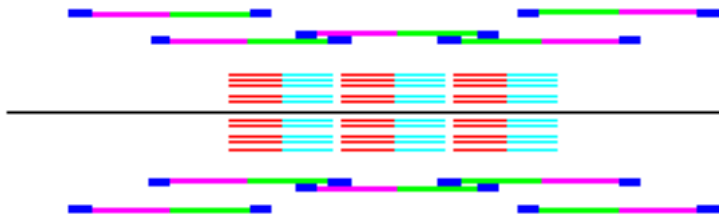




Layer 00

DAQ & Readout Time Study



CDF Note with
David Stuart
will appear soon

See also,
CDF Note 4783 (SVXII)
CDF Note 4784 (ISL)

- Program in positions of all SVXII & L00 **Chips** and **Pathways** (HDI's) (SVXII: 1,656 r- ϕ chips, 1,512 r-z chips, 360 pathways; L00: 108 r- ϕ chips, 48 pathways). Combine pathways to form **Groups** (72 for SVXII, 12 for L00) and **SuperGroups** (12 for SVXII, 6 for L00).
- Include only **GEOMETRY** with chip thickness of 300 microns (no magnetic fields, no energy loss, etc.). A **simple cluster model** is used to determine the number of hits per charged particle track.
- Use **ISAJET** to generate **Top Quark**, **DiJet** (PT(hard) > 10 GeV), and **Min-Bias** events at 2 TeV. Include pile-up with <3> and <6> min-bias collisions per crossing (30 cm interaction region).

www.phys.ufl.edu/~rfield/cdf/

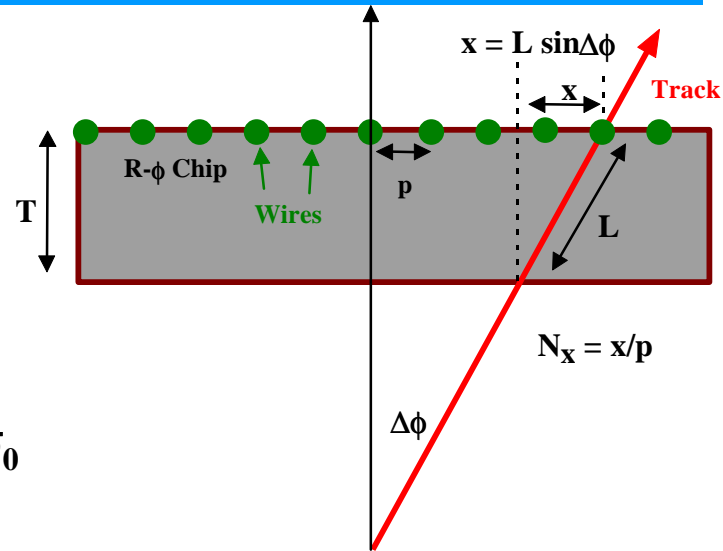


Layer 00

Naïve Cluster Model



- The cluster size, N_{cl} , is generated at random with 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 **pitch**. The standard deviation, σ , is given by $\sigma = f_{\sigma} \sigma_0$, where $\sigma_0 = 0.8$. The factor $f_{\sigma} = (x/p + 1)Q_0/Q$, where Q is the amount of charge produced by the track ($Q = \lambda L$) and $Q_0 = \lambda T$.
- The **number of "hits" per track** is given by
 $N_{hit} = N_{cl} + NN + N_{over}$ where $NN = 2$ for nearest neighbor and where the overhead is $N_{over} = 1 + 6 = 7$.



Corresponds to about 5% noise

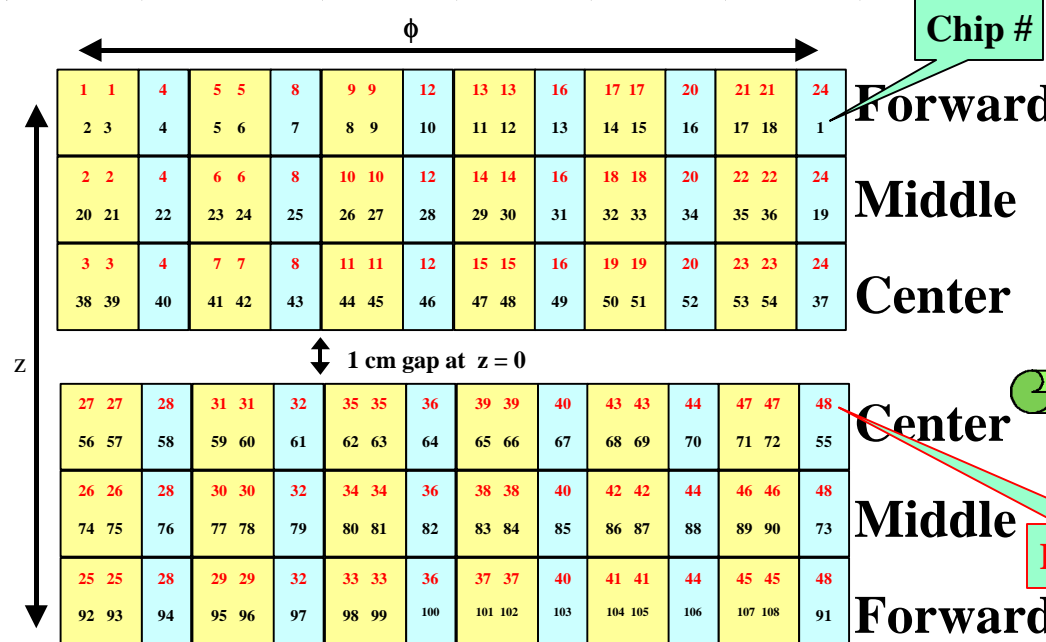


Layer 00 Chips & Pathways



L00: Number of Chips							
Radius	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

108 Chips (silicon area)
48 Pathways (HDI's)



Chip #

Chip Types:
 Forward inner
 Forward outer
 Middle inner
 Middle outer
 Center inner
 Center outer

Pathway Types:
 Forward
 Middle
 Center
 Inner

Pathway #

Outer Inner

Layer 00: Number of Pathways/Chips								
Forward	Middle	Center	Inner	Inner	Central	Middle	Forward	all
6/12	6/12	6/12	6/18	6/18	6/12	6/12	6/12	48/108

