HEARLIGHT

Deliverable D6.1

Project Website

Due date of deliverable: M2

Actual submission date: M3

Start date of the project: 1st April, 2020 **Duration:** 48 months

Lead organisation name: Institut Pasteur

Revision: V1

Dissemination level	
Public - PU	**X**
Confidential, only for members of the consortium (including Commission Services) - CO	
Classified, as referred to in Commission Decision 2001/844/EC - CI	

Table of contents

1. Summary

Objectives

Within the framework of Workpackage 6, the first deliverable for HearLight was to prepare a public website, including a project overview, information about the consortium members, as well as a section with news, events and publications. The website is HearLight's flagship communication tool and will serve as entry point for all interested stakeholders from various groups such as scientists, researchers, businesses, and the general public.

Rationale:

Institut Pasteur's communication department helped set up the website with input from the project management team at Institut Pasteur / Institut de l'Audition (Brice Bathellier, Maëlle Pichard, Katharina Kopf.

The website will be a "living document" and will be regularly updated with new input from our project partners, throughout the lifetime of the project. For example, a short text on the kick-off meeting has already been added.

Teams involved:

Institut Pasteur / Institut de l'Audition

- Brice Bathellier
- Maëlle Pichard
- Katharina Kopf
- Institutional communication at Institut Pasteur

2. Introduction

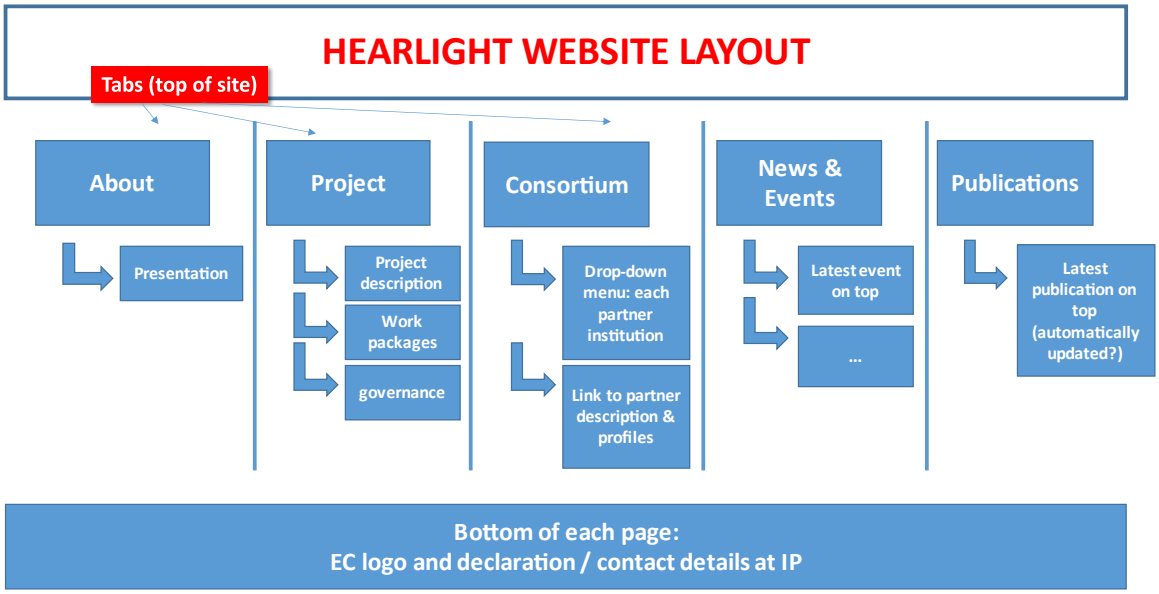
The aim of deliverable 6.1 was to present a functioning website very early in the project, that can be easily updated and completed with events, news and publications. The website was designed with help from the Institut Pasteur communications department, as well as an external provider, Jouve.

