Rapture3D Advanced

v2.9.11

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1 Introducing Rapture3D

Thanks for using Rapture3D! Rapture3D gives a full 3D surround sound experience through sophisticated use of Higher Order Ambisonics. This edition can handle small or large numbers of speakers, or headphones. Rapture3D can produce:

- 3D audio for use in the studio
- 3D audio for gaming
- 3D audio playback of ambisonic sound files

This is help for the "Advanced" edition of the software. There are "Game" and "User" editions too, and a "Universal" edition for cross-platform game development. The "Advanced" edition is special because it does the maths to allow you to set up custom speaker layouts and import personalised HRTFs. A range of preset are also available too, with a large number of configuration options.

The Advanced Speaker Layout software should be used to configure your speakers before Rapture3D is used in any of its forms.

1.1 The Rapture3D Decoder Studio Plugins

For work in the studio, the Rapture3D advanced decoder can be used as AAX or VST2 plugins within certain Digital Audio Workstations (DAWs) such as Reaper, Pro Tools or Max/MSP. They are not compatible with all DAWs because many cannot provide sufficiently wide busses.

1.2 The Rapture3D OpenAL Driver

For some games, the Rapture3D OpenAL driver can be used in place of the system OpenAL driver to take advantage of Rapture3D's sophisticated 3D audio rendering.

1.3 The Rapture3D Ambisonic Player

Rapture3D comes with a player for ambisonic sound files (typically .AMB files). Unlike standard "surround" mixes, these can reproduce full 3D audio.

2 Sound Card Set Up

Before doing anything else, you might want to take a moment to check that your audio hardware is set up correctly to work with Rapture3D.

In this advanced edition of Rapture3D, you can route channels of audio to specific audio outputs from your computer to set up non-standard or specially configured speaker layouts. This normally takes more time than with the automatic "Game" or "User" editions of Rapture3D, but is much more flexible.

Note that the AAX and VST2 plugins do **not** use these soundcard settings. This is because the plugins are hosted within another program (such as Pro Tools or Reaper) and it is that host program that will access the audio hardware and will need to be configured. However, when dealing with multichannel systems we **strongly** suggest using identical channel ordering in different configuration screens to avoid confusion or complicated rewiring later.

2.1 Audio On Windows

On Windows, the Rapture3D OpenAL driver and Rapture3D Ambisonic Player support audio output either through DirectSound or Steinberg ASIO.

2.1.1 Windows DirectSound

DirectSound-compatible sound cards are the normal type for Windows, so if other sounds are working then Rapture3D probably will too. If you want to use Rapture3D this way, you'll need to make sure Windows is configured properly so that Rapture3D can find out about all the speakers you want to use.

If you don't have a speaker layout fully set up, Rapture3D will normally try to default to sensible settings that match DirectSound. But this rather misses the point of this edition of the software! You'll probably want to use the Advanced Speaker Layout tool to tune things further so the sound is just as you'd like it.

2.1.1.1 Windows DirectSound Advanced Sound Card Set Up

For fine-grained configuration, Windows "Control Panel" is normally available from your Windows "Start" menu. Within this, depending on how you have it set up and your operating system, you will see a section with a names like "Sound", "Sounds, Speech, and Audio Devices" "Sounds and Audio Devices" or "Hardware and Sound".

When this is selected, you should see something like one of these:
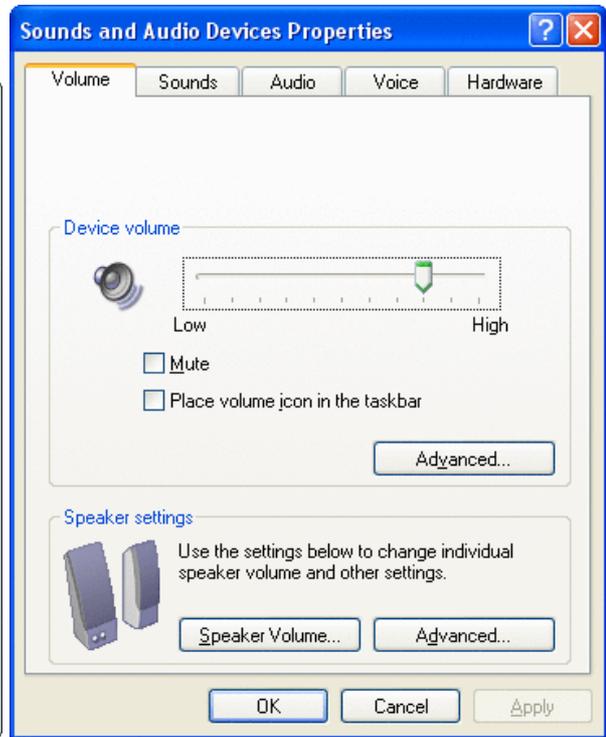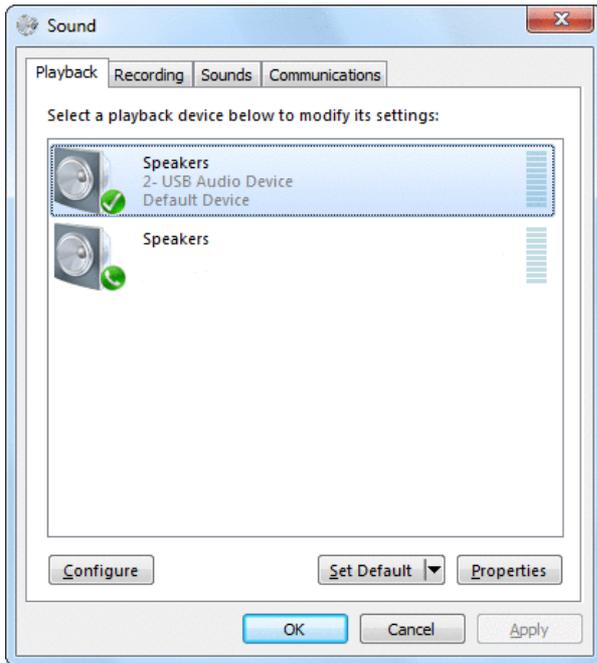
If you click through the tabs, you should see the audio settings you're using for other audio playback. If they don't look right, they will probably need to be reconfigured before you proceed.

Once you're done, click on the "Configure..." button if it's enabled (or "Advanced..." on older versions of Windows). This should bring up another window as below. If it doesn't, or if the button isn't enabled, it's probably just that your sound card is stereo only.
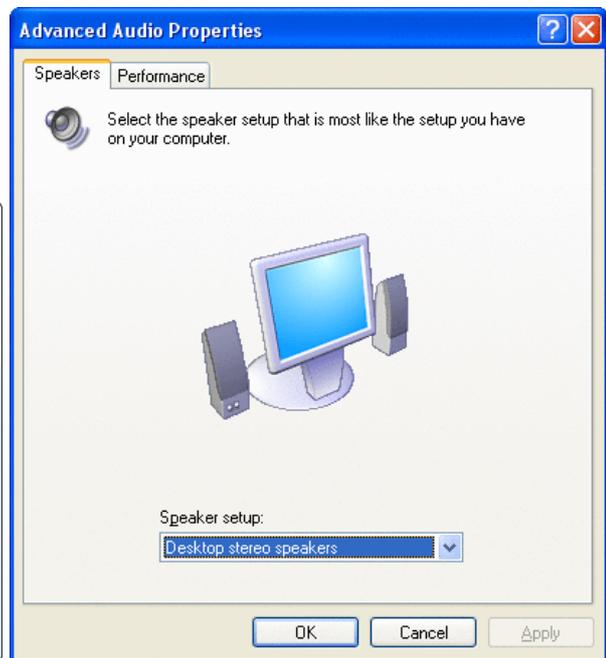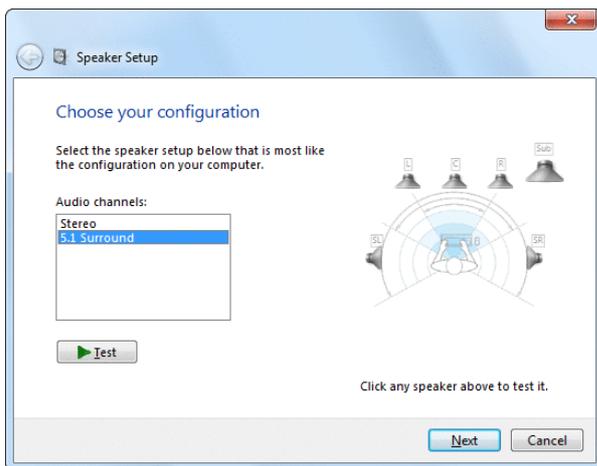
The important thing here is the "Audio channels" setting, or the "Speaker setup" choice on older versions of Windows. This should normally be set as close as possible to the actual layout of the speakers you're using.

Make sure that the layout you select shows all the channels you're going to want to use in the Speaker Layout Tool, even if they're not in the right places in the picture (you can always set up the routing and locations correctly in the layout tab). For instance, if your computer sound card has eight suitable outputs and you want to use a cube layout, you might be able to set DirectSound to 7.1 mode (which uses eight channels) and then set the correct routing (e.g. what DirectSound thinks is "Front Left" could be routed to "Lower Front Left" and so on). If you set Windows to only use stereo, then the only outputs you'll have to choose from on the layout tab will be "Left" and "Right", regardless of how many actual outputs there are on the back of your computer!

A word or warning: in principle 5.1 or 7.1 layouts include a subwoofer channel, so the cube set up described above is abusing this channel. In practice all of the soundcards we've seen route this straight out without doing anything "clever", but you might find sound cards or (more likely) your AV receiver trying to do bass management or other special processing with this channel. If you can't disable this, you'll need to work around this limitation when you set up your layout and resign yourself to using the subwoofer channel as a subwoofer.

Click on "OK" when you've finished making changes, or "Cancel" if you want to leave things as they were.

2.1.2 Steinberg ASIO

Most studio-grade audio hardware supports supports Steinberg ASIO. This is often the best way to access large numbers of channels, high audio fidelity and low latency processing.

If you have ASIO audio hardware then it may well come with its own configuration tool. You probably should check everything is set up correctly there and that your drivers are up to date before launching the Speaker Layout tool. After this, making an ASIO sound card work with Rapture3D should be straightforward, although normally each channel will need to be "wired" individually.

Your ASIO device should appear in the Audio Device section of the Layout tab when "Steinberg ASIO" is selected.

Some ASIO sound cards allow buffer sizes to be configured. 256 or 512 are sensible settings for gaming, although lower settings allow lower latency operation for studio use.

2.2 Audio On macOS

On macOS, audio is accessed through Core Audio and audio hardware will appear as normal. Your audio devices should appear in the Audio Device section of the Layout tab.

As always, please check your drivers are up to date!

3 Advanced Speaker Layout

Rapture3D itself is set up using the Advanced Speaker Layout tool. Normally, this appears under "Blue Ripple Sound" on the "Start" menu on Windows, or in a "Blue Ripple Sound" folder in your Applications area on macOS.
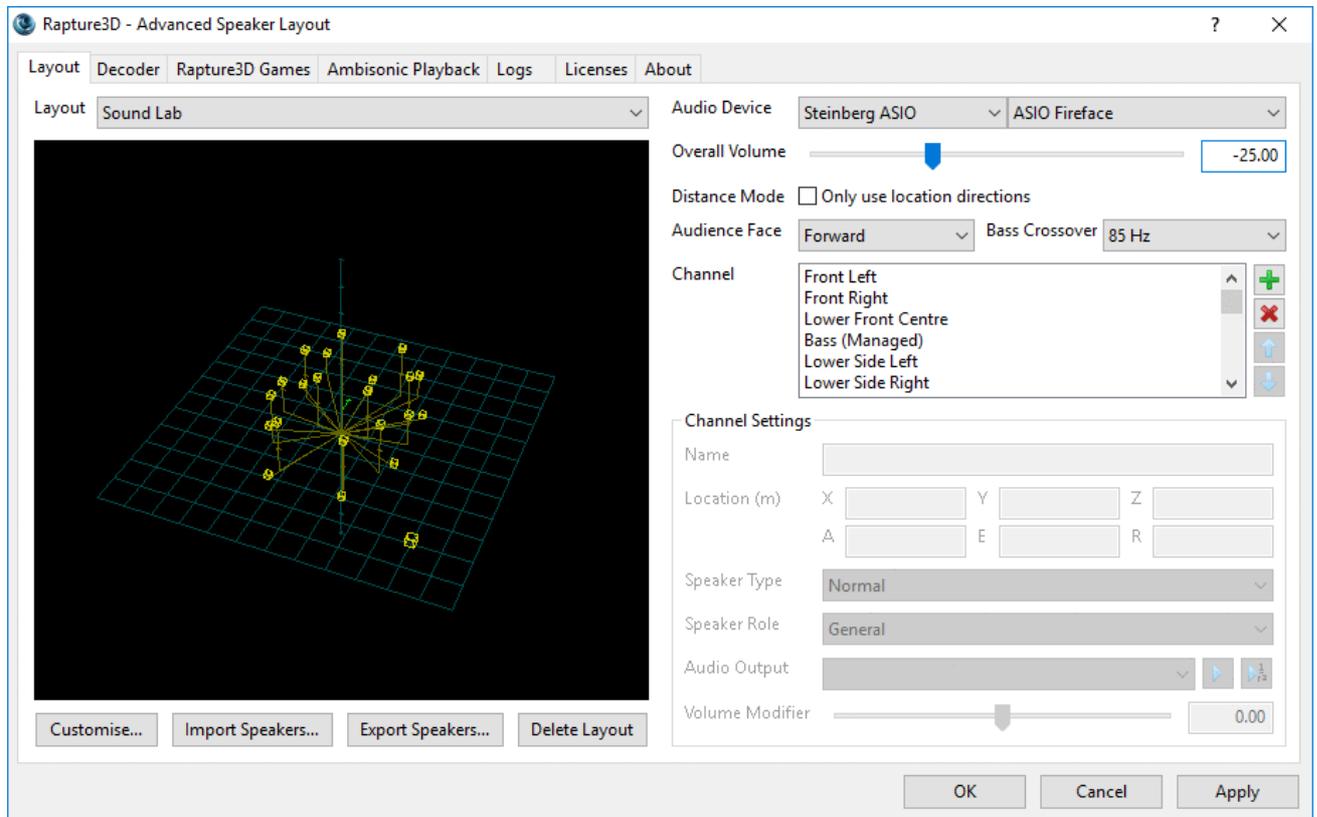
Set up is done in stages, each with its own tab:

1. On the Layout tab, check your sound card has been set up correctly and that the speaker (or headphone) layout is correct. You can also set up special speaker layouts and select non-standard audio outputs.
2. The Decoder tab can be used to select the decoder that will be used for the layout chosen on the previous tab.
3. On the Rapture3D tab, you can choose the settings that will be used when a game is running.
4. On the Ambisonic Playback tab, you can choose the settings that will be used when ambisonic playback is in use.

