X-Informatics Physics Use Case Discovery of Higgs Particle Part I

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http://www.infomall.org/X-InformaticsSpring2013/index.html

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2013

Big Data Ecosystem in One Sentence

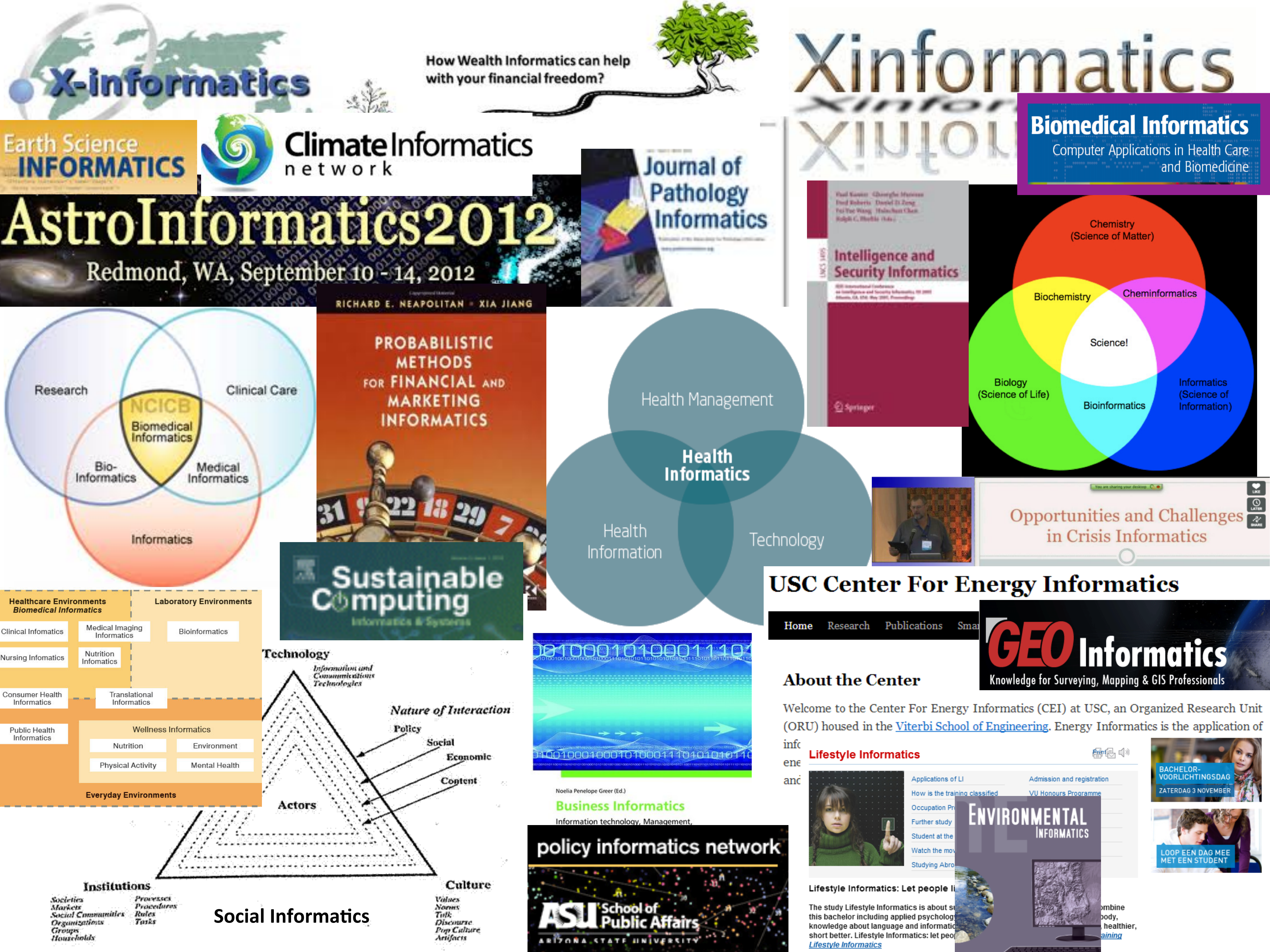
Use Clouds running Data Analytics Collaboratively processing Big Data to solve problems in X-Informatics (or e-X)

X = Astronomy, Biology, Biomedicine, Business, Chemistry, Climate, Crisis, Earth Science, Energy, Environment, Finance, Health, Intelligence, Lifestyle, Marketing, Medicine, Pathology, Policy, Radar, Security, Sensor, Social, Sustainability, Wealth and Wellness with more fields (physics) defined implicitly

Spans Industry and Science (research)

Education: Data Science see recent New York Times articles

http://datascience101.wordpress.com/2013/04/13/new-york-times-data-science-articles/



