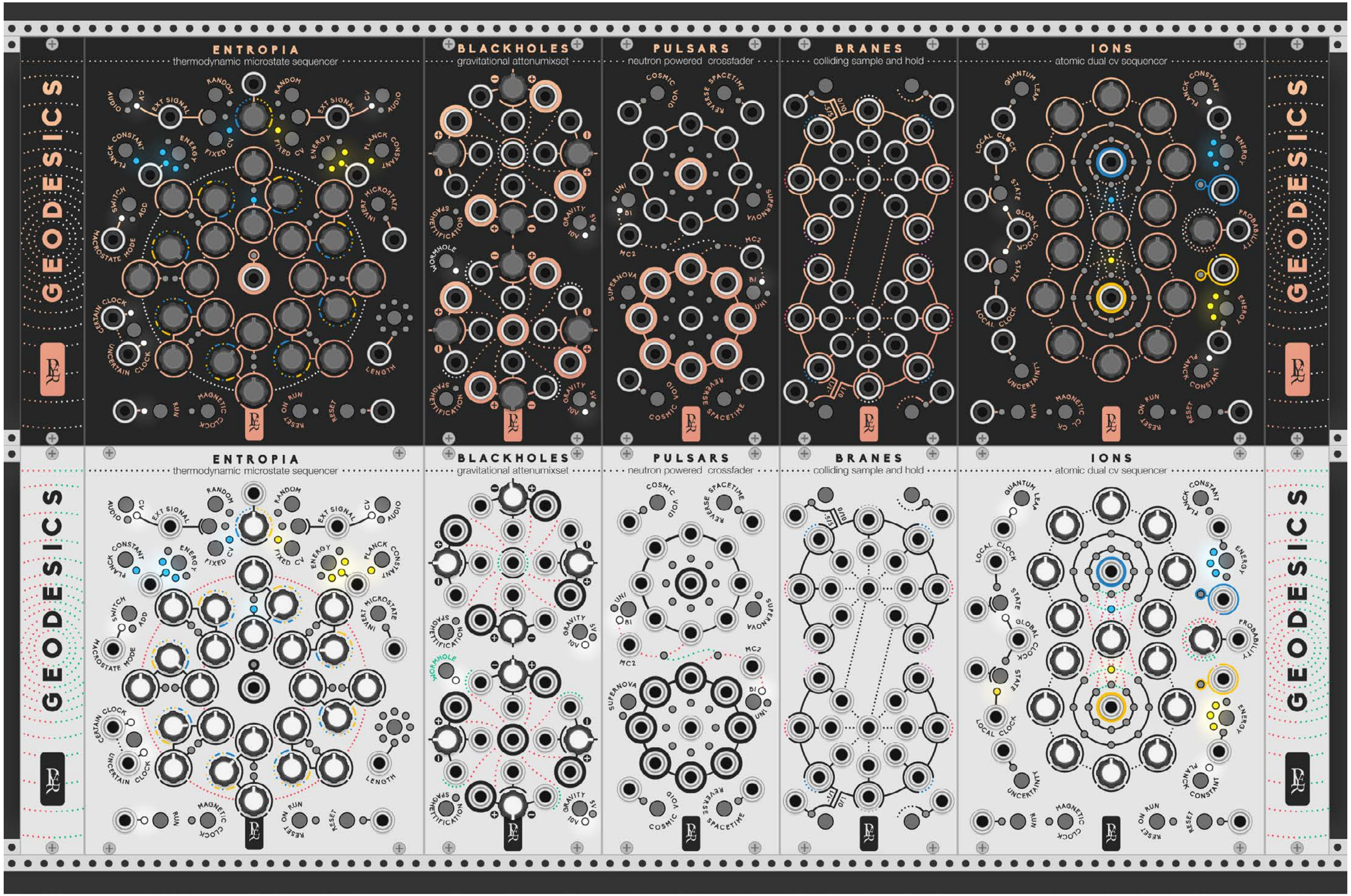
GEODESICS

A modular collection for VCV Rack by Pyer & Marc Boulé

User Manual - version 0.6.6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ENTROPIA
thermodynamic microstate sequencer
BLACKHOLES
gravitational attenumixset
PULSARS
neutron powered crossfader
BRANES
colliding sample and hold
IONS
atomic dual cv sequencer
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PHILOSOPHY

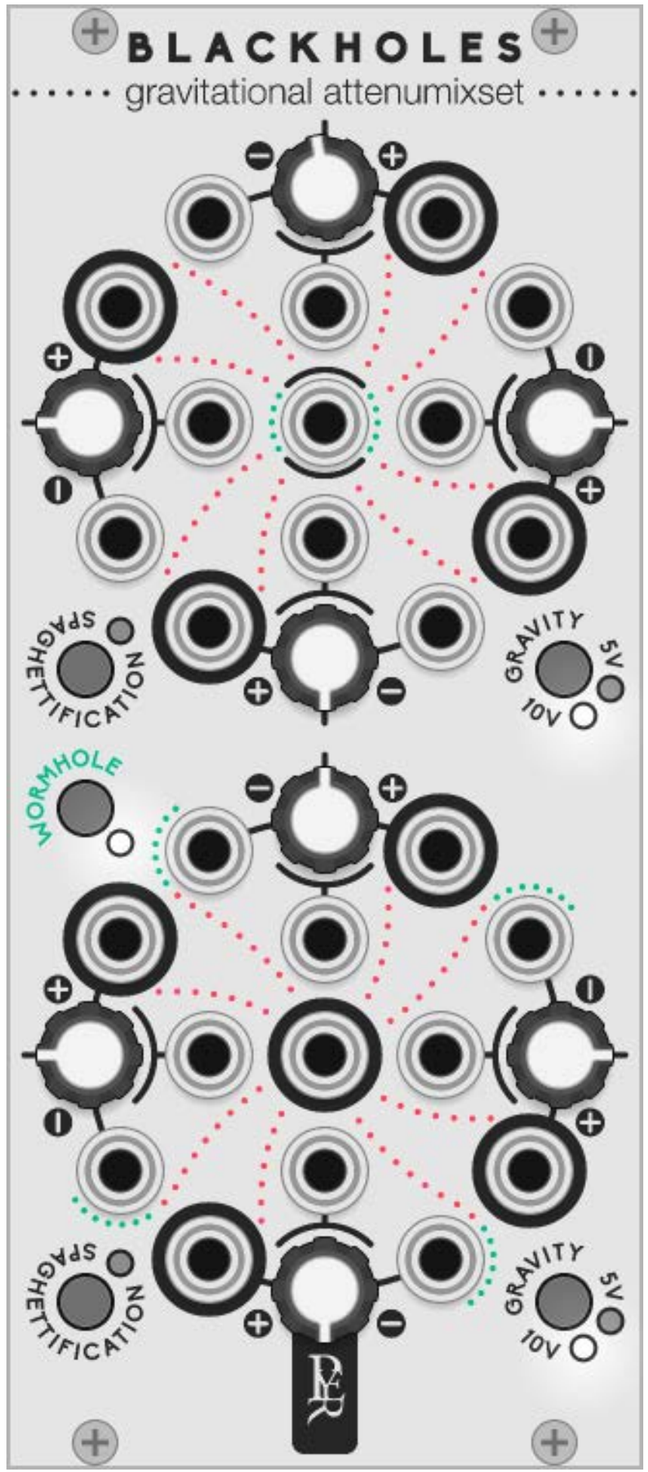
science inspires music

The modules are loosely inspired by astronomic events and physical theories. The goal is just to see how science can inspire us to create new music.

Every module is feasible in the hardware world, interacting elements are only knobs, buttons, LEDs and serigraphy. there is no right click option other than skin change.

For a more immersive concept, every parameter displayed uses terms related to the scientific phenomenon that inspires the module. It might be confusing at first but that's why this manual is here. As every unusual musical instrument, a learning curve is required to make the best of it.

While a lot of advanced science is involved, the final purpose is to create musical and creative instruments, effective and friendly to use.

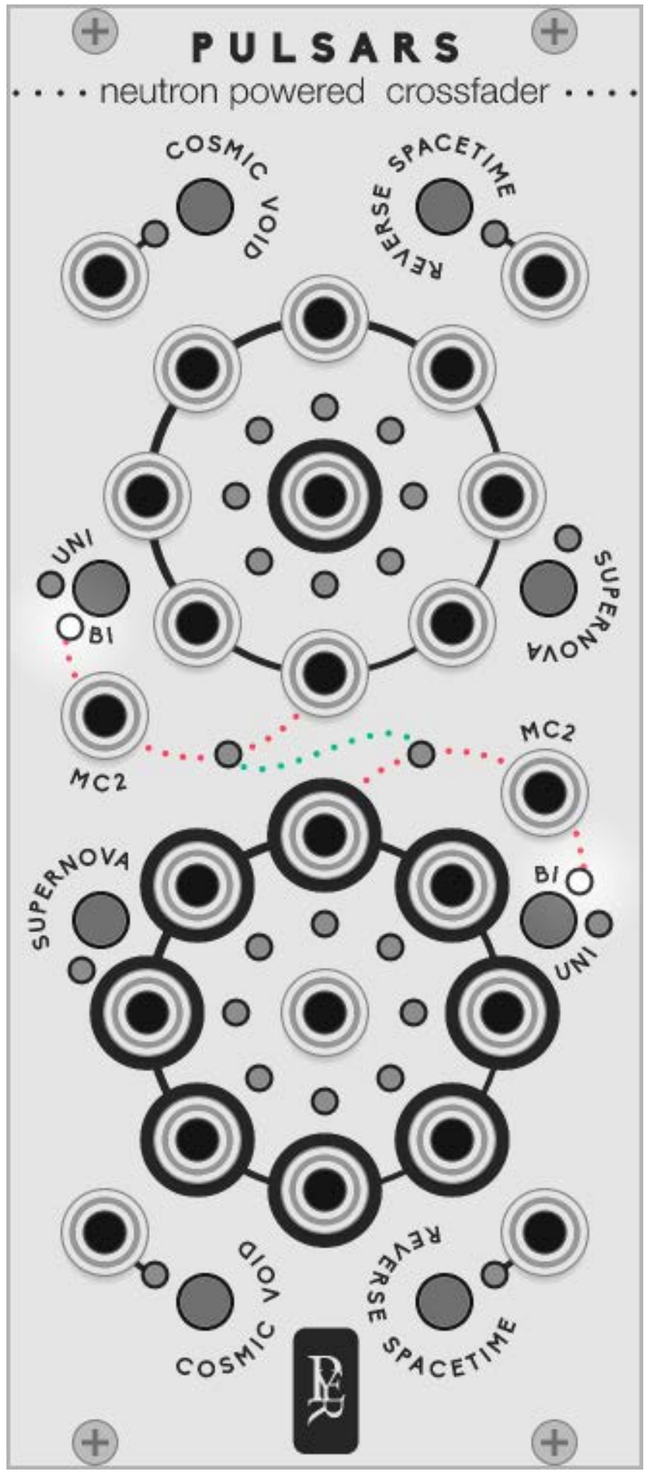


BLACK HOLES

gravitational voltage controled amplifiers

A black whole attracts everything that gravitates around its centre, even audio and CV signals…

BLACK HOLES is 8 vcas in two groups of 4, it's also two mixers with 4 channels each.



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neutrons powered rotating crossfader

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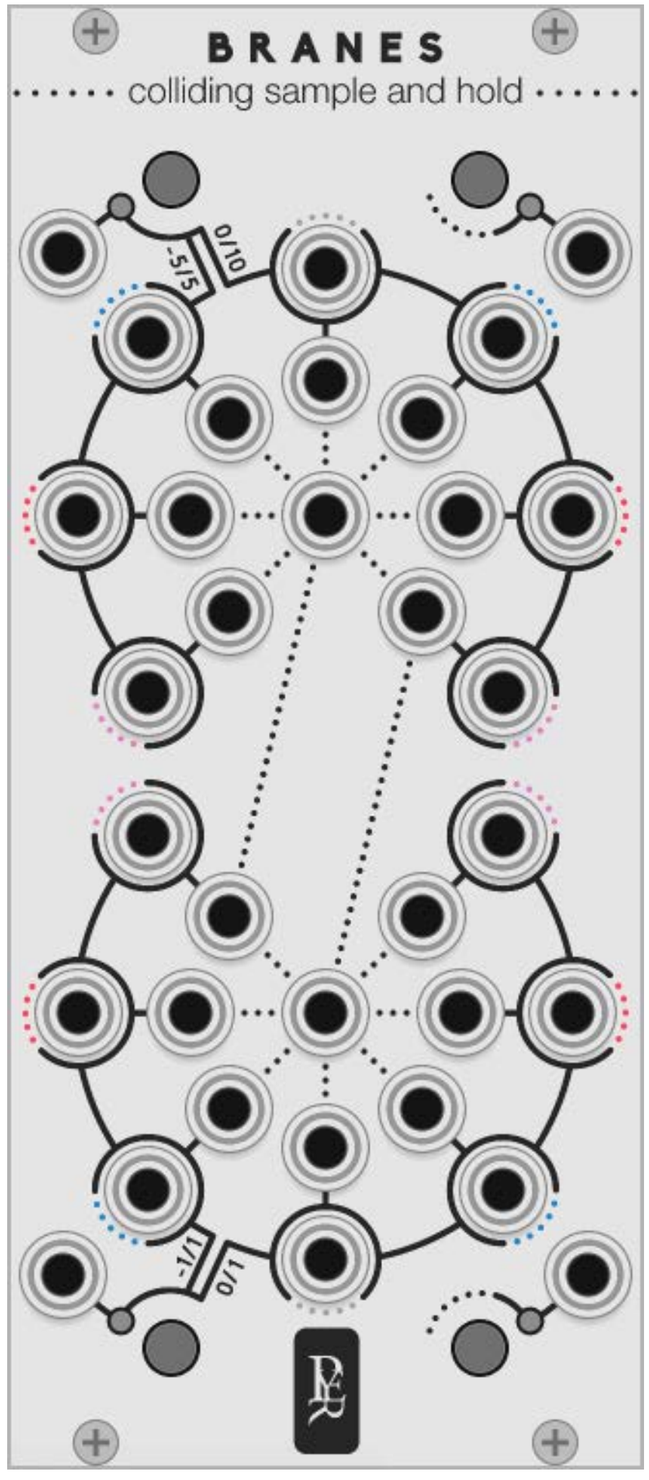

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colliding sample and hold

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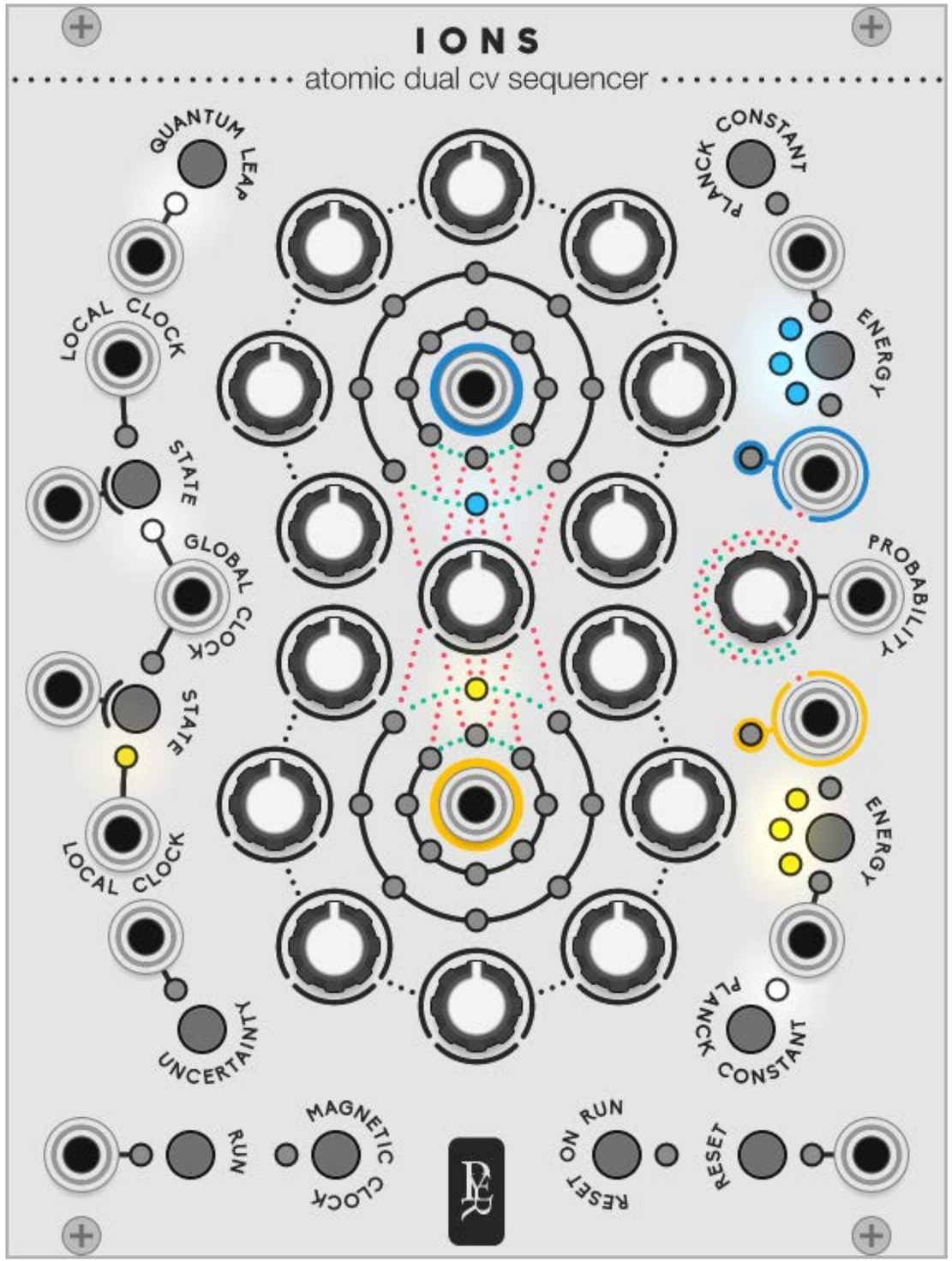
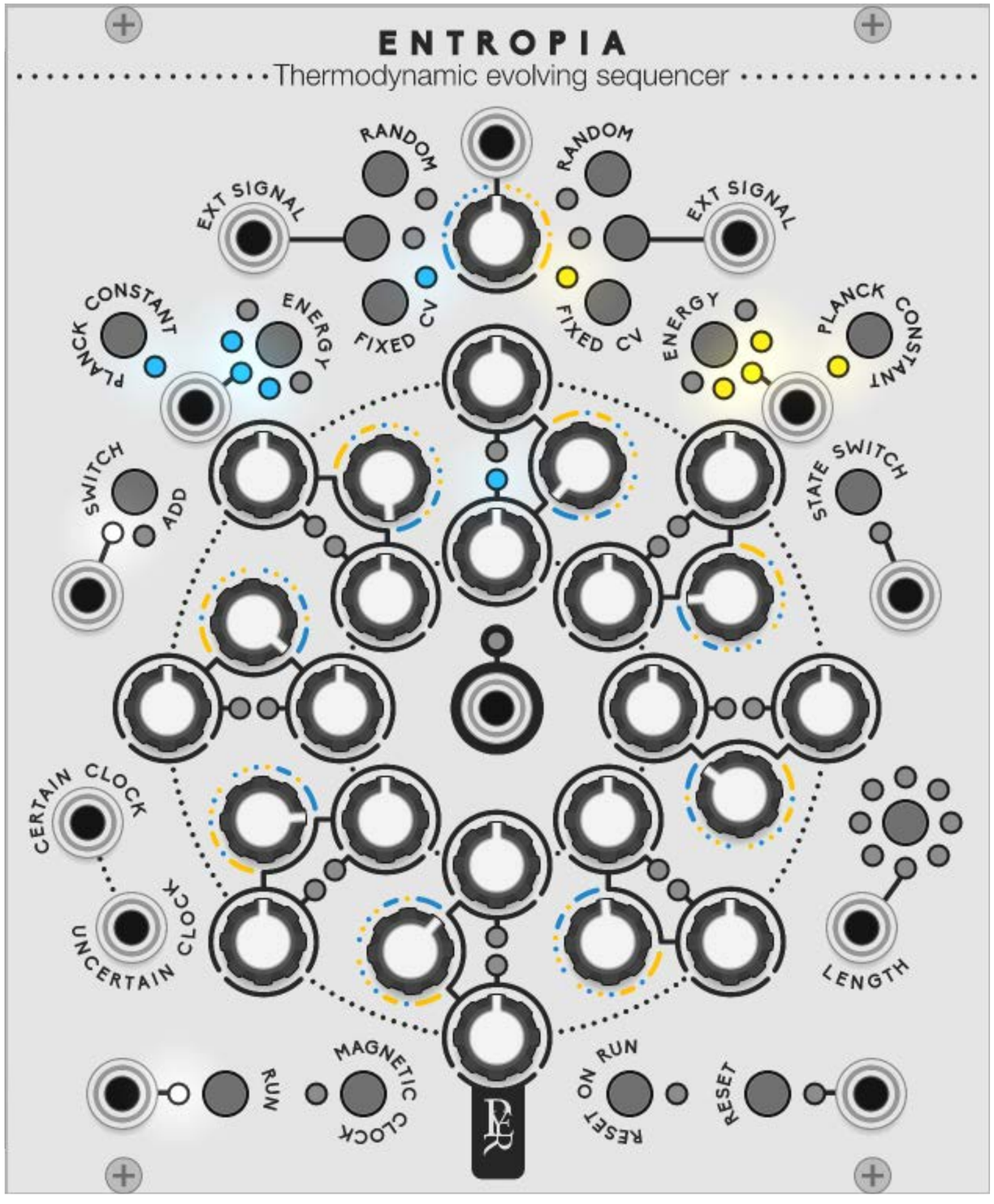


IONS

atomic duophonic voltage sequencer

An Ionic bond describes two atoms that exchanges electrons.

