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INTERNATIONAL LABORATORY
OF PLANT NEUROBIOLOGY

Director Prof. **Stefano Mancuso**

LINV AT FIRST GLANCE

The **International Laboratory for Plant Neurobiology** was founded in 2005 thanks to the generous funding of Ente Cassa di Risparmio di Firenze. LINV is part of the University of Florence and located in the scientific campus of Sesto Fiorentino, Firenze. Thanks to the immediate proximity of LINV to other institutes of biology, chemistry and physics, there is excellent potential for scientific collaboration and the establishment of networks.

Under the leadership of Stefano Mancuso, young students, post graduate and post-docs study several aspects of behaviour covering electrophysiology, physiology and cell/molecular biology.
LINV attracts researchers from all over the world, and it is associated with many institutes to exchange students, ideas and projects.

One of the main tasks of LINV is training young researchers in modern techniques of plant physiology, plant behaviour, molecular biology, stress physiology and many other research topics.
LINV @ Kitakyushu – The laboratory has an affiliated branch in Kitakyushu, Japan. Under the direction of Prof. Tomonori Kawano, young researchers work on the effect of light and oxidative stress in plants.

UNIVERSITÀ DEGLI STUDI FIRENZE

Director

Stefano Mancuso - University of Florence - stefano.mancuso@unifi.it

Scientific Advisory Board

Frantisek Baluska - IZMB - University of Bonn, Germany
Tomonori Kawano - LINV @ Kitakyushu – University of Kitakyushu Japan
Jinxing Lin - Chinese Academy of Sciences, Beijing, China
François Bouteau - Université Paris Diderot - France
Paco Calvo - University of Murcia - Spain

PLANT BEHAVIOUR

Plants can accurately compute their circumstances, use sophisticated cost benefit analysis, and take defined actions to mitigate and control diverse environmental insults.

They are capable of a refined self and non-self recognition, exhibit territorial behaviours and have complex communication skills. Communication and signalling in plants encompasses both chemical and physical communication pathways. Plants interact with animals. They attract them with colourful flowers or fleshy fruits to make sure their flowers get pollinated and their seeds dispersed. They offer sugary nectars to reward them for their protective services. Plants have a very rich social life, exhibiting different cooperative or antagonistic behaviours according to the degree of relativeness among them.

PLANT SIGNALLING AND COMMUNICATION

Scientific interest in plant movements, sensitivity, and possible intelligence has been continuously documented since the late 1800's.

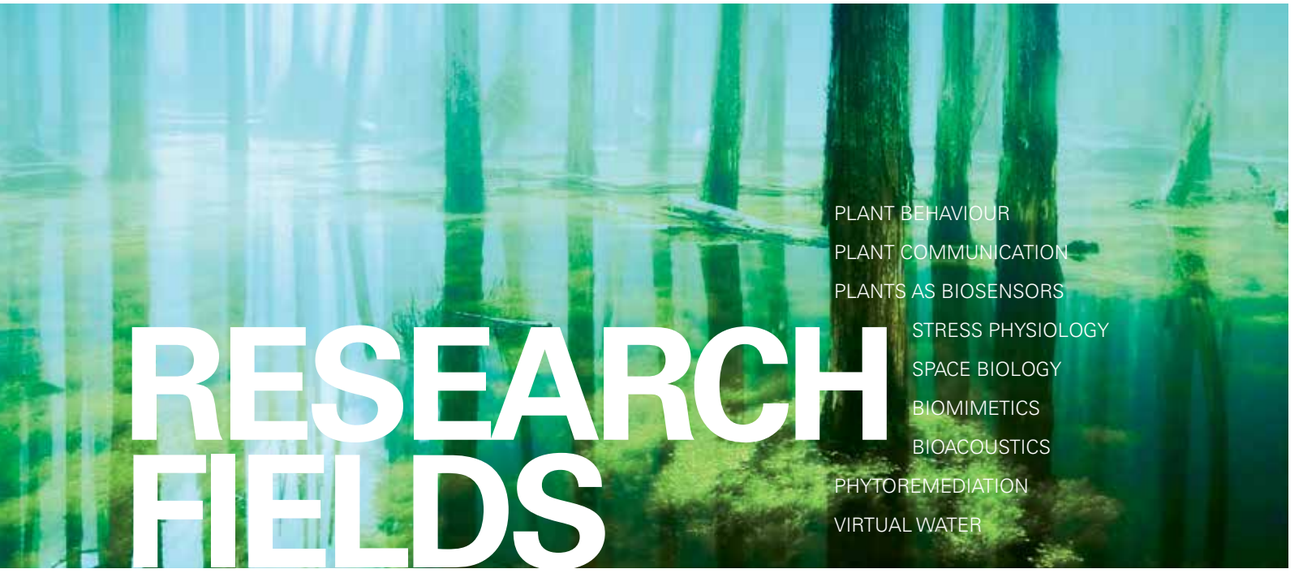
Studies on Plant Signalling covers diverse aspects of signalling and communication at all levels of plant organization, starting from single molecules and ending at ecological communities. Twentieth-century biology was dominated by attempts to reduce extremely complex biological phenomena to the actions of single molecules. While this process will continue in the future, we also need to integrate the avalanche of obtained data using system-based approaches.

