Minutes of the 128th Energy Calibration Meeting held on 2 May 1997

1 Logging status

Ronny Billen listed the work to be done for the logging. The database software and HP operating system have been upgrading, so the logging programs need to be recompiled and relinked. This has so far only been done for the watchdog programs which are already running.

Modified tables are needed for the RF system. In addition, the train current can now be logged for each octant. For each time sample it is proposed to record the mean, rms, maximum, minimum and instantaneous value.

2 K Modulation and NMR status

Giuseppe Mugnai reported that the k modulation cables (control and backleg windings) are all installed. More than half the interface boxes still have to be made and installed.

All the NMRs have been dismounted during the shutdown, and taken to Metrolab where they have been examined to understand the radiation damage. This is limited to the coil in the tip, where the insulating varnish and glue have degraded. The coils have all been replaced with a more radiation hard version (which was already tested in two probes last year). The data acquisition system is being upgraded to VME. The software should be more flexible and the changes transparent to the logging code. Extra channels are allowing the train current to be logged. During the startup, the locking of the probes will be checked at 45 GeV, and the minimum magnet setting at which locking occurs will be verified. It is hoped to achieve the polarisable energy of 41.2 GeV. The lower value of 39.4 GeV is probably too difficult. A new mechanical support (a lead slot) will be installed to enable the probe positions to be reproduced more exactly after an intervention.

3 Polarisation team plans

Massimo Placidi reviewed why extending the range of resonant depolarisation outside 40–60 GeV is difficult. Although the the NMRs will not lock below 40 GeV, since they need a minimum field to operate, the flux loop is available at all energies to cross calibrate. The polarisation time increases as the energy decreases. It is already about 10 hours at 40 GeV. However, the asymptotic level of polarisation is high, so the time needed to achieve 5% polarisation is still reasonable (less than 30 minutes). At high energy, the time to repolarise gets very short. It is already 0.5% per minute at 50 GeV.

The planning for weeks 25–27 is as follows:

- Establish polarisation at the Z with 90/60 optics. Measure the energy. (2 End of fill MDs.)

- Test the new depolarisation procedure for high energy, with continuous sweeping of the designated frequecy range. This is to avoid the problem of the fast polarisation build up. (1 End of fill MD.)
- Measure polarisation at peak-2 and 50 GeV in the same fill. (Time taken from physics.)
- Commission k modulation. This will take some end of fill MD time and can from then on can be done for several quads at a time during physics. (2 End of fill MD's)
- Test the new polarisation optics (probably 60/60). (2 times 8 hours in the MD of week 27).

4 Other requests for 1997

Bend modulation and cooling modifications will be presented at the next meeting on 1997 issues.

5 Energy loss and Sawtooth

Anke-Susanne Muller showed work in progress to check the RF model and measure the energy loss in the octants from the orbit sawtooth.

The method uses the 8 times 30 pickups in the arcs to look at the difference in orbit between electrons and positrons. The measured difference can be plotted vs. pick up number, and a straight line fit made for each arc. To translate the measured offset into a relative energy difference, the horizontal dispersion must be measured. This is also derived from a fit to the pick up data, including a sinusoidal part to account for the betatron oscillation. According to the measurements, the dispersion varies with time, and also varies along the arcs.

Rbom is defined as the energy difference across an (even) IP between two of the pickups, divided by the sum of the energy differences at all four even IP's. The energy loss in the arcs can be measured in the same fit. The measured energy loss per octant shows a spread of about 10 MeV. Summing the energy loss over all 8 octants, the mean is eg. 1.26 GeV and the rms 9 MeV at 86 GeV. The energy loss is also measured at 85, 80.5 and 45.5 GeV, and the expected E^4 behaviour can be tested. The measured energy loss does not quite agree with the prediction from MAD, with a constant discrepency of about 7 per cent.

It is hoped that the energy loss could give a measure of the absolute energy with a precision around $10^{-3} - 10^{-4}$. The new measure of Rbom from a fit to the pickups should be available online for the 1997 running.

6 RF measurements

Mike Hildreth summarised additional requests for RF measurements during the setting up. The cavity phase errors can be controlled if the forward and reflected powers of the cavities are calibrated. This should be possible parasitically in physics, although probably not at high energy.

Some extra measurements of cavity alignment to understand the systematic effects will be made during the phasing of the new cavities and checking of existing ones.

Small modifications to the RF code for the new SC cavities and removed CU cavities must be implemented.

7 Evolution of the extrapolation uncertainty

Pippa Wells showed an attempt to reproduce the extrapolation uncertainty model published in the CERN yellow report, and to compare this with our present analysis.

