Study of the interaction of e+e- pair background with the ILD detector

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Overview

- DDSim simulation of the interaction of e+e- pair background with the ILD_o1_v05 and ILD_l5_v02 detector models as implemented in DD4hep
  - Pair background generated with Guinea-pig, same as used by Alejandro and Eduard
- Focus on the occupancies in the tracker
- LCTuple processor used to store hit and MC particle information into a .root file
  - Facilitates the analysis of the vertices of the MC particles making hits in the tracker elements
- TrackerHitCounter processor (new) to count hits in all tracker layers and calculate the number of SimTrackerHits per unit area per run (1 run = 1 BX in this study)

Hit rates

System	Layer #	N_{hit} (cm^{-2} BX^{-1})
VXD	1	3.0 ± 0.5
	2	1.9 ± 0.4
	3	0.12 ± 0.03
	4	0.10 ± 0.03
	5	0.030 ± 0.011
	6	0.024 ± 0.010
SIT	1	$(4.2 \pm 1.4) \times 10^{-3}$
	2	$(2.7 \pm 1.3) \times 10^{-3}$
	3	$(1.4 \pm 0.6) \times 10^{-3}$
	4	$(1.2 \pm 0.5) \times 10^{-3}$
SET	1	$(2.4 \pm 0.9) \times 10^{-5}$
	2	$(2.6 \pm 1.2) \times 10^{-5}$

The uncertainties represent the standard deviations on a sample of 10 BX

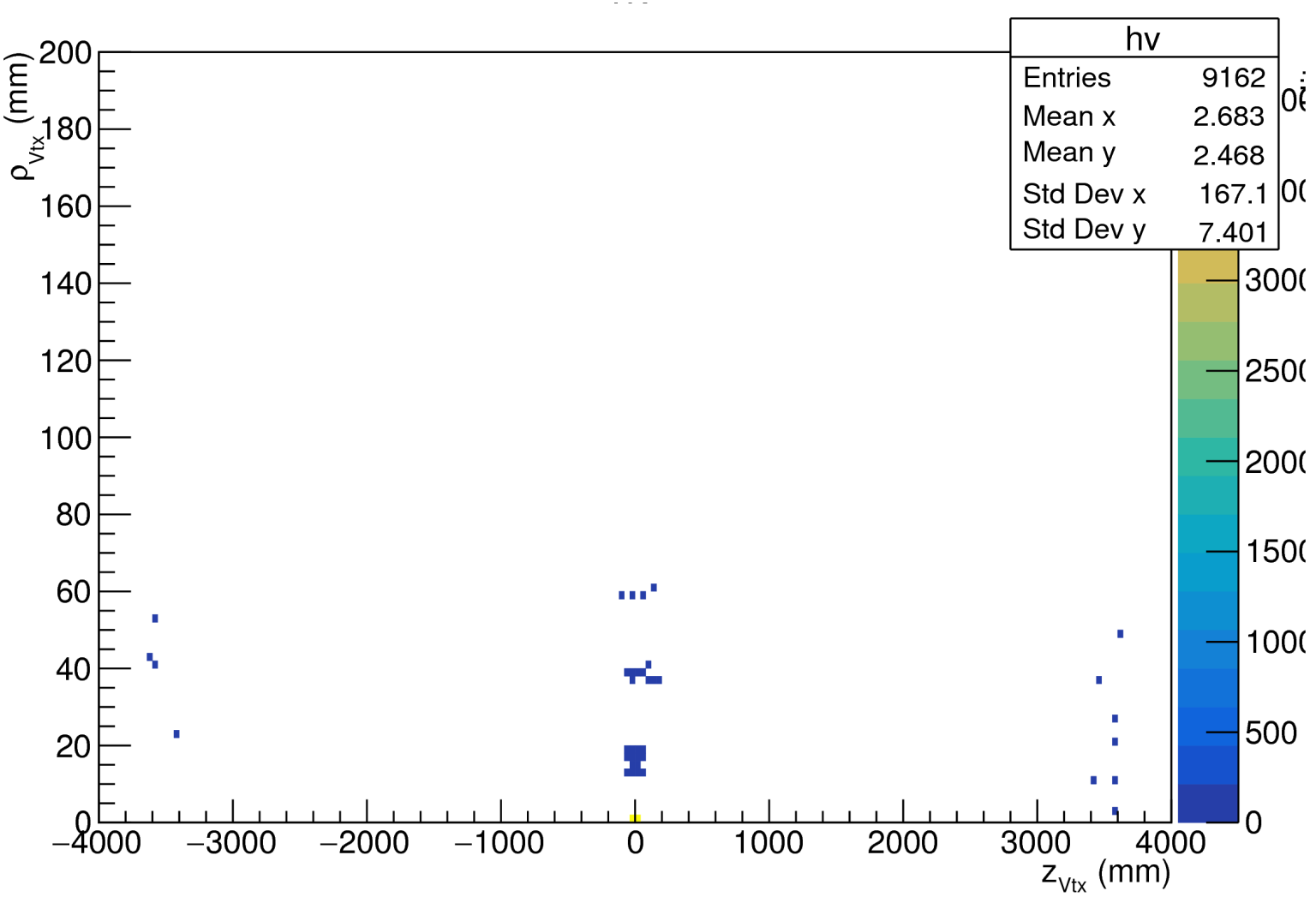
Hit rates (contd.)

