

## 2020 AT A GLANCE

Graphic summary  
of the annual report

**Kavli Institute  
for Systems Neuroscience**



**ff**  
Norwegian  
Centre of  
Excellence

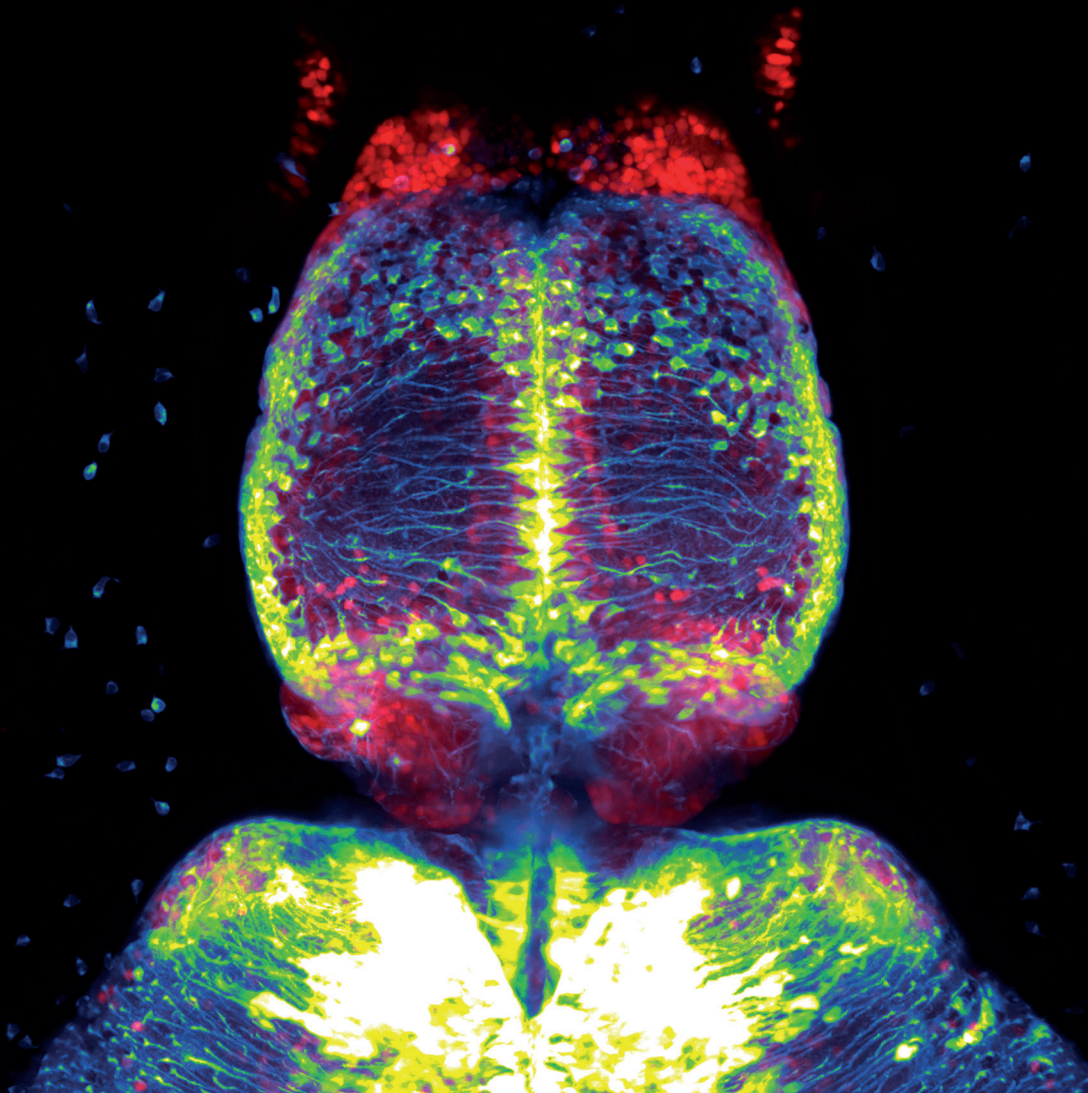
STIFTELSEN  
KRISTIAN  
GERHARD  
JESSEN

THE  
**KAVLI**  
FOUNDATION

**NTNU**  
Norwegian University of  
Science and Technology

Our Vision

*To understand the emergence  
of higher brain functions*



*The image shows parts of a zebrafish brain, including the structure called habenula. The green dots are parent cells, which can divide into new child brain cells. Zebrafish brains have a lot of these cells, a feature that gives these animals greater abilities to repair damage to the brain. Image courtesy of Stephanie Fore from the Yaksi Group / Kavli Institute for Systems Neuroscience.*

# Dear reader

We hope you'll enjoy this graphic summary of 2020 in fact and figures.

For those of you with a penchant for richer stories, kindly follow the YouTube QR-code found at the back of this folder to our extended annual report celebrating the start of a new decennium in sound and vision.