IONS is a two voices sequencer. While each voice has its own sequence, they can exchange their sequences as easily as an electron can jump from one atom to another.



ENTROPIA

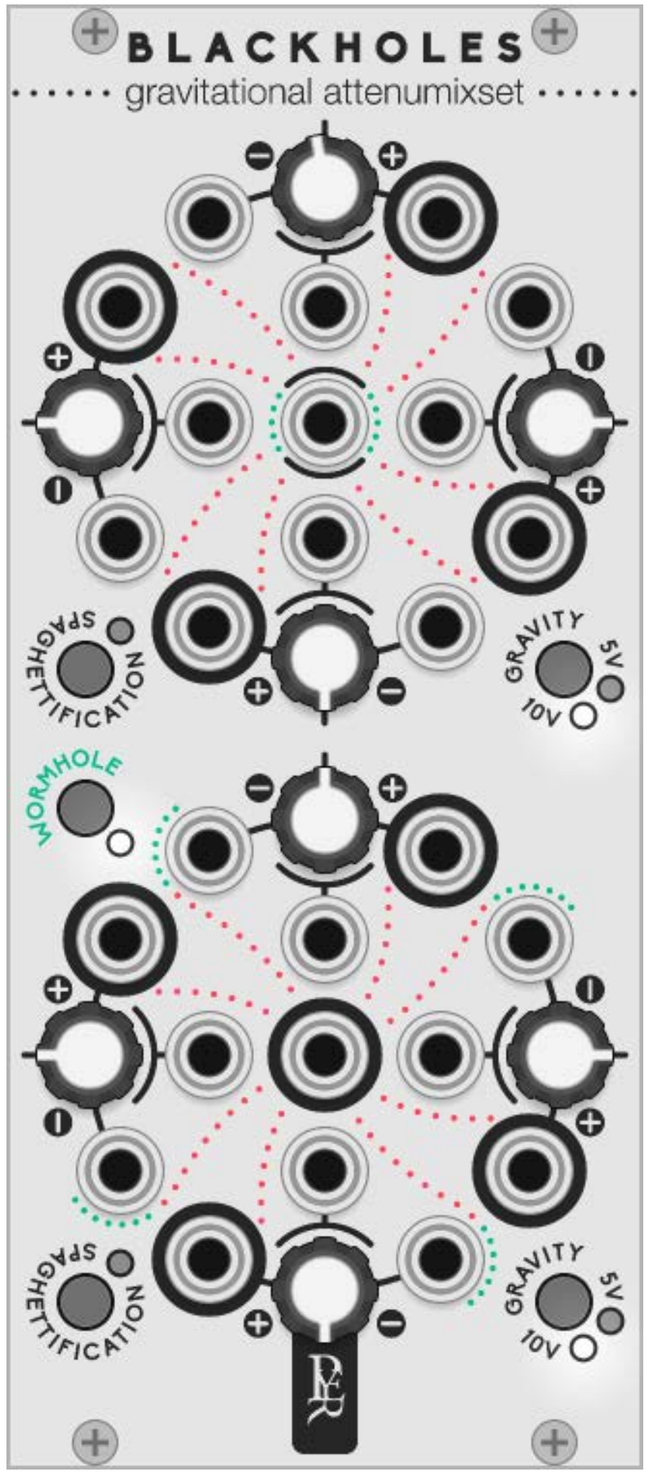
thermodynamic evolving sequencer

Entropy is a measure of disorder in a system: many microstates of atoms that create a rich and complex macrostate.

ENTROPIA is an 8-step sequencer with two values per step, and a probability to play one of the two values. Both values can be a defined sequence of voltages, a range controlled random source, or an external source.

GEODESICS

In Depth Concept



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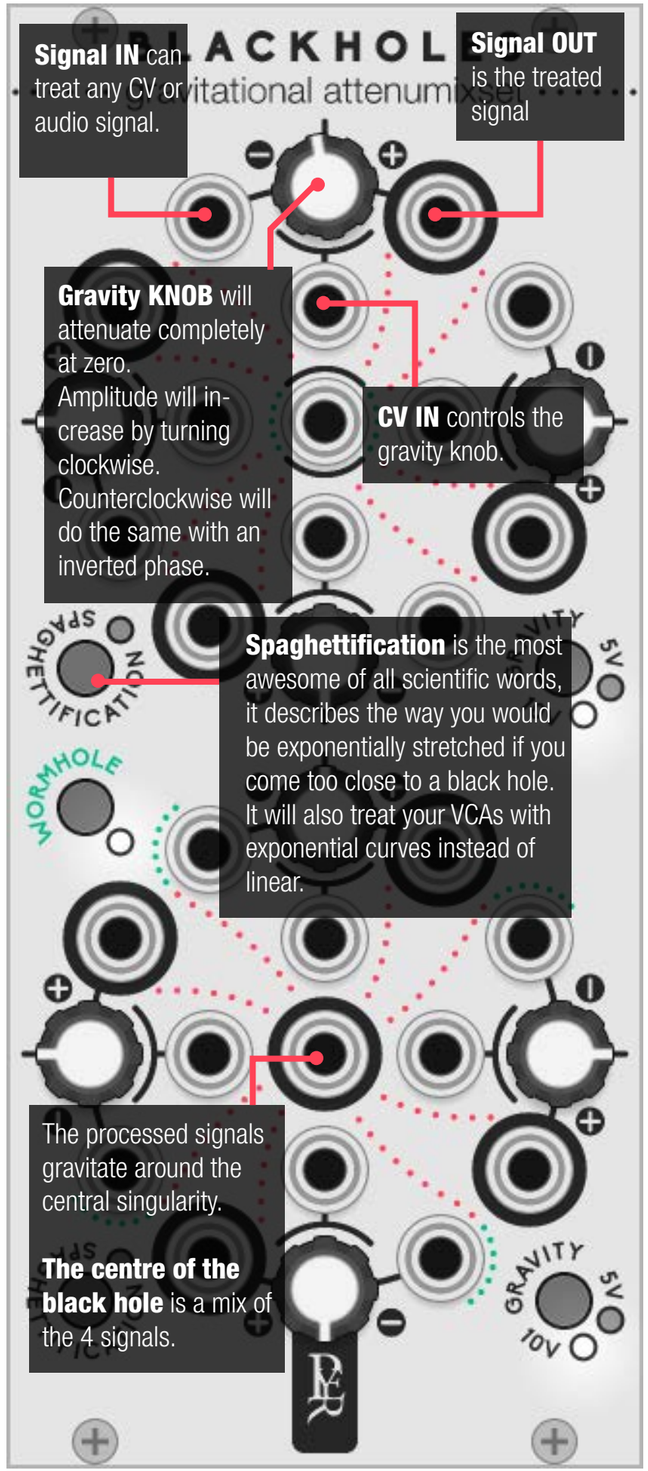

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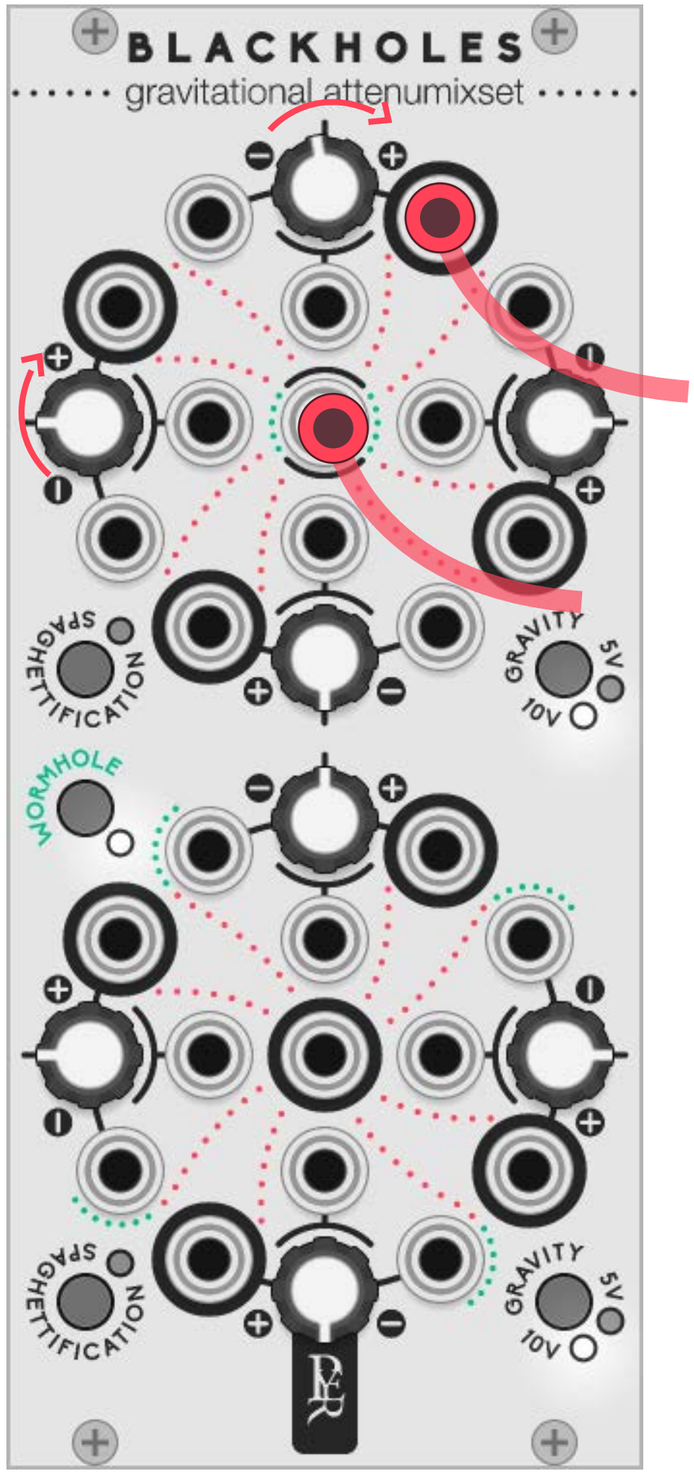

BLACK HOLES

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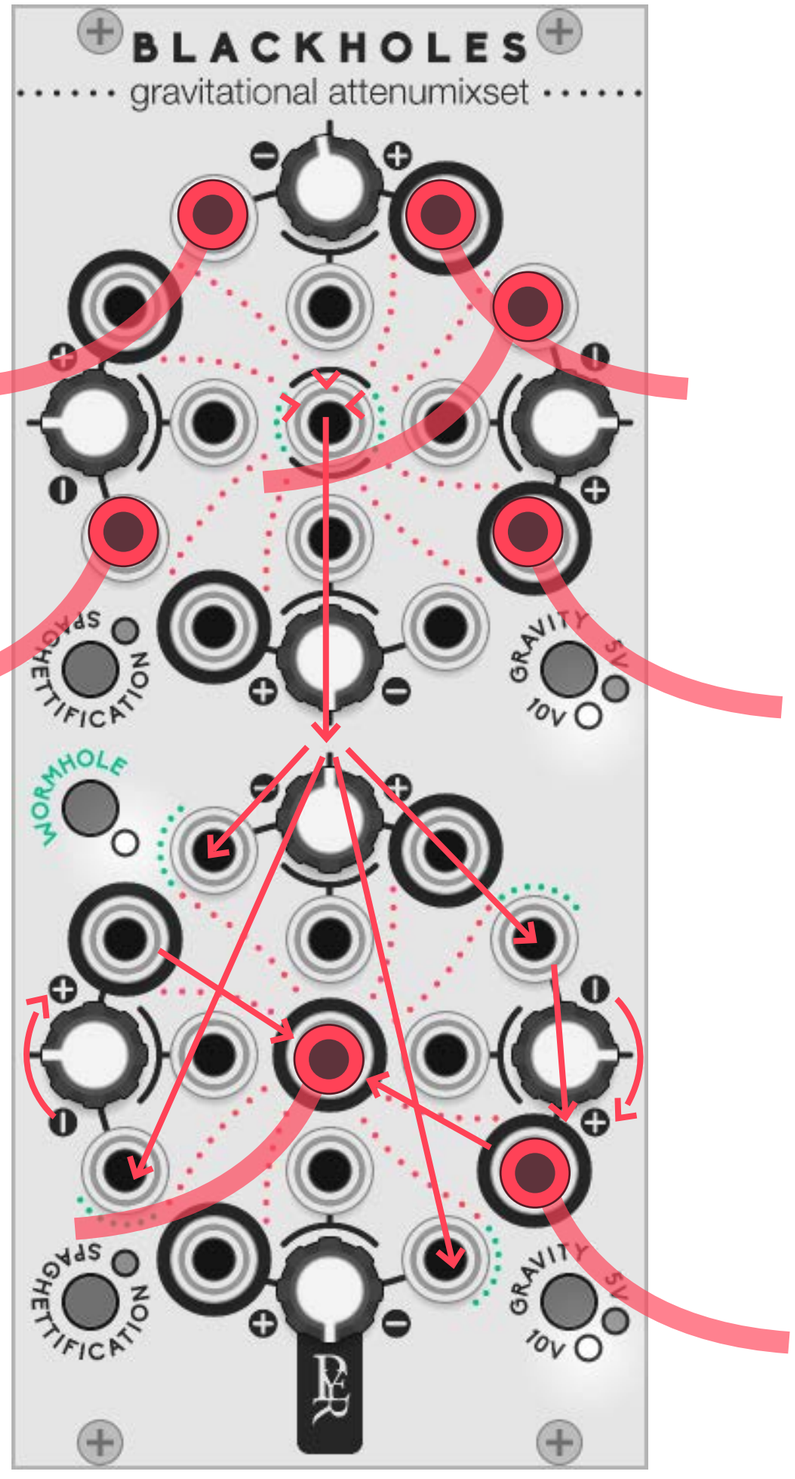
Mass control

When no input is plugged in, the knob acts to the output as a fixed CV generator. The centre still acts as a mixer. The values of the gravity knobs are all summed up in the mixer.

Gravity control

The modulation input can be set to -/+10 volts for enveloppe and gate sources, or -/+5 volts for LFO and VCO sources.



BLACK HOLES

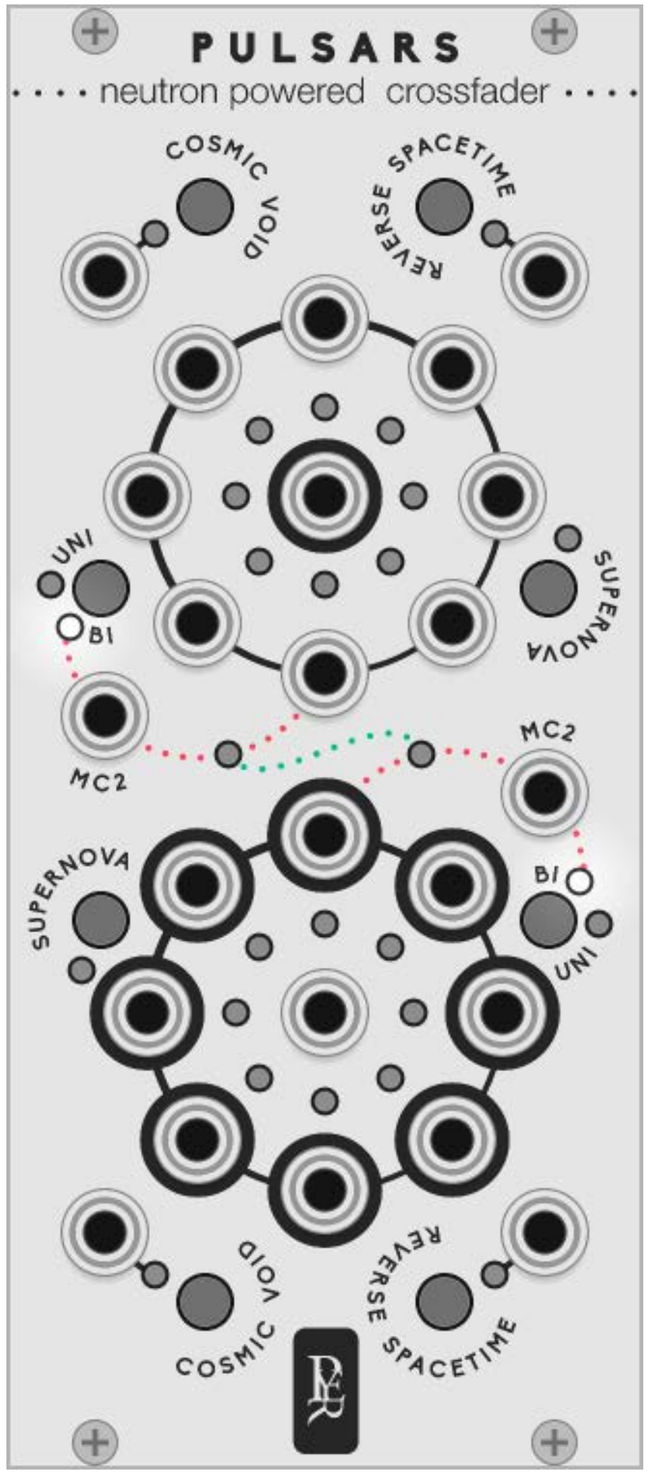
gravitational voltage controlled attenumixset

The Worm hole

No one knows what is inside a black hole. Some people think there could be a worm hole to a “white hole” that ejects everything the black hole has absorbed...

