Minutes of the 154th Energy Calibration Meeting held on 29 May 1998

1 Status of new energy files for 1997

Guy Wilkinson report that the necessary technical changes have now been implemented for the new energy files. In comparison to Moriond:

- A new energy record is now written if the RF frequency changes
- Horizontal orbit corrections are applied to physics and calibration data
- A new file of central orbit data has been used

The horizontal orbit correction accounts for almost all the difference between optics, so that the difference between polarisation data and the model prediction is less than 1 MeV for all fills except 4372 (1.5 MeV). There used to be a difference of 4MeV between 90/60 and 60/60 fills. The remaining difference between optics of less than 1 MeV will be examined more carefully and used in assigning a systematic uncertainty, but no optics correction will be applied.

Guy also showed a table of shifts in the mean beam energy for 183 GeV fills compared to the default Moriond tables. The horizontal orbit correction causes a shift of –2MeV, and the new RF strategy an additional shift of +5MeV, so the net shift is +3MeV. The largest variation in the mean is seen using fill 4372 (only 7 good NMR's) on its own, which is different from the average of all fills by 60 MeV.

Guy will check the relative weights assigned to different fills to be sure that 4-point polarisation fills contribute more to the average.

2 Linearity checks

Pete Renton gave a resume of Flux loop/polarisation/NMR comparisons in the range 40-55 GeV, showing residuals to a linear fit.

The 1997 flux loop data show a scatter of up to 1 MeV, which is significant compared to rms(NMR)/sqrt(N), where N is the total number of values in the fit i.e. up to 16 NMR's times 5 for the 5 flux loop measurements. (It was suggested that if there is little variation between flux loop measurements this might underestimate the error, since it does not account for correlations between different flux loop measurements). The 1998 data show even smaller residuals, of a few tenths of an MeV maximum. If 1997 and 1998 data are averaged, the scatter is further reduced. If both the peak-2 and peak points are included, the scatter increases due bias of 1 to 2 MeV observed when two points are taken very close together.

For the polarisation fills, Pete just considers the two four point fills. The scatter is increased when the horizontal orbit correctors are taken into account, with the residuals up to 2 MeV.

Pete then showed the extrapolation tests using the flux loop, where a fit of B_{FL} vs B_{NMR} is made in the 40-55 GeV range. The observed flux loop field at physics energy is then compared to the prediction from the NMRs using the low energy fit.

The difference between fit and measurement is consistent with zero for the earlier fills in the 1997, but increases 20 MeV for fill 4434, with an uncertainty of around 10 MeV. This difference persists if only NMR's that are working for all flux loop measurements are used. In 1998, the average difference is about 3–7 MeV, with an uncertainty of about 7 MeV from the rms scatter of NMR's divided by sqrt(16). If only the NMR's that were working throughout 1997 are used, the difference increases slightly to about 10 MeV.

The fitted NMR offsets are well correlated between 1997 and 1998.

In summary, in the range 40-55 GeV, the comparison of polarisation and NMR data shows a banana shaped non-linearity. The difference between fluxloop and NMR data varies significantly between fills in 1997. It would be useful to have standard logging information available during flux loop measurements. Over the full range 40–90 GeV, a given NMR shows reasonably reproducible but non-lineary behaviour compared to the flux loop. The average over NMR's shows less bias, but still with a net difference at physics energy of 10–20 MeV.

3 Dipole calibration in 1998

Joerg Wenninger realised that the out of date magnet calibration curves had been used for the 1998 machine set up, which brought back the about 150 MeV offset of the beam energy at physics energies. This was fixed in fill 4568. So the prescription for the first guess of the beam energy in 1998 becomes:

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Up to fill 4568:

        E_true =  E_nom + 150 MeV - 1.72 (MeV/Hz) * (fRF shift)
               =   94.5 + 0.15 - 0.17 = 94.48 GeV


The first shift of +150 MeV is to account for the main bend dipole
calibration curves, as implemented this year.

The second shift of -170 MeV is for the present setting of the RF
frequency of 100 Hz from nominal, and the 102/90 optics.

After fill 4568:

       E_true =  E_nom - 1.72 (MeV/Hz) * (fRF shift)
               =   94.5 - 0.17 = 94.33 GeV
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Joerg has also added a new word in the LEP tables which will give the best guess true energy derived from Enominal and fRF.

4 Injection dipole fields

Pippa Wells showed a comparison of the Injection dipole and main bed fields in 1998. The study used ntuples from Enrico's private NMR logging for fill 4568, in which the ramp was commissioned with the new magnet calibration curves, leading to pauses at several energies between 45 GeV and physics energy.

The Hall probe readings were used to select times at constant energy. All the NMR's in main bend magnets and two NMR's in injection dipoles were locking. The ratio of the average main bend field to the average injection field is constant at 0.51 to a relative precision of better than 10^{-3}. The injection dipoles contribute 1.4% of the total LEP bending field, so if their fields are proportional to the main bend fields to better than 10^{-3} over the 45 to 95 GeV range, they give an additional uncertainty in the extrapolation measured by the flux loop of less than 1 MeV.

The contributions to the uncertainty due to fields outside the flux loop are therefore:

- About 5 MeV for the main bend fringe fields (see Joerg's talk in the previous meeting
- Less than 1 MeV for the injection dipoles
- The 10total bending field, so even if their fields are only known to 1% relative precision, this gives an additional uncertainty of about 1 MeV.

5 Initial Dipole Energies

Anke Muller showed a comparison of the initial dipole energies from the Moriond files, and using the method of normalising NMR's to the flux loop before setting the overall scale from the polarisation data. The agreement seems to be reasonable, given that Anke only uses the two polarisation fills with four energy points.

6 Next meeting

The next meeting will be on Friday 5 June at 15:00 in the Pavillon, to review energy files, move towards final systematic errors and discuss the writing of the paper.

Stanislaw Jadach is at CERN. We will have another meeting on Friday 12 June with emphasis on the energy from radiative return events.

Pippa Wells, 2 June 1998