Effects of material in the CDF-II silicon detectors

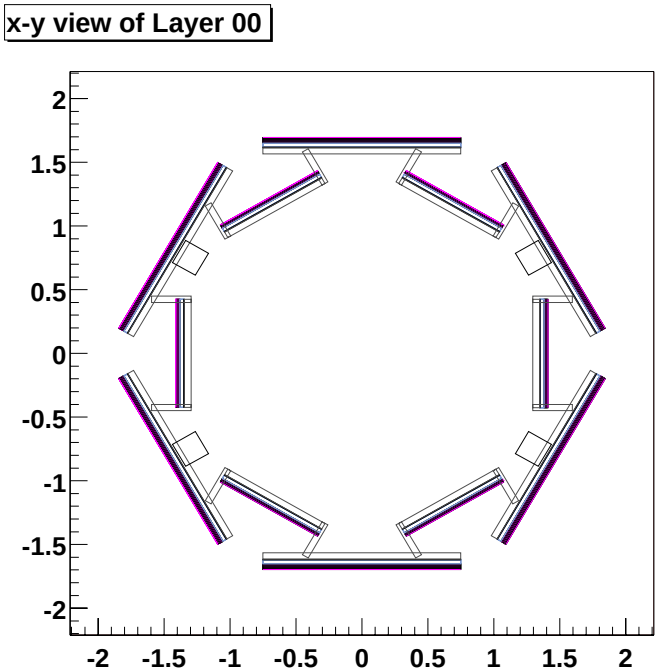
David Stuart, Fermilab

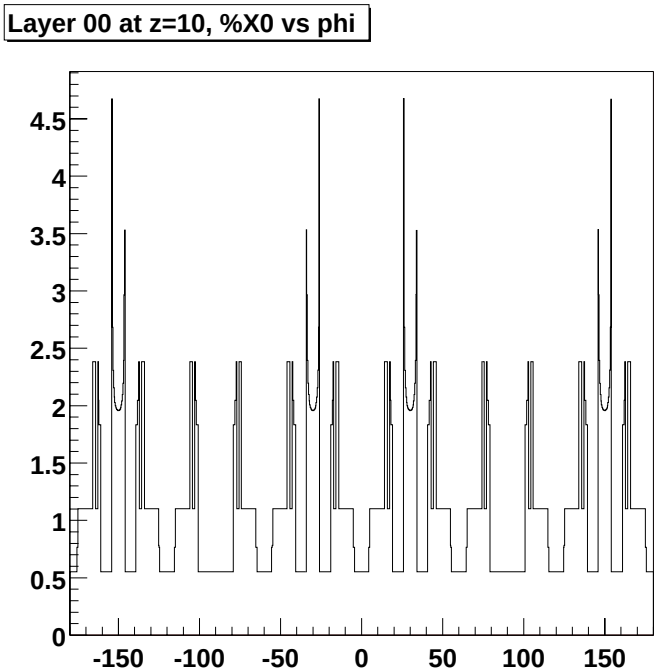
March 15, 2000

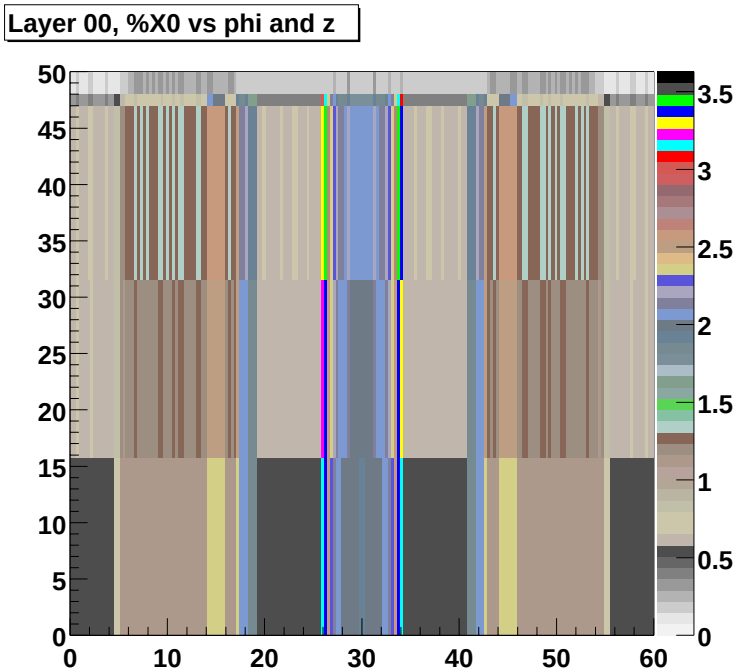
What do the tails of the X_0 distribution do to the tails of the resolution functions?

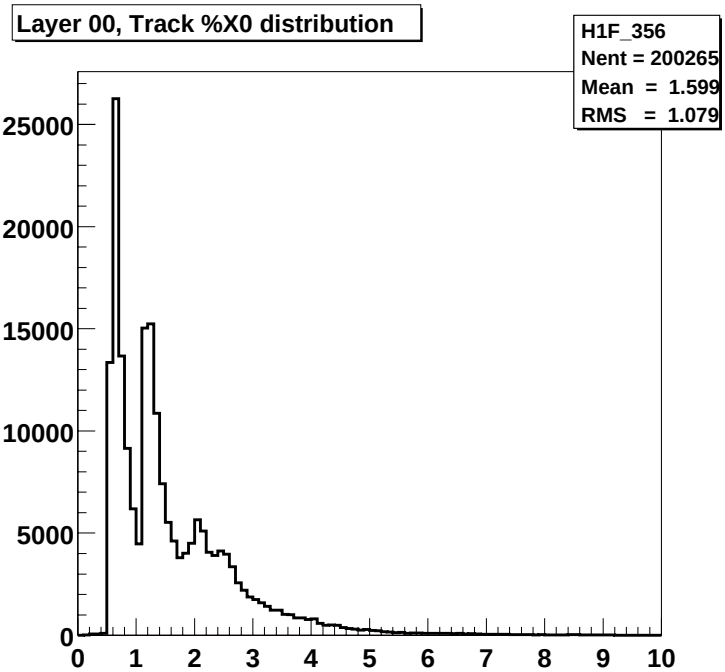
- Model material in gory detail.
- Do ray tracing on GENP tracks to integrate X_0
- Calculate 2D covariance matrix

Layer 00


x-y view of Layer 00
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2 -1.5 -1 -0.5 0 0.5 1 1.5 2

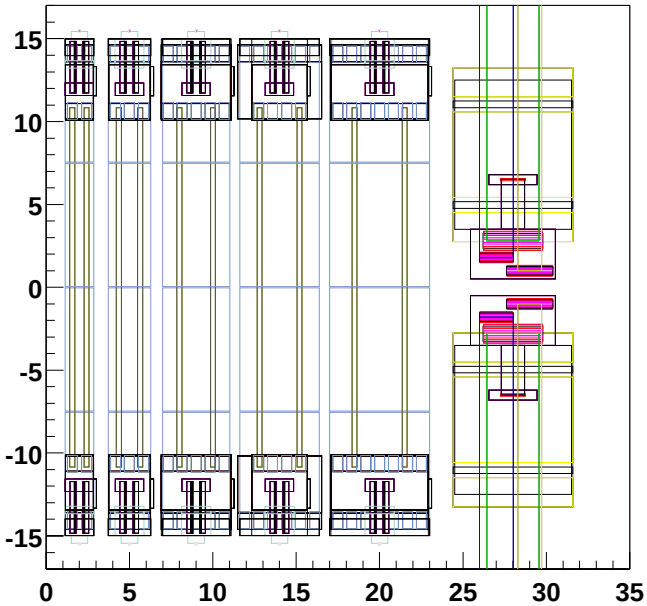

Layer 00 at z=10, %X0 vs phi
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
-150 -100 -50 0 50 100 150


Layer 00, %X0 vs phi and z
50
45
40
35
30
25
20
15
10
5
0
0 10 20 30 40 50 60
3.5
3
2.5
2
1.5
1
0.5
0

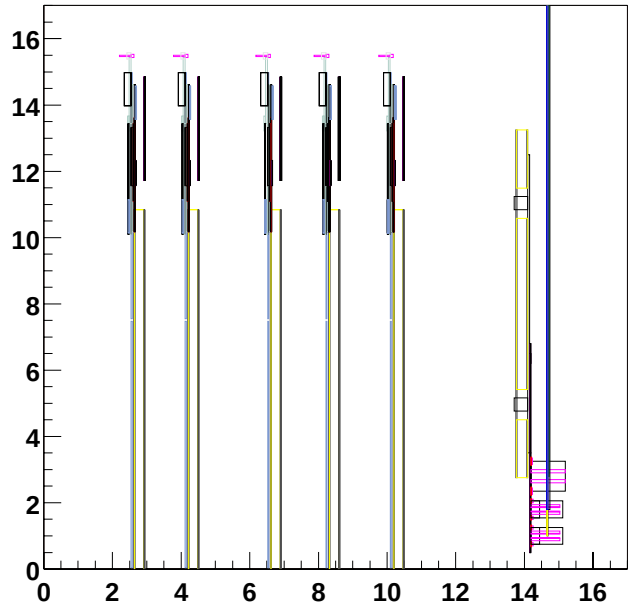

Layer 00, Track %X0 distribution
H1F_356
Nent = 200265
Mean = 1.599
RMS = 1.079
25000
20000
15000
10000
5000
0
0 1 2 3 4 5 6 7 8 9 10

