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Dr. John Peoples, Jr.
Director,
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Batavia, Illinois

Dear John:

I have just returned from the Electroweak session at Moriond, where the Fermilab results on the top quark were the highlight of the meeting. The meeting is useful in bringing perspective to the relationship of the Fermilab physics program and the European programs. In particular, in the important realm of Electroweak physics Fermilab has an opportunity now to make major contributions before LEP200 turns on. I would like to urge the Lab to capitalize on Fermilab's ability to make the unique and critical measurements of the top quark mass and the W mass to the level at which they give real information about the Higgs mass.

One of the main goals of LEP200 is a precision measurement of the W mass. The CERN goal is to get to a precision of 50 MeV/c^2 per detector with 3 years of running. I believe that with 200 pb^{-1} the CDF experiment has a good chance of achieving a precision of 60 MeV/c^2. Unlike in the case of the Z mass measurement, where LEP has improved our measurement by two orders-of-magnitude, the W mass measurement can be done at competitive accuracy with LEP, and appreciably earlier. The top mass precision will also improve appreciably from the present 13 GeV/c^2 to some number most likely in the 6-8 GeV/c^2 range, I believe. The top mass can only be measured at Fermilab until LHC turns on– improving the precision in a timely way should be a high priority goal of the Lab. Knowing early-on whether or not the Higgs is light can have an impact on LHC detector design and on LEP200 operation, for example.

Figure 1 shows the present status of the Electroweak fits, with the points from CDF and D0 in the $M_{Top} - M_W$ plane (the D0 W mass value is preliminary– the other values are submitted for publication). The precision of the CDF measurements, 13 GeV on M_{Top} and 180 MeV on M_W, represent the results from approximately 67 and 20 pb^{-1}, respectively (the W mass is from Run 1a– the top mass is from this first part of Run 1b). The curves represent the constraint in the M_W-M_{top} plane from LEP, calculated with higher order corrections.

Figure 2 shows the same plot with 60 MeV and 6 GeV uncertainties on M_W and M_{top}, respectively. I have taken the liberty of moving the central value to the CDF $W \rightarrow e\nu$ value to show that there is phase space for a very important measurement. Note that if D0 does as well, the uncertainties could be as small as 40 MeV and 4 GeV, depending on how much of the uncertainty is considered as common (the same considerations apply at CERN, where having 4 experiments allows predicted overall uncertainties as small as 25-30 MeV even though the goal is 50 MeV per detector.)

