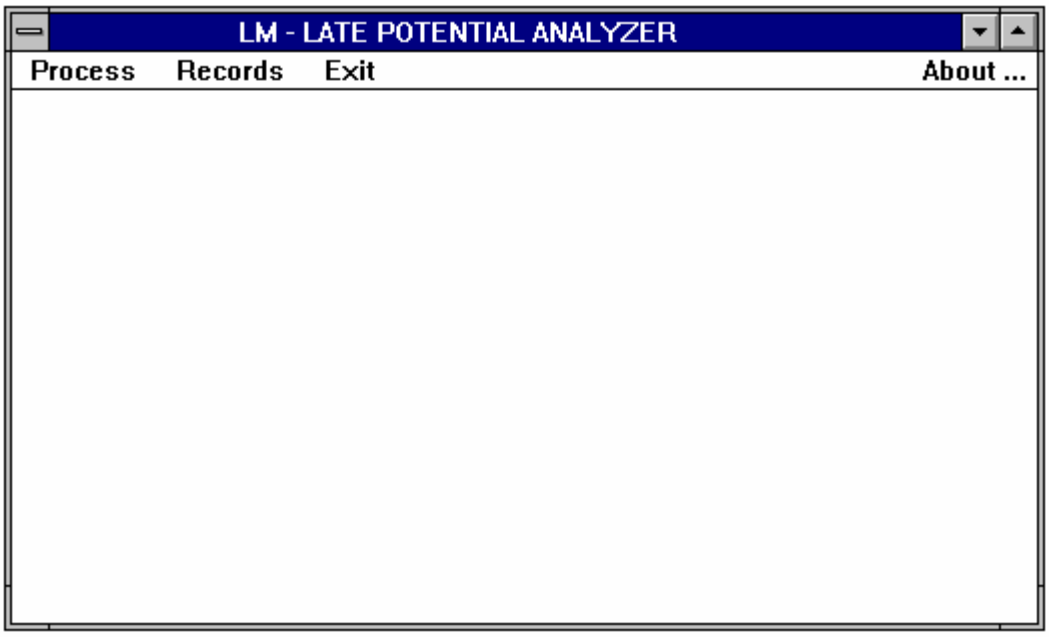
and select the **Reference Signal Lead.**

The Noise Measurement Interval (default: 50) determines the number of cardiac cycles to process prior to measure the Noise Level at the input.

The Reference Signal Renewal Interval (default: 15) determines the interval between Reference Signal updates in term of cardiac cycles. The Reference Signal is taken from the Adaptive Filter output corresponding to on of the Vector Leads: X, Y or Z.

The source of the Reference Output may be also selected in the last option.

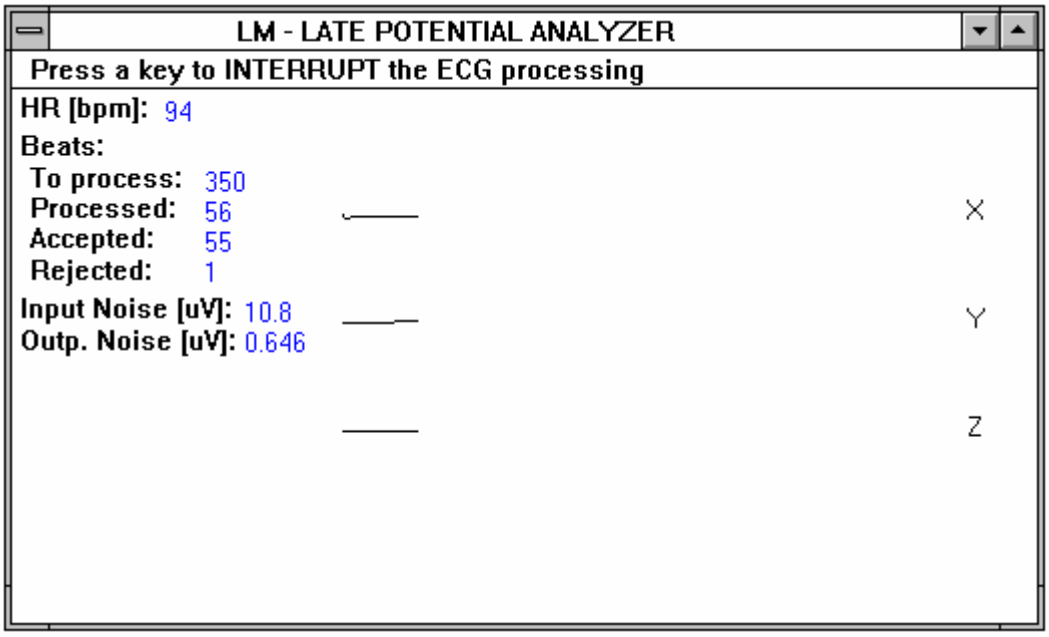
After entering and/or selection, the user must confirm or cancel. After doing this, the Main Menu screen will appear.



