LABORATORY OF EXPERIMENTAL HIGH ENERGY PHYSICS

SCIENCE FOR THE BENEFIT OF HUMANITY



Home Research Publications People Conference Presentations Instrument Shop Links Internal

particles

quarks
leptons
force particles
Higgs field….



life?

cosmology

extra dimensions
dark matter
dark energy
black holes

http://www.rockefeller.edu/events/string_fever/transcript.php

The laboratory

STUDENTS

http://physics.rockefeller.edu/dino/myhtml/students.html

1970 HEP lab established on campus, R. Cool HOL

1971 KG Associate Professor

1070s CERN: co-establish existence of quarks

Fermilab: confirm rising total cross sections

1980s Brookhaven: νp scattering → evidence for Z

1981 KG➔Prof.

1995 Fermilab: top-quark discovery (Luc Demortier)

1996 Fermilab: quark sub-structure search (Anwar Bhatti)

2000 Fermilab: running of strong coupling (Christina Mesropian)

2009 HERA @DESY lepto-quark search (Robert Ciesielski)

2009 Fermilab top-quark mass (Jim Lungu)

2010 Fermilab W-mass (Sarah Malik)

} Higgs mass?

1971 - Diffraction – npQCD (KG+lab) → dark energy?

Visiting fellow: Renata Rodrigues

Adjunct faculty: Sebastian White, Michele Gallinaro, Valery Khoze

Instrument shop: Vadim Sherman (supervisor), Josip Golia

Admin. secretary: Janet Kallo



current members 7+4+3 =1 4

1970s @ CERN: evidence for quarks

NY times, April 20, 1988

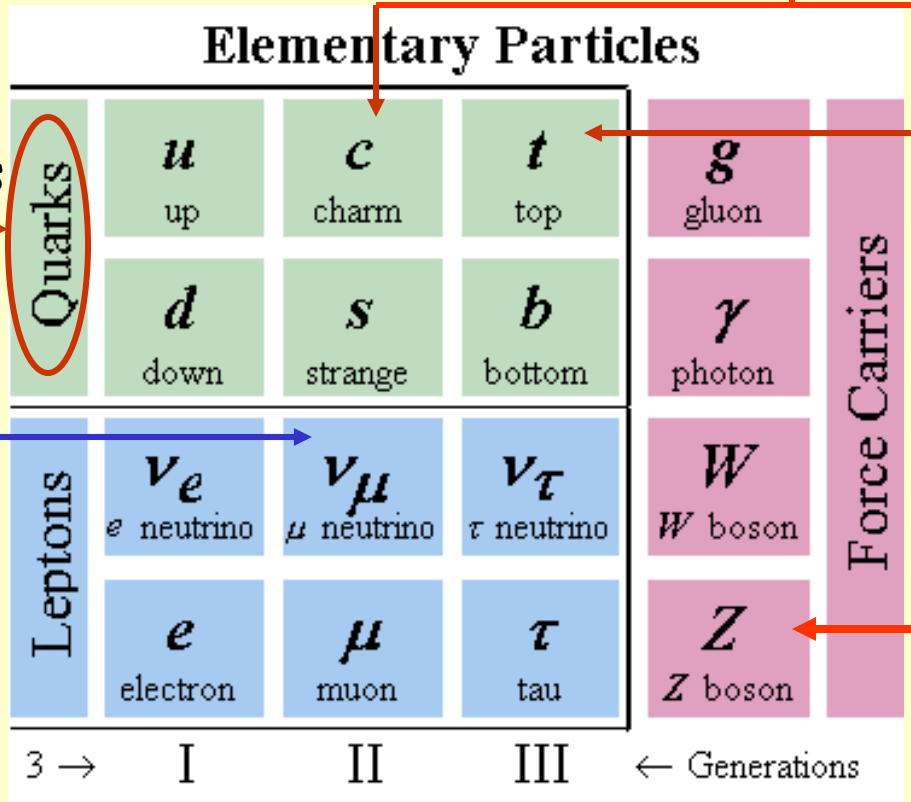
Dr. Cool, a professor of high-energy physics at Rockefeller University, also conducted research at the European Center for Nuclear Research in Geneva. It was there in the 1970's that he and colleagues performed experiments that, together with data from other investigators, showed the quark to be a building block of neutrons and protons. Previously, the neutron, proton and electron had been regarded as the fundamental particles in nature.



