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"Ideas for an SSC Open Geometry Forward Collider Detector to Measure CP-Violation in B-Decay"

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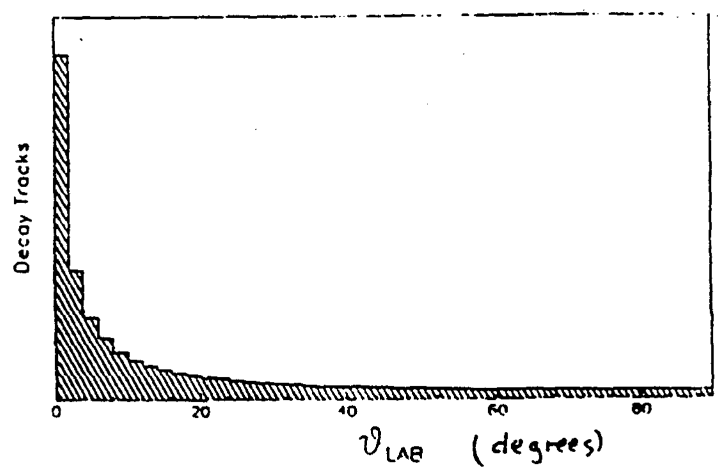
Dear Roy,

A collaboration, for which I am spokesman, recently submitted a proposal to the SPS-Committee for a new collider detector, dedicated to the study of Beauty physics (P238 and P238-Addendum appended). Since this proposal embodies a new approach to the study of B physics at hadron colliders, and by now has more than 6 physicist-years of trigger and detector Monte-Carlo simulation work behind it, I believe it has important implications for the SSC. I am writing to bring to your attention the essential arguments we have developed and to draw preliminary conclusions of the implications for B physics studies at SSC.

The first point is that the production of B-Mesons from gluon-gluon fusion is markedly polar in laboratory production angle at high energies. For example, the following figure (from ISAJET) shows the angular distribution of B-Meson decay products at the SSC.



This peaking argues for forward detectors (on both arms). For the apparatus proposed in P238, which is an extension of devices pioneered at the ISR, apertures of ±600 mrad around the beam pipes lead to about 60% of all $B\bar{B}$ events at the SSC having all the decay products of at least one of the B's fully contained in the detector aperture.

In a forward SSC spectrometer with aperture 2-600 mrad, the average momentum of the accepted B-mesons, $\langle P_B \rangle$ = 270 GeV/c, while central B's accepted in a rapidity range of, for example, −2 to +2 have $\langle P_B \rangle$ = 7 GeV/c. There are many clear experimental advantages of working with higher momentum samples of B-mesons in a forward planar detector, such as in particle identification with RICH counters, measurements of B proper decay time, reconstruction of exclusive final states with photons, etc.

The second essential point is that reconstruction of exclusive final states in B-decay with minimal background is made possible with the use of a somewhat unorthodox silicon micro-vertex detector, whose planar elements are perpendicular to the beam and installed inside the vacuum pipe (actually inside a secondary vacuum, to provide RF shielding and avoid contaminating the main machine vacuum). The detector planes are spaced every 4 cm throughout the ±30 cm (at the SPS) of the interaction region. The detectors, which are normally 2 mm from the beam, would be retracted about 10 cm from the beam line when the machine is not in 'stable beam' state.

Triggering is another essential point. With extensive and careful Monte-Carlo calculations, we have shown that data acquisition can be efficiently triggered by the results of sophisticated real-time computation of data from the micro-vertex detector. We anticipate being approved by CERN to perform a silicon test run in the SPS-Collider in 1990 in order to be certain that event-unrelated signals from beam halo and other 'noise' will be at a manageable level. The results of these tests, if successful, should be of great import to B physics programs at all future hadron colliders.

Extrapolation of the proposed SPS experiment to the SSC involves several important considerations:

- There is a natural limit to the useable luminosity which is determined by pileup considerations, complicated by the need for real-time pipelined calculations, and also by radiation damage to the silicon detectors due to the beam-beam interaction rate. We are currently studying this question for the SSC, although we think that, for this type of experiment with elaborate silicon systems close to the beams and in which exclusive final states are reconstructed, one probably will not want to run with luminosities larger than 10^{31} $cm^{-2}s^{-1}$.

- Our present two-spectrometer system (with θ_{min} = 10 mrad) and total length of ±11 meters would have to be supplemented by an additional spectrometer in order to extend coverage down to smaller θ_{min}. Our preliminary estimate (using ISAJET) is that the addition of a third spectrometer with aperture from 2 to 10 mrad will result in less than a 10% loss of B-mesons due to lost small angle particles in the beam pipe.

