

## Annotated Bibliography

## Primary Sources

Butterworth, Jon. *Most Wanted Particle: The inside Story of the Hunt for the Higgs, the Heart of the Future of Physics*. New York: Experiment, LLC, 2015. Print.

This source is a book written by a researcher at the Large Hadron Collider (LHC) at CERN, specifically the ATLAS experiment. The book covers the search for the Higgs boson, or the particle thought to supply other particles with mass and to have played a role in the beginnings of the universe and matter as we know them today. I used this source for information about the significance of the Higgs boson discovery in 2011-2012 (research data collected in both years confirmed its existence), as well as thoughts on the future uses of how the Higgs boson may be put to use in particle physics. The book also helped me understand why the Higgs boson was named after Peter Higgs, a physicist who proposed the particle's existence, as well as how the Higgs particle is a step towards the expansion of common knowledge and human thirst for discovery.

CERN. *Convention for the Establishment of a European Organization for Nuclear Research: Paris, 1st July, 1953: as Amended*. Geneva: CERN, 1971 - 57 p. Print.

This source is a document accessed from a webpage containing conference proceedings which officially establish the European Organization for Nuclear Research. The source was used to highlight the purpose of the creation and research of CERN. It also helped me better understand the limits imposed on what was done with the research, such as the prohibition of any military-related assistance for any of CERN's member nations.

de Rose, François. "Meetings That Changed The World: Paris 1951: The Birth Of CERN." *Nature* 455.7210 (2008): 174. *Advanced Placement Source*. Web. 16 Oct. 2015.

This source is an article accessed from the Ebsco database. Written by the chairman of the Paris 1951 meeting at the UNESCO headquarters regarding the establishment of what would eventually become CERN, the source gives a firsthand report of conflicting opinions and resolution at the influential meeting, now viewed as the true beginning of CERN. I used this source to show the widespread cooperation and interest in the idea of a new particle physics laboratory, but also how financial deprivation of many of the countries, as well as the favoring of the use of existing regional laboratories, led to the opposition of the construction and maintenance of a new laboratory and equipment to be operated at such a facility. The source also gave insight on the meeting from the leading chairman, which helped me understand how the meeting unfolded, including the opposition and support for the creation of CERN, as well as how a consensus was reached and how plans for funding and construction were put into action.

Heuer, Rolf, and Pier Oddone. *Scientific Opportunity: The Tevatron and the LHC* (15 Sept. 2010). *CERN Document Server*. CERN, 6 Oct. 2014. Web. 04 Mar. 2016. <<http://cds.cern.ch/record/1291610?ln=en>>.

This source is an article accessed from the CERN document server that is written by the director-generals of CERN and Fermilab regarding public understanding that the two organizations were locked in fierce competition and trying to uncover the mysteries behind the Higgs boson before the other organization. The authors speak contrarily to this understanding, stating that CERN and Fermilab actually collaborate more often than not, and each organization has played a key role in some momentous event at the other, such as the discovery of the top quark at Fermilab or the construction of the LHC at CERN. I used this source to describe the relationship between the two physics laboratories and to show that the United States and Europe have continued to cooperate since the origins of CERN when Isidor Rabi proposed the establishment of such a laboratory in Florence. The article also amended my previous understanding that Fermilab and CERN were sworn rivals and did not collaborate in any way to achieve goals such as the discovery of the Higgs boson.

International Science Policy Survey Group. *Science and Foreign Relations: International Flow of Scientific and Technological Information*. Washington: Office of Public Affairs, Division of Publications, 1950. Print. General Foreign Policy Ser.

This source is an article explaining the influence of international scientific collaboration on the foreign policies of the United States following World War II. I used this source to illustrate how the US benefited from the revival of the European scientific community through the creation of an international laboratory. The source helped me to realize that the main influences of US support of CERN came from the desire of political stability and security, as well as economic welfare, among other points.

Kowarski, L. "The Making Of CERN--An Experiment In Cooperation." *Bulletin Of The Atomic Scientists* 11.10 (1955): 354. *Science Reference Center*. Web. 16 Oct. 2015.

