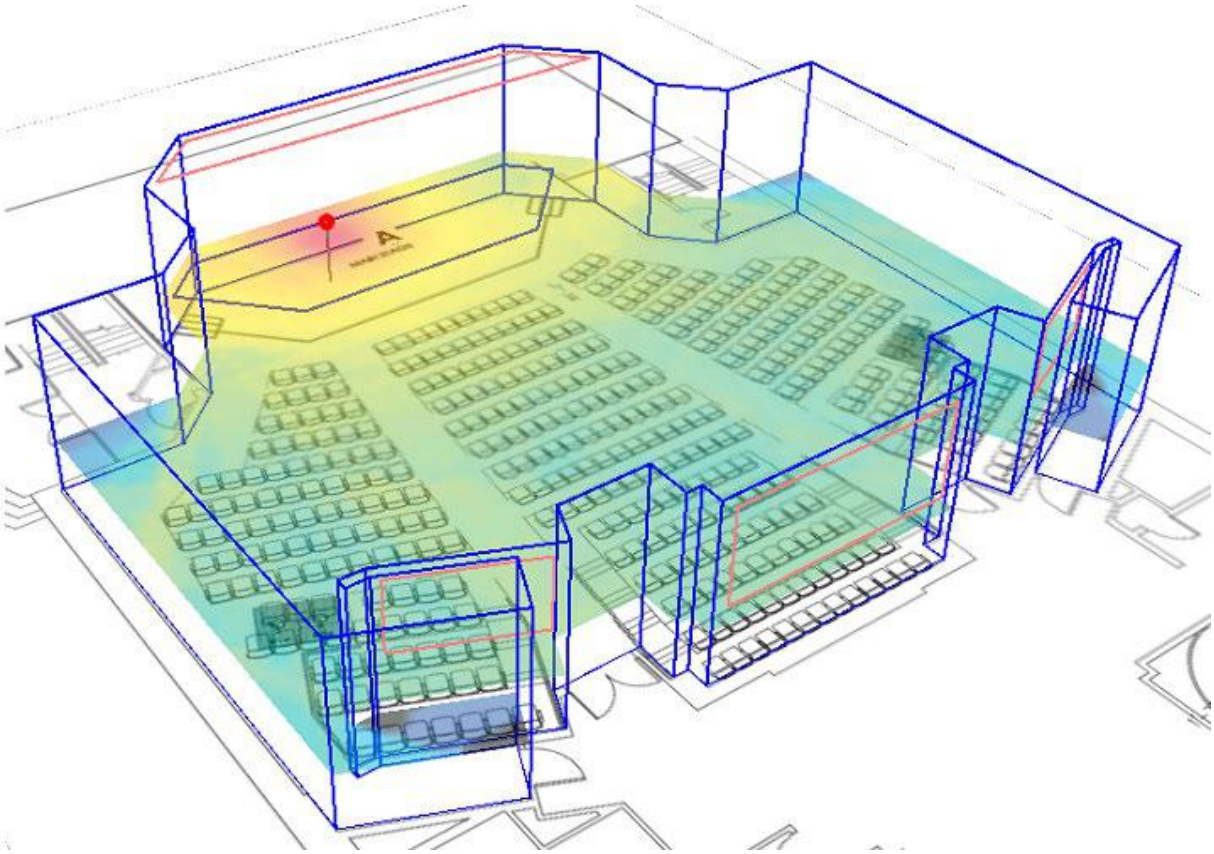
Rap-One II

User Guide – v 1.1.8

2019-03



Soft dB Inc.
1040. Belvedere Avenue, Suite 215
Quebec (Quebec) Canada G1S 3G3
Toll free: 1-866-686-0993 (USA and Canada)
E-mail: info@softdb.com

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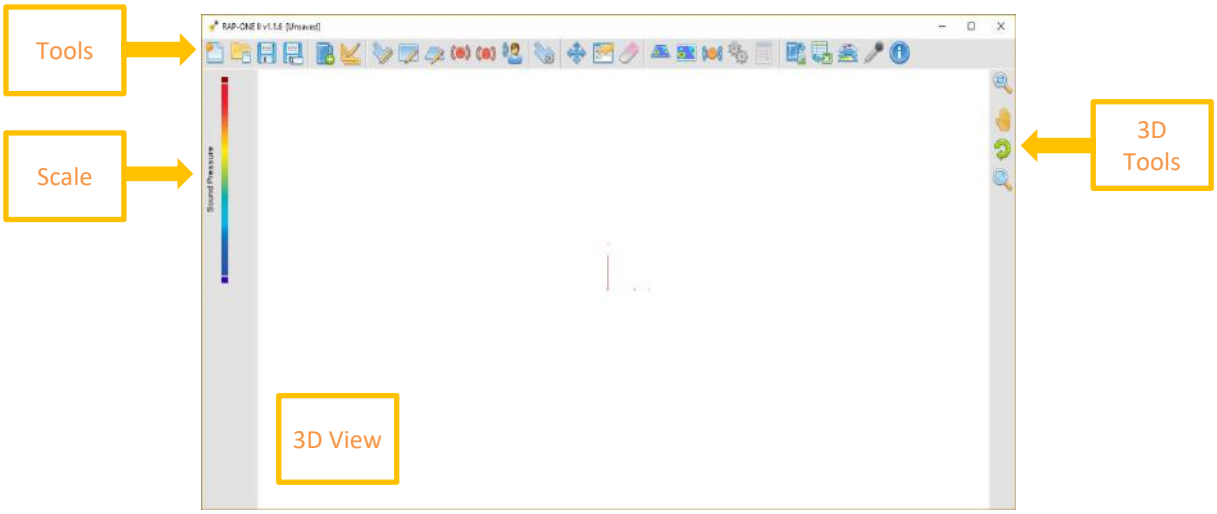
1 Introduction

This document is a user guide for anyone who wants to enjoy all the features of *RAP-ONE II,* an innovative and easy-to-use software that can analyze and manage sound in any room type. It can be used for many applications, such as industrial noise analysis, acoustical room design and more.

2 Modelling a Room

The main interface of *RAP-ONE II* features a 3D view as the main display panel. On the top pane are the main tools, the left pane shows the color scale and cursor attributes, and the right pane displays the 3D navigations tools.



2.1 Create a New Model

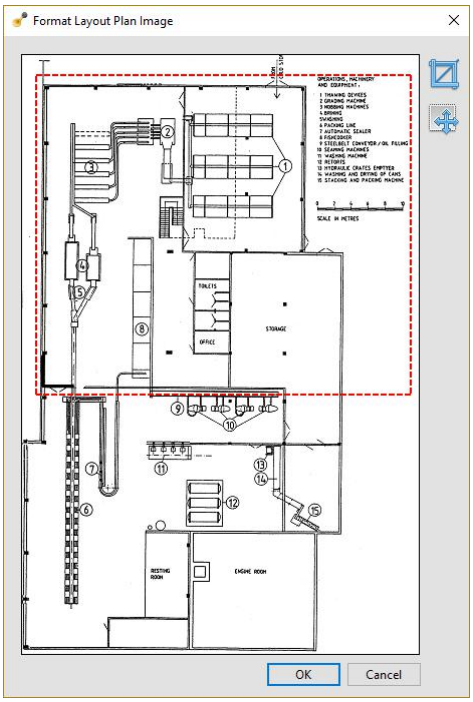
Click on the button to create a new model. Save your progress at any moment by clicking the button.

2.2 Import the Layout Image

The layout image is used as the drafting background. The layout image is laid on the floor and usually represents the floor plan of the modeled room.

Click on the button to import the background image.

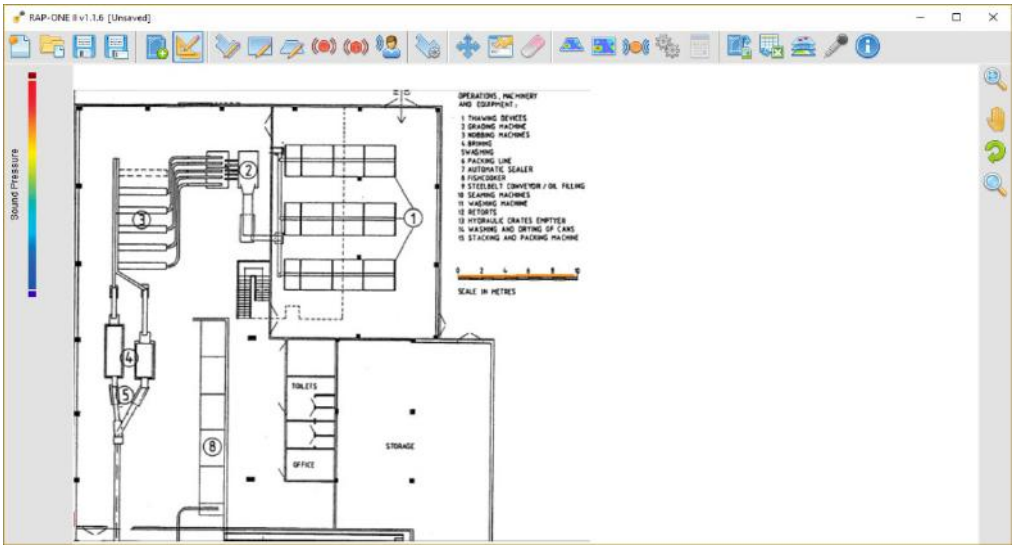
In the import window, you can crop the image and set the new origin if needed.



