# Spatialisateur

## **spat5** release notes

# Contents

# 1) Overview

Version 5.x of **Spat~** reached another milestone in software development, providing a flexible program architecture and effective user interfaces.

The key features of **Spat~** version 5.x are :

- a large number of objects can be modulated and scaled (up to 250 inputs/outputs)
- intuitive control interfaces facilitate the configuration of loudspeaker setups and the manipulation of the sound sources
- a better coherence in the architecture and the management of messages
- easy and efficient OSC control; supports pattern matching
- interoperability with existing tools
    - o.dot `https://github.com/CNMAT/CNMAT-odot/releases`
    - IanniX `http://www.iannix.org`
    - Trajectory Library `https://github.com/nadirB/Trajectory_Score_Library`
    - Antescofo `https://forum.ircam.fr/projects/detail/antescofo/`
    - ToscA `https://forum.ircam.fr/projects/detail/tosca/`
    - OSCar `https://forum.ircam.fr/projects/detail/oscar/`
    - etc.
- highly optimised GUIs. Revamped for better user experience and efficient GUI refresh rate
- thread-safe and efficient message dispatch
- fine control and customisation of objects
- various preset mechanisms
- stable and efficient MS Windows implementation
- supports Wave-field synthesis
- many new tools for: Ambisonics, Filter design, Time Code, Quaternions, FX, Geometrical operations, etc.
- huge HRTF database
- includes Panoramix (`https://forum.ircam.fr/projects/detail/panoramix/`) and ADMix tools (`https://forum.ircam.fr/projects/detail/admix/`)
- highly optimised DSP
- rich documentation

# 2) System Requirements

## 2.1) Platform

**Spat**∼ 5.x is compatible with:

- macOS **10.13** or higher, with Intel (x86_64) or Apple Silicon (arm64) processor.
- MS Windows 10 or higher
- Max/MSP 8.1 or higher (including Max 9)

| Minimum configuration | Recommended configuration |
|---|---|
| Cycling'74 Max/MSP 8.1 | Cycling'74 Max/MSP 8.6.5 |
| Mac Intel machine running macOS 10.13 | Mac Apple Silicon machine running macOS 14.x |

## 2.2) Spat∼ and AVX Extensions

Ircam Spat5 requires "relatively new" (CPU) hardware. More specifically, it requires CPU with AVX 1.0 extensions.

Typically such hardware extension is available on all mac/PC computers released after 2010.

If your hardware is older than that, spat5 objects might not work, typically resulting in a software crash anytime you try to load an object in Max. In case of a doubt, you can check if your hardware supports AVX 1.0.

On Windows, download and install the Intel Processor Diagnostic Tool ([https://downloadcenter.intel.com/download/19792/Intel-Processor-Diagnostic-Tool](https://downloadcenter.intel.com/download/19792/Intel-Processor-Diagnostic-Tool)) to run a diagnostic for your hardware. In the "CPU Features" tab, check if your processor has "AVX Support" (see Figure 1).

## 2.3) Spat∼ 3, 4 and 5

**Spat**∼ 5.x will run without problems if you have **Spat**∼ 4.x or **Spat**∼ 3.x already installed on your computer.

**Spat**∼ 5.x, **Spat**∼ 4.x and **Spat**∼ 3.x can live together in your Max/MSP® search path without conflicts.

## 2.4) Microsoft Windows Requirements

**Spat**∼ Windows version requires the `"Visual C++ Redistributable Packages for Visual Studio 2022"`. You can (freely) download it from Microsoft website: [https://www.visualstudio.com/downloads/](https://www.visualstudio.com/downloads/).

Select `"Microsoft Visual C++ 2022 Redistributable"` and `"x64"` and follow the instructions for installation. Restart Max after installation.
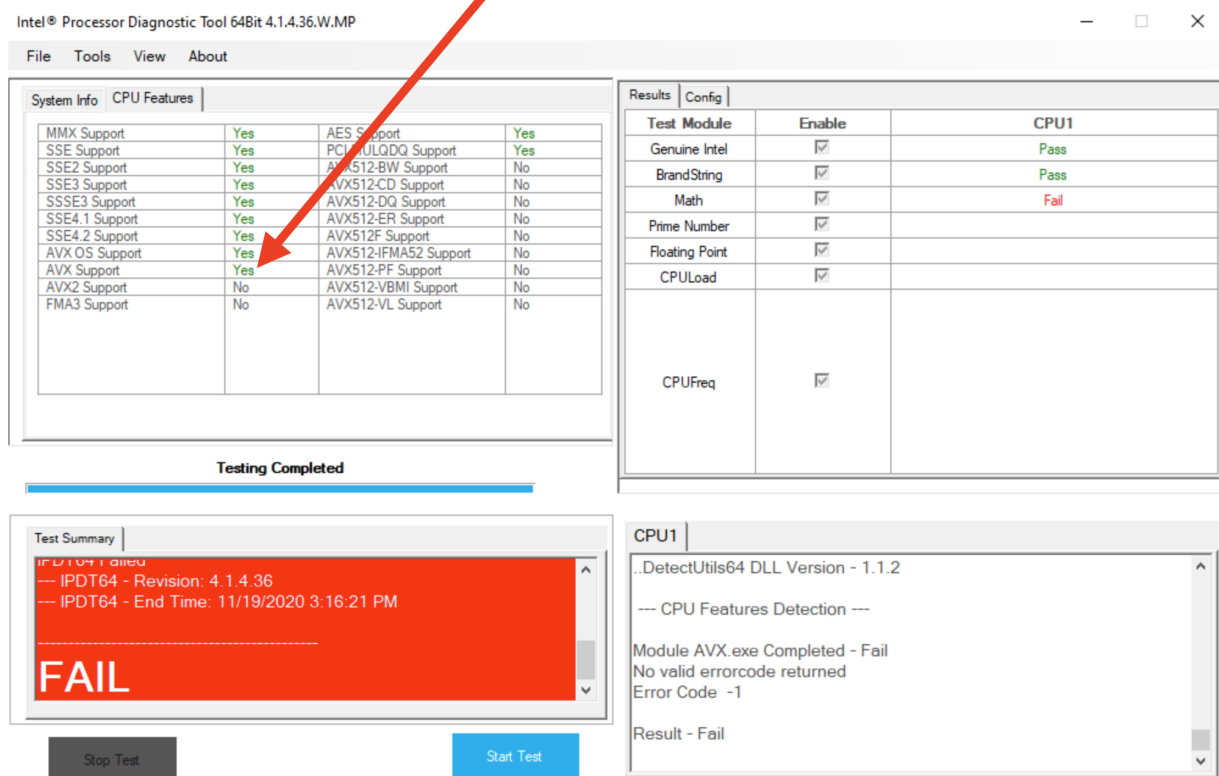
**Figure 1:** Checking AVX compatibility in the Intel Processor Diagnostic Tool for Windows

# 3) Installation

## 3.1) Standard installation, using Max/MSP Packages

You can install **Spat**∼ in the "Packages" folder.
For details, check http://cycling74.com/2013/03/11/max-6-feature-packages/
To do so:

- mount the **Spat**∼ disk image (i.e. double-click on the **Spat**∼ .dmg file) or unzip the **Spat**∼ .zip file.
- drag and drop the "spat5" folder into your Max Package folder. The Max Package folder is typically located in "∼/Documents/Max 8/Packages".

  Note the the ∼ symbol represents your home folder, so typically :
  "/Users/[username]/Documents/Max 8/Packages/spat5" for Max 8 on macOS
  "C:\Users\[username]\Documents\Max 8\Packages\spat5" for Max 8 on Windows
- launch Max/MSP® , go to the "Extras" Menu and choose "spat5 overview" in the list
- this opens the "spat5 Overview" patcher which allows to navigate in the **Spat**∼ help patches and tutorials

## 3.2) Manual installation
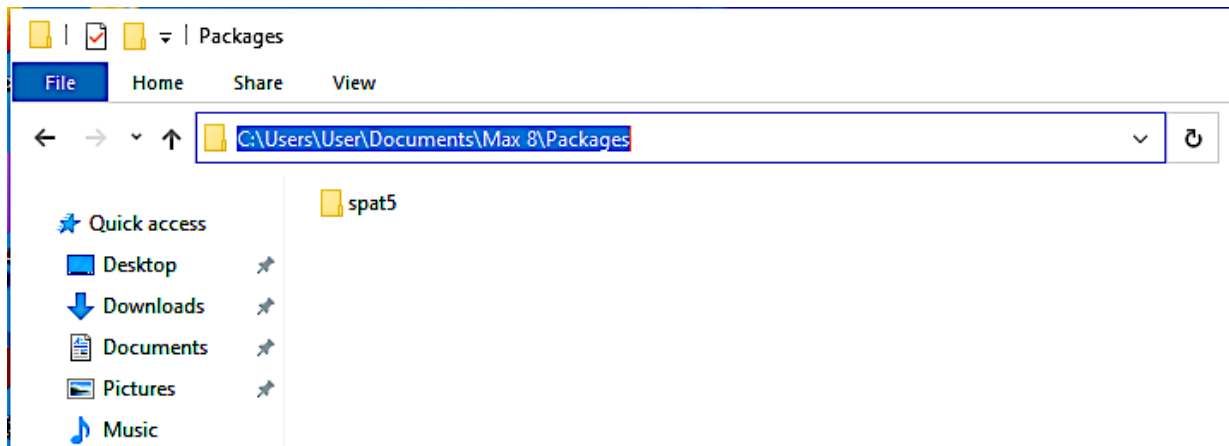
If you prefer a manual installation:

**Figure 2:** spat 5 installed in Max 8 Packages folder on Windows

- mount the **Spat~** disk image (i.e. double-click on the **Spat~** .dmg file).
- copy the whole "spat5" folder of the disk image where you want
- launch Max/MSP® , go to "Options", "File Preferences..." and add your "spat5" folder to the search path. Make sure the "Subfolders" box is ticked.

## 3.3) Troubleshooting for Windows

A frequent issue is to have an "Error 126 loading external". This error message appears in the Max Console when creating a spat5 object (or when opening a patcher that contains spat 5 externals). In that case, the spat5 external objects appear in red color in the patcher window and they are unusable. Typically, this issue arise when the spat5 files have not been properly copied into your "Max Packages" folder. spat5 requires a number of DLL libraries; these DLL files must be in the
`"C:\Users\[username]\Documents\Max 8\Packages\spat5\support"`
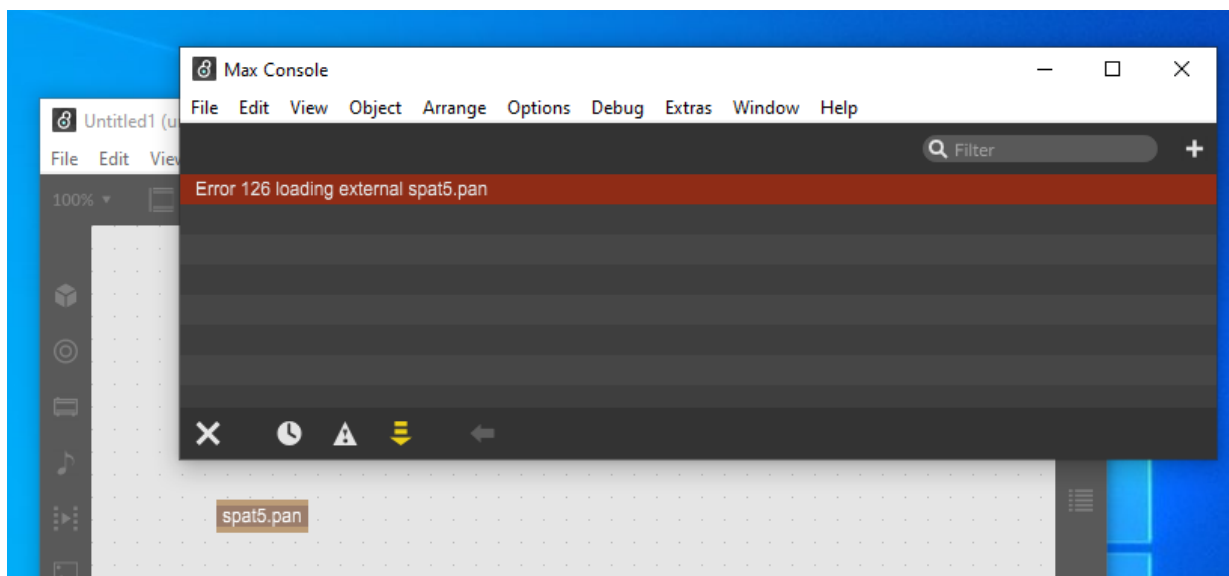folder so that Max can load them (and subsequently load the spat5 externals).



**Figure 3:** Frequent issue for Windows users

## 3.4) Quarantine on macOS 10.15+

If you are using macOS 10.15 Catalina (or higher), it is possible that the downloaded "spat5" files have been "quarantined" by the OS. As the result, the spat5 external objets wouldn't load in Max.

