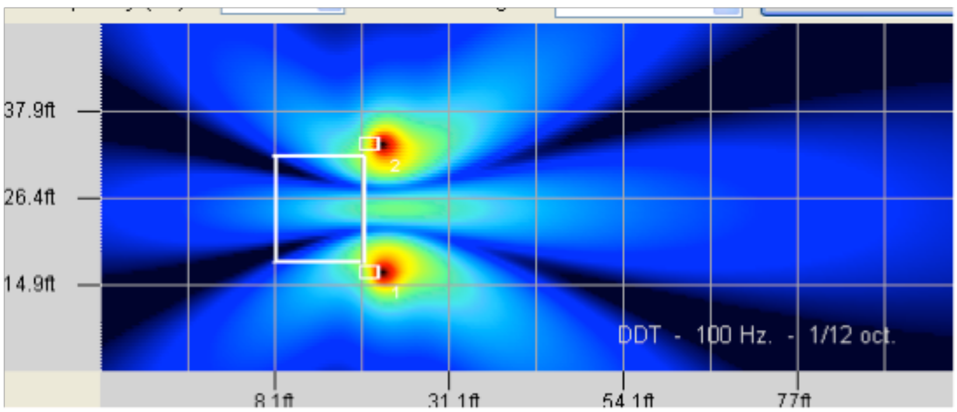
USER MANUAL FOR DDT2D

Welcome to the Danley Design Tool 2D program.

Introduction

DDT2D is a very powerful tool that lets the user visualize how sound propagates from loudspeakers, including subwoofers, and interacts with sound from other speakers and with the room. Working in 2D lets the user see phenomena with great detail which when presented in 3D may be hard to see due to the increased amount of data presented. Sometimes, 2D is a better way to view things. For example the effect of placing subwoofers on each side of a stage at 100 Hz (shown below) is very clear in 2D.



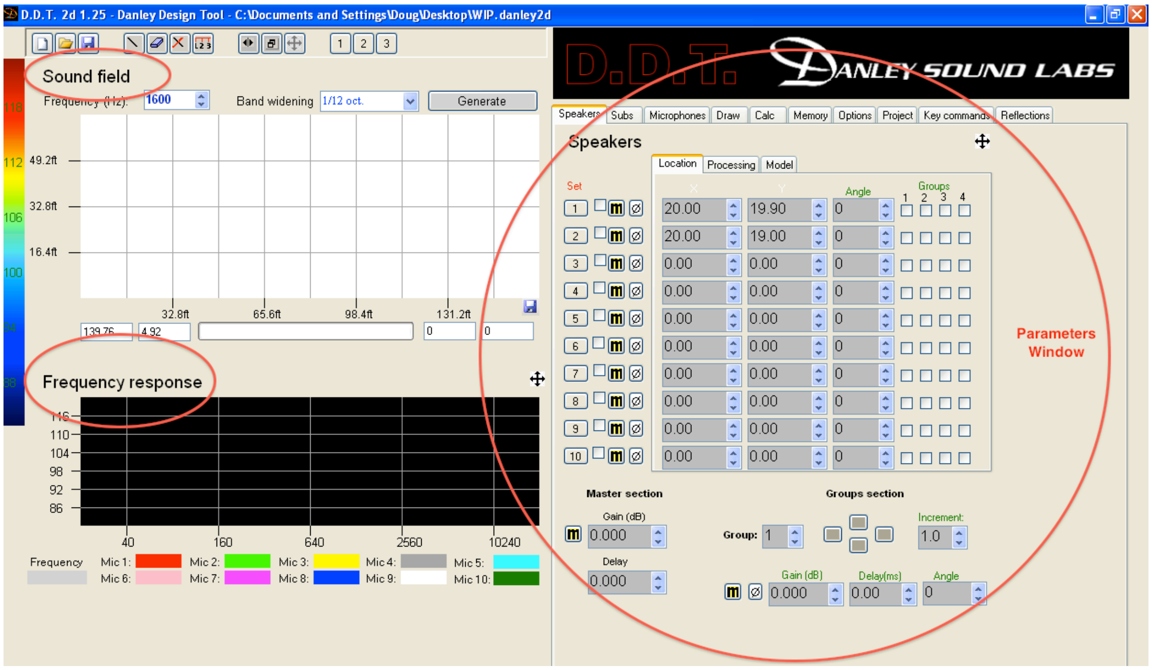
Installation

DDT2D comes as a self-installing program. Simply click on the icon and it will install. The program requires less than 20 mb of hard drive space.

Getting Started

When you first launch the program you will notice that there are 3 parts to the display. On the left, at the top of the screen there is the *Sound Field* window. This is where the 2D coverage maps are displayed. You can choose the frequency and the resolution of the display. See the section on the *Sound Field* window for more information.

Below the *Sound Field* window is the *Frequency Response* window where the frequency response of the system is displayed. The *Frequency Response* window becomes active when one or more microphones are placed in the sound field. The response of up to 10 microphone positions can be displayed at once. See the section on *frequency response* for more information.



DDT2D Screen

On the right, there are a number of drop-down tabs allowing the user to design the system to model. We call this part the Parameters Window.

Moving the Panels

When you see this symbol  you can grab it with the mouse and move the panel anywhere on the screen. this way you can customize the look of your screen and keep active tools that you use frequently. To return all panels to the default position click the default panel location button.

The Top Level Buttons

Moving the mouse over the buttons on the top left of the screen will display a “roll over” description of the function of the button. From left to right these are:

Create a New Project - start with a clean slate!

Open an Existing Project - opens the Windows Browse window

Save a Project - opens the Naming window and allows the user to save a project.

Draw Line - allows user to draw a line freehand in the *Sound Field* window

Erase Line - click erase line then mouse over the line you wish to remove

Erase All Lines - removes all lines from *Sound Field*

Measuring Tool - measures distances in *Sound Field* window. Distance in feet (or meters) and time in ms are displayed below the *Frequency Response* window.

Activate Scroll Bars - if the display is too small to show the entire DDT2D display, you can activate the Windows scroll bars.

Maximize/Minimize Sound Field Window - clicking this button will enlarge the *Sound Field* window to occupy most of the screen. Clicking again will return the *Sound Field* to default size.

Default Panel Location - returns all panels to default locations. (see Moving Panels)

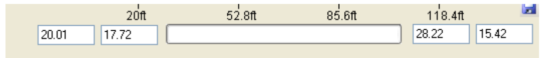
Memory - records *Sound Field* and *Frequency Response* to one of 3 memories. View using *Memory* tab.