SVXII

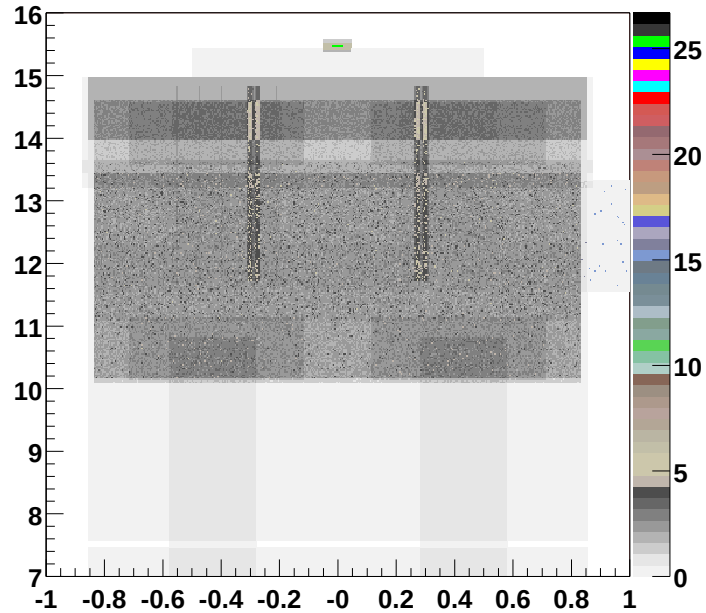
y-z view of a wedge of ladders



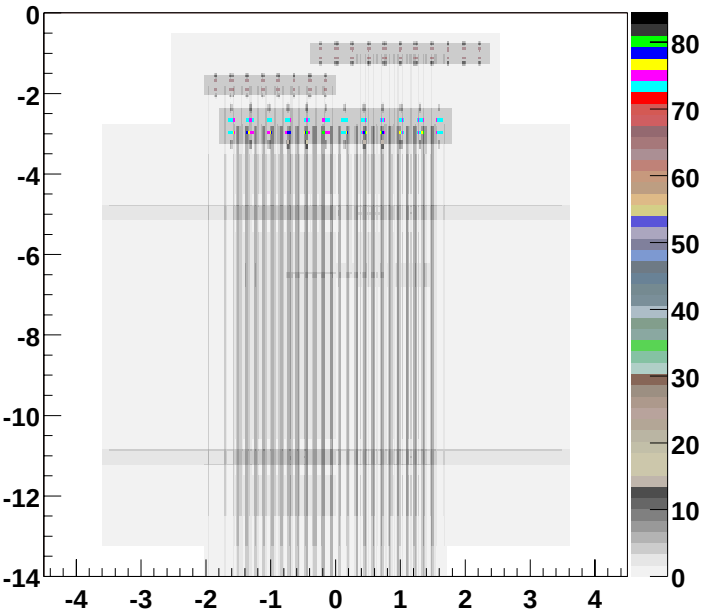
r-z view of a wedge



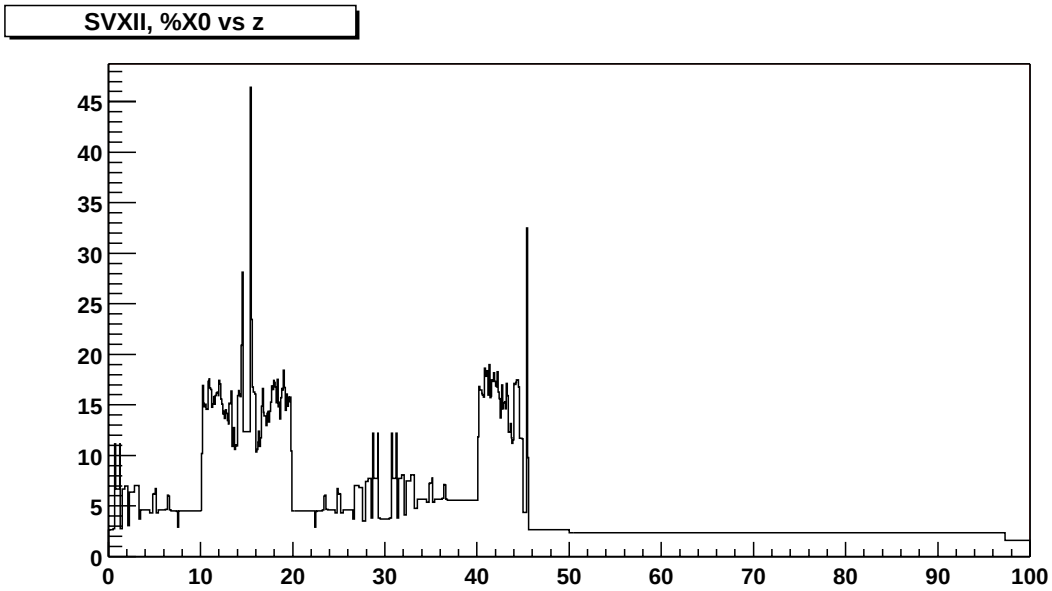
Layer 0 ladder%X0 vs y and z

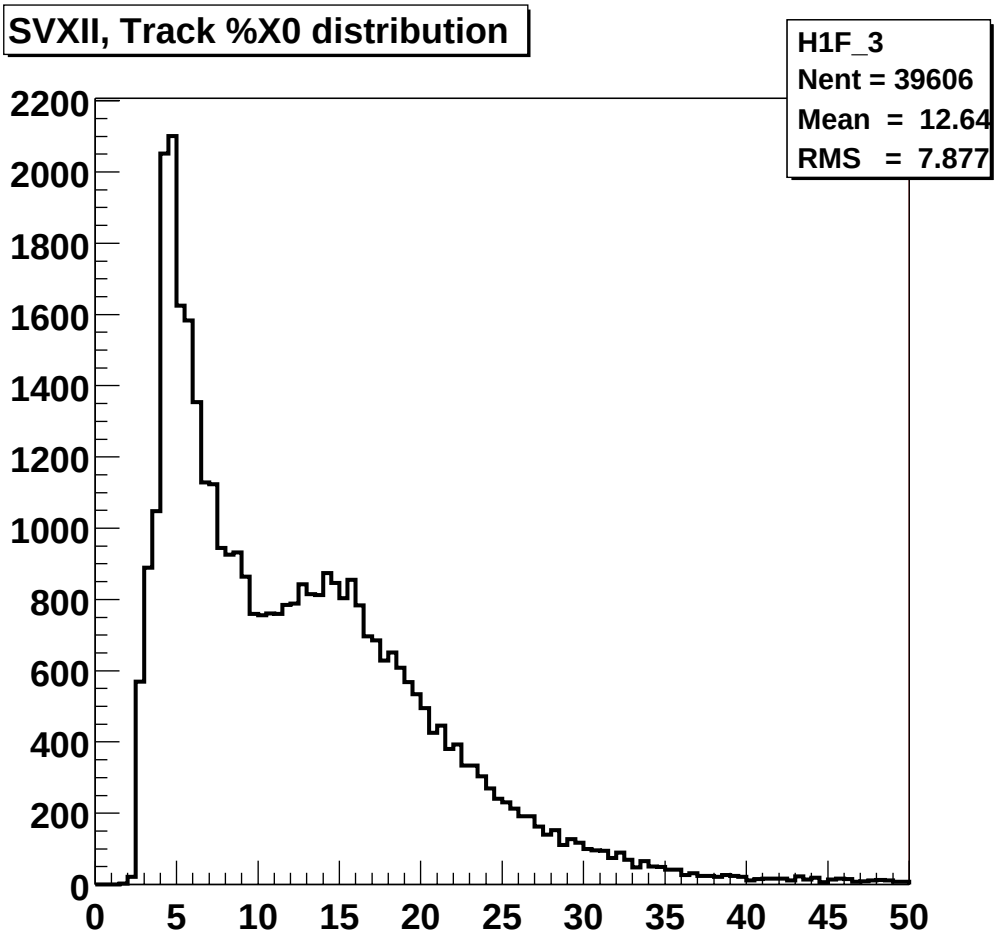


Portcard, %X0 vs y and z



SVXII (cont.)


SVXII, %X0 vs z
0
5
10
15
20
25
30
35
40
45
0
10
20
30
40
50
60
70
80
90
100


SVXII, Track %X0 distribution
H1F_3
Nent = 39606
Mean = 12.64
RMS = 7.877
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
0
5
10
15
20
25
30
35
40
45
50

The following material has not been included in the SVXII simulation:

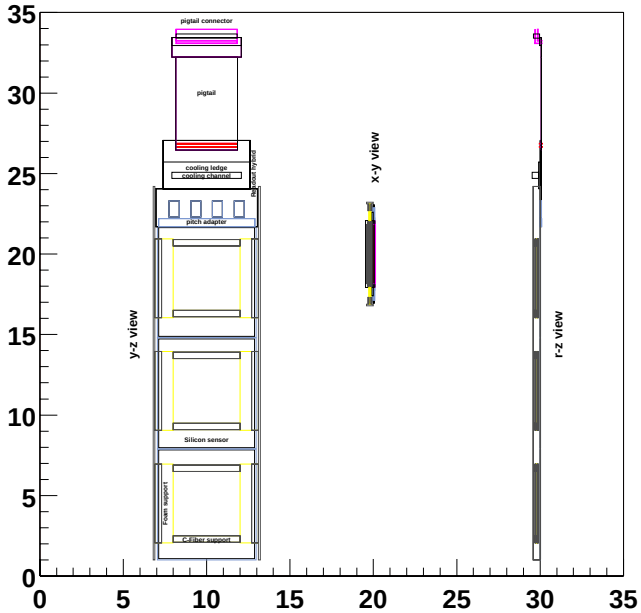
- The bulkheads other than the ledge and cooling channel directly beneath the readout hybrids. While this could be a large contributor, it is difficult to model.
- The discrete resistors and capacitors on the hybrids. Including these will be straightforward but time consuming.
- The cooling pipes other than the sections directly under the portcards. While these could be a large contributor, they are difficult to model.
- The radial sections of the HDIs. The sections that are parallel to the beamline are included. These radial sections will contribute large scatters for a small number of tracks, but they are difficult to model.
- The survey balls and support mounts. These will contribute large scatters for a small number of tracks, but including them will be time consuming.

