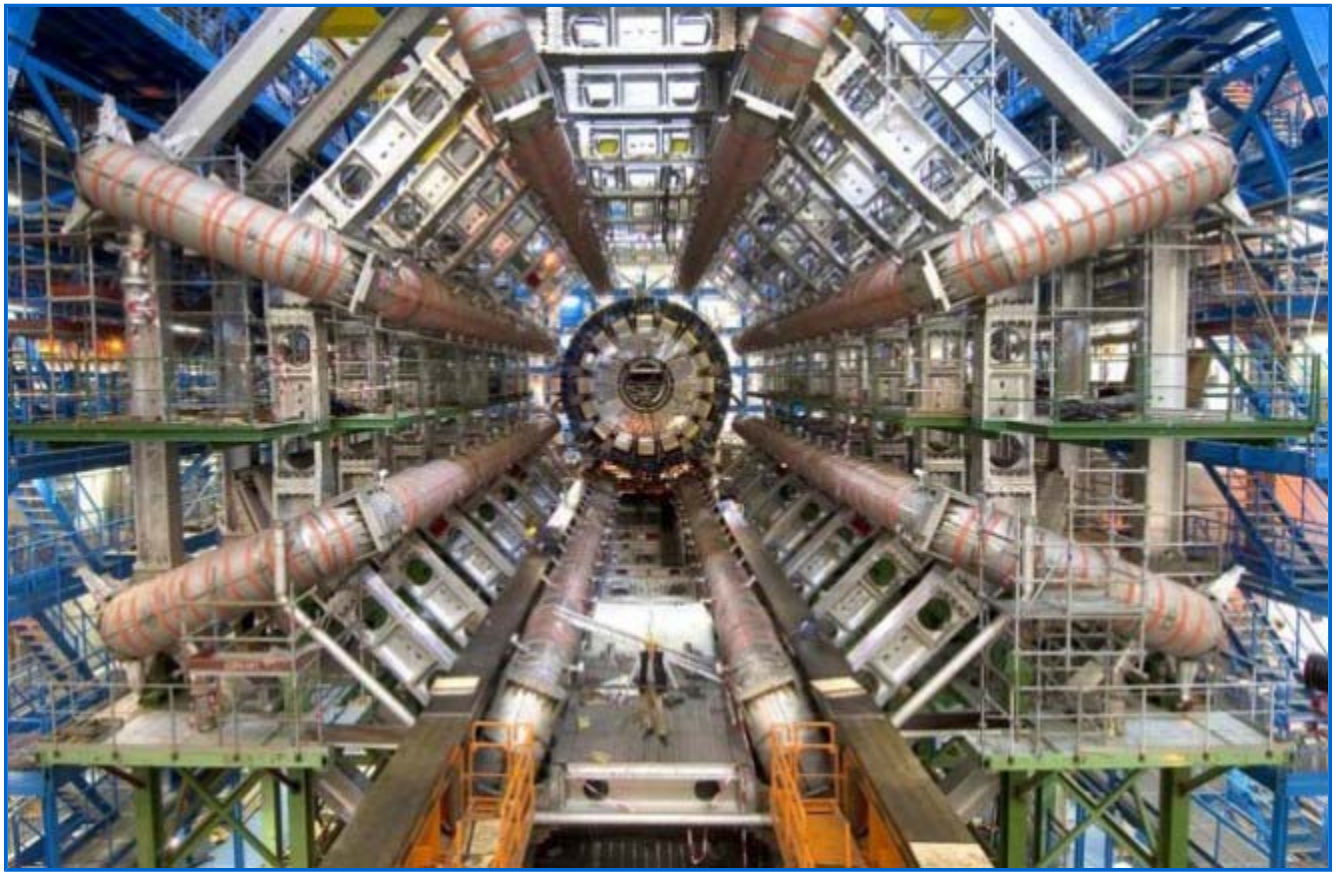
Large Hadron Collider Starts Edging Out Rivals

By Lisa Grossman October 15, 2010 | 1:00 pm | Categories: Physics



The Large Hadron Collider has made its first steps beyond the standard model of particle physics. With just four months of data gathered, the monster collider has already edged past the Tevatron, its particle-smashing rival.