3. Results

3.1 The website address

HearLight's online presence can be found at **https://www.hearlight-project.com/en**

3.2 The website structure and content



To be added at the bottom of each page

- Logo CE
- Declaration (GA) : *"This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 964568"*
- Contact: hearlightproject@pasteur.fr
- Coordinator: Brice Bathellier, Hearing Institute / Institut Pasteur

Homepage

"HearLight - towards optogenetic cortical implants for hearing impaired"

Image – to be defined

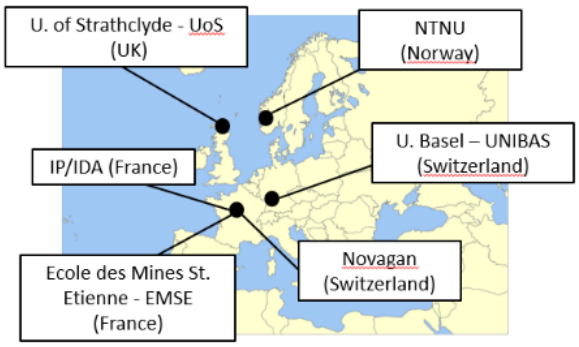
Links to News/Events/Publications

Links to HearLight LinkedIn page & multimedia channels

Contact form & email

1. About

The European Union's Horizon 2020 Future Emerging Technologies FET OPEN programme has awarded 3M€ to HearLight, a collaborative project coordinated by the Hearing Institute at Institut Pasteur (Paris, France).



Reuniting six European partners, including Swiss startup Novagan, HearLight aims a developing a new technology to restore audition for patients with impaired hearing.

Hearing loss affects almost half a billion people worldwide. For complete hearing loss, the only treatment currently is the cochlear implant, an electrical stimulator placed in the ear. Cochlear implants restore hearing in some patients, but with performance limitations that severely affect patients' quality of life.

HearLight aims to boost precision in auditory rehabilitation strategies for a broad range of deafness indications using a radically new approach targeted to the brain rather than to the ear. It will combine Bioelectronics and Optogenetics technologies to apply precise stimulation patterns in the auditory cortex, a crucial brain area for auditory perception. To achieve this on the longer-term, one of HearLight's aims is to develop thin, flexible and biocompatible electrode and LED arrays that one could slide within the circumvolutions of the human auditory cortex.

The other goal is to test different algorithms to transform sound information into brain stimulation patterns that can be perceived as precise sounds. If this brain-targeted restoration approach dramatically improves perception of the fine structure of sounds, as the project aims to demonstrate, it could provide a technology that significantly improves perception in treated patients giving access to hearing of music or conversations in a crowd, which are almost impossible with cochlear implants.

A dedicated website and social media strategy will inform the public and patient associations about the project. The consortium will also participate to relevant European events, "Open Science" national days and more.

2. Project

Project Description

Cochlear implants are the first and currently most successful sensory rehabilitation strategy, and equip thousands of hearing impaired patients. However, they suffer from strong information throughput

limitations, making music perception and speech intelligibility in noise impossible, extremely detrimental to implanted patients.

Project HearLight aims to establish a clear proof of concept for a radically new auditory rehabilitation strategy by direct stimulation of the main sound processing center in the brain, the auditory cortex. The auditory cortex not only offers one order of magnitude more interfacing surface, to boost information throughput, but it is also a plastic structure, adaptable to complex auditory codes, which could benefit from acoustic information preprocessing by modern artificial intelligence algorithms.

To demonstrate that cortical implants are feasible and outperform cochlear implants, artificial sound perceptions will be optogenetically generated via an LED display placed over the full extent of auditory cortex in behaving mice. Perceptual precision for a wide range of acoustic features will be precisely benchmarked against cochlear implant thanks to a range of psychophysical assays available in this animal model. The benefits of sound preprocessing by machine learning algorithms (deep learning networks) will be tested, and we will develop a new generation of ultrathin, flexible, biocompatible LED displays, that could be placed on the convoluted surface of human auditory cortex to activate precise and rich perceptions.

