CERN/LEPC 96-9
LEPC 44
4 December 1996

LEP EXPERIMENTS COMMITTEE

Minutes of the 44th meeting,
19 November 1996

OPEN SESSION

1. LEP2 status

M. Lamont reported on the status of LEP. Prior to the technical stop in August, a total luminosity of 12.1 pb^{-1} at 161 GeV and 0.5 pb^{-1} at the Z^0 (for detector calibration) had been delivered this year. After installing extra super-conducting (sc) rf cavities (bringing the total to 176) the LEP energy was raised to $\sqrt{s}$ = 172 GeV, marking the completion of LEP2 - Phase II. A total of 8.5 pb^{-1} at 172 GeV and 0.8 pb^{-1} at the Z^0 was delivered with 90/60 optics prior to a 3-day stop to re-cable the sextupoles for tests of the 108/90 optics. Over a period of two weeks, about 2 pb^{-1} had been delivered at 172 GeV with 108/90 optics.

With the 90/60 optics, LEP performed well at $\sqrt{s}$ = 172 GeV with 4x1 bunches per beam: a maximum current of 4.2 mA, a peak luminosity of 3.4×10^{31} $cm^{-2}s^{-1}$, a maximum integrated luminosity of 1.1 pb^{-1} per day, and low detector backgrounds. A small betatron coupling parameter (emittance ratio), κ=0.005, and large beam-beam tune shift of 0.04 have again been achieved. This performance is better than expected and indicates that the 90/60 optics may be suitable at even higher energies. Furthermore a beam polarization of 12% was achieved at E_b=50 GeV - the highest energy so far - which is an encouraging sign for LEP2 energy calibration.

In contrast, however, the performance of the 108/90 optics has not yet met expectations - but there has been little time so far for optimisation. Although a maximum current of 4.2 mA has been achieved, the peak luminosity has been limited to 2.2×10^{31} $cm^{-2}s^{-1}$ and a large coupling, κ, has been observed. Furthermore, high detector backgrounds have been experienced in two interaction regions (L3 and OPAL). The limited performance results from a relatively poor dynamic aperture at present, due to the higher sensitivity of this optics to machine imperfections.

During the 96-97 shutdown another 16 sc rf modules (64 cavities) will be installed and about one quarter of the warm copper cavities in IP2 will be removed. By June 1997 the installed rf cavities are expected to total 240 sc and 86 copper, providing a maximum operating accelerating voltage of 2.5 GV and a maximum operating energy $\sqrt{s}$ = 186-188 GeV. In view of the uncertainties with the optics, it is hard to reliably predict the LEP2 performance in 1997. However, with 4x2 bunches per beam, a total current of 8 mA at the start of a fill appears realistic for both the 90/60 and the 108/90 optics. This would give a peak luminosity of about 6×10^{31} $cm^{-2}s^{-1}$ and an average luminosity of about 1 pb^{-1} per day. With 108 days for physics, and after allowing for Z^0 calibration data, the total luminosity at high energy in 1997 would be about 100 pb^{-1}.

2. LEP energy calibration

M. Hildreth reported on the progress of the LEP Energy Working Group, both for Z^0 mass measurement with 93-95 data and for the high energy running with LEP2. Numerous sources of systematic shifts in the beam energy have been identified, each causing variations of between about 1 and 10 MeV. These have been carefully monitored and successfully modeled, providing overall uncertainties at the Z^0 from the LEP beam energy of $\sigma(M_Z)$ = 1.5 MeV and $\sigma(\Gamma_Z)$ = 1.7 MeV. The central value of the beam energy has recently been revised downwards (resulting in a shift in M_Z of about -4 MeV). This is due to a gradual rise of the beam energy during each fill (5-

10 MeV), which had been observed previously in the reference dipole, but as a much smaller effect (~1 MeV). The final uncertainties from the LEP beam energy compare favourably with the overall errors from the combined LEP detectors of $\sigma(M_Z) = 2.0$ MeV and $\sigma(\Gamma_Z) = 2.7$ MeV.

