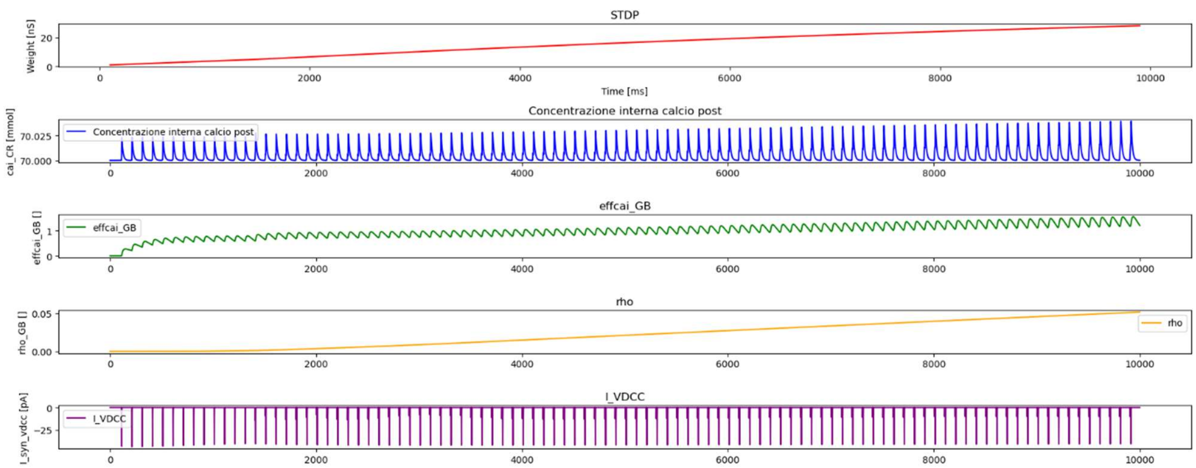
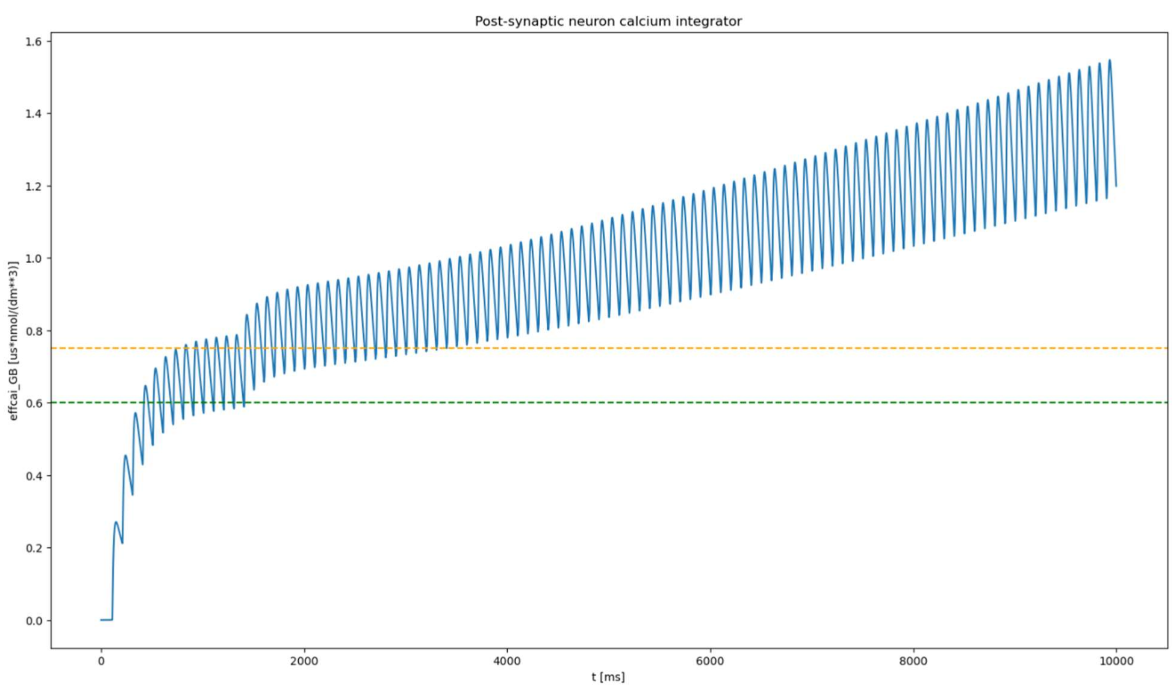
Report results

