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Neurophysiological substrates for locomotion-driven eye movements in the mouse

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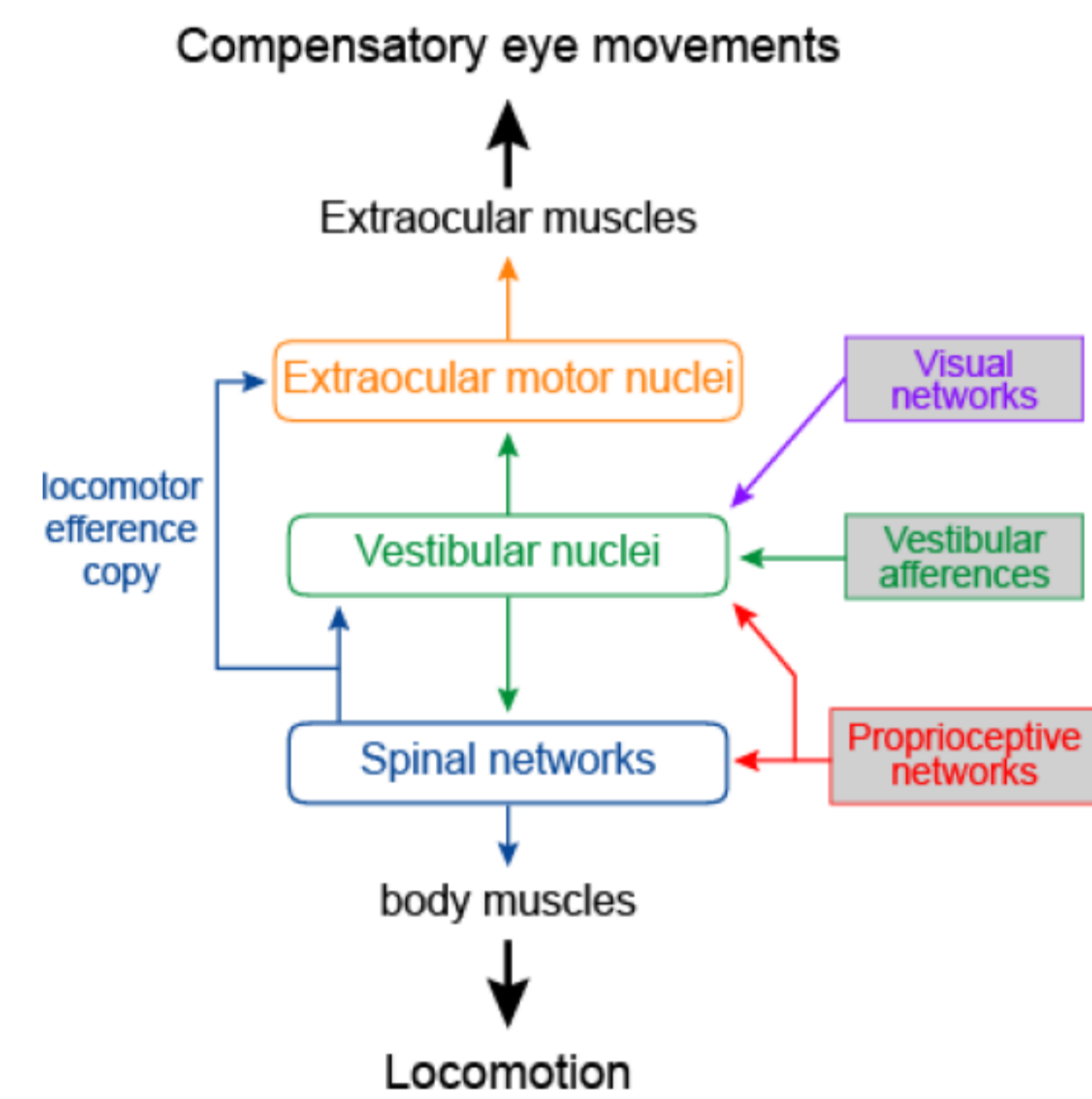
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Introduction