Plant Signalling will cover all plant sciences under one umbrella from the perspective of signalling and communication at all levels of biological organization by interlinking molecular biology with physiology and behaviour of individual organisms, up to the system analysis of whole plant societies and ecosystems. This integrative view will allow our understanding of communicative plants in their whole complexity.

PLANT
INTELLIGENCE

Plants have a very well organized sensing system, which allows them to explore efficiently the environment and to react rapidly to potential dangerous circumstances. Below and above ground, plants are aware of the space surrounding them.

Such responsiveness is, indeed, necessary to provide the appropriate actions in response to the environmental stimuli. Plants have memory, are able to learn, to solve problems and to make decisions. We firmly think that all the behaviors observed in plants, which look very much like learning, memory, decision-making, and intelligence observed in animals, deserve to be called by those same terms. In short: 1) plant are intelligent 2) intelligence is a quality of life and 3) the brain is not the pre-requisite for intelligence.



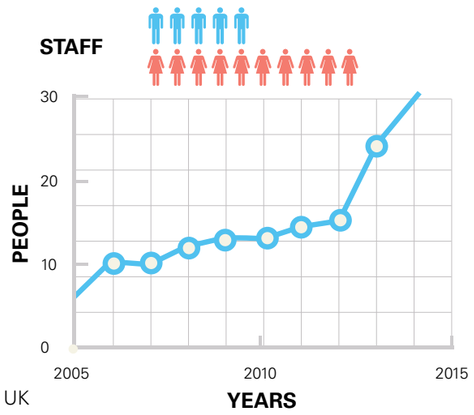
RESEARCH FIELDS

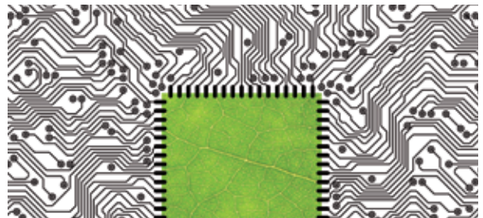
PLANT BEHAVIOUR
PLANT COMMUNICATION
PLANTS AS BIOSENSORS
STRESS PHYSIOLOGY
SPACE BIOLOGY
BIOMIMETICS
BIOACOUSTICS
PHYTOREMEDIATION
VIRTUAL WATER

PARTNERS

IZMB - University of Bonn - Research Centre - Germany
LINV @ Kitakyushu - University of Kitakyushu Research Centre - Japan
Chinese Academy of Sciences - Research Centre - China
Université Paris Diderot- Research Centre - France
Imperial College - Research Centre - UK
University of Tasmania - Research Centre - Australia
Centre for Evolutionary Biology - Research Centre - Australia
University of Fribourg - Research Centre – Switzerland
Center for Micro-BioRobotics IIT - Research Centre - Italy
Centro Nazionale della Ricerca - Research Centre - Italy
Università degli Studi di Torino - Academia - Italy
University of Southampton - Academia - UK
London Centre For Mathematical Sciences LBG - Research Centre - UK
Institute for Bioengineering of Catalonia (IBEC) - Research Centre, Spain
Laboratory of Intelligent Systems EPFL - Research Centre, Switzerland
Institute for Advanced Studies IMT - Research Centre - Italy
The Society of Plant Signalling and Behaviour - Society - US
Pnat - SME - Italy
WLAB - SME - Italy
Advantic Sistemas y Servicios - SME - Spain

