SpatGRIS

Tools for 2D and 3D sound spatialization

Developed by the
Spatial Immersion Research Group

G R I S

http://gris.musique.umontreal.ca/

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Programmer: Gaël LANE LÉPINE
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Manual

SpatGRIS 4.0.2
SpeakerView 1.0.1
ControlGRIS 2.0.2
BlackHole 0.6.1

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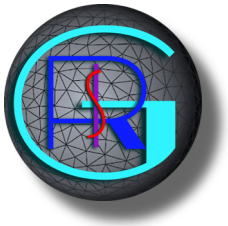

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Thanks to Yohan Brimicombe for creating the website: http://gris.musique.umontreal.ca

The current versions were developed in 2025 in collaboration with the Society for Arts and Technology in Montreal.
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1. General overview

1.1. SpatGRIS is a spatialization and localization tool

SpatGRIS performs spatialization and localization. Spatialization gives the listener the impression of being surrounded by sound. It is an immersive experience. Localization is a means of placing a sound at a very precise location in space and/or moving it. Both concepts can be used simultaneously in *SpatGRIS*.

1.1.1. Spatialization

Using its two algorithms, DOME or CUBE, *SpatGRIS* matches sound sources to a speaker configuration. The position of the sources is provided by OSC messages. Spatialization is achieved by a system of speakers in a physical space.

1.1.2. Localization

With the option of direct outputs (independent or spatialized), *SpatGRIS* allows direct access to speakers, for example to manage subwoofers, to place a sound on a particular speaker, or to use a channel-based spatialization approach.

1.2. SpatGRIS is a recorder and player

SpatGRIS allows you to record speaker outputs in spatialized mode (DOME or CUBE) or in two-channel mode (STEREO or BINAURAL); in two standards - WAV, AIFF -; and in two formats - Mono Files or Interleaved. With the PLAYER tool, *SpatGRIS* can play any multichannel work recorded with it.

1.3. SpatGRIS produces speaker configurations

The speaker configuration tool, *Speaker Setup*, can take the form of a DOME or the free form of a virtual CUBE.

1.3.1. DOME configuration

In the DOME, the distance between each speaker and the centre of the DOME is fixed. Sound sources can only be spatialized on the surface of the DOME.

1.3.2 CUBE configuration

In the CUBE, speakers can be arranged freely in space. There is no fixed distance between the speakers and the centre of the configuration. Unlike DOME configurations, sound sources can enter, pass through, and exit the configuration. Sound sources outside the configuration can be processed with attenuation parameters (volume and filter).

1.4. Speakers contribute to spatialization and localization

Each speaker has a unique number—whether in spatialized mode or direct output—and can be used for both functions: spatialization and localization, thanks to direct output features. A speaker can be part of spatialization and be a direct output at the same time.

1.5. What's new and improved?

• Compatibility with recent versions of macOS, from 11 (Big Sur) to 15 (Sequoia) and Apple Silicon Macs.
• *ControlGRIS2, SpatGRIS4* and *SpeakerView1* are also available for Windows 10 and 11 and Linux.

New features:

SpatGRIS4, upgrade to version 4, recent additions and fixes
- Updated with JUCE 8
- *SpatGRIS4* and *BlackHole* now have 256 channels each
- Attenuation settings are now continuously adjustable.
- Sources can be assigned to non-consecutive outputs, for example in an aggregated device.
- Speaker Setup Edition in CUBE and HYBRID modes: addition of a Global Sound Diffusion parameter.
- Speaker Setup Edition in CUBE modes: the possibility of adding groups and polyhedrons.
- Reference Pink Noise can be continuous or pulsed.

ControlGRIS2, upgrade to version 2, recent additions and fixes
- *ControlGRIS2* is both a plug-in and standalone software
- It has been upgraded to 256 channels
- Introduction of trajectories based on audio signal analysis according to different audio descriptors.
- Offers the possibility of placing signals outside the CUBE on the Z-axis.
- The Activate function can be used permanently.
- Standardization of the data entry method for the various parameters.
- Addition of vertical and horizontal scroll bars for better visualization.
- Possibility to choose the colours of each source.

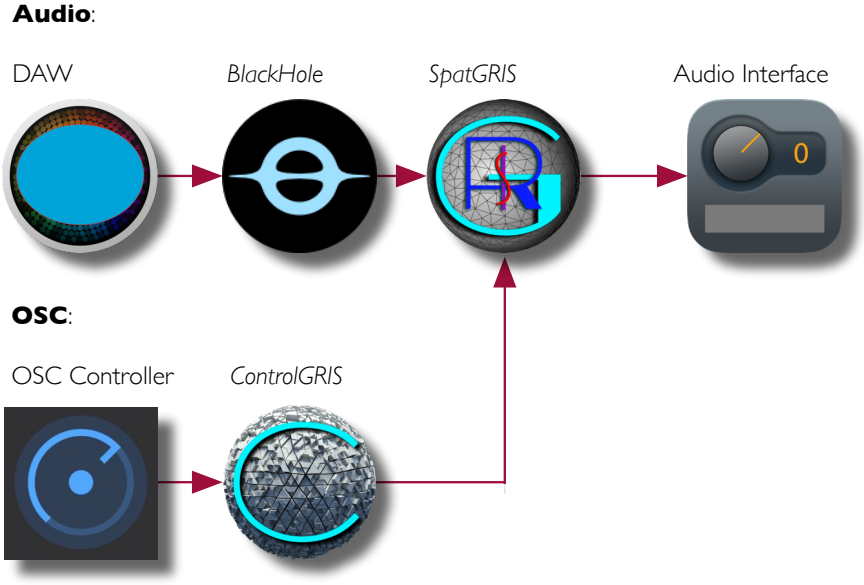
SpeakerView1, upgrade to version 1, recent additions and fixes
- SpeakerView1 is now a standalone application, available on the network.
- Communication settings have been added to *SpatGRIS* Settings.
- Several cameras with different viewpoints have been added.

2. INTRODUCTION

These instructions assume that you are familiar with the following tools:
• The Digital Audio Workstation (DAW) you use, compatible with AU, VST3, or AAX plug-ins.
• Your audio interface.

2.1. Architecture

The *SpatGRIS* system consists of three components:
• The *ControlGRIS2* plug-in, where trajectories are designed and recorded in a DAW (or any other OSC device).
• *SpatGRIS* itself, which spatializes the sound according to the selected speaker configuration.
• The *BlackHole* virtual interface,[1] which connects the DAW to *SpatGRIS*.
The architecture is as follows (audio and OSC operate in parallel):



2.2. SpatGRIS

SpatGRIS is a standalone software program that allows for the spatialization of sounds on different speaker configurations, in 2D or 3D. It can be used with the *BlackHole* virtual interface, which can provide up to 256 inputs and outputs . Trajectories are sent to *SpatGRIS* from the *ControlGRIS2* plug-in (or from any other OSC software). The audio spatialization itself is performed by *SpatGRIS* and sent to the audio interface.

2.2.1. History

The development of *SpatGRIS* began in 2020. It is a rewritten version of *ServerGris* (2018), *SpatGRIS2* (2020), and *SpatGRIS3* (2021). The first official version of *SpatGRIS 4* was released in January 2026.

2.2.2. System requirements

The software has been tested on the following operating systems:
• macOS from 11 Big Sur™ to 15 Sequoia™.
• It is native to Apple Silicon computers.
• Windows™ 10. 11.

2.2.3. Installation notes

• Download the latest version of *SpatGRIS* from SourceForge:
https://sourceforge.net/projects/spatgris4/
SpatGRIS for Mac includes a single installer in the same folder.

[1] *BlackHole* is not mandatory. Any software capable of sending audio to *SpatGRIS* can be used. *BlackHole* is a HAL plug-in.

SpatGRIS4
This includes:
• *SpatGRIS4*
• *SpeakerView1*
• *ControlGRIS2*, which includes the plug-in and standalone software.
And a series of independent installers.
BlackHole:
• The *BlackHole* virtual interface is in 16, 32, 64, 128, or 256 audio channel formats.

Notes for macOS users
• *SpatGRIS*, *SpeakerView, ControlGRIS2*, and a *utilities* folder are now installed in a GRIS folder in the Applications folder. You can rename the GRIS folder (to have multiple versions, for example), but it is not recommended to rename anything inside this folder.
• To facilitate the link between *SpeakerView* and *SpatGRIS*, we recommend that you allow *SpeakerView* to control your computer when prompted. If *SpeakerView* does not prompt you, go to System Preferences... > Privacy & Security > Accessibility, and allow *SpeakerView*.

SpatGRIS, SpeakerView, ControlGRIS2, and *BlackHole* will be updated separately. Please subscribe to our newsletter at http://gris.musique.umontreal.ca/ to be notified of updates.
An external Open Stage Control model[2] for *iPad*™ is available for *ControlGRIS2*.
An addendum manual for this *iPad* controller is available on SourceForge.

SpatGRIS for Windows has a single installer:
• *SpatGRIS* itself.
• *ControlGRIS2* as a compressed folder containing the different plug-in formats.
There is no Windows version of *BlackHole*. For Reaper™ users, there is the *ReaRoute* feature , which works similarly to *BlackHole*, but only for Reaper. It is possible to use *Jack* on Windows[3] . When *BlackHole* is mentioned in the manual, replace it with *ReaRoute* or *Jack* when using Windows.

2.2.4. BlackHole and macOS 14 Sonoma

NOTE: New BlackHole users on macOS 14 Sonoma and plus must use the latest version of the BlackHole 0.6.1 installer.

2.3. ControlGRIS2

There are now two versions of *ControlGRIS*. Version 1 remains available to ensure compatibility with existing projects that use it. And from 2026, *ControlGRIS2,* which introduces signal analysis. Both versions can coexist. This manual is dedicated to *ControlGRIS2*. For version 1, refer to the *SpatGRIS* 3.3.7 manual.

2.3.1. History

The development of *ControlGRIS* began in 2019. It is based on three older plug-ins: *OctoGris* (2010), *ZirkOSC* (2012), and *SpatGris1* (2017). The first version (1.1.0) of *ControlGRIS* was released in April 2020. The first version (2.0.1) of *ControlGRIS2* was released in January 2026.

2.3.2. System requirements

The plug-in has been tested on the following operating systems and DAWs:
• macOS 11 Big Sur™ to 15 Sequoia; Digital Performer™ 10 and 11; Ableton Live™ 11 and 12; Logic Pro™ 10; Reaper™ 6 and 7; Pro Tools™ 2025.6
• Native on Apple Silicon machines.
• Windows™ 10, 11[4] ; Reaper™ 6 and 7.

[2] There was a Lemur model for *ControGRIS*. The company's ownership has changed since then, and we no longer support it. The Lemur previous edition is still available on SpatGRIS3 website.
[3] For more information, see the following link: https://jackaudio.org/downloads/
[4] We have only tested it a little on Windows 11.

2.3.3. Installation Notes

ControlGRIS2 is included in the *SpatGRIS* installation program. Download the latest version from SourceForge:
https://sourceforge.net/projects/spatgris4/
Unzip the downloaded file. The different formats will be installed in the appropriate location. *ControlGRIS2* will appear in the "UdeM" folder on your SAN.

2.3.4. AU, VST3, AAX

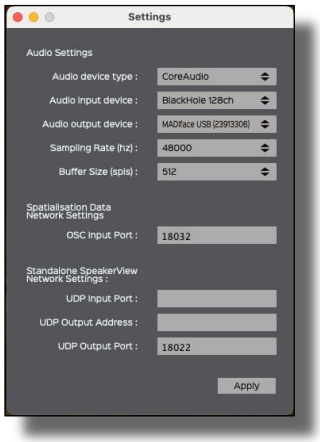
The Mac versions have been tested extensively, but the Windows 10 and 11 versions have not been tested as thoroughly! Feedback is welcome.
Here are a few things to note:

- Use the AU version in DP and Logic Pro on Mac
- Use the VST3 version[5] in Reaper and Live.
- Use the AAX version in ProTools[6] .
- For other DAWs, consult their manual to determine which version is best.

[5] The VST version is no longer supported.
[6] The AAX plug-in for Windows is signed with a self-issued certificate. It is not clear at this time whether this is sufficient for ProTools and/or Windows Defender.

2.4. Quick Start Guide

SpatGRIS receives *Open Sound Control (OSC)* data from *ControlGRIS2* to spatialize sounds in a speaker configuration. The sound is sent from the DAW to *SpatGRIS* via *BlackHole*.
Don't feel like reading the manual? Here are the basic steps for spatializing a stereo track on a standard audio interface.
NOTE: Set the buffer size to the same value in your DAW and in *SpatGRIS*. A value of 512, or even 1024 and above, is recommended.
This guide assumes that you have installed BlackHole 128 or an equivalent.
1. Open *SpatGRIS*.
2. Open Settings (File menu) and assign the audio input device to *BlackHole* 128ch and the audio output device to your audio interface (these settings are saved). Close the window.

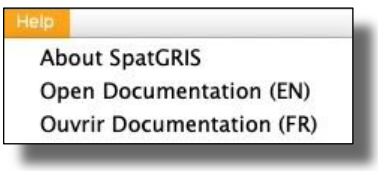


3. Open a DOME Speaker Setup (File menu -> Templates) or use the default one.
4. Open your DAW.
5. Assign the audio output of your DAW to *BlackHole* 128ch.
6. Create a stereo track and assign the outputs to *BlackHole* 128ch 1-2.
7. Insert a *ControlGRIS2* plug-in on this track and set it to DOME mode.
8. The number of sources should already be initialized and set to two, and the First Source ID set to one.
9. Select Circular Fully Fixed in Sources Link and start your DAW.
10. Play with Source No. 1 and see the result in *SpatGRIS*.
11. The colour of the sources is that of the sources selected in Sources (the red dots in this example).
You are now ready to play and record automations.

NOTE: In each DAW track, the audio output channel numbers must correspond to the OSC source numbers (defined by the First Source ID parameter) in the corresponding *ControlGRIS2* instance for the sound to be spatialized in *SpatGRIS*. If this is not the case, the spatialization will be silent or will not work properly.

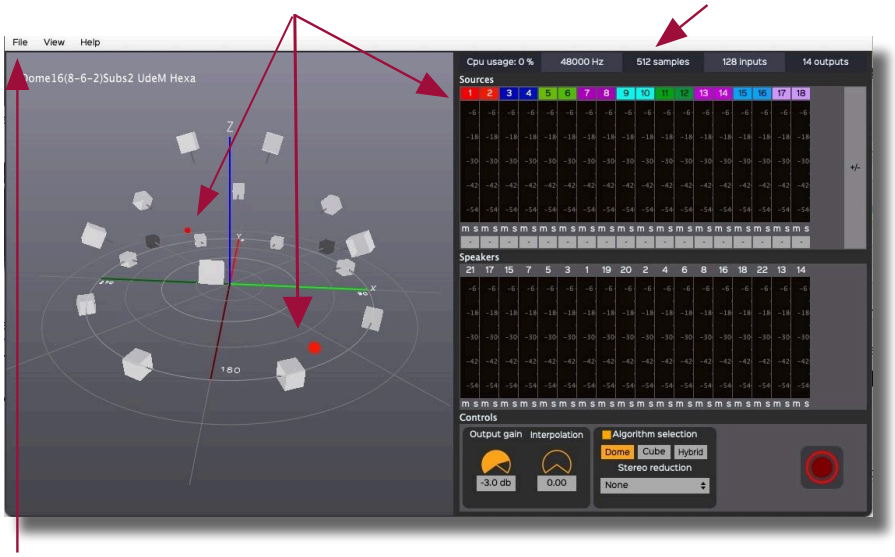
Questions? Need clarification? Read the manual!

This manual can be found in the Help menu:



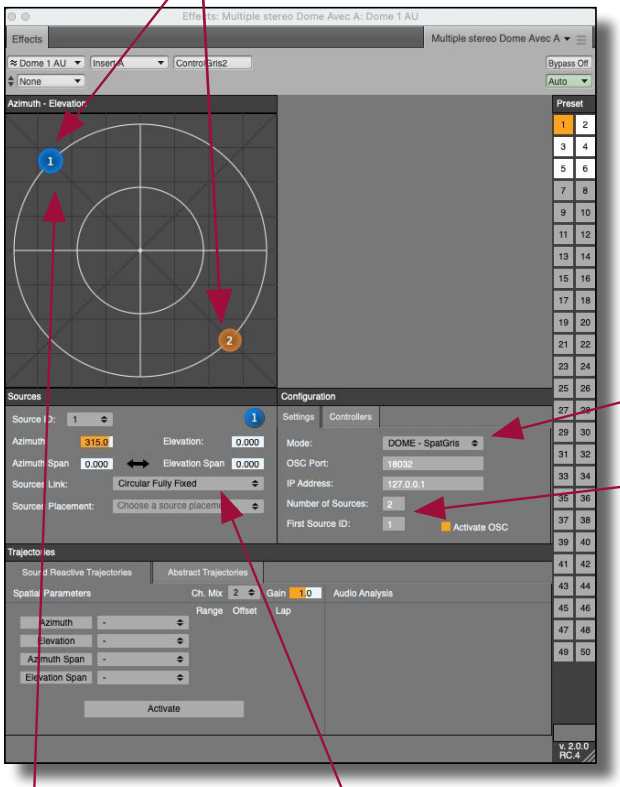
11. The red dots represent the stereo track 1-2

2. Settings (File menu)



3. Open a DOME speaker setup (File menu)

6. This is a stereo track



7. Select the DOME mode

8. Number of sources (2) and 1st source ID (1)

10. Play with source no 1

9. Select Circular Fully Fixed

3. Connections

3.1. Connecting the DAW to SpatGRIS

3.1.1. Open SpatGRIS

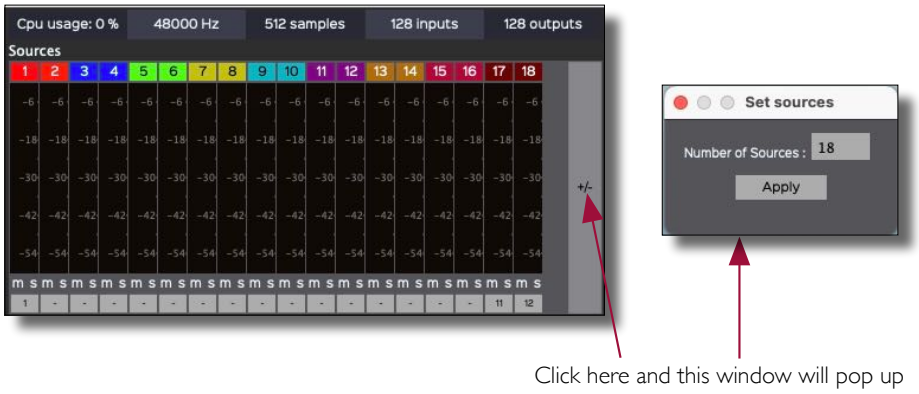
The first time you open *SpatGRIS*, you will need to:
• Determine the number of sources (up to 256). 64 is sufficient in most cases, fewer sources mean less load on the processor. You can also use one of the projects included in the File -> Project Templates menu.
• Create a speaker setup or use one from the File -> Speaker Setup Templates menu.
After these first two steps, save the Speaker Setup and the project in a folder of your choice. The next time you start *SpatGRIS*, the last Speaker Setup and the last saved project will be loaded automatically.

3.1.2. Adjusting the output level

By default, the output level of *SpatGRIS* is set to unity gain: 0.00 dB. It may be necessary to attenuate or increase it, especially if this is your first time trying out the system!

3.1.3. Assign the DAW to BlackHole

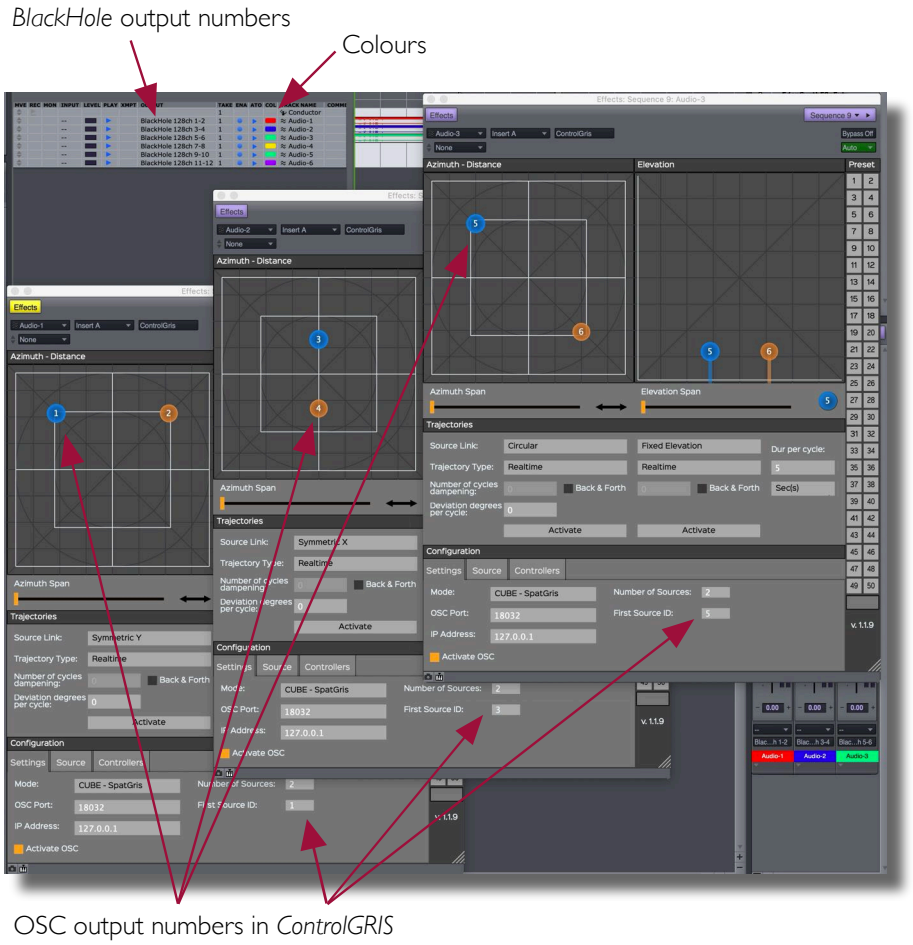
Open your DAW and assign *BlackHole* as the audio output device. *BlackHole* should be detected like any other audio interface available in Core Audio. It is possible to assign a certain number of active channels depending on the number defined by the Set Sources command (± icon).



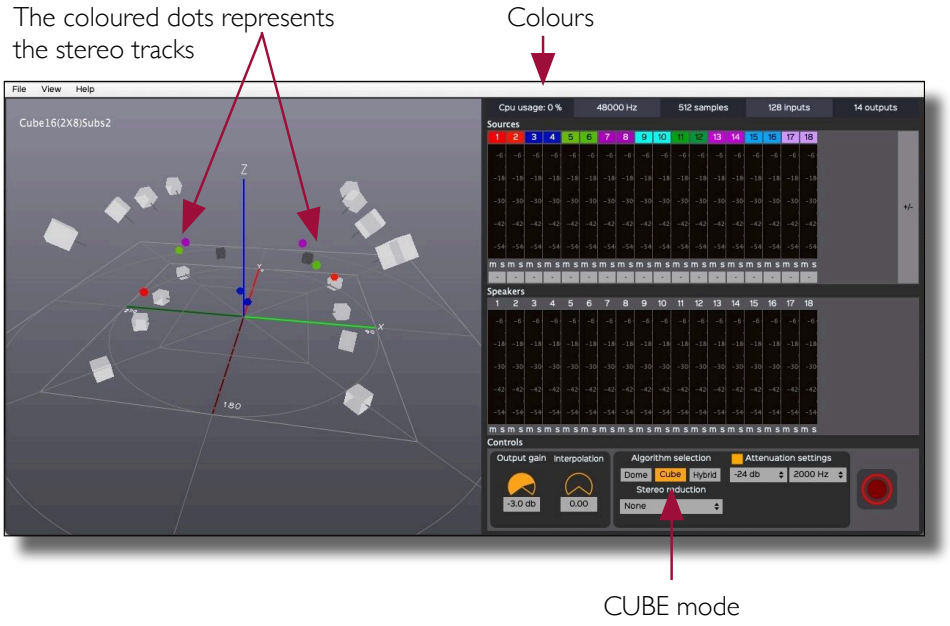
3.2. Connect ControlGRIS2 to SpatGRIS

3.2.1. Numbering audio and OSC channels

Spatialization is managed by *SpatGRIS*, which receives OSC signals from *ControlGRIS2*. It is mandatory that the audio output channel numbers in the DAW correspond to the OSC source numbers (defined by the First Source ID parameter) in the corresponding *ControlGRIS2* instance for the sound to be spatialized in *SpatGRIS*.
In the following example, three stereo tracks (red, blue, and green) are assigned to the *BlackHole* channel pairs 1-2, 3-4, and 5-6. The three *ControlGRIS2* instances use the same OSC numbering: 1-2, 3-4, and 5-6.



For clarity, it is recommended to use the same colour scheme in the DAW as in *SpatGRIS*.

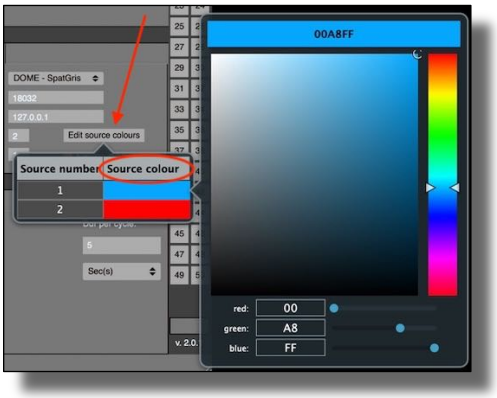


NOTE: If, by mistake, you use the same OSC numbers in more than one instance of *ControlGRIS2*, the sources in *SpatGRIS* will oscillate between different positions because they will receive two (or more) identical positions from different *ControlGRIS2 instances*. This is a good indicator that something needs to be corrected.

