Software Overview

WinMLS

A PC-based measurement application

by Pat Brown

Syn-Aud-Con has just completed its third Architectural Acoustics Measurement and Prediction (AAMP) seminar. The most recent event was at NSCA in Las Vegas. All three have been filled to capacity. We were fortunate to have Peter Mapp as a co-instructor at two of the three. The AAMP seminar is built around the impulse response of a loudspeaker/room system. This makes the seminar independent of any specific measurement platform, since several are available that can measure the impulse response and perform the processing routines necessary to extract meaningful information from the data. One measurement application approved for use in the seminar is WinMLS™. It is a very powerful application developed by Morset Sound Development of Norway. The following overview of WinMLS should serve to familiarize the reader with some details of this application and provide some general theory on room measurements in general.

It's nearly impossible to discuss measurements without the use of acronyms. In this article, IR stands for "impulse response." SUT stands for "system under test." MLS stands for "maximum length sequence." USB stands for "universal serial bus." And finally, S/N stands for "signal-to-noise ratio."

The Maximum Length Sequence

The MLS test stimulus is a binary string (1's and 0's) that is generated by the program, stored in local memory, and fed to the system under test (SUT). The signal is re-acquired with a microphone and compared to the signal that was stored. A complex comparison of the two yields the IR of the system. Since its inception, WinMLS has grown to support other stimulus types, most notably the logarithmically-swept sine wave.

Gathering Data

We will examine this in terms of the acquisition method and the required hardware. WinMLS is a software tool that requires hardware to perform measurements. It supports most Windows™ sound cards, but as many users of all platforms have found, the internal sound cards of some notebook PCs are not ideal for this task. A number of cost-effective third party USB audio devices are widely available. I have used a number of these successfully with WinMLS. USB is not without its own set of problems (see "DSP Control," this edition). I have achieved the most reliable and consistent performance with WinMLS using a PCMCIA sound card – the VXPocket™ from Digigram. Morset offers a package that includes the software, VXPocket, mic, and phantom power. This Type 1 PCMCIA card uses a "dongle" for all I/O connections. This allows for an extremely portable measurement system, but the user must take care with the dongle to avoid damaging it or the PC card. I normally strain-relieve mine to the LCD
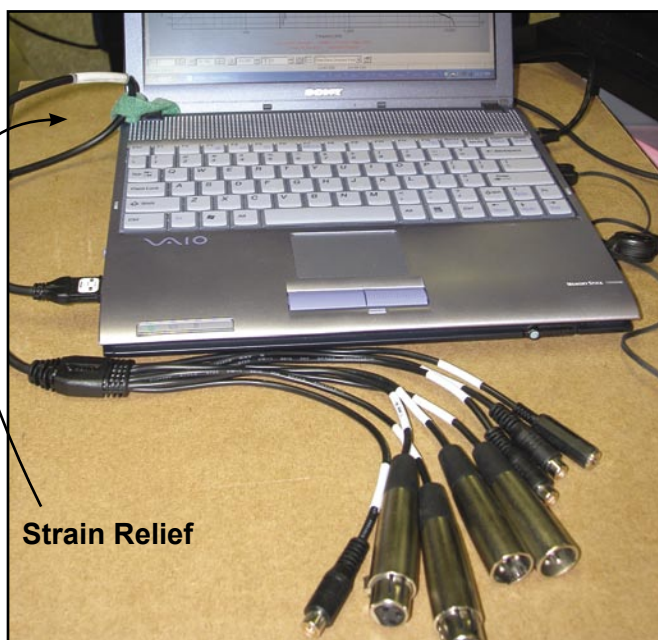

