Occupancy and Readout Time Study of Layer 00

Rick Field and David Stuart

August 1, 1999

Abstract

An occupancy and readout time study of layer 00 is presented for antiproton-proton collisions at 2 TeV with pile-up. Charged particles travel in straight lines (*no magnetic field*) and a simple geometric cluster model is used to convert particle tracks into "hits" in the silicon chips. The effects of multiple interactions (*pile-up*) are included but we do not include the secondary scattering of the particles within the silicon (or within the detector material). The overall number of detector hits (*event size*), the chip with maximum hits (*max chip*), the readout pathway (HDI) with the maximum hits (*max path*), and the event readout time are some of the observables studied. The maximum pathway readout time and the maximum group (portcard) and super-group readout times are compared to the SVXII (r-ϕ component only). For dijet events (plus <3> min-bias) and 1.6% noise, the maximum pathway readout times for layer 00 and the SVXII are essentially identical, with the layer 00 time greater in 49% of the events and the SVXII time greater in 51% of the events. For top quark events (plus <3> min-bias), the maximum pathway readout time for layer 00 is, on the average, about 0.4 μs longer than the SVXII with the layer 00 time greater in 68% of the events. The maximum group and super-group readout times for layer 00 are considerable shorter than for the SVXII. For dijet events at (plus <3> min-bias), the maximum group readout time for the SVXII is, on the average, about 4.2 μs longer than layer 00 and the maximum super-group readout time for the SVXII is, on the average, about 39 μs longer than layer 00.

I. Introduction

To make layer 00 compatible with use in SVT, the readout scheme must be such that the L00 readout time is not significantly longer than the SVXII r-ϕ readout time. Using geometry and a simple cluster model we have modeled the occupancy and readout time for various layer 00 designs to optimize the readout scheme. Here we present the results for the final design. We simulate "hits" in the SVXII and layer 00 and compare the event readout times on an event-by-event bases. We use the same techniques to analysis layer 00 that we previously used to study the SVXII [1] and the ISL [2]. Charged particles produce straight line "tracks" through the silicon detectors (*no magnetic field*). The effects of multiple interactions (*pile-up*) are included but we do not include secondary scattering of the particles within the silicon (or within the detector material). We use ISAJET 7.32 [3] to simulate dijet events (P_T(hard) > 10 GeV), top quark events, and minimum bias (min-bias) events in antiproton-proton at 2 TeV. We have not tuned the Monte-Carlo to fit data The number of min-bias collisions per event are generated according to a Poisson distribution and the interaction point, z, of the top and the min-bias collisions are generated with a Gaussian distribution. The mean number of min-bias collisions per event and the root-mean-square deviation from the mean, σ_z, considered in this paper are shown in Table 1.1.

Table 1.1. Beam conditions for antiproton-proton collisions at 2 TeV examined in this paper.

Average Number of Min-Bias Interactions	Width of Interaction Region σ_z
3	30 cm
6	30 cm

II. Layer 00 Chips, Readout Pathways, and Groups (Notation)

Layer 00 consists of six identical z-modules (2 forward, 2 middle, 2 central), with a 1 cm gap at z = 0, as shown in Fig. 2.1. Each z-module consists of 18 chips (*silicon areas*), 6 inner and 12 outer.

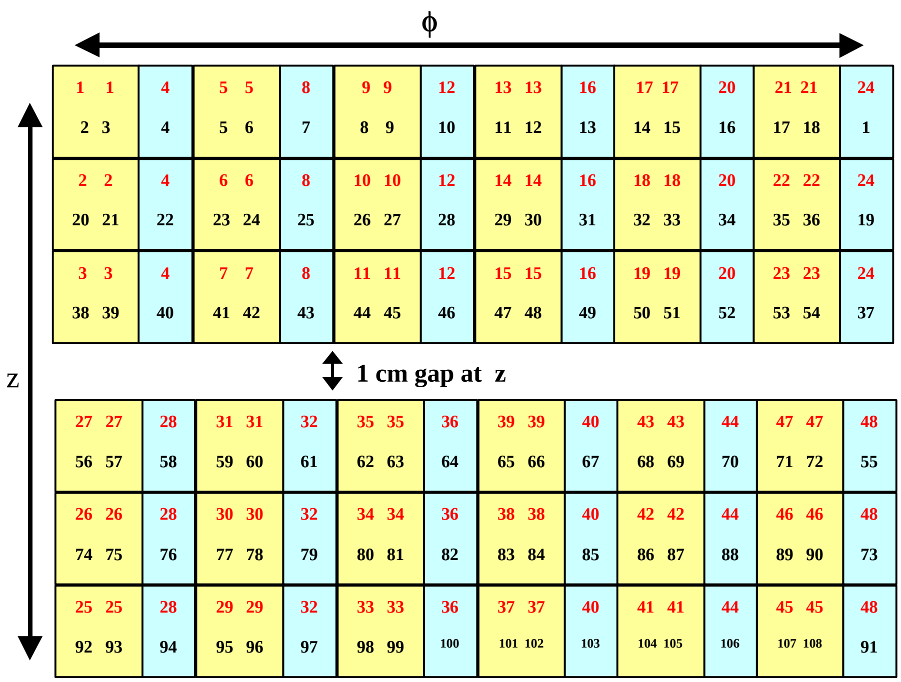

Fig. 2.1. Layer 00 chips (forward outer, forward inner, middle outer, middle inner, central outer, central inner) and pathways (forward, middle, central, inner). The upper number is the pathway label and the lower number is the chip label.

Layer 00 has a total of 108 chips as shown in Table 2.1 and 48 readout pathways (HDI's) as shown in Table 2.2. There are six distinct chip types (forward outer, forward inner, middle outer, middle inner, central outer, central inner) and four distinct readout pathway types (forward, middle, central, inner). The forward, middle and central pathways have two chips per pathway, while the inner pathways have three chips per pathway.

Table 2.1. The six distinct layer 00 chip types (forward outer, forward inner, middle outer, middle inner, central outer, central inner).

Layer 00: Number of Chips							
	Forward	Middle	Central	Central	Middle	Forward	sum
inner	6	6	6	6	6	6	**36**

outer	12	12	12	12	12	12	**72**
sum	**18**	**18**	**18**	**18**	**18**	**18**	**108**

Table 2.2. The four distinct layer 00 readout pathway (*i.e.* HDI) types (forward, middle, central, inner).

Layer 00: Number of Pathways	
	Paths/Chips
Forward	6/12
Middle	6/12
Center	6/12
Inner	6/18
Inner	6/18
Center	6/12
Middle	6/12
Forward	6/12
Sum	**48/108**

Four layer 00 readout pathways are connected to a portcard to form one readout "group". Layer 00 readout groups are formed by combining neighboring forward, middle, and inner readout pathways as shown in Fig. 2.2. For example, group A consists of pathways 1, 2, 3, and 4 (chips 1, 3, 4, 20, 21, 22, 38, 39, 40). There are 12 identical layer 00 readout groups each consisting of 4 pathways and 9 chips. "Super-Groups" are formed by combining left (z < 0) and right (z > 0) groups corresponding to the same ϕ. There are six layer 00 super-groups each consisting of 8 pathways and 18 chips. A super-group is significant since it is the highest granularity level for SVT.

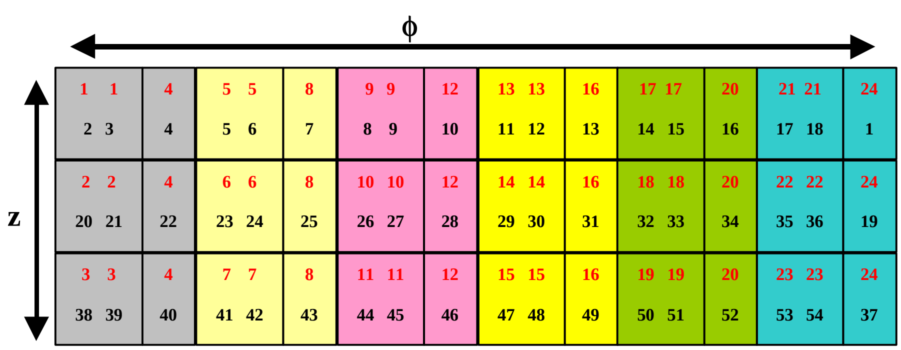

Fig. 2.2. The six left (z < 0) layer 00 groups. Layer 00 readout "groups" (*i.e.* portcards) are formed by combining neighboring forward, middle, and inner readout pathways.

III. The Simple Cluster Model

Here we use a same simple geometric cluster model that we used to study the SVXII [1] and the ISL [2]. The cluster size, N_{cl}, is generated at random according to a Gaussian distribution with mean, $\langle N_{cl} \rangle$, computed as follows:

$$\langle N_{cl} \rangle = x/p + 1.5,$$

where x is the x-component of the track length L ($x = L\sin\Delta\phi$) and p is the r-ϕ pitch (1/p is the density of wires) as illustrated in Fig. 3.1.

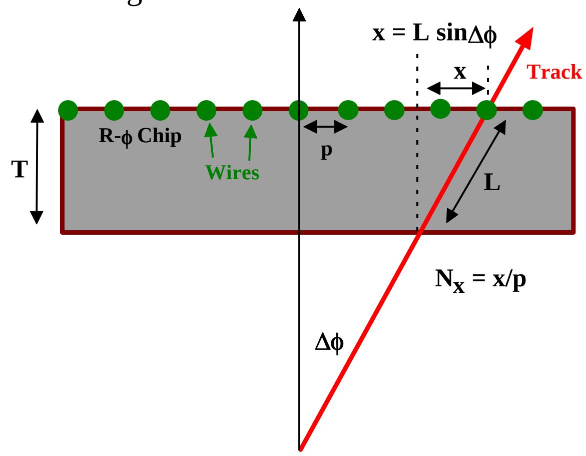

Fig. 3.1. Illustration of the simple cluster model used in this paper.

The standard deviation of the Gaussian distribution, σ, is computed according to, $\boldsymbol{\sigma = f_\sigma \sigma_0}$, where $\boldsymbol{\sigma_0 = 0.8}$ and the factor f_σ is given by

$$\mathbf{f_\sigma = (x/p+1)Q_0/Q,}$$

where Q is the amount of charge produced by the track ($Q = \lambda L$) and $Q_0 = \lambda T$ is the amount of charged produced by a track with $\Delta\phi = 0^o$. The chip thickness, T, is 300 microns and the amount of charge per unit length along a charged track, λ, is about 80 electrons/micron. If a track deposits less the 2,000 electrons of charge then it goes undetected (*this happens rarely*). Note that Q_0/f_σ is the amount of charge per wire for the track (f_σ is the wires per Q/Q_0). The idea here is to make the fluctuations from the mean, σ, larger when there is less charge per wire. For straight through particles ($\Delta\phi = 0^0$), the above formula yield $\langle N_{cl} \rangle = 1.5$ and $\sigma = 0.8$ which agrees with SVX' data [4].

The number of "hits" per track is given by

$$\mathbf{N_{hit} = N_{cl} + NN + N_{over},}$$

where **NN = 2** for nearest neighbor hits (one on each side of the cluster) and where N_{over} is the overhead. In this study we take $N_{over} = 7$, which implies a noise of 2 wires per chip (1.6%) plus nearest neighbor hits (7 = 3 x 2 + 1)

Fig. 3.2 shows the probability of at least one hit in layer 00 for charged particles produced in dijet events at with pile-up (<3> min-bias) as a function of the pseudo-rapidity of the charged particle.

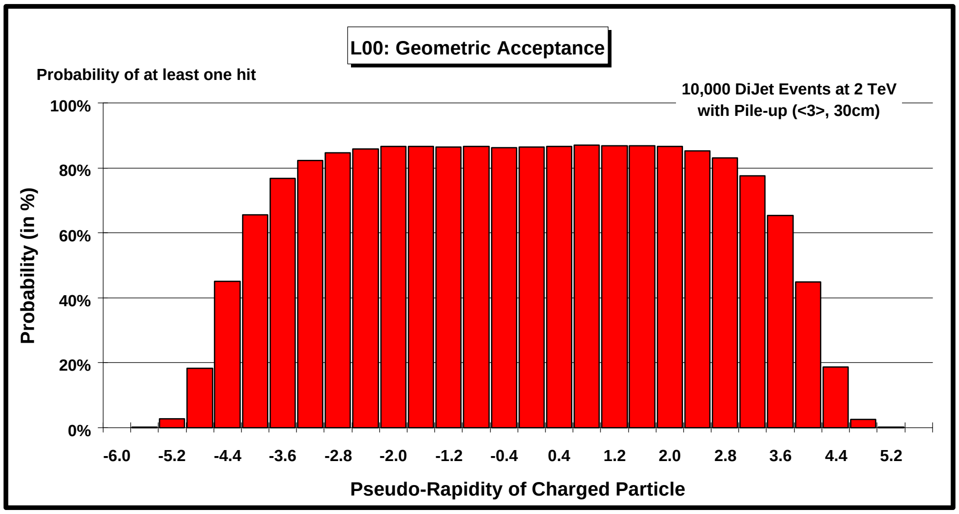

Fig. 3.2. Shows the probability of at least one hit in layer 00 for charged particles produced in dijet events at 2 TeV with pile-up (<3> min-bias, σ_z = 30 cm) as a function of the pseudo-rapidity of the charged particle.

