

# Coherent One Way (COW) QKD Protocol

INSTITUIÇÕES ASSOCIADAS



João António<sup>1</sup>, Daniel Pereira<sup>2,3</sup>, Armando N. Pinto<sup>2,3</sup>

Physics Department<sup>1</sup>,  
Department of Electronics, Telecommunications  
and Informatics<sup>2</sup>,  
University of Aveiro, Aveiro, Portugal  
Instituto de Telecomunicações,<sup>3</sup> Aveiro, Portugal

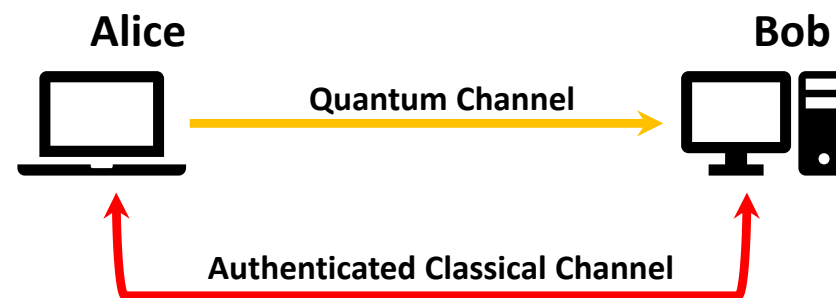


# Quantum Key Distribution

- Quantum Key Distribution (QKD) is a secure way of create and share a unique random key between two spatially distant parties.
- Polarization QKD vs Time Bin QKD.

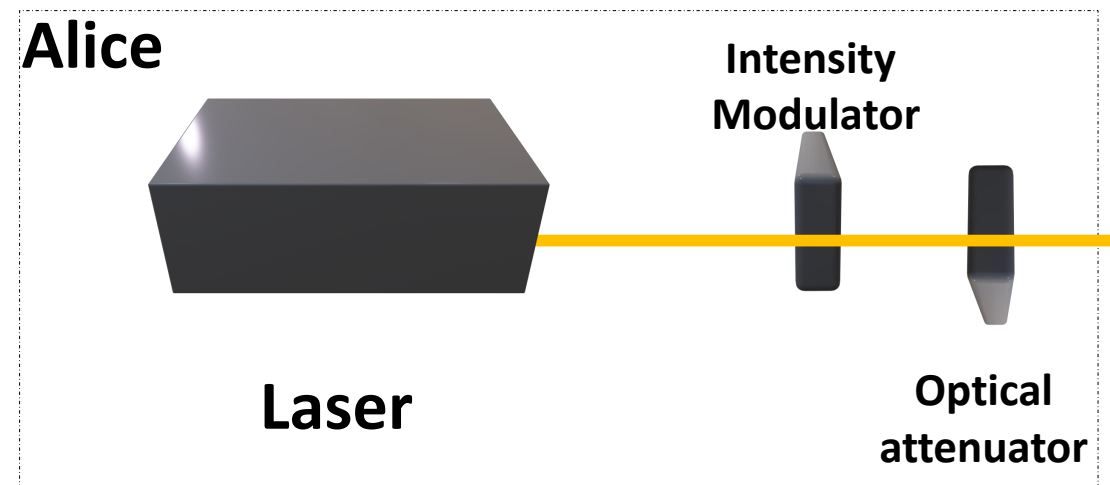
They use:

- One quantum channel (with one way transmission)
- And one authenticated classic channel (can be eavesdropped but can't be modified).



# Time Bin QKD

- The Coherent One Way (COW) protocol was elaborated by Nicolas Gisin et al in 2004.
- Uses time bin encoding.
- It has a very simple setup.