Black Hole 2 can become a white hole. The mixed signal from Black Hole 1 travels through the wormhole and feed the unused inputs of Black Hole 2. It then becomes a 1x4 multiplier. The signal can be treated differently by each output. The worm hole can be closed if needed with the button.

The mass control combined with the worm hole trick will manage both amp and offset of an external signal.



PULSARS

neutrons powered rotating crossfader

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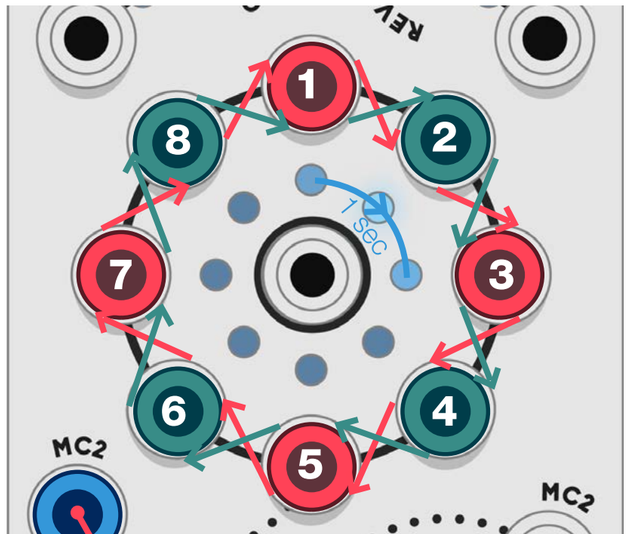
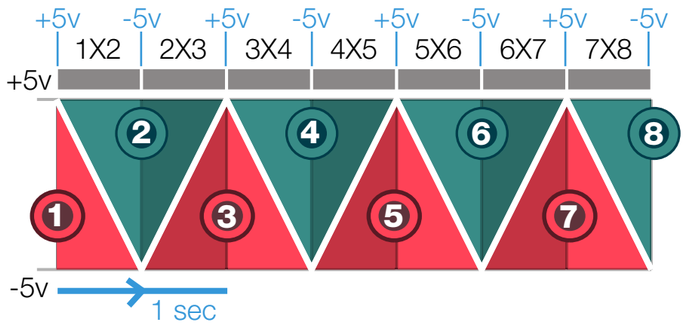
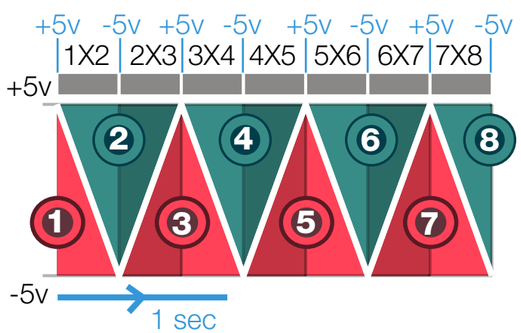


white line on the graph +/- 5 volts



At each peak, PULSAR starts another crossfade sequence. Any value between +5 and -5 will be interpreted as a mixed value between the first and the second source.



The speed of the sequence is defined by the rate of the MC2 Signal.

PULSARS

neutrons powered rotating crossfader

MC2 is the energy needed for a pulsar to spin on itself.

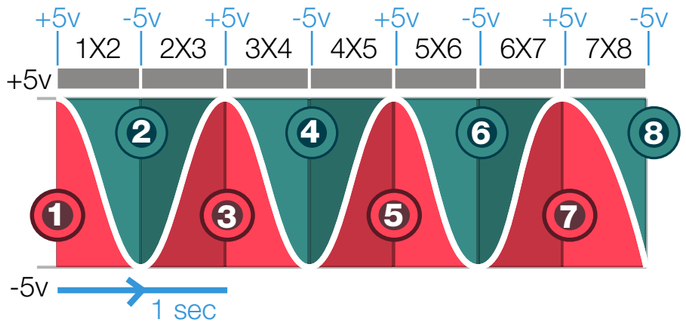
Pulsars needs a 5v binaural CV signal to power its rotation (**MC2 IN**).
When no MC2 is connected to the second pulsar, they are both driven by the first MC2

The first connected cable defines the start of the cycle

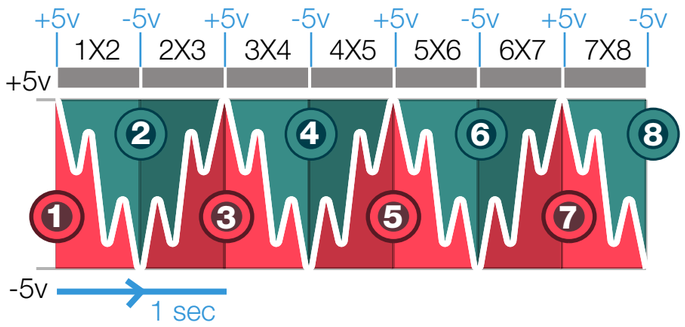
The rotation starts at **source 1** when it receives +5v.

It will reach **source 2** when it receives –5v

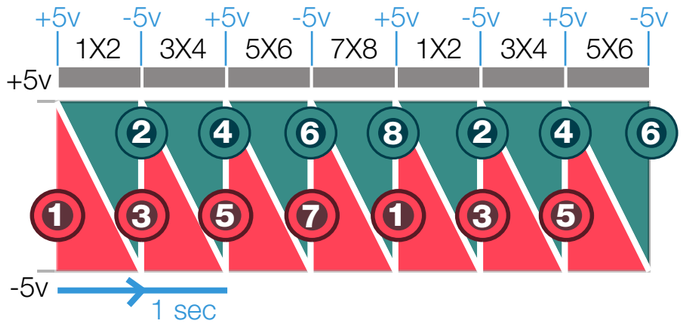
It will reach **source 3** when it receives +5v…



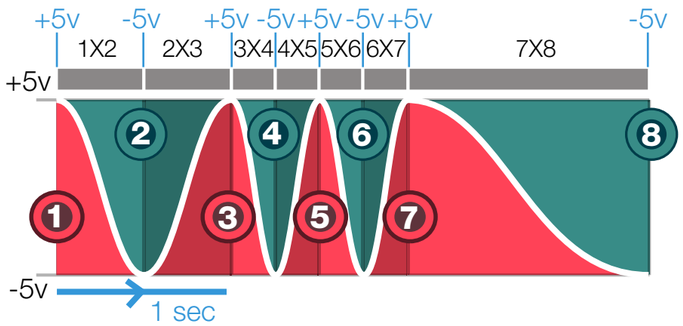
A triangle wave will make linear crossfade, while a **sine wave** will create an exponential cross-fade



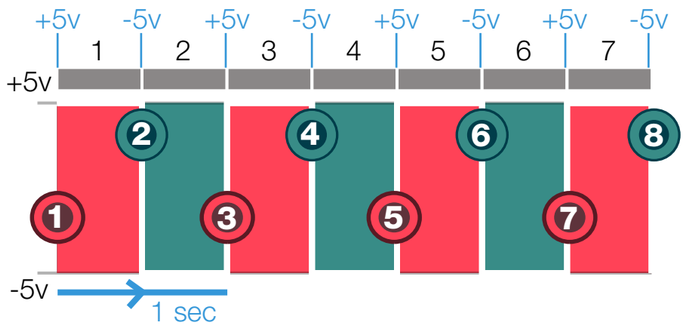
A folded wave source will create backwards and forwards effects



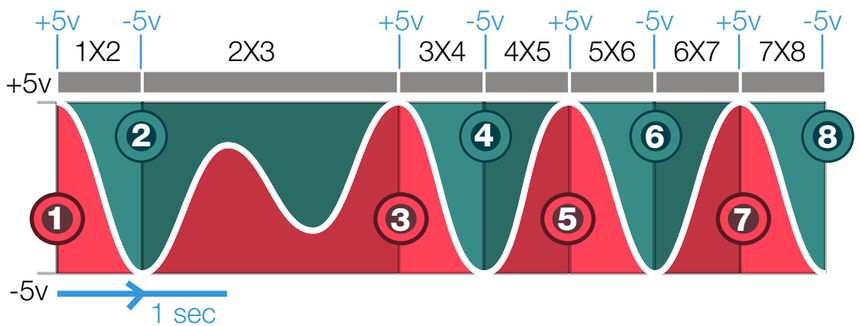
A sawtooth wave will switch from one step to another without transition



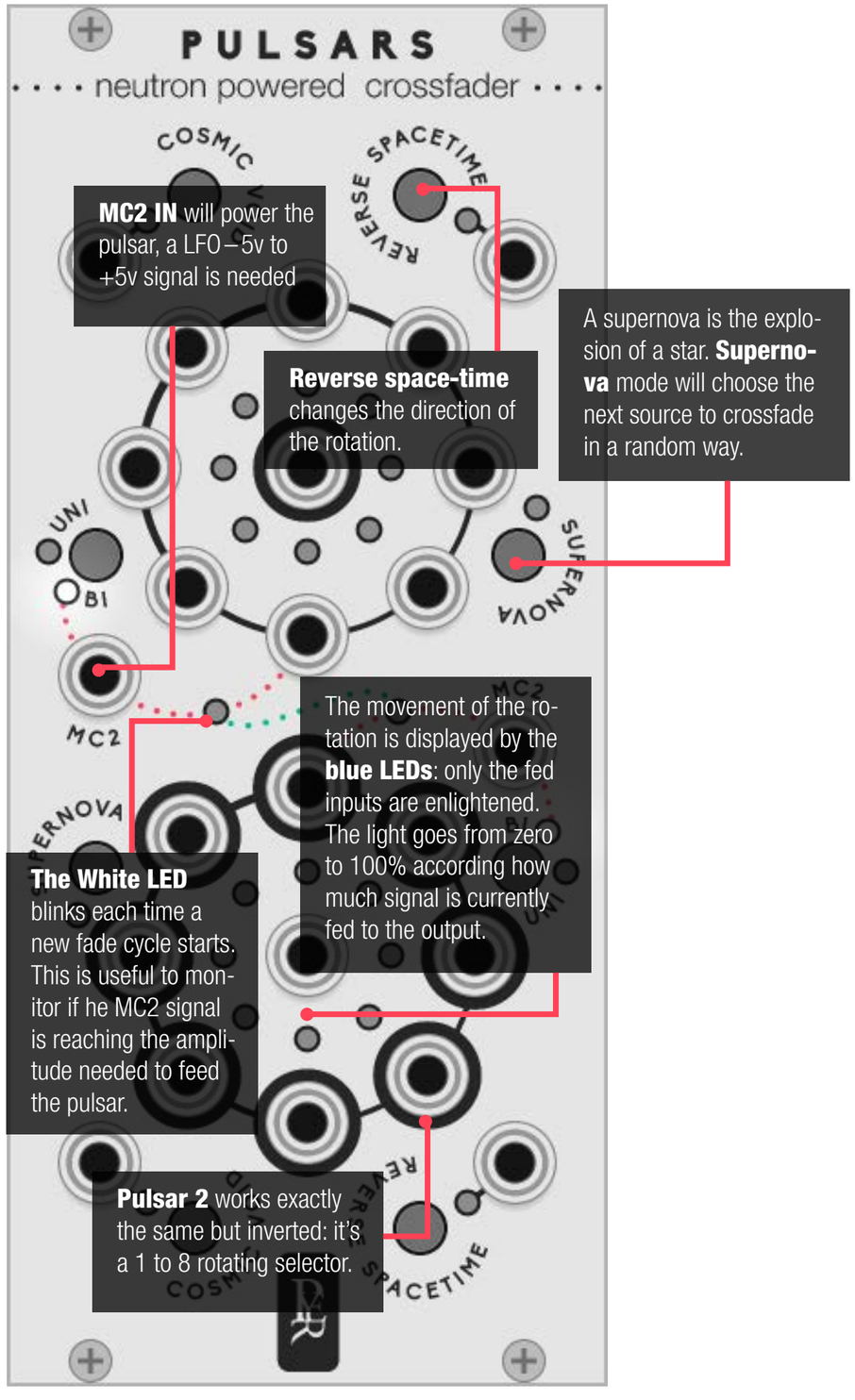
Modulating the rate of the signal will make some steps shorter and can create some rhythmic variations



A square wave won't create a cross fade effect, it can then be used as a standard sequential switch.



Modulating the amplitude of the signal can create some interesting rhythmic effects as it only switches to the next step when it reaches +/- 5 volts.

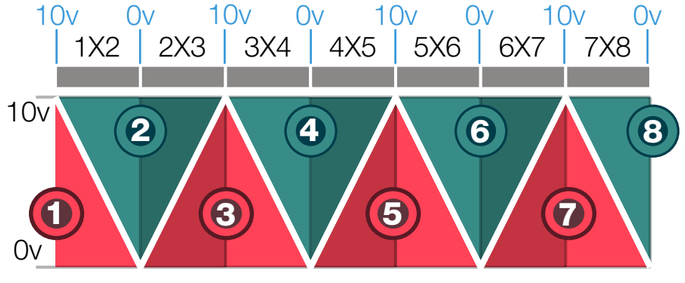


PULSARS

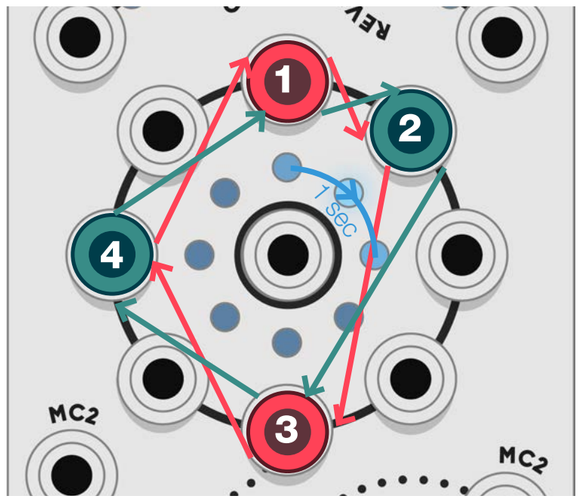
neutrons powered rotating crossfader

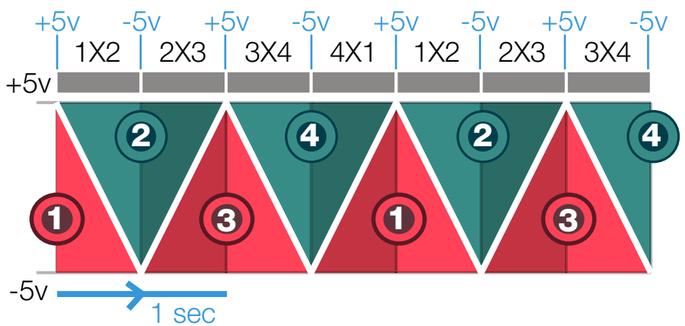
Unipolar - Bipolar

The MC2 is set to recieve a -/+5v bipolar signal. When configured to Unipolar, This will set the MC2 to receive a 0/10v to react with envelope generators. A new cycle will be started each time the MC2 Signal reaches 0 or 10 Volt.



Cosmic void mode **OFF**





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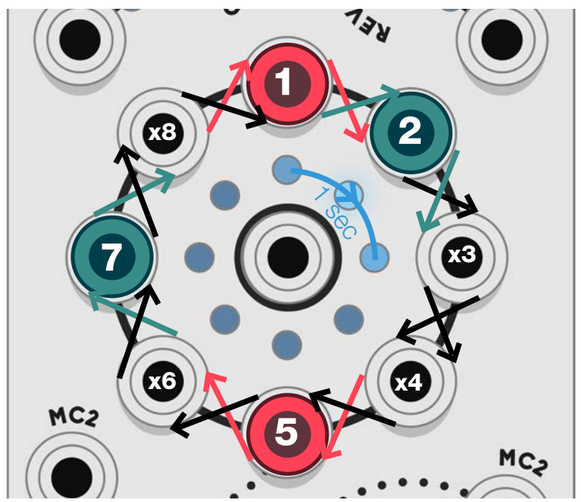
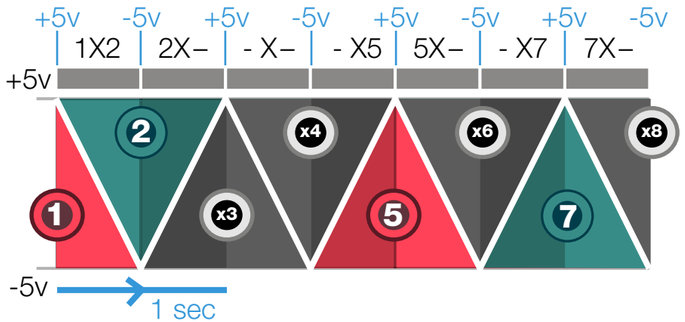
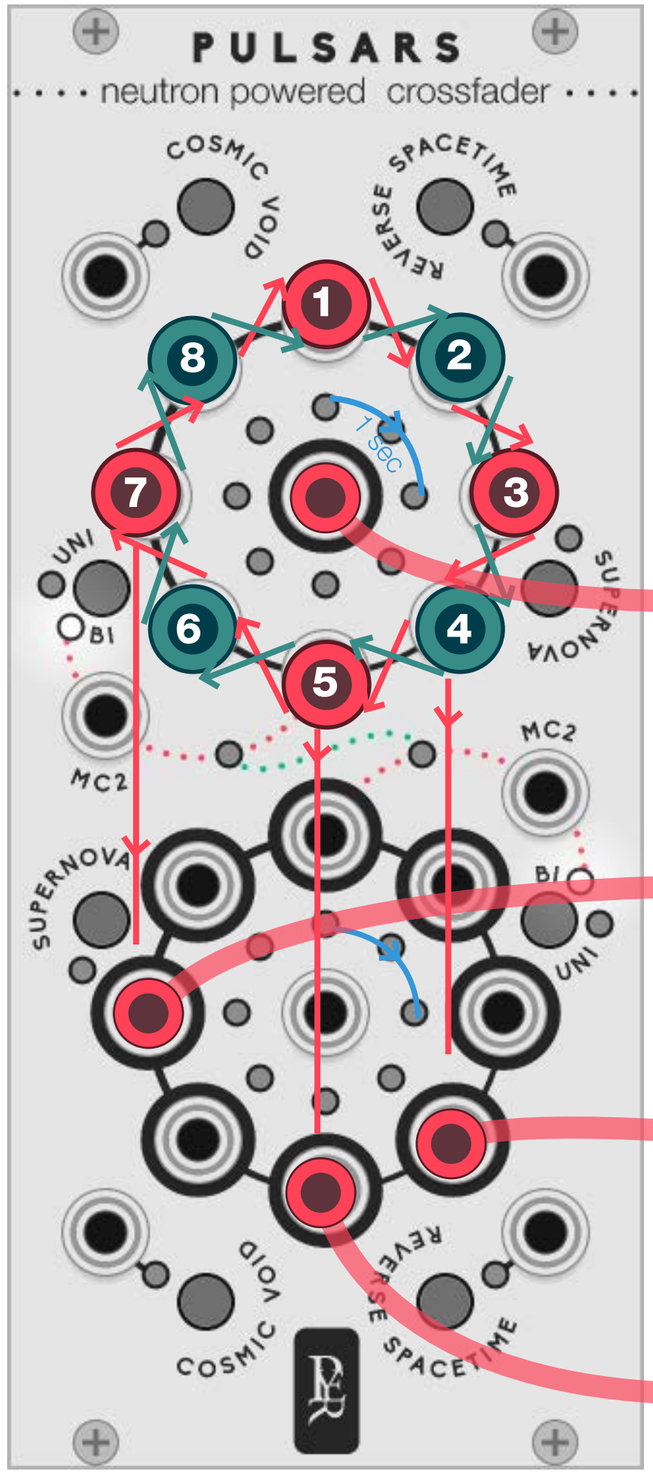


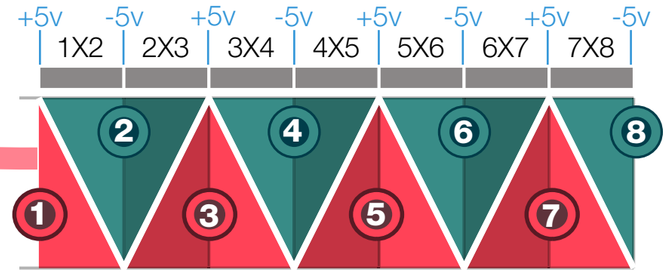


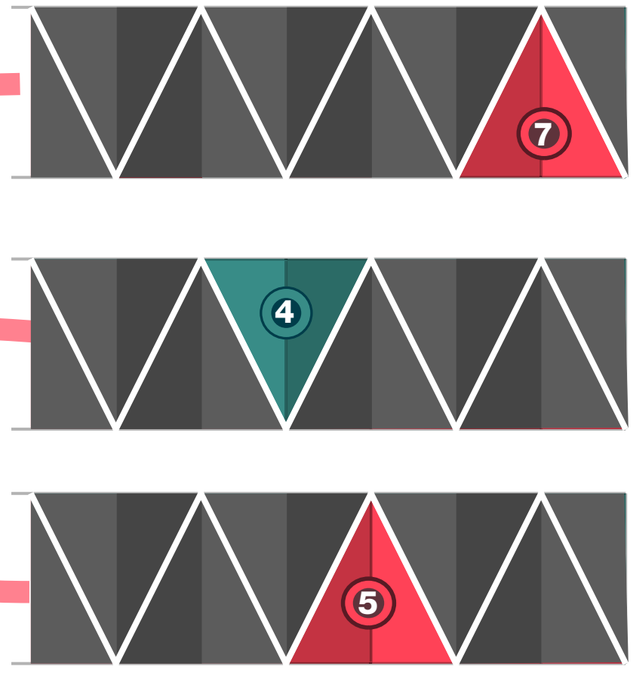
Cosmic Void mode

By default, Pulsars takes only account of the fed inputs, wherever they are plugged along the way. If only 3 inputs are fed, Pulsar will be a 1 to 3 switch.

