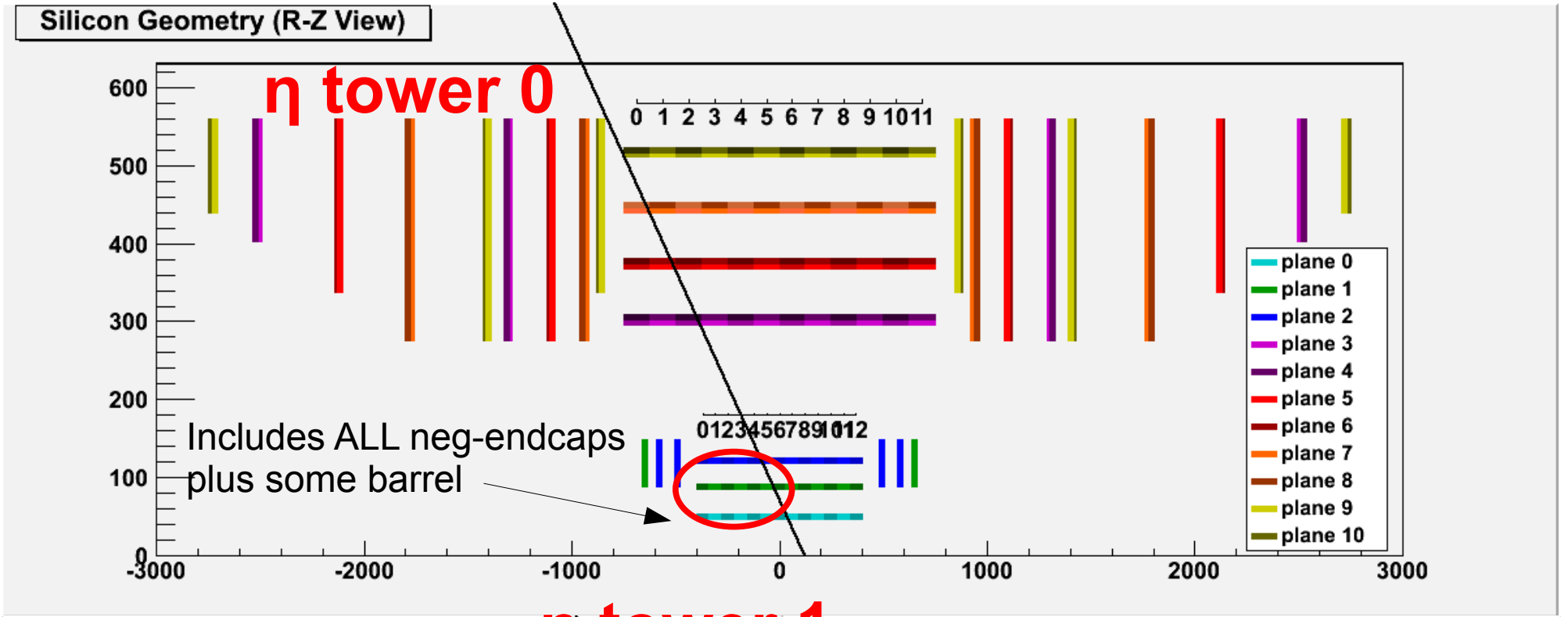