At LEP2, since there is no beam polarization near the physics energy, an alternative technique must be developed. The aim is to make precise beam energy measurements by resonant depolarization at two - and preferably more - points in the region of the Z^0 and as high above as possible (perhaps up to 55-60 GeV). This calibrates, at these energies, the flux loop and NMR measurements of the magnetic field in LEP dipoles. The beam energy at a higher point is then determined from the flux loop and NMR measurements, which are corrected by the (extrapolated) lower-energy calibrations. A large apparent discrepancy (30 MeV) that had been observed between measurements made at 45 GeV and 50 GeV was found to be due to sideband resonances, and there is now good agreement. The near-term goal is to achieve a precision for Moriond '97 of $\sigma(E_{beam}) = 50$ MeV at $\sqrt{s} = 161$ GeV, with a final goal of $\sigma(E_{beam})$ ~15 MeV for LEP2 (to be compared with the expected combined LEP experimental error $\sigma(M_W) = 30$-40 MeV for 500 pb^{-1}).

3. Reports from the LEP experiments

OPAL	A. Ball
ALEPH	F. Ragusa
DELPHI	J. Timmermans
L3	D. Stickland

All experiments reported successful data taking at 172 GeV, with high efficiency. The main problem had been large backgrounds for L3 and OPAL with the 108/90 optics; if extrapolated to 186 GeV they would prevent at least one of the detectors (L3) from operating.

Each experiment observes a clear W signal at 172 GeV in the reconstructed mass from $W^+W^- \rightarrow q\bar{q}\ q\bar{q}$ and $q\bar{q}l\nu$ decays, but only preliminary cross section and mass measurements are available at present. The new data have revealed no clear evidence for new physics, with cross section upper limits of about 0.5 pb. The main puzzle is the ALEPH 4-jet peak in the total-mass region of 105 GeV, which has been further strengthened by the new data. The ALEPH peak now contains 18 events, with only 3.1 events expected from standard processes. None of the other three detectors confirms this signal.

Concerning energy preferences for 1997, DELPHI and L3 requested running the whole year at the highest available energy, whereas ALEPH and OPAL wish to keep open the option to run the second part of the year at 161 GeV, assuming sufficient luminosity could be provided, in order to improve the threshold measurement of m(W).

4. Report on the Electroweak Working Group

Bob Clare reported on the recent progress of the LEP Electroweak Working Group. The most significant changes have occurred in the measurements of the heavy flavour branching fractions of the Z^0. The preliminary new values are $R_b = 0.2178 \pm 0.0011$ and $R_c = 0.1715 \pm 0.0056$, in good agreement with the Standard Model values of 0.216 and 0.172, respectively. A large number of electroweak parameters are now very precisely determined; in particular, the combined measurement of the weak mixing angle is $\sin^2\theta^{lept}(\text{eff}) = 0.23165 \pm 0.00024$.

CLOSED SESSION

Present: S. Bethke, J. Drees, P. Hansen, H.-J. Hilke, K. Hübner, G. Kantardjian, J. Kirkby (Secretary), K.-H. Kissler, M. Klein, T. Lohse, M. Mangano, B. Mansoulié, R. Mount, S. Myers, J. Panman, L. Pape, S. Pokorski, I. Videau, P. Wells, D. Williams and P. Zerwas (Chairman).

Apologies: M. Calvetti, J. Dainton, L. Foà, G. Goggi and R. Marshall.

1. Approval of the minutes of the 43rd meeting

The minutes of the 43rd meeting (LEPC 96-7/LEPC 43) were approved without modification.

2. Chairman's report

On behalf of the committee, the chairman congratulated the machine team for raising LEP's energy to a new record of 172 GeV and successfully achieving the luminosity goal.

