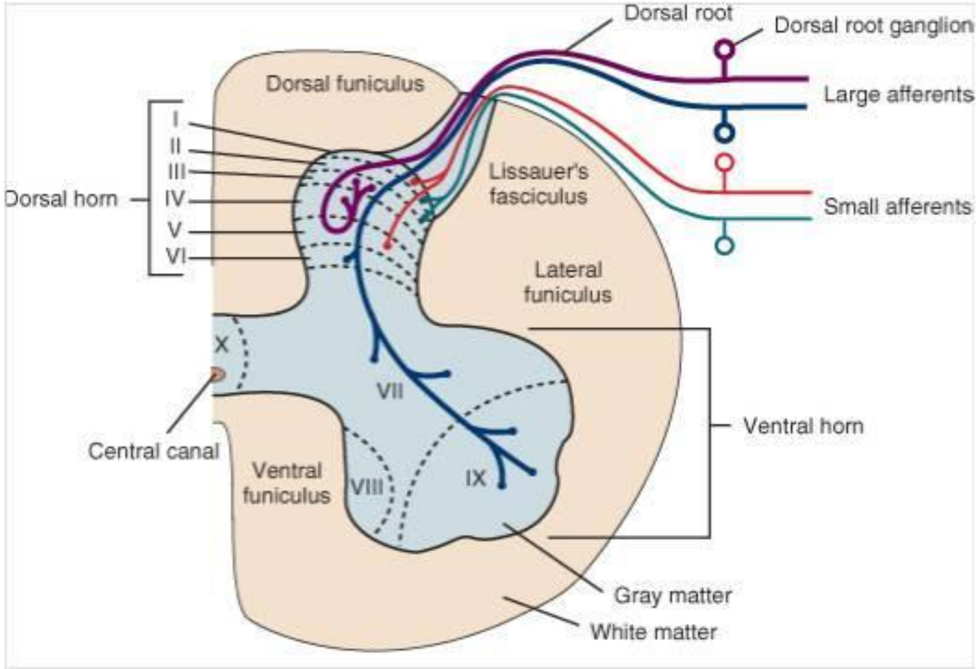
National Academy of Sciences of Ukraine
Bogomoletz Institute of Physiology

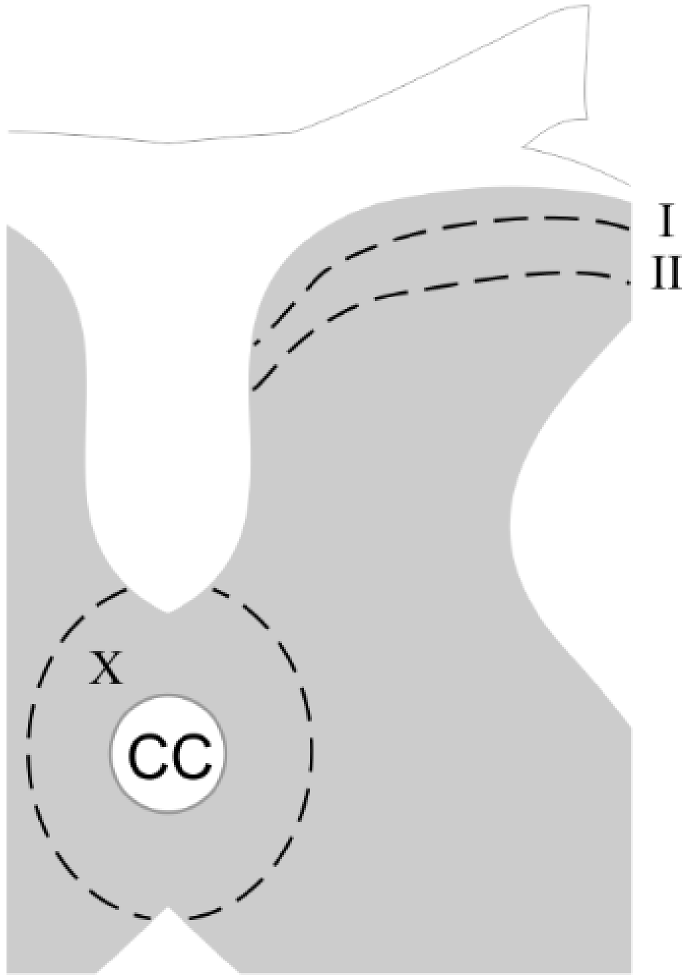
The role of lamina X neurons in nociception



Source: www.studyblue.com

Volodymyr Krotov

Multiple physiological functions of spinal lamina X neurons

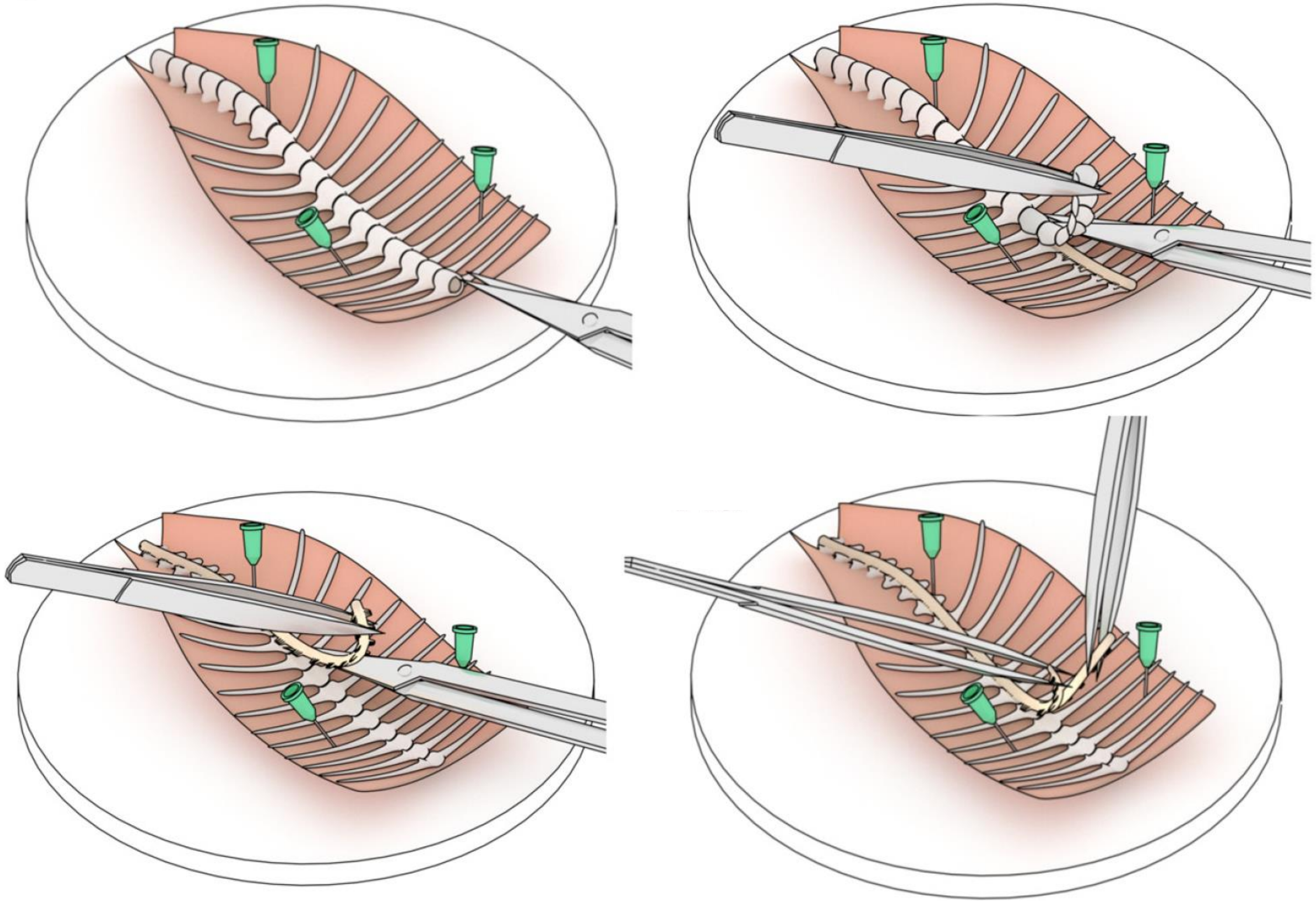


- **Visceral nociception**
- Somatosensory integration
- Autonomic regulation
- Modulation of motor neuron output

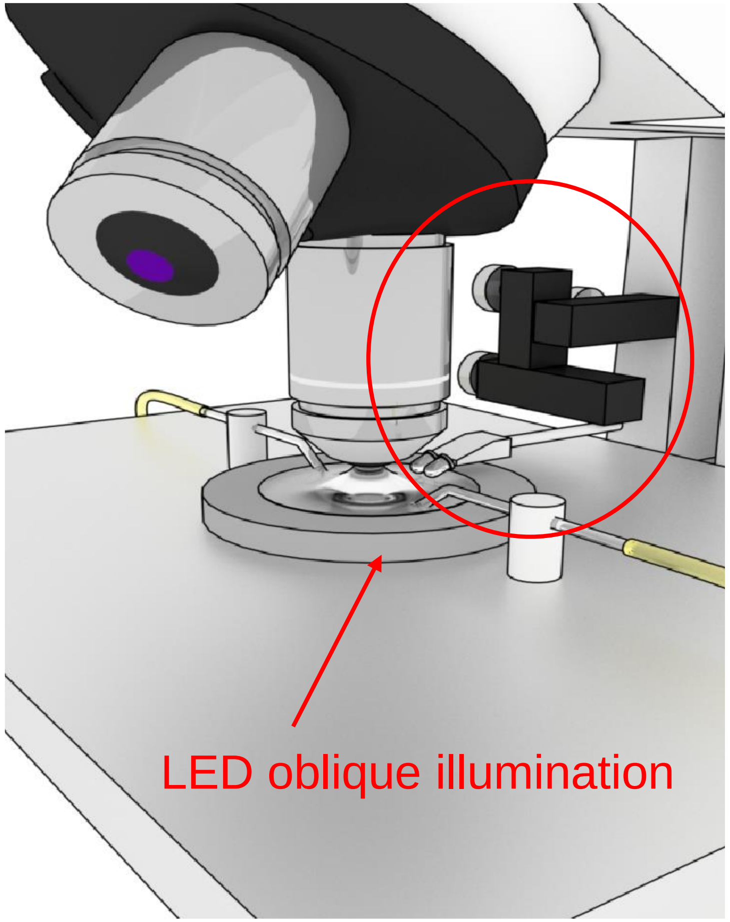
Experimental approach

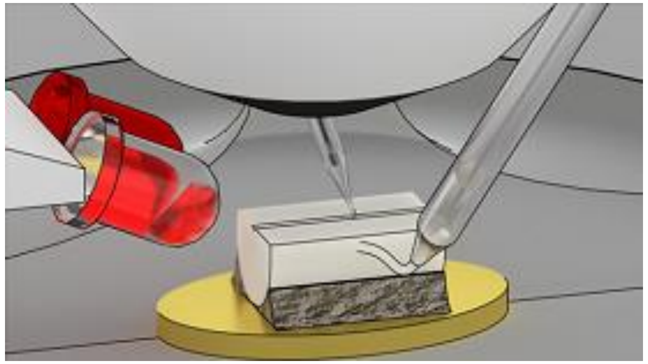
Experimental approach: *ex-vivo* spinal cord preparation

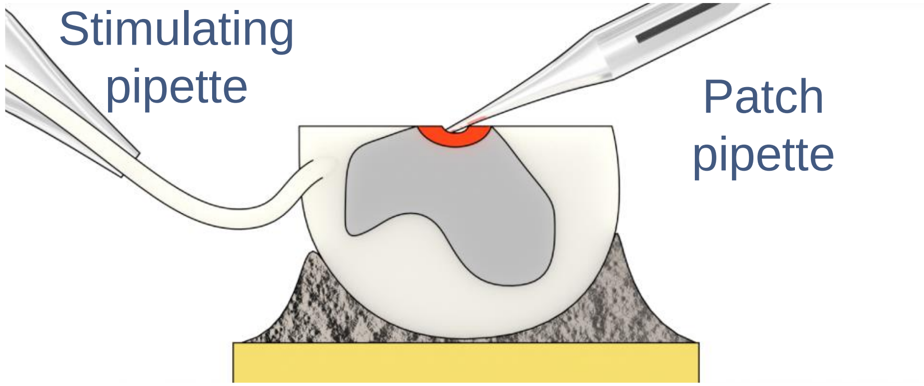
Hemisected spinal cord with spared dorsal & ventral roots



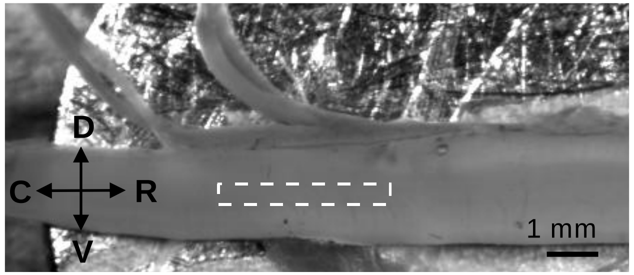
Experimental approach: LED oblique illumination technique