Normally license set-up happens automatically, but if it didn't or if you want to move a license to another machine, you can use the Licenses tab to manage your Blue Ripple Sound licenses.

There's also a Logs tab that you might want to look at if you're troubleshooting.

Click on "Apply" or "OK" when you're happy with your changes, or "Cancel" if you want to leave things as they were. Note that if there is a game running when you do this, Rapture3D will attempt to restart itself, so make sure you save your place first as some games may not like this.

The About tab has information about us (Blue Ripple Sound), the edition of the software you're using and other third-party software we've used, plus some legal stuff. Please read!

3.1 How Are You Getting On?

A message may appear in red at the bottom left of the screen indicating any issues with the current set up. These messages are intended to help guide you through the set up process.

Rapture3D won't work properly until such issues are resolved - if you try to use it in the meantime, it may attempt to recover so you may get some sound, though possibly not exactly what you wanted.

3.2 The Layout Tab
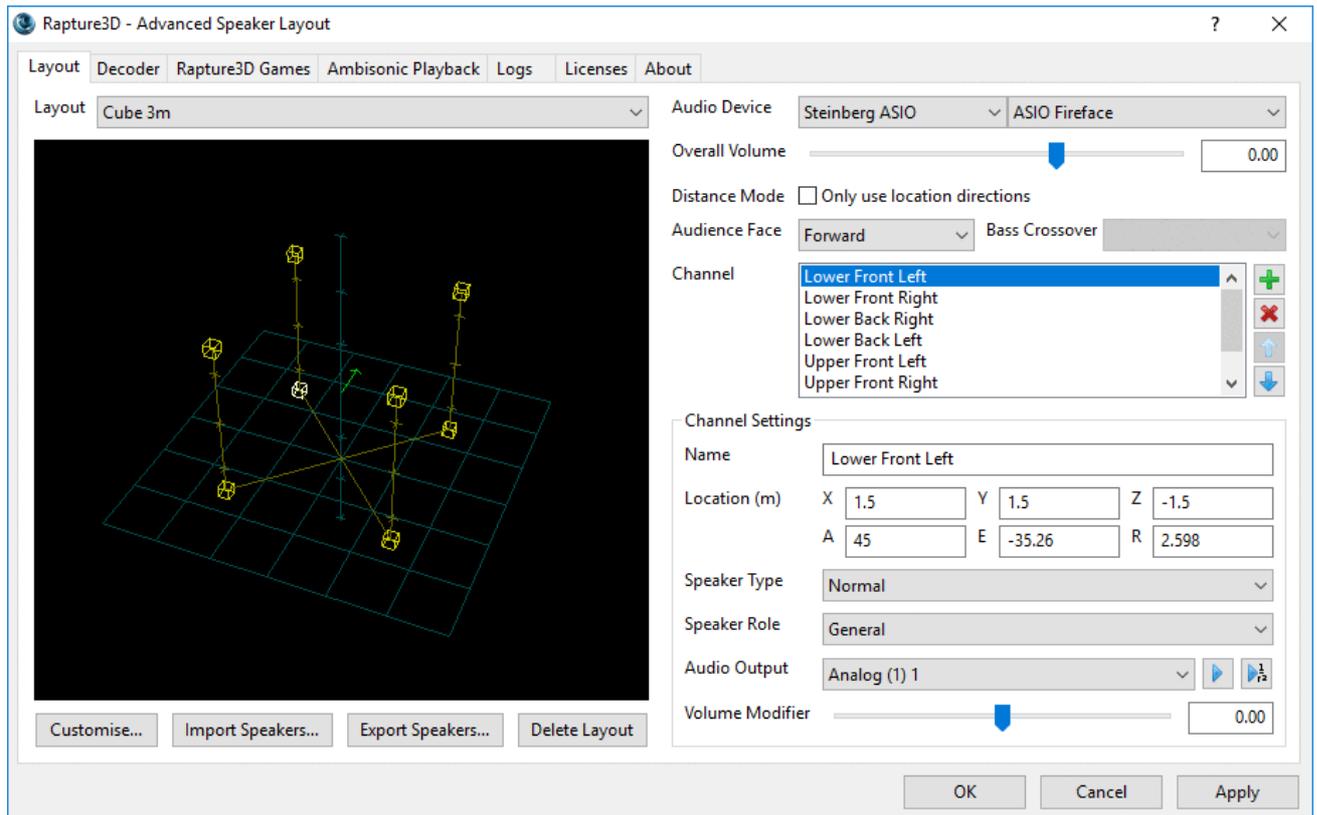
This is where most of the "action" happens with the advanced edition of the software. It's worth spending a few minutes to understand what's going on here.

This tab lets you tell Rapture3D how your speakers are set up, so that it can work out how to feed sound to them to produce the best spatial imaging. If you use a customised layout you will need to "compute a decoder" on the next tab after you have finished here.

On Windows, if you are familiar with the "Game" or "User" editions of the software we should probably warn you that this edition does *not* automatically synchronize with your Windows settings. Everything is under manual control, so if you want to use a DirectSound sound card then you need to make sure everything is set correctly in Windows Control Panel yourself before starting up the Advanced Speaker Layout program.

Preset speaker layouts with decoders are provided. However, even if you are using a standard multichannel layout for which there is a preset (such as 5.1) we generally recommend that you customise the layout using this tab rather than using the preset directly. In particular, it is good to tell Rapture3D the speaker distances that are in use (disable "Only use location directions" and change the "R" location settings) and correct the azimuths if they are not exact (and elevations if you are using a 3D layout).

3.2.1 Preset Layouts

This edition of Rapture3D comes with support for the following preset layouts. For most of them, it's probably easiest just to select them and look at the image to see where the speakers are expected.

| Format	Description
Stereo	This is a straightforward layout using two speakers.
Headphone Stereo	This is what should be selected if you're using a set of headphones.
Mono	Just one speaker is available.
Quad	Four speakers at the corners of a square.
Surround 5.0/5.1	5.0 is an arrangement with front left, right and centre speakers and two "surround" speakers at the side or back. 5.1 adds a subwoofer, which can go anywhere in the room. These layouts assumes that the four corner speakers are set out roughly in a square, which is slightly different to the "standard" ITU layout below. We find that many gamers and sound positioning systems use this.
Surround 5.0/5.1 (ITU)	These are versions of the "Surround 5.0" or "Surround 5.1" layouts that you may well have set up if you're following cinema conventions rather than gaming ones. These layouts have larger gaps between speakers to the side and rear, as recommended by the ITU (International Telecommunication Union). Specifically, your front left and right speakers are expected to be 30 degrees from front centre and the "side" speakers at 110 degrees. Try changing the Layout drop-down between the options and see which one looks most like the actual layout you're using. Don't worry about the location of the large "subwoofer" in the picture - this can go anywhere in the room.
Surround 5.1.2	This is an eight-channel layout formed from a 5.1 layout with two additional ceiling speakers, to the left and right above the listener. The corner speakers of the 5.1 are assumed to be set out roughly in a square.
Surround 5.1.2 (ITU)	This is an eight-channel layout formed from a 5.1 ITU layout with two additional ceiling speakers, to the left and right above the listener. The corner speakers of the 5.1 are assumed to be at standard ITU angles.
Surround 6.0/6.1	These layouts are similar to "Surround 5.0 (ITU)" and "Surround 5.1 (ITU)", adding a central rear speaker.
Surround 7.0/7.1	This adds two more speakers to "Surround 5.0 (ITU)" and "Surround 5.1 (ITU)", so there are two side and two back speakers.
Surround 7.1 (Wide)	This is a widescreen speaker layout used in some cinemas, where placement of sounds across the screen for many viewers is prioritised over immersion and front/rear balance.
Surround 3D7.1	This layout takes a bit of effort to set up, but is well worth the effort as it allows sounds to be placed above and below! (It works fine for stereo and 5.1 films too.)
Surround 7.1.2 (Dolby Atmos)	This format is similar to "Surround 7.1" with two additional ceiling speakers, to the left and right above the listener. This is a common bed format in Dolby Atmos.
Surround 7.1.4	This format is similar to "Surround 7.1", adding four "Top" speakers in a square above the listener.

Format	Description
Surround Stereo	It's possible you have your computer set up using stereo (i.e. two channels) but you're feeding the audio to another box with a "surround decoder" which will do some clever stuff and then feed to more than two speakers. "Dolby Pro Logic" is an example of this. If you select this option in Rapture3D we'll try to generate a compatible signal (make sure you select the right "Method" on the "Decoder" tab though). These systems typically don't work as well as feeding the surround speakers directly, but they aren't bad.
Auro-3D (9.1, 10.1, 11.1 and 13.1)	These are Auro-3D speaker layouts, using 10, 11, 12 or 14 channels. They are 3D layouts using a set of raised speakers above the normal channels of ITU 5.1. Auro-3D 9.1 adds raised speakers above the 5.1 corner speakers. Auro 10.1 adds a further speaker directly above the centre of the room, Auro 11.1 adds a raised front centre speaker and Auro 13.1 adds the back speakers from normal ITU 7.1.
IMAX (5.0, 6.0 and 12.0)	These layouts are used in IMAX theatre systems.
Surround 10.2	This is a 12 channel layout developed by Tomlinson Holman for cinema use, using seven front channels including two raised channels, three surround channels and two subwoofers. This is *not* the same as the 10.2 layout used in Steinberg Nuendo, which is closer to Auro-3D 10.1.
Hamasaki 22.2	This is a 24 channel layout used in the Ultra High Definition Television standard.
Circle (16/32)	These are arrangements of 16 or 32 speakers in a horizontal circle.
Cube	This is an arrangement of eight speakers at the corners of a cube. This can produce good vertical images, although gaps can appear in the middle of the faces.
Twisted Cube	This is an arrangement of eight speakers at the corners of a cube, but with the upper layer rotated by 45 degrees. This rotation improves coverage on the horizontal plane.
Dodecahedron	This is an arrangement of twenty speakers at the corners of a dodecahedron.
Hexagon 1/2	These are arrangements of six speakers in a horizontal circle. There are two versions, shifted by a 30 degree rotation.
Icosahedron	An arrangement of twelve speakers at the corners of an icosahedron.
Octagon 1/2	These are arrangements of eight speakers in a horizontal circle. There are two versions, shifted by a 22.5 degree rotation.
Octahedron	This places the speakers on the corners of a regular octahedron ("bi-triangle") arranged so the front and back planes are vertical. This is actually the same as the Surround 3D7.1 layout without the subwoofer and Front Centre speakers.
Compatibility ("Compat.") Modes	These modes appear on Windows only and are actually the same as other layouts with similar names. They can simply be ignored for most purposes (they're used by the "User" and "Game" editions of the software).

Only some settings can be changed for preset layouts. If you need to change more (for instance if you want to change the location of one speaker) then you should create a new layout based on the existing one.

3.2.2 Creating New Layouts

To create a new layout, select "New..." from the Layout drop-down and choose a name for your new layout. You might prefer to start out with a copy of an existing layout - just use the "Base On Existing Layout" drop-down from the window that comes up. Or you can start out with no speakers and add them one by one, or import them.

Alternatively, you can just select the layout you want to base your new one on and click the "Customise..." button.
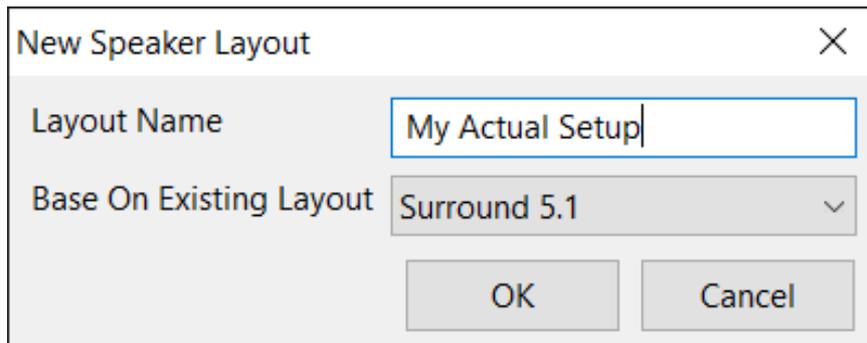
A quick introduction to designing good speaker layouts is available.

