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THE IMPACT OF THE e-p OPTION ON ISABELLE EXPERIMENTAL AREAS

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I. INTRODUCTION

There have been many suggestions for the expansion of existing or planned storage rings to include high energy e-p collisions. We will not discuss the physics potential here, but there is a general concensus that a facility with protons colliding with electrons and positrons of selectible helicity would provide great insight into weak interactions, nucleon structure, etc., in a way not duplicated at e^+e^-, pp, nor $\bar{p}p$ machines. In this report we will comment on some aspects of the addition of a 10-20 GeV electron ring to Isabelle.

II. ASSUMPTIONS

As a model for the electron ring we have used a machine radius of 360 m and have added straight sections of ± 125 m about the e-p interaction point for the beam gymnastics needed to rotate the electron polarization from the natural transverse orientation to the desired longitudinal direction.

We have assumed that Isabelle is primarily a p-p collider whose prolific physics output will deter long shutdowns. In considering possible ep collision points we have avoided the existing large facility hall at 8 o'clock, since that will clearly contain a relatively permanent setup, and the wide angle hall at six o'clock, since in that area the experiments would be severely limited by the need to dump the Isabelle proton beams.

I. LOCATION OF THE ELECTRON RING

There are at least three possible locations for the electron ring:

A. Located in the same tunnel as the pp rings, providing the possibility of ep collisions at any interaction region.

B. Located in a separate tunnel outside the main tunnel, providing ep collisions at one interaction region only. The two possible locations are the 2 and 4 o'clock areas as shown in Fig. 1.

C. Located in a separate tunnel tangent to the main ring, at two straight sections. The arcs joining the two straight sections can be either within or outside the region enclosed by the ISABELLE tunnel.* The interaction regions are at 4 o'clock and 10 o'clock as shown in Fig. 2.

Each of these has advantages and disadvantages. We just mention ose that affect the ISABELLE experimental areas design:

1. Option A allows up to 6 ep interaction regions and areas, option B just one and option C up to two.
2. Option A constrains the design of ep interaction region severely, in particular the straight sections with the polarization rotators must be accommodated within the straight section of the ISABELLE tunnel. Options B and C with the outside arcs do not have this constraint.
3. Option A has an extra beam pipe, containing the stored electron beam, passing through pp interaction regions. This is at least a nuisance for the pp detectors. We know of one solution where the electron beam passes through each pp interaction diamond. Its beam can be within the confines of the pp vacuum pipe at least over the length of a central detector. Figure 3 gives a three dimension impression of this arrangement.

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*In order to reduce the interference with the pp rings, the ring totally inside has a radius of 300 m with 200 m straight section. The outside version has a radius of $\approx$ 600 m with 300 m straight sections.

4. Option A would have the most interference between the electron ring and the proton rings during installation and operations. Option C has less interference, and option B has the least.
5. Option C underlines the desirability of moving the second major facility hall, now planned for 10 o'clock, to 12 o'clock in order to leave 10 o'clock available for ep physics.

IV. THE ep INTERSECTION

It has been recently proposed (BNL Proposal: Electron-proton Interaction Experiment by Y. Cho et al., May 1981) that the electron beam cross over in vertical plane (see Figure 4). Near the ep interaction point, a zero-degree crossing angle is established by means of vertical bending magnets. Strong quadrupoles produce the low β necessary for high luminosity. Further away from the intersection point, a spin rotator is present at each side. They rotate the electrons spin from transverse as it leaves the arc, to longitudinal at the intersection and back to transverse upon entering the next arc. The total length is about 250 meters or 125 meters on each side of the interaction region. The position of the magnets is totally antisymmetric with respect to the intersection region. This means that the electron beam is below the proton beams upon entering the straight section and above it upon leaving it (or above it upon entering and below it upon leaving). The maximum excursions are 1 meter in the vertical and 0.5 m in the horizontal plane while in the arcs the electron beam is at least 0.5 m above or below the proton beams. These are only estimates since the final design of the spin rotators is not yet available. The final design should be taken into account in determining the elevation of the proton rings in order to avoid later excavation.

V. EXPERIMENTAL HALLS FOR e-p COLLISIONS

In order to estimate the size of the hall we have examined earlier proposals for ep experiments, in particular the most recently proposed ep detector (Fermi Lab Proposal 659). In all cases the apparatus would fit comfortably in the Isabelle straight sections and the length of any

existing hall is adequate though if the small angle hall is used, the larger section should be in the direction of the protons. The typical radius of the apparatus is 3-4 m so a deeper floor would be required (maybe 5 m below the beam) than exists in the areas at 2 and 4 o'clock. The ep detectors are no different in this than the pp central detectors. The polarization rotators are located within the ISABELLE tunnel. It should be noted that these considerations are independent of actual location of the electron ring: that is, independent of which option of Section III is chosen. With this in mind we suggest very strongly that any machine plumbing and electrical connections be kept well away from the beam region -- for example, the existing trenches in the open area must not be used for permanent connections.

