MEMORANDUM

To: Members of the LEPC (only)

From: G. Wolf, Chairman LEPC

Subject: LEPC Meeting, June 15/16 1982

Here is the summary of the conclusions of the LEP Committee with respect to the physics questions.

1. Consider $Z^0$ decays. What fraction of $Z^0 \rightarrow b \bar{b}$ events can the detector identify by the electron or muon decay mode. With what accuracy can one determine the forward/backward asymmetry for $b$ quarks. Assume $B(b \rightarrow e\nu$ hadrons) = 0.1 and $10^5 Z^0$ decays.

1.1. The fraction of leptons from cascade ($b\rightarrow c \rightarrow l$) or $c$ quark decays contaminating the $b\rightarrow l$ sample differs for the different experiments due to different cuts applied and was, therefore, considered to be not relevant in the evaluation of the proposed detectors.

1.2. Suppression of contamination by hadrons:

a) electrons: all experiments do about equally well,

b) muons: L3 is better because of the short decay path but using other type of information (e.g. kinks to spot decays in the central detector) other experiments can do almost as well.

1.3. In the inclusive lepton measurement systematic errors are important. Therefore, the measurement should be done by several experiments.

1.4. The analysis of events with two leptons in the final state should give an almost background free result.

2. Consider $Z^0$ decays into $B$ mesons. What limit can one put on the $B$ lifetime from a measurement of the decay vertex.

Using a vertex detector it appears feasible to tag decaying particles with lifetimes of the order $\gtrsim 5 \times 10^{-14}$ sec. Other handles to enrich the sample of decay candidates (e.g. lepton detection or particle identification for $D$ or $B$ mesons) will probably be needed.
3. What is the expected accuracy for neutrino counting from a measurement of
   a) the $Z^0$ width
   b) the process $e^+e^- \rightarrow Z^0 + \gamma$

3.1. Because of the large $Z^0$ width a photon energy resolution of

\[ \frac{\Delta E}{E} \leq 15\% \] is adequate.

3.2. To suppress background (e.g., $e^+e^- \rightarrow e^+e^-\gamma$) showering particles have
   to be detected down to small angles ($\Theta < 0.1$).

3.3. The ability to measure the photon direction (to see whether the
   $\gamma$ comes from the interaction point) is probably important.

3.4. LOGIC can't do the measurement well (point 3.2.).

4. If toponium exists with a mass of 70 (120) GeV can one detect the $P$ wave
   states $X_L$ via transition from the vector state

   a) $\zeta' \rightarrow \gamma + \gamma + \gamma_1^+ + \gamma_2^-$

   b) $\zeta' \rightarrow \gamma + p^3(\bar{t} + \bar{t})$

   Assume

\[ M(\zeta') - M(\gamma) = 0.2 \text{ GeV} \]
\[ M(\gamma) - M(\zeta) = 0.4 \text{ GeV} \]
\[ \Gamma(\zeta) = \Gamma(\zeta') = 70 \text{ keV} \]
\[ \Gamma(\zeta \rightarrow ee) = 7 \text{ keV} \]
\[ \Gamma(\zeta' \rightarrow ee) = 3 \text{ keV} \]
\[ B(\zeta' \rightarrow \gamma^3p) = 0.03 \]
\[ B(\gamma^3p + \gamma^3\mu) = 0.7 \]

4.1. To do the experiment will require an enormous amount of luminosity.

4.2. The decay sequence $\zeta' \rightarrow \gamma^3p + \gamma^3\gamma + \gamma^3\mu^+\mu^-$ can probably be detected
   by all experiments as shown by OPAL.

4.3. If one wants to do the experiment at all do it with L3. The
   energy resolution and the segmentation of the shower counter of
   L3 is suitable for this measurement.
5. Search for Higgs in the reaction
\[ e^+e^- \rightarrow Z^0 + H^0 \]
where the mass of $H^0$ is 50 GeV.

6. If charged Higgs exist with a mass between 30 and 90 GeV can one detect
\[ e^+e^- \rightarrow H^+H^- \]

5.6. 1. From the point of view of background and mass resolution the best way is to study the lepton final states:
\[ e^+e^- \rightarrow Z^0 X \]
\[ \rightarrow e^+e^- \]
All experiments perform about equally well.

2. Ratewise the search for Higgs is better done by studying hadronic jets.

3. The measurement of the energy of hadronic jets is improved by a hadron calorimeter. All experiments perform about equally well with the exception of LOGIC which has no hadron calorimeter.

4. The search for new particles by measuring e.g. jet-jet effective masses will be an important physics issue at LEP. For this reason it seems highly desirable to have at least one detector with a good hadron calorimeter.

7. Will the detector see minimum ionizing free quarks of charge $Q = 1/3$ and $2/3$. In case the quark is superstrongly interacting, it is interesting to know how much material there is between beam and tracking chamber.

7.1. In the search for free quarks the capability to trigger on particles with charge $Q = 1/3$ is useful. This is true for OPAL and LOGIC.

7.2. Because of the very low rate expected a search for free quarks has to be planned from the beginning.

7.3. Detectors which sample tracks many times (TPC, jet chamber) and/or have Cherenkov counters have a clear advantage, such as ALEPH, OPAL, DELPHI.

The background from normal one-photon annihilation into hadrons should be taken into account, for each question. Assume 5 quarks with 30 GeV for the $t$-mass.