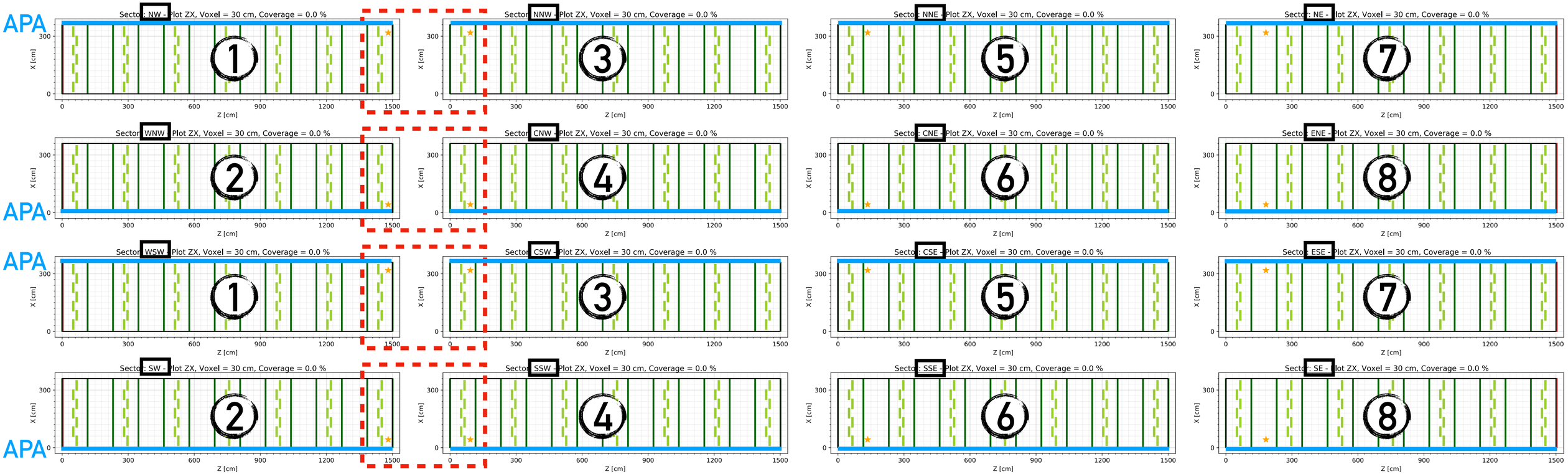
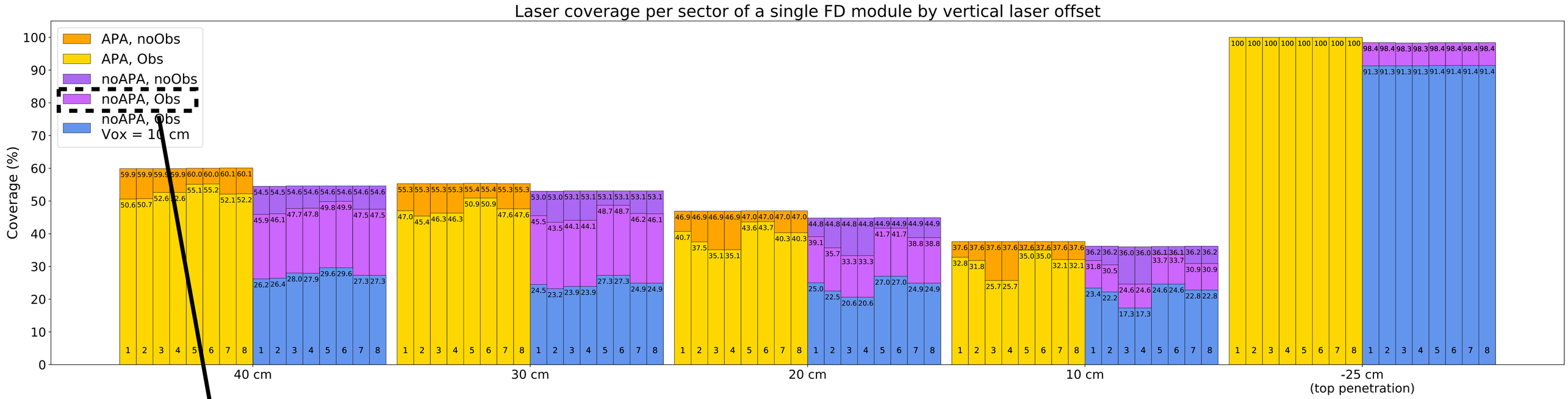
Simulation update

New ray-set, 5 vertexes, openings

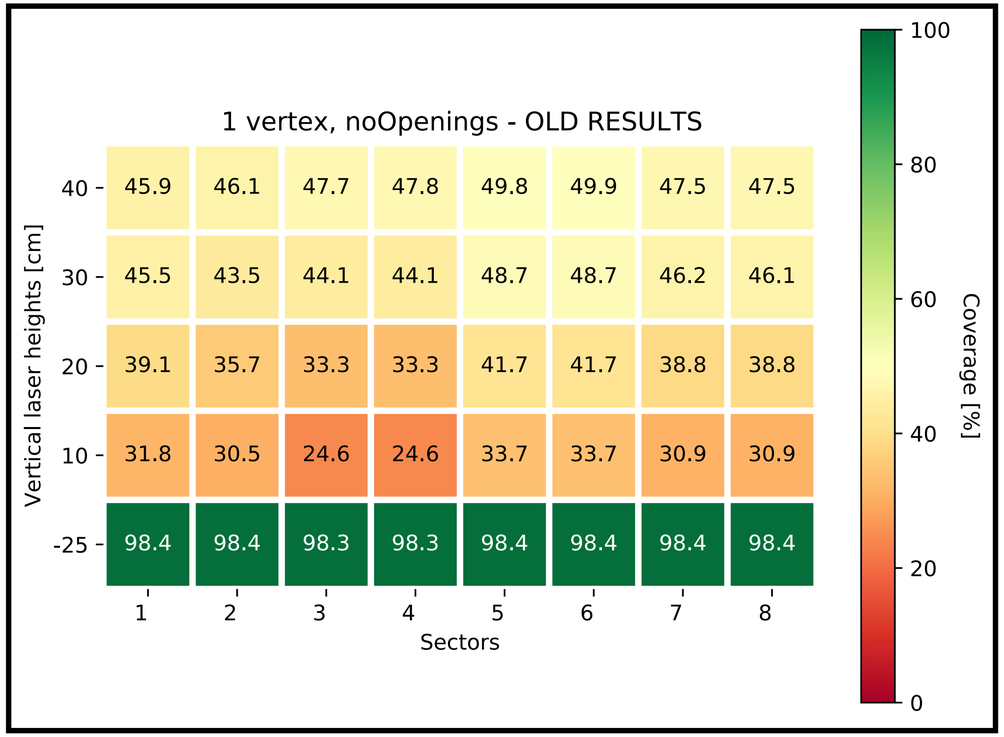
Mattia - Feb 24, 2021


APA
Sector: NW - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
1
Sector: NNW - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
3
Sector: NNE - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
5
Sector: NE - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
7
Sector: WNW - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
2
Sector: CNW - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
4
Sector: CNE - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
6
Sector: ENE - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
8
APA
Sector: WSW - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
1
Sector: CSW - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
3
Sector: CSE - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
5
Sector: ESE - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
7
Sector: SW - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
2
Sector: SSW - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
4
Sector: SSE - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
6
Sector: SE - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
8
APA
X [cm]
Z [cm]
0
300
600
900
1200
1500



NoAPA, Obs, Voxel = 30 cm

	1	2	3	4	5	6	7	8
40	45.9	46.1	47.7	47.8	49.8	49.9	47.5	47.5
30	45.5	43.5	44.1	44.1	48.7	48.7	46.2	46.1
20	39.1	35.7	33.3	33.3	41.7	41.7	38.8	38.8
10	31.8	30.5	24.6	24.6	33.7	33.7	30.9	30.9
-25	98.4	98.4	98.4	98.4	98.4	98.4	98.4	98.4



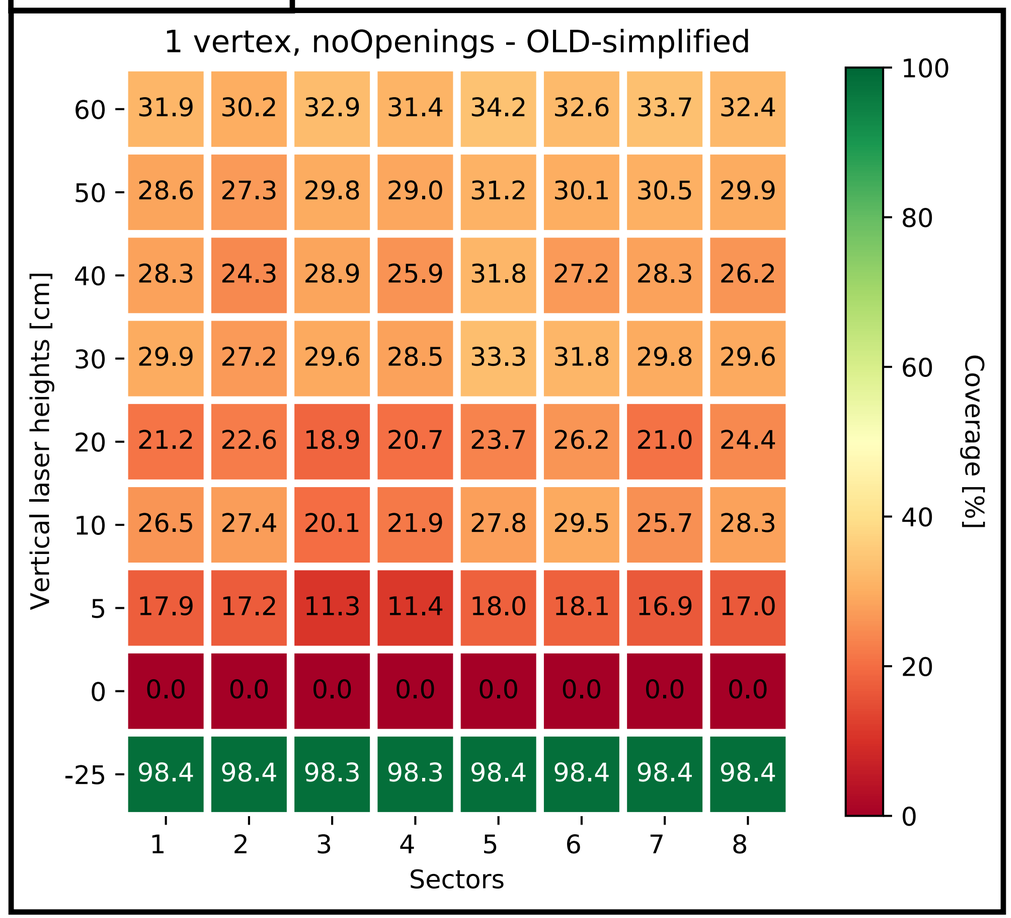
1 Vertex,
no Openings,
NoAPA, Obs,
Voxel = 30 cm

Vertex above FCP-gap

Sector 5, vLaserOffset = 40

Sector 5, vLaserOffset = 40
Number of total generated tracks: **165012**
Number of rays not crossing the detector: 0
Number of rays blocked by obstacles: 137789
Number of rays crossing the active region: 27223
Covered voxels: 11963 of 24000; Coverage = 49.8%

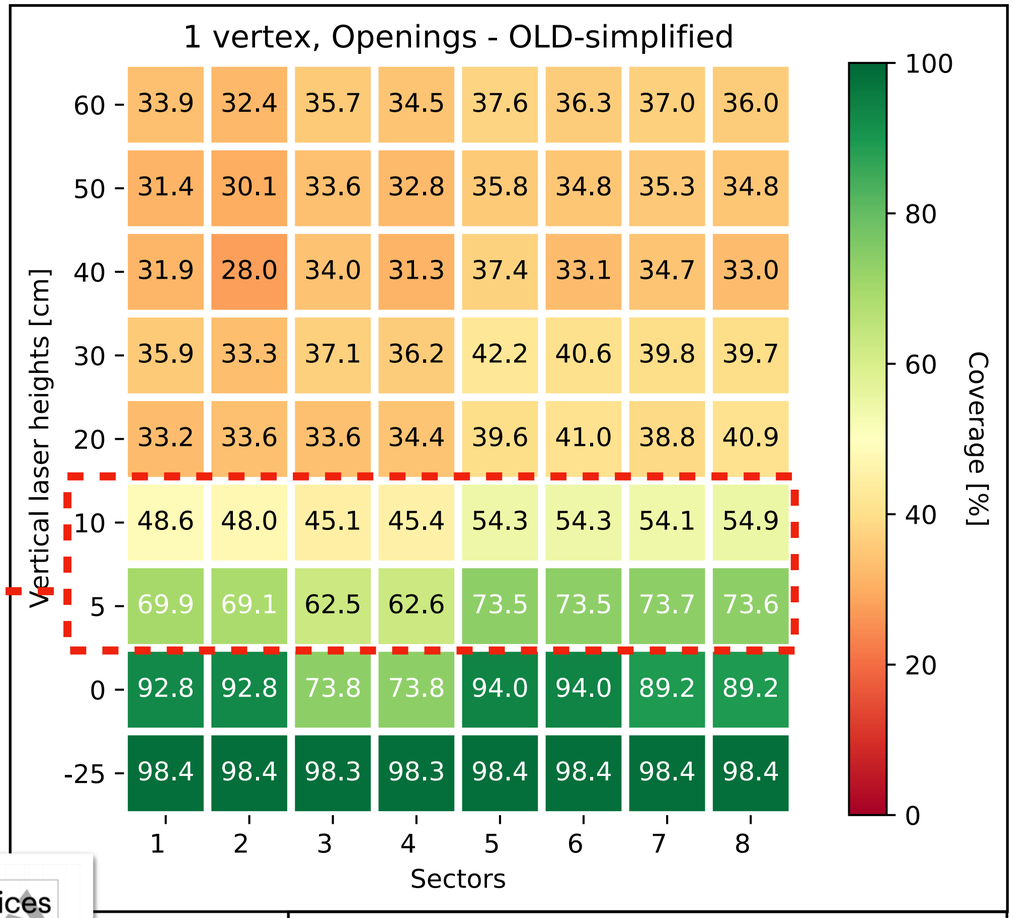
Vertex above FCP



Sector 5, vLaserOffset = 40

[20210220-172506]: Track summary
Number of total generated tracks: **4429**
Number of rays not crossing the detector: 0
Number of rays blocked by obstacles: 3925
Number of rays crossing the active region: 504
[20210220-172506]: Computing coverage for the single sources...
Covered voxels Source 0: 7624 of 24000; Coverage Source 0 = 31.8%

1 Vertex,
Openings,
NoAPA, Obs,
Voxel = 30 cm



	Standard source	
	5 cm	0 cm
1	49.2%	70.0%
2	48.7%	69.4%
3	45.2%	62.6%
4	45.5%	62.6%
5	54.3%	73.5%
6	54.4%	73.5%
7	54.3%	73.7%
8	54.9%	73.7%

	Dual rotary, 5 vertices	
	5 cm	0 cm
1	78.8%	93.4%
2	77.8%	93.3%
3	68.8%	77.5%
4	68.6%	77.5%
5	81.7%	94.6%
6	82.2%	94.5%
7	80.4%	90.6%
8	80.5%	90.5%

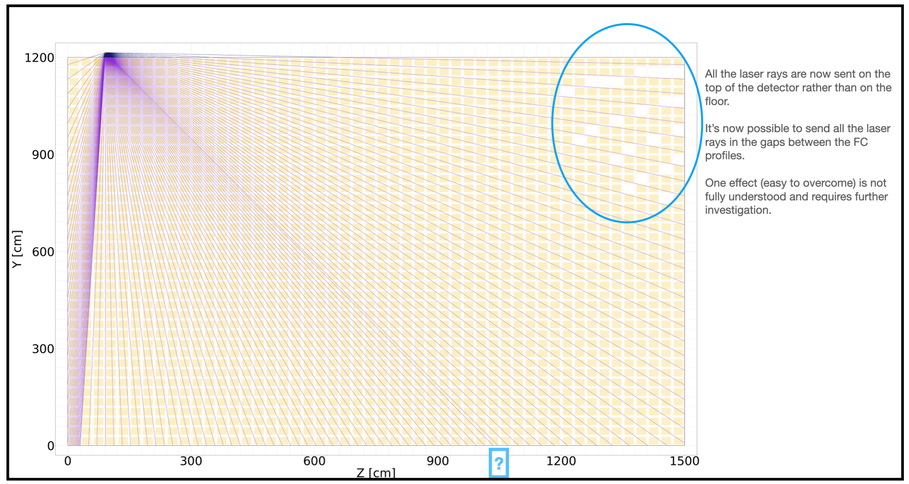
Preliminary

Preliminary

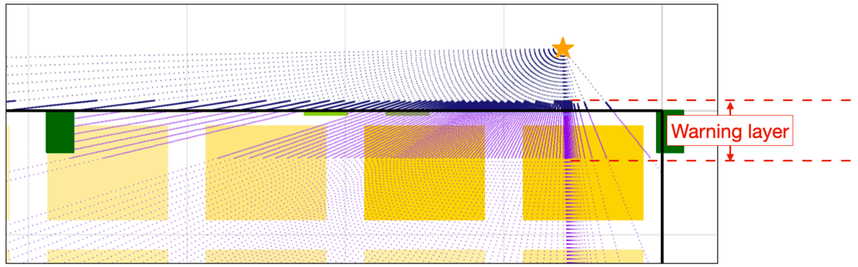
Can be improved

Track summary
Number of total generated tracks: **4429**
Number of rays not crossing the detector: 0
Number of rays blocked by obstacles: 3690
Number of rays crossing the active region: 739
Computing coverage for the single sources...
Covered voxels Source 0: 8983 of 24000;
Coverage Source 0 = 37.4%

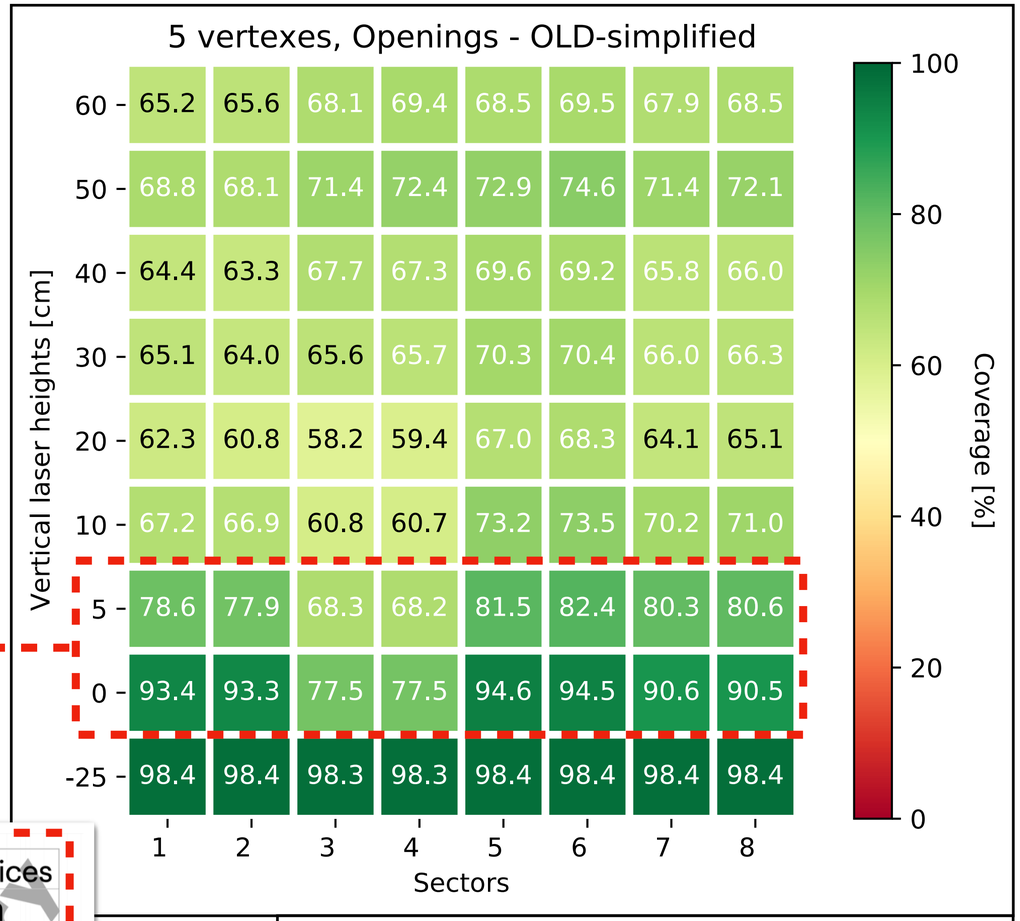
Wed. meeting - Jan 06, 2021



Smart Line3D density increase got lost at some point
-> Reestablished
-> Implemented on the end-walls too.
Now the density increases only if it the end-wall has obstacles on it



5 Vertexes,
Openings,
NoAPA, Obs,
Voxel = 30 cm



	Standard source	
	5 cm	0 cm
1	49.2%	70.0%
2	48.7%	69.4%
3	45.2%	62.6%
4	45.5%	62.6%
5	54.3%	73.5%
6	54.4%	73.5%
7	54.3%	73.7%
8	54.9%	73.7%

	Dual rotary, 5 vertices	
	5 cm	0 cm
1	78.8%	93.4%
2	77.8%	93.3%
3	68.8%	77.5%
4	68.6%	77.5%
5	81.7%	94.6%
6	82.2%	94.5%
7	80.4%	90.6%
8	80.5%	90.5%

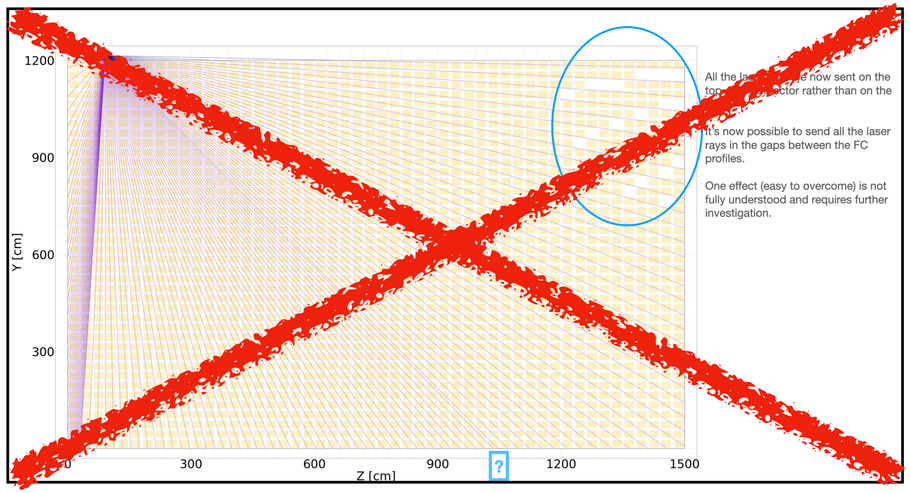
Preliminary

Preliminary

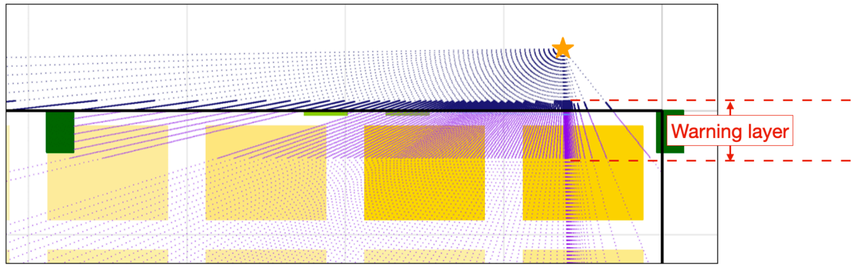
Can be improved

Track summary
Number of total generated tracks: **22145**
Number of rays not crossing the detector: 0
Number of rays blocked by obstacles: 18353
Number of rays crossing the active region: 3792
Computing coverage for the single sources...
Covered voxels Source 0: 16715 of 24000;
Coverage Source 0 = 69.6%

Wed. meeting - Jan 06, 2021



Smart Line3D density increase got lost at some point
-> Reestablished
-> Implemented on the end-walls too.
Now the density increases only if it the end-wall has obstacles on it



Then, the study for a more efficient ray-set started

1. Generate secondary vertexes - keep the even/odd symmetry
(`offset = ((int(sector))+1)%2*360/nVertices/2` i.e. odd: 0˚, even: 36˚ - 5 vertexes)

2. Define the desired interval between arrival points on the floor (= half voxel size)
VS keep a fixed increment (safe with height variation)

3. For each secondary vertex, find the xStart, xEnd (±60˚ from the vertex projection)

4. Find the edges of each of the gaps (basically we are converting to FCgap units).
Define the increment accordingly to the desired interval at the floor.
At this point, we have a number of coordinates in x.
Rays will be sent on those lines. Problem is reduced to two dimensions

5. For each x coordinate, find the two (z,y=TopFC)-points corresponding to the detector edges on z at the end of the track. Linear increment. Find the increment interval required for the desired track density

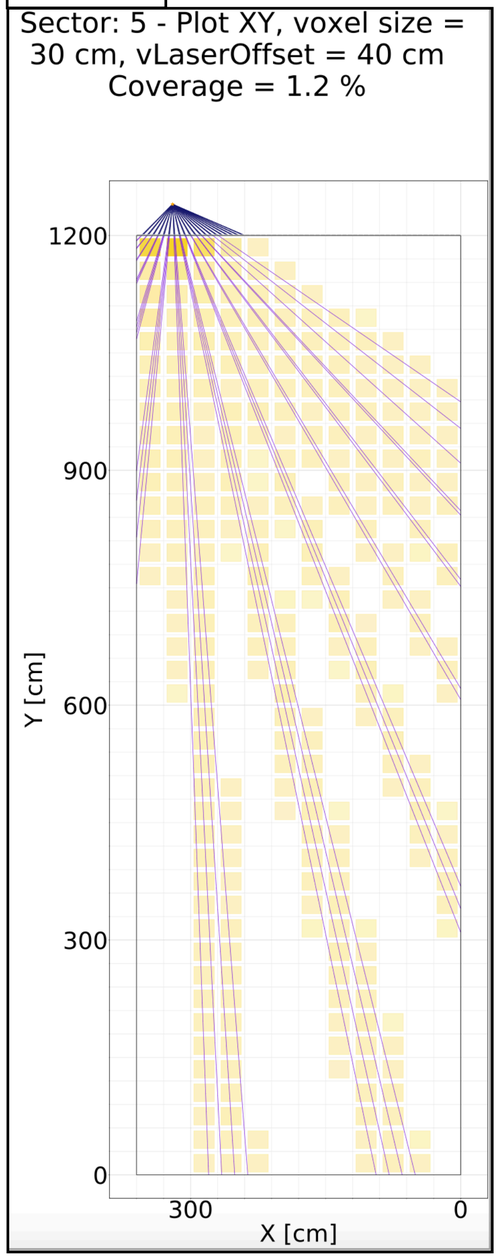
6. Propagate over y keeping the destination increment constant while addressing each ray on the top-FC - working on the z coordinate
(`z = (L[1]-y)*tanTheta`)

7. Apply x,y,z density reduction factors
```
angleStep = safeAngleOpening*(1+int(vLaserOffset/safeLaserOffset))
densityReductionFactor = int(angle/angleStep)
nReducedDivisions = int(nDivisions/densityReductionFactor) +1
```

