

SDC
SOLENOIDAL DETECTOR NOTES

SI DISK ARRANGEMENT FOR 8 HITS

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1. Introduction.

In SDC-92-293 an arrangement of 13 small Si disks was shown to provide a much smoother distribution of hits vs. eta than is obtained for the TDR layout, which requires both large and small disks. (To maintain the momentum and impact parameter resolution of the TDR configuration in the intermediate region, one must rely on the accuracy at larger radius provided by the gas microstrips.) In SDC-92-303 it was shown that the barrel radii in the TDR should be reduced by about 3% to eliminate cracks in azimuthal coverage of stereo layers.

After the first note, Abe Seiden asked that a layout be produced in which the number of hits, averaged over z vertex position, is flat at eight, i.e. undiminished in the disk region compared to the barrel. One of the motivations for his request was a simulation by Kathy O'Shaughnessy of pattern recognition capability vs. Si layer inefficiency in the TDR layout. Her study indicated that the region where the sensitivity to Si layer inefficiency is greatest is the region ($0.9 < \eta < 1.4$) of transition between the barrel and the disks.

2. Summary.

If the slightly smaller barrel layer radii in SDC-92-303 are adopted, it is possible to arrange the disks to obtain an average of 8 hits independent of rapidity. The fluctuations in this average are less than 0.1 hit. (If the barrel radii in the TDR are used, there is insufficient overlap between disk 1 and barrel layer 8 to achieve an average of 8 hits near $\eta=1$.)

If 13 disks are used, one obtains 8 hits out to $\eta=2.2$, falling to 6 hits at $\eta=2.5$. For each additional disk beyond 13, the eta range for 8 hits is increased by 0.1. When one considers separately the average for tracks emanating from $z < 0$ ($z > 0$), in the $z > 0$ disk region the number of hits increases (decreases) typically by about 0.7, and never by more than 1.

The 13 disk layout presented here is contained within $|z| < 155$ mm, resulting in a Si detector length that is only 60% of that in the TDR configuration.

3. Assumptions.

As in SDC-92-293, barrel layers were approximated as circular cylinders, disks were approximated as plane annuli, and disk inner and outer radii were fixed at 151 and 392 mm. No account was taken of the fact that a single disk is split into two planes of detectors. This has been studied at LASL and is a modest effect (see SDC-92-293). Hits were based on the intersection with these Si layers of straight tracks emanating from the beam axis. The axial coordinate of the vertex was smeared by a gaussian of 50 mm rms.

4. Calculation.

As in SDC-92-293, calculation of average number of hits vs. eta was performed by an Excel program with a granularity such that the uncertainty in average number of hits at any eta is less than 0.05. Calculation and plotting of one

trial configuration required about two minutes of real time. The disk positions were obtained by starting from a configuration (SDC-92-293) with reasonably uniform hit response and then by varying the position of each disk. The enhanced smoothness in the number of hits vs. η , compared to SDC-92-293, is the result of more prolonged effort in using the calculation tools, rather than in any change of method.

Given that the objective is to produce a uniform number of hits vs. η , the disk positions are well determined. Perturbation of the axial position of any disk by more than about 1%, or 10 mm at $z=1$ m, would produce a noticeable nonuniformity.

5. Disk layout.

Figure 1 is a scale drawing of the 13 disk layout that is the result of this study, and Fig. 2 shows the average number of hits vs. η corresponding to it. As in SDC-92-293, the left hand side of the plot shows the hits for the barrel layers only, while the right hand side displays the combined barrel+disk hits. Table 1 summarizes the sizes and positions of the Si elements.

Since the disks are separated roughly by $\Delta(\eta) = 0.1$, each additional disk beyond 13 will increase the coverage for eight hits by the same $\Delta(\eta)$. To achieve eight hit uniformity out to $\eta=2.5$, at least 15 disks are required. However, 13 disks still provide at least six hits out to $\eta=2.5$. The region $\eta>2.2$ where the average number of hits falls below eight is safely beyond the point at which the hits are mixed between barrel layers and disks. Therefore this region is better able to withstand a moderate loss.