3.2.3 Import and Export

Press these buttons to import or export layout information. Generally we recommend use of .SLF files as this loads or saves the complete description of the layout, including audio output configuration and overall and individual speaker volumes.

3.2.4 Delete Layout

Press this button to delete a layout that you have created. This should not be used for preset layouts.

3.2.5 Audio Device

This comes in two parts. The left-hand part selects what software audio framework is in use and the right-hand part selects the actual audio device within that framework.

On Windows, two frameworks are supported:

  • Microsoft DirectSound - this allows access to "standard" Windows sound cards.
  • Steinberg ASIO - this allows access to low-latency studio kit.

On macOS, the Core Audio framework is supported.

The devices listed will depend on the actual sound cards (or other audio hardware) attached to your computer.

When you select something here, the channels will be connected up automatically to the channels available, assuming there are enough of them. This wiring may well be wrong though, so you should check and test the individual Audio Outputs.

3.2.6 Overall Volume

This gain control is applied *in combination* with volume controls in other places. It should be used to get the speaker levels in roughly the right place for comfortable listening. Other volume controls can be used for fine control. Note that changes to these volume controls are not made until "OK" or "Apply" are pressed.

Having said that, please set it *really low* before testing out any of your channels so you don't blow any speakers or damage your ears. We're assuming you're being sensible with external

amplification here - please be careful to make sure your whole signal chain won't damage any kit or ears.

Please please please test the levels on this tab before starting up anything else. If you start a game with volumes set to high levels (e.g. because you've wired straight to active speakers - yes, we've done this and are speaking from experience) then you can end up reaching for your mains power switch to make the deafening noise stop quickly enough.

3.2.7 Distance Mode

This won't be editable if you're using a preset layout. Create a new layout based on the current one if you want to modify it.

This control indicates whether or not you're providing accurate information about *how far away* the speakers are from the centre (the base of the green arrow in the picture). If "Only use location directions" is selected, then the software will pretend that all the speakers are the same distance away and that the exact distance isn't actually known. This reduces the quality of the soundfield reconstruction.

The distance compensation takes into account the fact that sound from distant speakers will arrive at the centre later than sound from closer speakers.

Also, more distant speakers will typically be driven at higher levels than closer ones. For these purposes, the reference distance is 1m, and a speaker at a distance of r metres will typically be driven with a gain (in decibels) roughly $20 \log_{10}(r)$ louder that it would at the reference distance (this is roughly 6dB for each doubling of distance). If you are concerned about clipping, or volume levels close to the speakers, you may wish to compensate for this using the Overall Volume control above.

Enabling the "Only use location directions" switch is sensible if you don't have accurate measurements and your speakers are roughly the same distance away from the centre. You'll see the graphics update to show how this makes the layout look.

3.2.8 Audience Face

This tells Rapture3D the directions that audience members face while listening. It affects the psychoacoustic cues used during tinted decoding. Options are:

- Forward - audience members are assumed to be upright or seated, and facing forwards along the X axis. This is usual for computer games and film.
- Forward/Upright - this is a blend between Forward and Upright modes.
- Upright - audience members are assumed to be upright. This is usual in a space where people can walk around freely, sit or stand.
- Free - here no assumptions are made about how the audience members are oriented. This is somewhat unusual.

3.2.9 Bass Crossover

When at least one speaker is a sub-woofer with role "Bass (Managed)" (see below), Rapture3D uses bass management for all but "Basic" decoders.

When bass management is in use, a crossover filter can be used to route low frequencies to the bass-managed sub-woofers and to remove them from other decoder channels. The selected bass crossover is the middle frequency of this filter, measured in Hertz. If your speakers have crossovers build in, make sure they are all set the same and select "External" from the drop down menu, which disables the Rapture3D crossovers. Using crossovers in both Rapture3D and your speakers is not

recommended as it is likely to result in a loss of sound energy around the crossover frequencies.

If you have more than one bass-managed sub-woofer, Rapture3D may generate a bass decoder for low frequency spatialisation, using soundfield reconstruction. Typically, four or more sub-woofers are required. Otherwise, a mono bass signal is used and bass is not spatialised.

To check if bass spatialisation is in use, see the "Bass Soundfield Reconstruction Decoders" section of the report when computing decoders. You may wish to check this before finalising your speaker layout.

3.2.10 Channel

Use this to select the channel to be edited within the "Channel Settings" region below.

The buttons to the side can be used to add or delete channels, or move individual channels up and down.

3.2.11 Channel Settings

This region shows the settings for the speaker selected in the "Channel" control above. The corresponding speaker is indicated in white in the image.

3.2.11.1 Name

This won't be editable if you're using a preset layout.

This is the name of the channel.

3.2.11.2 Location

This won't be editable if you're using a preset layout.

This is the location of the speaker, expressed in Cartesian and Polar coordinates relative to an origin shown in the graph at the base of the green arrow, in metres.

The coordinate system is arranged as follows:

Positive X	Forwards
Negative X	Backwards
Positive Y	Left
Negative Y	Right
Positive Z	Up
Negative Z	Down

Azimuth ("A") is measured anticlockwise (left) from the front and elevation ("E") is measured upwards from the horizontal. Radius ("R") is measured outwards from the origin, in metres.

Note that if you've enabled "Only use location directions", then the actual graphics drawn will always crush or stretch the actual speaker location drawn so it's the same distance from the origin. This can be quite confusing so you might want to switch it off while tweaking locations.

When "Only use location directions" is not enabled then measurements are in *metres*. This does actually matter as the internal calculations use the speed of sound.

3.2.11.3 Speaker Type

This won't be editable if you're using a preset layout.

Use this to indicate each speaker's type. Generally these should all be set to "Normal" except for a "Sub-Woofer" if one is present. However, if you have a number of additional tweeters you may wish to indicate these using the "Small" option.

Note that if you select a subwoofer, you'll need to set the speaker role to either "Bass (Managed)" or "Bass (LFE Only)" so the decoder generator knows whether it should do its own bass management or leave it to your AV receiver.

3.2.11.4 Speaker Role

This won't be editable if you're using a preset layout.

Normally speakers are "General" speakers, which means they are used for general sound spatialisation. However, some special speakers have other roles in addition to (or instead of) this. For instance, some games send dialogue directly to a "Front Centre" (or "Front Centre (Dialogue Only)") speaker if one is present, bypassing the general sound spatialisation engine.

The following roles have special behaviour:

- Inactive - this excludes the speaker from use in decoders.
- Front Centre (Dialogue Only) - if this is selected, then the speaker will be *excluded from the decoder* when it is generated on the Decoder tab. This is useful where the front centre speaker is actually a different kind of speaker designed specifically for dialogue. Rapture3D supports an extension that allows dialogue from the game to be fed to the speaker even though it is not used for the main 3D audio stream.
- Bass (LFE Only) - if this is selected for a subwoofer, then the speaker will be *excluded from the decoder* when it is generated on the Decoder tab. This is useful in the normal case where the output from Rapture3D is going to be fed to an external AV receiver or other piece of audio kit which is going to perform bass management - in this case, the external device will make sure an appropriate level of bass ends up in the speaker. Further, Rapture3D supports an extension that allows bass low frequency effects from the game to be fed to the speaker even though it is not used for the main 3D audio stream.
- Bass (Managed) - if this is selected for a subwoofer, then Rapture3D will perform bass management and generate an audio stream containing only low frequencies for this speaker. *Do not do this if you are using an AV receiver or other external kit with bass management* as this will already be doing this job and probably knows more about your speakers.

If you're not clear about the choice between the two Bass settings above, select "Bass (LFE Only)" first and see if your sub produces enough bass. If it doesn't, try the "Bass (Managed)" setting instead.

3.2.11.5 Audio Output

Use this to select the actual audio output on the Audio Device you selected that should be used to feed sound to the selected speaker.

Turn the volume down and press one of the "Play" buttons to play a test tone, then bring the level up a little and try again until it's about right. This can be used to make sure the speakers are all at the same level and wired up correctly.

3.2.11.6 Test Play Buttons

There are two play buttons which can be used to send a test tone to a speaker. The ordinary one on the left sends a test tone directly to a speaker, taking into account the overall and channel levels.

The right hand play button also takes into account how far away the speakers are from the middle of the room, so more distant speakers play more loudly (which is also what happens during decoding). This means that you can check all the speaker levels from the centre of the room. This button becomes unavailable when "Only use location directions" is enabled (see "Distance Mode" above).

3.2.11.7 Volume Modifier

All the speakers should be at roughly the same volume level. Use the "Volume Modifier" to tweak individual speaker gains if necessary.

3.2.12 What's next?

Once you have set up your layout correctly so that everything looks right, you will probably want to proceed to the Decoder tab. If you see the following message, this just indicates that you haven't chosen a decoder method yet, which is typically because you haven't generated one yet. This is all managed on the Decoder tab.
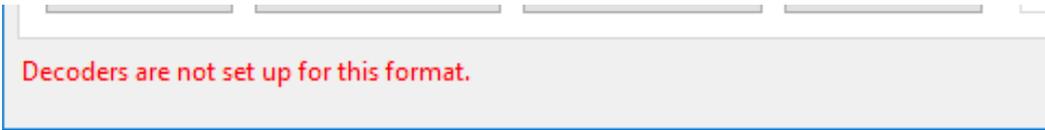
If you see other errors relating to audio outputs, it isn't necessary to fix them before using the VST plugins, because the VST plugins do not talk to audio outputs directly. These are managed by your DAW, which will need separate configuration.

3.3 The Decoder Tab
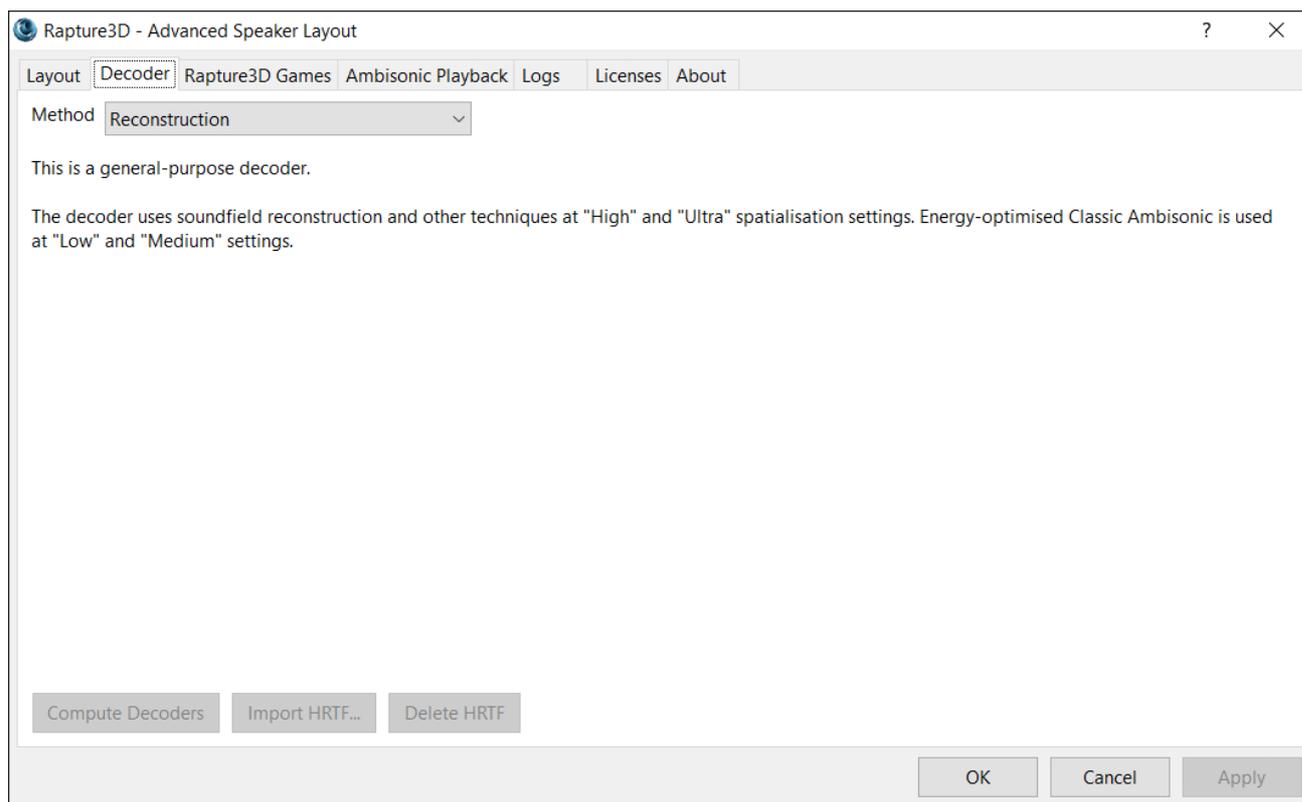
This tab is used to determine the mathematical method used to feed audio to the layout set up on the Layout tab. This mathematical method is known as a "Decoder".

