

LEP EXPERIMENTS COMMITTEE

Minutes of the 56th meeting,
3 November 2000

OPEN SESSION

1. Status of LEP

R. Bailey reported that a total luminosity of 233 pb⁻¹ was delivered by LEP in 2000, of which 147 pb⁻¹ was above 206 GeV total energy. During September there were some electrical problems with the SPS which had affected operations. Nevertheless, 57 pb⁻¹ luminosity above 206 GeV was delivered during September and October. Concerning possible LEP operation in 2001, extra accelerating voltage could be obtained by installing a newly refurbished sc rf module (50 MV) and by repairing weak cavities already installed at LEP (40 MV). This would allow operation at 208.2 GeV with a margin of 1 klystron. Although LEP would again be operating at its limit, and would face difficulties with the sc rf system, synchrotron radiation damage and tunnel movements due to civil engineering work, a realistic goal is to expect 1.1 pb⁻¹/day average luminosity above 208 GeV, indicating a total expected luminosity of 200 pb⁻¹ for a 6-month run.

2. LEP detector reports

ALEPH	P. McNamara
DELPHI	P. Lutz
L3	M. Felcini
OPAL	A. Quadt

The four detectors reported on the outcome of their Higgs search. ALEPH has no new candidates and a total of three four-jet events with high weights (i.e. very signal-like) above 109 GeV mass. After re-processing the DELPHI data with new tracking calibrations, a previous four-jet candidate at 114 GeV has been assigned a low weight. DELPHI now finds an overall $\sim 1\sigma$ deficit of events at high mass. L3 has observed an H_{vv} candidate with high weight at 114 GeV. This event has two clear b vertices but has a low p_T which is close to the pre-selection cut and whose value may change after the final detector calibrations are implemented. Although none has a high weight, OPAL observes high mass events and has a slight excess.

3. LEP Higgs working group report

P. Igo-Kemenes reported on the combined Higgs analysis from the four detectors. The excess of events is in agreement with a SM Higgs of mass (115 +1.3 -0.9) GeV (2 σ errors). The excess at 115 GeV is incompatible with being a background fluctuation at 2.9 σ combined statistical significance. The significance per experiment for ALEPH, DELPHI, L3 and OPAL, respectively, is 3.4 σ , background-like, 1.8 σ , and 1.3 σ . The observed decay channels are in agreement with expectations for a SM Higgs. The "reference sample" of data recorded prior to the 5 September presentations has 2.2 σ significance (after re-analysis), only one experiment shows signal-like events and in only one channel (4 jets). The addition of the new data shows a positive trend: 2.9 σ significance, three experiments show signal-like events and in two channels (4 jets and jjvv). If there is a real signal at 115 GeV then operation of LEP in 2001 for a 200 pb⁻¹ sample at 208 GeV would produce a (5.3 \pm 0.5) σ Higgs discovery.

CLOSED SESSION

Present: G. Altarelli, R. Cashmore, J. Colas, M. Delfino, M. Doser, L. Evans, F. Gasparini, V.G. Goggi, K. Hübner, P.O. Hulth, P. Igo-Kemenes (part-time), P. Janot, L. Jonsson, J. Kirkby (secretary), W. Lohmann, L. Maiani, J. May, C. Matteuzzi, T. Müller, S. Myers, Y. Sirois, A. Smith, M. Spiro (chairman), R. Tenchini.

Apologies: N. Harnew, M. Mangano, R. Miquel.

1. Approval of the minutes of the 55th meeting

The minutes of the 55th meeting (LEPC 2000-006/LEPC 55) were approved without modification.

2. Chairman's report

The chairman joined with CERN management and the committee in congratulating the LEP machine team for the high performance of LEP during 2000 at its peak energy. The four experiments and the Higgs working group were also congratulated for their impressive physics analyses and for the innovative techniques they have developed for combining the data.

