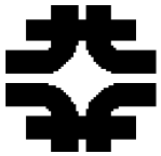


Fermilab: its program & future

Harry Weerts

Fermilab/Michigan State University

Who is the speaker ?

Introduction:

Hendrik (Harry) Weerts
Born in 1950 in Netherlands, to school there
Study physics in Aachen, Germany
After Ph.D (1981) came to Fermilab as postdoc
Faculty at MSU since 1983
Research remained at Fermilab
(large experiment at Tevatron Collider, Dzero)
Live in Sugar Grove
Currently spending 1 year at Fermilab to work on next big project (I hope): Int. Linear Collider.

My work and my hobby are the same:
physics/science and solving nature's puzzles.

My Science

Also like woodworking and construction; we are/have remodeled a 1960's bungalow ……..

My non Science life

Last, but not least, family: Ellie and I and 4 kids

Introduction to Fermilab

Fermilab is dedicated to research in particle physics, with the goal of understanding the fundamental nature of matter, energy, space, and time.

- Fermilab is the largest U.S. laboratory for research in Particle Physics.
  - 2200 employees
  - 3000 scientist-users
    - 1800 domestic
    - 1200 foreign
  - 40% of US particle physicists do their research here.
- The highest energy accelerator in the world is the Tevatron.

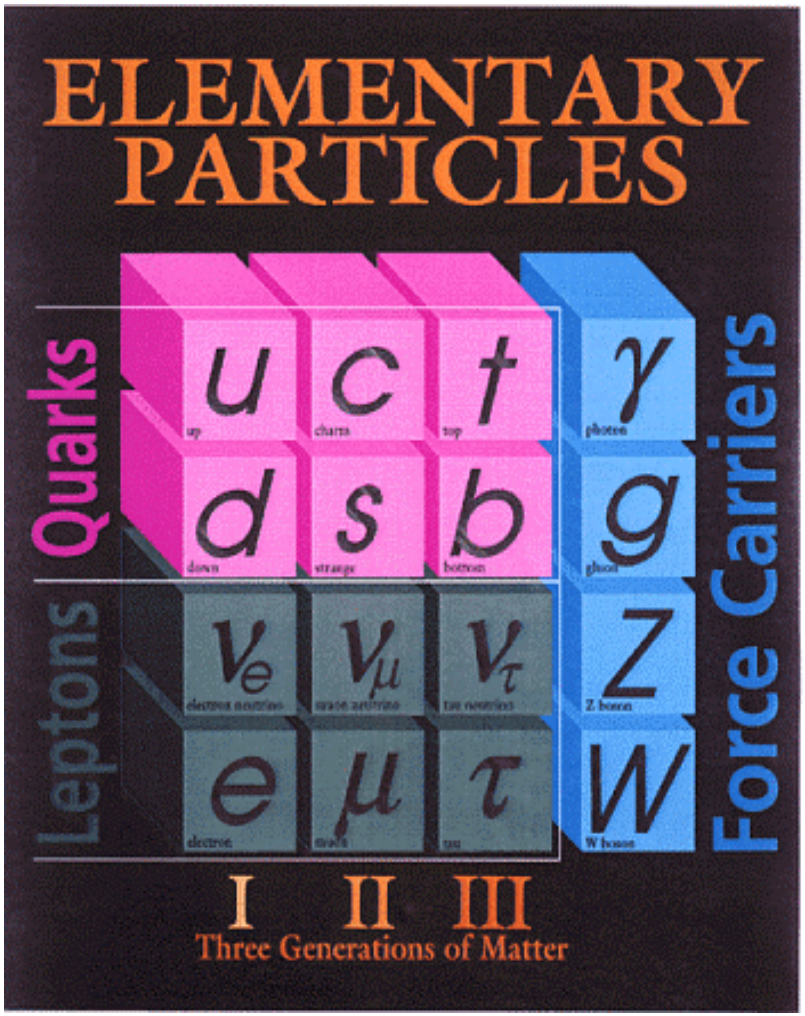
High Rise in moonlight

The main laboratory "High Rise" at sunset with reflection in Swan Lake

Many architectural exceptional buildings, but also regular ugly lab space

Elementary Particles we know

Results of particle physics experiments/theory over last 30 years at few labs around the globe



- 27 Nobel prizes for experimental discoveries and theoretical breakthroughs.
- Fermilab experiments discovered the top and bottom quarks and first saw the tau neutrino.

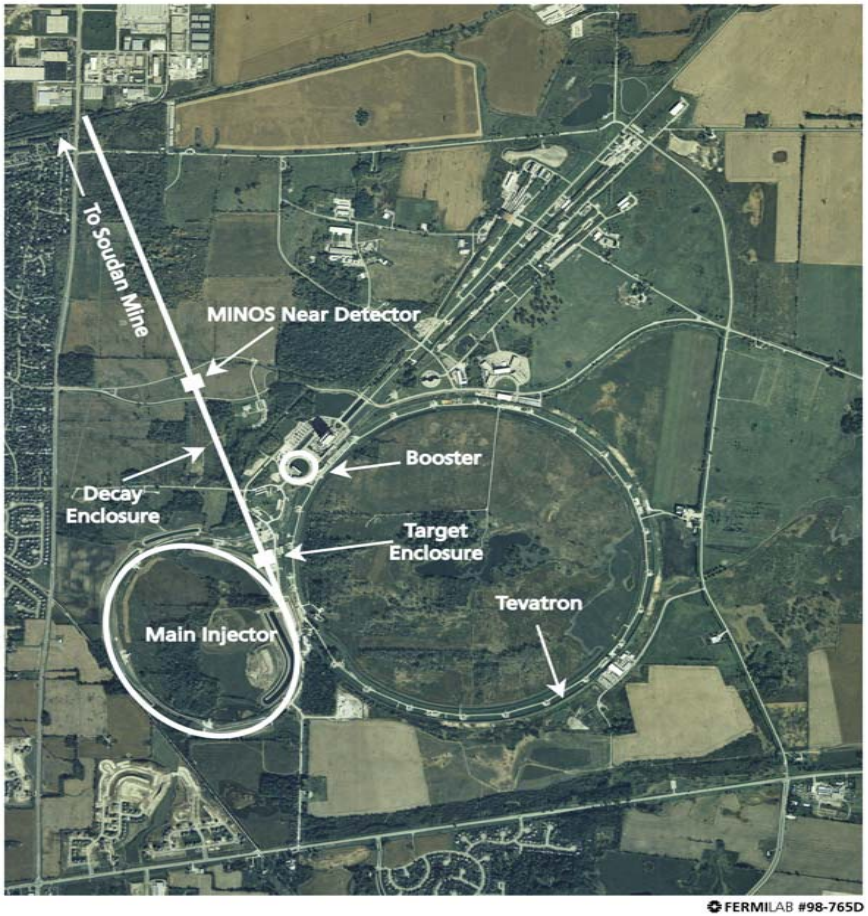
The unknown:

