

Foreword



Five Years IST Austria

In the course of history five years do not seem like a long time. But whoever of you has (or knows) children will affirm that the first five years in the life of a child are the period with the most amazing advances, formative developments and surprising challenges. Since June 2009, when the campus was officially opened, IST Austria has grown from being a fascinating, but risky idea to a fully operative, first-rate research institute with now 31 professors, almost 300 scientists plus support staff and 80 administrative members. I would like to take this occasion to thank all of you for your amazing effort and ceaseless diligence, which has made the success of IST Austria possible.

We commemorate the Institute's birthday with a number of public and internal events in the coming weeks. On May 25 we will celebrate our Open Campus Day with the award ceremony for the school competition, a family lecture by Björn Hof, presentations by numerous research groups, experiments for kids and refreshments for the adults. On June 3 the Science-Industry Talk will take place, jointly organized by the Federation of Austrian Industries (IV) and IST Austria. The subject of this year's panel discussion could serve as slogan for our common goal: "Spotting Talent(s)". On June 26 we will have the chance to celebrate at our annual summer BBQ.

I urge all of you to participate in these festivities and to celebrate our success so far. And whoever is familiar with children will know that there is more to come.

Thomas A. Henzinger | President

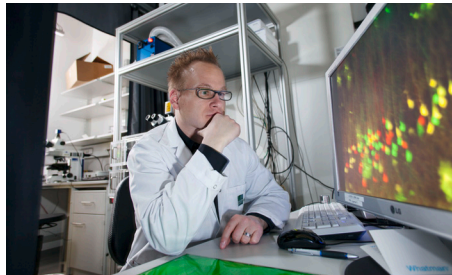


Herbert Edelsbrunner named EATCS fellow

For the first time, the European Association for Theoretical Computer Science (EATCS) has named ten of its members as the recipients of an EATCS fellowship. Among the laureates is IST Austria Professor Herbert Edelsbrunner who, according to the EACTS Fellows Selection Committee, was selected for „his tremendous impact on the field of computational geometry“. The distinction is awarded for outstanding contributions to theoretical computer science.

Edelsbrunner joined IST Austria in 2009. A native Austrian, the computer scientist spent most of his career in the USA, teaching and researching at the University of Illinois at Urbana-Champaign and later at Duke University (North Carolina). The focus of his current research is on computational topology, an area he pioneered and whose methods address the importance of shape and the recognition, matching, and classification of shape from data.

EATCS is an international organization founded in 1972. Its aim is to facilitate the exchange of ideas and results among theoretical computer scientists as well as to stimulate cooperation between the theoretical and the practical community in computer science.



Simon Hippenmeyer receives HFSP grant

Simon Hippenmeyer, Assistant Professor at IST Austria has been awarded a Program Grant by the Human Frontier Science Program (HFSP) together with three research groups in the US and the UK. HFSP program grants support novel collaborations among teams of scientists. The project "Quantitative structure-function analysis of cerebral cortex assembly at clonal level" is funded with US \$ 400'000/year (€ 290'000), for three years.

The researchers seek to understand how the cortex, the brain region that controls all higher order brain functions such as perception, emotion, language and cognition, is constructed. The cortex has a strikingly clear structure: cortical neurons form vertical columns, and all neurons within a column are connected by precise synapses to form local circuits. How these precise circuits are assembled in repetitive columns during development is not understood yet. The researchers assume that cortex assembly is fundamentally influenced by the order in which neurons are born, called the neuronal lineage. Hippenmeyer and his colleagues will examine how individual neuronal lineages develop both structurally and functionally.

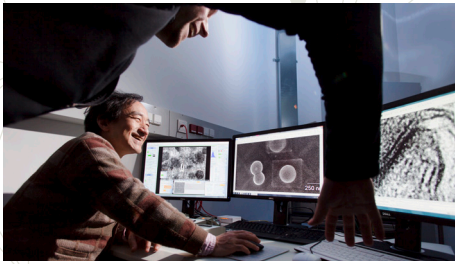


Krishnendu Chatterjee – Promoted to Professor

Krishnendu Chatterjee was promoted to Professor on April 1. Krishnendu Chatterjee, a computer scientist, is the second Assistant Professor to have been promoted, following Michael Sixt's promotion in the fall of 2013. This is the result of a tenure evaluation, a compulsory evaluation according to IST Austria's performance-orientated career model for scientists, the tenure-track model.

