2021 AT A GLANCE

Graphic summary of the annual report

Kavli Institute for Systems Neuroscience

Norwegian Centre of Excellence

European Research Council
Established by the European Commission

TROND MOHN FOUNDATION

STIFTELSEN KRISTIAN GERHARD JEBSEN

THE KAVLI FOUNDATION

NTNU
Norwegian University of Science and Technology

Our Vision

To understand the emergence of higher brain functions

BETWEEN SPACE AND TIME
This is a brain slice of the area called lateral entorhinal cortex (LEC), which organises aspects of our sense of time. This area of the brain receives nerve fibers (coloured cyan) coming from neurons in the medial entorhinal cortex (MEC), where our sense of space is generated. The fibers provide input to the yellow neurons found across cell layers II and II of LEC. The connection from MEC fibers to LEC neurons establishes a direct link between the two brain areas. Image courtesy of Eirik S. Nilssen from the Witter Group / Kavli Institute for Systems Neuroscience

Dear reader

It has been a challenging year for the world, but it has left us stronger.

In 2021, the Kavli Institute has grown by four new research groups, one new research centre, and an experienced administrative director. We made new discoveries about the brain's remarkable mechanisms and abilities; we educated promising next-generation neuroscientists; we increased the proportion of female leaders and are two steps closer to our goal of a truly diverse and gender-balanced workforce; we invented next-level neuro-science tools to be shared freely, open-source and open-access, as all knowledge should be.

Please enjoy our graphic summary of 2021 in facts and figures.

For first access to the most recent brain discoveries made by our Trondheim team of researchers, focus your mobile camera at the QR-code on the back cover of this folder and follow the instructions.

May-Britt Moser, Edvard Moser, Bjarne Foss
Directors of the Kavli Institute for Systems Neuroscience

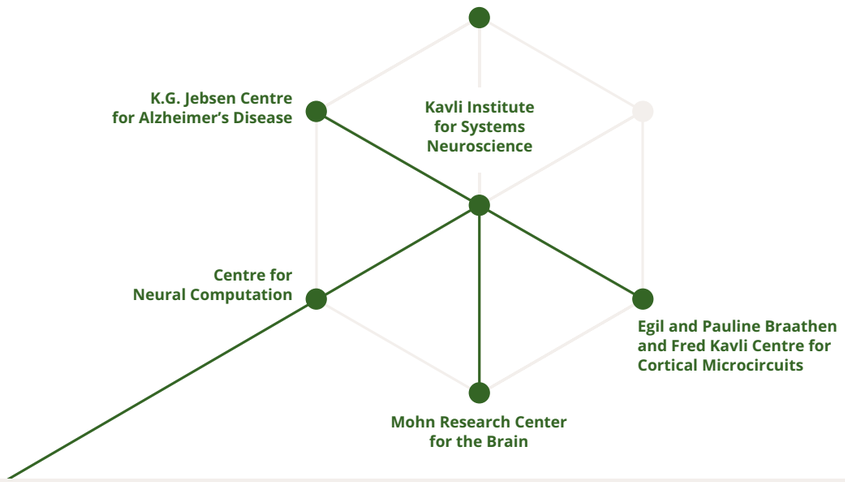
Organisational chart 2021

TRINITY OF DIRECTORS

EDVARD MOSER
Scientific Director

MAY-BRITT MOSER
Scientific Director

BJARNE FOSS
Administrative Director



RESEARCH GROUP LEADERS

MAY-BRITT MOSER
Moser Lab

EDVARD MOSER
Moser Lab

MENNO WITTER
Witter Lab

EMRE YAKSI
Yaksi Lab

GIULIA QUATTROCOLO
Quattrocolo Lab

TOBIAS NAVARRO SCHRÖDER
Navarro Schröder Lab

YASSER ROUDI
Roudi Lab

JONATHAN WHITLOCK
Whitlock Lab

CLIFFORD KENTROS
Kentros Lab

MAXIMILIANO NIGRO
Nigro Lab

MARYAM ZIAEI
Ziaei Lab

Institute, centres and infrastructure

> ***Understanding the brain is one of the greatest challenges to science, with brain disorders affecting one in three Europeans during their lifetime.***

KAVLI INSTITUTE FOR SYSTEMS NEUROSCIENCE (KISN)

The Kavli Institute for Systems Neuroscience is a leading research environment in Trondheim. The lab that preceded the institute was founded by Nobel Laureates May-Britt Moser and Edvard Moser in 1996 to investigate the emergence of higher brain functions.

