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Recent Experience with Backgrounds at the SLC

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Abstract

During the 1990 SLC/Mark II runs, machine backgrounds visible in the new vertex detectors were studied. These detectors had active elements at radii from 3 to 17 cm and were subjected to backgrounds unique to linear colliders. We describe recent progress in identifying sources and developing control techniques.

I. Introduction

During the original Mark II run at the Stanford Linear Collider (SLC) in the summer of 1989, the most significant background was from synchrotron radiation generated while focusing the beams to a collision. Studies at that time[1] found that the source was non-Gaussian tails on the beams, and that the backgrounds could be controlled to some extent using collimation and careful manipulation of the beam optics.

The SLC was shut down in the Fall of 1989 for various upgrades, including improvements to the collimation systems. An additional four set of collimators, a total of 16 jaws, where installed at the end of the linac. The collimators in the Beam Switch Yard (BSY) and Final Focus System (FFS) were repositioned to allow more flexibility in operation.

Also during this time two new vertex detectors were installed in the Mark II.[2] The inner one is the Silicon Strip Vertex Detector[3] (SSVD) which has 18,000 silicon strips at about 3 cm radius. Outside it is the Drift Chamber Vertex Detector[4] (DCVD) which contains 34 layers of sense wires from 5 to 17 cm radius. Together these chambers provide unprecedented tracking accuracy for a collider detector. As part of their installation, the Mark II internal masking's hermeticity was improved by adding more material in every accessible gap and the masks were realigned.

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II. Operation

The SLC made a short engineering run during January 1990, followed by a longer run for physics during the summer of 1990. From the start, synchrotron background in the main Mark II tracking chamber was significantly reduced from the prior years run. Occupancies, which had been typically 15% to 20% during the previous year, were now below 5%. The improvement is attributed to the additional collimators at the end of the linac, which made it possible to do both primary and secondary collimation in a region with zero nominal dispersion. The additional masking material, including the material of the vertex detectors, also contributed.

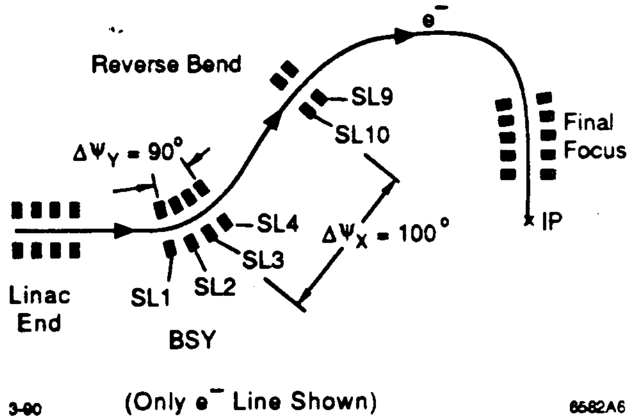

Figure 1 The general layout of SLC collimation. Thirty-two movable collimator jaws are located at the end of the linac, 16 in each side of the Beam Switch Yard and Arcs, and 19 in each side of the Final Focus System.

Unfortunately, backgrounds in the new vertex detectors were larger than expected. Figure 2 shows a typical event. The noticable features are the curved tracks, which are charged particles with transverse momenta up to about 10 MeV/c, and the dark areas which are thought to be curled-up electron tracks from soft photon conversions. This background was strongly biased toward low radius and very rarely extended beyond the DCVD.

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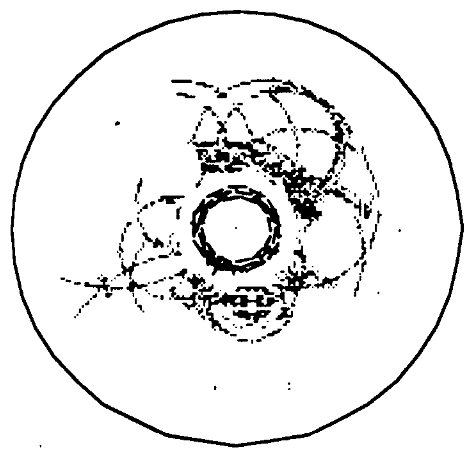

Figure 2 Backgrounds in a typical Mark II event. The outer circle represents the DCVD outer wall at 17 cm radius. The 36 line segments near the center are the individual silicon modules of the SSVD. The DCVD sensitive area is in between. Approximately 15% of the DCVD time bins have been fired. Each hit is drawn twice due to the ambiguous drift direction. The spots outside the circle are hits found in the Mark II main tracking chamber - it's occupancy is negligible.

The SSVD's occupancy was in the range of 2% to 10%, while the DCVD occupancy averaged 15% with some periods much higher. The SSVD has a much finer granularity than the DCVD, which combines with insensitivity to low energy photons to reduce the effect of these backgrounds. The DCVD tracking information could be used up to occupancies of approximately 40%.

The near-photographic information from the DCVD made it possible to study the origin of the background tracks, although no Z (along the beam axis) information was available. It appears that the tracks are coming from energetic showers in the masks near the Mark II. Simulations indicate that of order 1 beam particle hitting masks inside the detector, 50 particles hitting the beampipe inside the final triplet magnets, or 1,000 on the inner 100 microns of the mask at the entrance to the final triplet would reproduce the background density.

The optics and collimation should make it impossible for any of these regions to be hit directly by beam particles, and studies indicate that the source is most likely edge scattering from upstream collimators. Unfortunately, these collimators are needed to remove large beam tails created by various non-linear processes in the linac and transfer lines. It becomes an operational problem to balance the various good and bad effects of collimation.

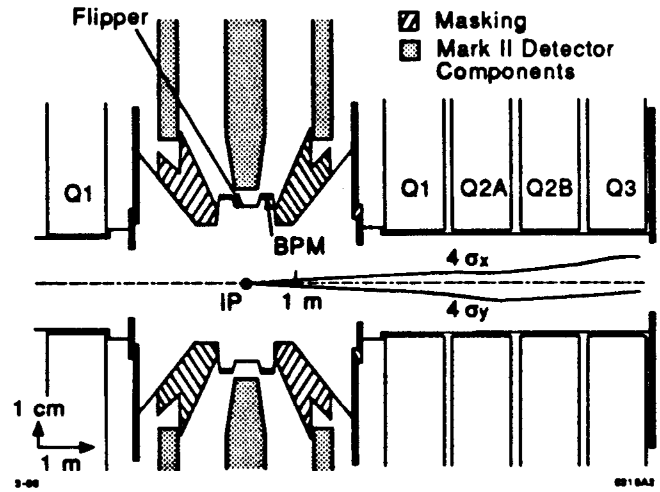

Figure 3 Masking and beam line components near the Mark II detector. Particle trajectories are shown for four times the nominal angle at the IP in both X and Y.

III. Prospects

The Mark II has now been replaced on the SLC beam line by the Stanford Large Detectors (SLD). SLD has newly designed masking, no vertex drift chamber, a main drift chamber with significantly less material and different final triplets. All of these are expected to reduce it's sensitivity to machine backgrounds. Additionally, work proceeds on controlling the SLC emittance and beam profile. An engineering run is planned for this summer to investigate the effects of these changes.

IV. Acknowledgments

We would like to thank the SLC operations and maintenance staff whose tireless attention to the machine made these observations possible.

V. References

[1] R. Jacobsen et al., "Detector Background Conditions at Linear Colliders", *5th International Conference on Instrumentation for Colliding Beam Physics*, Novosibirsk, USSR March 1990, pp. 455-461

[2] G. Abrams et al., "The MARK II Detector for the SLC", Nucl. Instrum. Methods, vol A281 pp. 55-80 1989

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