Quantum Technologies, 2018/19

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Coherent One Way (COW) QKD Protocol

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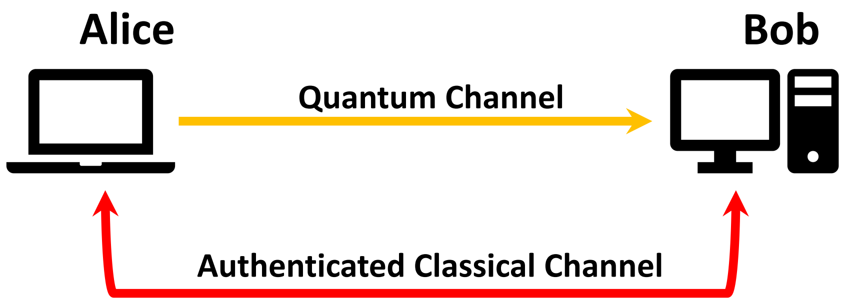
Quantum Key Distribution

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

They use:

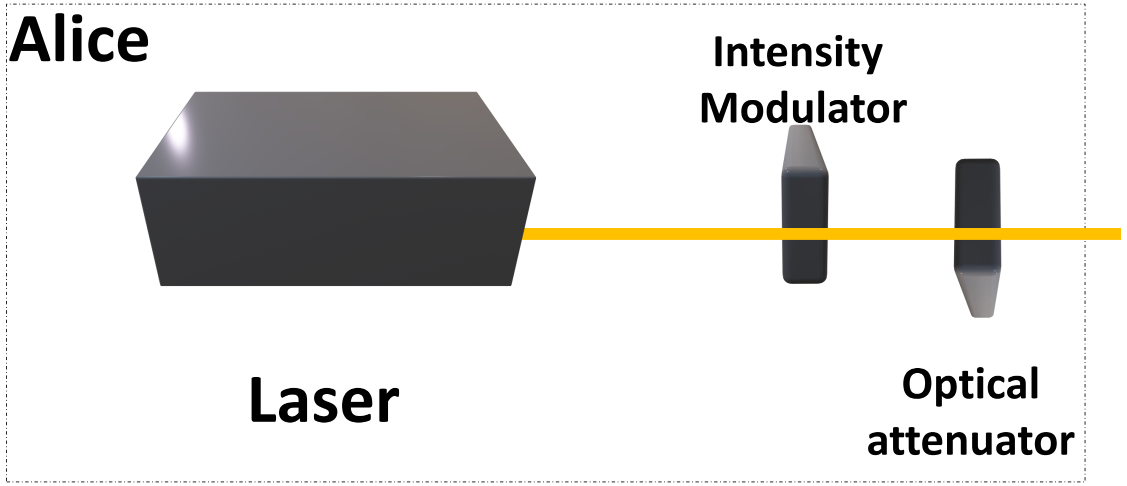
- One quantum channel (with one way transmission)
- And one authenticated classic channel (can be eavesdropped but can't be modified).



Ouellette, Jennifer. "Quantum key distribution." Industrial Physicist 10.6 (2004): 22-25.

Time Bin QKD

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



Gisin, Nicolas, et al. "Towards practical and fast quantum cryptography." arXiv preprint quant-ph/0411022 (2004)