To avoid this issue, you need to remove the quarantine. To do so, you need to open the Terminal application, and execute the following command :

`xattr -d -r com.apple.quarantine [path/to/extern/directory]`

Examples :

`xattr -d -r com.apple.quarantine "~/Documents/Max 8/Packages/spat5"`

`xattr -d -r com.apple.quarantine "~/Documents/Max 7/Packages/spat5"`

Further information is available here :

https://cycling74.com/articles/using-unsigned-max-externals-on-mac-os-10-15-catalina

Once you have removed the quarantine, you can start Max, and spat5 external objects should work properly.

# 4 ) Spat∼ Package content

The **Spat**∼ folder contains the following subfolders:

- `docs/` : documentation, release notes and reference documentation used in help patches
- `examples/` : a brief tutorial to highlight the functionalities of **Spat**∼ for first-time users (and others)
- `externals/` : external objects (for macOS or Windows)
- `extras/` : the **Spat**∼ overview patchers
- `help/` : help patchers
- `javascript/` : some javascript extensions
- `media/` : filters database (hrtf used for binaural and transaural applications), presets and other resource files
- `patchers/` : patchers for macOS and Windows. Most of them are designed to be used as bpatchers
- `support/` : additional DLL dependencies required for Windows

# 5) Bug reporting guidelines

Please report any problems you experience with clear and complete information, including steps to reproduce, software and system information, and where possible, an isolated example patch and crash log. Crash logs are located in the following folder :

`"~/Library/Logs/DiagnosticReports"` for macOS

`"C:\Users\[username]\AppData\Roaming\Cycling ’74\Logs"` for Windows

With all bug/crash reports please provide your support information dictionary (Max menu->About Max->Copy support information to clipboard), a clear example patch with steps to reproduce, and crash logs where relevant.

Below is a template you can use for reporting bugs. With clear and complete information, it is more likely we will be able to reproduce and fix a problem quickly.

- Summary: Provide a descriptive summary of the issue.
- Steps to Reproduce: In numbered format, detail the exact steps taken to produce the bug.
- Expected Results: Describe what you expected to happen when you executed the steps above.
- Actual Results: Please explain what actually occurred when steps above are executed.
- Regression: Describe circumstances where the problem occurs or does not occur, such as software versions and/or hardware configurations.
- Notes: Provide additional information, such as references to related problems, workarounds and relevant attachments.

# 6) Changelog

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Release Version :  5.3.5
Release Date    :  03/2025


* spat5.virtualspeakers~ : fix possible crash when initializing in Live (thanks to smallotus)
* spat5.panoramix~ : improved error messages when invalid OSC messages are received
* spat5.converb~ : added @outputmode attribute + many internal improvements (thanks to Nadine Schuetz)
* fix possible samplerate mismatch for a number of command line tools (spat5.ctc~, spat5.hoa.em32~, etc.)
* all DSP objects : fix possible audio bug when signal vector size > 8192
* spat5.hoa.warp~ : fix possible memory allocation in the audio thread
* spat5.hoa.focus~ : fix possible memory allocation in the audio thread
* spat5.shuffle~ : fix possible memory allocation in the audio thread
* spat5.hoa.binaural~ : faster loading time (only one mode is initialized now)
* spat5.hoa.binaural~ : built-in hrtf are automatically re-loaded if samplerate changes
* spat5.ir.infos : added new descriptors, changed syntax a bit
* all binaural objects : warn about invalid date format in SOFA file (but dont throw an error)
* vbap : more robust phantom calculation for some geometries
* spat5.ebur128~ : improved precision
* spat5.conv~ : added "/channel/[index]/mute" message
* spat5.conv~ : added "/mubu" message to load IR from MuBu
* spat5.panoramix : fix color issue with bus send when muted and grouped
* spat5.viewer : added zoom factor when in azim-elev viewpoint
* audiofilecompare command line tool : renamed spat5.sf.compare
* audiofilezeropad command line tool : renamed spat5.sf.zeropad
* spat5.smk~ : txt files now include averaged SNR over all measurement channels
* spat5.granulator~ : fix possible bug with random position
* spat5.osc.route : properly preserve atom type when only one atom in the list (thanks to Mathieu Chamagne)
(also applies to spat5.snapshot~, spat5.isnan~, spat5.osc.unslashify)
* spat5.granulator~ : added new options for random parameters (random range, random enum, etc.) (thanks to vichug)
* all objects : minor optimization when parsing OSC messages
* all objects : more robust parsing of @initwith attribute (detect missing '/' character)
* added spat5.tuto-binaural-1.maxpat (thanks to janmeinema)
* spat5.viewer : added optional label for the listener icon
* spat5.wfs : added bang message; added "/get" messages
* added spat5.osc.tcpsend and spat5.osc.tcpreceive
* spat5.hoa.binaural~ : added "/itd/scaling" message
* spat5.octavebank~ : added "/fraction" message for 1/3rd octave (or finer) resolution
* spat5.octavebank~ : drastically improved filters' stability (for higher orders)
* spat5.smk~ : fix crash on Windows when sweep order > 16 (thanks to mloudjean)
* spat5.meter~ : double-click on gain fader does not return to default value (0dB) to prevent accidental clicking (thanks to joyce
* added spat5.lms~
* spat5.converb~ : sections bounds can now be arbitrary (e.g. 0) (thanks to Emma Margetson)
* spat5.converb~ : added message "/discardbeforetod"
* added spat5.hrtf.normalize (as Max object, and as command line tool)
* spat5.smk~ : added options for lowcut filter (was previously in a separate patcher)
* spat5.smk~ : fix bug with incorrect max/SNR level estimations
* spat5.hoa.binaural~ : fix tiny bug (incorrect magLS filter design around Nyquist frequency)
* spat5.speaker.layout : added "hfu-klangdom" (thanks to Norbert Schnell)
* spat5.smk~ : fix bug when cycles > 1 (sweep signal was erroneously shifted by 1 sample)


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Release Version :  5.3.4
Release Date    :  10/2024


* all objects : improved OSC messaging (faster parsing)
* spat5.panoramix~ : improved OSC messaging (faster parsing)
* spat5.panoramix~ : faster loading time for presets
* spat5.routing : fix bug (improper fill diagonal) when window is closed
* spat5.sfrecord~ : fix possible sync issue with message "/record/samples"
* spat5.osc.route, spat5.osc.routepass, spat5.osc.ignore : added "slash" argument to replicate the behavior of CNMAT OSC-route
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* spat5.panoramix : optimize mute/solo processing (avoid possible memory allocation)
* spat5.panoramix~ : fix bug with stereo and multi track not feeding the right amount of signal into the reverb bus (thanks to Alex
* updated to Juce 7.0.12
* spat5.panoramix, spat5.panoramix~ : added (beta) message /bus/[index]/reference/xyz
* spat5.hoa.blur~ : added "/mode" message
* fix ITD values for "kemar" HRTF (thanks to Jean-Marc Jot)
* spat5.osc.route, spat5.osc.routepass : slightly changed the behavior (when using wildcards)
* all objects : added "/snapshot/insert" messages (thanks to Lorenzo Pagliei)
* all objects : added "/snapshot/store/bytitle" message
* all objects : added "/snapshot/recall/bytitle" message
* all objects : added "/snapshot/delete/bytitle" message
* all objects : added "/snapshot/sort address" message
* spat5.grids : added message "/linear-%d-%f" for linear array with a prescribed spacing
* spat5.ircamverb~ : fixed infinite reverb not working (thanks to Tom Mays)
* spat5.frequencyresponse : fix minor bug with "/fir/load" message
* added spat5.tuto-iko-2.maxpat
* added spat5.dsp.monitor~.maxpat
* added spat5.iko.decoder~.maxpat
* fix bug in spat5.sf.resample
* spat5.panoramix : fix OSC send for /mute messages
* spat5.leslie~ : adding missing attributes in status window
* all GUI objects : fix possible crash when using cmd+w or ctrl+w shortcut (juce issue?)
* nearfield binaural panning : fix audible clicks with distance attenuation (thanks to Mathieu Chamagne)
* spat5.hoa.beamix : added /vumeters/visible message and other display options
* spat5.viewer : improved scaling of background image
* spat5.viewer : fix rotation of background image
* added spat5.mscohere~
* spat5.panoramix : improved shortcut window; added new shortcuts
* spat5.panoramix : added track PFL monitoring (Pre-Fade Listen)
* spat5.hoa.aformat~ : fix bug when filtering is off
* spat5.spat~ : fix incorrect power level for cluster and late reverb sections (thanks to Jean-Marc Jot)
* spat5.sf.resample : improved rendering time (thanks to Natasha Barrett)
* spat5.*.embedded : fix severe memory leak, happening in rare contexts (thanks to Philip Meyer)
* spat5.viewer : added touch message notifications (thru the 2nd outlet)
* spat5.panoramix : touch messages are properly sent when touching directly in the spat viewer interface (thanks to Sylvain Cadars)
* all GUI objects : dont open UI in fullscreen mode if Max is already fullscreen (thanks to Lorenzo Pagliei)
* spat5.conv~ : improved thread-safety when loading IR from buffer~ (thanks to Diemo Schwarz)
* spat5.speaker.layout : added new layouts
* updated spat5.style.js and all patchers for improved readability with Max9 default theme


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Release Version :   5.3.3
Release Date    :   03/2024


* spat5.viewer : added new options for /source/number init message
* spat5.panoramix : fix possible crashes when /numio is inconsistent between /bus and /reverb
* spat5.panoramix~ : minor optimization for stereo tracks
* spat5.panoramix : renamed "/interpolation/time" to "/ramp/time" for various bus, for consistency reasons
(backward compatibility is preserved)
* added spat5.random.rotation (thanks to Manuel Poletti)
* spat5.osc.route : now preserve typed-messages
* spat5.hoa.directivity : added new patterns
* spat5.hoa.beam : added "/selectivity" message
* minimum required macOS version is now 10.13+
* spat5.hoa.decoder~ : cpu optimization for power compensation
* spat5.hoa.decoder~ : power compensation is now compatible with dual-band decoding
* spat5.hoa.compensation~ is now deprecated (used the compensation option in spat5.hoa.decoder~)
* spat5.pan : added bang message
* spat5.hlshelf : only deliver through 2nd outlet when /params message received
* spat5.conv~ : changed dry/wet behavior when mono input and multichannel IRs
* spat5.panoramix : can now use "/mono" as an alias for "/track"
* spat5.panoramix : added "/forward" message to address OSC messages to named elements.
Example: '/forward "Mono 1" /azim 25.0' is equivalent to '/track/1/azim 25.0'

where '/track/1' is the OSC address of the element named "Mono 1".
* spat5.viewer : /backgroundimage/opacity changed from [0 - 1] to [0 - 100] for consistency. Minor compatibility break!
* spat5.panoramix : added option to "consolidate" session
* ADMix renderer : extended to 128I / 128O
* spat5.speaker.layout : added "espro-89"
* spat5.conv~ : fix possible, rare, crash when loading IR
* spat5.conv~ : improved thread-safety when loading IR
* spat5.wfs~ : added message "/delay/switchtonearest" (use 1 for legacy behavior)


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Release Version :   5.3.2
Release Date    :   11/2023


* spat5.early~ : fix possible crash with @inputs 2 and @channels odd
* spat5.osc.slashify : fix duplicated output messages
* spat5.osc.slashify : slight change of behavior : "/track/1 azim [float]" will now output "/track/1/azim [float]"
instead of "/track/1 azim [float]"
* spat5.panoramix : avoid long timeout at initialization when no network connection available
* all GUI objects : added "/snapshot/renumber" message
* all GUI objects : added "/snapshot/sort" message (alphabetical sorting)
* all GUI objects : dump outlet reports "/snapshot/current"
* all GUI objects : added "/dump/snapshots" message
* all GUI objects : added "/snapshot/jump" message(s) for "immediate recall"
* spat5.fir~, spat5.pan~, spat5.spat~ : added "/fir/implementation" for HRIR rendering
* added spat5.tuto-snapshots
* spat5.compressor : displays a dot for input RMS level (only when @channels is 1)
* spat5.hoa.beam, spat5.hoa.display, spat5.hoa.focus : various cosmetic improvements
* spat5.cross3~ : added "/getresponse" message
* spat5.conv~ : fix bug when switching DSP on/off
* spat5.spectroscope~ : /overlap and /smoothing now expressed in percent, for consistency
* spat5.viewer, all objects : added coordinate format "/xy_" : set x and y, and keep current z unchanged
* updated IPP and MKL libraries
* Windows : upgraded from VS2019 to VS2022
* spat5.transform, spat5.scale : added messages "/scaling/azim" and "/scaling/elev"
* added spat5.sfplaylist~
* added spat5.tfestimate~
* spat5.pan~ : fix some weird edge cases with automatic phantom speakers for vbap
* added spat5.waveform, spat5.waveform.embedded
* spat5.equalizer: added messages "/clipboard/copy" and "/clipboard/paste"
* spat5.compressor: added messages "/clipboard/copy" and "/clipboard/paste"
* added spat5.hoa.directivityshaper, spat5.hoa.directivityshaper.embedded
* spat5.hoa.binaural~ : added many new options
* added spat5.headphoneeq~
* Panoramix : added headphone EQ on Binaural bus and Monitoring
* added spat5.hoa.em64~
* Panoramix : /eigenmike is replaced by /em32. Backward compatibility is preserved.
* Panoramix : added /em64 track format
* Panoramix : added notifications for track inside/outside the WFS focused area
* spat5.boids : fix /flyrect message; changed order of arguments (minor compatibility break)
* Panoramix : added bus send 'G' and 'H'
* spat5.meter~ : added "/processwhenwindowclosed". slightly changed some messages for consistency
* spat5.meter~ : added "/controllers/visible"
* Panoramix : "prefilter" is now on by default on WFS bus
* all objects: message "/snapshot/loaded" sent through the dump outlet when a snapshot file is re-loaded
* added spat5.espro.brir
* added spat5.dsptime~
* spat5.wfs~ : fix very subtle and minor bug when varying delays
* Panoramix : added "/mirror/z" on Eigenmike tracks
* spat5.granulator~ : fix possible clicks, added "/freq/min" and "/freq/max" messages
* spat5.tapout~ : added "/delay/mode" message (variable delay or crossfade)
* spat5.tapout~ : added "/freeze" message
* spat5.wfs~ : fix issues with xdelay mode (incorrect crossfade time)
* spat5.oper : fix source presence not properly delivered through high-level outlet when distance changes

