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#### Review of PhD theses of M. Vacek

I received the Dissertation Thesis of Michael Vacek about 'Single Photon Light Detection and Ranging for Spaceborne Application' for review and rating.

This thesis endeavours on the state-of-the-art improvements in the field of space-born altimetry and transfer using single photon counting approach.

#### Content:

The thesis employs with the application of the single-photon detection for spaceborn laser altimetry as well as spaceborne single photon time transfer. These are very interesting and valuable tools for future planetary science missions because they could help to reduce the resource – in respect to mass, power and volume for future missions for exploration of our solar system.

The authors did review single photon space-born applications and analyzed their issues and limits. He developed a simulator for a single photon altimeter and investigated the performance and its feasibility for an asteroid mission. Furthermore, he developed and tested the performance of a single photon altimeter demonstrator (breadboard) with focus on the Time-to-digit converter (TDC).

He looked carefully into the single photon data processing chain and algorithm. In that context he investigated the application of the Kalman filter to process the photon counting data. He not only provided the theoretical tools but also look to verify the results by simulations by the single-photon (SP) altimeter simulator and by laboratory measurements. He also investigated the possibility to gain slope and roughness measurements by the described methods, where all scenarios were generated by the SP- simulator. Experimental data were obtained by a SP- demonstrator that he has developed.

Additionally, he described at the end of his thesis his optical design of the ELT detector optics.

#### Rating:

The thesis covers a very interesting field of scientific applications for future space missions. Michael Vacek designed and developed the mathematical modeling toolchain for single photon altimetry for scientific space experiments. Furthermore he developed a





SP- laser altimeter simulator for a planetary mission and a demonstrator with a TDC that he has tested.

Michael Vacek also developed a novel single photon algorithm that is applicable for autonomous navigation systems that require low resources in respect to hardware and computation power. The algorithm may also be applied as signal to photon discriminator in one way ranging scenarios.

Mr. Michael Vacek has clearly demonstrated that he is capable to solve complex scientific tasks. He has adequately documented his work and the results.

I propose to the examination panel to accept his thesis for the defence.

I am rating the thesis 'Single Photon Light Detection and Ranging for Spaceborne Applications'

as: 'very good' (suma cum laude).

Dr. Harald Michaelis

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