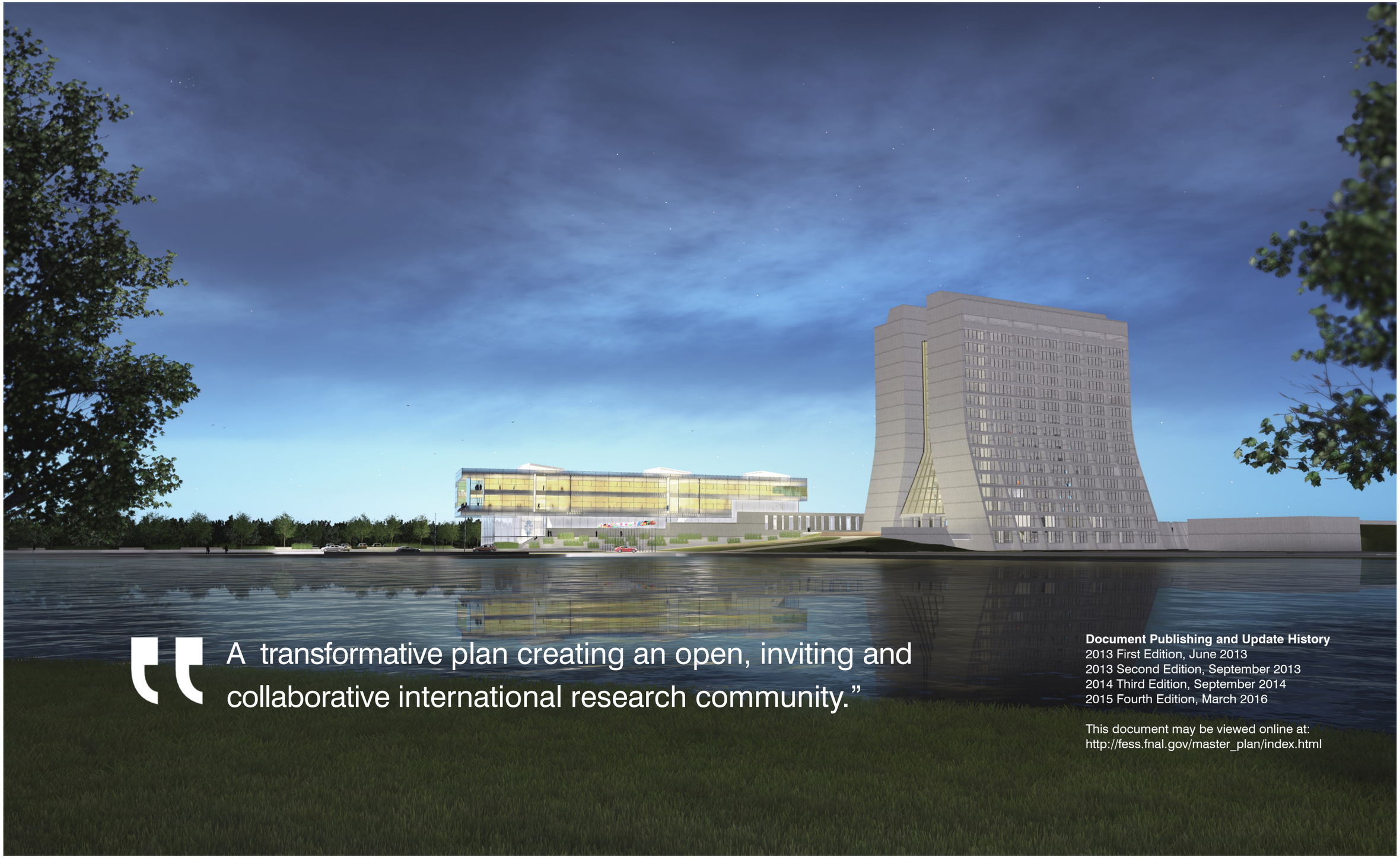
Fermilab

2015 campus master plan

U.S. DEPARTMENT OF ENERGY | Office of Science

Fermi Research Alliance LLC



"A transformative plan creating an open, inviting and collaborative international research community."

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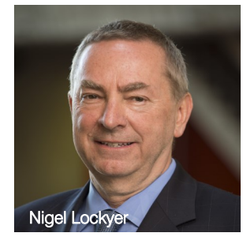
Nigel Lockyer

Michael Weis

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Director's Statement

The Fermilab Campus Master Plan presents a vision for how to centralize, consolidate and modernize the facilities of a laboratory hosting a world-leading, accelerator-based neutrino program. The plan's implementation will position Fermilab as one of the top research destinations of choice for present and future generations of particle physicists.

Fermilab will be a place where researchers and staff easily connect, work collaboratively and exchange ideas in their quest to lead, inspire and enable scientists from all over the world. Just as we look to our strategic laboratory plan to direct the laboratory's scientific program, we look to the Campus Master Plan for providing a place to make the scientific program possible.

Nigel Lockyer, Fermilab director

DOE Perspective

The implementation of this plan will solidify Fermilab's position as the dedicated United States particle physics laboratory and ensure its capability to remain a vital national asset and one of the leading laboratories worldwide. The plan connects the land, equipment facilities and resource planning to the Department of Energy's scientific mission, fulfilling the DOE Office of Science stewardship role while integrating the vision for the future of high-energy physics into a master plan for the campus.