*May-Britt Moser & Edvard Moser*  
*Scientific Directors of the Kavli Institute*



# Organizational chart 2020

## GROUP LEADERS



**MAY-BRITT MOSER**  
Moser Lab  
Scientific Director



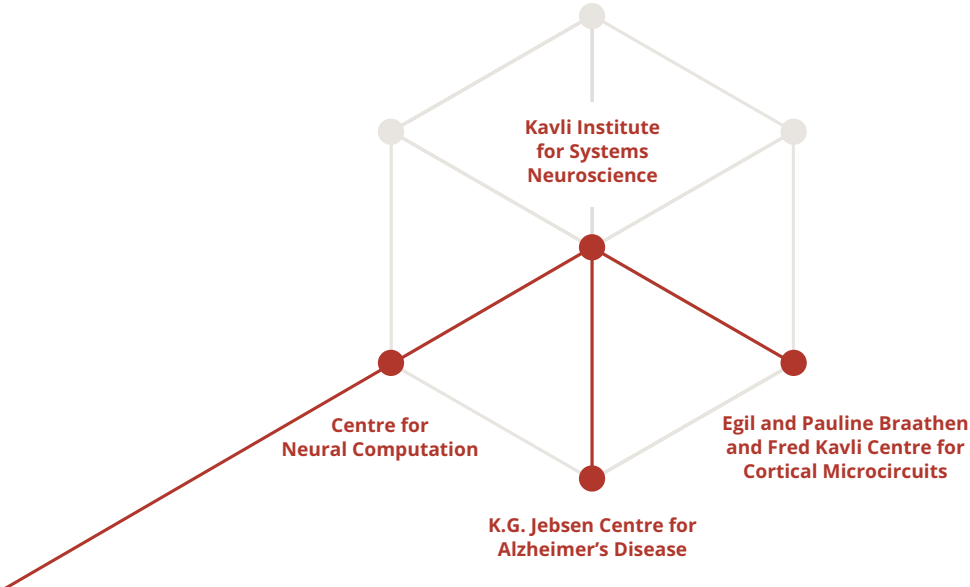
**EDVARD MOSER**  
Moser Lab  
Scientific Director



**MENNO WITTER**  
Witter Lab



**JONATHAN WHITLOCK**  
Whitlock lab



**YASSER ROUDI**  
Roudi Lab



**CLIFFORD KENTROS**  
Kentros Lab



**EMRE YAKSI**  
Yaksi Lab



**RAPHAEL KAPLAN**  
Doeller - Kaplan Lab

# Institute and centres

## **KAVLI INSTITUTE FOR SYSTEMS NEUROSCIENCE (KISN)**

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 systems and codes.

The institute staff is in 2020 organized in eight work units: Seven research groups with associated teams of scientists, students, and supporting staff; and one central support group consisting of an administrative team, a communication team, a veterinary and vet-tech team, and technical staff.

The department is responsible for an international master's degree programme in neuroscience, has joint responsibility for the PhD programme in Medicine and Health Sciences at NTNU and for the Norwegian Research School in Neuroscience funded by the Research Council of Norway.

The Kavli Institute, founded as a research group by Nobel Laureates May-Britt Moser and Edvard Moser in 1996, is a Centre of Excellence (CoE) since 2002, a Kavli Foundation Institute since 2007, an Egil and Pauline Braathen and Fred Kavli Centre since 2015, a department at the Faculty of Medicine and Health Sciences at the Norwegian University of Science and Technology (NTNU) since 2017, and a Stiftelsen Kristian Gerhard Jebsen Centre since 2020.

## **CENTRE FOR NEURAL COMPUTATION (CNC)**

How does the mammalian brain generate its own codes in the non-sensory cortices? This question marks the inception of understanding subjective experience. A path was opened in this terra incognita in 2005 when the Moser group discovered grid cells in the entorhinal cortex of the brain. Grid cells provide a metric for the brain's spatial mapping system. Since their matrix-like firing pattern is generated within the brain independently of specific sensory features, these cells provide unprecedented access to the principles for neural coding in higher-order association cortices. The centre uses these cells as a springboard for unravelling operational principles of the mammalian cortex.

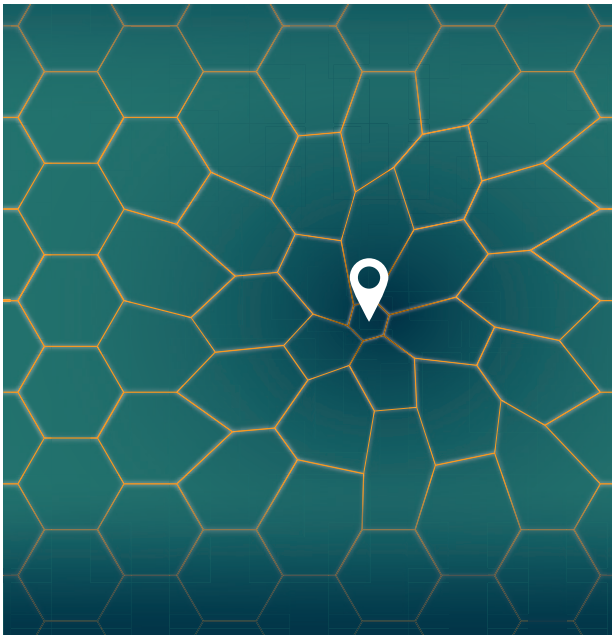
The Centre for Neural Computation is a Research Council of Norway Centre of Excellence. It has assembled a dedicated expert team to decipher the fundamental codes of the brain's circuits for space, time, memory, sensory integration, and action planning – the mechanisms by which signals from specialized networks of neurons are generated, transformed, stored and retrieved by local and global network operations.

