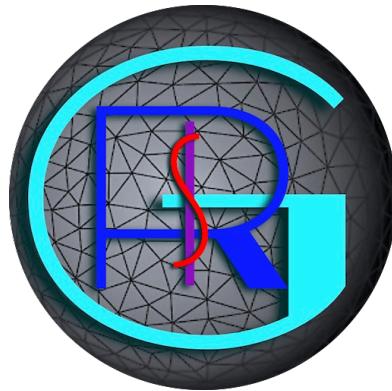


SpatGRIS



Tools for 2D and 3D sound spatialization

Developed by the
Groupe de Recherche en Immersion Spatiale
GRIS

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

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Manual

SpatGRIS 3.2.4
ControlGRIS 1.4.1
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Table of Contents

I. GENERAL PRESENTATION	5
1.1. SpatGRIS is a mixer	5
1.1.1. An external mixer.....	5
1.1.2. An internal mixer.....	5
1.2. SpatGRIS does spatialization and localization.....	5
1.2.1. Spatialization	5
1.2.2. Localization.....	5
1.3. SpatGRIS is a recorder and a player	5
1.4. SpatGRIS makes speaker setups	5
1.5. The speakers can be part of the spatialization and the localization	5
1.6. The three sections of SpatGRIS.....	6
1.7. What's new and improved in SpatGRIS?	6
1.8. Groupe de Recherche en Immersion Spatiale (GRIS)	6
2. INTRODUCTION	7
2.1. Architecture	7
2.2. SpatGRIS.....	7
2.2.1. History.....	7
2.2.2. System requirements	8
2.2.3. Installation notes.....	8
2.2.4. Access to the microphone.....	8
2.3. ControlGRIS.....	9
2.3.1. History.....	9
2.3.2. System requirements	9
2.3.3. Installation notes.....	9
2.3.4. AU, VST, AAX	9
2.4. Quick Start Guide	10
3. CONNECTIONS	12
3.1. Connect the DAW to SpatGRIS	12
3.1.1. Open SpatGRIS.....	12
3.1.2. Adjust the output level.....	12
3.1.3. Assign the DAW to BlackHole.....	12
3.1.4. Multiclient	12
3.2. Connect ControlGRIS to SpatGRIS.....	13
3.2.1. Numbering audio and OSC	13
3.2.2. Sources Colour	14
4. CONTROLGRIS	15
4.1. Introduction.....	15
4.2. Graphical interface.....	15
4.3. Configuration panel	16
4.3.1. Settings.....	16
MODE.....	16
OSC Port.....	16
IP Address	16
Number of Sources	16
First Source ID	16
4.3.2. Sources	16
4.3.3. Controllers.....	17
4.4. Spatialization views	17

4.4.1 View in DOME mode	17
4.4.2. Spans in DOME mode.....	18
4.4.3. View in CUBE mode.....	18
4.4.4. Spans in CUBE mode.....	19
4.4.5. CUBE Elevation in Normal or Extended Top mode.....	19
4.4.6. CUBE Elevation in Extended Top and Bottom mode.....	20
4.5. How to use ControlGRIS	20
4.5.1. Load the plugin on a track.....	20
4.5.2. Save presets and recording automation.....	20
4.5.3. Recall presets.....	21
4.6. Trajectories	21
4.6.1. Sources Link.....	22
Azimuth-Elevation (DOME) and Azimuth-Distance (CUBE) Links.....	22
Elevation Links (CUBE mode only)	22
4.6.2. Trajectory Type	22
Azimuth-Elevation (DOME) and Azimuth-Distance (CUBE) Trajectory Type.....	23
Elevation (CUBE only) Trajectory Type	23
Other settings	23
Realtime.....	23
Drawing	24
Shift-Click in Drawing mode.....	24
Activate.....	25
Trajectory recording in the DAW	25
4.6.3. A special case: the pendulum	25
4.6.4. Presets and automated trajectory.....	25
5. SPATGRIS.....	27
5.1. Introduction.....	27
5.2. Change the setup not the spatialization.....	27
5.3. Settings.....	28
5.4. Controls	29
5.5. The DOME and the CUBE.....	29
5.5.1. DOME.....	29
5.5.2. CUBE	30
5.5.3. Attenuation settings in CUBE or HYBRID mode	30
5.5.4. Convert from DOME to CUBE and vice versa	31
5.5.5. Spatialization in 2D and 3D	32
5.6. The HYBRID mode: DOME and CUBE in the same project.....	32
5.6.1. What is saved in HYBRID mode?	32
5.7. Speaker Setup.....	33
5.7.1. Speaker Setup Edition	33
5.7.2. Speakers' order and image representation	34
5.7.3. Minimal requirements	35
5.7.4. Direct outputs.....	35
Independent direct outputs.....	35
Spatialized direct outputs	35
5.7.5. Show Speaker Numbers.....	36
5.8. Sources and Speakers.....	37
5.8.1. Mute and Solo	38
5.8.2. Peak indicators and Reset	38
5.9. STEREO reduction.....	38
5.9.1. STEREO	38
5.9.2. BINAURAL	39
5.10. Recording.....	39
6. PLAYER.....	41

6.1. To make a recording for the PLAYER	41
6.2. To open and to play a project with the PLAYER	41
6.2.1. Open the listening speaker setup.....	41
6.2.2. Open the PLAYER window and load the files.....	42
6.2.3. To play the piece	43
6.2.4. DOME in CUBE or CUBE in DOME.....	43
6.2.5. Regarding the direct outs in the PLAYER.....	44
6.3. To save a PLAYER project.....	45
7. MENUS.....	46
7.1. File menu	46
7.2. View menu	46
7.3. Naming and Saving	47
7.4. Representations.....	48
7.4.1. 3D Representation.....	48
7.4.2. 2D Representation.....	49
7.5. Performance and CPU burst	49
7.6. Help Menu	49
8. ADDENDUM	50
8.1. Sources Link descriptions.....	50
8.1.1. Azimuth-Elevation and Azimuth-Distance.....	50
8.1.2. Elevation (CUBE mode only).....	51
8.2. Trajectory descriptions.....	52
8.2.1. Azimuth-Elevation and Azimuth-Distance.....	52
8.2.2. Elevation (CUBE mode only).....	53
8.3. OSC messages in SpatGRIS	53
8.4. OSC messages in ControlGRIS	55
8.5. Open Stage Control and Lemur	55
8.6. Uninstall	55
8.6.1. SpatGRIS.....	55
8.6.2. ControlGRIS	55
9. KNOWN ISSUES AND WARNINGS	56
9.1. Known issues	56
9.1.1. SpatGRIS.....	56
9.1.2. ControlGRIS	56
9.1.3. SpatGris, the plugin and SpatGRIS, the software	56
9.2. Reaper	56
9.2.1. Mono tracks	56
9.3. Logic Pro	56
9.3.1. Lack of Surround outputs	56
9.3.2. Activate buttons	56
9.4. Digital Performer II and Automated presets	56
9.5. To use SpatGRIS in a live situation, use the same value of the buffer size.....	57
9.6. Apple M1 and Monterey (12.6).....	57
INDEX	58



I. General presentation

I.1. SpatGRIS is a mixer

I.1.1. An external mixer

Using its two algorithms DOME or CUBE, *SpatGRIS* maps the sources - which come from any audio software – to a speaker setup. The position of the sources is provided by OSC messages. The spatialization is done outside *SpatGRIS*, through a speaker system in a physical space.

I.1.2. An internal mixer

With the functions STEREO and BINAURAL, *SpatGRIS* renders a two-channel reduction mix, either for monitor speakers, or for headphones. Spatialized sounds and direct outputs are included in this reduction. The spatialization is always linked to the position of the loudspeaker in space, whatever the mode *SpatGRIS* is in.

I.2. SpatGRIS does spatialization and localization

The spatialization gives the listener the impression of being surrounded by the sound. It's an immersive experience. The localization is a way to place a sound at a very precise place in the space. The two concepts can be superimposed.

I.2.1. Spatialization

The DOME and CUBE algorithms spatialize the sound in the space in a way that is determined by the speaker setup and the room in which it is installed. The OSC sources are spatialized.

I.2.2. Localization

SpatGRIS locates sounds at specific coordinates using the direct output function. There are two types of direct outputs: spatialized or independent. The direct outputs are localized.

I.3. SpatGRIS is a recorder and a player

SpatGRIS allows recording the speaker outputs in spatialized modes (DOME or CUBE) or two-channel modes (STEREO or BINAURAL) under two standards - WAV, AIFF - and two formats - Mono Files or Interleaved. With the PLAYER tool, *SpatGRIS* can play any multichannel works encoded with it.

I.4. SpatGRIS makes speaker setups

The speaker setup can adopt the form of a DOME - with a fixed distance of 1.00 between every point of the surface from the centre of the DOME, or the free form of a virtual CUBE, made of two zones — an interior zone — where the sound stays untouched — and an exterior zone — where the sound is altered in volume and frequency content.

I.5. The speakers can be part of the spatialization and the localization

Each loudspeaker has a unique number — whether in spatialized mode or as a direct output — and can be used for these two functions: spatialization and localization, thanks to the new direct output functions. This is a major conceptual difference compared to previous versions.

1.6. The three sections of SpatGRIS

There are three sections in *SpatGRIS* that are saved independently: Project, Speaker Setup and Settings.

- Save Project. A project is coupled with a work that contains a certain number of sources.
- Save Speaker Setup. A speaker setup is coupled with a physical installation placed in a space.
- Save Settings. User settings are linked to a workstation (computer and audio interface), including the stereo outputs.

1.7. What's new and improved in SpatGRIS?

What's new

- *SpatGRIS*, version 3.2.1, introduces a new tool, the PLAYER, which allows *SpatGRIS* to be used as a standalone software to play any piece encoded by it to any speaker setup.
- *ControlGRIS*, version 1.4.1, provides the possibility to place signals outside the CUBE on the Z axis.
- *SpatGRIS*, version 3.1.3 introduces a new HYBRID mode that combines the DOME and the CUBE algorithms.
- *SpatGRIS* is independent from any audio virtual device, either Jack, Enzian or BlackHole. It's the user's choice
- Direct outs now have two functions: Independent, for dedicated speakers like subwoofers; Spatialized, with which the sound can be sent exclusively to any loudspeaker that is part of the speaker setup.
- Compatibility with the newest version of MacOS, from 10.15 (Catalina) to 12.6 (Monterey) and new machines (M1).
- ProTools compatibility with the addition of the *ControlGRIS* AAX format.
- STEREO and BINAURAL can be assigned to any outputs of the sound card.
- Several speaker setups and projects templates are now integrated in the software.
- Windows version of *ControlGRIS* and *SpatGRIS*.
- New xml format (3.2.1) to save projects, speaker setups and algorithms.

Improvements

- *SpatGRIS* is more dynamic in its connection to the audio interfaces, both in input and output
- CPU usage has been enhanced drastically, especially in CUBE and BINAURAL modes
- The Speaker Setup Edition has been greatly optimized
- Loading complex speaker setups is almost instantaneous
- BINAURAL mode is much better than before
- Better compatibility in the parameters between *ControlGRIS* and *SpatGRIS*
- A lot of very practical enhancements and changes in the terminology!

1.8. Groupe de Recherche en Immersion Spatiale (GRIS)

Director: Robert Normandeau

Main programmer: Gaël Lane Lépine

Consultant: Devin Roth, creator of BlackHole

Assistants: Mélanie Frisoli, Nicola Giannini, David Piazza

Former programmers: Samuel Béland, Olivier Bélanger, Vincent Berthiaume.

Former assistants: Simone d'Ambrosio, Theo Mathien, Raphaël Néron-Baribeau, Ofer Pelz, Dominic Thibault, Alexis Langevin-Tétrault, Vincent Monastesse, David Ledoux, Yohan Brimicombe, Christophe Lengelé.

Former trainees: Ludovic Laffineur, Antoine Landrieu, Nicolas Masson.

The GRIS received research grants from Hexagram, SSHRC and FRQSC since 2008. Our actual funding will last up to 2025.

Thanks to Yohan Brimicombe for the creation of the web site:

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

2. INTRODUCTION

These instructions assume that you are familiar with the following tools:

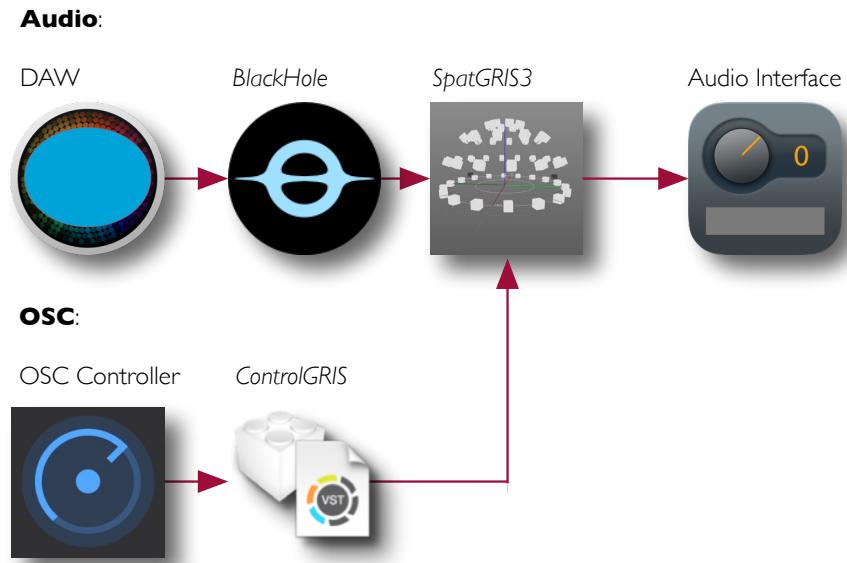
- Any DAW that can use AU, VST, VST3 or AAX plugins
- Your audio interface.

2.1. Architecture

The SpatGRIS system is made of three elements:

- The *ControlGRIS* plugin where the trajectories are designed and recorded in a DAW (or any OSC device).
- The *SpatGRIS* itself that spatializes the sound, according to the setup of the speakers done in the Speaker Setup Edition window.
- The virtual audio device *BlackHole*¹ which connects the DAW to *SpatGRIS*.

The whole architecture, including these elements, looks like this (audio and OSC are working in parallel):



NOTE: In each track of the DAW, it's mandatory that the audio output channel numbers match the OSC source numbers in the corresponding *ControlGRIS* instance to have the sound be spatialized in *SpatGRIS*. Failure to do so will lead to silence or frozen spatialization.

2.2. SpatGRIS

SpatGRIS is a standalone application that allows the spatialization of sounds on different speaker configurations, in 2D or 3D. It could be used with the virtual audio device *BlackHole* that may provide up to 128 inputs and outputs. The trajectories are sent from the *ControlGRIS* plugin, or from any other OSC software² to *SpatGRIS*. 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) and *SpatGRIS2* (2020). The first official version of *SpatGRIS* is 3.0.0 and was released in August 2021. It was our first *Jack*³ free spatialization tool!

¹ *BlackHole* is not mandatory. Any software that can send audio to *SpatGRIS* can be used. So far, it seems that only *BlackHole* allows 128 channels. *BlackHole* is a HAL plugin.

² See the format of the OSC messages in the Addendum.

³ *JackRouter* is a HAL plugin that was not compatible with MacOS 10.15 and up, and was not supported anymore.

2.2.2. System requirements

The software has been tested on the following OS:

- macOS from 10.15 Catalina™ to 12.6 Monterey™
- It is native on Apple Silicon M1 machine (version 3.1.8 and up).
- Windows™ 10.

2.2.3. Installation notes

- Download the latest version of *SpatGRIS* from SourceForge:

<https://sourceforge.net/projects/SpatGRIS/>

SpatGRIS for Mac comprises two installers in the same folder:

SpatGRIS_v3:

- *SpatGRIS* itself
- *ControlGRIS* as a compressed folder with the different formats of the plugin.

BlackHole:

- The virtual audio device *BlackHole* that provides 128 audio channels between the DAW and *SpatGRIS*.

SpatGRIS, *BlackHole* and *ControlGRIS* will be updated separately. Please subscribe to our newsletter to be informed about the software updates on our web site.

Two external controllers are available for *ControlGRIS*:

- An Open Stage Control patch for iPad™
- A Lemur patch⁴ for iPad™.

An Addendum manual pertaining to these *iPad* controllers is available on SourceForge.

SpatGRIS for Windows has one installer:

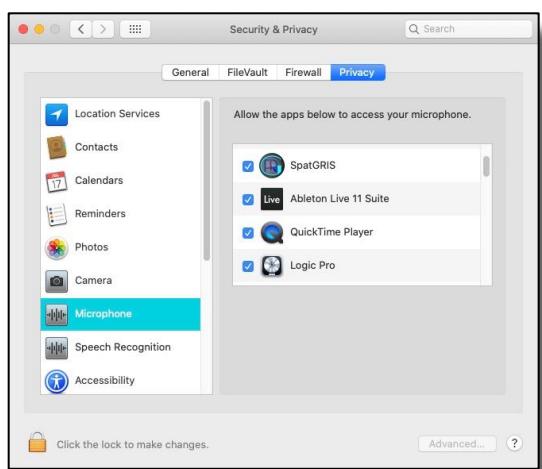
- *SpatGRIS* itself
- *ControlGRIS* as a compressed folder with the different formats of the plugin.

There is no Windows version of *BlackHole*. For Reaper™ users, there is the ReaRoute function, which works similarly to *BlackHole*, but only for Reaper. It is possible to use Jack on Windows⁵. When *BlackHole* is mentioned in the manual, replace it by ReaRoute or Jack when using Windows.

2.2.4. Access to the microphone

NOTE: Very important for Catalina (10.15) users and up.

Make sure that *SpatGRIS* has access to the microphone in the System Preferences, Security & Privacy:



⁴ Designed by Christophe Lengelé

⁵ See this link for more information: <https://jackaudio.org/downloads/>

If you have many versions of *SpatGRIS* in your computer, uncheck them all, open *SpatGRIS3* and give it access to the microphone. If you have checked the right one, this message will pop up:



Quit and reopen it.

2.3. ControlGRIS

ControlGRIS is an OSC⁶ plugin available in AU, VST, VST3 and AAX formats (Mac) and VST and AAX formats (Windows). This free and open-source plugin sends OSC data to *SpatGRIS* to spatialize multiple sound sources on a variable set of speakers. Different modes of source links and a trajectory system are provided for spatialization of mono, stereo and multichannel sources (up to eight channels).

