

**CZECH TECHNICAL UNIVERSITY IN PRAGUE****Faculty of Biomedical Engineering****Supervisor's evaluation of Doctoral thesis: Magnetic field imaging in biological systems with nanometric resolution, Ing. Josef Souček, Kladno 2024**

The thesis of Ing. **Josef Souček** deals with a hot topic of developing nanoscale quantum sensors by studying nitrogen-vacancy (NV) centers in diamonds, their photodynamics and the effects of the environment with a promising avenues for the creation of sensitive advanced chipsets, pivotal for quantum measurements and diagnostic applications in nanomedicine. The central idea of the thesis combines quantum state readout of a NV diamond device reacting on changes in its close biomolecular environment with an electrochemical device. The work has been executed in the framework of cooperation between the FMBE CTU and the University Hasselt University in Belgium (UHasselt). The thesis assembles high level of multidisciplinary scientific work with a large potential for biomedical applications.

Initially, Josef studied the fundamental physics governing signal generation, exploring the photodynamics of a single NV center and analyzing its spin-contrast properties. Subsequently, he probed the impact of the crystal environment on the photoelectrical signals and quantum efficiency, determining the possible origins of non-standard phenomena such as positive photocurrent detected magnetic resonance (PDMR). We demonstrate the usage of ground-state level anti-crossing (GSLAC) in photoelectrical spin-state readout.

In the second part of his thesis, he focused on the development of a quantum chipset for both single-crystal diamond and ND particles. Two types of quantum chipset prototypes were designed and fabricated, with numerical modelling employed to elucidate microwave field distribution and resonance patterns. For single crystal diamond chipsets, in-depth testing was conducted to mitigate microwave-induced interference, which is critical for detecting low photocurrents from single NV centers. In the final stage of his work, Josef explored the potential for integrating this chipset into a microfluidic chamber. The chipset for the nanodiamond particles was evaluated for its heating properties, which is crucial for keeping neurons alive, using theoretical calculations and experimental measurements. Furthermore, He also performed the in vitro sensing of the magnetic field at the attached nanodiamonds to the neuron cells.

Josef is an enthusiastic and hard-working student and an excellent team worker. Josef presented his results at several international conferences. His work has been executed by Josef fully independently and it is a part of publications which he authored or co-authored or submitted as a first author. His dissertation took up his full time, because he collected a huge amount of independent experimental and theoretical work, including mathematical modelling. He has my full credit for selecting this not trivial topic of quantum sensing. I fully recommend the thesis for defense.

In Prague, March 25, 2024

Mgr. Zdeněk Remeš, PhD.