

MATERIAL TESTING

tkLayout developers meeting

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Testing algorithm

1. Build test case with controlled amount of material
2. Get elements **coordinates**
 - from tklayout run
3. Build model with **expected** material in each element
4. **Calculate** thickness in radiation length
5. Correlate tklayout **output** with **expected** calculation

	Unit=g/m	Unit=mm	Unit=g
Module Service=false	<p>Module</p> $\times moduleLength$ No accumulation No conversion Scaling possible	<p>Module</p> $\times moduleSurface \times \rho$ (sensor surface) No accumulation No conversion Scaling possible	<p>Module</p> $\times 1$ No accumulation No conversion Scaling possible
Module ring R of N Service=true	<p>Following supports $S_{R+1} \dots S_i \dots S_N$</p> $\times numModules_R \times supportLength_i$ Accumulation Conversion(1:1 by default, with warning) Scaling possible	<p>Following supports $S_{R+1} \dots S_i \dots S_N$</p> $\times numModules_R \times supportSurface_i \times \rho$ Accumulation Conversion(1:1 by default, with warning) Scaling possible Deprecated warning	Error
Rod(barrel) Service=false	<p>All supports $S_1 \dots S_i \dots S_N$</p> $\times numModules_1 \times supportLength_i$ No accumulation No conversion Scaling not possible	<p>All supports $S_1 \dots S_i \dots S_N$</p> $\times supportSurface_i \times \rho$ No accumulation No conversion Scaling not possible	<p>All supports $S_1 \dots S_i \dots S_N$</p> $\times numModules_1 \times \sum_{j=1}^N supportLength_j$ No accumulation No conversion Scaling not possible
Rod(barrel) Service=true	<p>All supports $S_1 \dots S_i \dots S_N$</p> $\times numModules_1 \times supportLength_i$ No accumulation Conversion Scaling not possible	<p>All supports $S_1 \dots S_i \dots S_N$</p> $\times supportSurface_i \times \rho$ No accumulation Conversion Scaling not possible Deprecated warning	Error
Layer/Disk Service=false	<p>All supports $S_1 \dots S_i \dots S_N$</p> $\times supportLength_i$ No accumulation No conversion Scaling not possible	<p>All supports $S_1 \dots S_i \dots S_N$</p> $\times supportSurface_i \times \rho$ No accumulation No conversion Scaling not possible	<p>All supports $S_1 \dots S_i \dots S_N$</p> $\times \sum_{j=1}^N supportLength_j$ No accumulation No conversion Scaling not possible
Layer/Disk Service=true	<p>All supports $S_1 \dots S_i \dots S_N$</p> $\times supportLength_i$ No accumulation Conversion Scaling not possible	<p>All supports $S_1 \dots S_i \dots S_N$</p> $\times supportSurface_i \times \rho$ No accumulation Conversion Scaling not possible Deprecated warning	Error

Compute expected material for g/m unit

Cylinder, L g/m of material M

$$\frac{X_0}{X_{0M}} = \frac{L/1000}{2\pi r \cdot X_{0M}} \cdot \frac{e^\eta + e^{-\eta}}{2}$$

Disk, L g/m of material M

$$\frac{X_0}{X_{0M}} = \frac{L/1000}{\pi(r_1 + r_2) \cdot X_{0M}} \cdot \frac{e^{2\eta} + 1}{e^{2\eta} - 1}$$

- ✓ For **layers** rods, L is:
 - the set material multiplied by the number of rods
- ✓ For **disks** “rods”, L is:
 - the set material multiplied by the number of modules of the first ring

Compute expected material for mm unit

Cylinder, L mm of material M

$$\frac{X_0}{X_{0M}} = \frac{L \cdot \rho_M}{X_{0M}} \cdot \frac{e^\eta + e^{-\eta}}{2}$$

Disk, L mm of material M

$$\frac{X_0}{X_{0M}} = \frac{L \cdot \rho_M}{X_{0M}} \cdot \frac{e^{2\eta} + 1}{e^{2\eta} - 1}$$

- ✓ For layers and disks rods, L is:
 - the set material (not replicated for rod or modules)

Compute expected material for g unit

Cylinder, L g of material M

$$\frac{X_0}{X_{0M}} = \frac{L}{2\pi r(z_2 - z_1) \cdot X_{0M}} \cdot \frac{e^\eta + e^{-\eta}}{2}$$

Disk, L g of material M

$$\frac{X_0}{X_{0M}} = \frac{L}{\pi(r_2^2 - r_1^2) \cdot X_{0M}} \cdot \frac{e^{2\eta} + 1}{e^{2\eta} - 1}$$

- ✓ Unit g can't be used for rods in layers and disks

Compute expected material for one barrel module m

Equivalent g/m cylinder c

$$L_c = \frac{L_m}{w} \cdot 2\pi r$$

Equivalent mm cylinder c

$$L_c = L_m$$

Equivalent g cylinder c

$$L_c = \frac{L_m}{w} \cdot 2\pi r$$

- ✓ c is the middle longitudinal segment of m rotated in φ
- ✓ valid analysis if track gun at fixed φ
- ✓ w = module width

Compute expected material for one endcap module m

Equivalent g/m disk d

$$L_d = \frac{L_m}{w} \cdot \pi(r_1 + r_2)$$

Equivalent mm disk d

$$L_d = L_m$$

Equivalent g disk d

$$L_d = \frac{L_m}{w} \cdot \pi(r_1 + r_2)$$

- ✓ d is the middle longitudinal segment of m rotated in φ
- ✓ valid analysis if track gun at fixed φ
- ✓ w = module width

Tests map

		Unit=g/m (linear dens.)		Unit=mm (thickness)		Unit=g (weight)	
Module	Barrel	Service=false	Service=true	Service=false	Service=true	Service=false	Service=true
	Endcap	test22 ¹	test4, test5	test23 ¹	test13b	test24 ¹	Error
Rod	Barrel	test22d ¹	test6bis, test14	test23d ¹	test13	test24d ¹	Error
	Endcap	test20	test1a, test1b, test1c, test1d, test2, test5, test7 ² , test8 ² , test9 ² , test10 ² , test10bis ² , test10ter ² , test11 ³ , test11bis ³	test3bis, test3ter	test3, test3quater	test21	Error
Layer/Disk	Barrel	Error	Error	Error	Error	Error	Error
	Endcap	test19	test19bis	test18	test18bis	test17	Error

¹Studied blocking track gun at $\pi/2$ and converting in equivalent cylinder/disk

²Test conversions

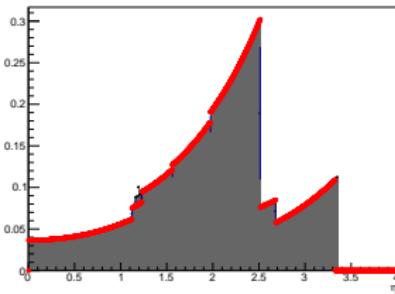
³Test scaling

Test1a

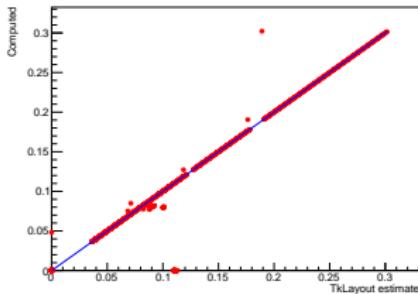
100g/m of Cu in the rods of the first layer of the pixel barrel

- ✓ 12 rods
- ✓ $L = 1200$ for every element

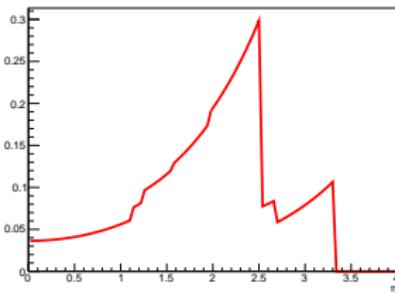
TkLayout estimate vs computed



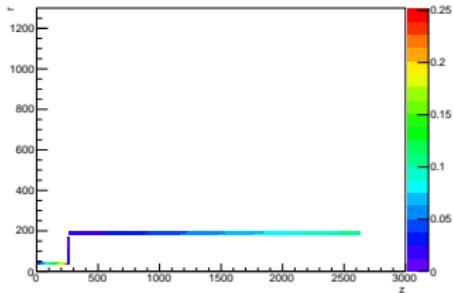
Correlation



Computed function



Computed map

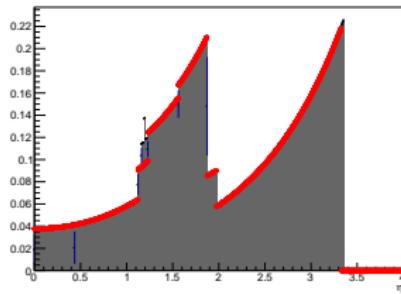


Test1b

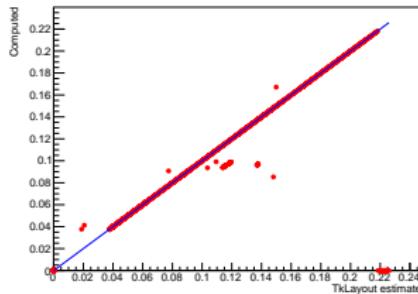
100g/m of Cu in the rods of the second layer of the pixel barrel

- ✓ 24 rods
- ✓ $L = 2400$ for every element

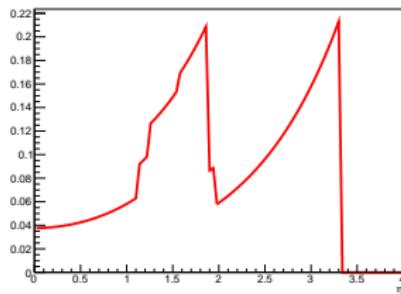
TkLayout estimate vs computed



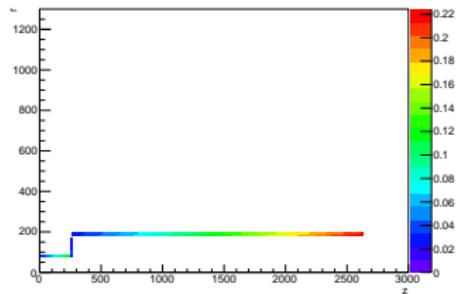
Correlation



Computed function



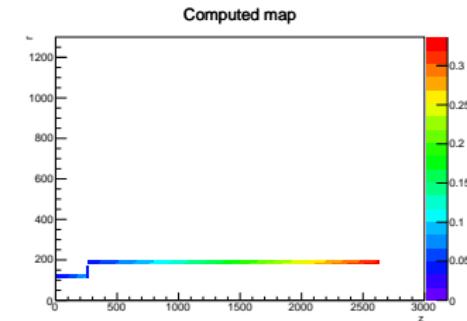
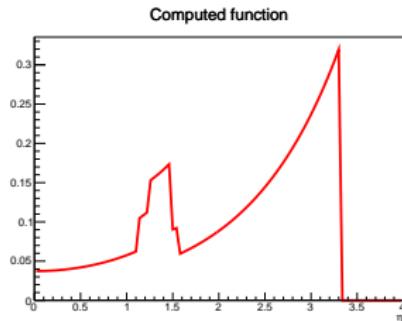
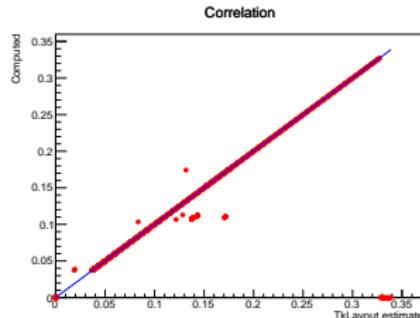
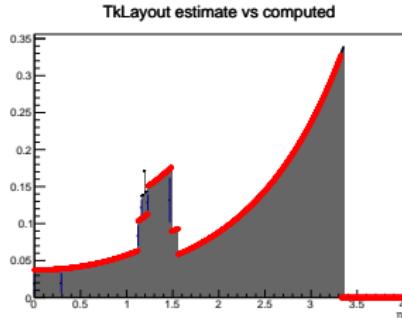
Computed map



Test1c

100g/m of Cu in the rods of the third layer of the pixel barrel

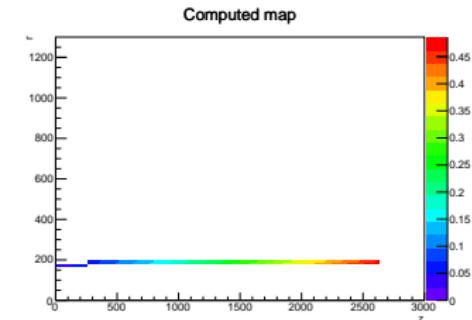
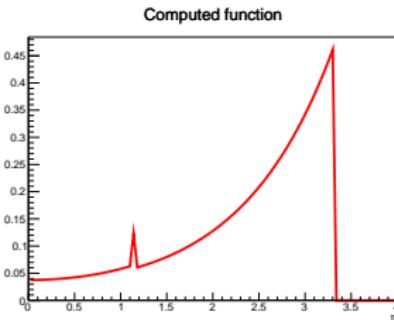
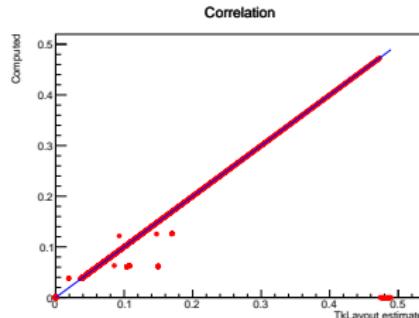
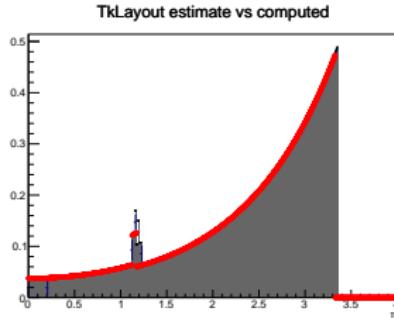
- ✓ 36 rods
- ✓ $L = 3600$ for every element



Test1d

100g/m of Cu in the rods of the fourth layer of the pixel barrel

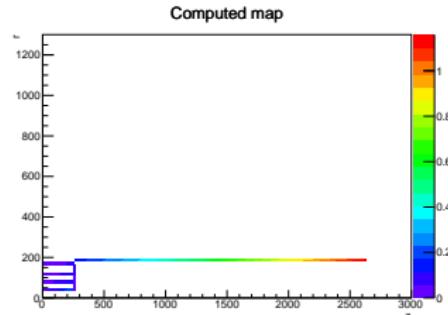
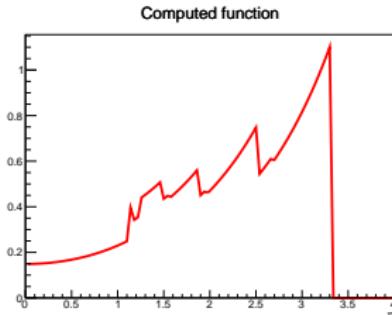
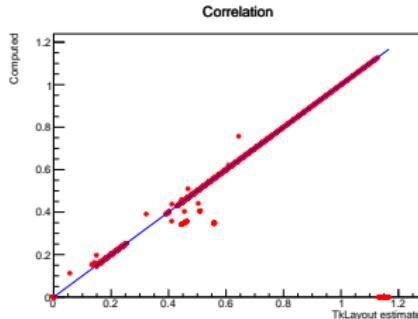
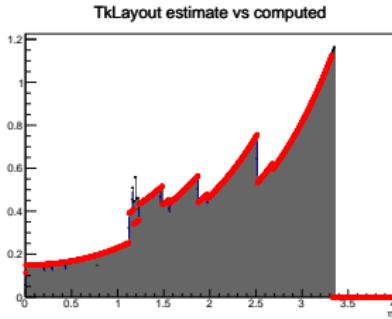
- ✓ 52 rods
- ✓ $L = 5200$ for every element