Krishnendu Chatterjee studies the theoretical foundations of game theory and formal verification. Game theory, the study of interactive decision problems, can be used to study problems in logic and set theory, economics, cell development, population and evolutionary biology, and software systems. Chatterjee's focus lies in the study of games played on graphs. As the behavior of software can be modeled and analyzed using graph games, the mathematical methods of game theory help in the development of safe software.

Krishnendu Chatterjee joined IST Austria as Assistant Professor in June 2009. Chatterjee was awarded an ERC Starting Grant in 2011.



Watching proteins at work

Green Fluorescent Protein (GFP) revolutionized cell biology, and the way researchers study the micrometer world. Ryuichi Shigemoto, Professor at IST Austria, seeks a similar revolution for electron microscopy and the nanometer world. To function, proteins act with other proteins and form stable complexes like ion channels. Currently, researchers can only use biochemical or fluorescent methods to study the composition of proteins and protein complexes. There is no way to see the composition of a single complex in the tissue it acts in. In a project

funded by the FWF, Ryuichi Shigemoto will develop a new method of visualizing single proteins and even subunits of ion channels by electron microscopy (EM). A small tag is added to proteins using a knock-in method, so that when the gene coding for the protein of interest is expressed, a small tag is added to this protein. In EM, an electron beam scans a sample, and a metal particle that scatters electrons is used to visualize a target.

Shigemoto and colleague Akio Ojida will synthesize chemical probes that covalently attach metal particles to the protein tag. The new method's resolution will distinguish molecules that are only 2-3 nanometers apart from each other, giving qualitatively new information on proteins and protein complexes. The Shigemoto lab will use this method to precisely localize ion channels in neurons, analyze the subunits that make up ion channels, and count their absolute numbers. This data is fundamental for analyzing how neurons integrate signals and compute outcomes.

Long Night of Research at IST Austria

The campus was buzzing with excitement until midnight: On April 4, the "Long Night of Research" was successfully held on campus from 4:30pm to midnight. 500 visitors were drawn to IST Austria to learn about the findings of eight scientific institutions from Lower Austria. The varied program included presentations, talks and films.



Auxin flow directed by cytokinin

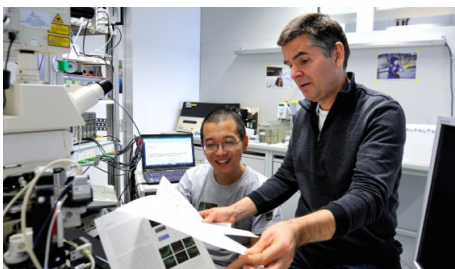
Plant hormones auxin and cytokinin control many events in plant development, and crosstalk between the two occurs at several levels. The direction in which auxin flows is crucial for plant development and responses to stimuli from the environment. In a paper in *Current Biology*, a team of researchers

around Eva Benková, Assistant Professor at IST Austria, including first author Peter Marhavý, Postdoc at IST Austria, and Jiří Friml, Professor at IST Austria, show that cytokinin acts as a polarization cue that controls the direction of auxin flow.

The direction in which auxin flows is largely defined by PIN transporters. They transport auxin from the cell, and are polarly located on only some membranes of the cell. The flow of auxin depends on where PIN transporters are. In their paper, the researchers show that during the lateral root primordia development in *Arabidopsis*, cytokinin eliminates the PIN1 transporter on membranes parallel to the tip of the new root, but does not eliminate PIN1 on membranes perpendicular to the root tip. This directs the auxin flow towards the tips of newly formed primordia. The researchers also show that



the removal of PIN proteins only at the membranes parallel to auxin flow depends on the degree to which PIN proteins are phosphorylated. Auxin flow towards the root tip is therefore guided by PIN1 removal through cytokinin, which in turn depends on the phosphorylation of PIN1. This is a conceptually novel way of auxin flow polarization driven by cytokinin during development.



