

I. IDENTIFICATION DATA

Title of the Thesis:	High Accuracy Local Positioning Network for the Alignment of the Mu2e experiment
Name:	Bc. Jana Bohumila Hejduková
Type of Thesis:	Master Thesis / Diplomová práce
Faculty:	Faculty of Civil Engineering / Fakulta stavební
Assigning Department:	Department of Mathematics / katedra matematiky K101
Reader of the Thesis:	Dipl.-Ing. Markus Schlösser
Institute:	DESY - Deutsches Elektronen-Synchrotron Ein Forschungszentrum der Helmholtz-Gemeinschaft Fachgruppe MEA2 -Vermessung (GeoDESY), Hamburg

II. EVALUATION OF SINGLE CRITERIA

Difficulty of the Assignment of the Thesis	Extraordinary difficult
<i>Here you can insert your comments.</i>	
<p>One major part of the thesis was the planning and efficient measurement of a new network for a particle physics experiment, called Mu2e, at Fermilab (USA). It is necessary to consider the future visibility of network points, while the installation of the experiment and the supporting infrastructure has not yet started. Furthermore it is necessary to get information from the experimental physicists (or from the group leader of the alignment group) about the required alignment accuracy of the different parts of the experiment. Furthermore the data evaluation with existing software packages (mainly GeoPAN) had to be performed, the results had to be validated.</p> <p>For a student without any major experience in this field of work, i would consider this to be „extraordinary difficult“.</p>	

Completion of the Thesis	Fulfilled
<i>Assess whether the thesis fulfils the assignment. If there are any reservations, please comment them. If the thesis exceeds the assignment, please comment it too.</i>	
The assigned tasks have been completely fulfilled.	

Selected solution procedure	Excellent
<p>The pre-planning phase, gathering information and transforming it into the necessary formats, was done in a correct way. The estimation of visibility was done by careful consideration and the use of an extension to an existing software package that is not widely known. This is a good strategy, because the experimental area does have many structural elements like pillars, latches, etc. that have to be taken into account when planning the network.</p> <p>Furthermore the limitations of the existing network adjustment software at Fermilab have to be considered when reviewing the selected solution procedure. GeoPAN does not allow for the adjustment of free networks, nor does it allow for the direct inclusion of levelling data as height differences between points. It also does not give information about network design parameters as proposed by W. BAARDA, that would have been helpful during the design phase of the network. A workaround for these limitations had to be found, which was done in an excellent way, so that the resulting coordinates are very close to the results that would have been obtained with a correct Least Squares Adjustment and free network. This is essential for the ongoing adjustment work of the Mu2e experiment.</p> <p>The evaluation and purchase of other software packages would have been clearly beyond the scope of this Thesis.</p>	

Scientific level	B
<i>Assess the level of expertise of the final thesis, the use of the knowledge gained from the study and the specialized literature, the use of the documents. Also appreciate the student's ability to perceive the problem solved in a broader context and apply the engineering approach to solving.</i>	
Planning, measurement and network adjustment were done in an excellent way. The results are presented in a proper way, however, some graphical representation of the huge amount of data produced during this work could clarify the results; especially network plots with error ellipses would have been very helpful. Some of the conclusions could have been worked out more clearly, like the differences between the used concepts (3D-cartesian vs. ellipsoidal coordinate system).	
Formal and language level, clarity of work	A
<i>Assess the correct use of formal entries contained in the work. Assess the typography and language of the work and its overall comprehensibility.</i>	
The assigned task has been structured and documented in a very good way. The Thesis is structured logically, without flaws. There are some minor errors in spelling and grammar, which are absolutely acceptable for a non-native speaker. I therefore consider this to be grade A.	
Sources, citations, references	A
<i>Explain to the student's activity in acquiring and using study materials to solve the final work. Review the selection of sources. Verify that violation of citation ethics has occurred and whether bibliographic quotes are complete and in accordance with citation practices.</i>	
Citations and references are without error. There are a multitude of sources available for network adjustment. A good selection was made, however some more sources might have improved the scientific level of this work. After considering the available time and the amount of practical and numerical work for this Thesis, I consider this to be (still) on grade A.	
Further comments	

III. TOTAL EVALUATION, QUESTIONNAIRE, DRAFT CLASSIFICATION

Summarize the aspects of the final work that most affected your overall assessment. Please indicate any questions the student should answer in defense of the final thesis before the commission.

The existing concept of planning and measuring precise networks for accelerator alignment has been understood by the candidate. It has been adopted to the actual problem and extended by an automated approach to estimate the visibility of points in a difficult environment, without being on site in person. The network adjustment has been done in a correct way. Considering the limitations of the available software, an approach has been chosen that gives mostly undisturbed results, concerning the functional model. Since the estimated network will be used for the alignment of the Mu2e experiment in the near future, this is essential.

Taking into account the amount of practical work and data analysis involved in this Thesis, the available time was very short.

I would give the candidate the following questions:

1. Could you please clarify, why "Using of a pure 3D Cartesian system for larger reference networks is not recommended" (Conclusions of Thesis)?
2. Could you please explain the differences between the two approaches (3D-cartesian vs. ellipsoidal coordinate system) in terms of theoretically required corrections for laser tracker and levelling data.

I evaluate the submitted final thesis by the classification degree:

A

Date: Hamburg (Germany), 19.06.2017

Signature: Markus Schlösser