
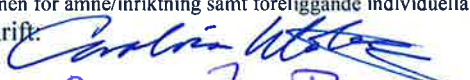




# INDIVIDUELL STUDIEPLAN FÖR UTBILDNING PÅ FORSKARNIVÅ

Blå ifyllningsfält vid upprättande. Vid revision berörs såväl blå som svarta ifyllningsfält. Obs att sidorna ska signeras.  
Notes refer to explanations in English

<b>Ämne och inriktning</b> <sup>1</sup> . Computerized Image Processing		<b>Nyantagning</b> <sup>2</sup> <input type="checkbox"/> Revidering år: <b>2015</b>
<b>Forskarstuderande</b> Namn <sup>3</sup> : <b>Omer Ishaq</b> Personnummer <sup>4</sup> : <b>791209-1233</b>		
Behörighetsgivande grundutbildning (benämning, omfattning, utbildningsort, datum) <sup>5</sup> : B.Sc. (Computer Systems Engineering) at the Ghulam Ishaq Khan Institute of Engineering and Technology (GIKI), Pakistan, 1998-2002 M.Sc. (Computing Sciences) at the Simon Fraser University (SFU), Canada, 2005 - 2008 Lecturer at Air University (AU), Pakistan, 2008 - 2011		
Utbildningen ges inom forskarskolan (anges i tillämpliga fall) <sup>6</sup> :		
<b>Nyantagning:</b> Jag har tagit del av bestämmelserna för utbildning på forskarnivå vid teknisk-naturvetenskapliga fakulteten, inklusive den allmänna studieplanen, samt vad som gäller enligt studieplanen för rubricerade forskarutbildningsämne/inriktning. Jag avser att följa de riktlinjer för min forskarutbildning som anges i denna individuella studieplan och är medveten om att planen årligen kommer att revideras. <sup>7</sup>		
<b>Revisioner:</b> De prestationer som redovisas och de planer som anges för resten av studietiden är uppställda i samförstånd med huvudhandledaren och biträdande handledare.		
Datum (date): 2015/03/20		Underskrift (signature): 
<b>Handledare</b> <sup>8</sup> Minst två handledare skall utses. För mer information om vad som krävs för att få utses till handledare, se handbokens avsnitt om antagning. Jag har tagit del av bestämmelserna för utbildning på forskarnivå vid teknisk-naturvetenskapliga fakulteten, inklusive den allmänna studieplanen, samt vad som gäller enligt studieplanen för rubricerade forskarutbildningsämne/inriktning. Vi åtar oss att bedriva handledning för genomförandet av utbildningen i enlighet med innehållet i fakultetens allmänna studieplan, studieplanen för ämne/inriktning samt föreliggande individuella plan.		
Datum: 2015/03/20	Huvudhandledare: Carolina Wahlby	Underskrift: 
Datum: 2015/03/20	Bitr. handledare: Vladimir Curic	Underskrift: 
Datum:	Bitr. handledare:	Underskrift:
<b>Förändringar vad avser handledarskap</b> <sup>9</sup> Professor Ewert Bengtssons is retiring this year, and therefore we have decided to include Vladimir Curic to replace him on the supervision committee for the rest of the Ph.D. study duration.		
<b>Väsentliga förändringar i förhållande till tidigare plan</b> <sup>10</sup> <input type="checkbox"/> Makera rutan om det skett väsentliga förändringar avseende huvudhandledare eller annat som påverkar forskarutbildningens uppläggning och/eller disputationdatum. <i>Specifera på sista sidan.</i> I de fall väsentliga ändringar i förhållande till tidigare upprättad plan gjorts, dvs rutan har markerats, fordras prefektens fastställande av den reviderade studieplanen.		
<b>Forskarutbildningsansvarig professor</b> <sup>11</sup> Jag godkänner föreliggande studieplan för utbildning på forskarnivå inom angivet forskarutbildningsämne och inriktning. Datum: 2015/03/20 Namn: Carolina Wahlby Underskrift: 		
<b>Prefekt</b> <sup>12</sup> Institution: <input type="checkbox"/> <b>nyantagning:</b> Undertecknad prefekt fastställer å fakultetsnämndens vägnar utbildningens uppläggning och gör bedömningen att studiestöd kan påräknas i enlighet med högskoleförordningens föreskrifter under förutsättning att studierna sköts. Institutionen tillhandahåller resurser för utbildningens genomförande vad avser arbetsvillkor, forskningsmiljö, utrustning och tillgång till handledning. <input type="checkbox"/> <b>väsentliga förändringar:</b> Undertecknad prefekt fastställer den reviderade studieplanen med bedömning och utfästelser enligt ovan.		
Datum:	Namn:	Underskrift:
<b>Planerad tidpunkt för studieplansrevision, lic-examen och disputation</b>		
Planeras lic-examen som delmål? <sup>13</sup> <input type="checkbox"/> Ja <input checked="" type="checkbox"/> Nej		Om ja, ange planerad tidpunkt:
Planerad tidpunkt för disputation <sup>14</sup> : 2016/04/01	Revision av denna plan senast <sup>15</sup> : 2015/09/15	