System	Layer #	N_{hit} (cm^{-2} BX^{-1})
FTD	1	0.036 ± 0.012
	2	0.020 ± 0.007
	3	0.013 ± 0.004
	4	0.011 ± 0.004
	5	0.006 ± 0.003
	6	0.004 ± 0.002
	7	(3.3 ± 1.7) x 10^{-3}

System		N_{hit} (BX^{-1})
TPC	Total	270 ± 540

The uncertainties represent the standard deviations on a sample of 10 BX

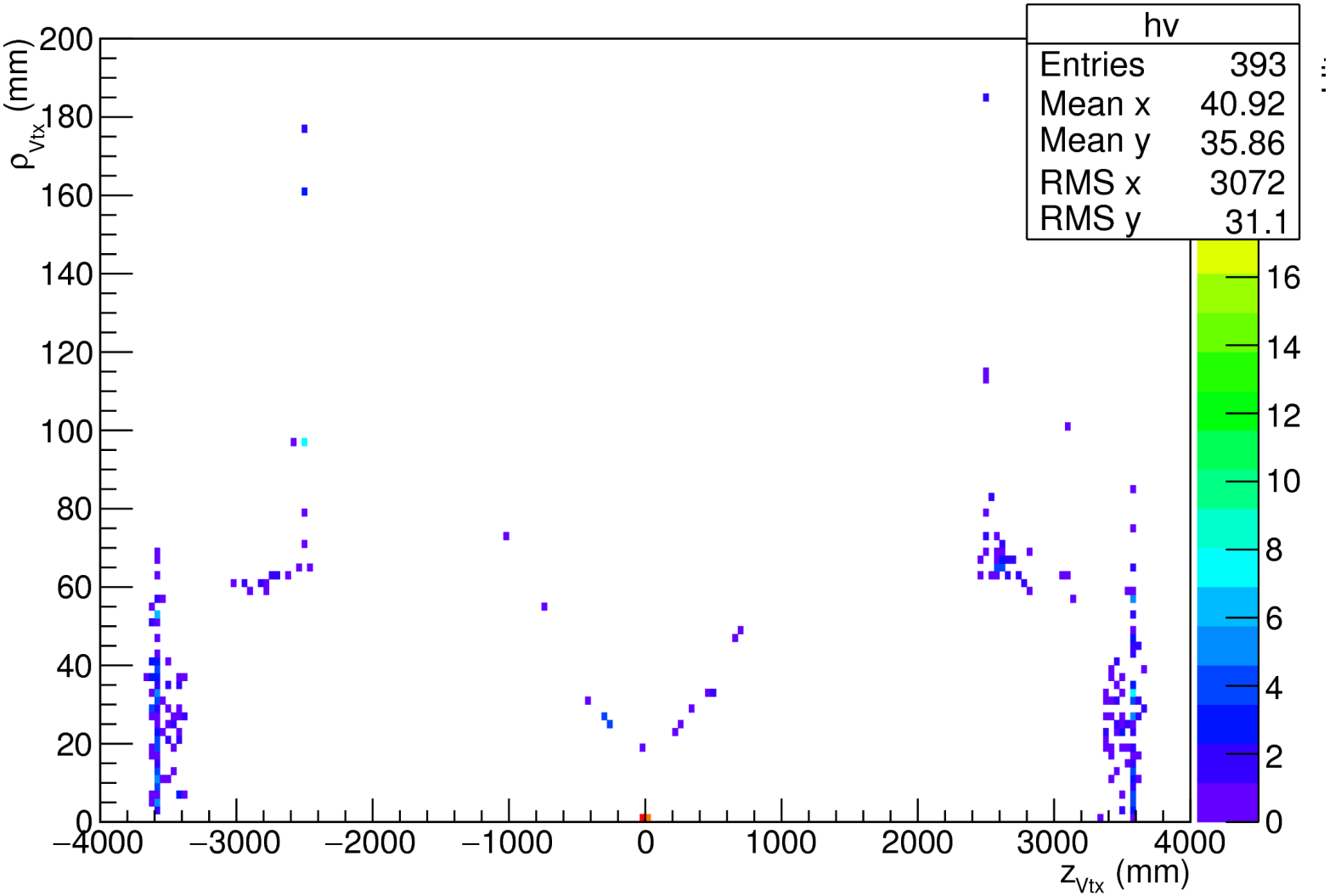
Origin of the hits in VXD (MC vertices)



Only ~4 permille of SimTrackerHits are made by MC particles with abs(z_{vtx}) > 3 m

Origin of the hits in SET (MC vertices)

