

# Sample Champion - Application note # 11

## Room Acoustics - Acoustical Parameters Measurement

This application note describes how to use the Sample Champion Room Acoustics plugin for computing RT20, RT30, RT custom, EDT, D50, C50, C custom and TS parameters (see the ISO 3382 normative).

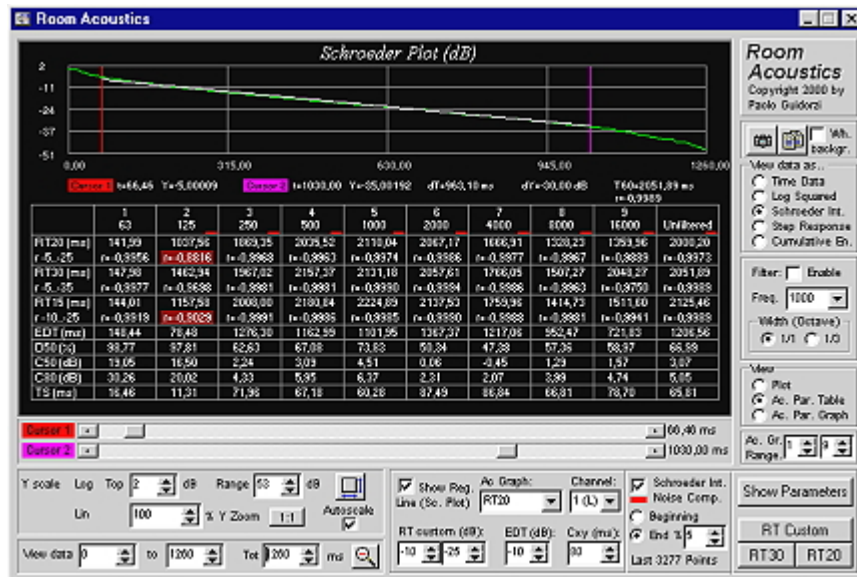


Figure 1 - Room Acoustics plugin window

### Room Response Measurement

First of all a Room Impulse Response has to be measured by using the main program, Sample Champion. This kind of measurement is done by placing the sound source (fed by the MLS signal) and the microphone (at listening position) inside the room under test. The sound field should be diffuse.

The ISO 3382 normative gives some guidelines for this kind of measurement (performed by using MLS signals):

- The sound source should be as close to omni-directional as possible
- The sound pressure level might be low because the SNR can be increased by averaging several measurement cycles
- The microphone should be omni-directional

- Microphone position should be far from the nearest reflecting surface at least 1/4 of wavelength, i.e. normally about 1 m
- The minimum microphone-source distance should be at least:

$$d_{\min} = 2\sqrt{\frac{V}{cT}}$$

meters, where  $V$  is the room volume,  $c$  is the speed of sound and  $T$  is the expected reverberation time. More information can be found in the ISO/DIS 3382 normative.

The room response can be measured by using Sample Champion simply by starting an average cycle of measurements.

**NOTE 1:** The length of the MLS signal must be greater than the expected reverberation time, otherwise the tail of the room impulse response will wrap at the beginning of the measurement (see [MLS theory page](#) about this). For example, by using a sample rate of 48 kHz for a measurement in a large room with reverberation time of about 2 s, a MLS length of 128K = 2719.7 ms must be used (or better 256K, to have a larger margin).

**NOTE 2:** The measured Impulse Response gives information for the specific point of the room where the microphone is placed.

### ● RT20, RT30, RTcustom

The Room Impulse Response gives information about the **reverberation time** by mean of the Schroeder Plot (a detailed explanation of this analysis technique is described in the [Application Note #12](#))

