

## **SeCorr 05 – Help and Description**

**Version:** 11.xx

**State:** 08/01/2004

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### 1 Preface

Being able to operate the software is only one thing you need for using the correlation procedure. It is also important to know which proceeding is to be used and appropriate, and when. But every measurement is different, and it is impossible to give a universally applicable "formula". These operating instructions, however, do not merely describe how to operate the software – they also provide background information on functions requiring explanation.

We recommend you to proceed as follows so that you can make yourself familiar with the correlation procedure:

First, get to know the main screen. Important terms are explained in the following chapter.

Use tape recordings for your first measurements according to the standard measuring procedure which will be described step-by-step. The tape recordings are available from us in the form of a "test and teach-yourself" cassette or CD.

Use the tape recordings also for the additional functions.

Then try the "real world" – for example, use an opened hydrant as an "artificial leak" whose location is known.

The following instructions assume a basic familiarity with Windows applications – including, for example, how to open a menu, how to work with the mouse, how to start a function, entering and deleting, etc.

We hope that SeCorr 05 will bring you great success and help you to make work easier.

Hermann Sewerin GmbH

## 1.1 Program Requirements and Installation

The program can be operated under Windows 95/98/2000/XP. The minimum resolution is 640 x 480 dots per inch. To operate the hardware, it is required that Hermann Sewerin GmbH correctly installs the PC CARD (respectively A/D card) in Gütersloh.

This concerns also systems on which an (older) PC-CARD is already installed. The hardware is updated using software which is not included on the installation data medium.

Use the default working directory (C:\CORWI) for installation. However, you may also assign other directory names under the path C:\. The settings of the Windows desktop can be freely defined. The file to be executed is called "cw.exe". The file name of the relevant icon is "secorr.ico".

### **Selection of the Program Language**

It is not always possible to use the installation wizard to select the desired program language. In this case, proceed as follows:

Install the program only in a language that you understand.

Start the program and select the desired language file, with the name "CWXX####.lan", in the "Settings / Language" menu.

"XX" is the abbreviation of the relevant language. You can change this setting anytime you like.

### **Software registration**

Before you can use the software for measurements, you must "register" it with the registration key in the help menu. This key corresponds to the serial number which is printed on the delivery note handed over to you together with the software licence. Pay attention to capital and small letters.

Note: The registration key is saved to file "cweig.wir".

Should a re-registration be necessary, file "cwstart.cor" must be deleted.

### **De-Installation**

(It is very easy to undo the installation. Just activate the "UNWISE.EXE" file.)

### 2 Getting to Know the Main Screen

The main screen appears immediately after starting the software. It contains various fields and graphic elements. Information on their meaning is indicated in the "info line" at the bottom of the screen.

To make yourself familiar with the main screen, we recommend to move the cursor to any field about which you require information and to observe the info line.

#### 2.1 Length and Sound Velocity

Entering the length of the measuring section (L1) and sound velocity (V1).

You can change the displayed values by clicking on them with the mouse and entering the new value.

Optionally:

Clicking onto the area next to the editing field opens the "Pipe Data" table. You can additionally enter the material if you click onto the relevant field (material / dimension / DN). The material will then also be added to the protocol print-out.

The measurement result is immediately recalculated every time a value is entered.

#### 2.2 Correlation Function (CCF)

The correlation function (CCF) uses peaks to indicate where a leak may be located. The time-delay difference ( $\Delta t$ ) is displayed on the x axis in ms (i. e. milliseconds). The highest peak is automatically highlighted. However, you can select any other point by clicking on it with the mouse. The measurement result is immediately recalculated according to the currently highlighted position. The flag at the highlighted position indicates the set time-delay difference, while the number in the info line refers to the cursor position.

### 2.3 Coherence Function and Filters

This representation is used to set the (mathematical) filters. Using the filtering function may return better results since interfering areas can be faded out. The frequency is displayed on the x axis. Large values in the function indicate that these areas contain noise which is particularly suitable for calculating the correlation function. Filters can be set in two forms:

a) It is recommended to use a certain frequency range for the correlation. You can set the filter limits by double-clicking onto the coherence function with the left mouse-button. The correlation function, and thus the measurement result, are immediately recalculated. The filter limits can be reset as often as required. This "learning-by-doing" will help you to find out which setting leads to the best results.

b) Certain frequencies should not be used for correlation (i. e. faded out). You can set the left-hand and right-hand filtering limits by clicking on the right mouse button. Re-click with the right mouse button onto the marking to remove the limit. It is possible to set several markings.