In this 13 disk 8 hit layout, the furthest disk is separated from the origin by only 1.55 m. This same distance is 2.58 m in the TDR layout. Therefore the layout that is the result of this study is much more compact, offering potential simplification of the mechanical system. Also, more room is left for the intermediate tracker, especially if it takes the form of Si rather than gas microstrip modules.

6. Comparison to TDR layout.

For comparison to Figs. 1 and 2 and Table 1, Figs. 3 and 4 and Table 2 display the same information for the TDR layout.

7. Vertex Dependent Fluctuations.

For the 13 disk 8 hit configuration, Figures 5 and 6 display the average number of hits vs. η for events with vertices in the regions $z<0$ and $z>0$, respectively. For most of the barrel region, the number of hits is independent of z . In the disk region, the dependence grows to a maximum of ± 1 hit near $\eta=1.9$. Usually it is considerably less. If the number of hits were distributed as a gaussian about the mean, the difference between the two plots would amount to about 1.6 standard deviations. Therefore, the rms deviation in the number of hits is always less than about 1.25, and is usually less than 1.

Table 1. Layout of Si elements for 8 hits with 13 small disks.

element	zmin	zmax	rmax	rmin	etamin	etamax
barrel 1	-300	300	87	87	-1.951	1.951
barrel 2	-300	300	116	116	-1.679	1.679
barrel 3	-300	300	174	174	-1.313	1.313
barrel 4	-300	300	203	203	-1.182	1.182
barrel 5	-300	300	233	233	-1.071	1.071
barrel 6	-300	300	262	262	-0.980	0.980
barrel 7	-300	300	320	320	-0.836	0.836
barrel 8	-300	300	349	349	-0.779	0.779
disk 1	328	328	392	151	0.761	1.518
disk 2	364	364	392	151	0.830	1.614
disk 3	434	434	392	151	0.955	1.778
disk 4	500	500	392	151	1.063	1.913
disk 5	575	575	392	151	1.176	2.047
disk 6	676	676	392	151	1.313	2.204
disk 7	806	806	392	151	1.468	2.377
disk 8	923	923	392	151	1.592	2.510
disk 9	1028	1028	392	151	1.692	2.617
disk 10	1134	1134	392	151	1.784	2.714
disk 11	1253	1253	392	151	1.879	2.813
disk 12	1384	1384	392	221	1.974	2.534
disk 13	1550	1550	392	221	2.084	2.646

Table 2. Layout of Si elements in TDR.

element	zmin	zmax	rmax	rmin	etamin	etamax
barrel 1	-300	300	90	90	-1.919	1.919
barrel 2	-300	300	120	120	-1.647	1.647
barrel 3	-300	300	180	180	-1.284	1.284
barrel 4	-300	300	210	210	-1.154	1.154
barrel 5	-300	300	240	240	-1.048	1.048
barrel 6	-300	300	270	270	-0.958	0.958
barrel 7	-300	300	330	330	-0.816	0.816
barrel 8	-300	300	360	360	-0.758	0.758
disk 1	330	330	390	150	0.768	1.530
disk 2	380	380	390	150	0.863	1.660
disk 3	440	440	390	150	0.969	1.797
disk 4	520	520	390	150	1.099	1.957
disk 5	610	610	390	150	1.230	2.111
disk 6	720	720	390	150	1.373	2.272
disk 7	850	850	390	150	1.521	2.435
disk 8	1020	1020	390	150	1.689	2.615
disk 9	1220	1220	390	150	1.858	2.793
disk 10	1460	1460	465	225	1.862	2.569
disk 11	1820	1820	465	285	2.074	2.553
disk 12	2180	2180	465	345	2.249	2.543
disk 13	2580	2580	465	405	2.415	2.551

