



**Fermi National Accelerator Laboratory**  
INTENSE MidTerm Review Meeting, June 24, 2022  
Emanuela Barzi



# Fermilab is America's particle physics and accelerator laboratory

We bring the world together to solve the mysteries of matter, energy, space and time.



Wilson Hall

# Fermilab at a glance

## America's Particle Physics and Accelerator Laboratory

As the United States' premier particle physics laboratory, we do science that matters.

### FERMILAB PROCUREMENT FY18

**\$183 M<sup>+</sup>**

U.S. SPENDING

**\$63 M<sup>+</sup>**

ILLINOIS SPENDING

**\$58 M<sup>+</sup>**

SMALL BUSINESS CONTRACTS

### USER FACILITIES

Fermilab Particle Accelerator Complex

U.S. Hub for the CMS Experiment at the Large Hadron Collider at CERN

### FOR MORE INFORMATION

Email: [fermilab@fnal.gov](mailto:fermilab@fnal.gov)  
[www.fnal.gov](http://www.fnal.gov)

**\$437 M**  
BUDGET IN FY18

### MAJOR PARTNERSHIPS

#### Deep Underground Neutrino Experiment

World's flagship neutrino experiment with more than 1,000 scientists from over 30 countries

#### PIP-II particle accelerator

215-meter-long particle accelerator to be constructed at Fermilab with major international contributions

#### LCLS-II X-ray Laser

Design and construction of 19 superconducting cryomodules needed for the LCLS-II X-ray laser at DOE's SLAC laboratory

#### Quantum Science

Apply expertise and knowledge in quantum systems in collaboration with industry and other research institutions

**4,800<sup>+</sup>**



Employees, scientists from across the U.S. and over 50 countries use Fermilab's accelerators, detectors and computing facilities each year