This source is an article accessed from the Ebsco database. Written by physicist Lew Kowarski less than a year after the official establishment of CERN, the article illustrates the beginnings of CERN, from the first meetings to the provisional stages to the official ratification process. The article also gives Kowarski's thoughts on the future success of CERN and how it has already become a focal point in European collaboration and cooperation in high-energy physics. I mainly used this source to collect background information, as well as information about early cooperation across national governments. The source also furthered my understanding about the communication efforts between different countries and amongst different professions, such as the many exchanges between physicists and financialists.

Lippincott, Sara. "A Conversation With Valentine L. Telegdi – Part I." *Physics In Perspective* 9.4 (2007): 434. *Advanced Placement Source*. Web. 25 Jan. 2016.

This source is an article accessed from the Ebsco database containing a personal interview with physicist Valentine L. Telegdi about his life in physics and his endeavors which took him from Europe to the United States and back again, at which point Telegdi worked at CERN for a short period of time. I used this source to provide an example of one of many physicists who traveled back to their home continent to work at CERN after World War II. Telegdi states in his reasons for returning to Europe that CERN was “well funded” and provided him and other physicists with advanced equipment to do research. The personal interview gave a firsthand account of what job opportunities in physics were like during the war, and gave me insight on how these opportunities and the war itself influenced physicists’ decisions during and after the war regarding the location of their studies.

"Marshall Plan Announced." Harvard University, Cambridge. 5 June 1947. *History.com*. Web. 21 Jan. 2016.  
<<http://www.history.com/topics/world-war-ii/marshall-plan/speeches/marshall-plan-announced>>.

This source is an audio recording accessed from a website of Secretary of State George C. Marshall initiating the Marshall Plan in a speech at Harvard University on 5 June 1947. In his speech Marshall talks about the purpose of his plan - to rebuild European economy and maintain international political stability through this economic reconstruction. I used this source to highlight the purpose of the Marshall Plan and to show how the purpose served as part of the foundation for Isidor Rabi’s initiative at the Fifth General Conference of UNESCO in 1950. The speech helped me understand how the United States, despite its openness to assisting European countries, refused to help any country that would restrict the reconstruction of another.

Noyes, Dan. "About CERN." *CERN Accelerating Science*. CERN, 19 Jan. 2012. Web. 2 Nov. 2015. <<http://home.cern/about>>.

This source is a webpage on the CERN website containing a timeline of the influential events in CERN’s history. Clicking on the timeline gives one access to a detailed overview of the history of CERN, from its origins in the late 1940s to the recent discovery of pentaquarks in 2015. Many of the timeline entries have accompanying images, such as a paper with the signatures of the delegates from the twelve founding member states to ratify the CERN convention and officially establish the organization. I used this source to find information on CERN’s Proton Synchrotron (PS) and how it was a key advance in particle physics at the time. The source also helped me understand the order in which CERN’s accelerators were inaugurated and decommissioned, and how each contributed to CERN’s overall objective: to research and to solve the mysteries of the early universe. I also used the timeline to gain a basic overview of CERN’s creation, from the formation of the provisional CERN in 1952 to the establishment of the official organization in September 1954.

O'Lunaigh, Cian. "The Birth of the Web." *CERN Accelerating Science*. CERN, 11 Dec. 2013. Web. 1 Nov. 2015. <<http://home.cern/topics/birth-web>>.

This source is a webpage explaining how Tim Berners-Lee, a scientist at CERN, created the World Wide Web in 1989. This development has drastically influenced the world as we know it today by allowing for mass distribution and unclassified viewing of information worldwide. I used this source to provide an example of CERN's legacy and how the organization has contributed to modern global society. It also helped me understand the purpose of the first web server and how the web was released for public use.

O'Lunaigh, Cian. "The Higgs Boson." *CERN Accelerating Science*. CERN, 21 Jan. 2014. Web. 9 Nov. 2015. <<http://home.cern/topics/higgs-boson>>.

This source is a webpage from the CERN website on the Higgs boson. The article basically states that the Higgs was discovered on 4 July 2012 at CERN's Large Hadron Collider, and the source was solely used for this information. I also came to understand how the Higgs relates to modern particle physics and how Peter Higgs and François Englert, particle theorists who proposed the idea of a "Higgs field", of which the Higgs boson is a carrier, were awarded the Nobel Prize as a result of this discovery.

Schopper, Herwig. "CERN's Early History Revisited." *Physics Today* 58.4 (2005): 87. *Advanced Placement Source*. Web. 16 Oct. 2015.

