Entanglement User Manual

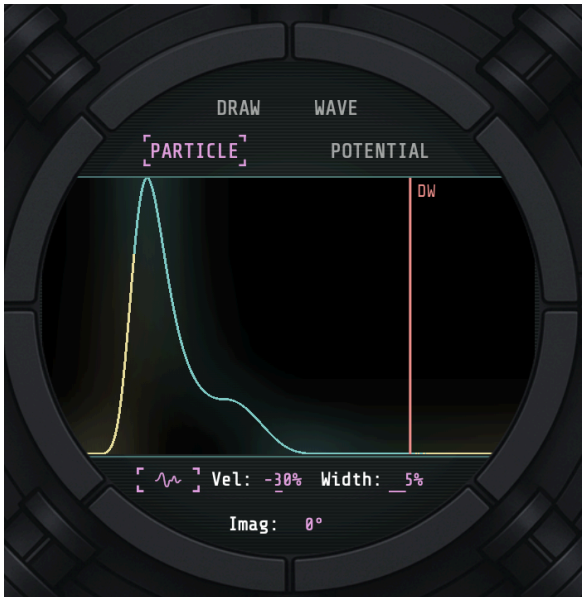
Synopsis

Entanglement uses a 1D quantum wave function (Schrödinger equation) to produce waveforms for use in a dual polyphonic wavetable synthesizer. You can add energy (wave packets / quantum particles) to the simulation in various different ways and those waveforms will evolve and transform based on the equation and your settings. You can also add environmental factors (Potentials) to transform the energy (waveform) in different ways. Additionally, you are able to manipulate the resulting waveform (stretching, warping, quantizing, smoothing, FM, etc). You can derive your waveform from the wave function simulation in various ways which result in different waveform types and thus different sounds. Each oscillator source (I and II) has its own independent wave function, energies, potentials, and settings. Both source oscillators may also be quantum entangled resulting in further complex oscillations. That coupled with an internal modulation system makes this device a powerhouse for insane sound design from basic synth sounds, to complex evolving sounds, to crazy mind blowing sounds. The evolving nature and very compelling

transformations of the waveforms through the quantum wave function sets this synth apart from the many other wavetable synthesizers out there.

You have two Source oscillators (I - pink and II - green) with independent settings / simulations, the next several sections will cover their independent settings.

The Quantum Wave function Interface

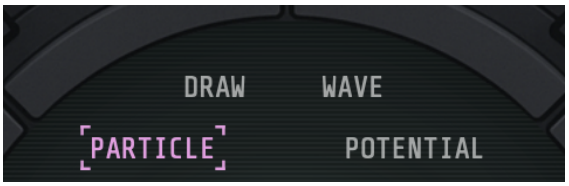


Here is the main visual display of the waveform derived from the wavefunction. There are also various settings in this section for adding/removing energies and environmental factors.

The visual shows the waveform AFTER it is derived from the wavefunction and all the manipulations, etc are applied to it. The colors represent which direction of the velocity for each part of the wavefunction energies/particles are heading (blue goes to the right and yellow to the left). The higher frequency of a wave particle/energy, the faster it moves (higher velocity, “Vel”). The red lines represent the environmental factors (Potentials) and the letter next to them tells you which type (more below). Clicking on this visual can add or remove energy/potentials depending on the Cursor mode (more below). You can design the initial quantum wavefunction state and then each time a voice is created it starts at that initial state and progresses from there. This visual may display the latest active voices’ waveform or the initial waveform state depending on the settings (more below). The derived waveform comes front he wave values in the wave function simulation which consist of two planes (sets) of wave values: the *Real* and *Imaginary* (you can think of them as two waveforms in the simulation). These can either be used individually or combined to get our resulting single waveform to hear. More about this in the “Wave Value Mode” section below.

Cursor Modes

In this section you can select between four different Cursor Modes which change the interaction that



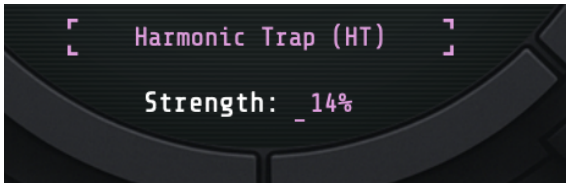
occurs when you clock/drag on the waveform display.