* spat5.panoramix : added solo buttons for busses
* spat5.panoramix : fix bug when recalling presets containing solo(s)
* spat5.panoramix : fix bug when creating a new track while other track(s) is soloed
* spat5.spat~ : fix bug where late reverb was not rotated with "/listener/yaw" message
* added spat5.mcsfplayer128~.maxpat
* spat5.panoramix : added "spat5.panoramix.speaker.directions.maxpat" for easy setup of speaker directions
* Panoramix : added channel delays on Master
* Panoramix : added per-bus send delay (syntax: "/track/[index]/bus/[letter]/delay" )
* Panoramix : added "/bus/send/display"


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Release Version :   5.3.1
Release Date    :   05/2023


* spat5.wfs, spat5.wfs~ : major optimizations for moving sources
* spat5.delay~, spat5.wfs~, spat5.binaural~ : optimization for allpass delay interpolation
* spat5.hoa.display : added several display options
* all DSP objects : fix possible issue when some of the inlets are disconnected
* spat5.osc.fromdict : now (partially) supports nested dictionaries
* spat5.trajectories : added "/time" message to scroll within the timeline
* spat5.spat~, spat5.panoramix~ : fix issues with macOS Audio Workgroups
* spat5.*.embedded : minor refresh optimization
* spat5.fir~ : added option to load FIRs from audio file
* spat5.oper.embedded : fix graphic issue on Windows
* spat5.adm.* : better error messages if <audioProgramme> or <audioContent> is missing
* spat5.panoramix : added "/options/solo/mode" : latch or exclusive
* spat5.panoramix~ : fix critical bug with delay/gain calibration incorrectly (not) applied
* spat5.hoa.directivity : several improvements and new features
* spat5.hoa.display : added "/zoom/lock", "/radial/scale", "/legend/visible" messages
* spat5.panoramix : added "/window" messages on WFS bus
* spat5.panoramix, spat5.panoramix~ : added "/bus/[index]/ignorez" message


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Release Version :   5.3.0
Release Date    :   03/2023


* spat5.panoramix : fix possible crash when recalling snapshot (after deleting tracks)
* spat5.panoramix : can now reload session files made with a different value of @internals
* spat5.smk~ : various improvements (patchers and externals)
* spat5.viewer : added orientation messages for microphones
* spat5.viewer : added image messages for microphones
* spat5.viewer : changed orientations messages for eigenmike; for consistency with other elements;
this makes a minor compatibility break with previous versions.
* spat5.sweep~ : added second outlet for sync signal
* spat5.smk~ : added one DSP outlet for signal-rate sync. Warning : minor compatibility break with previous versions!
* spat5.smk~ : added warning message if no input signal
* spat5.file.infos : added "/launch/app" message to launch an application, with optional arguments.
* spat5.adm.play~, spat5.adm.renderer~ : improved compatibility with ITU-R BS.2076-2 and Dolby Atmos
* spat5.calibrate.delay~ : added "/busy" status and output figures
* spat5.calibrate.gain~ : added output figures
* spat5.panoramix~ : fix missing delay processing on reverb bus
* spat5.panoramix~ : minor cpu optimization
* spat5.equalizer : added "/sidebar/visible" and "/channel/visible" messages
* spat5.filterdesign : added new prototypes
* added spat5.hoa.weighting~
* upgraded to Juce 7 (including Metal rendering on macOS)
* spat5.sf.* : fix possible crashes
* added spat5.project
* spat5.pan~, spat5.spat~ : fix various bugs with 3D vbap, and with automatic phantom speakers
* spat5.speaker.config : added /display/zoom notifications (window outlet)
* added spat5.hoa.equivalentorder
* spat5.pansig~ : fix spurious warnings with hoa3d
* spat5.pan~ : fix spurious warnings with phantom speakers

* spat5.spat~ : fix issues with verbose mode
* spat5.ircamverb~ : slightly changed the delays calculation, but improved compatibility with spat5.spat~
* spat5.oper, spat5.viewer : fixed issue with yaw angle incorrectly recalled when recalling snapshots or presets.
* spat5.sfplay~ : added "/close" message
* snapshot window : added option to "store everything except /window"
* spat5.spat~, spat5.reverb~, spat5.ircamverb~, spat5.panoramix~, spat5.multiverb~ : added "/decay/variation" message
* spat5.panoramix~ : audio is muted while loading preset (safety)
* spat5.panoramix~ : optimized loading of presets
* spat5.panoramix : fix a possible bug when deleting a Reverb, and then recreating a similar Bus
* spat5.oper : added message "/source/[index]/reset"
* spat5.panoramix~ : fix bug with delay linkedtodistance not working properly on Mono and Stereo tracks
* spat5.hrtf.infos : added diffuse-field calculation
* spat5.cascade.inverse : now supports OSC bundles
* spat5.binaural~ : added notification (rightmost outlet) when an HRTF dataset is loaded
* spat5.hrtf.infos : added notification (rightmost outlet) when an HRTF dataset is loaded
* spat5.panoramix : added copy/paste functionalities in routing windows
* spat5.panoramix : improved early gains (improved compatibility with spat5.oper)
* spat5.oper, spat5.roomsize, spat5.ircamverb, spat5.panoramix, etc : slight changes
in the room size law. Minor compatibility break.
* added spat5.elliptique~
* spat5.sfplay~ : at the end of the loop, always return to beginning of the file
(slight change compared to previous behavior)
* spat5.sofa.loader : fix bug when using "recently used" box
* spat5.spat~, spat5.panoramix~, spat5.wfs~ : now support macOS workgroup for efficient audio multithreading
* spat5.viewer : several minor improvements
* spat5.hrtf.infos, spat5.binaural~ : load built-in hrtf with the proper sampling rate
* spat5.compressor, spat5.compressor~ : increased maximum expander ratio
* spat5.panoramix : new options to copy tracks or buses settings


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Release Version :   5.2.9
Release Date    :   09/2022


* spat5.viewer : now supports color for listener
* spat5.conv~ : improved "/buffer" messages to load i-th source channel to j-th destination channel
* all binaural objects : added "/load IRC_1040" to load built-in 1040 HRTF set
* spat5.viewer : added "path" elements (see help patcher)
* spat5.viewer : added "/listener/orientation/visible" message
* added spat5.supperware.maxpat and spat5.tuto-supperware-1.maxpat
* spat5.hoa.em32~ : very minor improvement for high-cut filter
* spat5.sfplay~ : added "/loop/end" notifications
* spat5.sfplay~, spat5.sfrecord~ : added @rendering attribute for offline (non-realtime) use
* spat5.quat.toeuler, spat5.quat.fromeuler : added "/system" message (intrinsic vs extrinsic coordinate system)
* spat5.osc.var : added "append" and "prepend" message
* spat5.filterdesign : slightly improved filter stability
* spat5.filterdesign : faster calculation
* spat5.filterdesign : warning message when filter design fails
* spat5.panoramix : added air frequency on reverb bus
* spat5.conv~ : added message "/load [filename] [srcChannel] [destChannel]" to load one channel from an IR file
* spat5.cascade~ : added message "/dsp/drywet"
* spat5.conv~, spat5.converb~ : added message "/dsp/drywet"
* spat5.compressor~ : added message "/dsp/drywet"
* spat5.fir~, spat5.velvet~, spat5.rake~, spat5.dcfilter~, spat5.graphiceq~, spat5.hlshelf~ : added message "/dsp/drywet"
* spat5.clip~, spat5.delta~, spat5.deltaclip~, spat5.noisegate~, spat5.tanh~, spat5.softclipping~ : added message "/dsp/drywet"
* spat5.air~, spat5.doppler~, spat5.leslie~ : added message "/dsp/drywet"
* spat5.hoa.mirror~, spat5.hoa.focus~, spat5.hoa.rotate~, spat5.hoa.blur~, spat5.hoa.dominance~, spat5.hoa.warp~ : added message "/
* spat5.matrix~, spat5.diagmatrix~, spat5.routing~, spat5.allpass~, spat5.comb~ : added message "/dsp/drywet"
* added spat5.hoa.conv~
* all GUI objects : major improvements to the snapshot window
* spat5.tuto-presets : added new presets
* spat5.barycenter : improved error handling.


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Release Version :   5.2.8
Release Date    :   07/2022


* spat5.trajectories : added "/restart" message
* spat5.periactes : improved "/window/enable" message
* spat5.sfrecord~ : added "/forcerf64" message
* spat5.sfplay~ : fix possible issues reading WAV RF64 files
* spat5.ircamverb~ : fix initialization issue (when not connected to spat5.ircamverb)
* all objects : fix potential deadlock with incorrect OSC address
* all GUI embedded object : major rendering improvement
* added spat5.tuto-mtr.maxpat
* added spat5.tuto-presets.maxpat, thanks to Nadir Babouri
* all GUI objects : "/snapshot/import" and "/snapshot/export" now open a dialog window
* spat5.delay~ : added "/delay/mode" message (variable delay or crossfade)
* spat5.hoa.em32~ : added attribute @order (default = 4)
* all DSP objects : "/dsp/mute" now applies a short ramp when muting/un-muting (minor compatibility break)
* all DSP objects : "/dsp/bypass" now applies a short ramp when bypassing (minor compatibility break)
* all DSP objects : added message "/dsp/mute [boolean] [number]" where the second argument specifies the duration of the ramp (in m
* all DSP objects : added message "/dsp/bypass [boolean] [number]" where the second argument specifies the duration of the ramp (in
* all DSP objects : added "/dsp/mute/ramptime" and "/dsp/bypass/ramptime" messages : set the ramp time (in msec) for mute and bypas
* spat5.hlshelf, spat5.ircamverb, spat5.oper : fix filter issue (window not editable) when recalling snapshots
* (almost) all objects : added "/verbose/timestamp" option for timestamping messages printed in the Max console
* Panoramix-Ircam : extended to 128 I/O (instead of 128 I / 64 O)
* spat5.speaker.config : added one outlet for window notifications
* spat5.speaker.config : added "/controllers/visible" message
* all objects : fix possible crash when loading session in Ableton Live
* spat5.grids : added "circular-ccw" grid
* spat5.viewer : added "/keypress" messages
* spat5.speaker.layout : added "marseille-prism-lab"
* spat5.pan~ : fix crash with nfchoa panning
* spat5.distance : fix various bugs
* spat5.hoa.zm1~ : updated microphone positions
* added patcher spat5.wfs.options
* spat5.wfs, spat5.wfs~ : added new options for "large stage adapter" (LSA)
* spat5.ltc.decoder~ : added "/fps/auto" message
* spat5.oper, spat5.spat~ : fix issues with "/listener/orientation" message
* spat5.noisegate~ : fix audio clicks when gating
* spat5.oper, spat5.spat~, spat5.oper_ : fix missing "/spread/mode" and "/spread/law" messages
* added spat5.yin~
* spat5.oper, spat5.spat~, spat5.oper_ : fix missing "/neighbors" messages
* added spat5.quat.multiply
* updated spat5.studio4.decoder~
* spat5.speaker.config : avoid unnecesasry updates
* spat5.decoder~ : fix initialization bug for transaural mode
* spat5.adm.renderer~ : added @mc attribute
* spat5.adm.play~ : added @mc attribute
* ADMix-Renderer-Ircam.maxpat : ported to MC