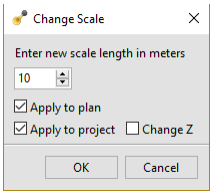
2.3 Define the Model Scale

Once the layout image is imported, the scale must be set.

Click on the button to select the scale tool. With the scale tool selected, click on the layout a first point and a second point between which the real-world distance is known.



When the second point is set, enter the distance in the scale prompt.



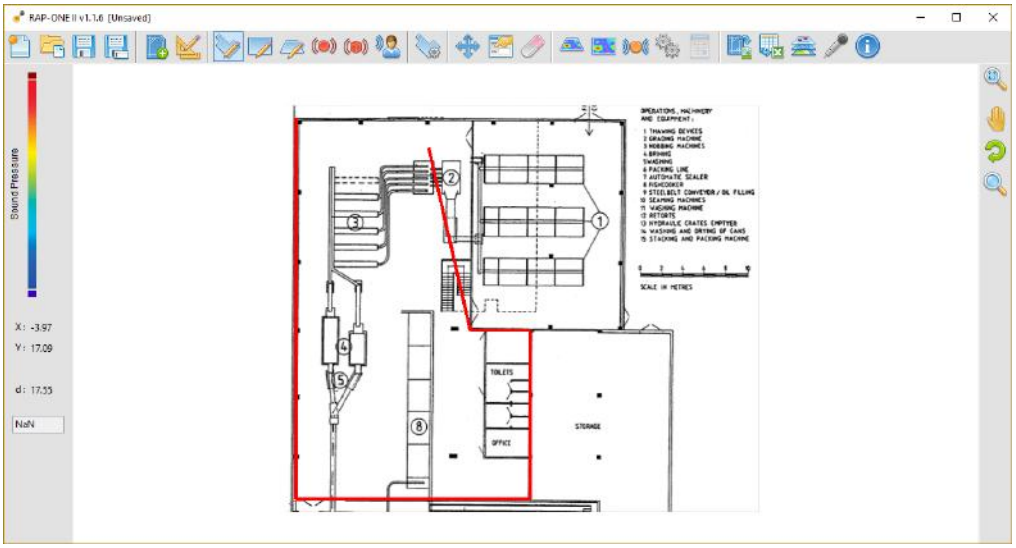
Note: Additional options allow changing the scale of the layout image, model XY and/or model XY and Z. These options are mainly useful when changing the scale of an existing model.

2.4 Draft the Room Outer Walls

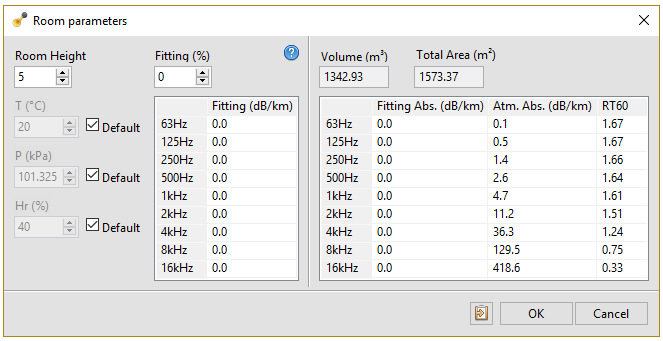
When the layout image is imported with an appropriate scale, the room outer walls are now to be drafted.

Click on the button to select the room drafting tool. With the drafting tool selected, click on the layout image at each corner of the outer walls. To end drafting, click on the initial corner.

Note: You can draw right angle wall by holding down the shift *key while drafting.*



Upon closing the outer walls, the room properties interface is shown. Enter the room height to complete the room model.



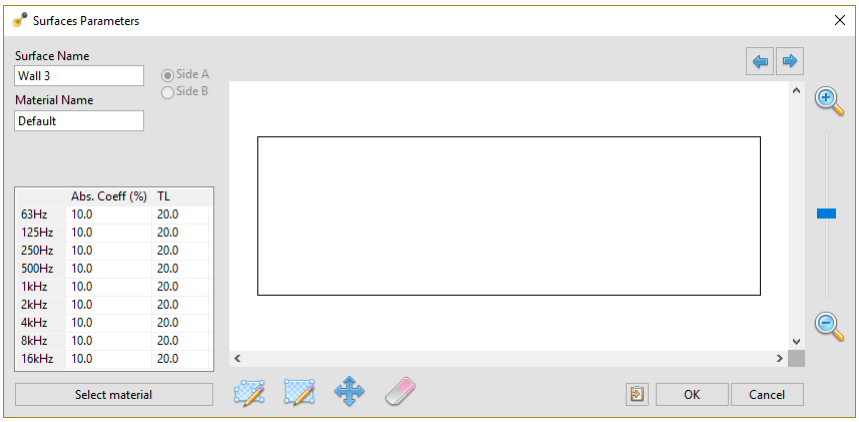
Note: The room properties interface also allows setting the air absorption and fittings absorption. It also allows to assess the general RT-60 of the model (refer to section 6.9 for more info).

The room properties interface can be recalled at any moment by clicking on the *button.*

2.5 Define the Acoustic Properties of Walls

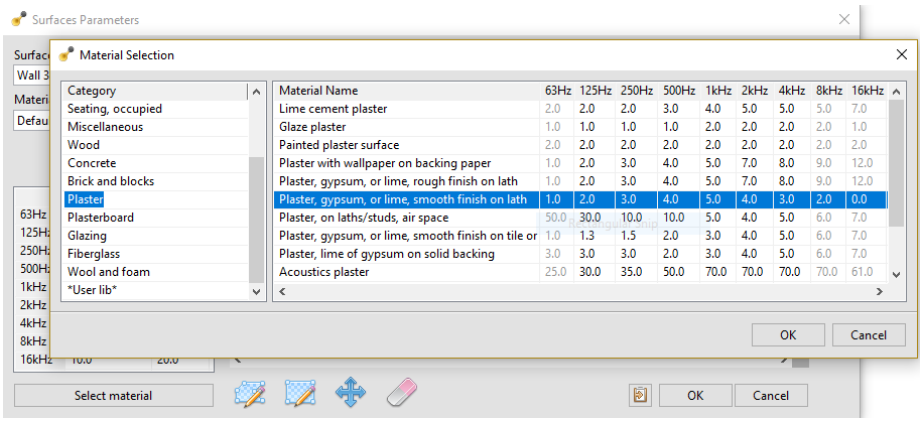
Back in the model, click on a room wall to select it. With a wall selected, click on the button to open the surface properties interface.

Note: More than one wall can be selected at the same time.



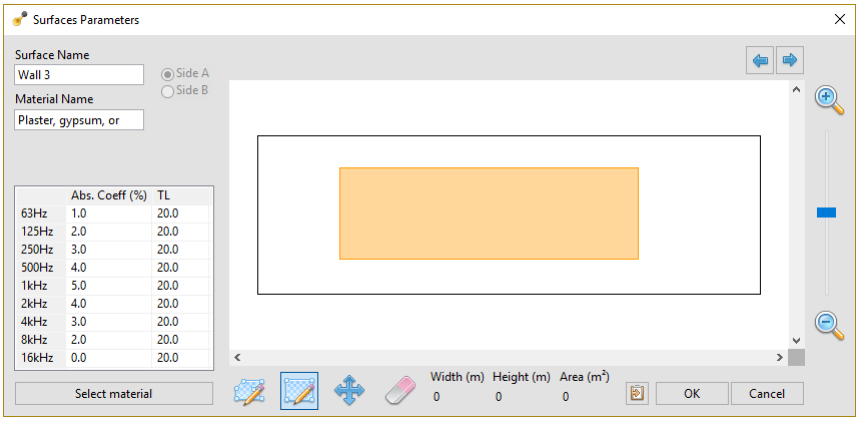
Enter the absorption coefficients and the transmission loss in the table.