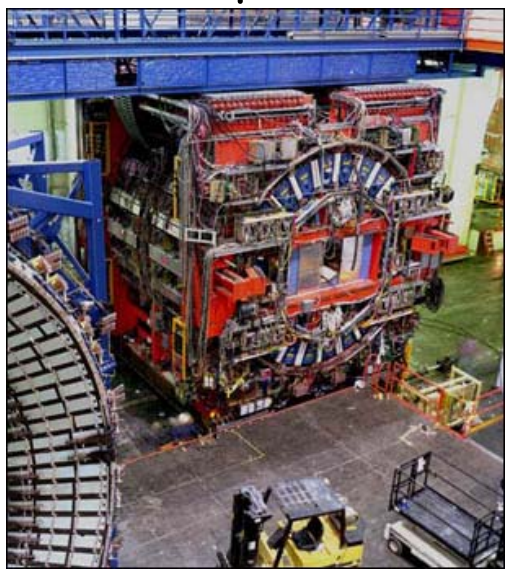
- What is the Higgs boson (mass)
- The present theory describes all known forces and particles, with one very important exception: gravity.
- New Physics: more particles, extra dimensions ??

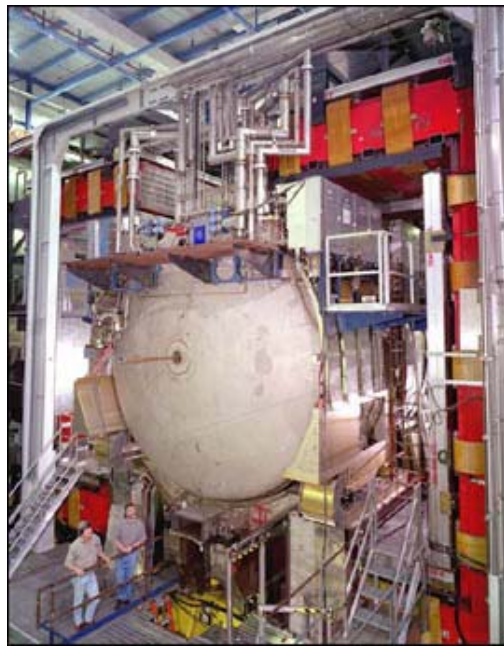
Current Science program Ia

Tevatron Collider; collide protons and antiprotons

Energy frontier & unique in world: Search for new physics; precision top mass; Higgs ……







Two large experiments are taking data and will continue to be energy frontier until about ~2008
New experiment in 2009.

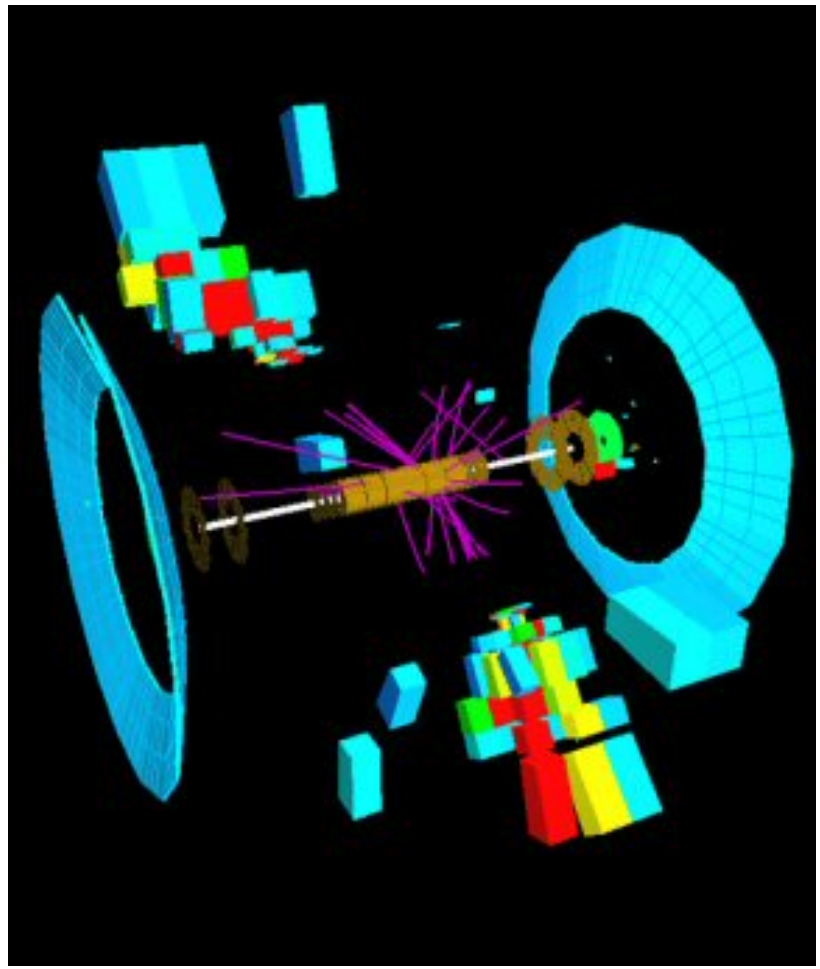
This progam will move to CERN in ~ 4-5years; US & Fermilab involved