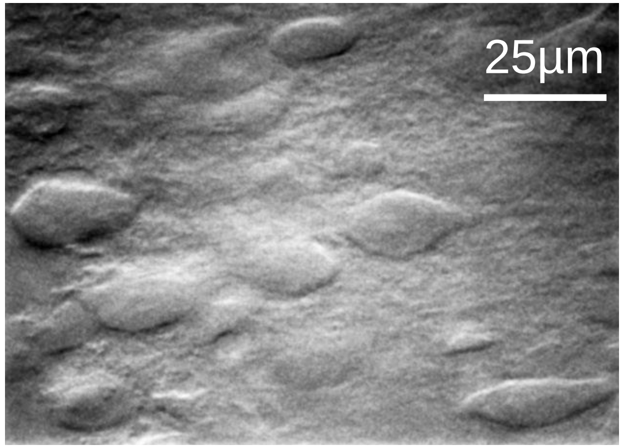






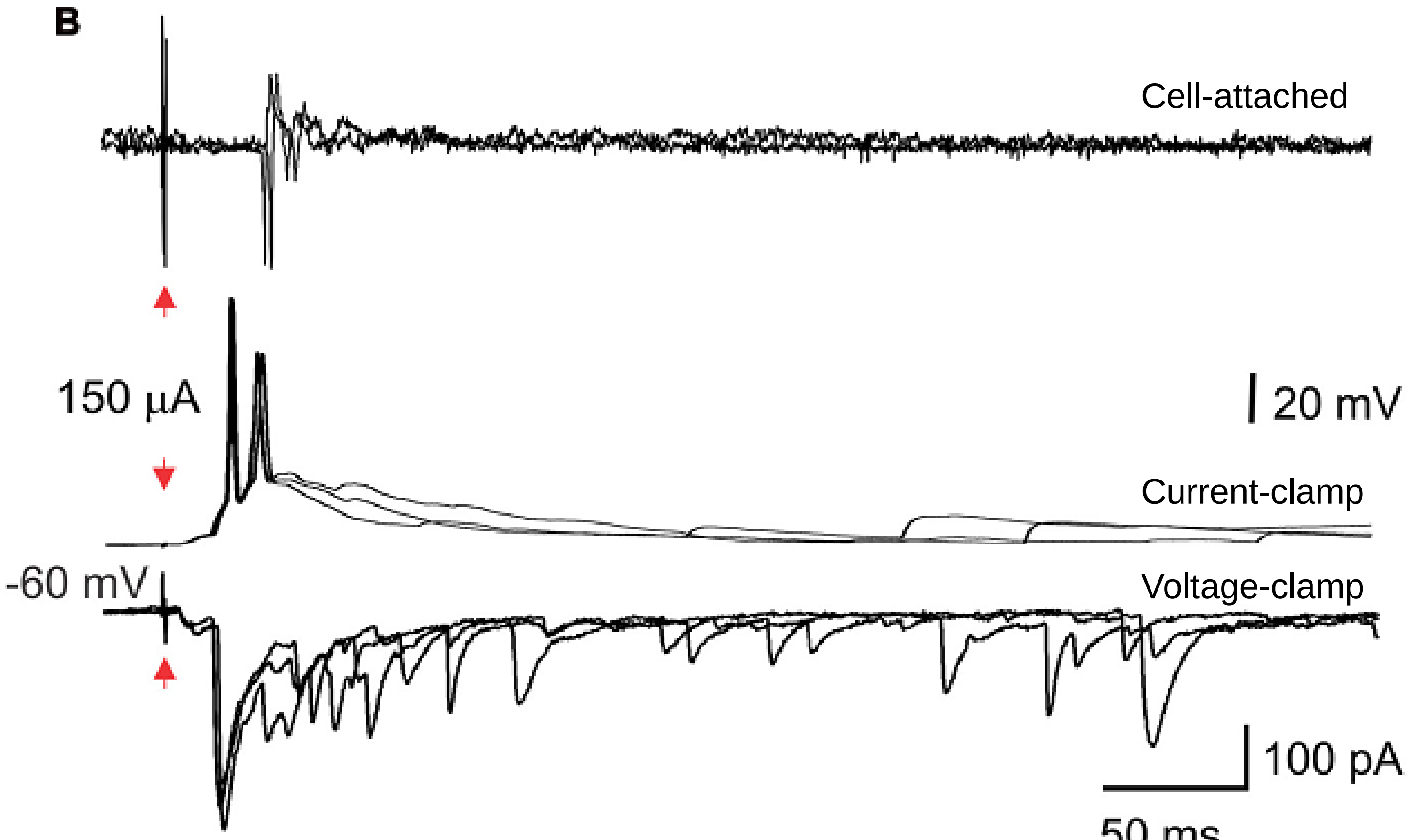
Hemisected spinal cord with spared dorsal roots



