LKCMedicine PhD Research Project Submission Form

**Research Theme** (Please indicate as appropriate)

☐ Dermatology & Skin Biology  ☐ Family Medicine & Primary Care
☐ Health Systems & Population Health  ☐ Infection & Immunity
☐ Metabolic Disorders  ☒ Neuroscience & Mental Health
☐ Medical Education  ☐ Others (Please specify):

**Research Project Title:**

Cognitive Enhancement with Non-invasive Deep Brain Stimulation

**Project Description:**

Cognition is a core feature of the brain function, which makes it possible to solve problems through insight or bring innovation to the society. However, whether such an ability can be enhanced is a matter of debate, and the mechanistic underpinnings of cognitive enhancement are poorly understood. Here we combine a novel non-invasive brain stimulation method developed by Grossman et al. (2017) with our behavioural methods in mice to study whether we can enhance their cognitive abilities. Moreover, we will adapt a new 2-photon microscopy to probe the activity of tens of thousands of neurons from the mouse cortex while the mouse is engaged in a behavioural task, and investigate how the deep brain stimulation transforms patterns of neural activity. Furthermore, by developing novel brain-wide neural connectivity mapping strategies, we will attempt to understand anatomic changes accompanied by behavioural and functional changes mediated by the deep brain stimulation. Such a holistic approach to understand the neural circuit and enhance cognitive abilities would provide a basic framework for further understandings of neurological disorders such as age-related cognitive impairments, which are an emergent issue and urgent action is required for their prevention and reversal.

**Brief summary of main Methodologies and/or Techniques to be learned during the proposed PhD (experimental or analytical):**

The PhD student will learn a new technology of deep brain stimulation at Grossman laboratory at Imperial College London and combine it with various neuroscience tools at Makino laboratory at Nanyang Technological University.

**Keywords:** Non-invasive deep brain stimulation, behaviour, 2-photon calcium imaging, virus-mediated circuit mapping
### Supervisor(s)

**Primary Supervisor**

<table>
<thead>
<tr>
<th>Name of Supervisor:</th>
<th>Hiroshi Makino</th>
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<tbody>
<tr>
<td>Designation:</td>
<td>Assistant Professor</td>
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<td>Email:</td>
<td><a href="mailto:hmakino@ntu.edu.sg">hmakino@ntu.edu.sg</a></td>
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**Co-Supervisor (need not be determined at this time)**

<table>
<thead>
<tr>
<th>Name of Supervisor:</th>
<th>Nir Grossman</th>
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<tr>
<td>Designation:</td>
<td>Lecturer</td>
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<tr>
<td>Email:</td>
<td><a href="mailto:nirg@imperial.ac.uk">nirg@imperial.ac.uk</a></td>
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### Main Location of Research Work (Please indicate as appropriate)

- [ ] LKCMedicine Experimental Medicine Building @ Yunnan Campus
- [x] LKCMedicine Clinical Sciences Building @ Novena Campus

**Others (Please specify):** Imperial College London

### Other Information

1. Does the proposal need IRB’s approval?  
   - [ ] Yes  
   - [x] No

2. Does the project involve contact with patients?  
   - [ ] Yes  
   - [x] No

3. Is there a potential for overseas academic exchange as part of this research project?  
   - [x] Yes  
   - [ ] No

   **If “Yes”, please specify:** The PhD student will be mentored by Dr Nir Grossman at Imperial College London as part of the thesis project.