The exact list of items on the "Method" drop-down depends on the particular layout. For instance, the "Reconstruction" option in the picture above is available for multi speaker arrangements (e.g. Surround 5.1) but not for Stereo or Headphone Stereo, which have some thoroughly different options. Whichever option you select, the text below the drop-down describes how this method will work. Try flipping through the options to see what you're choosing from. Some of these options make quite noticeable differences to how things will sound.

3.3.1 The "Compute Decoders" Button

If you've just set up a custom layout on the Layout tab, there won't be any methods listed here yet. This is because preparing the decoders is a complex process and can take a few minutes. We don't do it until you're sure everything else is set up.

Once you *are* sure, make sure you don't need your computer for up to half an hour and press the "Compute Decoders" button to start the process. If there are issues these are typically reported quickly. Things can go wrong in a number of ways, most typically because the speaker layout isn't good. You may wish to see our guide to Layout Design.

Decoder generation produces a report that may or may or not be interesting reading for you. Either way, click "OK" to save all your changes and your new decoders or "Cancel" to go back and make further changes.

Once decoders have been computed, the button will be disabled. It will re-enable if you change any of your speaker locations or suchlike on the Layout tab (changing volumes doesn't have this effect).

Note that the decoder generation procedure available here generates decoders of the type described under "Multi Speaker Methods" below. "Basic" decoders will not be available for some

layouts where they would perform particularly badly.

3.3.2 The "Import HRTF..." Button

Rapture3D has support for import of custom HRTFs from AES69 files. The button is only enabled when the layout is set to "Headphone Stereo".

3.3.3 The "Delete HRTF" Button

This can be used to delete custom HRTFs that were imported previously. It is only enabled when the selected decoder method is a custom HRTF.

3.3.4 Decoder Methods

Since you can flip through the decoder methods anyway, we'll just describe some of the concepts here so they make a bit more sense. Decoder methods have a variety of pros and cons. Some of them use more or less CPU power, some of them are more or less sensitive to how accurately you've set your speakers up and some of them actually will work better for people with differently shaped heads! The best thing to do is to try some and listen...

3.3.4.1 Headphone Stereo Methods and Binaural

Several of the headphone decoders use HRTFs. HRTFs tell us how sound travels past a human head and into the ear and provide a great way to provide a realistic sound image over headphones, often known as Binaural stereo. However, human heads are not all the same shape. We provide six main "colours" of HRTF - you might like to try these out to find the one that works best for you. At best HRTFs can place sounds anywhere, including behind and above. However, if they don't really match your head shape you may find "confusion" occurring, with sounds that should be behind appearing to be above etc. If you find this happening, try a different HRTF.

HRTF	HRTF-based headphone decoders using psychoacoustic cues to present sounds in full 3D. Amber is often a good choice. Emulations of Google's YouTube binaural decoders are included, but please note that these are first order only.
Custom HRTF	Custom HRTF-based headphone decoders using psychoacoustic cues to present sounds in full 3D. These can be imported from AES69 files.
Simplified HRTF (Amber)	Version of the Amber HRTF, massively simplified so it is is not frequency-dependent. This places relatively light load on your CPU.
Panner	This splits sounds between the left and right ears using carefully optimised panning functions. This places relatively light load on your CPU.

The HRTFs provided are based on academic data sets available on the Internet - thanks to all involved! They've been processed for use with Rapture3D, so any problems are entirely our responsibility. We've given the data sets colour names like "HRTF (Red)" for simplicity, but you can see where the HRTF actually came from in the text shown on this tab.

If you don't want to use an HRTF data set you can just select "Panner". This will provide a perfectly serviceable plain stereo image. You can save a few CPU cycles this way too, although the Simplified HRTF is no more expensive.

3.3.4.2 Stereo Speaker Methods

If you're just using a normal stereo system then "Panner" is probably what you want here.

Panner	This splits sounds between the left and right speakers using carefully optimised panning functions. This places relatively light load on your CPU.
HCTC Stereo	HRTF-based Cross-Talk Cancellation. Requires accurate speaker set up at an angle of 50 degrees.
HCTC Stereo (Narrow)	HRTF-based Cross-Talk Cancellation. Requires accurate speaker set up at an angle of 20 degrees. Amber only.

The HCTC Stereo options can work well if your speakers are set up very accurately and if you don't move your head much. They're not suited for use with multiple listeners. They're also dependent on you finding an HRTF data set that works okay for you (the same problems apply as described for HRTF headphone stereo above). But they're well worth a try, particularly if you're using desktop or laptop speakers.

But - why only two speakers? To get the best out of Rapture3D you could try using a sound card that lets you connect more...

3.3.4.3 Multi Speaker Methods

If you're using proper surround sound systems with four or more speakers (e.g. 5.1, 7.1 or 3D7.1) or a custom layout for which you've computed your own decoders then these options are available:

Basic	This method produces a resilient decoding which should play well on a range of speaker systems including large venues. It should be used if your speakers are only roughly in the right places or if your CPU is struggling to keep up.
Reconstruction	This is the default setting. It produces a solid image and uses a sensible amount of CPU power. It relies on the speaker layout being set up accurately and is optimised for a domestic or studio listening environment.
Tinted Reconstruction	This is a more expensive option in CPU terms, but performs HRTF-based tinting on the audio stream to strengthen the spatial image. For some people, this can even give a sense of sounds being above and below when all speakers are all at the same height!

For some preset layouts with a front centre speaker, there are variants of the methods above. This is because, for compatibility with speaker sets with a special dialogue front centre speaker, the front centre speaker may be used usually for dialogue only. Note that these methods are not created when you generate custom decoders. You can decide whether dialogue speakers are used or not in your decoder by selecting "Front Centre" or "Front Centre (Dialogue Only)" when setting up your layout.

Basic (Front Pan) Reconstruction (Front Pan) Tinted Reconstruction (Front Pan)	As above, but use the front centre speaker for panning as well as dialogue. Use this if you are confident that your front centre speaker has the same response as the others.

For 5.1 and 7.1 preset layouts, a "Pro Logic IIz" method is also available.

Pro Logic IIz	This uses phase to encode additional spatial information into 5.1 or 7.1 output which can be decoded to additional upper-front speakers by compatible receivers. These methods use the front centre speaker for panning as well as dialogue.

3.3.4.4 Surround Stereo Methods

These are offered if you selected "Surround Stereo" or "Surround Stereo (Compat.)" options on the Layout tab. Just select the method that matches the surround decoder you are using. If none match, you probably want to switch your layout back to ordinary Stereo.

Dolby Pro Logic	This is compatible with Dolby Pro Logic decoders. Your decoder may be able to make use of a centre speaker and one or two surround speakers at the back of the room.
Dolby Pro Logic II	This is compatible with Dolby Pro Logic II decoders. Your decoder may be able to make use of a centre speaker and two surround speakers at the back of the room.
Dolby Stereo	This is compatible with Dolby Surround decoders. Your decoder may be able to make use of a centre speaker and one or two surround speakers at the back of the room.
Matrix QS	This is compatible with Matrix-QS decoders. These are fairly rare.
Matrix SQ	This is compatible with Matrix-SQ decoders. These are fairly rare.
UHJ Stereo	This is compatible with ambisonic UHJ Stereo decoders. These are fairly rare. A "short" version of this is available, with lower latency and quality.

Note that the encoders used here aren't all "official" ones. However, they should be compatible.

3.4 Importing HRTFs from AES69 Files

3.4.1 Introduction

Head-Related Transfer Functions (HRTFs) are the heart of a technique that allows 3D audio to be played back on headphones. They work by simulating the acoustic behaviour of the human head and ears, so the sound fed from the headphones into the ear canal is similar to what would have arrived there if a real sound had passed around a real human head.

This allows improved 3D imaging on headphones with sounds to the sides, behind, and above and below. And if you're lucky, in front as well (it seems to be harder to "fool" the brain here, particularly when the ears contradict the eyes, or sounds do not move as expected when the head moves).

There is a recording technique known as "binaural" recording which produces similar audio, typically by placing small microphones just in the entry to the ear canal. HRTF processing can be thought of as "synthetic binaural".

3.4.2 The Personalisation Problem

HRTFs are subtly different for different people, because their heads and ears are not the same size or shape. Because of this, different HRTFs work more or less well for different people and ideally we would use one based on an accurate measurement of the acoustics of a person's head.

Rapture3D comes with a number of preset HRTFs which work well for most people. The "Amber" HRTF is particularly good. But it is possible to do even better using an HRTF tailored for the individual.

3.4.3 The AES69 File Format

AES69 is a standard file format agreed at the start of 2015, based on the SOFA file format. This stores HRTF data as Head-Related Impulse Responses (HRIRs) and most such files can be read by Rapture3D Advanced.

3.4.4 macOS Minimum Version

The importer does not work correctly with some older versions of the Apple vecLib library. We do not recommend use of this software on versions of macOS prior to 10.10.

3.4.5 How Do I Get An AES69 File For My Head?

This is probably the most difficult part! We do **not** do this for you. Once again, we're taking the "build it and they will come" approach.

A number of people do have accurately measured HRTFs. These have normally been created as part of research projects and involve elaborate experiments, typically in an anechoic space and using a large number of speakers. If these measurements are in AES69 form, you should be able to import them into Rapture3D Advanced.

In addition, significant research is going into the *estimation* of individual HRTFs, for instance using photographs or 3D scans of the head. Hopefully, as this technology matures, it should be possible to write the estimated HRTFs into AES69 files. This is very exciting as it brings personal HRTFs "into the living room!"

We don't provide these measurement or estimation tools, so we're only providing one piece of the puzzle here. But hopefully it is a useful one.

3.4.6 Importing AES69 HRTFs Into Rapture3D Advanced

When Rapture3D Advanced loads an AES69 file, it adds a "Custom HRTF" to the list of available headphone decoders, which can then be used like the preset HRTFs. To set this up, do the following:

1. Go to the Layout Tab and switch the layout to "Headphone Stereo". Check the audio outputs are directed to actual headphones.
2. Then, go to the Decoder Tab and press the "Import HRTF..." button.

This should bring up the "HRTF Import Options" window:
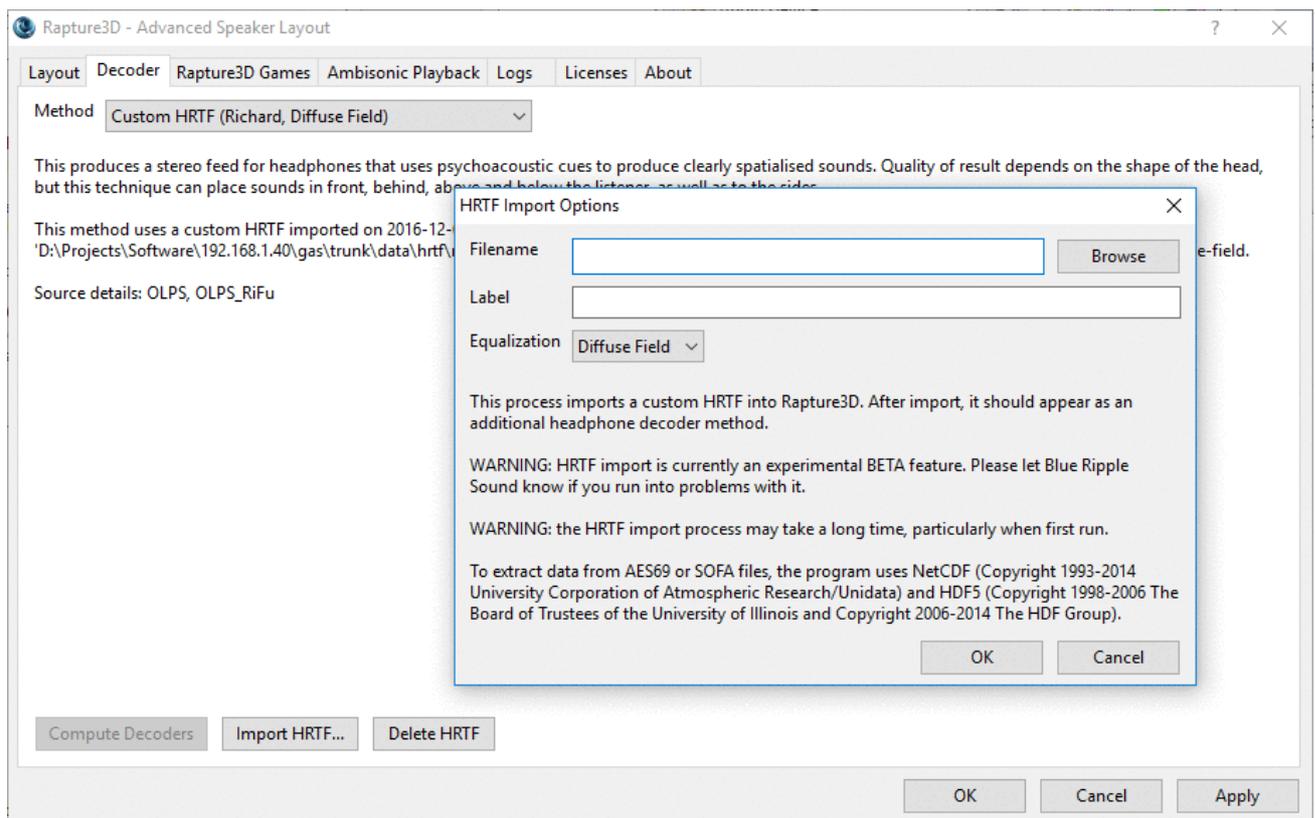
The fields are as follow:

- The "Filename" is the name of the AES69 file you want to import. You can type it in, or use the "Browse" button to find it.
- The "Label" is how the HRTF will be labelled in Rapture3D after import. It will show up as a "Custom HRTF" in the list of decoders available for the "Headphone Surround" layout.
- The "Equalization" determines how the overall HRTF frequency response is balanced during the import process. Generally, you should set this to the type of headphones you are using ("Diffuse Field" or "Free Field"). If this processing has already been applied in the AES69 file, you can leave this option "Off". If in doubt, it is usually best to set this to "Diffuse".