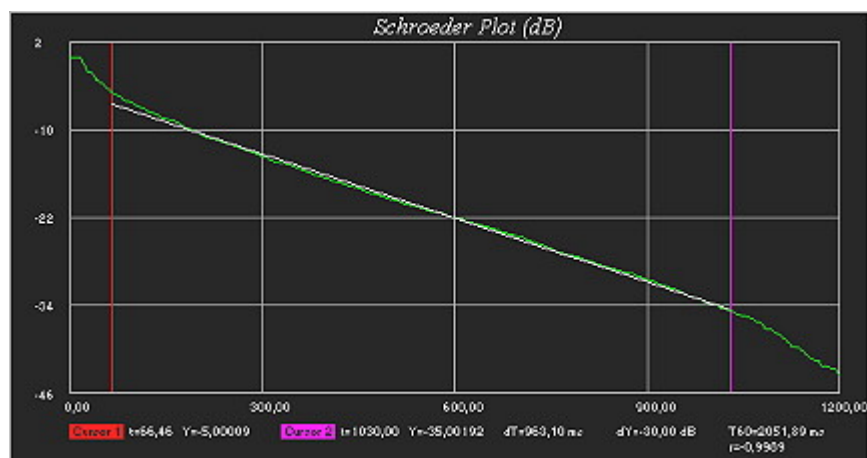


Figure 2 - RT30, obtained from the Schroeder Plot.  
The white line is the regression line

**RT20** is the reverberation time of the room (the time required for a sound decaying of 60 dB) evaluated over a 20 dB decay range in the Schroeder Plot (from -5 to -25 dB), using linear regression techniques. It is the time distance between the -5 dB and the -25 dB points of the Schroeder Plot, multiplied by 3 (actually the computation is more accurate because the plugin uses the values on the regression line).

**RT30** is the reverberation time of the room evaluated over a 30 dB decay range (from -5 to -35 dB), using linear regression techniques.

**RTcustom** is the reverberation time of the room evaluated over a decay range set by the user, using linear regression techniques.

For every parameter, the correlation coefficient *r* is shown. A value close to -1 indicates a perfect fit of the linear regression over the decay curve. When the value is greater than -0.95, a red alert is shown to indicate a loss of accuracy.

The plugin allows computing these parameters manually on the unfiltered Schroeder Plot or on the Schroeder Plot filtered in **Octave** or **1/3 Octave** bands (standard IEC 1260). A **noise compensation** algorithm is implemented and optionally used by the plugin, when possible. The user can choose whether computing the noise floor power from the beginning (before the first peak) or at the end of the Impulse Response (when the impulse has decayed under the noise level).

The values of these parameters are computed for all octave bands in a single step, by pressing the "Show Parameters" button.

They can be viewed in tabular form or as a graph.

