A Multi-Node Quantum Network with Defects in Diamond

Ph.D. proposal

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November 23, 2018

INTRODUCTION

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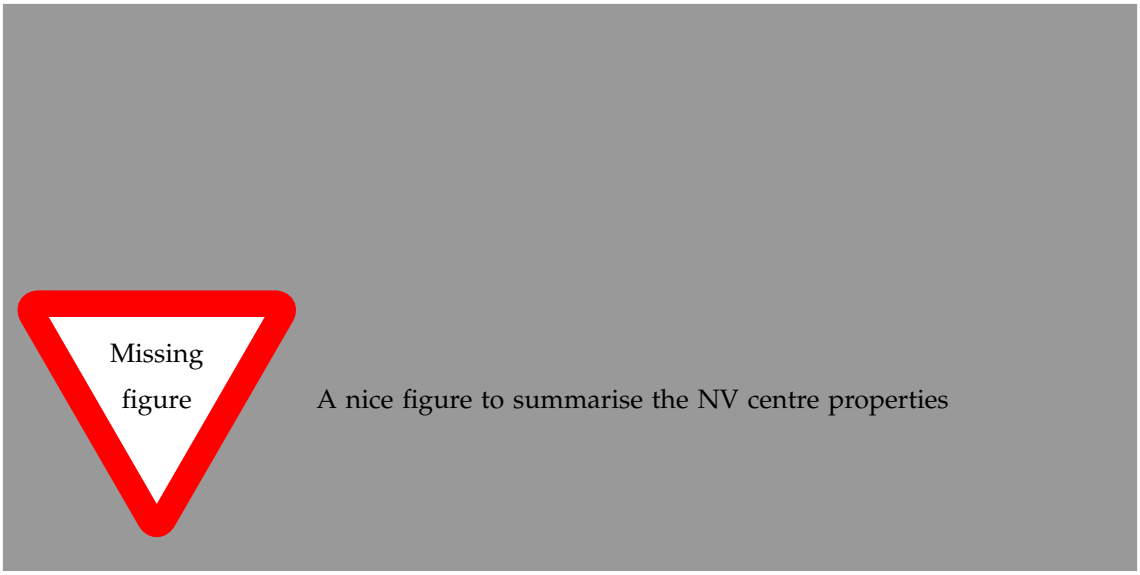

Figure 1: The NV centre as a quantum network node. a) The NV is an atomic defect in diamond with trapped ion-like properties. b) Spin selective optical transitions allow for high-fidelity initialization and single-shot read-out. c) Neighbouring C^{13} atoms can be used as quantum memories. d) Entanglement can be generated among remote NVs.

1 RESEARCH GOALS

The goal of my Ph.D. is:

DEMONSTRATION OF QUANTUM APPLICATIONS ON A MULTI-NODE NETWORK.

Breakdown how to do it

2 THE NV CENTRE AS A QUANTUM NETWORK NODE

Quantum networks are expected to deliver definitive security for communication, blind quantum computation, improved clock synchronization and more exotic applications such as connecting far apart telescopes [3].

A node of such a network needs to: 1) generate entangled states with other nodes, 2) manipulate quantum states and 3) store quantum states. The Nitrogen-Vacancy (NV) centre in diamond is a promising candidate to act as node of such a network, as it fulfils all the mentioned requirements. Figure 1 summarises the fundamental properties of the NV centre.

Recent work from our group demonstrated the on-demand generation of remote entanglement between two NV centres with rates up to 39 Hz [2]. Such high rates are a consequence of moving from a two-photon detection protocol, such as the one used in Ref. [1], to a single-photon protocol.