Strain Relief

Figure 1 - The VXPocket is a PCMCIA card that uses a "dongle" for connections. Inputs and outputs are balanced XL mic or line level.
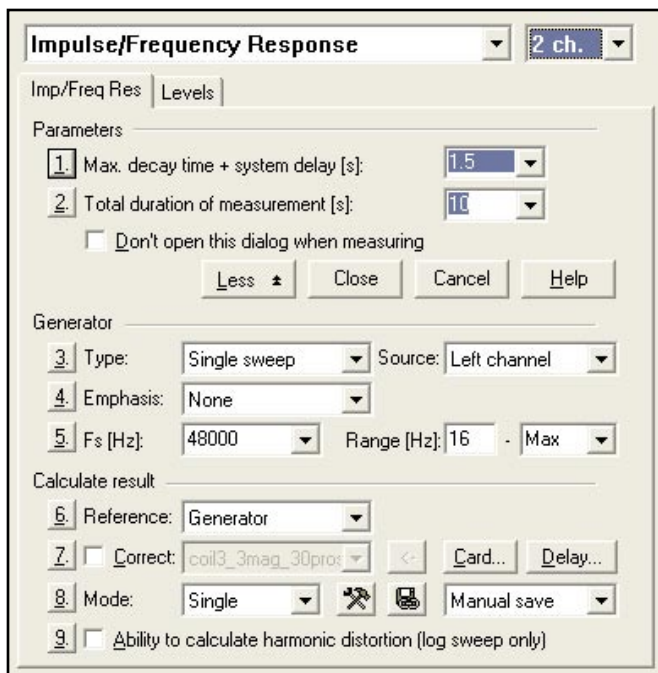
Figure 2 - A dialog box allows the measurement parameters to be selected. Absolute calibration is possible for SPL measurements.

hinge with a Velcro strap (Fig. 1) since my PC does not have a standard port available for the included strain relief. The program supports .wav files, so you can gather the IR by other means and use WinMLS solely as a display/post-processing tool.

The first step of performing an electroacoustic measurement is the selection of the data acquisition method. WinMLS gathers the IR of a system without using an impulse as the stimulus. As such, there are some setup parameters that must be set prior to running a measurement. A setup "Wizard" can aid in setting things properly or the user can bypass the wizard and enter the parameters manually. Here is a look at the major measurement settings (Fig. 2):

Item 1 - The time span of the measurement (this must be greater than the total decay of the SUT).

Item 2 - The total duration of the measurement. This value should exceed the time span entered in step 1. WinMLS will then extend the measurement time to fill the time span entered. If "Single Sweep" is selected, the time span will be filled by a single, log-swept sine wave. If "Multiple Sweeps" is selected, the time span will be filled by multiple short log-sweeps with averaging. Either method will yield better signal-to-noise ratios for the data than shorter spans. The user can keep increasing the time span until the desired S/N ratio is achieved.

Item 3 - The stimulus type is selected next. The dialog displays the stimulus type, along with the strength of using that particular stimulus. This is a very useful feature, since no stimulus is ideal for all measurement situations.

Item 6 - The reference signal - The heart of IR testing with personal computers is the comparison of the
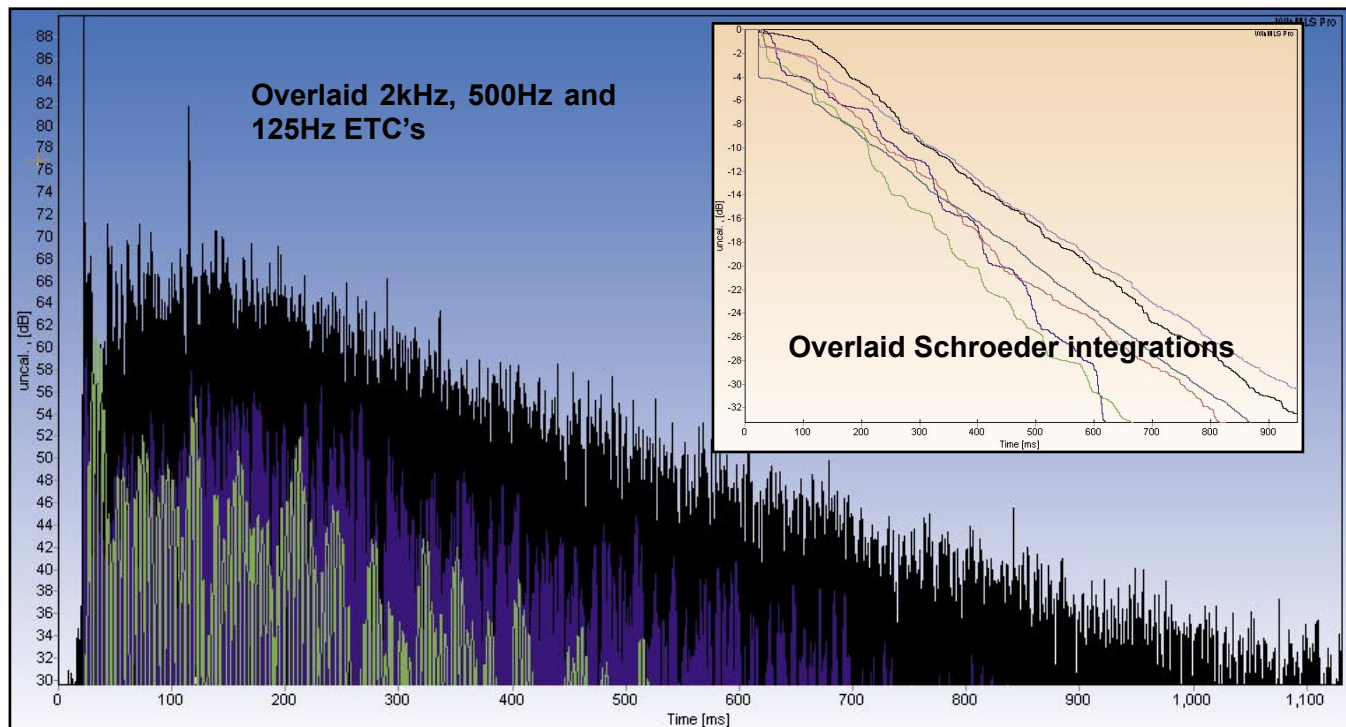