3.3. Colours of the sources

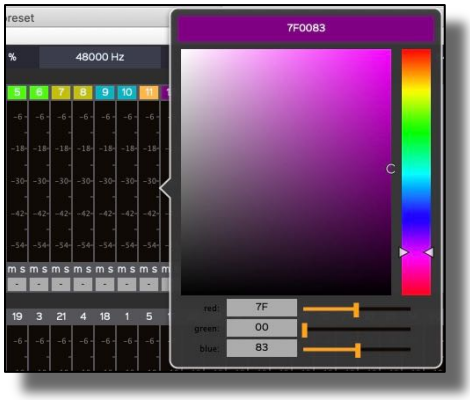
3.3.1. Colours of the sources in ControlGRIS2

You can change the colour of each source in *ControlGRIS2* using the Edit source colours menu. This allows you to choose the colour of your choice for each source. Right-clicking on a colour allows you to use the same colour on the next source. The colours chosen in *ControlGRIS2* are automatically transferred to *SpatGRIS4*.
Right-clicking on the Source colour column header changes all sources with the visible colour prism.



3.3.2. Colours of the sources in SpatGRIS4

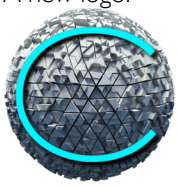
The colour of sources in *SpatGRIS* can be set to any value by clicking on the colour square. This opens a window in which you can set the colour parameters. This is the colour you will see in the 2D or 3D window. If you are using a large number of sources, it is recommended that you design your colour configuration carefully.
After closing this window, right-clicking on a colour allows you to use the same colour on the next source. This allows you to assign the same colour to a pair of sources or to several contiguous sources.



There is also a command in the View menu, Colourise Sources (Opt-C), which allows you to use the visible colour prism to colour all sources.

4. ControlGRIS2

A new logo:



ControlGRIS2 offers two options, depending on the mode selected in *SpatGRIS*:

- DOME.
- CUBE.

These two modes will be explained in detail in the *SpatGRIS* section.

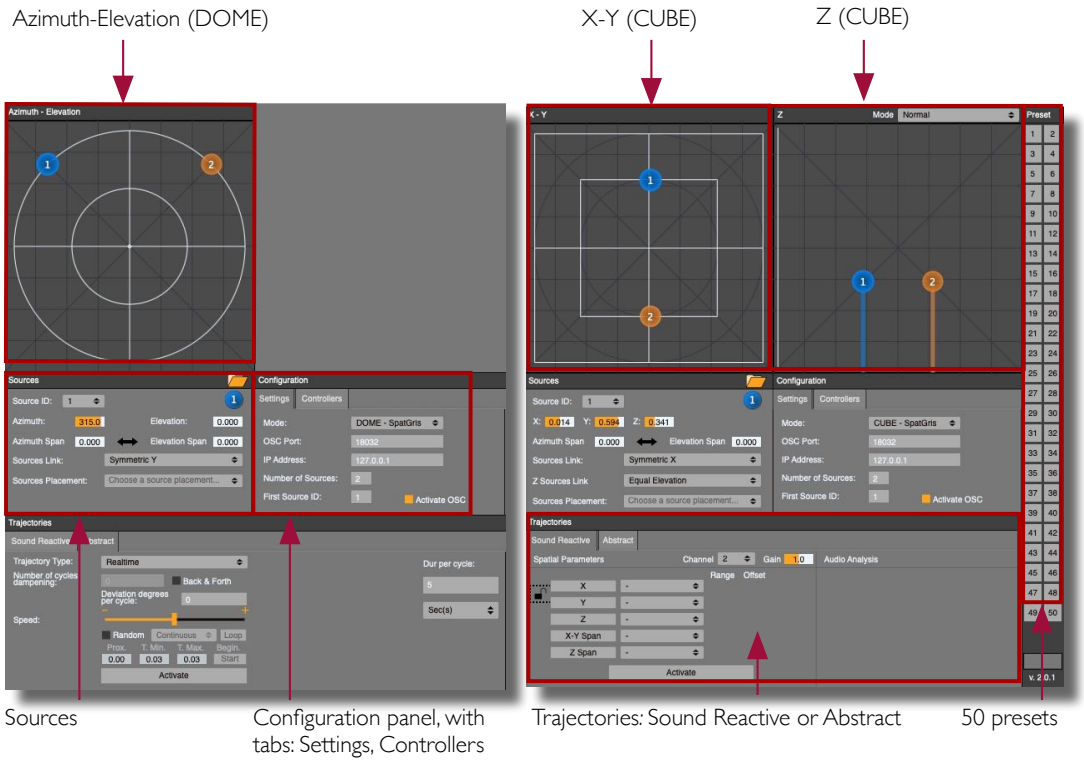
4.1. Introduction

ControlGRIS2 is an OSC spatialization plug-in/software. This plug-in allows you to move multichannel sound sources across a variable set of speakers. Several source linking modes and a trajectory system are provided to enable the spatialization of mono, stereo, quad, 5.1, or multichannel sources up to 256 channels. *ControlGRIS2* can now read audio for analysis. It then generates OSC data that is sent to *SpatGRIS*. The audio itself is sent from the DAW directly to *SpatGRIS* via *BlackHole*.

This document describes the instructions for use and the specific functions of *ControlGRIS2*. It is assumed that the user has sufficient knowledge of the host software and can perform the basic functions to configure it.

4.2. Graphical interface

The graphical interface allows you to place sound sources. It is slightly different in DOME mode than in CUBE mode . In DOME, the distance is set to 1.00, so only the Azimuth and Elevation parameters need to be adjusted. In CUBE, the three parameters, X, Y, and Z, can be adjusted on two different windows.

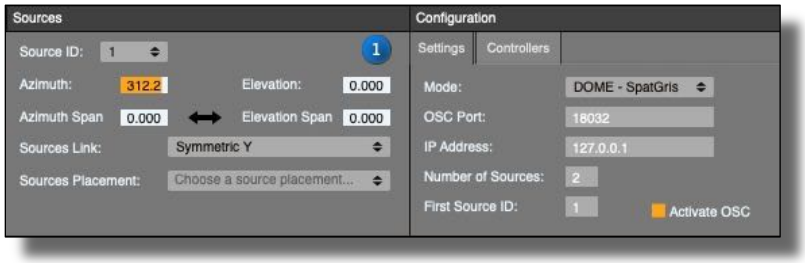


4.3. Scroll bars

A new feature in *ControlGRIS2* is the addition of vertical and horizontal scroll bars. It is now possible to minimize the size of the plug-in while still having access to all available parameters.

4.4. Configuration Panel

The configuration panel provides access to the various plug-in settings. These settings are grouped under two menus: Sources and Configuration.

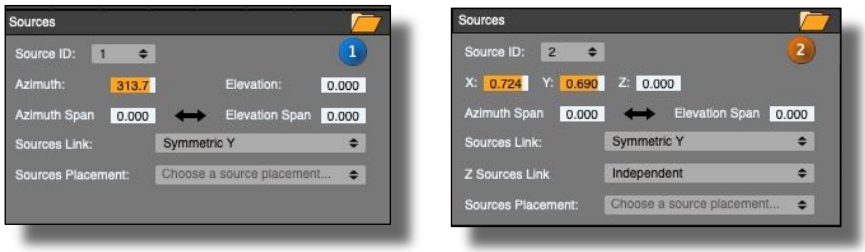


4.4.1. Sources

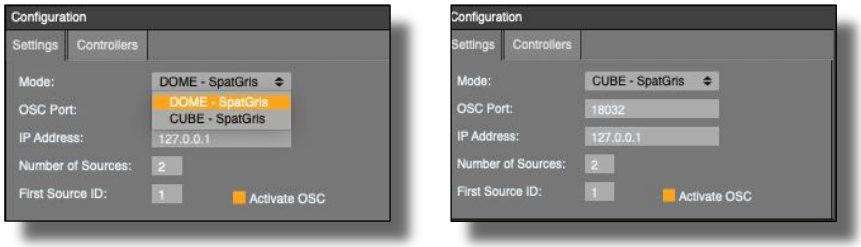
Under the Sources tab, you can precisely position the sources using the text boxes. With the Sources Placement option, you can position the sources at equal distances, clockwise, or in an alternating order. To do this, simply select the desired distribution from the drop-down menu.

In addition, it is possible to manually adjust the position of each source by entering its polar (DOME) or Cartesian (CUBE) coordinates, or by manually dragging the source on the graph. In the Source ID drop-down menu, first select the number

of the source to be moved. Then enter its new coordinates.



4.4.2. Configuration Settings



MODE

DOME mode is based on the VBAP[7] algorithm designed by Ville Pulkki. In this mode, space is represented by a dome where the distance between each point on the surface and the centre of the dome is equal to 1.00. CUBE mode is based on the original MBAP algorithm[8] designed by Gaël Lane Lépine . In this mode, space is represented by a cube inside which it is possible to design any speaker configuration.

OSC Port

This is the OSC port number for communication between *ControlGRIS2* and *SpatGRIS*. They must be set to the same number. 18032 is the default value.

IP Address

The default value is 127.0.0.1, which corresponds to the address of the internal device (i.e., your computer). This value can be changed to send the OSC to an external computer.

Number of Sources

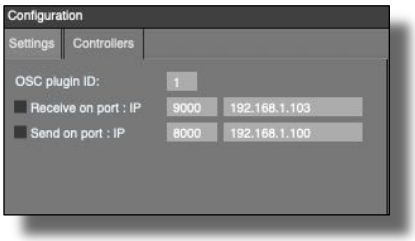
The number of sources per track corresponds to the number of audio channels. This number is limited to 256 channels.

First Source ID

This number must be unique and different for each audio channel. You must use the same numbers for audio and OSC. If you only have mono tracks, the numbers are sequential. If you have stereo tracks, you will only have odd numbers to place here: 1, 3, 5, etc., because even numbers are automatically assigned to the right channel of each stereo track. And if you are working with octophonic sound files, the first source ID will be 1, the second octophonic track will start at 9, etc.

[7] Vector Base Amplitude Panning
[8] Matrix Base Amplitude Panning

4.4.3. Configuration Controllers



ControlGRIS2 can be controlled by an external Open Sound Control (OSC) controller[9] . There is an interface designed for Open Stage Control that allows you to control *ControlGRIS2* parameters from an *iPad*[10] .

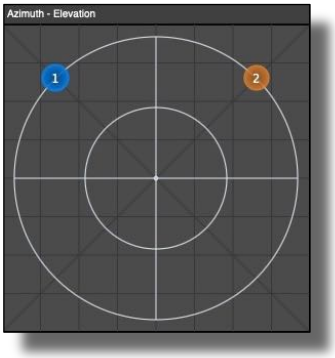
- OSC output plugin ID: to control different instances of *ControlGRIS2*, each must have a different ID.
- Receive and Send must be set according to the appropriate OSC channels (default: 9000 and 8000).
- IP port addresses must be set according to your Wi-Fi network, whether public or local. The computer and controller must be on the same network. *ControlGRIS2* automatically receives the input address from your network. See the Open Stage Control manual for more information.

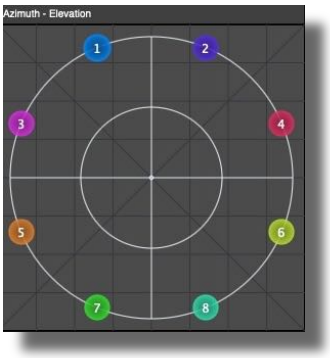
4.5. Spatialization views

ControlGRIS2 operates in two different modes for sound spatialization: DOME and CUBE.

4.5.1 View in DOME mode

In DOME mode, the graphical interface is limited to Azimuth-Elevation . In this mode, the sound is spatialized on the surface of the dome. While a source placed in the centre is at the top of the dome, a source placed at the periphery is at the bottom of the dome.
The dome is shown here from top to bottom, with examples of a stereo source on the left and an octophonic source on the right:

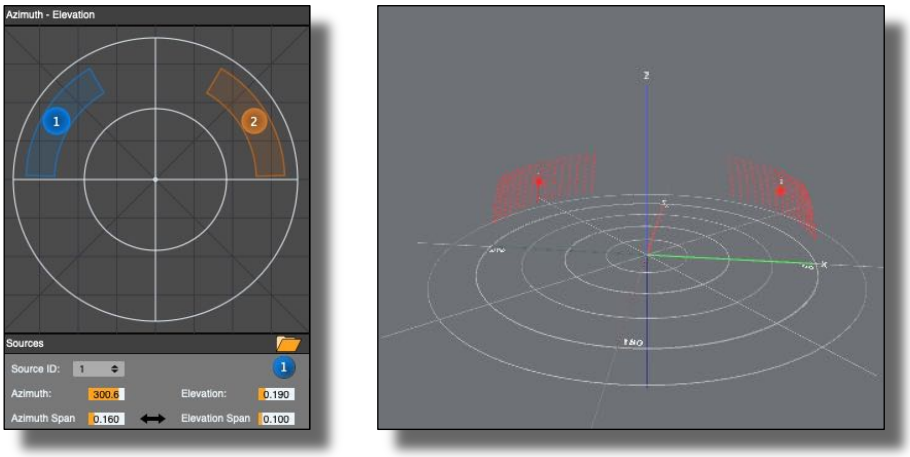




[9] http://opensoundcontrol.org
[10] See the Open Stage Control manual for more information.

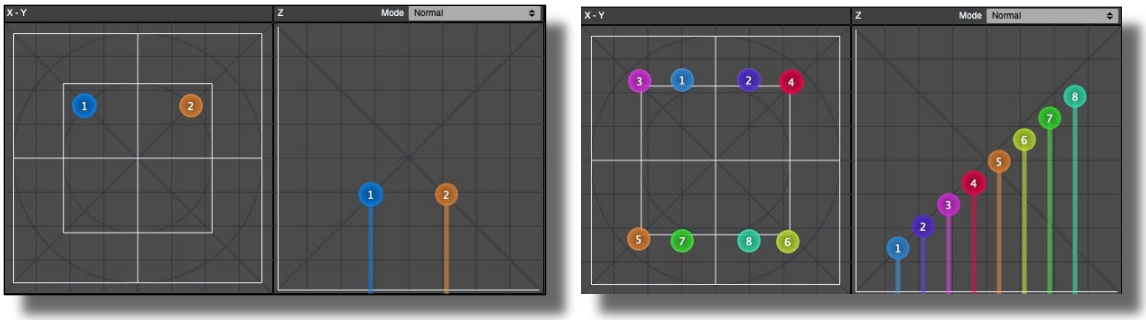
4.5.2. Spans in DOME mode

In DOME mode, Span settings are available for azimuth and elevation. Span allows the signal to be extended to an area wider than the source itself. Spans resemble an arc on either side of the source:



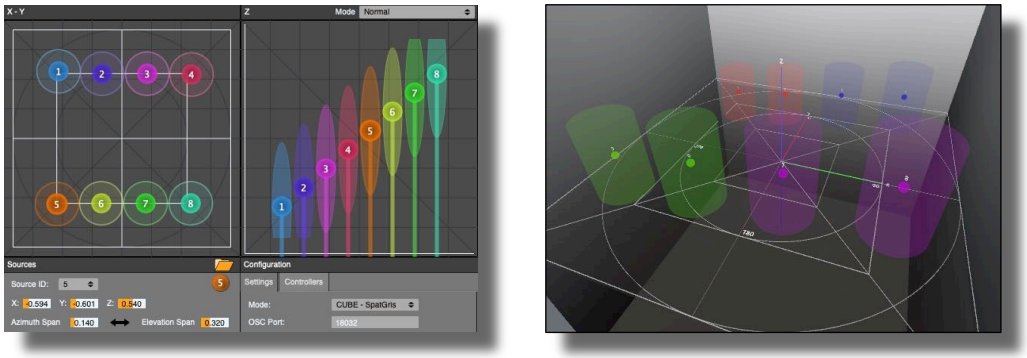
4.5.3. View in CUBE mode

In CUBE mode, the graphical interface is divided into two screens: X-Y and Z. CUBE mode adds distance and allows you to move a sound inside or outside the speaker configuration (represented by the inner white square in *SpatGRIS*). The CUBE is shown from above on the left and in profile on the right (the 3D view only appears in *SpatGRIS*). Examples of stereo and octophonic sources:



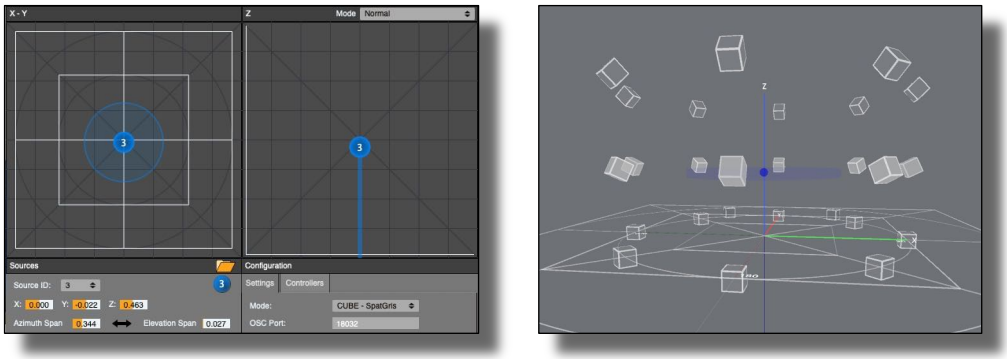
4.5.4. Spans in CUBE mode

In CUBE mode, spans resemble a cylinder surrounding the source:



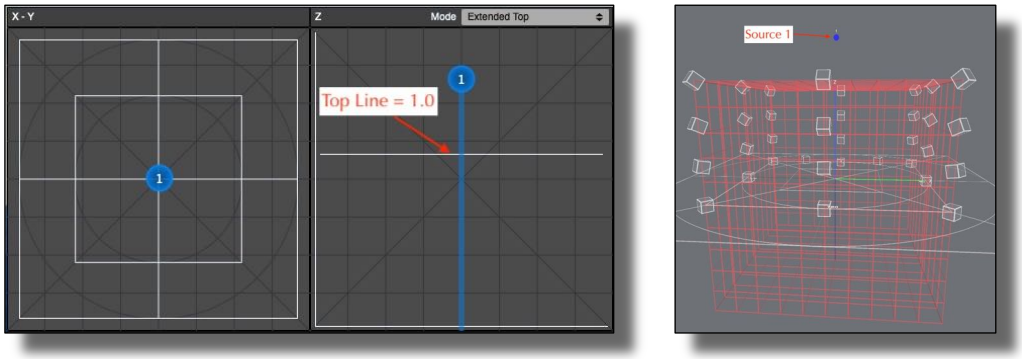
In some CUBE configurations, where most of the speakers are distributed on the walls and ceiling, a source may be lost in the centre of the room. If you want to create a flat sound disc that only activates the speakers located at the same

height as the source, you can add a little Azimuth Span:



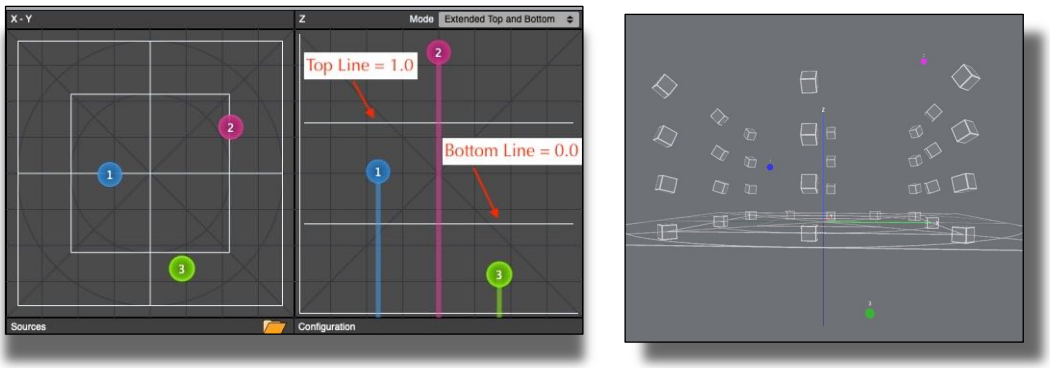
4.5.5. Elevation in CUBE in Normal or Extended Top mode

ControlGRIS2 offers the possibility of placing a source outside the CUBE on the X, Y, and Z-axes. In Extended Top mode, a white horizontal line appears in the elevation display. This line represents the value 1.0 used in Normal mode. It is from this point that the *SpatGRIS* attenuation parameters begin to take effect in elevation. Sources will be filtered in volume and/or frequency as they move away from the top of the CUBE:



4.5.6. Elevation in CUBE in Extended Top and Bottom modes

A second line appears in Extended Top and Bottom modes to attenuate sounds sent below the floor (for those lucky enough to have access to a full cube!). The top line represents the value 1.0 in Normal mode. The bottom line represents the value 0.0 in Normal mode:



NOTE: It is not possible to go below the floor in a complete sphere with *ControlGRIS2* in DOME mode. However, it is possible to do so using any software that sends OSC data directly to *SpatGRIS*.

4.6. How to use ControlGRIS2

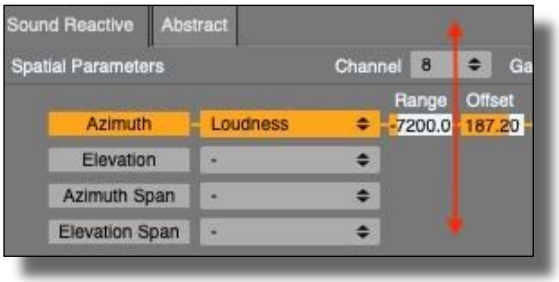
ControlGRIS2 is a plug-in that can be inserted into any track requiring spatialization. *ControlGRIS2* includes a trajectory system that can write predefined movements quickly and efficiently. The automation function of the host software allows you to record and reproduce the movements of the sources. It is therefore essential to understand the different automation modes of your preferred host software.

4.6.1. Keyboard shortcuts

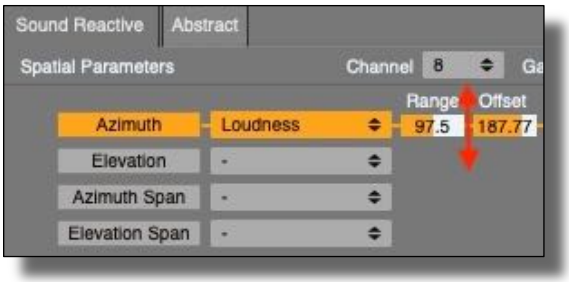
Double-click to enter a numeric value:

Opt[11]-click (⌥-click) to reset to default value:

Vertical click to quickly change values, negative or positive:



Shift-click vertically for fine values:



4.6.2. Loading the plug-in onto a track

ControlGRIS2 loads in the same way as any other AU or VST3 plug-in. Most often, *ControlGRIS2* is loaded at the end of the track's effects chain.

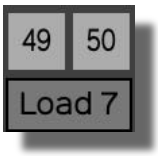
NOTE: In each track of the SAN, the audio output channel numbers must correspond to the OSC source numbers in *ControlGRIS2* (defined by the First Source ID parameter) for the sound to be spatialized in

[11] On Mac, most keyboards identify Option (Opt), while others identify Alt for the same key. In this manual, the name Opt is used.

***SpatGRIS*. If this is not the case, the spatialization will be silent or will not work properly.**

4.6.3. Saving memories and recording automations

It is possible to save some of the *ControlGRIS2* plug-in settings in the 50 memory banks provided. The shortcuts are as follows:
• Shift-Click Memory Number: Save.
• Memory number click: Load.
• Opt -Click Memory Number: Delete.
These functions appear under line 49-50 and flash yellow after an operation:



These memories allow you to save and recall only the following parameters:
• Source positions (Azimuth-Distance-Elevation or X-Y-Z). These can also be automated.

Parameters that are not saved but can be automated:
• Spans.
• Link Sources and Alt Link Sources.
• Speed
• Presets.
• Bypass.

The following parameters are neither saved nor automated, as they are used to automatically generate a trajectory that will be written by the DAW itself:
• Spans link.
• Trajectory Type.
• Duration per cycle.
• Sec(s)/Beat(s).
• Number of cycles dampening.
• Deviation degrees per cycle.
• Back & Forth.
• Activate.
Configuration tab
• The entire Configuration tab is not saved in memory (it is saved with the DAW project). It is not advisable to modify these parameters within a track.

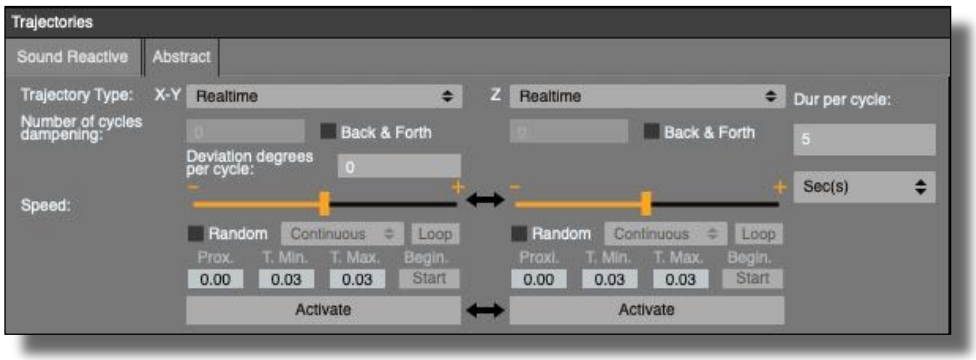
NOTE: Although it is possible to save the position of all sources in the presets, only the automation of source #1 can be saved in the sequencer. Source #1 is the leader, while the other sources are followers.