Component	Calculated mass	Spreadsheet mass	Measured mass
L0 ϕ hybrid	2.2	-	3.6
L0 $\phi + z$ hybrids	4.34	6.2	-
L0 full ladder	14.1	19.5	-
L1 ϕ hybrid	3.2	-	-
L1 $\phi + z$ hybrids	6.1	7.5	-
L1 full ladder	22.3	23.7	-
L2 ϕ hybrid	5.2	-	6.8
L2 $\phi + z$ hybrids	9.7	10.4	-
L2 full ladder	34.11	35.0	-
L3 ϕ hybrid	6.2	-	7.6
L3 $\phi + z$ hybrids	9.9	12.3	-
L3 full ladder	36.9	41.1	-
L4 ϕ hybrid	7.1	-	9.0
L4 $\phi + z$ hybrids	13.1	15.1	-
L4 full ladder	47.5	50.5	-
Three full barrels	15,625	17,156	-

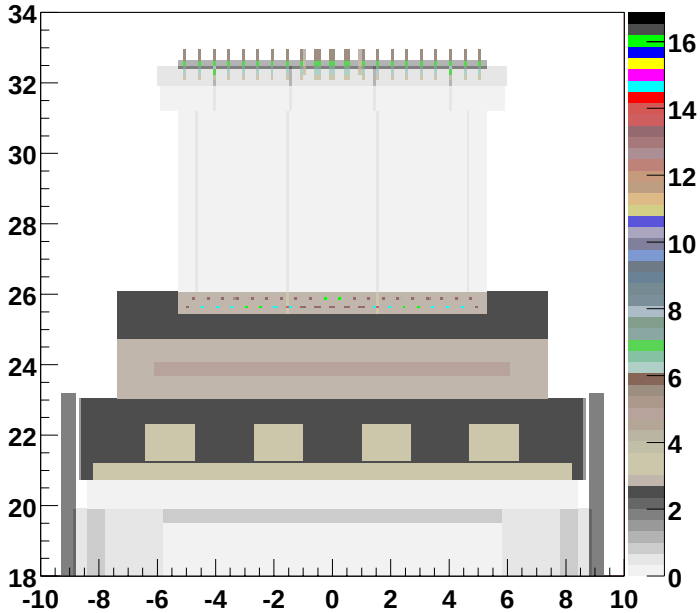
Figure 1: Masses of SVXII components are tabulated. The mass calculated by the program used in this study, "Calculated mass", is compared to the mass calculated in the SVXII material spreadsheet and where possible to measurements. The ladder masses in this program are about 10% below the full spreadsheet masses because of unsimulated subcomponents. This indicates the level to which this study underestimates the actual material in SVXII.