Figure 3 - A variety of time domain displays are available. Octave-fraction filters are nicely implemented.

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stimulus with the response of the SUT (acquired with a microphone in acoustic testing). WinMLS is very versatile in how this is done. One method is to use one channel of the sound card as the reference, and the other channel to collect the response of the SUT. This method allows almost any broadband stimulus to be used to excite the SUT. WinMLS also allows an "Internal" reference to be used, which frees up both sound card channels for collecting the response of the SUT. The most obvious application of this approach is stereo or binaural measurements, something that I am finding increasingly relevant when analyzing rooms. The ability to gather two-channel data with two-channel hardware is a major advantage of this application.

Level setting is an important part of data collecting. WinMLS makes facilitates this with a "Test" mode with input meters. It can control the gain settings of the VXPocket, which makes level setting fast and accurate.

Data File Format

The data can be saved in a proprietary WinMLS format. It can also be converted to MLSSA™ (DRA Laboratories) or Windows™ .wav file format. This versatile method of data handling is absolutely vital to a modern measurement system. I often find it useful to get a "second opinion" on data analysis. The .wav format allows me to open data collected with WinMLS
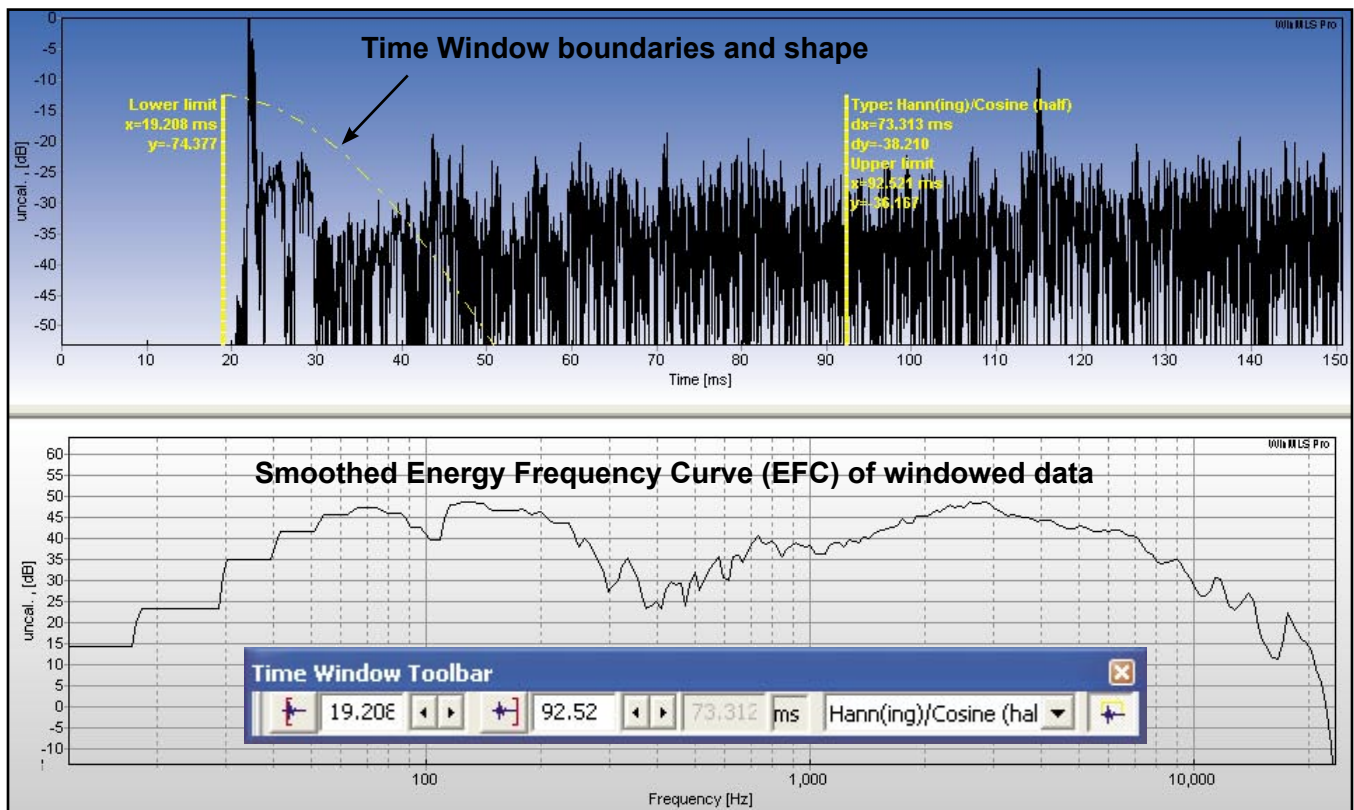
in other applications, including .wav editors such as SoundForge™ or Wavelab™.

