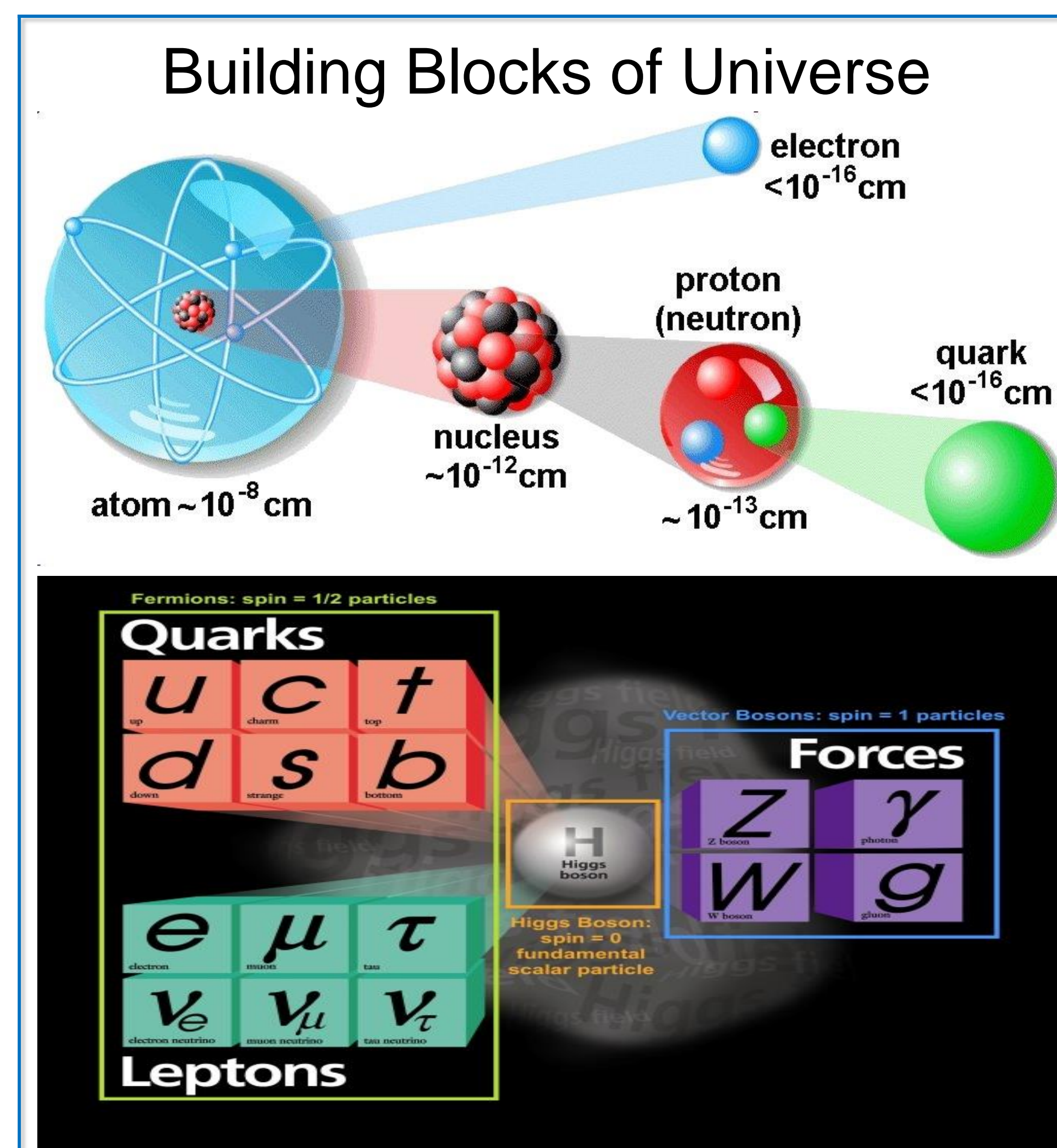




Building Blocks of Universe



electron $<10^{-16}$ cm

proton (neutron) $\sim 10^{-13}$ cm

quark $<10^{-16}$ cm

atom $\sim 10^{-8}$ cm

nucleus $\sim 10^{-12}$ cm

Fermions: spin = 1/2 particles

Quarks		
u	c	t
d	s	b

Vector Bosons: spin = 1 particles

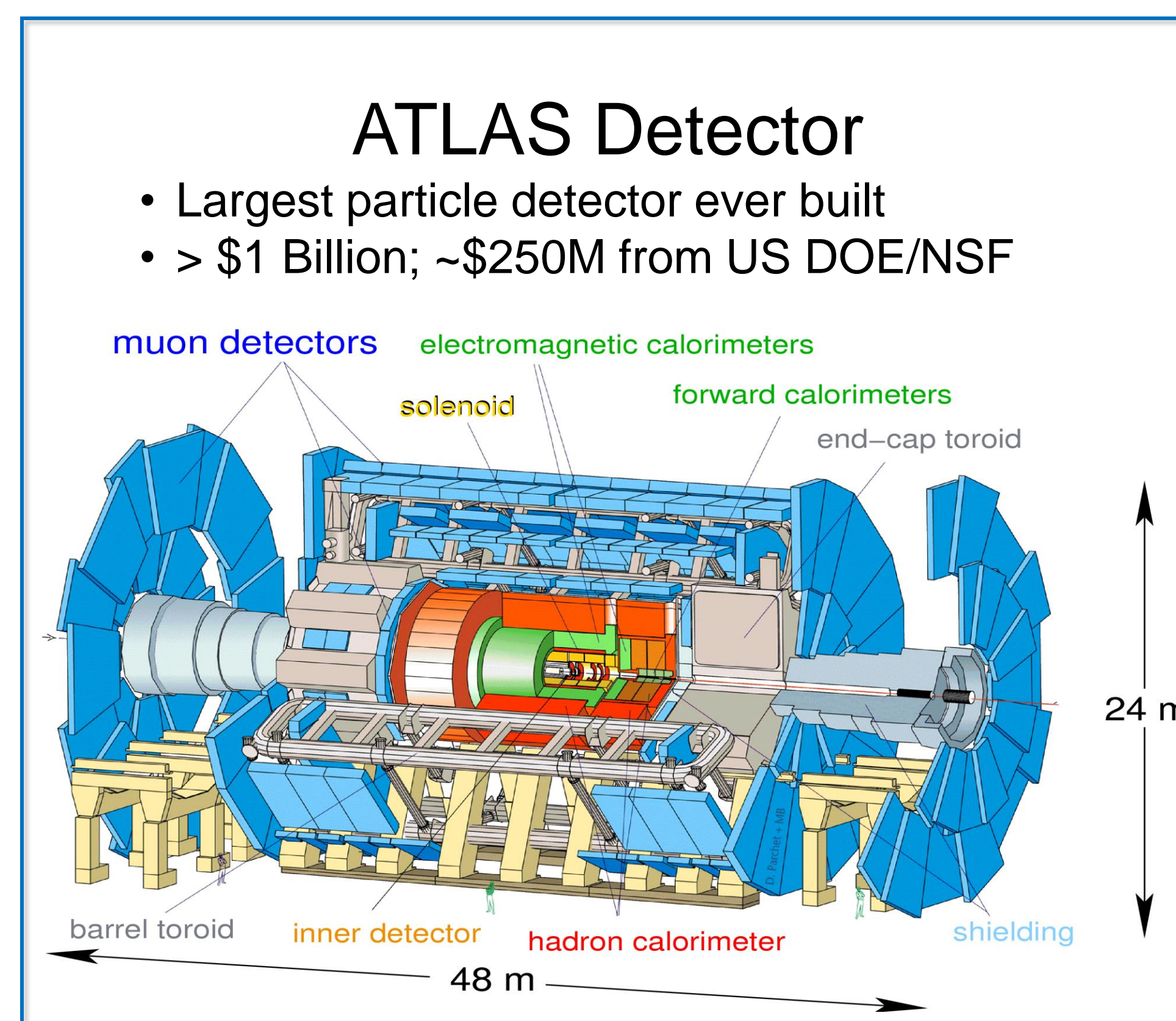
Forces	
Z	γ
W	g

Higgs Boson: spin = 0, fundamental scalar particle

Leptons		
e	μ	τ
ν_e	ν_μ	ν_τ

ATLAS Detector

- Largest particle detector ever built
- > \$1 Billion; ~\$250M from US DOE/NSF



muon detectors, electromagnetic calorimeters, solenoid, forward calorimeters, end-cap toroid, barrel toroid, inner detector, hadron calorimeter, shielding