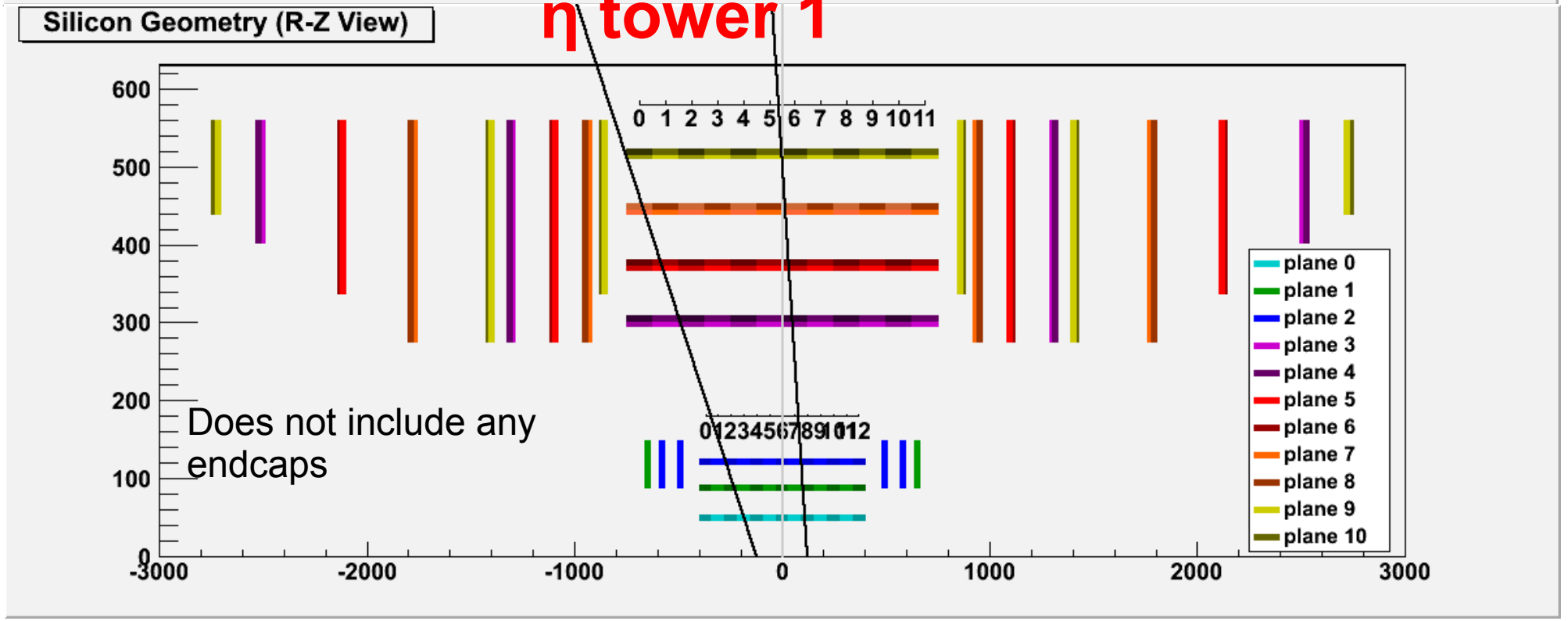
Phi-Eta towers

