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Physics issues on triggering

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Abstract. The detectors at the ILC are planned to run without hardware trigger. The physics constraints for a pure software trigger are discussed.

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1. Introduction

The detector at the international linear collider (ILC) should be able to run 'triggerless' which means that all events can be read out and then be analysed with the offline reconstruction program in a trigger farm. The event rates for 'high Q^2' events like W-pairs or $q\bar{q}$ are low, about 0.1/train. However, there is a significant rate of 40/train for Bhabha scattering at low angles, 15/train for $\gamma\gamma \to \ell^+\ell^-$ and 200/train for $\gamma\gamma \to q\bar{q}$.

All events are potentially interesting. For example, $\gamma\gamma$ processes and supersymmetry with a small mass difference [1] are difficult to distinguish. The vertex detector and a TPC integrate over about 100 bunch crossings. A naive trigger would thus keep all data, if the $\gamma\gamma$ events are kept.

According to the TESLA TDR [2] the data flow in this case is about 1 GB/s which would result in 10 PB/y which is ten times the LHC rate and probably too much.

2. Possibilities to reduce the data size

For an LDC-like detector the data rate is about 50% by the TPC, 40% by the ECAL, 5% by the vertex detector and 5% by the other detectors [2] where most of the data volume in all detectors is from background hits. For Bhabha events the data reduction is easy since all data apart from the forward calorimeters can be deleted. For the ECAL and most detectors from the 'rest' a time stamping to one bunch is possible. This allows for a reduction in the data rate by a factor ten. Further reduction would require the selection of 'interesting regions'. Showers from

background photons in the ECAL may also be eliminated by their non-pointing nature. For a TPC the tracks drift through the whole detector and are reconstructed as not coming from the interaction point and not matching to the silicon detectors if wrong bunch crossing is assumed. In addition the background tracks are mostly electrons so that additional $\mathrm{d}E/\mathrm{d}x$ cuts can help, making also here a factor 10 or more possible.

For the vertex detector a completely unbiased way to reduce the data size is probably difficult. Some reduction may be possible by a cut on the cluster shape. Once the pattern recognition algorithm is understood a large reduction can be achieved by deleting unused hits especially in the innermost layer.

In total, an unbiased reduction of a factor 10 seems feasible bringing the data rate to the LHC level. Further reduction requires to cut into the $\gamma\gamma$ events which may also be an option at a later stage.

3. Conclusions

It should be possible to keep all physics events at the ILC with a data flow comparable to LHC experiments. If this is the aim the 'software trigger' can not only select interesting events as a conventional trigger but it also has to delete part of the raw data based on the reconstructed information. This requires a complete reconstruction of the data at least in the TPC and the vertex detector. The computing power of the trigger farm may thus become a limiting factor.

References

[1] Z Zhang, *These proceedings*

[2] G Alexander *et al*, *TESLA: The superconducting electron positron linear collider with an integrated X-ray laser laboratory.* Technical design report. Part IV: A detector for TESLA, DESY-01-011D