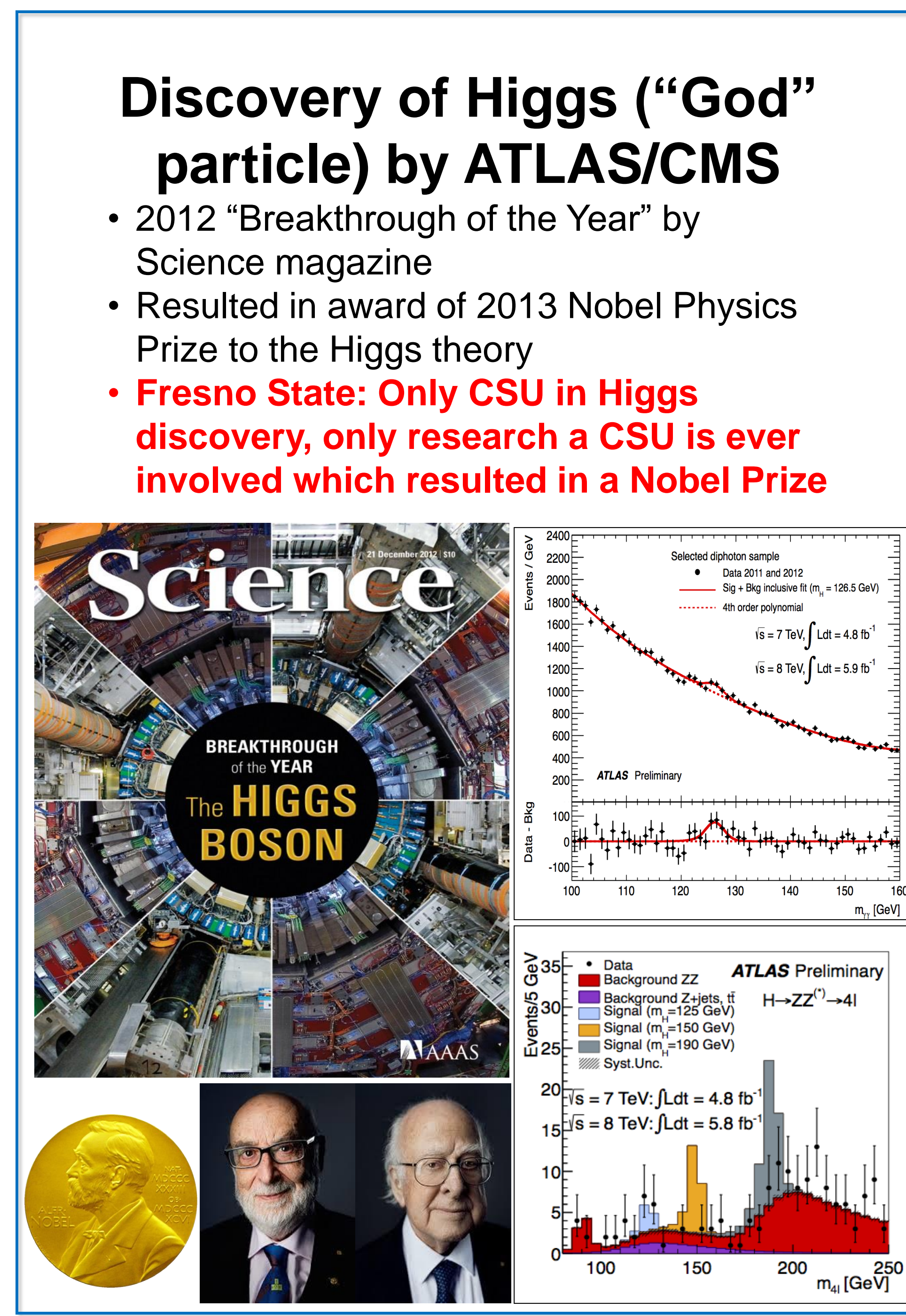
24 m, 48 m

ATLAS Collaboration

- ~3000 physicists from ~200 institutions of 40 countries all over the world
- ~500 physicists from 40 US universities (Harvard, Yale, MIT, Chicago, Columbia, UC-Berkeley, Michigan, Stanford, UPenn, Washington, Wisconsin, etc.) and 4 US national labs (ANL, BNL, LBL, and SLAC)
- Fresno State is the only CSU campus on ATLAS**