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Release Version :   5.2.7
Release Date    :   03/2022


* spat5.panoramix : fix possible crash when loading preset
* added spat5.hoa.rotate (control rate equivalent of spat5.hoa.rotate~)
* added spat5.hoa.correlate
* spat5.panoramix~ : fix issue with wfs speaker directions when changing bus connections
* spat5.hoa.rotate~ : cpu optimization
* spat5.panoramix : fix possible crash when saving file without write permission
* spat5.panoramix~ : fix possible issues when sending an eigenmike track to a bus with different order
* spat5.osc.udpreceive : improved thread-safety
* spat5.osc.udpsend : added "disconnect" and "reconnect" messages
* spat5.speaker.layout : added new layouts
* spat5.whichthread : added new info
```

* spat5.decoder~ : fix various issues when changing decoder type
* update a number of help patchers
* spat5.speaker.config : added many cosmetic messages
* all GUI objects : floating windows are now NSPanel
* many objects : increase the allowed maximum number of sources/inputs
* spat5.colormap : fix @initwith not working
* all objects : fix possible crash with parameter_mode enabled
* updated Spat5-Benchmark.pdf
* spat5.hlshelf : fix bug with bang message
* spat5.panoramix : added yaw, pitch, roll dials on Monitoring track and Binaural Bus
* spat5.cross3~ : added "/band/[index]/mute" message
* spat5.hoa.beam, spat5.hoa.beam~ : simplified OSC syntax for beam control
* spat5.hoa.focus, spat5.hoa.focus~ : simplified OSC syntax for beam control
* spat5.grids : fix bug with 'spiral' grid
* spat5.spat~ : fix "/verbose" message not working
* spat5.ircamverb~ : add missing "/early/width" message
* spat5.sfplay~ : fix bug with position outlet not working when "@mc 1" and signal outlet is disconnected
* spat5.multiverb~ : improved filter stability
* spat5.sfplay~ : added support for LIST chunk, for marker labels in wav files
* spat5.viewer : selected elements are reflected in all UI views
* spat5.viewer : fix blank pixel at the outer right of the window
* spat5.viewer : fix label font size initialization
* spat5.viewer : "/window" messages are output through the 2nd outlet
* spat5.viewer : fix initialization bug "/listener/lookat"
* added shell tool : spat5.sf.tomcfx
* added spat5.velvet~
* spat5.viewer : added "/unitcircle/visible", "/unitcircle/color", "/unitcircle/radius" messages
* spat5.oper : fix minor issues with "/set" messages actually triggering output
* spat-sdif-renderer : speed up rendering time, especially for short files.
* spat5.oper_ : supports parameter_enable
* spat5.compressor~, spat5.limiter~ : properly reports latency
* spat5.adm.record~ : supports @mc
* spat5.oper_ : added "/bang" message
* spat5.fact2crit : fix bang message that was not working
* spat5.osc.speedlim : fix possible crashes (thread concurrency issues)
* spat5.osc.unslashify : fix possible crashes (thread concurrency issues)
* all GUI objects : added "/window/background/transparency" message


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Release Version :   5.2.6
Release Date    :   11/2021


* spat5.sfplay~ : added "/dump/axml" message
* updated to Juce v 6.1.2
* updated IPP and MKL to v 2021.4.0
* panoramix : new options on AB bus to configure the mic pair
* spat5.viewer, spat5.oper : bang message delivers the speaker directions
* spat5.pan~, spat5.spat~ : default panning type is now vbap, instead of angular
* spat5.pan~, spat5.spat~ : added abap2d and abip2d (angle-based panning)
* spat5.wfs, spat5.wfs~ : major refactoring (again!)
* spat5.wfs.grid, spat5.wfs.config : deprecated, no longer needed
* spat5.wfs, spat5.wfs~ : slight improvements in the gain scaling law
* spat5.ebur128~ : cpu optimization; internal refactoring; delivers some new criteria
* spat5.ebur128~ : now works with arbitrary speaker layouts
* added abstraction spat5.mc.r128~
* spat5.hoa.beam~ : removed 64 beams limit


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Release Version :   5.2.5
Release Date    :   08/2021


* compatible with arm64 (Apple Silicon) (requires Max 8.2+)
* spat5.grids : fix missing "upper-*" grids

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* all objects : fix possible hang with coordinate conversion/modulo
* spat5.fir~ : added "/implementation" message
* spat5.hoa.compensation~ : fixed various bugs and improved calculation time
(this also impacts "decoder compensation" in HOA decoders and HOA Bus on Panoramix)
* spat5.pan~ : minor improvements to phantom speakers
* spat5.speaker.layout : added "iem-cube"
* spat5.colormap : added 50 new maps
* spat5.panner.metrics : added new metrics
* spat5.hoa.scope~ : added "/resolution" message
* spat5.panoramix~ : fix potential lock issue (vu-meter thread)
* spat5.rms~, spat5.snapshot~, spat5.ebur128~, spat5.meter~, spat5.compressor~, spat5.noisegate~ : fix possible threading issue
```

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Release Version :   5.2.4
Release Date    :   07/2021
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* now requires Max 8, and macOS >= 10.11
* spat5.hoa.focus : added "/background/color" message
* spat5.hoa.focus : added "/zoom/lock" message
* spat5.hoa.focus : zoom is now expressed in percent
* spat5.osc.unique : added "mode" attribute
* spat5.oper_ : fix minor issues with "/drop" and "/drop/mode" messages
* spat5.oper_ : improved initialization
* spat5.wfs, spat5.wfs~ : properly search files in search path
* spat5.viewer : improved orientation manipulations
* spat5.viewer : added "/direction" message to specify direction axis
* spat5.wfs~ : added "/prefilter" message
* spat5.eq : fix initialization issues with @initwith or @embed attributes
* added spat5.fir~
* spat5.panoramix~ : added pre-filter on WFS bus
* spat5.panoramix : fix bugs with groups when recalling presets
* spat5.conv~ : major cpu optimizations
* spat5.conv~ : defer load of IR in background thread to avoid audio clicks
* spat5.hostinfos : added "/system/sleep", "/system/logout"
* improved documentation and ref-pages for several objects
* spat5.viewer : added "/area/[index]/trigger" message
* added "spat5.tuto-viewer-7.maxpat" demonstrating area triggers
* all GUI objects : added dump notification for "/preset/loading" (immediately before loading preset)
* added spat5.rake~ on Windows
* spat5.wfs.config : major refactoring
* spat5.grids : added Poisson disc sampling (2D and 3D)
* added spat5.evert.fdn~ on Windows
* spat5.hoa.directivity, spat5.hoa.beam~ : supercardiod pattern can now be computed for arbitrary order
* spat5.hoa.directivity, spat5.hoa.beam~ : added dolph-chebyshev pattern
* spat5.grids : added "/format" message
```

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================================================================================
Release Version :   5.2.3
Release Date    :   05/2021
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* all objects : major optimization in snapshot interpolation
* spat5.grids : fix tiny issues with healpix, lebedev and fliege grids
* updated lib matio
* audiofileconcat : added option to sort files (alphabetical or natural sort)
* spat5.delgen : fix possible bugs with /minsum message
* spat5.panoramix~ : fix bug with "/convention" not properly rendered on HoaStream
and B-format tracks
* spat5.panoramix : fix display bug for hoa order on HoaStream tracks
* spat5.oper : fix possible bugs with the "distance" slider (when distance is smaller than radius)
* all objects : optimized aed to xyz conversion
* spat5.mirror, spat5.transform : fix /mirror/x and /mirror/y that where inverted
* spat5.panoramix : fix possible crash when deleting 'Multi' tracks (and reloading session)
* spat5.panoramix~ : fix bug with Direct-to-Master track, when the input signal is discontinued
```

```
* spat5.evert : added quaternion orientation messages for sources and listener
* all GUI objects : added "/window/export/image [file]" message
* spat5.panner.metrics : added "/speakers/label/visible" message
* spat5.evert~ : improved "/info" message
* spat5.spat~ : fix critical bug with early reflections for stereo sources
* spat5.spat~ : fix critical bug with panrev for stereo sources
* spat5.panoramix~ : fix bug with reverb on transaural bus
* spat5.spat~ : fix major bug with binaural iacc
* spat5.panoramix : fix copy/paste settings for linux
* spat5.panoramix : fix minor display issue with track d2b
* spat5.panoramix~ : fix possible bugs with bus thru
* spat5.panoramix~ : direct to master track contributes to LFE only if output routing is made
* spat5.filterdesign : added new filter topologies (more accurate at high frequencies)
* spat5.panoramix : added hoa focus component on eigenmike and zylia tracks
* spat5.pan~ : added missing parameters in the status window, when using diffuse panning
* spat5.evert~ : added messages to mute direct sound
* spat5.evert : added "/hoa/order" message to set HOA order for simulation of source directivity
* spat5.panoramix~ : save cpu when early reflections are muted
* spat5.panoramix : fix (benign) bug when creating a wfs bus
* spat5.speaker.layout : added new layouts
* spat5.wfs~, spat5.panoramix~ : fix various bugs with xdelay mode
* spat5.wfs~, spat5.panoramix~ : minor cpu improvements
* spat5.panoramix~ : added parallel mode (multi-threading) for tracks
* added spat5.weightingfilter
* added spat5.boids
* spat5.colormap : added "/random" and "/distinct" messages


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Release Version :   5.2.2
Release Date    :   03/2021


* spat5.panoramix : fix bugs with bus divergence
* spat5.sofa.loader, spat5.sofa.infos, etc. : updated according to AES69-2020 SOFA 2.0 standard
* spat5.panoramix : added missing notification for "/lfe/cutoff/bypass"
* spat5.compressor, spat5.panoramix : new link mode (multi-mono / link all / link to 1st)
* spat5.panoramix : improved groups processing
* spat5.panoramix : fix bug with "trim" not in groups
* spat5.panoramix : added automatic groups for all tracks sent to a given bus
* spat5.hoa.beam~ : fix various bugs with gain normalization
* added spat5.quat.frommatrix
* added spat5.hoa.directivity
* spat5.panoramix : group "all" is renamed "all tracks" for consistency
* spat5.hoa.focus, spat5.hoa.beam : minor optimizations
* spat5.oper : fix bug with aperture, at low frequencies, for some yaw values (bug since 2007!)
* spat5.evert~ : added @bands attribute; added anti-phase filter in FDN;
* spat5.panoramix~ : fix possible crash with wfs (with 3D speaker layouts)
* spat5.binaural~ : fix possible crashes in Ableton Live
* spat5.panoramix : added "no decoding" option for HOA bus
* spat5.panoramix~ : various optimizations (DSP and control)
* spat5.panoramix  : tiny optimization in distance attenuation calculation
* spat5.wfs~ : added (expert users) options for online calculation of gains/delays
* spat5.graphiceq : minimized ripples in the band edges
* spat5.panoramix : fix missing messages for d2m/[index]/delay/bypass and d2b/[index]/delay/bypass
* spat5.spat~ : fix loading of HRTF for stereo input sources
* added spat5.graphiceq2, spat5.graphiceq3
* spat5.panoramix : avoid unecessary notifications for /group messages
* spat5.wfs.config : fix bug with linear array
* updated Spat5-Benchmark.pdf
* all objects : fix possible issues with NaN values
* spat5.panoramix~ : fix bug with stereo AB bus
* spat5.panoramix : fix bug with group edition
* spat5.panoramix : fix bug with reverb send offset for Multi tracks
* spat5.panoramix~ : fix possible crash with HoaStream tracks
```

* updated spat5.panoramix2tosca for new panoramix syntax
* spat5.panoramix : fix bug with "/bformat/[index]/sorting" message
* spat5.panoramix : added reverb mute button on HoaStream, AFormat, and Bformat tracks
* spat5.panoramix : fix gain scaling
* spat5.panoramix : added delay bypass button on several tracks
* all objects : added message "/post/version details"
* all DSP objects : fix critical bug with filter's crossfade
* SOFA : updated netcdf libraries
* JUCE : updated to 6.0.7
* spat5.delay~ : added "/freeze" message
* spat5.oper_ : added missing "/source/[index]/pitch" message
* spat5.oper, spat5.spat~ : added "/panrev" messages for late reverb


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Release Version :   5.2.1
Release Date    :   12/2020