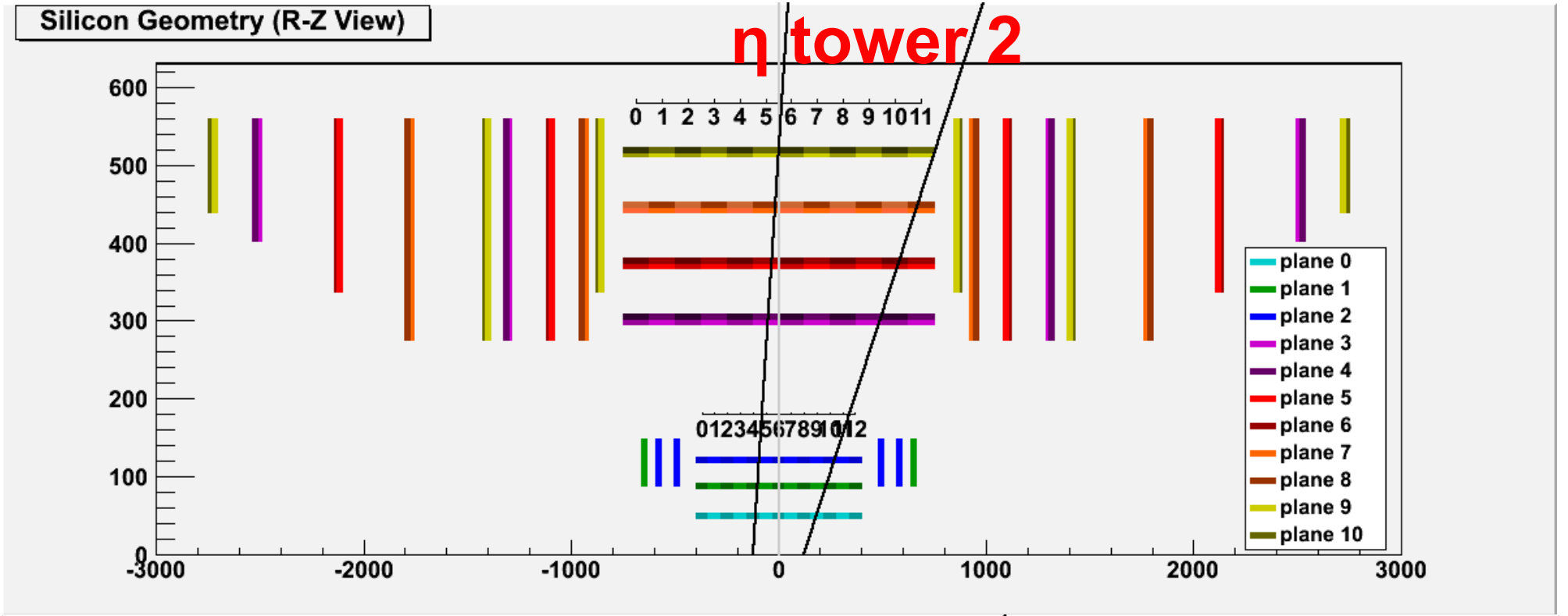
- FTK TP introduces parallel processing units working in different phi-eta towers:
  - 2 towers along phi
  - 4 towers along eta
- We need a realistic simulation for how much we can reduce **#clusters** AND **#patterns**
- Today: first results with the following caveats:
  - Implemented only for reg2, but easy to generalize
  - Not fully optimized (further improvements possible)
  - Heavily limited by discrete tower bounds
    - Tower bounds are currently always at module bounds
      - E.g., pixel B-layer has 16 phi-towers but only 22 modules