**Preliminär avhandlingstitel**<sup>16</sup>: Digital Image Processing with Applications in Quantitative Microscopy**Finansieringsplan för utbildningsperioden**<sup>17</sup>

Planeringen skall anges översiktligt för hela utbildningen men preciseras för det första året. Uppdateras vid revidering (på ny rad).

Typ av studiestöd/anställning:

☒ Doktorandanställning

☐ Utbildningsbidrag år 1, följt av doktorandanställning

☐ Annat

Period

2012/02/20-2016/04/01

Finansiering från:

SciLife Uppsala/VR

Vid "Annat", specificera vad, ev med särskilda bilagor:

**Övrig planering**

Planerad omfattning och karaktär av undervisning och institutionsarbete mm under kommande året (uppdateras vid revidering)<sup>18</sup>:

None.

Planerade tjänstledigheter, ed. under kommande året (uppdateras vid revidering).<sup>19</sup>:

**Faktisk tidsfördelning**<sup>20</sup> (anges vid revidering)

Med studietid avses nettotid för forskarutbildning ((forskning och FU-kurser); dvs undervisning, föräldraledighet etc ska *inte* inräknas.

Antagningsdatum<sup>21</sup>: 2012-02-20

Period (datum from-tom)	Studietid (mån eller %)	Undervisning, inst.tjänstgöring (mån eller %)	Övrigt, ange vad	Övrigt, omfattning (mån eller %)
2012-02-20-2012-09-11	100% ~6 months			
2012-09-12-2012-12-31	96% ~3.34 months	4 % teaching ~0.16 months		
2013-01-01-2013-06-30	100% ~6.0 months			
2013-07-1-2013-09-12	73% ~1.8 months		27% parental leave ~0.7 months (3 weeks)	
2013-09-12-2013-12-31	94% ~3.26 months	6% teaching ~0.24 months		
2014-01-01-2014-03-30	100% ~3.0 months			
2014-04-01-2014-08-31	100% ~5.0 months			
2014-09-01-2014-03-20	100% ~6.66 months			
	Total: ~35 months			

**Utbildningens framåtskridande**<sup>22</sup>

Totalt genomförd nettostudietid (mån).<sup>23</sup>: 35 per den 2015-03-20

50 % av fordringarna för doktorsexamen uppnådda / beräknas nås den: 2014/04/01

80 % av fordringarna för doktorsexamen uppnådda / beräknas nås den: 2015/06/01

Normalt skall 50% vara uppnått efter 24 och 80% efter 38 månaders nettostudietid. Om doktoranden inte bedöms ha uppnått 50 % eller 80 % av fordringarna vid dessa tidpunkter bör institutionen utreda orsakerna och vidta åtgärder. Maximal nettostudietid: 48 månader.

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### Översiktlig målbeskrivning för studierna.

Enligt högskoleförordningen är målen för utbildning på forskarnivå att doktoranden uppnår mål vad gäller "kunskap och förståelse", "färdighet och förmåga" samt "värderingsförmåga och förhållningssätt".

**Ange, så konkret som möjligt (ev med hjälp av bilaga)<sup>24</sup>**

#### a) Individuella kunskaps- och färdighetsmål. Hur målen ska nås anges under "kurser mm"<sup>25</sup>

1. A better understanding of the image acquisition techniques and modalities used in the quantitative microscopy, including general familiarity with the different types of acquisition modalities.
2. Familiarity with domain specific knowledge such as overview of drug development and microbiology.
3. Thorough exposure to the state of the art image analysis algorithms.
4. Review of seminal and modern research papers in the field including, but not limited to, monthly paper discussion seminars.
5. A better understanding of supplementary subjects such as engineering optimization, applied mathematics, research methodologies and visualizing and presenting research.
6. Attend weekly research meetings, including meetings targeting specific research topics.
7. Act as a reviewer/sub-reviewer for conference manuscripts.