**31,000<sup>+</sup>**

Students in K-12 programs

**2,300<sup>+</sup>**

PhDs based on research at the lab

**230<sup>+</sup>**

Teachers attending workshops

### FLAGSHIP LBNF / DUNE PROJECT

**\$1 B<sup>+</sup>** ECONOMIC OUTPUT

Estimates based on first decade of planning, construction and operations

**\$500 M<sup>+</sup>**

LOCAL EARNINGS

**\$20 M<sup>+</sup>**

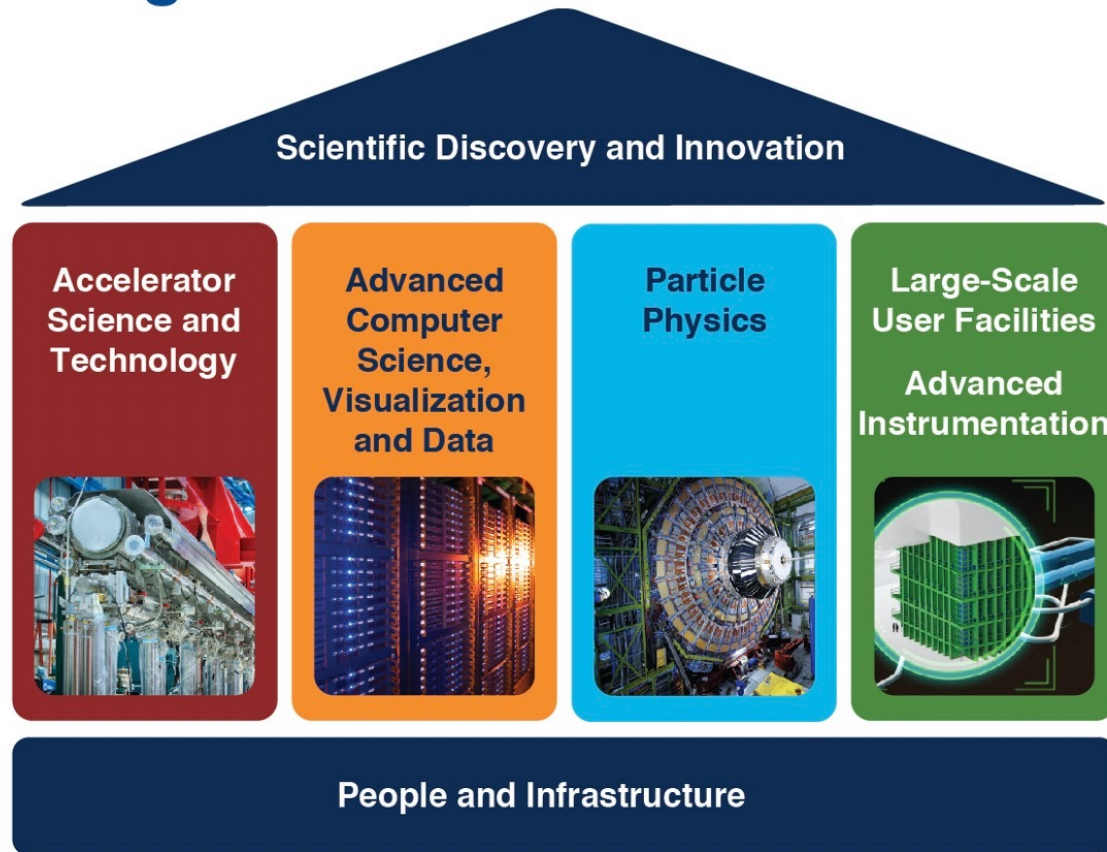
ILLINOIS TAX REVENUE

**6,800 acres**

including restored, tall-grass prairie

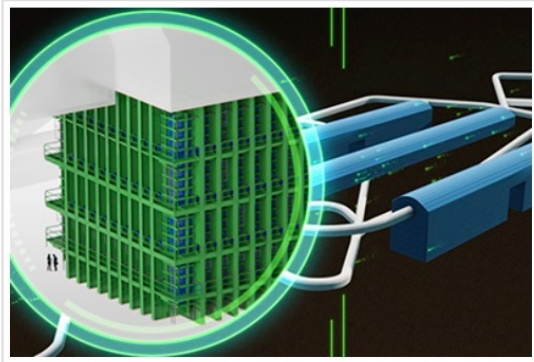
Celebrating **50** years of science & technology

# Fermilab Program



Make the best use of lab core capabilities + people + infrastructure to strengthen the field of particle physics in the U.S. and host the world to advance scientific discovery and innovation

## NEUTRINOS



These tiny particles, studied in world-leading Fermilab experiments, could be key to a deeper understanding of our universe. The flagship experiment will be the Deep Underground Neutrino Experiment, to be conducted at the future Long-Baseline Neutrino Facility.

## FERMILAB AND THE LHC



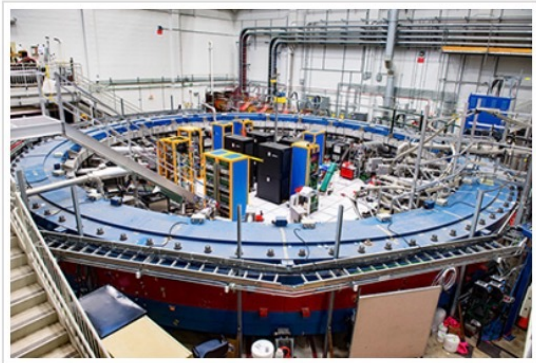
Fermilab scientists play a significant role in LHC research, particularly in the CMS experiment.

## DARK MATTER AND DARK ENERGY



Fermilab scientists were some of the first to bring together the worlds of astrophysics and particle physics to study topics such as dark matter and dark energy.

## MUONS



Particles called muons could help scientists see hidden or rare processes in the subatomic realm.

## MORE FUNDAMENTAL PARTICLES AND FORCES



Experiments at Fermilab use cutting-edge accelerator and detector technology to learn the secrets of elementary particles and forces.

## THEORY



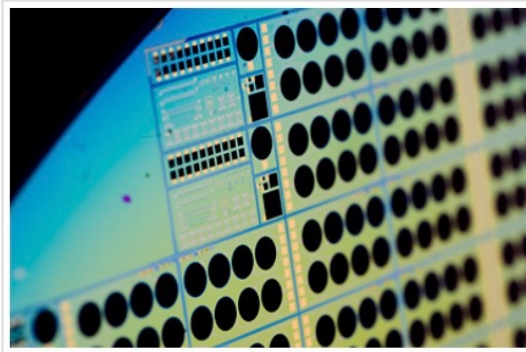
The advancement of particle physics research depends on the partnership between theory and experiment.