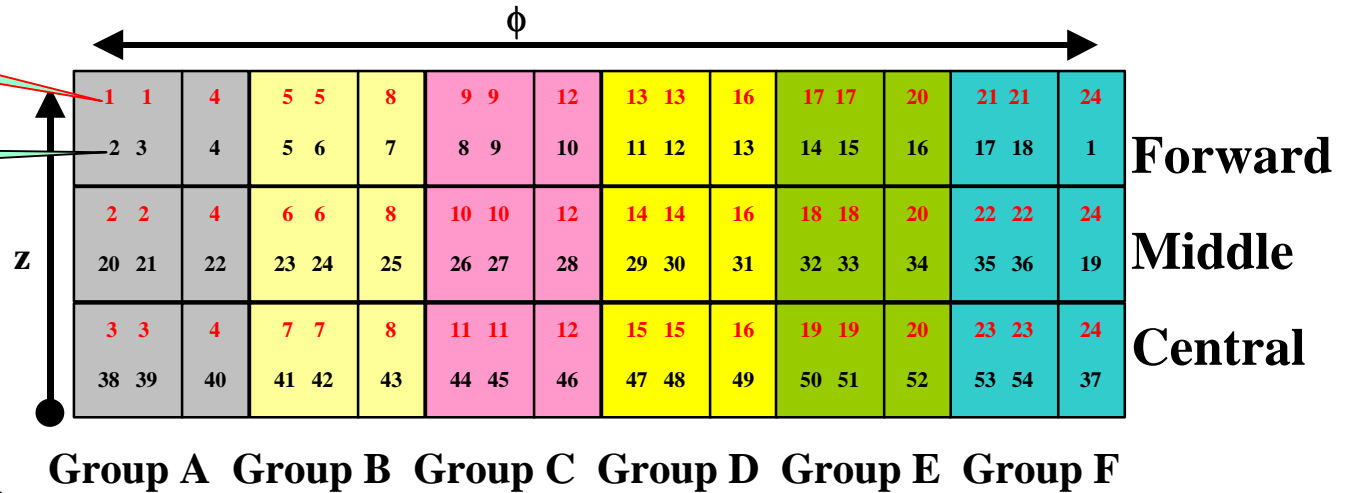


Layer 00 Groups & SuperGroups



Pathway #

Chip #



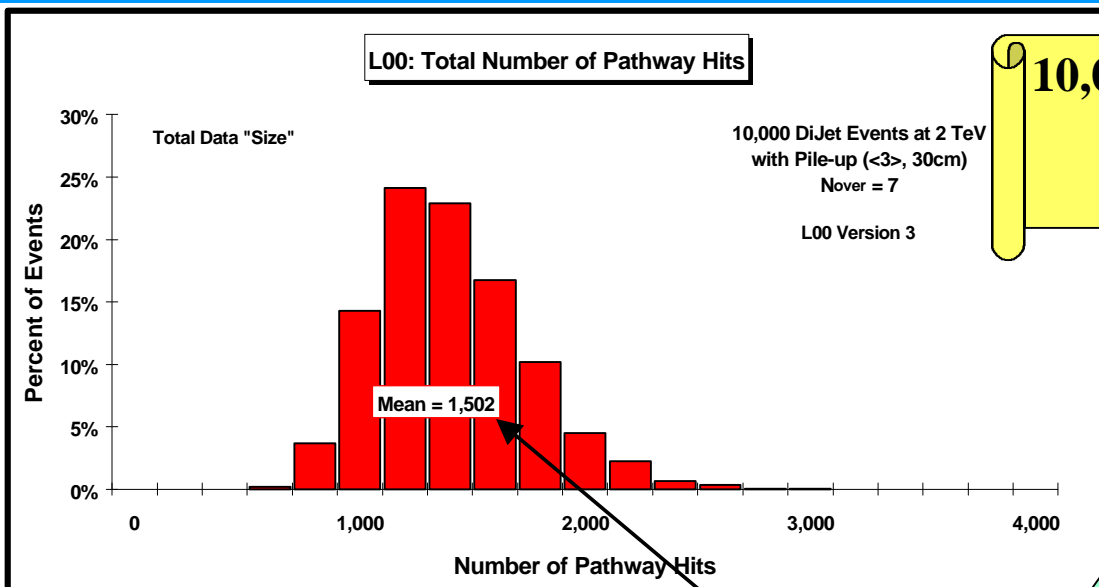
L00: Groups	
	Paths/Chips
Group A	4/9
Group B	4/9
Group C	4/9
Group D	4/9
Group E	4/9
Group F	4/9
Group F	4/9
Group E	4/9
Group D	4/9
Group C	4/9
Group B	4/9
Group A	4/9
All Groups	48/108

L00: SuperGroups	
	Paths/Chips
SuperG A	8/18
SuperG B	8/18
SuperG C	8/18
SuperG D	8/18
SuperG E	8/18
SuperG F	8/18
All SuperG	48/108

12 Groups (4 paths, 9 chips)
6 SuperGroups (2 groups)



Layer 00 Total Chip Hits



**10,000 DiJet Events at 2 TeV
with Pile-up
<3>, 30 cm, Nover = 7**

Average Total Chip Hits

L00: Average Total Chip Hits							
Radius	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

L00: Average Hits/Chip							
Radius	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

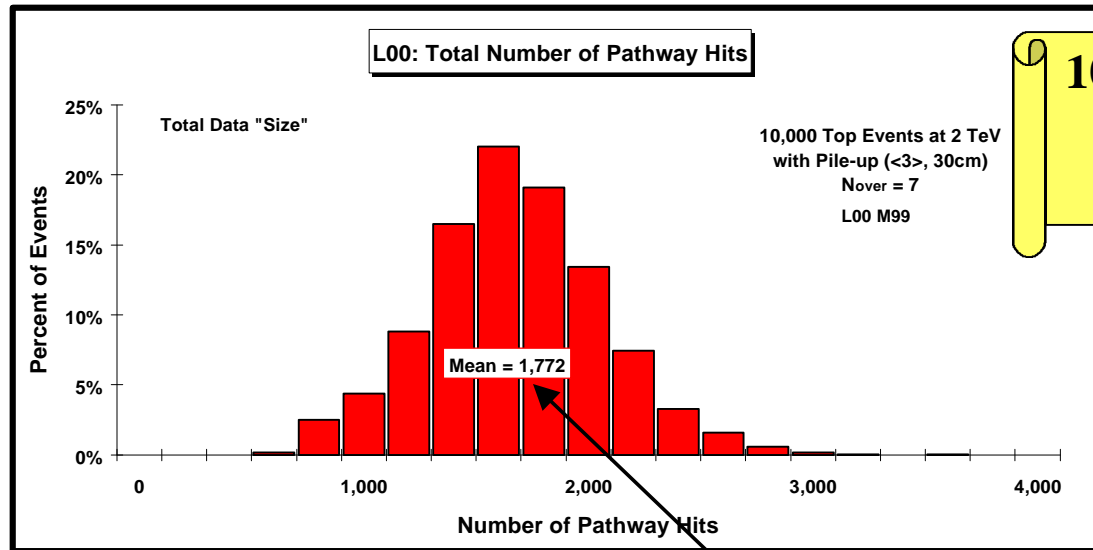
Average Total Occupation:

$$1,502 / (108 * 128) = 10.9\%$$

Average Hits per Chip



Layer 00 Total Chip Hits



**10,000 Top Events at 2 TeV
with Pile-up
<3>, 30 cm, Nover = 7**

Average Total Chip Hits

L00: Average Total Chip Hits							
Radius	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

