Final polarization values for 2003

We recommend to use “rescaled’ online values only. There are few “event” mode measurements and were mainly used to understand the polarimeter measurements and correct the online values accordingly.

1) From the comparison between the offline and online measurements the online values must be rescaled (multiplied) by:
blue – 1.09
yellow – 1.05

2) Using the 2004 jet data we have a first direct measurement of the analyzing power for pC scattering at 100 GeV. On the basis of the “recalibrated” analyzing power the polarization values must be rescaled (multiplied) by:
blue – 1.23
yellow – 1.21

The overall rescaling factors of the online polarization values are:
blue – 1.34
yellow – 1.27

For instance, the measurement 3524.003 in the blue ring rescales as:
$35.39\,\% \rightarrow 35.39\% \times 1.09 \times 1.23 = 47.45\,\%$

These final polarization values are reported on our polarimeter web page:
http://www4.rcf.bnl.gov/~cnipol/

The (relative) systematic error is (see below):
blue – 18.6 %
yellow – 16.8 %

Final polarization values for 2004

We recommend to use “rescaled’ online values only. During the last part of the 2004 run few “event” mode measurements were taken. They were mainly used to understand the polarimeter measurements and correct the online values accordingly.

During the run, between fills 5234 and 5235 the polarimeter has been recalibrated. Two different sets of rescaling factors must be used.

fill # ≤ 5234
- blue – 1.25
- yellow – 1.21

fill # ≥ 5235
- blue – 1.08
- yellow – 1.11

These final polarization values are reported on our polarimeter web page:
http://www4.rcf.bnl.gov/~cnipol/

The (relative) systematic error is (see below):
blue – 12.0 %
yellow – 16.6 %

Discussion on systematic errors, recalibrating with 2004 jet result
(see RHIC note CA-D / AP / #171 O. Jinnouchi et al. and Osamu RSC February 2005 presentation https://www.bnl.gov/riken/RSC/RSCXXXII02102005.htm)

2003

Uncertainty^2=
(1) (8.5%)^2 +
(2) (9.8%)^2 +
(3) (3.0%)^2 +
(4) (0.0%)^2 +
(5) (7.3%)^2 +
(6) (0.0%)^2 +
(7) (4.0%)^2 +
(8) (10.0%)^2 =
(18.6%)^2 for blue

Uncertainty^2=
(1) (8.5%)^2 +
(2) (9.8%)^2 +
(3) (3.0%)^2 +
(4) (0.0%)^2 +
(5) (9.2%)^2 +
(6) (0.0%)^2 +
(7) (2.0%)^2 +
(8) (4.0%)^2 =
(16.8%)^2 for yellow

The numbers in parenthesis refer to the following notes:

1. Blue beam polarization uncertainty from jet measurement in 2004: dP/P=8.5%.

2. Energy correction uncertainty: 12 ug/cm^2 dead layer. This leads to an uncertainty on the beam polarization of dP/P = 9.8%.

3. Event selection / mass cut dependences in 2004, dP/P=3%.

4. Other systematic errors in 2004 for the "calibration" with the jet target. The main method that we have to determine measurement errors is the χ^2 for individual fits to asymmetry for each strip. For 2004 this gave a χ^2/ndf of 70/68 with 2 parameters to the φ fit, using only the statistical errors for the asymmetries. Therefore the measurement contribution to the systematic error is negligible compared to the other errors. (This is also small compared to the event selection systematic, indicating that the event selection was effectively independent of this – i.e. relatively the same for each strip.)

Polarization profile. If the polarization is not flat over the beam, the jet, the carbon polarimeter, and the experiments sample the polarization differently so this would give a correction and systematic error. We do not have evidence of such a profile from the 2004 run. We don't recall a profile in 2003 either. The issue came up mainly in run 4. Osamu discusses this on p8-9 of his presentation, and concludes that the polarization is consistent with flat, with apparent polarization drop only at 1/4 intensity max or below. There were 5 scans, yellow horizontal target (2 scans), blue vertical target (1 scan), blue horizontal target (2 scans). Although we could take the approach that we cannot prove the polarization flat except to a certain sensitivity and then generate a systematic error from this, we recommend that we assign no systematic error for this. We have also measured the profiles carefully in 2005 and found either no profile (blue) or a drop in polarization only beyond 1/4 max intensity. This was done for both vertical and horizontal targets.