PERFORMANCE





OUR VIEW OF PLANTS

Plants are dynamic and highly sensitive organisms that actively and competitively forage for limited resources, both above and below ground; they accurately compute their circumstances, use sophisticated cost-benefit analysis, and take defined actions to mitigate and control diverse environmental insults. Plants are capable of a refined recognition of self and non-self and are territorial in behaviour. This new view sees plants as information processing organisms with complex communication throughout the individual plant. Plants are as sophisticated in behaviour as animals but their potential has been masked because it operates on time scales many orders of magnitude less than that operating in animals.

MAIN EQUIPMENT

LINV is equipped with advanced instrumentation for plant physiology, molecular biology, biomechanics, electrophysiology and microscopy imaging.
Among our main instruments:

MEA system – monitors the spontaneous and evoked electrical activity of cells and tissues.

VIP system for the non-invasive and real-time measurament of net ion fluxes (or gas molecules) from plant cells and living tissues

PTR-MS-TOF - the most sensitive and complete mass spectrometer on the market for the study of volatile compounds emitted in a complex system. It has a resolution of about 20 pptv and can identify the full spectrum of volatile with molecular weights ranging between 0 and 7000.

Centrifuge for hyper-gravity experiments
The centrifuge creates an acceleration of 1-5 g to perform experiments in hypergravity conditions for cells and small plants.

Leaf gas exchange
A portable gas exchange system (Li-6400XT) with the integrated fluorescence chamber head (Li-6400-40; Li-Cor Inc.) enables the simultaneous measurements of leaf gas exchange and chlorophyll fluorescence parameters.

Microscopy imaging:
- Leica confocal laser scanning microscope
- Zeiss fluorescence inverted Axio observer Z1
- Zeiss fluorescence Stereo Discovery V12

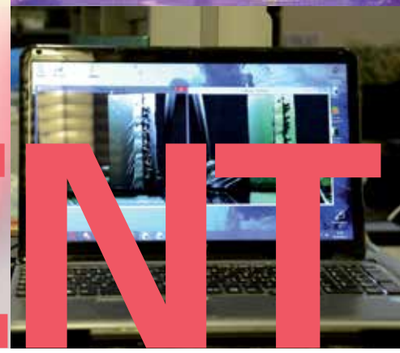
3D printer and 3D scanner

Keyence - 2D laser micrometre, a high precision, non-contact sensor for root morphology

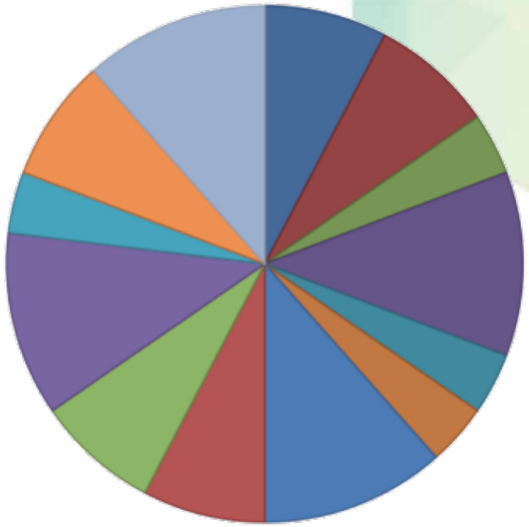
Electrical Impedance Spectroscopy (EIS).
A repeatable and non-destructive method to study the properties of cell membranes. EIS applications in plant tissues are numerous. It can be used to assess physiological stresses, freezing or heat injuries, dormancy induction, nutritional deficiency etc.





