

Challenge 2: Wireless recording of the electrophysiology of cognition in psychiatric disease models

Surgery Questions and Answers

Specification - weight:

Q. How critical is the weight requirement of 3g?

A. Very critical, as this is a UK Home Office guideline.

Q. How much of the weight would be taken by the microdrive?

A. This may vary depending on the particular implant, but assume around 50%.

Q. Are there already microdrives for tetrode placement that are light enough to meet the 3g limit?

A. Yes, and Lilly is looking at lighter solutions

Specification – battery life:

Q. How long do experiments last?

A. Preferably 24hr, we would like to record in sleep periods as well.

Q. How critical is 24hr battery life?

A. 24 hrs would be preferred but 12hr could work.

Specification – channels:

Q. Can you compromise on 16 channels?

A. We would much prefer not to.

Q. Can you compromise on 12 bits per channel?

A. 12 bits is standard and, given the range of voltages we're interested in and the fact that signals may be riding on fairly large transients, anything less than 12 bits might be risky.

Specification – other:

Q. What are the sizes of the electrophysiological signals that need to be recorded?

A. As small as 50uV for action potentials, and as large as $\pm 1000\mu\text{V}$ for some oscillations. Total signal strength can be larger, depending on transients in the recording.

Q. What compromises can be made with the specification?

A. Not on weight, but other parameters could be relaxed if necessary. This must be treated case-by-case - different solutions may require different compromises, but these will have to be weighed against compromises required of other solutions in the final competition.

Q. Can you compromise on 36KHz sampling rate?

A. Yes, but to 20KHz should be considered the minimum

Q. How many microdrives will you need for multisite recording using silicon probes or tetrodes?

A. A microdrive may consist of multiple individual drive unit. Silicon probes need one drive unit each if they target different brain regions. Note that a single silicone probe might feed as few as 4 or as many as all 16 of the recording channels. A 16 channel system of 4 tetrodes would need 4 drives.

Q. How long does it take to adjust tetrode or silicon probe placing?

A. That depends on the number of drive units to be adjusted. A 64 channel drive carrying 16 tetrodes takes about 2 weeks to position everything. A 16-channel 4-tetrode system or silicone probes would require significantly less, but allow at least 1 week.

Q. Should the sampling be continuous, or can it be action-potential (spike) triggered?

A. We would like to be able to record local field potentials (LFP) as well as action potentials, so some (if not all) of the channels should be sampled continuously. If the solution envisages separate dedicated channels for LFP and spikes, we recommend at least 4 LFP channels in addition to 16 for spikes. The spike channels can be threshold triggered but must be sampled at 20KHz (minimum) as detailed above. LFP channels should be sampled at 6000 Hz in order to estimate the phase of 200Hz ripple oscillations, but rates as low as 1500 Hz are acceptable.

Q. Do we need to record continuously for 24 hours?

A. Ideally yes, but in practice probably not. 16 hours recording is acceptable, allowing a researcher to leave an animal overnight and change the battery/storage the following morning.

We are particularly interested in periods when the animal is actually performing the task. A single trial may last up to 6 minutes and up to 100 trials should be allowable. Therefore the total recording time could be as low as 600 minutes. The maze is equipped with detectors which generate a TTL pulse when the subject enters or leaves the test area of the maze, which could facilitate this type of block-recording.

Q. Are electrode, microdrive and recording/analysis software solutions also required?

A. The solution should ideally interface with existing microdrives and allow streams of data to be written to a hard-drive. Offline analysis will make use of existing solutions. Software is only required insofar as it is essential for initial acquisition of the analog signals from the connectors on our microdrives, and storage or transmission of those signals.

Q. What if I believe the specification is impossible to achieve

A. Submit a solution that explains why not, and propose what can be achieved. Then we can discuss the options!

Data analysis:

Q. Is data analysis expected to be entirely automated?

A. Some visual QC will be needed, but we don't consider analysis of the data to be an integral part of the challenge - solutions for this are already in existence.

Data recording:

Q. Are the 8 event inputs positional or are there other possibilities?

A. Yes, they generated by an infrared beam. They may also indicate food retrieval, the beginning of a trial, etc.

Q. Are 8 event inputs enough? Would you want to scale up in the future?

A. We should consider this option, provided it doesn't interfere compromise other aspects of the recording.

Q. What kind of positional data will be recorded – video as well as beam crossings?

A. Yes, ideally. Synchronization of those signals with electrophysiology may be considered an aspect of the challenge.

Q. Are you interested in measuring time spent in different parts of the maze?

A. Yes, which can be done from the beam crossing data.

Software:

Q. How far would you like to see software development taken?

A. Focus on the essentials and keep it simple e.g. no need for fully integrated video recording with beam cross and electrophysiological data.

Q. Do you need development of data management systems?

A. No, this is already well developed.

Validation:

Q. Where will animal work be carried out?

A. This can be at Lilly or one of the mazes could be situated at another centre.

Q. Is there a validation test set for the proposed solution?

A. We have significant amounts of data collected from tethered animals which can be used to compare with the new system. We will investigate the possibility of producing an analog test signal which could be used for validation.

Q. Could this project be run with an initial feasibility study?

A. Yes.

Cost:

Q. Is there a cost limit for a system that delivers the specification?

A. For this particular maze design, current tethered systems are not useable, but may range from £20,000-£50,000. A better comparison would be existing telemetry systems (e.g. Triangle Biosystems) which come close but do not offer the recording times we require.

Information about study design:

Q. Are the animals food deprived?

A. Not prior to the experiment, but for the duration of the recording, their only food source is the maze.

Q. Would you like a solution that could be applied to other behavioural paradigms?

A. Yes if possible