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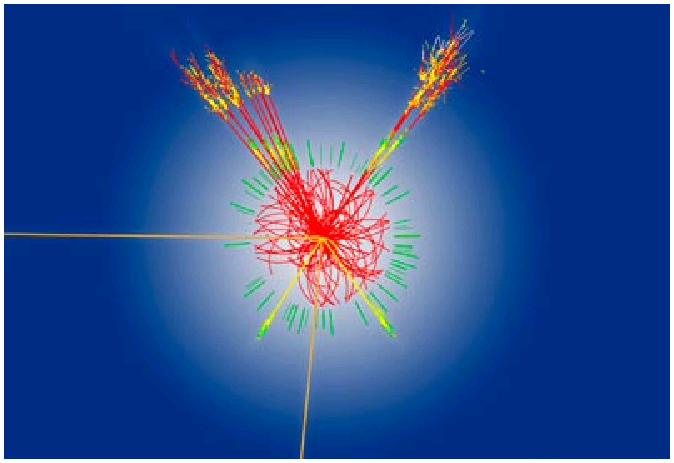
Higgs hunters face long haul

Feb 4, 2010 8 comments



Eyes on the prize: simulation of a Higgs event in the LHC's ATLAS

Apart from being so huge, complex and expensive, CERN's Large Hadron Collider (LHC) is perhaps most famous for having broken down just nine days after it switched on in September 2008. Fourteen months and some CHF40m of repairs later, the LHC came spectacularly back to life late last year as jubilant physicists collided particles at record-breaking energies.

But to reduce the chances of the LHC being derailed again by a similar accident, physicists at the Geneva lab have decided to run the collider at just half its design energy for the next 18-24 months. The decision will potentially increase the time it will take the CHF6bn machine to unearth new fundamental particles, particularly the Higgs boson.

Under the latest schedule announced this week, the 27 km circumference collider will begin to smash beams of protons into one another at an energy of 7 TeV (3.5 TeV per beam) in early March. Experiments will then continue until its detectors have accumulated one "inverse femtobarn" of data – roughly 10 trillion proton–proton collisions – with the run ending after two years at the latest. By the time it was shut down on 16 December last year after just four weeks of operation, the LHC had delivered more than 50,000 collision "events" at a record energy of 2.36 TeV to its two largest particle detectors, ATLAS and CMS.

> 5 TeV per beam now looks very risky
>
> **Roger Bailey, CERN**

The previous plan to step the collision energy to 10 TeV this year was shelved following lab tests carried out late last year that simulated the accident of 19 September 2008. It occurred when a connection between two of the LHC's superconducting magnets evaporated while carrying a current of 8.7 kA, puncturing the machine's liquid-helium cooling system and causing significant collateral damage.

By opting to run at just 7 TeV, CERN is playing it safe. "5 TeV per beam now looks very risky," LHC operations leader Roger Bailey told *physicsworld.com*.

Risky business

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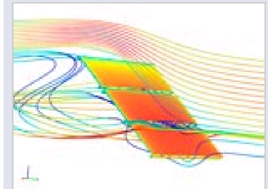

Once the 7 TeV run is over, CERN will shut the LHC down in 2012 for a year or more to prepare it to go straight to maximum-energy 14 TeV collisions in 2013. This will be a complex job that will involve replacing some 10,000 superconducting magnet connections with more robust ones.

However, Chiara Mariotti, who co-convenes the Higgs working group on the CMS experiment, says that choosing to stay at lower energies is a big price to pay in terms of the Higgs search. "We will need more than twice the data at 7 TeV compared to that needed at 10 TeV to reach the same discovery potential," she says. "At this energy we can at best expect to exclude a Higgs with a mass between 155 and 175 GeV."

Her CMS colleague Tommaso Dorigo, who has written extensively about the Higgs search on his blog, reckons the hope of discovering the Higgs boson at the LHC before 2012 is "faint".