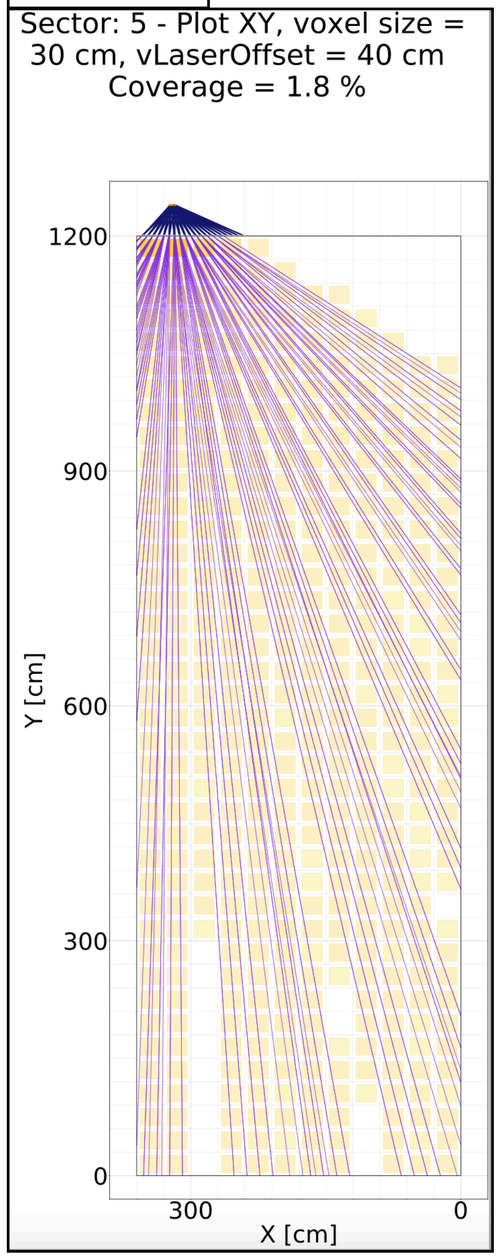
8. Apply APA-filter

9. Find the best compromise coverage VS number of tracks

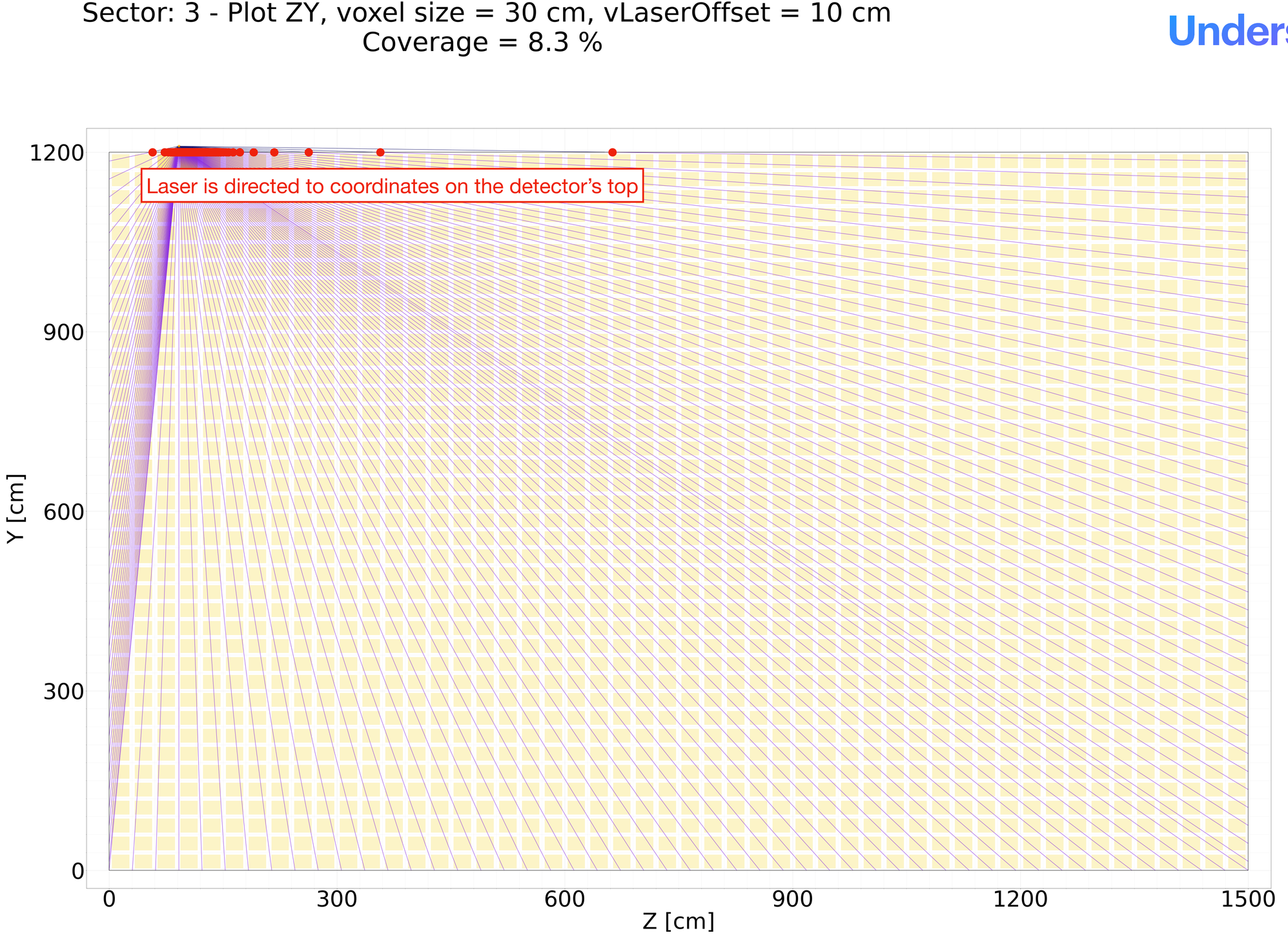
1 vertex



5 vertexes

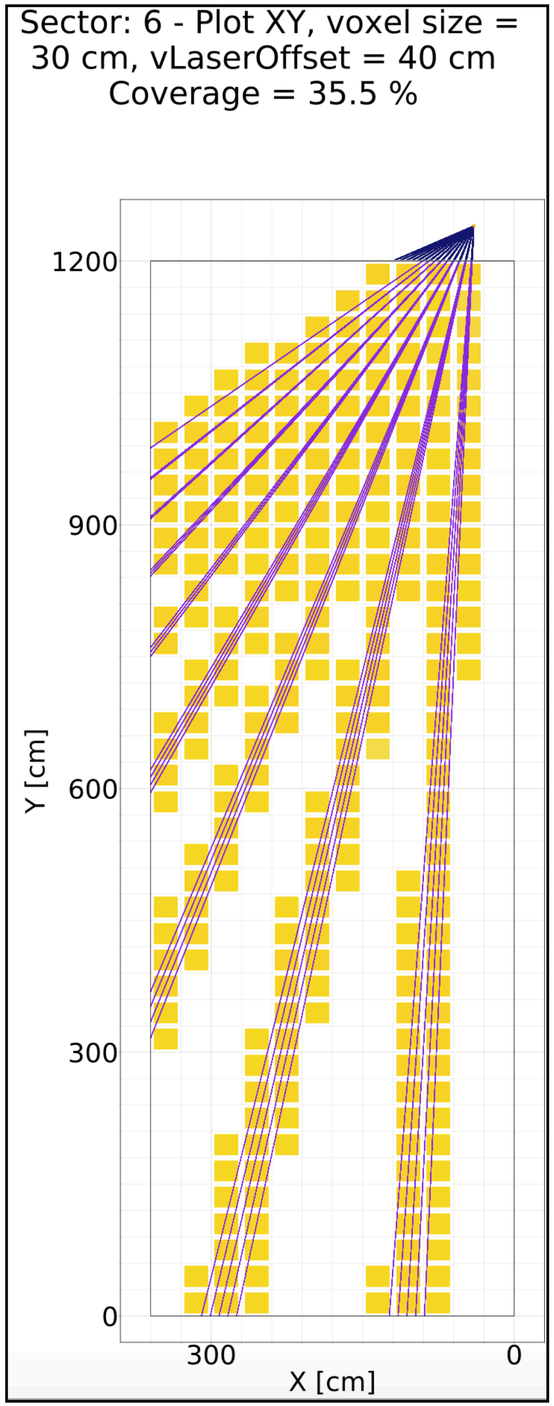


Understanding distances

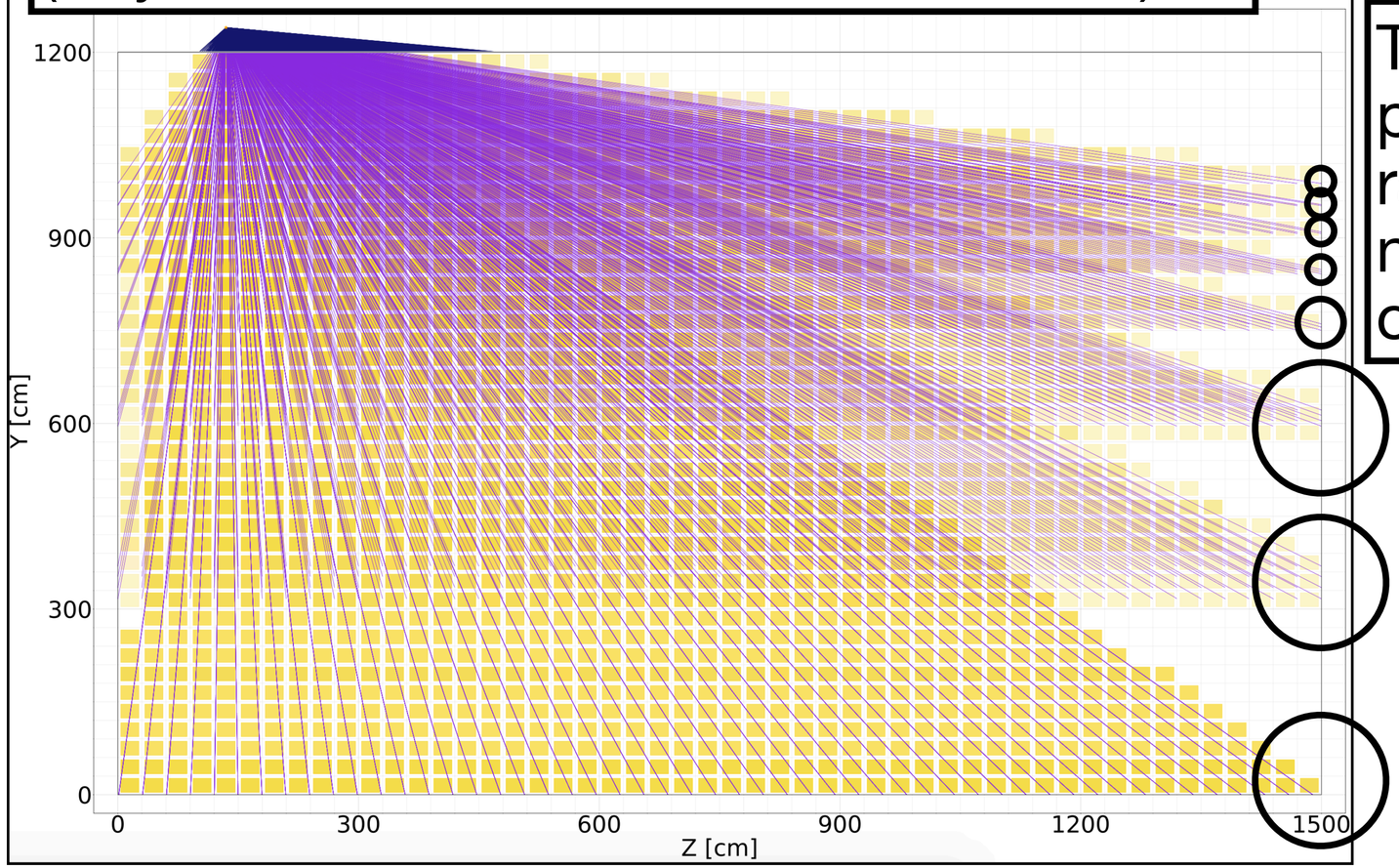


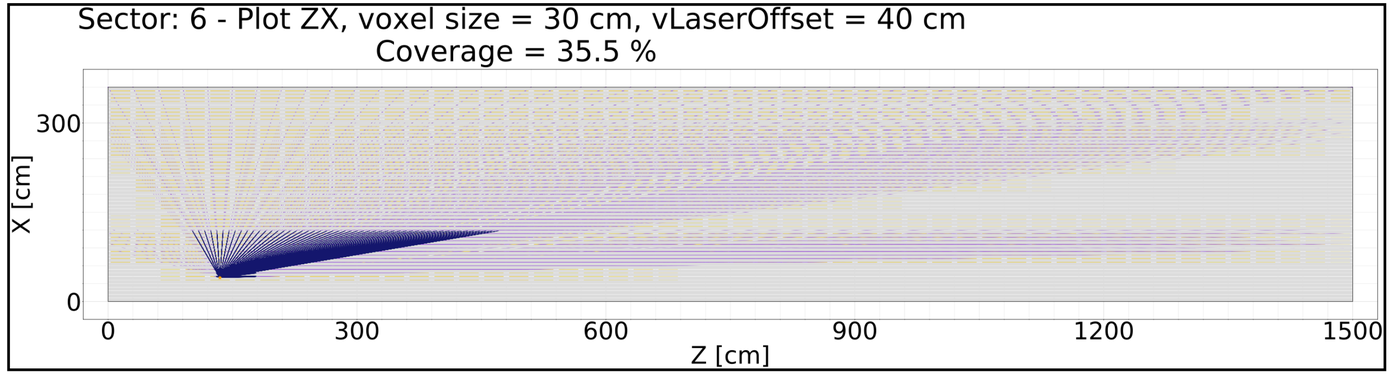
- Rays are only directed at the Top of the TPC level
- One single track successfully hits each single voxel on the sector's floor and on the sector's side
- This is only one sector's slice x = x(fire-point)

Scanning FCgaps (1)



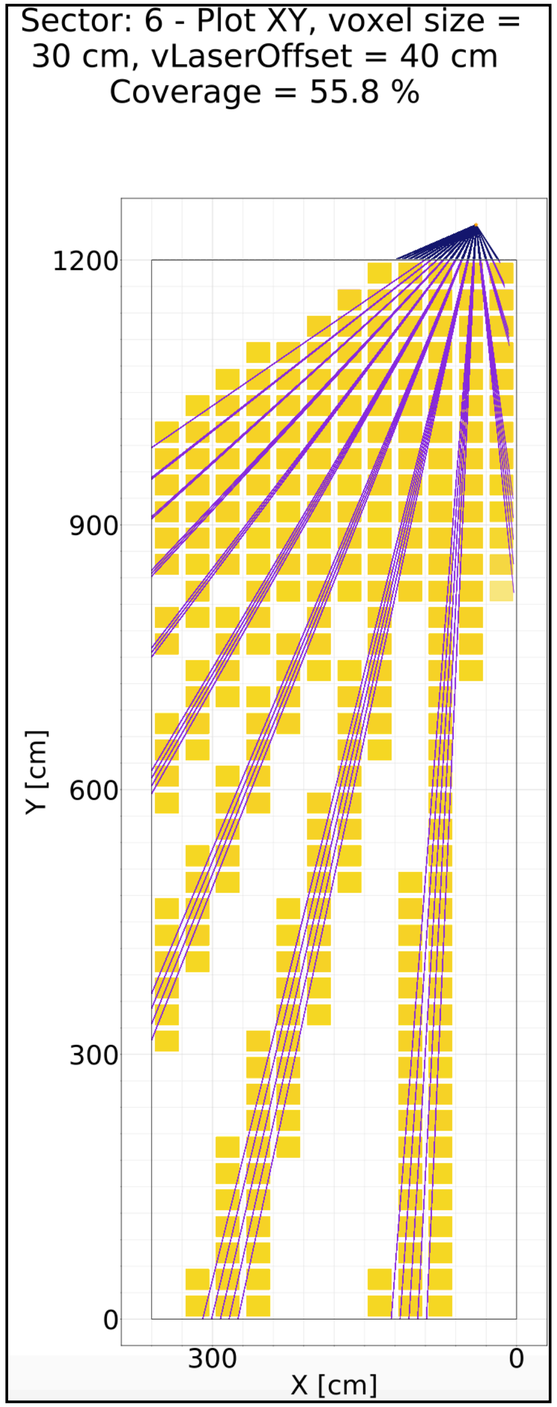
Horizontal propagation
(Rays here are not directed to the sides)



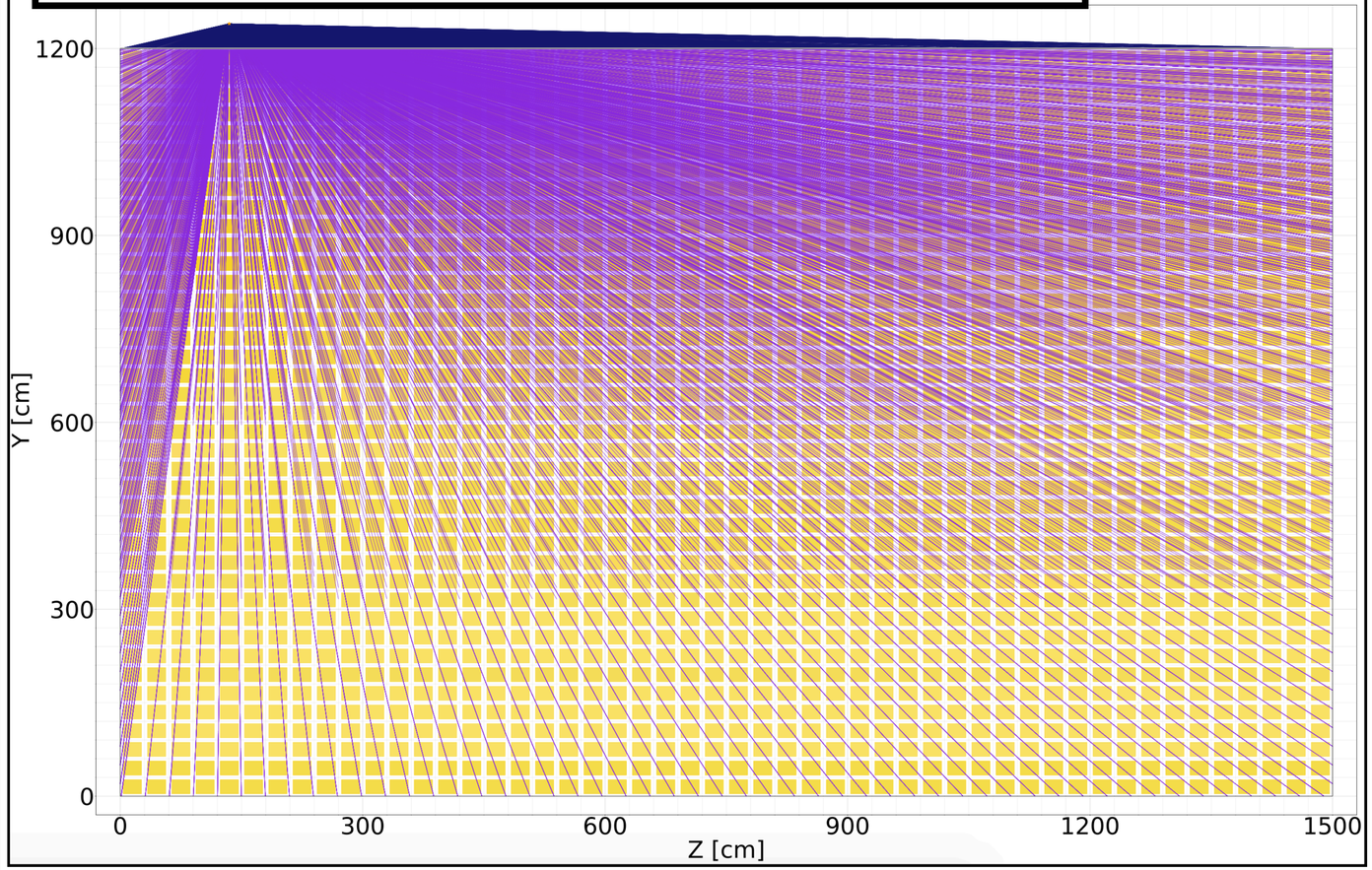


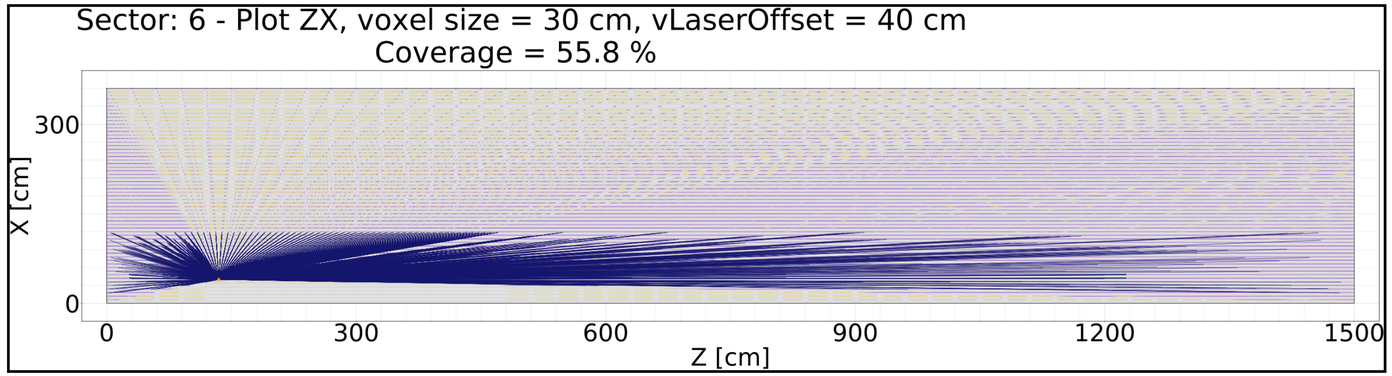
The correct z-propagation of laser rays directed to the next gaps needs one more iteration

Scanning FCgaps (2)



Horizontal + vertical propagation
(Rays are also directed to the sides)

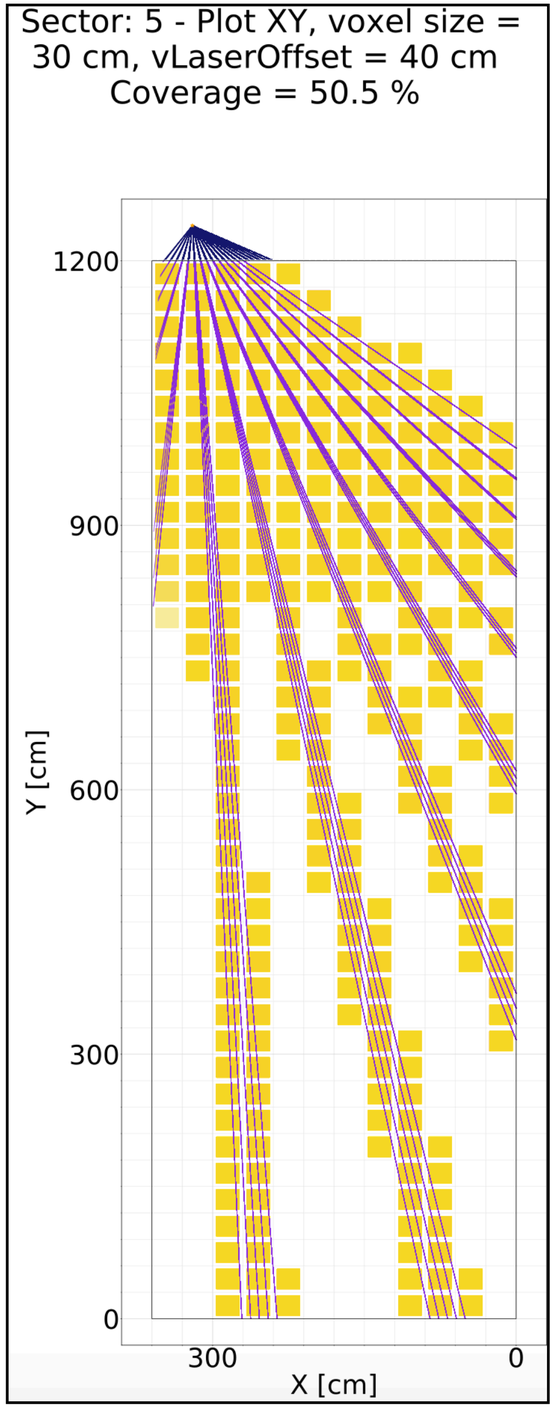


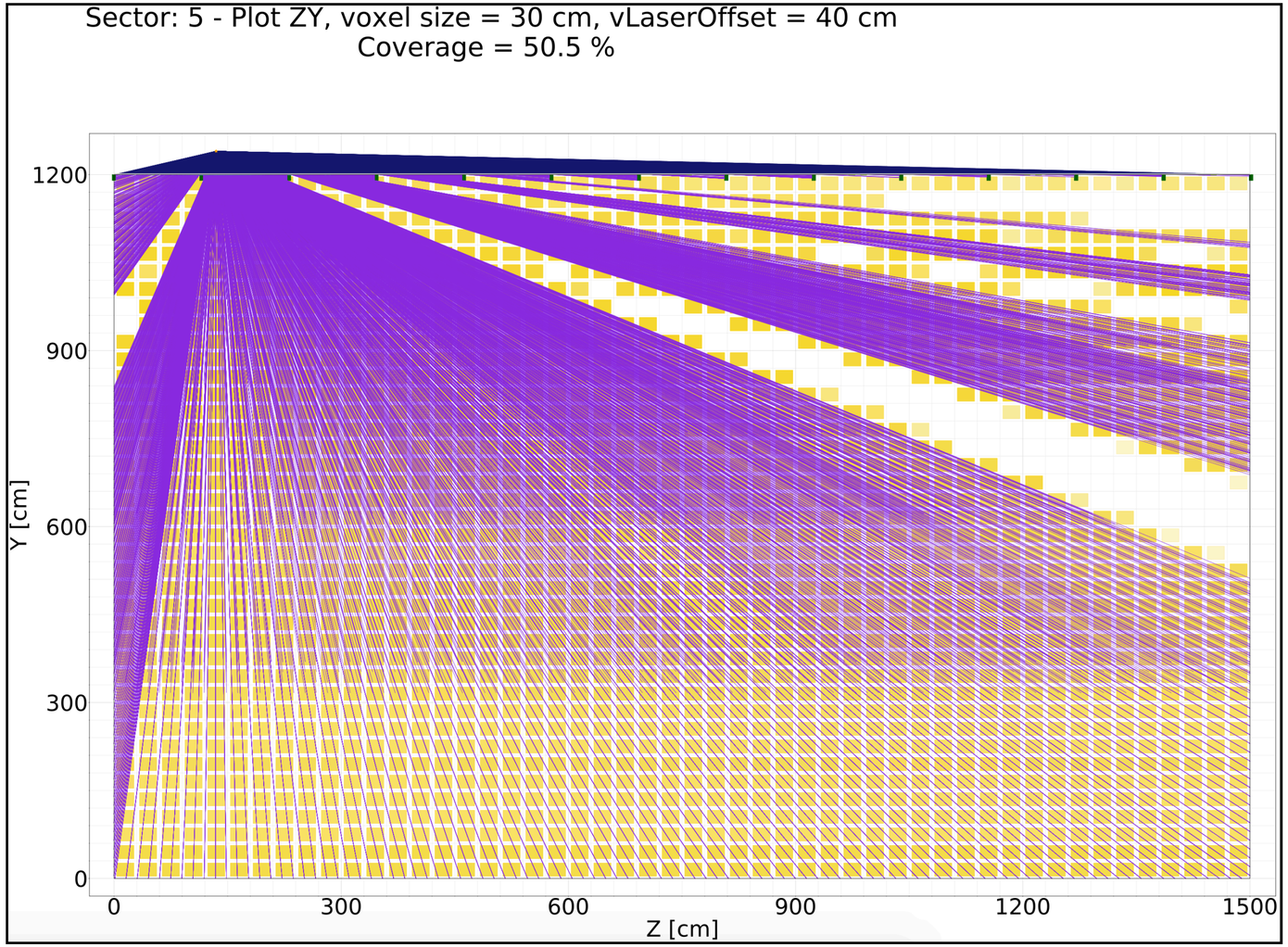


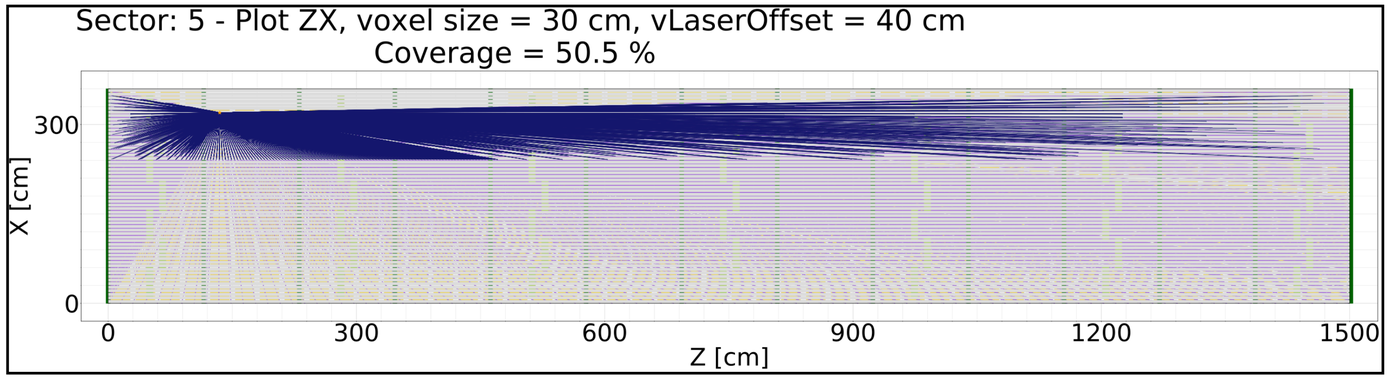
So far, I only included the FC profiles as obstacles…