- Clear vision requires the eye to be stable in relation to the visual scene
- **Gaze stabilization** depends primarily on the sensorimotor transformation of visual and vestibular inputs
- In the *Xenopus*, there is also a **predictive feed-forward** signal from the spinal cord **central motor pattern generators (CPGs)** participating in gaze stabilization during locomotion (Lambert et al., 2012)



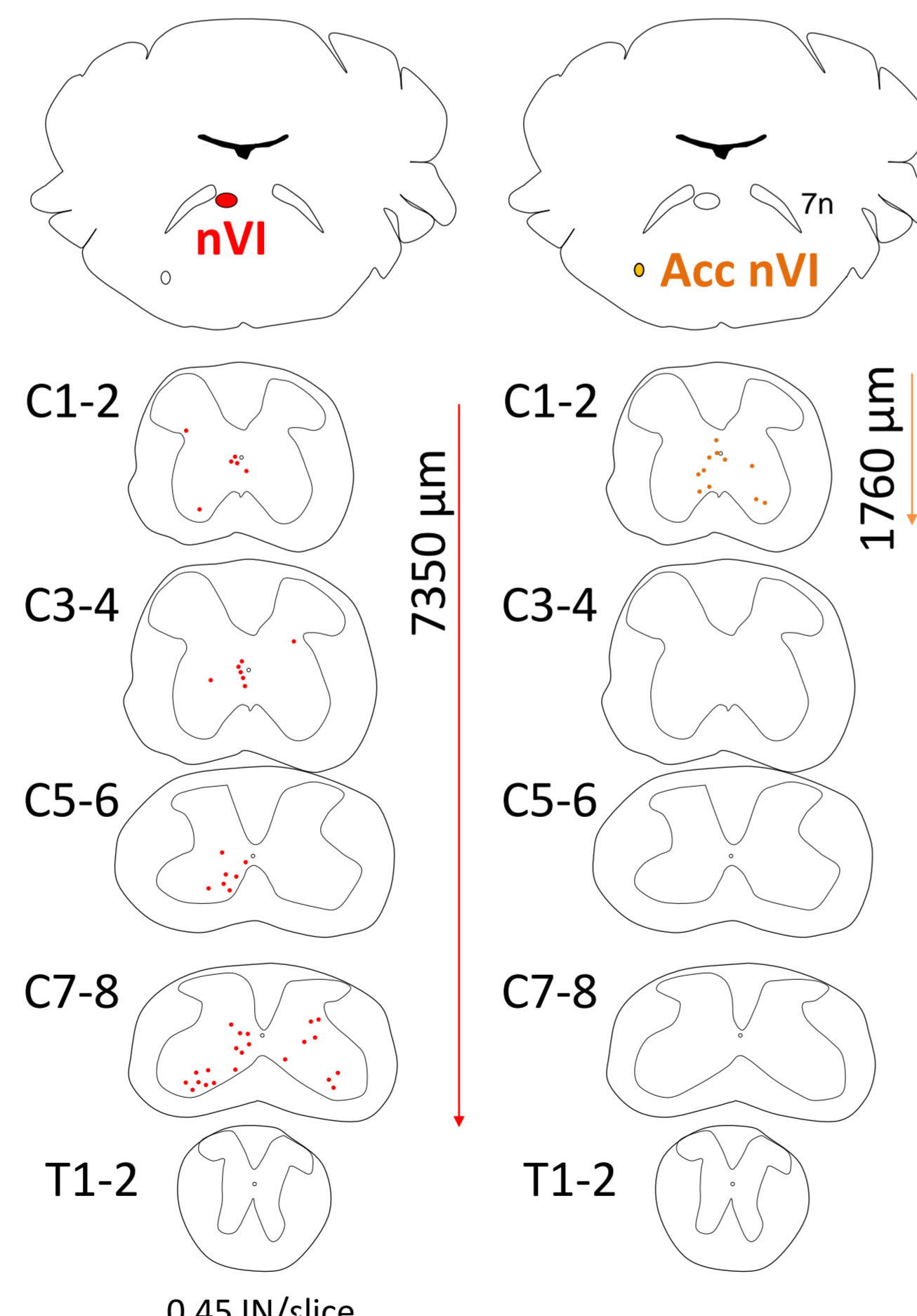
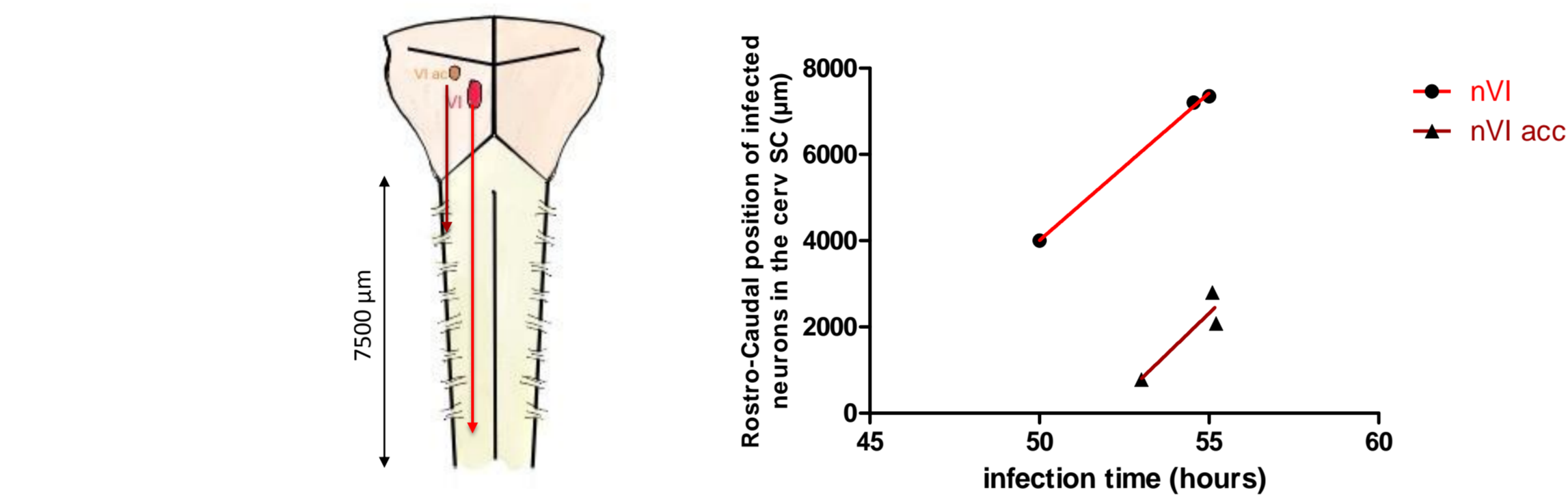
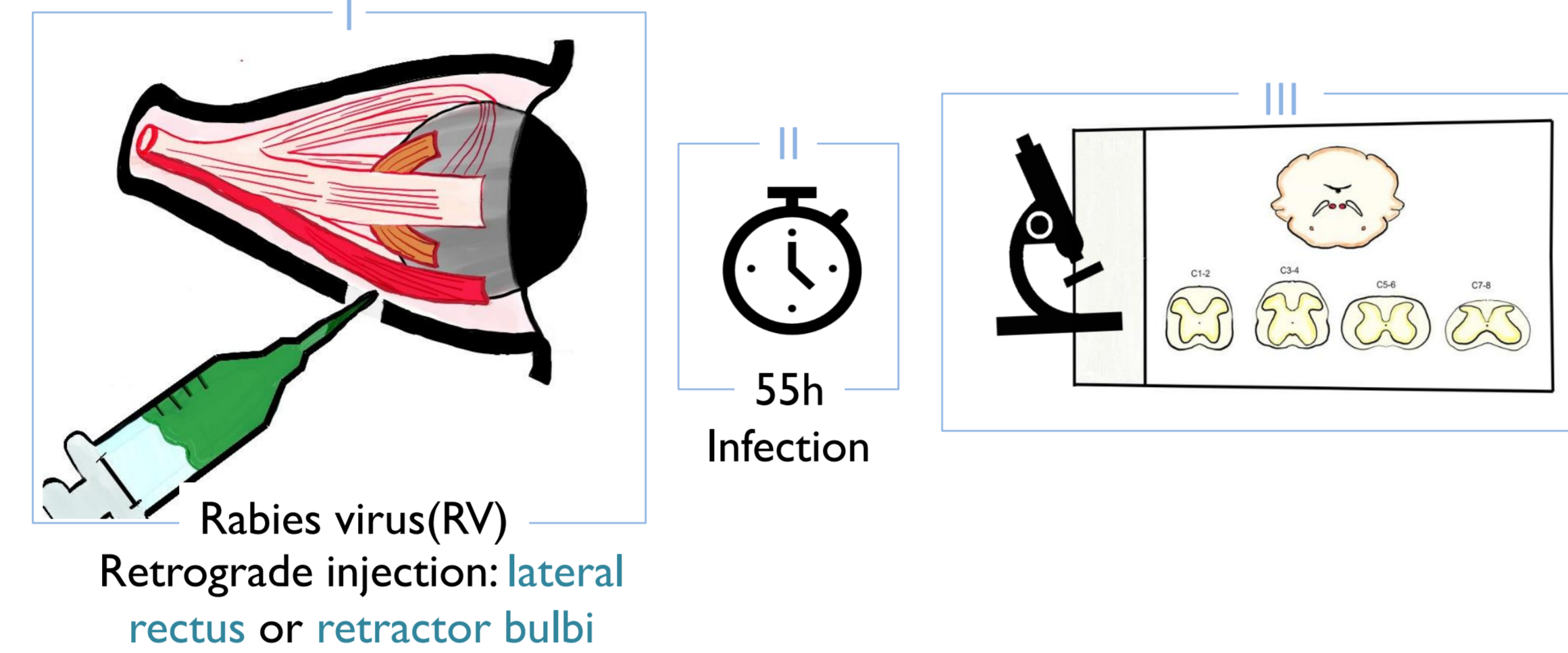
Aims