Michael Weis – DOE Fermi Site Office manager

Jim Siegrist – DOE Office of Science associate director for high energy physics

Nigel Lockyer

Michael Weis
DOE Fermi Site Office Man-

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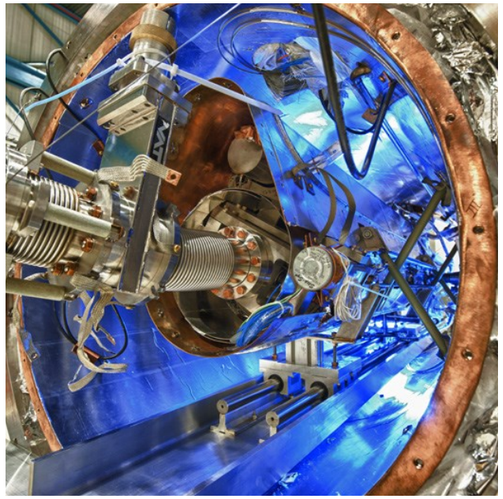
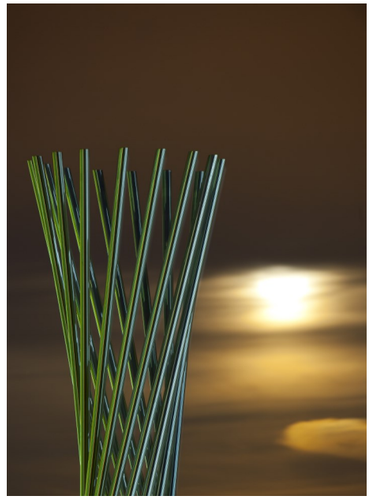
1 Introduction





Fermilab explores the universe, captures imaginations and inspires future generations.

foreword

What are we made of? How did the universe begin? What secrets do the smallest, most elemental particles of matter hold, and how can they help us understand the intricacies of space and time? Since 1967, Fermilab has worked to answer these and other fundamental questions to enhance our understanding of everything we see around us.

However, much has changed in the world of basic science research since 1967. The system of national laboratories, made up of the places where answers are researched, is undergoing a transition. The postwar laboratory model, expressed in scattered, dark and narrow bunker-like places, is giving way to open and transparent international centers for generating and sharing knowledge.

The Fermilab Campus Master Plan presents a transformative plan to create an open, inviting and collaborative international research community for 21st-century science.

Charting a path for the transition, it establishes the framework and the key elements of the Fermilab campus, reflecting a vision for future development. It synthesizes the collective goals and aspirations for the laboratory, giving them form and organization, and defines a realistic plan for implementation.

The plan is organized in three parts. Part one introduces the laboratory and provides background information, campus geography and planning context. Part two presents campus wide initiatives to organize and design the campus for future development. Part three describes development projects culminating in an international research community, with the scientific tools and supporting infrastructure to enable the next generation of world-leading research.

> The Fermilab Campus Master Plan presents a vision for how to centralize, consolidate and modernize, with the goal of hosting a world-leading accelerator-based neutrino program."
>
> Nigel Lockyer, Fermilab director

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background

The campus

About the laboratory

Fermilab, the only U.S. national laboratory dedicated totally to particle physics, was founded in 1968. Fermilab's 1,700 employees and 2,000 scientific users advance humankind's understanding of matter, energy, space and time by carrying out a world-leading program of discovery. The laboratory's core skills include experimental and theoretical particle physics; astrophysics; and accelerator science; R&D for accelerator and detector technologies; the construction and operation of large-scale facilities; and high-performance scientific computing.

Fermilab is managed by the Fermi Research Alliance LLC, an organization made up of the University of Chicago and a consortium of 86 universities. All of the laboratory's buildings are owned by the U.S. Department of Energy. The usage is predominantly divided among research and development space and administrative facilities.

The laboratory is home to one of the largest accelerator facilities in the world, including a powerful accelerator complex, test accelerators and infrastructure for the development of accelerator technologies. The laboratory's accelerator complex produces the world's most powerful high-energy beam of neutrinos, mysterious subatomic particles studied by scientists around the globe. It also provides intense beams that allow scientists to study ultrarare processes in nature. Its staff and users build, operate and lead experiments to investigate dark matter, dark energy and ultrahigh-energy cosmic rays. Additionally, Fermilab is a U.S. hub for research at the Large Hadron Collider and for R&D for the next generation of particle accelerators and detectors for use in science and society.

By the numbers

The Fermilab Campus occupies 6,800 acres of primarily farmland 42 miles west of Chicago in Batavia, Illinois. The land was purchased by the state of Illinois and turned over to the Atomic Energy Commission (a precursor to the Department of Energy). The site includes hundreds of buildings totaling about 2.4 million gross square feet of space. The laboratory includes 122 acres of parking lots and hundreds of miles of utility infrastructure, including roads, electrical, natural gas, industrial cooling water, potable water and sanitary systems.