Sound Field Controls

Frequency- selects the ⅓ octave center for the sound field simulation

Band Widening - selects the bandwidth of the simulation

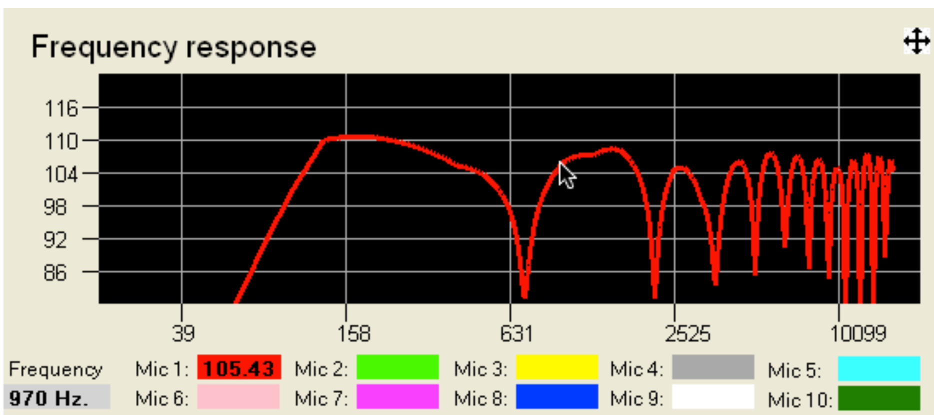
Generate - generates the sound field simulation



Parameter Boxes - shown above, display the position of the cursor. The lefthand pair of boxes indicate the realtime position in X,Y coordinates of the curser. The righthand set of boxes indicates the position of the last mouse click. The large box in the center is the progress box, active while DDT2D calculates the Sound Field

The Frequency Response Window

There are no controls in the frequency response window. To see the frequency response at any location, or in up to 10 locations, place microphones in the *Sound Field*. The response will immediately appear in the *Frequency Response* Window. Move your curser over a response curve. The frequency will appear in the grey box, and the amplitude will appear in the colored box corresponding to the curve.

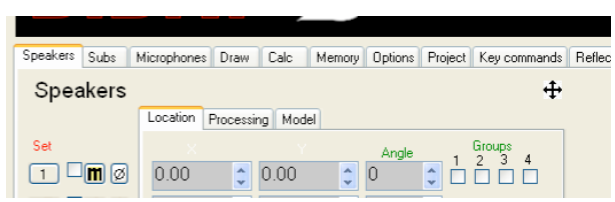


The Parameters Window

Speakers Tab

Location

Selecting the *Speakers* tab will display 3 sub menus or tabs, with the Location tab showing. DDT2D allows the placement of up to 10 full-range speakers in the *Sound Field* window



Using the mouse, click on a location in the *Sound Field* window. Click the set button to place a speaker in the position selected .

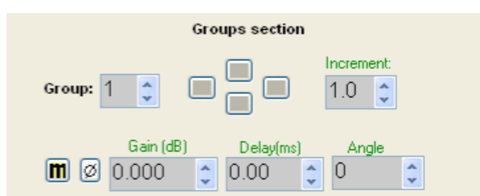
- the small square to the right of the Set button, makes the speaker active when checked. When checked, the speaker will be displayed in the *Sound Field.* When de-selected (unchecked) the location will remain but the speaker will be invisible.

Mute button, leaves the speaker visible, but mutes the output.

-Phase button, reverses the polarity of the loudspeaker when selected. The button will turn red when selected

- the next three columns allow for manual placement and orientation of the speakers. The first column selects the X or horizontal position, and the next column selects the Y or vertical position on the *Sound Field.* Note: the use of the terms horizontal and vertical refer to the axis of the graph and not the orientation of the speaker. For example, when viewing a speaker in the plan view, the Y axis represents typically the width of the room. When viewing the elevation, or side view of a speaker, the Y axis will represent the vertical dimension. The final column is the rotation of the speaker. In Plan view, using the *angle* control will rotate the speaker about its vertical axis, with a negative angle turning the speaker clockwise. When using a side or elevation view, the *angle* control tilts the speaker up or down with a negative angle pointing it downwards.

- Groups. An individual loudspeaker can be assigned to 1 or all of 4 groups. All loudspeakers assigned to a group can be controlled as a group, buy using the controls in the **Groups section** at the bottom of the *Speakers* screen.



The group can be muted, the polarity of the entire group flipped, the gain can be changed, delay added and the angle of the speakers in the group adjusted. Using the 4 boxes between the *group select* and the *increment* boxes moves the entire group around, each click moving the group by the increment selected in the *increment* box.

The Master section, to the left of the Groups section adjusts the gain and delay of *all* loudspeakers.

Processing

Selecting the *Processing* tab brings up a new window where the gain and delay of a speaker can be adjusted. The set, on/off, mute and polarity functions remain active. In addition there is a *crossover* selector, (default condition on or active) which allows a crossover to be part of the processing for a speaker.

Model

When the *Model* tab is selected a new window is displayed where the user can select from among the Danley Sound Labs family of full-range (i.e. not subwoofers) loudspeakers. Each loudspeaker is listed in both plan view or side view. The set, on/off, mute and polarity functions remain active.

Subs Tab

Location

The Subs tab/ Location is identical in function to the Speakers Tab described above. However the user may place up to 20 subwoofers in the *Sound Field* window.

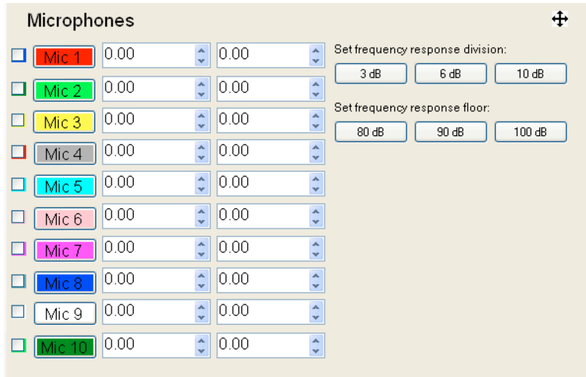
Processing

The processing tab is identical in function to the Speakers tab/ Processing described above.

Model

The Model tab is identical in function to the Speakers Tab/ Model described above. DDT2D version 1.25 includes 3 of the Danley subwoofers, the TH812, the DBH 218LC, and the TH118. In addition, we have included an idealized " true omni" subwoofer.

Microphones Tab



DDT2D allows for up to 10 microphones to be placed in the *Sound Field* window. The Microphone tab window is shown above. The small square button turns the microphone on or off. The colored box with the mic number inside is similar in operation to the 'set' button in the Speaker Tab. Clicking on a location in the *Sound Field* then clicking the colored box will place a mic in the location selected. The next two columns are the location columns. The first column selects the X or horizontal position, and the next column selects the Y or vertical position on the *Sound Field*. Note: the use of the terms horizontal and vertical refer to the axis of the graph and not the orientation of the microphone.

The boxes on the right set the scale of the *Frequency Response* graph. The user can select 3, 6, 0r 10 db per division, and the bottom of the graph i.e. 0 on the y axis can be 80,90 or 100 dBSPL. If the mouse has a scroll wheel, place the mouse over the *Frequency Response* screen and click on the Y axis. The curser will turn to an up/ down arrow and the user can select vertical resolutions other then the 3,6 and 10 dB. Moving the curser to the center of the *Frequency Response* window and the curser will return to the default crosshair. Moving the scroll wheel will now adjust the *horizontal* axis.