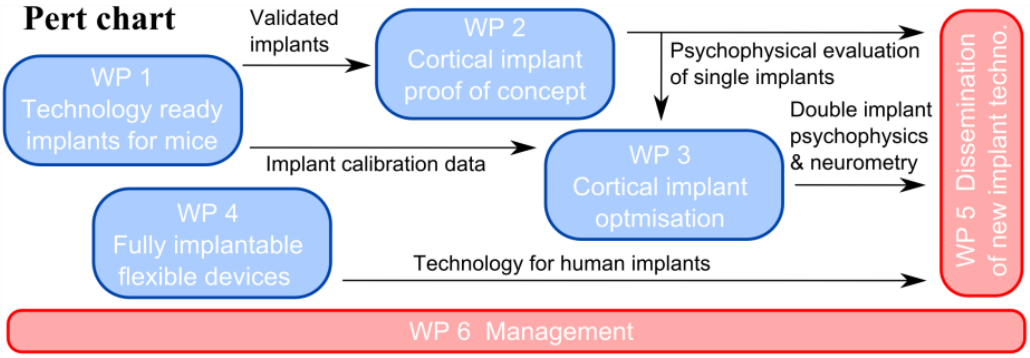
Together, these brain-interfacing and bioelectronics innovations will enable a new implant strategy in that promises to be a major changer for hearing restoration quality in deaf patients, and pave the way for improvement of other sensory restoration strategies.

Workpackages

The work plan is arranged within six work packages of total duration of 48 months for which we anticipate three project reporting periods: at M12, M30 and M48. Specifically, we will establish the first documented proof of concept of cortical implants for auditory restoration in three steps, that include design of technology-ready tools [WP1] to establish the superiority of cortical implants over cochlear implants in mice [WP2] and eventually craft synergic approaches between the two implant strategies [WP3].

In parallel, an important microfabrication effort will be made to prepare the next generation of flexible optogenetic implants for patients by inserting OLED or µLED arrays in parylene circuits [WP4].

Careful consortium management [WP6] and results exploitation by active dissemination and preparation of a strategy for clinical transfer [WP5] will ensure a wide impact of the project.



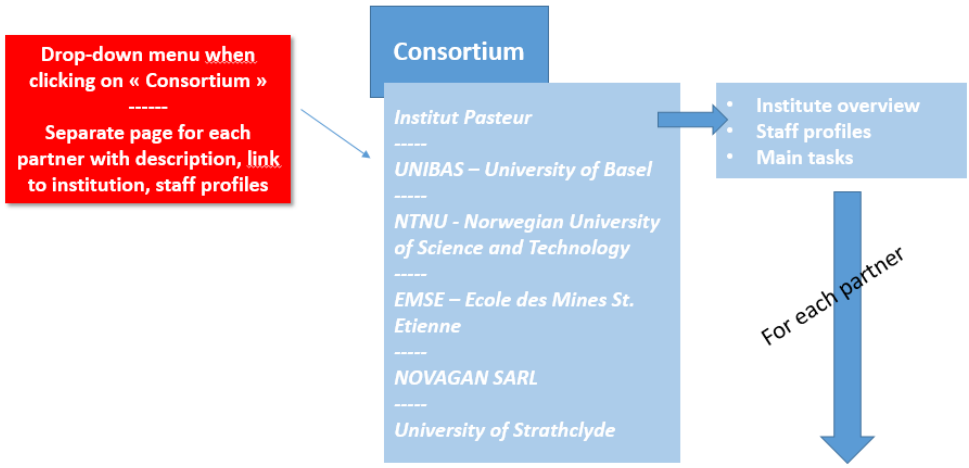
Governance

Management Team at Institut Pasteur

Brice Bathellier, Hearing Institute: scientific coordinator
Maëlle Pichard, Grants Office: reporting, amendments, consortium meetings
Katharina Kopf, Grants Office: daily management, communication, liaising with the consortium, budget management, tracking of deliverables

3. Consortium

(avec menu déroulant pour cliquer directement sur le partenaire concerné): icônes institutions avec lien vers leur profil/photos chercheurs)



IP – Institut Pasteur

Institut Pasteur is a private, state-approved non-profit foundation for biomedical research, established in 1887 by Louis Pasteur and hosting some 2,782 people including approximately 600 tenured scientists, several hundred PhD students and post-doctoral fellows, dedicated engineers and technicians, as well as administrative staff.

As one of the most prestigious health research institutions in the world, 10 Institut Pasteur researchers have received a Nobel Prize. It has always worked closely with the industry and its Business Development and Technology Transfer Department operates as a gateway between inside research and outside product development.

The Institut Pasteur is also at the centre of a unique international network of 32 institutes, stretching across all five continents and all affiliated in partnerships.