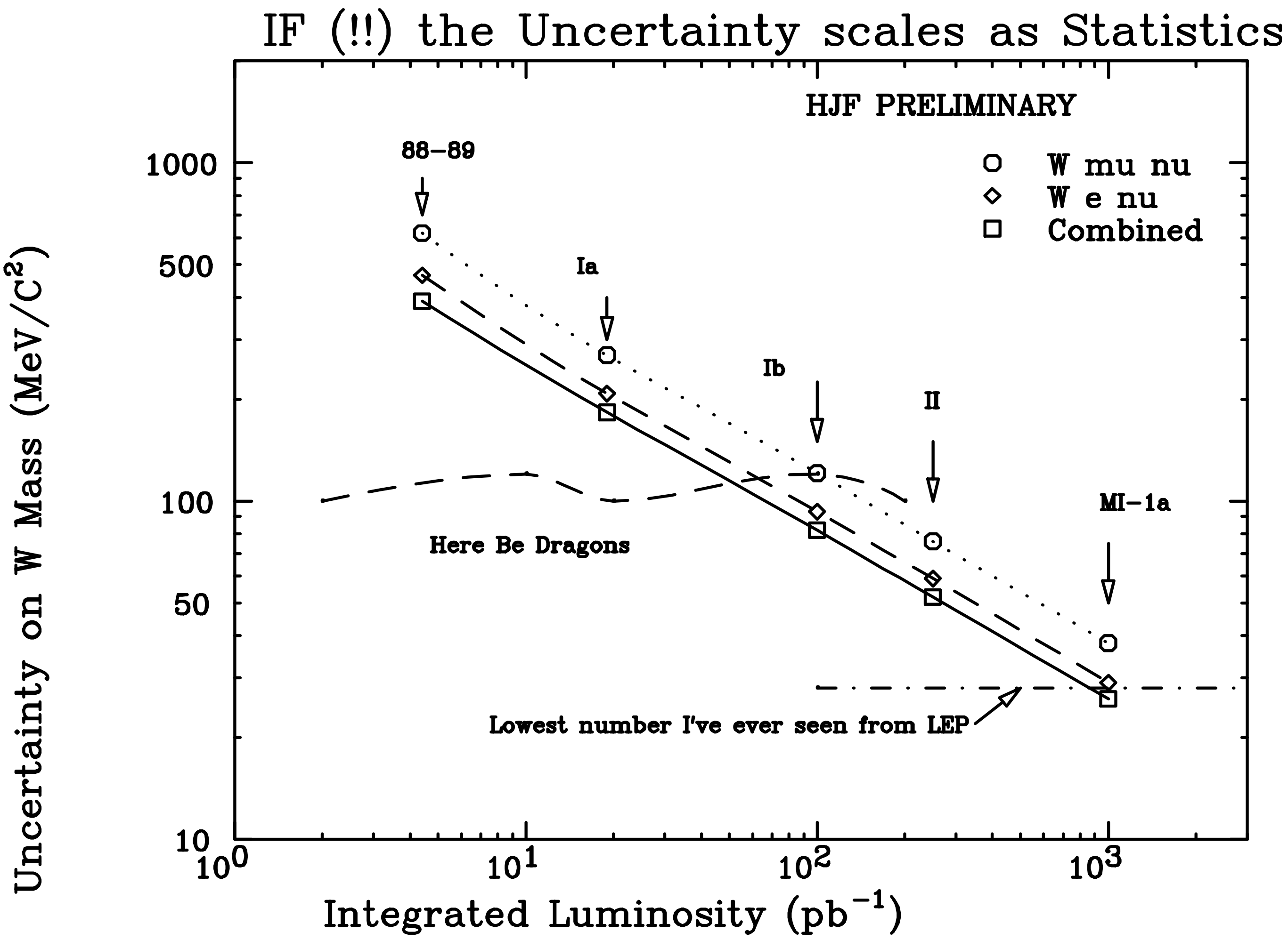
The new CDF W mass measurement has an uncertainty of 180 MeV, and is derived from 20 pb^{-1}. Our measurement from the 1988-89 run has an uncertainty of 390 MeV, derived from 4 pb^{-1}. If we had managed to follow a $\sqrt{L}$ scaling law (where L is the luminosity), we would have achieved 174 MeV– in fact we're very close to this. Figure 3 shows a prediction made before Run Ia of what this scaling predicts. Note that the Ia prediction has been met. For the future, with 200 pb^{-1} one would expect a factor of $\sqrt{10}$ better than the 180 MeV, i.e. better than 60 MeV. D0 could presumably do as well, lowering the error bars shown by $\sqrt{2}$. The CDF number alone probably leaves less than a factor of 2 improvement to CERN, and there is even less for LEP if D0 does comparably well or better.

Is this realistic? Almost all of the uncertainties at the present level are determined by the data, and hence by statistics. There is no guarantee that this will continue, but we can see already new handles on reducing systematics that we have not so far used (for example, David Saltzberg has suggested using the fact that the width measurement is sensitive to many of the same systematics, and hence can limit them substantially better than other methods).

In summary, Fermilab has an accessible opportunity to make far-reaching precision measurements of the top and W masses well ahead of LEP200. Run II will be too late for the W mass measurements to be competitive. A goal of 200 pb^{-1} would allow exploiting this important physics opportunity, as well as allowing a wealth of studies of the top quark to be done with higher statistics. The discovery of top should spur us to push harder to get more data rather than allow us to relax. I hope the Lab takes a close look at the physics that can be gained by running as hard as we can to 200 pb^{-1} versus the costs. There is a remarkable opportunity here.

Sincerely,

Henry Frisch



IF (!!) the Uncertainty scales as Statistics
HJF PRELIMINARY
W mu nu
W e nu
Combined
88-89
Ia
Ib
II
MI-1a
Here Be Dragons
Lowest number I've ever seen from LEP
Uncertainty on W Mass (MeV/C^2)
Integrated Luminosity (pb^{-1})
1000
500
100
50
10
10^0
10^1
10^2
10^3