

**ITU KALEIDOSCOPE**  
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# EXPLORATION OF NON-INTRUSIVE OPTICAL INTERVENTION THERAPY BASED ON THE INDOOR SMART LIGHTING FACILITY

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# Nature Light is important for life on the earth

- Photosynthesis
- Maintenance of temperature
- Maintains Body clock
- Energy for bio-molecules synthesis
- Circadian rhythm
  - the biological clock is a functional system consisting of photoreceptor neurons

## Artificial light(Incandescent lamp) contribute to human being

- The artificial light source is perhaps one of the most important inventions for human beings
- Incandescent lamp
- Fluorescent lamp (low pressure gas discharge lamp)
- LED technology
- Higher efficiency
  - Electricity usage for lighting reduced to 4%
- More time
  - People spending indoor time of 87%

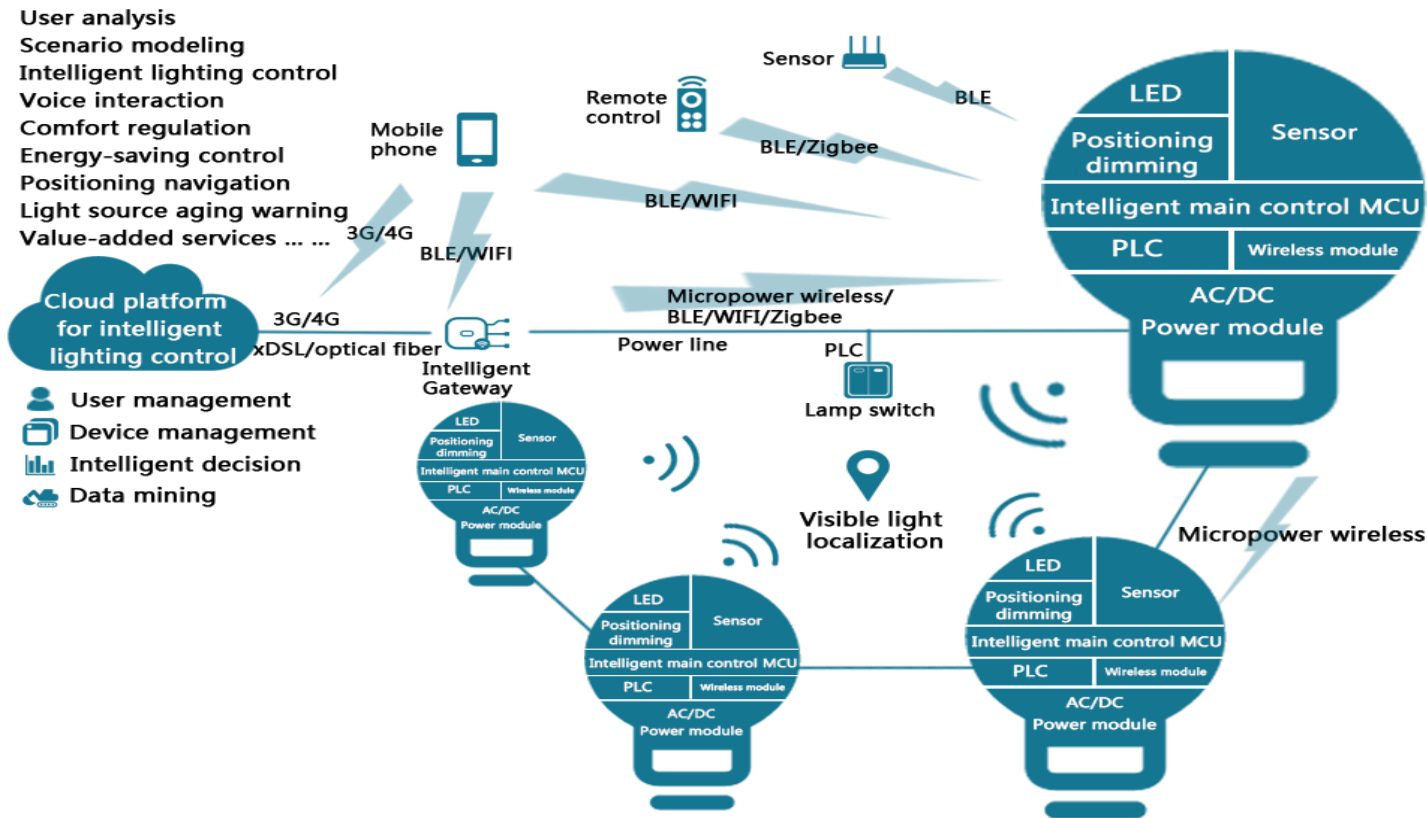
## The strategic roadmap from 2015 to 2025 of the European Lighting Association



