1.1 Requirements & Constraints

List all requirements for your project. Separate your requirements by type, which may include functional requirements (specification), resource requirements, physical requirements, aesthetic requirements, user experiential requirements, economic/market requirements, environmental requirements, UI requirements, and any others relevant to your project. When a requirement is also a quantitative constraint, either separate it into a list of constraints, or annotate at the end of requirement as "**(constraint)**." Ensure your requirements are realistic, specific, reflective or in support of user needs, and comprehensive.

Kilo-qubit (scale) Ytterbium Ion-Trap Quantum Computer (QC) Design

Fundamental:

- **Design a quantum computer that can be scaled to hold thousands of qubits**
- **The design should utilize memory ion traps that preserve qubits for longer times (10s of machine cycles). These need to have transport access, but need not be optical hardware addressable.**
- **The design should also utilize computational ion-traps, which are the standard within current ion-trap QC designs.**

Resource:

- **Mike and Ike quantum physics book**
- **Honeywell Ion-Trap Quantum Computer Design Documentation/Review**
- **Papers, lectures, and virtual classes on ion traps and quantum computation**
- **Quantum Computer design software**
- **A suitable word processor (Microsoft Office / G Suite) for documentation**

Physical:

- **The design of the QC must be of a reasonable size (classical desktop sized)**
- **The QC design must be in line with the fabrication capabilities of Sandia[sic] labs, our design implementation collaborators**
- **QC must be capable of performing low-wnoise / interference ion transport along the trap.**
    - **Note: Software based "transport" (swapping) mechanisms exist, but are impractically error-prone.**
    - **Physical ion-transport is the standard, and minimal ion transport distance is prioritized to decrease error from noise exposure along the transport channel.**

Aesthetic:

- **There are no aesthetic requirements, as the design will most likely be virtual on our end, and at a nano-meter scale when implemented.**

User Experiential:

- **The design should theoretically work as expected, according to the rules of quantum computation.**
- **Control, error correction, and optimization of quantum gates and circuits need to reliably provide expected performance with minimal user overhead. Documentation on implementation of these features should be provided, but not necessary for use.**

Economic / Market:

- **There are no economic requirements**
- **There may be economic constraints**
    - **The ability to product QC-level components is not one that Iowa State possesses**
    - **We would need to utilize outside labor and outside funding to physically build any components**

        - **Labor in the form of Sandia[sic] labs, our design partner**
    - **We may or may not get far enough to prototype anything, but if we do, we will work within the constraints of any grants and financing we can get.**

Other:

- **Submit a patent for our design if successful**

1.2 Engineering Standards

What Engineering standards are likely to apply to your project? Some standards might be built into your requirements (Use 802.11 ac wifi standard) and many others might fall out of design. For each standard listed, also provide a brief justification.

Due to the nature of our design work, few existing standards will be utilized. The few that will be used are IEEE Quantum Standards

- **P1730 - Standard for Quantum Computing Definitions**
    - **Through the development of this computer, we must communicate effectively. Adhering to standard definitions will be a must**
- **P1731 - Standard for Quantum Computing Performance Metrics & Performance Benchmarking**
    - **At the end of the development of the computer, we will use standard benchmarking procedures in our simulations to evaluate the performance of our proposed design**