When the cosmic void mode is on, PULSARS take account of the empty inputs, it will always be a 1 to 8 switch, and if it goes through a non-fed input, it will send a zero volts signal. This mode is useful to create rhythmic or tremolo effects.







PULSARS

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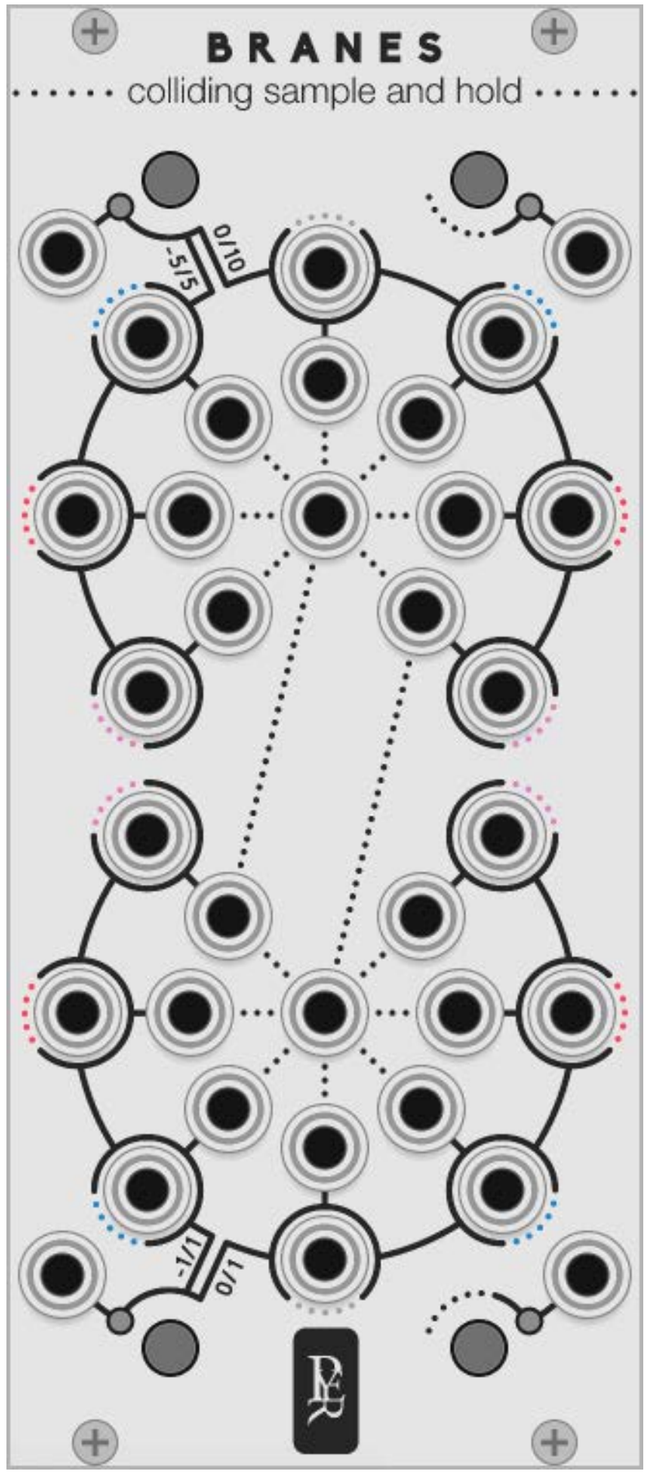
Multidimensional trick

If no input is connected to Pulsar 2, it will send the separate input of Pulsar1 amplified by its rotation. This is useful if you want to have stereo effect of post treatment of each source.



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colliding sample and hold

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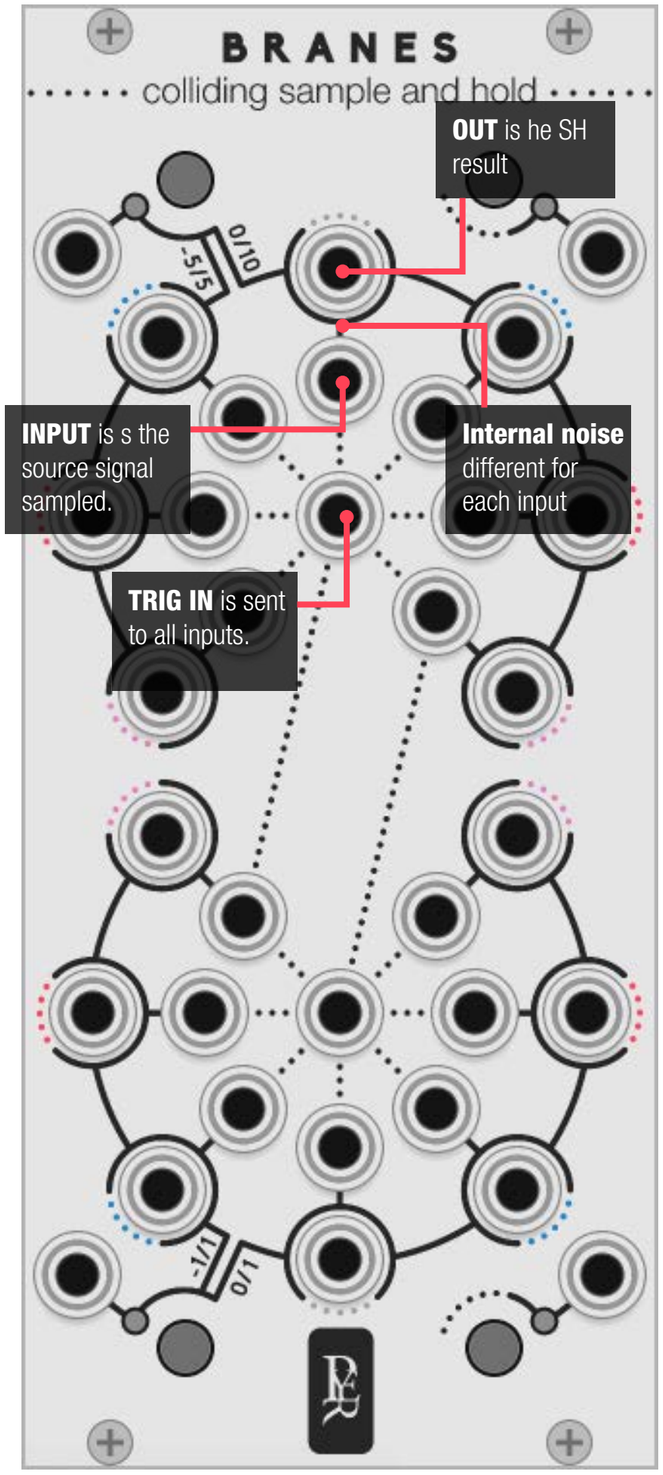


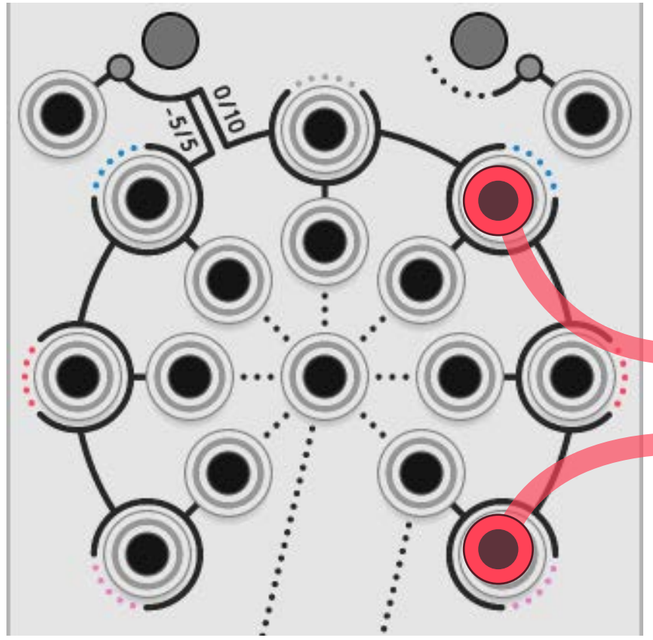
BRANES

colliding sample and hold

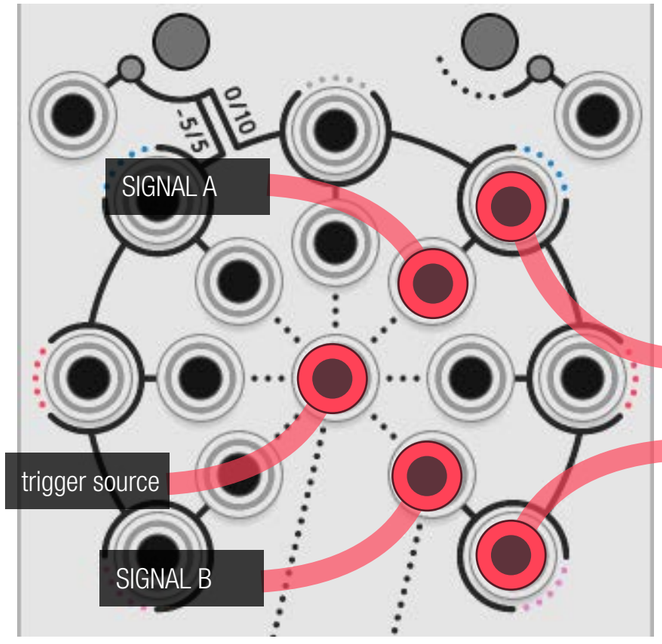
The Idea came from the Buchla Music Easel with its 4 uncorrelated random sources: random and different

Each output has its own internal noise generator, with different colours so you can have 7 different random CV driven by the same trigger without any external input.

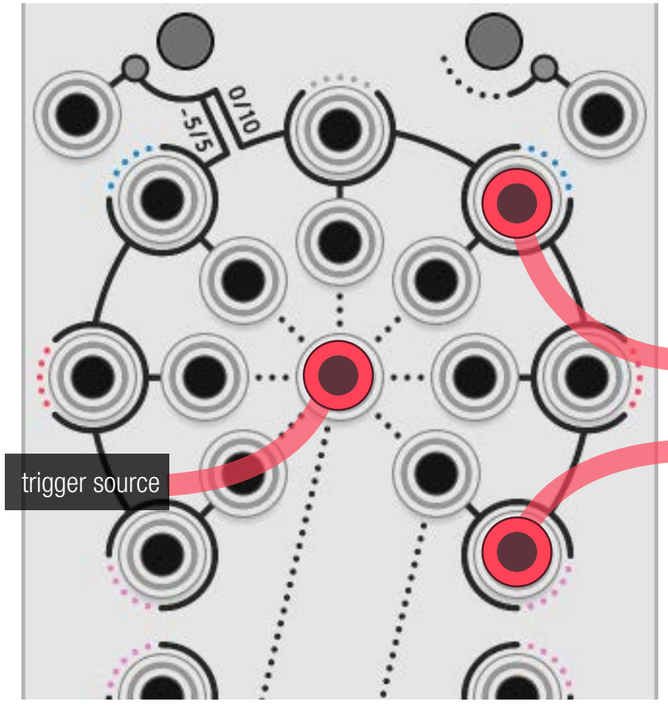
The noise generator is bypassed when an input source is connected.



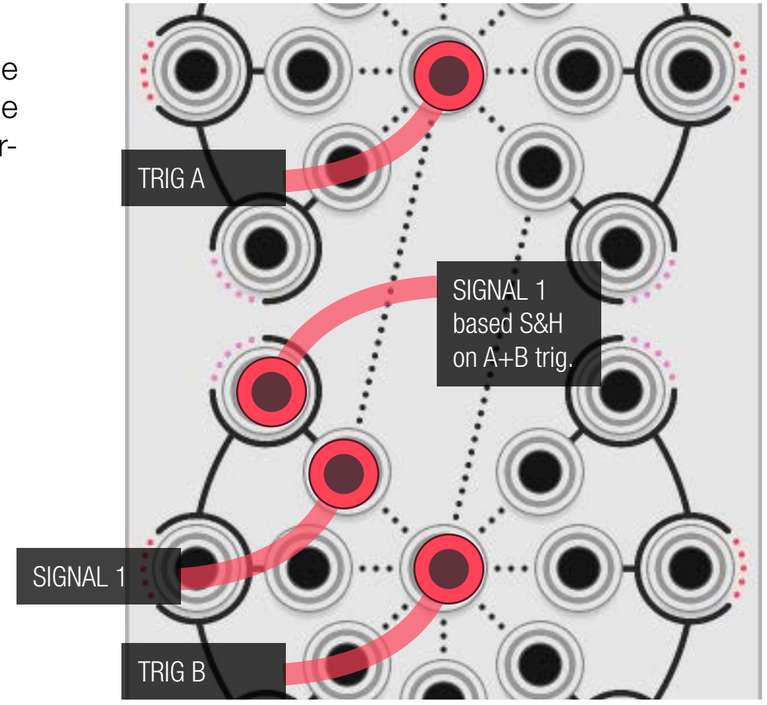
When no trigger or input source is connected: The outputs are just noise sources, different kinds of noise for each.



When a trigger and an input are connected, the noise generator is bypassed, and the S&H uses the input as material.

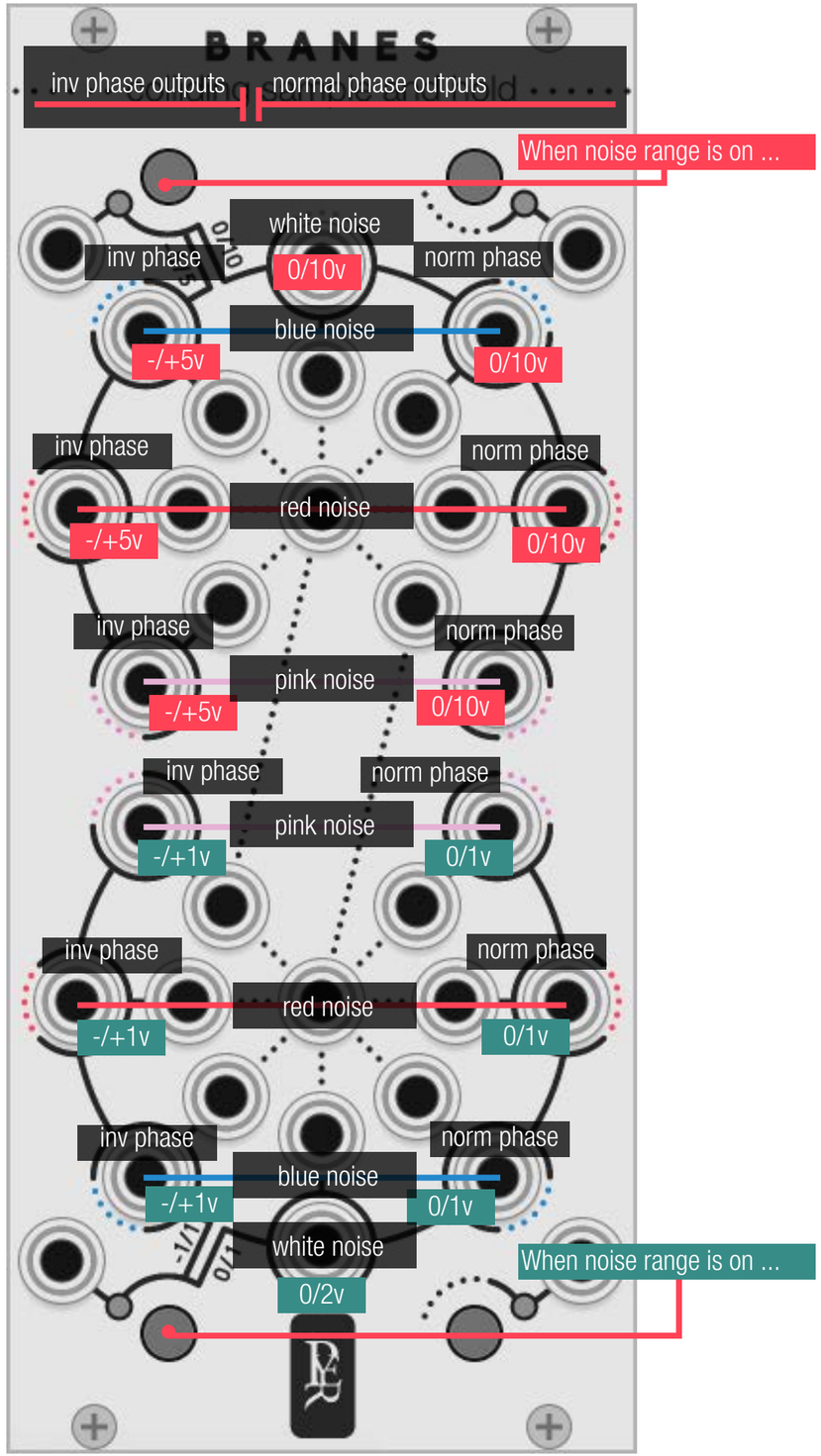


When a trigger is connected, the outputs use the trigger to sample and hold their internal noise generator and send random CV.