2.3.1. History

The development of *ControlGRIS* began in 2019. It was inspired by three older plugins, *OctoGris* (2010), *ZirkOSC* (2012) and *SpatGris1* (2017). The first version (1.1.0) was released in April 2020.

2.3.2. System requirements

The software has been tested on the following OS and DAWs:

- macOS from 10.15 Catalina™ to 12.6 Monterey™; Digital Performer™ 10 and 11; Ableton Live™ 10 and 11; Logic Pro™ 10; Reaper™ 6; Pro Tools™ 2021.12
- It is native on Apple Silicon M1 machine (version 1.3.2 and up).
- Windows™ 10; Reaper™ 6.

2.3.3. Installation notes

Download the latest version of *ControlGRIS* from SourceForge (the installer is included in the *SpatGRIS* installer):

<https://sourceforge.net/projects/spatgris3/>

Decompress the downloaded file. The different formats will be installed in their proper location. *ControlGRIS* appears under the "UdeM" folder of your host application.

2.3.4. AU, VST, AAX

Mac versions were intensively tested but the Windows 10 version, not that much!

Here are some particularities:

- Use the AU version in DP and Logic Pro on the Mac;
- Use the VST version in Reaper and Live;
- Use the AAX version in ProTools⁷;
- Refer to the manual of your preferred DAW to determine which version is better.

⁶ Open Sound Control

⁷ The AAX plugin for Windows is signed using a self-issued certificate. It is unclear for now whether this is sufficient for ProTools and/or Windows Defender.

2.4. Quick Start Guide

SpatGRIS receives Open Sound Control (OSC) data from *ControlGRIS*, to spatialize the sounds within a set of speakers. The sound itself is sent from the DAW to *SpatGRIS* via *BlackHole*.

Don't need/want to read the manual? Here are the basic steps to spatialize a stereo track on a 64-output audio interface.

NOTE: Adjust the Buffer size to the same value in both your DAW and SpatGRIS. A value of 256 and up is recommended.

1. Open *SpatGRIS*

2. Open the Settings (File menu) or click them directly in the Info bar and assign the Audio input device to *BlackHole 128ch* and the Audio output device to your audio interface (you must do that only the first time). Close the window.



3. Open a DOME Speaker Setup (File menu) 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 *ControlGRIS* plugin on this track and set it to DOME mode

8. The number of sources should be already initialized and set at 2 and First Source ID set at 1

9. Select Circular Fully Fixed in Sources Link

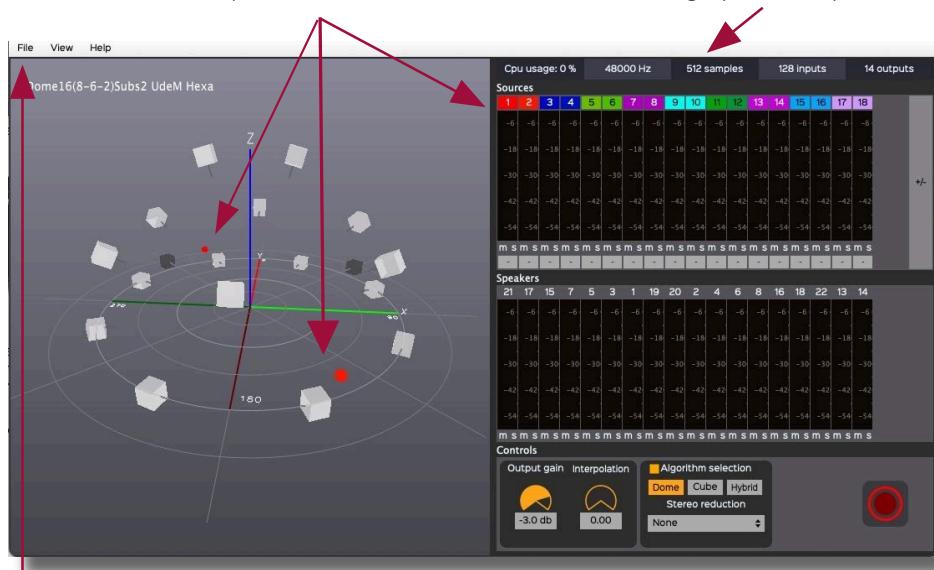
10. Play with Source No. 1 and see the result in *SpatGRIS*

11. The colour of the sources are the ones selected in the Sources (the red dots in this example)

You are now ready to play and record automation.

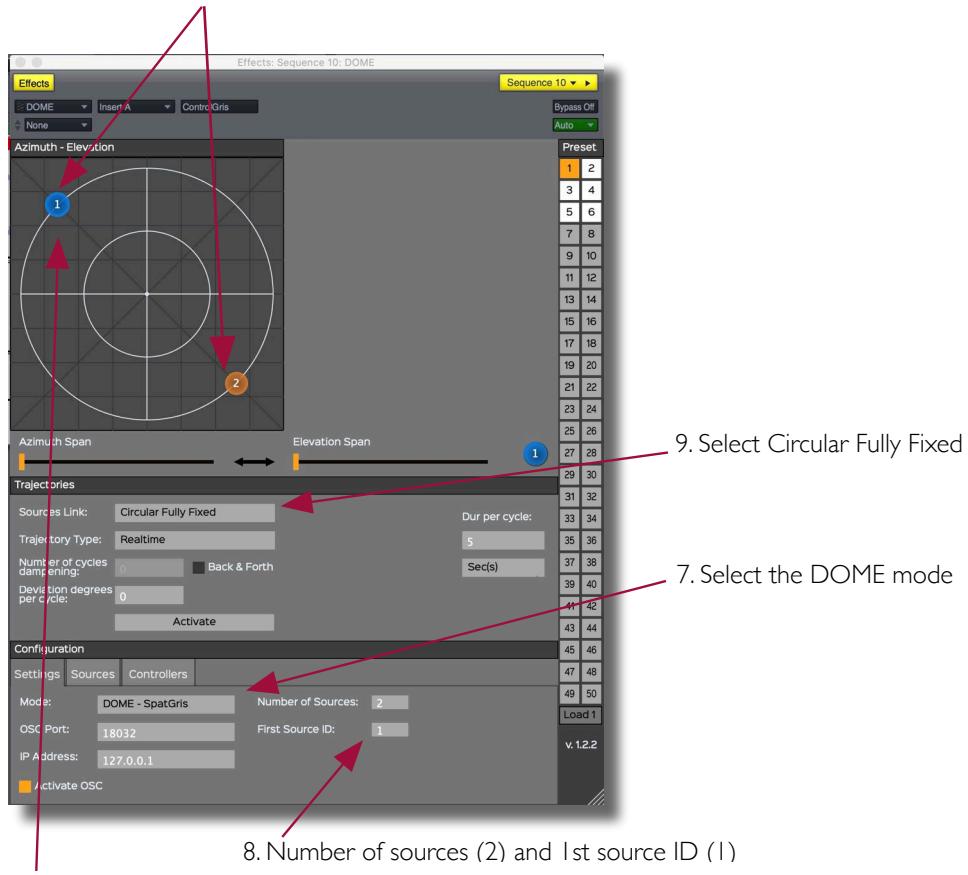
11. The red dots represent the stereo track 1-2

2. Settings (File menu)



3. Open a DOME speaker setup (File menu)

6. This is a stereo track



10. Play with source no 1

Questions? Details? Read the manual!

This manual is in the Help menu:



3. Connections

3.1. Connect the DAW to SpatGRIS

3.1.1. Open SpatGRIS

The first time you open *SpatGRIS*, you'll have to:

- Determine the numbers of sources (up to 128). 64 would be enough in most cases, but fewer sources mean less CPU load. Or use one of the projects included in the Templates menu.
- Design a speaker setup or use one in the Templates menu.

After these first two steps, save the speaker setup and the Project. Following sessions will automatically open the last saved speaker setup and Project at the start-up of *SpatGRIS*.

3.1.2. Adjust the output level

By default, the output level of *SpatGRIS* is set to unity gain: 0.00 dB. It may need to be attenuated or increased, especially if it is the first time you try 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 in the Core Audio system. *SpatGRIS* will automatically detect the presence of the audio software connected to it and will allocate a certain number of active channels according to the number set in the Set Sources text box (\pm icon).

3.1.4. Multiclient

SpatGRIS is a multiclient software, which means that it can connect to multiple audio software at the same time. Keep in mind, though, that its primary usage is to spatialize sounds coming out of a single DAW. The software receives two types of information:

- Audio signals from *BlackHole*
- OSC data from *ControlGRIS*.

Both signals are needed for the sound spatialization. For direct outputs, only the audio signal is needed.

If you use only one DAW, there is no problem, and we recommend that the audio channels and the OSC channels correspond and are identified with the same numbers. Things become a little bit more complicated if you intend to use more than one software at a time.

- *BlackHole* has a limited number of 128 channels in total. If you want to connect a DAW with 24 channels and another one with 8 channels, keep in mind that the second DAW will have to be set to channels No. 25-32 in *BlackHole* and will need *ControlGRIS* to use the corresponding OSC numbers.

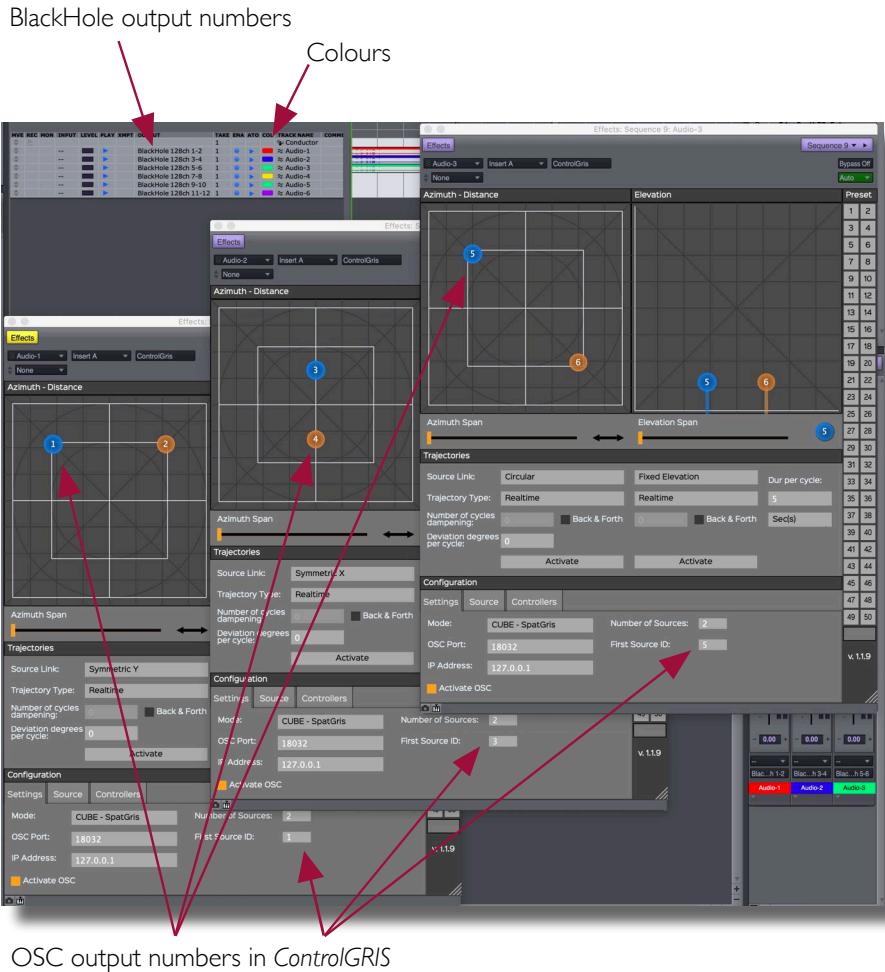
NOTE: Adjust the Buffer size to the same value in both your DAW and SpatGRIS. A value of 256 and up is recommended.

3.2. Connect ControlGRIS to SpatGRIS

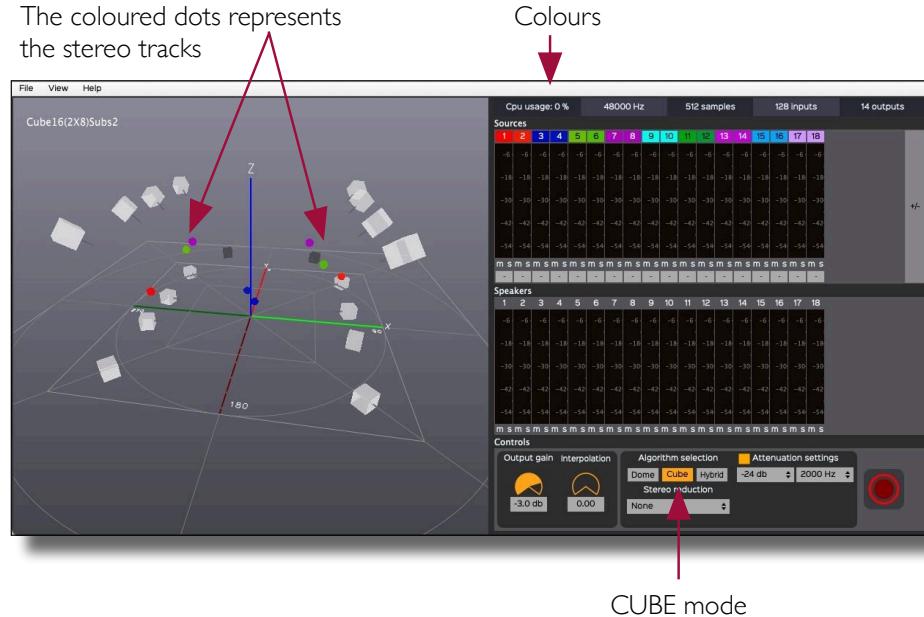
3.2.1. Numbering audio and OSC

The spatialization is handled by *SpatGRIS* which receives OSC data from *ControlGRIS*. It is mandatory to synchronize *BlackHole* audio output numbers in the DAW with the OSC numbers in *ControlGRIS*.

In the following example, three stereo tracks (red, blue, and green) are assigned to *BlackHole* channel pairs 1-2, 3-4 and 5-6. The three instances of *ControlGRIS* use the same OSC numbering: 1-2, 3-4 and 5-6.



To help to keep things clear, it is recommended to use the same colour scheme in the DAW and in *SpatGRIS*.



NOTE: If by mistake, you are using the same OSC numbers in different tracks, the sources in *SpatGRIS* will shake because they will receive two identical positions (or more) from different instances of *ControlGRIS*. It's a good indicator that something is wrong.

3.2.2. Sources Colour

The colour of the sources can be set to any value by clicking in the colour square. It opens a window where you can set the parameters of the colour. This is the colour you will see in the 2D or the 3D window. If you use a lot of sources, it is recommended that you design your colour set carefully.

After closing this window, by using the right-hand click on a colour, you can set the same colour to the next source on the right. You can set this way the same colour to a pair of sources or to many contiguous sources.



4. ControlGRIS

ControlGRIS is an OSC plugin that offers two modes, according to the mode chosen in SpatGRIS:

- DOME
- CUBE

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

4.1. Introduction

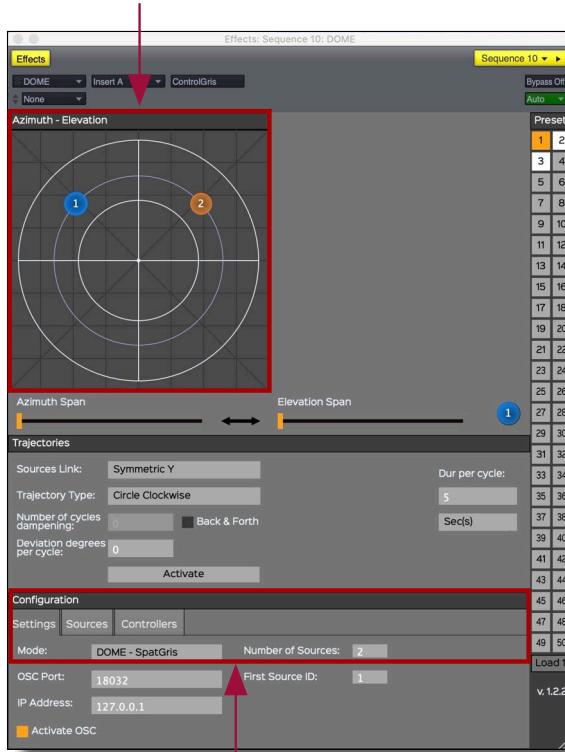
ControlGRIS is an OSC sound spatialization plugin. This plugin allows movements of multichannel sound sources on a variable set of speakers. Several source link modes and a trajectory system are provided to allow the spatialization of mono, stereo, quad, 5.1 or multichannel sources of up to eight channels. ControlGRIS doesn't handle audio, only data which is sent to SpatGRIS. The audio itself is sent from the DAW directly to SpatGRIS.

This document describes the operating instructions and functions specific to ControlGRIS. It is assumed that the user has a working knowledge of the host software and can perform basic functions to configure it.

4.2. Graphical interface

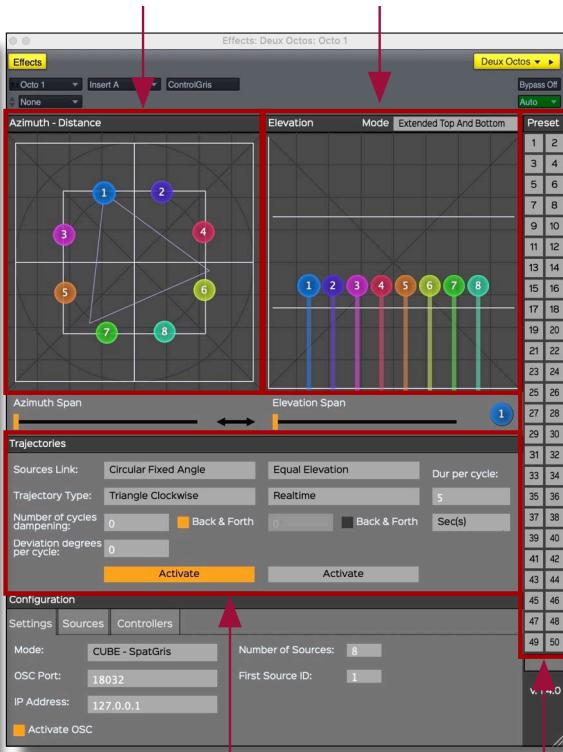
The graphical interface allows the placement of the sound sources. It is slightly different in DOME than in CUBE mode. In DOME, since the Distance is fixed at 1.00, there are only the Azimuth and Elevation parameters to adjust. In CUBE, the three parameters, Azimuth-Distance and Elevation are adjustable on two different windows.