Test2

100g/m of Cu in the rods of all the layers of the pixel barrel

- ✓ $L = \text{rods} * 100$ for layers
- ✓ $L = L_{\text{inLayer}} + L_{\text{inDisk}}$ for disks and last cylinder

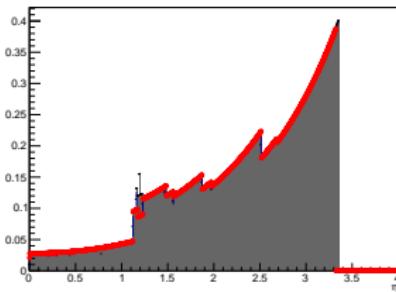


Test3

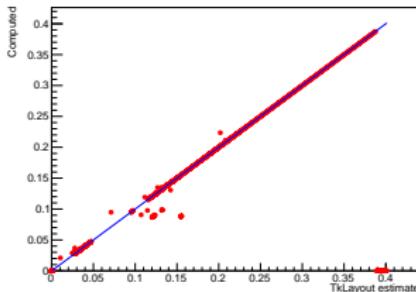
0.1mm of Cu in the rods of all the layers of the pixel barrel, exiting

- ✓ $L = 0.1$ for layers
- ✓ $L = L_{inLayer} + L_{inDisk}$ for disks and last cylinder (**deprecated feature**)

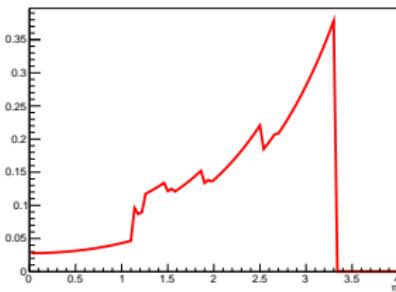
TkLayout estimate vs computed



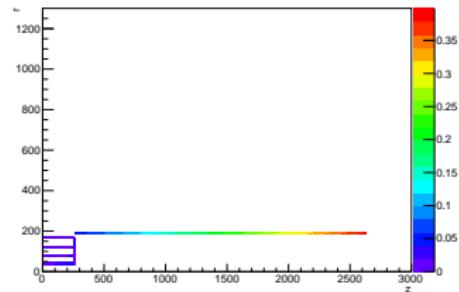
Correlation



Computed function



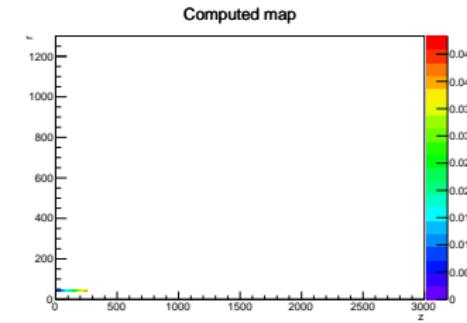
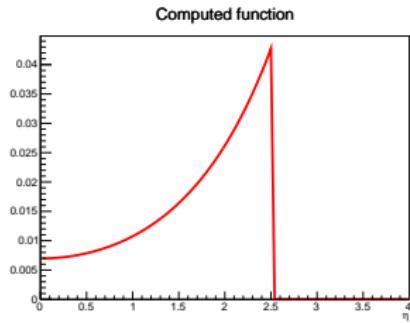
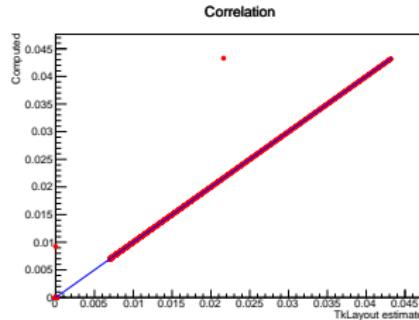
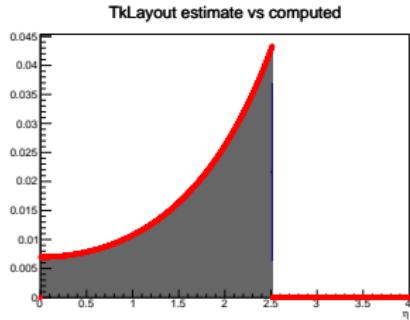
Computed map



Test3bis

0.1mm of Cu in the rods of first layer of the pixel barrel, not exiting

✓ $L = 0.1$ for all elements

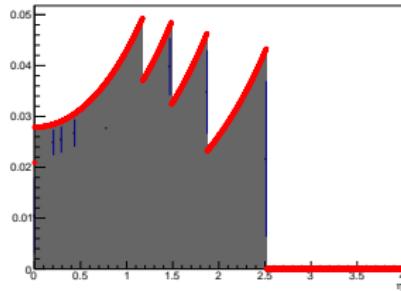


Test3ter

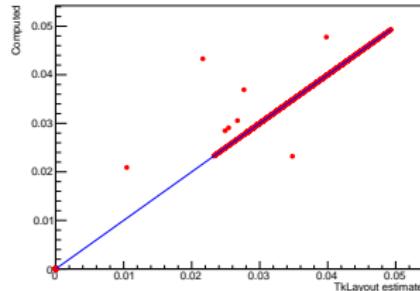
0.1mm of Cu in the rods of all the layers of the pixel barrel, not exiting

✓ $L = 0.1$ for layers

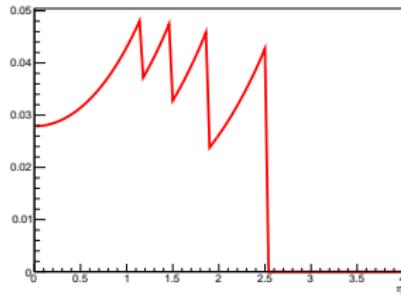
TkLayout estimate vs computed



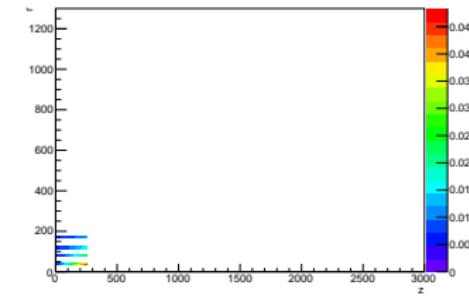
Correlation



Computed function



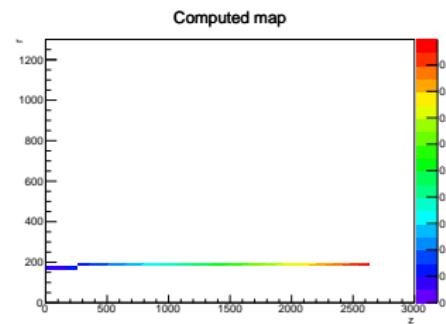
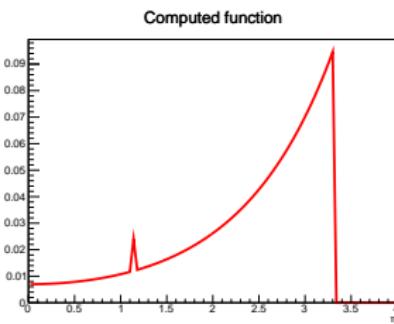
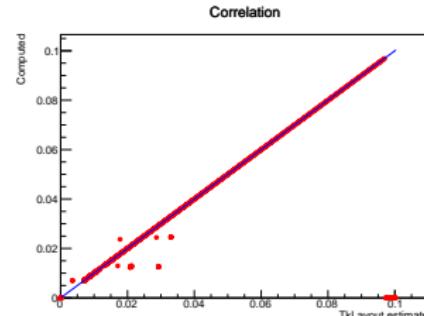
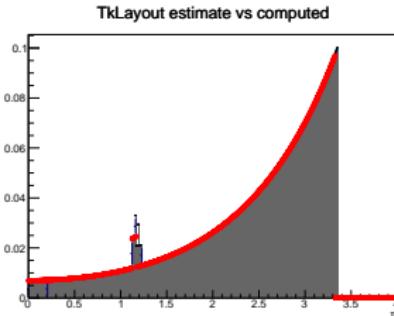
Computed map



Test3quater

0.1mm of Cu in the rods of first layer of the pixel barrel, exiting

✓ $L = 0.1$ for all elements

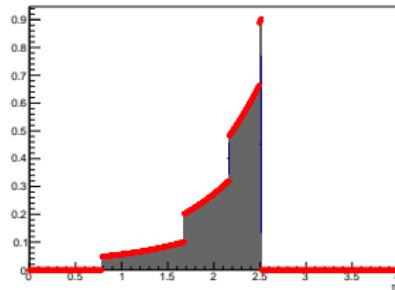


Test4

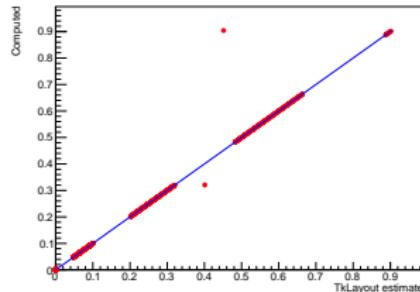
100g/m of Cu exiting from modules of the first layer of the pixel barrel

✓ $L = (\text{rods} * 100) + L_{\text{previousCylinder}}$ for cylinders

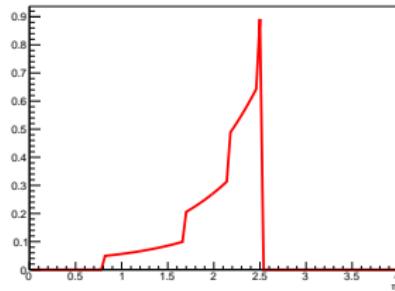
TkLayout estimate vs computed



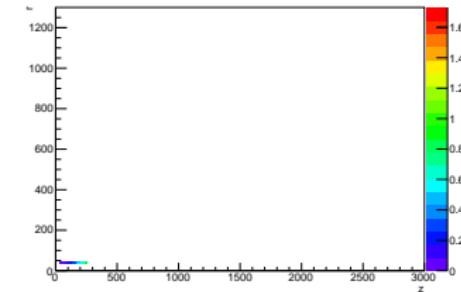
Correlation



Computed function



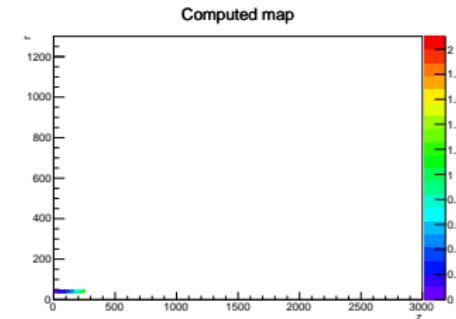
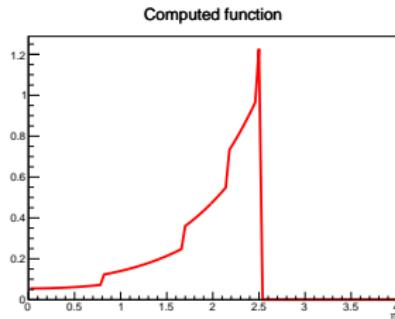
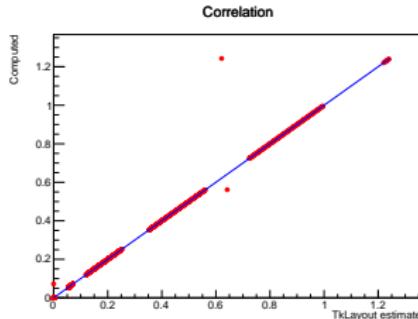
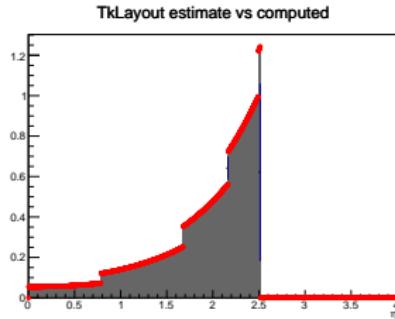
Computed map



Test5

100g/m of Cu exiting from modules and 150g/m in the rods

- ✓ $L = (\text{rods} * 100) + L_{\text{previousCylinder}}$ for cylinders
- ✓ $L = (\text{rods} * 150)$ in layer

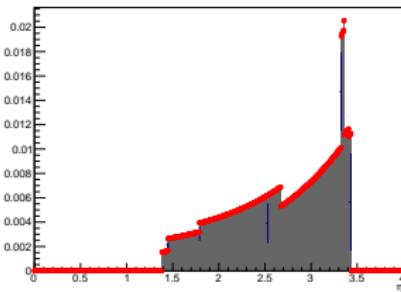


Test6

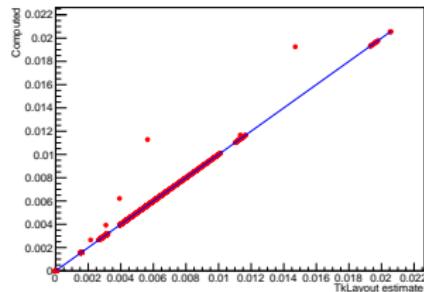
100g/m of Cu in the first disk of pixel endcap