Draw Tab

The *Draw* tab gives access to a number of drawing tools which let the user create complex rooms in the *Sound Field* window. IMPORTANT! The lines drawn with the tools under the *Draw* tab, have no acoustic properties. The sound goes right through them. DDT2D allows for freehand drawing or drawing using the X/Y coordinate method. See Tutorial #1 for a detailed demonstration on how to draw with the X/Y coordinate system. Arbitrary shapes, circles and text boxes can be placed on the *Sound Field* window

CALC Tab

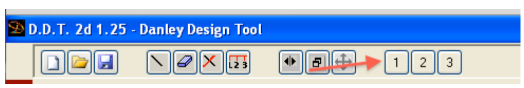
The CALC tab contains a number of useful tools for sound system and general audio work. The F-L-T calculator displays the relationship between frequency (f) wavelength (L) and period (t). Enter two of the three variables and the calculator will display the third. The next calculator displays the relationship between distance in feet or meters and the time that a sound wave will take to traverse that distance. There is also a handy feet to meters converter.

The adding dBs tool allows the user to enter 2 decibel values, select somewhere on a continuum between coherent and incoherent, and the calculator will display the summation .

Finally there is a Log tool that lets the user enter a ratio of voltages or powers and the calculator displays the ratio in dB.

Memory Tab

There are 3 memories which can store and retrieve coverage and response curves for easy comparison.



When you have a coverage map and a response you wish to save, click one of the 3 buttons shown above. Then by selecting the *Memory* tab you will be able to compare the curves saved in memory.

Options Tab

The options tab allows the user to set certain parameters for DDT2D. The grids can be turned on and off, and the user can select between imperial and metric units. In addition, this is the tab where the crossover controls are located.

Air Attenuation

By selecting this option and entering the temp and humidity DDT2D will accurately include the effect of air attenuation on the frequency response, per ISO 9613-1.

Crossovers

DDT2D allows the user to build 2 way systems using a variety of crossover options. In addition, under the *Speaker / Processing* and *Sub / Processing* , the user can choose to turn off or bypass the crossover on any device. The default setting has the crossover active, or “on”.

Project Tab

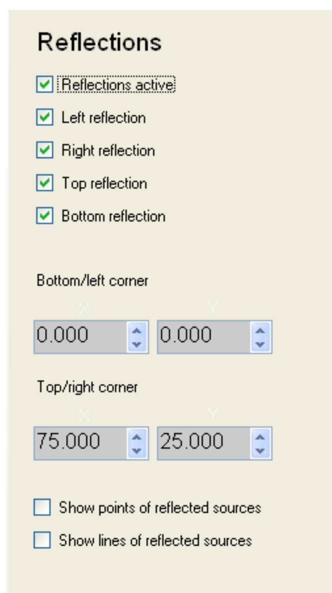
The project tab has the tools for saving and opening DDT2d projects and adding notations to projects.

Key Commands Tab

The key command tab is simply a listing of the key stroke equivalents or key board shortcuts.

Reflections Tab

Reflective surfaces can be created in DDT2D using the tool under the *Reflections* tab. In the current (1.29) release the user is limited to rectangular rooms. Frequencies below 3kHz can be mapped and the result of the reflections shown in both windows. The user can make each of the surfaces active or inactive to study the effect of reflecting surfaces on the response and coverage. The rectangle is formed by entering the coordinates of the lower left and upper right corner.

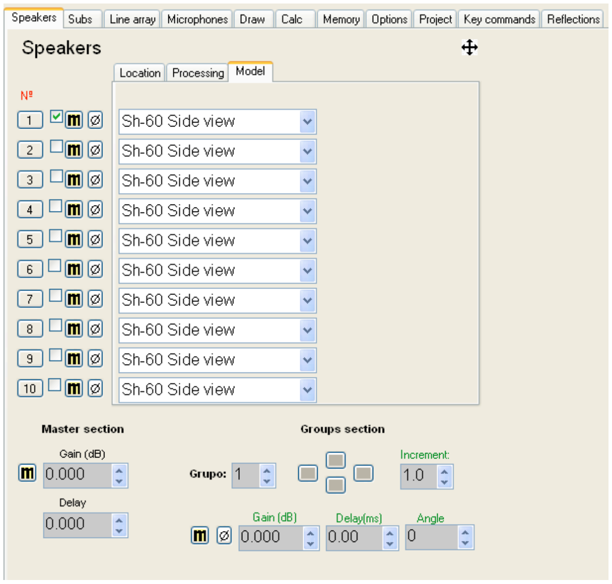


TUTORIAL 1. A simple sound system

As a way to get familiar with the various parts of DDT2D, lets design and model a simple 2 way sound system. Lets start with a PLAN view of the system. The PLAN view is looking down from above. With DDT2D you don't need to build a room unless you want to. You can examine the way speakers couple, for instance, without building a room first. So lets look at a few options before we put them in a room. Suppose we are trying to decide if a pair of loudspeakers would be best placed together in the center of the room, or one on each side of the stage. Lets assume the the stage is 18 feet wide. Lets first place a loudspeaker on stage right.

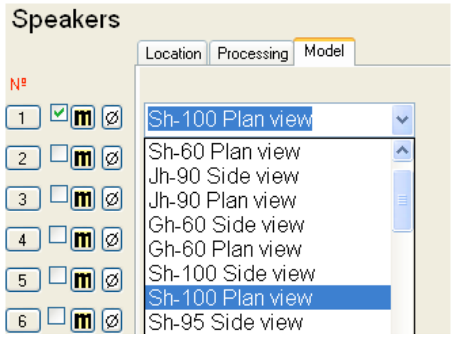
-Click on the *Speakers* tab on the right hand Variables Window

- Now select the *Model* tab.

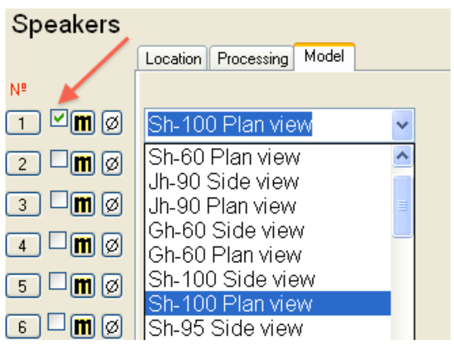


you can see that DDT2D allows you to place 10 loudspeakers and create groups - more on that later.

- Lets choose the SH100 from the pull down arrow on the right end of the box showing the SH60 Side view. Because we are modeling in 2d, the user has to decide between the side view or the Plan view. For this example we are using the SH100 plan view

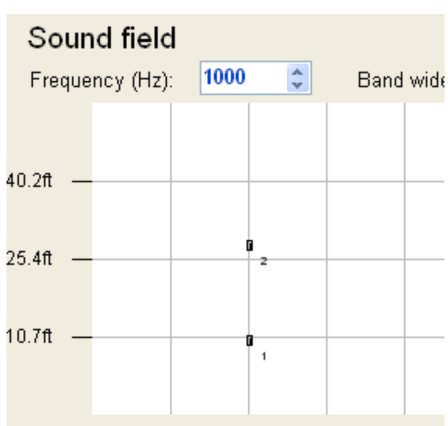


Selecting the box indicated by the arrow, makes the chosen speaker active. The *M* button next to it, is a *Mute* button, which leaves the speaker on the screen, but mutes the output. The phase button flips the polarity of the speaker.