Buildings and sculpture

Laboratory founder Robert Wilson helped design the centerpiece of the site, the stately 16-story Robert Rathbun Wilson Hall, inspired by a Gothic cathedral in Beauvais, France. The building serves as a central meeting place, housing the laboratory's cafeteria and the campus' largest concentration of offices. Adjoining Wilson Hall to the south is the 830-seat Norman F. Ramsey Auditorium, which hosts numerous talks and cultural events. Wilson also influenced the unique design and character of several other founding-era buildings and structures on campus and created several of the site's iconic sculptures.

Natural setting

But structures make up just a small portion of the Fermilab site. The campus includes over 2,500 acres of natural areas such as tallgrass prairie, oak savanna, open water marsh, sedge meadow and floodplain forest. These rich and diverse ecosystems provide habitat for many kinds of wildlife, including upwards of 300 species of birds, numerous uncommon butterflies, dragonflies and other insects, thriving populations of amphibians and reptiles, and mammals such as coyotes and mink. Visitors to the site enjoy hiking, fishing, bird watching, bicycling, cross-country skiing and photography.

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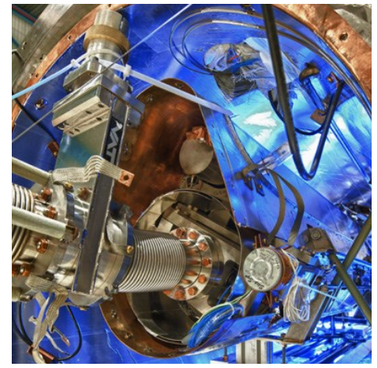
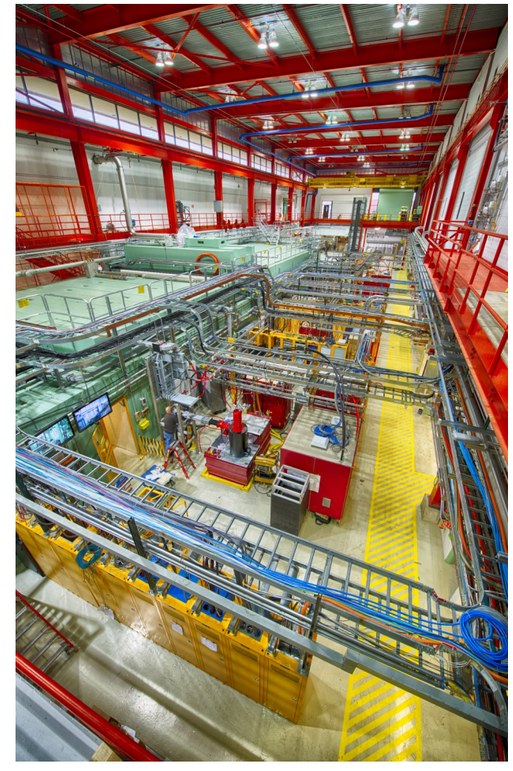
What people value most about Fermilab

Science



Particle physicists explore the building blocks of matter to answer questions all of us have asked ourselves.



Fermilab has been at the forefront of particle physics for more than 40 years. Integral to Fermilab's far-reaching mission, in its singular role as America's particle physics laboratory, is the building and operation of world-leading scientific facilities.

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International community and worldwide reach

The people of Fermilab form an international community of scientists, engineers and support staff. Intellectual curiosity is energized by sharing a zeal for discovery and by working collaboratively and cooperatively on common goals.

As an international center for particle physics research, Fermilab's scientists work with thousands of physicists around the world to conduct experiments probing the nature of matter, energy, space and time.

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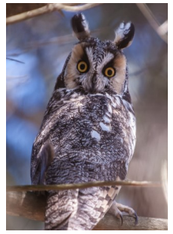
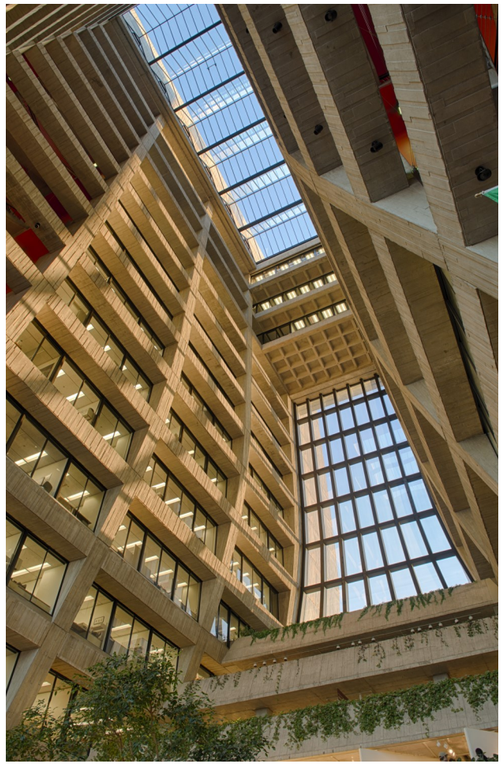
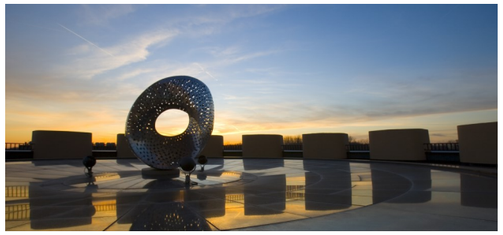
Ecology

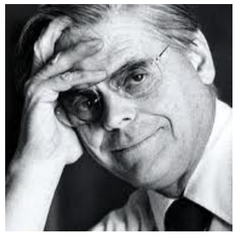


Fermilab's 6,800-acre site has become an island of green, surrounded by residential, commercial and light industrial activity. Because of its nature preserve quality, Fermilab's neighbors view it as a positive ecological and environmental asset to the region. Fermilab is very accessible and is regularly visited by our neighbors for recreation and simply to enjoy the natural landscape. Hiking, fishing, bird watching, bicycling, cross-country skiing and photography are some of the activities enjoyed by visitors.

