Modeling the linear optics CNOT gate

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Motivation

- Mode-matching is the most significant problem facing LOQC gate operation
- Can we model it and understand its effects?
- What can we do with such a model?

What is mode-matching?

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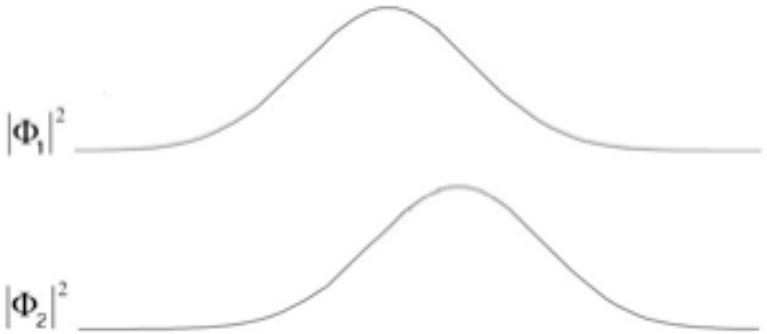
Temporal mode-mismatch



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Spatial mode-mismatch

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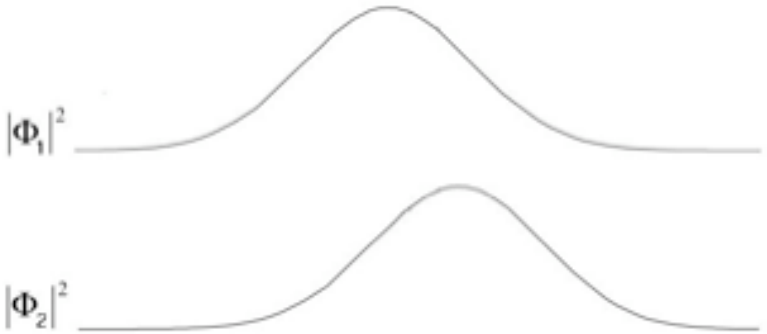

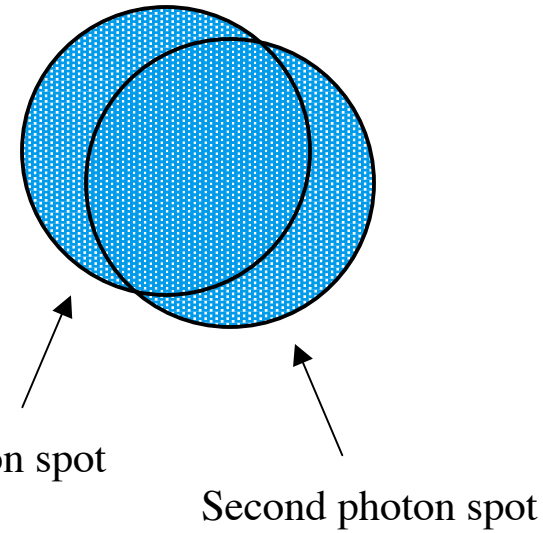

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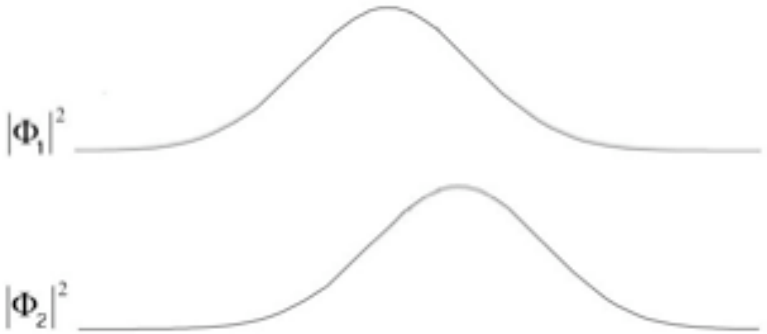