Alice - COW protocol

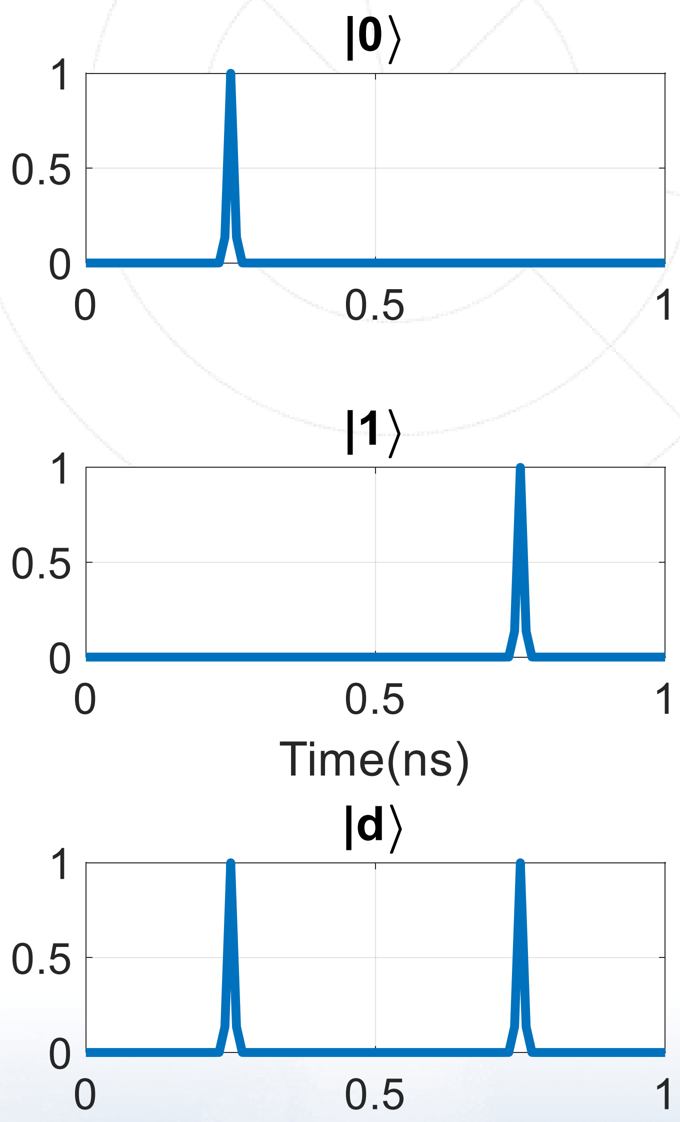
Step 1 Alice creates a random key using:

$$|0\rangle = |\alpha\rangle|\emptyset\rangle = \quad Logical\ 0$$

$$|1\rangle = |\emptyset\rangle|\alpha\rangle = \quad Logical\ 1$$

$$|d\rangle = |\alpha\rangle|\alpha\rangle = DecoyState$$

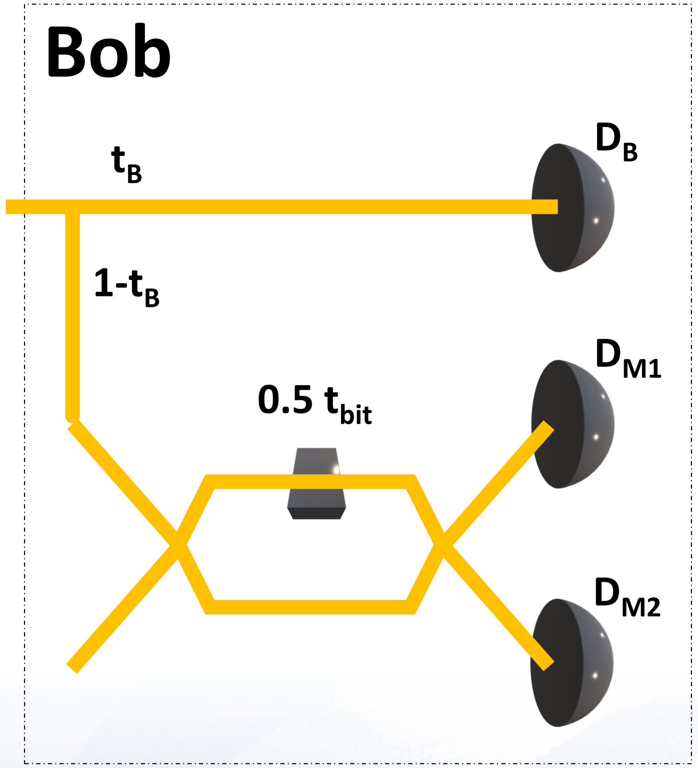
Where $|\emptyset\rangle$ is the vacuum state and $|\alpha\rangle$ is a coherent state of light with intensity $\mu = |\alpha|^2 << 1$.



