Minutes of the 152nd Energy Calibration Meeting held on 8 May 1998

1 Non-meetings since the last formal minutes

For the record, the meeting of 20 March was cancelled. There was a discussion on 27 March of Pippa Wells' presentation on behalf of the working group to the LEPC on 31 March. Guy Wilkinson gave a seminar on the LEP1 analysis on 20 April. These talks can be found on the working group web pages. During April, there were informal discussions to verify that the logging etc. was in order for the 1998 run.

2 Fills with strange initial energies

Guy Wilkinson has independently checked whether fills with an anomalous initial energy can be explained by strange values of the main bend current. There is general good agreement between the starting bend current and the initial energy, explaining fills 4082, 4143 and 4176. (Joerg Wenninger previously showed that errors in the bending modulation explained these strange current settings).

In contrast to Joerg's observations, Guy found that currents were logged for the earliest part of the year. Fills 3928 to 3939 and 4428 to 4434 have "normal" currents, but low energies

Two fills have a low starting energy, but 15 minutes later have a normal value. This is likely to be a synchronisation problem, with the time of start of physics being incorrectly flagged.

3 Further analysis of flux-loop/NMR data

Guy Wilkinson has written a program to digest Joerg Wenninger's flux loop data and produce easy to analyse files, which are on /afs/cern.ch/phys/lep/lepecal/97/rawdata/flux.

A two parameter straight line fit is made to $B_{\mathrm{NMR}} = a + bB_{\mathrm{FL}}$ in the 40–55 MeV range. The residuals are then examined comparing different "fills" (i.e. different flux loop measurements) and different magnets (i.e. different NMR's). The residuals are converted to their equivalent value in MeV.

The average over the NMR's of the residuals is about zero for fill 4000, and about 15 MeV for fill 4434, where fewer NMR's are working. For the latter fill, this is only just over a 1 sigma deviation, from the rms/sqrt(N) of working NMR's.

In the 40-55 MeV region, the residuals are up to 2 MeV, and are not always the same banana shape for each fill.

For each NMR in turn, the scatter of predicted physics energies over the 5 flux loop measurements was also found. The rms's span 2 to 18 MeV, with an average value of 11 MeV. The reproducibility of the NMR/FL fit is therefore good for each NMR in turn, and much of the change in central value can be attributed to the change in the number of working NMR's according to this analysis.

Guy them showed slides from Peter Renton, with a similar analysis. Details of the quality cuts vary, but the general conclusions are the same as Guys, namely: The flux loops behave the same way for a particular NMR. Different NMR's show a different total change. The scatter over flux loops is equivalent to an 11 MeV error.

Pete also concludes that we need more flux loop measurements. Joerg Wenninger reported that many have been made so far during the cold checkout, but only 4 of those with the NMR's working in addition.

4 Tests of flux-loop systematic effects

In general it was noted that the effect of "close by" points in the flux loop is typically only 2 MeV. This is relevant to whether the peak and peak-2 points should both be included, and also causes a sharp rise in the residual plots around 91.5 GeV where there are three points close together. This is too small an effect to explain any bias of 10 to 20 MeV in the average over NMR's.

Marcel Heemskerk showed the results of systematic studies with the flux loop in the ISR test lab. Previously, no dependence on step size had been observed, but when the steps are very close together, there is a change in the total measured field. Several example flux loops were shown, followed by a plot with total ramp vs number of steps (or equivalently vs. stepsize). The total field is apparently lower with a large number of steps. Joerg Wenninger commented that he had seen no such dependence of total field on the number of steps with the full LEP ring.

The flux loop drift in the ISR was observed to depend strongly on the excitation current. While the drifts in the full LEP flux loop are a few mG per second (which is measured and corrected in the flux-loop measurement), the drifts in the ISR are -0.2 G per second, and vary by up to 0.05 G per second with excitation current. This makes the measurement sensitive to the number of steps, but is not a large enough effect to explain the variation seen. Marcel also showed tests of the non-closure of the flux-loop cycle in the ISR test magnet. The non-closure is 0.2 to 2 G, while in LEP Joerg sees values between 0.1 and 0.25 G (depending on the number of steps on the way up – the smallest non-closure is with 1 step up and 1 down). The NMR's see a very small non-closure, which is explained by the normal magnet hysteresis.

5 Polarisation plans

Massimo Placidi showed a list of polarisation goals. Nearly all studies will be made with the 60/60 optics, but there is again a need to cross-calibrate with the 102/90 physics optics. However, this cross-calibration should be done in a dedicated MD, rather than trying to do an end of fill measurement during the Z running.

6 Review of overall plans

From internal note 98-01, the following work was identified as needing to be done before finalising the 1997 analysis. *Commentary from the discussion in the meeting has been added:*

- Implementing an exact treatment of RF frequency shifts. *We know how to do this. On its own, it might not merit giving the experiments energy files with new central values, although to properly assess the error, the easiest way would probably be just to make new energy files and calculate the new central values.*

- Improving the systematic understanding of the flux loop from the ISR test set up, to be backed up by tests with the full LEP ring at the end of April or in May. *As shown in this meeting, the ISR test set up gives qualitative agreement with the full LEP observations. However, the varying drift and large non-closure make it difficult to establish quantitative models. There is some disagreement on how much of the bias seen in the full-LEP flux loops can be attributed to the sampling of NMR's. This is to be clarified before a final error assignment can be made.*

- A more thorough evaluation of systematic uncertainties on parts of the bending field outside the flux loop. *There are now NMR's in the injection dipoles, which should allow this error to be approximately halved once they have been cross calibrated with the NMR's in the main bends.*

- Further simulation of the interplay between horizontal orbit corrector and central frequency effects. *Joerg has made simulations. MAD suggests that the effect should have been double counted... the central frequency and orbit correctors both change the energy. This is probably a big enough effect to merit releasing new energy files, being an 11 MeV shift on a large chunk of the data.*

Those present agreed that once these issues are resolved, a short paper with the status of the 1997 analysis could then be written.

So far, the requests presented at Chamonix have been met. They are listed here for completeness.

- NMR's all to be refurbished before startup. Replace coils in middle of year?

- Prefer polarisation MD early in year (NMR radiation damage)

- Changes to the cooling system to reduce temperature excursions

- Scatter of E_{NMR} vs E_{pol} seems to be low, so prefer four or five long MD measurements to frequent short MD's with
  - Many energy points in one fill (60/60 optics)
  - Big effort to increase lever arm to achieve pol at 60 GeV (60/60 optics)

- More time to understand flux loop (time without beam... cold checkout?). Also make controlled tests in ISR tunnel
- Flux loop measurement close in time to polarisation measurement

7 Next meetings and plans

The next meetings are expected to be on Friday 15 May and Friday 29 May at 15:00 in the Pavillon. By this time, we should have made a decision on whether new energy files are needed before publishing a paper on the 1997 data.

Pippa Wells, 13 May 1998