

# Application of Spiking Neural Networks Based on Sunway TaihuLight

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# Spiking Neural Network

- operate using spikes, which are discrete events that take place at points in time, rather than continuous values.
- is determined by **differential equations** that represent various biological processes, the most important of which is the membrane potential of the neuron.

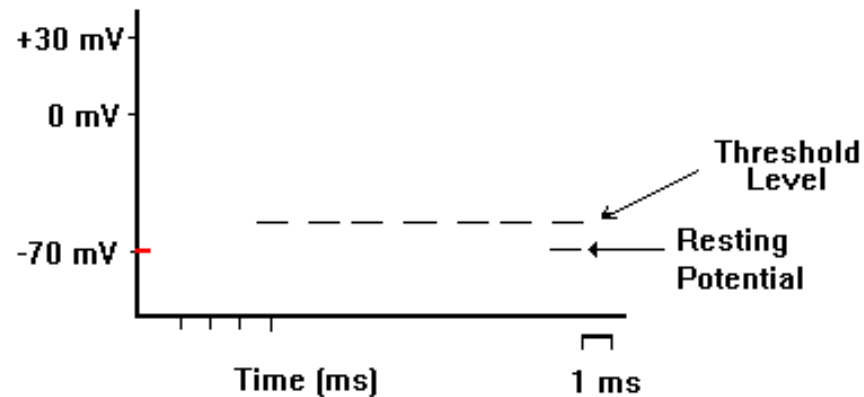
\cite{https://towardsdatascience.com/spiking-neural-networks-the-next-generation-of-machine-learning-84e167f4eb2b}



Differential equation for membrane potential  
in the Leaky Integrate-And-Fire(LIF) model

$$I(t) - \frac{V_m(t)}{R_m} = C_m \frac{dV_m(t)}{dt}$$

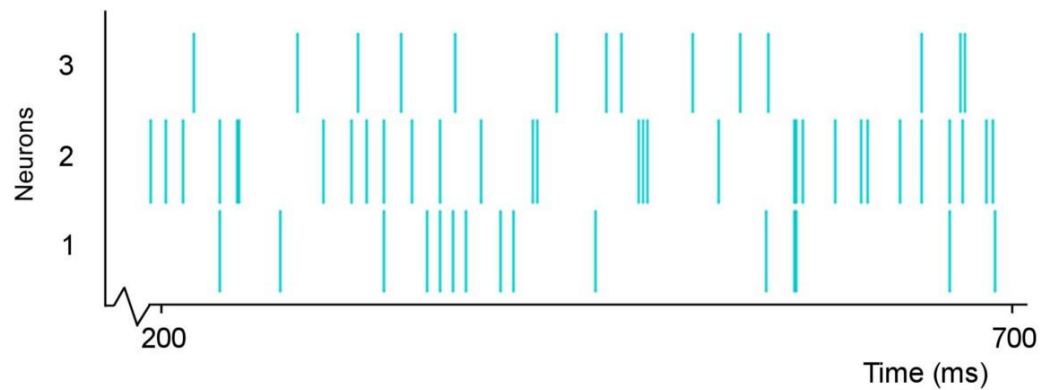
Membrane potential behavior during a spike



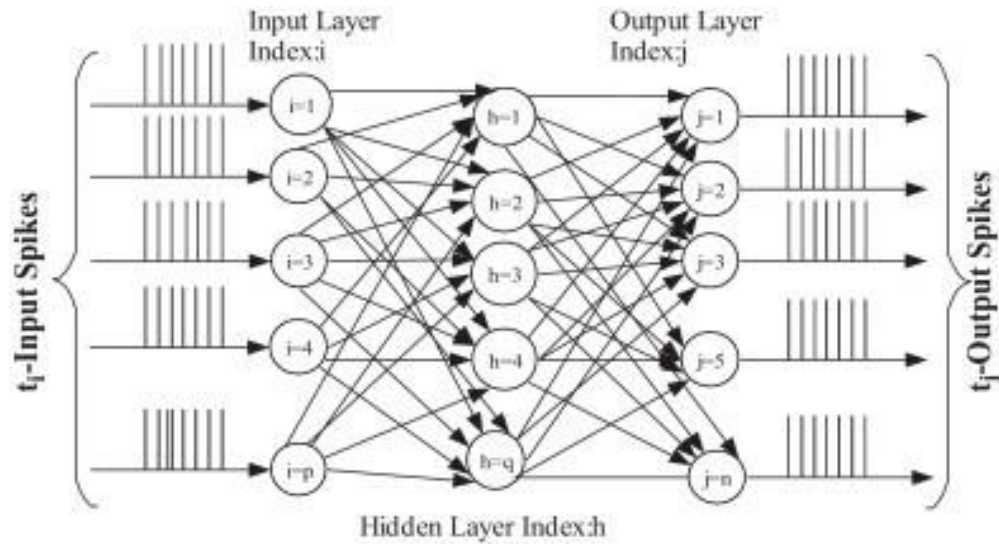
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## Spike trains for a network of 3 neurons