Azimuth-Elevation (DOME)



Configuration panel of the plugin, subdivided in tabs: *Settings*, *Sources*, *Controllers*

Azimuth-Distance (CUBE)

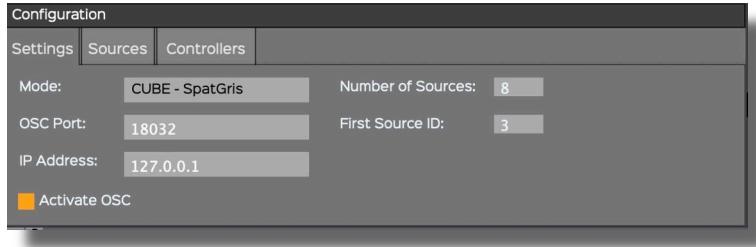


Trajectories: Sources Link and automated Trajectory parameters

50 presets

4.3. Configuration panel

The configuration panel gives access to different plugin parameters. These settings are grouped under three tabs: Settings, Sources and Controllers.



4.3.1. Settings

MODE

The DOME mode is based on the VBAP algorithm designed by Ville Pulkki. In this mode, the space is represented by a dome where the distance between every point of the surface to the centre of the dome is equal to 1.00.

The CUBE mode is based on an original MBAP⁸ algorithm designed by Gaël Lane Lépine. In this mode, the space is represented by a cube within which it is possible to design any kind of speaker setup.

OSC Port

This is the OSC port for communication between *ControlGRIS* and *SpatGRIS*. They should be set to the same one. 18032 is the default value.

IP Address

The default value here is 127.0.0.1 which corresponds to the address of the internal device (i.e. your computer). This 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 in the track. The number is limited to eight channels (as it is in most DAWs).

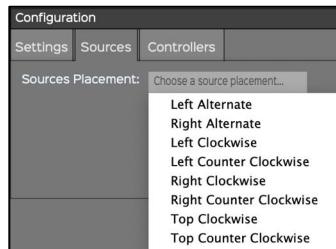
First Source ID

This number should be unique and different for each audio channel. You must set the same numbers for audio and for OSC.

If you have only mono tracks, the numbers are successive. If you have stereo tracks, you'll have only odd numbers to put here: 1, 3, 5, etc. because the even numbers are set automatically to the right channel of each stereo track. And if you work with octophonic sound files, the first source ID will be 1, the second octophonic track will start at 9, etc.

4.3.2. Sources

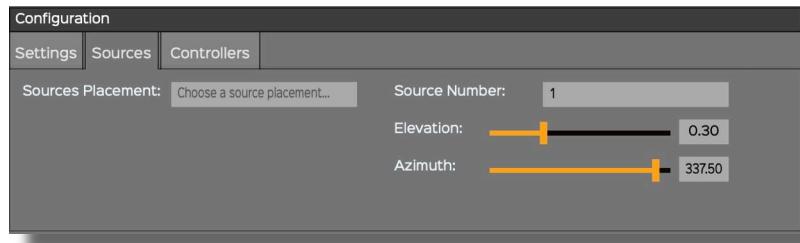
Under the Sources tab, it is possible to accurately position sources by using the graphical interface or the text boxes. Using Sources Placement, it is possible to position sources equidistantly, following a clockwise or alternate order. To do so, simply select the desired layout from the drop-down menu.



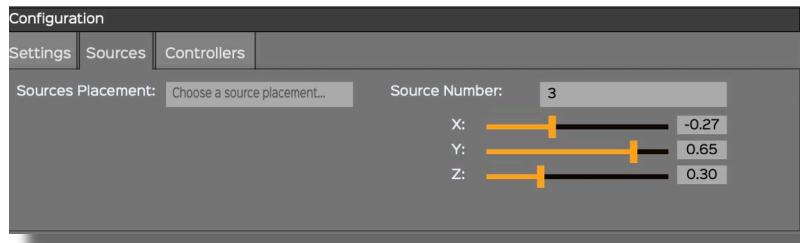
⁸ Since version 3.2.0, the LBAP, Layer Base Amplitude Panning, designed by Olivier Bélanger, is not in use anymore.

Moreover, it is possible to manually adjust the position of each source by entering its polar (DOME) or cartesian (CUBE) coordinates. From the Source Number drop-down menu, first select the number of the source to be moved. Then, enter its new coordinates.

In DOME, Elevation and Azimuth correspond to the current polar coordinates of the selected source:

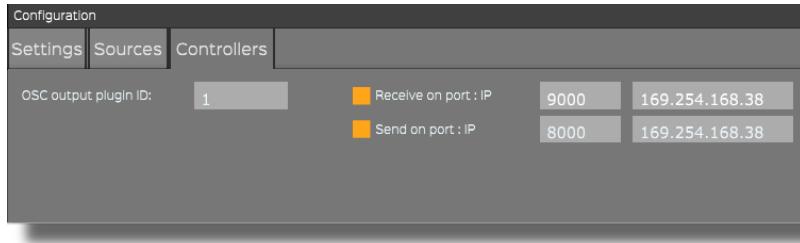


In CUBE, X, Y, and Z correspond to the current cartesian coordinates of the selected source:



NOTE: Manual positioning of individual sources only works when Independent mode is chosen under Sources Link.

4.3.3. Controllers



ControlGRIS can be manipulated via an external Open Sound Control⁹ (OSC) controller. There is an interface made in Open Stage Control and one made in Lemur to manipulate ControlGRIS parameters from an iPad¹⁰.

- OSC output plugin ID: to control different instances of ControlGRIS, each one should have a different ID
- Receive and Send should be set accordingly to the proper OSC channels (Default: 9000 and 8000)
- IP port addresses should be set accordingly to your Wi-Fi network, either public or local¹¹. Both the computer and the controller should be on the same network. ControlGRIS automatically receives the input address from your network.

4.4. Spatialization views

ControlGRIS works in two different modes for sound spatialization: DOME and CUBE.

4.4.1 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. Whereas a source placed in the centre is at the top of the dome, a source placed at the periphery

⁹ <http://opensoundcontrol.org>

¹⁰ See the Addendum manual for more information.

¹¹ See the Open Stage Control manual for that: <https://openstagecontrol.amm.net/>

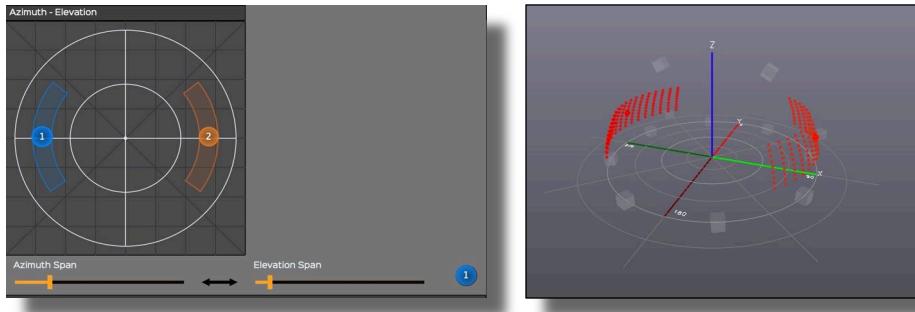
is at the bottom of the dome.

The dome is represented here from the top, examples with stereo sources on the left, octophonic sources on the right:



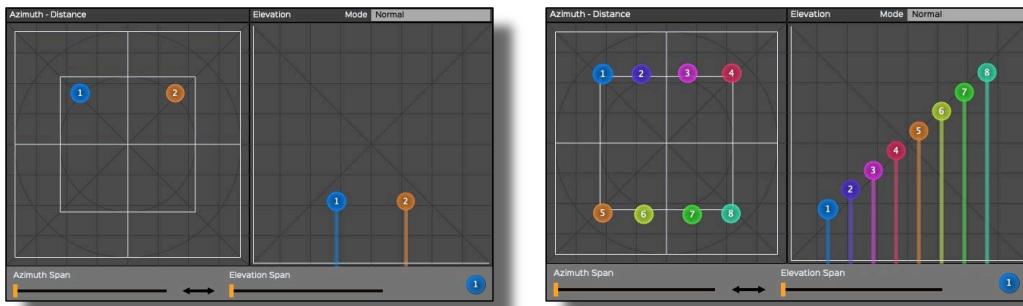
4.4.2. Spans in DOME mode

In both modes, Span parameters are available for azimuth and elevation. Span spreads the signal to a larger zone than just the source itself. In DOME mode, the spans look like an arc on each side of the source:



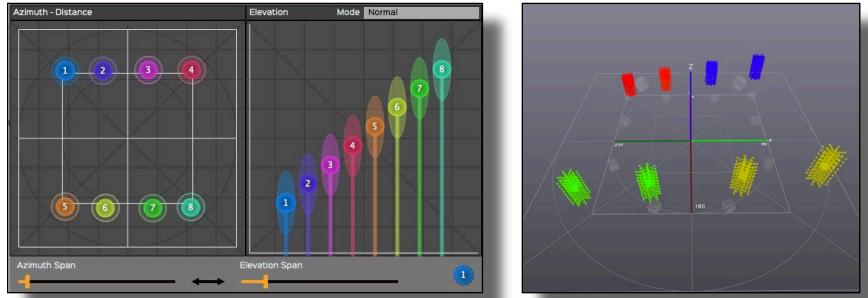
4.4.3. View in CUBE mode

In CUBE mode, the graphical interface is divided between two screens: Azimuth-Distance and Elevation. The CUBE mode adds distance and allows moving a sound inside or outside the speaker setup (represented by the internal white square). The CUBE is represented from the top on the left and in profile on the right (the 3D view shows only in SpatGRIS). Examples for stereo and octophonic sources:

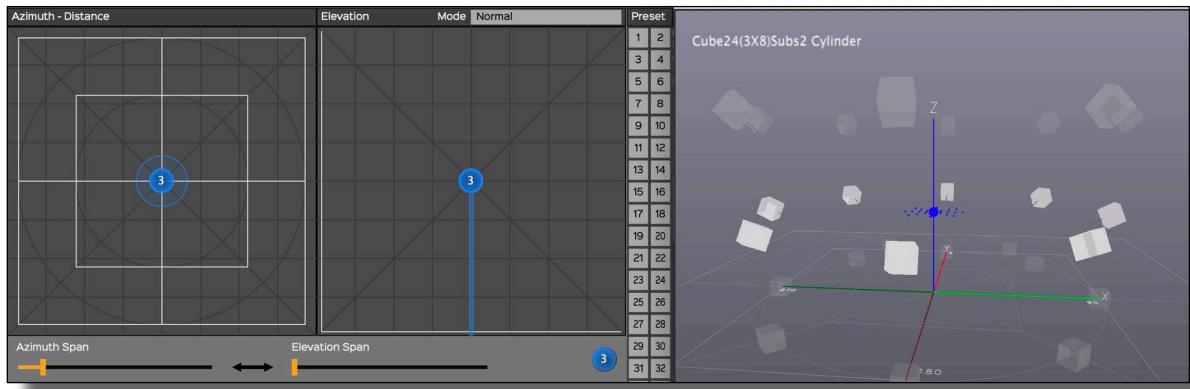


4.4.4. Spans in CUBE mode

In CUBE mode, the spans look like a cylinder wrapped around the source:

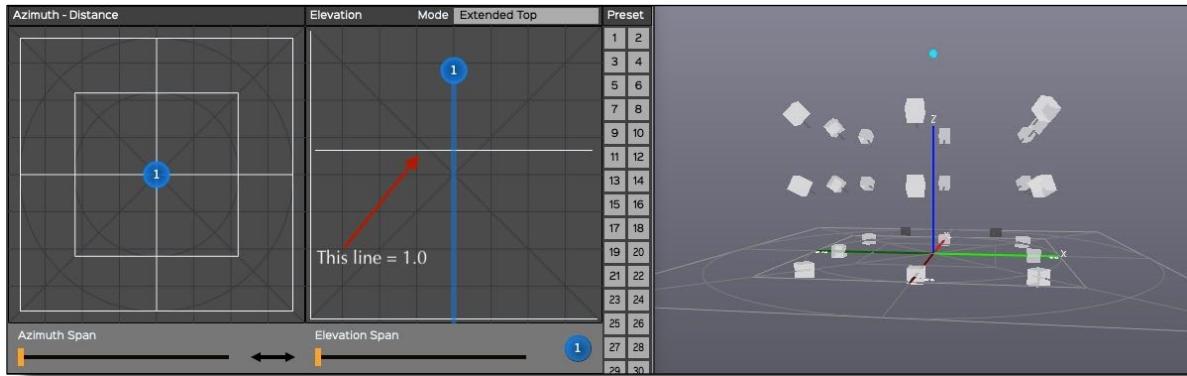


In some CUBE setups, where most speakers are spread across the walls and the ceiling, a source can be lost in the centre of the hall. If you wish to create a flat sound disk that activates only the speakers located at the same height as the source, you can add a bit of Azimuth Span:



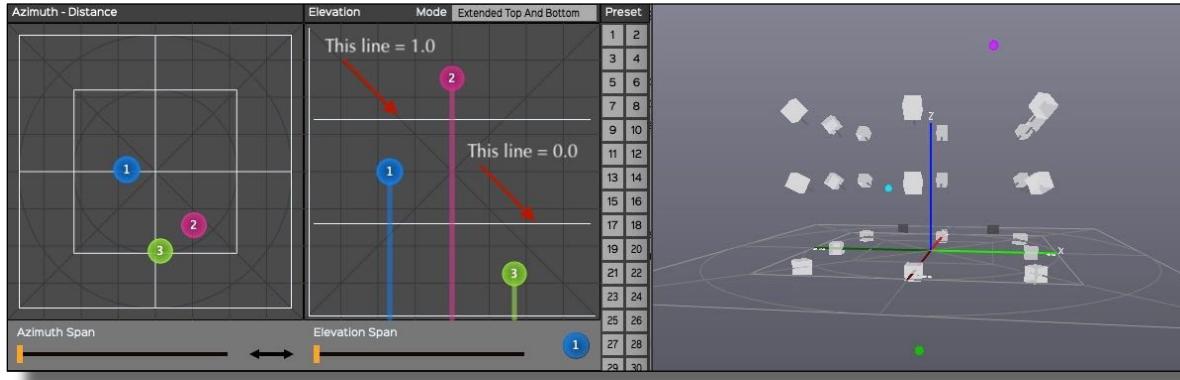
4.4.5. CUBE Elevation in Normal or Extended Top mode

Since version 1.4.1, ControlGRIS offers the possibility to put a source outside of the CUBE in elevation. This was already possible on the x and y axes, and it is now possible on the z axis. When using the Extended Top mode, a white horizontal line appears in the elevation diagram. This line represents the value 1.0 used in Normal mode. This is the point at which SpatGRIS Attenuation Settings start to take effect in elevation. Sources will be filtered either in volume and/or in frequencies as they move further away from the top of the cube:



4.4.6. CUBE Elevation in Extended Top and Bottom mode

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



NOTE 1: Older projects can still be used in Normal mode where the full range from 0.00 to 1.00 is still available.

NOTE 2: It's not yet possible to go below the floor in a complete sphere with ControlGRIS. in DOME mode. We are working on that. But it's possible to do so by using any software that sends OSC directly to SpatGRIS.

4.5. How to use ControlGRIS

ControlGRIS is a plugin that can be inserted on any track that requires spatialization. ControlGRIS comprises a trajectory system that can write predefined movements quickly and efficiently. The automation function of the host software assures the recording and playback of the source's movements. It is therefore essential to understand the various automation modes in your preferred host.

4.5.1. Load the plugin on a track

ControlGRIS is loaded similarly to any other AU or VST plugin. Most often, ControlGRIS is loaded at the end of the insert chain of the track.

NOTE: In each track of the DAW, it's mandatory that the audio output numbers match the OSC numbers in the corresponding ControlGRIS to have the sound be spatialized in SpatGRIS. Not doing that will lead to silence, or to frozen spatialization.

4.5.2. Save presets and recording automation

It is possible to save some of the ControlGRIS plugin parameters within the 50 provided preset slots. The shortcuts are:

- Shift-Click Preset number: Save
- Click Preset number: Load
- Opt¹²-Click Preset number: Delete.

These functions appear below the rows 49-50:



These presets allow you to save and recall the following parameters only:

- Source positions (Azimuth-Distance-Elevation). These can also be automated.

¹² On the Mac, most keyboards use Option (Opt), while others use Alt. Opt will be used in this manual.

The parameters that are not saved but can be automated:

- Spans
- Sources Link and Sources Link Alt
- Presets
- Bypass.

The parameters that are not saved and not automated, because they are used to automatically generate a trajectory that will be written by the DAW itself:

- Spans link
- Trajectory Type
- Dur per cycle
- Sec(s)/Beat(s)
- Number of cycles dampening
- Deviation degrees per cycle
- Back & Forth
- Activate.

Configuration tab

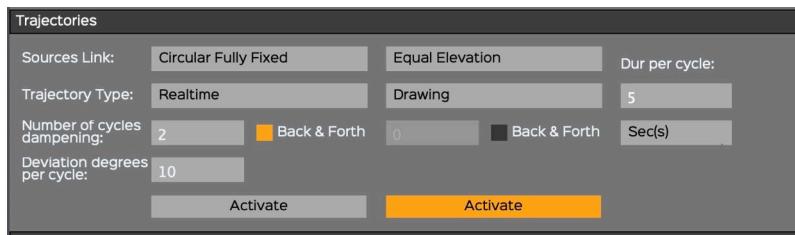
- The whole Configuration tab is not saved in the preset (this one is saved with the DAW project). It is not a good idea to change these settings within a track.

NOTE: While it is possible to record the position of all sources in presets, it is only possible to record the automation of the source No. 1 in the sequencer. Source No. 1 is the leader while other sources are followers.

