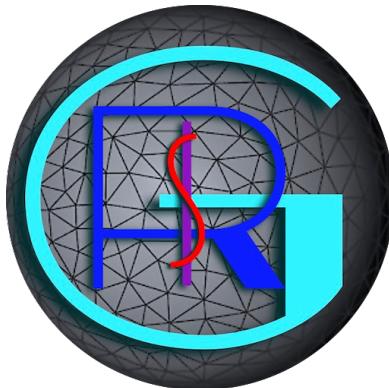


SpatGRIS3



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

*SpatGRIS3 3.2
ControlGRIS 1.4
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I. General presentation

I.1. SpatGRIS3 is a mixer

I.1.1. An external mixer

Using its two algorithms DOME or CUBE, SpatGRIS3 maps the sources - which come from any audio software – to a speaker setup. The position of the sources is provided through OSC messages. The spatialization is done outside SpatGRIS3, through a speaker system in a physical space.

I.1.2. An internal mixer

With the functions STEREO and BINAURAL, SpatGRIS3 makes a two-channel reduction mixing, 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 chosen.

I.2. SpatGRIS3 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 determined by the speaker setup and the room in which it is installed. The OSC sources are spatialized.

I.2.2. Localization

SpatGRIS3 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. SpatGRIS3 is a recorder and a player

SpatGRIS3 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 - MULTIPLE MONO or INTERLEAVED. With the *Player* function, SpatGRIS3 can play any multichannel works encoded with it.

I.4. SpatGRIS3 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 to 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 power and spectrum.

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

Each loudspeaker has a unique number — whether in spatialized mode or 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 SpatGRIS3

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 to an 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 SpatGRIS3?

What's new

- SpatGRIS3, version 3.2, introduces a new function, the *Player*, that allows using SpatGRIS as a standalone software to play any piece encoded by it to any speaker setup.
- SpatGRIS3, version 3.1.3 introduces a new Hybrid mode that combines the DOME and the CUBE algorithms.
- SpatGRIS3 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 for instance; Spatialized, with which the sound can be sent exclusively to any loudspeaker that is part of the speaker setup.
- Compatibility with the newest MacOS, from 10.14 (Mojave) to 12.3 (Monterey) and new machines (M1).
- ProTools compatibility with the addition of the AAX format of ControlGRIS.
- 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 SpatGRIS3.
- New xml format (3.1.8) to save projects, speaker setups and algorithms.

Improvements

- SpatGRIS3 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 SpatGRIS3
- 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:

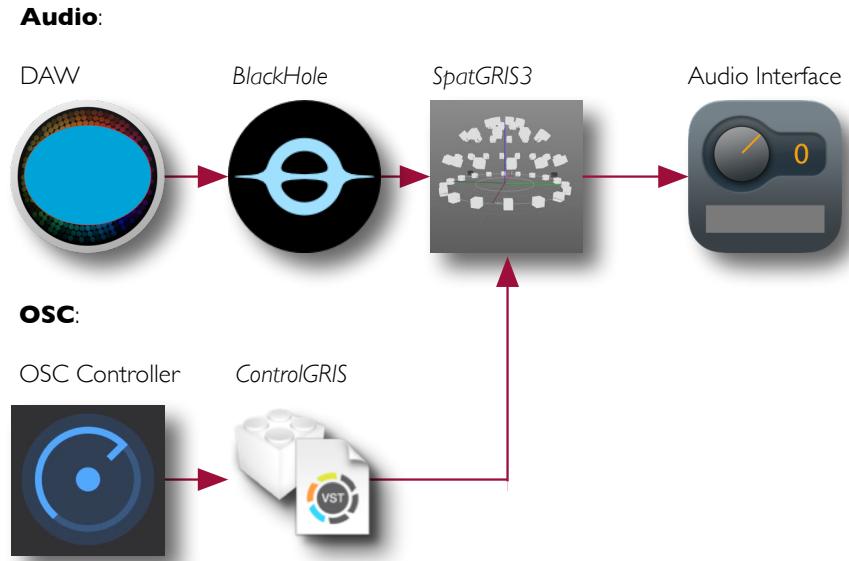
- Any DAW that can use AU, VST, VST3 or AAX plugins
- Your audio interface.

2.1. Architecture

The SpatGRIS3 system is made of three elements:

- The ControlGRIS plugin where the trajectories are designed and recorded in a DAW (or any OSC device)
- The SpatGRIS3 itself that spatializes the sound, according to the setup of the speakers done in the Speaker Setup Edition
- The virtual audio device *BlackHole*¹ that connects the DAW to SpatGRIS3.

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



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 being spatialized in SpatGRIS3. Not doing that will lead to silence or freeze spatialization.

2.2. SpatGRIS3

SpatGRIS3 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 would provide up to 128 inputs and outputs. The trajectories are sent from the ControlGRIS plugin, or from any other OSC software² to SpatGRIS3. The audio spatialization itself is performed by SpatGRIS3 and sent to the audio interface.

2.2.1. History

The development of SpatGRIS3 began in 2020. It is a rewritten version of ServerGris (2018) and SpatGRIS2 (2020). The first official version of SpatGRIS3 is 3.0.0 and was released in August 2021. It's our first *Jack*³ free spatialization tool!

¹ *BlackHole* is not mandatory. Any software that can send audio to SpatGRIS3 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 is not compatible with MacOS 10.15 and up, and is not supported anymore.

2.2.2. System requirements

The software has been tested on the following OS:

- MacOS from 10.14 Mojave™ to 12.5 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 *SpatGRIS3* from SourceForge:

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

SpatGRIS3 for Mac comprises two installers in the same folder:

SpatGRIS_v3:

- *SpatGRIS3* 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 *SpatGRIS3*.

SpatGRIS3, *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 patch for iPad™.

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

SpatGRIS3 for Windows has one installer:

- *SpatGRIS3* 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 *ReaRoute*, which works closely to *BlackHole*, but just for Reaper⁴. It is also possible to use Jack in 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 to Mojave (10.14) and up users.

Make sure that *SpatGRIS3* has access to the microphone in the System Preferences, Security & Privacy:



⁴ For other software users, there is a donationware called <https://vb-audio.com/Cable/> that sorta works, although it sometimes seems to have trouble staying in sync with *SpatGRIS* and is limited to 32 channels.

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 *SpatGRIS3* 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 10.14 Mojave™ to 12.5 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 *SpatGRIS3* 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 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

SpatGRIS3 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 *SpatGRIS3* 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.

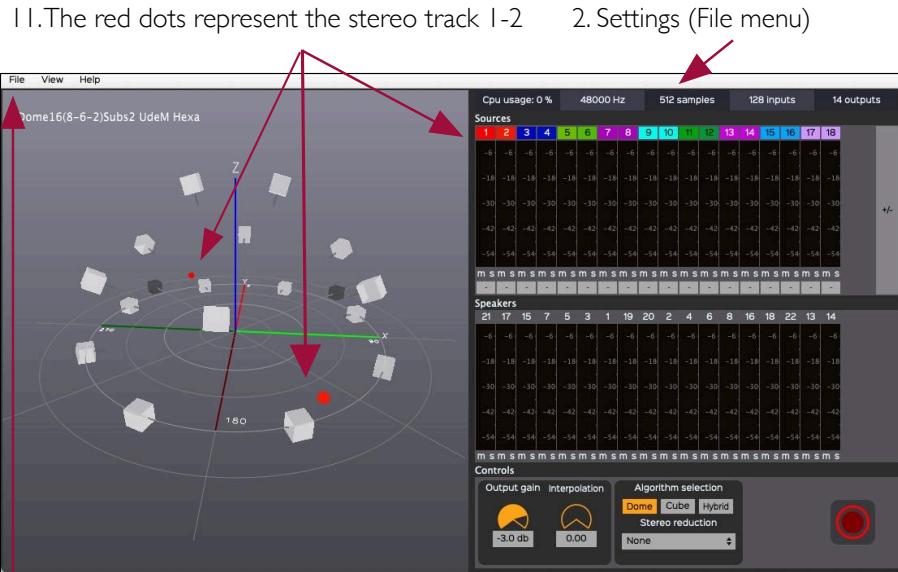
NOTE: Adjust the Buffer size at the same value in your DAW and in SpatGRIS3. Value of 256 and plus is recommended.

1. Open *SpatGRIS3*
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



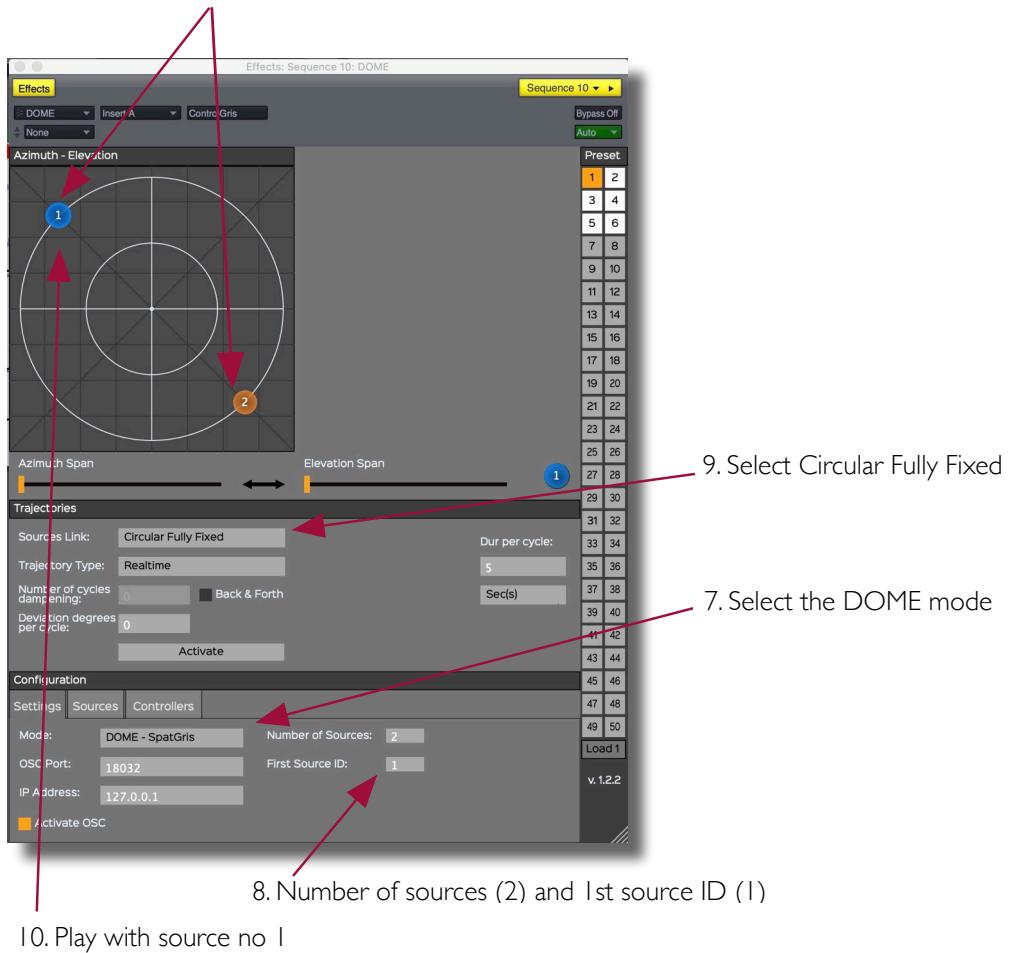
3. Open a DOME Speaker setup (File menu) or use the default one
4. Open your DAW
5. Assign the audio output of your DAW to *BlackHole 128ch*
6. Create a stereo track and assign the outputs to *BlackHole 128ch* 1-2
7. Insert a *ControlGRIS* plugin in this track in DOME mode
8. Number of sources should be already initialized and set at 2 and First Source ID at 1
9. Select *Circular Fully Fixed* in Sources Link
10. Play with Source No. 1 and see the result in *SpatGRIS3*
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



Questions? Details? Read the manual!

This manual is in the Help menu:



3. Connections

3.1. Connect the DAW to SpatGRIS3

3.1.1. Open SpatGRIS3

The first time you open *SpatGRIS3*, 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 *SpatGRIS3*.

3.1.2. Adjust the output level

By default, the output level of the *SpatGRIS3* is set to unity gain: 0.00 dB. It may need to be attenuated or increased, especially 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 would be seen like any other audio interface in the Core Audio system. *SpatGRIS3* 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

SpatGRIS3 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* with the corresponding OSC numbers.