## full spiking neural network



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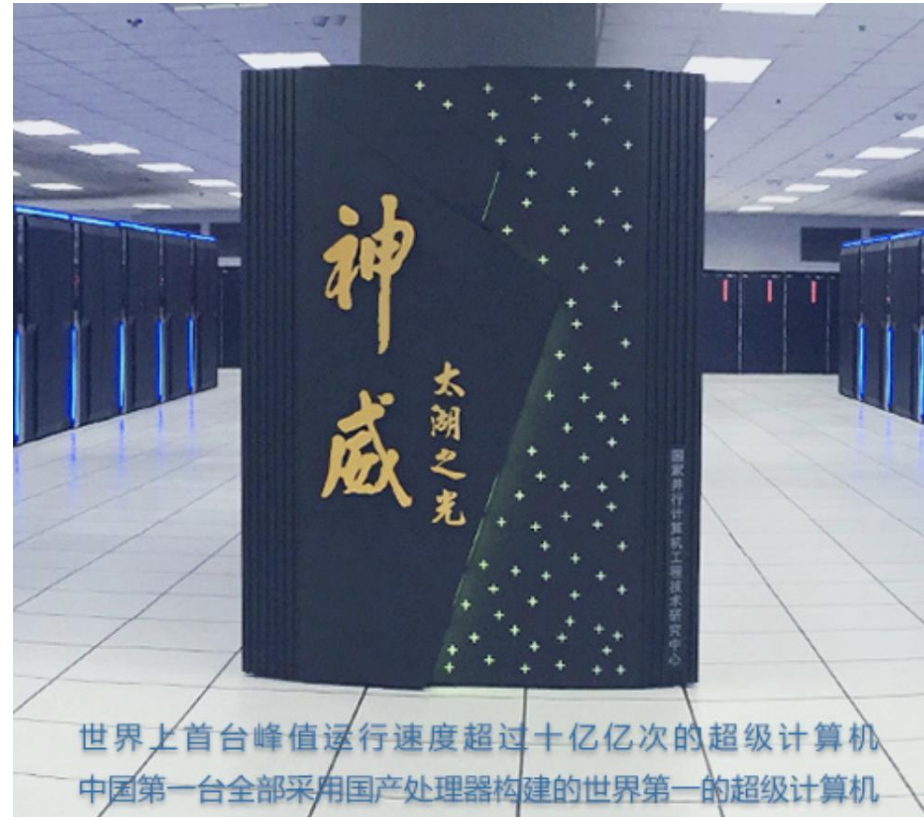


# Sunway TaihuLight

(Chinese: 神威·太湖之光) is a Chinese supercomputer,

as of June 2018, is ranked **second in the TOP500** list, with a LINPACK benchmark rating of 93 petaflops.

The Sunway TaihuLight was the world's fastest supercomputer for two years, from June 2016 to June 2018, according to the TOP500 lists.