* spat5.panoramix~ : minor CPU optimization (RMS metering)
* spat5.panoramix : optimize GUI painting for macOS >= 10.14
* spat5.spat~ : minor CPU optimization (cluster processing)
* updated Spat5-Benchmark.pdf
* spat5.osc.prepend, spat5.osc.append : fix crash when pattern contains '#' character
* spat5.panoramix~ : added transaural bus
* spat5.shuffle~, spat5.reverb~ : fix bugs with Householder matrix
* spat5.hoa.plot : added messages "/display/yaw", "/display/pitch", "/display/ypr", etc.
* spat5.hoa.slaconv~ : added "/info" message
* spat5.hoa.slaconv~ : improved help patcher
* spat5.hoa.slaconv~ : added warning messages if filter order mismatch
* all objects : warning message for OSC messages ending with '/' character
* spat5.panoramix : fix various issues with floating windows
* spat5.pan~ : divergence can operate even when spread is 0
* spat5.panoramix : added message "/bus/[index]/speakers/editor/window/open"
* spat5.panoramix : added message "/bus/[index]/speakers/editor/window/title"
* all GUI objects : minor look-and-feel changed for toggle buttons
* spat5.wfs, spat5.wfs~ : can now compute coefficients on the fly
* spat5.wfs, spat5.wfs~ : added gain scaling factor
* spat5.panoramix : added gain scaling factor for WFS bus
* spat5.room~ : extended to multiple sources (minor compatibility break)
* spat5.viewer, spat5.oper : fix issues when the source distance was set to 0
* all GUI objects : added dump notification for "/preset/loaded" and "/preset/saved"
* spat5.panoramix : fix minor issue with "/options/vumeters/visible" message
* macOS 10.9 is now the minimum deployment platform
* spat5.panoramix : added messages "/options/dock/viewer/window/title", "/options/dock/equalizer/window/title"
* spat5.panoramix : added "/direct/gain/offset", "/early/gain/offset" and "/reverb/gain/offset"
* spat5.ltc.trigger~ : changed behavior of 2nd outlet (delivers more useful messages)(minor compatibility break)
* updated qhull library
* updated IPP and MKL libraries
* spat5.calibrate.gain~ : added "/stop" message
* spat5.pan~, spat5.spat~, spat5.panoramix~, etc : more warning/error detections for loudspeaker setup
* spat5.spat~ : fix some spurious error messages (hoa)
* spat5.panoramix : added "/lfe/cutoff/bypass" message
* spat5.grids : added new spherical grids
* added spat5.granulator~
* spat5.hostinfos : added base64, base32 and base16 encoding/decoding
* spat5.viewer : added message "/source/[index]/proportion/add [float]" to increase/decrease proportion


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Release Version :   5.2.0
Release Date    :   11/2020


* spat5.delay~ : added "thiran2" and "thiran3" interpolation modes
* spat5.filterdesign : improved documentation
* spat5.grids : added many aliases

* spat5.routing : improved "/row/*/color" messages
* spat5.turntable : fix bug where the socket connection would always failed
* added spat5.screencapture
* spat5.calibrate.delay~ : fix possible crash
* spat5.conv~ : major CPU improvement on Windows
* spat5.folder.infos : fix "/findfolders" message not working
* spat5.file.infos : fix spurious error messages with directories
* OSC : improved support for UTF8 strings
* spat5.smk~ : added "/options/saverawtxt", "/options/saveirtxt", "/options/saveaxml", "/options/savelog" messages
* spat5.smk~ : overwritten files are now deleted (rather than moved to trashbin) for efficiency
* spat5.calibrate.gain~ : fix possible crash
* spat5.pan~, spat5.panoramix~, spat5.spat~ : fix possible crash when using invalid loudspeaker setups for LBAP
* spat5.hoa.binaural~ : fix bug with "/norm" message
* spat5.hoa.binaural~ : added new "/mode" message. changed default mode to "t-design"
* spat5.panoramix~ : fix critical bug where speaker gains/delays were not applied to reverb bus
* spat5.panoramix : added divergence on vbap/vbip busses
* added spat5.hoa.slaconv~
* spat5.panoramix~, spat5.pan~, etc. : fix potential issues with zenith/nadir phantom speakers
* spat5.panoramix : added delay on LFE bus
* spat5.hoa.decoder~ : fix possible crashes with CSAD
* spat5.hoa.decoder~ : fix possible crashes with phantom speakers
* spat5.hoa.decoder~ : added safety guards to avoid decoder blow-up
* spat5.hoa.decoder~ : fix bugs with regularized-mode-matching
* spat5.sfplay~ : fix scheduling bug with [int] and "/start" message
* spat5.panoramix : fix "/neighbors/exponent" not working
* reduced size of the distribution package for Windows
* spat5.ltc.encode~ : added "/forward" and "/backward" messages
* all objects : fix possible crashes in Ableton Live
* spat5.panoramix~ : cpu optimization for HOA busses
* spat5.panoramix~ : minor cpu optimization for compressors (when channels are linked)
* spat5.oper_ : added "/reverb/[index]/roomsize" message
* spat5.oper : improved documentation
* spat5.trajectories : fix issue with "/rate" message
* spat5.panoramix : speed up preset loading time
* spat5.panoramix : added "/options/parallel/bus" message for multi-threading (use at your own risks).


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Release Version :   5.1.9
Release Date    :   09/2020


* spat5.speaker.layout : updated Geneva CME layout
* spat5.speaker.layout : added "immersive audio lab haw hamburg"
* spat5.speaker.layout : minor update to zkm kubus layout
* spat5.sfplay~ : added "/dump/metadata" message
* spat5.sfplay~ : added "/seek/marker/bylabel" message
* spat5.sfplay~ : added "/seek/marker/byid" message
* spat5.sfplay~ : now reads CUE chunk of WAV files for markers
* Panoramix-Ircam.maxpat : added predefined speaker layouts
* spat5.panoramix : improved various warning messages
* spat5.simone : fix minor issues in help patcher
* spat5.viewer, spat5.simone, etc : fix GUI issues on Windows
* spat5.viewer : fix possible crash with /area messages
* added missing offline /media/tools for Windows
* spat5.panoramix : added option to dock/undock the EQ/compressor window
* spat5.hoa.em32~ : added "/export/filters" and "/export/matrix" messages
* added "spat5.hoa.decoder~" command line tool in /media/tools
* minor improvements to all command line tools


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Release Version :   5.1.8
Release Date    :   08/2020


* spat5.panoramix : fix minor display bug in HOA bus

* spat5.panoramix : added "Hoa Stream" tracks (as input)
* spat5.panoramix : added focus FX on A-format and B-format tracks
* panning : added "/spread/mode [azim/elev/x/y/z]" for single direction spreading
* spat5.ir.infos : added "/buffer" message
* spat5.ir.analysis : added "/buffer" message
* spat5.hoa.decoder~ : added "/export/coll" message
* spat5.hoa.decoder~ : added "/export/iemplugins" message
* updated Spat5-Benchmark.pdf


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Release Version :   5.1.7
Release Date    :   06/2020


* spat5.sfplay~ : can now read BWF metadata (delivered through the dump outlet)
* spat5.hoa.em32~ : added "/fftsize" message
* updated to juce 5.4.7
* minimum macOS version is now 10.8
* added spat5.wav.insertaxml
* added spat5.wav.extractaxml
* added spat5.wav.generateaxml
* spat5.pan~ : added "/format" message
* spat5.decoder~ : added "/format" message
* spat5.hoa.decoder~ : added new warning messages
* spat5.hoa.decoder~ : added orthonormality error estimation, in the "/info" message
* added spat5.sf.trim
* spat5.hostinfos : added "/timezone" message
* spat5.sfrecord~ : added "/insertaxml" message
* spat5.colormap, spat5.hoa.scope~ : added new colormaps
* spat5.transform : now preserves list of speaker coordinates given by "/speakers" messages
* removed spat5.hoa.metrics and spat5.vbap.metrics. They are replaced and supersed by spat5.panner.metrics
* spat5.hoa.decoder~ : added constant spread ambisonic decoder (CSAD)
* spat5.grids : added new grids chebyshev-tdesign and gauss-tdesign
* added spat5.hoa.intensity~
* spat5.speaker.layout : now also supports all the types known in spat5.grids
* spat5.speaker.layout : added "/format" message
* spat5.calibrate.delay~ : added "/stop" message. Minor improvements.
* added spat5.fact2crit
* added spat5.complementarybank~
* VBAP : added "/phantom/auto" message : try to automatically add a phantom speaker in the appropriate direction
* added spat5.hoa.downscale~
* spat5.rms~ : added "/rounding" message
* spat5.hoa.beam~ : fix possible issues with normalization; added new beampatterns
* spat5.conv~ : added "/channel/[index]/fir" message
* spat5.hoa.decoder~ : when the speaker setup is 2D, the decoder now automatically
downscales the HOA stream to 2D.
* all panning/decoding objects : more and more sanity checks on loudspeaker setup
* spat5.abs2rel : aperture messages are now bypassed
* spat5.hoa.decoder~ : added regularized-MMAD decoding (RMMAD)
* spat5.pan~ : added "csp" panning type
* spat5.hoa.decoder~ : now compatible with stereo speaker setups
* spat5.panoramix : changed minimum distance to 0.1m


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Release Version :   5.1.6
Release Date    :   03/2020


* spat5.osc.udpreceive : added @quiet attribute
* spat5.viewer, spat5.oper : added "/speakers/visible [list]" and "/sources/visible [list]" messages
* spat5.ircamverb~ : added "/early/interpolation/mode", "/early/interpolation/time",
"/cluster/interpolation/mode", "/cluster/interpolation/time", "/reverb/interpolation/mode", "/reverb/interpolation/time"
* spat5.osc.record~ : fix bug with time stamps
* spat5.reverb.timeview : added "/early/gains" and "/cluster/gains" messages
* spat5.roomsize : fix output messages when "/roomoffset" is changed

```
* spat5.delgen : added missing FullPacket method
* spat5.converb~ : added "/clear" message
* spat5.osc.play~ : fix issue where messages were improperly delivered in the audio thread
* spat5.spat~ : fix bug with stereo sources when early, cluster and reverb are muted
* spat5.spat~, spat5.pan~: fix possible clicks with AB panning
* spat5.osc.view, spat5.osc.display : added "visible" attribute
* spat5.panoramix~ : fix bug with LBAP bus
* spat5.panoramix~ : fix various bugs with 'Multi' tracks
* spat5.osc.play~ : added new outlet; added "/report" and "/coalesce" message
* updated Spat5-Benchmark.pdf
* spat5.conv~ : added non-realtime processing mode ("/operating/mode" message)
* spat5.evert~ : added FDN
* spat5.viewer : added "/ruler/unit" message
* spat5.osc.var : added "dump" message
* added spat5.tuto-viewer-6
* added spat5.hoa.encoder command line tool
* spat5.meter~ : mouse drag on fader is now relative not absolute
* added spat5.jitter : deviate and randomize coordinate messages
* added spat5.jittering abstraction
* spat5.scale : added "/scaling/xy" and "/scaling/xyz" messages
* spat5.translate : added "/offset/xy" and "/offset/xyz" messages
* spat5.transform : added "/scaling/xy" and "/scaling/xyz" messages
* spat5.transform : added "/offset/xy" and "/offset/xyz" messages
* added spat5.colormap
* added spat5.trajectories
* spat5.viewer : added "/source/[index]/image [string]" message
* spat5.viewer : added "/speaker/[index]/image [string]" message
* spat5.roomsize, spat5.oper : fix issues with "/roomoffset"
* spat5.evert~ : added "/fdn/roomoffset" message
* spat5.panoramix : now possible to rename busses
* spat5.osc.interpolate : added "filterout" attribute
* all objects : added many "/snapshot" messages; added snapshot interpolation, import, export
* all objects : added many "/status/copytoclipboard" messages
* added spat5.snapshot.management.maxpat
* added spat5.common.messages.maxpat
* added spat5.mc.hoa.live.gain7~.maxpat
* all spat5.*.embedded : added the missing "/pattr/store" message
* added spat5.octavebank~
* spat5.routing : improved help patcher, and error messages


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Release Version :   5.1.5
Release Date    :   11/2019


* spat5.osc.route, spat5.osc.routepass, spat5.osc.prepend, spat5.osc.append :
improved abstraction support with #1 - #9
* spat5.panoramix : added "/track/[index]/equalizer/reset" message
* spat5.sfplay~ : added misc options
* spat5.filterdesign : minor improvement
* spat5.pan : minor optimization (output only the messages for the necessary source(s))
* added "spat5.known.colors.maxpat" abstraction
* added "spat5.compressor.settings.maxpat" abstraction
* spat5.compressor~ : fix bug when outlets are not connected
* added spat5.ltc.toms and spat5.ltc.fromms
* spat5.ltc.trigger~ : minor improvements
* spat5.panoramix~ : now properly searches hrtf files in Max search paths
* spat5.panoramix : added outlet for /window messages
* spat5.pan~ : fix spurious error messages with /sources and /speakers messages
* added spat5.ltc.easydecode~
* spat5.ltc.encode~ : added "/speed" message
* spat5.osc.var : "load" message now searches in Max search path
* spat5.osc.var : "load" message in right inlet wont trigger output
* spat5.osc.record~ : added "/noduplicate" message
```

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* all objects : added selective "/dump" message. See "spat5.tuto-dump-1.maxpat" for details


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Release Version :   5.1.4
Release Date    :   10/2019