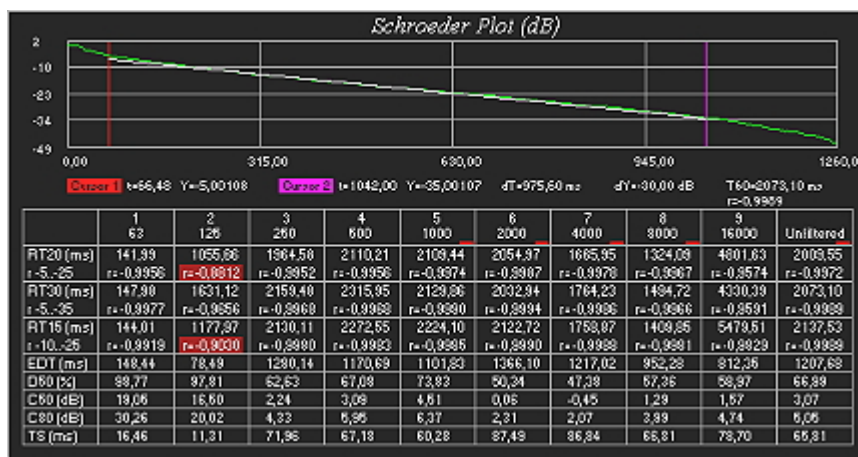


Figure 3 - RT30, computed for all octave bands

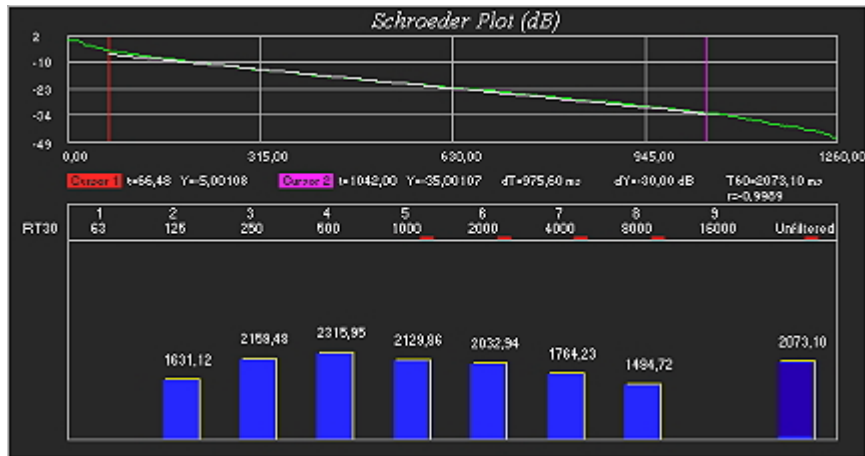


Figure 4 - RT30, graph for all octave bands

The noise compensation algorithm can be applied only when certain mathematical conditions are satisfied. When this happens (and the noise compensation option is enabled), a small red rectangle is shown near the octave band number.

### ● EDT

The EDT parameter (**Early Decay Time**) is the reverberation time, measured over the first 10 dB of the decay. This gives a more subjective evaluation of the reverberation time. The user can also change the decay interval of this parameter. As RT parameters, the EDT is computed for every octave band. It is expressed in ms.

### ● D50

The D50 parameter (**Definition or Deutlichkeit**) is the **early to total sound energy ratio**. It is defined as:

$$D_{50} = \frac{\int_0^{0.050s} p^2(t) dt}{\int_0^{\infty} p^2(t) dt}$$

and expressed in percentage.

### ● C50, C custom

The C50 parameter (**Clarity or Klarheitsmass**) is the **early to late arriving sound energy ratio**. It is defined as:

$$C_{50} = 10 \log \left( \frac{D_{50}}{1 - D_{50}} \right)$$

and expressed in dB. It is common practice to calculate this parameter also over 80 ms (C80). The user can set this time interval (C custom).

## ● TS

The TS parameter (Centre Time) is the **time of the centre of gravity of the squared impulse response**. An high value is an indicator of poor clarity. It is defined as:

$$TS = \frac{\int_0^{\infty} t \cdot p^2(t) dt}{\int_0^{\infty} p^2(t) dt}$$

and expressed in ms.

## ● Use of the Room Acoustics Plugin

A Room Impulse Response must be measured or loaded in the main program. If you load an I.R. file, select in the Settings|General window a buffer and MLS lengths equal or greater than the I.R. length to be loaded, otherwise the end of the impulse will be lost.

Open now the Room Acoustics plugin and press F5.

The impulse response can be shown in different ways (Data, Log Squared, Schroeder Integration, Step Response and Cumulative Energy).

- Select "View Data as..." Schroeder Plot
- Press the "View ALL data" button (Unzoom)
- Uncheck Autoscale
- Enable the Filter and select the desired Octave or 1/3 Octave band

Now press the "RT20" button. The two cursors will be positioned at the -5 dB and -25 dB points of the plot and the RT20 will be computed and shown in the right lower corner of the graphic screen. The position of the cursors can be changed manually if desired.

**NOTE:** The **noise compensation** option leaves to the user the possibility to choose whether the noise must be evaluated at the beginning or at the end of the I.R. file. The choice depends basically on the considered Impulse Response. Probably when the initial silence gap before the first peak is short, it's better to use the "End" option. This often occurs when measuring Room Impulse Responses in small rooms and the source-microphone distance is low. When measuring an I.R. in large rooms or halls, it could be useful to use the "Beginning" option. Anyway the number of points used for evaluating the silence portion of the file is written by the plugin below the Noise Compensation Enable/Disable checkbox. If the number of points is too low, try changing the option settings. Note that when the filter is enabled the initial gap could become small or null; in these cases use the "End" option.

By pressing the "Show Parameters" button, all parameters will be computed and shown in a tabular form.

The values of the parameters can also be plotted as bar graphs, by selecting the "Ac. Par. Graph" in "View" mode.

All computed parameters can be exported to Clipboard and the graphic plots can be saved to disk as image files.