ISL

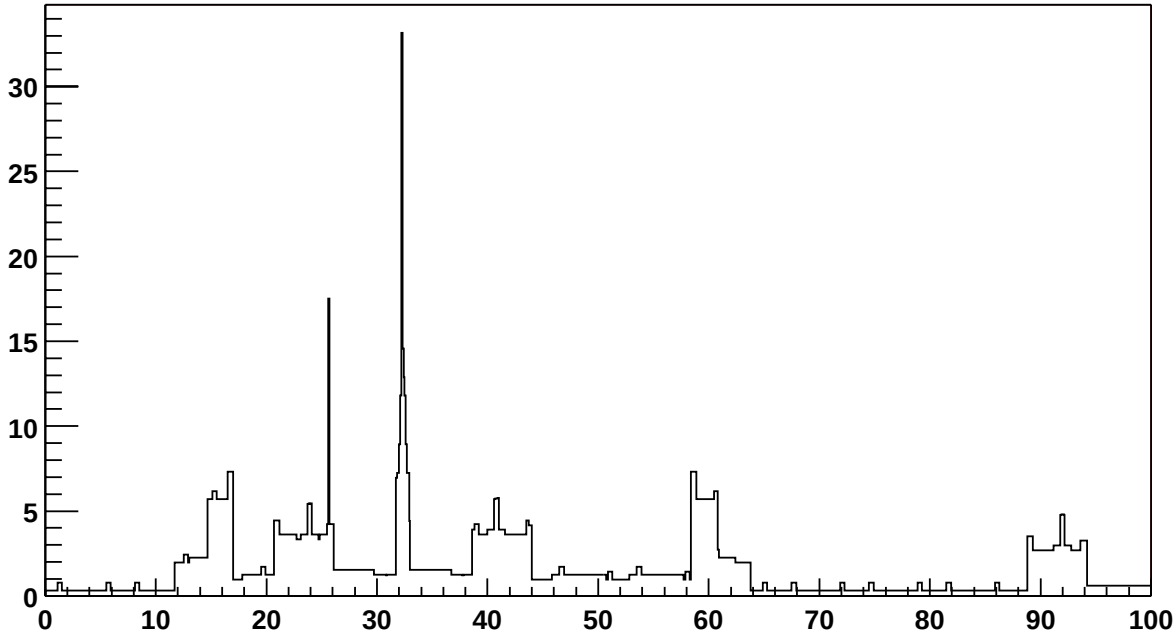
ISL 1/2-ladder



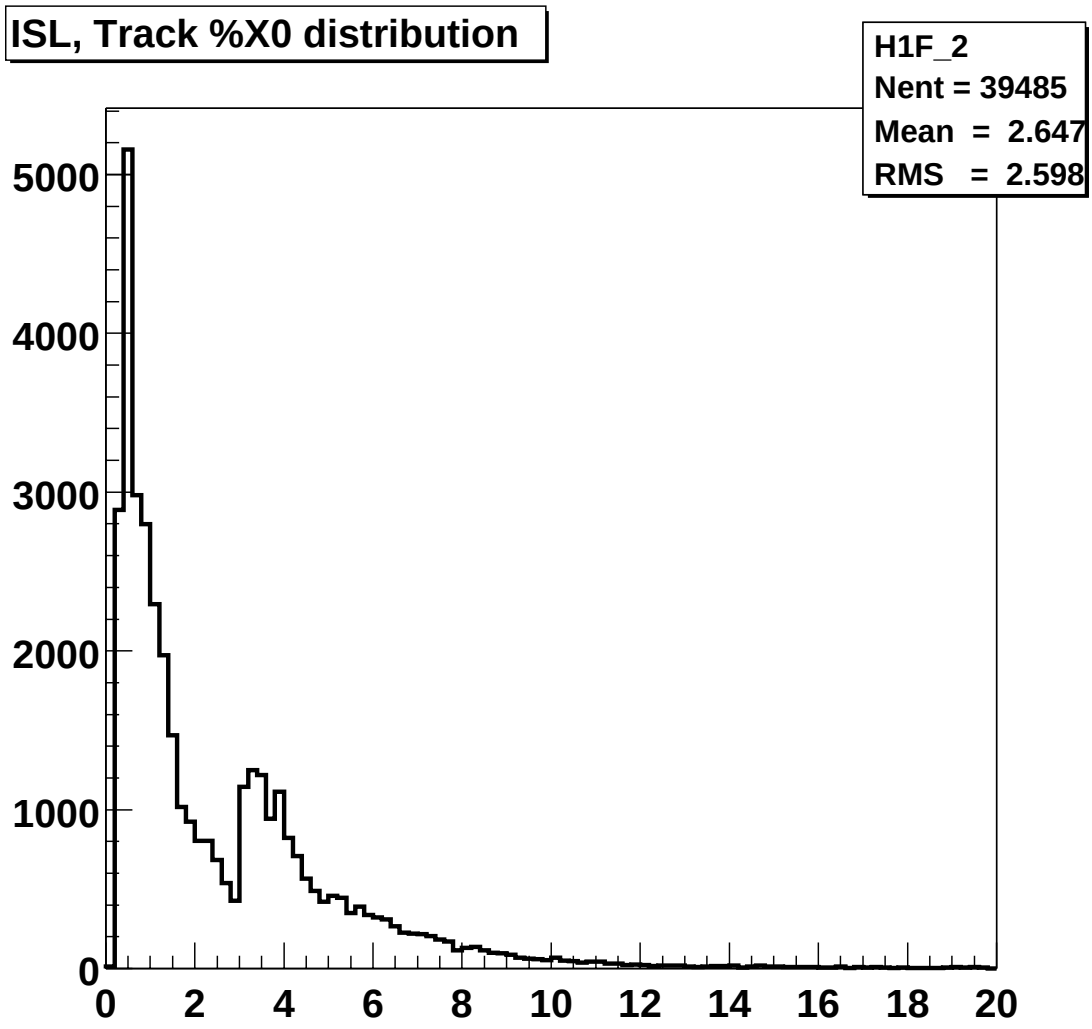
ISL 1/2-ladder, %X0 vs phi and z



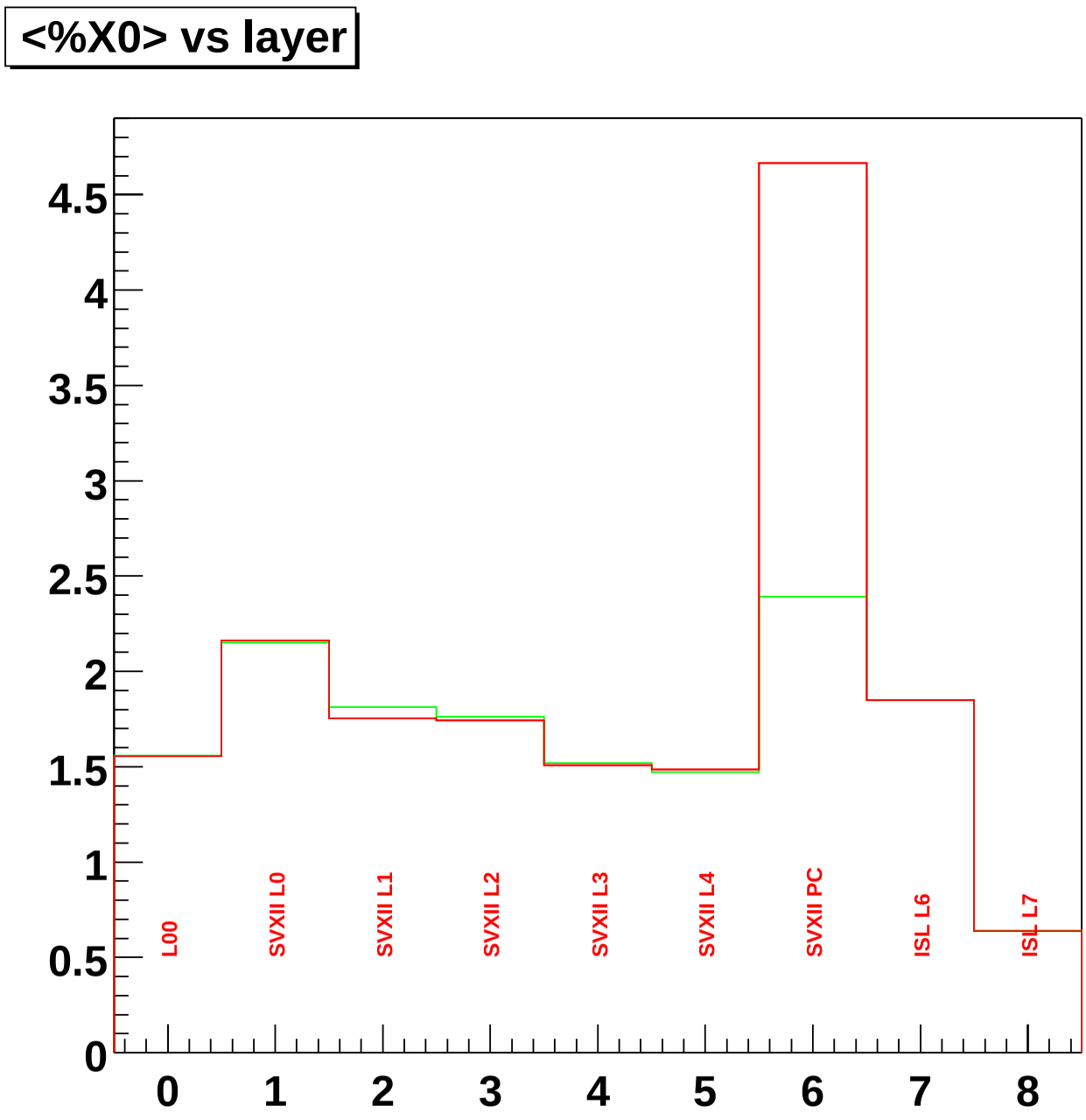
ISL, %X0 vs z



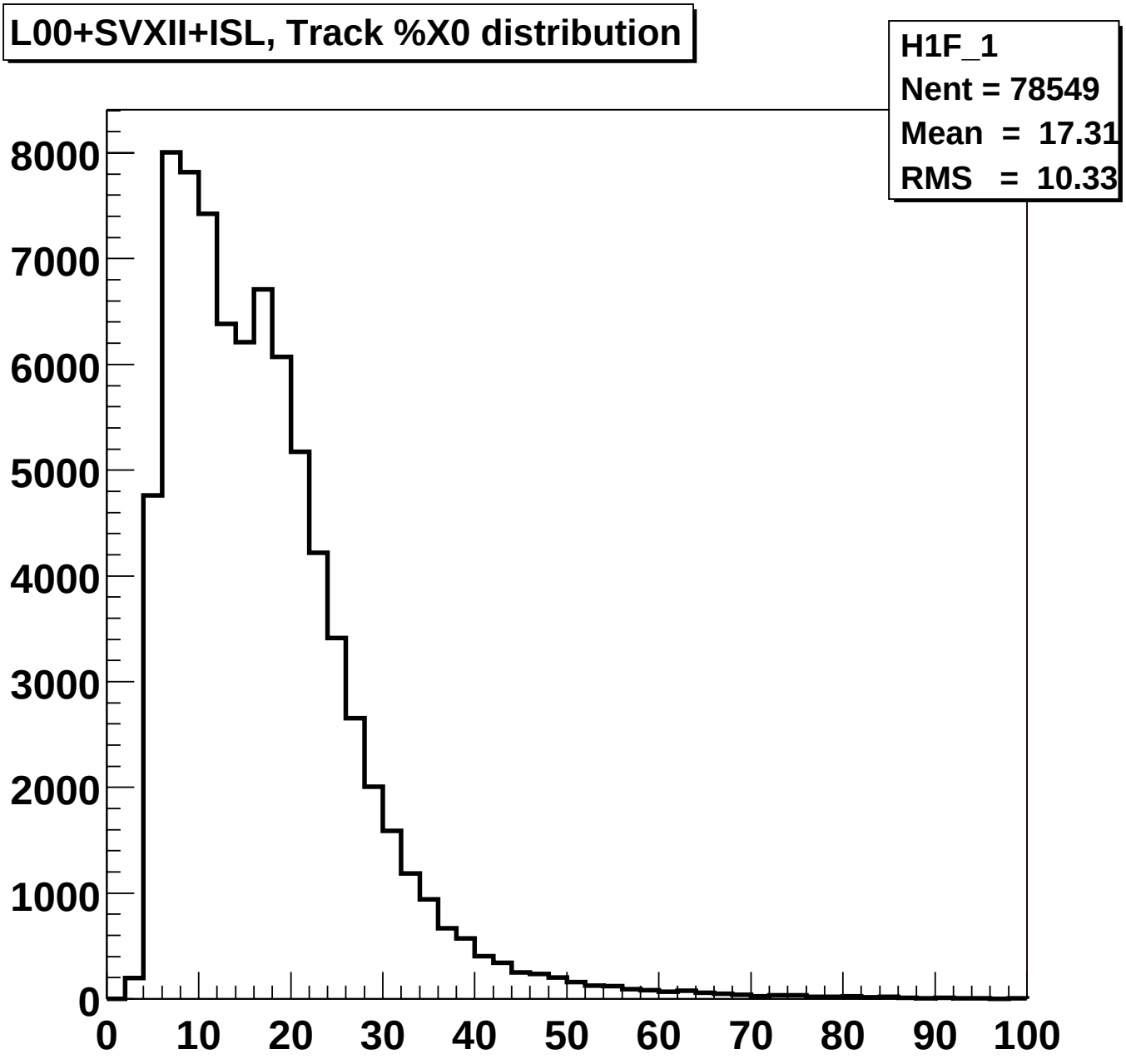
ISL (cont.)


ISL, Track %X0 distribution
H1F_2
Nent = 39485
Mean = 2.647
RMS = 2.598
5000
4000
3000
2000
1000
0
0
2
4
6
8
10
12
14
16
18
20

