International School of Brain Cells & circuits "Camillo Golgi"

The Ettore Majorana Foundation and Centre for Scientific Culture opened, in 2015, the International school of brain cells & circuits dedicated to the Italian Nobel laureate "Camillo Golgi".
The brain, with 10^{12} neurons interacting through 10^{15} synapses, is quite surely the most complex structure of the whole Universe. Neurosciences are systematically tackling brain functions at multiple complexity levels, from cells to microcircuits to the whole brain. Understanding the brain is a Grand Challenge for the Humankind with social implications in the biomedical and technological fields. Multiscale computational modelling is a new powerful approach for understanding the brain that has recently been supported by international initiatives like the *Human Brain* Project and EBRAINS.
The school of Brain Cells & Circuits will face hot topics in modern Neuroscience, providing the basics of understanding, fuelling discussion, and helping to form a critical perspective in the new generation of Neuroscientists. Our vision is that, to explain brain functions, it is fundamental to integrate molecular and cellular knowledge into microcircuits and large-scale networks using multiscale computational models. The school is now supported by the EBRAINS training programme.

Further reading can be found in the review articles:

Modelling the brain: Elementary components to explain ensemble functions
Authors: *Egidio D'Angelo and Claudia Gandini Wheeler-Kingshott* (2017)
Il Nuovo Cimento. DOI: 10.1393/ncr/i2017-10137-5 pp. 297-333

The coming decade of digital brain research - A vision for neuroscience at the intersection of technology and computing.
Authors: *Amunts,* et al. (2022).
Zenodo. DOI: 10.5281/zenodo.6345821

The quest for multiscale brain modelling
Authors: *Egidio D'Angelo and Viktor Jirsa* (2022)
Trends Neurosci. 2022 Jul 26; S0166-2236(22)00125-4.
doi: 10.1016/j.tins.2022.06.007.

A Decade of Discovery: The Erice *Camillo Golgi* School – Modeling the Brain from Neurons to Large-Scale Signals and Digital Twins in Health and Disease 2-7th December 2025

Ettore Majorana Foundation and Centre for Scientific Culture
Erice (Italy)



Course Directors: *Egidio D'Angelo, Claudia Gandini Wheeler-Kingshott and Viktor Jirsa*
***Course Admin**: Alessia Bonafede*

2025 marks 10 years of the School of Brain Cells and Circuits dedicated to "Camillo Golgi". The 2025 Course will consider the journey of these 10 years and look forward to where we are with modelling the brain and its dynamics, towards clinical applications. Over the years we have formed a partnership with EBRAINS that offers an ideal ecosystem for collaborations and sharing of data and tools. Indeed, the school operates in synergy with another EBRAINS workshop (EITN https://www.eitn.org/) where the latter offers the possibility to dive deeper into the computational side of virtual brain modelling, while in Erice we will foster in depth discussions on fundamental neuroscience and clinical issues. This year, we will continue to dig deep into the brain digital twin. What are the cornerstones of a virtual brain? What can a virtual brain give to medicine? Use cases will lead clinical discussion on unmet needs. Why should we keep modelling molecular, cellular, microcircuits and large-scale properties of the brain? What are we missing in the scaffold of the brain digital twin? How can we personalise it in a way to maximise benefit for the single patient? And after demonstrating the benefits of virtual brain modelling for individual patients, how can we democratise the technology to reach everyone? The problem not only requires understanding of single neurons and local microcircuits as well as of global network behaviours but also understanding of the essential technological tools available in different community settings. The course will include discussion on where we are and where we want to go. From the discussion sections and networking events of the course we will forge new collaborations and foster the development of ideas on what to concentrate on in years to come.

FOUNDATION ZOOM LECTURE SERIES
Foundation lectures that we encourage all attendees to view can be found here: https://shorturl.at/vbfZR

Programme

Arrival day – Tuesday 2nd December 2025

9pm: Evening gathering in the Marsala Cellar St. Rocco Monastery
Marsala wine and marzipan pastries typical of Erice.
Music and chats as people join in.

