Course analysis Microscopy SK2500/SK2501/FSK3500/FSK3501 HT 2019

- Number of credits: 6p for SK2500/FSK3500, 7.5 p for SK2501/FSK3501 (4 p exam A-F, 2 p labs P/F, 1.5 p seminar P/F on SK2501)
  Course responsible: Anna Burvall and Ilaria Testa, both on lectures and labs
  Other teachers: -
  Teaching hours: 26h lectures, 16 h labs, 4 h seminar (SK2501/FSK3501 only)
  Number of registered students: 8 on SK2500, 2 on FSK3501, 2 on SK2501 and 0 on FSK3500
  Number of students at exam: 8 on SK2500 , 2 on SK2501, 2 on FSK3501
  Number of pass at exam: 8 on SK2500, 2 on SK2501, 2 on FSK3501
  Levels of pass: 100% on SK2500, 100% on FSK3501, 100% on SK2501 on exam after first attempt

    12 students (100%) pass on labs

    4 students (100%) pass on seminar (FSK3501 and SK2501)
  Total pass level: In total 84% pass after first exam and 100% with re-exam
  Number or answers to course evaluation: 4 (33%)

Course objectives:

After completing the course the student should be able to:

- adjust the illumination system to obtain optimal performance in transmission microscopy.
- select a suitable light source and optical filters, and correctly adjust the illumination system for fluorescence microscopy.
- select a suitable objective (correction, immersion etc) for various types of microscopic investigations.
- select a suitable contrast method (phase contrast, DIC, fluorescence, darkfield etc) and correctly use this technique to obtain high-quality images.
- calculate the expected image quality regarding resolution and signal-to-noise ratio for different practical imaging situations.
- understand and be able to describe the physical limitations for microscope performance concerning resolution and signal-to-noise ratio.
- describe performance for different types of microscopes by using (and in some simple cases calculating) optical transfer functions.
- select a suitable sampling density for digital image recording in microscopy.
- do computer processing of microscopic images to visualise three-dimensional structures.

- perform quantitative measurements in microscopic images using a computer.

Feedback from students: course evaluation

- Did the course, as a whole, allow you to develop useful knowledge or skills?
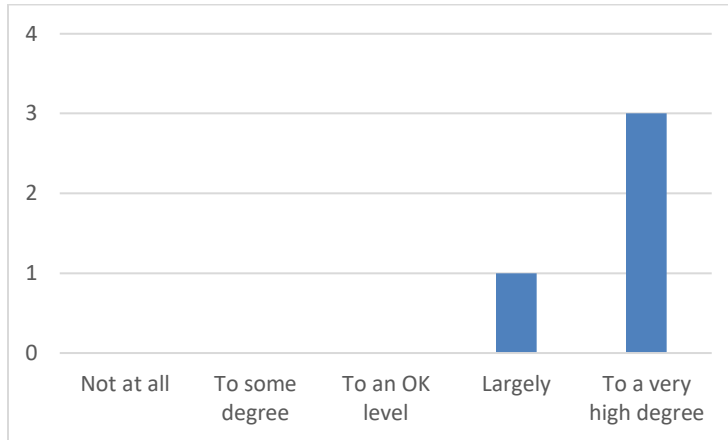
- What was good (i.e., should not be changed)?

  Student_1. It was a very good lecture setup with videos for the first half and then a live session for the second part.
  Student_2. Only 1 lab report to submit, for instance. Lectures worked well. Most things were good.
  Student_3. I really like the structure of the course where we had 1 hour pre-recorded video to watch and then a zoom meeting where we discussed the topic.
  Student_4. I liked the content very much. I also thought that the examination form was good with the oral exam and written exam.

- What can be improved?

  Student_1. It would be helpful with more clarity of in which plane (specimen plane, image plane) the presented formulas are to be used. Maybe a table towards the end of the course with all resolution limits, their corresponding plane and microscopy method. Also more clarity in when to use which resolution limits in calculations for the different kinds of microscopy. For example the different resolution limits in confocal microscopy.
  Student_2. Reduce the 3 confocal lectures to 2 and increase one lecture around sampling or contrast methods etc. More difficult exercises could be gone through during last lecture. We get told to do the problems given during the course, then it's silly to only go through them during the last lecture.
  Student_3. Nothing.
  Student_4. Would be nice to get some more lab experience, maybe get a chance to use STED.

- In particular, comment on the changes to digital format. For example the combination of video recording and live zoom sessions, the distance labs or the exam format.

  Student_1. As said earlier the lecture setup was a winning concept. The distance labs also worked very well and it was great to have zoom breakout rooms for the different lab groups. It was however also helpful to have the first two labs in person.