- ✓ 24 modules on first ring of disk
- ✓ $L = (24 * 100)$ in every element

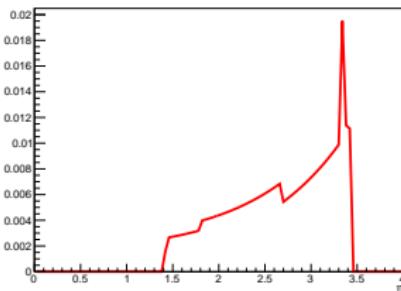
TkLayout estimate vs computed



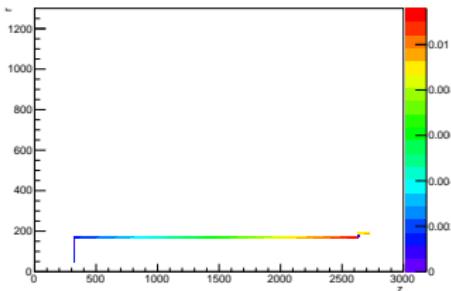
Correlation



Computed function



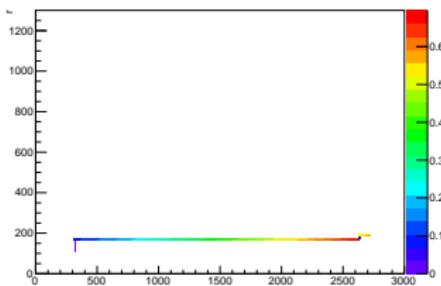
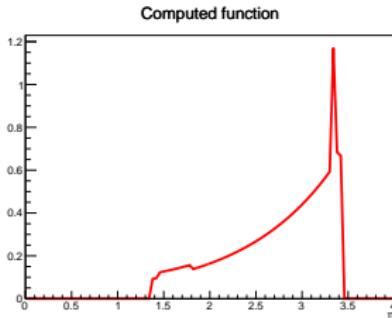
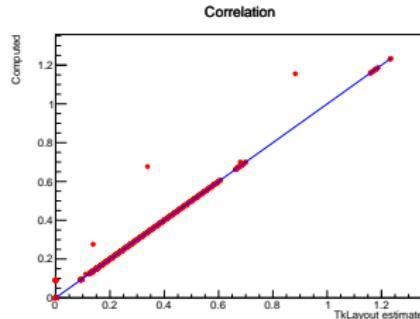
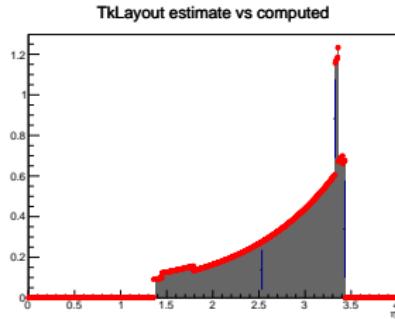
Computed map



Test6bis

100g/m of Cu exiting from the first disk modules of pixel endcap

- ✓ 24 modules on first ring of disk, 36 on second
- ✓ $L = (24 * 100)$ in service disk, $L = (60 * 100)$ in others

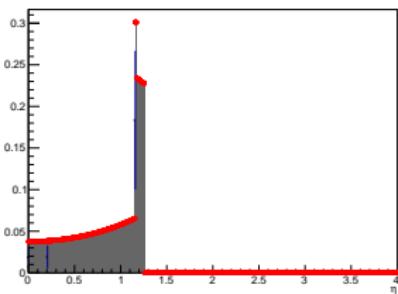


Test7

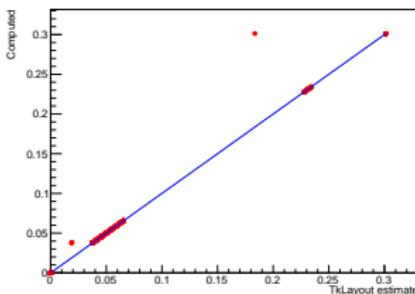
100g/m of Cu in the fourth layer and conversion 1g/m → 0.1g locally

- ✓ $L = (\text{rods} * 100)$ in layer
- ✓ $L = (\text{rods} * 100 * 0.1)$ in flange

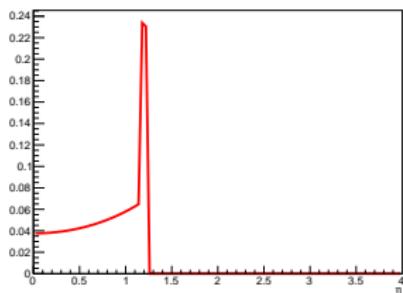
TkLayout estimate vs computed



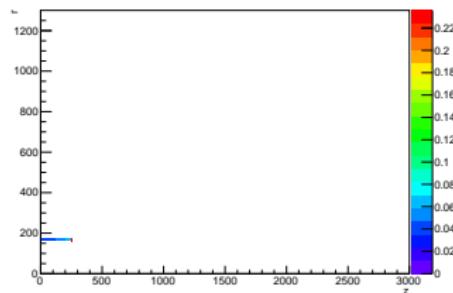
Correlation



Computed function



Computed map

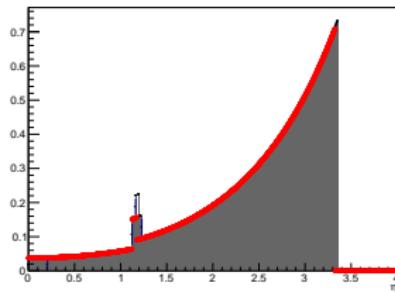


Test8

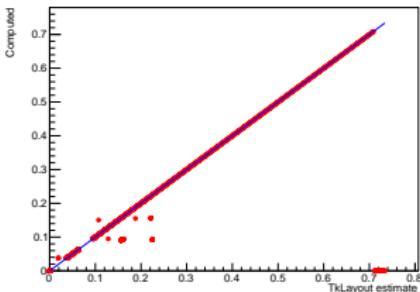
100g/m of Cu in the fourth layer and conversion $1g/m \rightarrow 1.5g/m$ exiting

- ✓ $L = (\text{rods} * 100)$ in layer
- ✓ $L = (\text{rods} * 150)$ in second cylinder

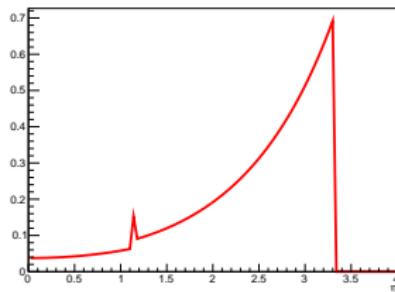
TkLayout estimate vs computed



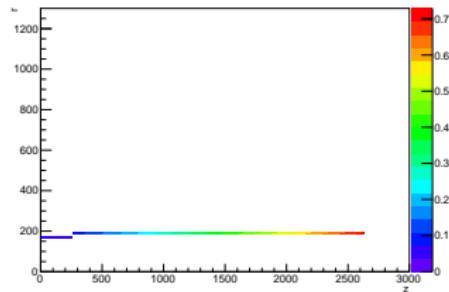
Correlation



Computed function



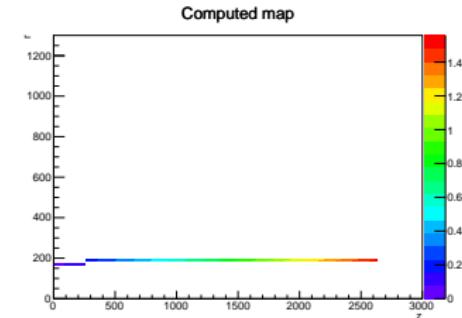
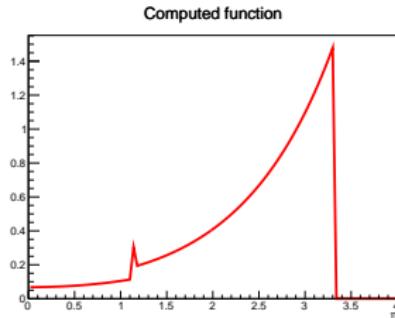
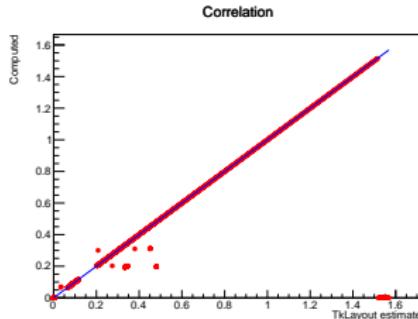
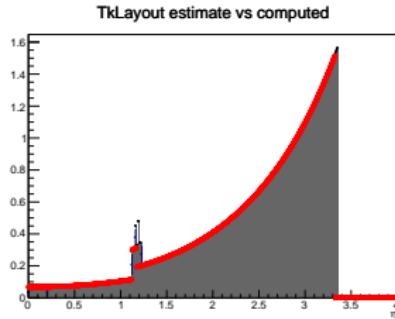
Computed map



Test9

100g/m of Cu and 150g/m of Al in the fourth layer and conversions

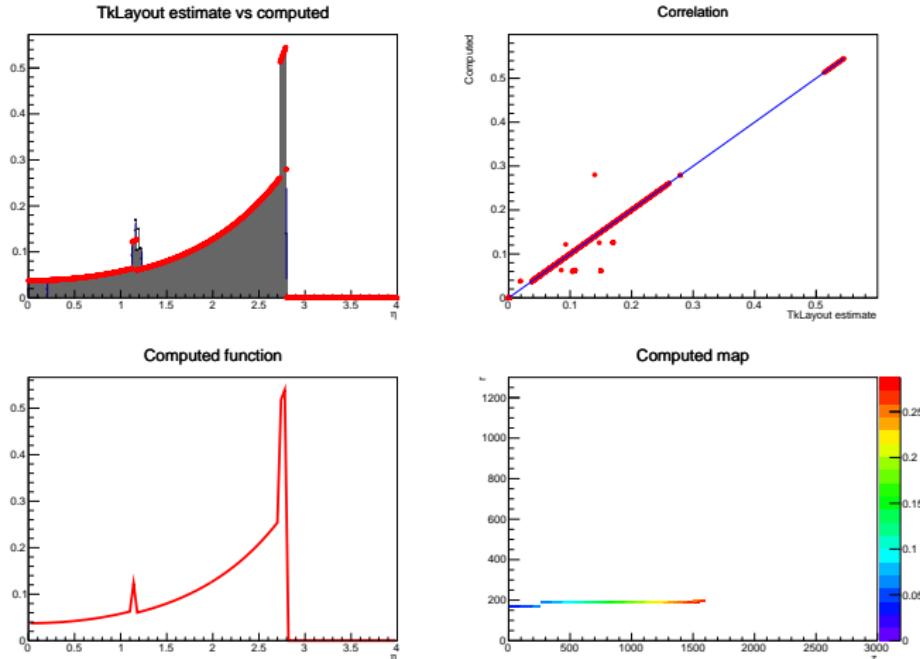
- ✓ $1\text{g}/\text{m} \text{Cu} \rightarrow 2\text{g}/\text{m} \text{Cu}$ exiting
- ✓ $0.1\text{g}/\text{m} \text{Al} \rightarrow 0.15\text{g}/\text{m} \text{Al}$ exiting



Test10

100g/m of Cu in the fourth layer and conversions

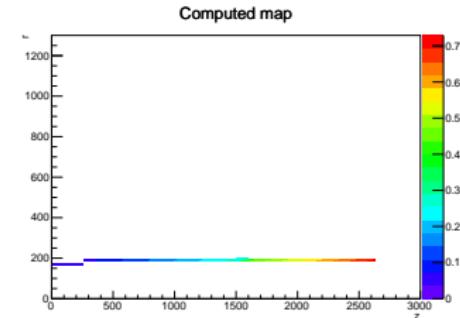
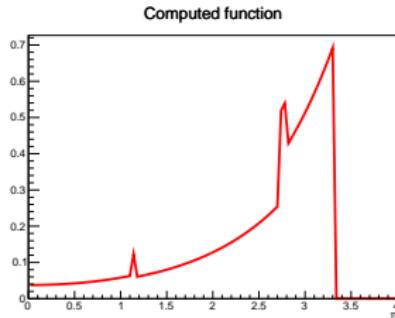
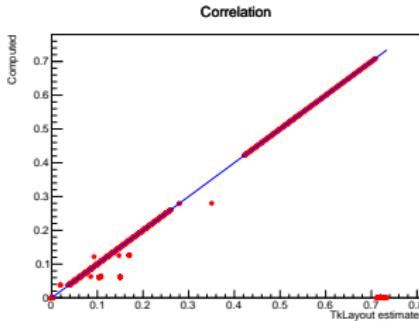
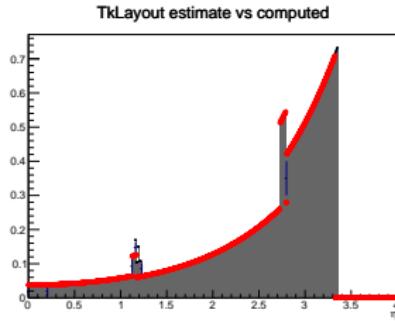
- ✓ $1\text{g}/\text{m} \rightarrow 1\text{g}/\text{m}$ exiting in the flange
- ✓ $1\text{g}/\text{m} \rightarrow 0.1\text{g}$ local in the second level



Test10bis

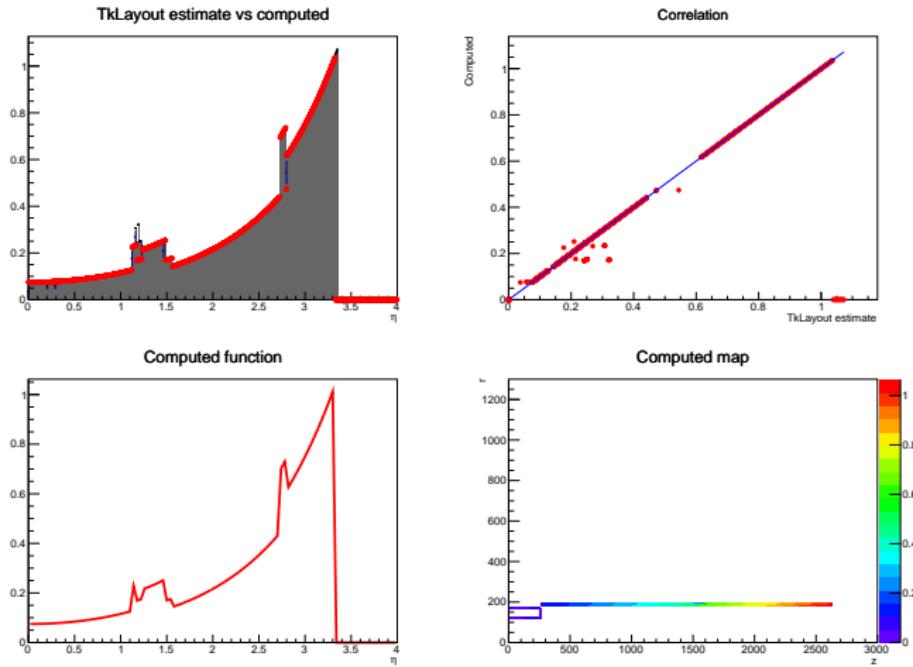
100g/m of Cu in the fourth layer and conversions

- ✓ $1\text{g}/\text{m} \rightarrow 1\text{g}/\text{m}$ exiting in the flange
- ✓ $1\text{g}/\text{m} \rightarrow 0.1\text{g}$ local + $1.5\text{g}/\text{m}$ exiting in the second level



Test10ter

Same as test10bis plus 100g/m of Cu in the third layer with no destination for second level conversion

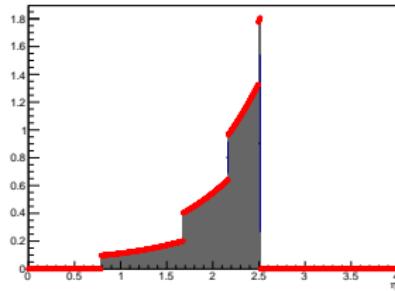


Test11

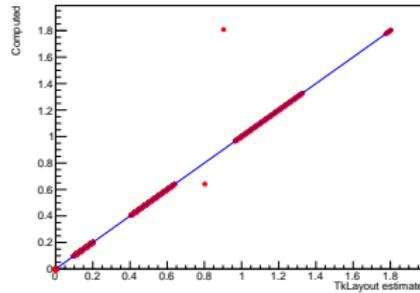
100g/m of Cu exiting from modules of first layer with