Group 4

<u>Results</u>:

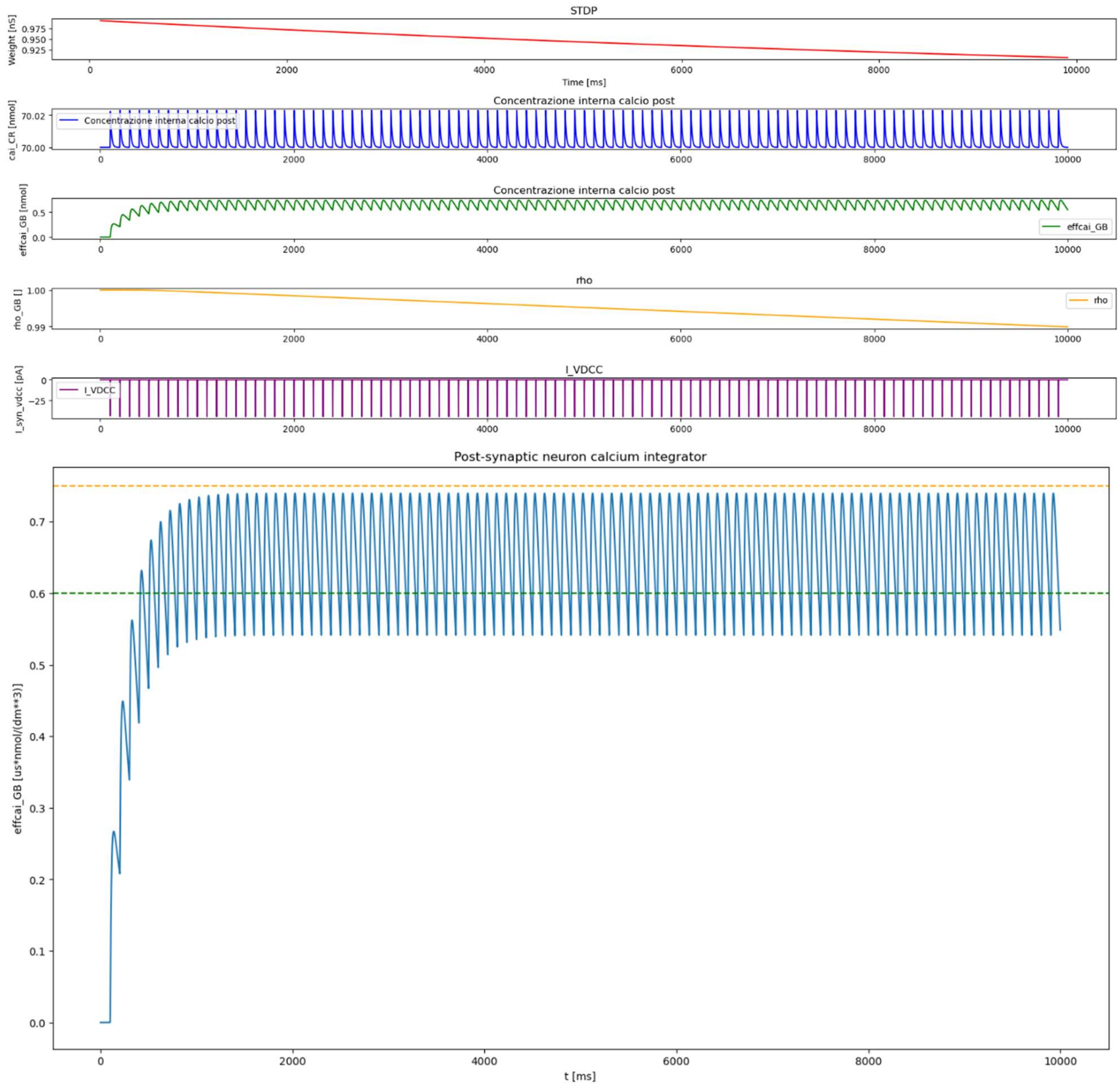
1) The first obtained result uses a model based on the original one in which VDCC channels, calcium integrators and the equation for the variation of rho depending on the calcium integrator are implemented. The synapse is the one given to us in the beginning.
   Pre before post simulation:





As it can be seen in this simulation the calcium integrator overcome both the thresholds thus leading to an increase in rho values and consequently an increase in synapse weight potentiation even if in this model using the first synaptic model the weight is not dependant on rho as opposed to successive results.