Correctly including all of them would reproduce the simulation results I presented in September 2020

Adding Obstacles

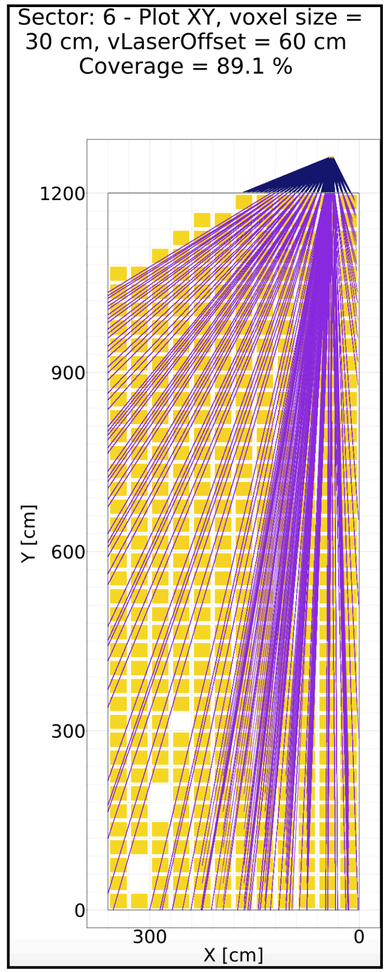


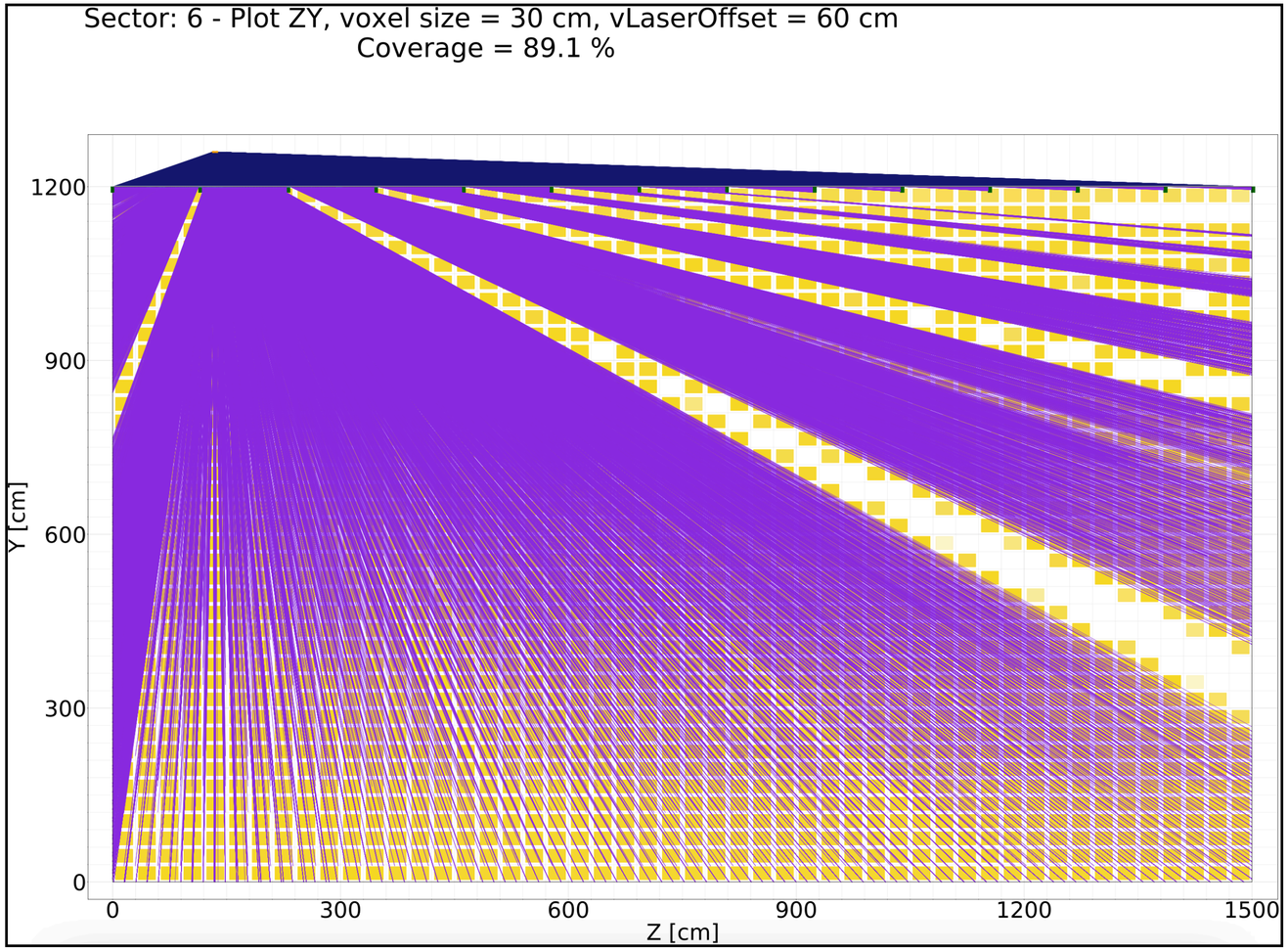


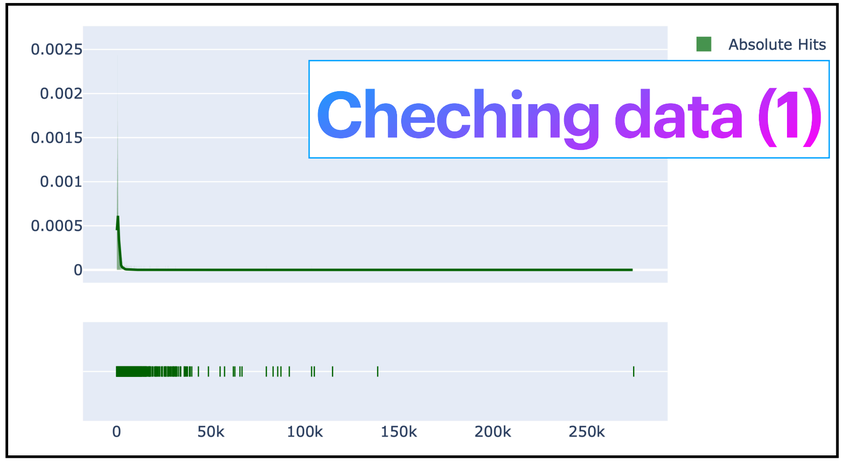


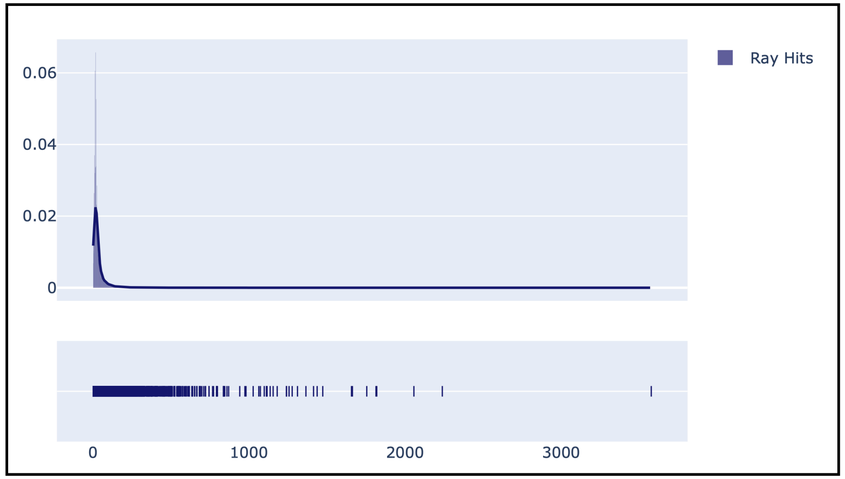
This is Sector 5. All pictures are available at: https://drive.google.com/drive/folders/1nw17esTx1rs6vZlnbBTneGkdPfgNTIzf?usp=sharing

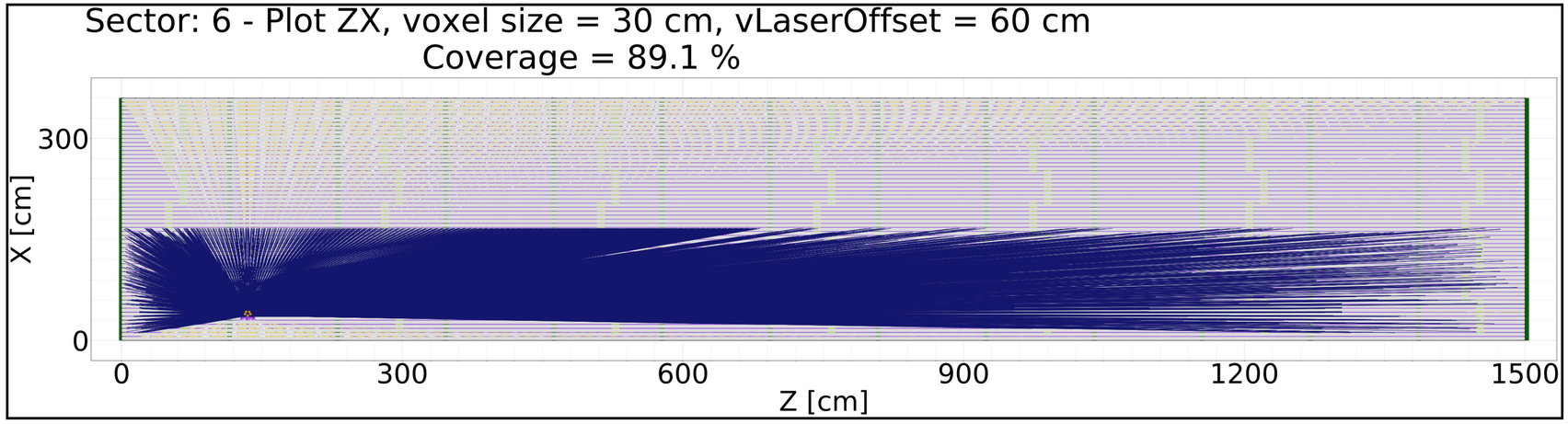
Cheching data (1)

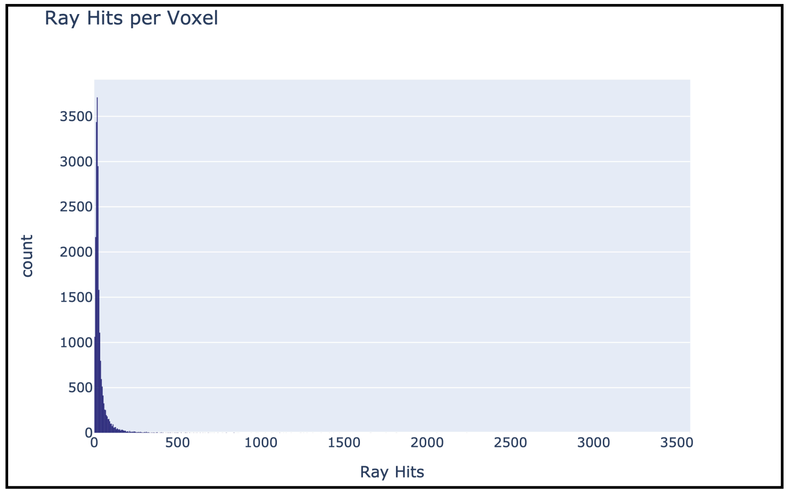




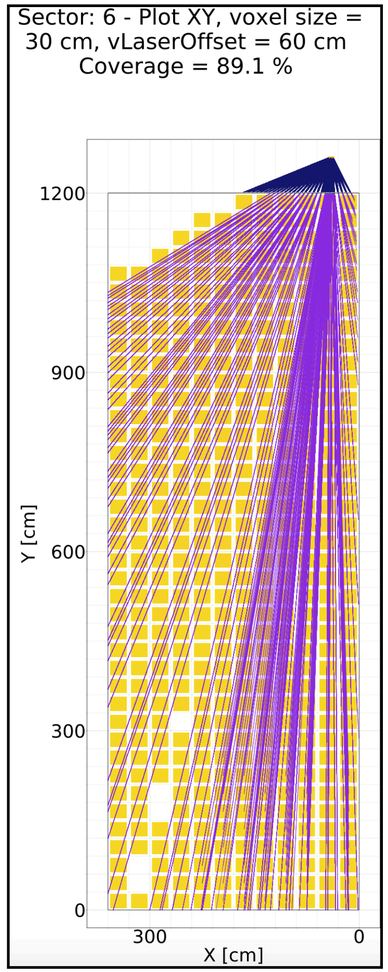


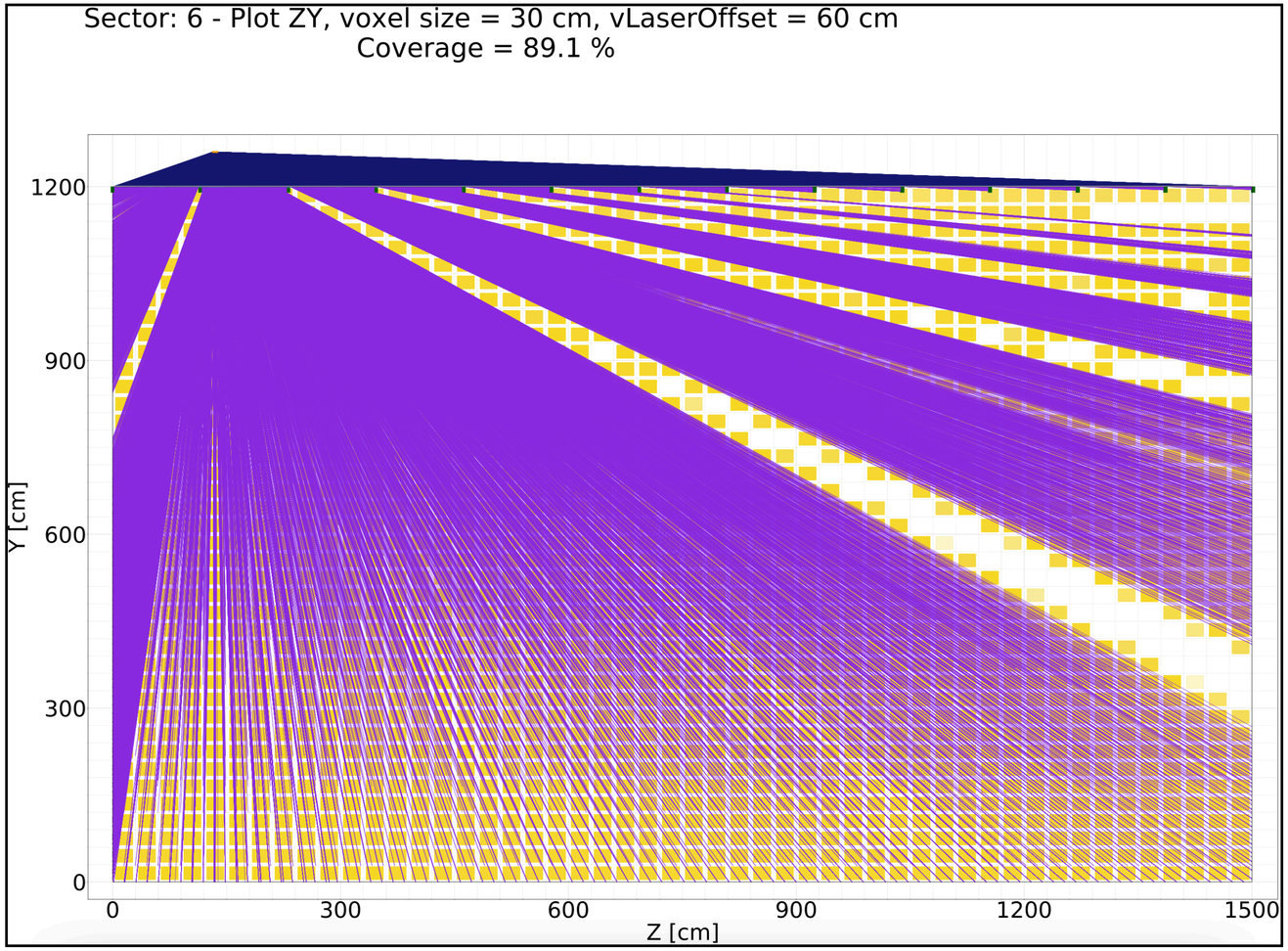


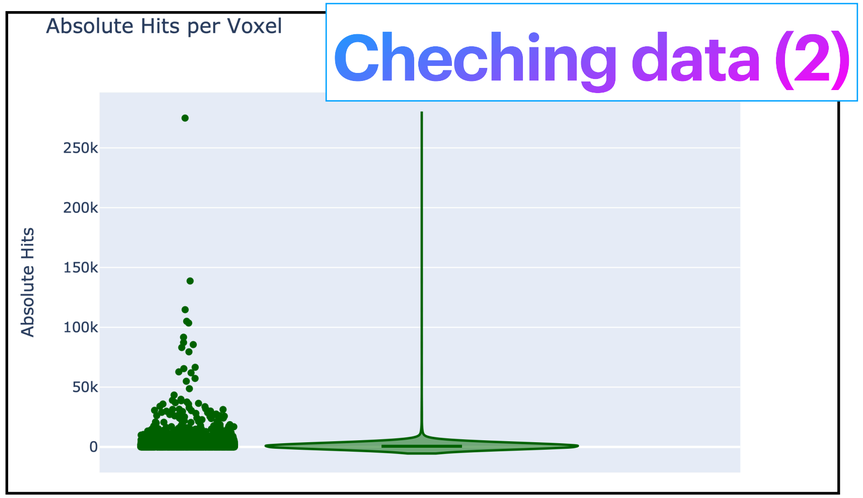


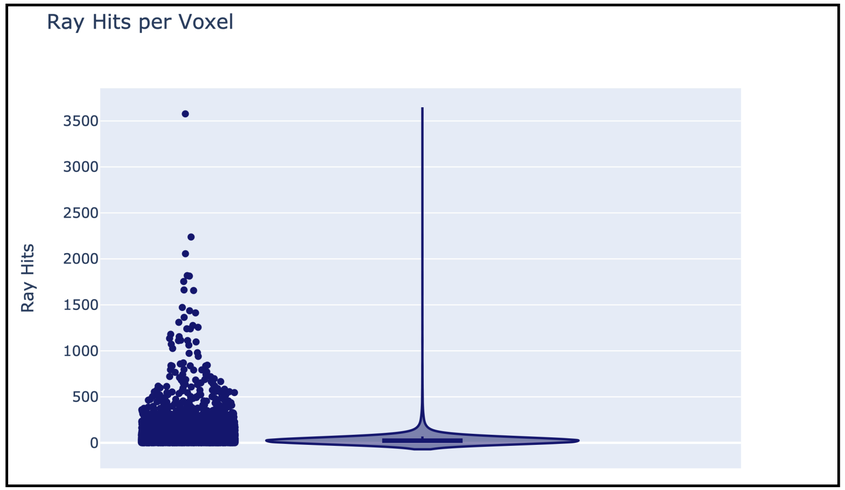


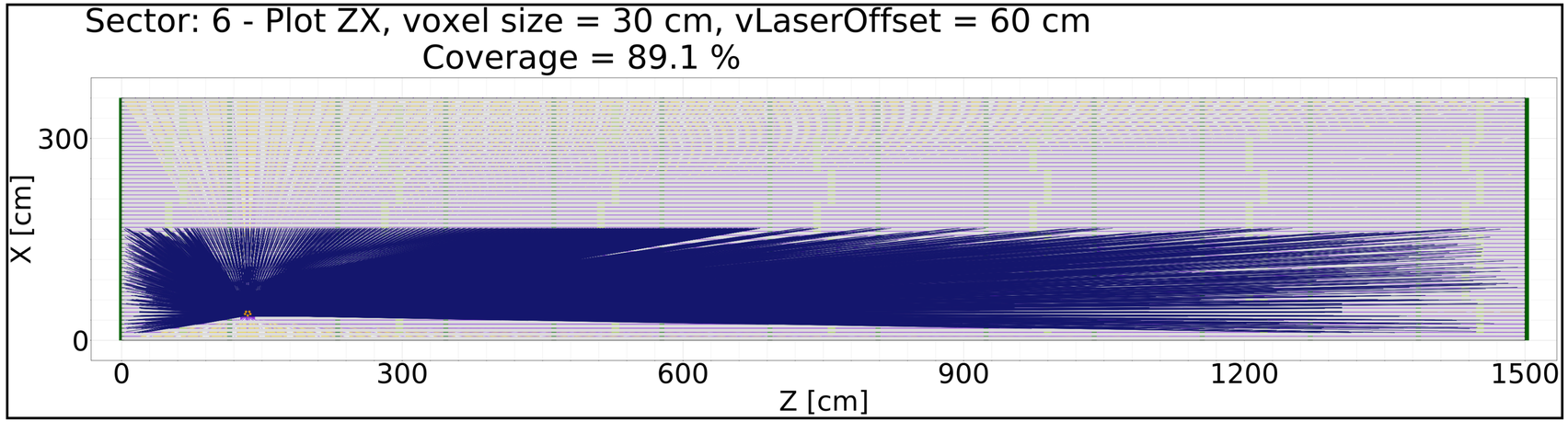
Cheching data (2)