✓ scaling with reference strip numbers halved

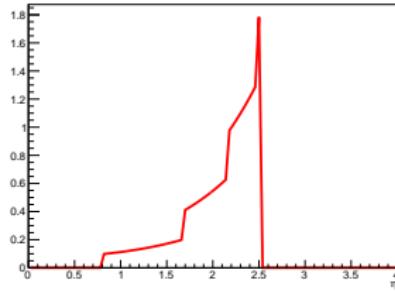
TkLayout estimate vs computed



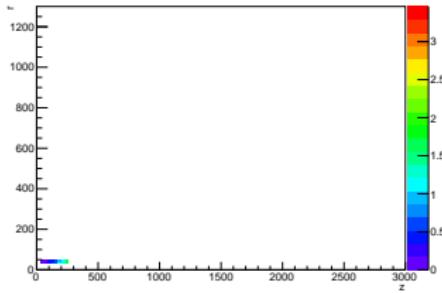
Correlation



Computed function



Computed map

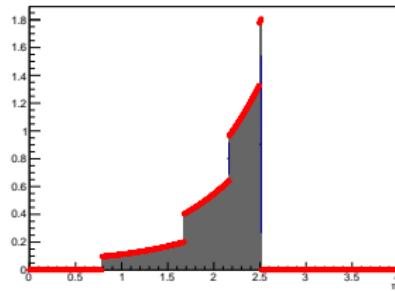


Test11bis

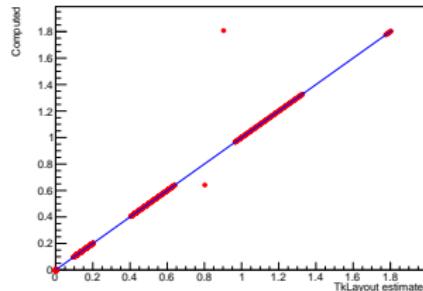
100g/m of Cu exiting from modules of first layer with

✓ scaling with reference segment numbers halved

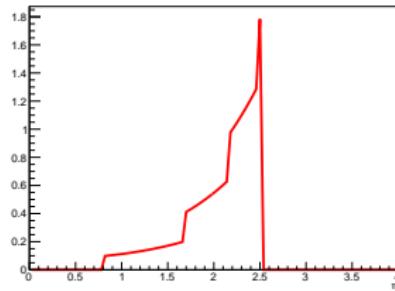
TkLayout estimate vs computed



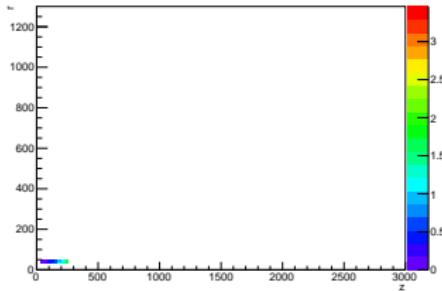
Correlation



Computed function



Computed map

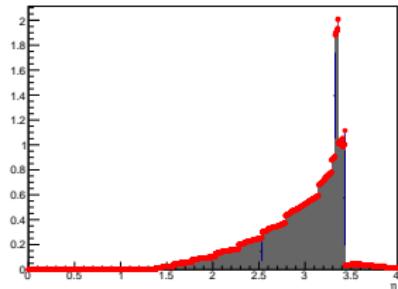


Test12

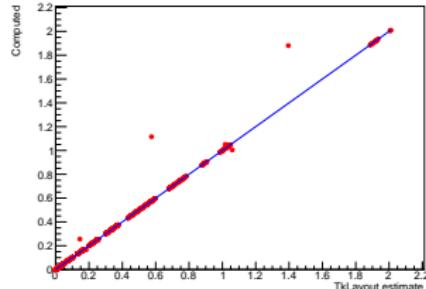
0.1mm of Cu in the disks

✓ service true

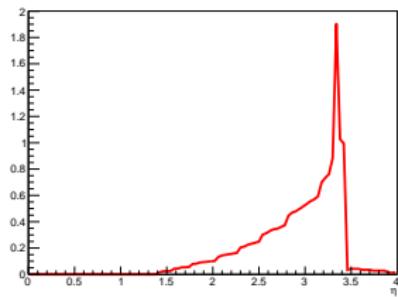
TkLayout estimate vs computed



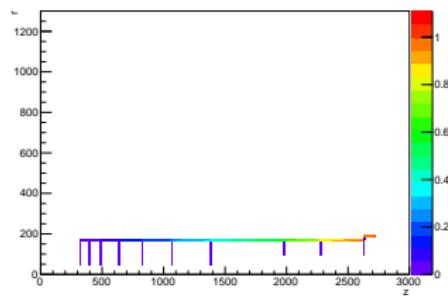
Correlation



Computed function



Computed map

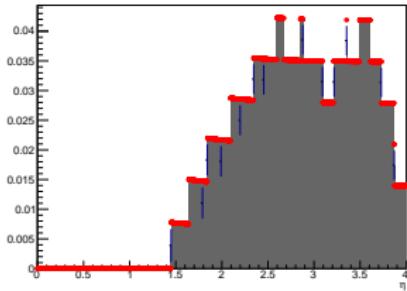


Test12bis

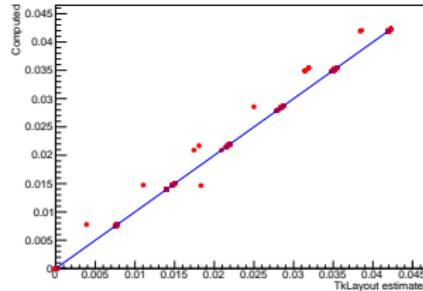
0.1mm of Cu in the disks

✓ service false

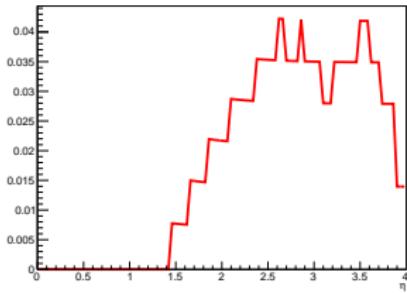
TkLayout estimate vs computed



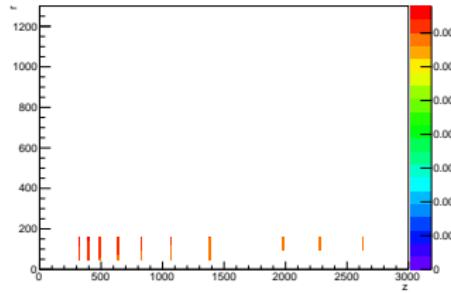
Correlation



Computed function



Computed map

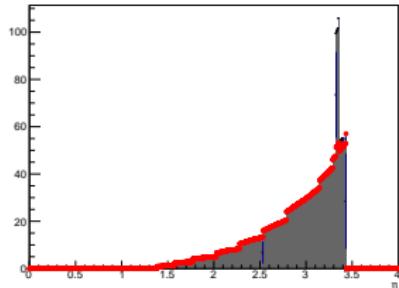


Test13

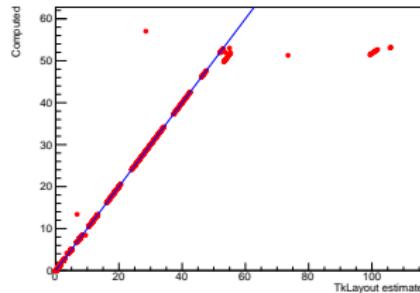
0.1mm of Cu from the modules of disks

✓ service true

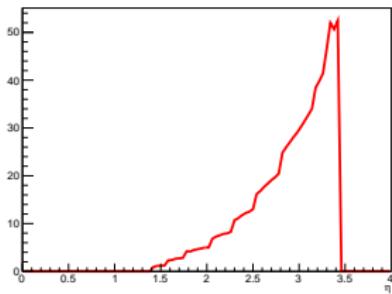
TkLayout estimate vs computed



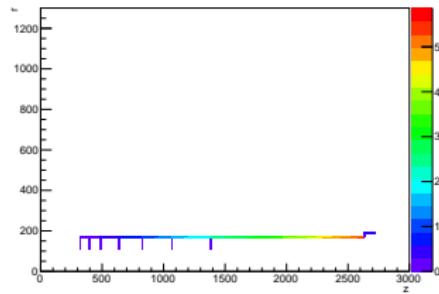
Correlation



Computed function



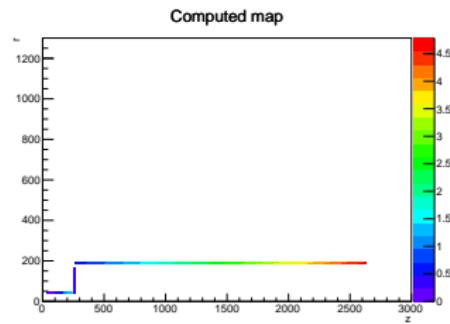
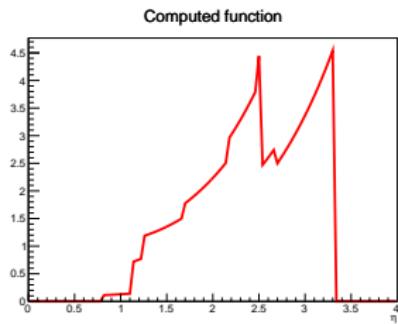
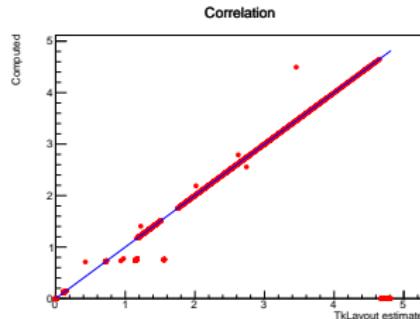
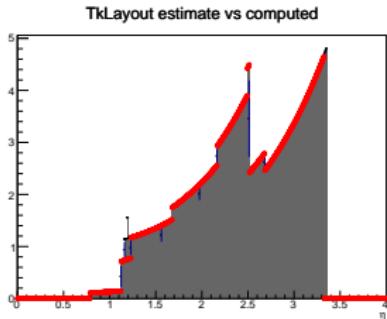
Computed map



Test13b

0.1mm of Cu from the modules of the first layer

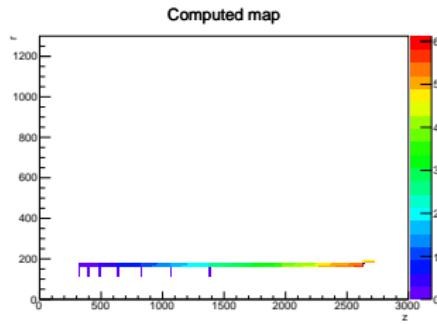
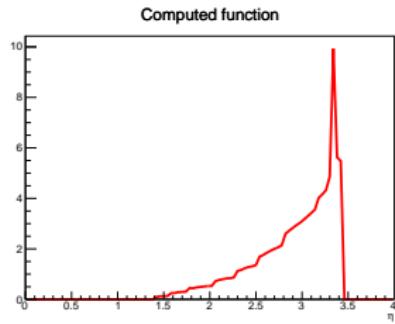
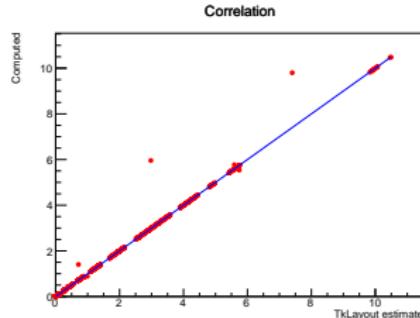
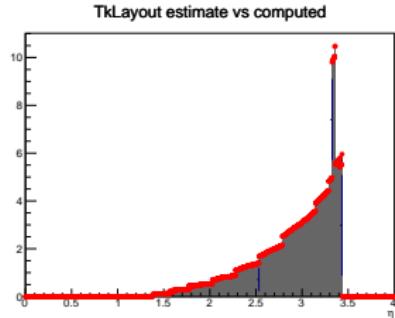
✓ service true