X-informatics
How Wealth Informatics can help with your financial freedom?
Xinformatics
Earth Science INFORMATICS
Climate Informatics network
Biomedical Informatics
Computer Applications in Health Care and Biomedicine
Journal of Pathology Informatics
AstroInformatics2012
Redmond, WA, September 10 - 14, 2012
Intelligence and Security Informatics
Chemistry (Science of Matter)
Biochemistry
Cheminformatics
Science!
Biology (Science of Life)
Bioinformatics
Informatics (Science of Information)
RICHARD E. NEAPOLITAN · XIA JIANG
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NCICB
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Informatics
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About the Center
Welcome to the Center For Energy Informatics (CEI) at USC, an Organized Research Unit (ORU) housed in the Viterbi School of Engineering. Energy Informatics is the application of
Healthcare Environments
Biomedical Informatics
Laboratory Environments
Clinical Infomatics
Medical Imaging Informatics
Bioinformatics
Nursing Infomatics
Nutrition Infomatics
Consumer Health Informatics
Translational Informatics
Public Health Informatics
Wellness Informatics
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Environment
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Lifestyle Informatics: Let people
Lifestyle Informatics

Physics-Informatics
Looking for Higgs Particle
and Counting Errors
Introduction

http://grids.ucs.indiana.edu/ptliupages/publications/Where%20does%20all%20the%20data%20come%20from%20v7.pdf

This analysis raw data → reconstructed data → AOD and TAGS → Physics is performed on the multi-tier LHC Computing Grid. Note that every event can be analyzed independently so that many events can be processed in parallel with some concentration operations such as those to gather entries in a histogram. This implies that both Grid and Cloud solutions work with this type of data with currently Grids being the only implementation today.

