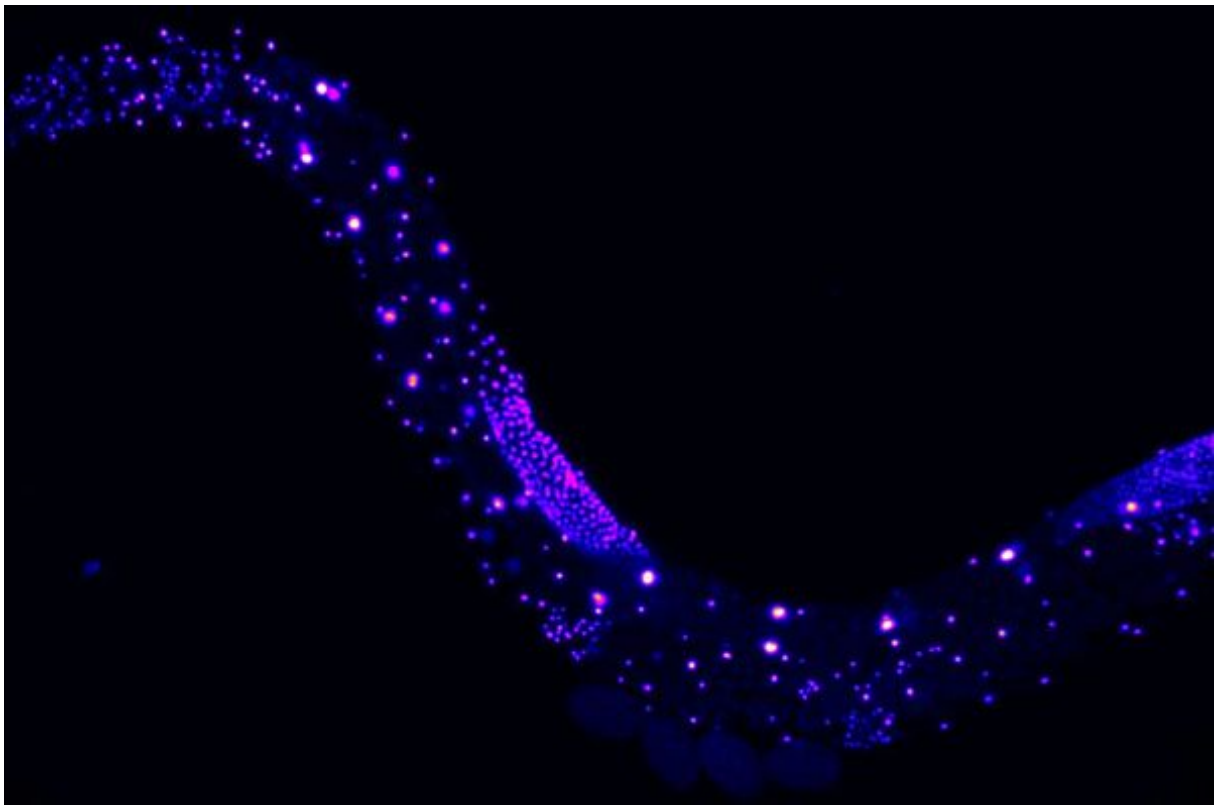

C. elegans senses its physical environment to adapt its movement

While studying the nematode Caenorhabditis elegans, ICFO researchers and collaborators have discovered that touch receptor neurons can detect the friction generated by the ground as the worm crawls. The worm can thus actively move to explore its surroundings and adjust its position accordingly. These results have been recently published in Nature Communications.