Investigate the existence of a **locomotor-induced gaze stabilizing mechanism in mammals**

To do so, this project:

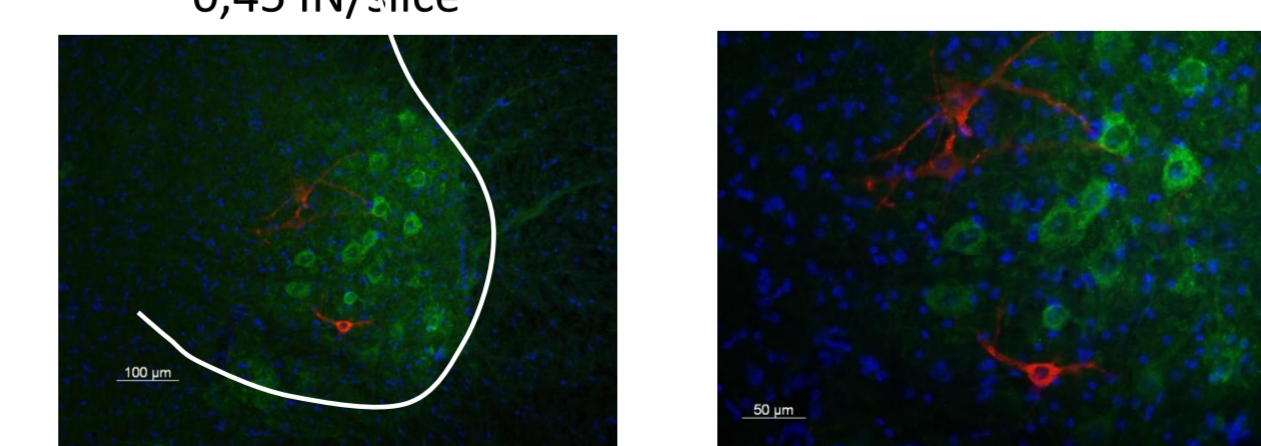
1. Identifies the neuronal substrates of the spino-extraocular pathway: retrograde trans-synaptic tracing of spinal premotor neurons projecting onto abducens motoneurons
2. Investigates its behavioral outputs: videocolography tracking to quantify eye movements during treadmill locomotion of head-fixed, premammillary decerebrated mice

