

Executive Summary

The Interfaculty Research Cooperation (IRC) *Decoding Sleep* at the University of Bern is an interdisciplinary research initiative dedicated to understanding the mechanisms and functions of sleep, from neuronal circuits to cognition, mental health, and clinical applications. By integrating expertise from neuroscience, medicine, psychology, engineering, and computational sciences, the consortium investigates how sleep influences brain function, learning, memory, creativity, consciousness, and disease.

Over the course of the project, the program generated important insights into the neural mechanisms regulating sleep and wakefulness, particularly the role of the thalamus in sensory processing, cognition, arousal, and sleep stability. Research demonstrated how sleep shapes learning and memory, influences creativity, and contributes to the regulation of conscious experience. Several projects also identified links between sleep disturbances and neurological or psychiatric conditions, including depression, narcolepsy, stroke, psychosis, epilepsy, and neuroinfectious diseases.

A major achievement of the IRC was the development of innovative technologies to measure and manipulate sleep. These included machine-learning approaches for analyzing neural activity and a novel closed-loop stimulation system capable of selectively modulating slow-wave sleep, opening new perspectives for sleep-based interventions in depression and other disorders.

Beyond scientific discoveries, the consortium established key infrastructures such as NeuroTec, the Sleep Motion Lab, and the Swiss Sleep House, creating a sustainable platform for translational sleep research and clinical innovation. Through more than 100 publications, substantial external funding, and the training of over 40 early-career researchers, *Decoding Sleep* has significantly strengthened sleep research in Switzerland and positioned the University of Bern as an internationally recognized center for interdisciplinary sleep science.

Welches Wissen schaffte die IFK?

Im Wesentlichen sind es die folgenden Ergebnisse, die wir im Rahmen des IFK erzielt haben.

- 1) better understanding through experimental and human approaches of the key-role of the **thalamus** in controlling sleep-wake as well as cognitive and pain mechanisms
- 2) recognition of new sleep-related interventions to improve **learning** and **cognitive** performance and to better understand **conscious** experiences and **creativity**
- 3) improvement of our insights into the role in humans of sleep and **sleep disorders** (e.g. sleep apnea) as modulators of **mental** (e.g. depression, psychoses) and **brain** (e.g. stroke, epilepsy, coma, narcolepsy, neuro-infectious diseases, Parkinsonism) disorders and recognition of new **sleep-related biomarkers** to improve their diagnosis and treatment

- 4) establishment of new **computational** and **machine learning techniques** for investigations neural functions that take place during sleep, wakefulness and related pathological conditions

b) Welche Innovationen brachte die IFK hervor?

- 1) Novel approaches in data science related to sleep that are unique to Bernese sleep research
- 2) Bridging clinical and basic research groups at a large scale, and in new configurations that go beyond standard interdisciplinary collaborations.
- 3) Creation of new platforms (**NeuroTec**), laboratories (**Sleep Motion Lab**) and units (**Sleep House**) to promote sleep research and novel approaches such as telemedicine, wearables devices.
- 4) New educational programs (International **Postgraduate Sleep Master** (60 ECTS, **Neuroscience Bachelor** (30 ECTS) and training of over 40 young scientists (Postdocs, PhDs, MD-PhDs, Clinical PhDs, master students)
- 5) **10.6 million CHF** in research grants and one European patent application

Liste der Publikationen

Die top 15 publications sind unten aufgeführt. Es sind insgesamt über 100 Publikationen entstanden.

Adamantidis, A. R., Herrera, C. G. & Gent, T. C. Oscillating circuitries in the sleeping brain. **Nature Reviews Neuroscience** **20**, 746-762 (2019).

Alnes, S. L., De Lucia, M., Rossetti, A. O. & Tzovara, A. Complementary roles of neural synchrony and complexity for indexing consciousness and chances of surviving in acute coma. **NeuroImage** **245**, 118638 (2021).

Baillieux, S., Dekkers, M., Brill, A.-K., Schmidt, M. H., Detante, O., Pépin, J.-L., Tamisier, R. & Bassetti, C. L. Sleep apnoea and ischaemic stroke: current knowledge and future directions. **The Lancet Neurology** **21**, 78-88 (2022). (Review)

Bandarabadi, M., Herrera, C. G., Gent, T. C., Bassetti, C., Schindler, K. & Adamantidis, A. R. A role for spindles in the onset of rapid eye movement sleep. **Nature Communications** **11**, 1-12 (2020).

Bassetti, C. L., Kallweit, U., Vignatelli, L., Plazzi, G., Lecendreux, M., Baldin, E., Dolenc-Groselj, L., Jennum, P., Khatami, R. & Manconi, M. European guideline and expert statements on the management of narcolepsy in adults and children. **European Journal of Neurology** **28**, 2815-2830 (2021).

Castegnetti, G., Tzovara, A., Khemka, S., Melinščak, F., Barnes, G. R., Dolan, R. J. & Bach, D. R. Representation of probabilistic outcomes during risky decision-making. **Nature Communications** **11**, 1-11 (2020).

Facchin, L., Schöne, C., Mensen, A., Bandarabadi, M., Pilotto, F., Saxena, S., Libourel, P. A., Bassetti, C. L. & Adamantidis, A. R. Slow waves promote sleep-dependent plasticity and functional recovery after stroke. **Journal of Neuroscience** **40**, 8637-8651 (2020).

Gutierrez-Herrera, C. G., Girard, F., Bilella, A., Gent, T. C., Rocco-Waldmeyer, D. M., Adamantidis, A. & Celio, M. R. Neurons in the Nucleus papilio contribute to the control of eye movements during REM sleep. **Nature Communications** **10**, 1-11 (2019).

Komagata, N., Latifi, B., Rusterholz, T., Bassetti, C. L., Adamantidis, A. & Schmidt, M. H. Dynamic REM sleep modulation by ambient temperature and the critical role of the melanin-concentrating hormone system. **Current Biology** **29**, 1976-1987. e1974 (2019).

Latorre, D., Kallweit, U., Armentani, E., Foglierini, M., Mele, F., Cassotta, A., Jovic, S., Jarrossay, D., Mathis, J., Zellini, F., Bassetti CL*, Sallusto F*. T cells in patients with narcolepsy target self-antigens of hypocretin neurons. **Nature** **562**, 63-68 (2018)
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Markovic, A., Kaess, M. & Tarokh, L. Environmental factors shape sleep EEG connectivity during early adolescence. **Cerebral Cortex** **30**, 5780-5791 (2020).

Nissen, C., Piosczyk, H., Holz, J., Maier, J. G., Frase, L., Sterr, A., Riemann, D. & Feige, B. Sleep is more than rest for plasticity in the human cortex. **Sleep** **44**, zsaa216 (2021).

Ruch, S. & Henke, K. Learning during sleep: a dream comes true? **Trends in Cognitive Sciences** **24**, 170-172 (2020). (Review)

Tzovara, A., Amarreh, I., Borghesani, V., Chakravarty, M. M., DuPre, E., Grefkes, C., Haugg, A., Jollans, L., Lee, H. W. & Newman, S. D. Embracing diversity and inclusivity in an academic setting: Insights from the Organization for Human Brain Mapping. **NeuroImage** **229**, 117742 (2021).

Züst, M. A., Ruch, S., Wiest, R. & Henke, K. Implicit vocabulary learning during sleep is bound to slow-wave peaks. **Current Biology** **29**, 541-553. e547 (2019).