However, the decision to run at lower energies still offers plenty of opportunity for CERN researchers, who could make major discoveries such as supersymmetric particles – or even something totally unexpected – relatively early. Indeed, the run energy of 7 TeV is still 3.5 times greater than at the Tevatron collider at Fermilab in the US, which until December was the world's most powerful collider. What will be discovered – if at all – depends largely on how heavy such new particles are and on how easy they are to spot among "background" processes taking place in the proton–proton collisions.

Friendly rivalry

The Higgs boson is the last missing piece of the Standard Model of particle physics, and its discovery would confirm the most compelling explanation physicists have for how elementary particles acquire mass. Although the theory does not predict the mass of the Higgs boson, precision measurements of known Standard Model particles mean that its mass is unlikely to be more than 186 GeV. Meanwhile, direct searches made at CERN's Large Electron–Positron collider – the forerunner to the LHC – rule out a Higgs that is lighter than 114 GeV.

> There is less and less room for the Higgs to hide
>
> **Stefan Söldner-Rembold, D0 experiment**

Efforts are therefore being focused on the region inbetween, and not only by physicists who work at the LHC. Keen to spot evidence for the Higgs first, researchers at the Tevatron's two experiments – CDF and D0 – have spent the past few years feverishly gathering data from proton–antiproton collisions at an energy of 1.96 TeV. These experiments suggest that physicists could be in for a long slog: a joint paper accepted for publication this week in *Physical Review Letters* rules out a Higgs with a mass of around 165 GeV, while disfavouring (at lower statistical significance) the region 160–180 GeV. "There is less and less room for the Higgs to hide," says D0 co-spokesperson Stefan Söldner-Rembold.

A lighter Higgs?

Although such exclusion limits allow physicists on both sides of the Atlantic to focus more sharply on the region where the Higgs might exist, the data – when taken with indirect limits from measurements at previous colliders – tentatively point to a light Higgs, which would be harder to discover. For example, a Higgs weighing less than about 140 GeV would be less likely to decay into pairs of W or Z bosons, which would leave clear, quick-to-find signatures in the LHC's detectors, and more likely to decay into pairs of b-quarks, which are much harder to distinguish from background. The LHC experiments would therefore need to collect more data to build a strong enough statistical case to identify a Higgs "signal".

Although the Tevatron does not have the capability to discover the Higgs outright – that task will only be possible with the LHC – it could produce the first strong hints of the particle's existence if the Higgs is lighter than about 160 GeV. "There is very high level of excitement at Fermilab and in other places including the US Department of Energy [which funds the laboratory]," say D0 co-spokesperson Dmitri Denisov. "But in order to claim evidence for Higgs we need to see the signal, not just exclude other areas. And keep in mind that the Higgs might not exist at all."

The Tevatron is now expected to run in tandem with the LHC's 7 TeV run until the end of 2011 following President Obama's budget request, which was made earlier this week. "Anything beyond that is a guess," says CDF co-spokesperson Jacobo Konigsberg.

> The Tevatron result certainly is adding more pressure for the LHC to join this race without delay
>
> **Pedro Teixeira-Dias, ATLAS experiment**

As the high-energy baton passes from Fermilab to CERN, the race for the Higgs and perhaps other ground-breaking discoveries is on. "The Tevatron result certainly is adding more pressure for the LHC to join this race without delay," says ATLAS physicist Pedro Teixeira-Dias. "Compared with the Tevatron the LHC will have a much higher Higgs cross-section and a better signal-to-background ratio, even at 'just' 7 TeV. But the Tevatron is now at the top of its game and is clearly not to be discounted. We live in exciting times."

About the author

Matthew Chalmers is a science writer based in Bristol, UK

8 comments

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1 **Ragtime**
Feb 4, 2010 11:28 PM
Prague, Czech Republic

Simulation of Higgs event

followed by dilepton decay is equivalent to this one, which was used for detection of top-quark. In addition, from Standard model follows, the product of Higgs boson Yukawa coupling to the left- and right-handed top quarks have nearly the same rest mass (173.1±1.3 GeV/c2) like those predicted for Higgs boson (178.0 ± 4.3 GeV/c2). It means, Higgs boson was observed already at Tevatron as a product of top-quark coupling.