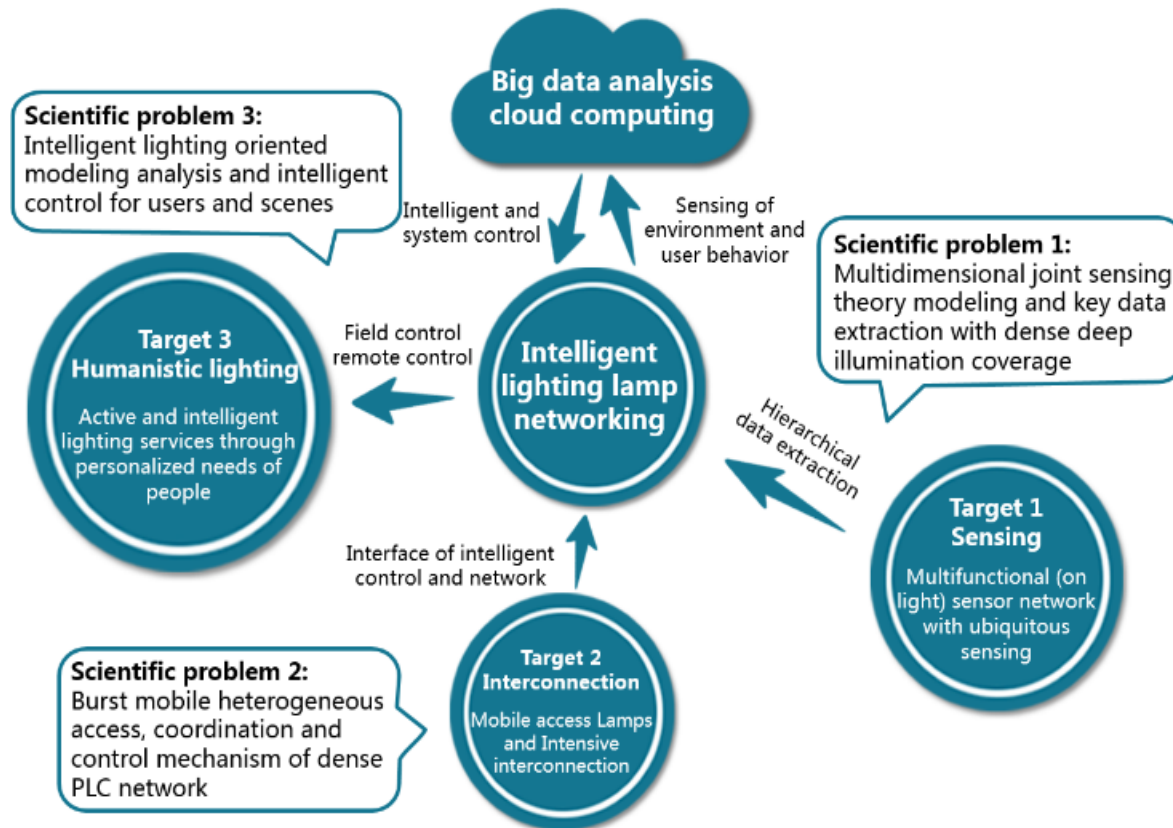
# 87%time indoor, What LED (modulated) light can do other than illumination

- Network
  - LED (modulated) light make network for not only energy but also information
  - Narrow band position system
  - Broad band transmission system
- Health care
  - Light can reduce amyloid- $\beta$  ( $A\beta$ ): biomarker of Alzheimer's Disease(AD)
  - LED light with different color temperatures may relieve depression and epilepsy
  - non-intrusive treatment