Discovery of Higgs ("God" particle) by ATLAS/CMS

- 2012 "Breakthrough of the Year" by Science magazine
- Resulted in award of 2013 Nobel Physics Prize to the Higgs theory
- Fresno State: Only CSU in Higgs discovery, only research a CSU is ever involved which resulted in a Nobel Prize**



Science
BREAKTHROUGH of the YEAR
The HIGGS BOSON

Selected diphoton sample
Data 2011 and 2012
Background ZZ, $\gamma\gamma$, $\tau\tau$
Signal ($m_H = 125$ GeV)
Signal ($m_H = 150$ GeV)
Signal ($m_H = 190$ GeV)
Syst. Unc.

ATLAS Preliminary
H \rightarrow ZZ \rightarrow 4l
 $\sigma = 7$ TeV; $\int \mathcal{L} dt = 4.8$ fb $^{-1}$
 $\sigma = 8$ TeV; $\int \mathcal{L} dt = 5.9$ fb $^{-1}$

ATLAS Preliminary
Data
Background ZZ
Signal ($m_H = 125$ GeV)
Signal ($m_H = 150$ GeV)
Signal ($m_H = 190$ GeV)
Syst. Unc.

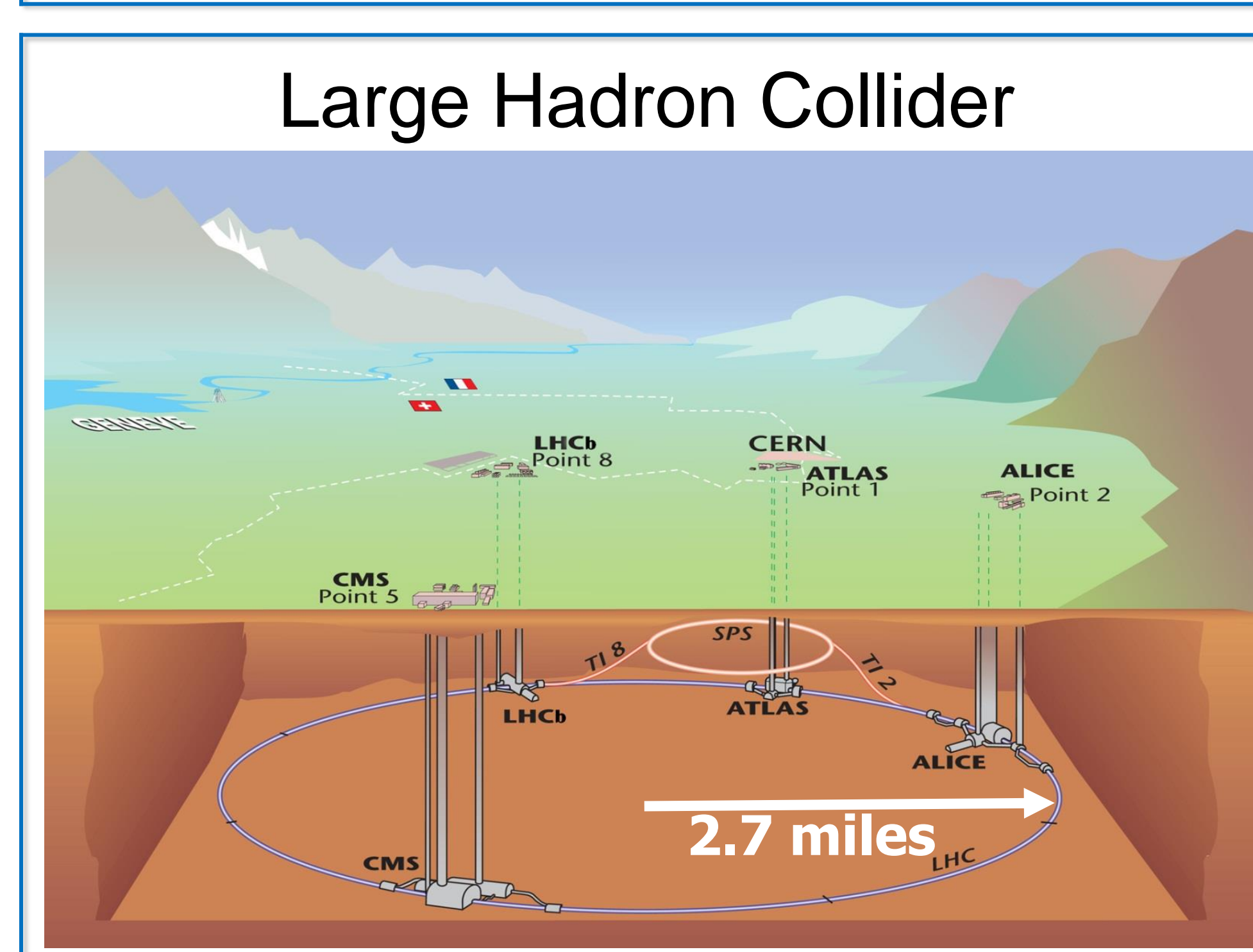
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 $\sigma = 8$ TeV; $\int \mathcal{L} dt = 5.8$ fb $^{-1}$