“The surprising thing for me is how quickly the experiments started to top the Tevatron data,” commented theoretical particle physicist Ulrich Baur of the State University of New York at Buffalo, who is not on the LHC team but whose theoretical predictions laid the groundwork for new research done there. “You really see the power of the Large Hadron Collider coming in here.”

The contest concerns an exotic hypothetical particle called an excited quark. In the standard model — the theoretical picture of what physicists think matter is made of — atomic nuclei are broken down into protons and neutrons, which are broken down further into fundamental particles called quarks

and gluons. Electrons, which orbit atomic nuclei and give atoms their distinctive characters, are also considered fundamental particles.

Under the standard model, that's as far as it goes. You can't break a quark or an electron into anything smaller.

"But it turns out the model, we know it's not the complete picture," said particle physicist Andreas Warburton of McGill University in Montreal. Particle physicists turn to enormous colliders to refine the model and search for particles that break it.

The excited quark is one such "exotic beast," Warburton says. It's a lot like a regular quark, only heavier, meaning it's composed of an even more fundamental particle the standard model doesn't account for.

Physicists don't know how much the excited quark should weigh, if it exists, but they have set lower limits on its mass. The Tevatron, housed at Fermilab in Illinois, ruled out the existence of excited quarks with masses less than 870 billion electronvolts (about 927 times more massive than a proton).

The ATLAS (A Toroidal LHC ApparatuS) experiment has beaten that record by about 75 percent. In a paper published October 11 in *Physical Review Letters*, Warburton — plus a nine-page-long list of collaborators, presented alphabetically from Aad to Zutshi — reported a lower mass limit of 1,260 billion electronvolts. In a report posted on the ATLAS collaboration website but not yet published in a journal, the team pushed the limit up to 1,530 billion electronvolts.

"What you're seeing here is the incredible power of the LHC's higher energy," Warburton said. "In four months of data we were able to significantly extend the previous limit with just a fraction of the data sample."

The feat is "kind of a milestone" for LHC physicists, Warburton says. It's even more impressive considering the collider's rocky start, beginning with an accident in 2008 and other setbacks that led to a shutdown lasting more than a year.

"After all these delays and accidents two years ago, [the LHC] is now delivering," Baur said. "It is delivering at a very rapid pace, and the experiments are really doing a terrific job analyzing the data that are coming out."

There are some areas where the LHC, which already has achieved 3.5 times the Tevatron's peak energy and is expected to double, just has the older collider beat. But in some contests — most notably the hunt for the Higgs boson, the theoretical particle that may be the reason all other particles have mass — the Tevatron still has a fighting chance.

"We have an edge, because we've been taking data for such a long time. We're really ahead of the game," said Fermilab particle physicist Jacobo Konigsberg. "Right now we have been excluding regions of mass where the Higgs might be already at the Tevatron. It'll be a while until the LHC starts doing that."

Konigsberg, Baur and Warburton all mentioned that they're looking forward to new limits on the excited quark mass from ATLAS's competitor within the LHC, CMS (Compact Muon Solenoid).

"Things are moving very quickly," Konigsberg said. "The LHC is really taking off, and that's a wonderful thing to see."

Image: The ATLAS Experiment at CERN

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Posted by: Joe_Williams | 10/15/10 | 3:02 pm |

I am in no way a physicist, but how is it possible, per what the article says has been experimentally calculated at Fermilab, for an individual quark, which makes up part of the structure of a proton, to weigh a minimum of 927 times what the proton itself weighs? Am I the only person confused on how the components of a structure cannot weigh less (but minimum 927 times MORE) than the structure they make up? That would be like having a part in a car that weighs 1000 tons by itself, but the whole car only weighs 2 tons…