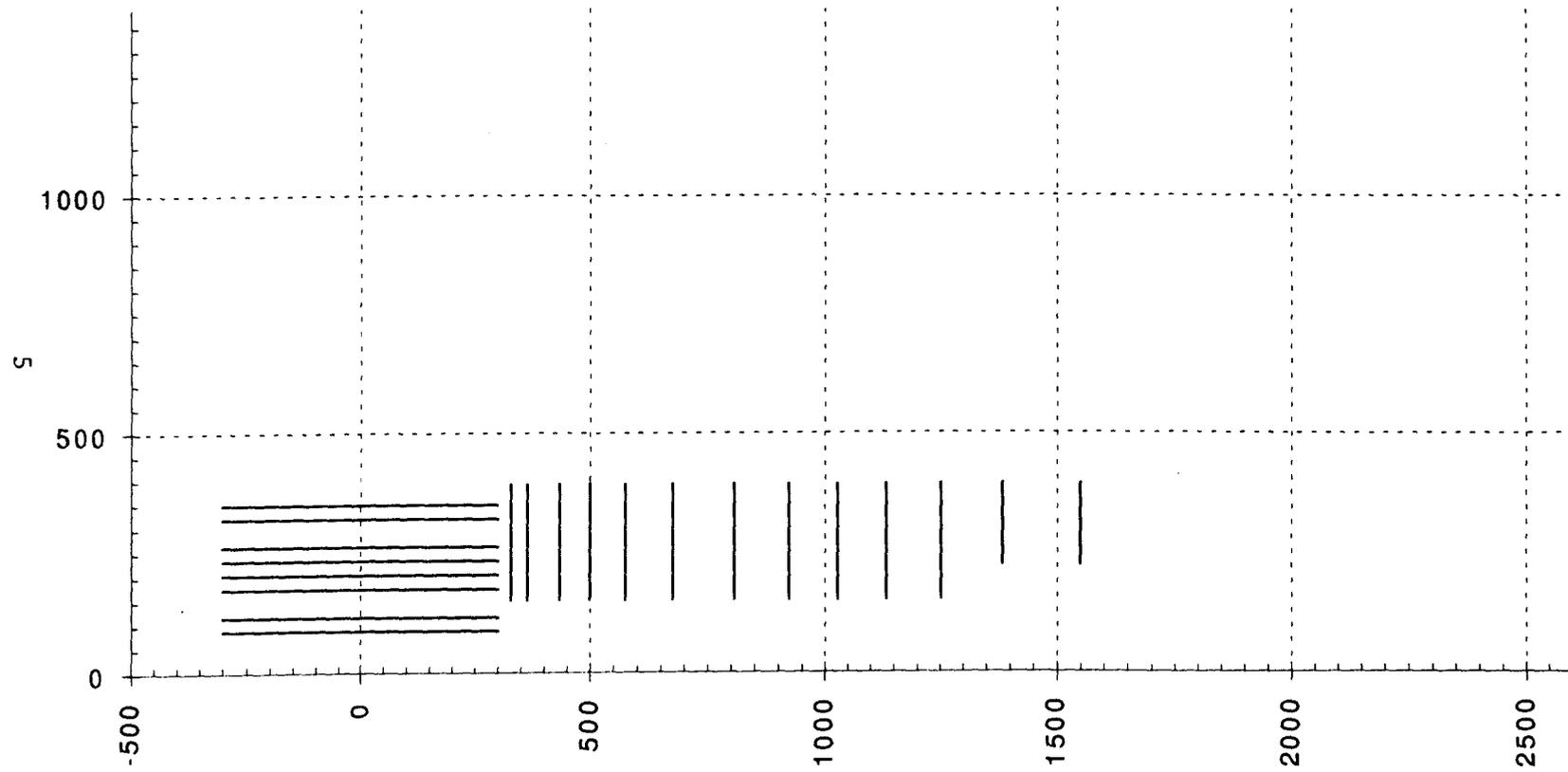


FIG. 1. Layout of Si elements for 8 hits with 13 small disks.