The system is now ready to start ECG processing.

3.2. Starting the ECG Processing

ECG processing is triggered by clicking the option **Process** of the Main Menu and then the option **Adaptive Filtering** of the Process Menu. The following DYNAMIC screen will appear:

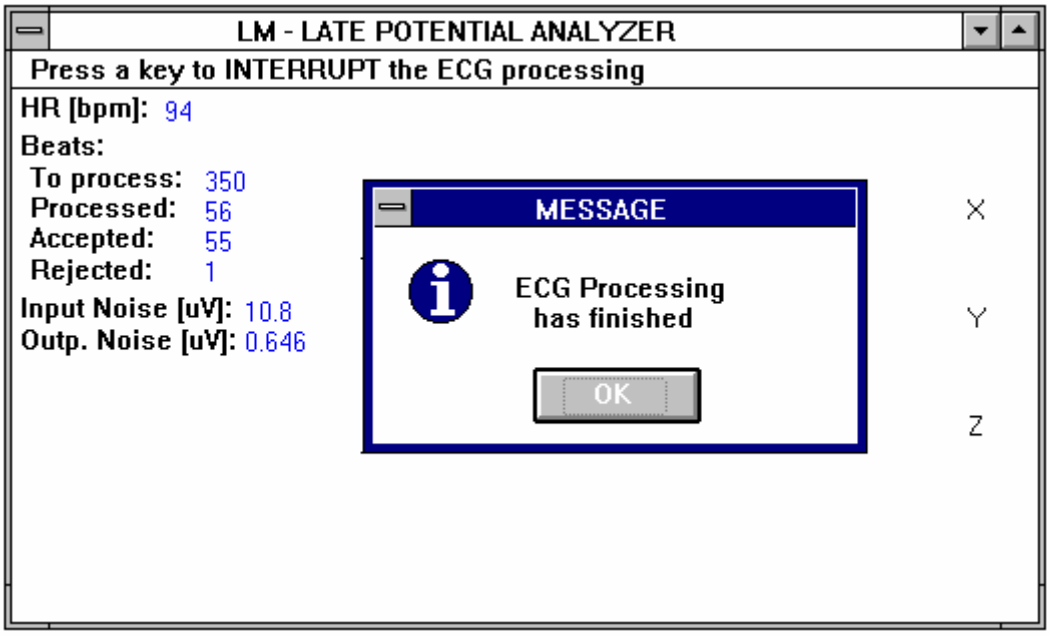


The information shown in the screen is the following:

a) HR: Heart Rate on a cycle-to-cycle basis.
b) Beats to process: it is the maximum number of cardiac cycles to process.
c) Beats processed: number of beats already processed.
d) Beats accepted: number of beats which has an adequate correlation level and are accordingly accepted.
e) Beats rejected: number of beats rejected due to bad correlation level.
f) Input Noise Level: this value remains null until the noise level is measured
g) Output Noise Level: this value shows the estimate of the final noise after the input noise level is measured.