# Alice - COW protocol

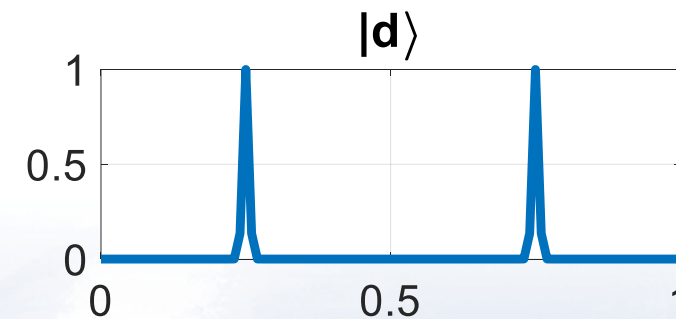
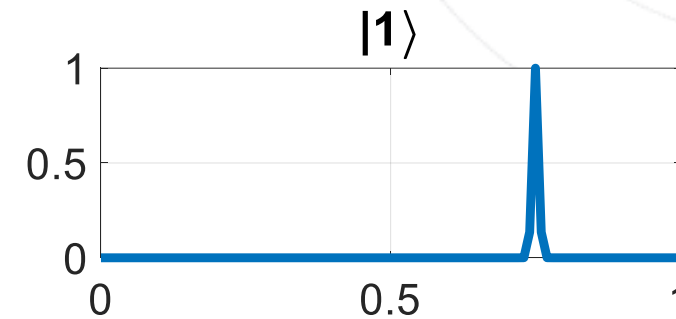
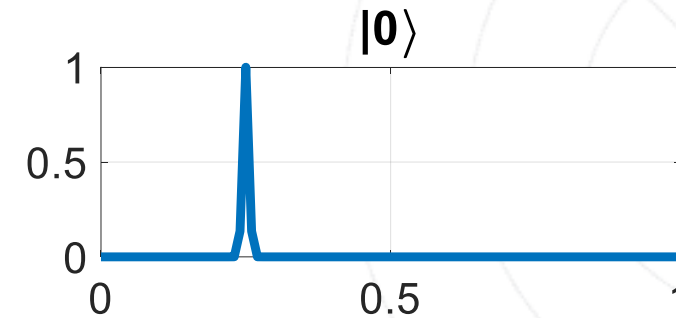
**Step 1** Alice creates a random key using:

$$|0\rangle = |\alpha\rangle|\emptyset\rangle = \textit{Logical 0}$$

$$|1\rangle = |\emptyset\rangle|\alpha\rangle = \textit{Logical 1}$$

$$|d\rangle = |\alpha\rangle|\alpha\rangle = \textit{DecoyState}$$

Where  $|\emptyset\rangle$  is the vacuum state and  $|\alpha\rangle$  is a coherent state of light with intensity  $\mu = |\alpha|^2 \ll 1$ .