Note: Predefined properties can be selected from the materials library by clicking on the "Select material" button.

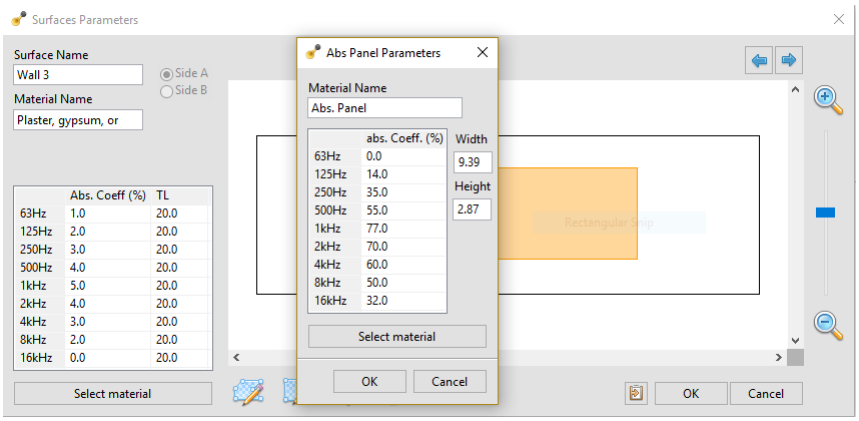


2.5.1 Draw Absorption Panels

Click on the button to select the absorption panel drawing tool. With the panel drawing tool selected, click the first corner and opposite corner of the absorption panel on the wall drawing.



Once the panel is drawn, its absorption coefficient can be set by double-clicking on the panel.



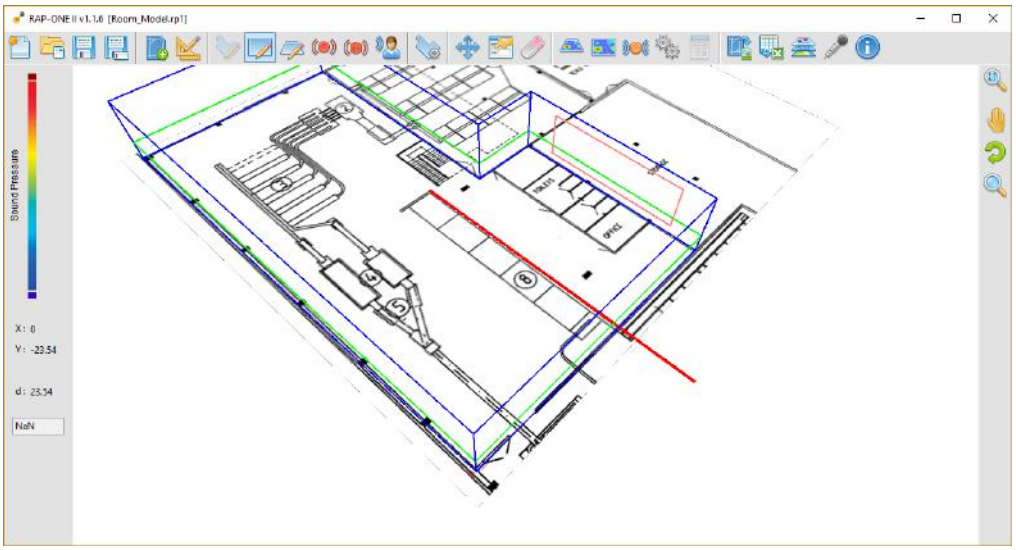
Note: Irregular shaped absorption panels can be drawn using the tool.
Absorption panels can be moved around using the tool.
Absorption panels can be deleted using the tool.

2.6 Draft Barriers

Barriers are walls present inside the model boundaries. The barriers can be either vertical or horizontal. Both sides can have different absorption coefficients and they also feature a transmission loss.

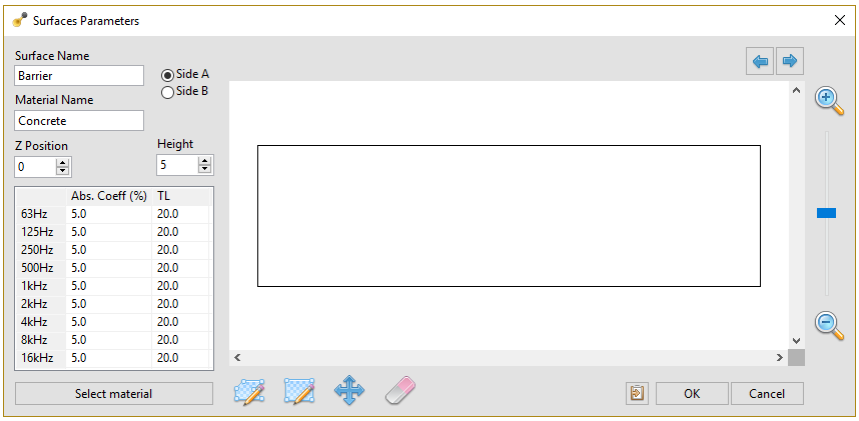
2.6.1 Vertical Barrier

Click on the button to select the Vertical Barrier Drawing tool. With the drawing tool selected, click on the barrier start vertex and click a second time on the end vertex.



Note: Hold the "shift" key while drafting to draw orthogonal lines.
Clicking on another wall vertex will "snap" the barrier vertex to this other vertex.
Crossing any wall will crop the barrier. This can be used to create a room dividing wall.

Upon drawing these two points, the barrier properties interface is launched.

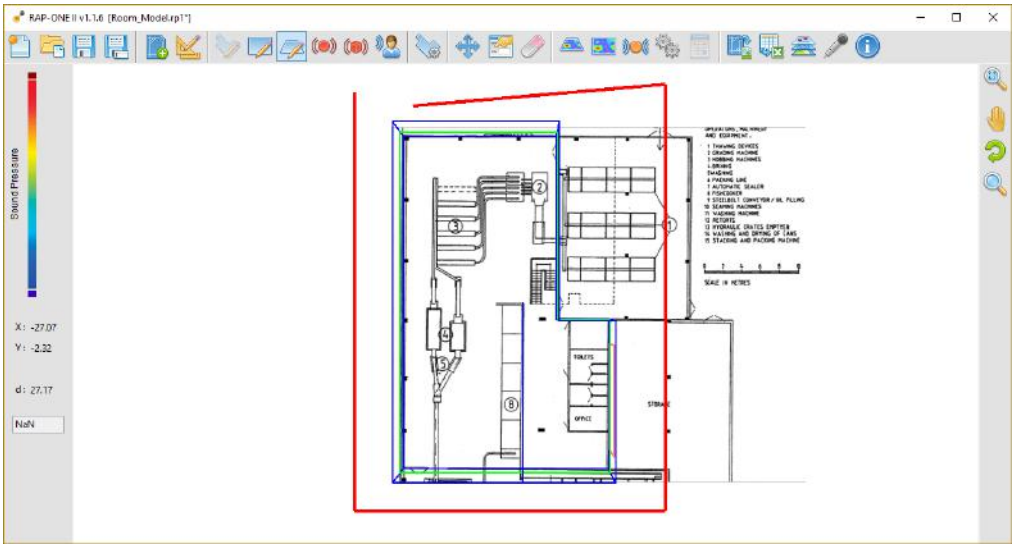


On this interface, the height and Z position can be defined as well as the acoustical properties.

Note: Barriers have two sides: side A and side B. Refer to the labels on the 3D view to identify the side.

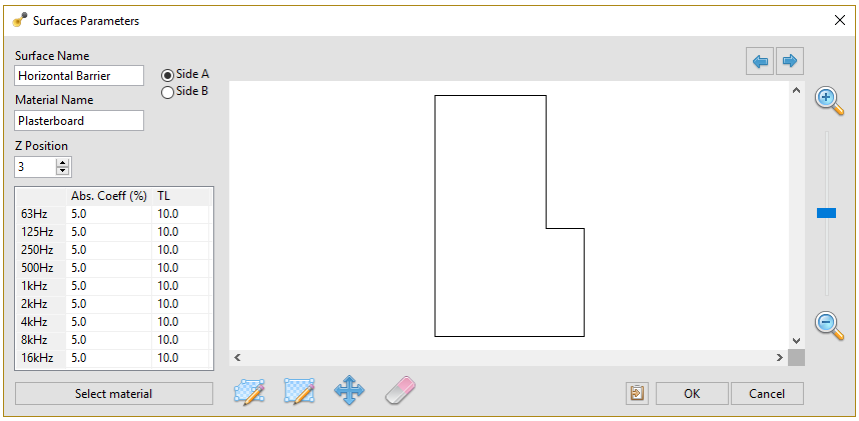
2.6.2 Horizontal Barrier

Click on the button to select the Horizontal Barrier Drawing tool. With the drawing tool selected, successively click on the barrier vertices and click on the starting point to complete.