Today, the Kavli Institute is an interdisciplinary village of experts with the common desire to understand how complex information is encoded in high-level neural networks and how complex behaviours arise from these codes and systems.

The institute staff is organized in ten research groups and several support groups such as Animal Tech, Technical Group, Kavli Communication, and an Administrative team.

Centres
The neuroscience research institute, led by Edvard Moser, May-Britt Moser and Bjarne Foss, now comprises four research centres:

- Centre for Neural Computation (CNC)
- Egil and Pauline Braathen and Fred Kavli Centre for Cortical Microcircuits (BKC)
- K.G. Jebsen Centre for Alzheimer's Disease (JCA)
- Mohn Research Center for the Brain (MCB)

Education
The department is responsible for an international master's degree programme in neuroscience. It has joint responsibility for the PhD programme in medicine and health sciences at NTNU. The Norwegian Research School in Neuroscience (NRSN) is organised and run by the institute with support and participation of the major Norwegian universities.

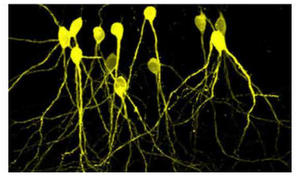
Infrastructure
The institute is the national host of NORBRAIN, a large-scale infrastructure for neuroscience technology, with facilities located at the University of Oslo (UiO), the University of Bergen (UiB), and the Norwegian University of Science and Technology (NTNU) in Trondheim. The institute is also host to the only Viral Vector Core in Norway, supplying labs across the world with state-of-the-art viral research tools.

History
The Kavli Institute for Systems Neuroscience consists of a Centre of Excellence (CoE) awarded by the Research Council of Norway since 2002, a Kavli Foundation Institute since 2007, a Braathen-Kavli Centre since 2015, a department at the Faculty of Medicine and Health Sciences at Norwegian University of Science and Technology (NTNU) since 2017, a Foundation Stiftelsen Kristian Gerhard Jebsen Centre since 2020, and a Trond Mohn Foundation Research Centre since 2021.

Centre for Neural Computation

K.G. Jebsen Centre for Alzheimer's Disease

Braathen and Kavli Centre for Cortical Microcircuits



Mohn Research Centre for the Brain

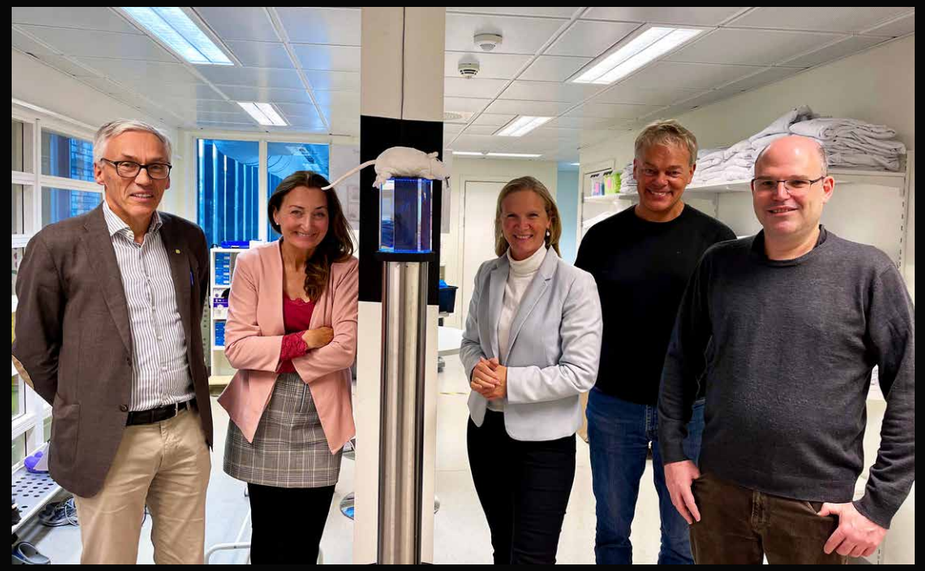
NORBRAIN

VIRAL VECTOR CORE

RESEARCH SCHOOL

TFSR
Research Fund of the Kavli Institute for Systems Neuroscience

Visit from The Research Council of Norway



TOOLING UP:
September 2021, Mari Sundli Tveit, CEO of The Research Council of Norway, visited the Kavli Institute. She learned about the recent technological innovations of neuroscience research tools developed/co-developed at the Kavli Institute, like Mini2P (2022), Neuropixels 2.0 (2021), and the Viral Vector Core (2019).

