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LETTERS

Top Quark Search

Faye Flam's article "Researchers quell quark rumor: The top is still at large" (News & Comment, 24 July, p. 475) raises some issues that are more important to high-energy physics than whether or not the top quark really has been seen. The article states that the disagreement between physicists in the Collider Detector at Fermilab (CDF) collaboration and Gary Goldstein, Krzys Sliwa, and Richard Dalitz is "about the significance of the discovery [of candidate top quark events] and the extent to which outsiders like Goldstein and Dalitz should have access to their colleagues' unpublished data." My impression from reading the article is that the work of Goldstein *et al.* did not receive a fair review and that the "godfather committee" focused its criticism on the fact that the "outsiders" did not have a right to study the data in the first place. Innovative research is always controversial. The very essence of the scientific process is criticizing and responding to criticism.

CDF points to the top quark discovery rumors as reason enough not to share the data. Physicists are by nature conservative when it comes to evaluating the work of someone other than themselves. Upon hearing the rumors, most of my colleagues were intrigued but skeptical. There was no "damage" caused by these rumors, as the article implies.

CDF's accusation that the releasing of the 1988–1989 data violated the unwritten ethics of sharing data with outsiders seems to me to be a straw man. How long do government-supported experimenters have exclusive rights to data? Even the data from the Cosmic Background Explorer satellite were released after more than a year of analysis. The current procedure is analogous to theorists copyrighting their ideas and not allowing anybody to use them until they decide to permit their use. Of course CDF should have first shot at analyzing its own data, but after 3 years why should it not be available to everyone in the scientific community?

In order for CDF to continue doing the top-rate physics it is known for, scientific disputes should not be judged in secret; outside experts should be allowed to examine the issues.

Oscar Hernández
Department of Physics,
McGill University,
Montreal, Quebec, Canada H3A 2T8

I wish to respond to Flam's article "Researchers quell quark rumor: The top is still at large." When Flam contacted me a few weeks ago asking that I comment on the status of my work on top quarks at the Collider Detector at Fermilab (CDF) and on the article which appeared in the 27 June 1992 *New Scientist*, I declined any comment. I did so because the physics analysis as well as the internal CDF review of all top quark searches is still under way. While I still consider any comments to reporters premature, I feel compelled to set the record straight.

In 1991, Goldstein and Dalitz developed an elegant method (*1*) for analyzing the one, already published, CDF high transverse–energy "electron-muon" event. In February 1992, I suggested to Goldstein, my colleague at Tufts University, a modification to their original method in order to extend the Dalitz-Goldstein analysis technique to events of the "lepton+4jets" type. In close collaboration, Goldstein, Dalitz, and I jointly developed a computer program modifying the original method of Goldstein and Dalitz. The resulting technique, along with Monte Carlo modeling, but not involving any experimental data, has been submitted for publication. Goldstein and I presented informal progress reports on the modified method to CDF in March and April 1992.

In addition to being on the faculty at Tufts University, I am also a member of the CDF collaboration and the leader of Tufts' CDF Group. Having developed, together with Goldstein and Dalitz, a modified analysis technique, I proceeded to apply this modified method to the analysis of CDF experimental data. I am in agreement with statements by CDF spokespersons that only persons intimately familiar with software developed by the CDF collaboration and with the experimental configuration can perform a credible analysis of such data applying proper corrections and taking into account various features of the actual detector instrumentation.

I made available to Goldstein summary files of lepton and jet momenta for a small number of interesting events identified by my analysis and informed him of some preliminary results of my CDF data analysis. I did not believe that sharing my progress and results from some interesting events with a colleague who had co-developed the method "violated an unwritten code of ethics by sharing data with outsiders," as suggested in Flam's article. I have not given access to either the actual raw CDF data or to any subset of raw or "processed data" which could provide the basis of any conclusive physics analysis.

I respect the CDF policy of not releasing data until they are validated and until such release is authorized by the CDF internal "blessing" procedures. I have no dispute with the CDF policy; we are all aware of situations where sporadic events or partial indications have led to mistaken claims and retractions.

Krzysztof Sliwa
Department of Physics,
Tufts University,
Medford, MA 02155

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Detecting Explosives

Because airline luggage inspection is an important application of science and technology, we would like to clarify some points discussed in A. Fainberg's excellent and comprehensive article "Explosives detection for aviation security" (20 March, p. 1531).

The "associated production" technique is singled out by Fainberg as one of the four newer nuclear methods for detecting explosives. We have been evaluating this method for the Department of Energy (DOE), primarily for national security applications such as arms control verification of nuclear (or chemical) weapons, which include a conventional high-explosive component. To our knowledge, no DOE funds are now directed toward airport security.

The strongest advantage for associated production (which is usually referred to as the "associated-particle" method for neutron-inelastic scattering) is its ability to penetrate, identify, and image explosives, that is, to provide a *separate* tomographic image of each elemental constituent within sealed containers. All chemical elements having larger atomic numbers than 4 (beryllium) are measurable. In particular, data have been collected by Nuclear Diagnostics Systems (NDS) showing detection of more than a half dozen high explosives (such as C4, PBX, and TNT) on the basis of carbon, oxygen, and nitrogen ratios. Because of this wide-ranging capability for nondestructive examination, applications of this technology have been pursued not only for arms control and luggage inspection but also for drugs and other contraband.

Fainberg mentions the need for "an appropriate, reliable accelerator." In fact, NDS has developed a state-of-the-art, compact-sealed, continuous deuterium-tritium accelerator that incorporates a tritium target and an alpha-detecting scintillator. An electrode focuses the ion beam so that neutrons are produced from a small "spot" (with a diameter of 1 millimeter) needed for imaging. This design differs significantly from well-logging neutron generators.

Ten of the accelerators have been built and improved since 1985 and used by NDS. Their average operating life was about 2000 hours at an output of 10^6 neutrons per second; seven are still operable at less than 10^6 neutrons per second. A full system was recently delivered to Argonne National Laboratory and was operating the next day A rate of more than 10^7 neutrons pe second was achieved during qualification tests. Because the associated-particle method strongly discriminates against background, operating radiation levels are lower than for other high-energy radiation generator techniques.

The signal and background for a specific application depend on the neutron output, the efficiency and solid angle of the gamma-ray detectors, pulse pile-up, accidental coincidences, and other factors. The optimum neutron output is about 10^6 neutrons