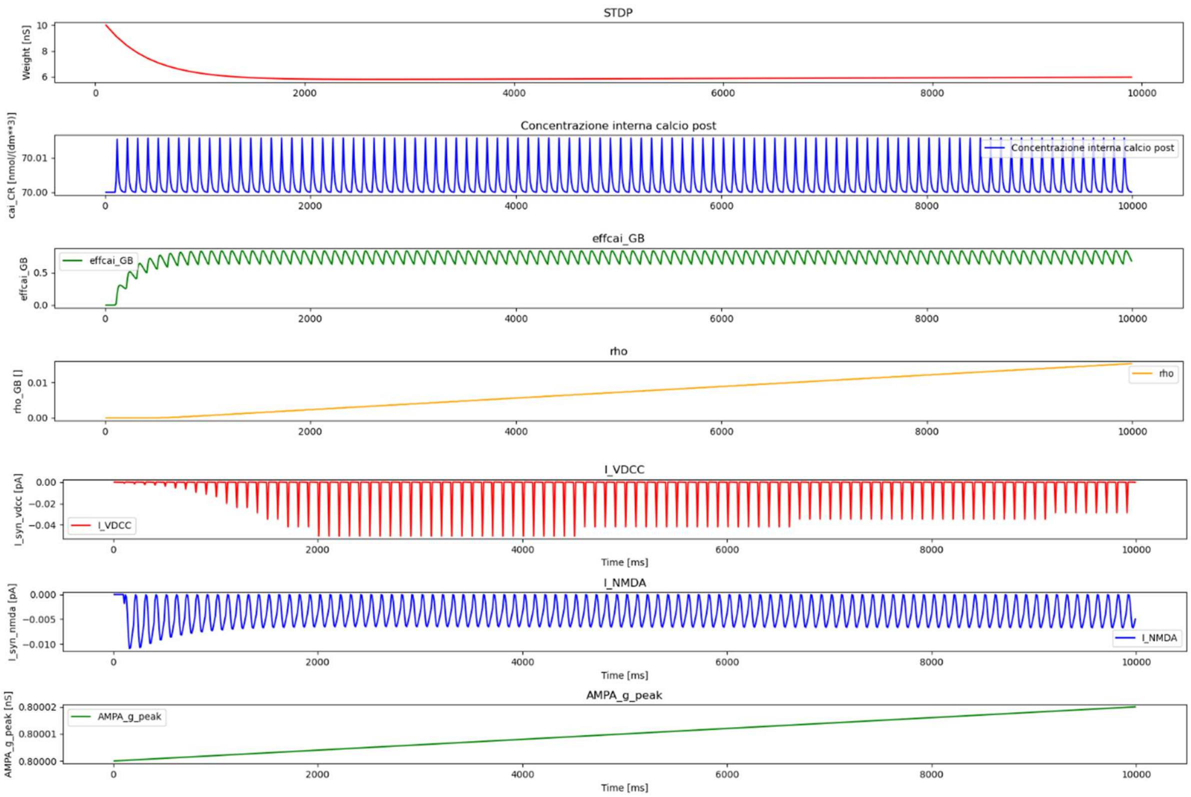
Post before pre simulation:

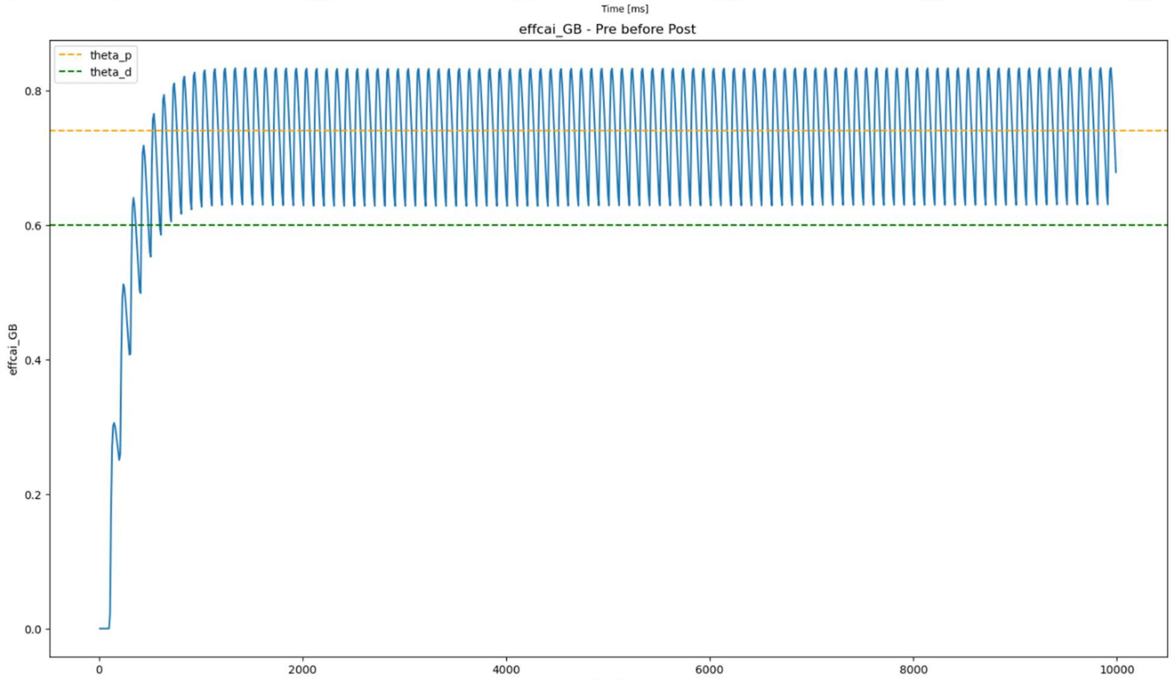


In this simulation instead the calcium integrator is such to reach just the depression threshold reducing in turn rho values and synaptic weight as described before.

2) The second batch of results was obtained using the same neuron model as the previous results implementing also the equation to characterize the maximum allowed AMPAR channel conductance based on rho values to describe the ltp or ltd effects on the AMPAR channels. The synapse model used implements a vesicular release model in which the baseline amount of vesicle available after stable condition (no previous discharge close in time) in the presynaptic neuron also describing the effects of ltp or ltd on the synaptic weight, obtained considering both the short term vesicular dynamics and the long term effect due to rho influence.

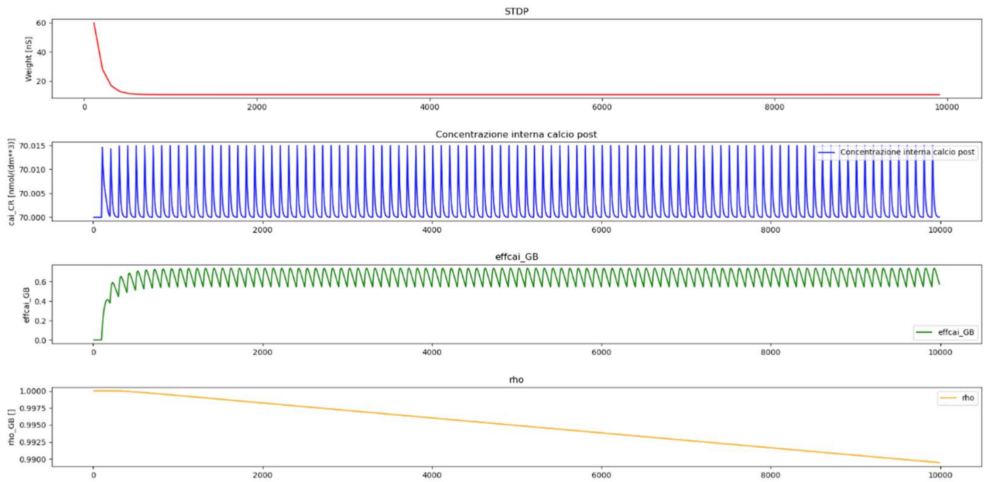
   Pre before post simulation:

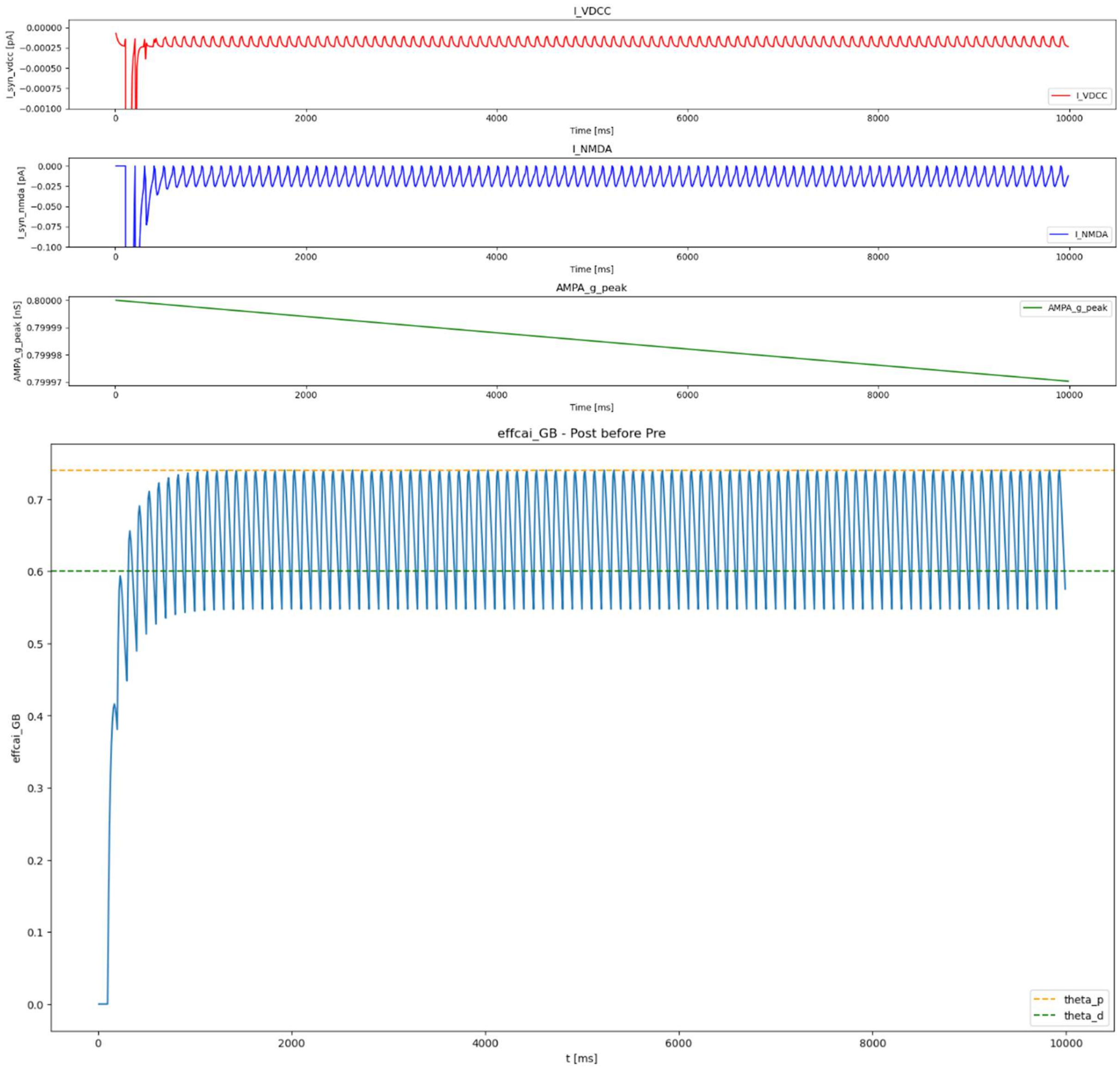




In this simulation the synaptic model based on the vesicle was implemented and as can be seen the effects of the calcium dynamics on rho lead to an increase in rho as the potentiation threshold is overcame. The synaptic weight however shows the decrease due to the vesicle reduction after stimulation in the simulation as the time scale to observe the long term effects of ltp is out of proportion for the protocol we implemented. It can be also noted that the maximum conductance for the AMPAR channels follows the behaviour of rho increasing when rho increases and decreasing in the post before pre simulation following.