Note: Hold the "shift" key while drafting to draw orthogonal lines.
Clicking on another wall vertex will "snap" the barrier vertex to this other vertex.
Crossing any wall will crop the barrier. This can be used to create a room dividing suspended ceiling.

Upon drawing the barrier, the properties interface is launched.



On this interface, the height can be defined as well as the acoustical properties.

Note: Barriers have two sides: side A and side B. Refer to the labels on the 3D view to identify the side.

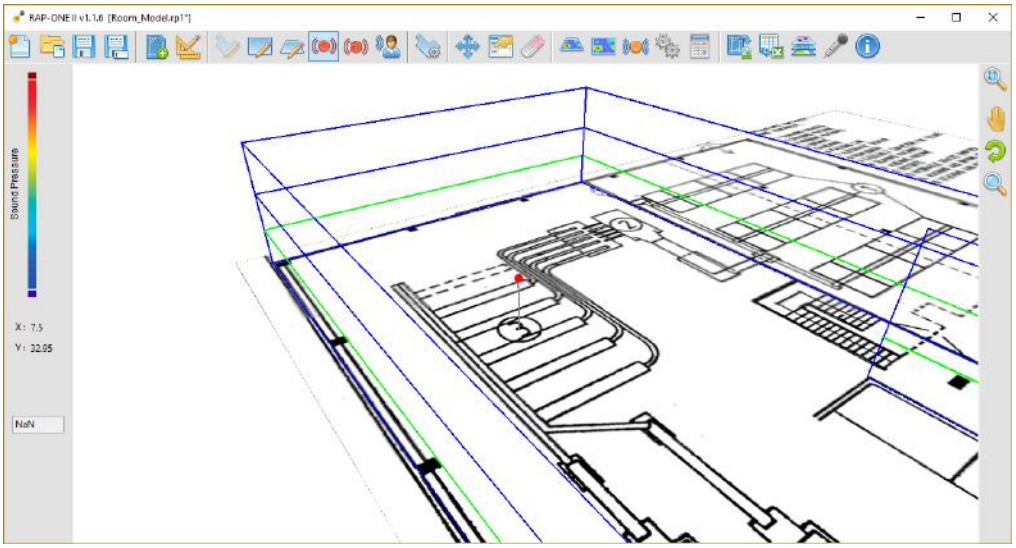
2.7 Define Sources

Rap-One II features two different types of sources: point sources and box sources.

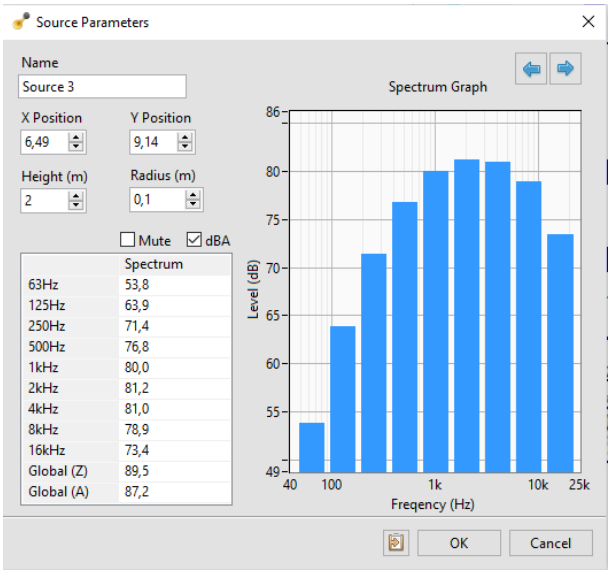
2.7.1 Point Sources

Point sources are omnidirectional sound sources characterized by a point-size origin.

Click on the button to select the point source tool. Click on the layout to set the XY position of the source.



Upon defining the source position, the Source Properties interface is shown.



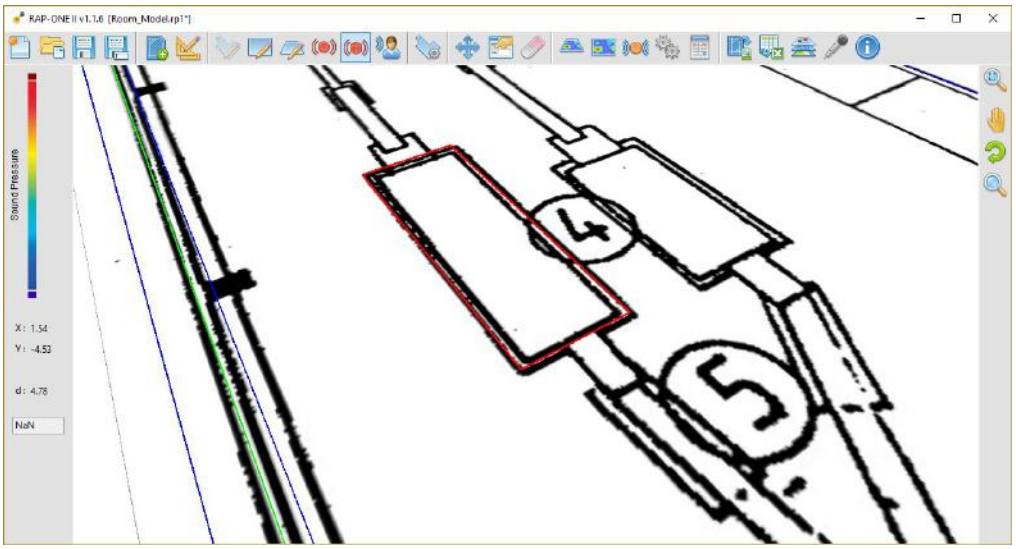
On this interface, you can set the source height as well as the power spectrum.

Note: The "radius" parameter allows defining a real-world dimension to the sound source. This parameter will determine the near-field behaviour of the sound source. Set this parameter to the approximate size of the real-world source.
The "Mute" check-box allows turning the source OFF.
The "dBA" check-box displays the spectrum levels with the "A" weight

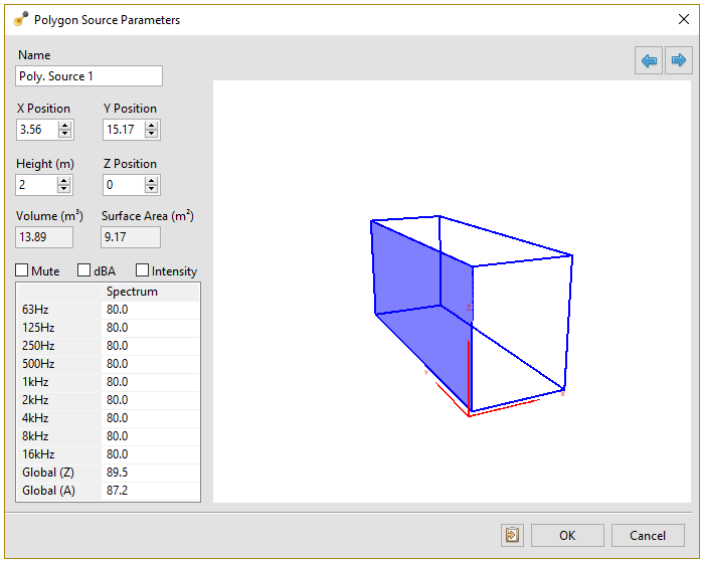
2.7.2 Box Sources

Box sources are sound sources characterized by a rectangular box where each face radiates sound energy.

Click on the button to select the box source tool. Click on the layout to set the first corner of the sound source and then click on the opposite corner to complete.



Upon defining the source position, the Source Properties interface is shown.



On this interface, you can set the source height as well as the power spectrum for each face. Click on the 3D view to select the box faces to be edited.

Note: The "Mute" check-box allows turning each the box sources faces OFF.
The "dBA" check-box displays the spectrum levels with the "A" weight.
The "Intensity" check box allows to enter the spectrum values as intensity levels instead of power levels.