This source is an article accessed from the Ebsco database, and is the first of three letters to the editor on influential figures in the establishment of CERN. The letter is written by a former director-general of CERN, and gives credit to Isidor I. Rabi as well as many renowned European physicists who supported Rabi's initiative and helped to create CERN, including some Nobel Prize laureates. This source was used for background information, such as the initial purpose behind CERN's creation and how World War II influenced Rabi's initiative. It also gives a quote from Rabi stating that the creation of the atomic bomb "had a large part in making CERN possible...", which helped me understand how recent advances in physics paved the way for CERN's creation.

"The Significance of Cern." *CERN Document Server*. N.p., 29 Mar. 2006. Web. 9 Nov. 2015. <<https://cds.cern.ch/record/938897?ln=en>>.

This source is an audio recording accessed from the CERN document database, containing a speech by CERN Director-General Victor F. Weisskopf from 1976. Weisskopf talks about the political, economic, and social influence that CERN had on Europe in its early years as an international organization. I used this source as a reference for early impacts of CERN in the context of World War II, such as the reunification of Europe's scientific community and the division of the cost of research equipment so as not to endanger any specific country economically. The source also gave me a firsthand account of CERN's significance from a leader of the organization.

United Nations Educational, Scientific and Cultural Organization (UNESCO). *RECORDS OF THE GENERAL CONFERENCE OF THE UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION - FIFTH SESSION - FLORENCE, 1950*. Paris: UNESCO, July 1950. Print.

This source is a compilation of the resolutions put forth and adopted at the Fifth General Conference of UNESCO in Florence, Italy, in 1950. The document was accessed from the UNESCO database. I used the records for Isidor Rabi's initiative and resolution in particular, as Rabi's proposal triggered the series of events that would eventually culminate in the creation of CERN. I discovered that Rabi advocated for international European physics laboratories to improve and restrengthen European physics collaboration in the wake of World War II. The size of the document also helped me gain insight on the surplus of issues UNESCO had to deal with around the time period that the idea that would become CERN was first proposed.

## Secondary Sources

Aczel, Amir D. *Present at the Creation: The Story of CERN and the Large Hadron Collider*. New York: Crown, 2010. Print.

This source is a book about the Large Hadron Collider at CERN, how it was created, how it operates, and what scientists and researchers hope to accomplish through the use of the “ultimate particle accelerator”. I used this source as a reference for information on how CERN scientists, from CERN’s creation in 1954 until present day, have explored subatomic particles for peaceful purposes, and how they have exchanged their findings with the world and each other. The book also gave some historical context information, such as J. J. Thomson’s discovery of the electron in 1898, and some background on the creation of CERN. It helped me understand the inner workings of CERN and how multiple diversified teams “compete” against each other in a friendly, productive, collaborative fashion, while at the same time gathering crucial information on what the universe was like in its early moments.

Bailey, Ellen. "Enrico Fermi." *Enrico Fermi* (2006): 1-3. *History Reference Center*. Web. 31 Oct. 2015.

This source is an article accessed from the Ebsco database that gives an overview of Enrico Fermi, credited to be the “father of the atom bomb”. The source was used to gather information about Fermi and how he influenced the trajectory of nuclear physics during the end of World War II and the beginning of the Cold War. I also came to understand how Fermi was able to make a name for himself after immigrating to the United States and stemming from a family that could not afford a high-quality education.

"CERN." *Britannica School*. Encyclopædia Britannica, Inc., 2015. Web. 26 Oct. 2015. <<http://school.eb.com/levels/high/article/22146#>>.

This source is an article accessed from the Britannica database which gives an overview of CERN, its history, its achievements, and its purpose. I used the source to gain basic information on the topic, such as the change in the name of the organization (from “Conseil Européen pour la Recherche Nucléaire” to “Organisation Européen pour la Recherche Nucléaire”) and the size of the CERN laboratory in Geneva. This source also helped me solidify my knowledge of the purpose of CERN’s existence and the notable accelerators in the organization’s history.

"Cold War." *Britannica School*. Encyclopædia Britannica, Inc., 2015. Web. 31 Oct. 2015. <<http://school.eb.com/levels/high/article/24721>>.