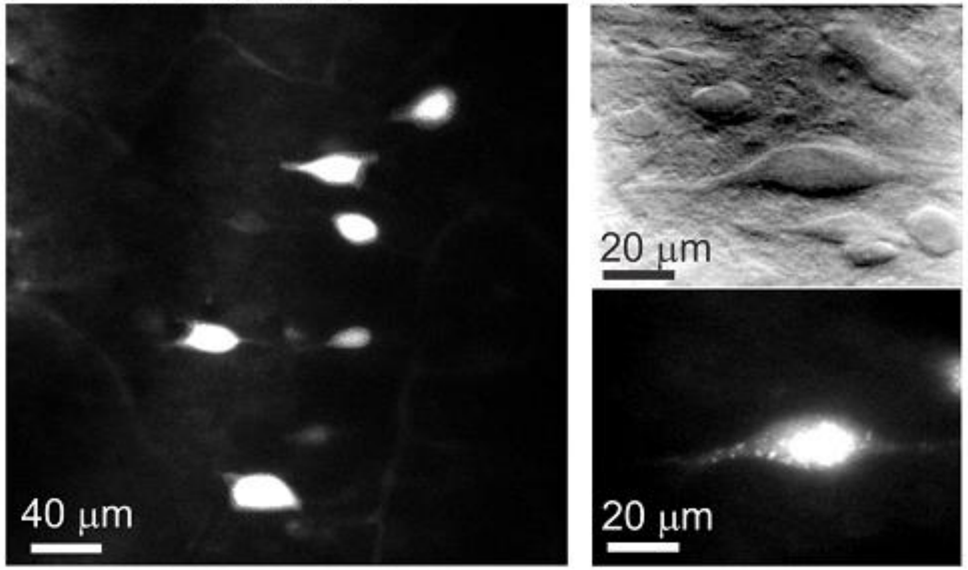


Experimental approach: electrophysiology & fluorescent labeling

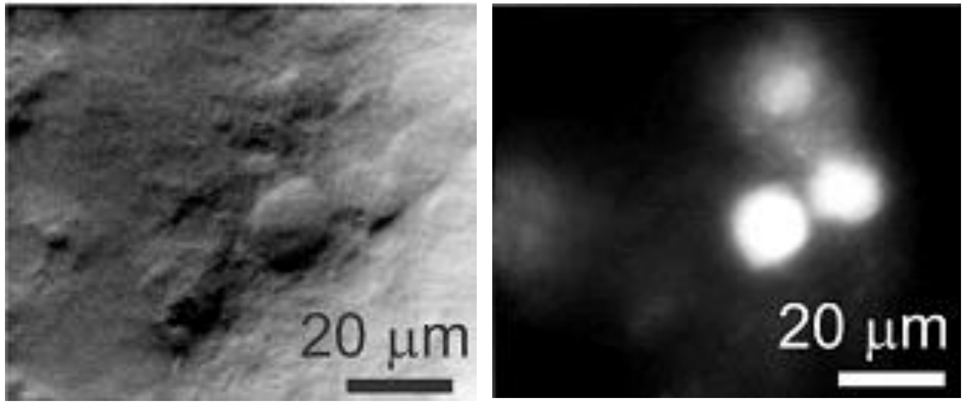
Electrophysiological experiments



Spino-thalamic projection neurons

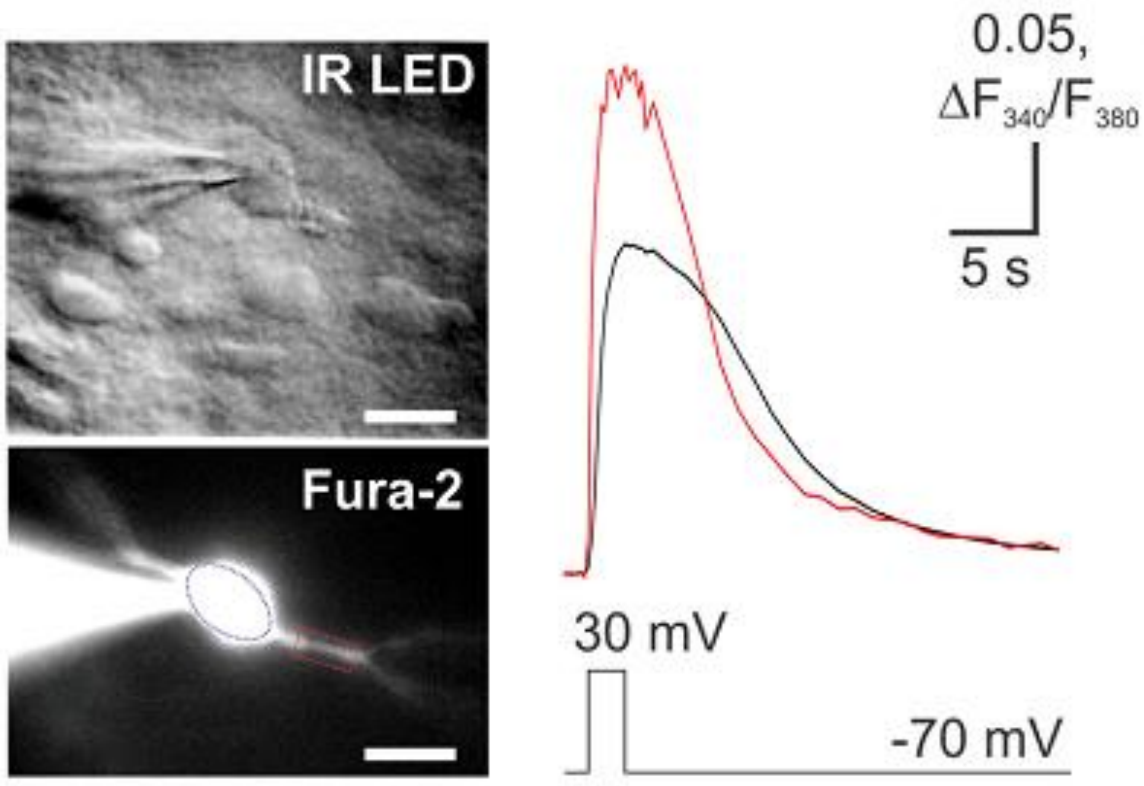


Sympathetic preganglionic neurons

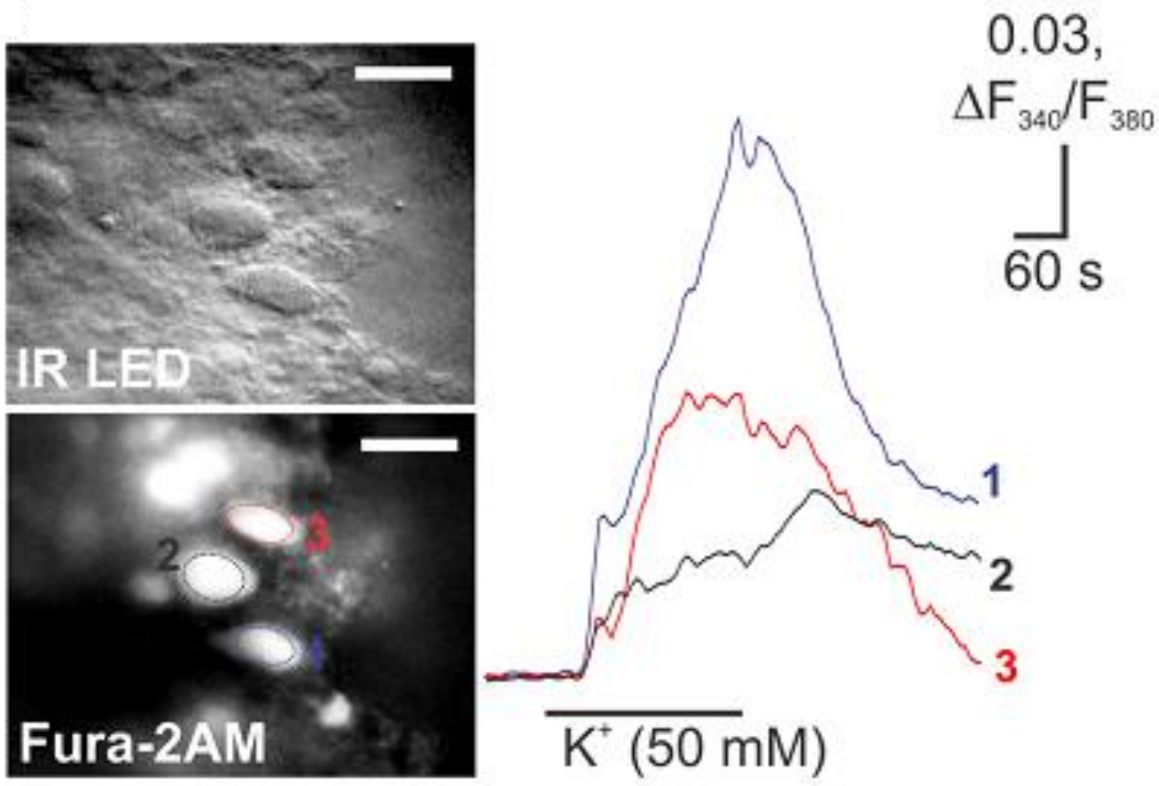


Experimental approach: calcium imaging

Cell-impermeable calcium dye

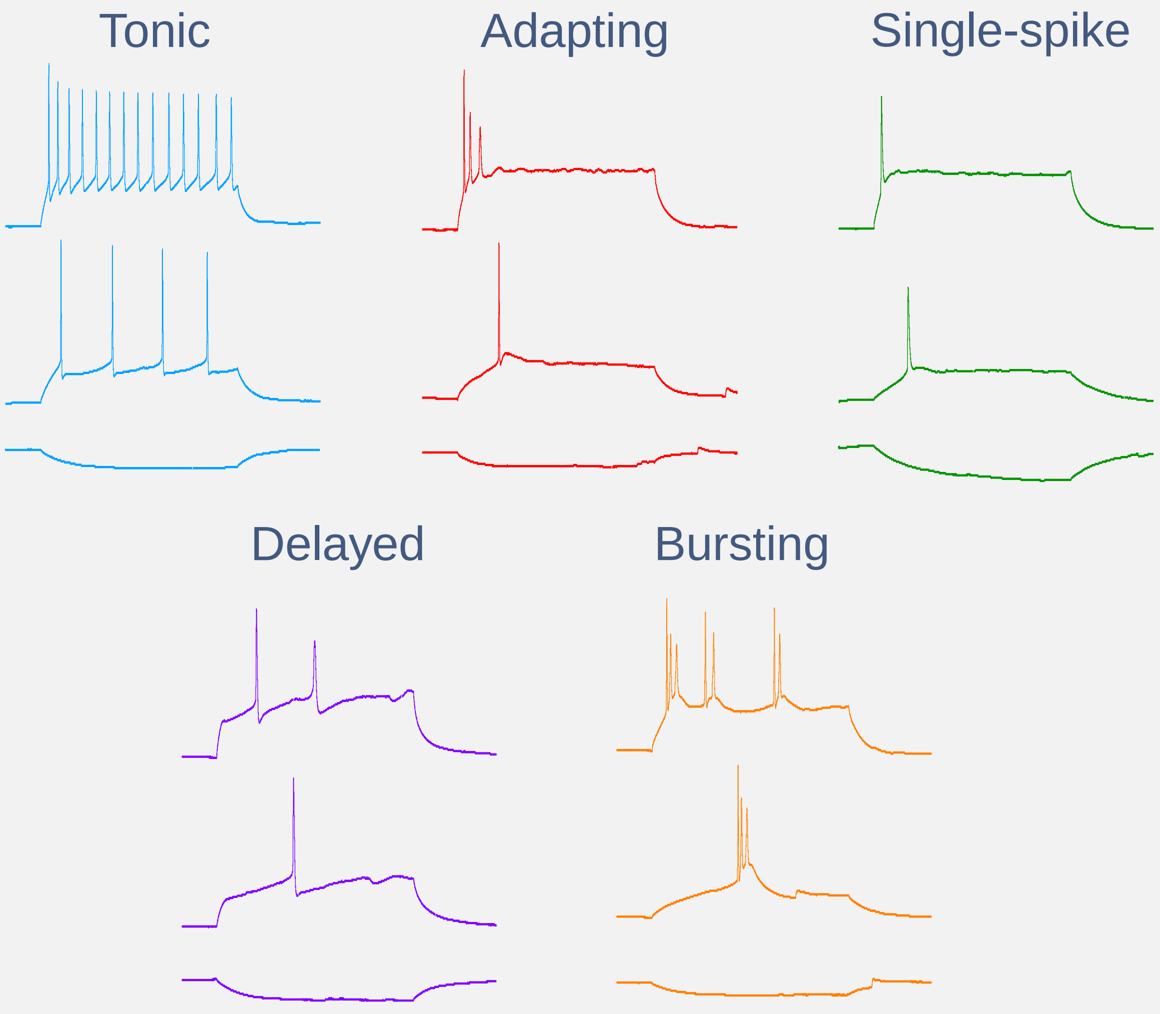


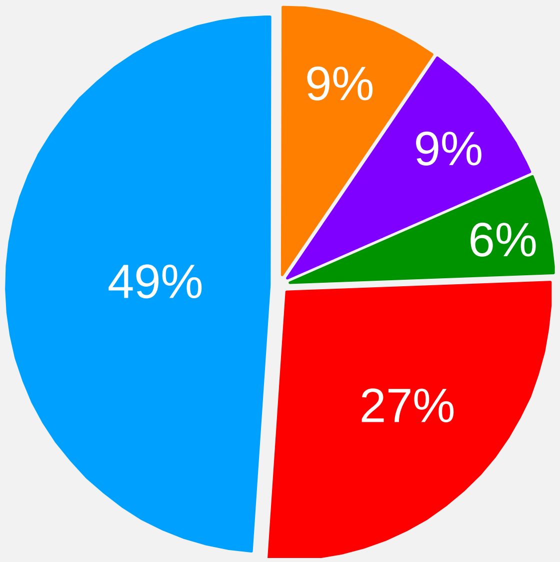
Cell-permeable (AM) calcium dye



Intrinsic properties and afferent supply of lamina X neurons

Diversity of lamina X neurons

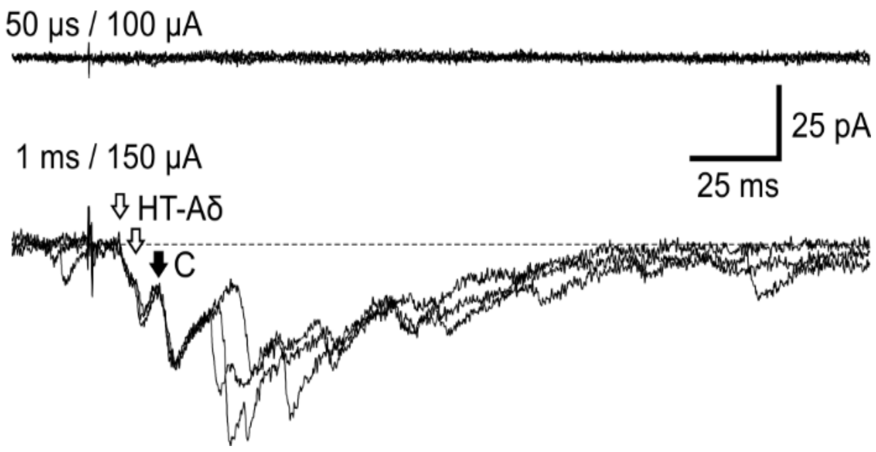


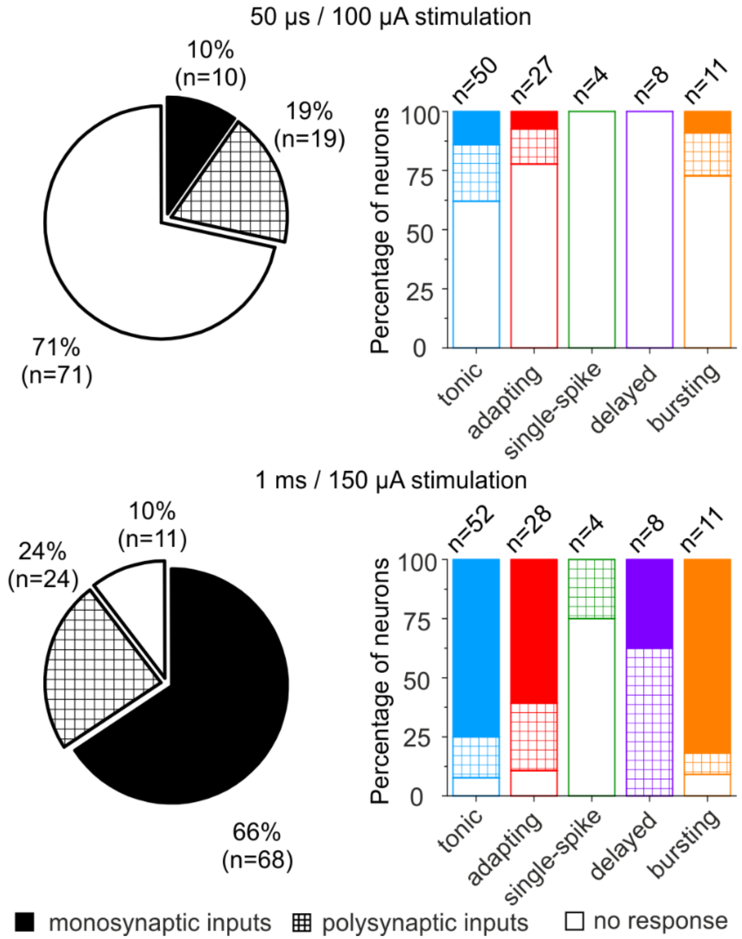


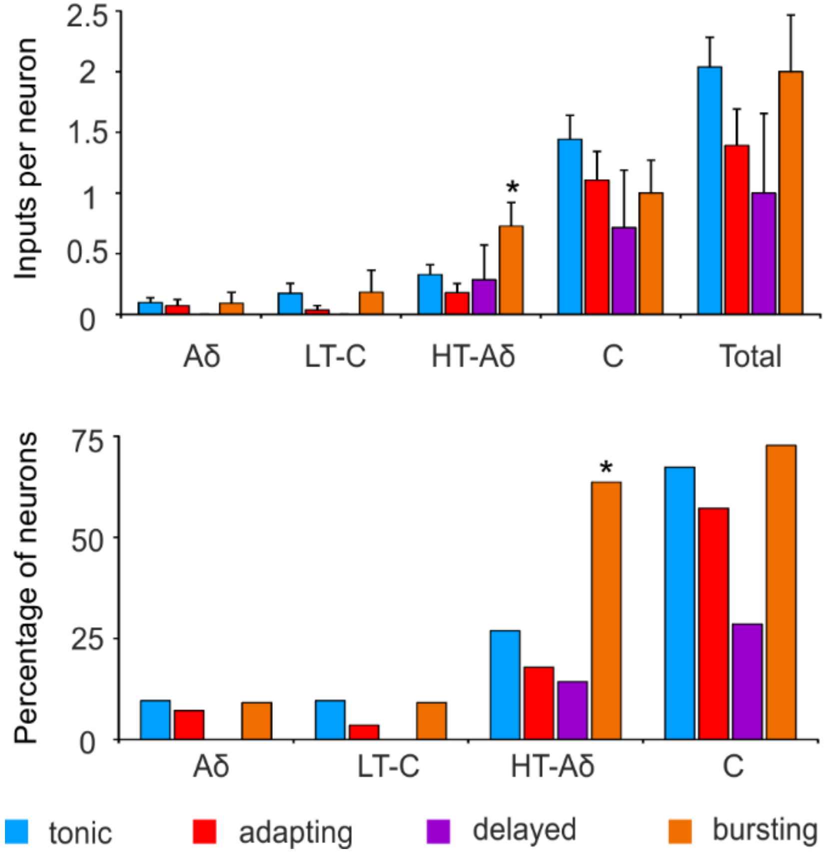
Lamina X neurons show many features common to the pain-processing neurons from the superficial dorsal horn.

Firing pattern	Capacitance	Resistance	RMP
Tonic (n=66)	43 ± 2 pF	0.69 ± 0.06 GΩ	-59 ± 1mV
Adapting (n=36)	27 ± 3 pF	1.03 ± 0.15 GΩ	-54 ± 2 mV
Single-spike (n=8)	32 ± 2 pF	0.76 ± 0.11 GΩ	-51 ± 2 mV
Delayed (n=12)	64 ± 12 pF	0.48 ± 0.15 GΩ	-56 ± 2 mV
Bursting (n=13)	71 ± 9 pF	0.45 ± 0.07 GΩ	-60 ± 1 mV

Primary afferent inputs to lamina X neurons



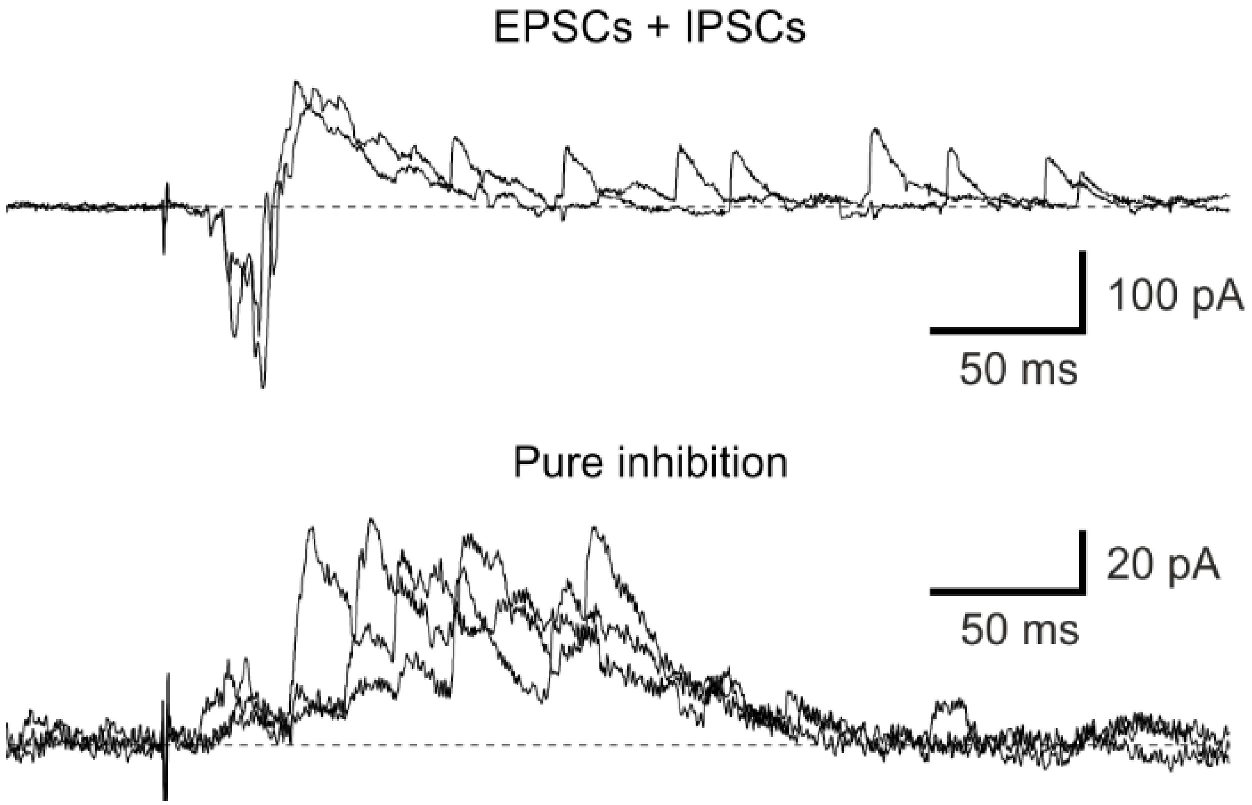


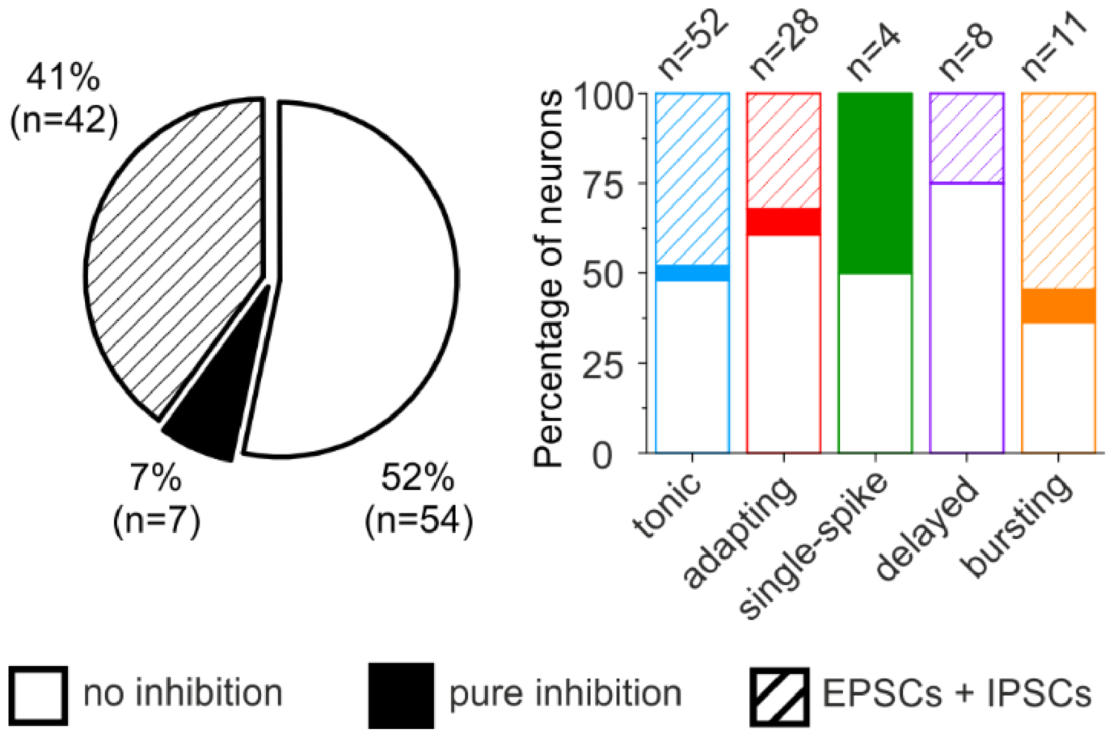


The majority of lamina X neurons receive functional monosynaptic inputs from the high-threshold Aδ and C afferents.

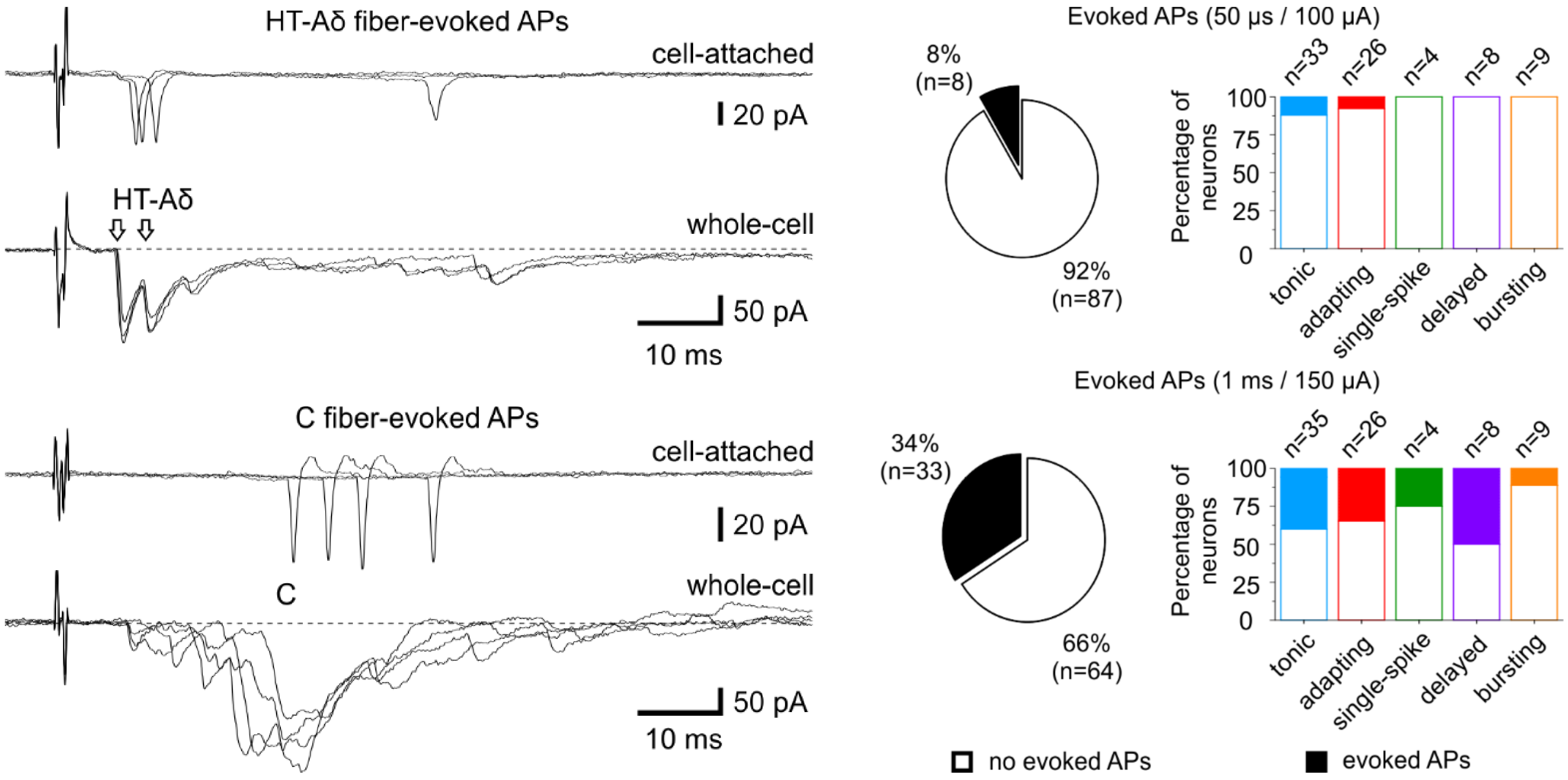
Inhibitory components of primary afferent input

About a half of lamina X neurons show primary-afferent-driven polysynaptic inhibition.



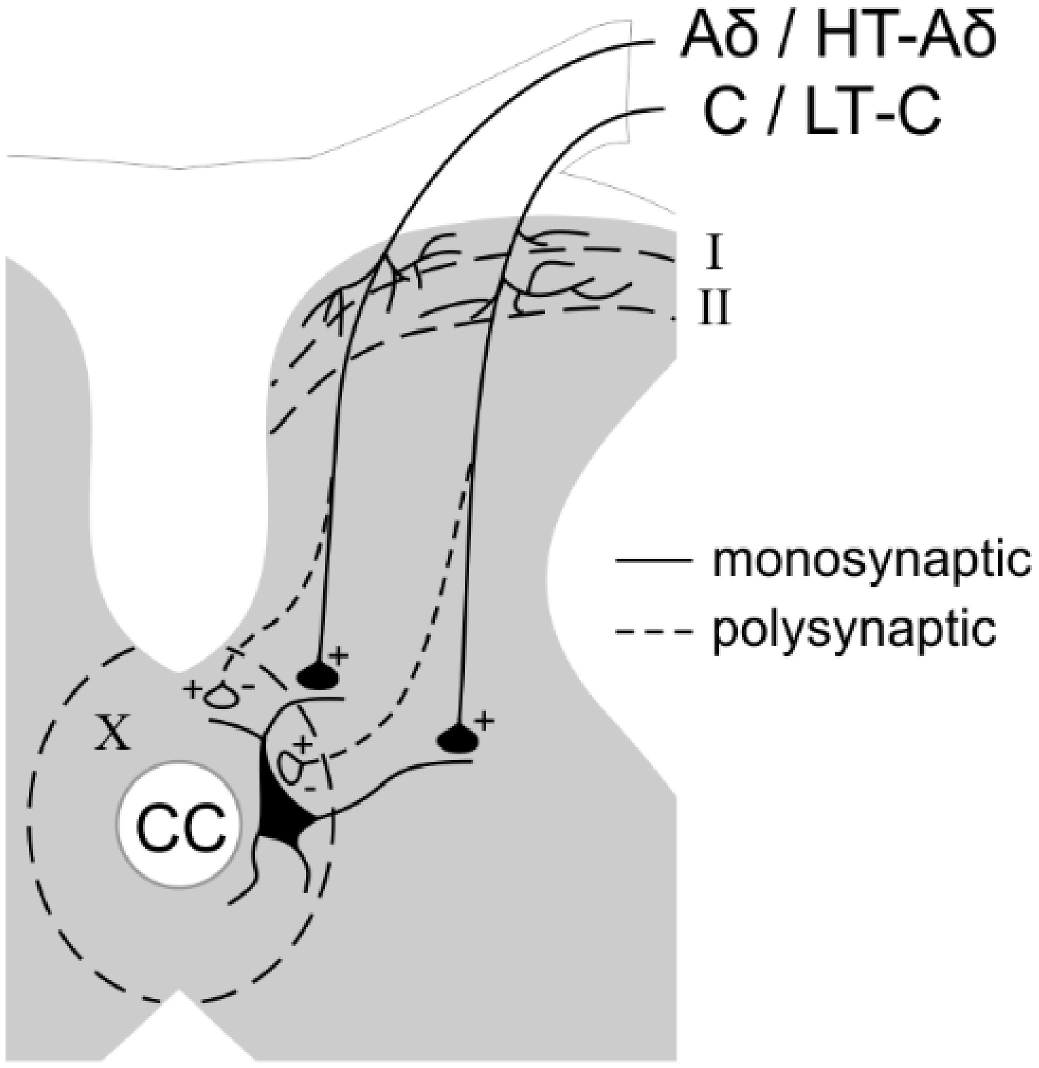


Afferent-driven firing of lamina X neurons



About 1/3 of lamina X neurons fire in response to the activation of high-threshold primary afferents.

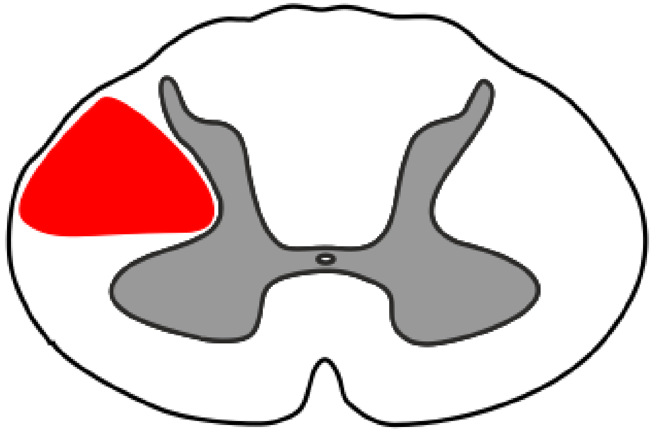
Organization of primary afferent inputs to lamina X neurons



Lamina X neurons are active elements of the intrinsic spinal network, that are directly targeted by nociceptive afferent fibers and process diverse modalities of peripheral input.

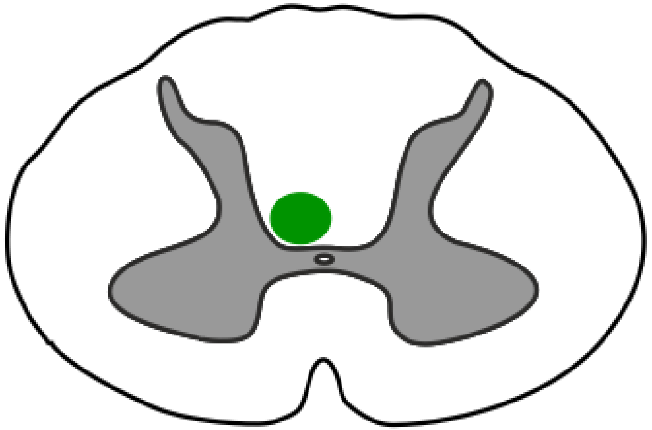
Descending modulation
of
lamina X neurons

Descending tracts of the spinal cord



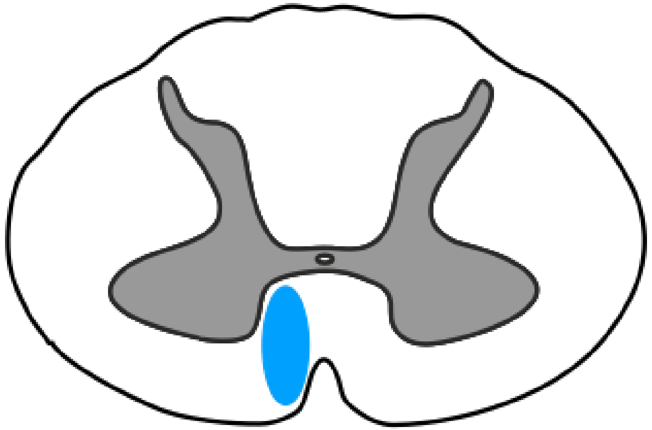
Dorsolateral funiculus (DLF)

- Lateral vestibulospinal tract
- Rubrospinal tract
- Reticulospinal tract
- Axons from RVM and PBNs (GABA, 5-HT, NE, enkephalins)



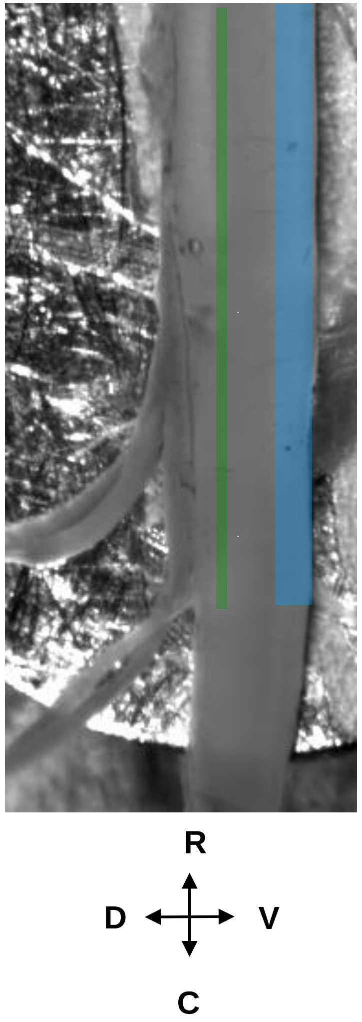
Posterior funiculus

- Main corticospinal tract (CST)

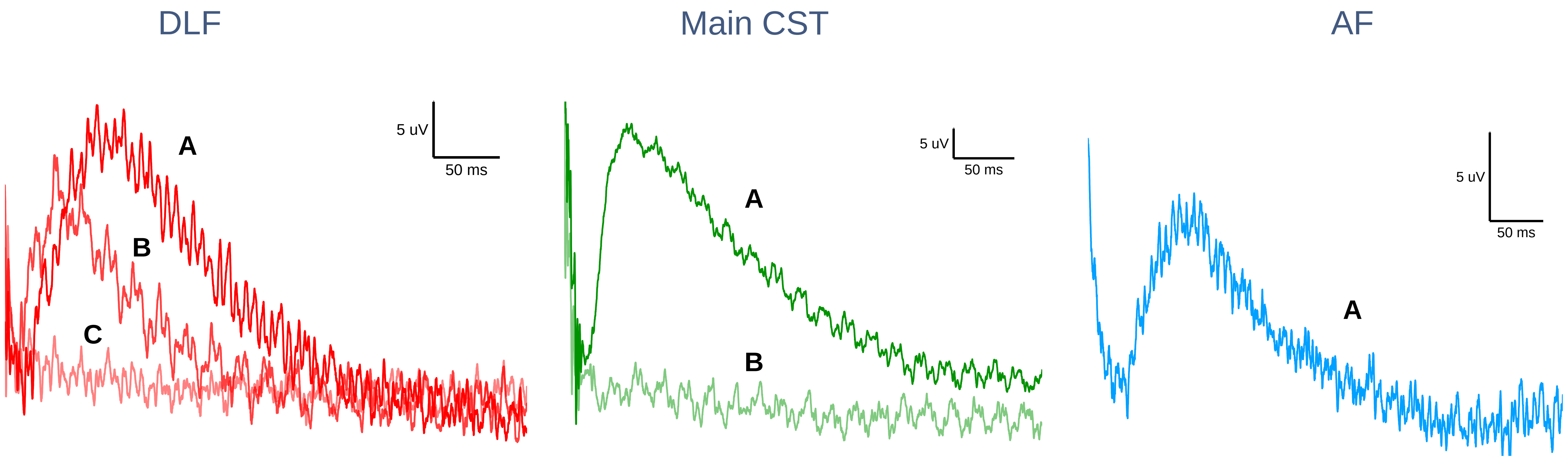


Anterior funiculus (AF)

- Corticospinal tract (CST)
- Reticulospinal tract
- Medial vestibulospinal tract

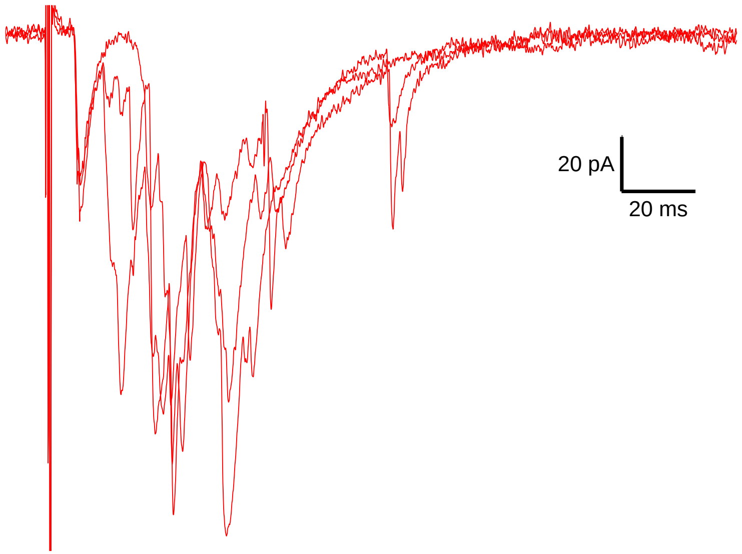


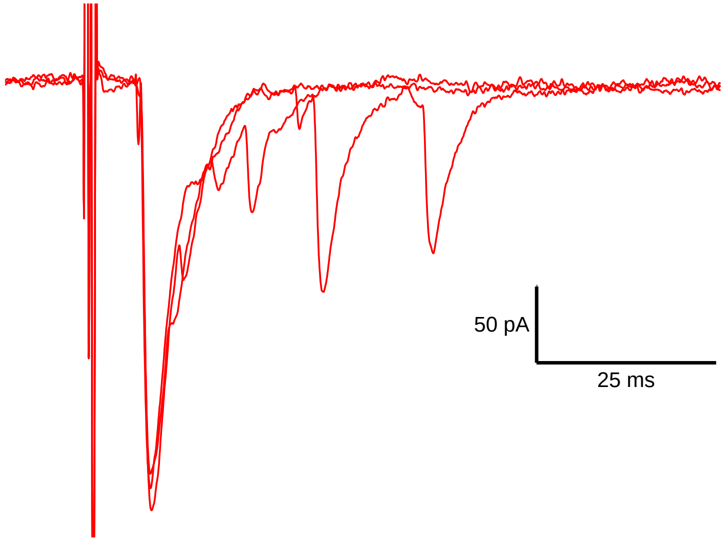
DRPs in response to stimulation of descending tracts



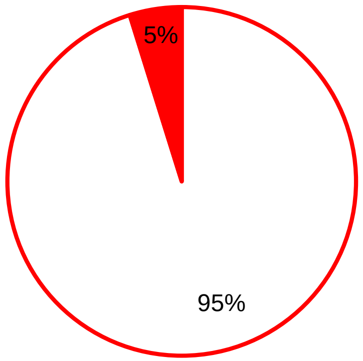
A - Krebs   **B** – Krebs+CNQX+AP5   **C** – Krebs+CNQX+AP5+bicuculline