Here with Bjarne Foss, May-Britt Moser, Edvard Moser, Yoram Burak, Siri Forsmo (Dean), Rajeevkumar Nair Raveendran, Maryam Ziaei, Ruben Duque do Vale, Soledad Gonzalo Cogno, Hanna Eneqvist, and Emilie Ranheim Skytøen.

Highlights

HIGH IMPACT PUBLICATIONS

1. **Steinmetz NA, ..., Gardner RJ, ..., Vollan AZ, .. Lee AK, Moser EI, O´Keefe J, Renart A, Svoboda K, Mausser M, Haesler S, Carandini M, Harris TD (2021). Neuropixels 2.0: A miniaturized high-density probe for stable, long-term brain recordings. *Science*, 372, eabf4588.**
2. **Kropff E, Carmichael JE, Moser EI, Moser M-B (2021). Frequency of theta rhythm is controlled by acceleration but not speed in running rats. *Neuron*, 109, 1029-1039.**
3. **Schönsberg F, Roudi Y, Treves A (2021). Efficiency of local learning rules in threshold-linear associative networks. *Physical Review Letters,* 126(1), 018301.**

Bartoszek EM, Ostenrath AM, Jetti SK, Serneels B, Mutlu AK, Chau KTP, Yaksi E (2021). Ongoing habenular activity is driven by forebrain networks and modulated by olfactory stimuli, *Current Biol,* **31**(17), 3861-3874.e3.

Franco LM, Yaksi E (2021). Experience-dependent plasticity modulates ongoing activity in the antennal lobe and enhances odor representations. *Cell Reports*, **37**(13), 110165.

Frey M, Nau M, Doeller CF (2021). Magnetic resonance-based eye tracking using deep neural networks. *Nat Neurosci* **24**, 1772–1779.

Julian JB, Doeller CF (2021). Remapping and realignment in the human hippocampal formation predict context-dependent spatial behavior. *Nat Neurosci* **24**, 863–872.

Ledergerber D, Battistin C, Blackstad JS, Gardner RJ, Witter MP, Moser M-B, Roudi Y, Moser EI (2021). Task-dependent mixed selectivity in the subiculum. *Cell reports*, **35**(8), 109175.

Moser EI, Moser MB, Siegelbaum SA (2021). The hippocampus and the neural basis of explicit memory storage. In Kandel E. et al.: *Principles of Neuroscience*, 6th Edition, Chapter 54, pp. 1327-1357.

Nigro MJ, Kirikae H, Kjesberg K, Nair RR, Witter MP (2021). Not all that is gold glitters: PV-IRES-Cre mouse line shows low efficiency of labelling of parvalbumin interneurons in perirhinal cortex. *Front Neural Circuits* **15**: 781928

Ohara S, Blankvoort S, Nair RR, Nigro MJ, Nilssen ES, Kentros C, Witter MP (2021). Local projections of layer Vb-to-Va are more prominent in lateral than in medial entorhinal cortex. *Elife*. **10**:e67262.

Quattrocolo G, Dunville K, Nigro MJ (2021). Resurgent sodium current in neurons of the cerebral cortex. *Front Cell Neurosci,* **15**: 760610

Roos TT, Garcia MG, Martinsson I, Mabrouk R, Israelsson B, Deierborg T, Kobro-Flatmoen A, Tanila H, Gouras GK (2021). Neuronal spreading and plaque induction of intracellular Abeta and its disruption of Abeta homeostasis. *Acta Neuropathol*, **142**(4), 669-68.

Syversen IF, Witter MP, Kobro-Flatmoen A. Goa PE, Navarro Schröder T, Doeller CF (2021). Structural connectivity-based segmentation of the human entorhinal cortex. *Neuroimage* **245**.