Test14

100g/m of Cu from the modules of the first disk

✓ service true

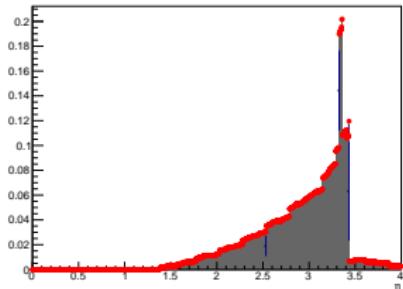


Test15

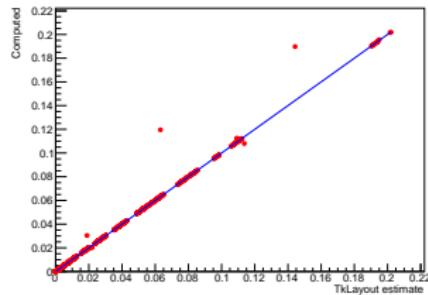
100g/m of Cu in the disk of endcap

✓ service true

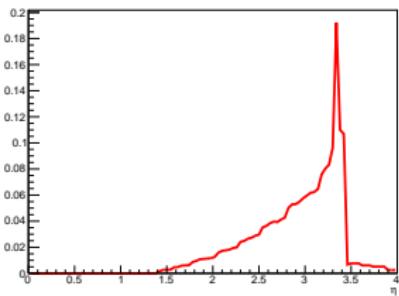
TkLayout estimate vs computed



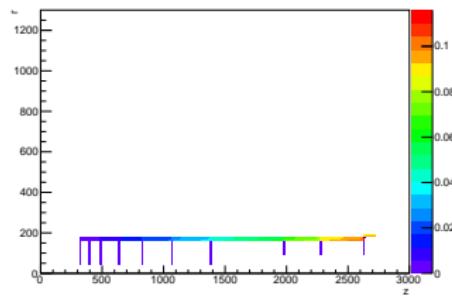
Correlation



Computed function



Computed map

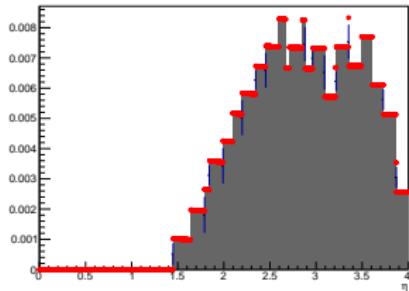


Test15bis

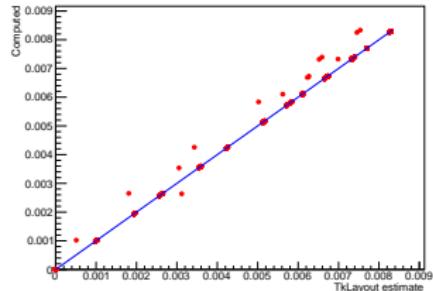
100g/m of Cu in the disk of endcap

✓ service false

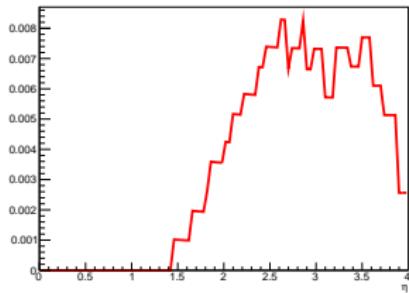
TkLayout estimate vs computed



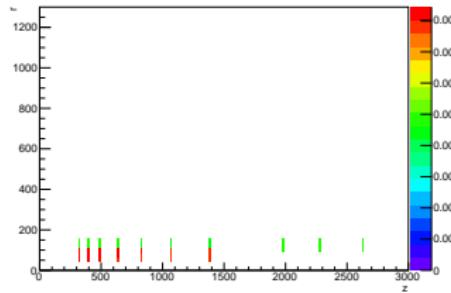
Correlation



Computed function



Computed map

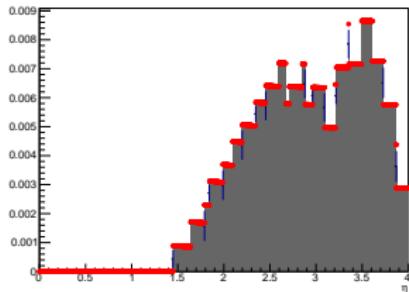


Test16

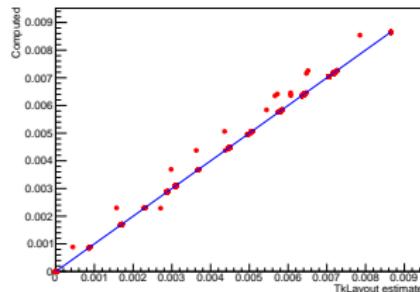
10g of Cu in the disk of endcap

✓ service false

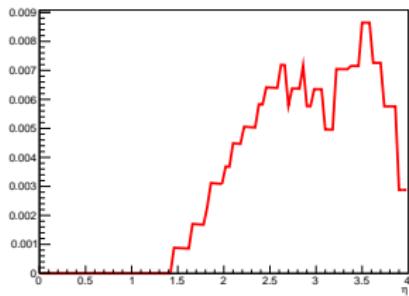
TkLayout estimate vs computed



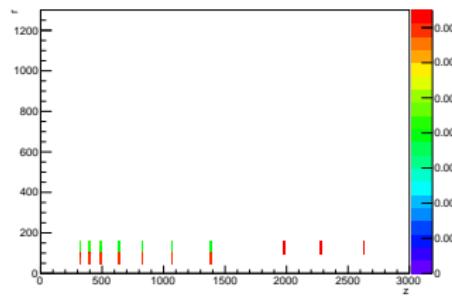
Correlation



Computed function



Computed map

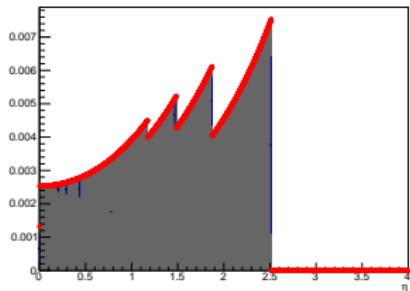


Test17

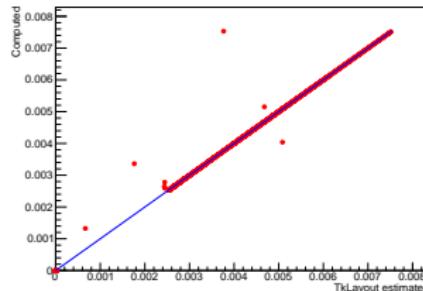
10g of Cu in the layers of barrel

✓ service false

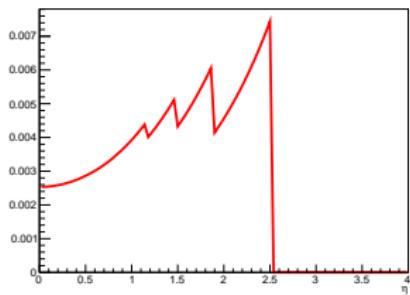
TkLayout estimate vs computed



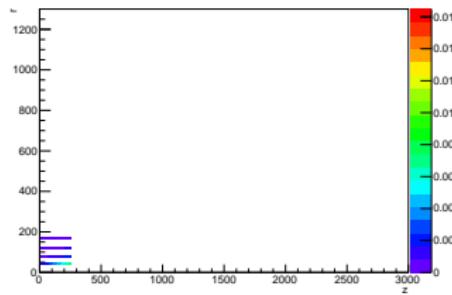
Correlation



Computed function



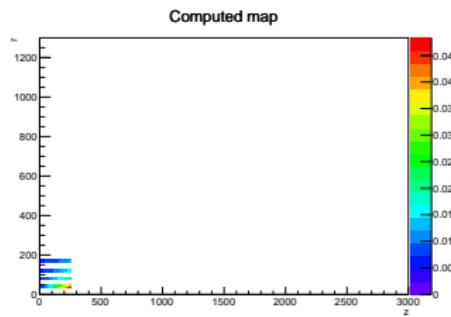
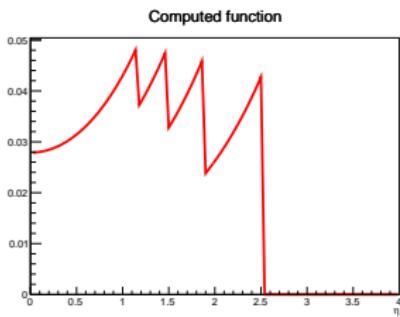
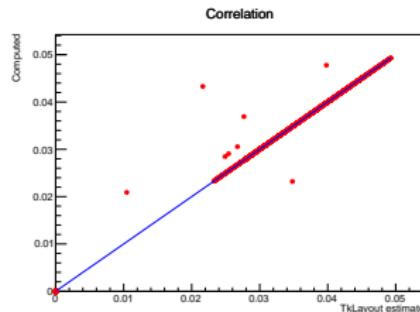
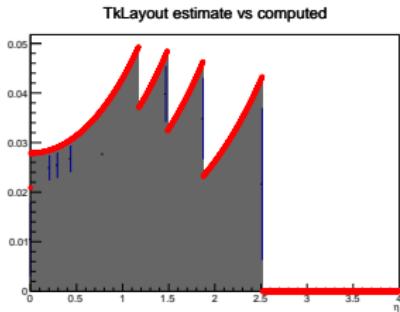
Computed map



Test18

0.1mm of Cu in the layers of barrel

✓ service false

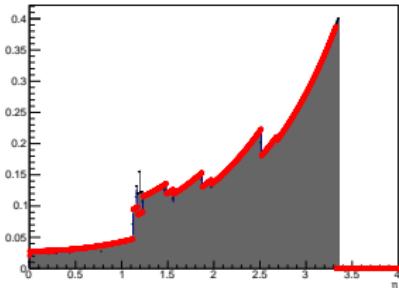


Test18bis

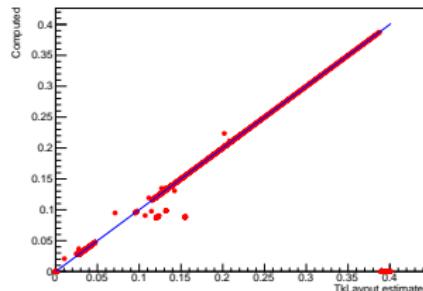
0.1mm of Cu in the layers of barrel

✓ service true

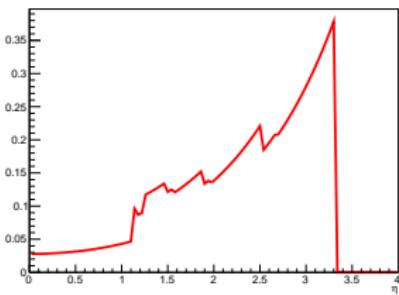
TkLayout estimate vs computed



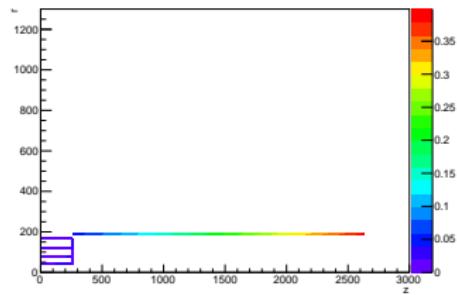
Correlation



Computed function



Computed map

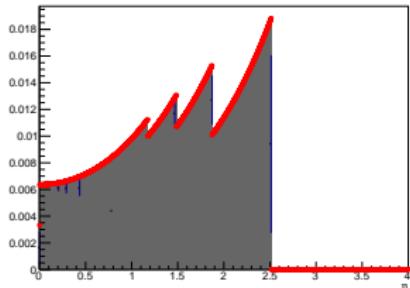


Test19

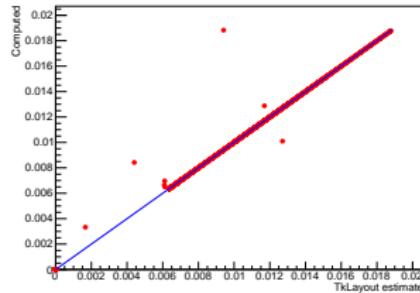
100g/m of Cu in the layers of barrel

✓ service false

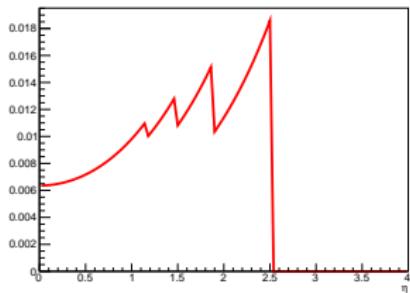
TkLayout estimate vs computed



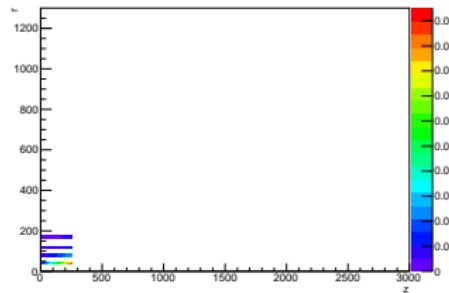
Correlation



Computed function



Computed map

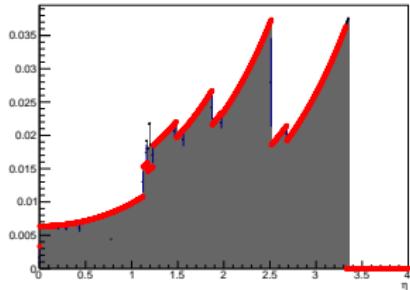


Test19bis

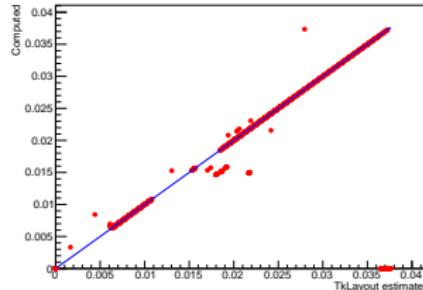
100g/m of Cu in the layers of barrel

✓ service true

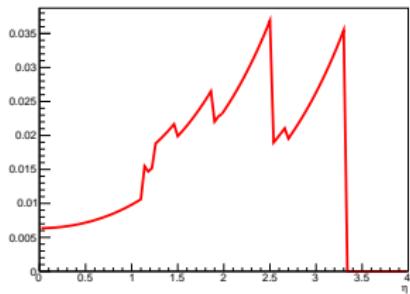
Tklayout estimate vs computed



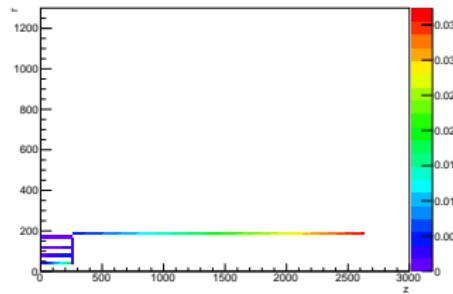
Correlation



Computed function



Computed map

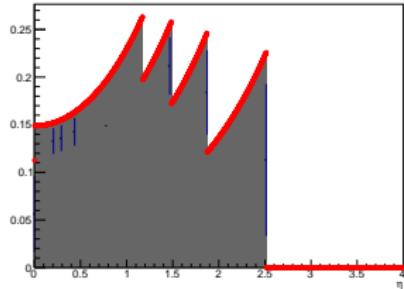


Test20

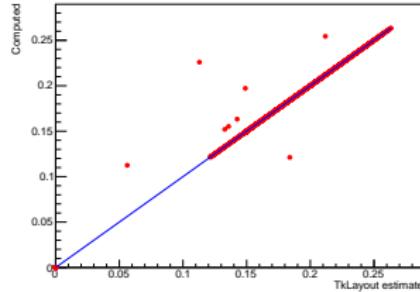
100g/m of Cu in the rods of barrel

✓ service false

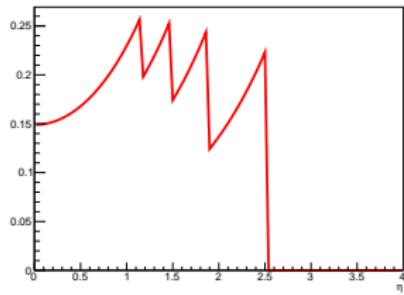
TkLayout estimate vs computed



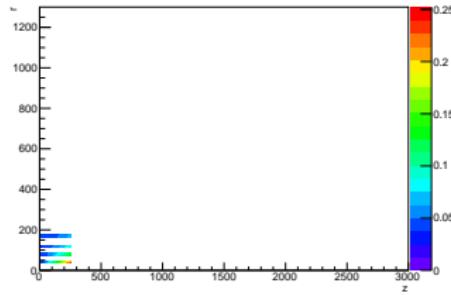
Correlation



Computed function



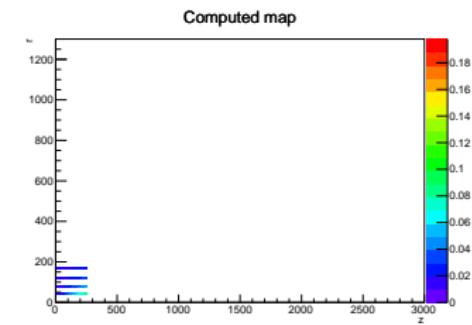
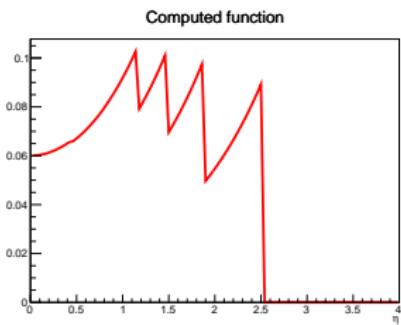
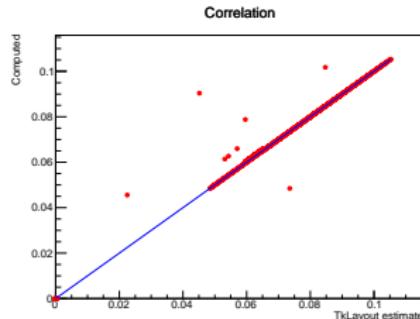
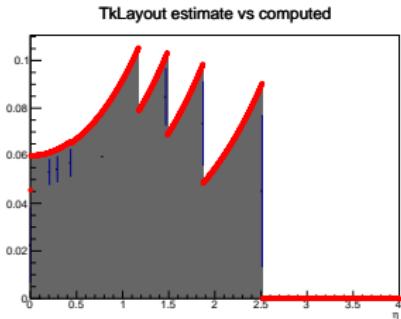
Computed map



