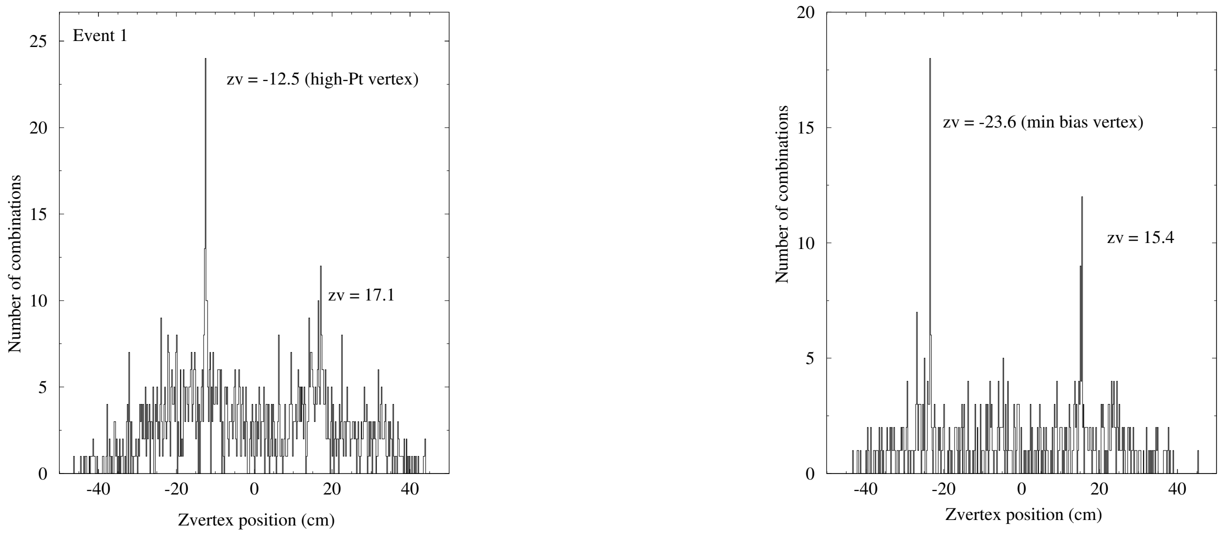

Figure 1: Reconstructed z-vertex distribution for two different $Z \to b\bar{b}$ events with 2 additional min-bias interactions overlayed. The arrows represent the location of the "true" vertex positions. The reconstructed positions (zv) are also displayed.

1 z-vertex Finder

We explore the feasibility of determining the z position of the primary event vertex in the Level 2 trigger system using the hits in the 90° stereo view of silicon ladders in layers 1 and 3 of the inner four barrel segments of the Silicon Vertex Detector. Using these detector elements we can measure the z vertex position in the range $-30 \leq z \leq 30$ cm with a resolution of 525 μm.

The distributions of reconstructed vertices for two different events with $Z \to b\bar{b}$+2 min-bias interactions are shown in Fig. 1. The true positions of the vertices that lie within $\pm$ 40 cm is indicated by arrows on the two figures. For the first event, we reconstruct two out of these three. The third vertex is at 45 cm, beyond the acceptance region of the detector. In this event the high-p_T vertex is correctly identified at -12.5 cm. In the second event shown in fig. 1, again we reconstruct only 2 vertices, (the third being out of range at -76 cm). The two vertices are reconstructed at -23.6 cm and 15.4 cm. We note that in this event the high-p_T vertex is at 15.5 cm, while our algorithm identified the vertex at -23.6 cm as the high-p_T vertex. We also note that there is room to improve the peakfinding algorithm. For example, if one were to account for the track multiplicity in the two neighbouring bins in the peak finder then the correct highp_T vertex could have been found in the second event.

