Introduction to Jefferson Lab

What is Jefferson Lab?

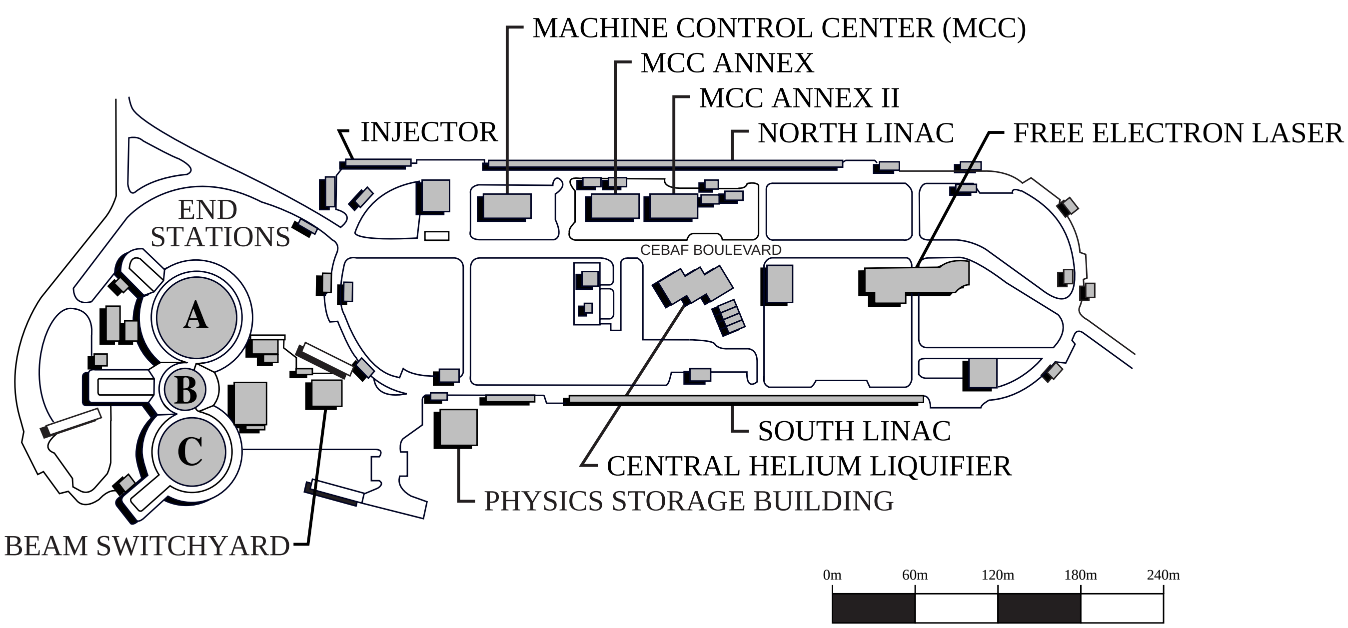
Jefferson Lab is a laboratory for basic research in nuclear physics. Nuclear physics is the science of studying the nucleus of the atom. Jefferson Lab also works with industry to develop technologies for businesses to use and with schools to motivate students and assist teachers.

Jefferson Lab's mission is to provide scientists around the world with opportunities to experiment with and learn more about nucleons.

Jefferson Lab's main instrument is a machine, called an accelerator, that is able to make electrons go really fast. The accelerator is in an underground, racetrack-shaped tunnel, 1.4 km around, that delivers a beam of electrons to experiments in three large experimental halls called end stations.

The facility is owned by the government's Department of Energy (DOE) and is managed by the Southeastern Universities Research Association (SURA). SURA is a group of 53 universities in fifteen southeastern states and the District of Columbia. SURA also manages other large research projects in the southeastern region of the United States.

About $600 million was spent over ten years to build the facility in Newport News, Virginia. Scientists from around the world are currently using Jefferson Lab's accelerator for experiments to study the nucleus of the atom. These experiments can take months to run. Once scientists complete their work at the lab they must analyze the data they have gathered. What they find out may change what we know about the structure of nuclear matter, making Jefferson Lab a vital instrument of the scientific world.