Current Science Program Ib

Tevatron Collider; collide protons and antiprotons

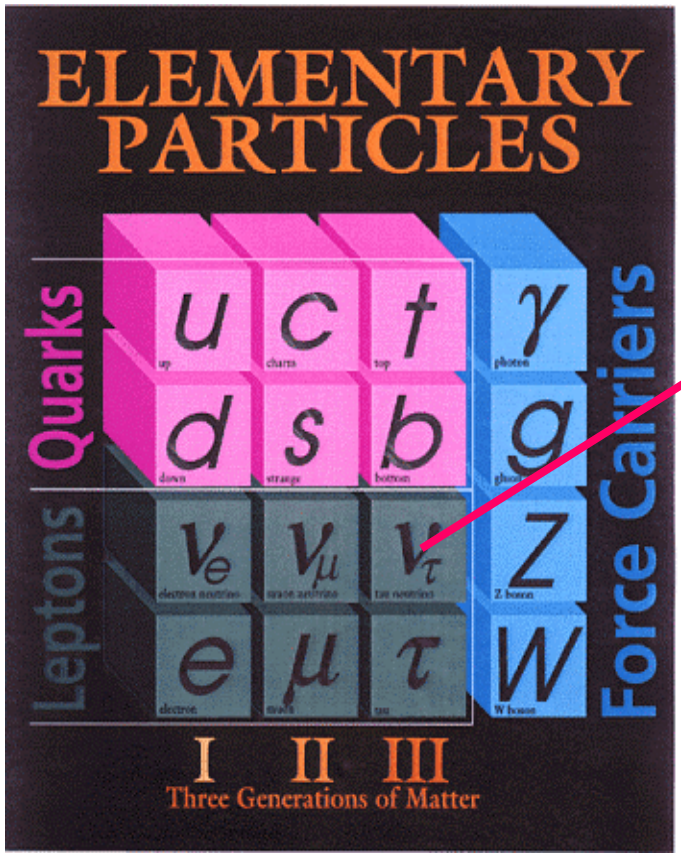
Size of international collaboration (Dzero)

Information used in analysis of data from detector



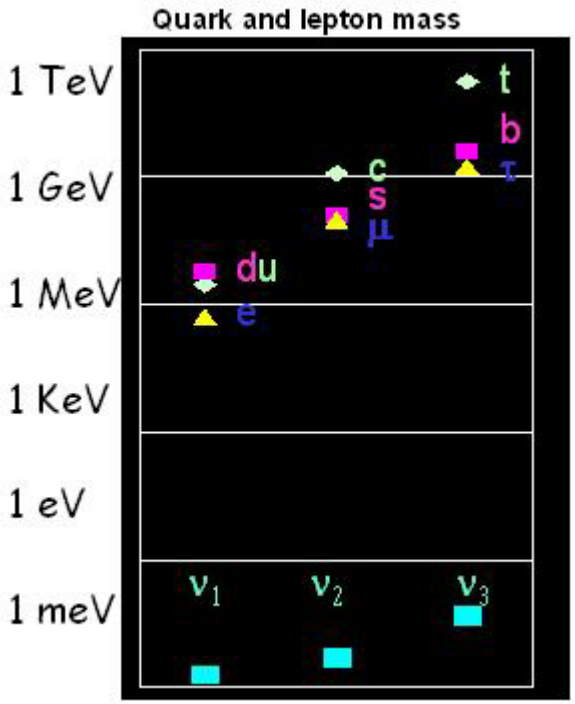
Current program IIa

Neutrinos: Study of smallest particles:neutrinos and their behavior



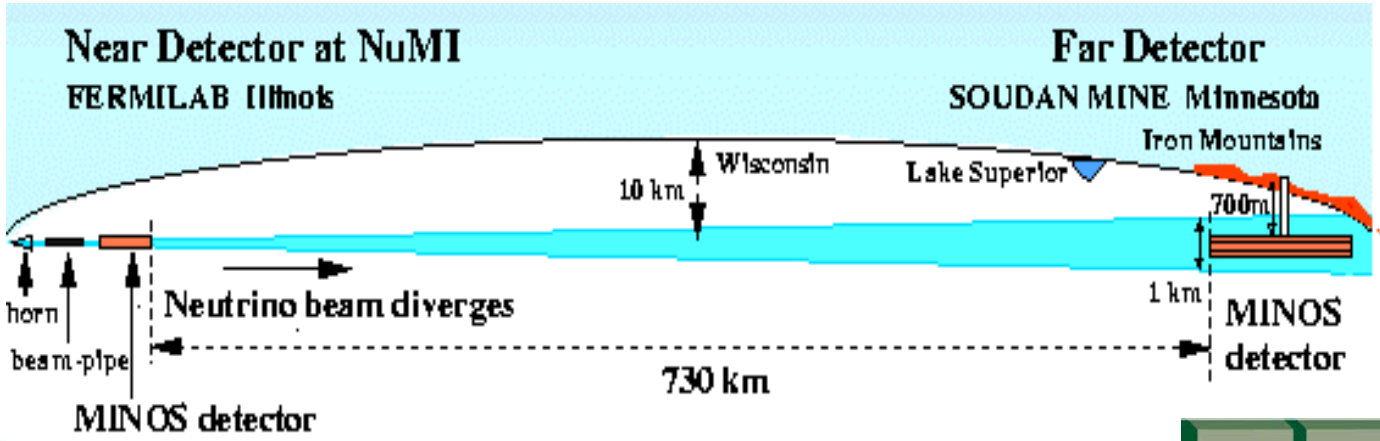
Characteristics: no electric charge, do not like to interact, all around us and "no" mass……

Mass very small & oscillations. Field of study



Current program is in place and will produce physics until about 2012 and beyond

Current program IIB: NuMi/Minos



Start program in 2005. Run for many years. Expect surprises & new experiments

Current program……

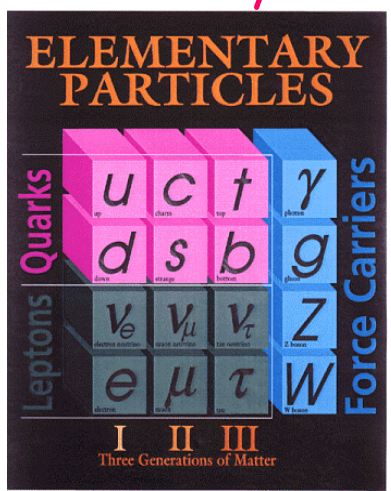
Up to now described the current scientific program.

