

Penumbra

LIVE GRANULAR PROCESSOR

The half-shadow between sound and texture

Version 1.5 — User Manual

by Apophenia

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1. Introduction

Penumbra is a real-time granular processor (VST3) that continuously captures incoming audio into a circular buffer and scatters it back as overlapping grains — tiny windowed slices of the recorded sound. By controlling grain size, density, position, pitch, and spread, you can transform any incoming signal into evolving textures, lush pads, rhythmic stutters, or impossible atmospheres.

The plugin combines a live grain engine with two tempo-syncable LFOs, an envelope follower, a built-in stereo delay and reverb, MIDI triggering, burst mode, an interactive XY pad, and a motion recorder that captures and replays your XY gestures. Everything is designed to run in real time without pre-loading samples — whatever you feed it becomes the material.

Key Features

- Live grain capture (no sample loading) with 0.1–30 second buffer
- Polyphonic grain scheduler with up to dozens of simultaneous overlapping grains
- Four window shapes (Hann, Triangle, Trapezoid, Blackman)
- Pitch shift ± 24 semitones with optional musical-scale quantization
- Per-grain filter (low-pass / high-pass) with separate “grain filter” tone
- Freeze + Reverse + Feedback for sustained textures and self-oscillation
- Two LFOs with five shapes and DAW tempo sync, each routed to your choice of destination
- Envelope follower with five routing destinations
- Built-in stereo delay (with ping-pong) and reverb
- MIDI note trigger with velocity sensitivity
- Burst mode (fires 2–8 grains per trigger for stuttered hits)
- Interactive XY pad with motion recording and playback
- Real-time waveform display showing buffer contents and grain positions
- Preset browser, parameter locks for randomization, A/B undo/redo

How Granular Synthesis Works

Penumbra writes incoming audio continuously into a circular buffer of configurable length. A scheduler then triggers short overlapping grains read from anywhere in that buffer. Each grain is shaped by a window function (a smooth envelope that fades it in and out), independently pitched, panned, and filtered, then summed with all the other live grains into the output. By layering many overlapping grains per second — sometimes dense clouds, sometimes sparse fragments — the result ranges from subtle thickening to complete deconstruction of the source.

2. Installation

System Requirements

- Windows 10 or later (64-bit)
- A VST3-compatible DAW (Bitwig, Ableton Live, FL Studio, Reaper, Cubase, Studio One, etc.)
- 4 GB RAM minimum
- Intel / AMD x64 processor (SSE4.2+)

Install Steps

1. Close your DAW.
2. Copy **Penumbra.vst3** to your VST3 plugin folder (typically `C:\Program Files\Common Files\VST3` or your custom VST3 path).
3. Restart your DAW — it should rescan and detect Penumbra under the *Apophenia* manufacturer.
4. Insert Penumbra as an effect on an audio track or bus.

NOTE Penumbra is a stereo effect plugin. It does not require a sidechain input — all granular processing operates on the main input bus. To use it as a sound generator, feed it a sample, drum loop, or any audio source and tweak from there.

3. Quick Start

Five steps to hear Penumbra in action:

1. Insert Penumbra on a track containing audio (a pad, drum loop, vocal, anything sustained works best).
2. Set **Dry/Wet** to around 60–80% so you hear plenty of the granular signal.
3. Hit play. You should hear granular streams — if not, turn **Grain Density** up.
4. Sweep **Position** from left to right — you are scrubbing through the live buffer.
5. Push **Pitch Random** up to about 6–12 semitones for evolving texture.

TIP For long, evolving pads, enable **Freeze**. Penumbra stops writing new audio to the buffer and infinitely loops the frozen material — perfect for capturing a moment and sustaining it indefinitely while you sculpt with the other controls.

4. Interface Overview

Penumbra's interface is organized into functional sections, each grouping related controls. The top of the window shows the plugin name, version, and global status indicators (Freeze, MIDI, Delay, etc.).

Section Layout

- **Header** — plugin name, version, preset browser, A/B, undo, randomize, menu.
- **Waveform Display** — live buffer contents with current grain positions overlaid.
- **Grain Engine** — size, density, position, position random, stereo spread.
- **Pitch** — pitch shift, pitch random, scale quantization.
- **Tone** — filter cutoff, filter type, window shape, grain filter.
- **Modulation** — LFO 1, LFO 2, envelope follower.
- **FX** — delay, reverb.
- **XY Pad** — two-axis controller with motion recording.
- **Output** — dry/wet, output gain, input gain, stereo width, peak meters.
- **Status Bar** — hovered-control tooltip and active mod indicators.