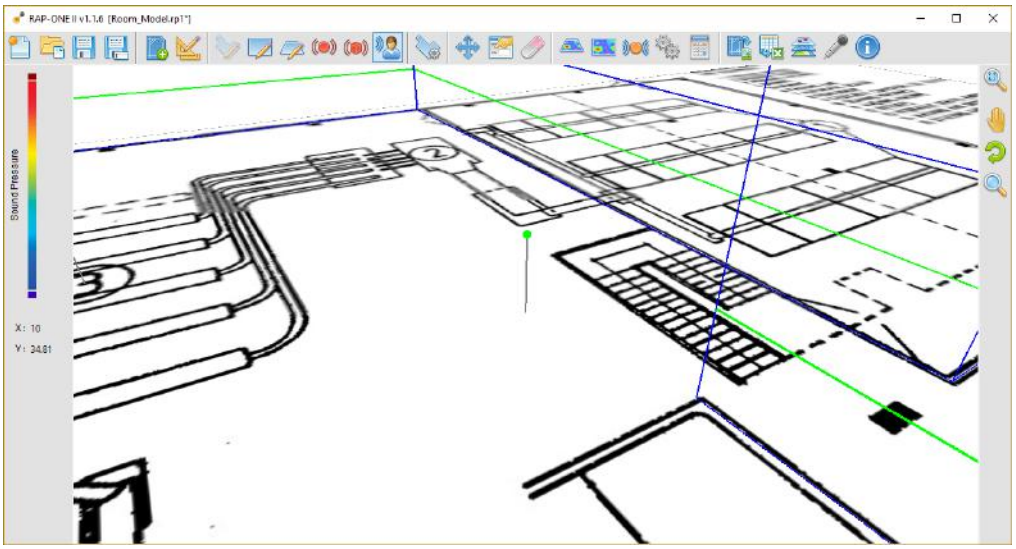
Note: To navigate the 3D view:
Orbit: Click and drag the mouse wheel while holding the Ctrl key.
Zoom: Turn the mouse wheel while holding the Ctrl key.
Pan: Click and drag the mouse left while holding the Ctrl key.

3 Calculating the Model

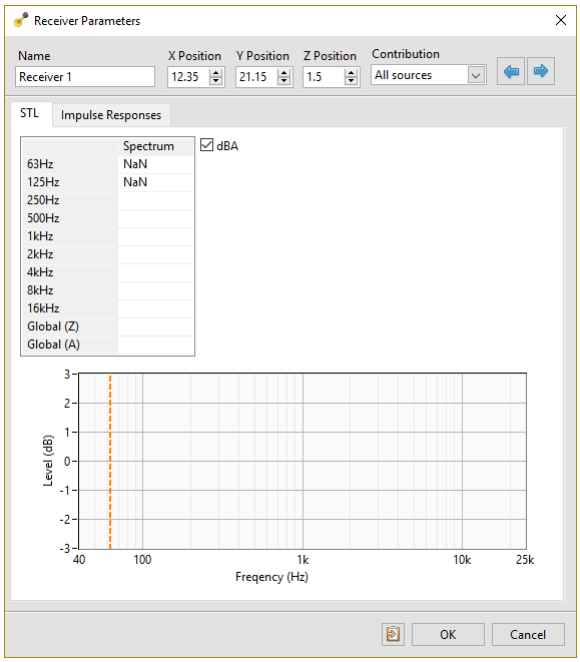
3.1 Define Receivers

The receivers are used to assess the detailed sound field parameters at a precise location.

Click on the button to select the receiver tool. Click on the layout to set the XY position of the receiver.



Upon defining the receiver position, the Receiver Properties interface is shown.



On this interface, you can set the receiver height.

Note: At this point the simulation results are not available since the model is still to be calculated.

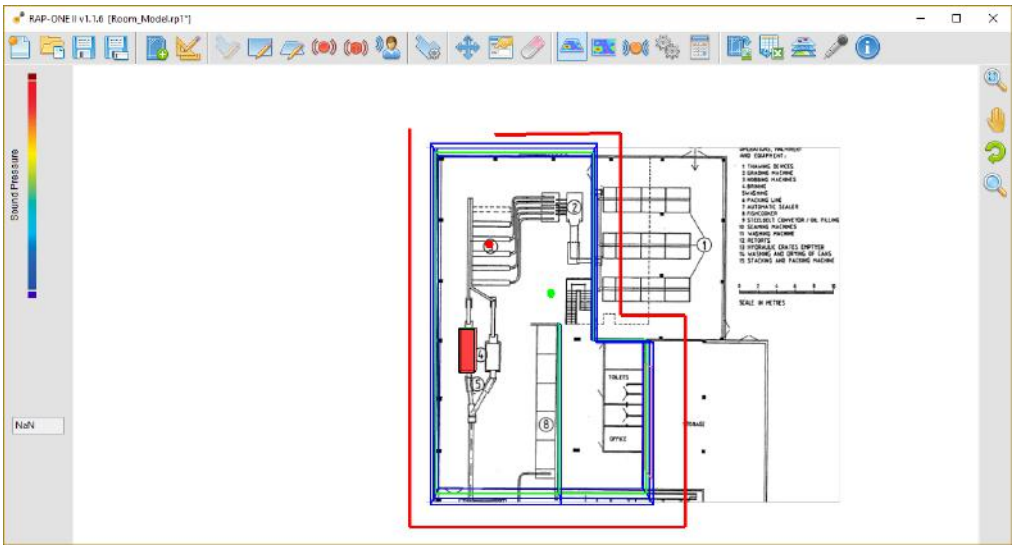
3.2 Define the Sound Map

The sound map is used to display the simulated sound field as a colored map. The sound map can be either horizontal or vertical.

Note: A horizontal sound map is created by default when the room is created.
The sound map can be selected by clicking the its boundaries.

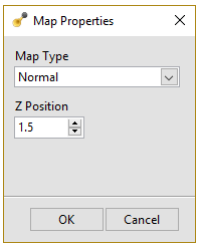
3.2.1 Horizontal Sound Map

Click on the button to select the horizontal Map Drawing tool. With the drawing tool selected, successively click on the sound map vertices and click on the starting point to complete.



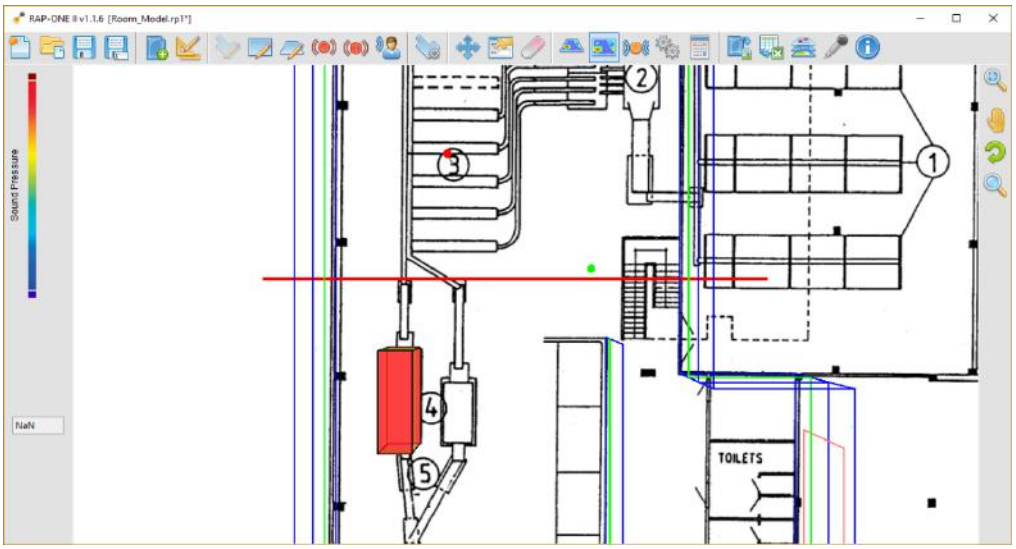
Note: Hold the "shift" key while drafting to draw orthogonal lines.
Clicking on another wall vertex will "snap" the map vertex to this other vertex.
Crossing any wall will crop the sound map. This can be used to cover to whole room.

Upon drawing the sound map, the properties interface is launched to enter the height of the sound map.



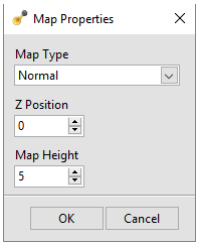
3.2.2 Vertical Sound Map

Click on the button to select the Vertical Sound Map Drawing tool. With the drawing tool selected, click on the sound map start vertex and click a second time on the end vertex.



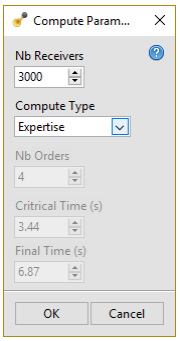
Note: Hold the "shift" key while drafting to draw orthogonal lines.
Clicking on another wall vertex will "snap" the map vertex to this other vertex.
Crossing any wall will crop the map. This can be used to create a map reaching from one wall to another.

Upon drawing these two points, the sound map properties interface is launched to enter the height and the Z position of the sound map.