### 2.4 Time Zoom / Frequency Zoom

These functions change the scale of the x-axis shown onscreen. If the "Zoom" function is activated, the relevant marking will be placed in the centre of the screen.

### 2.5 The yellow (green) signal is not OK

If this field flashes in red, signal reception may not be sufficiently stable to transmit the signals from the transmitters without interference. Check the signal transmitters, the signal section (obstacles, distance) and the connections on the control devices. This message is also displayed if the signal connection is still usable for a correlation. Indications of this are the acoustic reception of noise signals on the control device (headphones) and the visual representation of the noise signals (noise) on the main screen.

### 2.6 Noise

The noise recorded by the microphones is indicated as a "running" display.

The buttons located next to the field have the following function:

V Magnification / reduction of the representation

+ Manual amplification of the signal. This is only required if the automatic amplification is to be suppressed.

- Manual attenuation of the signal.

### 2.7 Yellow (green) channel level

The bar shows the noise intensity. The automatic amplification / attenuation within the control device is not taken into consideration. For this reason, the display shows the noise level which is emitted by the signal transmitter without interference.



### 3 Performing a Standard Measurement

Before performing a standard measurement, it is required to start up the hardware (signal transmitter and control devices) and to open the main screen. This is the screen which is displayed after starting the program.

#### 3.1 Manual

When performing a standard measurement, no additional functions are used. The following workflow description simulates a "real-life" situation and can be taken for practising.

#### Sound Velocity, Measurement Section

Enter the length of the measurement section and the sound velocity.

Step	Instruction/remark
Open the "Settings" menu.	
Select "One pipe section".	The "Pipe data" windows appears.
Enter the length of the measurement section.	Click into the "Measurement section" field. The measurement section is defined as the "water-filled pipe section" between the microphones.
Enter the sound velocity.	Click into the matching field of the table. The entry depends on the diameter (DN) and material of the pipe.
Confirm your entry with "OK".	The entered values appear on the main screen in the fields "L1" and "V1". It is also possible to enter the values directly.

### 3 Performing a Standard Measurement

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#### Start and Continue

<b>Step</b>	<b>Instruction/remark</b>
Check acoustically the reception of both noise signals.	Use headphones.
Activate the "Start" function in the menu bar.	The calculation is started. In the first phase, 16 averaging processes (individual measurements) are performed.
Control the representations of the correlation function (CCF) and the measurement result.	Sometimes 16 averaging processes are not sufficient to obtain a clear correlation function, i. e. no distinct peak is displayed. The marking in the correlation function fluctuates between the individual averaging processes.
Click on the "Continue" button in the menu bar.	The calculation is continued to improve the correlation function. In total 32 averaging processes were performed up to now. (With each activation of the "Continue" function, the number of averaging processes is duplicated.)

#### Measuring Result

<b>Step</b>	<b>Instruction/remark</b>
The measuring result is displayed.	The length specifications above the "symbolical representation of the measurement section" refer to the location of channel 1 or 2.

### 3.2 Wizard

After starting the Wizard you will be guided step by step through the procedure for entering the required values. The Wizard is strongly recommended for operators who are using SeCorr 05 only occasionally, such as standby service technicians.

In contrast to the manual standard measurement, the frequency analysis is automatically performed after the correlation.

As result, the wizard will output several "Leakage location of channel 1" and indicate the "Quality of measurement". The larger the value representing the "Quality of measurement", the higher will be the probability that a noise source (or the leakage you are searching for) is really located at this position.

"Interference suppression" is always set to "Automatic" if the wizard is used.

### 3.3 Evaluating the Measurement Result

If the correlation procedure is used, the subjective assessment of the form of the correlation function plays a significant role. The experience required for this cannot be taken from books – only practice makes perfect.

You can find a few examples in the "Exercises" chapter which you can use for practising.