IV. Average Chip Hits and Maximum Chip Hits

Table 4.1 shows the average total chip hits and the average hits per chip for the six distinct chip types (forward outer, forward inner, middle outer, middle inner, central outer, central inner) for dijet events at with pile-up (<3> min-bias) assuming 1.6 % noise (N_{over} = 7). The average total chip hits (*i.e*. average data size) is 1,502 corresponding to an average detector occupation of around 11% (divide 1,502 by the total number of wires 108 x 128 = 13,824). Fig. 4.1 shows the distribution of the total number of readout pathway (HDI) hits (*same as the total number of chip hits*) in for dijet events.

Table 4.1. Average total chip hits and average hits per chip for the six distinct chip types listed in Table 2.1 for 10,000 dijet events at 2 TeV with pile-up (<3> min-bias, σ_z = 30 cm) and assuming 1.6 % noise (N_{over} = 7).

Layer 00: Average Total Chip Hits							
	Forward	Middle	Central	Central	Middle	Forward	sum
inner	74	88	99	100	89	73	**523**
outer	141	165	184	185	166	139	**979**
sum	**214**	**253**	**283**	**284**	**255**	**212**	**1,502**

Layer 00: Average Hits/Chip							
	Forward	Middle	Central	Central	Middle	Forward	all
inner	12	15	17	17	15	12	**15**
outer	12	14	15	15	14	12	**14**
all	**12**	**14**	**16**	**16**	**14**	**12**	**14**

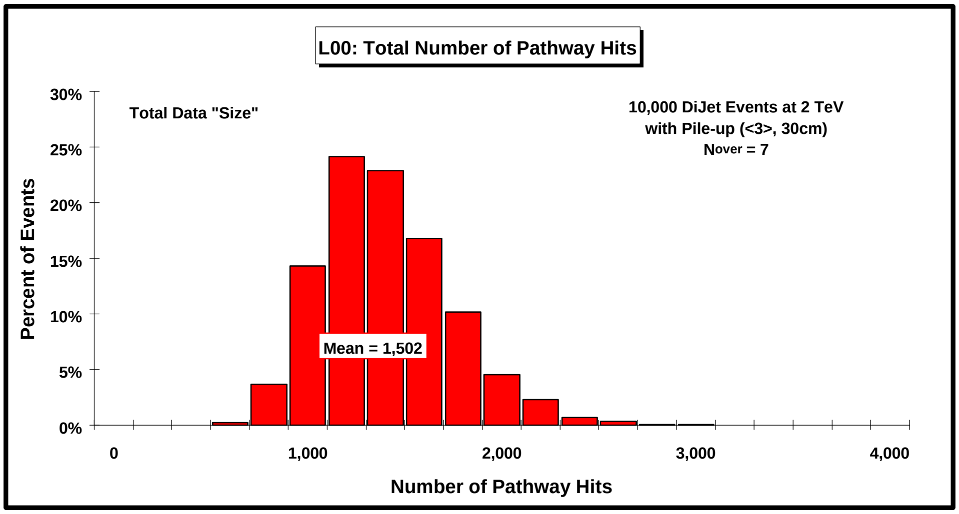

Fig. 4.1. Distribution of the total number of readout pathway (HDI) hits in layer 00 for dijet events at 2 TeV with pile-up (<3> min-bias, σ_z = 30 cm) assuming 1.6% noise (N_{over}=7).

Table 4.2 shows the average total chip hits and the average hits per chip for the six distinct chip types (forward outer, forward inner, middle outer, middle inner, central outer, central inner) for top quark events with pile-up (<3> min-bias) assuming 1.6 % noise (Nover = 7). Fig. 4.2 shows the distribution of the total number of readout pathway (HDI) hits (*same as the total number of chip hits*) in for top quark events. For top quark events the average total data size is considerable larger that for dijets (1,772 compared to 1,502).

Table 4.2. Average total chip hits and average hits per chip for the six distinct chip types listed in Table 2.1 for 10,000 top quark events at 2 TeV with pile-up (<3> min-bias, σ_z = 30 cm) and assuming 1.6 % noise (Nover = 7).

	Layer 00: Average Total Chip Hits						
	Forward	**Middle**	**Central**	**Central**	**Middle**	**Forward**	**sum**
inner	85	106	120	119	105	83	**618**
outer	160	199	221	221	196	158	**1,154**
sum	**244**	**305**	**341**	**340**	**301**	**241**	**1,772**

	Layer 00: Average Hits/Chip						
	Forward	**Middle**	**Central**	**Central**	**Middle**	**Forward**	**all**
inner	14	18	20	20	18	14	**17**
outer	13	17	18	18	16	13	**16**
all	**14**	**17**	**19**	**19**	**17**	**13**	**16**

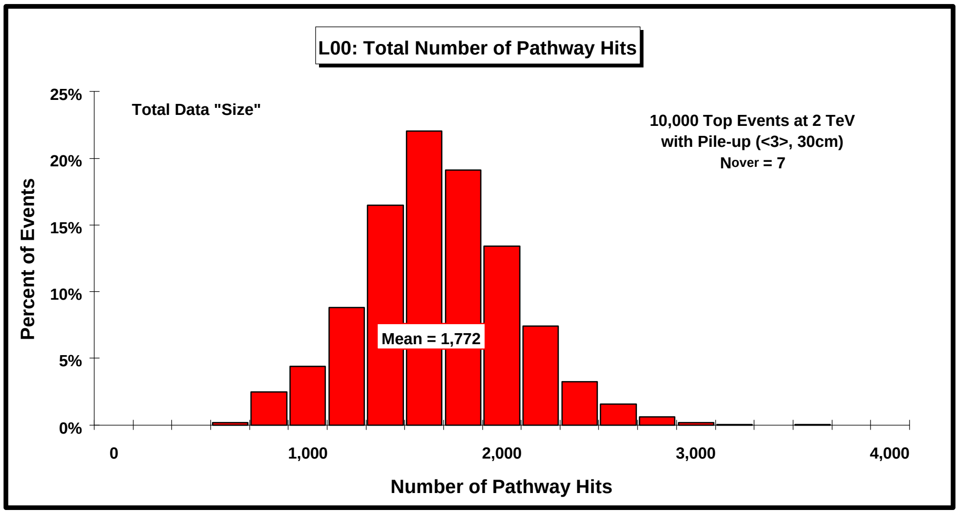

Fig. 4.2. Distribution of the total number of readout pathway (HDI) hits in layer 00 for top quark events at 2 TeV with pile-up (<3> min-bias, σ_z = 30 cm) assuming 1.6% noise (N_{over}= 7).

Table 4.3 shows the average total chip hits and the average hits per chip for the six distinct chip types (forward outer, forward inner, middle outer, middle inner, central outer, central inner) for dijet events with pile-up (<6> min-bias) and assuming 1.6 % noise (N_{over} = 7). Fig. 4.1 shows the distribution of the total number of readout pathway (HDI) hits (*same as the total number of chip hits*) in for dijet events. Dijet events plus <6> min-bias have a larger average total data size that top quark events plus <3> min-bias (1,905 compared to 1,772).

Table 4.3. Average total chip hits and average hits per chip for the six distinct chip types listed in Table 2.1 for 10,000 dijet events at 2 TeV with pile-up (<6> min-bias, σ_z = 30 cm) and assuming 1.6 % noise (N_{over} = 7).

	Layer 00: Average Total Chip Hits						
	Forward	**Middle**	**Central**	**Central**	**Middle**	**Forward**	**sum**
inner	92	114	130	130	114	92	**670**
outer	172	210	236	237	210	171	**1,235**
sum	**264**	**324**	**366**	**366**	**323**	**263**	**1,905**

	Layer 00: Average Hits/Chip						
	Forward	**Middle**	**Central**	**Central**	**Middle**	**Forward**	**all**
inner	15	19	22	22	19	15	**19**
outer	14	17	20	20	17	14	**17**
all	**15**	**18**	**20**	**20**	**18**	**15**	**18**

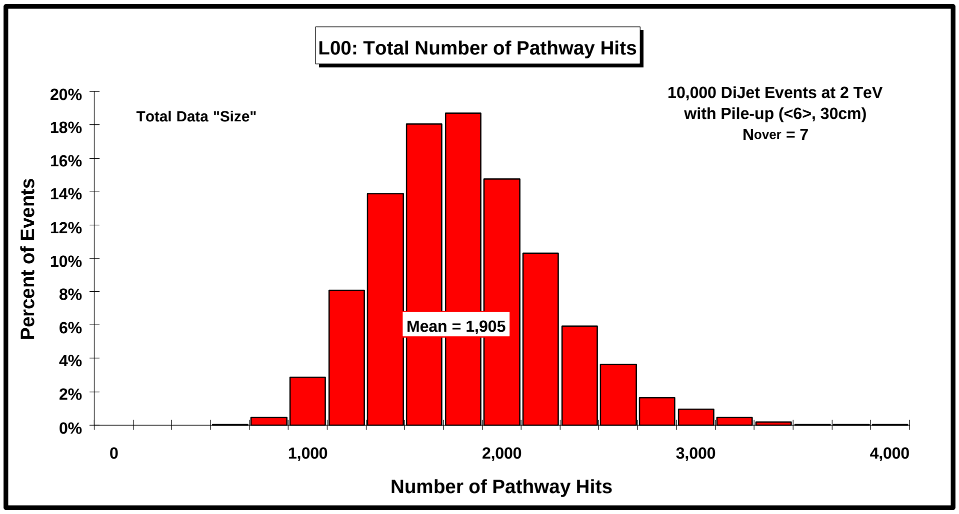

Fig. 4.3. Distribution of the total number of readout pathway (HDI) hits in layer 00 for dijet events at 2 TeV with pile-up (<6> min-bias, σ_z = 30 cm) assuming 1.6% noise (N_{over}= 7).

Table 4.4 shows the average number of hits in the single layer 00 chip with the maximum hits for the six regions (forward outer, forward inner, middle outer, middle inner, central outer, central inner) for dijet events at with pile-up (<3> min-bias) and assuming 1.6 % noise (N_{over} = 7). The average maximum chip hits for all chips in the detector is considerably large than it is for a single region. For example, the average maximum chip hits for the central outer region is 27 while for all chips it is 43. The overall chip with maximum hits does not always occur in the same region, it fluctuates from region to region. Fig. 4.4 shows the distribution of the number of hits in the chip with the maximum hits per event for dijet events. The average maximum chip hits is 43 as shown in Table 4.4. This corresponds to an average maximum chip occupation of about 34% (divide 43 by 128) and a readout time for this one chip of 1.7 μs.

Table 4.4. Average maximum chip hits for the six distinct chip types listed in Table 2.1 for 10,000 Dijet events at 2 TeV with pile-up (<3> min-bias, σ_z = 30 cm) and assuming 1.6 % noise (N_{over} = 7).

Layer 00: Average Maximum Chip Hits							
	Forward	Middle	Central	Central	Middle	Forward	all
inner	18	22	25	25	22	18	
outer	20	24	27	27	24	20	
all							43

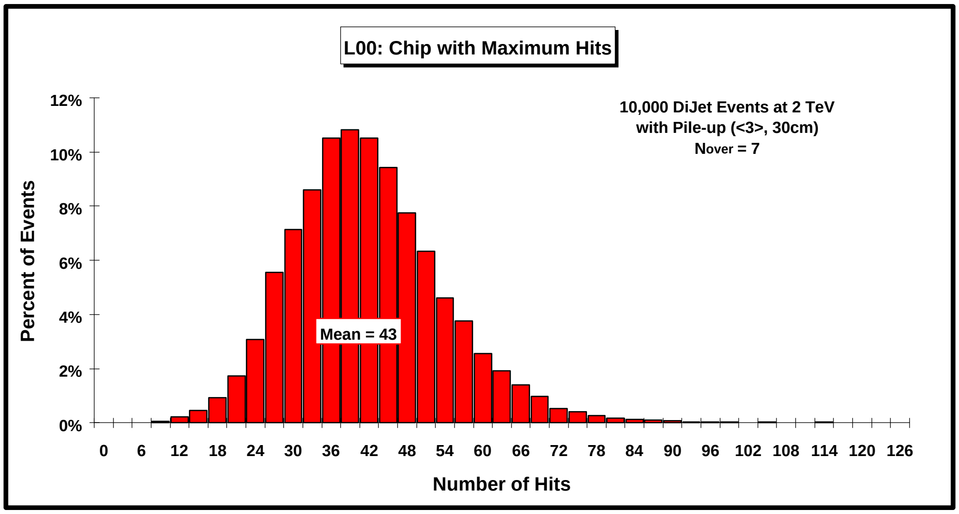

Fig. 4.4. Distribution of the number of "hits" in the layer 00 chip with the maximum hits per event for dijet events at 2 TeV with pile-up (<3> min-bias, σ_z = 30 cm) assuming 1.6% noise (N_{over}=7).

