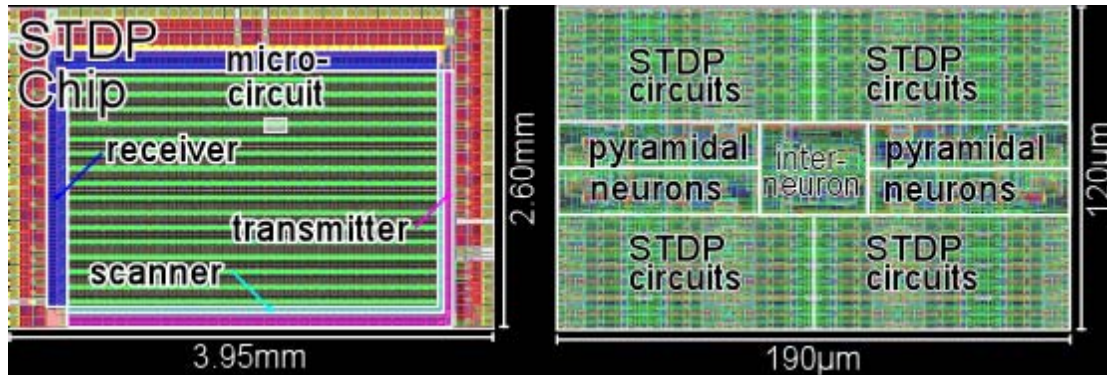


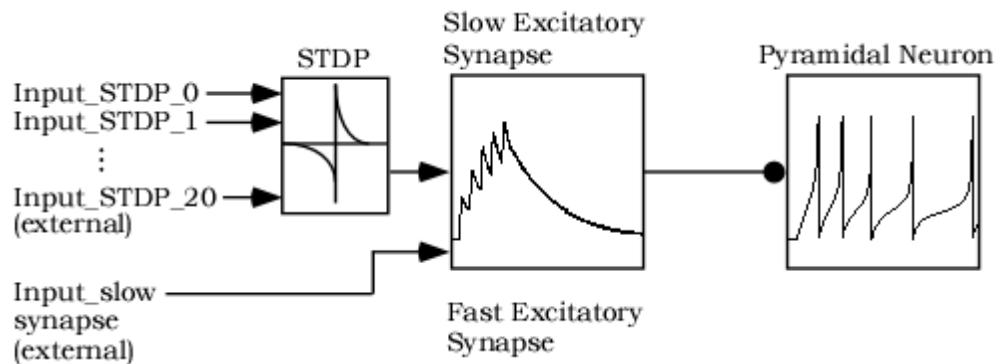
Inputs, Outputs, and Connectivity



The chip has a 16 x 16 array of 'microcircuits'.

**Each microcircuit includes 1 interneuron and 4 pyramidal neurons.
Each pyramidal neuron has 21 plastic synaptic (STDP) inputs.**

Pyramidal Cell: Somatic slow excitation



Twenty-one STDP synapses and a fixed synapse provide slow excitation.

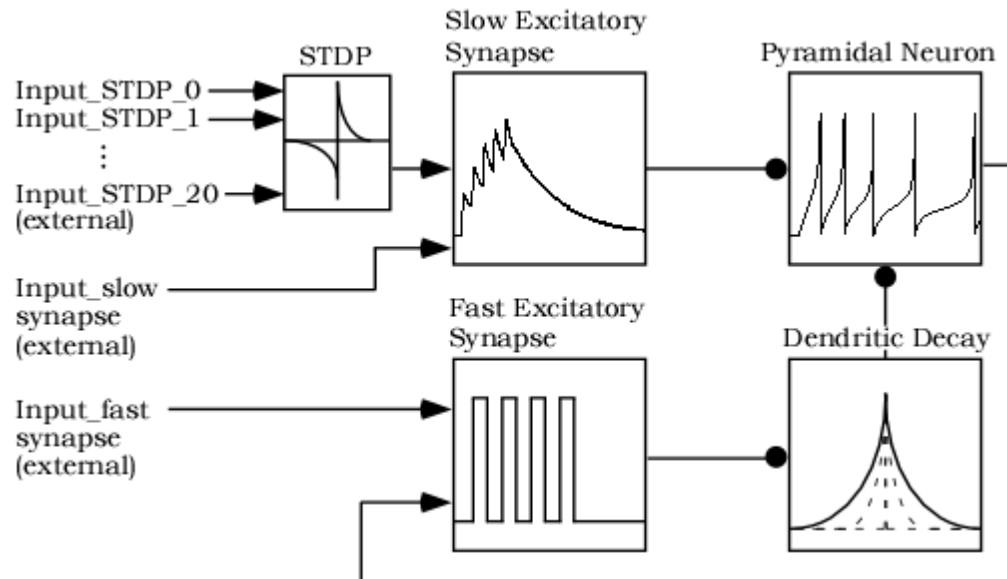
All 21 STDP inputs, as well as a fixed (nonplastic) input, excite the same population of synaptic receptors.