### EGIL AND PAULINE BRAATHEN AND FRED KAVLI CENTRE FOR CORTICAL MICROCIRCUITS (BKC)

The hippocampal formation of the brain generate our sense of space and time, and organize the content of our experiences and memories. The neurons in these brain areas answer the hallmark questions of episodic memory: when, where and what happened?

Special neurons in the entorhinal cortex of the hippocampal formation are vulnerable to Alzheimer's disease. These neurons are among the very first to die in the earliest stages of the disease. The Braathen-Kavli Centre is a basic research centre aiming to understand the healthy workings of these brain functions, and investigate why these neurons are especially vulnerable to the disease.

The centre is realized by a donation from philanthropist Pauline Braathen, joined by her late husband Egil Braathen's nieces and nephew Mona Arnesen, Anita Lien, and Erik Ruud.



### K.G. JEBSEN CENTRE FOR ALZHEIMER'S DISEASE (JCA)

JCA is a national research centre that brings together scientists across disciplines, uniting university and hospital, in the common goal of discovering the onset of Alzheimer's disease and the early stages of its development.

The centre's vision is *to translate Nobel Prize-winning brain research from laboratory to patient*. Research activities span from basic research in rats and mice to clinical research in humans. Each step is quality assured with translational research, where promising results from basic science on healthy brains are translated to brains that have been affected by Alzheimer's disease, and the most significant findings in the human brain disease are translated into animal models for testing before results are reintroduced to humans.

The Jebsen Centre will foster a healthy scientific discourse and provide the society with quality assured scientific facts about Alzheimer's disease and the brain. Jebsen researchers have access to state-of-the-art technology from the NORBRAIN 2 and NORBRAIN 3 research infrastructure programmes.

The centre was made possible by a donation from the Foundation Stiftelsen Kristian Gerhard Jebsen, with contributions from the Central Norway Regional Health Authority, NTNU's Faculty of Medicine and Health Sciences, St. Olav's Hospital, and the National Association for Public Health.

*Deforming the metric of cognitive maps distorts memory.  
Image courtesy of Jacob Bellmund in the Doeller-Kaplan Group / Kavli  
Institute for Systems Neuroscience.*

# Highlights

## HIGH IMPACT PUBLICATIONS

1. Fore, S., Acuña-Hinrichsen, F., Mutlu, K. A., Bartoszek, E. M., Serneels, B., Fatauros, N. G., Chau, K. T. P., Cosacak, M. I., Verdugo, C. D., Palumbo, F., Ringers, C., Jurisch-Yaksi, N., Kizil, C., & Yaksi, E. (2020). Functional properties of habenular neurons are determined by developmental stage and sequential neurogenesis. *Sci Adv*, 6(36).
2. Bellmund, J. L. S., de Cothi, W., Ruiter, T. A., Nau, M., Barry, C., & Doeller, C. F. (2020). Deforming the metric of cognitive maps distorts memory. *Nat Hum Behav*, 4(2), 177-188.
3. Nau, M., Navarro Schröder, T., Frey, M., & Doeller, C. F. (2020). Behavior-dependent directional tuning in the human visual-navigation network. *Nat Commun*, 11(1), 3247.

Bellmund, J. L. S., Polti, I., & Doeller, C. F. (2020). Sequence Memory in the Hippocampal-Entorhinal Region. *J Cogn Neurosci*, 32(11), 2056-2070.

Blankvoort, S., Descamps, L. A. L., & Kentros, C. (2020). Enhancer-Driven Gene Expression (EDGE) enables the generation of cell type specific tools for the analysis of neural circuits. *Neurosci Res*, 152, 78-86.

Carvalho, M. M., Tanke, N., Kropff, E., Witter, M. P., Moser, M. B., & Moser, E. I. (2020). A Brainstem Locomotor Circuit Drives the Activity of Speed Cells in the Medial Entorhinal Cortex. *Cell Rep*, 32(10), 108123.

Kermen, F., Darnet, L., Wiest, C., Palumbo, F., Bechert, J., Uslu, O., & Yaksi, E. (2020). Stimulus-specific behavioral responses of zebrafish to a large range of odors exhibit individual variability. *BMC Biol*, 18(1), 66.

Kermen, F., Lal, P., Fatauros, N. G., & Yaksi, E. (2020). Interhemispheric connections between olfactory bulbs improve odor detection. *PLoS Biol*, 18(4), e3000701.

Nair, R. R., Blankvoort, S., Lagartos, M. J., & Kentros, C. (2020). Enhancer-Driven Gene Expression (EDGE) Enables the Generation of Viral Vectors Specific to Neuronal Subtypes. *iScience*, 23(3).