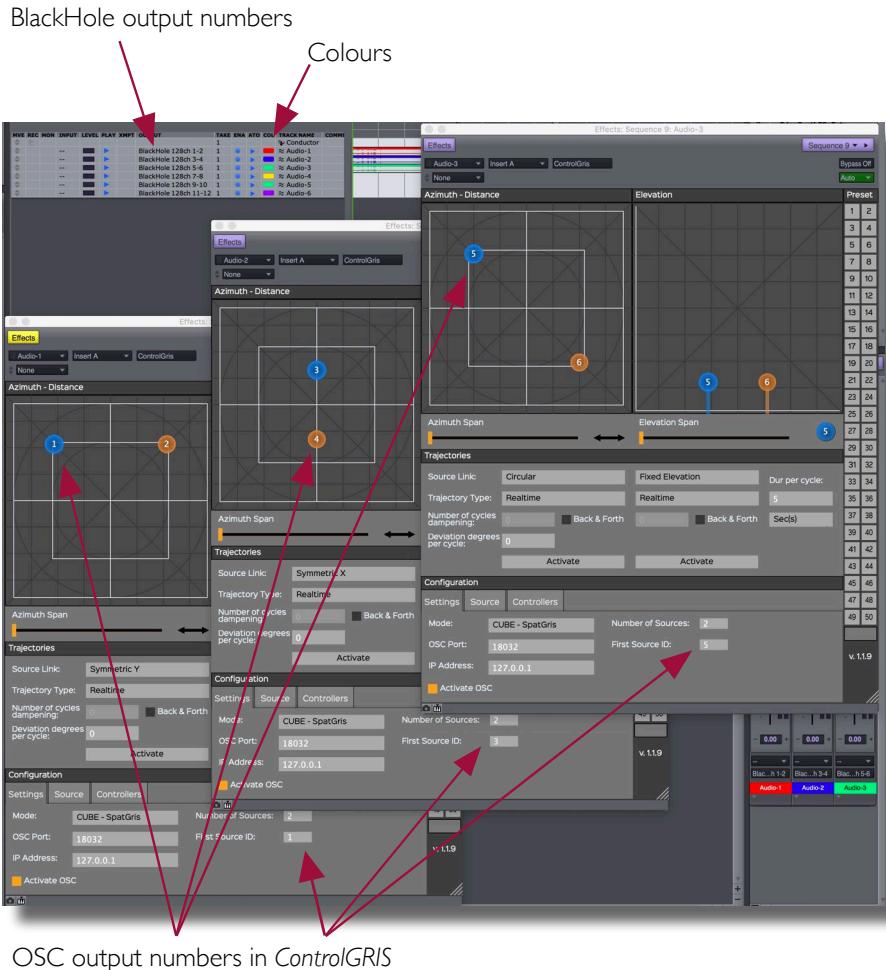
NOTE: Adjust the Buffer size at the same value in your DAW and in SpatGRIS3. Value of 256 and plus is recommended.

3.2. Connect ControlGRIS to SpatGRIS3

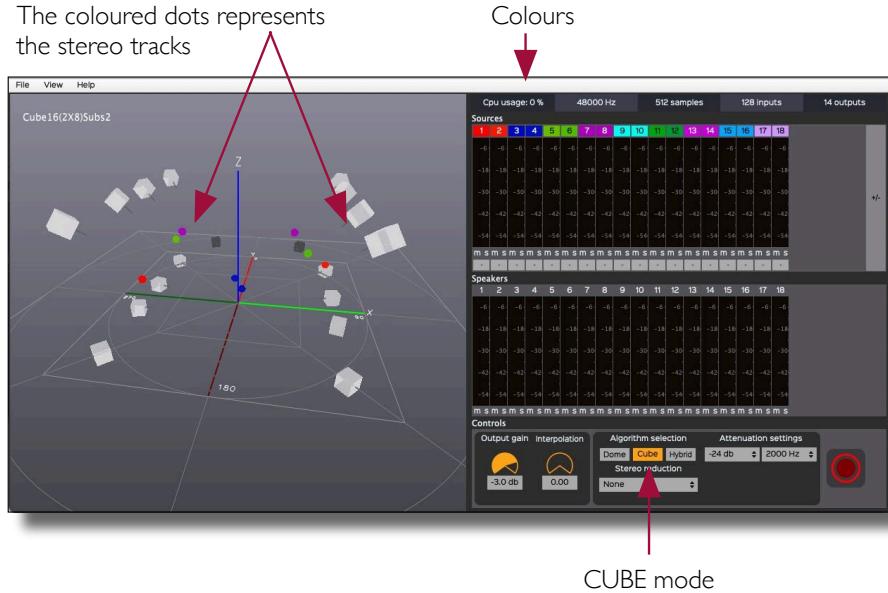
3.2.1. Numbering audio and OSC

The spatialization is handled by *SpatGRIS3* 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* 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 better to use the same colour scheme in the DAW and in *SpatGRIS3*.

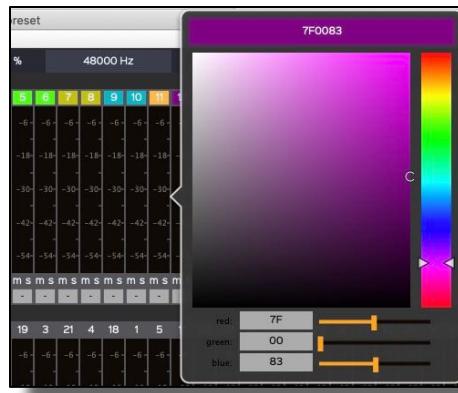


NOTE: If by mistake, you are using the same OSC numbers in different tracks, the sources in *SpatGRIS3* will shake because they will receive two identical positions (or more) from different *ControlGRIS*. It's a good indicator that something is wrong.

3.2.2. Sources Colour

The colour of the sources can be set to any value by clicking in the colour square. 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 SpatGRIS3:

- DOME
- CUBE

These two modes will be explained in detail in the *SpatGRIS3* section.

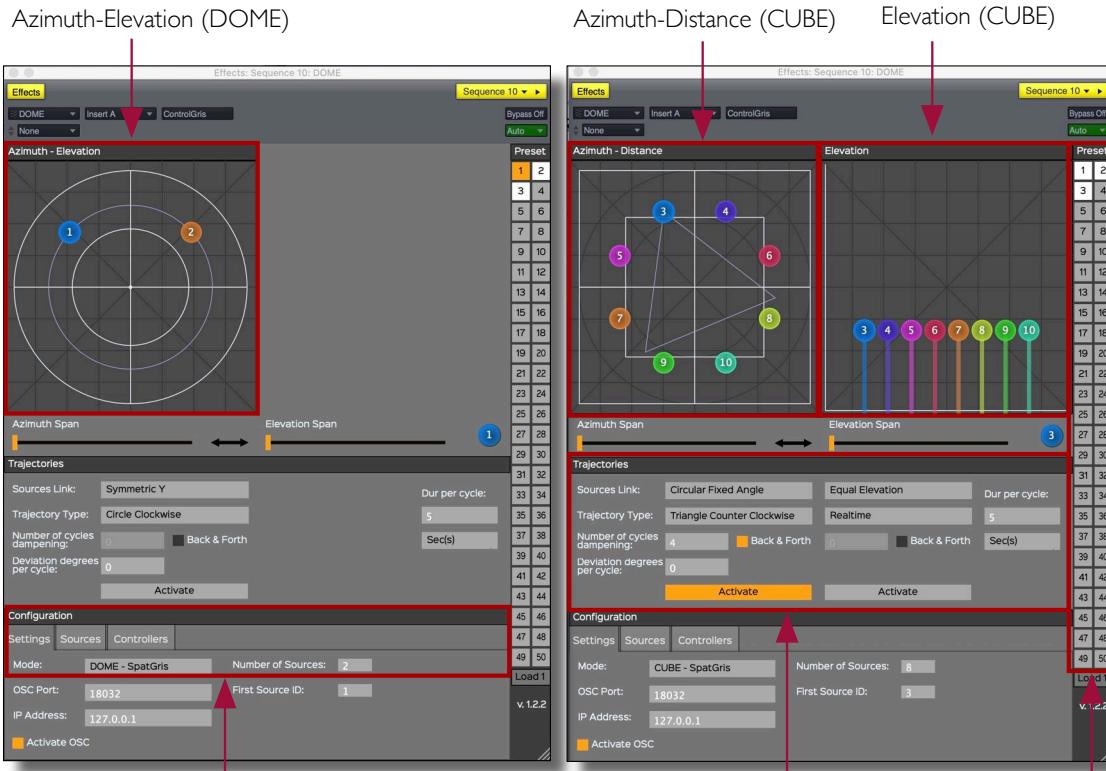
4.1. Introduction

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 up to eight channels. ControlGRIS doesn't handle audio, only data which is sent to *SpatGRIS3*. The audio itself is sent from the DAW directly to *SpatGRIS3*.

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.

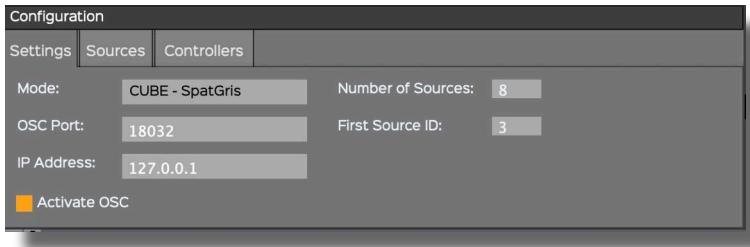


Configuration panel of the plugin, subdivided in tabs: Settings, Sources, Controllers

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 SpatGRIS3. 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).

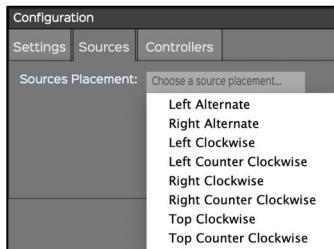
First Source ID

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

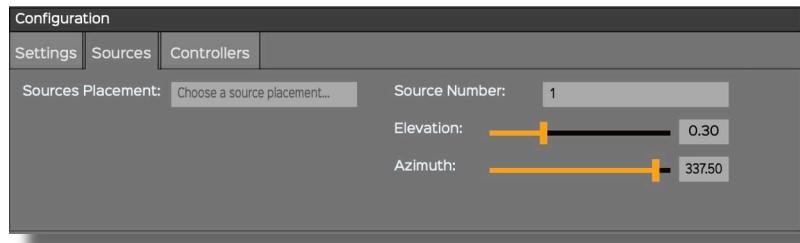
Under the Sources tab, it is possible to accurately position sources by using the graphical interface or the text boxes. Using Sources Placement, it is possible to position sources equidistantly, following a clockwise or alternate order. To do so, simply select the desired layout from the drop-down menu.



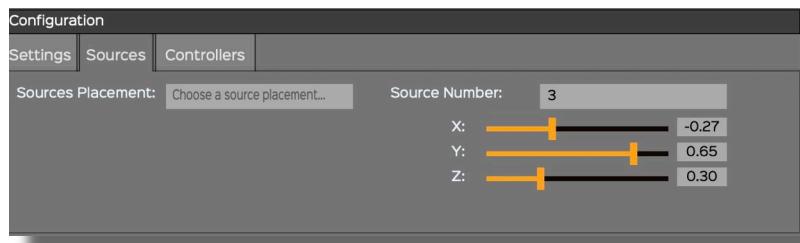
⁸ Since version 3.2.0, the LBAP, Layer Base Amplitude Panning, designed by Olivier Bélanger, is not in use anymore.

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:

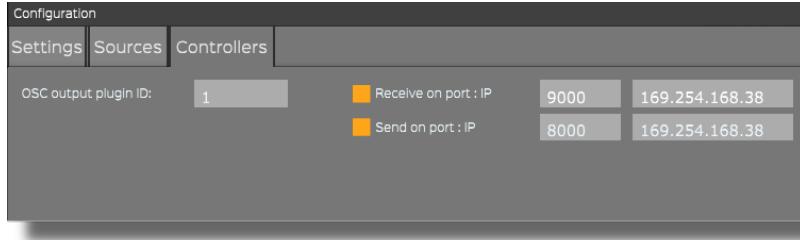


In CUBE, X, Y, and Z correspond to the current Cartesian coordinates of the selected source:



NOTE: Manually positioning the sources works only 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 receives automatically 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 is at the bottom of the dome.

⁹ <http://opensoundcontrol.org>

¹⁰ See the Addendum manual for more information.