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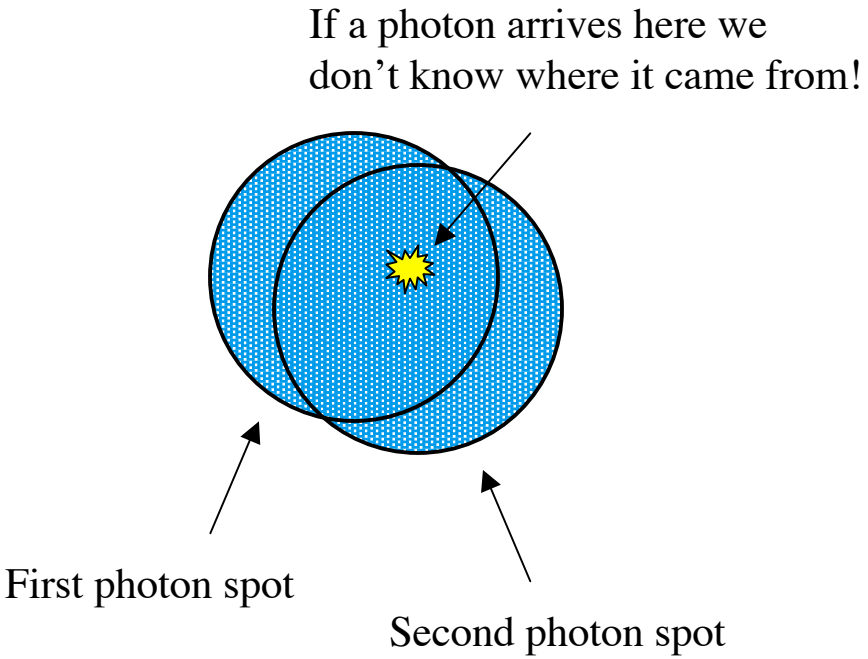

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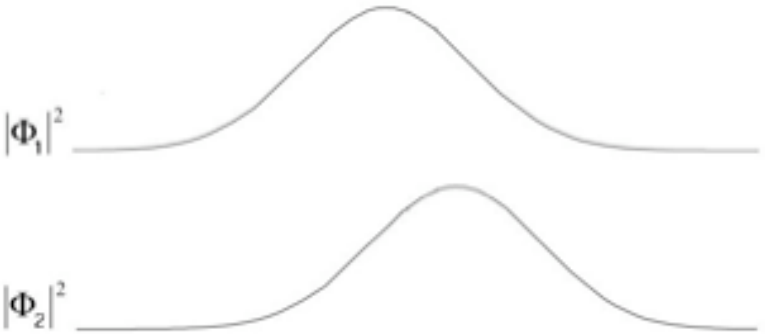

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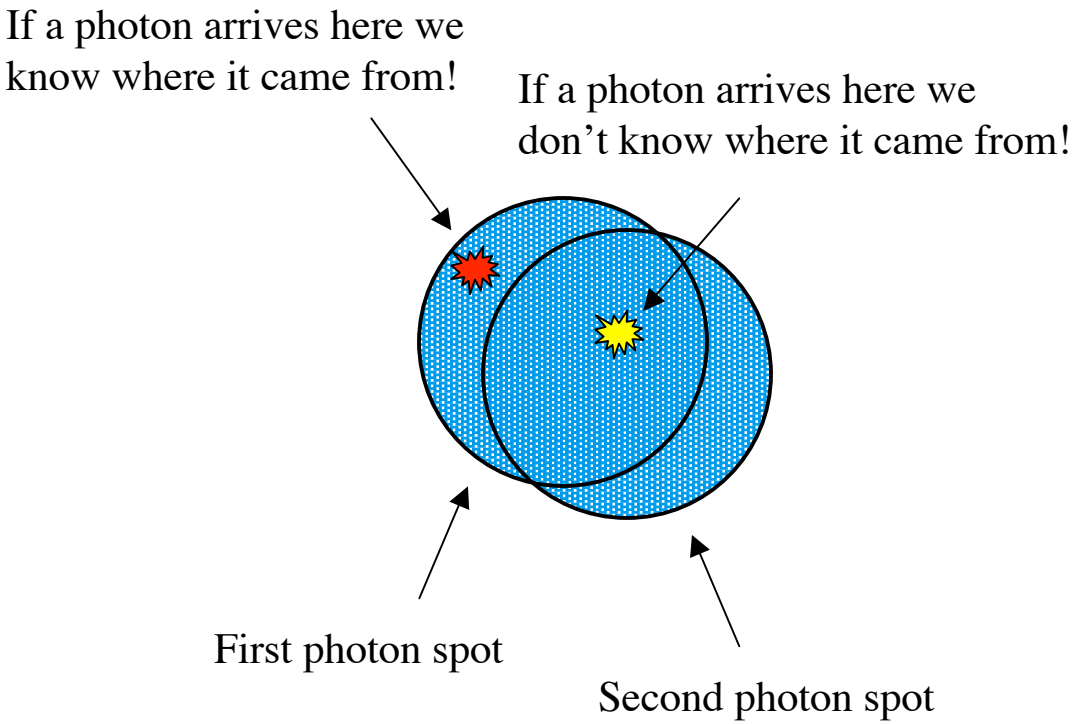