Once your have chosen your settings, press "OK" to start the process. This can take quite some time, especially the first time it is done for a particular set of directions. Typically this is a few minutes, but for very large modern data sets (more than a few thousand angles) you may wish to run the import overnight.

After you have imported your AES69 file, it should appear as a "Custom HRTF" in the list of decoders available for the "Headphone Surround" layout. You can delete it by selecting it and pressing the "Delete HRTF" button.

3.4.7 HRTF Checking

Rapture3D performs a significant amount of processing during import, some of which is quite sensitive to the quality of the HRIR data in the AES69 file. During processing, it checks some key features of the HRTF, and if the data looks suspicious it will warn you. If the data looks positively wrong, it will stop.

Typical reasons for issues include:

- Excessive windowing or filtering of data.
- Inconsistent speaker or microphone levels or placement in recordings.
- Incorrect coordinates in the AES69 file. (Well, we've not actually seen this yet, but we're expecting to, because AES69 allows fairly complex geometric transformations.)
- Inconsistent polarity when synthesizing data for low frequencies.

3.5 The Rapture3D Games Tab
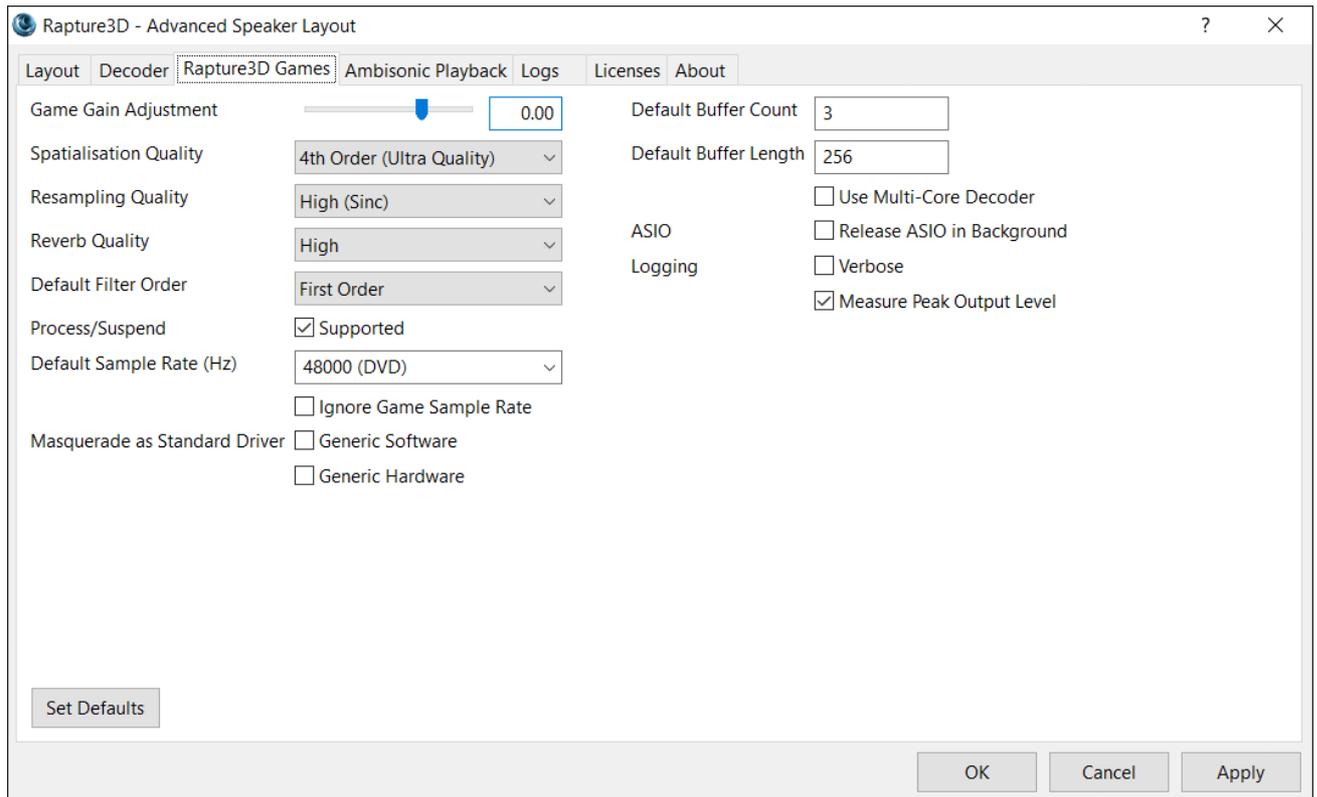
Here's where gaming settings are selected. You can tune these to make the best use of the hardware you have available. If in doubt, just press the "Set Defaults" button to choose settings that make sense. If quality setting are too high, you may find that audio "skips" or other parts of the game such as the graphics engine struggle to keep up and become jumpy.

3.5.1 Game Gain Adjustment

This gain control is applied *in combination* with the volume settings on the Layout tab and any volume controls in the game itself. Note that changes to this volume control are not made until "OK" or "Apply" are pressed. Assuming you've set the overall volume sensibly, this can usually be left at 0dB - just use volume controls in the game or on external hardware while playing.

3.5.2 Spatialisation Quality

This determines the quality of spatial rendering (3D sound) used by Rapture3D. Note that this control works on conjunction with the actual decoder method chosen on the Decoder tab.

3.5.3 Resampling Quality

This determines the quality of sample rate conversion used by Rapture3D. This can be particularly expensive in CPU terms.

3.5.4 Reverb Quality

This determines the quality of the reverb algorithm conversion used by Rapture3D. Note that in "Low" mode, only one reverb is allowed. Most games only use one reverb (but not all!).

3.5.5 Default Filter Order

This determines the slope of the filters used by Rapture3D if the game does not specify. Normally this should be set to "First Order".

3.5.6 Process/Suspend

OpenAL allows context processing to be suspended, which Rapture3D supports by default. It is sometimes useful to switch this feature off during game development.

3.5.7 Default Sample Rate

When a game that uses OpenAL starts up, it may indicate the sample rate it would like Rapture3D to use. If it doesn't, this value is used instead. Generally this can be left at 48000Hz, which is supported natively by a lot of sound cards.

3.5.8 Ignore Game Sample Rate

If this is enabled then the Default Sample Rate above is used *regardless of any request from the game*. This can be useful with audio hardware that does not allow more than one sample rate or if you want to force Rapture3D to run at a lower rate to reduce CPU load.

3.5.9 Masquerade as Standard Driver (Windows Only)

These options allow Rapture3D to "pretend" to be the Generic Software or Generic Hardware OpenAL drivers. This is quite technical and dangerous and should only be enabled if you're really sure you know what you're doing.

The reason that using these switches is dangerous is because, to make them useful, you also need to remove other OpenAL drivers, which have names of form *_oal.dll, from your Windows system and game directories. These include the real Generic Software and Hardware drivers (typically provided by wrap_oal.dll). The idea here is that you can remove all other OpenAL drivers from your system so that Rapture3D (provided by rapture3d_oal.dll) is the only OpenAL driver present. You can then tell Rapture3D to masquerade as the Generic Software driver so that games will not be aware that they are using a new driver. This allows Rapture3D to run with quite a few OpenAL games that predate it and which don't have an option to select which OpenAL driver should be used.

Bear in mind that some game installers will reinstall the DLLs you deleted so it's worth checking after an installation to ensure they haven't crept back.

As mentioned before, this approach is quite dangerous. It doesn't work with all OpenAL games (particularly those that require EAX, which is deprecated and not supported by Rapture3D). You may break your game installation which would require a reinstall. Also, in principle deleting the wrong files from Windows system directories can destabilise your entire system, so you might need to reinstall the whole of Windows, which is something we can't help you with! So be really careful and *only do this sort of thing if you're sure you're comfortable with the risks*.

3.5.10 Buffer Configuration

The default buffer length can be set. Bear in mind that this is just a suggestion - actually your audio card may prefer something different and Rapture3D will go with that. A default buffer length of 256 is generally recommended, though you may find that lengths of 512 or 1024 help if you experience stuttering or are using a complicated decoder.

On Windows, an additional buffer count setting can be used. Generally, lower buffer counts lower latency too, but setting the count too low can introduce stuttering.

If you're wondering what "latency" means, here this is essentially the time delay between initial audio processing and the sound being sent out of the back of your computer. We work hard to make this as quick as possible, but in the end latency is generally limited by the quality of your audio hardware and its driver.

3.5.11 Use Multi-Core Decoder

If you have a multi-core system (likely these days), this can be enabled to allow the decoder to run on a separate core. This allows more complex decoders to be used, but increases latency slightly.

3.5.12 Release ASIO in Background (Windows Only)

If you have problems using ASIO in more than one piece of Windows software simultaneously, you may wish to enable this. It causes the Rapture3D OpenAL engine to stop using ASIO while its output is silent and the software that it is running within is not the foreground application.

3.5.13 Logging Options

These options affect what is written to the Logs tab while gaming:

- Enabling the "Verbose" check box causes more detail to be written.
- Enabling the "Measure Peak Output Level" check box writes lines to the log indicating the peak level reached. Note that this is the peak level within the software rather than a level seen in your external audio kit or the actual sound level in the room. Rapture3D drops the audio level automatically when clipping would occur. If this happens too much then quality can be reduced.

3.6 The Ambisonic Playback Tab
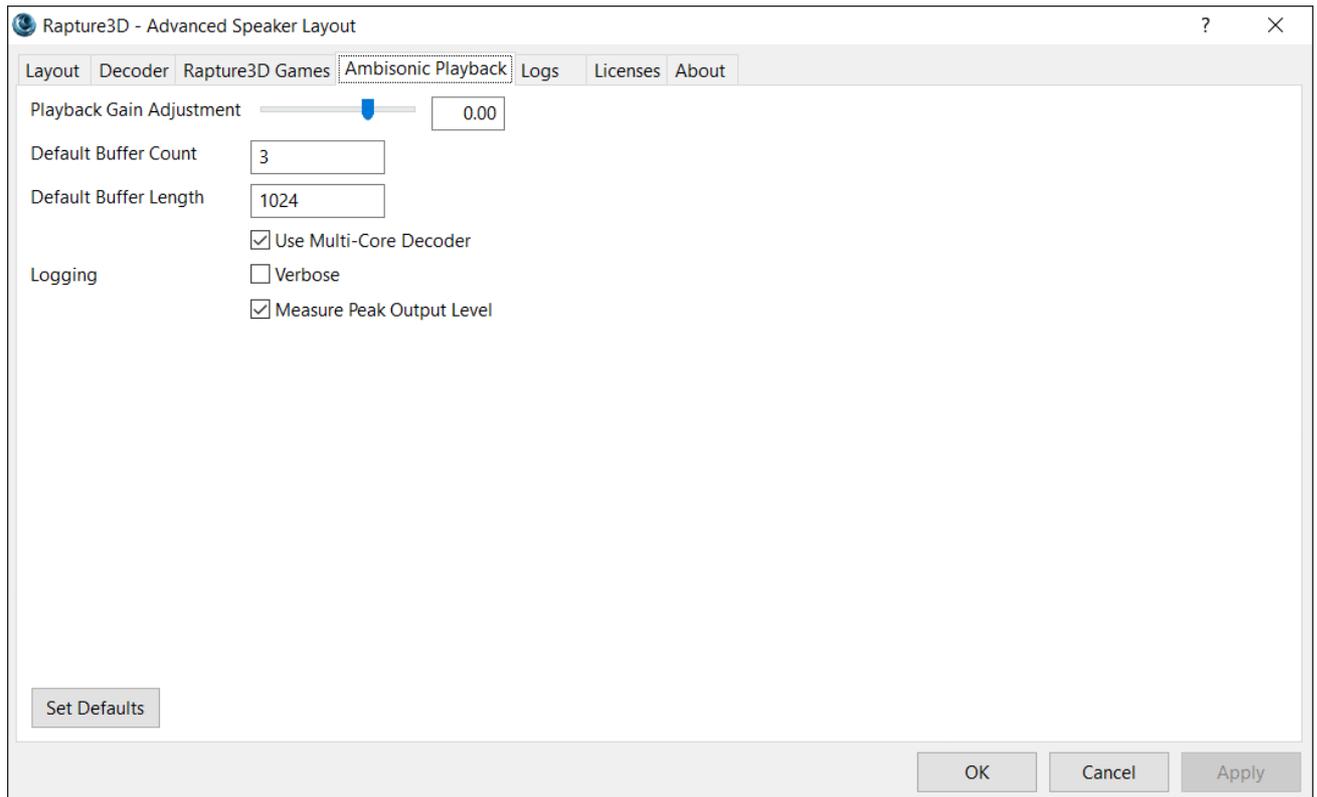
Here's where the settings are that are used during ambisonic playback in the Rapture3D Player. The settings are probably as you want, but you can press the "Set Defaults" button to select ones that make sense.