PRIZES, HONORS, AWARDS, AND ELECTIONS TO REPUTABLE COMMITTEES

Christian Doeller
- Franklin Institute Bower Award Committee
- Memberships in selection, review and strategic committees: DFG (SFB; research groups), Max Planck Society (Dioscuri, IMPRS, Cognition School, core commissions MPI Biological Cybernetics & MPI Biological Intelligence; several appointment committees for directors and group leaders)

Bjarne Foss
- Member of University Board at KTH Royal Institute of Technology, Stockholm

Cliff Kentros
- Review Editor, Frontiers in Systems Neuroscience

Edvard Moser
- Scientific Advisory Board of Friedrich Miescher Institute, Basel
- International Steering Committee of the Edmond and Lily Safra Center for Brain Science at the Hebrew University of Jerusalem
- International Scientific Advisory Board of Chinese Institute of Brain Research, Beijing
- Honorary Fellow of the Royal Institute of Navigation, London
- Member of Editorial Board, Neuron
- Member of Editorial Board, Hippocampus

May-Britt Moser
- Honorary Fellow of the Royal Institute of Navigation, London
- Member of the Novo Nordic Prize committee for Advances in Medicine
- Member of Editorial Board, Hippocampus

Yasser Roudi
- Member of Editorial Board, Journal of Computational Sciences

Jonathan Whitlock
- Council of Norwegian Neuroscience Society, Norway
- Cajal Advanced Training Program Experts Committee
- Committee for Faculty Appointments and Promotions at the Weizmann Institute, Israel
- Human Frontiers Science Program (HFSP), Fellowship Review Committee

Menno Witter
- Member of the International jury of the BIAL Award in Biomedicine 2021
- Member of the Expert evaluation committee of the Accreditation organization of the Netherlands and Flanders to assess reaccreditation of educational programs at the University of Groningen, The Netherlands
- Re-appointed as visiting professor, Faculty of Medicine, Tohoku University, Sendai, Japan

Emre Yaksi
- Invited to become adjunct faculty member Koç University Research Center for Translational Medicine, Koç University School of Medicine, Istanbul, Turkey
- Cajal Advanced Training Program Experts Committee
- Renewed Associate investigator, NCMM, Norway

Maryam Ziaei
- Diversity and Equality Committee Member of the Organization for Human Brain Mapping
- Management Committee Member for COST Action representing Norway on “Evidence-based physical activity in old age (PhysAgeNet)”
- Review Editor, Frontiers in Psychology

Asgeir Kobro-Flatmoen
- K.G. Jebsen Foundation Best Public Dissemination Award 2021, Norway

Ragnhild Irene Jacobsen
- The 2021 Brain Power Award (Hjernekraftprisen 2021), Norway

Matthias Nau
- 2021 Otto-Hahn Medaille of the Max Planck Society for outstanding PhD thesis

GRANTS

Clifford Kentros
- The TMS Brain Research Initiative, Trond Mohn Foundation

Edvard Moser
- ERC Synergy grant KILONEURONS, with Hebrew University of Jerusalem
- The TMS Brain Research Initiative, Trond Mohn Foundation

May-Britt Moser
- The TMS Brain Research Initiative, Trond Mohn Foundation

Giulia Quattrocolo
- The Research Council of Norway, Researcher Project for Young Talent
- The TMS Brain Research Initiative, Trond Mohn Foundation

Menno Witter
- The TMS Brain Research Initiative, Trond Mohn Foundation

Emre Yaksi
- The Research Council of Norway, Researcher Project for Groundbreaking Research
- Collaborative FWO (The Research Foundation – Flanders) grant with Prof Lut Arckens (KULeuven, Belgium)

INTERNATIONAL CONFERENCES ORGANIZED

May-Britt Moser
- Louis Jeantet Symposium on Neurobiology, in coordination with C. Petit, B. Roska, Geneva, Switzerland

Giulia Quattrocolo
- Kavli Neuro Futures series, in coordination with the Kavli Foundation

Yasser Roudi
- Summer School on Mathematical Methods in Computational Neuroscience, Kavli Science Centre, Eresfjord, Norway.

Jonathan Whitlock
- Kavli Neuro Futures series, in coordination with the Kavli Foundation.