#### b) Vetenskapliga mål (projekt mål). Mer detaljer samt hur målen ska nås anges i "beskrivning av forskningsområde" samt i "individuell forskningsplan"<sup>26</sup>

1. Development of research tools and scripts.
2. Writing research papers detailing the research outcomes and attending conferences and seminars.
3. Investigation and evaluation of localization methods in microscopy, including compressed sensing, super-resolution microscopy, and biomedical data with high levels of noise.
4. Evaluation of morphological changes in zebrafish.
5. Development and evaluation of machine learning pipelines for detection and classification of fluorescent markers in microscopy. Eventually, the classified fluorophores may be used for object tracking applications.
6. Quantitative measurement of different characteristics (e.g., area, percentage overlap etc.) of fluorescent signals.

#### c) Andra individuella mål. Mer detaljer hur målen ska nås anges under "övrig planering"<sup>27</sup>

1. Took a course in biology/microbiology to develop a better understanding of the application domain.

### Kort beskrivning av forskningsområde och vetenskapliga frågeställningar<sup>28</sup>

Här anges bla. om delprojektet ingår i ett större projekt och i så fall specifikt vilken del doktoranden skall bidra till. Specificera, i förekommande fall, särskilda utfästelser från institutionens sida t.ex. vad gäller tillgång till specifik utrustning ed.

Field of Research:

Computerized Quantitative Microscopy

Project Overview:

This PhD position is part of an interdisciplinary research collaboration between the Science for Life Laboratory and the research program in Image Analysis and Man-machine Interaction at the Centre for Image Analysis, Department for Information Technology, Uppsala University. The focus will be on quantitative microscopy and computerized image analysis with applications in bioscience.

Scientific Aims of the Project:

At present, the student is involved in a few projects focused on the development of methods for quantitative image analysis with focus on computational super resolution microscopy. In particular we are working on methods for classifying and localizing fluorescent signals from real data from both short and long exposure timings. In addition, we are focusing on development of tools for assisting in the ground truth specification of fluorescent signals from real images. We are exploring deep learning convolutional networks for better detection of these fluorescent signals. We are planning to compare methods trained on manually annotated data with those trained on synthetic data and evaluate the potential of using deep learning for this type of applications. Previously we have worked on quantitative evaluation of novel fluorescent biomarkers as well as the evaluation of morphological changes in whole organisms. We are planning to extend the deep

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learning to exploring its usability for analysis of cultured cells and cells in tissue, where image background is structured rather than random.

Competence of the supervisors:

All supervisors are active quantitative image analysis researchers and cognizant of the research problems and potential research directions in the field/topic.

#### **Individuell forskningsplan<sup>29</sup>**

En sammanfattande preliminär plan, översiktligt för hela utbildningen och mer preciserad för det första året (ev som särskild bilaga). Ange även ev planerade vistelser vid andra akademiska eller icke-akademiska institutioner (plats, tidpunkt, vistelsens längd).<sup>30</sup>

En detaljerad planering för första året görs under den första studietiden.

Planeringen uppdateras vid revidering, använd fältet nedan.

Initially, the research focused on the automatic, accurate and robust measurement of the deformation/curvature of the zebra fish tail. The results of this work were published at the International Symposium on Biomedical Imaging (ISBI) in 2013. In addition the results were also discussed at relevant local conferences/seminars such as the SSBA symposiums, SciLifeLab day and the BioImage Informatics conference.

Following this initial study of fish morphology in relation to drug treatment in 2D images from multi-well plates we looked in to 3D aspects of similar analysis. For this purpose we developed a hardware platform/stage and some software tools for optical projection imaging and the subsequent reconstruction in 3D.

In 2013, we have focused on methods for point source detection and signal detection, particularly in super resolution microscopy using compressive sensing, where the goal is to develop a fast method using greedy optimizers which have results similar to the ones obtained from more traditional convex methods. Results of this approach were disseminated as an oral presentation at the 22<sup>nd</sup> International Conference on Pattern Recognition (ICPR). In addition, during late 2013 and 2014 we worked on developing methods for quantification of different visual characteristics (percentage overlap, area, intensity and signal to noise ratio) of rolling circle amplification (RCA) products/signals in microscopy images. A manuscript with results has been submitted for journal publication.