This program put in place over a decade ago. Took long time to put in place, even longer to get science out…….

Did not describe all programs, but only major ones…..

Future program will depend on many things, new insights, new experimental results

One of most dramatic results has come from studying universe i.e. astrophysics: universe **not** mainly made of



Observations from universe

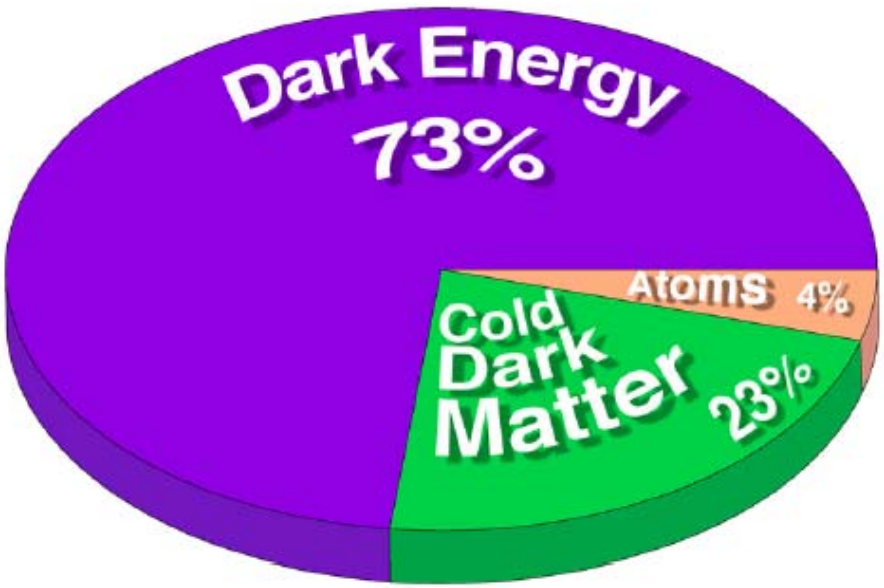
Questions about universe:

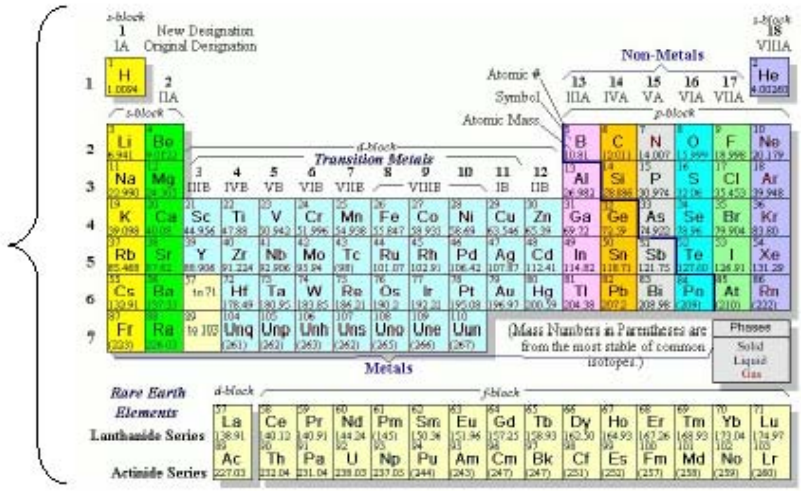
Where is anti matter ?

Most mass in universe not in SM particles

Dark matter; new particle needs to be found

Acceleration of expanding universe: Dark energy ??