Signal Flow

```
INPUT → CIRCULAR BUFFER → GRAIN SCHEDULER →  
PITCH SHIFT → WINDOW → GRAIN FILTER → SUM →  
FEEDBACK → GLOBAL FILTER → DELAY → REVERB → DRY/WET → OUTPUT
```

5. Parameter Reference

All controls support right-click for context menu (set default, enter value, lock from randomize). Hover any control to see its current value and a brief description in the status bar.

5.1 Grain Engine

Grain Engine CORE

The heart of Penumbra. These controls shape how grains are sliced and scheduled.

- **Grain Size** (10–500 ms) — length of each individual grain. Shorter sizes (<30 ms) produce buzzy, pitched textures; medium sizes (50–150 ms) give smooth pad-like flow; long sizes (200–500 ms) feel like a slow tape echo.
- **Grain Density** (1–50 grains/sec) — how many grains the scheduler fires per second. Low density = sparse glitchy fragments; high density = continuous wash.
- **Stereo Spread** (0–100%) — randomizes each grain's pan position across the stereo field. At 0% all grains stay center; at 100% they scatter fully L/R.

5.2 Buffer & Position

Buffer & Position READ-HEAD

- **Buffer Length** (0.1–30 s) — size of the circular capture buffer. Short buffers loop fast (tight stutters); long buffers store more material for variety.
- **Position** (0–100%) — the central read-head position within the buffer. 0% = oldest stored sample, 100% = newest (the live edge).
- **Position Random** (0–100%) — random offset added to the read position per grain. Higher values scatter grains across the buffer for chaotic textures.

5.3 Pitch & Quantization

Pitch TUNING

- **Pitch Shift** (± 24 semitones) — constant pitch offset applied to every grain.
- **Pitch Random** (0–24 semitones) — random pitch variation per grain. Combine with Pitch Scale for musical results.
- **Pitch Scale** — quantize randomized pitches to a musical scale: *Off, Chromatic, Major, Minor, Pentatonic, Blues, Whole Tone*. With Off the pitch is continuous; with a scale, randoms snap to the nearest scale degree.

5.4 Window & Filter

Window Shape TONE

The envelope applied to each grain. Different shapes give different timbres:

- **Hann** — smooth raised cosine. The cleanest, most musical default.
- **Triangle** — linear fade-in/out. Slightly brighter, more attack.
- **Trapezoid** — flat sustain with fast fades. Most aggressive, can introduce clicks at very small sizes — useful for rhythmic stutters.
- **Blackman** — gentler than Hann, softer attacks. Best for clouds and pads.

Global Filter TONE

- **Filter Cutoff** (20 Hz–20 kHz, log) — cutoff frequency for the post-grain biquad filter.
- **Filter Type** — LP (low-pass) or HP (high-pass).
- **Grain Filter** (0–100%) — per-grain tone shaping applied before the grain is summed. Independent of the global filter.

5.5 Stereo

Stereo Width IMAGE

- **Stereo Width** (0–200%) — final stereo width of the granular output. 0% = mono, 100% = original, 200% = exaggerated mid/side spread.

5.6 Freeze, Reverse, Feedback

Freeze / Reverse / Feedback

SUSTAIN

- **Freeze** — stop writing new audio to the buffer. Grains continue reading from the current contents indefinitely. Essential for capturing a sound moment and sustaining it.
- **Reverse** — play each grain backwards.
- **Feedback** (0–100%) — routes a portion of the granular output back into the input. At higher values the output recirculates and self-evolves; can self-oscillate if pushed too high.

TIP Freeze + high Feedback + slow Position drift creates evolving drone textures that never repeat. Great for ambient beds.

5.7 LFO 1 & 2

LFOs

MODULATION

Two independent low-frequency oscillators. Each has the same controls:

- **Rate** (0.01–20 Hz, log) — LFO frequency in free mode.
- **Sync** — DAW tempo sync division: *Free*, *1/1*, *1/2*, *1/4*, *1/4D*, *1/8*, *1/8D*, *1/16*, *1/16D*, *1/32*. *D* = dotted.
- **Depth** (0–100%) — modulation amount.
- **Shape** — *Sine*, *Tri*, *Saw*, *Sqr*, *S&H*.
- **Target** — routing destination: *Position*, *Size*, *Pitch*, *Filter*, *Spread*.