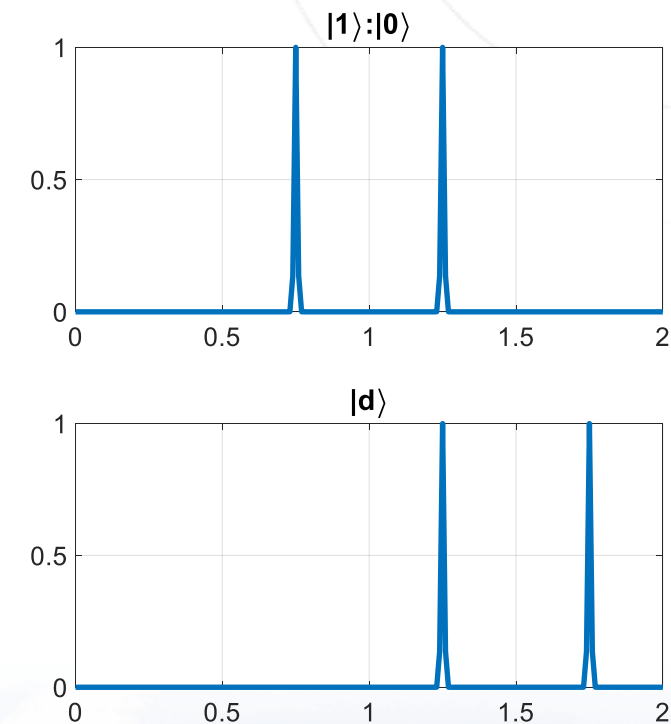
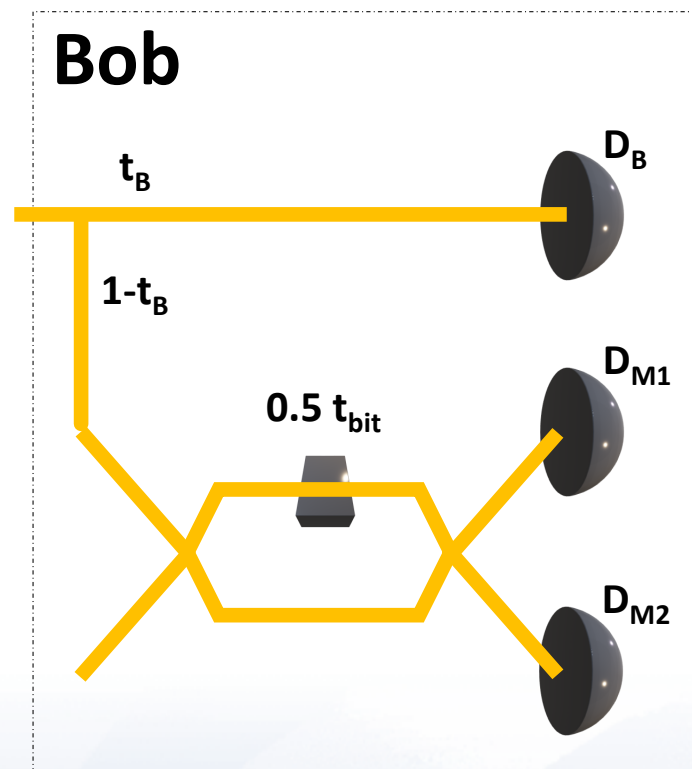


# Bob - COW protocol

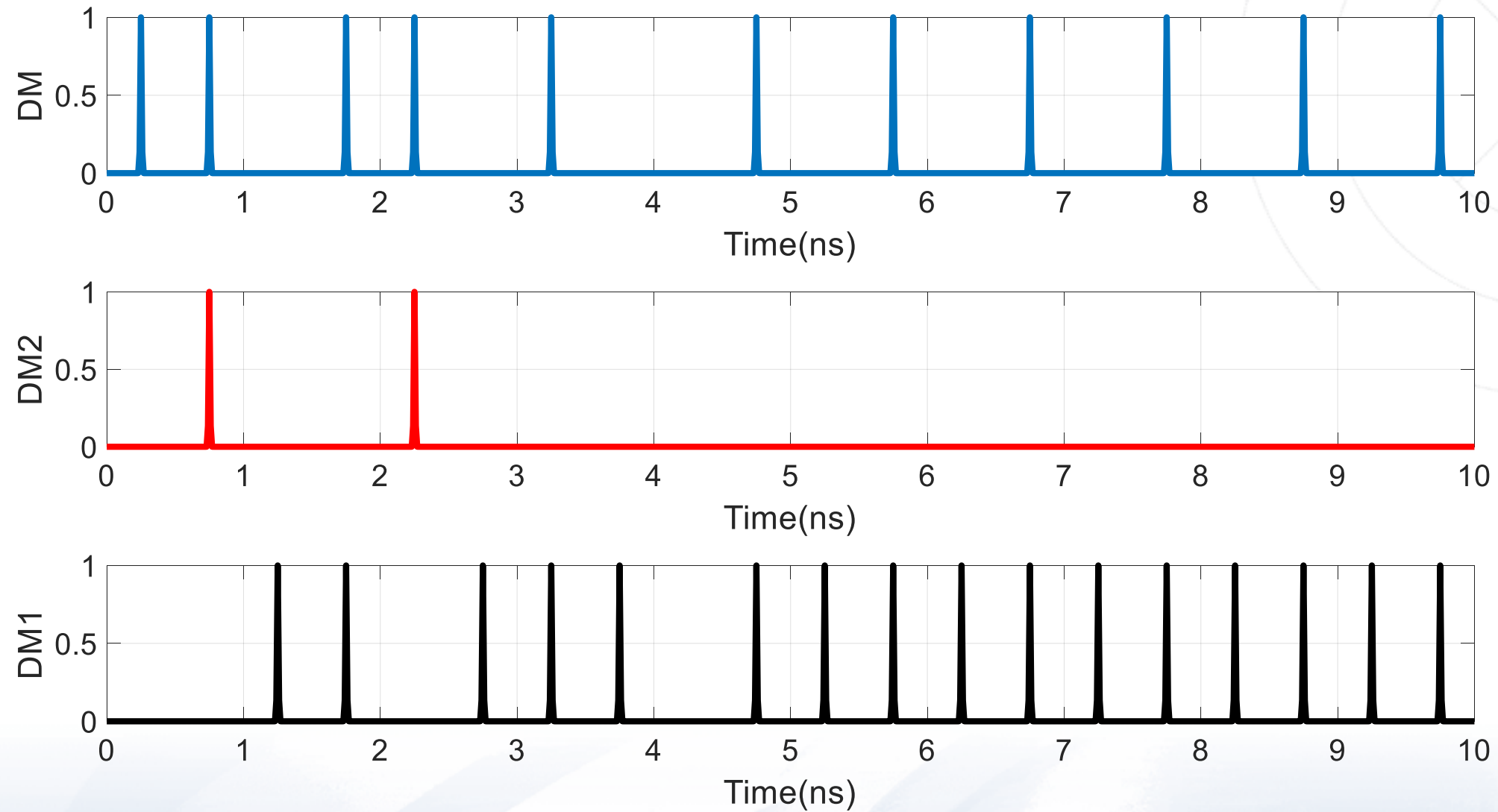
**Step 2** A fraction  $t_B$  of the photons go into the photon counter  $D_B$ , where the bits are discriminated by the time of arrival.