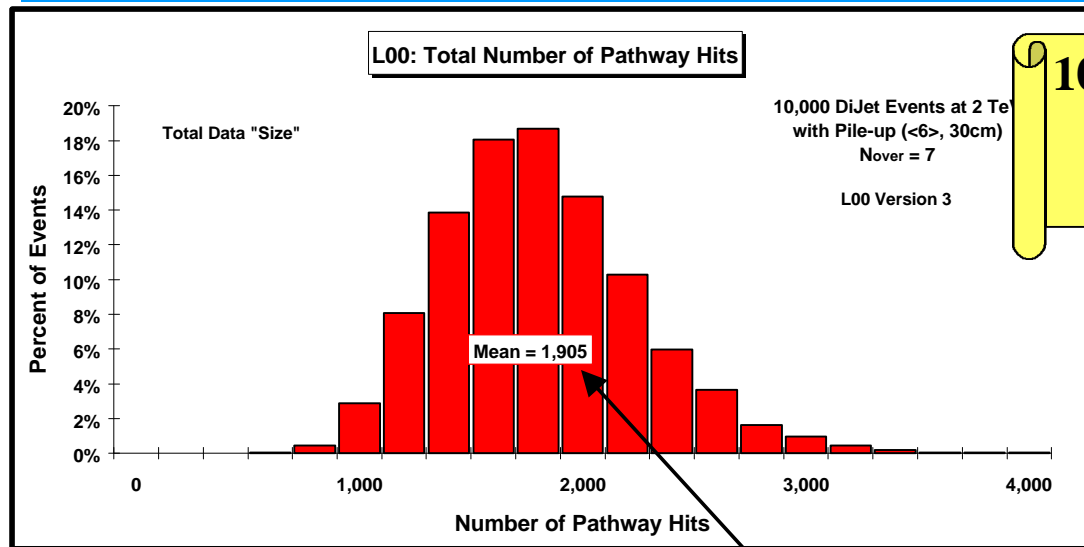
L00: Average Hits/Chip							
Radius	Forward	Middle	Central	Central	Middle	Forward	all
inner	14	18	20	20	18	14	17
outer	13	17	18	18	16	13	16
all	14	17	19	19	17	13	16

**Average Total Occupation:
 $1,772 / (108 * 128) = 12.8\%$**

Average Hits per Chip



Layer 00 Total Chip Hits



**10,000 DiJet Events at 2 TeV
with Pile-up
<6>, 30 cm, Nover = 7**

Average Total Chip Hits

L00: Average Total Chip Hits							
Radius	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

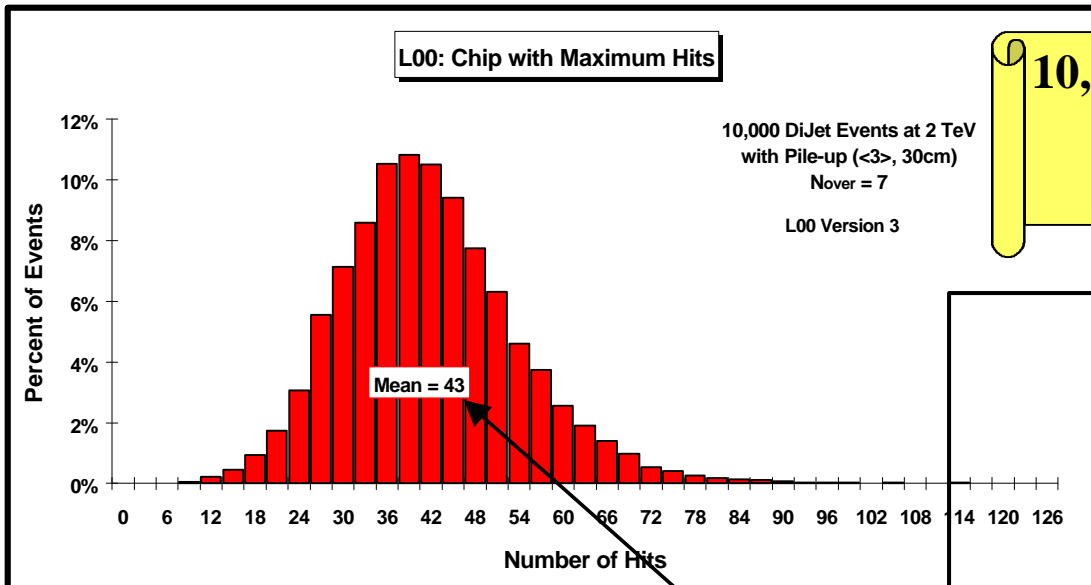
L00: Average Hits/Chip							
Radius	Forward	Middle	Central	Central	Middle	Forward	all
inner	15	19	22	22	19	15	19
outer	14	17	20	20	17	14	17
all	15	18	20	20	18	15	18

**Average Total Occupation:
 $1,905 / (108 * 128) = 13.8\%$**

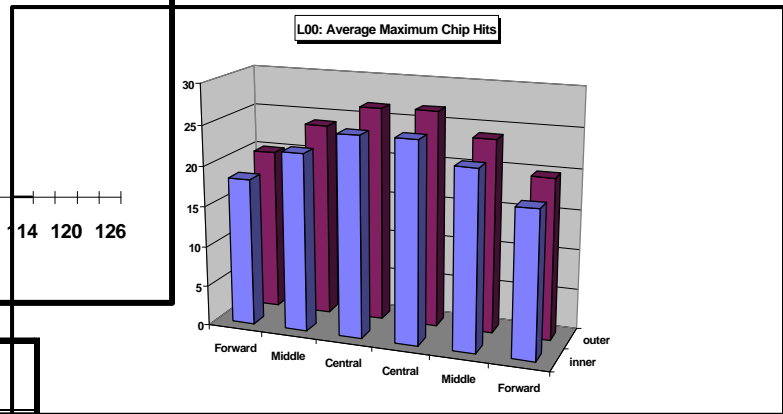
Average Hits per Chip



Layer 00 Chip with Maximum Hits



**10,000 DiJet Events at 2 TeV
with Pile-up
 $\langle 3 \rangle$, 30 cm, Nover = 7**



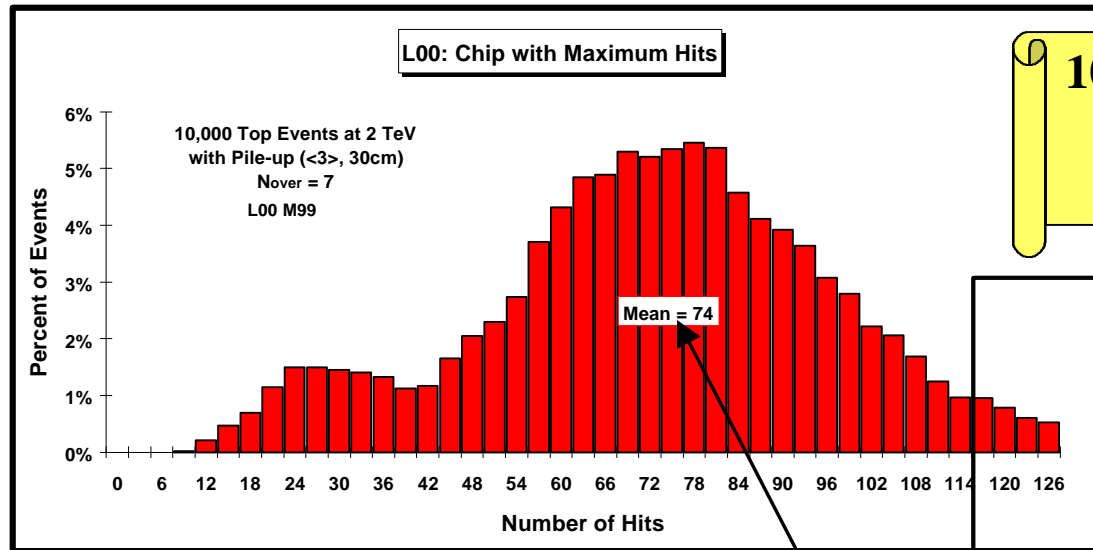
L00: Average Maximum Chip Hits							
Radius	Forward	Middle	Central	Central	Middle	Forward	all
inner	18	22	25	25	22	18	
outer	20	24	27	27	24	20	
all							43