## Architecture

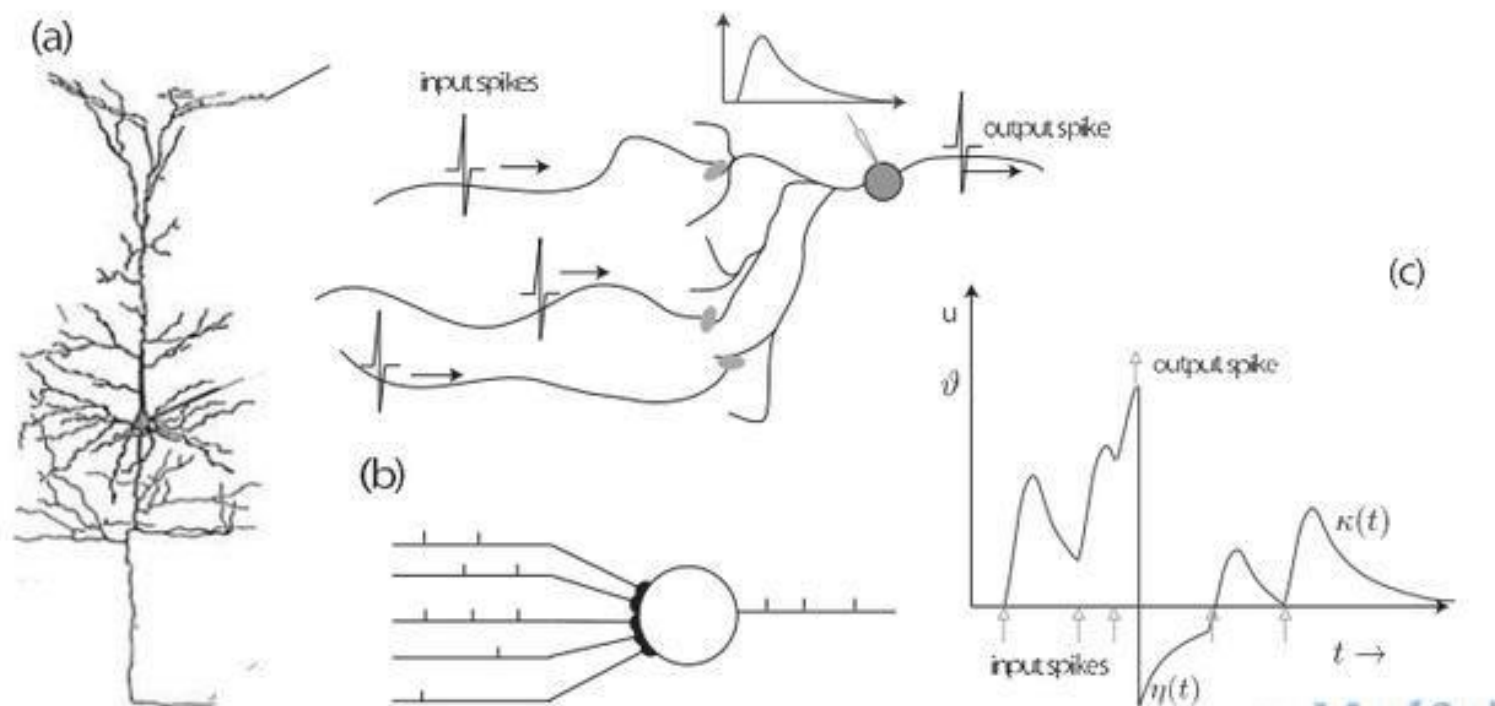
The Sunway TaihuLight uses a total of 40,960 Chinese-designed SW26010 manycore 64-bit RISC processors based on the Sunway architecture.

Each processor chip contains 256 processing cores, and an additional four auxiliary cores for system management (also RISC cores, just more fully featured) for a total of 10,649,600 CPU cores across the entire system.

The processing cores feature 64 KB of scratchpad memory for data (and 16 KB for instructions) and communicate via a network on a chip, instead of having a traditional cache hierarchy.

Power	15 MW (LINPACK)
Operating system	Sunway RaiseOS 2.0.5 (based on Linux)
Memory	1.31 PB (5591 TB/s total bandwidth)
Storage	20 PB
Speed	1.45 GHz (3.06 TFlops single CPU, 105 PFLOPS LINPACK, 125 PFLOPS peak)





脉冲神经元：真实的生物神经元通过脉冲-尖峰（pulses - spikes）序列进行信息传输。上图中，（a）一个神经元的突触树、轴突和细胞体；（b）上部分：从其它神经元得到的输入脉冲从突触向突触后的神经元传递；下部分：模型的简化图。（c）神经细胞。



```
# swcaffe @ psn004 in ~/online1/yaotc/CARLsim3-master/projects/hello_world [11:14:48] C:104
```

```
$ bsub -I -N 1 -np 1 ./hello_world
```

```
Job <42234515> has been submitted to queue <q_sw_expr>
```

```
waiting for dispatch ...
```

```
dispatching ...
```

```
*****  
***** Welcome to CARLsim 3.1 *****  
*****
```

```
***** Configuring Network *****
```

```
Starting CARLsim simulation "hello_world" in USER mode
```

```
Random number seed: 42
```

```
Running COBA mode:
```

```
- AMPA decay time           = 5 ms  
- NMDA rise time (disabled) = 0 ms  
- GABAA decay time          = 6 ms  
- GABAb rise time (disabled) = 0 ms  
- GABAb decay time          = 150 ms
```

```
***** Setting up Network *****
```

```
Number of neurons = 126
```

```
Potentially maximum number of post synapses per neuron = 9
```

```
Potentially maximum number of pre synapses per neuron = 117
```

```
Max axonal delay = 1
```

```
Group input(0):
```

```
- Type           = EXCIT  
- Size           = 117  
- Start Id       = 9  
- End Id         = 125  
- numPostSynapses = 9  
- numPreSynapses = 0  
- Refractory period = 0.00000
```

```
Group output(1):
```

```
- Type           = EXCIT  
- Size           = 9  
- Start Id       = 0  
- End Id         = 8  
- numPostSynapses = 0  
- numPreSynapses = 117
```

```
Connection ID 0: input(0) => output(1)
```

```
- Type           = FIXED  
- Min weight     = 0.00000  
- Max weight     = 0.05000  
- Initial weight = 0.05000  
- Min delay      = 1  
- Max delay      = 1
```