The two Colliding S&H

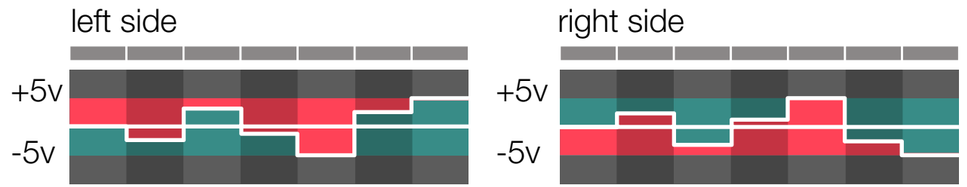
They work as expected, but their trigger source is an addition of the two trigger sources. It allows you to create polyrhythmic melodies.



The inverted phase noise generators

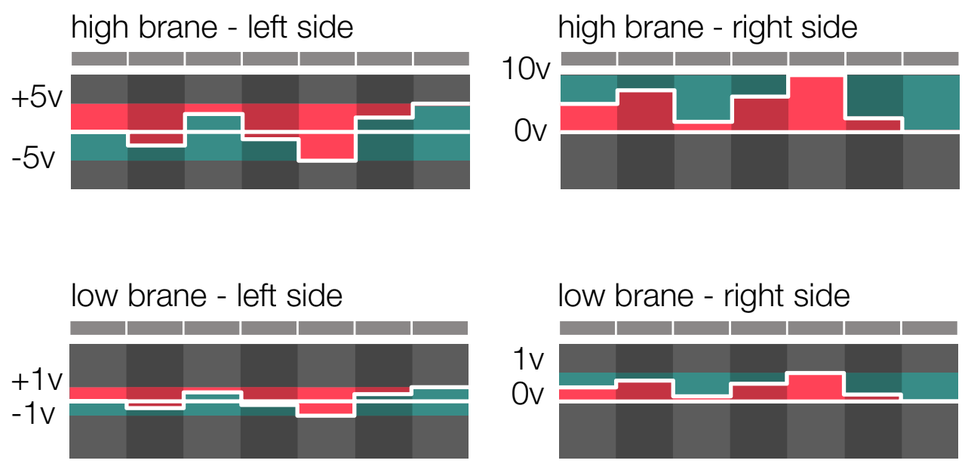
Every noise generator on the left-hand side is the inverted phase version of the right-hand side.

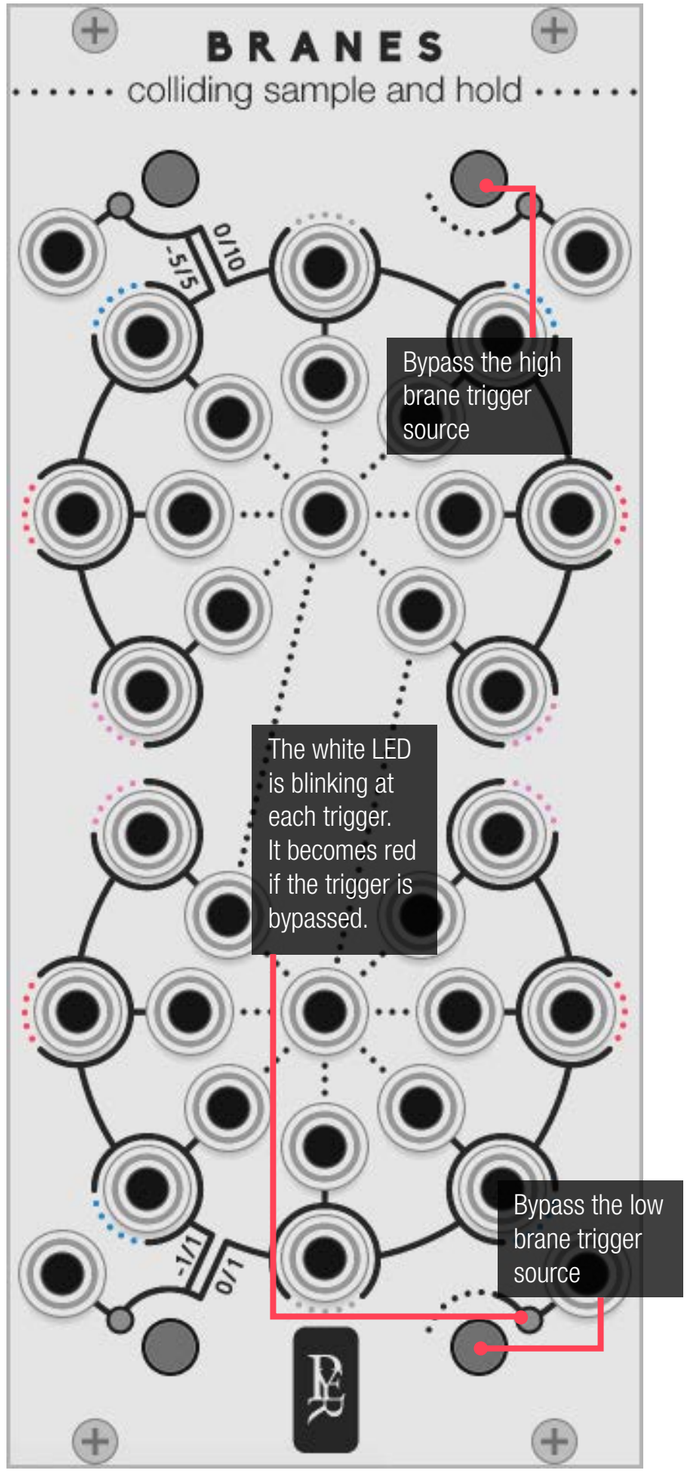
It is not really useful as a noise source, but when the noise is sampled, every left-hand side output will provide the opposite value of the right-hand side.



Range noise button

The noise generators are emitting signals from -5 to +5 volts, so will be the sampled signal. This can be too wide for pitch control, or too small for 0 to 10 volts modulation input. While this is usually fixed with an external VCA, the noise range button will change the range and offset of each noise generator according the following rules:





BRANES

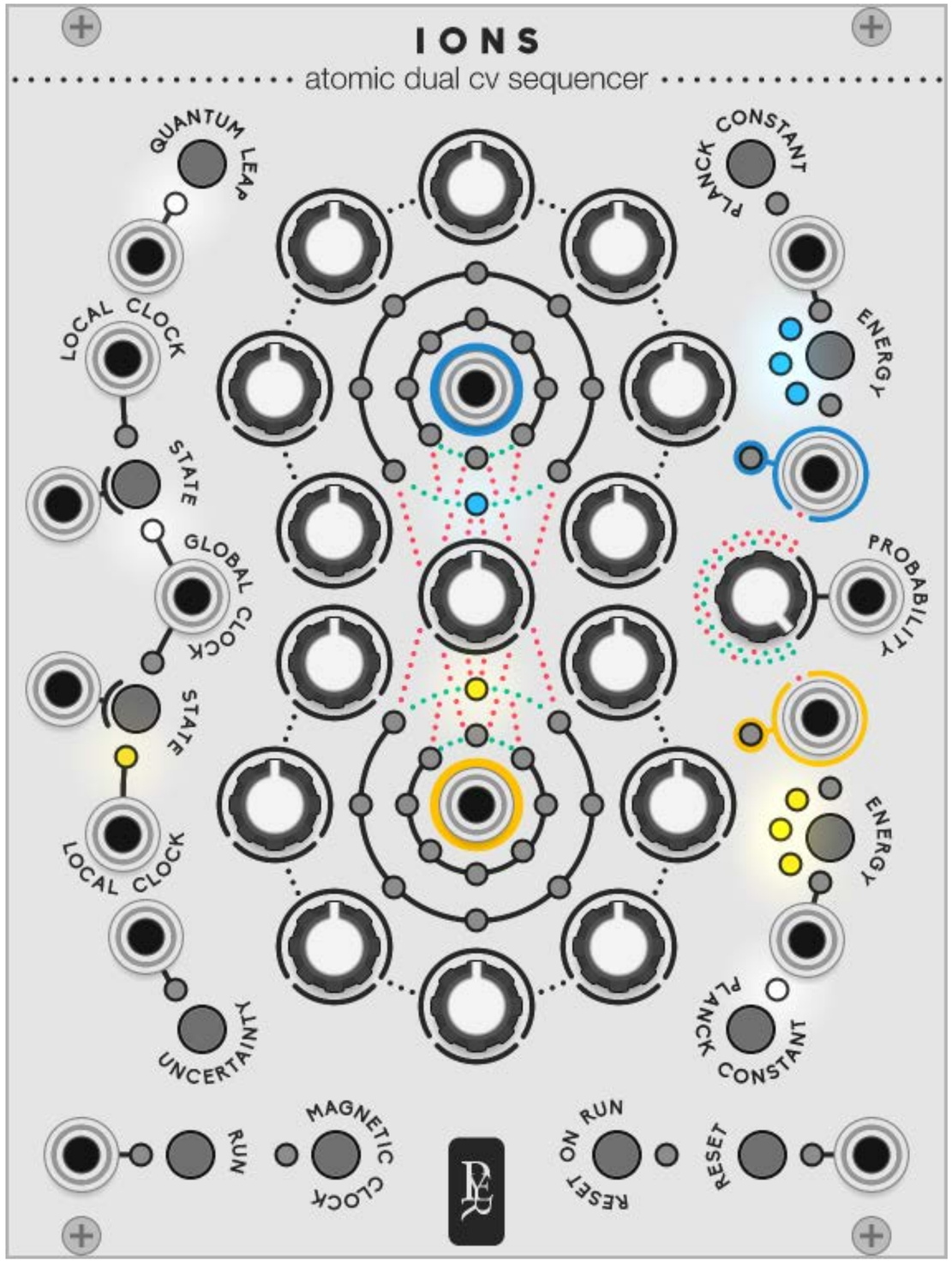
colliding sample and hold

The vibrations button

When the trigger source connected, the vibration button lights on: the brane starts to vibrate and to sample the signals on every trigger. When the vibrations are bypassed, every output will send the unsampled source input or noise.

This is useful to switch between the original signal and the quantised one.

It can also be used to momentary bypass one of the two triggers of the colliding outputs.



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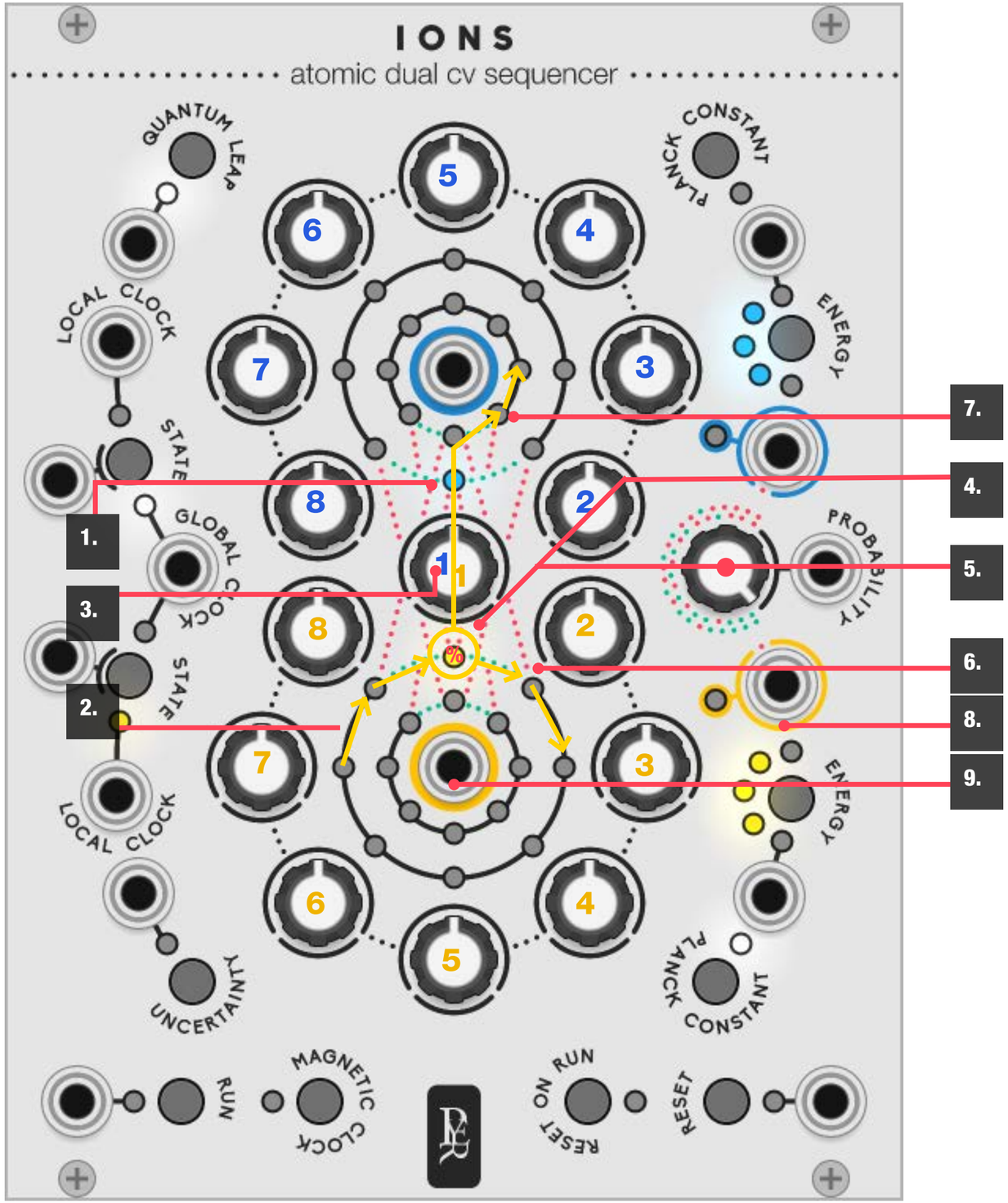
IONS is a two voices sequencer. While each voice has its own sequence, they can exchange their sequences as easily as an electron can jump from one atom to another.



How it handles the sequence

1. The two CV voices are the blue electron and the yellow electron, they each gravitate around their blue and yellow core (CV OUT).

2. The electrons are both cycling through their own 8-step sequence.

3. They share the first step of their own sequence.

4. Each time they pass through step 1, they have a **probability to switch to the other core** and run on through the other sequence. The electron still emits from its original output, but it steals the notes from the other sequence.

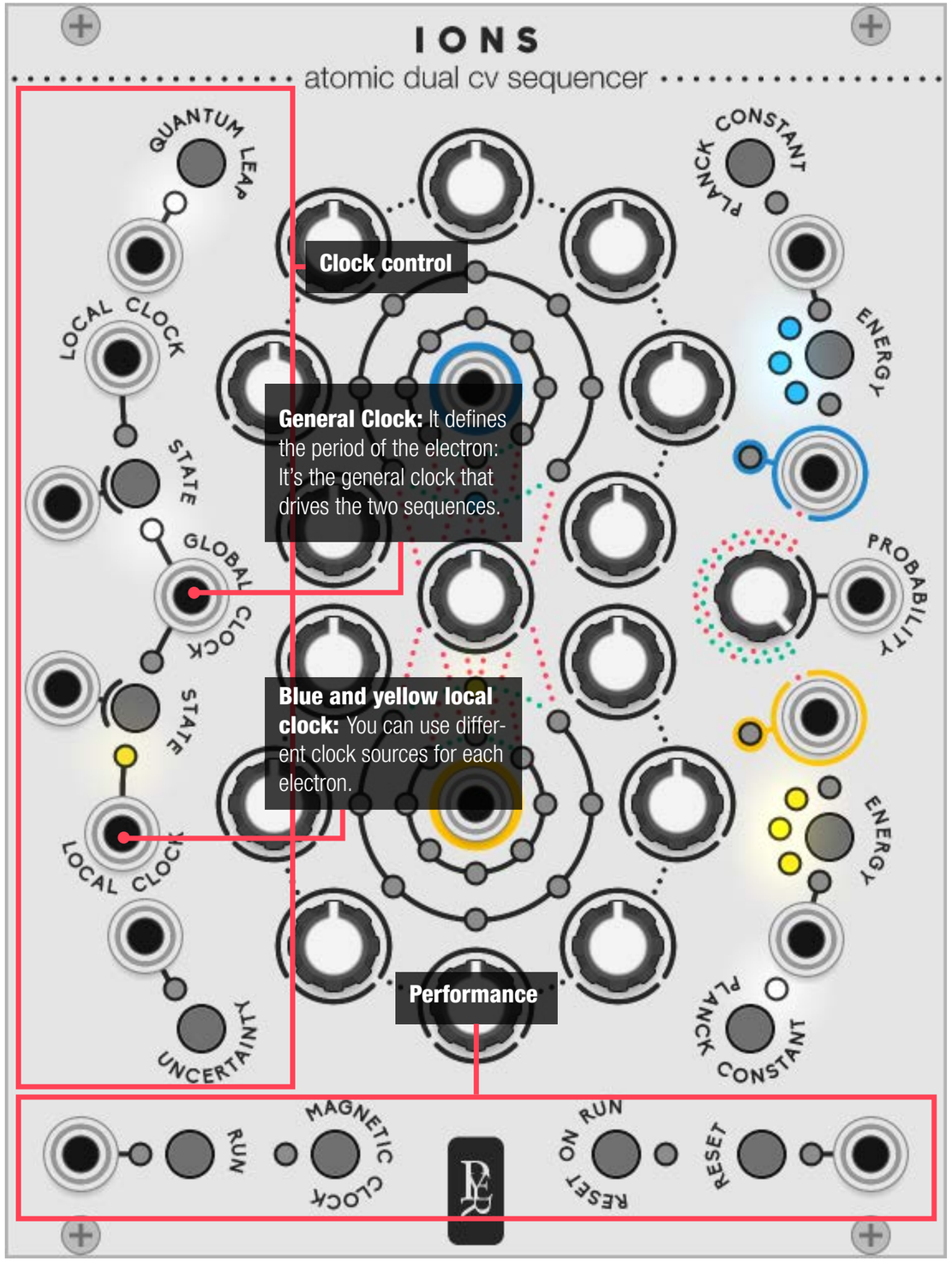
5. The probability to switch is controlled by the probability knob. And can be automated. While they share the same probability knob, they don't have the same engine, so they might be both together on the same core.

6. With a **probability of zero**, they will never switch and always stay a proper 2 voices **8 steps seq**.

7. With a **probability of 100**, they will always switch and always stay a proper 2 voices **16 steps seq**.

8. A trigger is emitted each time an electron jumps from one atom to another.

9. The Core is always linked to the original electron. The yellow core is always emitting the CV values that the yellow electron is passing through, even when it gravitates around the blue core.