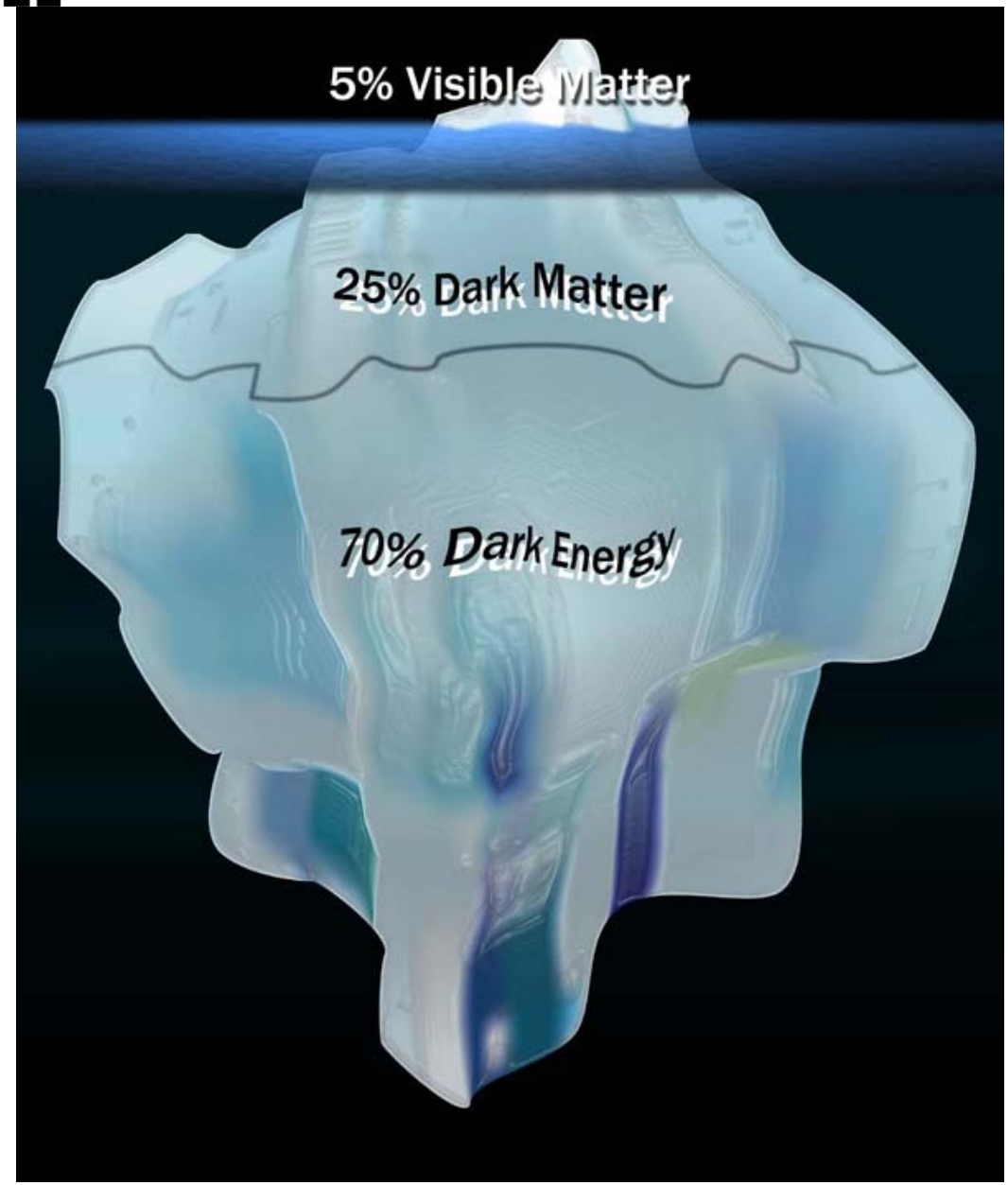




So ONLY 4% of universe consist of particles we know.

A lot left to find.....

State of knowledge of universe…



The "Iceberg" picture of our understanding of universe.

Next step is to address this at accelerators and find the corresponding particles and understand what dark matter and energy are

Long term future I

The first BIG step in understanding "iceberg" will the Large Hadron Collider (LHC) at CERN

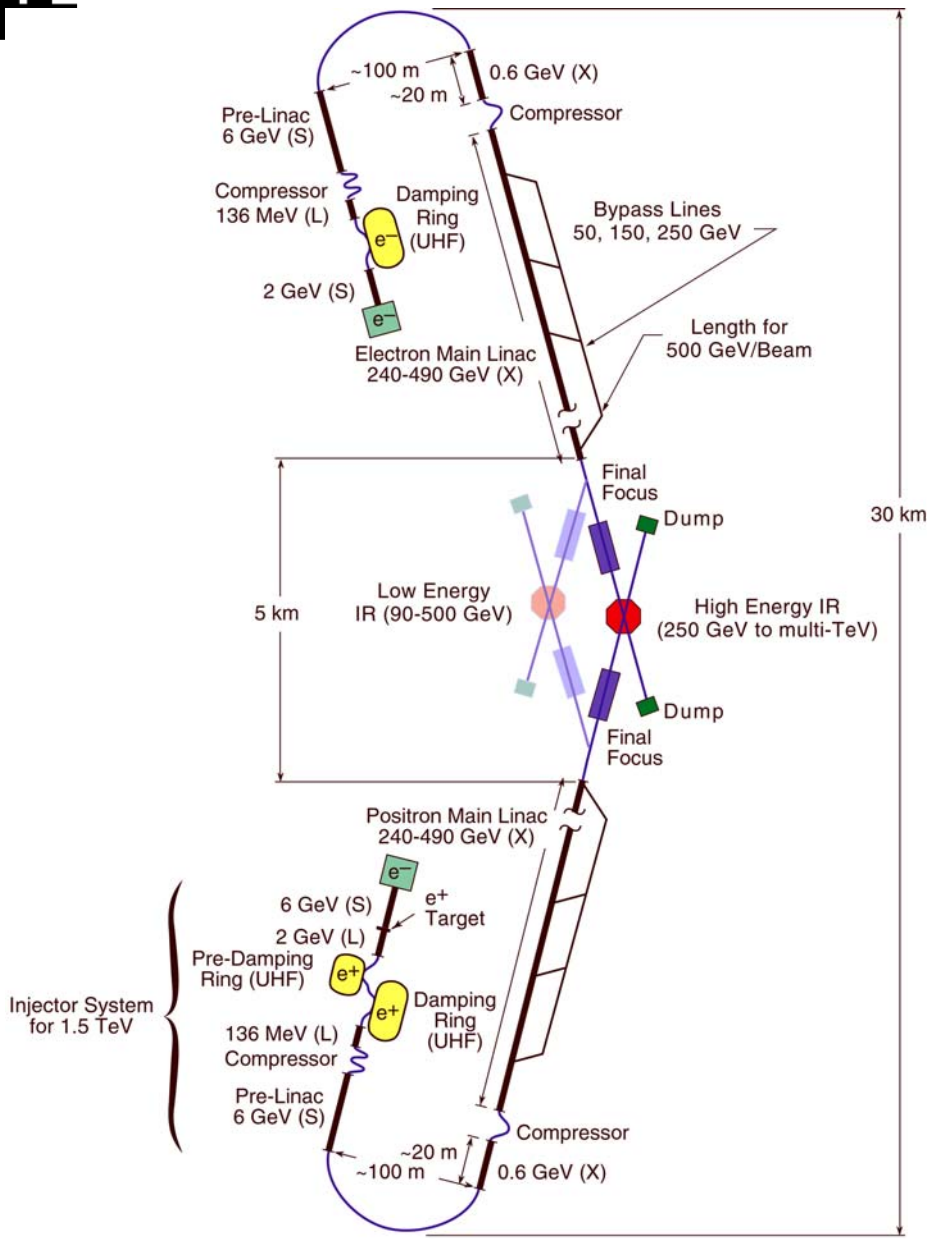
LHC will start around 2007-2008…..very large project and large participation from US.