3.3 Configure the Calculation Parameters

Click on the button to open the Calculation Parameters interface.



On this interface, select the required precision level:

- **Control**: This degree of precision allows for fast computing but is limited in precision for advanced acoustical properties. This method is recommended for industrial environment with many sources where only the sound levels are required.
- **Expertise**: This degree of precision allows for a reasonable computing time while achieving appropriate precision for acoustical parameters. This method is recommended for ordinary rooms where reverberation time needs to be assessed as well as sound levels.
- **Precision**: This degree of precision allows maximum precision on acoustical parameters. This method is recommended for performance spaces where high precision is required.

Note: Custom parameters can be set in order to further tune the computing time and precision required. Refer to section 6 for more info.

3.4 Launching the Calculation

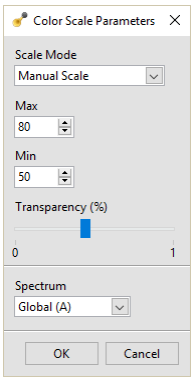
Click on the button to launch the calculation. Once the calculation process is completed, the sound map and local receivers will be updated.

4 Interpreting Results

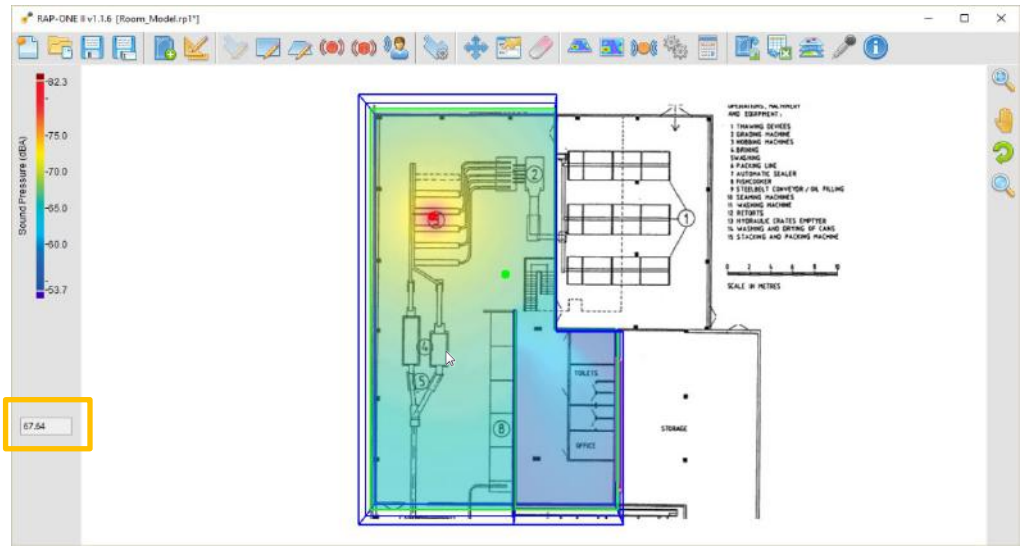
Once the model is computed, the sound map will display the sound field as a color map and receivers will have their data updated.

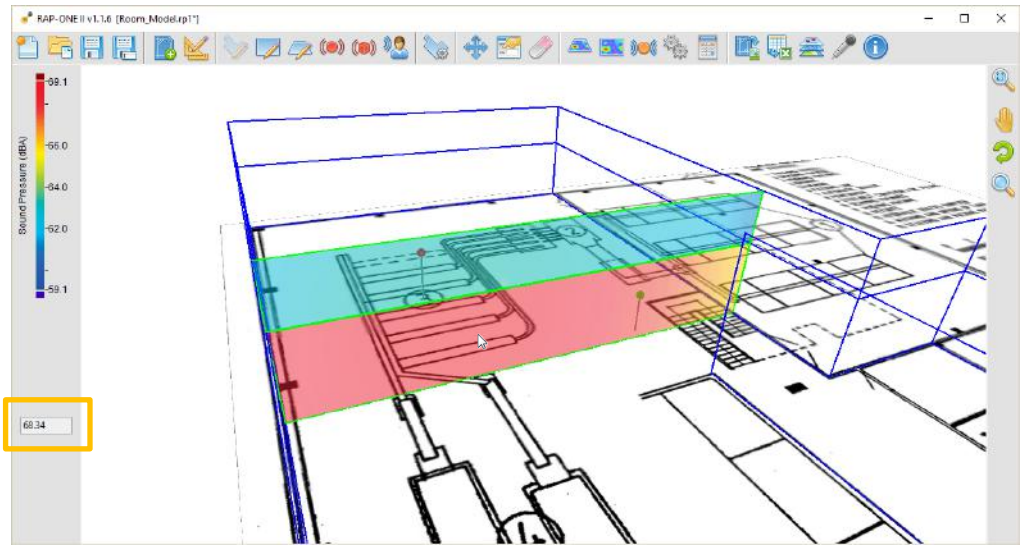
4.1 Sound Map

Click on the color scale on the display pane to determine the color scale range as well as the displayed frequency band. The color scale can display any octave band or global level.



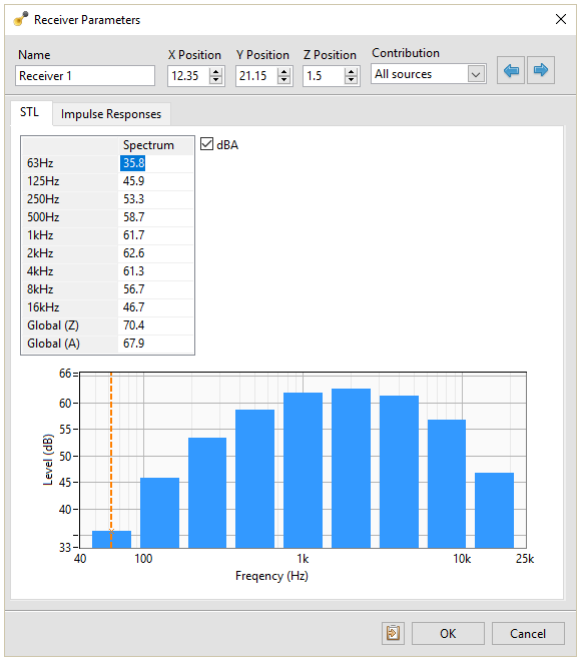
Move the mouse cursor on the sound map to display the respective sound level on the display pane.

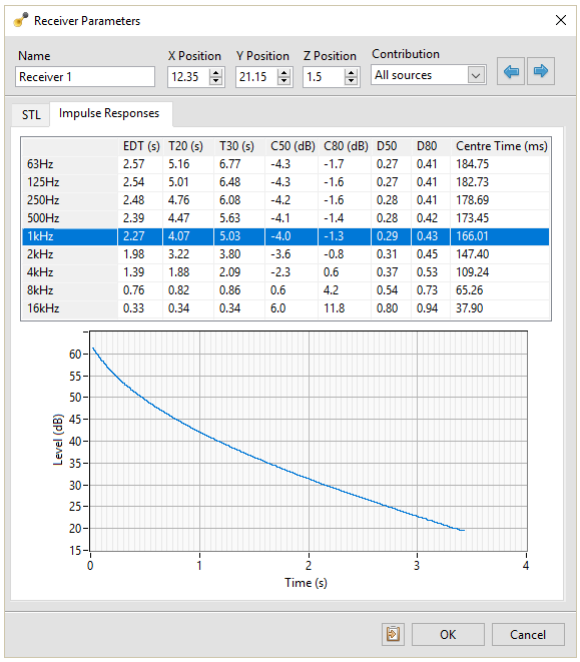




4.2 Receivers

Click on the receiver to select it and click on the button to display the acoustical parameters for this receiver:





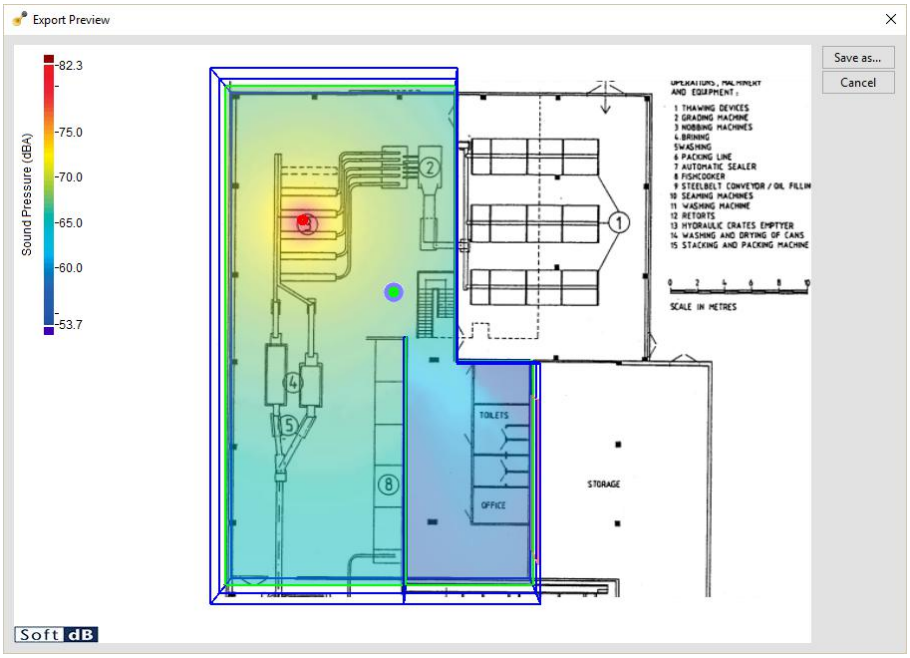
The first tab displays the sound level while the second tab contains the advanced acoustic parameters.