Read time of 1.7 μ s

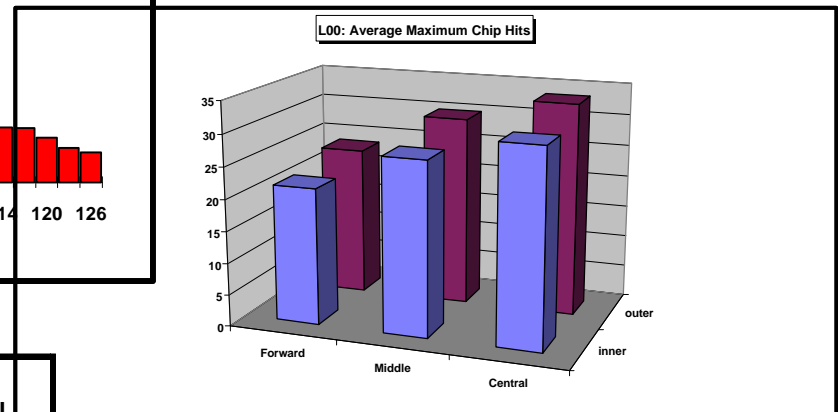
Average Maximum Chip Hits



Layer 00 Chip with Maximum Hits



**10,000 Top Events at 2 TeV
with Pile-up
 $\langle 3 \rangle$, 30 cm, Nover = 7**



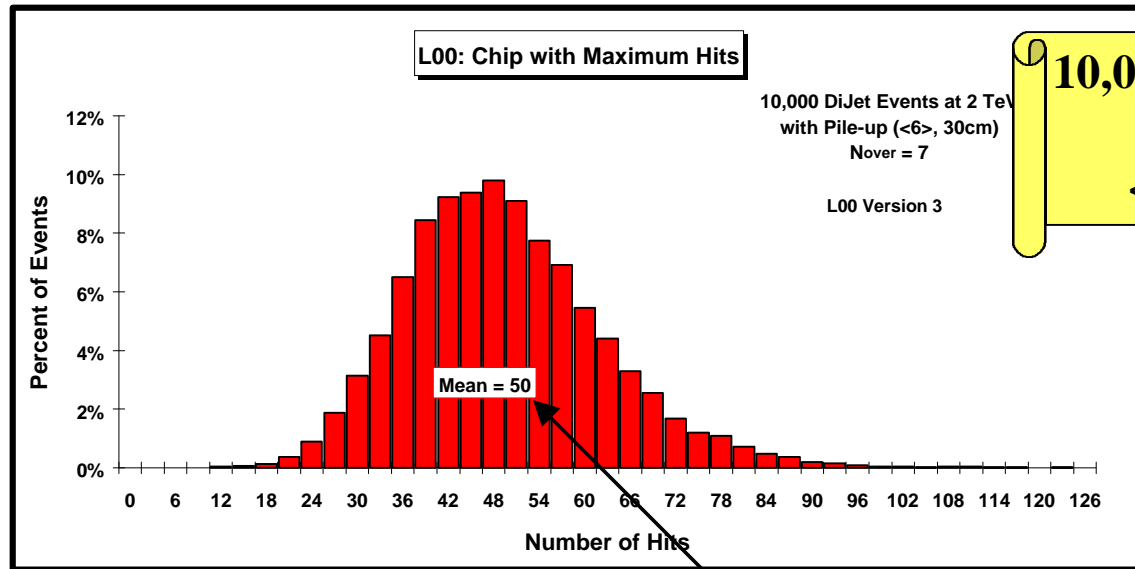
L00: Average Maximum Chip Hits							
Radius	Forward	Middle	Central	Central	Middle	Forward	all
inner	22	27	31	31	27	21	
outer	24	30	33	33	29	23	
all							74

Read time of 3 μ s

Average Maximum Chip Hits



Layer 00 Chip with Maximum Hits



**10,000 DiJet Events at 2 TeV
with Pile-up
<6>, 30 cm, Nover = 7**

L00: Average Maximum Chip Hits

Radius	Forward	Middle	Central	Central	Middle	Forward	all
inner	23	28	32	32	28	23	
outer	25	30	34	34	30	25	
all							50

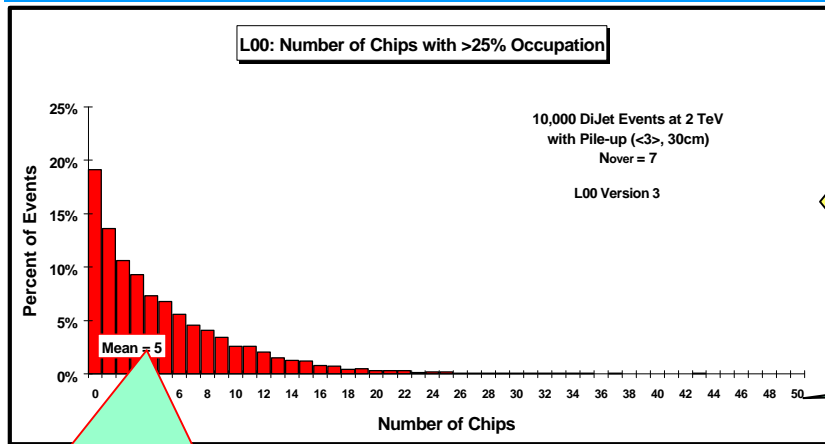
Average Maximum Chip Hits

Read time of 2 μ s



Layer 00

Chip with Large Occupation

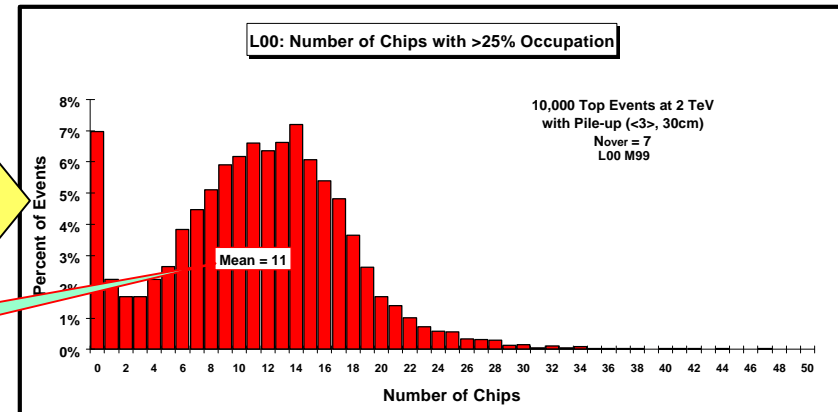


10,000 **DiJet** Events at 2 TeV
with Pile-up
<3>, 30 cm, Nover = 7

Number of Chips per event
with >25% Occupation

There are, on the average, 5 chips
per event with >25% occupation!