## The illustration on smart lighting system



## Schematic diagram of IoL with the focus on main technical challenges and research objectives



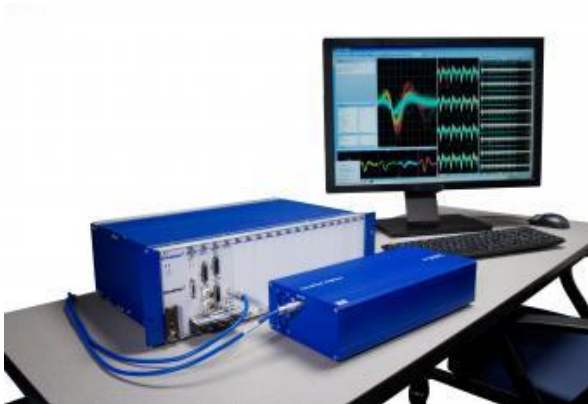
- The Nobel Prize in Physiology or Medicine 2017 was awarded to Jeffrey C. Hall, Michael Rosbash and Michael W. Young for their discoveries of molecular mechanisms controlling the circadian rhythm
- “Gamma frequency entrainment attenuates amyloid load and modifies microglia” , Nature 540:230–235, December 8, 2016
- Edward S.Boyden, “Noninvasive Deep Brain Stimulation via Temporally Interfering Electric Fields”, Cell 169, 1029–1041, June 1, 2017
- World Health Organization, Mental health of older adults. December 2017
- Cui Zhe, Hao Luoxi, Xu Junli, “A Study on the Emotional and Visual Influence of the CICU Luminous Environment on Patients and Nurses”, Journal of Asian Architecture and Building Engineering, 2017

## Motivation of the experiment

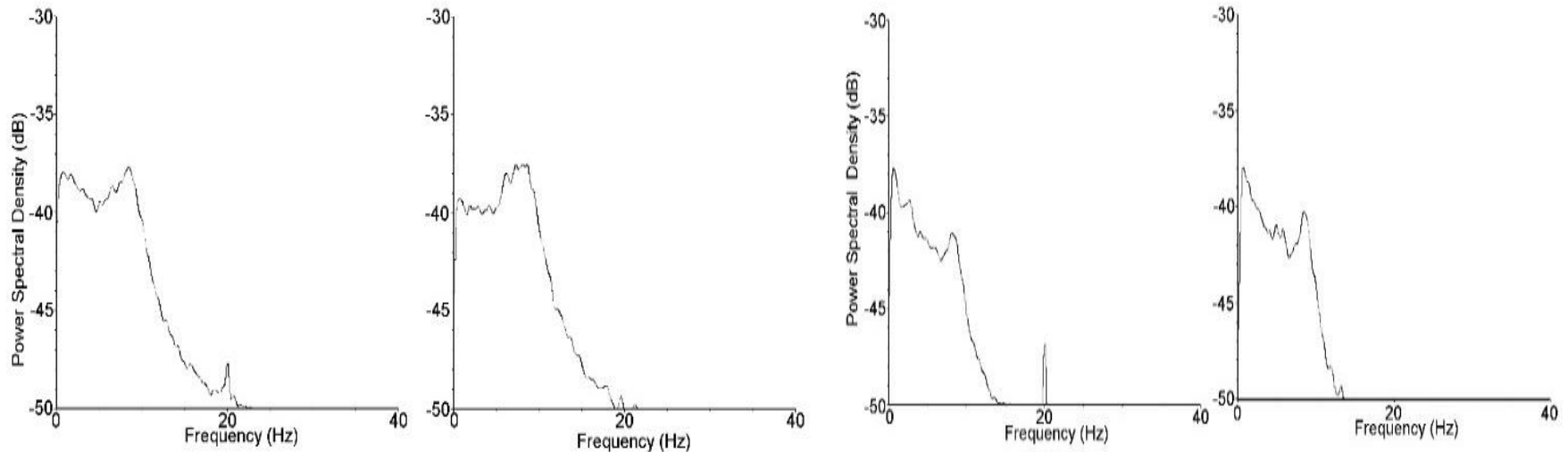
- Existing work has shown that light affects biological rhythms, neurons, brain and other aspects of organism
- The biological mechanism of these effects is not clear now
- It will take a long time to explain biological mechanism
- We hope to study the possibility of quantitative control effects through an experiment
- Core of the experiment is modulated LED lights
- Neural signal acquisition devices