For your own safety, please adhere to the following basic instructions on handling measurement results:

The measurement result is based on the markings in the correlation function, i. e. L1 and V1. In simple terms, the correlation function represents, qualitatively and chronologically, the relation between the two noise signals. It is generally not possible to distinguish between leakage noise (that is the noise that we are looking for) and other background noise. For this reason, the measurement result does not always represent a leakage point; background noise can also be the cause!

### 3 Performing a Standard Measurement

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If no specific noise signal is present, the measurement result may be arbitrary. The marking in the correlation function is automatically set to the maximum correlation-function value.

Negative values (e. g.  $-2.00\text{ m}$  /  $52.00\text{ m}$ ) do not necessarily mean that the leakage point lies outside the measurement section. They indicate that the values entered for the measurement section length or for the sound velocity deviate from the actual values.

Wherever possible, an additional localization with the help of other devices (e. g. electro-acoustic methods) should be carried out to increase the reliability of the correlation measurement.

## 4 Additional Functions ("Settings" Menu)

### 4.1 Measuring the Sound Velocity

To obtain exact measurement results, it is important to enter the correct sound velocity. However, the sound velocity values listed in the following table are only approximate values. Apart from that, it may also be possible that you do not know the pipe dimensions or material. For this reason, measuring the sound velocity is not only practical but may also be essential.

This function requires a noise source.

- You can use an opened hydrant, for example,
- which generates a clear display in the correlation-function field, thus being "correlatable"
- whose location must be known
- whose location should not lie in the central range of the measurement section, in order to increase the measuring precision.

If the measurement section consists of varying pipe sections (different materials or dimensions), the sound velocity measurement will lead to incorrect results.

Select the "Sound Velocity Measurement" function in the "Settings" menu. All other required instructions can be taken from the "accompanying procedure explanation".

The result – i. e. the calculated sound velocity – is indicated in the "vb" field.

Tip: The determined sound velocity can be entered in your individual sound velocity table and saved for later measurements ("Settings" menu / table).

## 4 Additional Functions ("Settings Menu")

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For professionals:

The working directory contains several sound velocity tables:

"cwsvelst.dat": standard, file currently used by the correlator

"cwsvelin.dat": individual, file created by the user

"cwsvelst\_de.dat": international validity, in its contents identical with the original file "cwsvelst.dat"

"cwsvelst\_fr.dat": proved quite satisfactory in France

By renaming files in the working directory the individual file can be changed permanently into the standard file.

### 4.2 3-Point Measurement

This function permits to perform a background sound velocity measurement and to determine the exact noise position. The advantage of this method is that the leak can be localized with high precision and minimum effort.

Procedure: Two measurements are performed one after the other. Between the measurements the location of one of the microphones is not changed.

Generally, the same conditions apply as is the case with sound velocity measurements. In addition, it is also required for at least one of the two measurements that the leakage point lies within the measurement section.

The measurement result is based on the determined sound velocity "vb", and it can be read off both under the last measurement (\*\*L) and the preceding measurement (L1).

Select the function in the "Settings" menu. All other required instructions can be taken from the "accompanying procedure explanation".

### 4.3 One / Two / Three Pipe Sections

If the measurement section consists of varying dimensions or materials, the sound velocity is not uniform. This situation is characterised by several pipe sections with various sound velocities.

Step	Instruction/remark
Open the "Settings" menu.	
Select the number of pipe sections.	The "Pipe data" windows appears.
Enter the length of pipe sections L1 and L2, as well as L3, if required.	L1 starts at the yellow channel 1! Proceed with entering L2 and L3, if required.
Enter the sound velocities V1 and V2 as well as V3, if required (use mouse or keyboard).	V1 starts at the yellow channel 1! Proceed with entering V2 and V3, if required.
Confirm your entry with "OK".	The entered values appear in the appropriate fields of the main screen.

However, the remaining workflow steps do not differ from that of the standard measurement.

### 4.4 Table

The values in this sound velocity table cannot be edited. They are default values and thus only approximate values. They may differ from place to place!

In this window, you can enter and save individual sound velocity values. Manual entries are recommended, for example, if you have found out that your individual sound velocity values are differing (sound velocity measurement). You can scroll the table by clicking onto the "Pipe Material" and "Pipe Diameter" fields.

### 4.5 Parameters

Select the "Parameter" option in the "Settings" menu. Here you can define various measurement parameters and save them according to your individual working methods.