In the second half of 2014, we focused on methods for reliable detection of point light sources in other types of microscopy images. In particular, we focused on development of tools for assisting human observers in the annotation of a ground truth datasets for fluorescent signals that can subsequently be used for training machine learning methods for signal identification. A manuscript detailing the developed tool has been submitted for publication at a journal.

In early 2015, we intend to combine our tools for manual annotation (and the resultant annotated data) with deep learning approaches for evaluating the potential of machine learning based solutions for signal detection and classification. In particular, it would be interesting to see if a multi feature/metric machine learning approach outperforms the traditional single-metric thresholding based methods. In the latter half of 2015, we will employ the proposed detection approach also for other types of fluorescent signals.

Spring/summer 2015:

- \* Implement deep learning, create larger manually annotated dataset, compare with synthetic data and different approaches for avoiding over-fitting and explore generated filters. Prepare manuscript.
- \* Literature study with focus on aspects of the thesis (which will also be part of the thesis 'kappa', for example methods for signal detection (2.5p) and deep learning (2.5p)).
- \* Study previous theses from CBA to get a picture of content and layout.
- \* Prepare for pre-dissertation seminar early September 2015; by this date we plan to have a clear picture of the content of the thesis (complete table of contents, with subheadings) and a general outline for remaining papers. We will also decide on an external committee member to invite for this pre-examination seminar.

We intend to produce one more conference (ISBI or ICPR, deadline 20151220) or journal manuscript on the continued work during the fall of 2015.

Early part of 2016 will be spent in exploring promising spinoff approaches of our above-mentioned experiments and writing of the Ph.D. thesis:



**Utvärdering:** Uppföljning av föregående planer samt forskningsplanering med betoning på det kommande året (ev som särskild bilaga)<sup>31</sup>

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1. We have developed an algorithm for automatic and accurate identification of the zebra fish tail and the measurement of its deformation/curvature, the results have been presented at the International Symposium on Biomedical Imaging (ISBI) 2013.
2. Moreover, we have developed a lego-based prototypical low cost 3D microscopic image acquisition robot based on optical projection tomography and software tools for performing image alignment.
3. We have developed method for quantifying the compactness, brightness and signal overlap for different types of florescent signals. The results have been submitted for journal publication to Nature Scientific Reports in early 2015.
4. We have evaluated the use of greedy optimizers for compressed sensing based super resolution microscopy methods at high fluorophore density and noise and analyzed the effect of estimating the point spread function on signal recovery and presented this work at the International Conference on Pattern Recognition (ICPR) 2014 in the form of an oral presentation.
5. We have developed a tool for assisting human observers in the annotation of a ground truth dataset, a manuscript has been submitted to the Bioinformatics Journal in early 2015.

Avklarade (rapporterade) forskningsarbeten (ev som särskild bilaga)<sup>32</sup>

Uppsatser, konferenser, seminarier etc. Ange uppsatsernas status (manuskript, insänt, accepterat, tryckt).

### Work completed after initiating PhD studies:

#### Conference/seminar posters

- Omer Ishaq, Carolina Wählby, **SpotObserver: accurate visual annotation of fluorescent signals using a two-alternative forced-choice approach.** (Submitted to Bioinformatics Journal).
- Carl-Magnus Clausson, Linda Arngården, Omer Ishaq, Axel Klaesson, Malte Kühnemund, Karin Grannas, Björn Koos, Xiaoyan Qian, Petter Ranefall, Hjalmar Brismar, Carolina Wählby, Ola Söderberg, **Compaction of rolling circle amplification products increases signal integrity and signal-to-noise ratio.** (Submitted to Nature Reports).
- Omer Ishaq, Johan Elf, Carolina Wählby, **An evaluation of the Faster STORM method for super resolution microscopy.** In International Conference on Pattern Recognition (ICPR), August 2014. (Oral Presentation).
- Omer Ishaq, Joseph Negri, Mark-Anthony Bray, Alexandra Pacureanu, Randall T. Peterson and Carolina Wählby. **Automated Quantification of Zebrafish Tail Deformation for High-Throughput Drug Screening.** In International Symposium on Biomedical Imaging, April 2013.
- Omer Ishaq Centre, Joseph Negri, Mark-Anthony Bray, Alexandra Pacureanu, and Carolina Wählby. **Image-based drug screening in Zebrafish.** In SciLife Day, Uppsala, August 23, 2012.
- Omer Ishaq, Joseph Negri, Mark-Anthony Bray, Alexandra Pacureanu, and Carolina Wählby. **Image-based drug screening in Zebrafish.** In BioImage Informatics, September, 2012.
- Omer Ishaq, Joseph Negri, Mark-Anthony Bray, Alexandra Pacureanu, Randall T. Peterson and Carolina Wählby. **Automated Quantification of Zebrafish Tail Deformation for High-Throughput Drug Screening.** Svenska sällskapet för automatiserad bildanalys (SSBA), 2013. (Oral Presentation)
- SciLifeLab Day spring 2013, Poster Presentation.
- Omer Ishaq, **Light Tomography**, BioVis Symposium, 2013. (Invited Talk)