3.6.1 Playback Gain Adjustment

This gain control is applied *in combination* with the volume settings on the Layout tab and the volume control in the player. It is not a live control and is only read when playback begins. Assuming you've set the overall volume sensibly, this can usually be left at 0dB - just use the volume control in the player or on external hardware while actually listening.

3.6.2 Buffer Configuration

The default buffer length can be set. Bear in mind that this is just a suggestion - actually your audio card may prefer something different and we'll go with that. A default buffer length of 1024 is generally recommended, though you may find that a length of 2048 or 4096 helps if you experience stuttering. You may be able to get away with lengths of 512 or even lower, which can reduce latency.

On Windows, an additional buffer count setting can be used. Generally, lower buffer counts lower latency too, but setting the count too low can introduce stuttering. If in doubt, just use the defaults.

If you're wondering what "latency" means here, here this is essentially the time delay between initial audio processing and the sound being sent out of the back of your computer. We work hard to make this as quick as possible, but in the end latency is generally limited by the quality of your audio hardware and its driver.

Latency doesn't normally matter much for music playback.

3.6.3 Use Multi-Core Decoder

If you have a multi-core system (likely these days), this can be enabled to allow the decoder to run on a separate core. This allows more complex decoders to be used, but increases latency slightly.

3.6.4 Logging Options

These options affect what is written to the Logs tab during ambisonic Playback:

- Enabling the "Verbose" check box causes more detail to be written.
- Enabling the "Measure Peak Output Level" check box writes lines to the log indicating the peak level reached during playback. Note that this is the peak level within the software rather than a level seen in your external audio kit or the actual sound level in the room. Rapture3D drops the audio level automatically when clipping would occur. This is useful but can reduce playback quality, so it's generally best avoided.

3.7 The Logs Tab
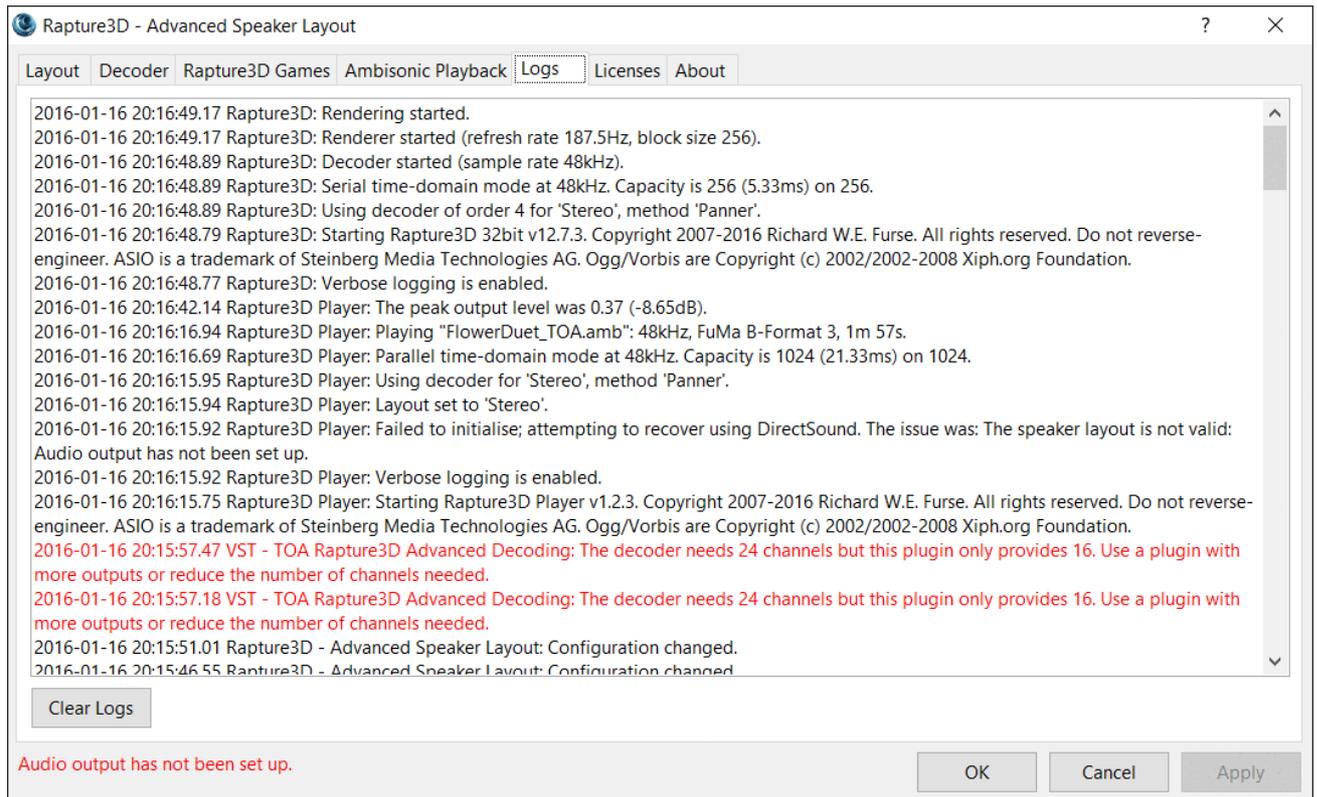
This tab can be useful for troubleshooting. It shows recent events concerning Rapture3D and related Blue Ripple Sound software. The first thing to point out is that *lines appear in reverse time order*, so the latest message is at the top.

Log entries come from a variety of sources and depend on what you've been doing. Note that Rapture3D is started up twice by many games, once to check its features and once to actually use it.

The "Clear Logs" button clears the logs immediately.

3.8 The Licenses Tab
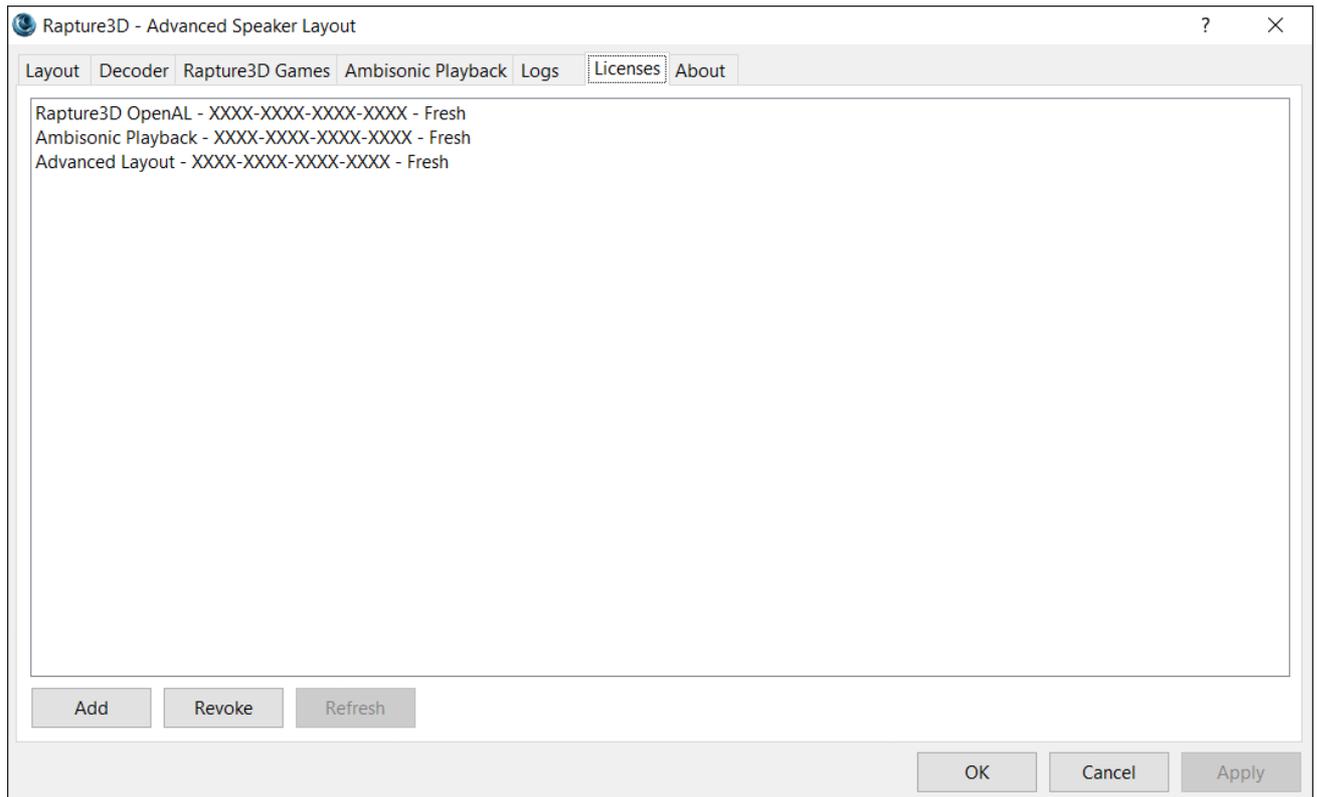
This tab should list the licenses you have. Licenses can be added using the "Add" button, assuming you have an Internet connection. The license comes in the form of a hyphenated string of characters where the "XXXX-XXXX-XXXX-XXXX" is in the example above.

Licenses are available from Blue Ripple Sound.

3.8.1 How Licenses Work

Once a day, when you use Rapture3D or a similarly licensed piece of Blue Ripple Sound software, the software "phones home" across the Internet to refresh the license. No personal information is transmitted and encryption is used. This tab will tell you if your licenses are fresh. If they aren't, the text here will change and eventually the software will stop working, typically a month after the last successful refresh. Some licenses (typically trial or beta testing licenses) expire automatically and permanently, so you'll need to get another one to keep using the software.

3.8.2 Hardware Changes

The license is stored with a short description of your machine. This means that if your machine changes, for instance if you upgrade the CPU or switch the network card, your machine may seem to be different and license checks may fail. The best thing to do if you're upgrading some hardware is to revoke the license before making the change and to add it back again afterwards.

If you run into trouble, please get in touch with Blue Ripple Sound from the email address you used when buying the software and hopefully we can sort things out.

3.8.3 Revoking Licenses

Licenses can only be used on one machine, so if you want to move your license from one machine to another you need to revoke it. This is done with the "Revoke" button. You'll also be asked if you

want to do this if you uninstall Rapture3D. Note that this requires an Internet connection.

If you revoke your license *write it down somewhere* if you haven't kept your original documentation, so you have it to hand when you want to install Rapture3D somewhere else!

4 The Rapture3D Decoder Studio Plugins

This version of Rapture3D ships with AAX and VST2 decoder plugins for use within studio Digital Audio Workstations (DAWs), in particular Reaper and Pro Tools Ultimate.

The plugins use the current layout settings made in the Rapture3D GUI's layout tab, except for the hardware connections, which are ignored. These need to be set separately in your DAW.

The plugins are intended particularly for work with Third Order Ambisonic (O3A) streams, although they can also be used with lower order streams, using SN3D or FuMa encoding. There are various other O3A plugins libraries available from Blue Ripple Sound.

4.1 Setup

You may need to activate your plugins before use, using the Blue Ripple Sound License Manager, which normally can be found in a Blue Ripple Sound folder on the Start menu (on Windows) or in your Applications folder (on macOS).

4.2 Compatibility

These plugins expect busses with at least 16 channels, which (at the time of writing) most Digital Audio Workstations (DAWs) cannot handle. Some are limited at 2 channel stereo and many are limited at the 8 channels used for 7.1 surround mixes. **These plugins _will not work correctly_ with these DAWs**, which may even crash. You may wish to try Pro Tools Ultimate or Reaper.

4.2.1 AAX

Rapture3D Advanced decoding can also be used with Pro Tools Ultimate or Pro Tools HD 12.8.2 and later. Pro Tools keeps careful track of exactly what stem formats are present on tracks and busses; this is a powerful feature which helps avoid mistakes and ensure plugins are used in the right places. However, Rapture3D Advanced uses arbitrary output formats, which Pro Tools may or may not know about.

To handle this, the AAX plugins "misuse" their output stem formats by setting them to 7.1 or third order ambisonics, regardless of the actual output format in use in Rapture3D. This is simply to access the right number of output channels (8 or 16 respectively). A number of block decoders can be used together to provide support for higher output channel counts. This is described in more detail below.

4.2.2 VST2

The plugin library works as a VST2 "shell" plugin. This means that a number of individual audio plugin effects are provided by a single library file. Your VST host may have a slightly different way of managing these plugins to ordinary ones. For instance, in Max/MSP the vst~ plugin uses library filenames and "subname" messages to specify the individual plugin within the library.

Four versions of the main decoder plugin are provided, differing only in their output channel count (16, 32, 64 or 128). Pick the smallest one with enough channels for your speaker rig. The plugins have names like "O3A Decoder - Rapture3D Advanced (16 Channels)".