Particle

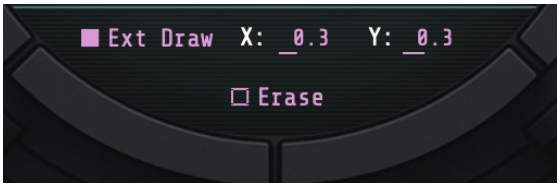
In this mode clicking on the visual adds quantum particles (wave packets) of energy to the wave function. The X position of your click is the center of the wave packet and the Y position is the amplitude. You can choose from various *Shapes*. The only realistic one is the “Sine” wave option which mimics an actual gaussian free quantum particle. The other shapes (square, ramp, triangle, noise, chirped, phase jump, alt lobes, phase flip, logistic, skew saw) give more experimental results. Sine and Chirped options give beautiful cascading harmonic series of different flavors. *Vel* sets the frequency and thus speed of the wave packet. It is bipolar with negative velocities going to the left and positive to the right. *Width* sets the width of the wave packet. *Imag* offsets/rotates the phase of the imaginary plane from the real plane of the added particle. This will change the shape and dynamics/movements of the added particle (for example a value of 90 degrees will cause the particle to split in half and go two opposing directions).

Potential

Here you can add/remove different environmental factors which will transform and affect the particles/energies differently. The speed of the simulation (dt scaling) will dramatically affect their behavior for most potentials. There is also a separate scaling factor for the Potential strength alone which I will cover in a later section where the *Speed* resides. There are various Potential options and each has a *Strength* or similar parameter to scale its effect. Unlike the other parameters in the Cursor Mode section, these strength parameters apply to all instances of their associated Potentials, whereas the others apply the settings to the next created particle/wave/etc. You can click to create/remove a potential and drag to change its position. NOTE: it is easiest to tell the effect of a potential visually especially when in the uncombined single *Value Mode* (more about that below) and many may produce a lot of noiseness or high frequencies which you can smooth out with the *Smooth* parameter (covered below).

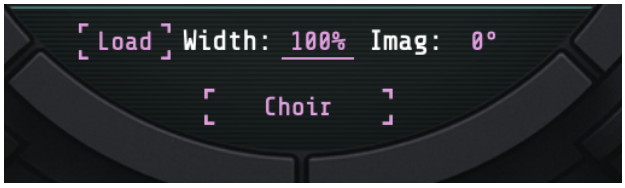


Draw



In this mode clicking and dragging free draws energy. If *Erase* is on it removes energy. *Ext Draw* allows for drawing using the *X* and *Y* values if enabled. This way you can map drawing to a controller or automate it for “Etch A Sketch” like drawing.

Wave



In this mode you can add other single cycle waveform shapes directly into the wave function. There are many built in waveform options in the *Shape* parameter from simple to complex. But you can also load your own .wav/.aif files here for use (ideally use single cycle waveforms as they are downsampled to 512 values)! *Width* changes the width of the waveforms when adding them. *Imag* does the exact same thing as in the Particle mode where it offsets the phase of the values in the imaginary plane from the real plane which (depending on your waveform shape) may change the direction/dynamics of the waveform transformation in the wavefunction. If you have the simulation speed at 0% and in the uncombined single *Value Mode*, then you can play these waveforms back just as a normal wavetable oscillator (note put the *Edge* value to 0% to avoid buzzy artifacts if you do this, more in a later section below). However if you turn the simulation speed up your waveforms will transform as energies in the wavefunction!

Wave Value Modes

In this section we select how we derive our audible single waveform to use from the two waveforms in the simulation (the Real and Imaginary *Planes*). You can select to either combine those waveforms (left option) or just select one of them for use (right option) with the *Values* setting. If combined, you can select which combined *Mode* you would like to use which are just different math equations to combine each wave value (r = Real value, i = Imaginary value). Each math equation will give you a different resulting

waveform and thus a different sound. Some are polar (centered at the bottom) or bipolar (centered at the middle) and some are smoother or noisier.

If you select the single option instead you will get two different options under *Planes* (which refer to the two waveform sets). Enabling *Imaginary* will use the imaginary waveform (real is used by default). However, if you enable *Stereo* it will use both waveforms and hardpan each of them left and right resulting in a wide stereo sound especially depending how much the two waveforms differ (which can change depending on settings and how you created the energies).