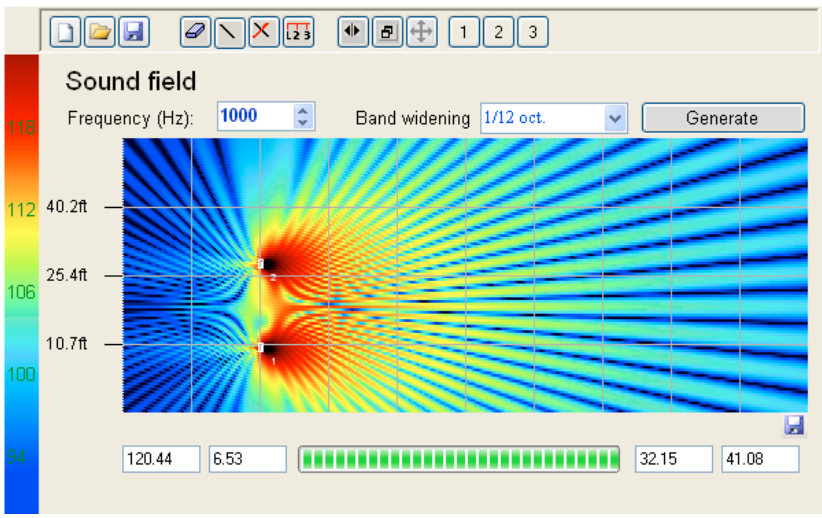
- Now select the *Location* tab. This will let us place the loudspeaker on the *Sound Field* screen. The first column in the X or horizontal position. The next column is the Y or vertical position. Remember that this is a 2D model. The words Horizontal and Vertical are relative! Lets set the position of the first speaker at 20.00 , 10.00

- Choose a second SH100 and place it at 20.00, 28.00. You should see something like this.

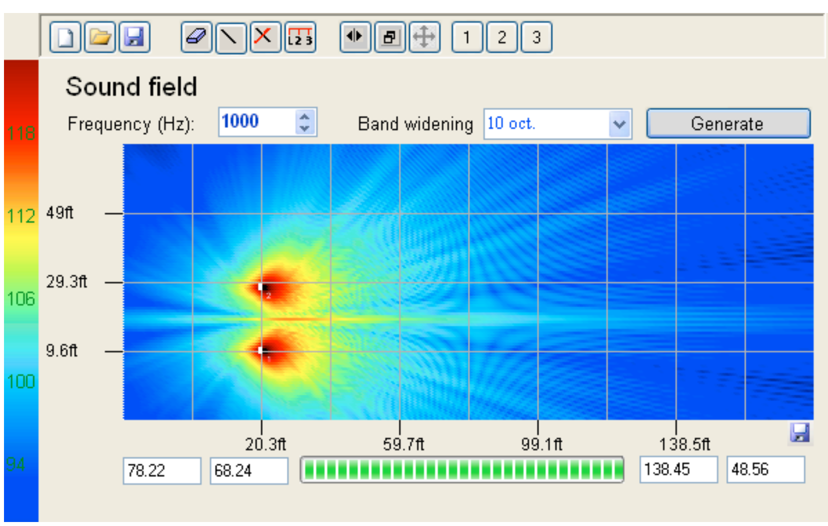


Note, if you have a scroll wheel on your mouse, you can zoom in and out of the *Sound Field* window. Simply place cursor over the *Sound Field* window and the scroll wheel will become active. Holding the Left button down while the cursor is in the *Sound Field* window will re-position field of view, but keep all of the actual locations the same. If you don't have a scroll wheel, the I and O keys will also zoom in and out of the *Sound Field* window.

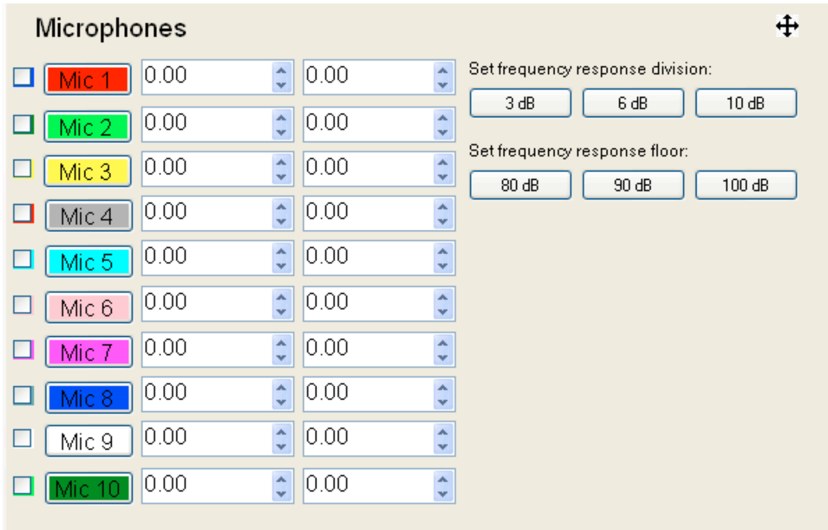
- Now you can do your first simulation! Press the space bar, or click the generate key. You will see the 1KHz coverage plot.



Experiment with different frequencies. Click generate after selecting a new frequency to plot. 1/12th of an octave is the highest frequency resolution, possible, but you can also choose to display the average of the full 10 octave response, shown below.

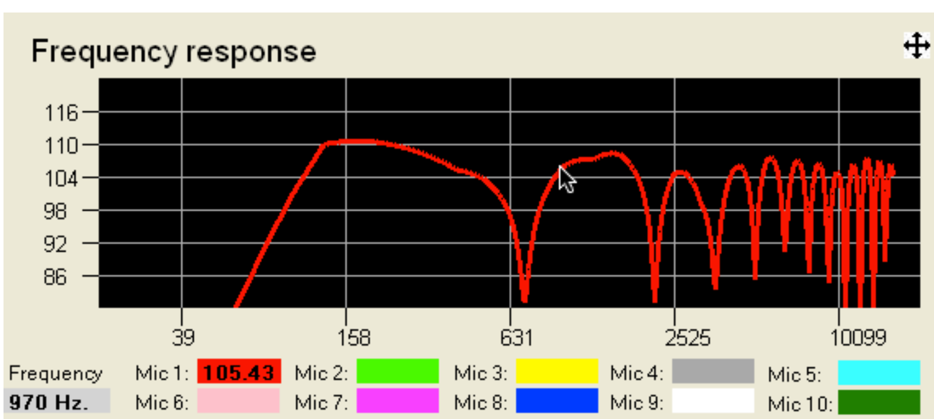


Now, lets take a look at the frequency response of our sound system. To do this, we need to place at least one “microphone” in the *Sound Field.* Select the *Microphones* tab.



DDT2d allows the user to place up to 10 microphones in the *Sound Field* window.

Lets place a microphone about 45 feet from the speakers slightly off center. Enter the numbers 65.00 , 17.00 in the two columns. When you click the square box to the left of Mic1 to activate the mic, you will see a red response curve appear immediately in the *Frequency Response* window.



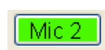
This is the frequency response of the system at that point in space. There is clearly allot of "comb filtering" due to the arrival times from the two speakers. To confirm this you could simply mute one of the speakers. You will see the response immediately flatten out.

To Mute a speaker, pull down the Speaker tab and click on the  next to the speaker you wish to Mute.