New mechanism for fast neuron signalling identified

IST Austria Professor Peter Jonas and postdoc Hua Hu identified a new mechanism for reliable, fast transmission in basket cells of the brain in a *Nature Neuroscience* paper.

Basket cells play a key role in information processing in the hippocampus. Signal transmission has to be fast and reliable: basket cells convert an

incoming excitatory signal into an outgoing inhibitory signal within up to a millisecond, and this output signal is distributed to a large number of target cells. Two major mechanisms are thought to allow signals to travel quickly and reliably: a large axon diameter and a coating of the axonal surface with myelin. As their axons are thin and branch extensively, large axon diameter cannot be at work in basket cells. Myelination can also not be involved, as a high density of sites of synaptic transmission prevents the formation of myelin coverage. The researchers asked how basket cells are then able to transmit signals quickly and reliably. They identify a new subcellular mechanism: a controlled increase in the density of Na⁺ channels and conductance in axons of basket cells.

Jonas and Hu show that impulses are initiated close to the cell body and then travel highly reliably along the axon. Basket cell axons show a stepwise increase in Na⁺ channel density and conductance

from the cell body to the proximal axon, where action potentials are initiated. Channel density and conductance increase gradually along the rest of the axon. Na⁺ channels in the axon are also more rapidly inactivated than channels in the cell body. Jonas and Hu develop a cable model of basket cells, showing that a low Na⁺ channel density is enough for reliable action potential propagation, but the observed high channel density is necessary for the speed of propagation. When blocking Na⁺ channels using tetrodotoxin, signals are transmitted reliably, but more slowly, and the frequency of action potential generation is reduced. Axonal Na⁺ channel density affects both reliability and speed of signal transmission, and the characteristic high frequency firing in basket cells.

Hu and Jonas identify a new mechanism for reliable fast signaling in vertebrate neurons, previously only described in invertebrates.

Science and success: young researchers at IST Austria

Postdocs and PhD students in several groups at IST Austria recently published insights from their research and received prizes for their work.

Alvaro Ingles-Prieto receives a Dan David scholarship endowed with \$15'000 by the Dan David Foundation. Dan David scholarships support promising projects corresponding to a chosen theme with a focus on the past, present or future. In his project that won a Dan David scholarship in the field Present – combatting memory loss, Alvaro Ingles-Prieto, Postdoc in the group of Harald Janovjak, designs light-controlled proteins to restore learning and memory in animal models of Alzheimer's disease.

Jose Guzman and Alois Schlögl, researchers in the group of Peter Jonas at IST Austria, together with Christoph Schmidt-Hieber at University College London, present Stimfit, a free application for quantifying electrophysiological data. Stimfit, a free cross-platform software package for cellular neurophysiology, contains fast algorithms to measure and analyze the electrical signals used by neurons to communicate. Stimfit is scriptable in Python, a platform widely used in neuroscience. Stimfit was presented in frontiers in Neuroinformatics, and is released under the GNU General Public License at www.stimfit.org.

Urszula Kania, PhD student in the group of Jiří Friml at IST Austria, is lead author of a review on cell polarity in *Open Biology*, an open access biology journal by the Royal Society. In their review, the authors compare the molecular toolkit for polarization in plants and animals. In plants, this toolkit centers around ROP GTPases while in animals, PAR proteins are the main players in the polarization of epithelial cells. Additionally, the authors survey the methods used for analyzing polarity in plants.



Open Campus

IST Austria celebrates its fifth birthday, and cordially invites you to the Open Campus 2014 on May 25. At this campus party for the whole family, scientists present their current projects and invite you to experiment. During campus tours you get a chance to look researchers over their shoulder. Experiment- and creativity workshops, a water-rocket competition and a dedicated kids program cater to kids from 3 to 12 years old. The Open Campus starts at 12 noon with the kids program and food and drink, the campus party then kicks-off at the official opening at 1pm. Come and join us, and help yourself to a slice of the birthday cake at the opening. More information at ist.ac.at/opencampus.

