How did D-Zero discover the top quark without a silicon vertex detector?

Rajendra Raja, Fermilab

Hermeticity and Electron Identification

- The silicon vertex detector is acknowledged to be the “sine qua non” of the CDF top quark discovery. Without it, the QCD fake background events would have overwhelmed the CDF signal.
- D0 had no silicon vertex detector. Yet it managed to discover the top quark. How?
- The answer lies in D0’s hermeticity and its electron identification algorithm.
- With the original non-hermetic design, the QCD background would have been higher by a factor of ~3 in the e+jets and the µ+jets channels.
- D0 used a sophisticated multivariate electron ID tool, the H-Matrix. Without it, D0 had no magnetic field to deliver energy/Momentum matching. The QCD fake background would have been higher by another factor of ~3 in the µ+jets channel.
- The D0 discovery paper had 17 events with a background of 3.8 events. This background would have increased to ~15 events, making the discovery impossible.
- In this paper, explore the events that made the hermeticity and the H-Matrix a reality in D0 by means of a series of vignettes.

Hermeticity

- The DO calorimeter design was initially highly non-hermetic. The package report shows the following.
- The central calorimeter had 32 phi-segments in each of its layers.
- There was a forward cone of CDF run I, which was never designed to measure the E_{T} of forward particles by itself.
- No attention was paid in the design report on the Central/End Cap transition region.
- In short, hermeticity did not seem high on the list of design goals.

Hermeticity-Adoption of Geant3

- We decided in 1985 to adopt Geant3 at the simulation level. Others supported DDSYM, a parameterized Monte Carlo. Geant3 permitted multiple hermeticity studies. DDSYM did not.
- I fed the D0 calorimeter geometry into Geant with careful attention to dead material and cracks.
- Geant3 was a slow program and already had MIP’s those days to be obtained using 16 microvox. One could not simulate large numbers of 2-Jet events to study the effects of inhomogeneities. One had to do something better.

The quality factor technique was the result. We could estimate the effects of calorimeter inhomogeneities using single particle responses, assuming an overall minimum-bias distribution of single particles.

The Software Support Group

- The productive members of the software support group who deserve special mention are Fritz Bartlett, Mike Diesburg, Stu Fuehs, Al Jonckheere, Stan Kazowski, Lee Lueking, Wyatt Merritt, Bob Novick, Laura Paterno, and Harrison Prosper. We also had significant help from the accelerator controls group under Peter Lucas.

By 1994, we had set the top quark limit to 132 GeV/C^{2} and analyzed the Event 417 to show that it was top like. Multivariate analyses were beginning to be made. The difference in analyses between 1994 and the discovery paper in 1995 was merely in optimizing a few cuts to be sensitive to higher mass top quarks and adding more data.

Respectfully submitted

Rajendra Raja

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