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1 STDP and Triplet

Figure 1 shows STDP curves for identical parameters (maximum LTP, LTD, same time constants) for different initial weights of the memristive device. As can be seen, there is some weight dependence especially for the LTP side, i.e. lower weights (lower initial currents) tend to have a higher weight increase. The time windows are not affected by the initial weight, as they are determined by the time constants of the pre- and postsynaptic stimulation waveforms.

Figures 2 and 3 give a comparison of triplet measurements with and without postsynaptic adaptation. As can be seen, postsynaptic adaptation affects mainly the lower right quadrant, causing the triplets near the origin to exhibit LTD, not LTP, in accordance with the measurements of [1]. This behaviour is identical to the one found in [2]. Fig. 3 shows triplet reproduction with slightly modified parameter settings compared to the triplet figure in the main manuscript. As evident, at the expense of somewhat worse performance in the upper right quadrant (upper right corner going towards LTD), the performance in the upper left and lower right quadrant especially with regard to the LTP-area reproduction of [1] is significantly improved.

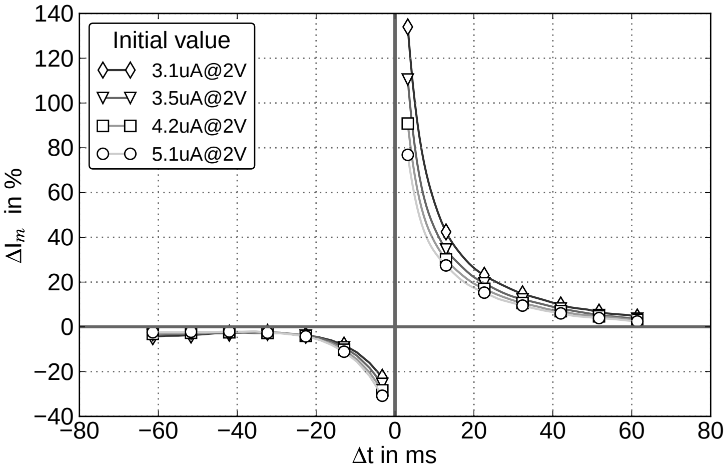

Figure 1: Measurements of STDP curves with identical parameter settings for different initial weights (expressed as currents at a DC measurement voltage across the memristive device of 2V)

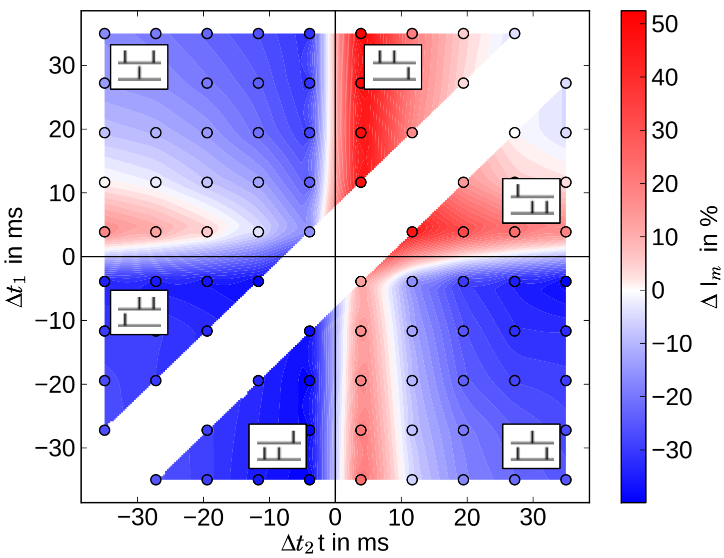

Figure 2: Measurements of the triplet protocol without adaptation

Table 1 lists the parameters that were used for the simulations with the memristive device model. In Table 2, the parameters for the simulations with the original LCP model are given.

References

[1] R. Froemke and Y. Dan, "Spike-timing-dependent synaptic modification induced by natural spike trains," *Nature*, vol. 416, pp. 433–438, 2002.

[2] C. Mayr and J. Partzsch, "Rate and pulse based plasticity governed by local synaptic state variables," *Frontiers in Synaptic Neuroscience*, vol. 2, pp. 1–28, 2010.

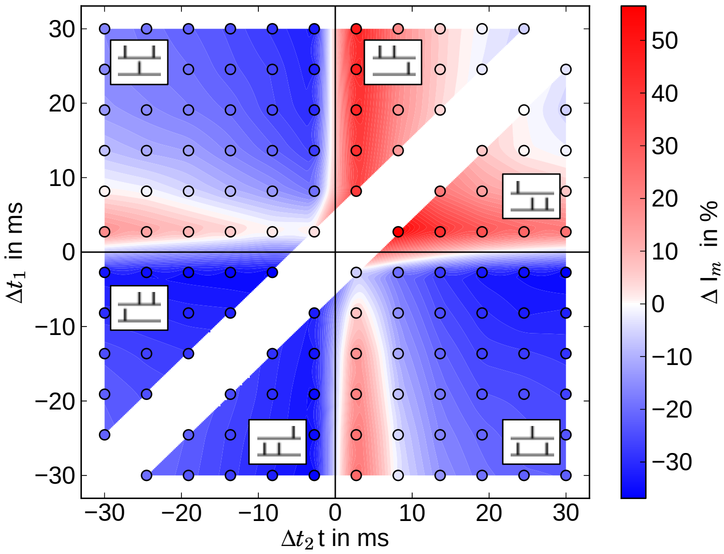

Figure 3: Measurements of the triplet protocol with adaptation

Table 1: Device Model Parameters

PARAMETER	**VALUE**
d_1	0.8
d_2	0.5
I_{01}	$37.2 \cdot 10^{-6}$
I_{02}	$2 \cdot 10^{-6}$
φ_1	1.8
φ_2	1.8
α_1	$10 \cdot 10^{-6}$
α_2	$8 \cdot 10^{-6}$
β_1	2.0
β_2	3.5

Table 2: Parameters for Original LCP Rule

PARAMETER	**VALUE**
τ_{pre}	15ms
$\hat{G}$	1nS
τ_{post}	35ms
U_{p}	150mV·ms
U_{refr}	-8mV
B	$(1\text{pC})^{-1}$