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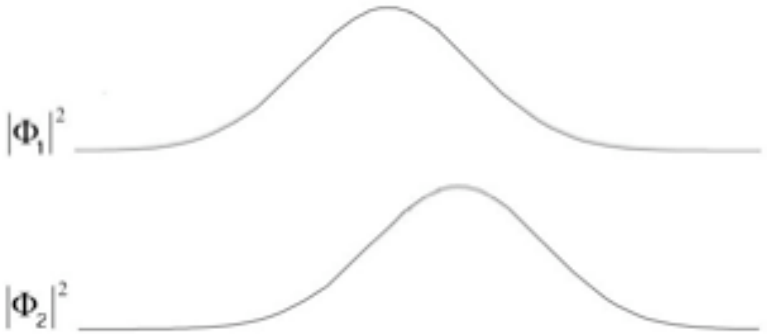

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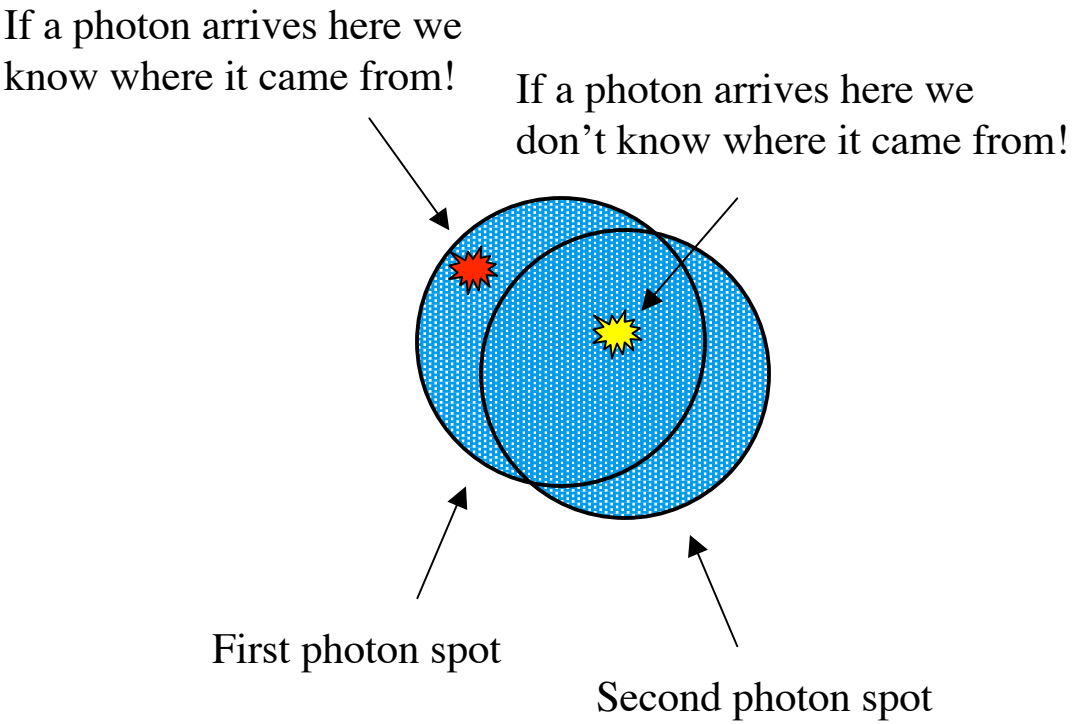
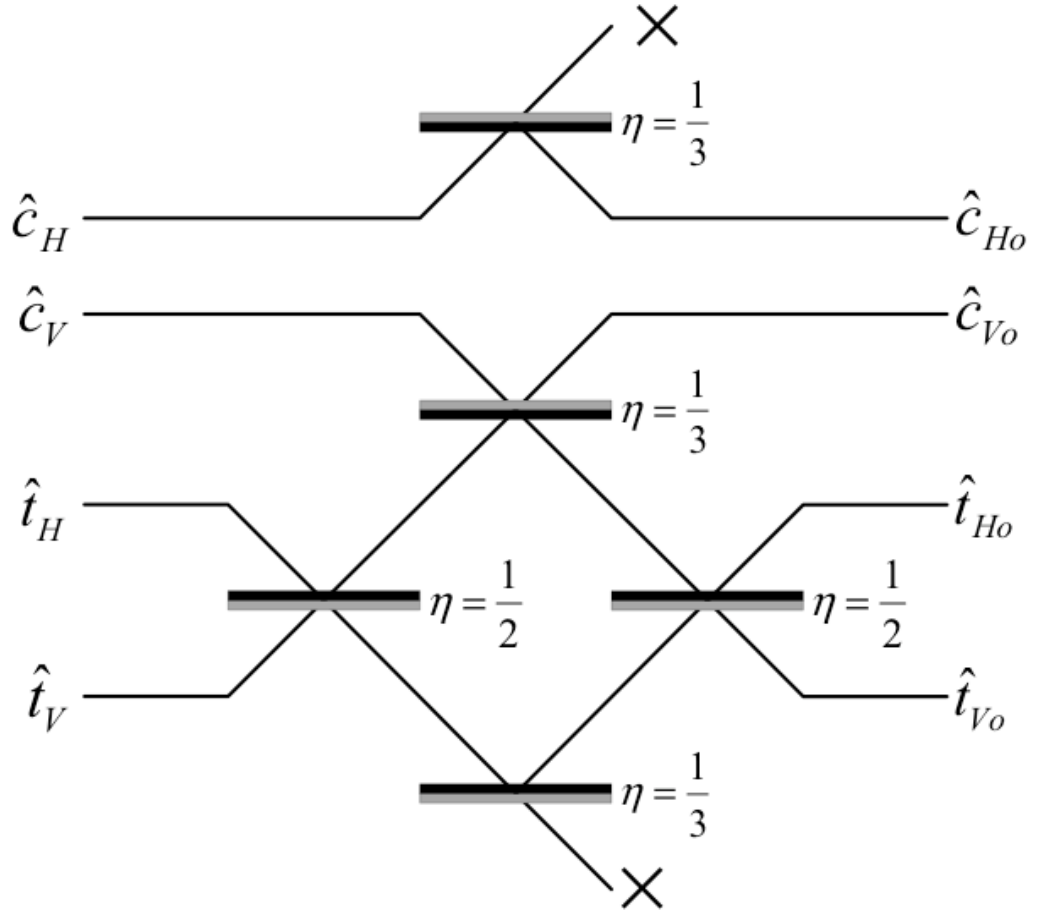