10,000 **Top** Events at 2 TeV
with Pile-up
<3>, 30 cm, Nover = 7

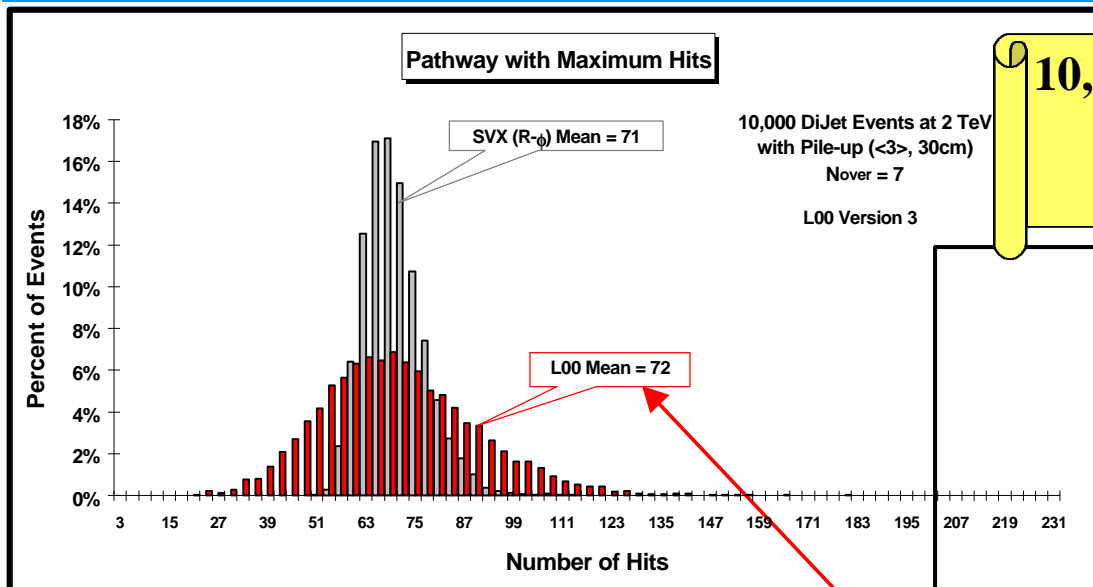


There are, on the average, 11 chips
per event with >25% occupation!

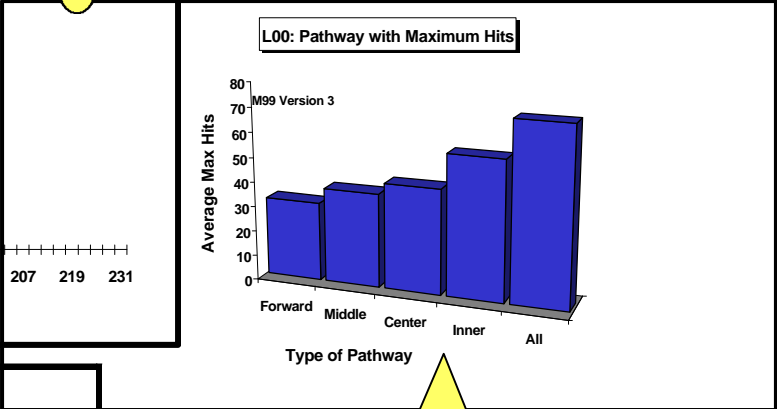


Layer 00

Pathway with Maximum Hits



10,000 DiJet Events at 2 TeV with Pile-up
 $\langle 3 \rangle$, 30 cm, Nover = 7



L00: M99 Version 3 Pathway with Maximum Hits								
Forward	Middle	Center	Inner	Inner	Central	Middle	Forward	all
32	38	42	56	56	42	38	32	72

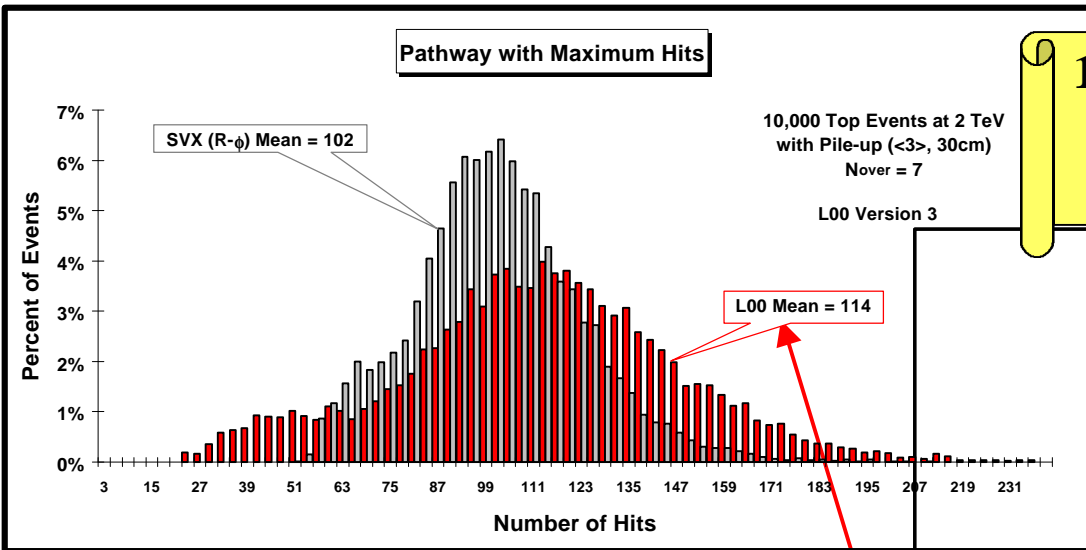
Average Maximum Pathway Hits

Average Maximum Pathway Hits vs Type of Pathway

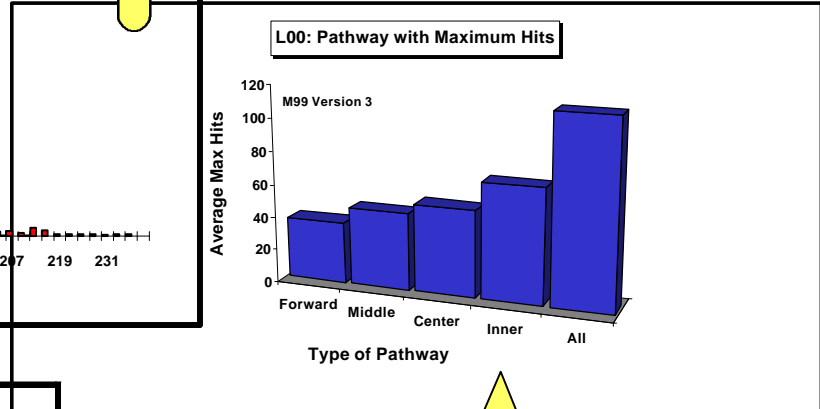


Layer 00

Pathway with Maximum Hits



10,000 Top Events at 2 TeV with Pile-up <3>, 30 cm, Nover = 7



L00: M99 Version 3 Pathway with Maximum Hits								
Forward	Middle	Center	Inner	Inner	Central	Middle	Forward	all
37	47	53	70	69	53	46	37	114