4.6.4. Recalling memories

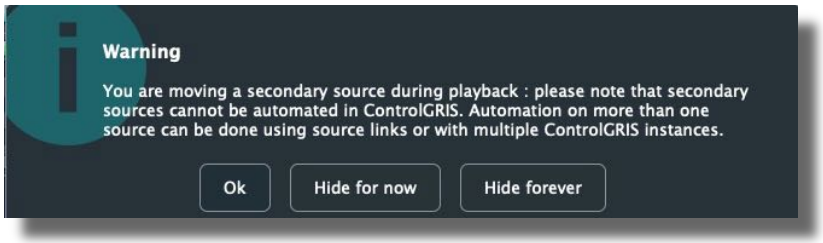
As mentioned above, memories only store the position of sources. When a memory is loaded, the sources are positioned according to the stored data. However, keep in mind that your DAW also has a memory of the previous position of the sources, and the two can interact in strange ways. Very often, it is only when you start the sequencer that the sources take their actual position. To avoid any ambiguity, memory selection can be automated.

4.7. Abstract trajectories

Abstract trajectories are those that allow you to automate the movement of sound sources using mathematical formulas. In the Trajectories control panel, under Abstract, you can define and adjust certain parameters. The concept behind trajectories is that there is one leading source, while the others are followers. Only source #1 in each instance of *ControlGRIS2* can be the leader.



If you try to record automation for a source other than source #1, you will get this warning:



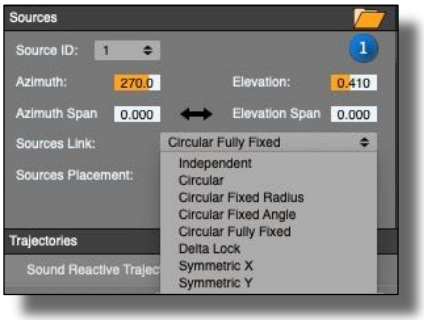
4.7.1. Sources Link

Independent mode is only available for initially placing sources independently on a multichannel track. However, the position of the sources cannot be automated independently. Only the automation of source #1 can be recorded. Therefore, once the sources have been placed, it is necessary to choose another Sources Link before recording the automation.

Azimuth-Elevation (DOME) and X-Y (CUBE) Sources Links

In the Sources tab, under the Sources Link drop-down menu, you can choose different ways to link sources together. Depending on the number of channels in an audio track, some links may not be available:

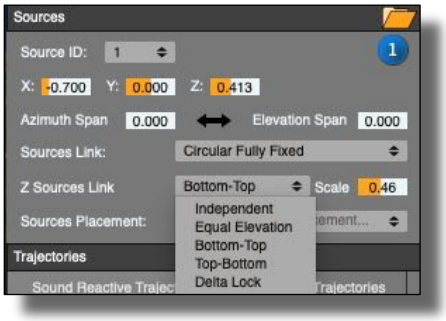
- Mono: Independent only.
- Stereo: all links
- Multichannel: all except Symmetric X and Y.
- Detailed representations of Azimuth-Elevation and X-Y links are presented in Addendum 8.1.1.



Z Sources Links (CUBE mode only)

In CUBE mode, Z Links between sources are independent of X and Y settings.

• Detailed representations of Z Links are presented in Addendum 8.1.2.



4.7.2. Trajectory Types

Automating the movement of a source is very simple thanks to the different types of trajectories available.

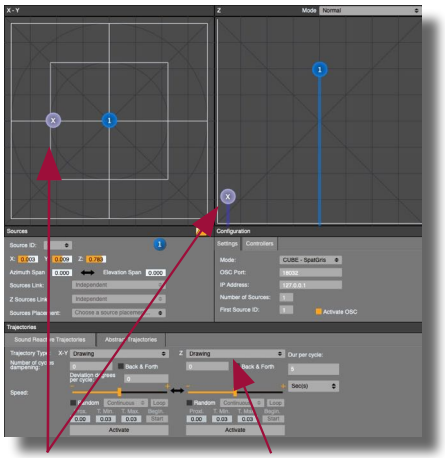
• Detailed representations of trajectories are presented in Addendum 8.2.

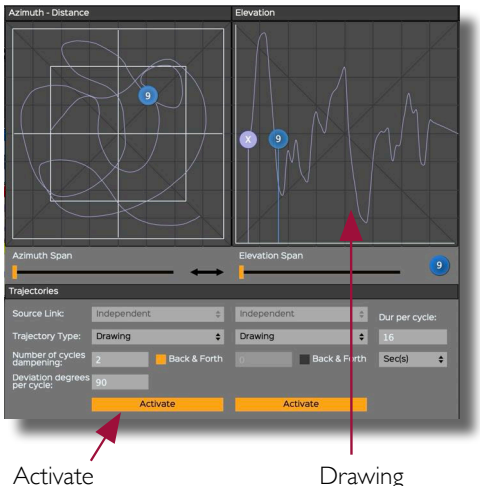
Realtime

This is the usual way to record automations: you move a parameter manually (or several parameters) and it is recorded in the SAN.

Drawing

Drawing mode is a freehand mode. When you select it, a pale gray cross appears, which you use to draw a trajectory. The duration of the trajectory and the drawing are temporarily stored in the plug-in. In Azimuth-Elevation (DOME) or X-Y (CUBE), it is the position that is recorded. In Z (CUBE only), the position in time is recorded. Both windows share a cycle that can be modified using the usual parameters. To see the trajectory in action, you can activate the Activate buttons and play the sequence. When the sequencer stops, the activation buttons become inactive again. Modifications can be made, then Activate can be enabled again. Once you are satisfied with the result, you can save the trajectory in the SAN.



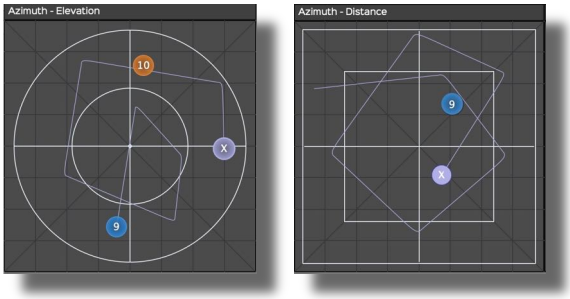


Modifiers:

- Dur per cycle
- Number of cycles dampening
- Deviation degrees per cycle
- Back & Forth

Shift-Click in Drawing Mode

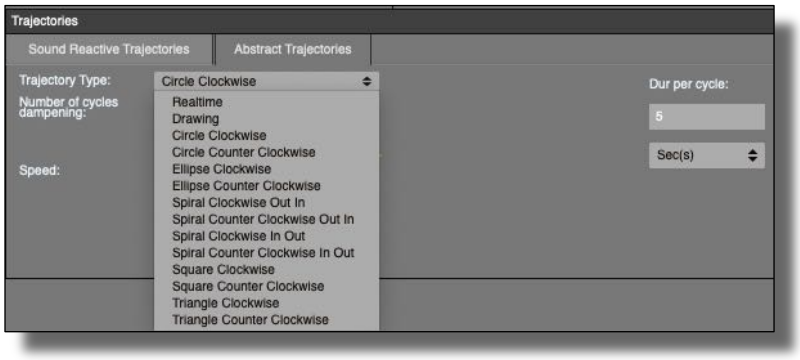
By pressing the Shift key in Drawing mode, you can draw straight lines or irregular geometric shapes in the Azimuth-Elevation (DOME) or X-Y (CUBE) window. Each time you click, a new angle is created. Don't forget to click one last time when you're done!



NOTE: Be careful with freehand trajectories, as they are temporary. If you click anywhere in the window after drawing a trajectory, or if you close the plug-in or session, it will be automatically deleted. Only one gesture can be recorded temporarily at a time. The X cross may be hidden behind one of the sources. Simply move one of them to find it back.

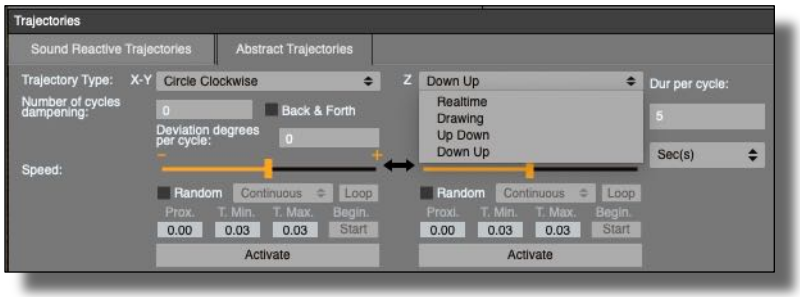
Azimuth-Elevation (DOME) and X-Y (CUBE) Trajectory Type

A drop-down menu allows you to select different types of trajectories, such as circle, ellipse, spiral, square, and triangle, clockwise or counterclockwise.



Z (CUBE only) Trajectory Type

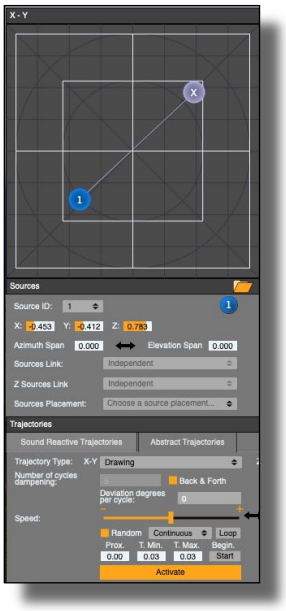
A drop-down menu with different trajectory types allows you to choose from a variety of trajectories, such as Up-Down, Down-Up.



4.7.3. A special case: the pendulum

A specific use of Shift-Click in Drawing mode can be used to design a pendulum. If a simple line is drawn with Shift-Click, it forms the basic element of a pendulum. Then, the Dur per cycle, Dampening, Deviation, and Back & Forth functions

can be used to make this pendulum very interesting. It can be placed anywhere in space.



4.7.4 Modifications to Trajectories

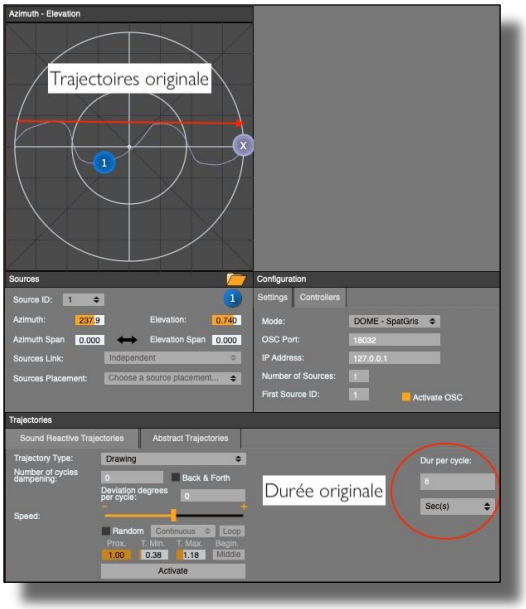
Duration per cycle
The duration of the trajectory in seconds or beats (linked to the MIDI tempo of the host sequencer).

Number of cycles dampening
The number of cycles during which dampening will occur. Total duration = Duration per cycle x Number of cycles x 1.5. Dampening only works with Back & Forth.

Back & Forth
Back-and-forth trajectory.

Deviation degrees per cycle
The deviation in degrees per cycle, on the 360° circle.

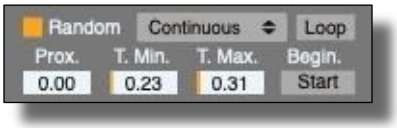
Speed
It is possible to vary the speed of a trajectory, slowing it down or speeding it up using the sliders. In CUBE mode, they can be independent or linked together. Opt-click returns the values to the centre. Speed can be automated.



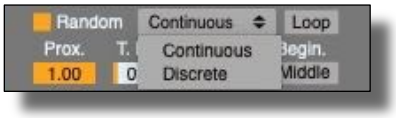
Here we see a trajectory in Drawing mode (see 4.6.2) that lasts 8 seconds. This mode is useful for understanding all the possible modifications with the Random function.

Random

The random function allows you to vary the Back & Forth, Deviation degrees per cycle, Dur. per cycle, and Speed parameters.



• Continuous , or Discrete
Move from one point to another continuously or directly, by jumping.



• Loop: On-Off (Continuous mode only)
If Loop is OFF: the next random point chosen will always be within +/- half of the points on the trajectory (multiplied by Prox.). For example, with a Prox of 1.00, the source will NOT move more than half of the trajectory in either direction.
If Loop is ON: the next random point chosen will be within a range of +/- the entire trajectory. Loop does not limit movement along the trajectory and does not take into account the distance traveled in either direction, which means that the source can loop along a trajectory.

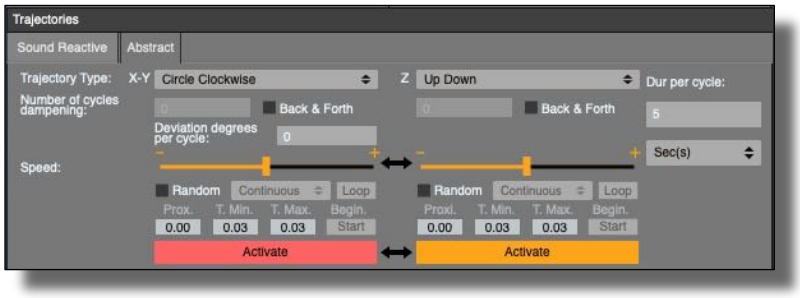
• Prox.: Proximity, more or less close to the starting value.
Scale from 0.00 to 1.00 as a percentage from 0% to 100%.

• T Min.: Minimum duration difference. Scale from 0.03 to 5.00.
• T Max.: Maximum duration deviation. Scale from 0.03 to 5.00.
This is the actual time in milliseconds. 0.03 is equivalent to a movement every 30 ms. (more easily observable in Discrete mode). If T.Min. and T.Max. have the same value, the source will be assigned a new position at regular intervals.
If T.Min. and T.Max. have different values, the source will be assigned a new position at a random time within the Min-Max interval.

• Begin : From the beginning (Start) or middle (Middle) of the trajectory.

See the different examples of trajectories obtained with the Random function in chapter *4. Abstract Trajectories, examples of the Random function* in the separate document *Tips and Tricks.*

Activate



The Activate button is used to record trajectory automations in the DAW.
When you press it, it turns orange (like the one on the right), and *ControlGRIS2* waits for the sequencer to start. When the sequence is launched, the plug-in starts the trajectory according to the specified parameters. The movement produced can be recorded — X, Y, and Z coordinates of source #1 — like any other automation. When the sequencer stops, the activation buttons return to the OFF state. It is important to place the read head in the correct position before pressing the Activate button and starting the sequence.
Pressing the Activate button with the Shift key makes it turn red (like the one on the left), which means that it is permanently activated, even if the sequencer stops.
NOTE: Be careful not to delete your previously recorded data.

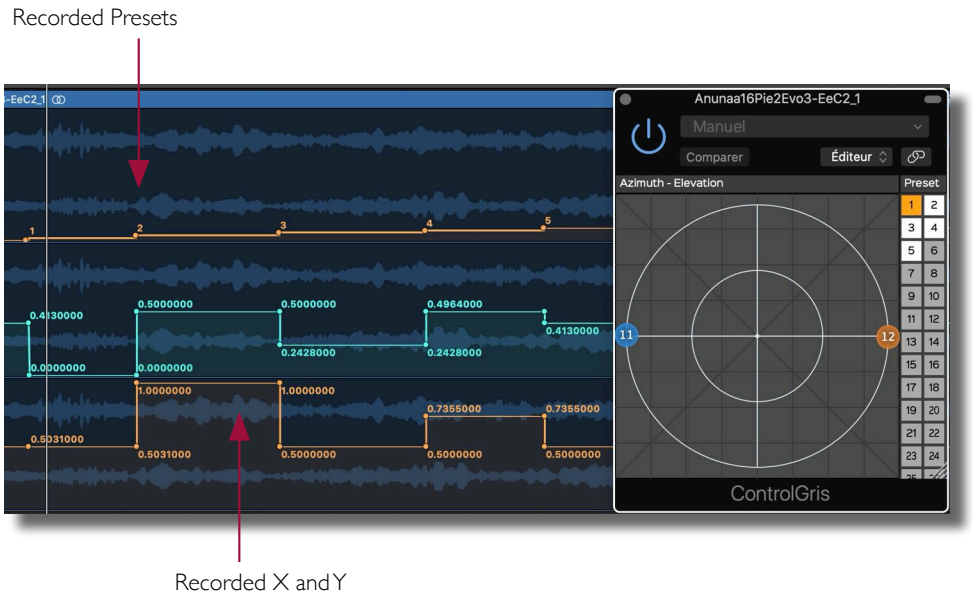
Recording the trajectory in the SAN

As explained above, *ControlGRIS2* waits for the host sequencer to start before beginning a trajectory. Tracks containing *ControlGRIS2* can be configured in writing mode (Touch, Latch, or Write — depending on your DAW options) to record source movements as automations. These automations are then available for playback and editing.

NOTE: Only source #1 (leader) is recorded, with the other sources being followers. It is always preferable to record trajectory automations in the DAW after finding the right settings, as this frees up the CPU used by *ControlGRIS2*.

4.7.5. Automated memories and trajectories

It is possible to save memory selections in the sequencer. However, to avoid conflicting information between automated trajectories and automated presets (which store the x-y position of sources), when recording automation, the x and y coordinates stored in memory will be automatically entered into the x-y curves of the automation. Automated memories are designed primarily to allow sudden changes in the position of sources.



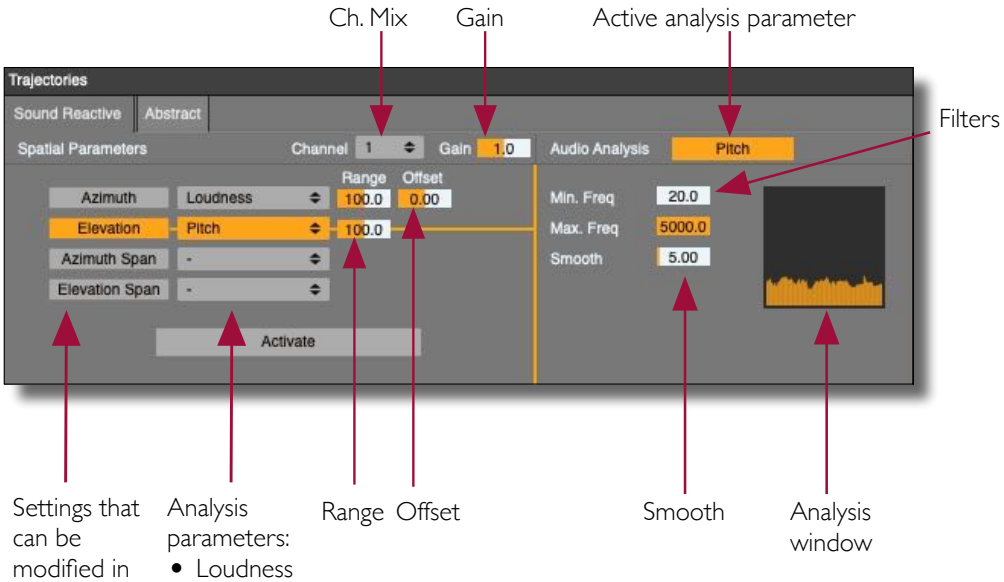
NOTE: Be careful. If you overwrite existing X and Y automations, they may conflict with the information stored in the memories. This will certainly result in audio anomalies.

4.8. Sound Reactive trajectories

The great new feature of *ControlGRIS2* is the ability to generate trajectories based on the analysis of the audio signal you want to spatialize. Sound Reactive trajectories are those that allow you to automate the movement of sound sources using audio signal analysis and audio descriptors. With this feature, trajectories are dependent on the audio content and reflect internal variations in the signal.

NOTE: It is important to take the time to experiment with audio descriptors, as they are far from being an exact science!

4.8.1. Sound Reactive trajectories in DOME mode



The parameters that can be configured in DOME mode are Azimuth, Elevation, Azimuth Span, and Elevation Span.
The analysis parameters available are:
• Loudness : this is the perceived sound energy, which depends on the level, frequency, content, and duration of the sound element. Generally associated with sound volume.
• Centroid : the spectrum centroid is the weighted average frequency of a signal's frequencies, used to measure its brightness or "brilliance." The centroid is more effective for noisy sounds, where the pitch is unclear.
• Spread : the width of the harmonic spectrum.
• Noise : the analysis detects the difference between a noisy sound and a sound with a discernible pitch.
• Pitch : the pitch of the sound. Works well with very precise pitches.
• Iterations Speed : the speed at which the sound repeats. This allows iterative or percussive sounds to be analyzed.

Spatial Parameters

• Ch. Mix : Number of the channel selected for analysis. Or MIX: all channels.
• Gain : This allows you to decrease or increase the level of the analyzed signal. Nominal: 1.0. Scale from 0 to 2.
The active analysis parameter is displayed in yellow.

Audio Analysis

The variables vary depending on the selected analysis parameter. Here, Pitch:
• Min. Freq and Max. Freq: Filters used for analysis in Hz.
• Min.: from 20 to 4000 Hz.
• Max.: from 70 to 5000 Hz.
• Smooth : Parameter for smoothing spectral content. 0-100.
NOTE: Low frequency analysis with Pitch works best with a high buffer size of 1024 or better, 2048.

Range

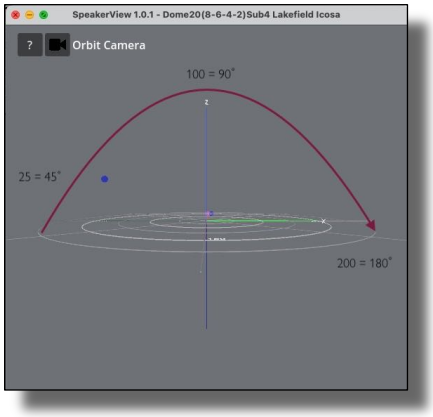
Range of the register. Think of Range as a path along a trajectory. This trajectory varies depending on the parameter assigned. A circle of 360° for azimuth; a value between 0 and 1 for elevation.

• From -10,000 to +10,000. Nominal value: 100, which corresponds to 100% of the trajectory.

Depending on the parameter assigned:

• In Azimuth or linked X-Y: ± 0-360°. Examples: 25= 90°; 50 =180°; 100 = 360°. 1000 = 10 X 360°; etc.

• In Elevation, X, Y, Z, and spans. Examples: Elevation in DOME: 25 = 45°; 100 = 90°, i.e., at the top; 200 = 180°, semicircle, low-high-low (maximum value).

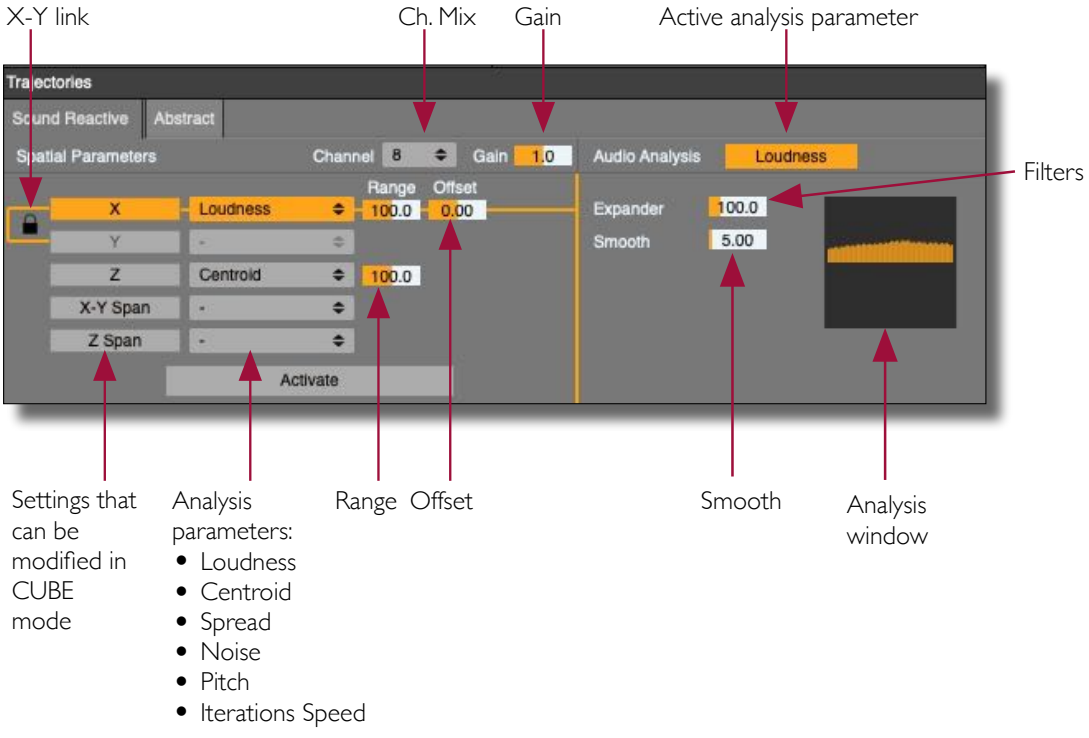


Offset

Standard deviation from the mean. This allows the entire range to be moved down (-) or up (+).