## Experiment method and set up

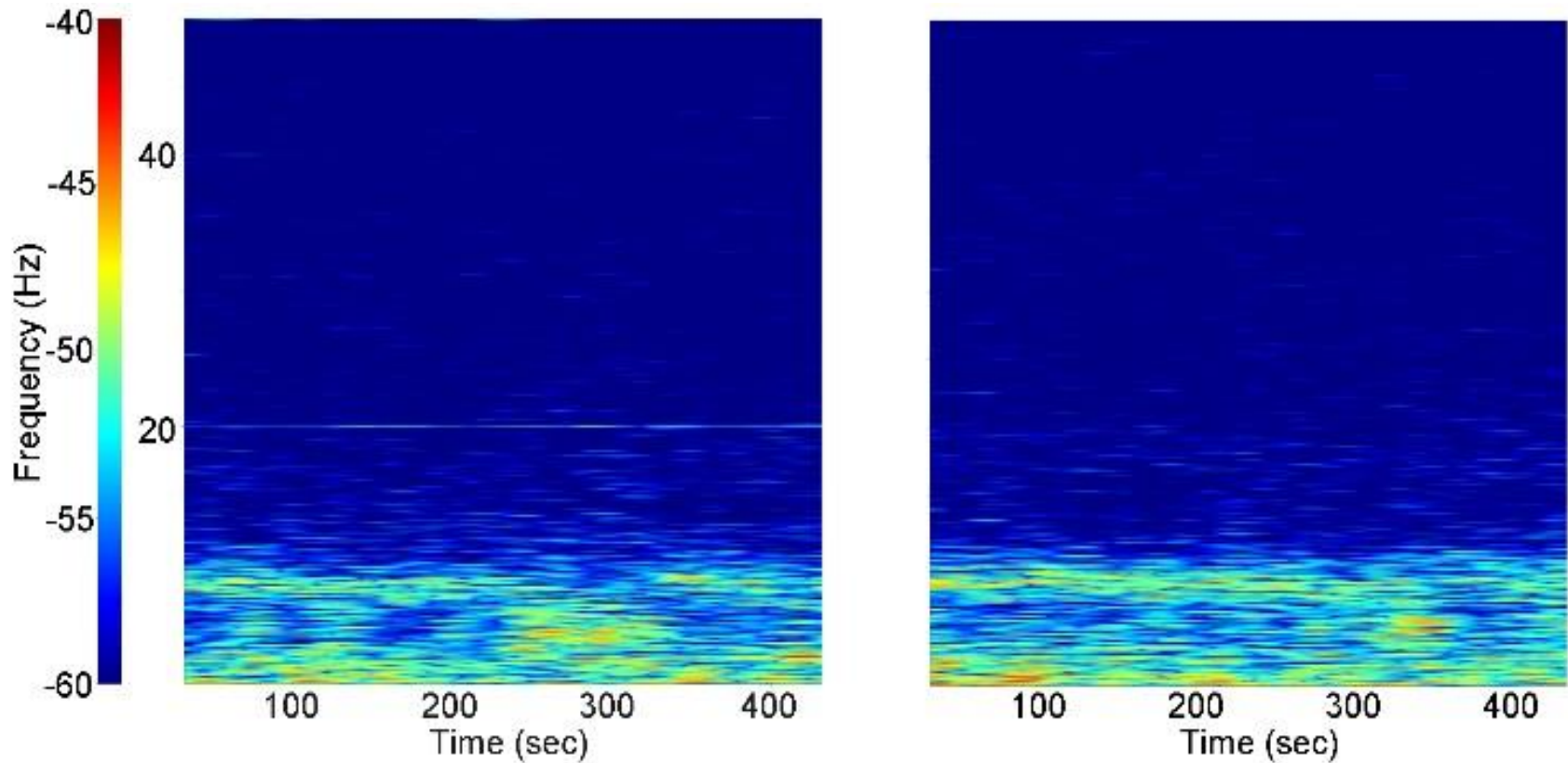
- 40 Hz scintillation frequency LED
- Multichannel in-vivo recording
- local field potential (LFP) signal
- Certain brain region (hippocampus):Memory



## Modulated Light influents the neuron firing (1/2)



## Modulated Light influents the neuron firing (2/2)



- Now
  - Experiments shows the firing of neurons in mouse brain can be controlled by the modulated visible light
  - Preliminary result shows that LED can control brain wave in different frequency range
- Future
  - Tune the different brain wave frequency to control the state of brain
  - Whether different modulation method will have different effect or efficacy

## Brain wave in different frequency



GAMMA:  
Active Thought



BETA:  
Alert, Working



ALPHA:  
Relaxed, Reflective



THETA:  
Drowsy, Meditative



DELTA:  
Sleepy, Dreaming

**If we can tune the brain wave  
with LED, we might control the  
state of the brain**

## An interesting project from Laura D. Lewis

- During human non-rapid eye movement (NREM) sleep, the electroencephalogram (EEG) exhibits low-frequency ( $<4$  Hz) oscillatory dynamics that support memory and neural computation
- **Laura D. Lewis** demonstrate that the sleeping brain exhibits waves of CSF flow on a macroscopic scale, and these CSF dynamics are interlinked with neural and hemodynamic rhythms
- If modulated visible light can produce neurons oscillatory, there is hope that controlling cerebrospinal fluid (CSF) could make it possible to clean the harmful substances in the human brain

## Co-authors



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Thank you