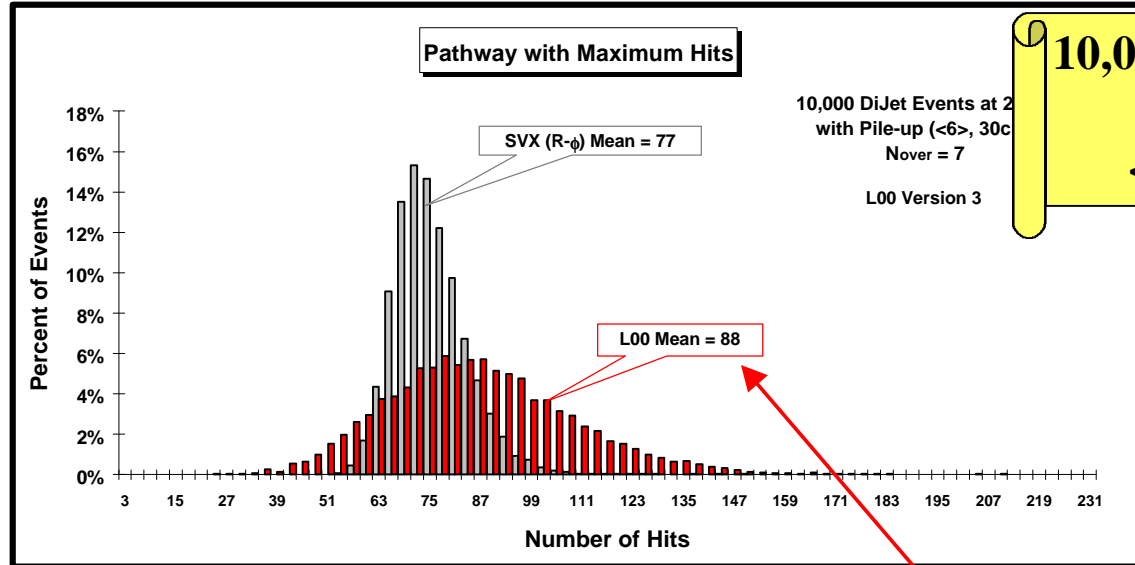
Average Maximum Pathway Hits

Average Maximum Pathway Hits vs Type of Pathway



Layer 00

Pathway with Maximum Hits



10,000 **DiJet** Events at 2 TeV with Pile-up <6>, 30 cm, Nover = 7

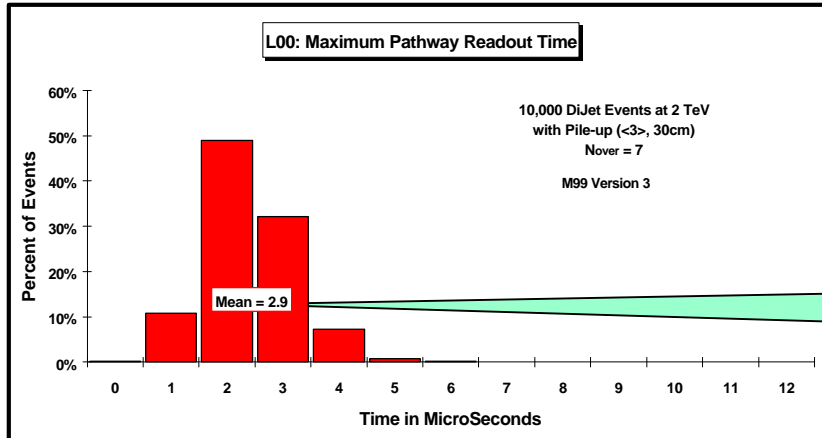
L00: M99 Version 3 Pathway with Maximum Hits								
Forward	Middle	Center	Inner	Inner	Central	Middle	Forward	all
39	48	54	72	72	54	48	39	88

Average Maximum Pathway Hits



Layer 00

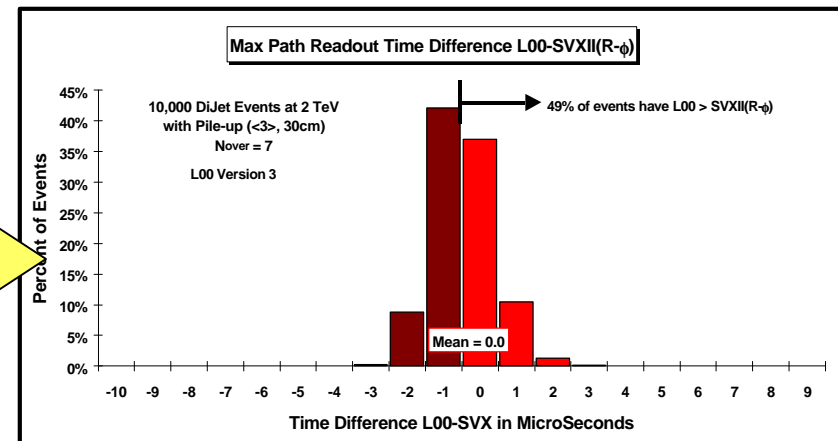
Max Path Readout Time



**10,000 DiJet Events at 2 TeV
with Pile-up
 $\langle 3 \rangle$, 30 cm, Nover = 7**

**Average readout time
of 2.9 μ s.**

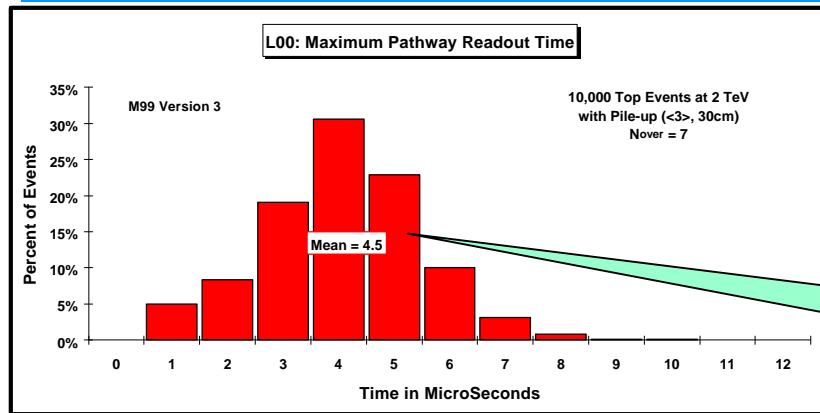
**Event-by-Event Readout Time Difference
L00 - SVXII(R- ϕ) mean = 0.0 μ s**





Layer 00

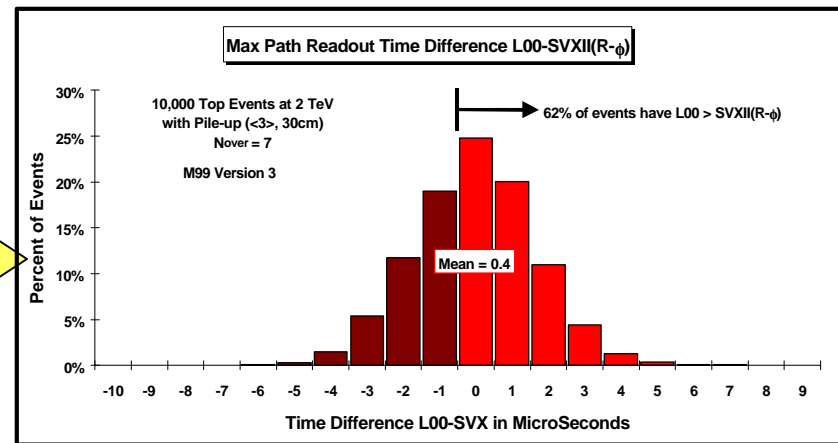
Max Path Readout Time



**10,000 Top Events at 2 TeV
with Pile-up
<3>, 30 cm, Nover = 7**

**Average readout time
of 4.5 μ s.**

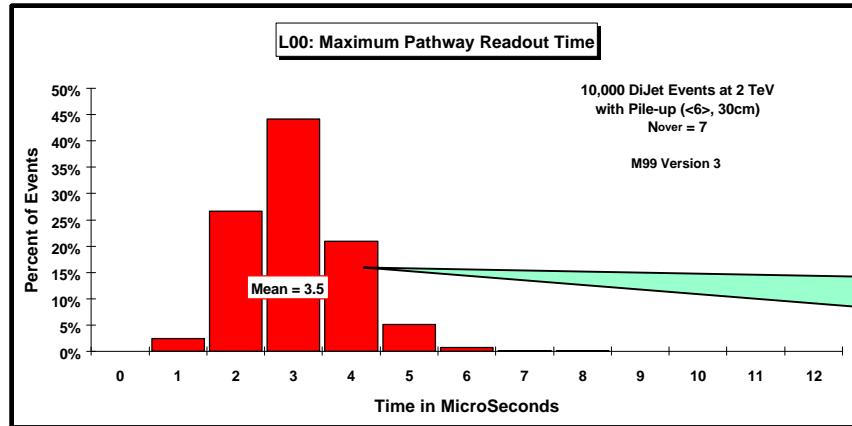
**Event-by-Event Readout Time Difference
L00 - SVXII(R- ϕ) mean = 0.4 μ s**