## SCIENTIFIC COMPUTING



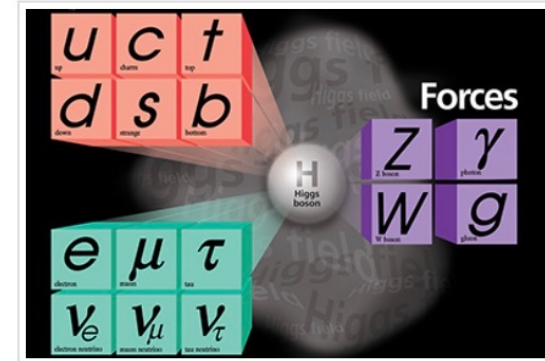
Experimental particle physics demands state-of-the-art computing facilities and computing experts to make them work.

## RESEARCH & DEVELOPMENT



Fermilab's R&D programs develop new technologies to meet the challenges of particle physics research.

## KEY DISCOVERIES

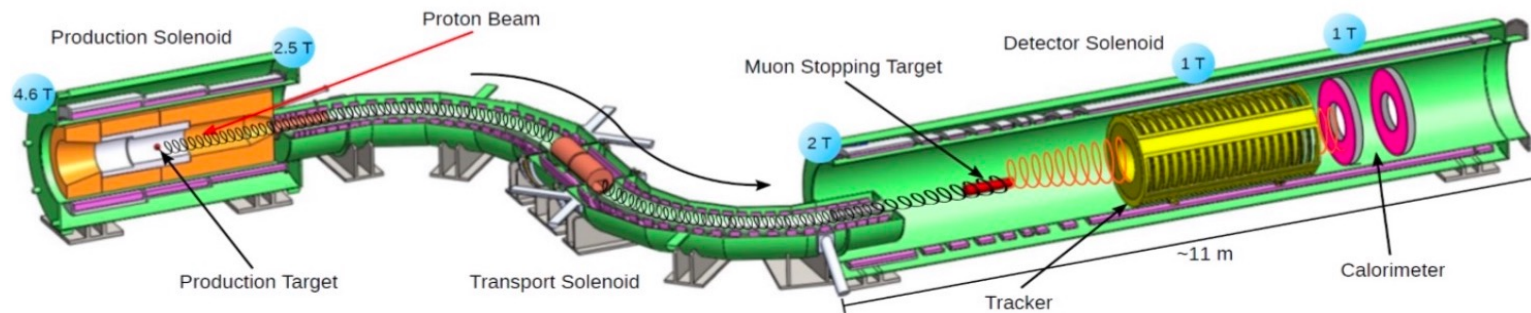


Fermilab has already played an important role in developing our understanding of the universe on the smallest and largest scales.

