

Bridging Brain Science and Clinical Care in the 4th BMPN Annual Meeting

Gathering of experts focuses discussion on clinical unmet needs and uses of photonic techniques in neuroscience, medicine and clinical care.

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On Tuesday 4th of November, the Barcelona Medical Photonics Network (BMPN) celebrated the fourth edition of its annual meeting. The BMPN formally launched in March 2021 as a platform to promote the research and development activities in photonics being carried out in the Barcelona region through long-standing collaborations between ICFO and its biomedical and clinical partners.

This year's edition was organized by and held at ICFO, where the speakers explained their experience in applying advanced optical technologies to address brain related scientific and clinical challenges. **Prof. Oriol Romero Isart**, ICFO Director, opened the event by emphasizing the importance of multidisciplinary science and cross-collaboration between scientists, technologists, and clinicians to deliver innovative solutions for patients. He also highlighted ICFO's commitment to strengthening the Light for Health program, a goal clearly embodied

by the BMPN meeting.

Optical technologies for neuroscience and brain disorder therapies

Prof. Josep Dalmau (IDIBAPS-CaixaResearch Institute, Hospital Clinic), introduced the first section of the BMPN by describing his work on autoimmune encephalitis -severe disorders that cause neurological and psychiatric dysfunctions due to antibodies attacking neural receptors. Using high-resolution optical imaging, including STORM microscopy in collaboration with ICFO's SLN facility led by **Dr. Pablo Loza**, his team visualized receptor clusters and tracked how antibodies lead to receptor internalization and neuronal dysfunction. These insights have already informed new therapeutic strategies, significantly improving many patients' conditions. Future research will focus on understanding how the disease damages working memory and how this function can be efficiently restored.

Next, **Dr. Merce Masana** (Institute of Neurosciences, University of Barcelona) emphasized the importance of mapping brain circuitry to decode and modulate symptoms of neurological disorders. Her research targets Huntington's disease, caused by a mutated protein that disrupts neural communication, producing movement disorders. She explored the potential of optogenetics -using light to activate neurons and modulate neuronal activity- to restore function in affected circuits. Mouse studies demonstrated improvements in motor learning and in some cases coordination. Dr. Masana now plans to further examine which symptoms respond best and whether long-term recovery is possible through this method.

Prof. Francisco Ciruela Alferez (Medical School, University of Barcelona) then introduced the concept of photopharmacology, which uses light to control drug activation with high precision. His team developed photocaged morphine (pc-MOR), an inactive compound that becomes active only when exposed to light. This innovation maintains considerably morphine's analgesic properties while reducing tolerance, dependence, and side effects such as constipation. Prof. Ciruela also discussed recent advances in remote and wireless photopharmacology, highlighting the growing potential for clinical applications.

After the break, **Prof. Joseph Culver** (Washington University), a close collaborator of **ICREA Prof. at ICFO Turgut Durduran**, presented his work on high-density diffuse optical tomography to study language processing through wearable systems capable of full-head coverage. His group also used brain activity data from movie-viewing experiments to decode visual and auditory stimuli, distinguishing between responses to social agents, objects and natural organisms, and textural scenes.

Light-based techniques for retinal diseases research

The final section focused on retinal research. **Dr. Montse Sole** (Institute of Neuroscience, Autonomous University of Barcelona) discussed the potential of FAIM-L -a neuronal variant of the FAIM protein- as a novel therapeutic target for neurodegeneration. Her team noticed that FAIM-L loss is linked to Alzheimer's and Tau pathologies and hypothesized that this might

promote neurodegeneration. Experiments showed FAIM deficiency does not trigger brain degeneration, but it does in the retina, suggesting new therapeutic pathways.
Dr. Zohreh Hosseinzadeh (Radboud University Medical Center) followed with advances in creating functional retinal organoids and retinal implants for vision recovery. She discussed clinical trials where a chip was implanted at the back of the eye and subjects successfully performed several visual tasks. Dr. Hosseinzadeh also explained the VISION project, which aims to combat blindness by creating retinal organoids from stem cells, showing that these engineered organoids exhibit real retinal activity and hold great potential for scalable vision restoration therapies.

A fruitful ongoing collaboration

Overall, the 4th BMPN edition showed the importance of the interconnection between photonics and medical research, highlighting and placing a special interest in how optical tools can be harnessed for monitoring and unfolding hidden features of brain activity. Ariadna Martinez, ICFO Light for Health program coordinator, concludes: i¿½After three successful editions at our partner institutions across Barcelona, we have been delighted to welcome collaborators, colleagues, and friends to our own premises for this fourth annual gathering of the BMPN.i¿½ And she adds: i¿½Technology should not be seen as a service we call upon when we need a tool, but as a co-designer. None of us can imagine what we don't know, and this is why communication and collaboration are so important. When clinicians understand what light can do inside the brain, and when technologists understand what a patient truly needs, then we start designing solutions that neither group could have imagined alone.i¿½