Art and architecture







> I have always felt science, technology and art are importantly connected…"
>
> Robert Wilson, Fermilab founder

Fermilab's respect for art and architecture is rooted in the founder's philosophy. "I have always felt science, technology and art are importantly connected; indeed, science and technology seem to many scholars to have grown out of art. In any case, in designing an accelerator, I proceed very much as I do in making a sculpture."

Robert Wilson, Fermilab founder

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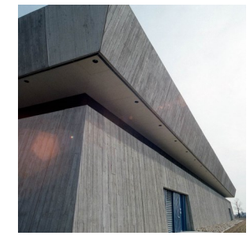
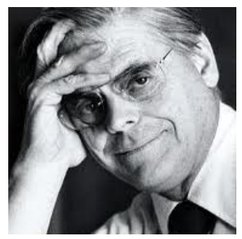
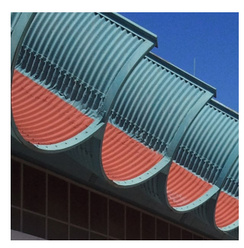
History of campus development



1968

1970s

1980s

"A building is not just a place to be, it is a way to be." Frank Lloyd Wright

1990s

2000s

2010s

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campus geography

Developed regions

Introduction

How did the campus come to be? What has influenced its current configuration? The campus geography is a combination of both natural and manmade influences. In 1967 the 6,800 acres were purchased by the state of Illinois. The land was later transferred to what is now the Department of Energy for the creation of Fermilab. The area was largely farmland, with the exception of the small town of Weston, Illinois. The town, now known within Fermilab as the Village, became the headquarters for the administration and construction of the newly formed laboratory. Existing single-family homes on the site were repurposed, relocated and grouped to serve as offices, laboratories and residences. Premanufactured barn-like structures were erected in the Village to temporarily house machine shops and development facilities. This is where planning and construction of the accelerators, permanent buildings and utility systems that form the backbone of today's Fermilab took place. A system of roads evolved from the existing rural road network, and new roads were created to reach the accelerators and research buildings.

Meanwhile efforts began, and continue today, to address the many opportunities presented by the open, undeveloped land. While a vital asset for future accelerator construction, this land has become an important natural setting of diverse habitat communities and ecological areas.

Then, as now, the laboratory geography is a combination of natural setting, research buildings, accelerators, roads and utilities. The series of maps on the following pages illustrate the components that form the campus.