# Fermilab Muon Campus

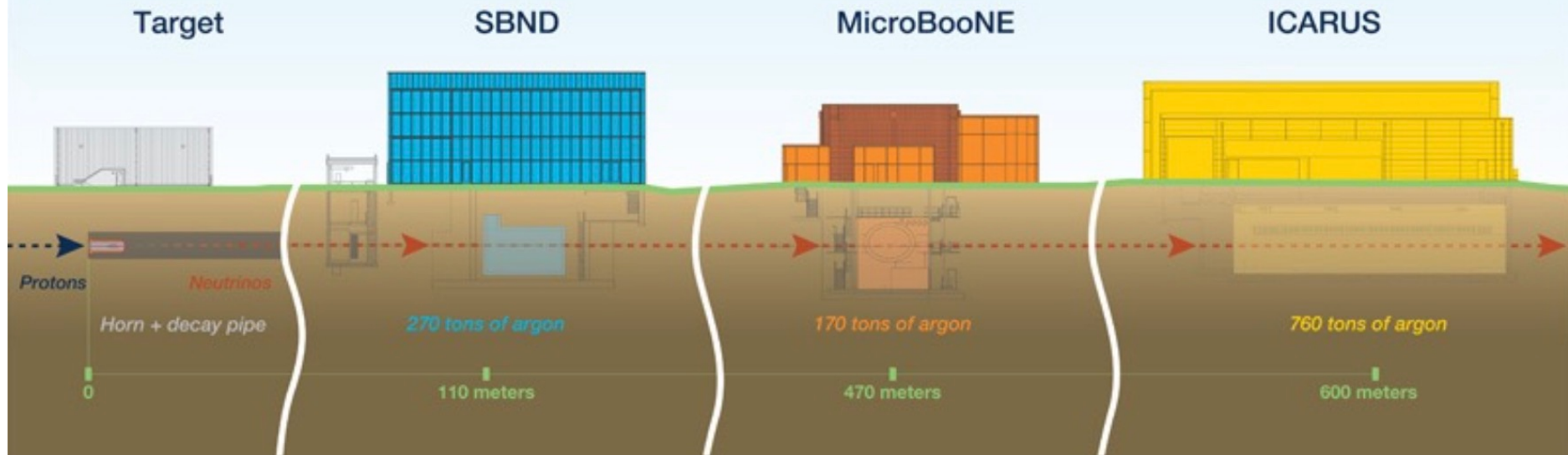


## Muon-to-electron conversion Experiment (Mu2e) at Fermilab





# Short-Baseline Neutrino Program at Fermilab

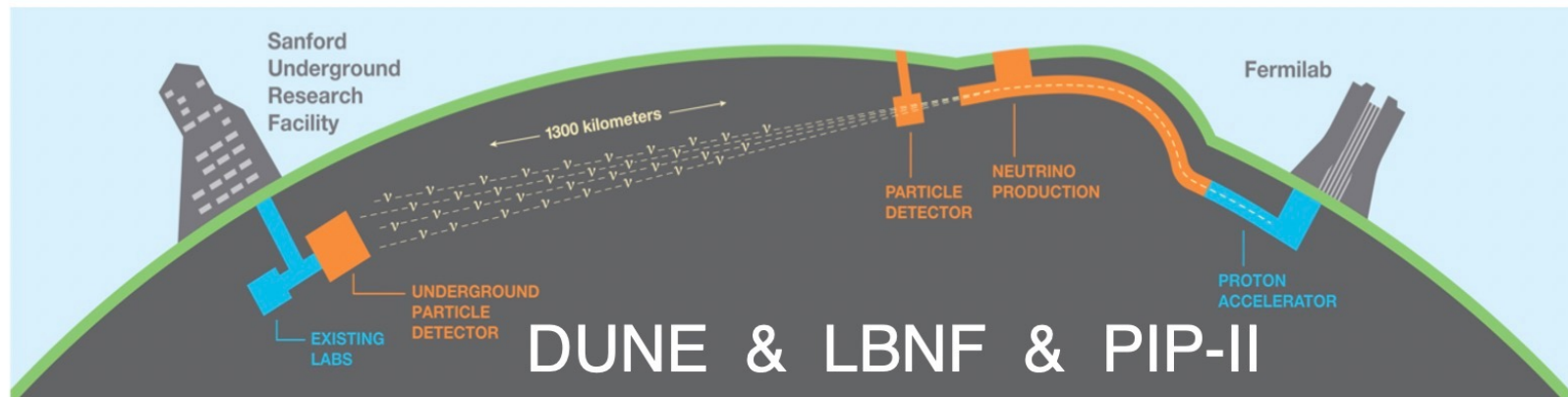




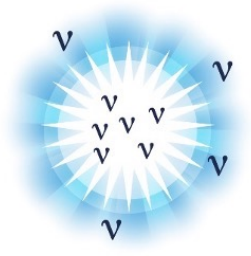
# Building for Discovery

## Strategic Plan for U.S. Particle Physics in the Global Context

- Lab strategic plan is aligned with the P5 Plan
- Fermilab's primary 10-year goal: a **world-leading neutrino science** program
  - Anchored by the Long-Baseline Neutrino Facility (**LBNF**) and Deep Underground Neutrino Experiment (**DUNE**)
  - Powered by megawatt beams from an upgraded and modernized accelerator complex made possible by the Proton Improvement Plan II (**PIP-II**)
- First international mega-science project based at a DOE national laboratory



# DUNE Science Goals



## Origin of matter

Discover what happened after the big bang:  
Are neutrinos the reason the universe is made  
of matter?