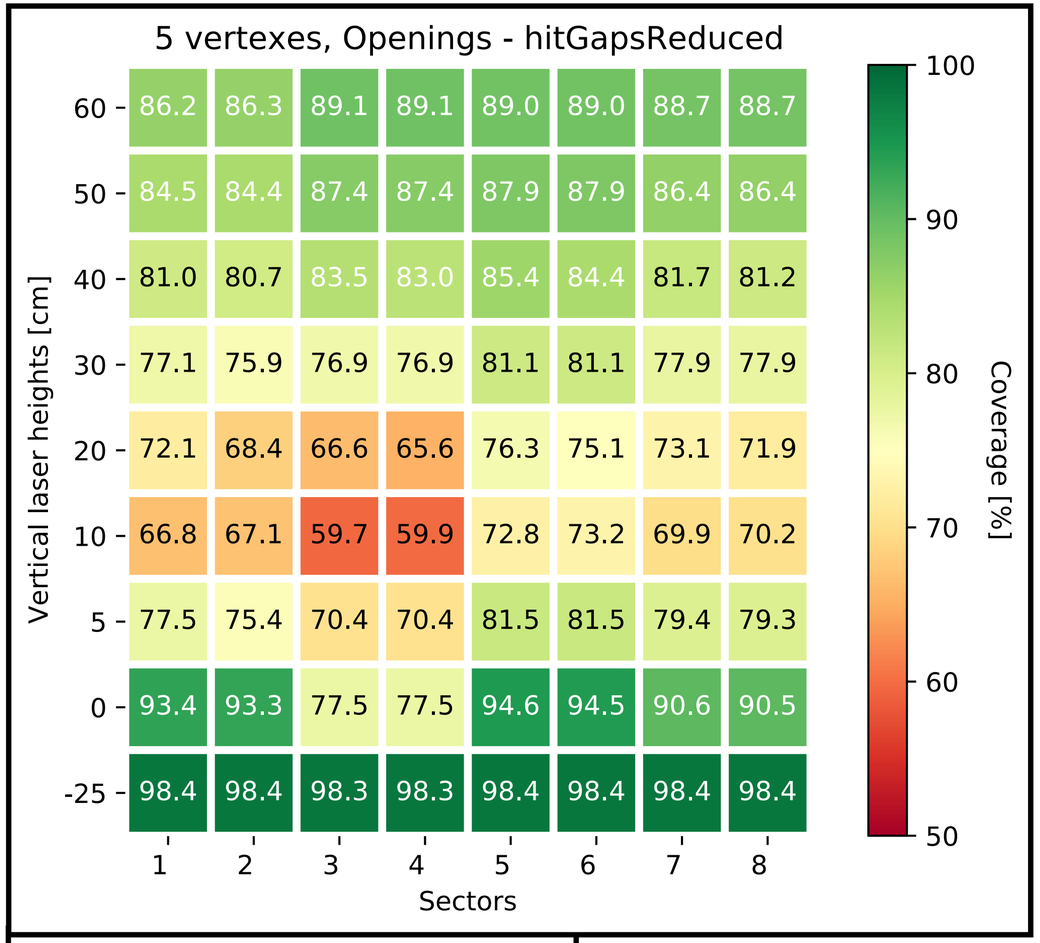


	absolute hits	ray hits
(15.0, 1185.0, 1365.0)	2445	17
(15.0, 1185.0, 1395.0)	338	18
(15.0, 1185.0, 15.0)	7308	104
(15.0, 1185.0, 1335.0)	1924	13
(15.0, 1185.0, 1305.0)	1130	10
(15.0, 1185.0, 1275.0)	1132	25
(15.0, 1185.0, 1245.0)	2329	19
(15.0, 1185.0, 1095.0)	2346	16
(15.0, 1185.0, 1125.0)	2740	17
(15.0, 1185.0, 1155.0)	1293	21

	absolute hits	ray hits
count	21386	21386
mean	962.0901057	36.94201814
std	3517.251851	78.65429909
min	1	1
25%	303	12
50%	467	20
75%	819	35
max	274899	3577

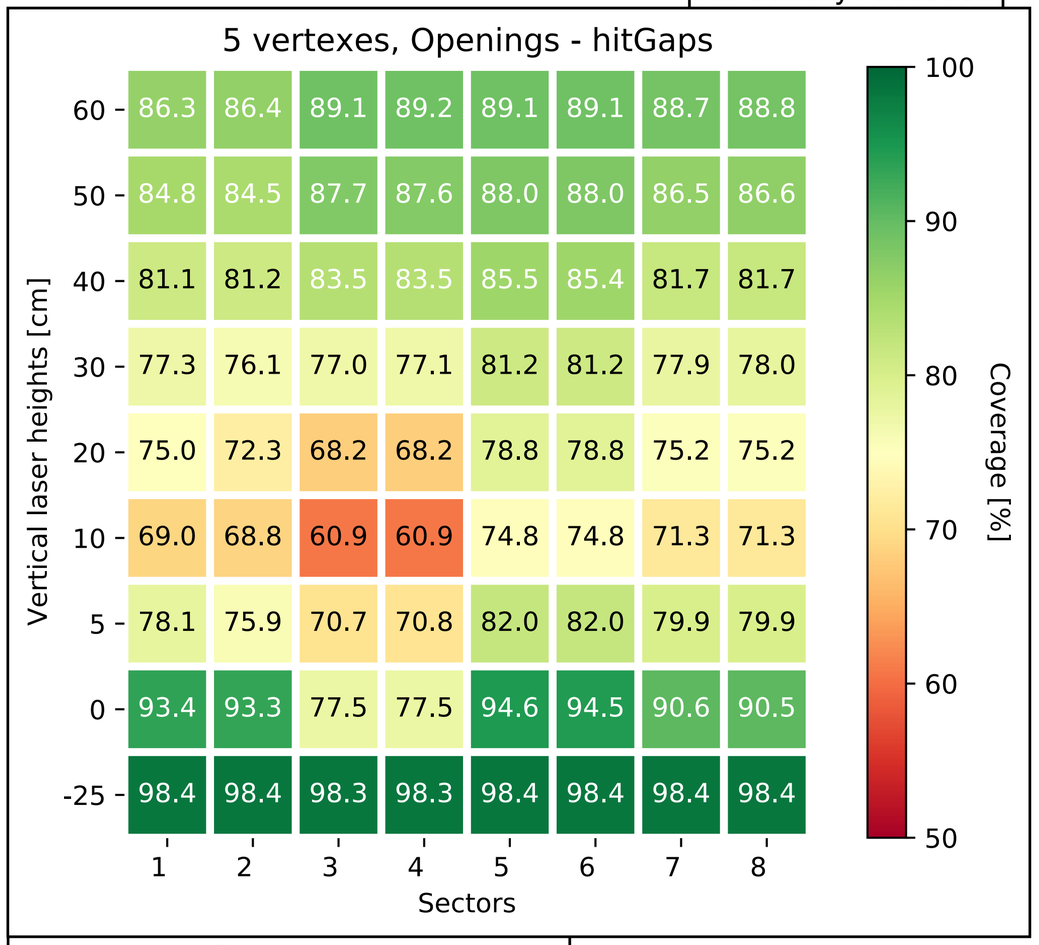
5 Vertexes,
Openings,
NoAPA, Obs,
Voxel = 30 cm

Mattia's favorite



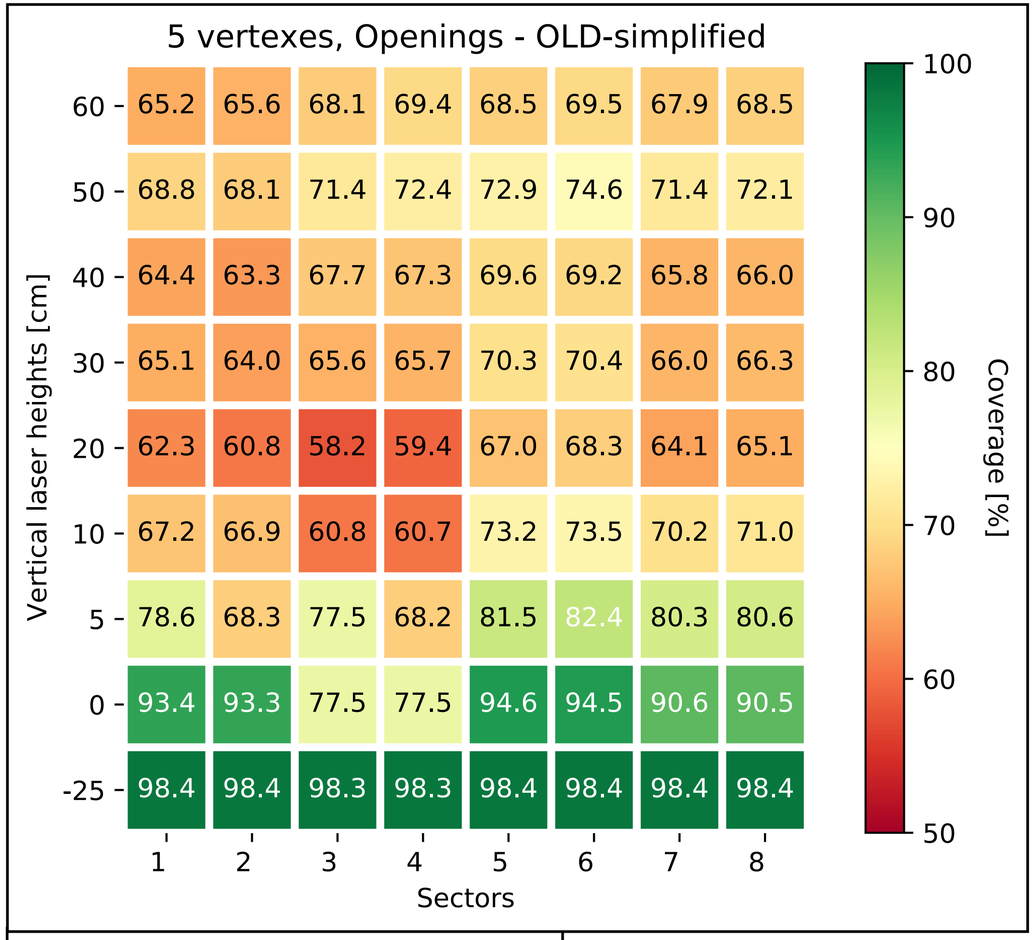
Sector 5, vLaserOffset= 40
Track summary
Number of total generated tracks: **34718**
Number of rays not crossing the detector: 0
Number of rays blocked by obstacles: 18443
Number of rays crossing the active region: 16275
Computing coverage for the single sources...
Covered voxels Source 0: 20486 of 24000;
Coverage Source 0 = 85.4%

No density reduction



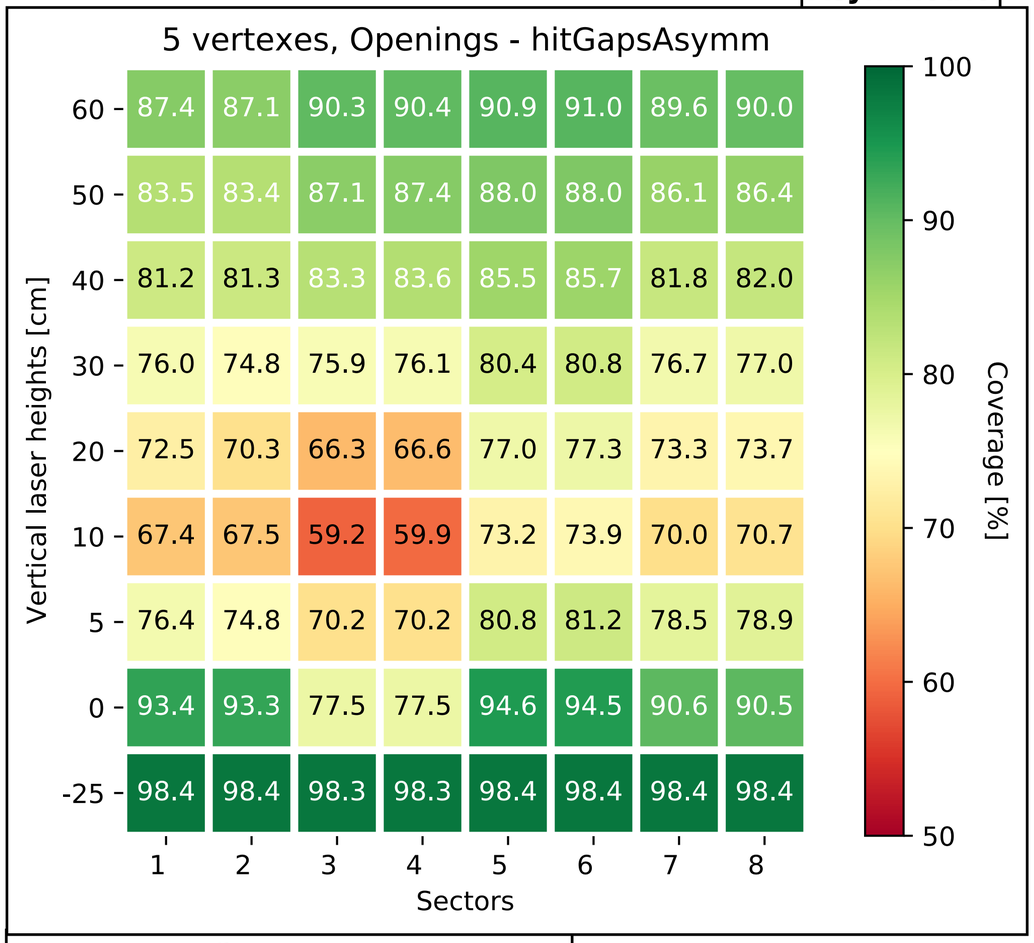
Sector 5, vLaserOffset= 40
Track summary
Number of total generated tracks: **49158**
Number of rays not crossing the detector: 0
Number of rays blocked by obstacles: 31217
Number of rays crossing the active region: 17941
Computing coverage for the single sources...
Covered voxels Source 0: 20509 of 24000;
Coverage Source 0 = 85.5%

5 Vertexes,
Openings,
NoAPA, Obs,
Voxel = 30 cm



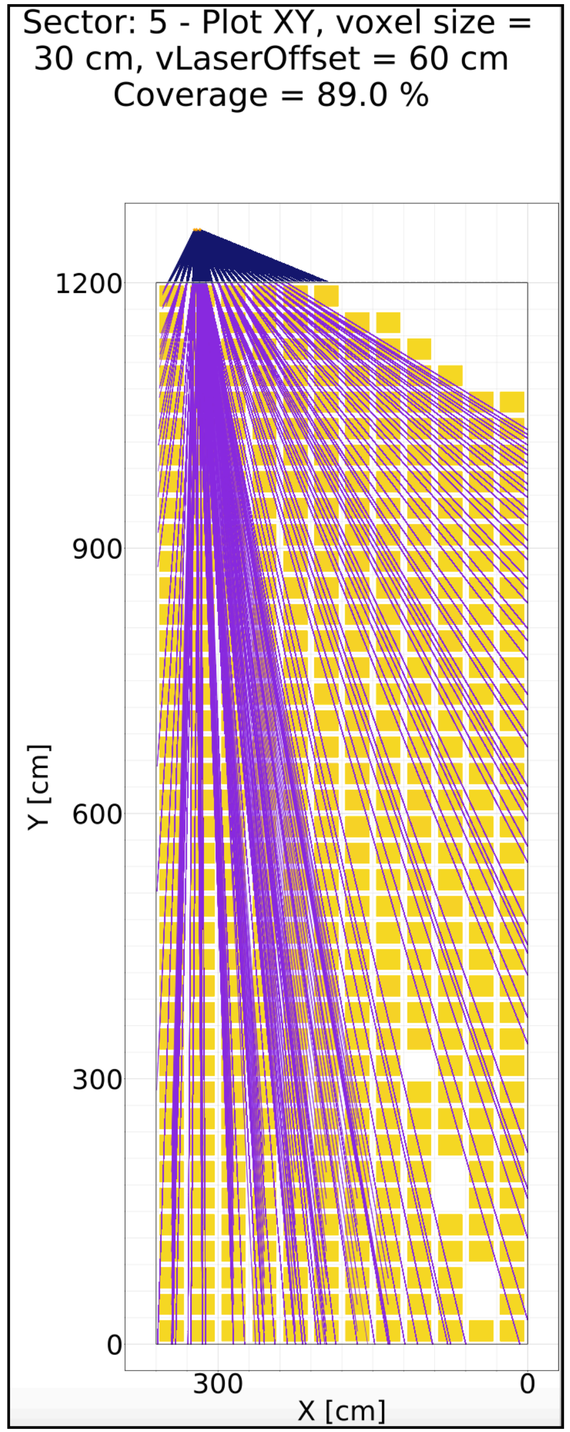
Sector 5, vLaserOffset= 40
Track summary
Number of total generated tracks: **22145**
Number of rays not crossing the detector: 0
Number of rays blocked by obstacles: 18353
Number of rays crossing the active region: 3792
Computing coverage for the single sources...
Covered voxels Source 0: 16715 of 24000;
Coverage Source 0 = 69.6%