This source is an article accessed from the Britannica database that gives an overview of the Cold War, its origins, the happenings in the countries involved, and its end. I used the webpage to pinpoint the “pinnacle” of the Cold War, from 1948 to 1953. I came to understand that in that time period the international tensions between the democratic

United States alliance and the Communist Soviet alliance as both countries began inching closer and closer to armed conflict though never actually reaching that point.

"The Cold War." - *John F. Kennedy Presidential Library & Museum*. N.p., n.d. Web. 01 Nov. 2015. <<http://www.jfklibrary.org/JFK/JFK-in-History/The-Cold-War.aspx>>.

This source is a webpage that describes the Cold War and John F. Kennedy's influence on the United States' role in the international tensions. I used this source as an overview of the Cold War and its beginnings, such as how the Soviets assumed control over Eastern Europe with their Communist regime while the United States and the United Kingdom worked to preserve traditional government control in Western Europe. This gave me an understanding of the context of CERN's existence and why the creation of CERN was such an influential step in the reunification of Western European countries.

"Empedocles." *Britannica School*. Encyclopædia Britannica, Inc., 2016. Web. 19 Jan. 2016. <<http://school.eb.com/levels/high/article/32550>>.

This source is an article accessed from the Britannica database which gives a description of the ancient Greek Empedocles, known for his theory of the four elements, which was favored and accepted by the world until the turn of the nineteenth century. I used this source to gain an overview of who Empedocles was and what he accomplished to provide context for the birth of particle physics. I also came to understand how Empedocles theorized that nothing is created or destroyed, but instead that everything is transformed, a theory humans still acknowledge today.

"Ether." *Britannica School*. Encyclopædia Britannica, Inc., 2016. Web. 16 Mar. 2016. <<http://school.eb.com/levels/high/article/33121>>.

This source is a concise article accessed from the Britannica database which summarizes the origins, role in pre-19th century physics, and eventual disregard of the classical element called "ether" or "aether", focusing mainly on ether's undetectability and virtual transparency. I used this article to display how the theory of the existence of ether was created and introduced by Aristotle and how it became the fifth classical element along with earth, water, air and fire. The webpage also revealed to me the invalidation of the ether element specifically, and how its invalidation paved the way for Albert Einstein to develop his theory of relativity with no restrictions that would have been brought on by the existence of ether.

"Fermi National Accelerator Laboratory." *Britannica School*. Encyclopædia Britannica, Inc., 2015. Web. 22 Nov. 2015. <<http://school.eb.com/levels/high/article/34056>>.

This source is an article accessed from the Britannica database that gives an overview of Fermilab, an American particle physics laboratory in Illinois. The webpage briefly explains the establishment of Fermilab, named after renowned physicist Enrico Fermi, and the organization's achievements, including the construction and use of the Tevatron,

for a while the world's most powerful particle accelerator with maximum energies of up to about 1 teraelectron volt. I used this source to give an example of an organization that rivaled CERN's scientific endeavors and to show why America supported the existence of CERN but did not decide to actively participate in the international physics activity conducted at CERN. The source also helped me understand that until Fermilab's establishment in the 1960s and the inauguration of the Tevatron in the 1980s, CERN was close to unrivaled in advances in particle physics research.

Giudice, Gian Francesco. *A Zeptospace Odyssey: A Journey into the Physics of the LHC*. Oxford: Oxford UP, 2010. Print.

This source is a book about the Large Hadron Collider and the expectations that particle physicists have for the new particle accelerator. The source also talks about how the LHC is a step in the direction of a new age in discovery and research. I used this source to illustrate how the LHC is not to be used solely for discovery, but also for answers to questions and debates yet to be solved. The source was also key in helping me understand how physicists used previous theories, such as the theory of the existence of the Higgs particle, to predict what will be discovered at the LHC.

Halpern, Paul. *Collider: The Search for the World's Smallest Particles*. Hoboken, NJ: John Wiley & Sons, 2009. Print.

This source is a book explaining the purpose of the Large Hadron Collider at CERN and predicting what mysteries the machine will reveal in its lifetime. The book also talks about particle accelerators and colliders before the LHC and the laws and forces of physics that drive the colliders. I used this source as a reference for some of CERN's first colliders and how the technologies at CERN have developed since the organization's establishment, as well as some controversy over developments at the LHC between physicists and the general public, namely the fear that microscopic black holes would be produced during research and swallow up the world. The book helped me to better understand CERN's initial methods of finding out more about the universe, such as early accelerators like the Proton Synchrotron (PS). I also found information on how CERN's founders, including Isidor I. Rabi, were against the idea of a military-based organization and did not approve of the destructive use of any research conducted at CERN, especially in the wake of the Second World War.