#### Symposiums attended:

- Svenska sällskapet för automatiserad bildanalys (SSBA) symposium, 2012.
- Svenska sällskapet för automatiserad bildanalys (SSBA) symposium, 2014.
- Phenotype based drug discovery, Stockholm, April 2014.
- SciLifeLab Day Spring 2014.
- The versatile zebrafish model system, Uppsala 2014.

### Work completed prior to initiating PhD studies:

#### Journal Articles & Book Chapters

- Darren M. Wells, Andrew P. French, Asad Naeem, Omer Ishaq, Richard Traini, Hussein Hijazi, Malcolm J. Bennett<sup>1</sup> and Tony P. Pridmore. **Recovering the dynamics of root growth and development using novel image acquisition and analysis methods.** Philosophical Transactions of the Royal Society B, 2012.
- Omer Ishaq, Ghassan Hamarneh, Roger Tam, Anthony Traboulsee, and David Li. **Effects of mid sagittal plane selection on corpus callosal area.** Multiple Sclerosis (special supplementary journal issue of all oral presentations in the 22<sup>nd</sup> Congress of the European Committee for Treatment and Research in Multiple Sclerosis (ECTRMS) 2006. Also appeared in ECTRMS 2006), 12(1):S173, 2006.

**Work completed prior to initiating PhD studies:**  
**Conference Articles & Posters**

- Neda Changizi, Ghassan Hamarneh, Omer Ishaq, Aaron Ward, Roger Ward. **Extraction of the Plane of Minimal Cross-Sectional Area of the Corpus Callosum using Template-Driven Segmentation.** In 13th International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI), pages Part III: 17-24, 2010.
- Omer Ishaq, Ghassan Hamarneh, Roger Tam, and Anthony Traboulsee. **Longitudinal, Regional and Deformation-Specific Corpus Callosum Shape Analysis for Multiple Sclerosis.** In IEEE Engineering in Medicine and Biology (IEEE EMBC), pages 2110-2113, 2007.
- Omer Ishaq, Ghassan Hamarneh, Roger Tam, and Anthony Traboulsee. **Effects of Mid Sagittal Plane Perturbation and Image Interpolation on Corpus Callosum Area Calculation.** In IEEE International Symposium on Signal Processing and Information Technology (IEEE ISSPIT), pages 197-202, 2006.
- Omer Ishaq, Ghassan Hamarneh, Roger Tam, Anthony Traboulsee, and David Li. **Effects of mid sagittal plane selection on corpus callosal area.** In 22nd Congress of the European Committee for Treatment and Research in Multiple Sclerosis (ECTRMS) (Also appeared in Multiple Sclerosis Journal 12(1):S173, 2006), pages 616, 2006.
- Ghassan Hamarneh, Aaron Ward, Chris McIntosh, Ben Smith, Lisa Tang, Ahmed Saad, Yonas Weldeselassie, and Omer Ishaq. **Medical Image Analysis.** In TechMed, Vancouver, May 16, 2007.