RU and the SM

Glashow, Salam, and Weinberg – 1979 Nobel prize

predict C in 1979 – Glashaw, Iliopoulos (RU), Miani



CERN 1970s

evidence for q's

My PhD thesis@ CU 1962 (thesis '63)

Fermilab 1995

BNL 1981

$\nu_\mu p \rightarrow \nu_\mu p$

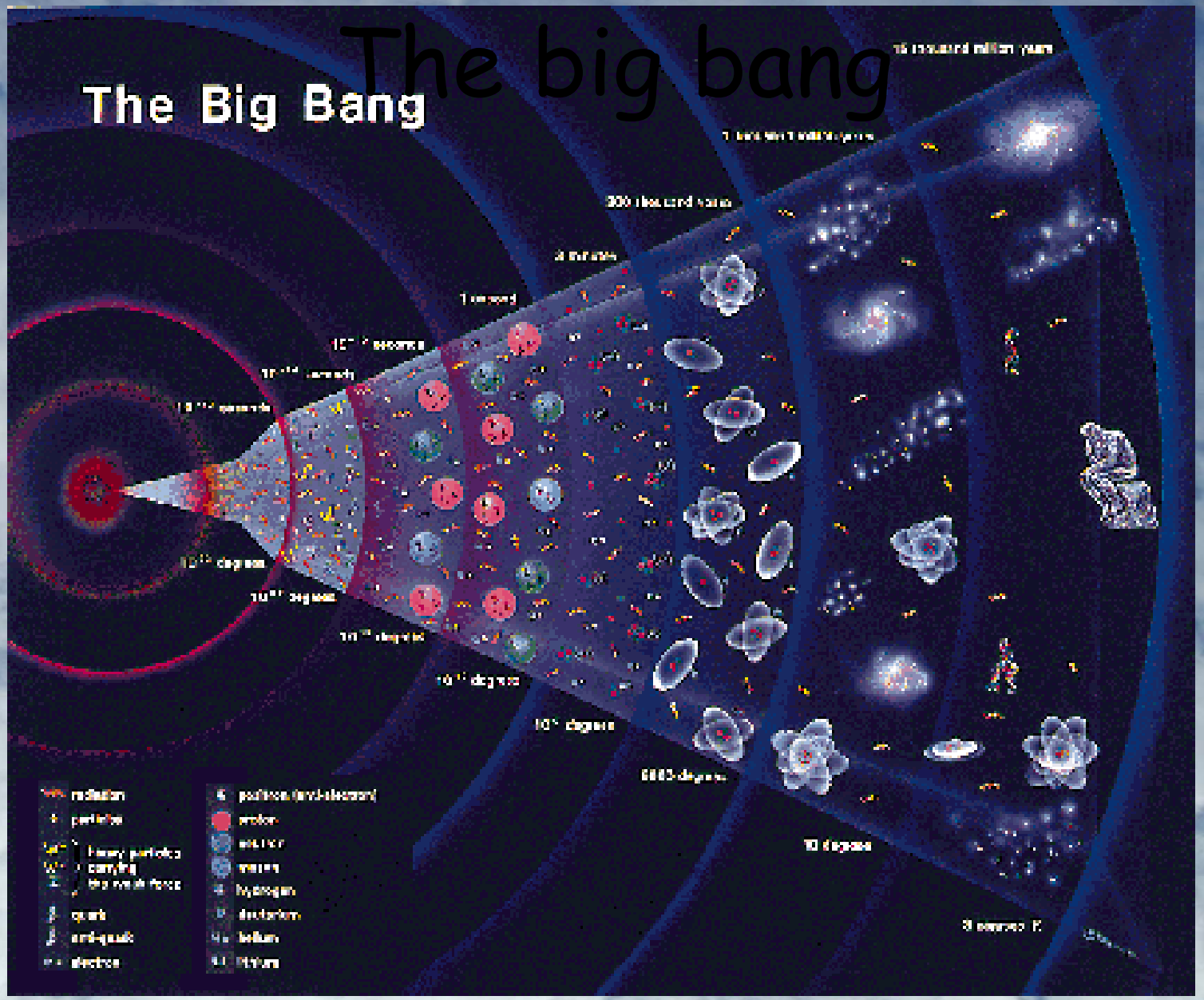
evidence for Z

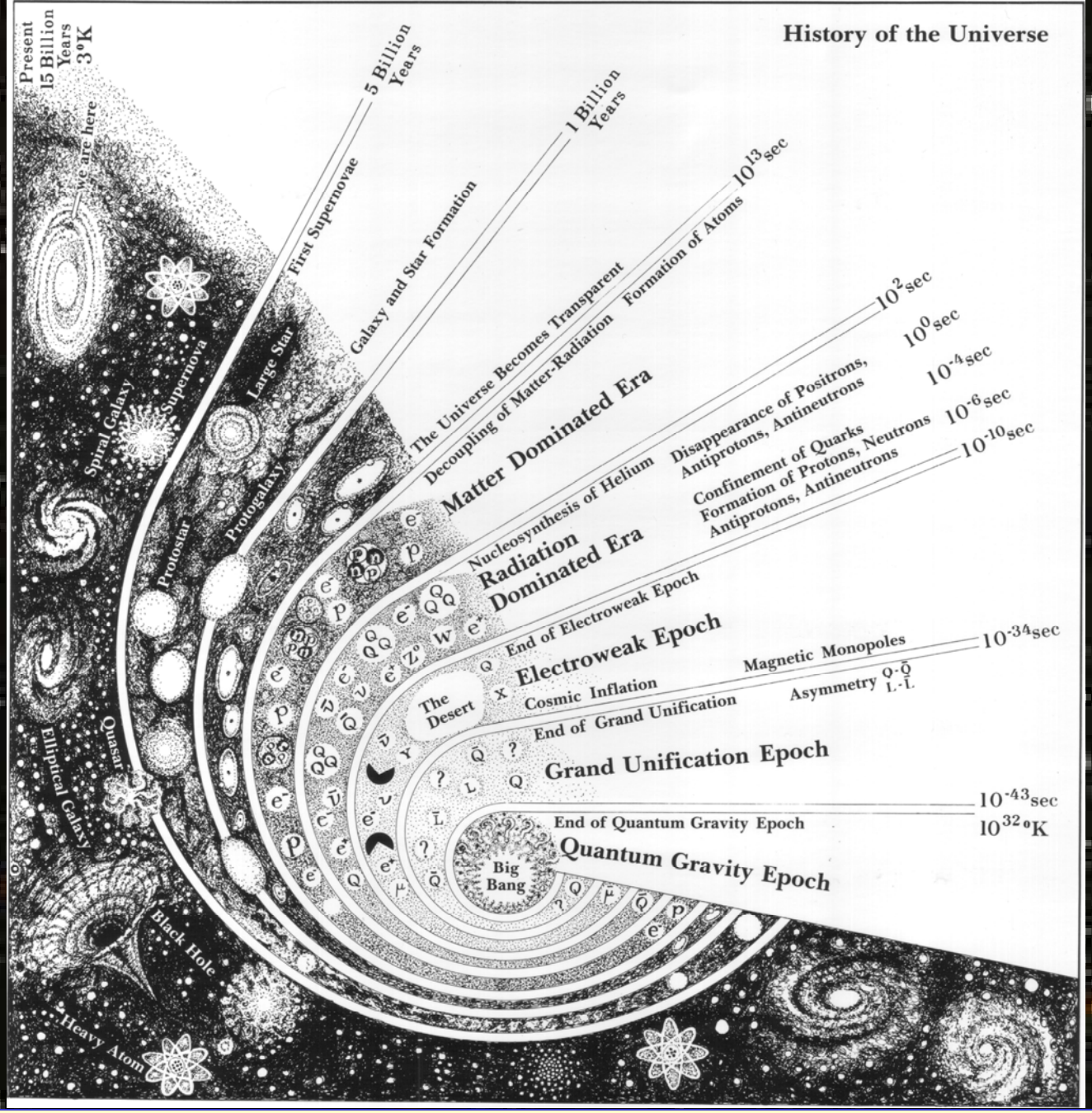
Z discovered directly in 1983 at CERN

$M_\gamma, g = 0$ $M_{W,Z} \sim 100\ M_p$ $M_{top} \sim M_{gold}$

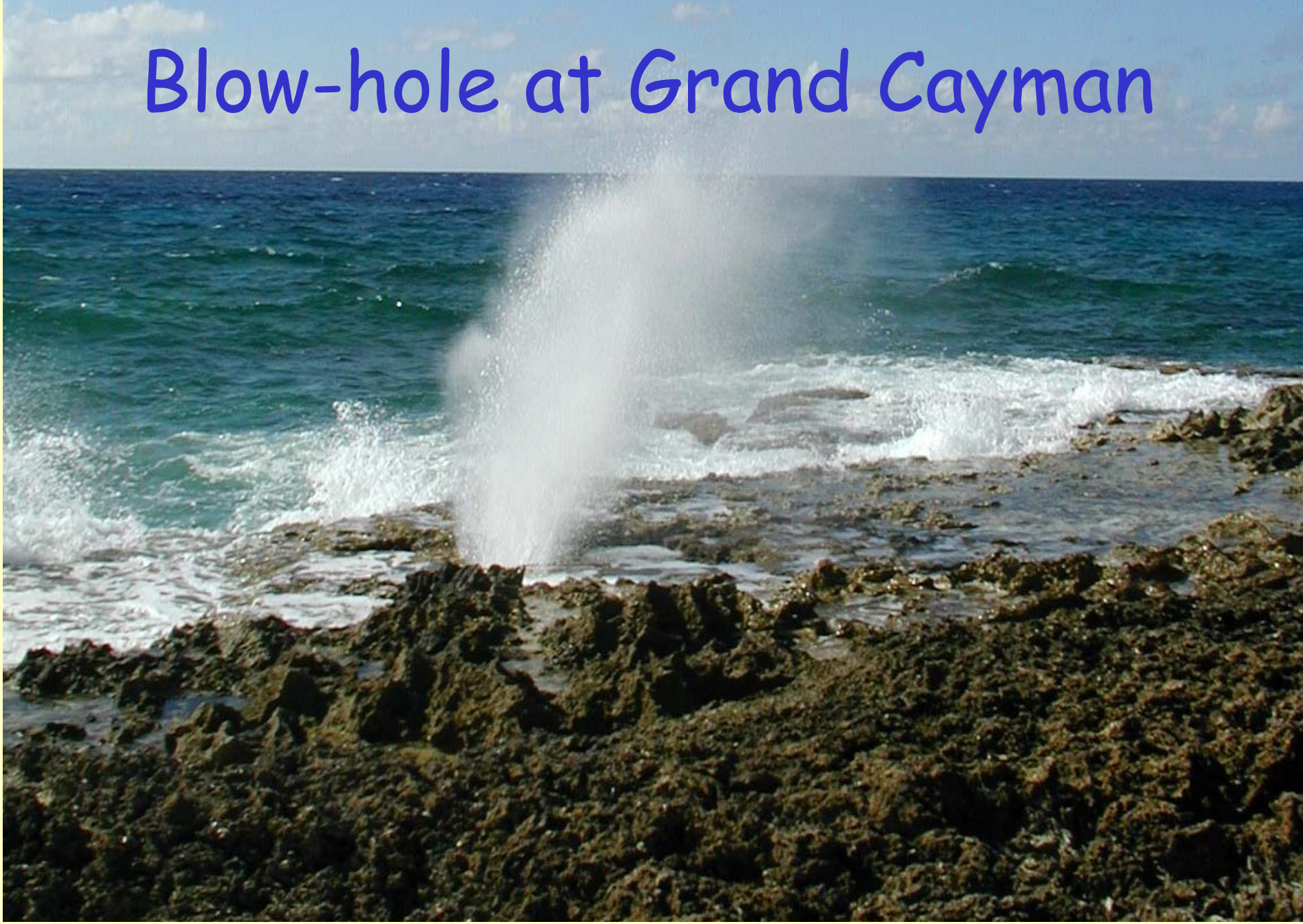
Higgs field generates mass

The big bang




History of the Universe
Present
15 Billion Years
3°K
we are here
5 Billion Years
First Supernovae
1 Billion Years
Galaxy and Star Formation
The Universe Becomes Transparent
Decoupling of Matter-Radiation
Formation of Atoms
10^{13}sec
Spiral Galaxy
Supernova
Large Star
Protostar
Protogalaxy
Matter Dominated Era
Nucleosynthesis of Helium
Disappearance of Positrons, Antiprotons, Antineutrons
10^{2}sec
10^{0}sec
Confinement of Quarks
Formation of Protons, Neutrons
Antiprotons, Antineutrons
10^{-4}sec
10^{-6}sec
10^{-10}sec
Radiation Dominated Era
End of Electroweak Epoch
Electroweak Epoch
The Desert
Cosmic Inflation
Magnetic Monopoles
10^{-34}sec
End of Grand Unification
Asymmetry
Grand Unification Epoch
10^{-43}sec
End of Quantum Gravity Epoch
10^{32}°K
Big Bang
Quantum Gravity Epoch
Quasar
Elliptical Galaxy
Black Hole
Heavy Atom

Blow-hole at Grand Cayman



black hole eats star!



AP Photo

In this illustration, an arrow points to the doomed star. Part of its mass, shown by the white stream, was swallowed by the black hole.

