A selection of Fermilab’s greatest hits

1985
First proton–antiproton collisions in the Tevatron (lithium lenses; antiproton cooling techniques; low-beta focusing quadrupoles)
Measurement of the magnetic moments of strange hyperons (creation of charged and neutral hyperon beams)
CP violation in K decays (intense neutral kaon beams; precision electromagnetic calorimetry)

1999
Dedication of the Main Injector

1981
Charm observed in hadronic production (high-energy proton beams; silicon-vertex detectors; and trigger processors)

1996
Discovery and measurements of the $B_s$ meson (first silicon-vertex detector in a hadron collider)
Sloan Digital Sky Survey sees first light (Fermilab built data acquisition and other systems)

1997
E288 discovers $b$ quark (high-luminosity 400 GeV accelerator)
Neutron therapy used in cancer treatment (secondary neutron beams; use of medical radiology)

1990
Proton therapy demonstrated at Loma Linda University Medical Center (cyclotron design and extraction of proton beams)

1991
Fixed-target experiment detects $b$ decays (emulsion targets; downstream particle detectors)

1992
US agrees to contribute to LHC accelerator and detectors

1995
CDF and D0 discover top quark (scintillating-fibre and silicon-vertex detectors; Tevatron technology)

1998
Single-top production at Tevatron (mutivariate techniques; computer farms)

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2000
DONUT directly observes tau neutrino (emulsion-vertex detector; very short-baseline neutrino beam)

2006
Cryogenic Dark Matter Search sets new limits on dark matter (Fermilab provided detector technology and project management)
MINOS begins neutrino observations (long-baseline neutrino beam from Main Injector; near and far detectors)

2010
MINERvA begins operations (fine-grained scintillator; short-baseline neutrino beam)

2012
Dark Energy Survey begins (Fermilab led construction of DECam, the world’s largest CCD camera for astrophysics)

2014
Mu2e experiment approved (superconducting solenoids operating within a strong radiation field)
NOvA experiment begins data-taking (powerful long-baseline neutrino beamline; liquid-scintillator detector)
US CMS upgrade programme approved (project management; technical infrastructure; and detector expertise)

2015
CERN and US sign co-operation agreement for the HL-LHC and neutrino programmes (powerful low-beta quadrupoles; large liquid-argon neutrino detectors)

2017
ICARUS cryostat arrives from CERN (joining SBN and MicroBooNE for the short-baseline neutrino programme)
Neutrino-beam power record of 700 W set by Main Injector

2016
South Pole Telescope launches improved CMB study (Fermilab responsible for detector cryostat)

2013
Magnet for Muon g-2 experiment arrives from Brookhaven

2007
CMS Remote Operations Center and LHC Physics Center at Fermilab dedicated

2008
The LHC starts up at CERN (low-beta quadrupoles; detector expertise provided by Fermilab)
First dark-matter search with Chicago land Observatory for Underground Particle Physics (bubble-chamber technology)

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Timeline representing a subset of Fermilab’s milestones (a full list of Fermilab achievements can be found at 50.fnal.gov/timeline). All image credits: Fermilab.
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Scientists summoned from all parts of Fermilab had gathered in the auditorium on the afternoon of 30 June 1977. Murmurs of speculation ran through the crowd about the reason for the hastily scheduled colloquium. In fact, word of a discovery had begun to leak out [long before the age of blogs], but no one had yet made an official announcement. Then, Steve Herb, a postdoc from Columbia University, stepped to the microphone and ended the speculation: Herb announced that scientists at Fermilab Experiment 288 had discovered the upsilon particle. A new generation of quarks was born. The particle, a b quark and an anti-b quark bound together, meant that the collaboration had made Fermilab’s first major discovery. Leon Lederman, spokesman for the original experiment, described the upsilon discovery as “one of the most expected surprises in particle physics”.

The story had begun in 1970, when the Standard Model of particle interactions was a much thinner version of its later form. Four leptons had been discovered, while only three quarks had been observed – up, down and strange. The charm quark had been predicted, but was yet to be discovered, and the top and bottom quarks were not much more than a jotting on a theorist’s bedside table. In June of that year, Lederman and a group of scientists proposed an experiment at Fermilab (then the National Accelerator Laboratory) to measure lepton production in a series of experimental phases that began with the study of single leptons emitted in proton collisions. This experiment, E70, laid the groundwork for what would become the collaboration that discovered the upsilon.

Meanwhile, experiments at Brookhaven National Laboratory and at the Stanford Linear Accelerator Center were searching for the charm quark. These two experiments led to what is known as the “November Revolution” in physics. In November of 1974, both groups announced they had found a new particle, which was later proven to be a bound state of the charm quark: the J/psi particle. Some semblance of symmetry had returned to the Standard Model with the discovery of charm. But in 1975, an experiment at SLAC revealed the existence of a new lepton, called tau. This brought a third generation of matter to the Standard Model, and was a solid indication that there were more third-generation particles to be found.

Fermilab experiment E288 continued the work of E70 so much of the hardware was already in place waiting for upgrades. By the summer of 1975, collaborators completed construction on the second spectrometer arm and submitted a new proposal, number 288, in February 1974 – a single-page, six-point paper in which the group promised to get results, “publish these and become famous”. This two-arm experiment would be called E288.

The charm dimension

After what Wilson jocularly refers to as “horsing around,” the group tightened its goals in the spring of 1977.

June 2017 marks 40 years since a bump in fixed-target data at the E288 experiment led to Fermilab’s first major discovery: the b quark.