Anything which introduces distinguishability!

The linear optics CNOT gate



- Dual rail encoding
- Operates in coincidence
- Non-deterministic (success probability of 1/9)

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- Representing photons: $|1\rangle \rightarrow \int_{-\infty}^{\infty} \alpha(t)|1\rangle_t \mathrm{d}t$

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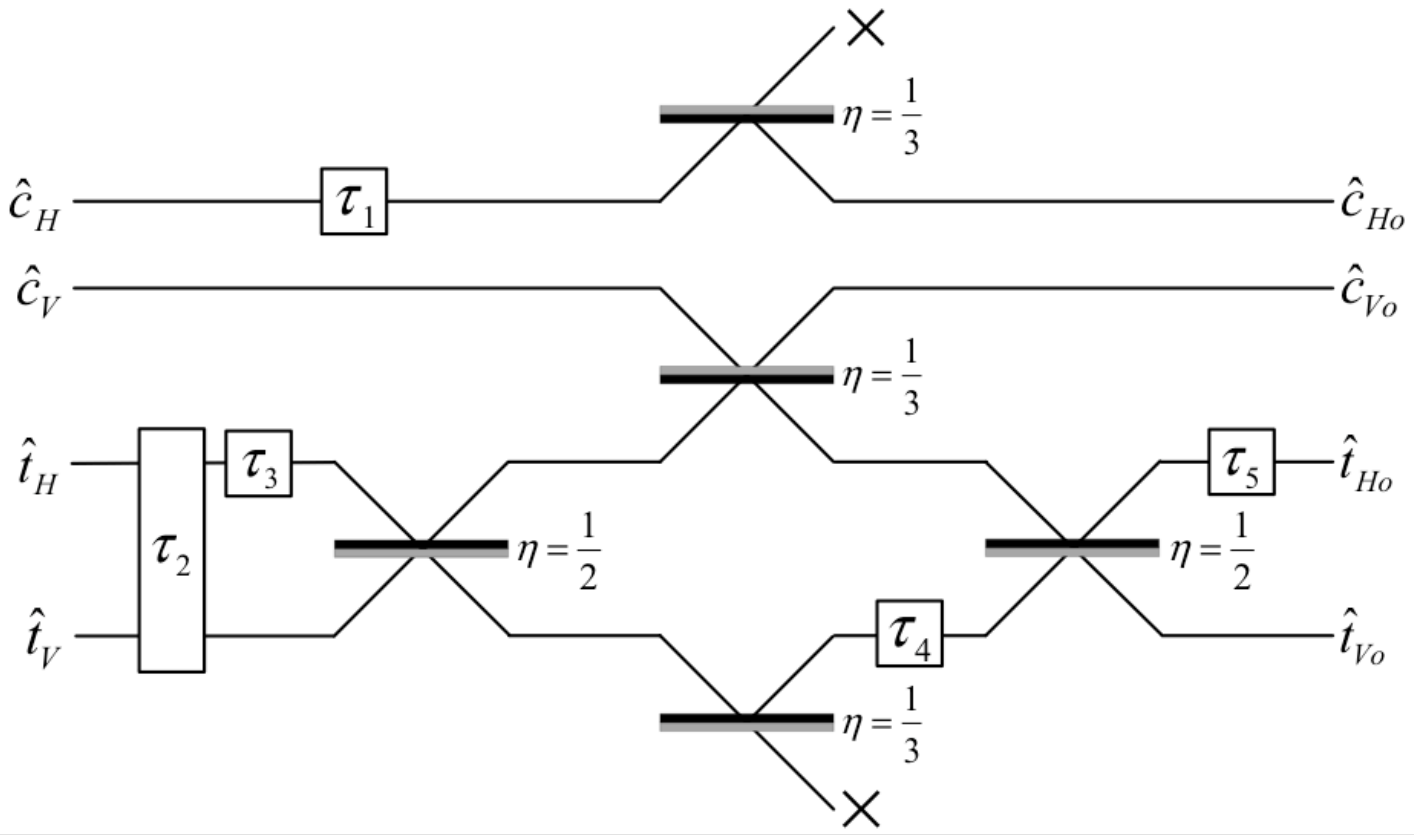

•Model distinguishability by displacing wavefunction (parameters τ_1- τ_5)

•From experimental data, τ_1- τ_5 can be estimated!

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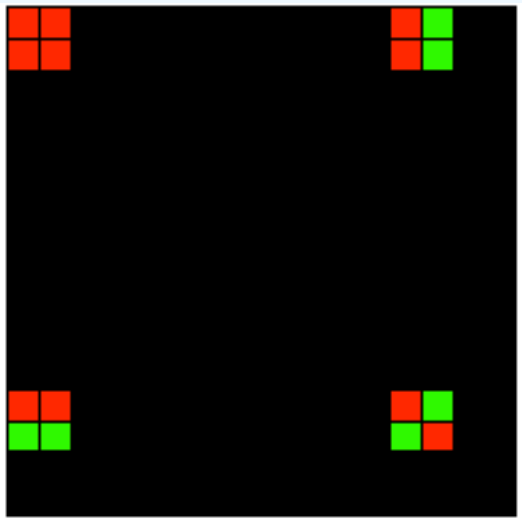