We estimate that, due to a number of reasons (mainly: larger B cross section, σ_B/σ_{total} ratio, available luminosity and forward collimation of B decay products), a factor of at least 500 times larger event samples should be obtainable at the SSC than at the SPS-Collider. This should place such an experiment well over the threshold to perform quality CP-violation studies in B decay.

I anticipate that, by the time of your May 1990 deadline for letters-of-intent, a new collaboration will have formed around the ideas developed by the P238 collaboration and summarized in this letter. Some fraction (to be determined) of our existing SPS collaboration will likely form the nucleus of such a new collaboration. Until then, I would like to request that the SSC laboratory consider an experiment of the type discussed here as one of the possible options for future SSC experiments.

Peter Schlein

Peter E. Schlein
Professor of Physics

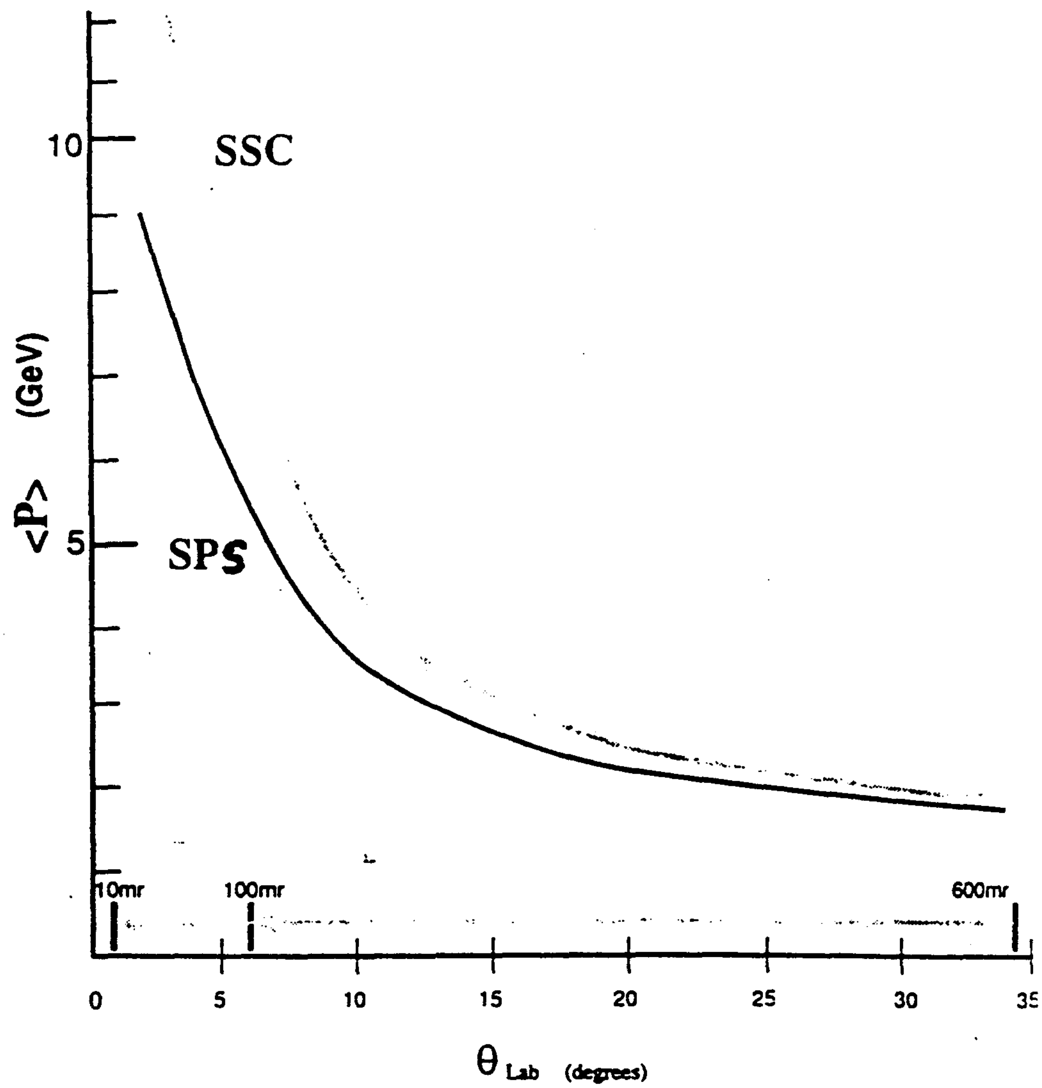


Figure 1: Average B decay track Momentum vs. Laboratory Angle.