Data Display and Analysis

WinMLS is extraordinarily versatile with regard to displaying the IR and its derivatives. The Time Domain displays include the raw IR on a linear or log vertical scale. ETC and Step Function displays are also included, as is the Schroeder curve used for decay time assessments. The IR can be filtered in bandwidths ranging from 4 octaves to 1/n-octave, where n is an integer (Fig. 3). The filter order is also user-selectable. This is the most versatile filter setup that I have seen on a PC-based platform.

Frequency domain data can be displayed simultaneously with time domain data (Fig. 4). A Time Window toolbar allows the window type and span to be selected. The time span can also be adjusted by dragging the window edge with the mouse. The FFT is performed automatically each time the window is changed. A wide variety of time windows are included, and the shape of each can be overlaid on the IR. The window implementation is intuitive, visual and versatile. For these reasons, WinMLS is my tool-of-choice for teaching windowing techniques in our seminars.

Frequency domain plots include Spectrum, Relative

Figure 4 - Simultaneous display of the ETC, time window, and spectrum.

Energy Time Frequency (ETF) display of a full-range loudspeaker in a small room.
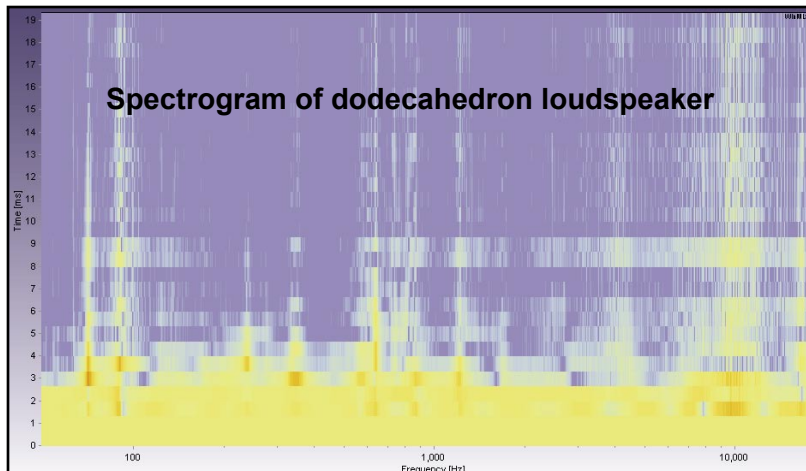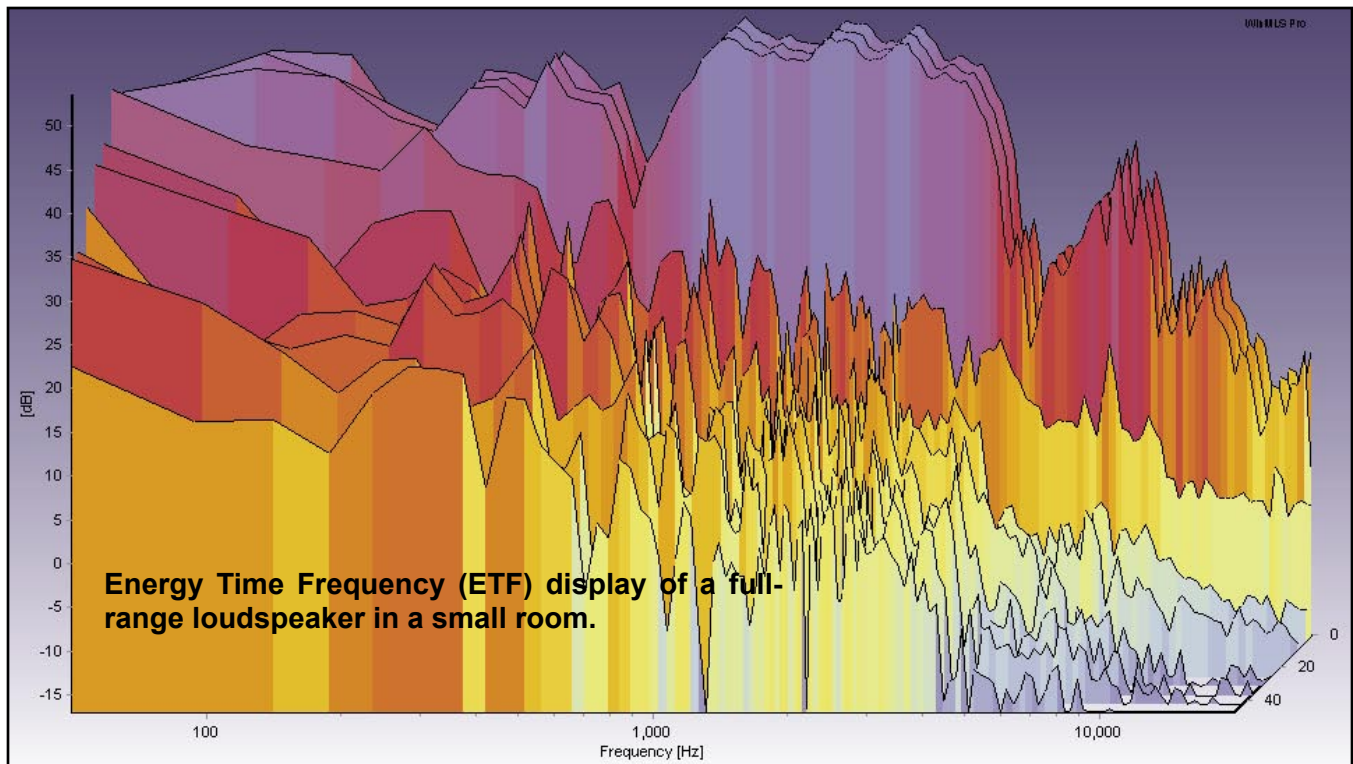

Spectrogram of dodecahedron loudspeaker

Figure 5 - Joint domain displays include waterfalls (ETF and CSD) and the spectrogram. These allow decaying energy output from loudspeakers or rooms to be observed. The plots can be rotated, rescaled and further customized by the user.

Phase and Group Delay. The Phase displays allow Minimum Phase, Excess Phase, Wrapped and Unwrapped views. It also allows the user to select the frequency range used to remove the excess delay. The smoothing algorithms are the most powerful that I have seen to date.