The Hearing Institute
The IP members of Hearlight proposal all belong to the Hearing Institute (Institut de l'Audition), a new IP research centre gathering more than 60 research scientists of different expertise on auditory perception, physiology and mechanisms of auditory deficits. The Institute's mission is to implement and promote fundamental and translational research to on auditory perception and related deficits. It has access to all IP facilities, but also has its own state of the art facilities for mouse behaviour, optical brain imaging, optogenetic, electrophysiology and histology.

The scientific environment at the Hearing Institute includes also specialists of human cochlear implant and genetics therapy in the cochlea. The expertise of these scientists in human auditory rehabilitation will help constructing the exploitation plan for cortical implant technologies during the Hearlight project as well as the unique expertise of IP for exploitation of biological results into biomedical applications.

Staff profiles (add pictures)
Dr. Brice Bathellier is CNRS Research Director, and director of the "Auditory system dynamics and multisensory processing team", at the Hearing Institute, the new research center of Institut Pasteur. He is a specialist of mouse auditory system imaging, electrophysiology (in particular in auditory cortex), mouse auditory behaviors, and computational modeling.

Dr. Nicolas Michalski is IP Research Scientist, and director of the "Plasticity and central auditory system team" at the Hearing Institute. He is a specialist of auditory physiology and cell biology (cochlea and cortex). He will provide mouse models of deafness for testing cortical implants in congenitally deaf mice (WP2.3).

Dr. Jérémie Barral is CNRS Research Scientist, and director of the "Neural Coding in the Auditory System team". He is a specialist of cochlea biophysics and optogenetics. His team will perform optogenetic stimulation of the mouse cochlea to compare neurometric performance of optogenetic cochlear and cortical implants (WP4.1).

Maëlle Pichard

Main project tasks
- Electrophysiological calibration in cortex of mouse optogenetics cortical implants in WP1.2 & 1.3 and of optogenetic stimulation in cochlea (WP3.1)
- Behavioural measurements for psychophysics in normal and optogenetically implanted mice WP2.1 & 2.3
- Analysis of calibration data for the neurometric evaluation of implant strategies in WP3.1
- Biocompatibility assays in WP4.1-3.
- Project management in WP6
- Organization of dissemination events in WP5
- Contribution with expertise of the biomedical field to the exploitation and business plans in WP5.

UNIBAS – University of Basel

Founded in 1460, the University of Basel is the oldest university in Switzerland and has a history of success going back over 550 years. Today, it has around 12,700 students from over a hundred nations (24% are international students), including 2,800 PhD students.

The University of Basel comprises seven faculties covering a wide spectrum of academic disciplines and leads research and education in its affiliated clinics and university hospitals. It regularly ranks among the 100 top universities in the world in international rankings,. Life Sciences is one of the five strategic focal areas of the university.

Altogether, the University was involved in over 270 EU projects (FP7 and H2020) and has received 52 ERC grants, participated in 47 MSCA project and 17 FET project under H2020. For research projects,

the University of Basel has received around 70 Mio EUR from FP7 and around 78 Mio EUR so far from H2020.

Staff profiles (add pictures)
Dr Tania Rinaldi Barkat holds a M.Sc. in Chemistry and PhD in Neuroscience from the EPFL. She joined the Department of Biomedicine of University of Basel as a professor in neurophysiology in January 2015 after a postdoc in Takao Hensch's lab at Harvard University, where she defined a critical period for plasticity in the developing auditory system. She is a specialist of auditory system physiology and plasticity, cochlear implants, and mouse auditory behavior. In 2014, Tania was awarded an ERC Starting grant from the European Reseach Council. In 2013, she received the Lundbeck Foundation Fellowship and in 2007 the EPFL Dimitris N. Chorafas Foundation award for outstanding PhD thesis.
Tania Barkat is a member of the Harvard Society of Fellows since 2008.

Main project tasks
- Task 1.1. in vivo testing of electrical stimulation arrays
- Task 2.1 Establishment of mouse psychophysics standard
- Task 2.2 Testing of mouse psychophysics with cochlear implants
- Task 3.2 Testing of mouse psychophysics with double implants (cochlear and cortical)

NTNU – Norwegian University of Science and Technology

NTNU is Norway's largest university with just over 40,000 students and more than 7,000 employees. While it was founded in 1910, it can trace its roots back to 1760 and the Royal Norwegian Science Society (DKNVS). The main seat of the University is located in Trondheim, with additional campuses in Gjøvik and Ålesund. NTNU has eight faculties as well as units such as the NTNU Science Museum and the NTNU University Library.