Palumbo, F., Serneels, B., Pelgrims, R., & Yaksi, E. (2020). The Zebrafish Dorsolateral Habenula Is Required for Updating Learned Behaviors. *Cell Rep*, 32(8), 108054.

Rattner, A., Terrillion, C. E., Jou, C., Kleven, T., Hu, S. F., Williams, J., Hou, Z., Aggarwal, M., Mori, S., Shin, G., Goff, L. A., Witter, M. P., Pletnikov, M., Fenton, A. A., & Nathans, J. (2020). Developmental, cellular, and behavioral phenotypes in a mouse model of congenital hypoplasia of the dentate gyrus. *Elife*, 9, Article e62766.

Tombaz, T., Dunn, B. A., Hovde, K., Cubero, R. J., Mimica, B., Mamidanna, P., Roudi, Y., & Whitlock, J. R. (2020). Action representation in the mouse parieto-frontal network. *Sci Rep*, 10(1), 5559.

## PRIZES, HONORS, AWARDS, AND ELECTIONS TO REPUTABLE COMMITTEES IN 2020

### May-Britt Moser

- Gunnerus Medal, Royal Norwegian Society of Sciences and Letters
- Appointed member of Novo Nordisk Prize Committee
- Member of Louis Jeantet Prize Committee
- Editorial Board Member of Hippocampus

### Edvard Moser

- Gunnerus Medal, Royal Norwegian Society of Sciences and Letters
- 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
- International Scientific Advisory Board of Friedrich Miescher Institute, Basel
- Editorial Board Member of Neuron
- Editorial Board Member of Hippocampus

### Clifford Kentros

Review Editor for Frontiers in Systems Neuroscience



**Emre Yaksi**

Re-elected as Associate investigator for NCMM

**Jonathan Whitlock**

- Kavli Institutes in Neuroscience Forum at Yale University, Connecticut, USA
- HFSP post-doctoral fellowship review committee

**Menno Witter**

Re-Appointed as visiting professor at the Medical school and NeuroGlobal program of Tohoku University, Sendai, Japan

**Matthias Nau**

- Elsevier/Vision Research Award, Vision Science Society, USA
- Trainee Professional Development Award, Society for Neuroscience, USA

**GRANTS****Edvard Moser**

ERC Synergy grant KILONEURONS with Hebrew University of Jerusalem

**Maximiliano Jose Nigro**

Marie Skłodowska-Curie Fellowship RhinalMultiSense from the European Commission

**Jonathan Whitlock**

FRIRPRO researcher grant, Research Council of Norway

**INTERNATIONAL CONFERENCES ORGANIZED****Yasser Roudi**

- Dimensionality Reduction and Population Dynamics in Neural Data, Stockholm
- Summer school on mathematical methods in computational neuroscience, Kavli Moen Gard

**PHD DEFENCES CARRIED OUT AT KISN IN 2020**

Stéphanie Forè (f), Christine M. Lykken (f), Carmen Diaz (f), Øyvind A. Høydal (m), Matthias Nau (m)