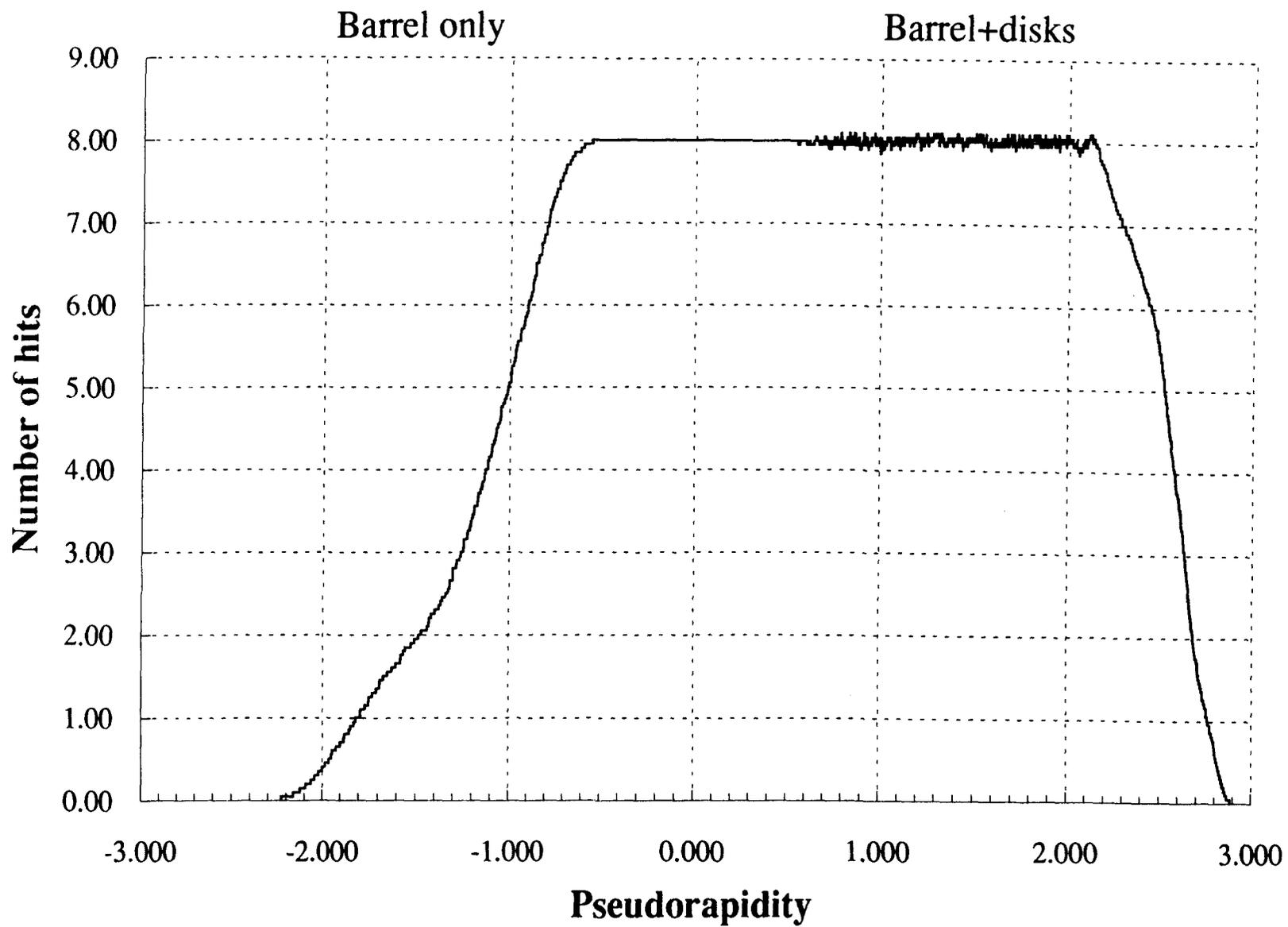


FIG. 2. Average number of hits for 13 small disk 8 hit layout.