* spat5.ctc~ : notifications when loading hrtf files
* spat5.spat~ : fix missing attributes in status window when panning type is nearfieldbinaural
* spat5.abs2rel : now handles sources' yaw
* spat5.panoramix : fix bug when recalling blur value in HOA bus
* Panoramix : update for Mojave and Catalina security permissions
* spat5.ltc.encode~ : added "/pause", "/resume", "/switch" messages


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Release Version :   5.1.3
Release Date    :   09/2019


* spat5.align~ : improved and clarified some error messages
* spat5.panoramix : fix error messages with "/master/channel/[index]/equalizer/filters/params"
* spat5.ircamverb~ : fix bug with early reflections panning
* spat5.hoa.scope~ : now outputs location of maxima, minima
* spat5.panoramix : EQ filter order is now properly exposed to grouping
* spat5.panoramix : fix logic error with mute/solo when tracks are grouped
* spat5.panoramix : fix potential bugs with group management
* spat5.panoramix : fix crash with high-order low-pass filter in EQ
* spat5.transpan~ : fix panpot layer not updated when source moves
* all objects : minor OSC optimization
* spat5.wfs : fix spurious warning message for sample rate mismatch
* spat5.viewer : added "/source/[index]/hidewhenmute" message
* spat5.oper, spat5.oper_, spat5.spat~ : fix bugs with panrev parameter
* all objects : fix possible crashes in Ableton Live
* spat5.panoramix : added "/options/dock [boolean]" message
* spat5.panoramix : added "/options/dock/floating [boolean]" message
* spat5.graphiceq~ : added "/crossfade/duration [number]" message
* spat5.graphiceq, spat5.graphiceq~ : added "/gain/db [number]" message
* spat5.hoa.decoder~ : improved SVD stability
* spat5.pan~ : added "/layering" option for building LBAP layers
* all objects : added option to specify end-of-line character when using "/preset/export"
* spat5.align~ : added "/soundvelocity" message
* spat5.osc.iter : added [int] argument to specify the number of messages in each chunk
* added spat5.osc.size
* spat5.panoramix : improved pop-up window for multi-screen usage
* spat5.decoder~, spat5.hoa.decoder~, panoramix : added phantom speaker option for HOA decoders
* added spat5.osc.chunk
* spat5.pan~, spat5.panoramix : added new options for LBAP : "/layering/type", "/layering/panning/type"
* all objects : fix possible crash when parameter mode is enabled
* added spat5.quat.interpolate
* spat5.pan~, spat5.panoramix, spat5.spat~ : added "/neighbors/maxdistance" option for KNN panning
* added spat5.osc.interpolate


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Release Version :   5.1.2
Release Date    :   06/2019


* spat5.panoramix : "/window" messages are properly saved with preset
* spat5.osc.udpreceive : fix possible bugs (truncated OSC bundles)
* spat5.panoramix2tosca : extended to stereo tracks
* spat5.oper, spat5.oper_ : fix reverb gain when changing destination room
* spat5.simone : added "/style" message
* spat5.panoramix : added per channel EQ on Master track
* most GUI objects : "/color" messages now support strings, e.g. "/color blue"
* spat5.osc.fromdict : fix memory leak + optimization
* spat5.equalizer : optimized drawing
```

* spat5.ltc.trigger~ : various improvements (minor compatibility break)
* spat5.equalizer : added @channels attribute (minor compatibility break)
* spat5.hostinfos : added "/push/notification" message
* spat5.osc.ignore, spat5.osc.route : fix possible bug with bundles containing wildcards
* spat5.panoramix : added "/output/mode" on Master track
* all objects : CPU optimization when processing OSC messages
* added spat5.hoa.shelving
* spat5.pan~, spat5.ircamverb~ : avoid spurious error messages with aperture/orientation messages
* spat5.grids : added new grids for upper hemisphere
* spat5.ircamverb, spat5.ircamverb~, spat5.oper, spat5.spat~, spat5.roomsize : added "/reverb/roomoffset" message
* spat5.viewer : added YZ viewpoint


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Release Version :   5.1.1
Release Date    :   04/2019


* spat5.panoramix : fix bug with distance slider on "Multi" tracks
* spat5.viewer : fix various bugs with /multi elements
* spat5.cluster~, spat5.reverb~, spat5.spat~, etc. : fix potential crash when using
a non-power of two number of internal channels
* spat5.hostinfos : added "/system/reboot" message
* spat5.hoa.scope~ : added "/colorbar/visible" message
* spat5.hoa.zm1~ : fix possible crashes
* spat5.panoramix~ : fix spurious error messages with vbap bus
* spat5.osc.display : added @title attribute
* added spat5.mcsfplayer~.maxpat
* spat5.panoramix : fix possible crash when loudspeakers are coincident
* spat5.hoa.zm1~ : adding new encoding methods ("/mode" message)
* spat5.panoramix : fix tiny bug with speaker labeling ("/bus/[index]/speaker/[index]/name")
* spat5.hoa.scope~ : added to windows release
* spat5.panoramix~ : fix various issues with Eigenmike tracks
* added spat5.hoa.triangle
* added spat5.hoa.plot
* spat5.panoramix : added message "/bus/[index]/listener/ypr" for binaural bus
* spat5.hoa.scope~ : disable computation when window is not visible (economy mode)
* spat5.hoa.focus : fix minor bug with elevation messages
* spat5.file.infos : added md5 checksum
* spat5.hoa.focus : added reset button
* added spat5.hoa.fx~ and spat5.tuto-hoa-3
* spat5.smk~ : added session log file
* many DSP objects : improved inlets/outlets description when @mc = 1
* spat5.viewer : fix possible crash with sources' history


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Release Version :   5.1.0
Release Date    :   03/2019


* added spat5.hoa.dominance~ : dominance effect (1st order only)
* spat5.hoa.focus : added keyboard shortcut for circular constraint
* spat5.matrix~ : added "/clear" message
* spat5.sfplay~ : on "/open" message, tries to automatically detect file extension if missing
* spat5.sfplay~ : added @mc attribute
* spat5.grids : added new grids
* added spat5.simone.generator
* spat5.simone : added "/cell/[index]/angle/add" message
* added spat5.quat.fromvectors
* added spat5.sf.resample, spat5.sf.merge
* all GUI objects : fix possible issues with full screen mode
* spat5.doppler~ : added "/soundvelocity" message
* added spat5.rake~
* all DSP objects : fix @mc attribute when operating in a standalone
* spat5.panoramix : optimized GUI repaint
* spat5.oper, spat5.viewer : fix possible crash with invalid osc patterns

* spat5.cross3~ : fix possible crash with high order filters
* spat5.panoramix : added pitch and roll rotation to A-format, B-format, and Eigenmike tracks
* all GUI objects : added "/window/opaque" and "/window/titlebar" messages
* added spat5.hoa.warp~ : warping in the HOA domain
* spat5.panoramix : changed the default metering mode to "peak" instead of "rms" (for efficiency)
* spat5.panoramix : monitoring track is now muted by default (for efficiency)
* spat5.spat~ : minor cpu improvement
* added spat5.hoa.zm1~
* upgraded to juce 5.4.3
* spat5.panoramix : added menu to delete unused tracks/bus
* spat5.panoramix : when a file (sofa, sdif, etc.) cannot be found, try to fold back to another directory
* spat5.panoramix : added zylia track
* spat5.speaker.layout : added new layouts
* spat5.equalizer, spat5.filterdesign : improved filter stability (especially for higher orders)
* spat5.panoramix : added mute button for reverb send on eigenmike tracks
* spat5.sfplay~ : fix bug when @mc 1 (no output signal if second outlet not connected)
* spat5.panoramix : fix spurious error with "/backgroundimage" messages
* spat5.meter~, spat5.spectroscope~ : added @mc attribute
* spat5.osc.midimap : fix bug when reloading a xml file with duplicated entries
* spat5.hoa.scope~ : added @mc attribute
* spat5.panoramix : added "/options/clearsolo" message
* added spat5.cascade.resample


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Release Version :   5.0.9
Release Date    :   01/2019


* spat5.panoramix : improved allrad decoding
* spat5.panoramix~ : minor optimization
* spat5.decoder~, spat5.hoa.decoder~, spat5.panoramix~ : optimized dual-band HOA decoding
* spat5.pan~ : added dual-band vector-base panning (dualbandvbp). See help patcher
* spat5.wfs.config : added warning for non consistent speaker layout
* spat5.pan~ : improved error and warning messages
* spat5.spat~ : fix spurious error messages when switching from 2D to 3D HOA
* spat5.panoramix : fix minor memory leak
* all objects : fix possible crash (thread-safe issue)
* spat5.panoramix : improved "/session/delete/byaddress" message
* spat5.pan~, spat5.panoramix~, spat5.spat~, spat5.pan : added LBAP, layer-based amplitude panning
* spat5.panoramix : major optimization of preset loading time (and track/bus addition or deletion)
* spat5.panoramix : added new global settings
* spat5.panoramix : vumeter refresh rate is now stored with preset
* spat5.viewer : changed "/backgroundimage/xoffset" to "/backgroundimage/offset/x", for consistency (minor compatibility break)
* spat5.panoramix~ : significant CPU optimization (signal routing)
* spat5.panoramix, spat5.hoa.decoder~, etc : added allrad+ ambisonic decoder
* spat5.panoramix, spat5.hoa.decoder~, etc : added mvlad ambisonic decoder
* spat5.hoa.decoder~ improved warning and error messages
* spat5.hoa.encoder~, spat5.panoramix~, spat5.spat~ : cpu optimization for HOA encoding
* spat5.sfplay~ : now outputs the list of AIFF markers upon loading a file
* spat5.oper : fix initialization bug with omni/room filter
* spat5.knn : fix various bugs and crashes
* spat5.panoramix : Monitoring, Master, and Options strips can now be renamed
* spat5.viewer : added "/source/[index]/mute" message
* spat5.reverb~, spat5.panoramix: fix default delays when @channels > 8
* spat5.viewer, spat5.oper : added "/source/[index]/radius/visible" message
* spat5.viewer, spat5.oper : added "/source/[index]/orientation/mode" message
* spat5.quat.toeuler, spat5.quat.fromeuler : added @initwith attribute
* upgraded to juce 5.4.1
* fixed @embed attribute for spat5.*.embedded objects
* spat5.frequencyresponse, spat5.hlshelf, etc. : added "/xtick/color", "/ytick/color" messages
* spat5.frequencyresponse : added "/xtick/position" message (cf help patcher)
* spat5.frequencyresponse : added "/marker" messages (cf help patcher)
* spat5.osc.unslashify : fix bug with FullPacket
* spat5.oper : added "/spread" message and knob

* spat5.oper : added mute/bypass for axis/omni filters
* @initwith, @embed, @mc attributes now appear in the inspector (but cannot be edited)
* all GUI objects : added "/window/hidesondeactivate" for application-wide floating windows
* spat5.viewer : added "/source/1/history" messages (cf help patcher)
* added spat5.hoa.beam, spat5.hoa.beam~, spat5.hoa.beam.embedded (experimental)
* all GUI objects : the "/window" messages are now stored with the object state
* all GUI objects : the @embed attribute can now be dynamically changed
* all *.embedded objects : added "/status" and "/help" messages
* all *.embedded objects : fixed possible memory leak
* AVX extensions are now required for spat5 on macOS
* spat5.osc.append, spat5.osc.prepend : cpu optimization + improved thread-safety
* spat5.hoa.em32~ : fix possible crash when changing "/mode"
* added spat5.sf.split : audio file splitter
* all DSP objects : fix possible crash in Ableton Live
* spat5.osc.udpreceive : added "disconnect" and "reconnect" messages
* all DSP objects : improved inlets/outlets description when @mc = 1


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Release Version :   5.0.8
Release Date    :   10/2018


* spat5.grids : added "/project/tocube" message (cf help patch)
* spat5.viewer : "/backgroundimage" now searches in Max paths
* spat5.grids : added new types of grids
* spat5.panoramix : fix possible crash with WFS bus
* most objects : better parsing of OSC coordinate messages
* spat5.panoramix~ : improved error messages with invalid WFS files
* spat5.air~ : fix OSC messages improperly processed
* spat5.doppler~ : fix OSC messages improperly processed
* spat5.oper : fix issue with OpenGL rendering engine
* added spat5.random.poly.maxpat
* spat5.osc.replace : added @tautological attribute + improved help patcher
* spat5.pan~, spat5.spat~, spat5.panoramix~ : fix bug with KNN panning (gain normalization)
* spat5.panoramix : added stereo tracks
* spat5.wfs.config : min distance is now 1m
* spat5.osc.unslashify : fix possible type issue with OSC pattern starting with int
* spat5.oper, spat5.viewer : fix spurious error message with /backgroundimage
* spat5.oper : /roomsize is now an alias for /room/size
* spat5.panoramix : added @embed attribute
* spat5.folder.infos : added "/sort" message
* improved overview patcher
* fixed @mc not working on Windows
* spat5.panoramix : fix several bugs (e.g. bformat tracks)
* spat5.viewer, spat5.oper, etc : added "/source/[index]/tofront", "/source/[index]/toback" messages
to change the z-order of the element, and ease the mouse selection
* spat5.panoramix~ : fix possible bug(s) with Eigenmike track
* spat5.panoramix : faster preset loading time
* spat5.panoramix : added "/track/[index]/tofront", "/track/[index]/toback" messages
* spat5.panoramix : track color can now be changed on the fly
* spat5.clip~ : fix OSC parsing
* spat5.gammatone : fix spurious error messages
* spat5.spat~ : minor improvement to the /parallel mode
* spat5.spat~ : added "/phantom/nadir", "/phantom/zenith" messages


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Release Version :   5.0.7
Release Date    :   09/2018


* spat5.osc.udpsend, spat5.osc.udpreceive : fix bug when the objects were eating all cpu
* spat5.panoramix : fix "Angular2D" shown twice in the bus creation menu
* spat5.viewer : added viewpoint selection to the settings panel
* added spat5.gopro.decode : decode UDP packets from GoPro VR Player (Kolor)
* spat5.osc.speedlim : now works with osc bundles

* spat5.calibrate.gain~ : added /db suffix to output messages (minor compatibility break)
* spat5.spat~ : doppler is now off by default (in agreement with spat5.oper) (minor compatibility break)
* spat5.matrix : now ready to be used
* added spat5.matrix~
* all GUI: /window/scale now expressed in %  (minor compatibility break)
* spat5.scale : can now operate on bundles
* spat5.converb~ : fix spurious error messages (/dsp/mute, /dsp/bypass)
* all objects : improved @initwith parsing and processing
* all objects : fix attributes auto-completion
* spat5.panoramix~ : minor cpu improvements
* spat5.panoramix : input and bus routing can be edited on the fly
* panoramix : improved osc parsing for routing messages
* spat5.adm.room~ : fix duplicate messages in OSC status bundle
* spat5.meter~ : added fader; added option to disable rms filters
* spat5.smk~ : fix issues when interrupting a measurement
* added spat5.ir.infos
* added spat5.ir.analysis
* added spat5.hybrid~ (experimental)
* added spat5.eq
* spat5.filterdesign : fix bugs with chebyshev-2, and improved overall filter stability
* spat5.oper : fix possible memory leak
* spat5.oper : added "/style" message to display acoustical criteria / perceptual factors
* spat5.viewer (and others) : added /azimdist message to set azimuth and distance
* spat5.viewer (and others) : improved error messages
* documentation : fixing several spelling mistakes
* spat5.osc.view (and others) : avoid possible crash with corrupted FullPacket
* spat5.conv~ : added @inputs attribute (i.e. extension to multiple IRs)
* spat5.osc.slashify : fix potential crash
* spat5.panoramix~ : fix bug when reloading preset with WFS bus (source positions not recalled)
* spat5.panoramix : added rms/peak option for vu-meters
* spat5.panoramix : vu-meters options can now be modified on the fly
* added spat5.whichthread : for debug purpose
* spat5.panoramix : vbap2D bus can now work in mono
* spat5.panoramix : added bus send ’E’ and ’F’ (but not visible in the GUI)
* spat5.oper : fix bug with "/format" message
* spat5.panoramix : fix bug with "move" track interface
* spat5.panoramix : fix subtile and rare threading issue (possible crash)
* spat5.panoramix~ : fix possible crash when loudspeakers are coincident
* spat5.panoramix : added "/session" messages to create/delete track or bus
* spat5.file.infos : added "/reveal" message
* spat5.panoramix : added "Reveal" button to show the current preset file in Finder
* added : spat5.compressor.embedded, spat5.eq.embedded, spat5.equalizer.embedded, spat5.filterdesign.embedded,
spat5.graphiceq.embedded, spat5.hlshelf.embedded, spat5.hoa.display.embedded, spat5.hoa.focus.embedded,
spat5.hoa.metrics.embedded, spat5.ircamverb.embedded, spat5.matrix.embedded, spat5.oper.embedded,
spat5.routing.embedded, spat5.sofa.loader.embedded, spat5.speaker.config.embedded, spat5.vbap.metrics.embedded,
spat5.viewer.embedded, spat5.zplane.embedded


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Release Version :   5.0.6
Release Date    :   06/2018

* added Spat5-ReferencePages.pdf
* spat5.align~ : clarified reference page
* spat5.osc.replace : added @initwith attribute
* improved many help patchers and reference pages
* all objects : minor optimization when parsing OSC messages
* added spat5.osc.pak
* added spat5.osc.pack
* added spat5.osc.unique
* added spat5.osc.queue
* spat5.pan~ : increased maximum ramp time
* spat5.transpan~ : fix duplicate messages in status bundle; renamed a few OSC messages for clarity
* spat5.sfplay~ : now supports sony wave64 (w64) file format

* spat5.reverb~, spat5.early~, spat5.cluster~ : added "/channel/[index]/delay" messages
* spat5.sfrecord~ : added "/record/samples" message
* spat5.ircamverb~ : fix benign error messages
* spat5.leslie~ : fix bug (spatialization not working)
* several objects : increased the max number of speakers (from 128 to 250)
* all DSP objects : increased maximum number of inlets/outlets (Max8 only)
* vbap / vbip : added option to insert phantom speaker at the zenith and/or nadir
* vbap / vbip : added new triangulation mode (more robust) (see spat5.pan~ help patcher)
this affects : spat5.pan, spat5.pan~, spat5.spat~, spat5.panoramix~, etc.
* spat5.hoa.scope~ : fix colorbar
* added spat5.vbap.metrics
* spat5.panoramix : added option to insert phantom speaker at the zenith and/or nadir (vbap and vbip busses)
* spat5.panoramix : /bus/[index]/delay/bypass and /bus/[index]/spread/bypass properly stored in presets
* snapshots : fix keyboard focus issues
* spat5.hoa.metrics : added "/speakers/label/color" message
* spat5.panoramix : added tooltip bubbles in routing matrix
* spat5.panoramix : fix minor display issues when resizing window
* spat5.panoramix : fix bug with /monitoring and /d2m routing window refresh


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Release Version :   5.0.5
Release Date    :   06/2018

* spat5.transform : can now deliver bundles, for efficiency
* added spat5.barycenter
* spat5.panoramix : added "/monitoring/listener/ypr" message
* spat5.panoramix : added "/bus/[index]/orientation" message (for HOA bus)
* spat5.panoramix : added "/bus/[index]/ypr" message (for HOA bus)
* spat5.panoramix, spat5.hoa.focus : minor cpu optimizations
* all objects : minor optimization when parsing OSC messages


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Release Version :   5.0.4
Release Date    :   05/2018

* added spat5.isnan~
* added spat5.cascade.inverse
* spat5.hoa.scope~ : added new colormap schemes
* spat5.grids : added list output
* added spat5.fton, spat5.ntof
* spat5.osc.view, spat5.osc.display : added font size attribute
* spat5.oper : fix issues with /source/*/solo message
* spat5.oper : tab names follow source names
* spat5.smk~ : added waterfall plot matlab scripts
* spat5.osc.replace : can now operate on bundles
* spat5.viewer : added /grid/thickness message
* spat5.viewer : /proportion and /zoom now express as percentage. warning: might break compatibility
* spat5.viewer : renamed /display/offsetx to /display/offset/x
* spat5.viewer : added /legend/unit message
* spat5.viewer : added settings panel (/settings/editable [boolean], /settings/visible [boolean])
* spat5.panoramix : added /early/gains and /early/delays messages for Mono and Multi tracks
* spat5.panoramix : avoid possible crash when @inlets and @outlets are not consistent
* all GUI objects : added workaround for pattr support. see spat5.tuto-osc-2
* spat5.panoramix : fix bug with /bus/B/mute message


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Release Version :   5.0.3
Release Date    :   05/2018

* spat5.viewer : added "/layout auto" --> automatically update according to the loudspeaker positions
* spat5.oper : fix bug with /axis or /omni messages (missing notifications)
* spat5.oper_ : fix spurious error messages
* spat5.oper_ : added @internals attribute