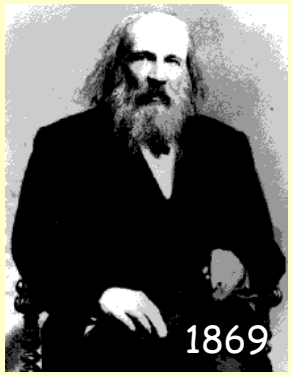
Star No Match for Black Hole

Elementary Particles

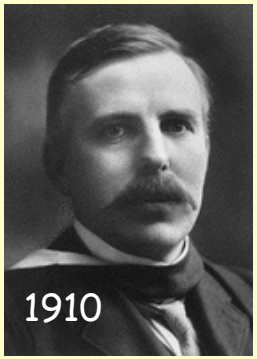


450 BC







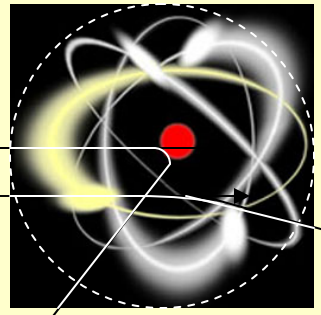




Aristotle	Demokritos	Mendeleyev	Thomson	Rutherford	Gell-Mann
earth water air fire	atom	periodic table	electron	nucleus	quarks