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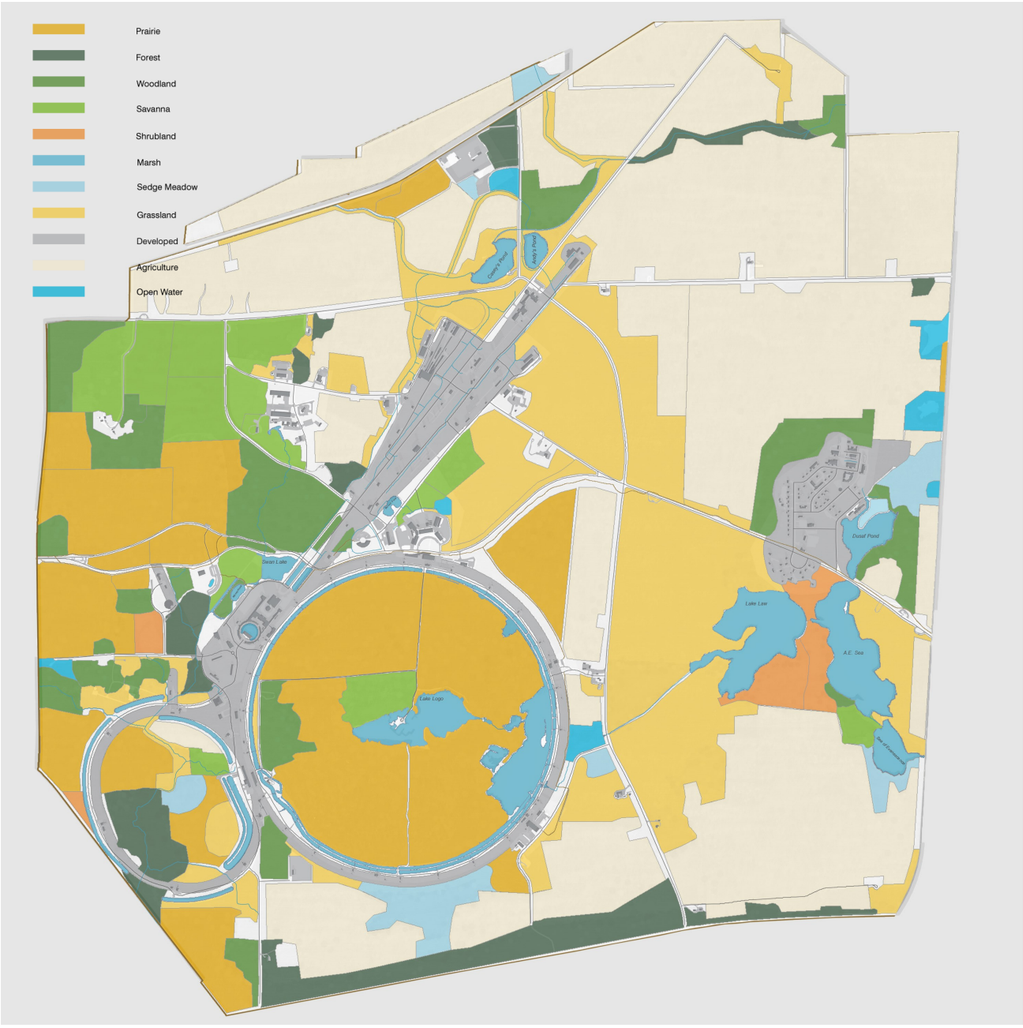
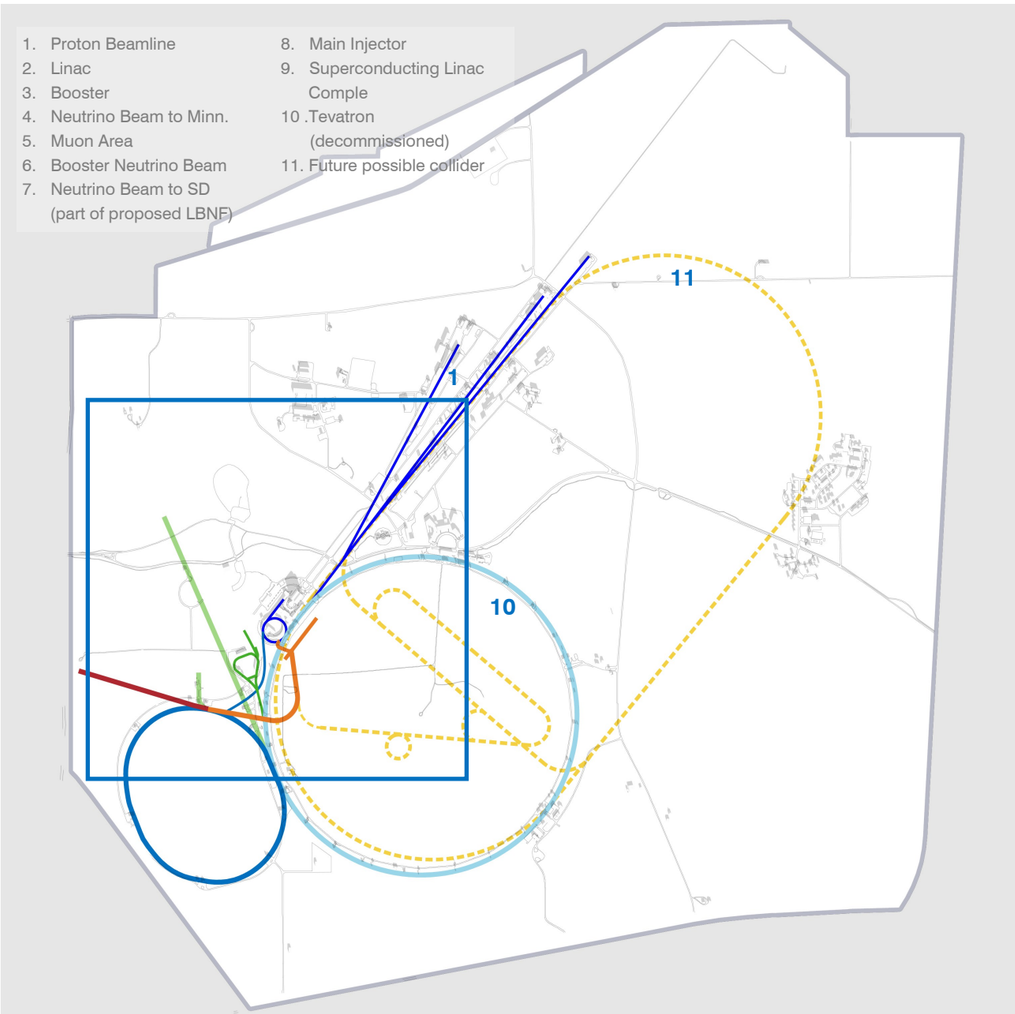
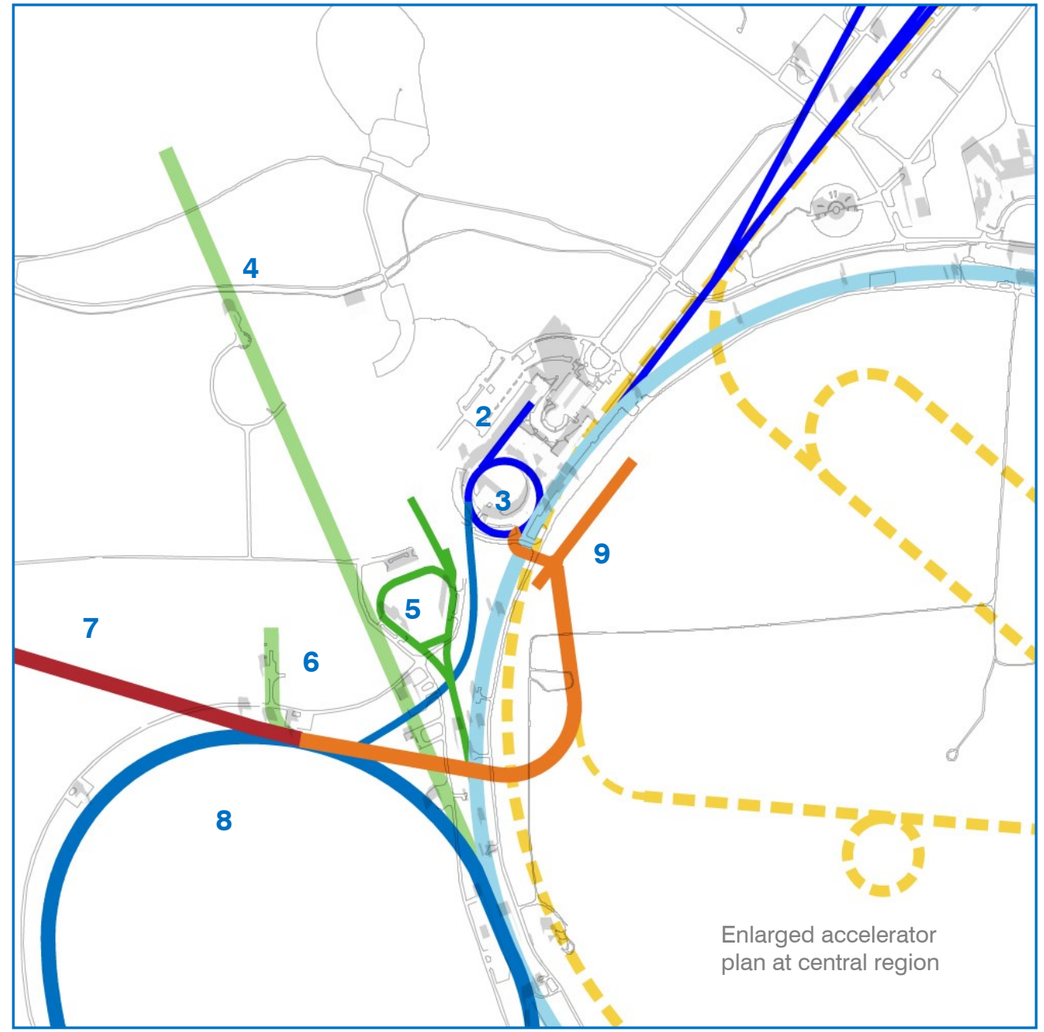
Habitat communities