This population is modeled with a single synaptic receptor circuit.

The transmitter these two input types evoke is modeled by two cleft circuits; their decay rates may differ.

Thus the rise-times can be different, even though the synaptic amplitude is the same.

Pyramidal Cell: Dendritic fast excitation



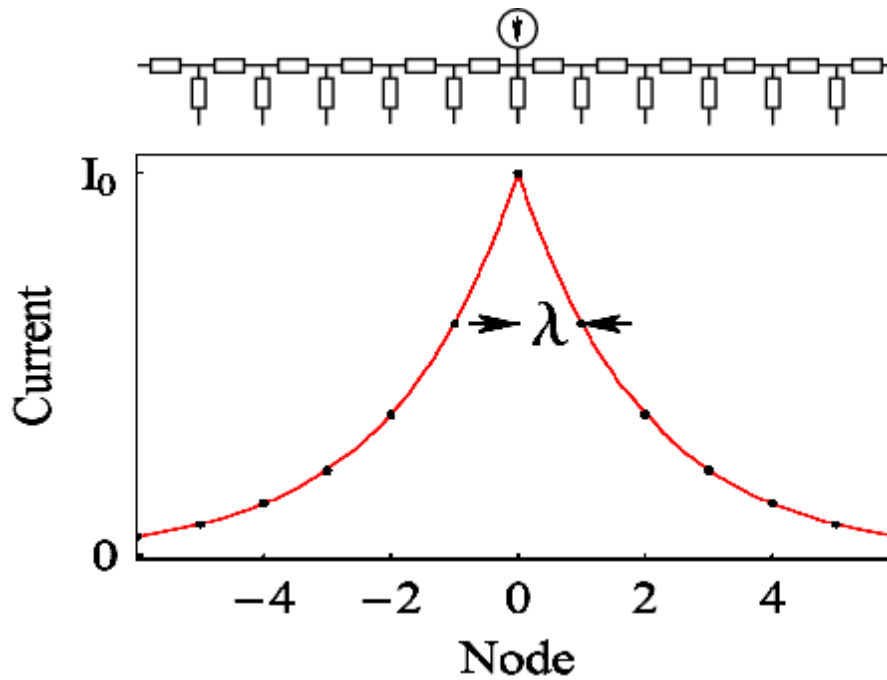
Recurrent connections and an external input provide fast excitation.

Pyramidal cells excite each other locally using fast synapses, unlike the STDP synapses, which are slow.

These recurrent connections target their dendritic arbor, unlike the STPD synapse, which target the soma.

They excite the same population of synaptic receptor, modeled with a single synapse circuit.

Dendritic arbor



Cable model captures decremental current spread in dendritic arbor.

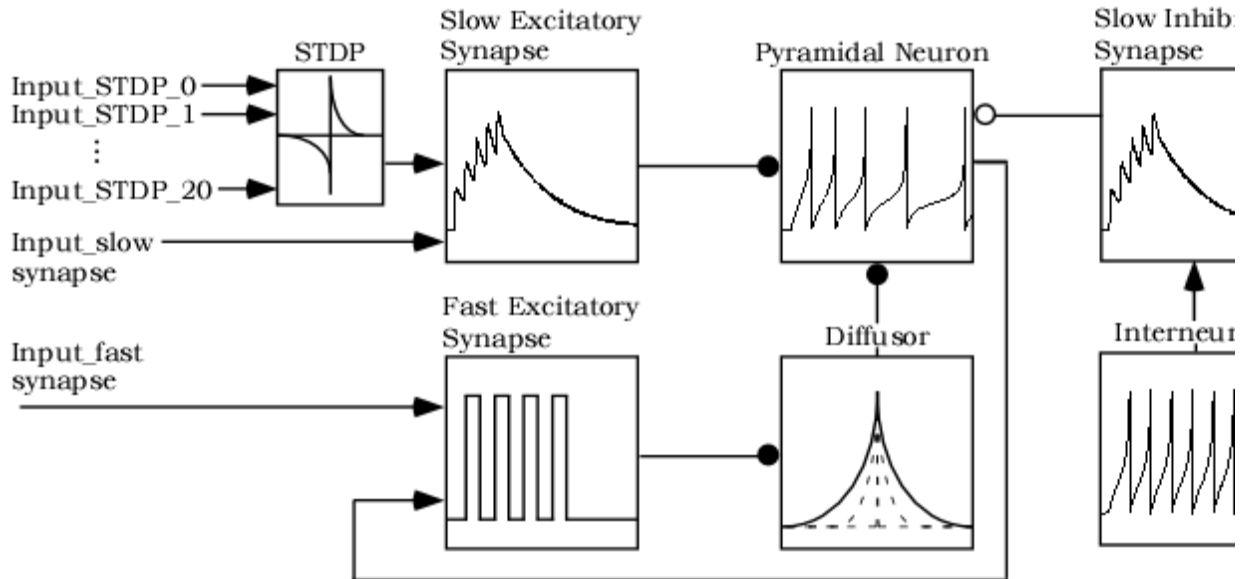
Synaptic input decays as it propagates along the dendrite, toward the soma; a cable behaves the same way.