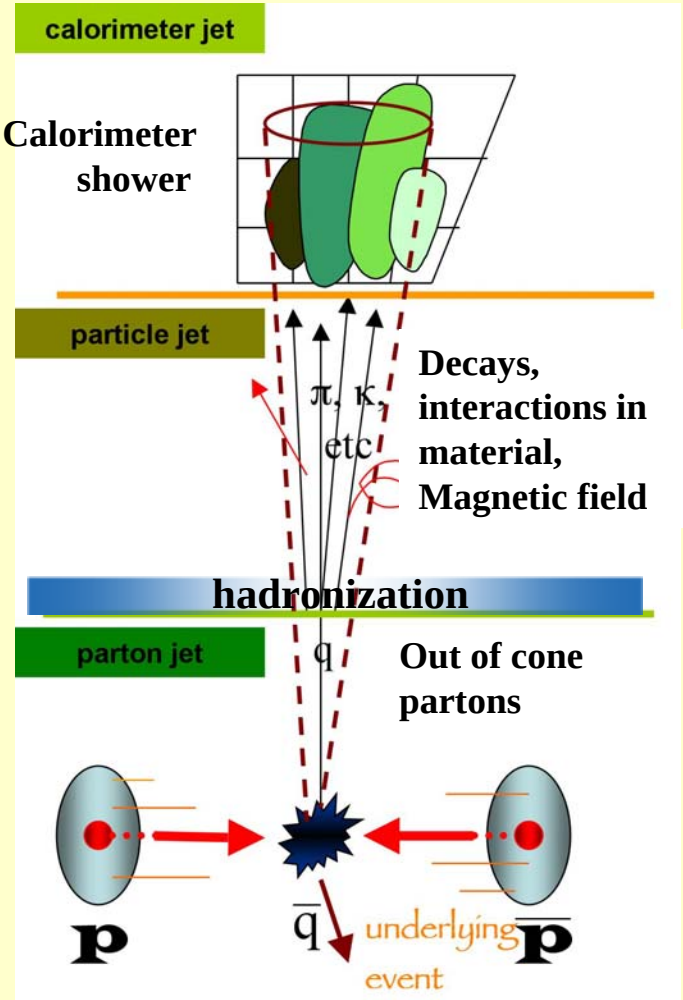
Rutherford Experiment

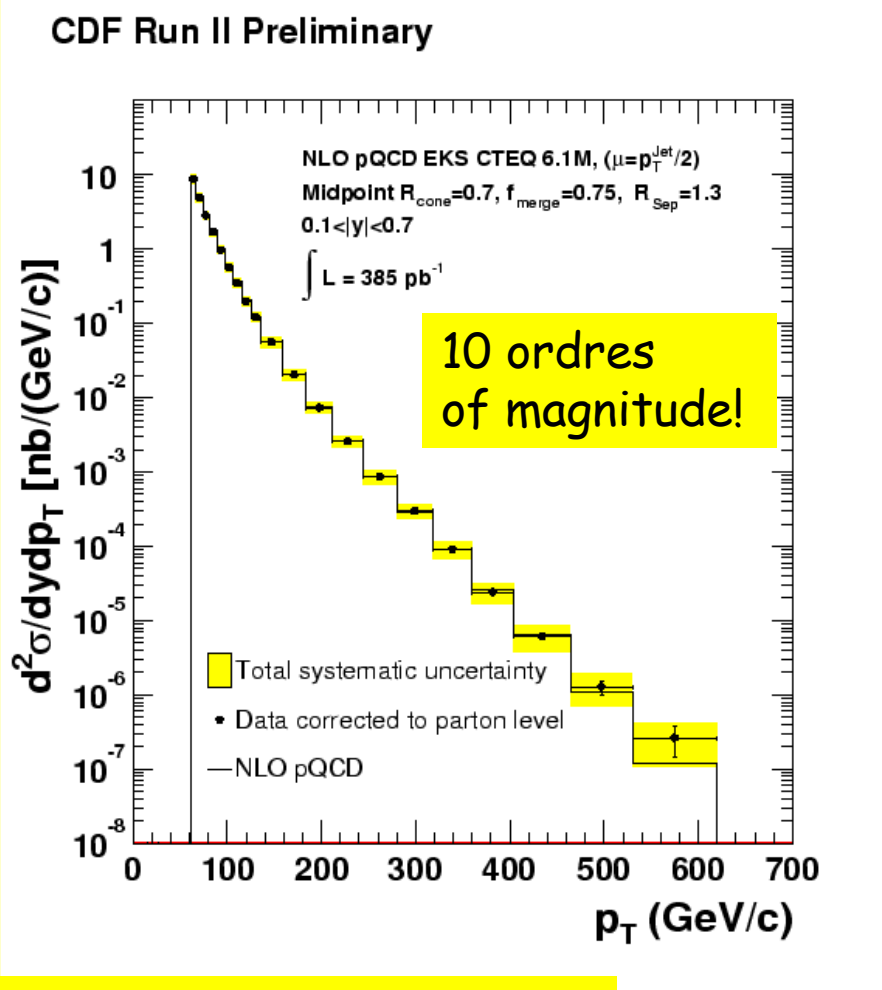
Source → α-particles