Staff profiles (add pictures)
Pr. John de Mello is a professor of chemistry and the director of NTNU's strategic initiative in nanoscience and functional materials, NTNU Nano. Prior to this, he was a professor of nanomaterials in the chemistry department at Imperial College. HIs research is focused on controlled production processes for functional materials and devices, and their application in photonics, electronics and biosensors. He has published over 130 papers (H-Index 53), five book chapters and four patents. He was a co-recipient of the Royal Society's Brian Mercer Award for Innovation in Nanotechnology and is a former Royal Society Industry Fellow.

He was a co-founder of Molecular Vision Ltd. - an Imperial College spin-out company specialising in the use of organic light-emitting diodes and photodiodes for chemical sensing. Molecular Vision was acquired by Abingdon Health in 2015, winning Abingdon the UK Medtech Dealmaker of the year award in OBN's annual life-sciences competition (see https://tinyurl.com/yyy5332m).

Main project tasks
- Application of high resolution organic light-emitting diode displays and waveguide structures as external 2D light-sources for optogenetic stimulation.
- Development of low resolution OLED matrices as embeddable 2D light-sources for optogenetic stimulation.

EMSE – Ecole des Mines de Saint-Etienne

Ecole des Mines de Saint-Etienne (EMSE), a member of Institut Mines-Télécom (IMT) is an engineering school dedicated to the education and training of generalist and specialized engineers, who are

oriented towards industrial research. Another important mission of EMSE is the training of graduate students and young researchers, as well as high-level scientific research in partnership with national and international collaborators across Europe and the world, in a variety of interdisciplinary domains.

The school has several centers of excellence dedicated to industrial and academic research, among which Microelectronic Center of Provence represents the school's leadership capacity in the fields of bioelectronics for interfacing the world of organic electronics with biology, flexible and stretchable electronics, operational research, hardware security and internet of things.

Staff profiles (add pictures)
Dr. Charles Rezaei-Mazinani is an assistant professor in the Department of Bioelectronics (BEL) at the Ecole des Mines de Saint-Étienne (EMSE). He did his Master's degree in Systems Design jointly at Fachhochschule Kaernten (Austria) and the Academic Medical Center of the University of Amsterdam. He attained his Ph.D. degree in BEL (2017), where he worked on the development of organic photodetectors for neuroscience applications. Thereafter, he accomplished his postdoctoral fellowship in the Center for Interdisciplinary Research in Biology (CIRB) at the Collège de France. At CIRB he worked on developing algorithmic and machine learning approaches for analyzing in vivo 2-photon and micro-endoscopic imaging data, for the understanding of odor and place encoding in the mouse cortex.

As a newly recruited assistant professor (November 2019), his research is focused on using electronic and opto-electronic materials for designing and developing novel biocompatible optical and electronic devices for interfacing neural networks in the brain. This process includes design, characterization and fabrication of high-performance probes to acquire and analyze neural data. The ultimate objective is to apply such devices in neuroscience and to translational medicine in order to improve diagnostics and treatments in epilepsy and Alzheimer disease.

Main project tasks
- Design and fabrication of electrocorticography devices, integration of organic light emitting diodes (OLED) and µ-LED in flexible-implantable devices, electrical and electrochemical characterization and testing

NOVAGAN

Thanks to straight collaborations with EPFL and its customers, NOVAGAN has developed state-of-the-art technologies in epitaxy and micro-technological processing for optoelectronic devices made of GaN semiconductors. The team has more than 15 years' experience both in epitaxy, device physics and process development of LEDs and laser diodes and has access to state-of-the-art equipments in a class 100 clean room.

NOVAGAN is the first supplier of epiwafers for the fabrication of CW blue InGaN laser diodes (LDs) and the first company to demonstrate InGaN superluminescent light emitting diodes (SLEDs) emitting in the blue with its partners.

With technological and design experts, NOVAGAN can offer prototyping service and highly customizable products. We can help our customers at every step of the fabrication chain of optoelectronic device emitting from near UV to the full visible domain.