The linear extrapolation in the yellow report was reproduced without problem. The quadratic extrapolation in the yellow report assumes that the curve of true energy vs. setting energy goes through the origin. A discrepency between the new and old calculations of this quadratic uncertainty was resolved shortly after the meeting. The old calculation in fact assumes a linear behaviour between zero and the lowest energy polarisation point, and after this a quadratic behaviour. The third set of curves in the yellow report assume that the flux loop provides an independent measurement of the energy with precision 2×10^{-4}. In the error analysis of the 1996 data, we have taken the approach that the polarisation points "calibrate" the flux-loop and NMR magnetic measurements. An additional error for "non-linear" behaviour of the energy evolution (i.e. those contributions to the error not coming from the dipoles or from edge effects) was then assumed to be covered by the large uncertainty assigned.

To achieve our target of less than 15 MeV error in the case of linear extrapolation, we need to increase the "test" lever arm to 10 GeV, and improve the error on each point to 2 MeV.

As might be expected, a more model-independent approach of fitting a quadratic to three or more polarisation points in the range around 40–60 GeV, assuming 2 MeV independent errors at each point, results in an error of at least 35 MeV, i.e. far larger than the target.

8 93-95 analysis

Mike Koratzinos showed his continuing tests of the "truely 2d" model (also known as the "Guy" model, because it uses Guy Wilkinson's binning of the NMR48 rise in bins of time-of-day and time-of-fill). The consistency checks comparing 2D2T and "truely 2d" look very promising. There is an open question about the BOF/EOF calibrations. For the truely 2d model, and with updated tide coefficient, for 1995, he found a "delta

delta" (model - Epol) of 0.0, with an rms of 0.5 MeV. This seems to contradict the mean delta delta of 1.0 MeV that has been presented at previous meetings for various "average behaviour" models, and that has been explained by the atypical sampling of the rise by BOF fills.

8.1 Mail from Mike appended to the minutes

The following is an e-mail from Mike with the complete set of BOF/EOF tests for 1993 and 1995.

Please note that I think that I have understood the apparent difference of the mean value of the 1995 delta-delta(e). As you remember the mean now appeared to be close to zero, whereas Guy (and myself) had shown at previous meetings numbers which were closer to 1MeV.

The difference comes from the following:

1) I am using the 'fine binning' trully 2D model of Guy. He has shown results of his 'coarse binning' model. The difference of the two models on the means of the delta-delta(e) is 0.6MeV. The difference on the lumi weighted mean energy over the year is negligible:
p-2: 0.08MeV/beam
p : 0.29MeV/beam
p+2: 0.00MeV/beam
(fine binning numbers are higher)

2) I am using one BOM number per fill, but I do interpolate between successive BOM readings. Thus the BOM contribution has a mean of 0.1MeV instead of zero.

I can therefore explain 0.7MeV of the difference between what I have showed in the last meeting and what Guy showed some meetings ago.

The numbers are given in the table.

Note that in 1993 both models are doing considerably worse.

please note that fill 1772 was the discarded temperature experiment, where the excursion was about 7.6MeV and our models can explain only about 5MeV. I have no BOM info for this fill.

Also, fill 1849 was during the period of very high BOM gradients, but I only have very little BOM information (no values between 11-10-93 07:40:45 and 15-10-93 17:16:45 - the calibs were at 11-10-00 19:51:00 and 12-10-00 06:30:00)

[Yes, I do persomally believe (without being able to substantiate it) that the key to our model inadequecies lies in the lack of reliable BOM information.]

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GUY       == trully 2d model, fine binning
GUY_COARSE==       "         , coarse binning
MTG       == fine binning, projections
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1995
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fill	GUY	GUY_COARSE	MTG	
2929	-.36	-.25	-.45	(per beam)
3022	-.39	.45	1.04	
3029	.00	.95	.22	
3030	-.53	.74	-.16	
3036	.48	.25	1.45	
3064	.78	1.39	1.10	
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mean/rms	.0/.5	.6/.6	.5/.8	

1993
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fill	GUY	MTG
1636	.72	1.05
1734	-.76	-1.13
1772	-2.75	-2.65
1811	2.40	1.45
1849	-3.57	-2.71
1888	.38	.38
1892	.10	-.55
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mean/rms	-.5/2.1	-.6/1.7

>>>These numbers complete what I had shown in the last meeting <<<

9 AOB

Bernd Dehning introduced the new technical student, Florian Sonnemann, who will work on the simulation and implementation of k modulation for polarisation.

10 Next meetings

The next two meetings will be:

- Friday 16 May at 14:00, emphasis on 93-95 analysis
- Friday 23 May at 15:00. Update on 97 planning, and then discussion of 93-95 analysis.

Pippa Wells, 5 May 1997.