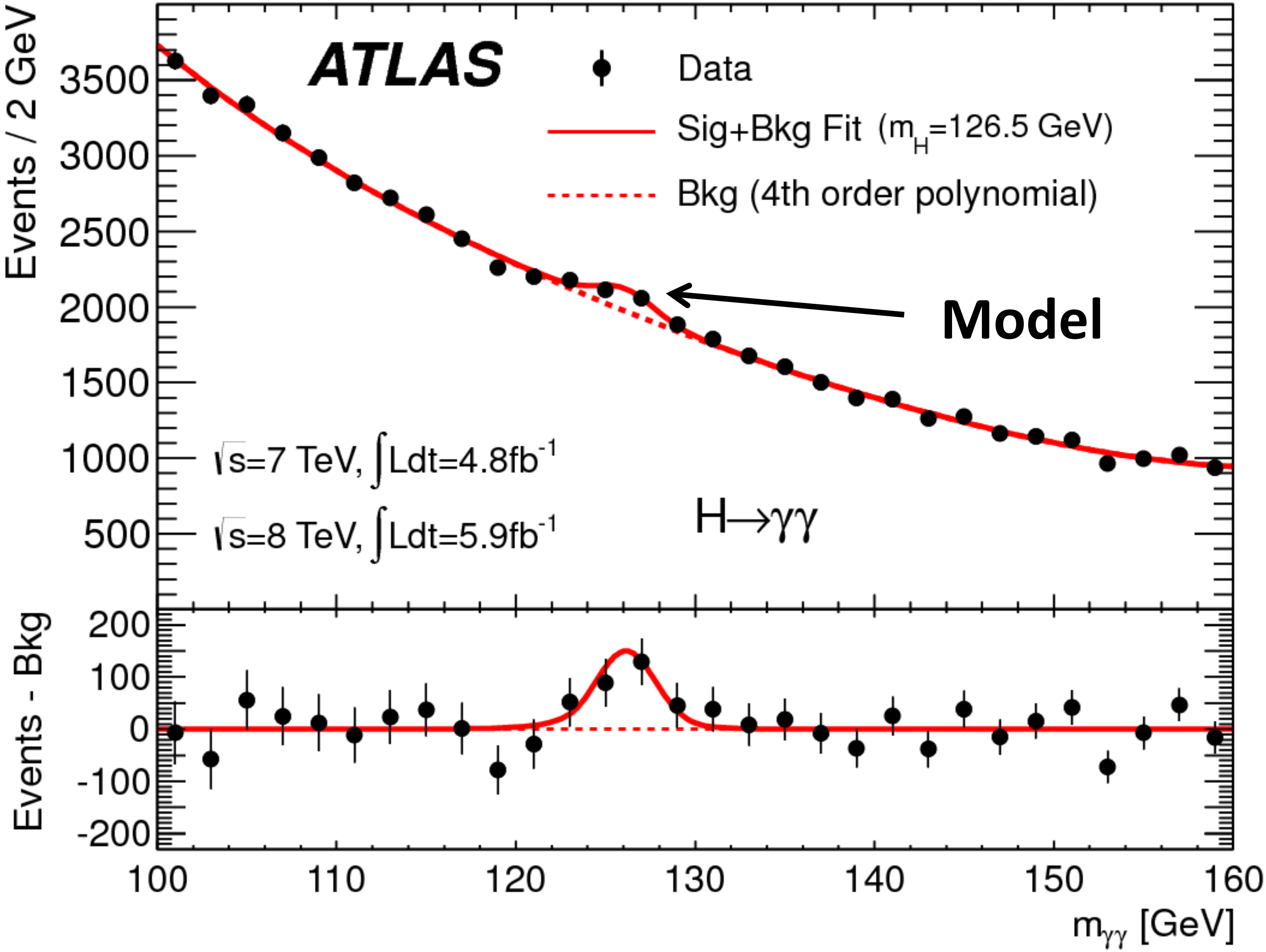
ATLAS Expt

Note LHC lies in a tunnel 27 kilometres (17 mi) in circumference

Higgs Event

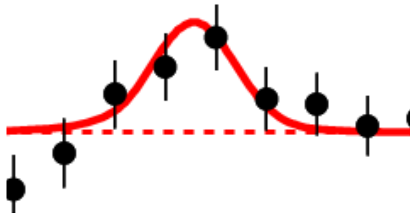
The LHC produces some 15 petabytes of data per year of all varieties and with the exact value depending on duty factor of accelerator (which is reduced simply to cut electricity cost but also due to malfunction of one or more of the many complex systems) and experiments. The raw data produced by experiments is processed on the LHC Computing Grid, which has some 200,000 Cores arranged in a three level structure. Tier-0 is CERN itself, Tier 1 are national facilities and Tier 2 are regional systems. For example one LHC experiment (CMS) has 7 Tier-1 and 50 Tier-2 facilities.

http://www.quantumdiaries.org/2012/09/07/why-particle-detectors-need-a-trigger/atlasmgg/



Personal Note

- As a naïve undergraduate in 1964, I was told by Professor that bumps like



- Were particles. I was amazed and found this more intriguing than anything else I had heard about so I decided to do PhD in area.
- Note errors; measurements have errors that are SQRT(N) (N~2000 measured # of events)
  - Central Limit theorem that dominates design and study of all such event-based experiments

More Details

- To get that acceleration, the scientists at CERN used the Large Hadron Collider, which is buried under the French/Swiss border. It's a circular path that's about 16.8 miles long and about 330 feet below the surface. The Collider has about 9,300 magnets, which are super-cooled to -456.25 degrees Fahrenheit. This enables the Collider to get protons to 99.99% of the speed of light. The protons run through six different detectors, which run different experiments and the amount of electricity that powers it is incredible – **120 Megawatts** – about as much as all of the homes in the neighboring Swiss Canton of Geneva.
- The Large Hadron Collider took about a decade to construct, for a total cost of about $4.75 billion. Computing power is also a significant part of the cost of running CERN – about $286 million annually. Electricity costs alone for the LHC run about $23.5 million per year. The total operating budget of the LHC runs to about $1 billion per year.
- The Large Hadron Collider was first turned on in August of 2008, then stopped for repairs in September until November 2009. Taking all of those costs into consideration, the total cost of finding the Higgs boson ran about **$13.25 billion.** That's a large amount, but there are over 50 billionaires on the Forbes list actually worth more than that.

Physics-Informatics
Looking for Higgs Particle
Experiments

Experiments

- ATLAS (A Toroidal LHC Apparatus) is one of the seven particle detector experiments (ALICE, ATLAS, CMS, TOTEM, LHCb, LHCf and MoEDAL) constructed at the Large Hadron Collider (LHC), a particle accelerator at CERN (the European Organization for Nuclear Research) in Switzerland.
- ATLAS is 45 metres long, 25 metres in diameter, and weighs about 7,000 tons. The experiment is a collaboration involving roughly 3,000 physicists at 175 institutions in 38 countries
- The Compact Muon Solenoid (CMS) experiment is one of two large general-purpose particle physics detectors built on the Large Hadron Collider (LHC) at CERN in Switzerland and France.
  - Approximately 3,600 people, representing 183 scientific institutes and 38 countries, form the CMS collaboration who built and now operate the detector.
  - It is located in an underground cavern at Cessy in France, just across the border from Geneva.

Budgets

- US Department of Energy particle physics budget $777M a year
  - LHC is flagship project but may not
- ATLAS + CMS (2 largest experiments) are 6,000 people which is perhaps $500M a year