Table 4.5 shows the average number of hits in the single chip with the maximum hits for the six regions (forward outer, forward inner, middle outer, middle inner, central outer, central inner) for top quark events with pile-up (<3> min-bias) and assuming 1.6 % noise (N_{over} = 7). Here, the average maximum chip hits for the central outer region is 33 while for all chips it is 74 (corresponding to a readout time of about 3 μs for the chip). Fig. 4.5 shows the distribution of the number of hits in the chip with the maximum hits per event for top quark events. The average maxim chip hits is 74, as shown in Table 4.5, corresponding to an average maximum chip occupation of about 59%.

Table 4.5. Average maximum chip hits for the six distinct chip types listed in Table 2.1 for 10,000 top quark events at 2 TeV with pile-up (<3> min-bias, σ_z = 30 cm) and assuming 1.6 % noise (N_{over} = 7).

Layer 00: Average Maximum Chip Hits							
	Forward	Middle	Central	Central	Middle	Forward	all
inner	22	27	31	31	27	21	
outer	24	30	33	33	29	23	
all							74

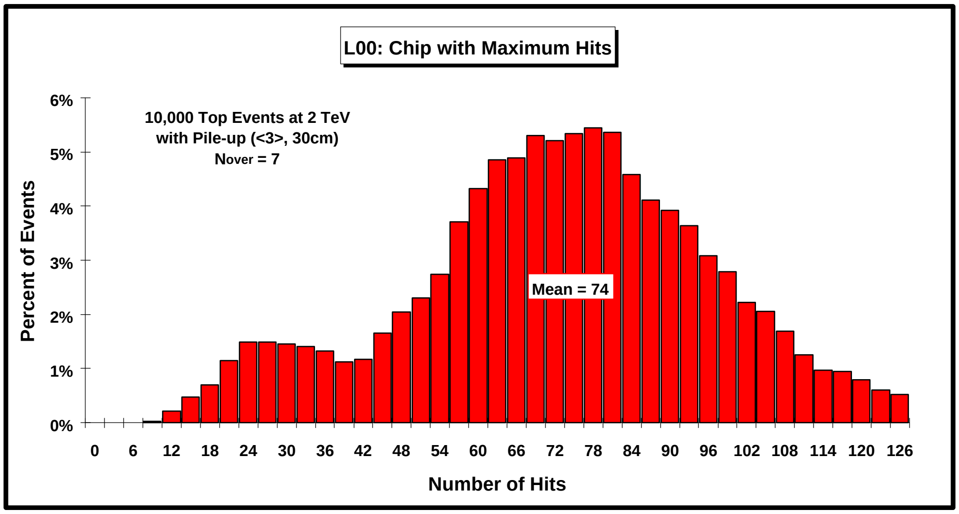

Fig. 4.5. Distribution of the number of "hits" in the layer 00 chip with the maximum hits per event for top quark events at 2 TeV with pile-up (<3> min-bias, σ_z = 30 cm) assuming 1.6% noise (N_{over}=7).

Table 4.6 shows the average number of hits in the single chip with the maximum hits for the six regions (forward outer, forward inner, middle outer, middle inner, central outer, central inner) for dijet events at 2 TeV with pile-up (<6> min-bias) and assuming 1.6 % noise (Nover = 7). Here, the average maximum chip hits for the central outer region is 34 while for all chips it is 50 (corresponding to a readout time of about 2 μs for the chip). It is interesting to note that the average maximum hits in the central outer region is slightly larger than that observed for the top quark events in Table 4.5 (34 compared to 33). However, the average maximum chip hits for *all chips* is very much larger for the top quarks events (74 compared to 50). This is due to the larger fluctuations in the top quark events (compare Fig. 4.4 with Fig. 4.5). Fig. 4.6 shows the distribution of the number of hits in the chip with the maximum hits per event for dijet events with pile-up (<6> min-bias). The average maximum chip hits is 50 as shown in Table 4.6.

Note that while dijet events plus <6> min-bias have a large average data size (1,905 compared to 1,772) and "hotter" cells in the outer central region (34 compared to 33) than do top quark events plus <3> min-bias, the overall average maximum chip hits (*for the entire detector*) is considerably larger for the top quark events (74 compared to 50).). This because the top quark events have larger fluctuations.

Table 4.6. Average maximum chip hits for the six distinct chip types listed in Table 2.1 for 10,000 dijet events at 2 TeV with pile-up (<6> min-bias, σ_z = 30 cm) and assuming 1.6 % noise (Nover = 7).

Layer 00: Average Maximum Chip Hits							
	Forward	Middle	Central	Central	Middle	Forward	all
inner	23	28	32	32	28	23	
outer	25	30	34	34	30	25	
all							50

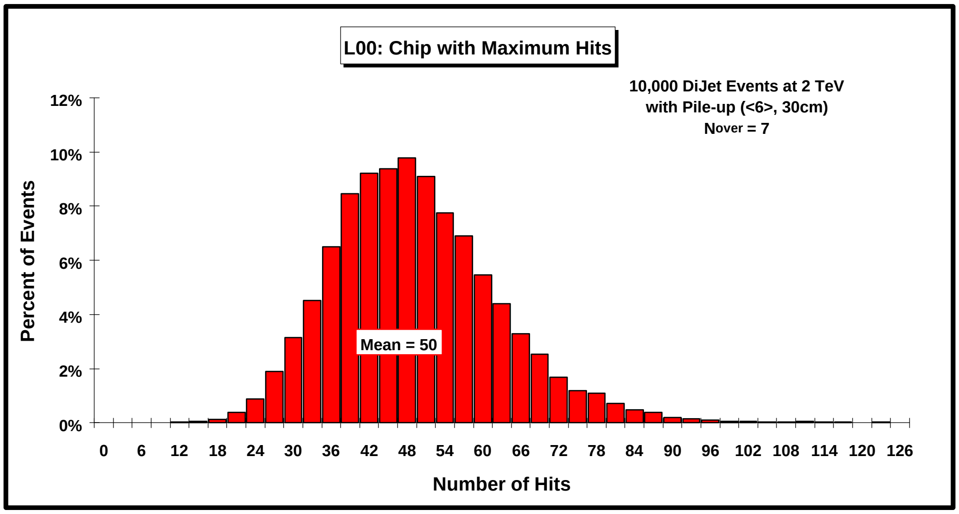

Fig. 4.6. Distribution of the number of "hits" in the layer 00 chip with the maximum hits per event for dijet events at 2 TeV with pile-up (<6> min-bias, σ_z = 30 cm) assuming 1.6% noise (N_{over}=7).

Although the average layer 00 chip occupation is small (16/128 = 12.5% for dijet events with <3> min-bias), in each event there can be some chips with moderate occupation. Fig. 4.7 shows the percent of events with N chips with the occupation greater than 25% for dijet events with pile-up (<3> min-bias) assuming 1.6% noise (N_{over} = 7). There are, on the average, 5 chips with greater than 25% occupation. For top quark events (Fig. 4.8) the average number of chips with greater than 25% occupation increases to 11. Furthermore, Fig. 4.8 shows that for top quark events there is a 10% probability of finding greater that 20 chips with greater than 25% occupation.

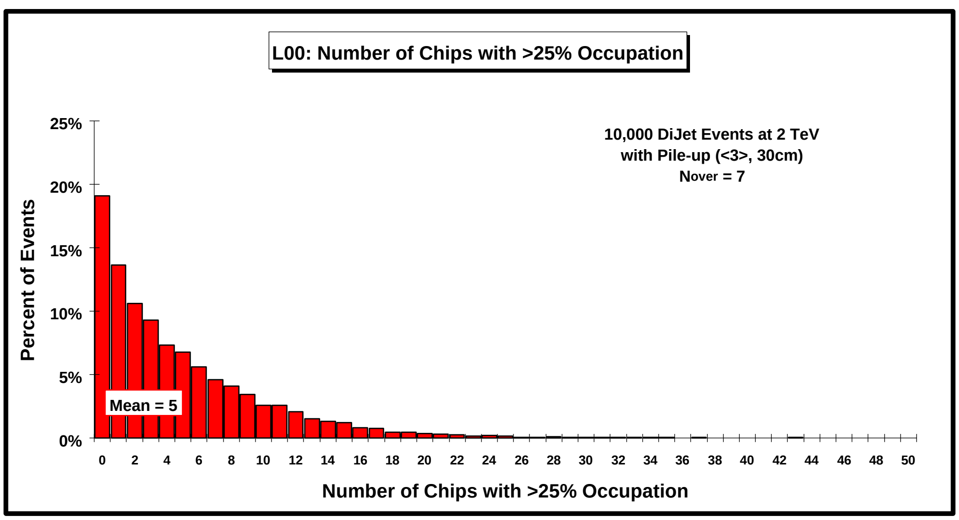

Fig. 4.7. Percent of events with N layer 00 chips with the occupation greater than 25% for dijet events at 2 TeV with pile-up (<3> min-bias, σ_z = 30 cm) assuming 1.6% noise (N_{over}=7).

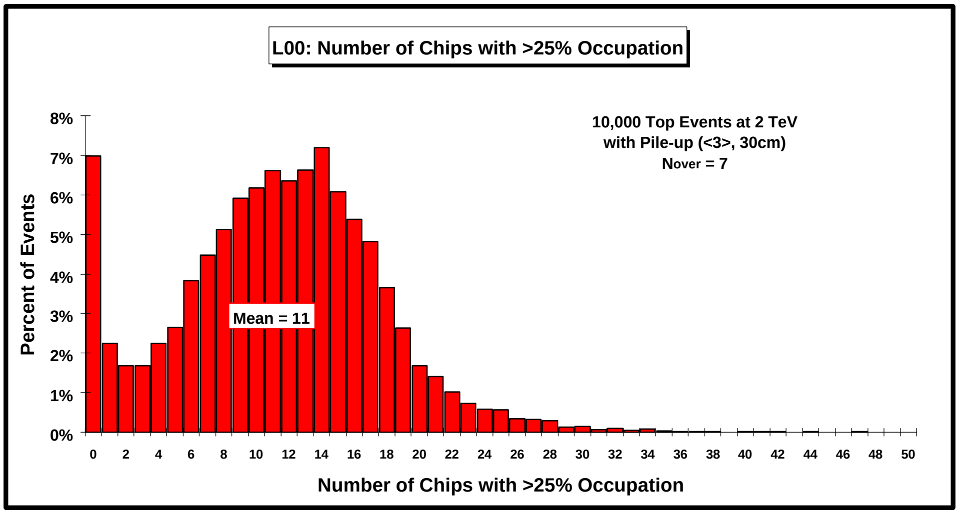

Fig. 4.8. Percent of events with N layer 00 chips with the occupation greater than 25% for top quark events at 2 TeV with pile-up (<3> min-bias, σ_z = 30 cm) assuming 1.6% noise (N_{over}=7).

V. Pathway with the Maximum Hits

Table 5.1 and Fig. 5.1 show the number of hits in the layer 00 readout pathway (HDI) with the maximum hits for the four distinct readout pathway types from Table 2.2 (forward, middle, central, and inner) averaged over 10,000 dijet events with pile-up (<3> min-bias) assuming 1.6% noise (N_{over}= 7). The inner pathways (with 3 chips/pathway) are the "hottest" with, on the average, 56 hits. For dijet events plus <3> min-bias the overall average maximum pathway hits is 72. Fig. 5.2 shows the distribution of the number of hits in the layer 00 readout pathway with the maximum hits per event and the r-ϕ component of the SVXII readout pathway with the maximum r-ϕ hits, for the dijet events. The average maximum pathway hits for layer 00 and the SVXII(r-f) are approximately the same (72 compared to 71), however the distributions are quite different. The layer 00 distribution is much broader, indicating much larger fluctuations in layer 00 than in SVXII.