Herd, Alex. "Cold War." *The Canadian Encyclopedia*. Historica Canada, 6 Feb. 2006. Web. 2 Nov. 2015. <<http://www.thecanadianencyclopedia.com/en/article/cold-war/>>.

This source is a webpage that gives an overview of the Cold War and Canada's position during the Cold War. I used this source to strengthen my historical context regarding the Cold War and to make note of the collapse of the previously sturdy Soviet-American alliance that crumbled into opposing viewpoints. The webpage also helped me understand what points of interest influenced this collapse, such as diplomacy (democracy vs. Communism).

Hermann, Armin, John Krige, Ulriche Mersists, Dominique Pestre, and Lanfranco Belloni. *Vol. 1: Launching the European Organization for Nuclear Research*. Amsterdam: North Holland, 1987. Print.

This source is a book explaining in depth the history of the European Organization for Nuclear Research, from its first beginnings through the provisional stage of its existence to the ratification of its twelve founding member states in 1953 and 1954. The source highlighted the influential conferences in the establishment of CERN, including the Fifth General Conference of UNESCO, at which Isidor Rabi proposed his initiative to construct a nuclear physics laboratory in Western Europe. The book also contained a brief section on historical context, mainly how high-energy accelerator physics had developed over time up to the origins of CERN. I used this source to make note of how not all of Europe's scientists approved initially of the idea of a supranational organization for particle physics and how many believed that there was an easier method for European scientific reintegration. The source also helped me in understanding the reactions from each participating country to each conference held for the establishment of CERN and the opinions expressed by different countries at such conferences.

"Higgs boson." *Britannica School*. Encyclopædia Britannica, Inc., 2015. Web. 3 Sep. 2015. <<http://school.eb.com/levels/high/article/40396>>.

This source is an article accessed from the Britannica database which gives an overview of the Higgs boson, a subatomic particle thought to make other particles massive. The webpage was used to gain basic information on the Higgs, such as how it was named after Peter Higgs, a physicist who proposed the existence of a mass-bestowing "Higgs field" in 1964. I also used this source to acquire a basic understanding of what the Higgs particle means for physics, such as what it explains and what laws of physics it dictates.

Khan, Sameen Ahmed. "CERN's Early History Revisited." *Physics Today* 58.4 (2005): 87. *Advanced Placement Source*. Web. 16 Oct. 2015.

This source is an article accessed from the Ebsco database, and is the second of three letters to the editor on influential figures in the establishment of CERN. The letter talks about physicist Edoardo Amaldi and his contributions to the organization, and highlights as well early skepticism and opposition to Amaldi's and CERN's initiative. I used this source to broaden my range of people in the history of CERN beyond Isidor Rabi. The letter helped me understand how Amaldi assisted other physicists and called meetings to complete crucial steps in the making of CERN.

Krige, John. "CERN's Early History Revisited." *Physics Today* 58.4 (2005): 89. *Advanced Placement Source*. Web. 16 Oct. 2015.

This source is an article accessed from the Ebsco database, and is the third of three letters to the editor on influential figures in the establishment of CERN. The letter gives credit

and respect to the previous two entries and reminds readers of the author's intent on describing Isidor I. Rabi's influence on CERN's creation. I used this source to show that Rabi abided by the previously instituted Marshall Plan and Schuman Plan, designed to rebuild the demolished European economy after World War II, when proposing his initiative to establish CERN. The letter also helped me understand how Rabi was opposed to the idea that CERN would be used for military purposes, and how he stressed that all research done at CERN would be publicized and used for peaceful advances in particle physics.

Krige, John. "I. I. Rabi And The Birth Of CERN." *Physics Today* 57.9 (2004): 44. *Advanced Placement Source*. Web. 21 Oct. 2015.

This source is an article accessed from the Ebsco database which elaborates on Isidor I. Rabi's influence on the creation of CERN. I used this source to gather information on the historical context of the time period of CERN's establishment and on Rabi, credited to be the "father" of CERN. The source was also used to highlight how America was involved with the creation of CERN, a European organization, and why Rabi was the person to propose CERN's establishment even though he was not a European. The article also helped me understand Rabi's motivation behind lobbying for the creation of a multinational physics lab in Europe, as well as the status of particle physics during World War II and the Cold War.