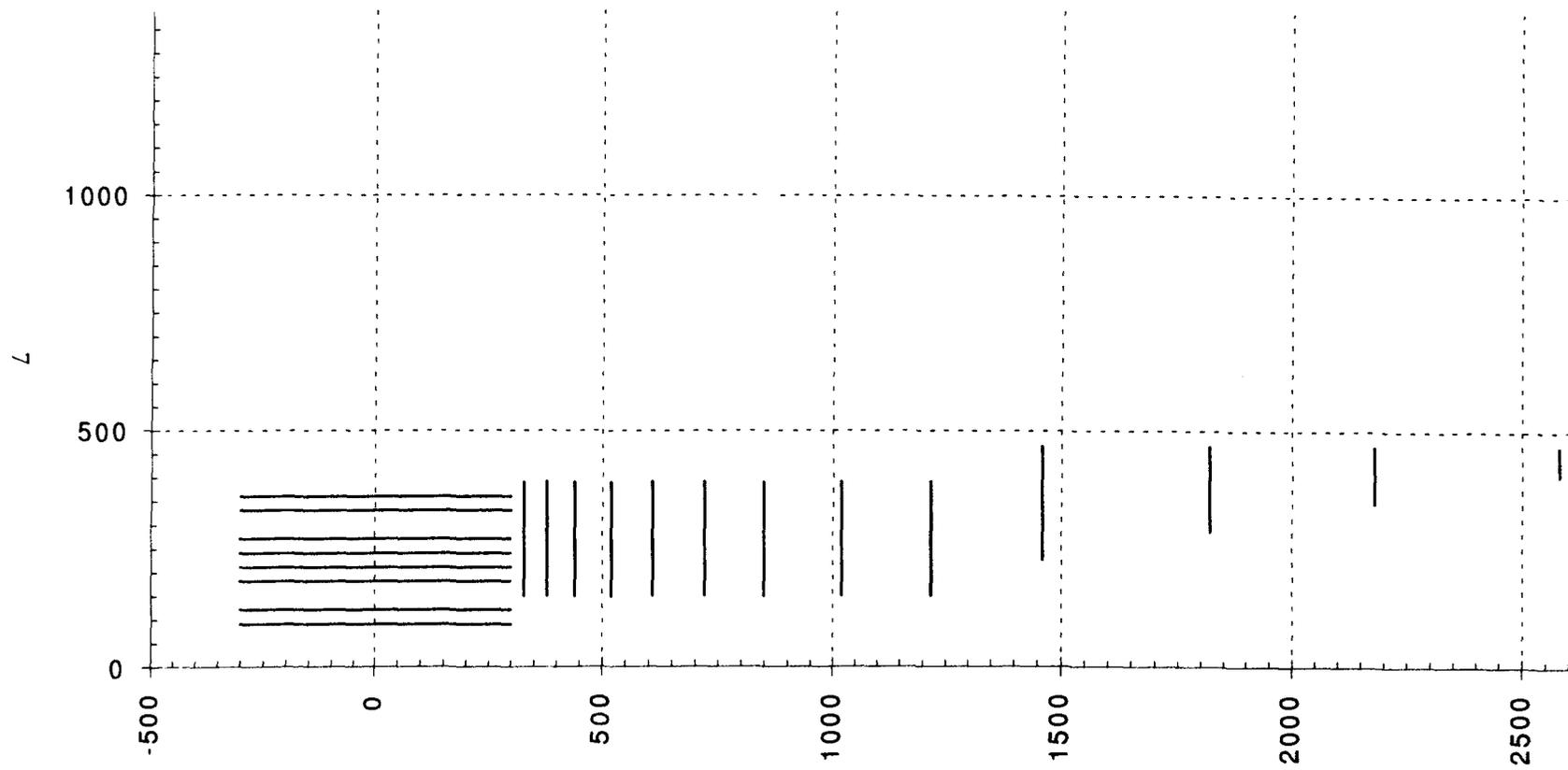


FIG. 3. Layout of Si elements in TDR.