Responses of lamina X neurons to DLF stimulation

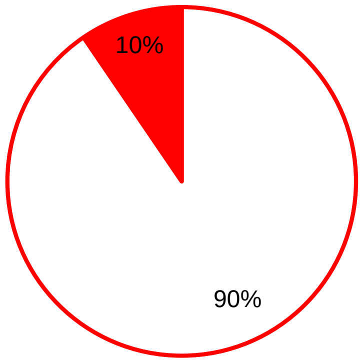


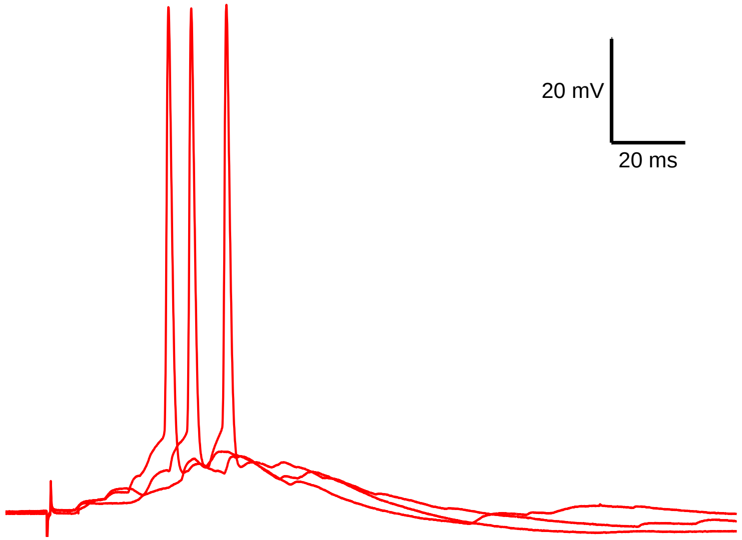


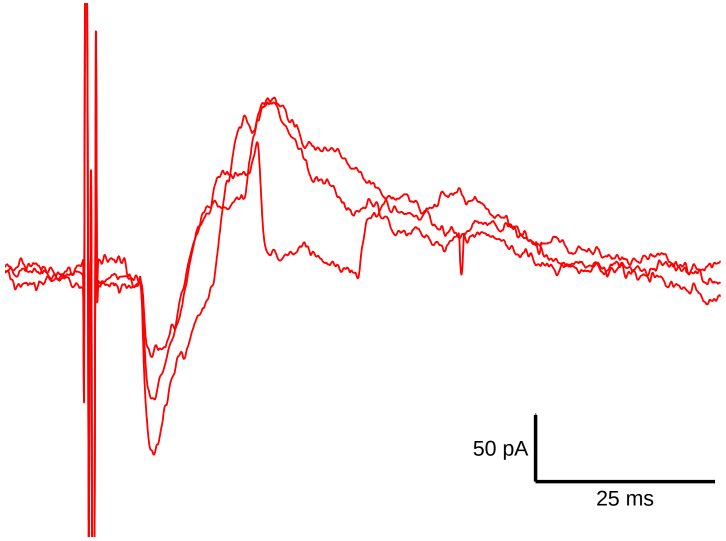
APs



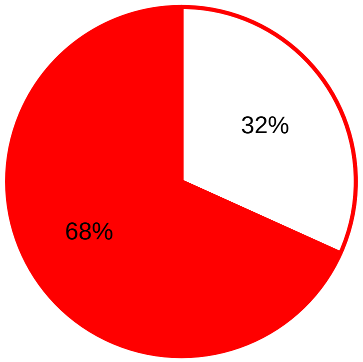
Monosynaptic EPSCs



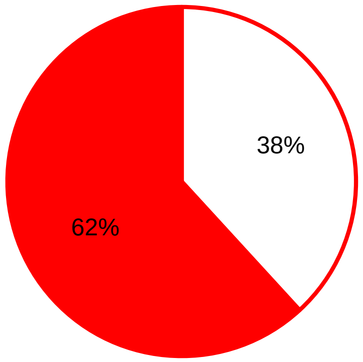




Polysynaptic EPSCs

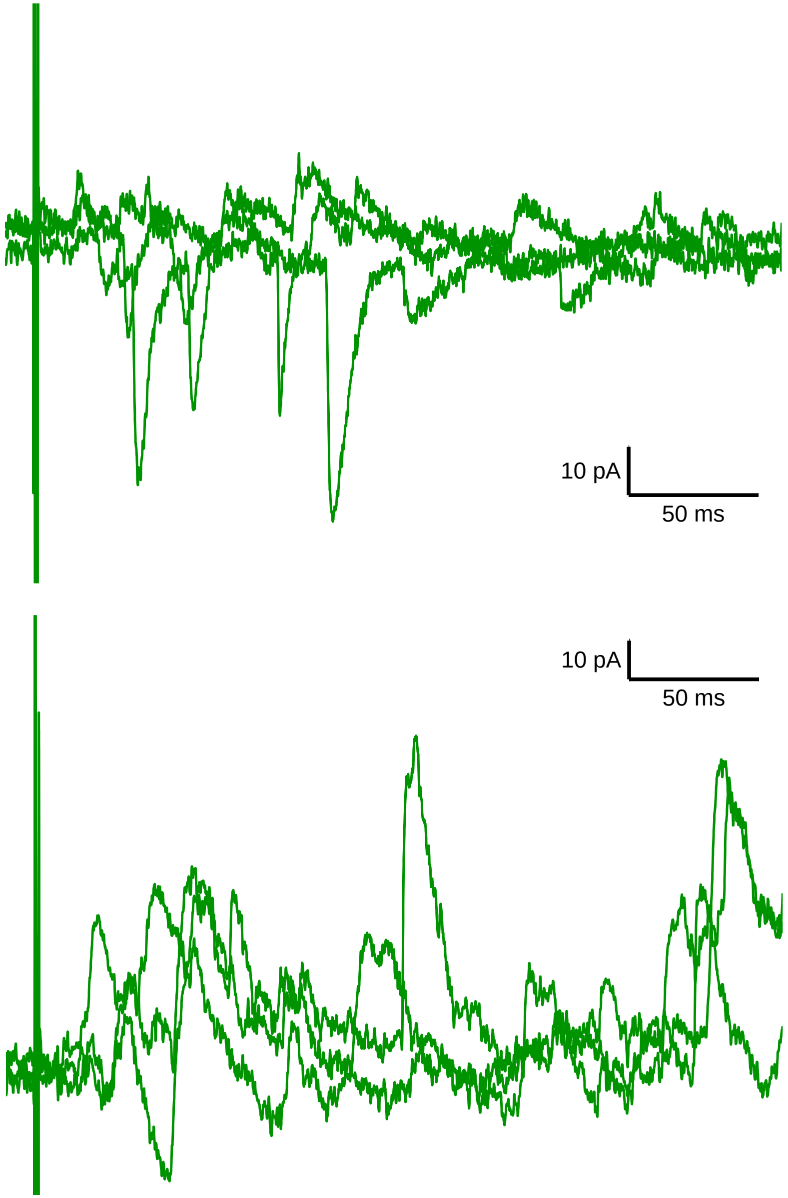


Polysynaptic IPSCs

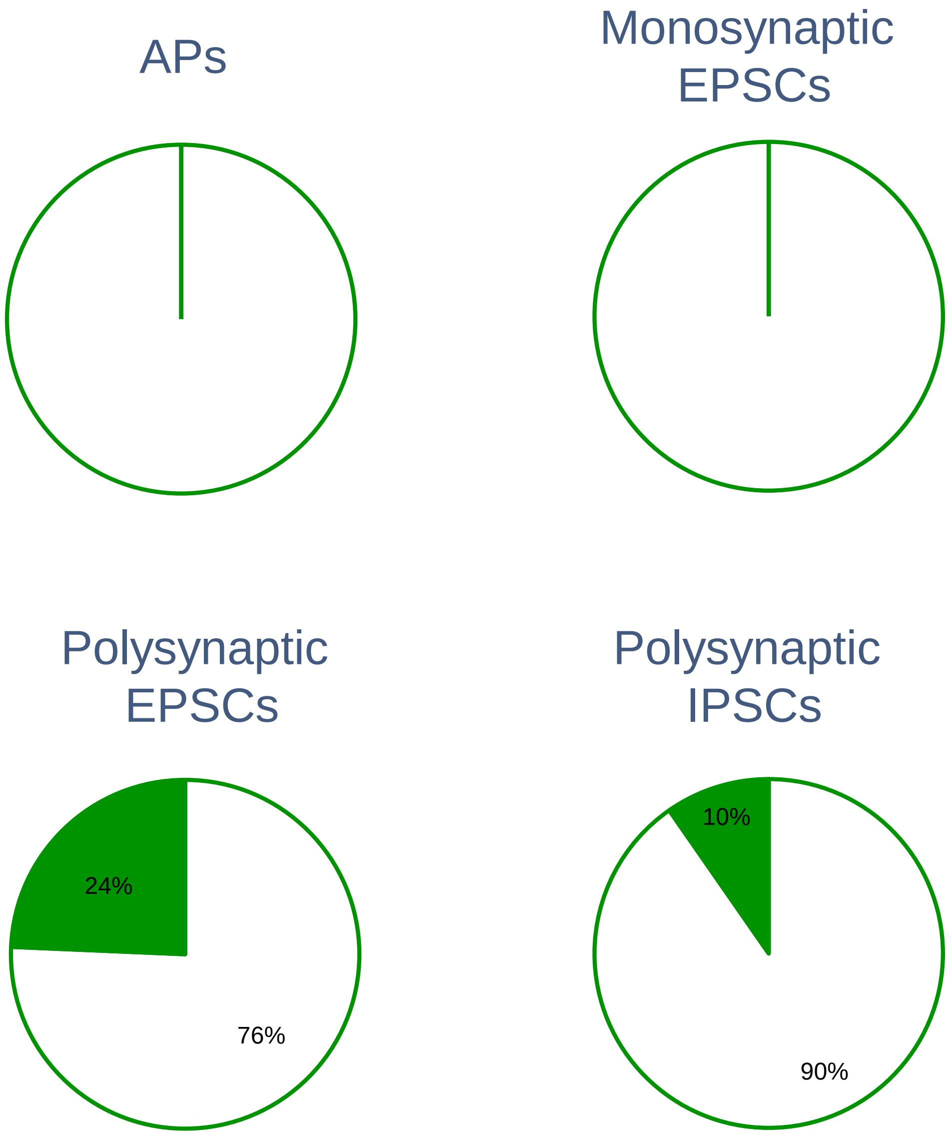


Stimulating pulse: 1ms / 200 uA / 0.1 Hz

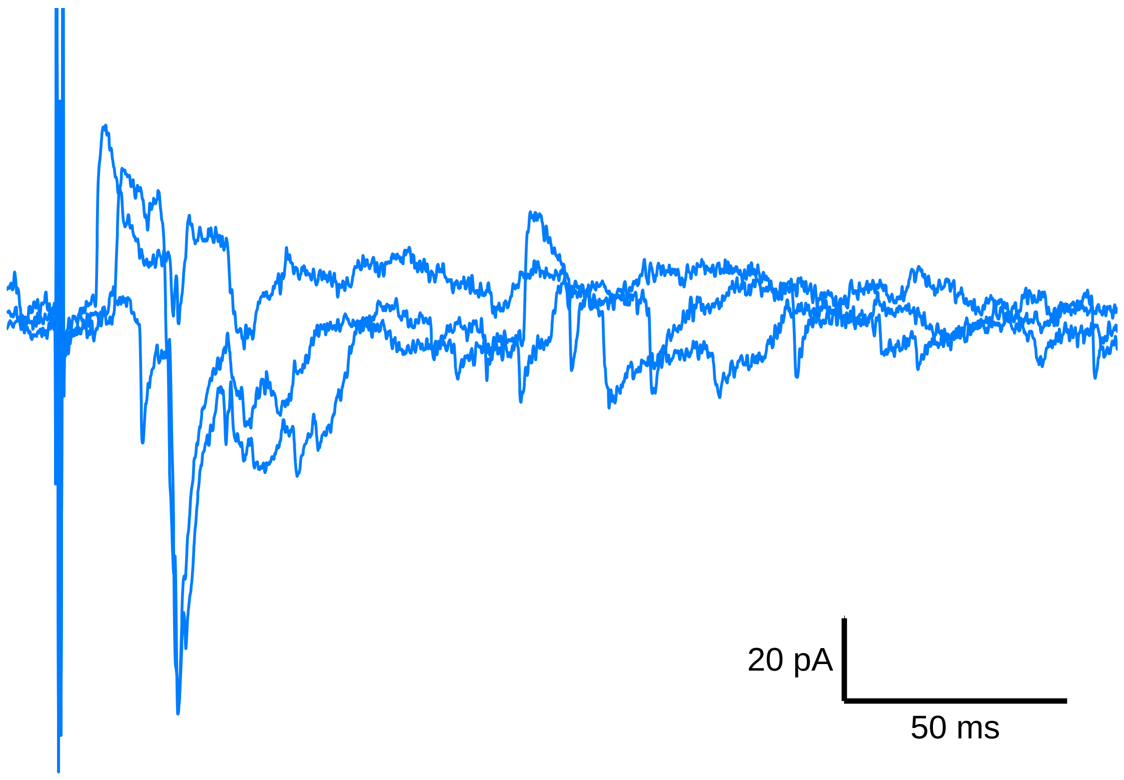
Responses of lamina X neurons to main CST stimulation