Joint-Domain Displays

Werner Heisenberg discovered that it was impossible to observe both the position of a particle and its velocity simultaneously. The Heisenberg Uncertainty Principle can also be applied to time and frequency. Since the definition of time is inverse-frequency, one cannot get more detail about one without sacrificing detail about the other. Joint domain displays sacrifice

detail in both views to allow both to be observed.

The joint-domain displays in WinMLS include the ETC (Energy Time Frequency) and CSD (Cumulative Spectral Decay). These can be displayed as waterfall plots or as 2-dimensional spectrograms (Fig. 5). As with the other post-processing routines, a wide variety of calculation options are available.

Acoustic Metrics

The IR can be given a "score" to quantify energy ratios, speech intelligibility, clarity, etc. It is educational to combine these acoustic "metrics" with listening exercises to assess what they sound like. Any score given to an impulse response will by nature be a gross over-simplification of reality. Even so, such metrics are quite useful in quantifying the changes made to a sound system or room. Just be careful when comparing data from different venues. A 0 dB "C50" in one space can sound drastically different than the same score from another space.

Perhaps the most powerful aspect of WinMLS is the way that it handles calculation of the various acoustic metrics. It includes menu selections to quickly get speech intelligibility data, decay times, ISO 3382 metrics, and others. This intense feature set makes WinMLS a viable measurement platform for acousticians as well as sound system designers.