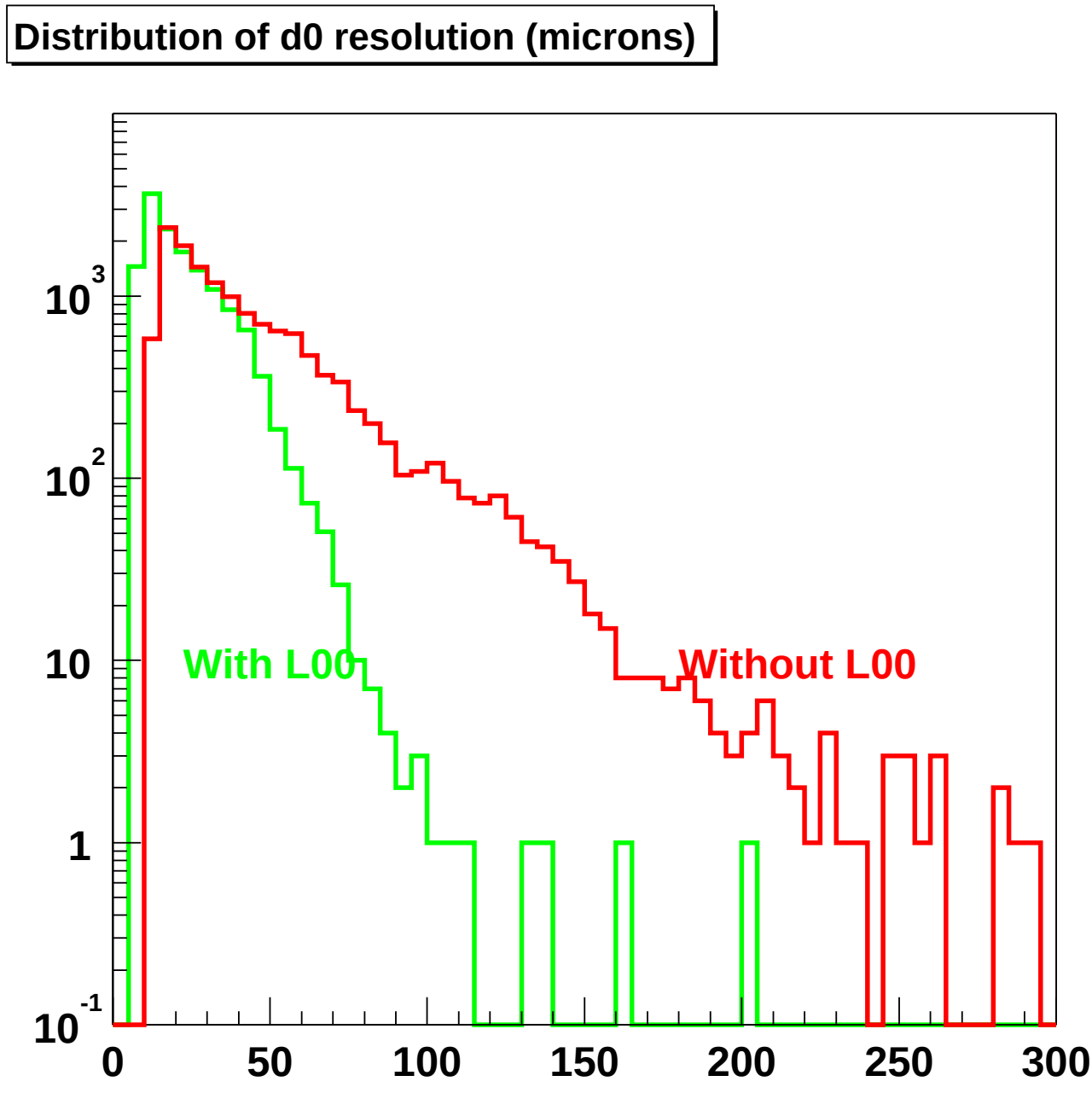
L00+SVXII+ISL Average X_0



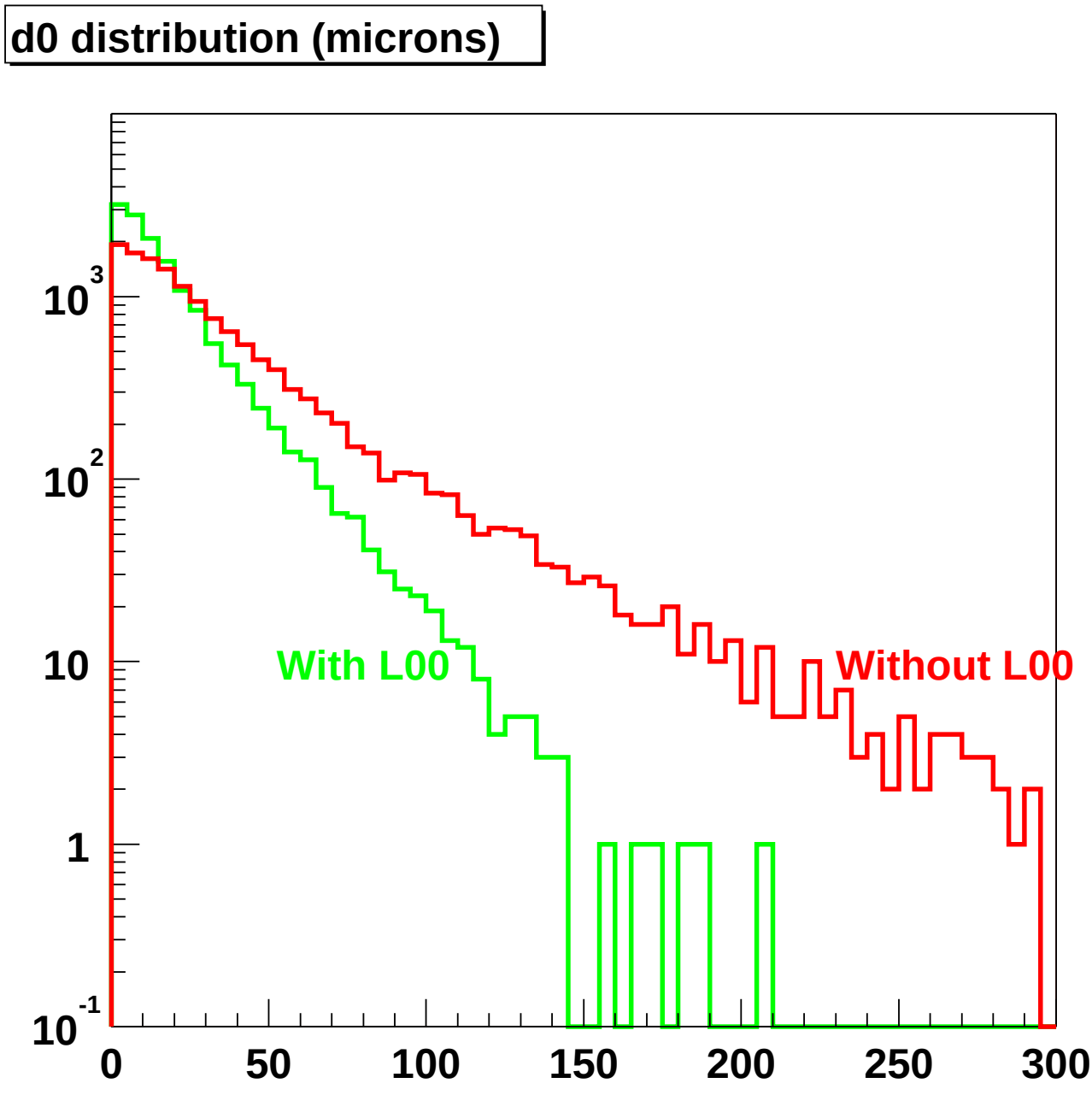
L00+SVXII+ISL X_0 distribution



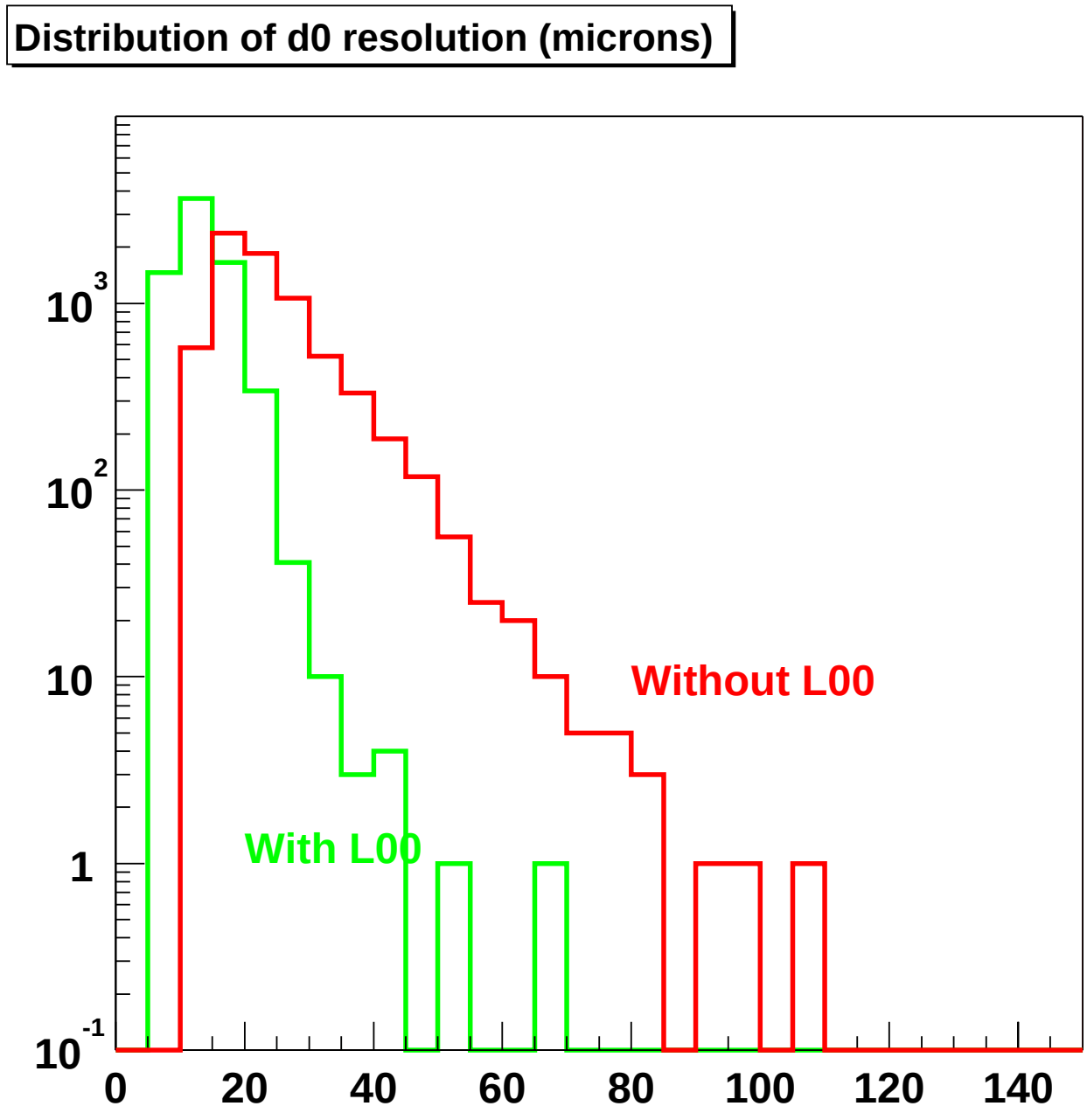
d_0 resolution, $p_T > 0.5$, $|\eta| < 1.0$