Krige, John. "The Influence of Developments in American Nuclear Science on the Pioneers of CERN." (1983): *CERN Document Server*. Web. 25 Jan. 2016.  
<<https://cds.cern.ch/record/151765/files/CERN-CHS-1.pdf>>.

This source is an article accessed from the CERN document server about how advances in American physics and other nuclear sciences affected the judgment of European physicists who were influential in the creation of CERN. The author explains that America served as a model and a resource for the European physics community, but also a threat to young physicists and the community itself in the aftermath of the Second World War and the beginning of the Cold War. I used this source to show that many of Europe's physicists did end up being drawn to the United States for its advances in physics, referred to now as the European "brain drain". The article also gave me the understanding that American physics advances had a positive affect as well as a negative effect on the European community, and that physicists such as Isidor Rabi and company took both sides of the issue into account when making decisions.

Krige, John. "Isidor I. Rabi And CERN." *Physics In Perspective* 7.2 (2005): 150. *Advanced Placement Source*. Web. 30 Sept. 2015.

This source is an article accessed from the Ebsco database describing Isidor I. Rabi's involvement and initiative in the creation of CERN. The article stresses Rabi's adherence to the Marshall and Schuman Plans and how he shaped his initiative around the aims of the two plans: to reunify and reconstruct the Western European governments and

economy. This article was used to highlight those purposes of Rabi's initiative. The source also helped me understand how Rabi's plan for CERN would combat the Communist regime that had taken control of Eastern Europe during the Cold War.

Lecuyer, Christophe, and David C. Brock. "From Nuclear Physics To Semiconductor Manufacturing: The Making Of Ion Implantation." *History & Technology* 25.3 (2009): 193. *Advanced Placement Source*. Web. 27 Oct. 2015.

This source is an article accessed from the Ebsco database that elaborates on ion implantation, its origins in nuclear physics, and how it was used in the manufacturing process. I used this source specifically to gather information on Robert Van de Graaff, a physicist from MIT, and how he built signature "Van de Graaff" accelerators for the United States during World War II. This helped me understand how particle physics and particle accelerators gradually emerged in the 1930s and 1940s, all culminating into the creation of CERN and the United States-based Fermilab.

Lincoln, Don. *The Large Hadron Collider: The Extraordinary Story of the Higgs Boson and Other Stuff That Will Blow Your Mind*. Baltimore: Johns Hopkins University Press, 2014. Print.

This source is a book published after the discovery of the Higgs boson that elaborates on the Large Hadron Collider and the events leading up to the discovery of the particle thought to bestow mass on other particles. The source also had a small section dedicated to a concise history of CERN, which I used to gather information about early accelerators at CERN and how their turn-ons propelled CERN into the global scientific spotlight. The source also helped me understand how CERN reunified the countries of Europe after the continent was swept by war and destruction.

"Manhattan Project." *Britannica School*. Encyclopædia Britannica, Inc., 2016. Web. 19 Jan. 2016. <<http://school.eb.com/levels/high/article/50535>>.

This source is an article accessed from the Britannica database which gives an overview of the Manhattan Project, which produced and detonated the first atomic bombs during World War II. The article also gives information about the funding and leadership for the project, as well as scientists involved in the project such as Albert Einstein and J. Robert Oppenheimer. I used the source to provide evidence on how the United States used the Manhattan Project to become the first country to wield the power of the atom in such a way that entire cities could be demolished, as evident by the bombings of Hiroshima and Nagasaki, and I came to understand how America's detonation of the atomic bomb made the country the most powerful country in military force and gave them a near monopoly on atomic warfare until the detonation of the first Soviet atomic bomb a few years later.

"North Atlantic Treaty Organization (NATO)." *Britannica School*. Encyclopædia Britannica, Inc., 2015. Web. 1 Nov. 2015. <<http://school.eb.com/levels/high/article/56176>>.

This source is an article accessed from the Britannica database which gives an overview of NATO, short for the North Atlantic Treaty Organization. The article was used to acquire historical context during CERN's creation and to give an additional example of post-World War II European collaboration through the establishment of an international organization. It helped me to understand that there were other ongoing projects in fields other than science and physics whose aims were to reintegrate the war-torn countries of Europe and resist the impending Soviet threats brought on by the Cold War.