Half of the other photons are delayed by  $0.5 t_{bit}$  interacting with the half of non-delayed bits.

Therefore  $D_{M2}$  (constructive photon counter) should only click when:



# Monitoring line - COW protocol





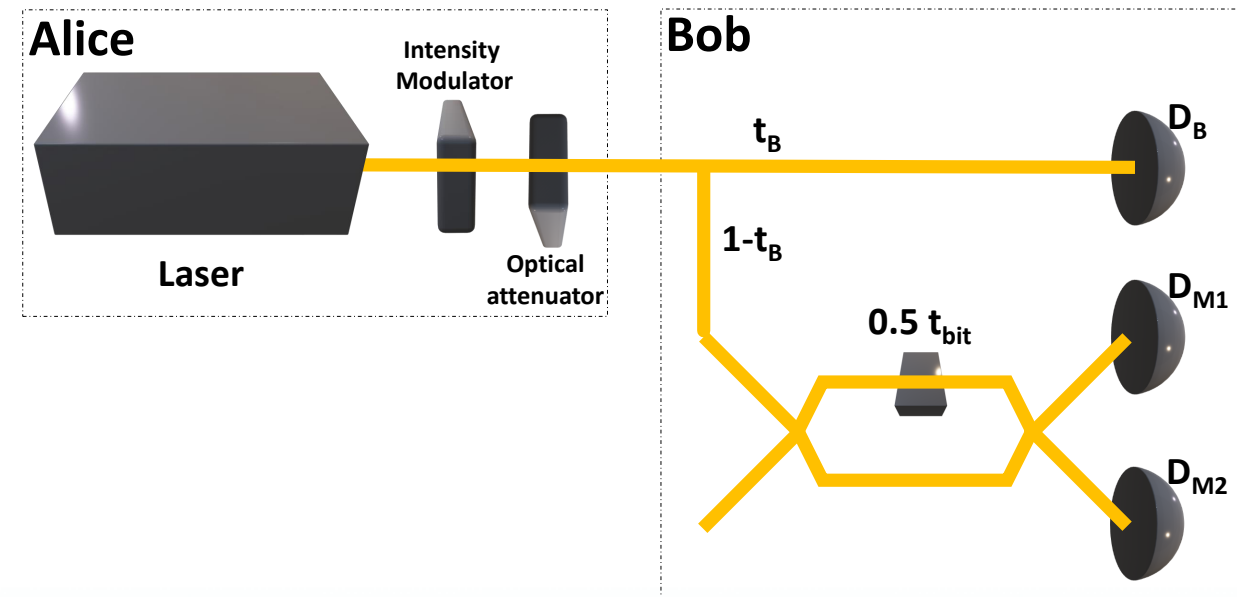
# Testing Visibility and Errors - COW protocol