# Facts

30

nationalities represented in  
KISN's workforce of

123

employees

---

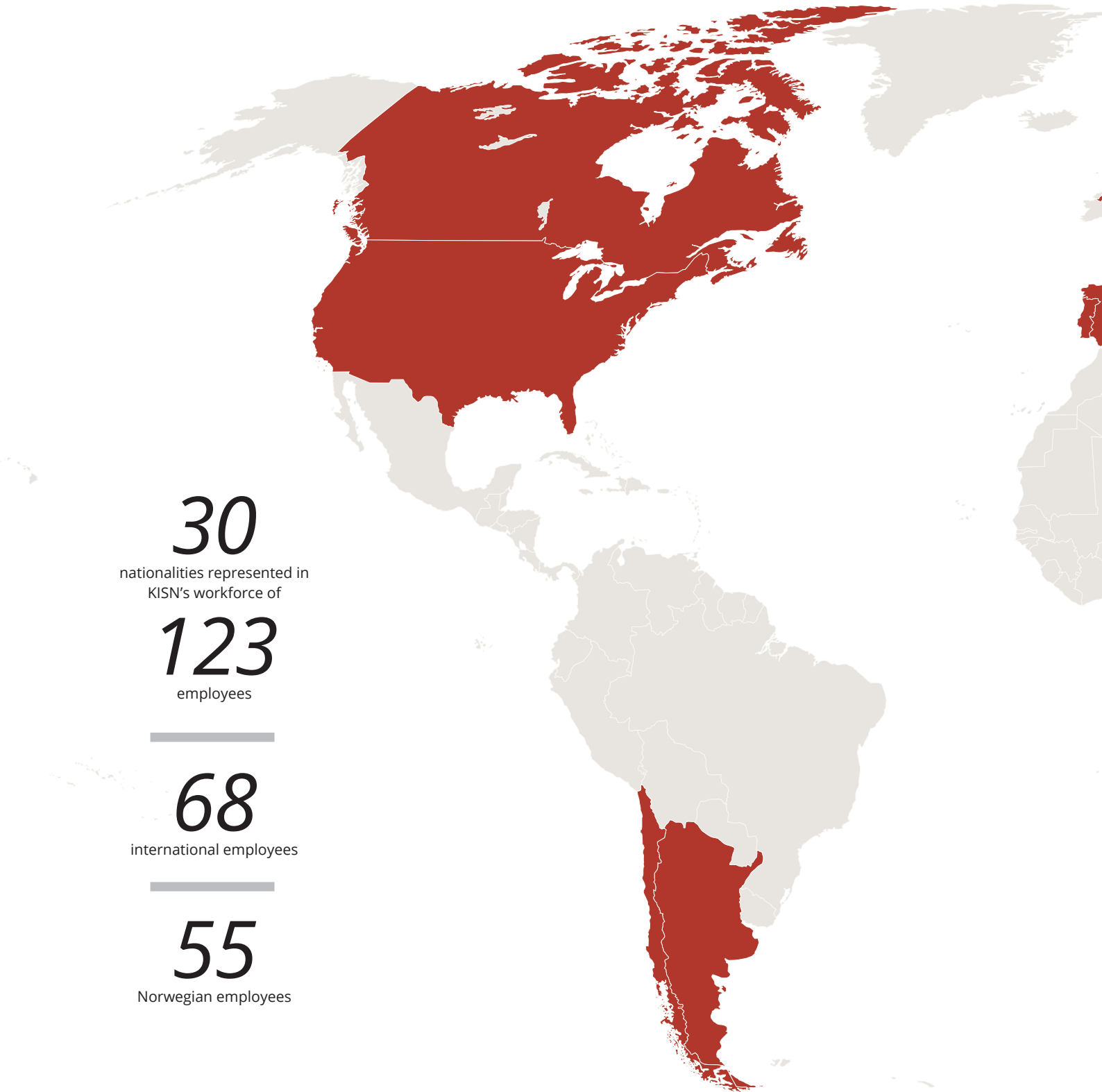
68

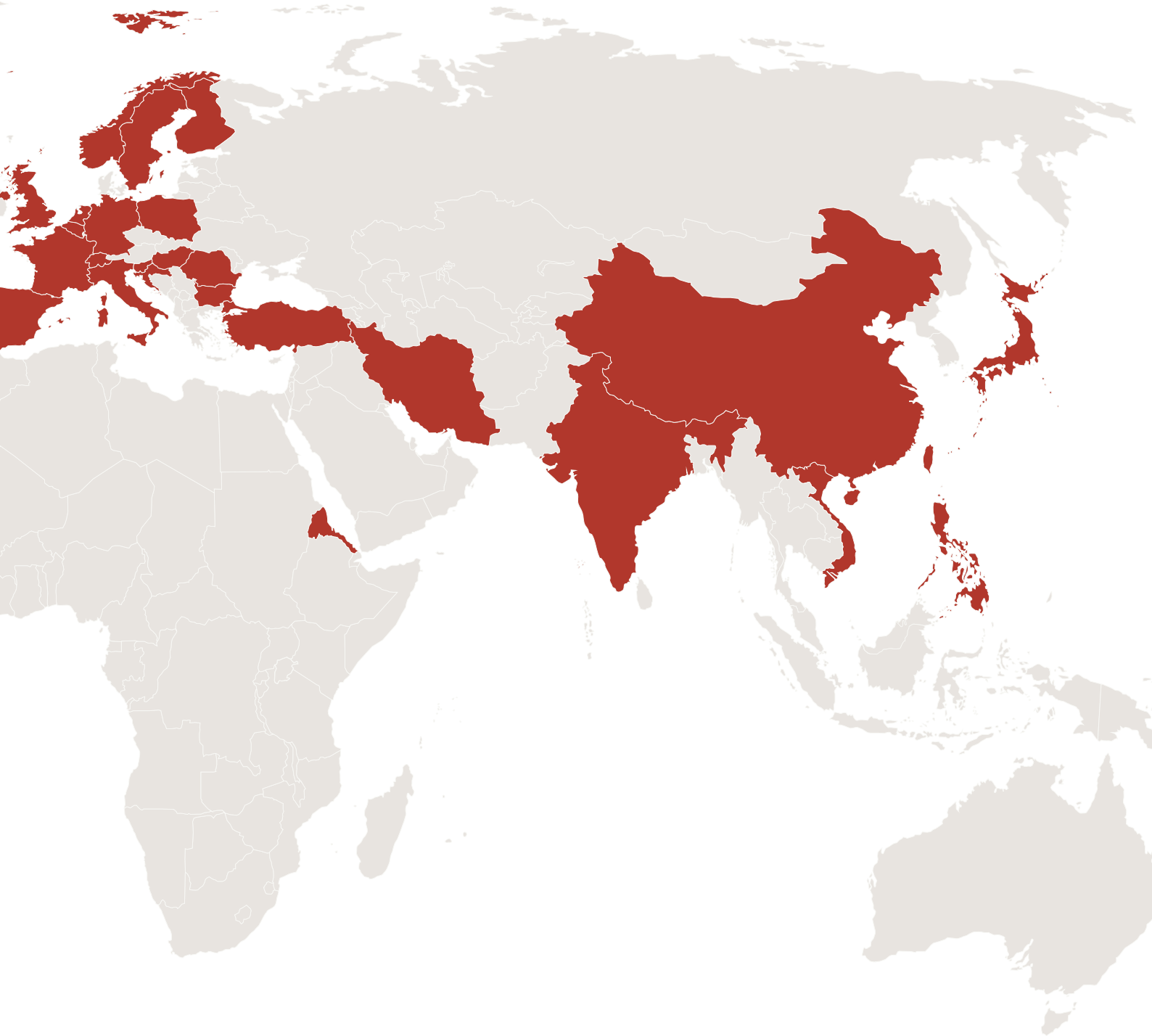
international employees

---

55

Norwegian employees





# Annual accounts 2020

## INCOME

Norwegian Research Council: Centre of Excellence	17 500 000
Norwegian Research Council: Other	49 100 000
International funding	13 360 000