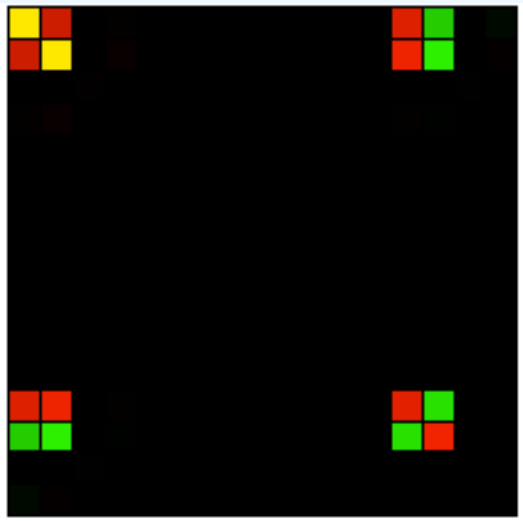
- Experimental insight!
  - We know where things are going wrong
- Can make Quantum Process Tomography easier!
  - Requires less experimental data
  - More flexibility in choice of measurements



Ideal CNOT process



Experimental process

Conclusion

- Modeling mode-matching in optical gates is a powerful tool
  - Experimental insight
  - Simplification of Quantum Process Tomography
- Approach may be applicable in other architectures
  - Identify physically significant processes
  - Construct suitable gate model