Important: CERN and Fermilab are becoming THE only two labs in world that will have accelerators.

Next large machine/accelerator: International Linear Collider (ILC)

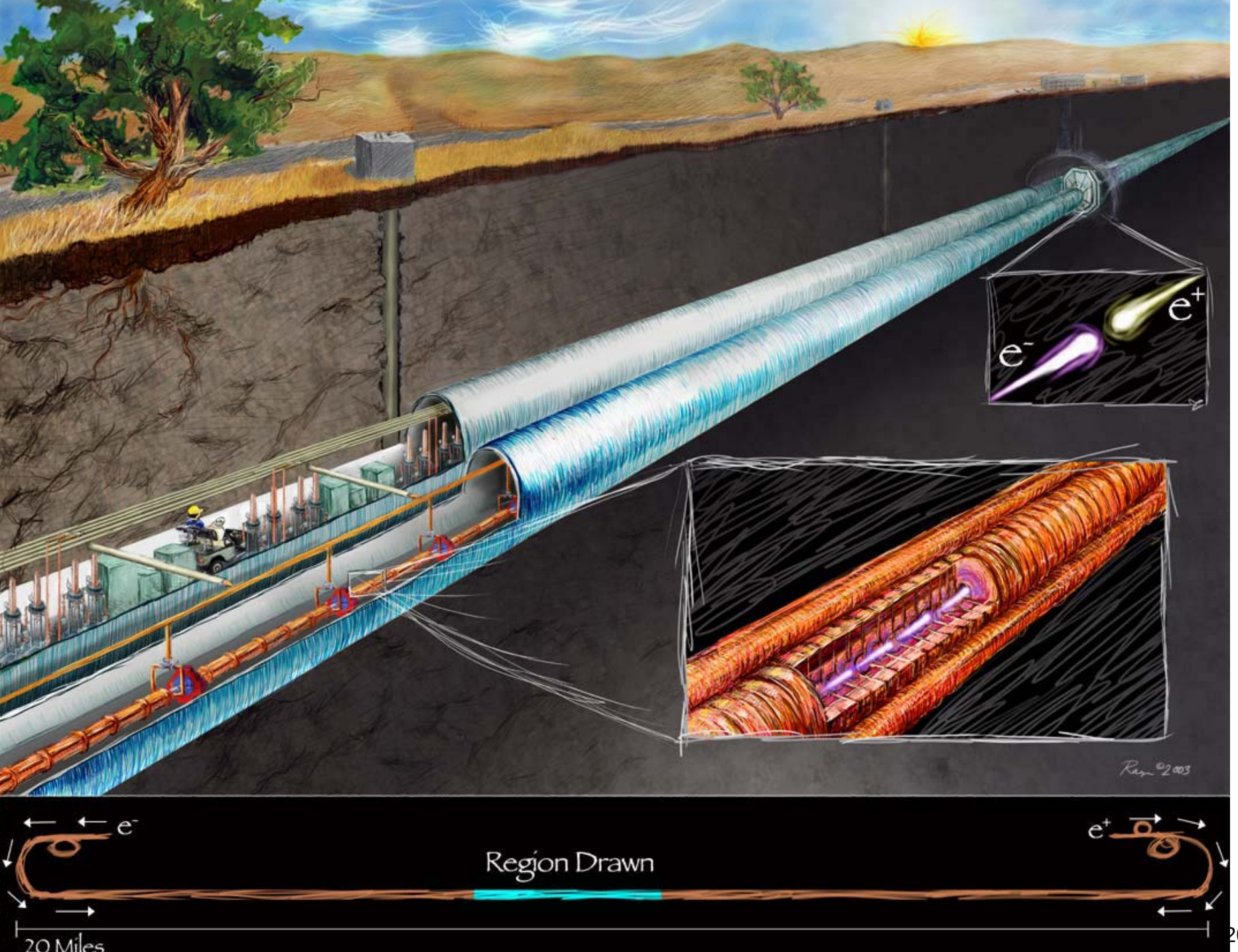
This is an international project. Fermilab wants to host it and that is what we are working towards.

ILC I



Very different from anything ever done:

- Large size (does not fit Fermilab site)
- Time scale: ~2015 start operations
- Large construction project before
- Unique facility in the world
- Truly international facility (funded by many countries)
- Cost too large for one country (many B$)
- A lot of hurdles to be overcome
- Footprint about 20 miles long


e-
e+
e-
e+
Region Drawn
20 Miles

A ILC time line (rough)

2005 Write initial conceptual design report and establish international design team.

2006-2008 R&D on components and write Technical Design Report

~2008 Selection of site from candidate sites

2009 Start construction

2009-2015 Construction

2015 Start operation.

A long away ahead of us. If ILC would come to Fermilab, Fermilab would be the premier particle physics facility in the world for decades to come.

Summary & Conclusion

Fermilab has an excellent current program of research:

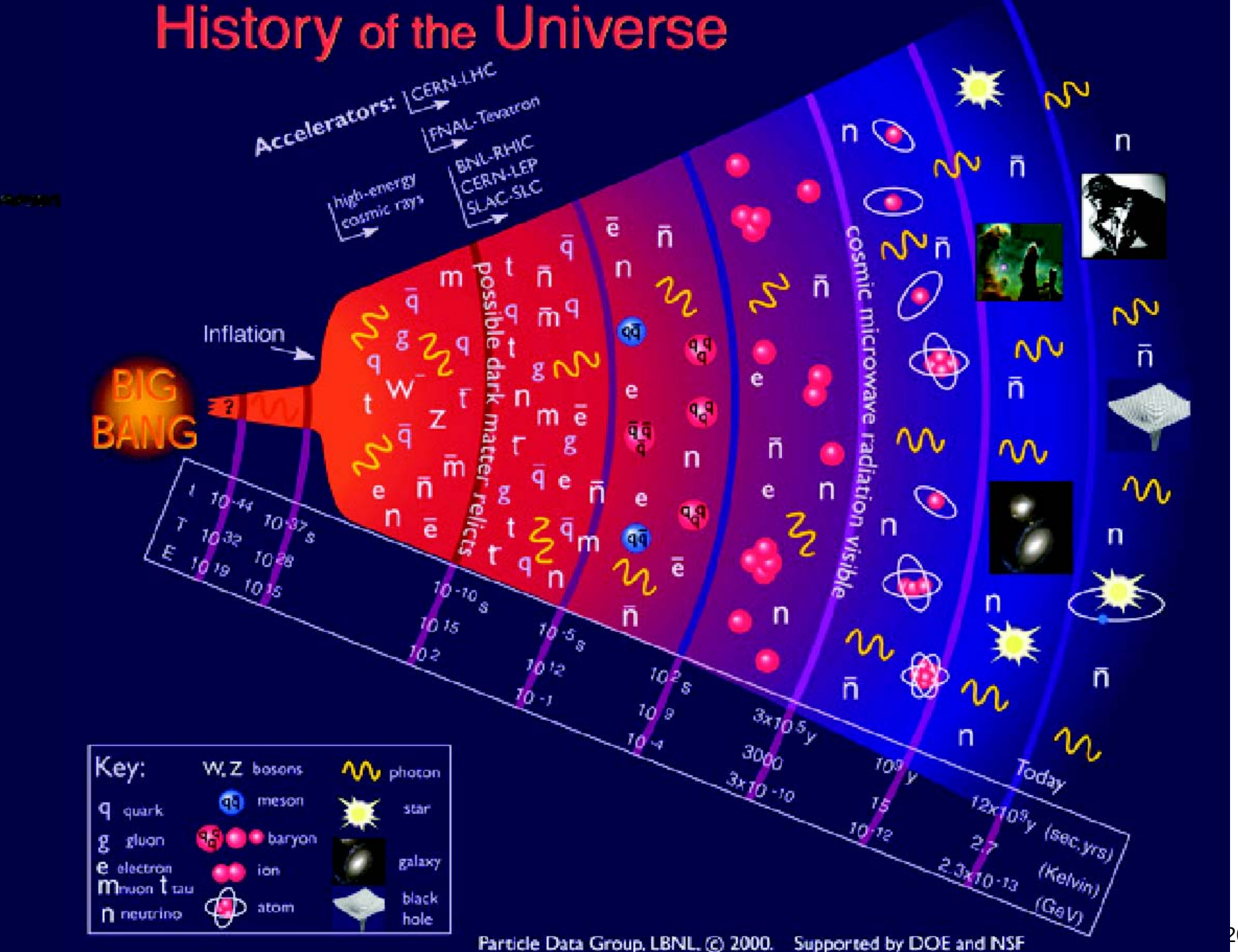
Tevatron Collider until about 2009 energy frontier

Neutrino program cutting edge and
adjustable/upgradeable to needs and future results

Effort is starting on locating next truly LARGE machine at Fermilab. Long way to go and many hurdles to be overcome.

The beginning of a large challenge….

