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Effect of scattering material in the neutral beam line on the asymmetry measured by the Cherenkov Compton polarimeter

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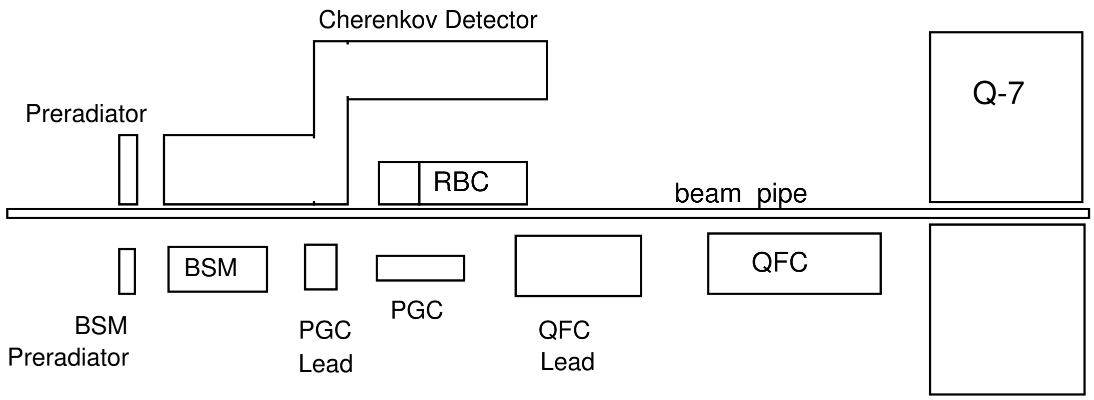
1 Introduction

In 1995, when the south final focus beamstrahlung monitor (BSM) lead pre-radiator was stuck in the neutral beam line beside the Compton Cherenkov Polarimeter, this caused significant increase in the level of background in Cherenkov detector due to rescattering of beamstrahlung radiation. It also caused low asymmetry contamination in Cherenkov detector due to showering of Compton photons [1].

For the '96 run, a number of new detectors were installed in this area. To see whether these detectors and their pre-radiators might cause similar problems, we checked the background level and the ratio of asymmetries in channels 7 and 8 observed during the '96 run for various detector configurations.



The small signal size in channel 8 makes it particularly sensitive to low asymmetry contamination. Assuming that low-asymmetry signal is the same in both channel 7 and channel 8, the effect on channel 7 asymmetry, which is used for polarization measurement, is given by

$$A_7^c - A_7^m = r_{8/7} \times \frac{A_7^m - A_b}{A_8^m - A_b} \times (A_8^c - A_8^m)$$

where A_j^c is asymmetry in channel j in the absence of background Compton signal, A_j^m is the measured asymmetry, A_b is asymmetry of background signal, and $r_{8/7}$ is the ratio of the normal channel 8 signal to the normal channel 7 signal (about 0.07) . The second factor on the right-hand-side of the above equation varies from 1.14 to 1.18 , as A_b varies from zero to 0.1 .

Therefore, relative change in the channel 7 asymmetry is approximately

$$\frac{A_7^c - A_7^m}{A_7^c} = 0.0812 \times \left(\frac{A_8^c}{A_7^c} - \frac{A_8^m}{A_7^m}\right)$$

Theoretical value of A_8/A_7 , based on Monte Carlo simulation combined with the table scans data, varied from 0.993 to 0.999 through the $'96$ run. This agrees with the average value of A_8/A_7 measured for all nominal polarimeter runs (with no autoscans active), which is 0.997 ± 0.003 .

2 Quartz Fiber Calorimeter removable lead.

Normal position of the QFC removable lead shutter is "IN" the neutral beam line when the beams are in collision. There were two periods during the $'96$ run when the shutter remained "OUT" of the beam for considerable time. The table below compares A_8/A_7 measured during these periods with the measurements during adjacent periods when the QFC lead was "IN".

	Period 1	Period 2
A_8/A_7 with lead “OUT”	0.999 ± 0.011	0.978 ± 0.021
A_8/A_7 with lead “IN”	0.991 ± 0.008	0.977 ± 0.014
relative change in A_7 due to low-asymmetry contamination, between measurements with lead “OUT” and lead “IN”	(0.06 ± 0.11) %	(0.02 ± 0.20) %
relative change in A_7 due to low-asymmetry contamination, between measurement with lead “IN” and theoretical value	(0.04 ± 0.07) %	(0.15 ± 0.12) %

Backgrounds in the Cherenkov detector did not show any dependence on the QFC lead shutter position.

Note that removing the QFC lead from the neutral beam means moving the point where Compton photons are scattered 23 cm downstream (where they are scattered by the QFC itself) , and this has no visible effect on the Cherenkov detector. Removing the QFC itself from the beam would move this point just about 19 cm further downstream (to Q7 quad) .

3 Radiative Bhabha Counter

RBC with its tungsten pre-radiator was in the SFF except for the period from June 13 to June 26, when it was removed from the tunnel for repair. The table below compares A_8/A_7 measured during this period with the measurements during adjacent periods of time.

A_8/A_7 with RBC “OUT”	0.998 ± 0.016
A_8/A_7 with RBC “IN”	0.993 ± 0.011
relative change in A_7 due to low-asymmetry contamination, between measurements with RBC “OUT” and RBC “IN”	(0.04 ± 0.16) %
relative change in A_7 due to low-asymmetry contamination, between measurement with RBC “IN” and theoretical value	(0.02 ± 0.09) %

4 Polarized Gamma Counter

The table below compares A_8/A_7 measured with various thicknesses of PGC pre-radiator in the neutral beam (single beam operation) to the measurement with no PGC lead in the beam (beams in collision).

PGC lead thickness	A_8/A_7	relative change in A_7 due to low-asymmetry contamination, between this measurement and measurement with lead “OUT”	relative change in A_7 due to low-asymmetry contamination, between this measurement and theoretical value
0	0.998 ± 0.024	0	(0.01 ± 0.20)
1 inch	0.957 ± 0.032	(0.33 ± 0.32)	(0.34 ± 0.26)
1.5 inch	0.955 ± 0.033	(0.35 ± 0.33)	(0.36 ± 0.27)
2 inch	0.955 ± 0.033	(0.35 ± 0.33)	(0.36 ± 0.27)

Inserting 1 inch PGC pre-radiator in the neutral beam when the beams were colliding increased the background by factor of 3.2 in channel 4 , and by factor of 1.5 in channel 7.

5 References

[1] M. Fero , P.L. Reinertsen , B.A. Schumm , M. Swartz , E. Torrence
”Compton Polarization Measurement : 1995”
SLD-Physics-Note-50, November 1996