Layer 00

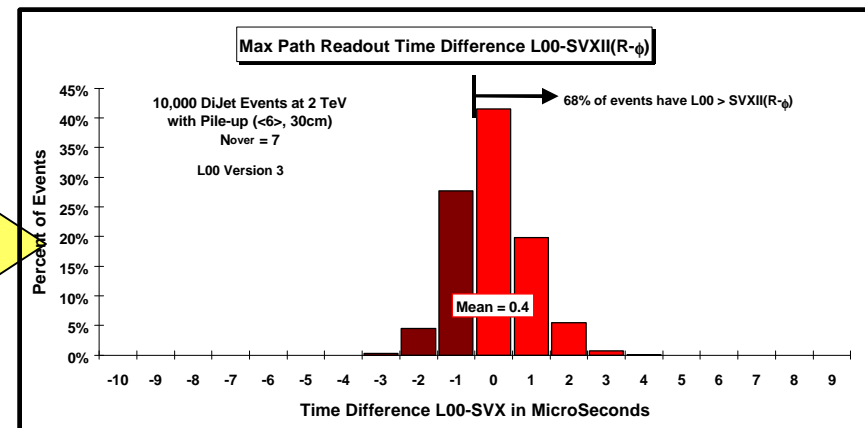
Max Path Readout Time



**10,000 DiJet Events at 2 TeV
with Pile-up
 $\langle 6 \rangle$, 30 cm, Nover = 7**

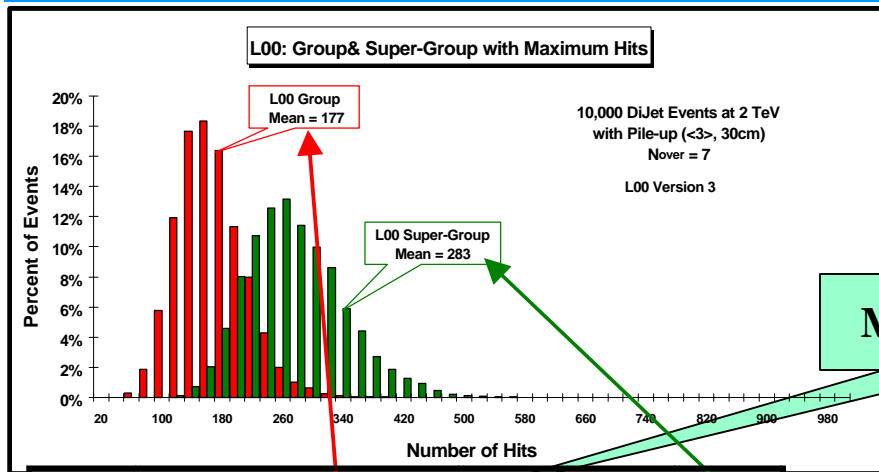
**Average readout time
of 3.5 μ s.**

**Event-by-Event Readout Time Difference
L00 - SVXII(R- ϕ) mean = 0.4 μ s**





Layer 00 Group & SuperGroup Max Hits



**10,000 DiJet Events at 2 TeV
with Pile-up
<3>, 30 cm, Nover = 7**

Max Group Hits

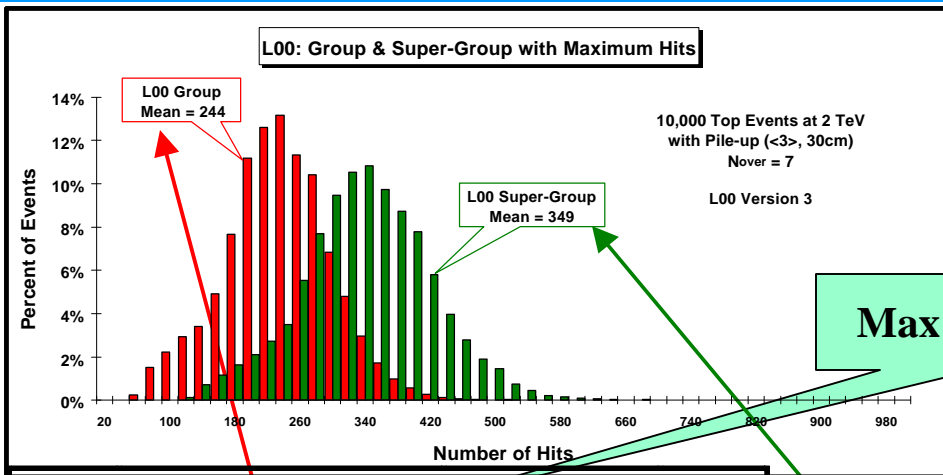
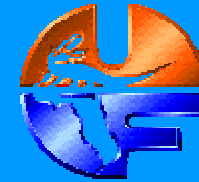
Max SuperGroup Hits

L00: M99 Version 3 Groups						
	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

L00: M99 Version 3 Super-Groups						
	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



Layer 00 Group & SuperGroup Max Hits



**10,000 Top Events at 2 TeV
with Pile-up
<3>, 30 cm, Nover = 7**

Max Group Hits

Max SuperGroup Hits

L00: M99 Version 3 Groups						
	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

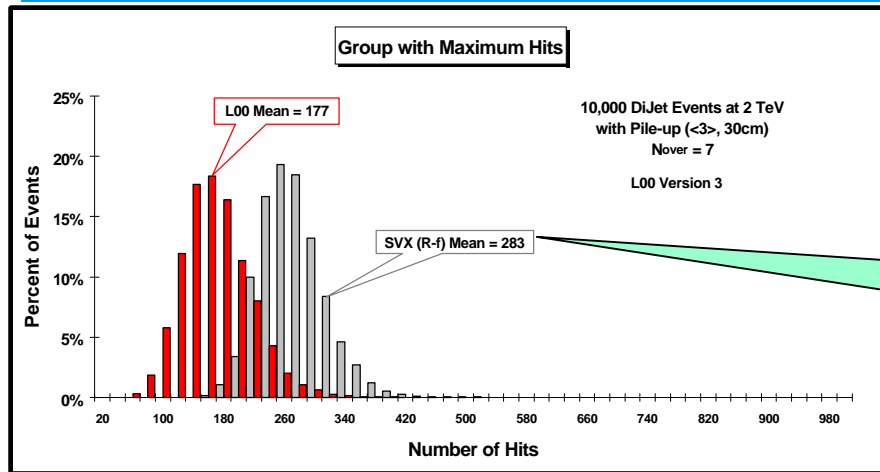
L00: M99 Version 3 Super-Groups						
	Ave Hits	%Max	Max Hits	Paths/Chips	Max Group	Read Time
SuperG A	295	16.6%	352	4/9	194	14.1
SuperG B	295	16.6%	349	4/9	194	14.0
SuperG C	295	17.0%	349	4/9	194	14.0
SuperG D	295	16.5%	346	4/9	194	13.8
SuperG E	296	16.7%	347	4/9	194	13.9
SuperG F	296	16.7%	352	4/9	194	14.1
All SuperG	1,772	100%	349	48/108	244	14.0