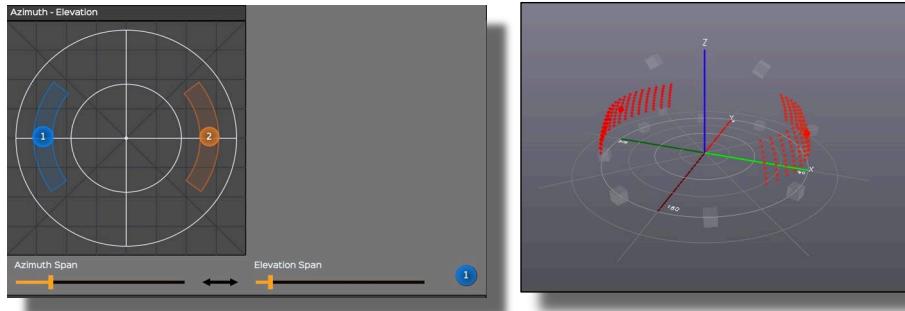
¹¹ See the Open Stage Control manual for that: <https://openstagecontrol.amm.net/>

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



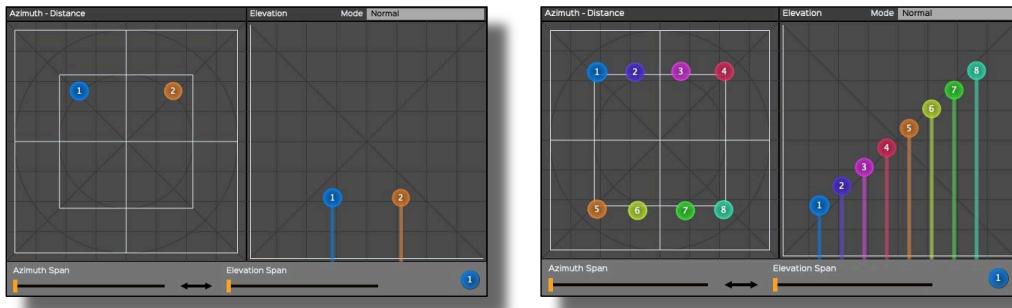
4.4.2. Spans in DOME mode

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:



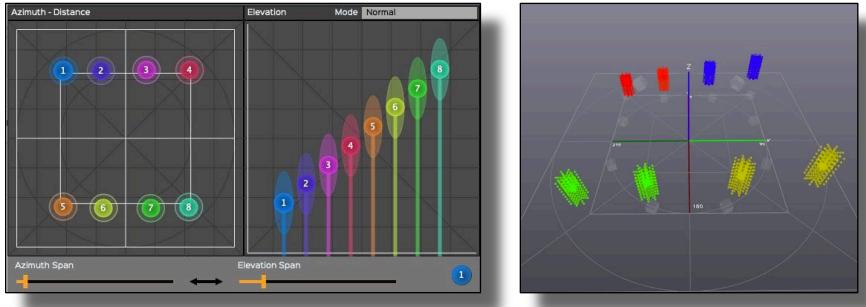
4.4.3. View in CUBE mode

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 SpatGRIS3). Examples in stereo and octophonic sources:



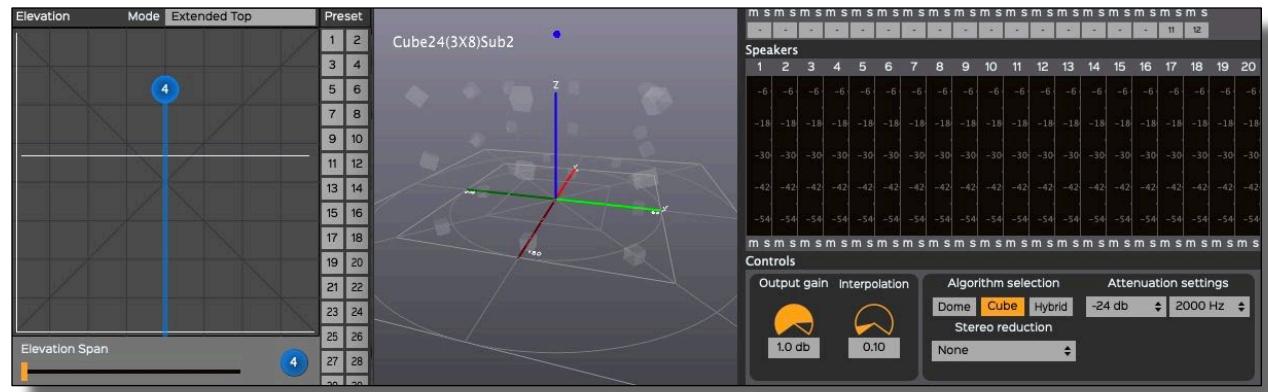
4.4.4. Spans in CUBE mode

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



4.4.5. CUBE Elevation in Normal or Extended Top mode

Since version 1.3.5, ControlGRIS offers the possibility to put the source outside of the CUBE in elevation. This was already possible on X-Y axes, and it is now possible on 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 from where the SpatGRIS3 Attenuation Settings start to take effects in elevation. Sources will be filtered either in volume and/or in frequencies as they are going further away from the top of the cube:



NOTE: Older projects can still be used in Normal mode.

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 being spatialized in SpatGRIS3. Not doing that will lead to silence, or to freeze spatialization.

4.5.2. Save presets and recording automation

It is possible to save some of the ControlGRIS plugin parameters within the 50 provided presets. 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:



To create such presets allows you to save and recall only the following parameters:

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

Parameters that are not saved but can be automated:

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

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

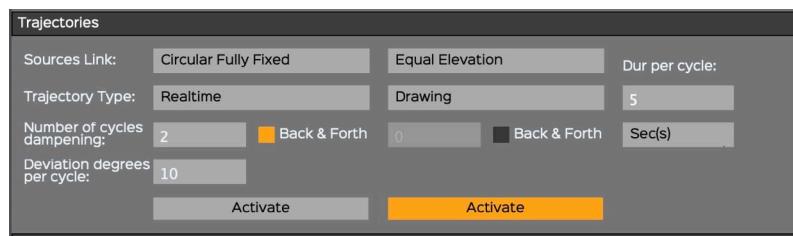
- The whole Configuration tab is not saved in the preset (this one is saved with the DAW project). It is not a good idea to change these settings within a track.

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.

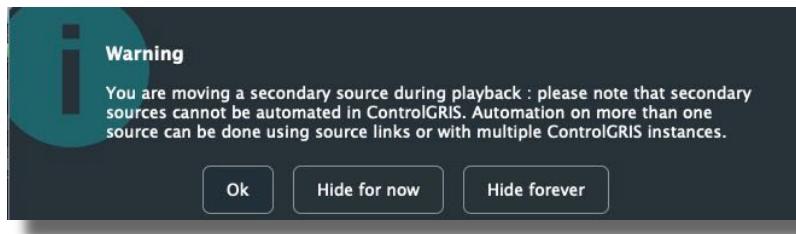
4.6. Trajectories



It is possible to automate the movement of the sources using predefined trajectories. Within the *Trajectories* control

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

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:

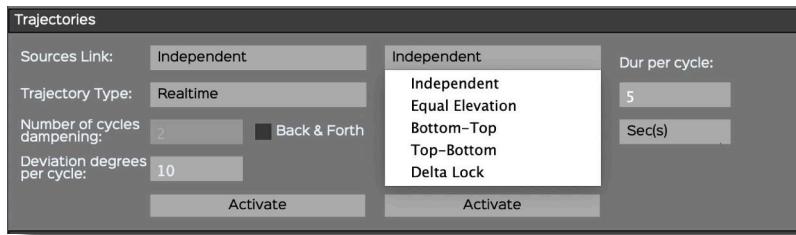
- Mono: Independent only
- Stereo: all links
- Multichannel: all but Symmetric X and Y.
- Detailed representations of the Azimuth-Elevation and Azimuth-Distance Links are shown at the Addendum 7.1.1.



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.



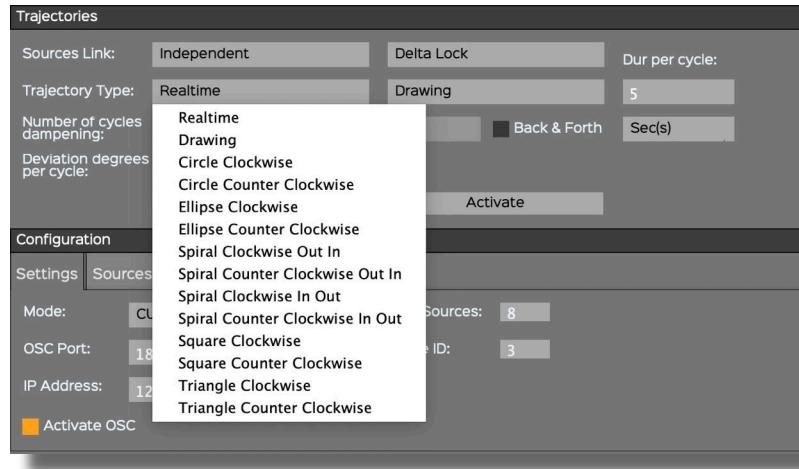
4.6.2. Trajectory Type

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.

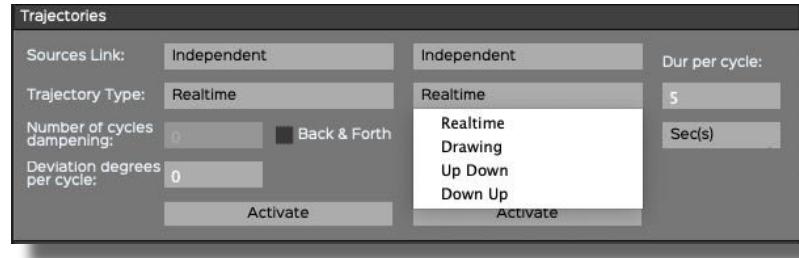
Azimuth-Elevation (DOME) and Azimuth-Distance (CUBE) Trajectory Type

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



Other settings

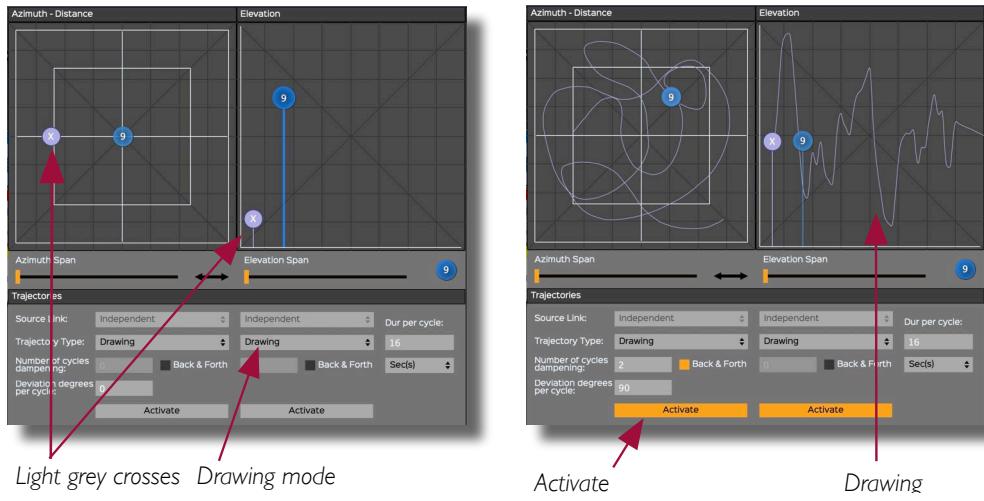
- The duration of the trajectory in second(s) or beat(s) (linked to the MIDI tempo of the host sequencer)
- The Number of cycles dampening: the total duration = Dur per cycle x Number of cycles x 1,5. Dampening works only with Back & Forth.
- The Back & Forth option
- The Deviation degrees per cycle.

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.



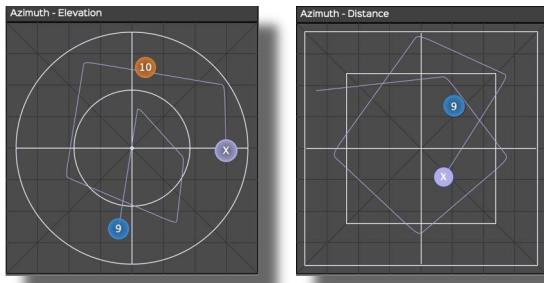
Modifiers:

- 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.

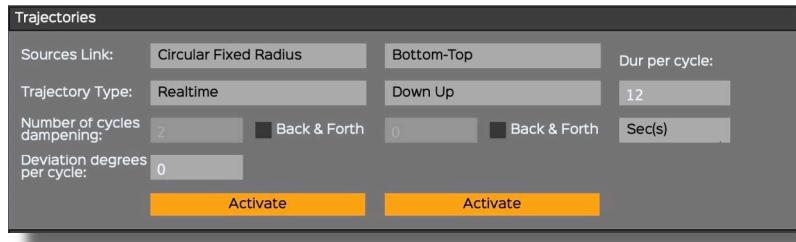
Shift-Click in Drawing mode

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.