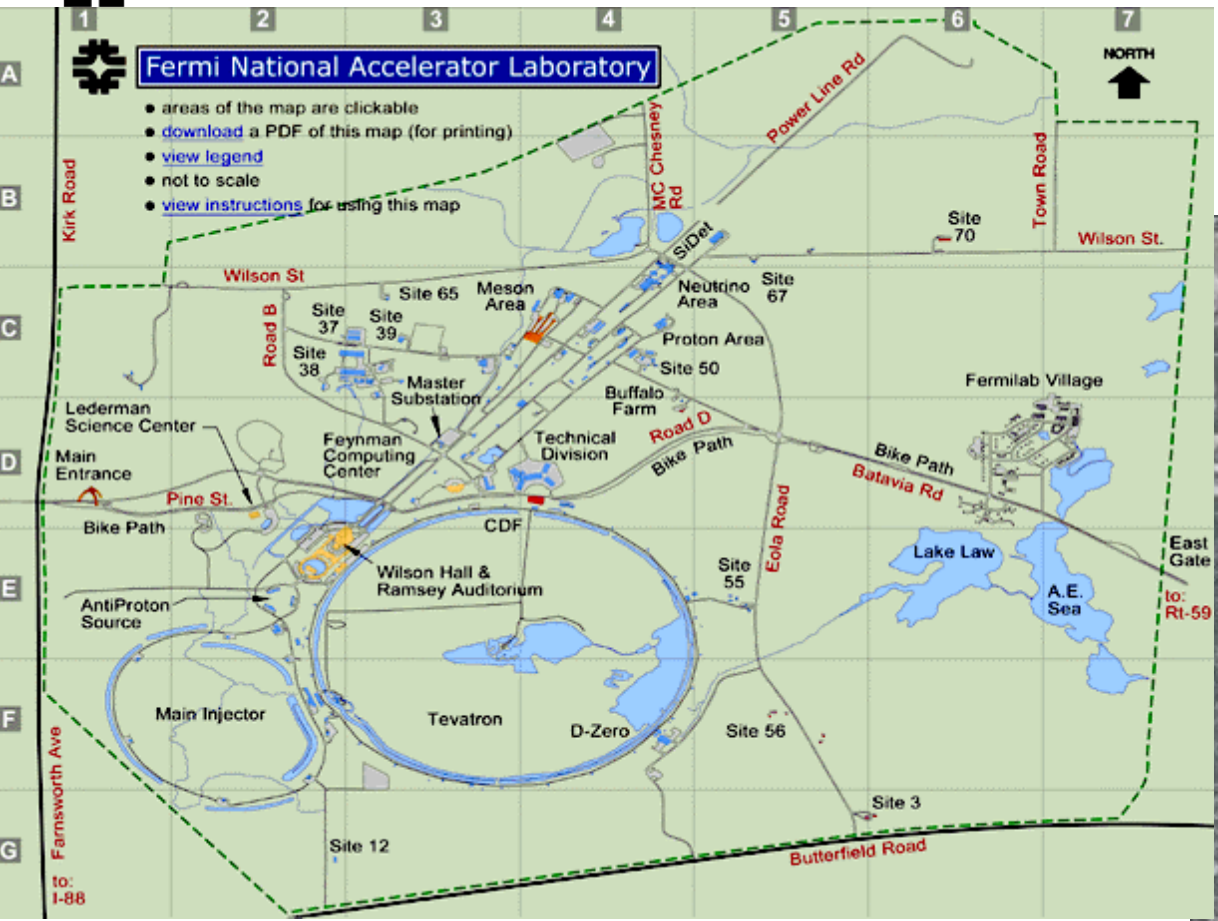
THE END

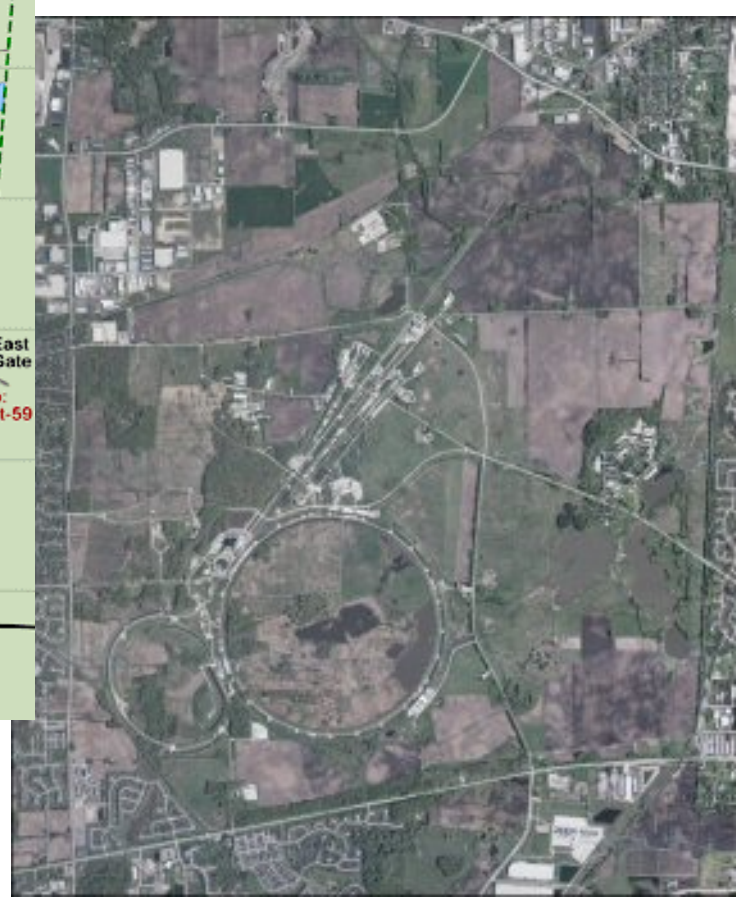

History of the Universe
Accelerators:
CERN-LHC
FNAL-Tevatron
BNL-RHIC
CERN-LEP
SLAC-SLC
high-energy cosmic rays
Inflation
BIG BANG
possible dark matter relics
cosmic microwave radiation visible
Today
Key:
q quark
g gluon
e electron
m muon t tau
n neutrino
W, Z bosons
meson
baryon
ion
atom
photon
star
galaxy
black hole
Particle Data Group, LBNL, © 2000. Supported by DOE and NSF

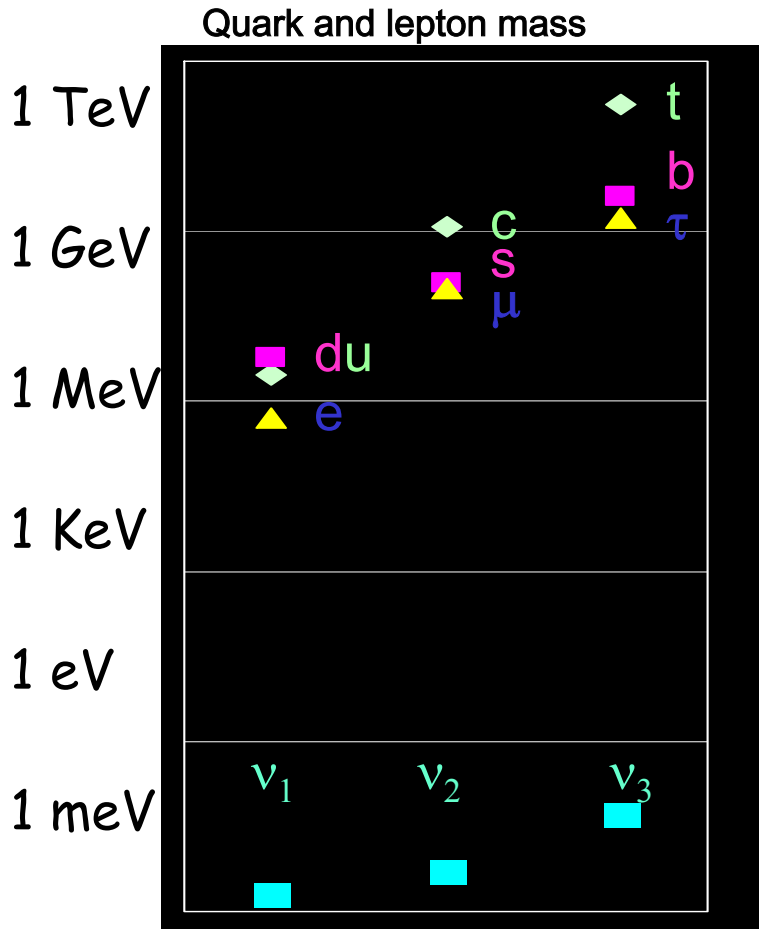
2004

Fermilab, what is it ?

H.Weerts






Quark and lepton mass
1 TeV
1 GeV
1 MeV
1 KeV
1 eV
1 meV
t
b
τ
c
s
μ
du
e
ν1
ν2
ν3

Who is the speaker ? 2

April 2003

September 2003