Large angle scattering → atoms have nuclei

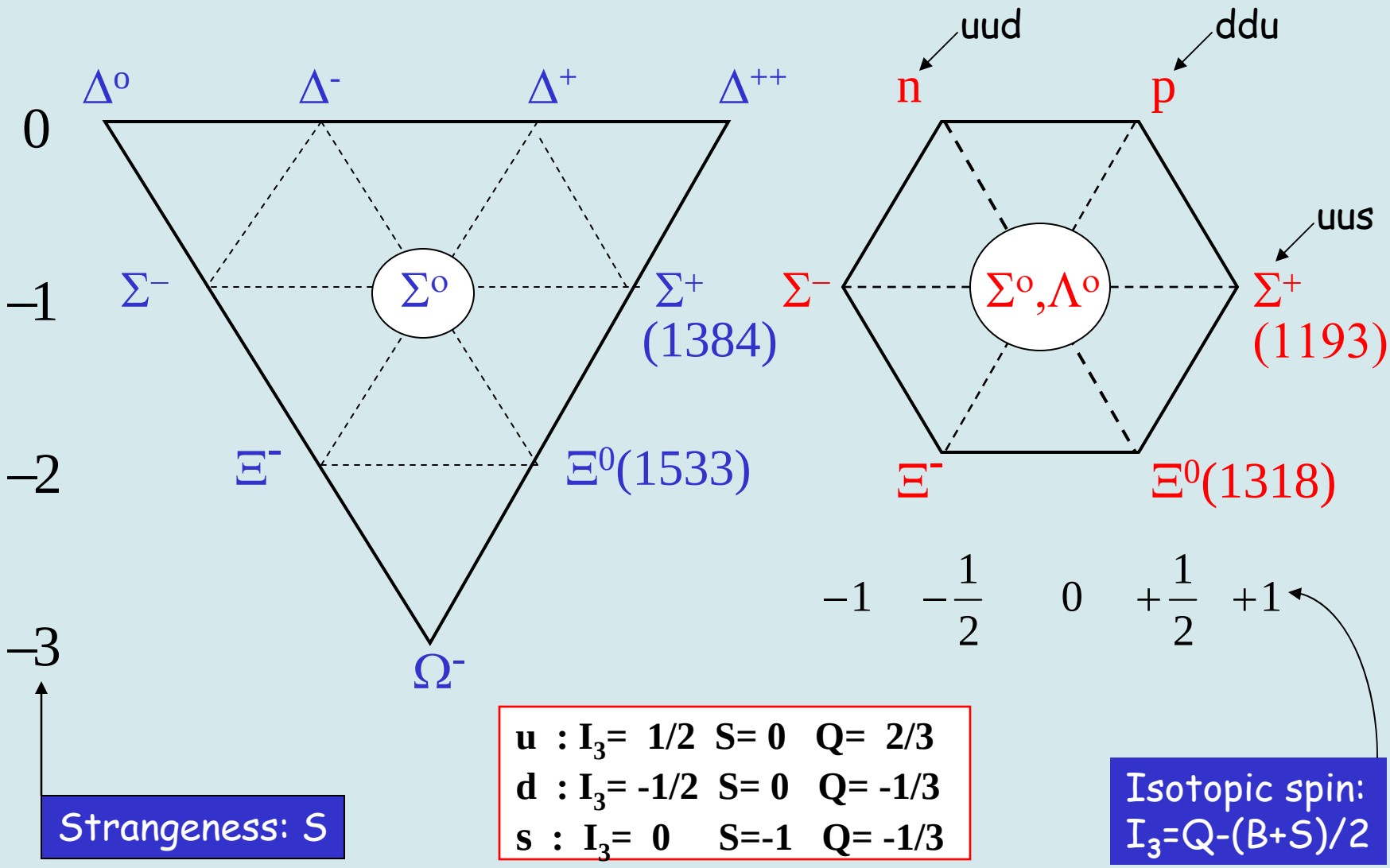
Searching for quark substructure at Fermilab