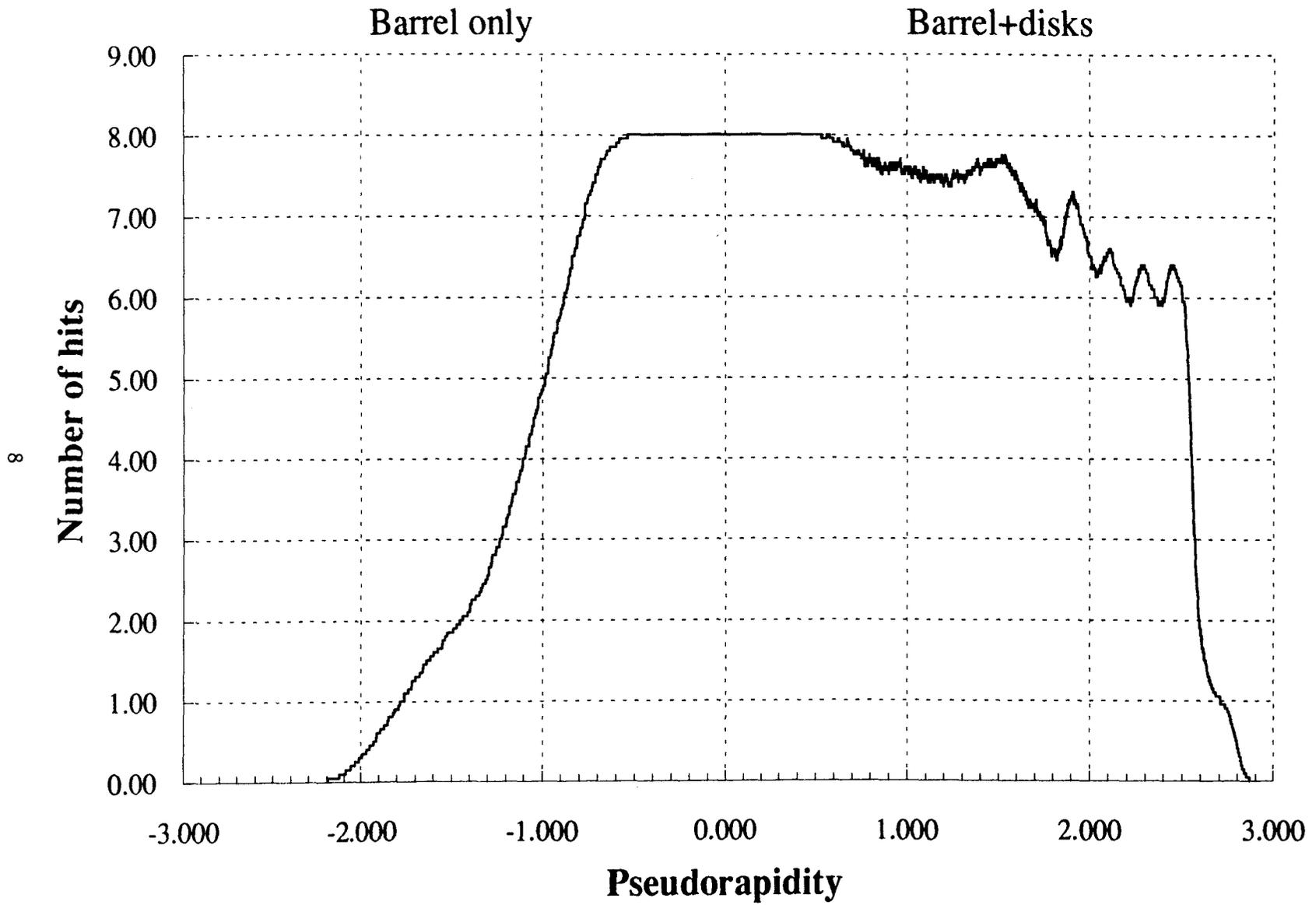


FIG. 4. Average number of hits vs. η for TDR layout.