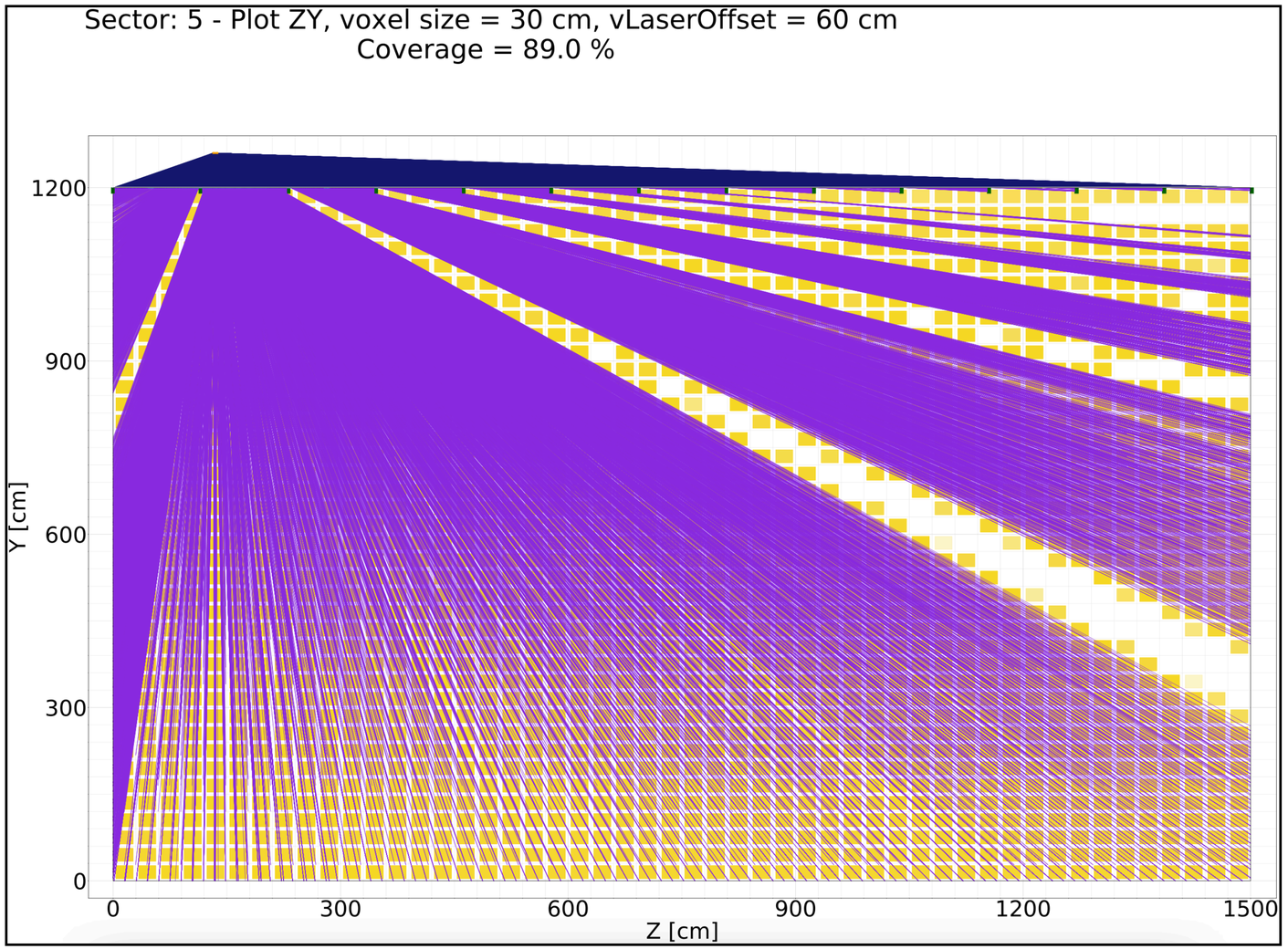
Asymmetric

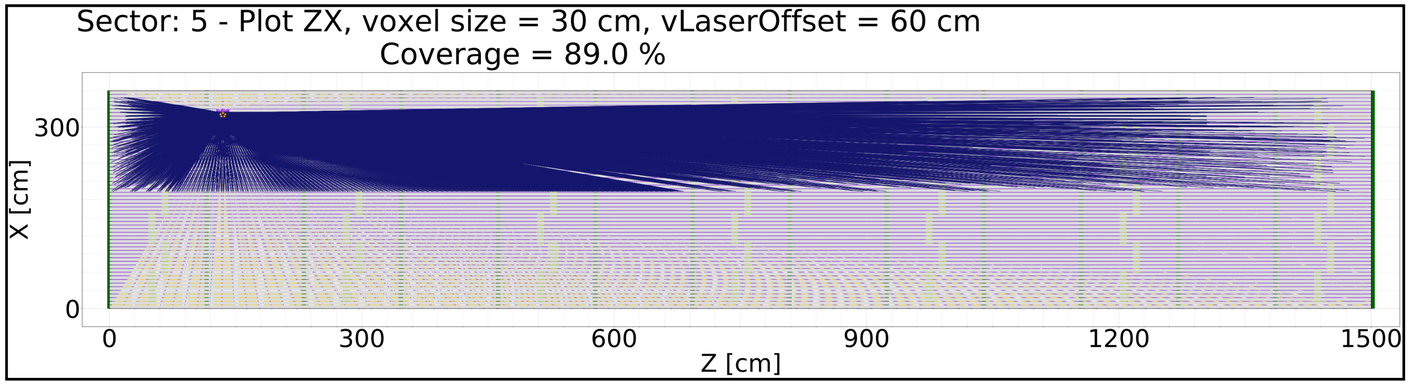


Sector 5, vLaserOffset= 40
Track summary
Number of total generated tracks: **37523**
Number of rays not crossing the detector: 0
Number of rays blocked by obstacles: 20913
Number of rays crossing the active region: 16610
Computing coverage for the single sources...
Covered voxels Source 0: 20515 of 24000;
Coverage Source 0 = 85.5%