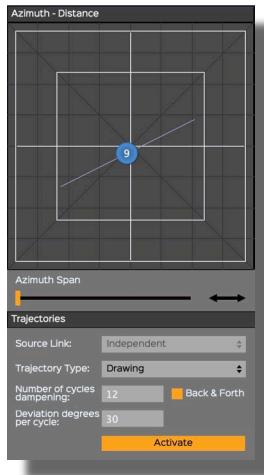
Trajectory recording in the DAW

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

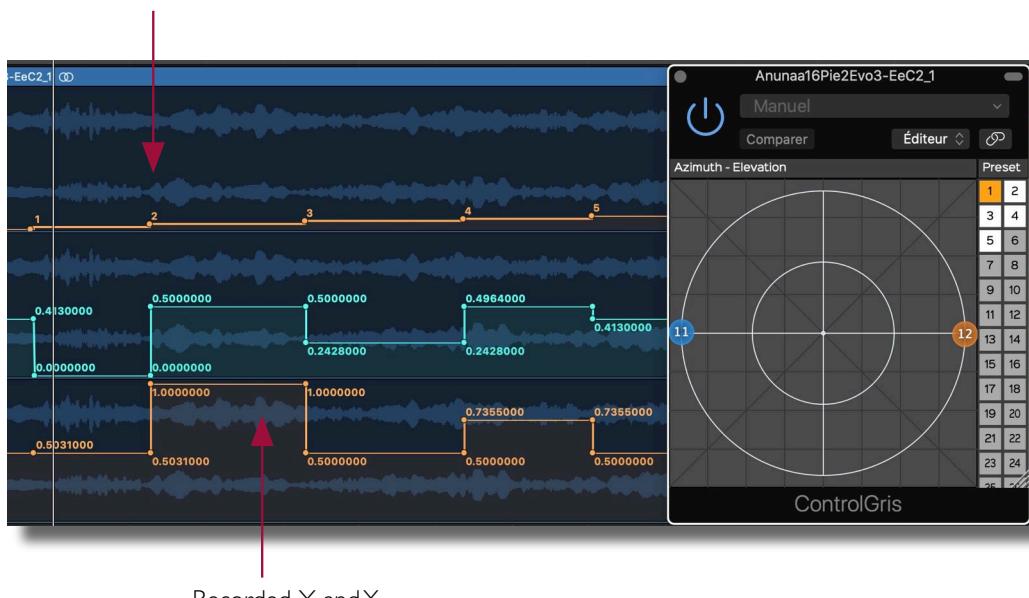
A specific use of the Shift-Click in Drawing mode can be used to design a pendulum. If a simple line is drawn with Shift-Click, it constitutes the basic element of a pendulum. Then the Dur per cycle, Dampening, Deviation and Back & Forth can be used to make this pendulum very interesting. It can be placed 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 (that 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. SpatGRIS3

- SpatGRIS3 is a mixer
- SpatGRIS3 does spatialization and localization
- SpatGRIS3 is a recorder
- SpatGRIS3 makes speaker setups.

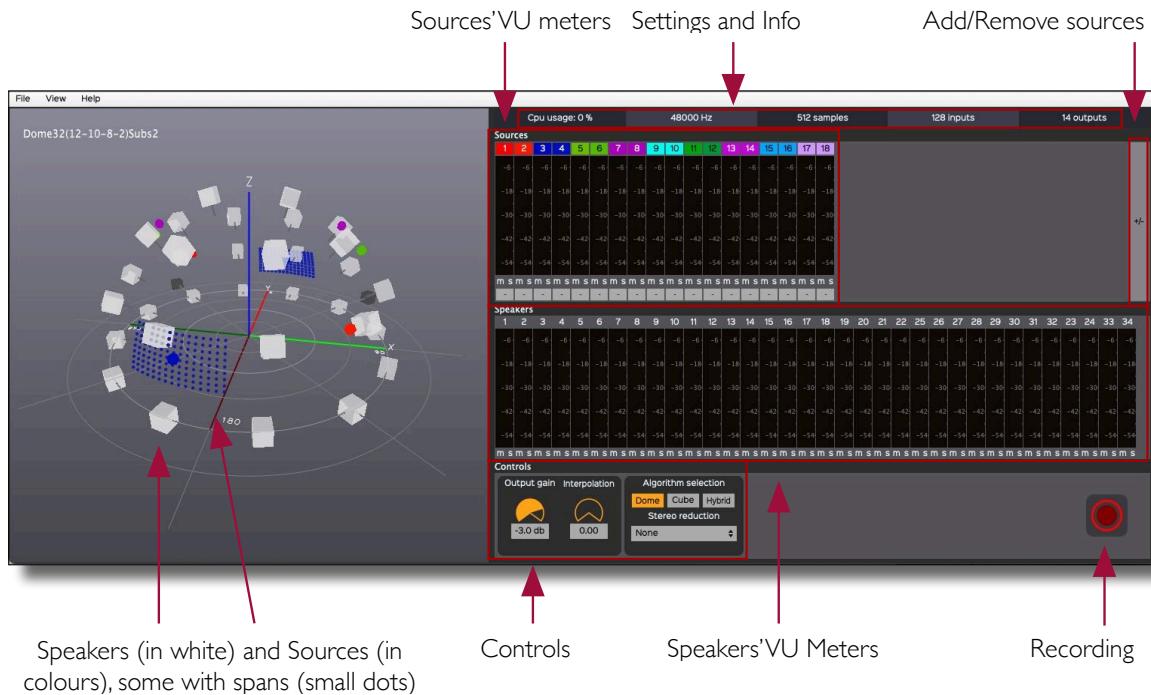
5.1. Introduction

There are three sections in *SpatGRIS3* 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 *SpatGRIS3*.
- **Save Speaker Setup.** A speaker setup is coupled to an installation placed in a space. This is the section on the left of *SpatGRIS3*.
- **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-,)

The *SpatGRIS3* window is divided into different zones:

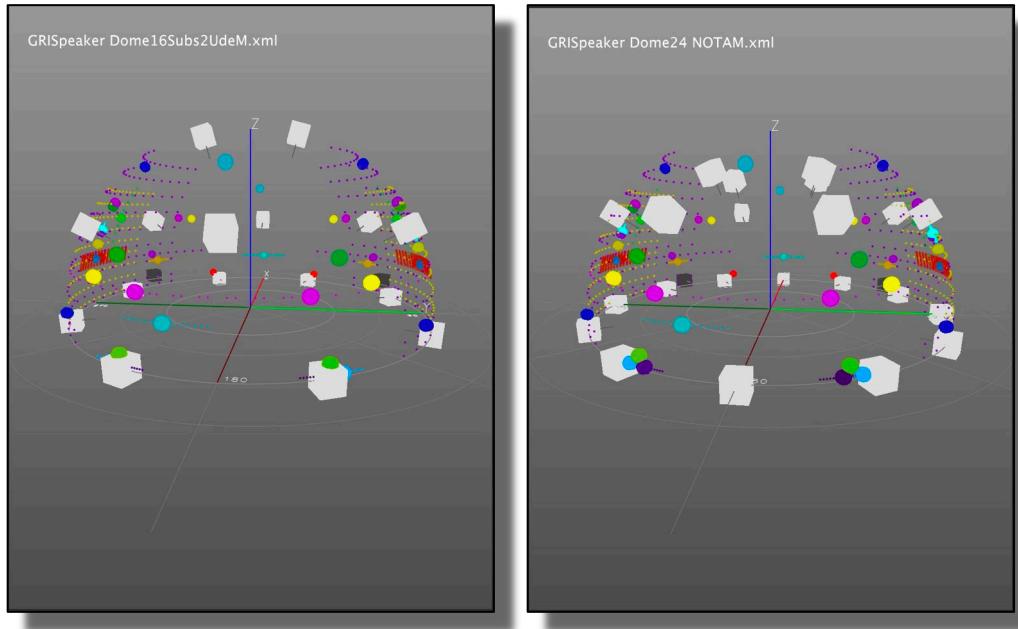
- Sources and Speakers in a 3D view
- VU Meters
- Settings and Info
- Controls
- Recording



5.2. Change the setup not the spatialization

The most interesting feature in *SpatGRIS3* 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 just 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 SpatGRIS3.

General Settings:

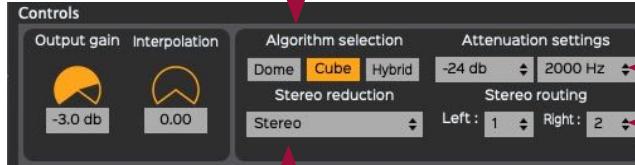
- OSC Input Port: default is 18032 which is the same as *ControlGRIS*. If you want to use another incoming OSC device, you must change this number accordingly.

Close

Your settings are automatically saved. Under the name of the version of *SpatGRIS3*, the document is located here (Mac):
 • ~/Library/Application Support/GRIS/SpatGRIS3.0.0 (for example).

5.4. Controls

- Algorithm selection: DOME, CUBE or HYBRID



- Attenuation settings in CUBE or Hybrid modes only:

- Level: from 0 to -72 dB

- Low-pass filter freq.: 125Hz to 16kHz

- Stereo reduction: specific channels for STEREO and BINAURAL

- 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. Default at 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.

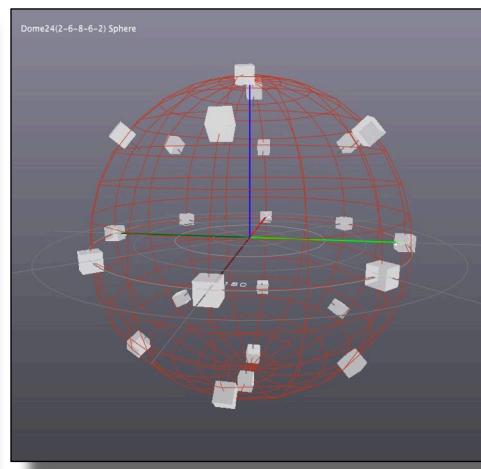
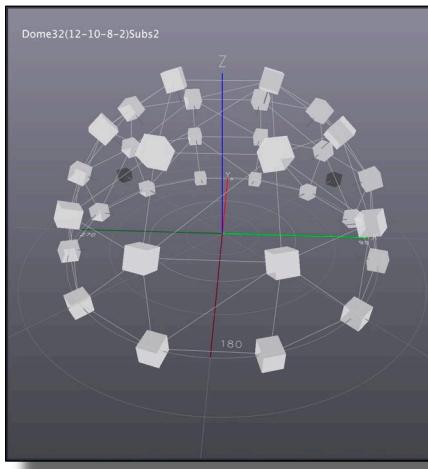
5.5. The DOME and the CUBE

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

5.5.1. DOME

The DOME is based on VBAP (Vector Base Amplitude Panning), an algorithm created by Ville Pulkki in 2001. It allows the user to spatialize the sound under a dome of speakers by placing it according to the relative amplitude of three speakers (instead of 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 see it (Opt-O)!



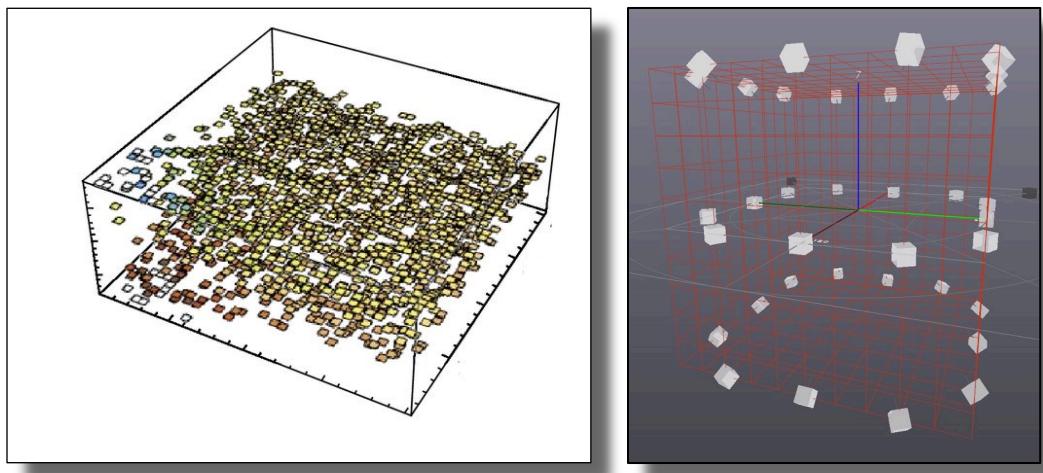
5.5.2. CUBE

Since version 3.2.0, the CUBE is based on MBAP (Matrix Base Amplitude Panning). 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 is considered according to the placement of the sound to simulate the natural behaviour of a sound that is moving away.