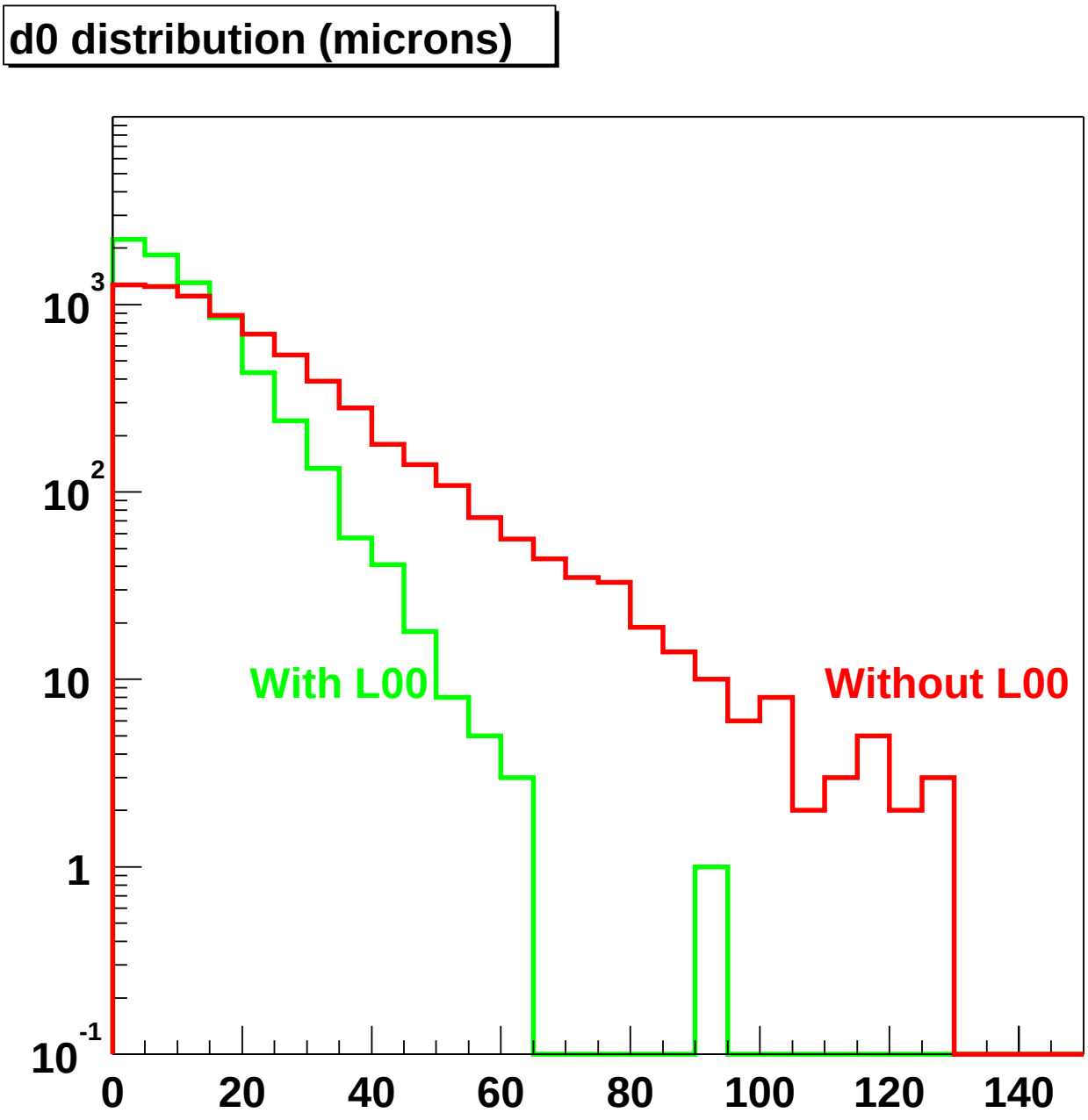
d_0 distribution, $p_T > 0.5$, $|\eta| < 1.0$



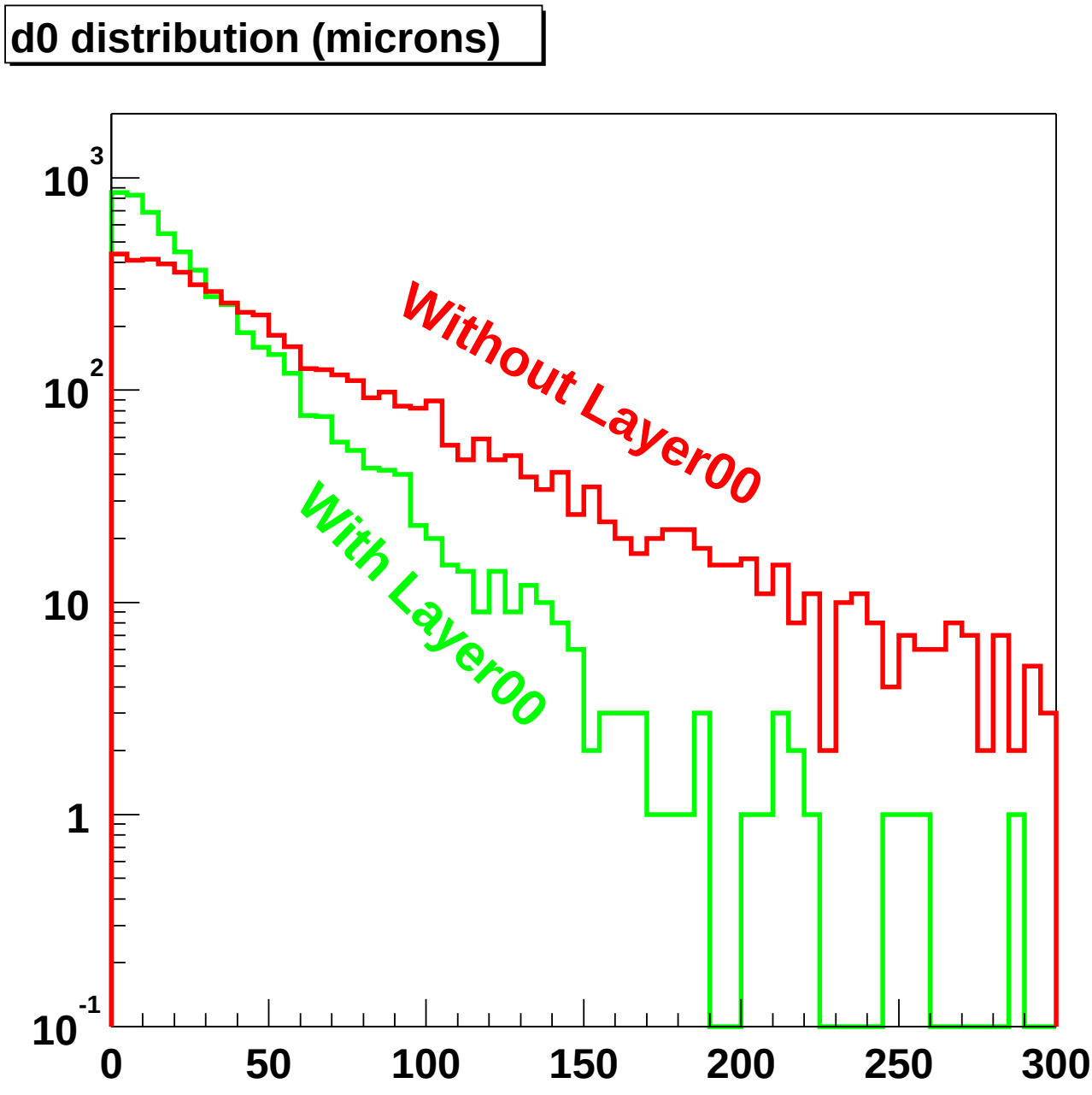
d_0 resolution, $p_T > 2.0$, $|\eta| < 1.0$



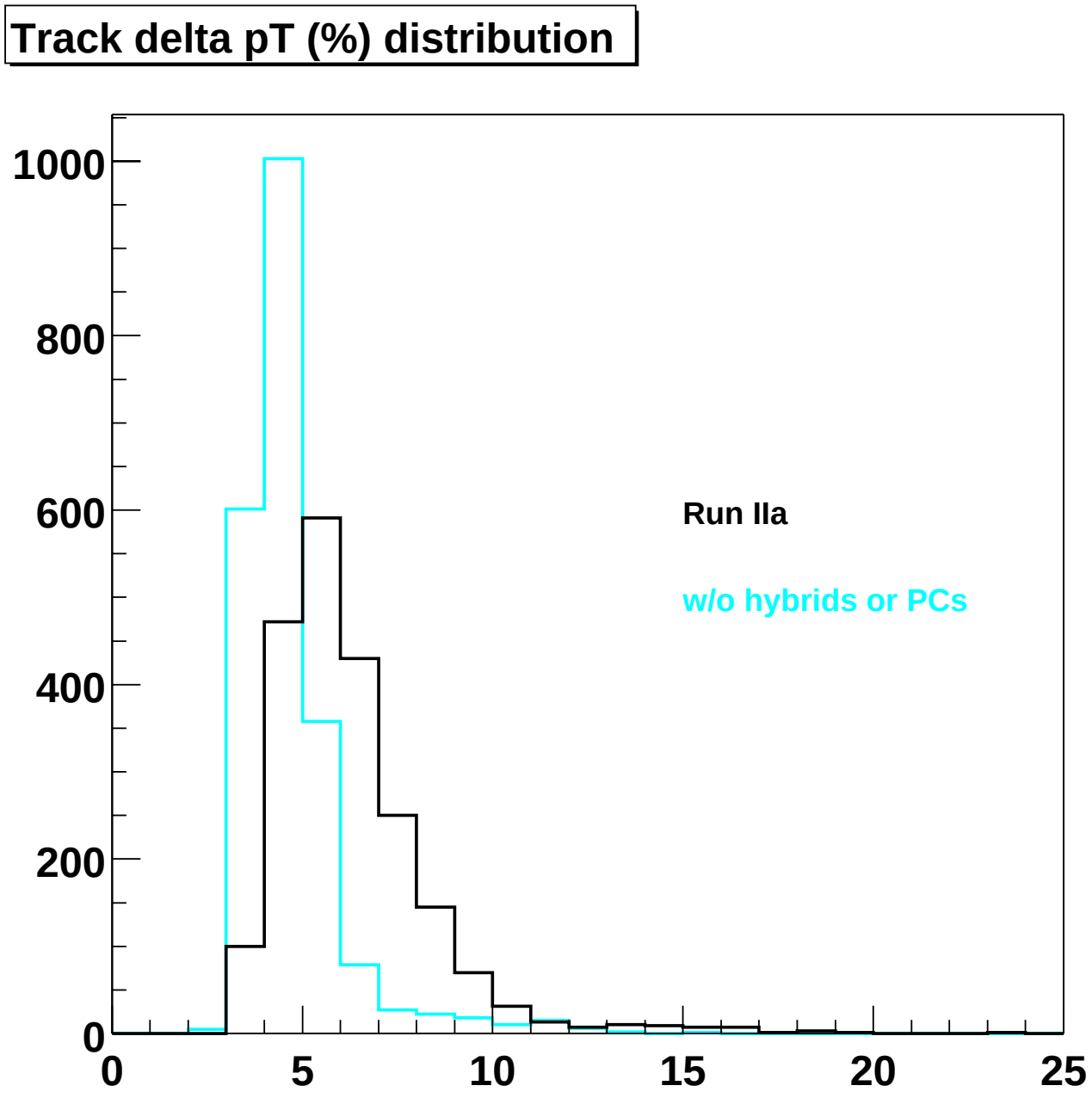
d_0 distribution, $p_T > 2.0$, $|\eta| < 1.0$