SVXII



Group with Maximum Hits



10,000 DiJet Events at 2 TeV with Pile-up <3>, 30 cm, Nover = 7

SVXII: Overall average max group hits = 283

The SVXII has 6*12 = 72 groups and 12 SuperGroups

SVXII: Ave Max SuperGroup

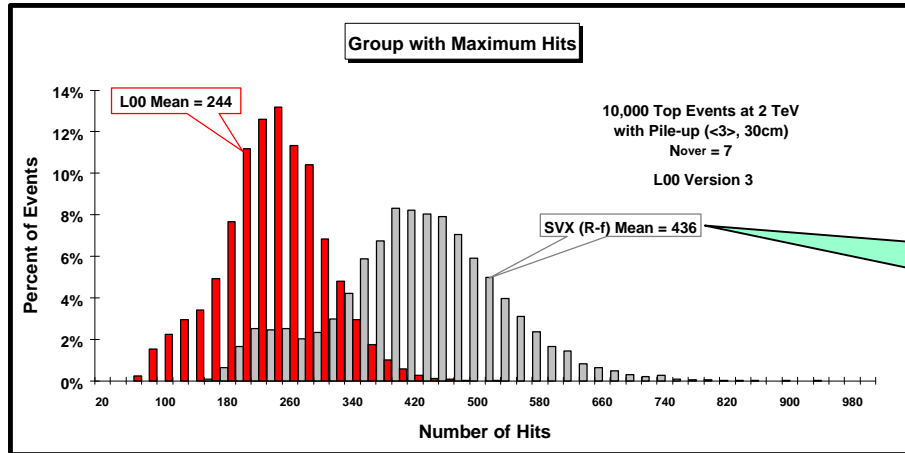
SVXII iphi	Ave Max Group & SuperG Hits (R-Phi only)						10,000 DiJet Events
	iz= 1	2	3	4	5	6	SuperG
1	273	282	279	279	281	265	1,237
2	272	285	289	292	283	269	1,274
3	270	279	279	281	278	270	1,243
4	280	289	291	296	285	275	1,269
5	263	285	292	291	282	266	1,245
6	274	285	291	287	281	276	1,271
7	267	278	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



SVXII



Group with Maximum Hits



10,000 Top Events at 2 TeV with Pile-up
 $\langle 3 \rangle$, 30 cm, Nover = 7

SVXII: Overall average max group hits = 436

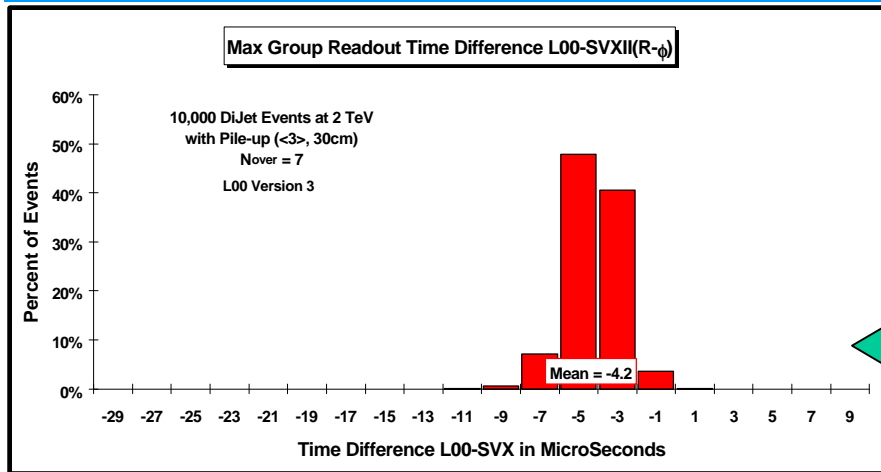
The SVXII has 6*12 = 72 groups and 12 SuperGroups

SVXII: Ave Max SuperGroup

SVXII iphi	Ave Max Group & SuperG Hits (R-Phi only)					10,000 Top Events	
	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



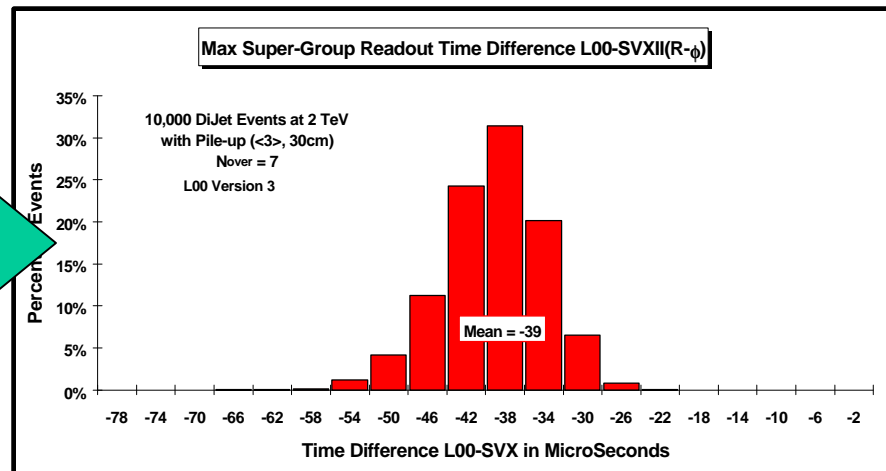
Layer 00 Group & SuperG Readout Time



10,000 DiJet Events at 2 TeV
with Pile-up
 $\langle 3 \rangle$, 30 cm, Nover = 7

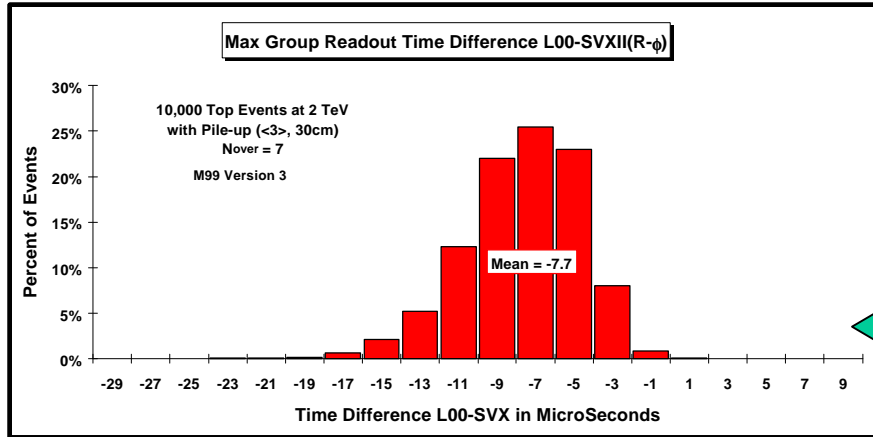
Max Group Readout Time Difference
L00 - SVXII(R- ϕ) mean = -4.2 μ s

Max SuperGroup Readout Time
Difference L00 - SVXII(R- ϕ)
mean = -39 μ s





Layer 00 Group & SuperG Readout Time



10,000 **Top** Events at 2 TeV
with Pile-up
 $\langle 3 \rangle$, 30 cm, Nover = 7

Max Group Readout Time Difference
L00 - SVXII(R- ϕ) mean = -7.7 μ s

Max SuperGroup Readout Time
Difference L00 - SVXII(R- ϕ)
mean = -44 μ s