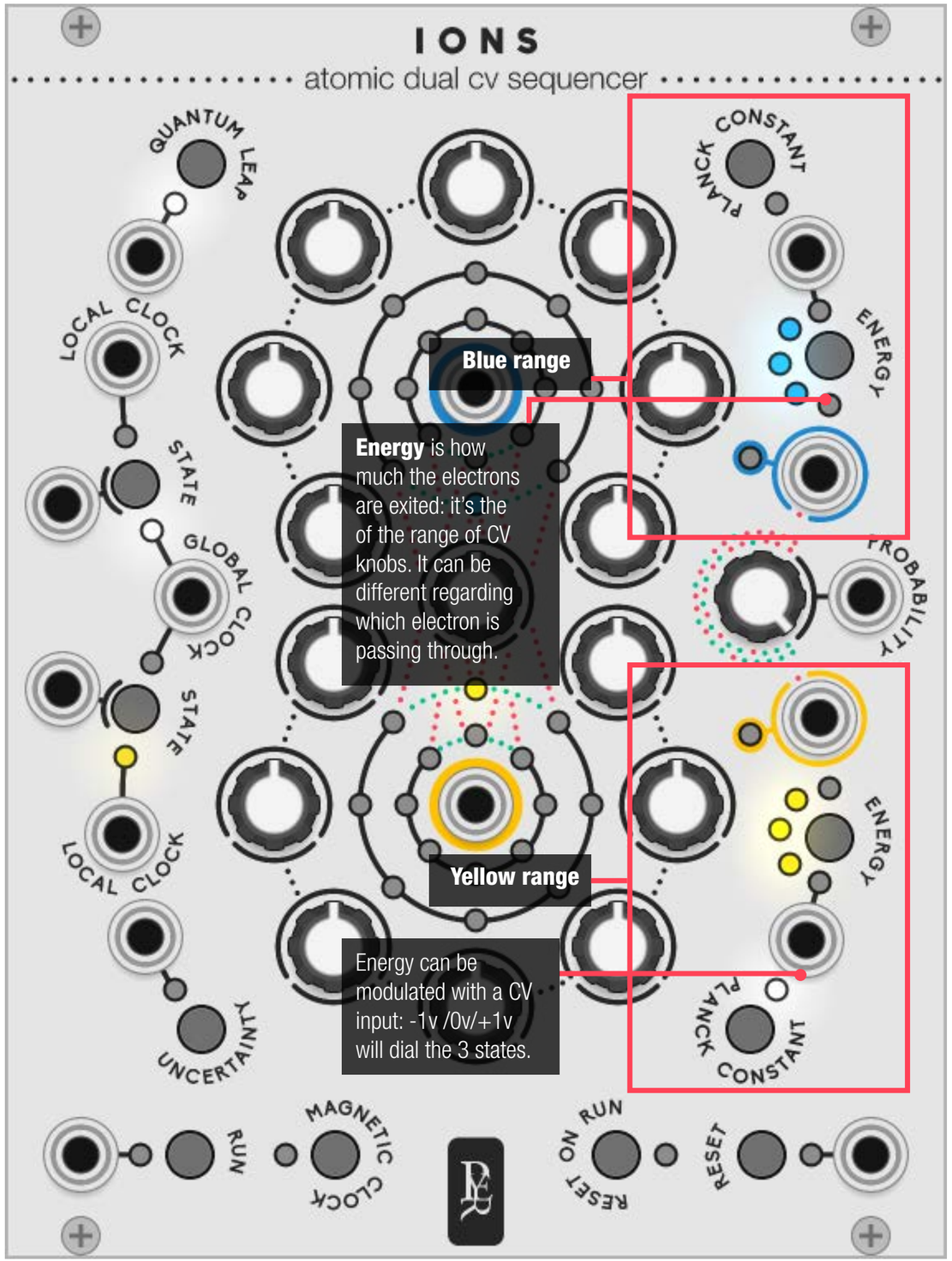
How it handles the clock:

IONS does not have an internal clock. You can use a clock for driving both sequencers at the same time, or a different clock for each sequencer … or both at the same time.

The State button: in our world, nothing can be two opposite things at the same time. But in the quantum world, an electron can have one status, or another … or both at the same time.
The state button cycles between 3 stages: each electron can be driven by the golbal clock, or their own clock … or the addition of both, for polyrhythmic effects.

State Mod can be modulated with a CV input: -1v will use the local clock. +1v will use the global clock. Anything in between will use both clocks

The magnetic clock will excite the electrons in an alternative way: It's a manual clock. It is active when the experiment is not running, to set the CV value step by step. It is also active when the experiment is running, to interact with the sequence manually, adding a bit of human mess.



How it handles the CV values:

Energy is the range of the CV knobs. Each electron has its own energy setting. When passing through a CV step, the blue electron can interpret the value with a different range than the Yellow one would do if it passes through the same step. The behaviour of energy is depending on the Planck constant.

The Planck Constant: In 1900, Max Planck discovered that the electrons were not sharing energy on a smooth and continuous way, but by very small bits: "quantums". The Planck mode will quantise the CV output and modify the energy behaviour.

When the **Planck constant is OFF**, IONS is a smooth CV sequencer with Energy defining the range of CV:

-/+ 1 volt

-/+ 5 volts

-/+ 10 volts

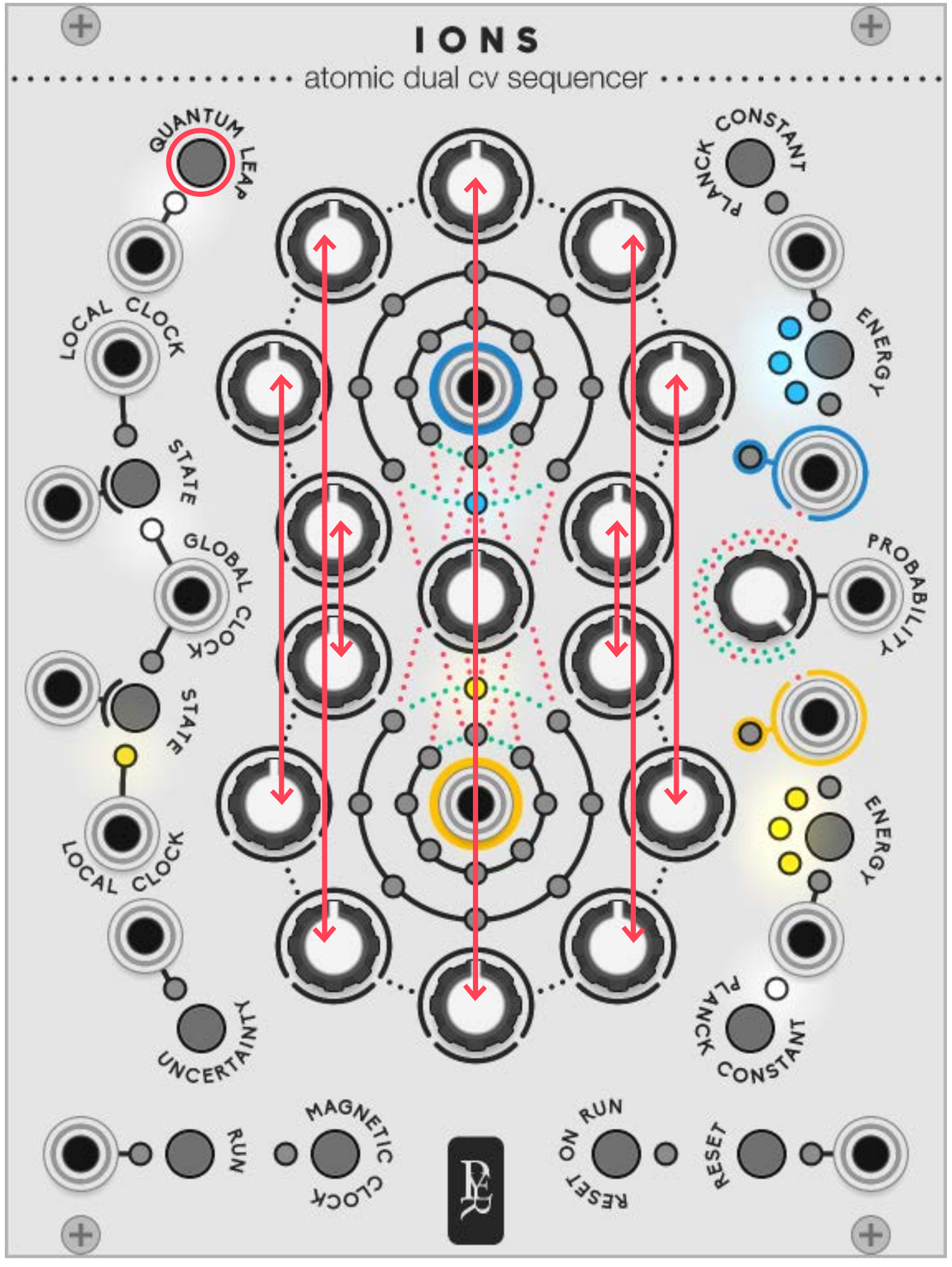
When the **Planck constant is ON**, IONS is a chromatic sequencer with Energy defining the range of CV:

1 octave

3 octaves

5 octaves

The planck constant can be set for each channel separately to generate both a melody and a free CV sequence at the same time.



Alternate Modes

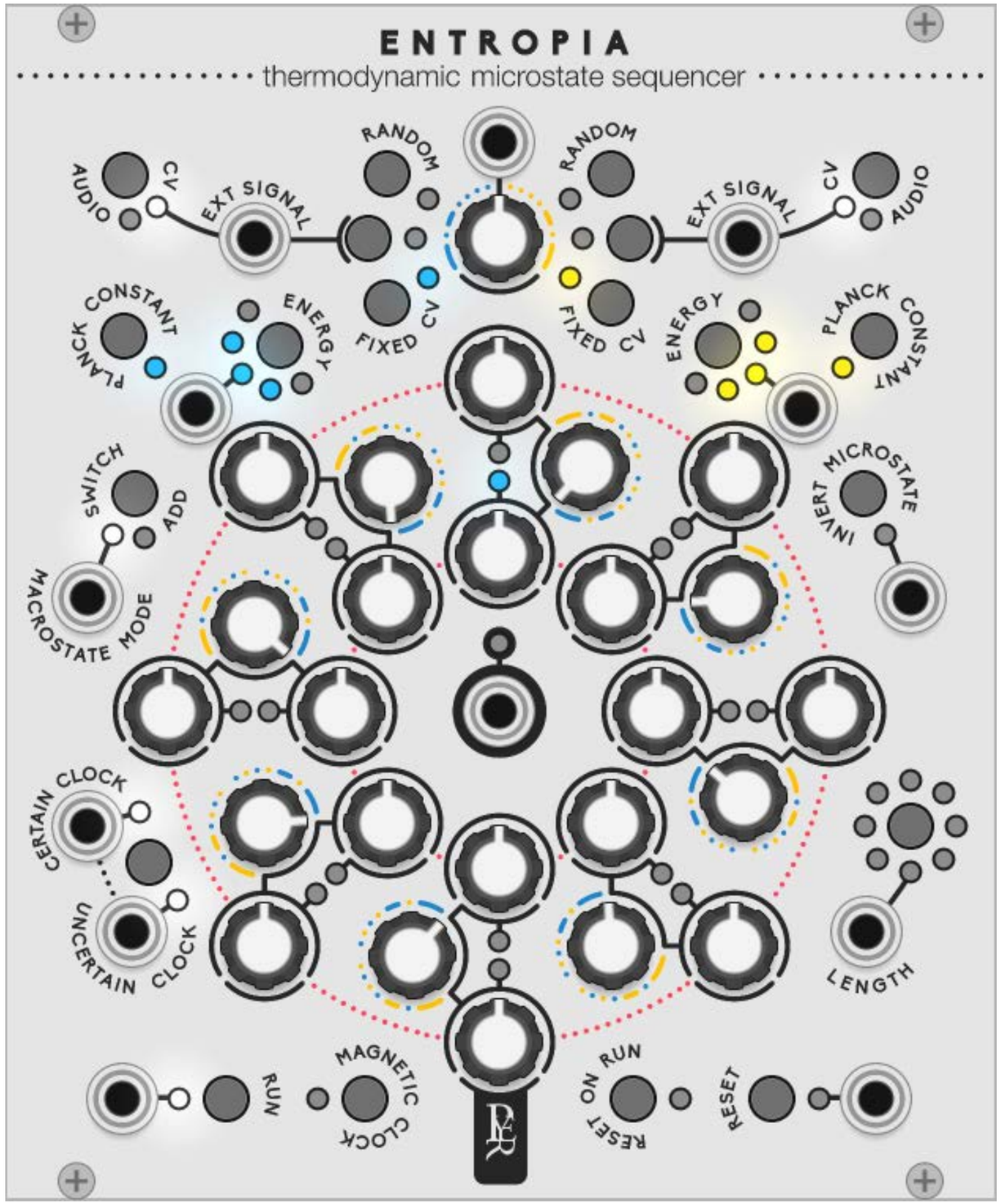
Quantum leap introduces a strange effect from quantum physic. Every step can be a gate to switch to the other core. By a smart automation of the probability knob, you can run an 8 step seq and decide to steal some notes from the other seq to have some variations.

Uncertainty principle. In quantum mechanics, Heisenberg discovered that there is no way to know with certitude both the speed and the position of a particle. Uncertainty will add different flavours of randomness in the position of the electron.

- Every trigger sent by the local clocks will move the electrons forward on a random number of steps (small values are more likely, for musical purposes).
- Every trigger sent by the reset button will place the electrons in a random place in the sequencer.
- Every trigger sent by the global and magnetic clocks will continue to work normally, one step at the time.

With Uncertainty mode ON, 4 levels of randomness can be achieved:

- **Order:** using only the global clock will move the electrons on a regular step by step way.
- **Casual random:** using both global and local clock input, with a regular clock on global and an occasional clock on local (divided, gate sequence or even manual trigger) to have some random jumps in a regular sequence
- **Linear random:** using only the local clock to have a forward random walk.
- **Chaos:** sending a clock into the reset input to have a complete random sequence. In this case, the jump probability becomes useless.



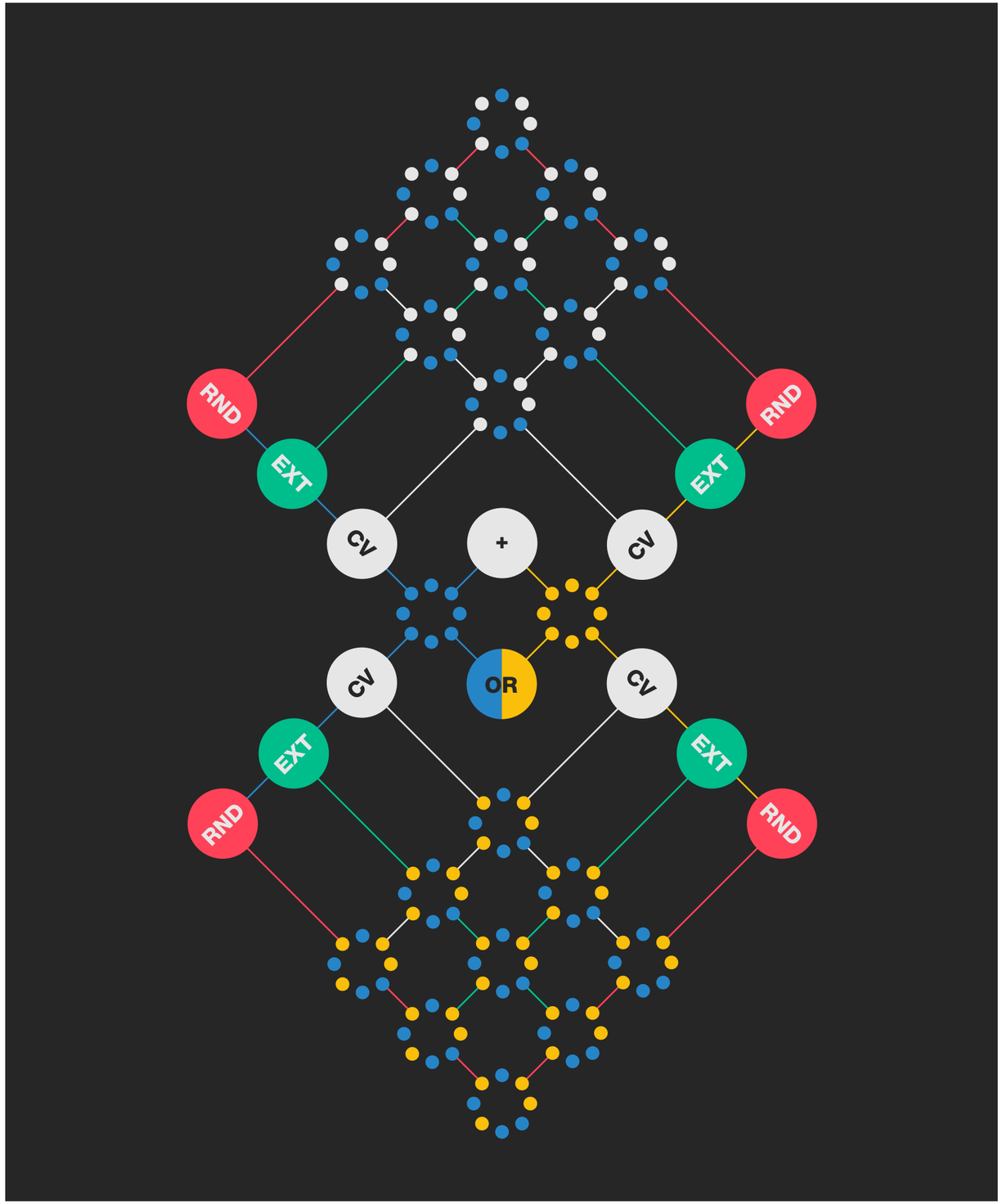
ENTROPIA

thermodynamic microstate sequencer

Entropy is a measure of disorder in a system: many microstates of atoms that create a rich and complex macrostate.

ENTROPIA is an 8-step sequencer with two values per step, and a probability to play one of the two values. Both values can be a defined sequence of voltages, a range controlled random source, or an external source.

While the controls might be intimidating, this manual will present the module in 3 concepts: the two sequences, the way they blend, and their nature to be chosen by the user.