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2 **Ragtime**
Feb 5, 2010 12:17 AM
Prague, Czech Republic

Higgs boson as an unparticle

Recently D. Stancato & J. Terning proposed unparticle character of Higgs bosone. In agreement with this Hawking reckons, that a number of "partner" particles will emerge, instead, thus making prof. Higgs upset by his stance. This is not so difficult to understand, because from common perspective the unparticle hypothesis would effectively mean, no distinct Higgs particle signal will be ever found, until we achieve collider jets, composed of unique particles to demonstrate it - because Higgs field interaction would have a character of "kink" widespread over ultraviolet part of mass-energy spectrum.

Such field exists at all scales and it manifests by Casimir force mediated by virtual photons at micrometer scale, or dark matter at megaparsec scale, for example. It means, this field has a scale invariant character of fuzzy unparticles, which are changing their size accordingly to carrier particles.

In more illustrative way, Unhiggs field is analogous to coat of virtual quarks, in which all elementary particles are surrounded at small distances. This coat glues particles together at smallest distances. It's responsible for so called Yukawa coupling, responsible for pairing and gluing of nucleons and quarks inside of atom nuclei, for formation of top-quark pairs, glueballs, pentaquark and another artifacts, which were observed recently at Tevatron.

The title of recent NS article "In SUSY we trust: What the LHC is really looking for" illustrates, physicists are well aware of the conceptual problems of Higgs field concept. Dual situation appeared recently in media, when scientists started to speculate, (primordial) gravitational waves cannot be found at all due the "quantum-spread", which renders detectors of gravitational waves useless. With respect to AdS/CFT duality the success or problems with particle search at Planck scale will be replicated/mirrored at cosmological scales and vice-versa.

The most problematic part of Unhiggs detection at LHC is the strangelet controversy: it could enable formation of clusters of particles, analogous to stable microscopic black holes predicted by Randall-Sundrum model.

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3 **Oliver K. Manuel**
Feb 5, 2010 3:59 AM
United States

WHY THE CONTINUED DELAY?

"CERN's Large Hadron Collider (LHC) is perhaps most famous for having broken down . . ."

Now "physicists at the Geneva lab have decided to run the collider at just half its design energy for the next 18-24 months."
- - - - - - -
Has someone at CERN has finally recognized the inherent dangers to the reputation of the entire physics community when the theoretically predicted Higgs particle is actually tested?

That's how it looks to me,
Oliver K. Manuel
Emeritus Professor of
Nuclear & Space Sciences
Former NASA PI for Apollo

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4 **Ragtime**
Feb 5, 2010 4:47 AM
Prague, Czech Republic

Quote:

> *Originally posted by **Oliver K. Manuel***
> when the theoretically predicted Higgs particle is actually tested

There is nothing very much to test, in fact. The Standard Model does not predict the mass of the Higgs boson and supersymmetry predicts whole families of Higgs bosons, as opposed to a single Higgs particle of the Standard Model.

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5 **Ivan Gorelik**
Feb 5, 2010 4:07 PM

According to my theory of Magnetic Hole (MH), the Earth can be exploded as a result of magnetic collapse at MHs, which can be created at one of proton-proton collisions. The theory is based at two independent and absolutely different math proves, giving almost the same result, - dangerous MHs can be created at p-p collisions with energy about 0.25 TeV per proton, if magnetic moment of x-boson is equal to magnetic moment of proton.

So, I understood that CERN and other scientific organizations, promoting the particle collisions with energies more then 0.1 TeV per particle, can kill me, my relatives, my friends, and my planet. In order to prevent the murder I wrote several letters to authorities of my country and to authorities of other countries. I wrote several letters to Prosecutor's Office of my country. Most of my letters were resent to Russian Academy of Sciences, where they were thrown into rubbish by a secretary of Nuclear Physics Section of RAS.