Enabling *ABS Values* will give you the absolute value of the waveform so that they are always centered from the bottom instead of the center and often resulting in a sound with more body. Enabling *BL* activates bandlimitting for anti-aliased wave playback (sometimes it sounds better without thus having an option).

Below this is a quantum *Collapse* option. If “Off” waveforms are free flowing in a state of superposition (for our purposes this means the waveforms just exist as they are). If you collapse them to “Position” the waveform will disappear and a particle of *Shape* (chosen just below) will appear at the part of the waveform with highest energy (meaning that is the most likely place a particle would be). This can sometimes create interesting glitchy and noisy sounds and really depends on the nature of the waveform. If the waveform has a lot of noise/complexity it will just be a narrow particle jumping around. Collapsing to “Momentum” mathematically does a similar thing but in the phase/momentum space instead of the positional space. This practically results in different types of complex sine waves modulating based on the *Shape* parameter. This also can result in jumpy glitchy sounds although generally more full and smooth. Both these modes are something to play around / experiment with as they can vary a lot depending on the initial waveform they are collapsing.

Simulation Rate

Using the *Speed* knob you can affect the overall rate that the simulation runs at (scales the dt). To the left of it you have 3 framerate options H/M/L (High, Medium, Low). These produce a significant difference in CPU usage. They change the framerate and the dt is scaled underneath to keep the perceptual speed consistent. In ost cases, there is no real audible difference between the three

framerates so it is highly suggested you use “L” or at least “M” mode and you will save a ton of CPU. However, in certain circumstances “L” may produce a different sound from the lower framerate so you may prefer M. H is almost never necessary, but if you are in a rare situation where you do hear a difference and prefer H and can afford the massive CPU spike then it is an option. To the right of speed you can *Reverse* the simulation (negative dt) and *Link* the speed scaling to the host’s BPM (120bpm is 1:1 speed scaling). Below the speed are parameters for *Kinetic* and *Potential* scaling (select yo view either one with the K/P toggle). Speed scales the dt which affects the rate of change for both the *Kinetic* hamiltonian (essentially the rate in which the waveform values change) AND the *Potential* hamiltonian (essentially the rate in which Potentials affect the waveform). However, using these parameters allows you to scale those rates individually. Potential is low by default as it is generally more desirable for sound design to keep it low.

Waveform Manipulations

There are three parameter menus for waveform manipulations and additional wave function settings. Most of these do not affect the wavefunction simulation itself and are applied afterwards, but some do.

Amp

These parameters affect the amplitude values of the waveform. The *Clip Mode* sets how amplitude values are handled, particularly when they go over the ceiling or below the floor values. “Hard Clip” hard clips values. “Soft Clip” soft clips values. “Fold” reflects values back (and if they reach the floor they are reflected back up). “Normalize” normalizes values which is very useful for many settings and keeping the volume consistent. Also there are some settings that make the values explode and normalization is very useful/necessary for getting interesting results in those settings. “Compress” does a compression of the values using the *Thresh* value to the right. *Pre* scales the amplitudes BEFORE they enter the amplitude mode, while *Post* scales them afterwards. *Smooth* applies a smooth function to the values to round them off. *Damp* dampens the values over time which could be useful for many effects (NOTE: dampening amount is linked with the simulation speed).

Warp

Stretch stretches/compresses the values to the left or right. *Warp* compresses/stretches values to and from the center. *FM* is an fm amount/index applied to the waveform values and *Ratio* sets the FM ratio frequency of the frequency modulation. NOTE: this is not an active oscillator but a shaping of the waveform itself so the results are different. *Width* affects the width of the peaks in the waveforms, lower values make them narrower and higher make them wider. *Steps* adds a quantization to the amplitude of the wavevalues set in a number of steps.

