Summary: A neuromorphic system capable of interfacing biological neurons to standard neuromorphic chips in a closed loop configuration is proposed, the system uses the address event-representation protocol to handle large synaptic fan-outs.

Neural prostheses have the capacity to radically change the way in which we interact with our environment. Current brain-machine interfaces are limited to using digital system to interact with living systems severely limiting the bandwidth of communication. To date there has been limited comprehensive work on combining neuromorphic architectures with neural-interfaces. In this work we present a neuromorphic system capable of interfacing biological neurons to standard neuromorphic chips using Address Event-Representation protocol in a closed loop configuration.

The design of this system aims at interfacing in-vitro neurons grown on multielectrode arrays, via AER. In such systems, the design of the neuromorphic interface between the electrodes and the AER constitutes a major challenge. Our design attempts to address this incorporating a conductance-based synapse at interface which is fully integrated into the neuromorphic chip.

In Fig. 1 a) we show a side by side comparison of a state of the art neural recording system [1] and the proposed neuromorphic interface. We present a block diagram of the proposed system in Fig 1 b), a signal flow description follows. While in the reading state the microelectrode transmits the voltage signal from the cellular environment to a spike detector that converts action potentials into discrete events. Using AER they are routed to their artificial neural targets. When an artificial neuron has a neuron from the culture as the post-synaptic target, the AER fabric passes the event to the interface logic corresponding to that electrode, which gates the electrode to stimulate instead of record. The conductance based synapse and the stimulus generator convert the event into a biologically appropriate signal.