**Step 3** Alice tell the times of the decoy. Bob checks if the  $D_{M2}$  has fired during a decoy time.

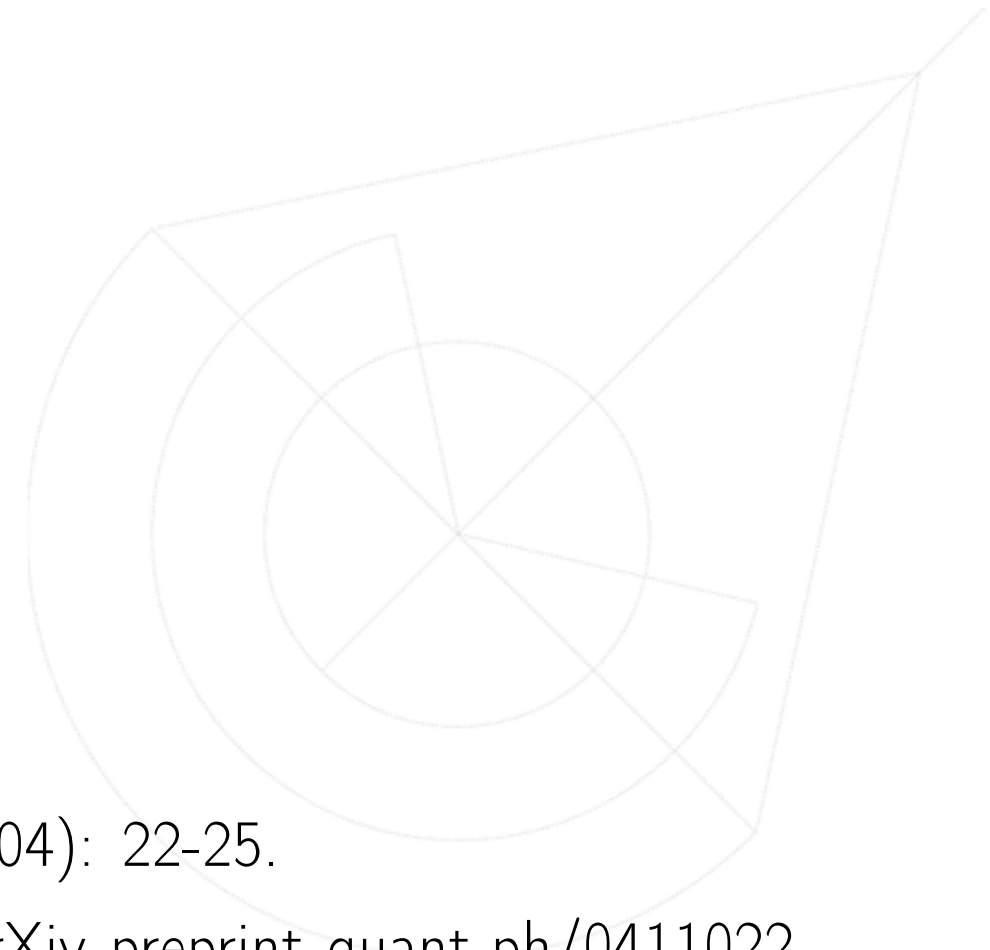
**Step 4** Bob reveals the other times that he had a detection in  $D_{M2}$ , Alice verifies if they belong to a  $|1\rangle : |0\rangle$ .

**Step 5** Bob reveals the times that  $D_B$  fired, and they use those as key.

**Step 6** They calculate QBER and then run error correction and privacy amplification.



E-mail: joaoantonio@ua.pt



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