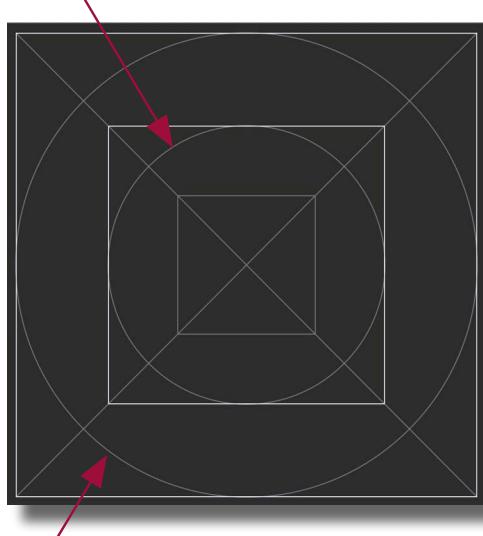
Like its name suggests, the algorithm is based on a complex matrix of multiple points, registered on tables, that are triggered by the sound as it moves. The location and the number of the points are determined by the speakers' location.

- In CUBE mode, there is an inner circle in the middle of the space. Within this circle, there is no attenuation or filtering. Outside this circle, attenuation and/or filter can be applied to simulate the vanishing of a sound at a faraway distance. The numbers entered here are the values reached at the outer circle:

- Attenuation (dB): from 0 to -72, by -12dB steps.
- Filtering (Hz): from 125 to 16000, by exponential steps.
- Attenuation and filtering are independent.
- In Elevation, the attenuations start at the top of the cube.



Inner circle: attenuation and filtering starts here



Outer circle: attenuation and filtering reaches their maximum values here

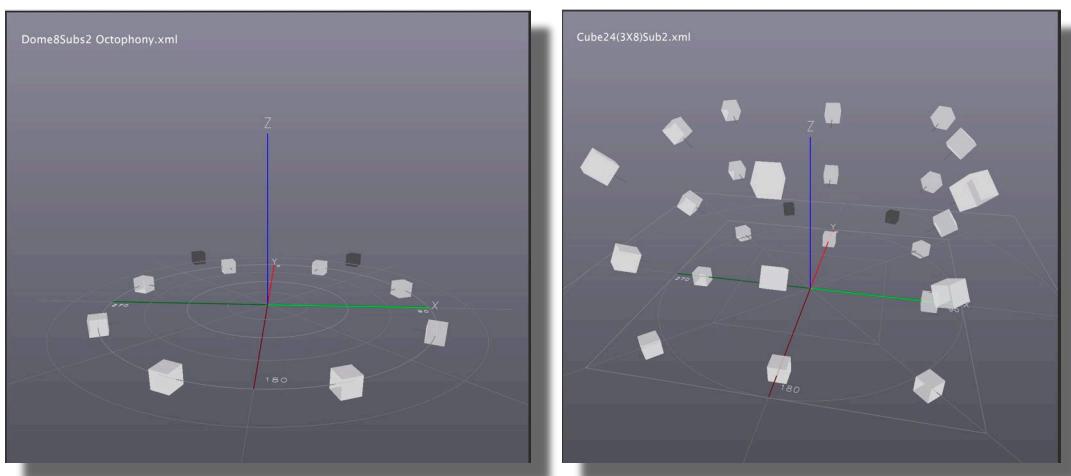
5.5.3. Convert from DOME to CUBE and vice versa

In the case of switching from DOME to CUBE, SpatGRIS3 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 during the transition from the DOME algorithm to the CUBE algorithm, but not in the opposite case.

5.5.4. Spatialization in 2D and 3D

SpatGRIS3 is capable of 2D and 3D spatialization either in DOME or CUBE mode. It can be useful to use SpatGRIS3 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 SpatGRIS3 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?

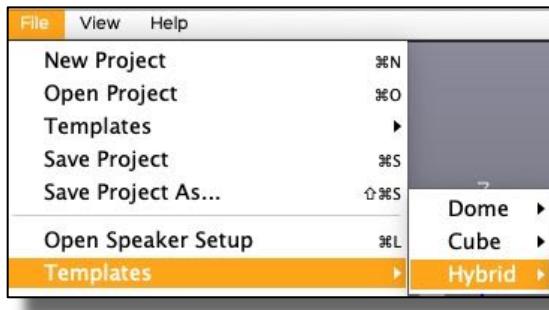
There are two information saved in Hybrid mode:

- the Hybrid mode itself is saved with the speaker setup and/or with the project (hence 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. You'll have to manually chose the Hydrid mode to see them appearing. 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, edited them, and then Save Speaker Setup As under the name of your choice.



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	-0.37	0.93	0.00	338.2	0.0	1.00	0.0	0.0	x	
2	0.37	0.93	0.00	218.0	0.0	1.00	0.0	0.0	x	
3	-0.93	0.37	0.00	291.8	0.0	1.00	0.0	0.0	x	
4	0.93	0.37	0.00	68.2	0.0	1.00	0.0	0.0	x	
5	-0.93	-0.37	0.00	248.2	0.0	1.00	0.0	0.0	x	
6	0.93	-0.37	0.00	118.0	0.0	1.00	0.0	0.0	x	
7	-0.37	-0.93	0.00	336.0	0.0	1.00	0.0	0.0	x	
8	0.37	-0.93	0.00	158.2	0.0	1.00	0.0	0.0	x	
9	-0.72	0.48	0.50	303.4	30.0	1.00	0.0	0.0	x	
10	0.72	0.48	0.50	56.6	30.0	1.00	0.0	0.0	x	
11	-0.72	-0.48	0.50	236.6	30.0	1.00	0.0	0.0	x	
12	0.72	-0.48	0.50	123.4	0.0	1.00	0.0	0.0	x	
13	0.00	0.87	0.50	0.0	30.0	1.00	0.0	0.0	x	
14	-0.00	-0.87	0.50	160.0	30.0	1.00	0.0	0.0	x	
15	-0.34	0.00	0.94	270.0	70.0	1.00	0.0	0.0	x	
16	0.34	0.00	0.94	90.0	70.0	1.00	0.0	0.0	x	
17	-0.99	0.99	0.00	315.0	0.0	1.40	0.0	0.0	x	
18	0.99	0.99	0.00	45.0	0.0	1.40	0.0	0.0	x	

- You can adjust the output *Gain (dB)* and put a *Highpass* filter (0 is off, value in Hz, minimum 20 Hz) on each speaker to calibrate the setup
 - An *Output* patch connects the speakers to the output number of your audio interface
 - *Azimuth* is the plane angle, from 0° to 360°. If you put a number greater than 360, it will be adjusted to a real value
 - *Elevation* is the angle from 0° to 90° (or to -90, if you use a complete sphere). If you put a number greater than 90, it will be adjusted to a maximum of 90°
 - *Distance* from the speaker to centre of the setup. In DOME mode, the distance is set at 1.
 - You can also enter the values with X, Y and Z coordinates.
- Reference Pink Noise: On/Off
Default -20 dB, to calibrate the outputs

Except for Distance which is set to 1.00 in DOME mode (by definition), speaker setup parameters can be set by polar (Azimuth, Elevation, Distance) or by Cartesian values (X, Y, Z). By experience, we recommend polar coordinates for DOME and Cartesian coordinates for CUBE.

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.

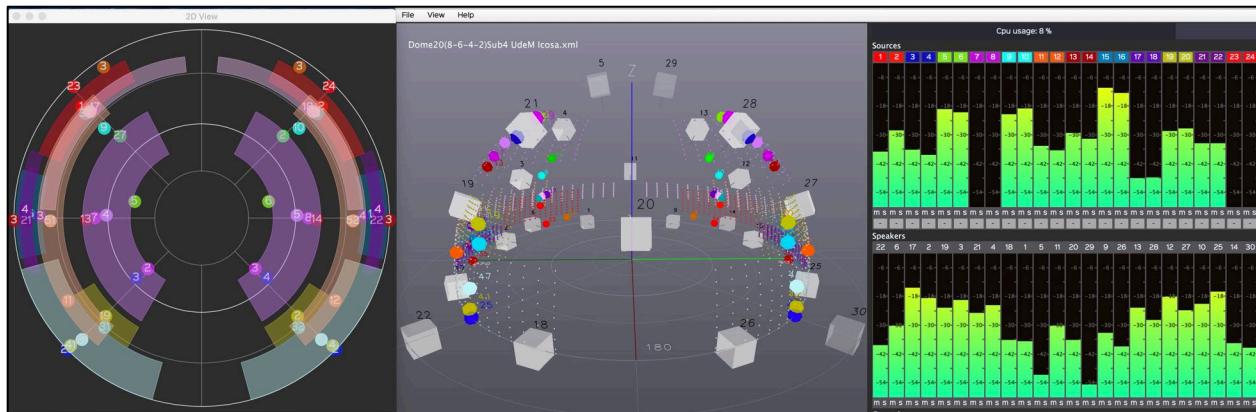
Consecutive order:

Configuration Speakers										Speakers									
Output	X	Y	Z	Azimuth	Elevation	Distance	Gain (dB)	Highpass	Direct	1	2	4	6	8	7	5	3	9	10
= 1	-0.38	0.92	0.00	337.5	0.0	1.00	0.0	0.0	■	-6	-6	-6	-6	-6	-6	-6	-6	-6	
= 2	0.38	0.92	0.00	22.5	0.0	1.00	0.0	0.0	■	-18	-18	-18	-18	-18	-18	-18	-18	-18	
= 4	0.92	0.38	0.00	67.5	0.0	1.00	0.0	0.0	■	-30	-30	-30	-30	-30	-30	-30	-30	-30	
= 6	0.92	-0.38	0.00	112.5	0.0	1.00	0.0	0.0	■	-42	-42	-42	-42	-42	-42	-42	-42	-42	
= 8	0.38	-0.92	0.00	157.5	0.0	1.00	0.0	0.0	■	-54	-54	-54	-54	-54	-54	-54	-54	-54	
= 7	-0.38	-0.92	0.00	202.5	0.0	1.00	0.0	0.0	■	m	m	m	m	m	m	m	m	m	
= 5	-0.92	-0.38	0.00	247.5	0.0	1.00	0.0	0.0	■	m	m	m	m	m	m	m	m	m	
= 3	-0.92	0.38	0.00	292.5	0.0	1.00	0.0	0.0	■	m	m	m	m	m	m	m	m	m	
= 9	-0.70	1.21	0.00	330.0	0.0	1.40	0.0	0.0	■	m	m	m	m	m	m	m	m	m	
= 10	0.70	1.21	0.00	30.0	0.0	1.40	0.0	0.0	■	m	m	m	m	m	m	m	m	m	

Odd and even order followed by direct outputs:

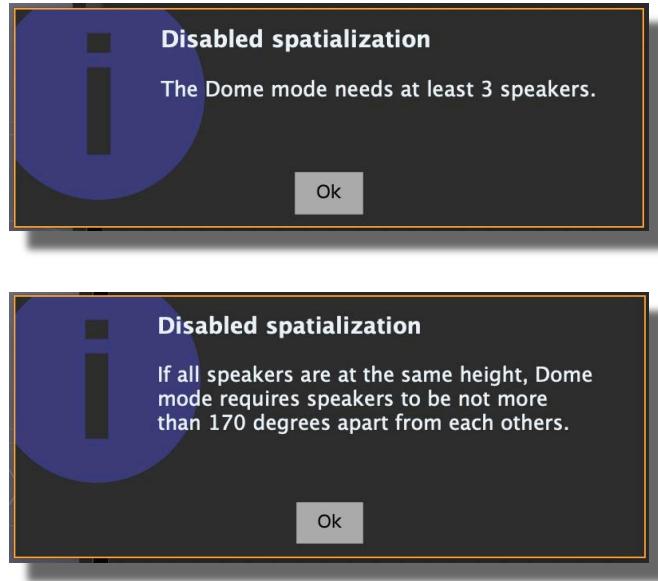
Configuration Speakers										Speakers									
Output	X	Y	Z	Azimuth	Elevation	Distance	Gain (dB)	Highpass	Direct	1	3	5	7	2	4	6	8	9	10
= 1	-0.38	0.92	0.00	337.5	0.0	1.00	0.0	0.0	■	-6	-6	-6	-6	-6	-6	-6	-6	-6	
= 3	-0.92	0.38	0.00	292.5	0.0	1.00	0.0	0.0	■	-18	-18	-18	-18	-18	-18	-18	-18	-18	
= 5	-0.92	-0.38	0.00	247.5	0.0	1.00	0.0	0.0	■	-30	-30	-30	-30	-30	-30	-30	-30	-30	
= 7	-0.38	-0.92	0.00	202.5	0.0	1.00	0.0	0.0	■	-42	-42	-42	-42	-42	-42	-42	-42	-42	
= 2	0.38	0.92	0.00	22.5	0.0	1.00	0.0	0.0	■	-54	-54	-54	-54	-54	-54	-54	-54	-54	
= 4	0.92	0.38	0.00	67.5	0.0	1.00	0.0	0.0	■	m	m	m	m	m	m	m	m	m	
= 6	0.92	-0.38	0.00	112.5	0.0	1.00	0.0	0.0	■	m	m	m	m	m	m	m	m	m	
= 8	0.38	-0.92	0.00	157.5	0.0	1.00	0.0	0.0	■	m	m	m	m	m	m	m	m	m	
= 9	-0.70	1.21	0.00	330.0	0.0	1.40	0.0	0.0	■	m	m	m	m	m	m	m	m	m	
= 10	0.70	1.21	0.00	30.0	0.0	1.40	0.0	0.0	■	m	m	m	m	m	m	m	m	m	

Here is an example of a speaker order that represents the stereo projection on the Y-axis (See 5.8.1 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 according to the Y-axis:

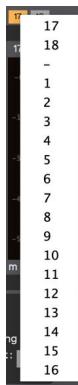


5.7.3. Minimal requirements

The DOME in particular needs minimal requirements to perform the VBAP algorithm. 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 *SpatGRIS3*, 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 *SpatGRIS3*. 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 in the *SpatGRIS3*.