The dendrite's membrane and axial conductance are mimicked with transistors (called diffusors).

The conductance ratio determines the electrotonic length (aka, space-constant); it is adjustable in the silicon model.

The dendritic arbors of pyramidal cells and interneurons can have different electrotonic lengths.

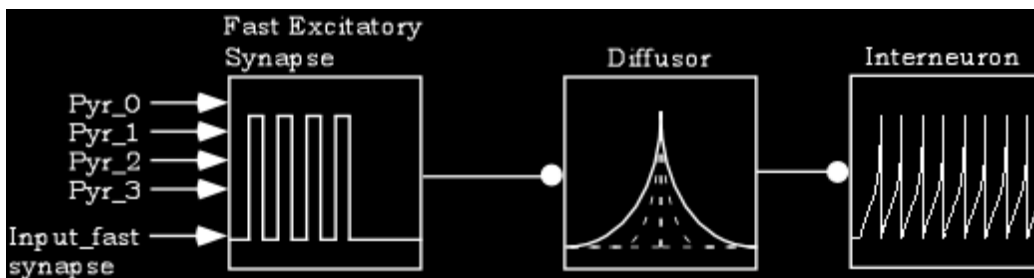
Pyramidal Cell: Slow inhibition



Interneurons input provide slow inhibition.

A pyramidal cell receives somatic slow inhibition from its local interneuron.

