Chapter 1

Introduction

Chapter 2

Ion Trap Apparatus

A vast effort is spent on the initial build-up of the an ion trap system, but throughout the life of the experiment, a greater effort is spent on its daily maintenance. I hope that this chapter will serve as a resource for future members of the FastGates team, as well as provide a useful recipe for anyone building a similar system.

Due to the size and complexity of the system, we introduce an inital overview of the design, motivated by the desired functions. As the name suggests, an ion trap experiment aims to confine arrays of single ions, this is achieved by static and dynamic electric fields which, due to the ions possesing non-zero electric charge, can provide trapping potentials, section 2.2. Due to the fragility of the internal states of the ion (these are state of the art sensors after all), we must take great care in isolating the ion from any noisy environment. This neccesitates the use of ultra-high vacuum (UHV) systems, section 2.3, vibration isolation, and magnetic shielding, section 2.1. To manipulate the internal electronic states of the ion, we create local electric and magnetic fields using RF antennae and, in this work, lasers, sections 2.4 and 2.5. Finally, to interface with the apparatus we have built, at the time scales set by our interaction strengths, we require a sophisticated and custom control system which is discussed in section 2.6.

2.1 System Design

2.2 The Ion Trap

2.2.1 Trap RF Chain

2.2.2 Trap DC Voltages

2.3 Vacuum System and Beam access

2.4 Laser systems

2.5 Narrow Line Width 729 Laser

2.5.1 Single Addressing System

2.6 Sinara Hardware and Artiq

Chapter 3

Experiment Characterisation

Before we can dive into running novel experiments involving the motion and spin of the atoms, we need to characterise our apparatus. This allows us to both benchmark our system against state of the art results, and to reveal any current limitations of the apparatus which we may need to address.

Chapter 4

Outlook

4.1 Appendix