Exploring Nuclei at Jefferson Lab

Over eighty years ago, scientists described the atom as a nucleus with orbiting electrons. Later, the nucleus was found to contain protons and neutrons (nucleons). Now each nucleon is seen as a collection of three quarks.

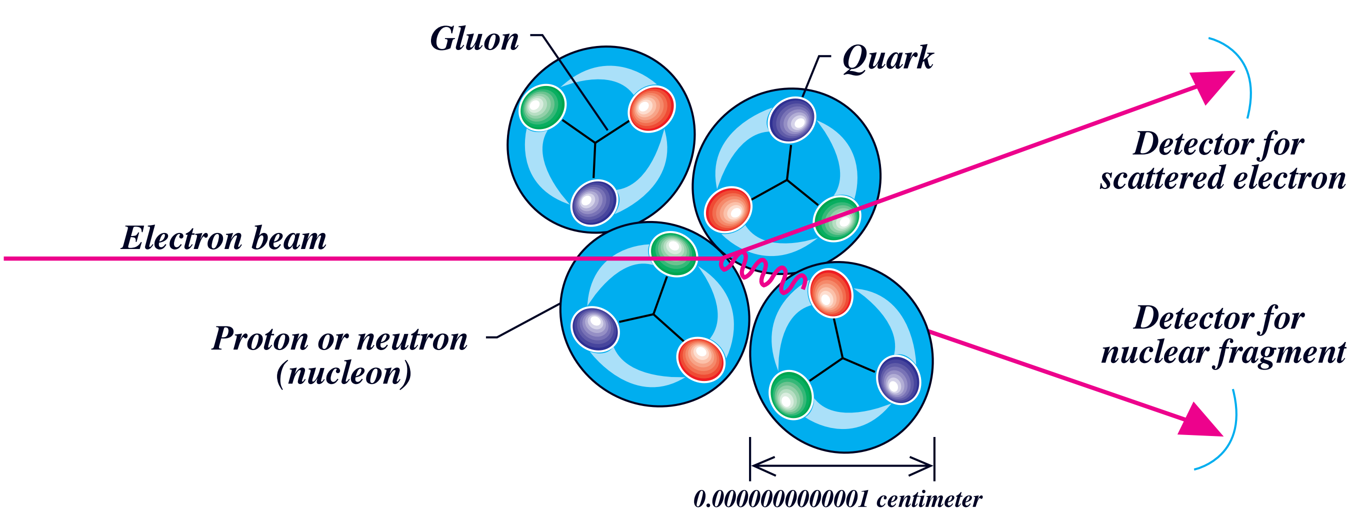
Scientists need Jefferson Lab to broaden their understanding of how quarks interact in the nucleus. Jefferson Lab provides scientists with beams of electron probes to explore the quark structure of the nucleus.

Point-like electrons can probe the nucleus with extreme accuracy. They interact cleanly with quarks in nuclear matter. The ‘fingerprint’ of each interaction - a deflected electron and one or more nuclear fragments - provides clues about the subnuclear world (see diagram below).