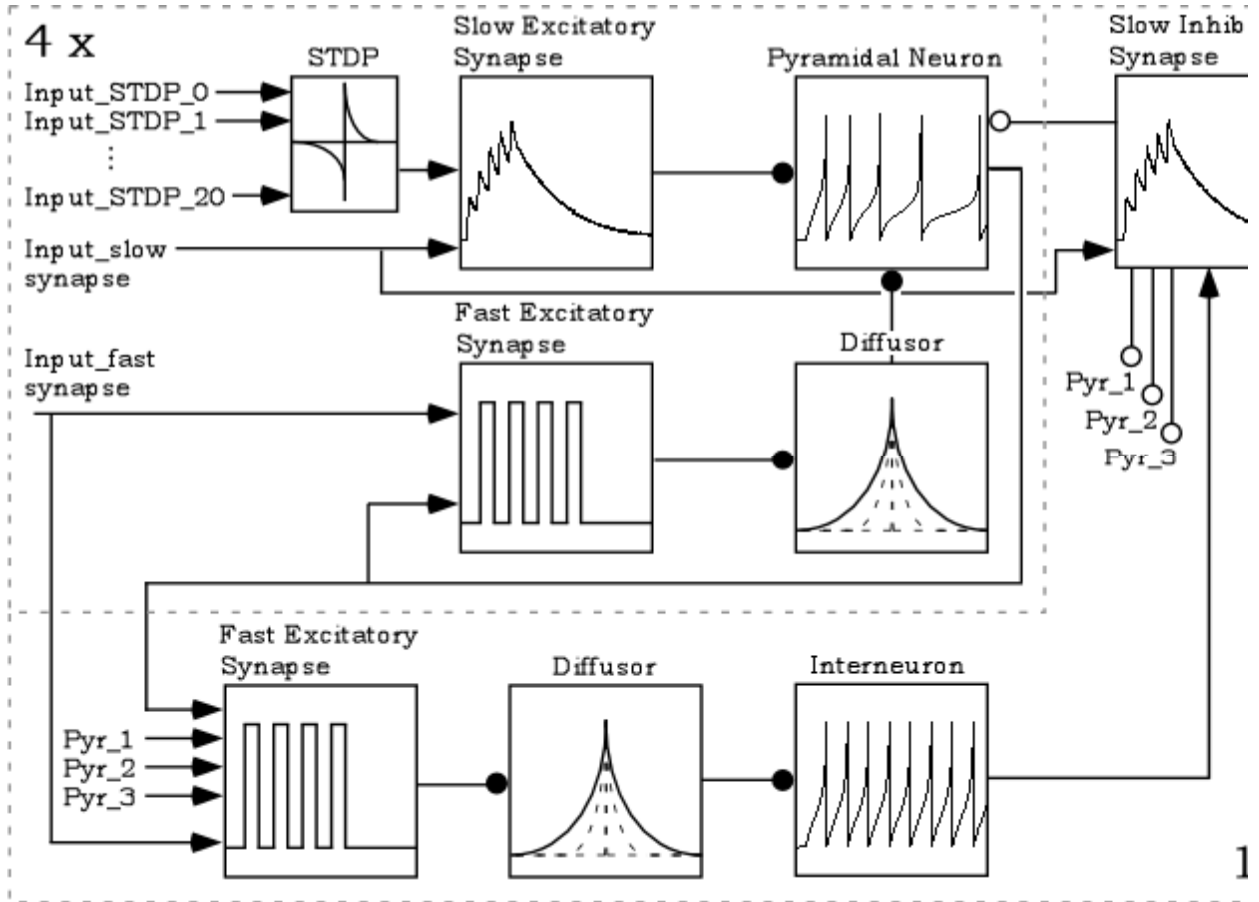
Interneuron: Fast Excitation



An interneuron receives fast excitation.

An interneuron receives fast excitatory synaptic input from neighboring pyramidal cells through its dendritic arbor.

Complete Microcircuit Connections



1

Some inputs drive multiple targets.

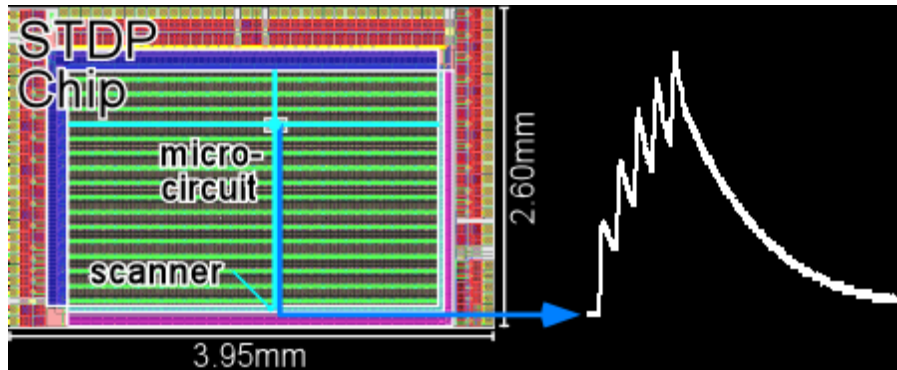
Many inputs are shared.

-the fixed input to the slow excitatory synapse (Input_slow) also drives the slow inhibitory synapse

-both inputs to a pyramidal neuron's fast excitatory synapse (input_fast and its own spike) drive the interneurons fast excitatory synapse as well

Although the same signal drives multiple inputs, their strengths can be controlled independently.

Scanner



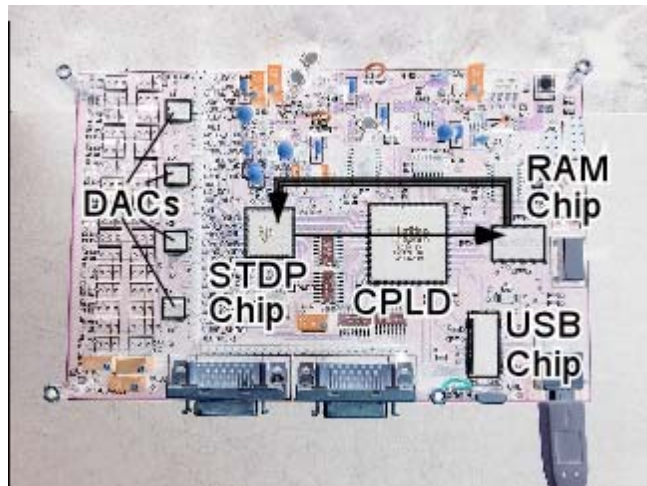
The scanner selects a single element within a single microcircuit.

The scanner can select a pyramidal neuron's membrane, its slow excitatory synapse current, or its m-current conductance.

It can select an interneuron's membrane or its slow inhibitory current.

Further, the scanner can read out each STDP element's state sequentially.

Look-up Table



A look-up table is implemented using a RAM.

When a pyramidal neuron spikes it can excite up to 32 (arbitrary) synapses on the chip.