CTU
CZECH TECHNICAL UNIVERSITY IN PRAGUE

THESIS REVIEWER'S REPORT

I. IDENTIFICATION DATA

Thesis title:	Comparison of methods for calculating coherence and cross-frequency coupling of brain oscillations in animal models
Author's name:	**Jakub Benetin**
Type of thesis :	bachelor
Faculty/Institute:	Faculty of Electrical Engineering (FEE)
Department:	Department of Circuit Theory
Thesis reviewer:	Susan Leemburg
Reviewer's department:	Medical Faculty in Pilsen, Charles University

II. EVALUATION OF INDIVIDUAL CRITERIA

Assignment — **challenging**

How demanding was the assigned project?

The thesis covers a range of computational approaches, and includes both simulation- and in vivo analyses. This is an extensive range for a bachelor's project.

Fulfilment of assignment — **fulfilled**

How well does the thesis fulfil the assigned task? Have the primary goals been achieved? Which assigned tasks have been incompletely covered, and which parts of the thesis are overextended? Justify your answer.

The work explores methods of analyzing phase-amplitude coupling in neural signals using a number of simulations, with special focus on the role of different signal-to-noise-ratios. After deciding that Mean Vector Length Modulation Index and Phase-Locking Value Modulation Index yielded better results than wavelet coherence, the former two methods were applied to real mouse LFP signals under baseline conditions and after increased activation of PV-interneurons. This work matches the goals set out for this thesis and thus fulfills the task set out.

Methodology — **correct**

Comment on the correctness of the approach and/or the solution methods.

I appreciate the detailed comparison and validation of methods on simulated signals, followed by application to real LFP signals. I think this is a very nice approach to validate and select an analysis strategy.
However, in figure 3.11 and 3.12 individual statistical tests and effect size statistics are used to compare changes in PAC within each mouse before and after C21 injection. This is an incorrect approach. I think that the decision not to group/average the small number of mice is fine, but the statistical testing should be skipped on the resulting N=1. A within-mouse effect size measure may seem robust, but in this case a statement like "value was increased by X" is more correct.

Technical level — **A - excellent.**

Is the thesis technically sound? How well did the student employ expertise in the field of his/her field of study? Does the student explain clearly what he/she has done?

The work is overall clearly explained. The student explains clearly why and how next step was performed and how it connected to the previous one. In some cases, I would have preferred slightly more extensive figure captions, or reference to specific panels within multi-panel figures when a specific comparison is made in the text. However, the consistent layout of figures within the thesis makes this only a very minor issue.

Formal and language level, scope of thesis — **A - excellent.**

Are formalisms and notations used properly? Is the thesis organized in a logical way? Is the thesis sufficiently extensive? Is the thesis well-presented? Is the language clear and understandable? Is the English satisfactory?

The thesis is well written in clear and correct English, with a logical structure.

Selection of sources, citation correctness — **A - excellent.**

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Does the thesis make adequate reference to earlier work on the topic? Was the selection of sources adequate? Is the student's original work clearly distinguished from earlier work in the field? Do the bibliographic citations meet the standards?
Previous literature is referenced appropriately. The student has taken great care to distinguish his own work and analysis decisions from earlier work.

Additional commentary and evaluation (optional)
Comment on the overall quality of the thesis, its novelty and its impact on the field, its strengths and weaknesses, the utility of the solution that is presented, the theoretical/formal level, the student's skillfulness, etc.
Please insert your comments here.

III. OVERALL EVALUATION, QUESTIONS FOR THE PRESENTATION AND DEFENSE OF THE THESIS, SUGGESTED GRADE

Summarize your opinion on the thesis and explain your final grading. Pose questions that should be answered during the presentation and defense of the student's work.

The thesis "Comparison of methods for calculating coherence and cross-frequency coupling of brain oscillations in animal models" gives a quite extensive comparison of methods to estimate cross-frequency modulation in neural signals. I particularly enjoyed how the choice of method for analyzing in vivo signals was justified by doing a series of simulations as 'ground work'. This is a very nice approach.

The thesis is clearly written and contains quality figures that illustrate the analyses and reasoning within.

I have two questions about the work:

Firstly a technical point: A shuffled LFP signal was used as noise in the simulation analyses. Is there are reason why this was chosen over, for example, adding white noise to the simulated signals?

Secondly: The first part of the thesis focuses heavily on the effects that signal-to-noise ratio had on detection of phase-amplitude modulation. Noise is always a possible problem for in vivo LFP recordings, but I wonder if there was a specific reason to focus on SNR before deciding on the method. Was there perhaps a reason to expect that C21 would lead to noisier LFPs, or relatively less phase modulation? Or was the decision simply based on the best time-frequency trade-offs under a series of theoretical noise levels?

The grade that I award for the thesis is **A - excellent.**

Date: **30.5.2024**

Signature: