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LEP SPECTROMETER PROJECT

Summary Notes of the 25^{th} meeting held on February 18, 1999

Present: R. Assmann, D. Cornuet, B. Dehning, M. Hildreth, W. Kalbreier, J. Montes, G. Mugnai, S. Myers (chairman), J. Poole, J. Palacios, J. Prochnow, F. Roncarolo, E. Torrence, J. Wenninger, G. Wilkinson

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Comments to Summary Notes of previous meeting - None

Sensitivity of LEP BOM Measurements to Higher-Order Multipole Signals - R. Assmann showed some work he and Bernd have been doing in applying some calculations and measurements of the effects of higher-order multipole signals on BPM measurements. They use a calculation (originally from SLAC) of the multipoles that are induced on BPM buttons to predict the effects of different beam sizes and offsets from the geometrical centre of the pickup on the actual position measurement. The dipole terms are used to make the position measurement itself (the quadrupole terms cancel when you do this), and what is left are sextupole terms of the form

$$\delta x = x_b \left(\frac{3(\sigma_x^2 - \sigma_y^2)}{a^2} + \frac{x_b^2 - y_b^2}{a^2} \right).$$

Here, δx is the shift in the measured horizontal beam position, x_b and y_b are the horizontal and vertical offsets of the beam from the geometrical centre of the BPM, σ_x and σ_y are the horizontal and vertical beam sizes, and a is the radial distance from the BPM centre to the buttons (4.2 cm). The shift thus depends on the horizontal and vertical beam sizes, and, less strongly, on the horizontal and vertical offsets. As an example, Ralph looked at the situation at the Spectrometer location. Since the Spectrometer sits between a focussing and a defocussing quad, the β functions vary rapidly across the BPMs. At the BPM closest to Q17, $\beta_x = 133.5$ m and $\beta_y = 10$ m; at the other end near Q18, $\beta_x = 18.9$ m and $\beta_y = 131.6$ m. The horizontal dispersion also changes by a factor of two at the two quads. This implies that the beam sizes will be very different on the two arms of the Spectrometer, which could result in apparent position shifts that look like a change in angle of one arm with respect to the other. The estimate is that in order to control the sextupole component to the required 1 micron level, the beam must stay within 166 microns of the horizontal geometric centre of the BPMs. There were a few ideas mentioned on how to measure this. More thought is obviously needed to make sure we can control this effect. An SL Note will appear soon on these results.

Results from the Mapping Mole - F. Roncarolo gave an overview of the results he has obtained with a small chariot that was designed to make a map of the dipole field by moving inside the vacuum pipe. The chariot is equipped with two NMR probes and, now, with a 1000-turn coil in order to measure the end fields. The chariot can make maps automatically; each map takes about 30 minutes. The longitudinal position along the dipole is measured with an interferometer. All of the results presented are from maps made on a standard MB magnet in the ISR tunnel. This is significant in that the temperature coefficient of the MB is about 10

times larger than the MBI that will be used for the Spectrometer, and the MB is, seemingly, more prone to environmental perturbations. Also, the magnetic field is only half as large as the MBI at a given energy.

The coil itself is only 2.5 cm wide, but has an effective area of about 0.2 square meters because of the high number of turns. Federico showed tests on the reproducibility of the integral field measured by the coil compared with the NMRs inside the dipole, and results in the end field region. A primary focus of his studies has been to examine the reproducibility/accuracy of the measurements as a function of the "step size" over which the chariot is moved for each measurement point. As expected if there is random noise on the coil integrator, the precision with which the end field is measured increases with decreasing step size. Relative reproducibility of between 4×10^{-5} and 2×10^{-4} has been achieved with step sizes between 8 and 1 cm. Federico also showed some results for the reproducibility of the integral of the total bend field. His set of 32 maps has a large temperature gradient, but, once this is corrected, the integral of the core field has an rms of 2×10^{-6}, and the total field has an rms of about 5×10^{-6}. This is similar to what is being achieved with the MBI mapping setup, and under worse conditions... These results look very promising, since this chariot will provide the only cross check of the MBI maps before and after the move to the LEP tunnel. We should be able to easily see effects of a few times 10^{-5}, which is the required precision.

Results from the Mapping in the ISR - M. Hildreth showed a summary of the mapping progress. To date, more than 300 maps have been made of the MBI. This number has increased dramatically within the last week, as the crew down in the ISR have implemented and automatic scanning procedure which allows continuous acquisition of data. We can now make almost 50 maps per day. Mike gave some numbers to characterise the quality of the magnetic field that is coming out of the mapping analysis. The integral of the core field is reproducible over many consecutive measurements (no degauss in between) to the 2×10^{-6} level or better. The integral of the total field in the same case is reproducible to between 2×10^{-5} and 5×10^{-6}, depending on energy. (The noise in the Hall probes is essentially constant, so the relative error is less at 100 GeV than at 41 GeV.) The reproducibility of the crucial relationship between the field measured by the reference NMR probes and the total integral seems to be about 2×10^{-5} over several days. More tests are needed to insure these numbers, but to date, everything looks pretty decent.

Mike also gave an outline of the proposed set of production maps to be made over the next two weeks, which can be found in copies of the transparencies. Additional maps will be made at a low energy ($\sim$ 10 GeV) and above 100 GeV (103 GeV) so that the proper calibration curve for the dipole can be put in the LEP database.

The next meeting will be on Thursday, 4th March.

M. Hildreth