Table 5.1. Average maximum pathway hits per event in the forward, middle, center, and inner region of layer 00, for 10,000 dijet events at 2 TeV with pile-up (<3> min-bias, σ_z = 30 cm) and assuming 1.6 % noise (N_{over} = 7).

Layer 00: Pathway with Maximum Hits								
Forward	Middle	Center	Inner	Inner	Central	Middle	Forward	all
32	38	42	56	56	42	38	32	72

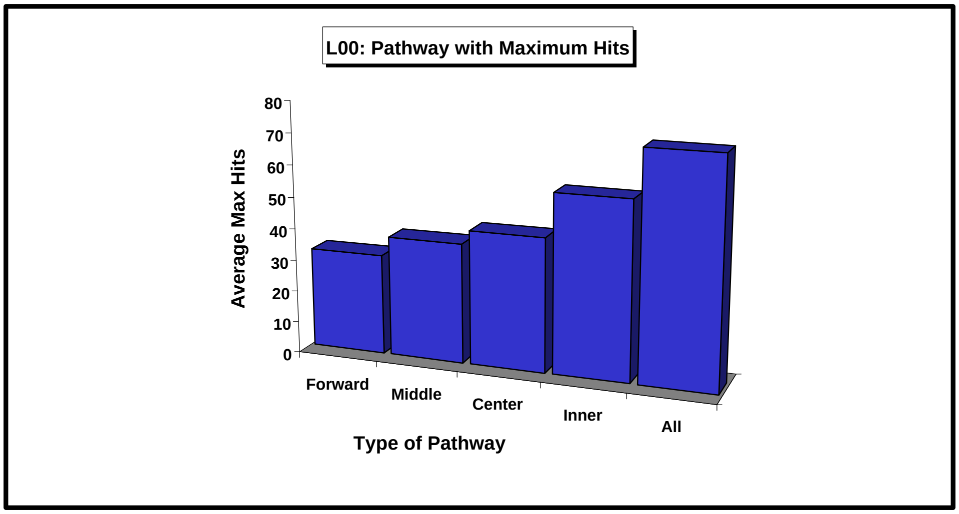

Fig. 5.1. Average maximum pathway hits per event in the forward, middle, center, and inner region of layer 00, for dijet events at 2 TeV with pile-up (<3> min-bias, σ_z = 30 cm) and assuming 1.6 % noise (N_{over} = 7).

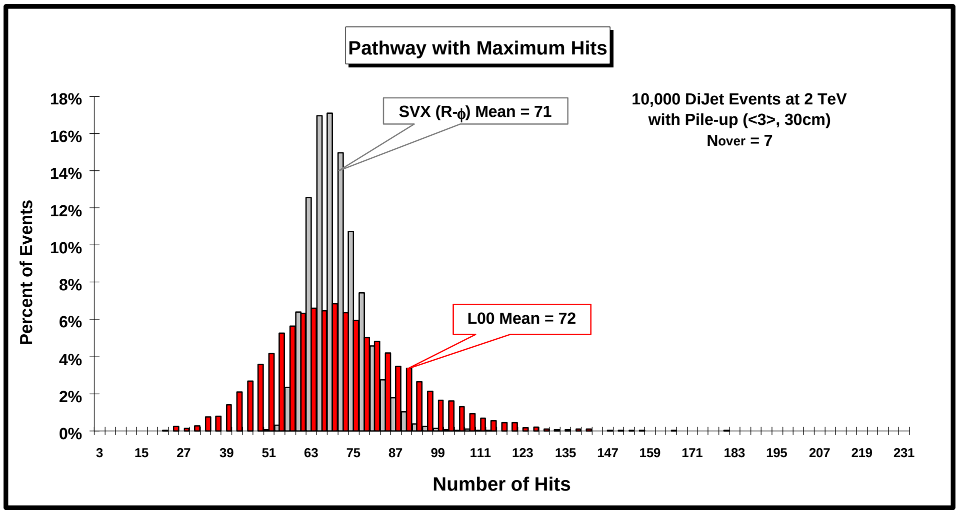

Fig. 5.2. Distribution of the number of hits in the layer 00 readout pathway with the maximum hits per event and the r-ϕ component of the SVXII readout pathway with the maximum r-ϕ hits, for dijet events at 2 TeV with pile-up (<3> min-bias, σ_z = 30 cm) assuming 1.6% noise (N_{over}=7)

Table 5.2 and Fig. 5.3 show the number of hits in the layer 00 readout pathway (HDI) with the maximum hits in the forward, middle, central, and inner region averaged over 10,000 top quark events with pile-up (<3> min-bias) assuming 1.6% noise (N_{over}= 7). The lack of symmetry between the left (z < 0) and right (z > 0) half of the detector is due to the limited statistics (and the large fluctuations of top quark events). The overall average maximum pathway hits for layer 00 increases from 72 for dijet events to 114 for top quarks. Fig. 5.4 shows the distribution of the number of hits in the layer 00 readout pathway with the maximum hits per event and the r-ϕ component of the SVXII readout pathway with the maximum r-ϕ hits, for the top quark events. For SVXII, the overall average maximum pathway hits (r-ϕ component) increases from 71 for dijet events to 102 for top quarks. For top quark events the average maximum pathway hits is slightly larger for layer 00 than for the SVXII (r-ϕ component) (114 compared to 102) and again the layer 00 distribution is broader.

Table 5.2. Average maximum pathway hits per event in the forward, middle, center, and inner region of layer 00, for 10,000 top quark events at 2 TeV with pile-up (<3> min-bias, σ_z = 30 cm) and assuming 1.6 % noise (N_{over} = 7).

Layer 00: Pathway with Maximum Hits								
Forward	Middle	Center	Inner	Inner	Central	Middle	Forward	all
37	47	53	70	69	53	46	37	114

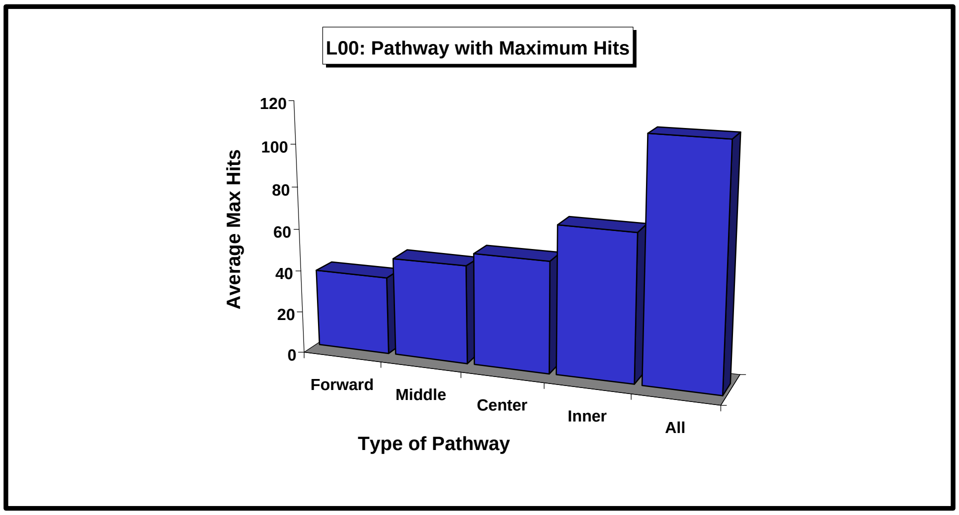

Fig. 5.3. Average maximum pathway hits per event in the forward, middle, center, and inner region of layer 00, for top quark events at 2 TeV with pile-up (<3> min-bias, σ_z = 30 cm) and assuming 1.6 % noise (N_{over} = 7).

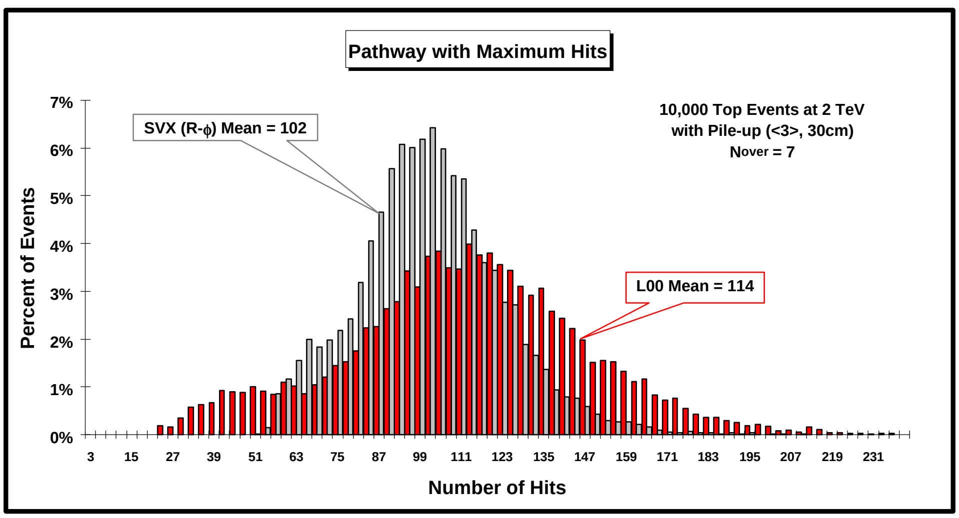

Fig. 5.4. Distribution of the number of hits in the layer 00 readout pathway with the maximum hits per event and the r-ϕ component of the SVXII readout pathway with the

maximum r-ϕ hits, for dijet events at 2 TeV with pile-up (<3> min-bias, σ_z = 30 cm) assuming 1.6% noise (N_{over}=7)

Table 5.3 shows the number of hits in the layer 00 readout pathway (HDI) with the maximum hits in the forward, middle, central, and inner region averaged over dijet events with pile-up (<6> min-bias) assuming 1.6% noise (N_{over}= 7). Here the overall average maximum pathway hits for layer 00 is 88. Fig. 5.5 shows the distribution of the number of hits in the layer 00 readout pathway with the maximum hits per event and the r-ϕ component of the SVXII readout pathway with the maximum r-ϕ hits, for the dijet events. The average maximum pathway hits for layer 00 and the SVXII (r-ϕ component) are nearly the same (88 compared to 77), with layer 00 again having a wider distribution (*i.e.* more fluctuations).

Table 5.3. Average maximum pathway hits per event in the forward, middle, center, and inner region of layer 00, for 10,000 dijet events at 2 TeV with pile-up (<6> min-bias, σ_z = 30 cm) and assuming 1.6 % noise (N_{over} = 7).

Layer 00: Pathway with Maximum Hits								
Forward	Middle	Center	Inner	Inner	Central	Middle	Forward	all
39	48	54	72	72	54	48	39	88

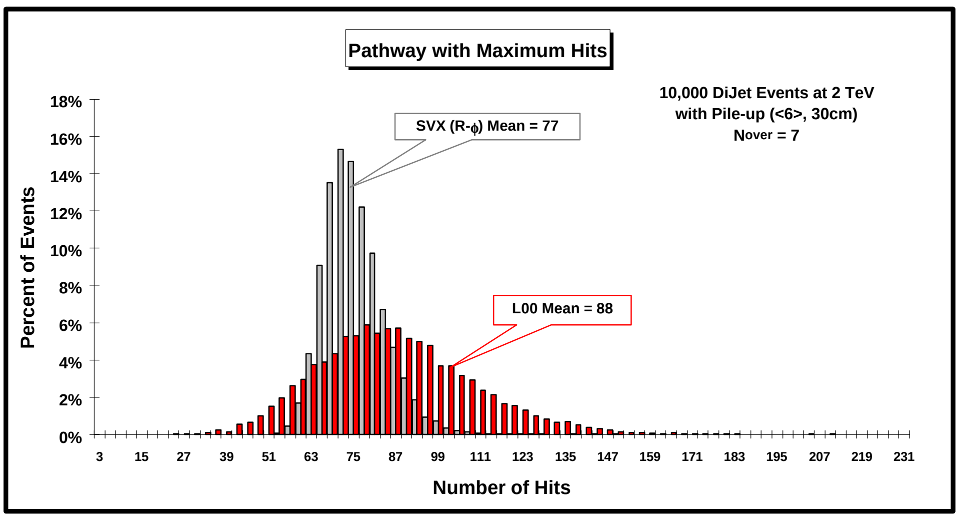

Fig. 5.5. Distribution of the number of hits in the layer 00 readout pathway with the maximum hits per event and the r-ϕ component of the SVXII readout pathway with the maximum r-ϕ hits, for dijet events at 2 TeV with pile-up (<6> min-bias, σ_z = 30 cm) assuming 1.6% noise (N_{over}=7)

VI. Maximum Pathway Readout Time

The overall readout time of the event is governed by the readout pathway with the maximum number of hits. The readout time is simply the number of hits in the readout pathway with the maximum hits divided by 25 MHz. Fig. 6.1 shows the distribution of readout times for layer 00 pathway with the maximum hits per event, for dijet events with pile-up (<3> min-bias) assuming 1.6% noise (N_{over}= 7). The average maximum pathway readout time is about 2.9 μs. Fig. 6.2 shows the distribution of layer 00 readout times, for top quark events with pile-up (<3> min-bias) assuming 1.6% noise (N_{over}= 7). Here the average maximum pathway readout time increases to 4.5 μs. Fig. 6.3 shows the distribution of layer 00 readout times, for dijet events with pile-up (<6> min-bias) assuming 1.6% noise (N_{over}= 7). In this case, the average maximum pathway readout time is about 3.5 μs.