CERN

- CERN stands for European Organization for Nuclear Research in French
- ~10,000 scientists from ~100 countries
- Birth place of two Nobel Prizes and the World Wide Web

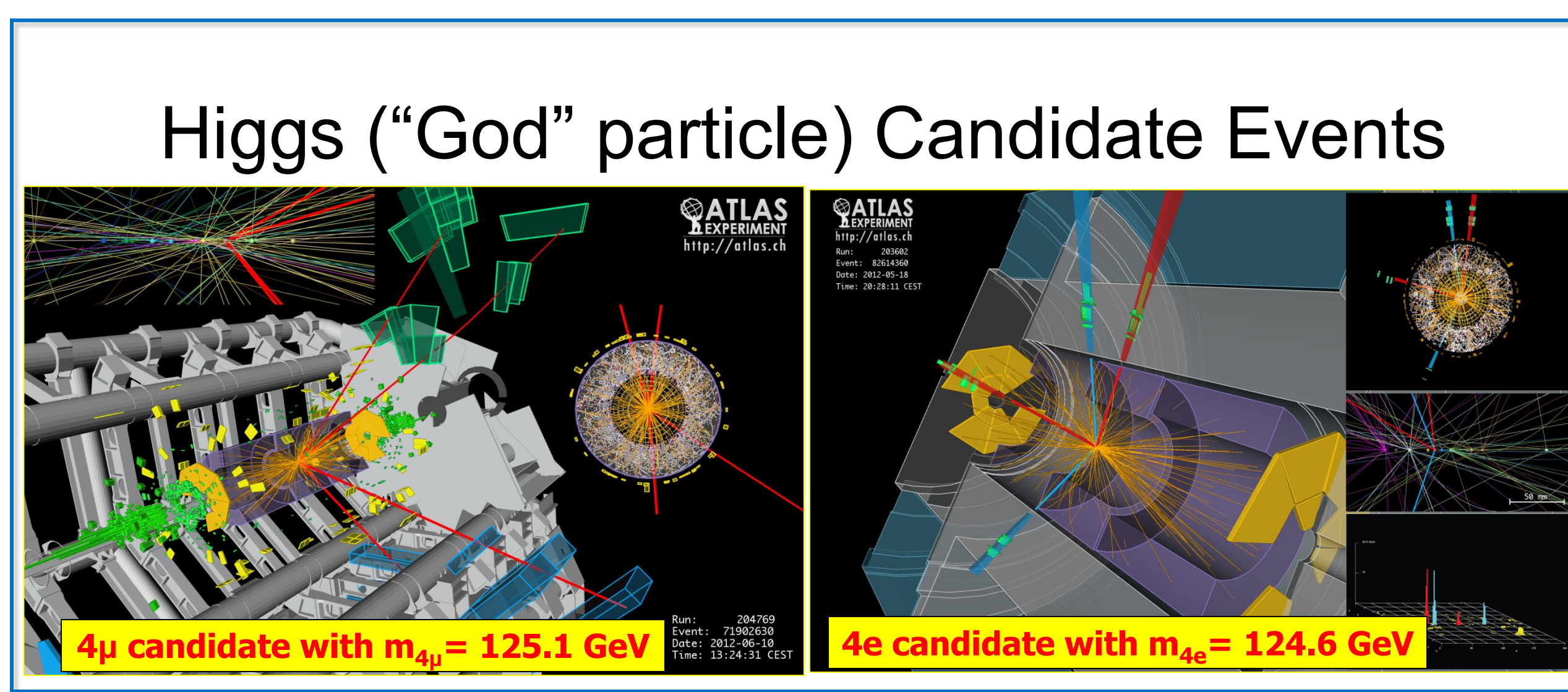


Large Hadron Collider



2.7 miles

Higgs ("God" particle) Candidate Events



4 μ candidate with $m_{4\mu} = 125.1$ GeV

4e candidate with $m_{4e} = 124.6$ GeV

Fresno State ATLAS Program

- Faculty: Dr. Yongsheng Gao (2007 to present)
- Postdocs: Dr. Harinder Bawa (2008 to present) and Dr. Andrew Lowe (2010 to 2012)
- 11 Master graduate students and undergraduate students
- Supported by \$145K (CSM), \$183K (Provost), \$100K (ORSP), \$15K/year (CSM) and ~\$6K/year (IRA), etc
- \$460K NSF Elementary Particle Physics (EPP) core grant (2009 to 2012 with \$138K indirect): First ever such grant to a CSU campus.
- \$620K NSF Major Research Instrumentation (MRI) grant (2010 to 2012 with \$90K indirect): Fresno State (Lead) with 8 subcontractors: U. of Chicago, Columbia, Hampton, Michigan State, Northern Illinois, New York, Stony Brook, and U. of Washington)
- \$511K NSF Elementary Particle Physics (EPP) core grant (2012 to 2015 with \$142K indirect)
- \$360K NSF Elementary Particle Physics (EPP) ATLAS membership fee to CERN since 2007 (~\$17K per physicist per year)
- Pending ~\$250K NSF International Research Experience for Students (IRES) proposal (2015 to 2018): Is being recommended for funding by NSF
- Pending ~\$840K NSF Elementary Particle Physics (EPP) core grant renewal proposal (2015 to 2018 with ~\$240K indirect)
- Pending ~\$1M NSF Major Research Instrumentation (MRI) grant proposal (2015 to 2016 with ~\$152K indirect): Fresno State (Lead) with 17 subcontractors: U. of Chicago, Columbia, Cornell, Florida International, Kansas, Michigan State, Nebraska, Northern Illinois, Northeastern, Notre Dame, New York, Purdue-Calumet, Rutgers, Stony Brook, SUNY-Buffalo, Vanderbilt, and U. of Washington