Conclusion

I first ran across WinMLS a couple of years ago when investigating various measurement platforms to use in sound system design and room testing. The AAMP seminar was in its formative stages, and I was looking for alternative

Figure 6 - An automated routine yields octave-band reverberation time data.

data acquisition and analysis applications to what I was already using. WinMLS was a powerful program, even in its infant stages. I was also intrigued that its developer, Lars Morset, is pursuing a Ph.D. in violin acoustics. The fact that he was also working on software indicates that he is interested in understanding the underlying physics of "good sound." Over the past two years I have seen WinMLS "come of age" through the continued dedication of Lars and his staff. The program has had its share of glitches, but I judge an application largely by the willingness of the developer to acknowledge and work through the problems. Software development is a rocky road fraught with many perils, but WinMLS has emerged as a powerful measurement platform that is worthy of consideration by anyone involved with sound. The developers have sought to
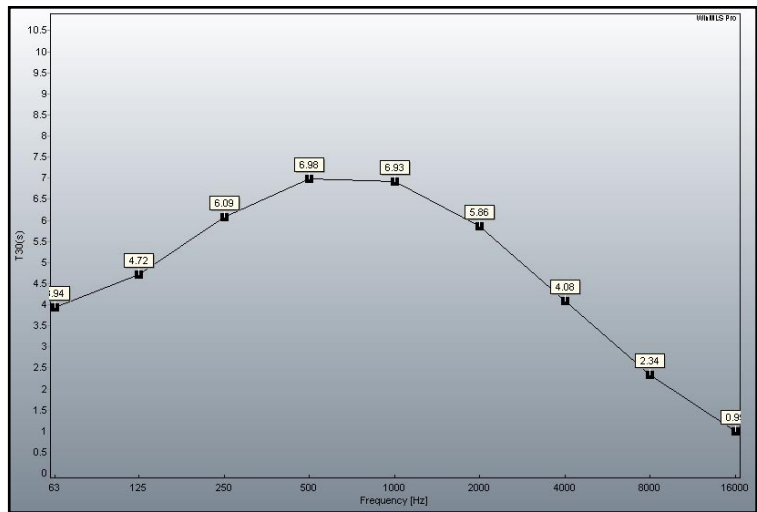
retain the versatility that a high-end program should have, instead of watering it down to make it more palatable to the larger markets. Rather than remove features and options, they have provided customizable toolbars and setups, as well as a large variety of customizable "wizards" to simplify the gathering and viewing of data, and this without alienating the user that wants to control everything manually (my camp). As such, this program should have as much appeal to the novice user that doesn't need the subtleties of endless options, as it does to the advanced user that might use the program as a research tool. Multi-channel versions of the program are used for research at B&W Loudspeakers and RPG, Inc.

This overview was of the beta version of the program. The release version is due this Spring.

A demo version of WinMLS is available online at www.winmls.com. The site also provides support via e-mail and a user's forum. Telephone support is also available. *pb*

F[Hz]	63	125	250	500	1000	2000	4000	8000	16000
snr[dB]	37.6	42.2	47.6	42.8	46.4	50.8	54.5	43.5	25.0
edr[dB]	43.1	47.4	56.0	51.9	55.5	59.8	59.8	49.4	30.3
EDT[s]	3.47	3.61	4.76	7.23	6.70	5.41	2.66	0.41	0.12
T30[s]	4.24	4.64	5.79	6.82	6.75	5.94	3.82	2.34	2.39
corr	-0.993	-0.998	-0.999	-1.000	-1.000	-1.000	-0.999	-0.999	-0.999
T20[s]	3.64	4.62	5.75	7.00	6.76	5.81	3.56	2.22	2.39
corr	-0.994	-0.998	-0.998	-0.999	-1.000	-1.000	-0.999	-0.999	-0.998
Tc[ms]	184	257	267	350	215	161	58	23	18
C50(dB)	0.1	-5.6	-2.8	-2.1	2.0	2.8	6.5	10.0	11.6
C80(dB)	0.3	-4.9	-1.1	-1.5	2.4	3.3	7.2	10.9	12.3
D50(%)	51	22	34	38	61	65	82	91	94
STI	0.57	Rating:	Fair						
STIrMal	0.59	Rating:	Fair						
STIrFem	0.61	Rating:	Good						
RASTI	0.51	Rating:	Fair						
%ALcons	7.9								
r[m]	8.1								

Copy   Print   Help   — Data Acceptable — Data Questionable

Figure 7 - ISO3382 and speech intelligibility scores are displayed in a customizable table.