4.5.3. Recall presets

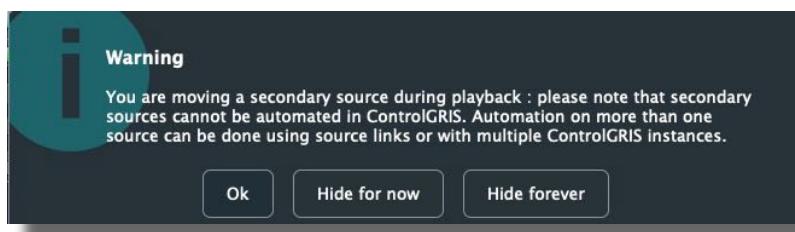
As mentioned above, the presets store only the position of the sources. When loading a preset, the sources will be placed according to the memory. Keep in mind though that the sequencer also has a memory of the previous position of the sources, and both can interact strangely. Very often then, it's only when you start the sequencer that the sources take their real positions. To avoid any ambiguity, you can automate the preset numbers.

4.6. Trajectories



It is possible to automate the movement of sound sources using predefined trajectories. Within the Trajectories control panel, you can set and adjust these movements to the musical context. The concept behind the trajectories is that there is a source leader while the others are followers. Only the source No. 1 can be the leader.

If you try to record the automation of any other source than No. 1, you'll get this warning:



4.6.1. Sources Link

The Independent mode in multichannel is available only to place the sources independently at first. But the position of sources can't be automated independently. Only the automation of the Source No. 1 is recorded. Therefore, after placing the sources, a different source link should be chosen before recording the automation.

Azimuth-Elevation (DOME) and Azimuth-Distance (CUBE) Links

Within the *Trajectories* section, under the *Sources Link* drop-down menu, it is possible to choose different ways of linking sources together. Depending on the number of channels, some links may not be available:

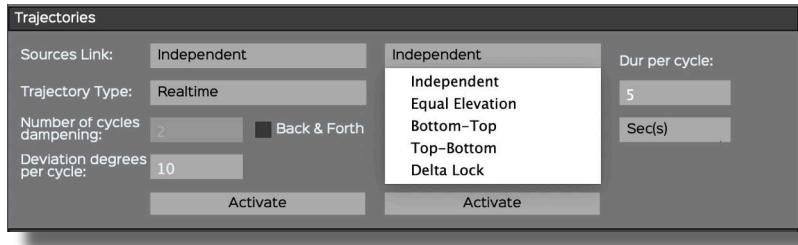
- Mono: Independent only
- Stereo: all links
- Multichannel: all but Symmetric X and Y.
- Detailed representations of the Azimuth-Elevation and Azimuth-Distance Links are shown at the Addendum 7.1.1.



Elevation Links (CUBE mode only)

In CUBE mode, the Elevation Links between sources is independent from the Azimuth-Distance.

- Detailed representations of the Elevation Links are shown at the Addendum 7.1.2.



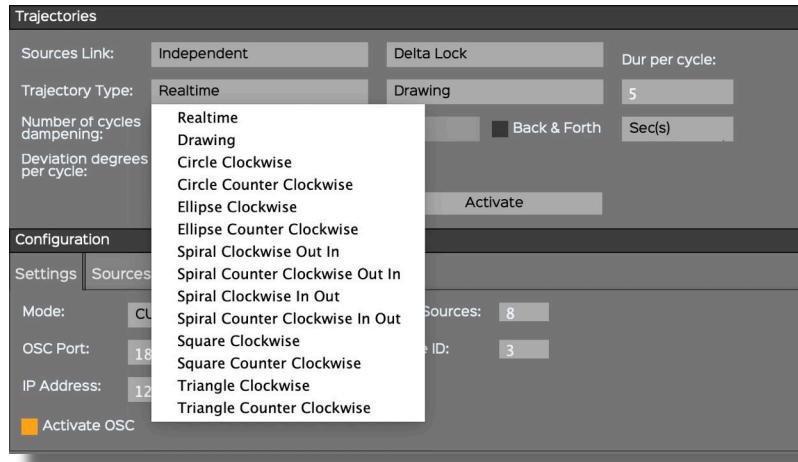
4.6.2. Trajectory Type

Automating the movement of a source is quite simple with the different trajectory types provided.

- Detailed representations of the Trajectories are shown at the Addendum 7.2.

Azimuth-Elevation (DOME) and Azimuth-Distance (CUBE) Trajectory Type

A drop-down menu with different types of trajectories allows you to select from a variety such as *Circle*, *Ellipse*, *Spiral*, *Square* and *Triangle*, either in *Clockwise* or *Counter Clockwise* mode.



Elevation (CUBE only) Trajectory Type

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



Other settings

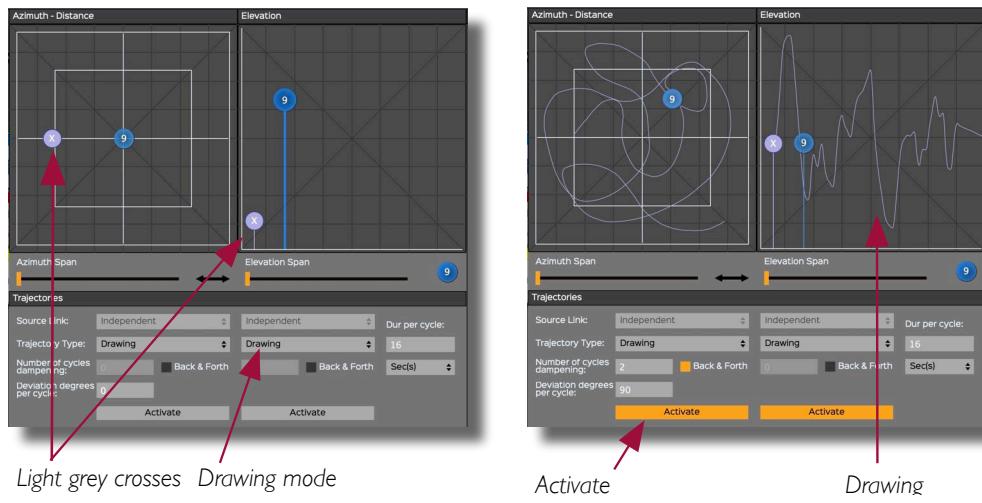
- The duration of the trajectory in second(s) or beat(s) (linked to the MIDI tempo of the host sequencer)
- The Number of cycles dampening: the total duration = Dur per cycle x Number of cycles x 1,5. Dampening works only with Back & Forth.
- The Back & Forth option
- The Deviation degrees per cycle.

Realtime

This is the usual automation recording: you move a parameter (or several parameters) and it is recorded in the DAW.

Drawing

The Drawing mode allows you to draw a trajectory directly into the plugin itself. This trajectory can then be modified by editing the duration, dampening and deviation. When the desired settings are found, they can be recorded in the DAW itself.



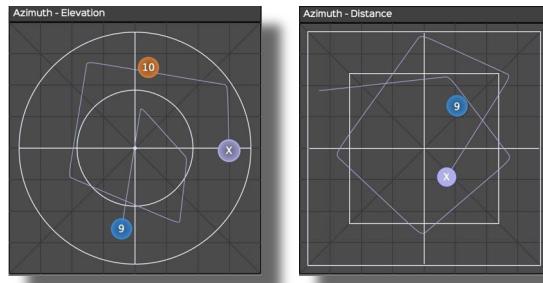
Modifiers:

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

The Drawing mode is a freehand mode. When you select it, a light grey cross will appear with which you draw a trajectory. The timing of the trajectory and the design are temporarily stored within the plugin. In Azimuth-Elevation (DOME) or Azimuth-Distance (CUBE), it's the position that is recorded. In Elevation (CUBE only) it's the position over time. Both windows share a cycle that can be modified with the regular parameters. To see the trajectory in action, you can turn on the Activate buttons and play the sequence. When the sequencer stops, the Activate buttons return to off. Changes can be made and then it's possible to switch on Activate again. Once satisfied with the results, you can then record the trajectory in the DAW.

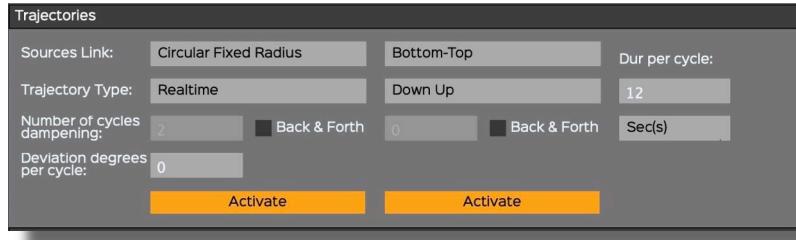
Shift-Click in Drawing mode

If Shift is pressed in the Drawing mode, it's possible to design straight lines or irregular geometrical figures in the Azimuth-Elevation (DOME) or the Azimuth-Distance (CUBE) window. Every time you click, a new angle is created. Don't forget to click one last time once you're finished!



NOTE: Be careful with the freehand trajectory, it's temporary. If you click anywhere in the window after drawing a trajectory, or close the plugin or the session, it will automatically be erased. Only one gesture can be temporarily recorded at a time. The X cross can be hidden behind one of the sources. Just move one of those to find it back.

Activate



Pressing the Activate button makes *ControlGRIS* wait for the start of the sequencer. When the sequence is initiated, the plugin will start the trajectory according to the specified settings. The movement produced can be recorded — X, Y and Z coordinates of the source No. 1 — like any other automation. When the sequencer stops, the Activate buttons return to off. It's important to put the play head at the right position before pressing on the activate button and putting the sequence into play.

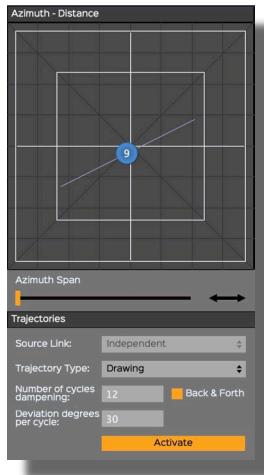
Trajectory recording in the DAW

As explained above, *ControlGRIS* waits for the host sequencer to start before starting a trajectory. The tracks that contain *ControlGRIS* as an insert can be set in a write mode (Touch, Latch, or Write — depending on the options within your DAW) to record the sources' movements as automation. This automation is then available for playback and editing.

NOTE: Only the source No. 1 (leader) is recorded, the other sources being followers. It is always preferable to record the automation of trajectories in the DAW after you have found the right settings, because it frees up the CPU used by ControlGRIS.

4.6.3. A special case: the pendulum

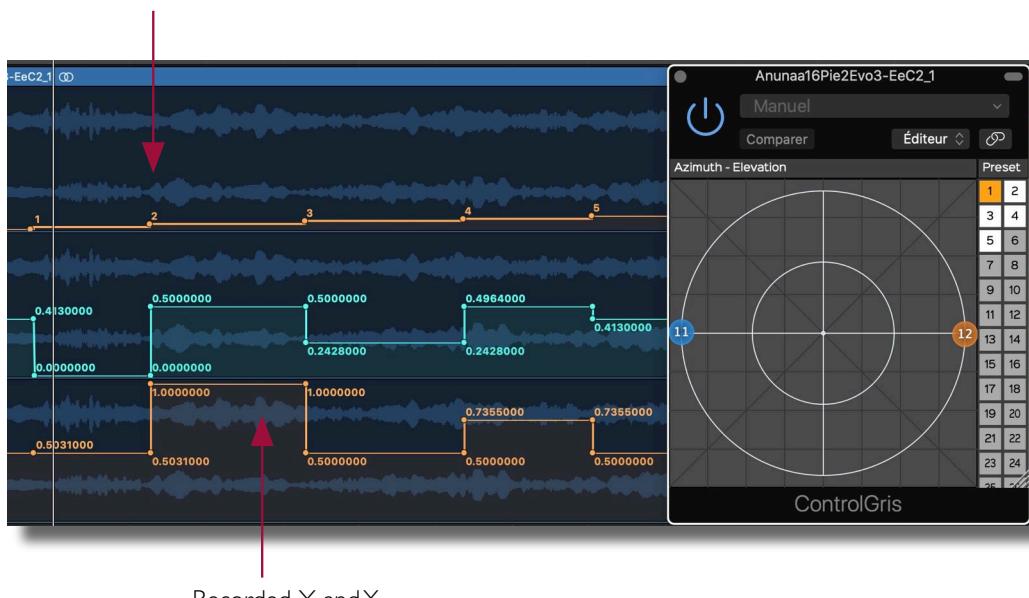
A specific use of the Shift-Click in Drawing mode can be used to design a pendulum. If a simple line is drawn with Shift-Click, it constitutes the basic element of a pendulum. Then the Dur per cycle, Dampening, Deviation and Back & Forth can be used to make this pendulum very interesting. It can be placed anywhere in the space.



4.6.4. Presets and automated trajectory

It's possible to record the presets number in the sequencer. But to avoid contradictory information between automated trajectories and automated presets (which stores x-y position of the sources), in automation recording, the x and y coordinates, registered in the preset, will be automatically written in the x-y automation curves. The automated presets are designed essentially to offer the possibility to apply sudden changes in the position of the sources.

Recorded Presets



NOTE: Be careful with that. If you overwrite the already existing X and Y curves, they might become in competition with the information stored in the presets. Then you will certainly get audio glitches.

5. SpatGRIS

- SpatGRIS is a mixer
- SpatGRIS does spatialization and localization
- SpatGRIS is a recorder
- SpatGRIS makes speaker setups.

5.1. Introduction

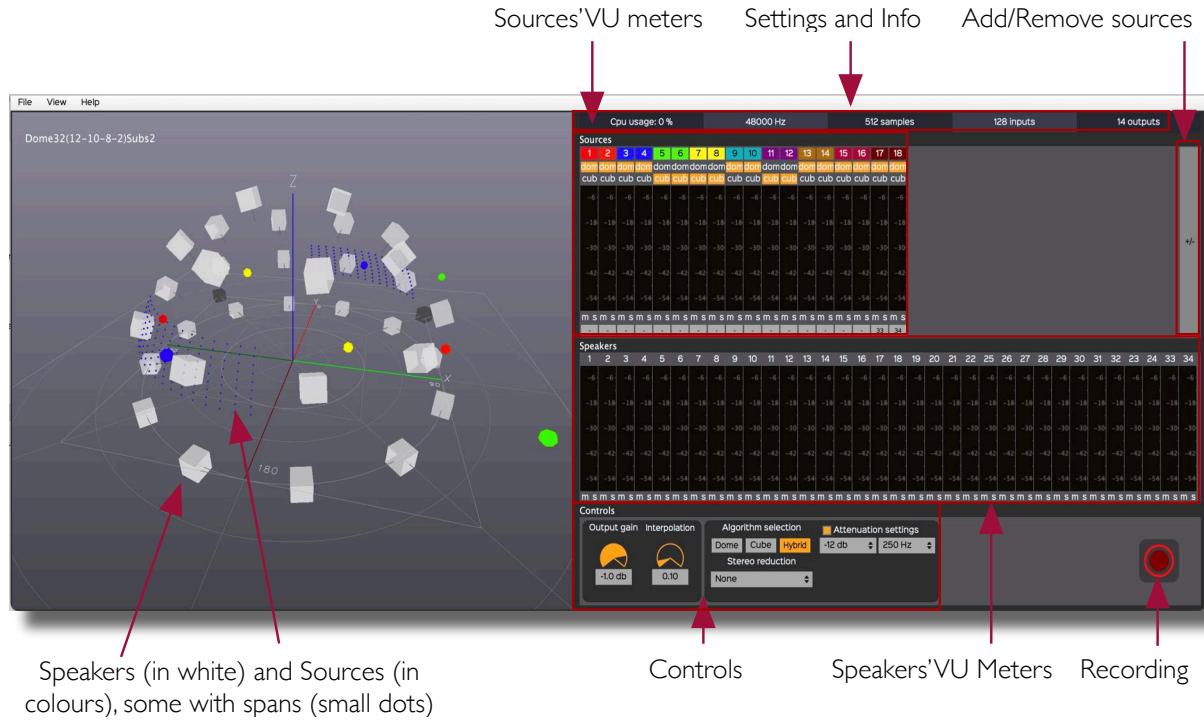
There are three sections in *SpatGRIS* that are saved independently: Project, Speaker Setup and Settings.

- **Save Project.** A project is coupled with a work that contains a certain number of sources (outputs from the DAW) and the algorithm used. This is the section on the right of *SpatGRIS*.
- **Save Speaker Setup.** A speaker setup is coupled to an installation placed in a space and the algorithm used. This is the section on the left of *SpatGRIS*.
- **Save Settings.** User settings are linked to a workstation — computer and audio interface — including the stereo outputs (even without showing it). Most of the settings are shown in the Info bar. Click the Info bar or Settings in the File menu (Cmd-,)

NOTE: Projects and Speaker Setups save the algorithm. This one should be the same in both documents that are opened at the same time.

The *SpatGRIS* window is divided into different zones:

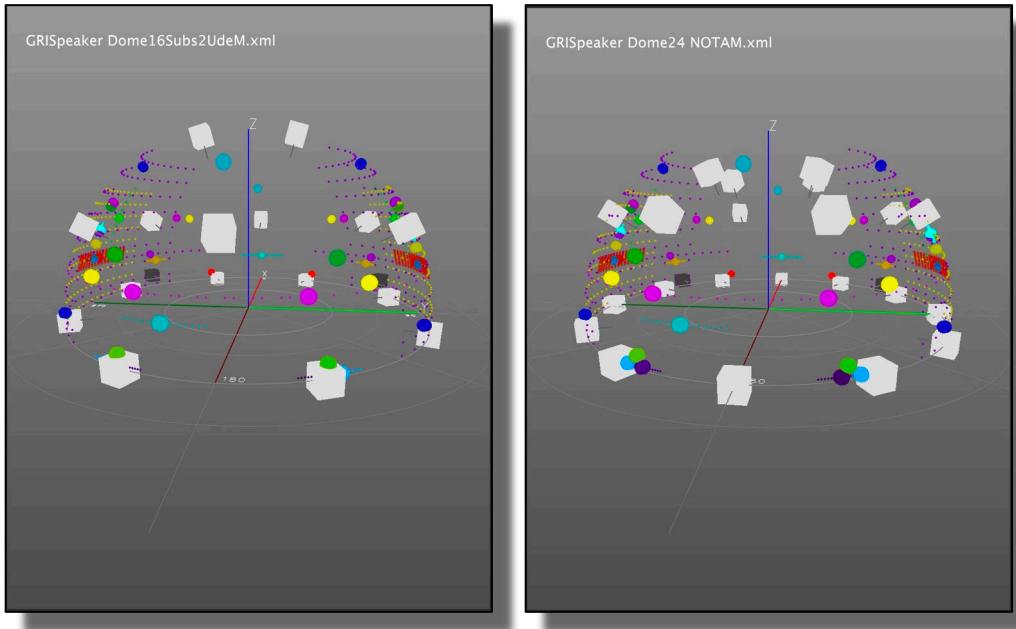
- Sources and Speakers in a 3D view
- VU Meters
- Settings and Info
- Controls
- Recording



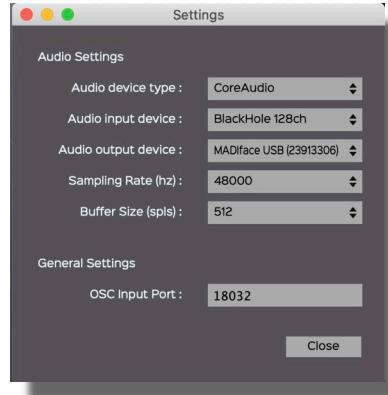
5.2. Change the setup not the spatialization

The most interesting feature in *SpatGRIS* is that the Sources, which come from the DAW and represent the audio and the spatialization of your work, are independent of the speakers. So, if you initially defined a very complex spatialization structure for a specific speaker arrangement, you could play it on any other speaker setup afterwards, especially in DOME mode. You simply have to change the speaker setup from one location to the next.