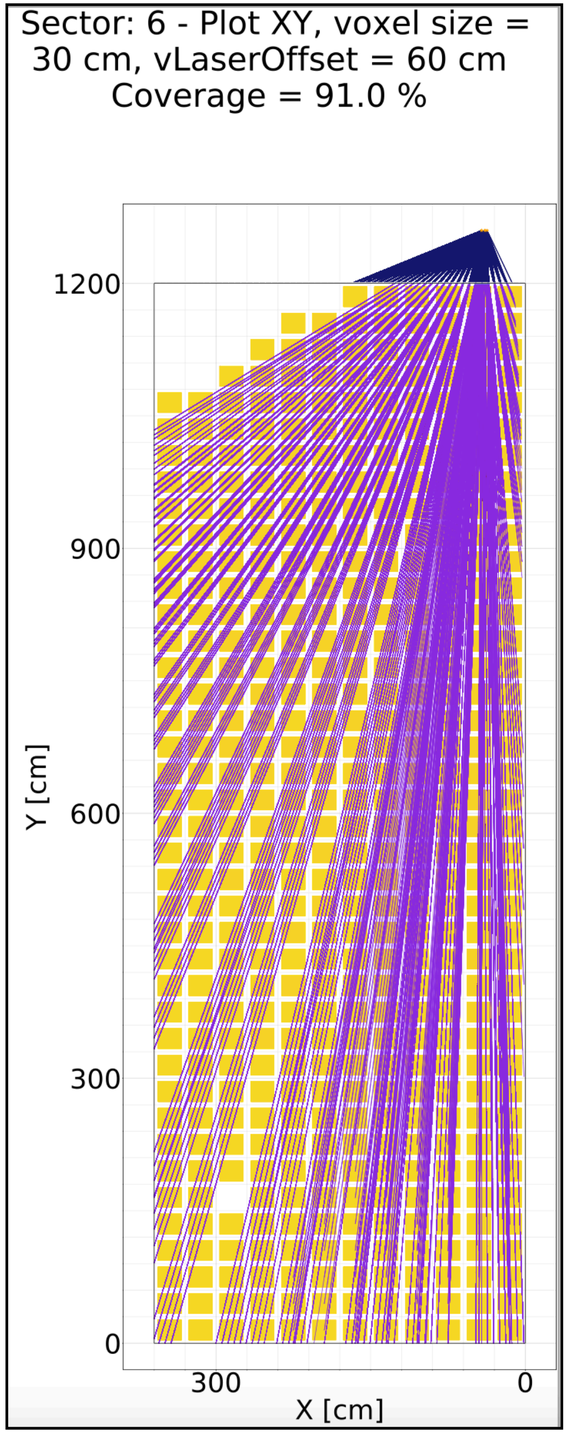
hitGapsReduced

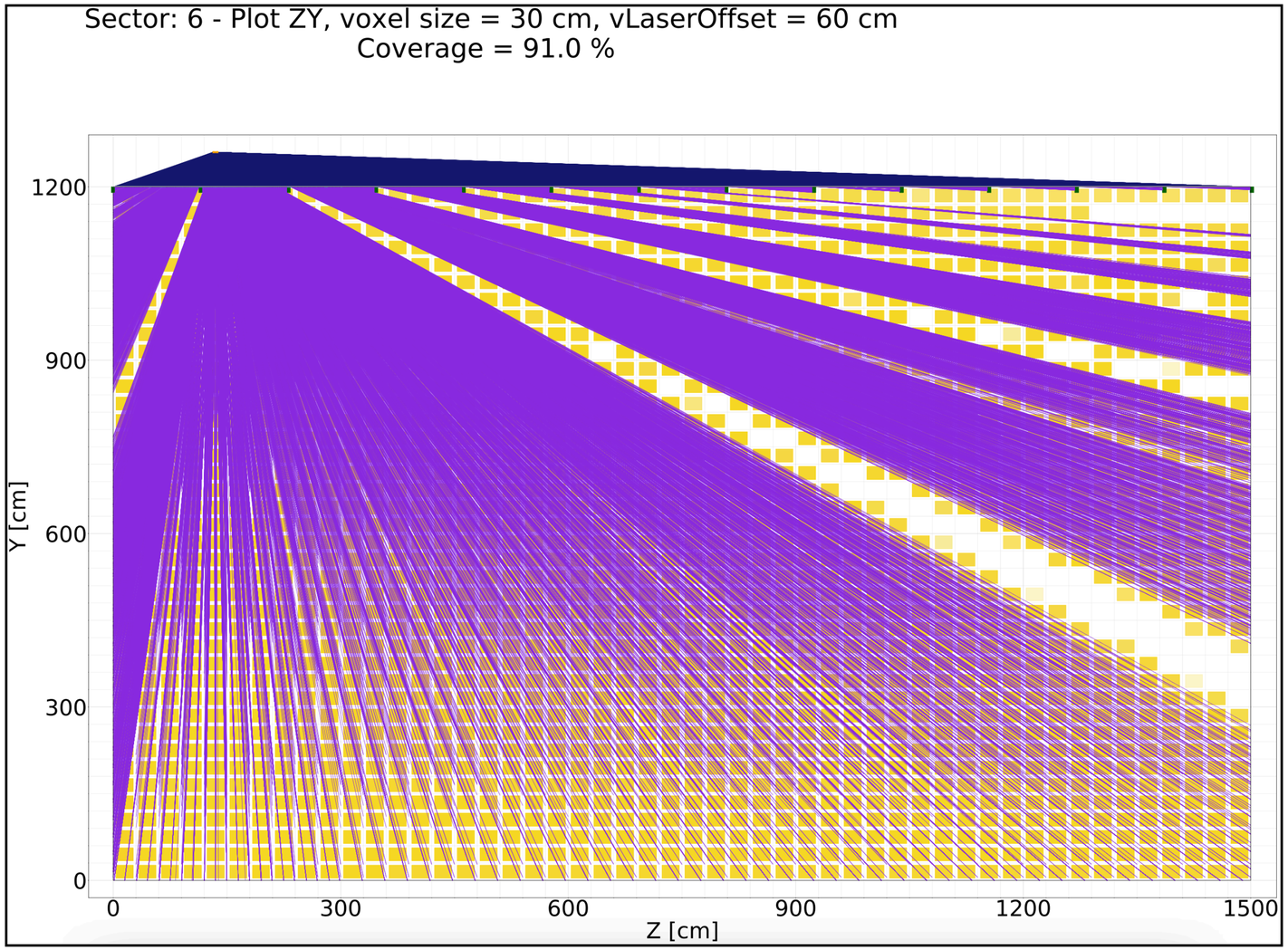


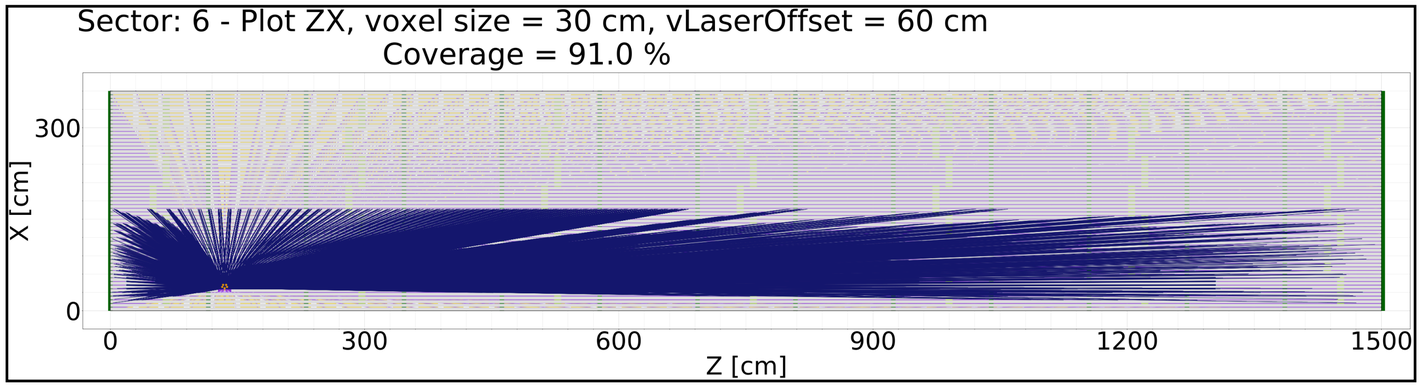




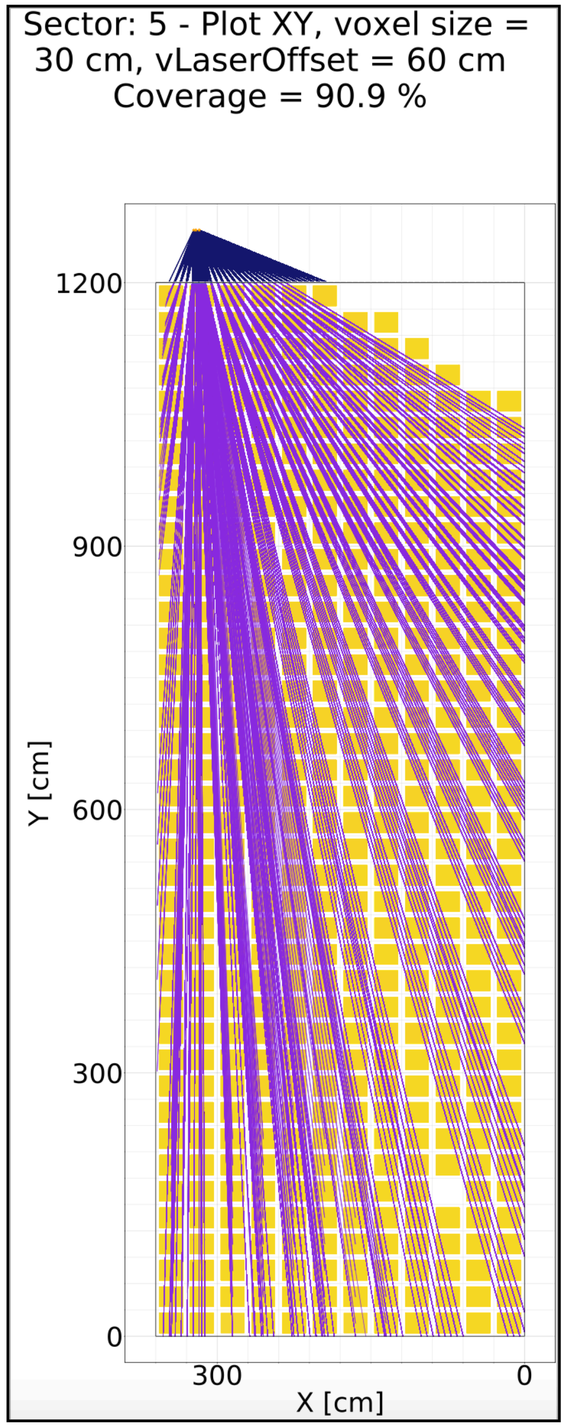
hitGapsAsymm

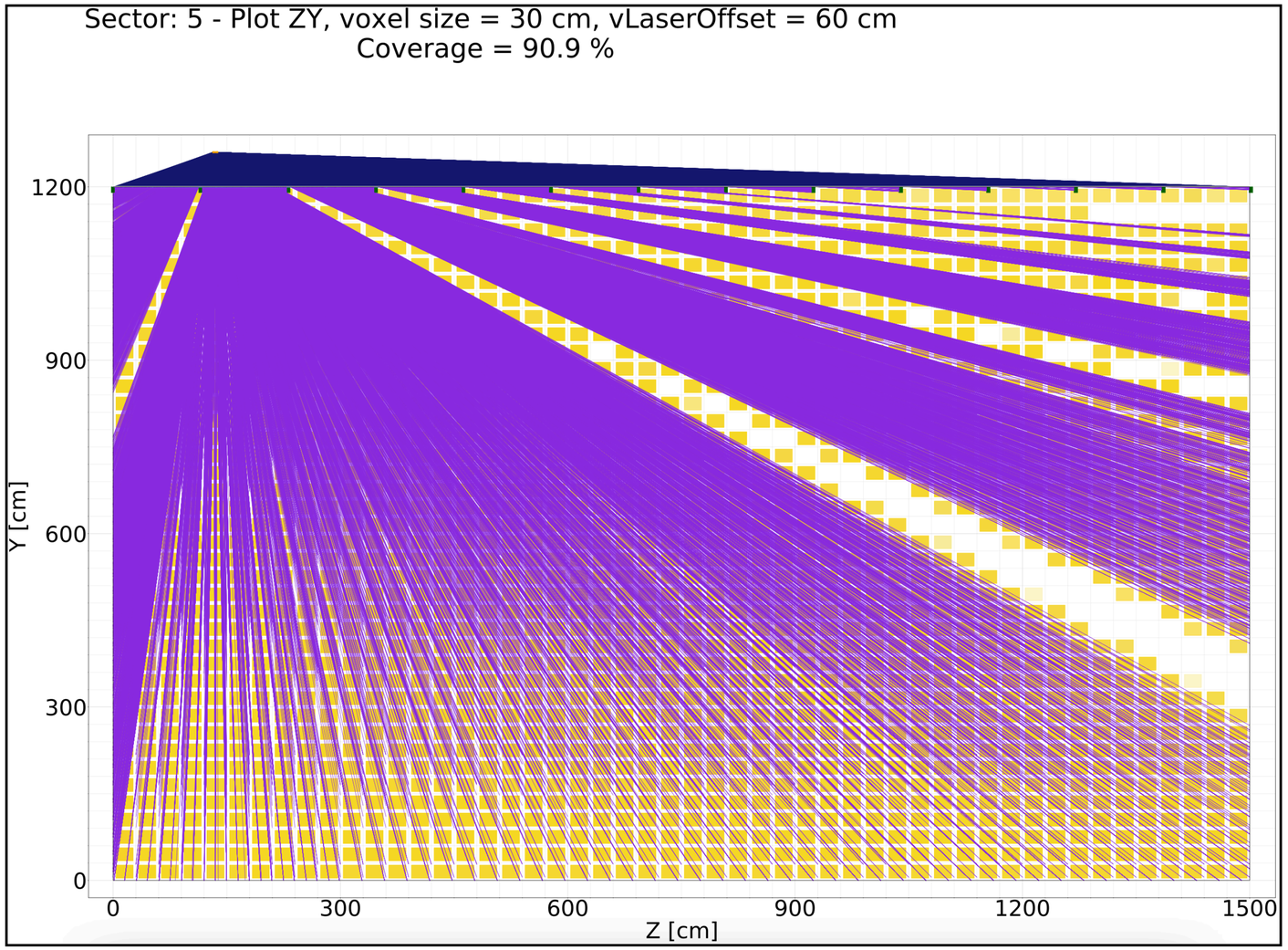


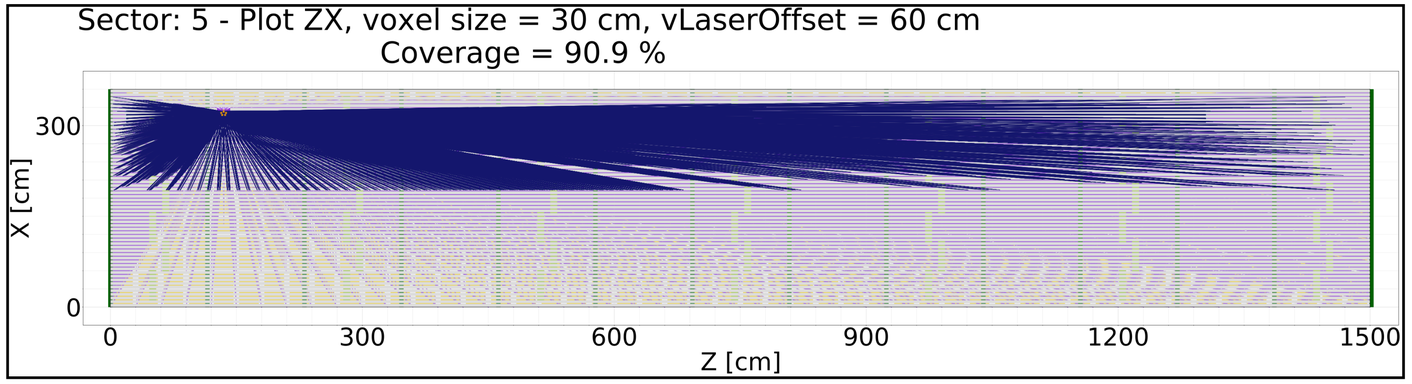




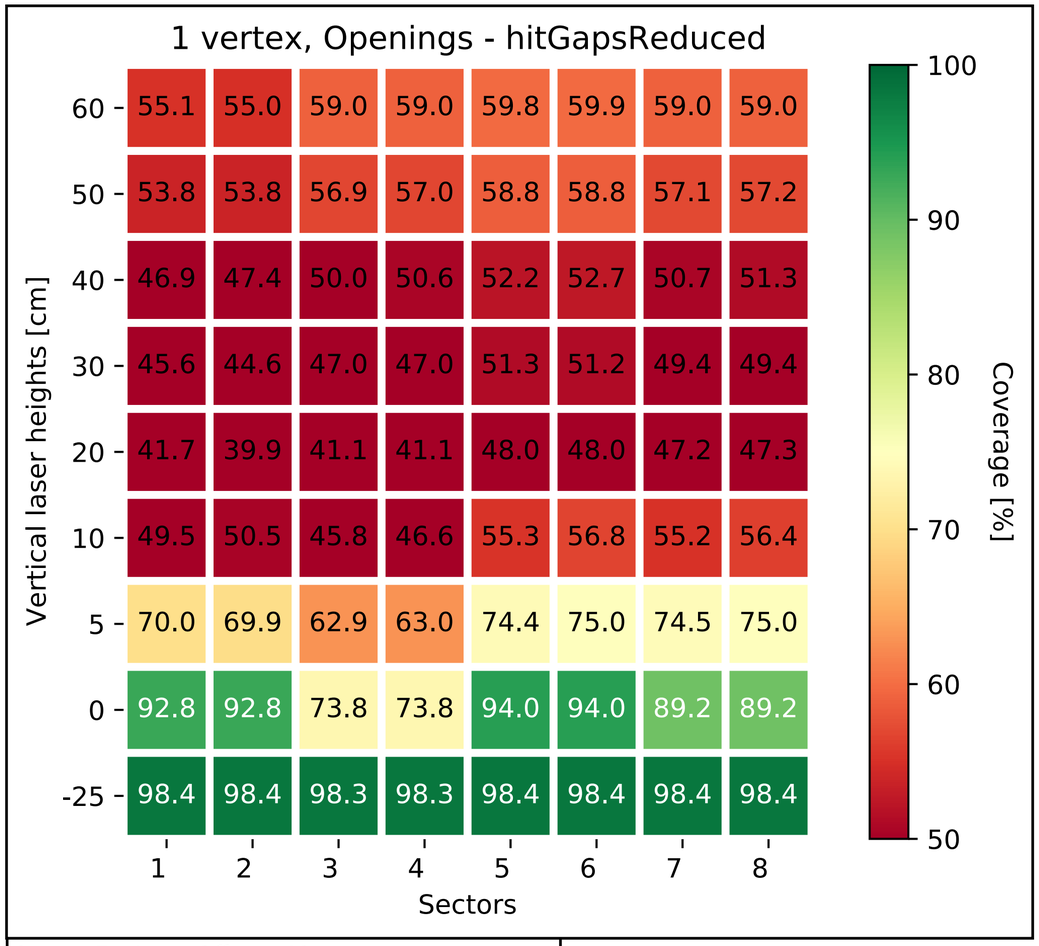
hitGapsAsymm





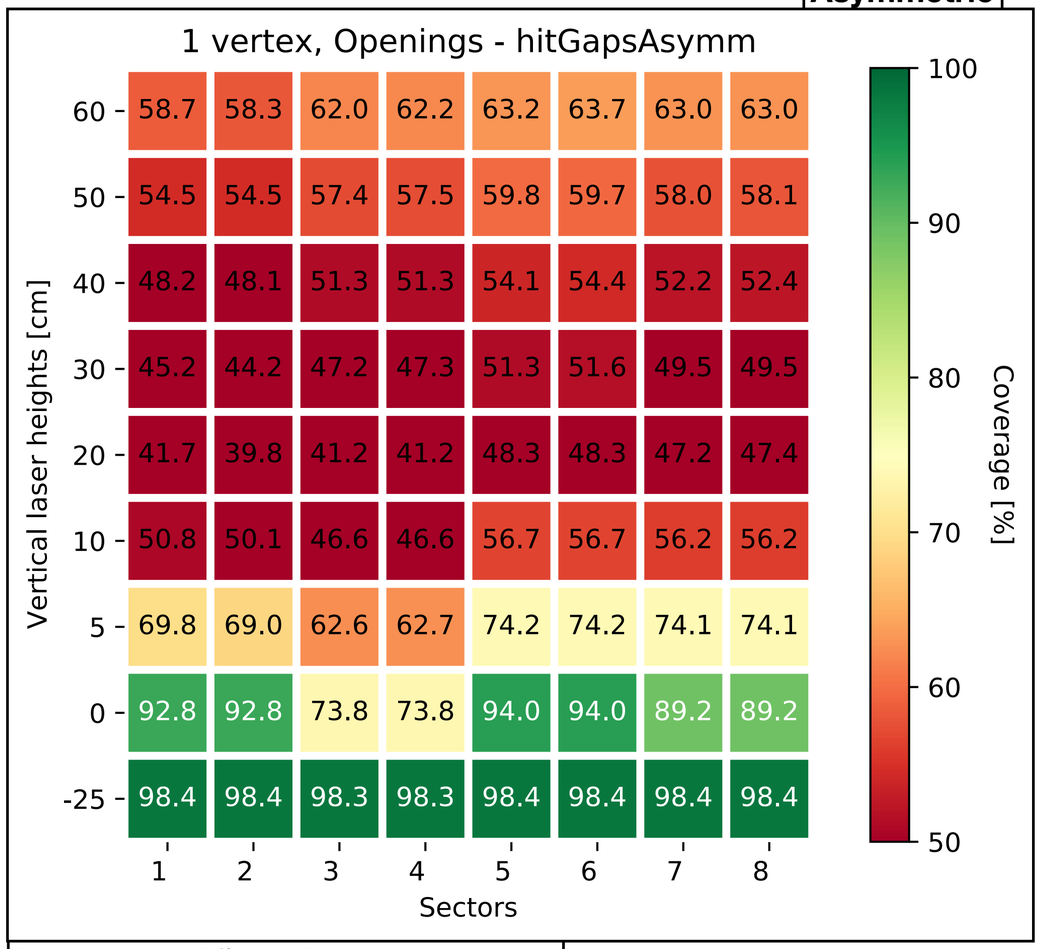


1 Vertex,
Openings,
NoAPA, Obs,
Voxel = 30 cm



Sector 5, vLaserOffset= 40
Track summary
Number of total generated tracks: **6613**
Number of rays not crossing the detector: 0
Number of rays blocked by obstacles: 3694
Number of rays crossing the active region: 2919
Computing coverage for the single sources...
Covered voxels Source 0: 12528 of 24000;
Coverage Source 0 = 52.2%

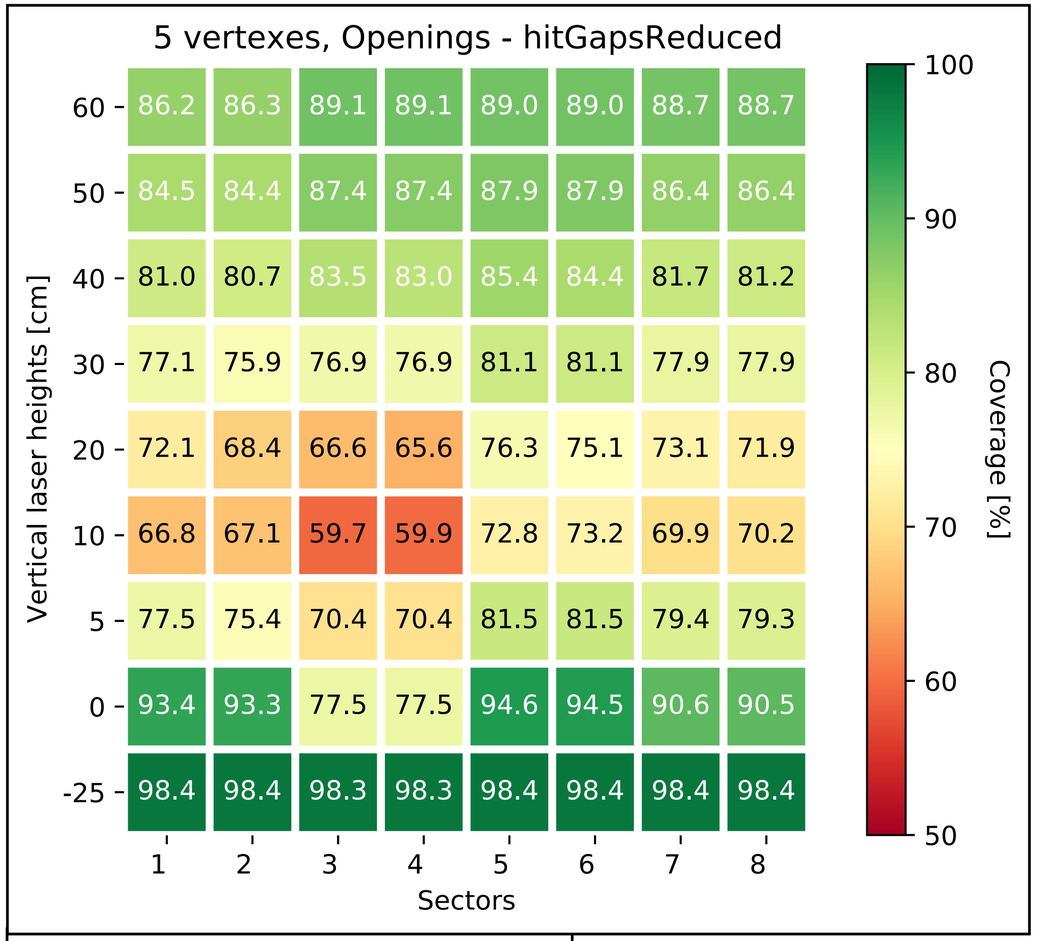
Asymmetric



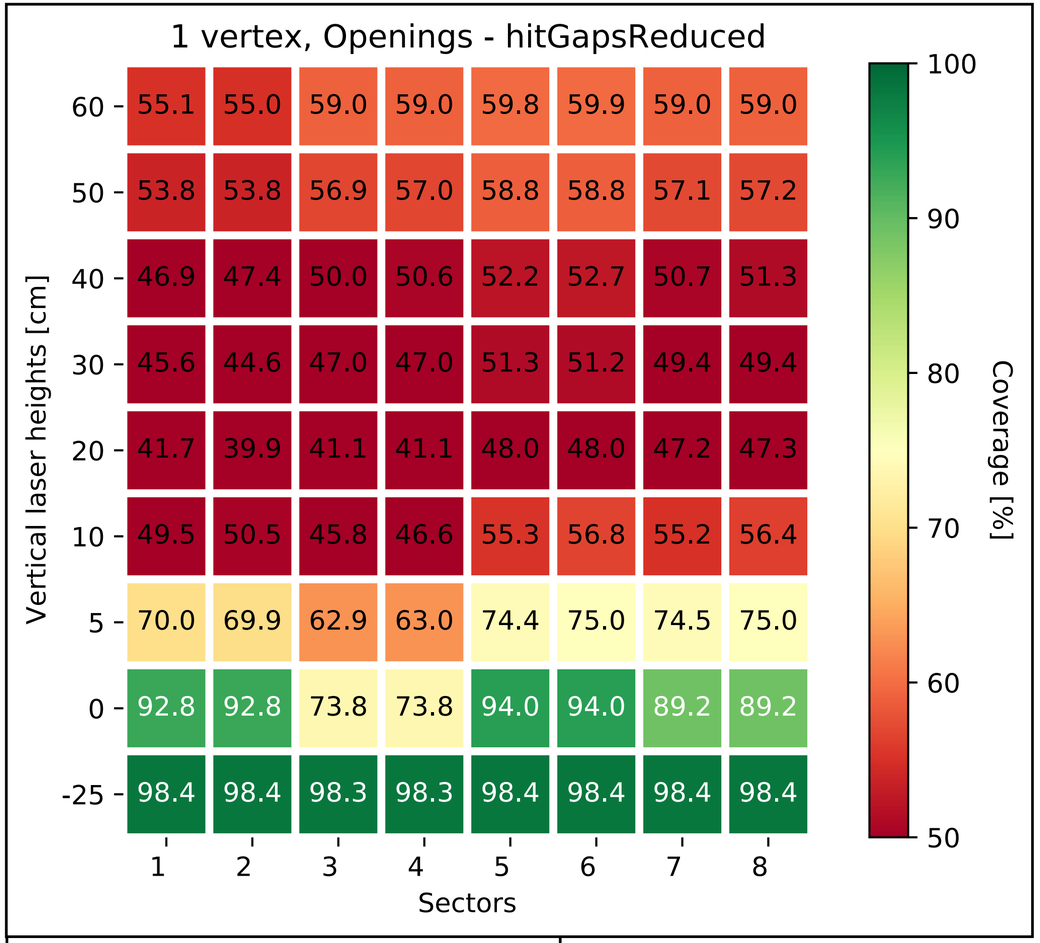
Sector 5, vLaserOffset= 40
Track summary
Number of total generated tracks: **7389**
Number of rays not crossing the detector: 0
Number of rays blocked by obstacles: 4152
Number of rays crossing the active region: 3237
Computing coverage for the single sources...
Covered voxels Source 0: 12981 of 24000;
Coverage Source 0 = 54.1%

Openings, NoAPA, Obs, Voxel = 30 cm

5V-1V Comparison



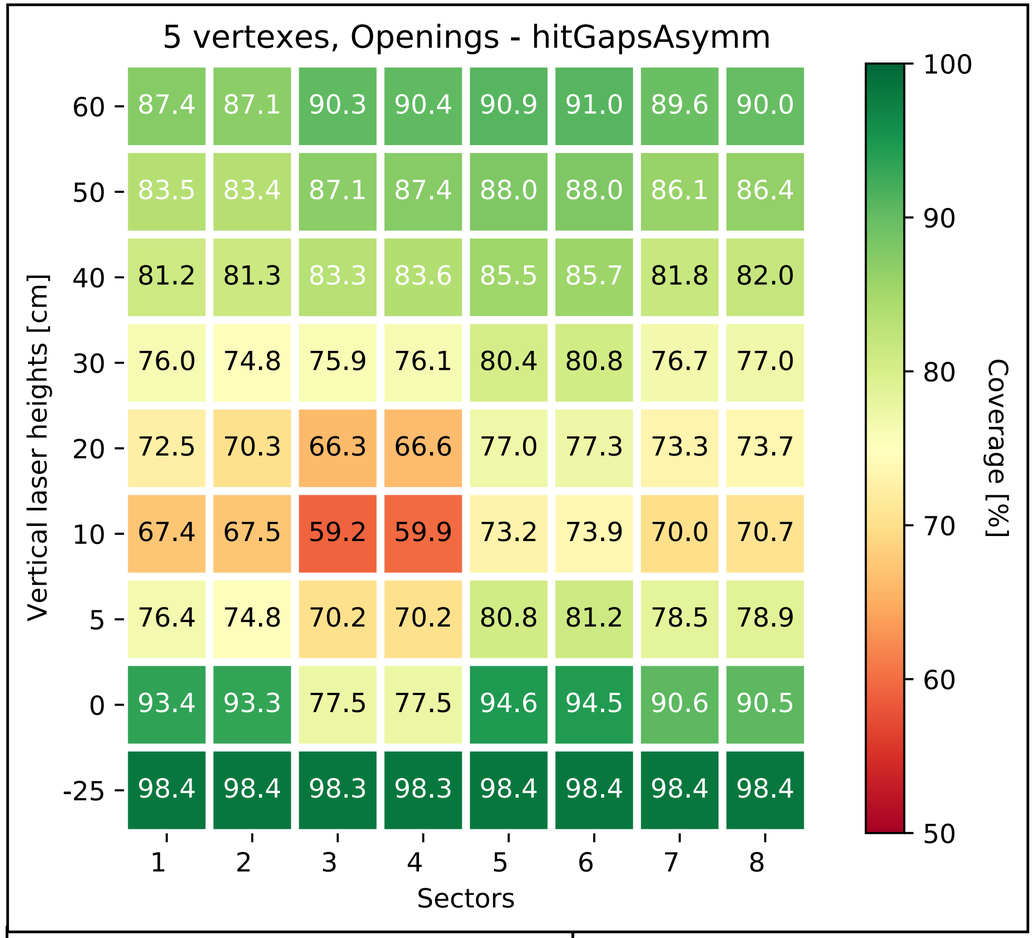
Sector 5, vLaserOffset= 40
Track summary
Number of total generated tracks: **34718**
Number of rays not crossing the detector: 0
Number of rays blocked by obstacles: 18443
Number of rays crossing the active region: 16275
Computing coverage for the single sources...
Covered voxels Source 0: 20486 of 24000;
Coverage Source 0 = 85.4%