In addition, a "block" decoder provides eight selectable channels of output. In some DAWs (such as Reaper), a number of these can be used in parallel to allow decoding for large numbers of channels on multicore CPUs. For instance, for a 24 channel decode, the first block decoder might output channels 1-8 on one track, the second channels 9-16 and so on. In addition, the order can be

lowered to reduce load. This plugin is named "O3A Decoder Block - Rapture3D Advanced".

Most DAWs have a VST plugin "path", which is a list of directories which will be searched for VST2 plugins. You may need to change this path to point at the location of the plugins, or move the plugins there. By default, these plugins are installed into `/Library/Audio/Plug-Ins/VST` on macOS. Various directories may be used on Windows, but `C:\Program Files\Steinberg\VST2` is not uncommon.

4.2.3 Buffering

In most modes, these plugins use internal buffering with a length of 128 samples. For smooth CPU load, you may need to ensure your DAW buffer size is a multiple of this.

4.3 O3A Decoder (16, 32, 64 and 128 Channels) - Rapture3D Advanced
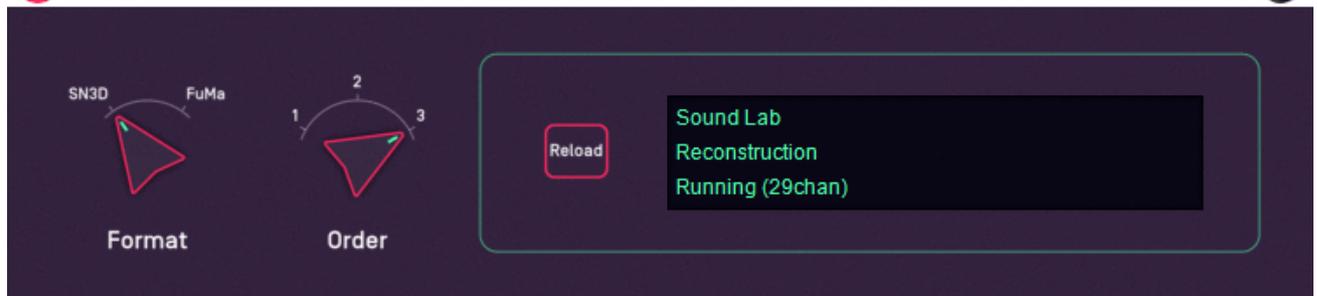
4.3.1 Host Support

4.3.1.1 O3A Decoder (16 Channels) - Rapture3D Advanced

Host Type	Support
AAX	Yes, output mapped to a standard ambisonic (SN3D) stem
VST2	Yes

4.3.1.2 O3A Decoder (32 Channels) - Rapture3D Advanced

Host Type	Support
AAX	No
VST2	Yes

4.3.1.3 O3A Decoder (64 Channels) - Rapture3D Advanced

Host Type	Support
AAX	No
VST2	Yes

4.3.1.4 O3A Decoder (128 Channels) - Rapture3D Advanced

Host Type	Support
AAX	No
VST2	Extreme channel count excludes most hosts (even Reaper)

4.3.2 Audio

4.3.2.1 O3A Decoder (16 Channels) - Rapture3D Advanced

	Channels	Content
Input	16	O3A
Output	16	Configurable (mapped to ambisonics for AAX)

4.3.2.2 O3A Decoder (32 Channels) - Rapture3D Advanced

	Channels	Content
Input	16	O3A
Output	32	Configurable

4.3.2.3 O3A Decoder (64 Channels) - Rapture3D Advanced

	Channels	Content
Input	16	O3A
Output	64	Configurable

4.3.2.4 O3A Decoder (128 Channels) - Rapture3D Advanced

	Channels	Content
Input	16	O3A
Output	128	Configurable

4.3.3 Controls

- Order
- Reload
- Format

4.3.4 Description

This plugin is not self-contained. It uses the decoder currently selected within the separate Rapture3D Advanced layout manager application, which must also be installed and set up. This decoder is intended for monitoring or playback in studios and concert venues where a specific and measured speaker layout is in use.

The channel routing ("Audio Device", "Audio Output" and so on) set up in the Rapture3D layout tab is *not* used, but the channel gains are. The channels appear in the same order as shown there. You can change this order using Reaper's routing matrices, or in the layout tab (which is normally better). If you want to create silent output channels for unused outputs this can be achieved by adding a channel with an "Inactive" speaker role.

When many channels are used this plugin can produce high CPU loads, which may result in stuttering if decoding is attempted in real time. In some DAWs (e.g. Reaper) the CPU load can be distributed better by tuning buffer sizes, and instead using the 'block' decoder plugin.

Only the sixteen channel version of this plugin is available as an AAX plugin. The 'block' decoder can be used to achieve higher channel counts. Please note that the output of this plugin is *not* an ambisonic feed; the third order ambisonic stem format is only used to create a 16 channel output. Channel outputs appear in the order set up in the Rapture3D configuration screen.

4.3.4.1 Mastering - A Word of Caution

Rapture3D Advanced allows you to calibrate for your speaker array precisely and can give fantastic results. However, if you are using it to produce a decoded surround sound master for distribution (e.g. 5.1) then it is important to remember that your audience will probably not be using exactly the same speaker setup as you. Rapture3D may have applied subtle equalization and other processing to make the decode work well for you, but which may make it sound *worse* on another system.

Because of this, when mastering for distribution you should normally make sure you use "standard" speaker layout angles, and no distance information. Our presets should be a good start point here. Further, the "Basic" decoder method is usually the best choice as this is the least affected by bad speaker placement.

We recommend the use of this plugin while monitoring, for the best experience of the mix while working on it. However, at the actual point of finalising a surround master it is important not to use any calibration which was specific to the mastering room. A simple way to do this (without the hassle of reconfiguring this plugin) is to use the standard preset decoders from the Blue Ripple Sound O3A Decoding plugin library.

4.3.5 Controls

4.3.5.1 Control: Order

Normally this should be set to three for work with Third Order Ambisonic (O3A) streams. For lower order streams, for instance from a first order (four channel) B-Format microphone, the order should be set to match the stream. Dropping the order to match the stream exactly can give a slightly better decode and uses less CPU.

4.3.5.2 Control: Reload

This button reads the currently active Rapture3D settings into the plugin. To reconfigure this plugin, change the settings in the Rapture3D speaker layout application, press "Apply" or "OK" and then press the "Reload" button on the plugin. Active Rapture3D settings are also reloaded when the plugin is started. Settings are not otherwise kept between sessions.

4.3.5.3 Control: Format

The input format describes the first order ambisonics that is being fed into this plugin. Setting this incorrectly will give bad results. The options are:

- "SN3D" (in the ACN channel ordering) is the format used by the O1A and O3A plugins. It is used by some recent first order microphones and is sometimes known as "AmbiX".
- First order "FuMa" is the same as "Classic" WXYZ B-Format, which dates back to the 1970's. It was used in versions of these plugins prior to version 2.0 and some hardware and software uses it, including a number of 3D microphones.

4.4 O3A Decoder Block (8 Channels) - Rapture3D Advanced
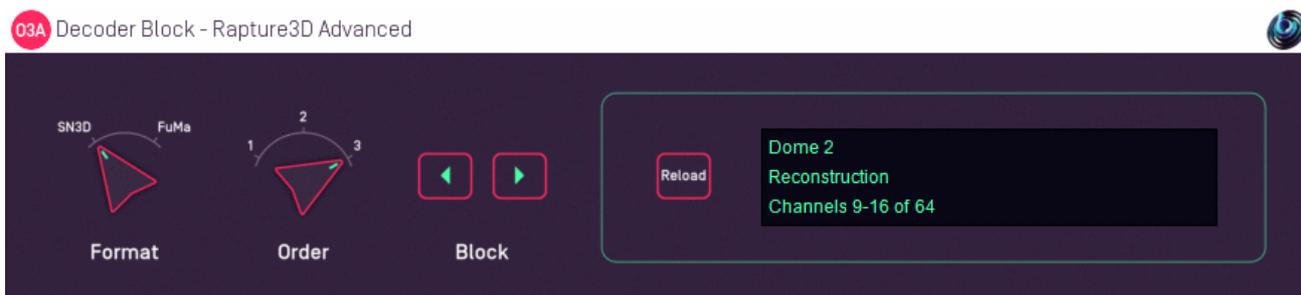
4.4.1 Host Support

Host Type	Support
AAX	Yes, output mapped to 7.1 stem
VST2	Yes

4.4.2 Audio

	Channels	Content
Input	16	O3A
Output	8	Configurable (mapped to 7.1 for AAX)

4.4.3 Controls

- Order
- Block Range
- Reload
- Format

4.4.4 Description

This plugin is very similar to the O3A Decoder - Rapture3D Advanced plugins. It is intended for use with decodes with many channels, from which is manages a block of just eight. For instance, the plugin might be configured to output channels 1-8, or 9-16, and so on.

This allows a number of copies of the plugin to be set up in parallel to produce all the channels needed for a particular decode.

Arranging for the decode to happen in this way allows some DAWs to distribute the decoder CPU load over a number of CPU cores, which make it possible to perform huge decodes in real time. Typically, one instance of this plugin is used per track.

The AAX version of this plugins labels its eight-channel output as 7.1 for compatibility with Pro Tools' stem format management, regardless of the actual format in use. Channel outputs appear in the order set up in the Rapture3D configuration screen. If you actually want to decode to 7.1, please note that the channel ordering for 7.1 in Pro Tools is not the same as in the standard Rapture3D preset. If this is inconvenient, customise the 7.1 decoder layout and reorder the channels. You may also wish to switch the "Front Centre (Dialogue Only)" channel's Speaker Role to "Front Centre" as otherwise the front centre will be silent in normal use.

4.4.5 Controls

4.4.5.1 Control: Order

Normally this should be set to three for work with Third Order Ambisonic (O3A) streams. For lower order streams, for instance from a first order (four channel) B-Format microphone, the order should be set to match the stream. Dropping the order to match the stream exactly can give a slightly better decode and uses less CPU.

4.4.5.2 Control: Block Range

Block range controls which output channels from the decoder are produced by this plugin. It has values such as "1-8", "9-16" and so on.

4.4.5.3 Control: Reload

This button reads the currently active Rapture3D settings into the plugin. To reconfigure this plugin, change the settings in the Rapture3D speaker layout application, press "Apply" or "OK" and then press the "Reload" button on the plugin. Active Rapture3D settings are also reloaded when the plugin is started. Settings are not otherwise kept between sessions.

4.4.5.4 Control: Format

The input format describes the first order ambisonics that is being fed into this plugin. Setting this incorrectly will give bad results. The options are:

- "SN3D" (in the ACN channel ordering) is the format used by the O1A and O3A plugins. It is used by some recent first order microphones and is sometimes known as "AmbiX".
- First order "FuMa" is the same as "Classic" WXYZ B-Format, which dates back to the 1970's. It was used in versions of these plugins prior to version 2.0 and some hardware and software uses it, including a number of 3D microphones.

5 The Rapture3D OpenAL Driver

OpenAL allows games to make use of special OpenAL "drivers" which provide 3D audio algorithms. These algorithms may be provided in software or hardware.

Rapture3D includes a software OpenAL driver with some particularly interesting algorithms. Amongst other things, it uses Higher Order Ambisonics for superior 3D audio spatialisation.

5.1 Using The Driver On Windows

On Windows, the driver is a special file called `rapture3d_oal.dll`.

5.2 Using The Driver On macOS

On macOS, the Rapture3D driver is a special file called `libOpenAL.Rapture3D.dylib`. It is configured with the Games tab in the layout program.

Unlike Windows, macOS does *not* have an OpenAL "router" driver to allow software to switch between alternative OpenAL implementations, so it is tricky to change the OpenAL driver away from the default Apple implementation without doing bad things to your system. Be careful!

5.3 Configuration

Ideally, the game will have been written to use this driver. When it hasn't, it may still be possible to make it work by switching to it using the game's configuration screens or by replacing the system's default OpenAL driver. However, this involves modification to system files so we cannot recommend this for ordinary users. If you do go ahead, ensure you keep a copy of the original driver so you can return your system to its original configuration.

The driver can be configured with the "Games" tab.