Here's an example of a piece designed for a 16-speaker setup (on the left), presented on a 24-speaker system (on the right), quite different from the original, just by switching from one setup to the next.
 As you can see, all the sources remain at the exact same coordinates. They will be played by different speakers but heard at the same location in the concert hall.



5.3. Settings



Audio Settings

- Audio device type: Core Audio (default)
- Audio input device: *BlackHole* (ideally)
- Audio output device: the audio interface of the system
- Sampling Rate (Hz): from 44100 to 192000
- Buffer Size (spl): from 16 to 2048. Adjust the Buffer size at the same value in your DAW and in SpatGRIS.

General Settings:

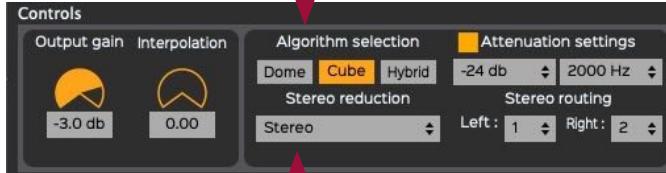
- OSC Input Port: default is 18032 which is the same as *ControlGRIS*. If you want to use another incoming OSC device, use this port number as the output port of that device, otherwise you must change this number accordingly.

Close

Your settings are automatically saved. Under the name of the version of *SpatGRIS*, the document is located here (Mac):
 • ~/Library/Application Support/GRIS/SpatGRIS.0.0 (for example).

5.4. Controls

- Algorithm selection: DOME, CUBE or HYBRID



- Two channels reduction: BINAURAL or STEREO
- Interpolation: this is a smoothing factor. If you hear some glitches when a sound is moving from one speaker to the next, you can adjust this value for smoother transitions. The higher the value, the higher the CPU usage. The default value is 0.00.
- Gain: the default value is the unity gain of the outputs at 0.00 dB. It can be adjusted here. The maximum gain is +12 dB.
- Attenuation settings in CUBE or HYBRID mode only:
 - On/Off
 - Level: from 0 to -72 dB
 - Low-pass filter freq.: 125Hz to 16kHz
- Stereo routing: specific channels for STEREO and BINAURAL

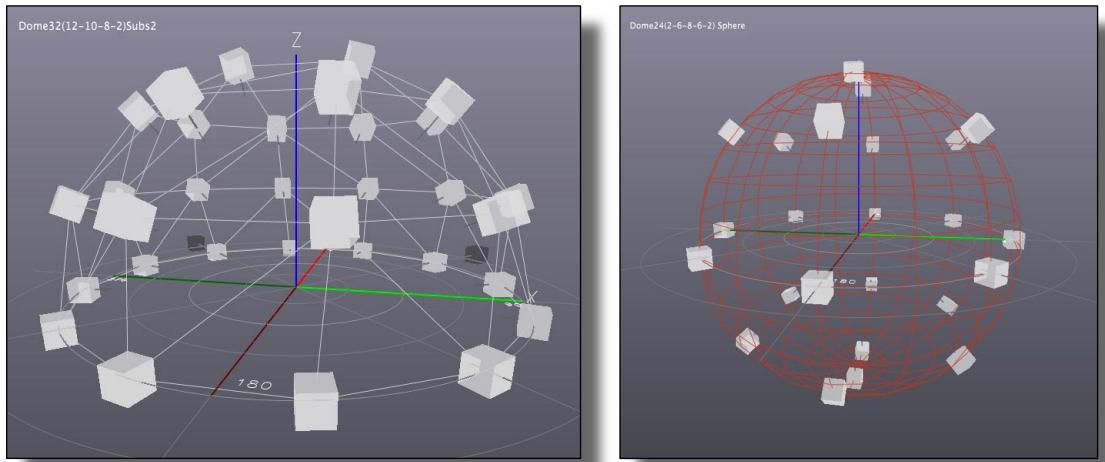
5.5. The DOME and the CUBE

In DOME mode, it is possible to move and place the sources on the surface of the speaker setup while in CUBE mode it is possible to move and place the sources inside and outside the speaker setup.

5.5.1. DOME

The DOME, based on VBAP (Vector Base Amplitude Panning), allows the user to spatialize the sound under a dome of speakers by placing it according to the relative amplitude of three speakers (as opposed to two in stereo panning). Therefore, the dome is made of triangles of speakers. This way, the sound can travel smoothly within the dome, with no bumps or holes.

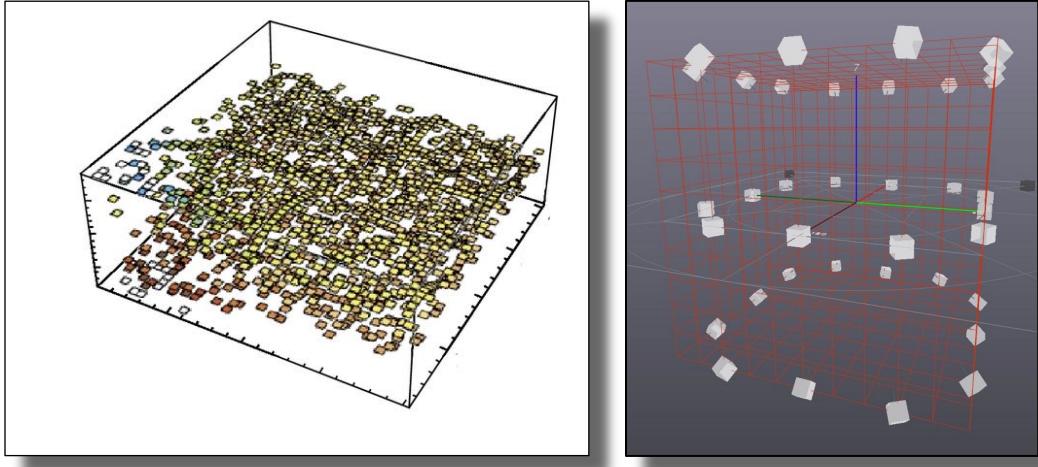
It is possible to see the triangles by choosing Show Speaker Triplets (Opt-T) in the View menu. If you have the chance to use a sphere, it is possible to show it (Opt-O)!



5.5.2. CUBE

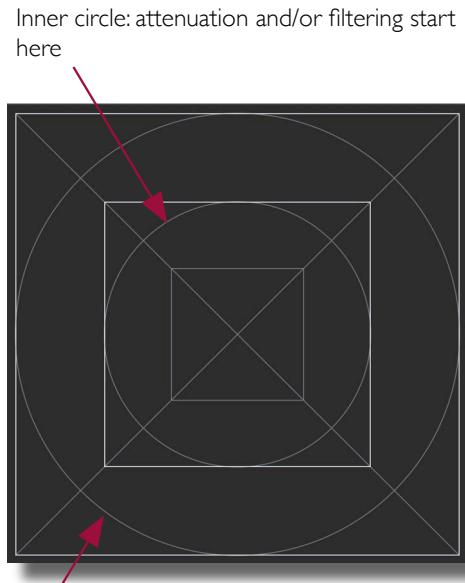
Since version 3.2.0, the CUBE is based on MBAP (Matrix Base Amplitude Panning) and it allows the placement of a source anywhere in a space represented by a cube. But it is not limited to the shape of a cube. Any speaker setup can be placed within a cube (including a dome!) Therefore, any sound installation or concert situation can be simulated here. In CUBE mode, the distance of the source exiting the circle of speakers is considered to simulate the natural behaviour of the sound moving away.

Like its name suggests, the algorithm is based on a complex matrix of multiple points, registered on tables, that are triggered by the sound as it moves. The location and the number of the points are determined by the speakers' location.



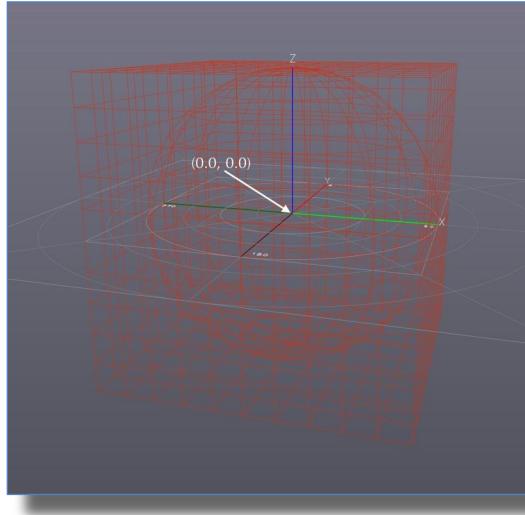
5.5.3. Attenuation settings in CUBE or HYBRID mode

In CUBE mode and HYBRID modes, there are an inner circle and an outer circle in the middle of the Speaker Setup. Within the inner circle, attenuation and/or filtering are not applied. Outside the inner circle, attenuation and/or filtering can be applied to simulate the vanishing of a sound at a faraway distance. At the outer circle, attenuation and filtering reach their maximum values. You can indicate these maximum values in the Attenuation settings menus. In HYBRID mode, Attenuation settings work only on CUBE sources.



Outer circle: attenuation and/or filtering
reach their maximum values here

Actually, the inner circle is a sphere within which the attenuation settings start to be calculated from the «floor», that is to say from the coordinates (0,0,0):



Attenuation settings parameters:

Value
0 dB
-12 dB
-24 dB
-36 dB
-48 dB
-60 dB
-72 dB

Value
125 Hz
250 Hz
500 Hz
✓ 1000 Hz
2000 Hz
4000 Hz
8000 Hz
16000 Hz

- On/Off
- Attenuation (dB): from 0 to -72, in -12dB steps.
- Filtering (Hz): from 125 to 16000, in octave steps.
- Attenuation and filtering are independent.
- In Elevation, attenuation starts at the top (Extended Top) and at the bottom (Extended Top and Bottom) of the cube.
- Attenuation Settings work also in STEREO and BINAURAL mode.

NOTE: Attenuation Settings are saved within the Project.

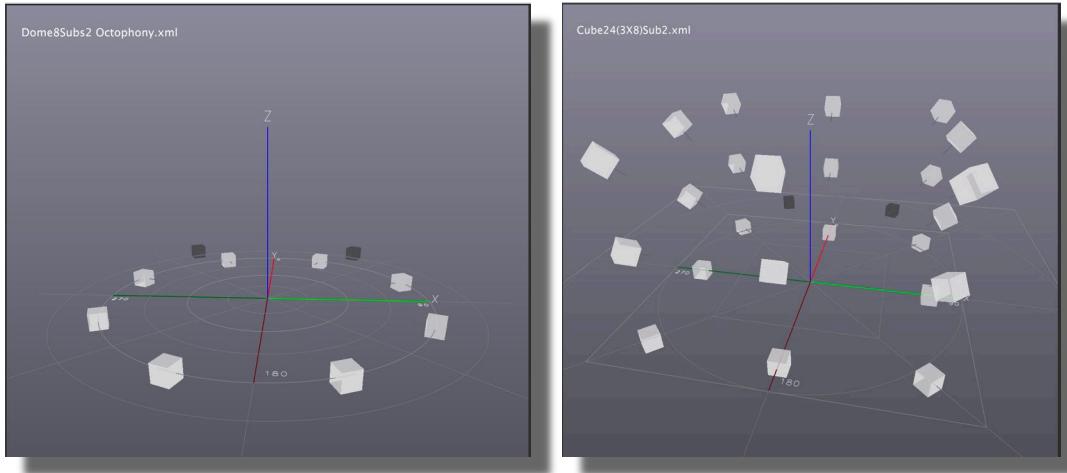
5.5.4. Convert from DOME to CUBE and vice versa

In the case of switching from DOME to CUBE, SpatGRIS uses XYZ coordinates of the setup to maintain the integrity of the setup. This does not apply to the transition from CUBE to DOME, since in the VBAP algorithm there is no choice except to adjust the distance to 1.00. Elevation and Distance do not have the same behaviour in the DOME and CUBE algorithms. A speaker setup retains its appearance and XYZ coordinates when transitioning from the DOME algorithm to the CUBE algorithm, but not the other way around.

5.5.5. Spatialization in 2D and 3D

SpatGRIS is capable of 2D and 3D spatialization either in DOME or CUBE mode. It can be useful to use *SpatGRIS* in 2D with DAWs that are stereo-only like Ableton Live and Pro Tools native. Doing so gives these stereo DAWs the possibility to manage multispeaker environment like cinema standards. But of course, the real power of *SpatGRIS* lies in its 3D capabilities.

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



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

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



The Sources menu is then changed to offer the possibility of choosing between the dome or the cube independently for each source:



The hybrid mode uses the DOME algorithm, which means that the speaker setup must be a dome (if not, you will be asked to convert it) within which the sources can be moved according to CUBE behaviours where it's possible to move the sound inside or outside the dome of speakers. In HYBRID mode, the spans keep their usual dome or cube behaviour.

5.6.1. What is saved in HYBRID mode?

There are two pieces of information saved in HYBRID mode:

- the HYBRID mode itself is saved with the speaker setup and/or with the project (hence the different templates);
- the selection of the DOME or the CUBE algorithm for each source is saved with the project.

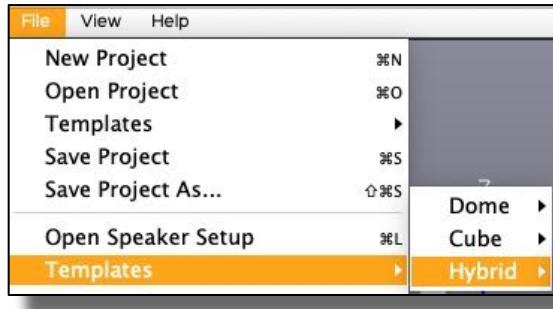
If an old HYBRID project (prior to version 3.1.8) is open in DOME or CUBE mode, the selections of the sources won't show up. You'll have to manually chose the HYBRID mode to see them appear. But if you have an already HYBRID

speaker setup opened, they will show automatically.

5.7. Speaker Setup

To design a speaker setup is the first step of the process. It is done in the *Speaker Setup Edition* window (View menu, Opt-W).

A Templates menu is provided with different speaker setups in DOME, CUBE or HYBRID format. The speaker setups in the Templates can't be modified. You can use them, edit them, and save them under the name of your choice by using Save Speaker Setup As from the File menu.



5.7.1. Speaker Setup Edition

A speaker configuration is created by determining the number of speakers in each level and their location (polar or Cartesian coordinates). By using the Add Speaker or the Add Ring button, individual or group of speakers can be added to the setup.

Output	X	Y	Z	Azimuth	Elevation	Distance	Gain (dB)	Highpass	Direct	delete
- 1	0.76	0.76	0.00	45.0	0.0	1.08	0.0	0.0	x	
- 2	0.76	0.28	0.00	70.0	0.0	0.81	0.0	0.0	x	
- 3	0.76	-0.28	0.00	110.0	0.0	0.81	0.0	0.0	x	
- 4	0.76	-0.76	0.00	135.0	0.0	1.08	0.0	0.0	x	
- 5	-0.76	-0.76	0.00	225.0	0.0	1.08	0.0	0.0	x	
- 6	-0.76	-0.28	0.00	250.0	0.0	0.81	0.0	0.0	x	
- 7	-0.76	0.28	0.00	315.0	0.0	0.81	0.0	0.0	x	
- 8	-0.76	0.76	0.00	315.0	0.0	1.08	0.0	0.0	x	
- 9	0.76	0.76	0.83	45.0	37.7	1.36	0.0	0.0	x	
- 10	0.76	0.28	0.85	69.8	17.7	0.0	0.0	0.0	x	
- 11	0.76	-0.28	0.85	110.2	17.7	0.0	0.0	0.0	x	
- 12	0.76	-0.76	0.83	135.0	37.7	1.36	0.0	0.0	x	
- 13	-0.76	-0.76	0.83	225.0	37.7	1.36	0.0	0.0	x	
- 14	-0.76	-0.28	0.85	249.8	46.4	1.17	0.0	0.0	x	
- 15	-0.76	0.28	0.85	290.2	46.4	1.17	0.0	0.0	x	
- 16	-0.76	0.76	0.83	315.0	37.7	1.36	0.0	0.0	x	
- 17	-0.51	1.41	0.00	340.0	0.0	1.50	0.0	0.0	x	
- 18	0.51	1.41	0.00	350.0	0.0	1.50	0.0	0.0	x	

- Reference Pink Noise: On/Off
- Default -20 dB, to calibrate the outputs

- Output *Gain (dB)* and *Highpass* filter (0 is Off, a value defines the cutoff point in Hz, with a minimum of 20 Hz,) to calibrate the setup

- An *Output* patch connects the speakers to the output number of your audio interface

DOME:

- *Azimuth* is the plane angle, from 0° to 360°.
- *Elevation* is the angle from 0° to 90° (or to -90, if you use a complete sphere).
- *Distance* from the speaker to centre of the setup. In DOME, the distance is fixed at 1.00.

CUBE:

- In this mode, you can enter the values with X, Y and Z coordinates.
- The Global Sound Diffusion adjustment, which affects the entirety of the speaker setup.