You may also alter settings to enhance the visual representation, which – in individual cases – may even lead to better results. However, no general recommendations can be made – just try out and adjust the settings according to your needs.

The default parameters were selected so as to produce optimum measurement results in most cases.

#### 4.5.1 Interference Suppression

Function for reducing the negative effect of temporary interferences (vehicles, pedestrians).

If the "interference suppression" function is activated, it is assumed that optimum results can be achieved in those moments in which the measured noise (signal) is relatively low. In this case, the leakage noise – which is always present – remains preponderantly undisturbed. In moments in which the signal is relatively loud, the additional noise must come from an interference source in all probability, leading to much less reliable measurement results. Interference suppression ensures that the correlation (averaging) is only performed in those moments in which the signals lie within a certain level range (volume). If the signals lie outside the level range, the measurement is interrupted. The level range is limited by the upper threshold and the lower threshold. During the measurement, these thresholds for signal 1 and 2 are indicated as red horizontal lines on the left or right edge of the screen (see level indication in the illustration). The level range is newly defined each time the measurement is started. At each start, the correlator takes the measured level values as reference values.

Check the information on the measuring progress indicated in the info line.



### a) Manual (Standard Setting)

This setting is recommended, if you want to work with maximum interference suppression and if you desire greatest possible influencing control for measurements.

If the interruption is too long, it is possible to manually increase the level range, thus reducing the sensitivity level. The measurement is continued with the operator ignoring a certain level of interfering noise. If the current level values fall below the level range, an adjustment is automatically performed, i. e. the correlator is set to a more "sensitive" level.

### b) Automatic

This setting is recommended for standard situations and ensures reliable results.

After a defined interval, the level range is automatically and slowly increased, if the current level values lie permanently above the level range. Just as with the manual setting, the level values are automatically adjusted if they lie below the level range. Therefore, the automatic re-adjustment is performed in both directions.

"Interference suppression" is always set to "Automatic" if the wizard is used.

### c) "Off"

It is recommended to select this setting only in situations which are marked by frequently returning, strongly varying signals resulting in the measurement being constantly interrupted, thus preventing a correlation completely.

The interference suppression is disabled. With this setting, it is accepted that interfering noise is jamming the leakage noise from time to time.

### 4.5.2 Filtering

#### a ) Manual Filtering

If you select this setting, filtering is performed only manually. This means that you can edit a measurement manually after a defined number of averaging processes (see "Frequency Analysis").

#### b) Automatic Filtering

The frequency analysis is automatically started after each individual measurement. The frequency analysis can also be performed if the function is started in the "File" menu after a normal measurement.

### 4.5.3 Totalling / Averaging

With "Totalling" all individual results (averaging processes) are used for the representation of the correlation function. If "Averaging" is selected, only the most recent averaging processes are used. This means that the correlation function reflects more accurately the current noise situation.

### 4.5.4 Correlation Function

Rising: The correlation function rises towards the upper limit as the number of averaging processes increases.

Not rising: The correlation function is standardised at the upper limit during the first averaging.

### 4.5.5 Rectangular / Hanning

If "Rectangular" is selected, signal filtering is precisely performed at the marked point. With "Hanning", the range of the marked point is faded in with soft transitions.

### 4.5.6 Amplification

This option permits you to modulate manually the amplification of the input signals.

### 4.5.7 Cross-Correlation / Autocorrelation

If "Cross-Correlation" (CCF) is selected, the noise source to be located must lie within the measurement section. The measurement is carried out with both channels (1 and 2). With "Autocorrelation" (ACF), either channel 1 or channel 2 is used. The second signal required for correlation is generated by the reflection of the noise to be located at a reflection point, which must be received by the channel being used. Since the energy of the reflected noise signals is generally extremely low, it is recommended to use this procedure only in special cases. Autocorrelation may be useful, if the pipe contains gases.

The location of the reflection point must be known.

The autocorrelation function always runs symmetrically. Only the negative range of the autocorrelation ( $\Delta t < 0$ ) is significant.

### 4.5.8 Sampling Frequency

The continuous time signal of channel 1 and 2 is sampled and digitised with a particular frequency, the sampling frequency.