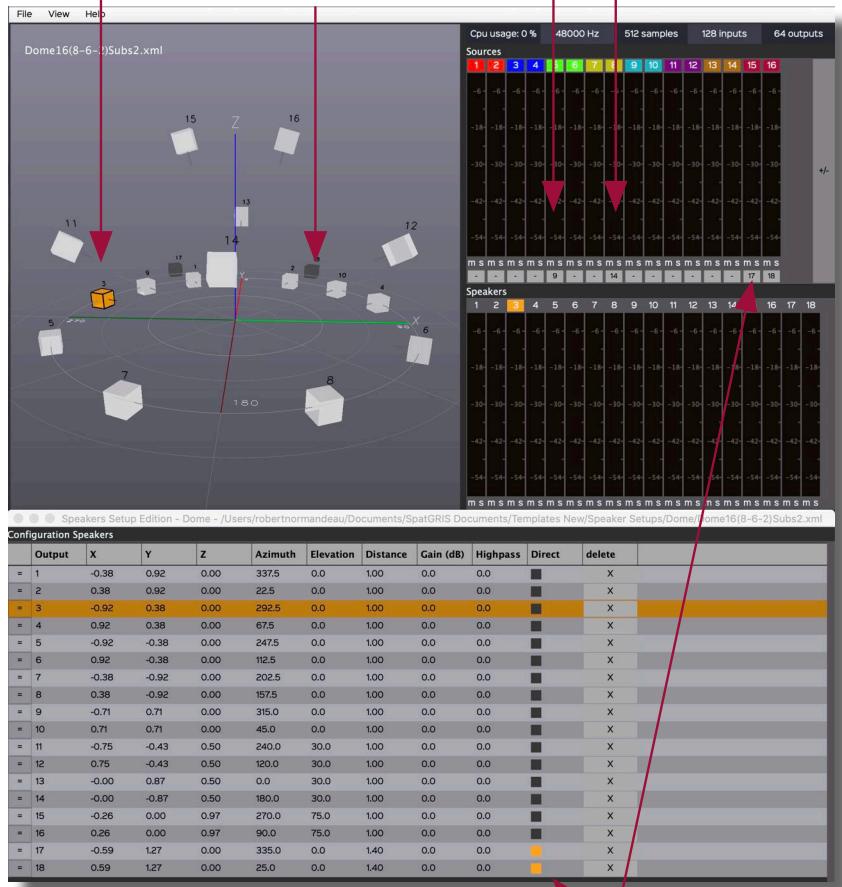
One can see the distinction when selecting a direct output. The first numbers, at the top of the column (17-18) are independent direct outputs. The other numbers (1-16) can be used as a spatialized direct output.

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:

Speaker no 3 selected

Spatialized direct outputs: number 9-14

Independent direct outputs in black



Independent direct outputs: number 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!

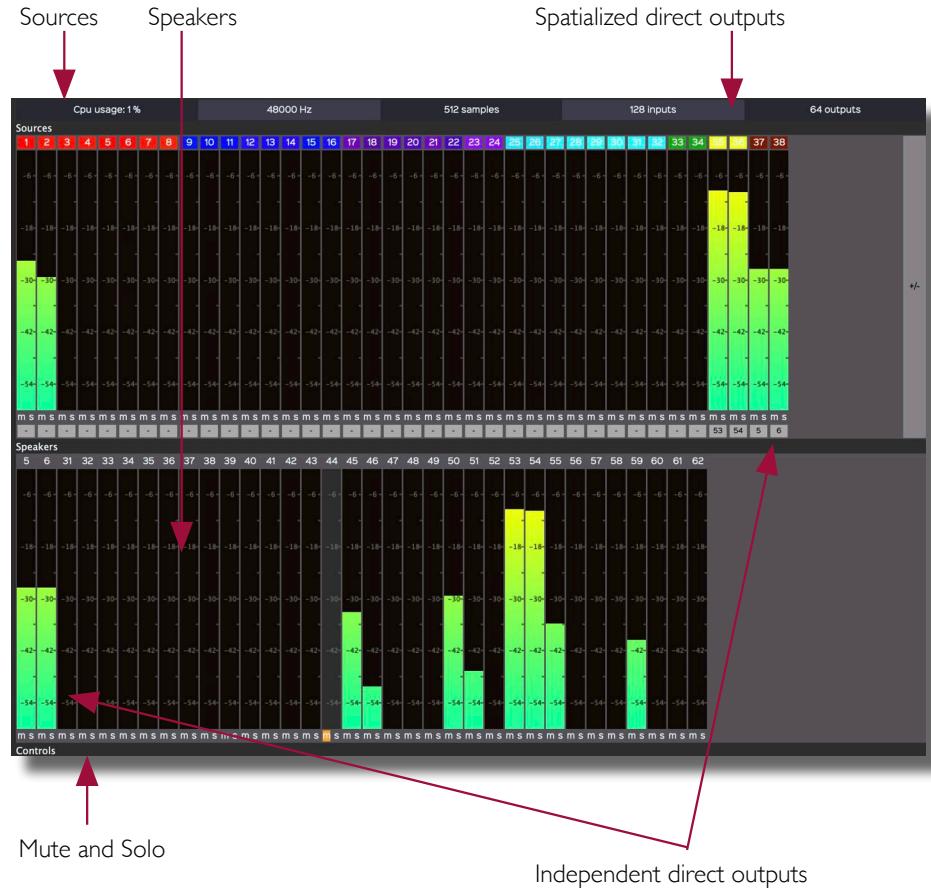
5.7.5. Show Speaker Numbers

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 Numbers works only 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

SpatGRIS3 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).

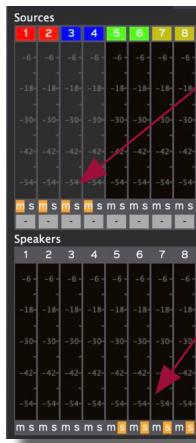


In this example, the sources are made of 4 X octophonic sources (1-32), plus 1 X stereo source (33-34), 1 X stereo spatialized direct outputs (35-36 sent to 53-54) and 1 X independent direct output (37-38, assigned to 5-6) for a total of 38 sources identified by different groups of colours, distributed 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 due to technical considerations, the output level in STEREO compared to BINAURAL differs considerably, depending on the number of sources. Please adjust your listening level accordingly.

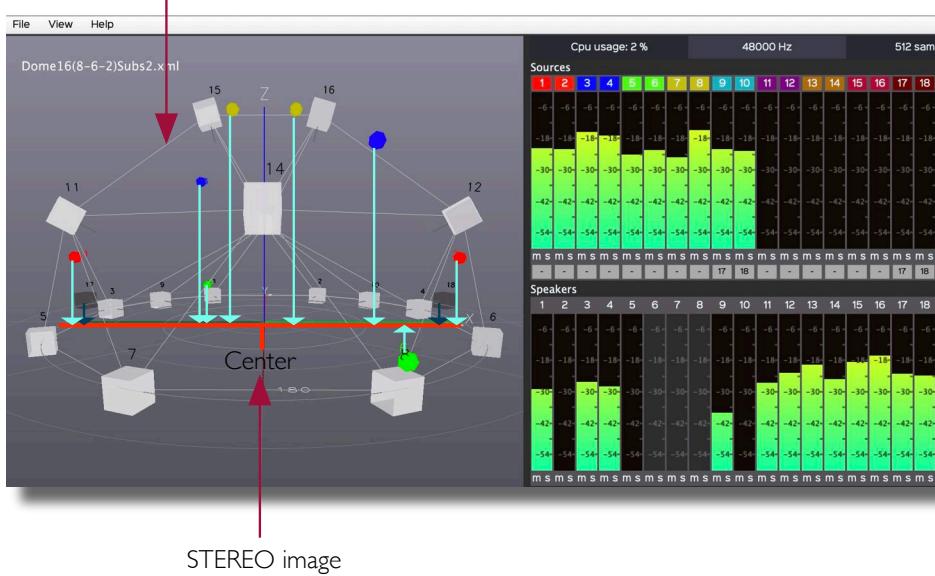
5.9.1. Stereo

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 speakers of your sound card are available for the Stereo reduction. Computer speakers 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



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 not available. 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), SpatGRIS3 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 is bigger 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 SpatGRIS3.

2. To record the spatialization to audio channels that correspond to the number of the speakers in the setup.

SpatGRIS3 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 are limited to 2 GB
- WAV are 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.

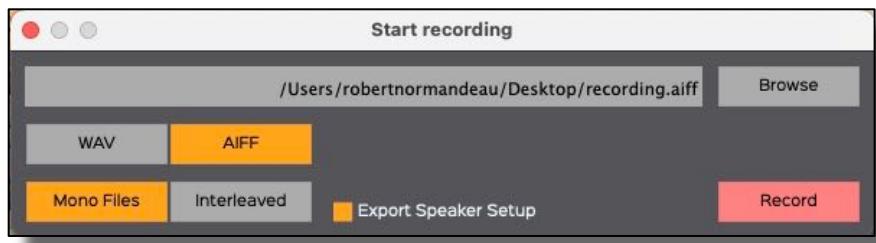
¹⁴ CAF (Core Audio Format) and Wave RF64 will eventually be implemented enabling size to exceed 4 GB.

6. Player

SpatGRIS3, version 3.2 and up, introduces a new function, the *Player*, that allows using *SpatGRIS3* as a standalone software to play any piece encoded by it to any speaker setup. The main idea with the *Player* is to help the diffusion of multichannel sound files 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

To make a recording for the *Player* is almost identical to make a normal recording. The main difference is that in addition to record the audio files themselves, *SpatGRIS3* exports the coordinates of the speaker setup used. 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 the 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 to keep the output numbers in the name of the audio files. There is no way to keep this information in an interleaved sound file.



6.2. To read a project with the Player

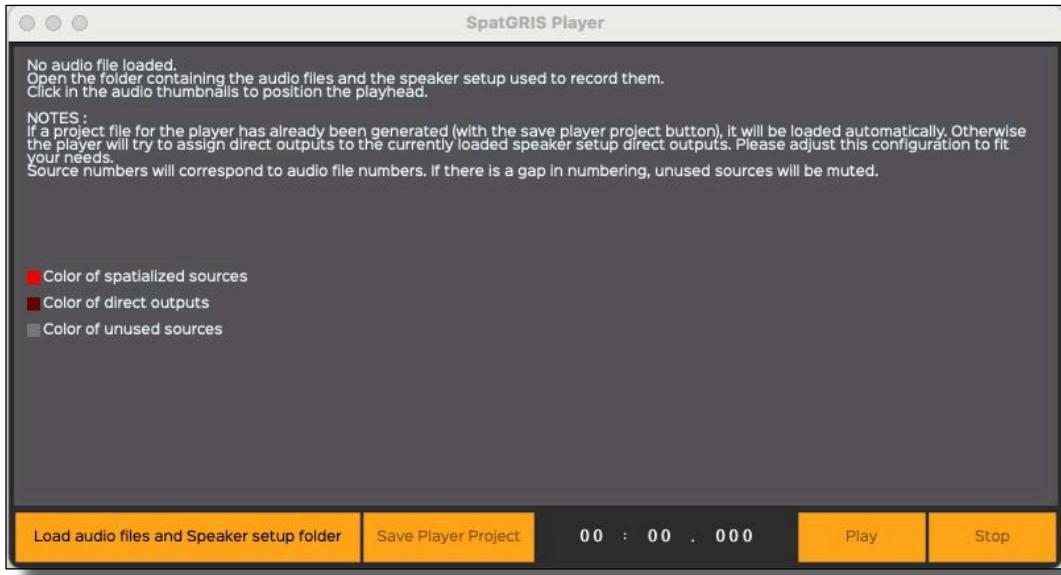
Once the recording is done, you can send the folder that includes the sound files and the speaker setup to a listener who would use a different setup. Or you can use it yourself to play the recording on a different setup.