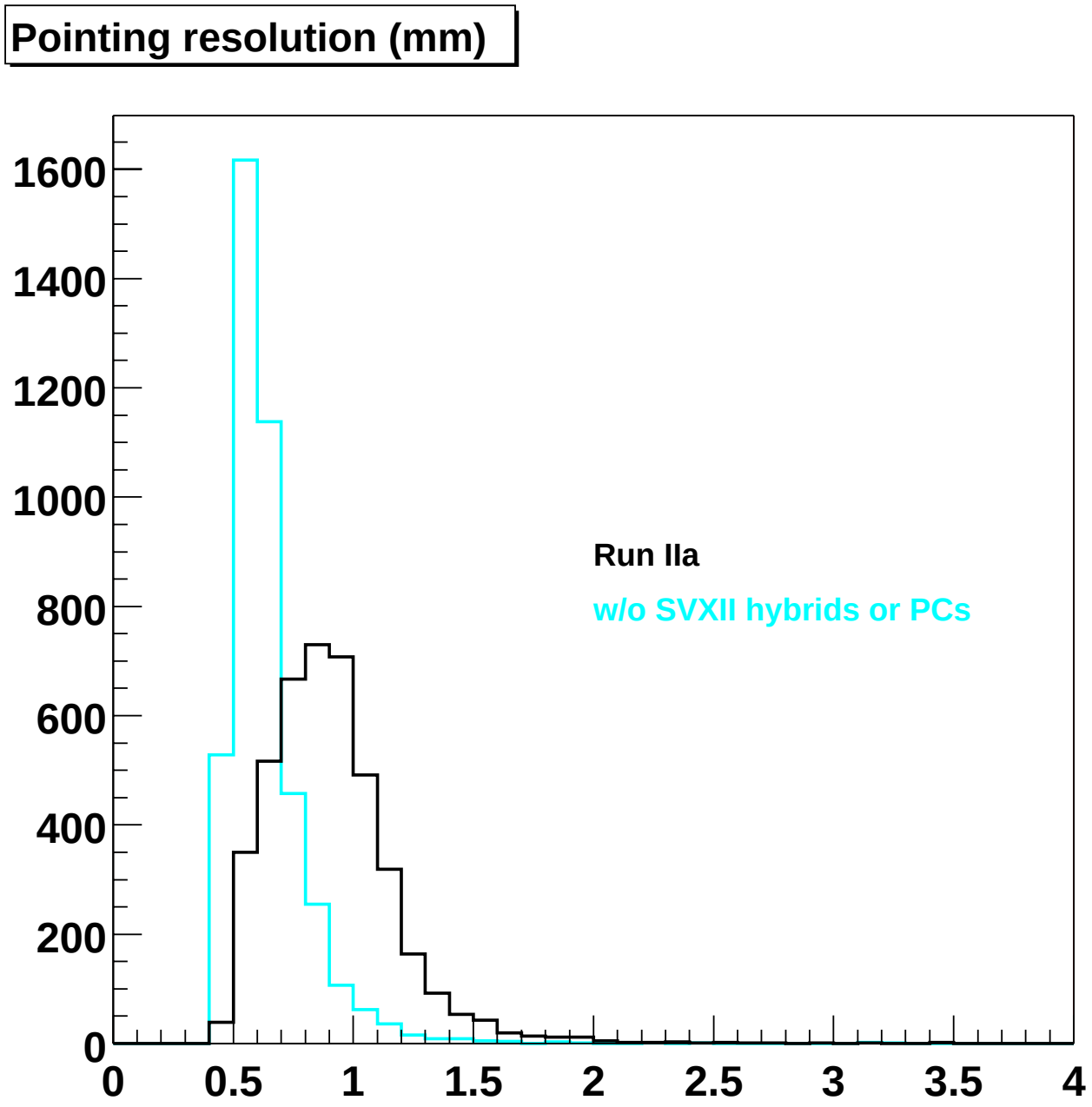
d_0 distribution, $p_T > 0.5$, $|\eta| > 1.0$



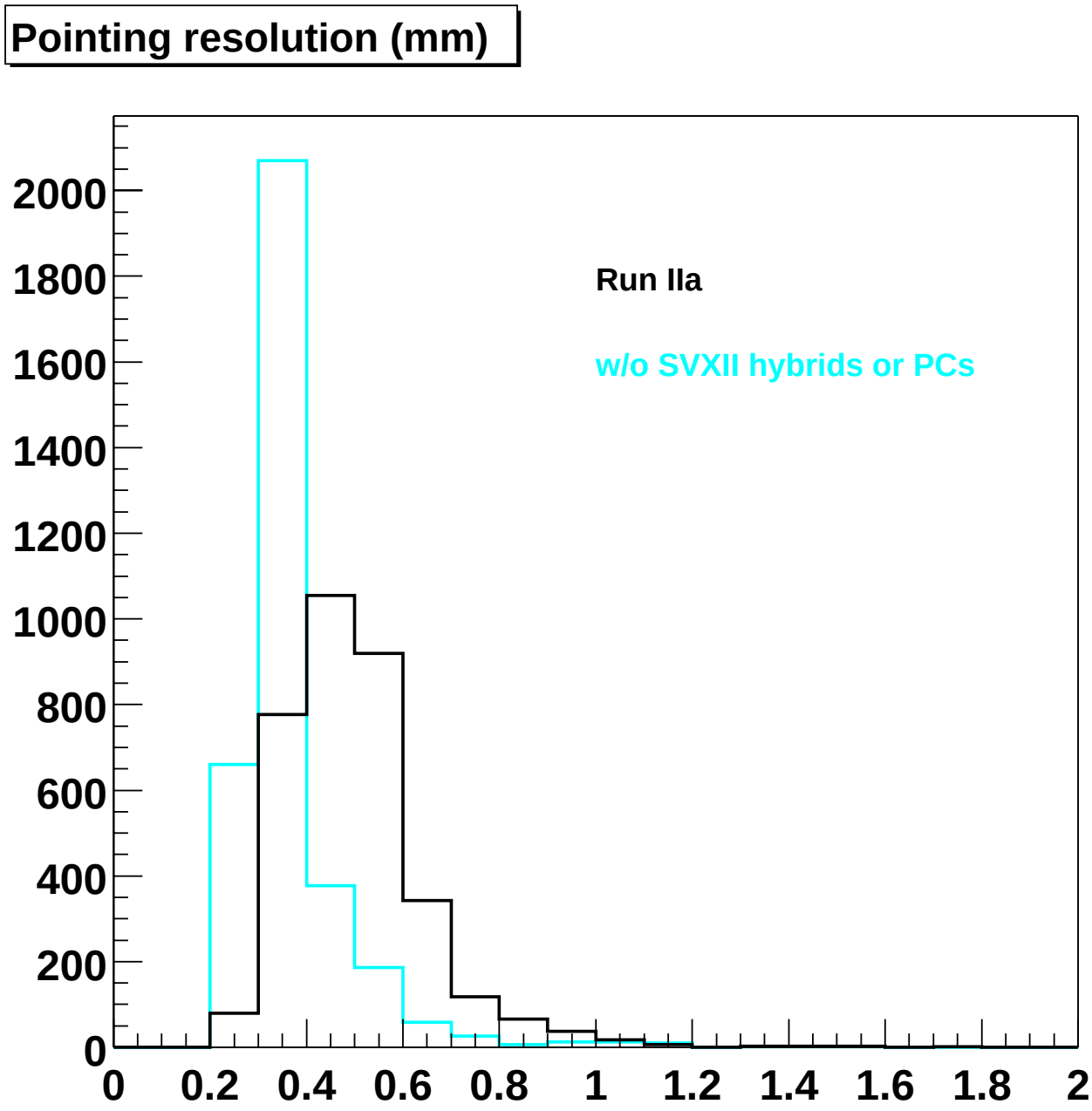
p_T resolution, $p_T \approx 0.5$, $|\eta| > 1.0$



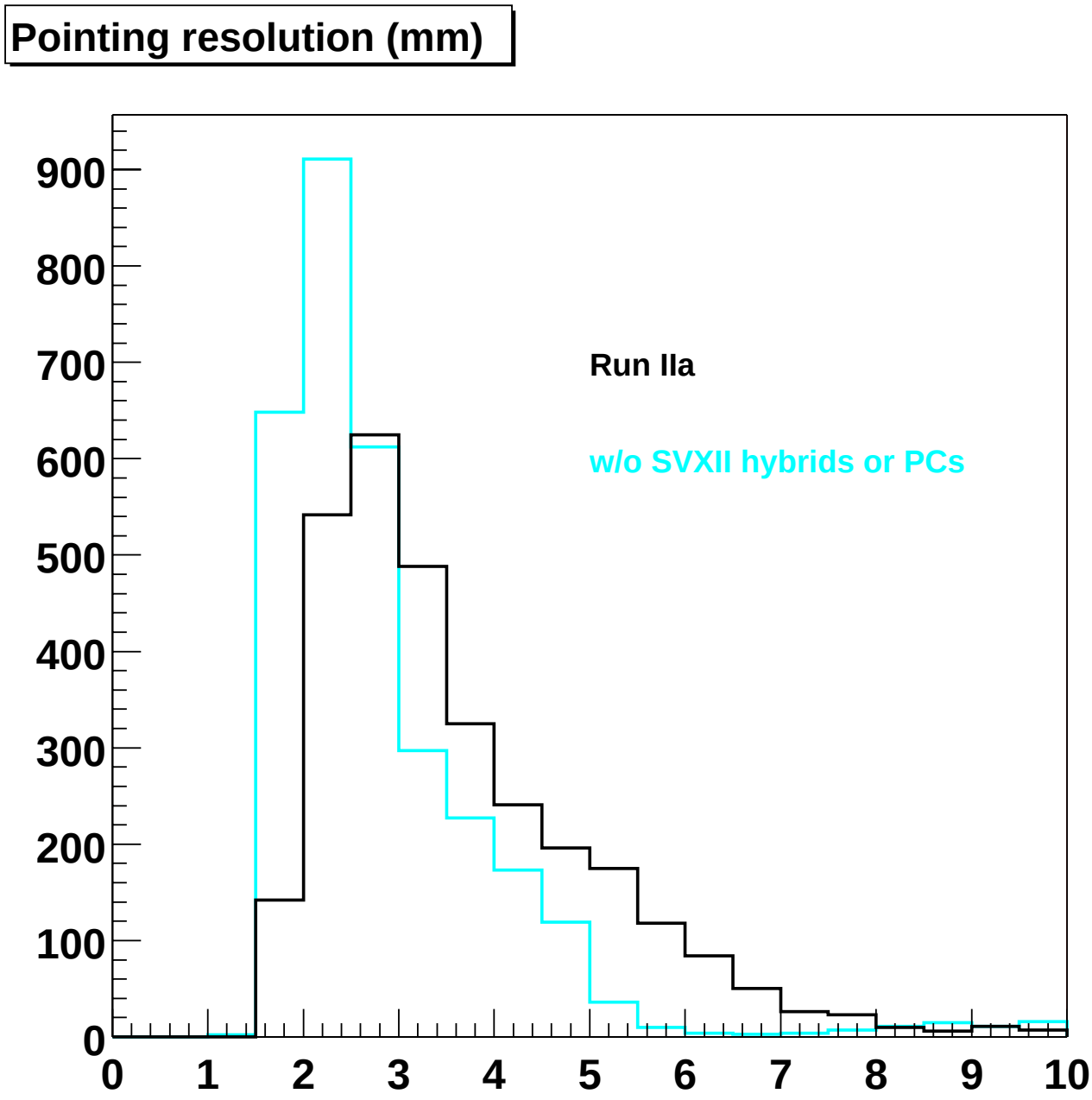
Pointing resolution into ISL
$p_T > 0.5$, $|\eta| > 1.0$