If "Automatic sampling frequency" is selected, the sampling frequency is set to the maximum and the current sampling frequency is displayed. Select "Manual sampling frequency" if you want to set the frequency manually. You can then gradually set the sampling frequency. All following measurements are performed with this sampling frequency.

The lower the sampling frequency, the less time is required for calculating the averaging processes. However, the used sampling theorem demands a sampling frequency which is at least twice as high as the highest frequency contained in the signal! Setting the sampling frequency too low may lead to faulty measurements. For this reason, it is recommended to decrease the sampling frequency only in special cases, e. g. if extreme low-frequency noise is to be measured.

### 5 Changing the Main Screen ("Views" Menu)

Depending on your requirements or preferences, it is possible to display various windows on the main screen.

Apart from the windows described in the "Main Screen" chapter, you may select:

#### **Top Function (DTF)**

The DTF is mathematically derived from the filtered correlation function. It should be used in difficult cases, since it can produce significant improvements in the peak.

Please note: The cursor can be used just as in the correlation function. The measurement result always relates to the representation in which the marking was last set.

#### **Cross Spectrum**

This representation should be applied in the same way as the "coherence function". However, due to its different derivation the cross spectrum has a different form.

Please note: The cursor can be used just as in the coherence function. The measurement result always relates to the representation in which the marking was last set.

#### **Yellow Channel 1 (Green Channel 2) Spectrum**

The "spectrum" indicates the intensity of the noise over the frequency. You can observe each individual channel and also set filters separately in each channel.

Please note: The cursor can be used just as in the coherence function. The measurement result always relates to the representation in which the marking was last set.

## 6 Documentation (Menu "File")

### 6.1 Protocol

First select "File" in the menu bar, then "Protocol". A protocol box is opened in which you can enter site-specific data (see also "Saving the Start Settings").

### 6.2 Saving

Select "File" in the menu line, then "Save".

All measurement parameters and the protocol are saved.

#### File Name

File name and directory can be freely selected. It is recommended to use "cor" as file extension, just like the default setting.

### 6.3 Opening a File

Select the "Open file" option in the "File" menu.

Select the desired measurement by double-clicking on it.

You can edit the saved measurements using filters and save them under any name.

### 6.4 Printing

Select one of the options available in the "File" menu.

### 6.5 Print-Out of the Company Logo

A default illustration is inserted in the upper right-hand corner of the print-out. This picture is saved as CWLOGO.BMP. If you want to use another picture (for example your company logo) in the print-out, you may delete the BMP file. You can then save a bitmap file of your choice under the same name. Requirements: Bitmap file (BMP), smaller than 64 Kbytes, black/white (two-tone), width x height ratio = 2:1, if possible.

### 6.6 SeCorr 08

Function for measurement read-out from correlator SeCorr 08. A file "SeCorr 08" is created in the directory from which the SeCorr 05 application was started.

## 7 Optimisation

The location is based on the correct determination of the time-delay difference. If the leakage noise is sufficiently loud and if there are no background noise sources, the time-delay difference is adequately well-displayed after only a few averaging processes (4 to 16). But what can be done if no sufficiently clear peak can be generated? The following instructions cannot substitute practice and experience still required in difficult situations. However, they will help you to learn the basic operations. Be that as it may, you must always remember one thing: If the leakage noise does not reach the microphones with sufficient intensity, no correlation is possible!

### 7.1 Number of Averaging Processes

If a result is unsatisfactory after the initial series of averaging processes, you can improve it by increasing the number of cycles. The result is improved because the calculation is based on a greater body of information on the chronological behaviour of the leakage noise. Experience has shown that the result can only rarely be additionally improved if more than 64 to 128 averaging processes are selected.

### 7.2 Filters

We recommend to use the features of the (mathematical) filters. Unfortunately it is hardly possible to give any generally valid "formula". Only your own experience, i. e. learning by doing, will lead to success. We recommend to work through the exercises.

In most cases, it is only practical to select frequency ranges for the correlation function in which the coherence function does clearly stand out from its environment, i. e. where there is peak.

Individual frequencies from various interference sources generate a uniformly sinusoidal correlation function. They can be recognised in the spectra as sharp lines.

### 7.3 Frequency Analysis / Automatic Filtering

The frequency analysis is based on statistical methods which are used for automatically filtering the coherence function, so that it is possible to obtain optimum correlation results.