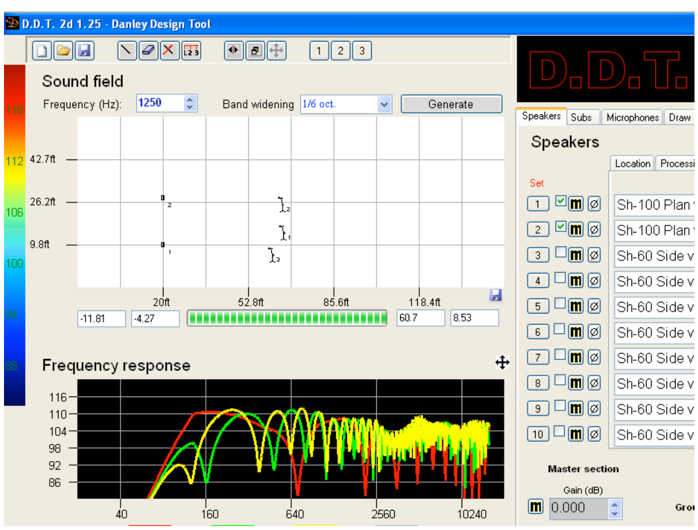
You should also notice that the response starts rolling off at around 150 Hz.

Note: When you move your mouse over the *Frequency Response* window the cursor becomes a cross, and the frequency at the cursor is displayed in the grey box labeled *frequency* at the bottom left of the display. The amplitude or level of each mic is displayed in the colored box associated with each curve. In the example shown above, the level at Mic 1 is 105 dB SPL at 970 Hz.

-Go to the *Options* tab and you will see that there is a crossover set at 150 Hz. If you lower the crossover to its lowest setting of 70 Hz, you will see the frequency response curve update automatically.

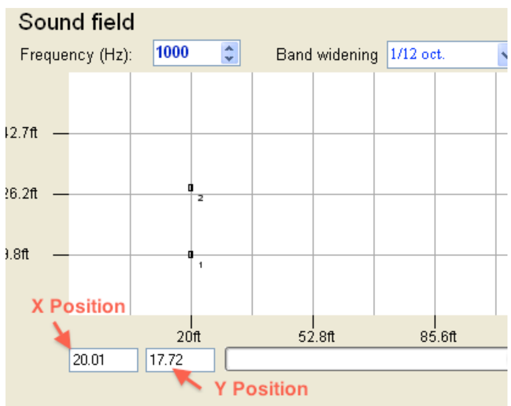
-Now lets place a few more mics just for fun! You can enter x,y coordinates as we did before, but there is a faster way! Move the mouse to a location in the *Sound Field* window where you would like to place a mic, say in front of speaker number 2. Click on that location, then click on the green box 

Mic # 2 will appear in front of speaker#2, and a new, green curve appear in the *Frequency Response* window. This is the response pretty much right in front of speaker # 2. If you wish you can also look a the response in front of speaker #1 as well, or the response anywhere you wish! Here I have placed a third mic in front of speaker #1, slightly closer to the speaker.

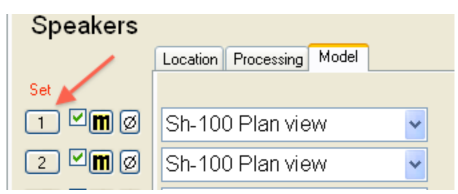


-You may recall that when we started this exercise , we set out to see if speakers on each side of the stage is better then a pair placed in the middle over head. Lets save this design in memory so that is will be easy to compare it to our next design. Click the 1 button at the top of the window. This will save this design, the coverage map and the frequency response screen to the first of 3 available memories.

-Now, lets try to modify our design to see what would happen if we were to put the two speakers together hung over the stage. Pull down the *Speakers* tab and lets learn a different way to move or place a speaker. Move the mouse to the *Sound Field* window. As you move the curser around, you will see the numbers in the left set of position boxes will change.

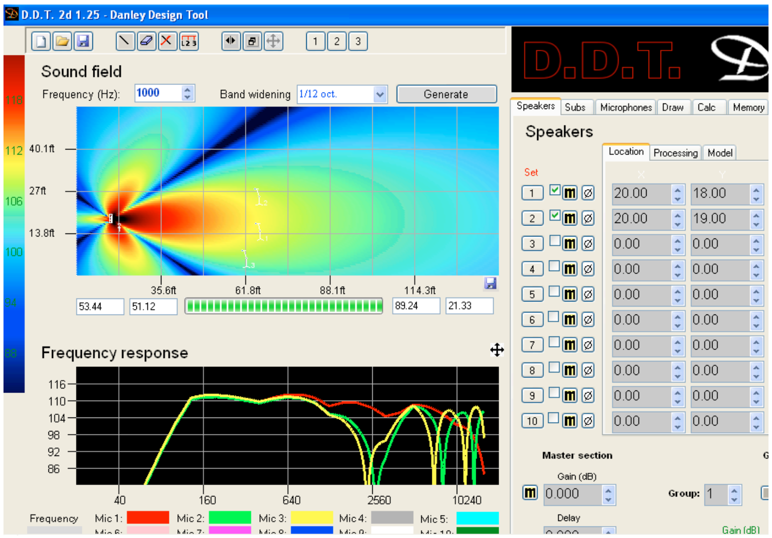


-Click at a location close to 20,18. Now pull down the *Speakers* tab. Click on the *set* button next to speaker 1.

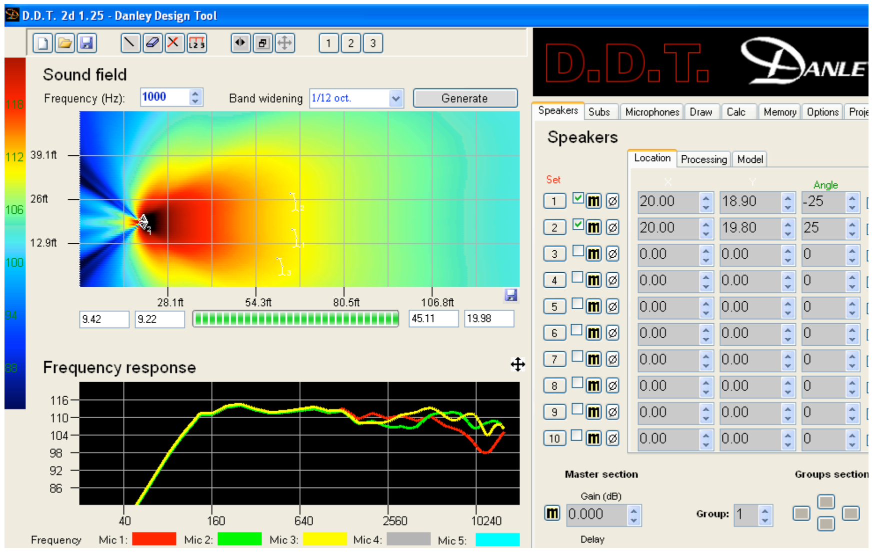


-You will notice that speaker # 1 will jump to this location. You can use this "point and click" technique to quickly place speakers or microphones anywhere in the *Sound Field* window. You can also edit the location using the x and y fields under the location tab.

-Ok, using what ever technique you wish, lets get the two speakers to 20.00, 18.00 and 20.00, 19.00. This will place the speakers side by side. Click on *generate*. The response is much better in the middle, but now there huge notches in the response on mic # 2 and 3. You can save this design to memory 2. If you select the tab *Memory* from the Variables Window, you will see the graphics from the first design. Clicking on the number tabs allows you to compare the results of the two designs.



