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ACCELERATOR DEPARTMENT
Informal Report

4 π DETECTOR FOR CORRELATION EXPERIMENTS

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ABSTRACT

A conceptual design of a 4 π detector for ISA-BELLE involves a counter hodoscope with 302 elements and an array of proportional wire chambers with 8950 wires. Such a detector could be used for correlation experiments and measurements of total cross section, as has been done by the Pisa-Stony Brook group at the ISR.

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MASTER

A relatively simple detector that covers approximately 4π solid angle is a useful source of information on particle correlations. This has been shown by the Pisa - Stony Brook experiment at the ISR. This note shows how a similar detector for ISABELLE might look. It could also be used for measurements of total cross section, as in the Pisa - Stony Brook case.

Among the types of correlation experiments that could be done are the following:

- 1) Two particle correlations in rapidity, y .
- 2) Two particle correlations in azimuth, ϕ .
- 3) Correlation with identified particle in wide angle spectrometer.
- 4) Correlation with identified particle in small angle spectrometer.

This detector records charged particles without identification or momentum measurement. It consists of a scintillation counter hodoscope like that used by Pisa - Stony Brook. This surrounds the crossing region as completely as practical. In addition, a second detector level is planned, consisting of proportional wire chambers with two-dimensional readout, (delay-line or charge-division, whichever proves more practical). The wire chambers will give improved resolution, help discriminate against δ -rays, showers, etc. First results could be obtained with hodoscopes only.

No track segments are generated in this detector. Eventually more complete information will come from impactometer and hadron spectrometer data.

The geometrical arrangement is a simple one, with all components fitted on a vacuum system which is basically a pipe about 50 meters long and large enough to enclose both beam lines. At the ends of this pipe, separate vacuum pipes emerge that are 8 cm in diameter.

At the intersection the vacuum pipe is 30 cm in diameter. A central detector encloses it, extending ± 2.5 meters as shown in Figs. 1 and 2. This is shown as a long box, made up of counter elements 25 cm long. There are thus 4×20 elements in the central detector.

To close off the ends there are three beam-line hodoscopes that are basically ring-shaped. (The Pisa - Stony Brook detector had two.) These are designated, "A", "B", and "C." They cover successively smaller angles, with slight overlap. In each case the smallest radius is about 4 cm from the beam. Detectors "A" and "B" fit into constrictions in the vacuum pipe; detector "C" goes at the end of the large pipe, fitted around the two smaller ones. Figures 3 through 5 show details of hodoscopes "A", "B", and "C".

<u>Detector</u>	<u>Position (m)</u>	<u>Angle</u>	
		<u>Min (mrad)</u>	<u>Max (mrad)</u>
A	2.5 m	20	70
B	6.25 m	12	26
C	17.0 m	2.9	17

In most cases the radial extent of the hodoscope elements is 1.25 cm, so the resolution varies from 0.5 to 0.073 mrad. The highest resolution is at the smallest angle, keeping counting rates conservative for luminosities $\leq 10^{31}$. Operation would not be satisfactory at full luminosity. At a luminosity of 10^{31} the overall event rate of $\sim 4 \times 10^5$ per second is greater than seems reasonable from a data-handling point of view. Accepted events would be much fewer.

The wire chambers for the central region would be about 45 cm by 500 cm, with wires in the short direction. With 5 mm spacing (or with several closer wires grouped) each has 1000 wires. At the beam hodoscope positions, "A", "B", and "C" small wire chambers are used, with dimensions 40 cm by 15 cm. Wires run in the 40 cm direction. With 1 mm spacing each has 150 wires. A group of 6 chambers provides an approximately annular coverage with considerable redundancy. This is shown in Fig. 6 for a typical case. A special thin chamber is required to fit between vacuum pipes at position "C".

The wires are disposed perpendicular to the beam so that the rapidity for a particle (using the usual approximation) is given by the wire firing. Position along the wire is used for azimuthal correlation for which resolution need not be as good. The wire chambers give an improvement in resolution of about a factor of 10.

All the components are quite moderate in size, with transverse dimensions no more than 50 cm, so the arrangement is long (about 35 meters) and thin. The appearance of Fig. 1 is a bit misleading because the lengthwise scale is compressed by a factor of 50. The constriction in the vacuum pipe at detector "A", for example, is really 10 cm in diameter and 50 cm long, so there is a reasonable amount of space for light pipes, wiring, etc. The unenclosed solid angle due to the four beam pipes is:

$$4 \times \pi \times \frac{4^2}{1700^2} = 0.7 \times 10^{-4} \text{ steradian}$$

ROUGH ESTIMATE OF COST:
(in \$1000)

HODOSCOPES:

302 counters, light pipes, phototubes and electronics @ 500	\$151
Vacuum tank	50
Computer, slow data handling	50
Cabling	<u>50</u>
	\$301
Contingency, 20%	<u>60</u>
	\$361

WIRE CHAMBERS:

Central detector - 4000 wires @ 40	\$160
Beam line detectors - 4950 wires	198
Additions to computer	<u>50</u>
	\$408
Contingency, 20%	<u>82</u>
	\$490
OVERALL TOTAL	<u><u>\$851</u></u>

Fig. 1. 4π Detector for Correlation Experiments

Fig. 2
Central Hodoscope
Length along beam - 5 meters

Fig. 3
Beam Hodoscope "A"

Fig. 4
Beam Hodoscope "B"

Fig. 5
Beam Hodoscope "C"

Fig. 6
Wire Chamber Configuration
Position "A"