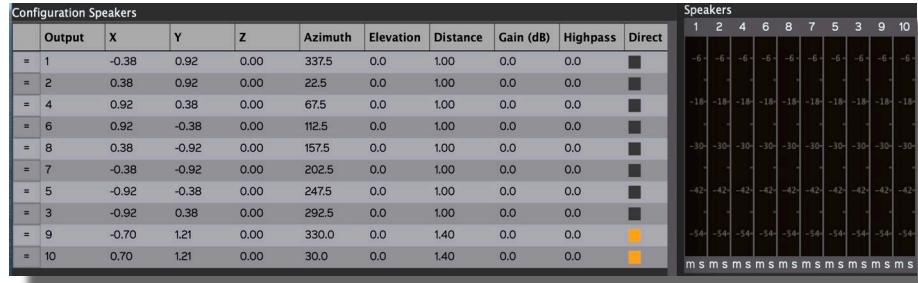
Since the introduction of the MBAP (version 3.20 and up) in CUBE mode, the Global Sound Diffusion parameter allows changing the diffusion of the sound globally for the whole set of speakers. Precise localization is obtained with a small value, higher values will result with a blurred spatial image.

Except for Distance which is set to 1.00 in DOME mode (by definition), speaker setup parameters can be set by polar values in DOME (Azimuth, Elevation) or by Cartesian values in CUBE (X, Y, Z). The other set of values is grayed out.

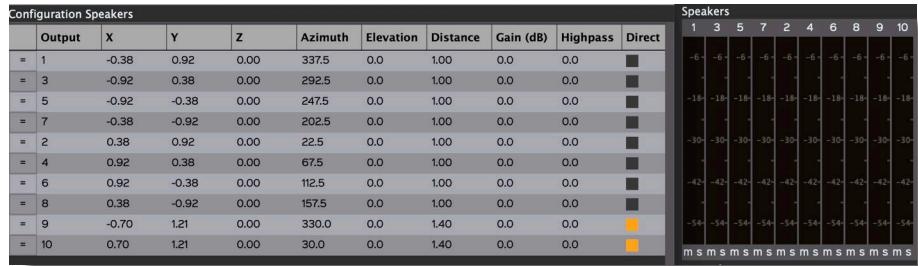
5.7.2. Speakers' order and image representation

Every column in the Speaker Setup Edition can arrange the whole series of speakers (except Gain and Highpass). The most important one is the Output column where you can move manually or automatically each speaker. This order will be reflected in the Speakers VU-meter ordering.

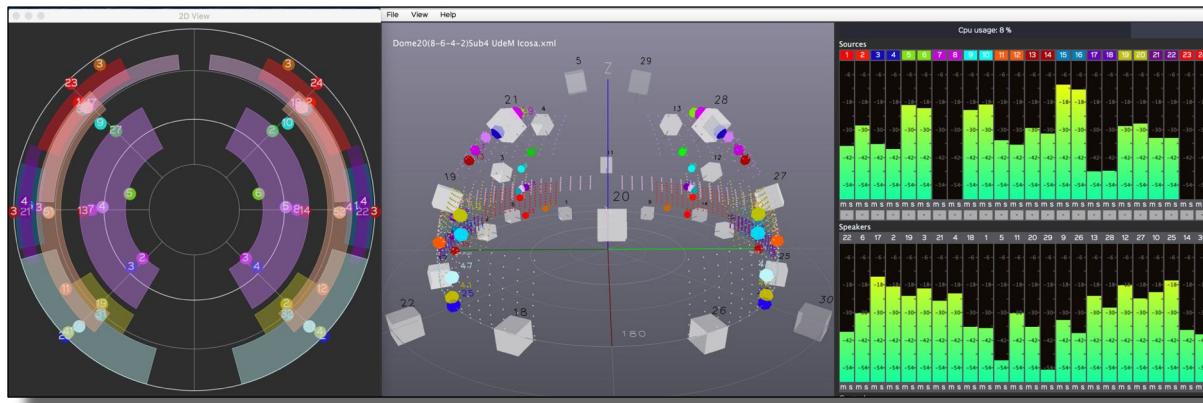
Consecutive order:



Odd and even order followed by direct outputs:



Here is an example of a speaker order that represents the stereo projection on the Y-axis (See 5.9.1 for more information). One can see on the speaker VU-meter section how the energy is distributed from the left to the right in the dome. The speakers 11 and 20 are in the centre, and the subs on the extreme left and right like they are placed in the studio. All the other speakers are equally distributed along the Y-axis:



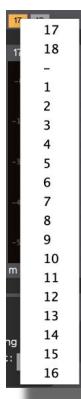
5.7.3. Minimal requirements

The DOME in particular needs minimal requirements to perform the VBAP calculations. If the speaker setup doesn't fulfill them, you'll be warned by one or two of these messages:



5.7.4. Direct outputs

It is possible to add speakers that are assigned to direct outputs, which means that they are not part of the spatialization algorithm. There are two types of direct outputs in *SpatGRIS*, which was not the case before.



Independent direct outputs

There are independent direct outputs intended for special uses like the subwoofers. These speakers are identified with an orange rectangle in the speaker setup edition. Their placement in the setup is not that critical, since they are independent of the spatialization, but if you intend to downmix your project in a two-channel format, their sound will be placed in the stereo image according to their left-right position. They are represented in black in the 3D speaker view.

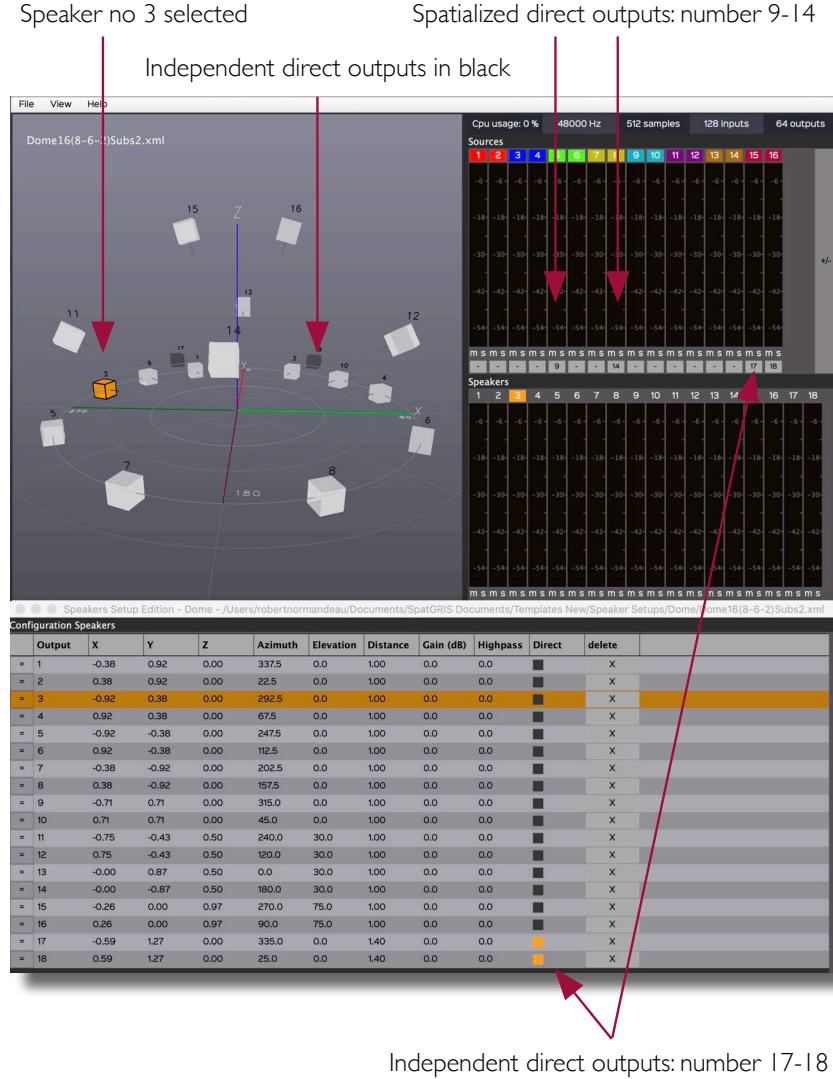
Spatialized direct outputs

This is a new feature in *SpatGRIS*. Any speaker in the setup can be used as a direct output and continue to be used by the spatialization algorithms. Every source has a direct output box that is empty by default. Any speaker number can be put in there. The difference between the types of direct outputs is that independent outputs are used only for that purpose. There is no distinction in the speaker 3D view for these direct outputs.

Spatialized direct outputs were created by Samuel Béland, a major improvement of *SpatGRIS*.

One can see the distinction 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 a spatialized direct output.

In the following example, source 5 is sent directly to speaker 9 and source 8 to speaker 14. Both speakers 9 and 14 remains in the DOME configuration. Finally, we have sources 15-16 sent to independent direct outputs 17-18:



NOTE: As the direct outputs are assigned to specific outputs, if you open a project with direct output numbers different from the actual speaker setup, you may find some silent outputs! There is no warning for that!

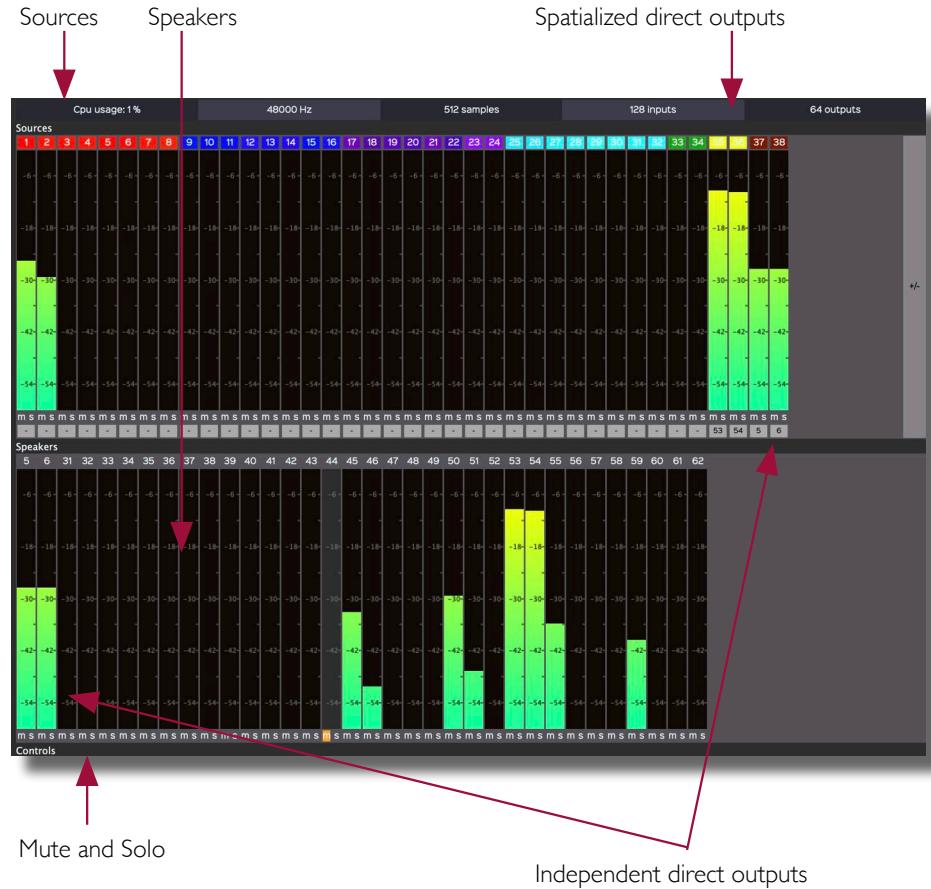
5.7.5. Show Speaker Numbers

The location of the speakers and their numbers can be viewed in the 3D window by choosing the Show Speaker Numbers option (Opt-Z¹³). Direct outputs are shown in black. Clicking on a speaker or its number selects it; Right-clicking deselects it. In the above image, speaker 3 is selected and independent direct outputs 17-18 are in black. Show Speaker Numbers only works if Show Speakers is active in the View menu.

¹³ It seems that on some Azerty keyboard, this key combination is not working. The function is still available though.

5.8. Sources and Speakers

SpatGRIS receives audio signals from the DAW and sends them to the speakers. The two main sections are the Sources (from the DAW through BlackHole) and the Speakers. There are also the direct outs that are sent directly from the sources to these speakers (for subwoofers, for instance).

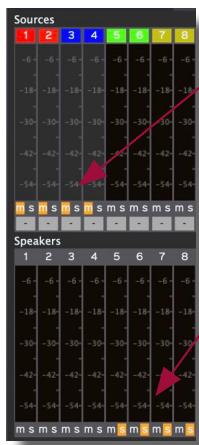


In this example, the sources are made of 4 X octophonic sources (1-32), plus 1 X stereo source (33-34), 1 X stereo spatialized direct outputs (35-36 sent to 53-54) and 1 X independent direct output (37-38, assigned to 5-6) for a total of 38 sources identified by different groups of colours, distributed on a 32-speaker dome with 2 independent direct outs (5-6).

5.8.1. Mute and Solo

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

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



5.8.2. Peak indicators and Reset

The meters are calibrated in peak. There is a general Reset Meter Clipping in the view menu (Opt-M).

5.9. STEREO reduction

For various reasons and due to technical considerations, the output loudness of STEREO differs considerably from BINAURAL, depending on the number of sources. Please adjust your listening level accordingly.

Note: The Attenuation Settings, used in Cube or Hybrid mode, are in used in stereo reduction.

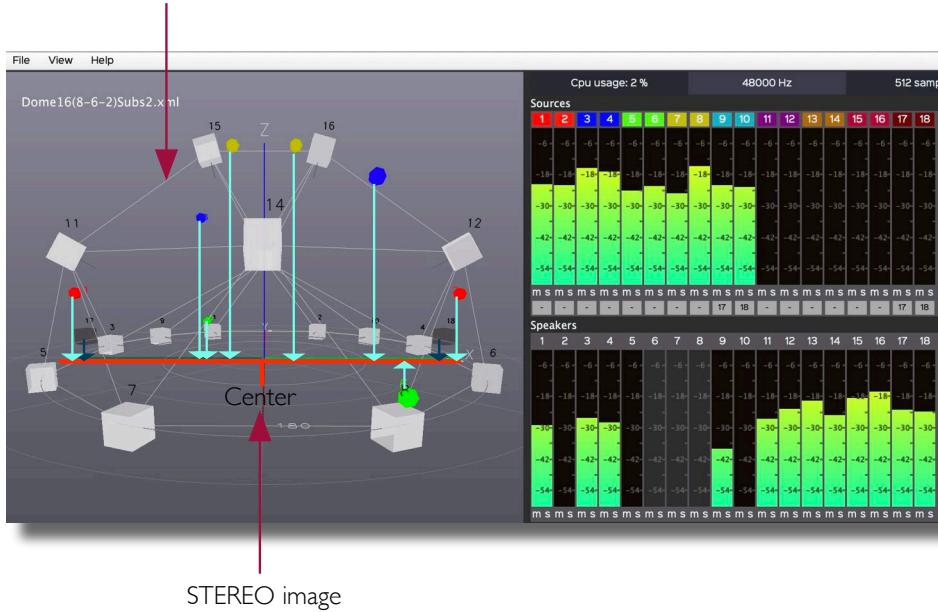
5.9.1. STEREO

There is a STEREO mode to listen to a complex project on a pair of speakers. All the sounds are sent to the corresponding speakers depending on their location (left to left, right to right, no elevation). When STEREO is selected, the stereo routing option appears that let you choose the outputs of your choice, depending on your sound card. Only your sound card outputs are available for the stereo reduction. When using the computer internal sound card, the outputs are allocated to numbers 1 and 2.



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

Triplets in DOME mode



STEREO image

5.9.2. BINAURAL

This algorithm was implemented to help users to 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 localization of sounds in the space. It is a set of phase and amplitude calculations for listening on headphones. Primarily, it is designed for 5.1 reproductions or immersive listening on headphones, situations found in the gaming and the VR industries. To minimize the number of calculations (HRTF can be very demanding in terms of computing power), SpatGRIS first calculates a VBAP spatialization over 16 speakers (with the BINAURAL_SPEAKER_SETUP, made invisible in this version) and then transfers the result to HRTF. Don't worry, even if your speaker setup contains more than 16 speakers, no information is lost in the process. BINAURAL modes use the stereo outputs of your choice. Both Spans are available in BINAURAL mode.

5.10. Recording

When the automation of the spatialization is completed, you have two options:

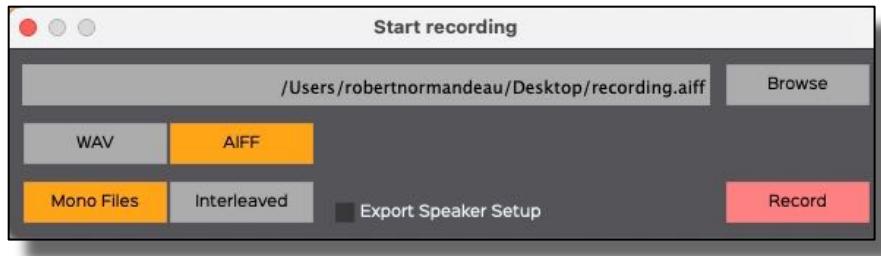
1. To play the piece "live" with your DAW and SpatGRIS.
 2. To record the spatialization to audio channels that correspond to the number of the speakers in the setup. SpatGRIS records mono files (AIFF or WAV according to your preferences) or one interleaved file.
- To record: press the big red button on the bottom right of the main window.



A pop-up window will then open, allowing you to specify:

- The location of the recorded files
- Their name
- The format: WAV or AIFF
- The number of files: Mono Files or Interleaved.

Pressing the Record button will start the recording and the timer, and it will change the Record button to a blinking one. When it's completed, you can press the Record button again to stop the recording. You can then import the separate mono files (or an interleaved file) into any DAW to play your piece in concert.



Keep in mind that with interleaved files, there are some limitations, and these limitations are reached quite rapidly on big projects:

- AIFF is limited to 2 GB
- WAV is limited to 4 GB¹⁴

Also, if you record a file with many channels, you'll find very few DAWs capable of opening it. So, it's preferable to record Mono files.