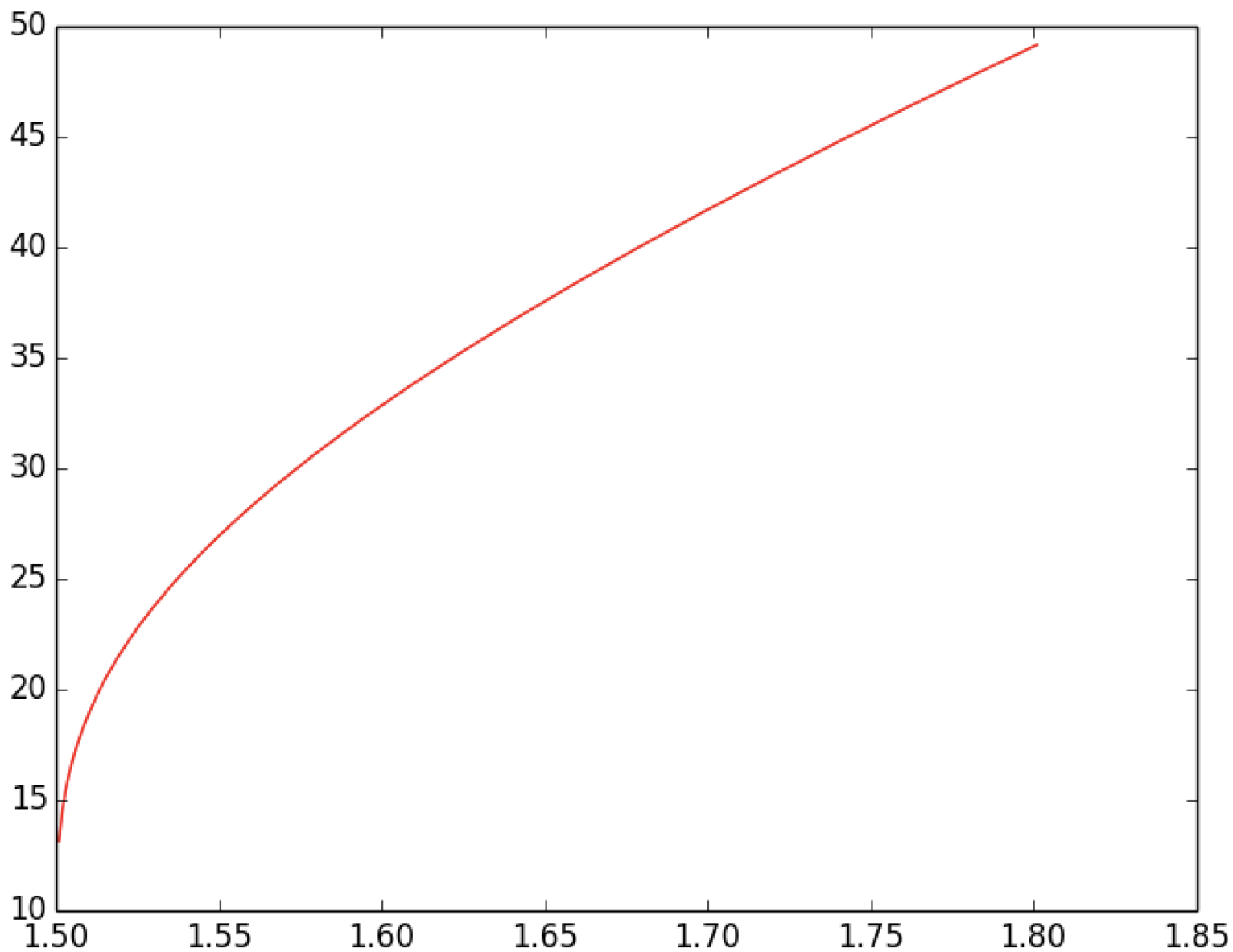


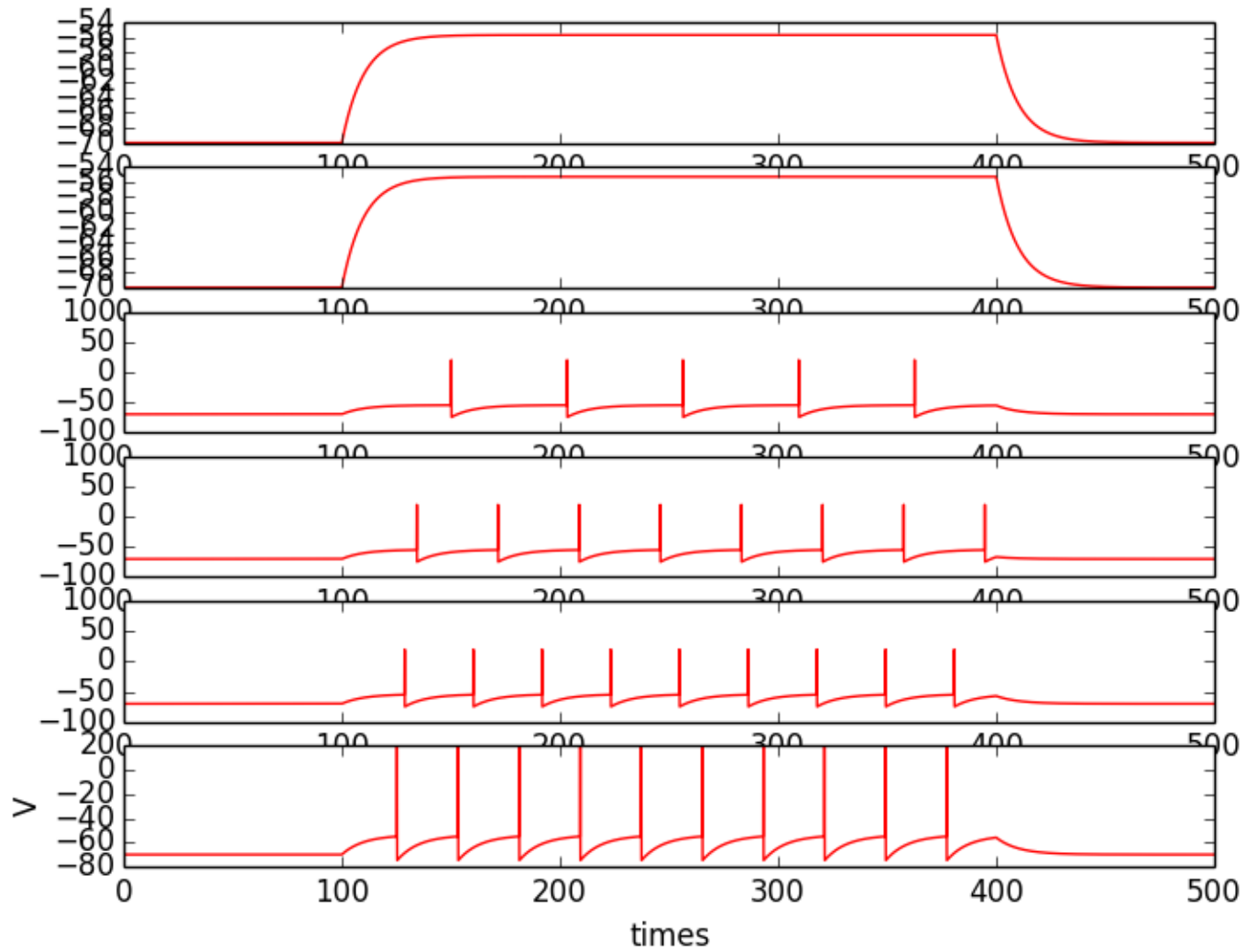


```
Network Parameters:  numNeurons = 24696 (numNExcReg:numNIhReg = 7.1:0.0)
                     numSynapses = 600324
                     maxDelay = 1
Simulation Mode:      COBA
Random Seed:          42
Timing:               Model Simulation Time = 10 sec
                     Actual Execution Time = 0.00 sec
Average Firing Rate:  2+ms delay = 0.000 Hz
                     1ms delay = inf Hz
                     Overall = 54.609 Hz
Overall Firing Count: 2+ms delay = 0
                     1ms delay = 13486255
                     Total = 13486255
```

\*\*\*\*\*











# THANKS



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University of Chinese Academy of Sciences