The X, Y and Z ECG is presented dynamically on the screen.

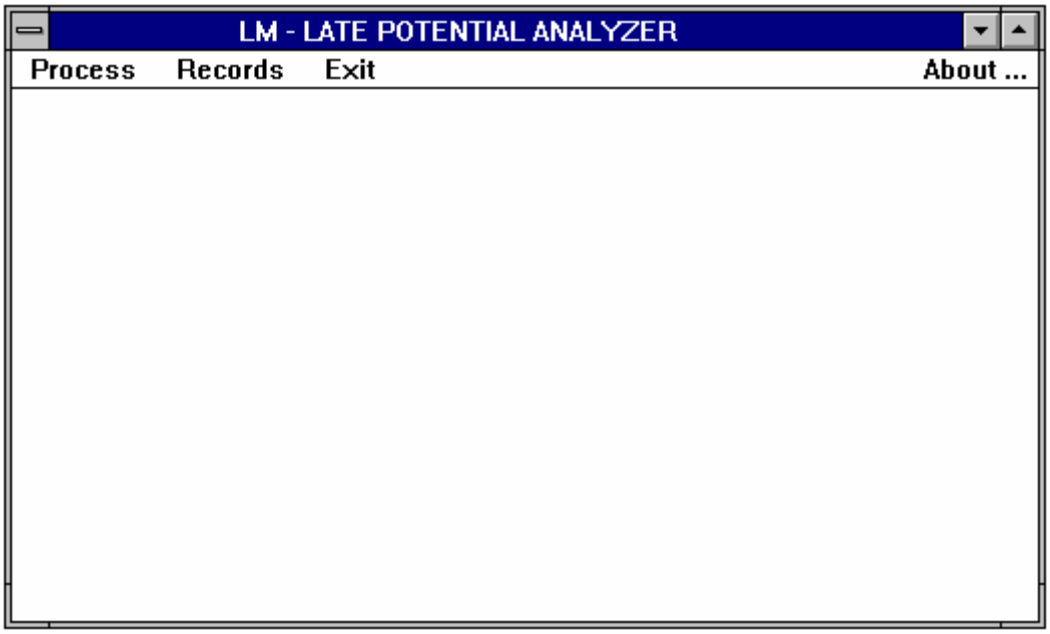
After finishing the ECG processing, the software stores the three Vector Leads and the Patient Demographic Information in the hard disk. This record is therefore ready for analysis. The following screen will appear:



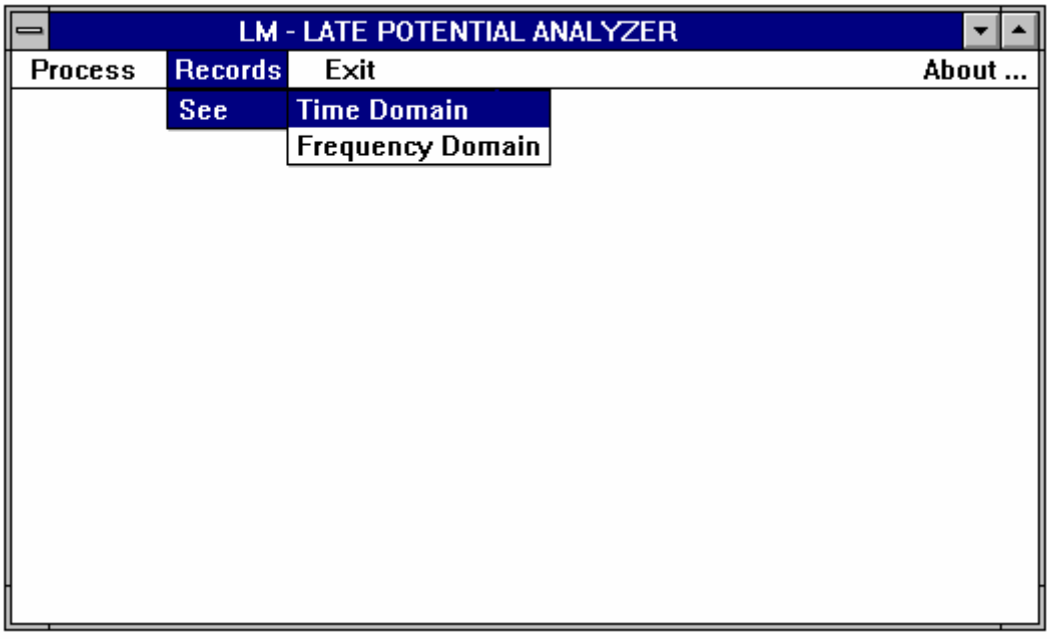
After clicking the OK button, the Main Menu Screen will appear.