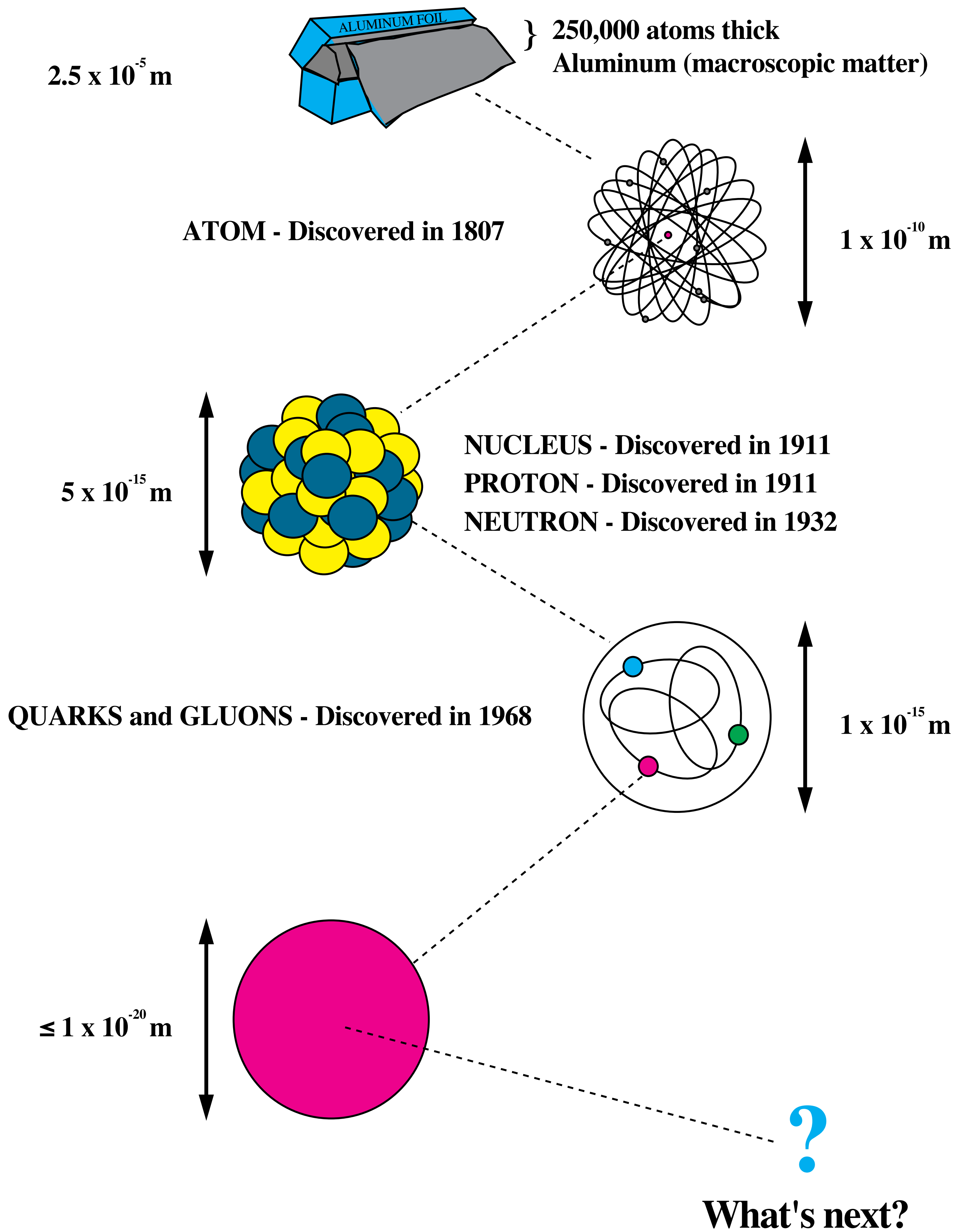
When the beam is directed through an experiment’s target - typically a small, thin sheet of material whose nuclei are under study - unimaginably tiny electron-quark interactions result. The exact interactions are the ‘fingerprints’ of the experiment. These interactions are recorded automatically by spectrometers and detectors in the end stations. Collecting the thousands to millions of fingerprints required for each experiment may take weeks or even months. Later, aided by computers, nuclear physicists use this data to understand the mysteries of nuclear structure.

Studying the world of the very small requires equipment that is very large. Jefferson Lab’s electron accelerator is 1.4 km around. The detectors used to ‘watch’ the experiments weigh thousands of tons each. Scientists use these huge machines to ‘see’ the quarks and gluons inside an atom’s nucleus - particles that are less than 0.0000000000001 cm across!

The main goal of Jefferson Lab’s scientific program is to understand the structure and behavior of the nucleus and its parts. Scientists use the electron accelerator to study how the nucleus and its pieces are put together and interact with each other. Jefferson Lab is like a powerful microscope used for studying the atom’s nucleus.



How Scientists' Ideas About Matter Have Changed



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