DØ Event 417 **The Gold Plated Top Event***



In 1993, while scanning the express stream, Boaz Klima found event 417, which had an very high E_T electron, a high p_T muon, 3 jets and large missing E_{T} making it an outstanding candidate for a top event, since expected backgrounds are small.

Finding a "Golden" Event D0 Side View 417 10-JAN-1993 02:41 3-AUG-1993 23:34 Run 58796 Event 0.3 <E< 1.4 3.3 **<E ⊲** 4.3 ELEC TAUS VEES OTHER

Event has Spurious A Layer Hits

Event 417 failed the original top selection because spurious muon A-layer hits gave the muon track very low momentum. This can be seen in the end view (below). Other aspects of this event were checked by many experts to see that all other systems worked properly.



Muon Track Hits

Dave Hedin blew up the view of the muon hits to about 10 feet. He measured the track with meter sticks on his basement floor at home. He also redid the alignment. He calculated the momentum with and without the A layer hits. The fit with the A layer needed large multiple scatters in the calorimeter and magnet iron and had low probability.

Kinematic Parameters of Event 417

 $E_{T}^{e} = 98.8 \pm 1.6 \text{ GeV}$ $p_{T}^{\mu} = 195 \text{ GeV/c}$ (>40 GeV/c at 95% CL) $E_{T}^{j_{T}} = 24.9 \pm 4.3 \text{ GeV}$ $E_{T}^{j2} = 22.3 \pm 5.6 \text{ GeV}$ $E_{T}^{j3} = 6.7 \pm 3.6 \text{ GeV}$ Missing $E_T = 102 \text{ GeV}$

This event survived the final Run 1 cuts, since it has such high momentum and missing E_{T} .



Muon

Daria Zieminska and Dave Hedin exchanged ~30 e-mail messages on the fits for this track to determine the muon momentum more precisely. Using fits by hand and prototype computer code they determined the muon momentum to be greater than 100 GeV/c.



Background Probabilities

Suman Beri, Puspha Bhat, Jim Cochran, and Harrison Prosper were among those who worked on calculating the probabilities for this event to be produced by various background processes. The probability was 10 to 1 that this event was top. Event 417, which was the world's first observed top event, was presented at conferences in 1993.







Top Quark Mass from Event 417

Ulrich Heintz, Raja, and Mark Strovink worked on a likelihood calculation, based on a method inspired by Dalitz, Goldstein, and Kondo, which determined that the event was consistent with top masses of 100-200 GeV/c². The likelihood was maximized at mass(top) =145 GeV/ c^2 . Later, Harrison Prosper calculated the top mass for event 417 using a new kinematic method. He estimated that the mass(top) = $163 \pm 36 \text{ GeV/c}^2$.







(First two pages from the logbook of Dave Hedin Sample Logbook Pages: and last three pages are from the logbook of Harrison Prosper.)





Publication

The parameters of Event 417 and likelihood mass determination was submitted for publication at the end of 1993 and appeared in a PRL article entitled "Search for the Top Quark" in April, 1994. This event also survived later, tighter cuts, and was included in the final DØ Run I dilepton results, published in 1998.



 \rightarrow Note: This is a personal view of finding and interpreting aspects of the most spectacular top candidate event in DØ. The full task of assembling and analyzing the complete top quark sample required the dedicated talents of a much broader group of people. Sharon Hagopian



8 20 th = -2.8 X, Y, Z may = -70:2, 24.5, 126.5 U, V, M, ms = -23, 92, 32. , 00 Z 4 X Y Ø Z - 155. 8229 249.0461 /01.8716 - 155. 8219 248.7412 /05.363 - 155. 8129 248.7412 /05.363 - 155. 81273 30. 3807 /06. 2782 - 155. 81273 30. 3807 /06. 2782 ε Tut = 418 yb = 27.7,0 197 100 Entries 4 NDOF 80 Mean 7.729 75 P(f/ti) _____11.94 H->en RMS Top Candidate u ET h & e ET h & 10 1.14 .29 63 -08 2.20 60 32 7.09 99, 09 5.76 E, J = 0.044 pb 50 p(flww) 40 -155, 8302 306, 1056 102, 7855 5 X DR I 0,3 1.6 WW -> en 1 XOR2 1.5 2.2 24 .56 3.63 20 25 <u>3-2-0 -155.8 300.4 116.7</u> 3-0 +155.8 <u>306.1</u> 112.9 P(8 7772) Z-> CT-OM, Steve (17) 100 90 .42 4.84 112 58796-417 64 -.70 3.50 1.11 4.09 1.19 2.94
 Adule
 2.2. efficiency
 Ends
 E
 Eplans in the

 117 tracks
 plane
 6.7. 57
 9
 .01

 6.3. 74 \$.04
 2
 101
 36
 3.442.38

 1.32
 3
 17. 73
 4.35
 .32
By assumption $(\chi^2_{\rm B} - \chi^2_{\rm S})/2 - DATA$ $(\chi^2_B - \chi^2_S)/2 - WW$ 208 1445 40 $P(f|data) = \sum P(f|H_i) P(H_i)$ 3,87 156 . 81 .31 3,38 99 .74 3.43 63 .26 .63 .25 58 .33 2.42 22 .88 1.43 120 1478-1860 45 .14 4.28 none Mean 21.85 Mean 1.310 30 20.50 = .75 " = .32 100 RMS 8.046 where HI = ti, HI = WN, Ho = Zoit, HA Zeve 20 $\begin{array}{c} 5 = 4 \cdot .75^{\circ} .25 = .42 \\ 4 = .55^{\circ} .25^{\circ} = .21 \\ 1 = 4 \cdot .75^{\circ} .25^{\circ} = .21 \\ 1 = .45^{\circ} .75^{\circ} .23^{\circ} = .05 \\ 0 = .25^{\circ} = .024 \end{array}$ 0 65 69 9.3.72 59 60 1.11 20 1.5 IN CHIJZ $\mathcal{E}_{1}\mathcal{O}_{\mathbf{Z}(\tau\tau)} = 0.\mathbf{B}_{2}$ 80 # tracks eft 22 254 175 132 217 ,89 € 0.20 pb else and the P(H.) are the a priori probabilities 413 5 0:1 .19 22 254 .75 [32 17 .89 232 140 .83 60 in yet -.73 5.96 -1.80 5.184 -.72 0.76 $P(\ell\bar{\ell}) = \frac{0.20}{27.7} = \frac{7.6}{100}$ A each component. CD): - 351 30 .48 207 22.75 4.54 30 12 1.97 (jut=24 mm) H1(4) 1.08 1 there 0,1 ~ same E= .66 -.08 40 $(\chi^2_{\rm B} - \chi^2_{\rm S})/2 - Z$ to τ, τ 2 plane 2 plane 3 plane From Bayes theorem out of 25 trucks, 20 $P(H_j|P) = \underline{P(F|H_j)P(H_j)}$ P(H) = 0.2/27.7 P(WW) = 0.044/27.7 P(z) = 0.044/27.7Drift Dist To 4 place 2,82 56 .29 .2.52 A 55 -33 55 51 -35 3,39 17 1,35 0,84 62556-516 83 -67 6.21 hone 15 -30 2.51 20 25 50 70 = 7.6 ×10-3 · p(f/data) (1.6 xco) =//: 4.6 $(\chi^2_{\ B} - \chi^2_{\ S})/2 - \text{TTBAR}(140)$ 122 والسابسيانة العرزيات 132 4.3