Physics Letters B
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ELSEVIER

http://www.sciencedirect.com/science/article/pii/S037026931200857X

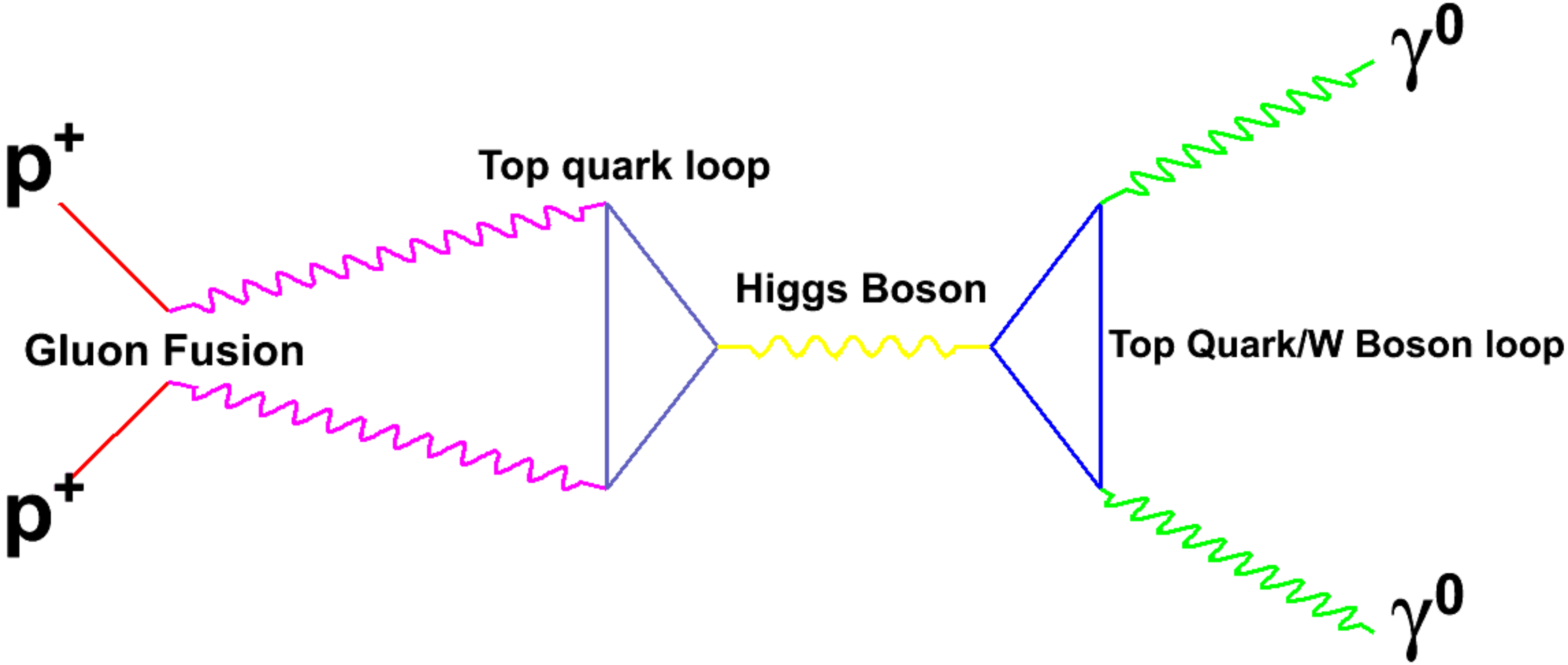
Observation of a new particle in the search for the Standard Model Higgs boson with the ATLAS detector at the LHC ☆

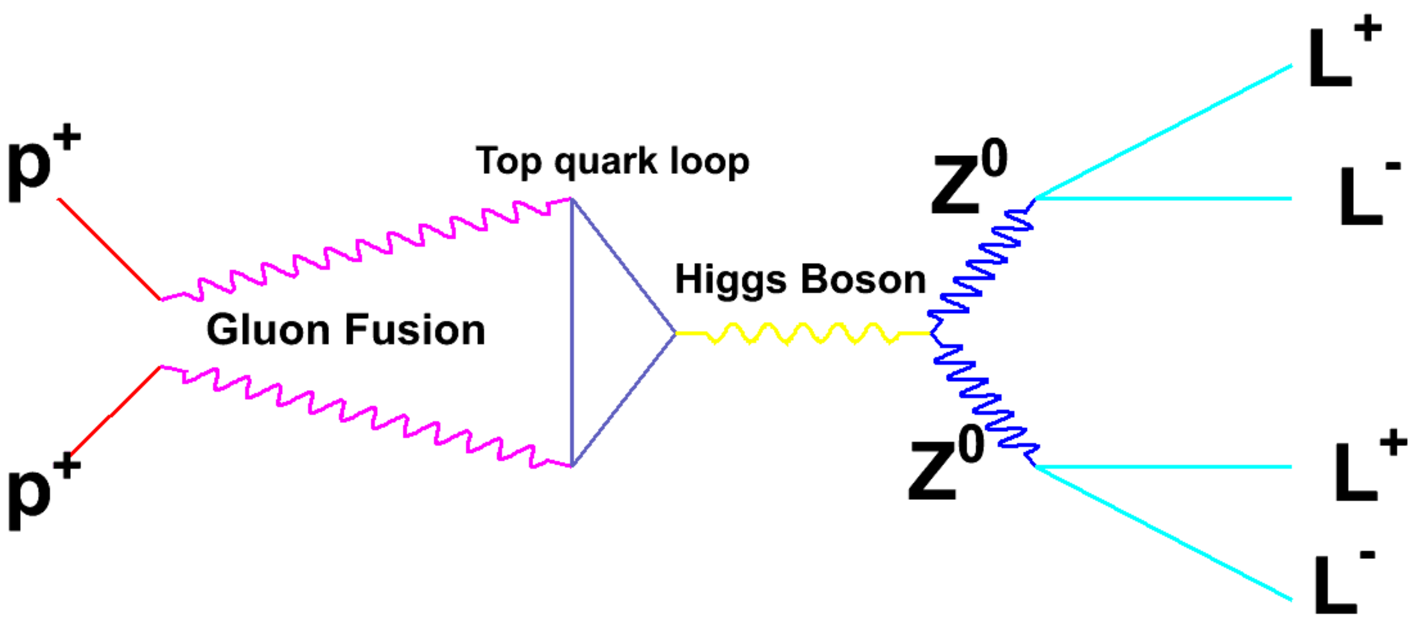
Universally Available

This paper is dedicated to the memory of our ATLAS colleagues who did not live to see the full impact and significance of their contributions to the experiment.