Other public/private	12 310 000
Norwegian University of Science and Technology	67 772 000
Ministry of Education and Research: Moser Nobel - Prize Funds	12 000 000

<b>TOTAL INCOME</b>	<b>172 300 000</b>
---------------------	--------------------

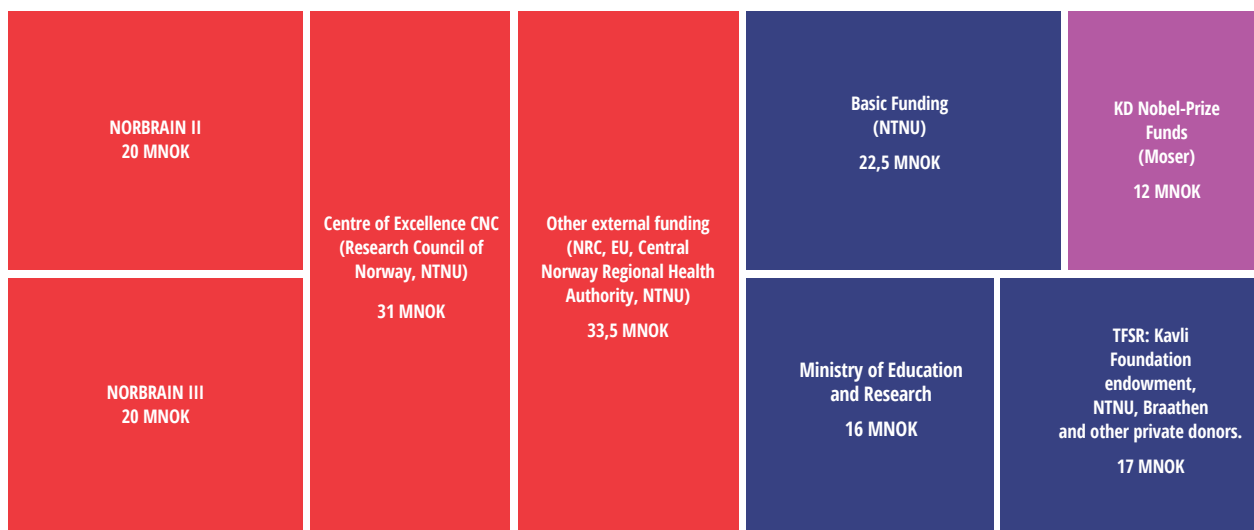
## EXPENSES

Payroll and indirect expenses	98 260 000
Equipment	41 550 000
Other operating expenses	26 592 000