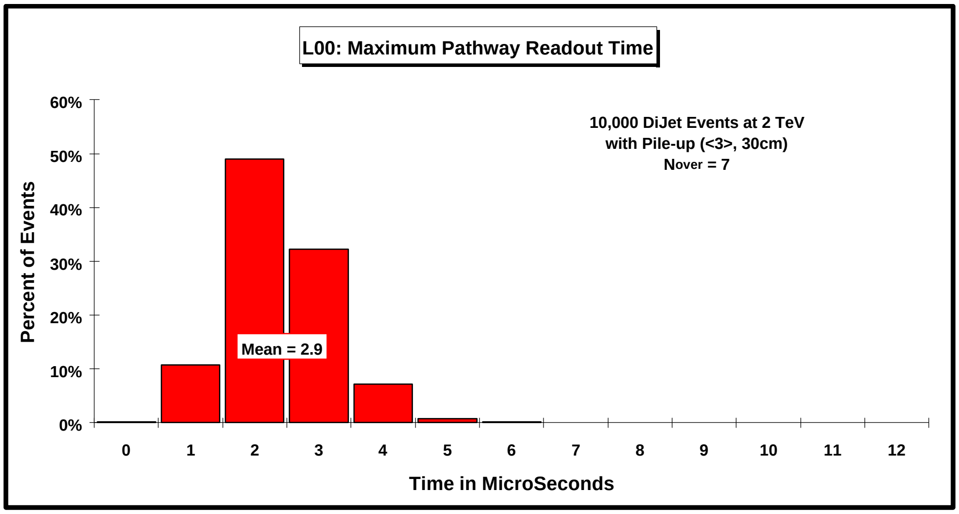

Fig. 6.1. Distribution of the layer 00 maximum pathway readout time, for dijet events at 2 TeV with pile-up (<3> min-bias, σ_z = 30 cm) assuming 1.6% noise (N_{over}= 7).

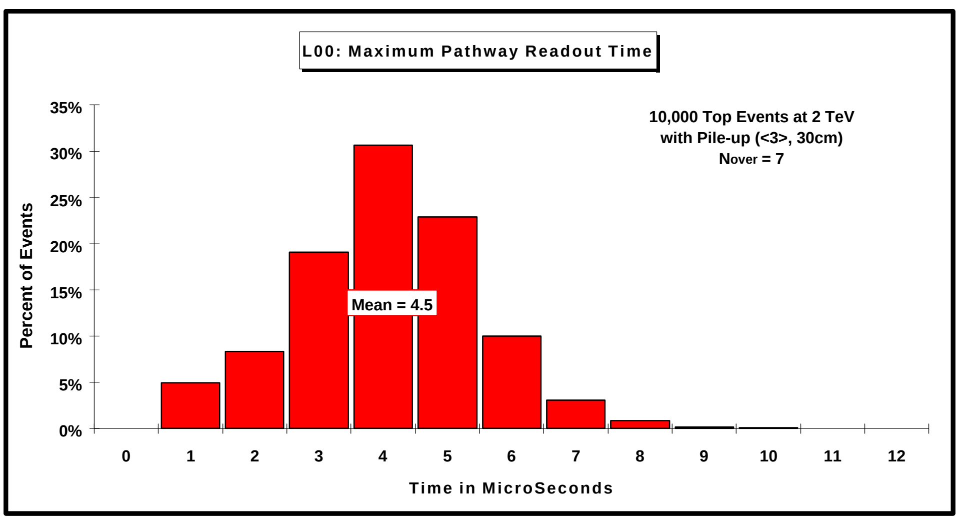

Fig. 6.2. Distribution of the layer 00 maximum pathway readout time, for top quark events at 2 TeV with pile-up (<3> min-bias, σ_z = 30 cm) assuming 1.6% noise (N_{over}= 7).

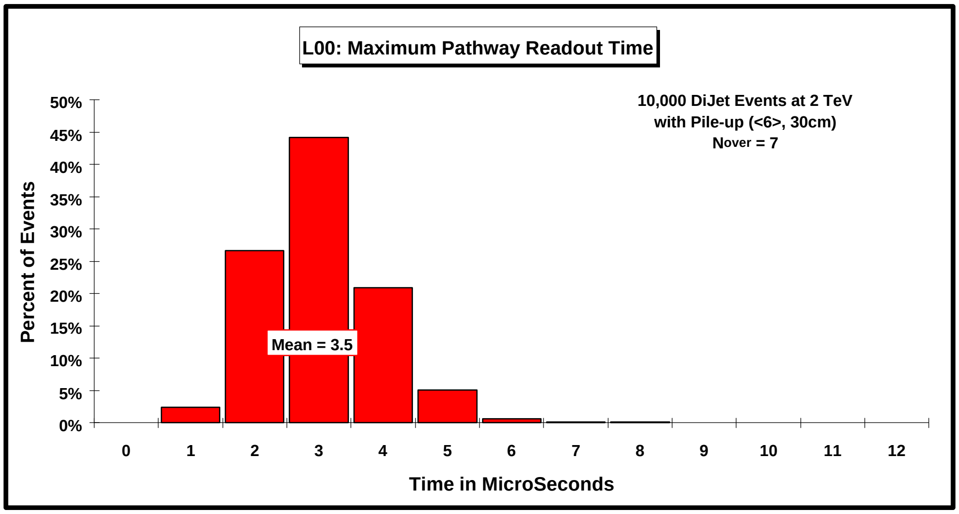

Fig. 6.3. Distribution of the layer 00 maximum pathway readout time, for dijet events at 2 TeV with pile-up (<3> min-bias, σ_z = 30 cm) assuming 1.6% noise (N_{over}= 7).

Fig. 6.4 shows the distribution of the event-by-event maximum pathway readout time difference between layer 00 and the SVXII (r-ϕ component only), for dijet events with pile-up (<3> min-bias) and 1.6% noise (N_{over}= 7). At this noise level, the maximum pathway readout time for layer 00 and SVXII are comparable with layer 00 time greater in 49% of the events and the SVXII time greater in 51% of the events. Although, the average pathway readout time is about zero, the distribution in Fig. 6.4 is broad and ranges form –3 µs to 3 µs.

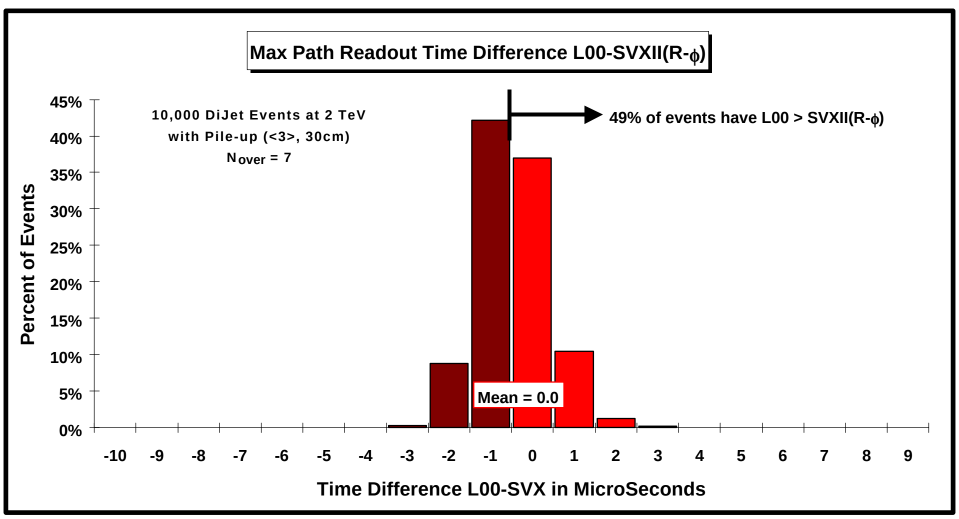

Fig. 6.4. Event-by-event maximum pathway readout time difference between layer 00 and the R-ϕ component of the SVXII. The plot shows L00-SVXII(R-ϕ) for dijet events at 2 TeV with pile-up (<3> min-bias, σ_z = 30 cm) assuming 1.6% noise (N_{over}=7). The average readout time difference is zero with layer 00 having the longer readout time in 49% of the events.

Fig. 6.5 shows the distribution of the event-by-event maximum pathway readout time difference between layer 00 and the SVXII, for top quark events with pile-up (<3> min-bias) and 1.6% noise

(N_{over}= 7). For top quark events, the maximum pathway readout time for layer 00 is, on the average, about 0.4 μs longer than the SVXII (r-ϕ component) with the layer 00 time greater in 68% of the events. Fig. 6.6 shows the distribution of the event-by-event maximum pathway readout time difference between layer 00 and the SVXII, for dijet events with pile-up (<6> min-bias) and 1.6% noise (N_{over}= 7). Here the readout time for layer 00 is again, one the average, about 0.4 μs longer that the SVXII (r-ϕ component) with the layer 00 time greater in 62% of the events. The average maximum pathway readout time difference L00-SVXII(r-ϕ) is similar for dijet events with <6> min-bias and top quark events with <3> min-bias, however, the distributions differ. The distribution of the event-by-event readout time difference L00-SVXII(r-ϕ) is much broader for top quark events with <3> min-bias than for dijet events with <6> min-bias.

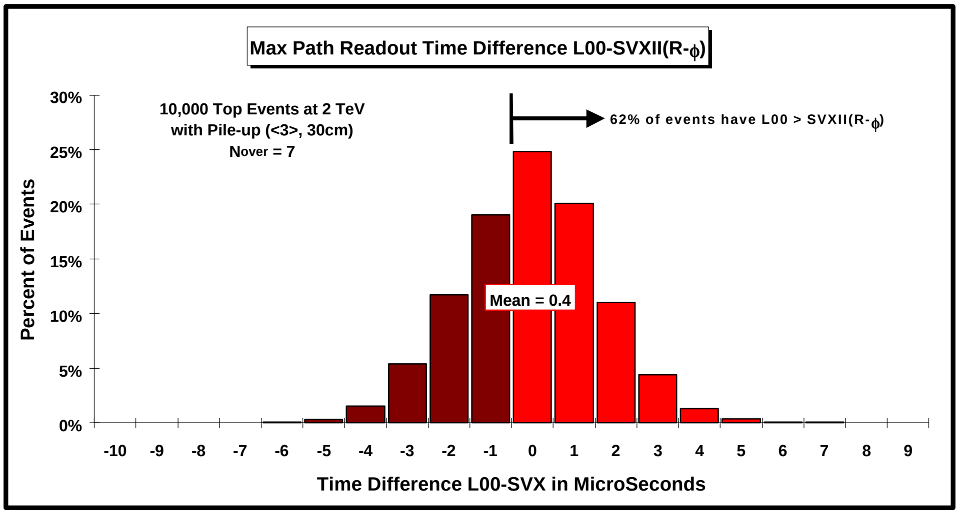

Fig. 6.5. Event-by-event maximum pathway readout time difference between layer 00 and the r-ϕ component of the SVXII. The plot shows L00-SVXII(r-ϕ) for top quark events at 2 TeV with pile-up (<3> min-bias, σ_z = 30 cm) assuming 1.6% noise (N_{over}= 7). The average readout time difference is 0.4 μs with layer 00 having the longer readout time in 62% of the events.