Ecologically sensitive areas

Accelerator complex





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planning context

Introduction

A plan is a set of actions conceived to achieve some desired outcome. To create a master plan, the desired outcome must be clearly understood.

Twenty-first-century science needs a 21st-century laboratory. What does that mean? How will it look and feel? How is it organized? What does it imply about the current state of the laboratory? Where does the lab fall short? What is missing?

To provide answers, the Fermilab master planning team developed the guiding principles for the Campus Plan. These seven principles provide the underpinning ideals for the plan. They bring the values, needs and qualities envisioned for a 21st century laboratory.

A second valuable resource for planning context are the themes described in the laboratory strategic plan. These themes, developed by Fermilab management, describe Fermilab's core competencies. The competencies help to direct the planning process and priorities. The themes are summarized on page 27.

The planning team embarked on a critique of the current campus to understand how it measured up to the guiding principles. This critique was approached from two directions. The first was internal. We engaged Fermilab staff and management on the campus' needs and its direction for the future. The second involved gaining outside perspectives. Fermilab management engaged the services of John Ronan Architects, a noted Chicago design firm. Ronan provided observations based on his expertise of state-of-the-art campus and building design. Outside critique and working sessions were also conducted with the university architect from the University of Chicago. The resulting *Current Perspectives on the Campus: A Self-Critique* represents the outcome of these studies.

Finally, planning context looks briefly at the state of the current campus infrastructure: roads, utilities, transportation and circulation.

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Guiding principles

Support cutting-edge research

The laboratory strategic plan describes how to use the laboratory's existing world-class accelerators and infrastructure and build new capabilities to support groundbreaking particle physics and accelerator science research. Campus planning and development projects will be driven by the priorities delineated in this strategic plan.

Enhance the campus experience

Fermilab's campus shall contain a diversity of inviting, accessible and safe places for the enjoyment and interaction of staff and visitors. Improvements will be made to pedestrian walkways and bicycle paths to increase safety, improve functionality and enhance opportunities for cultural and social engagement.