• Values vary depending on the parameter assigned.

4.8.2. Sound Reactive trajectories in CUBE mode



The parameters that can be modified in CUBE mode are X, Y (which can be grouped), Z, X-Y Span, and Z Span. The analysis parameters available are the same as in DOME mode.

4.8.3. How to use audio descriptors

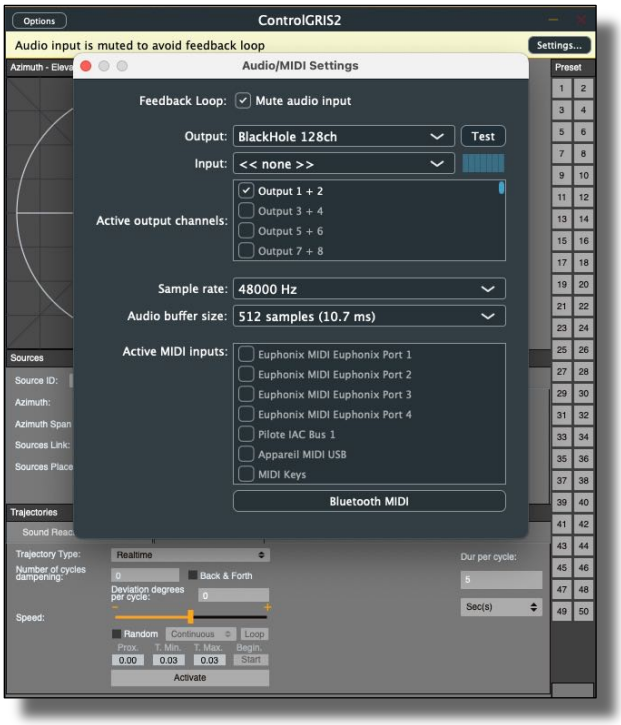
Audio descriptors are not accurate in many contexts. It is difficult to obtain objective results and, in reality, that is not their purpose. It takes a lot of experimentation to obtain results that are usable for your creative needs. Take the time to vary the analysis parameters and familiarize yourself with the concepts behind them.
For more information, visit the Fluid Corpus Manipulation project (FluCoMa) website:
https://learn.flucoma.org/reference/

- Loudness
- Pitch
- SpectralShape: Centroid, Spread, and Noise
- OnsetSlice: Iterations Speed.

You can also consult the MapSPAT manual[12] :
https://github.com/GRIS-UdeM/MapSPAT/blob/main/MapSPAT-UserManual.pdf

4.8.4. ControlGRIS2, software version

There is now a software version of *ControlGRIS2*. It is almost identical to the plug-in version, except that it offers the possibility of controlling *SpatGRIS* without having to insert it into a sequencer. The standalone version has 256 OSC channels, an audio input port (currently inactive) and an audio output port. Sound Reactive trajectories are inactive, as they are disconnected from an audio input.



One of the features of this version is the ability to import a Speaker Setup from *SpatGRIS* in order to automatically distribute audio tracks from a sequencer to *SpatGRIS*. This allows you to overcome the barrier of the number of tracks allowed in the audio tracks of most sequencers.
It is now possible to import Speaker Setups from *SpatGRIS* into *ControlGRIS2*. This is done from the small folder displayed in the Sources tab. Clicking on the folder opens a standard window that gives access to the desktop. To open a Speaker Setup, simply open it first in *SpatGRIS* and save it to your computer. Then open it in *ControlGRIS2*. This feature is available in the software version only.

[12] https://github.com/GRIS-UdeM/MapSPAT

5. SpatGRIS

• *SpatGRIS* performs spatialization and localization.
• *SpatGRIS* is a recorder and player.
• *SpatGRIS* manufactures speaker devices.

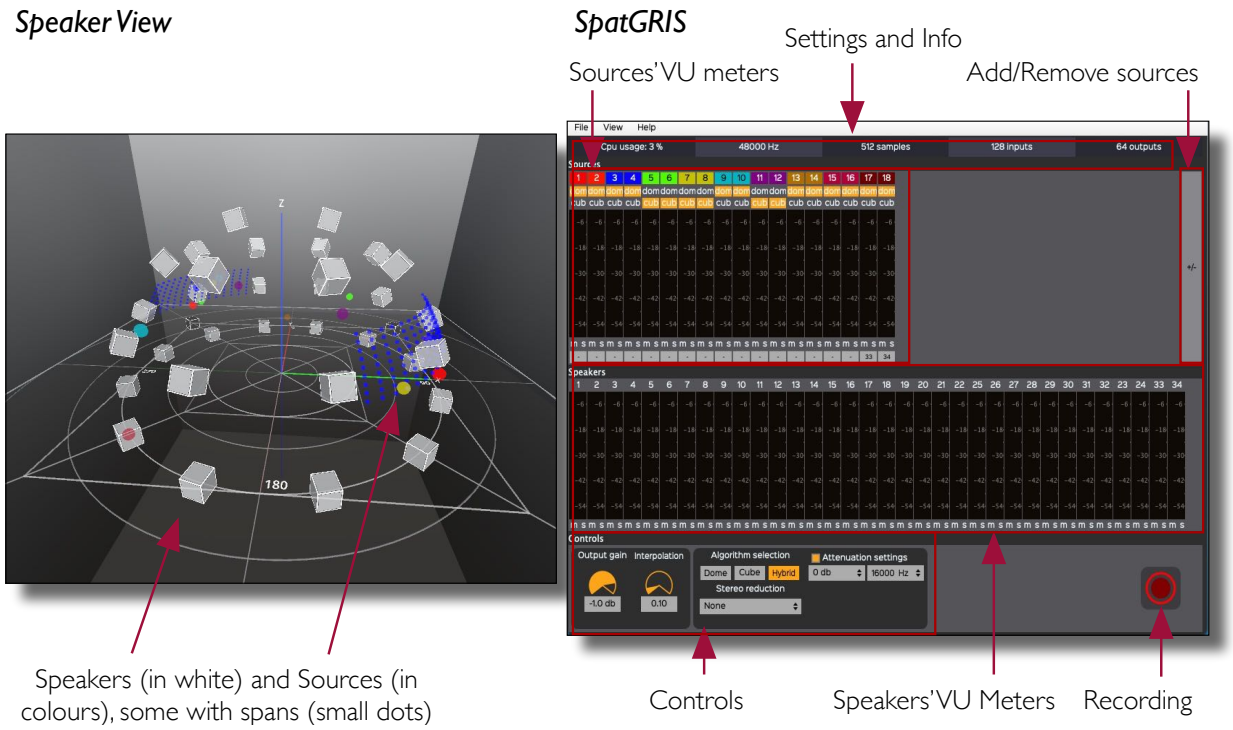
5.1. Introduction

SpatGRIS has three components that are saved independently: Project, Speaker Setup, and Settings.
• **Save Project** . A project is linked to a work that contains a certain number of sources (DAW outputs) and the Mode used.
• **Save Speaker Setup** . A speaker setup is linked to an installation placed in a space and to the algorithm used. This is the section shown in *SpeakerView*.
• **Save Settings** . User settings are linked to a workstation—computer and audio interface—including the stereo outputs used for stereo reduction. Most settings are displayed in the information bar. To view them, click on the information bar or on Settings in the File menu (Cmd-,).

NOTE: DOME and CUBE modes are saved in Speaker Setups and Projects, but HYBRID mode is only saved in Project. The last document opened — whether a Speaker Setup or a Project — determines the Mode.

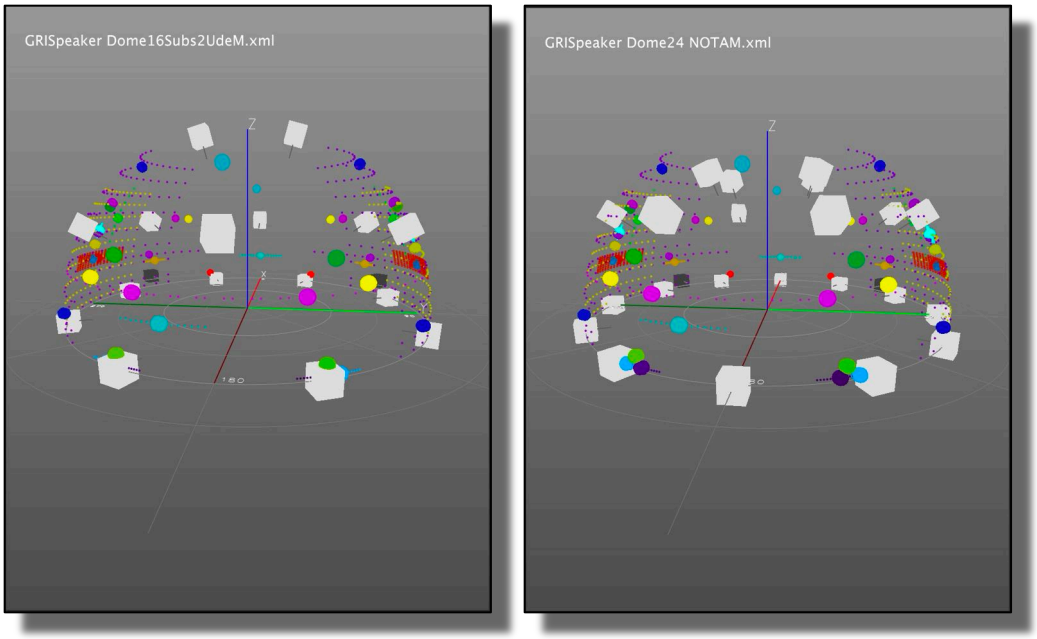
The *SpatGRIS* window is divided into different areas:
• Sources
• VU Meters.
• Settings and Info.
• Controls.
• Recording.

SpeakerView displays speakers and sources in the 3D view.

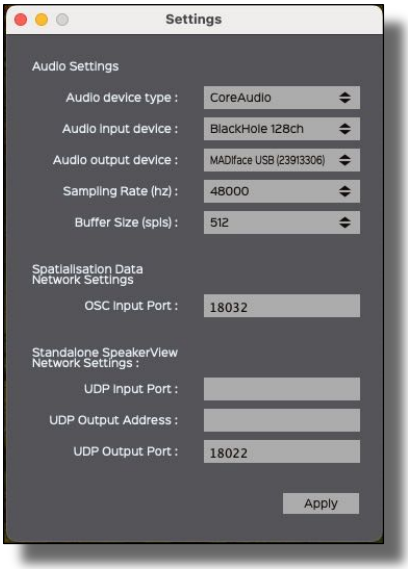


5.2. Change the speaker configuration, not the spatialization

The most interesting feature of *SpatGRIS* is that sources, which come from the DAW and represent the audio and spatialization of your work, are independent of the speakers. So, if you initially defined a very complex spatialization structure for a specific speaker configuration, you could play it on any other speaker configuration afterwards, especially in DOME mode, which corresponds to an algorithmic standard. All you have to do is change the speaker's configuration from one location to another.
Here is an example of a piece designed for a 16-speaker system (left), presented on a different 24-speaker system (right), simply by switching from one setup to another.
As you can see, all sources remain at the same coordinates. They will be played by different speakers but heard in the same place in the concert hall.



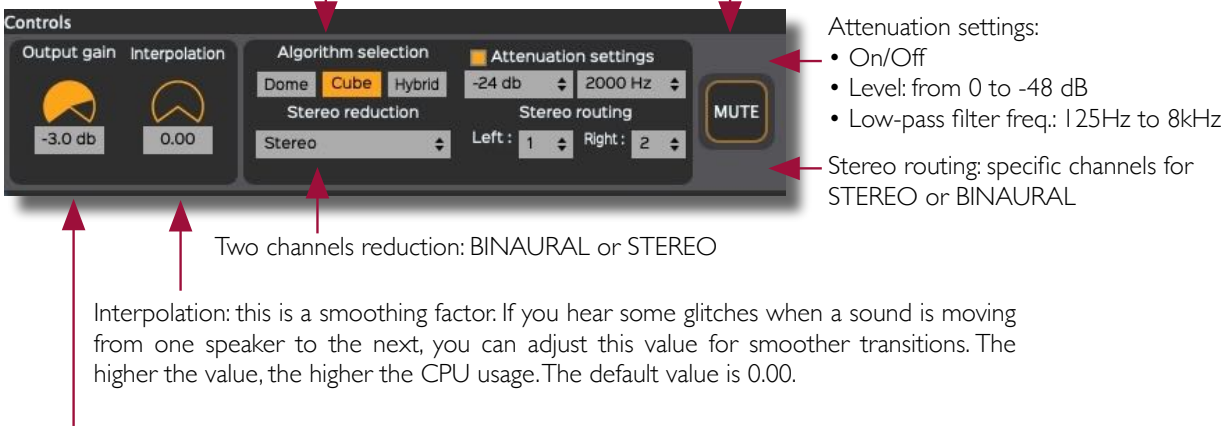
5.3. Settings



Audio Settings
• Audio device type: Core Audio (default).
• Audio input device: *BlackHole* (or equivalent).
• Audio output device: your audio interface.
• Sampling Rate (Hz): from 44100 to 192000, depending on your audio interface.
• Buffer Size (spls): from 16 to 2048. Adjust the buffer size to the same value in your DAW and in *SpatGRIS*.
Spatialization Data Network Settings
• OSC Input Port : 18032 (default)
Standalone SpeakerView Network Settings
• See Chapter 6 on *SpeakerView*.

Your settings are automatically saved and can be found here (Mac):
• ~/Library/Application Support/GRIS/SpatGRIS4.0.1.xml (for example).

5.4. Controls

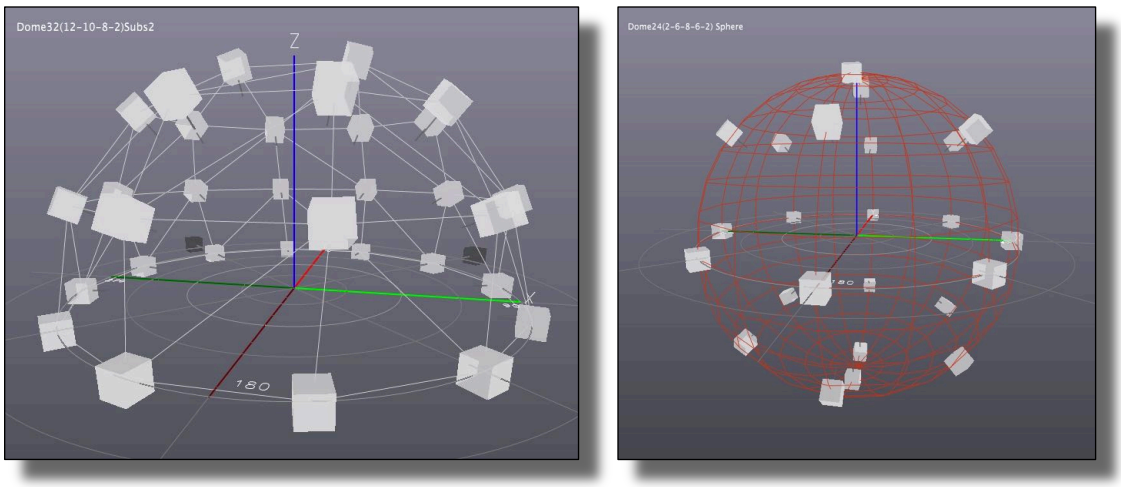


5.5. DOME and CUBE

In DOME mode, sources can only be placed on the surface of the dome formed by the speakers, while in CUBE mode, sources can be placed inside and outside the speaker setup.

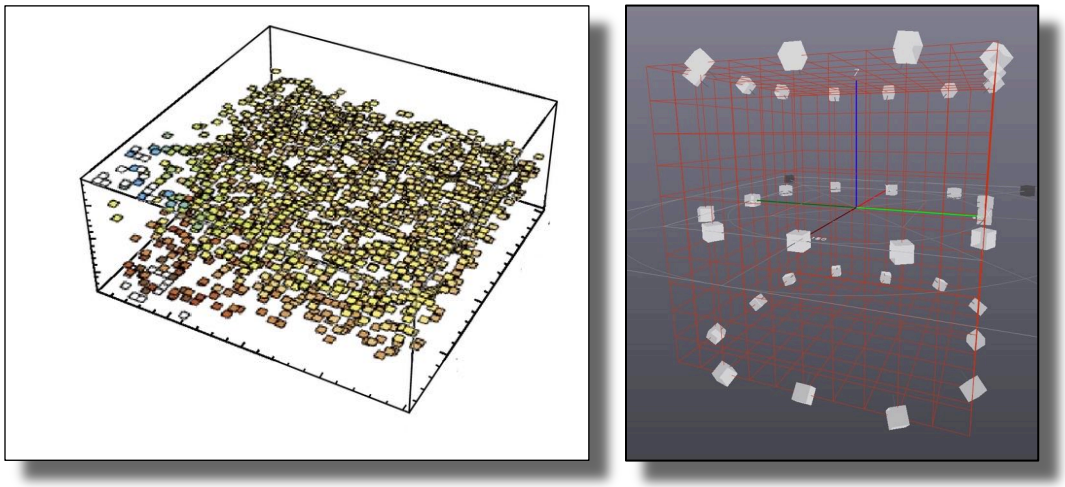
5.5.1. DOME

DOME, based on the VBAP (Vector Base Amplitude Panning) algorithm, allows the user to spatialize sound on a dome of speakers based on the relative amplitude of three speakers (as opposed to two in stereo panning). The dome is therefore made up of speaker triangles. In this way, sound can propagate smoothly across the surface of the dome, without bumps or holes.
You can see the triangles by selecting Show Speaker Triplets (Opt-T) in the View menu. If you are lucky enough to be using a complete sphere, you can display it (Opt-O)!



5.5.2. CUBE

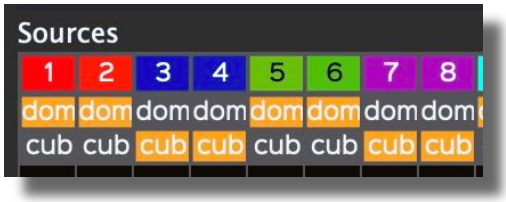
CUBE mode is based on the MBAP (Matrix Base Amplitude Panning) algorithm and allows you to place a source anywhere in a space represented by a cube. But it is not limited to the shape of a cube. Any speaker configuration can be placed in a cube (including a dome!). Therefore, any sound installation or concert situation can be simulated here. In CUBE mode, sources can be moved outside the limits of the speaker setup. The distance is then taken into account to simulate the natural behaviour of sound as it moves away, according to the Attenuation settings.
As its name suggests, the algorithm is based on a precalculated three-dimensional matrix of several points per speaker that determines the amplitude of a source at a specific position.



5.6. HYBRID mode: DOME and CUBE in the same project

HYBRID mode is not really a new algorithm, but a combination of the DOME and CUBE algorithms. HYBRID mode can be selected in the Algorithm section:

The Sources menu is then modified to offer the possibility of choosing between a dome or cube behaviour independent of each source:



HYBRID mode uses the DOME algorithm, which means that the speaker configuration must be a dome (if this is not the case, you will be asked to convert it). Within this, sources can be moved according to the CUBE behaviour, which allows sources to be moved inside or outside the speaker dome. In HYBRID mode, spans retain the usual behaviour of the mode selected for each source.

5.6.1. What is saved in HYBRID mode?

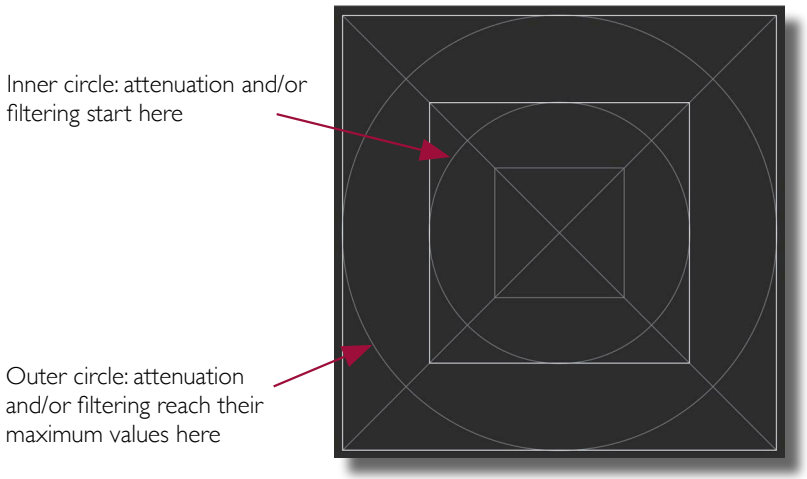
Two types of information are saved with a project in HYBRID mode:
- The HYBRID mode itself is saved exclusively with the project.
- The selection of the DOME or CUBE algorithm for each source is also saved with the project.

5.6.2. Which mode is loaded with Speaker Setup and Project?

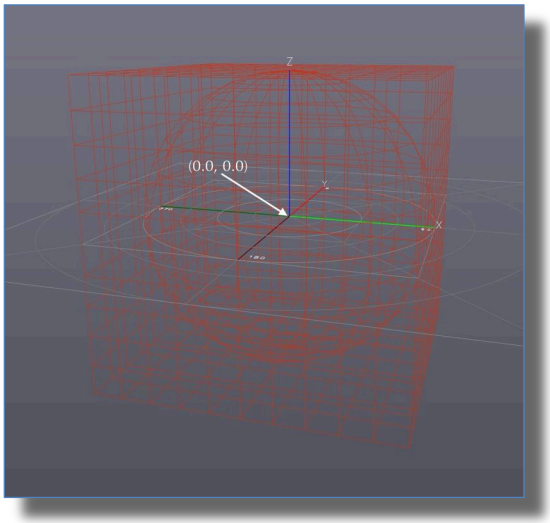
As a rule, it is always the last document opened — Speaker Setup or Project — that determines the algorithm used by *SpatGRIS*.
See details in chapter 9.7. Technical Information.

5.6.3. Attenuation settings in CUBE or HYBRID mode

In CUBE and HYBRID modes, there is an inner circle and an outer circle in the middle of the Speaker Setup. In the inner circle, attenuation and/or filtering are not applied. Outside the inner circle, attenuation and/or filtering can be applied to simulate the fading of a sound as it moves away. At the outer circle, attenuation and filtering reach their maximum values. These can be adjusted in Attenuation settings. In HYBRID mode, Attenuation settings only work for CUBE sources.



In fact, the inner circle is a sphere within which the attenuation parameters begin to be calculated from the "floor," i.e., from the coordinates (0,0, 0,0):



Attenuation settings:

- On/Off
- Volume (dB): from 0 to -48, continuously adjustable.
- Filtering (Hz): from 125 to 8 000, continuously adjustable.
- Volume and filtering are independent.
- In elevation, attenuation begins at the top (Extended Top) and bottom (Extended Top and Bottom) of the cube.
- Attenuation settings also work in STEREO and BINAURAL modes.

NOTE: Attenuation settings are saved in the project.

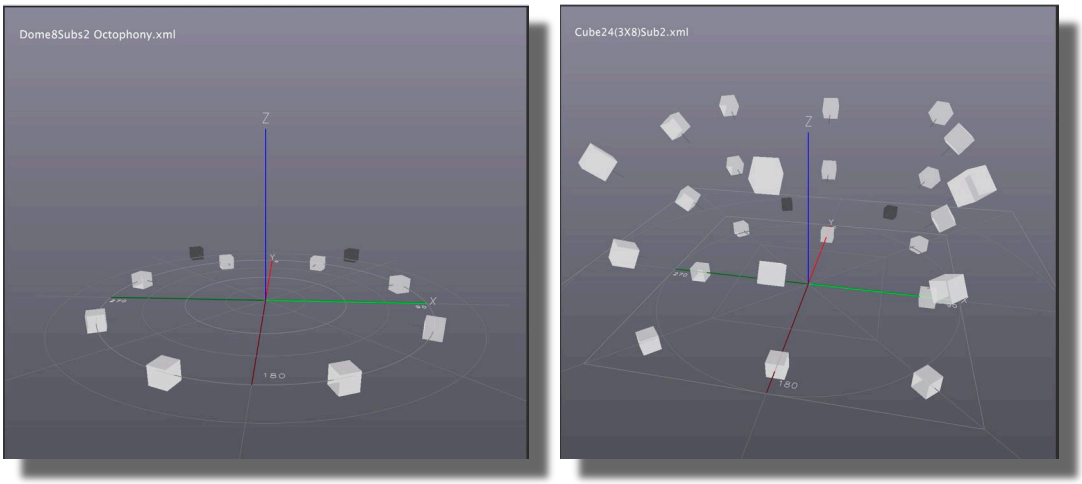
5.6.4. Conversion from DOME to CUBE and vice versa

When converting from DOME to CUBE, *SpatGRIS* uses the X, Y, Z coordinates of the Speaker Setup to maintain the integrity of the Speaker Setup. This does not apply when converting from CUBE to DOME, since in the VBAP algorithm, the distance is always adjusted to 1.00. Elevation and distance do not behave in the same way in the DOME and CUBE algorithms. A Speaker Setup retains its appearance and X, Y, Z coordinates when transitioning from the DOME algorithm to the CUBE algorithm, but not vice versa.