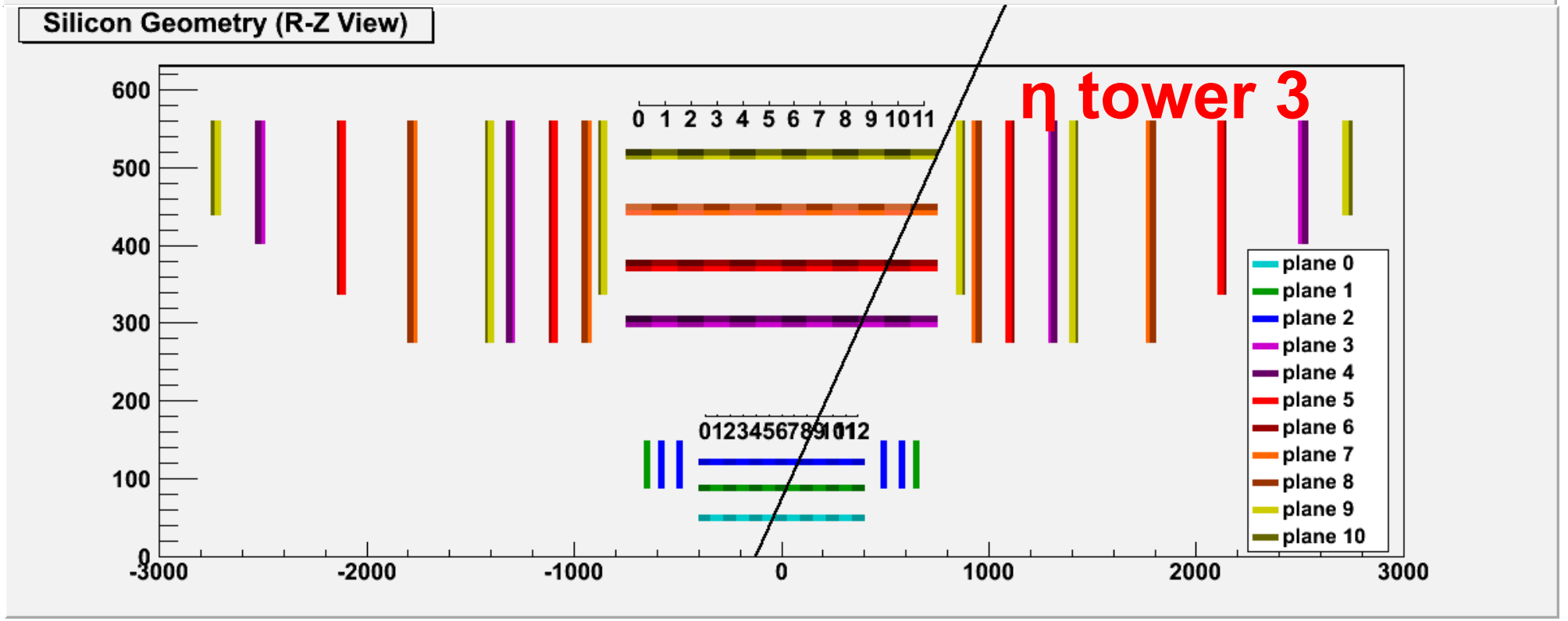
What was done

- Wrote two complementary pieces of simulation:
  - Hit-level simulation (using 3E34 WH events)
    - Used to establish eta partitioning
    - Graphical choice of initial tower bounds in R-Z plane
    - Counts # of clusters flowing into each tower
  - Sector-level simulation
    - Used to quantify eta and phi partitioning
    - Ensures that with the chosen tower bounds, each sector falls at least into one tower (aka *bootstrap from sectors*)
      - Also, estimates loss of coverage if some bounds are overly tight
    - Since all modules are identical along phi, this can also be used to deduce reduction in #clusters due to phi partition


Silicon Geometry (R-Z View)
η tower 0
Includes ALL neg-endcaps
plus some barrel
plane 0
plane 1
plane 2
plane 3
plane 4
plane 5
plane 6
plane 7
plane 8
plane 9
plane 10


Silicon Geometry (R-Z View)
η tower 1
Does not include any
endcaps
plane 0
plane 1
plane 2
plane 3
plane 4
plane 5
plane 6
plane 7
plane 8
plane 9
plane 10


Silicon Geometry (R-Z View)
η tower 2
0 1 2 3 4 5 6 7 8 9 10 11
0 1 2 3 4 5 6 7 8 9 10 11 12
plane 0
plane 1
plane 2
plane 3
plane 4
plane 5
plane 6
plane 7
plane 8
plane 9
plane 10
600
500
400
300
200
100
0
-3000
-2000
-1000
0
1000
2000
3000


Silicon Geometry (R-Z View)
η tower 3
0 1 2 3 4 5 6 7 8 9 10 11
0 1 2 3 4 5 6 7 8 9 10 11 12
plane 0
plane 1
plane 2
plane 3
plane 4
plane 5
plane 6
plane 7
plane 8
plane 9
plane 10
600
500
400
300
200
100
0
-3000
-2000
-1000
0
1000
2000
3000

Tower boundaries

- In eta, I tightened the bounds so that some of the sectors do not fit into any tower.
  - Lost ~3k sectors / 100k, mostly at the bottom
  - Coverage reduced by 1.18%
    - Effect on efficiency will be smaller (maybe negligible).
- In phi, I decided not to cut too tight at the boundaries, so all sectors survive.
  - This could be tightened, especially with intra-module tower bounds
  - Note: focused on barrel region, but saw similar performance in endcaps (based on a brief look)