Test21

10g of Cu in the rods of barrel

✓ service false

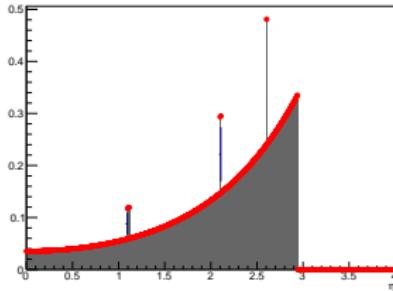


Test22

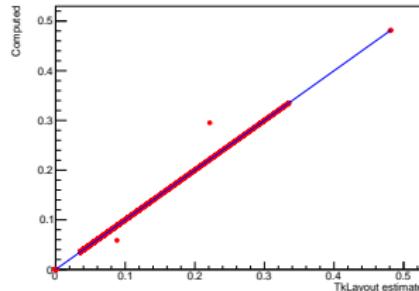
100g/m of Cu in the modules of layer 1 of barrel

✓ service false

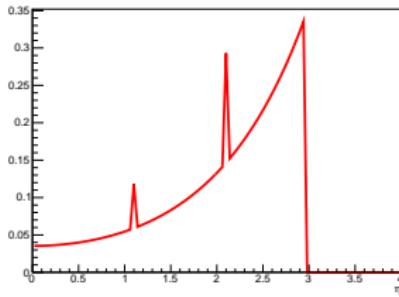
TklLayout estimate vs computed



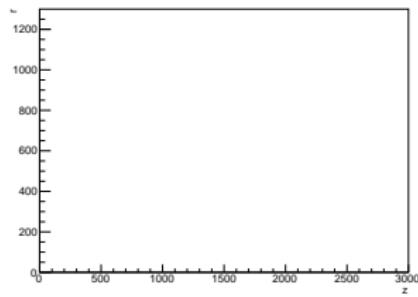
Correlation



Computed function



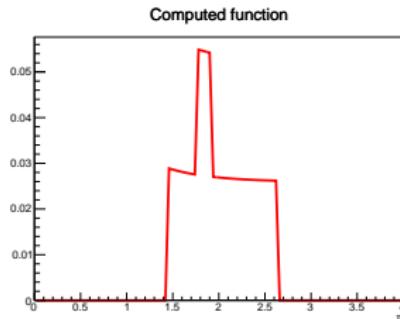
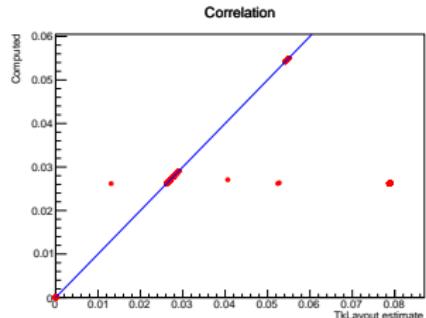
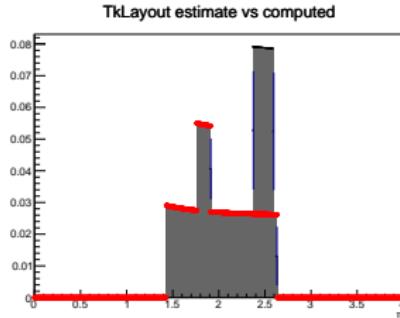
Computed map



Test22d

100g/m of Cu in the modules of disk 1 of endcap

- ✓ service false
- ✓ the second peak is because modules overlaps

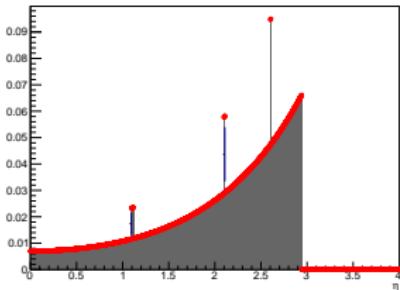


Test23

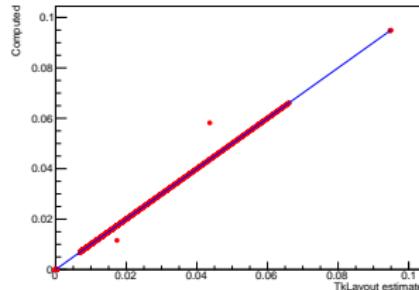
0.1mm of Cu in the modules of layer 1 of barrel

✓ service false

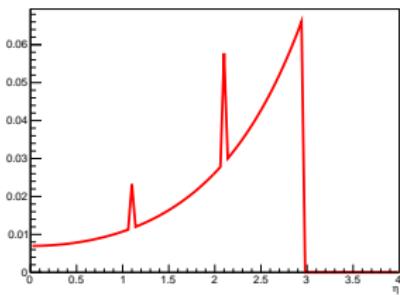
TkLayout estimate vs computed



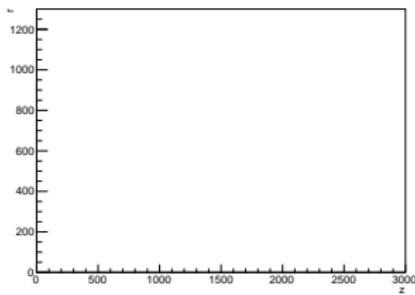
Correlation



Computed function



Computed map

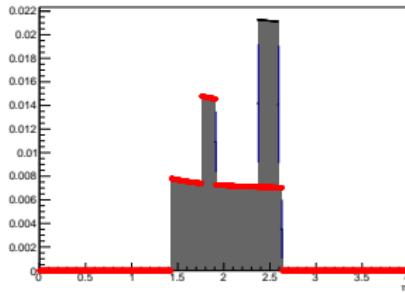


Test23d

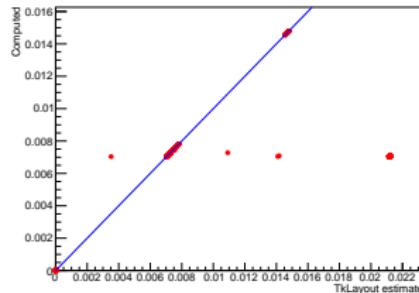
0.1g/m of Cu in the modules of layer 1 of barrel

- ✓ service false
- ✓ the second peak is because modules overlaps

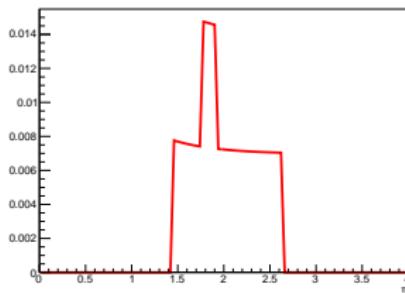
TkLayout estimate vs computed



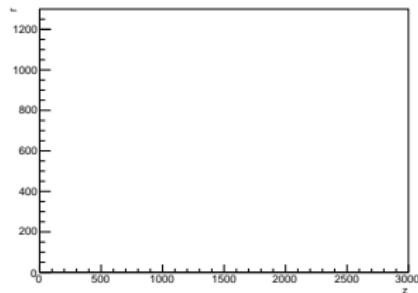
Correlation



Computed function



Computed map

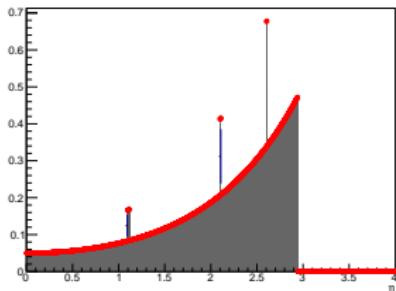


Test24

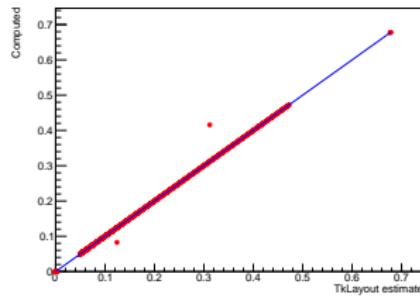
10g of Cu in the modules of layer 1 of barrel

✓ service false

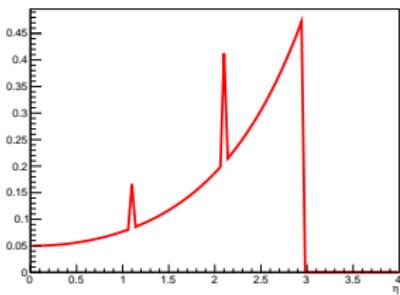
TkLayout estimate vs computed



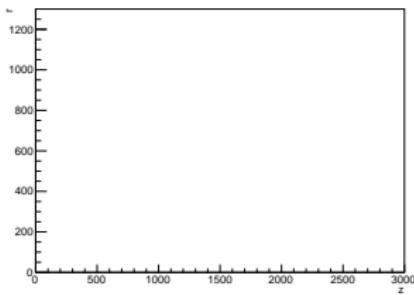
Correlation



Computed function



Computed map

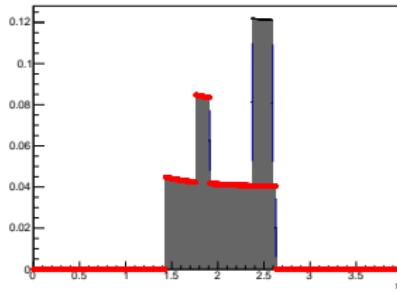


Test24d

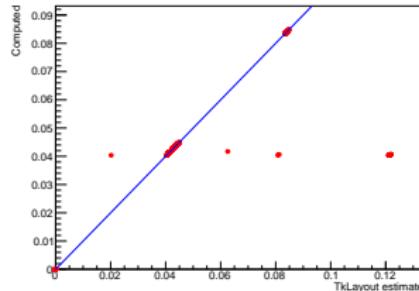
10g of Cu in the modules of layer 1 of barrel

- ✓ service false
- ✓ the second peak is because modules overlaps

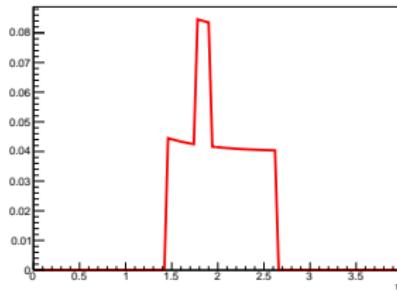
TkLayout estimate vs computed



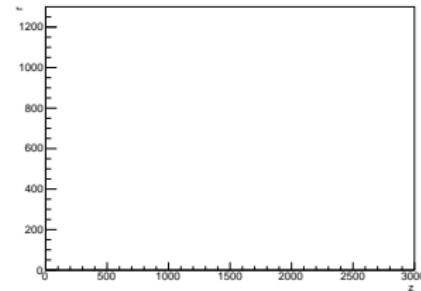
Correlation



Computed function



Computed map



Expected elements

test1a

```
zMin(mm),rMin(mm),Zmax(mm),rMax(mm),direction,quantity,unit,X0(g/cm2),density(g/cm3)
0.1,35.837,250.5,45.837,H,1200,g/m,12.86,8.96
255.6,35.837,265.6,73.847,V,1200,g/m,12.86,8.96
255.6,73.847,265.6,114.538,V,1200,g/m,12.86,8.96
255.6,114.538,265.6,166.368,V,1200,g/m,12.86,8.96
260.5,184.368,2632.87,194.368,H,1200,g/m,12.86,8.96
```

test1b

```
zMin(mm),rMin(mm),Zmax(mm),rMax(mm),direction,quantity,unit,X0(g/cm2),density(g/cm3)
0.1,73.847,250.5,83.847,H,2400,g/m,12.86,8.96
255.6,73.847,265.6,114.538,V,2400,g/m,12.86,8.96
255.6,114.538,265.6,166.368,V,2400,g/m,12.86,8.96
260.5,184.368,2632.87,194.368,H,2400,g/m,12.86,8.96
```

test1c

```
zMin(mm),rMin(mm),Zmax(mm),rMax(mm),direction,quantity,unit,X0(g/cm2),density(g/cm3)
0.1,114.538,250.5,124.538,H,3600,g/m,12.86,8.96
255.6,114.538,265.6,166.368,V,3600,g/m,12.86,8.96
260.5,184.368,2632.87,194.368,H,3600,g/m,12.86,8.96
```

test1d

```
zMin(mm),rMin(mm),Zmax(mm),rMax(mm),direction,quantity,unit,X0(g/cm2),density(g/cm3)
0.1,166.368,250.5,176.368,H,5200,g/m,12.86,8.96
260.5,184.368,2632.87,194.368,H,5200,g/m,12.86,8.96
```

test2

```
zMin(mm),rMin(mm),Zmax(mm),Rmax(mm),direction,quantity,unit,X0(g/cm2),density(g/cm3)
//layers
0.1,35.837,250.5,45.837,H,1200,g/m,12.86,8.96
0.1,73.847,250.5,83.847,H,2400,g/m,12.86,8.96
0.1,114.538,250.5,124.538,H,3600,g/m,12.86,8.96
0.1,166.368,250.5,176.368,H,5200,g/m,12.86,8.96
//rings
255.6,35.837,265.6,73.847,V,1200,g/m,12.86,8.96
255.6,73.847,265.6,114.538,V,3600,g/m,12.86,8.96
255.6,114.538,265.6,166.368,V,7200,g/m,12.86,8.96
//final layer
260.5,184.368,2632.87,194.368,H,12400,g/m,12.86,8.96
```

test3

```
zMin(mm),rMin(mm),Zmax(mm),rMax(mm),direction,quantity,unit,X0(g/cm2),density(g/cm3)
//layers
0.1,35.837,250.5,45.837,H,0.1,mm,12.86,8.96
0.1,73.847,250.5,83.847,H,0.1,mm,12.86,8.96
0.1,114.538,250.5,124.538,H,0.1,mm,12.86,8.96
0.1,166.368,250.5,176.368,H,0.1,mm,12.86,8.96
//rings
255.6,35.837,265.6,73.847,V,0.1,mm,12.86,8.96
255.6,73.847,265.6,114.538,V,0.2,mm,12.86,8.96
255.6,114.538,265.6,166.368,V,0.3,mm,12.86,8.96
//final layer
260.5,184.368,2632.87,194.368,H,0.4,mm,12.86,8.96
```