Maybe the SH100 was not a good choice because although they couple well at low frequencies, (see the very close agreement from all 3 mics below 600 Hz) the SH100 is not designed to be "arrayable". You can clearly see the cancellations in both the response and in the coverage. Lets try a third design. If you go to the *Speakers* tab, you can simply click on *Model* and select different speakers. Lets try a pair of SH50s, plan view. You will need to zoom in to see it, but if you place the two SH50 at the 18 and 19 ft locations they will hit each other. So lets put one at 18, and one at 19.80 ft. Then, because the SH50 is a 50 degree cabinet, using the *Angle* adjustment tool, set speaker 1 to an angle of -25 degrees, and speaker 2 to an angle of 25 degrees. Now the two can be moved together so that they are tight packed. You should end up with the two speakers at 20. 18.9 and 20 , 19.8 or some set of coordinates where the speakers are .9ft apart. Notice the improved coverage and the smooth response as the two speakers combine. Save this design to memory 3.

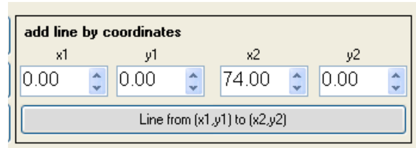


-So, now if you select the *Memory* tab from the "variables" window, by choosing tab 1 , 2 or 3, you should be able to review your 3 designs! Take this opportunity to save your design by clicking on the disk icon (*save current project)* or by clicking on the *Project* tab. You might consider naming this project my_first_model_plan or something to that effect to remind yourself that this is a plan view of your system.

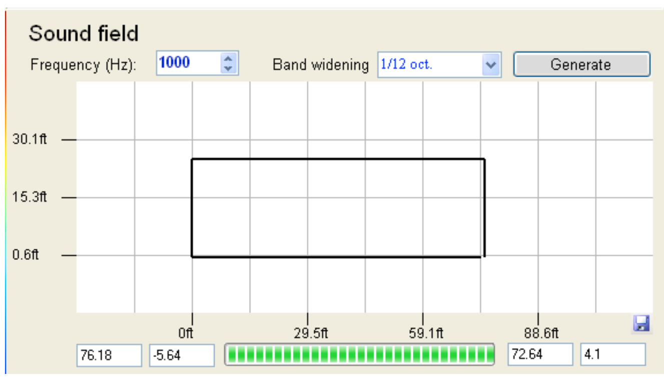
-Lets take our exploration one step further. It is pretty clear that putting a pair of SH50 speakers in the center of our room will be the best way to get the coverage and response we want. *But what if we wanted to add a subwoofer. Should we fly it up in the ceiling or place it on the ground?*

-The first step is to re- orient ourselves. In the last part of this exercise, we were looking down from the top at the plan view. Even though we did not actually build a room, the y axis was representing the left - right dimension of the room and the x axis represented the front - back dimension. Now we are going to look at the elevation view. The y axis will be the up-down and the x will be the front- back. So lets clear the *Sound Field* screen by turning off our speakers and microphones.

-Lets try the *Draw* tool. DDT2d allows you to draw rooms of any shape to get a better handle on coverage. These “rooms” or shapes do not have any acoustical properties at all. DDT2d does allow you to build *rectangular* rooms which do have acoustical properties, but we will cover that feature later.

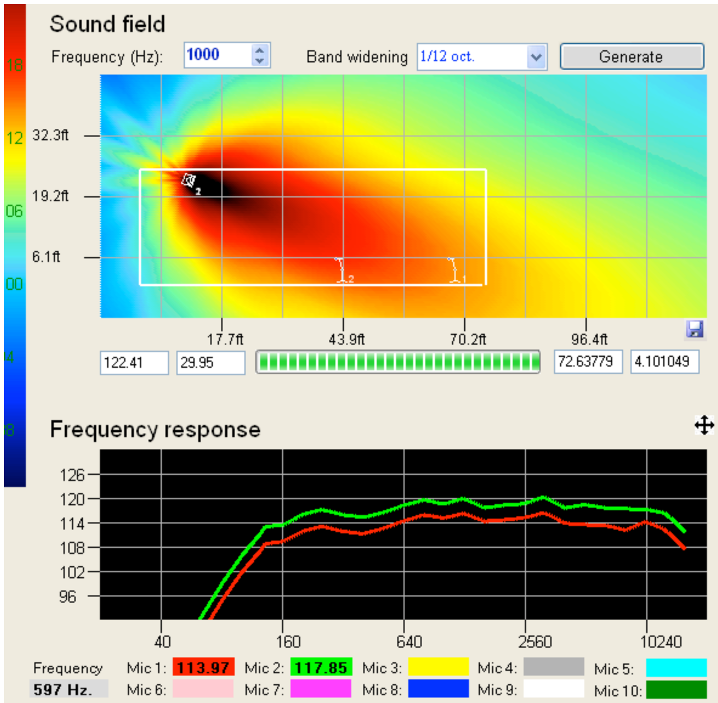


Lets assume that our room is 75 feet long and 25 feet high. We can draw a rectangle of those dimensions using the tools available under the *Draw* tab. You can draw lines freehand using the *Draw Line* tool, but lets use the *add line by coordinates* tool. Lets draw the floor first. x1 should be 0.00, y1 0.00, x2 75.00 and y2 0.00 . When you click on “line from (x1,y2) to (x2,y2) a horizontal line will appear in the *Sound Field* window. This represents the floor of our room. Next add a line from (0.00,0.00) to (0.00,25.00). This should draw the front wall. The ceiling should be (0.00,25.00) to (75.00,25.00) and the back wall should be (75.00, 25.00) to (75.00, 0.00). When you are done the room should look like this.