3.3. Analyzing records

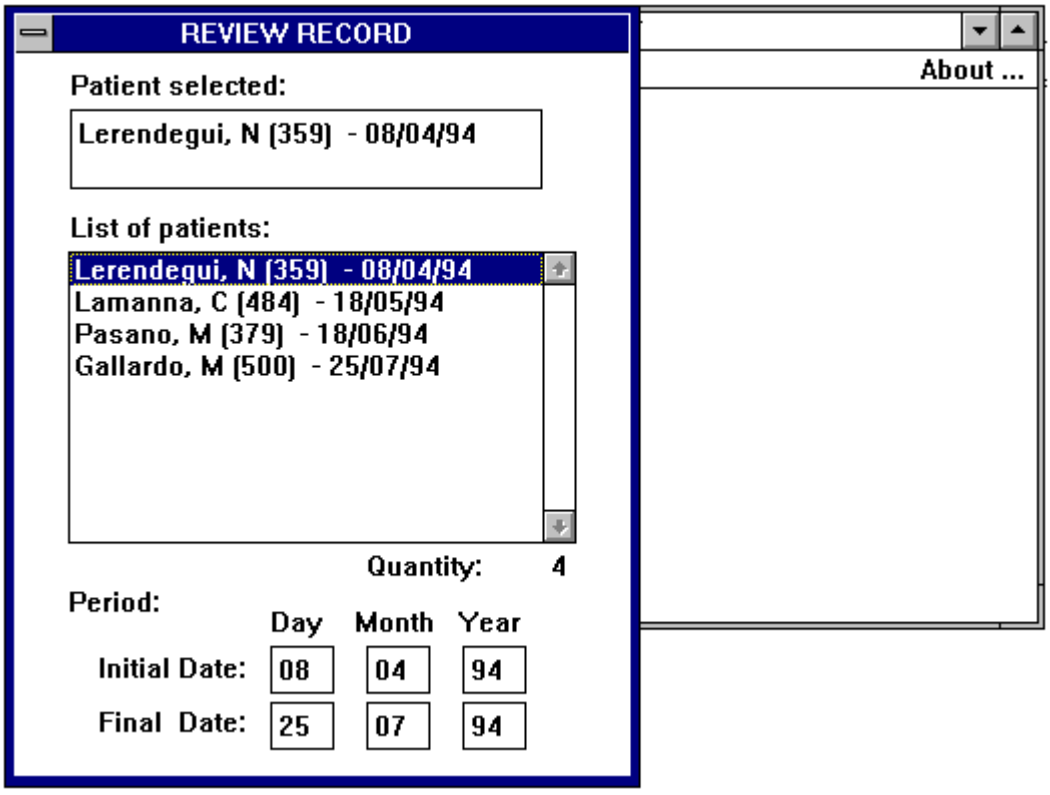
The data records stored in memory may be analyzed by entering the option **Records** from the Main Menu.