6.2.1. Open the listening speaker setup

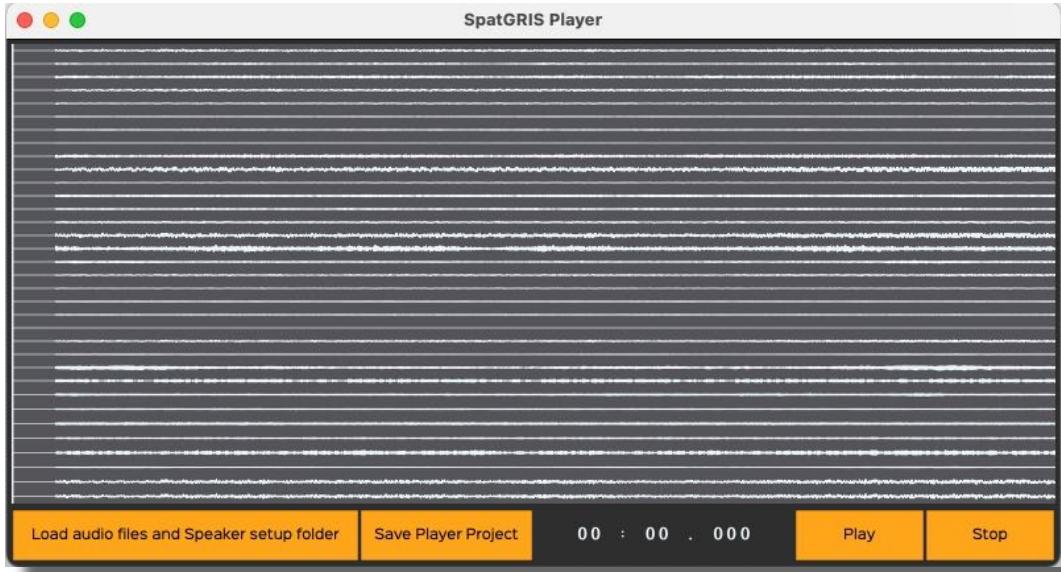
Open the speaker setup in *SpatGRIS3* on which you intend to listen to the spatialized work. It could be a custom setup or a setup from the templates.

6.2.2. Open the Player window

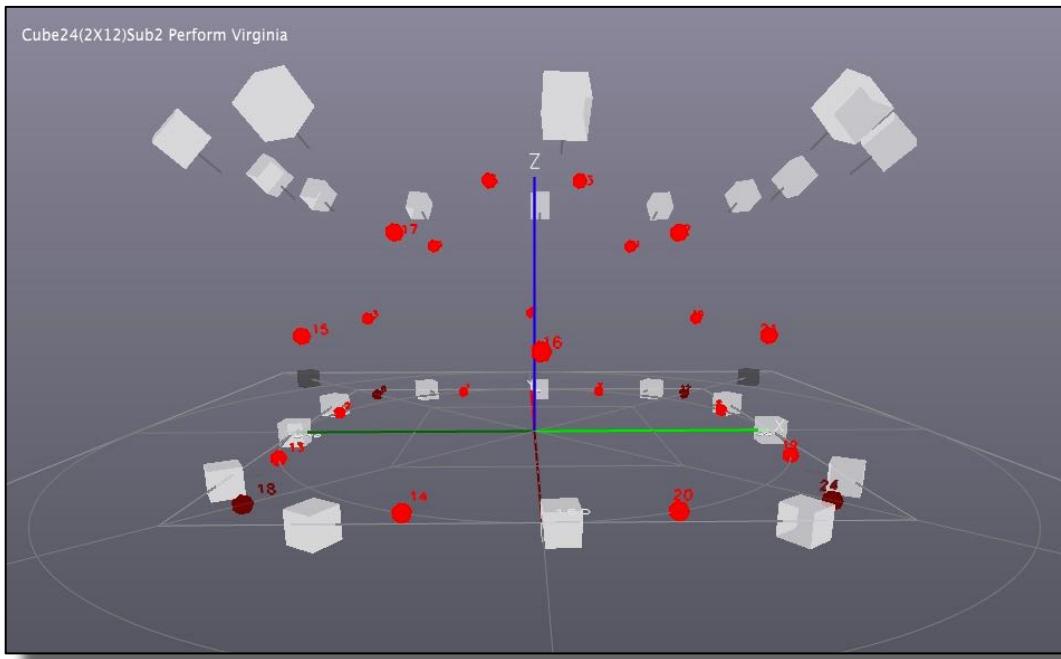
View Menu —> Show Player View



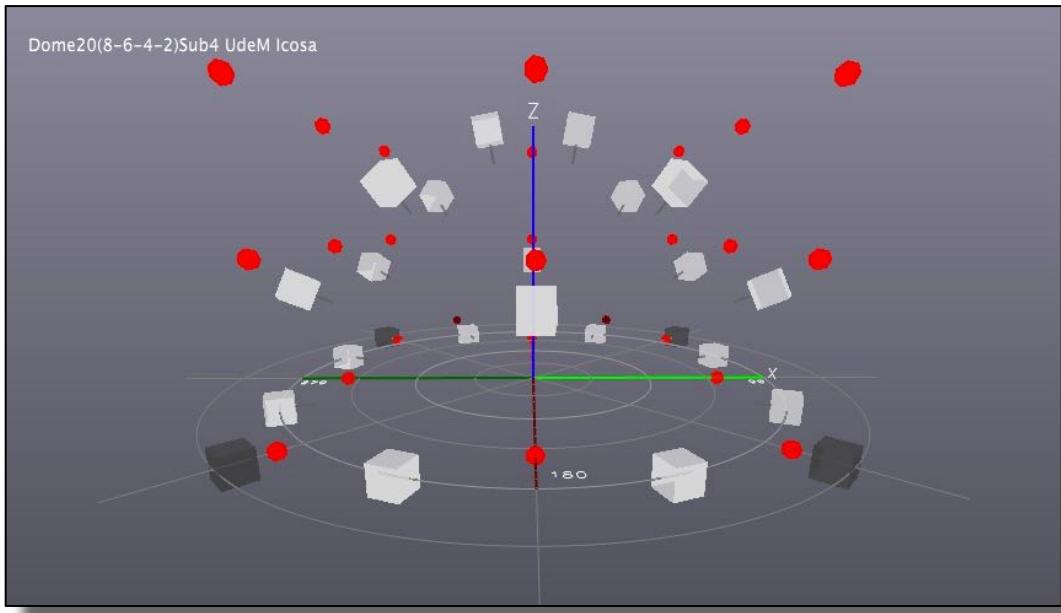
Load audio files and Speaker setup folder. The player is now showing the basic waveform of the audio files:



The current project loaded in SpatGRIS3 is being replaced by the recorded project. Here's an example of a recording made with a dome setup (Dome24(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:



Another example, with the exact opposite, a cube recording (Cube24(3X8)Subs2) played within a dome (Dome24(8-6-4-2)Subs4). As one can see the shape of the original cube is well reproduced in the listening dome:



6.2.3. Regarding the direct outs in the Player

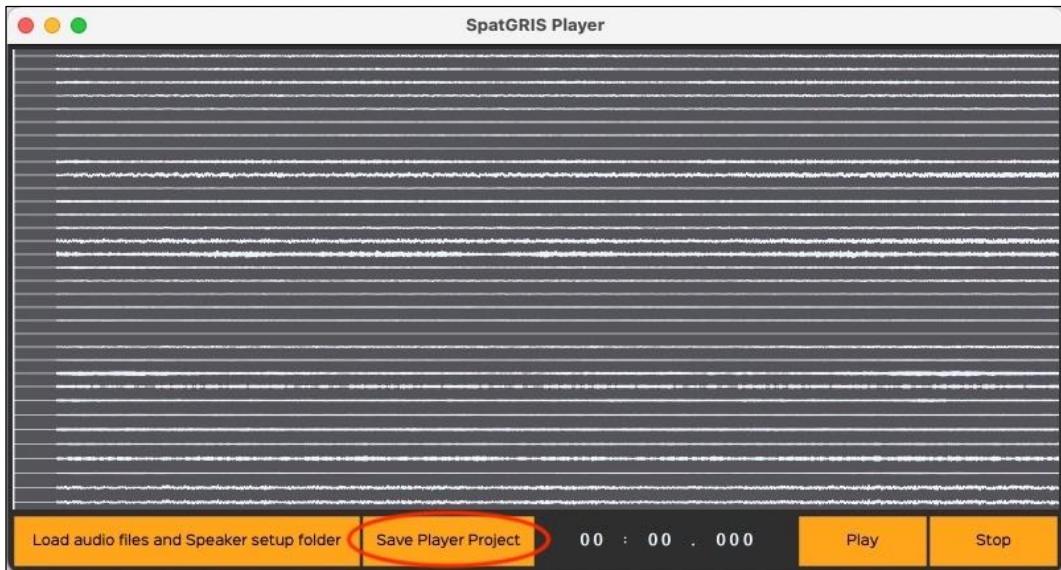
The Player will try to assign direct outputs to the currently loaded speaker setup direct outputs.

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
-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
-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
m	s	m	s	m	s	m	s	m	s	m	s	m	s	m	s	m	s	m	s	m	s	m	s
-	-	-	-	-	-	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 than 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.

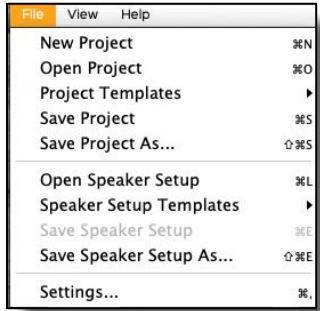


NOTE: A player project remains active until the Player window is open. When you close it, SpatGRIS3 switches to its normal input mode, waiting for audio and OSC to come from either a sequencer or any other software.

7. Menus

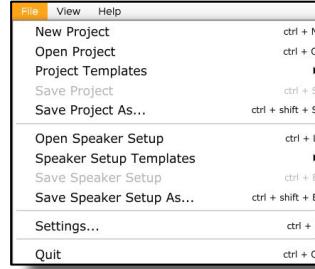
7.1. File menu

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



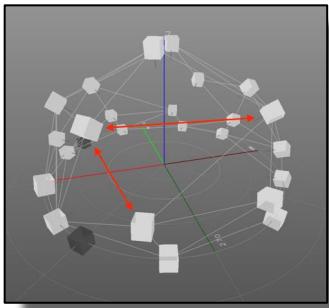
- Create a New Project
- Open an existing one
- Open a project from the Project or Speaker Templates folder. These templates can't be modified but they can be edited and saved as a new file
- Save Project or Save As — make a copy
- Open a Speaker setup
- Open a speaker setup from the Templates folder.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

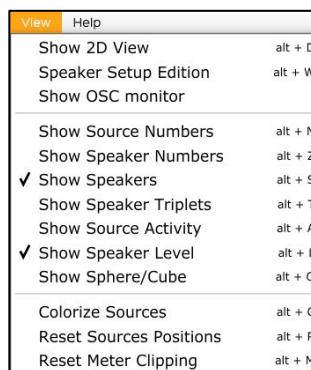


7.2. View menu

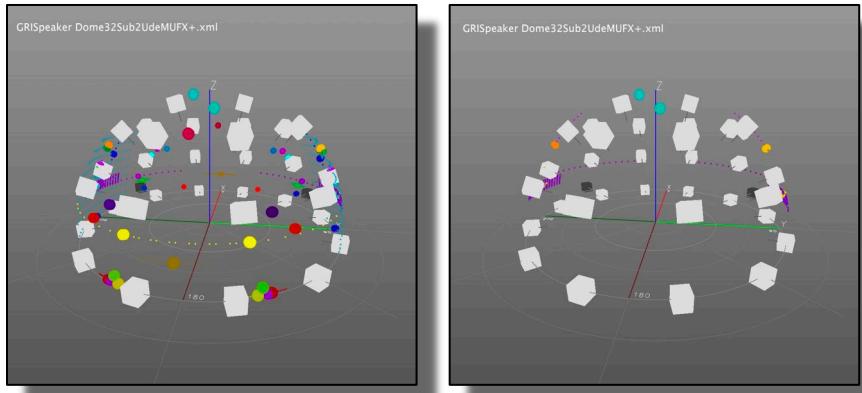
Under the View menu, you can choose from different perspectives to visualize the speakers and sources in real time. The key modifier in this menu is Option (Opt) for Mac and Alt for Windows.