ENTROPIA

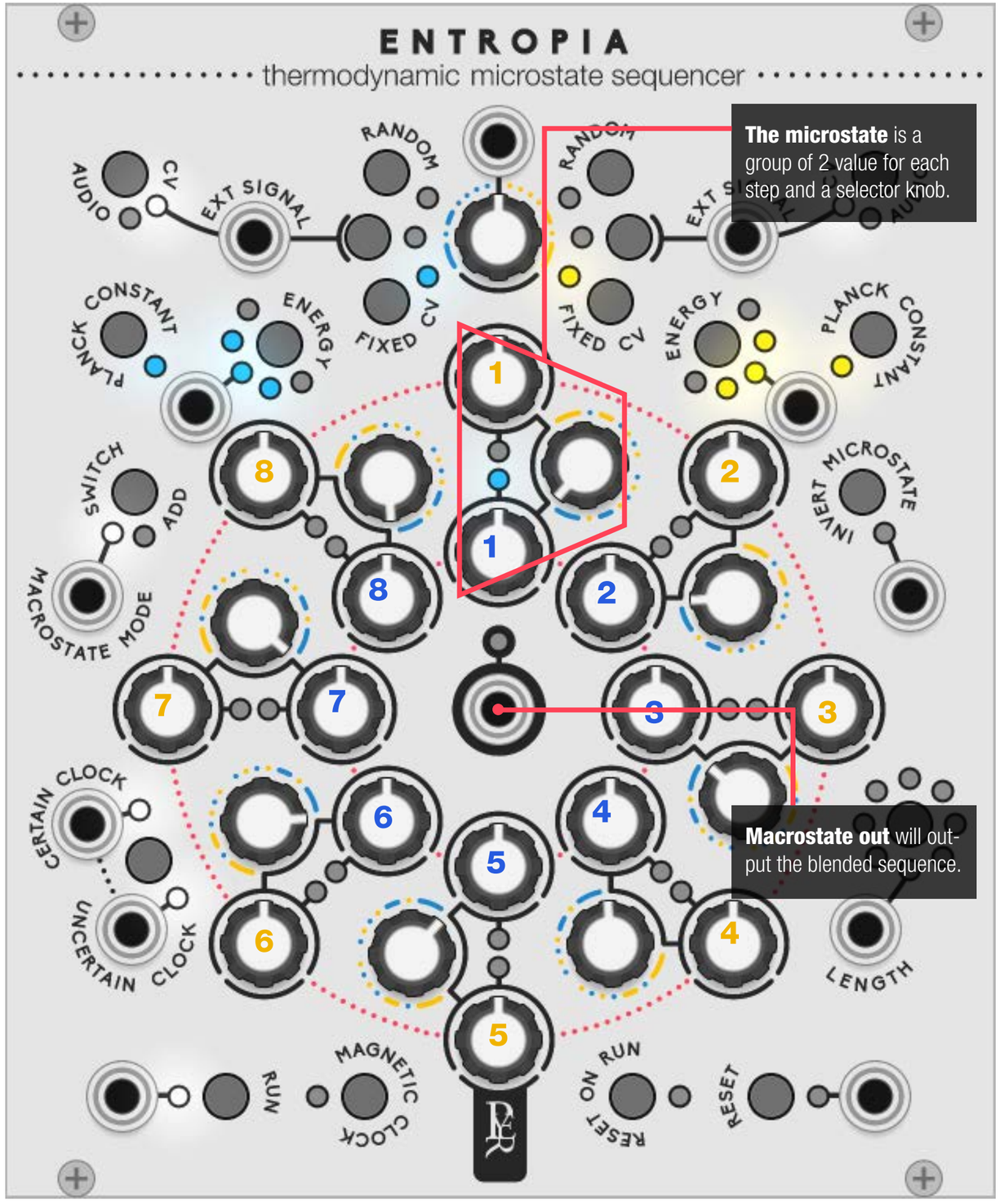
thermodynamic microstate sequencer

While the controls might be intimidating, this manual will present the module in 3 concepts:

The 2 sequences
- Blue
- Yellow

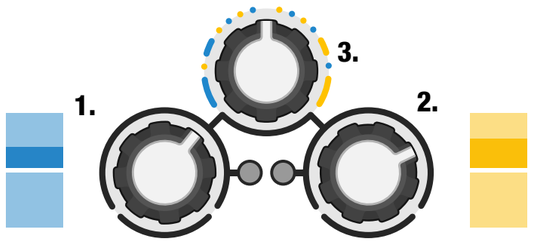
The 2 modes to blend them together
- Switch (OR)
- Add (+)

The 3 sources for each sequences
- Fixed cv
- External
- Random

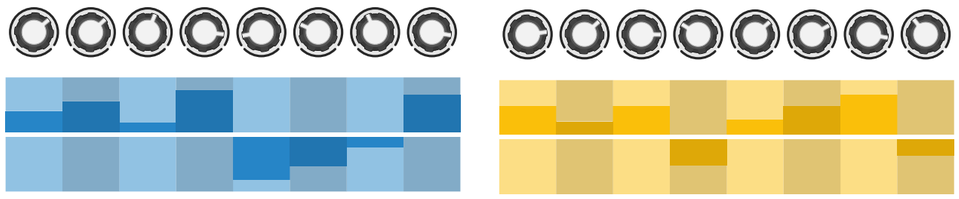


Microstate and macrostate: the two sequences

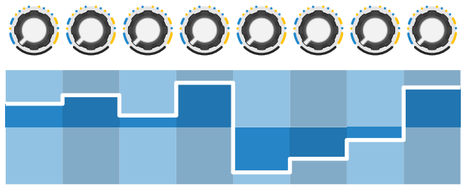
Each step of the sequencer is a **microstate:** a group of 3 knobs:
1. The blue state - primary (inner circle sequence)
2. The yellow state - secondary (outer circle sequence)
3. The probabilistic state selector



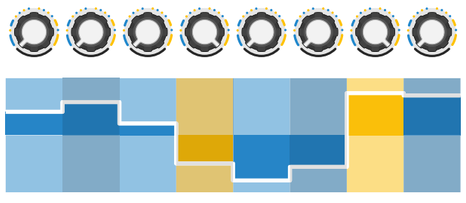
All the blue knobs and the yellow knobs determine a **blue and a yellow sequence**. The position of the state selector will define the probability to play the blue value, or the yellow one. The resulting sequence is the **macrostate.**

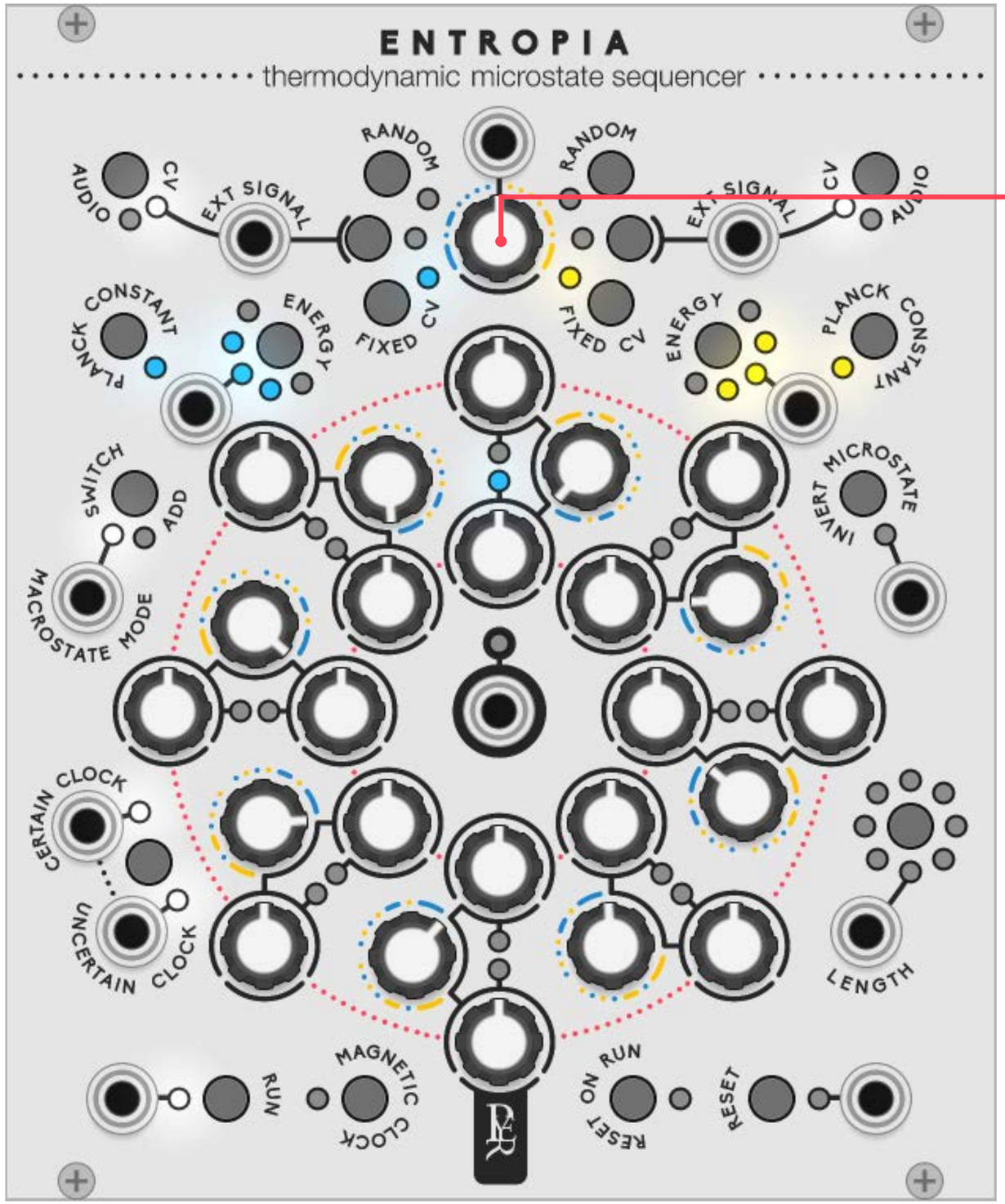


- All selectors set to full blue will only play the blue sequence, same case for yellow settings.

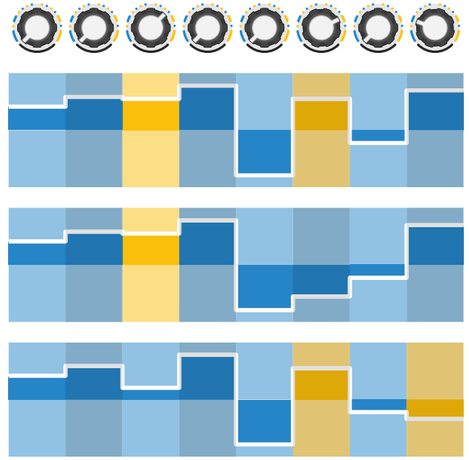


- Some selectors set to full blue and others set to full yellow will mix the sequence in a determined way.



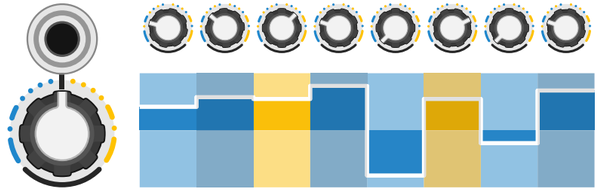


- In between value will create some probabilistic choices for each step.

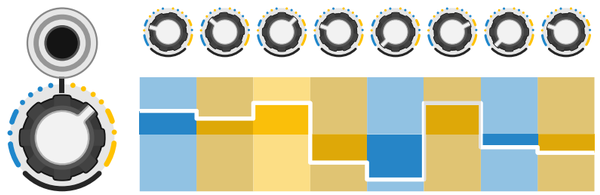


The probabilities for each step can be controlled all together by the **knob on the top**, which will add an offset to each knob. This knob is CV controllable with a -5V to +5V range.

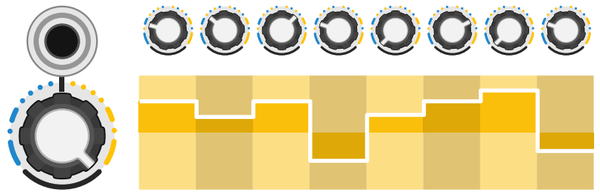
- When the offset knob is centred, it does not affect the knobs.



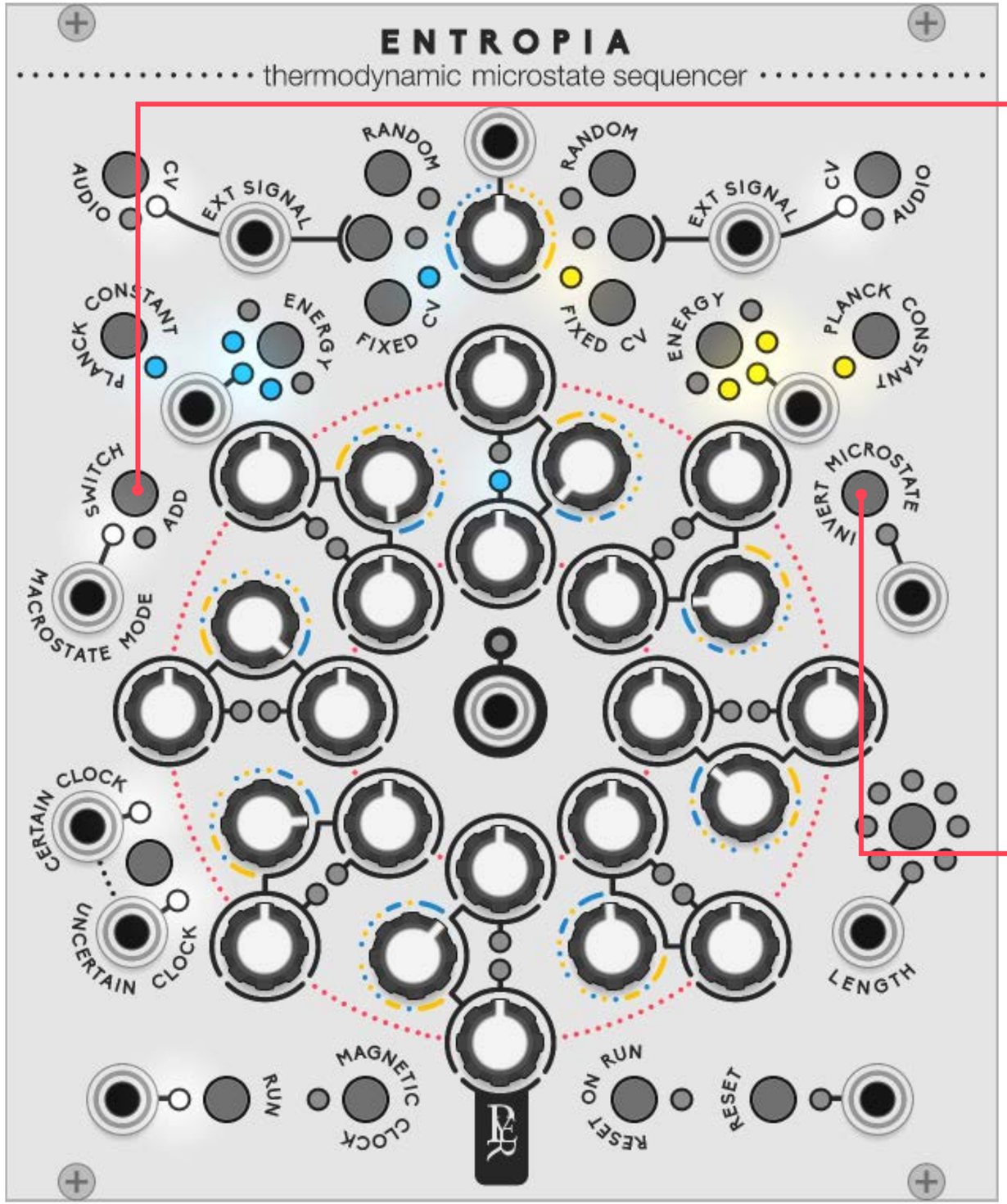
- When the offset knob is turned in the yellow direction, it adds an offset to the yellow direction for every step.



- When the offset knob is fully turned to yellow, every step will play the yellow value, no matter what the knob position is.



Slowly sweeping this knob from blue to yellow will gradually transform one sequence into another. The LED of each step will blink in their colour if they are selected when played. Ultimately, the led linked to the output will continuously light up in the colour of the selected value being played.

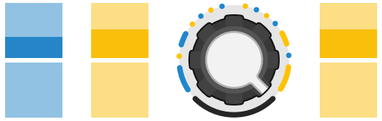


The Modes

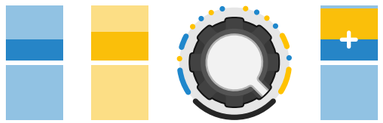
Macrostate switch / add: The default way for the sequence to blend together is switch: it will select one of the two values for each step, but another mode offers the possibility to add the two values instead of switching them. In this case, the blue sequence is considered as the default sequence, and the yellow is the added value (or subtracted if yellow is negative voltage).

When the yellow value is selected, the output sends the addition of the blue and yellow value. This allows to affect the original sequence instead of replacing it.

Switch mode

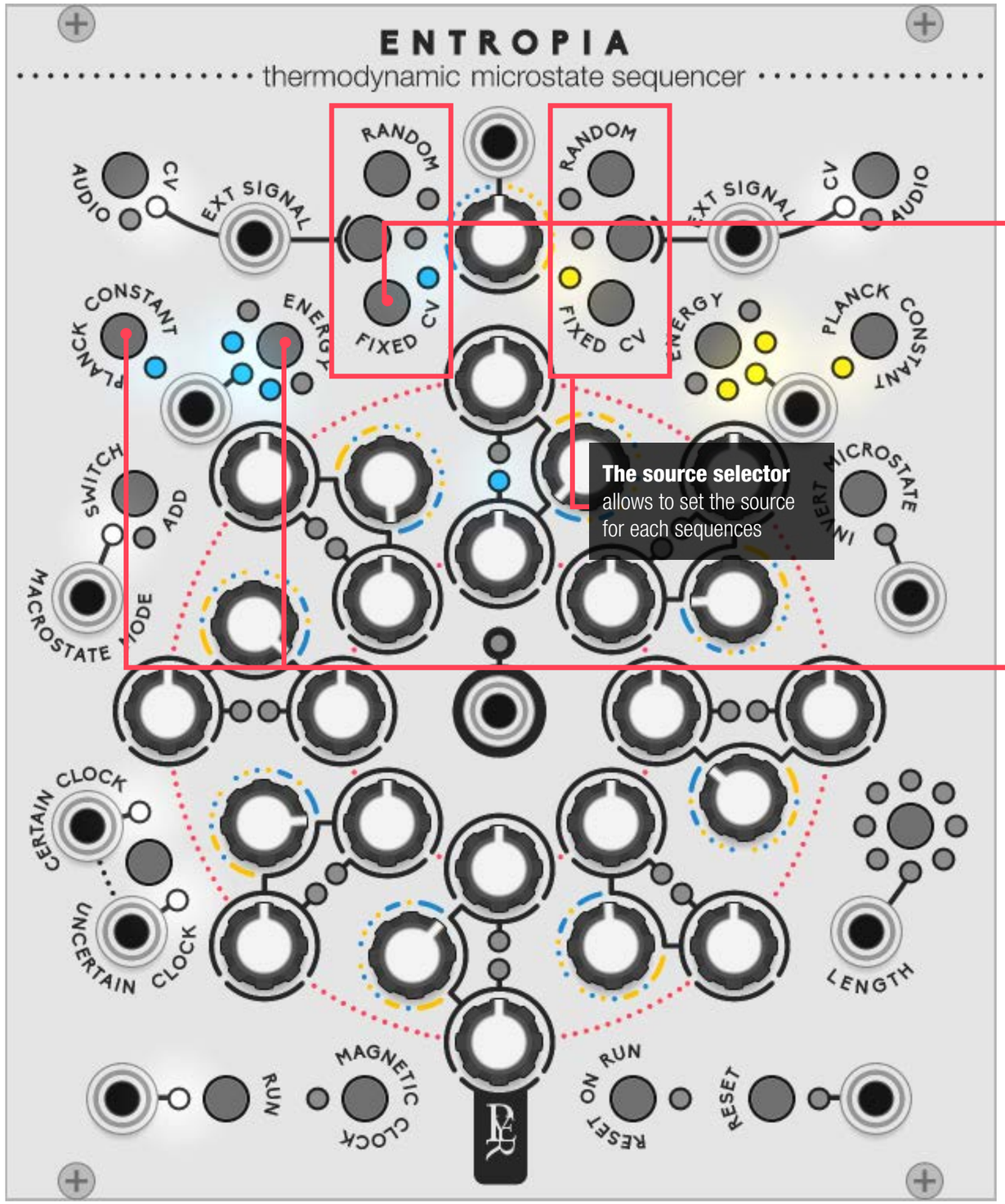


Add mode



Invert microstate: will switch the selected value with the other one. It is active when the sequencer is not running, for composition purposes along with the magnetic clock to monitor each value.

It can also be used while running as a manual intervention, or with a trigger source, faster than the clock to add rhythm and tremolo effect in the sequence.



The 3 sources for each sequence

Each sequence can output CV signals as expected, but they also can have different roles. The nature of each sequence (the blue and the yellow one) can be defined separately.

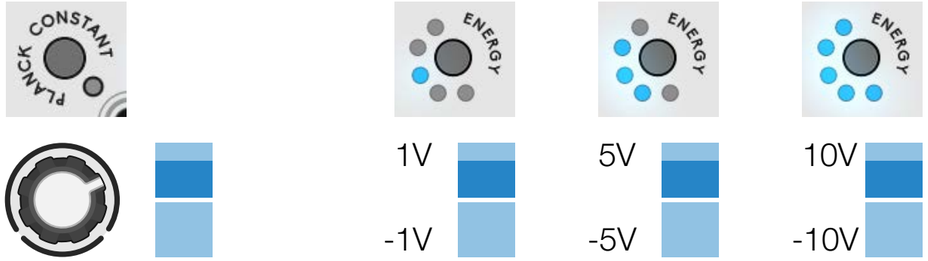
Fixed CV

Each knob defines a fixed voltage value as most sequencers works.