```
* added spat5.printbytes : low-level debugging of FullPacket
* spat5.smk~ : minor improvement in exported matlab scripts; added option for repeated measurement
* spat5.file.infos : fix /launch message on Windows
* minor improvements to the help patchers


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Release Version :   5.0.2
Release Date    :   05/2018


* all objects : improved error messages
* spat5.pan~ : added documentation about binaural geometrical models
* added spat5.hoa.binaural~ : transcodes HOA stream to binaural (experimental)
* all objects : fix issues with utf8 characters
* ADM renderer : added output routing matrix
* spat5.speaker.config : minor improvements
* ADM renderer : fix mute/solo for multi programs ADM files
* panoramix : added b-format track
* vbap, vbip, allrad : improved triplet visibility tests
* spat5.panoramix~ : fix HOA focus and HOA blur bypass not working
* spat5.hoa.aformat~ : added high-cut filter; minor improvements
* spat5.osc.slashify : minor change for list of symbols
* added new ambisonics tutorials
* spat5.panoramix : now supports OSC messages /layout, /grid, /display, etc. to tweak the viewer window
* spat5.pan, spat5.pan~ : added divergence option (experimental): automatic spread for source close to the origin
* added tutorial for compatibility with AmbiX, ICST, HoaLibrary
* spat5.panoramix : fix bug with /set/track messages
* spat5.panoramix : added some touch messages (experimental)
* spat5.hoa.focus, spat5.panoramix : double-click now resets the selected beam to default
* spat5.hoa.em32~, spat5.panoramix~ : fix issue with method 4 encoding
* spat5.osc.print : added optional timetag
* spat5.viewer : added several options for areas' display (border color, fill color, thickness, etc.)
* added spat5.constraint : apply constraints to coordinate messages
* spat5.panoramix : fix issues with bypass of delays
* spat5.panoramix, spat5.sofa.loader : fix refresh of HRTF list not working
* panoramix : added a-format track
* spat5.osc.record~ : fix strange bug with incoming time signal
* spat5.osc.record~ : fix crash when inserting OSC bundles
* spat5.osc.record~, spat5.osc.play~ : added message "/memory/clear time1 time2", and "/memory/offset"
* spat5.frequencyresponse : added load message; improved resolution
* spat5.panoramix : fix tiny issue with output vumeter visibility
* spat5.panoramix : increased maximum reverb time
* spat5.filterdesign, spat5.equalizer, spat5.panoramix : improved filter stability
* added spat5.hoa.metrics : compute and display metrics for HOA decoders
* spat5.osc.trim : added option to trim end of pattern
* added spat5.hoa.scope~ : RMS metering for HOA 2D/3D sound-field (cpu intensive...)
* spat5.spat~ : improved error messages
* spat5.oper : fix several critical bugs
* spat5.wfs.config : increased maximum distance
* spat5.panoramix, spat5.panoramix~ : lot of internal refactoring
* spat5.adm.play~, spat5.adm.renderer~ : fix several issues with jumpPosition and interpolationLength
* added spat5.distance : compute distances and angles between sources and speakers
* spat5.filterdesign : fix possible crash
* spat5.panoramix~ : fix bug with routing of Monitoring strip
* spat5.smk~ : added /stop message
* spat5.decorrelate~: fix bug when changing /allpass/number
* spat5.decorrelate~: power normalization instead of amplitude normalization of filters
* spat5.hoa.metrics : fix minor bug with energy vector
* updated User Manual PDF
* spat5.panoramix : display speaker positions per bus
* spat5.viewer : added hoa fields
* spat5.spat~ : added several missing parameters for pan (/spread, /divergence, /neighbors, etc.)
* spat5.hoa.rotate~ : fix bug with quaternions
* added spat5.hrtf.infos
```

```
* spat5.smk~ : many improvements and new abstraction patchers
* spat5.panoramix : store additional viewer attributes in presets


================================================================================
Release Version :   5.0.1
Release Date    :   03/2018


* spat5.sfrecord~ : fix possible scheduling issue with /record message
* spat5.sfplay~ : fix possible scheduling issue with /start and /stop messages
* all objects with /open message: fix possible utf8 encoding issue with file path
* all objects with /open message: fix possible issues with file path like "Macintosh HD:/Users/etc"
* added spat5.version
* added documentation for B-format and UHJ processing
* added new abstraction patchers for TransPan
* spat5.wfs.config : now export areas containing virtual grid
* ADM : fix issue with Cartesian flag
* spat5.panoramix~, spat5.hoa.compensation~ : fix possible overload/NaN with allrad decoder
* spat5.spat~ : added "/parallel [boolean]" message
* spat5.adm.play~ : supports ADM files with multiple audioProgrammes. Updated patchers.
* spat5.panoramix~ : fix bug with /channel/*/gain/db messages for Multi tracks
* spat5.panoramix~ : fix crash with Multi tracks
* spat5.binaural~, spat5.pan~, spat5.panoramix~ : fix major bug with binaural processing


================================================================================
Release Version :   5.0.0
Release Date    :   03/2018


