# Comment on the Impact of Vertex Detectors on Triggering and Data Acquisition in the General Purpose 4π Detector

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In this note we consider the impact that standard vertex detector designs for the generic 4π detector might have on data acquistion and triggering. We take as given the general purpose detector as described in the 1984 Snowmass report and silicon vertex detectors as discussed there and at the workshop on new solid state devices held at Berkeley on Oct. 28, 1985.

We conclude:

1. Assuming zero suppression at the detector, neither the amount or the processing techniques required for the kind of data generated by silicon detectors is a significant perturbation on the data acquisition system.

2. Vertex detector information could be available as soon as 1 microsecond after the level 1 trigger. However, it is probable that track data including momentum information from the central detector will be necessary before impact parameters can be calculated.
3. Not enough work has been done to understand the physics requirements and the pattern recognition algorithms for vertex detectors in the SSC context. In particular, the question of what the size and shape of the detector elements should be came up repeatedly at the Berkeley workshop. A group at Snowmass 86 could usefully pull together and extend the Monte Carlo simulations of CDF, SLD, and others. In addition, data from the Fermilab fixed target program could be analyzed. If leptons within jets can be identified, the impact parameter of the lepton might be a very powerful tag for heavy flavors in the jet.

## Data Acquisition

Ideas[1] were discussed at the Berkeley workshop using CCDs as shift registers that would allow storing the information for 1 microsecond in 30 ns buckets. (Figure 1) This particular design is based on CCD registers, but alternative technologies (FET shift registers) are also possible. Input bandwidth limitations are the most serious problem with the CCD design. Typical designs have 50K to 100K readout channels. Assuming a detector coverage of 4 units in rapidity, a minimum bias event will contribute an average of 24 tracks/event, while a 1 Tev hadronic jet is expected to have an average multiplicity of 30. Assuming zero suppression and 8 bits of pulse height information per hit, the total amount of data per 30 ns bucket, even at $10^{33}$, is unlikely to exceed 1 to 2K bytes. This amount of data could certainly be read out in a few microseconds.

## Triggering and Data Selection

One purpose of the vertex detector is to identify secondary vertices in order to tag heavy flavors and taus. Another is to identify new, unexpected topologies. In this section we raise a number of issues that should be considered in devising strategies with the hope that this work can be continued at Snowmass 86.

1. backgrounds: secondary interactions, strange particle decays, effects due to multiple scattering and noise. Radial location may help eliminate secondary interactions.

2. Unless there is information in the non-bend view, impact parameters can not be calculated without track by track momenta from the central tracking chamber. Assuming a 1 T

field and detector layers at 3, 6, and 9 cm, a 10 Gev track deviates by 1 mm from a straight line between the inner and other layers. On the positive side, the $7\mu$ $\sigma$ interaction point is a very powerful constraint.

3. Momentum information is also needed to eliminate low momentum tracks whose multiple scattering simulates a finite impact parameter.

4. What does physics require? ( We are NOT addressing the question of intrinsic B physics here nor do we want to presume we know exactly what will be the interesting physics at the time the SSC is operational.) How many and what species of short lived particles do we expect in hadronic jets? Is the distribution of short lived particles different in the hadronic decays of W's and Z's? What signatures will the known short-lived particles produce in the proposed detectors and what algorithms can identify them? What kind of sensitivity to new phenomena do the proposed geometries have? Can something be learned from distributions of impact parameters or is it necessary to actually distinguish topologies of secondary vertices? Just finding secondary vertices will not distinguish, except in a few cases, between B's, double charm production, and various

combinations of backgrounds in association with charm production.

Other uses of the vertex detector, such as helping with tracking in the central detector and distinguishing multiple events in one crossing, place considerably different demands on the vertex detector than does secondary vertex detection.

## References

1. Proceedings of the Workshop on New Solid State Detectors in High Energy Physics, Berkeley, October 28 - 30, 1985, in preparation.

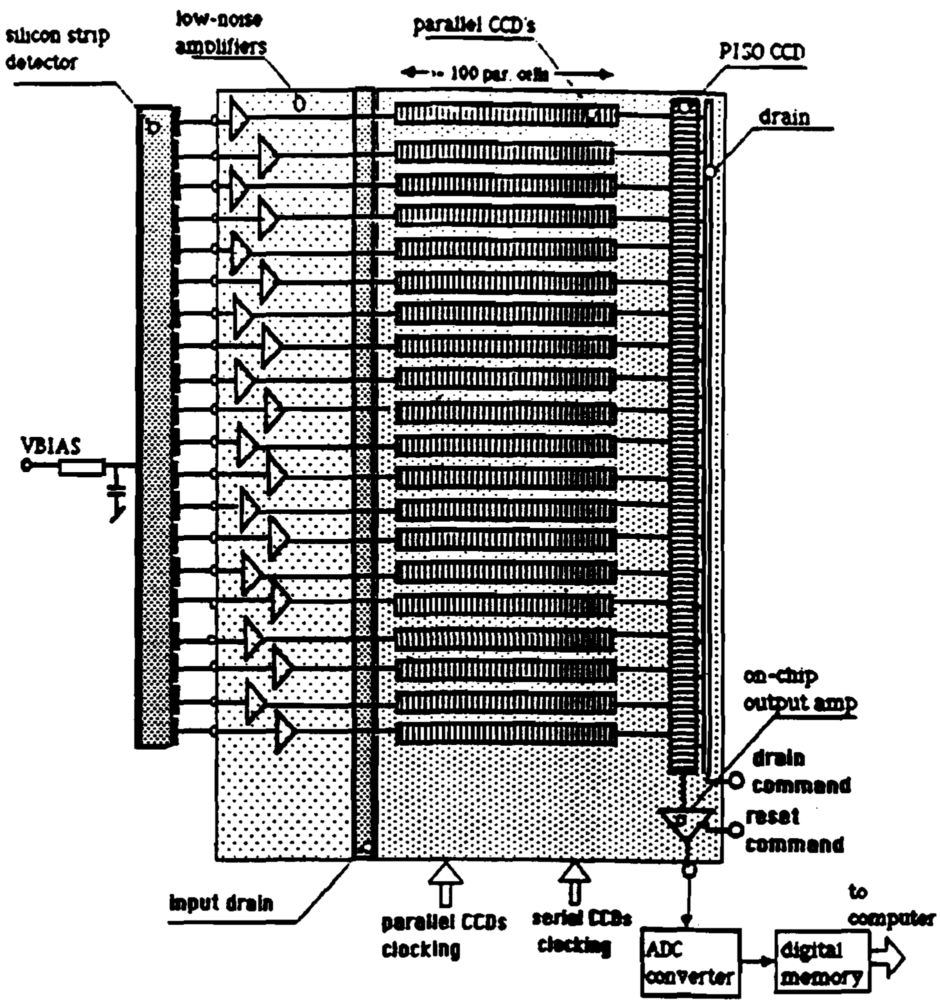


Figure 1: Conceptual design for integrated amplifer/CCD sampling strip detector readout. (CERN/Phillips)