5.6.5. 2D and 3D spatialization

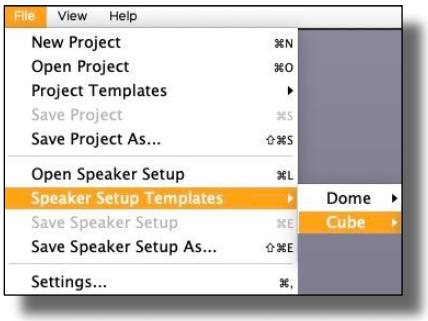
SpatGRIS can spatialize in 2D and 3D in DOME or CUBE mode. It can be useful to use *SpatGRIS* in 2D with DAWs that are stereo only, such as Ableton Live and Pro Tools Native. This gives these stereo DAWs the ability to handle multispeaker environments, such as cinema standards. But, of course, the real power of *SpatGRIS* lies in its 3D capabilities.

The following images show an example of a 2D speaker configuration—an octophony—and a 3D configuration—a cube of 24 (3x8) speakers.



5.7. Speaker Setup

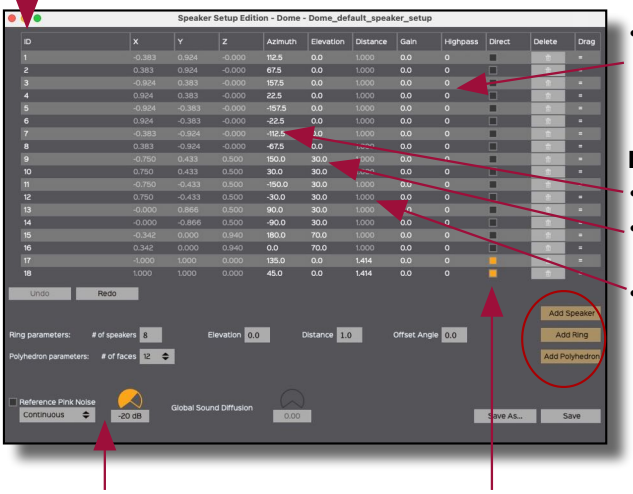
The design of a speaker setup is the first step in the process. It is done in the *Speaker Setup Edition* window (menu View, Opt-W).
A Templates menu is provided with various Speaker Setups in DOME or CUBE format. The Speaker Setups provided in the Templates cannot be modified. You can use them, edit them, and save them under a different name using Save Speaker Setup As in the File menu.



5.7.1. Speaker Setup DOME Edition

In DOME mode, Cartesian values are grayed out. A speaker configuration is created by determining the number of speakers in each level and their location (polar coordinates). Add Speaker allows you to add an individual speaker. Add Ring and Add Polyhedron allow you to add groups of speakers. In CUBE mode (Cartesian coordinates), Add Grid is added.

- ID connects a speaker to the output number of your audio interface.



- Output Gain (dB) and Highpass, which defines the cutoff point in Hz, minimum value 20 Hz. At 0, the filter is disabled. Use to calibrate the configuration.

DOME:

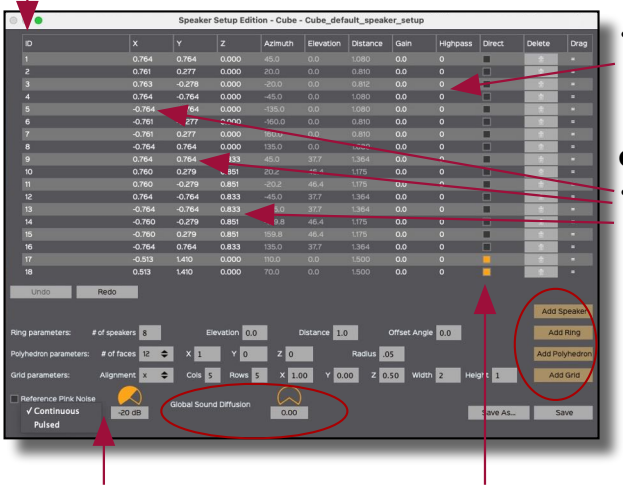
- Azimuth is the angle, from 0° to 360°.
- Elevation is the angle between 0° and 90° (or -90, if you are using a full sphere).
- Distance between the speaker and the centre. In a DOME, the distance is fixed at 1.00.

- Reference Pink Noise: On/Off
- Continuous or Pulsed
- Défaut: -20 dB, to calibrate the outputs
- Direct outs

5.7.2. Speaker Setup CUBE Edition

In CUBE mode, the polar values are grayed out. The Global Sound Diffusion parameter allows you to modify the sound diffusion globally for all speakers. Precise localization is obtained with a small value, while higher values will result in a blurred spatial image. This parameter can also influence the fluidity of the trajectories.

- ID connects a speaker to the output number of your audio interface.



- Output Gain (dB) and Highpass, which defines the cutoff point in Hz, minimum value 20 Hz. At 0, the filter is disabled. Use to calibrate the configuration.

CUBE:

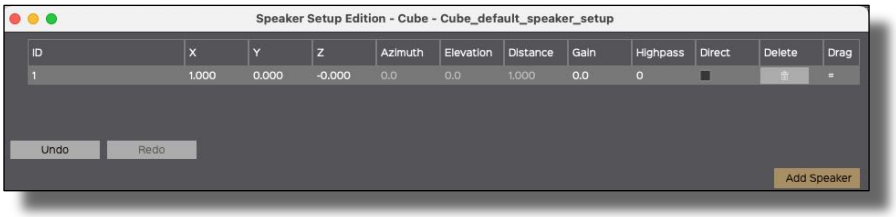
- In this mode, you can enter values using the X, Y, and Z coordinates.

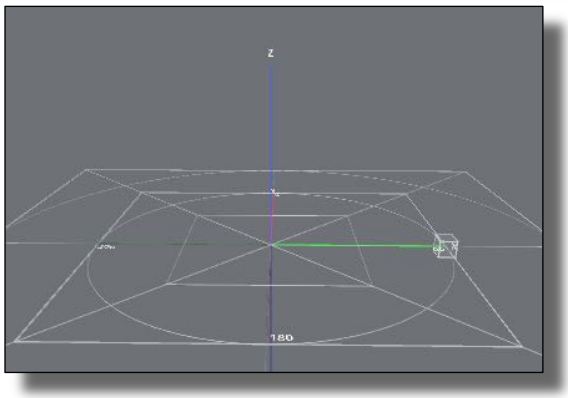
- Reference Pink Noise: On/Off
- Continuous or Pulsed
- Défaut: -20 dB, to calibrate the outputs
- Direct outs

5.7.3. Add Speaker, Ring, Polyhedron, and Grid

5.7.3.1. Add Speaker

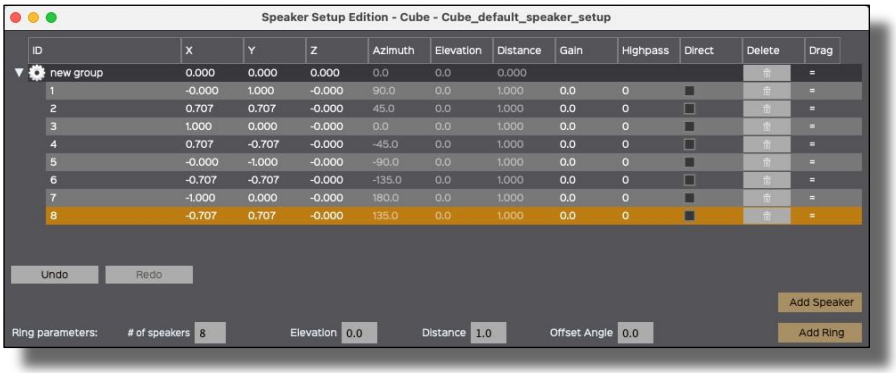
One speaker at a time

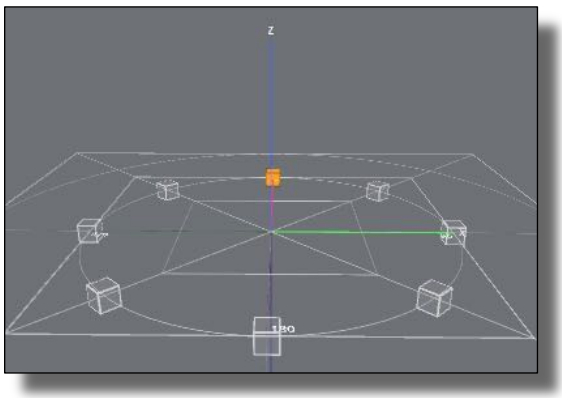




5.7.3.2. Add Ring

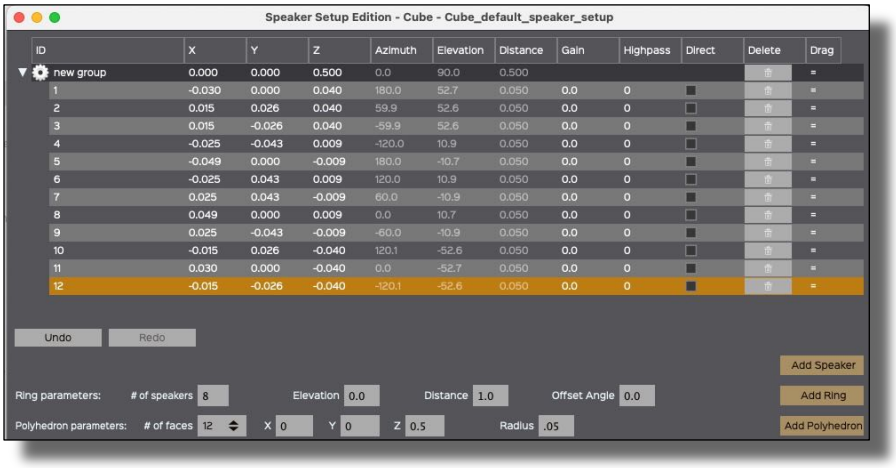
A circle of speakers.

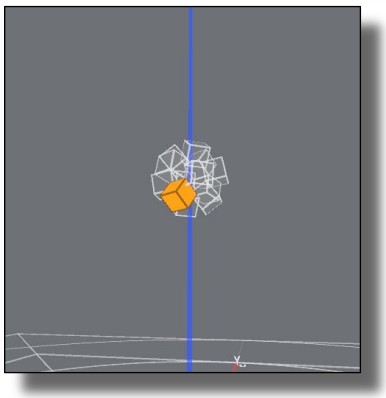




5.7.3.3. Add Polyhedron

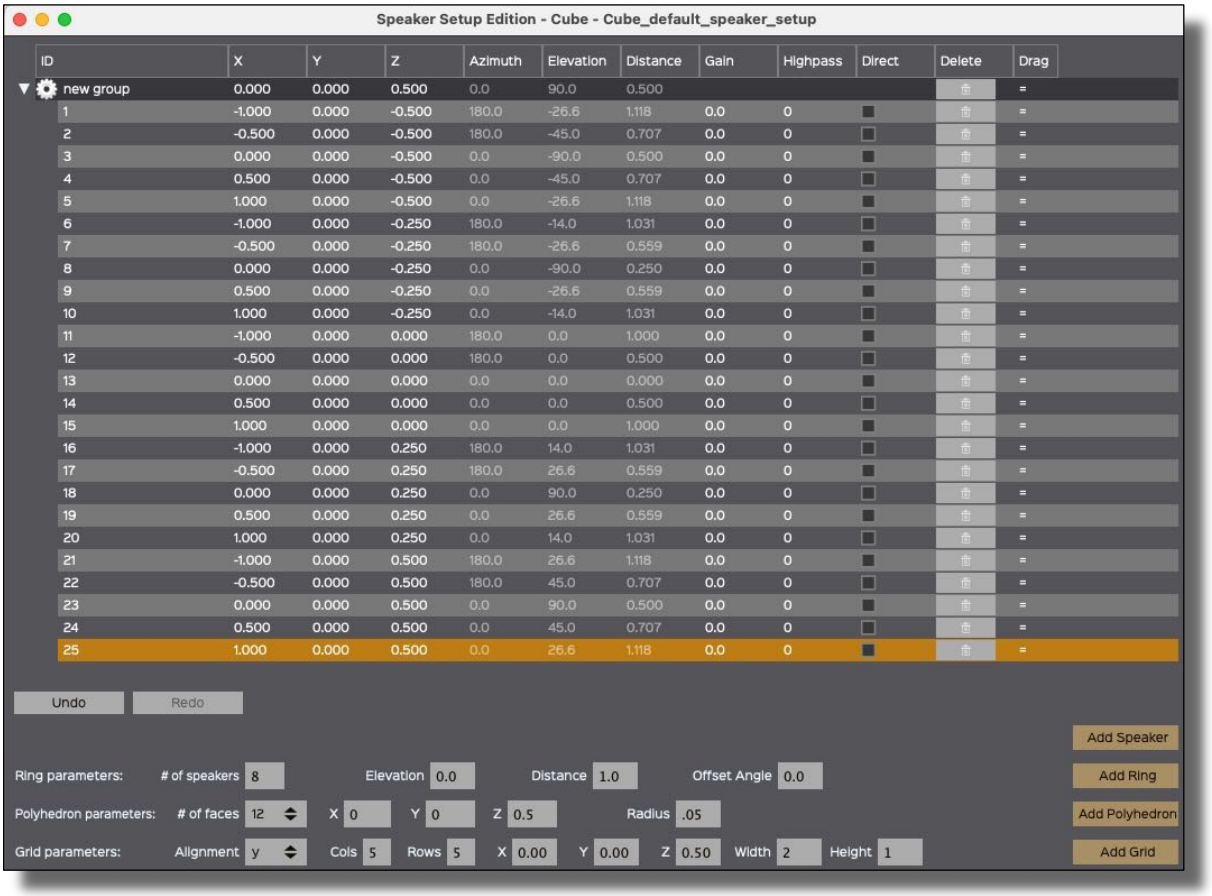
A group of speakers that are part of the same enclosure (such as the SAT's Audiodices).

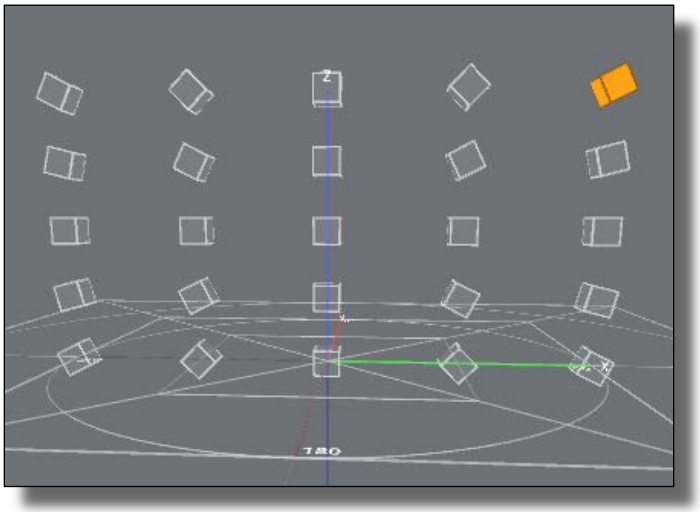




5.7.3.4. Add Grid

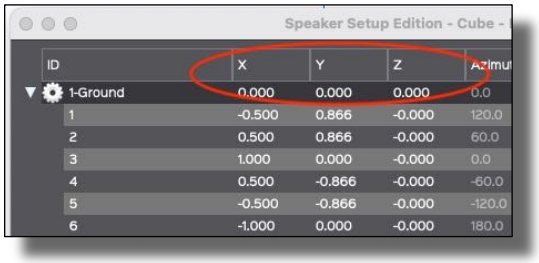
A group of speakers in the form of a grid or wall.





5.7.3.5. Offset value for X, Y and Z in Cube mode

In Cube mode, it is possible to vary the values of X, Y and Z by adding or subtracting a modification value for the entire group.



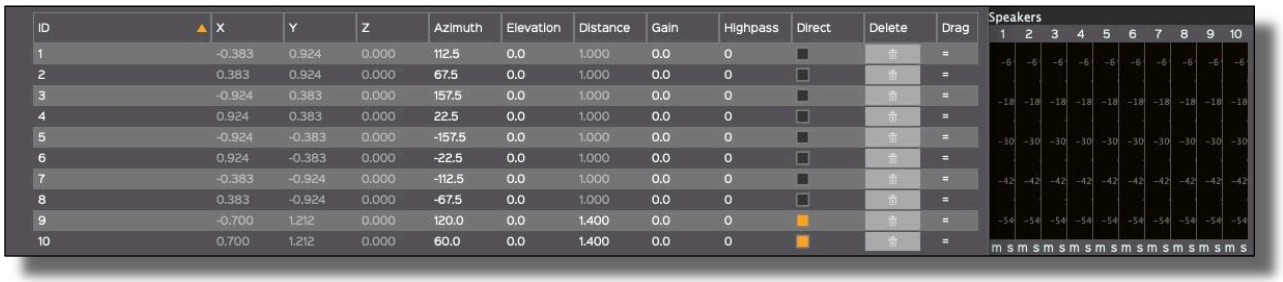
ID	X	Y	Z	Azimu
1-Ground	0.000	0.000	0.000	0.0
1	-0.500	0.866	-0.000	120.0
2	0.500	0.866	-0.000	60.0
3	1.000	0.000	-0.000	0.0
4	0.500	-0.866	-0.000	-60.0
5	-0.500	-0.866	-0.000	-120.0
6	-1.000	0.000	-0.000	180.0

NOTE: Ring, Polyhedron and Grid are groups. This is a new feature of *SpatGRIS4*. Therefore, any speaker setup that contains groups can't be open in previous version of *SpatGRIS*.

5.7.4. Speaker order and visual representation

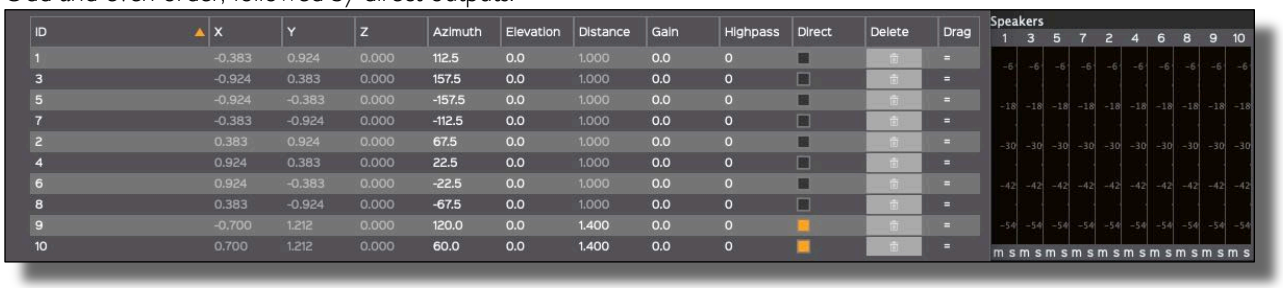
By clicking at the top of each column (except for Gain and Highpass) in the Speaker Setup Edition window, the speaker order can be arranged. The Drag column is where you can manually move each speaker. This order will be reflected in the order of the speaker VU meters.

Consecutive order:



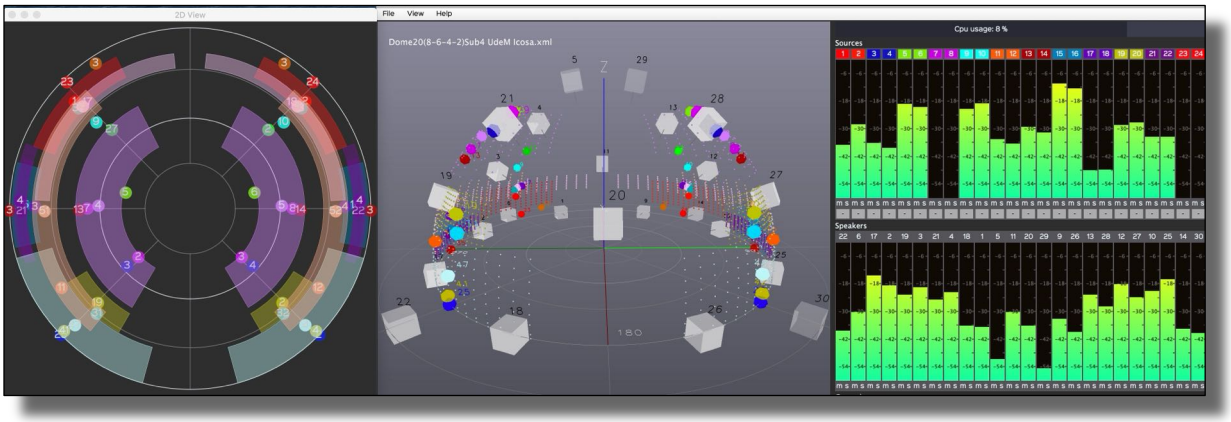
ID	X	Y	Z	Azimuth	Elevation	Distance	Gain	Highpass	Direct	Delete	Drag
1	-0.383	0.924	0.000	112.5	0.0	1.000	0.0	0			=
2	0.383	0.924	0.000	67.5	0.0	1.000	0.0	0			=
3	-0.924	0.383	0.000	157.5	0.0	1.000	0.0	0			=
4	0.924	0.383	0.000	22.5	0.0	1.000	0.0	0			=
5	-0.924	-0.383	0.000	-157.5	0.0	1.000	0.0	0			=
6	0.924	-0.383	0.000	-22.5	0.0	1.000	0.0	0			=
7	-0.383	-0.924	0.000	-112.5	0.0	1.000	0.0	0			=
8	0.383	-0.924	0.000	-67.5	0.0	1.000	0.0	0			=
9	-0.700	1.212	0.000	120.0	0.0	1.400	0.0	0			=
10	0.700	1.212	0.000	60.0	0.0	1.400	0.0	0			=

Odd and even order, followed by direct outputs:



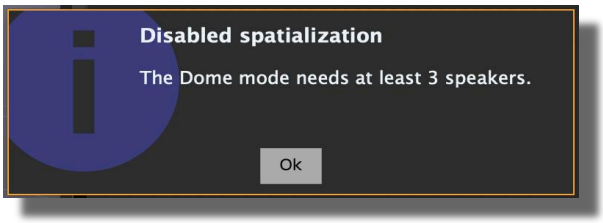
ID	X	Y	Z	Azimuth	Elevation	Distance	Gain	Highpass	Direct	Delete	Drag
1	-0.383	0.924	0.000	112.5	0.0	1.000	0.0	0			=
3	-0.924	0.383	0.000	157.5	0.0	1.000	0.0	0			=
5	-0.924	-0.383	0.000	-157.5	0.0	1.000	0.0	0			=
7	-0.383	-0.924	0.000	-112.5	0.0	1.000	0.0	0			=
2	0.383	0.924	0.000	67.5	0.0	1.000	0.0	0			=
4	0.924	0.383	0.000	22.5	0.0	1.000	0.0	0			=
6	0.924	-0.383	0.000	-22.5	0.0	1.000	0.0	0			=
8	0.383	-0.924	0.000	-67.5	0.0	1.000	0.0	0			=
9	-0.700	1.212	0.000	120.0	0.0	1.400	0.0	0			=
10	0.700	1.212	0.000	60.0	0.0	1.400	0.0	0			=

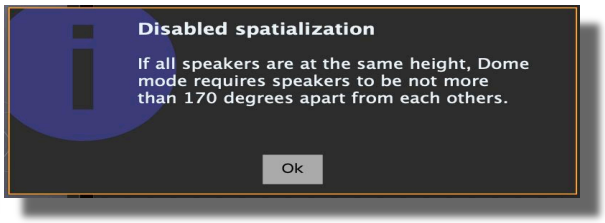
Here is an example of speaker order that represents the actual position of the speakers in a studio relative to the Y-axis (see 5.9.1 for more information). You can see in the speaker's VU meter section how the energy is distributed from left to right in the dome. Speakers 11 and 20 are in the centre, and the subs are on the far left and right, as in a studio. All other speakers are evenly distributed along the Y-axis:



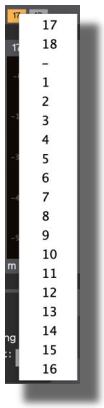
5.7.5. Minimum requirements

The DOME requires minimum conditions to perform VBAP calculations. If the speaker configuration does not meet these requirements, you will be notified by one or two of these messages:





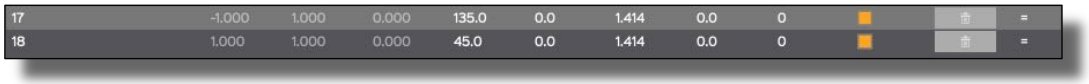
5.7.6. Direct outputs



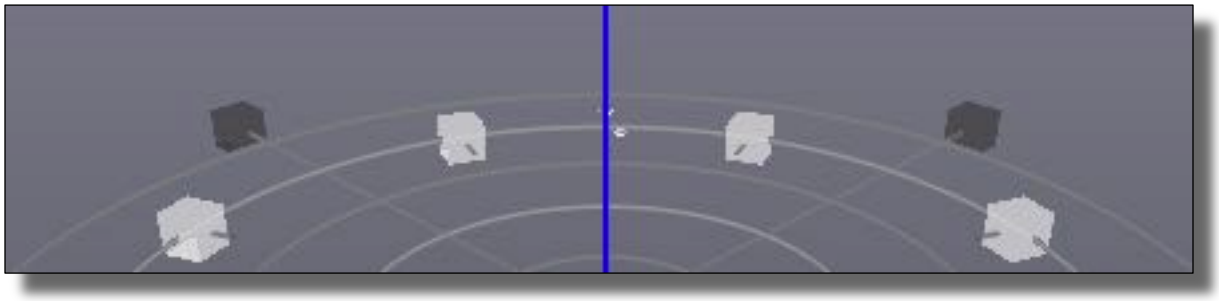
A sound source can be sent directly to a speaker via a direct output. There are two types of direct outputs in *SpatGRIS*.