ATLAS Collaboration *

G. Aad[48], T. Abajyan[21], B. Abbott[111], J. Abdallah[12], S. Abdel Khalek[115], A.A. Abdelalim[49], O. Abdinov[11], R. Aben[105], B. Abi[112], M. Abolins[88], O.S. AbouZeid[158], H. Abramowicz[153], H. Abreu[136], B.S. Acharya[164a, 164b], L. Adamczyk[38], D.L. Adams[25], T.N. Addy[56], J. Adelman[176], S. Adomeit[98], P. Adragna[75], T. Adye[129], S. Aefsky[23], J.A. Aguilar-Saavedra[124b, a], M. Agustoni[17], M. Aharrouche[81], S.P. Ahlen[22], F. Ahles[48], A. Ahmad[148], M. Ahsan[41], G. Aielli[133a, 133b], T. Akdogan[19a], T.P.A. Åkesson[79], G. Akimoto[155], A.V. Akimov[94], M.S. Alam[2], M.A. Alam[76], J. Albert[169], S. Albrand[55], M. Aleksa[30], I.N. Aleksandrov[64], F. Alessandria[89a], C. Alexa[26a], G. Alexander[153], G. Alexandre[49], T. Alexopoulos[10], M. Alhroob[164a, 164c], M. Aliev[16], G. Alimonti[89a], J. Alison[120], B.M.M. Allbrooke[18], P.P. Allport[73], S.E. Allwood-Spiers[53], J. Almond[82], A. Aloisio[102a, 102b], R. Alon[172], A. Alonso[79], F. Alonso[70], A. Altheimer[35], B. Alvarez Gonzalez[88], M.G. Alviggi[102a, 102b], K. Amako[65], C. Amelung[23], V.V. Ammosov[128, □], S.P. Amor Dos Santos[124a], A. Amorim[124a, b], N. Amram[153], C. Anastopoulos[30], L.S. Ancu[17], N. Andari[115], T. Andeen[35], C.F. Anders[58b], G. Anders[58a], K.J. Anderson[31], A. Andreazza[89a, 89b], V. Andrei[58a], M.-L. Andrieux[55], X.S. Anduaga[70], S. Angelidakis[9], P. Anger[44], A. Angerami[35], F. Anghinolfi[30], A. Anisenkov[107], N. Anjos[124a], A. Annovi[47], A. Antonaki[9], M. Antonelli[47], A. Antonov[96], J. Antos[144b], F. Anulli[132a], M. Aoki[101], S. Aoun[83], L. Aperio Bella[5], R. Apolle[118, c], G. Arabidze[88], I. Aracena[143], Y. Arai[65], A.T.H. Arce[45], S. Arfaoui[148], J.-F. Arguin[93], E. Arik[19a, □], M. Arik[19a], A.J. Armbruster[87], O. Arnaez[81], V. Arnal[80], C. Arnault[115], A. Artamonov[95], G. Artoni[132a, 132b], D. Arutinov[21], S. Asai[155], S. Ask[28], B. Åsman[146a, 146b], L. Asquith[6], K. Assamagan[25], A. Astbury[169], M. Atkinson[165], B. Aubert[5], E. Auge[115], K. Augsten[127], M. Aurousseau[145a], G. Avolio[163], R. Avramidou[10], D. Axen[168], G. Azuelos[93, d], Y. Azuma[155], M.A. Baak[30], G. Baccaglioni[89a], C. Bacci[134a, 134b], A.M. Bach[15], H. Bachacou[136], K. Bachas[30], M. Backes[49], M. Backhaus[21], J. Backus Mayes[143], E. Badescu[26a], P. Bagnaia[132a, 132b], S. Bahinipati[3], Y. Bai[33a], D.C. Bailey[158], T. Bain[158], J.T. Baines[129], O.K. Baker[176], M.D. Baker[25], S. Baker[77], P. Balek[126], E. Banas[39], P. Banerjee[93], Sw. Banerjee[173], D. Banfi[30], A. Bangert[150], V. Bansal[169], H.S. Bansil[18], L. Barak[172], S.P. Baranov[94], A. Barbaro Galtieri[15], T. Barber[48], E.L. Barberio[86], D. Barberis[50a, 50b], M. Barbero[21], D.Y. Bardin[64], T. Barillari[99], M. Barisonzi[175], T. Barklow[143], N. Barlow[28], B.M. Barnett[129], R.M. Barnett[15], A. Baroncelli[134a], G. Barone[49], A.J. Barr[118], F. Barreiro[80], J. Barreiro Guimarães da Costa[57], P. Barrillon[115], R. Bartoldus[143], A.E. Barton[71], V. Bartsch[149], A. Basye[165], R.L. Bates[53], L. Batkova[144a], J.R. Batley[28], A. Battaglia[17], M. Battistin[30], F. Bauer[136], H.S.