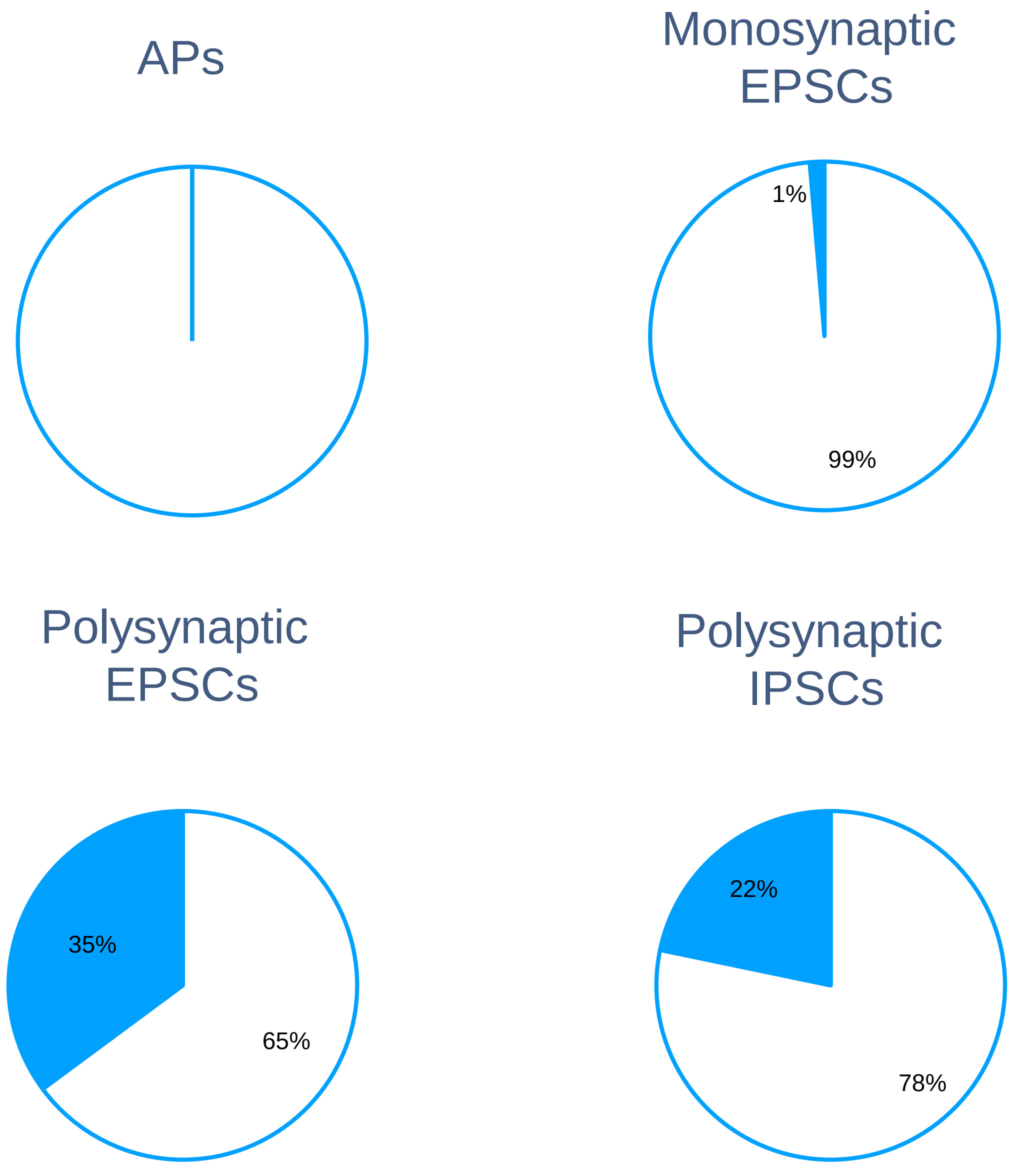


Stimulating pulse: 1ms / 200 uA / 0.1 Hz



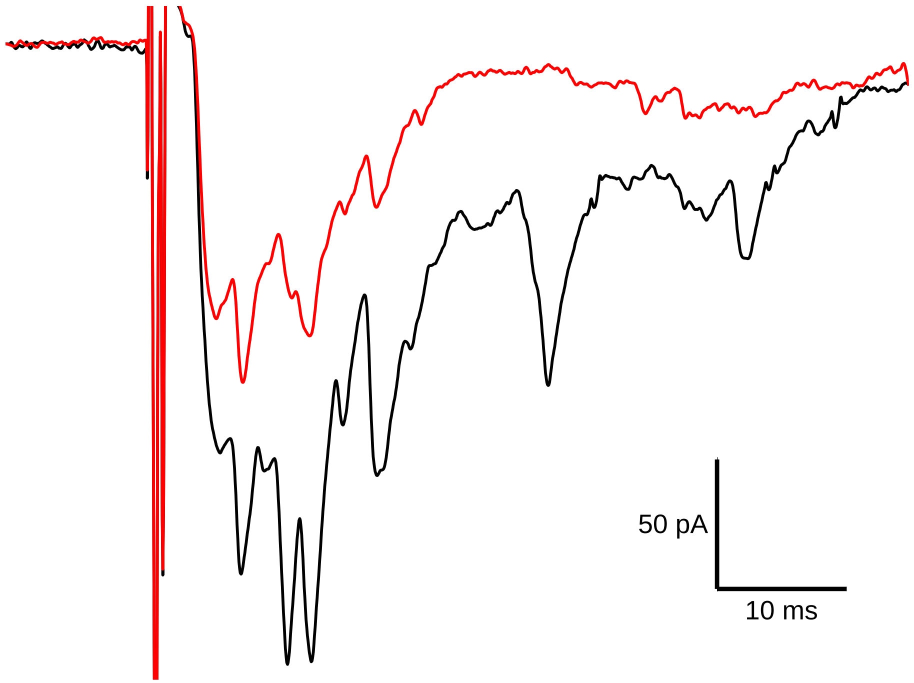
Responses of lamina X neurons to AF stimulation

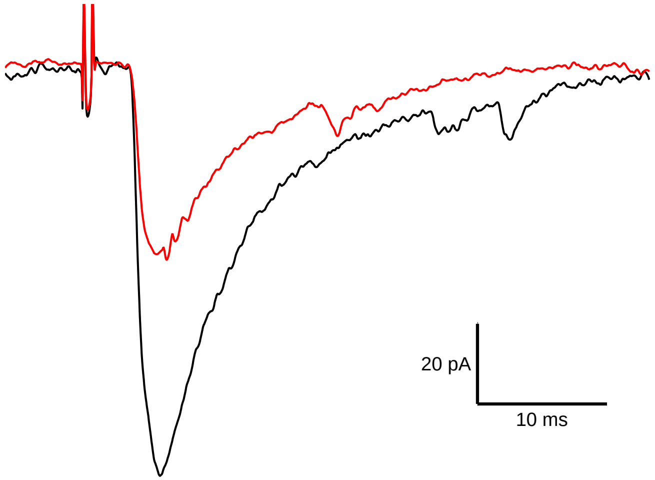


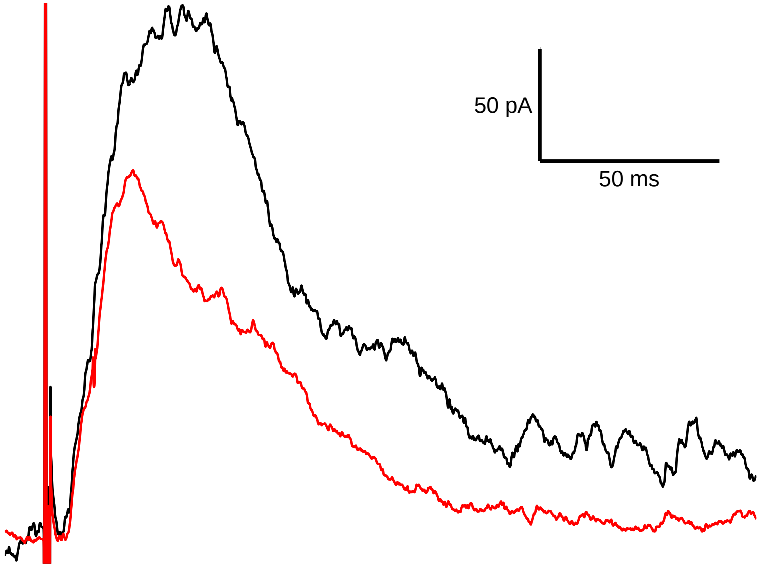


Stimulating pulse: 1ms / 200 uA / 0.1 Hz

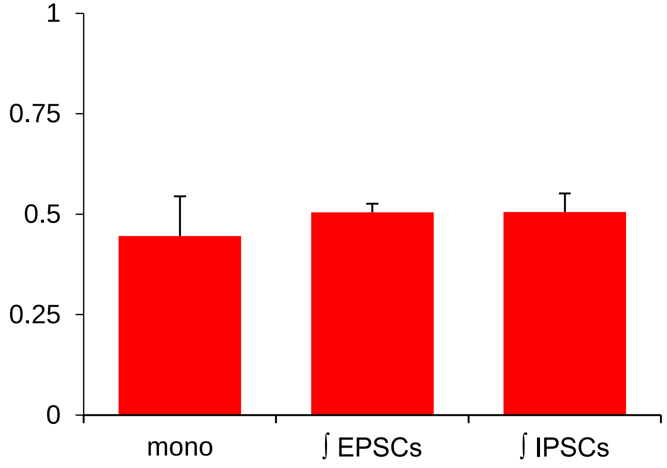
Effects of DLF stimulation on PA-induced currents