3. Discussion on the Higgs search

An extensive discussion took place on the evidence presented in the open session for a Higgs signal near 115 GeV, and on the request by the four collaborations to extend the operation of LEP into 2001 in order to collect 200 pb⁻¹ data above 208 GeV. The discussion centred on the following two aspects:

i) How convincing are the excess events as being a Higgs signal near 115 GeV?

The committee expressed several concerns with the evidence for a Higgs: the mass plot does not show a clear excess, the significance is only 2.9σ and is contributed equally by a few (4) high-mass events with a large weight and by a larger number of lower-mass events with lower weights, there is some instability of the events as detector calibrations are improved, the single jjvν event with a high weight is very close to a p_T cut and could disappear after data re-processing, as yet there is no charged lepton candidate, and the analysis of the data is tricky.

On the other hand, the committee noted that the new combined data are more convincing overall than are previous samples for the presence of a Higgs; the trend is a strengthening of the signal hypothesis. Candidates have appeared in other experiments and in a new channel. The observations are consistent with a Higgs at 115 GeV. An H_{νν} → jjvν candidate has been seen. However the statistical importance of this event should not be over-emphasized since it contributes about 0.4σ to the overall significance. Said equivalently, the significance of the signal is reasonably robust to the loss of any single event.

Although the mass plot does not show a clear excess, it does not convey the full statistical power of the data. When all data are included, the excess of the 4 high-mass events with high weight is strengthened by lower weight events at lower masses. This is as expected for a real signal, given the experimental mass resolutions and the possibility of wrong jet pairings.

Furthermore no evidence has been found for systematic biases. The high-mass excess is unlikely to be explained as an unknown systematic effect that causes pileup of events at the kinematic limit. This is demonstrated by the absence of a high-mass excess in 500 pb⁻¹ of data taken during 1998-99 at energies between 189 and 205 GeV. This study also shows that the standard model backgrounds appear to be understood at these energies - and therefore presumably are also understood at 206 GeV.

ii) What is the Higgs discovery potential if LEP operates in 2001?

Although the statistical significance would suggest a probability of only about 0.2% that the present excess is due to a background fluctuation, the committee considers the conservative likelihood of a Higgs near 115 GeV to be about "50/50" based on the present data. If there is indeed a Higgs at a mass of 115 GeV, then a 200 pb⁻¹ sample at 208 GeV is expected to lead to a 5.3 σ discovery. This would correspond to a signal of about 20 events (of which 2 may be lepton events, Hee/H $\mu\mu$), and a background of 10 events. The committee noted that there is unfortunately no single channel that is background-free. If the Higgs mass is at the upper end of the present uncertainty, at 116 GeV, then the expected significance would be reduced to 4.3 σ (14 signal, 1.4 lepton and 7 background events) - and, with a downward fluctuation, could be as low as 3.8 σ . Therefore, even if the present events are due to a Higgs, there is roughly a 20% probability that its mass is too high for a 1-year extension to establish a discovery. In summary, the committee considers there are sizable prospects for a Higgs discovery if LEP operates in 2001.

In addition to these aspects, several other points were raised. It was recognised that the LHC is a superior machine for the Higgs and that LEP is operating at its very limit. On the other hand, LEP is well-placed to resolve the question of a Higgs near 115 GeV in the short term and, because of its low backgrounds, is the best machine to measure the HZZ coupling.

In conclusion, the committee finds the combined evidence for a Higgs near 115 GeV already to be quite significant and considers that there are sizable prospects for a major discovery to be made at LEP, but also a non-negligible risk that no definite conclusion would be reached. Therefore, considering only LEP and its operation costs, the committee considers that an extension in 2001 to collect 200 pb⁻¹ above 208 GeV would be justified. However the committee also recognises that an extension could have a serious impact on the LHC and, in view of this, there was no consensus to recommend an extension.

4. Next LEPC meeting

The date of the next meeting of the LEPC is **Tuesday, 6 March 2001**, and the presently-foreseen date for the LEPC in the remainder of 2001 is 13 November.

J. Kirkby