Edge

This sets the behavior that happens to values as they reach the left/right edge of the screen. These settings DO affect the wavefunction simulation. *Edge Mode* sets the edge mode. The left option wraps values around, this is the cleanest option and one that is standard in the simulation. The middle option mirrors/reflects the values at the edges. At low simulation speeds this works as stated but at higher speeds this causes explosions of values so using normalization amp mode is recommended here (you will get some interesting effects with that!). The far right option is scrolling which dampens the values as they reach an edge. *Edge Fade* sets the amount of amplitude fading that occurs at the edges (this setting does not affect the simulation). This is to prevent clicky sounds that may or may not happen as values reach the edges. Additionally, this can introduce a strong fundamental especially at higher values. However, for certain situations (for example using a pure sine tone in single plane value mode with no simulation running) it can introduce some slight buzziness so you can set it to 0% if desired in those situations. *Flip Plane Values* supposedly assigns the real values to the imaginary values and vice versa at the edges. However in reality it only assigns the real to the imaginary as it has more interesting effects. At slow speeds with certain edge modes this will cause the values to erupt at the edges. So I'd recommend either using this with higher speeds or to use an amp mode other than normalization (Big Bang preset demonstrates this).

Noisy Edges does a dirtier algorithm of the edge modes and adds noise to the values as they reach the edges.

Reinitializing

This section deals with parameters related to the waveform state reinitialization. As mentioned, you can design an initial waveform state and each time you create a new voice from a MIDI note that voice starts at the Initial state. When the *Legato* parameter is enabled, if you press legato notes (holding one or more notes and pressing another) those legato voices' wave states will also be reinitialized. However, if disabled then legato voices will continue their wave state from where the latest active voices' left off. You can also enable *Auto* reinitialization for active voices at a set *Rate* to get rhythmic, stuttering or other results. This rate can be in free MS or *Synced* note divisions.

Initial Quantum State Editing

Saving the initial quantum state has some nuanced options. If *Initial State Edit* is enabled, then the waveform visual only ever displays the initial state of the wave function that each new voice starts at. Additionally, editing the wavefunction with your cursor only applies to the initial state and not active voices. If disabled, then if there are active voices the center display shows the latest active voices' current state, and if there are no active voices it displays the initial state. If you do any editing of the waveform when an active voices' state is displayed, it does NOT edit the initial state at all but applies those changes to all currently active voices only.

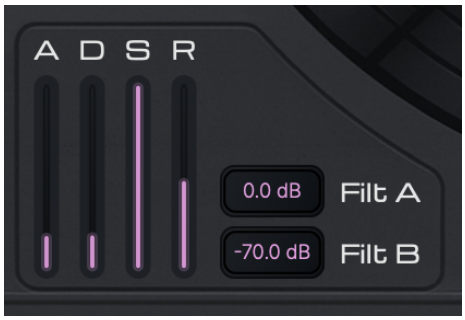
If *Autosave Edits* is enabled then every change of energy you make to the initial quantum state is saved for later recollection (ie in a saved project or preset). If *Autosave* is disabled then you must press either *Save Init* or *Use Current Voice* to save a state of energy for later recollection. *Save Init* simply saves the current initial quantum state to memory for later recollection. *Use Current Voice* (which you can

press whether *Autosave* is enabled or not) will save the current energy state of the latest currently active voice (which is visualized). This is useful if you like where the energy has progressed to and want to have the voice start initially at that state. If *Autosave* is disabled, you also have the ability to *Revert* to the last saved state. So you can make edits freely but if you desire to, you can revert back (NOTE: if *Autosave* is enabled you cannot do this as each change is saved to memory, and you must then rely on edit-undo to undo changes). *Clear* clears all energy in the initial state (NOTE: not in active voices). *Copy* copies the energy values and Potentials to the other source oscillator. NOTE: this does not copy other settings such as manipulations etc.

Basic Source Settings

Here we have more typical settings for the source oscillators. In the image to the left, on the top is the *Panning* and *Gain*. Below you have pitch *Transposition* and *Fine* tuning.

In the right image you have the amplitude ADSR. To the right of that you have the amount of gain for the source sent to *Filter A* and *Filter B* (NOTE: if the filter routing mode is set to Serial then there is only a *Filter A* gain option as the sound goes through each filter in serial).