Existing min-overlap dataflow

SCT ss=12
PIX ss=24x18

Total reduction in #SS (for busiest tower)

#SS in busiest tower

Reduction is with respect to minimum overlap config

Plane	#clu	#clu	#SS	Reduction in η				Min η	Reduction in φ		Min φ	Tot	#SS
	(45°OL)	(10°OL)	(10°OL)	η0	η1	η2	η3		φ0	φ1			
0	2629	2184	1629	1.8	1.7	1.8	1.8	1.7	1.33	1.33	1.33	2.26	720
1	2886	1992	1591	2.1	2.1	2.1	2.2	2.1	1.75	1.4	1.4	2.94	541
2	3221	2356	1903	2.4	2.7	2.7	2.4	2.4	1.5	1.5	1.5	3.6	529
3	2871	1877	1659	2.9	4.1	4.1	2.8	2.8	1.67	1.67	1.67	4.68	355
4	2884	1879	1656	2.9	4.1	4.1	2.8	2.8	1.67	1.67	1.67	4.68	354
5	2944	2024	1796	3.2	3.8	3.8	3.1	3.1	1.5	2	1.5	4.65	386
6	2932	2019	1785	3.1	3.8	3.8	3.1	3.1	1.5	2	1.5	4.65	384
7	3034	2069	1842	3.4	3.6	3.6	3.3	3.3	2	1.6	1.6	5.28	349
8	3035	2069	1836	3.4	3.5	3.6	3.3	3.3	2	1.6	1.6	5.28	348
9	3057	2128	1888	3.3	3.8	3.8	3.2	3.2	1.8	1.8	1.8	5.76	328
10	3025	2113	1876	3.3	3.8	3.8	3.2	3.2	1.8	1.8	1.8	5.76	326
	Std Deviation of the points:			Frac of patterns:					Frac of patterns:			min	max
	350	240	200	4.9	3.57	3.65	4.83	3.57	1.87	2.15	1.87	6.68	10.54

Reduction in # of sectors, patterns, roads, and fits in each tower

RECALL: FROM NAOKI'S SLIDES

Region

Average number of hits for each layer in **one region (minimum overlap)**	
Pixel 1	**1951 ±10**
Pixel 2	**2029 ± 10**
Pixel 3	**2270 ± 13**
SCT 4	**1925 ± 9**
SCT 5	**1938 ± 9**
SCT 6	**2066 ± 9**
SCT 7	**2055 ± 9**
SCT 8	**2134 ± 9**
SCT 9	**2133 ± 10**
SCT 10	**2239 ± 10**
SCT11	**2224 ± 10**

Sub Region

Average number of hits for each layer in **one Sub region (minimum overlap)**	
Pixel 1	**574.4 ± 3.1**
Pixel 2	**521.5 ± 2.7**
Pixel 3	**537.6 ± 2.9**
SCT 4	**368.9 ± 1.6**
SCT 5	**371.8 ± 1.6**
SCT 6	**359.7 ± 1.5**
SCT 7	**358.5 ± 1.6**
SCT 8	**340.6 ± 1.5**
SCT 9	**340.9 ± 1.5**
SCT 10	**332 ± 1.4**
SCT11	**329 ± 1.4**

These are clusters, not superstrips (?)

x8

More on pixel layers

- Recall the phi partition performance:
  - Reduction in # of cluster = 1.33
  - Loss in efficiency = 0%
- What if we narrow b-layer overlap by 1 module?
  - Reduction in # of clusters = 2.0
  - Loss in sector coverage = 2.65%
- How do we get here? - partition inside the modules (not just on the boundaries)
  - Expected reduction will be **between 1.33 and 2.0**