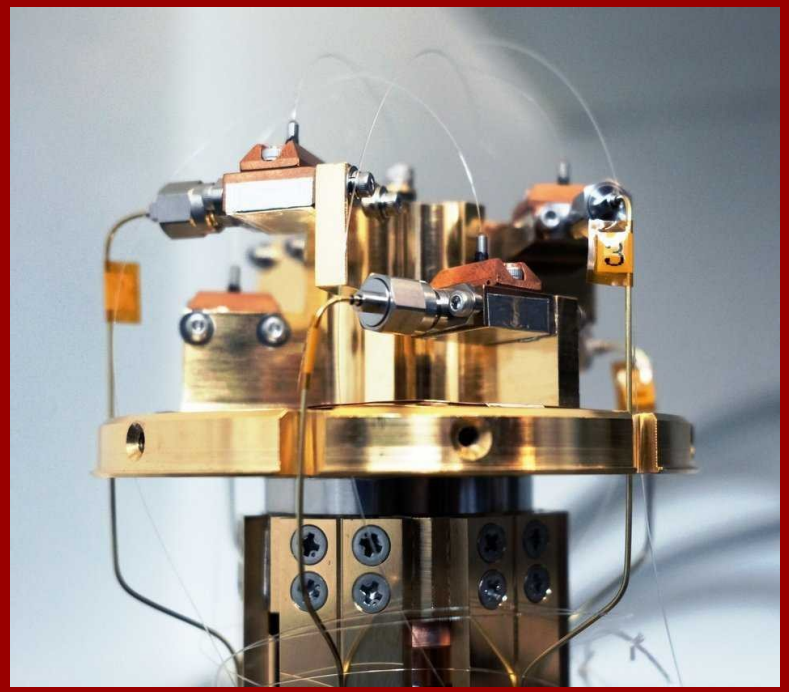


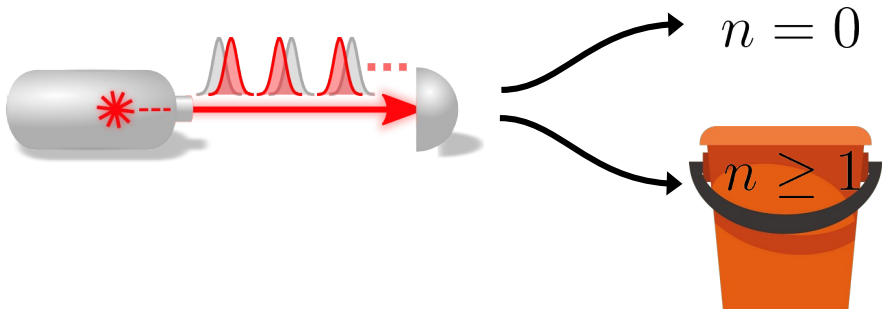
Learning to count photons

Resolving photon numbers from superconducting nanowire single-photon detector signals by machine learning.

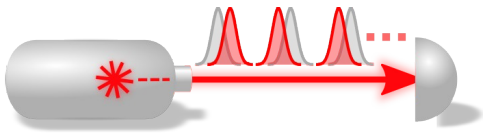
Case description for QST-Hack 2025
DTU Physics

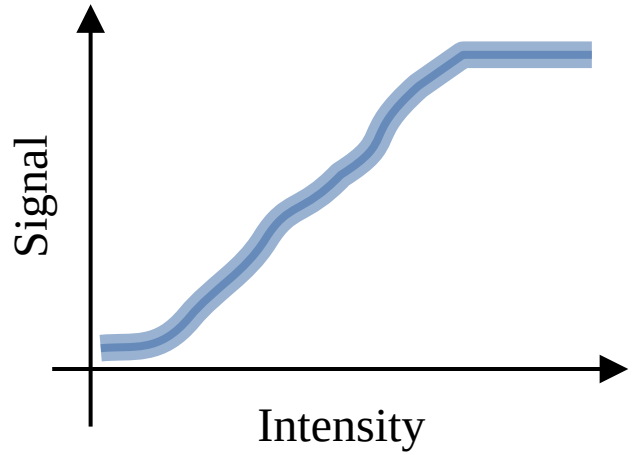
Most photodetectors

- ‘Zero’ / ‘One or more’

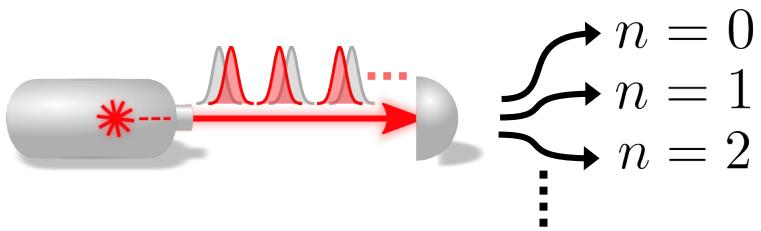


- ‘Lots’….