He announced the formation of four new working groups for preparing combined results from the LEP detectors. The full list of LEP working groups and their chairpersons is as follows (the new groups are starred):

1. B lifetime	Lucia Di Ciaccio / DELPHI
2. B mixing	Olivier Schneider‡ / ALEPH
3. Electroweak	Robert Clare / L3
4. Four-jet events *	Dieter Schlatter / ALEPH
5. Higgs *	Peter Igo-Kemenes / OPAL
6. LEP energy	Pippa Wells / OPAL
7. QCD *	Siegfried Bethke / OPAL
8. SUSY *	Luc Pape / DELPHI

‡ contact person

3. Discussion on physics aspects of the open session

The committee noted that the recent measurements of R_b and R_c in Z^0 decays are bringing the world average into agreement with the Standard Model, in contrast with the situation a year ago. While the new values of R_b and R_c leave room for new physics, they no longer require it.

Regarding LEP2 data, the committee was once again impressed by the rapid production of physics results by the LEP detectors at a new energy. Several interesting events have been observed which are candidates for new physics but which could be also be explained by standard processes. The most significant anomaly is the ALEPH four-jet signal, which is now well beyond a possible statistical fluctuation and in clear contradiction with the other three detectors. Not surprisingly, the events may be interpreted within extended SUSY models, for example by pair production of charginos of mass 53 GeV. The committee looks forward to further high energy data and to hearing at a future meeting of the progress of the joint LEP working groups on this and other subjects.

4. Discussion on LEP2 energy calibration

The committee was pleased to hear of the resolution of the earlier inconsistency between the flux loop and NMR measurements on the one hand and the resonant depolarization measurement on the other. This should allow the beam energy to be known to $\sigma \sim 50$ MeV in the near future, which is sufficiently precise as not to limit present measurements of the W mass. The LEP coordinator

indicated that resonant depolarization measurements will be attempted in 1997 at beam energies of 55 GeV and 60 GeV in order to improve the precision of the extrapolation to higher energy.

5. Report from the LEP Coordinator on planning for the 1997 LEP schedule

The LEP Coordinator presented the draft schedule for 1997 (attached). The totals for 1997 are 108 days for physics and 27 days for machine development.

The choice of optics for 1997 will be made at the Chamonix Workshop, 14-17 January 1997; the primary choice is between 90/60 and 108/90, although 90/90 is a possible third option. Based on present knowledge, both 90/60 and 108/90 could probably operate up to the highest LEP2 energy. Furthermore they are estimated to have similar potential for luminosity at higher energies, since the 108/90 optics has so far not provided any improvement in the dynamic aperture.

The committee discussed the large detector backgrounds for L3 (Point 2) and OPAL (Point 6) with the 108/90 optics. Due to the presence of copper cavities near these experiments (which take up more space), there is an optics asymmetry between points 2/6 and points 4/8. The high backgrounds may also be connected with the poor dynamic aperture (resonances). The committee encouraged the work in progress to understand these backgrounds and find solutions.

6. Discussion on the LEP schedule for 1997

An initial discussion took place on the LEP energies for physics in 1997 and on the detector calibration data at the Z^0. In the latter case, a total of 1 pb^{-1} of Z^0 data at the start of the run satisfies the requirements of three detectors (ALEPH, DELPHI and OPAL), whereas the fourth detector (L3) requires 2.5 pb^{-1} of Z^0 data at the start of the run. The committee was pleased to note that improvements in the L3 TEC calibration procedure, notably after including the SMD, have reduced the requirements from the previous figure of 4 pb^{-1} of Z^0 data. The extra requirement of L3 beyond the other detectors is now reduced to 1.5 pb^{-1} (which is estimated to require an additional period of about 3 days for 90/60 optics, or 4.5 days for 108/90 optics). After a lengthy discussion, it was decided to formulate the recommendation on the Z^0 calibration data at the May meeting, when the planning for the initial high-energy running would also be discussed. At that time a better estimate can be made of the time required to collect Z^0 data, since a decision on the optics should be known from the '97 Chamonix workshop.

7. A.O.B.

The chairman announced that a LEP2 physics jamboree is scheduled at CERN for the afternoon of 25 February 1997, to be organized within the framework of the Particle Physics Seminars.

8. Next LEPC meeting

The dates of the next meeting of the LEPC are **Thursday-Friday, 29-30 May 1997**.

J. Kirkby