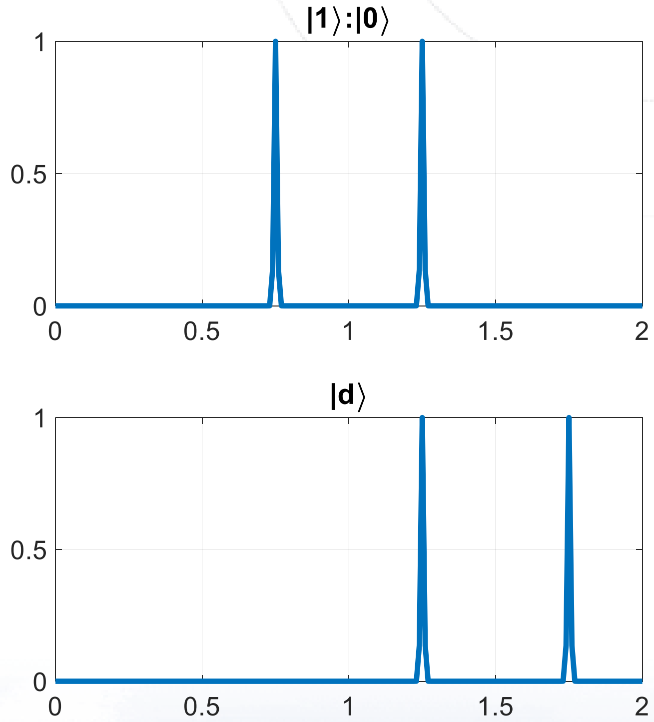
Bob - COW protocol

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.

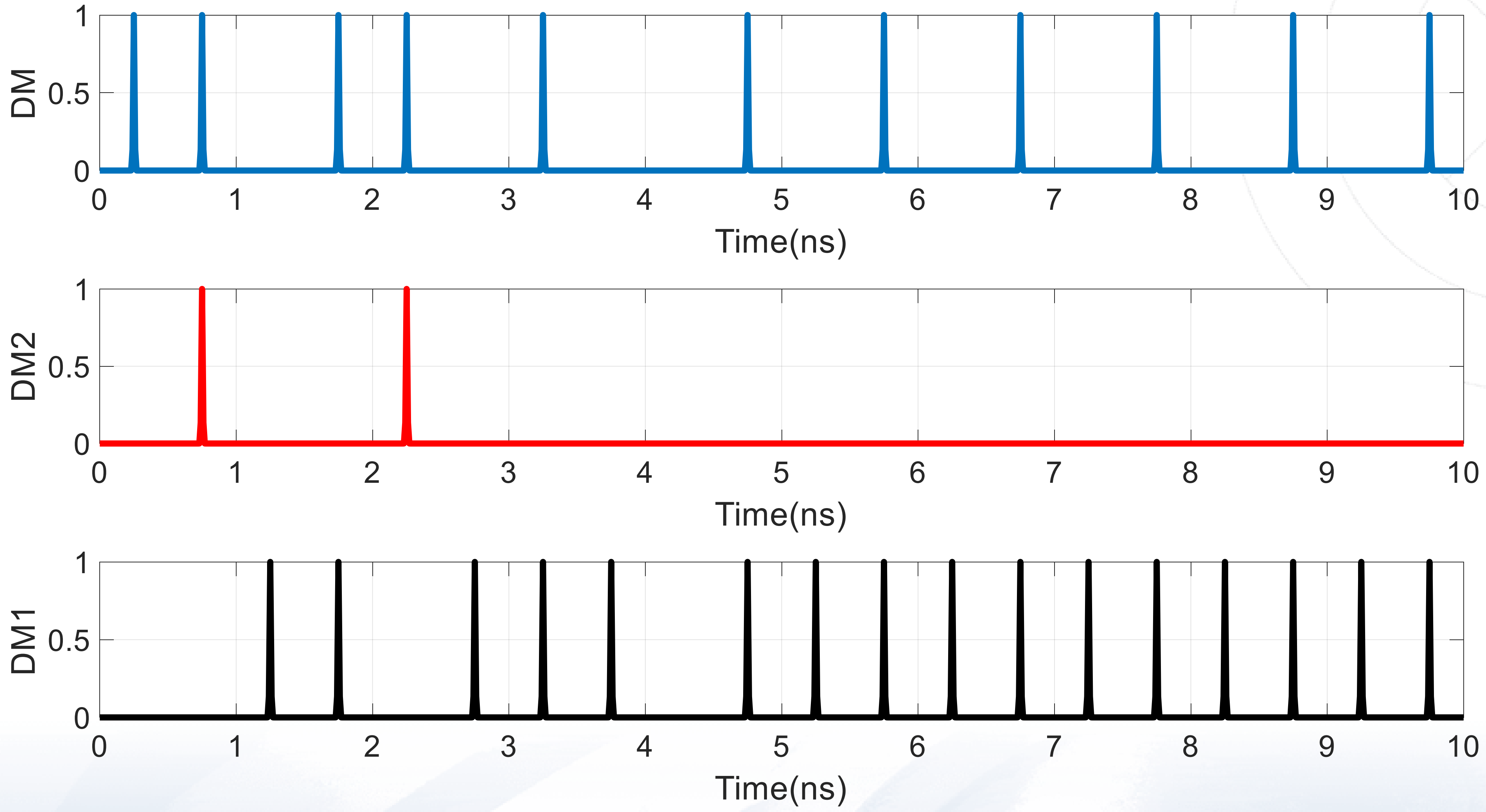
Half of the other photons are delayed by 0.5 t_{bit} interacting with the half of non-delayed bits.