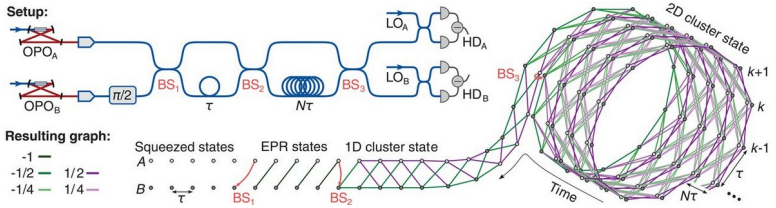




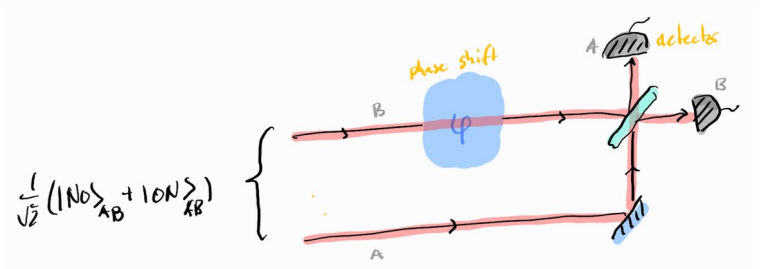
Photon-number resolving detectors – a holy grail of quantum optics



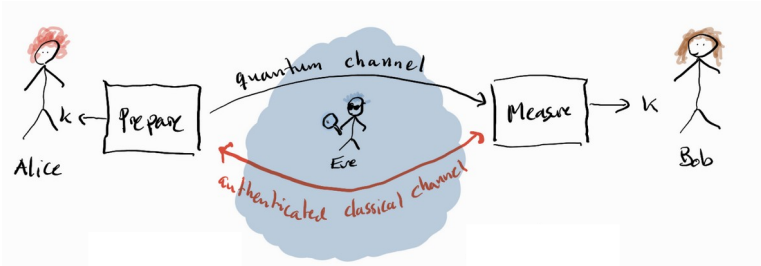
Universal optical quantum computing



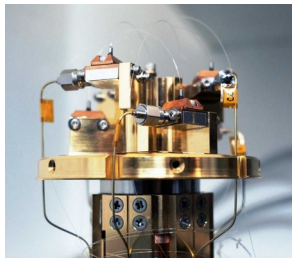
Quantum-enhanced sensing



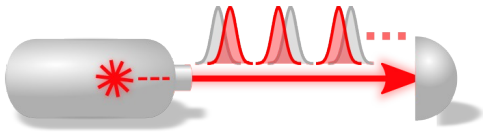
Secure quantum communication

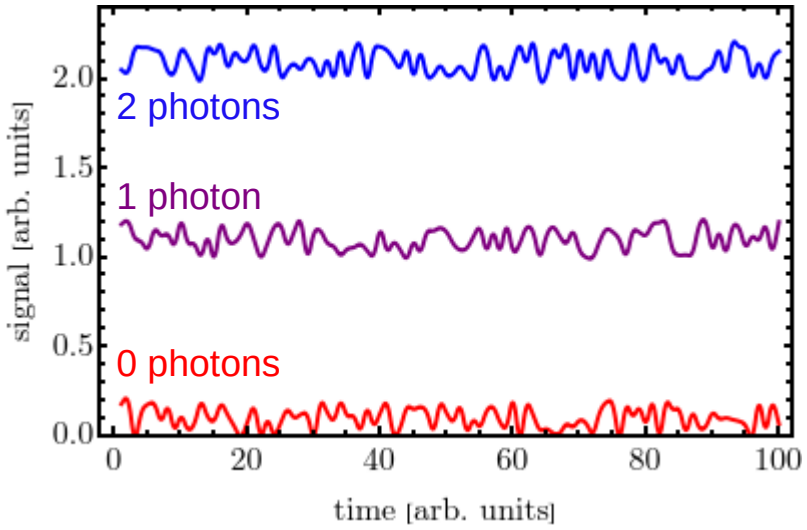


We do have photodetectors that can resolve photon number!