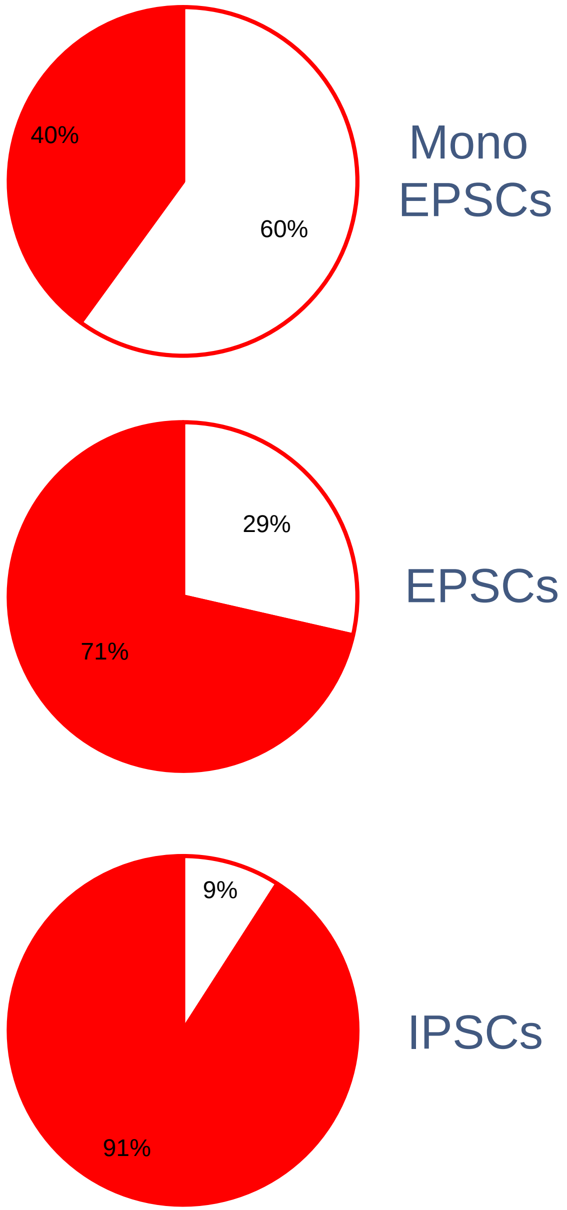






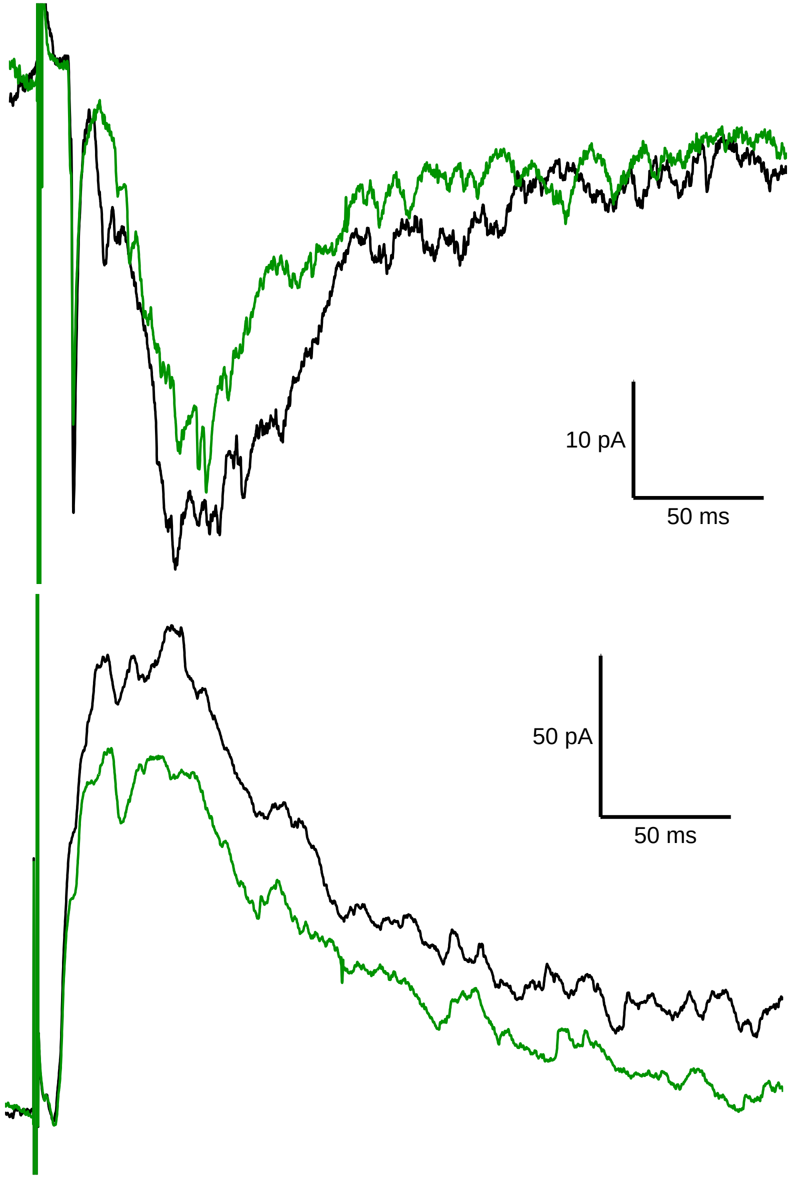
DLF-induced decrease of PA-EPSCs/IPSCs



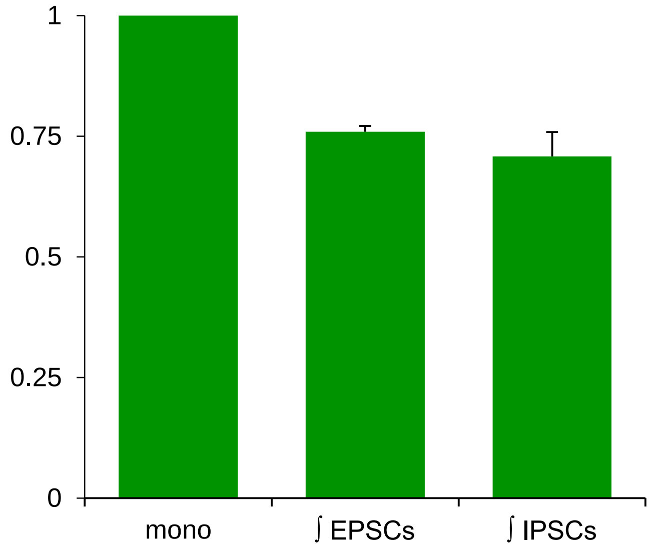


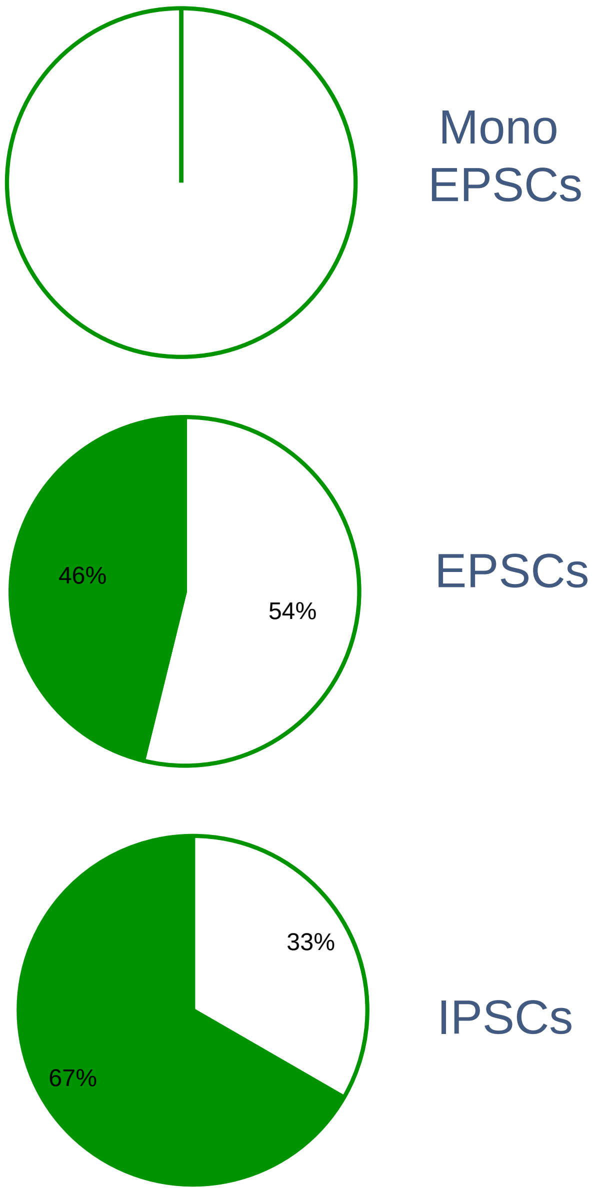
Stimulating pulses: PA - 1ms / 150 uA / 0.1 Hz; DLF - 1ms / 200 uA / 5 Hz

Effects of main CST stimulation on PA-induced currents



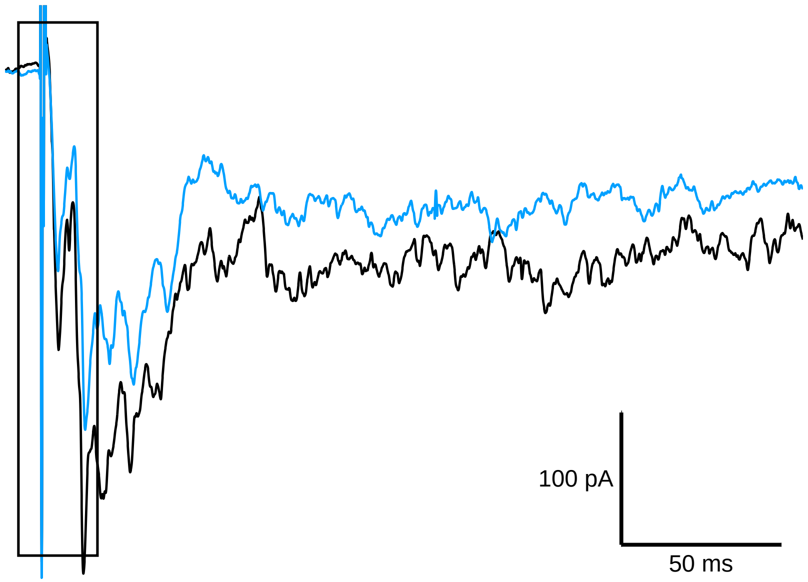
Main CST-induced decrease of PA-EPSCs/IPSCs

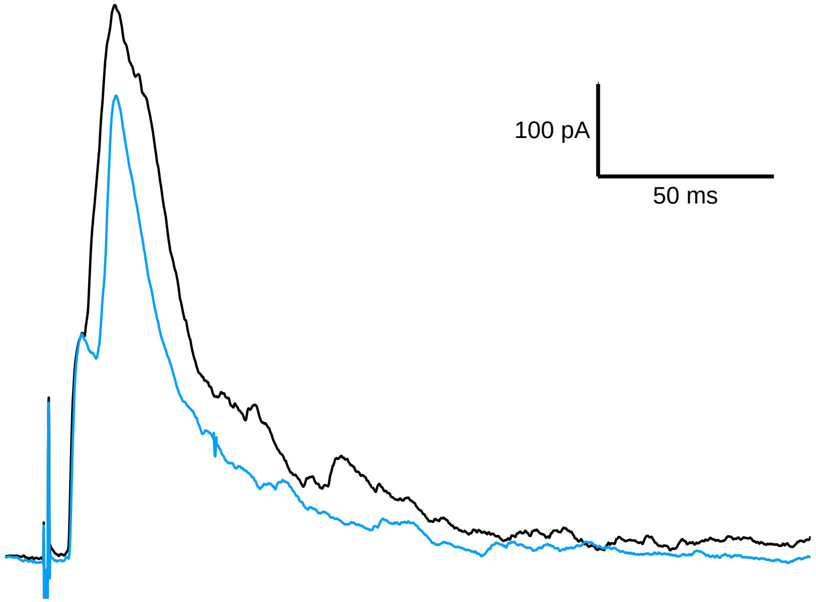


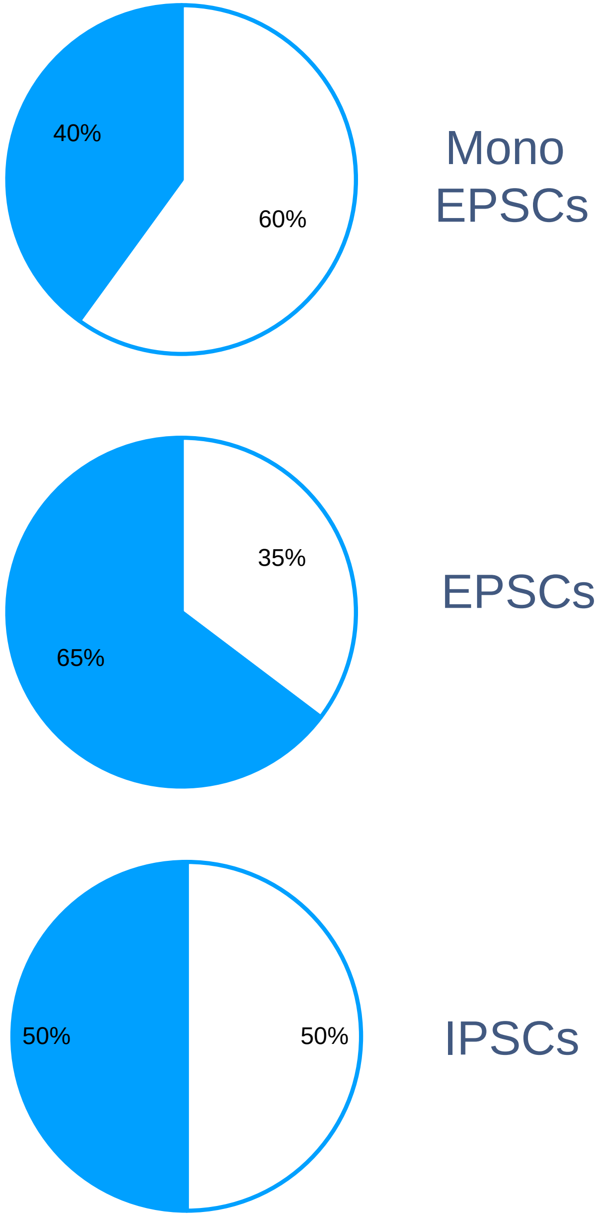


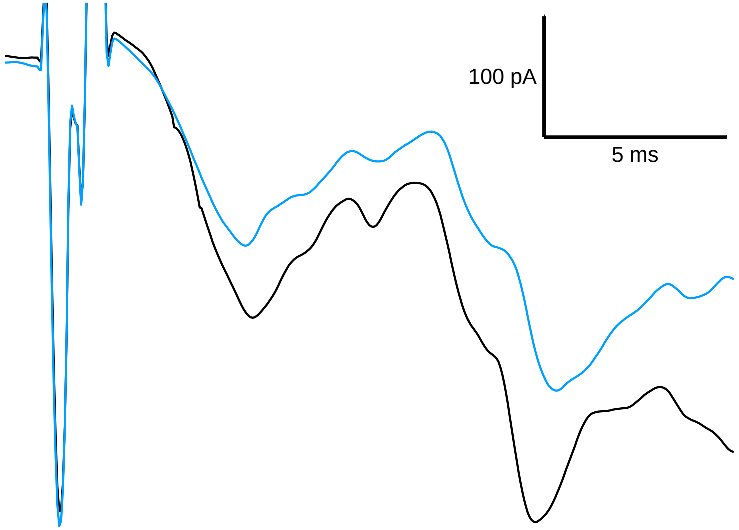
Stimulating pulses: PA - 1ms / 150 uA / 0.1 Hz; main CST - 1ms / 500 uA / 5 Hz

Effects of AF stimulation on PA-induced currents

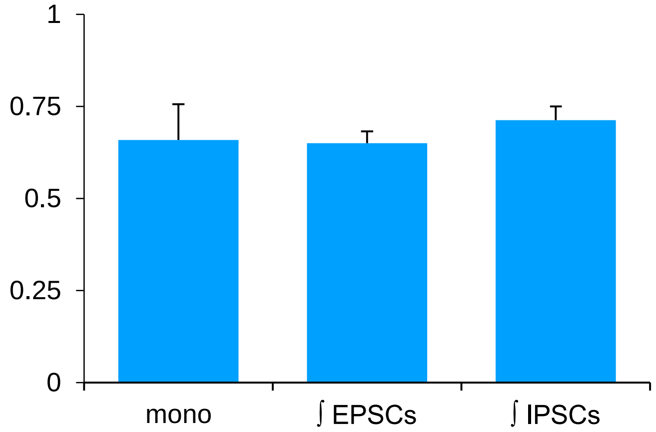








AF-induced decrease of PA-EPSCs/IPSCs



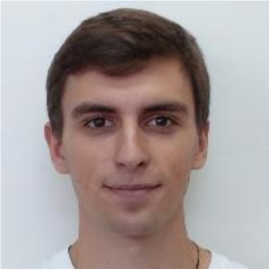
Stimulating pulses: PA - 1ms / 150 uA / 0.1 Hz; AF - 1ms / 200 uA / 5 Hz

Contributors

Prof. Pavel Belan

Prof. Nana Voitenko

Prof. Boris Safronov



Evgen Sheremet

Olga Kopach, PhD

Andrew Dromaretsky

Anastasia Tokhtamysh

Thank you
for your attention