CS35L Presentation Script:

(Slide 1) Hello, my name is Jaehyung Park and my topic for the presentation is “This New Discovery Could Put Quantum Computers within Closer Reach”. **(Next slide)**

(Slide 2) Before I begin with, I want to briefly explain how a quantum computer works. Modern computers follow the Von Neumann Architecture which is shown on the right image. This architecture shows that a computer is consisted with a CPU that has a control unit and an arithmetic logic unit, a memory unit that stores data and instructions, and an input and output device. This architecture allows modern computers to have versatility that only requires to change the software to reuse the hardware. Quantum computers, however, uses a different type of microarchitecture that is based on Shor’s algorithm as its main quantum algorithm to aim for a specific purpose of computation, such as encryption or NP-complete problems. **(Next slide)**

(Slide 3) Unlike modern computers that use classical bits which are ones and zeros, quantum computers use quantum bits, or other known as qubits to do its computation. Qubits can be both zeros and ones at the same time, which makes quantum computers to show superior performance over modern computers. More specifically, a modern computer can process only 2 bits of information which are 0 and 1. But, with 2 qubits for example, a quantum computer processes a superposition of each of these four states, (00, 01, 10, 11). This allows qubits to contain four bits of information. This implies that N qubits are equivalent as 2^N classical bits, which is huge**. (Next slide)**

(Slide 4) So, all of this show that quantum computers are superfast that can immensely decrease the time to do complex computation, but there are some conditional drawbacks that needs to be fixed. One is the main processing chip has to be cooled close to absolute zero temperature to get quantum effects and two it needs to be shielded to take less Earth’s magnetic field for its stable performance. Now, researchers from Florida State University MagLab team discovered a new approach to drastically reduce the effect of Earth’s magnetic field by implementing the idea how noise canceling headphones work. **(Next slide)**

(Slide 5) So, what is the discovery? It is called the atomic clock transitions. Katherine Noyes from Computerworld mentioned “with carefully designed tungsten oxide molecules that contained a single magnetic holmium ion, the MagLab team was able to keep a holminum qubit working coherently for 8.4 microseconds” which makes it long enough to perform useful computational tasks. In molecular magnets level, this time is very long that can make a difference. **(Next slide)**

(Slide 6) The research is based on a powerful method that is applied to trapped ions in the context of frequency standards and autonomic clocks. This method is in use of particular spin transitions which are inherently robust to external perturbations. In other words, the electron spin qubits based on clock transitions mitigates the effects of magnetic or electric field noise arising from nearby interfaces. Since quantum computing processors are confined in a shielded container, the purpose is to reduce the effects of Earth’s magnetic or electric field that can cause bottleneck the performance and stability. **(Next slide)**

(Slide 7) So our question still remains, how does this discovery actually work? The results show that clock transitions in Si:Bi (Silicon:Bismuth) can be used to produce magnetic field-insensitive spin qubits with directly measured coherence times of several seconds. These qubits would be insensitive to magnetic field noise arising, which clock transitions can be designed to be immune from electric charge noise. Eventually, atomic clock transitions will allow quantum computing processors to be immune from the effects of electric fields. **(Next slide)**

(Slide 8) Since the atomic clock transition method is still in research, researchers are expecting some tangible improvements of quantum computing over the next few decades to be widely used in real life applications. There are parallel computing to increase performance and use this performance in military use. Lockheed Martin bought a D-Wave quantum computer couple of years ago for classified uses. Other applications are artificial intelligence, especially in machine learning and optimization to solve problems. Also, quantum computers will be in a great demand for encryption and code breaking and there are plans with NASA and Google to improve web search and make robots to hunt for exo-planets and optimizing air-traffic controls. **(Next slide)**

(Slide 9) And this is the reference page. Just an FRI, I would love to elaborate this whole topic in an easier way, but the journal is quite hard to understand and this is the best I could do. Thank you for listening.