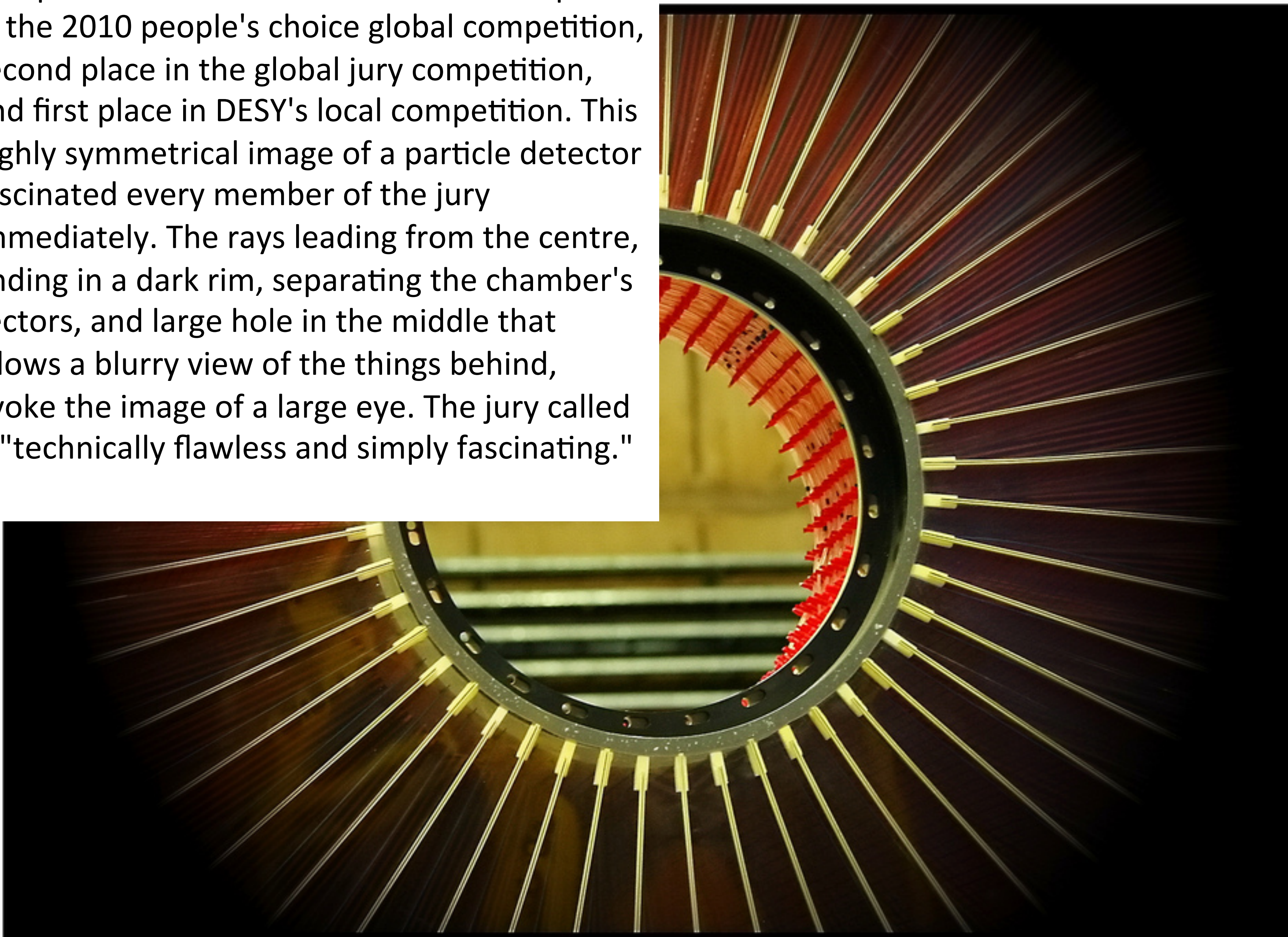


These "Feynman diagrams" define a model. It cannot be calculated exactly but approximate calculations are possible