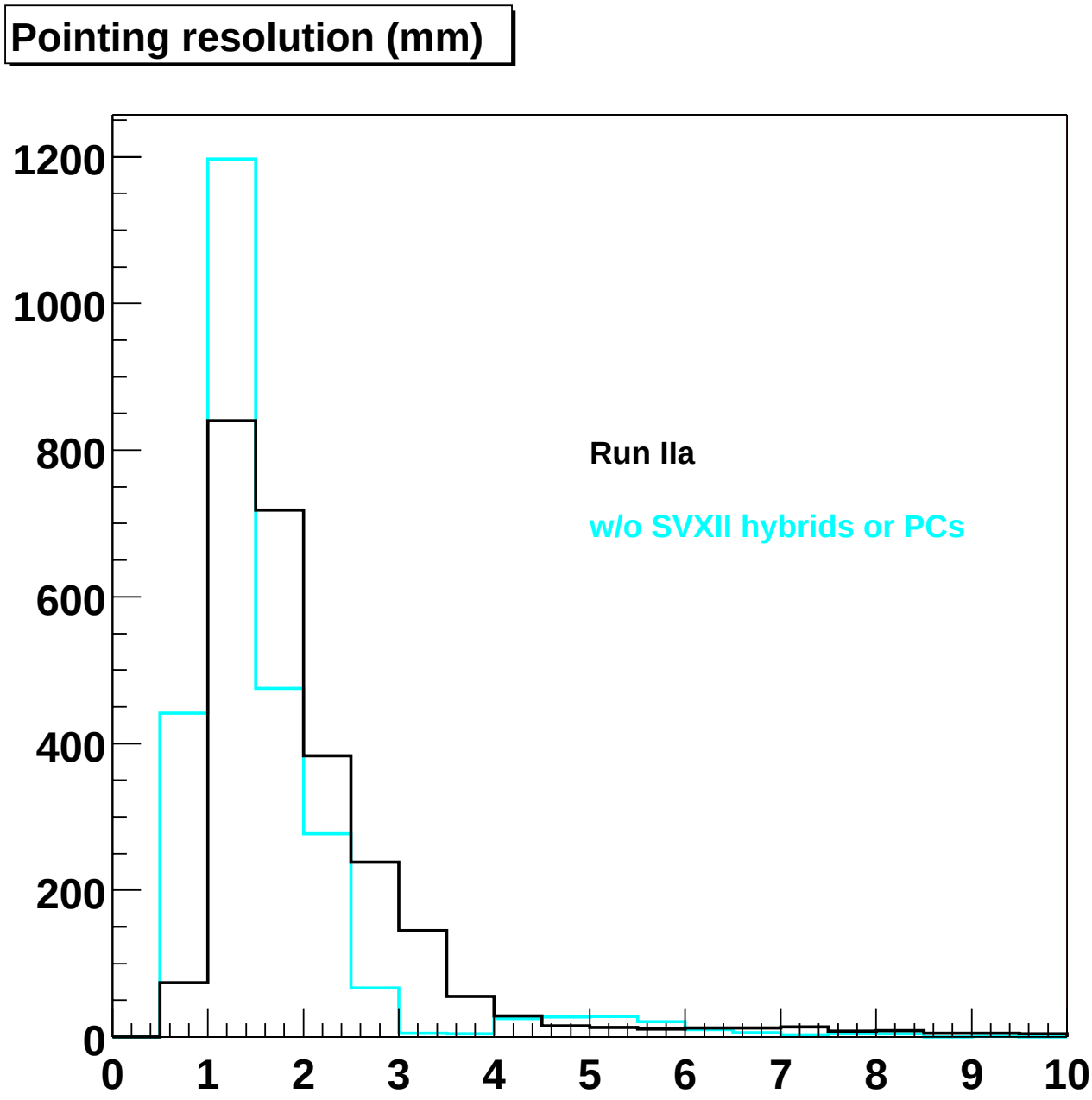
Pointing resolution into ISL
$p_T > 1.0$, $|\eta| > 1.0$



Pointing resolution into COT
$p_T > 0.5$, $|\eta| > 1.0$

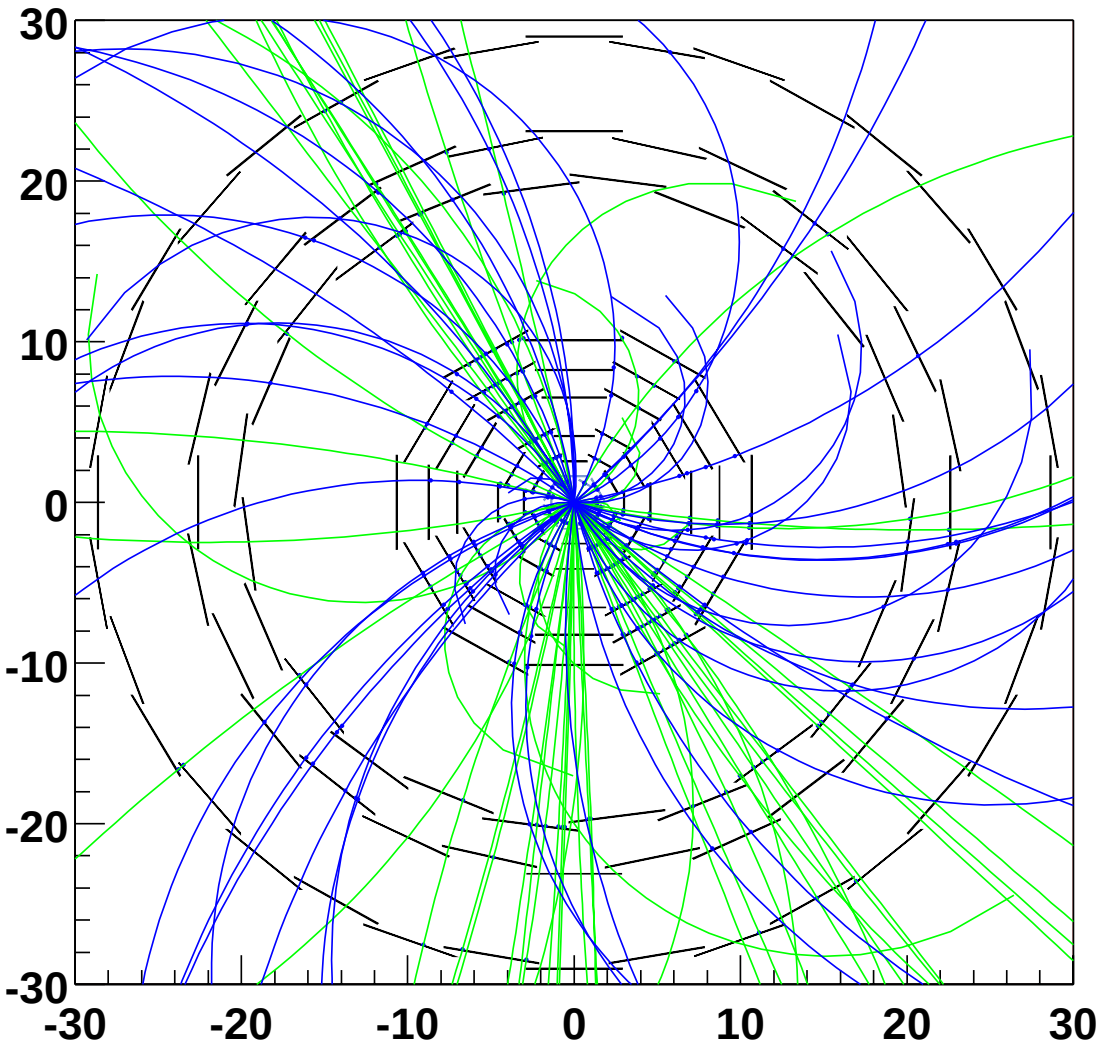


Pointing resolution into COT
$p_T > 1.0$, $|\eta| > 1.0$



Secondaries

Simulation studies show a factor of two increase in multiplicity due to secondaries. Reducing that buys more instantaneous luminosity...and fewer tapes.



Conclusion

- Material will hurt in Run IIa.
  Loss of inner or outer layers would make it hurt more.
- Reducing material $\Rightarrow$ improvements of $>$ a few 10%.
- So, keep it light!

Thanks to Amy Connolly, Stephan Van De Brink, Joel Goldstein, and Tim Nelson for help in digging up material info. Thanks to Young-Kee Kim for help understanding the electron id effects.