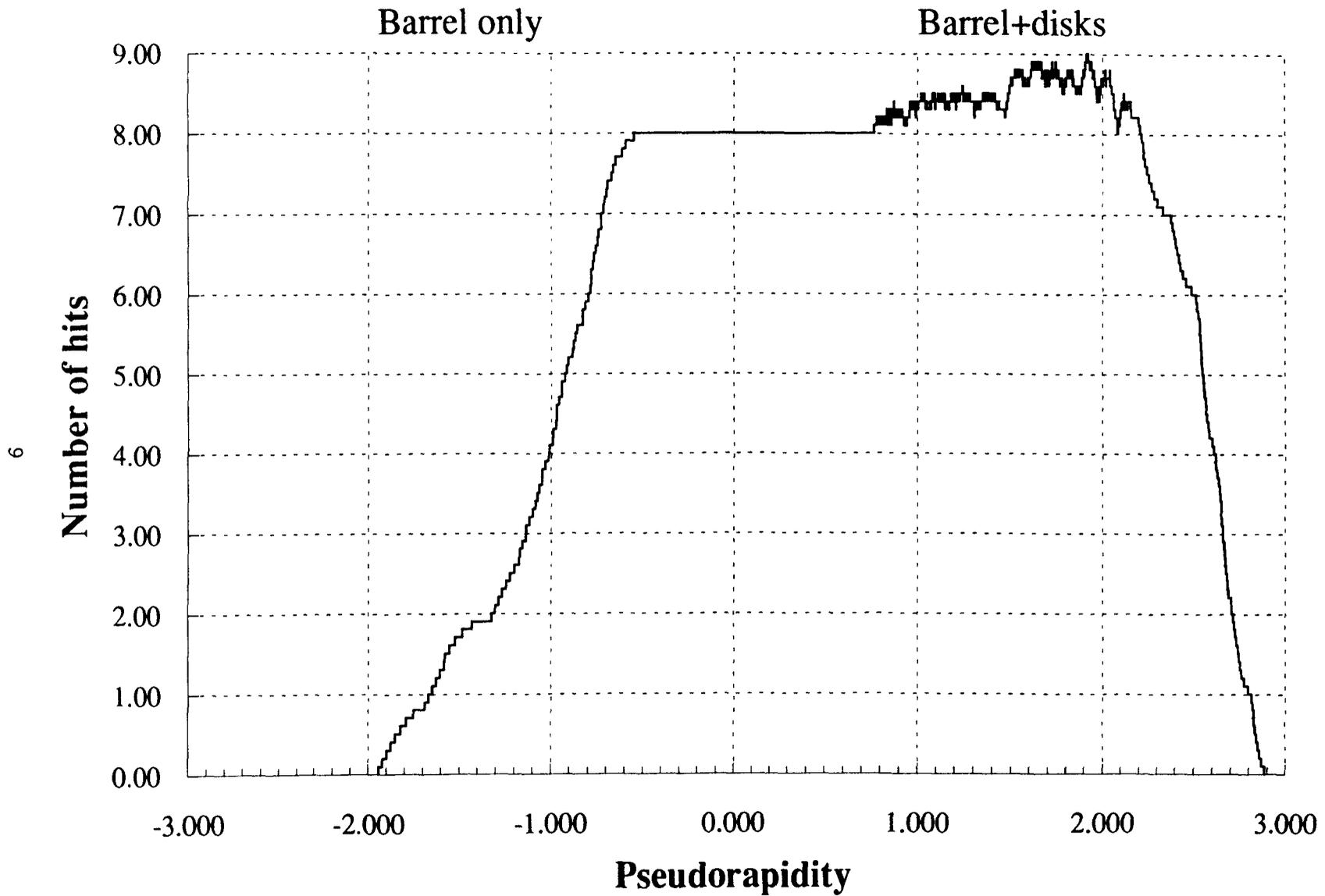


FIG. 5. Average number of hits vs. η for 13 small disk 8 hit layout, for tracks emanating from $z < 0$ only.