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Caenorhabditis elegans, a one-millimeter-long worm, is commonly used as a model animal to study mechanosensation, the ability of animals to detect and convert mechanical forces (such as touch, pressure, or stretch) into electrical signals that the brain can interpret. **Touch receptor neurons (TRNs)**, located along the animal's body wall, were long thought to passively sense simple touch stimuli as they occurred, triggering the corresponding avoidance response. Now, a team of ICFO researchers, **Dr. Aleksandra Pidde**, **Dr. Montserrat Porta de la Riva**, **Dr. Costanza Agazzi**, **Dr. Carmen Martinez Fernandez**, **Alice Lorrach**, **Dr. Neus Sanfeliu Cerdan** and **Dr. Alba Calatayud Sanchez**, led by **ICFO Prof. Michael Krieg**, and

in collaboration with the Centre Internacional de Metodes Numerics en Enginyeria (CIMNE) and the Universitat Politecnica de Catalunya (UPC), has shown in a Nature Communications study that these receptors **can also detect velocity-dependent forces, such as the friction** exerted by the surface on which the worm crawls. This means that **the worm can generate movements to actively gather sensory information** about its environment, rather than merely receiving input passively.

i¿½When an organism moves, it needs to feel the surface. Without this feedback, we bare y can walk and maintain posture - a feeling we experience when our legs fall asleep,i ?½ explains Prof. Michael Krieg, lead author of the article. i¿½Crawling animals also us this proprioceptive feedback, gathered through specialized mechanoreceptors, to optimi e the energy spent during locomotion.i¿½ As a result, the worm's body wall is constantly sensing how fast it's moving and how much resistance it encounters from the surface, allowi g it to move efficiently and adapt to changing envir nments. In particular, the researchers have identified a previously unknown behavioral func ion for PVM, one of the six neurons responsible for sensing gentle mechanical stimuli in C. elegans. This neuron appears to selectively sense soft substrates and send this information to proprioceptive neurons (neurons that sense the position and movement of the animal's own body), so that the worm can adjust its posture and movement in a similar way to how plantar mechanoreceptors in our feet work.

This connection between mechanoreceptors and proprioceptors was further exemplified by studying mutant C. elegans with disrupted MEC-4 activity (a specialized protein that helps the worm detect mechanical forces and convert them into electrical signals). These specimens displayed lethargic behavior and reduced mobility, suggesting that the ability to detect and transmit mechanical input is vital for efficient movement.

Overall, the study shows for the first time that body-substrate contact plays an important role in spatial navigation in eye-less animals as they move.

Reference:

Pidde, A., Porta-de-la-Riva, M., Agazzi, C. et al. Mechanosensory encoding of surfa e mechanics optimizes locomotion. Nat Commun **17**, 9083 (2026).
DOI: https://doi.org/10.1038/s41467-026-75352-7

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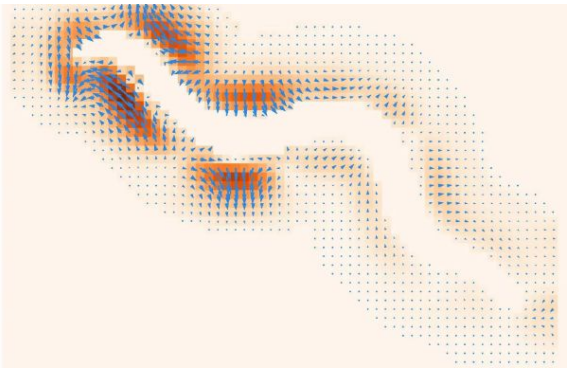
tres of Excellence in R&D (CEX2024-001490-S)[MICIU/AEI/10.13039/501100011033], from undacio Privada Cellex, Fundacio Mir-Puig, and from Generalitat de Catalunya through the C RCA and Research program. ICFO is the recipient of the Severo Ochoa Award of Excel ence of MINECO (Government of Spain). JJM and AB acknowledge Severo Ochoa program (CEX2018-000797-S). JJM is also financially supported by grant PID2020-116141GBI0 funded by MCIN/AEI, and grant SGR 01049 from the local government Generalitat de Catalunya.



Traction/force field exerted by a C. elegans animal when it crawls in a deformable substrate.