Note: If one of the table boxes is empty, you may need to increase the calculation precision level. Refer to section 3.3 for more info.

5 Exporting Data

5.1 Export the Model 3D Image

Click on the button to export the current 3D model view. The image export allows to adjust the picture before exporting.



5.2 Exporting Data

Click on the button to export the data as a spreadsheet .txt file. The exported file contains:

- Basic information on the project
- Room parameters,
- Surface parameters,
- Source parameters,
- Receiver parameters and results.

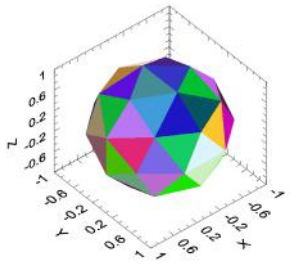
Note: Data can be exported for each element individually by clicking on the *button on each properties interface. This will copy the data table to the clipboard.*

6 Calculation Method

RAP-ONE II uses a pyramid tracing method to simulate sound propagation in a room. This method uses pyramid beams as the sound propagation vector. Unlike other approaches where only the center axis of the pyramid is used in the propagation algorithm [3][4][5], *RAP-ONE II* carries all pyramid edges in the propagation algorithm. This feature enables much greater precision than the central axis approach while still offering a reasonable computing time.

6.1 Source Modelling

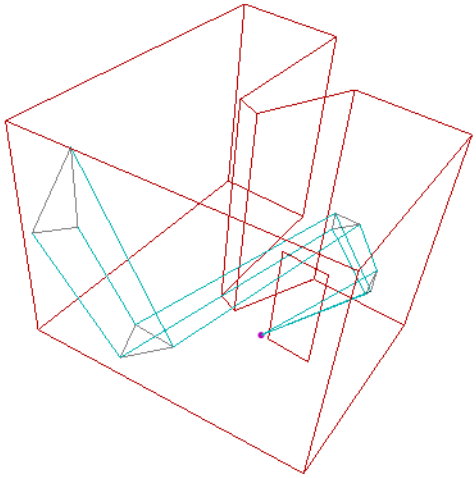
For each source, *RAP-ONE II* projects 60 triangular pyramids in the room. Each pyramid carries the sound energy of the source.



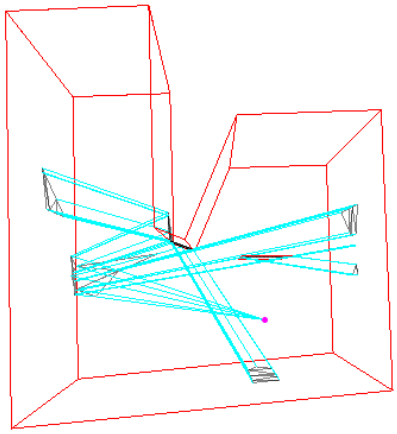
Note: The number of pyramids used to characterise the sound source is not critical as each pyramid carries an infinite number of rays. Moreover, these pyramids are subject to split as they interfere with objects along their propagation path allowing them to naturally increase in number over distance.

6.1.1 Pyramid Tracing Algorithm

The pyramid starts at the origin of the sound source and is projected in the model following its edges. When the pyramid intersects a surface, its edges are reflected in a specular way to continue the propagation. Every time the pyramid is reflected on a surface, its energy is decreased by the absorption coefficient of the surface.



When the pyramid intersects with more than one surface, a clipping algorithm is used to split the pyramid into separate beams to continue the propagation:



When the intersected surface is a barrier, the pyramid is furthermore divided in a reflected by and a transmitted beam. This transmitted beam is attenuated by the transmission loss of the barrier.

Note: The transmission loss is also considered for the reflected beam but is usually of minimal importance due to its low effect with respect to the absorption.

6.2 Scattering

Scattering occurs each time a pyramid is reflected form a surface. Scattering is modelled as a point source located on the center of the beam projection on the wall and radiates energy in the room. Different parameters are considered to get the best results such as the beam incidence angle, projection patch area, etc.

6.3 Diffraction

Diffraction is applied to a surface if it has floating edges or an obtuse angle with other surfaces according to ISO 9613-2 [11]. *RAP-ONE II* models a simple diffraction only for the direct field, as the diffraction has minimal effect indoors.

6.4 Late Propagation and Residual Energy

Even when using a high order number, there is still energy left in the pyramids to be radiated. If this energy is left over, a significant error both in the sound level and decay is observed. Thus, this residual energy must be radiated back in the model to get precise results [1].

While the early part of the sound propagation is calculated using the complete pyramid tracing algorithm, the late part of the sound propagation is calculated using a simplified pyramid model. This simplified pyramid model estimates the future path of the pyramid based on its past trajectory and radiates the energy back to the visible receivers. Many parameters such as mean absorption, mean path length, and growth rate are considered to get precise results.

The transition between early and late parts is set by the *Critical Time*. The late part of the sound propagation will be calculated until the *Final Time* is reached.

6.5 Receiver Modelling

Receivers are modelled as a point in space. When a pyramid interferes with a receiver, it radiates its energy using the following equation:

$$I = \frac{W}{4\pi \cdot r^2}$$

Where: I is the sound intensity at the receiver,
W is the sound power of the source,
r is the distance from the source to the receiver.

Air absorption and Fittings absorption is also taken into account on the propagation path.

6.6 Time Decay

RAP-ONE II uses backward integration to calculate the time decay for each receiver. This method models the interrupted noise method described in ISO 3382-1 [7].

The evaluation of time decay curves is performed as described in ISO 3382-1 [7] and features the following quantities:

- Early Decay Time (EDT),
- RT-60 (T20 and T30),
- Clarity (C50 and C80),
- Definition (D50 and D80),
- Centre Time (TS).

6.7 Air Absorption

The air absorption is calculated following ISO 9613-1 [10] and is expressed in dB/km

6.8 Fittings Absorption

The fittings are the various obstacles in space which scatter and absorb propagating sound. The fittings absorption is added to the air absorption in order to model the energy decrease through the fittings space. The Fittings absorption is expressed in dB/km and a Fittings percentage is defined to set the room fitted proportion.

Note: The fittings absorption can also be used to fit experimental measurements of reverberation times.

6.9 Overall Reverberation Time

To help modelling, the global reverberation time is calculated using Eyring formula [2]:

$$T_{60} = \frac{0.161 \cdot V}{-S_T \cdot \ln(1-\bar{\alpha}) + 0.921 \cdot \Delta L_{air} \cdot V}$$

Where: S_T is the total surface of the room,
α is the average absorption coefficient of the room,
ΔL_{air} is the atmospheric absorption including fittings,
V is the volume of the room.

7 Tools and Shortcuts

7.1 3D View Navigation

Click on the button to select the orbiting tool and click/hold the mouse left button to pan. The same function can be achieved by performing a click/hold on the mouse left button while holding the Ctrl key.

Click on the button to select the panning tool and click/hold the mouse left button to pan. The same function can be achieved by performing a click/hold on the mouse wheel.

Click on the button to select the zooming tool and click/hold the mouse left button up and down to zoom. The same function can be achieved by rotating the mouse wheel.

Click on the button to automatically adjust the 3D view.

7.2 Moving Objects

Most objects such as sources, receivers and barrier vertices can be moved. Click on the button to select the Move tool. With the tool selected, click and drag an object to move it.

Note: For sources and receivers, holding the Shift key while dragging changes the height.

7.3 Deleting Objects

Click on the button to select the eraser tool. With the tool selected, click on the object to delete it. The same function can be achieved by first selecting the objects to delete and hit the Delete key.