The following screen will appear:



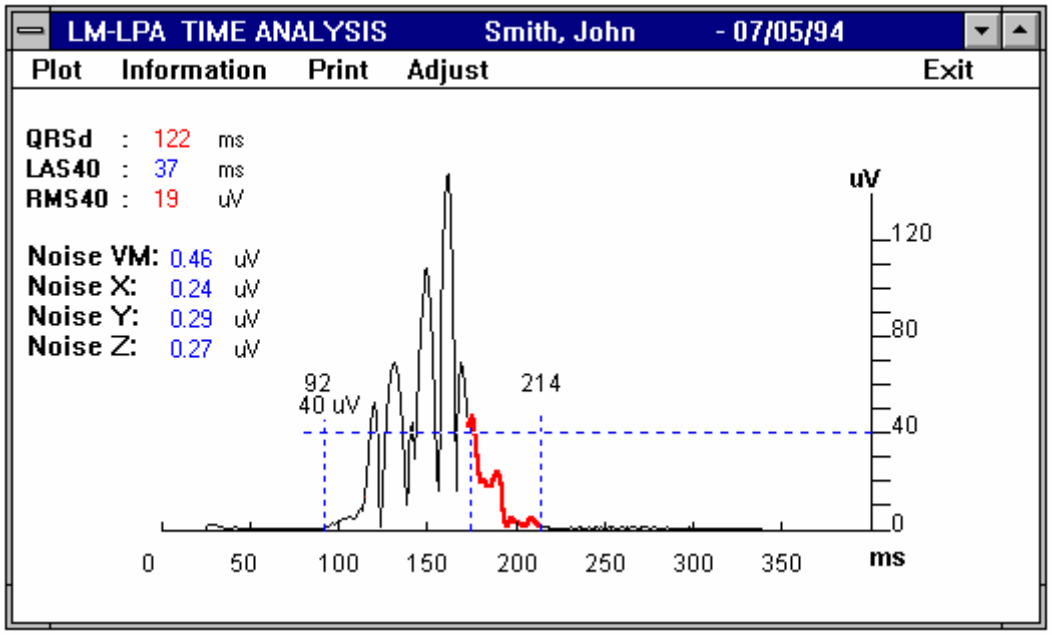
The user may select Time Domain or Frequency Domain analysis by clicking the corresponding option. A dialog box is presented in order to select the record to review:



The user may select a particular record, o define a time period in order to reduce the number of records in the list. The software provides a comprehensive identification of records providing: Last and First names of patient, number of beats processed and study date. Patient selection is done as usual.

3.3.1. Analysis in the Time Domain

After selecting a particular patient record, the LM-LPA will show the following screen:



The screen presents the plot of the Vector Magnitude, including the onset and offset of the QRS complex, the standard Time Analysis Parameters: QRSd, LAS40 y RMS40, and the residual noise.

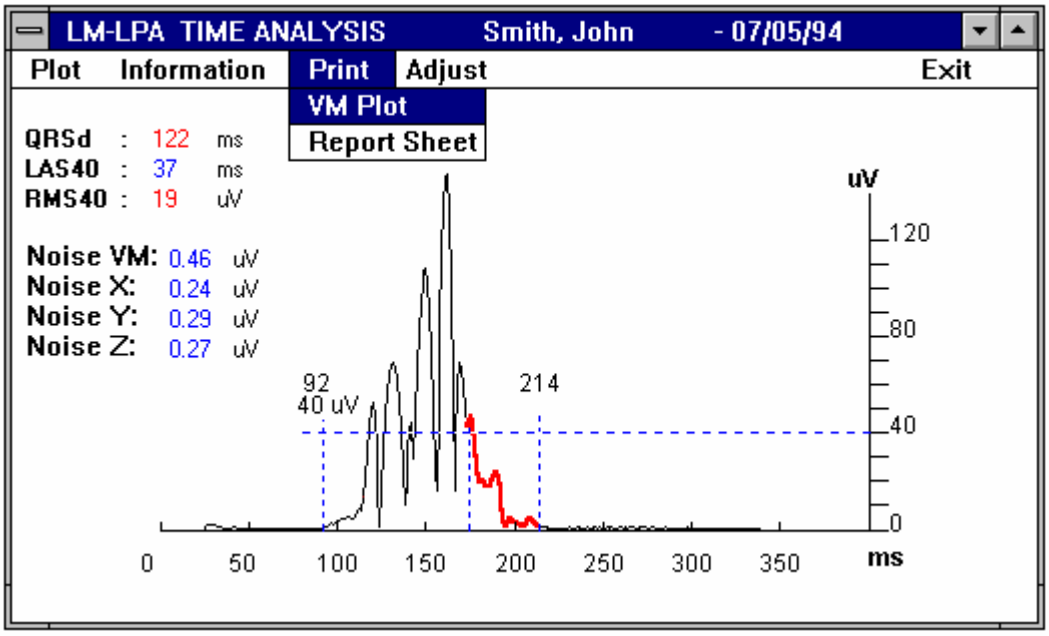
When the Time Analysis Parameters are pathologic, the values are presented in red color. The adopted threshold values follow the criterion established by Gomes for pathologic values:

QRSd ≥ 120 ms
LAS40 ≥ 38 ms
RMS40 ≥ 20 µV

The last 40ms of Vector Magnitude Signal is highlighted in red color.

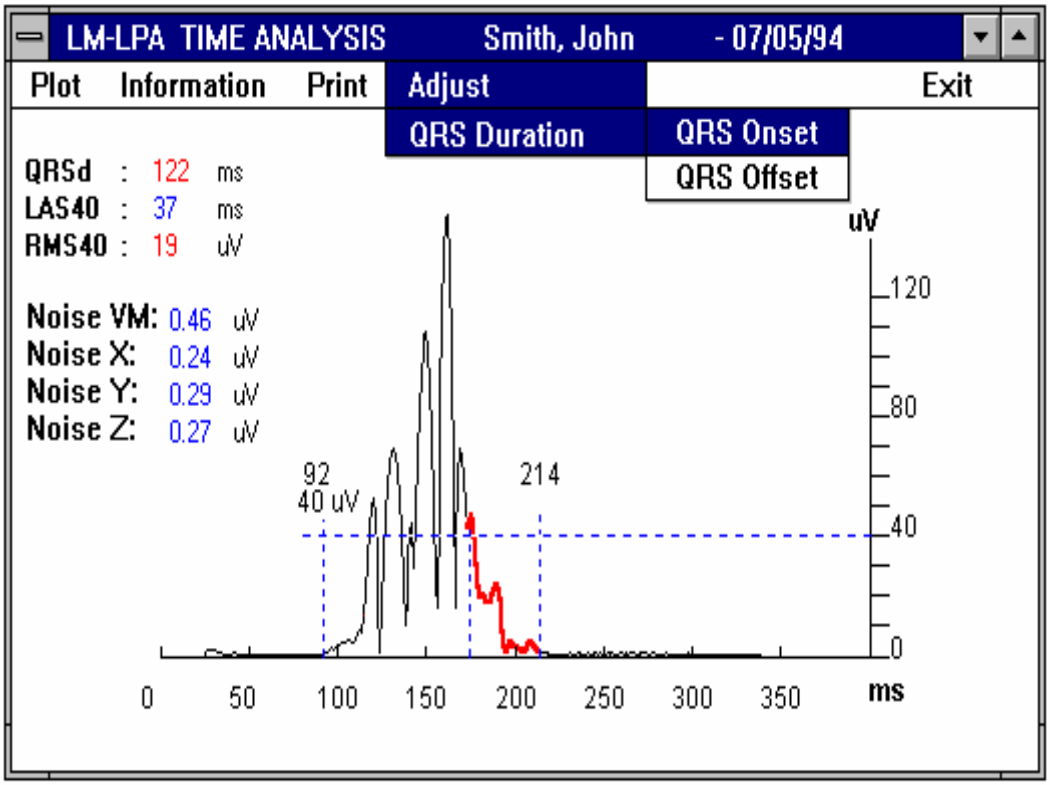
The **Information** option of the menu presents **Patient Data** and **Process Data**.