1. Neuronal substrates of the spino-extraocular pathway

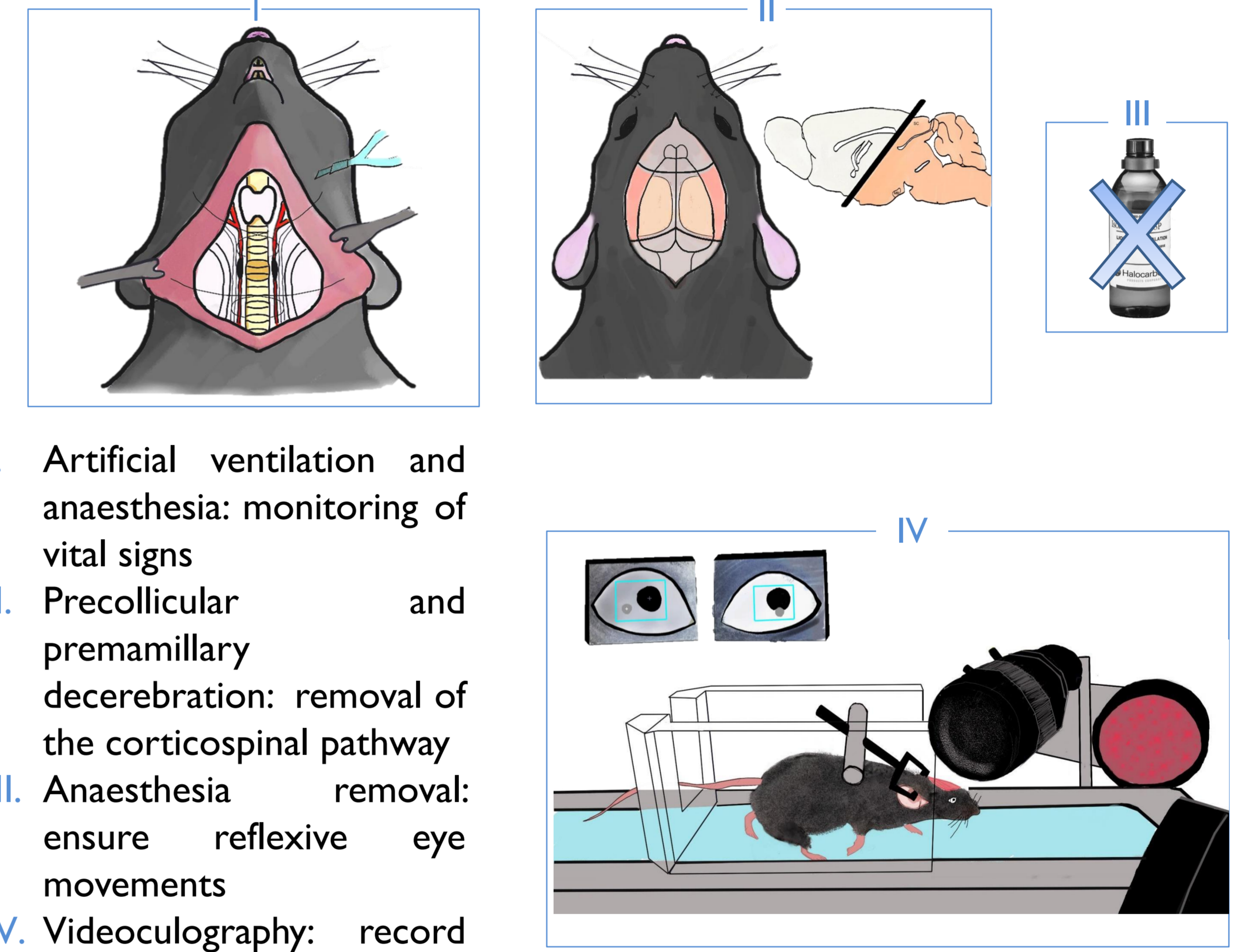


After the injection in the lateral rectus, the distribution of the RV+ premotor interneurons in the cervical:

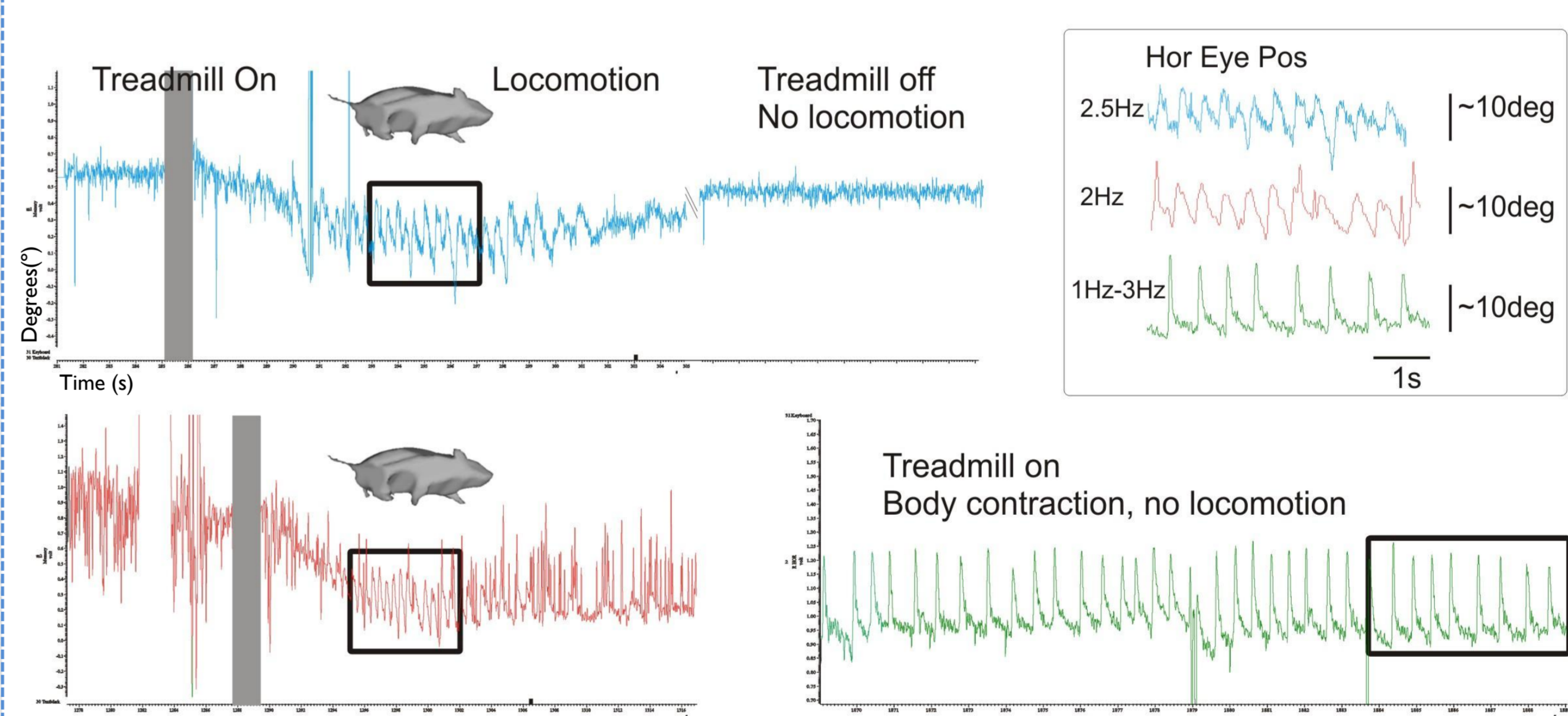
- ✓ Bilateral, but mostly ipsilateral, medial and ventral
- ✓ Mainly located in the cervical's ventral horn and around the central canal
- ✓ Both conditions display infected neurons all along the cervical. Injection on the lateral rectus (nVI marked): wide distribution of marked interneurons in C7-8. Injection on the retractor bulbi (accessory nVI): no neurons marked below C2.