test3bis

```
zMin(mm),rMin(mm),Zmax(mm),rMax(mm),direction,quantity,unit,X0(g/cm2),density(g/cm3)
0.1,35.837,250.5,45.837,H,0.1,mm,12.86,8.96
```

test3ter

```
zMin(mm),rMin(mm),Zmax(mm),rMax(mm),direction,quantity,unit,X0(g/cm2),density(g/cm3)
0.1,35.837,250.5,45.837,H,0.1,mm,12.86,8.96
0.1,73.847,250.5,83.847,H,0.1,mm,12.86,8.96
0.1,114.538,250.5,124.538,H,0.1,mm,12.86,8.96
0.1,166.368,250.5,176.368,H,0.1,mm,12.86,8.96
```

test3quater

```
zMin(mm),rMin(mm),Zmax(mm),rMax(mm),direction,quantity,unit,X0(g/cm2),density(g/cm3)
0.1,166.368,250.5,176.368,H,0.1,mm,12.86,8.96
260.5,184.368,2632.87,194.368,H,0.1,mm,12.86,8.96
```

test4

```
zMin(mm),rMin(mm),Zmax(mm),rMax(mm),direction,quantity,unit,X0(g/cm2),density(g/cm3)
35.5,35.837,105.5,45.837,H,1200,g/m,12.86,8.96
105.5,35.837,175.5,45.837,H,2400,g/m,12.86,8.96
175.5,35.837,245.5,45.837,H,3600,g/m,12.86,8.96
245.5,35.837,250.5,45.837,H,4800,g/m,12.86,8.96
```

test5

```
zMin(mm),rMin(mm),Zmax(mm),rMax(mm),direction,quantity,unit,X0(g/cm2),density(g/cm3)
//modules effects
35.5,35.837,105.5,45.837,H,1200,g/m,12.86,8.96
105.5,35.837,175.5,45.837,H,2400,g/m,12.86,8.96
175.5,35.837,245.5,45.837,H,3600,g/m,12.86,8.96
245.5,35.837,250.5,45.837,H,4800,g/m,12.86,8.96
//rod effect
0.1,35.837,250.5,45.837,H,1800,g/m,12.86,8.96
```

test6

```
zMin(mm),rMin(mm),Zmax(mm),rMax(mm),direction,quantity,unit,X0(g/cm2),density(g/cm3)
//disks
316.97,44.733,326.97,110.655,V,100,g/m,12.86,8.96
316.97,110.655,326.97,159.99,V,100,g/m,12.86,8.96
//long layer
316.97,165.09,2632.87,175.09,H,100,g/m,12.86,8.96
//final layer
2632.97,184.368,2722.97,194.368,H,100,g/m,12.86,8.96
//conjunction disk
2632.97,174.99,2642.97,184.268,V,100,g/m,12.86,8.96
```

test6bis

```
zMin(mm),rMin(mm),Zmax(mm),rMax(mm),direction,quantity,unit,X0(g/cm2),density(g/cm3)
//disk (only the second)
316.97,110.655,326.97,159.99,V,2400,g/m,12.86,8.96
//long layer
308.97,165.09,2632.87,175.09,H,6000,g/m,12.86,8.96
//final layer
2632.97,184.368,2722.97,194.368,H,6000,g/m,12.86,8.96
//conjunction disk
2632.97,174.99,2642.97,184.268,V,6000,g/m,12.86,8.96
```

test7

```
zMin(mm),rMin(mm),Zmax(mm),rMax(mm),direction,quantity,unit,X0(g/cm2),density(g/cm3)
0.1,166.368,250.5,176.368,H,5200,g/m,12.86,8.96
250.6,156.368,255.6,176.368,V,520,g,12.86,8.96
```

test8

```
zMin(mm),rMin(mm),Zmax(mm),rMax(mm),direction,quantity,unit,X0(g/cm2),density(g/cm3)
0.1,166.368,250.5,176.368,H,5200,g/m,12.86,8.96
260.5,184.368,2632.87,194.368,H,7800,g/m,12.86,8.96
```

test9

```
zMin(mm),rMin(mm),Zmax(mm),rMax(mm),direction,quantity,unit,X0(g/cm2),density(g/cm3)
0.1,166.368,250.5,176.368,H,5200,g/m,12.86,8.96
0.1,166.368,250.5,176.368,H,7800,g/m,24.01,2.7
260.5,184.368,2632.87,194.368,H,10400,g/m,12.86,8.96
260.5,184.368,2632.87,194.368,H,11700,g/m,24.01,2.7
```

test10

```
zMin(mm),rMin(mm),Zmax(mm),rMax(mm),direction,quantity,unit,X0(g/cm2),density(g/cm3)
0.1,166.368,250.5,176.368,H,5200,g/m,12.86,8.96
260.5,184.368,1550,194.368,H,5200,g/m,12.86,8.96
1500,194.468,1600,199.468,H,520,g,12.86,8.96
```

test10bis

```
zMin(mm),rMin(mm),Zmax(mm),rMax(mm),direction,quantity,unit,X0(g/cm2),density(g/cm3)
0.1,166.368,250.5,176.368,H,5200,g/m,12.86,8.96
260.5,184.368,1550,194.368,H,5200,g/m,12.86,8.96
1500,194.468,1600,199.468,H,520,g,12.86,8.96
```

test10ter

```
zMin(mm),rMin(mm),Zmax(mm),rMax(mm),direction,quantity,unit,X0(g/cm2),density(g/cm3)
0.1,166.368,250.5,176.368,H,5200,g/m,12.86,8.96
260.5,184.368,1550,194.368,H,5200,g/m,12.86,8.96
1500,194.468,1600,199.468,H,520,g,12.86,8.96
```

test11

```
zMin(mm),rMin(mm),Zmax(mm),rMax(mm),direction,quantity,unit,X0(g/cm2),density(g/cm3)
35.5,35.837,105.5,45.837,H,2400,g/m,12.86,8.96
105.5,35.837,175.5,45.837,H,4800,g/m,12.86,8.96
175.5,35.837,245.5,45.837,H,7200,g/m,12.86,8.96
245.5,35.837,250.5,45.837,H,9600,g/m,12.86,8.96
```

test11bis

```
zMin(mm),rMin(mm),Zmax(mm),rMax(mm),direction,quantity,unit,X0(g/cm2),density(g/cm3)
35.5,35.837,105.5,45.837,H,2400,g/m,12.86,8.96
105.5,35.837,175.5,45.837,H,4800,g/m,12.86,8.96
175.5,35.837,245.5,45.837,H,7200,g/m,12.86,8.96
245.5,35.837,250.5,45.837,H,9600,g/m,12.86,8.96
```

test12bis

```
zMin(mm),rMin(mm),Zmax(mm),rMax(mm),direction,quantity,unit,X0(g/cm2),density(g/cm3)
//disks
316.97,44.733,326.97,110.655,V,0.1,mm,12.86,8.96
316.97,110.655,326.97,159.99,V,0.1,mm,12.86,8.96
391.97,44.733,401.97,110.655,V,0.1,mm,12.86,8.96
391.97,110.655,401.97,159.99,V,0.1,mm,12.86,8.96
486.97,44.733,496.97,110.655,V,0.1,mm,12.86,8.96
486.97,110.655,496.97,159.99,V,0.1,mm,12.86,8.96
633.97,44.733,643.97,110.655,V,0.1,mm,12.86,8.96
633.97,110.655,643.97,159.99,V,0.1,mm,12.86,8.96
821.97,44.733,831.97,110.655,V,0.1,mm,12.86,8.96
821.97,110.655,831.97,159.99,V,0.1,mm,12.86,8.96
1063.97,44.733,1073.97,110.655,V,0.1,mm,12.86,8.96
1063.97,110.655,1073.97,159.99,V,0.1,mm,12.86,8.96
1374.97,44.733,1384.97,110.655,V,0.1,mm,12.86,8.96
1374.97,110.655,1384.97,159.99,V,0.1,mm,12.86,8.96
1974.97,95.09,1984.97,159.99,V,0.1,mm,12.86,8.96
2276.97,95.09,2286.97,159.99,V,0.1,mm,12.86,8.96
2624.97,95.09,2634.97,159.99,V,0.1,mm,12.86,8.96
```

test13

```
zMin(mm),rMin(mm),Zmax(mm),rMax(mm),direction,quantity,unit,X0(g/cm2),density(g/cm3)
//disks
316.97,110.655,326.97,159.99,V,2.4,mm,12.86,8.96
391.97,110.655,401.97,159.99,V,2.4,mm,12.86,8.96
486.97,110.655,496.97,159.99,V,2.4,mm,12.86,8.96
633.97,110.655,643.97,159.99,V,2.4,mm,12.86,8.96
821.97,110.655,831.97,159.99,V,2.4,mm,12.86,8.96
1063.97,110.655,1073.97,159.99,V,2.4,mm,12.86,8.96
1374.97,110.655,1384.97,159.99,V,2.4,mm,12.86,8.96
//cylinders
316.97,165.09,2632.87,175.09,H,2.4,mm,12.86,8.96
316.97,165.09,2632.87,175.09,H,3.6,mm,12.86,8.96
391.97,165.09,2632.87,175.09,H,2.4,mm,12.86,8.96
391.97,165.09,2632.87,175.09,H,3.6,mm,12.86,8.96
486.97,165.09,2632.87,175.09,H,2.4,mm,12.86,8.96
486.97,165.09,2632.87,175.09,H,3.6,mm,12.86,8.96
633.97,165.09,2632.87,175.09,H,2.4,mm,12.86,8.96
633.97,165.09,2632.87,175.09,H,3.6,mm,12.86,8.96
821.97,165.09,2632.87,175.09,H,2.4,mm,12.86,8.96
821.97,165.09,2632.87,175.09,H,3.6,mm,12.86,8.96
1063.97,165.09,2632.87,175.09,H,2.4,mm,12.86,8.96
1063.97,165.09,2632.87,175.09,H,3.6,mm,12.86,8.96
1374.97,165.09,2632.87,175.09,H,2.4,mm,12.86,8.96
1374.97,165.09,2632.87,175.09,H,3.6,mm,12.86,8.96
1974.97,165.09,2632.87,175.09,H,3.6,mm,12.86,8.96
2276.97,165.09,2632.87,175.09,H,3.6,mm,12.86,8.96
2624.97,165.09,2632.87,175.09,H,3.6,mm,12.86,8.96
//final cylinder
2632.97,184.368,2722.97,194.368,H,3.6,mm,12.86,8.96
//conjunction disk
2632.97,174.99,2642.97,184.268,V,3.6,mm,12.86,8.96
```

test13b

```
zMin(mm),rMin(mm),Zmax(mm),rMax(mm),direction,quantity,unit,X0(g/cm2),density(g/cm3)
//layer
35.5,35.837,105.5,45.837,H,1.2,mm,12.86,8.96
105.5,35.837,175.5,45.837,H,2.4,mm,12.86,8.96
175.5,35.837,245.5,45.837,H,3.6,mm,12.86,8.96
245.5,35.837,250.5,45.837,H,4.8,mm,12.86,8.96
//disks
255.6,35.837,265.6,73.847,V,4.8,mm,12.86,8.96
255.6,73.847,265.6,114.538,V,4.8,mm,12.86,8.96
255.6,114.538,265.6,166.368,V,4.8,mm,12.86,8.96
260.5,184.368,2632.87,194.368,H,4.8,mm,12.86,8.96
```

test14

```
zMin(mm),rMin(mm),Zmax(mm),rMax(mm),direction,quantity,unit,X0(g/cm2),density(g/cm3)
//disks
316.97,110.655,326.97,159.99,V,2400,g/m,12.86,8.96
391.97,110.655,401.97,159.99,V,2400,g/m,12.86,8.96
486.97,110.655,496.97,159.99,V,2400,g/m,12.86,8.96
633.97,110.655,643.97,159.99,V,2400,g/m,12.86,8.96
821.97,110.655,831.97,159.99,V,2400,g/m,12.86,8.96
1063.97,110.655,1073.97,159.99,V,2400,g/m,12.86,8.96
1374.97,110.655,1384.97,159.99,V,2400,g/m,12.86,8.96
//cylinders
316.97,165.09,2632.87,175.09,H,2400,g/m,12.86,8.96
316.97,165.09,2632.87,175.09,H,3600,g/m,12.86,8.96
391.97,165.09,2632.87,175.09,H,2400,g/m,12.86,8.96
391.97,165.09,2632.87,175.09,H,3600,g/m,12.86,8.96
486.97,165.09,2632.87,175.09,H,2400,g/m,12.86,8.96
486.97,165.09,2632.87,175.09,H,3600,g/m,12.86,8.96
633.97,165.09,2632.87,175.09,H,2400,g/m,12.86,8.96
633.97,165.09,2632.87,175.09,H,3600,g/m,12.86,8.96
821.97,165.09,2632.87,175.09,H,2400,g/m,12.86,8.96
821.97,165.09,2632.87,175.09,H,3600,g/m,12.86,8.96
1063.97,165.09,2632.87,175.09,H,2400,g/m,12.86,8.96
1063.97,165.09,2632.87,175.09,H,3600,g/m,12.86,8.96
1374.97,165.09,2632.87,175.09,H,2400,g/m,12.86,8.96
1374.97,165.09,2632.87,175.09,H,3600,g/m,12.86,8.96
1974.97,165.09,2632.87,175.09,H,3600,g/m,12.86,8.96
2276.97,165.09,2632.87,175.09,H,3600,g/m,12.86,8.96
2624.97,165.09,2632.87,175.09,H,3600,g/m,12.86,8.96
//final cylinder
2632.97,184.368,2722.97,194.368,H,52800,g/m,12.86,8.96
//conjunction disk
2632.97,174.99,2642.97,184.268,V,52800,g/m,12.86,8.96
```

```
zMin(mm),rMin(mm),Zmax(mm),rMax(mm),direction,quantity,unit,X0(g/cm2),density(g/cm3)
//disks
316.97,44.733,326.97,110.655,V,100,g/m,12.86,8.96
316.97,110.655,326.97,159.99,V,100,g/m,12.86,8.96
391.97,44.733,401.97,110.655,V,100,g/m,12.86,8.96
391.97,110.655,401.97,159.99,V,100,g/m,12.86,8.96
486.97,44.733,496.97,110.655,V,100,g/m,12.86,8.96
486.97,110.655,496.97,159.99,V,100,g/m,12.86,8.96
633.97,44.733,643.97,110.655,V,100,g/m,12.86,8.96
633.97,110.655,643.97,159.99,V,100,g/m,12.86,8.96
821.97,44.733,831.97,110.655,V,100,g/m,12.86,8.96
821.97,110.655,831.97,159.99,V,100,g/m,12.86,8.96
1063.97,44.733,1073.97,110.655,V,100,g/m,12.86,8.96
1063.97,110.655,1073.97,159.99,V,100,g/m,12.86,8.96
1374.97,44.733,1384.97,110.655,V,100,g/m,12.86,8.96
1374.97,110.655,1384.97,159.99,V,100,g/m,12.86,8.96
1974.97,95.09,1984.97,159.99,V,100,g/m,12.86,8.96
2276.97,95.09,2286.97,159.99,V,100,g/m,12.86,8.96
2624.97,95.09,2634.97,159.99,V,100,g/m,12.86,8.96
//cylinders
316.97,165.09,2632.87,175.09,H,100,g/m,12.86,8.96
391.97,165.09,2632.87,175.09,H,100,g/m,12.86,8.96
486.97,165.09,2632.87,175.09,H,100,g/m,12.86,8.96
633.97,165.09,2632.87,175.09,H,100,g/m,12.86,8.96
821.97,165.09,2632.87,175.09,H,100,g/m,12.86,8.96
1063.97,165.09,2632.87,175.09,H,100,g/m,12.86,8.96
1374.97,165.09,2632.87,175.09,H,100,g/m,12.86,8.96
1974.97,165.09,2632.87,175.09,H,100,g/m,12.86,8.96
2276.97,165.09,2632.87,175.09,H,100,g/m,12.86,8.96
2624.97,165.09,2632.87,175.09,H,100,g/m,12.86,8.96
//final cylinder
2632.97,184.368,2722.97,194.368,H,1000,g/m,12.86,8.96
//conjunction disk
2632.97,174.99,2642.97,184.268,V,1000,g/m,12.86,8.96
```