To generate printouts is necessary to press the **Print** option of the Time Analysis Window. The following window will appear:



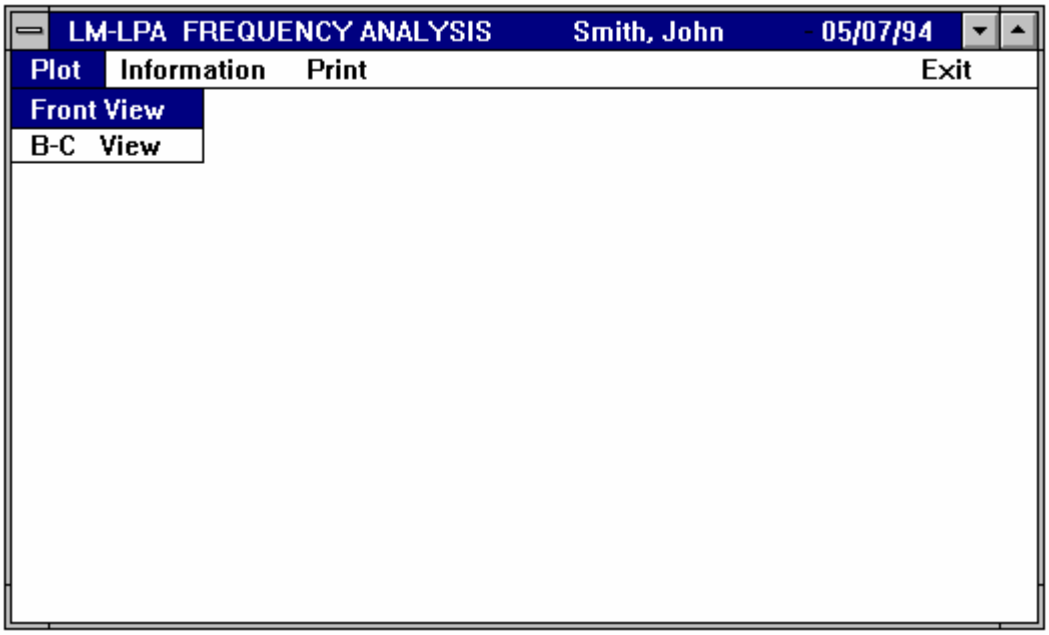
The user may print the Vector Magnitude Plot or Edit/Print the Report Sheet by clicking the corresponding option of the menu.

The user also may adjust QRS Onset and Offset times in order to make a more specific diagnosis. This option is available inthe Time Analysis Window through clicking **Adjust** in the command bar.