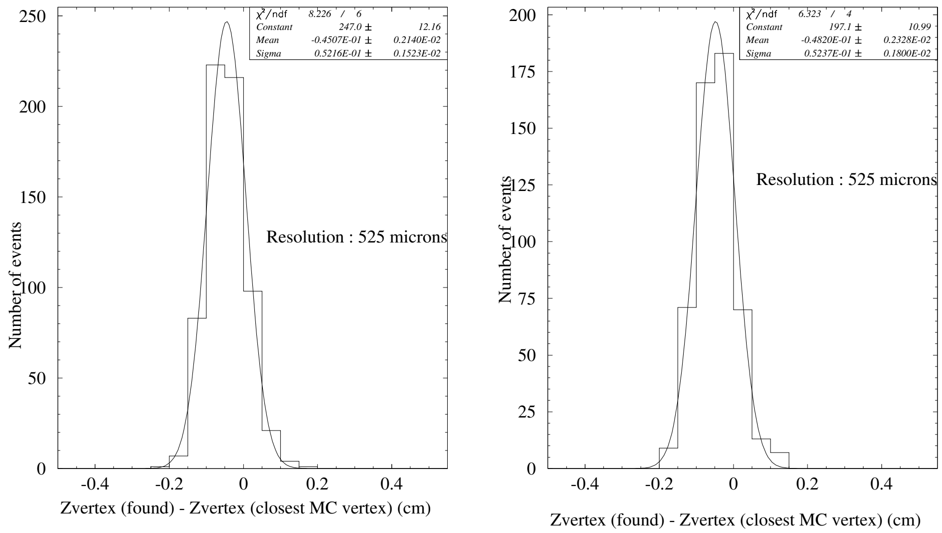

Figure 2: Reconstructed z-vertex resolution for $Z \to b\bar{b}$ events (left) and with 2 overlayed min-bias events (right).

1.1 Vertex Resolution

The resolution of the z-vertex measurement using the above algorithm is found to be 550 μm for events with one high-p_T interaction. For events with 2 additional min-bias events overlayed, the vertex resolution is determined to be 610 μm. In fig. 2, we plot the resolution for both MC samples. From these figures we can conclude that the vertex resolution does not significantly degrade with additional interactions in the event.

1.2 Efficiency for finding the High p_T Vertex

Due to the limited acceptance of the silicon detector elements with 90° strips, (only four inner barrels out of six), the reconstruction of z-vertices with this method is limited to ± 30 cm around the center of the detector. The rms width of the luminous region during Run II is expected to be 25 cm. About 30% of the events have the high-p_T vertex outside this region. For these either no vertex is found or a min-bias vertex inside this acceptance region (reconstructed with 97% efficiency) is incorrectly identified as the high-p_T vertex.

We select a sample of $Z \to b\bar{b}$ events in which the event vertex is within $\pm$ 25 cm. In this sample the efficiency for reconstructing a vertex in the $Z \to b\bar{b}$ events is 98% and as there is only one vertex in the event, we always identify the correct vertex as the high-p_T vertex. If we superpose 2 min-bias interactions on these $Z \to b\bar{b}$ events, the efficiency of reconstructing at least one vertex in these events is 99%. The efficiency for identifying the correct vertex as the high-p_T vertex is 78%. In these events there maybe one or more vertices within the acceptance region and we find that the efficiency to reconstruct a vertex in this environment is about 85%.

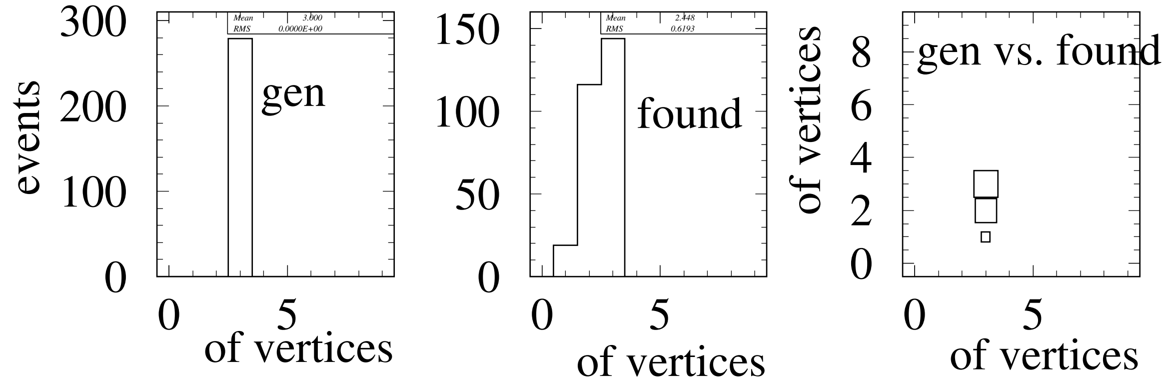

Figure 3: Generated and reconstructed vertex multiplicity for $Z \to b\bar{b}$ events with 2 additional min-bias events overlayed.