Young Scientist Symposium

On May 16, 2014, PhD students and postdocs at IST Austria host the third Young Scientist Symposium with the title "Synchronize! Clocks, Rhythms and Communication Across the Sciences". The one-day meeting brings together international experts and a broad audience of scientists to foster discussion on progress and problems. Further information on the event is available on the symposium website: ist.ac.at/young-scientist-symposium-2014

IST Lecture

On June 5, Iain Couzin holds the next IST Lecture, entitled "From Democratic Consensus to Cannibalistic Hordes: The Principles of Collective Behavior". The public lecture starts at 5pm in the Raiffeisen Lecture Hall.

Science Industry Talk

Organized jointly by IST Austria and the Federation of Austrian Industries (IV), the Science-Industry Talk series strengthens the relationship between industry and basic research. This year's talk will focus on identifying and fostering talent. A panel of Edward Astle, Friedrich Prinz, Marie Ringler, Helga Rübbsamen-Schaeff and Falk Strascheg discusses the topic of „Spotting Talent(s)“. The Science-Industry talk takes place on June 3, at 5pm at IST Austria. Please register for the event by May 23 at ist.ac.at/sit.

COLLOQUIUM SPEAKERS

PAST SPEAKERS (FEBRUARY - APRIL): Martin Fussenegger, ETH Zurich (Feb 17) | Rupak Majumdar, Max Planck Institute for Software Systems (Feb 24) | Jan Philip Solovej, University of Copenhagen (Mar 3) | Niloy J. Mitra, Stanford University (Mar 10) | Lotte Sogaard-Andersen, Max Planck Institute for Terrestrial Microbiology (Mar 17) | Ivan Bjerre Damgård, Aarhus University (Mar 24) | Joachim Spatz, Max Planck Institute for Intelligent Systems (Mar 31) | Mustafa Khammash, ETH Zurich (Apr 7) | Tobias Meyer, Stanford University

FUTURE SPEAKERS (MAY - JUNE): Natasha Raikhel, University of California Riverside (May 5) | Monika Ritsch-Marte, Innsbruck Medical University (May 12) | Michisuke Yuzaki, Keio University (May 19) | Tony Hyman, Max Planck Institute of Molecular Cell Biology and Genetics, Dresden (May 26) | Magnus Nordborg, GMI (June 16) | Tom Muir, Princeton University (June 23) | Lior Pachter, University of California Berkeley (June 30)

SELECTED RECENT PUBLICATIONS

Cytokinin Controls Polarity of PIN1-Dependent Auxin Transport during Lateral Root Organogenesis | Marhavy P, Duclercq J, Weller, B, Feraru E, Bielach A, Offringa R, Friml J, Schwechheimer C, Murphy A & Benkova E, 2014 | *Current Biology* 24, 1031-1037.

A supercritical density of Na⁺ channels ensures fast signaling in GABAergic interneuron axons | Hu H & Jonas P, 2014 | *Nature Neuroscience* 17, 686-693.

Stimfit: quantifying electrophysiological data with Python | Guzman SJ, Schloegl A & Schmidt-Hieber C, 2014 | *Frontiers in Neuroinformatics* doi: 10.3389/fninf.2014.00016.

Searching for collective behavior in a large network of sensory neurons | Tkačik G, Marre O, Amodei D, Schneidman E, Bialek W & Berry MJ, 2014 | *PLoS Computational Biology* 10, e1003408.

How to fake auxiliary input | Jetchev D & Pietrzak K, 2014 | LNCS Theory of Cryptography Conference 8349, 566-590.

Markov decision processes with multiple long-run average objectives | Brázdil T, Brožek V, Chatterjee K, Forejt V & Kučera A, 2014 | *Logical Methods in Computer Science* 10, 13.

Deterministic and stochastic aspects of the transition to turbulence | Song B & Hof B, 2014 | *Journal of Statistical Mechanics: Theory and Experiment* 2, P02001.

Optogenetic countering of glial acidosis suppresses glial glutamate release and ischemic brain damage | Beppu K, Sasaki T, Tanaka KF, Yamanaka A, Fukazawa Y, Shigemoto R & Matsui K, 2014 | *Neuron* 81, 314-320.

On the mass concentration for Bose-Einstein condensates with attractive interactions | Guo Y & Seiringer R, 2014 | *Letters in Mathematical Physics* 104, 141-156.

A full list of publications from IST Austria can be found at publist.ist.ac.at.