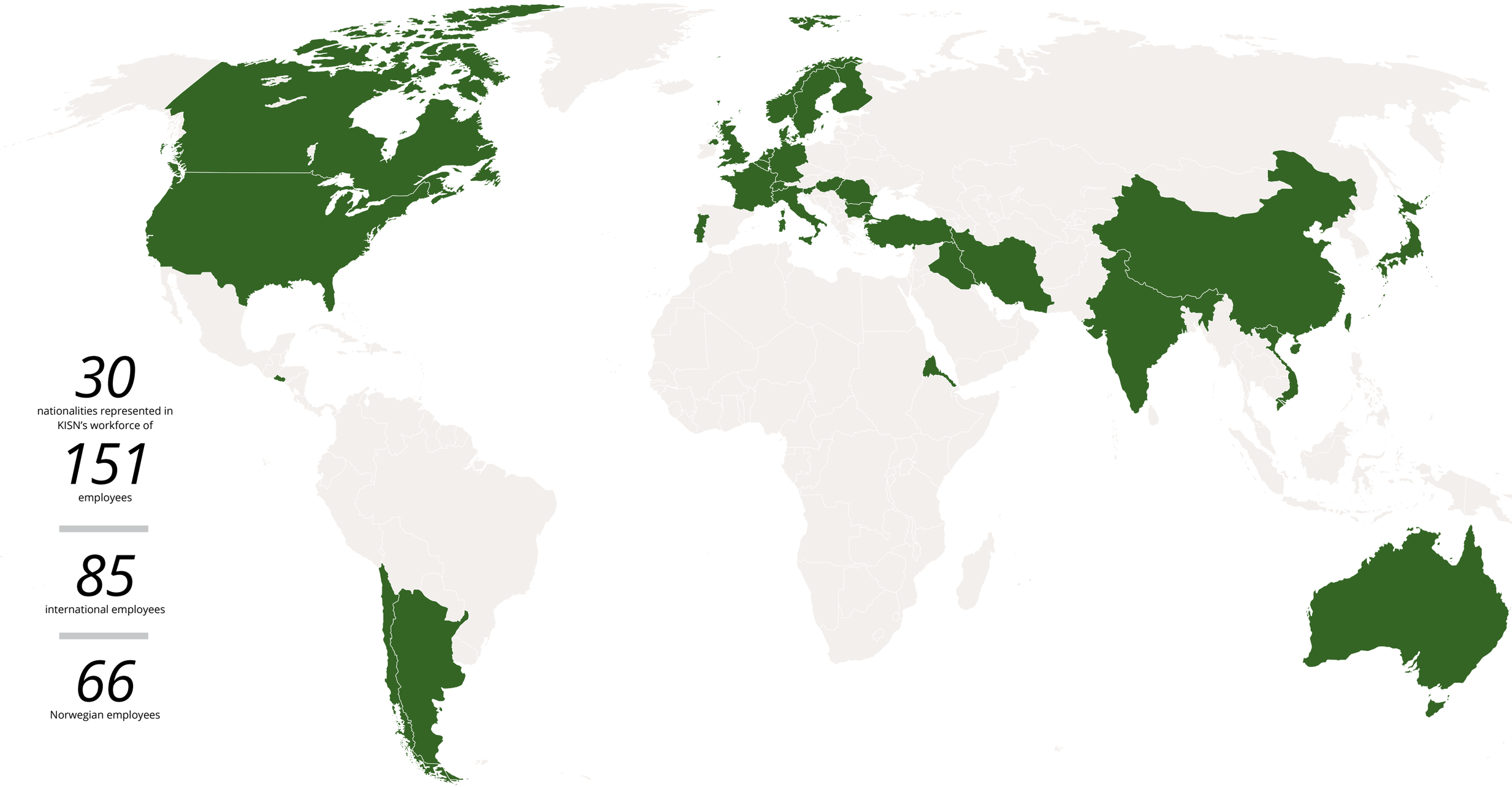
Menno Witter
- International Primate Neurobiology School, Kyoto, Japan.

Emre Yaksi
- Neuronal Ensembles, USA/Norway/Online
- Zebrafish Neural Circuits and Behavior online seminar series, France/Israel/Norway/Online

PHD DEFENCES CARRIED OUT AT KISN

Christa Ringers (f), Ingrid Framås Syversen (f), Fabrizio Palumbo (m)

Facts



30
nationalities represented in KISN's workforce of

151
employees

85
international employees

66
Norwegian employees

Annual accounts 2021

INCOME	
Research Council of Norway (RCN): Centre of Excellence (CoE)	23 700 000
RCN FRIPRO, infrastructure, and other	23 800 000
EU Research Framework Programme (incl. ERC)	12 500 000
Other public/private (K.G. Jebsen, T. Mohn, TFSR, matching, KD, etc.)	36 200 000
Norwegian University of Science and Technology	41 600 000
Ministry of Education and Research: Mosers Nobel Prize Funds	12 200 000
TOTAL INCOME	**150 000 000**

EXPENSES	
Payroll and indirect expenses	91 700 000
Equipment	15 200 000
Other operating expenses	43 100 000
TOTAL EXPENSES	**150 000 000**

75 per cent of the Institute's total income is derived from external competitive funding, whereas 25 per cent is semi-permanent institute funding from the Norwegian government and the institute's research fund, TFSR.