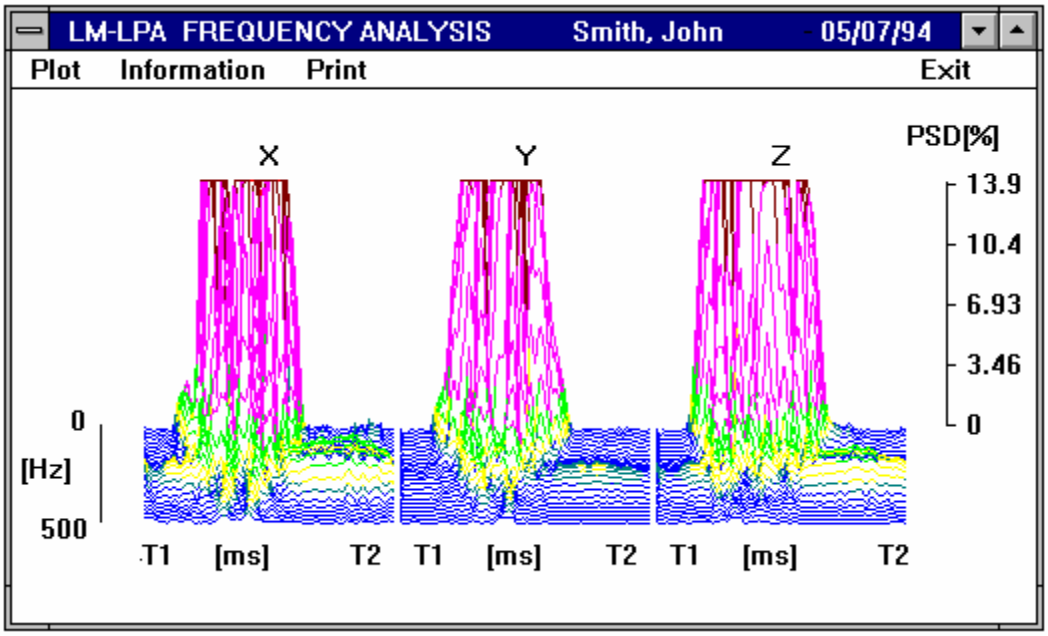


3.3.2. Analysis in the Frequency Domain

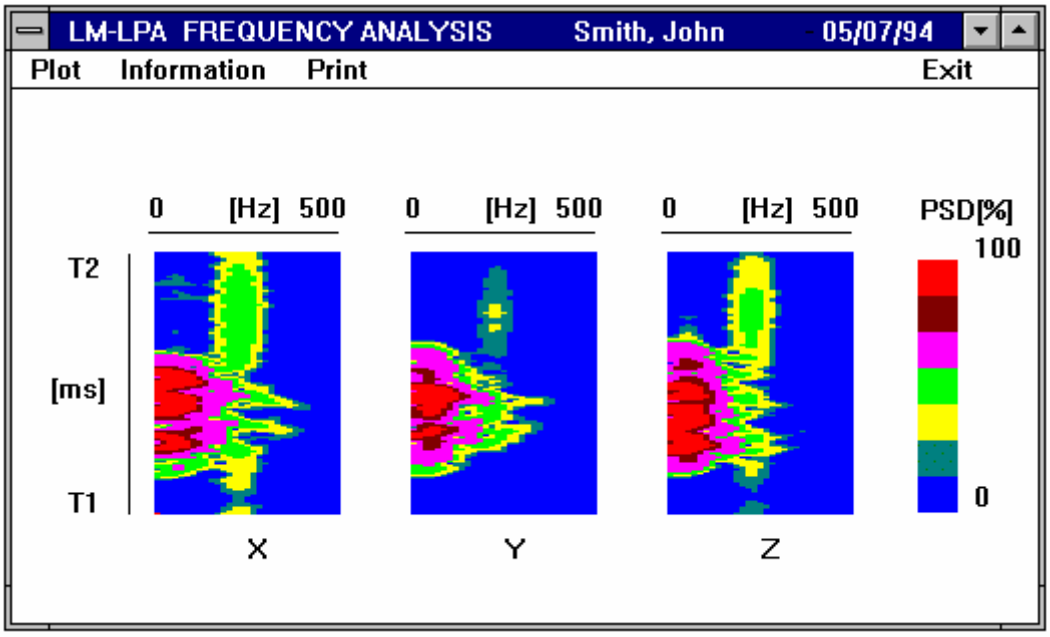
After selecting a particular patient record, the LM-LPA will show the Frequency Analysis Screen. The user may select the type of figure to plot by pressing the **Plot** option in the command bar.



Front View plot:



Bidimensional-Color View plot:



3.4. Simultaneous patient-records presentations

Since the GBI LM-LPA runs under Windows environment, several records may be presented on the screen simultaneously.

This is done by opening several applications and adjusting the size of the windows opened. This is particularly useful in cases of "follow-up" or for checking the evolution of a cardiac disease of a patient.