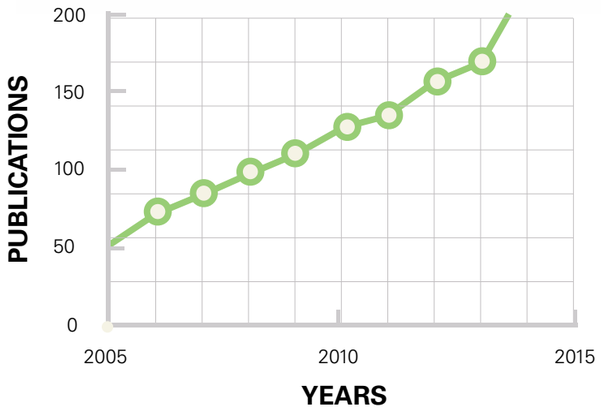


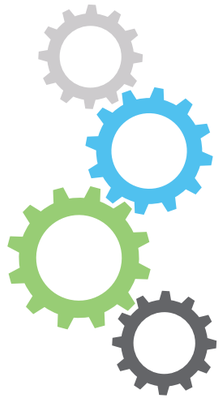
INTERNATIONAL LAB



- Germany
- Slovakia
- Israel
- Polland
- USA
- Spain
- France
- Cech Rep
- Belarus
- Australia
- UK
- Chile
- Other countries

PUBLICATIONS





FUNDED PROJECTS

2014 Progetto Medusa (Jellyfish Barge) Ente Cassa di Risparmio di Firenze e Regione Toscana.
2013 VOLATOM - Ente Cassa di Risparmio di Firenze
2013 VESPA – Vegetal System for Pollution Avoidance, The Ministry of Defence.
2012 PRIN 2012 – Pro-ROOT
2012 PLEASED FET-OPEN FP7
2012 PLANTOID FET-OPEN FP7
2012 Marie Curie FP7-PEOPLE-2012-IEF
2012 ESA "Fly your thesis!"
2012 Bando FIRB - Programma "Futuro in ricerca" The global virtual-water network: social, economic, and environmental implications –ViWaN
2012 ARIADNA – ACT ESA Seed-driller
2012 A.R.I.A. Gli alberi come rilevatori dell'inquinamento ambientale - Regione Toscana
2011 ESA "Spin your thesis!"
2011 ESA "Drop your thesis!"
2010 Plant bioacoustics BOSE spa
2010 Plant and Gravity Ente Cassa di Risparmio di Firenze
2010 NEAR 52nd ESA-PFC
2010 ESA "Spin your thesis!" 2010
2010 ASI-BIOKIS ISS through STS-134 mission
2009 51st ESA-PFC
2008 SOFILVU – Arsia Regione Toscana
2008 DLR Drop Tower Campaign
2008 ARIADNA – ACT ESA "Bioinspiration by plants' roots"
2008 49th ESA-PFC
2008 47th ESA PFC
2007 46th ESA-PFC
2006 GOOD-FOOD FP6
2006 9th DLR-PFC
2006 43rd ESA-PFC
2006 PRIN – MIUR
2005 NOAPORM - 41st ESA-PFC
2004 LINV project Ente Cassa di Risparmio di Firenze

RELEVANT PUBLICATIONS

M Gagliano, M Renton, M Depczynski, S Mancuso (2014). Experience teaches plants to learn faster and forget slower in environments where it matters
Oecologia, 1-10

M Gagliano, S Mancuso, D Robert (2012). Towards understanding plant bioacoustics. Trends in plant science 17 (6), 323-325

M Ciszak, D Comparini, B Mazzolai, F Baluska, FT Arecchi, F Tito Arecchi, Tamás Vicsek, Stefano Mancuso (2012). Swarming behavior in plant roots. PLoS One 7 (1), e29759

F Baluška, S Mancuso, D Volkmann, PW Barlow (2010) Root apex transition zone: a signalling–response nexus in the root. Trends in plant science 15 (7), 402-408

Baluska F., Lev-Yadun S., Mancuso S. (2010) Swarm intelligence in plant roots. Trends in Ecology & Evolution 25: 682-683

E Masi, M Ciszak, G Stefano, L Renna, E Azzarello, C Pandolfi, S Mugnai, F Baluška, FT Arecchi, S Mancuso (2009). Spatiotemporal dynamics of the electrical network activity in the root apex. Proceedings of the National Academy of Sciences 106 (10), 4048-4053

ED Brenner, R Stahlberg, S Mancuso, J Vivanco, F Baluška, E Van Volkenburgh (2006). Plant neurobiology: an integrated view of plant signalling. Trends in plant science 11 (8), 413-419

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