You may perform the automatic coherence function for both, running measurements as well as already saved measurements.

### 7.4 Connecting the Microphones

Make sure that the microphones are firmly and securely plugged into their sockets. Remove any dirt or rust.

### 7.5 Accessories

Use suitable accessories and auxiliary equipment. Use "hydrophones" for plastic pipes. The "Active" filter makes additional features available. You can use the "teach yourself" cassette to check the system and to keep your level of knowledge up-to-date with a minimum of effort.

### 7.6 Selecting the Location

Use different locations for placing the microphones. Even remote locations can generate better results if the sound transmission is improved.



**7.7 Saving Time**

If it turns out during a measurement that it is not possible to record a peak, all run-up efforts to collect precise data on the pipe were in vain. Practice has shown that it might be better to start the measurement with estimated pipe data. If it turns out that the assumed pipe length is greater and/or the sound velocity lower than expected, a possible peak will appear in any case within the correlation function – which simply cannot be "overlooked".

Also with this more practice-oriented approach, it is still required to determine the pipe data precisely.

### 8 Measurement Accuracy

Each measurement is performed to locate a leakage point as accurately as possible. The calculation is based (apart from the time-delay difference) on the length of the measurement section and the sound velocity, i. e. the pipe data. These values must be determined as accurately as possible. If you want to find out to what extent the result will deviate if the pipe data was inaccurately entered, we recommend to enter dummy values in the main screen.

This will show, for example, that when there is a peak in the centre of the correlation function ( $\Delta t = \text{small}$ ) a change in the sound velocity has hardly any effect on the measurement result. However, this means for you: You should move the microphones in order to focus on the exact leakage location which you have localized only roughly beforehand. This will often make it unnecessary to measure the sound velocity.

**9 Saving the Start Settings**

The program is started with default start settings. These include, for example:

- Measurement section L1 = 150 m
- All settings of the "Settings" and "Parameters" menus
- The entries in the protocol.

If you want to change these start settings, proceed as follows. The new settings will be active the next time the program is started.

- Start the program
- Open the file CWSTART.COR in the working directory
- Change the current settings
- Select "File\Save" (file name: CWSTART.COR)

Note: If you want to delete your modifications and to use the default start settings, delete the CWSTART.COR file and restart the program. In this case, however, it is required to register the software again.

**10 Exercises**

In the MESSUNGEN sub-directory you will find a number of exercises or sample measurements which you can use for practising. After opening a measurement you will find more relevant information under "Protocol".

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## 11 Appendix

### 11.1 History of Program Modifications

Version	Date of *.exe file	
11.00	08.01.2004	The program can be run under Windows 95, 98, 2000, XP professional (32 bit). Measurement read-out from correlator SeCorr 08 under file/SeCorr 08. Changing form of sound velocity table "cwsvelst.dat". See Measuring the Sound Velocity. Saved measurements can generally not be continued.
10.11	06.07.2001	The program can be run under Windows 95, 98, 2000 and Windows NT 4.0 (32-bit version). Measurements from previous versions can <u>no</u> longer be read. Files can be saved under any name. Registration of demo software with a registration key. The interference suppression function can be switched off. Even for longer measurement sections the coherence function is longer indicated as divided segments.
8.00	xx/xx/2000	Optimisation of the frequency display in the range below 7 Hz. The coherence peak in the range between 0 and approx. 12 Hz was eliminated. Revision of the interference suppression. (Frequency analysis) System crash with no printer connected. This error was eliminated. A "Wizard" was created to guide the user through the program. Extension of the fade-out function for frequencies of the coherence function and spectra.
7.00	03.11.1999	An error concerning the 3-point measurement was eliminated: The 3-point measurement works also with running noise deactivation. Transmissions are regularly checked, not only at the start of a measurement.
6.80	22.12.1998	Elimination of a problem occurring in connection with the printer resolution and of an error message triggered if certain printers are used for printing.
6.70	3.6.1998	Creation of a universal program (demo version, A/D converter and PC-Card version).

## 11.2 Abbreviations

CCF = Cross-Correlation Function

CHF= Coherency Function

L1= Length 1 (2 or 3 also possible)

V1= Velocity 1 (2 or 3 also possible)

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