5.8 Envelope Follower

Envelope Follower

MODULATION

- **Env Follow** (0–100%) — depth of envelope-driven modulation.
- **Env Target** — routing destination: *Filter*, *Pitch*, *Size*, *Spread*, *Dry/Wet*.

The envelope follower tracks the input signal's amplitude and uses it to drive whatever destination you select — e.g., open the filter on louder input, narrow the spread on quiet sections, etc.

5.9 Delay

Stereo Delay TIME

- **Delay Time** (10–2000 ms, log) — delay length.
- **Delay Feedback** (0–95%) — amount of delayed signal fed back in.
- **Delay Mix** (0–100%) — how much delayed signal mixes into the output. At 0 the delay is bypassed.
- **Ping Pong** — bounces the delay between L and R channels.

5.10 Reverb

Reverb SPACE

- **Reverb Decay** (0.1–10 s, log) — RT60 decay time of the reverb tail.
- **Reverb Damping** (0–99%) — high-frequency damping inside the reverb. Higher values = darker tail.
- **Reverb Mix** (0–100%) — how much reverberated signal mixes into the output.

5.11 MIDI Trigger

MIDI Trigger MIDI

- **MIDI Trigger** — when enabled, incoming MIDI notes trigger individual grains (or bursts in Burst Mode) with pitch tracking. Disabled = continuous scheduler runs as normal.
- **Velocity Sens** (0–100%) — how much MIDI velocity scales the grain's amplitude.

5.12 Burst Mode

Burst Mode RHYTHM

- **Burst Mode** — when enabled, each trigger event (from MIDI or scheduler) fires multiple grains in rapid succession instead of one.
- **Burst Count** (2–8) — number of grains per burst.

Useful for stuttered hits, rolled drum textures, or rhythmic granular bursts triggered by MIDI.

5.13 Mix & Output

Output LEVELS

- **Input Gain** (–24 to +12 dB) — gain applied to the incoming signal before it enters the buffer.
- **Dry/Wet** (0–100%) — balance between dry input and granular output.
- **Output Gain** (–24 to +6 dB) — final output trim, applied after the limiter.

A built-in soft limiter sits on the output to protect against clipping when feedback or many overlapping grains push the signal too hot.

6. XY Pad & Motion Recorder

The XY pad gives you simultaneous control over two parameters with mouse or touch. Both axes can be re-assigned via right-click menu on the pad.

Motion Recorder

Below the XY pad, a record button captures your gesture motion. Once recorded, the playback button replays the gesture in a loop, automating the two assigned parameters with whatever timing and shape you played. Useful for hands-free evolving performances or for layering automation that would be tedious to draw.

- **Record** — arms the recorder. Move the XY pad to capture motion.
- **Play** — loops the recorded gesture continuously.
- **Stop** — halts playback and returns to manual control.
- **Clear** — erases the recorded motion.

7. Presets

Penumbra ships with a curated factory preset bank covering pads, textures, stutters, rhythmic grains, ambient drones, and creative experiments. Use the preset browser (header bar) to step through presets with the < and > arrows or select directly from the dropdown.

User Presets

User presets are saved as XML files in `%APPDATA%/Penumbra/Presets/` with the extension `.gfxpreset`. Click **Save** in the preset browser, give your preset a name, and it will appear under the *User* category in the dropdown.

Randomize & Parameter Locks

The **RND** button randomizes most parameters within musically useful ranges. To prevent specific parameters from being randomized, hold `Ctrl` and click any knob to lock/unlock it — locked knobs are marked visually and skipped during randomization.

8. Tips & Tricks

TIP Lush evolving pad

Feed Penumbra a sustained chord. Set Grain Size around 200 ms, Density 15, Position Random 30%, Stereo Spread 60%, Pitch Random 7 st with *Minor* scale quantization. Enable Freeze. Add Reverb Mix 40% and slow LFO 1 on Position. Endless texture from a single chord.

TIP Rhythmic stutters

Feed a drum loop. Grain Size 50 ms, Density 30, Window = Trapezoid, Position Random 5% (tight). Sync LFO 1 to 1/16, route to Position with high depth. The output becomes a beat-synced glitch loop locked to your DAW tempo.