THE RESEARCH FUND OF THE KAVLI INSTITUTE FOR SYSTEMS NEUROSCIENCE

Trondheim Foundation for Scientific Research (TFSR)

TFSR is a non-profit organization with the sole purpose of providing research funds to the Kavli Institute for Systems Neuroscience, in support of scientific advancement in the field of fundamental neuroscience to the benefit of humanity.

Approximately one-half of the Foundation's research fund comes from The Kavli Foundation, established by the late Norwegian-American business¬man and philanthropist Fred Kavli. Other major contributors are Pauline Braathen and the nieces and nephew of Egil Braathen, the Norwegian organization Ensliges Landsforbund (EL), Selskabet for Trondhjems Bys vel, Sparebankstiftelsen SMN, Gjensidigestiftelsen, and since 2021 Nils-Jarle Sætre with his successful fundraising campaign "Til topps mot Alzheimer". In addition, the foundation has received larger and smaller amounts from individuals, companies, organizations, as well as testamentary gifts and donations from funerals. TFSR appreciates all contributions.

The image to the right: The Foundation visited the Kavli research labs in November 2021.
First row from left: Gunnar K. Nilsen, May-Britt Moser, Hans Jørgen Stang, Edvard Moser. Second row from left: Janicke Udbye Løvaas, Bjarne Foss, Jan Morten Dyrstad, Rune Haglund, Anne Lise Ryel.

Boards

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University of Bergen

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May-Britt Moser
Professor
Director of Centre for
Neural Computation

Edvard Moser
Professor
Director of KISN

Menno Witter
Professor

Yasser Roudi
Professor

Jonathan Whitlock
Associate professor

Clifford Kentros
Professor

Emre Yaksi
Professor

Christian Doeller
Professor 20%

Giulia Quattrocolo
Researcher

Tobias Navarro Schröder
Associate professor

Maximiliano Nigro
Researcher

Maryam Ziaei
Associate professor

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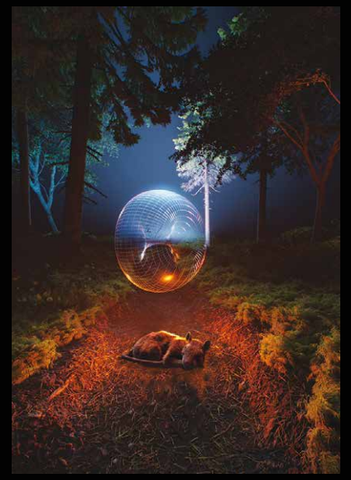

WE MOVE ALONG THE SURFACE OF A DONUT
Whether the rat is exploring, running, dreaming, or resting deeply asleep, its brain's GPS constituted by the joint activity of grid cells always move along the surface of a torus. This first insight into how the mammalian brain organizes high-level brain function in neural networks, also labelled grid cells 2.0, was published on BioRxiv in 2021 by Kavli researchers (peer-reviewed version published in Nature, 2022).

The cover image, and the image you see above, are artistic interpretations of the donut we navigate by, made by Helmet and Kavli Communication.

The image to the right, shows the neural data from a network of grid cells in the brain of Roger the rat, collected by Moser Group researcher Richard Gardner.

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MOHN RESEARCH CENTER FOR THE BRAIN
EGIL AND PAULINE BRAATHEN AND FRED KAVLI CENTRE FOR CORTICAL MICROCIRCUITS

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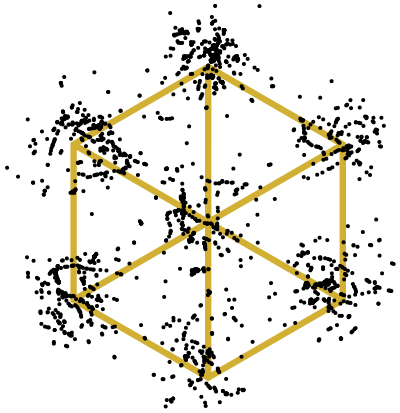

Kavli Institute
for Systems Neuroscience