The distributions of the number of generated and found vertices with $|z| < 25$ cm which were correctly reconstructed for these events are shown in fig. 3. The last plot of this figure shows the correlation between the number of generated and correctly reconstructed vertices.

The distributions of the generated and found z-vertex positions are shown in fig. 4.

1.3 Benefits from the knowledge of the z-vertex

Currently the Level 3 system for Run II is allocated a 25 ms time budget for reconstructing an event in a L3 node. It is not clear whether there is enough time to unpack the hits from the Silicon Vertex Detector and use them to implement a fast z-vertex finding. If this is not feasible then it would be advantageous to compute the z-vertex at Level 2 in hardware and pass it along to Level 3 for use in further computations of global quantities, e.g. the E_T of jets and electrons.

One of the reasons that the knowledge of z-vertex position is only beneficial to electrons at Level 3 is that the Level2 electron cluster energy resolution is about 25%. There the E_T is dominated by the trigger tower readout resolution. This may be different for jets as the jet clustering at Level2 is equivalent to large trigger tiles for RunI (or maybe an even better scheme) and so one should investigate the improvement for jet E_T turn on curves in Level2 and the improvements from using the event z-vertex. The study for jets is currently in progress[**?**].

1.3.1 Electron E_T thresholds at L3

Knowledge of the z-vertex position at Level 3 is extremely beneficial. During Run I, the Level 2 electron algorithm used the "slow z" position from Level 0 in order to get a better

