

Description of the WACQT Graduate Course:  
"Hands-on Quantum Technology in Sweden"

KTH:

**" Single and entangled photons and their use in quantum communication "**

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**Scheduling of the lab:** November 2019 (21 – 23.11.2019)

**Format:** Each student will attend the introduction lectures and will give a flash talk literature review. For the labs the students will be divided in groups of 3. Current maximum student's capacity is 24. The group perform the measurement together and write a report which first will be peer-reviewed and then graded (P/F).

**Time table:**

		Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8
Day 1	...-3pm	Travel							
	3pm-4pm	Welcome Reception							
	4pm-6pm	Introduction Lecture							
Day 2	8am-12noon	Lab 1	Lab2	Lab3	Lab4	Quiz and Literature review presentation			
	12noon-1pm					Lunch			
	1pm-2pm	Lunch				Lab1	Lab2	Lab3	Lab4
	2pm-6pm	Quiz and Literature review presentation							
Day 3		Travel							

**Lab:**

The lab consists in measurements of various quantum light sources:

- Lab1: Cryogenic on-demand single photon source,
- Lab2: Quantum emitter at the telecommunication band,
- Lab3: Room-temperature quantum emitter
- Lab4: Parametric down-conversion source

Each lab will feature different quantum optical measurements and effects, for example: Single quantum emitter spectroscopy, Hanbury Brown and Twiss measurements, interference measurements, Entanglement and Bell's inequality, and Rabi oscillation of a 2-level system.

### **Learning objectives:**

The students will be able to

- Reflect on the concept of quantum light sources and identify advantages and disadvantages of different technologies.
- Align and perform quantum optical experiments.
- Apply theoretical models and predictions to evaluate the experimental data.
- Demonstrate professional communication skills to disseminate research results.
- Critically assess the work of their peers and give appropriate feedback on written reports.

### **Teaching and learning activities**

- Introduction lecture to the topic and the laboratory
- Up to four experimental setups will be made available simultaneously during Day 2.
- The Lab activity takes 5 hours (8am-1pm, 1pm-6pm)
- Each Lab is unique and the groups will focus on different aspects of quantum light sources and their applications
- Each student gets a paper to read and present the main message to their peers.
- Each group of students has to answer a quiz dedicated to their Lab.

### **Assessment and feedback**

Following and understanding the introduction lecture is a requirement to get access to the lab. After the lecture a round of questions will be asked to verify that each individual student is familiar with the topic and also with the work environment (lab safety). Based on this assessment the teacher defines groups and assigns the labs. Each student group will write a lab report (10 pages max). The assessment will have two steps: first a formative step including peer feedback (the teachers appoint pairs of peer-pairs for this), followed by revision of the report and a summative assessment of the second-version report by the teachers. At the end of day 1 each student will be given a short research paper. They have to present the main message to their peers in a 2min flash talk. The literature flash talk will be peer-reviewed in an open discussion. In addition, each group hands in their answers to the quiz before the end of day 2. To pass the entire module course all 3 assignments (quiz, flash talk, and lab report) have to be passed.

### **Literature**

<https://www.nature.com/articles/nphoton.2016.186>

<https://www.nature.com/articles/nphoton.2015.282>

<https://iopscience.iop.org/article/10.1088/1361-6633/aa6955>

<https://www.nature.com/articles/nnano.2017.218>

<https://arxiv.org/pdf/1901.06367.pdf>

<https://www.qutools.com/qued/>