Independent Direct outputs

There are independent direct outputs for special uses, such as subwoofers . These speakers are identified by an orange rectangle in the Speaker Setup Edition window.



Their placement in the configuration is not important, since they are independent of the spatialization. However, if you intend to mix your project in a two-channel format, these direct outputs will be placed in the stereo image according to their left-right position. They are shown in black in the 3D view of the speakers.



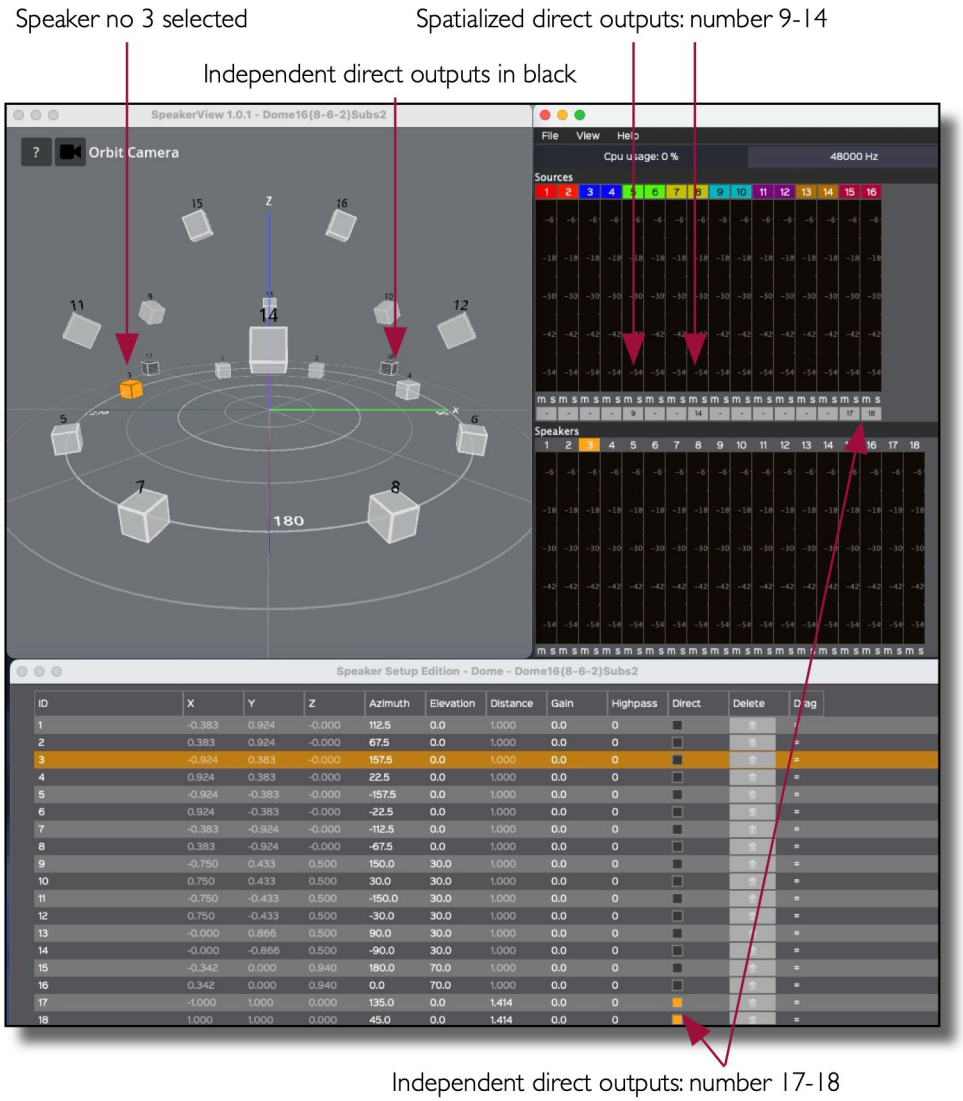
Spatialized Direct outputs

In *SpatGRIS*, any speaker can be used as a direct output and still be used by spatialization algorithms. Each source has a direct output value that is empty by default. Any speaker number can be placed there. The difference between direct output types is that independent outputs are only used for this purpose. There is no distinction in the 3D view of the speaker for spatialized direct outputs[13] .

The distinction can be seen when selecting a direct output. The first numbers at the top of the column (17-18) are independent direct outputs. The other numbers (1-16) can be used as spatialized direct outputs.

[13] Spatialized direct outputs were created by Samuel Béland , a major improvement to SpatGRIS.

In the following example, source 5 is sent directly to speaker 9 and source 8 to speaker 14. Speakers 9 and 14 remain in the DOME configuration. Finally, sources 15-16 are sent to independent direct outputs 17-18:



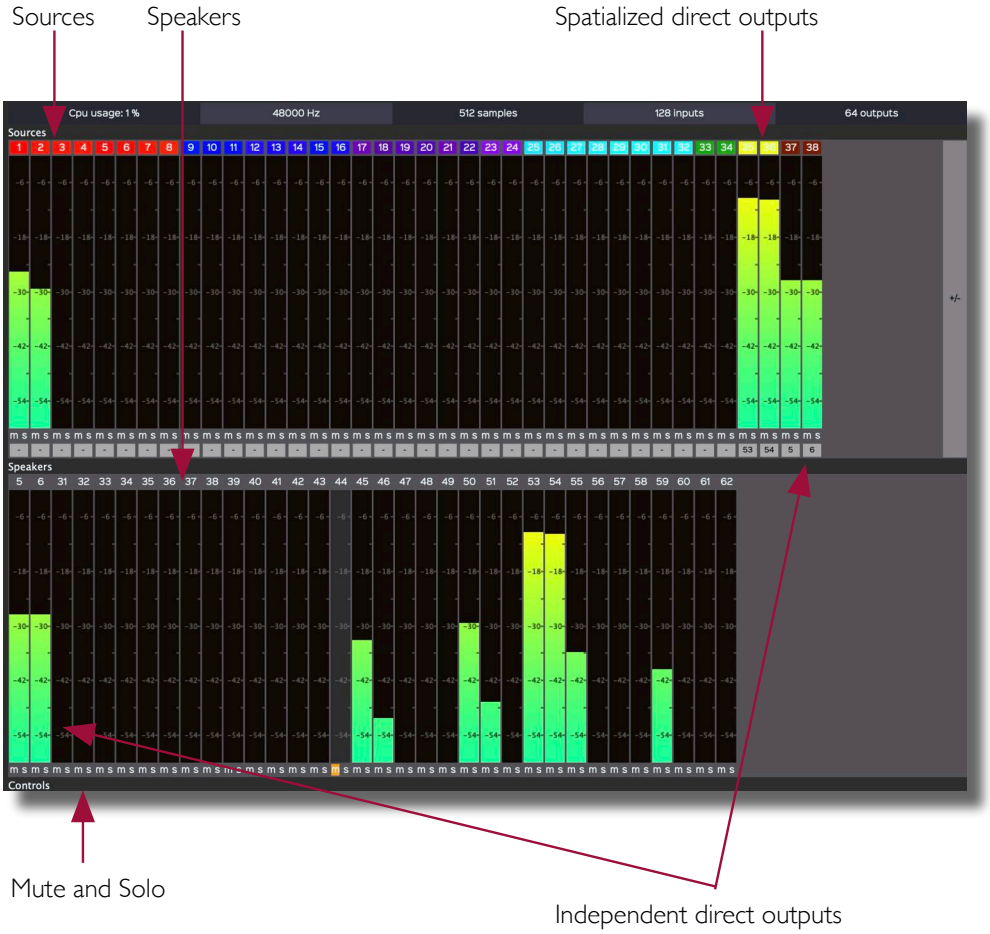
NOTE: Since direct outputs are assigned to specific outputs, if you open a project with a different number of direct outputs than the speaker setup you are using, some outputs may be muted! There is no warning about this!

5.7.7. Show Speaker Numbers

The location of the speakers and their numbers can be viewed in *SpeakerView* by selecting the Show Speaker Numbers option . Direct outputs are displayed in black. Clicking on a speaker or its number selects it; another left click deselects it. In the image above, speaker 3 is selected and the independent direct outputs 17-18 are black. Show Speaker Numbers only works if the Show Speakers option is enabled in the View menu.

5.8. Sources and Speakers

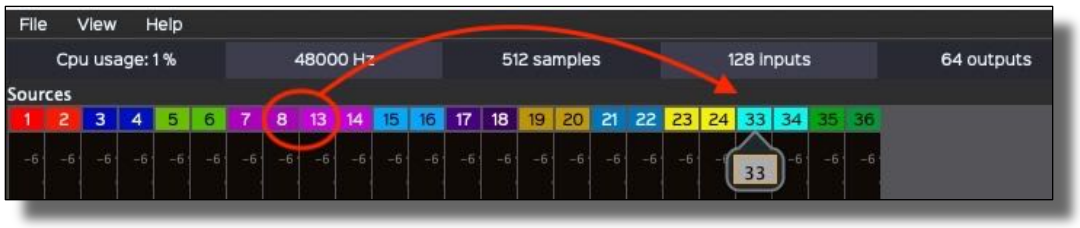
SpatGRIS receives audio signals from the DAW and sends them to the speakers. The two main sections are Sources (from the DAW via *BlackHole*) and Speakers. There are also direct outputs that are sent directly from the sources to certain speakers (for subwoofers, for example).



In this example, the sources consist of four octophonic sources (1-32), plus one stereo source (33-34), two spatialized stereo direct outputs (35-36 sent to 53-54), and two independent direct outputs (37-38, assigned to 5-6) for a total of 38 sources identified by different colour groups, distributed over a dome of 32 speakers with 2 independent direct outputs (5-6).

5.8.1 Non-consecutive sources

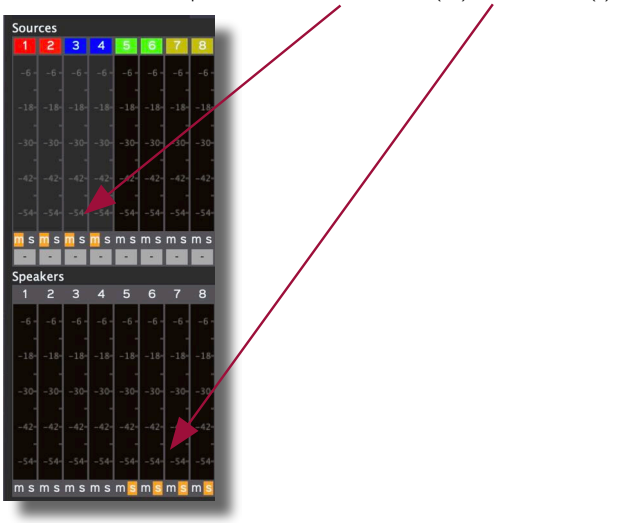
You can select any source using the keyboard shortcut Opt-click on the source number. This can be very useful when using an aggregated device, which includes interfaces with a large number of inputs and outputs. In the example, we see that sources 9 to 12 have been reassigned to 33 to 36. The latter have automatically moved to their logical location. The number 33 is obtained with Opt-click:



5.8.2. Mute and Solo

Each source and each speaker have a Mute button and a Solo button.

All sources and speakers can be muted (m) or soloed (s).



5.8.3. Peak indicators and reset

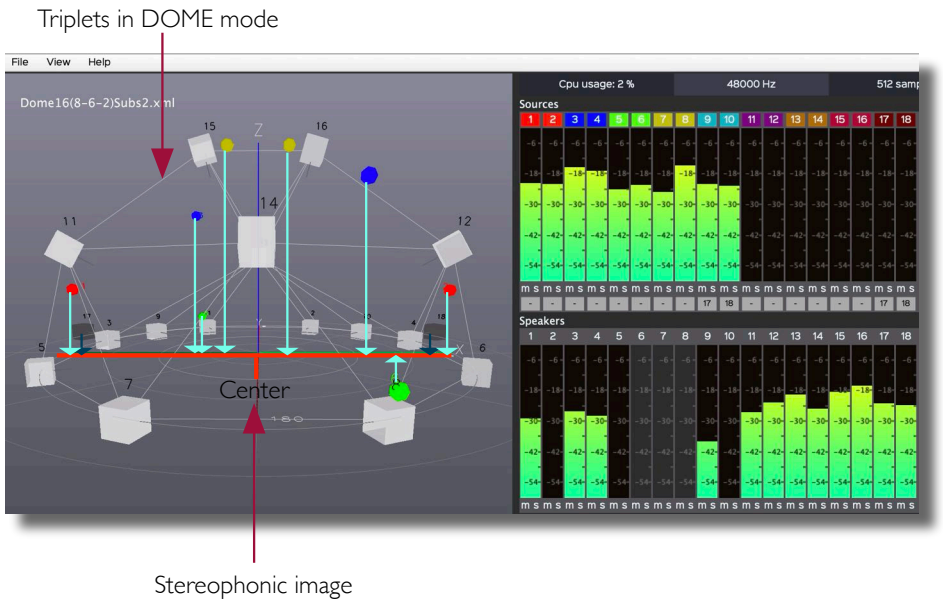
A peak indicator is available for Sources and Speakers. There is a general reset function, Reset Meter Clipping, in the View menu (Opt-M).

5.9. Stereo reductions

5.9.1. STEREO

There is a STEREO mode for listening to a complex project on a pair of speakers. All sounds are sent to the corresponding speakers according to their location (left to left, right to right, no front-back axis, no elevation). When STEREO is selected, the stereo routing option appears, allowing you to choose the outputs of your choice, depending on your sound card. Only the outputs of your sound card are available for stereo reduction. When using the computer's internal sound card, the outputs are assigned to numbers 1 and 2.

This mode can be used to reduce a multichannel project to stereo. Sources are simply placed on the Y-axis, from left to right. Only Azimuth Span is used in STEREO mode, not Elevation span. Keep in mind that sources, except for direct outputs, are never placed directly on one speaker, but on several speakers — at least three on a DOME, many more on a CUBE. Thus, the projection of sources is probably not as accurate as it is on this representation!



5.9.2. BINAURAL

This algorithm was implemented to help users work on 3D spatialization from home when access to a speaker dome is limited or unavailable. It is based on a head-related transfer function (HRTF). HRTF is a function that reproduces the way we perceive the location of sounds in space. It involves a set of phase and amplitude calculations for headphone listening. Its advantage is that it preserves the location of sounds in the front-back and top-bottom dimensions. It provides better sound immersion than stereo.
It is primarily designed for 5.1 reproductions or immersive headphone listening, situations commonly found in video games and the virtual reality industry. BINAURAL mode uses the stereo outputs of your choice. Both Spans are available in BINAURAL mode.
For various reasons and due to technical considerations, the output sound level in STEREO mode differs significantly from that in BINAURAL mode, depending on the number of sources. Please adjust your listening level accordingly.

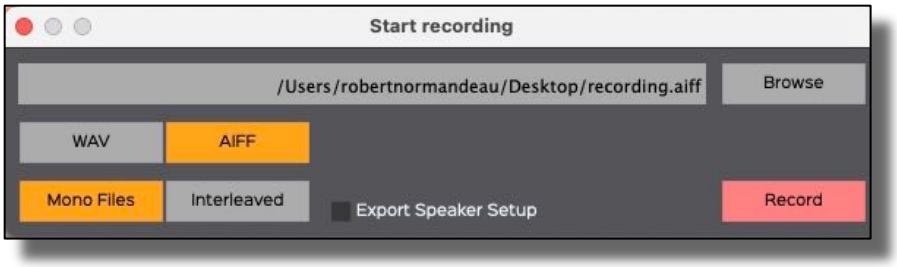
NOTE: Attenuation Settings used in CUBE or HYBRID mode are functional in both stereo reductions.

5.10. Recording

When the spatialization composition is complete, you have two options:
1. Play the track "live" with your DAW and *SpatGRIS*.
2. Record the spatialization on as many audio tracks as there are speakers in the configuration.
SpatGRIS records mono files (AIFF or WAV, depending on your preferences) or an interleaved file.

To record: press the large red button at the bottom right of the main window.

A pop-up window will open, allowing you to specify:
• The location of the saved files.
• Their name
• The format: WAV or AIFF.
• The type of file: multiple mono files or a single interleaved file.
• The option to export the Speaker Setup for the Player function (see Chapter 7).
Pressing Record starts recording and the timer, and the record button flashes. Once the recording is complete, press the record button again to stop. You can then import the separate mono files (or one interleaved file) into any digital audio workstation to play your track live.



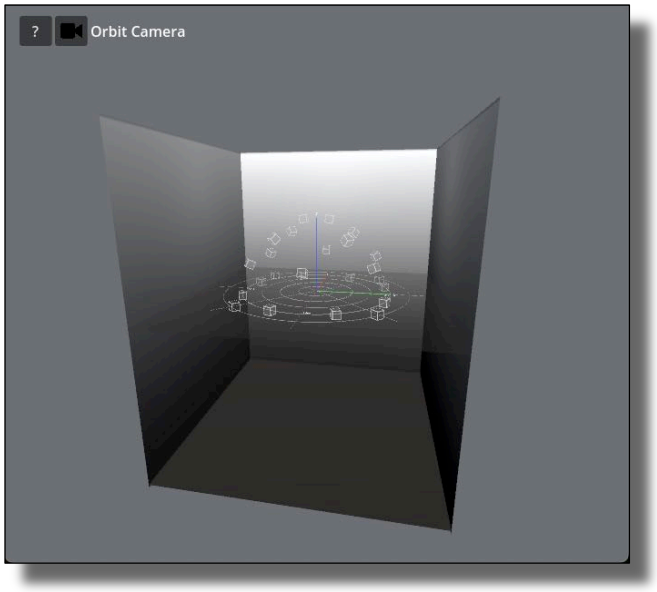
Keep in mind that with interleaved files, there are certain limitations, and these limitations are reached quickly on large projects:
- AIFF is limited to 2 GB.
- WAV is limited to 4 GB[14] .
Furthermore, if you record an interleaved file with many channels, you will find very few SANs capable of opening it[15] . It is therefore preferable to record mono files.

[14] The CAF (Core Audio Format) and WAV RF64 formats will eventually be implemented, which will allow for more than 4 GB.
[15] Reaper can open 128-channel files. To our knowledge, it is the only one of its kind.

6. SpeakerView

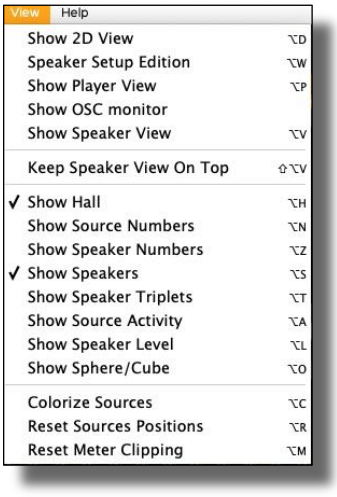
A new logo:

The 3D representation of the speakers is supported by an independent application called *SpeakerView* . The transparency of the speakers, the readability of the numbers, and the fluidity of the movements have been significantly improved. *SpeakerView* is shown here with the Show Hall (Opt-H) feature :



6.1. Visibility and keyboard shortcuts

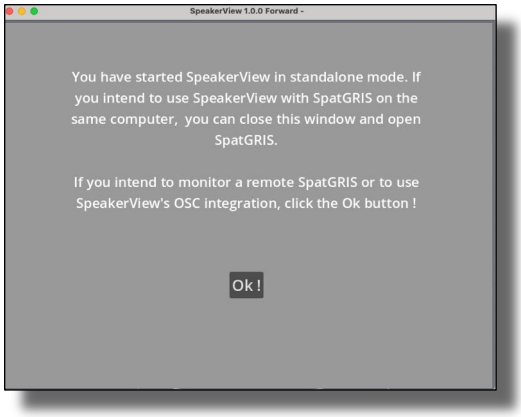
SpeakerView is displayed at the same time as *SpatGRIS*. However, it can be opened or closed independently (Mac: Opt-V; Windows: Alt-V).
The keyboard shortcuts in the *SpatGRIS* View menu control the *SpeakerView* display options:



6.2. Two separate applications

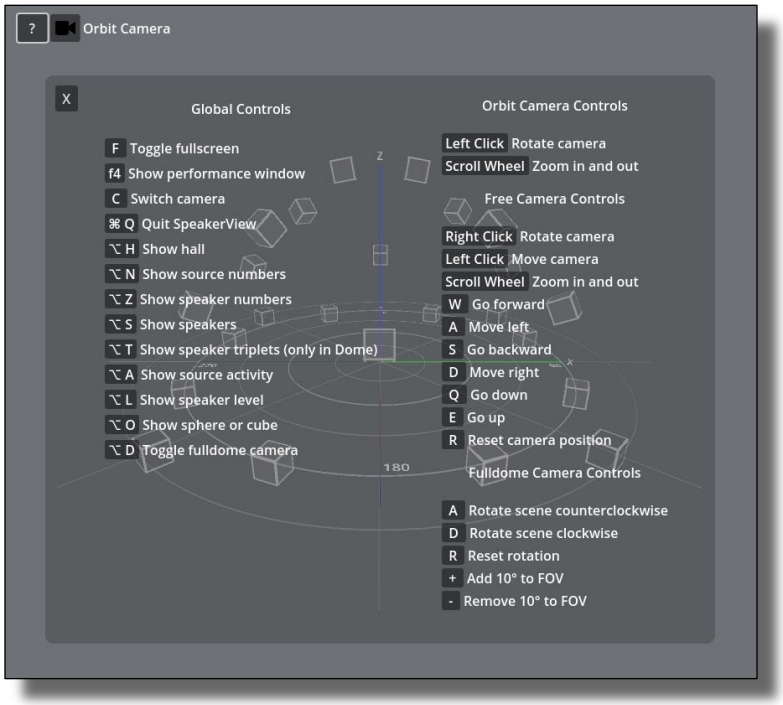
SpeakerView is a separate application from *SpatGRIS*. It can be moved and resized independently. It can also be forced to remain on top of *SpatGRIS* (Keep SpeakerView on Top, Shift-Opt-V).

NOTE: *SpeakerView* is a standalone application, but the user does not need to worry about this, as *SpatGRIS* will take care of everything. We strongly recommend that you do not launch *SpeakerView* from the Finder or the Dock. If it is open in this way, the following warning message will appear:



From there, you have two choices:
- Close *SpeakerView* and open *SpatGRIS*. *SpeakerView* will open automatically.
- Click OK to use *SpeakerView* as a standalone application that can receive multiple OSC messages.

6.3. SpeakerView, a standalone application



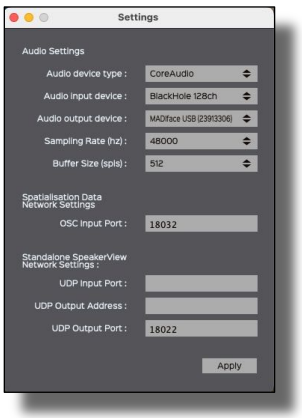
6.3.1. Menus

All the menus displayed in the View menu of *SpatGRIS* that directly concern *SpeakerView* are reproduced here with the aim of using the software as a standalone application.

In addition to these menus, the Global Controls section includes:
• F: Toggle fullscreen: full screen.
• f4: Show performance window: SpeakerView performance.
• C: Switch camera (between Orbit and Free): switch between Orbit and Free cameras.
• ⌘ Q: Close SpeakerView: exit SpeakerView.
• ⌥ D: Toggle fulldome camera: switch to the full dome camera.

NOTE: When the menu window is open, you cannot move around in space.

6.3.2. Settings



New settings are available here to enable communication between *SpatGRIS* and *SpeakerView* in standalone mode:
UDP: User Datagram Protocol
• UDP Input port
• UDP Output Address
• UDP Output port

6.3.3. Cameras

There are now three cameras (viewpoints) in SpeakerView:
• Orbit
• Free
• Fulldome
The first two cameras alternate with the C key.

Orbit Camera Controls

This is the standard camera found in previous versions of *SpatGRIS*.
• Left Click: Rotate camera.
• Scroll Wheel: Zoom in and out.

Free Camera Controls

• Right Click: Rotate camera
• Left Click: Move camera
• Scroll Wheel: Zoom in and out.
• W: Move forward
• A: Move right
• S: Move backward
• D: Move left
• Q: Move up
• E: move down
• R: Return the camera to its default position.

Fulldome Camera Controls

- A: Rotate counterclockwise
- D: Rotate clockwise
- R: Return the camera to its default position.
- +: Add 10° to FOV (Field Of View)
- -: Remove 10° from FOV

7. PLAYER

The PLAYER allows *SpatGRIS* to be used as standalone software to play any piece recorded by *SpatGRIS* with any speaker configuration. The main idea behind the PLAYER is to facilitate the distribution of multichannel works among different users and for different speaker configurations. Works created with a DOME Speaker Setup can be played on a CUBE Speaker Setup and vice versa. Direct outputs are assigned automatically but can be adjusted manually afterwards.

7.1. Making a recording for the PLAYER

The procedure for recording a piece for playback with the PLAYER is almost identical to that of a normal recording. The main difference is that, in addition to recording the audio files themselves, you must export the coordinates of the Speaker Setup used by activating the Export Speaker Setup function. The audio files and the Speaker Setup will be placed in the same folder and must remain there for the PLAYER to function properly. These coordinates will be used by the PLAYER to correctly position the sources in any Speaker Setup.

NOTE: Only mono files work with the PLAYER. You will get an error message if you try to open an interleaved file. The reason for this is that the PLAYER uses the output numbers in the audio file names for spatialization. There is no way to encode this information in an interleaved audio file.