no substructure found down to ~ 10^{-17} cm

SYMMETRY



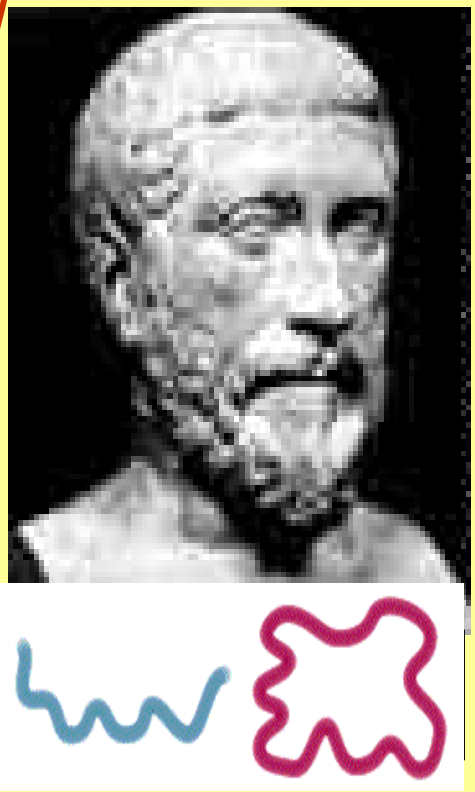
u : I_3= 1/2 S= 0 Q= 2/3
d : I_3= -1/2 S= 0 Q= -1/3
s : I_3= 0 S=-1 Q= -1/3

String Theory

http://www.aboutscotland.com/harmony/prop.html

Particles correspond to the vibration modes of a string in 10 dimensions

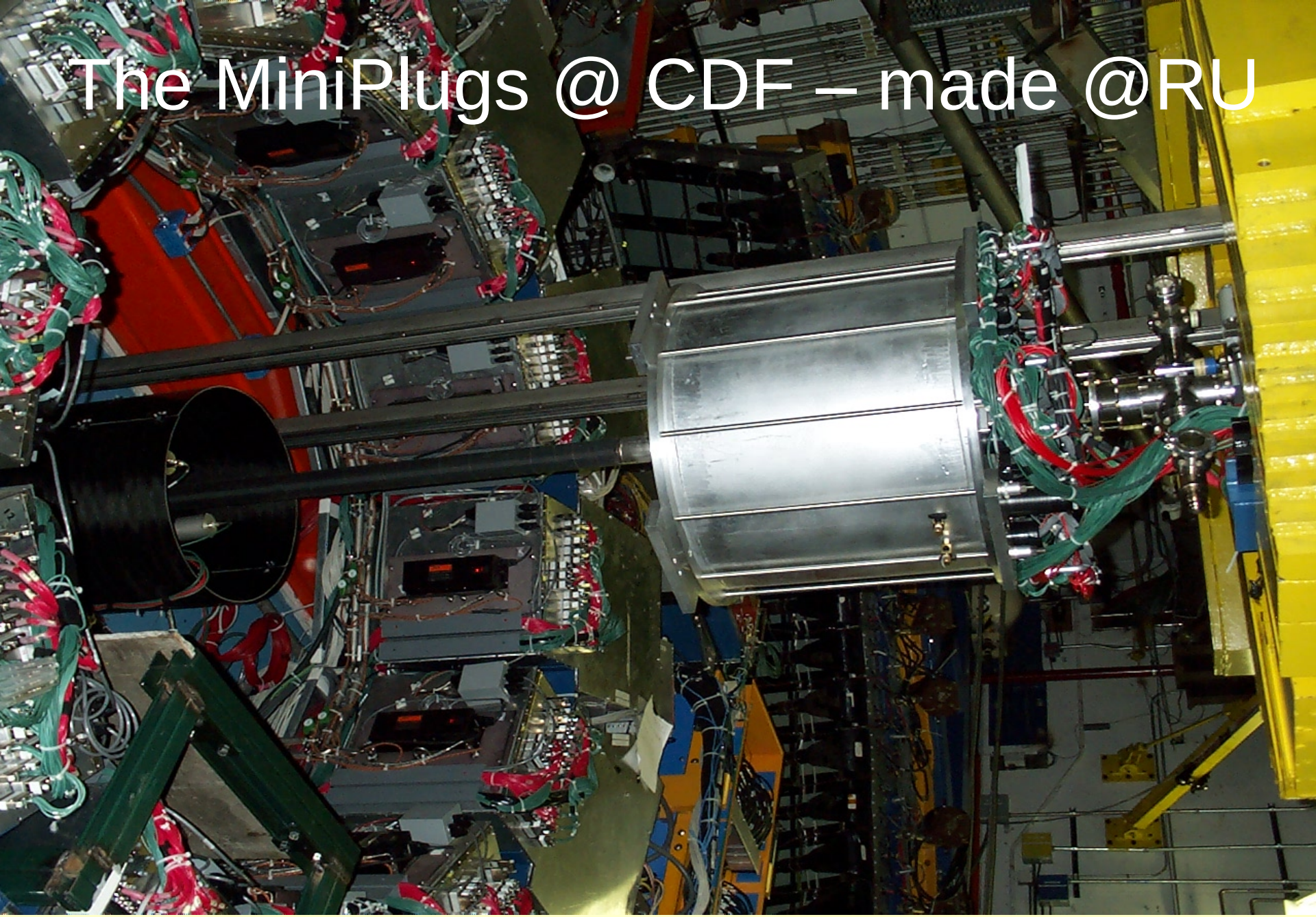
Pythagoras applied it to music in 400 BC:
1+2+3+4=10