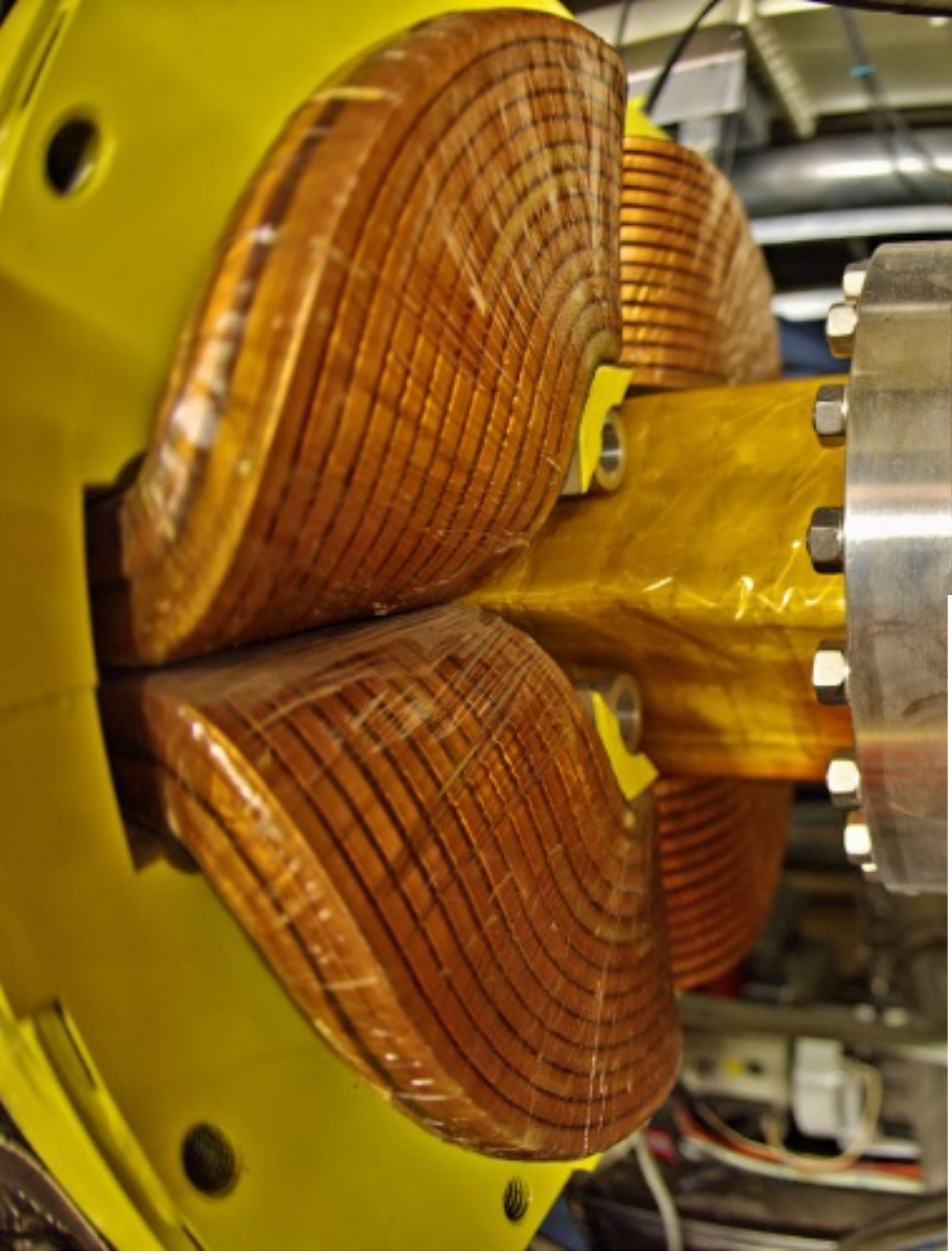
http://biologos.org/blog/what-is-the-higgs-boson

Physics-Informatics
Accelerator Picture Gallery of Big Science

This portrait of a wire chamber won first place in the 2010 people's choice global competition, second place in the global jury competition, and first place in DESY's local competition. This highly symmetrical image of a particle detector fascinated every member of the jury immediately. The rays leading from the centre, ending in a dark rim, separating the chamber's sectors, and large hole in the middle that allows a blurry view of the things behind, evoke the image of a large eye. The jury called it "technically flawless and simply fascinating."



http://www.interactions.org/cms/?pid=6002



This image of two quadrupole magnets won third place in the 2010 global jury competition and second place in DESY's local competition. The global jury noted the photo's sense of humor, and the DESY jury's association with this image was "monstrous force." The image manages to combine seemingly contradictory things – there is no doubt that its subject is something technical, mechanic, scientific, but at the time the coils of the quadrupole magnets seem organic, like two greedy mouths. A well crafted visualisation of technical processes that captures the beholder's attention.