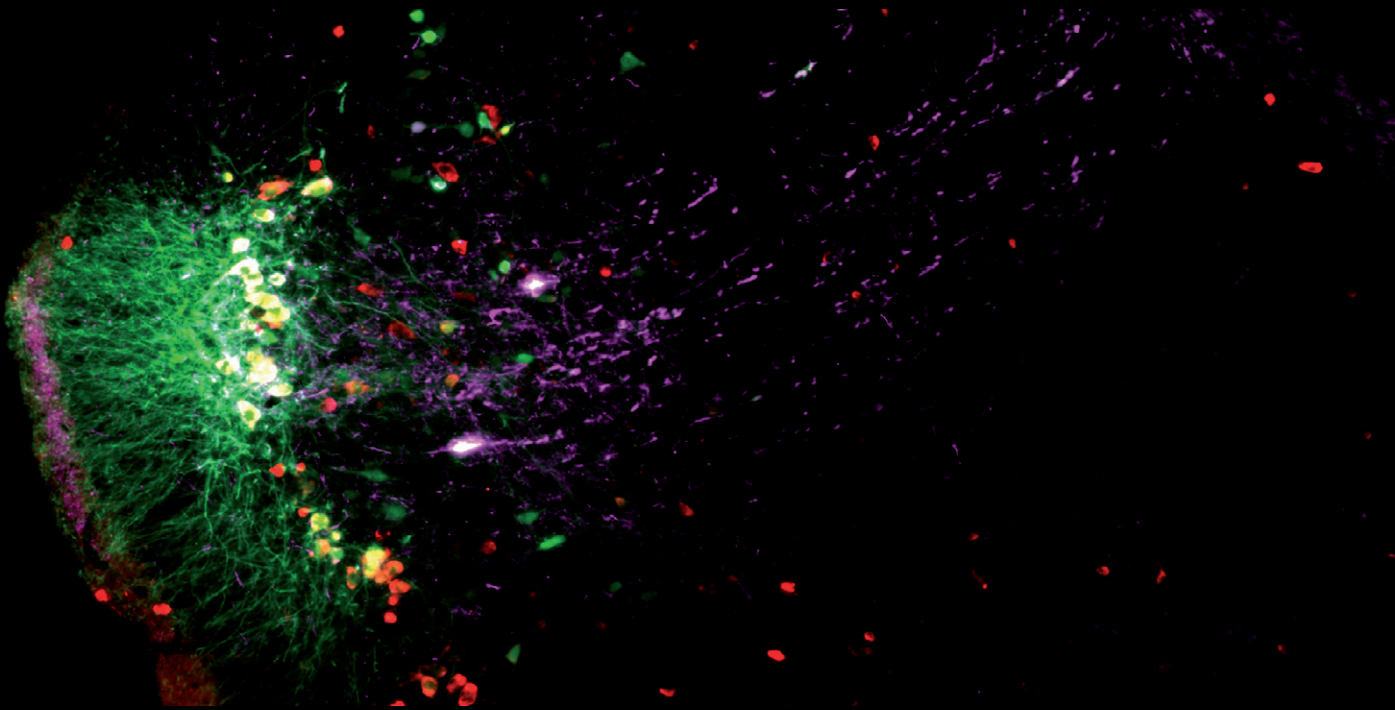
<b>TOTAL EXPENSES</b>	<b>166 402 000*</b>
-----------------------	---------------------

\* 5,6 MNOK in available funds - Moser Nobel Prize contribution

## SOURCES OF INCOME



Red boxes show competitive external project funding. Blue and violet boxes show semi-permanent institute funding.



*A novel model of Alzheimer's disease. These cells belong to the entorhinal cortex area of the brain of an Alzheimer's disease model rat. Colour coding signifies GFP for green, Reelin for red, and phospho-tau for pink. Image courtesy of the Kentros Group / Kavli Institute for Systems Neuroscience.*

## FINANCIAL STATEMENT

Despite the unexpected occurrence of COVID-19, the Kavli Institute maintained a high level of activity in 2020. Through effective reorganization of the labs, a safe and healthy workplace was maintained while ensuring that many years of development and research were not lost.

The net reduction of financials is mainly caused by the large investments in 2019, which continued in 2020 but not at a similar scale. Omitting the equipment investments, the Institute experienced a small net increase in funding this year.

In 2020, the Kavli Institute had several successful project applications, including a K.G. Jebsen Centre (Alzheimer's Research) and an ERC Synergy Grant (KiloNeurons), which will have a substantial financial impact on the Institute in the years to come.

Prospects for 2021 are appealing. We are expecting a further increase in activity as the above mentioned funds are fully effectuated. New upgrades for equipment and technology will elevate our research to the next level of systems neuroscience.

# Boards

## THE BOARD OF THE KAVLI INSTITUTE FOR SYSTEMS NEUROSCIENCE



**Bjarne Foss**  
Chairman  
Pro-Rector Research, NTNU



**Siri Forsmo**  
Dean Faculty of Medicine  
and Health Sciences,  
NTNU



**Cynthia Friend**  
President  
Kavli Foundation



**Chris Martin**  
Director of Physical Sciences  
Kavli Foundation



**Robert Clifford**  
Representative of  
Pauline Braathen



**Grethe Aasved**  
Director  
St. Olav's Hospital



**Stig Slørdahl**  
CEO, Central Norway Regional  
Health Authority



**Jan Morten Dyrstad**  
Associate professor  
Department of Economics,  
NTNU



**Tore O. Sandvik**  
County Council Chair  
Trøndelag County



**Edvard Moser**  
Secretary, Professor  
Kavli Institute, NTNU



**May-Britt Moser**  
Secretary, Professor  
Kavli Institute, NTNU

**THE SCIENTIFIC ADVISORY BOARD FOR THE KAVLI INSTITUTE FOR SYSTEMS NEUROSCIENCE**



**Carla Shatz**  
Chairman  
Professor  
Stanford University



**Larry Abbott**  
Professor  
Columbia University, New York



**Catherine DuLac**  
Professor  
Harvard University,  
Massachusetts



**Rainer Friedrich**  
Professor  
Friedrich Miescher Institute for  
Biomedical Research, Basel



**Tony Movshon**  
Professor  
New York University School  
of Medicine



**Erin Schuman**  
Professor  
Max Planck Institute for Brain  
Research, Frankfurt am Main



**Michael Yassa**  
Director of Center for the  
Neurobiology of Learning  
and Memory,  
University of California at Irvine