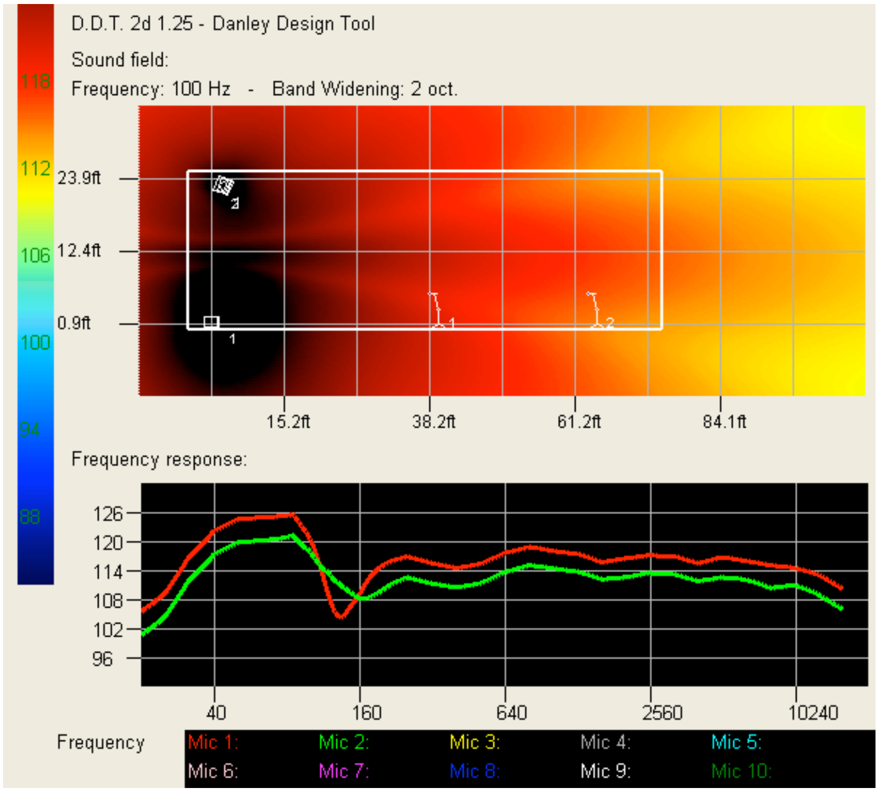


-Now we can place our speakers. Choose the *Speaker* tab, and select SH50, side view. Lets place one, 10 feet from the front wall, and 2 ft down from the ceiling. We could point at the desired position and click *set,* but entering the coordinates is more precise. The coordinates should be (5.00, 23.00). Remember our design called for two SH50s side by side. Lets add a second speaker at the same location. Even though we cant see the second speaker from this perspective, DDT2d will accurately model the sound pressure level and frequency response of the combined speakers. Notice in the *Location* tab under *Speakers*, you can assign any speaker to one of 4 groups. This is a convenient way to change the position or processing of an entire cluster of speakers. Lest assign our two SH50s to group 1. If we click *Generate*, we can see that we need to angle our speakers down to cover the audience which, presumably, will be on the floor! Now use the tool at the bottom of the *Speakers* window labeled “*Group Section*”. Make sure that Group 1 is selected, and enter -20 in the *angle* box. Both of the SH50s will now point 20 degrees down. Re-generate the coverage , and you will see that the speakers now point at the floor!

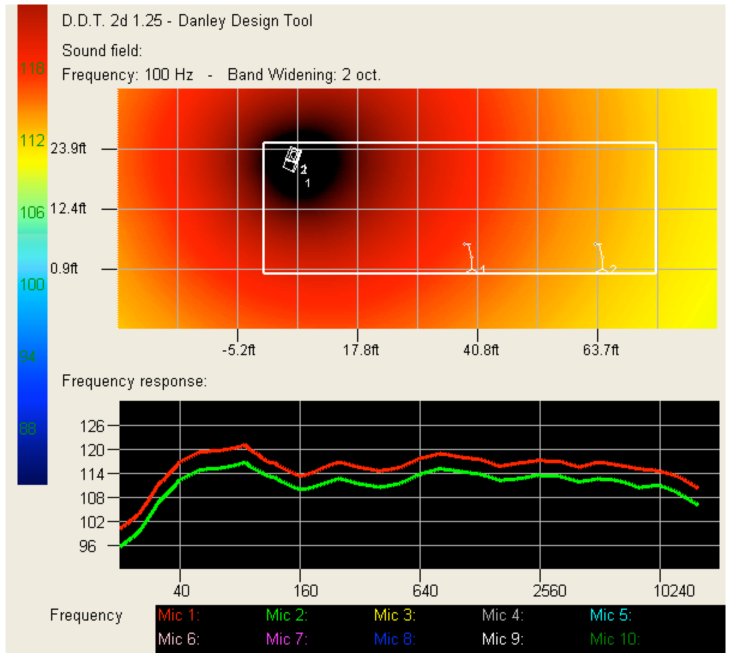
-Lets add a few mics to check the response. Place one mic towards the back of the room and one about half way down. You should see that the response looks virtually the same in both positions, the nearer one being somewhat louder. Your model should look something like this.



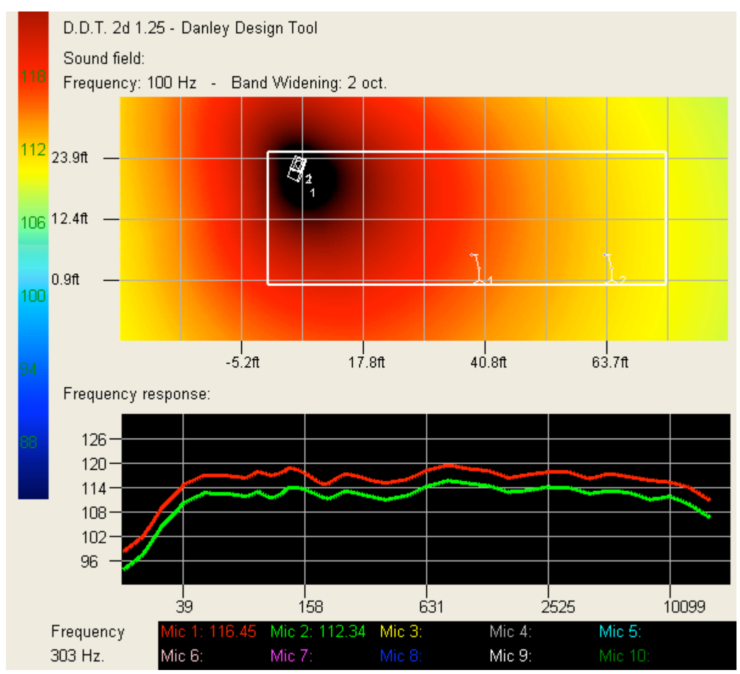
-Now, finally, we can add our subwoofer and experiment with location. Lets start with the Sub on the floor. Lets choose the TH118, and place it under the SH50s on the floor. Because of the size of the TH118, the Y axis will need to be about 1.4 ft to show it sitting on the floor. Make sure that the crossover buttons are selected (default condition) on both the SH50s and the TH118. The crossover select button is under the *Processing* tab. Reviewing our Danley Sound Labs Spec sheet, we see that the SH50is rated down to 50 Hz and the TH118 is rated up to 225 Hz. This means we could select a crossover frequency somewhere between 80Hz and 225 Hz. This is one of the strengths of using DDT2D to evaluate a sound system. You can try different crossover frequencies, different slopes and different alignments to find the best possible set of parameters. Lets start with a crossover set to 100Hz. Remember, the crossover point is set under the *Options* tab.



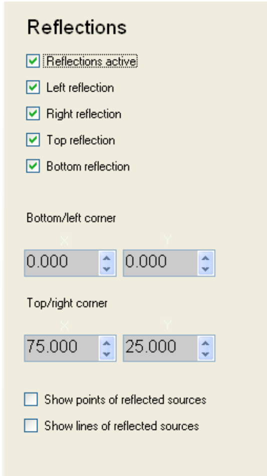
Choosing the frequency of 100 Hz and setting the Band Widening to 2 octaves will let you see how the SH 50s and the TH118 interact. You can see from the *Sound Field* that there is considerable interference between the two. It can also be seen in the frequency response. Adjusting the gain, delay and crossover characteristics can improve this system significantly. However, it is unlikely that you will find a combination of settings where the response at the 2 microphones will be the same. Lets look what happens if you move the sub up to the ceiling with the SH50s. Moving the Sub to the coordinates of 6.00 / 20.30 with a -20 angle (not really necessary)