VI. SUMMARY

The ep option should be kept in mind at all phases in the construction of ISABELLE. The following points are immediately obvious:

1. The second open area should be moved from 12 o'clock to 10 o'clock.
2. The location of the proton beam should be compatible with the spin rotators.
3. For the ep detector, the floor should be $\gtrsim$ 5 m below the beam.
4. Permanent plumbing and cabling should not be close to the intersection points.

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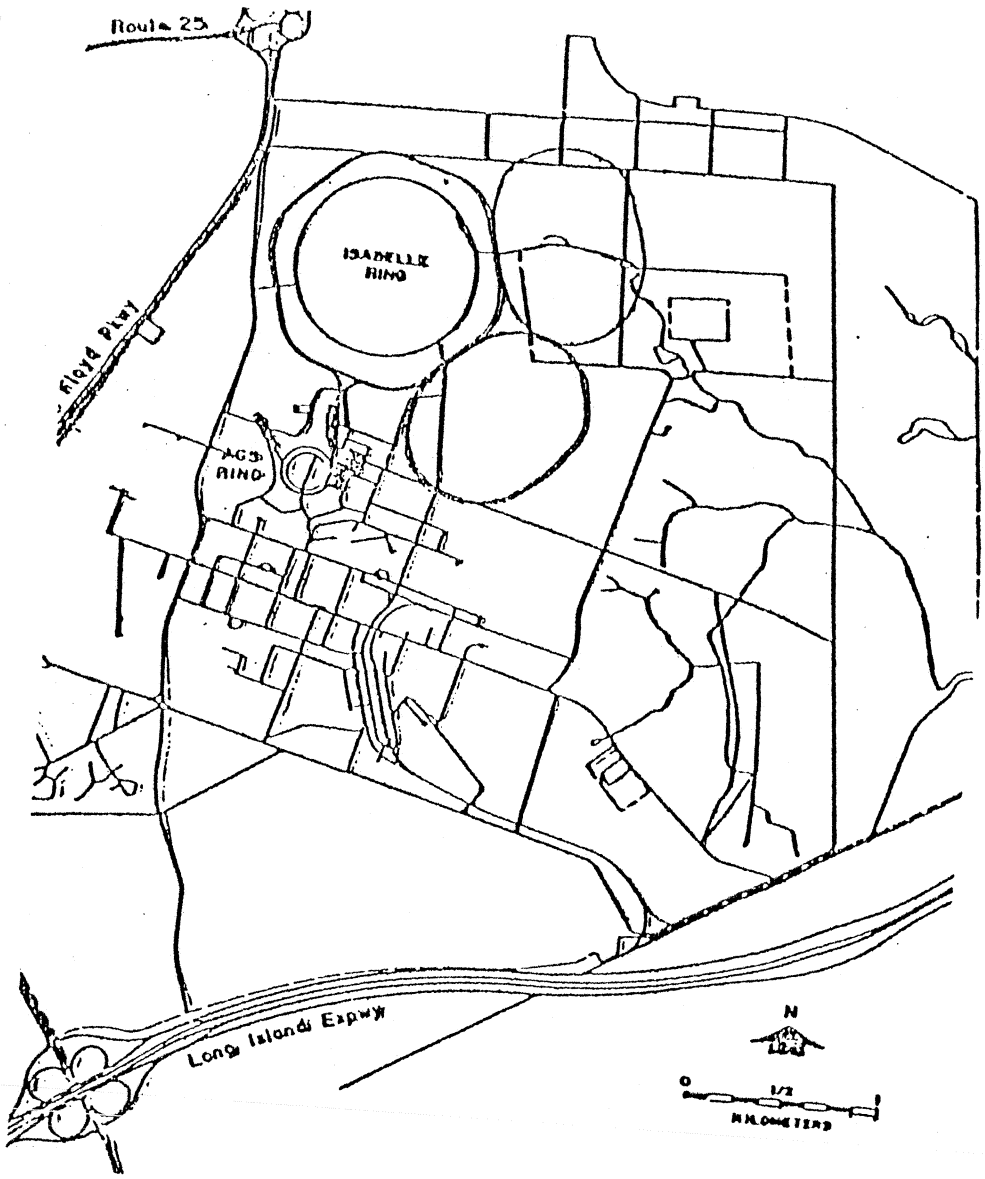