7.4 Opening Object Properties

Select the object(s) and click on the button to open the corresponding properties interface. Many objects of the same type can be selected at the same time to modify their parameters all at once.

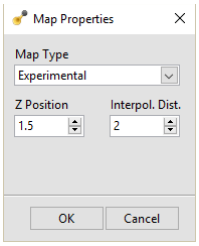
Note: To select multiple object at the same time, holding the Shift key will open a drop-down menu with all object behind the cursor.

7.5 Layers Visibility

Click on the button to set which objects are visible on the 3D view.

8 Experimental map

To change de map display mode, click on the map boundary to select it. With the map selected, click on the button to open the map properties interface.

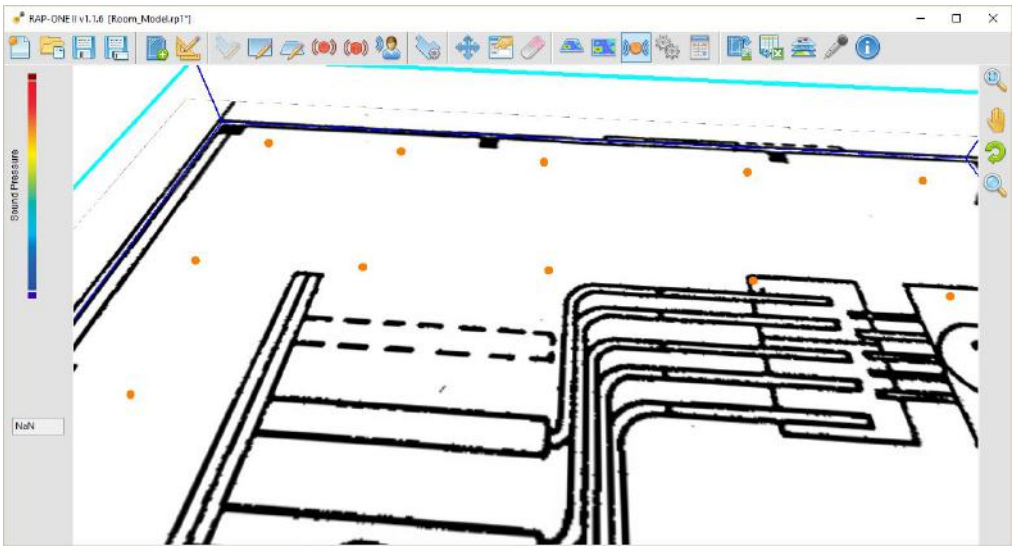


On this interface, the map type can be defined as well ad the Interpolation maximum distance of each experimental receivers.

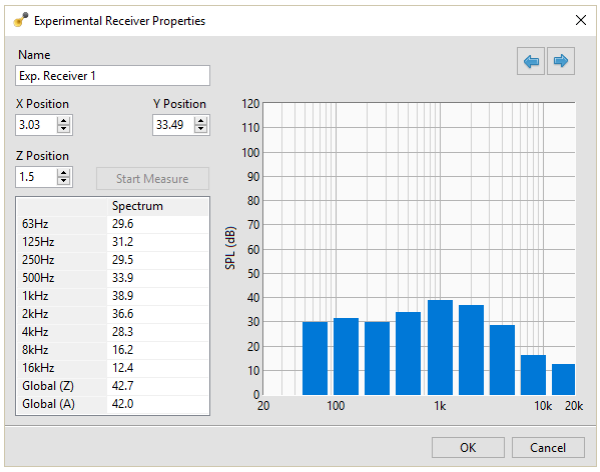
8.1 Define Experimental Receiver

The experimental receivers are used as an interpolation point for the simulated sound map.

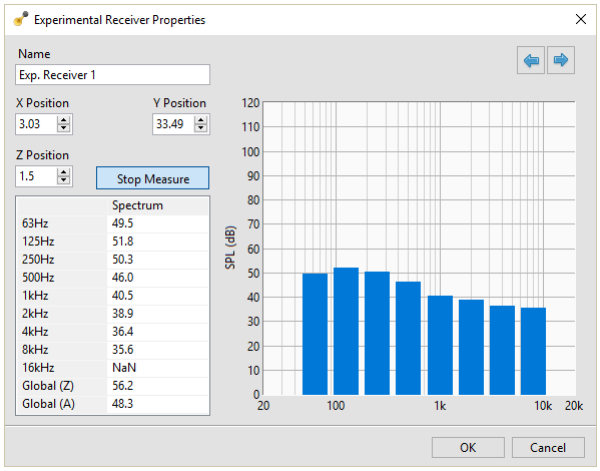
Click on the button to select the experimental receiver tool. Click on the map plane to set the position of the experimental receiver.



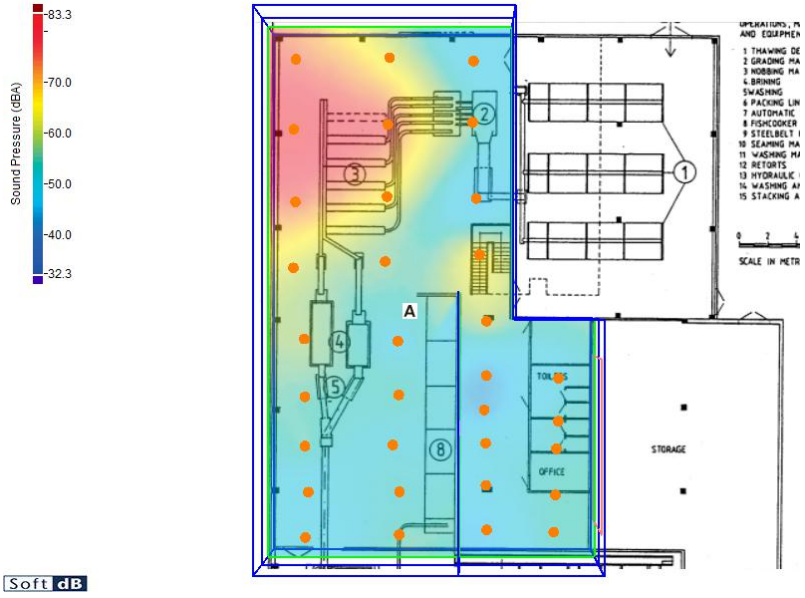
Once the experimental receiver is placed, click on it to select it and click on the button to display the acoustical parameters for this experimental receiver.



The spectrum can also be measured with a Piccolo II or a Mezzo hardware.

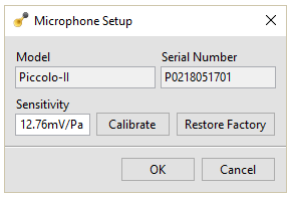


Note: Refer to https://www.softdb.com/products/mezzo/ or https://www.softdb.com/products/piccolo2/ for more information.

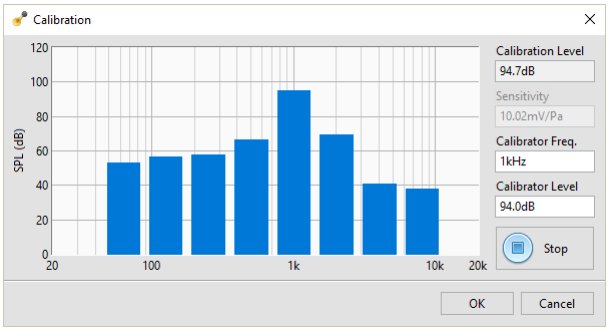


8.2 Microphone Setup

If you have a Piccolo II of a Mezzo hardware, click on the button to open the microphone setup interface.



On this interface, you can calibrate the microphone or reset the microphone sensitivity to factory. Click on the “Calibrate” button to open the calibration interface.



On this interface, you can adjust the calibrator frequency and the calibrator level.

8.3 Interpolation Method

RAP-ONE II use the Kriging interpolation method calculate the experimental map. The Kriging method gives the best linear prediction of the intermediate values and is suitable for the sound map interpolation [17].

9 Software Installation

You can download the software installer using this link:

https://www.softdb.com/software.php?rap-one

9.1 Minimum Requirements

	Minimum Requirements
Operating System	Windows 7 sp1, Windows 8.1, Windows 10
CPU	Dual-Core at 2.4 GHz
Memory	2 GB RAM
Hard drive	300 MB free hard disk space
Port	USB 2.0
Display Resolution	800 x 600

9.2 Licensing

RAP-ONE II can be used in demo mode without licence. In this demo mode, only 4 walls can be drafted and a maximum of one source is permitted.

To use the full features of RAP-ONE II, a licence must be used. The licence can be either a USB dongle or a software key. Click on the button to view the licensing status of your copy of *RAP-ONE II* or to enter a software license key.

10 References

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