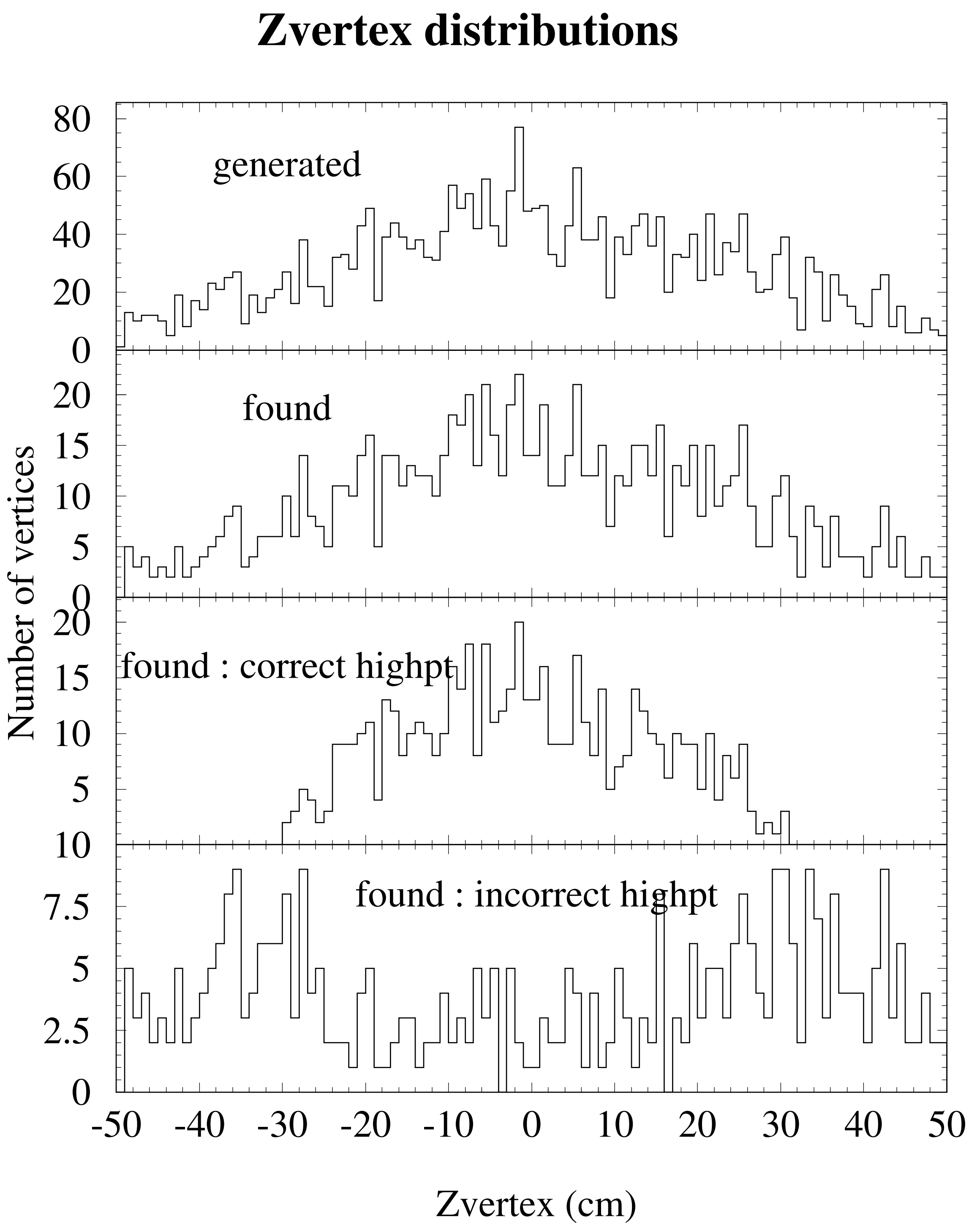

Figure 4: Generated and reconstructed z-vertex resolution for $Z \to b\bar{b}$ events with 2 additional min-bias events overlayed.

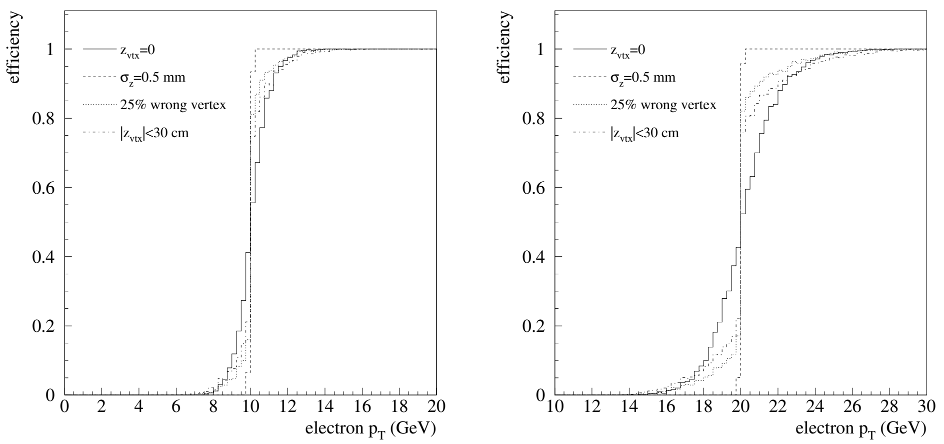

Figure 5: Turn on curves for electrons with $E_T = 10$ GeV (left plot) and 20 GeV (right plot). The solid curve is with z-vertex at zero, the dashed curve is with a reconstructed z-vertex with 100% reconstruction efficiency while the dotted curve takes into account the z-vertex reconstruction efficiencies as described in the text

estimate of the electron E_T.

We have simulated the effect of the resolution, the limited acceptance and efficiency of our z-vertex determination technique in a multiple interaction environment on the electron E_T turn on curves. We carried out this simulation for electrons at two different thresholds 10 and 20 GeV.

We model the turn on curves by generating single electron tracks and smearing them with the calorimeter Energy resolution of $13\%/\sqrt{E_T}$. The turn on curve with z-vertex position taken to be at zero for all events is shown by the solid line in fig. 5. The turn on curve with a z-vertex position measurement with a resolution of 600 μm is shown by the dashed curve. In reality the turn on curve will not be as sharp as this ideal case because of additional interactions and the limited acceptance of the 90° detectors. If the correct vertex is found in 78% of events with 2 additional interactions we get the dotted curve. If in addition the correct vertex is only found if it is at $|z| < 30$ cm we get the dash-dotted curve. The latter represents a realistic estimate of the best achievable turn on curve. There still is a significant improvement in the E_T threshold due to the knowledge of the position of the z-vertex by our algorithm. This improvement implies that we can trigger more efficiently with lower rates on single electrons at Level 3.