7.2. Opening and playing a project with the PLAYER

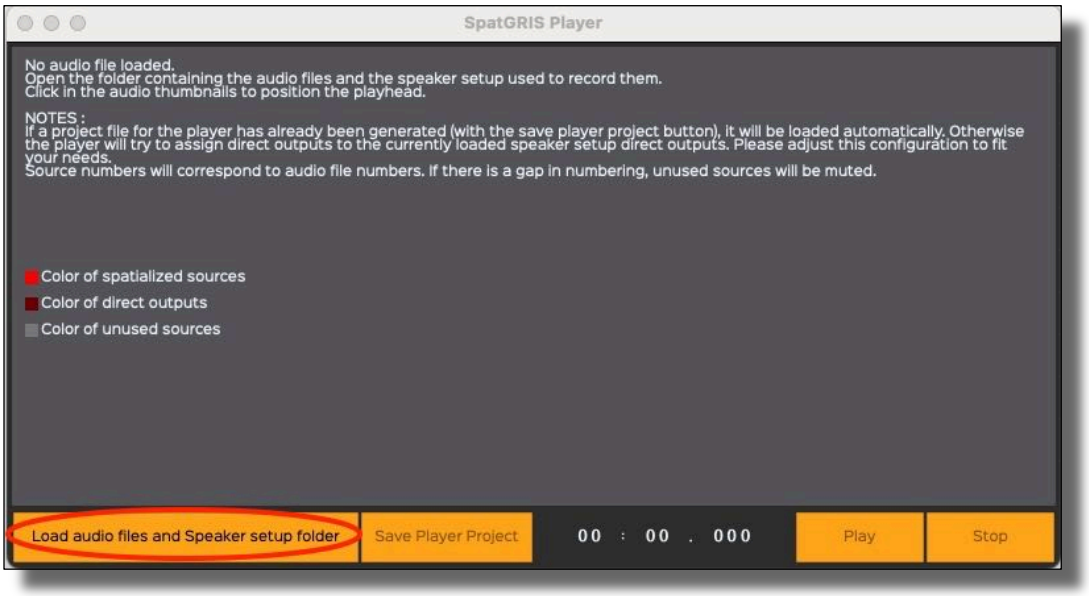
Once the recording is complete, you can send the folder containing the sound files and the Speaker Setup to a listener who uses a different speaker system. You can also use it yourself to listen to the recording on a different speaker system.

7.2.1. Open the Speaker Setup for listening

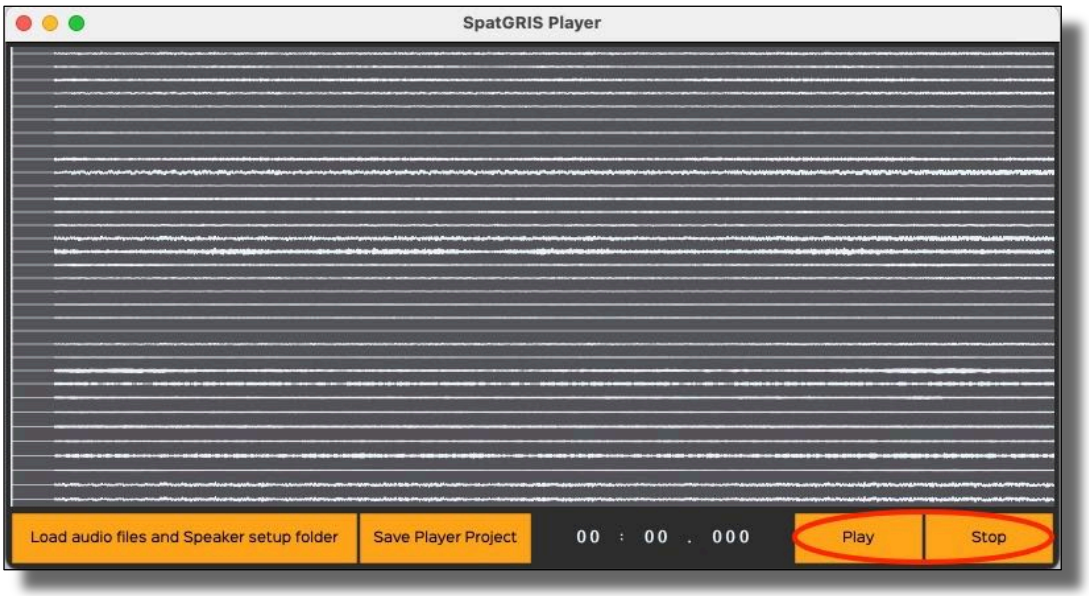
Open the Speaker Setup in *SpatGRIS* on which you intend to listen to the spatialized work. This can be a custom configuration or a configuration from the Templates.

7.2.2. Open the PLAYER window and load the files

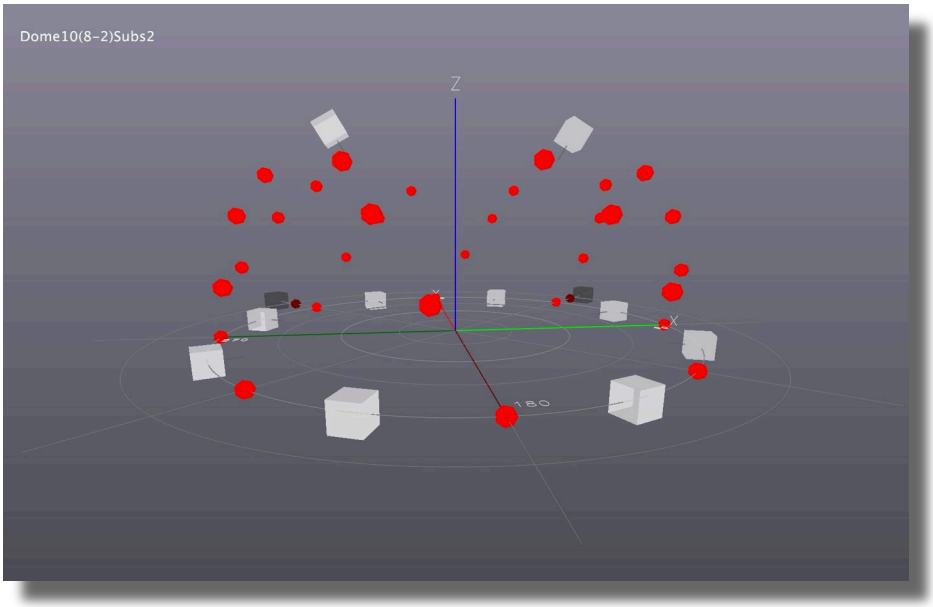
View Menu —> Show Player View
Load the audio files and Speaker Setup folder:



The PLAYER now displays the waveform of the audio files:



The PLAYER also displays the speaker setup used to record the work. The location of the original speakers is indicated in red:



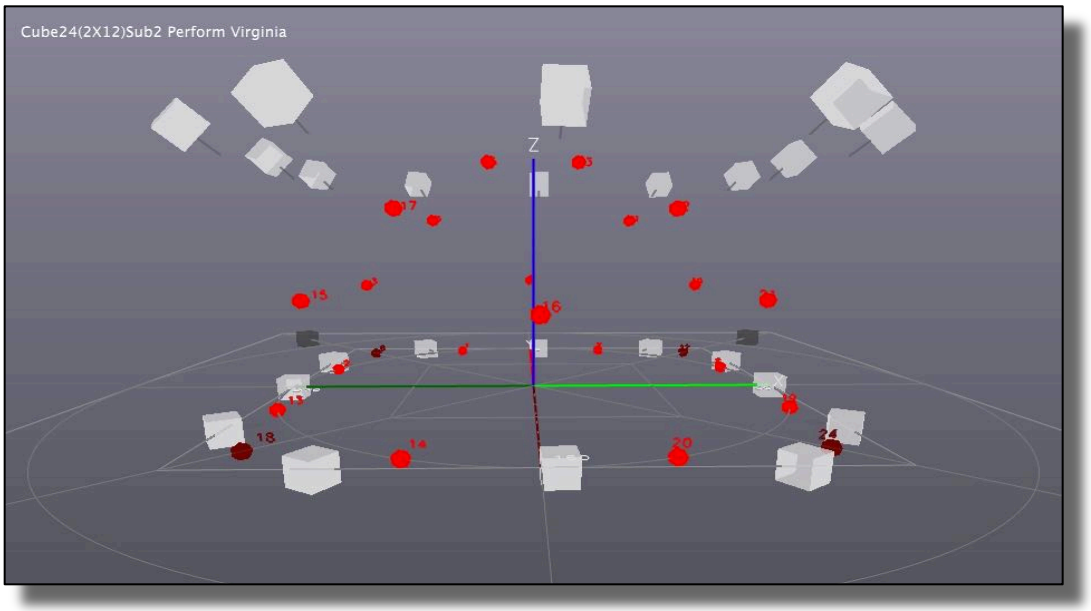
Please note that the current project loaded in *SpatGRIS* is automatically replaced by the project from the recording.

7.2.3. Playing the piece

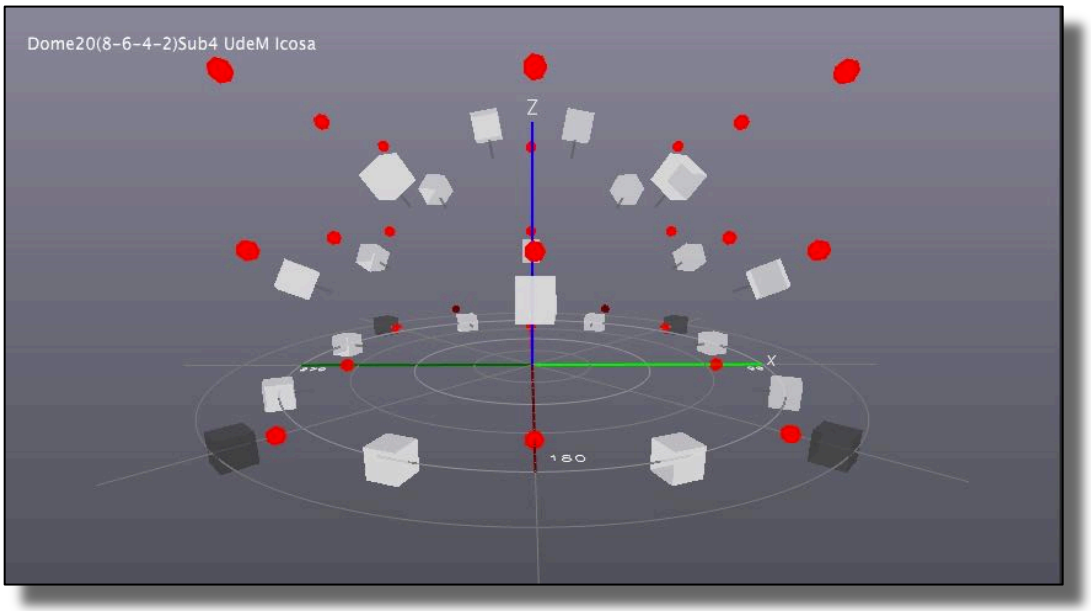
The PLAYER is now ready to play the piece. Simply use the Play and Stop buttons. It is also possible to click anywhere in the audio file to start playback from that point.

7.2.4. DOME in CUBE or CUBE in DOME

Here is an example of a recording made with a dome (Dome20(8-6-4-2)Subs4) and played in a cube (Cube24(2X12)Subs2). As can be seen, the shape of the original dome is well reproduced in the listening cube:

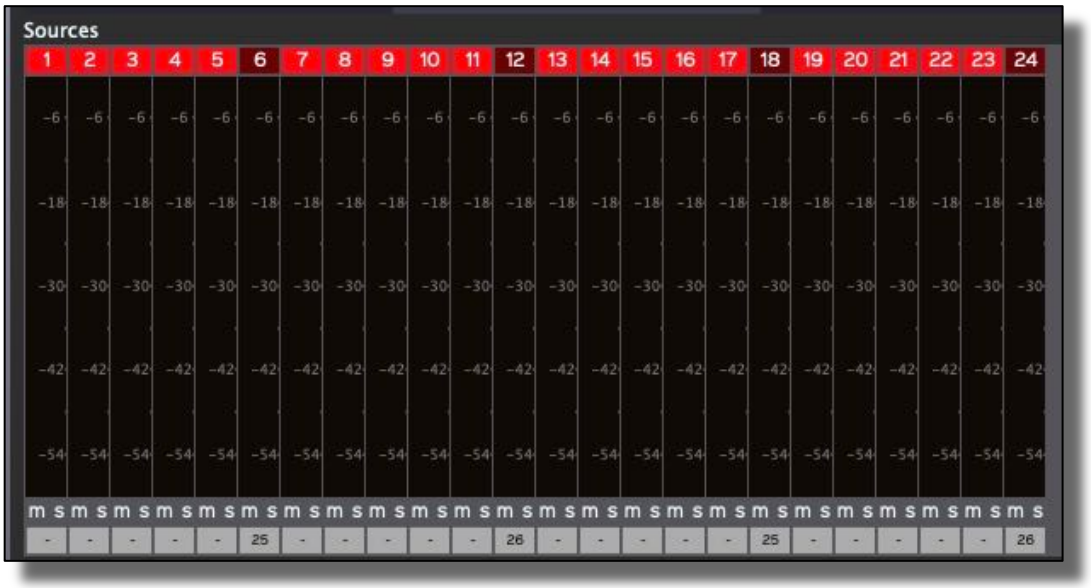


Here is another example showing the opposite situation, a cube recording (Cube24(3X8)Subs2) played in a dome (Dome20(8-6-4-2)Subs4). As can be seen, the shape of the original cube is well reproduced in the listening dome:



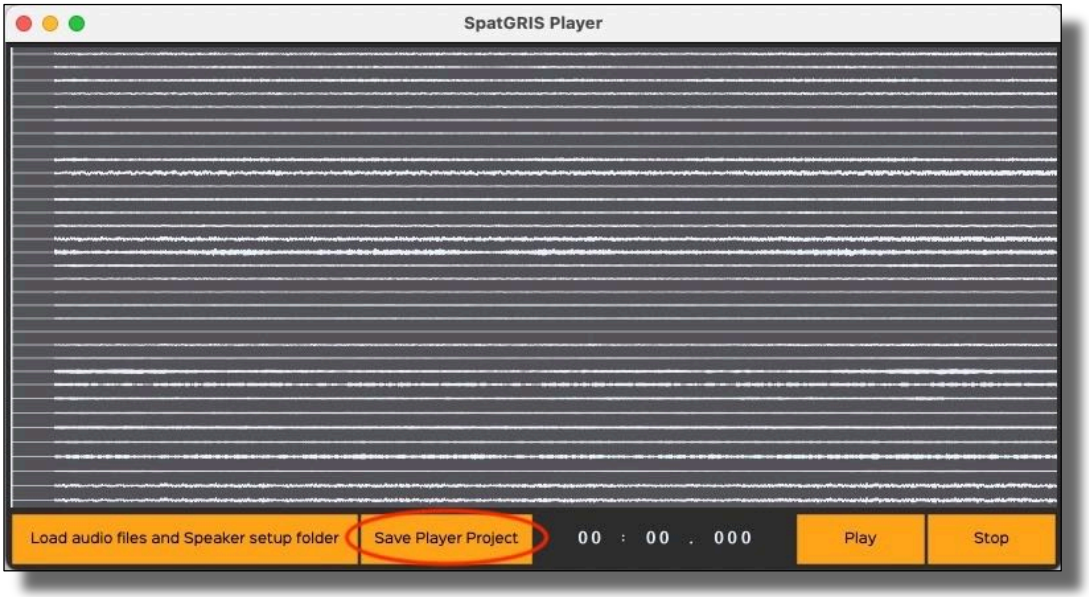
7.2.5. Direct outputs in the PLAYER

The PLAYER will attempt to assign the original direct outputs to the direct outputs of the listening device.
In the first example, the original configuration had four direct outputs (numbers 6-12-18 and 24). But in the listening configuration, there are only two direct outputs (25 and 26). The PLAYER has alternately assigned the original direct output numbers to the direct outputs available in the listening configuration. These output numbers can be adjusted manually afterwards:



7.3. Saving a PLAYER project

If you have modified any part of the PLAYER project, you can save it using the Save Player Project button. This document will automatically be placed in the same folder as the audio files and speaker configuration. The File Saved! button will flash for a while during the process. All files must remain in the same folder. The next time you use the Load audio files and Speaker Setup folder button, everything will be placed correctly according to how it was saved.

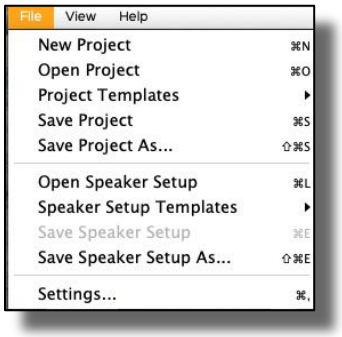


NOTE: A PLAYER project remains active as long as the PLAYER window is open. When you close it, *SpatGRIS* switches to its normal input mode, waiting for audio and OSC from a sequencer or other software.

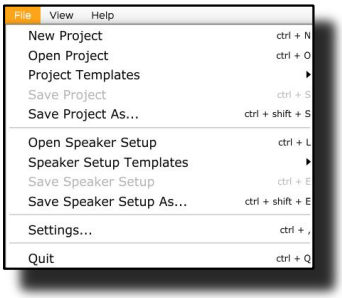
8. Menus

8.1. File Menu

In the File menu, you will find all the project-related functions where you can:

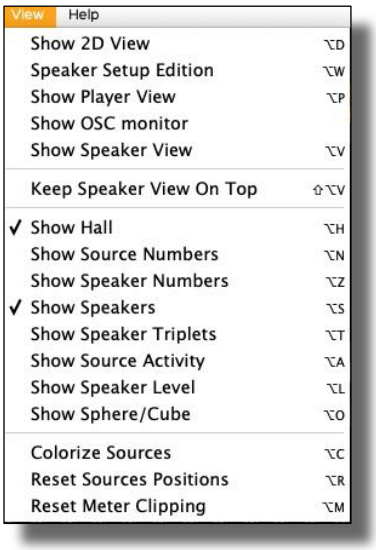


- Create a New Project.
- Open an existing project.
- Open a project from the Project Templates folder. These templates cannot be modified, but they can be edited and saved as a new file.
- Save Project or Save As — to make a copy.
- Open a Speaker Setup.
- Open a Speaker Setup from the Speaker Setup Templates folder. These templates cannot be modified, but they can be edited and saved as a new file.
- Save Speaker Setup or Save As — to make a copy.
- Open the Settings window.



8.2. View Menu

In the View menu, you can choose different perspectives to view speakers and sources in real time. The modifier key for this menu is Option (Opt or ⌥) for Mac, and Alt for Windows .

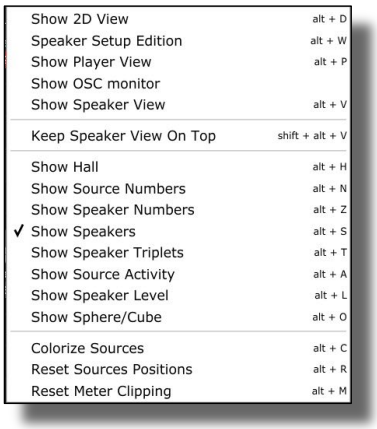


- Show 2D View: A 2D view from above the device is displayed, showing only the sources.
- Speaker Setup Edition: Opens a window providing access to all the settings for a speaker configuration.
- Show Player View: Opens the Player window.
- Show OSC monitor: For specialists! To help troubleshoot incoming OSC message streams.
- Show SpeakerView: Opens the 3D speaker window

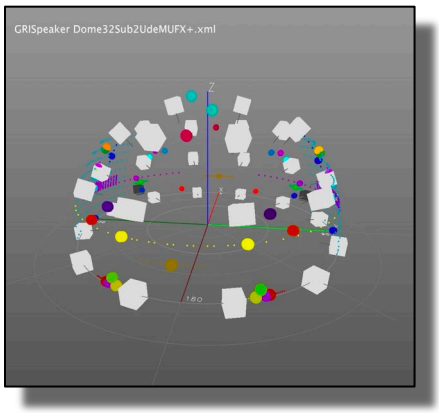
—

Keep SpeakerView on Top

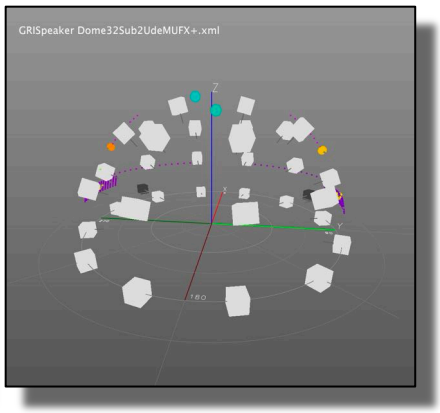
—



- Show Hall: Displays the walls of the room
- Show Numbers: Shows or hides the numbers of the sources and/or speakers displayed.
- Show Speakers: Shows or hides the speakers in the 3D view.
- Show Speaker Triplets: Shows or hides triplets in the 3D view in DOME mode. There are no triplets in CUBE mode.
- Show Source Activity: This option allows you to see the position and trajectories of sources (large dots) and their azimuth and elevation values (small dots), based on data sent by the *ControlGRIS2* plug-in. Note that there is nothing to see when the DAW is shut down. The threshold is set to -70 dB. When this option is not selected, all sources in a project are displayed, even when the DAW is stopped. This option can be useful for checking that there are no duplicate OSC channels sent by *ControlGRIS2* to *SpatGRIS*.



Show Source Activity Off: Displays the position of all sources



Show Source Activity On: Displays only the actual activity of sources in playback mode

• Show Speaker Level: Indicates the amount of energy delivered by each speaker. From gray (nothing) to white (maximum).
• Show Sphere/Cube: If you have the option to play in a complete sphere or cube!
—
• Colorize Sources: Sets all sources to a different colour in the visible spectrum, from red to purple. Please note that this option will erase any custom colours already in place.
• Reset Sources Positions : Resets the 3D view. When switching from one project to another, *SpatGRIS* may sometimes display sources from the previous project. This allows you to clear them.
• Reset Meter Clipping : Peak indicators can be reset individually by clicking on them, or globally with the Opt-M shortcut.
• Mute/Unmute All Speakers. Same as the Mute button.

8.3. Naming and saving

SpatGRIS has three components that are saved independently of each other: Project, Speaker Setup, and Settings.
• Save Project. A project is linked to a work.
• Save Speaker Setup. A speaker setup is linked to a physical installation in a space.
• Save Settings. These settings are linked to a workstation (computer and audio interface), including the stereo outputs used for stereo reductions.

Speaker Setups and Project documents are saved in .xml format . There is no distinction between the two. The Project document does not include the Speaker Setup; they are independent. Therefore, we strongly recommend two things:
• Add the words "Speaker Dome" or "Speaker Cube" to the name of your Speaker Setups and "Project Dome," "Project Cube," or "Project Hybrid" to the name of your project files.
• Save DOME or CUBE Speaker Setups in two separate folders within a folder named Speakers.
• Save *SpatGRIS* projects in three separate folders within a folder named Projects.
The Templates menus we provide with *SpatGRIS* are a good example of proper classification.

• Warnings regarding the document format
SpatGRIS always remembers the last Speaker Setup and Project that were opened.
If you try to open a *SpatGRIS* project with the Load Speaker Setup command (or vice versa), you will receive a warning:

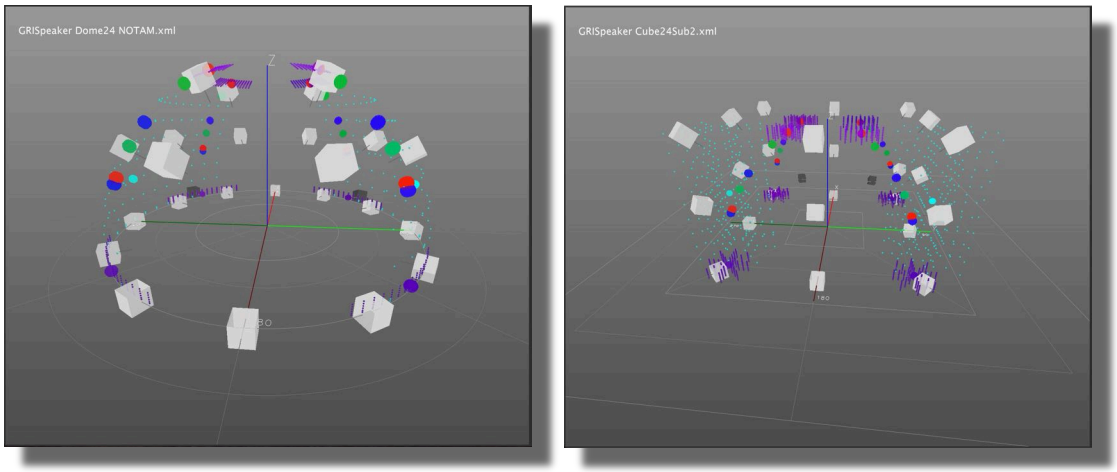
NOTE: *SpatGRIS4* documents use a format that is not backward compatible with *SpatGRIS* version 2. If you try to open a *SpatGRIS* project or speaker setup from version 2, you will get one of these scary messages! Your files are fine, but they are not compatible. Versions 3 and 4 are compatible.

8.4. Representations

SpatGRIS 3D and 2D views are available for DOME and CUBE modes. In DOME mode, sources are located on the surface and spans extend along that surface. In CUBE mode, sources can be placed anywhere in space and spans extend locally around the sources.