Figure 1: Possible Arrangements for Option B

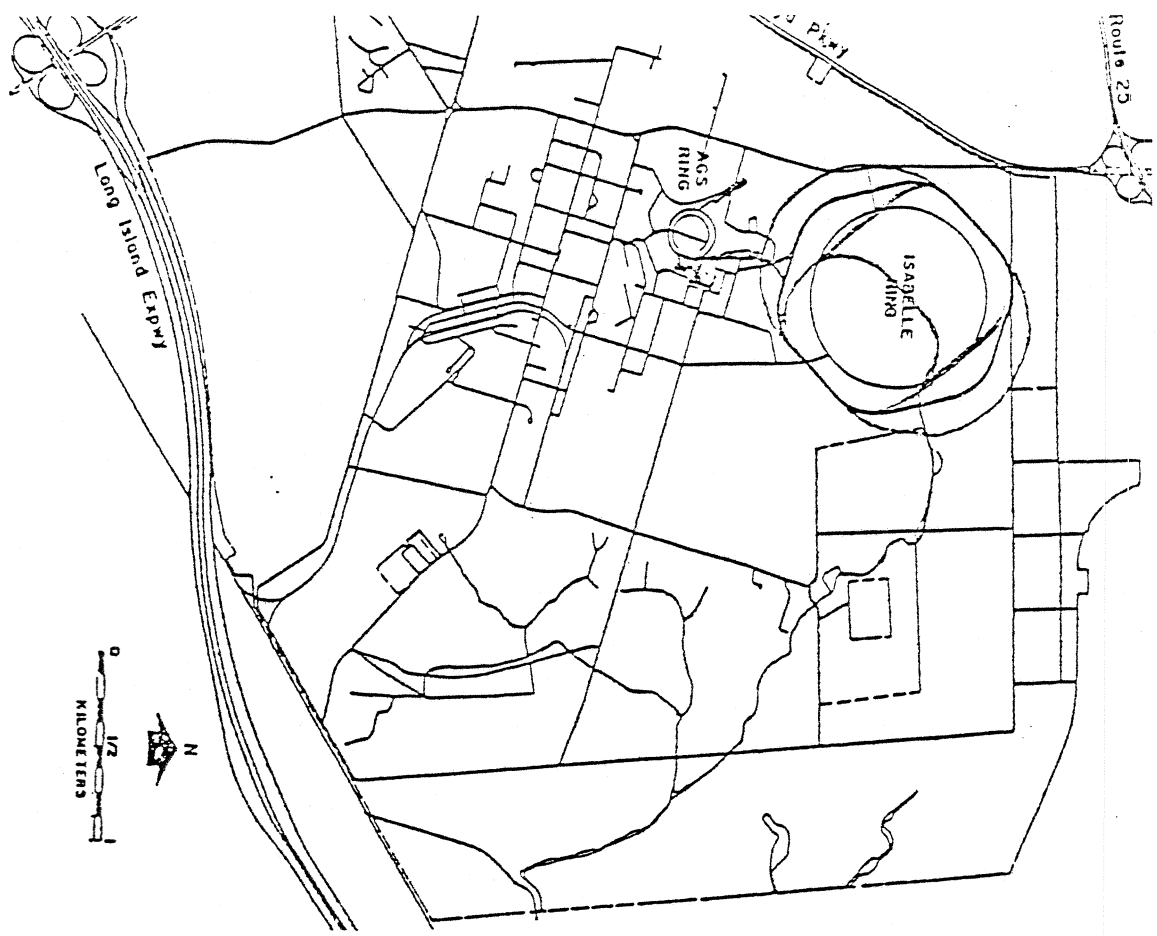


Figure 2: Possible Arrangements for Option C

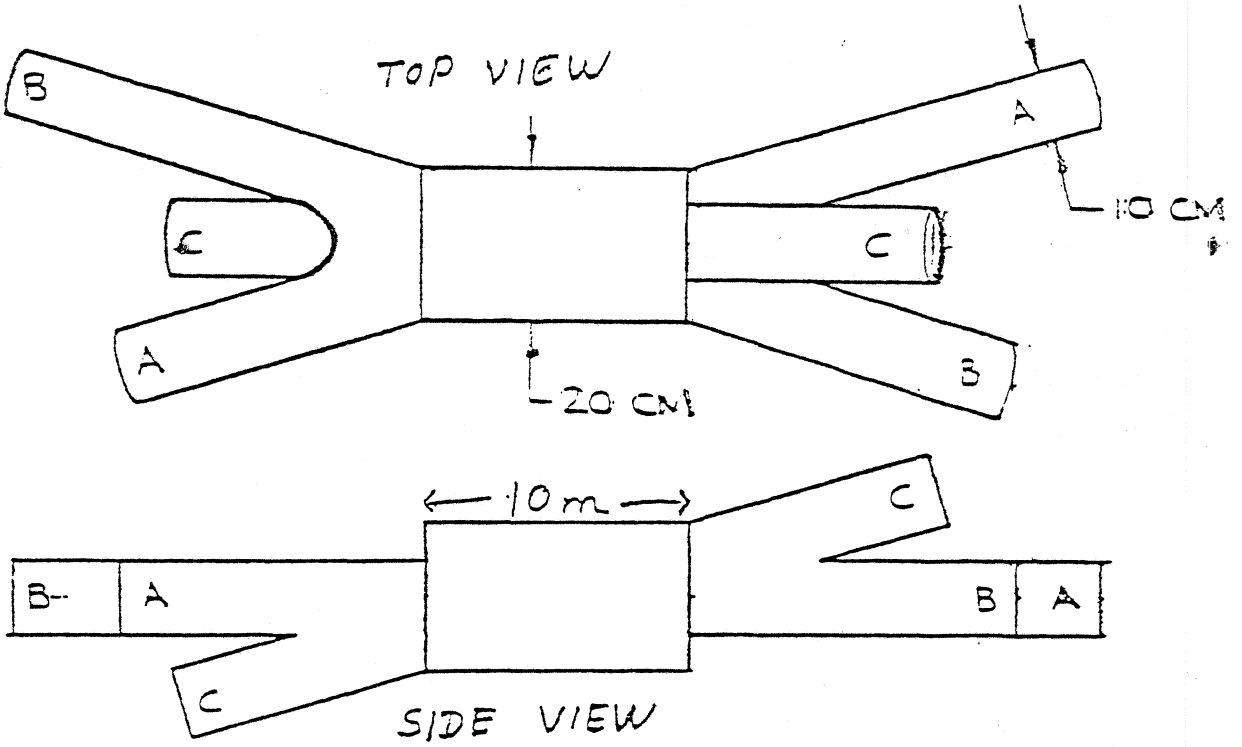