I attended (or I am currently attending) the following courses:

- Collaboration across disciplines (? GSC) — Ask Sandrine!
- PhD Start-up (2 GSC)
- Conversation skills (2 GSC)
- Casimir Course - Programming (5 GSC)
- Casimir Course - Electronics for Physicists (5 GSC)
- QuTech Academy - Quantum Communication and Cryptography (5 GSC)

8.2 *Supervision*

I have been supervising Hans K. C. Beukers, a MSc student, since February 2018. Hans has been working on setup improvements and techniques that, if successful, will increase the lifetime of our memory qubits.

8.3 *Outreach*

As an Early Stage Researcher (ESR) in the Marie Skłodowska-Curie Actions (MSCA) Innovative Training Network (ITN) Spin-NANO, I have to carry out outreach activities regarding my research field to the wider audience. I have currently carried out two outreach activities:

- January 2018, Sheffield, UK. Introduction to quantum- and nano-technologies to local high-school students, as part of an ITN meeting. — 1 GSC?
- September 2018, Brussels, BE. Two days stand about quantum technologies at the European Researchers Night, EU Parlamentarium, mainly to children between 5 and 10. — 2 GSC?

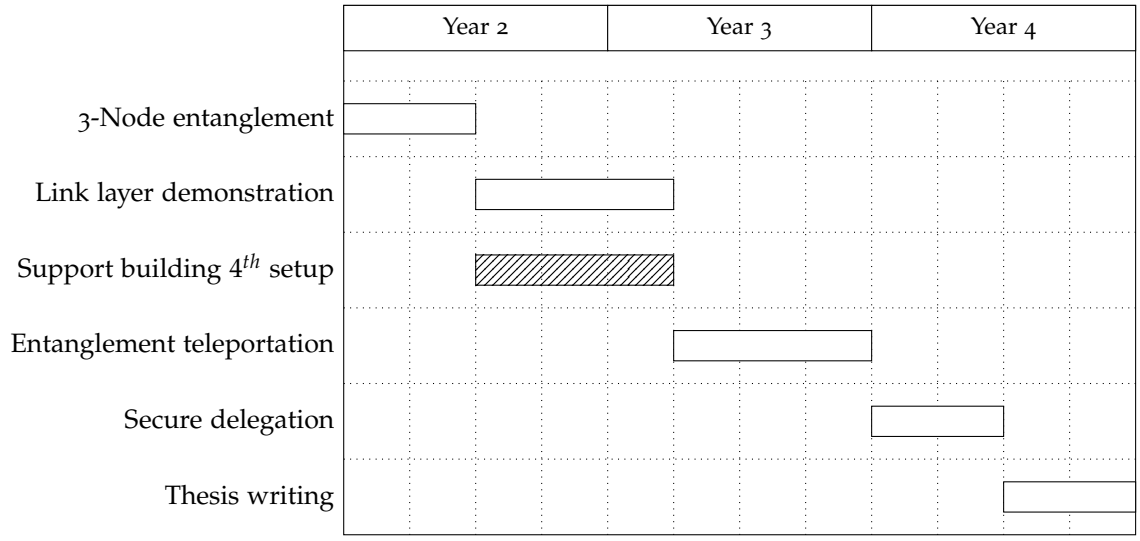

Figure 2: Proposed Ph.D. time-line.

Write caption. Explain 4th setup.

ACKNOWLEDGEMENTS

I would like to thank everybody.

actually thank people

REFERENCES

[1] B. Hensen et al. 'Loophole-free Bell inequality violation using electron spins separated by 1.3 kilometres'. In: *Nature* 526.7575 (Oct. 2015), pp. 682–686. DOI: 10.1038/nature15759.

[2] Peter C. Humphreys et al. 'Deterministic delivery of remote entanglement on a quantum network'. In: *Nature* 558.7709 (June 2018), pp. 268–273. DOI: 10.1038/s41586-018-0200-5.

[3] Stephanie Wehner, David Elkouss and Ronald Hanson. 'Quantum internet: A vision for the road ahead'. In: *Science* 362.6412 (Oct. 2018), eaam9288. DOI: 10.1126/science.aam9288.