"Particle accelerator." *Britannica School*. Encyclopædia Britannica, Inc., 2015. Web. 31 Dec. 2015. <<http://school.eb.com/levels/high/article/108531>>.

This source is an article accessed from the Britannica database that describes the properties of a particle accelerator and its uses in society, including nuclear physics. I used the article to acquire a brief overview of what a particle accelerator does and how its function relates to nuclear physics. I also came to understand how particle accelerators are used in professions other than subatomic physics, such as radiography and radiation therapy.

Perritano, John. "How CERN Works." *HowStuffWorks*. HowStuffWorks.com, 1 July 2008. Web. 2 Nov. 2015. <<http://science.howstuffworks.com/science-vs-myth/everyday-myths/cern1.htm>>.

This source is a webpage which gives an overview of CERN, its history, its purpose, and its latest achievements, particularly the discovery of the Higgs boson. I used the webpage to explain the reasons CERN exists, which are to explore the secrets of particle physics and to solve the mysteries of the universe immediately after the Big Bang, and how CERN has worked towards this goal through the construction of high-energy accelerators such as the Large Hadron Collider. The source also helped me understand how the CERN community has expanded and developed to encompass 21 member states, and how the central leadership at CERN functions.

"Physics." *Funk & Wagnalls New World Encyclopedia* (2014): 1p. 1. *Funk & Wagnalls New World Encyclopedia*. Web. 31 Oct. 2015.

This source is an article accessed from the Ebsco database that gives a description of the concept of physics, its history, its uses, and key events in its development. The source was used to collect examples of advances in physics, such as the discovery of the neutron by Sir James Chadwick in 1932. This helped me understand what events leading up to and during World War II resulted in the opportunity of making CERN to utilize these new discoveries.

Rigden, John S. "Isidor Isaac Rabi." *Great Lives From History: Scientists & Science* (2012): 738. *Science Reference Center*. Web. 30 Sept. 2015.

This source is an article accessed from the Ebsco database in which a description of Isidor I. Rabi is given, including his background, his work in atomic physics, and his contributions to both American and European physics. I used this source to show that before his involvement with CERN, Rabi supported and helped strengthen the American physics program to match their European competitors, and only after the Second World War did he switch gears and support the European scientific community. I also came to understand how Rabi used science to promote international peace and cooperation.

Sample, Ian. *Massive: The Missing Particle That Sparked the Greatest Hunt in Science*. New York: Basic, 2010. Print.

This source is a book about Peter Higgs and his theory of a “god particle” that gave other particles mass, what we now know today as the Higgs boson. I used this source minimally as an example of a setback that CERN encountered in the process of building the Large Electron-Positron collider (LEP) and how the fact that CERN straddled the French-Swiss border led to detriments from some of the surrounding community. I also came to understand how different land ownership laws in different countries can affect the construction of a facility that spans the border between the two nations.

"Sir Tim Berners-Lee." *Britannica School*. Encyclopædia Britannica, Inc., 2015. Web. 15 Nov. 2015. <<http://school.eb.com/levels/high/article/389930>>.

This source is an article accessed from the Britannica database, which gives an overview of Sir Tim Berners-Lee, the father of the World Wide Web, including his background in computing and his involvement with CERN. I used this source to provide supporting information for the creation of the Web, which changed modern society and allowed for the nearly limitless exchange of information. The source also helped me understand how Berners-Lee took up computing due to his parents’ involvement in the construction of the first commercially utilized computer.

"Subatomic particle." *Britannica School*. Encyclopædia Britannica, Inc., 2015. Web. 3 Sep. 2015. <<http://school.eb.com/levels/high/article/108593>>.

This source is an article accessed from the Britannica database that describes subatomic particles, how they operate, how they were discovered, and how they are put to use today. I used this source to acquire information about the origins of particle physics and early theories regarding what subatomic particles were known to exist at the time. From this I could understand how older theories, such as P.A.M. Dirac’s quantum field theory, were challenged by the discovery of new particles, such as the discovery of the positron (anti-electron) by Carl Anderson in 1932. I also used this source to show how the birth of particle physics and particle theory contradicted popular belief of the constitution of all things by the four universal elements (earth, water, air, fire).