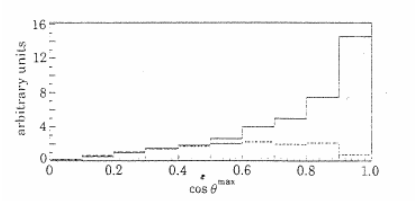
Pre-Evidence for the top quark from the Event Structure

G. Bellettini, M. Cobal, H. Grassmann, S. Leone
INFN, Pisa

In the early nineties the Fermilab Collider reached a luminosity which allowed a simple kinematic search for top to be successful. The method that we devised would work particularly well for a top of large mass. CDF main tool in the top search, the SVX detector which would detect an excess of b-quarks in top events, was getting ready but while the SVX was properly calibrated a kinematical analysis would already be practical. With luck, it could provide an earlier evidence for top events. Eventually, since the SVX tagging efficiency would be of the order of 50%, the kinematical selection would be able to rescue some untagged events.

In 1992 the Pisa group started an analysis comparing the kinematical structure of simulated top and W+3 parton background events. Simulations showed that jets in top events would be distributed about uniformly in space, while QCD jets should in general be emitted close to the initial state partons (i.e. the beams). This could be monitored by the variable "cosθ*", the jet angle in the event rest system. Background jets can also be close to the final state partons (gluons), giving pairs of jets close to each other. This can be measured by the variable ΔR. Monte Carlo calculations showed that reasonable cuts on cosθ* and on ΔR would select a signal-enriched sample with S/B ~1 for top masses above ~100 GeV.



A Montecarlo study submitted in 1993, published on Il **Nuovo Cimento, 107A, (1994) 75** "Exploiting the Single-Lepton Event Structure in the Search for the Top Quark."

Authors M. Cobal, H. Grassmann, S. Leone

In the signal enriched sample one could use the jet E_T's for identifying the top events. A simple likelihood method was devised combining the information from a set of high Et jets into a scalar variable Lrel. This was defined such that the background should be at ln(Lrel) < 0, the signal at ln(Lrel) > 0. The uncertainties of the Monte Carlo predictions were studied extensively and would not jeopardize this qualitative expectation.

The event structure analysis worked well on the data from Run 1.The Ln(Lrel) distribution in the data was very similar to the simulation for a superposition of top and background and showed an indication of a top signal. The candidate events at ln(Lrel) > 0 were certified further by an excess of events containing a fourth jet, and of b-tagged jets as expected for top.
Unfortunately, a consensus could not be reached within the Collaboration and these findings were not included in the "Evidence" paper of April 1994. However, they were made public on the same day as an INFN/Pisa University publication of the PhD thesis of Marina Cobal.

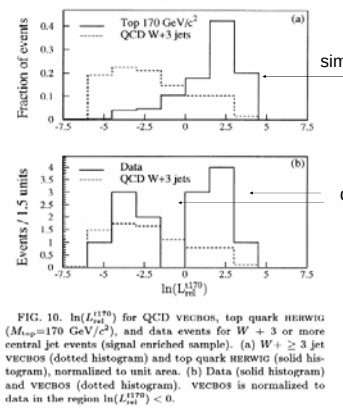


FIG. 10. $\ln(L^{t170}_{rel})$ for QCD VECBOS, top quark HERWIG (M_{top}=170 GeV/c^2), and data events for W + 3 or more central jet events (signal enriched sample). (a) $W+ \geq 3$ jet VECBOS (dotted histogram) and top quark HERWIG (solid histogram), normalized to unit area. (b) Data (solid histogram) and VECBOS (dotted histogram). VECBOS is normalized to data in the region $\ln(L^{t170}_{rel}) < 0$.

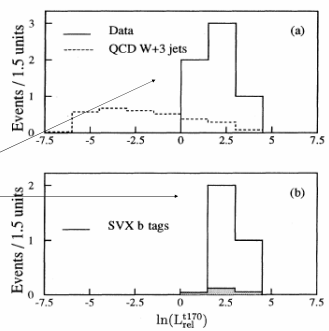
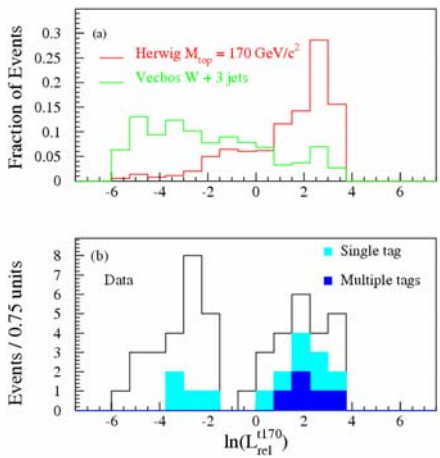


FIG. 16. Distribution in $\ln(L^{t170}_{rel})$ of $W+ \geq 4$ jet events. (a) Data with VECBOS prediction. (b) Events with a SVX secondary vertex and prediction (shaded) based on the observed jets in the events.

19 pb-1 of RunI data, analysis, PhD thesis of M. Cobal, submitted and discussed in February 1994.

Reported in Preprint INFN PI_AE-94/003 published on PRD 51 (1995) 4623



After the official announcement of top discovery, CDF agreed to publish the findings of the Ln(Lrel) analysis. In 67 pb(-1) of data the top signal was huge.

Measurement updated on 67pb-1,
published on PRD 52 (1995) R2605