test15bis

```
zMin(mm),rMin(mm),Zmax(mm),rMax(mm),direction,quantity,unit,X0(g/cm2),density(g/cm3)
//disks
316.97,44.733,326.97,110.655,V,100,g/m,12.86,8.96
316.97,110.655,326.97,159.99,V,100,g/m,12.86,8.96
391.97,44.733,401.97,110.655,V,100,g/m,12.86,8.96
391.97,110.655,401.97,159.99,V,100,g/m,12.86,8.96
486.97,44.733,496.97,110.655,V,100,g/m,12.86,8.96
486.97,110.655,496.97,159.99,V,100,g/m,12.86,8.96
633.97,44.733,643.97,110.655,V,100,g/m,12.86,8.96
633.97,110.655,643.97,159.99,V,100,g/m,12.86,8.96
821.97,44.733,831.97,110.655,V,100,g/m,12.86,8.96
821.97,110.655,831.97,159.99,V,100,g/m,12.86,8.96
1063.97,44.733,1073.97,110.655,V,100,g/m,12.86,8.96
1063.97,110.655,1073.97,159.99,V,100,g/m,12.86,8.96
1374.97,44.733,1384.97,110.655,V,100,g/m,12.86,8.96
1374.97,110.655,1384.97,159.99,V,100,g/m,12.86,8.96
1974.97,95.09,1984.97,159.99,V,100,g/m,12.86,8.96
2276.97,95.09,2286.97,159.99,V,100,g/m,12.86,8.96
2624.97,95.09,2634.97,159.99,V,100,g/m,12.86,8.96
```

test16

```
zMin(mm),rMin(mm),Zmax(mm),rMax(mm),direction,quantity,unit,X0(g/cm2),density(g/cm3)
//disks
316.97,44.733,326.97,110.655,V,5.72,g,12.86,8.96
316.97,110.655,326.97,159.99,V,4.28,g,12.86,8.96
391.97,44.733,401.97,110.655,V,5.72,g,12.86,8.96
391.97,110.655,401.97,159.99,V,4.28,g,12.86,8.96
486.97,44.733,496.97,110.655,V,5.72,g,12.86,8.96
486.97,110.655,496.97,159.99,V,4.28,g,12.86,8.96
633.97,44.733,643.97,110.655,V,5.72,g,12.86,8.96
633.97,110.655,643.97,159.99,V,4.28,g,12.86,8.96
821.97,44.733,831.97,110.655,V,5.72,g,12.86,8.96
821.97,110.655,831.97,159.99,V,4.28,g,12.86,8.96
1063.97,44.733,1073.97,110.655,V,5.72,g,12.86,8.96
1063.97,110.655,1073.97,159.99,V,4.28,g,12.86,8.96
1374.97,44.733,1384.97,110.655,V,5.72,g,12.86,8.96
1374.97,110.655,1384.97,159.99,V,4.28,g,12.86,8.96
1974.97,95.09,1984.97,159.99,V,10,g,12.86,8.96
2276.97,95.09,2286.97,159.99,V,10,g,12.86,8.96
2624.97,95.09,2634.97,159.99,V,10,g,12.86,8.96
```

test17

```
zMin(mm),rMin(mm),Zmax(mm),rMax(mm),direction,quantity,unit,X0(g/cm2),density(g/cm3)
//layer 1
0.1,35.837,35.5,45.837,H,1.41,g,12.86,8.96
35.5,35.837,105.5,45.837,H,2.8,g,12.86,8.96
105.5,35.837,175.5,45.837,H,2.8,g,12.86,8.96
175.5,35.837,245.5,45.837,H,2.8,g,12.86,8.96
245.5,35.837,250.5,45.837,H,0.2,g,12.86,8.96
//layer 2
0.1,73.847,35.5,83.847,H,1.41,g,12.86,8.96
35.5,73.847,105.5,83.847,H,2.8,g,12.86,8.96
105.5,73.847,175.5,83.847,H,2.8,g,12.86,8.96
175.5,73.847,245.5,83.847,H,2.8,g,12.86,8.96
245.5,73.847,250.5,83.847,H,0.2,g,12.86,8.96
//layer 3
0.1,114.538,35.5,124.538,H,1.41,g,12.86,8.96
35.5,114.538,105.5,124.538,H,2.8,g,12.86,8.96
105.5,114.538,175.5,124.538,H,2.8,g,12.86,8.96
175.5,114.538,245.5,124.538,H,2.8,g,12.86,8.96
245.5,114.538,250.5,124.538,H,0.2,g,12.86,8.96
//layer 4
0.1,166.368,35.5,176.368,H,1.41,g,12.86,8.96
35.5,166.368,105.5,176.368,H,2.8,g,12.86,8.96
105.5,166.368,175.5,176.368,H,2.8,g,12.86,8.96
175.5,166.368,245.5,176.368,H,2.8,g,12.86,8.96
245.5,166.368,250.5,176.368,H,0.2,g,12.86,8.96
```

test18

```
zMin(mm),rMin(mm),Zmax(mm),rMax(mm),direction,quantity,unit,X0(g/cm2),density(g/cm3)
//layers
0.1,35.837,250.5,45.837,H,0.1,mm,12.86,8.96
0.1,73.847,250.5,83.847,H,0.1,mm,12.86,8.96
0.1,114.538,250.5,124.538,H,0.1,mm,12.86,8.96
0.1,166.368,250.5,176.368,H,0.1,mm,12.86,8.96
```

test18bis

```
zMin(mm),rMin(mm),Zmax(mm),rMax(mm),direction,quantity,unit,X0(g/cm2),density(g/cm3)
//layers
0.1,35.837,250.5,45.837,H,0.1,mm,12.86,8.96
0.1,73.847,250.5,83.847,H,0.1,mm,12.86,8.96
0.1,114.538,250.5,124.538,H,0.1,mm,12.86,8.96
0.1,166.368,250.5,176.368,H,0.1,mm,12.86,8.96
//rings
255.6,35.837,265.6,73.847,V,0.1,mm,12.86,8.96
255.6,73.847,265.6,114.538,V,0.2,mm,12.86,8.96
255.6,114.538,265.6,166.368,V,0.3,mm,12.86,8.96
//final layer
260.5,184.368,2632.87,194.368,H,0.4,mm,12.86,8.96
```

test19

```
zMin(mm),rMin(mm),Zmax(mm),rMax(mm),direction,quantity,unit,X0(g/cm2),density(g/cm3)
//layers
0.1,35.837,250.5,45.837,H,100,g/m,12.86,8.96
0.1,73.847,250.5,83.847,H,100,g/m,12.86,8.96
0.1,114.538,250.5,124.538,H,100,g/m,12.86,8.96
0.1,166.368,250.5,176.368,H,100,g/m,12.86,8.96
```

test19bis

```
zMin(mm),rMin(mm),Zmax(mm),rMax(mm),direction,quantity,unit,X0(g/cm2),density(g/cm3)
//layers
0.1,35.837,250.5,45.837,H,100,g/m,12.86,8.96
0.1,73.847,250.5,83.847,H,100,g/m,12.86,8.96
0.1,114.538,250.5,124.538,H,100,g/m,12.86,8.96
0.1,166.368,250.5,176.368,H,100,g/m,12.86,8.96
//rings
255.6,35.837,265.6,73.847,V,100,g/m,12.86,8.96
255.6,73.847,265.6,114.538,V,200,g/m,12.86,8.96
255.6,114.538,265.6,166.368,V,300,g/m,12.86,8.96
//final layer
260.5,184.368,2632.87,194.368,H,400,g/m,12.86,8.96
```

test20

```
zMin(mm),rMin(mm),Zmax(mm),rMax(mm),direction,quantity,unit,X0(g/cm2),density(g/cm3)
//layers
0.1,35.837,250.5,45.837,H,1200,g/m,12.86,8.96
0.1,73.847,250.5,83.847,H,2400,g/m,12.86,8.96
0.1,114.538,250.5,124.538,H,3600,g/m,12.86,8.96
0.1,166.368,250.5,176.368,H,5200,g/m,12.86,8.96
```

```
test21
zMin(mm),rMin(mm),Zmax(mm),rMax(mm),direction,quantity,unit,X0(g/cm2),density(g/cm3)
//layer 1
0.1,35.837,35.5,45.837,H,16.92,g,12.86,8.96
35.5,35.837,105.5,45.837,H,33.6,g,12.86,8.96
105.5,35.837,175.5,45.837,H,33.6,g,12.86,8.96
175.5,35.837,245.5,45.837,H,33.6,g,12.86,8.96
245.5,35.837,250.5,45.837,H,2.4,g,12.86,8.96
//layer 2
0.1,73.847,35.5,83.847,H,35.52,g,12.86,8.96
35.5,73.847,105.5,83.847,H,67.2,g,12.86,8.96
105.5,73.847,175.5,83.847,H,67.2,g,12.86,8.96
175.5,73.847,245.5,83.847,H,67.2,g,12.86,8.96
245.5,73.847,250.5,83.847,H,4.8,g,12.86,8.96
//layer 3
0.1,114.538,35.5,124.538,H,50.76,g,12.86,8.96
35.5,114.538,105.5,124.538,H,100.8,g,12.86,8.96
105.5,114.538,175.5,124.538,H,100.8,g,12.86,8.96
175.5,114.538,245.5,124.538,H,100.8,g,12.86,8.96
245.5,114.538,250.5,124.538,H,7.2,g,12.86,8.96
//layer 4
0.1,166.368,35.5,176.368,H,73.32,g,12.86,8.96
35.5,166.368,105.5,176.368,H,145.6,g,12.86,8.96
105.5,166.368,175.5,176.368,H,145.6,g,12.86,8.96
175.5,166.368,245.5,176.368,H,145.6,g,12.86,8.96
245.5,166.368,250.5,176.368,H,10.4,g,12.86,8.96
```

test22

```
zMin(mm),rMin(mm),Zmax(mm),rMax(mm),direction,quantity,unit,X0(g/cm2),density(g/cm3)
//Attention: for making this work you need to block the material track gun at phi=Pi/2
//Attention: the values in modules are distributed in equivalent cylinder ((100/22)*2*PI*26)
//first layer, 6 inner rods
-35.5,26,35.5,26,H,742.56,g/m,12.86,8.96
34.5,26,105.5,26,H,742.56,g/m,12.86,8.96
104.5,26,175.5,26,H,742.56,g/m,12.86,8.96
174.5,26,245.5,26,H,742.56,g/m,12.86,8.96
//first layer, 6 outer rods
// -35.5,32,35.5,32,H,913.92,g/m,12.86,8.96
// 34.5,32,105.5,32,H,913.92,g/m,12.86,8.96
// 104.5,32,175.5,32,H,913.92,g/m,12.86,8.96
// 174.5,32,245.5,32,H,913.92,g/m,12.86,8.96
```

test22d

```
zMin(mm),rMin(mm),Zmax(mm),rMax(mm),direction,quantity,unit,X0(g/cm2),density(g/cm3)
//Attention: for making this work you need to block the material track gun at phi=Pi/2
//Attention: the values in modules are distributed in equivalent disk ((100/30)*PI*64.9)
308.97,44.734,308.97,109.634,V,1616.54,g/m,12.86,8.96
314.97,95.09,314.97,159.99,V,2671.19,g/m,12.86,8.96
```

test23

```
zMin(mm),rMin(mm),Zmax(mm),rMax(mm),direction,quantity,unit,X0(g/cm2),density(g/cm3)
//Attention: for making this work you need to block the material track gun at phi=Pi/2
//first layer, 6 inner rods
-35.5,26,35.5,26,H,0.1,mm,12.86,8.96
34.5,26,105.5,26,H,0.1,mm,12.86,8.96
104.5,26,175.5,26,H,0.1,mm,12.86,8.96
174.5,26,245.5,26,H,0.1,mm,12.86,8.96
// //first layer, 6 outer rods
// -35.5,32,35.5,32,H,0.1,mm,12.86,8.96
// 34.5,32,105.5,32,H,0.1,mm,12.86,8.96
// 104.5,32,175.5,32,H,0.1,mm,12.86,8.96
// 174.5,32,245.5,32,H,0.1,mm,12.86,8.96
```

test23d

```
zMin(mm),rMin(mm),Zmax(mm),rMax(mm),direction,quantity,unit,X0(g/cm2),density(g/cm3)
//Attention: for making this work you need to block the material track gun at phi=Pi/2
308.97,44.734,308.97,109.634,V,0.1,mm,12.86,8.96
314.97,95.09,314.97,159.99,V,0.1,mm,12.86,8.96
```

test24

```
zMin(mm),rMin(mm),Zmax(mm),rMax(mm),direction,quantity,unit,X0(g/cm2),density(g/cm3)
//Attention: for making this work you need to block the material track gun at phi=Pi/2
//Attention the values in modules are distributed in equivalent cylinder ((10/22)*2*PI*26)
//first layer, 6 inner rods
-35.5,26,35.5,26,H,74.26,g,12.86,8.96
34.5,26,105.5,26,H,74.26,g,12.86,8.96
104.5,26,175.5,26,H,74.26,g,12.86,8.96
174.5,26,245.5,26,H,74.26,g,12.86,8.96
// //first layer, 6 outer rods
// -35.5,32,35.5,32,H,91.39,g,12.86,8.96
// 34.5,32,105.5,32,H,91.39,g,12.86,8.96
// 104.5,32,175.5,32,H,91.39,g,12.86,8.96
// 174.5,32,245.5,32,H,91.39,g,12.86,8.96
```

test24d

```
zMin(mm),rMin(mm),Zmax(mm),rMax(mm),direction,quantity,unit,X0(g/cm2),density(g/cm3)
//Attention: for making this work you need to block the material track gun at phi=Pi/2
//Attention: the values in modules are distributed in equivalent disk ((10/30)*PI*64.9)
308.97,44.734,308.97,109.634,V,161.65,g,12.86,8.96
314.97,95.09,314.97,159.99,V,267.12,g,12.86,8.96
```