Day 1 – Wednesday 3rd December 2025

10 YEARS OF ERICE: WHERE ARE WE?

08:30 – **Welcome**
Claudia Gandini Wheeler-Kingshott, Egidio D'Angelo & Viktor Jirsa

09:00 – **The history of the school of brain cells & circuits "Camillo Golgi"**
Egidio D'Angelo

10:00 – **The development of The Virtual Brain (TVB) & digital brain twins**
Viktor Jirsa

11:00-11:30 Coffee Break

11:30 – **10 years of cellular models**
Michele Migliore

12:15 – **10 years of microcircuits integration**
Claudia Casellato

13:00-14:30 Lunch in San Rocco cloister

14:30 – **The advent of mean field models in understanding brain dynamics**
Alain Destexhe

15:15 – **Cells & mean fields**
Nicolas Brunel

16:00 Coffee break

16:30 – **Poster lightening talks**

Day 2 – Thursday 4th December 2025

FROM DATA to MODELING STRATEGIES for PERSONALISATION

08:30 – **Microstructure modelling from magnetic resonance imaging (MRI)**
Marco Palombo

9:15 – **Essential neuron dynamics: learning from pathological behaviors**
Marisa Saggio

10:00-10:30 Coffee break

10:30 – **Modeling the biophysics of the brain**
Gaute Einevoll

11:15 – **Multiscale modeling of brain pathologies**
Alberto Mazzoni

12:00 – **General discussion: The quest for the true structural connectome**
Huifang Wang, Nigel Pedersen, Marta Gaviraghi and Eleonora Lupi

13:00-14:15 Lunch in San Rocco cloister

14:15 – **Keynote lecture: Rethinking the Brain: Possibility Spaces and the Science of Complexity**
Randy McIntosh

15:15 – **Modeling the pathological virtual brain**
Huifang Wang

16:00-16:30 Coffee break

16:30 – **Presentations from 2024 poster winners (10min + 5min questions)**
Computational Modeling theme:
1st Virtual Brain Twins for schizophrenia
Giacomo Preti
2nd Region-specific models
Roberta Maria Lorenzi
Imaging/experimental theme:
1st Integrating subject-specific conduction velocity
Eleonora Lupi

17:30 – **General Discussion: brain digital twins construction, data and modelling**
Moderators: Viktor Jirsa, Egidio D'Angelo & Alain Destexhe

Day 3 – Friday 5th December 2025

EBRAINS: DATABASES & TOOLS

8:30 – **The EBRAINS ecosystem**
Viktor Jirsa & Egidio D'Angelo

9:00 – **EBRAINS DEMOS**

NEURON: Single Neuron Models - *Michele Migliore*

NEST & BSB: Point neurons & microcircuits – *Dimitri Rodarie*

TVB: Modeling brain dynamics - *Anita Monteverdi*

12:15-13:00 Lunch break in San Rocco cloister

13:00 - Social outing & social dinner
Visit to Marsala and the Punic shipwreck
Social Dinner at "*La Torre di Nubia*" restaurant

Day 4 – Saturday 6th December 2025

CLINICAL IMPACT OF DIGITAL TWINS

09:00 – **The computing brain**
Gustavo Deco

9:45 – **Sleep and wake states in Epilepsy**
Nigel Pedersen

10:30-11:00 Coffee break

11:00 – **The multiple sclerosis virtual brain**
Claudia Gandini Wheeler-Kingshott

11:00 – **Posters session**

12:30-14:00 Lunch break & photo in San Rocco cloister

14:00 – **Democratising brain digital twins**
Shyam Diwakar

14:45 – **The answer of ultra-low MRI**
Mara Cercignani

15:30-16:00 Coffee break

16:00 – **The schizophrenic brain**
Nikos Koutsouleris

16:45 – **Poster award**
17:00 – **General discussion: The next 10 years: quo vadis?**

Day 5 – Sunday 7th December 2024

Farewell