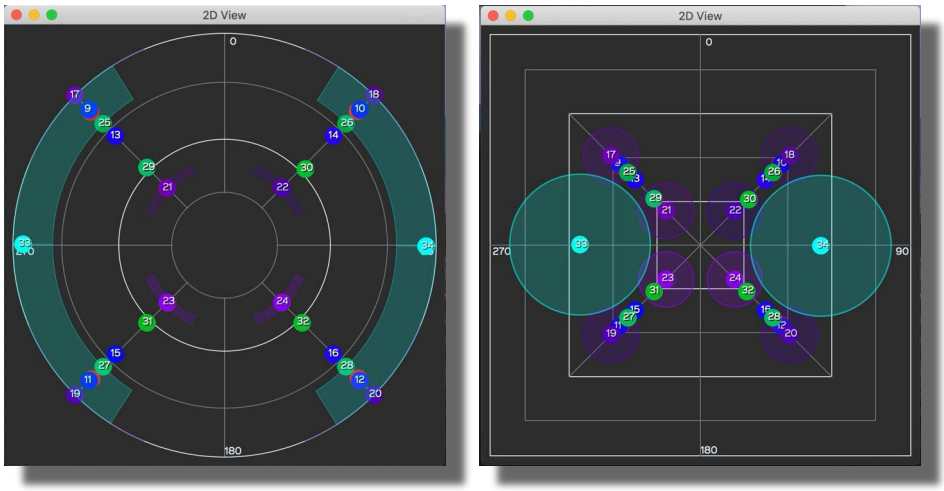
8.4.1. 3D representation

The 3D window in DOME mode (left) or CUBE mode (right) for the same session. Speakers and sources are represented:



8.4.2. 2D representation

The 2D view in DOME mode (left) or CUBE mode (right) of the same session. Only the sources are represented:

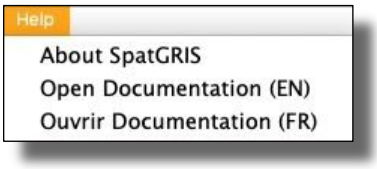


8.5. Performance and CPU workload

Performance with the *ControlGRIS2*/*SpatGRIS4* combination depends largely on the various parameters of your project. As a rule, a project with 64 audio channels sent to 64 speakers will work perfectly well on recent computers. We have tested projects with more than 100 audio channels on a configuration of 128 speakers, and it still worked well!
The factors that will significantly increase CPU usage by our tools are, in order of importance:
• Mode: CUBE is more demanding than DOME, as the former uses more speakers than the latter.
• spans: They distribute the signal to a larger number of speakers than when they are not used, and CPU demand therefore increases very quickly as their values increase.
• Interpolation : The interpolation factor allows certain sounds to transition more smoothly as they move from one location to another. Therefore, the higher this parameter is, the greater the number of speakers involved in the process, since a sound will reach a given speaker sooner and take longer to leave it (not to mention that this makes localization more blurred).
• The number of speakers used in *SpatGRIS*. We have measured comfortable performance with a configuration of 96 speakers, which is more than enough in most realistic situations!
• The number of tracks multiplied by the number of speakers determines the reliability of the installation. A few tracks on a large device will give the same result as many tracks on a small device.
If the CPU exceeds 100%, you will receive this alert:

8.6. Help Menu

The Help menu includes information about GRIS and this manual under the Open Documentation option.



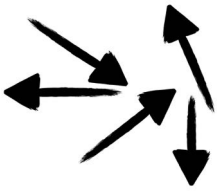
Take the plunge and have fun!

9. Addendum

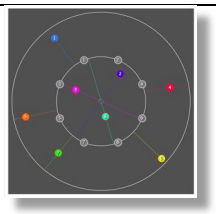
9.1. Sources Link descriptions

9.1.1. Azimuth-Elevation and X-Y

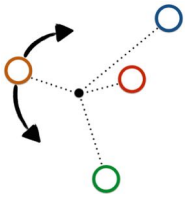
1) Independent MONO + STEREO + MULTIPHONIC



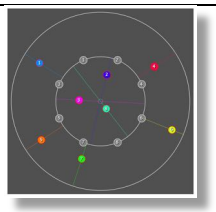
This mode is selected by default. Sources can be moved independently of each other.



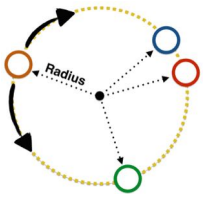
2) Circular STEREO + MULTIPHONIC



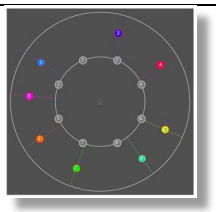
This mode allows for grouped circular movement. The angles between sources remain constant while the radius adjusts proportionally.



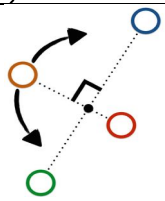
3) Circular Fixed Radius STEREO + MULTIPHONIC



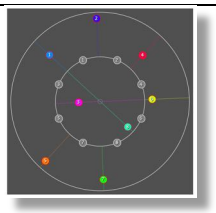
The sources are linked in a circular motion by the Radius parameter, which remains fixed and equal. The relative distance between each source and the centre is the same for all sources.



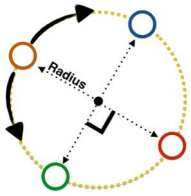
4) Circular Fixed Angle STEREO + MULTIPHONIC



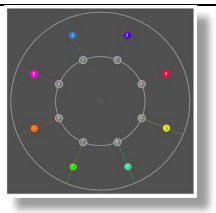
The sources are linked in a circular movement with the Angle parameter, which remains fixed and equal.
For example, in octophony, the opening angle between each of the sources will be set at 45°.



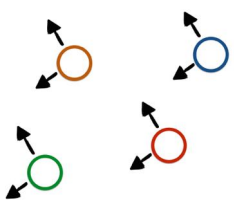
5) Circular Fully Fixed STEREO + MULTIPHONIC



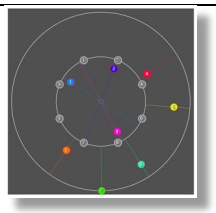
The sources are linked in a circular movement by the Radius and Angle parameters, which remain fixed and equal. The opening between the sources and their radius is therefore always identical.



6) Delta Lock STEREO + MULTIPHONIC

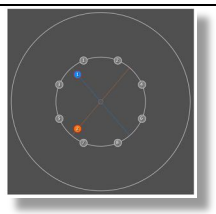


This mode locks the position of the sources relative to each other along the X and Y axes, without the possibility of rotation.

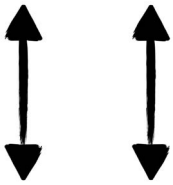


7) Symmetric X STEREO

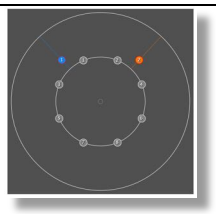
This mode allows symmetry between two sources along the X axis.



8) Symmetric Y STEREO



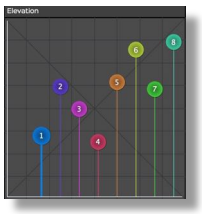
This mode allows symmetry between two sources along the Y axis.



9.1.2. Z (CUBE mode only)

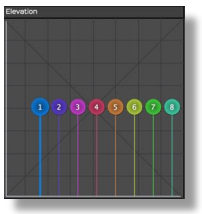
1) Independent MONO + STEREO + MULTIPHONIC

This mode is selected by default. Sources can be moved independently of each other.



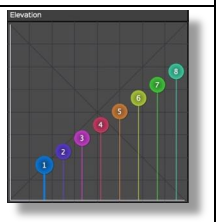
2) Equal Elevation STEREO + MULTIPHONIC

Same elevation for each source.



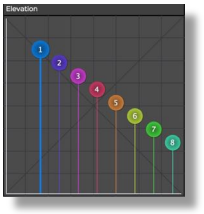
3) Bottom Top STEREO + MULTIPHONIC

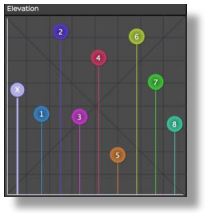
This mode locks the position of the sources from a minimum value to a maximum value in a linear relationship.



4) Top Bottom STEREO + MULTIPHONIC

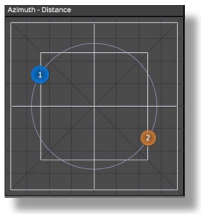
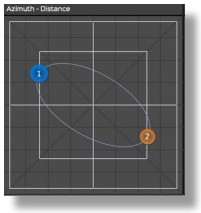
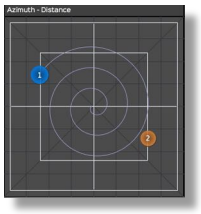
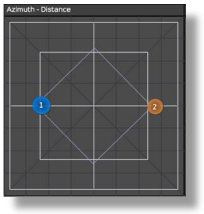
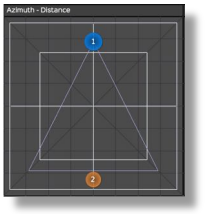
This mode locks the position of sources from a maximum value to a minimum value in a linear relationship.



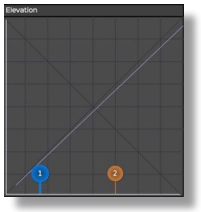
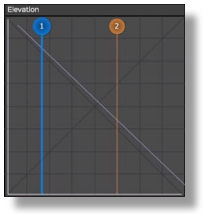
5) Delta Lock STEREO + MULTIPHONIC
This mode locks the position of sources relative to each other. 

9.2. Trajectories descriptions

9.2.1. Azimuth-Elevation and X-Y

1) Circle
Circular movement around the centre. Options: CW/CCW (clockwise/counterclockwise), Back & Forth, Dampening, Deviation. 
2) Ellipse
Elliptical movement around the centre. Options: CW/CCW (clockwise/counterclockwise), Back & Forth, Dampening, Deviation. 
3) Spiral
Concentric movement around the centre. Options: CW/CCW (clockwise/counterclockwise), Back & Forth (back and forth), Dampening (damping), Deviation (deviation). 
4) Square
Square shape around the centre. Options: CW/CCW (clockwise/counterclockwise), Back & Forth (back and forth), Dampening (damping), Deviation (deviation). 
5) Triangle
Triangular shape around the centre. Options: CW/CCW (clockwise/counterclockwise), Back & Forth, Dampening, Deviation. 

9.2.2. Z (CUBE mode only)

1) Down Up	
From bottom to top. Options: Back & Forth and Dampening.	
2) Up Down	
From top to bottom. Options: Back & Forth and Dampening.	

9.3. OSC messages in SpatGRIS

OSC messages can be sent directly to *SpatGRIS* without having to use *ControlGRIS2*.
OSC input port number: 18032 by default (can be changed in File -> Settings)

The server address is always /spat/serv.
Please note that angles are always measured clockwise, starting from the centre of the scene (positive Y direction).

`pol` moves a source using polar coordinates in radians.

#parameter	type	allowed values	meaning
1	string	`pol`	-
2	int	[1, 128]	Source index
3	float	any	azimuth angle
4	float	any	elevation angle
5	float	[-3.0, 3.0]	radius
6	float	[0, 1]	Horizontal span
7	float	[0, 1]	Vertical span

e.g.: The message /spat/serv pol 7 0.0 0.78 0.5 0.1 0.2 moves source #7 to the front, at mid-height and halfway from the origin, with a horizontal span of 10% and a vertical span of 20%.

deg Moves a source using polar coordinates in degrees.

index	type	Allowed values	meaning
1	string	deg	-
2	int	[1, 128]	Source index
3	float	any	azimuth angle
4	float	any	elevation angle
5	float	[-3.0, 3.0]	radius
6	float	[0, 1]	Horizontal span
7	float	[0, 1]	Vertical span

e.g.: The message /spat/serv deg 7 -90.0 45.0 0.5 0.1 0.2 moves source #7 to the far left, at half elevation and half distance from the space, with a horizontal span of 10% and a vertical span of 20%.

car moves a source using Cartesian coordinates.

index	type	Allowed values	meaning
1	string,	car	-
2	int	[1, 128]	Source index
3	float	[-1.66, 1.66]	x (left/right)
4	float	[-1.66, 1.66]	y (back/front)
5	float	[-1.66, 1.66]	z (down/up)
6	float	[0, 1]	Horizontal span
7	float	[0, 1]	Vertical span

e.g.: the message /spat/serv car 7 1.0 1.0 1.0 0.0 0.0 moves source no. 7 to the upper right corner, with no horizontal or vertical span.

clr clears the position of a source.

index	type	Allowed values	meaning
1	string	clr	clear
2	int	[1, 128]	Source index

e.g.: The message /spat/serv clr 7 clears the position of the seventh source.

alg sets a source's hybrid spatialization mode.

index	type	Allowed values	meaning
1	string	alg	-
2	int	[1, 128]	Source index
3	string	dome or cube	Algorithm

e.g.: The message /spat/serv alg 7 cube sets the spatialization algorithm for the seventh source to "cube" (only works in hybrid mode).

9.4. OSC messages in ControlGRIS2

Here are the OSC messages that *ControlGRIS2* can send and receive. The first number corresponds to the plug-in ID. The second number corresponds to the source number. These are the default values:

- /controlgris/1/traj/1/x value => [0.0;1.0]
- /controlgris/1/traj/1/y value => [0.0;1.0]
- /controlgris/1/traj/1/z value => [0.0;1.0]
- /controlgris/1/traj/1/xyz/1 value => [0.0;1.0]
- /controlgris/1/traj/1/xyz/2 value => [0.0;1.0]
- /controlgris/1/traj/1/xyz/3 value => [0.0;1.0]
- /controlgris/1/traj/1/xy values => [0.0;1.0] [0.0;1.0]
- /controlgris/1/traj/1/xyz values => [0.0;1.0] [0.0;1.0] [0.0;1.0]
- /controlgris/1/azispan value => [0.0;1.0]
- /controlgris/1/elespan value => [0.0;1.0]
- /controlgris/1/sourcelink value => 1 to 8
  1: Independent
  2: Circular
  3: Circular Fixed Radius
  4: Circular Fixed Angle
  5: Fully Fixed Circular
  6: Delta Lock
  7: Symmetrix X
  8: Symmetric Y
- /controlgris/1/sourcelinkalt value => 1 to 5
  1: Independent
  2: Equal Elevation
  3: Bottom-Top
  4: Top-Bottom
  5: Delta Lock
- /controlgris/1/presets value => 1 to 50
- /controlgris/1/elevationmode value => 1 to 3
  1: Normal
  2: Extended Top
  3: Extended Top and Bottom

9.5. Open Stage Control

An external template Open Stage Control for *iPad*™ is available for *ControlGRIS2*.
An addendum manual for this model is available on SourceForge.

9.6. Uninstalling

9.6.1. SpatGRIS

If you need to uninstall *SpatGRIS* or if you notice strange behaviour in the software, you will need to do so manually.
- Move the GRIS folder containing the applications themselves to the trash.
- Move these files to the trash:

~/Library/Preferences/ca.umontreal.musique.gris.spatgris.plist
~/Library/Preferences/ca.umontreal.musique.gris.controlgris.pkg.plist
~/Application Support/GRIS/ SpatGRIS.x.x.xml where x.x.x represents the version of *SpatGRIS* (4.0.1, for example).

9.6.2. ControlGRIS2

If you need to uninstall *ControlGRIS2* .
Here are the steps for Mac users:
- To uninstall the Audio Unit version, delete it from the following location:

~/Library/Audio/Plug-Ins/Components
- To uninstall the VST3 version, delete it from the VST3 folder in the following location:

~/Library/Audio/Plug-Ins/VST3.
• To uninstall the AAX version, delete it from the following location:
Macintosh HD/Library/Application Support/Avid/Audio/Plug-Ins/

9.7. Technical Information

9.7.1. Multi-client

SpatGRIS is multi-client software , which means it can connect to multiple audio software programs at the same time. Keep in mind, however, that its main use is to spatialize sounds coming from a single SAN, and it is quite rare for two SANs to coexist peacefully at the same time. The software receives two types of information:
• Audio signals from *BlackHole*
• OSC signals from *ControlGRIS2*.
Both signals are necessary for sound spatialization. For direct outputs, only the audio signal is necessary.
If you are using only one SAN, there is no problem, but it is mandatory that the audio output channel numbers match the OSC source numbers (defined by the First Source ID parameter) in the corresponding *ControlGRIS2* instance for the sound to be spatialized in *SpatGRIS*. If this is not the case, spatialization will be silent or will not work properly. Things get a little more complicated if you intend to use more than one software at a time...
• *BlackHole* has a limited number of 256 channels in total. If you want to connect one DAW with 24 channels and another with 8 channels, keep in mind that the second DAW will have to be set to channels 25-32 in *BlackHole*, and *ControlGRIS2* will need to use the corresponding OSC numbers.

NOTE: Set the buffer size to the same value in your DAW and in *SpatGRIS*. A value of 1024 or higher is recommended.

9.7.2. Binaural calculation

To minimize the number of calculations (HRTF can be very demanding in terms of computing power), *SpatGRIS* first calculates VBAP spatialization on 16 speakers (using BINAURAL_SPEAKER_SETUP, which is hidden in this version) and then transfers the result to HRTF. Don't worry, even if your speaker configuration contains more than 16 speakers, no information is lost in the process.

9.7.3. Which mode is loaded with Speaker Setup and Project, details?

A Speaker Setup (SS) followed by a Project (P):
1.1. SS Dome + P Dome = Dome.
2.1. SS Cube + P Cube = Cube.
3.1. SS Dome + P Cube = Cube. The SS dome is converted to an SS cube. The shape of the SS does not change, since the Cube algorithm accepts all domes (this can be confirmed by opening the Speaker Setup Edition window). Before closing the SS, you will be asked to save the changes.
4.1. SS Cube + P Dome = Dome. The SS cube is converted to a dome after the conversion message is approved.
5.1. SS Dome + P Hybrid = Hybrid.
6.1. SS Cube + P Hybrid = Hybrid. The SS Cube is converted to a Dome after approval of the conversion message.

In reverse order:
1.2. P Dome + SS Dome = Dome.
2.2. P Cube + SS Cube = Cube.
3.2. P Cube + SS Dome = Dome. The Cube project has been converted to Dome.
4.2. P Dome + SS Cube = Cube. The Dome project has been converted to Cube.
5.2. P Hybrid + SS Dome = Hybrid. This is the only exception where Hybrid takes priority, even though it was loaded first. This is because hybrid projects only work on SS Dome.
6.2. P Hybrid + SS Cube = Cube. Hybrid disappears from view, since we have just switched to Cube. This is normal. By then manually selecting Hybrid, the SS Cube is converted to Dome after approving the conversion message. The saved information from P Hybrid is then retrieved.

10. Known issues and warnings

There are so many different situations and configurations that it would be impossible for us to cover them all. So far, we have not found any situations where the system does not work at all. However, we have found situations where certain settings need to be adjusted before the system can work properly. Here are a few of them.

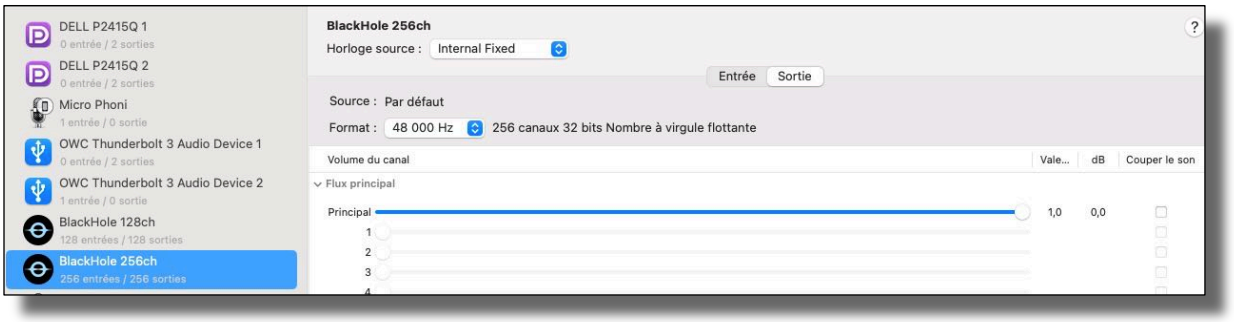
10.1. Known issues

10.1.1. SpatGRIS, the plug-in, and SpatGRIS, the software

For those who have used the *SpatGRIS* plug-in, you will notice that it no longer works on the latest macOS systems and Apple Silicon computers. We recommend switching to *ControlGRIS2*. Development of *SpatGRIS1* ended in 2018.

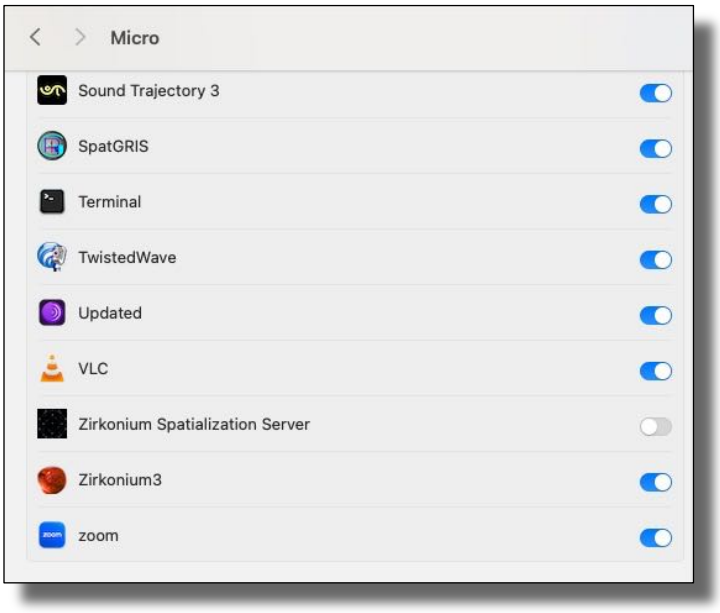
10.1.2. BlackHole volume at 0 dB

After installing or reinstalling *Blackhole*, make sure that the *BlackHole* volume is set to 0 dB in the Audio Midi configuration.



10.1.3. Microphone access

On macOS, make sure SpatGRIS has access to the microphone in System Preferences, Security & Privacy :



10.2. Reaper

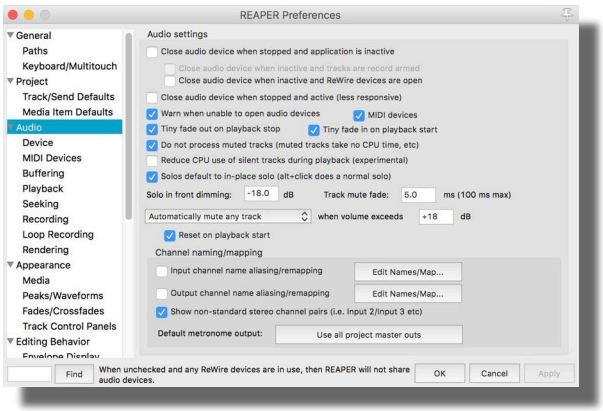
10.2.1. Mono tracks

- Create a track and insert an instance of *ControlGRIS2* and a mono audio file into it.
- Click the Route button to the right of the track's gain control knob.
- In the window that opens, uncheck Master send.
- At the bottom left of this window, click the Add new hardware output... button.
- At the very bottom of the list of outputs in the output interface are the individual mono outputs.
- Select the output that corresponds to the number assigned to the source in *ControlGRIS2*.

It is not necessary to pan mono sources to the left for odd tracks and to the right for even tracks, since Reaper's mono hardware outputs are used. Furthermore, Reaper's Master track is currently limited to 128 channels, so it is convenient to use Reaper's hardware outputs directly as described.

10.2.2. Preferences with Jack

In Reaper's Preferences, under the Audio tab: uncheck "Close audio device when stopped and application is inactive." Otherwise, *Jack* will lose contact with Reaper when it is inactive, and the system will never work.



10.3. Logic Pro

10.3.1. Single Surround Output

In Logic Pro, only one surround instance is possible. This means that it is not possible to have multiple multichannel tracks in Logic while using *SpatGRIS*. To avoid this restriction, only use mono and stereo tracks in Logic.

10.3.2. Activate button

When using *ControlGRIS2*'s preset paths, there is one exception regarding the Activate button in Logic Pro. If there is no audio left in the track at the stop position, the Activate button will not turn off. It will need to be turned off manually.

10.4. Digital Performer 11

10.4.1. Automation of memories

The automation of memories recorded in DP presents smooth curves instead of the expected square curves. This means that the transition from one automated memory to another is gradual, whereas it is expected to be discrete. MOTU has been aware of this for several years without providing any fixes. This is beyond our control.

10.5. Using SpatGRIS with live inputs

When using live inputs, we recommend using the aggregated device on a Mac. Based on our testing, the system is stable when you create an aggregate device comprising the sound card you are using and BlackHole. This aggregate device must be designated as the audio input and output device in your SAN and as the audio input and output device in SpatGRIS.
For channel numbering, please refer to the Audio/Midi Configuration application on your Mac once you have created your aggregate device. By placing your physical sound card as the first device item, you will not need to change the numbering of the speaker configurations. This workflow has been tested with Ableton Live.
For detailed information, please refer to the separate Tips & Tricks document.
For use on Windows, Jack seems to suffice, but we have not tested it extensively

NOTE: Adjust the buffer size to the same value in your DAW and in *SpatGRIS*. A value of 1024 or higher is recommended.

11. Tips and Tricks

There is now a separate document entitled *Tips and Tricks* that contains advice for users and unorthodox uses of the software.
This document will be updated and expanded regularly.

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