The value can be quantised to musical semi tones using the **Planck Constant** button, which refers to the smallest quantum of energy possible. The range of each knob can be defined with the **Energy** setting. This range will behave differently according to the Planck setting. The Fixed CV mode is the only one affected by the Planck/ Energy system.

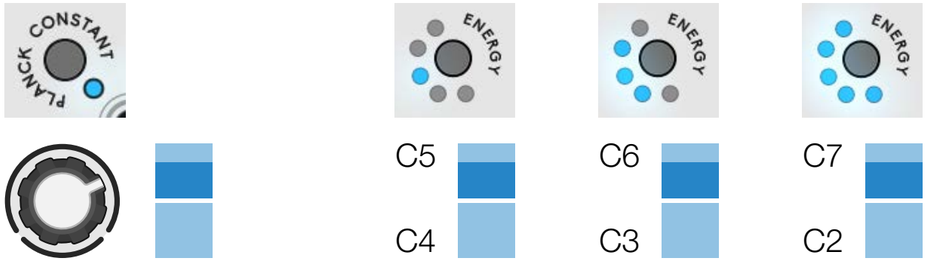
Planck Constant OFF

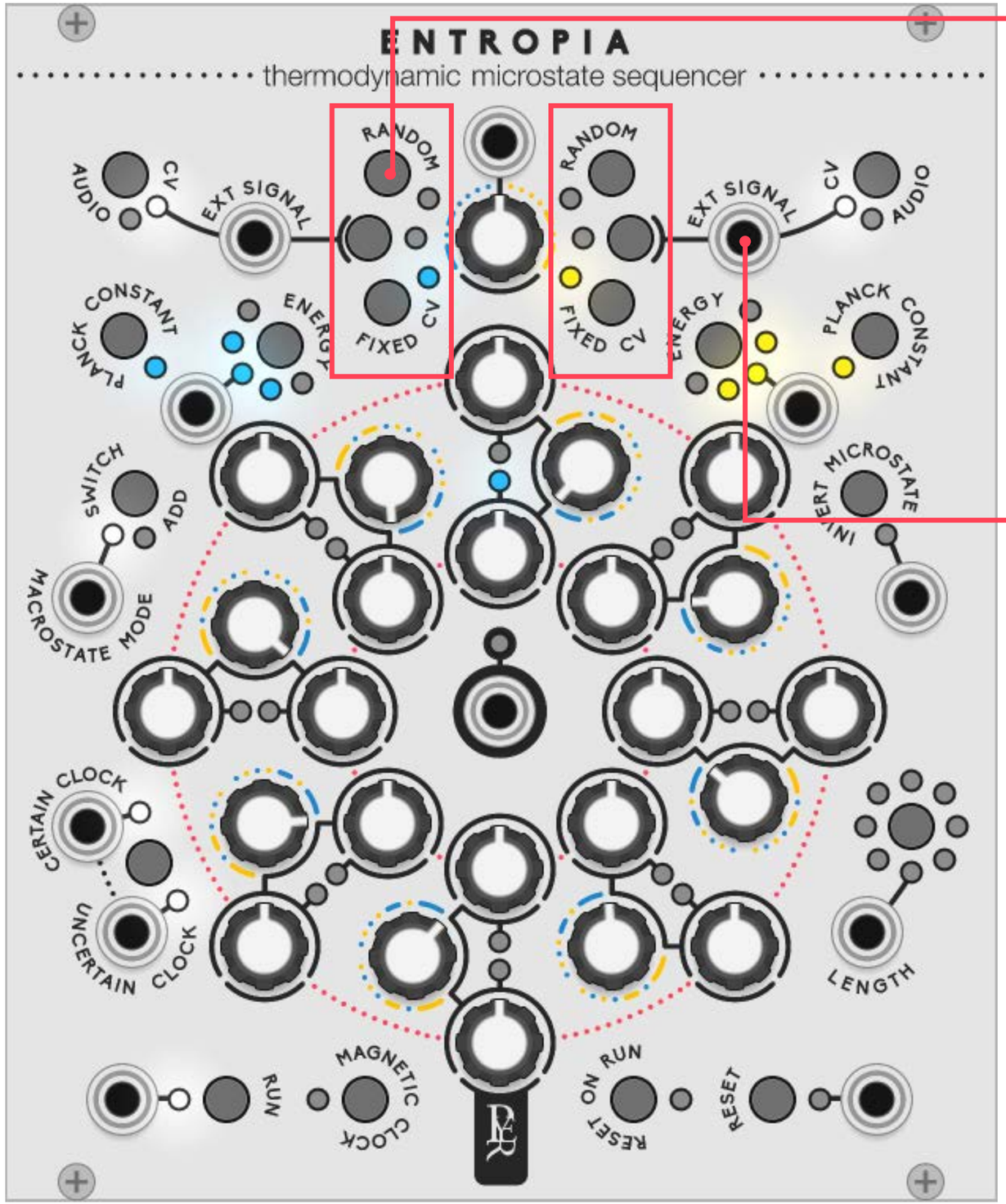
CV sequencer - smooth output



Planck Constant ON

V/Oct sequencer - 1/2 tone quantised output.

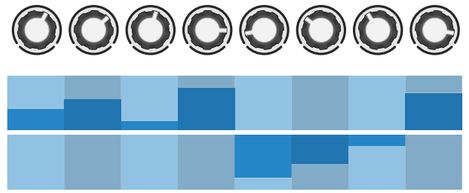




Random

The sequence can be entirely random, with an **internal random source** (0V to 5V) triggered at every clock beat. Each knob acts as an attenuverter for this random source. Extremes knob values will offer a wilder range of randomness (-5V to +5v). The behaviour of the knob is similar to a random sample and hold going through the attenuverter of BLACK HOLES

Knob sequence



Internal random source

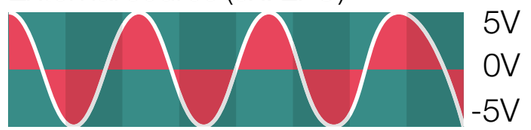
Output result

External signal

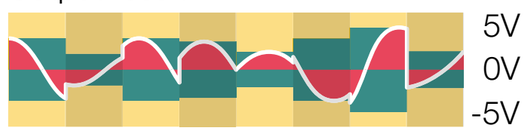
It can be **any CV or audio signal** going through the eternal signal input. The knob will act as an attenuverter for this signal with the same behaviour as BLACK HOLES. The external source can be another sequencer with preset or longer length, lfo signals, audio samples, … Anything synced with the clock of the sequencer will offer more structured result.

Knob sequence

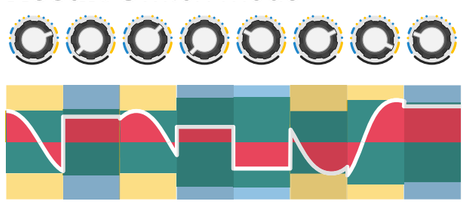
External source (ex: LFO)



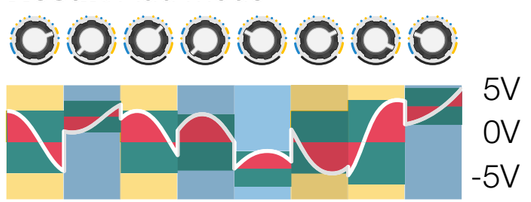
Output result

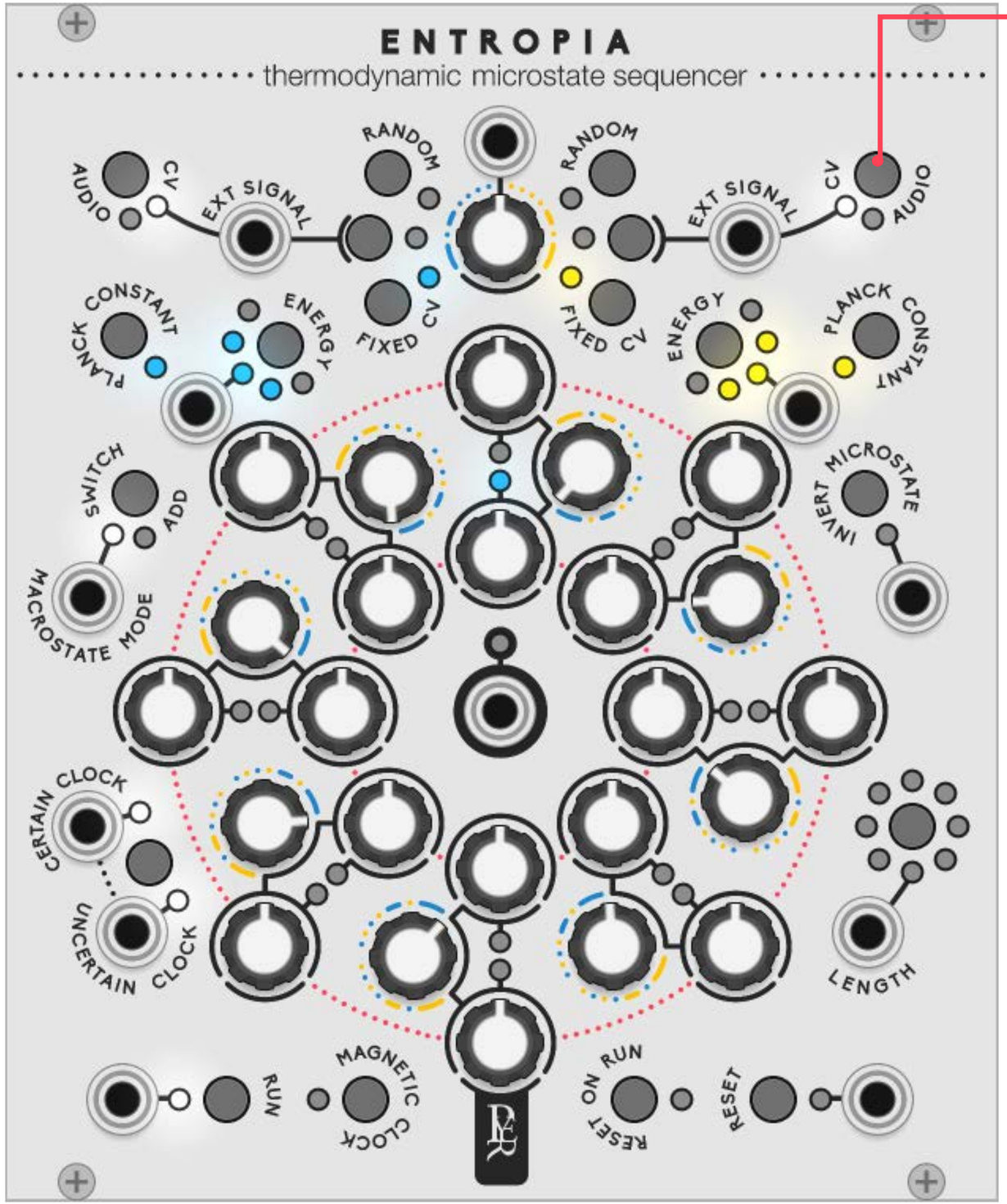


Result Switch mode



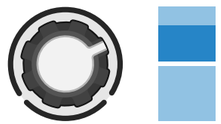
Result Add mode



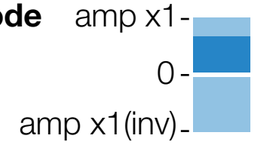


External audio mode

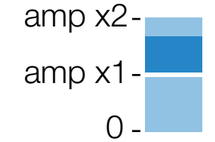
The external input is compatible with cv and audio. Each material will work in both modes, but the audio mode will add a light crossfade between each step to avoid unwanted pop and clicks. The audio mode will also change the knobs behaviour: they will become amplifiers instead of attenuverter.



CV mode



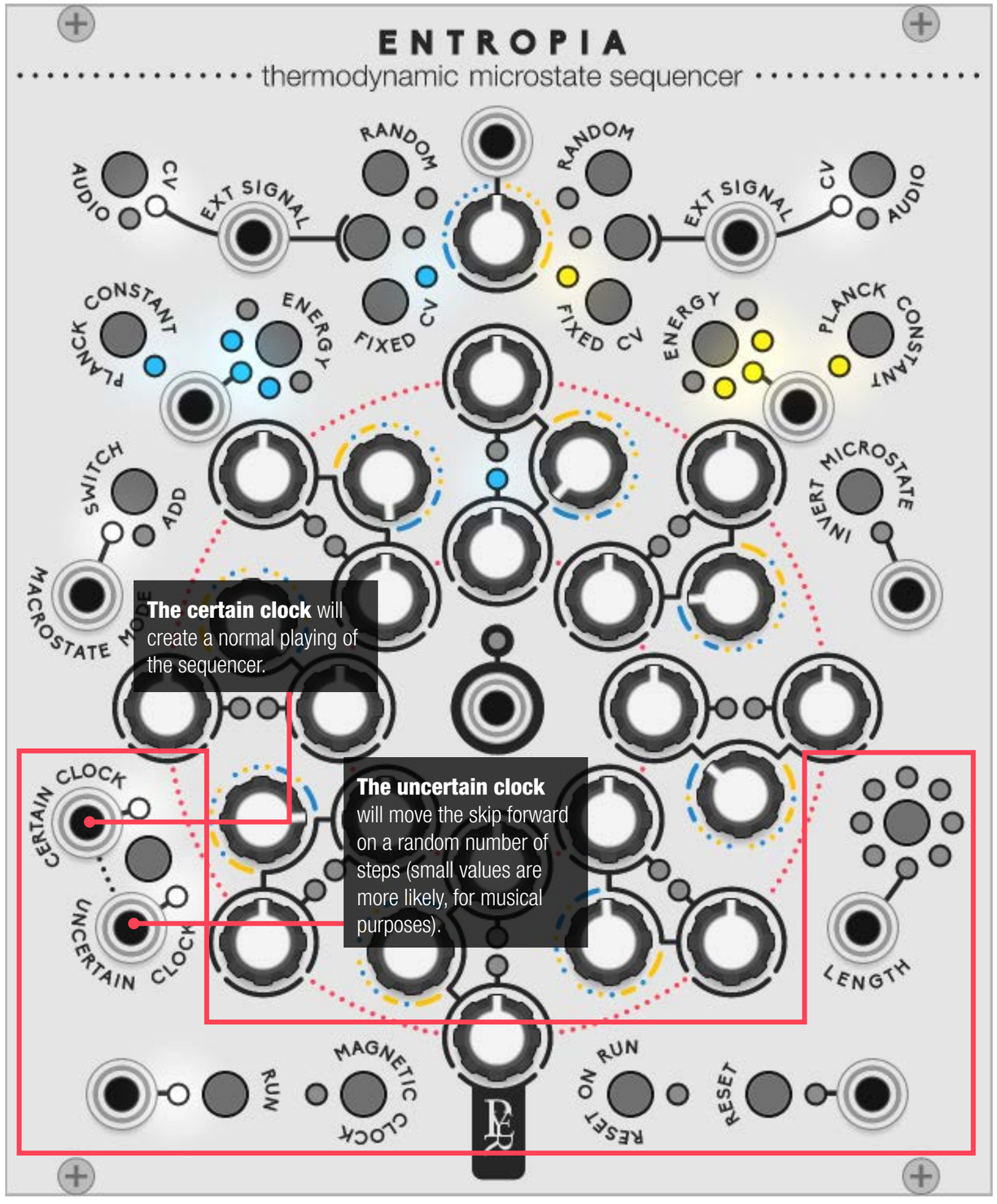
Audio mode



With 3 sources for both sequences and two blend modes there are 18 different ways to use the sequencer.

Some notable examples would be:

- **CV** switch **CV**
  Blending or replacing two sequences, transforming one sequence into another.
- **CV** switch **RANDOM**
  introducing chaos into a determined sequence up to complete random
- **CV** add **RANDOM**
  with small random range, a determined CV sequence can be perturbed for light being out of tune or hitting the next note in the scale instead of the determined one.
- **EXT** add **RANDOM**
  With external receiving another sequencer with clock sync to ENTROPIA, to add a bit of randomness to your favourite sequencer. The external sequence circle needs to be turned fully clockwise to respect the initial received value.
- **EXT** switch **EXT**:
  With each external receiving two different sequencers with clock sync to ENTROPIA, more advanced modules with preset of very long sequence length can be mixed together. Blue and yellow knobs need to be turned fully clockwise to respect the initial received value.
- **EXT** switch **EXT**:
  With two LFO signals (one slow and one fast), this will create a complex LFO signal with an amplitude defined for each step.



- **EXT** switch **EXT**:
  With two audio samples or complete sequenced synth voices. The sound can be step gated with the amp control for each knob, and then switched or mixed together.

Performance control

The bottom controls are the classic command of play, reset, and reset on run. **The length button** will kill steps. Each push will turn an additional led to red and won't play the matching step. This can be controlled by a 0 to10V input.

The Two clock inputs

There is no internal clock in ENTROPIA, it needs to be fed by a pulse signal. The certain clock will create a normal playing of the sequencer.

According to Heisenberg, Uncertainty principle means that there is no way to know with certitude both the speed and the position of a particle at the same time. Any pulse received in the uncertain clock input will result in a random jump of steps. The selector will bypass the clocks. Both clocks can be fed at the same time to combine a controlled ratio of chaos and order.

The magnetic clock will excite the electrons in an alternative way: It's a manual clock. It is active when the experiment is not running, to monitor and set the CV value step by step. Combined with the **State switch button**, it will allow to edit every value at will. It is also active when the experiment is running, to interact with the sequence manually, adding a bit of human mess.

A good start...

Here is the most basic way to use the sequencer and start having fun!

- Have the two sequences in fixed CV mode.
- Edit the blue and yellow value with magnetic clock and state switch.
- Turn the general knob to blue.
- Run the sequencer.
- While running, turn slowly the knob to yellow and listen the metamorphose of your sequence from the blue one to the yellow one.

GEODESICS

A modular collection for VCV Rack by Pyer & Marc Boulé

Geodesics has been created in July 2018 by **Pierre Collard** (industrial and graphic designer based in Brussels) and **Marc Boulé** (developer and creator of Impromptu Modular based in Montréal).

Just like many projects within VCV Rack, Geodesics is also a community effort and it would not have been possible without the help of many users, composers and developers participating one way or another to enhance the quality of the project.

Amoung them we would like to adress a special thank to those who helped us in the beta testing phases, who made toturials, who proposed their help in any way and those who brought the collection to life with some great pieces of music: **Omri Cohen, Georg Carlson, Xavier Belmont, Steve Baker, Marc Demers, Adi Quinn, Ben De Groot, Latif Karoumi, Espen Storo, Synthikat, Dave Phillis, Carbonic Acid**, **Martin Luders**, **Ghalebor, Stephen Askew, Lars Bjerregaard, Richard Squires, Lorenzo Fornaciari, Adi Quinn, NO rchestra, Poxbox23** and **Ananda Bhishma.**

Geodesics links
www.pyer.be/geodesics
vcvrack.com/plugins.html#Geodesics
github.com/MarcBoule/Geodesics

Creations from composers using Geodesics:
https://www.youtube.com/playlist?list=PLEh-5QLxa-BlqLl9rBcncUTFm2Lk-ZMgvZ

Tutorials on Geodesics by Omri Cohen:
https://www.youtube.com/playlist?list=PLEh-5QLxa-Blr4dsurkkwUehFsNl7T_Jv-

Marc's work links
github.com/MarcBoule/ImpromptuModular

Pierre's work links
www.pyer.be

Coded and released by Marc Boulé - Concept and visuals by Pierre Collard