HIGH ENERGY PHYSICS

office of high energy physics

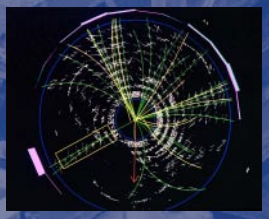
The High Energy Physics (HEP) program mission is to advance fundamental understanding of the physical universe by investigating physics at the smallest distance scales (elementary particle physics) as well as the largest (the geometry of the universe).

RECENT SCIENTIFIC ACHIEVEMENTS

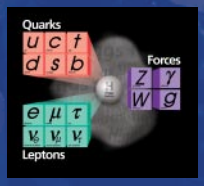
Dark Energy
Observations of supernovae have shown that the expansion of the universe is speeding up. The cause of this acceleration is still a mystery, but implies that most of the energy content of the universe is of a new form called "dark energy."

Neutrino Oscillations
Neutrino detectors have determined that the shadowy elementary particles known as neutrinos oscillate among three different "flavors" as they travel through space and have miniscule but non-zero masses.

Discovery and Characterization of the Top Quark
The discovery and subsequent determination of the mass of the top quark to high precision has allowed physicists to zero in on the mass of the undiscovered Higgs boson, a crucial component of the theoretical framework of particle physics.



Matter-Antimatter Oscillation of the B_s Meson
The B_s meson (a particle made up of a bottom quark bound to an anti-strange quark) oscillates rapidly into its antiparticle. The recent measurements of this oscillation have constrai ned the nature of new physics at the energy frontier, the "Terascale."



Pinning Down the Standard Model
Very precise measurements of the interactions of electron and positron beams have extended and refined our understanding of how the electromagnetic and weak interactions are unified in the Standard Model.

Plasma Wakefield Acceleration
Electrons surfing on a plasma wave (the wake left by a laser beam or an electron beam) have been accelerated within a meter to energies that require kilometer-long conventional accelerators.

MAJOR USER FACILITIES

The Tevatron, operated by Fermi National Accelerator Laboratory, is a proton-antiproton collider that now offers the world's highest energy particle collisions.

PEP-II, operated by Stanford Linear Accelerator Center, is an electron-positron collider that allows for precise investigations of elementary particle physics.

The Large Hadron Collider, a new accelerator that will collide protons at energies high enough to explore physics at the Terascale, is now under construction at CERN (European Organization for Nuclear Research) in Switzerland.

The Sloan Digital Sky Survey will produce a three-dimensional map of 100 million celestial objects, covering a quarter of the entire sky. Its studies of galactic clusters will shed light on dark energy.