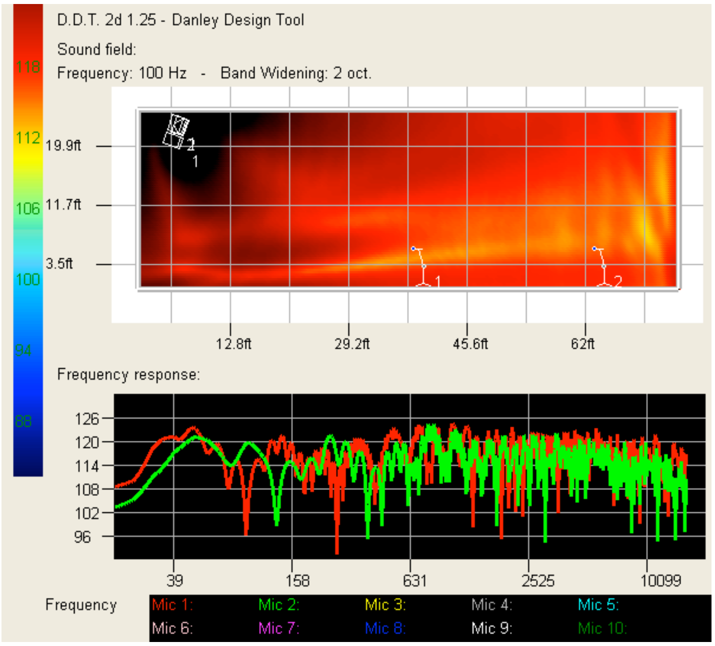
Moving the Sub to the ceiling immediately makes the response at the two mics virtually identical except for the level loss due to the difference in distance between the mics and speaker cluster. Again, feel free to experiment with different settings of the crossover, levels and delay. You may be able to improve on this design!Here is my best effort!



Lets do one more thing. Because our room is (conveniently) rectangular, we can actually look at what effect the room will have on our design. This is a worst case condition, where each of the surfaces is assumed to be 100% reflective. Select the *Reflections* tab. If you enter the coordinates of the lower left corner, 0, 0 and the top right corner 75, 25 you will create a rectangle of reflective surfaces which overlays the room we built earlier.



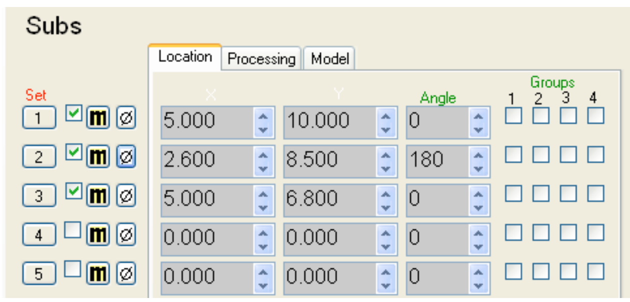
Of course you will notice immediately that our carefully tuned and "tweaked" sound system looks horrible. This is what it would look like in a reverb chamber with everything totally reflective. In the real world it will not be this bad. You will also notice that the *Sound Field* takes considerably longer to calculate.



Tutorial #2 A Cardioid Bass Array

As a way to get familiar with the operation of DDT2D, lets start by modeling a simple 3 box Cardioid bass array.

-Select the *Subs* pop down menu. You will see three tabs, *Location, Processing* and *Model.* Select *Model.* Lets use the sub labeled TH118. We will be using 3 subs in our model, so make sure that subs 1,2 and 3 are all set to the TH118 sub. Now select the *Location* tab. Set the fields in the first 3 subs as shown below.



This will place 3 TH118 subs in the *Sound Field* with the center one pointing backwards from 1&3.

- Now pull down the *Processing* tab and set the delay of TH118 #2 to 2.20 ms.

- Turn off the crossover by de-selecting the crossover box

-Flip the polarity of the center TH118

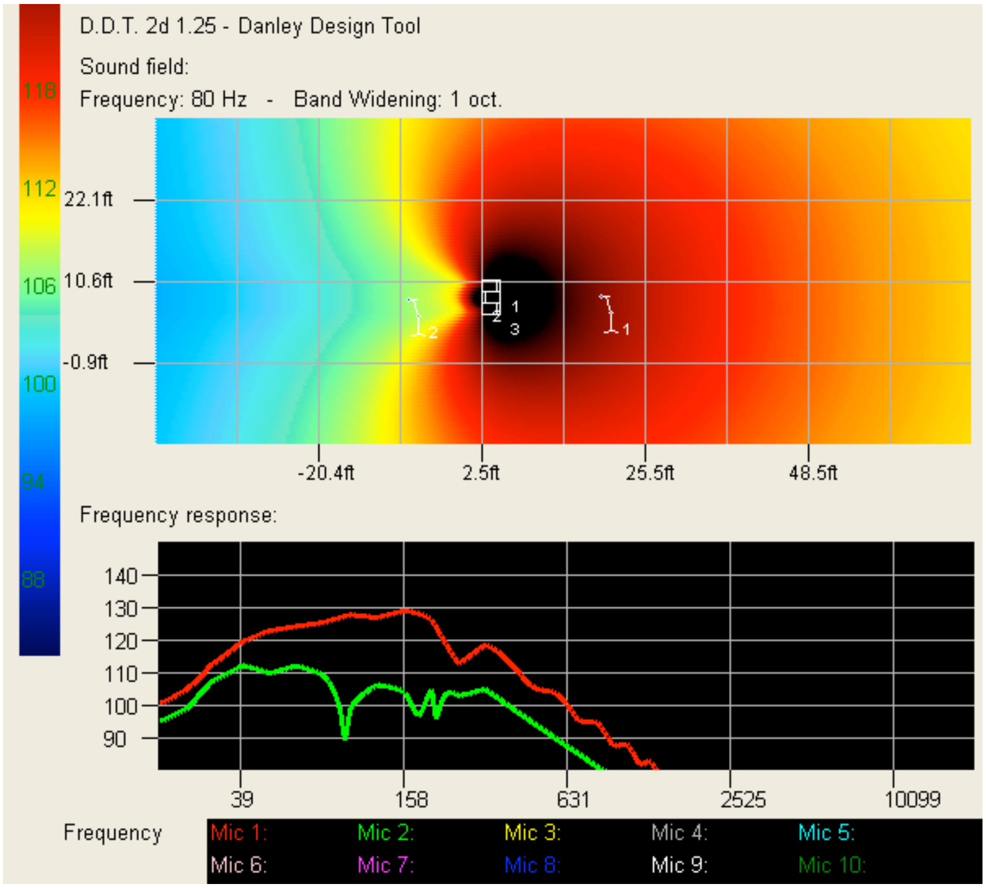
- In the *Sound Field* set the frequency to 80 Hz with the Band Widening to 1 octave.

- Generate a *Sound Field NOTE!! The screen will likely be totally black if you generate a Sound Field with out flipping the polarity of the center sub. You have essentially gone off the top of the amplitude scale. Reduce the drive level to all 3 subs and the Sound Field will map normally.*

- A convenient way to optimize your Cardioid array is to use the microphones.

- Select the *Microphones* Tab

- Click somewhere in front of the array then click on a colored microphone box. THis will place a microphone in front of the array. Now click somewhere behind the array and click on another colored mic box. A second mic will appear and you will now see the response in front of the array and the response behind the array. Using the delay, and level adjustments you can fine tune the array.



Your cardioid array should look something like this. Have fun experimenting!