## Black hole formation

Use neutrinos to look into the cosmos and  
watch the formation of neutron stars and black  
holes in real time



## Unification of forces

Move closer to realizing Einstein's dream of a  
unified theory of matter and energy

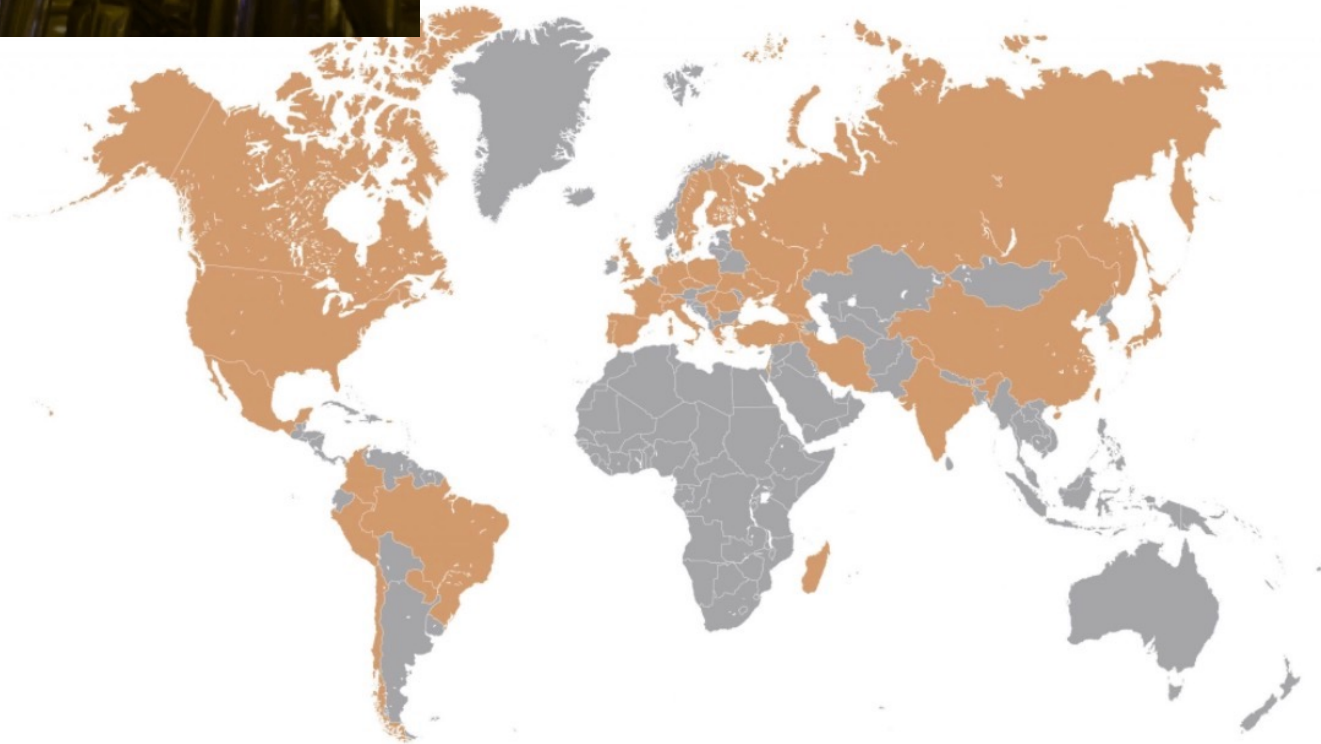
# Proton-Improvement Plan II (PIP-II) Accelerator



- First accelerator to be built with significant international involvement
- Unique technology (SRF CW with protons) to generate world's most intense neutrino beam and power new discoveries

# DUNE at LBNF

DUNE collaboration



**DUNE is the maximum expression of International Collaboration in the US**

## Academic and non Academic Partners

**Fermi National Accelerator Laboratory**, United States, Emanuela Barzi (barzi@fnal.gov)

**Yale University**, United, States, Bonnie Fleming (bonnie.fleming@yale.edu)

**Smart Engineering & Management**, Greece, Amanda Soukoulia  
(amanda.soukoulia@seems.gr)

**Harvard University**, United States, Roxanne Guenette (guenette@g.harvard.edu)

**The University of Chicago**, United States, David Schmitz (dwschmitz@uchicago.edu)

**Institute of High Energy Physics**, China, Hai-Bo Li (lihb@ihep.ac.cn)

**Slac National Accelerator Laboratory**, United States, Tracy Usher (usher@slac.stanford.edu)

**Clever Operation**, France, Radia Sia (r.sia@clever-operation.com)

Our collaborators at the Academic Partners in the US and Clever spend a lot of time at Fermilab. They will provide additional supervising capability to the Early Stage Researchers at Fermilab. Smart Engineering & Management (Greece) and the Institute of High Energy Physics (China) will provide Seminars and Lectures.