- Fresno State has authorship in every ATLAS publication (~100 papers each year in top physics journals)
- Reported by ABC-30, CBS-47, KSEE-24, Fresno Bee, etc.
- Center of CSU Nuclear and Particle Physics Consortium (NUPAC) which consists of 17 CSU campuses: Bakersfield, Channel Islands, Chico, Dominguez Hills, East Bay, Fresno, Humboldt, Los Angeles, Long Beach, Northridge, Pomona, Sacramento, San Bernardino, San Francisco, San Luis Obispo, Sonoma, and Stanislaus.
- CSU Chancellor's Office is interested in forming a new CSU-wide affinity group in physics & astronomy with Fresno State ATLAS program and CSU NUPAC as key components. Assistant Vice Chancellor Jim Till hosted meeting at Chancellor's Office on 5/23/2014 about forming the new affinity group.

CSU Students at CERN



Student Success

- 5 to 7 students from CSU NUPAC campuses to CERN every summer since 2008 on ATLAS research
- ~40 CSU students (mostly from Fresno State but also includes Channel Islands, Long Beach, Pomona, Sacramento) on ATLAS research so far
- Reported results at ATLAS Working Group meetings, regional/national conferences, and attended famous CERN Summer Student Lecture Series given by top physicists from all over the world
- Fresno State Online class to CSU NUPAC campuses
- After working at CERN: Teaching, high-tech companies, and Ph.D programs (UC-Berkeley, UCSD, UCSC, Iowa, Hamburg, CEA Saclay, HEPHY Vienna, etc.)
- <http://zimmer.csufresno.edu/~yogao/ATLAS/>
- ATLAS/CERN working experience prepares CSU students for their personal and professional success in an increasingly competitive, global, and multi-cultural society