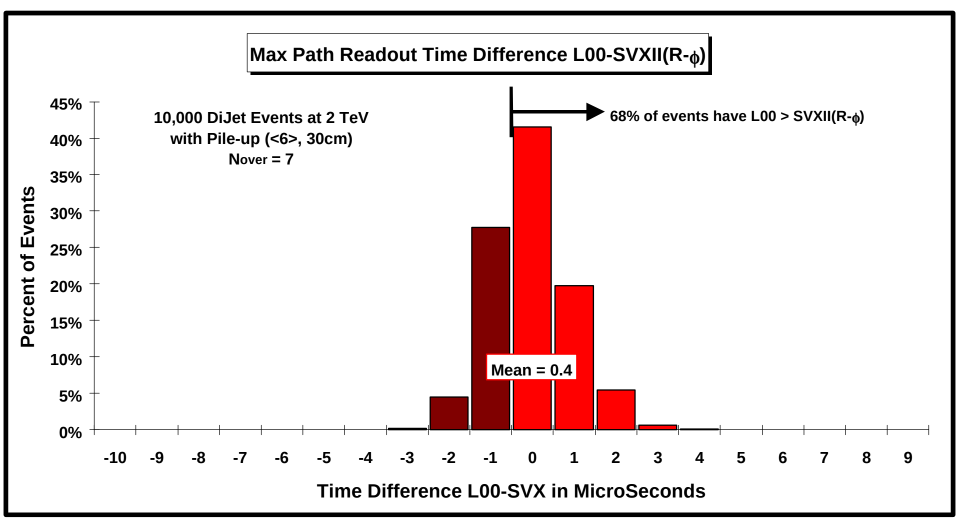

Fig. 6.6. Event-by-event maximum pathway readout time difference between layer 00 and the r-ϕ component of the SVXII. The plot shows L00-SVXII(r-ϕ) for dijet events at 2 TeV with pile-up (<6> min-bias, σ_z = 30 cm) assuming 1.6% noise (N_{over}= 7). The average readout time difference is 0.4 μs with layer 00 having the longer readout time in 68% of the events.

VI. Group and Super-Group with Maximum Hits

Table 6.1 shows the average number of hits in each of the 12 layer 00 readout groups (portcards), for dijet events with pile-up (<3> min-bias) assuming 1.6% noise (N_{over} = 7). A layer 00 readout group is formed by combining neighboring forward, middle, and inner readout pathways as shown in Fig. 2.2. Each of the 12 layer 00 readout groups consists of 4 pathways and 9 chips (see Table 6.2). Table 6.1 also shows the percentage of events in which the group contained the maximum number of hits and the average number of hits when the group was the maximum group (*max hits*). The average maximum hits in Table 6.1 is different from the average maximum hits in, for example, Table 5.1. Each row of Table 6.1 (except for the row labeled "all") corresponds to just one group, and "max hits" is the average number of hits for events in which that group was *the group with maximum hits within the entire detector*. Each entry in Table 5.1 contains more than one pathway, and there the maximum hits corresponds to the pathway with maximum hits within the given region (*may not be the pathway with the maximum hits within the entire detector*).

Table 6.1. Average number of hits in each of the 12 layer 00 groups for dijet events at 2 TeV with pile-up (<3> min-bias, σ_z = 30 cm) assuming 1.6% noise (N_{over}= 7). The table also shows the percentage of events in which the group contained the maximum number of hits and the average number of hits when the group was the maximum group (*max hits*). Also shown is the pathway with maximum hits contributing to the group (*max path*) and the average readout time of the group when the group was the maximum group. For the row labeled "all groups," "max hits" corresponds to the group with maximum hits.

	Layer 00: Group Information					
	Ave Hits	**%Max**	**Max Hits**	**Paths/Chips**	**Max Path**	**Read Time**
Group A	125	8.3%	176	4/9	47	7.0
Group B	125	8.8%	174	4/9	46	7.0
Group C	125	8.1%	178	4/9	46	7.1
Group D	125	8.0%	176	4/9	46	7.0
Group E	125	8.4%	179	4/9	47	7.1
Group F	125	8.1%	178	4/9	46	7.1
Group F	125	8.2%	172	4/9	46	6.9
Group E	125	8.5%	176	4/9	46	7.0
Group D	125	8.5%	179	4/9	46	7.1
Group C	125	8.3%	179	4/9	47	7.1
Group B	125	8.2%	179	4/9	47	7.2
Group A	126	8.6%	178	4/9	47	7.1

All Groups	**1,502**	**100%**	**177**	**48/108**	**72**	**7.1**

Table 6.1 also shows the pathway with maximum hits contributing to each group (*max path*) and the average readout time of the group when the group was the group with maximum hits within the detector. Since events are, on the average, azimuthally symmetric every group in Table 6.1 should be identical and be the maximum group exactly 100%/12 = 8.3% of the time. Deviations from azimuthal symmetry are due to the limited statistics. For all groups "max hits" is the group with maximum hits. For dijet events plus <3> min-bias the overall average maximum group hits is 177.

Fig. 6.1 shows the distribution of the number of hits in the layer 00 readout group with the maximum hits per event and the r-ϕ component of the SVXII readout group with the maximum r-ϕ hits, for dijet events with pile-up (<3> min-bias) assuming 1.6% noise (N_{over}=7). The average maximum group hits for the SVXII (r-ϕ component) is 283 compared to 177 for layer 00 (about a factor of 1.6).

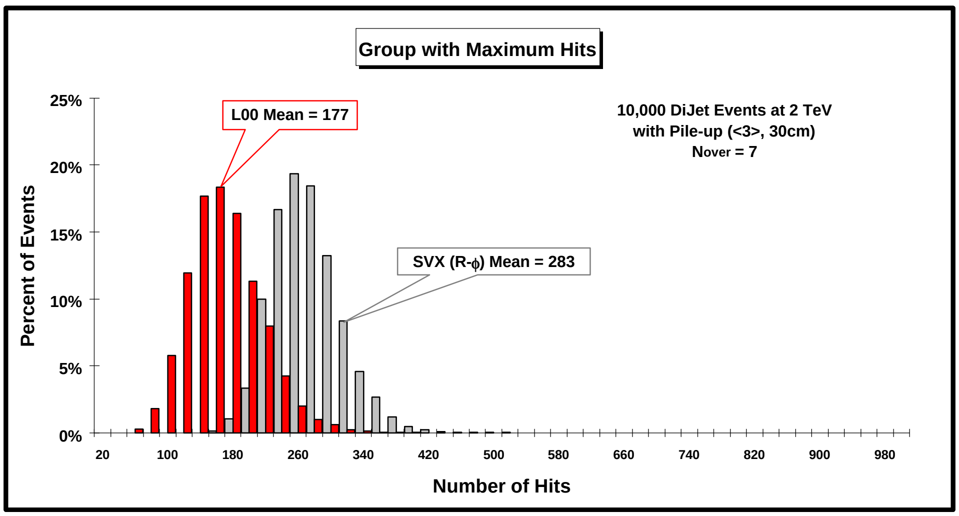

Fig. 6.1. Distribution of the number of hits in the layer 00 readout group with the maximum hits per event and the r-ϕ component of the SVXII readout group with the maximum r-ϕ hits, for dijet events at 2 TeV with pile-up (<3> min-bias, σ_z = 30 cm) assuming 1.6% noise (N_{over}=7).

An SVXII readout group corresponds to combining the 5 pathways (layer 0, 1, 2, 3, 4) within a single wedge within a half-ladder (*i.e.* one portcard). There are 72 SVXII readout groups (12 in ϕ times 6 in z) each consisting of 5 pathways and 23 r-ϕ chips (see Table 6.2). Table 6.3 shows the average number of hits (r-ϕ component only) in each of the 72 SVXII groups, for dijet events (plus <3> min-bias) assuming 1.6% noise (Nover = 7). An SVXII readout super-group is the sum of the six half-ladders corresponding to the same ϕ-wedge and contains 30 pathways and 138 chips (highest level of SVT readout granularity). Table 6.3 also shows the average number of hits (r-ϕ component only) in each of the 12 SVXII super-groups.

Table 6.2. Comparison of the number of readout pathways and chips per group and super-group for layer 00 and the SVXII (r-ϕ component).

Groups and Super-Groups		
	Layer 00 Paths/Chips	SVXII (r-ϕ) Paths/Chips
Groups	4/9	5/23
Super-Groups	8/18	30/138

Table 6.2. Average number of hits (r-ϕ component only) in each of the 72 SVXII groups (12 in ϕ times 6 in z) for dijet events at 2 TeV with pile-up (<3> min-bias, σ_z = 30 cm) assuming 1.6% noise (N_{over}= 7). The table also shows the average number of hits (r-ϕ component only) in each of the 12 SVXII super-groups (sum of iz = 1 to 6).

SVXII	Ave Group and Super-Group Hits (r-ϕ only)						
iphi	iz= 1	2	3	4	5	6	SuperG
1	196	208	216	215	208	195	1,239
2	201	215	223	223	213	200	1,274
3	196	208	215	216	207	195	1,236
4	201	215	222	223	214	200	1,274
5	196	209	216	216	208	195	1,239
6	201	215	224	224	214	199	1,276
7	196	208	216	215	208	195	1,237
8	200	215	223	223	214	199	1,274
9	197	208	215	215	207	195	1,236
10	201	216	223	222	214	199	1,274
11	196	209	215	215	207	195	1,238
12	200	215	223	223	214	200	1,274
sum	2,379	2,541	2,630	2,629	2,527	2,366	15,071

Table 6.4 shows the average number of hits (r-ϕ component only) in each of the 72 SVXII readout groups *when that group was the group with maximum hits within the entire detector*. The overall average maximum SVXII group hits (r-ϕ component only) is 283 as shown in Fig. 6.1.

Table 6.4. Average number of hits (r-ϕ component only) in each of the 72 SVXII groups (12 in ϕ times 6 in z) *when that group was the group with maximum hits,* for dijet events at 2 TeV with pile-up (<6> min-bias, σ_z = 30 cm) assuming 1.6% noise (N_{over}= 7). The overall average maximum group hits is 283 (see Fig. 6.1). Also shown is the average number of hits in each of the 12 SVXII super-groups *when that super-group was the super-group with maximum hits*. The overall average maximum super-group hits is 1,263.

SVXII	Ave Max Group & SuperG Hits (r-ϕ only)						
iphi	iz= 1	2	3	4	5	6	SuperG
1	273	282	279	279	281	265	1,237
2	272	285	289	292	283	269	1,274
3	270	279	279	281	278	270	1,243
4	280	289	291	296	285	275	1,269
5	263	285	292	291	282	266	1,245
6	274	285	291	287	281	276	1,271

7	267	278	288	277	285	267	**1,241**
8	275	281	286	288	285	278	**1,270**
9	272	282	279	283	286	268	**1,247**
10	272	287	290	284	290	271	**1,272**
11	270	287	282	280	280	266	**1,244**
12	273	284	290	291	290	275	**1,272**
all	**272**	**284**	**287**	**287**	**284**	**271**	**1,263**

Table 6.4 also shows the average number of hits (r-ϕ component only) in each of the 12 SVXII super-groups *when that super-group was the super-group with maximum hits within the entire detector*. Fir dijet events (plus <3> min-bias), the overall average maximum SVXII super-group hits (r-ϕ component only) is 1,263. Table 6.5 shows the average number of hits in each of the six layer 00 super-groups. The table shows the percentage of events in which the layer 00 super-group contained the maximum number of hits and the average number of hits *when the super-group was the maximum super-group within the entire detector*. The overall average maximum layer 00 super-group hits is 283 (see Fig. 6.2), compared to 1,263 for the SVXII (a factor of 4.5). The distribution of the number of hits in the layer 00 readout super-group with the maximum hits per event, for dijet events with pile-up (<3> min-bias) assuming 1.6% noise (N_{over}= 7) is shown in Fig. 6.2.

Table 6.5. Average number of hits in each of the six layer 00 super-groups, for dijet events at 2 TeV with pile-up (<3> min-bias, σ_z = 30 cm) assuming 1.6% noise (N_{over}=7). The table shows the percentage of events in which the super-group contained the maximum number of hits and the average number of hits when the super-group was the maximum super-group (*max hits*). Also shown is the group with maximum hits contributing to the super-group (*max group*) and the readout time of the super-group when the super-group was the super-group with maximum hits. For all super-groups "max hits" is the super-group with maximum hits.