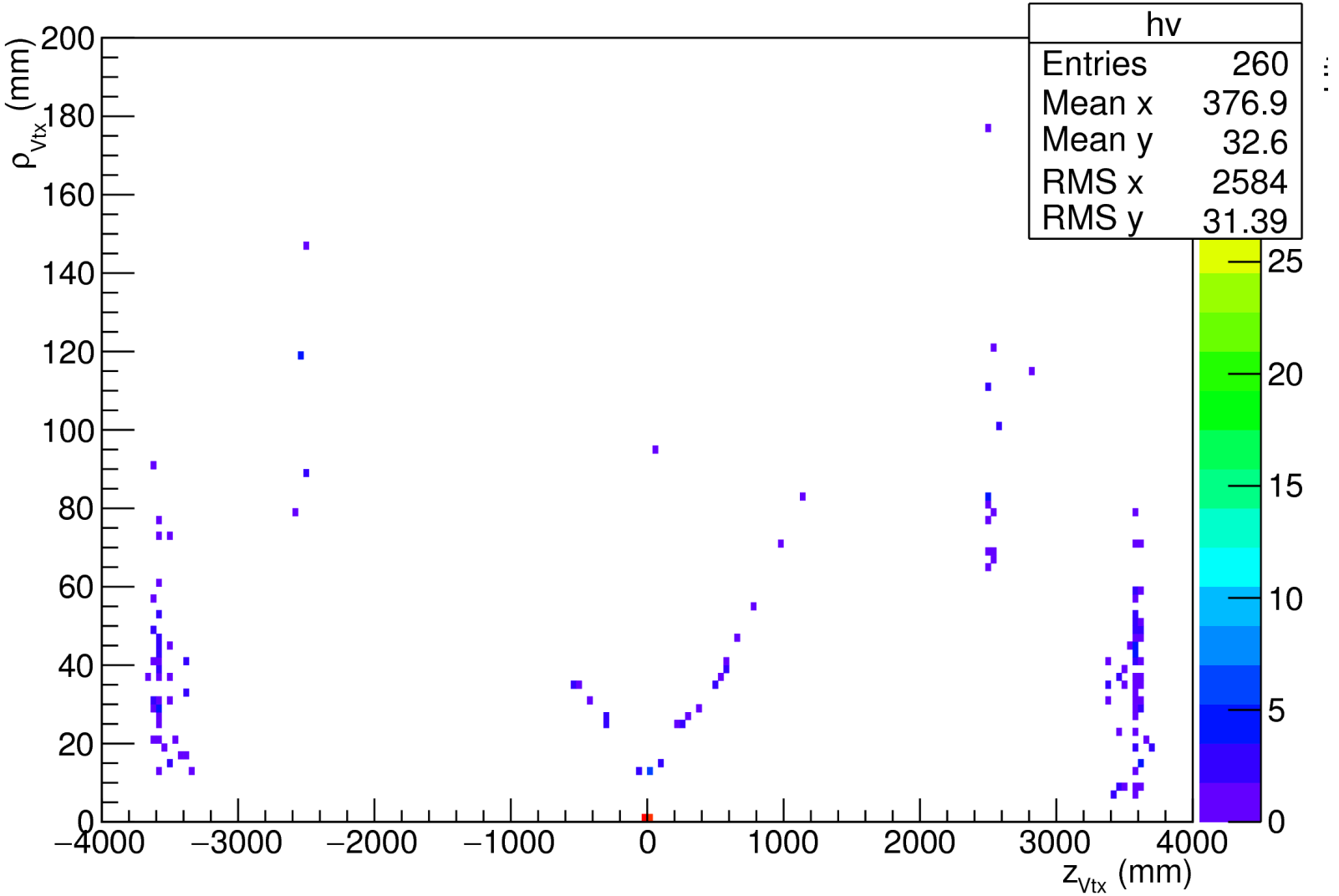
No Anti-DID field



64% of SimTrackerHits made by MC particles with abs(z_{vtx}) > 3 m

Origin of the hits in SET (MC vertices)

Nominal Anti-DID field



47% of SimTrackerHits made by MC particles with abs(z_{vtx}) > 3 m

Observations

- Very few hits in VXD from particles backscattered from BeamCal (a few permille, as opposed to 15-30% reported by Alejandro).
- Hit rate in VXD about ½ of the rate reported by Eduard, or ~¼ of the rate reported by Alejandro.
- AntiDID field reduces the rates in the outer tracker elements (e.g. by a factor 2 in SET), but has no significant effect on VXD.
- Tested a number of hypotheses (some redundant, because of my poor knowledge of the inner workings of ddsim)
  - "DDSim parameters prevent backscattered shower particles in BeamCal from being tracked" - **wrong**
  - "Tracking region must encompass (or reach) BeamCal in order to correctly register backscattered hits." - **correct**, small effect in VXD but large in, e.g., SET
  - "Something broken in iLCSoft v01-19-05 w.r.t. v01-19-02 (approximately the version used by Alejandro)" - **wrong**

Conclusions

- Significant disagreements with previous studies. The reasons are, as yet, unknown.
- The size of the “tracking region” defined in xml determines whether shower backscattering will be taken into account.
- With present results, one may conclude that the Anti-DID field improves the occupancies in the outer elements of the tracker, but not in the VXD