## THE SCIENTIFIC ADVISORY BOARD FOR THE K.G. JEBSEN CENTRE FOR ALZHEIMER'S DISEASE



**Karen Duff**  
Professor  
UK Dementia Research Institute  
London



**Tara Spires-Jones**  
Professor  
University of Edinburgh



**Emrah Düzel**  
Professor  
Otto-von-Guericke University  
Magdeburg



**Henrik Zetterberg**  
Professor  
Gothenburg University

## THE BOARD OF THE K.G. JEBSEN CENTRE FOR ALZHEIMER'S DISEASE



**Björn Gustafsson**  
Medical Director  
Central Norway Regional  
Health Authority



**Grethe Aasved**  
Director  
St. Olav's Hospital



**Edvard Moser**  
Professor  
Kavli Institute, NTNU



**Stig Slørdahl**  
CEO  
Central Norway Regional  
Health Authority



**Anne Rita Øksengård**  
Head of Research  
Norwegian Health Association



## THE SCIENTIFIC ADVISORY BOARD FOR NORBRAIN



**Tobias Bonhoeffer**  
Director  
Max Planck Institute of  
Neurobiology, Munich



**Erin Schuman**  
Professor  
Max Planch Institute for  
Brain Research, Frankfurt am Main



**Valentina Emiliani**  
Research Director  
Institute de la Vision, Paris



**Michael Hausser**  
Professor  
University College London

## THE BOARD OF NORBRAIN



**Björn Gustafsson**  
Medical Director  
Central Norway Regional  
Health Authority



**Ivar Prydz Gladhaug**  
Dean, Faculty of Medicine  
University of Oslo



**Per Sigvald Bakke**  
Dean, Faculty of Medicine  
University of Bergen

# Faculty 2020



**May-Britt Moser**  
Professor  
Director of Centre for  
Neural Computation



**Edvard Moser**  
Professor  
Director of Kavli Institute for  
Systems Neuroscience



**Menno Witter**  
Professor



**Clifford Kentros**  
Professor



**Jonathan Whitlock**  
Associate professor



**Yasser Roudi**  
Professor



**Christian Doeller**  
Professor

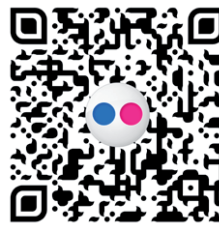


**Emre Yaksi**  
Professor



*If we didn't post about it,  
it didn't happen*

**Stay updated on the latest research news and events  
at KISN by following us on selected channels:**





**Feeling homesick?**

*Did you know that you have special neurons in your brain whose only job is to let you know how to get home to your loved ones?*

*“Home” is not just a geographical location in the world, but also a place and a process in your brain - a state of mind.*

*The gridcells stamp, designed by Enzo Finger for Posten Norway, reminds us that although many of us are restricted from travelling home for the holiday, there are a million ways to keep in touch with family and friends. Some of which have been practiced for centuries, or even millennia.*

*The Norwegian postal stamp honours Norwegian neuroscientists May-Britt Moser and Edvard Moser’s Nobel Prize awarded discovery of cells that constitute an inner GPS in the brains of mammals, including the human brain.*

**EDITORS:**

Edvard Moser  
May-Britt Moser  
Rita Elmkvist Nilsen

**CONTRIBUTORS:**

Rita Elmkvist Nilsen  
Pia Johansen  
Hallvard Ulsund  
May Brit Leirtrø Røstad  
Karoline Hovde  
Lise Krogh Berg  
Ole Kristian Indergård  
Paulo Jorge Bettencourt Girão

**COVER IMAGE:**

Enzo Finger/Posten Norge

**LAYOUT AND PRINT:**

Skipnes kommunikasjon AS

**DOWNLOAD:**

[www.ntnu.edu/kavli/outreach](http://www.ntnu.edu/kavli/outreach)

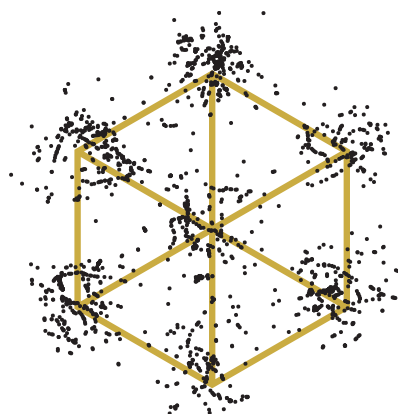




**KAVLI INSTITUTE FOR SYSTEMS NEUROSCIENCE  
CENTRE FOR NEURAL COMPUTATION  
K. G. JEBSEN CENTRE FOR ALZHEIMER'S DISEASE  
EGIL AND PAULINE BRAATHEN AND FRED KAVLI CENTRE FOR CORTICAL MICROCIRCUITS**

Norwegian Brain Centre, MTF5, NO-7491 Trondheim, Norway  
Telephone: +47 73 59 89 22 | Telefax: +47 73 59 82 94 | E-mail: [contact@kavli.ntnu.edu](mailto:contact@kavli.ntnu.edu)

**NTNU.EDU/KAVLI**



**Kavli Institute  
for Systems Neuroscience**