2. Eye movements during treadmill locomotion in decerebrated head-fixed mice



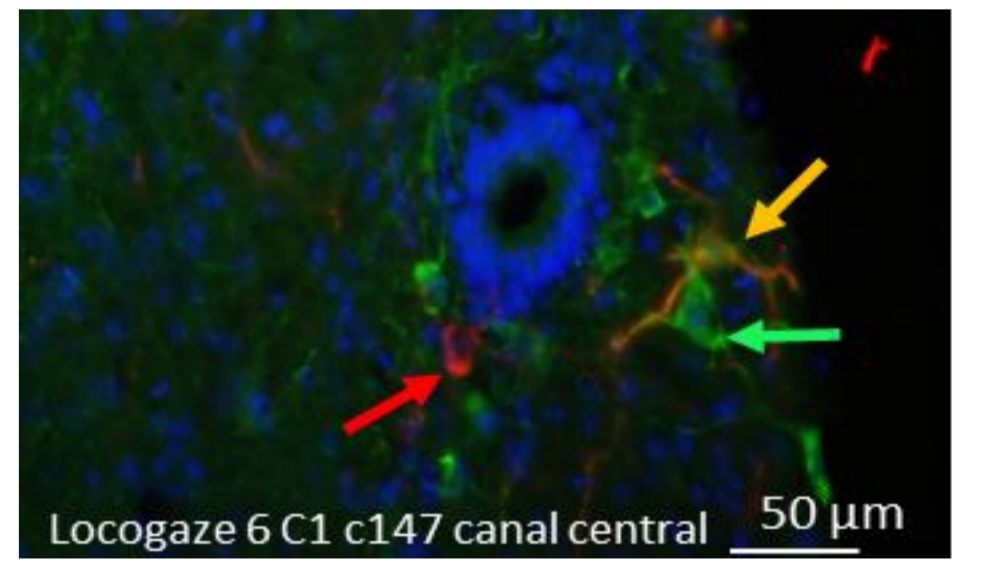
- I. Artificial ventilation and anaesthesia: monitoring of vital signs
- II. Precollicular and premammillary decerebration: removal of the corticospinal pathway
- III. Anaesthesia removal: ensure reflexive eye movements
- IV. Videocolography: record eye movements during spontaneous locomotion



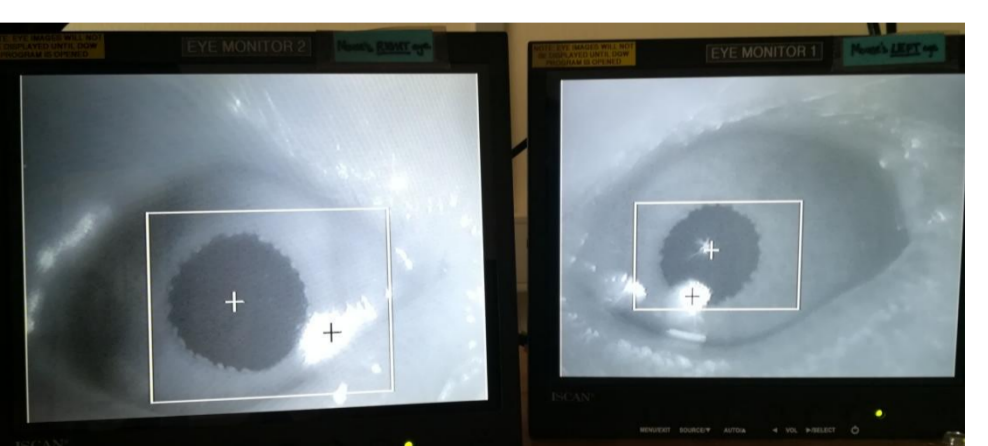
- ✓ Horizontal eye movements 2-6s after the onset of locomotion
- ✓ 10s long epochs of slow-phase eye movements
- ✓ Amplitude: 5-10°
- ✓ Frequency: 1-3Hz

Conclusion

1. Neuronal substrates of the efference copy: direct neuronal projections from the cervical to the abducens or to the accessory abducens



2. Due to the absence of vestibular and visual inputs during this experiment, the recorded horizontal eye movements are coherent with the behavioural output of an efference copy



Our results are the first evidence that **spinal-CPG can contribute to gaze stabilization in mammals** independently of visual and vestibular sensory inputs.