Reinforce community

Central to the scientific mission is the desire to foster a sense of community. The Campus Plan shall enhance the community building aspects of the laboratory by designing buildings and open spaces that bring together researchers and staff. This should result in the creation of vibrant centers of laboratory life, fostering the free exchange of ideas and enabling teamwork and collaboration.

Ensure the campus is welcoming and informative to local and international visitors

Fermilab has a long and important legacy as a place for science education and community outreach. An enriching experience for visitors is an important element of Fermilab's mission. The Campus Plan should provide a welcoming entrance and clear designation of visitor areas. The planning and design of the campus should consider the visitors, education and outreach in all aspects. Displays should promote the unique qualities of the site and explain what it has to offer in terms of science and nature.

Promote stewardship

Fermilab shall respect and manage the physical environment of its campus facilities and lands for the health and well-being of the laboratory, its staff, users, neighbors and visitors, and the ecosystems supported by the laboratory. Facilities should be designed and built in accordance with applicable guidelines for state-of-the-art sustainable design and energy conservation.

Ensure integrative planning and design

The planning and design of the campus shall integrate disciplines, connect communities, and coordinate scientific and supporting development with mobility, wayfinding, landscape and infrastructure initiatives.

Uphold the unique character of Fermilab

Fermilab has a tradition of architectural innovation and excellence defined by the founder's vision of "a utopian place" where physicists from around the globe could work in functional surroundings reflective of the magnificence of their discoveries and theories. This is evident in the design of many of its founding-era buildings and structures, representing architectural innovations for their time. The Campus Plan should perpetuate the founding vision while acknowledging what has changed in terms of science, values and performance since the founding of the laboratory.

Laboratory strategic planning themes

Neutrino science

A major aim of the Fermilab neutrino science program is to establish the first-ever large-scale international science facility hosted by the United States. The primary goal is to establish a flagship facility, the Long-Baseline Neutrino Facility, for a world-leading neutrino science program. The program needs high-power, high-energy neutrino beams, a short-baseline neutrino program, and R&D to develop the capabilities to build and operate LBNF and its associated experiment, the Deep Underground Neutrino Experiment, or DUNE.

Accelerator science

Accelerator science at Fermilab includes three core competencies: highest-intensity proton beams, highest-field superconducting magnets, and highest-gradient and highest-quality-factor accelerator cavities. Besides continuing R&D in these areas, the core competencies are used to advance accelerator facilities, develop new test facilities and support U.S. industrial competitiveness.

Large Hadron Collider science

Large Hadron Collider science includes goals dependent on laboratory capabilities to advance science at the energy frontier. Goals involve the lab's leadership role in the CMS collaboration, technological contributions to the LHC accelerator and CMS detector upgrades, and R&D for accelerator technology and the physics program of future colliders.

Precision science

Precision science involves experiments with muons that have the potential to lead physics to a low-mass Higgs boson, indicate the existence of new dark sectors responsible for dark matter, study nonstandard neutrino interactions and indirectly probe energy scales as high as 10^4 TeV.

Cosmic science

Cosmic science goals include exploration of cosmic acceleration through large-scale surveys to determine the nature of dark energy, studying the cosmic microwave background, leveraging lab expertise to advance the search for dark matter, and serving as a hub for cosmological data and data analyses.

Computational science

Computational science enables Fermilab's world-renowned scientific research program through leadership and excellence in scientific software and computing. Goals include the provisioning of common experiment analysis and DAQ frameworks, simulation tools and advanced computing fabric solutions, including both hardware and software. Computational science advances the scientific software and computing capabilities of Fermilab through close partnerships with Department of Energy's Advanced Scientific Computing Research program and helps drive the National Strategic Computing Initiative.

Building for science

Building for science is a crosscutting theme that includes goals for improving performance in projects and project management, adapting the organization to satisfy future needs, fostering innovation, and revitalizing lab facilities and infrastructure.

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Self critique: current perspectives on the campus

Fermilab employees and visitors appreciate the spirit in which the campus was originally designed and would like it upheld.

The laboratory should continue to recognize and enhance the founder's utopian vision, on which Fermilab was based and which informed its early design.

Some of the founding spirit seems to have been lost in the utilitarian and backward-looking design of the post-founding-era buildings and utilities.

Site development and building design during the post-founding era has been implemented around economy-oriented limitations and replications of the original buildings. This process has resulted in a site populated by rather nondescript, utilitarian structures.

Many of the founding-era buildings are not conducive to the workplace expectations of current and future generations of researchers.

Many of the early buildings do not prioritize quality of life or contribute a sense of place. Many of the buildings housing scientists and staff members feel as if they were designed from the outside in, prioritizing image or representation over improving experience and quality of life. They do not have usable outdoor spaces or clear and welcoming entrances.

Generally speaking, the campus is not pedestrian-friendly.

Similar to many offices and industrial campuses developed in the postwar period, the Fermilab campus was designed and meant to be experienced by automobile. Minimal accommodations exist for pedestrian travel. This conflicts with the sense of community Fermilab seeks to create among its scientists and staff members.

Some of the existing buildings tend to dominate, as well as distract from, the laboratory's natural landscape.