http://www.interactions.org/cms/?pid=6002

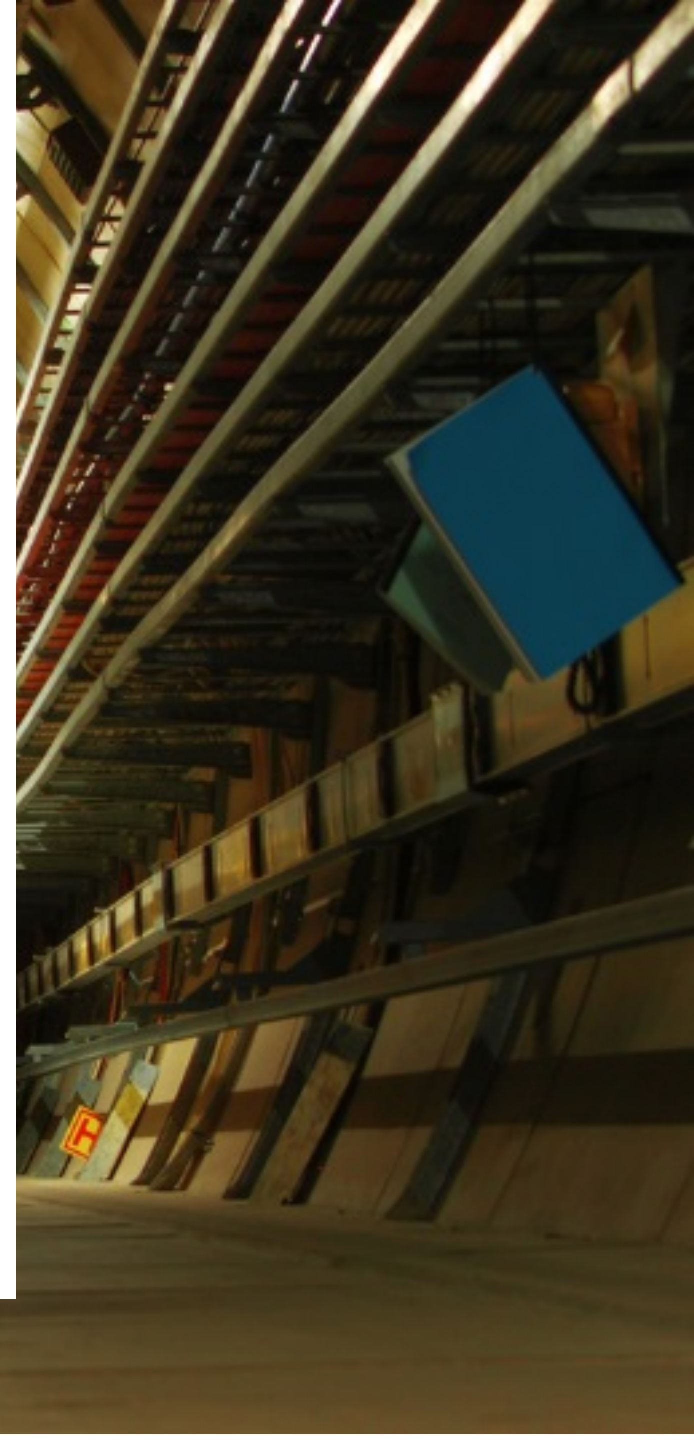
This image of an accelerator operator on shift in Fermilab's Main Control Room captured second place in the 2010 people's choice global vote and third place in Fermilab's local competition. The Main Control Room is a mission control center where scientists monitor the laboratory's accelerator complex 24 hours a day, seven days a week.

http://www.interactions.org/cms/?pid=6002

This classic image of HERA's (first electron-proton collider in the world) accelerator tunnel captured third place in the 2010 people's choice global vote, and third place in DESY's local competition. The photographer manages to guide the view around the corner and make the viewer curious about what's behind the bend. The image plays with light and shadow, conveys a sense of space, almost infinity, while at the same time incorporating technicality.

The HERA tunnel runs for most of its length of 6.3km outside the site of DESY and 10 m - 25 m deep under ground. There are four experimental halls with sizes of about 25 m x 43 m. The HERA ring tunnel has an inner diameter of 5.2 m The two storage rings for the electron (e) and proton (p) beams are mounted on top of each other. The magnets of the electron storage ring (lower) contain normal conductors and operate at room temperature.

The magnets of the proton storage ring (upper) need to produce a magnetic field of 4.7 Tesla for bending the high momentum proton beam in the arcs of the ring. To accomplish this, superconducting (s.c.) magnets which operate at a temperature of 4.4 K (-269 C) have been constructed.



http://www.interactions.org/cms/?pid=6002

Third place winner of the 2012 Jury Competition, showing the inside of the RHIC (Relativistic Heavy Ion Collider) tunnel, a 2.4-mile high-tech particle racetrack at Brookhaven National Laboratory.

http://www.interactions.org/cms/?pid=1032811

The Gran Sasso National Laboratory (LNGS) is one of four INFN national laboratories.

It is the largest underground laboratory in the world for experiments in particle physics, particle astrophysics and nuclear astrophysics. It is used as a worldwide facility by scientists, presently over 900 in number, from 29 different countries, working at about 15 experiments in their different phases.
It is located between the towns of L'Aquila and Teramo, about 120 km from Rome.
The underground facilities are located on a side of the ten kilometres long freeway tunnel crossing the Gran Sasso Mountain. They consist of three large experimental halls, each about 100 m long, 20 m wide and 18 m high and service tunnels, for a total volume of about 180,000 cubic metres.
The average 1400 m rock coverage gives a reduction factor of one million in the cosmic ray flux; moreover, the neutron flux is thousand times less than on the surface, thanks to the smallness of the Uranium and Thorium content of the dolomite rocks of the mountain.
The headquarters and the support facilities, among which offices, different services, library and canteen, are located in the external building.
The mission of the Laboratory is to host experiments that require a low background environment in the field of astroparticle physics and nuclear astrophysics and other disciplines that can profit of its characteristics and of its infrastructures.
Main research topics of the present programme are: neutrino physics with neutrinos naturally produced in the Sun and in Supernova explosions and neutrino oscillations with a beam from CERN (CNGS program), search for neutrino mass in neutrinoless double beta decay, dark matter search, nuclear reactions of astrophysical interest.

http://www.interactions.org/cms/?pid=1032811