Layer 00: Super-Group Information						
	Ave Hits	**%Max**	**Max Hits**	**Paths/Chips**	**Max Group**	**Read Time**
SuperG A	251	17.9%	284	8/18	150	11.4
SuperG B	250	17.2%	285	8/18	150	11.4
SuperG C	250	16.6%	284	8/18	150	11.4
SuperG D	250	16.3%	285	8/18	150	11.4
SuperG E	250	15.9%	281	8/18	150	11.2
SuperG F	250	16.1%	281	8/18	150	11.3
All SuperG	**1,502**	**100%**	**283**	**48/108**	**177**	**11.3**

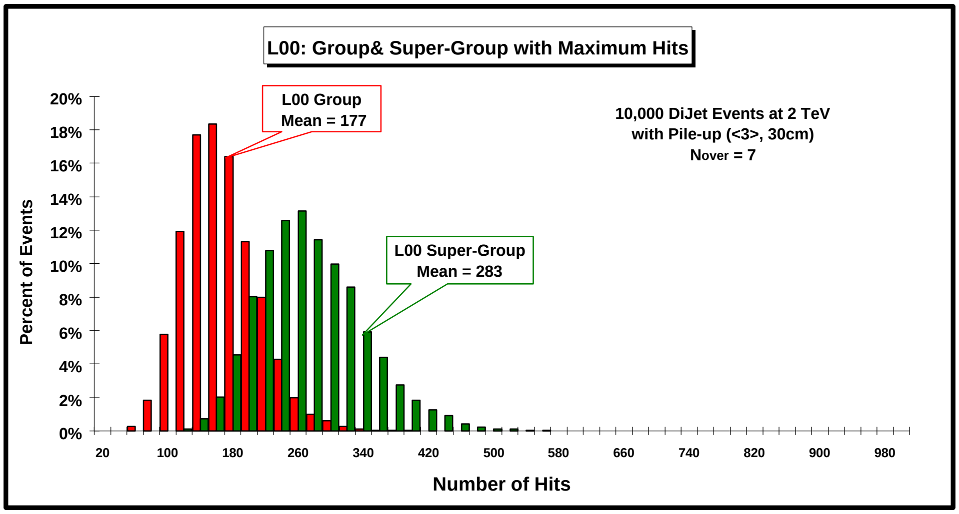

Fig. 6.2. Distribution of the number of hits in the layer 00 readout group with the maximum hits per event and the layer 00 readout super-group with the maximum hits per event, for dijet events at 2 TeV with pile-up (<3> min-bias, σ_z = 30 cm) assuming 1.6% noise (N_{over}=7)

Table 6.6 shows the average number of hits in each of the 12 layer 00 groups, for top quark events with pile-up (<3> min-bias) assuming 1.6% noise (Nover = 7). The table also shows the percentage of events in which the group contained the maximum number of hits and the average number of hits when the group was the maximum group (*max hits*) within the detector. Also shown is the pathway with maximum hits contributing to the group (*max path*) and the average readout time of the group when the group was the maximum group. For top quarks the layer 00 overall average maximum group hits is 244 compared to 177 for dijets. Fig. 6.3 shows the distribution of the number of hits in the layer 00 readout group with the maximum hits per event and the r-ϕ component of the SVXII readout group with the maximum r-ϕ hits. For top quark events (plus <3> min-bias) the average maximum group hits for SVXII (r-ϕ component is 436), which is about a factor of 1.8 larger than the layer 00 value of 244.

Table 6.6. Average number of hits in each of the 12 layer 00 groups for top quark events at 2 TeV with pile-up (<3> min-bias, σ_z = 30 cm) assuming 1.6% noise (N_{over}= 7). The table also shows the percentage of events in which the group contained the maximum number of hits and the average number of hits when the group was the maximum group (*max hits*). Also shown is the pathway with maximum hits contributing to the group (*max path*) and the average readout time of the group. For all groups "max hits" is the group with maximum hits.

Layer 00: Group Information						
	Ave Hits	%Max	Max Hits	Paths/Chips	Max Path	Read Time
Group A	148	8.2%	248	4/9	60	9.9
Group B	148	8.7%	243	4/9	60	9.7
Group C	149	8.6%	242	4/9	60	9.7
Group D	148	8.3%	244	4/9	60	9.8
Group E	149	8.5%	242	4/9	60	9.7

Group F	148	8.4%	246	4/9	60	9.8
Group F	148	8.7%	241	4/9	60	9.7
Group E	147	8.3%	244	4/9	59	9.8
Group D	147	8.2%	240	4/9	59	9.6
Group C	147	8.0%	243	4/9	59	9.7
Group B	147	7.9%	244	4/9	59	9.8
Group A	147	8.2%	246	4/9	59	9.8
All Groups	**1,772**	**100%**	**244**	**48/108**	**114**	**9.7**

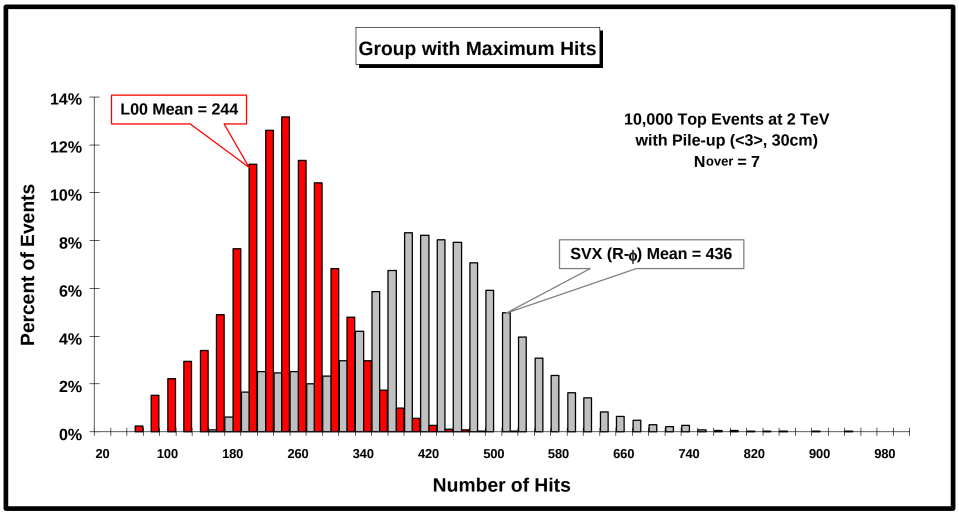

Fig. 6.3. Distribution of the number of hits in the layer 00 readout group with the maximum hits per event and the r-ϕ component of the SVXII readout group with the maximum r-ϕ hits, for top quark events at 2 TeV with pile-up (<3> min-bias, σ_z = 30 cm) assuming 1.6% noise (N_{over}=7).

Table 6.7 shows the average number of hits (r-ϕ component only) in each of the 72 SVXII groups, for top quark events (plus <3> min-bias). The table also shows the average number of hits (r-ϕ component only) in each of the 12 SVXII super-groups. Table 6.8 shows the average number of hits (r-ϕ component only) in each of the 72 SVXII groups *when that group was the group with maximum hits within the detector*. The overall average maximum SVXII group hits (r-ϕ component only) is 436 as shown in Fig. 6.3.

Table 6.7. Average number of hits (r-ϕ component only) in each of the 72 SVXII groups (12 in ϕ times 6 in z) for top quark events at 2 TeV with pile-up (<3> min-bias, σ_z = 30 cm) assuming 1.6% noise (N_{over}=7). The table also shows the average number of hits (r-ϕ component only) in each of the 12 SVXII super-groups (sum of iz = 1 to 6).

SVXII	**Ave Group and Super-Group Hits (r-ϕ only)**						
iphi	**iz= 1**	**2**	**3**	**4**	**5**	**6**	**SuperG**
1	196	208	216	215	208	195	**1,239**
2	201	215	223	223	213	200	**1,274**

3	196	208	215	216	207	195	**1,236**
4	201	215	222	223	214	200	**1,274**
5	196	209	216	216	208	195	**1,239**
6	201	215	224	224	214	199	**1,276**
7	196	208	216	215	208	195	**1,237**
8	200	215	223	223	214	199	**1,274**
9	197	208	215	215	207	195	**1,236**
10	201	216	223	222	214	199	**1,274**
11	196	209	215	215	207	195	**1,238**
12	200	215	223	223	214	200	**1,274**
sum	**2,379**	**2,541**	**2,630**	**2,629**	**2,527**	**2,366**	**15,071**

Table 6.8. Average number of hits (r-ϕ component only) in each of the 72 SVXII groups (12 in ϕ times 6 in z) *when that group was the group with maximum hits*, for top quark events at 2 TeV with pile-up (<6> min-bias, σ_z = 30 cm) assuming 1.6% noise (N_{over}= 7). The overall average maximum group hits is 436 (see Fig. 6.3). Also shown is the average number of hits in each of the 12 SVXII super-groups *when that super-group was the super-group with maximum hits*. The overall average maximum super-group hits is 1,448.

SVXII	**Ave Max Group & SuperG Hits (R-ϕ only)**						
iphi	**iz= 1**	**2**	**3**	**4**	**5**	**6**	**SuperG**
1	406	427	443	441	443	384	**1,423**
2	418	461	456	448	443	413	**1,458**
3	375	470	450	456	455	382	**1,428**
4	419	454	457	461	443	418	**1,458**
5	385	447	445	439	441	399	**1,446**
6	400	465	460	466	459	412	**1,462**
7	404	427	441	432	433	394	**1,429**
8	393	443	454	454	448	415	**1,453**
9	396	436	446	436	438	401	**1,426**
10	418	449	451	450	453	406	**1,453**
11	381	445	458	441	455	399	**1,426**
12	411	451	450	450	447	394	**1,458**
all	**403**	**449**	**452**	**450**	**447**	**403**	**1,448**

Table 6.8 also shows the average number of hits (r-ϕ component only) in each of the 12 SVXII super-groups *when that super-group was the super-group with maximum hits within the detector*, for the top quark events. The overall average maximum SVXII super-group hits (r-ϕ component only) is 1,448. Table 6.9 shows the average number of hits in each of the six layer 00 super-groups. The table shows the percentage of events in which the layer 00 super-group contained the maximum number of hits and the average number of hits *when the super-group was the maximum super-group*. For the top quark events, the overall average maximum layer 00 super-group hits is 349 (see Fig. 6.4), compared to 1,448 for the SVXII (about a factor of 4.1). The distribution of the number of hits in the layer 00 readout super-group with the maximum hits per event, for the top quark events is shown in Fig. 6.4.

Table 6.9. Average number of hits in each of the six layer 00 super-groups, for top quark events at 2 TeV with pile-up (<3> min-bias, σ_z = 30 cm) assuming 1.6% noise (N_{over}= 7). The table shows the percentage of events in which the super-group contained the maximum number of hits and the average number of hits when the super-group was the maximum super-group (*max hits*). Also shown is the group with maximum hits contributing to the super-group (*max group*) and the readout time of the super-group when the super-group was the maximum super-group. For all super-groups "max hits" is the super-group with maximum hits.

Layer 00: Super-Group Information						
	Ave Hits	%Max	Max Hits	Paths/Chips	Max Group	Read Time
SuperG A	295	16.6%	352	8/18	194	14.1
SuperG B	295	16.6%	349	8/18	194	14.0
SuperG C	295	17.0%	349	8/18	194	14.0
SuperG D	295	16.5%	346	8/18	194	13.8
SuperG E	296	16.7%	347	8/18	194	13.9
SuperG F	296	16.7%	352	8/18	194	14.1
All SuperG	**1,772**	**100%**	**349**	**48/108**	**244**	**14.0**

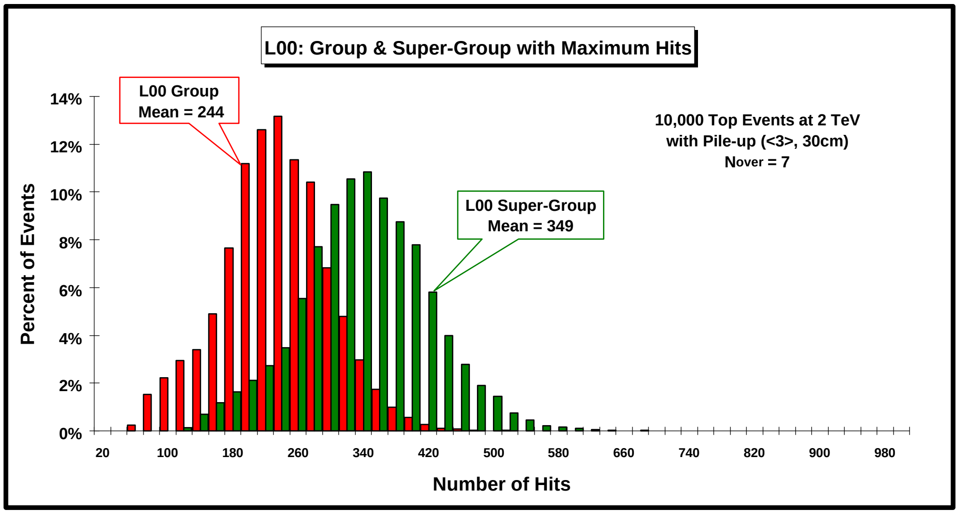

Fig. 6.4. Distribution of the number of hits in the layer 00 readout group with the maximum hits per event and the layer 00 readout super-group with the maximum hits per event, for top quark events at 2 TeV with pile-up (<3> min-bias, σ_z = 30 cm) assuming 1.6% noise (N_{over}= 7).