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



Monitoring line - COW protocol



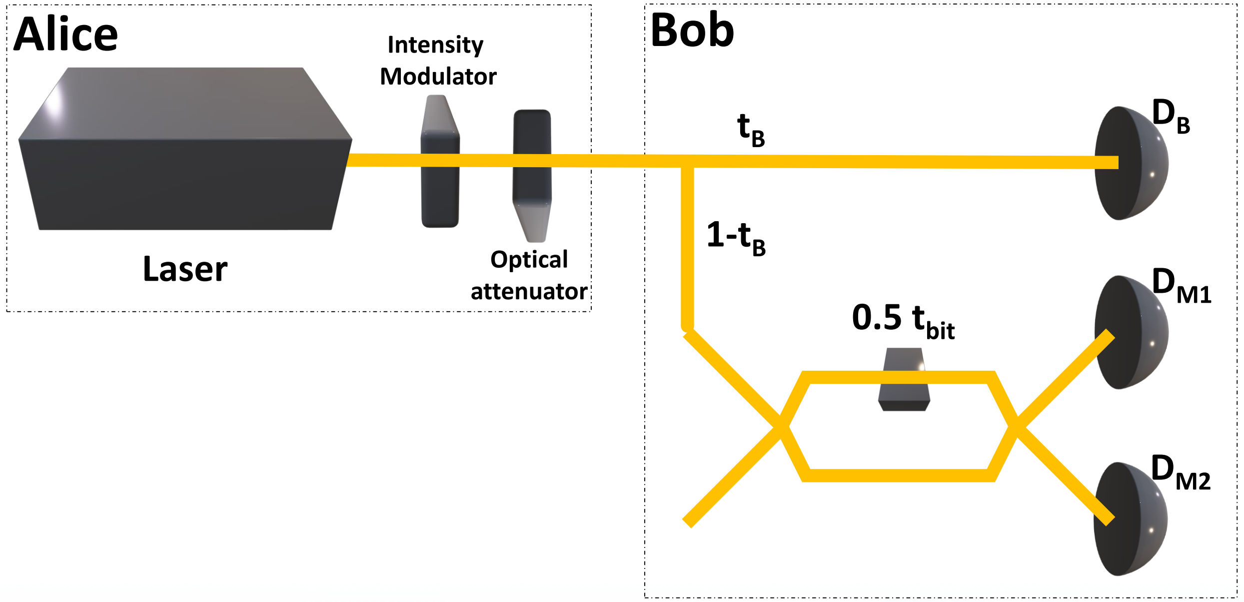
Testing Visibility and Errors - COW protocol

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 some part of the key.

Step 6 Alice and Bob run error correction and privacy amplification and end up with a secret key.



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- Gisin, Nicolas, et al. "Towards practical and fast quantum cryptography." arXiv preprint quant-ph/0411022 (2004).
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