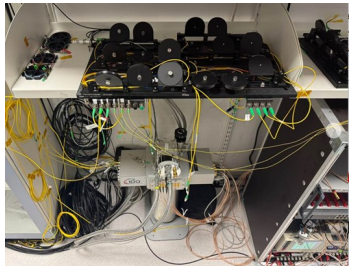


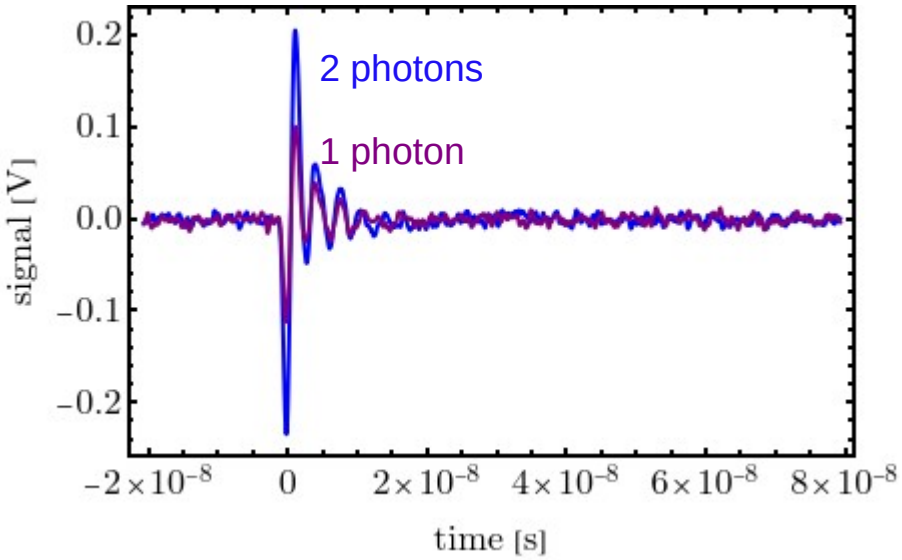
Ideally...





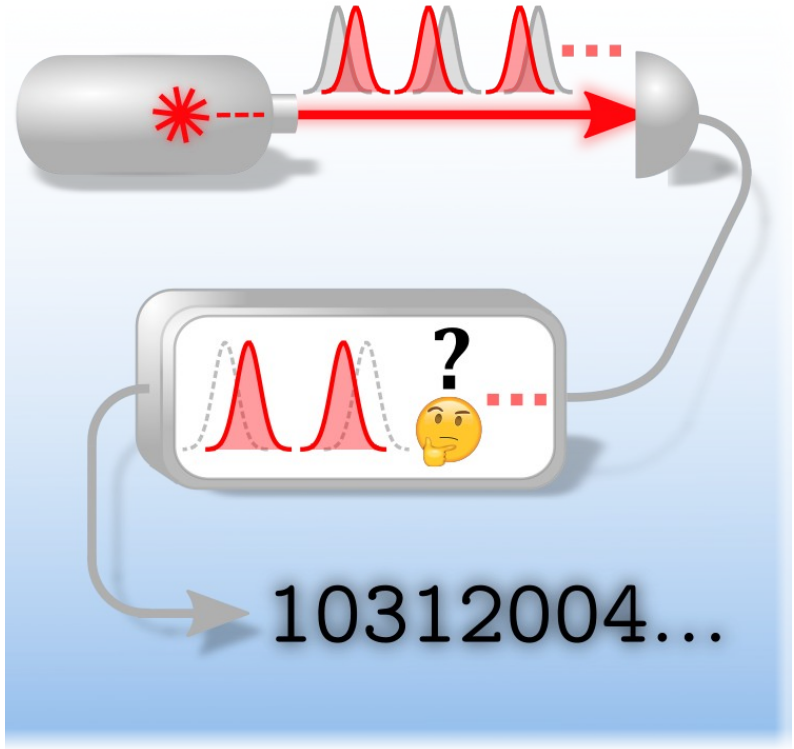
...but really.....





CHALLENGE

Build a classifier that can reliably assign signal traces to photon numbers!



CHALLENGE

Build a classifier that can reliably assign signal traces to photon numbers!

Target performance

parameter	value	comment
p(0|0)	> 0.999	needs to be stringent as it incurs "dark count"
p(1|1)	> 0.99	relaxed from 0.999 as it only reduces detection efficiency
p(0|1) + p(1|1)	> 0.999	needs to be stringent to not mess up with multiphoton terms
p(2|2)	> 0.93	0.93 is better than the EU-tender MP-SNSPD
p(3|3)	> 0.70	
p(4|4)	??	

Where $p(m|n)$ is the probability to output m when the true photon number is n.

Given

Generator of training data – i.e. simulated, noisy signal traces for known photon numbers.

(in Python)

Suggested tool

Python, PyTorch