- 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 to troubleshoot incoming OSC messages
- Show numbers: Show or hide the numbers of the showed 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. 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 Control/GRIS 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 slightly the speakers one from another and to 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, SpatGRIS3 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 documents
- Save the DOME, the CUBE or the HYBRID setups in three separate folders in a folder named *Speakers*
- Save SpatGRIS3 projects in three separate folders inside a folder named *Projects*.

The Templates menus we provide with SpatGRIS3 is a good example of the right classification.

- Document format warnings

SpatGRIS3 always remembers the last opened speaker setup and the last project.

If you try to open a *SpatGRIS3* project with the command Load Speaker Setup (or the opposite), you'll be warned:



NOTE: *SpatGRIS3* documents adopt a new format and are not backward compatible with older versions of *SpatGRIS*. By trying to open a *SpatGRIS3* project or a speaker setup in version 2, you'll get one of these scary messages! Your files are OK, just not compatible:

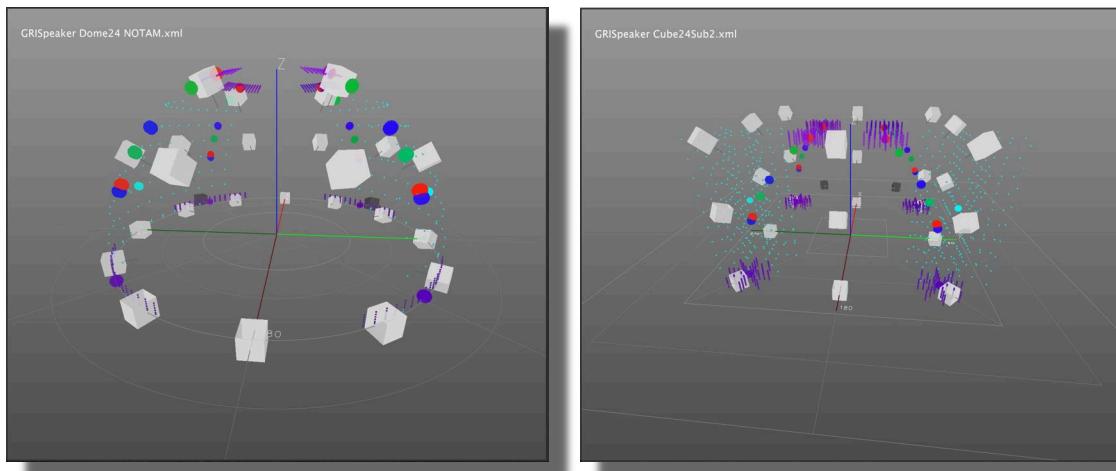


7.4. Representations

The 3D and 2D views in *SpatGRIS3* 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.

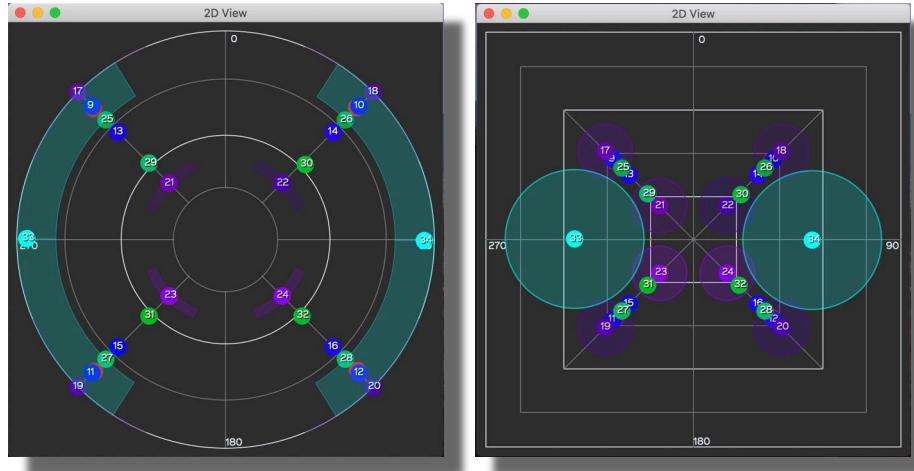
7.4.1. 3D Representation

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 ControlGRIS/SpatGRIS3 combination depends a lot 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 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. A setup with no spans will require only a half or a third of the performance of the same setup with active spans
- 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 SpatGRIS3. We measured comfortable performance with a 96-speaker setup, which is largely enough in most realistic situations!
- The number and the kinds of tracks: multiplying the number of tracks 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 on a small speaker setup.

If the CPU overpass 100%, this is what you get:

Cpu usage: 100 %

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.

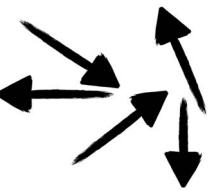
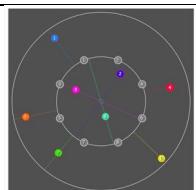
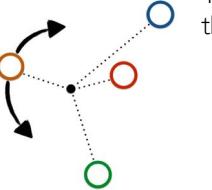
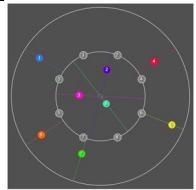
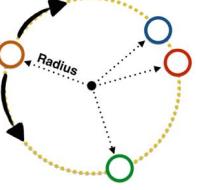
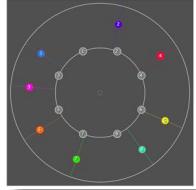
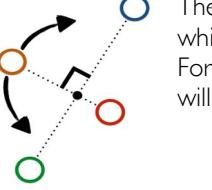
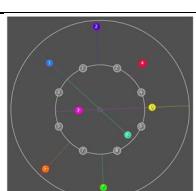
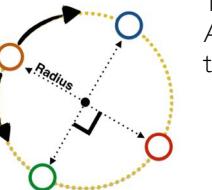
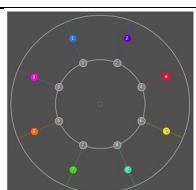
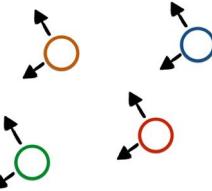
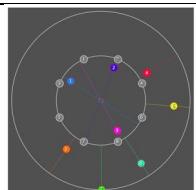


Take the plunge and have fun!

8. Addendum

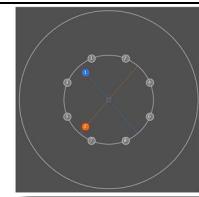
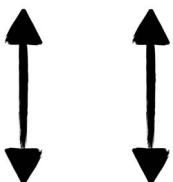
8.1. Sources Link descriptions

8.1.1. Azimuth-Elevation and Azimuth-Distance

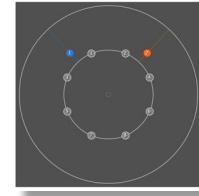
1) Independent MONO + STEREO + MULTIPHONIC	This mode is selected by default. The sources can be moved independently from one another.		
2) Circular STEREO + MULTIPHONIC	This mode enables the circular grouped movement. The angles between the sources remain constant while the radius adjusts proportionally.		
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

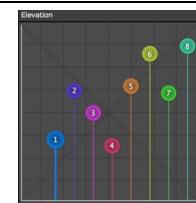
This mode enables the symmetry between two sources following the X axis.

**8) Symmetric Y STEREO**

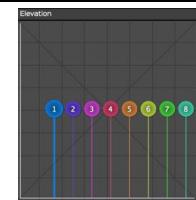
This mode enables the symmetry between two sources following the Y axis.

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

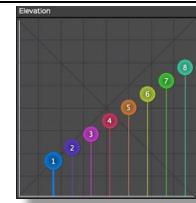
This mode is selected by default. The sources can be moved independently from one another.

**2) Fixed Elevation STEREO + MULTIPHONIC**

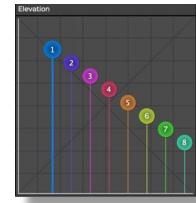
Same elevation for each source.

**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.



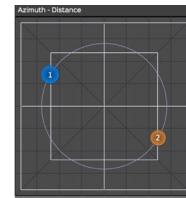
8.2. Trajectory descriptions

8.2.1. Azimuth-Elevation and Azimuth-Distance

1) Circle

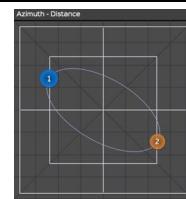
Circular motion around the centre.

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

**2) Ellipse**

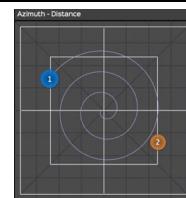
Elliptical motion around the centre.

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

**3) Spiral**

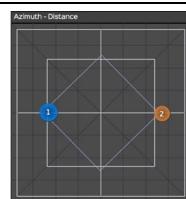
Concentric motion around the centre.

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

**4) Square**

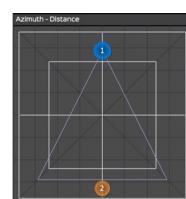
Square shape around the centre.

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

**5) Triangle**

Triangle shape around the centre.

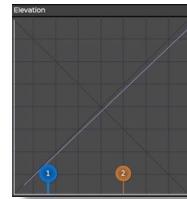
Options: CW/CCW, Back & Forth, Dampening, Deviation.



8.2.2. Elevation (CUBE mode only)

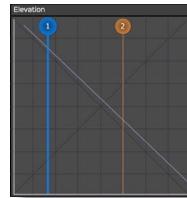
1) Down Up

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 SpatGRIS3

OSC can be sent directly to *SpatGRIS3* without having to use *ControlGRIS*.

OSC input port number: 18032 by default (can be changed in the 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	[0, π/2]	elevation angle
5	float	[0, 2.56]	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	[0, 90]	elevation angle
5	float	[0, 2.56]	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
- /controlgris/1/sourcelinkalt value => 1 to 5
- /controlgris/1/presets value => 1 to 50

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. SpatGRIS3

If you need to uninstall *SpatGRIS3*, or if you find strange behavior 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.rtf
~/Application Support/GRIS/ SpatGRIS3.x.x.xml where x.x is the version of *SpatGRIS3* (3.1.9 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 is 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. SpatGRIS3

- It seems that the software is quite bug free now, at the time of the launch of *SpatGRIS3*. 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 varies according to the DAW and the kind of tracks — audio, MIDI, Aux or Instruments — in which ControlGRIS is inserted (Issue # 94).
- ControlGRIS is on an intense process of refurbishment at the moment of writing. Stay tuned!

9.1.3. SpatGris, the plugin and SpatGRIS3, the software

For those who used the plugin *SpatGris*, you'll notice that it is still working in OSC mode with *SpatGRIS3*, the software. It seems that there are visual glitches in MacOS11 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

There are no mono tracks in Reaper, in the sense that only stereo outputs are available. To use mono tracks, you put a mono sound file in a track, assign this track to a stereo output and set the pan to the left. Repeat this operation with a second track assigned to the same stereo output but set the pan to the right. Insert a *ControlGRIS* in each track in mono with two different OSC numbers.

9.3. Logic Pro X

9.3.1. Lack of Surround outputs

In *Logic Pro X*, there is only one possible Surround instance. This means that it is not possible to have multiple multichannel tracks in *Logic* while using *SpatGRIS3*. 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 to off. They will have to be deactivated manually.

9.4. Digital Performer 11 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. Conflict with IP addresses

When using an external device to send OSC data to *ControlGRIS*, there could be a conflict between IP addresses. In the Controllers tab of the *ControlGRIS*, the IP port of the Mac is automatically recognized. But *ControlGRIS* will respect the hierarchy of IP addresses on the Mac, and, if a Mac is connected to the internet (or another external device like an Artist Mix) through an Ethernet cable, it will have precedence over the Wi-Fi connection. Thus, it won't be possible to connect an iPad to *ControlGRIS* because the incoming port address is set automatically, and it is not editable. In this case, the only way to use the iPad is to deactivate the Ethernet connection and leave only the Wi-Fi connection.

9.6. To use SpatGRIS3 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 SpatGRIS3 at the same value. Not doing this may conduct to digital distortion.

9.7. Apple M1 and Monterey (12.6)

Some users report distortions on this combination. Please make sure you are using the last version of BlackHole, which is 0.4.0 at the time of writing.

NOTE: Adjust the Buffer size at the same value in your DAW and in SpatGRIS3. A value of 256 and plus is recommended.

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