Minutes of the 138th Energy Calibration Meeting held on 5 September 1997

The bulk of the meeting concerned an update of the status of the Moller scattering experiment, and a review of other possible methods of measuring the energy.

(I have included some news from the LEPC meeting of 9 September in these notes.)

1 Next Polarisation MD

Massimo Placidi presented the plans for the next polarisation MD. The ramp with the 60/60 optics will be commissioned to 70 GeV. Then an attempt will be made to polarise at peak-2, apply HSM and make a calibration, followed by the same at 50 GeV. There will be a flux loop at the end with pauses for NMR locking.

2 Status of 1997 calibration

Marcel Heemskerk is making good progress with setting up automatic data checking and dst making.

The cooling regulation will be revisited next week, when the person needed to implement the software changes is back.

The Qs measurement still needs some work. (To be followed up with Andy Butterworth and Mike Lamont).

3 Moller scattering

John Field et al. have sent a brief Letter of Intent to the chairman of the LEPC, asking to present a detailed proposal to the LEPC in November. There is a chance of help on the gas jet target from NIKHEF.

Note from the LEPC: The chairman informed the LEPC that this letter had been received. Pippa Wells on behalf of the energy group stressed the physics arguments in favour of this measurement which is independent of the NMR/flux-loop extrapolation, and which offers a direct measurement of the beam energy at physics energy.

4 Precision of polarisation plus NMR/flux-loop extrapolation

In the context of the Moller discussions Pippa Wells summarised the expected precision of resonant depolarisation (RDP) plus extrapolation to physics energy with the NMR/flux-loop (ref. ECAL meeting of 2 May 1997 for details).

The major challenge of this measurement technique is to prove that the NMR/flux-loop extrapolation is precise at the 10^{-4} level between the maximum polarised energy and physics energy.

Note added after meeting after a private discussion with Joerg Wenninger: The flux loop samples more than 98% of the bending field of the normal dipoles. These dipoles make up 98.4% of the total bending field, with 1.4% from the injection dipoles and 0.2% from the 10% dipoles at the end of the straight sections. In other words, the flux loop samples directly 96.4% of the bending field. The remainder must therefore be controlled to the 1% level to achieve overall 10^{-4}.

5 Energy measurement with sawtooth

No presentation was made on this topic, since it has been shown in recent meetings.

6 Energy measurement from radiative return to Z

Pippa described a study by Graham Wilson (OPAL/DESY) that was made in the context of the linear collider workshop.

Graham looked at radiative returns to the Z, where the photon escapes down the beam pipe and the Z decays to mu pairs. From three body kinematics and the known Z mass, the energy of the photon and therefore the centre of mass energy can be derived from the angles of the muons w.r.t. the beam. This requires a theta measurement at the 1 mrad level. The statistical precision, taking into account the variation of cross-section with energy, would be 40 MeV on Ebeam at 96 GeV, with 500 pb-1 per experiment, combining all four experiments. There are systematic effects from the boost of the e+e- system and from ISR to be considered. Adding e+e- events, and possibly hadronic events, should improve the precision. Alain Blondel said he would expect the experimental acceptance to vary strongly with centre-of-mass energy.

We should make a more thorough study of this effect before the next LEPC (Nov 11), so that we can say whether this is ever going to be a useful cross check. With the current precision it gives an upper bound on the uncertainty, but does not compete with the hoped for accuracy. Could each experiment nominate one person to be responsible for putting together an evaluation on this time scale?

7 Precision Energy Spectrometer

Eric Torrence and Mike Hildreth presented a new idea based on the SLC beam energy measurement. The basic principle is to measure precisely the bend angle of the beam as it goes through a dipole with known strength.

At SLD this is achieved by looking at the distance between the synchrotron light given off before and after the spectrometer dipole. The bends to create synchrotron light are horizontal, and the spectrometer dipole is vertical. The absolute precision is 20 MeV, limited by survey precision.

The possibility of using a similar method to achieve a (relative) beam energy measurement at the 10 MeV level is being studied. A field map of one particular dipole in the LEP ring would be made, and BOM triplets on either side used to measure the bend angle of the beam going through this dipole.

To achieve 10^{-4} precision, the bend angle of 4 mrad must be measured to 0.4 μrad. For a 10m lever arm this implies stability and relative measurements at the 1μm level for the BOMs. The B field must also be surveyed to this precision. The absolute BOM positions etc. are not needed, because they can be calibrated using beam at 45 GeV. The measurement is therefore again depending on polarisation at lower energy. Many cross checks from varying the RF frequency can be made.

Adding wigglers to look at synchrotron light could be more reliable but much more expensive.

A possible location in the dispersion suppressor has been identified (either side of any odd or even IP). There is an isolated dipole with 3.8 mRad bend and no other magnets close by. A special steel dipole ("a nice magnet") could be considered to replace this dipole in the chosen location. BOM's with 1μm horizontal precision are known to be produced and are already used in synchrotron light sources.

Systematic limitations to be studied include long term BOM stability and coherent position shifts (eg. from asymmetric heating of the beam pipe by synchrotron radiation). (BOM to be followed up with Hermann Schmickler et al).

The field map of the dipole from the LEP design report indicates adequate uniformity over the central region seen by the beam. A full field survey at different energies would be time consuming (to be followed up with SL/MS group). It must be assessed whether it would then be sufficient to equip the dipole with dedicated NMR's and a flux loop to track the field.

Note from the LEPC: Pippa Wells mentioned to the LEPC that the radiative return events and this new spectrometer idea are under study. This provoked many questions from the committee on the details of the possible precision and time scales. Again, we are under pressure to provide a thorough assessment by November.

8 Next Meeting

The next two meetings will be at 15:00 in the Pavillon on the following dates:
Friday 19 September (chaired by Guy Wilkinson - OPAL meeting outside CERN)
Friday 26 September (chaired by Pippa Wells - ALEPH/DELPHI meetings outside CERN)

The main topics will be 1997 data quality and analysis, planning of future polarisation measurements, and making sure that people have been identified to follow up the radiative return and spectrometer ideas, as requested by the LEPC.

Pippa Wells, 10 September 1997.