¹⁴ CAF (Core Audio Format) and WAV RF64 will eventually be implemented enabling size to exceed 4 GB.

6. PLAYER

SpatGRIS, starting with version 3.2, introduces a new tool, the PLAYER, which allows to use SpatGRIS as standalone software to play any piece encoded by SpatGRIS to any speaker setup. The main idea of the PLAYER is to help the diffusion of multichannel works among different users and on different speaker setups. Works made in DOME setup can be played in CUBE setup and vice versa. Direct outputs will be assigned automatically but can be manually adjusted afterwards.

6.1. To make a recording for the PLAYER

The procedure for the recording of a piece for play back 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 used speaker setup by toggling 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 work properly. These coordinates will be used by the PLAYER to correctly position the sources in any given listening setup.



NOTE: Only mono files work with the PLAYER. You'll 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 name of the audio files for the spatialization. There is no way to encode this information in an interleaved sound file.



6.2. To open and to play a project with the PLAYER

Once the recording is done, you can send the folder that includes the sound files and the speaker setup to a listener who would use a different setup. Or you can use it yourself to play the recording on a different setup.

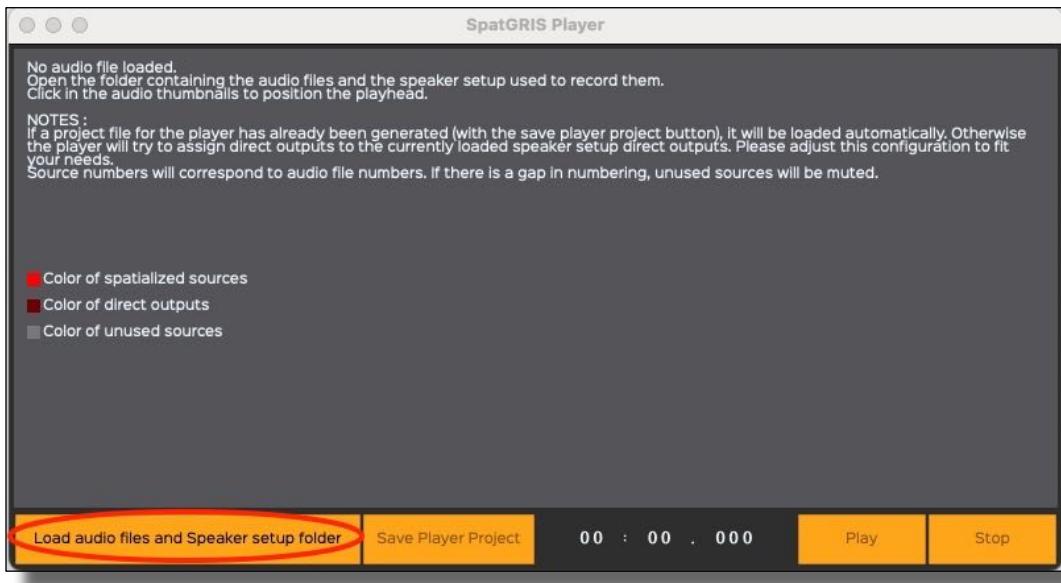
6.2.1. Open the listening speaker setup

Open the speaker setup in SpatGRIS on which you intend to listen to the spatialized work. It could be a custom setup or a setup from the templates.

6.2.2. Open the PLAYER window and load the files

View Menu —> Show Player View

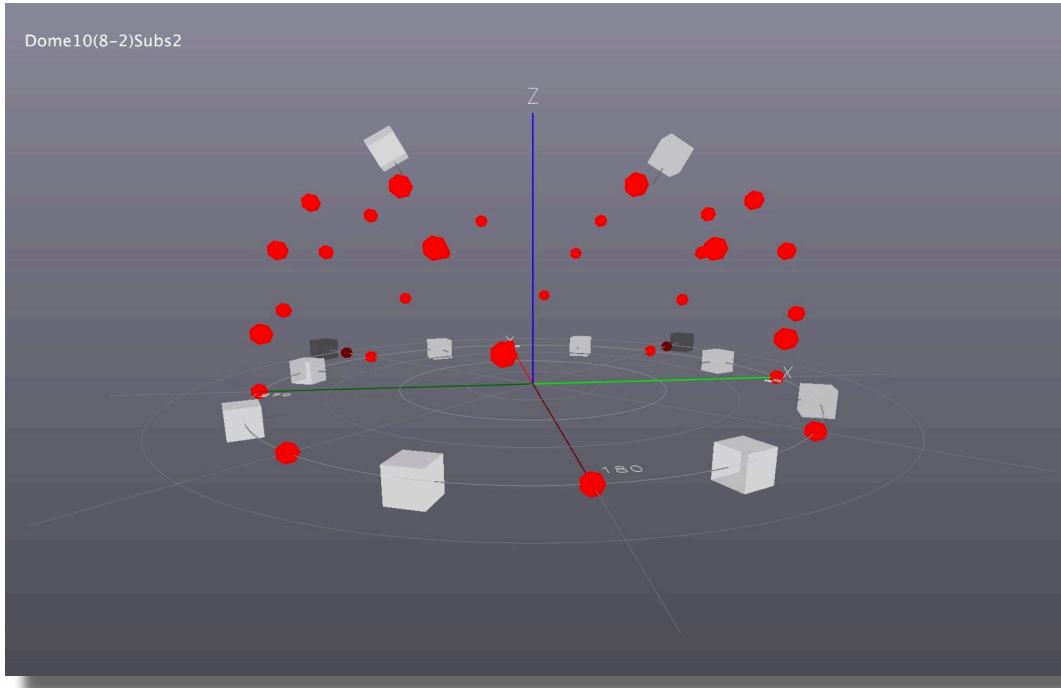
Load the audio files and Speaker Setup folder:



The PLAYER is now showing the basic waveform of the audio files:



The PLAYER will also show the speaker setup with which the work was encoded. The original speaker locations are showed in red:

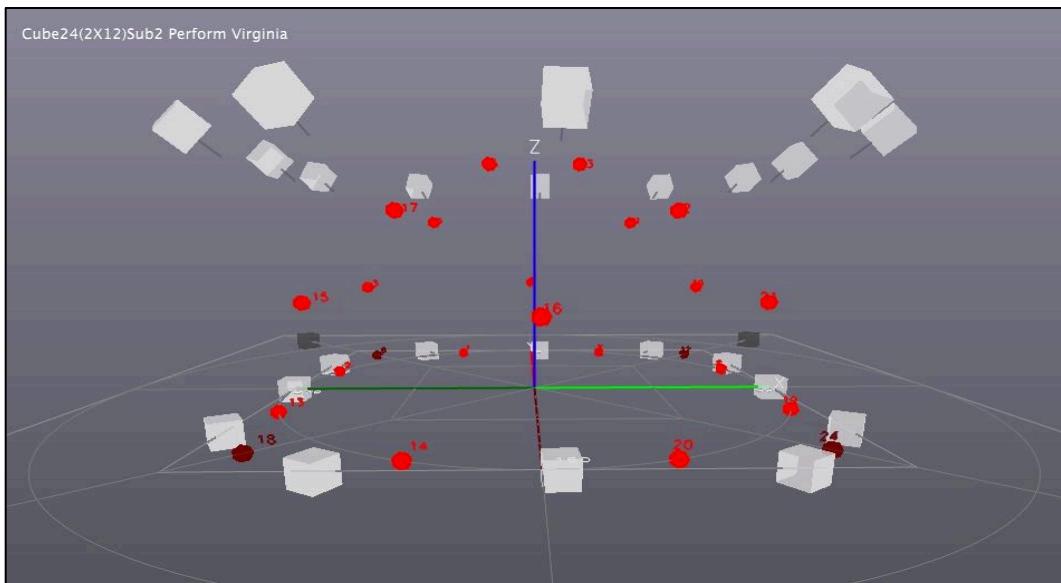


6.2.3. To play the piece

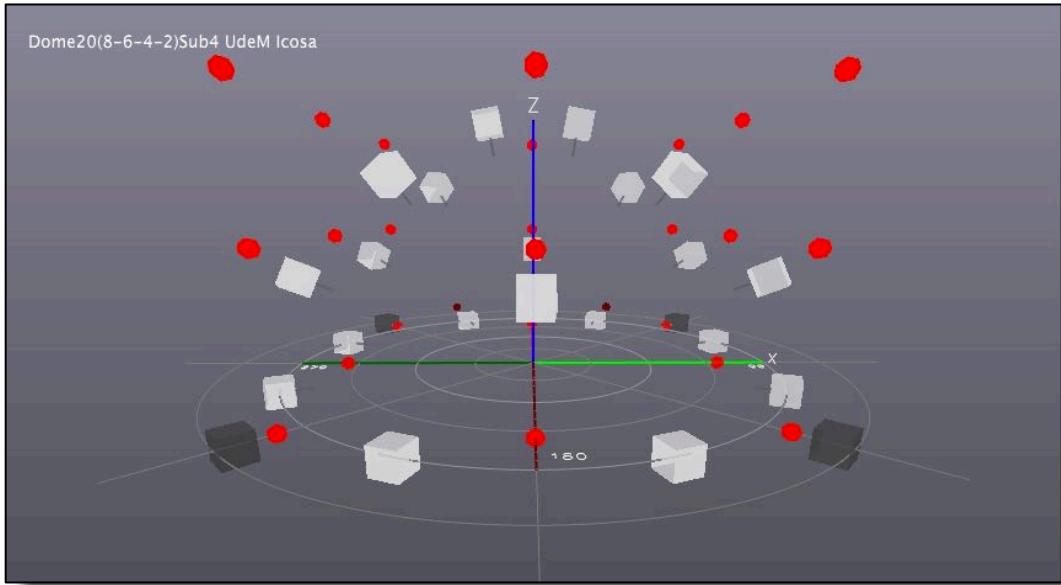
The PLAYER is now ready to play the piece. Just use the Play and Stop buttons. It's also possible to click anywhere in the soundfile to start the play from there.

6.2.4. DOME in CUBE or CUBE in DOME

The current project loaded in *SpatGRIS* is being replaced by the recorded project. Here's an example of a recording made with a dome setup (Dome20(8-6-4-2)Subs4) and played within a cube setup (Cube24(2X12)Subs2). As one can see 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 within a dome (Dome20(8-6-4-2)Subs4). As one can see the shape of the original cube is well reproduced in the listening dome:



6.2.5. Regarding the direct outs in the PLAYER

The PLAYER will try to assign direct outputs to the currently loaded speaker setup direct outputs.

In the first previous example, the original setup had four direct outputs (numbers **6-12-18** and **24**). But in the listening setup, there are only two direct outputs (**25** and **26**). The PLAYER assigned alternatively the direct out numbers from the sources to the available direct outs of the listening setup. These output numbers can be manually adjusted afterwards:

Sources		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	-6	
-18	-18	-18	-18	-18	-18	-18	-18	-18	-18	-18	-18	-18	-18	-18	-18	-18	-18	-18	-18	-18	-18	-18	-18	-18	
-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	-30	
-42	-42	-42	-42	-42	-42	-42	-42	-42	-42	-42	-42	-42	-42	-42	-42	-42	-42	-42	-42	-42	-42	-42	-42	-42	
-54	-54	-54	-54	-54	-54	-54	-54	-54	-54	-54	-54	-54	-54	-54	-54	-54	-54	-54	-54	-54	-54	-54	-54	-54	
m	s	m	s	m	s	m	s	m	s	m	s	m	s	m	s	m	s	m	s	m	s	m	s	m	
-	-	-	-	-	-	25	-	-	-	-	26	-	-	-	-	-	25	-	-	-	-	-	26	-	

6.3. To save a **PLAYER** project

If you have changed any element in the **PLAYER** project, it could be saved by using the Save Player Project button. This document will be placed automatically in the same folder as the audio files and the speaker setup. The File Saved! button will blink for a while during the process. All the files should 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 the way it was saved.

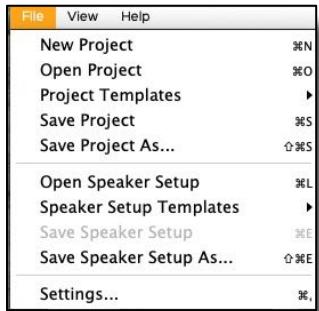


NOTE: A player project remains active until the **PLAYER** window is open. When you close it, **SpatGRIS** switches to its normal input mode, waiting for audio and OSC to come from either a sequencer or any other software.

7. Menus

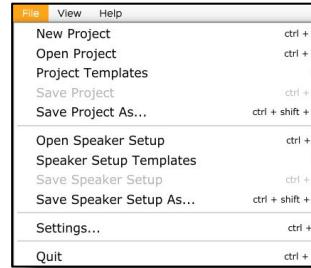
7.1. File menu

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



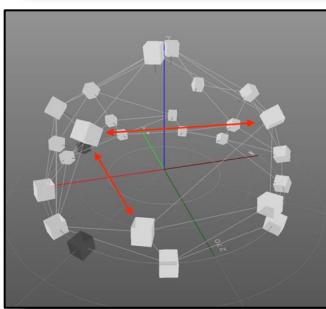
- Create a New Project
- Open an existing one
- Open a project from the Project or Speaker Templates folder. These templates can't be modified but they can be edited and saved as a new file
- Save Project or Save As — make a copy
- Open a speaker setup
- Open a speaker setup from the Templates folder. These templates can't be modified but they can be edited and saved as a new file
- Save Speaker Setup or Save As — make a copy

- Open the Settings window.

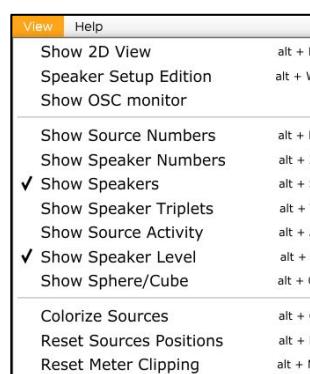


7.2. View menu

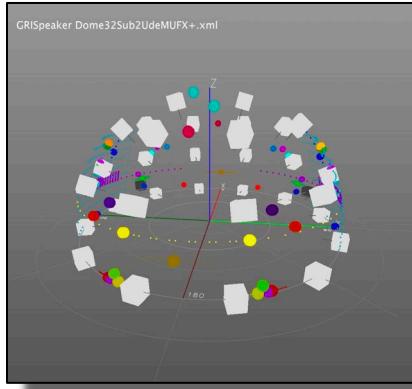
Under the View menu, you can choose from different perspectives to visualize the speakers and sources in real time. The key modifier in this menu is Option (Opt) for Mac and Alt for Windows.



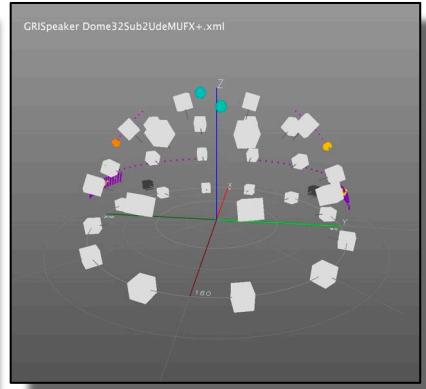
- Show 2D view: A 2D view from the top of the space is given with only the sources showing
- Speaker Setup Edition: Opens a window to access all the given parameters for a valid configuration of speakers
- Show OSC monitor: for specialists! To help troubleshooting incoming OSC message streams
- Show numbers: Show or hide the numbers of the displayed sources and/or speakers
- Show Speakers: Show or hide the speakers in the 3D view
- Show Speakers Triplets: Show or hide the triplets in the 3D view in DOME mode. Triplets reveal how the speakers are connected to each other, a very useful tool for troubleshooting a DOME speaker setup. There are no triplets in CUBE mode.
- Show Source Activity: This option allows you to see the trajectories of the sources (big dots) as well as their activity, displayed according to the Azimuth and Elevation Span (small dots) sent from the ControlGRIS plugin. Note that there is nothing to see when the DAW is stopped. The threshold is set at -70 dB. When not selected, all the sources are shown in a static 3D view, even when the DAW is stopped.



NOTE: If there is no line between two adjacent speakers or if a line is drawn from non-consecutive layers of speakers, then your speaker setup is not well designed. There could be silences when sounds move from one level to the next. You then must move the speakers slightly one from another and recompute your setup to see if the problem is solved.



Show Source Activity Off: shows the static position of all the sources in stop position



Show Source Activity On: shows only the real activity of the sources in play mode

- Show Speaker Level: Shows how much energy each speaker delivers. From grey (nothing) to white (maximum)
- Show Sphere/Cube: If you have the chance to play in a full sphere or cube!
- Colorize Sources: This option allows you to set all the inputs to a different colour within the visible spectra from red to purple. Be careful, it erases all the custom colours already in place.
- Reset Sources Position: When switching from a project to another, *SpatGRIS* could still show the sources from the closed project. Use this option to clear up the 3D view.
- Reset Meter Clipping: clipping indicators can be reset individually by clicking on them, or globally with Opt-M shortcut.

7.3. Naming and Saving

There are three sections in *SpatGRIS* that are saved independently: Project, Speaker Setup and Settings.

- Save Project. A project is coupled with a work.
- Save Speaker Setup. A speaker setup is coupled to an installation placed in a space.
- Save Settings. User settings are linked to a workstation (computer and audio interface).
- Save Settings. The stereo outputs are coupled to a specific audio interface.

Speaker setups and Project documents are saved under the .xml format. There is no distinction between them. The Project document doesn't include the speaker setup and they are therefore independent. Consequently, we strongly recommend two things:

- Add the word "Speaker Dome", " Speaker Cube" or " Speaker Hybrid" to the name of your speaker setups and "Project Dome", "Project Cube" or "Project Hybrid" to the name of your project files.
- Save the DOME, the CUBE or the HYBRID speaker setups in three separate folders in a folder named *Speakers*
- Save *SpatGRIS* projects in three separate folders inside a folder named *Projects*.

The Templates menus we provide with *SpatGRIS* is a good example of the right classification.

- Document format warnings

SpatGRIS always remembers the last opened speaker setup and the last project.