The natural landscape is a significant identifying characteristic of the Fermilab campus, making it unique among laboratories. The design of current buildings is not well integrated into the landscape.

Many of Fermilab's aging and inadequate facilities will need to be updated or replaced to accommodate the laboratory's scientific program plan.

Fermilab requires additional high-quality industrial, high-bay and other technical spaces to accommodate the laboratory's scientific program.

The campus has a haphazard feel due to the scattered nature of the structures, roadways and utilities about the site.

The organizational principle guiding the siting of buildings is unclear and lead to a rather random and dissonant overall character.

The visitor experience needs improvement.

Visitors on campus need to have a more welcoming and informative experience. The campus has weak entry points that are easily missed and do not convey a sense of arrival. The overall entry sequence is not a welcoming experience.

Public areas of the campus are not distinguished from private areas, and it is not clear which campus areas and buildings are open to the public and which are off limits.

Additionally, it is difficult for an outsider to understand what happens at Fermilab, and it is currently possible to pass through the site unaware that any scientific research is taking place.

Fermilab needs to facilitate a more international and collaborative environment.

From its founding in the village of Weston, Illinois (now the Village), Fermilab has developed in a geographically dispersed manner. This barrier to collaboration extends to our scientist guests, who often come from abroad for both short- and long-term visits. During their stay at the laboratory, they should feel that they are an active part of the laboratory's research environment, a goal that is currently blocked by their wide physical separation from the scientific centers of the laboratory.

The laboratory should use space efficiently.

The laboratory should strive toward alignment with comparable research institutions, generational and industry reference points and national laboratory trends. Additionally, buildings tend to be categorized by organization and divisions thereby not taking advantage of the possibilities and benefits of shared space.

The main entrance needs improvement.

The main entrance at Pine Street, aside from the sculpture “Broken Symmetry” by Robert Wilson, is unimpressive and disorienting to the uninitiated. One is not sure whether he is allowed to enter, and there is minimal indication as to what Fermilab is.

The vehicular circulation and wayfinding is inadequate and confusing.

The transportation and circulation system also present a number of challenges. The roadway layout was initially based on pre-existing rural roads. New roads were then added to access the experiments. Additionally, raised-earth berms shielding the Main Ring and linear accelerators, along with new and planned berms, interrupt roads and require alternative circuitous routes to get around campus.

Building identification and wayfinding signage throughout the site is minimal, inconsistent and inadequate.

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Infrastructure

Site utility systems

Effective and reliable site infrastructure to support the research community and the tools for science are vital to achieve Fermilab's mission. Currently, the primary distributions systems for utilities on the Fermilab site include domestic water, industrial cooling water, sanitary sewer, natural gas, electrical power, telecommunication and computing. The site has one central utility plant, the CUB, that provides both hot and chilled water to Wilson Hall and associated buildings in the campus' central district.

Here is a simple overview of the system by the numbers:

- 2 primary electrical substations
- 241 secondary substations
- 115 miles of underground electrical cable
- 3 miles of overhead transmission lines
- 27 miles of underground industrial cooling water piping
- 19 miles of underground domestic water piping
- 14 miles of underground sanitary piping
- 18 miles of underground natural gas piping

Two major utility upgrade projects are under way to address some of the challenges. One is the high-voltage electrical upgrade, replacing the Master Substation building and associated components, located about a quarter mile north of Wilson Hall. The other is the industrial cooling water upgrade, which involves the installation of a new ICW backbone-piping network from Casey's Pond to the Main Ring ICW system.

Many upgrades, improvements and repairs have been ongoing pursuits at Fermilab since its founding. However, as Fermilab is nearing its 50th anniversary, and as major new beamlines and accelerators are under development for the future, utility infrastructure will present challenges.

Transportation and circulation

Fermilab has an extensive system of 36 miles of roadway, connecting 122 acres of parking. The layout, largely based on pre-existing rural roads, has evolved to include additional roads as needed to access the experiments.

The campus has three entrances. The Pine Street entrance on the west is the main entrance and is marked by the sculpture "Broken Symmetry" by Robert Wilson. The Batavia Road entrance on the east is a major employee entrance for those traveling from the east. The Wilson Street entrance, at the northwest corner of the site, is primarily used for delivery, service and construction vehicles.

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Vision: What could Fermilab look like in twenty years?

The Campus Plan is based on a long-term vision of what the Fermilab Campus can become and how it might look, feel and function 20 years from now.

State of the art

Buildings will be state of the art places representing and furthering the advancement of Fermilab's ongoing research.

Welcoming and international

Campus improvements will continue to transform Fermilab into an ever more welcoming and international community of researchers.

Open and green

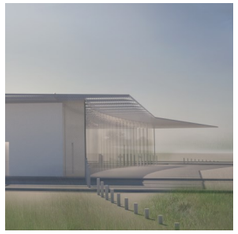
Consolidation of buildings will help preserve Fermilab's rich and diverse natural areas and make available other areas for future large-scale physics machines.

Consolidated and integrated

Currently diffuse facilities will be condensed into the central campus. Creativity and innovation will flourish as researchers and staff mingle in this distinct and vibrant place of research and collaboration.

Connected and engaged

The campus will be connected by various modes of transportation: walking, biking and, possibly, a campus shuttle.



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