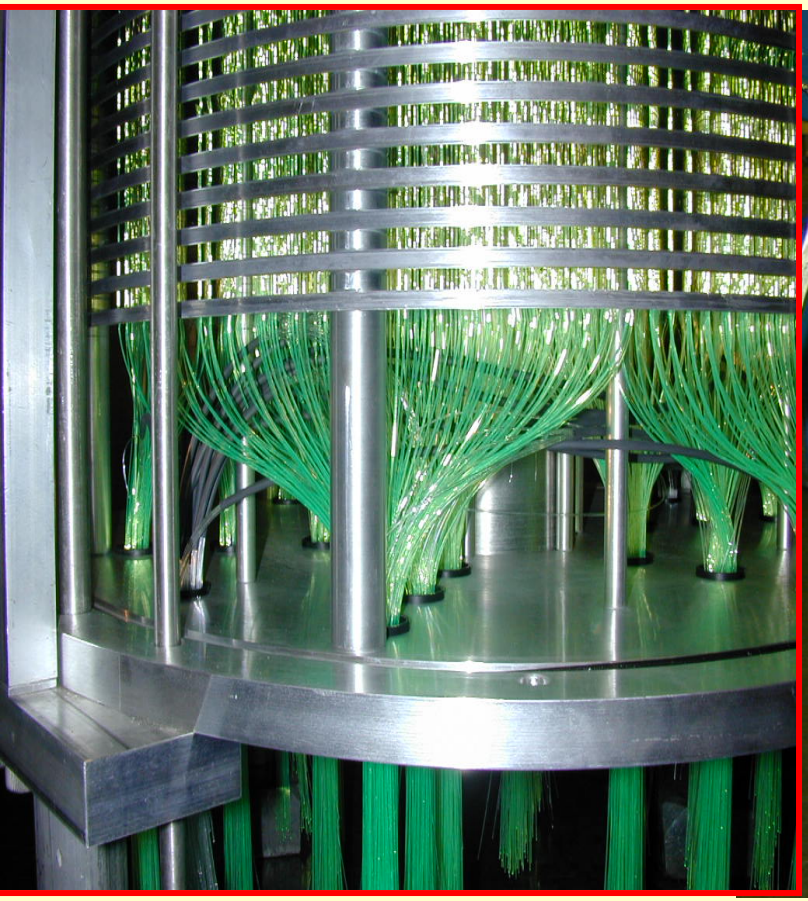
Gravity is included!



The MiniPlugs @ CDF – made @RU



MiniPlug Construction at Rockefeller





About 1500 wavelength shifting fibers of 1 mm dia. are 'strung' through holes drilled in 36 lead plates sandwiched between reflective Al sheets and guided into bunches to be viewed individually by multi-channel photomultipliers.

QCD – Quantum Chromo-Dynamics

The Theory of Strong Interactions



COLOR FORCE