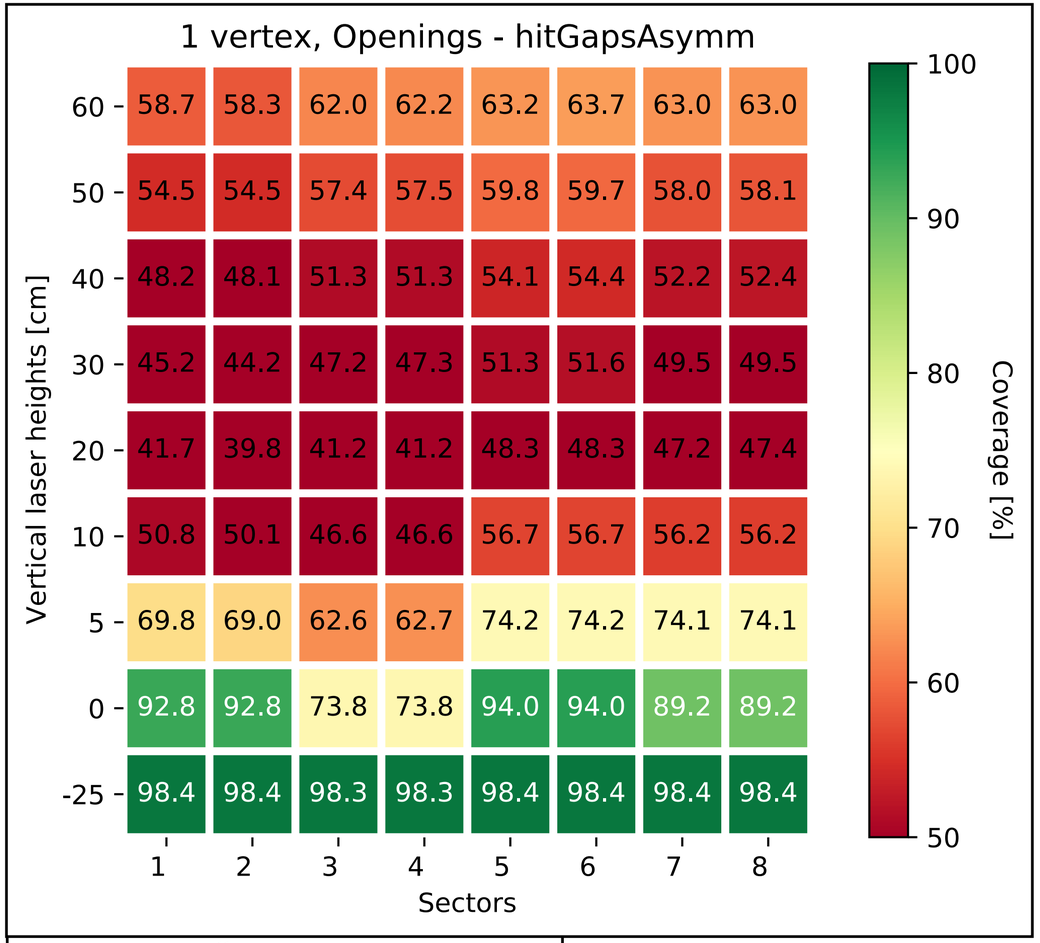
Sector 5, vLaserOffset= 40
Track summary
Number of total generated tracks: **6613**
Number of rays not crossing the detector: 0
Number of rays blocked by obstacles: 3694
Number of rays crossing the active region: 2919
Computing coverage for the single sources...
Covered voxels Source 0: 12528 of 24000;
Coverage Source 0 = 52.2%

Openings, NoAPA, Obs, Voxel = 30 cm

5V-1V Comparison



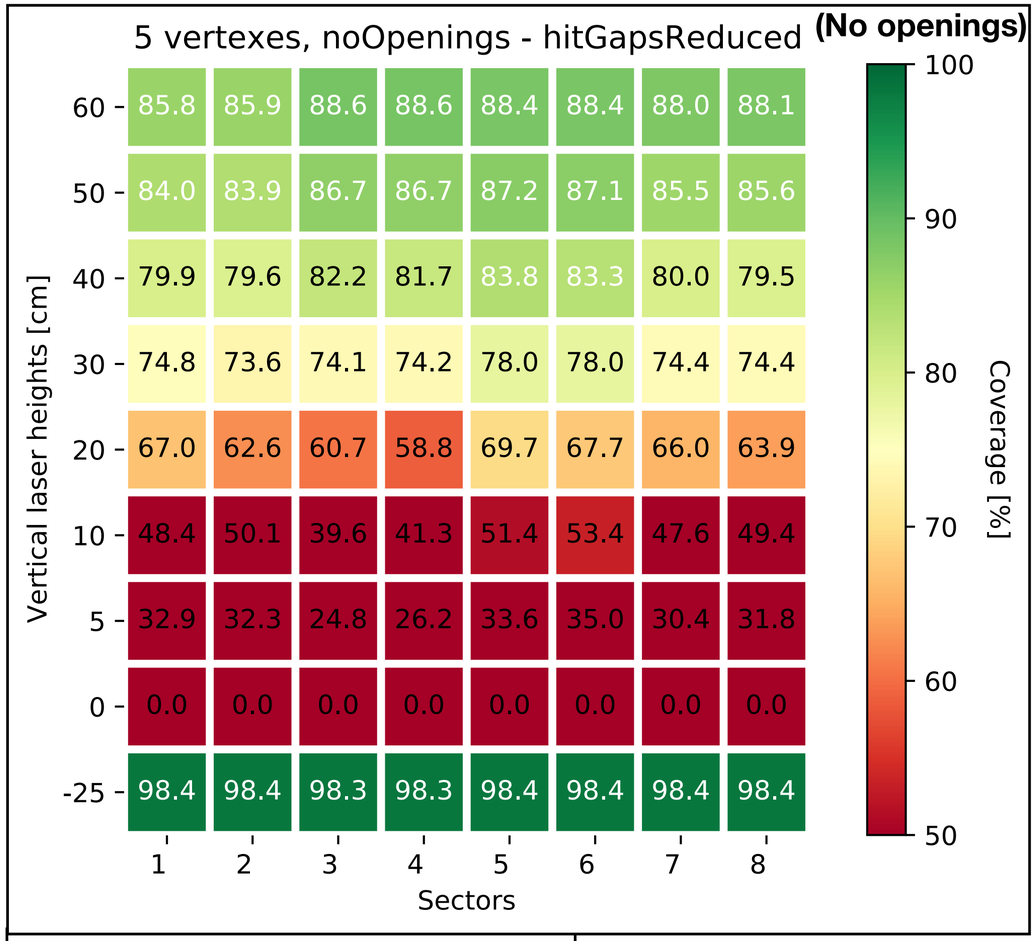
Sector 5, vLaserOffset= 40
Track summary
Number of total generated tracks: **37523**
Number of rays not crossing the detector: 0
Number of rays blocked by obstacles: 20913
Number of rays crossing the active region: 16610
Computing coverage for the single sources...
Covered voxels Source 0: 20515 of 24000;
Coverage Source 0 = 85.5%



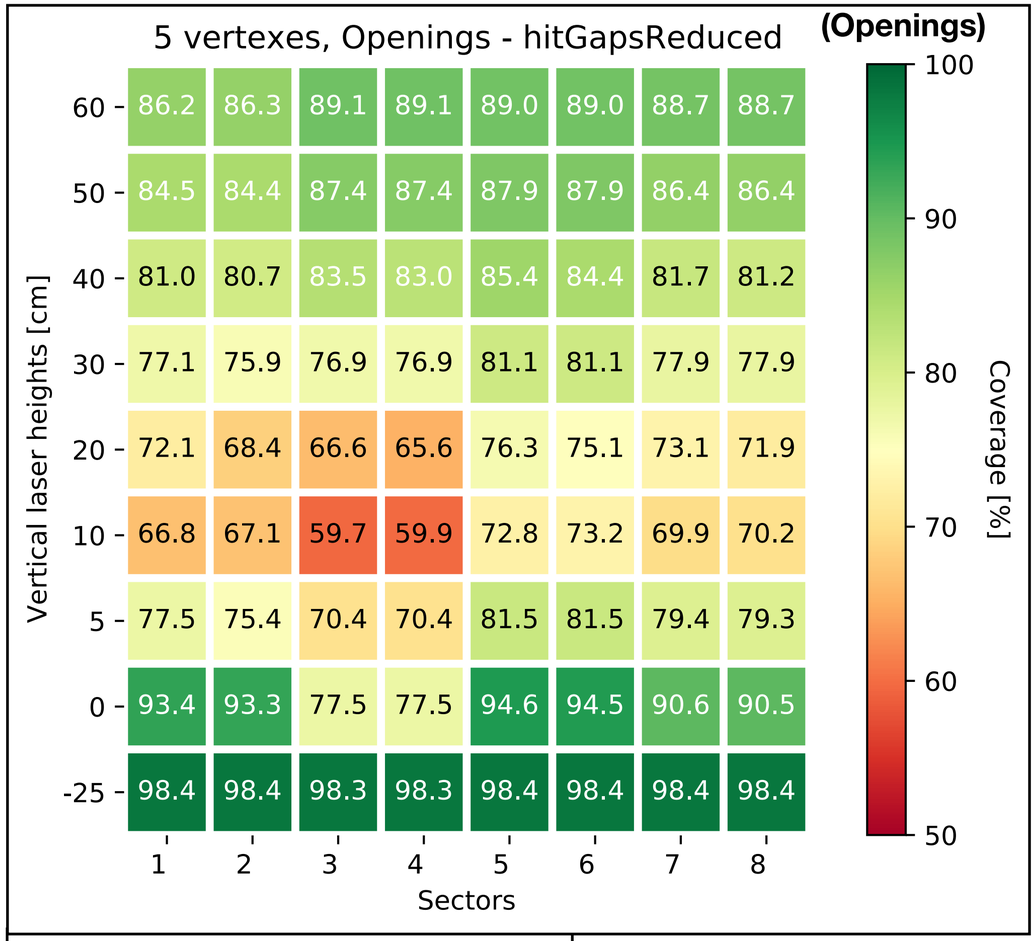
Sector 5, vLaserOffset= 40
Track summary
Number of total generated tracks: **7389**
Number of rays not crossing the detector: 0
Number of rays blocked by obstacles: 4152
Number of rays crossing the active region: 3237
Computing coverage for the single sources...
Covered voxels Source 0: 12981 of 24000;
Coverage Source 0 = 54.1%

Openings/no-Openings Comparison

- **5 vertices**
- 30 cm Voxel Size
- Obs,
- noAPA



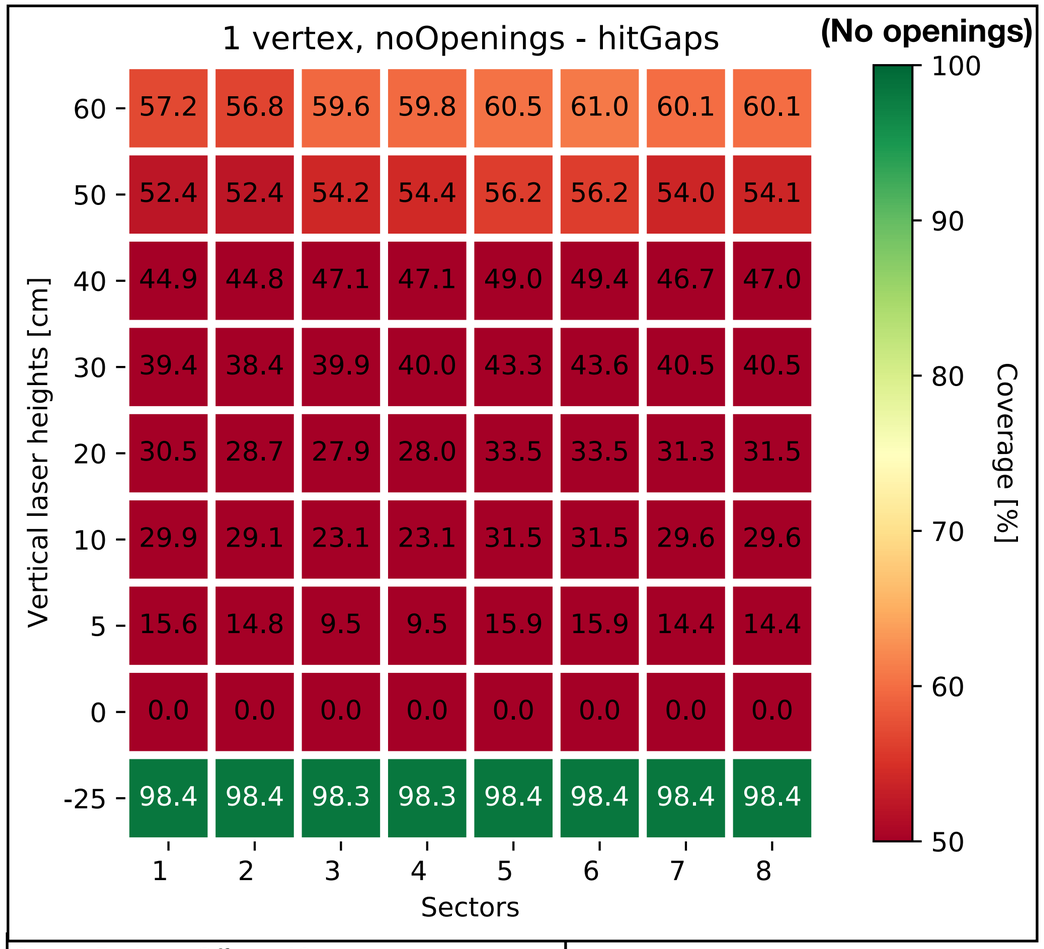
Sector 5, vLaserOffset= 40
Track summary
Number of total generated tracks: **33146**
Number of rays not crossing the detector: 0
Number of rays blocked by obstacles: 18692
Number of rays crossing the active region: 14454
Computing coverage for the single sources...
Covered voxels Source 0: 20115 of 24000;
Coverage Source 0 = 83.8%



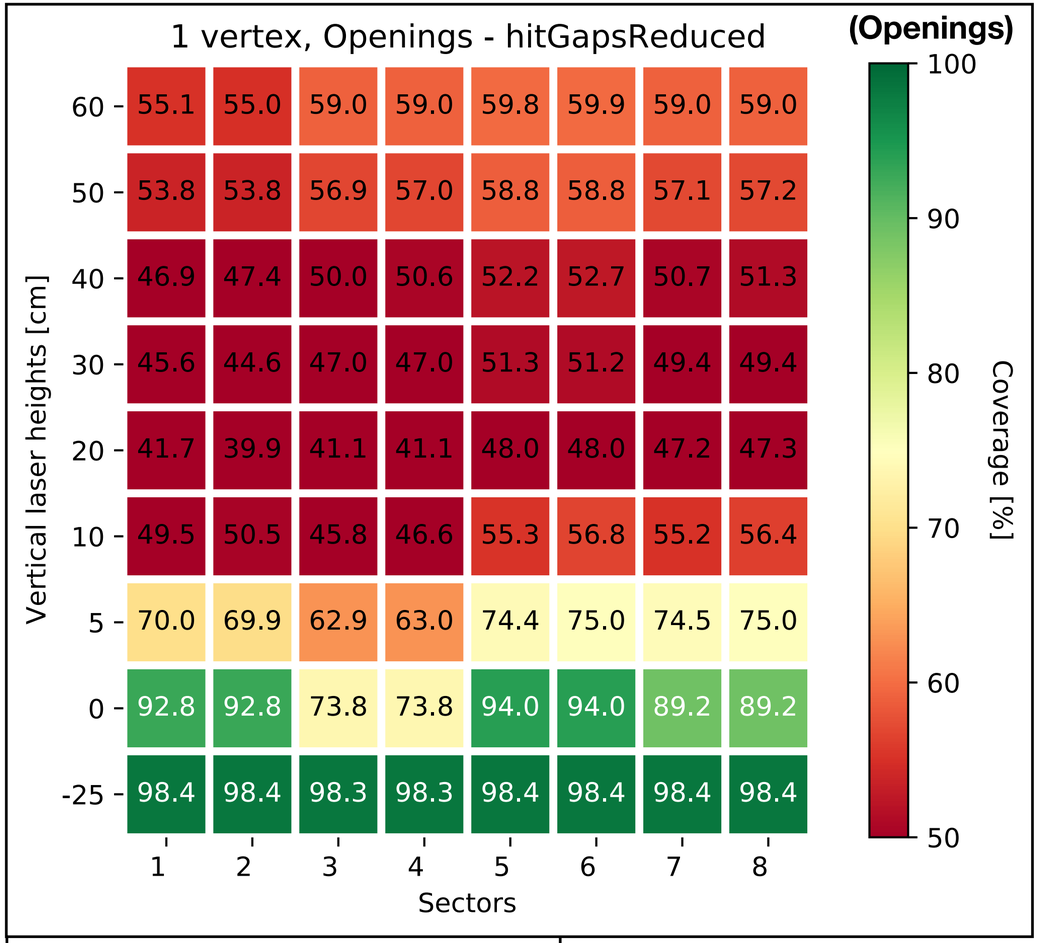
Sector 5, vLaserOffset= 40
Track summary
Number of total generated tracks: **34718**
Number of rays not crossing the detector: 0
Number of rays blocked by obstacles: 18443
Number of rays crossing the active region: 16275
Computing coverage for the single sources...
Covered voxels Source 0: 20486 of 24000;
Coverage Source 0 = 85.4%

Openings/no-Openings Comparison

- **1 vertex**
- 30 cm Voxel Size
- Obs
- noAPA



Sector 5, vLaserOffset= 40
Track summary
Number of total generated tracks: **7072**
Number of rays not crossing the detector: 0
Number of rays blocked by obstacles: 4123
Number of rays crossing the active region: 2949
Computing coverage for the single sources...
Covered voxels Source 0: 11755 of 24000;
Coverage Source 0 = 49.0%



Sector 5, vLaserOffset= 40
Track summary
Number of total generated tracks: **6613**
Number of rays not crossing the detector: 0
Number of rays blocked by obstacles: 3694
Number of rays crossing the active region: 2919
Computing coverage for the single sources...
Covered voxels Source 0: 12528 of 24000;
Coverage Source 0 = 52.2%