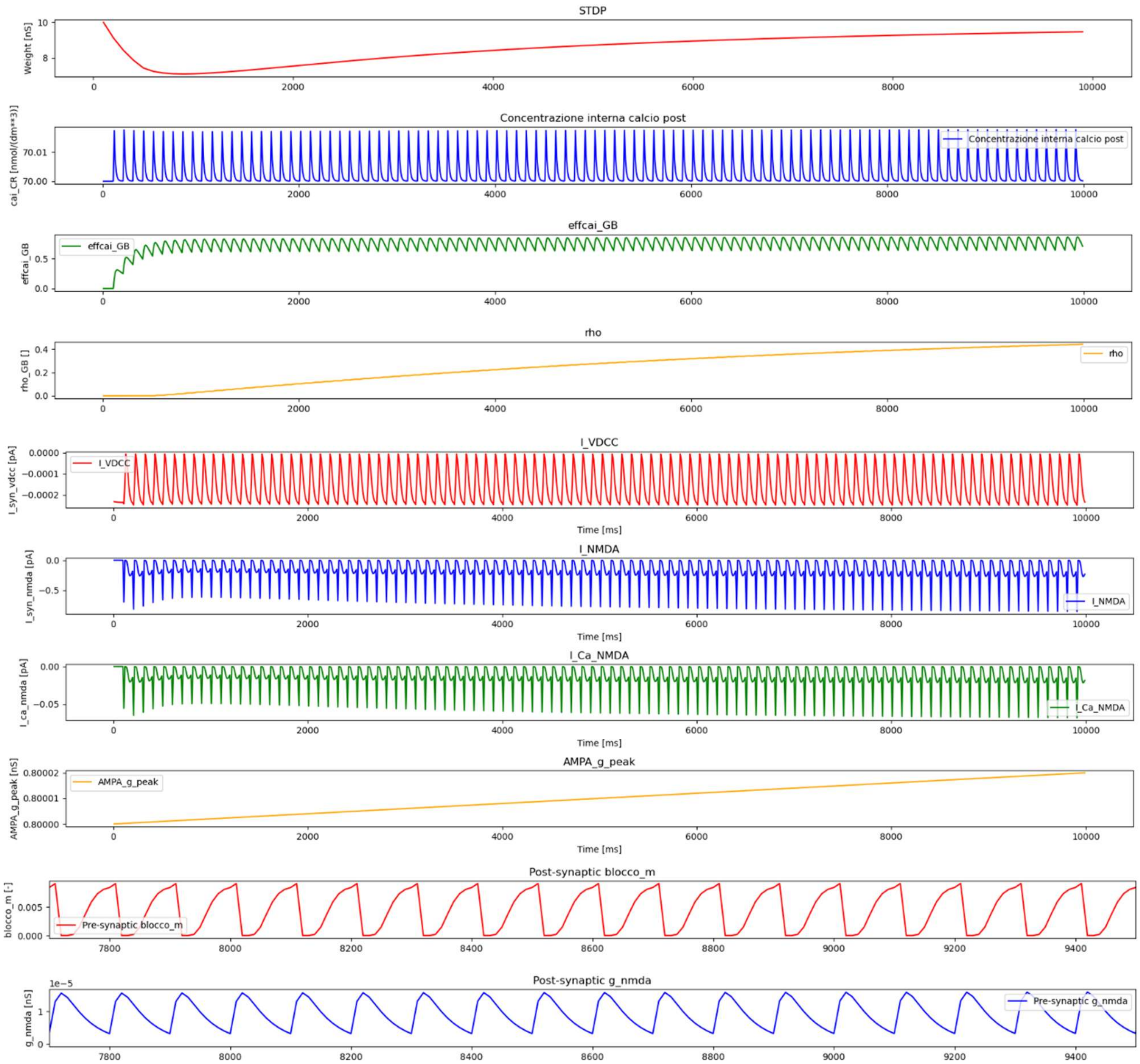
Post before pre simulation:





In this case the calcium integrator only reaches the depression threshold thus reducing rho values and maximum conductance for AMPAR channels.

3) The last results were obtained implementing the new equations for the dynamics of the AMPAR and NMDAR channels in order to optimally implement the spike weight, obtained using the same synaptic model as in point 2, inside the neural model and to adjourn the equations with those found in: *Kindemi et al (2022).* This implementation allowed a better representation of the calcium dynamics in the post synaptic neuron.
Pre before post simulation:


STDP
Weight [nS]
Concentrazione interna calcio post
cai_CR [nmol/(dm**3)]
Concentrazione interna calcio post
effcai_GB
effcai_GB
rho
rho_GB []
rho
I_VDCC
I_syn_vdcc [pA]
I_VDCC
Time [ms]
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AMPA_g_peak
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Post-synaptic blocco_m
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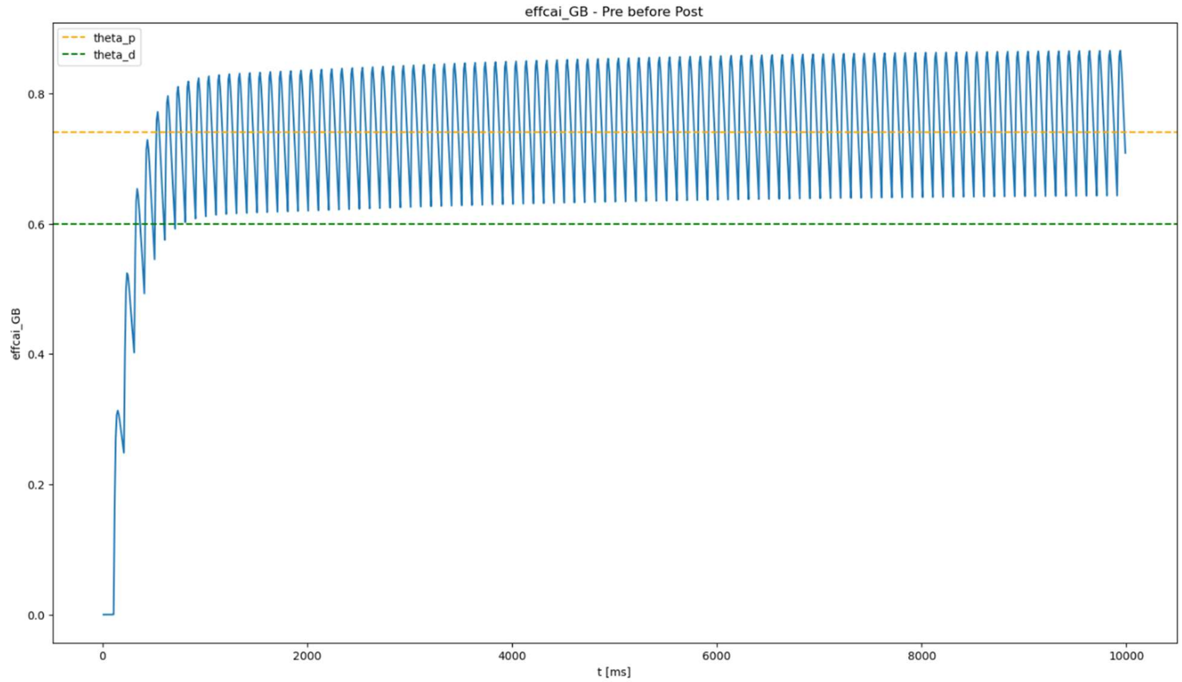
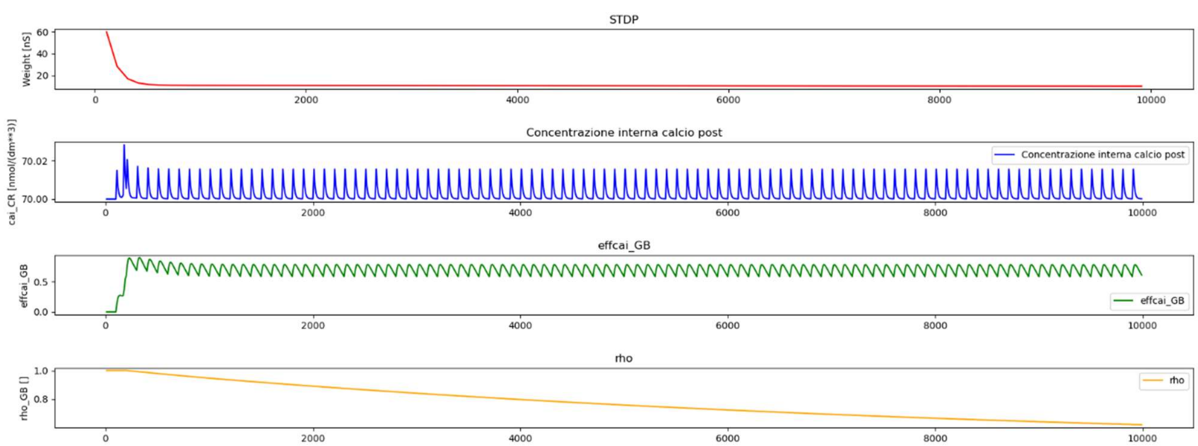
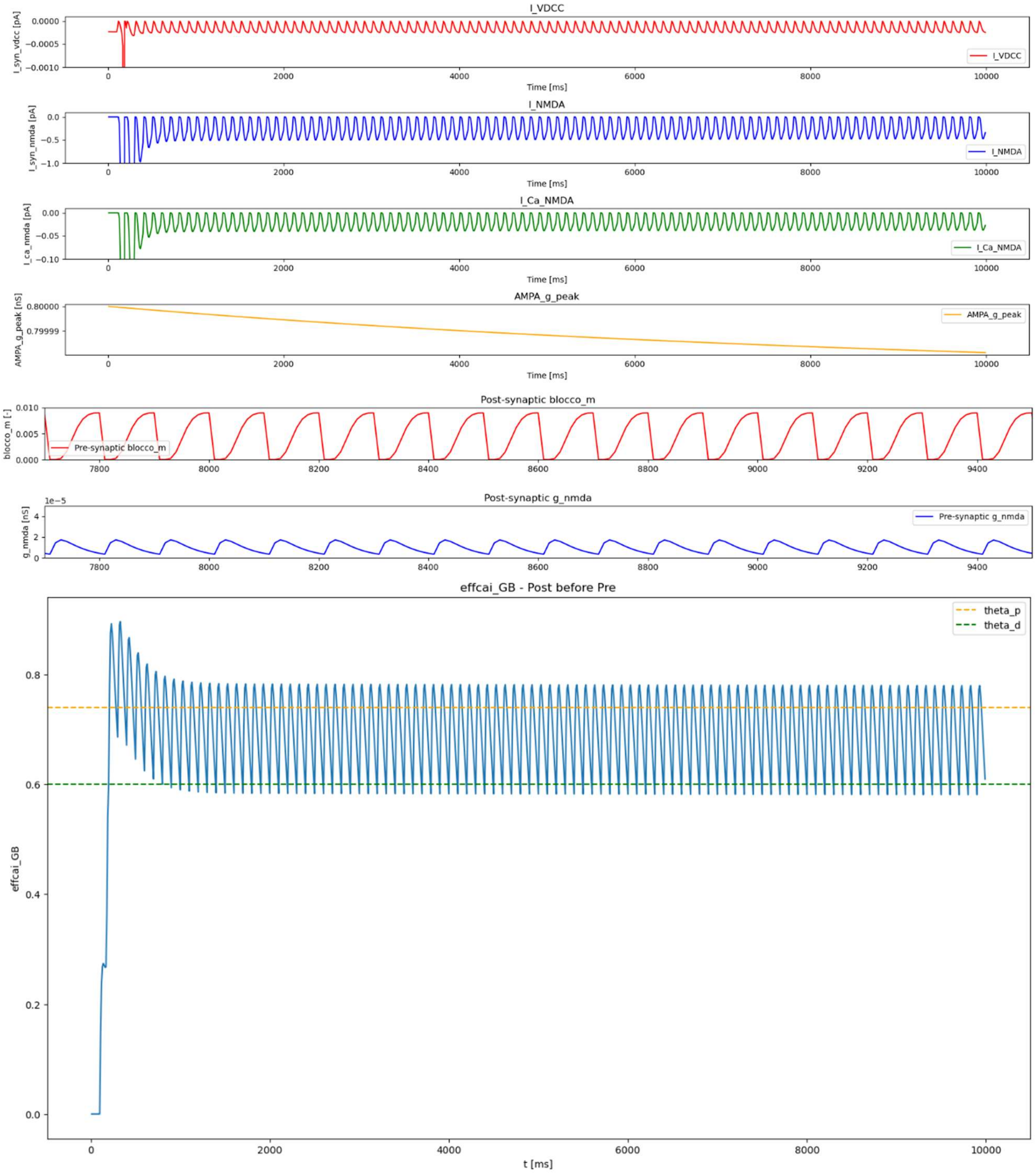


In this last results we decided to artificially boost the effect of the ltp in order to be able to assess the outcome as can be seen in the synaptic weight graph where in the latter part of the simulation an increase in synaptic weight can be noted. Rho of course increase as after an initial rise period the calcium integrator reaches the potentiation threshold.

Post before pre simulation:





In this simulation can be noted how instead even with increased impact of potentiation or depression in the long term the synaptic weight does not rise as rho diminishes due to the calcium integrator not reaching the potentiation threshold thus, as expected, in this case the effect is of ltd.