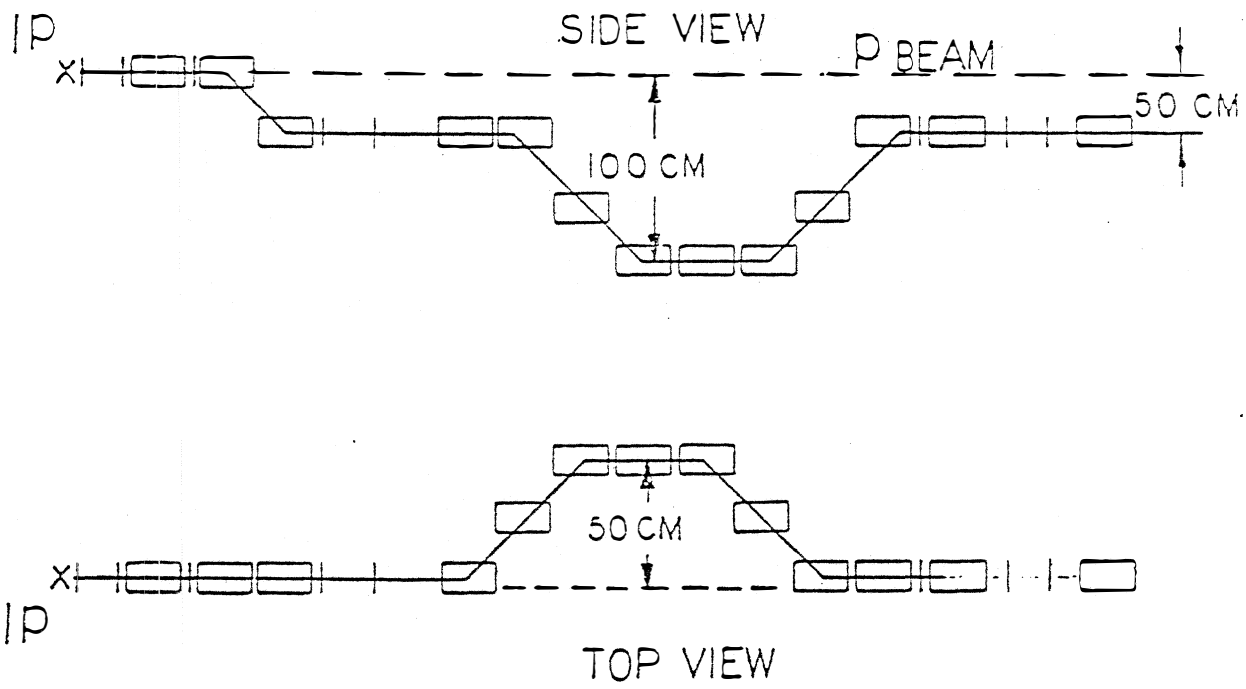


Figure 3: A Possible Beam-Pipe Configuration



OTHER SIDE ANTISYMMETRIC

Figure 4: The Electron Spin Rotator

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