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MINUTES OF THE $Z \rightarrow Q\bar{Q}$ MEETING

CERN, 10 November 1988

1. STATUS OF LINE SHAPE AND CROSS-SECTION FORMULAE

Alain Blondel reported on a systematic comparison of the weak corrections EXPOSTAR, ZAPPQ, and ZBATCH. Differences of more than 1% in the 'BORN' cross-sections are observed between EXPOSTAR and ZAPPQ, even though m_t, m_H, m_Z and C_{QCD} = {$(1+\alpha_s/\pi)$ in EXPOSTAR, $[1+\alpha_s/\pi + 1.405(\alpha_s/\pi)^2]$ in ZAPPQ} are the same.

ZAPPQ contains approximations that are, in principle, inaccurate, but EXPOSTAR contains plain bugs and inconsistencies. Once these are fixed, consistency at the $\pm 0.3\%$ level is obtained for light m_t. ZAPPQ is not reliable -- by construction -- for $m_t > 150$ GeV. ZBATCH, from Burgers as ZAPPQ, is slower but complete.

Differences between ZBATCH and EXPOSTAR appear in the total width -- the heavy top vertex included in ZBATCH and not in EXPOSTAR -- and in the ratios Γ_u/Γ_μ and Γ_d/Γ_μ; this must be investigated, failing which predictions for $R' = \Gamma_h/\Gamma_\mu$ will be erroneous.

2. DETERMINATION OF m_Z and Γ_Z

Lluis Garrido described how to fit physical parameters to the measured cross-sections. The effect of non-QED corrections is to change the expression of the Z propagator in ZAPPQ and ZBATCH:

$$\frac{1}{s - m_Z^2 + i m_Z \Gamma_Z} \longrightarrow \frac{1}{s - m_Z^2 + \Sigma_Z(s)} ,$$

where $\mathrm{Re}[\Sigma_Z(m_Z^2)] = 0$; thus one can write $\mathrm{Re}[\Sigma_Z(s)] = f(s-m_Z^2)$, $\mathrm{Im}[\Sigma_Z(s)]$ is proportional to s (phase space!), and the above expression can be rewritten as

$$\frac{1}{(1-f)\,[s-m_Z^2 + is\Gamma_Z/m_Z]} = \chi$$

with

$$\Gamma_Z = \frac{m_Z}{s}\,\mathrm{Im}[\Sigma_Z(m_Z^2)]\,\frac{1}{1-f} = \frac{\Gamma_Z^0}{1-f}\ .$$

When writing total cross-sections,

$$\sigma_x^{peak} = 12\pi\chi^2\ \Gamma_e^0\Gamma_x^0 = 12\pi\ \frac{\Gamma_e^0}{1-f}\,\frac{\Gamma_x^0}{1-f}\,\frac{1}{m_Z^2[\Gamma_Z^0/(1-f)]^2} = 12\pi\ \frac{\Gamma_e\,\Gamma_x}{m_Z^2\ \Gamma_Z^2}\ ,$$

the factor f causes a common redefinition of the total and partial widths.

In EXPOSTAR, the propagator is written

$$\frac{1}{s - m_Z^* + \sqrt{s}\ \Gamma_Z^*}\ ,$$

where both m_Z^* and Γ_Z^* are functions of s. One find that very accurately

$$\frac{\partial m_Z^*}{\partial s} = f \quad \text{and} \quad \Gamma_Z^*(s) \approx \frac{\sqrt{s}}{m_Z}\,\Gamma_Z^0\ ,$$

and the two formalisms are equivalent; f is about 1%, and results in

$$\Gamma_Z \simeq \Gamma_Z^0 + 25\ \mathrm{MeV}\ .$$

Fits were performed on EXPOSTAR and ZBATCH cross-sections with ZAPPQ with results out by at most 5 MeV for m_Z and Γ_Z.

To conclude:

i) we understand the difference between Γ_Z and Γ_Z^*;
ii) we now have fitting programs;
iii) we still need to understand what to fit exactly.

3. FITTING THE Z CROSS-SECTION

John Harton has used EXPOSTAR as a fitting program (rather time-consuming) to imagine an experiment fitting:

a) the first data point -- best results are obtained for

$$2\ E_{beam} \simeq m_Z - 2\ \mathrm{GeV};$$

b) the first data point and the next two; m_Z and Γ_Z are fit within 50 MeV for a total of 7500 events.

N_ν would be known to $\Delta N_\nu = 0.21$ if one had $\Delta L/L = 0.02$ (from σ_{peak})
N_ν would be known to $\Delta N_\nu = 0.43$ if one had $\Delta L/L = 0.05$ (from σ_{peak})
N_ν would be known to $\Delta N_\nu = 0.41$ from Γ_Z.
John uses a NAG fitting routine, which is much more convenient than MINUIT.

4. TWO-PHOTON BACKGROUND

Glen Cowan described background estimates obtained with his preliminary version of PHOT01, the two-photon event generator.

PHOT01 contains both QPM and VDM -- of course nobody knows to which extent these are two ways to generate the same events.

The generator allows generation of events above a user-controlled ($\gamma\gamma$) invariant mass W. It is checked that above relevant energies ($E_{tot} \geq 15$), using W > 1 or W > 3 leads to the same background.

Since large uncertainties exist in the prediction of two-photon cross-sections, the plan is to use reasonable energy and multiplicity cuts such as

$$E_{tot} > 25 \text{ GeV}, \quad N_{CH} \geq 3 ,$$

and to control the background using the P_Z distribution.

The question is clearly 'What are E_{tot} and P_Z' experimentally? With the above cuts, the background level is very low (a few 10^{-4} at the peak, a few 10^{-3} 4 GeV away from it) but very uncertain.

5. TAU-PAIR BACKGROUND

Stephen Haywood explained that the τ background is unimportant for m_Z, Γ_Z fitting: the cross-section has the same propagator effect. For the total cross-section, one has to correct for O(2%) τ contamination, which should be known very well. This is no problem.

6. MDST News

Stephen Haywood described the status of the mini-DST. The assembly of vertices and tracks is now quasi-ready. The rationale is to use

- for jets: all charged and neutrals associated with the main vertex,
- for charged tracks: all charged tracks associated with any vertex.

The ECAL-HCAL structure is not really in place yet. It was commented that the clustering is unnecessary for linear observables (thrust, energy, jet angle) and potentially damageable to quadratic observables (sphericity).

A discussion followed on how to make our studies more concrete. The work plan is now to use ALPHA and full GALEPH/JULIA to study background and event selection.

The 'hadron event flag' facility is to be written within ALPHA.

7. NEXT MEETING

Tuesday 13 December

14:00

room 2/1-034

Agenda

Monica Pepe: Energy flow

Haimo Zobernig: Jets

Ed Blucher: ALPHA facilities

Plus any other contributions:

- Bhabha background;
- trigger efficiency;
- more on fits etc.;
- quark charge asymmetry, polarization?