6 Rapture3D Ambisonic Player
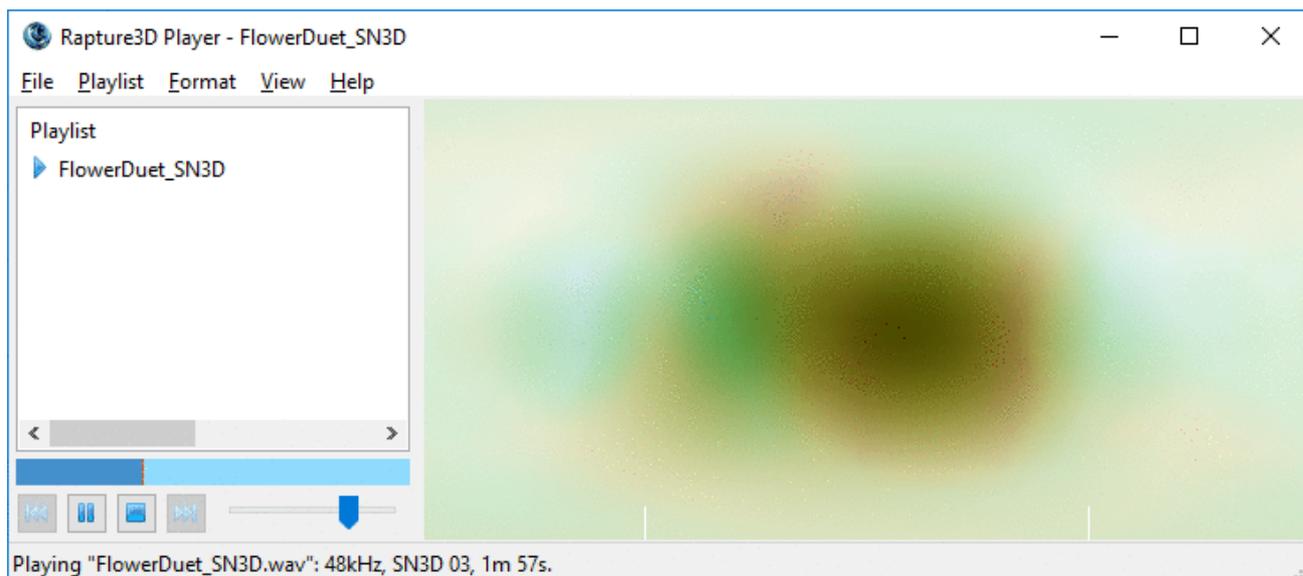
This edition of Rapture3D comes with an ambisonic sound file player. It uses the same layout and decoding configuration as the Rapture3D OpenAL game engine. It has its own tab for fine tuning. You'll need an "Ambisonic Playback" license, which should be listed on the Licenses tab.

If you do have ambisonic sound files around in .AMB format then well done! Hopefully you can just double-click on them and they'll play in full 3D! The player can also handle ambisonic audio contained in a range of other file formats, including simple Ogg/Vorbis files (.OGG or .OGA), though you'll probably want to open these directly from the application. In these cases, channel counts are used to infer the ambisonic order.

6.1 Playlists

The left pane shows the list of files that the player is working with at the moment. You can add them with the "Open..." or "Add..." options on the File menu. Drag and drop files to change their place in the play order and double-click to play.

Playlists can be loaded and saved as text files using the "Playlist" menu.

6.2 Formats

The player can handle audio using either the FuMa convention (which is backwards-compatible with "classic" ambisonics) or SN3D (ACN) convention.

When a multichannel audio file is read, the player can sometimes identify whether FuMa or SN3D is in use automatically. Specifically, .AMB files also use FuMa. To handle other cases, the Format menu can be used to control how files will be interpreted.

Depending on the decoder, up to third order FuMa is supported and up to fifth order SN3D, or seventh for custom decoders, although you may need a very powerful machine for multichannel speaker layouts or higher visualisation settings.

6.3 Controls

The bar below the playlist can be used to jump to particular locations in the audio that is currently selected.

Below that you'll find standard player controls. These are:

- Skip to previous track
- Play/pause
- Stop
- Skip to next track
- Volume

6.4 Status Bar

At the very bottom of the window is the status bar. This will tell you the details of the current audio that is playing and anything else you might need to know if there's a problem.

6.5 Visualisation

On the right hand of the player is a visualisation area. This will light up in different areas, depending on where sounds are coming from.

In case you're interested, the visualisation is actually based on the 3D information in the stream, using a projection similar to that used in maps of the world. Sounds playing above appear at the top in the image, sounds below appear at the bottom, sounds at the front appear in the middle, sounds to the left of that appear to the left of centre and so on. Sounds visualised on the left and right edges of the image are behind (the image "wraps around" at the back, again as in a map of the world). Note that typical real recordings produce extremely complex visualisations due to acoustic reflections.

The "View" menu gives some options to control the visualisation, including control of the quality used. Higher quality settings put more load on your CPU.

6.6 Command-Line (Windows Only)

For those of you that use the command-line, it's worth noting that on 32bit Windows (but not 64bit Windows or macOS), Rapture3D supports some command-line options, including a full-screen mode. Run it as "Rapture3dPlayer.exe -h" to find out more...

7 Technical Notes

7.1 3D7.1

3D7.1 is a variant of the 7.1 surround speaker arrangement. The original 7.1 surround speaker arrangement typically places three speakers at the front of the room, two at the sides and two at the back. Further, a subwoofer (the ".1" in the name) is placed somewhere in the room (it doesn't matter too much where). Quite a few computers come with 7.1 surround sound these days and there are packages for sale that allow it to be added if not. The arrangement of the main seven speakers here puts all speakers at the same height, which is a bit of a shame when using games where things are happening above and below!

The 3D7.1 speaker arrangement (invented by Simon N. Goodwin) is designed so that usually it can be used with existing 7.1 sound hardware. All you have to do is *change where you put your speakers*. It's also designed so that stereo material or 5.1 material will still play back well. The advantage is that games or other 3D audio software that can handle this speaker arrangement (e.g. via Rapture3D) can produce sound in proper *full 3D*!

7.1.1 Speaker Locations

Speakers should be placed as follows:

Original 7.1 Speaker Location	3D7.1 Speaker Location
Front Left	Upper Front Left
Front Right	Upper Front Right
Front Centre	Front Centre
Subwoofer	Subwoofer
Back Left	Upper Back Centre
Back Right	Lower Front Centre
Side Left	Lower Back Left
Side Right	Lower Back Right

More mathematically, six of the speakers (ignoring the front centre and subwoofer) should form a regular octahedron aligned so front and back faces are vertical.

7.1.2 Configuration

Once you have your speakers set up correctly, select "Surround 3D7.1" in the Layout tab and check the speakers are wired up correctly. You'll probably want to use the test tones to check the speakers are in the right order after all that work!

After this you can select a Decoder as usual.

7.2 Basic Speaker Layout Design

Speaker Layout design is as much an art as a science and there's a lot to it, so we're not going to go into huge detail here - instead, we're just providing a list of points to consider when setting up a custom speaker layout. Rapture3D will cope with most sensible speaker layouts that you are likely to throw at it.

7.2.1 Basics

First, some basic advice:

Decide where you want to put your speakers and how you're going to wire everything up before you start - and write it down. It'll save time later.

Secure raised speakers carefully. You'll forget they're there and they have further to fall.

Be *really careful* with wires, particularly if you're using raised speakers. Tripping over a cable attached to a speaker several metres in the air can be *extremely dangerous* - and expensive.

Be *really careful* about volume levels when setting up - and test everything, particularly before starting a game. It's also good practice to be set up so you know where your emergency "power off" button is in case you get volume settings wrong later.

Talk to your partner/kids/pets/etc. before setting up a really complex rig, particularly if it's going in the living room.

7.2.2 Room Preparation

Try to ensure there are no obstructions between the origin (where the listener's head should be) and the speakers.

Try to avoid reflective (hard) surfaces within or around the speaker array.

Again, please be really careful about cables and raised speakers.

7.2.3 Coverage

Rapture3D differentiates between "horizontal" (2D) and "periphonic" (3D) speaker layouts. Horizontal ones are all at the same height (all Z settings should be zero) and periphonic ones may have speakers placed anywhere in 3D space. Decide which you're going for before you start and then think about "coverage" accordingly.

"Coverage" is the largest gap between speakers (measured as an angle). Where there are large gaps, the quality of spatialisation is reduced. Ideally, make speakers equally spaced, either horizontally or periphonically, so that all the gaps are similar in size. Or at least avoid big gaps where possible (although some are inevitable, typically below). The decoder generation report will tell you the actual coverage angle you've ended up with.

Rapture3D will cope with some fairly silly speaker rigs, but you'll typically be missing spatial detail where speakers are missing.

7.2.4 Distance

Try to put all your speakers at roughly the same distance from the origin. Rapture3D will attempt to compensate for different distances (unless "Only use location directions" is selected) but this behaviour can be non-optimal, particularly in reflective rooms.

Note that Rapture3D assumes a reference speaker distance of 1m, and more distant speakers will typically be driven louder (see the Distance Mode section).

7.2.5 Configuring Rapture3D

Please either give the real speaker locations to Rapture3D or enable the "Only use location directions" switch. Rapture3D does some quite clever stuff with distance information if it's there, but if it isn't right then things can sound very wrong.

When configuring levels, a good method is to check all speakers produce the same output when measured 1m in front of them, for instance by use of an SPL meter attached to a piece of bamboo 1m long (but be careful not to damage your speakers!). The *left* "test" button will produce a test signal taking into account the overall and channel levels set, so after configuration this button should produce the same level for all speakers when measured this way. A cruder method is to check all speakers produce the same level at the centre of the room using the *right* test button (or the left button when "Only use location directions" is enabled). This typically does not produce such good results, but can be useful when time is short, access is difficult, or there is significant occlusion between the listening area and speakers.

The tinted reconstruction decoders are generated on the assumption that the audience is facing forwards (positive X). Therefore, please ensure that the locations given take this into account. If the audience isn't facing this way (e.g. because the audience may actually be wandering around in the listening space), we don't advise the use of front-facing tinted decoders. Instead, set "Audience Face" to "Upright" or "Free", or use a "Reconstruction" decoder.

7.2.6 Use Your Ears

Things don't always work well, typically because the room acoustic isn't as well behaved as one might like, or because the speakers are not set out well. If this happens, think about where the spatialisation isn't clear, because you might like to try moving your speakers so your coverage is better in that area. But don't forget to regenerate the decoder.

Try different things out - and have fun!

7.3 OpenAL Developer Notes

Here are some technical notes for developers who might be interested in tuning their games to get the best out of Rapture3D.

The Rapture3D OpenAL driver is built in software and so consists primarily of a driver dynamic library and a configuration tool. It comes in a number of editions with different licensing schemes and features. The "Game" edition is restricted to work only with the games it ships with.

7.3.1 OpenAL Specification

Rapture3D meets the full OpenAL 1.1 specification, including full support for alSuspendContext() and alProcessContext() to give much better control over scene content than many drivers.

All filters support high-pass as well as low-pass options as documented in the specification.

7.3.2 Ambisonics

Rapture3D's heart is a studio-grade 3D rendering core based on Higher Order Ambisonics. This allows great flexibility when the audio is "decoded" for an actual speaker arrangement, or headphones.

7.3.3 OpenAL Extensions

Rapture3D supports the following OpenAL extensions:

- ALC_ENUMERATE_ALL_EXT
- ALC_ENUMERATION_EXT
- ALC_EXT_CAPTURE
- ALC_EXT_DEDICATED
- ALC_EXT_EFX
- ALC_EXT_STATIC_BUFFER
- AL_EXT_BFORMAT
- AL_EXT_EXPONENT_DISTANCE
- AL_EXT_FLOAT32
- AL_EXT_FOLDBACK
- AL_EXT_IMA4
- AL_EXT_LINEAR_DISTANCE
- AL_EXT_MCFORMATS
- AL_EXT_MULAW
- AL_EXT_MULAW_BFORMAT
- AL_EXT_MULAW_MCFORMATS
- AL_EXT_OFFSET
- AL_EXT_STEREO_ANGLES
- AL_EXT_SOURCE_RADIUS

ALC_EXT_CAPTURE is only supported in the sense that the extension is present as required by the OpenAL specification. No capture device is provided.

ALC_EXT_DEDICATED allows sounds to be sent directly to a dialogue speaker or subwoofer if one is present.

ALC_EXT_FOLDBACK is a new extension that allows the game to capture mono or stereo downmixes of the game output, e.g. for movie clip recording.

AL_EXT_BFORMAT allows ambisonic B-Format material (WXYZ or WXY) to be used directly as game audio assets. Such material can contain a complete pre-rendered "soundscape" that can rotate with the orientation of the listener.

AL_EXT_STEREO_ANGLES allows stereo assets to be panned horizontally.

AL_EXT_SOURCE_RADIUS allows mono sources to change size.

7.3.4 Scalability and CPU Load

Rapture3D has configuration options to scale CPU load to meet the hardware available. Default settings choose sensible options if the user does not select them explicitly. The code has been tuned heavily for CPU load.

Rapture3D does not place any limits on how many sources, buffers, filters, effects or aux sends are used. The only limit is the CPU power available on the machine used.

7.3.5 Audio Quality

All internal processing is performed using 32bit floating point operations. Sample rate conversion options include linear and sinc interpolation. A lot of attention has gone into ensuring that control changes result in smooth audio flow.

7.3.6 Effects

Rapture3D supports the EFX interface for effects. The deprecated EAX interfaces are not supported. The following effects are available:

- AL_EFFECT_CHORUS
- AL_EFFECT_COMPRESSOR
- AL_EFFECT_DEDICATED_DIALOGUE
- AL_EFFECT_DEDICATED_LOW_FREQUENCY_EFFECT
- AL_EFFECT_DISTORTION
- AL_EFFECT_EAXREVERB
- AL_EFFECT_ECHO
- AL_EFFECT_EQUALIZER
- AL_EFFECT_FLANGER
- AL_EFFECT_REVERB
- AL_EFFECT_RING_MODULATOR

Note that the same reverb algorithm is used for AL_EFFECT_REVERB and AL_EFFECT_EAXREVERB although different parameters are exposed. All the available parameters are used, including the directional reverb controls. The algorithm is an optimised high-quality ambisonic reverb, producing B-Format output directly.