Now I do not believe in a possibility of peaceful solution of the problem. I think that courts will not stop the LHC and will not save us. I think that CERN will kill us soon with a probability of about 50%. What can I do to save my relatives and friends? Can I seat silently and wait for a death? Must I take a weapon and kill my potential killers? But how can I live further? I do not want to be a killer and I do not want that particle physicist would kill my people.

Notes:
1. Comparison with cosmic rays is incorrect and criminal.
2. Comparison with 1 TeV Tevatron collisions are incorrect, because magnetic induction in proton-antiproton collisions in the center between colliding particles is zero; in LHC it is doubled and critical.
3. CERN already performed about a million of 0.45 TeV collisions. Are such energy collisions safe? No, - the billionth 0.45 TeV collision can be the last for our planet. CERN already performed about 10 000 of 1.18 TeV collisions. The millionth such collision can be the last. In a several days CERN will make the first 3.5 TeV collision. It can be the last, - the Earth can be exploded.

Save yourself, your mother, your children – try to ban collisions with energy more than 0.1 TeV per particle...

darkenergy.narod.ru…

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6 **Ragtime**
Feb 5, 2010 7:58 PM
Prague, Czech Republic

Quote:

> *Originally posted by **Ivan Gorelik***
> ... CERN will kill us soon with a probability of about 50%....

Formation of stable microblack holes is expected at LHC as a direct consequence of theories, which should be tested by LHC. IMO these black holes are identical with those predicted by Randall-Sundrum models and strangelets, predicted by Searches of strangelets are planned for the LHC ALICE detector. Physicists are expecting formation of stable black holes by observation of both mono-jet, both di-jet suppressions during first year of experiments. CERN security analysis lacks many possible scenarios, for example the interaction of black holes via electromagnetic forces, collision of proton rays with speckles of dust, etc.

en.wikipedia.org…Micro_black_hole

en.wikipedia.org…Strangelet
www.iop.org…S52

Under these circumstances every attempt for collider experiments could be considered as a hazard to public safety and criminal act of international terrorism and should be banned immediately, until technology will allow us to continue in experiments in free cosmic space at safe distance from Earth.

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7 **gustavo_lopez**
Feb 9, 2010 11:33 PM

I just want to comment that we observe cosmic rays (at least an event per year) with energies at the center of mass 1000 times higher than the possible 14 TeV of the LHC, and we are still here. We have not observed any comet or planet disappearing because of the interaction of these cosmic rays with those object. So, whatever these high energy cosmic rays create (mini black holes, or other things) they are not harmful yet for us. So, it is still possible to make other machine, 50Tev-50Tev proton collider, without any problem.

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8 **zhigang324**
Feb 12, 2010 4:49 PM

What is God Particle? According my fresh thought:
1. It is a naked singularity of mass or the smallest black hole in the Universe;
2. It has huge naked mass, gravitation and inertia;
3. It is not a material particle;
4. It is not in the Standard Model of elementary particles;
5. It is an Ultimate Particle, cannot be decay;
6. Its Mass cannot be converted into energy;
7. The lowest limit of its mass is about 10.9μg, and the upper limit is about 0.67*10^6kg, that means that its mass may be exceeded one kilogram!
8. Estimated mass of Higgs Particle is about 16 orders of magnitude smaller than lower limit of Mass of God Particle at least. So the mass of God Particle is substantially undervalued by mainstream physics
9. So Higgs particle is not God particle;
10. And so I believe that to find the God particle with LHC is an impossible mission, LHC efforts will be ended in failure, and it is destined. I think that to find God Particle with colliders (such as LHC) is an extremely extravagant wrong way.

How to find God Particle?
Based on my bran-new thread, I design several kinds of very simple and very cheap physical experimental methods to find the God particle, to make a small black hole and to create new unknown stable material particles without using any accelerator or collider such as LHC.
Maybe to find God Particle is not a hard mission for me?
Revolution in Physics will soon arrival, believe me.

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