If you try to open a *SpatGRIS* project with the command Load Speaker Setup (or the opposite), you'll be warned:



NOTE: *SpatGRIS* documents adopt a new format and are not backward compatible with older versions of *SpatGRIS*. By trying to open a *SpatGRIS* project or a speaker setup in version 2, you'll get one of these scary messages! Your files are OK, just not compatible:

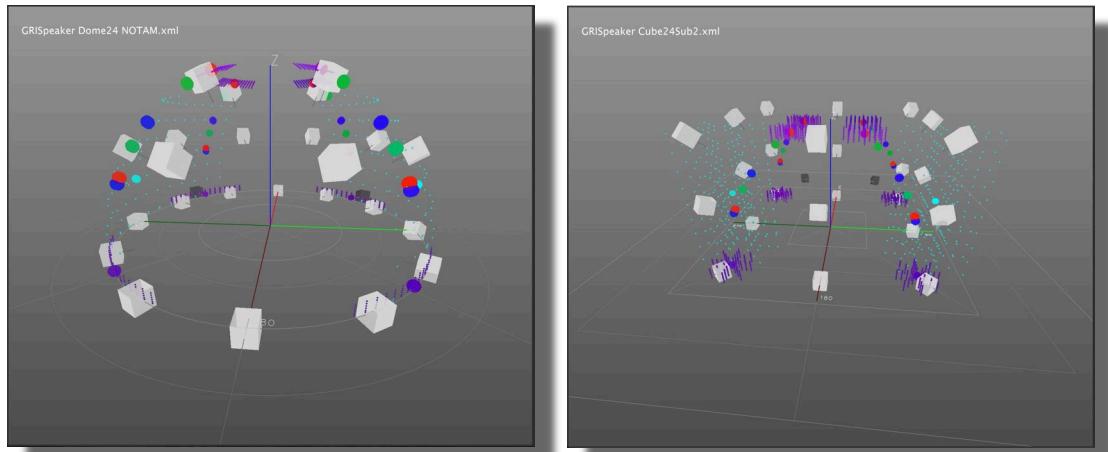


7.4. Representations

The 3D and 2D views in *SpatGRIS* are available for both DOME and CUBE modes. The sources on the DOME are on the surface and the Spans spread along that surface. In CUBE mode, the sources can be placed anywhere in the space and the Spans spread locally around the sources.

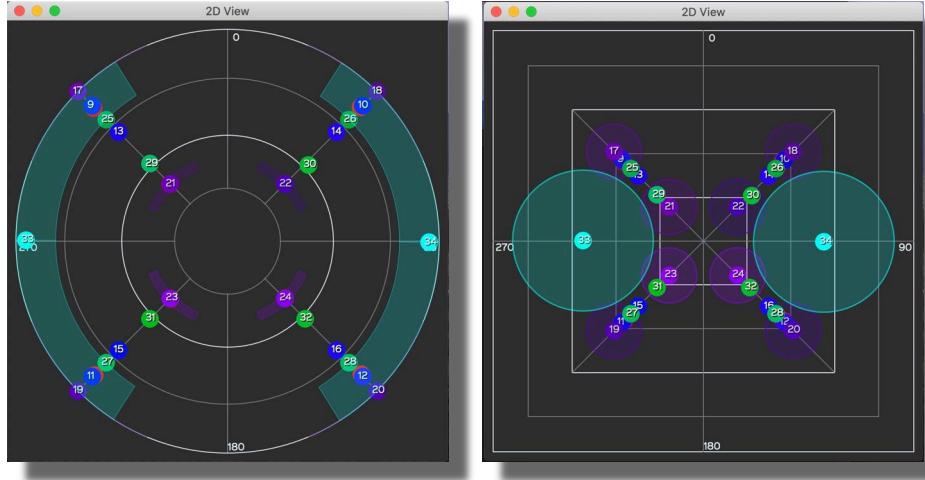
7.4.1. 3D Representation

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



7.4.2. 2D Representation

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



7.5. Performance and CPU burst

The performance of the *ControlGRIS/SpatGRIS* combination largely depends on the different settings in 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 over a 128-speaker setup and that was still working well!

The factors which will significantly reduce the CPU usage needed by our tools are, in order of importance:

- The Mode: CUBE is more demanding than DOME, since the former uses more speakers than the latter
- The Spans: they distribute the signal to more speakers than the normal settings, and therefore the CPU demand increases very rapidly as their values increase.
- The Interpolation: the interpolation factor helps some sounds to achieve a better transition time as they move from one place to the next. Therefore, the higher this parameter, the higher the number of speakers involved in the process, since a sound will reach a given speaker earlier and take more time to leave it (not to mention, it also blurs the localization)
- The number of speakers used in *SpatGRIS*. We measured comfortable performance with a 96-speaker setup, which is largely enough in most realistic situations!
- The number of tracks multiplied by the number of speakers determines the reliability of the setup. Few tracks over a big speaker setup will give the same result as many tracks over a small speaker setup.

If the CPU overpass 100%, this is the warning you'll get:



Want to know what to expect? Try it for yourself!

7.6. Help Menu

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

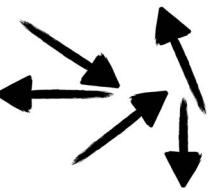
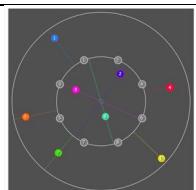
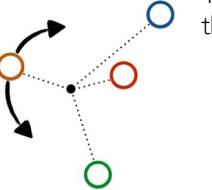
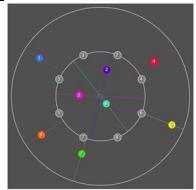
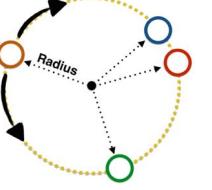
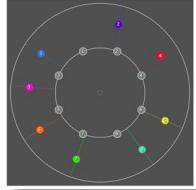
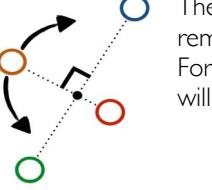
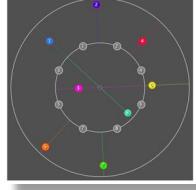
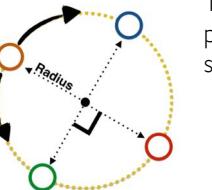
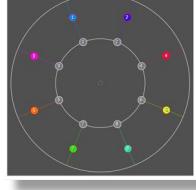
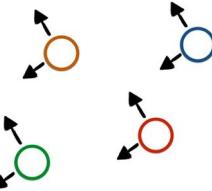
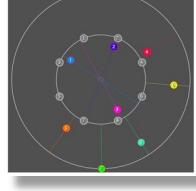


Take the plunge and have fun!

8. Addendum

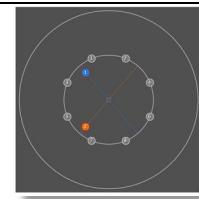
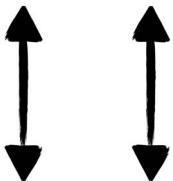
8.1. Sources Link descriptions

8.1.1. Azimuth-Elevation and Azimuth-Distance

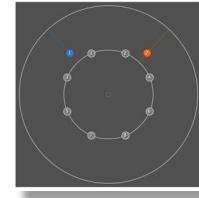
1) Independent MONO + STEREO + MULTIPHONIC	This mode is selected by default. The sources can be moved independently from one another.		
2) Circular STEREO + MULTIPHONIC	This mode enables the circular grouped movement. The angles between the sources remain constant while the radius adjusts proportionally.		
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 motion with the Angle parameter, which remains fixed and equal. For example, in octophony the opening angle between each of the sources will be fixed to 45°.		
5) Circular Fully Fixed STEREO + MULTIPHONIC	The sources are linked in a circular motion by both 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 in relation to others along the X and Y axes, without the possibility of rotation.		

7) Symmetric X STEREO

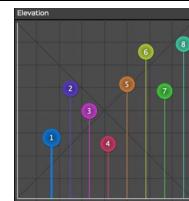
This mode enables the symmetry between two sources following the X axis.

**8) Symmetric Y** STEREO

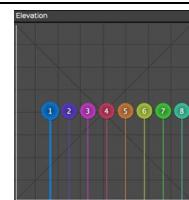
This mode enables the symmetry between two sources following the Y axis.

**8.1.2. Elevation (CUBE mode only)****1) Independent** MONO + STEREO + MULTIPHONIC

This mode is selected by default. The sources can be moved independently from one another.

**2) Fixed Elevation** STEREO + MULTIPHONIC

Same elevation for each source.

**3) Bottom Top** STEREO + MULTIPHONIC

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

**4) Top Bottom** STEREO + MULTIPHONIC

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



5) Delta Lock STEREO + MULTIPHONIC

This mode locks the position of the sources in relation to others.



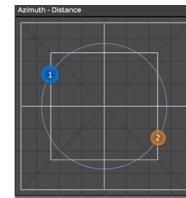
8.2. Trajectory descriptions

8.2.1. Azimuth-Elevation and Azimuth-Distance

1) Circle

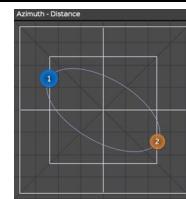
Circular motion around the centre.

Options: CW/CCW, Back & Forth, Dampening, Deviation.

**2) Ellipse**

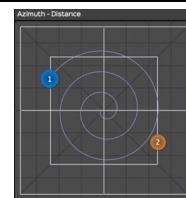
Elliptical motion around the centre.

Options: CW/CCW, Back & Forth, Dampening, Deviation.

**3) Spiral**

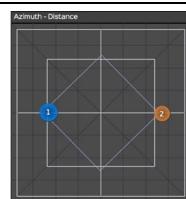
Concentric motion around the centre.

Options: CW/CCW, Back & Forth, Dampening, Deviation.

**4) Square**

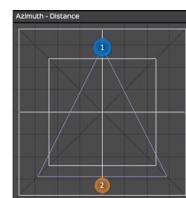
Square shape around the centre.

Options: CW/CCW, Back & Forth, Dampening, Deviation.

**5) Triangle**

Triangle shape around the centre.

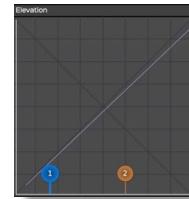
Options: CW/CCW, Back & Forth, Dampening, Deviation.



8.2.2. Elevation (CUBE mode only)

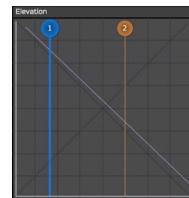
1) Down Up

From the bottom to the top.
Options: Back & Forth, Dampening



2) Up Down

From the top to the bottom.
Options: Back & Forth, Dampening



8.3. OSC messages in SpatGRIS

OSC can be sent directly to *SpatGRIS* without having to use *ControlGRIS*.

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 upstage center (the 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

ex : The message /spat/serv pol 7 0.0 0.78 0.5 0.1 0.2 moves the source #7 in the front at half elevation and placed at half the distance from the origin, with an 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

ex : The message /spat/serv deg 7 -90.0 45.0 0.5 0.1 0.2 moves the source #7 at the extreme left, at half elevation and half the distance of the space, with an 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

ex : The message /spat/serv car 7 1.0 1.0 1.0 0.0 0.0 moves the source #7 at the top right corner, with no horizontal or vertical spans.

clr clears a source's position.

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

ex : The message /spat/serv clr 7 clears the seventh source's position.

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

ex : The message /spat/serv alg 7 cube sets the seventh source's spatialization algorithm to "cube" (only works in *hybrid* mode).

8.4. OSC messages in ControlGRIS

There are the OSC messages that *ControlGRIS* can send and receive. The first number corresponds to the plugin ID. The second number corresponds to the source number. These are the default values:

- /controlgris/1/traj/1/x value
- /controlgris/1/traj/1/y value
- /controlgris/1/traj/1/z value
- /controlgris/1/traj/1/xyz/1 value
- /controlgris/1/traj/1/xyz/2 value
- /controlgris/1/traj/1/xyz/3 value
- /controlgris/1/traj/1/xy value
- /controlgris/1/traj/1/xyz value
- /controlgris/1/azispan value
- /controlgris/1/elespan value
- /controlgris/1/sourcelink value => 1 to 8
 - 1: Independent
 - 2: Circular
 - 3: Circular Fixed Radius
 - 4: Circular Fixed angle
 - 5: Circular Fully Fixed
 - 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

8.5. Open Stage Control and Lemur

Two external controllers are available for *ControlGRIS*:

- An Open Stage Control patch for iPad™
- A Lemur patch for iPad™.

An Addendum manual pertaining these iPad control of *ControlGRIS* is available on SourceForge.

8.6. Uninstall

8.6.1. SpatGRIS

If you need to uninstall *SpatGRIS*, or if you find some strange behaviour of the software, you'll have to do so manually.

- Put the application itself in the trash
- Put these files to the trash:

~/Library/Preferences/ca.umontreal.musique.gris.spatgris.plist
 ~/Application Support/GRIS/ SpatGRIS.x.x.xml where x.x.x is the version of *SpatGRIS* (3.2.1 for instance)

8.6.2. ControlGRIS

If you need to uninstall *ControlGRIS*.

Here are the paths for Mac users:

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

- To uninstall the VST3 version, delete it from the VST3 folder to 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. Known issues and warnings

There are so many different situations and setups that it would be impossible for us to cover them all. So far, we haven't found any situation where the system does not work at all. But we have found situations where some parameters must be adjusted before the system works properly. Here are a few of them.

9.1. Known issues

9.1.1. SpatGRIS

- It seems that the software is quite bug free now, at the time of the launch of *SpatGRIS* 3.2.3. Of course, we already have a list of enhancements that we plan to implement in the next few months! Don't hesitate to communicate with us if ever you have a suggestion or if you discover a malfunction.

9.1.2. ControlGRIS

- The usage of the Back & Forth option leads to many different and unpredictable behaviours that vary according to the DAW and the kind of tracks — audio, MIDI, Aux or Instruments — in which ControlGRIS is inserted (Issue # 94).
- ControlGRIS is in an intensive process of refurbishment at the moment. Stay tuned!

9.1.3. SpatGris, the plugin and SpatGRIS, the software

For those who used the plugin *SpatGris*, you'll notice that it is still working in OSC mode with *SpatGRIS*, the software. It seems that there are visual glitches in MacOS 11 and 12. We would certainly recommend switching to *ControlGRIS* in the future. The development of *SpatGris* ended in 2018.

9.2. Reaper

9.2.1. Mono tracks

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

There is no need to pan mono sources to the left for odd tracks and to the right for even tracks, since you don't have to choose the stereo outputs of Blackhole. Also, going through the Master limits us to 64 sources, after which you have to use the direct outputs; it is therefore better to always go through the direct exits.

9.3. Logic Pro

9.3.1. Lack of Surround outputs

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

9.3.2. Activate buttons

In trajectory automation, there is an exception about the activate button in *Logic X*. If there is no more audio in the track at the stop position, the *Activate* buttons will not turn off. They will have to be deactivated manually.

9.4. Digital Performer II and Automated presets

The recorded presets in DP (see 4.6.4. Presets and Automated trajectory) show soft curves instead of the square

expected ones. It means that changing from one automated preset to the next is very smooth and progressive, where it's expected to be drastic. We are working on that.

9.5. To use SpatGRIS in a live situation, use the same value of the buffer size

Be careful to adjust the buffer size of the DAW (or any other audio software) and *SpatGRIS* to the same value. Not doing this may conduct to digital distortion.

9.6. Apple M1 and Monterey (12.6)

- Some users report distortions on this combination. Please make sure you are using the latest version of BlackHole, which is 0.4.0 at the time of writing.
- There are a couple of graphical bugs with M1 computers (issues 344 and 378). We are working on redesigning the 3D representation window.

NOTE: Adjust the Buffer size to the same value, both in your DAW and *SpatGRIS*. A value of 256 and up is recommended.

Index

3

3D and 2D views · 48

A

access to the microphone · 8
Activate · 25
AIFF is limited to 2 GB · 40
AIFF or WAV · 39
Alt for Windows · 46
Apple Silicon M1 machine (version 1.3.2) · 9
Apple Silicon M1 machine (version 3.1.6) · 8
Attenuation (dB): · 31
automated presets · 25
automated trajectories · 25
Azimuth-Distance and Elevation · 18
Azimuth-Elevation · 17

B

Back & Forth · 23
BINAURAL · 6, 39
BlackHole · 8
Buffer size · 10, 12, 28, 57

C

Cartesian (CUBE) · 17
Catalina · 8
CPU usage · 49
CUBE · 15, 16, 30

D

dampening · 23
Deviation · 23
direct outputs · 35
Document format warnings · 48
DOME · 15, 16, 29
DOME, CUBE or HYBRID format · 33
DP · 9
Drawing · 24

E

Extended Top · 19

Extended Top and Bottom · 20

F

Filtering · 31
First Source ID · 16

G

Gaël Lane Lépine · 16
Global Sound Diffusion · 33

H

Head Related Transfer Function (HRTF) · 39
HYBRID mode · 32

I

Independent direct outputs · 35
Interpolation · 49
IP Address · 16

J

Jack · 8
JackRouter · 7

L

Lemur · 8, 17, 55
Logic Pro · 9, 56

M

Matrix Base Amplitude Panning · 30
MBAP · 33
microphone · 8
MIDI tempo · 23
minimal requirements · 35
Monterey · 8
multiclient · 12
Mute and Solo · 38

O

Olivier Bélanger · 16
Open Documentation · 49
Open Stage Control · 8, 17, 55
Option (Opt) for Mac · 46
OSC channels · 17
OSC input port · 53
OSC Input Port · 28
output level · 12

P

peak · 38
pendulum · 25
performance · 49
polar (DOME) · 17

R

Rearoute · 8
Record button · 39
Reset Input Position · 47
Reset Meter Clipping · 38, 47
right-hand click on a colour · 14

S

Samuel Béland · 35
Save Project · 27
Save Settings · 27
Save Speaker Setup · 27
Security & Privacy · 8
server address · 53
Shift-Click in Drawing mode · 24
Show Speaker Numbers · 36
Show Speaker Triplets · 29
silent outputs · 36
Sources Link descriptions · 50
Sources tab · 16

Spans · 19, 48, 49
SpatGris1 · 56
Spatialized direct outputs · 35
Speakers' order · 34
STEREO · 38
subwoofers · 35, 37

T

The threshold is set at -70 dB · 46
Trajectories · 21
Trajectory descriptions · 52
Triplets · 46

U

uninstall *ControlGRIS* · 55
uninstall *SpatGRIS* · 55

V

VBAP · 16
Vector Base Amplitude Panning · 29
Ville Pulkki · 16

W

WAV is limited to 4 GB · 40

X

xml format · 47

Z

ZirkOSC · 9
