Minutes of the 101st Energy Calibration Meeting held on 26 July 1996 at 15:00

1 Estimate of the 1996 beam energy using NMR's

Here is the description from Mike Koratzinos of his analysis

1.1 Year to year reproducibility

This point is more tricky than I originally thought: One cannot use the NMR in the reference magnet, since its geometry has been modified this year to be able to operate on both low and high energies. Therefore a nice comparison of 93-94-95-96 cannot be done. One can only use NMR4 and NMR8 and compare them to the 1995. Now, these NMRs have been taken out and back in again, and Enrico ensured me that they tried to reposition them in the same spot to within a millimetre or so; From his plots of the variation of the field versus longitudinal displacement, I estimate the error due to repositioning to be $\pm$20MeV per beam.

To go from gauss (which is what the NMR reads) to MeV I used the conversion factor obtained in 1995 by comparing the one calibration at the peak to the NMR4 and NMR8 values. The two large Z0 fills this year had therefore an energy of 45677 MeV.

Three of the early WW fills had an energy of 80596 MeV. Unfortunately for the late fills the NMRs 4 and 8 and not working reliably, but since the machine has not changed since those early fills, the early energy should be representative of the mean energy.

Note that this year to year error will disappear as soon as we have a energy measurement at 45GeV this year.

1.2 BOM error

Talking to Joerg, he has not seen any strange behaviour this year with the BOMs. I therefore take the full swing of the previous years (20MeV at 45GeV, therefore 40MeV at 80 GeV) as the error.

1.3 Tide error

Again, the full swing of the tides is $\pm$30MeV at 80GeV. If we have taken 9 random fills the error of the mean energy would be about $\pm$10MeV or less.

1.4 Extrapolation error

Here our only handle is the 1995 P-2 to P+2 data. Using the information from NMR4 and NMR8, and if we normalise at P-2, the mean offset of calibrations and NMR readings is:

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P-2: 0.0 +- 3.6/sqrt(14)
P+2: 1.0 +- 2.9/sqrt(12)
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As you can see, the non-linearity is about 1.0$\pm$1.4MeV. I take the error as an estimate since the central value is compatible with zero to get:

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non-linearity(45->80) = 1.4*(80-45)/1.8 = +-30MeV
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Of course this term cannot include any wild non-linearities, but this problem will always be had with all extrapolation methods. For the moment we can double the error to take into account any higher-order non-linearities.

1.5 Rise in a fill

Due to the fact that there is no magnet conditioning this year and we are operating in a regime where magnet instability might be larger when at the bottom of their hysteresis, we do see large drifts this year. The drifts are of the order of 20-30MeV in a fill per beam. in section 1 I have taken the energy of the fill about half way between start and finish. Till the analysis of the rise seen in a fill is done, we will have to assign an error of 20MeV due to this effect.

1.6 Summary

My quick analysis for the energy at 161GeV, using the information of nmr4 and nmr8 to establish the link with 1995 and derive the extrapolation error yields:

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average energy of WW running: 80600MeV/beam

error:        year-to-year reprod: 20MeV
              BOM:                 40MeV
              Tide:                10MeV
              extrapolation:       60MeV
              rise in a fill:      20MeV
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              Total:               80MeV/beam
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1.7 Further remarks from the meeting

Joerg Wenninger commented that some correction for the decrease of the effective length of the dipole magnets as energy increases should be made (about 2×10^{-4} in going from 45 to 80 GeV).

Mike also showed a plot of the energy vs. time in fill, for all the polarisation data. The data are consistent with a saturation term, but with very large errors. The implications for the 1993-95 paper and the final errors on the scan data will be discussed in future.

2 Flux loop measurements

Joerg Wenninger explained that he has now made 5 full flux loop measurements. These all give the same result to within 10MeV. The raw numbers for beam energies are:

nominal	flux loop
22	22.058
45.625	45.712
80.5	80.651

i.e. the flux loop indicates that the energy is around 2 per mil higher than the nominal setting at all energies. These measurements also agree with those made in 1995 on a shorter cycle.

In addition at 80.5 GeV there should be a correction of -0.014 GeV to account for the central frequency (which has now been measured to be 10 Hz lower than nominal). The tide correction should also be made to get the best possible precision.

Joerg also investigated the overshoot on the power converters, which is observed to be proportional to the ramp speed. This explains the inconsistency in the energy when going directly to 22 GeV compared with going to 20 GeV and then ramping slowly to 22 GeV that was seen last year. Between 5 and 50 A/s ramp speed, the overshoot is less than 10^{-4}. The fluxloop was therefore set to use a ramp speed of 50 A/s (compared to the maximum possible of 140 A/s). The normal "physics" ramp is 5 A/s.

3 LEP2 RF Model

Mike Hildreth has had a first look at the LEP2 RF Model. Plots are included with the minutes. The difference between Qs calculated and measured suggests that the overall RF voltage should be scaled by 0.975 (compared to 1.02 in 1995). Some drift in the phase of the cavities during a fill has been observed. The average Ecm energy shifts at IP's 2,4,6,8 are $19, -0.6, 8, -2$ MeV respectively, with an error of about 5MeV from the alignment uncertainties. The longitundinal boosts are $-78, -54, 38, -45$ MeV respectively. It is noticed that the corrections at IP's 4 and 8 are still largely anticorrelated, even though these IP's are now both equipped with significant SC RF. An "Rbom" quantity for each of the four IP's has been examined, but it is not clear that the best definition of this variable to check for misphasing has yet been established.

4 Beam sizes and Dispersion

John Yamartino commented on the observation that the beam size at peak+2 is smaller than at peak-2. This is because the vernier scale is calculated using the nominal Z peak energy, and the apparent measured beam size is therefore proportional to 1/Ebeam. The average beam size from peak+2 and peak-2 was used for the dispersion effect.

John also showed the expected scaling of dispersion effects to 161 GeV. The sensitivity to collision offsets is 7MeV/micron. The smallest beam size in y seen so far is 3 micron, so for a collision offset leading to a loss in luminosity as large as 50%, the shift in centre of mass energy would be 12 MeV.

Joerg commented that beam-beam deflection scans indicate that the verier settings are stable at the 1 micron level.

5 NMR operation and logging, ISR magnet

The full set of NMR data is now being logged in the test table. Cross checks with Enrico's private logging now show consitency. For the probes themselves, there have been some hardware problems with the old probes ("NMR4" and "NMR8"), due to heavy water leaking out of the head. This may be due to radiation damage.

The test dipole in the ISR tunnel is now being equipped with real LEP coils and vacuum pipe.

6 AOB

Mike Koratzinos is working on further checks of the correctors, and on converting the cernvm set up to run on a unix platform. Pippa Wells will look into getting a group area with a reasonable amount of disk space on afs.

7 Next Meeting

The next meeting will be at **10:00** on Friday 2 August in the pavillon. Let the record show that the unusual time is at the special request of M. Koratzinos.

Pippa Wells, 30 July 1996.