NOVAGAN has developed new fabrication methods to produce 1.5 µm LEDs and high density ultra-small pitch (<10µm) LED matrices. The technology allow the fabrication of color RGB

Staff profiles (add pictures)
Dr Eric Feltin obtained his Ph. D. in Physics from the University of Nice-Sophia Antipolis in 2003. His doctoral research at CNRS-CRHEA on the growth of GaN on silicon substrates by MOVPE is one of the founding works that opened the way to the realization of light emitting diodes (LEDs) on low cost silicon substrates, a major market under tremendous development now. He also developed a new method for producing high quality free-standing GaN substrates, a critical element used for the fabrication of UV-blue laser diodes. This method is patented and currently used in the industry.

He joined the LASPE laboratory at EPFL in 2004 where he managed the growth and technology development of GaN semiconductors heterostructures with particular emphasis on microcavities, VCSELs, LEDs UV-blue laser diodes and high electron mobility transistors.

In 2009 he founded the start-up NOVAGAN which is manufacturing III-Nitride epitaxial wafers used in the fabrication of semiconductors devices such as UV-blue laser diodes and LEDs and radio frequency high power electronics (radar, telecommunications, current converter, …).

He is the author and coauthor of more than 128 publications (H factor>36) in peer-reviewed international journals and holds one patent. He participated in many FP6 and FP7 European programs (EURONIM, STIMSCATT, NITWAVE, ULTRAGAN) and H2020 project (HILICO) and 6 Swiss research projects (2 as coordinator).

Jean-Michel Lamy. After his engineering studies at INSA Rennes, France, Jean-Michel Lamy got his PhD in physics and optoelectronics in 2008 from FOTON-CNRS. During his PhD, he was involved in simulation, fabrication and characterization of InP based VCSELs. In 2009, he moved to Tyndall national institute in the group of Professor B. Corbett where he worked on GaAs based VCSELs and then on edge emitting laser based on GaN. He joined the LASPE laboratory at EPFL in 2011 where he was in charge of the fabrication process of LEDs, edge emitting laser and VCSELs. Since 2016, he is the head of the microtechnology processing at NOVAGAN, developing microLEDs and other highly advanced optoelectronic devices.

He is the author or coauthor of more than 20 publications in peer-reviewed international journals.

Main project tasks
1. WP2: Design and fabrication of µLED matrix
2. WP4: Development of flexible microLED display
3. WP5 : WP5 leader in charge of the exploitation strategy and Exploitation and IP developer

UoS – University of Strathclyde

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Staff profiles (add pictures)
Professor Keith Mathieson holds a Royal Academy of Engineering (RAEng) Chair in Emerging Technologies and leads a research team of 8 (5 PHD and 3 post-doc) in the development of optoelectronic neurotechnologies. He is also Director of the Institute of Photonics (IoP), responsible for the financial operation and management of this cost centre with 60 staff and PGR students and an annual spend of approximately £2.4M. He has an h-index of 28 with over 2600 citations (Google Scholar).

In 2011, KM established a research group to develop novel photonic technologies used to further the understanding of neural circuits in the brain. In 2017 he was promoted to full professor and in 2019 was awarded an RAEng Chair in Emerging Technologies - one of only 28 such awards in the UK and one of only two in neurotechnology. This 10-year award has given the opportunity to focus research efforts on the development of novel technologies for in vivo and in vitro interfacing with the brain. The team has an international reputation in this field and has established long-term collaborations with some of the leading research groups worldwide.

He has worked at internationally leading institutions, such as Stanford University and the University of California Santa Cruz, where he helped develop a retinal prosthesis that is now implanted in human patients.

Main project tasks

- Microfabrication of microLED array devices based on a GaN-on-Sapphire semiconductor technology that provides individually addressable, high-intensity, biocompatible optoelectronic devices.
- Microfabrication of microLED membrane devices that can be transfer printed to parylene-C substrates from collaborating partners.

4. **News**
5. **Events**
6. **Publications**

4. Conclusions

We are pleased to have established our first official communication channel, the HearLight project website. This is a perfect way to showcase our exciting project for a large audience. The contact form, email address and links to social media channels will provide multiple entry points for our stakeholders to engage with the project team and maximise our outreach. The website will be continuously improved with enhanced content and news.