5. Systematic uncertainty for conversion from histogram mode to event mode in 2003. The adjustments were P_offline/P_online=1.09 (blue) and =1.05 (yellow). The distribution of the ratio gave χ^2 of 87 for 121 NDF for blue and χ^2=32/110 NDF for yellow, using uncorrelated errors statistical errors for online and offline. Clearly the errors are correlated. However, the correlation is complicated since the energy ranges are different, hence the A_N are different for online and offline. We choose to include no error for this ratio, but include an error for using the online data.

The number of online events is about 2× the number of offline events. Hence an online statistical error is roughly 1/root(2) smaller than offline. We have chosen the offline cuts to control systematic errors. It is incorrect to use the statistical error of the online without an additional systematic error for using the online data. We add a systematic error equal to the statistical error of the online. This is arbitrary, but is in a sense a minimum error – otherwise we should always use the online data. However, we think it is reasonably conservative. A maximum error would be the spread of the ratio of online to offline polarization, and this is also about 10%.

6. Energy correction for 2003. This is the question – does the 12 ug/cm^2 assigned in 2004 to cover the uncertainty of the energy scale include comparison to an energy scale in another year or not? In effect, it should if the method of obtaining the energy correction and the characteristics of the signal have not changed: the 12 ug/cm^2 assigned uncertainty represents an upper limit energy scale uncertainty from the energy correction, as measured for different conditions (injection, flattop, using different energy ranges to obtain the correction). When we compare the raw asymmetries for the strips, we include in our systematic error from that comparison the energy scale uncertainty for independent measurements of the energy correction with similar conditions. Each strip is treated independently, and we obtain the energy correction independently. The approximate sigma of the relative energy correction uncertainty in 2004 is about 5 ug/cm^2 at most. The dP=3%, blue and dP=1%, yellow systematic error assigned in 2003 includes this relative energy calibration systematic uncertainty since it is from the φ distribution of each strip asymmetry. This systematic error is included in item 8.

We are using the same method to obtain the energy correction in 2003 and 2004. We have shown that the method, when used independently on 72 strips (or 39 strips in 2003), we obtain a small variation in the energy correction. To carry the polarimeter calibration, A_N', from 2004 to 2003, this is sufficient. A_N' would then be an effective analyzing power. The situation changes when we use different electronics, such as when we eliminated the beam image pulse in 2005.

Therefore, the assigned uncertainty of 12 ug/cm^2 is reasonably (perhaps too) conservative, and that there should not be an additional energy scale uncertainty included for 2003. This discussion does not address the absolute energy scale, or the differences from eliminating the beam image pulse in 2005.

7. Event selections in 2003. The 2003 measurement systematic error should be included in the calculation of overall systematic error after we renormalize with the new A_N'. This systematic error for event selection, obtained from comparing 2 sigma and 3 sigma mass cuts, was less than 1.1 % in 2003 (p12, RHIC note 171). This is in polarization and is dP/P=0.5%/25%=2% in yellow and 1.1%/31%=4% in blue.

8. Systematics of 2003 measurement. This was obtained from the φ fit to the independent raw asymmetry measurements allowing radial polarization. This was 3% in polarization for blue and 1% in polarization for yellow. Therefore, the measurement systematic uncertainties in 2003 were dP/P=1%/25%=4% for yellow and 3%/31%=10% for blue.

2004

Uncertainty^2=

(1) (8.5%)^2 +
(2*) (0.0%)^2 +
(3) (3.0%)^2 +
(4) (0.0%)^2 +
(5) (7.4%)^2 +
(6) (0.0%)^2 +
(7) (3.0%)^2 +
(8*) (0.0%)^2 =

(12.0%)^2 for blue

Uncertainty^2=

(1) (8.5%)^2 +
(2) (9.8%)^2 +
(3) (3.0%)^2 +
(4) (0.0%)^2 +
(5) (9.3%)^2 +
(6) (0.0%)^2 +
(7) (3.3%)^2 +
(8*) (0.0%)^2 =

(16.6%)^2 for yellow

The numbers in parenthesis refer to the notes as for the 2003 errors. While some values are different, the meaning and estimation of the error is the same, except for 2*.

2*. The blue carbon polarimeter was calibrated with the jet target running at the same time. Therefore there is no need to add an error for the energy correction.

8*. The systematics of the measurement is negligible compared to the statistical error during the 2004 run.