TIP Tape echo emulation

Long Grain Size (350 ms), low Density (3–5), Buffer Length 3 s, Position near 80%, Pitch –1 st, Feedback 30%, Filter cutoff 4 kHz LP. Sounds like a warm degraded tape delay.

TIP Self-oscillating drone

Freeze on, Feedback around 85%, very small Grain Size, low Density. Penumbra will slowly self-evolve into a sustained drone with no original input needed once primed. Use Filter Cutoff and Pitch Shift to sculpt it. **Lower the output gain first** — this can get loud fast.

NOTE Be mindful of CPU at very high Grain Density (40+) combined with long Grain Size — you can easily have 50+ overlapping grains active. If you need to save CPU, lower density or use shorter grains.

A. Appendix: Full Parameter Reference

Grain Engine

PARAMETER	ID	RANGE	DEFAULT
Grain Size	grainSize	10 – 500 ms	100 ms
Grain Density	grainDensity	1 – 50 grains/sec	10
Position	position	0 – 100%	50%
Position Random	positionRandom	0 – 100%	0%
Stereo Spread	stereoSpread	0 – 100%	0%
Buffer Length	bufferLength	0.1 – 30 s	5 s
Window Shape	windowShape	Hann / Tri / Trap / Blackman	Hann

Pitch

PARAMETER	ID	RANGE	DEFAULT
Pitch Shift	pitchShift	±24 st	0
Pitch Random	pitchRandom	0 – 24 st	0
Pitch Scale	pitchScale	Off / Chrom / Maj / Min / Pent / Blues / WT	Off

Filter & Tone

PARAMETER	ID	RANGE	DEFAULT
Filter Cutoff	filterCutoff	20 Hz – 20 kHz	20 kHz
Filter Type	filterType	LP / HP	LP
Grain Filter	grainFilter	0 – 100%	0%

Sustain

PARAMETER	ID	RANGE	DEFAULT
Freeze	freeze	On / Off	Off
Reverse	reverse	On / Off	Off

PARAMETER	ID	RANGE	DEFAULT
Feedback	feedback	0 – 100%	0%

LFOs

PARAMETER	ID	RANGE	DEFAULT
LFO1 Rate / LFO2 Rate	lfo1Rate / lfo2Rate	0.01 – 20 Hz	1 Hz
LFO1 Depth / LFO2 Depth	lfo1Depth / lfo2Depth	0 – 100%	0%
LFO1 Shape / LFO2 Shape	lfo1Shape / lfo2Shape	Sine / Tri / Saw / Sqr / S&H	Sine
LFO1 Target / LFO2 Target	lfo1Target / lfo2Target	Position / Size / Pitch / Filter / Spread	Position
LFO1 Sync / LFO2 Sync	lfo1Sync / lfo2Sync	Free / 1/1 ... 1/32	Free

Envelope Follower

PARAMETER	ID	RANGE	DEFAULT
Env Amount	envAmount	0 – 100%	0%
Env Target	envTarget	Filter / Pitch / Size / Spread / Dry-Wet	Filter

Delay

PARAMETER	ID	RANGE	DEFAULT
Delay Time	delayTime	10 – 2000 ms	300 ms
Delay Feedback	delayFeedback	0 – 95%	30%
Delay Mix	delayMix	0 – 100%	0%
Ping Pong	delayPingPong	On / Off	Off

Reverb

PARAMETER	ID	RANGE	DEFAULT
Reverb Decay	reverbDecay	0.1 – 10 s	1.5 s
Reverb Damping	reverbDamping	0 – 99%	30%
Reverb Mix	reverbMix	0 – 100%	0%

MIDI & Burst

PARAMETER	ID	RANGE	DEFAULT
MIDI Trigger	midiTrigger	On / Off	Off
Velocity Sens	velocitySens	0 – 100%	50%
Burst Mode	burstMode	On / Off	Off
Burst Count	burstCount	2 – 8	4

Mix & Output

PARAMETER	ID	RANGE	DEFAULT
Input Gain	inputGain	–24 to +12 dB	0 dB
Dry/Wet	dryWet	0 – 100%	50%
Output Gain	outputGain	–24 to +6 dB	0 dB
Stereo Width	stereoWidth	0 – 200%	100%