  Student_2. The lectures split in 2 halves worked well. Online lab is always bad but was ok just cause most of us had used the confocal microscope before.
  It is always better with a campus exam. It is always so stressful to upload answers to canvas. We had plenty of time, but something always goes wrong giving a lot of stress. If it has to be done again, an improvement is to make sure we only have one file to upload, instead of one for each question.

  Student_3. I liked the lectures and the exam was we'll planned. Of course I would have learned more by doing the labs by myself instead of watching someone else do it, but it was the best thing to do during these circumstances!

  Student_4. I liked the format, it was definitely the best "digitalization" of any of the courses I've taken on zoom so far. I wish we could have done all of the labs in person as I feel like the distance lab format didn't really replace a physical lab at all. At the same time I understand the need to do it this way. Exam format was good. Lectures were also good, having the recordings was also helpful when revising for the exam.

Couse analysis

Judging both from the course evaluation and from the exam results, the course was appreciated and met the objectives.

Due to the pandemic Sars-Cov2 recommendations we re-adapted the format of the course as a mix of pre-recorded and live video lectures. The laboratories were also partially modified with lab 3 in a fully recorded format.

Lectures and Exercise:

We introduced new pre-recorded video material for each lecture. This material was uploaded in the course page. Each teacher pre-record about half of the course lectures with Anna focusing on image formation and aliasing and Ilaria on contrast methods and microscopy techniques.

Each pre-recorded lecture was matched with a live video-session which was not recorded. During these sessions we prepared new Q&A sync activities with mentimeter to foster active discussions. The live sessions were also split in half between the two teachers.

Judging by the students comments this format and the new material was successfully appreciated.

Exam:

We re-formatted the exam as oral discussion and written sync problem-solving. Both teachers were present during the oral discussion with pre-decided questions standardized for all the students within the same session. This strategy was thought to minimize potential biased. Even if initially the students were nervous since not used to live discussion as a form of examination, they rapidly gained confidence and successfully discussed each topic. The oral discussion was mandatory and sufficient to pass the course with grade E.

For higher grades was left to the students the decision to perform the problem-solving part. 90% of the students that passed the oral went for this option increasing their grading.

The new exam format was appreciated by the students as pointed out in the comments.

The course evaluation was performed in KTH Forms, using four questions. Only 4 students provided feedback probably due by the intense exam time. However, the feedback was well in line with an overall positive view on the course. This was particularly encouraging since the multiple changes in the format and in the exam introduced by the pandemic.

Next year's course

The students were, in general, happy with the course. One suggested, in line with Ilaria's view, that the confocal lectures could be somewhat shortened and other material included instead. The plan is to shorten the confocal lectures (lectures number 9-11) into two, and turn the extra lecture into a combination of a problem-solving session and introduction to STED. This will allow to dedicate additional time during lecture 12 and 13 - at the end of the course- to additional sync problem-solving and general comparisons within the techniques discussed in the whole course. On this line, mentimeter type of questionnaire followed by live discussions and reflections will be introduced.

Labs number 1 and 2 were run on campus, while labs 3 and 4 were run via pre-recorded material and over zoom. The students appreciated the labs but of course the lack of hands-on experience in lab 3, which was fully video recorded by the teachers, was noticed. Hopefully next years all lab will be done in persons and if not, we might think of additional synchronized activity to bring the students closer to the live instrument handling experience. For example, add to the pre-recorded lab a live session where students can instruct the teacher on which parameters to tune in the instrument to produce imaging data of a certain quality.

Lab 3, using the confocal microscope, is becoming a problem due to the instrument failure. The confocal microscope at AlbaNova is in bad shape and the scanning module show artifacts, making it difficult to acquire data which can be used for quantitative analysis. Since it may completely break soon, Ilaria will look into the possibility of using a confocal microscope at SciLifeLab.

Additionally, the students call for practical demonstration of STED microscopy and other advanced technique. We think that this type of experience will bring them closer to on-going research topic in microscopy enriching their motivation.

On this line, we are considering shortening lab 3 in the confocal lab and add another part, lab 3B, on STED microscopy. This laboratory experience can be done on Ilaria's STED research microscopes at the SciLifeLab.

We will also then re-arrange the instruction of current lab 3-4 by 1) shortening lab 3 to two hours and 2) add material on STED microscopy. Lab 4 will be also modified to include image SBR and resolution quantification on STED imaging data.

Altogether this is the list of changes planned for next year course:

- Shorten the third confocal lecture and add live solving exercise on confocal and STED microscopy with table of comparison between microscopy techniques.
- For lab 3, find out if we can use another confocal microscope and shorten the lab instructions.
- Add lab 3B on STED microscopy.
- For lab 4, modify tasks to include STED image analysis quantification.
- In a longer perspective, the imaging physics compendium should be updated including single molecule localization theory and exercise. (This was planned for HT20, but adaptation to the corona situation took precedence.)