**Kurser, planerade och avklarade, inklusive sådana som ger pedagogisk meritering, kopplat till kunskaps-och färdighetsmål samt kurskrav för inriktningen<sup>34</sup>**

Planeringen skall anges översiktligt för hela utbildningen men preciseras för det närmaste året

**Obligatoriska kurser:**

Kurs	Termin	Poäng (hp)	Godkänd (datum i UPPDOK)
Forskningsetik (min 2 hp)	VT-13	5	2013-02-25
Pedagogisk grundkurs (för de som ska undervisa på kurser på grund- och avancerad nivå)	planned	7.5	Starting 2015-04-12

**Övriga kurser:**

Kurs	Termin	Poäng (hp)	Godkänd (datum i UPPDOK)
Research methodology for image analysis	Sp-12	4	2012-06-07
Image Processing Using Graphs	Sp-12	5	2012-05-29
Quantitative Microscopy	HT-12	9	2013-01-22
Nonlinear multi-objective optimization	VT-13	5	2013-05-30
Classical and Modern Papers		7.5 approx	
Preparation for Introductory Biology: DNA to Organisms	HT-13	1	2014-04-16
Open-source software	VT-12	1	2013-06-25
Introduction To Biology	HT-14	6	2014-01-09
Applied Mathematics	HT-13	10	2013-10-23
Statistical Machine Learning	HT-14	6	2014-09-19
Super resolution florescence microscopy	HT-14	3	2014-07-14
Visualizing your science	VT-14	4	2014-12-19
Computational Python	HT-15	5	2014-11-14
literature studies (see plan)	HT-15	5	
Autonomous Navigation for Flying Robots (online)	?	6	

**Total: 64 hp Completed (90 Planned)**

Overview: courses in statistics and statistical analysis, future PhD-level courses offered at the Centre for Image Analysis, Swedish and international summer schools on different aspects of digital image processing. Courses related to the application areas, such as courses on optics and microscopy.

**Redovisning och utvärdering av övrig meriterande verksamhet** såsom deltagande (som lärare) i undervisning, annan pedagogisk meritering, avklarade kurser utöver kurskrav för inriktning, handledning av examenarbeten/studiebesök osv. Specificera (ev som särskild bilaga) vad som utförts, när det utfördes, i vilken omfattning, hur det utfördes och reflektera över resultatet.<sup>36</sup>

Omer has worked as a lecturer at Air University (AU), Pakistan, 2008 – 2011, prior to initiating his PhD studies. This should be take into consideration when discussing future teaching duties.

Omer was involved in the computer exercises of Image Analysis 2 for HT-12 and HT-13.

In addition, the student has spent ~2 months working on the 2012, 2013 & 2014 CBA annual reports. (3 weeks + 3 weeks + 1.5 weeks).



**Sammanfattande utvärdering av året som gått**<sup>38</sup> Ange kortfattat vad som gått bra och mindre bra under det gångna året (experiment, skrivarbete, uppfyllande av tidsplanering, undervisning, institutionstjänstgöring etc). Notera vilka insatser som behövs för att komma till rätta med eventuella problem.

Last year, the student completed 6 Ph.D. level courses, took part in an oral presentation at the ICPR 2014 and worked on experiments and tool development which resulted in two manuscripts.

**Handledning, organisation, omfattning och innehåll.**<sup>43</sup>

Ömsesidiga förväntningar mm har diskuterats om handledningen genomförande etc.<sup>44</sup>

x Ja ☐ Nej

Om nej, varför inte?

Utvärdering av hur det fungerat, både kvantitativt och kvalitativt.<sup>45</sup>

Handledare: We have discussed current projects in detail, and future projects in a broader perspective. Omer has shown good ability to grasp the ideas, proposed many ideas of his own, and already made progress. Omer started to look into methods for detection of point-source signals during the fall of 2012, and has since then developed a strong interest in super-resolution approaches and compressed sensing. There is also a growing interest for these methodologies within the SciLifeLab, including data from general fluorescence microscopy with high levels of noise as well as super-resolution microscopy. We have therefore decided to re-focus the project to approaches for this type of signal detection in 2D image data, rather than OPT.

Forskarstuderande: We have discussed the current/short-term projects as well as the potential long term direction of the research. We agree that for the foreseeable future we should concentrate on methods dealing with the detection of point source signals.

Kommentar (om handledningens organisation, omfattning, innehåll, kvalitet, t ex vad som går att förbättra etc.)<sup>46</sup>:

We have a microscopy meeting every other week on Mondays.

Meeting with Carolina 2 out of three weeks, The same for Vladimir, where every third meeting for Omer is with both supervisors.

#### Övrigt<sup>48</sup>

Här skall väsentliga avvikelser från tidigare studieplan som påkallar prefektens uppmärksamhet redovisas.