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MASTER

INTERSECTING STORAGE ACCELERATOR NOTES

Measurement of Multiplicity and Angular Distributions
in Multiparticle Production at ISABELLE

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Introduction

At the center of mass energies which will be available at ISABELLE it can be expected that the inelastic cross section will continue to be the dominant part of the total cross section. The first step of an experimental program for investigating these multiparticle final states would be to build a " 4π " solid angle detector around an ISABELLE intersecting region and measure charge particle and π^0 multiplicity and angular distributions as a function of colliding beam energy. At a later stage this 4π detector could be coupled to a spectrometer system designed to look at inclusive processes such as

$$pp \rightarrow X + \text{anything}.$$

Such a spectrometer could then be used to provide the trigger for the 4π detector allowing one to investigate "anything" as a function of particle X, its momentum and emission angle. The final and more complicated stage would be the construction of a 4π detector with a magnetic field in the intersecting region which could then determine the charge of the secondaries and momentum analyze them.

This report will be mainly concerned with identifying the design features of ISABELLE which will be needed to carry out the first step of the above experimental program.

Experimental Equipment and Layout

The 4π detector will consist of a large solid angle detector (from now on referred to as LAD), two small angle detectors (SAD) and two neutron detectors (see Figure a). The LAD will surround the 24" long interaction region with at least 16 gaps of nested cylindrical spark chambers and 16 gaps of flat chambers at each end (see Figure b). Twenty-five meters downstream of the interaction region, the beam pipe will be made to have a reentrant section which will neck down as close to the proton beam as possible. A SAD (Figure c) will be placed in these regions to pick up particles resulting from the decay of high momentum forward going fragments. Lead will be placed between some gaps of both LAD and SAD for π^0 detection. Triggering will result from the detection of charged particles in either LAD or SAD or a neutron event in the neutron detector. Since many elastic events will be detected by this apparatus, multiparticle cross sections could be normalized relative to the elastic cross section.

Experimental Requirements of ISABELLE

1. Variable beam momentum ranging from present ISR momentum to the maximum value possible.
2. Clashing beams intersecting at maximum angle. This is to keep the size of the interaction region short and consequently allows one to use reasonably sized detectors which will still surround the interaction region.
3. $\beta_x, \beta_y \sim 50$ meters to reduce angular spread in the proton beams.

Small angular spread in the proton beams means good angular resolution in the center of mass system of the forward going fragments which in general have high lab momenta. Increasing β results in longer intersecting regions, less luminosity and counting rate. However, the cross section for inelastic processes is quite

high and we have luminosity to throw away. Using $\beta \sim 50$ meters gives about $\pm 7^\circ$ angular resolution in the isobar center of mass system ($\Delta(1238) \rightarrow p\pi$ case).

This choice of β results in a 24" long interaction region and a beam size of $r_x \times r_y = 6.3 \text{ mm} \times 3.0 \text{ mm}$. See Table below.

$\beta_x(\text{m})$	$\beta_y(\text{m})$	$\theta_{\text{max}}(\mu\text{rad})$	Length of intersecting region (cm)	Counting rate per second for 10 amp currents	$\Delta \rightarrow p\pi$ Angular Resolution in isobar CMS (degrees)
3.3	2.8	492	16	1300×10^3	± 25
10	10	283	28	730×10^3	± 15
50	50	126	63	320×10^3	± 7
100	100	89	89	230×10^3	± 5
500	500	40	200	100×10^3	± 2.5
1000	1000	28	283	72×10^3	± 2.0

4. 50 Meters of Straight Section available to experimenters and space about 75 meters behind beam dipoles for the neutron detectors.

5. Negligible Beam Tails. It is important for the small angle detectors to approach as close to the beam as possible. If we look at the center of mass system of the forward going fragment then the size of the forward cone subtended by the inside radius of the small angle detector is given in the Table below.

Small Angle Detector inside radius (mm)	Forward Cone in Isobar CMS not seen by small angle detector (degree)	p_1 (MeV/c) for 216 GeV/c beam
10	$\pm 21^\circ$	86
20	± 41	173
30	± 62	259

For good detection efficiency this "miss" cone has to be minimized and the SAD has to approach as close as possible to the beam which at the SAD has dimensions $r_x \times r_y = 8.9 \times 5.5$ mm. To keep background at reasonable levels beam tails will have to be made very small.

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a) 4 π Detector at ISABELLE not to scale, top or side view

b) Large Angle Detector (cross sectional view)

c) Small Angle Detector (cross sectional view)