Quantum Entanglement

If both source oscillators (I and II) are enabled, then you have the ability to entangle their wave states. If only one is enabled you cannot entangle as there is no other to entangle to. You can entangle in either *Beam-Splitter* or *Cross-Kerr* modes. *Beam Splitter* gives you an *Angle* and *Continuous* parameter. *Angle* sets how the entanglement occurs or practically is balanced between the I and II wave states. Closer to each edge is a lighter amount of entanglement with the highest concentration in the center (inverts after the center). If *continuous* is enabled the entanglement will occur at every simulation frame instead of only at the start of each voice. This creates a more modulating almost

AM-like effect but much more complex as the waveforms become intertwined. The angle amount also affects the intensity/rate of this perceived modulation. If disabled the entanglement only occurs at the beginning of the voice practically meaning the waveform shapes of I and II will be combined based on the chosen angle.

Cross-Kerr instead is always continuous (although it doesn't produce the same modulating effect that Beam-Splitter does at continuous) and has two parameters: "I > II" and "II > I" which each give you a bipolar sensitivity of each Source's entanglement sensitivity to the others' (in the middle is a sensitivity of 0% which means that source's waveform won't change at all). If the sensitivity is higher (negative or positive) then the waveform will change more dramatically from the entanglement.

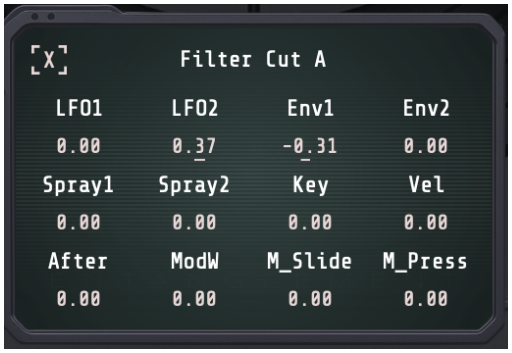
Overall entanglement gives you a very interesting/complex way for coupling different source waveforms to each other that doesn't happen through more conventional wave modulation methods.

Filters

You have two filters (A and B) that can be *Routed* in Parallel or Serial (the far left switch in the image). There is a dropdown menu for selecting the filter type. All filter types with 12 or 24 in their names are ladder filters. The rest are basic biquadratic filters. To the right you have the frequency *Cutoff* and *Q/Resonance* parameters.

Modulations

You may have noticed next to many parameters is a small button with this symbol to the left. Clicking this button opens that parameter's modulation send popup menu that you see to the right. There are various modulation sources you can assign to any modulatable parameter: 2 LFOS, 2 ADSR envelopes, 2 random "Spray" values created at the start of each voice, MIDI note "Key" pitch,



MIDI Velocity “Vel”, MIDI Aftertouch, MIDI Modwheel, MPE Slide, and MPE Pressure (NOTE: in some DAWs like Ableton you have to enable MPE for the plugin for usage). Each of these send values are bipolar so negative values invert the depth of modulation.

The 2 LFOs have standard parameters such as the LFO *Shape* (in addition to the basic LFO shapes there are three complex shapes and at the very bottom is an option for perlin noise). *Phase* sets the offset for the initial LFO phase position at the start of the voice. *Retrig* enables retriggering of the LFO at the set phase at the beginning of a new voice. You can set the *Rate* of the LFO in free Hz or *Synced* note division times (NOTE: this syncs the time of the length of the LFO cycle however, it does not sync it directly to the timestamp of the transport, for flexibility in use, therefore you still will need to play notes on time for them to be synced in phase).

The 2 modulator envelopes are quite simple and standard with *ADSR* options and a *Legato* option (if enabled legato retriggered voices will start the Attack at the place the last ADSR left off). You also get an option for repeating the envelope (when the decay finishes) and you can set the number of *Repetitions* where the highest value option is for “infinite” reps (looping).

Global Parameters and Header / Footer

There are two sections of global parameters.

To the left has an option for a simple *Overdrive*, a cheap *Spread* effect, and *Portamento* pitch gliding for legato notes set in MS.

Below there is a section of the header where you can choose the max number of Voices, as when as the global *Panning*, and *Gain* for the whole instrument.

On the left side of the header is the preset section. Here you can recall, save, and delta presets. The preset recollection has categories (on the left side) and the specific preset within a category (to the right).

In the footer you can see a description of the parameter you are hovering your mouse on as well as the current set value amount.

I hope you enjoy this device! Thank you so much for your interest and support <3

Please email me if you have bugs or other issues: dillonbastan@gmail.com

More: http://dillonbastan.com