VII. Maximum Group and Super-Group Readout Time

Fig. 7.1 and Fig. 7.2 show the distribution of the event-by-event maximum group and maximum super-group readout time difference between layer 00 and the SVXII (r-ϕ component only), for dijet events with pile-up (<3> min-bias) and 1.6% noise (N_{over}= 7). Here the maximum group readout time for the SVXII (r-ϕ component) is, on the average, about 4.2 μs longer than layer 00.

The maximum super-group readout time for the SVXII (r-ϕ component) is, on the average, about 39 μs longer than layer 00.

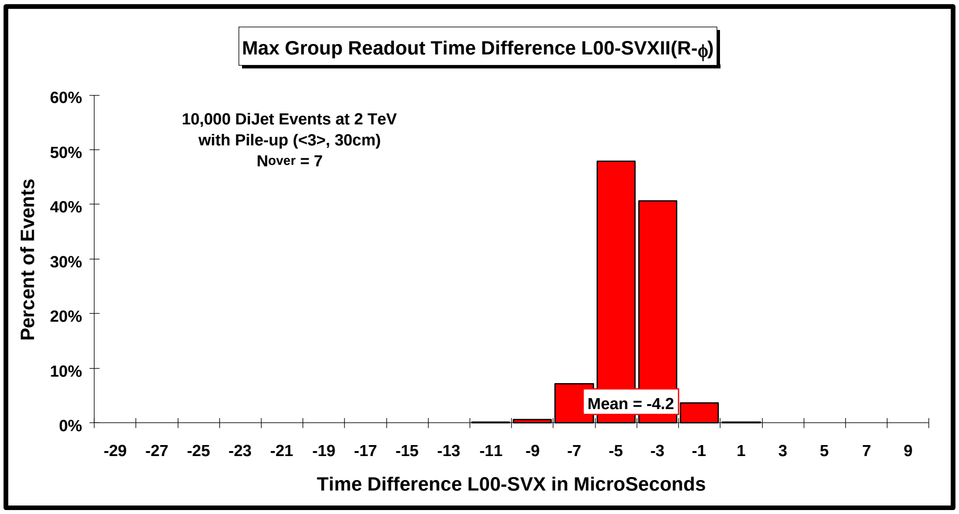

Fig. 7.1. Event-by-event maximum group readout time difference between layer 00 and the r-ϕ component of the SVXII. The plot shows L00-SVXII(r-ϕ) for dijet events at 2 TeV with pile-up (<3> min-bias, σ_z = 30 cm) assuming 1.6% noise (N_{over}=7). The maximum group readout time for the SVXII is, on the average, 4.2 μs longer than layer 00.

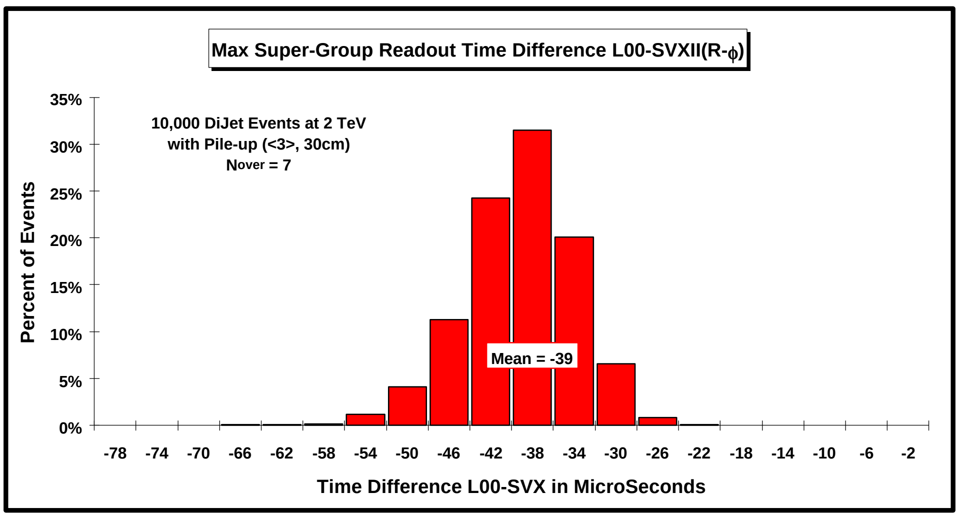

Fig. 7.2. Event-by-event maximum super-group readout time difference between layer 00 and the r-ϕ component of the SVXII. The plot shows L00-SVXII(r-ϕ) for dijet events at 2 TeV with pile-up (<3> min-bias, σ_z = 30 cm) assuming 1.6% noise (N_{over}=7). The maximum super-group readout time for the SVXII is, on the average, 39 μs longer than for layer 00.

Fig. 7.2 and Fig. 7.3 show the distribution of the event-by-event maximum group and maximum super-group readout time difference between layer 00 and the SVXII (r-ϕ component only), for top quark events with pile-up (<3> min-bias) and 1.6% noise (N_{over}= 7). For top quark events the maximum group readout time for the SVXII (r-ϕ component) is, on the average, about 7.7 μs longer than layer 00 and the maximum super-group readout time for the SVXII (r-ϕ component) is, on the average, about 44 μs longer than layer 00.

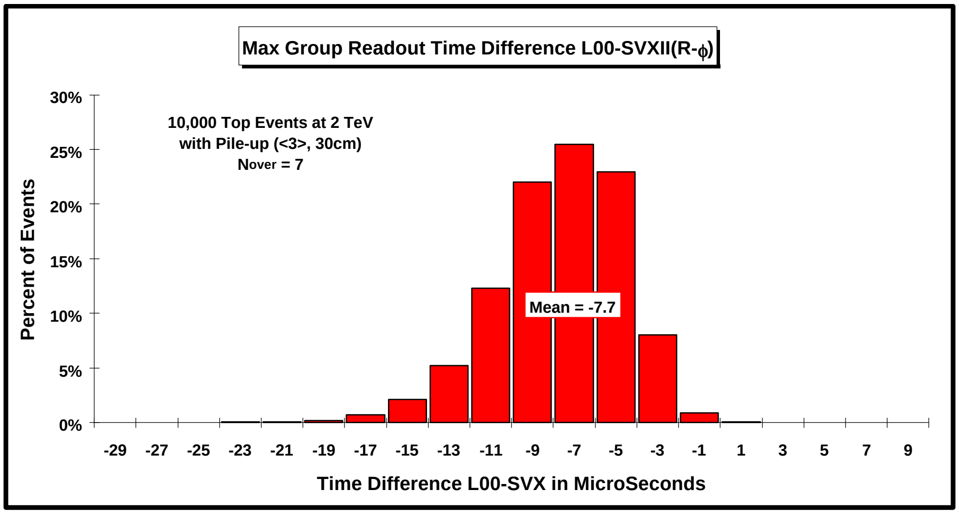

Fig. 7.3. Event-by-event maximum group readout time difference between layer 00 and the r-ϕ component of the SVXII. The plot shows L00-SVXII(r-ϕ) for top quark events at 2 TeV with pile-up (<3> min-bias, σ_z = 30 cm) assuming 1.6% noise (N_{over}=7). The maximum group readout time for the SVXII is, on the average, 7.7 μs longer than for layer 00.

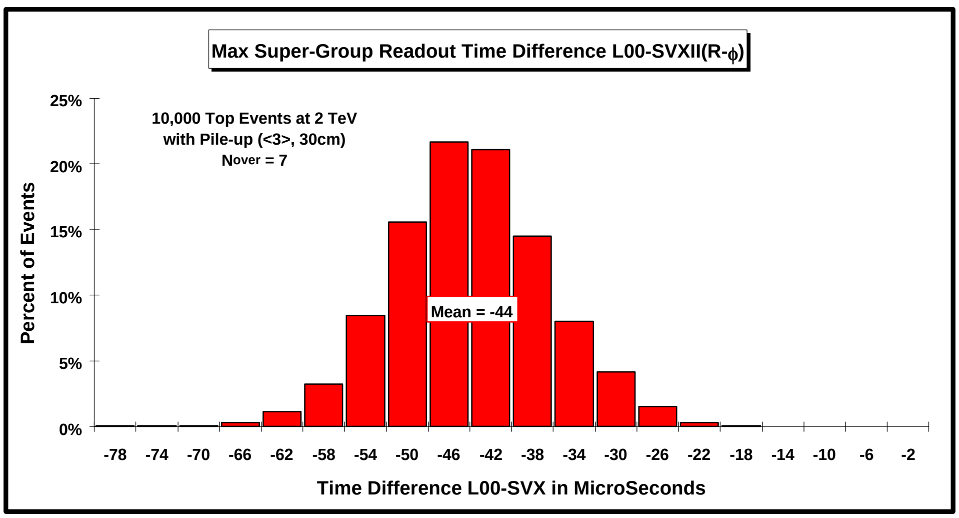

Fig. 7.4. Event-by-event maximum super-group readout time difference between layer 00 and the r-ϕ component of the SVXII. The plot shows L00-SVXII(r-ϕ) for dijet events at 2 TeV with pile-up (<3> min-bias, σ_z = 30 cm) assuming 1.6% noise (N_{over}=7). The maximum super-group readout time for the SVXII is, on the average 44 μs longer than for layer 00.

VIII. Summary and Conclusions

Our simulation of layer 00 has taught us the following:

1. *Layer 00 Chips with Large Occupation*
Although the average chip occupation is low (about 11% for dijets plus <3> min-bias and 13% for top quark events plus <3> min-bias), the average maximum chip occupation is much larger (about 34% for the dijet events and 59% for the top quark events). For dijet events plus <3> min-bias there are, on the average, 5 chips with greater than 25% occupation per event. For top quark events plus <3> min-bias, the average number of chips with greater than 25% occupation increases to 11. Furthermore, for the top quark events there is about a 10% probability of finding greater that 20 chips in an event with greater than 25% occupation.

2. *Layer 00 Event Size*
The total number of readout pathway (HDI) hits represents the overall "event size". The event size is very sensitive to the noise level. For dijet events with pile-up (<3> min-bias) assuming 1.6 % noise (N_{over} = 7), the average total layer 00 chip hits is 1,502 and increases to 1,772 for top quark events (<3> min-bias). For dijet events (plus <6> min-bias), the average total layer 00 chip hits is 1,905.

3. *Layer 00 Maximum Pathway Readout Times*
For dijet events with pile-up (<3> min-bias) assuming 1.6% noise (N_{over}= 7), the average maximum pathway readout time is 2.9 μs and increases to 4.5 μs for top quark events (<3> min-bias). For dijet events (<6> min-bias) assuming 1.6% noise (N_{over}= 7), the average maximum pathway readout time is 3.5 μs.

4. *Event-by-event Readout Time Comparison Layer 00 versus SVXII (r-ƒ component)*
For dijet events with pile-up (<3> min-bias) and 1.6% noise, the maximum pathway readout times for layer 00 and the SVXII (r-ϕ component) are essentially identical, with the layer 00 time greater in 49% of the events and the SVXII time greater in 51% of the events. For top quark events (<3> min-bias), the maximum pathway readout time for layer 00 is, on the average, about 0.4 μs longer than the SVXII (r-ϕ component) with the layer 00 time greater in 68% of the events. For dijet events (<6> min-bias) the maximum pathway readout time for layer 00 is also, on the average, about 0.4 μs longer that the SVXII (r-ϕ component) with the layer 00 time greater in 62% of the events. The maximum group and super-group readout times for layer 00 are considerable shorter than for the SVXII (r-ϕ component). For dijet events at (<3> min-bias), the maximum group readout time for the SVXII is, on the average, about 4.2 μs longer than layer 00 and the maximum super-group readout time for the SVXII is, on the average, about 39 μs longer than layer 00.

For SVT, the pathway, group, and super-group readout represent potential timing bottlenecks. Our simulations indicate that the layer 00 design will provide readout times that do not significantly exceed the SVXII r-ϕ readout time for any of these potential bottlenecks.

Acknowledgments

We would like to thank Joe Incandela for helpful discussions.

References

[1] Occupancy and Readout Time Study of the SVXII, R. D. Field and D. Stuart, CDF note CDF/ANAL/CDF/CDFR/4783 (1998).

[2] Occupancy and Readout Time Study of the ISL, R. D. Field and D. Stuart, CDF note CDF/ANAL/CDF/CDFR/4784 (1998).

[3] F. Paige and S. Protopopescu, BNL Report, BNL38034, 1986 (unpublished), version 7.32.

[4] H.Y. Chao, D. Glenzinski, J. Incandela, N.M. Shaw, F. Snider, D. Stuart, G. Unal, M.J. Wang, and W. Yao, CDF Note, CDF/TOP/DOC/PUBLIC/2946, 1995.