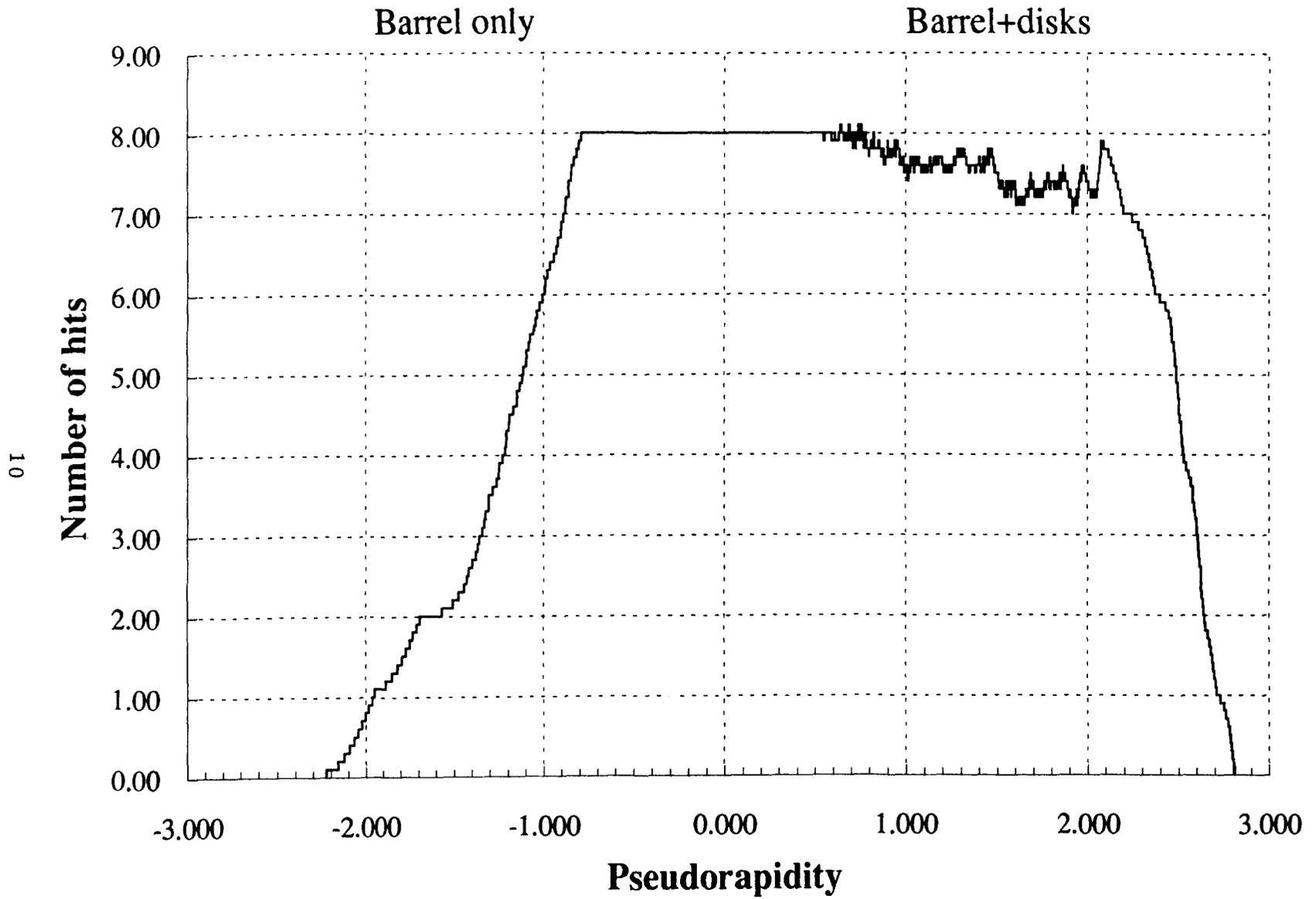


FIG. 6. Average number of hits vs. eta for 13 small 9 hit layout, for tracks emanating from z>0 only.