* panoramix : fix possible crash with Multi tracks
* spat5.osc.udpsend : don't use type int64 for backward compatibility with Max udpreceive
* spat5.decorrelate~ : fix seed issue
* spat5.decorrelate~ : added /export option; added /truncate option
* spat5.hoa.decoder~ : added /export option
* spat5.wfs : added /delay/scaling option
* spat5.calibrate.gain~ : added option for pink noise
* spat5.osc.udpreceive : fix possible crash when many instances are used at once
* all @numsomething attributes renamed @something (for simplicity and clarity).
e.g. @numchannels --> @channels
You'll need to update your patchers accordingly!
* improved error messages
* spat5.oper : fix many missing messages
* spat5.oper : added early shape
* spat5.smk~ pretty much finalized; new display of results
* spat5.viewer : added 'emphasis' option (emphasize sources when close to the mouse)
* spat5.oper : fix issues with air and infinite messages
* all: improved help patchers and reference pages
* spat5.hlshelf : added mute button
* spat5.plot : added bar mode
* added spat5.edc
* added spat5.hoa.aformat~
* spat5.osc.view : added shortcut (cmd+c) for copy to clipboard
* spat5.ircamverb : added independent mute button for each section
* spat5.osc.fromdict : fix possible crash
* spat5.converter : now works with OSC bundles
* spat5.transform : pass through all unprocessed messages
* spat5.spat~, spat5.oper : fix doppler effect
* spat5.cpu : fix possible crash
* changed a couple of OSC messages here and there;
hopefully that should not break compatibility with previous versions.
* spat5.wfs~ : fix error messages in help patcher
* spat5.osc.view : fix possible crash
* spat5.osc.display : fix possible crash
* spat5.panoramix~ : fixed possible crash with VBAP 3D bus when the loudspeaker setup happens to be planar.
* spat5.panoramix~ : added delay parameter on each bus
```

* spat5.panoramix~ : added listener rotation on binaural bus
* spat5.panoramix~ : improved HRTF management
* spat5.panoramix : added annotations to the OSC preset
* spat5.panoramix, spat5.panoramix~ : fix major bug with track number >= 10
* spat5.panoramix, spat5.panoramix~ : added HOA2D bus, VBIP3D and VBIP2D bus
* renamed all objects spat5 to avoid clash with previous versions
* added spat.osc.unslashify : break the osc pattern

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This manual originally was written by Jean-Marc Jot (under the editorial responsibility of Marc Battier).

Design of digital signal processing algorithms, overall architecture, and original implementation: Jean-Marc Jot.

Objective and perceptual characterization of room acoustical quality: Jean-Pascal Jullien, Eckhard Kahle, Olivier Warusfel.

Additional contributions: Véronique Larcher (binaural), Markus Noisternig (higher-order Ambisonic).

Design & Development of spat5: Acoustics & Cognition Research Group, UMR 9912 STMS Ircam–CNRS–Sorbonne Université.

Thanks: Gérard Assayag, Alexis Baskind, Georges Bloch, Xavier Chabot, Etienne Corteel, Eric Daubresse, Gerhard Eckel, Serge Lemouton, Martine Marin, Laurent Pottier, Leslie Stuck, and Zack Settel for instructive discussions and advice.

First English Edition of the documentation, March 1995.
Updated October 2006 by Terence Caulkins.
Updated October 2017 by Rama Gottfried.
Updated March 26, 2025.


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For additional information concerning subscriptions to the Forum, contact:
Paola Palumbo
Département des Interfaces Recherche / Création, Ircam
1, Place Igor-Stravinsky, 75004 Paris, France
Phone (33) (1) 44 78 48 43
General Fax (33) (1) 44 78 15 40
Email: mailto:Paola.Palumbo@ircam.fr

Send comments or suggestions to:
Karim Haddad
Département des Interfaces Recherche / Création, Ircam
1, Place Igor-Stravinsky, 75004 Paris, France
Phone:(33) (1) 44 78 16 05
Email: mailto:Karim.Haddad@ircam.fr

You may also email support requests (bug reports, requests for features..) to :
Olivier Warusfel
Acoustic and Cognition Research Team, Ircam
1, Place Igor-Stravinsky, 75004 Paris, France
Email: mailto:Olivier.Warusfel@ircam.fr

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zlib.h – interface of the 'zlib' general purpose compression library
version 1.2.11, January 15th, 2017

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Jean-loup Gailly; Mark Adler
jloup@gzip.org; madler@alumni.caltech.edu

## libcurl

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The "subscription type" is an Ircam product. It allows the user to enjoy certain benefits for a period of one year. The "Free" subscription allows the use of the software of the Forum under the "Free license" (see Article 4) of this contract, for a period of one year. It is the default use contract for IRCAM software, applicable as soon as an account is created on the forum.ircam.fr website. Subscriptions "Premium individual" and "Premium student" allow the use of the software of the Forum under the declination "Pro license" (see Article 4) of this contract for a period of one year. The institutional subscription allows the use of the Forum software under the "Academic license" (see Article 4) of this contract, for a period of one year.

### Article 2 – Forum Software

The IRCAM Forum offer includes all IRCAM software programs that can be downloaded from the ForumNet website, be they free or of charge.

This agreement applies to all IRCAM Forum software programs acquired by the user as of the date of purchase and/or download during the period of maintenance and service. In this agreement, both the terms "Software" and "Forum Software" refer to all IRCAM Forum software programs.

### Article 3 – Maintenance and Services

You are granted a one-year license to use the aforementioned software as a part of your IRCAM Forum membership. Past this date, you must renew your membership according to the terms in Section III. The Forum's objective is to develop a large community of computer music software users by offering tools and services and promoting dialogues among these users (social website, Forum workshops, etc.).

Forum members are encouraged to share the applications they create with the software.

## II – Permitted and licensed uses

### Article 4 – Software use domain

The IRCAM Forum software license is subject to the following variants according to the "subscription type" (see article 1).

**Free license:**

This license allows individual non-profit use for research, experimentation and artistic, non-commercial purposes. The subscription of a free account on the site forum.ircam.fr entails the direct application of this license of use on the set of the software having no other specific license.

**Pro license:**

This license allows individual use in a professional context during a public exhibition: public event, concert, exhibition, art installation, conference, exhibition, presentation, performance, publication; for non-commercial purposes. The "individual" and "student" Premium subscription entitles its holder to use software provided by IRCAM, as well as exclusive access to Premium technologies for four computer stations.

**Academic License:**

This license allows a group to a non-commercial internal professional use: educational program, training, school, university, conservatory, research and development laboratory, business, product development, startup, recording studio, music production studio; for non-commercial purposes. The "institutional" premium subscription entitles its holder to use the software provided by IRCAM, as well as the exclusive access to premium technologies for twenty computer stations owned by the organization and for use in the strict framework of its educational activities.

**Commercial license:**

Outside these areas, developments or services using Ircam software or the redistribution of Ircam software are subject to a specific authorization or license from IRCAM.

## Article 5 – Ownership and Commercial Distribution

All software programs, elements of any software programs, and documents copyrighted by IRCAM and distributed via the IRCAM Forum remain the property of IRCAM. These software programs cannot be rented, sold, or exchanged without prior consent from IRCAM.

## Article 6 – Copyright

The user is not authorized to modify or remove the names of the authors or the IRCAM copyright or the names of members present in any programs or documentation. The user is required to cite IRCAM during any presentation of any IRCAM software programs or their extensions.

## Article 7 – Disclaimer of Warranty

The software programs provided by IRCAM Forum are provided without warranties of any kind. IRCAM disclaims all warranties, express or implied. In no event will IRCAM be liable for damages, including any general, special, incidental or consequential damages arising out of the use or inability to use the program The entire risk as to the quality and performance of the program is with the user.

## Article 8 – Unauthorized Editions

Any independent development of IRCAM software programs that consist of a reproduction of a software program, or an element of any IRCAM software program will be considered counterfeit and any commercial distribution of any counterfeit version(s) will be considered an act of plagiarism.

## Article 9 – Cession

It is forbidden to copy any of the software programs provided to you by IRCAM, except for personal use. In this case, one copy of the software program(s) may be made.

## Article 10 – Legal Identity

An "individual" membership is provided only to a user that certifies that the IRCAM Forum software programs will be used only on his/her personal computer. You guarantee the precision of the information provided on your registration form. All registrations paid by an organization will pay the "organization" membership fee.

## Article 11 – Termination

This Agreement is effective until terminated. This Agreement will terminate immediately with notice from IRCAM if you fail to comply with any provision of this Agreement.

# III – Maintenance and Service

## Article 12 – Definition of Provisions of Services

### 12.1 Software Programs – Documentation – Technical Support

Beginning on the date of your membership, you will receive, for twelve months, software programs and documentation developed by IRCAM. These software programs are protected by a personal code (necessary for downloading and installing the software programs). This code is personal and may not be given to a third party.

Unless you renew your membership, when your one-year membership period expires, you no longer have access to the IRCAM Forum services or software programs. You do maintain, however, the right to use the elements received during your membership.

Once the one-year subscription date has passed, the software remains active and usable. However, IRCAM is not responsible of the loss of the authorization in the case of machine or HD change. In this case the subscriber is invited to renew their subscription to take advantage of any technical support (updates, forum-support, etc.)

### 12.2 Exchanges – Training – Information

User subscribed to Premium Forum enjoys a reduced price to IRCAM Forum Workshops (Paris and hors les murs), and also entitled to a discount on IRCAM training programs held by the IRCAM department of education and cultural outreach.

### 12.3 Additional Services – Discounts

You are entitled to discounts on tickets for the IRCAM concert season and the annual IRCAM ManiFeste Festival as well as free access to the IRCAM multimedia library.

## Article 13 – Domains of Use of Applications

The applications created by an IRCAM Forum member and made available to other Forum members can be used free of charge by IRCAM or by other IRCAM Forum members in the domains of research, teaching and educational activities, and musical production. Any use of the applications created by an IRCAM Forum member in any other domain, or any commercial distribution or redistribution of these applications requires authorization.

## Article 14 – Members' Obligations

### 14.1 Relations With IRCAM

You can propose developments to the IRCAM Forum team that will communicate these ideas to the development groups at IRCAM. IRCAM can distribute your developments as are, without any support. IRCAM can also decide, with your accord, to further develop your developments and to assure the documentation and support. IRCAM cannot guarantee the finalization of the developments proposed by users.

### 14.2 Relations with Other IRCAM Forum Members

IRCAM Forum members are encouraged to share their developments among themselves. These developments should be made known to IRCAM who will then pass them along to other IRCAM Forum members. You remain owner of the applications you have created. These applications, like all IRCAM software programs, may be used by IRCAM or by IRCAM Forum members only in the domains of research, teaching and educational activities, and musical production.

The user releases IRCAM from any appeals or actions that could arise (notably acts of infringement, eviction, personality rights, and image rights) on any basis for any author or copyright holder, performer or producer of pre-existing works, notably musical, intellectual, or graphical works, connected to the production of these applications or educational supports.

### 14.3 Responsibility for Publications in the Forum

ForumNet/IRCAM offers the possibility of writing articles and news, publishing events, videos, sharing critiques and commentaries in discussion groups. Users grant the right to IRCAM to publish these comments in any support, in any language, worldwide. It is understood that users' comments are written free of charge and IRCAM can use them free of charge.

Hence, you represent and warrant that you own all rights concerning the reproduction of medias used and release IRCAM from any unspecified claim by a third person, in particular concerning any and all copyrights.

## Article 15 – Ownership and Commercial Distribution

The extensions or developments you carry out on any IRCAM software programs remain your property, whether or not they were carried out with the assistance of IRCAM.

### Article 16 – Confidentiality and Exchanges of Information

You may not reveal or share any information marked "confidential" distributed by IRCAM. You authorize IRCAM to share your personal contact information with other IRCAM Forum members. IRCAM is not authorized to share your personal contact information with any other person or organization in accordance with the rules and regulations of the Commission Nationale de l'Informatique et des Libertés (CNIL), an independent French administrative authority whose mission is to ensure that data privacy law is applied to the collection, storage, and use of personal data.

### Article 17 – Term and Termination

Your membership to the IRCAM Forum is valid for twelve months beginning with your date of registration. If you choose not to renew your membership, or you cancel your membership, you loose all rights acquired during your membership although the conditions defined in articles 4, 5, 6, 7, 8, and 9 remain unchanged.

### Article 18 – Membership Fees

Membership fees and conditions may be revised at any time. Membership fees are identical in France and abroad.

## IV – IRCAM Forum Free Freeware License Agreement

### Article 19 – Conditions for Distribution and Use

The software programs covered by this Agreement are distributed in binary form only and are accompanied by examples. The user is free to create their own non-commercial applications for scientific research, educational activities, and musical production.

Any applications that result in a commercial product or service require separate written Agreement with IRCAM

The articles 4, 5, 6, and 7 apply to the Software Programs found in the Forum Free Package.

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